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BEAM ME! Life in the B1 beam line

D. Beavis

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Collider Accelerator Department
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Brookhaven National Laboratory
Associated Universities, Inc.
Upton, New York 11973

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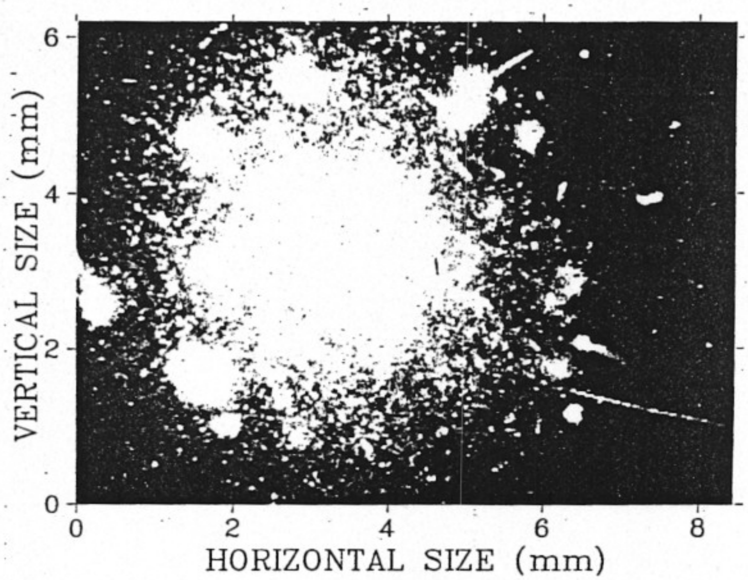

Fig. 4 Focussed beam profile of 14 GeV protons integrated for 1/30 sec during a 1/2 sec beam spill. Note the low to medium energy heavy ion tracks from nuclear fragmentation that are due to proton induced nuclear reactions.

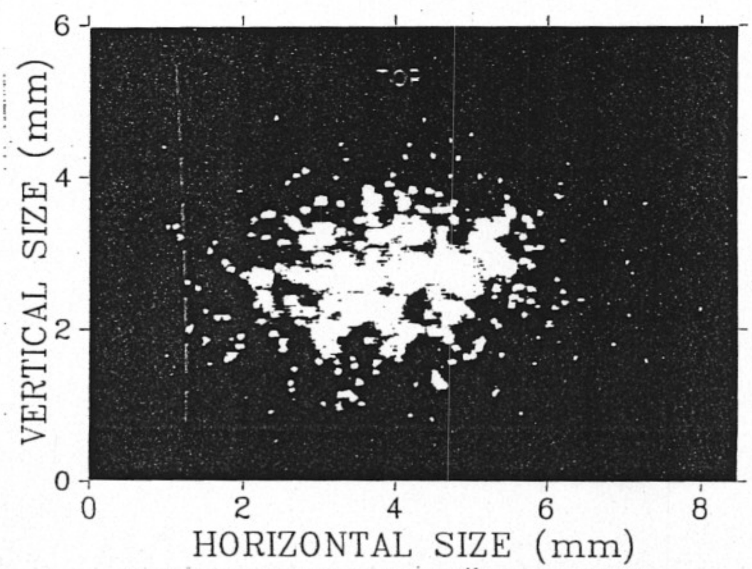

Fig. 3 Focussed beam profile of 14 GeV/amu ^{16}O ions integrated for 1/30 sec (one tv frame) during a 1/4 sec beam spill (see text).

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B1 BEAM LINE

Design Considerations

The B1 beam line was designed to satisfy several simple goals. These goals to transport heavy ion beams, transport secondary beams of either polarity from the B target, and satisfy the desired beam characteristics at the experimental target. Given below is a brief summary of these considerations and their effects on the beam line design and implementation.

The transport of full energy heavy ion beams to Experiment 802 established several beam line requirements. The rigidity of the ion beams at 14.25 GeV/nucleon requires the dipoles to have a field integral of 16.6 kg-m for each degree of bend. Therefore, there are constraints on the size of the dipole bends achievable in the beam line. This also implies that the dipole gaps should be as small as possible. Constraints on the types of quadrupole magnets that can be used to focus beams of such high rigidity are also imposed. The beam line should "view" a target station at zero degrees for the transport of the primary beam past the target station to the secondary beam line.

The next constraint on the beam line design comes from the experimental targeting requirements. A small beam spot size in the horizontal (x) and vertical (y) dimensions implies that the lateral magnification in both dimensions is less than or equal to unity. In addition, the beam transport matrix (R) must be as diagonal as possible at the experimental target. The requirement for small lateral magnification puts constraints on the relative separation between object position (target or ion source), the focussing elements (quadrupoles), and the image position (experimental target). To achieve horizontal stability during the spill requires the dispersion at the target position to be zero (R(1,6)=0 in transfer matrix). This arises because of the momentum bite stored in a strong focussing machine and the extraction process which causes the high momentum phase space to be extracted first, producing a correlation between the extracted momentum and the time within the flat-top. For proton running the momentum changes .6–.8% across the flat-top.

The obtainment of high beam purities for heavy ion beams puts constraints on the beam line instrumentation and vacuum. However, the beam line vacuum can be quite poor (100 microns) and still produce little contamination. Therefore, the primary goal is to avoid air gaps and to have vacuum compatible, plunging instrumentation in the beam line. The instrumentation will be discussed in another section below.

The use of secondary particles produced at the B target introduces several additional constraints. A four jaw collimator, B1C1, is located downstream of the first bend in order to provide for momentum selection. With point-to-point imaging from the B target to B1C1, a momentum resolution of 1–3% (the resolving power is 5/%) is achievable. This collimator also provides for intensity control of the secondary beam. A horizontal focus is required between B1D3 and B1D4 if a non-dispersive tune (R(1,6)=0) is to be achieved at the experimental target, since both bends in the beam line are in the same direction. Therefore, the horizontal focus at B1C1 is used to achieve momentum selection and the non-dispersive tune at the E802 target. During heavy ion running, the B1C1 collimator provides for removal of beam fragments produced upstream in the beam line, by selecting a momentum window centered about the beam momentum. It can also remove fragments that have more divergence than the beam if a point-to-parallel tune is used from the contamination source to B1C1 in the vertical dimension. The collimator can also be used as an intensity control for heavy ions, although this is a less desired function. The achievement of small secondary beam spots at the E802 target puts similar constraints on relative positions of elements as discussed for the heavy ion beams.

Most of the constraints limit the variability of the horizontal tune, but are less restrictive on the vertical focussing. This provides for some freedom in the vertical tuning depending on what is desired to be optimized, i.e. beam intensity, beam purity, spot size, or position stability.

The B1 Beam Line

The beam line is shown in AGS drawing D14-1269, which is not given here , but copies are available. Appendix A contains details of the beam line including: a listing of the beam elements, element positions, and various figures giving the field integrals as a function of current for the various magnets. Since some of the dipole curves are for magnets with gaps which are different from the actual gaps used in the beam line, it is necessary to appropriately scale the current and effective length with the ratio of the gaps. Accurate excitation curves (Bdl vs I) do not exist for all the dipoles. Past construction schedules have not allowed the attainment of proper measurements. These measurements should be conducted, when scheduling permits.

The transport of full energy heavy ion beams requires the use of both B1D1 and B1D2 to achieve the necessary bend of 4.87 degrees. During most secondary beam running, E791 will control the current of B1D1 (and B1Q1 and B1Q2) to bend the proton beam into their beam line. The B1 beam line is then designed to accept half energy (actually half-momentum) secondary particles of negative polarity. In this case, the magnet B1D2 can not be used since it would affect the transport of the beam for E791. A small magnet, B1D3, is then used to complete the necessary bend and put the beam on axis. Magnets B1D2 and B1D3 are powered by the same power supply. The power supply has a transfer switch which determines which of the magnets receives the current. In addition, when E791 controls the front quadrupoles there will not be a focus a B1C1 and the momentum acceptance of the beam line will be increased causing a momentum dispersed beam at the E802 target. When E791 is not running , E802 can select the polarity and the current of B1D1 thus providing the desired energy and polarity of the secondary beam.

The top energy of the beam line is limited by several considerations. Presently, the beam line is approved to use secondary beam up to 15 GeV/c. Naturally, the beam line has the capability to transport full energy proton beam with the use of B1D1 and B1D2. The beam line was approved to use both B1D1 and B1D2 for secondary positive running. However, later concern that the interlock devices used to prevent the excursion of the magnet currents to values large enough to enable transport of the primary proton beam (10^{12}–10^{13} protons/spill) were not sufficiently tested caused this approval to be removed. The beam line is therefore only allowed to use the combination of B1D1 and B1D3 for secondary beams. With these magnets it is not possible to tune the primary proton beam out of the B target cave. This decision will be reconsidered in the future when additional testing of the current limiting devices is completed. The maximum current in magnet B1D1 establishes the upper limit to the beam momentum of approximately 16 GeV/c.

Another consideration on the maximum allowed energy is the length of the beam stop. The beam stop is presently designed to stop 15 GeV/c muons. At higher energies the muons will begin to leak through the primary beam dump and produce safety problems. Therefore, the maximum energy allowed will be based on the amount of leakage.

A transport calculation of a secondary proton beam at 14.25 GeV/c is shown in Figure 1. This tune displays the qualitative features of most typical secondary beam tunes in the B1 line. Briefly, these are:

i)acceptance of the beam line is determined by the aperture of the front quadrupoles B1Q1 and B1Q2.

ii)A focus in both the vertical and horizontal dimensions at the B1C1 collimator.

iii)Horizontal size of the beam at B1C1 is determined by the momentum bite desired or the dp/p of the beam. This is clearly seen in Figure 2 which shows the same tune as Figure 1 but with dp/p=0.

iv)The larger aperture quadrupoles (B1Q3-B1Q6) at the back of the beam line are necessary if the limiting aperture of the beam line is to be located upstream of B1C1. This requirement helps to reduce halo in the experimental area.

v)The focus achieved at the experimental target of approximately 3mm verticle and 4mm horizontal. These numbers do not include halo.

Several secondary tune have been established for the beam line. In Tables I and II are the tune values for 2 GeV/c negatives and 14.5 GeV/c positives. To establish the same type of focussing at a different energy one can scale the currents from these tunes by the ratio of the momenta. Some violation of this scaling occurs because at high energies the magnets lose the linearity between field and current, and at low fields there can be substantial hysteresis effects (1–2%). For scaling over large changes, it is best to refer to the field integral curves verses current to take into account these non-linearities in the magnet behaviour.

The primary differences between secondary beam tuning and heavy ion beam tuning are beam emitance, object position, and intensity control. Details of the the heavy ion beam will be discussed next.

Heavy Ion Beams

The AGS extracts heavy ions with intensities ranging from 10^8–10^9 ions/spill. Presently, these intensities are needed for the feedback systems used for acceleration and extraction to operate. There are plans in the future to operate the AGS in an "open loop" mode, which when successful will enable the extraction of any intensity up to the maximum. However, until this operating mode is achieved it will be necessary to operate with intensities in the 10^8–10^9 ions/spill range. Since most experiments desire intensities on the level of 10^4 ions/spill it is necessary to introduce techniques to reduce the beam intensity by approximately four to five orders of magnitude.

The intensity reduction is accomplished using several simple techniques. The first stage of the intensity reduction is accomplished by using the beam splitting system in the AGS switchyard. This system consists of a series of electrostatic splitters and thin septum magnets which divides the beam into four pieces. This enables the four primary beam lines to run simultaneously and can be used to control the intensity to an individual beam line from approximately 1–100% of the extracted beam intensity. During the heavy ion running period in October/November 1986, this system was used to provide approximately 5% of the extracted beam to the B line for experiment 802.

The B transport optics are then used to provide a large defocussed beam (approximately 1in by 1in) on an intensity collimator. The intensity collimator, BC1, is a four jaw vacuum collimator located in the AGS switchyard cave, approximately 27 meters upstream of the B Target. The aperture of the collimator is adjusted to produce the maximum desired intensity in the B1 beam line. The collimator is not controlled by the experiment because of safety considerations. The collimator aperture is adjusted by MCR (main control room) and disconnected once the desired aperture is achieved. This procedure is necessary to prevent inadvertent movement of the collimator jaws which might allow the full AGS beam intensity to be delivered to experiment 802.

The remaining B transport elements are then used to deliver the beam to the B1 beam line. These elements consist of three quadrupoles (BQ11-BQ13) and a small pitching magnet. These magnets are under the control of MCR. MCR can be requested to adjust the currents of these magnets to achieve the type of tune desired into the B1 line. Last October/November these quadrupoles were used to achieve a focus near the B target. With a focus at the B target the heavy ion tuning can be viewed as identical to that of a secondary beam in the B1 line except for the difference in emittance (see Table III for tune from Oct./Nov. 1896). Tunes of this type (focussed at the B target) can produce large values of the transfer matrix R(3,4) (maps dy/dz to y; values of 4cm/1mr are easily achieved) from the intensity collimator to the B1C1 collimator. This enables the vertical jaws of B1C1 to remove projectile fragments with vertical divergence greater than the beam. However, based on previous experience, this type of tune appears not to be necessary. For April 1987 a simpler tune will be tried. The magnet settings for this tune are given in Table IV and the transport calculation of the beam envelope is shown in Figure 3. For this tune the quadrupoles BQ11-BQ13 are left off. The advantages of this tune are lower power consumption, fewer magnets used, and smaller lateral magnification (smaller beam size) at the experimental target.

Stability of the beam position on the experimental target is desired. With the above tune, the dispersion (R(1,6)) at the experimental target is zero. Therefore, if the tune is achieved in practice, then the beam should not move on the experimental target due to changes in the beam momentum. In addition, the transfer matrix element R(1,2) (maps dx/dz to x) is also approximately zero, which means the position should be stable with respect to possible changes of the angle that the ions come through the intensity collimator. A small dipole, B1D181, is located immediately downstream of B1D6, which can be used for servo-control of the beam position or linear ramping. Because of the difficulties in placing an active beam detection device in the beam line for servo-control of this magnet, it has been decided to use a linear function generator (ramp) on this magnet in order to provide additional stablity of the beam, if necessary. The magnet ramp is controlled by MCR at present. A ramp control from another magnet is being used for April 1987, which is why the ramping control is done from MCR. This was necessary to ensure that the control would be ready before the beginning of the heavy ion run. In the future, if this ramping is necessary, a dedicated ramping control will be added and will then be under E802 control.

A summary of the beam line characteristics is given in Table V.

BEAM LINE CONTROL

The beam line elements and spectrometer magnet are controlled using the program DIBBUK. A manual describing the commands and the system is given in appendix B. The manual is fairly clear and simple, so I will restrict my comments to a few simple points.

i) The polarity displayed is the actual polarity of the magnet.

ii) For dipoles, A polarity bends a positive beam left.

iii) For pitchers, A polarity bends a positive beam upwards.

iv) For a quadrupole, A polarity causes a positive beam to be focussed in the horizontal plane.

v) B polarity has the opposite effect.

vi) When adjusting the dipoles, it is important to remember that some of the dipole currents (B1D1 and B1D4-6) are monitored as part of the beam interlock system and therefore should not be adjusted beyond their allowed tolerances.

vii) When changing the focal point, if is usually required to change the current in the horizontal and vertical quadrupoles.

viii) The tune box uses DIBBUK values not current and it changes the setpoint for a magnet as it is being tuned.

ix) Several elements of the beam line (B1Q1,B1Q2, and B1D1) can sometimes be in shared status. Shared status means that you can observe the magnet values but you do not have control of the element. During these times, E791 is in control of the common portion of the B1/B5 beam lines. Should E802 need control of these elements, then target desk can be requested to put them under the control of E802.

B1 BEAM LINE INTERLOCK SYSTEM

The purpose of the beam line interlock system is to protect personnel from radiation hazards in the beam and by reaction products from beam interactions. The level of interlock security and redundancy depends on the potential hazard (dose) that may be achieved under normal and fault conditions. The B1 beam line interlock logic is given in Table C3. Some description of the interlock system is given in the radiation safety proposal for experiment 802, which is contained in appendix C. The protection is achieved by a series of hardwired gates, radiation monitors, beam plug, and current checks on magnets in the beam line. The actual combination used will depend on the mode of the operation of the beam line . The user should familiarize himself with these modes (negative secondaries, positive secondaries, and heavy ions) by following through the interlock logic given in Table C3. A brief description of these operating modes and the interlock system will be given below.

Area Interlocks

There are two interlocked areas associated with the B1 beam line. The first area is the B1 secondary cave. This area contains the downstream beam line transport elements and the vacuum box that contains the veto counters, UDEW. The access gate to this are must be reset to satisfy the beam line interlock. The gate panel has lights that indicate if the gate is reset. Also, the main B1 interlock panel has indicator lights that show which of the interlock points of the interlock logic are satisfied, including this gate. This security panel is located near the beam counter fast electronics between the E802 area fence and the E791 electronics house (two story condo). The gate into the B1 secondary cave can only be reset by health physics (HP). If the gate needs to be reset, call MCR and request that the gate be reset.

The second area protected by interlocks is the E802 experimental area. This area has two gates. The gate at the far end (west side) of the area near the back of the spectrometer platform is the B1 escape gate. The B1 area is sufficiently large that it requires two exit points in case of emergencies. This gate is hardwired into the interlock system. It can be used as an exit under any conditions. However, the gate has no keyed access mode, and is therefore not used for area access during normal beam operations. This gate has an indicator light on the main security panel. The main access gate is the gate at the back of the area near the beam stop. This gate has a key access panel for access control during beam operations. Indicator lights exist on the panel at the gate which give the status of the area and the gate. The gate is hardwired into the interlock logic . The gate has two keyed modes. The first is the reset by the experimenter. This enables the low intensity mode for secondary beam operations. The other reset mode is the HP reset position. This enables the high intensity mode for secondary beams and the heavy ion mode. This reset can only be done by HP. If the high intensity mode is required then request (through MCR) for HP to reset the B1 experimental gate. The HP reset over-rides the experimental reset and therefore the experimental reset is not required when the HP reset is used.

The experimental area must be properly "swept" before the experimental gate is reset. The person resetting the gate has the responsibility to clear the experimental area of all personnel before resetting the gate. It is very important that this person take the time to properly check the area, looking behind all obstructions for persons and physically walking the entire area. When the area sweep is being conducted, it is advised that the person close the gate and carry the key with him. This prevents other personnel from entering the area behind the him and possibly evading his attention. Any gate resetting with personnel in the area will result in loss of privilege for experimenter control of the gate. Should questions arise on the interlock procedure, consult with a knowledgeable person or the Liaison Physicist.

High/Low Intensity Modes

The B1 experimental area has a low and high intensity mode of operation. The low intensity mode is enabled by the experimenter reset on the B1 experimental area gate. The high intensity mode is enabled by the HP reset on the access gate. The distinction between these two modes of operation is the allowed level of beam intensity. The beam intensity is monitored by a radiation paddle in the beam line which measures the amount of beam. This monitor (NMC) has two trip points, one for low intensity and one for high intensity. These trip points are set by HP and the Liaison Physicist. Occasionally the response of this counter may change after the trip points have been set. Should this arise, the experimenter should call MCR and request that the level be readjusted. Problems with the low intensity can be circumvented on a temporary basis by using the high intensity mode.

The low intensity mode corresponds to a class IV radiation area (see Table C2). For normal operations of the B1 beam line this corresponds to an intensity of approximately 10^5 protons/spill (see Table C1). The high intensity mode corresponds to approximately 3×10^6 protons/spill (see Table C1). The small heavy ion fluxes allowed under low intensity operation are not very practical for data taking. Therefore, no low intensity mode presently exists for heavy ion operations.However, if such a mode is necessary for equipment debugging, then a low intensity mode can be incorporated. The low intensities allowed for heavy ion operations is a result of the small beam spot that can be achieved and the large quality factor associated with heavy ions relative to protons. However, the high potential hazard of the heavy ions is an in beam hazard. If appropriate enclosures, such as a beam pipe, prohibit direct access to the beam, then the surrounding area can be given a lower radiation class. The E802 experiment will be allowed to run at levels associated with class II radiation areas if there are no air gaps in the beam line and the beam is sufficiently controlled that it can not be tuned out of the beam pipe. This will be the expected mode of operation for the experiment. To maintain the beam in the small diameter beam pipe in the experimental area the tolerance on the current comparator will be decreased from the standard 15% to approximately 2-3%. Also, short periods of running at higher intensities may be allowed after review of the running history. Procedures will be implemented for short (1-2 shifts) runs at elevated intensities. In the future, additional devices will be implemented to enable longer periods of running at high intensities.

Current Comparator (B1D1/B1D4-6)

The B1 beam line has two primary bends, one by magnet B1D1 and the other by magnets B1D4 through B1D6 (connected in series). If the beam line is properly tuned for a particular momentum, then the ratio of the currents in the power supplies for these magnets should be a fixed value. A current comparator monitors the ratio of the currents in these power supplies to protect from inadvertent mis-tuning of the dipoles or power supply failures. Once a beam tune has been established, the experimenter should call MCR and request that the target desk zero the current comparator for the beam line. Once it has been set, it should not need readjustment. Normally, changes in the beam line energy should not require the current comparator to be reset. However, when changing from high energy (14.5 GeV/c) to low energy (2 GeV/c), the dipole B1D1 does not have a linear response and the current comparator will need to be reset. This is also necessary when switching from heavy ion operations to secondary beam operations, because of the use of B1D2 instead of B1D3 in the heavy ion mode. The current comparator also has a tolerance. The tolerance is usually set at 15% for secondary beam operations. The tolerance will be decreased to 2-3% during heavy ion operations to prevent tuning the beam out of the beam pipe. The tolerance setting is a radiation safety adjustment and should not be touched by the experimenter. Should the allowed tolerance present a problem to the experiment, then a request should be made to the Liaison Physicist to modify the setting. The tolerance is adjusted by the AGS beam line security personnel.

Negative Secondaries

The primary interlock protection during negative secondary beam operations is the beam plug and access gate. Measurements in the past have shown that with the collimator open (B1C1) and the transport elements on, that the beam plug reduces levels in the beam line to approximately 2mr/hr. Therefore, it provides sufficient protection for entry into the area. However, it is recommended that B1D1 be put in standby or the collimator B1C1 be closed (or both) if personnel will be working in the area for extended periods.

The beam plug control is in the E802 electronics house. The green light indicates that the area is safe (the beam plug is down in the beam line). The red light indicates that the beam plug is fully withdrawn. To operate the beam plug, hold the switch in the up position (to remove the plug) or in the down position (to put the plug in) until the appropriate light comes on. The plug usually takes about 7 seconds to move its full travel distance.

The experimental area can be accessed by putting in the beam plug and using the key in the experimental gate. After access, the beam can be operational by sweeping the experimental area, resetting the access gate, and removing the beam plug. It is not required to change any other beam line elements to access the area during negative secondary operations.

Positive Secondaries

The positive secondary beam has higher possible beam intensities than the negative and therefore has more potential hazard. Levels of 30 mr/hr have been measured in the experimental area at 15 GeV/c with the transport optics on, B1C1 open, and the beam plug in. It therefore appears that the beam plug does not provide sufficient protection for access to the area. Additional interlock logic is necessary to provide adequate protection. The power supplies for the first bend in the beam line (B1D1 and B1D2/B1D3) are therefore interlocked. To access the area during positive secondary beam operations one inserts the beam plug, puts B1D1 and B1D2/B1D3 in standby, and then opens the access gate with the key. To enable beam operations the experimenter should sweep the area, reset the access gate, power up B1D1 and B1D2/B1D3 to the proper setpoint, and then open the beam plug. These steps must be done in the order given or the interlock system will not be satisfied (see Table C3).

Heavy Ion Beams

Access to the area for heavy ion operations is the same as for positive secondary beam. It may be possible that the beam plug will provide sufficient protection without requiring that the dipoles be put in standby. This will be tested during the heavy ion run in April 1987 and if desired the interlock system can be modified. However, until that time the dipoles will be interlocked when the heavy ion beam is in operation.

Interlock Trips

The interlock system is "tripped" if any component violates the interlock logic. An interlock trip will cause the beam plug to be inserted and the AGS beam stops to go in (prevents additional beam from being injected and extracted). In addition, during heavy ion or positive secondary beams the power supplies for B1D1 and B1B2/B1D3 will be put in standby. To regain beam operation the experimenter should reestablish the interlock logic and push the interlock reset (located on the main security panel and in the E802 counting house). MCR should also be informed of the reason for the interlock trip.

AGS BEAM LINE INSTRUMENTATION

The AGS provides several types of devices for monitoring and tuning primary beam transport. The types of device will be briefly described below. The actual devices used will depend on the operation mode of the AGS (polarized proton, proton SEB, and heavy ion).

AGS Devices

A summary of the AGS devices is:

Ion Chambers—A device used to beam the beam intensity. Ion chambers are used during low intensity operation (heavy ions and polarized protons).

SEC—A secondary emission chamber used to measure beam fluxes during high intensity operations (proton SEB).

Target Telescope—A three fold coincidence of scintillation counters that view the target at 90 degrees in the lab. The device provides a relative measure of the number of interactions in the target. Target telescopes are used during proton SEB operations.

SWIC—A segmented wire ionization chamber. These devices provide x and y profiles of the beam. They are used for beam tuning. The type of SWIC that is used will depend on the operational mode of the AGS.

Flag—This is a material that fluoresces when the charged particle beam deposits energy in it. They are view by a video camera providing a two dimensional display of the beam. Flags are used during all operating modes, but the flag material used will depend on the intensity of the primary beam.

Loss Monitors— These devices are used by MCR to detect large beam losses in the primary beam transport. They are primarily used for proton SEB operations.

AGS B/B1 Beam Line Instrumentation—Secondary Beams

All AGS instrumentation signals are provided to E802 by means of signal cables or the T.V. monitor. The signal cables are located in the rack with the DIBBUK tune box. It is important to remember that these signals are connected to the AGS ground at their source. The signal cables come from the B' instrumentation racks near gate 9 to the B target cave. The T.V. monitor provides a display of some selected SWICs and flags as well as targeting information. A list of channel number to device for the T.V. monitor can be obtained from MCR.

The B line has an SEC, BSEC, located immediately upstream of the B target. The signal (discrete pulses) is carried on a cable into the E802 counting house. A conversion of the counts to particles is given on the T.V. monitor for the B target. The B target station also has a telescope , BTEL. The values are available on a signal cable and on the T.V. monitor. The ratio of BTEL to BSEC gives a measure of how well the beam is being targeted. These devices are used during proton SEB operations.

A flag and SWIC are located immediately upstream of the B target. The flag and SWIC displays are provided on one of the T.V. monitor channels (consult MCR for which channel). The SWIC signal (horizontal. and vertical.) is also available on signal cables for display on a scope.

Four plunging SWICs are being installed in the B1 line. These devices are intended for use during heavy ion operations but can be used for secondary beam tuning. They are not expected to be sensitive to minimum ionizing particles below a flux of approximately 10^6 particles/spill. These will be described below.

AGS B/B1 Beam Line Instrumentation—Heavy Ions

The relevant instrumentation will be listed in sequential order from the AGS switchyard. A SWIC and ion chamber are located in a 22 inch air gap immediately upstream of the intensity collimator, BC1. This collimator approximately 27 meters upstream of the B target and the instrumentation is often referred to by B384. The ion chamber counts are available by signal cable in the E802 counting House. In addition, a plunging vacuum flag is also located immediately before BC1. The flag and SWIC displays are available on the T.V. monitor.

A flag is located between BC1 and the B target. The display may not be available for the experimenter. It is used for initial tuning of the beam through the intensity collimator is probably not sensitive to the beam intensities that the experiment will run.

Four plunging vacuum SWICs are planned for installation in the B1 line. These SWICs have new high gain electronics which enable them to be sensitive to approximately 10^4 oxygen ions per spill. The experiment will be able to control insertion and removal of these SWICs. However, the location of the controls for the April 1987 run is not yet determined. It the future the controls will be located in the E802 counting house. All signals from these SWICs are available for display in the E802 counting house. These SWICs are:

A SWIC with 3 mm wire spacing will be located immediately upstream B1Q2. However, the high radiation levels in the area will prevent installation of this SWIC until the summer 1987.

A SWIC with 1 mm wire spacing will be located immediately downstream of the collimator B1C1.

A SWIC with 2 mm wire spacing will be located immediately upstream of B1D4.

A SWIC with 1 mm wire spacing will be located 1 meter upstream of the E7802 target.

An ion chamber is located immediately downstream of the zero degree snout of the B5C1 collimator. This ion chamber is used to measure the beam intensity transmitted through BC1 and to establish the aperture of BC1. The signal from the ion chamber is available in the counting house.

Several other signals are provided for timing relative to the AGS. These are:

T0, which is a positive pulse sent out at the beginning of the AGS main magnet ramp.

1 kc, which is a 1 kHz wave train with T0 superimposed. It is often used for old style predets.

10 kc, which is a 10 kHz wave train with T0 superimposed. It is often used for the programmable predets.

TABLE I

2 GeV/c Negative Tune

DIBBUK Name	Setpoint DIB. cnts	Polarity	Current (amps)
Q01	189.	A	118.
Q02	151.	B	95.
D01	416.	B	260.
D23	225.	B	225.
D46	290.	B	290.
Q34	160.	B	99.
Q56	124.	A	124.

1) Values taken from E802 Logbook IV page 50.

2) D46 is only magnet B1D5. B1D4 and B1D6 were "jumped" out to provide for more control of this bend at low momentum.

3) The power supply transfer switch for B1D2/B1D3 is in the B1D3 position.

TABLE II

14.5 GeV/c Positive Tune

DIBBUK Name	Setpoint DIB. cnts	Polarity	Current (amps)
Q01	1360.	B	850.
Q02	1065.	A	670.
D01	3550.	A	2219.
D23	1822.	A	1822.
D46	712.	A	712.
Q34	1150.	A	720.
Q56	890.	B	890.

1) Values achieved 12/9/86.

2) The power supply transfer switch for B1D2/B1D3 is in the B1D3 position.

TABLE III

14.5 GeV/c/nucleon Oxygen Tune

DIBBUK Name	Setpoint DIB. cnts	Polarity	Current (amps)
Q01	2829.	B	1768.
Q02	2240.	A	1400.
D01	3550.	A	2200.
D23	1069.	A	1069.
D46	1454.	A	1454.
Q34	2049.	A	1281.
Q56	1462.	B	1462.

1) Values from E802 Logbook III page 65.

2) The power supply transfer switch for B1D2/B1D3 is in the B1D2 position.

3) The quadrupoles BQ11–BQ13 were on (BQ11 and BQ12 in series at 2000A and BQ13 at 3200B).

4) The beam was focussed downstream of E802 pivot where the SWIC was located.

TABLE IV

14.5 GeV/c/nucleon Calculated April 1987 Tune

DIBBUK Name	Setpoint DIB. cnts	Polarity	Current (amps)
Q01	1387.	B	867.
Q02	1485.	A	928.
D01	3550.	A	2200.
D23	1069.	A	1069.
D46	1454.	A	1454.
Q34	2302.	A	1439.
Q56	1692.	B	1692.

1) The power supply transfer switch for B1D2/B1D3 is in the B1D2 position.

2) The quadrupoles BQ11–BQ13 will be off.

TABLE V

SUMMARY of B1 BEAM LINE CHARACTERISTICS

Secondary Beams

Source–B Target

x=1mm y=1mm

x′=2mr y′=6mr

dp/p=1–3%

Maximum Intensity is 10^7 negatives/spill (at 15 GeV/c)

Maximum Intensity is 10^8 positives/spill (at 15 GeV/c)

Maximum Energy (approved) is 15 GeV/c

E802 Target (73.6 meters from B target)

R(1,6)=0. (Non-dispersive)

x=2mm y=2mm

x′=2mr y′=4.5mr

Heavy ions (oxygen)

Source–BC1 Collimator Aperture (27 meters upstream of B target)

x=2mm y=2mm

x′=.06mr y′=.06mr

E802 Target

x=1mm y=.5mm

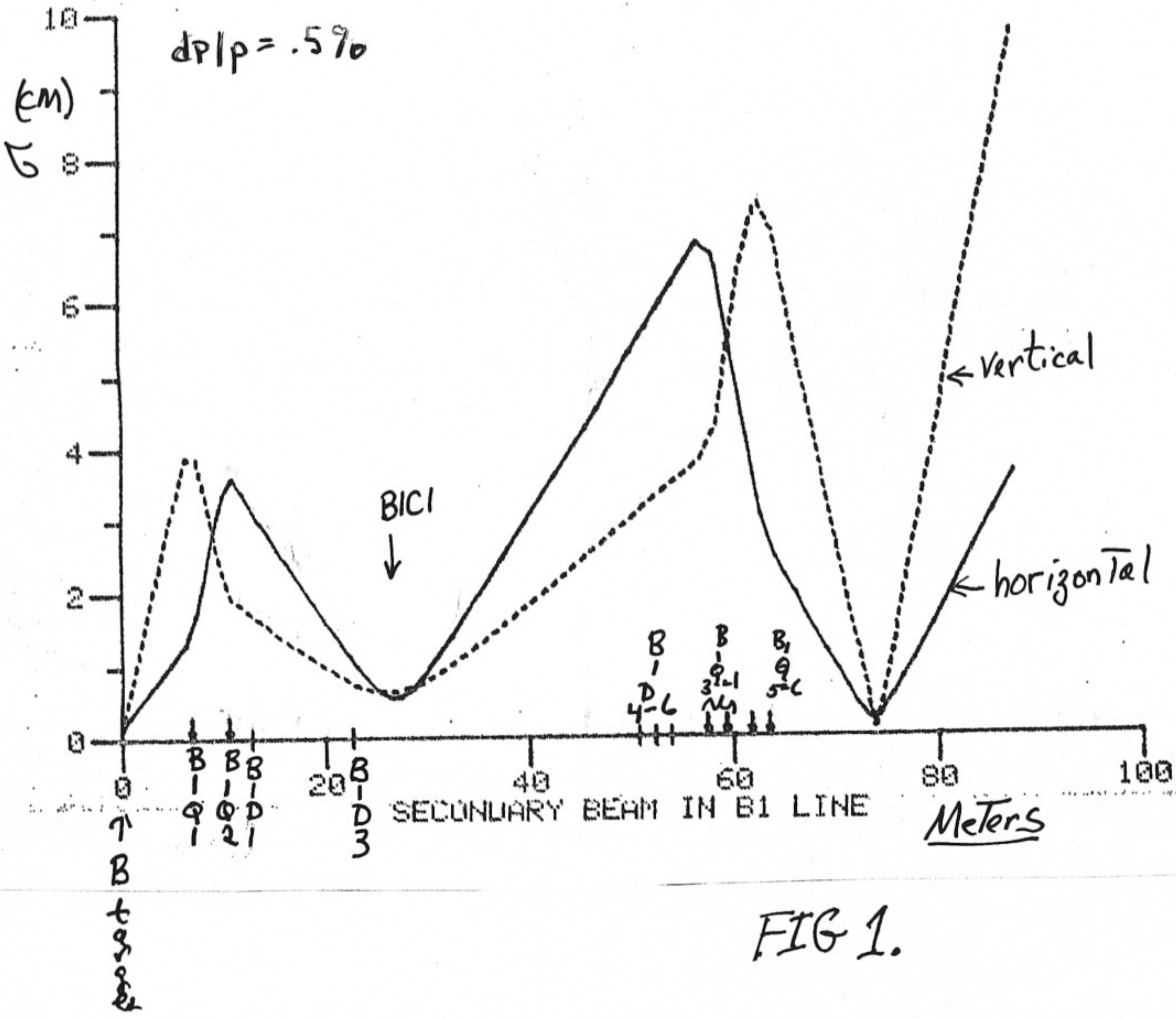
x′=1mr y′=2mr

FIGURE CAPTIONS

Figure 1: Beam size verses position (dp/p=.5%).

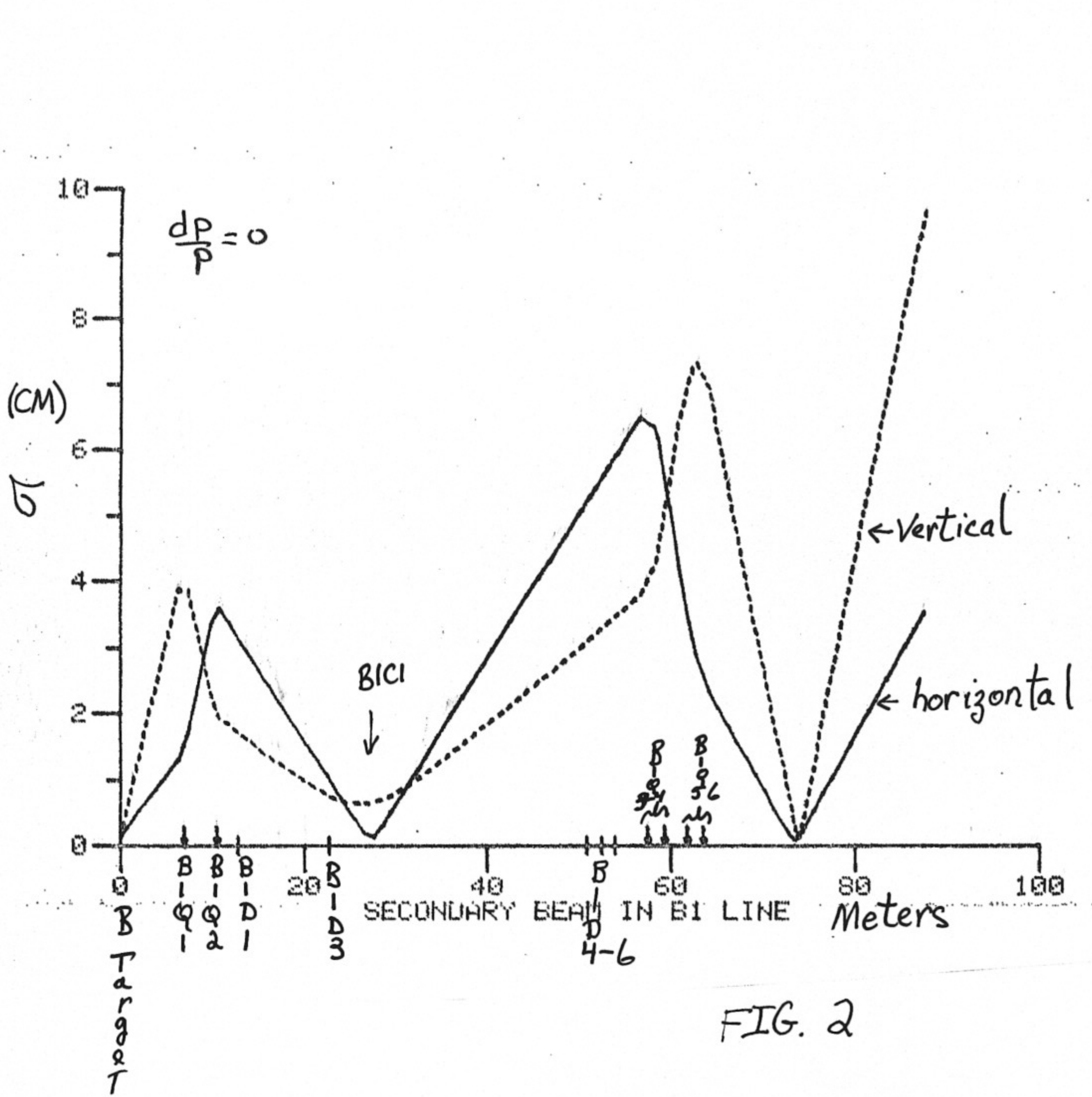
Figure 2: Same as Figure 1 except dp/p=0.

Figure 3: Beam size verses position for oxygen beam.



dp/p = .5%
σ (cm)
10
8
6
4
2
0
BICI
vertical
horizontal
0
20
40
60
80
100
SECONDARY BEAM IN B1 LINE
Meters
B-Q-1
B-Q-2
B-D-1
B-D-3
B-D-4-6
B-Q-3-4
B1-Q-5-6
B target

FIG 1.



$\frac{dp}{p} = 0$
σ
(CM)
0
2
4
6
8
10
20
40
60
80
100
BICI
vertical
horizontal
SECONDARY BEAM IN B1 LINE
Meters
B Target
B-Q1
B-Q2
B-D1
B-D3
B-D4-6

FIG. 2