Beam Monitoring at CDF

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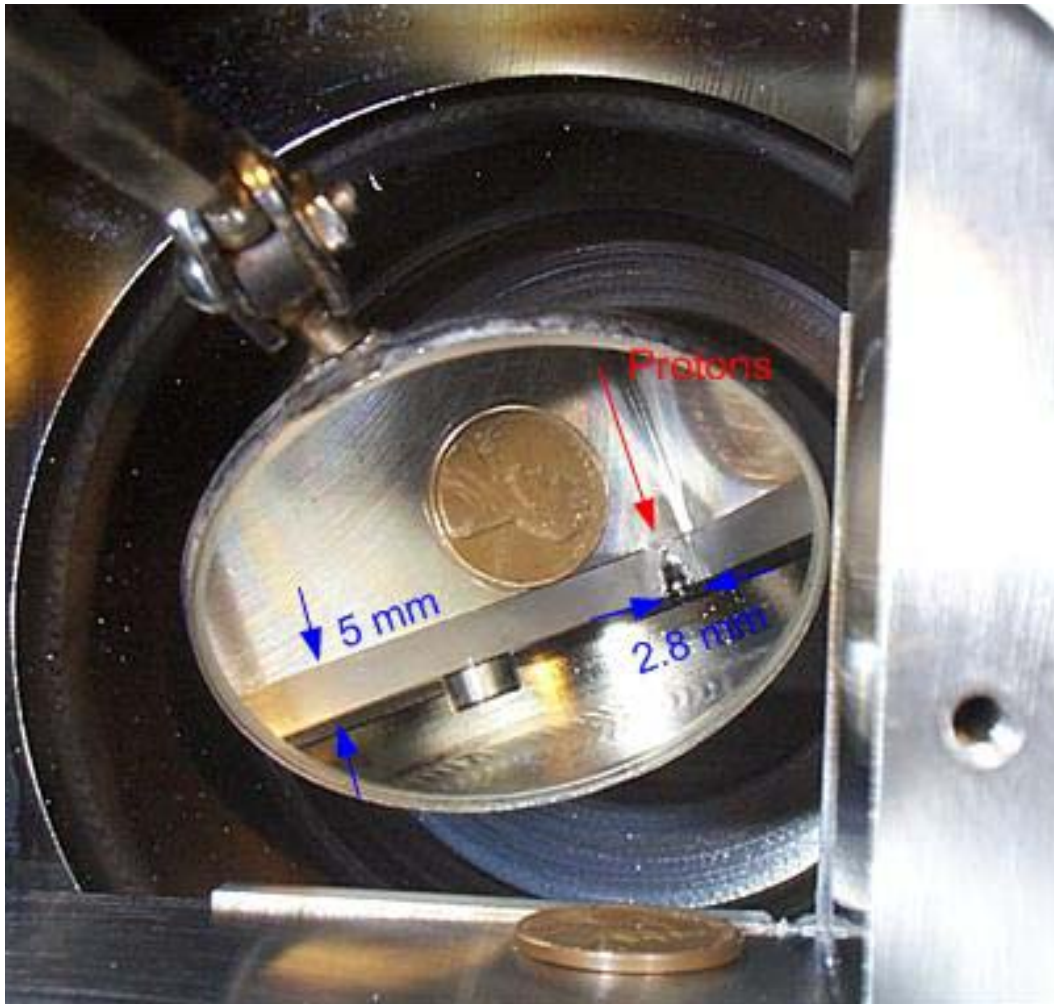
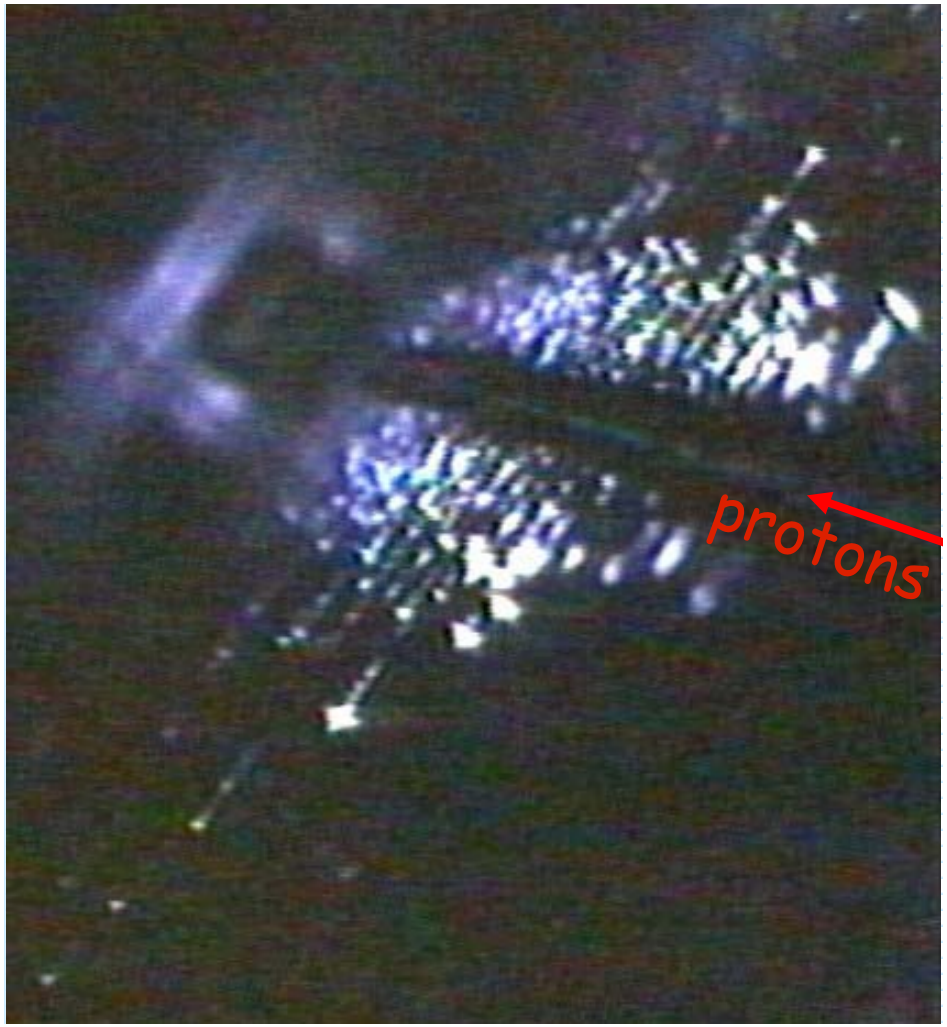
Fermilab

Corrector Magnet Quench 12/5/03



D49 "target" hit by proton beam
(5mm tungsten plate)

D03 collimator hit by proton beam
(1.5 m steel)



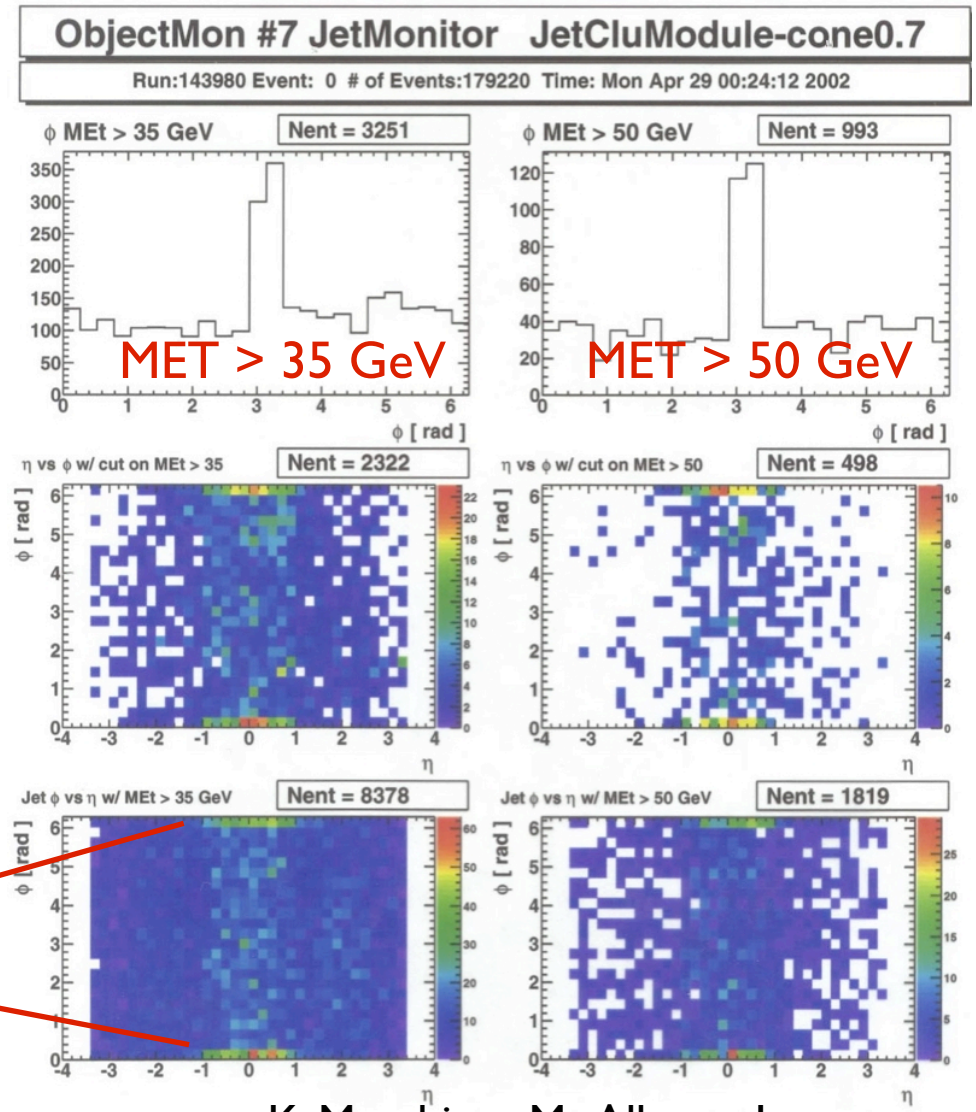
Physics Backgrounds

Jet triggers show peak at phi=0

Missing ET triggers show peak at phi=pi

Very energetic events

* Cause: diffuse beam halo interacting with roman pots (z=-60m)



K. Maeshima, M. Albrow, J. Spalding, K. Terashi

Why Monitor the Beam?

Manage backgrounds for your analysis:

- Reduce signal contamination

Maintain control of stored energy:

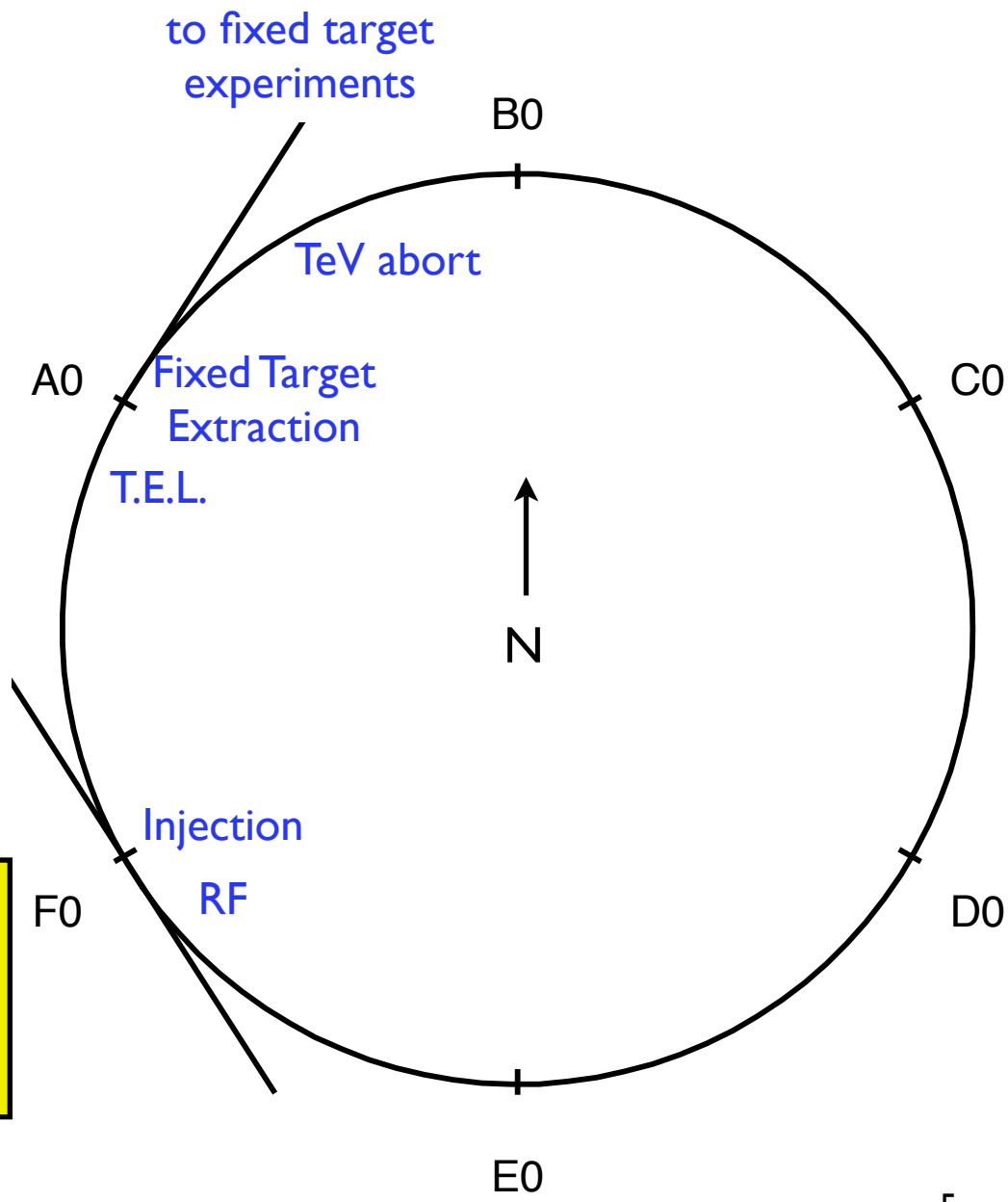
- 1 bunch = 10^{10} particles = 1.5 kJ (shot from high powered rifle).
- 2 x 36 counter rotating bunches can do a lot of damage!

Goal: Watch for indications of beam instability and take steps to correct the problem before the data are corrupted or damage is done to the detector.

Accelerator Map

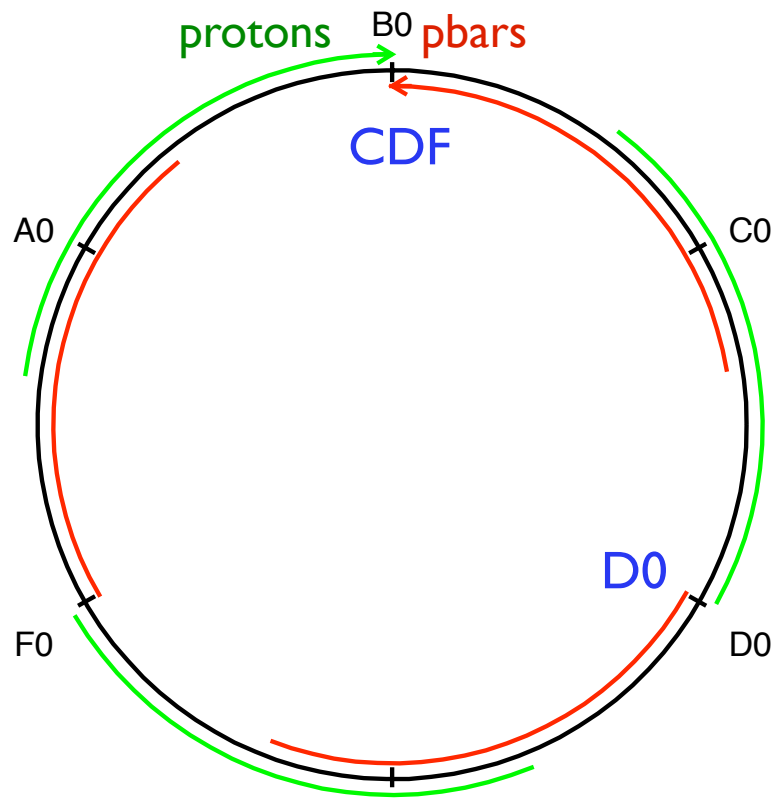
- 6 sectors (A-F)
- 5 houses/sector (0-4)
  - Accelerator access
  - Tevatron infrastructure (power, water, cryogenics, etc.)
- Naming convention for devices (magnets/collimators, etc.)

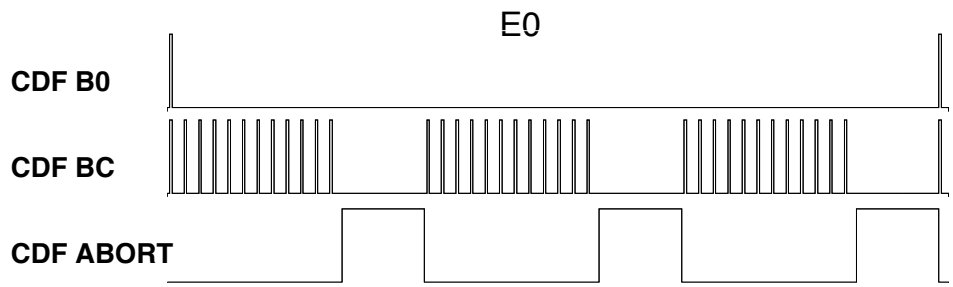
** Devices far from CDF affect beam quality



Beam Structure

- 36 1ns bunches in 3x12 bunch trains
- ~2us space between bunch trains
* Monitor losses (in time with beam)
* Monitor beam in abort gaps

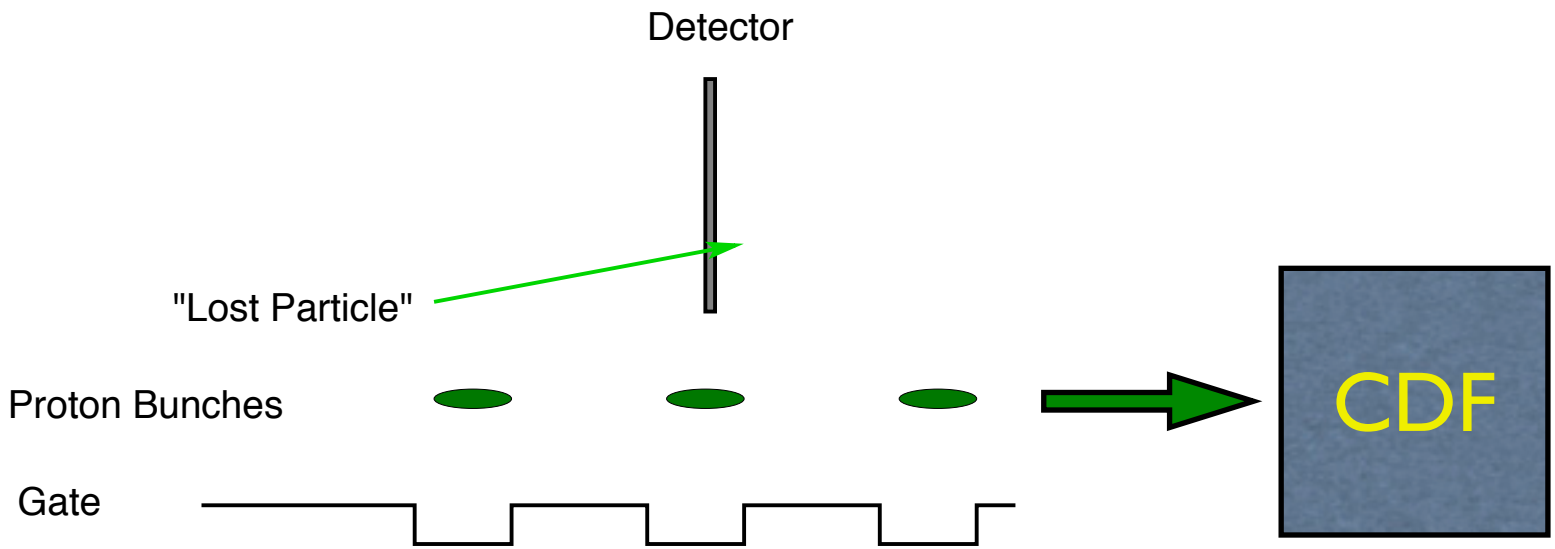




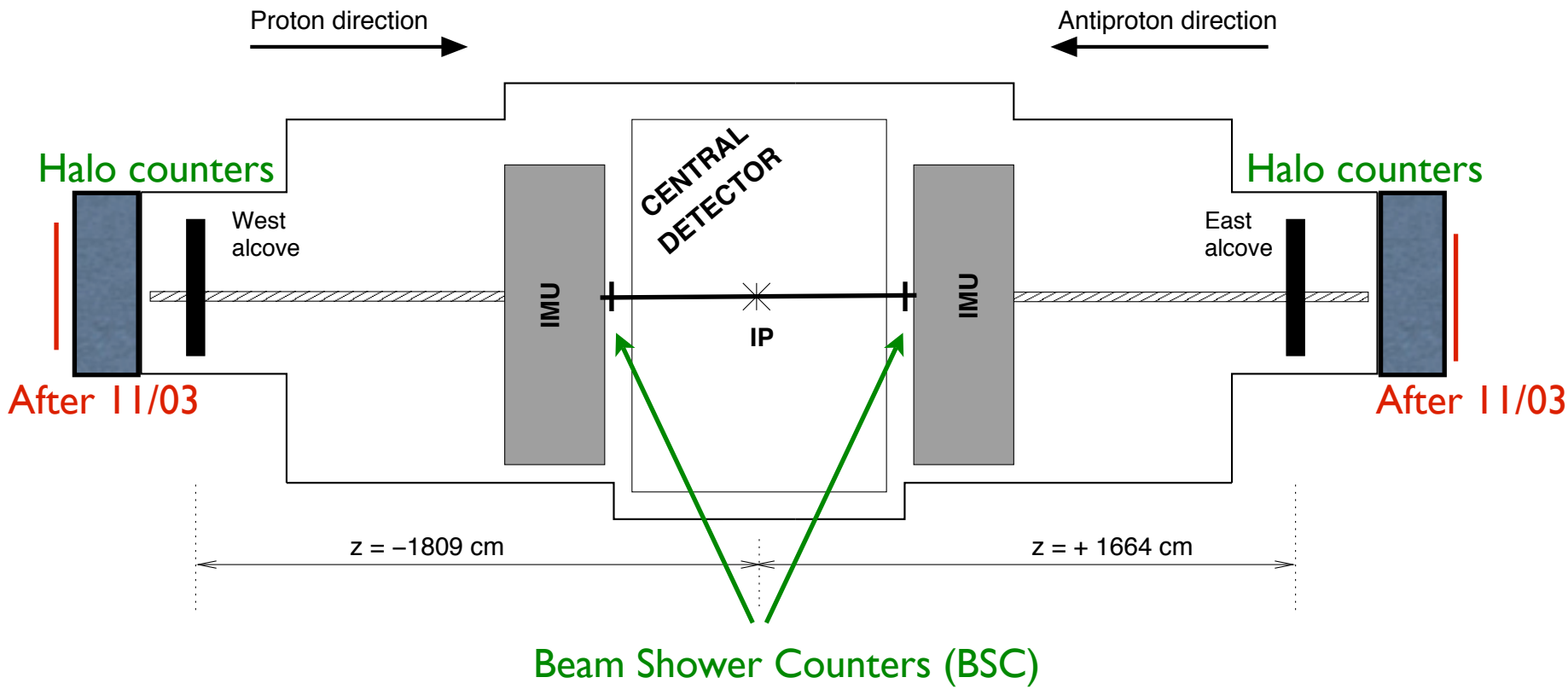
Calculating Losses

Beam Losses all calculated in the same fashion

- Detector signal in coincidence with beam passing the detector plane.
- ACNET variables differ by detector/gating method.



Beam Monitors

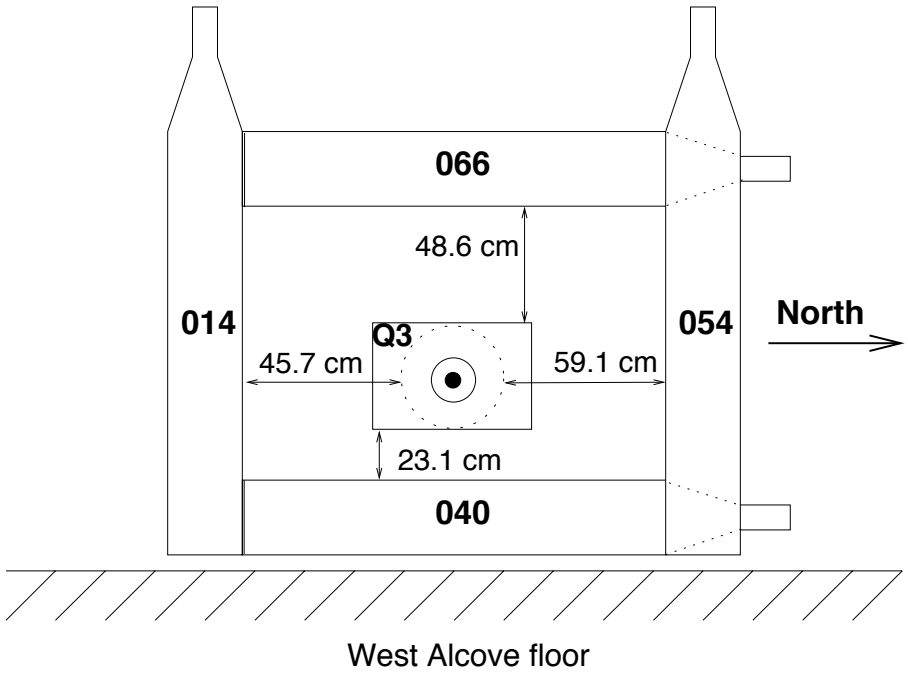


BSC counters: monitor beam losses and abort gap

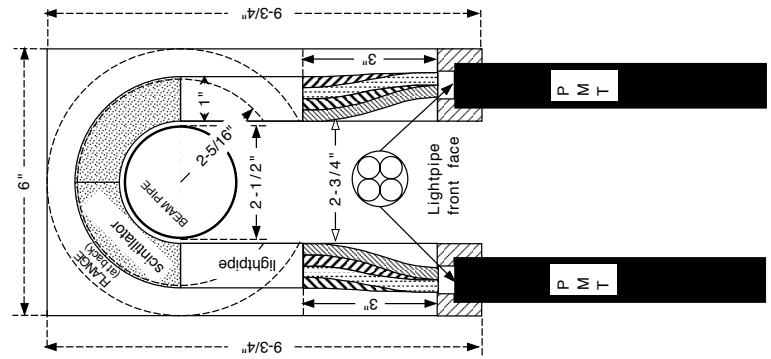
Halo counters: monitor beam halo and abort gap

Detectors

Halo Counters



Beam Shower Counters

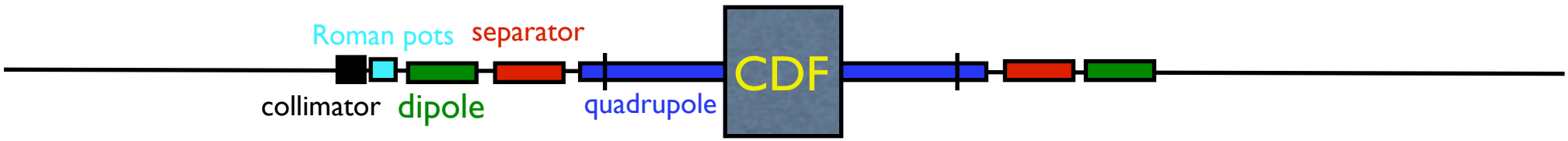


ACNET variables:

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)

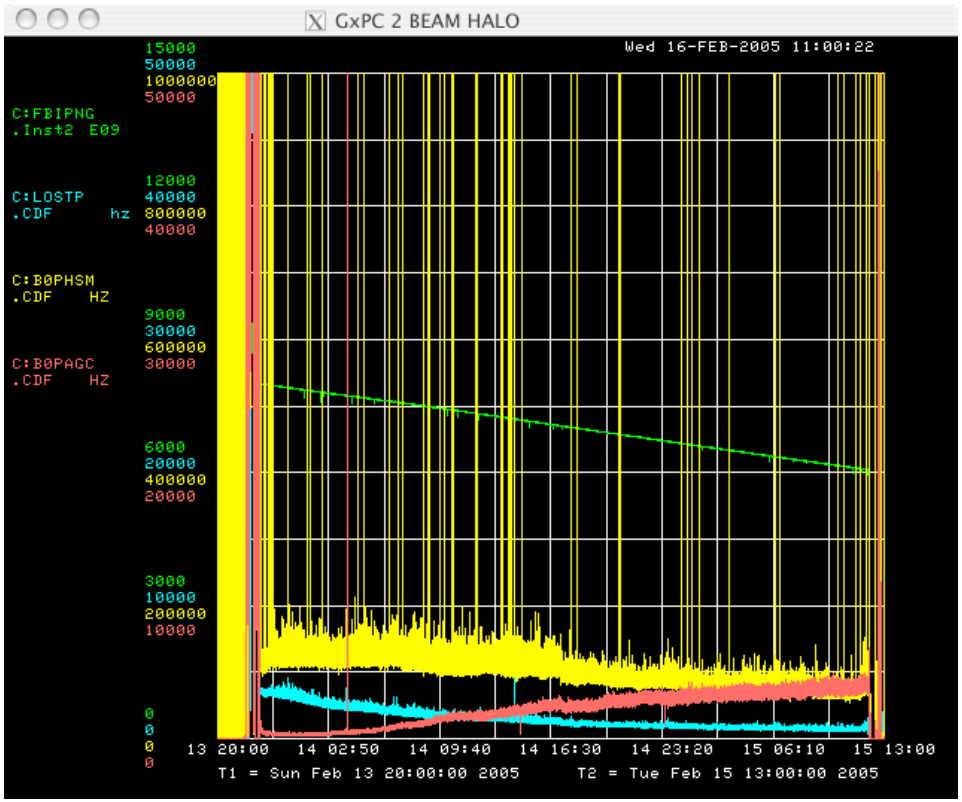
Beam Halo Counters



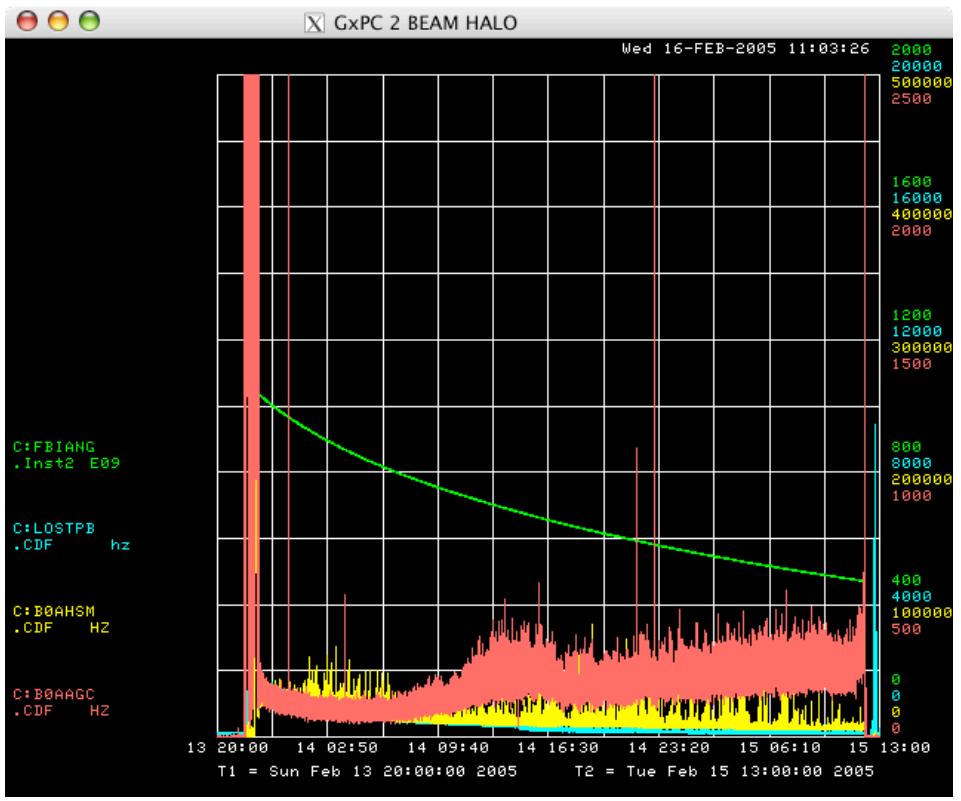
Good Store

- beam current
- losses
- halo
- abort gap losses

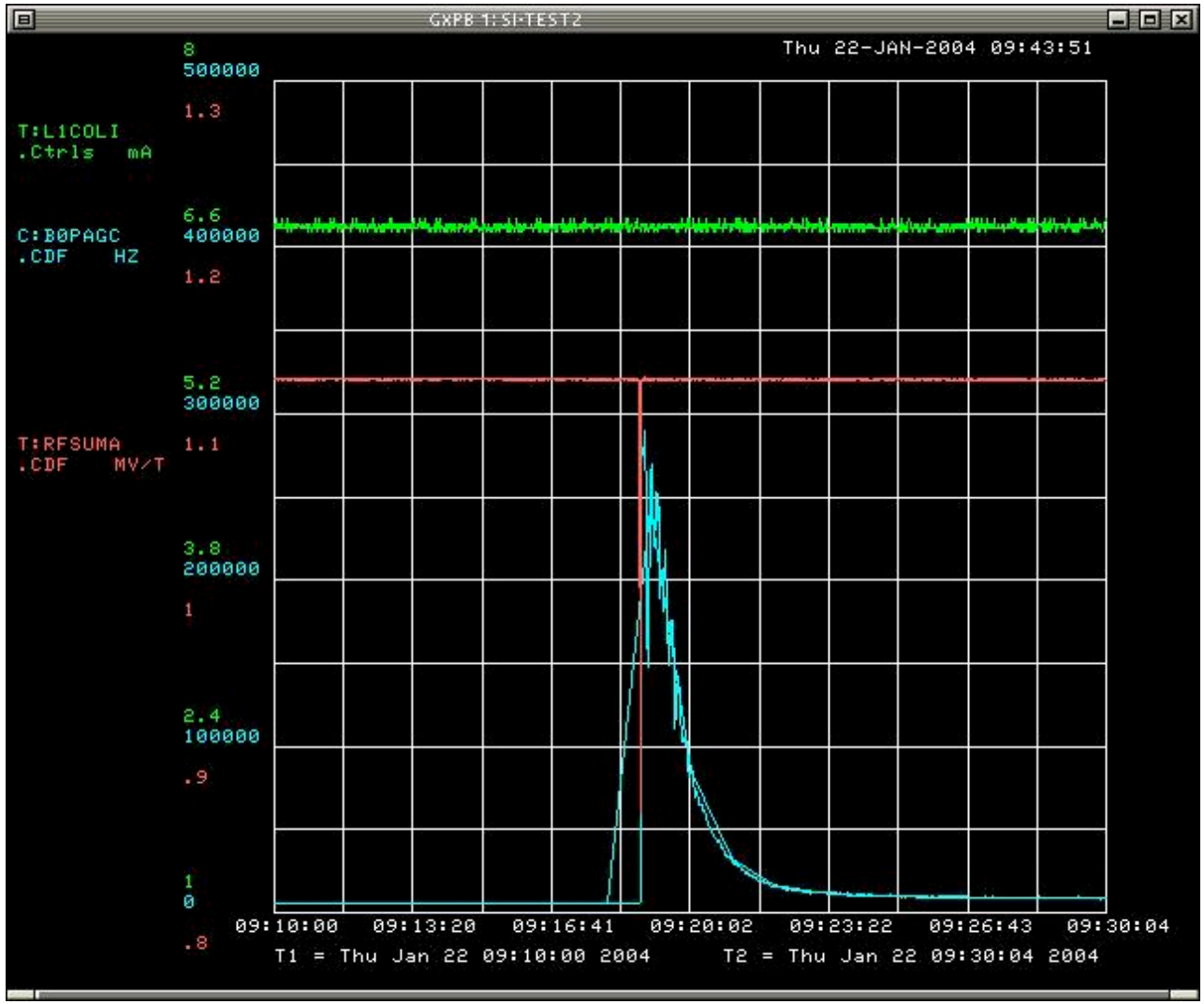
Protons



Anitprotons



RF Problem (spark?)



T:L1COLI

T:RFSUMA

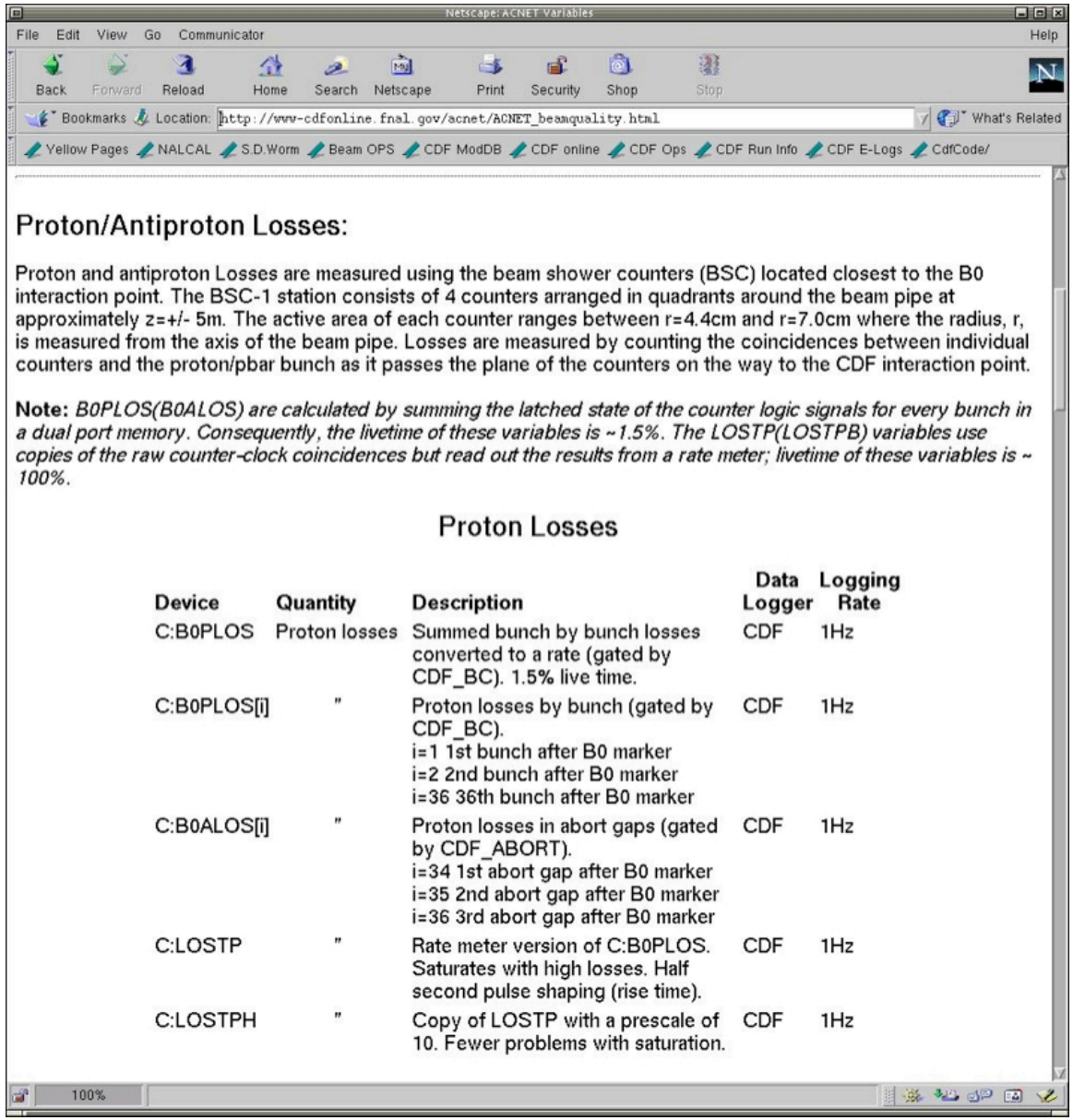
C:B0PAGC

Devices to Monitor

- Losses/Halo near CDF
  - loss monitors
  - halo monitors
  - chamber currents (muon)
- Beam in the abort gap (DC beam)
  - abort gap halo
  - sync. light
- Correlations with accelerator parameters
  - RF
  - artificial apertures
  - beam position
  - bunch length

Help Main Control Room Identify Problems

Documentation



http://www-cdfonline.fnal.gov/acnet/ACNET_beamquality.html

References

Beam and Halo Monitoring:

M. Karagoz-Unel, R.J. Tesarek, NIM A506 (2003) 7-19.

M. Gallinaro, FERMILAB-CONF-02-121-E(2002) 11.

http://www-cdfonline.fnal.gov/acnet/ACNET_beamquality.html

Beam Induced Backgrounds and Radiation:

http://ncdf67.fnal.gov/~tesarek/halo/joint_physics/020503

CDF note: 5873
CDF note: 5926
CDF note: 5960
CDF note: 6753
CDF note: 6761