CRYSTAL COLLIMATION EXPERIMENT AT THE TEVATRON (T-980): INSTALLATION REVIEW

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Fermilab

T-980 Installation Review
Fermilab, Batavia, IL
August 7, 2008

Review of the T980 Crystal Collimator Installation

Thursday, August 7, 2008, 1:30 – 3:30 PM

Committee: Phil Schlabach, Ron Lipton and Bruce Hanna

Involved: Roger Dixon, Ron Moore, Salah Chaurize, Cons Gattuso, and T980@FNAL (Annala, Carrigan, Drozhdin, Johnson, Mokhov, Reilly, Shiraishi, Still, Tesarek, Zagel)

Charge for Crystal Collimator Committee (1)

Roger Dixon:

T-980 proposes to install a crystal collimator in the E0 straight section of the Tevatron in order to test the feasibility of collimating the Tevatron beam using the crystal.

I would like you to assess the overall risk with respect to the impact on the Fermilab Collider program. In particular I would like you to write a brief report that addresses the following items:

Charge for Crystal Collimator Committee (2)

1. Assess the feasibility meeting the of the goals of the experiment within the time estimates given by the experimenters.

2. Assess the technical feasibility of the installation—Can the installation be completed successfully in the time estimated by the proponents?

3. Assess any risk to the integrity of the Tevatron that results from installing the proposed device.

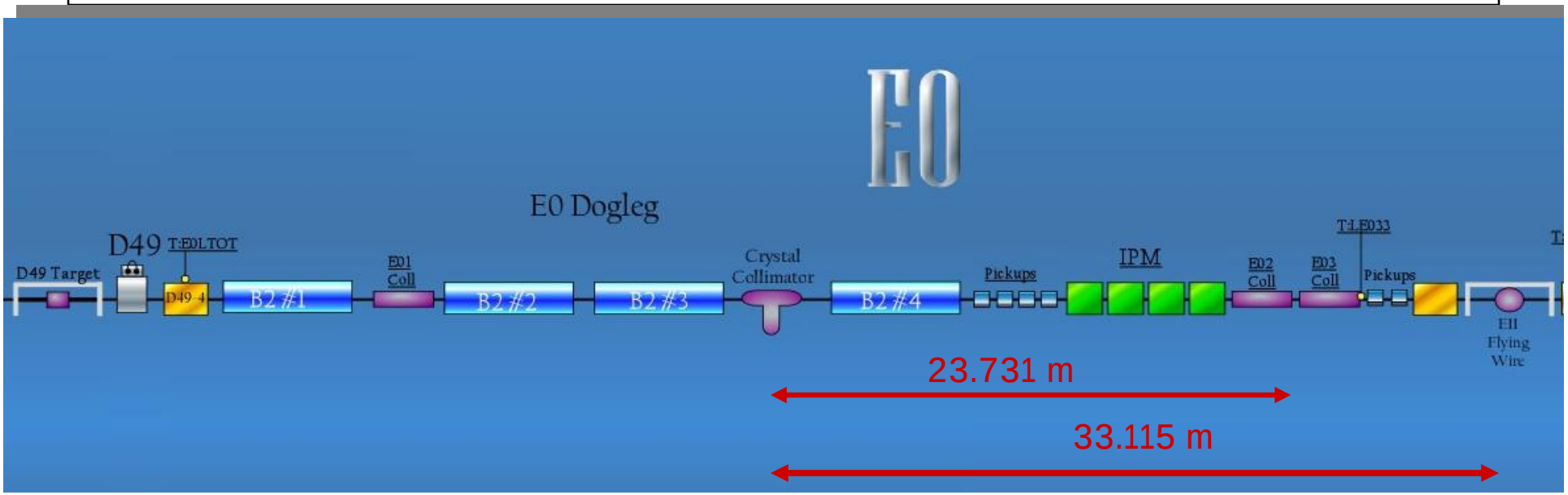
4. Assess the risk to both the Tevatron and the Collider experiments that results from executing the proposed experiments using the device after installation.

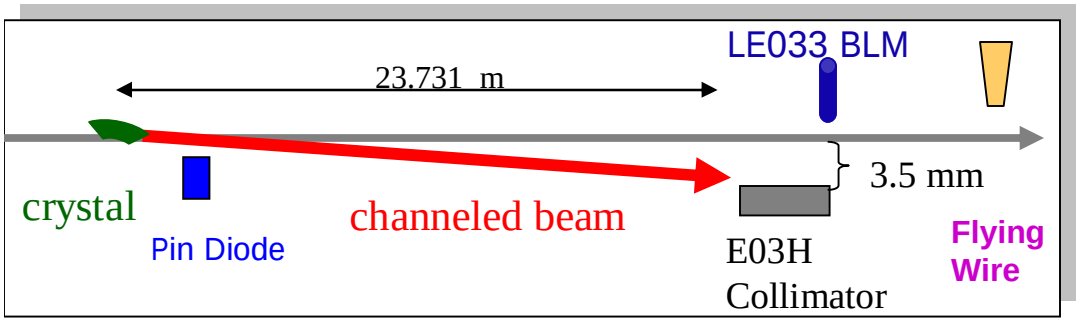
Review of the T980 Crystal Collimator Installation

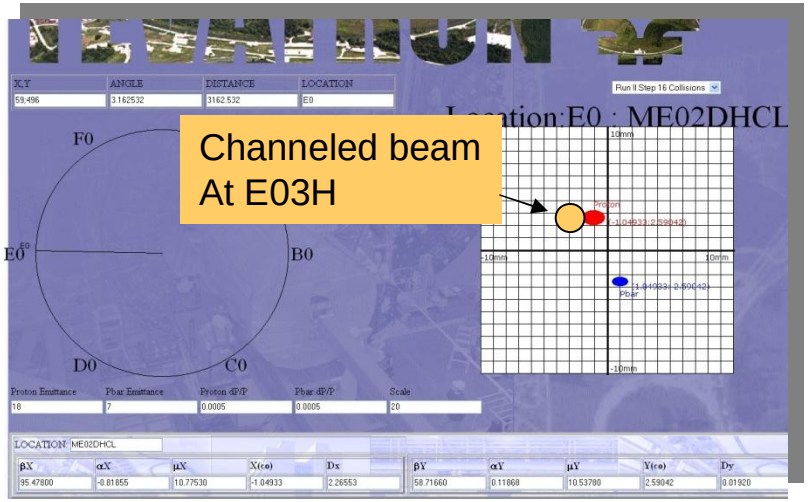
Presentations:

- Nikolai Mokhov, Intro (status, goals, timescale, impact on D0 & CDF)
- Rob Reilley, Goniometer modifications & improvements
- Dean Still, Installation, commissioning & early study plans
- Rick Tesarek, New E0 instrumentation (commissioning & study plans)
- Jim Zagel, Flying wires

E0 Crystal Collimation Layout

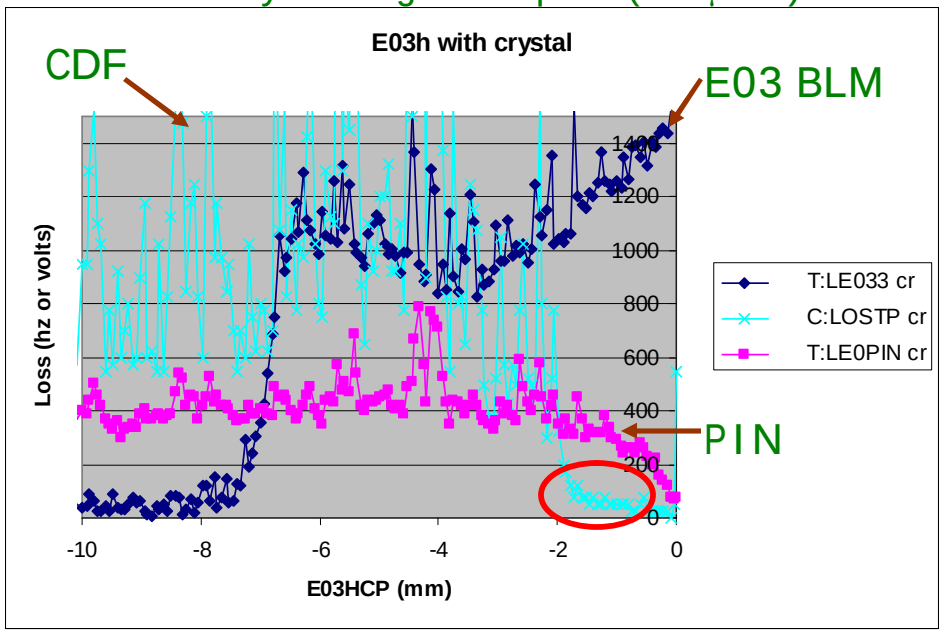


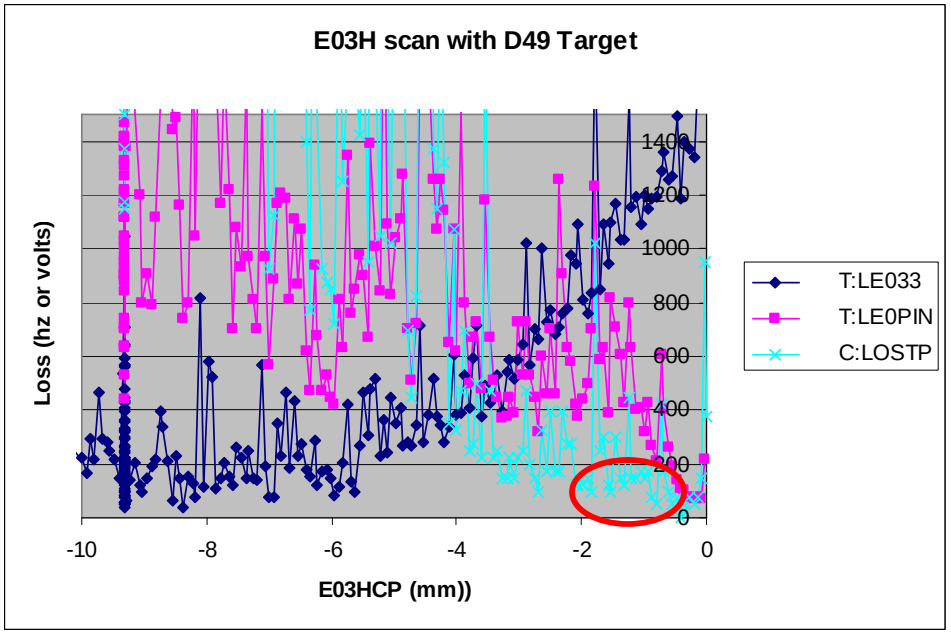




COMPARING EFFECTS OF PROTON HALO LOSSES FOR BENT CRYSTAL AND TUNGSTEN TARGET

Crystal aligned at peak (118 μrad)





Using the crystal:

1. The secondary collimator can remain further (1 mm or so) from the beam thus reducing impedance.
2. Almost a factor of 2 reduction of CDF losses (in agreement with modeling)!
3. A factor of >5 lower irradiation of downstream components

Goals for 2008 to Spring 2009 (Phase I)

Two phases as described in the T980 MoU

Phase I Goals

1. Measure channeled, volume-reflected (?) and scattered beams as well as beam losses downstream of the crystal setup in comparison with simulations.

2. Demonstrate reproducible beam loss reduction in the B0 and D0 in comparison with simulations, aiming at a routine use of the crystal based collimation in the Tevatron stores.

Goals for Spring 2009 to the End of Run II (Phase II)

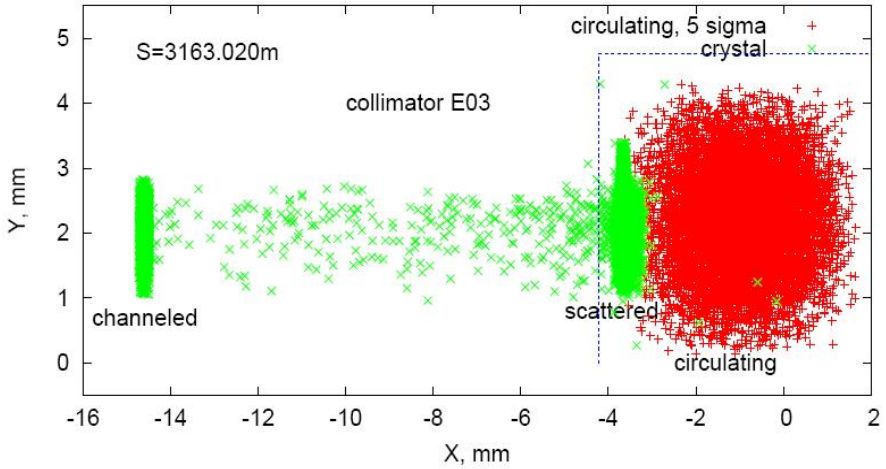
1. Test and confirm fundamental models of single-turn and multi-turn dynamics with crystals.

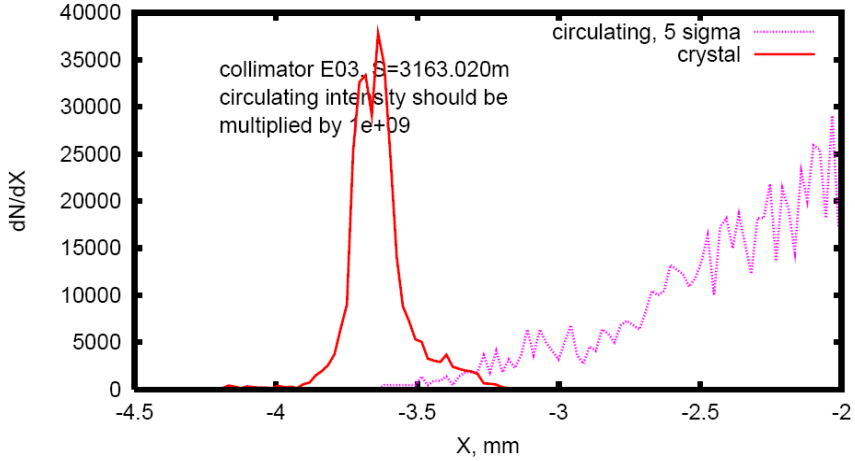
2. Develop optimal crystal/goniometer/instrumentation system for one- and two-plane collimation exploring and exploiting novel crystal technologies and newly understood phenomenon, volume reflection.

3. All of the above in conjunction with the CRYSTAL experiment at CERN SPS, aiming at a Phase II crystal-based collimation system for the LHC (performance, reduced impedance and heavy-ion option)

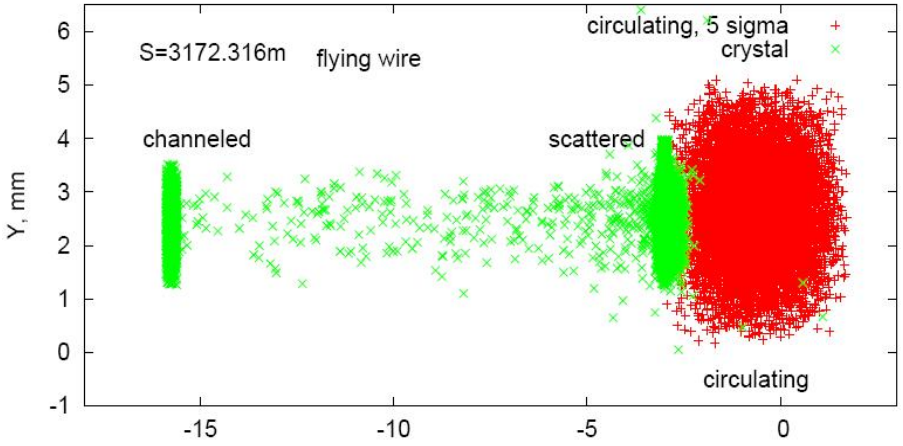
STRUCT/CATCH Simulations: Profiles at 9 Critical Locations in Tevatron with O-Shaped Crystal

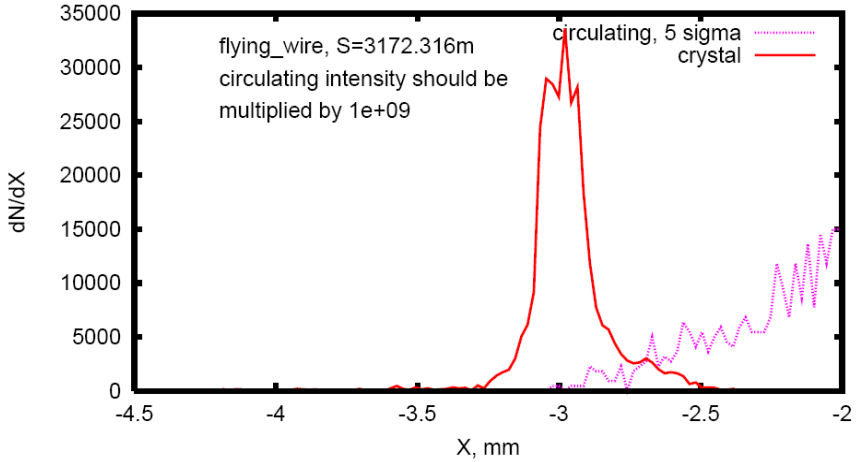
E03 collimator





E11 flying wire

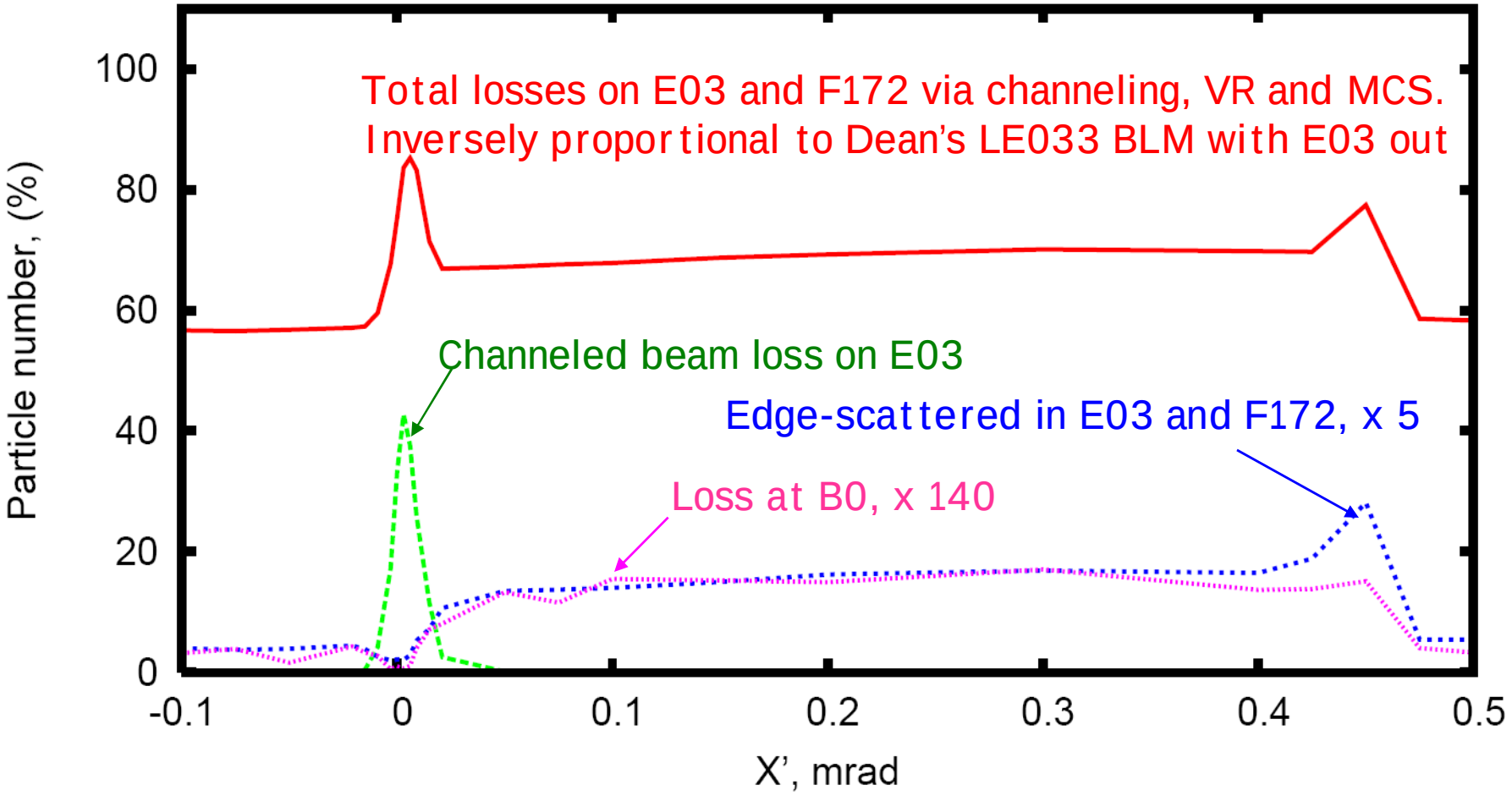




First turn, all collimators are retracted

A. Drozhdin

Multi-Turn Simulations with 0.44-mrad O-shaped Crystal



All collimators are in working positions

A. Drozhdin

Plans for Phase I

1. Installation at appropriate downtime or October mini-shutdown (10-12 hrs).

2. Commissioning: pre-beam and beam tests and End-of-Store studies (see Dean's talk).

3. Several EOS studies of beam dynamics and collimation efficiency aiming at reproducibility and BOS test.

4. Routine use of crystals in the Tevatron stores.

5. Preparation of new crystals, hardware and electronics for installation in the tunnel during the Spring 2009 shutdown.

6. Further plans, scope and beam requests depend on outcome of Phase I and are subject to a FNAL review and 2009-2010 run plans.

Impact on CDF/D0

- Benefit to CDF/D0: at least a factor of 2 reduction in beam loss (2005 data). Can be a more substantial reduction with new crystals and other hardware of (> June 2009).
- Possibly another crystal at F49 to reduce pbar losses in CDF/D0.
- Maximum possible luminosity loss in Phase I: 20 hrs, or 4.3 pb^{-1} out of 1300 pb^{-1}/yr, or 0.33% (compared to 0.68% difference in CDF and D0 luminosities).
- Nothing happens if the crystal doesn't channel (Dec. 2007 results).
- Minimal risk to the silicon: only the target at E0 is retracted, nothing else moves.
- Effect or risk to CDF/D0 with crystal collimator for full store (BOS)

(i) crystal works: losses reduced via efficient scraping;

(ii) crystal doesn't work: re-insert tungsten target, loose small amount of luminosity at beginning of store (10 minutes), beam losses the same.