Details of Fast Booster Losses During Collimator Studies

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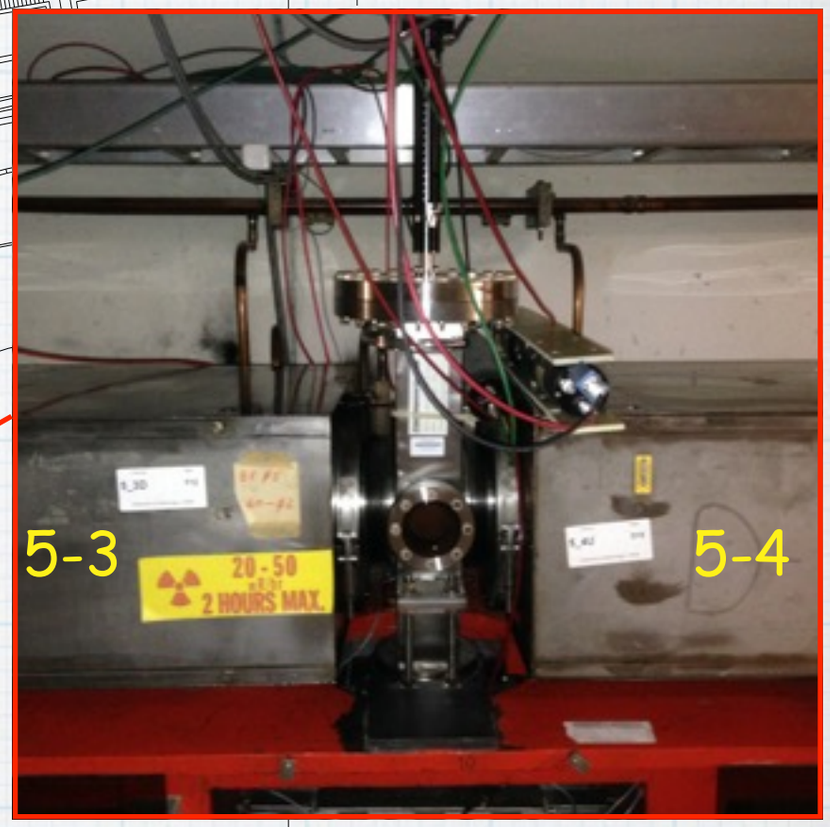
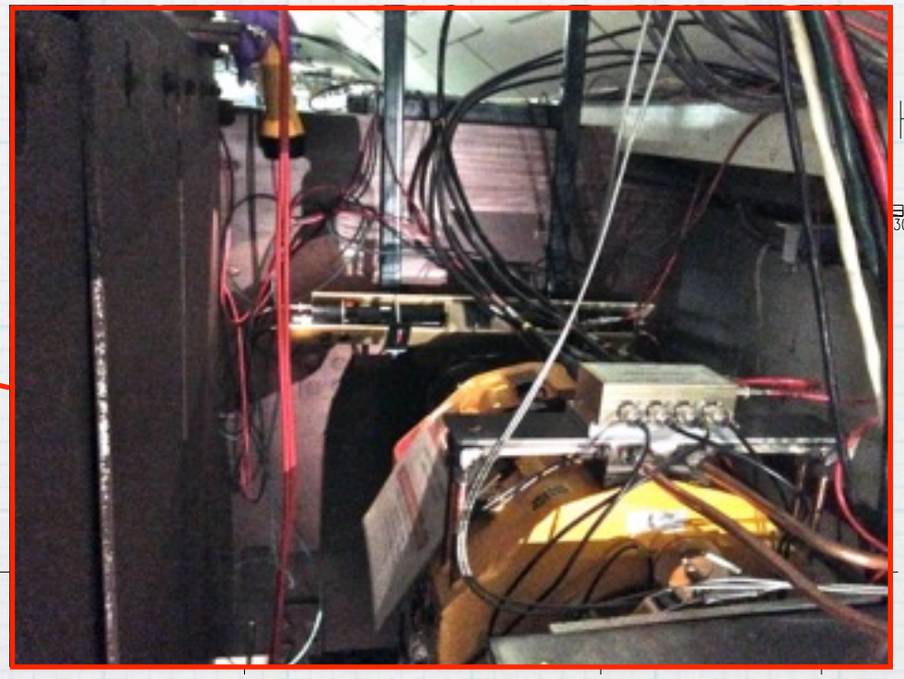
4/19/17

Review (FLM Module Locations)

Module Unwrapped





Horizontal Target

Vertical Target

Absorber 6A

Absorber 6B

Absorber 7

Review (Definitions/Readout)

Instrumentation measures rates/booster cycle (independent of beam):

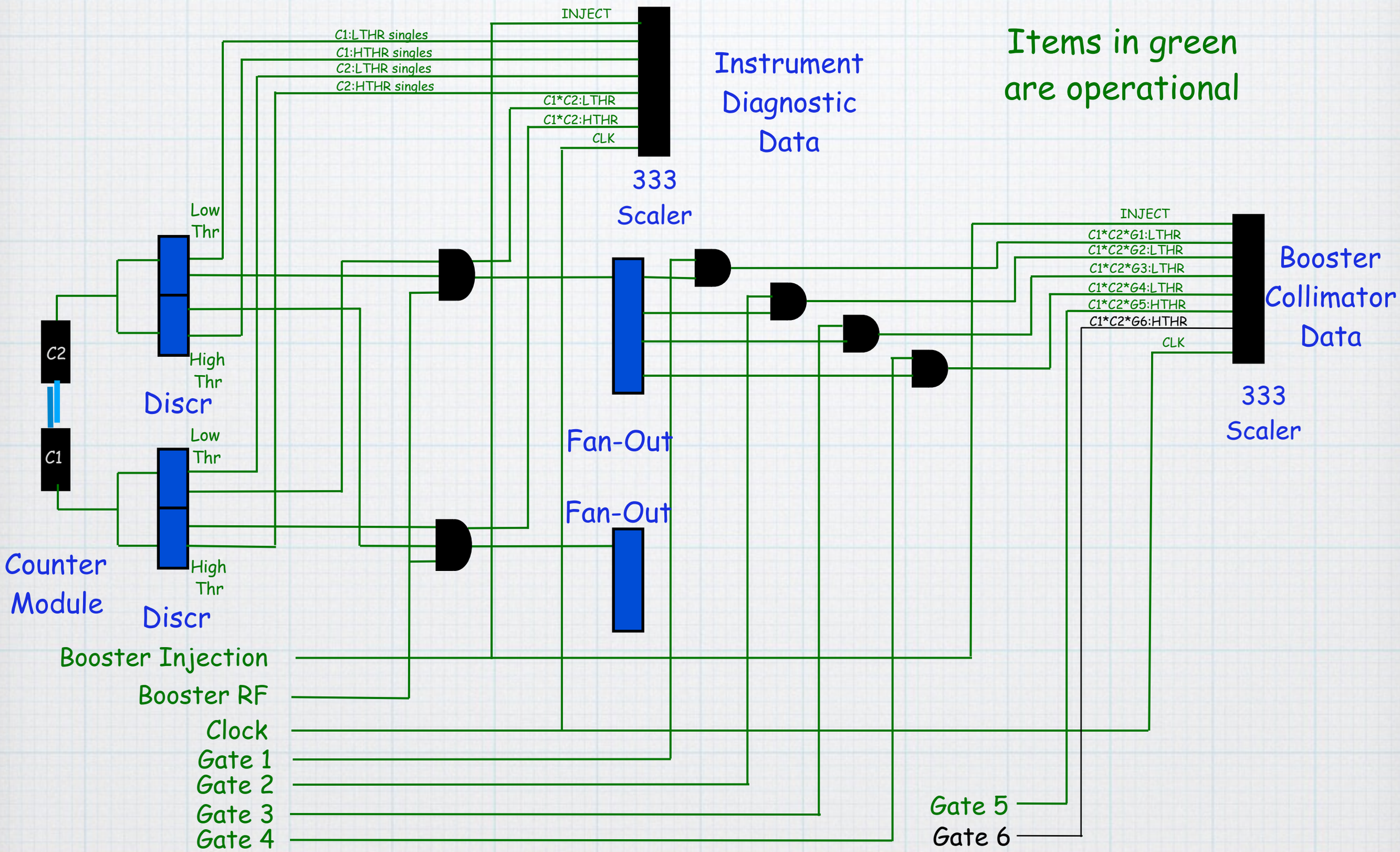
$$R(i) = \frac{s(i) - s(i-1)}{INJ(i) - INJ(i-1)} \cdot \frac{f_{CLK}}{CLK(i) - CLK(i-1)}$$

clock: 38.768 kHz TTL temp compensated oscillator

- Rates average signals over period between $12 events (~1.33s), normalized per booster cycle
  ➡Needs modification to read on different ~ 1Hz events
- Use 333 scaler module for readout
- Rates normalized by number of booster cycles between $12 events
- **Clock:** a periodic signal with a well known (stable) frequency. Because the booster RF is modulated it can't be a clock signal.
- **Booster RF:** Booster RF signal (logic level) to provide background rejection from non-prompt particles. Also counts "hits" for time-over-threshold discriminator.
- **Injection:** Signal that beam may be injected into the booster (beam may not be present)
- **Notch:** Signal that the extraction notcher has fired.
- **Gates:** Time intervals of interest to measure rates in counter modules.

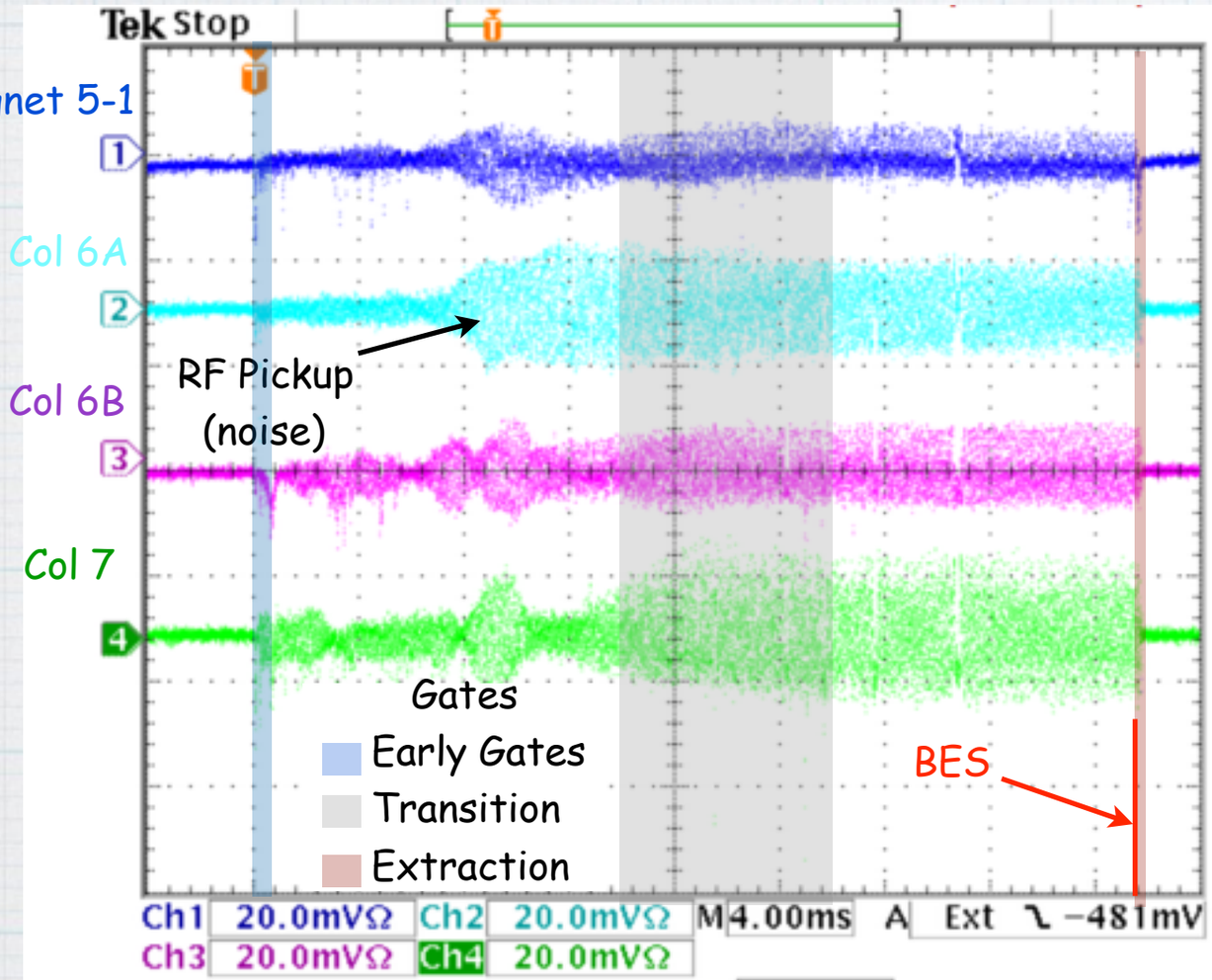
➡Radiation damage requires annual replacement (more in subsequent talk)

Review: (Readout Logic/module)



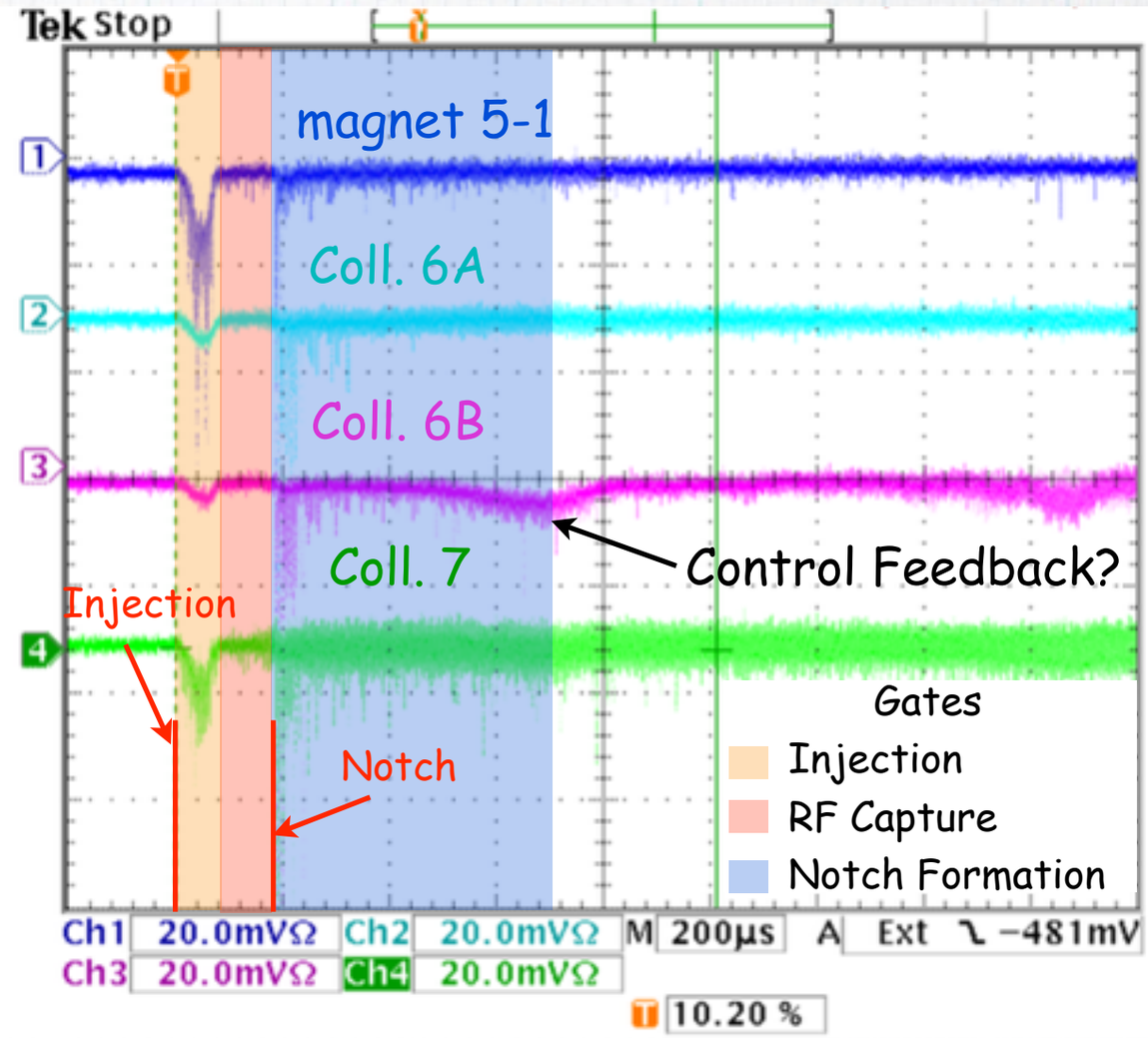
Review: (FLM Gates)

Entire Booster Cycle



Traces taken on 4/10/17

Early in Booster Cycle



Notes:

- RF pickup not amplified by PMT (raise gain to increase loss signal sensitivity)
- RF pickup amplitude reaches steady state when RF frequency nearly constant.
- Because "capture" gate width varies, rate is additionally normalized by gate width.

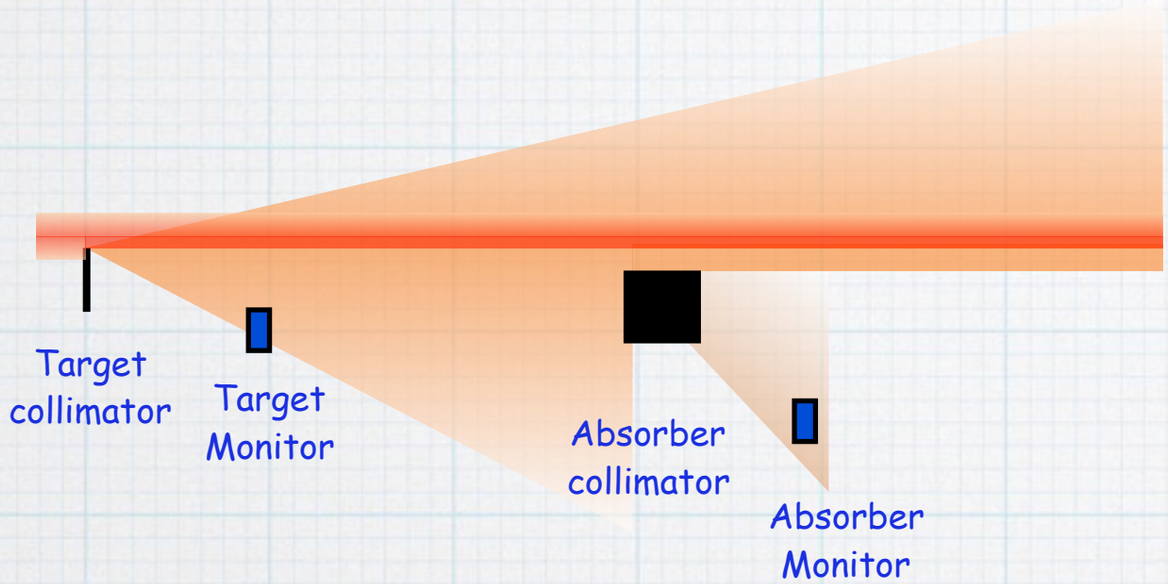
Gate #	Name	t(min)	t(max)
1	Injection	t_{inj}	t_{inj} + 100µs
2	Capture	t_{inj} + 100µs	t_{notch} - 0.02µs
3	Notch	t_{notch}	t_{notch} - 500µs
4	Transition	t_{inj} + 14,000µs	t_{inj} + 22,000µs
5	Extraction	t_{BES} - 1.6µs	t_{BES} + 1.6µs

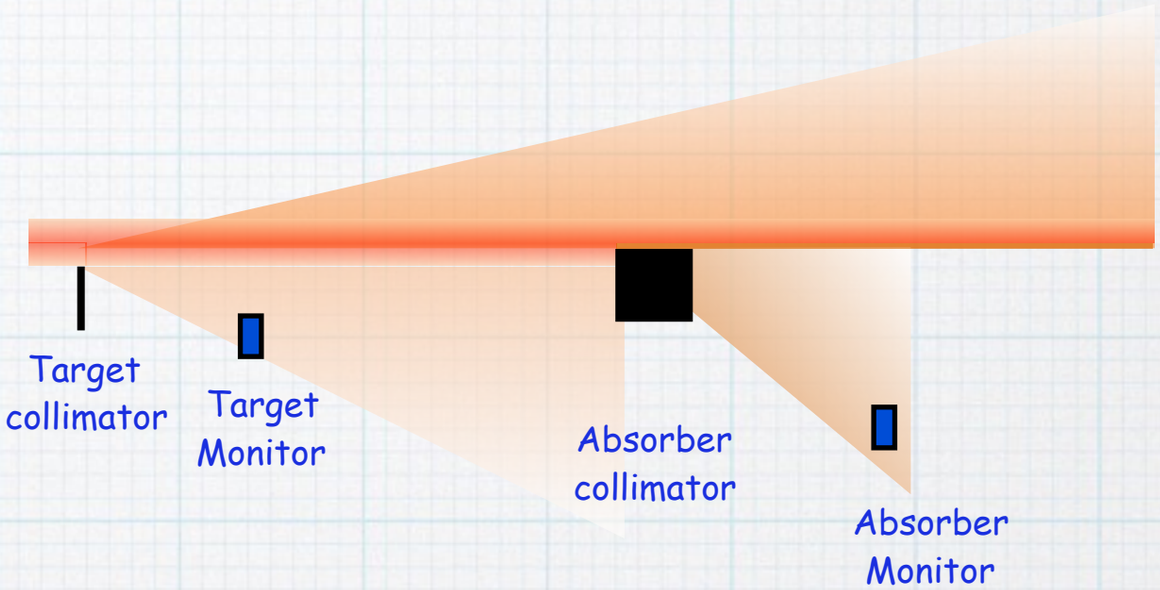
Review (ACNET Variables)

ACNET Variable	Definition
B:HT51Gx	Horizontal "target" (primary collimator), downstream of magnet 5-1
B:VT53Gx	Vertical "target" (primary collimator), downstream of magnet 5-3
B:L6AGx	Absorber (secondary collimator), downstream of collimator L6A
B:L6BGx	Absorber (secondary collimator), downstream of collimator L6B
B:L7AGx	Absorber (secondary collimator), downstream of collimator L7A

Gx = gate # x (x = 1-5)

Review (Collimator Configuration)





Collimators properly configured:

➡Absorber "shadows" target (absorber farther from beam core)

- moving target from beam lowers rates in both target and absorber monitors
- moving absorber from beam lowers only rate in absorber monitor*

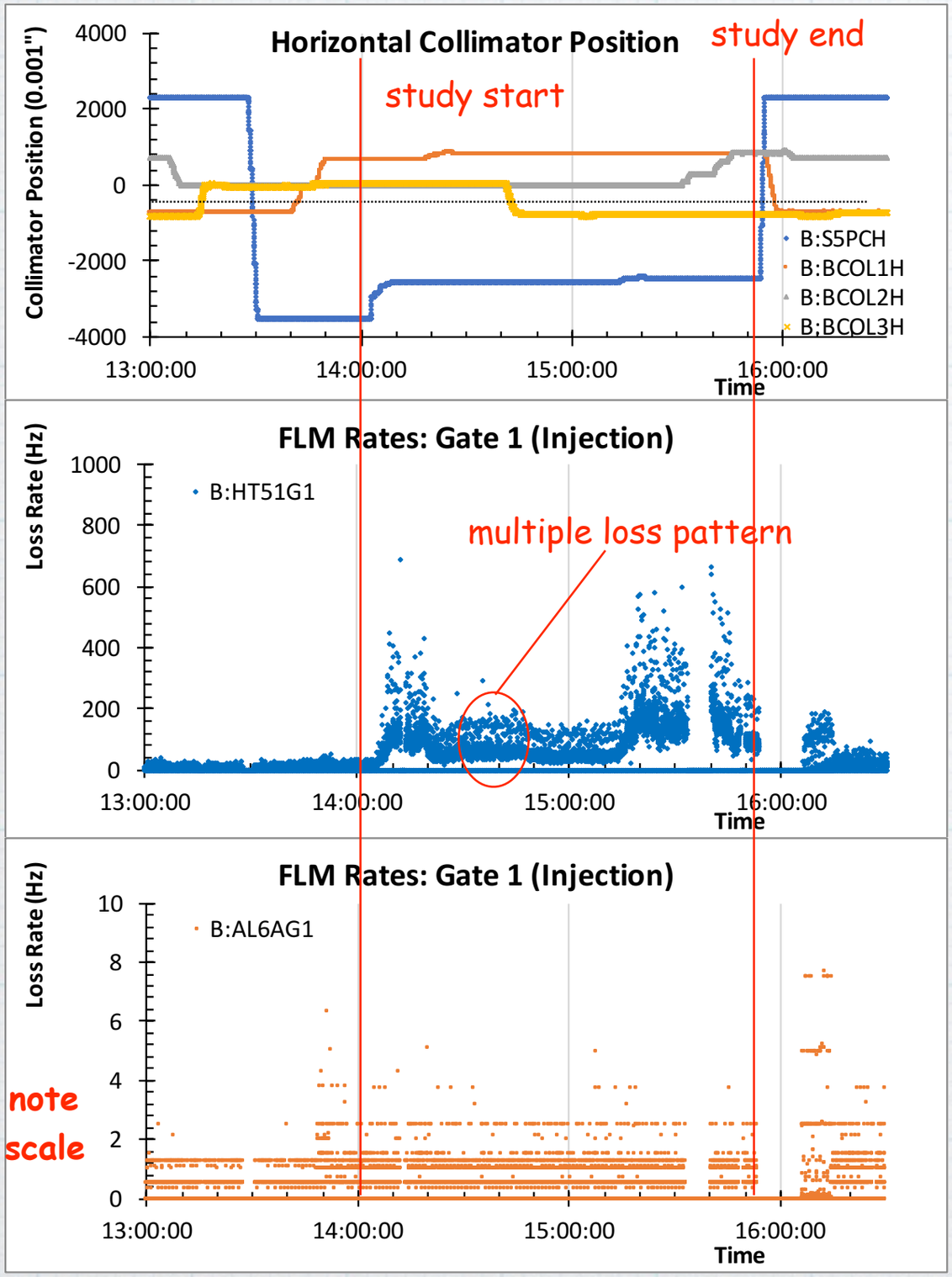
Collimators improperly configured:

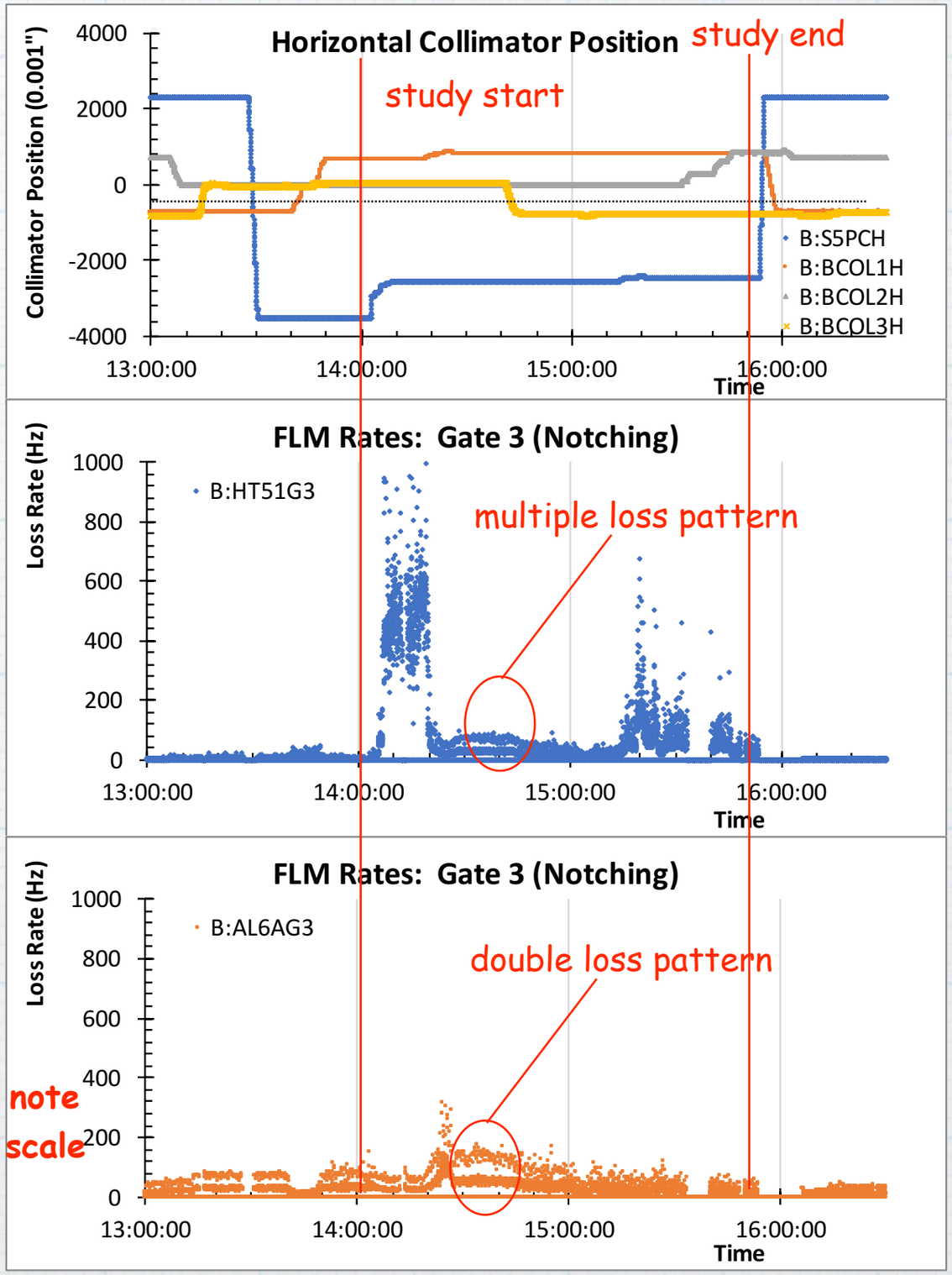
➡target "shadows" absorber (target farther from beam core)

- moving target from beam lowers only rate in target monitor
- moving absorber from beam lowers rates in both target and absorber monitors*

* If absorber starts completely out of beam, initial motion toward beam intercepts particles scattered by target, reducing target monitor rate from particles that initially scattered by target the previous revolution(s).

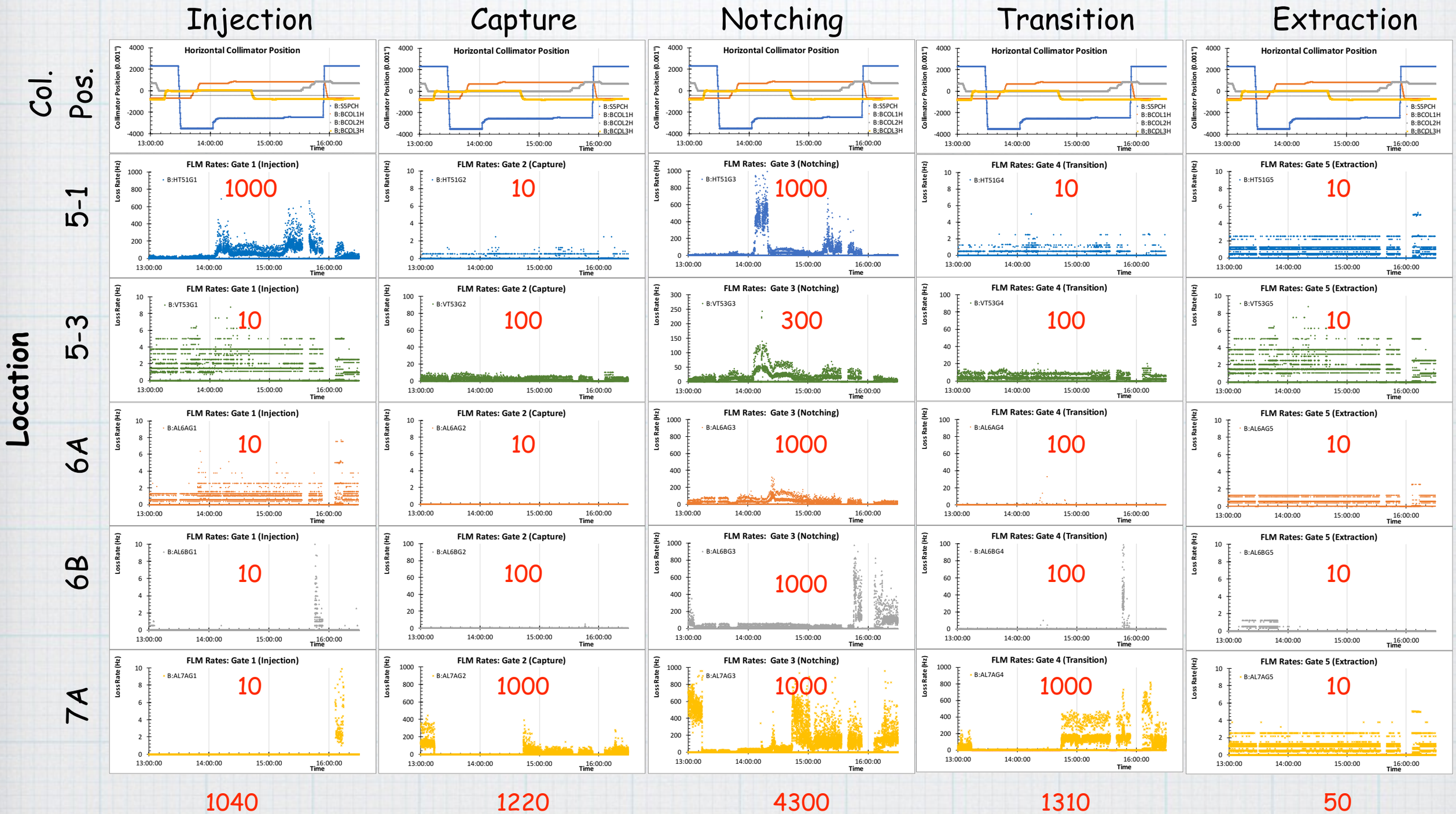
Collimator Study Detail (3/2/17 study)





All FLM Data

Gate



Summary

Observations:

- Losses at collimators still dominated by notch formation
- Optimization at injection <—> optimization at notching (for study configuration)
- Multiple loss rates for single booster event type ($17)

Breaking News:

- Observation of losses > 100μs prior to extraction (beam positioning for extraction)
- Modify extraction gate to include these extra losses.