

Booster Collimator Overview

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6/24/2004

Collimator Design paper:

“Commissioning of the Beam Collimation System at the Fermilab Booster.”

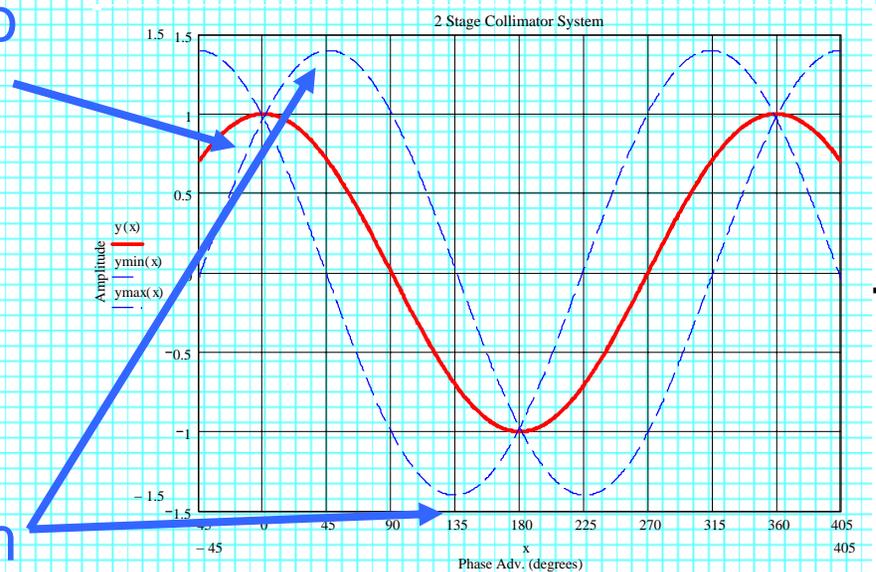
Drozhdin, Kasper, Lackey, Mokhov, Prebys, Syphers

Why do we have collimators?

- Their purpose is to clean up the beam halo and localize the proton losses particularly in shielded Booster periods Long 6 Long 7 and immediately downstream.
- Lower the losses around the rest of the machine, especially the RF cavities.

2-Stage Collimation

- Two primary collimators made up of copper foils and are moved close to the edge of the circulating beam after injection.
- Secondaries H&V (3) are positioned to intercept most of the particles scattered from the foil

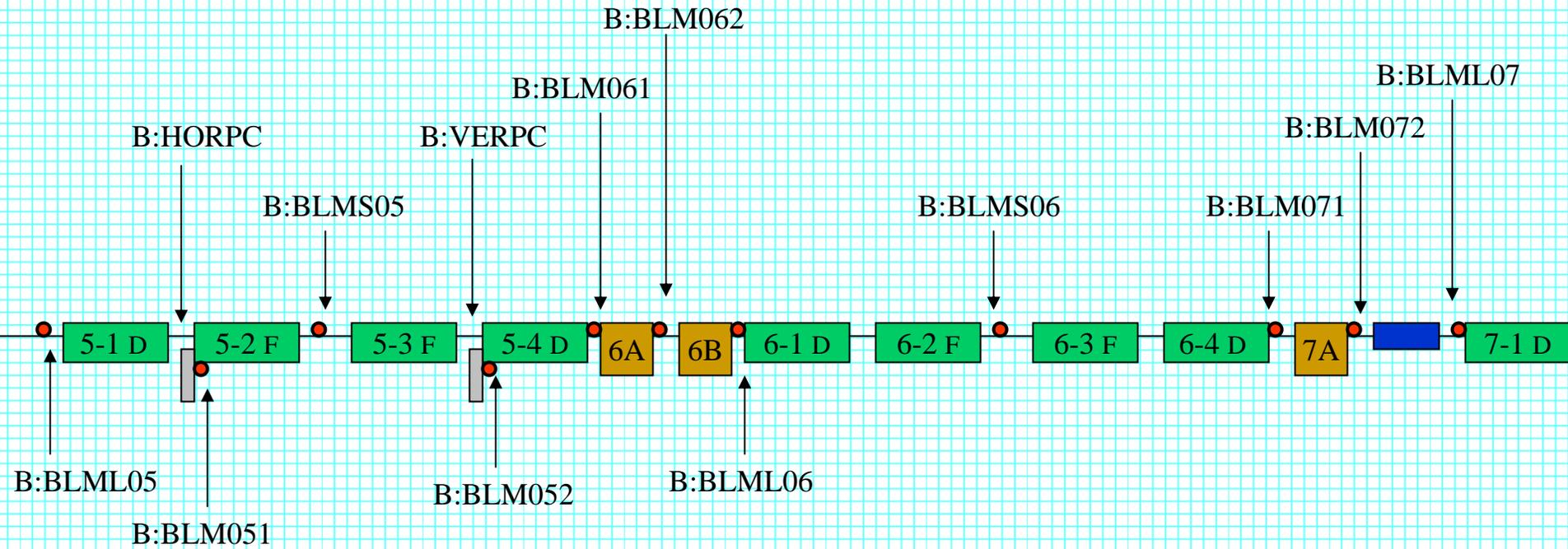


Short 5

Long 6

Short 6

Long 7



B:S5PCH - upstream mini-straight of Period 5

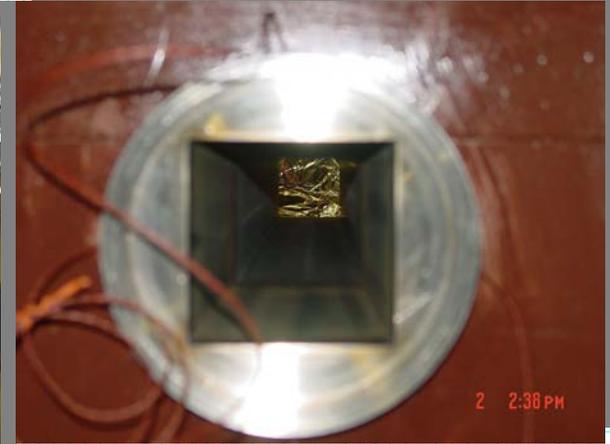
B:S5PCV - downstream mini-straight of Period 5

6A - upstream end of Long 6

6B - downstream end of Long 6

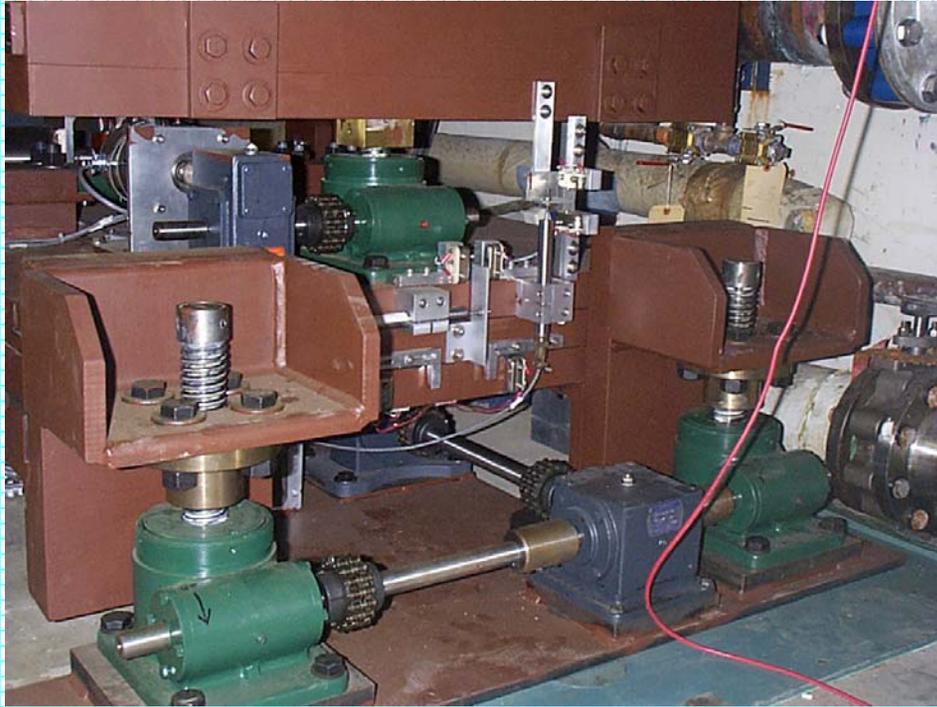
7A - upstream end of Long 7

Long 6 Collimator L6A&B



- Four Separate Degrees of Freedom:
 - Vertical
 - Horizontal
 - Yaw
 - Pitch
- All four motorized with stepper motors.
- One complete collimator with stand weighs 14.6 tons.

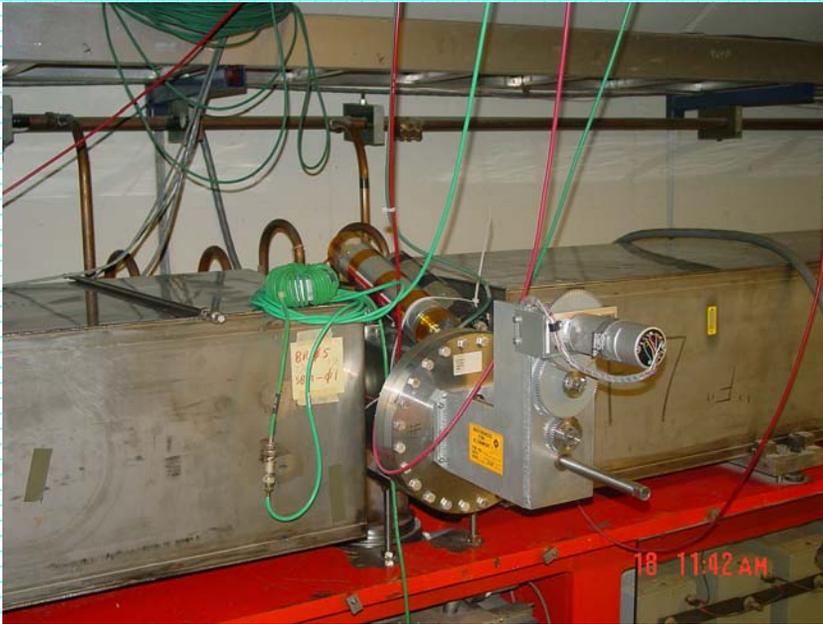
Long 6 Collimator



- Vertical Drives:
- 170 Volt motor drive system, 900 RPM max speed
- 4 10 ton screw jacks
- ± 1.5 inches of travel

- Horizontal Drives:
- 48 Volt motor drive, 900 RPM max
- Single 5 ton jack
- ± 1.5 inches of travel

Targets/Primary Foils



Horizontal at S5



Vertical at S5

Copper Target 0.3mm

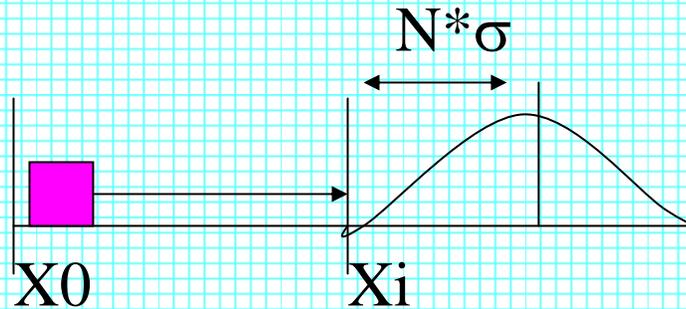


Copper side



Carbon side

Overview of New Software



Front
End

Fast
Processing :

Loss
Monitor &
Intensity

Feedback.

OAC

Global
Orchestration:

Employs states
and collimator
moving map.

Application

Configure/view,
Initiate Process:

Can use sequencer
initiate scraping.

Booster Collimator Hardware

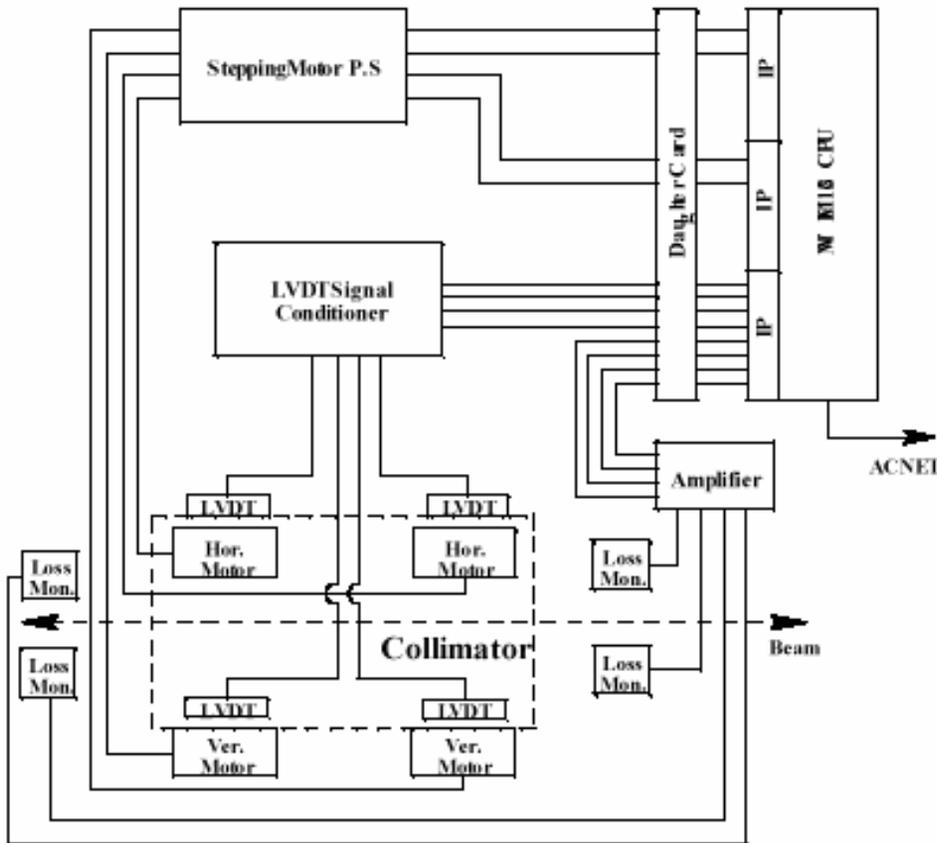


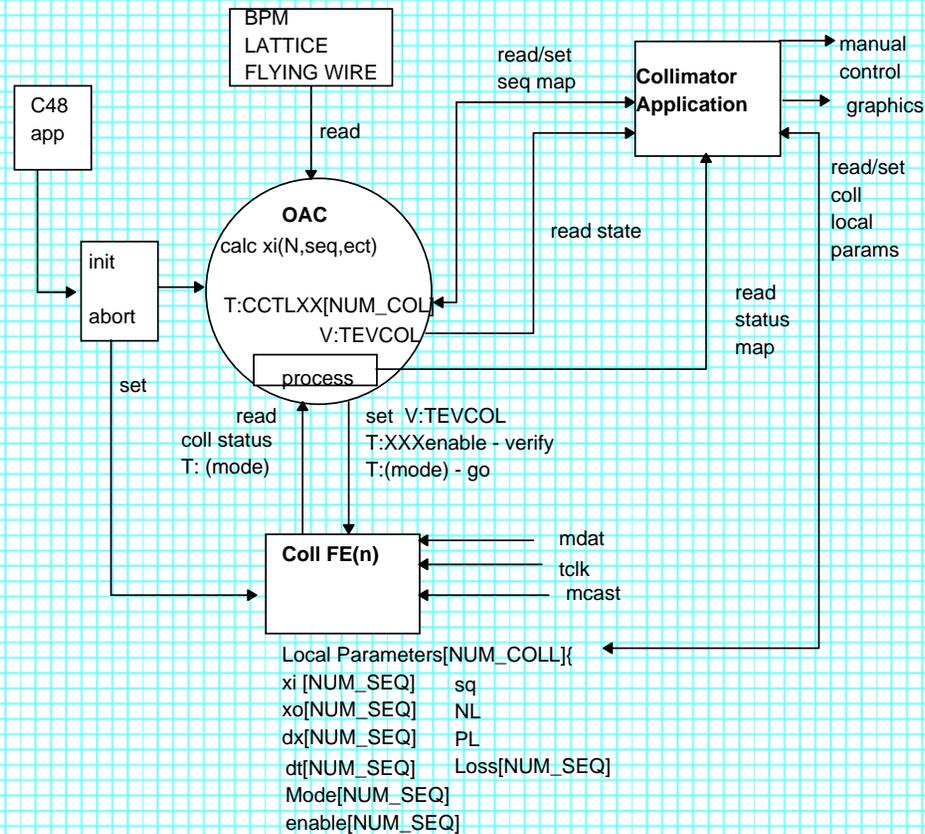
Figure 6.64. Block diagram of collimator control system



- VME based.
- BLM and B:CHG Inputs for feedback.

Collimator Controls Block Diagram

Collimator Global Controls Layout



B110 Application Page

B110 Booster Collimator Controls Pgm_Tools

23-JUN-04 14:39:00

Setup	SCRAPING SEQUENCE	Manual Move	Options
Setup Collimator Parameters for Seq: ◆2 Goto Out of Beam Position		Sequence	
Collimator Location ◆ L6AH ◆		COMMANDS	
Collimator Mode: ◆ Move→Xi ◆		A A A	
Collimator Status: ◆ T ◆		D T C	
Safe Position Xo: 1 mil		Move Sequence	
Goto Position Xi: 0 mil		::: Goto In Beam Shielding Pos.(3) . D .	
Loss Monitor Limit 0: 1.429 R/S		Recover Sequences	
Loss Monitor Limit 1: 1.429 R/S		:::Goto Out of Beam Position (2) . D .	
Coll. Current Pos. : 856 mil		:::okAbort ALL Collimator Movement	
Coll. Positive limit: 850 mil		::: Set State to (0)	
Retract Size : 0 mil		Test Movements	
		::: Test 4 (4) . D .	
		::: Test 5 (5) . D .	
		::: Test 6 (6) . D .	
		::: Retract all Hor Coll. (7) . D .	
		::: Retract all Ver Coll. (8) . D .	
		Collimator Status	
		◆Start SA Plot◆	
Max time between events 6 sec		Collimator	LVDT Curr Pos Status
Sample Time 1 15 10		S5H	-1317 -1185 IN
Sample Time 2 0 FF		S5V	-834.9 -915 IN
Sample Time 3 0 FF		L6AH	850.2 856 IN
Sample Time 4 0 FF		L6AV	-433.4 -430 IN
Sample Time 5 0 FF		L6BH	-735.8 -764 IN
Sample Time 6 0 FF		L6BV	698.8 701 IN
Sample Time 7 0 FF		L7H	-635.6 -695 IN
Sample Time 8 0 FF		L7V	-627.1 -625 IN

Messages

Program Init Complete on CNS139
All Collimator Front Ends are up.

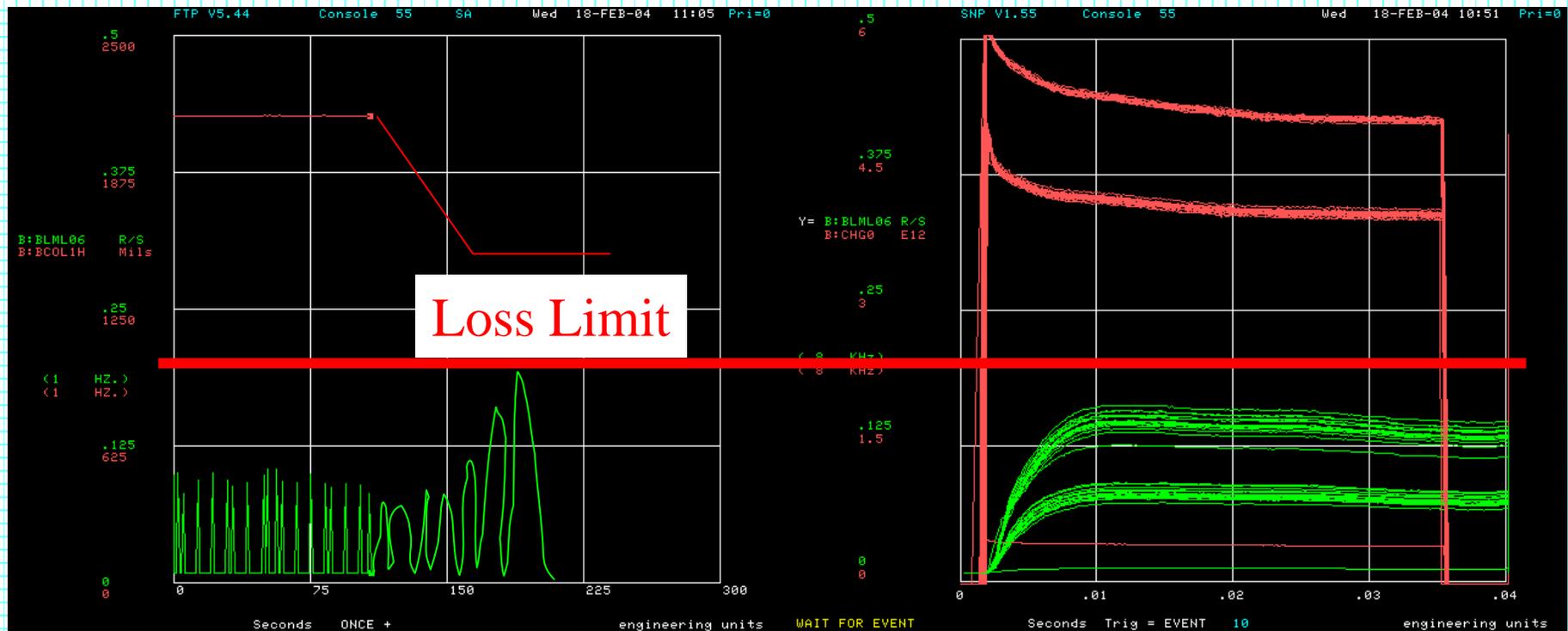
Controls from Booster Sequencer

```
B116      BOOSTER SEQUENCER      24-JUN-04 12:00:18  ♦Pgm_Tools♦
mode      edit      log      status      files      help
aggregate commands  -
::: Booster turn-off for access      p
::: Booster turn-on from access
ERR Remove Collimators from Beam
ERR Insert Collimators for Shield
::: HS/VL Ramped Correctors
ERR check out quads and sext
ERR Run Booster AC Mode
::: Run Booster DC Mode
::: Turn on MI8 Line
::: 400MEV POWER CYCLE
ERR daily status with hardcopy      n
1:20 of 32      +
Messages
SEQUENCER: (mode 6) begins on console 247 slot PB

Insert Collimators for Shield  -
::: ACKNOWLEDGE      .
::: CTL_DEVICE B:VL5CLF ON      .
ERR CTL_DEVICE B:VL6CLF ON      .
::: ACKNOWLEDGE      .
::: AUTO_PLOT L6AV Loss scan      .
::: AUTO_PLOT 16ah loss scan      .
::: BOOCOL MOVE 4      .
::: ACKNOWLEDGE      .
::: AUTO_PLOT L6BV Loss Scan      .
::: AUTO_PLOT 16bh Loss scan      .
::: BOOCOL MOVE 5      .
::: ACKNOWLEDGE      .
::: AUTO_PLOT L7V Loss Scan      .
::: AUTO_PLOT L7H Loss Scan      .
::: BOOCOL MOVE 6      .
1:20 of 22      +
```

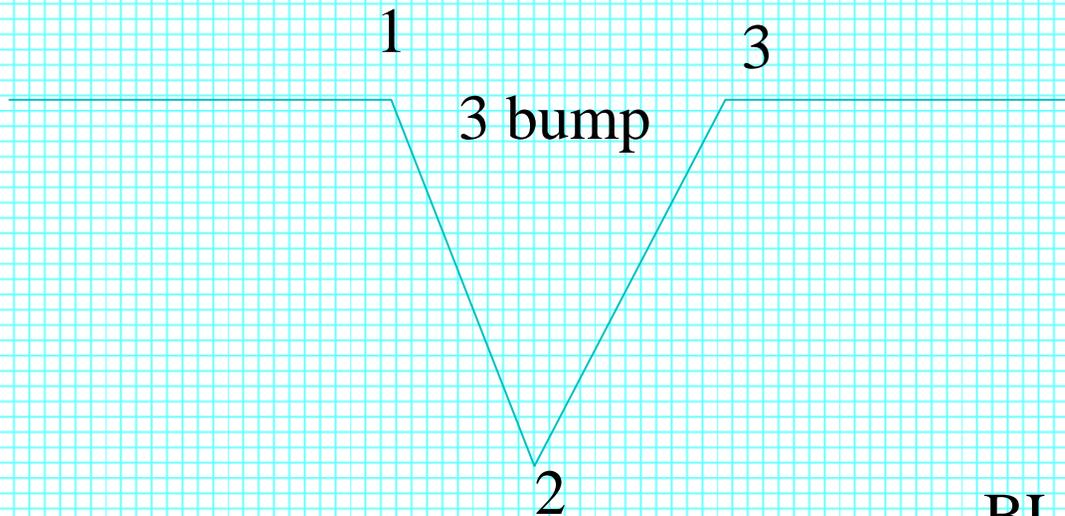
Slow Loss Monitor Feedback

- Local BLM's and B:CHG0 are sampled from event.
- Collimator moves under feedback and stops at loss limit.
- Protection for no beam movement and no beam in given time.



Fast Lost Monitor Feedback

- 1) Have to bump the beam into the collimator. Need hardware to process. Intend to bump on \$1D.



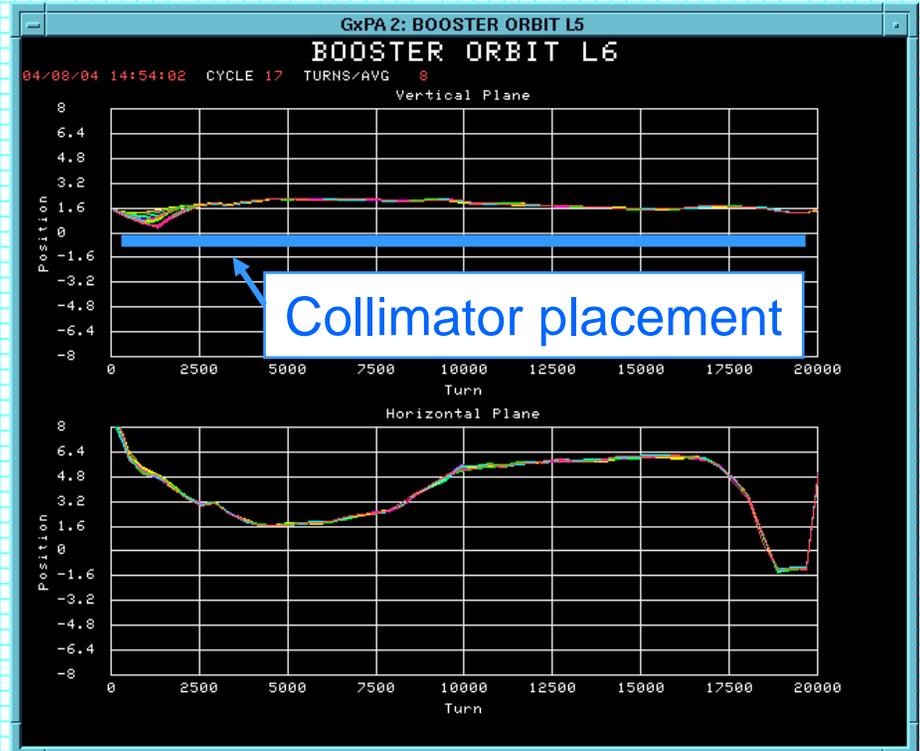
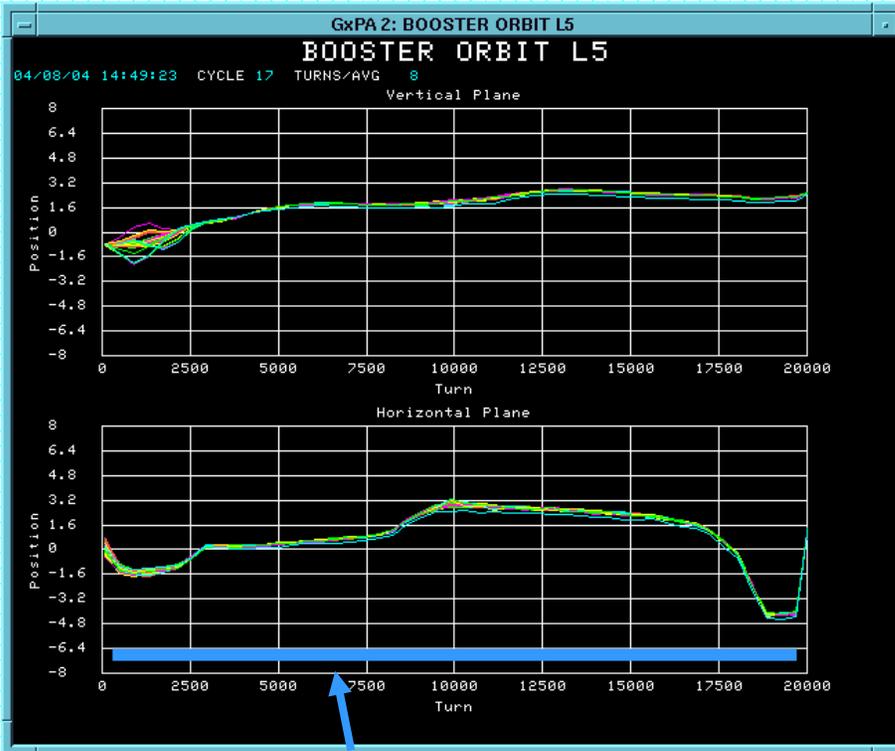
Bump box: Inputs 4 dipoles and scales 4 bumps output

BLM



Collimator

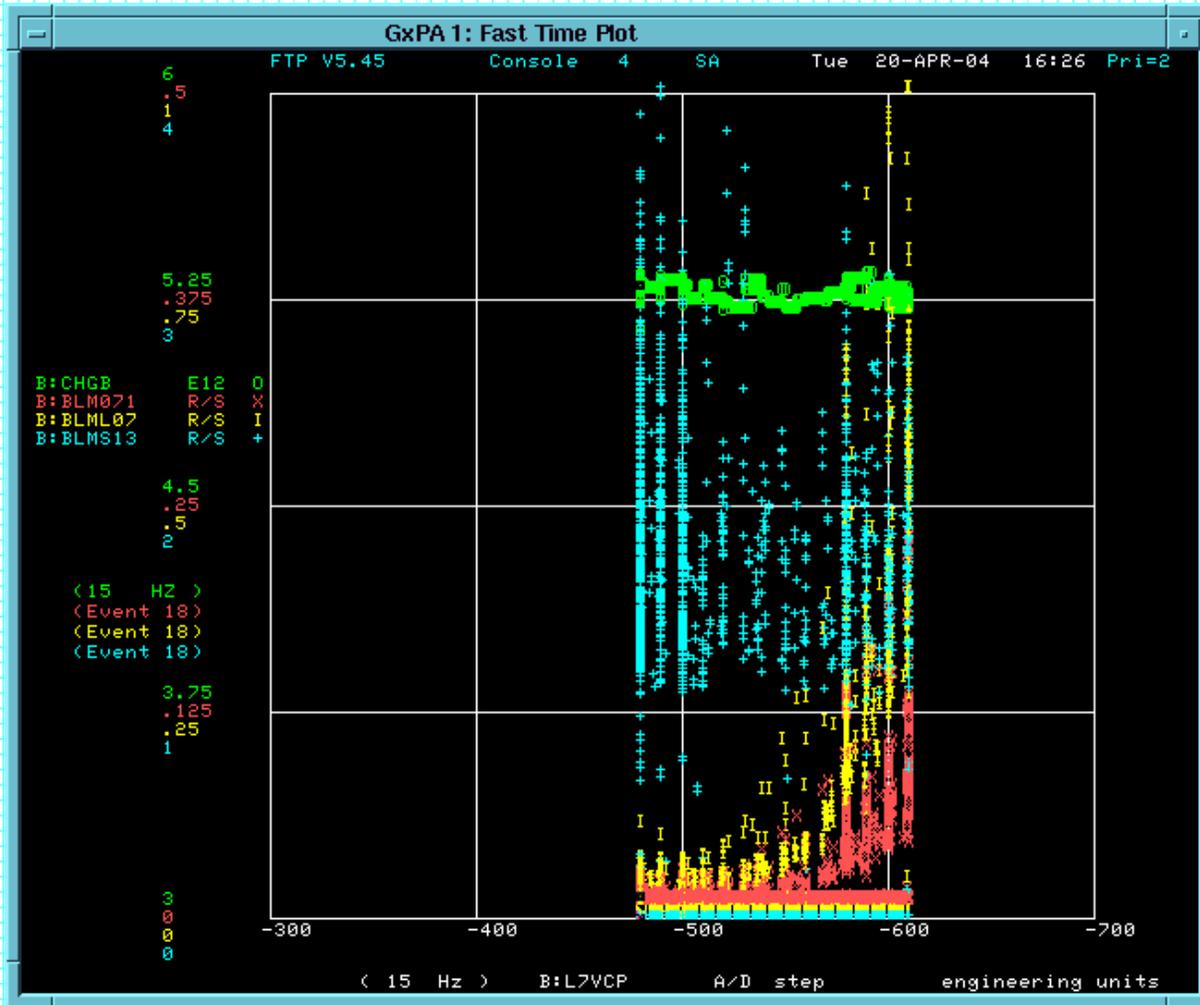
Orbits at Collimators



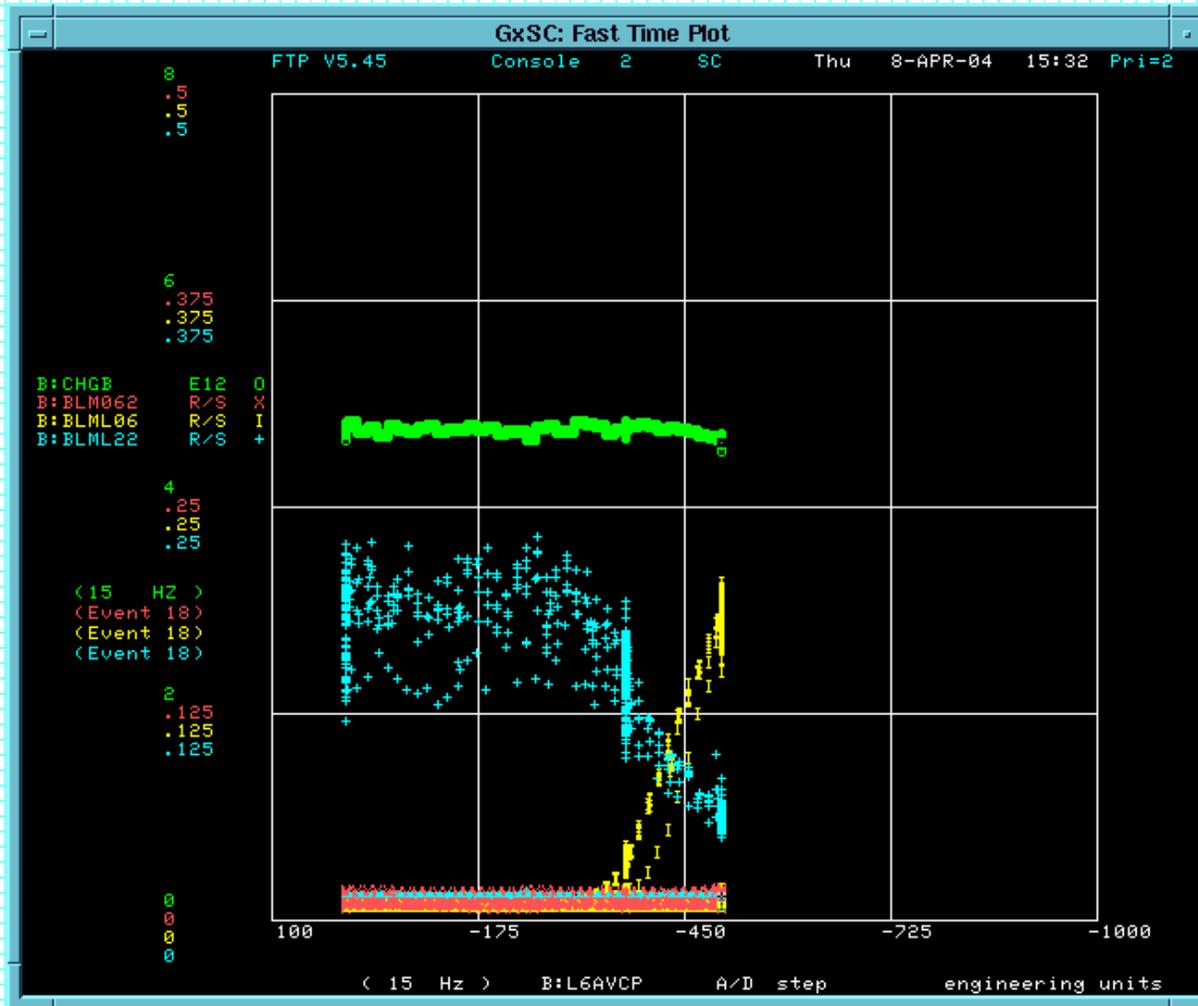
Positioning the Collimators

- Perform a collimator scan in small steps to detect beam edge (move into beam)
- Retract to edge of beam
- Observe beam intensities (\$1D and \$14) and losses
- Repeat for remaining primary and secondary collimators

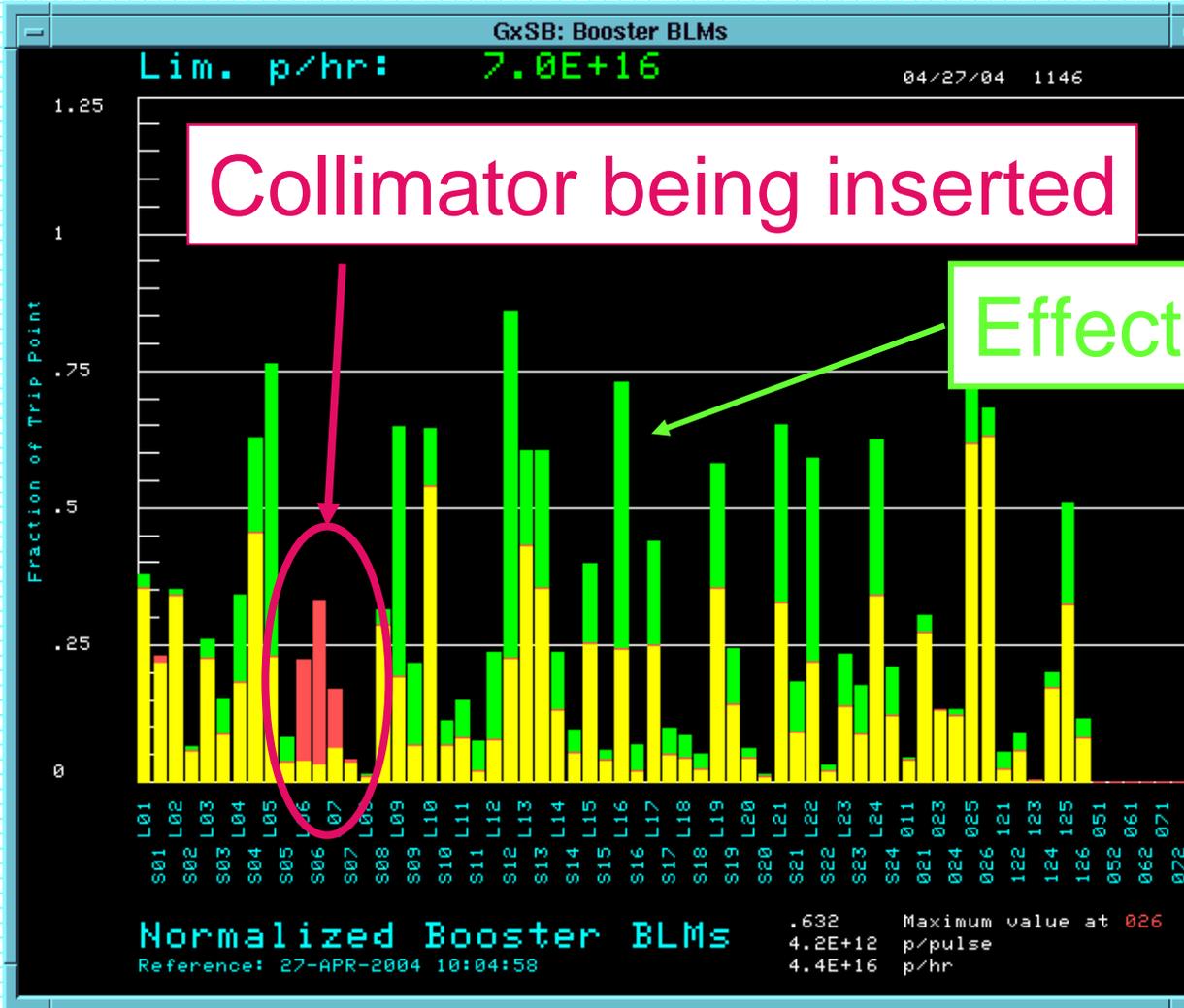
Collimator Loss Scans



Collimator Loss Scans

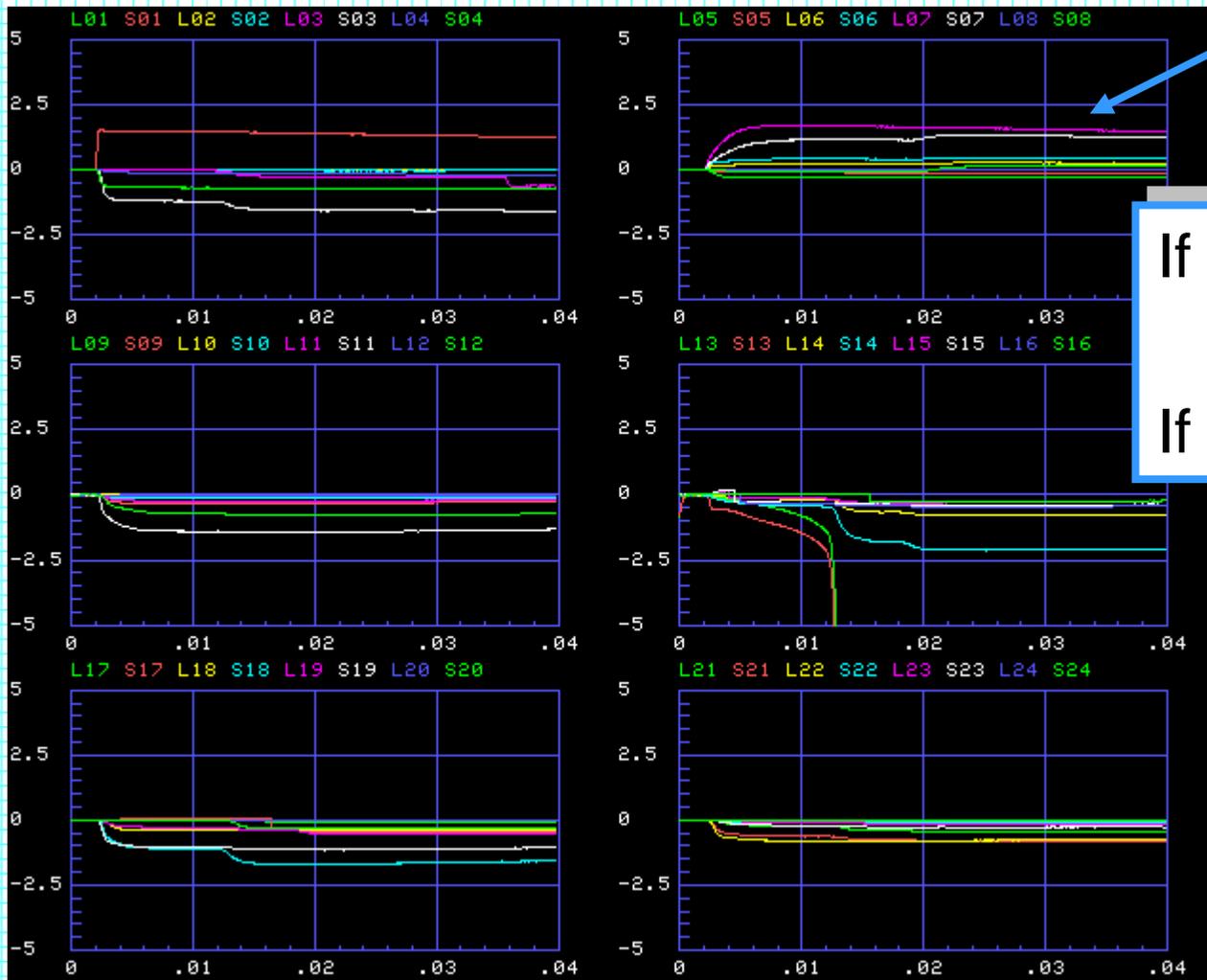


Effects of Collimators on Ring Losses



Ring Loss difference for Collimators

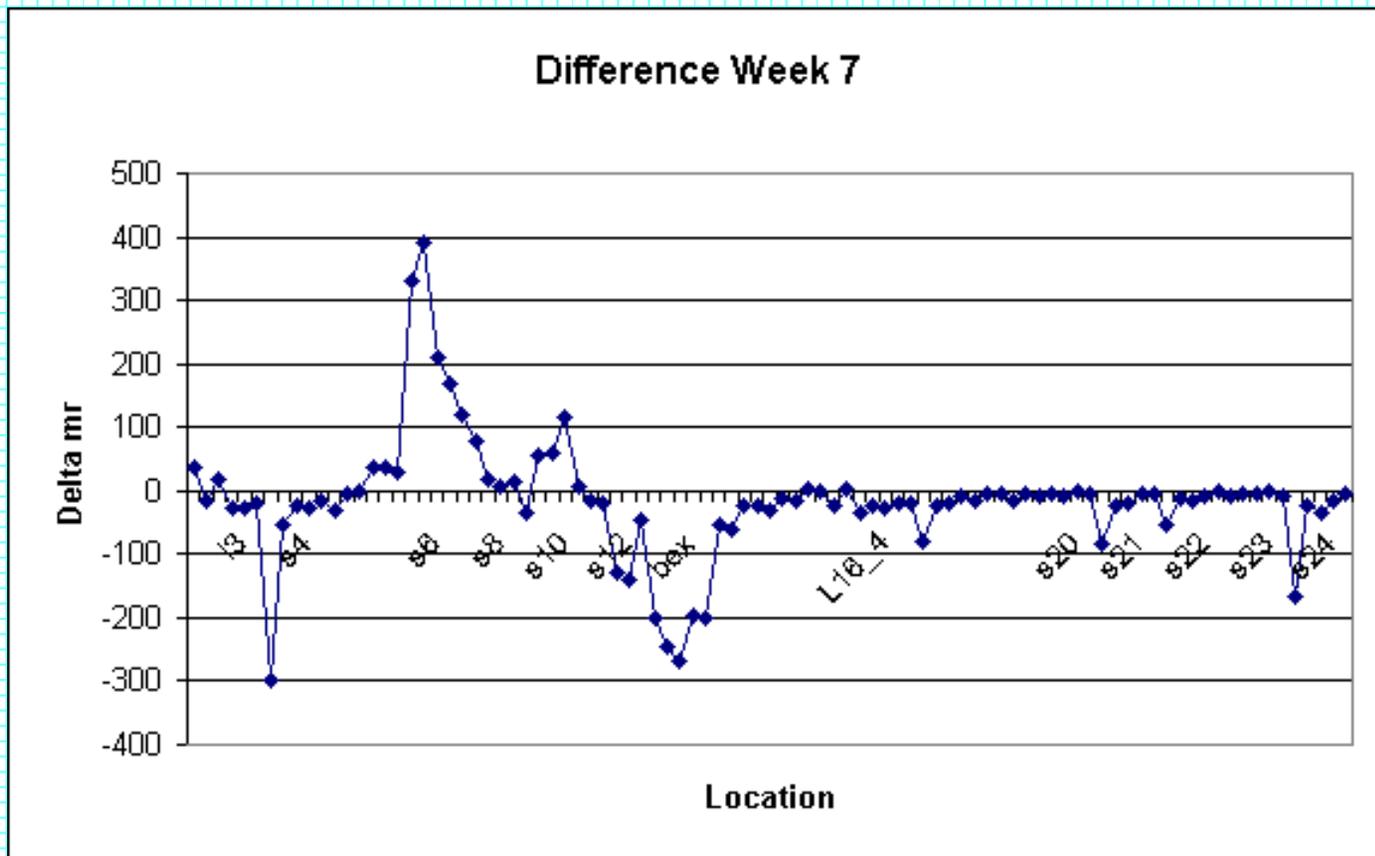
In and Out



Collimator location

If > 0 increased loss
If < 0 decreased loss

Rad Survey at week 7



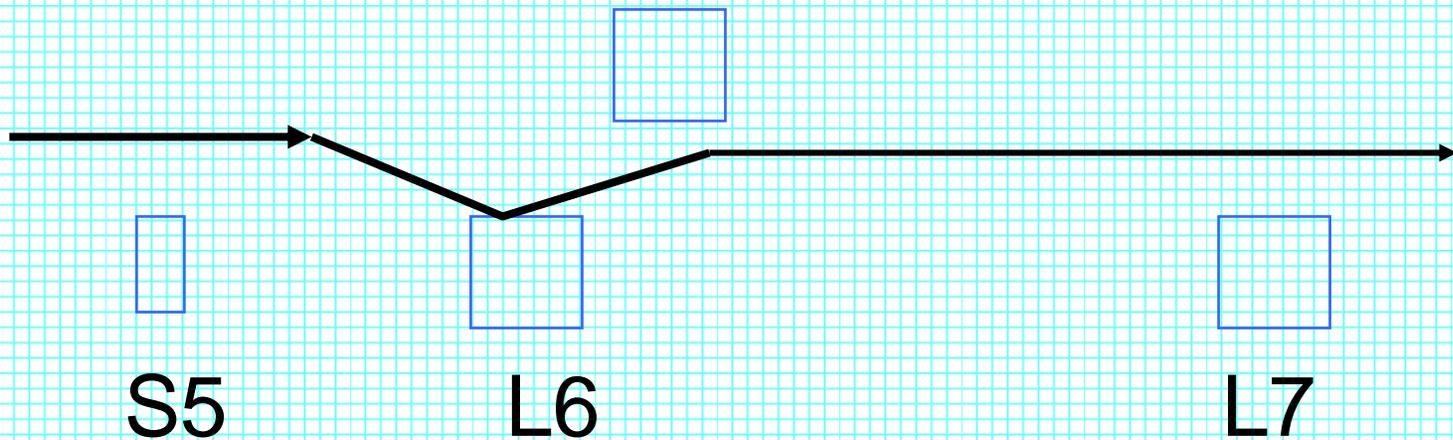
Problems/On going Work

- \$1D cycles are difficult for BLM and BPMs to gather data consistently and accurately.
- SNP have similar problems with \$1Ds plotting beam intensity and BLMs.
- Horizontal collimator movement has shown slippage.
- Still need to assess and maximize collimator efficiency.

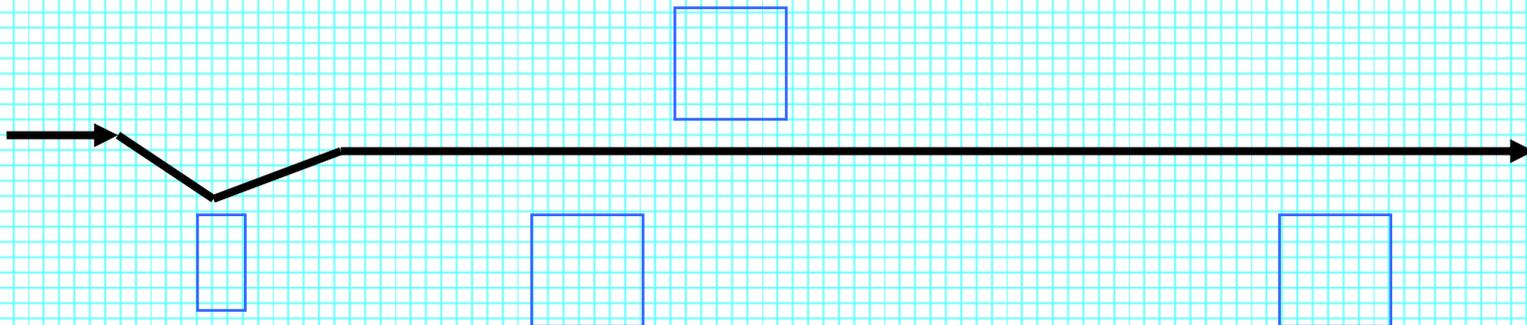


Orbit differences vs. 2 stage performance

Vertical Collimator and VL6 Bump



Horizontal Collimator and HS5 Bump



Conclusion:

- Are the collimators working – Yes at some level.
- The losses are being reduced around the ring.
- Have seen radiation levels at certain locations decreasing and/or staying constant.
- Gaining operational experience with using the collimators.

Happy people make happy Collimating

