BNL-99179-2013-TECH
C-A/AP/24;BNL-99179-2013-IR

Water Temperature vs. BtA Stability Explored

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September 2000

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Brookhaven National Laboratory

U.S. Department of Energy
USDOE Office of Science (SC)

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C-A/AP/24
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AGS Complex Machine Studies
Water Temperature vs. BtA stability Explored
Study Period: February 18th, 2000
Participants: C. Karns
Reported by: P. Sampson, C. Karns
Machine Booster and BtA
Beam: High Intensity Protons
Tools: CBMs, Spreadsheet, BtA Harps and Booster Gauss Clock
Aim: To study the effect that the water temperature change brought on by turning the Booster Main Magnet off has on BtA and transfer efficiency.

Water Temperature vs. BTA stability explored

1. Summary

This experiment was performed as part of the ongoing effort to determine the source of unexpected steering changes in the Booster to AGS (BtA) line. Since it was commissioned, this line has proven to need steering adjustments at regular intervals. Also of concern is that beam steering does not return to nominal when a file is loaded following any changes to the line (i.e. after a study). One thought was that changes in cooling water temperature, brought on by turning the Booster Main Magnet power supply (BMMPS) off, effect BtA transport elements, since many of these devices are cooled by the same system.

It was observed that turning off the BMMPS, made its cooling water temperature drop from 98°f to 92°f or 6%. There was no observable effect on power supply read backs for elements in the BtA line, however, changes were seen in the Booster Main Ring injection field. Further study is indicated.

2. Experiment

Transport between the AGS and Booster was optimized, then archived. Data for power supply read backs, Booster Main Ring fields, BtA harp positions and Booster extraction radius were recorded. The BMMPS was then turned off and the water temperature allowed to stabilize. Once stable, the MMPS was re-energized and sets of data for the above parameters were taken every 15 minutes until the cooling water reached normal operating temperature. A total of 5 sets of data were taken. Intensities were recorded throughout the exercise.

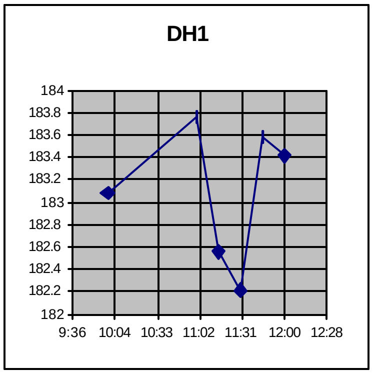
3. Results

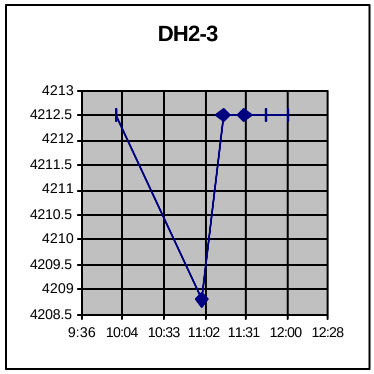
SpreadSheet read backs vs. Time for BtA elements:

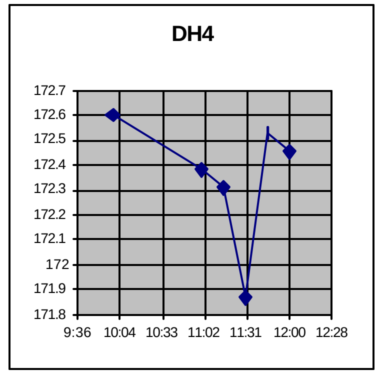
Time	DH1	DH2-3	DH4	DH127	DH158	DH5	DV007	DV030	DV120
10:00	183.08	4212.5	172.601	14.7582	4.0256	526.99	0.9267	-1.5275	0.5604
11:00	183.76	4208.8	172.381	14.7948	4.0256	527.97	0.9194	-1.5861	0.5604
11:15	182.56	4212.5	172.308	14.7729	4.0183	527.24	0.9267	-1.5495	0.5604
11:30	182.22	4212.5	171.868	14.7729	4.0183	526.75	0.9267	-1.5568	0.5677
11:45	183.59	4212.5	172.527	14.7655	4.011	527.24	0.934	-1.5568	0.5677
12:00	183.42	4212.5	172.454	14.7655	4.0256	527.24	0.9121	-1.5128	0.5531

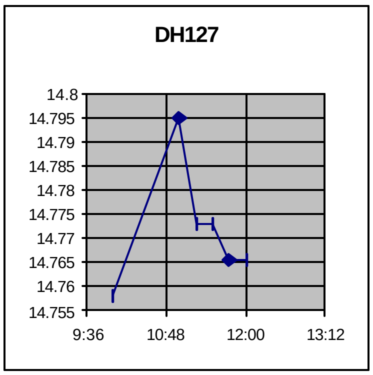
Time	DV181	QV1	QH2	QV3	QH4	QV5	QH6	QV7	QH8
10:00	7.8644	427.6	533.1	511.12	675.95	608.43	641.4	323.82	324.18
11:00	7.8425	427.85	532.85	511.36	680.1	607.7	641.4	323.45	329.18
11:15	7.8644	427.6	532.85	510.87	675.46	608.07	641.03	322.72	324.72
11:30	7.8718	427.36	533.1	510.87	675.71	608.43	640.67	323.45	324.3
11:45	7.8718	427.36	532.85	510.63	674.97	607.33	641.4	323.45	324.05
12:00	7.8571	427.6	532.85	511.12	678.39	607.7	641.4	323.82	323.93

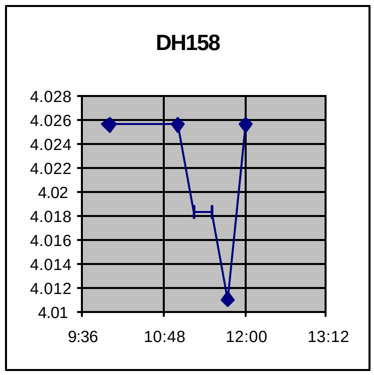
Time	QV9	QH10	QV11	QH12	QV13	QH14	QH15
10:00	519.66	147.35	258.242	378.97	560.45	318.69	0.49
11:00	517.09	144.96	258.242	376.75	558.25	330.17	1.59
11:15	520.17	143.59	258.315	377.26	559.23	325.29	1.34
11:30	518.8	146.84	258.168	377.61	560.93	317.47	1.34
11:45	518.63	147.01	258.022	378.63	560.69	318.2	0.98
12:00	519.14	146.84	258.242	379.14	559.96	319.67	2.44

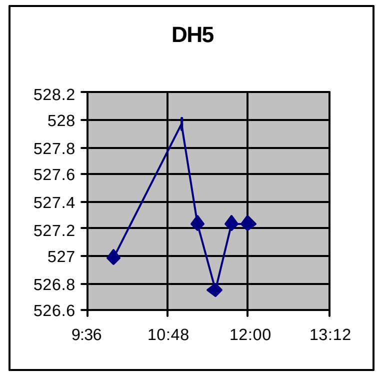

DH1
184
183.8
183.6
183.4
183.2
183
182.8
182.6
182.4
182.2
182
9:36 10:04 10:33 11:02 11:31 12:00 12:28

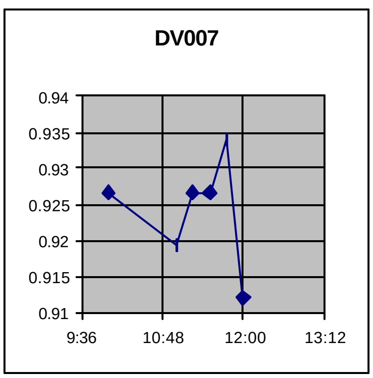

DH2-3
4213
4212.5
4212
4211.5
4211
4210.5
4210
4209.5
4209
4208.5
9:36 10:04 10:33 11:02 11:31 12:00 12:28

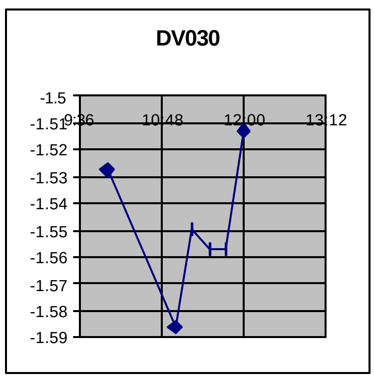

DH4
172.7
172.6
172.5
172.4
172.3
172.2
172.1
172
171.9
171.8
9:36 10:04 10:33 11:02 11:31 12:00 12:28

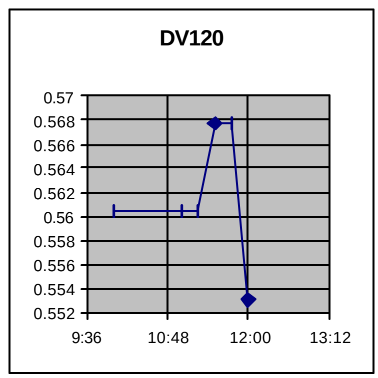

DH127
14.8
14.795
14.79
14.785
14.78
14.775
14.77
14.765
14.76
14.755
9:36 10:48 12:00 13:12

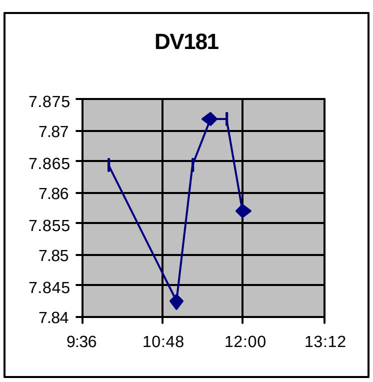

DH158
4.028
4.026
4.024
4.022
4.02
4.018
4.016
4.014
4.012
4.01
9:36 10:48 12:00 13:12

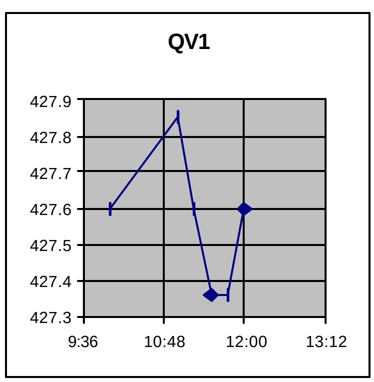

DH5
528.2
528
527.8
527.6
527.4
527.2
527
526.8
526.6
9:36 10:48 12:00 13:12

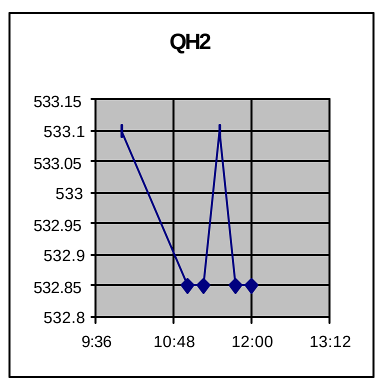

DV007
0.94
0.935
0.93
0.925
0.92
0.915
0.91
9:36 10:48 12:00 13:12

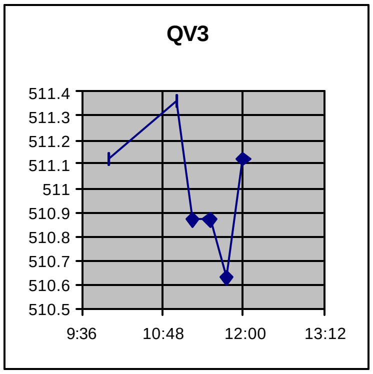

DV030
-1.5
-1.51
9:36 10:48 12:00 13:12
-1.52
-1.53
-1.54
-1.55
-1.56
-1.57
-1.58
-1.59

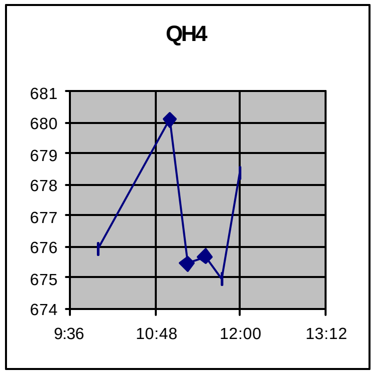

DV120
0.57
0.568
0.566
0.564
0.562
0.56
0.558
0.556
0.554
0.552
9:36 10:48 12:00 13:12

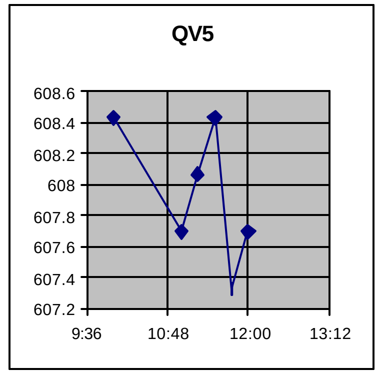

DV181
7.875
7.87
7.865
7.86
7.855
7.85
7.845
7.84
9:36 10:48 12:00 13:12

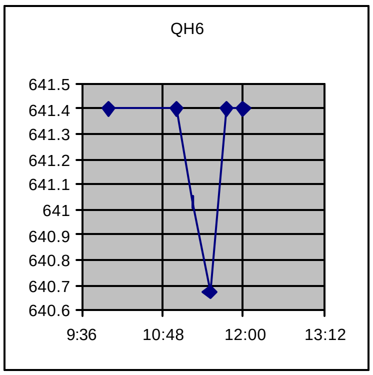

QV1
427.9
427.8
427.7
427.6
427.5
427.4
427.3
9:36 10:48 12:00 13:12

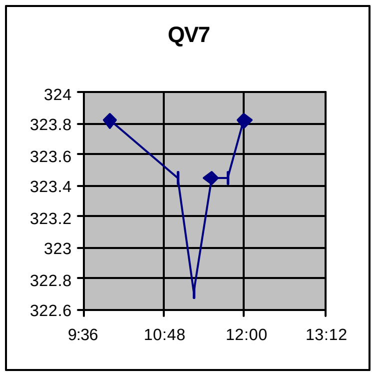

QH2
533.15
533.1
533.05
533
532.95
532.9
532.85
532.8
9:36 10:48 12:00 13:12

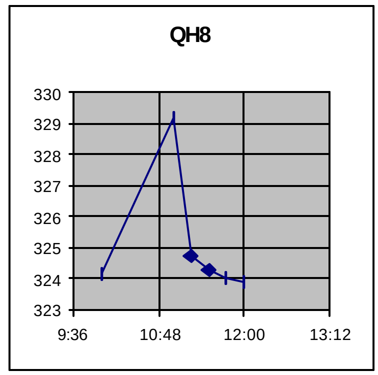

QV3
511.4
511.3
511.2
511.1
511
510.9
510.8
510.7
510.6
510.5
9:36
10:48
12:00
13:12

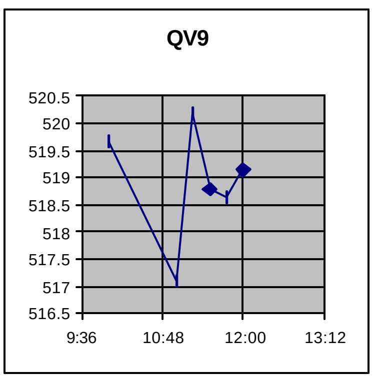

QH4
681
680
679
678
677
676
675
674
9:36
10:48
12:00
13:12

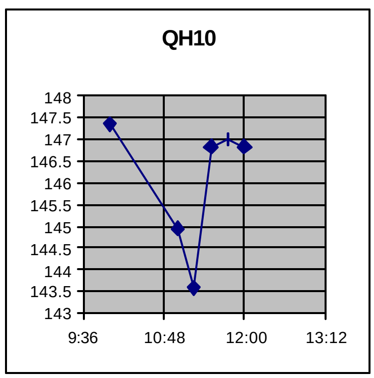

QV5
608.6
608.4
608.2
608
607.8
607.6
607.4
607.2
9:36
10:48
12:00
13:12

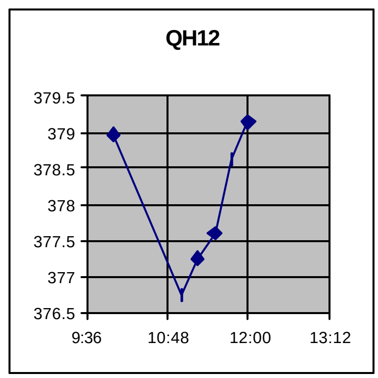

QH6
641.5
641.4
641.3
641.2
641.1
641
640.9
640.8
640.7
640.6
9:36
10:48
12:00
13:12

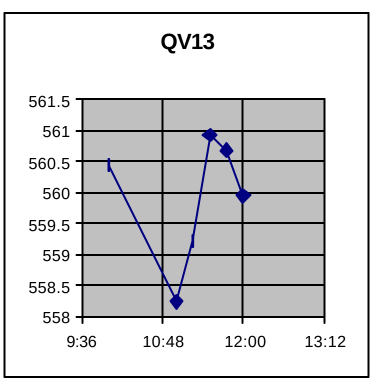

QV7
324
323.8
323.6
323.4
323.2
323
322.8
322.6
9:36
10:48
12:00
13:12

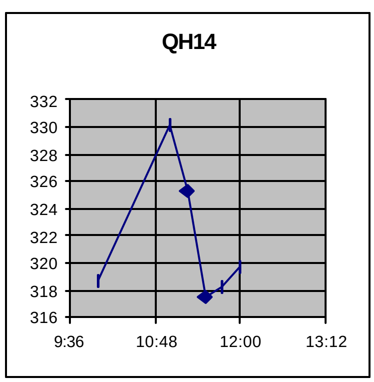

QH8
330
329
328
327
326
325
324
323
9:36
10:48
12:00
13:12

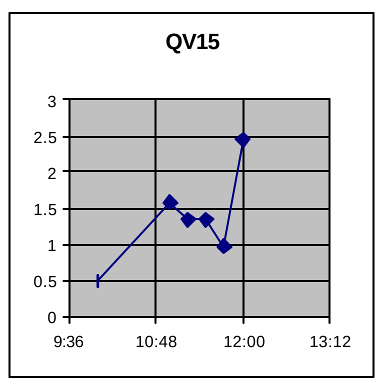

QV9
520.5
520
519.5
519
518.5
518
517.5
517
516.5
9:36
10:48
12:00
13:12


QH10
148
147.5
147
146.5
146
145.5
145
144.5
144
143.5
143
9:36
10:48
12:00
13:12


QH12
379.5
379
378.5
378
377.5
377
376.5
9:36
10:48
12:00
13:12

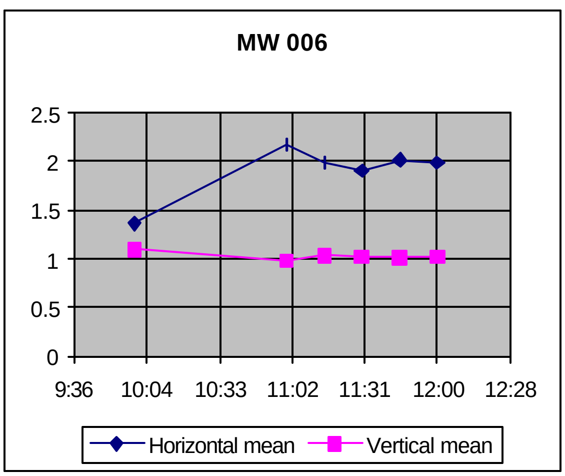

QV13
561.5
561
560.5
560
559.5
559
558.5
558
9:36
10:48
12:00
13:12

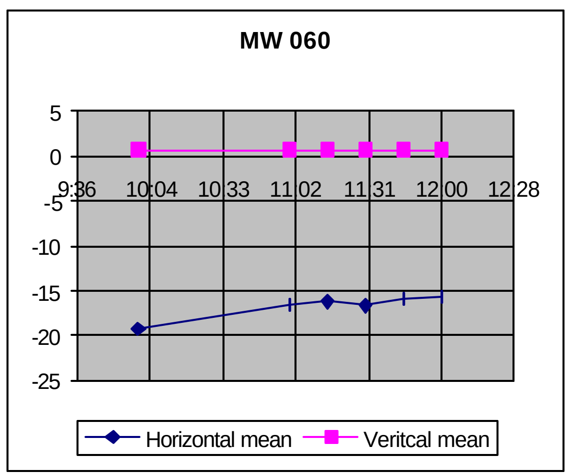

QH14
332
330
328
326
324
322
320
318
316
9:36
10:48
12:00
13:12

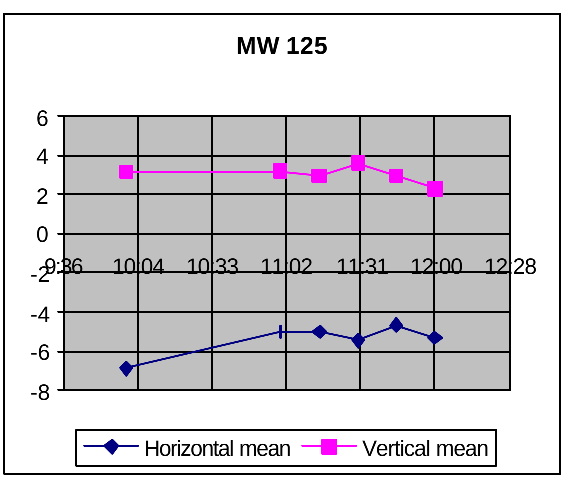

QV15
3
2.5
2
1.5
1
0.5
0
9:36
10:48
12:00
13:12

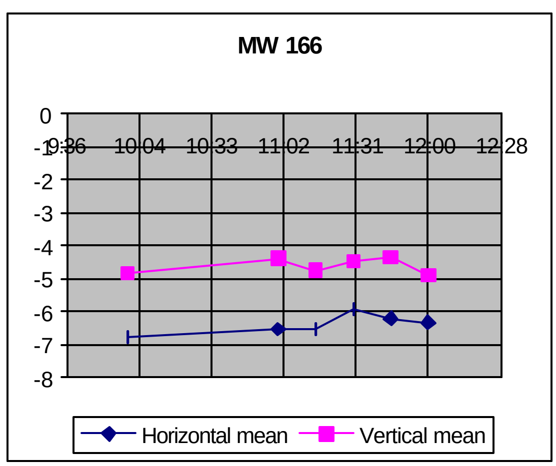
Position of beam envelope in BtA vs. Time (no changes in width were observed):

MW006					MW 060	
	H mean	V mean			H mean	V mean
10:00	1.36	1.09		10:00	-19.31	0.72
11:00	2.17	0.98		11:00	-16.58	0.72
11:15	1.98	1.03		11:15	-16.24	0.7
11:30	1.9	1.02		11:30	-16.63	0.72
11:45	2.01	1.01		11:45	-15.95	0.74
12:00	1.98	1.02		12:00	-15.74	0.71
MW 125				MW 166		
	H mean	V mean			H mean	V mean
10:00	-6.9	3.12		10:00	-6.79	-4.84
11:00	-5.03	3.2		11:00	-6.51	-4.39
11:15	-5	2.98		11:15	-6.52	-4.75
11:30	-5.44	3.59		11:30	-5.94	-4.49
11:45	-4.67	2.93		11:45	-6.21	-4.36
12:00	-5.33	2.29		12:00	-6.32	-4.88





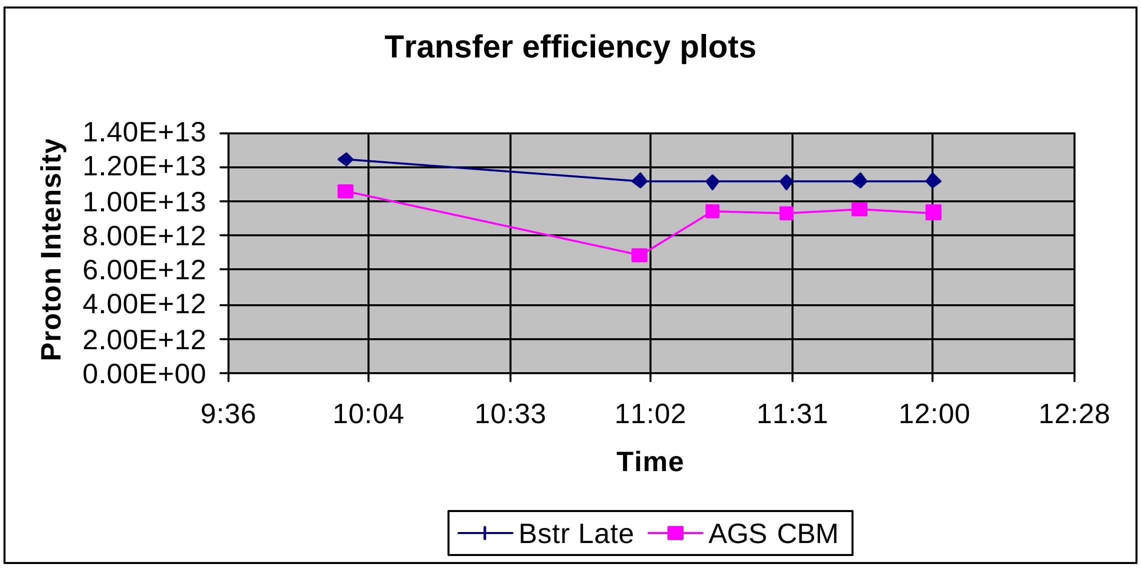




The following section shows how the overall efficiency behaved during the study period, each instance is representative of scalar reading on a single pulse:

Scalar read backs vs. Time:

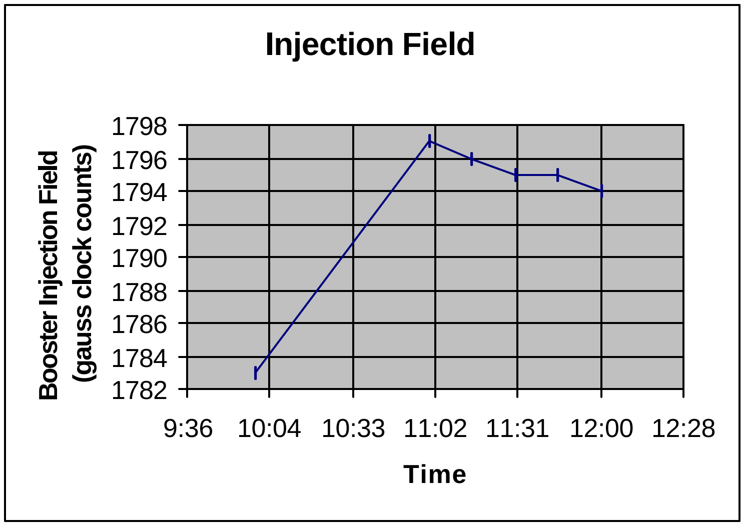
Time	BSTR input	BSTR early	BSTR late	AGS CBM	BTA efficiency
10:00	1.72E+13	1.34E+13	1.24E+13	1.06E+13	85.48%
11:00	1.70E+13	1.26E+13	1.12E+13	6.88E+12	61.43%
11:15	1.71E+13	1.27E+13	1.11E+13	9.42E+12	84.86%
11:30	1.72E+13	1.26E+13	1.11E+13	9.28E+12	83.60%
11:45	1.71E+13	1.27E+13	1.12E+13	9.50E+12	84.82%
12:00	1.71E+13	1.27E+13	1.12E+13	9.36E+12	83.57%



The Booster injection field was also recorded at the Booster's Injection Peaker value several times during the study period.

Gauss clock readings vs. Time

Gauss counts	
10:00	1783
11:00	1797
11:15	1796
11:30	1795
11:45	1795
12:00	1794



4. Conclusion:

Though turning off the Booster Main Magnet power supply does change the cooling water temperature, which is shared by BTA elements, there is no demonstrated proof that this affects the elements in the line. The data shows that before and after the water temperature change, the beam positions and power supply read backs are within normal tolerances. The fact that there appears to be some shift in the Booster's injection field after the supply is turned back on, suggests that further study of this may provide information helpful in solving the BTA instability problem.