Booster Collimator Overview

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Collimator Design paper:

"Commissioning of the Beam Collimation System at the Fermilab Booster."

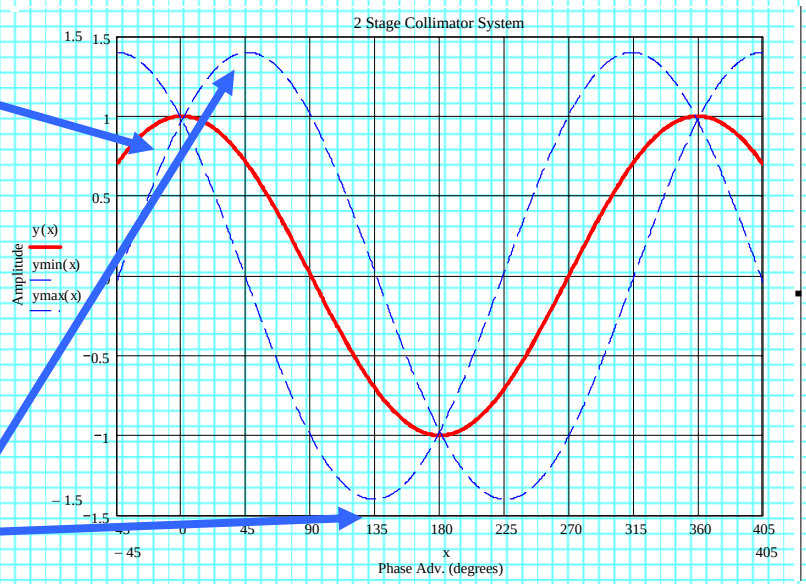
Drozhdin, Kasper, Lackey, Mokhov, Prebys, Syphers

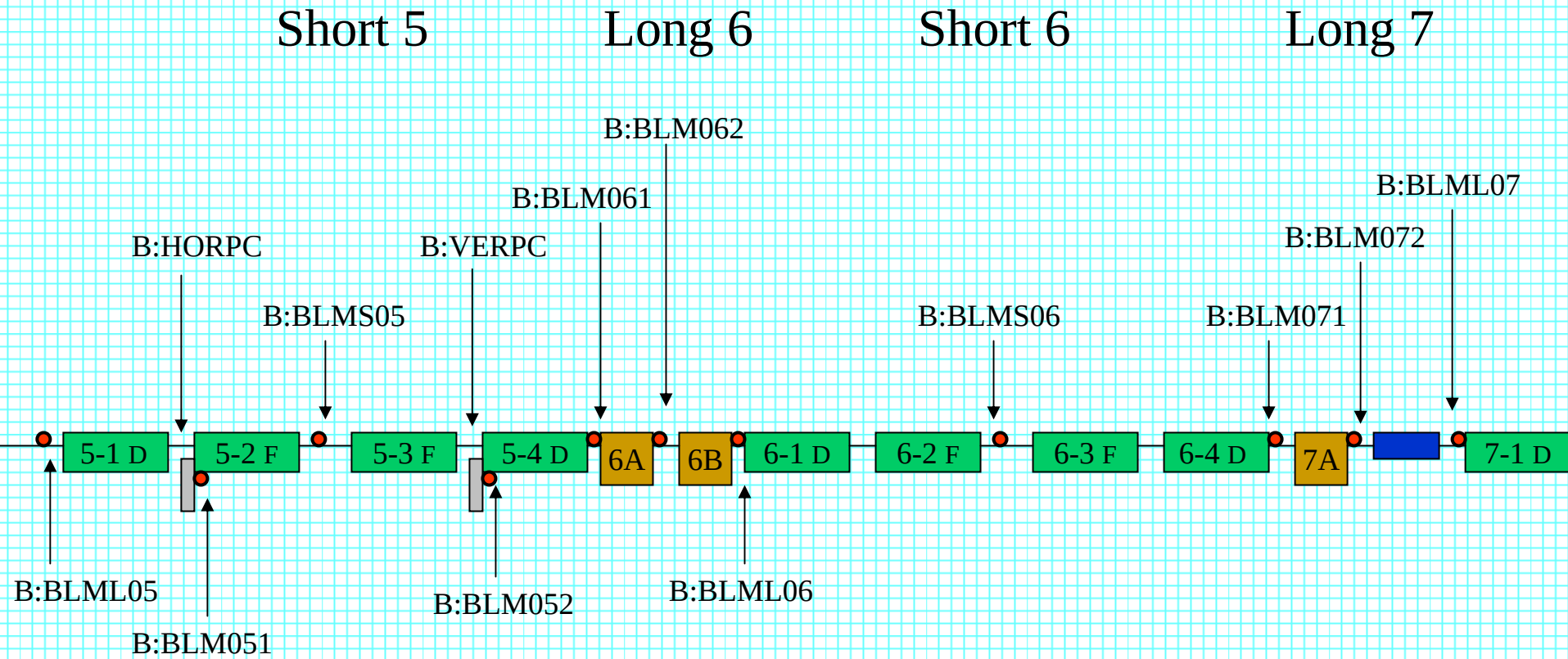
Why do we have collimators?

- 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





B:S5PCH - upstream mini-straight of Period 5

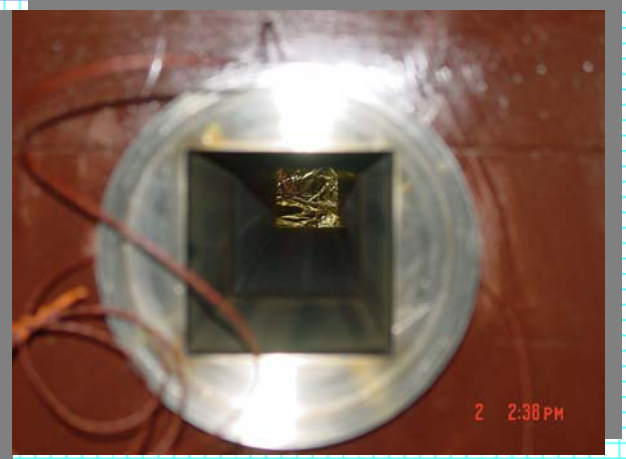
B:S5PCV - downstream mini-straight of Period 5

6A - upstream end of Long 6

6B - downstream end of Long 6

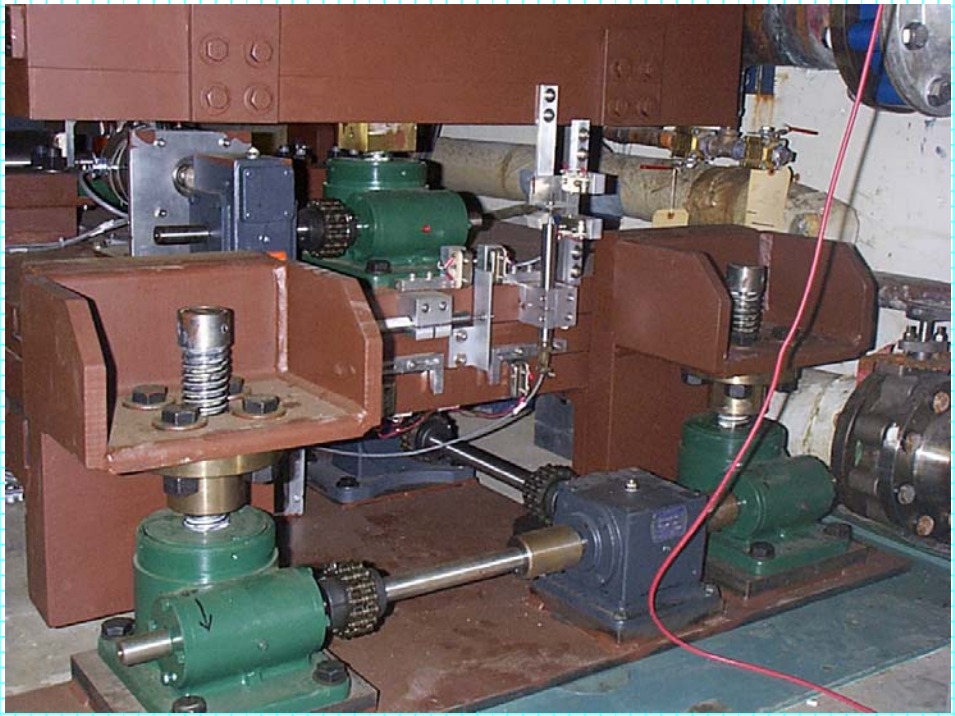
7A – upstream end of Long 7

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

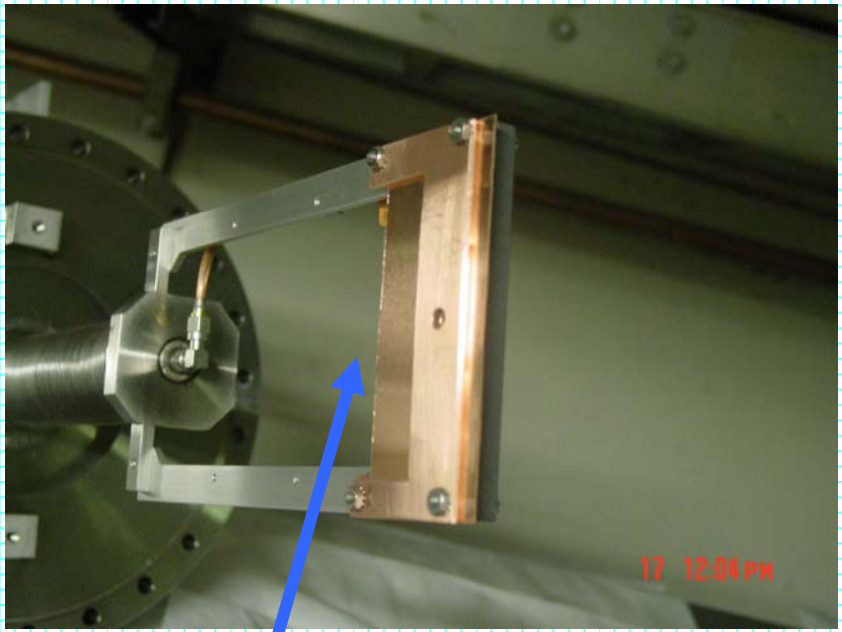
- Horizontal Drives:
- 48 Volt motor drive, 900 RPM max
- Single 5 ton jack
- ± 1.5 inches of travel

Targets/Primary Foils

Horizontal at S5

Vertical at S5

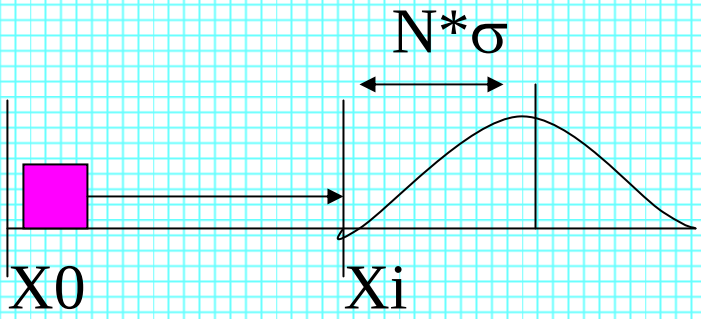
Copper Target 0.3mm



Copper side

Carbon side

Overview of New Software



Front End	OAC	Application
Fast Processing :	Global Orchestration:	Configure/view, Initiate Process:
Loss Monitor & Intensity Feedback.	Employs states and collimator moving map.	Can use sequencer initiate scraping.

Booster Collimator Hardware

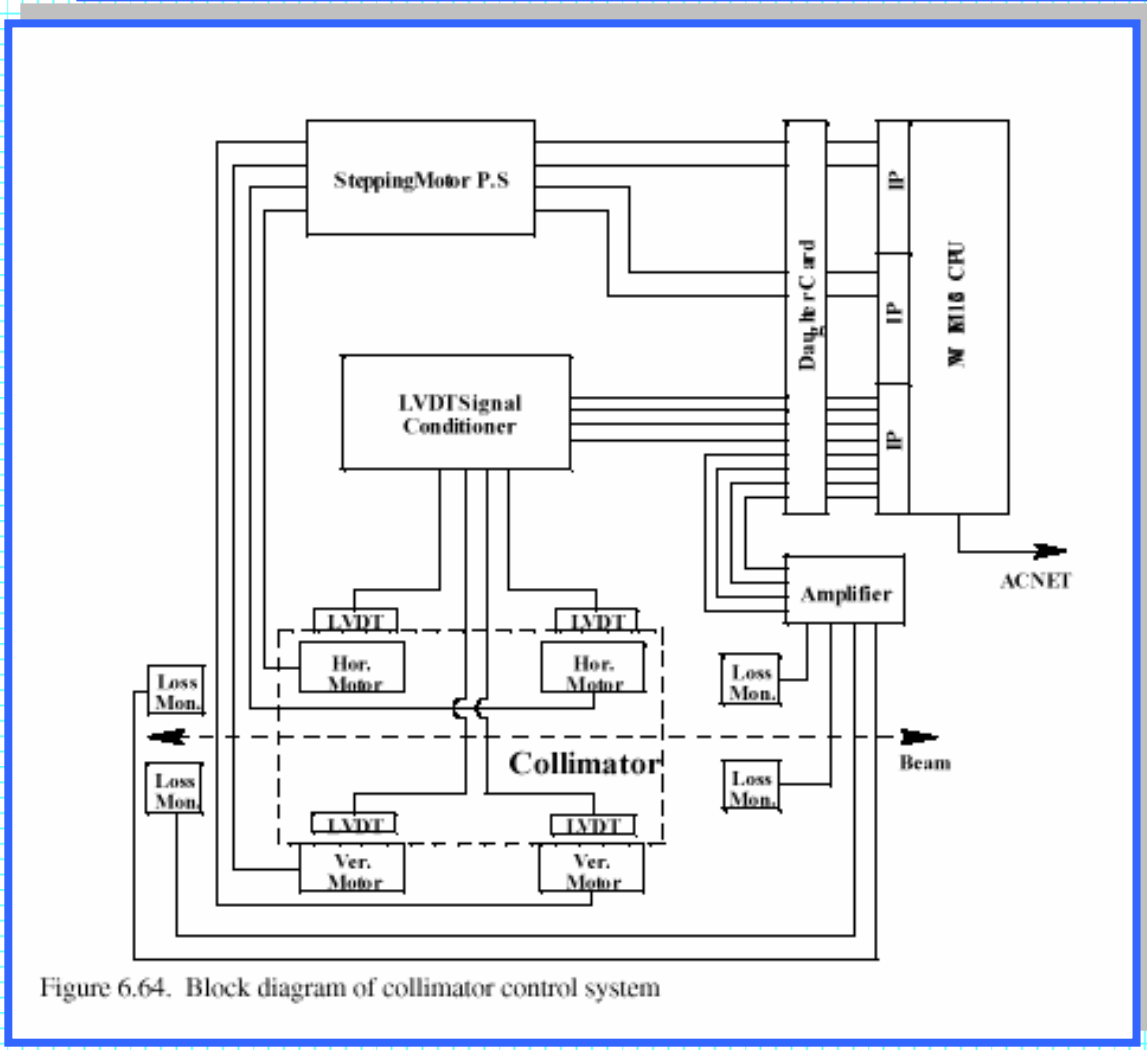
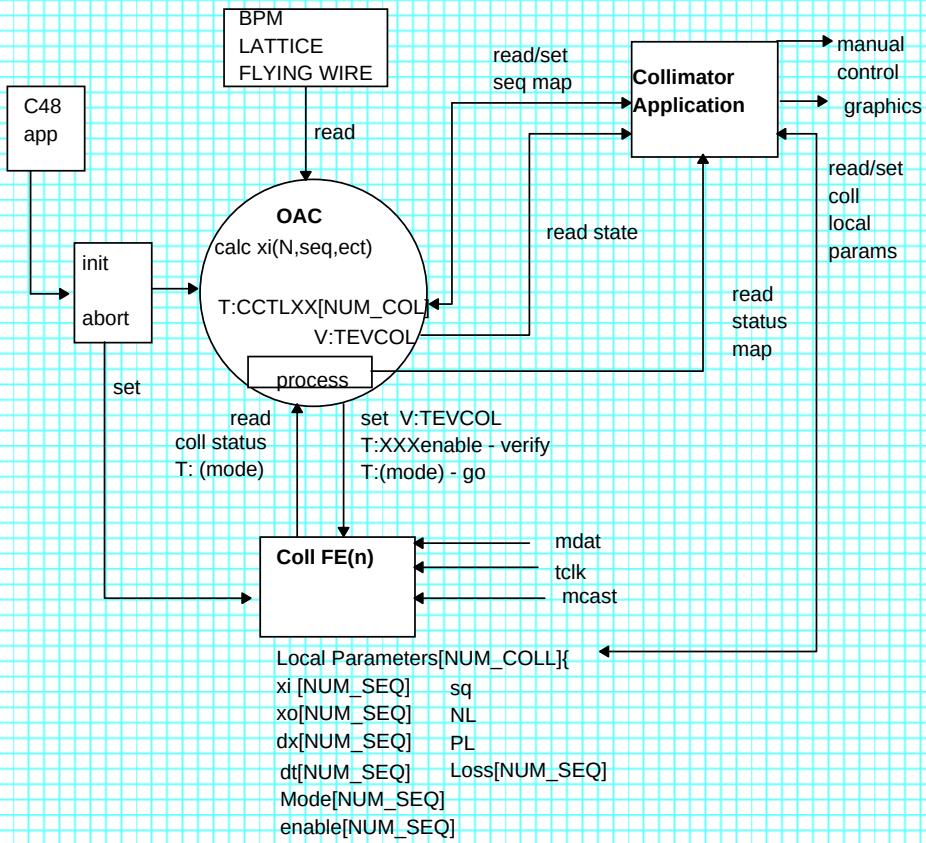


Figure 6.64. Block diagram of collimator control system

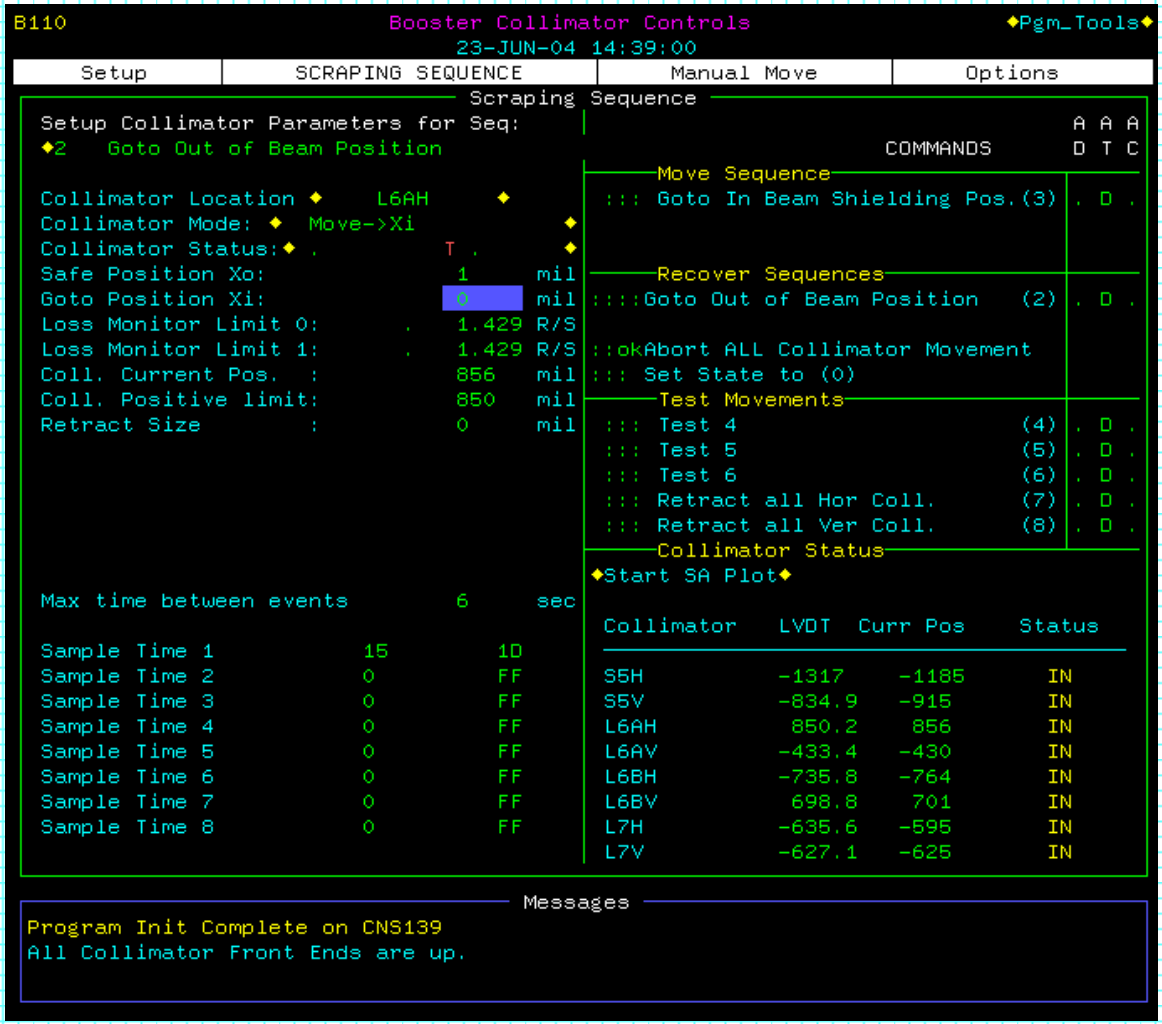
- VME based.
- BLM and B:CHG Inputs for feedback.

Collimator Controls Block Diagram

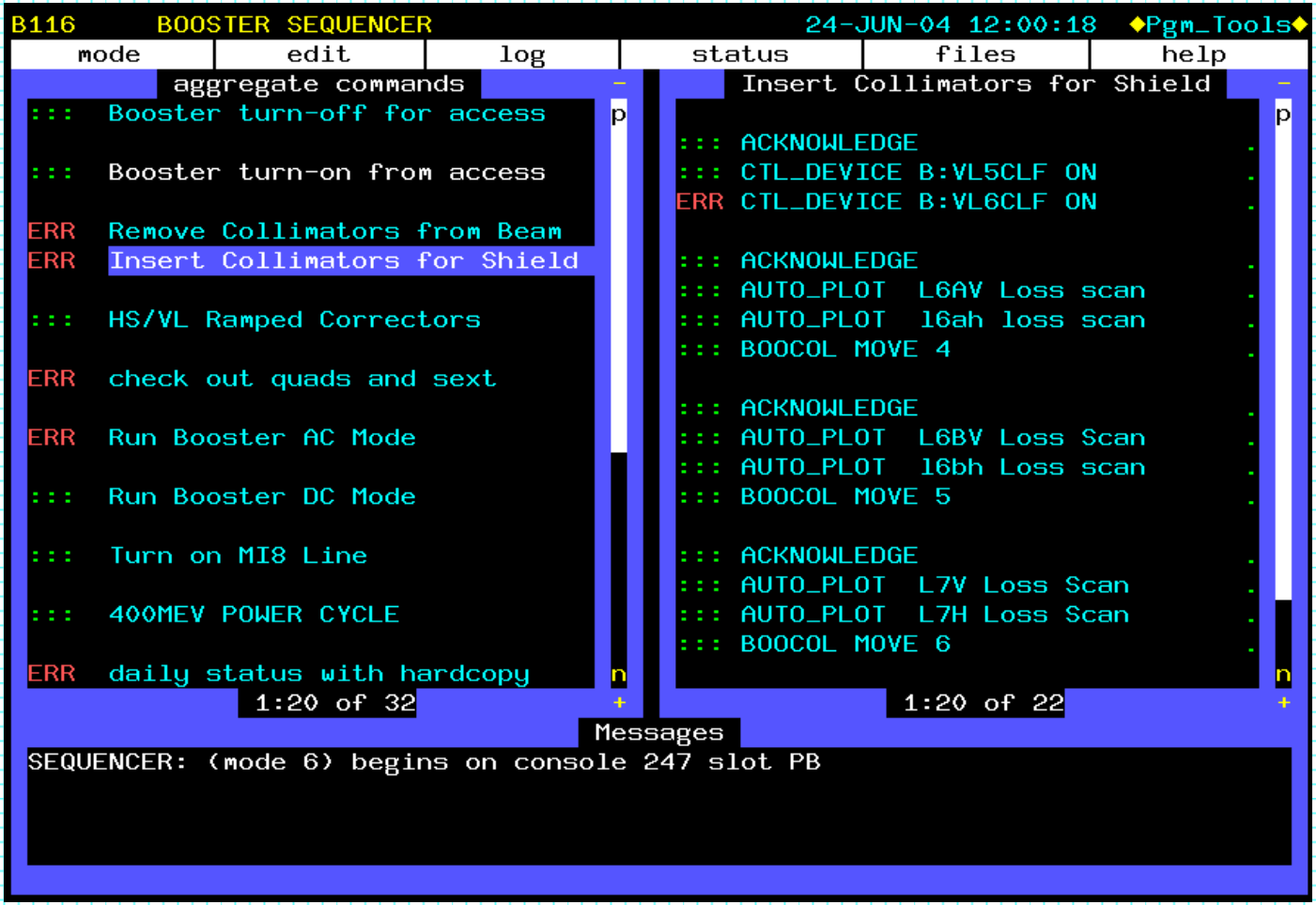
Collimator Global Controls Layout



B110 Application Page

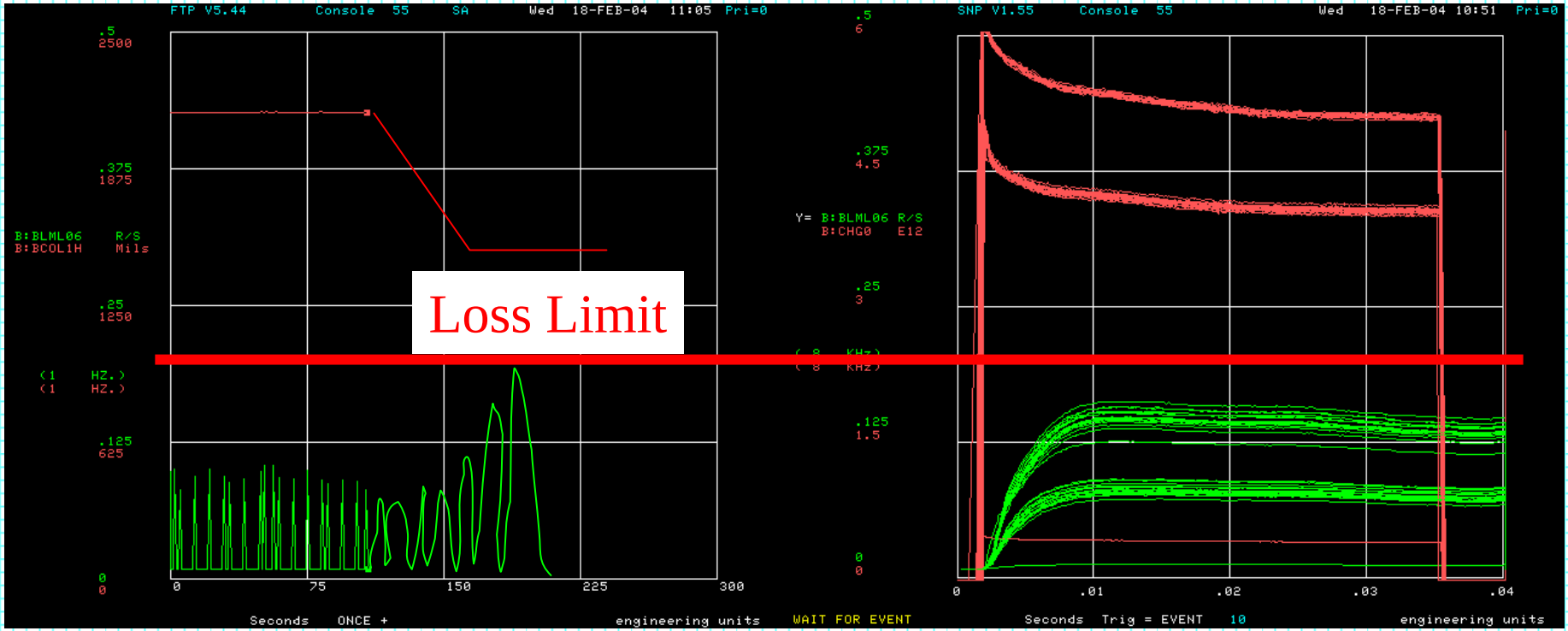


Controls from Booster Sequencer



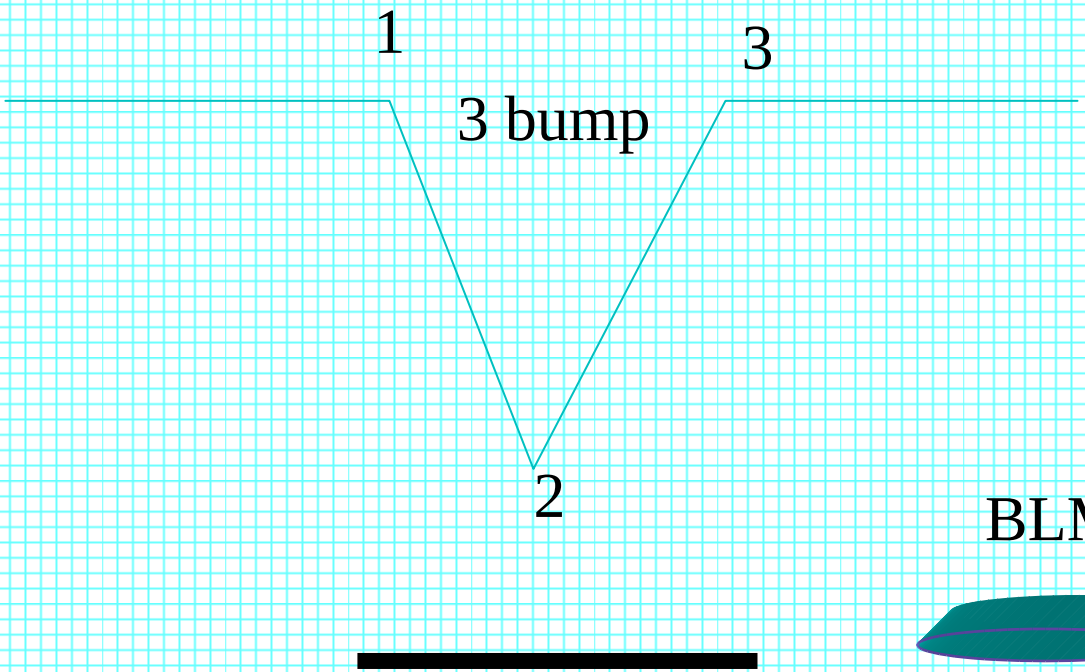
Slow Loss Monitor Feedback

- 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.



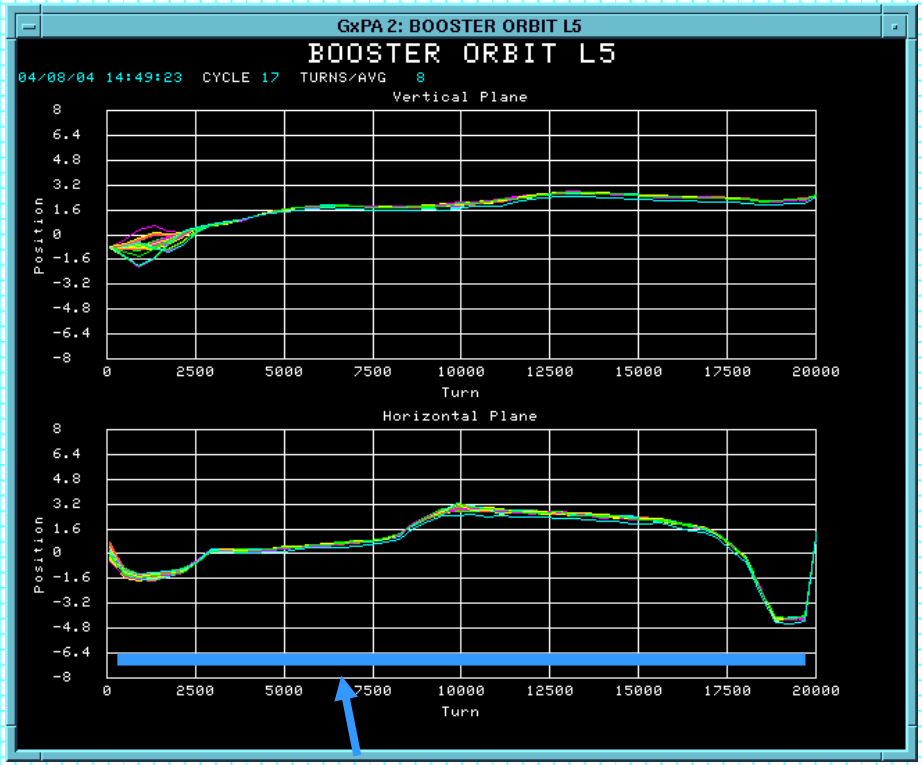
Fast Lost Monitor Feedback

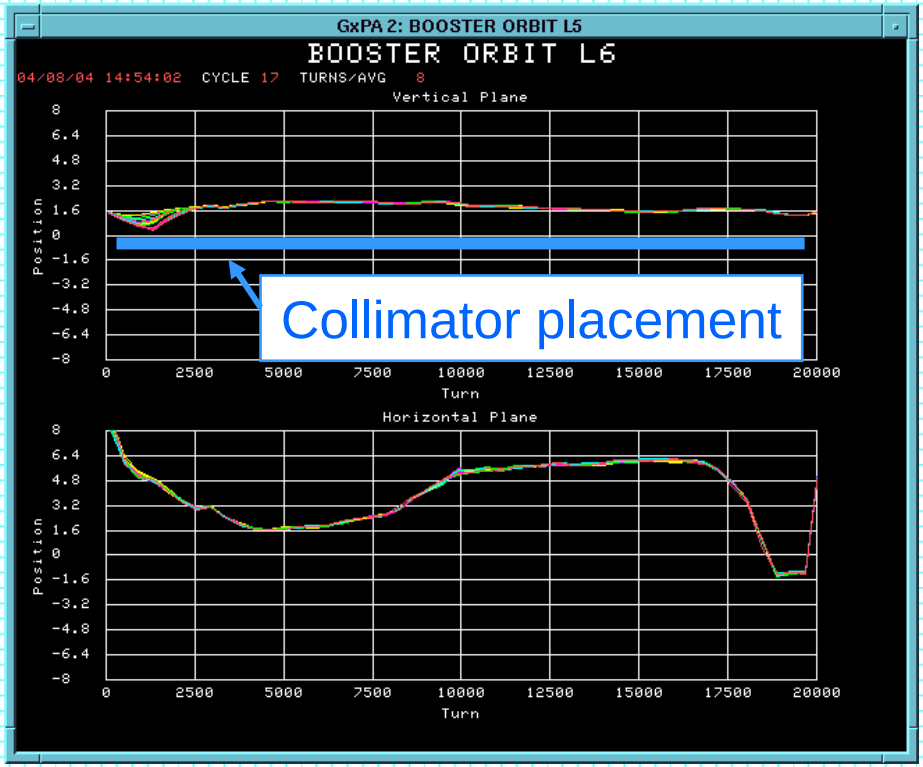
1) Have to bump the beam into the collimator. Need hardware to process. Intend to bump on $1D.



Bump box: Inputs 4 dipoles and scales 4 bumps output

Orbits at Collimators

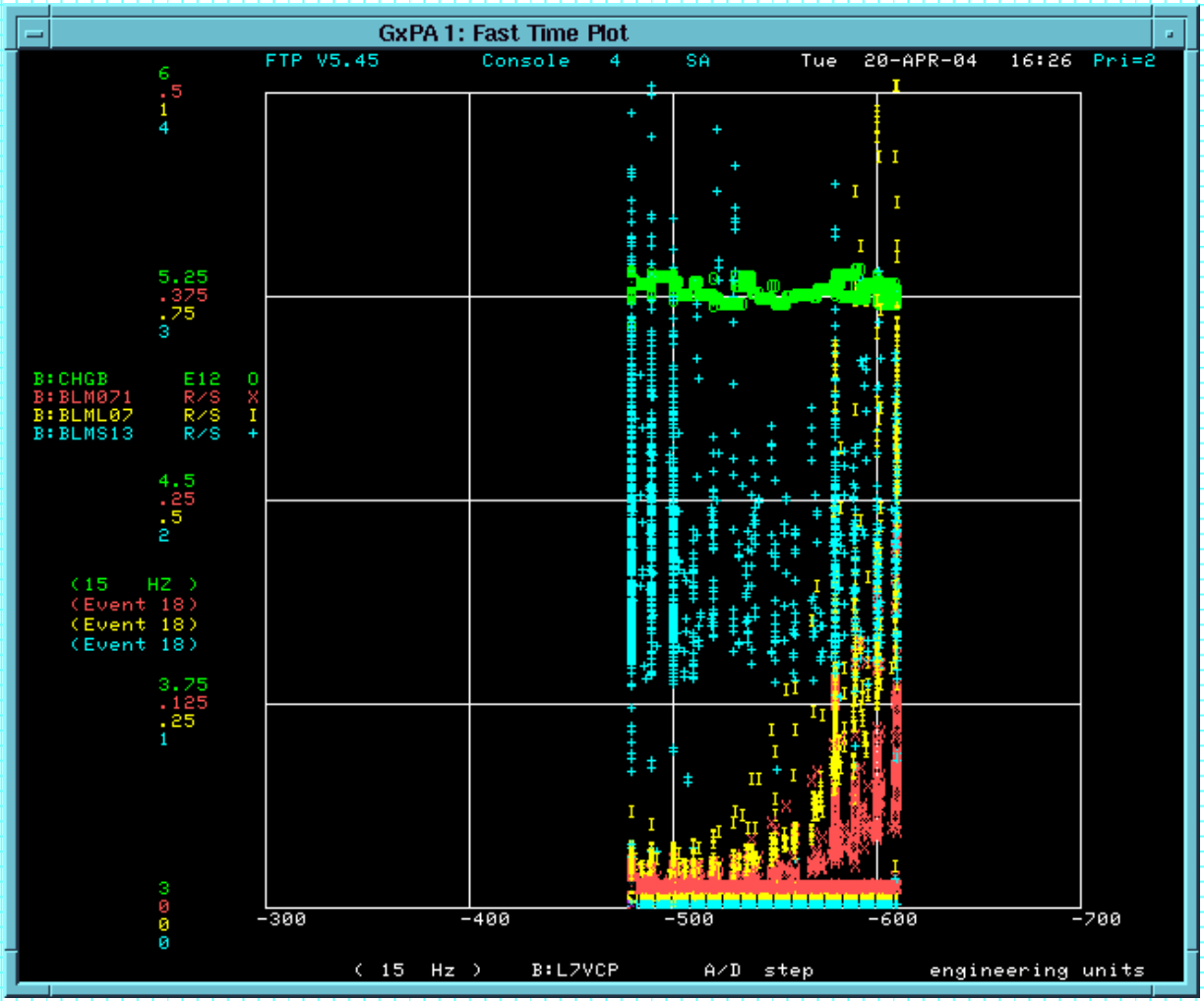




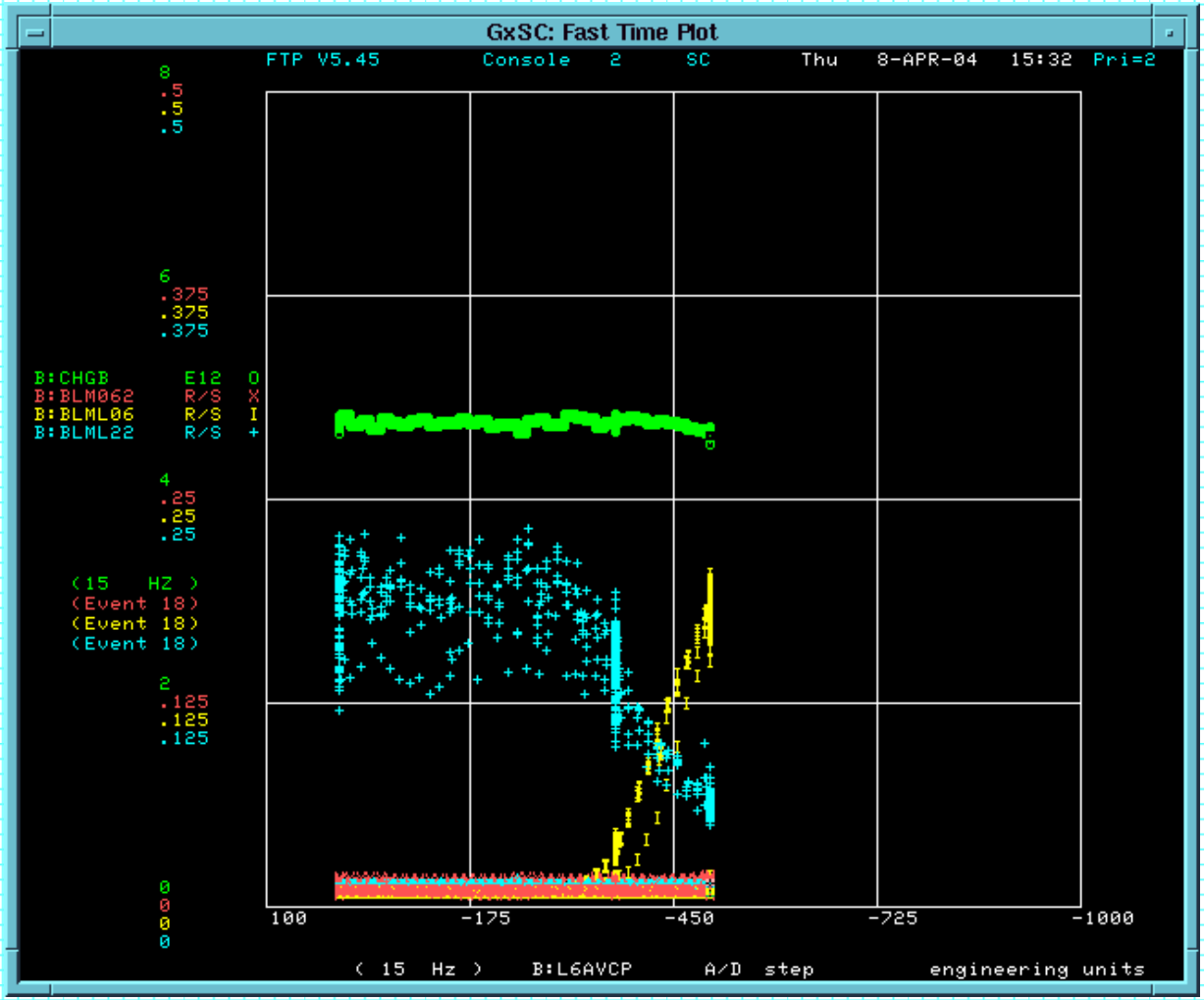
Positioning the Collimators

- 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

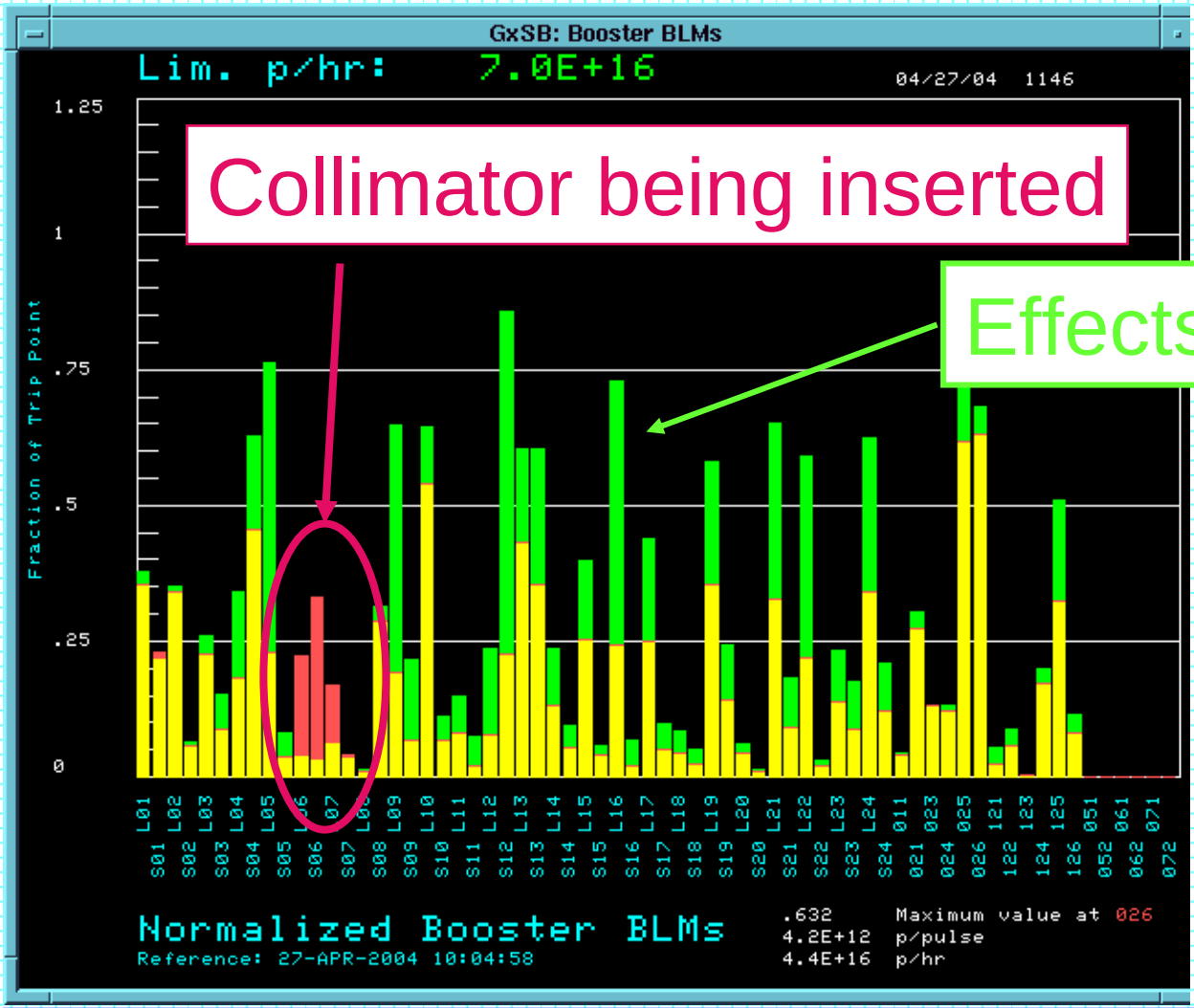
Collimator Loss Scans



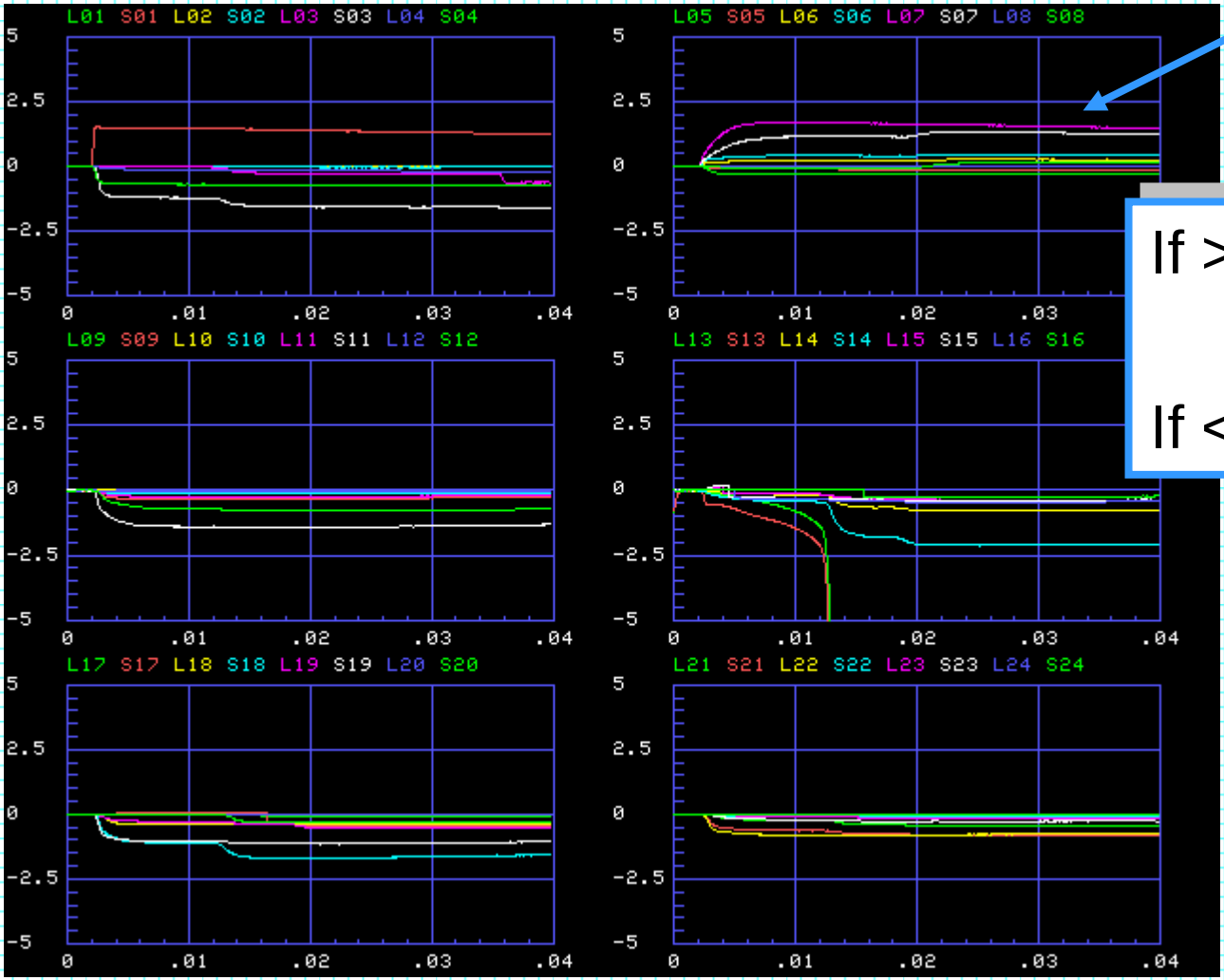
Collimator Loss Scans



Effects of Collimators on Ring Losses



Ring Loss difference for Collimators In and Out

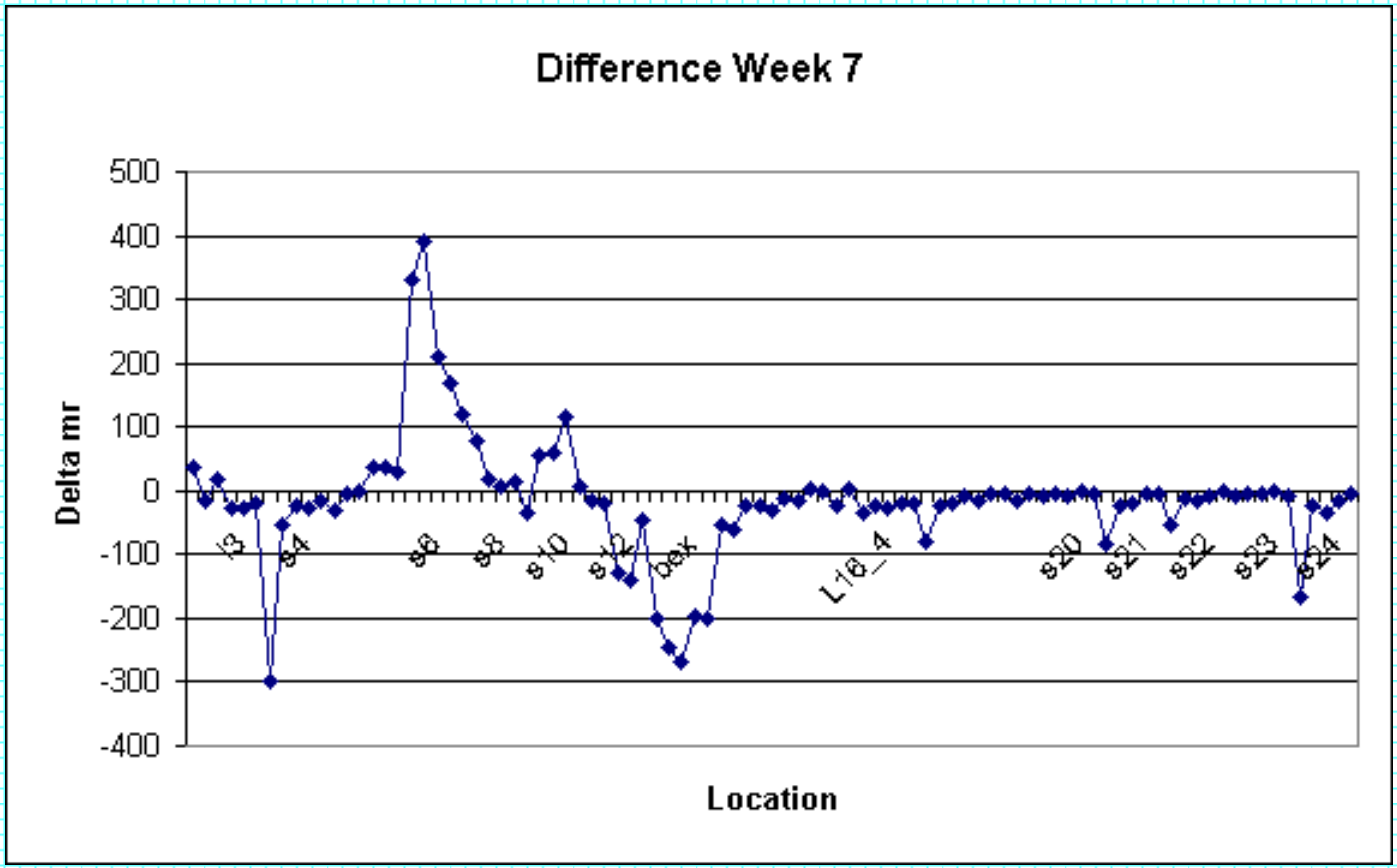


Collimator location

If > 0 increased loss

If < 0 decreased loss

Rad Survey at week 7

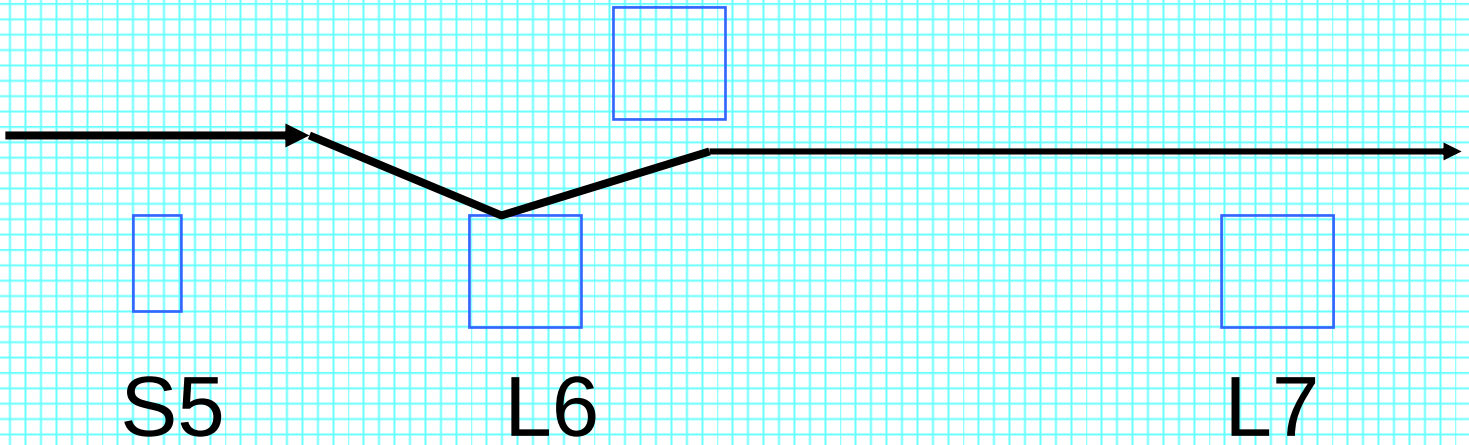


Problems/On going Work

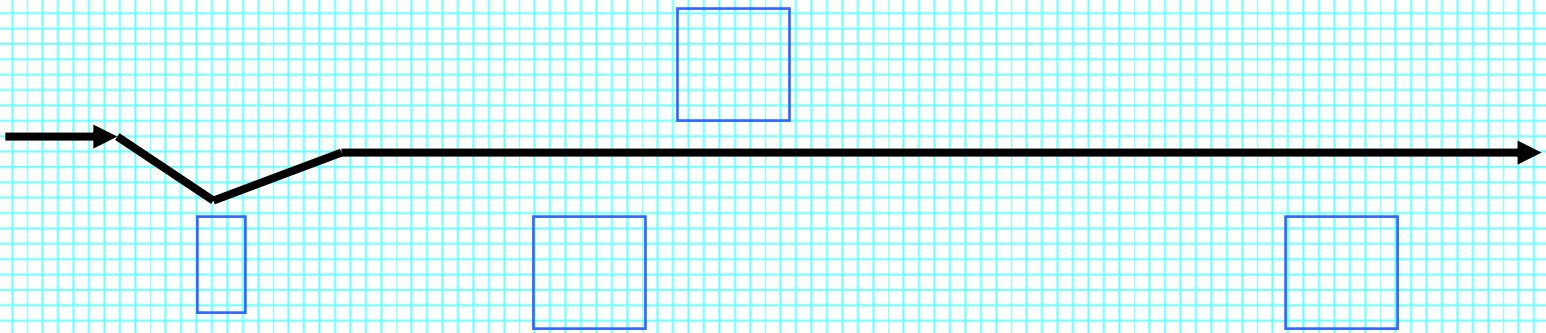
- $1D cycles are difficult for BLM and BPMs to gather data consistently and accurately.
- SNP have similar problems with $1Ds plotting beam intensity and BLMs.
- Horizontal collimator movement has shown slippage.
- Still need to assess and maximize collimator efficiency.

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