BNL-102184-2014-TECH

RHIC/AP/76;BNL-102184-2013-IR

ATR Operations Document Revision 1.0

W. MacKay

October 1995

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

RHIC/AP/76

ATR Operations Documentation

Editors: G.F. Dell, W.W. MacKay, S. Peggs

Authors: W.W. MacKay, T. Satogata, S. Tanaka, many others

Revision 1.0

October 25, 1995

RHIC/OPS/1

Contents

Chapter 1

Introduction

1.1 Why read this document?

This document consists almost entirely of World Wide Web pages, that have been printed as postscript files, and compiled into one enormous note.

One advantage of a hard copy of this manual is that it is convenient to carry around, or place in a binder, for easy reference when a computer screen is not readily available. Another advantage is that a tree structure (chapters, sections, subsections) is often easier to search than a web structure. The disadvantage is that the contents may be out of date, especially when things are changing rapidly - for example, when beamlines are being commissioned.

The name of each web page preceeds its entry in this manual. This enables the reader to go back and check for recent updates, by typing the name into a web viewer such as **netscape**. For example, when

/RHIC/ATR/index.html

appears in the text, the real thing can be viewed by entering

http://acnsun10.rhic.bnl.gov/RHIC/ATR/index.html

into the "Location" window in **netscape**.

It goes without saying that the compilers had a relatively easy (if time consuming) task in putting this document together; the real work was done by the authors of the web pages. Therefore, life being what it is, please send all positive comments to the compilers, and address all negtaive criticisms to the authors, whose names (should) appear with their progeny.

Chapter 2

General Information

2.1 Information on the ATR transfer lines

/RHIC/ATR/index.html

This is the "root directory" for many of the ATR pages.

Directory for info on the ATR

- Overview
- Coordinate systems
  - Global coordinate system for surveys
  - Local beamline coordinates
- Definitions and Ack!!-ronyms
- Commissioning & Vertical integration (Limited to AGS and RHIC)
- FEB extraction from AGS
- Installation Report (Database query)
- Safety system (Gates, interlocks, sweeps, ...)
- SiteWideName's (conventions and names)
- Application software

Some rather more esoteric stuff:

- Database descriptions and querries:
  - atr_gddb generic definition database.
  - atr_cal callibration database.

Related Topics

- Brookhaven National Laboratory
- AGS
- RHIC Home page
- RHIC Accelerator Home Page
  - RHIC Accelerator Physics (RAP)
  - Controls
  - RHIC Documentation
  - Installation
  - Instrumentation
  - Tour

Mangled by Waldo MacKay (waldo@bnl.gov).
Last update: 29 Sept., 1995

2.1.1 Overview

/RHIC/ATR/overview.html

Overview of ATR

RHIC is a dual ring collider for ions from protons up to fully stripped gold (100GeV/nucleon).

Over 670 meters of beam line are being built to transfer ions from the AGS to both of the collider rings. These transfer lines are divided into four sections: the U-line which matches beam from the AGS and provides final stripping of gold ions, the W-line which brings the beam along the 6-o'clock-to-12-o'clock symmetry line of RHIC. Starting at the switch magnet just upstream of a beam dump are the two large arcs: the X-line which brings the beam around to the Blue (cw) ring, and the Y-line which brings the beam around to the Yellow (ccw) ring.

2.2 Coordinate systems

2.2.1 Global coordinates

/RHIC/ATR/baseline.html

Global Coordinate System

The RHIC coordinate system is a three dimensional Cartesian system in meters with an origin somewhere above the Atlantic Ocean over forty kilometers to the southwest of RHIC. It is one of several systems used by the Survey and Alignment Group (SAG) at Brookhaven National Lab. The plane of the coordinate system passes through the six interaction regions of RHIC and is not parallel to the plane of the AGS (due to the earth's curvature). Additionally, the RHIC ring is about five feet lower than the AGS. In order to allow the earth's curvature in our optics model, we have effectively kinked (very slightly) the ATR at the two pitching magnets in the w-line in addition to the three ends of the ATR. The actual adjustments were made at the following elements:

- utv1 a slight pitch and roll,
- utv4 a slight pitch and roll,
- wp1 a slight extra pitch in addition to the -12.5mrad pitch,
- wp2 a slight pitch and roll in addition to the +12.5mrad pitch,
- xp1 and yp1 a slight roll and pitch correction.

In order to preserve the alignments of the beamlines with respect to the AGS and RHIC, certain coordinates of the transfer ATR lines have been baselined. For each magnet we define a coordinate called the intersection point (IP) that for a bending dipole is the intersection of the upstream and downstream rays of the design trajectory. For other devices with no bend angle, such as quadrupoles, the IP is defined as the magnetic center of the element. Although a small longitudinal shift of a quadrupole or trim should not change the design trajectory, a change of the IP for a bend or vertical pitch will propagate downstream to other elements. We have decided to baseline the IP's as the simplest way of monitoring that local modifications of the design do not foul up the rest of the beamlines.

A baselined ASCII file containes coordinate information for all the main dipoles, pitching magnets, quadrupoles, and some trim magnets in the U-, W-, X-, and Y-lines. The file consists of one line for each magnet. Each line consists of nine comma-separated fields:

1. survey name of the IP coordinate,
2. N coordinate of IP in RHIC system,
3. E coordinate of IP in RHIC system,
4. W coordinate of IP in RHIC system,
5. theta angle of trajectory cord through magnet relative to the E-axis,
6. phi angle of vertical pitch of cord,
7. psi angle of roll about the cord,

2.2.2 Local coordinates

/RHIC/ATR/beamcoords.html

Local beam line coordinate system

In the ATR transfer lines (U, W, X, and Y-lines) there is a local right-handed coordinate system (x, y, z) which moves along with the beam along the design trajectory. The z-axis is tangent to the design trajectory pointing downstream. The y-axis points up, and the x-axis points to the left in the beam's-eye-view which makes the system right-handed.

The cumulative s-coordinate for the beam location along the trajectory is measured from the beginning of the U-line (a lattice marker with SiteWideName "ubegin"). The beginning of the U-line (s=0) is located along the perpendicular bisector between the AGS dipoles H13 and H14.

For the Blue (clockwise) ring of RHIC, the same convention holds for the local coordinate system with the s=0 coordinate at the 6 O'clock crossing. In this case the x-axis points radially outward, the y-axis upward and the z-axis tangentially in the direction of the beam's velocity.

For the Yellow (counterclockwise) ring of RHIC, the convention must be modified, since we want to have the x-axis radially outward. The lesser of all evils was determined to be having the z-coordinate point in the direction opposite to the beam's motion. The y axis is still upward, and the (x, y, z)system is still right-handed. The cumulative s-coordinate is measured clockwise around the ring, with s=0 at the 6 O'clock crossing. With this convention, there is the added advantage that the two rings have s-coordinates which propagate in the same direction. Note that for the 4, 8, and 12 O'clock crossings the s-coordinates of the two rings differ by almost a meter.

Trim magnet conventions

In the ATR, positive angles in the trim magnets of the ATR should bend the beam in the $+x$ direction for horizontal trims, and in the $+y$ direction for vertical trims.

In the U-line there are seven trim magnets powered by old monopolar supplies with reversing switches: **psutv1, psuth2, psuth3, psutv4, psutv5, psuth6,** and **psutv7.** The "A" polarity of these old supplies should bend the beam to the left ($+x$) for horizontal trims and up ($+y$) for vertical trims.

The rest of the trim magnets have bipolar supplies with positive currents bending left ($+x$) and up ($+y$).

Main dipole conventions

In the ATR, for horizontal main dipoles positive angles bend the beam to the right ($-x$). For vertical pitching magnets, positive angles bend the beam downward ($-y$).

All main dipole supplies with the exception of the switching magnet supply **psswm** are monopolar, so that the currents are only positive for **psuarc4, psuarc8, pswarc20, psxarc90, psyarc90, pswp1,** and **pswp2.** The switching magnet supply is monopolar, but has a reversing switch.

The 100A bias supplies for the lambertson and last dipole magnets of the X and Y-arcs **(psxlamt, psylamt, psxd31t,** and **psyd31t)** are bipolar and should be wired so that a positive current adds to the positive buss current.

For more information see RHIC/AP/12 W. MacKay and S. Peggs, "Accelerator Physics coordinate conventions".

Mangled by Waldo MacKay (waldo@bnl.gov).
Last update: 3 Oct., 1995

2.3 Lexicon

/RHIC/defs/index.html

Definitions:

ADO
: An ADO is a program which runs on a front end computer which understands and talks to a piece or pieces of hardware. Some useful documentation includes:
  - ADO Classes
  - ADO Events

AdoIf
: The AdoIf is a library of functions to interface program on the console with ADO's running on front end computers.

ATR
: The AGS to RHIC beam transfer lines including the u, w, x and y beamlines.

BCM
: The beam current monitors are circular ferrites place around a ceramic break in the beam pipe. The monitor acts as a transformer with the beam acting as a primary winding and a secondary winding wound around the ferrite ring.

BLM
: The beam loss monitors are gas filled ionization chambers which are placed along the beam line near the beam pipe.

BPM
: Beam position monitors are stripline detectors for measuring the transverse location of the beam within the beam pipe. More info on BPM"s

CLC (Console level computer)
: A console level computer is a workstation (Typically a SUN) which is set up to run application codes with the environment of the main control room (MCR).

FEC (front end computer)
: A front end computer is a controller of a VXI/VME crate running VXWorks and is connected via the network to the console computers. The front end computer talks to various pieces of hardware.

MCR (Main Control Room)
: The Main Control Room is the Main AGS Control Room in Building 911. The ATR commissioning tests will be run from the MCR.

PET
: PET is a parameter editing tool which can be run on a console. It is an engineering level parameter page program with some plotting capabilities. It has been designed to talk to ADO's. The pages can be configured by ASCII files. Some useful documentation includes:
  - PET file format

PLC
: A type of computer used to perform low level controlling and monitoring of

hardware, such as power supplies, vacuum controllers, and radiation safety systems. Danged if I know what the acronym stands for! Maybe something like "Peculiar little computer".

RTDL

Real Time Data Link.

RSC

Radiation Safety Committee for the AGS and RHIC. It is currently chaired by Ken Reece.

VPM

VPM (Video Profile Monitor) refers to the combination of flag, camera and vidio frame grabber system for measuring profiles of the beam at twelve different locations in the ATR

VXWorks

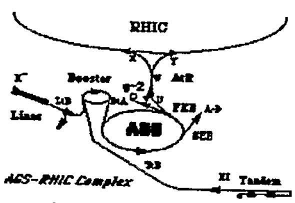
VXWorks is a real-time version of the Unix operating system which runs on front end computers.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 7 Sept., 1995

2.4 FEB extraction from AGS

//www.ags.bnl.gov/ tanaka/agsfeb.html

The AGS *New* FEB Extraction



Welcome to the AGS FEB Home Page atagsfeb.html the BNL AGS Accelerator Complex. The *new* FEB extraction system performs mutiple sigle bunch extraction (MSBE) of either a heavy ion beam for the Relativistic Heavy Ion Collider(RHIC) through the AtR Transfer Line or a high intensity proton beam for the muon g-2 Experiment(E821) at a rate of 30 Hz up to 12 times per AGS cycle.

General Information

- Introduction to FEB
- AGS Complex Chronicle(.ps)
- FEB Snapshots
- FEB Reports and Documentation

Activities in FY96

- FEB Information (meetings, news etc.)
- FEB(AtR) Commissioning & Run with Au77+
- FEB(V) Commissioning & Run with protons

---

sanki@bnl.gov
Updated:10.Oct.95

2.5 ATR commissioning

2.5.1 Beam requirements

/RHIC/ATR/vip/beamrequire.html

Beam Requirements for 1995 Commissioning

Ion species from AGS:	Gold (A=197, Z=79) Charge: +77 (2 electrons left)
Momentum:	>28.00*(Z/A) [GeV/c]
Intensity:	1x10^10 charges/bunch
Normalized emittance:	10pi [mm.mr]
Bunch length (95%):	~20ns (~7 ns with bunch rotation)
Bunch area (95%):	0.2 eV.sec/u (with bunch rotation)
dp/p:	~0.001
Timing signals:	30 +/- 0.1 microseconds before kicker
Operation mode:	Context switching with HIP/SEB roughly 1 every 10 to 20 cycles Generally only one bunch per FEB cycle
h(rf):	either 8 or 12
Running period:	Mid October through mid December

Last update: 19 Sept, 1995
Mangled by Waldo MacKay (waldo@bnl.gov).

2.5.2 Commissioning strategy

//RHIC/ATR/vip/comstrat.html

The AGS Operations Procedure Manual, AGS-TPL 95.10, is included in Appendix A

Commissioning Strategy for Fall 1995

The following rough outline quite possibly covers more than may be achieved in the two+ month period allotted for commissioning the line. In fact the absolute minimum which should be completed next fall is to transport beam reliably to the beam dump, perform the fault studies and satify the Radiation Safety Committee. We would hope that more could be done, although methods can be improved and retried during future running periods.

1. Things to do before beam tests
   1. check cooling water on magnets
   2. ramp magnets
   3. check polarities of magnets
   4. pump down line and check vacuum
   5. check interlocks
   6. check other hardware
      1. BPM's: cables and electronics.
      2. BLM's.
      3. Flags: read back pictures with calibration lights.
      4. Collimators: check motor control and location read-backs.
      5. Current transformers and electronics.
      6. Timing system: check signals.
   7. Test software and control system.
   8. Test safety system.
   9. Get documentation and training procedures in order.
   10. Pass all the review hurdles.
   11. Verify that all training has been preformed.
   12. Check new AGS features (with machines studies this spring, if and where possible).
       1. Extraction bumps around H10 and G10.
          1. Check the predicted knobs with proton beam.
          2. Measure tunes versus amplitude.
          3. What are the effects of sextupoles and bump amplitude on the beam?
       2. Demonstrate extracttion with fast kicker FKG10 for SBE (single bunch extraction) tests to B-line.
       3. Upgrade at least 5 PUE's (BPM's to the rest of the world) for sensitivity to gold beam.

        4. Install the H10 septum magnet this summer.
2. With beam
    1. Thread beam down the U- and W-lines.
        1. Steer the beam onto the flags.
        2. Measure the location with the BPM's.
        3. Verify magnet and BPM polarities with beam.
        4. After reaching a flag with a reasonable trajectory, remove the flag and go on to the next one.
    2. Measure the pulse stability from the AGS.
        1. Beam current.
        2. Position.
        3. Profile on flags.
    3. Do fault studies.
        1. Check for radiation leaks when the beam hits certain key elements. Of particular interest are:
            1. Access doors, particularly in the split region.
            2. Penetrations for ventilation shafts and cables.
            3. Thin shielding areas.
            4. The top of the berm where Thompson road crosses the beam line.
    4. Measure the transverse matrix elements (*C*, *S*, *C'*, *S'*) for both x and y.
        1. Measure the beam location at all BPM's.
        2. Change **utv1** by a small amount and remeasure the trajectory.
        3. Reset **utv1** to previous value and remeasure the trajectory.
        4. Change **uth2** by a small amount and remeasure the trajectory.
        5. Calculate the expected deviations and compare with data.
    5. Measure the dispersion elements of the beam line (*D*, *D'*).
        1. Measure the trajectory.
        2. Simulate a 0.1% momentum change by ramping all magnets up by 0.1%.
        3. Remeasure the trajectory.
        4. Calculate the values of *D* and *D'* at the BPM locations.
        5. Compare with the expected values.
    6. Measure the beam shape (hyperellipsoid)
        1. Measure the profile at flags **uf3**, **uf4**, and **uf5**
        2. Measure the profile at flags **wf1**, **wf2**, and **wf3**
        3. Attempt to measure momentum spread with collimator **uc1**.
        4. Calculate emittances, betas, and alphas (horiz and vert) at the flag locations.
    7. Measure dispersion of the beam.
        1. Change the momentum of the AGS extracted beam.
        2. Remeasure the trajectory.
        3. Calculate the values of dispersion functions (eta, eta') at the BPM

locations.

    4. Compare with the expected values.

8. Tune the U-line quads to best match the desired values going into the W-line.
    - Note that the dispersion should be zero at the entrance to the W-line (20 degree arc).
9. Tune the W-line quads to best match the desired values just upstream of **swm** (switch magnet).
    - Note that the dispersion just upstream of the switch magnet should also be zero.
10. Scan aperture

3. Things to do beyond the 1995 tests.
    1. Transport beam down the Y-line for the 1996 sextant test.
    2. Strip last electrons from gold ions.
    3. Timing signals for injection kickers.
    4. RHIC abort signal connections.
    5. Transport beam down the X-line and inject into the Blue ring.
    6. ...

2.6 Vertical Integration Projects (VIP)

2.6.1 VIP index

/RHIC/ATR/vip/index.html

This is the "root" page for the following set of web pages:

System and stuff for ATR Commissioning

(*Warning:* The following information is somewhat volatile, and should be used with caution.)

- Overview of Commissioning.
  - Definitions.
  - 1995 Beam Requirements
  - Schedule
  - Minutes and memos.
- SiteWideName's
- FEB extraction from AGS
- Magnet systems (power suppies, WFG's, ...)
- Injection kickers.
- Timing.
- Monitors
  - Beam threading (BPM's, ...)
  - Beam Loss Monitors.
  - Current transformers
  - Beam profile measurement system (flags, ...)

Nothing yet in the following:

- Collimators

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 7 Sept, 1995

2.6.2 RHIC injection kickers

/RHIC/ATR/vip/kickers/index.html

RHIC Injection kickers

The overall performance requirements are:

Performance Specification

Deflection angle	1.86 mradian (total for 4 magnets)
Beam rigidity	97.5 Tm
Rise time (1-99%)	95 ns
Flat top	20 ns
Flat top tolerance	+/-1%
Fall time	<800 ns
Minimum repetition	33 ms
Lifetime	>1,000,000 pulses

The individual magnet characteristics are:

Strength at 2000 A	0.0465 Tm
Propagation time	45 ns
Impedance	25 Ohms
High frequency cutoff	~25 MHz
Magnet aperture	48.4 mm wide by 52.1 mm high
Magnet length	1.12 m
H field deflection	~94%
E field deflection	~6%
Ceramic beam tube ID	41.3 mm
thickness	32 mm wall
Core material	
Ferrite	Ceramic magnetic CMD 5005
	15 sections: 50 mm long x 13.9 mm thic
Dielectric	Trans-Tech MCT - 100
	14 sections: 25 mm long x 13.9 mm thic
Bus bar/return frame	6061-T6 aluminum
Epoxy potting material	Conap Inc. RN1000

Mangled by Waldo MacKay (waldo@bnl.gov)

Last update: 7 Apr., 1995

2.6.3 ATR magnet tables in atr_gddb

/RHIC/ATR/vip/magnet/magnet_tables.html

There are several tables in the atr_gddb database which deal with magnets. All units are assumed to be in SI units (Amperes, meters, Tesla, ...).

First there is the *magnet_slot* table which contains information relative to the lattice, such as the SiteWideName, *GenericName*, and *SerialName* of the magnet or other beamline element within that slot. It does not contain information on vacuum components or BLM's. The *SiteWideName* is the primary key for this table. The colums are as follows:

```
SiteWideName:        SiteWideName of the element,
GenericName:         GenericName of the element, such as a model na
SerialName:          Actual serial id of what element is installed,
Orientation:         This specifies the direction of installation o
                     element: +1 for forward, -1 for reversed.  The
                     elements currently reversed are some dipoles.
sag_correction:      A transverse offset of magnet's center from de
                     trajectory to account for bending angles.
IP_fixed:            A flag for indicating that the IP has been def
```

Certain information which is specific to a particular element SerialName can be found in the *magnet_data* table. The primary key for this table is the *SerialName* which can be linked with the SerialName column of the *magnet_slot* table. The columns are as follows:

```
SerialName:          actual serial name of a particular device,
ftname:              link into "fid_offsets" table for generating
                     fiducials relative to the IP coordinates,
FieldName:           link into the "magnet_field" table for transfe
                     function information of a particular kind of m
long_corr:           a longitudinal correction which allows for a s
                     misalignment of the fiducial template used in
                     construction of some dipole magnets,
top_halfcore:        serial name of the top halfcore of a dipole ma
bottom_halfcore:     serial name of the bottom halfcore of a dipole
```

The two tables *magnet_slot* and *magnet_data* make up the *magnet_info* group of tables. An SDS file containing the data of these two tables may be generated by the command:

```
dbg2sds atr_gddb magnet_info
```

The view *magnet_survey* is a view of selected columns from the tables *magnet_slot* and *magnet_data*. This view is used by the program **atrfid** to generate survey fiducials for the beamline elements. Its columns are as follows:

```
SiteWideName:        SiteWideName of the element,
```

ftname: link into "fid_offsets" table,
Orientation: flag for reversed dipole stands,
long_corr: a longitudinal correction which allows for a s misalignment of the fiducial template used in construction of some dipole magnets,
IP_fixed: A flag for indicating that the IP has been def

Together with the *fid_offsets* table, the *magnet_survey* view form the group *fidgen* of tables/views which is used by the **atrfid** program to generate fiducials for the surveyors.

The columns of the *fid_offsets* table are:

ftname: name of group of fiducial offsets which links back to SerialName in the "magnet_data" table,
fidname: name of fiducial to be combined with a SurveyName to generate a specific fiducial survey name as used by th Survey and Alignment Group,
dx: horizontal transverse offset of the fiducial,
dy: vertical offset,
dz: longitudinal offset.

A complete list of fiducials which have been generated may be found in file $HOLY_LATTICE/ATR_common/fid_mike.list.

These fiducials may be by the **plot_atr** program with the command:

```
plot_atr -geometry 636x873+450+1 $HOLY_LATTICE/ATR_common/fid_mike.
```

With the mouse-cursor inside the graphed window, type "h" and a help message will give a list of possible commands for using this rather eccentric program.

Transfer functions for the various magnets are given by the *magnet_field* table whose columns are:

FieldName: key to select a given type of magnet data
sequence: sequence number for data
I: current in amperes
Transfunc: Bl/I for dipoles, Gl/I for quads
RefRadius: reference radius for multipole components (in :
UpDown: direction of ramp
=0 for simulation,
=+1 for up,
=-1 for down
b0: Normal dipole multipole (=1 for dipoles, =0 fo
b1: Normal quadrupole multipole (=1 for quads)
b2: Normal sextupole component
b3: Normal octopole component
b4: Normal decupole component
b5: Normal 12-pole component
a0: Skew dipole component
a1: Skew quadrupole multipole (=1 for quads)
a2: Skew sextupole component
a3: Skew octopole component

a4:	Skew decupole component
a5:	Skew 12-pole component

The definition of transfer function is the integral of B ds divided by the current. In a first approximation, the transfer function is a constant, but it more accurately drops off at high field due to saturation effects. All units are assumed to be in SI units (Amperes, meters, Tesla, ...).

A group of views *magfield* has been defined to quickly access the relevant information. This group consists of the views: *magquick* with the columns (from the tables *magnet_slot*, *magnet_field*, and *NameLookup*):

SiteWideName:	SiteWideName of the magnet from NameLookup
lattice_index:	Pointer into the Holy_Lattice flat SDS file
FieldName:	key into the "magquick" view for the transfer function of the magnet.
Scoord:	The s-coordinate from the beginning of the U-1

magfield with the columns from *magnet_field*:

FieldName:	key to select a given type of magnet data
sequence:	sequence number for data
UpDown:	direction of ramp =0 for simulation, =+1 for up, =-1 for down
RefRadius:	reference radius for multipole components (in :
I:	current in amperes
Transfunc:	Bl/I for dipoles, Gl/I for quads
b0:	Normal dipole multipole (=1 for dipoles, =0 fo
b1:	Normal quadrupole multipole (=1 for quads)

and the view *ufoil* with the single entry

Scoord:	the s-coordinate of the stripping foil in the

This *magfield* group may be dumped into an SDS file by the command:

```
dbg2sds atr_gddb magfield
```

There is a function **magfield_in_sds()** which may be used to read in the data from this SDS file as shown in the example code in the file $HORST/ATR/magnets/magfield_test.c. The SDS object structures are defined by the include file $HORST/include/gddb/magfield.h. In order to link the correct libraries with **gcc** you need to include something like

```
-L $(HORST)/lib/$(ARCH) -lgddb \
-L $(ISTKPLACE)/lib/$(ARCH) -lsds \
```

```
    -lm
```

in the command line.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 16 May, 1995

2.6.4 Current transformers

/RHIC/ATR/vip/transformer/index.html

ATR Beam Intensity Measurement

The charge in each bunch transferred from the AGS to RHIC will be measured at five strategic points along the transfer line. These are: (1) just after extraction from the AGS; (2) just after stripping and collimation; (3) immediately before entry into one of the two injection arcs; (4) at the end of each arc just before injection into RHIC.

The detectors will be current transformers, specifically the Integrating Current Transformer (ICT) type developed by Unser[1] for LEP. This design incorporates two toroidal transformer cores and is particularly suited to measuring the charge in short beam bunches. By passively stretching the initial pulse, the signal is converted downward in frequency prior to applying it to the transformer. This overcomes the core losses at high frequencies, while preserving the relative charge and, in addition, allows the electronics to be located further from the detector. While the temporal beam signal is lost in this technique, precision measurements are made possible over a wide range of beam intensities.

Each ICT will be mounted over a ceramic break in the beam pipe and covered by a copper enclosure to provide a path for the beam induced wall currents. Triaxial cable will be used to bring the signal to the electronics, which is as far as 150 meters away in one case. The use of this kind of cable will allow the transformer outputs to remain isolated electrically from the beam pipe and building grounds and yet provides for adequate shielding of the signal conductors in the presence of noise generated by nearby high current beam kickers and other devices.

The signal processing electronics needed for the ICT signal will be resident in the Eurocrates which also contain the BLM electronics. Processing consists of an accurately timed and compensated integration of the stretched charge signal and subsequent digitization by an analog to digital converter.

[1] K. B. Unser, "Measuring Bunch Intensity, Beam Loss and Bunch Lifetime in LEP", Proc. IEEE Particle Accelerator Conference EPAC 90, Nice, France, June 1991.

2.6.5 Beam loss monitors

/RHIC/ATR/vip/blm/index.html

Loss Monitors

excerpt from the RHIC Design Manual (April 1994)

Beam Loss Monitor System

The main functions of the Beam Loss Monitor (BLM) system for RHIC are:

1. To provide an abort signal to avoid quenching the superconducting magnets.
2. To provide a history (postmortem) of the losses preceding an abort to help identify the source of the problem.
3. To provide spatial and temporal loss data to assist in tuning the beam to reduce the losses. The RHIC BLM System will not be used for personnel protection.

The quench thresholds are taken as 2 mJ/g for "fast" losses and 8 mW/g for "slow" losses, where "fast" and "slow" are relative to the time-constant (100 msec) with which the cryogenic system can remove heat from the coils.

Data from the BLM system will be stored in a circular buffer which will stop on an abort to help diagnose the fault which led to the beam dump. The loss data in local memory will cover a period of about 10 sec, comparable to the BPM data.

The detectors will be placed at locations where they will be most sensitive to beam loss which might quench the magnets. The average spacing will be about 15 m. Relocatable units will be placed near injection or extraction equipment, or at temporary problem areas, where control of losses is especially critical. The distribution of detectors is shown in table 3. The electronics will be located in 24 alcoves and houses around the RHIC tunnel in the same racks as the BPM electronics. By using a modular design significant system expansion can be provided by adding more VXI/VME cards or crates.

Table 3: Distribution of Detectors

Location	Number Per Location	Total
Standard Triplet	6	72
Standard FODO	7	84
Standard Arc	23	138
rf Region	8	8

Collimators/Scrapers	2	8
Snake/Spin Rotators	2	24
Beam Dumps	8	16
Injection Region	6	12
Relocatable Units	20	20
Total		382

Determining which beam was the source of the radiation could be useful but would not prevent both beams from being dumped. Since individual detectors will not have directional characteristics, it may be possible to use signals from adjacent detectors to determine directionality. It has been estimated that four decades of dynamic range would be required. This will be taken as the design goal but will not be a design requirement.

An ion chamber of the type used successfully on the Tevatron will be used as the detector. After conversion of the signal from a current to a voltage, the output will be processed in several ways. It will be directly available as an analog signal via the multiplexer. The time response for electron collection will be comparable to a single turn. The output of the front-end amplifier will also go to an integrator which will accumulate data over several turns before being digitized and placed into the circular buffer. The signal to the integrator will be filtered to correspond to the digitizing rate. This will be necessary if the four decade range is to be achieved.

The signal will also be fed through a circuit block which simulates the magnet quench time response and then to a comparator which will generate an abort signal on crossing a reference level. Any of the 382 detectors will be able to trigger a beam dump. However, since some detectors will be located near higher loss locations, levels will be individually adjustable for each detector. Up to 16 event drivel levels will be available which will allow for energy increase and operational flexibility. There will be separate trip levels for fast and slow losses. The slow loss abort may be generated from data in the local memory. Each unit will be able to be masked to allow higher loss during studies or to disable bad channels. An indication of which detector and loss mode triggered the abort will be available in a status word. A means of checking the abort system calibration will be provided.

NAME

moveblm.sh -- script for updating positions of movable BLM's in atr_gddb

SYNOPSIS

moveblm.sh

This script updates the atr_gddb..otherelement database table for SiteWideName's which are listed in the atr_gddb..movableBLM table. It prompts the user for the relevant information. It should be run from the "mcr" account which has privileges to update this table.

A useful command line to use with pagetree would be something like:

```
xterm -geometry 165x32+1+1  -e moveblm.sh&
```

KNOWN BUGS

SEE ALSO

pagetree

2.7 Timing

/RHIC/ATR/vip/timing/index.html

THIS IS A COMPLETE REVISION

OF

RHIC REPORT AD/RHIC/RD-16 August 1993

last revision July 24, 1995

1.0 RHIC EVENT TIMELINE SYSTEM - RHIC EVENT TIMELINE SYSTEM

1. 1 INTRODUCTION

A modern accelerator must synchronize the operations of equipment over a wide area. To facilitate this synchronization the RHIC event system will provide a highly reliable, serial timing link to all equipment locations. Timing events and clocks from this link will be used to initiate hardware operations including changes in settings, state changes, and data acquisitions. Events may also be required by software running on systems not directly coupled to accelerator hardware. A standard clock frequency of 10 MHz, as presently used in the AGS and Booster, will provide adequate resolution for timing events in the RHIC acceleration and collision processes.

Two mechanisms are available for generating events on the RHIC timeline, direct hardware inputs and software initiated commands. Optically isolated TTL-level inputs are provided for each of the 256 possible event trigger inputs. Event sequences to initiate waveforms, fire kickers, and acquire data during the acceleration cycle, tune measurements, etc. will be implemented by cascading programmable delays. Clocks that are of a general interest, such as the 720 Hz clock generated by the main magnet power supply system will also be available on the RHIC timeline. Externally generated events may also come from other systems sensing unusual conditions with the beam. In the case of a beam abort, the abort event can be used to freeze circular buffers in digitizers for postmortem analysis.

RHIC event codes can be permanently assigned without regard to their timeline transmission priority level. The V100 event encoder module contains an event trigger to event code translation table. This table allows an event code trigger priority level to be adjusted relative to other event codes without changing, the event code.

An example of a software generated event would be one to activate new settings after they have been loaded and verified. Software generated events also provide a convenient way to commission new systems.

The probability exists that several event requests could occur simultaneously, or overlapped in time. Since only one event can be processed at a time, priority resolution is an integral part of the central encoding facility. Event contention is handled in hardware with highest priority given to input 0 and lowest given to input 255. It should be pointed out, however, that lower priority events being processed will not be interrupted by the arrival of a higher priority event request.

The RHIC central event encoder will be located in the 4 o'clock equipment house (currently located in the AGS 911b equipment room). The V100 event encoder, its V101 input modules, and supporting front end computer interface will occupy a single VME chassis. Each V101 input module can support 16 event trigger inputs. The event system interconnections are point-to-point, differential TTL. The V100 event encoder module is isolated from its receiver by transformer coupling at the receiver. The V100 event encoder initially drives a D09-E2440 fanout assembly which provides 16 buffered, TTL differential outputs. Some outputs will be used locally within the 4 o'clock house, and others will drive fiber-optic transmitters for transmission to remote

RHIC equipment locations.

At each remote RHIC equipment location, the optical transmission is converted to single-ended TTL, and buffered as differential TTL. Again the D09-E2440 fanout assembly is used to produce multiple outputs. General purpose V102 delay modules may be located in these remote locations, as well as other modules having direct timeline inputs (e.g. the waveform generator).

The V102 delay modules accept the RHIC event timeline transmission, decode selected event codes, and generate TTL compatible event pulses following individually programmable delay intervals. The module outputs have 50 ohm drive capability. It is recommended that equipment using these event pulses provide optical isolation to eliminate ground loops.

The event codes are transmitted using a serial modified Manchester code (bi-phase-mark). The transmission rate is 10 Bits/sec, and 1.2 usec are required to transmit an event code. The event timeline contains a continuous bi-phase-mark "ones' transmission during idle periods. A single event code transmission is shown in

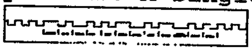
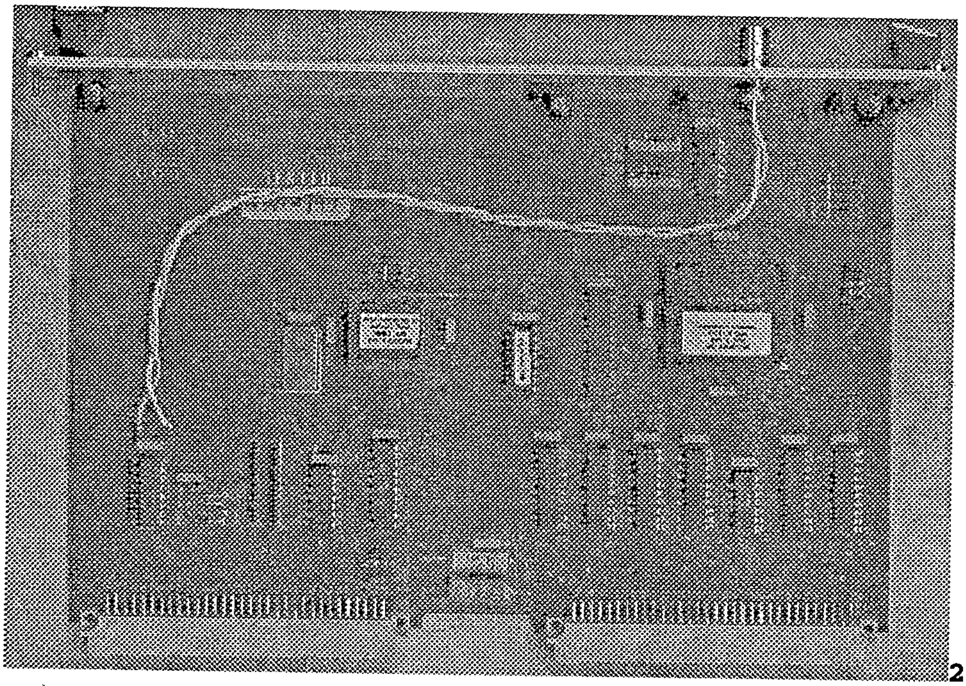


figure.

There is a 1.3 usec event code transmission delay built into the event encoder system. This delay allows very high priority events will be transmitted with minimum time jitter (-0, + 100 nsec). If a higher priority event trigger is received while a lower priority event trigger is being delayed, the delay is reset, and the high priority event code will be transmitted before the low priority event code (with its own 1.3 usec delay).

2.0 V100 EVENT ENCODER MODULE

Reference: 94028046 Module Assembly - V100 RHIC Timeline Encoder Module



2..1

Introduction

The V100 event encoder module is used to transmit RHIC event codes on the RHIC timeline. The encoder module is connected to a 16-position event input module bus. V101 event input modules determine the relative priority of its 16 event trigger inputs. If triggered, the V101 event input module delays 1.3 usec, and attempts to place its highest priority event trigger on the input module bus. However, the V101 event input modules are part of a serial, daisy chain, input module priority scheme. Thus, if other V101 event input modules have been triggered, the V101 event input module must have position priority (closest to the encoder module) in order to place its event trigger code on the bus.

The event trigger with the least numeric value has the highest priority. The V100 event encoder module converts event trigger inputs into RHIC event codes in a translation table. The event code is input to a serial non-return-to-zero to bi-phase-mark converter for transmission on the RHIC timeline.

When the V100 event encoder module receives an event trigger available from an V101 event input module the following occur:

- The event trigger code is loaded into a temporary buffer.
  - The event trigger code translated into an event code.
    - The translation table is memory mapped on the VMEbus. The translation table is available to the front end computer, except during event trigger to event code translation. The translation delay is transparent to the front end computer.
- The V100 event encoder module sends a BUSY signal to the highest priority V101 event input module, disabling the priority chain

while the transmission is in process.

- The translated event code is input to a serial non-return-to-zero to bi-phase-mark converter. As the code is serialized, a 'zero" start bit is added, and code parity (even) is generated. The output of the bi-phase-mark converter is transmitted over the RHIC timeline.
- The BUSY signal is terminated at the end of the event code parity bit transmission. This allows the V101 event input module priority system time to determine the next event trigger (if any) to be transmitted by the encoder module, and maintain minimum headway.
- The minimum inter-event code transmission headway is two bit times (two bi-phase-mark "ones").

2.2 V100 Encoder Module Front Panel

- VME SEL:
  - Green LED, indicates that the encoder module has been addressed as a VMEbus slave, read or write. Pulse stretched for visibility.
- OFFLINE:
  - Red LED, indicating that the front end computer has not enabled the module. The timeline carrier is output, but no event code can be transmitted.
- OUTPUT CONNECTOR:
  - Connector label EVENTLNK.
  - Amphenol 3-2225 twin-axial connector
  - EVENT
  - Green LED, indicating a timeline event code transmission. Pulse stretched for visibility.

2.3 V100 Event Encoder VMEbus Interface Details

2.3.1 V100 Event Encoder Module BASE_ADDRESS

The V100 event encoder module BASE_ADDRESS sets the base address for the event encoder system (encoder module, and 16 V101 event input modules). The V100 event encoder module base address is set in a 4-bit jumper patch. The simple VMEbus A16 decoding requires that the BASE_ADDRESS be a multiple of 0x1000, and that 0x1000 bytes are reserved for the event encoder and its input modules.

```
_______________MSB____________ADDRESS-16_____________LSB
_______________|15|14|13|12|11------------------------00|
```

```
BASE_ADDRESS |_X|_X|_X|_X|_0-----------------------0|
```

The first 0x800-bytes are reserved for the encoder module. Only 0x200-bytes are used, but simple address decoding prevent the use of the remaining 0x600-bytes for other purposes. If addressed between BASE_ADDRESS + 0x200-0x7FF, the event encoder will respond, however the results are undefined. Also, if addressed between BASE_ADDRESS + 0x42-0xFF (CSR and SRAM) the results are undefined.

Setting the encoder module base address also sets the input module base address. Each input module requires 0x80 bytes. As input modules are added to the system, each module will add an 0x80 bytes to the event encoder system response range (16 input modules maximum).

2.3.2 V100 Event Encoder Module VMEbus VMEid Message

Located at the BASE_ADDRESS is the 64-byte, read only, VME module VMEid message. Odd bytes contain the message, even bytes contain an ASCII ".".

2.3.3 V100 Event Encoder Module Command and Status Register

The command and status register is located at BASE_ADDRESS + 0x41. The register contains a single read-write bit; GO. GO is set to allow the encoder module to accept event triggers from the input module bus. If GO is reset, the front panel OFFLINE LED is illuminated.

If GO is reset, the V100 encoder module appears BUSY to the V101 input modules. If the input modules are enabled, event triggers can be processed, but not transferred to the encoder. As a result, triggered input modules will soon interrupt the front end processor.

```
_______________MSB--------------------------LSB
CMD_STAT_REG_|_0_|_0_|_0_|_0_|_0_|_0_|_0_|_GO|
```

2.3.4 V100 Event Encoder Module Event Code Translation Table

Event code translation table is located at BASE_ADDRESS + 0x100. The table converts input module event triggers to event codes for transmission on the timeline. The table address is the event trigger input module channel. The highest priority event trigger is table address 0x00. The contents of the table is the timeline event code. The V100 event encoder module Event Code Translation Table

```
_______________MSB-------EVENT CODE--------LSB
EVENT_IN_T00_|_e_|_e_|_e_|_e_|_e_|_e_|_e_|_e_| BYTE_0 highest priority
```

```
EVENT_IN_T01_|_e_|_e_|_e_|_e_|_e_|_e_|_e_|_e_| BYTE_1
EVENT_IN_T02_|_e_|_e_|_e_|_e_|_e_|_e_|_e_|_e_| BYTE_2
EVENT_IN_T03_|_e_|_e_|_e_|_e_|_e_|_e_|_e_|_e_| BYTE_3
"
"
EVENT_IN_TFF_|_e_|_e_|_e_|_e_|_e_|_e_|_e_|_e_| BYTE_FF lowest priority
```

where: EVENT_IN_Txy; x = V101 input module; y = V101 input module channel; and e = event code

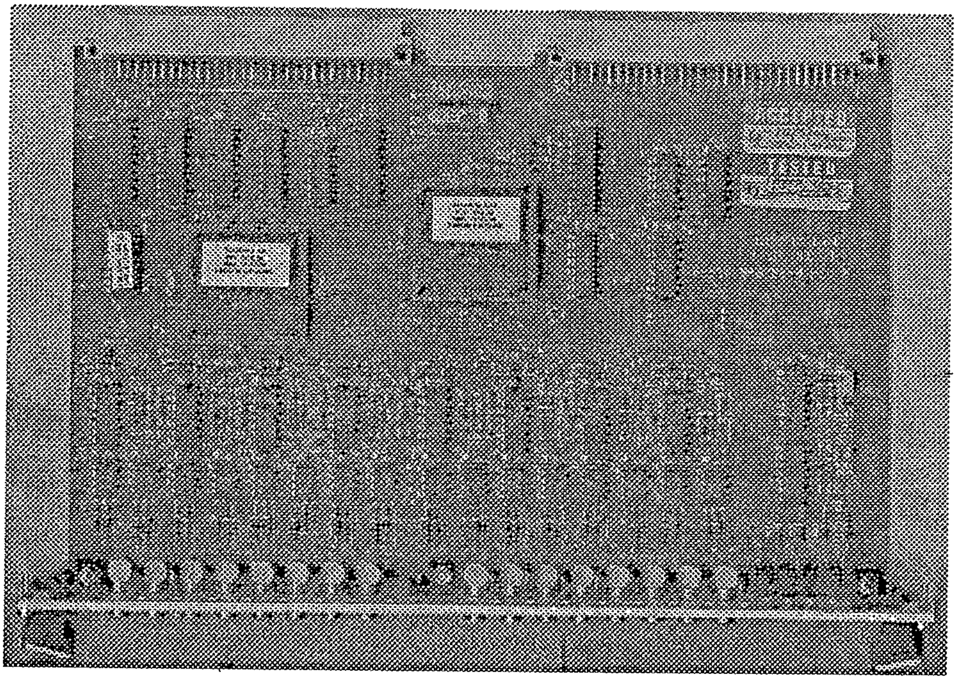
2.4 V100 Event Encoder Jumper Setup Details

The V100 event encoder module sets the BASE_ADDRESS of the V100 event encoder module, and its supporting V101 input modules. The V100 encoder module also sets the most significant nibble of the V101 module STATUS_ID (interrupt vector). The least significant nibble is the V101 input module input bus position.

V100 JUMPERS		
LOCATION	**JUMPER**	**FUNCTION**
JP[1..4]	ON = ZERO OFF = ONE	**VMEbus A16 ADDRESS A[15..12]**
JP[5..8]	ON = ZERO OFF = ONE	**INTERRUPT VECTOR STAT_ID[7..4]**

3.0 V101 EVENT INPUT MODULES

Reference: 94028050 Module Assembly - V101 RHIC Timeline Input Module



3.1 Introduction

Each V101 event input module accepts up to 16 event trigger inputs, and determines their relative priority. V101 event input module channel 0 has the highest priority and channel 15 the lowest priority. Sixteen input modules are required to support 256 events.

Event triggers can originate from two sources:

- V101 event input module trigger input:
  - Front panel LEMO NIM/CAMAC connectors
  - VMEbus P2 connector user pins
- VMEbus write to the V101 event input module trigger register

It is possible for a low priority trigger to be delayed by higher priority triggers. In this case there may be several transmission increments (1.2 usec/increment) from the trigger until the event is transmitted on the RHIC timeline.

As a result of event trigger priority processing, it is possible to have an extended delay before a low priority event trigger has been processed. Therefore, it is possible for a low priority channel to be retriggered before a previous trigger is processed. In this case the V101 event input module will detect the error, and set a flag in the V101 error register. The error flag indicates that one or more event triggers have been lost. If the channel interrupt is enabled, the error will generate a VMEbus interrupt. The interrupt status/ID vector is derived from a 4-bit jumper patch on the V100 Encoder Module, and the V101 Input module position on the input module bus. The V101 VMEbus interrupt request level is programmable. During interrupt service, the event front end computer can determine which event trigger channel caused the interrupt.

3.2 V101 Input Module Front Panel

- EXTERNAL TRIGGER INPUTS:
  - 16-LEMO NIM-CAMAC connectors
    - Terminated in 50 Ohms . Event triggers must have a minimum pulse width of 1 us and be capable of driving 2 volts into a 50 ohm load.
    - Optical isolation.
    - Green LED indicating the channel has been triggered by a VMEbus or external event trigger. Pulse stretched for visibility.
    - External trigger inputs available on P2 user pins.
- TRIGGER:
  - Green LED, indicating that one or more channels has been triggered by the VMEbus or external event trigger input. Pulse stretched for visibility.
- ERROR:
  - Red LED, indicating that one or more V101 event trigger channels have exceeded their input capacity, and one or more event triggers have not been transmitted. Pulse stretched for visibility. ERROR also indicates a VMEbus interrupt request (if interrupts are enabled).
- OFFLINE:
  - Red LED, indicating that the front end computer has not enabled the module. No event triggers can be processed by the module. However, the module will pass through triggers from active lower priority input modules.
- VME SEL:
  - Green LED, indicates that the input module has been addressed as a VMEbus slave, read or write. Pulse stretched for visibility.

3.3 V101 Event Input Module Characteristics

3.3.1 V101 Event Input Module BASE_ADDRESS

The V100 event encoder module supports up to 16 V101 event input modules. The 16 V101 event input module registers are separately addressed. The input module address is comprised of two parts; BASE_ADDRESS, and MODULE_ADDRESS. The simple decoding used in VMEbus A16 interface requires that the input modules be assigned a block of 0x800-bytes (2048). An V101 event input module address is obtained from the encoder module BASE_ADDRESS, and the module's position on the 16-position input module bus. The V101 event input module BASE_ADDRESS is:

	MSB-----------ADDRESS-16------------LSB									
	15	14	13	12	11	10	09	08	07	06---------00
BASE_ADDRESS	X	X	X	X	0	0	0	0	0	0-----------0
INPUT_OFFSET	0	0	0	0	1	0	0	0	0	0-----------0
MODULE_POSITION	0	0	0	0	0	Y	Y	Y	Y	0-----------0
MODULE_ADDRESS	X	X	X	X	1	Y	Y	Y	Y	0-----------0

Where:

XXXX is the BASE_ADDRESS of the V100 encoder module 0x1000-byte address block
YYYY is the input module event input bus position

NOTE: If an input module is addressed between MODULE_ADDRESS + 0x49 and MODULE_ADDRESS + 0x7F the module will respond, but the results are undefined.

3.3.2 V101 Event Input Module VMEbus Status/ID Message

Located at the input module base address, MODULE_ADDRESS, is the 64-byte, VMEid message. The message contains the module identification information. All even bytes contain an ASCII ".".

3.3.3 V101 Event Input Module Control Registers

The input module control registers are located at MODULE_ADDRESS + 0x40. The V101 event input module control registers are shown below.

The EVNT_CHAN_ENA register (read/write) is a byte addressable, word register, event trigger mask. The 16 V101 event input triggers are bit encoded in this register. Trigger channels are enabled by writing a one into the EVNT_CHAN_ENA register.

NOTE: If the EVNT_CHAN_ENA register is clear, the front panel OFFLINE LED will be illuminated. OFFLINE indicates that the module cannot generate event triggers.

The EVNT_CHAN_INT register (read/write) is a byte addressable, word register, interrupt mask. The 16 V101 event input module channel interrupt on trigger error are bit encoded in this register. Interrupt channels are enabled by writing a one into the EVNT_CHAN_INT register.

The EVNT_CHAN_TRG register (write only) is a byte addressable, word register, event trigger register. The 16 V101 event input module channels may be individually triggered by writing a one into the EVNT_CHAN_TRG register.

The EVNT_CHAN_ERR register (read only) is a byte addressable, word register, channel error register. If a V101 event input module channel has been enabled (EVNT_CHAN_ENA); and the channel is rapidly triggered by the EVNT_CHAN_TRG register (or EXTERNAL_INPUT); the channel bit in the EVNT_CHAN_ERR register will set if a second trigger input is received before the first trigger input has been processed. If the channel bit in the EVNT_CHAN_INT register is set, a V101 event input module interrupt will be generated. The register contents are cleared following a VMEbus read cycle.

The INT_STATUS/ID register (read only) is a byte register interrupt vector. The status I/D byte is obtained from a patch in the V100 encoder module, and the input module's input module bus position. INT_STATUS/ID[7..4] is obtained from the input module bus STAT_ID[7..4]. The input module position, input module bus SWR[10..7], is returned in the interrupt status/ID reply as INT_STATUS/ID[3..0].

The INT_LEVEL register (read/write) is a byte register interrupt request level. The value of INT_LEVEL[3..1] determines the interrupt request/reply level of the V101 event input module. This register must be initialized non-zero, as there is no interrupt request level 0.

	EVEN BYTE								ODD BYTE								
	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	
EVNT_CHAN_ENA																	channel enable, bit encoded
EVNT_CHAN_INT																	interrupt enable, bit encoded
EVNT_CHAN_TRG																	event trigger, bit encoded
EVNT_CHAN_ERR																	lost event(s), bit encoded
INT_STATUS/ID									7	6	5	4	3	2	1	0	
INT_LEVEL									0	0	0	0	0	3	2	1	

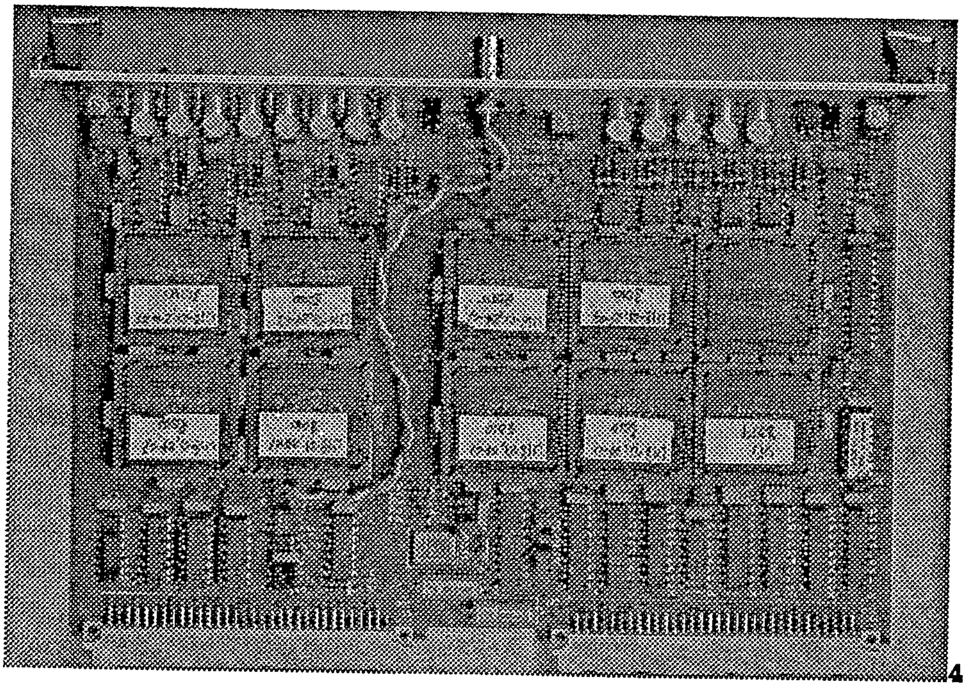
WARNING: There is no requirement for a full complement of 16 V101 event input modules. If V101 event input module is addressed, but not present, a VMEbus time-out will occur (BERR).

3.4 V101 Input Module Jumper Setup Details

There are no jumpers on the V101 input module. All setup is done on the encoder module

4.0 V102 DELAY MODULE

Reference: 94028072 Module Assembly - V102 RHIC Timeline Delay Module



4.1 Introduction

The RHIC timeline V102 delay module is a standard VME 6U module. Each module contains eight event output channels with programmable triggers (RHIC timeline event code, previous event output channel, or external), delay times, and delay clock (1 MHz and external).

The module has provision for a direct connection to the RHIC or AGS/Booster event timelines. The timeline events are transmitted short distances, point-to-point, using a twin-axial cable.

4.2 V102 Delay Module Functions

- Synchronizes to the RHIC timeline and detects the RHIC clock and timeline event codes.
  - Detects the RHIC timeline carrier.
  - Detects RHIC timeline event codes.
  - Each RHIC timeline event code is parity and frame checked. If an error is detected, the event is not processed.
  - Derives a 10 MHz clock from the RHIC timeline carrier.
  - Derives 1 MHz, 100 KHz, 10 KHz, and 1 KHz clocks from the 10 MHz clock.
    - The 1 MHz, 100 KHz, 10 KHz, and 1 KHz clocks may be synchronized to the event code stored in the V102 reset register.
    - The 100 KHz, 10 KHz, and 1 KHz clocks may be held on the event code stored in the V102 reset register, and released on the next channel 1 output pulse.
  - If enabled, generates a VMEbus interrupt on event code parity or framing error, or timeline carrier loss. The status/ID vector, and interrupt request level are programmable.
- Detects specified event codes on the timeline and:
  - Initiates an event channel programmable delay. Note - event channels may be programmed to respond to one or more timeline event codes.
  - The delay is developed in a 32-bit counter, programmed to count down.
    - The minimum delay is 1 count.
    - The maximum delay is 232 counts, 430 seconds at 10 MHz or 4300 seconds (70 minutes) at 1 MHz.
  - The channel delay clock may be selected from:
    - The 10 MHz clock derived from the RHIC timeline.
    - The 1 MHz clock derived from the RHIC timeline.
    - A common external clock. Note - the maximum frequency is 5 MHz.
  - Event channel trigger options are:
    - RHIC timeline event(s).
    - The preceding event channel trigger (an external trigger coupled by an external cable in the case of channel 1).
    - External trigger (channel pairs 1/2, 3/4, 5/6, 7/8).
    VMEbus command. See below for an additional trigger

option.

- At the end of the delay, an event channel output pulse is developed:
  - The pulse width is developed in a 16-bit counter, programmed to count down.
  - The minimum pulse width is one delay clock period.
    - 0.1 usec using the internal 10 MHz clock.
    - 1 usec using the internal 1 MHz clock.
    - 1/f ext using an external clock.
  - The maximum pulse widths are:
    - 6.5 msec using the internal 10 MHz clock.
    - 65 msec using the internal 1 MHz lock.
    - 216 x 1/fext using an external clock.
  - The pulse is capable of driving a 50 ohm load.
    - Minimum pulse level at the event decode module output is +3V.
    - Event channel outputs may be wire 'ored'.
    - Event channel outputs are available on the front panel and rear VMEbus P2 user pins.
    - The pulse sets a read only, bit in the clock/trigger selection register.
    - Event channel pair output pulse set/reset mode.
    - Available on channel pairs 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8:
    - The leading edge of the first channel (lower channel number) pulse output sets the pulse output of the second channel (higher channel number).
    - The leading edge of the second channel (higher channel number pulse output resets its pulse output.
- RHIC/AGS mode switch (module jumper patch).
  - When set in RHIC mode:
    - The clock outputs are differential TTL square waves with a 50% duty cycle. The pulse outputs are positive single ended.
  - When set to the AGS mode:
    - Outputs drive a 25 wire ribbon cable which mates to the D09-E1819 TTL to AGS pulse converter.
      - The clock outputs are negative going short pulses.
      - The pulse outputs are negative going.
      - Pulse period must be set to 0.1 or 1.0 usec pulse width in the clock/trigger selection register.

All triggers, timeline event, VMEbus, or external are synchronized to the selected clock (external or internal) before the delay count down begins.

Each V102 delay module is completely self supporting, once initialized. There can be more than one V102 delay module in a VME chassis. The module driver software should be capable of supporting a full chassis of 16 V102 delay modules. Each module requires its event code trigger mask table and registers to be initialized for proper operation. Once these items are initialized, no further support is required for normal operation. The items are;

- Event code trigger mask table, 256-bytes.
- Command and status register, 1-byte.
- Master reset event code register, 1-byte.
- Interrupt status/ID (vector), 1-byte.
- Interrupt level, 1- byte.
- 8-channel register sets:
  - delay counter register, 4-bytes.
  - pulse width register, 2-bytes.
  - clock, trigger, and mode register, 1-byte.
  - delay/pulse width counter stop/clear register, 1-byte.

4.3 V102 Delay Module Front Panel

- VME SEL:
  - Green LED, indicates that the delay module has been addressed as a slave, VMEbus read or write. Pulse stretched for visibility.
- EXTERNAL TRIGGER AND CLOCK INPUTS:
  - Four external trigger inputs; pairs 1/2, 3/4, 5/6, 7/8.
    - LEMO NIM-CAMAC connectors
    - Available on P2 user pins.
- Single external clock input; common to all channels.
  - LEMO NIM-CAMAC connector
  - Available on P2 user pin.
- INPUT CONNECTOR:
  - Amphenol 3-2225 twin-axial connector
    - Transformer coupling for galvanic isolation.
    - Available on P2 user pins.
- EVENTLNK:
  - Green LED, indicating timeline carrier detected.
- EVENT CHANNEL OUTPUTS:

- Eight event channels.
- LEMO NIM-CAMAC output connector.
  - Available on P2 user pins.
- Green LED indicating each output pulse. Pulse stretched for visibility.

4.4 V102 Delay Module Characteristics

4.4.1 V102 Delay Module BASE_ADDRESS

The V102 delay module BASE_ADDRESS is obtained from an address jumper patch. The V102 delay module is addressed VMEbus A16. The simple decoding used in the interface requires that the delay modules be assigned a block of 0x200-bytes (512).

	MSB				ADDRESS-16				LSB
	15	14	13	12	11	10	09	08---------------00	
BASE_ADDRESS	_X	_X	_X	_X	_X	_X	_X	0-----------------0	

4.4.2 V10 Delay Module VMEbus Status/ID Message

Located at the delay module BASE_ADDRESS, is the 64-byte, VMEid message. The message contains the module identification information. All even bytes contain an ASCII ".".

4.4.3 V102 Delay Module Control Registers

4.4.3.1 Command and Status Register

The command and status register is located at BASE_ADDRESS + 0x41. The register should be the last register set during V102/V104 module initialization. When GO sets the V102/V104 module will process timeline event codes, and pass the recovered event codes through the event code channel trigger mask table. If an event code channel trigger mask table output contains a one, and the channel is triggered.

NOTE: The front panel OFFLINE red LED indicates the state of the GO bit. If GO is reset, OFFLINE indicates that the delay module is not functional.

The interrupt enable bit (INEN) enables interrupts on timeline carrier failure or parity error. If the interrupts are not enabled the command and status may be read to determine any operating errors. The interrupt status bits are read only, and clear after a read.

The timeline derived clocks; 1 MHz, 100 KHz, 10 KHz, and 1 KHz, are controlled by the enable reset bit (ERST), and the hold bit (HOLD). If ERST is set and HOLD is reset, detection of the reset event code (RESET_EVT_CODE) will reset the timeline clock divider chain. If HOLD is set, ERST becomes a don't care. In this case 100 KHz, 10 KHz, and 1 KHz hold (clock divider held reset) when the reset event code (RESET_EVT_CODE) is detected. The hold is cleared by the next channel 1 event code. As the channel 1 event code clears hold, 1 MHz is reset.

```
BASE_ADDRESS + 0x41| 07----------------------------------00 |
CMD_STA_REG________|INTR|CLCF|__PE|___0|HOLD|ERST|INEN|__GO|
```

where: INTR = (read only)logic OR of bits 06 and 05
CLFL = (read only) timeline failure; no carrier detected
PE = (read only) timeline parity error detected
HOLD = (read/write) hold on RESET_EVT_CODE, release on channel 1
ERST = (read/write) reset the clocks when RESET_EVT_CODE is detected
INEN = (read/write) enable interrupt
GO = (read/write) command start the decode module

Note:
1. The CMD_STA_REG parity bit PE, CLFL, read only, is cleared after a VMEbus read cycle. An interrupt is generated for each parity error (if enabled).
2. The CMD_STA_REG timeline failure bit, CLCF, read only, is cleared by a VMEbus read following timeline restoration. A single interrupt is generated at the beginning of a timeline carrier failure.

4.4.3.2 Reset Event Code Register

Reset event code register is located at BASE_ADDRESS + 0x43. The register contents are compared to each event code received. If equal, the 1 MHz, 100 KHz, and 10 KHz counters are reset or held as described in paragraph 4.4.3.1 above.

```
BASE_ADDRESS + 0x43| 07----------------------------------00 |
RESET_EVT_CODE_____|_R7_|_R6_|_R5_|_R4_|_R3_|_R2_|_R1_|_R0_|
```

NOTE: The event code assigned as the reset event code is processed normally the remainder of the V102 module.

4.4.3.3 Interrupt Status/ID Register

The V102/V104 module interrupt status/ID register (interrupt vector) is located at BASE_ADDRESS + 0x45. The register is read/write. The contents of the status/ID byte are is determined by front end computer interrupt vector requirements. The contents of the register becomes the V102/V104 module interrupt status/ID (interrupt vector) returned during an interrupt cycle.

```
BASE_ADDRESS + 0x45| 07---------------------------------00 |
INTERRUPT_SID______|_I7_|_I6_|_I5_|_I4_|_I3_|_I2_|_I1_|_I0_|
```

4.4.3.4 Interrupt Level

The V102/V104 module interrupt level register is located at BASE_ADDRESS + 0x47. The register is read/write. The contents of the interrupt level register are used to determine the interrupt request level. The valid range of interrupt levels are 7..1. The contents of the interrupt level are compared to VMEbus A[3..1] during an interrupt cycle. If the module is requesting an interrupt, the request level must equal the response level before the module responds.

```
BASE_ADDRESS + 0x47| 07---------------------------------00 |
INTERRUPT_LEV______|___0|___0|___0|___0|___0|_L3_|_L2_|_L1_|
```

4.4.3.4 Event Delay Module Delay, Pulse Width, and Clock/Trigger Registers

The V102 event delay module event output channel delay, pulse width, and clock/trigger selection registers are a 64-byte block starting at BASE_ADDRESS + 0x48 as shown below.

The minimum value that may be assigned to the 32-bit delay register, and 16-bit pulse width register is one. If either register contains zero, the channel is disabled, even if properly triggered.

The counter control register selects the delay/pulse width counter trigger and clock. The counter stop register clears and stops the delay and pulse with counters. If the channel counter stop register STOP bit is set, the counters (delay and pulse width) are immediately cleared, and held clear until the STOP bit is cleared. STOP also clears the trigger-clock synchronizer, and disables the trigger input.

BASE_ADDRESS + 0x48	07							00
DELAY_MSB	C31	C30	C29	C28	C27	C26	C25	C24
DELAY	C23	C22	C21	C20	C19	C18	C17	C16
DELAY	C15	C14	C13	C12	C11	C10	C09	C08
DELAY_LSB	C07	C06	C05	C04	C03	C02	C01	C00
PULSE_MSB	P15	P14	P13	P12	P11	P10	P09	P08
PULSE_LSB	P07	P06	P05	P04	P03	P02	P01	P00
COUNTER_CTRL	PULS	FLIP	CLK1	CLK0	TRIG	INVT	TRG1	TRG0
COUNTER_STOP	0	0	0	0	0	0	0	STOP

where:
COUNTER_CTRL functions are:
PULS; channel has been triggered since previous register read, read only, clear after read.
FLIP; leading edge of the previous counter input sets the pulse output, and the leading edge of the channel output pulse resets the pulse output.
CLK[4..5] = 0 = no clock selected
CLK[4..5] = 1 = select 10 MHz clock
CLK[4..5] = 2 = select 1 MHz clock
CLK[4..5] = 3 = select external clock
TRIG; trigger channel immediately (may be used with other trigger modes)
INVT; invert the output pulse (normally positive true) TRG[1..0] = 0 = no trigger selected
TRG[1..0] = 1 = select timeline event trigger
TRG[1..0] = 2 = select external trigger (channel pairs 1&2, 3&4, 5&6, and 7&8 share triggers)

TRG[1..0] = 3 = select trigger on previous counter output (except channel 0)

V102 Event Delay Module Event Channel Output Register

4.4.3.5 V102 Module Event Code Channel Trigger Mask Registers

The V102 module event code channel trigger mask register is a 256 byte SRAM starting at the module BASE_ADDRESS + 0x100. The mask SRAM address is the received and verified event codes. The SRAM contents are bit encoded, trigger masks. The mask SRAM is addressed, and then its contents are used to mask each output channel's trigger. Output channels with a one in their trigger mask position are triggered.

	MSB							LSB
EVENT_CODE_00_	CH08	CH07	CH06	CH05	CH04	CH03	CH02	CH01
"								
"								
EVENT_CODE_FF_	CH08	CH07	CH06	CH05	CH04	CH03	CH02	CH01

4.5 V102 Delay Module Jumper Setup Details

V102 JUMPERS		
LOCATION	**JUMPER**	**FUNCTION**
JP[1..7]	ON = ZERO OFF = ONE	**VMEbus A16 ADDRESS A[15..9]**
V102 CLOCK RECOVERY CIRCUIT		
PRINTED WIRE FIXED OCTAVE 5 N2 N1 N0 L2	**JUMPERS JP8 JP9 JP10 L1 L0 N**	**CENTER FREQUENCY MHz**
0 0 1 0	ON OFF ON	12.2
"	ON OFF OFF	10.1
"	OFF ON ON	9.3
"	OFF ON OFF	8.6
"	OFF OFF ON	8.0
"	OFF OFF OFF	7.5
JP11	ON OFF	FRONT PANEL USER P2 PINS
V102 JUMPERS		
LOCATION	**JUMPER**	**FUNCTION**
JP12	ON OFF	**RHIC MODE** **AGS MODE**
JP[13..14]	**ON OFF** **OFF ON**	**PULSE[1..7] REFERENCE** **DGND** **AGND**

5.0 V103 RHIC MASTER RESET MODULE

Reference: 94028054 Module Assembly - V103 RHIC Master Reset Module

5.1 INTRODUCTION

The V103 RHIC master reset generator transmits two event codes on the RESETLNK to reset remote VME chassis in the RHIC control system. The RESETLNK is separate from other serial control lines such as the EVENTLNK or RTDL. Reset code sequence consists of a first code which must have its MSB set to one, and a second code which must have its MSB set to zero. The two code reset sequence is transmitted with minimum headway between codes. The resulting 14-bit reset code allows

16K unique RESET codes.

The RESET codes are transmitted to V108 utility modules installed in VME chassis with front end computers. The V108 utility module tests received RESET code parity, two code sequence (MSB's), and total transmission time. If all these tests pass, the RESET code is compared to a stored value. If the RESET code compares, the V108 utility module pulses the VME chassis VMEbus SYSRESET* signal line. This resets all the VME modules within the VME chassis.

The V103 master reset module is based on a V100 encoder module printed wiring board, 94028043. The primary modifications are made in the Altera EPLDs. No input modules are required to support the master reset module.

The V103 RHIC master reset module transmission is the same as the EVENTLNK transmission. The master reset module continuously transmits bi-phase-mark binary ones. Using the same transmission technique as the EVENTLNK allows the use of standard twin-axial cable, fiber optic cable, and fanout modules.

When commanded by its front end computer, the V103 master reset module transmits a 2-byte RESET code. Each code includes a binary zero start bit, 8-data bits (MSB first), even parity bit, and two stop bits (binary ones). The MSB (first bit) of each RESET code byte is used as a first-second byte indicator. 1.2 usec are required to transmit a code byte (2.4 usec for the RESET code sequence). The RESETLNK transmission line contains continuous bi-phase-mark "ones" transmission during idle periods, providing receivers with a 10 MHz clock.

5.2 V103 RHIC MASTER RESET MODULE CHARACTERISTICS

5.2.1 V103 RHIC Master Reset Module Addressing

The basic V100 encoder module VME A16 addressing is retained in the V103 master reset module. The V100 encoder module requires 0x1000 bytes, and its address patch is 4-bits. The V103 master reset module VME interface only utilizes 0x80-bytes of A16 address space. However, the 94028043 printed circuit board address patch is limited to 4-bits. Therefore, the V103 master reset module VME address must be one of the 16 shown:

0x0000, 0x1000, 0x2000 0x3000 .... or 0xF000

5.2.2 V103 RHIC Master Reset Module Registers

The V103 master reset module VMEbus data interface is D8(OE). The VMEid message utilizes the first 0x40-bytes of the address space. The VMEid even bytes are an ASCII ".", and the odd bytes are the VMEid message.

Three of the next four bytes are the V103 master reset module registers. In the command and status register, address base +0x041, a single ENAble bit controls the reset system. The master reset module cannot transmit RESET codes until ENAble is set. However, it will transmit the idle carrier when not enabled. The next two bytes, BASE_ADDRESS + 0x042 and 0x043 are the RESET code. The RESET code transfer from the front end computer to the reset module requires two byte transfers, not a one word transfer. As the second code byte is loaded, the VMEbus register write strobe starts a state machine controller to transfer the two bytes to the RESET code transmitter. The RESET code registers are VMEbus write only, the results of a VMEbus read are undefined.

VMEbus A16 register locations:

```
|15|14|13|12|11|10|09|08|07|06|05|04|03|02|01|00|
|SWR_PATCH__|_0__0__0__0__0__X__X__X__X__X__X__X| VME address block
|SWR_PATCH__|_0__0__0__0__0__0__X__X__X__X__X__X| VME status/ID PROM
|SWR_PATCH__|_0__0__0__0__0__1__X__X__X__X__0__1| command and status
register
|SWR_PATCH__|_0__0__0__0__0__1__X__X__X__X__1__0| RESET code first
byte
|SWR_PATCH__|_0__0__0__0__0__1__X__X__X__X__1__1| RESET code second
byte
```

5.2.3 V103 RHIC Master Reset Module Register Contents

The command and status register, BASE_ADDRESS + 0x041: a single ENAble bit controls the reset system. The master reset module cannot transmit RESET codes until ENAble is set. However, it will transmit the idle carrier when not enabled.

The next two bytes, BASE_ADDRESS + 0x042 and 0x043 are the RESET code. The MSB of each RESET code byte is reserved as a first byte (one), second byte (zero) indicator. The one, and zero is shown below, however they are software controlled. The remaining 14-bits of the RESET code encode VME chassis number. The RESET code transfer from the front end computer to the reset module requires two byte transfers, not a one word transfer. As the second code byte is loaded, the VMEbus register write strobe starts a state machine controller to transfer the two bytes to the RESET code transmitter. The RESET code registers are VMEbus write only, the results of a VMEbus read are undefined.

REGISTER	MSB							LSB	
CMD_STAT_REG	0	0	0	0	0	0	0	ENA	read/write
FIRST_RESET	1	X	X	X	X	X	X	X	write only
SECOND_RESET	0	X	X	X	X	X	X	X	write only

5.2.4 V103 Master Reset Module Jumper Setup Details

V103 JUMPERS		
LOCATION	JUMPER	FUNCTION
JP[1..4]	ON = ZERO OFF = ONE	VMEbus A16 ADDRESS A[15..12]

6.0 V104 DECODER MODULE

Reference: 94028175 Module Assembly - V104 RHIC Timeline Decoder Module

6.1 Introduction

The RHIC timeline V104 decoder module is a standard VME 6U module. The V104 decoder module is based on the V102 delay module printed wiring board 94028069. The primary difference is the removal of the Altera delay/pulse width EPLDs. Each module contains eight event output channels with programmable triggers (RHIC timeline event code, previous event output channel, or external), and fixed 1 uses pulse widths. The output pulses are triggered as soon as the channel event code is detected.

6.2 V104 Decoder Module Functions

- Synchronizes to the RHIC timeline and detects the RHIC clock and timeline event codes.
  - Detects the RHIC timeline carrier.
  - Detects RHIC timeline event codes.
  - Each RHIC timeline event code is parity and frame checked. If an error is detected, the event is not processed.
  - Derives a 10 MHz clock from the RHIC timeline carrier.
  - Derives 1 MHz, 100 KHz, 10 KHz, and 1 KHz clocks from the 10 MHz clock.
    - The 1 MHz, 100 KHz, 10 KHz, and 1 KHz clocks may be

synchronized to the event code stored in the V104 reset register.
      - The 100 KHz, 10 KHz, and 1 KHz clocks may be held on the event code stored in the V104 reset register, and released on the next channel 1 output pulse.
- If enabled, generates a VMEbus interrupt on event code parity or framing error, or timeline carrier loss. The status/ID vector, and interrupt request level are programmable.
- Detects specified event codes on the timeline and initiates a 1 usec output pulse.
   - The pulse is capable of driving a 50 ohm load.
      - Minimum pulse level at the event decode module output is +3V.
      - Event channel outputs may be wire 'ored'.
      - Event channel outputs are available on the front panel and rear VMEbus P2 user pins.
- RHIC/AGS mode switch (module jumper patch).
   - When set in RHIC mode:
      - The clock outputs are differential TTL square waves with a 50% duty cycle. The pulse outputs are positive single ended.
   - When set to the AGS mode:
      - Outputs drive a 25 wire ribbon cable which mates to the D09-E1819 TTL to AGS pulse converter.
         - The clock outputs are negative going short pulses.
         - The pulse outputs are negative going.

Each V104 decoder module is completely self supporting, once initialized. There can be more than one V104 decoder module in a VME chassis. The module driver software should be capable of supporting a full chassis of 16 V104 decoder modules. Each module requires its event code trigger mask table and registers to be initialized for proper operation. Once these items are initialized, no further support is required for normal operation. The items are;

- Event code trigger mask table, 256-bytes.
- Command and status register, 1-byte.
- Master reset event code register, 1-byte.
- Interrupt status/ID (vector), 1-byte.
- Interrupt level, 1- byte.

6.3 V104 Decoder Module Front Panel

- VME SEL:
  - Green LED, indicates that the delay module has been addressed as a slave, VMEbus read or write. Pulse stretched for visibility.
- INPUT CONNECTOR:
  - Amphenol 3-2225 twin-axial connector
    - Transformer coupling for galvanic isolation.
    - Available on P2 user pins.
- EVENTLNK:
  - Green LED, indicating timeline carrier detected.
- EVENT CHANNEL OUTPUTS:
  - Eight event channels.
  - LEMO NIM-CAMAC output connector.
    - Available on P2 user pins.
- Green LED indicating each output pulse. Pulse stretched for visibility.

6.4 V104 Decoder Module Characteristics

6.4.1 V104 Decoder Module BASE_ADDRESS

The V104 Decoder Module BASE_ADDRESS is obtained from an address jumper patch. The V104 Decoder Module is addressed VMEbus A16. The simple decoding used in the interface requires that the delay modules be assigned a block of 0x200-bytes (512).

```
_______________MSB____________ADDRESS-16_____________LSB
_______________|15|14|13|12|11|10|09|08--------------00|
BASE_ADDRESS   |_X|_X|_X|_X|_X|_X|_X|0----------------0|
```

6.4.2 V10 Delay Module VMEbus Status/ID Message

Located at the delay module BASE_ADDRESS, is the 64-byte, VMEid message. The message contains the module identification information. All even bytes contain an ASCII ".".

6.4.3 V104 Decoder Module Control Registers

6.4.3.1 Command and Status Register

The command and status register is located at BASE_ADDRESS + 0x41. The register should be the last register set during V102/V104 module initialization. When GO sets the V102/V104 module will process timeline event codes, and pass the recovered event codes through the event code channel trigger mask table. If an event code channel trigger mask table output contains a one, and the channel is triggered.

NOTE: The front panel OFFLINE red LED indicates the state of the GO bit. If GO is reset, OFFLINE indicates that the delay module is not functional.

The interrupt enable bit (INEN) enables interrupts on timeline carrier failure or parity error. If the interrupts are not enabled the command and status may be read to determine any operating errors. The interrupt status bits are read only, and clear after a read.

The timeline derived clocks; 1 MHz, 100 KHz, 10 KHz, and 1 KHz, are controlled by the enable reset bit (ERST), and the hold bit (HOLD). If ERST is set and HOLD is reset, detection of the reset event code (RESET_EVT_CODE) will reset the timeline clock divider chain. If HOLD is set, ERST becomes a don't care. In this case 100 KHz, 10 KHz, and 1 KHz hold (clock divider held reset) when the reset event code (RESET_EVT_CODE) is detected. The hold is cleared by the next channel 1 event code. As the channel 1 event code clears hold, 1 MHz is reset.

```
BASE_ADDRESS + 0x41| 07--------------------------------00 |
CMD_STA_REG________|INTR|CLCF|__PE|___0|HOLD|ERST|INEN|__GO|
where: INTR = (read only)logic OR of bits 06 and 05
CLFL = (read only) timeline failure; no carrier detected
PE = (read only) timeline parity error detected
HOLD = (read/write) hold on RESET_EVT_CODE, release on channel 1
ERST = (read/write) reset the clocks when RESET_EVT_CODE is detected
INEN = (read/write) enable interrupt
GO = (read/write) command start the decode module
```

Note:

1. The CMD_STA_REG parity bit PE, CLFL, read only, is cleared after a VMEbus read cycle. An interrupt is generated for each parity error (if enabled).

2. The CMD_STA_REG timeline failure bit, CLCF, read only, is cleared by a VMEbus read following timeline restoration. A single interrupt is generated at the beginning of a timeline carrier failure.

6.4.3.2 Reset Event Code Register

Reset event code register is located at BASE_ADDRESS + 0x43. The register contents are compared to each event code received. If equal, the 1 MHz, 100 KHz, and 10 KHz counters are reset or held as described in paragraph 6.4.3.1 above.

```
BASE_ADDRESS + 0x43| 07---------------------------------00 |
RESET_EVT_CODE_____|_R7_|_R6_|_R5_|_R4_|_R3_|_R2_|_R1_|_R0_|
```

NOTE: The event code assigned as the reset event code is processed normally the remainder of the V102 module.

6.4.3.3 Interrupt Status/ID Register

The V104 module interrupt status/ID register (interrupt vector) is located at BASE_ADDRESS + 0x45. The register is read/write. The contents of the status/ID byte are is determined by front end computer interrupt vector requirements. The contents of the register becomes the V102/V104 module interrupt status/ID (interrupt vector) returned during an interrupt cycle.

```
BASE_ADDRESS + 0x45| 07---------------------------------00 |
INTERRUPT_SID______|_I7_|_I6_|_I5_|_I4_|_I3_|_I2_|_I1_|_I0_|
```

6.4.3.4 Interrupt Level

The V104 module interrupt level register is located at BASE_ADDRESS + 0x47. The register is read/write. The contents of the interrupt level register are used to determine the interrupt request level. The valid range of interrupt levels are 7..1. The contents of the interrupt level are compared to VMEbus A[3..1] during an interrupt cycle. If the module is requesting an interrupt, the request level must equal the response level before the module responds.

```
BASE_ADDRESS + 0x47| 07---------------------------------00 |
INTERRUPT_LEV______|___0|___0|___0|___0|___0|_L3_|_L2_|_L1_|
```

6.4.3.5 V104 Module Event Code Channel Trigger Mask Registers

The V104 module event code channel trigger mask register is a 256 byte SRAM starting at the module BASE_ADDRESS + 0x100. The mask SRAM address is the received and verified event codes. The SRAM contents are bit encoded, trigger masks. The mask SRAM is addressed, and then its contents are used to mask each output channel's trigger. Output channels with a one in their trigger mask position are triggered.

```
_______________|MSB--------------------------------- LSB|
EVENT_CODE_00_|CH08|CH07|CH06|CH05|CH04|CH03|CH02|CH01|
"
"
EVENT_CODE_FF_|CH08|CH07|CH06|CH05|CH04|CH03|CH02|CH01|
```

6.4.5 V104 Decoder Module Jumper Setup Details

V104 JUMPERS		
LOCATION	**JUMPER**	**FUNCTION**
JP[1..7]	ON = ZERO OFF = ONE	**VMEbus A16 ADDRESS A[15..9]**
V104 CLOCK RECOVERY CIRCUIT		
PRINTED WIRE FIXED OCTAVE 5 N2 N1 N0 L2	**JUMPERS JP8 JP9 JP10 L1 L0 N**	**CENTER FREQUENCY MHz**
0 0 1 0	ON OFF ON	12.2
"	ON OFF OFF	10.1
"	OFF ON ON	9.3
"	OFF ON OFF	8.6
"	OFF OFF ON	8.0
"	OFF OFF OFF	7.5
JP11	ON OFF	FRONT PANEL USER P2 PINS
V104 JUMPERS		
LOCATION	**JUMPER**	**FUNCTION**
JP12	ON OFF	**RHIC MODE AGS MODE**
JP[13..14]	**ON OFF OFF ON**	**PULSE[1..7] REFERENCE DGND AGND**

2.8 Multiplexed Analog to Digital Converters

2.8.1 MADC Paper

/home/cfsa/http/htdocs/Hardware/map17.htm

THE RHIC GENERAL PURPOSE MULTIPLEXED ANALOG TO DIGITAL CONVERTER SYSTEM*

R. Michnoff, Brookhaven National Laboratory, Upton, NY 11973 USA

ABSTRACT

A general purpose multiplexed analog to digital converter system is currently under development to support acquisition of analog signals for the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. The system consists of a custom intelligent VME based controller module (V113) and a 14-bit 64 channel multiplexed A/D converter module (V114). The design features two independent scan groups, where one scan group is capable of acquiring 64 channels at 60 Hz, concurrently with the second scan group acquiring data at an aggregate rate of up to 80 k samples/second. An interface to the RHIC serially encoded event line is used to synchronize acquisition. Data is stored in a circular static RAM buffer on the controller module, then transferred to a commercial VMEbus CPU board and higher level workstations for plotting, report generation, analysis and storage.

I. DATA ACQUISITION REQUIREMENTS FOR ACCELERATORS

The most unique requirement for a data acquisition system for accelerators is that sampling of data must be synchronized to accelerator system timing. At the workstation level, data acquired from multiple locations, must be time correlated for plotting and analysis. Another critical requirement for the RHIC system is to provide a historical data buffer, where all data is stored in a continuous circular buffer at a relatively slow acquisition rate (typically 60 Hz) until a critical event such as a beam abort occurs. Selected historical data may then be viewed for analysis, and to determine conditions that caused the critical event. While data is being stored in the historical data buffer, the system must be capable of concurrently scanning a few selected channels at a much faster sampling rate for a snapshot period of time.

II. BACKGROUND

Based on the above requirements and after researching commercially available hardware, it was determined that a custom hardware solution was necessary. Various design options and system architectures were considered, and the finalized design is discussed herein.

III. SYSTEM ARCHITECTURE

A block diagram of the overall system architecture is shown in figure 1, and the front panel layout for each module is shown in figure 2.

The RHIC multiplexed analog to digital converter system also provides the capability to be interfaced with a user supplied sample and hold module. The sample and hold analog outputs connect to the analog input connector on the V114 module. The sample and hold control is generated by the scan trigger output on the V113 module, as shown in figure 3.

A hardware block diagram for the V113 and V114 modules is provided in figure 4. A photograph is also shown. The V113 controller module contains the VME bus interface, RHIC event link interface, data storage memory and all of the data acquisition system real-time intelligence. The V114 converter module contains the analog multiplexers, instrumentation amplifier, A/D converter, and a custom interface to the controller module through user defined pins on the VME bus P2 connector.

IV. SYSTEM FEATURES

A summary of the system's capabilities is detailed below.

A. Scan Groups

Two idendical scan groups are provided. Each scan group is configured with the following information.

a. Scan list containing all the channels to be scanned.
b. Arm trigger setup.
c. Halt trigger setup.
d. Scan trigger setup.

Typically scan group 0 will contain all defined analog inputs, and will be configured to continuously scan at a rate of 60 Hz for use as a history buffer. Data acquisition will be configured to halt on a specified system event for postmortem analysis of beam aborts. The front end computer reads this buffer to obtain the most recent data for each analog input.

Scan group 1 will normally be used to acquire data according to application specific channel selection and timing requirements.

The following parameters are programmable for each scan group.

Arm/halt trigger source

One source is used for both the arm and halt trigger. This is configurable to be one of the following.

a. Single event or logical OR of group of system events.
b. External trigger.

Scan trigger source

The scan trigger source is configurable to be one of the following.

a. Single event or logical OR of group of system events
b. External trigger.

Arm trigger setup

The arm trigger is defined as the condition that causes data samples to begin being stored in the data buffer. After the arm trigger occurs, data samples will be acquired and stored on every scan trigger until the halt trigger occurs. The arm trigger is configurable to be one of the following.

a. Arm immediately on start command from front end computer
b. Arm on arm/halt trigger source
c. Arm on ms delay after arm/halt trigger source

Scan trigger setup

The scan trigger is defined as the condition that causes a single acquisition of all channels in the scan group. Scan triggering will occur only when scanning is armed as defined by the arm trigger. The scan trigger is configurable to be one of the following.

a. Scan on every period of programmable on-board clock (μs resolution)
b. Scan on scan trigger source.
c. Scan on *n*th scan trigger source
d. Scan on programmable delay after scan trigger source (μs resolution)

Halt trigger setup

The halt trigger is defined as the occurrence of a condition that causes data acquisition to halt. After the halt trigger occurs, data acquistion will stop and an interrupt will be sent to the front end computer. The halt trigger is configurable to be one of the following.

a. Scan continuously until front end computer commands stop
b. Halt when data buffer full
c. Halt on arm/halt trigger source
d. Halt on ms delay after arm/halt trigger source
e. Halt on number of scans after arm/halt trigger source

Reset at end of scan

Each scan group may be configured to reset the arm/halt trigger and the scan enable at the end of each complete scan.

B. On-board Data Buffer Memory

Data buffer memory is typically divided into two buffers, one for the scan group 0 and one for the scan group 1. The data buffer size is programmable in number of full scans. A full scan consists of one reading for each channel in the scan group. Data will be stored in a circular fashion, where the oldest data is overwritten as new data is acquired.

The V113 module may be populated with 1, 2, 3, or 4 Mbytes of data storage memory. The entire data storage memory is mapped to VME A32 space on a switch selectable 4 Mbyte boundary (A31..A22). VME data transfers supported include D32, D16, D08(EO), and BLT (block mode transfer).

Event mask RAM (256 bytes), scan list RAM (256 bytes), program FLASH (128 Kbytes), and configuration registers are mapped to VME A24 space on a switch selectable 256 Kbyte boundary (A23..A18). VME data transfers supported for this area are D08(EO) only.

C. Maximum Scan Rates

Maximum scan rates supported are as follows:

64 chans at 60 Hz for one scan group simultaneously with an aggregate rate of 80 KHz for the second scan group (1chan at 80 KHz, 2 chans at 40 KHz, etc).

Maximum continuous throughput from the V113 controller module to the front end computer, then to the higher level workstation is dependent on the network bandwidth. The goal is to provide a continuous update of 6 channels at 720 Hz to the requesting workstation. This translates to a network bandwidth requirement of:

720 scans/sec * 6 samples/scan * 2 bytes/sample = 8640 bytes/sec

Faster acquisition will be provided with a snapshot mode, where the data acquisition is halted while the front end computer passes data to the higher level workstation.

V. ACKNOWLEDGEMENTS

Thank you to K. Seino, M. Shea, A. Franck, J. Gomilar, and J. Smedinghoff of Fermi National Accelerator Laboratory for describing the architecture, functionality and operational capabilities of the existing and future analog input systems at Fermi Lab during a trip in July 1993. Similar concepts were applied to the design of the BNL RHIC Multiplexed Analog to Digital Converter System.

2.8.2 MADC Specifications

/home/cfsa/http/htdocs/Hardware/madc4htm.htm

Accelerator Development Department RHIC Project

Brookhaven National Laboratory, Associated Universities Inc.

Upton, New York 11973

General Purpose Multiplexed Analog to Digital Conversion System

System Specification

(madc4htm.htm)

Robert Michnoff July 1995

Table of Contents

1.0 Overview

This document describes the RHIC general purpose multiplexed analog to digital converter system. The system consists of a custom intelligent VME based controller module (V113) and a 14-bit 64 channel multiplexed A/D converter module (V114). The design features two independent scan groups, where one scan group is capable of acquiring 64 channels at 60 Hz, concurrently with the second scan group acquiring data at an aggregate rate of up to 80 k samples/second. An interface to the RHIC serially encoded event line is used to synchronize acquisition. Data is stored in a circular static RAM buffer on the controller module, then transferred to a commercial VMEbus CPU board and higher level workstations for plotting, report generation, analysis and storage.

2.0 System Architecture

A generalized software block diagram is provided in figure 0. A block diagram of the overall system architecture is shown in figure 1, and the front panel layout for each module is shown in figure 2. A photograph is also available.

This architecture provides modularity and flexibility. Some possible configurations are as follows.

a. Multiple controller and analog module sets reside in a VME chassis with a single front end computer and additional unrelated VME cards.

b. A single controller and analog module set with a dedicated front end computer housed in a small VME chassis, and mounted in the cabinet where the analog signals are generated. This would minimize analog signal cabling lengths.

2.1 Analog input interface panel

The analog input interface panel provides a general purpose interface to individual analog inputs. This interface panel connects to the multipexer module or the sample and hold module. Input signal connectors are currently undefined. They may be lemo connectors, twinax connectors, coax connectors, or screw terminals. It is also possible that multiple signals generated from a single external enclosure will bypass the analog input interface panel and be connected directly to the multiplexer module or sample and hold module front panel.

2.2 Sample and Hold module (future)

The sample & hold module will provide 16 analog input channels. The sample and hold analog output connector connects to the analog input connector on the multiplexed analog to digital converter module. The sample and hold control is generated by the scan trigger output on the controller module.

The interconnecting diagram for sample and hold analog inputs is shown in figure 3.

2.3 Multiplexed Analog to Digital Converter module

The multiplexed analog to digital converter module provides a 14 bit analog to digital converter and accomodates 64 differential analog input channels. The interface and complete details for this module are defined in specification number ACS/RHIC/94-1922-001.

2.4 Controller module

The controller module contains all of the data acquisition system real-time intelligence. Capabilities for this module are detailed in section 4.

3.0 Hardware Block Diagram

A hardware block diagram for the multiplexed analog to digital converter module and the controller module is provided in figure 4.

4.0 CONTROLLER MODULE

Capabilities of the controller module are detailed in this section.

4.1 Scan Groups

Two idendical scan groups are provided. Each scan group is configured with the following information.

a. Scan list containing all the channels to be scanned.
b. Arm trigger setup.
c. Halt trigger setup.
d. Scan trigger setup.

Details on the configuration parameters are provide in section 4.7.

Typically scan group 0 will contain all defined analog inputs, and will be configured to continuously scan at a rate of 60 Hz for use as a history buffer. Data acquisition will be configured to halt on a specified system event for postmortem analysis of beam aborts. The front end computer can read this buffer to obtain the most recent data for each analog input.

Scan group 1 will normally be used to acquire data for a small number of channels in short bursts of time.

4.2 On Board Memory

Data memory is typically divided into two buffers, one for the scan group 0 and one for the scan group 1. The data buffer size is programmable in number of full scans. A full scan consists of one reading for each channel in the scan group. Data will be stored in a circular fashion, where the oldest data is overwritten as new data is acquired. When the halt trigger setup option is set to "halt when data buffer full" data will not be stored in a circular fashion.

Total data buffer memory size is 4 Mbytes. The entire data buffer memory is mapped to VME A32 space on a switch selectable 4 Mbyte boundary (A31..A22). VME data transfers supported include D32, D16, D08(EO), and BLT (block mode transfer).

Event mask RAM (256 bytes), scan list RAM (256 bytes), program EEPROM (64 Kbytes), and configuration registers are mapped to VME A24 space on a switch selectable 256 Kbyte boundary (A23..A18). VME data transfers supported for this area are D08(EO) only.

4.3 Maximum Scan Rates

Maximum scan rates supported will be at least the following:

64 chans at 60 Hz for one scan group simultaneously with an aggregate rate of 80 KHz for the second scan group (1chan at 80 KHz, 2 chans at 40 KHz, etc).

Maximum continuous throughput from the MADC Controller module to the front end computer, then to the higher level workstation is dependent on the ethernet network bandwidth. The goal is to provide a continuous update of 6 channels at 720 Hz to the requesting workstation. This translates to a network bandwidth requirement of:

720 scans/sec * 6 samples/scan * 2 bytes/sample = 8640 bytes/sec

Faster acquisition will be provided with a snapshot mode, where the data acquisition is halted while the front end computer passes data to the higher level workstation.

4.4 Memory Consumption

The following table provides calculations of data buffer sample periods at different scan frequencies. The calculations are based on each scan containing one 4 byte time stamp, and 4 bytes for each data value.

Scan Frequency Number of chans in list time period stored in 2 Mbyte data buffer

60 Hz 64 chans 120 seconds
720 Hz 64 chans 10 seconds
80 KHz 1 chan 3 seconds

Since the number of scans per buffer is programmable, it is possible to dedicate all data memory to one scan group to increase the stored time period. Also, other data storage formats will be available to increase the storage time period. For example, if data only is stored (2 bytes per data value), then a 2 Mbyte data buffer can hold 12 seconds of a single channel at 80 KHz.

4.5 System Configuration Parameters

The following system configuration parameters are programmable for the controller module. These parameters are common for both scan groups. The associated hardware registers are listed for each parameter. See section 4.11 for specific register definitions.

4.5.1 Scan group priority

The scan group priority is programmable to be one of the following.

a. If both scan groups are active, scanning will alternate on each data conversion.
b. Scan group 1 has highest priority. Scan group 0 will be scanned only if scan group 1 is not active.

hardware registers: 0x26003, bit 6

4.5.2 Time stamp clock source select

The time stamp clock source is programmable to be one of the following.

a. Board generated 1 microsecond clock. This is either an on-board 1 microsecond clock or a 1 microsecond clock derived from the event link. See bit 7 in register 0x26007.
b. Event bit number 6. When an event code occurs that has a logic one in bit 6 of the respective event mask ram location, the time stamp is incremented by 1.
hardware registers: 0x26003, bit 7

event mask ram: bit 6 in memory locations 0x20000 through 0x200ff

4.5.3 Board generated 1 microsecond clock select

The board generated 1 microsecond clock is programmable to be one of the following.

This 1 µs clock is used for the time stamp circuit and the delay trigger circuit. The on-board clock will automatically be used if the event link carrier error exists.

a. On-board 1 microsecond clock
b. 1 microsecond clock derived from event link.

hardware registers: 0x26007, bit 7

4.5.4 Multiplexer settling time

The multiplexer settling time is programmable from 0 to 15 microseconds. After the multiplexer channel is changed, the scan sequencer will wait for the programmed settling time before issuing the A/D converter start conversion pulse..

hardware register: 0x26007, bits 0 - 5

4.5.5 Voltage reference select

Voltage references are provided for analog input channels 62 and 63. The voltage reference value for each channel is individually selected via jumpers on the Multiplexed Analog to Digital Converter Board. One control bit is used for both channels 62 and 63, to select one of the following.

a. The actual external analog inputs for channels 62 and 63
b. The jumper selected reference voltage for channels 62 and 63.

hardware register: 0x26007, bit 6

4.5.6 VME Interrupt configuration

A single VME interrupt is generated by the controller module. The VME interrupt level and interrupt vector are programmable via on-board registers, and the interrupt is programmable to be generated by one or more of the following seven conditions.

a. VME command complete
b. sync event/data ready
c. CPU fail
d. A/D error (no response or data FIFO full)
e. Event link carrier error
f. Event link frame error
g. Event link parity error

hardware registers:
0x2a003 - interrupt enable
0x2a005 - interrupt vector
0x2a007 - interrupt level

4.5.7 FLASH code update

The controller module allows the on-board i960 program to be downloaded by VME to the on-board FLASH memory. Before writing to the FLASH memory, the code update must be enabled by writing a special code is to register 0x2a009.

hardware registers: 0x2a009

4.5.8 Reboot command

The controller module provides a feature for VME to reboot the board. A special code is written to register 0x2a009 to perform this operation.

hardware registers: 0x2a009

4.6 System Status Parameters

The following system configuration parameters are provided for the controller module. These parameters are common for both scan groups. The associated hardware registers are listed for each parameter. See section 4.11 for specific register definitions.

4.6.1 Voltage input range status

The voltage input range for all 64 analog input channels is selected via jumpers on the Multiplexed Analog to Digital Converter board. Status bits are provided to read the jumper selected range.

hardware register: 0x26002, bits 6 - 7

4.6.2 Interrupt/Error status

When the VME interrupt occurs, the interrupt status register is read by the interrupt handler to determine the cause of the interrupt. The error status register may be read outside the interrupt handler to determine the current status of the interrupt bits.

hardware registers:
0x2a011 - interrupt status
0x2a001 - error status

4.6.3 A32 base address

The A32 base address dip switch setting may be read by VME to determine the mapping location of the 4 Mbyte memory area.

hardware registers:
0x2a00f
0x2a009, bits 6-7

4.6.4 Memory module status

The controller module contains four memroy module sockets for the A32 memory area. Typically, four 1 MByte memory modules will be installed. However, it is possible to populate the board with only one, two or three modules. A status word is provided to determine the exact memory module population.

hardware register: 0x2a00b

4.6.5 FIFO status

The following FIFO status bits are provided.

a. Data FIFO empty
b. Data FIFO full
c. Data FIFO half full
d. Event FIFO empty
e. Event FIFO full

hardware register:
0x26002
0x24002

4.7 Data Buffer Configuration Parameters

The following data buffer parameters are programmable for each scan group. The associated hardware registers and setup structure elements are listed for each parameter. See the include file "madc2.h" for the definition of the buff_setup structure.

4.7.1 Arm/halt trigger source

One source is used for both the arm and halt trigger. This is configurable to be one of the following.

a. Single event or logical OR of group of system events
b. External trigger.

hardware registers:
0x24000 - trigger source select
0x24001 - external trigger select

4.7.2 Scan trigger source

The scan trigger source is configurable to be one of the following.

a. Single event or logical OR of group of system events
b. External trigger.

hardware registers:
0x24000 - trigger source select
0x24001 - external trigger select

4.7.3 Arm trigger setup

The arm trigger is defined as the condition that causes data samples to begin being stored in the data buffer. After the arm trigger occurs, data samples will be acquired and stored on every scan trigger until the halt trigger occurs. The arm trigger is configurable to be one of the following.

a. Arm immediately on start command from front end computer
b. Arm on arm/halt trigger source
c. Arm on ms delay after arm/halt trigger source

buff_setup structure:
arm_setup
arm_delay

4.7.4 Scan trigger setup

The scan trigger is defined as the condition that causes a single acquisition of all channels in the scan group. Scan triggering will occur only when scanning is armed as defined by the arm trigger. The scan trigger is configurable to be one of the following.

a. Scan on every period of programmable on-board clock (us resolution)
b. Scan on scan trigger source.
c. Scan on *n*th scan trigger source
d. Scan on programmable delay after scan trigger source (us resolution)

hardware registers:
0x26000 - trigger enable
0x28002 - delay trigger configuration
0x28000, 0x28001 - on-board clock count
0x28002 - on-board clock source select

4.7.5 Halt trigger setup

The halt trigger is defined as the occurrence of a condition that causes data acquisition to halt. After the halt trigger occurs, data acquistion will stop and an interrupt will be sent to the front end computer. The halt trigger is configurable to be one of the following.

a. Scan continuously until front end computer commands stop
b. Halt when data buffer full
c. Halt on arm/halt trigger source
d. Halt on ms delay after arm/halt trigger source
e. Halt on number of scans after arm/halt trigger source

buff_setup structure:
halt_setup
halt_delay

4.7.6 Reset at end of scan

Each scan group may be configured to reset the arm/halt trigger and the scan enable at the end of each complete scan.

hardware register: 0x26003, bits 0-1

4.7.7 Front End Computer data ready interrupt mode

The front end computer data ready interrupt mode is configurable to be one of the following.

a. No data ready interrupt

b. Interrupt when data acquisition halts
c. Interrupt on every *n*th scan, and when data acquisition halts

buff_setup structure:
interrupt_mode
int_scan_count

4.7.8 Data buffer size

The data buffer size is programmable in number of scans. The front end computer is responsible for insuring that the required amount of memory is available. The number of bytes in each scan is dependent on the number of channels in the scan list and the selected data storage format.

buff_setup structure: buff_size

4.7.9 Data buffer top pointer

The top of the data buffer is selected by the front end computer. This value is an offset in number of bytes from the top of the A32 memory area, and must reside on an even four-byte boundary.

buff_setup structure: buff_top_ptr

4.7.10 Data storage format

Section 4.9 of this document defines the data storage format options.

buff_setup structure: data_storage_format

4.8 Data Buffer Status Parameters

The following data buffer status parameters are provided for each scan group. The associated status structure elements are listed for each parameter. See the include file "madc2.h" for the definition of the buff_setup structure.

4.8.1 Current data buffer pointer

This is the scan number within the data buffer where the current data scan will be stored.

Note that this value will never be greater than buff_size as defined in the buff_setup structure.

buff_status structure: current_buff_ptr

4.8.2 Scan count since last sync event

This is a count of the number of scans since the last sync event occurred.

buff_status structure: current_buff_ptr

4.8.3 Buffer pointer at time of last sync event

This is the scan number within the data buffer at the time of the last sync event.

This is used for data syncronization across multiple boards.

buff_status structure: buff_ptr_at_time_of_last_sync

4.8.4 Scan count at time of last sync event

This is the count of the number of scans at the time of the last sync event.

This is used for data syncronization across multiple boards.

buff_status structure: scan_count_at_time_of_last_sync

4.8.5 Status flags

Individual bits in this parameter are used as status flags. The following status conditions are available.

BUFFER_ACTIVE
: This bit indicates that scanning is in progress, or that the buffer is waiting for an arm condition to occur.

BUFFER_FULL
: This bit indicates that the data buffer is full. This is also used to indicate that data storage has wrapped around in the circular data buffer.

WAITING_FOR_ARM_TRIG
: This bit indicates that the buffer is waiting for an arm trigger to occur.

WAITING_FOR_HALT_TRIG
This bit indicates that the buffer is waiting for a halt trigger to occur.

WAITING_FOR_ARM_DELAY
This bit indicates that the arm trigger has occurred and the buffer is waiting for millisecond arm time delay to expire.

WAITING_FOR_MS_HALT_DELAY
This bit indicates that the halt trigger has occurred and the buffer is waiting for the millisecond halt time delay to expire.

WAITING_FOR_SCAN_HALT_DELAY
This bit indicates that the halt trigger has occurred and the buffer is waiting for the scan count halt time delay to expire.

buff_status structure: status_flags

4.8.6 Arm delay count

This is the current value of the arm delay counter.

buff_status structure: arm_delay

4.8.7 Halt delay count

This is the current value of the halt delay counter.

buff_status structure: halt_delay

4.8.8 Interrupt scan count

This is the current value of the interrupt scan counter.

buff_status structure: int_scan_count

4.8.9 Bad scan status

Three parameters are used to define the current status of bad scans. since the last sync event. bad_scan_count is a count of the number of bad scans in the data buffer since scanning began. The i960 program counts the number of channels in the list for each scan. When the last channel is detected (the most significant bit in the channel is a logic 1), the i960 program compares the count of the number of channels in the list with the number defined by num_of_chans_in_list in the buff_setup structure. When the numbers are not equal, bad_scan_count is incremented. first_bad_scan is the scan number of the first bad scan. last_bad_scan is the scan number of the most recent bad scan.

buff_status structure: bad_scan_count

4.9 Data storage format

The system will be configurable to store data with or without a time tag, and with or without a channel number tag. The possible data storage format options are diagrammed below.

Option 0

Option 1

4.10 VME Memory Map

A32 address space 4 Mbyte boundary Boundary is selected via dip switches for vmea[31..22]			
Address range	**Description**	**Valid address / data modes**	**Size**
000000-3fffff	**Data buffer area**	**09,0d,0b,0f / D08(OE),D16, D32**	**4 Mbytes**

A24 address space 256 Kbyte boundary Boundary is selected via dip switches for vmea[23..18]			
Address range	**Description**	**Valid address / data modes**	**Size (actual used)**
00000-1ffff	FLASH memory	39,3d / D08(OE)	128 Kbytes
00000-0003f	IDPROM	39,3d / D08(O)	64 bytes (32 odd bytes)
20000-21fff	Event mask RAM	39,3d / D08(OE)	8 Kbytes (256 bytes)
22000-23fff	Scan list RAM	39,3d / D08(OE)	8 Kbytes (256 bytes)
24000-25fff	Event config registers	39,3d / D08(OE)	8 Kbytes (3 bytes)
26000-27fff	Scan list config registers	39,3d / D08(OE)	8 Kbytes (4 bytes)
28000-29fff	Delay trigger config registers	39,3d / D08(OE)	8 Kbytes (8 bytes)
2a000-2bfff	VME interface registers	39,3d / D08(O)	8 Kbytes (7 odd bytes)
2c000-2dfff	unused	--	8 Kbytes
2e000-2ffff	unused	--	8 Kbytes
30000-3ffff	unused	--	64 Kbytes

Address modes	
09	Extended (32-bit address) nonprivileged data access
0d	Extended (32-bit address) supervisory data access
0b	Extended (32-bit address) nonprivileged block transfer
0f	Extended (32-bit address) supervisory block transfer
39	Standard (24-bit address) nonprivileged data access
3d	Standard (24-bit address) supervisory data access

Data modes	
D08(O)	Single byte access, odd addresses only
D08(OE)	Single byte access, odd or even addresses
D16	Double byte access
D32	32-bit transfer

The MADC controller module does not support uneven double byte access (bytes 1-2).

The MADC controller module does not support triple byte access (bytes 0-2 or bytes 1-3).

4.11 VME Memory and Register Definitions

4.11.1 FLASH memory

The FLASH memory is used to store the on-board 80960 CPU program. The program in FLASH memory may be downloaded through the VME interface. The FLASH memory is normally read only, and is write enabled by writing a special code to the control command register (address 0x2a009).

4.11.2 IDPROM

The IDPROM overlays the first 32 odd bytes of the FLASH memory. The VME ID is a total of 64 bytes long. The even bytes are read from the FLASH memory. The format for the VME ID is the standard format that has been established for RHIC VME boards.

4.11.3 Event mask RAM

The least significant byte of the address in the event mask RAM represents each of the 256 possible event codes. Each of the 8 data bits in each event code address is used to define that a trigger pulse should or should not occur on the respective trigger signals. A bit value of 1 indicates that a trigger pulse should be generated, and a bit value of 0 indicates that a trigger pulse should not be generated. The following list defines the function of each bit in the event mask RAM.

Event Mask RAM Bit Definitions	
Bit number	**Function**
0	scan trigger for scan group 0
1	arm/halt trigger for scan group 0
2	scan trigger for scan group 1
3	arm/halt trigger for scan group 1
4	send event code to fifo
5	sync event, reset timestamp
6	timestamp clock event
7	delay timer clock event

4.11.4 Scan list RAM

The scan list RAM is divided in half. Address locations 0x22000 through 0x22007f contain the scan list for scan group 0, and address locations 0x220080 through 0x2200ff contain the scan list for scan group 1. The scan list fomat is diagrammed.

4.11.5 Event configuration registers

24000: rd/wr trigger config0 register - source select
- bits 1,0 - scan trigger 0 config
- bits 3,2 - halt/arm trigger 0 config
- bits 5,4 - scan trigger 1 config
- bits 7,6 - halt/arm trigger 1 config
  - 0 0 - trigger disabled
  - 0 1 - trigger on event only
  - 1 0 - trigger on external trigger only
  - 1 1 - trigger on external trigger OR event

--

24001: rd/wr trigger config1 register - external trigger select

bits 1,0 - scan trigger 0 config
bits 3,2 - halt/arm trigger 0 config
bits 5,4 - scan trigger 0 config
bits 7,6 - halt/arm trigger 1 config
0 0 - select external trigger 0
0 1 - select external trigger 1
1 0 - select external trigger 2
1 1 - select external trigger 3

--

24002: wr simulated event code

--

24002: rd status bits

bit 0 - event fifo empty
bit 1 - event fifo full
bit 2 - event link no carrier error
bit 3 - event link parity error
bit 4 - event link frame error
bit 5-7 - unused

4.11.6 Scan list configuration registers

26000: wr Trigger enable (not normally written to by VME)

Writing a bit value of 1 will enable the trigger, and a value of 0 will do nothing.
bit 0 - enable group 0 cascade scan trigger enable
bit 1 - enable group 1 cascade scan trigger enable
When the cascade trigger is enabled, the arm/halt event will enable the scan trigger.
bit 2 - enable group 0 scan trigger
bit 3 - enable group 1 scan trigger
bit 4 - enable group 0 arm/halt trigger
bit 5 - enable group 1 arm/halt trigger

--

26001: wr Trigger disable (not normally written to by VME)

Writing a bit value of 1 will disable the trigger, and a value of 0 will do nothing.
bit 0 - disable group 0 cascade scan trigger enable
bit 1 - disable group 1 cascade scan trigger enable
bit 2 - disable group 0 scan trigger
bit 3 - disable group 1 scan trigger
bit 4 - disable group 0 arm/halt trigger
bit 5 - disable group 1 arm/halt trigger

--

26003: rd/wr Config 0 register

bit 0 - when set to 1, group 0 arm/halt trigger will be reset at end of scan
bit 1 - when set to 1, group 1 arm/halt trigger will be reset end of scan
bits 3,2 (scan group 0 time stamp control - FUTURE)
bits 5,4 (scan group 0 time stamp control - FUTURE)

00 - do not store time tag
01 - store time tag with every data point
10 - store time tag on scan trigger
11 - store time tag on arm/halt trigger

bit 6 - priority

0 - If both scan groups are active, scanning will alternate on each data conversion

1 - Scan group 1 has highest priority. Scan group 0 will be scanned only if scan group 1 is not active.

bit 7 - time stamp clock source select

0 - time stamp clock source is on-board 1μs clock
1 - time stamp clock source is event #6

--

26007: rd/wr Config 1 register

bits 5..0 - analog multiplexer settling time

1 count = 16*pclk = 500 ns
programmable time = 0 to 31.5 us

bit 6 - voltage reference select

0 - select external inputs for chans 62 and 63
1 - select jumper selected reference voltage for chans 62 and 63

bit 7 - 1 μs clock select

This 1 μs clock is used for the time stamp circuit and the delay trigger circuit. On-board clock will automatically be used if event link carrier error exists.
0 - select on-board clock
1 - select clock derived from event link

--

26000: rd Trigger enabled/disabled status.

0 - trigger is disabled
1 - trigger is enabled
bit 0 - group 0 cascade scan trigger
bit 1 - group 1 cascade scan trigger

When the cascade trigger is enabled, the arm/halt event will enable the scan trigger.

bit 2 - group 0 scan trigger
bit 3 - group 1 scan trigger

bit 4 - group 0 arm/halt trigger
bit 5 - group 1 arm/halt trigger

--
26001: rd Trigger status.
0 - trigger is not active
1- trigger is active
bit 0 - group 0 scan trigger
bit 1 - group 1 scan trigger
bit 2 - group 0 arm/halt trigger
bit 3 - group 1 arm/halt trigger
--
26002: rd Status bits.
bit 0 - set (1) indicates data fifo empty
bit 1 - set (1) indicates data fifo full
bit 2 - set (1) indicates data fifo half full
bit 3 - set (1) indicates event fifo empty
bit 4 - set (1) indicates event fifo full
bit 5 - set (1) indicates A/D converter error
End of convert pulse was not detected within timeout period.
bit 7,6 - A/D converter selected voltage input range
Range is selected via jumpers on the A/D converter board.
These bits indicate the selected range.
00 -10 VDC to + 10 VDC
01 -5 VDC to +5 VDC
10 0 VDC to +10 VDC
11 Unused (Also indicates that A/D converter board is probably not connected)

4.11.7 Delay trigger configuration registers

28000: rd/wr Group 0 scan trigger delay counts lsbyte
28001: rd/wr Group 0 scan trigger delay counts msbyte
--
28002: rd/wr Group 0 control bits
bits 2,1,0 -> clock source select
000 - direct clock input (1us)
001 - clock input /10 (10us)
010 - clock input /100 (100us)
011 - clock input /1000 (1ms)
100 - clock input /10000 (10ms)

101 - count delay timer clock events (event #7)
110 - count scan trigger pulses
111 - none

bit 3

0 - count down begins on scan trigger.
pulse out occurs after programmed delay counts.
1 - continuous rate generator.
pulse out occurs after programmed delay counts, and count down automatically restarts

bit 4

0 - pulse out is delayed.
1 - pulse out follows scan trigger.

bit 5

0 - sync event will not reset counter.
1 - if rate generator is selected, sync event will reset counter.

--

28003: rd Group 0 lsbyte of count down value.
28003: wr unused

--

28004: rd/wr Group 1 scan trigger delay counts lsbyte
28005: rd/wr Group 1 scan trigger delay counts msbyte

--

28006: rd/wr Group 1 control bits
bit definition is same as for Group 0 control bits (register 28002)

--

28007: rd Group 1 lsbyte of count down value.
28007: wr unused

4.11.8 VME interface registers

2a011: rd Interrupt status
This register indicates the cause of an interrupt.
When this register is read, the interrupt request will be cleared. However, the interrupt status bit will remain in the logic 1 state until the error condition is cleared.
bit 0 - VME command complete interrupt
bit 1 - sync event/data_ready interrupt
bit 2 - CPU fail interrupt
bit 3 - A/D error (no response) interrupt
bit 4 - Event link carrier error interrupt
bit 5 - Event link frame error interrupt
bit 6 - Event link parity error interrupt

--

2a001: rd Error status

The bits in this register are identical to the interrupt status register, addr 2a011.
Reading this register will NOT cause the interrupt to be cleared.
The front end computer may poll this register after an interrupt occurs, to determine if the error condition still exists.

--

2a003: rd/wr Interrupt enable

The interrupt is enabled when the corresponding bit is high.
bit 0 - VME command complete interrupt
bit 1 - sync event/data_ready interrupt
bit 2 - CPU fail interrupt
bit 3 - A/D error (no response) interrupt
bit 4 - Event link carrier error interrupt
bit 5 - Event link frame error interrupt
bit 6 - Event link parity error interrupt

--

2a005: rd/wr Interrupt vector

bit 0-7 - VME interrupt vector

--

2a007: wr VME Interrupt level

bit 0-2 - interrupt level that the MADC controller module uses to interrupt VME bus.

--

2a007: rd Interrupt level and status bits

bit 0-2 - interrupt level
bit 3 - eeprom code-update
bit 4 - cmd boot
bit 5 - sys fail 0=FAIL, 1=NORMAL
bit 6 - a32sel22 - dip switch setting for address line a22 in a32 base address
bit 7 - a32sel23 - dip switch setting for address line a23 in a32 base address

--

2a009: wr Control command register.

eeprom code-update enable - To enable eeprom code update, write abH, then 9aH to this register.
To disable eeprom code update, write any 8-bit value, excluding abH, 9aH, and 39H.

-

Reboot command - To reboot the MADC controller module, write abH, then 39H to this register.

--

2a009: rd Interrupt level and status bits

bit 0-2 - interrupt level
bit 3 - eeprom code-update
bit 4 - cmd boot
bit 5 - sys fail
bit 6 - a32sel22 - dip switch setting for address line a22 in a32 base address
bit 7 - a32sel23 - dip switch setting for address line a23 in a32 base address

--

2a00b: rd only Memory module PD1, PD0 error.
Bus error will not ocur on write attempt.
bits 1,0 - first memory module (lowest address)
bits 3,2 - second memory module
bits 5,4 - third memory module
bits 7,6 - fourth memory module (highest address)
0 0 - 256k by 32 memory module installed
0 1 - 64k by 32 memory module installed
1 0 - 16k by 32 memory module installed
1 1 - no memory module installed

--

2a00d: wr only Write to this register will trigger interrupt to cpu.

--

2a00f: rd only a32 base address
dip switch setting for address lines a31..a24 in a32 base address
bits 7..0 = a32sel31..a32sel24

4.12 On-Board i960 CPU Memory Map

i960 CPU address space			
Address range	**Description**	**Size**	**Region Width**
5000,0000-5000,07ff	Non-volatile RAM	2 Kbytes (2K x 8)	8 bits
6000,0000-6000,0002	VME Interface Control	3 bytes (3 x 8)	8 bits
7000,0000-7000,0007	Scan list config registers	8 bytes (8 x 8)	8 bits
8000,0000-8000,0000	Data FIFO	4 bytes (1 x 32)	32 bits
9000,0000-9000,0000	Event FIFO	1 byte (1 x 8)	8 bits
a000,0000-a001,ffff	Private RAM	128 Kbytes (32K x 32)	32 bits
b000,0000-b03f,ffff	Shared RAM	4 Mbytes (1M x 32)	32 bits
f000,0000-f001,ffff	FLASH program storage	128 Kbytes (128K x 8)	8 bits

4.12.1 VME Interface Control (write only)

6000,0000: Send interrupt to VME to indicated that VME command is complete
6000,0001: Send interrupt to VME to indicate one of the following:
  1. Sync event occurred
  2. Data is ready to be transferred to VME

6000,0002: Clear SYSFAIL bit. This should be done after cpu initialization is complete.
  If CPU FAIL is asserted, SYSFAIL will not clear.

4.12.2 Scan List Configuration Registers

7000,0000: wr Trigger enable.
  Writing a bit value of 1 will enable the trigger, and a value of 0 will do nothing.
  bit 0 - enable group 0 cascade scan trigger enable
  bit 1 - enable group 1 cascade scan trigger enable
    When the cascade trigger is enabled, the arm/halt event will enable the scan trigger.
  bit 2 - enable group 0 scan trigger
  bit 3 - enable group 1 scan trigger
  bit 4 - enable group 0 arm/halt trigger
  bit 5 - enable group 1 arm/halt trigger

--

70000,0001: wr Trigger disable.
  Writing a bit value of 1 will disable the trigger, and a value of 0 will do nothing.
  bit 0 - disable group 0 cascade scan trigger enable
  bit 1 - disable group 1 cascade scan trigger enable
  bit 2 - disable group 0 scan trigger

bit 3 - disable group 1 scan trigger
bit 4 - disable group 0 arm/halt trigger
bit 5 - disable group 1 arm/halt trigger

--

7000,0002: wr Trigger reset.

Writing a bit value of 1 will reset the trigger, and a value of 0 will do nothing.

bit 0 - reset group 0 scan trigger
bit 1 - reset group 1 scan trigger
bit 2 - reset group 0 arm/halt trigger
bit 3 - reset group 1 arm/halt trigger

--

7000,0000: rd Trigger enabled/disabled status.

0 - trigger is disabled
1- trigger is enabled

bit 0 - group 0 cascade scan trigger
bit 1 - group 1 cascade scan trigger

When the cascade trigger is enabled, the arm/halt event will enable the scan trigger.

bit 2 - group 0 scan trigger
bit 3 - group 1 scan trigger
bit 4 - group 0 arm/halt trigger
bit 5 - group 1 arm/halt trigger

--

7000,0001: rd Trigger status.

0 - trigger is not active
1- trigger is active

bit 0 - group 0 scan trigger
bit 1 - group 1 scan trigger
bit 2 - group 0 arm/halt trigger
bit 3 - group 1 arm/halt trigger

--

7000,0002: rd Status bits.

bit 0 - set (1) indicates data fifo empty
bit 1 - set (1) indicates data fifo full
bit 2 - set (1) indicates data fifo half full
bit 3 - set (1) indicates event fifo empty
bit 4 - set (1) indicates event fifo full

--

7000,0003: rd only Config 0 register

bit 0 - when set to 1, group 0 arm/halt trigger will be reset at end of scan
bit 1 - when set to 1, group 1 arm/halt trigger will be reset end of scan

bits 3,2 (scan group 0 time stamp control - FUTURE)
bits 5,4 (scan group 0 time stamp control - FUTURE)
00 - do not store time tag
01 - store time tag with every data point
10 - store time tag on scan trigger
11 - store time tag on arm/halt trigger
bit 6 - priority
0 - If both scan groups are active, scanning will alternate on each data conversion
1 - Scan group 1 has highest priority. Scan group 0 will be scanned only if scan group 1 is not active.
bit 7 - time stamp clock source select
0 - time stamp clock source is on-board 1us clock
1 - time stamp clock source is event #6

--

7000,0007: rd only Config 1 register
bits 6..0 - analog multiplexer settling time
1 count = 4*pclk = 121.21 ns
programmable time = 0 to 7.636 us

4.12.3 Data FIFO

8000,0000 : rd Read event code from event FIFO
8000,0000 : wr Clear FIFO

4.12.4 Event FIFO

9000,0000 : rd Read event code from event FIFO
9000,0000 : wr Clear FIFO

4.13 On-Board 80960 CPU Hardware Interrupts

INT 0 Sync Event Interrupt
Data sync event from timeline.
The CPU will copy current scan count and pointer info for reading by VME, then the CPU will send sync interrupt to VME.

--

INT 1 1 ms Clock Interrupt
This interrupt is used by the CPU to time Arm trigger delays and Halt trigger delays. When this interrupt occurs, the CPU will also read the 'Data Fifo Empty Bit' to

determine if data is available in the FIFO.

--

INT 2 Data FIFO Half Full Interrupt

This interrupt notifies the CPU that data is available in the FIFO.

--

INT 3 Event FIFO Interrupt

This interrupt notifies the CPU that a timeline event is available in the FIFO.

--

INT 4 Arm/Halt Trigger 0 Interrupt

This interrupt notifies the CPU that the scan group 0 Arm/Halt trigger event has occurred .

--

INT 5 Arm/Halt Trigger 1 Interrupt

This interrupt notifies the CPU that the scan group 0 Arm/Halt trigger event has occurred .

--

INT 6 VME Command Interrupt

This interrupt notifies the CPU that the a VME command needs processing. A memory location in shared memory will be dedicated for this function. VME will first write a command request to this dedicated memory location, then issue a VME command Interrupt. The CPU will read and process the command, then write a return code to another dedicated memory location in shared memory. VME will either poll the return code memory location, or wait for the command complete interrupt to determine that the command processing has completed.

5.0 Software Control Descriptions

5.1 Sending Commands from VME to On-Board 80960 CPU

The front end computer sends commands to the MADC Controller module by first writing the appropriate command code and associated parameters to the command structure 'vme_command' in shared memory. Then the front end compuer writes to register 0x2a00d to interrupt the on-board 80960 CPU. When the 80960 CPU program detects this interrupt, the command structure is read, and the requested command is executed. When command execution is complete, the 80960 CPU program writes a response code to the structure 'vme_response' in shared memory, then issues a VME interrupt to indicate that the command is complete. The front end computer reads the response code to determine if the command was executed successfully.

The front end computer may either poll the response code memory location, or wait for the command complete interrupt to be received. Before issuing each command, the front end computer should first initialize the response code to some unused value. This can be used to verify that the 80960 CPU has updated the response code.

Following is a list of valid commands. The include file madc2.h defines the command codes and response codes.

5.1.1 Start Acquisition

Command code: START_ACQ

Parameters: group number

When this command is recieved, the i960 CPU program reads the buffer setup structure for the requested scan group number, and then starts acquisition based on the parameters in the setup structure.

Valid values for group number: 0, 1

Valid response codes:
- CMD_DONE
- INVALID_CMD_CODE
- INVALID_GROUP_NUM
- INVALID_ARM_CODE
- INVALID_HALT_CODE
- INVALID_DATA_FORMAT
- INVALID_INT_MODE
- BUFF_TOP_PTR
- BUFF_SIZE
- NO_CODE

5.1.2 Stop Acquisition

Command code: STOP_ACQ

Parameters: group number

When this command is recieved, the 80960 CPU program stops acquisition for the requested scan group number.

Valid values for group number: 0, 1

Valid response codes:
  CMD_DONE
  INVALID_CMD_CODE

5.2 Data Synchronization Across Multiple Boards

The following scheme has been developed to provide data synchronization across multiple boards during continuous scanning. Refer to the figure.

The front end computer will be interrupted on every occurrence of a dedicated sync event (maybe once every 5 seconds). On this interrupt, the front end computer will read the memory locations containing 1) the number of scans at time of last sync event and 2) the data pointer at time of last sync event. The number of scans will be added to the 'total scan count' in the front end computer. This 'total scan count' represents the number of total scans since acquisition for the scan group was started. An independent count will be accumulated for each scan group on each controller module. This scheme allows data to be synchronized across all MADC controller boards in the system on every occurrence of the sync event. If one board is restarted, then all boards will be synchronized again on the next sync event.

Chapter 3

Site Wide Names

Although more than one name may apply to a RHIC object, the preferred name, especially in the context of controls software, is the **SiteWideName**. SiteWideName conventions are similar, but somewhat different, in the Blue and Yellow rings of RHIC.

3.1 Naming conventions

/RHIC/ATR/sitewidename.html

This is the "root" page that leads to a description of **SiteWideNames**, and naming conventions, in the ATR:

Site Wide Names

SiteWideName's for the ATR may be divided into several categories:

- Tunnel elements in the ATR.
  - * beamline optical elements (magnets, etc.)
    - Conventions for SiteWideName's of beam line elements.
    - g-2 Primary V-line elements.
  - *beam loss monitors
  - *beam dump
  - *vacuum components
- Other SiteWideName's.
  - *electronics racks
  - *power supplies
    - Conventions for SiteWideName's of magnet power supplies.
  - Timing system
    - *Delays
    - *Events (RHIC event link)
    - *Events (RTDL)

Note: Selections with a preceding "*" are database queries.

There is also a SiteWideName browser which queries the **atr_gddb** database.

Mangled by Waldo MacKay (waldo@bnl.gov).
Last update: 25 June, 1995

3.2 SWN conventions for power supplies

/RHIC/ATR/psswn.html

Site wide names of magnet power supplies are usually formed by adding a "ps" to the front of the magnet's SiteWideName except in the following cases:

- **psuarc4** for the 4 degree dipole bus in the U-line consisting of **ud1** and **ud2.**
- **psuarc8** for the 8 degree dipole bus in the U-line consisting of **ud3** through **ud6.**
- **pswarc20** for the 20 degree dipole bus in the W-line consisting of **wd1** through **wd8.**
- **psxarc90** for the large arc in the X-line with dipoles **xd1** through **xd31** and lambertson magnet **xlamb.**
- **psyarc90** for the large arc in the Y-line with dipoles **yd1** through **yd31** and lambertson magnet **ylamb.**
- **psxd31t** for the trim 100A bipolar supply across **xd31.**
- **psyd31t** for the trim 100A bipolar supply across **yd31.**
- **psxlamt** for the trim 100A bipolar supply across **xlamb.**
- **psylamt** for the trim 100A bipolar supply across **ylamb.**

All the rest of the ATR elements are powered by single supplies with a one-to-one correspondence.

3.3 SWN conventions for optics

/RHIC/ATR/swn – optics.html

SiteWideName's for beamline components

Magnets for the ATR fall into several categories: horizontal dipoles, vertical pitching magnets, quadrupoles, trim dipoles, and lambertsons. Other beam line elements include a stripping foil, flags, beam position monitors, current transformers, collimators, vacuum equipment and beam loss monitors. Within the AGS and RHIC rings are also ferrite kicker magnets.

There are several different types of names which are used for each element within the definition of the lattice, and for survey information, but there is a unique SiteWideName for each element which should be used at the top level of the control system and for operations.

SiteWideName's for elements in the transfer lines begin with the name of the beamline (u, w, x, or y) in which the element resides, with the exception of the switching magnet upstream of the beam dump. For logical reasons dealing with tracking programs, the switching magnet is considered to be in both the X- and Y-lines, so we have decided to give it the SiteWideName: "swm" for switch magnet. Note that SiteWideName's are typed in lower case on the computer.

The rest of the SiteWideName's for the transfer lines are generally made up of three or four fields:

beamline dev_type number mod

where ***beamline*** is the single letter designator for the beamline, ***dev_type*** is a mnemonic for the type of element, and ***number*** is sequence number of the particular element within the specified beamline. The modifier ***mod*** is used at present only for collimator jaws and some vacuum components.

Since there is only one stripping foil, there is no ***number*** in its SiteWidename.

Device types for typical ATR elements are as follows:

```
Magnets:
      d       horizontal dipole (with or without gradient)
      p       vertical pitching dipole (no gradient)
      q       quadrupole
      th      horizontal trim steering magnet
      tv      vertical trim steering magnet
      lamb    lambertson magnet
      swm     switching magnet (pure dipole)
```

```
Beam monitors:
      bh       single plane beam position monitor (horizontal)
      bv       single plane beam position monitor (vertical)
      b        dual plan beam position monitor (horizontal & vertical
      f        flag profile monitor
      xf       current transformer

Collimators and foils:
      foil     stripping foil
      c        collimator

Vacuum components:
      ip       ion pump
      rv       roughing valve
      sv       sector valve
      fv       fast valve
      cc       cold cathode gauge
      tc       thermocouple gauge
```

(A larger official list of RHIC mnemonics is available.)

The sequencing of trim magnets does not distinguish between horizontal and vertical, even though the *dev_type* does. The sequencing for beam position monitors is similar to trim magnets. Sequencing of vacuum components is done by setting *number* to the sector number within the beamline for the given element and using a letter *mod* beginning from A for the upstream end of the sector and running down the alphabet for identical devices within the sector.

The modifiers for collimator jaws are "l" for a left jaw and "r" for a right jaw.

Since the V-line for the g-2 experiment branches off from the U-line, just upstream of the 8 degree bend, we refer to the two V-line dipoles sharing a common vacuum chamber as VD3 and VD4.

Mangled by Waldo MacKay (waldo@bnl.gov).
Last update: 22 June, 1995

Chapter 4

Application Software

/RHIC/RAP/Documentation/Apps/root.html

This is the "root" page for application software documentation:

RHIC Application Software Documentation

RHIC Accelerator Physics (RAP)

Last modified September 21, 1995, by Satogata

	Section	Description	
1.	Introduction	Introduction to this documentation, brief explanations.	
2.	Projects	The list of current application projects, with documentation links.	
3.	Managers	The list of current managers, with documentation links.	
4.	Software release procedures	How to release applications, glish scripts and pet files	New
5.	Applications review notes	Notes from ongoing applications reviews, including style comments and comments on individual applications.	
6.	APPS styles and rules	Including ProjTemplate, file structure, and brief notes on the console environment.	
7.	Environment variables	Relevant ENVIRONMENT variables, and current assignments.	

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **September 21, 1995**

4.1 Introduction

/RHIC/RAP/Documentation/Apps/introduction.html

RHIC Application Software Documentation: Introduction

RHIC Accelerator Physics (RAP)

Last modified September 11, 1995, by Satogata

Location

The software development area for RHIC (and ATR) applications and managers is on the RHIC Accelerator Physics (RAP) fileserver, "owl.rhic.bnl.gov". It can be reached with the command "`cd $APPS`" on development workstations. *$APPS* is a UNIX environment variable set at login on the "zoo" workstation domain.

Directory Structure and Style

Each application developer is assigned a **Project** directory inside which one or more applications are developed. The structure follows that in the 'project template' directory *$APPS/ProjTemplate* - each top-level project directory has subdirectories which contain source code for applications or libraries, public and private header files, application-specific startup data and Xt app-default files, etc. (Contact Todd Satogata for more info.)

Similarly, manager developers develop in directories below the *$APPS/manager* directory, and libraries which are used by a variety of applications developers may be placed in the directory *$APPS/libraries* to be shared.

There is a brief style guide that should be followed by applications developers. This style guide includes such conventions as where both generic and application-specific data files are located with respect to environmental variables such as *$RELEASE_DIR*, as well as comments on installation and release procedures. This style guide is, by necessity, a live document, and constantly evolving.

Prerelease, Release, Replication

At appropriate intervals the **appmeister** (Todd Satogata, satogata@bnl.gov), performs an

apps release of all the applications and managers. This places the executables, libraries, et cetera, into the area /ride on the RHIC Controls Section development file server, cfsa.rhic.bnl.gov, along with myriad software developed and maintained by the RHIC Controls Group. The **appmeister** is also responsible for all other technical aspects of the $APPS area.

Whenever necessary, the current **release** of controls software is **replicated** onto the disks of the operational consoles in the */usr/controls* directory. Scripts used to perform the replication are the responsibility of Rich Casella (rac@bnl.gov) - they copy and **strip** application binaries, scripts, app-specific data and app-default files, as well as canonical data. *(Question: what about documentation?)* They explicitly do not replicate libraries or source code.

Part of the application look-and-feel is determined by the default console environment characteristics set by the **mcr** user, since all consoles are logged in as him/her/it. The default **mcr** environment is the joint responsibility of the zoo system administrators, Rich Casella and Roger Katz (roger@bnl.gov).

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
LastUpdate: **September 11, 1995**

4.2 Projects

/RHIC/RAP/Documentation/Apps/projects.html

RHIC Application Software Documentation: Projects

RHIC Accelerator Physics (RAP)

Last modified September 20, 1995, by Satogata

The following is meant to explicitly follow the organization of **pagetree** on operations consoles during the 1995 ATR commissioning run. If this is not the case, please email or call Todd Satogata.

Links in the **Application** column point to brief descriptions of each application and project following this list. Links beneath the **Doc Update** column point to online documentation provided by the applications programmers and systems commissioners.

	Application	Type	Developer	Phone	Doc Update	App Release
0.0	pagetree	GUI	Waldo MacKay	3076	7 Sep 95	?
1.0	plot_atr	GUI	Waldo MacKay	3076	7 Sep 95	?
2.0	Magnet Control/Display	GUI	Jorg Kewisch	5653	21 Sep 95	?
2.1	PS Digital Control	PET	Jorg Kewisch	5653	21 Sep 95	?
3.0	Orbit Display	GUI	Todd Satogata	5452	Never	?
4.0	Event Link	PET	Waldo Mackay	3076	Never	?
5.0	BLM Display	GUI	Steve Tepikian	4845	Never	?
5.1	BLM Digital Control	PET	Steve Tepikian	4845	Never	?
6.0	MADC Control	PET	Jorg Kewisch	5653	Never	?
7.0	Current Display	PET	Dong-Ping Deng	2197	19 Sep 95	?
8.0	Profile Monitor Display	GUI	Ping Zhou	7779	15 Sep 95	?
			Utilities			
1.	Pet Program	GUI	Don Shea	2931	Feb 28 95	?
2.	tabdis	GUI	Waldo Mackay	3076	7 Sep 95	?

Descriptions of applications and projects

pagetree

Graphical startup of RHIC/ATR applications programs.

plot_atr

Display of ATR beamline, including site-wide names, magnet outlines, tunnel walls (where available) and site coordinates.

Magnet Control and Display

Graphical interface for tweaking and setting ATR magnet strengths and currents. Step-stone storage and retrieval allow primitive user-driven ramps to be constructed.

Power Supply Digital Control
Control of status, on/off settings and other digital power supply readbacks from a pet page, or set of pet pages.

Orbit Display and Archival
Display and archival of beam trajectories along ATR, including position information from flags when applicable.

Event Link Pet Page
Pet page displaying event codes for the ATR REL (RHIC Event Line), as well as channel control and status for event encoders.

BLM Display and Control
Display and archival of beam loss monitor readings along ATR.

BLM Digital Control Pet Page
Control of BLM integrator timing, power supply settings, readback and status.

MADC Control/Graphing Pet Page
MADC Control/Graphing Pet Page

MADC Control/Graphing Pet Page
MADC Control/Graphing Pet Page

Transformer Control / Current Measurement
Transformer Control / Current Measurement

Profile Monitor Display
Profile Monitor Display

Pet Program
Pet Program

tabdis -- glish tabular display
tabdis -- glish tabular display

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **September 20, 1995**

4.3 Managers

/RHIC/RAP/Documentation/Apps/managers.html

RHIC Application Software Documentation: Managers

RHIC Accelerator Physics (RAP)

Last modified September 11, 1995, by Satogata

This page lists the current **managers** in development by, or available to, applications programmers for ATR and RHIC. Managers are high-level controls programs which convert between relatively low-level FEC access (usually using ADOIF calls) and high-level physics-oriented descriptions of the accelerator suitable for applications programs (usually in glish).

The following is meant to be a list of managers in development for the 1995 ATR commissioning run. Please report any discrepancies by email or call to Todd Satogata, x5452.

Links in the **Manager** column point to brief descriptions of each manager following this list. Links beneath the **Doc Update** column point to online documentation provided by the manager programmers and systems commissioners, when available.

Manager	Developer	Phone	Doc Update	Manager Release
BPMs / Orbit	Todd Satogata	5452	Never	?
Loss Monitors	Steve Tepikian	4845	Never	?
Magnets / Power Supplies	Jorg Kewisch	5653	Never	?
Profile Monitors	Ping Zhou	7779	Never	?
Timing System	Unknown	????	Never	?

Descriptions of managers

Bpm/Orbit Manager

Provides hooks into sets of bpm control by site-wide names of bpms; includes control of gain settings, status readback and relevant timing control. Does not include modeling or hooks into profile monitor system.

Beam Loss Monitor Manager

Magnet Manager

Video Profile Monitor Manager

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **September 11, 1995**

4.4 Application release procedure

/RHIC/RAP/Documentation/Apps/release.html

RHIC Application Software Documentation: Release Procedure

RHIC Accelerator Physics (RAP)

Last modified October 4, 1995 by Satogata

Applications Software Releases

NOTICE

A scheduled replication onto *all* consoles is now being performed at 12:30 PM every Tuesday from the standard release area, `/ride/release/$(ARCH)` (`/usr/controls` on development consoles). Applications should be released whenever code changes result in new features being added, fixed or changed -- they should not be driven by a schedule of console replications. Intermediate replications will be performed at the discretion of the replicators.

Release Procedure for Applications

The following procedure must be followed by applications developers to release their softare into `/usr/controls` on development consoles when necessary. Please call Todd (x5452) or Smita (x3924) if you have any questions or concerns, or to get the user password for the 'release' account. This is a modified version of the release procedure documented by the RHIC Controls group in the file "/ride/documentation/releaseProc.fm.html".

1. As yourself, build your application normally by typing 'make' on a development SUN architecture machine (or whichever architecture you happen to want to release for.) This forces a cleaner compilation, as well as avoids file protection problems and conflicts with the 'release' user later. Test your application locally as you deem necessary.

2. Change any menuTree paths in your app-defaults files to point down data directories in /usr/controls, the final replication path. There are cleaner alternatives to this -- the release makefiles automatically substitute environment variables of the

form `${ENV}`; if you use these files, talk to Don or Todd.

3. Switch users to the 'release' user with the command "`su - release`" The '-' reads the entire environment such as .cshrc and .login. See above for who to contact for this password.

4. Type the command "`openPerms`". This opens permissions on the /ride/release directory to the 'release' user.

5. Check that your `RELEASE_DIR` is `/usr/controls`. If you are feeling particularly fretful, check that this is a symbolic link to `/ride/release/$(ARCH)`.

6. Type the command

```
make release
```

to release the program.

7. Type the command

```
closePerms
```

to close the permissions to the release directory.

8. Email relevant users and <satogata@bnl.gov> to inform people of the release.

Pet Page and Glish Script Release

There are still unfortunately a couple of loose ends regarding release and replication of PET pages and glish scripts. My suggestion is to keep these scripts and files in the 'data' area just like other data for applications. For an example of the (2-line!) Makefile to release pet pages in this way, have a look at the directory

```
/apps/orbit/BpmPet
```

The Makefile here -- which can be copied *without change* for other pet areas -- will release pet pages into `${RELEASE_DIR}/data/PetPages`. This can be edited to also release into subdirectories, so in the future we can organize Pet page releases and replications as we see fit.

Glish scripts should be kept in the 'data' area of the application that they were written for; e.g. `OrbitDisplay.g` is application-specific, and is released to the data/OrbitDisplay area as the tree file for this application is.

Testing Released Software

Once released, controls and applications software may be tested a variety of ways without the requirement of replication to a console. The `atr` and `mcr` users each use released software immediately on development consoles (as opposed to operations consoles, which require a replication). Therefore, a reasonable procedure to test newly released software is to run `pagetree` on a development console as one of these users, and see if your software runs, including setup files, pagetree data file entries, etc. If the pagetree data file startup needs to be changed, contact Todd.

Prerelease testing may also be done at a similar level by checking that your `RELEASE_DIR` environment variable is set to `/ride/prerelease/$ARCH` on a development console, then testing as usual.

I would greatly appreciate any suggestions regarding more robust or appropriate software testing procedures.

Comments?

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **4 Oct 1995**

4.5 Software review notes

/RHIC/RAP/Documentation/Apps/review.html

RHIC Application Software Documentation: Review

RHIC Accelerator Physics (RAP)

Last modified September 11, 1995 by Satogata

Application Environment Review Comments and Updates

The following is a list of suggestions and comments about applications programs standards and development from ATR crew chiefs (Steve Peggs, Waldo MacKay, Dejan Trbojevic, Jie Wei, Jorg Kewisch), AGS operators (Jon Laster, Willem VanAsselt) and Todd Satogata on Friday, August 25 1995. They have been updated to include comments from another later meeting with Leif Ahrens and Ken Reece of the AGS. Starred items (*) are considered critical; (?) items are considered quite low priority.

These pages will be updated routinely to include continued commentary on applications as well as updates from developers when issues are addressed. Application hypermail resources, when available, will supplant this page in the future.

	Section Name	Developer	Phone	Web Doc Updated?
1.	General Comments for All Apps	All Developers		**11 Sep 95**
2.	Pet Pages	All Developers		**20 Sep 95 - some**
3.	Pet Program	Don Shea	2931	**Never**
4.	Page Tree	Waldo MacKay	3076	**7 Sep 95**
5.	Plot_ATR	Waldo MacKay	3076	**7 Sep 95**
6.	MagControl and MagDispl	Jorg Kewisch	5653	**Text**
7.	Orbit Display	Todd Satogata	5452	**Never**
8.	BLM Display	Steve Tepikian	4845	**Never**
9.	Profile Monitor App	Ping Zhou	7779	15 Sep 95
10.	Current Monitor App	Dong-Ping Deng	2197	19 Sep 95
11.	Event Link Pet Page	Waldo Mackay	3076	**Never**
11.	MADC Control Pet Page	Jorg Kewisch	5653	**Never**

General Comments -- All Apps

- ***** Help Menus and Documentation, Third-Button Help**
  Help menus and online documentation *must* be improved; third-button help popups is a convention that both AGS and pet pages are already using. It is possible to put attributes into pet startup files for internal documentation of pet pages (See Don Shea for help on this), as well as to put online help into the app-defaults X11 resource file of applications. (See Ted D'Ottavio for help on this.) Help on specific devices from within applications would also be, well, helpful (from Jon Laster.)

- ***** Information Bar: Displaying Date, Time and Cycle Info**
  Where possible, dates and times should be displayed on pages. Jon Laster suggested that we design an 'information bar' that could be incorporated into applications underneath their menu bars, including info such as date, time, AGS cycle number, status (including status of whatever current dataset is being displayed) and perhaps application-dependent status information and an editable comment.

- ***** Consistent Labeling of Fields and Graph Axes**
  Where units are applicable, *use them*! Also use graph legends to label graph data, and sidebar windows if displays are too cluttered.

- ***** Dataset Save Conventions**
  All saved datasets should include a *comment* field, browsable by a suitable application at a later date. This may develop to a file browser that displays comments and file types along with filename info, but this is a long-term project. For now, popups that request and display this comment field upon save or load are enough. Maybe. Included in the save should also be relevant information from the information bar, above.

- ***** Consistent Use of Environment Variables**
  Environment variables should not be assumed to be present -- i.e. the `getenv()` return should be checked to be *sure* it is non-NULL. (Using this without checking often results in hard-to-debug segmentation faults when an environment variable is not set, as Todd knows from experience!) Environment variable standards should be used for startup, canonical, volatile, application storage and log data.

- ***** Unselecting Pull-Down Menus**
  Currently pull-down menus evidently cannot be unselected once selected, save for selecting one of their entries. This is a topic of concern for Ted D'Ottavio, as it's a UI Tool problem.

- ***** ADOs Should Be Checked for Async Updates**
  Some ADOs currently in the field update information asynchronously when they are changed -- a good practice, as this updates pet and any other application with an async registered on that ADO. We should ferret out the ones that don't comform to this and change them.

- **Use a Message Area for Messages**
  If you have a message area in an application, *use it* for informational and warning messages. Additional methods may be added to the UIMessageArea object to handle color changes for warning situations.

- **Use `rhicErrors` for ADO/Other Error Reporting**
  Talk to Don Shea about this if you're not sure what it is; rhicErrors is a class library that gives users access to string representations of common ADO error codes. (Don: Could this be incorporated into the libadoIf?)

- **Provide Tabular Formats For Data Display**
  Jon Laster and other operations folks would like tabular displays of array data as well as graphs for BPM and BLM information, as well as any other info that presents itself in this manner. The 'pet' method of tabular display can likely be used with very few changes.

- **Conform for Any Means of Application Exit**
  Traditionally, Ted has build applications using TreeBuilder and the UI Toolkit that `exit()` immediately if the 'Close' button is selected from the upper left window manager pulldown menu. (In UI programs, this is capturing a UIWindowMenuClose event.) All methods of exiting an application (with the possible exception of glish 'terminate' and NULL events) should pop a confirmation window. Also, from Jon Laster, this confirmation window should allow a 'Return' keypress to confirm exiting.

- **Keyboard Accelerator Standards**
  Common conventions should be established for standard control keys within applications. (e.g. Ctrl+Q is 'Quit...', Ctrl+S is 'Save...', etc.)

- **One-Field Two-Click Confirmation Scheme**
  The confirmation method for pet (click on a field with left button to hilite, then click again with middle button to send or confirm) is considered to be a good one, and should be followed wherever possible when fields or buttons send settings to hardware.

- **Glish Event Conventions for User Interfaces**
  Tying user interfaces together later, if necessary, will be much easier if we put the hooks in with the first generation. This implies a standard set of UI and glish events for such things as window resizing, graph rescaling, etc. Steve Tepikian, Don Shea and Todd are currently discussing addressing this issue for the BPM and BLM display programs.

- **Zooming Clicks on UIGraph**
  By default zooming should be turned *off* on UiGraph objects, only to be turned on explicitly with the right mouse button menu. (A help menu could also be added underneath that menu, btw.) Since the control environment is click-focus, a focusing click on an application's graph window can also accidentally zoom the graph.

- **??? Expert, Help and Print Buttons on Menu Line**
  Some technical options (such as ADO communication and information) can be

relegated to an 'expert' menu, placed at the upper right of application menu bars if present. Standard utilities that every application supports, such as printing and help, may also be placed here, though for '95 ATR tests third-button help and PrintTool printing will probably have to suffice.

Pet Pages

- ***** Some Critical Cells Should Default to Non-Editable**
  E.g. cells such as the timeline event codings on the events page. It's easy enough to set a cell editable again if really necessary, but cells where one entry has system-wide impact or is very sensitive should definitely be made to default to non-editable. This can be set up in the pet page startup files on a page-by-page basis.

- **??? Pet Page Documentation**
  According to Don, there is currently no mechanism for user-supplied help in pet (i.e., specific to a particular pet startup page.) Doc for pet pages should be arranged on the web for '95, with the addition of a 'help' button popping a user-supplied help file later.

Pet Program

- ***** FEC Down Causes Pet to Hang**
  When pet fires up and attempts to contact a crate which is offline (either turned off or encountering network problems), it hangs with no status information displayed. A timeout might be included or some other alarm to inform the operator that the particular front end pet is failing to contact is down.

- ***** Pet Does Not Warn on FEC Name Resolution Failure**
  When pet starts on some consoles which have NIS problems, and does not resolve the fec name properly to an IP address, it displays the pet page with completely blank fields for data. This is an error state and pet should warn the user, telling which FEC name it is having trouble resolving (if possible).

- **Deiconify Event Should Trigger 'Get All'**
  When deiconifying a pet page, the user likely wants 'live' data. Catching the

UIDeiconify event and throwing a 'get all' to refresh the data on the page is a good idea -- alternatively a standard operations procedure could be to type ^A when deiconifying any iconfied pet page.

- **Unsigned Byte Display Problem**
  Pet has a bug on Suns that displays unsigned bytes as though they were signed, possibly causing confusion when displaying REL event codes and other unsigned byte data. This is actually related to a Glish/Value class problem, it seems.

- **Field Selection and Editing Inconsistencies**
  Users can select cells that have no data in them, and 'edit' data in so-called uneditable cells (that is, point, click and type -- pet won't let you actually *change* the value, however). These are minor but valid annoyances.

Page Tree

- ***** Double Clicks to Start Applications**
  Using single clicks to start applications violates established conventions and is generally annoying since user often start two applications with a double-click. Use double-clicks on an app name to start up a given application.

- **`stderr/stdout` Are Used For Error Reporting and Not Directed**
  Either an xterm could be popped with pagetree to report statuses and errors, or -- more appealingly -- a scrolling text area could be added to pagetree, much in the same manner as 'startup'. This way application startup information and errors are all shown in one log.

- **??? Change Application Start Messages**
  Currently pagetree prints a message in the message field that is the name of the application just started. Include something in this message such as 'Starting' to let the user know it's actually starting the bugger, and not just an informational message.

- **??? Name Fields Do Not Resize With Window Resize**
  This is really picky, actually, but true; could you possibly catch a stdwindow UIResize event?

Plot_ATR

- ***** Change Verbosity**
  Allow a command-line switch to turn on (or off) the coordinate printout when zooming, or keybind a key for this info. This info stands a good chance of clogging the pagetree log.

- **Display Coordinate Ranges Onscreen**
  Perhaps a small label showing currently zoomed coordinate ranges could be done easily, in one of the upper corners. This actually goes along with the previous comment, and might be a better implementation.

- **Supply Online Help; `stderr/stdout` Are Currently Used**
  It would be nice to have a display of online help somewhere instead of having to find the controlling xterm. Suggestions include a small modal window popup (from pressing 'h') or another app, 'plot_atr help', that's started at the same time plot_atr is.

- **Set Limits for Zooming**
  Zooming too far in one direction or the other creates something ugly. Best just to check limits and lock out at some point, either when too small (scale on order of meters) or too large (scale on order of tens of thousands of meters.)

- **??? Glish Interface**
  It would be *very* keen to have a plot_atr interface where someone passes a SWN in and it zooms to that spot in the beamline. Probably too much to ask at this point, though, since there's currently no provision for a combined X event/Glish interface without UITools.

MagControl and MagDispl

- ***** DOIT With Middle Mouse Button Crashes App**
  This appears when this button is first hilited with the left mouse button, probably 'armed'. Error returned is an X 'BadValue' error.

- ***** Change Units In Some Places, Foil Strategy**
  'Energy' should be 'Gamma', for example. Is this energy/gamma before or after the stripping foil, and could some control of the stripping foil strategy be

included?

- ***** Dependent/Independent Variables Are Not Clear**
  When one scales energy, one usually means to keep the kick strength *constant* but vary the the underlying current to the magnet. This is not what is done currently -- energy (gamma) scales even the kick strength in mrad. This is likely not correct for procedures like measuring dispersion.

- **Display Comment or Label for each Step-Stone**
  If for no other reason than to clarify matters, especially when printing.

- **Display Power Supplies and Magnets in Beamline Order**
  That is, display them in their order down the beamline instead of alphabetical order.

- **Loading 'Live' Field Readings?**
  Can one load the current settings from the field into magdisp? This would be very nice to do for small tweaks and changes to the machine unless 'doit' button only sends fields that have changed. If this is the case, hilite the fields that have changed.

- **Save and Load to *APP_STORE/APP_VOLATILE*; Saving Ramp Groups?**
  Currently this application saves and loads to/from Jorg's home area. Ramps (sets of step-stones) should be set up in the application *$APP_STORE* area by Waldo and Jorg for hysteresis cycling. It would also be very nice to be able to store sets of step-stones together, but this can be faked using directory structures for '95.

- **Asynchronous Status Readbacks?**
  Is the status readback asynchronous on this page, or just the PS digital control pet page?

- **??? Combine Two Displays Into One**
  It would be nice, although there is some shared data between the two displays and some disparate data (such as file load and save).

- **??? Field Style Comments and Changes**
  Default fields could be widened to include typical information such as error code readbacks. Also, do you really like blue and black text?? :-)

- **??? Include Power Supply Label Fields on Magnets to Show Busing?**

A pie-in-the-sky thing, really, but it would be nice to see a list of which magnets are on which power supply somehow. This would certainly help debug wireup problems that are database-driven.

Orbit Display

- ***** Display Plane Information, One or Both Planes**
  There is no label telling the user which plane(s) they're working with. A second graph should be added when doing dual-plane work as well.

- ***** Display BPM/Flag Locations**
  BPM and flag locations and SWN's could be included on the beamline graph. Flags should also be displayed in a different color if possible, possibly with 'in' or 'out' status info.

- ***** Display Mode Information and BPM Gain Settings/Statuses**
  BPM gains and statuses should be displayed in a table somewhere on the application screen. This table may even be editable (probably not though), but it should at least display, one one screen, all BPM gains and statuses together for printing and perusal. The acquisition mode and operational plane (pretty apparent with the above suggestion) should be displayed as well.

- **??? Include Running Differences**
  Include a shot-to-shot difference mode? This is posibly useful for diagnosis.

- **??? Display Line Labels on Beamline Graph**
  It would be nice to have labels for the various lines (U, W, Y) on the beamline graph (Jon Laster).

BLM Display

- ***** Display Mode Information, BLM Gain Settings/Statuses**
  BLM gains and statuses as well as power supply statuses and settings should be displayed in a table somewhere on the application screen. This table may even be editable (probably not though), but it should at least display, one one screen, all current BLM gains and statuses together for printing and perusal. The

acquisition mode and should be displayed as well.

- ***** Labels Need More Consistency and Coherence**
  Vertical scale units are probably 'counts'. Multiple plots are not labeled, nor are any plots labeled with the buffer number or any sort of identifier to discriminate them.

- ***** Clarify Menus, Include Mode Settings Under 'Acquisition' Menu**
  What are 'Start' and 'Stop' buttons? What are the buffer buttons good for? Why should you ever empty the buffer -- is it rotating? Have a look at Orbit program with continuous and single-shot acquisition modes.

- ***** What Data Is Saved? Gain Settings and Power Supplies?**
  Gain settings, power supply settings and comments should be stored with every data set.

- **Differences from Reference and Running Differences**
  As in the BPM/Orbit program, running differences and differences from a given set of reference readings would be very helpful.

- **??? Default to Logarithmic Y Axis?**
  This may or may not be a better default than the current linear axis; operational experience will decide this for us.

Profile Monitor App

- ***** Review comments forthcoming**

Current Monitor App

- ***** Review comments forthcoming**

Event Link Pet Page

- ***** Review comments forthcoming**

MADC Pet Page

- ***** Review comments forthcoming**

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **11 Sept 1995**

4.6 Styles and rules

/RHIC/RAP/Documentation/Apps/styles.html

RHIC Application Software Documentation: Style Guide

RHIC Accelerator Physics (RAP)

Last modified September 11, 1995, by Satogata

The various styles and rules associated with applications development are intended to help, rather than hinder, the developer. Unnecessary complication has been avoided and the consensus of the Continuing Task Force has been followed, wherever possible. Of course, the developer is free to ignore some of the apps conventions (at his own peril) so long as the true goal of guaranteed performance in the control room is met. Control room performance criteria include, for example, *reliable and consistent data storage* and *consistent look-and-feel.*

Makefiles and $APPS/ProjTemplate

Included in the $APPS area is the template directory $APPS/ProjTemplate. This area typifies the recommended organization a simple application's development area. Beneath each top-level application directory (e.g. *$APPS/Orbit*), there are subdirectories for each library or set of associated binaries. Sample application library and binary makefiles (quite simple, in fact) are available underneath the $APPS/ProjTemplate area. There are also areas that are shared between several different applications, including

$APPS/libraries
: Libraries shared among applications, including those for string manipulation (mackay@bnl.gov), lattice display (tepikian@bnl.gov) and dynamic glish connections (jorg@bnl.gov).

$APPS/manager
: Glish-based high-level managers for subsystems, such as BPMs, magnets and BLMs. Manager documentation is forthcoming; systems commissioners and application programmers have more information.

File Structures and Data Management

The application file structure distinguishes between **volatile**, **archival**, **start-up**, and **canonical** data. Correct use of the application file structure is made easier by the availability of various environment variables. The default console environment also constrains the developer -- for example, **volatile** files saved to console disks are not backed up, and are not readily available at other consoles.

Database Access

Console Environment

Following the tradition of the Apollo computers used for AGS control, all consoles used for RHIC and ATR operations will be logged in as the user **mcr**. The console environment determined in large part by the **mcr** user is different in various ways from the AGS/Apollo paradigm, both in terms of the standard set of windows (or icons) presented, and in terms of philosophy of use. For example, in 1995 it will be possible to launch ATR applications and pet pages from a default pagetree menu. If the **startup** utility familiar to Apollo users is ported to the Suns, it too will be available for launching. The document "AGS and RHIC Environment" by Tom Clifford summarizes several other environmental f eatures - such as mounts, dependencies, and database servers - that have been aired in Continuing Task Force meetings.

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
LastUpdate: **September 11, 1995**

4.7 Environment variables

/RHIC/RAP/Documentation/Apps/env.html

RHIC Application Software Documentation:

Environment Variables

RHIC Accelerator Physics (RAP)

Last modified September 11, 1995, by Satogata

Application Data Storage Conventions

There are at least five different classifications of data used by applications in the APPS area -- startup, canonical, volatile, application storage and log. These data areas should be referenced with environment variables (using the `getenv()` system call) and application-names (#def'd in header files if possible) within high-level controls applications, as specified in the following list. Directory organization beneath these areas is application-specific.

- **Startup data:** $RELEASE_DIR/data/<app-name>/
  This is where tree files and application-specific startup data files are located upon release from the $APPS area. These data files are released and replicated to control consoles at the same time and in the same manner as applications programs. (e.g. `pagetree/rhic.pages`.)

- **Canonical data:** $CANON/<database-name>/
  This is where database tables and groups common to many applications programs are located upon release from the $APPS area. Currently this area contains **holy_lattice** and **atr_gddb** directories, including design optics, aperture and design information for the ATR. These tables are released and replicated to control consoles as well. (e.g. `holy_lattice/YTransfer/Namespace`.)

- **Volatile data:** $APP_VOLATILE/<app-name>/
  This is where 'live' and temporary data are stored while running a particular application. *This area is local to each console,* implying that volatile data is not accessible from other consoles, nor is it ever backed up. Examples are myriad, including error logs and reports, temporary simulation results and datasets, mirrors of SDS shared memory partitions, etc.

- **Application save data:** $APP_STORE/<app-name>/
  Application save data is data that is explicitly saved by the user or the application for backup and archival. All of this data is resident on **cfsb** (the control room file server), and exported and available to each console and applications thereon.

- **Log data:** $LOGS/<app-name>/
  Here log data means debugging and informational messages generated by applications. (This is in contrast to *logging* machine data, which is volatile or applications storage.) This data is stored locally on each console to avoid multiple-instance log interweaving. This is explicitly separate from volatile data for clarity.

APPS Developer Environment Variables

The following variables are used by programmers during development, especially within the application Makefiles:

- **ARCH:** Machine architecture, usually *SUN* or *SGI*.
- **APPS:** Top-level of applications area, usually */apps*.
- **RELEASE_DIR:** Release or shadowed testing directory, usually */usr/controls/* on control room consoles or */ride/release/$(ARCH)/* on development consoles.

See application conventions for more info on use of the following environment variables.

- **CANON:** Canonical data.
- **APP_VOLATILE:** Volatile (temporary and console-local) data storage.
- **APP_STORE:** Centralized backed-up data storage.
- **LOGS:** Log data, including informational and debugging messages.

Maintained by Todd Satogata / (516) 282-5452 / satogata@bnl.gov
Last Update: **September 11, 1995**

Chapter 5

Databases

The two main SYBASE databases used for ATR work are **atr_gddb** and **atr_cal**. This chapter describes the structure of their contents.

5.1 Generic Definition DataBase, atr_gddb

/www.rhichome.bnl.gov/cgi – bin/atr_describe.sh

Document generation time: Oct 11 1995 4:08PM

Description of the "atr_gddb" database.

This document shows what is currently in the database. (Some of the text descriptions of things may be old, if the the appropriate tables have not been updated.)

Quick index:

- Groups of tables and views
- Ungrouped tables and views
- Stored procedures

Groups of tables and views:

```
There are several useful tools for dealing with groups of tables.
(See the local UNIX man pages for "dbtools".)

Note to programmers:
Header files (for C and C++) can be found along the "$HORST/include" p
for most of these groups.  (The "header_info.h" file is located along
"$DBAPPLICATIONS/include" path.)  By including these paths in your
compilations, you should get the file (if it has been generated by "db
Functions for reading and writing SDS versions of the groups are locat
in "$HORST/lib/$ARCH/libgddb.a".
```

- beam_init
- blinit
- blm
- blout
- db_NameLookup
- fidgen
- generic_dev
- header_info
- html
- installation
- madc_channel

- magfield
- magnet_info
- picture_info
- ps_basic
- ps_ref
- ps_view
- real_dev
- SWNdesc
- table_desc
- tunnel_lines

Ungrouped tables and views:

- blm_serial
- BodyHarm
- bpm_orientation
- generic_bpm_info
- halfcores
- Integral
- MAD_type
- magnet_field
- magnet_field_bak
- movableBLM
- names
- nominal_bends
- ps_estimate
- ps_installation
- quad_transf
- SWNameAdo
- SWNameAdo_bak
- tcelement
- tunnel_arcs_bak
- tunnel_lines_bak

Stored procedures:

- dbg2sds_all
- describe
- fill_blm_avg
- html_describe_doc

- html_get_doclines
- html_group_list
- html_gt_list
- html_list_anchor
- html_p_list
- html_procedure_list
- html_t_list
- html_table_describe
- html_ungrouped_list
- initserial
- installed
- set_ps_limits
- undocumented
- what
- whatsit

Group *beam_init*

The C header file is "gddb/beam_init.h".

nominal beam parameters for various ion species (to be used with 'bl').

The tables and views in this group are:

- beam_init

Group *blinit*

The C header file is "gddb/blinit.h".

Lattice models and schemes for the "bl" program.

The tables and views in this group are:

- bl_lattices
- bl_monitors
- bl_tweaks

Group *blm*

The C header file is "gddb/blm.h".

BLM information about wiring and calibration.

The tables and views in this group are:

- blm_avg
- blm_HV
- blm_wire

Group *blout*

The C header file is "gddb/blout.h".

Definition of SDS objects for output from the bl program. These tables are just for the definition of the SDS structures and should not be filled in with values.

The tables and views in this group are:

- bl_elts
- bl_football
- bl_model_info
- bl_model_names
- bl_orbit
- bl_twiss

Group *db_NameLookup*

The C header file is "gddb/db_NameLookup.h".

This is an SDS header file for the NameLookup table in the atr_gddb database. The lengths of character strings are different from the definitions of Namespace made in the include files in $HORST/slotspace/include.

The tables and views in this group are:

- NameLookup

Group *fidgen*

The C header file is "gddb/fidgen.h".

Magnet fiducial information for installation.

The tables and views in this group are:

- fid_offsets
- magnet_survey

Group *generic_dev*

The C header file is "gddb/generic_dev.h".

Info for generic device descriptions and wireup.

The tables and views in this group are:

- Connectable
- Connects
- ConnectType
- Contains
- Device
- DeviceType
- Spigot
- SpigotOwn

Group *header_info*

The C header file is "Dbapps/header_info.h".

This lists how tables are collected into associated groups in SDS and *.h files.

The tables and views in this group are:

- header_groups
- header_tables

Group *html*

The C header file is "gddb/html.h".

This group contains some information for generating HTML documentation from the database.

The tables and views in this group are:

- htmldoclines

Group *installation*

The C header file is "gddb/installation.h".

Information for installation of magnets etc.

The tables and views in this group are:

- installation

Group *madc_channel*

The C header file is "gddb/madc_channel.h".

descibes which signal goes into which madc channel

The tables and views in this group are:

- madc_channel

Group *magfield*

The C header file is "gddb/magfield.h".

Shortened views to get magnet field vs current info.

The tables and views in this group are:

- magfield
- magquick
- ufoil

Group *magnet_info*

The C header file is "gddb/magnet_info.h".

Magnet information for installation.

The tables and views in this group are:

- magnet_data
- magnet_slot

Group *picture_info*

The C header file is "gddb/picture_info.h".

Information for drawing pictures of the beamlines.

The tables and views in this group are:

- generic_size
- otherelement
- pi_NameL

Group *ps_basic*

The C header file is "gddb/ps_basic.h".

Fundamental power supply definitions.

The tables and views in this group are:

- ps_data
- ps_limits
- ps_slot

Group *ps_ref*

The C header file is "gddb/ps_ref.h".

reference values for power supply information.

The tables and views in this group are:

- ps_ref

Group *ps_view*

The C header file is "gddb/ps_view.h".

A view to the power supply information.

The tables and views in this group are:

- ps_view

Group *real_dev*

The C header file is "gddb/real_dev.h".

Info for specific instances of devices related to the generic device descriptions and wireup.

The tables and views in this group are:

- PS_Mag_Wireup
- RealContains
- RealDevices

Group *SWNdesc*

The C header file is "gddb/SWNdesc.h".

Description of the object of a SiteWideName

The tables and views in this group are:

- SWNdesc
- SWNtable

Group *table_desc*

The C header file is "gddb/table_desc.h".

A table for describing database tables.

The tables and views in this group are:

- table_desc

Group *tunnel_lines*

The C header file is "gddb/tunnel_lines.h".

tunnel walls, etc., for plot_atr

The tables and views in this group are:

- tunnel_arcs
- tunnel_lines

Table: *beam_init*

beam_init is not listed in the "table_desc" table.

- examine

Table: *bl_elts*

The table "bl_elts" is just a template for an SDS object for the output from the "bl" program. The column names are:

```
        name:           SiteWideName of element,
```

```
s:              s coordinate of element's downstream end,
s0:             s coordinate of element'ss upstream end,
mi_ind:         pointer into bl_model_info SDS object,
e_ind:          pointer into element object of lattice file,
l_ind:          pointer into lattice object of lattice file,
type:           type of element from $LAMBDA/include/lattice_d
NLtype:         type of element from $HORST/include/names_devi
NL_ind:         index into NameLookup file.
```

Note that the type and NL_type for a given element may indicate different element types, for example: The vertical trim magnet "utv1" has

```
type = ATTR_SBEND, and
NLtype = IS_V_STEER.
```

This is because in the lattice definition, "utv1" has a non-zero design value in order to aim the survey coordinates correctly from the AGS to RHIC.

- examine

Table: *bl_football*

The table "bl_football" is just a template for an SDS object for the o from the "bl" program. The column names are pretty self-descriptive of the 21 unique elements of the beam hyperellipsoid matrix. The 15 e of the lower triangle are not included, since the matrix is symmetric.

- examine

Table: *bl_lattices*

The table "bl_lattices" contains information for constructing a lattic model for the "bl" program from various lattice and Namespace SDS file (usually from the Holy_Lattice area). A "model" is a particular group of beamline elements to be appended in a prescribed order. A given mo may have multiple entry lines, given with a monotonically increasing "sequence" number. The columns are used as follows:

```
model:          model name for a particular part of the
                lattices of various machines or beam lines
                to be concatenated together,
sequence:       a monotonic entry number for this model,
holy:           flag for location of source of this segment
                of the model (=0 for current path, =1 for
```

	Holy_Lattice, =2 for a tcelemnt from the tcelement table.),
lattice:	file name of the lattice SDS file or a tceleme name,
Namespace:	file name of the Namespace file or blank for a tcelement,
first:	SiteWideName of first element to use or blank if from the beginning or end of the file,
last:	SiteWideName of last element to use or blank if from the beginning or end of the file,
direction:	=1 for forward ordering of this segment or =-1 to reverse the order.

- examine

Table: *bl_model_names*

The table "bl_model_names" is just a template for an SDS object for th output from the "bl" program. The column names are:

model_name:	name of the model used from the "bl_lattices"
scheme_name:	name of the scheme.
db_name:	name of the database containing the "blinit" g

- examine

Table: *bl_monitors*

The table "bl_monitors" lists beamline elements where output from the "bl" program should be produced. There can be several schemes of moni and tweakable elements for a given model. The columns are as follows:

model:	model name of a model defined in "bl_lattices"
scheme:	a key to a group of tweakable elements within model,
monitor:	SiteWideName of an element used as a monitor.

- examine

Table: *bl_orbit*

The table "bl_orbit" is just a template for an SDS object for the output from the "bl" program. The column names are:

x:	x of trajectory calculated at element,

```
xp:     x' of trajectory calculated at element,
y:      y of trajectory calculated at element,
yp:     y' of trajectory calculated at element,
z:      z of trajectory calculated at element,
u:      dp/p of trajectory calculated at element.
```

- examine

Table: *bl_tweaks*

The table "bl_tweaks" lists beamline elements that can be tweaked with a model. There can be several schemes of tweakable elements and monit for a given model. The columns are as follows:

```
model:          model name of a model defined in "bl_lattices"
scheme:         a key to a group of tweakable elements within
                model,
element:        a SiteWideName of an element which can be twea
```

- examine

Table: *bl_twiss*

The table "bl_twiss" is just a template for an SDS object for the outp from the "bl" program. The column names are pretty self-descriptive of Twiss and dispersion functions, as well as phase advances.

- examine

Table: *blm_avg*

The table "blm_avg" lists the average sensitivity and slope for each BLM signal line. These are averaged over all the cans connected to the signal line. The columns are as follows:

```
signal:         SiteWideName of the BLM signal.
sensitivity:    sensitivity [pA/R/Hr] at 1400V averaged over a
                 attached to this signal line.
sigma:          standard deviation of the sensitivity averaged
                 all cans attached to this signal line.  Here
                 sigma = sqrt[ (<x**2>-<x>**2) * n/(n-1) ].
slope:          slope of sensitivity with voltage [pA/R/hr/kV]
```

```
                    at 1400V averaged over all cans attached to t
                    line.
```

- examine

Table: *blm_HV*

The table "blm_HV" keeps track of how the high voltage is wired for the BLM cans. The columns are as follows:

```
HV:     High voltage line.
can:    SiteWideName of a can connected to this high voltage 1
```

- examine

Table: *blm_serial*

The table "blmser" links the SerialName from the "atr_cal" database table "blm_calib" to a given site wide name location in the tunnel. The columns are as follows:

```
can:            SiteWideName of the BLM can location in the tu
                These column entries match "can" entries in th
                tables "blm_HV" and "blm_wire", as well as the
                "SiteWideName" column of the table "othereleme
SerialName:     Serial name of the BLM can from the "atr_cal"
                database.
```

- examine

Table: *blm_wire*

The table "blm_wire" links the BLM signal lines to individual ionization chambers (cans). The columns are as follows:

```
signal: SiteWideName of the signal line.
can:    SiteWideName of the ionization chamber.
```

- examine

Table: *BodyHarm*

The table "BodyHarm" contains magnet measurment data from the Magnet Division for magnets in the ATR. The date is from the short coils for fields in the body of the magnet (no end effects). This table is identical in from to the "BodyHarm" table for the cryogenic RHIC magnets. The columns are as follows (some descriptions are incomplete):

Magnet:	Id of magnet.
ColdMass:	
RunNum:	Data run number for measurements.
TestDate:	Date of measurments.
MeasCoil:	probe Id.
Element:	
RefRadius:	reference radius for multipoles.
Analysis:	
Currnt:	current in amperes.
UpDown:	direction of ramp.
WarmCold:	warm for all ATR magnets.
a0-&>;a10:	skew multipoles.
b0-&>;b10:	normal nultipoles.
TransFunc:	transfer function B/I? for dipoles and G/I? fo
FieldAngle:	
FldAngVar:	
FldAngSTD:	
Notes:	
LoginName:	
ModDateTime:	

- examine

Table: *bpm_orientation*

The table "bpm_orientation" has information about how a particular bpm has been installed. The columns are:

SerialName:	serial name of the bpm
top:	port in the top position
left:	port in the left position (beam's eye)
bottom:	port in the bottom position
right:	port in the right position (beam's eye)

- examine

Table: *Connectable*

Connectable is not listed in the "table_desc" table.

- examine

Table: *Connects*

Connects is not listed in the "table_desc" table.

- examine

Table: *ConnectType*

ConnectType is not listed in the "table_desc" table.

- examine

Table: *Contains*

Contains is not listed in the "table_desc" table.

- examine

Table: *Device*

Device is not listed in the "table_desc" table.

- examine

Table: *DeviceType*

DeviceType is not listed in the "table_desc" table.

- examine

Table: *fid_offsets*

The "fid_offsets" table contains a list of fiducials and their offsets relative to the element center for a given element or type of elements

The columns are as follows:

ftname:	name of group of fiducial offsets which links back to SerialName in the "magnet_data" table,
fidname:	name of fiducial to be combined with a SurveyName to generate a specific fiducial survey name as used by th Survey and Alignment Group,
dx:	horizontal transverse offset of the fiducial,
dy:	vertical offset,
dz:	longitudinal offset.

- examine

Table: *generic_bpm_info*

The table "generic_bpm_info" contains some generic information about bpm types. Its columns are:

GenericName:	the generic name of a bpm,
nplanes:	how many active planes in the design,
id:	inner diameter in meters.

- examine

Table: *generic_size*

The table "generic_size" provides a set of outline dimensions for disp elements along the beamline. Its columns are:

GenericName:	GenericName of element
xoff:	transverse horizontal offset of center
yoff:	vertical offset of center
zoff:	longitudinal offset of center
dx:	width of element
dy:	height of element
dz:	length of element
pen:	pen number for drawing pictures

Here the element is assumed to be a rectangular box.

- examine

Table: *header_groups*

The "header_groups" and "header_tables" tables define groups of tables

for use with the dbapplications tools. The entries in the "header_gro
table are:

groupname:	the name of a group of related tables,
filename:	filespecs for writting a C header file with the utility "db2gh",
comment:	a short description of the group (255 chars or less).

Type "man dbgroups" from owl.rhic.bnl.gov for more information.

- examine

Table: *header_tables*

The "header_groups" and "header_tables" tables define groups of tables for use with the dbapplications tools. The entries in the "header_tab
table are:

groupname:	the name of a group of related tables,
sequence:	a number for ordering the tables within a grou This must be unique for tables within a partic group. The order should be such that tables c be written without causing trigger problems.
tablename:	the name of a table within the group.
dbname:	the name of the database in which to find the table. At present this should be just the (de current database.
host:	This is for future expansion with different se
prefix:	a prefix to be added to the SDS structure name when there may be a conflict with other tables from other databases.

Type "man dbgroups" from owl.rhic.bnl.gov for more information.

- examine

Table: *htmldoclines*

The table "htmldoclines" contains some lines to be included in the HTM documentation output by the "describe_doc_html" stored procedure. The columns are as follows:

ind:	an index name for a part of the file. At pres only "head", "begin", "end" will be used for the section, beginning of section, and end of the section, respectively.

```
sequence:      a sequence order for lines within an index sec
line:          the text to be output.
```

- examine

Table: *installation*

The "installation" table contains information about installation of co in the tunnel. The structure of this table changes from time to time work is done. Currently the columns are as follows (I hope.):

```
name:          SiteWideName of component,
fids_defined:  Fiducials have been defined for the surveyors.
In_Tunnel:     The component is located on its stand within
               the tunnel.
Surveyed:      The component has been surveyed, if necessary.
Bussed:        Major power bussing for magnets has been compl
               in the tunnel.
Vacuum:        The beampipe has been pumped down for this com
Water:         The water connections have been made for this
               component.
ctrl_wires:    Other control/sensor wires have been connected
               the component.
SA_test:       Have stand alone tests been completed.
```

This table is updated every few days, so some things may not be quite date.

- examine

Table: *Integral*

The table "Integral" contains magnet measurment data from the Magnet Division for magnets in the ATR. The date is from the long probe coils for fields including the ends of the magnets. This table is identical in from to the "Integral" table for the cryogenic RHIC magnets. The columns are as follows (some descriptions are incomplete):

```
Magnet:        Id of magnet.
ColdMass:
BNLorVend:
RunNum:        Data run number for measurements.
TestDate:      Date of measurments.
MeasCoil:      probe Id.
Element:
RefRadius:     reference radius for multipoles.
```

```
Analysis:
Currnt:          current in amperes.
UpDown:          direction of ramp.
WarmCold:        warm for all ATR magnets.
a0-&>;a10:       skew multipoles.
b0-&>;b10:       normal nultipoles.
TransFunc:       transfer function Bl/I for dipoles and Gl/I fo
FieldAngle:
Notes:
LoginName:
ModDateTime:
```

- examine

Table: *madc_channel*

madc_channel is not listed in the "table_desc" table.

- examine

Table: *magnet_data*

The "magnet_data" table contains information specific to an actual ser number of an element. These entries are joined to the "magnet_slot" t through the SerialName column. The columns are as follows:

```
SerialName:         actual serial name of a particular device,
ftname:             link into "fid_offsets" table for generating
                    fiducials relative to the IP coordinates,
FieldName:          link into a the "magnet_field" table for trans
                    function information of a particular kind of m
long_corr:          a longitudinal correction which allows for a s
                    misalignment of the fiducial template used in
                    construction of some dipole magnets,
top_halfcore:       serial name of the top halfcore of a dipole ma
bottom_halfcore:    serial name of the bottom halfcore of a dipole
```

- examine

Table: *magnet_field*

The table "magnet_field" contains transfer function information for the the various types of magnets in the ATR lines. The columns are as follows:

```
FieldName:      key to select a given type of magnet data
sequence:       sequence number for data
I:              current in amperes
Transfunc:      Bl/I for dipoles, Gl/I for quads
RefRadius:      reference radius for multipole components (in :
UpDown:         direction of ramp
                        =0 for simulation,
                        =+1 for up,
                        =-1 for down
b0:             Normal dipole multipole (=1 for dipoles, =0 fo
b1:             Normal quadrupole multipole (=1 for quads)
b2:             Normal sextupole component
b3:             Normal octopole component
b4:             Normal decupole component
b5:             Normal 12-pole component
a0:             Skew dipole component
a1:             Skew quadrupole multipole (=1 for quads)
a2:             Skew sextupole component
a3:             Skew octopole component
a4:             Skew decupole component
a5:             Skew 12-pole component
```

- examine

Table: *magnet_field_bak*

magnet_field_bak is not listed in the "table_desc" table.

- examine

Table: *magnet_slot*

```
The "magnet_slot" table contains information for individual beamline l
of elements, such as magnets, flags, bpm's, etc.  It does not contain
tion on vacuum components.  The colums are as follows:

   SiteWideName:        SiteWideName of the element,
   GenericName:         GenericName of the element, such as a model na
   SerialName:          Actual serial id of what element is installed,
   Orientation:         This specifies the direction of installation o
                        element: +1 for forward, -1 for reversed.  The
                        elements currently reversed are some dipoles.
   sag_correction:      A transverse offset of magnet's center from de
                        trajectory to account for bending angles.
   IP_fixed:            A flag for indicating that the IP has been def
```

- examine

Table: *movableBLM*

The table "movableBLM" contains a list of BLM can names which are considered movable and can be moved via the worldwideweb form. The columns are as follows:

```
SiteWideName:    SiteWideName of the BLM can.
```

- examine

Table: *NameLookup*

The "NameLookup" table lists the elements ATR lattice designs and associates disparate but equivalent names for each of these elements. This is a combination of the Holy_Lattice Namespace files:

```
$HOLY_LATTICE/YTransfer/Namespace  and
$HOLY_LATTICE/BTransfer/Namespace
```

The C-header file $HORST/include/gddb/db_NameLookup.h describes the SDS version of this table as dumped to

```
$HOLY_LATTICE/ATR_common/db_NameLookup.sds
```

The function db_NameLookup_in_sds() reads builds an SDS object from the SDS file. The columns are:

```
lattice_index:   a pointer into the lattice object of the SDS f
atom_index:      a pointer into the Twiss and Survey files
fid_index:       not used for ATR data
network_index:   not used at present
type:            an integer device type code as defined by the
                 $HORST/include/names_devicetypes.h
orientation:     +/-1 indicating direction of installation in t
Machine:         ="ATR" for the ATR.
InOut:           not used for ATR.
Section:         ='U', 'W;, 'X', or 'Y' for the corresponding b
DeviceName:      mnemonic for type of device (see below).
DevNo:           a sequence number for devices within a beamlin
SiteWideName:    the SiteWideName (see below).
SurveyName:      a corresponding name for the surveyors.
SerialName:      serial name of installed component.
LatticeName:     name used in the lattice description.
```

GenericName:	a model name for the device.
CoordinateType:	specifier for the type of coordinates
Scoord:	"s"-coordinate along the beam line of center o device, generally in the center of the element
Sequiv:	same as Scoord for the ATR.
Ncoord:	RHIC N (north) coordinate.
Wcoord:	RHIC W (height) coordinate.
Ecoord:	RHIC E (east) coordinate.
theta:	azimuthal direction of beam relative to the E-
phi:	vertical pitch angle of beam.
psi:	roll angle about the beam.

- mnemonic list from "common_gddb..DevMnemonic" table.
- SiteWideName description.

- examine

Table: *nominal_bends*

The table "nominal_bends" contains the nominal bend angle for bend mag such as dipoles, pitches, lambertsons, and the switch magnet. Its col

SiteWideName:	Site wide name of the element
InOut:	This is blank for the ATR
Section:	Beamline name in upper case ('U', 'W', 'X' or
Machine:	='ATR'
angle:	the bend angle in radians

Note that InOut and Machine are in this table for compatability with t RHIC rings. (SiteWideName, InOut, Section, Machine) form a primary ke the NameLookup table if everything gets lumped into a single table in future.

- examine

Table: *otherelement*

The table "otherelement" contains information about tunnel elements which are not listed in the "NameLookup" table. At present, this includes vacuum components, BLM's, and the beam dump. The columns are as follows:

SiteWideName:	SiteWideName of the element.
GenericName:	generic model name of the element.
ds:	downstream distance (s) from middle of beam li element "dsof" (negative values are upstream).
dsof:	SiteWideName of an reference element for deter

	of 3d coordinates.
dx:	horizontal transverse displacement of element design trajectory.
dy:	vertical displacement of element from design t

- examine

Table: *ps_data*

The table "ps_data" contains a description of actual power supplies. The columns are as follows:

psserial:	serial name for the actual power supply in thi
model:	model name of the type of power supply,
V_rating:	maximum operating voltage,
I_rating:	maximum current,
polarity:	polarity information,
Int_card:	type of integration card (digital/analog),
regulation:	fractional regulation level.

- examine

Table: *ps_estimate*

The values in the "ps_estimate" table are estimates of what the actual operating currents might be. They were used in calculating power requ for the ATR. The columns are as follows:

SiteWideName:	site wide name of the power supply,
Vdc:	estimated operating voltage,
Idc:	estimated operating current.

Clearly, the trim magnet values should be much less on average.

- examine

Table: *ps_installation*

The table "ps_installation" tracks installation of magnet power suppli for the ATR. Most entries are 0 for incomplete, or 1 for completed. At present the columns are:

name:	SiteWideName of the power supply,
finished:	construction complete,

in_house:	moved into house,
bussed:	power bus connections made,
water:	water connections made, if any,
dac:	dac installed.

- examine

Table: *ps_limits*

The table "ps_limits" contains other operational limits for the magnet power supplies. The rows are as follows:

SiteWideName:	site wide name of the power supply,
Max_I_safety:	a current limit for safety considerations (suc for keeping the coils from overheating, or for radiation considerations),
Min_I_safety:	a minimum limit for safety considerations. Th current should stay between the "Max_I_safety" and "Min_I_safety" values for safe operation.
Max_I_advice:	an advisory limit for maximum current,
Min_I_advice:	an advisory limit for minimum current,

- examine

Table: *PS_Mag_Wireup*

PS_Mag_Wireup is not listed in the "table_desc" table.

- examine

Table: *ps_ref*

ps_ref is not listed in the "table_desc" table.

- examine

Table: *ps_slot*

The table "ps_slot" contain a list of magnet power supplies for the AT

psserial:	serial name for the actual power supply in thi

```
SiteWideName:   site wide name for a power supply slot,
house:          location of the power supply slot.
```

- examine

Table: *quad_transf*

The table "quad_transf" is under development

- examine

Table: *RealContains*

RealContains is not listed in the "table_desc" table.

- examine

Table: *RealDevices*

RealDevices is not listed in the "table_desc" table.

- examine

Table: *Spigot*

Spigot is not listed in the "table_desc" table.

- examine

Table: *SpigotOwn*

SpigotOwn is not listed in the "table_desc" table.

- examine

Table: *SWNameAdo*

The table "SWNameAdo" lists ADO's which are associated with a particul

```
SiteWideName.  The columns are:

        SiteWideName:    Site wide name of a particular device/element,
        ADOName:         Name of a particular ADO instance.
```

- examine

Table: *SWNameAdo_bak*

SWNameAdo_bak is not listed in the "table_desc" table.

- examine

Table: *SWNdesc*

The table "SWNdesc" has quick descriptions (up to 80 chars) of various things which have SiteWideName's. The columns are as follows:

```
SiteWideName:    SiteWideName of the thing.
type:            type of SiteWideName keys into "SWNtable"
comment:         The definition or description.
```

- examine

Table: *SWNtable*

The table "SWNtable" connects a SiteWIdeName listed in the table "SWNdesc" through "SWNdesc.type" to the appropriate table where more information may be found. The columns are as follows:

```
type:            type of SiteWideName keys into "SWNtable"
tablename:       name of table to look for information.
```

- examine

Table: *table_desc*

```
This table gives comment lines for describing the various tables in th
database.  It has the following three columns:
   name:  the name of a table in the database,
   num:   an ordered line sequence number for the comment
   line:  the actual comment line (up to 80 characters).
The combination of (name, num) form a unique clustered index.
```

- examine

Table: *tcelement*

```
The table "tcelement" contains information about trajectorily challeng
elements.  This table may eventually be moved into the optics database
"atr" for the ATR.  It is in a prototype stage to replace some old opt
tables which point to SDS files in the Holy_Lattice directory.  The ta
contains coefficients of Taylor series up to 6th order.  The columns a

        tcename:        a name of a tcelement,
        ind0:           0th order index,
        ind1:           1st order index,
        ind2:           2nd order index,
        ind3:           3rd order index,
        ind4:           4th order index,
        ind5:           5th order index,
        ind6:           6th order index,
        value:          value of coefficient.

Only nonzero coefficients need to be specified. Currently indices run
0 to 5 for nonzero values.  An entry of 255 (tinyint) should be used f
indices higher than needed for a particular coefficient.
```

- examine

Table: *tunnel_arcs*

The table "tunnel_arcs" contains some drawing information for the "plot_atr" program. Each row contains the 2-D information for drawing an arc in the "D" projection. The columns are as follows:

```
        x0:     The "E" coordinate of the center of curvature.
        y0:     The "N" coordinate of the center of curvature.
        r:      The radius of the arc
        theta0: The angle of the beginning endpoint.
        theta1: The angle of the final endpoint.
```

Note that theta0 and theta1 are measured in degrees counterclockwise from the parallel to the E-axis.

- examine

Table: *tunnel_arcs_bak*

tunnel_arcs_bak is not listed in the "table_desc" table.

- examine

Table: *tunnel_lines*

The table "tunnel_lines" contains some drawing information for the "plot_atr" program. Each row contains the 2-D endpoints of a line segment to be plotted in the "D" projection. The columns are as follows:

```
x0:     The "E" coordinate of the first endpoint.
y0:     The "N" coordinate of the first endpoint.
x1:     The "E" coordinate of the second endpoint.
y1:     The "N" coordinate of the second endpoint.
```

- examine

Table: *tunnel_lines_bak*

tunnel_lines_bak is not listed in the "table_desc" table.

- examine

View: *bl_model_info*

The view "bl_model_info" is just a template for an SDS object for the output from the "bl" program. The output just mirrors the information of the model from the "bl_lattices" table. The column names are:

```
holy:             flag for location of source of this segment
                  of the model (=0 for current path, =1 for
                  Holy_Lattice, =2 for a tcelemnt from the
                  tcelement table.),
lattice:          file name of the lattice SDS file or a tceleme
                  name,
```

```
Namespace:      file name of the Namespace file or blank for
                a tcelement,
first:          SiteWideName of first element to use or blank
                if from the beginning or end of the file,
last:           SiteWideName of last element to use or blank
                if from the beginning or end of the file,
direction:      =1 for forward ordering of this segment or
                =-1 to reverse the order.
```

- examine

View: *halfcores*

The view "halfcores" provides a list of serial names for the halfcores in ATR dipoles. Its columns are:

```
SiteWideName:         SiteWideName of dipole,
SerialName:           SerialName of installed dipole,
top_halfcore:         serial name of top halfcore,
bottome_halfcore:     serial name of bottom halfcore.
```

- examine

View: *MAD_type*

The view "MAD_type" is an example of a view from tables in two differe databases: "NameLookup" from the "atr_gddb" database and "magnet_piece from the "atr" lattice optics definition database. The columns are:

```
SiteWideName:   SiteWideName of the element from "NameLookup"
type:           the name of an element type used by the "MAD"
                 program
```

The SQL create statement for this view was:

```
create view MAD_type as
   select SiteWideName, atr..magnet_piece.type
     from NameLookup, atr..magnet_piece
     where LatticeName=atr..magnet_piece.name
```

- examine

View: *magfield*

The view "magfield" is a view of relevant pieces of the "magnet_field" table. The columns are as follows:

FieldName:	key to select a given type of magnet data
sequence:	sequence number for data
UpDown:	direction of ramp =0 for simulation, =+1 for up, =-1 for down
RefRadius:	reference radius for multipole components (in :
I:	current in amperes
Transfunc:	Bl/I for dipoles, Gl/I for quads
b0:	Normal dipole multipole (=1 for dipoles, =0 fo
b1:	Normal quadrupole multipole (=1 for quads)

- examine

View: *magnet_survey*

The view "magnet_survey" is a view of selected columns from the tables "magnet_slot" and "magnet_data". This view is used by the program "atrfid" to generate survey fiducials for the beamline elements. Its columns are as follows:

SiteWideName:	SiteWideName of the element,
ftname:	link into "fid_offsets" table,
Orientation:	flag for reversed dipole stands,
long_corr:	a longitudinal correction which allows for a s misalignment of the fiducial template used in construction of some dipole magnets,
IP_fixed:	A flag for indicating that the IP has been def

- examine

View: *magquick*

The view "magquick" links the SiteWideName to lattice_index and FieldName for magnets in the ATR. The columns are as follows:

SiteWideName:	SiteWideName of the magnet from NameLookup.
lattice_index:	Pointer into the Holy_Lattice flat SDS file.
FieldName:	Key into the "magquick" view for the transfer function of the magnet.
Scoord:	The s-coordinate from the beginning of the U-1

- examine

View: *names*

The view "names" gives a subset of columns from the "NameLookup" table with easier names to type. The columns are:

n:	SiteWideName of element,
s:	the Scoord of the element,
lat:	LatticeName of the element,
gen:	GenericName of the element,
survey:	SurveyName of the element,
dev:	DeviceName of the element,
devno:	DevNo of the element.

- examine

View: *pi_NameL*

The view "pi_NameL" is a narrower view of "NameLookup" with a little b the "magnet_slot" table. The columns are:

SiteWideName:	SiteWideName of element.
Section:	section name (beam line) of element.
GenericName:	generic name of the element.
orientation:	the orientation: forward (+1) or reversed (-1)
CoordinateType:	the type of coordinates (IP, Mech ctr, Traj ct
Scoord:	the position along the beamline.
Ncoord:	the N (~north) coord.
Wcoord:	the W (height) coord.
Ecoord:	the E (~east) coord.
theta:	the azimuthal angle.
phi:	the pitch angle.
psi	the roll angle.
sag_corr:	a shift of the element center from the given c (This is primarily for dipoles.)

- examine

View: *ps_view*

The view "ps_view" is a useful combination of information from the "ps_basic" group of tables. The rows are as follows:

SiteWideName:	site wide name of the power supply,
psserial:	serial name for the actual power supply in thi
polarity:	polarity information,
V_rating:	maximum operating voltage,
I_rating:	maximum current,

```
Max_I_safety:     a current limit for safety considerations (suc
                  for keeping keeping the coils from overheating
                  for radiation considerations.),
Min_I_safety:     a minimum limit for safety considerations.  Th
                  current should stay between the "Max_I_safety"
                  and "Min_I_safety" values for safe operation.
Max_I_advice:     an advisory limit for maximum current,
Min_I_advice:     an advisory limit for minimum current,
Int_card:         type of integration card (digital/analog),
regulation:       fractional regulation level.
```

- examine

View: *ufoil*

The view "ufoil" contains the s-coordinate location of the stripping foil relative to the beginning of the U-line. It has one entry:

```
Scoord:           the s-coordinate from the beginning of the U-l
```

- examine

Procedure: *dbg2sds_all*

The procedure "dbg2sds_all" generates a separate line with a dbg2sds command for each group in the atr_gddb database. The output from this procedure may be piped into a shell to generate SDS files for all groups in this database.

Procedure: *describe*

The stored procedure "describe" reads a description from the "table_de table for a database object if the description exists. Its use is as

```
describe $name
```

where $name is a database object from the sysobjects table.

Procedure: *fill_blm_avg*

The procedure "fill_blm_avg" truncates the table "blm_avg" and regenerates the averages of sensitivties and slopes for the BLM cans on each signal line. The callibration data is from the "atr_cal..blm_calib" table, and table joins are made to the signal via data stored in the "atr_gddb..blm_wire" and "atr_gddb..blm_serial" tables.

Procedure: *html_describe_doc*

The procedure "html_describe_doc" generates documentation in an HTML f

Procedure: *html_get_doclines*

The procedure "html_get_doclines" selects lines of HTML code from the "htmldoclines" table for a given "ind" value. It takes as a single argument, the "ind" value as search key.

Procedure: *html_group_list*

The procedure "html_group_list" lists (in an HTML format) the groups o tables and views defined by the "header_info" group.

Procedure: *html_gt_list*

The procedure "html_gt_list" generates a series of lists (in HTML form of tables and views in all the groups.

Procedure: *html_list_anchor*

The stored procedure "html_list_anchor" generates a listed HTML anchor reference. Its syntax is
        htmlanchor
where is the name of the anchor to reference, and
 is the text to be displayed.

Procedure: *html_p_list*

The procedure "html_p_list" generates a description in HTML format for eadh procedure using data in the "table_desc" table.

Procedure: *html_procedure_list*

The procedure "html_procedure_list" generates a list (in HTML format) of all procedures.

Procedure: *html_t_list*

The procedure "html_t_list" generates a description in HTML format for eadh table and view using data in the "table_desc" table.

Procedure: *html_table_describe*

The stored procedure "html_table_describe" reads a description from th table for a database object if the description exists. Its use is as

```
html_table_describe $name
```

where $name is a database object from the sysobjects table.

Procedure: *html_ungrouped_list*

The procedure "html_ungrouped_list" generates a list (in HTML format) of all tables and views not in a group.

Procedure: *initserial*

The procedure "initserial" updates the "magnet_slot" and "magnet_data" tables by changing the SerialName entries in both tables to a new valu will only do this if the initial value of the SerialName looks like a SiteWideName (ie., if it begins with a lower case 'u', 'w', 'x', or 'y The syntax is:

```
initserial $SWN, $newSN
```

where $SWN is the SiteWideName of the element, and $newSN is the new S

Procedure: *installed*

The stored procedure "installed" gets installation information about t from the "installation" and "magnet_slot" tables in the atr_gddb datab Its use is as follows:

```
installed $pat
```

where $pat is an SQL string matching pattern for a SiteWideName.

The returned columns indicate the following:

name: SiteWideName of the element

IP:	= 1 if an IP has been defined for this element = 0 if not
fids:	Have fiducials been defined for this element?
Tunnel:	Has the element been installed in the tunnel?
Surveyed:	Has the element been surveyed?
Bussed:	Has the main power bus been connected to this magnet.
ctl_wires:	Have the other wires been connected to this de
Vacuum:	Has the vacuum system been pumped down and lea checked for this device?
Water:	Have the cooling water connections been comple
SA_test:	Has the stand alone test been completed for th device?

- execute

Procedure: *set_ps_limits*

The procedure "set_ps_limits" is a temporary procedure which was used to set up some quasi-almost-questionably reasonable (maybe/maybe not) values in the "ps_limits" table. This will most likely be deleted in the future.

Procedure: *undocumented*

The procedure "undocumented" lists tables, views, and procedures which which have not been entered into the "table_desc" table.

Procedure: *what*

The stored procedure "what" finds and gives some information about obj (tables, views, rules, etc.) and/or columns by matching a patern to en in the system tables for the atr_gddb database. The system stored pro "sp_help" and "sp_helptext" can be quite useful for finding out about objects listed in the "sysobjects" table. The usage for "what" is:

```
what $pat
```

where $pat is an SQL pattern for matching a string.

Procedure: *whatsit*

The procedure "whatsit" gives the column names, and types for table/vi which match a pattern. The usage is

```
whatsit $pat
```

where $pat is a table/view name or an SQL pattern.

About this document:

The actual HTML code is written by the SYBASE server when this page is invoked, so things should be reasonably up to date, with the exception of some of the structure definitions of tables under development. Each of the tables and views has an **examine** link, which may be used to view the data currently stored in the database table(s). (An actual database querry is sent when the **examine** link is invoked.

Tables and views are generally grouped into **groups** of related tables. A view is a kind of window which looks at selected data from various tables within the database. A view does not have any extra data, but may present data from various tables and other views in a different way. (Data from other databases may even be included in a view.) (return status = 0)

5.2 Calibration database, atr_cal

/www.rhichome.bnl.gov/cgi – bin/atr_cal_describe.sh

Document generation time: Oct 11 1995 4:14PM

Description of the "atr_cal" database.

This document shows what is currently in the database. (Some of the text descriptions of things may be old, if the the appropriate tables have not been updated.)

Quick index:

- Groups of tables and views
- Ungrouped tables and views
- Stored procedures

Groups of tables and views:

```
There are several useful tools for dealing with groups of tables.
(See the local UNIX man pages for "dbtools".)

Note to programmers:
Header files (for C and C++) can be found along the "$HORST/include" p
for most of these groups.  (The "header_info.h" file is located along
"$DBAPPLICATIONS/include" path.)  By including these paths in your
compilations, you should get the file (if it has been generated by "db
Functions for reading and writing SDS versions of the groups are locat
in "$HORST/lib/$ARCH/libgddb.a".
```

- header_info
- html
- table_desc

Ungrouped tables and views:

- blm_calib
- BodyHarm
- Integral
- magnames

Stored procedures:

- html_describe_doc
- html_get_doclines
- html_group_list
- html_gt_list
- html_list_anchor
- html_p_list
- html_procedure_list
- html_t_list
- html_table_describe
- html_ungrouped_list
- undocumented
- what
- whatsit

Group *header_info*

The C header file is "Dbapps/header_info.h".

This lists how tables are collected into associated groups in *.h files.

The tables and views in this group are:

- header_groups
- header_tables

Group *html*

The C header file is "gddb/html.h".

This group contains some information for generating HTML documentation from the database.

The tables and views in this group are:

- htmldoclines

Group *table_desc*

The C header file is "gddb/table_desc.h".

A table for describing database tables.

The tables and views in this group are:

- table_desc

Table: *blm_calib*

The table "blm_calib" contains calibration information for the BLM ionization chambers. The columns are as follows:

```
SerialName:     The serial name of the can.
calib-date:     The date of calibration (ignore time).
sensitivity:    Measured sensitivity in [pA/R/hr] at a positiv
                bias of 1400V.
slope:          Measured slope in [pA/R/hr/V] at a positive bi
                of 1400V.
comment:        Up to 80 characters of comments.
```

- examine

Table: *BodyHarm*

The table "BodyHarm" contains magnet measurment data from the Magnet Division for magnets in the ATR. The date is from the short coils for fields in the body of the magnet (no end effects). This table is identical in from to the "BodyHarm" table for the cryogenic RHIC magnets. The columns are as follows (some descriptions are incomplete):

```
Magnet:         Id of magnet.
ColdMass:
RunNum:         Data run number for measurements.
TestDate:       Date of measurments.
MeasCoil:       probe Id.
Element:
RefRadius:      reference radius for multipoles.
Analysis:
Currnt:         current in amperes.
UpDown:         direction of ramp.
```

WarmCold:	warm for all ATR magnets.
a0-&>;a10:	skew multipoles.
b0-&>;b10:	normal nultipoles.
TransFunc:	transfer function B/I? for dipoles and G/I? fo
FieldAngle:	
FldAngVar:	
FldAngSTD:	
Notes:	
LoginName:	
ModDateTime:	

- examine

Table: *header_groups*

The "header_groups" and "header_tables" tables define groups of tables for use with the dbapplications tools. The entries in the "header_gro table are:

groupname:	the name of a group of related tables,
filename:	filespecs for writting a C header file with the utility "db2gh",
comment:	a short description of the group (255 chars or less).

Type "man dbgroups" from owl.rhic.bnl.gov for more information.

- examine

Table: *header_tables*

The "header_groups" and "header_tables" tables define groups of tables for use with the dbapplications tools. The entries in the "header_tab table are:

groupname:	the name of a group of related tables,
sequence:	a number for ordering the tables within a grou This must be unique for tables within a partic group. The order should be such that tables c be written without causing trigger problems.
tablename:	the name of a table within the group.
dbname:	the name of the database in which to find the table. At present this should be just the (de current database.
host:	This is for future expansion with different se
prefix:	a prefix to be added to the SDS structure name when there may be a conflict with other tables

from other databases.

Type "man dbgroups" from owl.rhic.bnl.gov for more information.

- examine

Table: *htmldoclines*

The table "htmldoclines" contains some lines to be included in the HTM documentation output by the "describe_doc_html" stored procedure. The columns are as follows:

ind:	an index name for a part of the file. At pres only "head", "begin", "end" will be used for the section, beginning of section, and end of the section, respectively.
sequence:	a sequence order for lines within an index sec
line:	the text to be output.

- examine

Table: *Integral*

The table "Integral" contains magnet measurment data from the Magnet Division for magnets in the ATR. The date is from the long probe coils for fields including the ends of the magnets. This table is identical in from to the "Integral" table for the cryogenic RHIC magnets. The columns are as follows (some descriptions are incomplete):

Magnet:	Id of magnet.
ColdMass:	
BNLorVend:	
RunNum:	Data run number for measurements.
TestDate:	Date of measurments.
MeasCoil:	probe Id.
Element:	
RefRadius:	reference radius for multipoles.
Analysis:	
Currnt:	current in amperes.
UpDown:	direction of ramp.
WarmCold:	warm for all ATR magnets.
a0-&>;a10:	skew multipoles.
b0-&>;b10:	normal nultipoles.
TransFunc:	transfer function Bl/I for dipoles and Gl/I fo
FieldAngle:	
Notes:	

```
LoginName:
ModDateTime:
```

- examine

Table: *magnames*

The table "magnames" gives a correspondence between the magnet measurements and actual serial names of magnets. The columns are as follows:

```
SerialName:     Serial name of magnet listed in atr_gddb..magn
Magnet:         The Magnet Division's name of the measured mag
```

Most of the dipoles were measured without vacuum chambers. After measurments these magnets were taken apart and reassembled with vacuum chambers. Not all magnets were measured.

- examine

Table: *table_desc*

The table "table_desc"gives comment lines for describing the various tables in the database. It has the following three columns:

```
name:   the name of a table in the database,
num:    an ordered line sequence number for the comment
line:   the actual comment line (up to 80 characters).
```

The combination of (name, num) form a unique clustered index.

- examine

Procedure: *html_describe_doc*

The procedure "html_describe_doc" generates documentation in an HTML f

Procedure: *html_get_doclines*

The procedure "html_get_doclines" selects lines of HTML code from the "htmldoclines" table for a given "ind" value. It takes as a single argument, the "ind" value as search key.

Procedure: *html_group_list*

The procedure "html_group_list" lists (in an HTML format) the groups o tables and views defined by the "header_info" group.

Procedure: *html_gt_list*

The procedure "html_gt_list" generates a series of lists (in HTML form of tables and views in all the groups.

Procedure: *html_list_anchor*

The stored procedure "html_list_anchor" generates a listed HTML anchor reference. Its syntax is

htmlanchor

where is the name of the anchor to reference, and
is the text to be displayed.

Procedure: *html_p_list*

The procedure "html_p_list" generates a description in HTML format for eadh procedure using data in the "table_desc" table.

Procedure: *html_procedure_list*

The procedure "html_procedure_list" generates a list (in HTML format) of all procedures.

Procedure: *html_t_list*

The procedure "html_t_list" generates a description in HTML format for eadh table and view using data in the "table_desc" table.

Procedure: *html_table_describe*

The stored procedure "html_table_describe" reads a description from th table for a database object if the description exists. Its use is as

```
html_table_describe $name
```

where $name is a database object from the sysobjects table.

Procedure: *html_ungrouped_list*

The procedure "html_ungrouped_list" generates a list (in HTML format) of all tables and views not in a group.

Procedure: *undocumented*

The procedure "undocumented" lists tables, views, and procedures which which have not been entered into the "table_desc" table.

Procedure: *what*

The stored procedure "what" finds and gives some information about obj (tables, views, rules, etc.) and/or columns by matching a patern to en in the system tables for the atr_gddb database. The system stored pro "sp_help" and "sp_helptext" can be quite useful for finding out about objects listed in the "sysobjects" table. The usage for "what" is:

```
what $pat
```

where $pat is an SQL pattern for matching a string.

Procedure: *whatsit*

The procedure "whatsit" gives the column names, and types for table/vi which match a pattern. The usage is

```
whatsit $pat
```

where $pat is a table/view name or an SQL pattern.

About this document:

The actual HTML code is written by the SYBASE server when this page is invoked, so things should be reasonably up to date, with the exception of some of the structure definitions of tables under development. Each of the tables and views has an **examine** link, which may be used to view the data currently stored in the database table(s). (An actual database querry is sent when the **examine** link is invoked.

Tables and views are generally grouped into **groups** of related tables. A view is a kind of window which looks at selected data from various tables within the database. A view does not have any extra data, but may present data from various tables and other views in a different way. (Data from other databases may even be included in a view.) (return status = 0)

Chapter 6

Safety

6.1 Safety features

/RHIC/ATR/safety/features.html

Last update: 26 June, 1995

Features of the ATR/RHIC safety system

Design and Implementation

- Redundant microswitches on access doors.
- Dual critical devices.
  - Reachback devices disabled if either critical device fails.
- Fail-safe design: fail into a safe state.
- PLC's monitoring system and controlling modes.
  - Two peer groups will be used this fall.
    - Peer 3 for zones: US, U, Wup, VT, VTP, V1, D6, and M.
    - Peer 5 for zones: Wdn, X, and Y.
    - Some elements are monitored by both Peers
      - Specifically WGS1 has four microswitches.
  - Two independently coded programs run in each peer group: either one may force a safer mode.
- The system will be tested with procedures to be approved by the RSC.

Restricted and Controlled Accesses

Only properly trained people will be allowed access to the ATR.

- Controlled access to a specific region:
  - Only one gate will be used for entrance and exit.
  - Simultaneous key and electrical strike release is required.
  - An operator will be stationed by the gate to allow only qualified people to enter.
- Restricted access to a specific region:
  - Special "0" keys similar but not identical to the "256" keys of the AGS will be used.
  - The rules for using these "0" keys similar to the 256 keys.

For detailed information about the system, contact Bob Frankel.

Mangled by Waldo MacKay (waldo@bnl.gov)

6.2 Radiation gates and zones

/RHIC/ATR/safety/gates.html

Radiation gate and zone locations.

Gate names

The names are made up of a beamline name, a two letter gate code, and a sequence number. The gate codes are defined as follows:

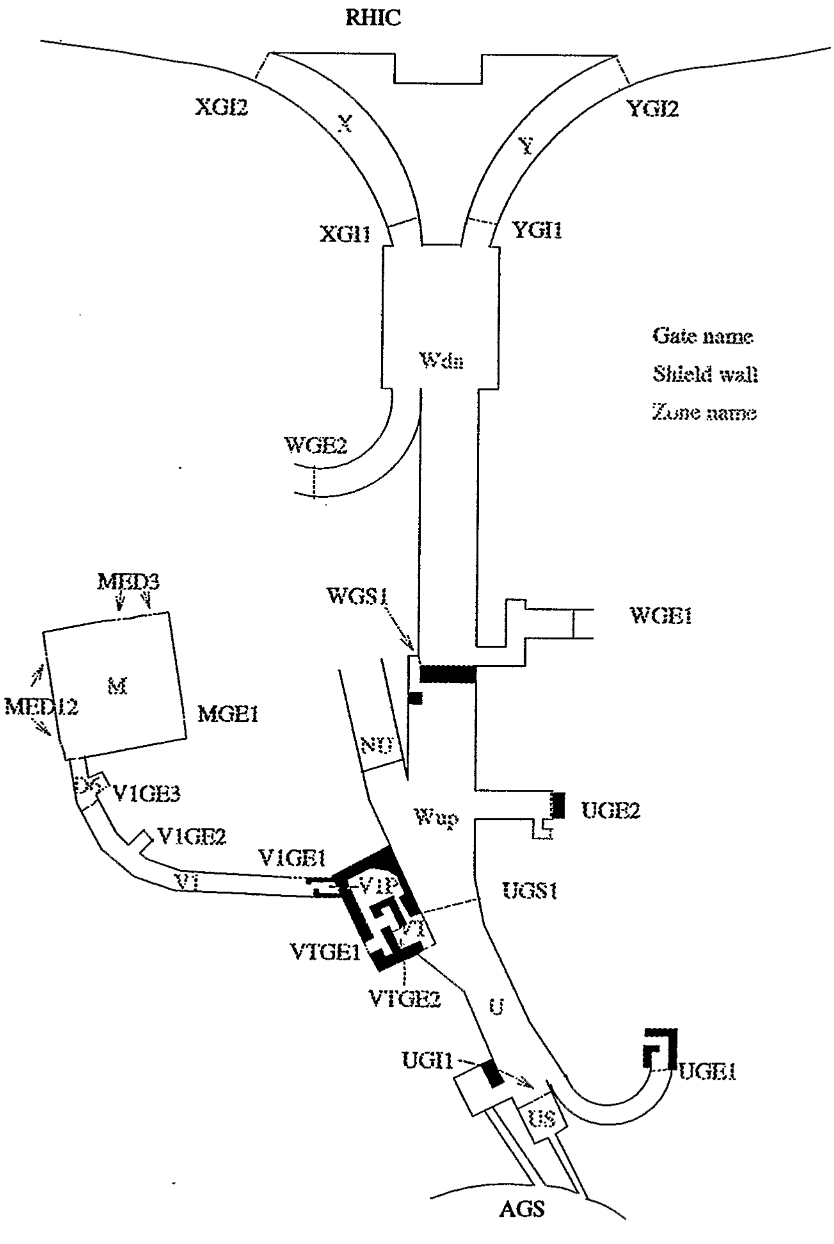
```
ED  Walkout emergency door
GS  Sectionalizing gate
GE  Entry gate
GI  Interlocking gate
```

Zone names

```
US  U-line stub tunnel
U   U-line downstream of stub tunnel
Wup W-line upstream of shield wall
Wdn W-line downstream of shield wall
X   X-line tunnel
Y   Y-line tunnel
VT  Inner g-2 target cave
V1P V1-line primary cave inside V-target blockhouse
V1  V1-line downstream of blockhouse
D6  V1D6 pit at end of V1 line
M   Muon storage ring
```

The gates UGI1 and UGS1 will not be necessary starting next fall, so they will not be interlocked. The zones Wup, U, and US will effectively be a single area as far as sweeps and access are concerned.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 24 June, 1995


RHIC
XGI2
X
Y
YGI2
XGI1
YGI1
Wdn
Gate name
Shield wall
Zone name
WGE2
MED3
WGS1
WGE1
M
MED12
MGE1
NU
V1GE3
Wup
UGE2
V1GE2
V1GE1
V1P
UGS1
V1
VTGE1
VTGE2
U
UGI1
UGE1
US
AGS

6.3 Radiation rate classifications

/RHIC/ATR/safety/radclasses.html

Radiation Security System Classification

General Guideline for AGS Radiation Security System Classification and Application

Allowable Radiation				Access		
Radiation Area Name	**AGS Class**	**Whole body absorbed dose rate or dose equivalent rate**	**30GeV Large Beam Fluence Rate [p/cm^2/hr]**	**Access when area is reset**	**Sweep/Reset Authority**	**Enclosures and Gates**
Very High Radiation	I	>500 rad/hr	>3.9x10^9	Absolute Prohibition	Operator or RSC designate	Impregnable enclosures, Interlocks
High Radiation	II	>50 rem/hr <500 rad/hr	>1.1x10^8 <3.9x10^9	Special Procedure	Health Physics or RSC designate	Full enclosure, Interlocks
	III	>5 rem/hr <50 rem/hr	>1.1x10^7 <1.1x10^8	Health Physics Supervision	Health Physics or RSC designate	Walls/fixed fences, Interlocks
	IV	>0.1 rem/hr <5 rem/hr	>2.3x10^5 <1.1x10^7	Authorized Individuals	Authorized Individuals	Walls/fences, Locked gates
Radiation	V	>0.005 rem/hr <0.1 rem/hr	>1.1x10^4 <2.3x10^5	Rad worker or escorted visitor	Not required	Signs every 20', Ropes at perimiters
Control	VI	>0.00005 rem/hr <0.005 rem/hr	>1.1x10^2 <1.1x10^4	GERT trained or escorted	Not required	Signs at entrances

Note: The information in this table comes from *AGS Operation Procedures Manual*: Section 9.1.11 Revision 02 (18 May, 1995).

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 26 June, 1995

6.4 Chipmunks

/RHIC/ATR/safety/chipmunks.html

List of Chipmunk Locations along the U, V, W, X, and Y-lines

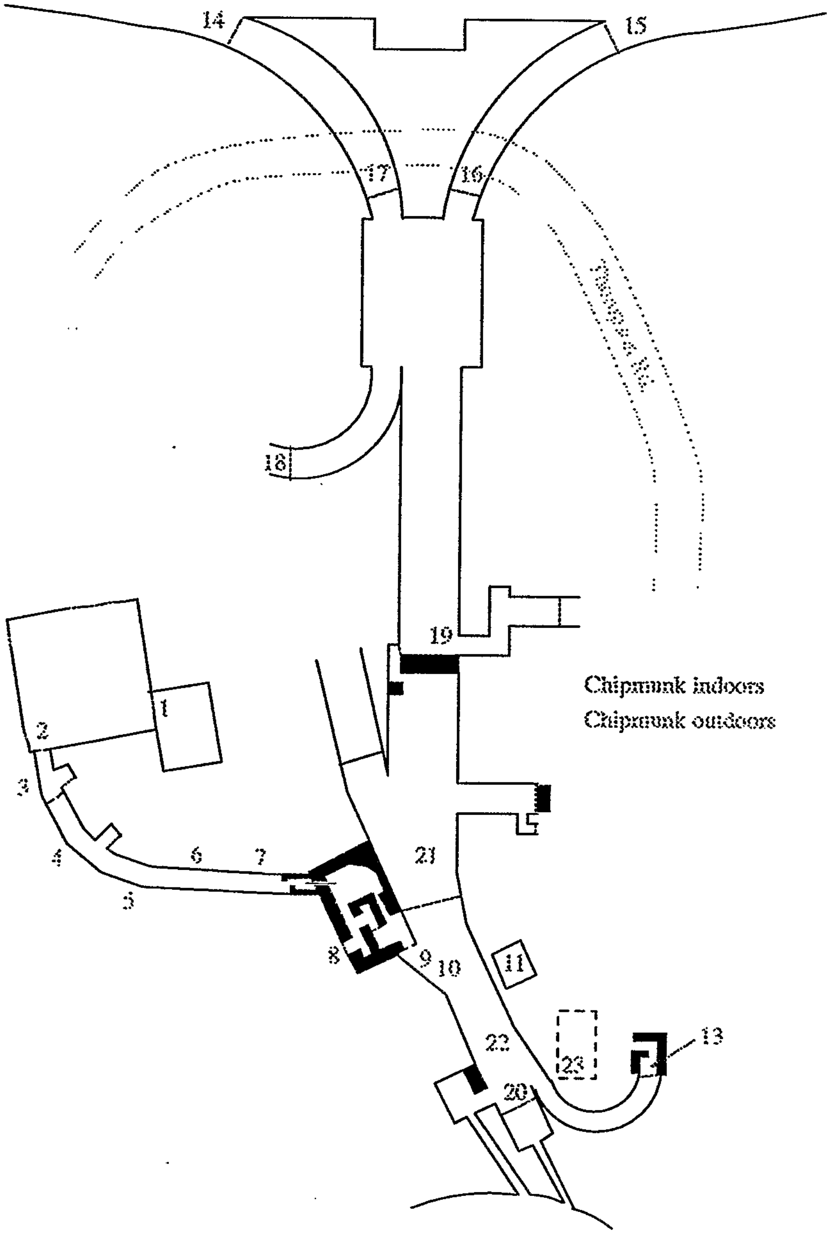
Name	Reset Group	Location
C1	M	inside Muon Ring Control Room
C2	M	inside SW corner of Building 919 (g-2 experiment?)
C3	V1	along V1 tunnel.
C4	V1	along V1 tunnel.
C5	V1	along V1 tunnel.
C6	V1	along V1 tunnel.
C7	V1	along V1 tunnel.
C8	VT	outside gate VTGE1 (outer entrance g-2 target blockhou
C9	VT	on berm downstream of VQ9 (two required).
C10	VT	on berm downstream of VQ9 (two required).
C11	VT	dehumidifier room (igloo).
C13	U	outside gate UGE1 (upstream entrance to U-line).
C14	XY	at gate XGI2 (downstream end of X-line).
C15	XY	at gate YGI2 (downstream end of Y-line).
C16	XY	S edge of Thompson Rd. above Y-line.
C17	XY	S edge of Thompson Rd. above X-line.
C18	W	inside weather door at gate WGE2 (entrance near beam d
C19	W	downstream of W-line shield wall.
C20	U	downstream of U-line stub tunnel.
C21	U	on berm downstream of collimators uc2 and uc3.
C22	U	on berm downstream of collimator uc1.
C23	U	at corner of power substation nearest upstream U-line.
C12	-	spare channel not implemented.

The precise locations of C3 through C7 are yet to be determined.

%

%A postscript version of this figure is available.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 22 June, 1995


14
15
17
16
18
19
Chipmunk indoors
Chipmunk outdoors
1
2
3
4
5
6
7
21
8
9
10
11
22
23
13
20

6.5 Critical devices

/RHIC/ATR/safety/criticaldevs.html

ATR Beamline Access and Critical Devices.

For FEB (fast extracted beam) opertation of the ATR to the beam dump (wbd) at the end of the W-line, the beamline zones will be grouped into logical regions for access and sweeps.

Fall 1995 running with Gold Ions

Access to ATR upstream of shield wall (Zones: US, U, and Wup)

Film badges are currently required! Currently this region is a radiation *controlled access* region requiring a film badge and activation checks for removing material. During and after next fall's running, the area will become a class I radiation area with beam, and a class IV area with no beam in the AGS ring. Critical devices for this area are:

```
Radiation class (beam on):    I (no access)
Radiation class (beam off):   IV
Device #1:                    BF6        (Booster)
Device #2:                    BDH1, BDH2 (Booster)
```

Access to ATR north of shield wall (Zones: Wdn, X, and Y)

These areas are currently unconstrolled areas (class VI) and no film badge is required. Next fall these areas will become controlled areas **requiring badges**.

We would like to have access to the areas downstream of the shield wall (between wd6 and wd7) when beam is being transported to the *g*-2 experiment. In order to guarantee that no radiation is produced downstream of the wall, two devices must be interlocked so that their power supplies are disabled for either *restricted access* or *controlled access.*

When we are running beam to the dump at the end of the W-line, the complete ATR transfer lines must be secured with *access prohibited.* The areas north (downstream) of the shield wall will be able to be put into controlled or restricted access mode by disabling two "critical devices": the *8 degree* and *20 degree* bends.

```
Radiation class (beam on):    I   (no access)
Radiation class (beam off):   IV
Device #1:                    ud3-6 (8 degree bend)
      power source:           psuarc8
      location of supply:     A house
Device #2:                    wd1-8 (20 degree bend)
      power source:           pswarc20
      location of supply:     1000P
```

Access to the *g*-2 inner target cave (Zone: VT)

Access to the *g*-2 inner target cave will be **prohibited** while beam is being transported in the U-line.

```
Radiation Class (U-line beam) I   (no access)
Radiation Class (g-2 beam)    I   (no access)
Radiation Class (no AGS beam) IV? (before Jan '96 g-2 run)
Radiation Class (no AGS beam) ? (after g-2 run)
                                    to be determined.

Device #1:                    BF6
Device #2:                    BDH1, BDH2
```

Access to the *g*-2 outer target cave (V1-primary) (Zone: V1P)

Access to the *g*-2 outer target cave will be **prohibited** while beam extracted into the U-line. Access with no FEB extraction, but with beam in the AGS might be possible, if the RSC agrees.

```
Radiation Class (U-line beam) I   (no access)
Radiation Class (g-2 beam)    I   (no access)
Radiation Class (no FEB beam) IV? (before Jan 96 g-2 run)

Device #1, and #2:            UD1, UD2  (4 degree bend)
      power source:           psuarc4
                                 two independent contactors
```

Access to *g*-2 beam lines beyond the target blockhouse (Zones: V1, D6, and M)

These areas should be accessable during the Fall '95 FEB tests with heavy ions to the W-line beam dump.

Future considerations for *g*-2, the Sextant test and beyond

These will be determined by the Radiation Safety Committee in the future.

---

g-2 Experiment with High Intensity Protons

Critical Devices for the V1, D6, and M zones will be:

```
Device #1:                    V1D1 -- V1 dipole
Device #2:                    V1D2 -- V1 dipole
```

Sextant test

For the sextant test in the fall of 1996, the 4 and 5 o'clock sextant will become a class I radiation area with beam. For access into the RHIC tunnel (4-5 and 6 o'clock sections), the critical devices in the ATR will probably be the switching magnet *swm* and the 90 degree dipole busses in the X- and Y-lines.

```
Device #1:                      swm
      power source:             psswm
      location of supply:       1000P
Device #2 (for X-line side):    xd1-xd31 and xlamb
      power source:             psxarc90
      location of supply:       1000P
Device #2 (for Y-line side):    yd1-yd31 and ylamb
      power source:             psyarc90
      location of supply:       1000P
```

For the sextant test the reversing switch in the switching magnet power supply will need to be disabled so that only one polarity may be used.

Stored beams in RHIC

With stored beams in the RHIC rings, the X and Y zones will need to have *prohibited access* to prevent exposure. Most likely access could be made to zones (Wdn, ...) upstream provided there is no hazard radiation from upstream operations.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 25 June, 1995

6.6 Fault studies

/RHIC/ATR/safety/faultstbl.html

Fault Studies for Fall 1995 Heavy Ion Run to W-dump

#	Loss location	Control Elements	Measurement Location
1	H10 septum	H10 bump	With septum off, what do we see at stub tunnel?
2	ud1,ud2	psuarc4 off	End of zero degree port.
			End of stub tunnel.
3	uq4	psuarc4	Outside gate UGE1.
4	uc1	Jaws: uc1l, uc1r [1]	Outside gate UGE1.
			Corner and floor of substation nearest U-line.
			Along 0-degree line toward g-2 and vertical shaft.
			With chipmunks at WGS1.
5a	ud3 ---> ud5	psuarc8	In igloo.
			Gate VTGE1 (g-2 blockhouse).
			Trenches east and west of line.
5b	uc2	Jaws: uc1l, uc1r [1]	In igloo.
			Gate VTGE1 (g-2 blockhouse).
			Trenches east and west of line.
6	Old Neutrino line.	pswarc20 off.	Entrances and pipes from old neutrino area (Gate #5).
			With chipmunks at WGS1.
7	wp1	pswarc20	Overhead survey shaft and sleeve to east.
8	wd3	pswp1	UGE2, vertical shaft, and equipment room.
9	wd6	pswarc20, pswth1 [2]	10" sleevs to east (wd6 near floor).
			Downstream of shield wall.
10a	wd7	pswarc20, pswth1 [2]	Outside WGE1.
			On top of berm. (This area is thinner than downstream.)
10b	wd1 [3]	psutv7 [2]	10" sleeves to west of tunnel through old neutrino line.
11	wq2	pswarc20	Vertical ventilation shaft west of wp2.

12a	wq6 or swm	pswp2, pswtv6 [2]	WGE2.
			Thompson Road.
			Vertical survey shaft on top of berm downstream of swm.
			Sleeves to 1000P (W) power supply house.
			At end of X, Y-arcs. (Gate XGI2, and YGI2.) [4]
12b	Beam dump "wbd"	Standard condition.	WGE2.
			Thompson Road.
			Vertical survey shaft on top of berm downstream of swm.
			Sleeves to 1000P (W) power supply house.
			At end of X, Y-arcs. (Gate XGI2, and YGI2.) [4]
12c	W-line split.	pswp2, pswth5	Ends of X, Y-arcs while beam is scanned [4].

Notes:

1. Each jaw has a length of 6" of tungsten. The pair of jaws may be overlapped.
2. Some tuning may be required from other elements to generate desired losses.
3. This should be less than the wd6 fault into the 10" sleeves, so may be unnecessary. The wd6 fault study should be performed first.
4. Because of the symmetry, only one arc will be necessary. There will be a chipmunk at the end of each arc to provide continuous monitoring.

Mangled by Waldo MacKay (waldo@bnl.gov)
Last update: 22 June, 1995

Appendix A

Operation Procedure Manuals

AGS OPERATIONS PROCEDURE MANUAL

AGS-TPL 95.10 COMMISSIONING/OPERATING THE AtR LINE WITH HEAVY IONS

Text Pages 8

Approved by: ______________________ 10/9/95
Accelerator Division Head Date

Concurrence by: ______________________ 10/9.
Associate Head Collider Date

Revision 00
October 5, 1995

1.0 Purpose

The purpose of this procedure is to provide a general guide for the commissioning of the U and W lines of the AtR with the ultimate goal of obtaining a beam quality suitable for RHIC operation. Since this is a brand new beam line, no exact procedure exists for tuning up the beam line. Part of the purpose of this commissioning run is to develop a detailed understanding of the line. The intention of this procedure is to give a rather general idea of the commissioning steps. While some steps may seem rather specific, they are given more as an example of how we may proceed and should not necessarily be rigidly followed. The exact details and order of steps which will actually be performed will depend on the actual performance of the AGS extraction, various beam-line components, beam quality, noise backgrounds, etc., as well as our changing and hopefully improving understanding of the AtR as commissioning progresses.

2.0 Responsibilities

2.1 It is the responsibility of the MCR Operator/Coordinator and Accelerator Physics (AtR) Crews to use this procedure as a guideline for setting up beam transport to the beam dump at the end of the W-line and for investigating the optical properties of the AtR during commissioning.

2.2 It is the responsibility of the AtR Crews to make entries in the RHIC Log Book. The purpose of the log book is to improve communication between shifts and to provide an archive of information which will aide in the further analysis and commissioning of the AtR and RHIC. Good experimental log book practices should be used. All entries should be made legibly in permanent ink, with lines through errors. All entries should be initialed. Loose leaf pages and pictures should be securely attached to the log book, preferably with tape. (It is not acceptable to leave loose pages in the log book.) Information which should be included in the log book should include:

2.2.1 who is on shift,

2.2.2 description of each experiment performed,

2.2.3 relevant data file names,

2.2.4 description of problems encountered with hardware and software,

2.2.5 description of the remedies of problems with hardware and software, 2.2.6 any other relevant information which might improve the understanding, analysis, commissioning, and future operation of the AtR and RHIC.

The log book should be kept in the MCR during the runs, except for short trips to the copy machine.

2.3 Problems with hardware and software should also be logged in the on-line "trouble log" by the appropriate Controls or Operations person.

3.0 Prerequisites

3.1 Radiation Safety Check-Off List for HI FEB Operations has to be completed.

3.2 Radiation Safety Check-Off List for HI FEB Operations in AtR has to be completed.

3.3 Required sweep procedure checklists have been carried out for the U and Wup, Wdn, X, Y. VT, and V1 Primary lines.

3.4 FEB extraction has been set up in accordance with AGS-TPL 95.09, "Commissioning/Operating the FEB/SB(M)E for Heavy Ions".

4.0 Precautions

4.1 AGS-TPL 95.08, "Operational Safety Limits for Initial Commissioning of the AtR".

5.0 Procedures

The following outline quite possibly covers more than may be achieved in the two month period allotted for commissioning the line. In fact, the minimum goals which should be completed during this run are to transport beam reliably to the beam dump, and perform the fault studies. We expect that more will be done, although methods can be improved and retried during future running periods.

5.1 Set up FEB extraction to the AtR from the AGS following procedure AGS-TPL 95.09, "Commissioning/Operating the FEB/SB(M)E for Heavy Ions".

5.2 Thread beam down the U-line and W-lines to the beam dump.

NOTE:

Beam position monitors (BPMs), flags, and beam loss monitors (BLMs) should provide location information as the beam is steered down to the dump. Additional trajectory information at the quadruples may be obtained by varying the quadrupole strength and looking for shifts in positions measured by BPMs and flags downstream of the quadrupole; a beam centered on a quadrupole should not show any shift on downstream detectors.

Timing delays for gating the electronic readouts may have to be adjusted as the beam is threaded down the line. The upstream detectors may be particularly susceptible to noise from the pulsed kicker (FKG10) and septum (SMH10) magnets.

5.2.1 Insert flags uf1 and uf2, either of which has a sufficient thickness to fully strip the last two electrons from the gold ions.

NOTE:

There will be a bit of emittance blowup from multiple scattering. Flag uf1 should remain in during the initial beam steering, since the beam rigidity (p/q) would increase if it were removed. The estimated blow up in emittance from flag uf1 for a $\pi\epsilon^{N}_{95\%} = 10\pi \times 10^{-6}m$ Gold beam is about 50% horizontally and about 3.6% vertically.

5.2.2 Set the power supplies for all trim magnets to zero current.

5.2.3 Determine the best guess for the momentum ($p = p_g$) of the AGS beam at extraction.

5.2.4 Set the power supplies for the quadrupoles to their nominal currents using the best momentum guess p_g and charge state $Z = 79$.

5.2.5 Set the bend power supplies for the horizontal bends: psuarc4, psuarc8, and pswarc20, and the vertical bends: pswp1 and pswp2 to their nominal values for the momentum guess p_g and charge state $Z = +79$.

5.2.6 Start extracting the beam into the U-line. Adjust FEB extraction from the AGS to center beam on flag uf1 by adjusting the SMH10 septum strength and H10 bump strength.

> NOTE:
>
> For the initial beam threading we should use single bunches per AGS cycle with out 1 x 10^8 gold ions per bunch.

5.2.7 Adjust the 4° bend (psuarc4) to center the beam on uf2.

> NOTE:
>
> The BLMs and first four BPMs should aid in this. The first pair of trim magnets may also help aiming the beam through the long pipe between the AGS tunnel and the U-line stub tunnel between ub2 and uq4.

5.2.8 Extract flag uf2 and insert flags uf3, uf4, and uf5.

5.2.9 Adjust the 8° bend to center the beam horizontally through BPMs ub5, ubh6, and ubv7 and flag uf3. Use trims uth3 and utv4 to help, if necessary.

5.2.10 Check the beam position at uf4, ub8, and uf5.

> NOTE:
>
> Trims uth6 and utv7 may help center the beam, if necessary. At this point beam should be reasonably well threaded through the U-line.

5.2.11 Extract flags uf3, uf4, and uf5 and insert flags wf1, wf2, and wf3.

5.2.12 The next position monitor is wbv1 which comes just before dipole wd5 in the 20° bend. Using the actual currents from the 4° and 8° bends, a correction to the guessed rigidity may be made. Adjust the 20° bend (psuarc20) and first pitching magnet pswp1 to center the beam through wbv1, wb2, wb3, and wbh4.

> NOTE:
>
> Trims wth1, wtv2, and wth3 may help to keep the beam in the aperture. The BLMs should be watched carefully in this region. One or two of the movable BLMs may be placed along the line to help increase the segmentation of the loss monitors.

5.2.13 Adjust the second pitching magnet wp2 so that the beam passes through the center of flags wf1, wf2, wf3, and BPMs wbh5, wbv6, and wb7.

> NOTE:
>
> Trims wth4, wth5, and wtv6 and loss monitors may help keep the beam within the aperture.

5.2.14 Place movable beam loss monitors in front of the dump near the beam pipe. Scan the beam slightly horizontally and vertically to verify that the beam is not scraping the pipe somewhere between flag wf3 and the dump.

> NOTE:
>
> At this point, the beam should be hitting the dump.

5.2.15 Compare the beam currents read by beam current transformers uxf1, uxf3, and wxf1 with each other and with the AGS current monitors.

> NOTE:
>
> Some adjustment of the timing delays for the transformers may be necessary.

5.2.16 Measure the pulse-to-pulse stability of the beam in the AtR, with particular attention paid to beam current, position, and profile on flags.

5.3 Do fault studies using procedure AtR Commissioning Fault Studies Plan. Check for radiation leaks when the beam hits certain key elements. Of particular interest are:

5.3.1 access doors particularly UGE1, UGE2, and WGE2;

5.3.2 penetrations for ventilation shafts and cables;

5.3.3 thin shielding areas;

5.3.4 the top of the berm where Thompson Road crosses the beam line.

5.4 Measure the transverse matrix elements (C, S, C', S') for both horizontal and vertical motion. Good locations for measuring positions and slopes of the trajectory are:

5.4.1 at the beginning of the line between uf1 and ub1, 5.4.2 in the stub tunnel between ub3 and uf2,

5.4.3 at the end of the U-line between uf4 and ub8 with uq13 current set to zero, and

5.4.4 at the end of the W-line between wf2 and wf3 with wq5 and wq6 currents set to zero.

> NOTE:
>
> With the quadrupoles turned off, only a simple drift remains between detectors and changes in slope may be easily measured.

5.4.5 Measure the beam location and slopes at various locations along the beam line for several incident beam locations and slopes by adjusting the upstream steering elements.

5.4.6 Extract the matrix coefficients of the transfer matrix between points of measurement for a particular segment of the beam line. Compare with the predicted values.

5.5 Measure the dispersion elements of the beam line (D, D'). (Note that this is not the same as the dispersion function of the beam, but just the dispersion components of the transfer matrix for a given section of beam line.)

5.5.1 Measure the trajectory,

5.5.2 simulate a 0.1% momentum change by ramping all magnets up by 0.1%.

5.5.3 Remeasure the trajectory.

5.5.4 Calculate the values of D and D' at the BPM locations.

5.5.5 Compare with the expected values.

5.6 Measure the beam shape (transverse hyperellipsoid).

5.6.1 Retract flag uf1 and insert flag uf2.

> NOTE:
>
> The last two electrons will now be stripped by uf2, which is at an optimum location for stripping. The estimated blowup in emittance from flag uf2 for a $\pi\epsilon^N_{95\%}$ - $10\pi \times 10^{-6} m$ Gold beam is about 5.6% in both planes.

5.6.2 Readjust the line upstream of flag uf2 for the increased rigidity (p/q with Z = +77). Use the left jaw uc2l of the second collimator to catch the ions which are not fully stripped.

5.6.3 Measure the profiles at flags uf3, uf4, uf5, wf1, wf2, and wf3.

> NOTE:
>
> The profiles should be taken on individual flags, with the upstream flags retracted (except for uf2 which is used at the stripping foil), since each foil tends to increase the emittance through multiple scattering. After the beam line is better understood this multiple scattering effect may be calibrated, and multiple flag measurements may be made for a single beam pulse.

5.6.4 Calculate emittances, βs, and αs (horizontal and vertical) at the flag locations.

5.7 Measure dispersion of the beam.

5.7.1 Use flag uf2 for a stripping foil.

5.7.2 Measure the trajectory.

5.7.3 Change the momentum of the AGS extracted beam.

5.7.4 Remeasure the trajectory.

5.7.5 Calculate the values of dispersion functions (η, η') at the BPM locations. (Flag measurements may also be used, particularly uf2 with no adjacent BPM, and uf3, uf4, wf3 and wf4 where there is only single plane information from the adjacent BPMs).

5.7.6 Compare with the expected values.

5.8 Measure momentum spread with collimator jaws ucll and uclr.

5.8.1 Compare with AGS measurements of momentum spread.

5.9 Tune the U-line quadruples to best match the desired values going into the W-line.

> NOTE:
>
> The dispersion between ub6 and wdl should be zero.

5.10 Tune the W-line quadrupoles to best match the desired values just upstream of swm (switch magnet).

NOTE:
The dispersion between wp2 and swm should also be zero.

5.11 Scan the aperture down the line.

5.12 Study the stripping efficiency on flag uf2.

6.0 Documentation

None.

7.0 References

7.1 AGS-OPM-TPL 95.08, "Operational Safety Limits for Initial Commissioning of the AtR".

7.2 AGS-OPM-TPL 95.09, "Commissioning/Operating the FEB/SB(M)E for Heavy Ions".

7.3 Radiation Safety Check-Off List for HI FEB Operations in AtR.

7.4 AGS-OPM-TPL 95.11, "Procedure for Sweeping the AtR and g-2 Beam Lines for Controlled Access and related checklists for U and Wup, Wdn, X, Y, Vt, and V1P beam line areas".

7.5 AtR Commissioning Fault Studies Plan.

8.0 Attachments

8.1 Site-Wide Names for beamline components.

AGS OPERATIONS PROCEDURE MANUAL

2.11 ACCELERATOR PHYSICISTS and SYSTEMS SPECIALISTS

Text Pages 1 through 3

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Revision No. 01

Approved: D. Lowenstein 10/2/95
AGS Department Chairman Date

P. Ingrassia, E. Lessard

2.11 ACCELERATOR PHYSICISTS AND SYSTEMS SPECIALISTS

1. Purpose

To provide instructions to Accelerator Physicists and System Specialists to directly make changes to the state of the accelerator or perform accelerator studies.

Definitions:

Dedicated Study -- a study which explores new ways to configure parts of the accelerator. These studies are scheduled in advance by the Scheduling Physicist and announced to Users since the studies are sometimes destructive from the point of view of the Physics Program. These studies require Accelerator Physicists and Systems Specialists to follow this procedure and to complete the "AGS Safety Review Sheet for Dedicated Accelerator Studies."

Study -- a study in which the Accelerator Physicist or System Specialist actively participates in the adjustment of machine parameters without requiring Operations to physically interface the Accelerator Physicist or Systems Specialist to the machine. Typical examples are calibrating PUEs or checking if a Tune Meter is working properly. These studies do not require notification of the Scheduling Physicist. These studies require Accelerator Physicists and Systems Specialists to follow this procedure, but they DO NOT complete the "AGS Safety Review Sheet for Dedicated Accelerator Studies."

2. Responsibilities

2.1 It is the responsibility of Accelerator Physicists and Systems Specialists to request permission from the on-duty Operations Coordinator prior to using the controls of the AGS Complex.

2.2 It is the responsibility of the on-duty Operations Coordinator to record authorization to use the accelerator controls in the Operations Coordinator's Log Book, and to sign the Safety Review Sheet for Dedicated Accelerator Studies (AGS OPM ATT 2.11.a).

2.3 It is the responsibility of the Accelerator Division Head, Associate Division Head, or Deputy to review all dedicated studies to determine if additional training, design review, formal safety review or written procedures are required.

3. Prerequisites

3.1 Permission by Operations Coordinator is required.

3.2 Permission is to be granted only to persons who are authorized, having completed the appropriate training program.

4. Precautions

Unless authorized by the Security Group Leader, either Accelerator Physicists or Systems Specialists may not exercise control of the security system components at the MCR_2 and MCR-1 control consoles.

5. Procedure

5.1 The Accelerator Physicist or Systems Specialist shall make the on-duty Operations Coordinator, or his designate, aware of any test or work plan that he wishes to execute at the controls of the accelerator.

5.1.1 IF the study qualifies as a Dedicated Study, THEN the Accelerator Physicist or Systems Specialist shall complete items 1 through 6 of the Safety Review Sheet for Accelerator Studies (see AGS OPM ATT 2.11.a)

5.2 The on-duty Operations Coordinator, or his designate, will grant authorized Systems Specialists or Accelerator Physicists access to the controls.

5.3 The on-duty Operations Coordinator, or his designate, will ensure that the proposed test or work plan is within the Safety Envelope of the AGS Complex.

5.3.1 If the study qualifies as a Dedicated Study, THEN the on-duty Operations Coordinator, or his designate, shall ensure completion of the Safety Review Sheet for Accelerator Studies and sign it.

5.4 IF the study qualifies as a Dedicated Study, THEN the Accelerator Division Head, Associate Division Head or Deputy shall review the study to determine if additional training, design review, formal safety review or written procedures are required.

5.4.1 IF additional training, design review, formal safety review or written procedures are needed, THEN the Accelerator Division Head, Associate Division Head, or Deputy shall ensure these reviews or procedures are initiated by informing the Head of the AGS Safety Section or AGS Associate Chair for Safety.

6. Documentation

6.1 The Operations Coordinator will make an entry into the Operations

Coordinators Log Book that notes permission given to an Accelerator Physicist or Systems Specialist and what test or work plan was performed.

6.2 The Operations Coordinator will collect completed Safety Review Sheets for Accelerator Studies, and any associated outlines of the study, and maintain them in a log/ring binder dedicated for this purpose. This log/ring binder is to be retained in the MCR.

6.3 Accelerator Physicists or Systems Specialists will summarize their work in the appropriate Start-up Book or in the Operations Log Book as well as, if appropriate, in their personal data book.

7.0 <u>Attachments</u>

7.1 AGS-OPM-ATT 2.11.a, "AGS Safety Review Sheet for Dedicated Accelerator Studies."

AGS OPM ATT 2.11.a AGS Safety Review Sheet for Dedicated Accelerator Studies

AGS OPM Procedures in which this Attachment is used.		
2.11		

Revision No. 00

Approved: D Lowenstein 10/2/95
AGS Department Chairman Date

E. Lessard

AGS Safety Review Sheet for Dedicated Accelerator Studies

1) Study Period:

Study #________________ Planned Start Date: __________________(Actual date can be different than planned date)

2) Title and Content of Study:

Title:
Briefly state the setup steps for this study that you wish Operations to take care of (or attach an outline):
Goal:
Equipment to be used:

3) List Others Who Will Work On the Study:

First and Last Name	Affiliation (Role in Study)	Phone Number

4) List Potentially Hazardous Equipment or Potentially Hazardous Operations Introduced by the Study (See Other Side). If none, then state none:

5) Qualifications:

Are you currently qualified as an Accelerator Physicist or Systems Specialist? __ Yes __ No
Are Other Job Qualifications Necessary for Study: __ Yes __ No If yes, please list Job Category or Permit Qualification:

6) Accelerator Physicist or Systems Specialist Completing This Form:

Name	Life or Guest #	Address	Telephone (pager)
Signature:			Date:

7) Review Authority (Accelerator Division Head, Associate Division Head or Deputy):

Signature:	Safety Review Yes No	Date:

8) Operations Coordinator:

Signature:	Outline Attached _Yes _No	Date:

SEE INSTRUCTIONS ON REVERSE SIDE

Instruction Summary

Item No.	Description	Responsibility
1	Study # (e.g., 95-01 for first study in 1995), and Proposed Start Date (actual start date may be different)	Accelerator Physicist or Systems Specialist
2	Title, please use a descriptive but brief title. Give an overview of the setup and clarify what you want Operations to do.	Accelerator Physicist or Systems Specialist
3	Listing of persons in study. Indicate persons who will work in the MCR manipulating controls on behalf of the study.	Accelerator Physicist or Systems Specialist
4	Listing of Potentially Hazardous Equipment or Potentially Hazardous Operations: Are you going to bring any equipment near its maximum rating? For example: lasers, pumps, cryostats, pressure devices, vacuum devices, liquid or gas mixing systems, rf devices, beam splitters, transport magnets, spectrometer magnets, power supplies or any devices capable of producing high-temperature (that is, devices with cooling systems)? Any study-related introduction of compressed air or gas systems, microwave devices, noise greater than 85 dBa, or welding and burning tools? Any possibility that oil or water may begin leaking as a result of the study? Will any studies-related equipment or activities require special written procedures or permits to operate? Will there be study-related changes to interlocks, Radiological Area designations, or fire protection systems? Are you going to disable equipment-protective systems?	Accelerator Physicist or Systems Specialist (list on other side)
5	Qualifications of person performing study. Indicate other qualifications necessary to perform study; for example: RSC Committee Member, Division Head, Permit C (Ring and Cave Trained), Permit G (Escort Trained), Working Hot Permit, Radiation Work Permit, etc.	Accelerator Physicist or Systems Specialist
6	This form should be completed by the Accelerator Physicist or Systems Specialist who performs the study and signed.	Accelerator Physicist or Systems Specialist
7	Determine if additional training, design review, formal safety review or procedures are required. Indicate if a formal safety review or a review of procedures by Safety Section is required. Determine if the accelerators can safely tolerate the changes to machine parameters that are performed during the study. Determine if the Accelerator Safety Envelope may be breached.	Accelerator Division Head, Associate Division Head or Deputy
8	If the study extends beyond your shift, notify the next on-duty OC about the study. Indicate if a studies outline is to be attached. Place this completed form, and any studies outlines, in a dedicated log book / ring binder in the MCR.	Operations Coordinator

Appendix B

Alphabetical List of Sitewide Names

SiteWideName	type	comment
ulm1.1	blm	Beam loss monitor can
ulm10.1	blm	Beam loss monitor can
ulm11.1	blm	Beam loss monitor can
ulm12.1	blm	Beam loss monitor can
ulm13.1	blm	Beam loss monitor can
ulm14.1	blm	Beam loss monitor can
ulm15.1	blm	Beam loss monitor can
ulm16.1	blm	Beam loss monitor can
ulm2.1	blm	Beam loss monitor can
ulm2.2	blm	Beam loss monitor can
ulm3.1	blm	Beam loss monitor can
ulm3.2	blm	Beam loss monitor can
ulm3.3	blm	Beam loss monitor can
ulm4.1	blm	Beam loss monitor can
ulm4.2	blm	Beam loss monitor can
ulm5.1	blm	Beam loss monitor can
ulm5.2	blm	Beam loss monitor can
ulm5.3	blm	Beam loss monitor can
ulm6.1	blm	Beam loss monitor can
ulm6.2	blm	Beam loss monitor can
ulm6.3	blm	Beam loss monitor can
ulm6.4	blm	Beam loss monitor can
ulm6.5	blm	Beam loss monitor can
ulm7.1	blm	Beam loss monitor can
ulm7.2	blm	Beam loss monitor can
ulm8.1	blm	Beam loss monitor can
ulm8.2	blm	Beam loss monitor can
ulm9.1	blm	Beam loss monitor can
wlm1.1	blm	Beam loss monitor can
wlm1.2	blm	Beam loss monitor can
wlm1.3	blm	Beam loss monitor can
wlm2.1	blm	Beam loss monitor can
wlm2.2	blm	Beam loss monitor can
wlm3.1	blm	Beam loss monitor can
wlm3.2	blm	Beam loss monitor can
wlm4.1	blm	Beam loss monitor can
wlm4.2	blm	Beam loss monitor can
wlm5.1	blm	Beam loss monitor can
wlm5.2	blm	Beam loss monitor can
wlm5.3	blm	Beam loss monitor can
wlm6.1	blm	Beam loss monitor can
wlm6.2	blm	Beam loss monitor can
wlm7.1	blm	Beam loss monitor can
wlm8.1	blm	Beam loss monitor can
wlm8.2	blm	Beam loss monitor can
xlm1.1	blm	Beam loss monitor can
xlm10.1	blm	Beam loss monitor can
xlm10.2	blm	Beam loss monitor can
xlm10.3	blm	Beam loss monitor can
xlm10.4	blm	Beam loss monitor can
xlm11.1	blm	Beam loss monitor can
xlm11.2	blm	Beam loss monitor can
xlm11.3	blm	Beam loss monitor can
xlm11.4	blm	Beam loss monitor can

SiteWideName	type	comment
xlm11.5	blm	Beam loss monitor can
xlm11.6	blm	Beam loss monitor can
xlm12.1	blm	Beam loss monitor can
xlm12.2	blm	Beam loss monitor can
xlm12.3	blm	Beam loss monitor can
xlm12.4	blm	Beam loss monitor can
xlm12.5	blm	Beam loss monitor can
xlm13.1	blm	Beam loss monitor can
xlm14.1	blm	Beam loss monitor can
xlm15.1	blm	Beam loss monitor can
xlm16.1	blm	Beam loss monitor can
xlm2.1	blm	Beam loss monitor can
xlm3.1	blm	Beam loss monitor can
xlm3.2	blm	Beam loss monitor can
xlm3.3	blm	Beam loss monitor can
xlm3.4	blm	Beam loss monitor can
xlm4.1	blm	Beam loss monitor can
xlm4.2	blm	Beam loss monitor can
xlm4.3	blm	Beam loss monitor can
xlm4.4	blm	Beam loss monitor can
xlm5.1	blm	Beam loss monitor can
xlm5.2	blm	Beam loss monitor can
xlm5.3	blm	Beam loss monitor can
xlm5.4	blm	Beam loss monitor can
xlm6.1	blm	Beam loss monitor can
xlm6.2	blm	Beam loss monitor can
xlm6.3	blm	Beam loss monitor can
xlm6.4	blm	Beam loss monitor can
xlm7.1	blm	Beam loss monitor can
xlm8.1	blm	Beam loss monitor can
xlm9.1	blm	Beam loss monitor can
xlm9.2	blm	Beam loss monitor can
xlm9.3	blm	Beam loss monitor can
xlm9.4	blm	Beam loss monitor can
ylm1.1	blm	Beam loss monitor can
ylm10.1	blm	Beam loss monitor can
ylm10.2	blm	Beam loss monitor can
ylm10.3	blm	Beam loss monitor can
ylm10.4	blm	Beam loss monitor can
ylm11.1	blm	Beam loss monitor can
ylm11.2	blm	Beam loss monitor can
ylm11.3	blm	Beam loss monitor can
ylm11.4	blm	Beam loss monitor can
ylm11.5	blm	Beam loss monitor can
ylm11.6	blm	Beam loss monitor can
ylm12.1	blm	Beam loss monitor can
ylm12.2	blm	Beam loss monitor can
ylm12.3	blm	Beam loss monitor can
ylm12.4	blm	Beam loss monitor can
ylm12.5	blm	Beam loss monitor can
ylm13.1	blm	Beam loss monitor can
ylm14.1	blm	Beam loss monitor can
ylm15.1	blm	Beam loss monitor can
ylm16.1	blm	Beam loss monitor can

SiteWideName	type	comment
ylm2.1	blm	Beam loss monitor can
ylm3.1	blm	Beam loss monitor can
ylm3.2	blm	Beam loss monitor can
ylm3.3	blm	Beam loss monitor can
ylm3.4	blm	Beam loss monitor can
ylm4.1	blm	Beam loss monitor can
ylm4.2	blm	Beam loss monitor can
ylm4.3	blm	Beam loss monitor can
ylm4.4	blm	Beam loss monitor can
ylm5.1	blm	Beam loss monitor can
ylm5.2	blm	Beam loss monitor can
ylm5.3	blm	Beam loss monitor can
ylm5.4	blm	Beam loss monitor can
ylm6.1	blm	Beam loss monitor can
ylm6.2	blm	Beam loss monitor can
ylm6.3	blm	Beam loss monitor can
ylm6.4	blm	Beam loss monitor can
ylm7.1	blm	Beam loss monitor can
ylm8.1	blm	Beam loss monitor can
ylm9.1	blm	Beam loss monitor can
ylm9.2	blm	Beam loss monitor can
ylm9.3	blm	Beam loss monitor can
ylm9.4	blm	Beam loss monitor can
ulm1	blm-signal	Beam loss monitor signal line.
ulm10	blm-signal	Beam loss monitor signal line.
ulm11	blm-signal	Beam loss monitor signal line.
ulm12	blm-signal	Beam loss monitor signal line.
ulm13	blm-signal	Beam loss monitor signal line.
ulm14	blm-signal	Beam loss monitor signal line.
ulm15	blm-signal	Beam loss monitor signal line.
ulm16	blm-signal	Beam loss monitor signal line.
ulm2	blm-signal	Beam loss monitor signal line.
ulm3	blm-signal	Beam loss monitor signal line.
ulm4	blm-signal	Beam loss monitor signal line.
ulm5	blm-signal	Beam loss monitor signal line.
ulm6	blm-signal	Beam loss monitor signal line.
ulm7	blm-signal	Beam loss monitor signal line.
ulm8	blm-signal	Beam loss monitor signal line.
ulm9	blm-signal	Beam loss monitor signal line.
wlm1	blm-signal	Beam loss monitor signal line.
wlm2	blm-signal	Beam loss monitor signal line.
wlm3	blm-signal	Beam loss monitor signal line.
wlm4	blm-signal	Beam loss monitor signal line.
wlm5	blm-signal	Beam loss monitor signal line.
wlm6	blm-signal	Beam loss monitor signal line.
wlm7	blm-signal	Beam loss monitor signal line.
wlm8	blm-signal	Beam loss monitor signal line.
xlm1	blm-signal	Beam loss monitor signal line.
xlm10	blm-signal	Beam loss monitor signal line.
xlm11	blm-signal	Beam loss monitor signal line.
xlm12	blm-signal	Beam loss monitor signal line.
xlm13	blm-signal	Beam loss monitor signal line.
xlm14	blm-signal	Beam loss monitor signal line.
xlm15	blm-signal	Beam loss monitor signal line.

SiteWideName	type	comment
xlm16	blm-signal	Beam loss monitor signal line.
xlm2	blm-signal	Beam loss monitor signal line.
xlm3	blm-signal	Beam loss monitor signal line.
xlm4	blm-signal	Beam loss monitor signal line.
xlm5	blm-signal	Beam loss monitor signal line.
xlm6	blm-signal	Beam loss monitor signal line.
xlm7	blm-signal	Beam loss monitor signal line.
xlm8	blm-signal	Beam loss monitor signal line.
xlm9	blm-signal	Beam loss monitor signal line.
ylm1	blm-signal	Beam loss monitor signal line.
ylm10	blm-signal	Beam loss monitor signal line.
ylm11	blm-signal	Beam loss monitor signal line.
ylm12	blm-signal	Beam loss monitor signal line.
ylm13	blm-signal	Beam loss monitor signal line.
ylm14	blm-signal	Beam loss monitor signal line.
ylm15	blm-signal	Beam loss monitor signal line.
ylm16	blm-signal	Beam loss monitor signal line.
ylm2	blm-signal	Beam loss monitor signal line.
ylm3	blm-signal	Beam loss monitor signal line.
ylm4	blm-signal	Beam loss monitor signal line.
ylm5	blm-signal	Beam loss monitor signal line.
ylm6	blm-signal	Beam loss monitor signal line.
ylm7	blm-signal	Beam loss monitor signal line.
ylm8	blm-signal	Beam loss monitor signal line.
ylm9	blm-signal	Beam loss monitor signal line.
fg1	board	Video Frame grabber board
fg2	board	Video Frame grabber board
fg3	board	Video Frame grabber board
fg4	board	Video Frame grabber board
vmux	board	Video multiplexer board for the flag cameras
wbd	dump	Beam dump at end of W-line.
ev-0.1Hz	event	RHIC event: every 10 seconds
ev-0.2Hz	event	RHIC event: every 5 seconds
ev-10Hz	event	RHIC event: 10Hz clock
ev-1Hz	event	RHIC event: every second
ev-60Hz	event	RHIC event: 60Hz clock
ev-720Hz	event	RHIC event: 720Hz clock
ev-AGST0	event	RHIC event: beginning of AGS cycle
ev-AGSflatEnd	event	RHIC event: end of AGS flattop
ev-AGSflatStart	event	RHIC event: beginning of AGS flattop
ev-ATRWFG1	event	RHIC event: Wave form generator event
ev-ATRWFG2	event	RHIC event: Wave form generator event
ev-ATRWFG3	event	RHIC event: Wave form generator event
ev-FEBbunch	event	RHIC event: 30 microseconds before the kicker fires (0.1microsecond accuracy)
ev-FEBrequest	event	RHIC event: request an extracted FEB bunch
ev-RHICBPMmail	event	RHIC event: Asynchronous event for BPM DSP board updates
swm	optics	Switch magnet at end of W-line
ub1	optics	Dual plane BPM in U-line
ub2	optics	Dual plane BPM in U-line
ub3	optics	Dual plane BPM in U-line
ub4	optics	Dual plane BPM in U-line
ub5	optics	Dual plane BPM in U-line
ub8	optics	Dual plane BPM in U-line
ubegin	optics	Optical marker at beginning of U-line

SiteWideName	type	comment
ubh6	optics	Horizontal plane BPM in U-line
ubv7	optics	Vertical plane BPM in U-line
uc1l	optics	Left collimator jaw downstream of uq6 and stripping foil
uc1r	optics	Right collimator jaw downstream of uq6 and stripping foil
uc2l	optics	Left collimator jaw downstream of 8 degree bend
uc2r	optics	Right collimator jaw downstream of 8 degree bend
uc3l	optics	Left collimator jaw upstream of uq11
uc3r	optics	Right collimator jaw upstream of uq11
ud1	optics	Pure dipole magnet in 4 degree bend of U-line
ud2	optics	Pure dipole magnet in 4 degree bend of U-line
ud3	optics	Focusing dipole in 8 degree bend of U-line
ud4	optics	Defocusing dipole in 8 degree bend of U-line
ud5	optics	Defocusing dipole in 8 degree bend of U-line
ud6	optics	Focusing dipole in 8 degree bend of U-line
uf1	optics	Flag profile monitor at beginning of U-line
uf2	optics	Flag profile monitor upstream of stripping foil
uf3	optics	Flag profile monitor upstream of 20 degree bend
uf4	optics	Flag profile monitor upstream of 20 degree bend
uf5	optics	Flag profile monitor upstream of 20 degree bend
ufoil	optics	Stripping foil upstream of uq6
uq1	optics	U-line quadrupole
uq10	optics	U-line quadrupole
uq11	optics	U-line quadrupole
uq12	optics	U-line quadrupole
uq13	optics	U-line quadrupole
uq2	optics	U-line quadrupole
uq3	optics	U-line quadrupole
uq4	optics	U-line quadrupole
uq5	optics	U-line quadrupole
uq6	optics	U-line quadrupole
uq7	optics	U-line quadrupole
uq8	optics	U-line quadrupole
uq9	optics	U-line quadrupole
uth2	optics	Horizontal trim magnet in U-line
uth2.1	optics	Horizontal trim magnet in U-line stub tunnel.
uth3	optics	Horizontal trim magnet in U-line
uth6	optics	Horizontal trim magnet in U-line
utv1	optics	Vertical trim magnet in U-line
utv2.2	optics	Vertical trim magnet in U-line stub tunnel.
utv4	optics	Vertical trim magnet in U-line
utv5	optics	Vertical trim magnet in U-line
utv7	optics	Vertical trim magnet in U-line
uxf1	optics	Current tranformer at beginning of U-line
uxf3	optics	Current transformer at end of U-line
vb1	optics	Dual plane BPM in Primary V-line
vb2	optics	Dual plane BPM in Primary V-line
vbegin	optics	Optical marker at beginning of Primary V-line
vd3	optics	Upstream dipole of g-2 switching pair
vd4	optics	Downstream dipole of g-2 switching pair
vepm	optics	External profile monitor in Primary V-line
vf1	optics	Flag in Primary V-line
vq10	optics	V-line quadrupole in primary V-line
vq11	optics	V-line quadrupole in primary V-line
vq12	optics	V-line quadrupole in primary V-line

SiteWideName	type	comment
vq9	optics	V-line quadrupole in primary V-line
vtgt	optics	Primary V-line pion production target for the g-2 experiment
vth2	optics	Horizontal trim magnet in Primary V-line
vtv1	optics	Vertical trim magnet in Primary V-line
vxf1	optics	Current transformer in Primary V-line
wb2	optics	Dual plane BPM in W-line
wb3	optics	Dual plane BPM in W-line
wb7	optics	Dual plane BPM in W-line
wbh4	optics	Horizontal plane BPM in W-line
wbh5	optics	Horizontal plane BPM in W-line
wbv1	optics	Vertical plane BPM in W-line
wbv6	optics	Vertical plane BPM in W-line
wd1	optics	Defocusing dipole in 20 degree bend of W-line
wd2	optics	Focusing dipole in 20 degree bend of W-line
wd3	optics	Defocusing dipole in 20 degree bend of W-line
wd4	optics	Focusing dipole in 20 degree bend of W-line
wd5	optics	Defocusing dipole in 20 degree bend of W-line
wd6	optics	Focusing dipole in 20 degree bend of W-line
wd7	optics	Defocusing dipole in 20 degree bend of W-line
wd8	optics	Focusing dipole in 20 degree bend of W-line
wf1	optics	Flag profile monitor upstream of switching magnet
wf2	optics	Flag profile monitor upstream of switching magnet
wf3	optics	Flag profile monitor upstream of switching magnet
wp1	optics	Upstream pitching magnet in W-line
wp2	optics	Downstream pitching magnet in W-line
wq1	optics	W-line quadrupole
wq2	optics	W-line quadrupole
wq3	optics	W-line quadrupole
wq4	optics	W-line quadrupole
wq5	optics	W-line quadrupole
wq6	optics	W-line quadrupole
wth1	optics	Horizontal trim magnet in W-line
wth3	optics	Horizontal trim magnet in W-line
wth4	optics	Horizontal trim magnet in W-line
wth5	optics	Horizontal trim magnet in W-line
wtv2	optics	Vertical trim magnet in W-line
wtv6	optics	Vertical trim magnet in W-line
wxf1	optics	Current tranformer at end of W-line
xb12	optics	Dual plane BPM in X-line
xb5	optics	Dual plane BPM in X-line
xbh10	optics	Horizontal plane BPM in X-line
xbh4	optics	Horizontal plane BPM in X-line
xbh6	optics	Horizontal plane BPM in X-line
xbh8	optics	Horizontal plane BPM in X-line
xbv1	optics	Vertical plane BPM in X-line
xbv11	optics	Vertical plane BPM in X-line
xbv2	optics	Vertical plane BPM in X-line
xbv3	optics	Vertical plane BPM in X-line
xbv7	optics	Vertical plane BPM in X-line
xbv9	optics	Vertical plane BPM in X-line
xd1	optics	Defocusing dipole in X-line
xd10	optics	Focusing dipole in X-line
xd11	optics	Focusing dipole in X-line
xd12	optics	Defocusing dipole in X-line

SiteWideName	type	comment
xd13	optics	Defocusing dipole in X-line
xd14	optics	Focusing dipole in X-line
xd15	optics	Focusing dipole in X-line
xd16	optics	Defocusing dipole in X-line
xd17	optics	Defocusing dipole in X-line
xd18	optics	Focusing dipole in X-line
xd19	optics	Focusing dipole in X-line
xd2	optics	Focusing dipole in X-line
xd20	optics	Defocusing dipole in X-line
xd21	optics	Defocusing dipole in X-line
xd22	optics	Focusing dipole in X-line
xd23	optics	Focusing dipole in X-line
xd24	optics	Defocusing dipole in X-line
xd25	optics	Defocusing dipole in X-line
xd26	optics	Focusing dipole in X-line
xd27	optics	Focusing dipole in X-line
xd28	optics	Defocusing dipole in X-line
xd29	optics	Defocusing dipole in X-line
xd3	optics	Focusing dipole in X-line
xd30	optics	Focusing dipole in X-line
xd31	optics	Pure dipole magnet at end of 90 degree arc in the x-line.
xd4	optics	Defocusing dipole in X-line
xd5	optics	Defocusing dipole in X-line
xd6	optics	Focusing dipole in X-line
xd7	optics	Focusing dipole in X-line
xd8	optics	Defocusing dipole in X-line
xd9	optics	Defocusing dipole in X-line
xend	optics	Optical marker at end of X-line
xf1	optics	Flag profile monitor at end of X-line
xf2	optics	Flag profile monitor at end of X-line
xlamb	optics	Lambertson magnet at end of X-line
xp1	optics	Vertical pitching magnet upstream of lambertson xlamb
xq1	optics	X-line quadrupole
xq2	optics	X-line quadrupole
xq3	optics	X-line quadrupole
xq4	optics	X-line quadrupole
xq5	optics	X-line quadrupole
xq6	optics	X-line quadrupole
xth3	optics	Horizontal trim magnet in X-line
xth4	optics	Horizontal trim magnet in X-line
xth5	optics	Horizontal trim magnet in X-line
xth7	optics	Horizontal trim magnet in X-line
xth9	optics	Horizontal trim magnet in X-line
xtv1	optics	Vertical trim magnet in X-line
xtv10	optics	Vertical trim magnet in X-line
xtv2	optics	Vertical trim magnet in X-line
xtv6	optics	Vertical trim magnet in X-line
xtv8	optics	Vertical trim magnet in X-line
xxf1	optics	Current tranformer at end of X-line
yb12	optics	Dual plane BPM in Y-line
yb5	optics	Dual plane BPM in Y-line
ybh10	optics	Horizontal plane BPM in Y-line
ybh4	optics	Horizontal plane BPM in Y-line
ybh6	optics	Horizontal plane BPM in Y-line

SiteWideName	type	comment
ybh8	optics	Horizontal plane BPM in Y-line
ybv1	optics	Vertical plane BPM in Y-line
ybv11	optics	Vertical plane BPM in Y-line
ybv2	optics	Vertical plane BPM in Y-line
ybv3	optics	Vertical plane BPM in Y-line
ybv7	optics	Vertical plane BPM in Y-line
ybv9	optics	Vertical plane BPM in Y-line
yd1	optics	Defocusing dipole in Y-line
yd10	optics	Focusing dipole in Y-line
yd11	optics	Focusing dipole in Y-line
yd12	optics	Defocusing dipole in Y-line
yd13	optics	Defocusing dipole in Y-line
yd14	optics	Focusing dipole in Y-line
yd15	optics	Focusing dipole in Y-line
yd16	optics	Defocusing dipole in Y-line
yd17	optics	Defocusing dipole in Y-line
yd18	optics	Focusing dipole in Y-line
yd19	optics	Focusing dipole in Y-line
yd2	optics	Focusing dipole in Y-line
yd20	optics	Defocusing dipole in Y-line
yd21	optics	Defocusing dipole in Y-line
yd22	optics	Focusing dipole in Y-line
yd23	optics	Focusing dipole in Y-line
yd24	optics	Defocusing dipole in Y-line
yd25	optics	Defocusing dipole in Y-line
yd26	optics	Focusing dipole in Y-line
yd27	optics	Focusing dipole in Y-line
yd28	optics	Defocusing dipole in Y-line
yd29	optics	Defocusing dipole in Y-line
yd3	optics	Focusing dipole in Y-line
yd30	optics	Focusing dipole in Y-line
yd31	optics	Pure dipole magnet at end of 90 degree arc in the y-line.
yd4	optics	Defocusing dipole in Y-line
yd5	optics	Defocusing dipole in Y-line
yd6	optics	Focusing dipole in Y-line
yd7	optics	Focusing dipole in Y-line
yd8	optics	Defocusing dipole in Y-line
yd9	optics	Defocusing dipole in Y-line
yend	optics	Optical marker at end of Y-line
yf1	optics	Flag profile monitor at end of Y-line
yf2	optics	Flag profile monitor at end of Y-line
ylamb	optics	Lambertson magnet at end of Y-line
yp1	optics	Vertical pitching magnet upstream of lambertson ylamb
yq1	optics	Y-line quadrupole
yq2	optics	Y-line quadrupole
yq3	optics	Y-line quadrupole
yq4	optics	Y-line quadrupole
yq5	optics	Y-line quadrupole
yq6	optics	Y-line quadrupole
yth3	optics	Horizontal trim magnet in Y-line
yth4	optics	Horizontal trim magnet in Y-line
yth5	optics	Horizontal trim magnet in Y-line
yth7	optics	Horizontal trim magnet in Y-line
yth9	optics	Horizontal trim magnet in Y-line

SiteWideName	type	comment
ytv1	optics	Vertical trim magnet in Y-line
ytv10	optics	Vertical trim magnet in Y-line
ytv2	optics	Vertical trim magnet in Y-line
ytv6	optics	Vertical trim magnet in Y-line
ytv8	optics	Vertical trim magnet in Y-line
yxf1	optics	Current transformer at end of Y-line
psswm	ps	Power supply for the switching magnet
psuarc4	ps	Power supply for the 4 degree bend in the U-line
psuarc8	ps	Power supply for the 8 degree bend in the U-line
psuq1	ps	Power supply for quadrupole in the U-line
psuq10	ps	Power supply for quadrupole in the U-line
psuq11	ps	Power supply for quadrupole in the U-line
psuq12	ps	Power supply for quadrupole in the U-line
psuq13	ps	Power supply for quadrupole in the U-line
psuq2	ps	Power supply for quadrupole in the U-line
psuq3	ps	Power supply for quadrupole in the U-line
psuq4	ps	Power supply for quadrupole in the U-line
psuq5	ps	Power supply for quadrupole in the U-line
psuq6	ps	Power supply for quadrupole in the U-line
psuq7	ps	Power supply for quadrupole in the U-line
psuq8	ps	Power supply for quadrupole in the U-line
psuq9	ps	Power supply for quadrupole in the U-line
psuth2	ps	Power supply for U-line trim magnet
psuth3	ps	Power supply for U-line trim magnet
psuth6	ps	Power supply for U-line trim magnet
psutv1	ps	Power supply for U-line trim magnet
psutv4	ps	Power supply for U-line trim magnet
psutv5	ps	Power supply for U-line trim magnet
psutv7	ps	Power supply for U-line trim magnet
pswarc20	ps	Power supply for 20 degree bend in the W-line
pswp1	ps	Power supply for upstream pitching magnet in the W-line
pswp2	ps	Power supply for the downstream pitching magnet in the W-line
pswq1	ps	Power supply for W-line quadrupole
pswq2	ps	Power supply for W-line quadrupole
pswq3	ps	Power supply for W-line quadrupole
pswq4	ps	Power supply for W-line quadrupole
pswq5	ps	Power supply for W-line quadrupole
pswq6	ps	Power supply for W-line quadrupole
pswth1	ps	Power supply for W-line trim magnet
pswth3	ps	Power supply for W-line trim magnet
pswth4	ps	Power supply for W-line trim magnet
pswth5	ps	Power supply for W-line trim magnet
pswtv2	ps	Power supply for W-line trim magnet
pswtv6	ps	Power supply for W-line trim magnet
psxarc90	ps	Power supply for X-line dipole buss
psxd31t	ps	Trim power supply for X-line dipole xd31
psxlamt	ps	Trim power supply for X-line lambertson magnet
psxp1	ps	Power supply for X-line pitching magnet
psxq1	ps	Power supply for X-line quadrupole
psxq2	ps	Power supply for X-line quadrupole
psxq3	ps	Power supply for X-line quadrupole
psxq4	ps	Power supply for X-line quadrupole
psxq5	ps	Power supply for X-line quadrupole
psxq6	ps	Power supply for X-line quadrupole

SiteWideName	type	comment
psxth3	ps	Power supply for X-line trim magnet
psxth4	ps	Power supply for X-line trim magnet
psxth5	ps	Power supply for X-line trim magnet
psxth7	ps	Power supply for X-line trim magnet
psxth9	ps	Power supply for X-line trim magnet
psxtv1	ps	Power supply for X-line trim magnet
psxtv10	ps	Power supply for X-line trim magnet
psxtv2	ps	Power supply for X-line trim magnet
psxtv6	ps	Power supply for X-line trim magnet
psxtv8	ps	Power supply for X-line trim magnet
psyarc90	ps	Power supply for Y-line dipole buss
psyd31t	ps	Trim power supply for Y-line dipole yd31
psylamt	ps	Trim power supply for Y-line lambertson magnet
psyp1	ps	Power supply for Y-line pitching magnet
psyq1	ps	Power supply for Y-line quadrupole
psyq2	ps	Power supply for Y-line quadrupole
psyq3	ps	Power supply for Y-line quadrupole
psyq4	ps	Power supply for Y-line quadrupole
psyq5	ps	Power supply for Y-line quadrupole
psyq6	ps	Power supply for Y-line quadrupole
psyth3	ps	Power supply for Y-line trim magnet
psyth4	ps	Power supply for Y-line trim magnet
psyth5	ps	Power supply for Y-line trim magnet
psyth7	ps	Power supply for Y-line trim magnet
psyth9	ps	Power supply for Y-line trim magnet
psytv1	ps	Power supply for Y-line trim magnet
psytv10	ps	Power supply for Y-line trim magnet
psytv2	ps	Power supply for Y-line trim magnet
psytv6	ps	Power supply for Y-line trim magnet
psytv8	ps	Power supply for Y-line trim magnet
ulm-ps1	ps	HV power supply for BLM's in A-trailer
wlm-ps1	ps	HV power supply for BLM's in 1000P (W-house)
xlm-ps1	ps	HV power supply for BLM's in 1007E
ylm-ps1	ps	HV power supply for BLM's in 1005E
5A-1	rack	PLC rack in 1005E
5B-1	rack	BLM instrumentation rack in 1005E
5B-2	rack	BPM instrumentation rack in 1005E
5B-3	rack	Instrumentation rack in 1005E
5B-4	rack	Controls rack in 1005E
5B-5	rack	Controls rack in 1005E
5C-1	rack	Rack of trim magnet power supplies in 1005E
5C-2	rack	Rack of trim magnet power supplies in 1005E
5C-3	rack	Rack of magnet voltage taps in 1005E
5C-4	rack	Rack in 1005E
5C-5	rack	Rack in 1005E
7A-1	rack	PLC rack in 1007E
7B-1	rack	BLM instrumentation rack in 1007E
7B-2	rack	BPM instrumentation rack in 1007E
7B-3	rack	Instrumentation rack in 1007E
7B-4	rack	Controls rack in 1007E
7B-5	rack	Controls rack in 1007E
7C-1	rack	Rack of trim magnet power supplies in 1007E
7C-2	rack	Rack of trim magnet power supplies in 1007E
7C-3	rack	Rack of magnet voltage taps in 1007E

SiteWideName	type	comment
7C-4	rack	Rack in 1007E
7C-5	rack	Rack in 1007E
A-1	rack	Magnet voltage taps in the A-House
A-2	rack	Rack for Trim magnet PLC in the A-House
A-3	rack	Rack for quadrupole PLC in the A-house
A-4	rack	Rack for g-2 trim magnet supplies (uth2.1, utv2.2)
ATRL-1	rack	Intrumentation rack in the A-trailer
ATRL-2	rack	BPM Instrumentation rack in the A-trailer
ATRL-3	rack	BLM Instrumentation rack int the A-trailer
ATRL-4	rack	Controls rack in the A-trailer
ATRL-5	rack	Controls rack in the A-trailer
ATRL-6	rack	Vacuum rack in the A-trailer
ATRL-7	rack	Vacuum rack in the A-trailer
ATRL-8	rack	Collimator rack in the A-trailer
ATRL-9	rack	g-2 rack in the A-trailer
WA-1	rack	Safety system rack in 1000P
WA-2	rack	BPM instrumentation rack in 1000P
WA-3	rack	BLM instrumentation rack in 1000P
WA-4	rack	Instrumentation rack in 1000P
WA-5	rack	Controls rack in 1000P
WA-6	rack	Controls rack in 1000P
WA-7	rack	Controls rack in 1000P
WA-8	rack	Rack in 1000P
WA-9	rack	Rack in 1000P
WB-1	rack	Safety system rack in 1000P
WB-2	rack	Vacuum rack in 1000P
WB-3	rack	Vacuum rack in 1000P
WB-4	rack	Vacuum rack in 1000P
WB-5	rack	Rack for magnet voltage taps in 1000P
WB-7	rack	Rack for trim magnets in 1000P
WB-8	rack	Rack for trim magnets in 1000P
WB-9	rack	Rack for trim magnets in 1000P
WC-2	rack	Rack for X and Y arc interlocks in 1000P
WC-4	rack	Rack for W-line quadrupole PLC in 1000P
acc1	vacuum	Cold-cathode gauge between AGS and U-line
ucc1a	vacuum	Cold-cathode gauge
ucc1b	vacuum	Cold-cathode gauge
ucc2a	vacuum	Cold-cathode gauge
ucc2b	vacuum	Cold-cathode gauge
ucc3a	vacuum	Cold-cathode gauge
ucc3b	vacuum	Cold-cathode gauge
ucc4a	vacuum	Cold-cathode gauge
ucc4b	vacuum	Cold-cathode gauge
ucc5a	vacuum	Cold-cathode gauge
ucc5b	vacuum	Cold-cathode gauge
ucc6a	vacuum	Cold-cathode gauge
ucc6b	vacuum	Cold-cathode gauge
ucc7a	vacuum	Cold-cathode gauge
ucc7b	vacuum	Cold-cathode gauge
ufs6	vacuum	fast-valve-sensor
ufv6	vacuum	fast-valve
uip1	vacuum	ion-pump
uip2	vacuum	ion-pump
uip3	vacuum	ion-pump

SiteWideName	type	comment
uip4	vacuum	ion-pump
uip5	vacuum	ion-pump
uip6	vacuum	ion-pump
uip7	vacuum	ion-pump
urv1	vacuum	roughing-valve
urv2	vacuum	roughing-valve
urv3	vacuum	roughing-valve
urv4	vacuum	roughing-valve
urv5	vacuum	roughing-valve
urv6	vacuum	roughing-valve
urv7	vacuum	roughing-valve
usv1	vacuum	sector-valve
usv2	vacuum	sector-valve
usv3	vacuum	sector-valve
usv4	vacuum	sector-valve
usv5	vacuum	sector-valve
usv6	vacuum	sector-valve
usv7	vacuum	sector-valve
utc1	vacuum	thermocouple
utc2	vacuum	thermocouple
utc3	vacuum	thermocouple
utc4	vacuum	thermocouple
utc5	vacuum	thermocouple
utc6	vacuum	thermocouple
utc7	vacuum	thermocouple
vsv1	vacuum	Sector-valve separating U-line from V-line
wcc1a	vacuum	Cold-cathode gauge
wcc1b	vacuum	Cold-cathode gauge
wcc2a	vacuum	Cold-cathode gauge
wcc2b	vacuum	Cold-cathode gauge
wcc3a	vacuum	Cold-cathode gauge
wcc3b	vacuum	Cold-cathode gauge
wcc4a	vacuum	Cold-cathode gauge
wcc4b	vacuum	Cold-cathode gauge
wcc5a	vacuum	Cold-cathode gauge
wcc5b	vacuum	Cold-cathode gauge
wcc6a	vacuum	Cold-cathode gauge
wcc6b	vacuum	Cold-cathode gauge
wcc7a	vacuum	Cold-cathode gauge
wcc7x	vacuum	Cold-cathode gauge
wcc7y	vacuum	Cold-cathode gauge
wip1	vacuum	ion-pump
wip2	vacuum	ion-pump
wip3	vacuum	ion-pump
wip4	vacuum	ion-pump
wip5	vacuum	ion-pump
wip6	vacuum	ion-pump
wip7	vacuum	ion-pump
wrv1	vacuum	roughing-valve
wrv2	vacuum	roughing-valve
wrv3	vacuum	roughing-valve
wrv4	vacuum	roughing-valve
wrv5	vacuum	roughing-valve
wrv6	vacuum	roughing-valve

SiteWideName	type	comment
wrv7	vacuum	roughing-valve
wsv1	vacuum	sector-valve
wsv2	vacuum	sector-valve
wsv3	vacuum	sector-valve
wsv4	vacuum	sector-valve
wsv5	vacuum	sector-valve
wsv6	vacuum	sector-valve
wsv7	vacuum	sector-valve
wtc1	vacuum	thermocouple
wtc2	vacuum	thermocouple
wtc3	vacuum	thermocouple
wtc4	vacuum	thermocouple
wtc5	vacuum	thermocouple
wtc6	vacuum	thermocouple
wtc7	vacuum	thermocouple
xcc1a	vacuum	Cold-cathode gauge
xcc1b	vacuum	Cold-cathode gauge
xcc2a	vacuum	Cold-cathode gauge
xcc2b	vacuum	Cold-cathode gauge
xcc3a	vacuum	Cold-cathode gauge
xcc3b	vacuum	Cold-cathode gauge
xcc4a	vacuum	Cold-cathode gauge
xcc4b	vacuum	Cold-cathode gauge
xcc5a	vacuum	Cold-cathode gauge
xcc5b	vacuum	Cold-cathode gauge
xcc6a	vacuum	Cold-cathode gauge
xip1	vacuum	ion-pump
xip2	vacuum	ion-pump
xip3	vacuum	ion-pump
xip4	vacuum	ion-pump
xip5	vacuum	ion-pump
xip6	vacuum	ion-pump
xrv1	vacuum	roughing-valve
xrv2	vacuum	roughing-valve
xrv3	vacuum	roughing-valve
xrv4	vacuum	roughing-valve
xrv5	vacuum	roughing-valve
xrv6	vacuum	roughing-valve
xsv1	vacuum	sector-valve
xsv2	vacuum	sector-valve
xsv3	vacuum	sector-valve
xsv4	vacuum	sector-valve
xsv5	vacuum	sector-valve
xsv6	vacuum	sector-valve
xtc1	vacuum	thermocouple
xtc2	vacuum	thermocouple
xtc3	vacuum	thermocouple
xtc4	vacuum	thermocouple
xtc5	vacuum	thermocouple
xtc6	vacuum	thermocouple
ycc1a	vacuum	Cold-cathode gauge
ycc1b	vacuum	Cold-cathode gauge
ycc2a	vacuum	Cold-cathode gauge
ycc2b	vacuum	Cold-cathode gauge

SiteWideName	type	comment
ycc3a	vacuum	Cold-cathode gauge
ycc3b	vacuum	Cold-cathode gauge
ycc4a	vacuum	Cold-cathode gauge
ycc4b	vacuum	Cold-cathode gauge
ycc5a	vacuum	Cold-cathode gauge
ycc5b	vacuum	Cold-cathode gauge
ycc6a	vacuum	Cold-cathode gauge
yip1	vacuum	ion-pump
yip2	vacuum	ion-pump
yip3	vacuum	ion-pump
yip4	vacuum	ion-pump
yip5	vacuum	ion-pump
yip6	vacuum	ion-pump
yrv1	vacuum	roughing-valve
yrv2	vacuum	roughing-valve
yrv3	vacuum	roughing-valve
yrv4	vacuum	roughing-valve
yrv5	vacuum	roughing-valve
yrv6	vacuum	roughing-valve
ysv1	vacuum	sector-valve
ysv2	vacuum	sector-valve
ysv3	vacuum	sector-valve
ysv4	vacuum	sector-valve
ysv5	vacuum	sector-valve
ysv6	vacuum	sector-valve
ytc1	vacuum	thermocouple
ytc2	vacuum	thermocouple
ytc3	vacuum	thermocouple
ytc4	vacuum	thermocouple
ytc5	vacuum	thermocouple
ytc6	vacuum	thermocouple