Beam Quality Monitoring for CDF Silicon

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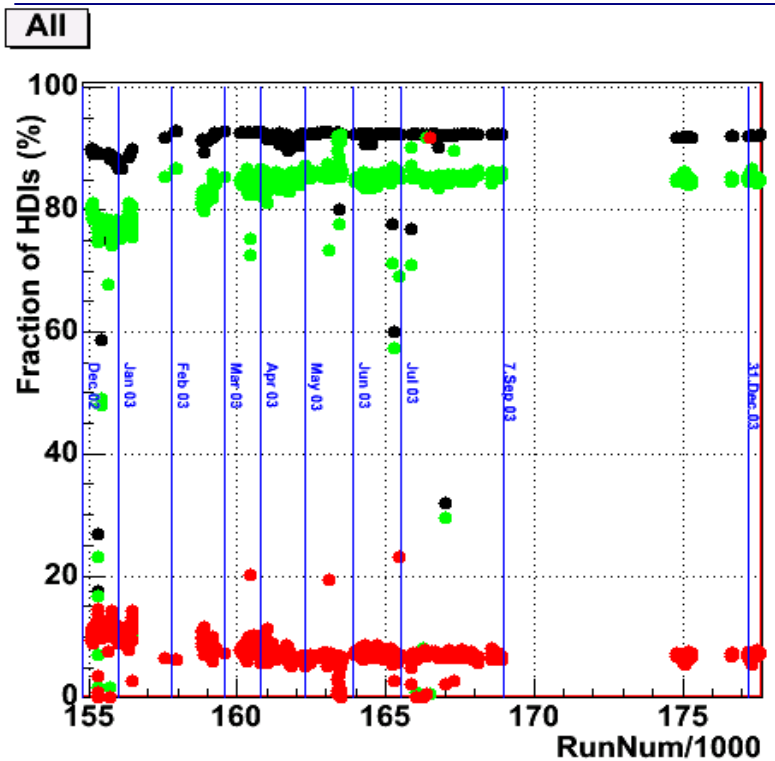
on behalf of the

CDF Silicon Operations Group

- Status of Detector.
- History and Implementation of TevMon.
- Recent Beam Quality Issues.
- Summary and Proposal for Rate Adjustments.

Detector Status



	Before	After	Now
Powered	92.5	91.7	92.1
Good/All	86.2/	84.4/	84.9/
Good/Pw'd	93.2	92.0	92.2
Bad/All	6.3/	7.4/	7.2/
Bad/Pw'd	6.8	8.0	7.2

NB: a ladder is bad if it has > 1% errors

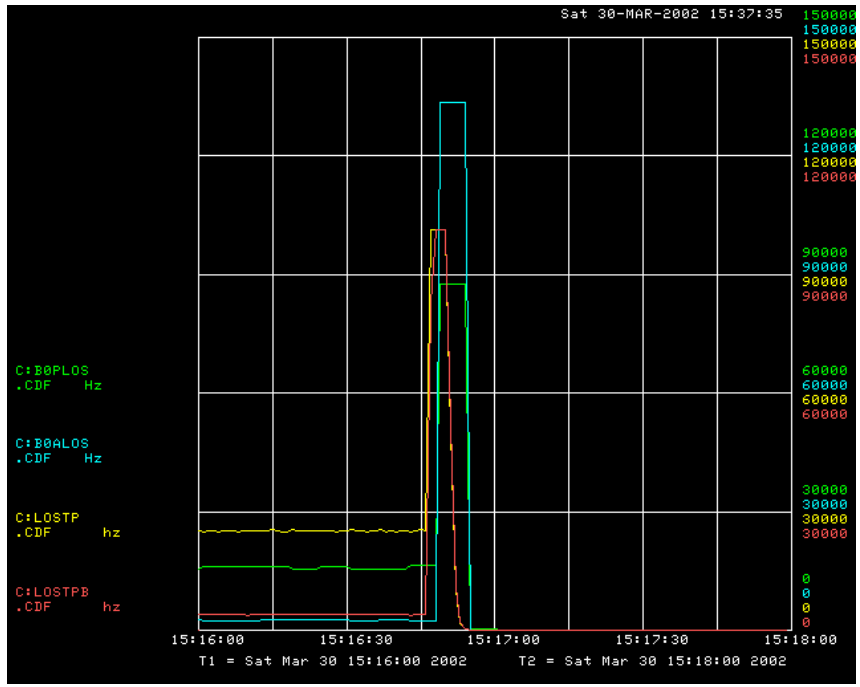
- This is as good as it gets: Status will only go 'down' from here.
  - -Recently salvaged 2 ladders in 24 hour access with medium to high risk assessment. Other broken ladders more prohibitive.
  - - Radiation damage visible but not yet an issue.

Silicon operations approach is 'conservative' in the best sense of the word …..

History of Beam Incidents

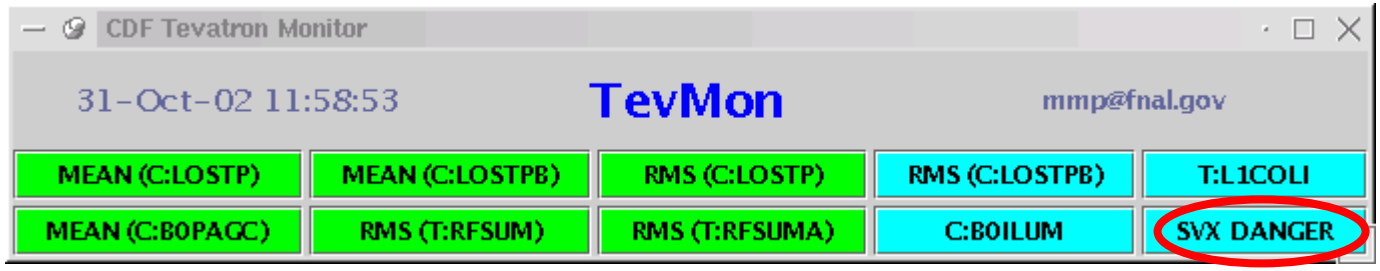
- Obviously cannot protect against spontaneous equipment failure:
  - 11/09/02 Abort Kicker Prefire – 2 chips on 2 ladders
  - 12/01/03 Abort Kicker Mis-Timing – 2 chips on 2 ladders
  - 12/20/03 A0 Power Failure - 2 chips on 1 ladder

- But hopefully helps protecting against catastrophic beam failure like
  - 03/30/02 RF failure/DC beam /Quench – 31 chips on 6 ladders, 1 ladder lost bias.
  - Dose was 1.5 Rad over ~ 150 ns
    > 10 MRad/sec



TevMon was conceived as automated tool which should alert shift crew about 'abnormal' beam conditions

TevMon – Automated Beam Quality Monitoring



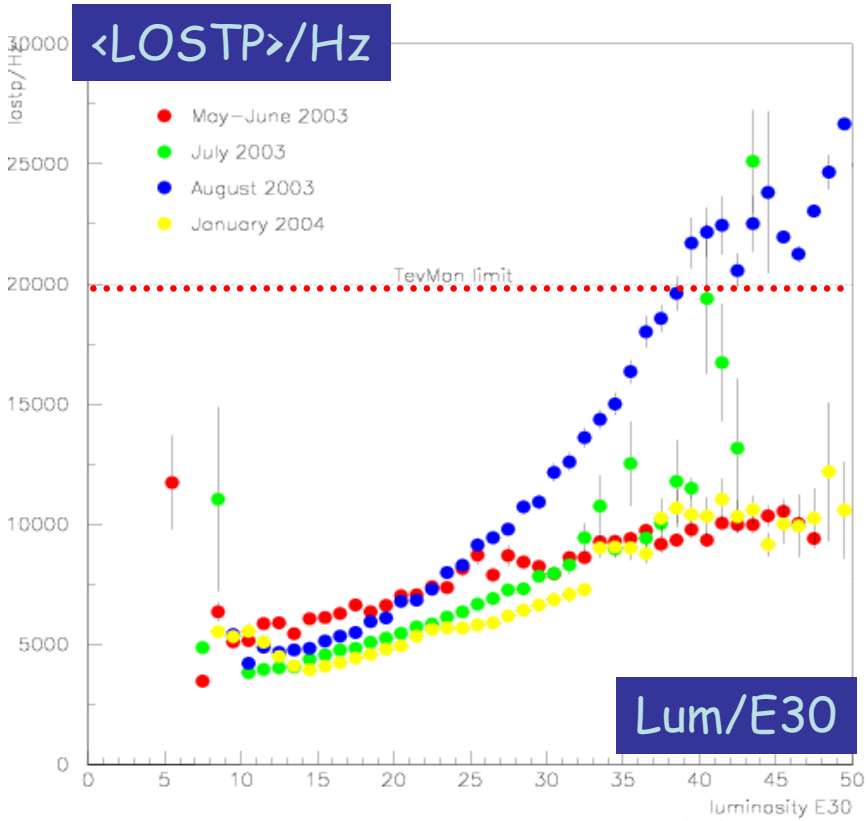
http://b0dap61.fnal.gov/~cdfdaq/tevmon.html

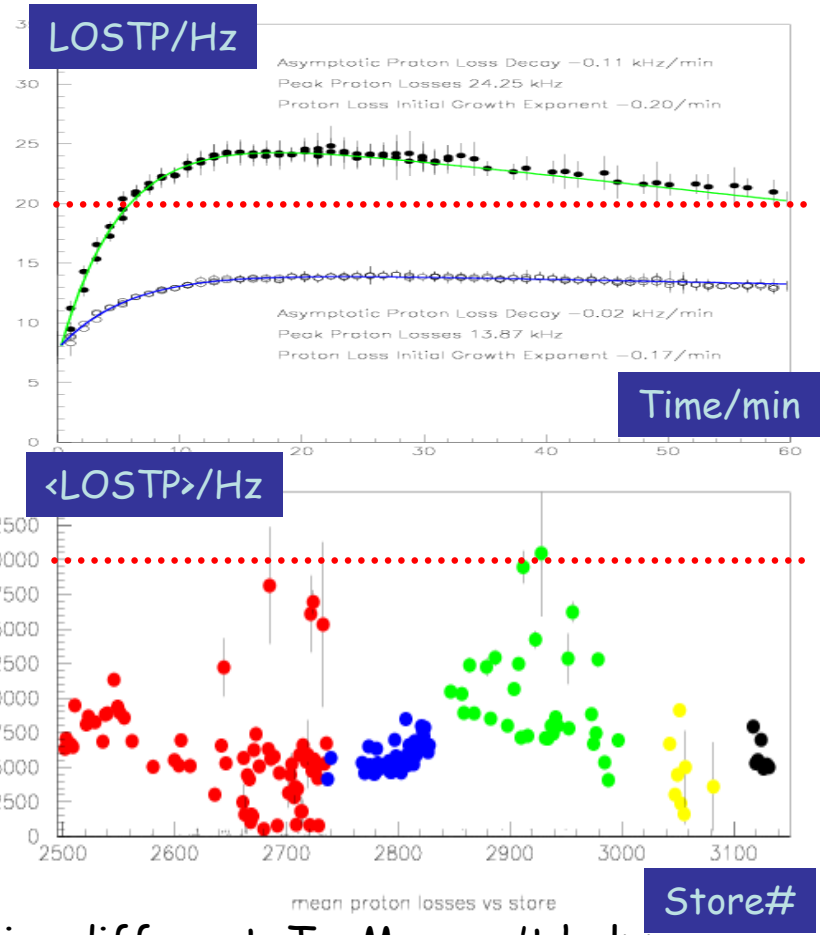
Used by CDF shift crew to make switch on decision – effectively used as an 'autopilot'.
=> TevMon decision needs to be safe and (over-)efficient in alerting shift crew about abnormal beam conditions

Monitoring (and choice) of variables is (just) '**common sense**' and (our) '**experience**':

- **The electron lens is on**
  - Monitor w/ ACNET variable T:L1COLI
- **The level of DC beam and particle in abort gaps is 'normal'**
  - Monitor w/ ACNET variables C:B0PAGC and C:B0AAGC gated on abort gaps
  - No sudden unexplained longitudinal growth of beam (T:SBDMS)
  - No sudden unexplained change in luminosity (ΔC:B0ILUM > 10%)
- **The Tevatron Radio Frequency (RF) system is stable**
  - Monitor w/ ACNET variables , T:RFSUM and T:RFSUMA
- **The Tevatron losses are minimal and stable**
  - LOSTP, LOSTPB < 20 kHz, ΔLOSTP, ΔLOSTPB < 2.5 kHz/hour
  - No persistent spikes > 25 kHz
  - No unexplained sudden change in rates

Adjusting TevMon limits





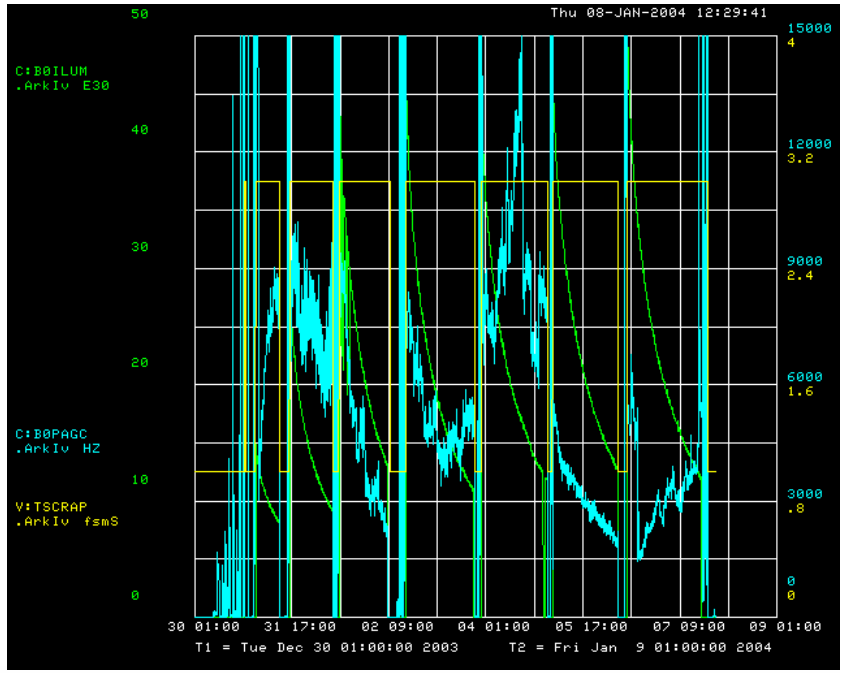
- TevMon limits have been derived from experience of recent *good* stores.
- If 'good' tomorrow is supposed to mean something different, TevMon can't help: We need to decide whether
  - these stores are abnormal and potentially more dangerous OR
  - there is another 'mode of operation' which is just as safe

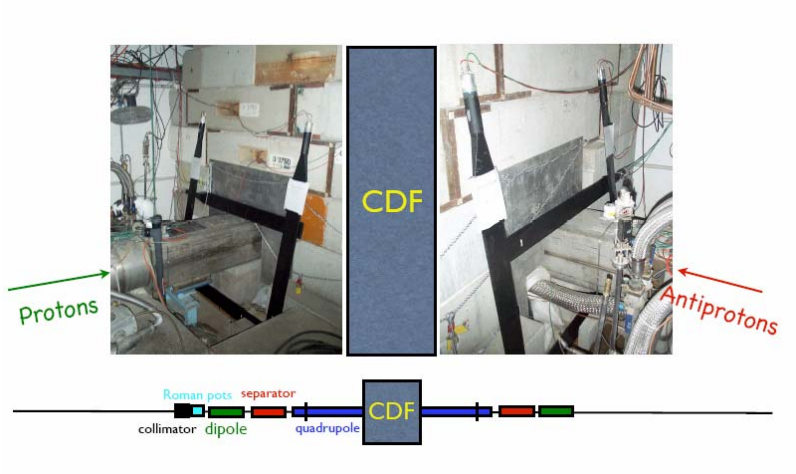
  It would help in this decision making to have an assessment by AD.

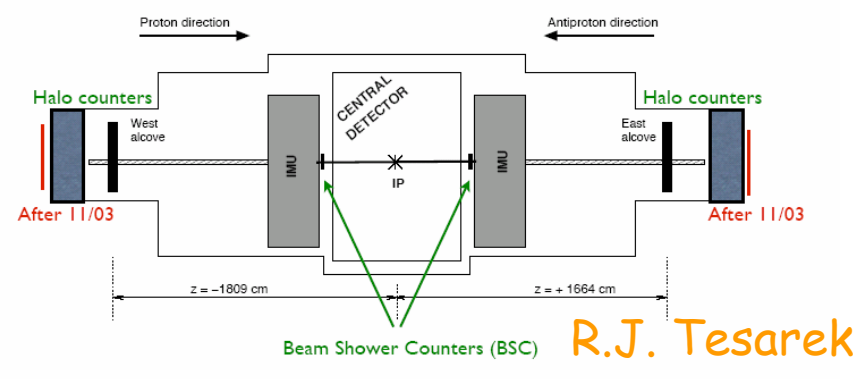
Recent Beam Quality Issues

'High' Abort Gap Losses in recent stores:

- Measured by scintillator counters which are gated to measure proton losses in-time and losses from the abort gap.
- Issue is complicated by the fact that the counters moved during the shutdown -> Rick's Talk.

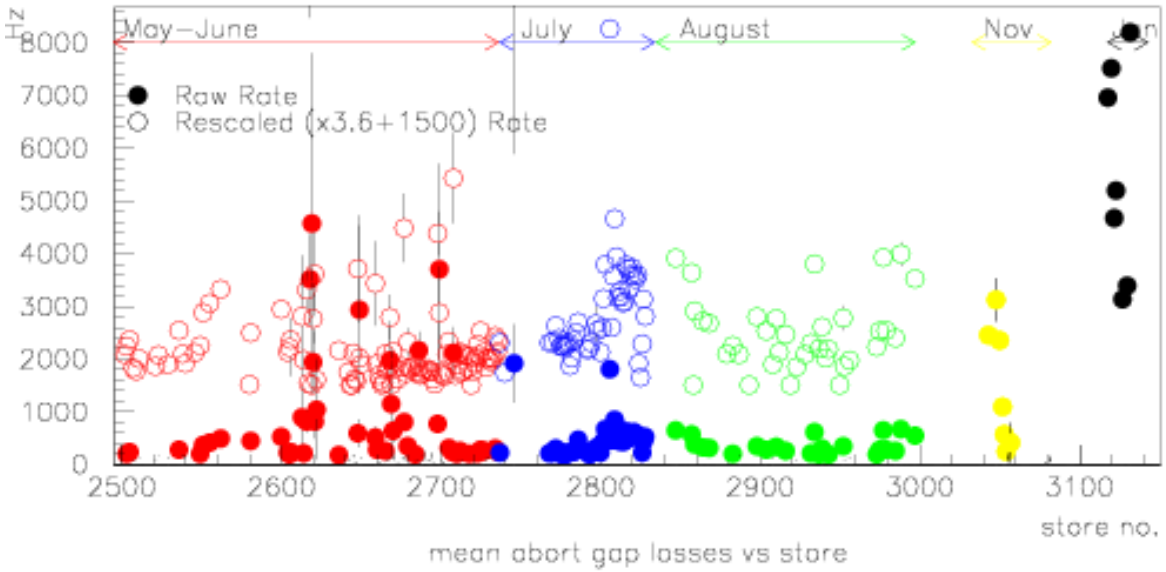


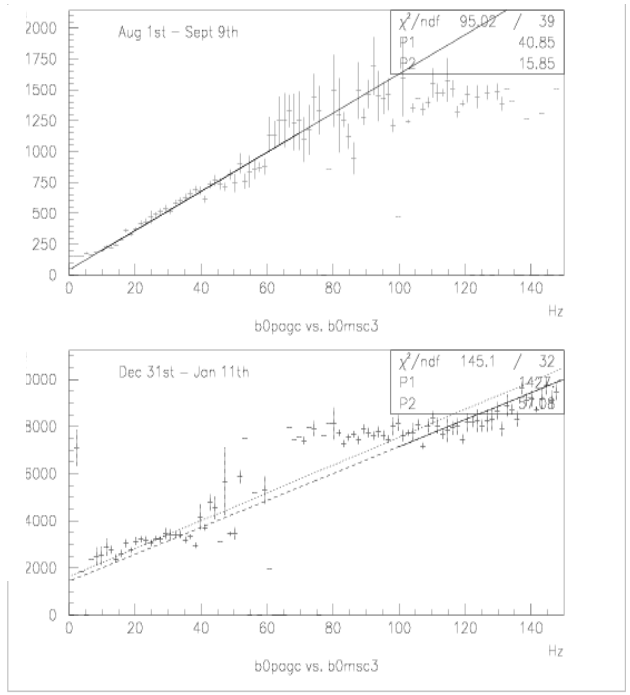




Recent Beam Quality Issues (cont'd)

- We rescaled the halo counters (which moved) to the beam shower counters (which stayed) in periods where the latter were operational





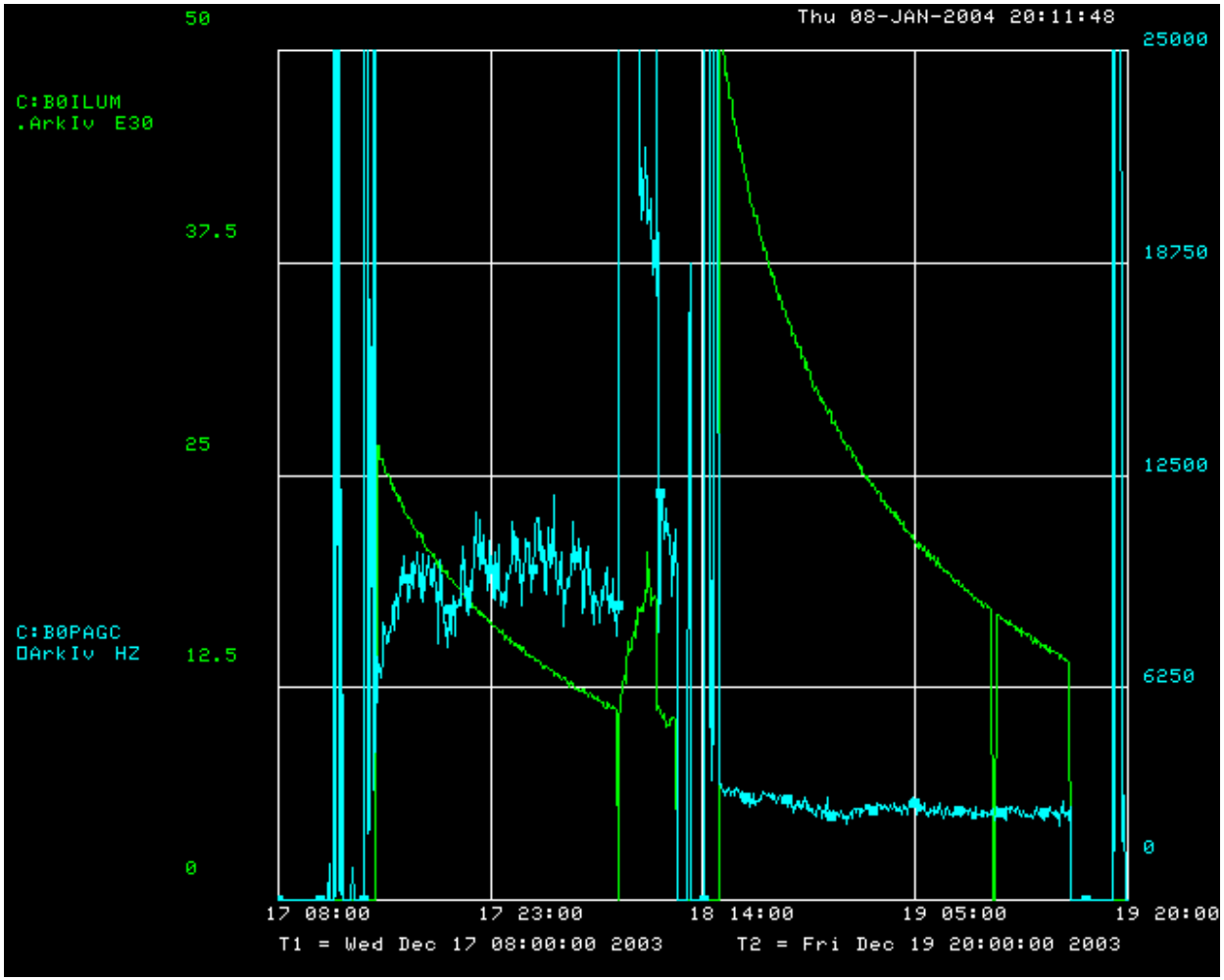
- The TevMon abort gap limit of 10kHz would then move to ~30KHz

BUT:

- The abort gap rates are still elevated by a factor of ~2-3 in the Jan period.
- There are large store-to-store fluctuations

Do we need to worry ??

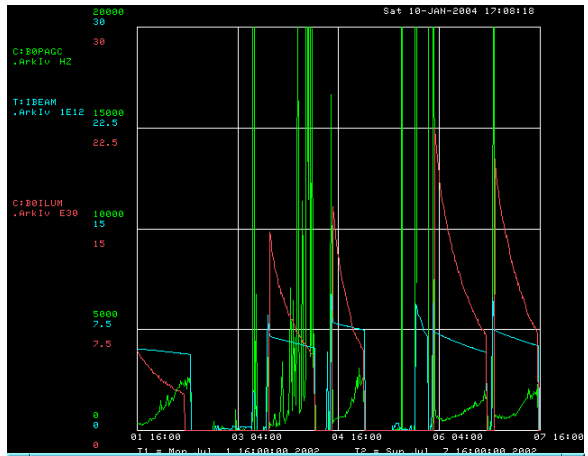
Store to Store Fluctuations

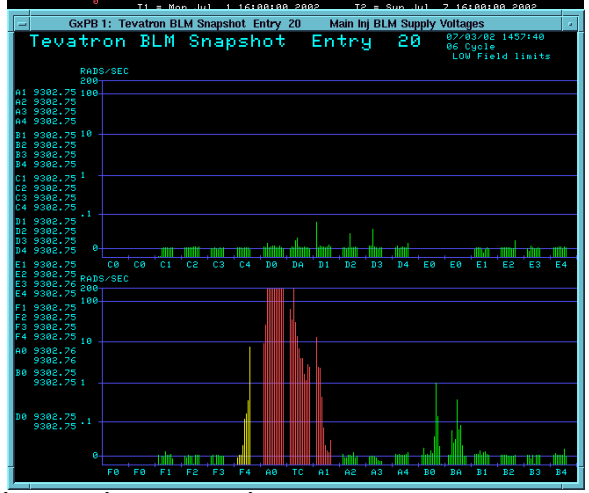


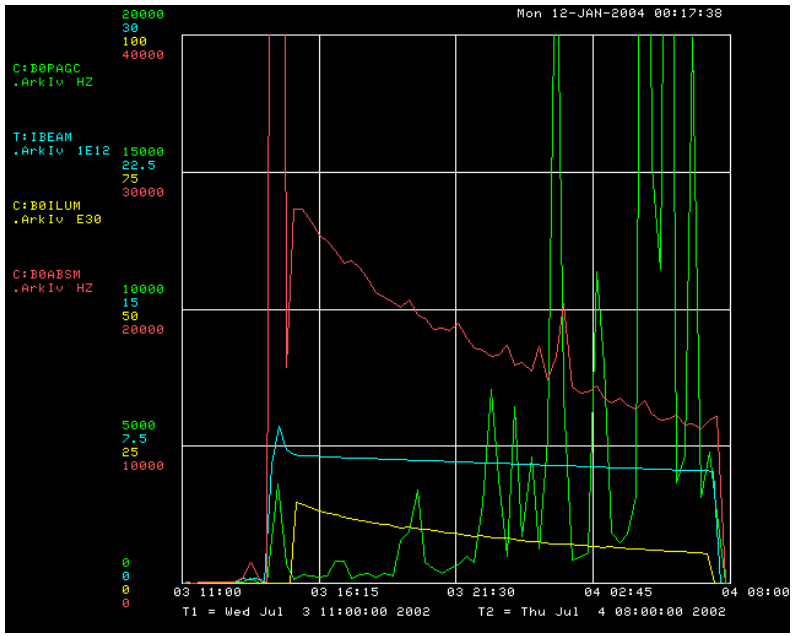
What changes in between these stores ? Should we/do we care ?

Once we did the right thing …

- On July 4th, 2002 in store #1493, an RF station went OFF and abort gap losses skyrocketed
- Silicon was taken to standby around 00:30h
- On abort, B2,BA and BB quenched. Appreciable rate at B0.







BUT: The abort gap loss rate on abort was only ~6kHz
(23 kHz re-scaled) – hardly more than a factor of two than the predecessor stores.

NB: aborts of two recent 36x4 and 36x0 stores with 30 kHz abort gap rate appear to have been clean. Interprete difference as a margin of error.

Summary

- CDF silicon detector is in good shape – it won't get any better (but likely worse over time).

- Beam loss rates as a measure of beam quality is 'common sense' – but what's safe and what not is not an exact science (at least not for me):

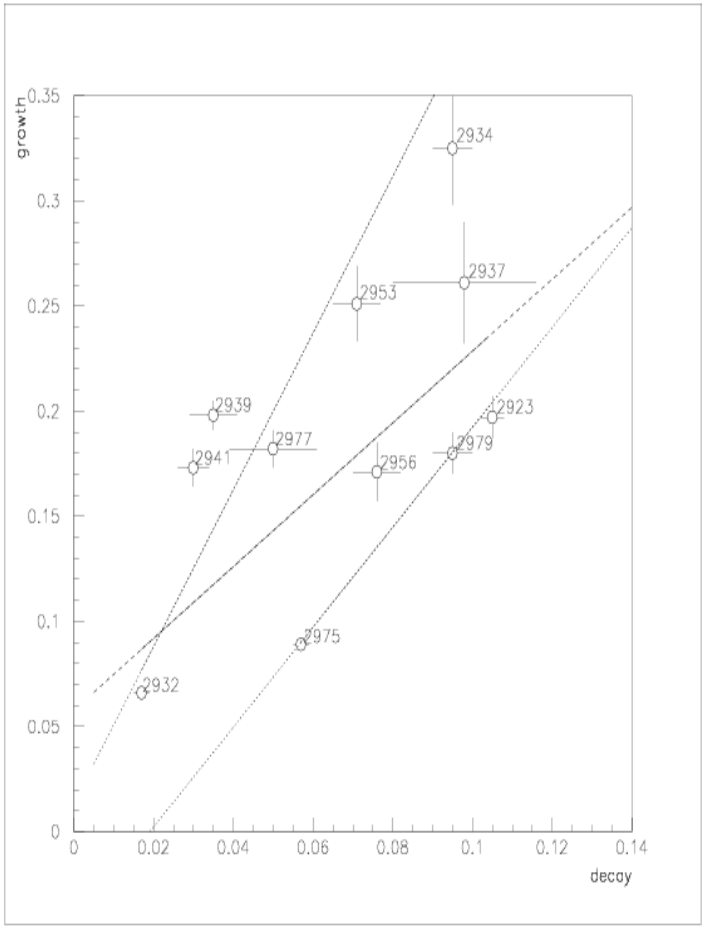
  - Be 'phenomenological' and develop 'trust' over time
    - Not clear what to do with non-continuous step
  - If deeper understanding of mechanisms can be claimed:
    - Have to normalize/derive limits from one-shot incidents where we might actually sit on distributions
  - Could Shot Data Analysis put this on firmer ground ? (Store survival probability vs. rates)

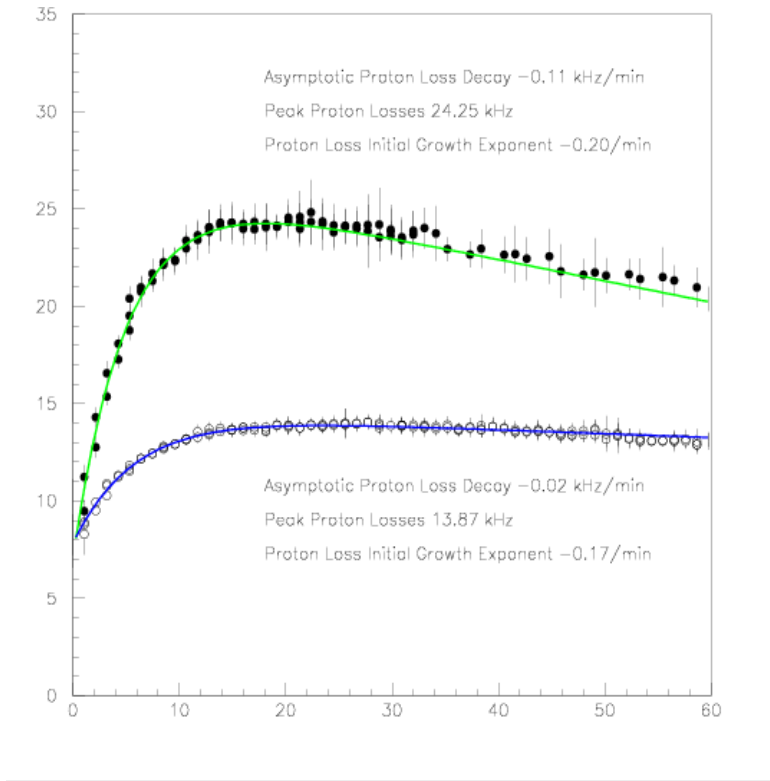
- Agreement needs to be achieved between CDF and AD of what constitutes a 'dangerous' beam condition which merits beam tuning
- Your advice is greatly appreciated.

Pending this meeting's insights - Proposal:

- 15kHz warning level and request to re-tune while silicon remains in
- 20 kHz will require silicon to go to standby immediately.

A closer look at Jekyll and Hyde

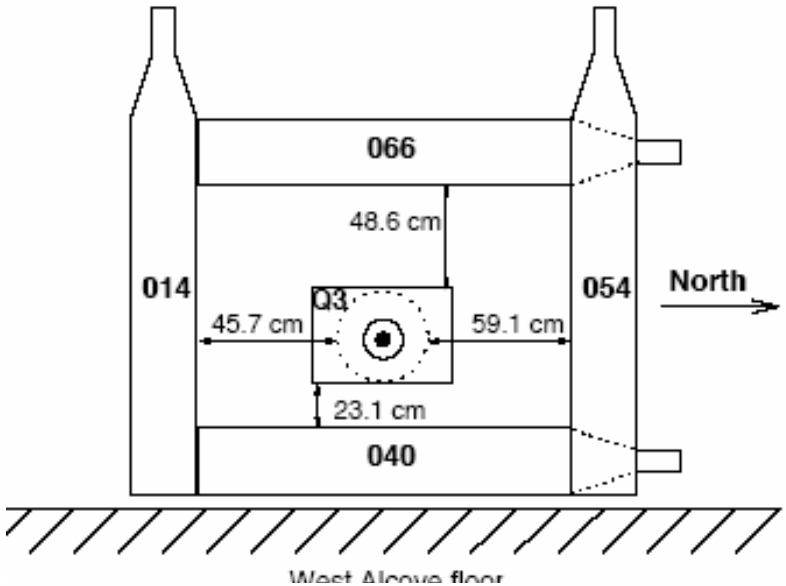




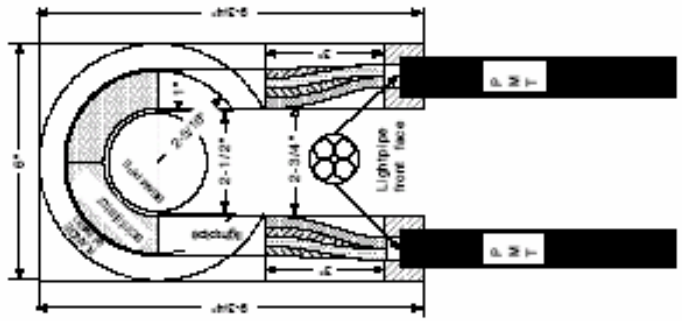
- Rate of growth and decay seem to be correlated – same mechanism at work?
- Are there two bands – two modes of operation ?

Detectors

Halo Counters



Beam Shower Counters



ACNET variables:

B0PHSM: beam halo
B0PBSM: abort gap losses
B0PAGC: 2/4 coincidence abort gap losses

B0PLOS: proton losses (digital)
LOSTP: proton losses (analog)
B0MSC3: abort gap losses (E*W coincidence)

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