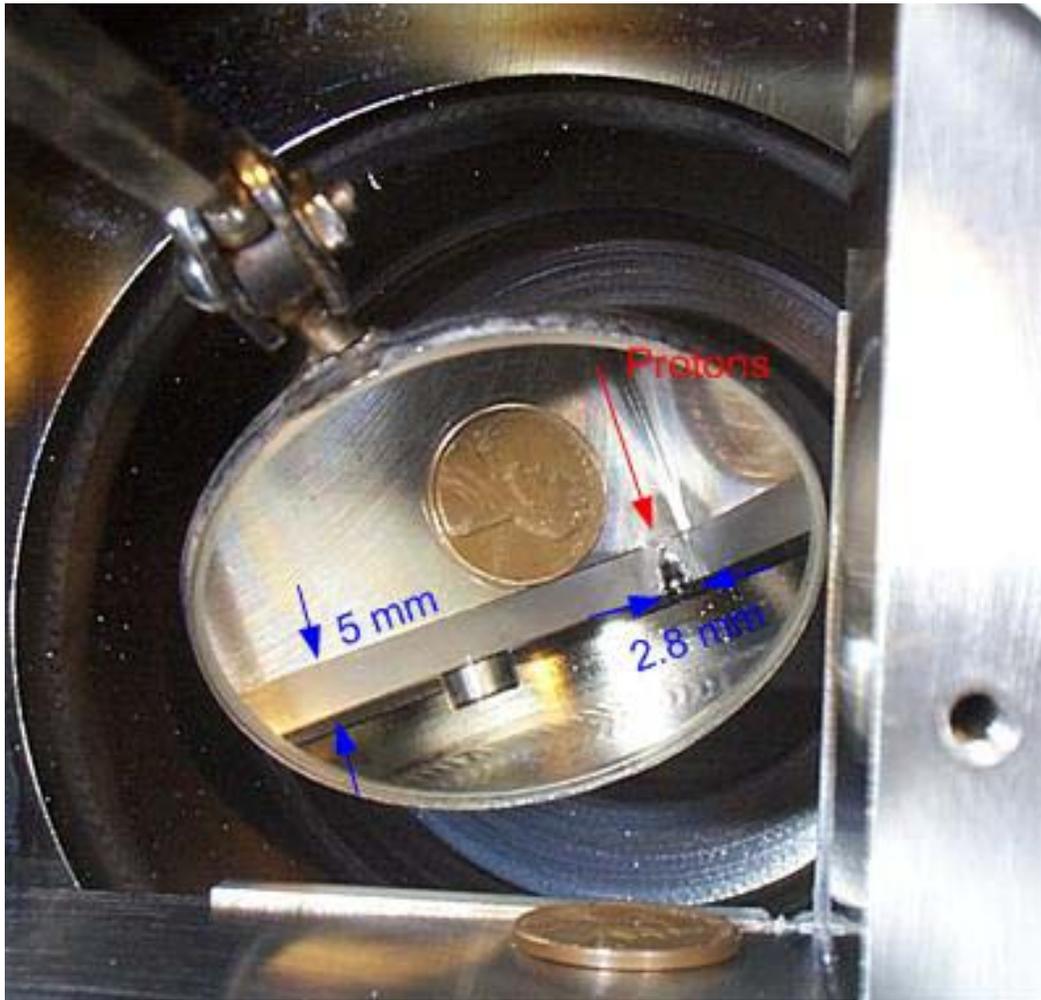


Beam Monitoring at CDF

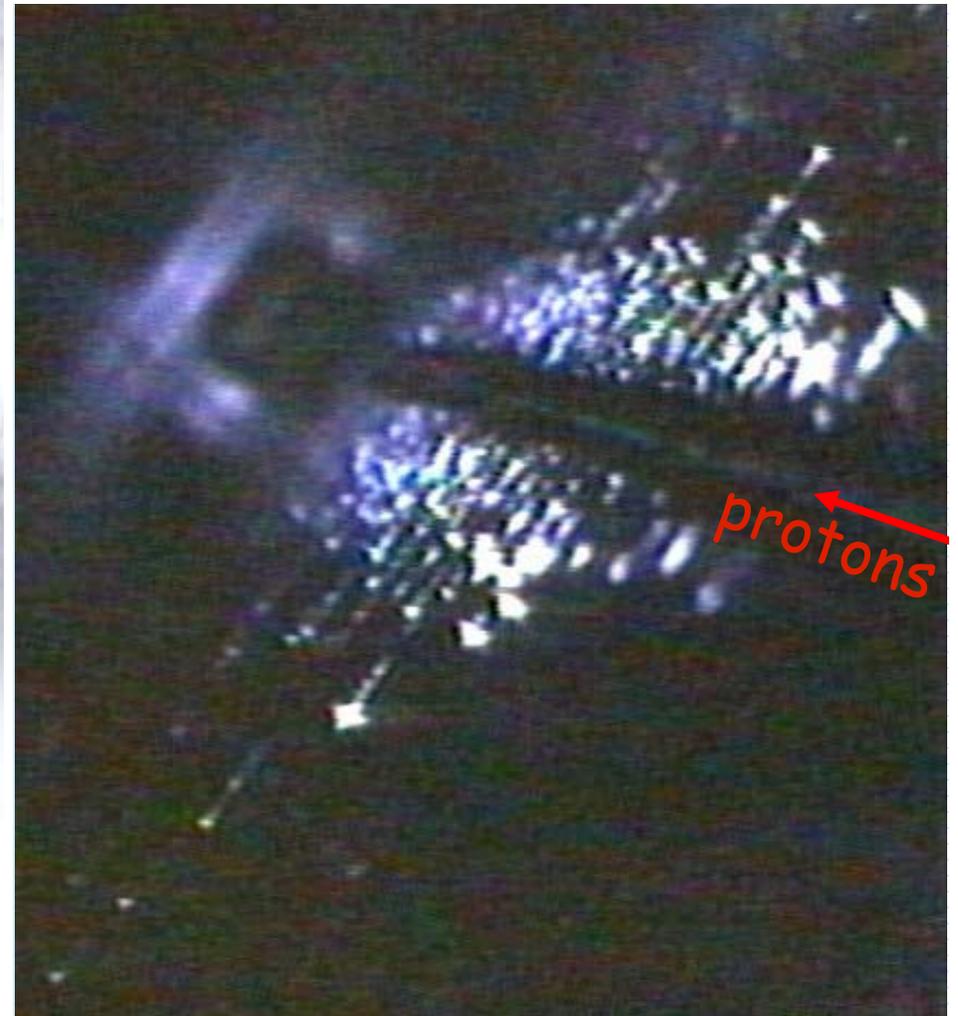
R.J. Tesarek
Fermilab

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

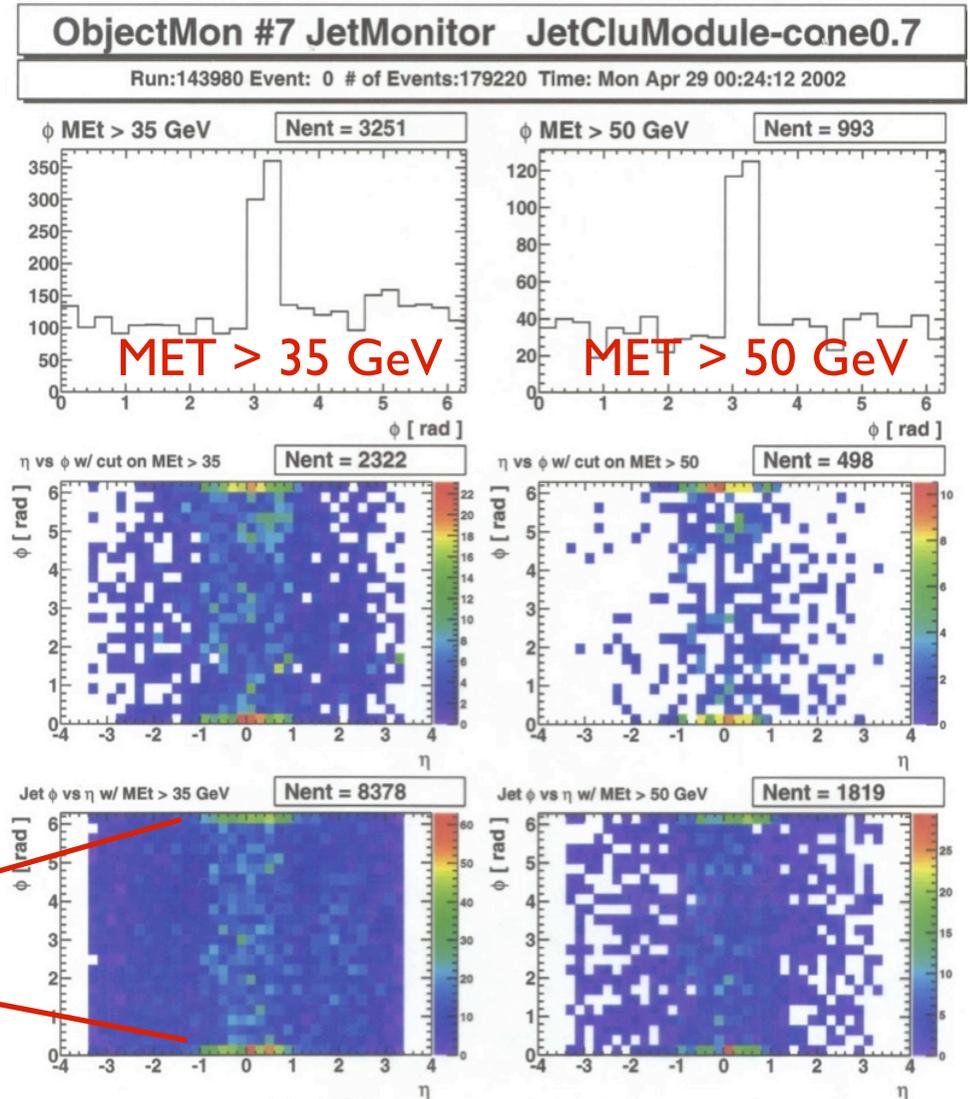
Jet triggers show peak at $\phi=0$

Missing ET triggers show peak at $\phi=\pi$

Very energetic events

* Cause: diffuse beam halo interacting with roman pots ($z=-60\text{m}$)

Hot spots



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:

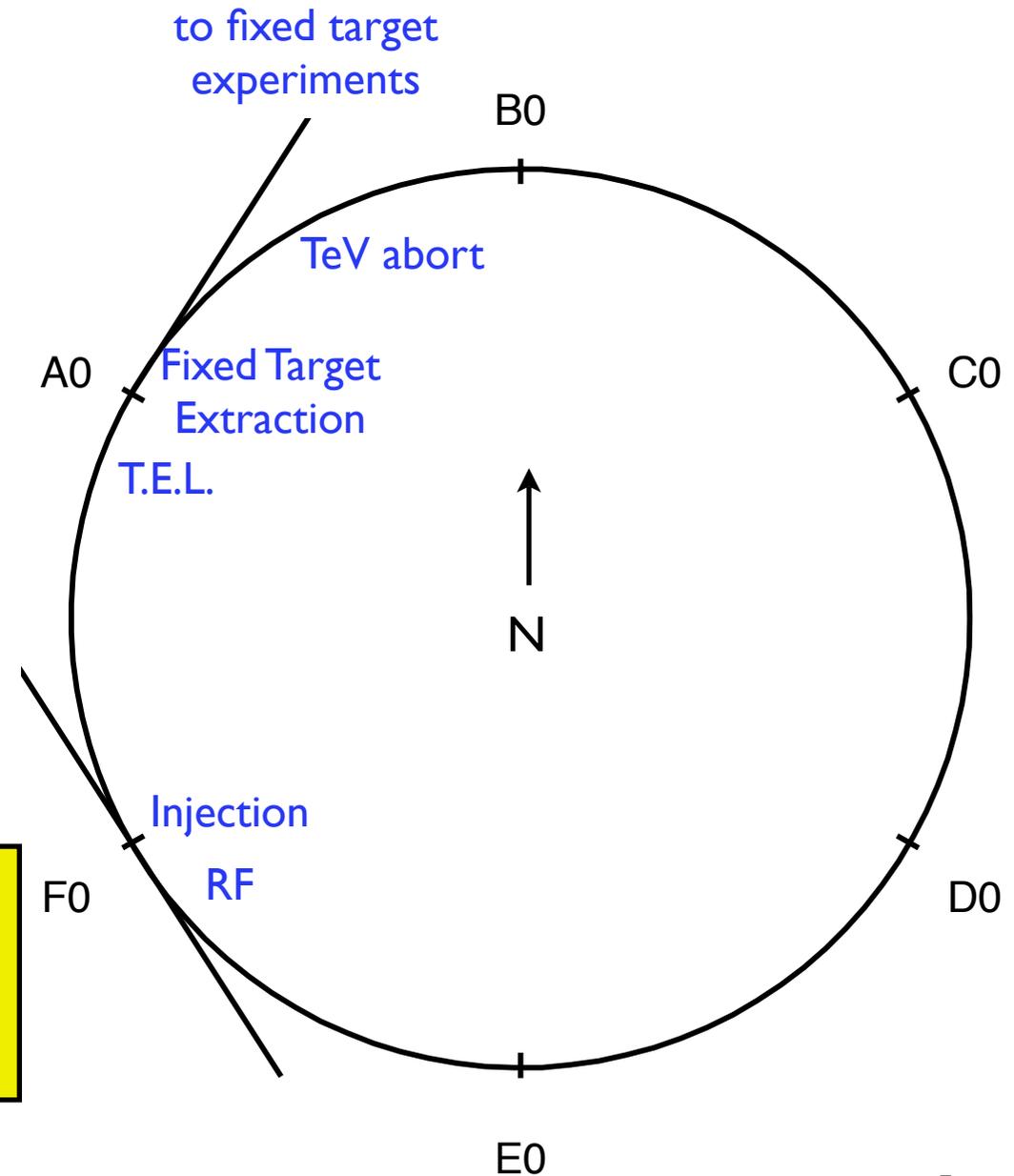
- 1 bunch = 10^{10} particles = 1.5 kJ (shot from high powered rifle).
- 2 x 36 counter rotating bunches can do a lot of damage!

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.)

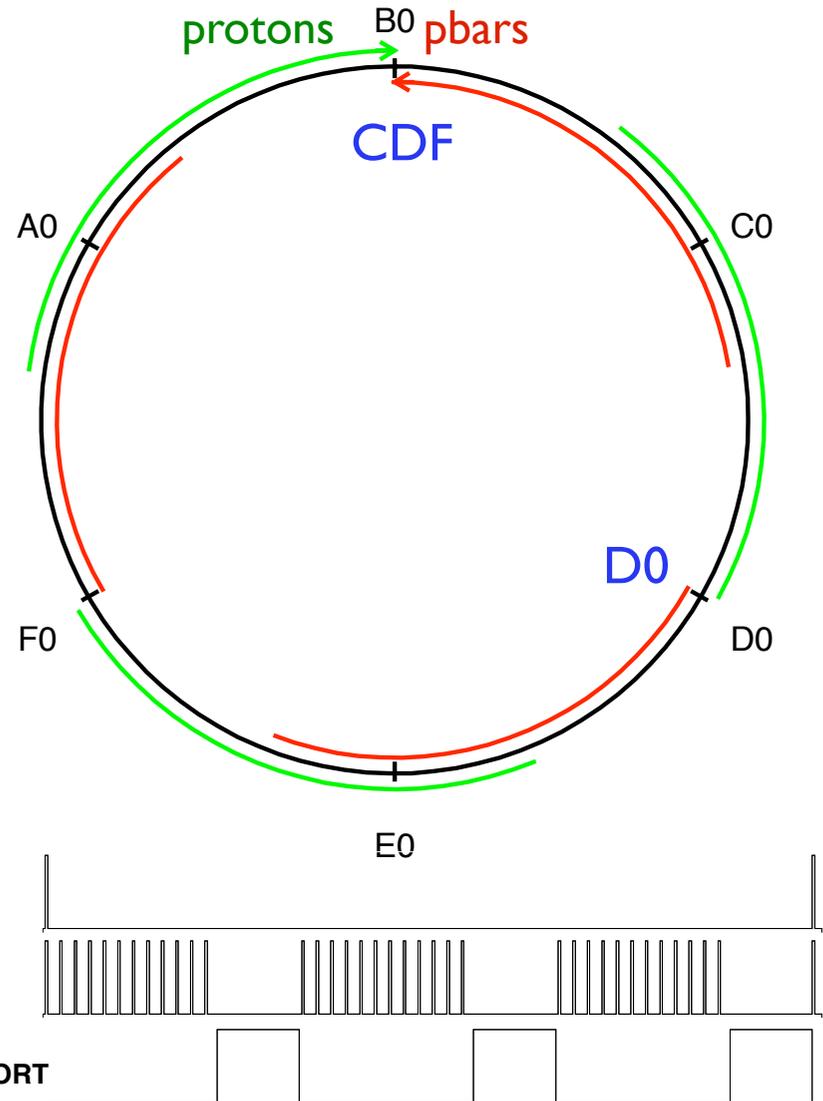
** Devices far from CDF affect beam quality



Beam Structure

Tevatron

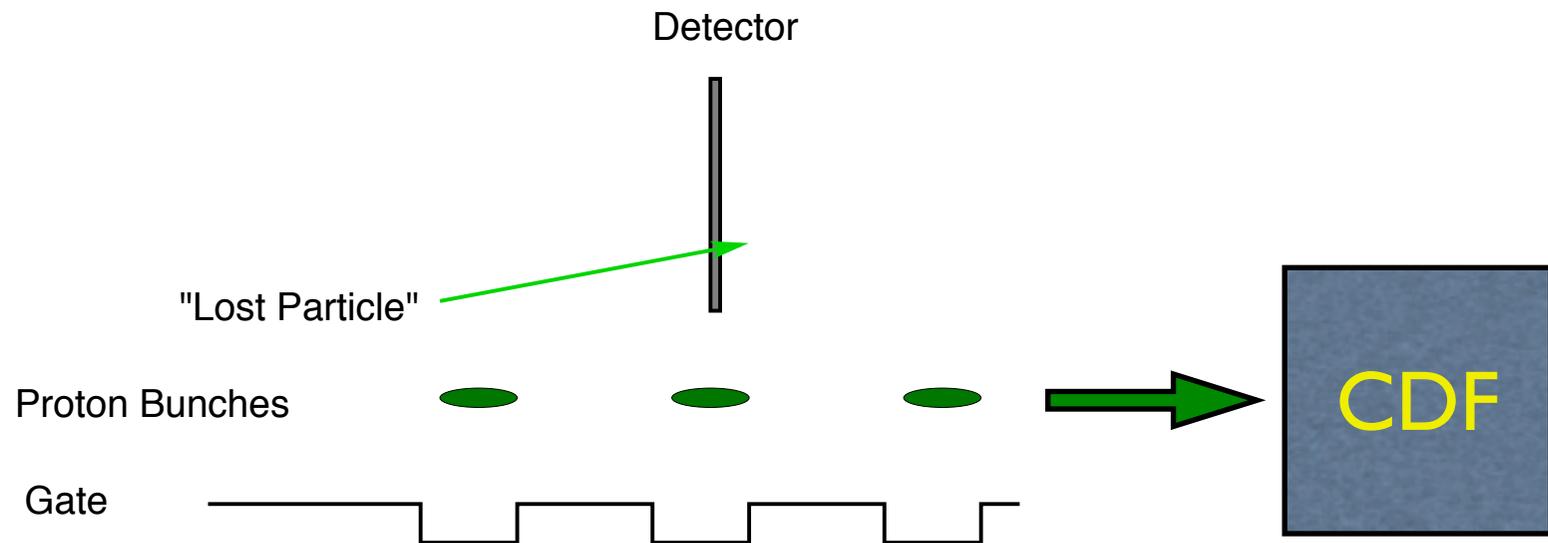
- 36 Ins bunches in 3x12 bunch trains
- ~2us space between bunch trains
- * Monitor losses (in time with beam)
- * Monitor beam in abort gaps



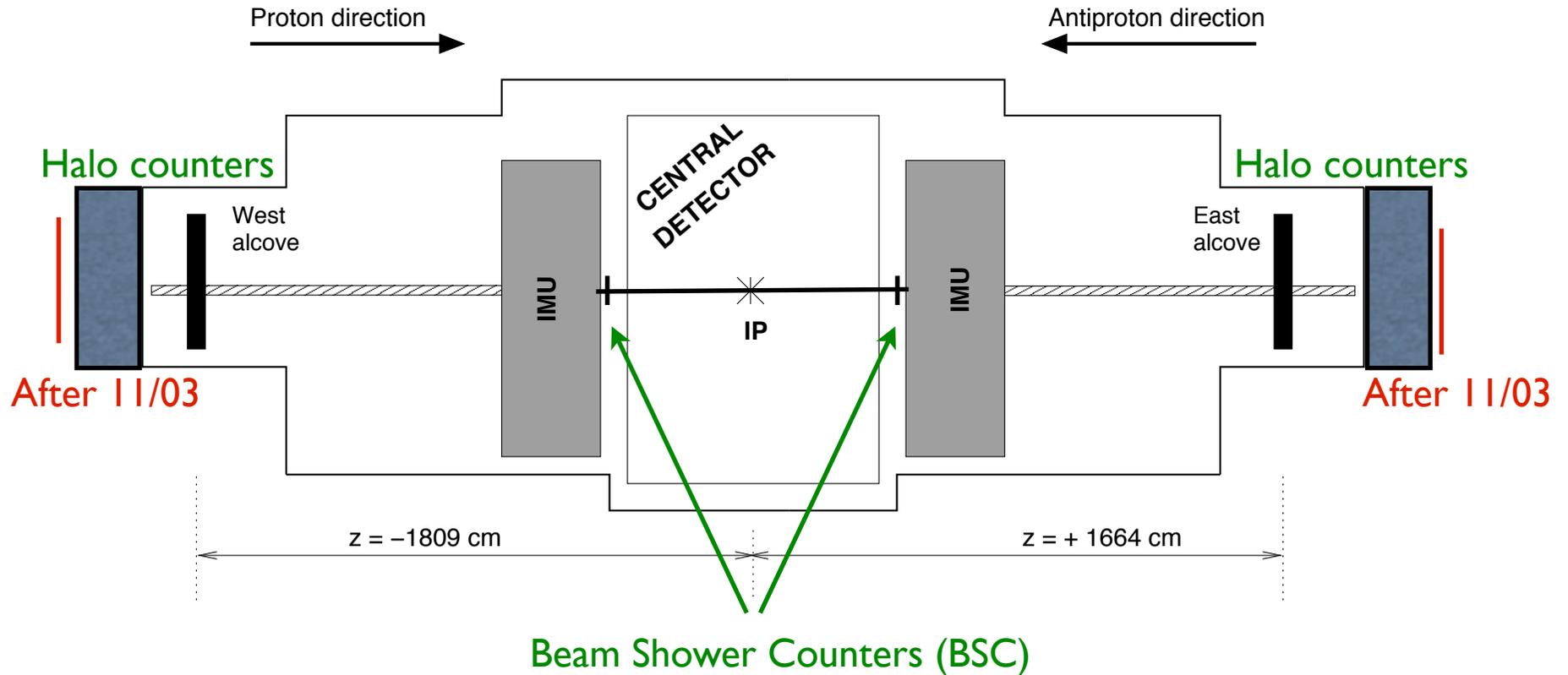
Calculating Losses

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

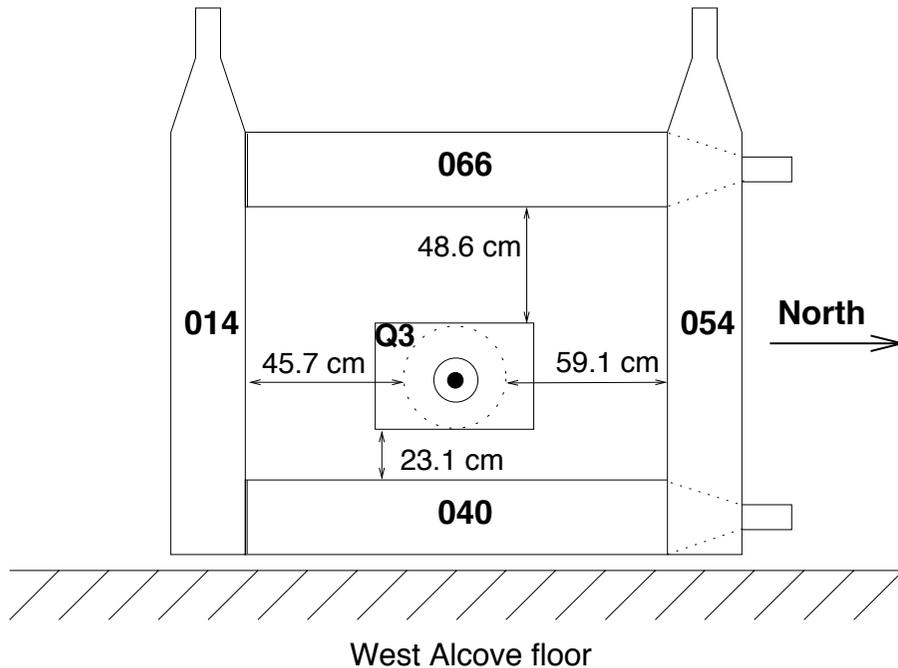


BSC counters: monitor beam losses and abort gap

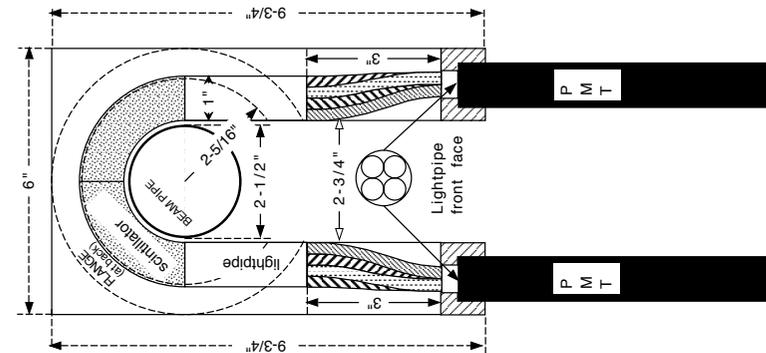
Halo counters: monitor beam halo and abort gap

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

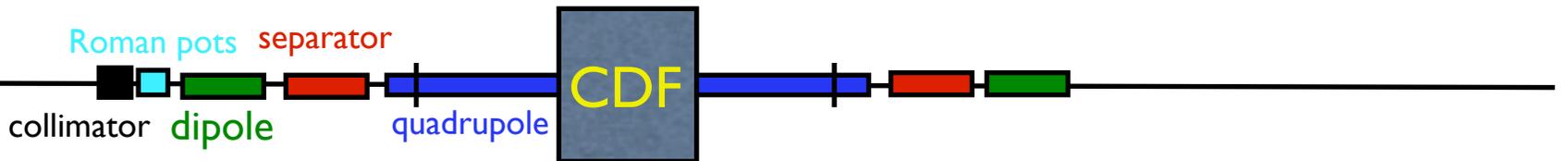


Protons

Antiprotons

CDF

Roman pots separator

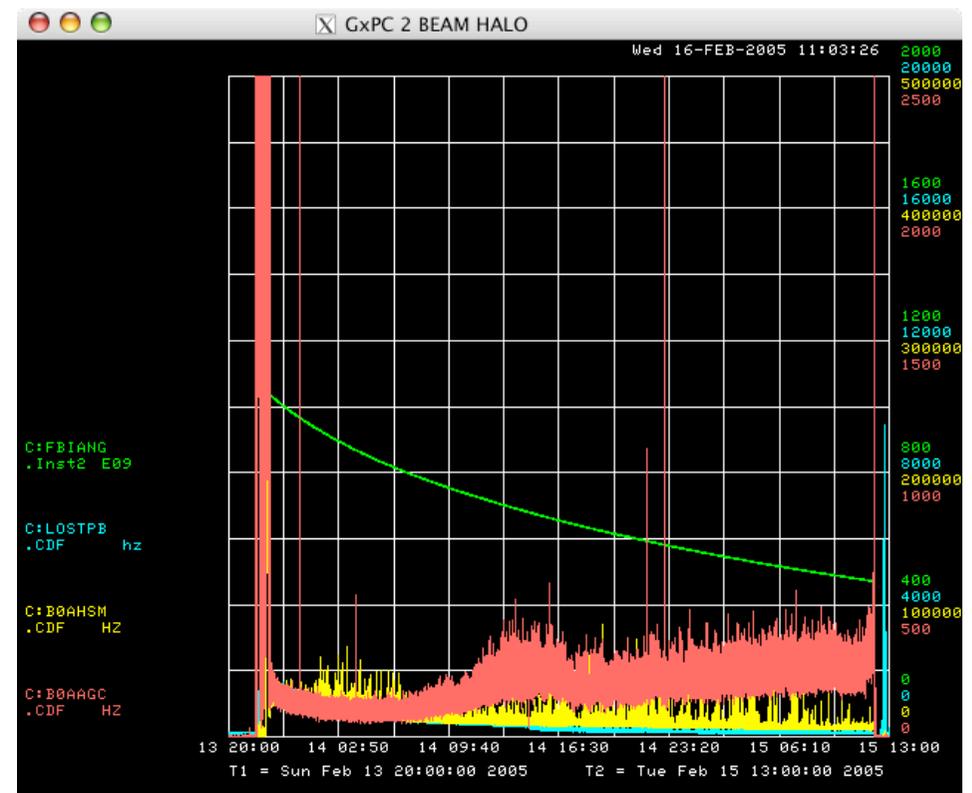
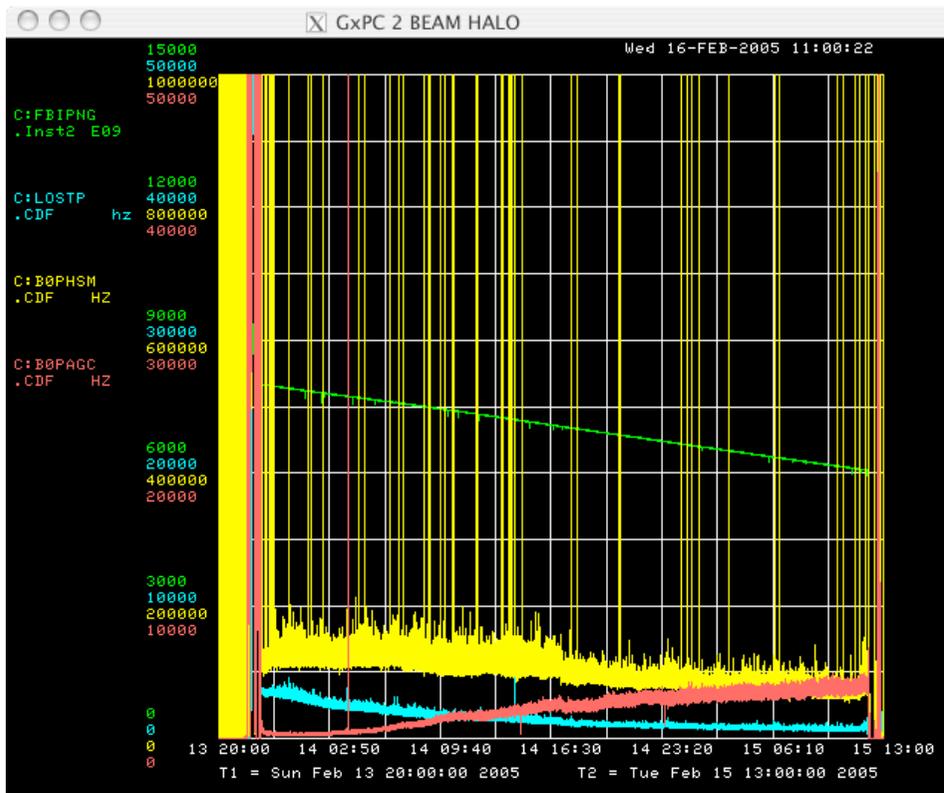


Good Store

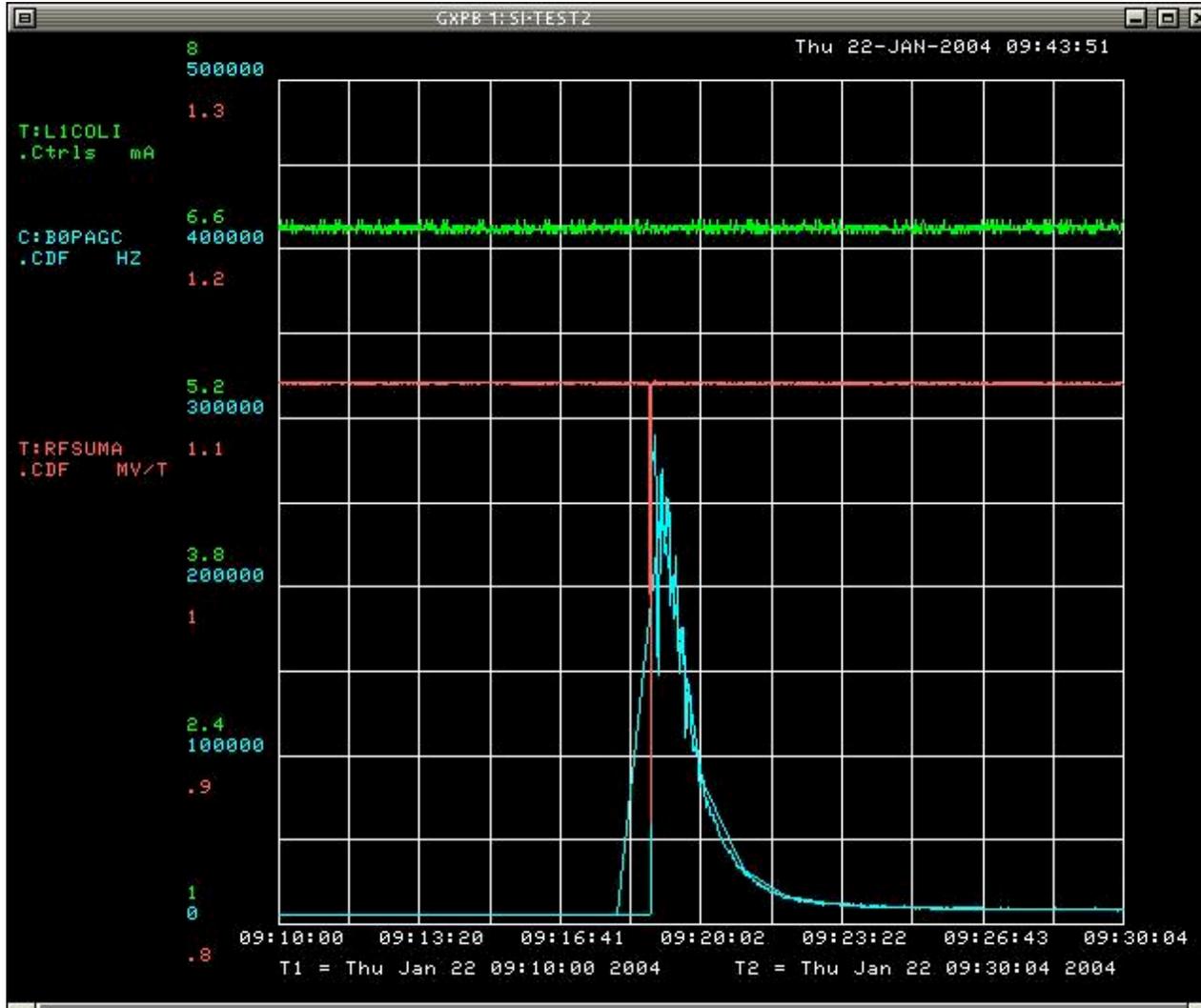
- beam current
- losses
- halo
- abort gap losses

Protons

Antiprotons



RF Problem (spark?)

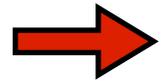


T:LICOLI

T:RFSUMA

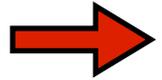
C:B0PAGC

Devices to Monitor



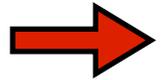
Losses/Halo near CDF

- 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

Proton/Antiproton Losses:

Proton and antiproton Losses are measured using the beam shower counters (BSC) located closest to the B0 interaction point. The BSC-1 station consists of 4 counters arranged in quadrants around the beam pipe at approximately $z = \pm 5$ m. The active area of each counter ranges between $r = 4.4$ cm and $r = 7.0$ cm where the radius, r , is measured from the axis of the beam pipe. Losses are measured by counting the coincidences between individual counters and the proton/pbar bunch as it passes the plane of the counters on the way to the CDF interaction point.

Note: *B0PLOS(B0ALOS)* are calculated by summing the latched state of the counter logic signals for every bunch in a dual port memory. Consequently, the livetime of these variables is $\sim 1.5\%$. The *LOSTP(LOSTPB)* variables use copies of the raw counter-clock coincidences but read out the results from a rate meter; livetime of these variables is $\sim 100\%$.

Proton Losses

Device	Quantity	Description	Data Logger	Logging Rate
C:B0PLOS	Proton losses	Summed bunch by bunch losses converted to a rate (gated by CDF_BC). 1.5% live time.	CDF	1Hz
C:B0PLOS[i]	"	Proton losses by bunch (gated by CDF_BC). i=1 1st bunch after B0 marker i=2 2nd bunch after B0 marker i=36 36th bunch after B0 marker	CDF	1Hz
C:B0ALOS[i]	"	Proton losses in abort gaps (gated by CDF_ABORT). i=34 1st abort gap after B0 marker i=35 2nd abort gap after B0 marker i=36 3rd abort gap after B0 marker	CDF	1Hz
C:LOSTP	"	Rate meter version of C:B0PLOS. Saturates with high losses. Half second pulse shaping (rise time).	CDF	1Hz
C:LOSTPH	"	Copy of LOSTP with a prescale of 10. Fewer problems with saturation.	CDF	1Hz

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