Recent Operating Experience at the Antiproton Source Target Hall

3rd High Power Targetry Workshop

September 12, 2007

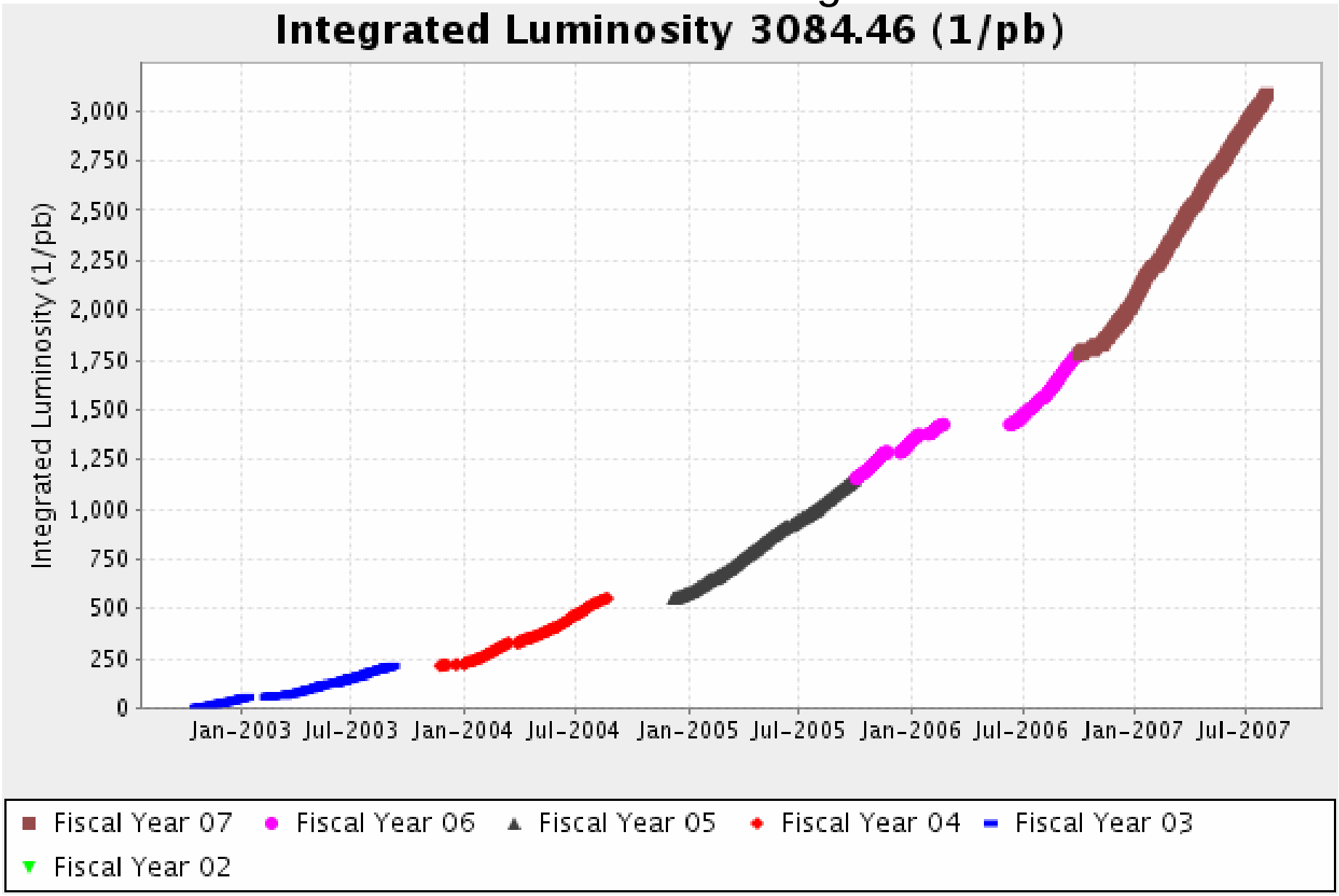
Fermilab
Accelerator Division
Antiproton Source Department

Anthony Leveling

Synopsis of this talk

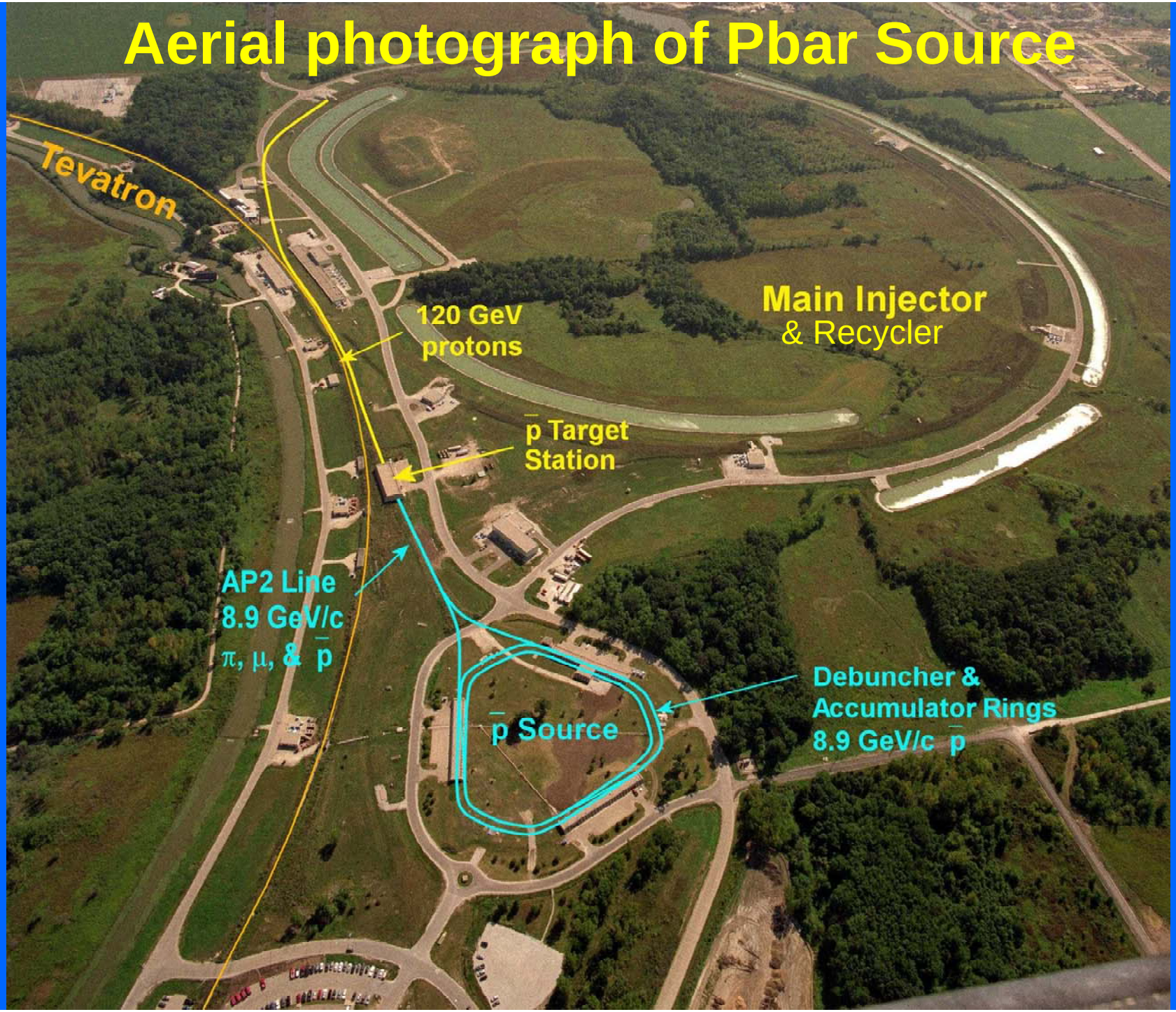
- Tevatron collider performance
  - Integrated luminosity by year
- Anti-proton source role
  - Prior to May 2004
  - After May 2004
  - Performance
- Target station operating experience
  - Target developments since 2003
  - Recent observations and developments

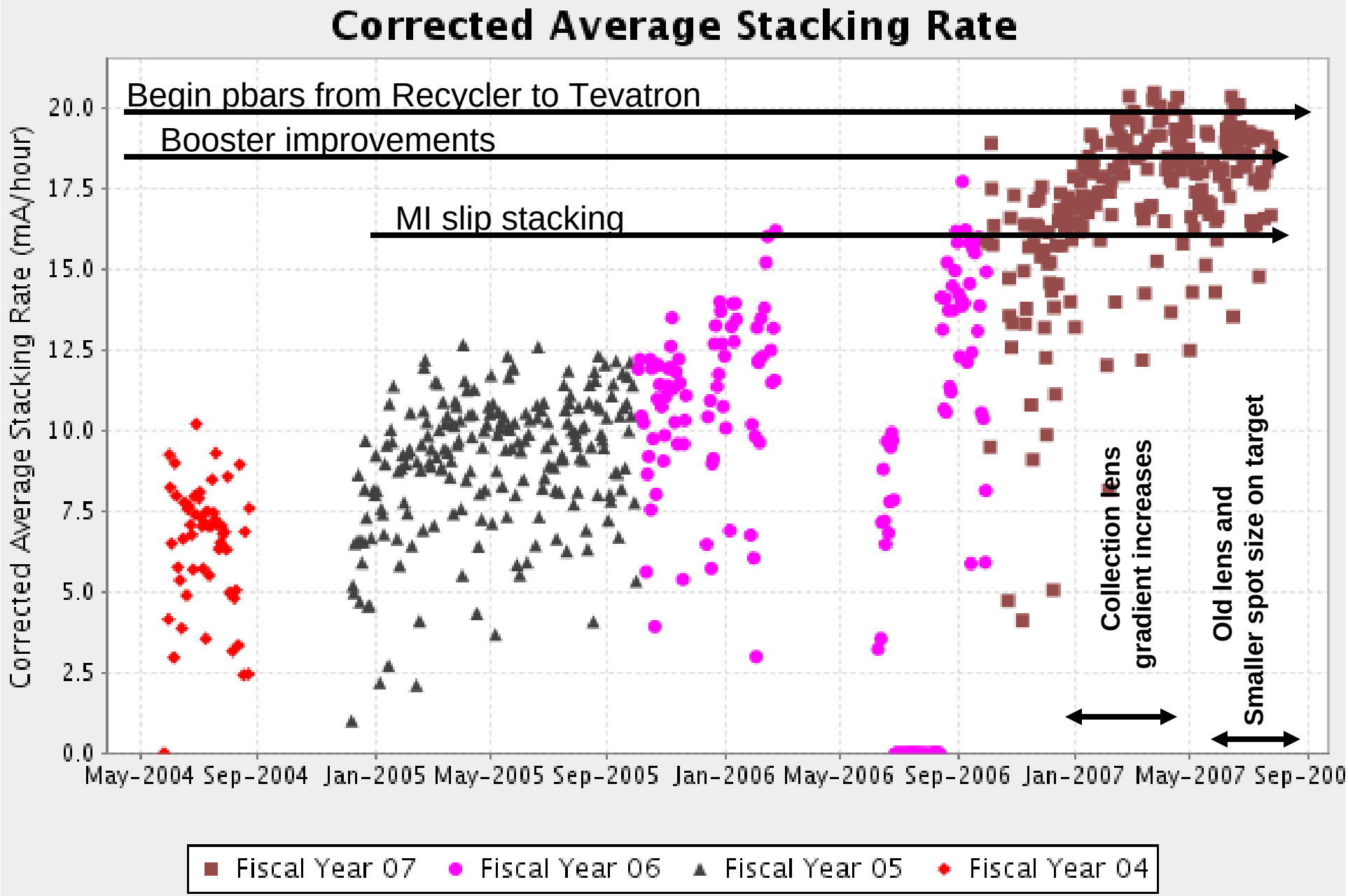
Tevatron Collider Program

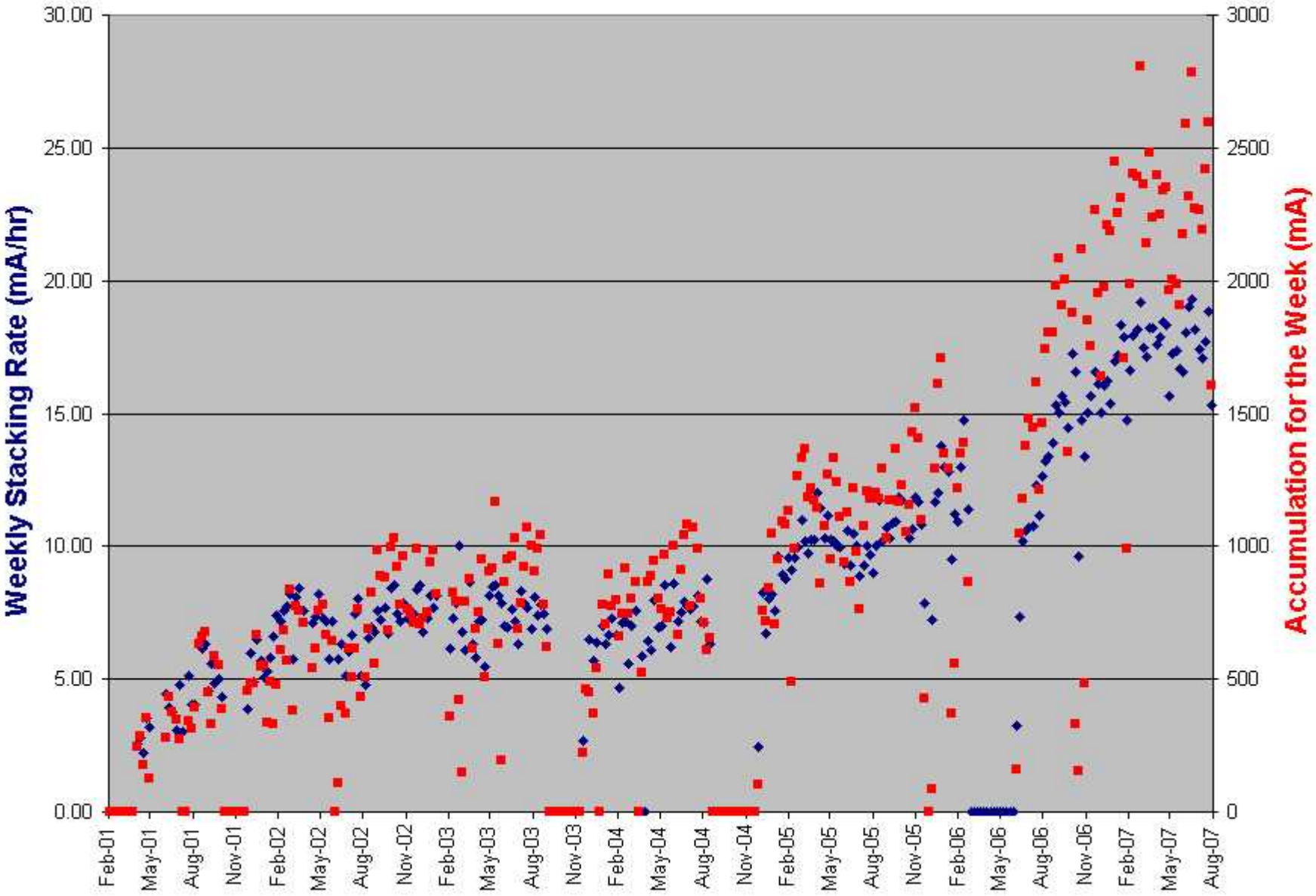


A. Leveling - Fermilab

Aerial photograph of Pbar Source



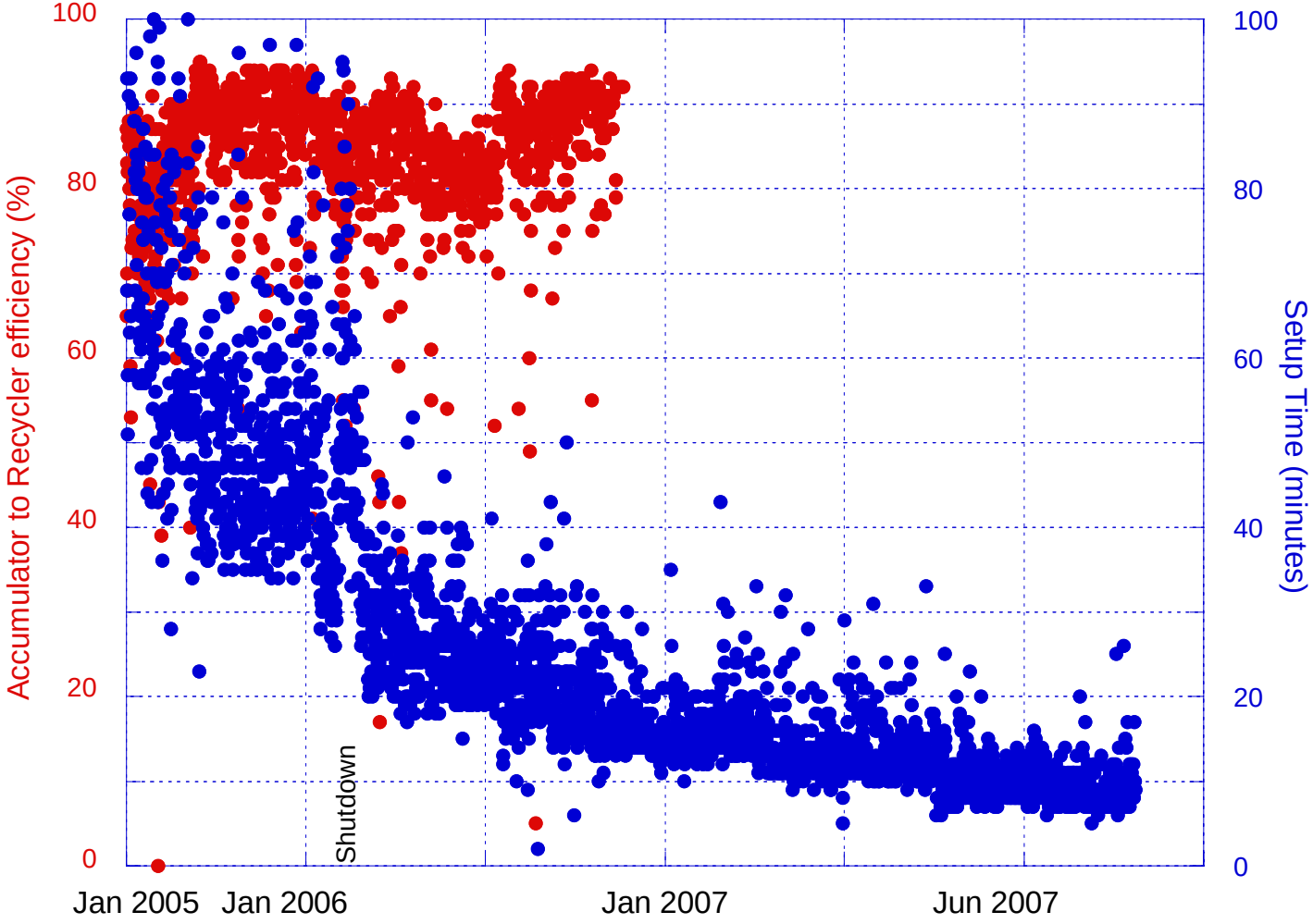

Corrected Average Stacking Rate
Begin pbars from Recycler to Tevatron
Booster improvements
MI slip stacking
Collection lens gradient increases
Old lens and Smaller spot size on target
Corrected Average Stacking Rate (mA/hour)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
May-2004
Sep-2004
Jan-2005
May-2005
Sep-2005
Jan-2006
May-2006
Sep-2006
Jan-2007
May-2007
Sep-200
Fiscal Year 07
Fiscal Year 06
Fiscal Year 05
Fiscal Year 04



A. Leveling - Fermilab

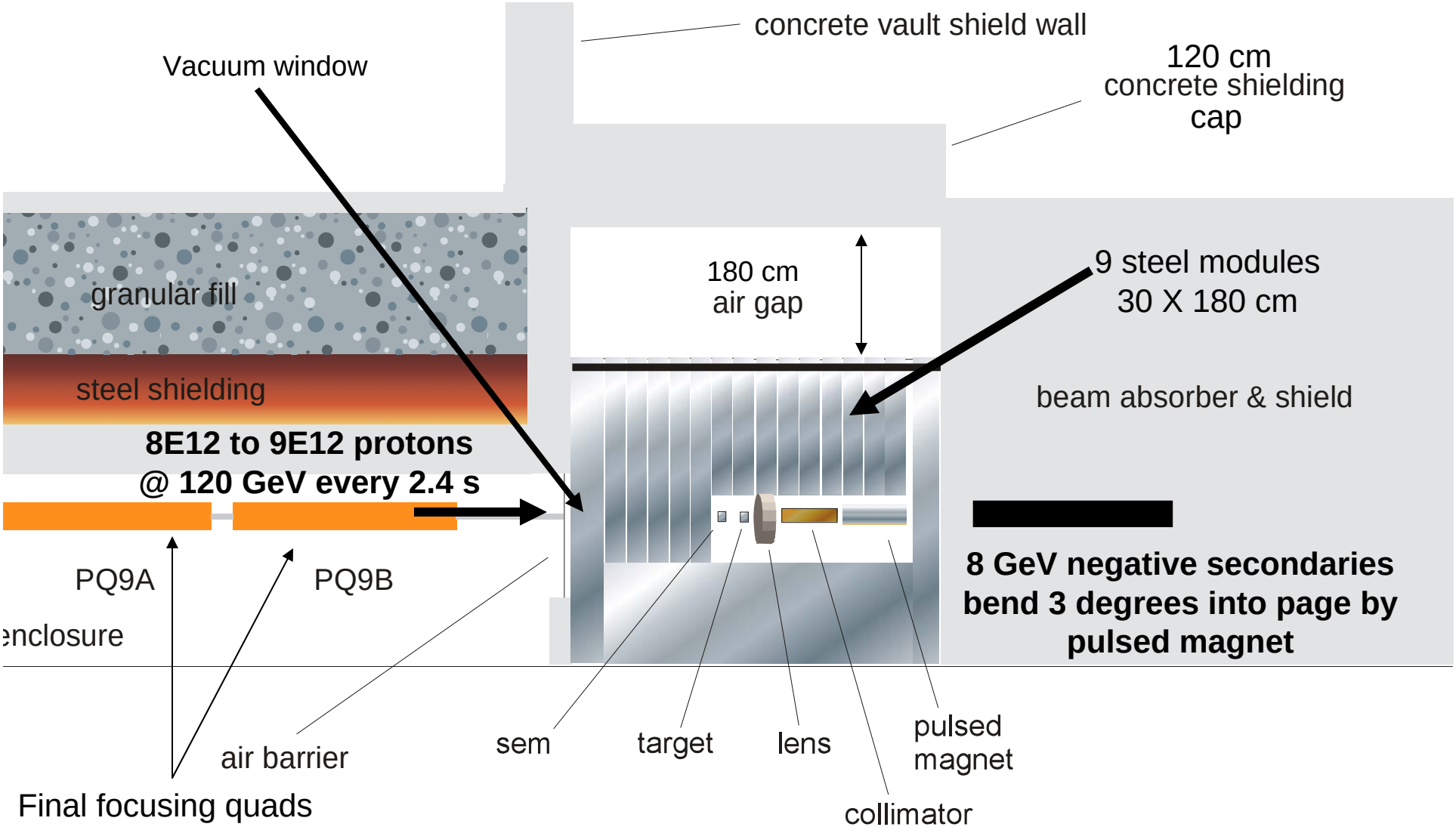
Recycler shots

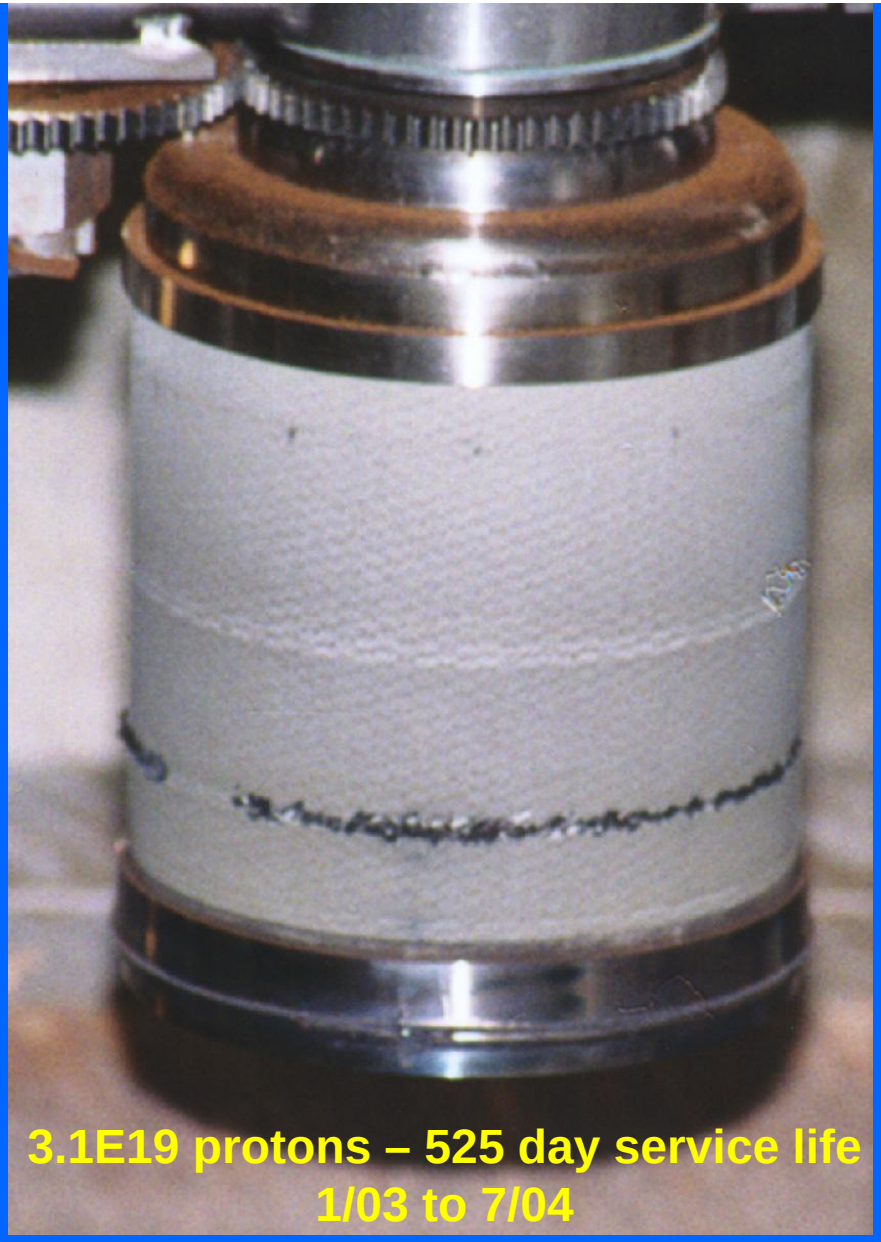
Transfer Efficiency and Setup Time

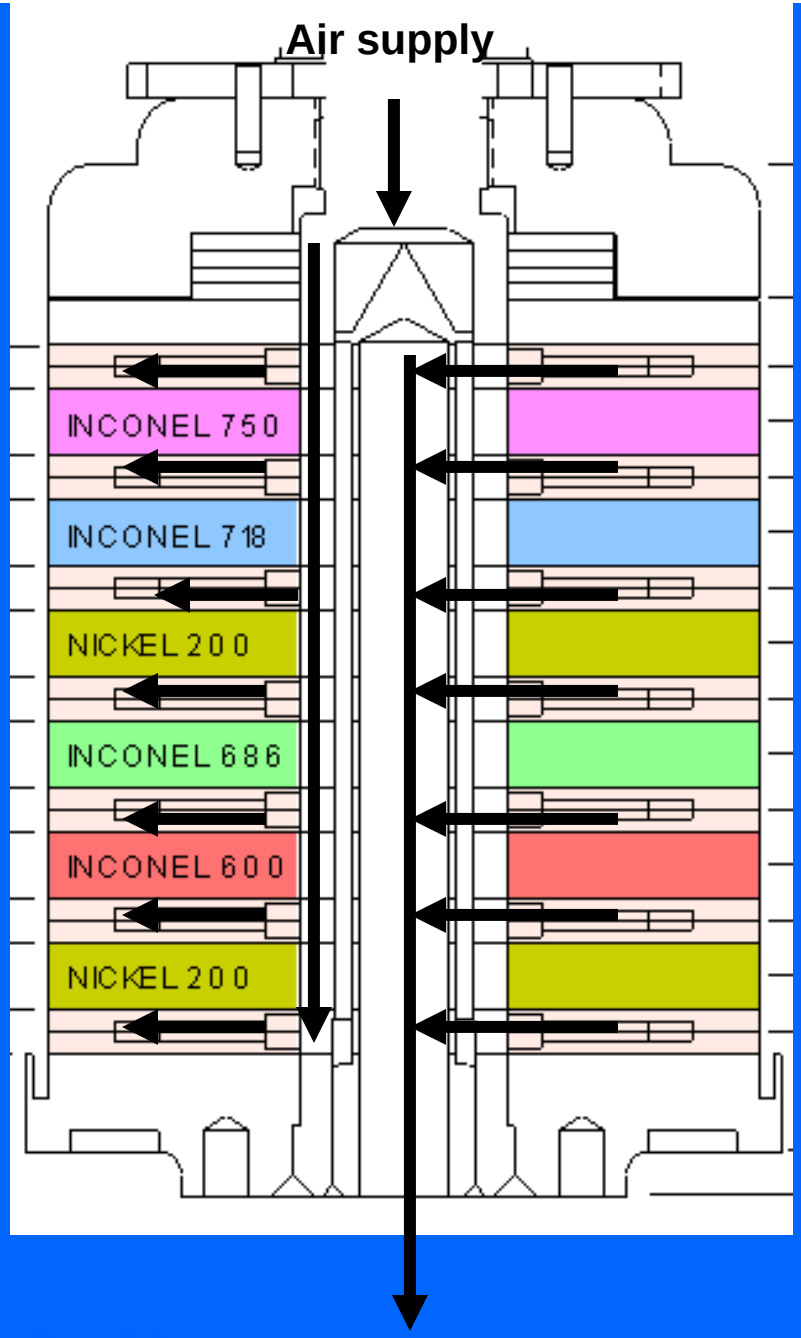


A. Leveling - Fermilab

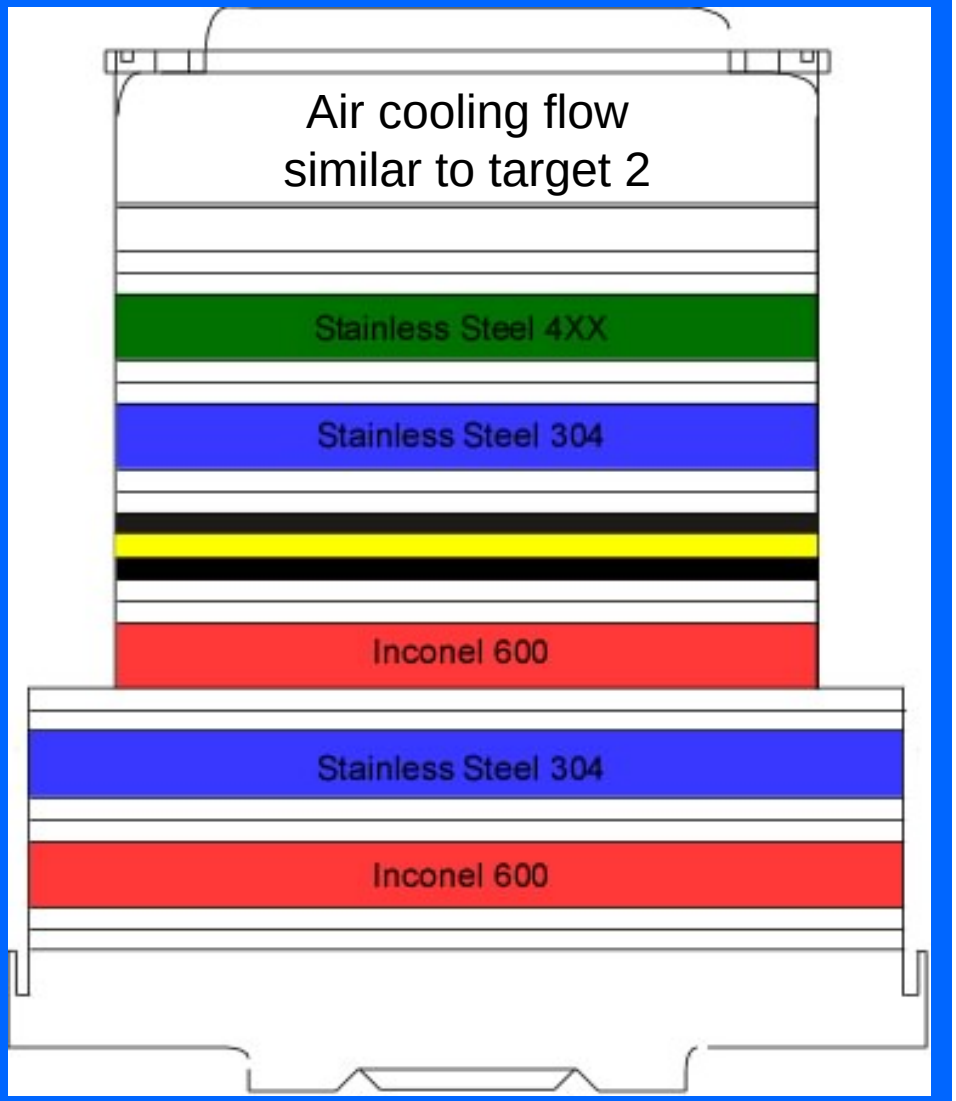
APO Service Building Upstream End and Target Vault Partial Elevation View







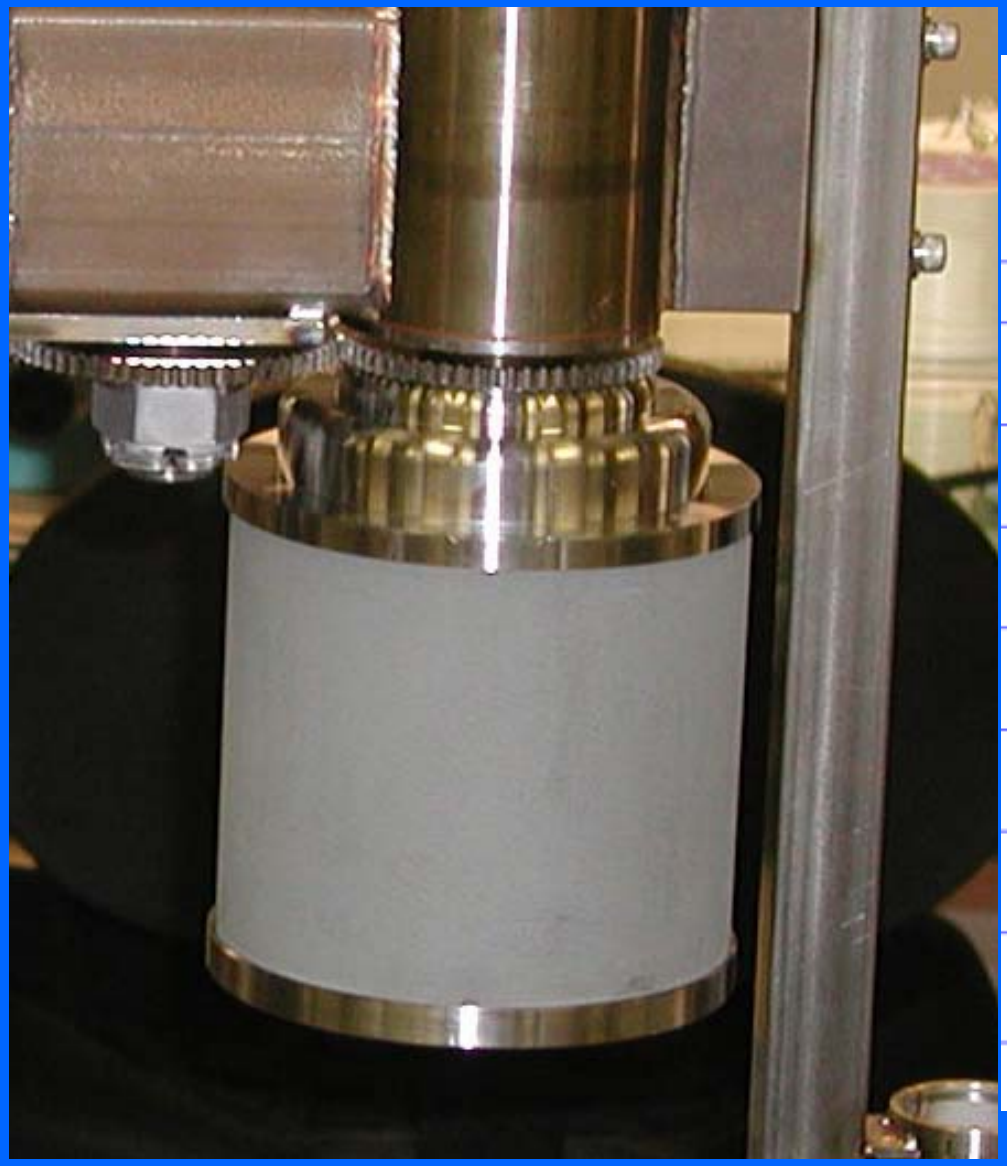
Target 2
Six 0.95 X 10 cm diameter target disks
Seven copper cooling disks

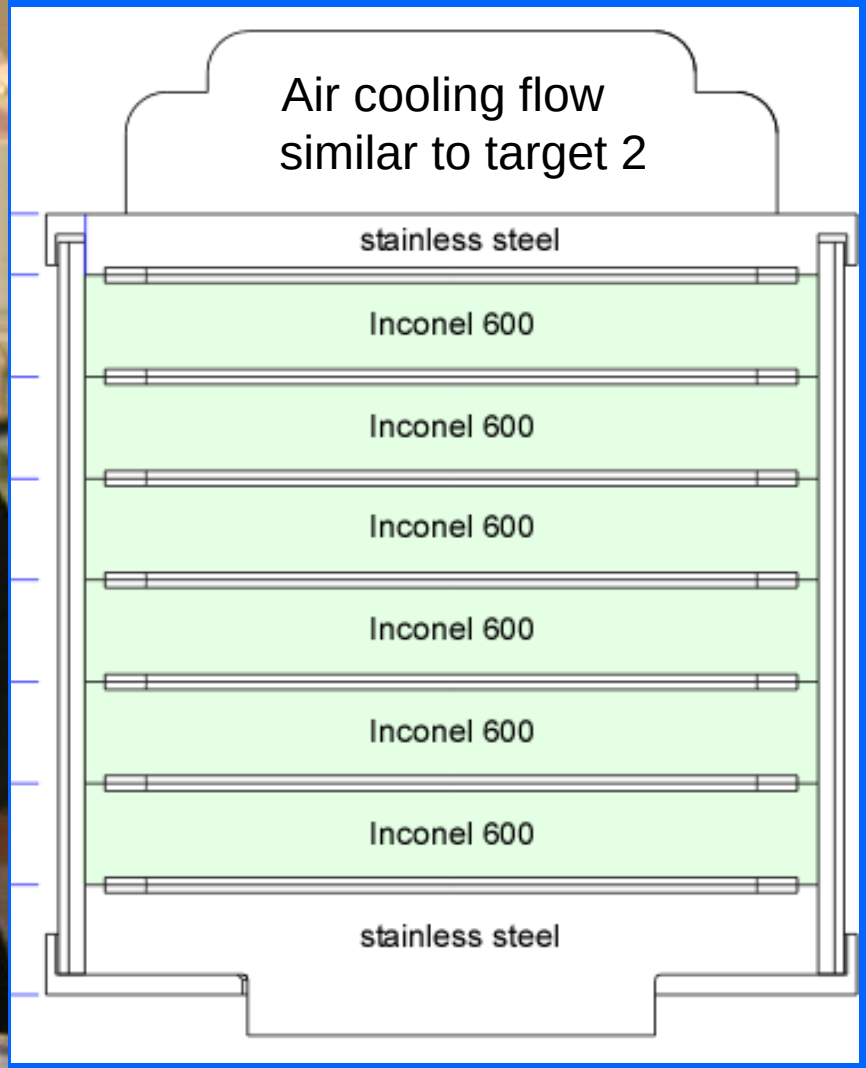


Target 3

Four 0.95 X 10 cm disks with carbon-carbon cover

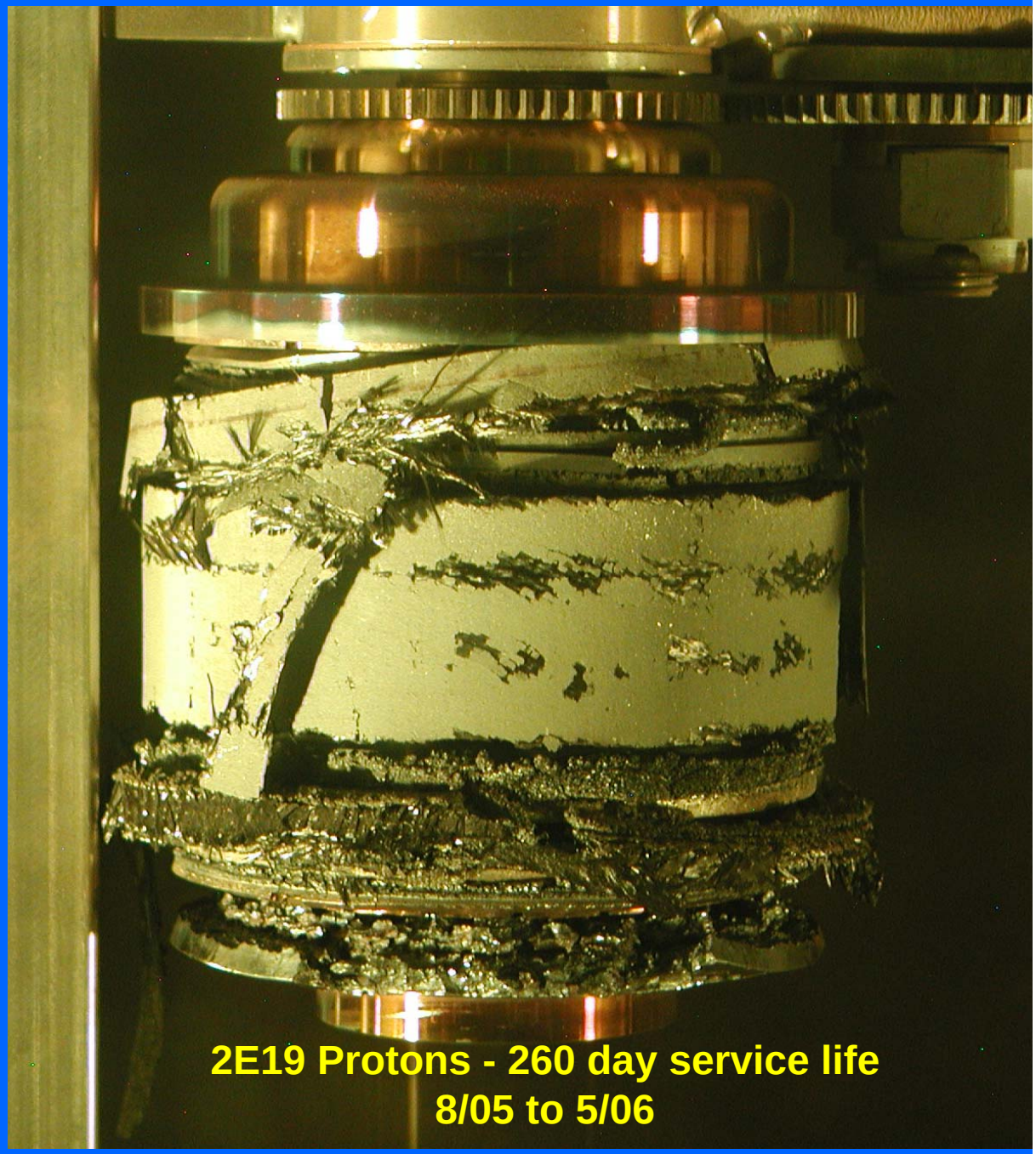
Two 0.95 X 12.7 cm disks with Ti cover (destroyed by the beam)

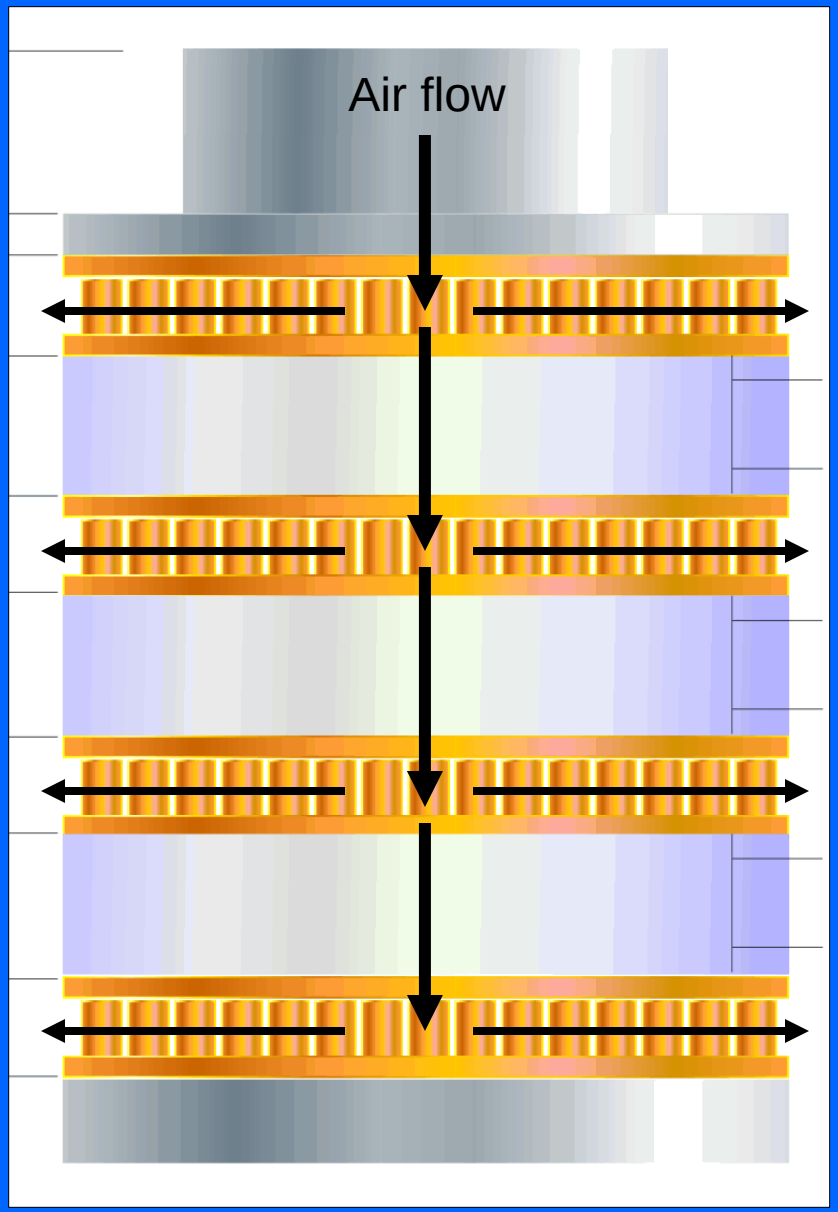




Target 4 – new
Six 1.6 X 11.4 cm disks
With carbon-carbon cover

- Target 4 end of life
- Improved 120 GeV optics
- 120 um spot size
- First target to sputter target material
- October 2005 had to increase spot size to 200 um(?)



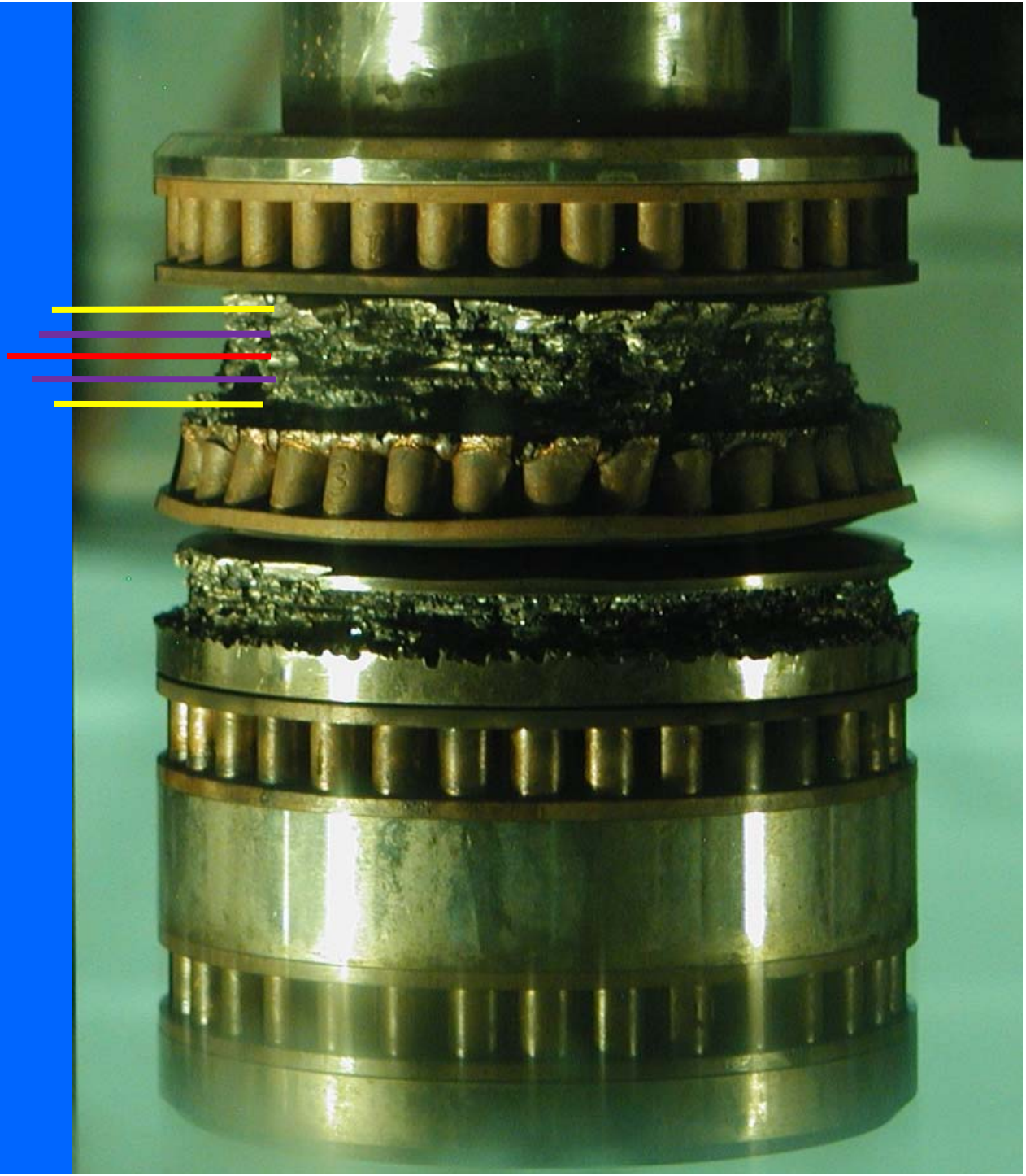


Target 5
Three disks 2.15 X 11.4 cm

Center 10 days

Above/below center 7 days

Outer positions 4 to 5 days



Target 5

1.7E19 protons
133 day service life
5/06 to 9/06

Target 6

2E19 protons
119 day service life
9/06 to 1/07

Target 7

2E19 protons
105 day service life
1/07 to 5/08

200 um spot size

High Gradient Collection Lens

- Introduced 10/2006 to 12/2006
  - 15% improvement in target yield
    - Record stacking rate achieved 2/2007
- Lens (transformer) failed in 5/2007
- Had to revert to original lens design
  - Stacking rate dropped off 10 to 15%

US Beam Sweeping System

- Commissioned beginning end 04/2007
- Just the upstream system
- 50% improvement in target lifetime
- 1 to 2% reduction in yield
- Reduced spot size to ~140 um
  - regained stacking rate lost by lens changeout

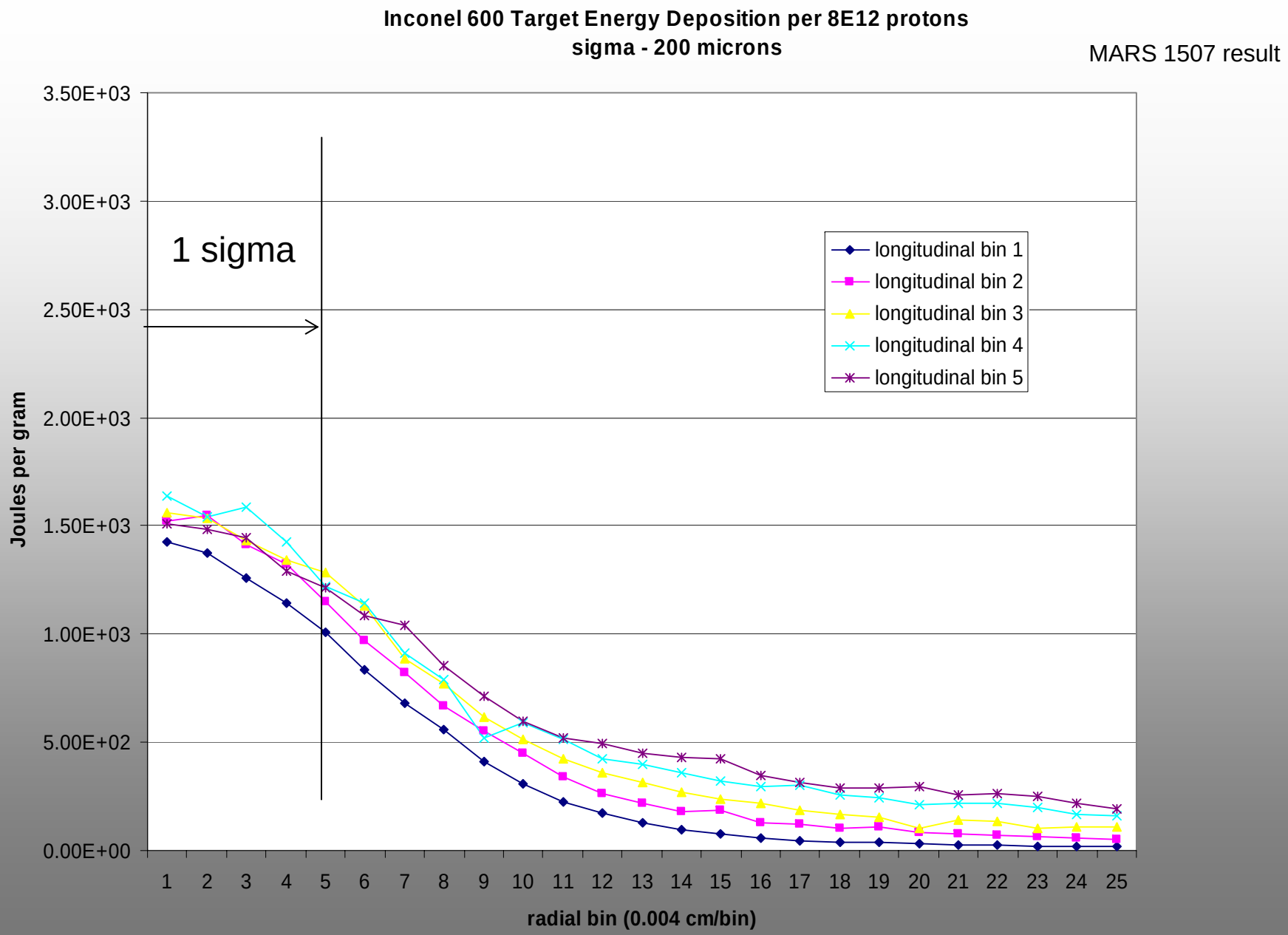
Target 8

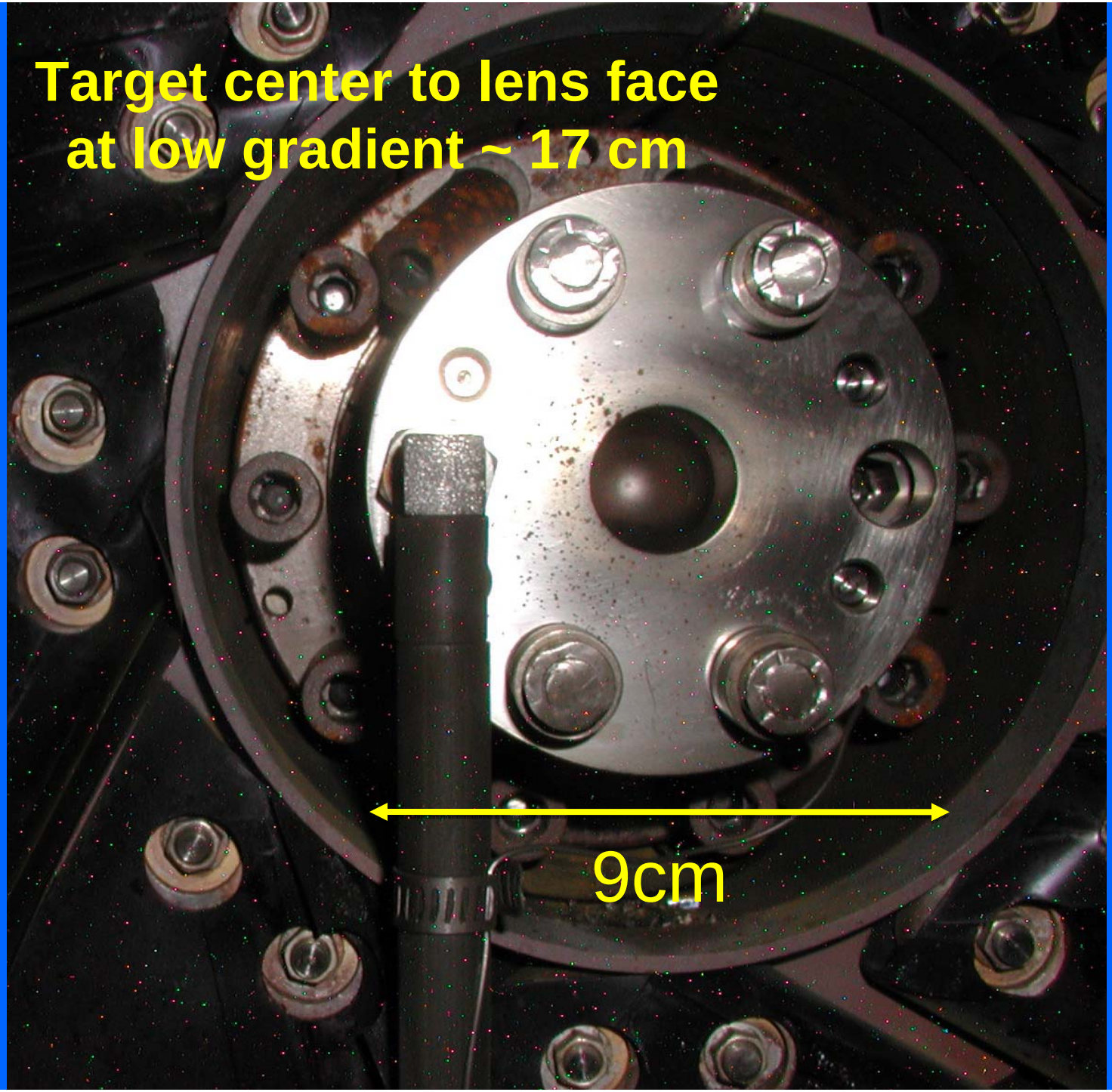
Top disk - 200 micron beam sigma with beam sweeping radius ~0.3 mm

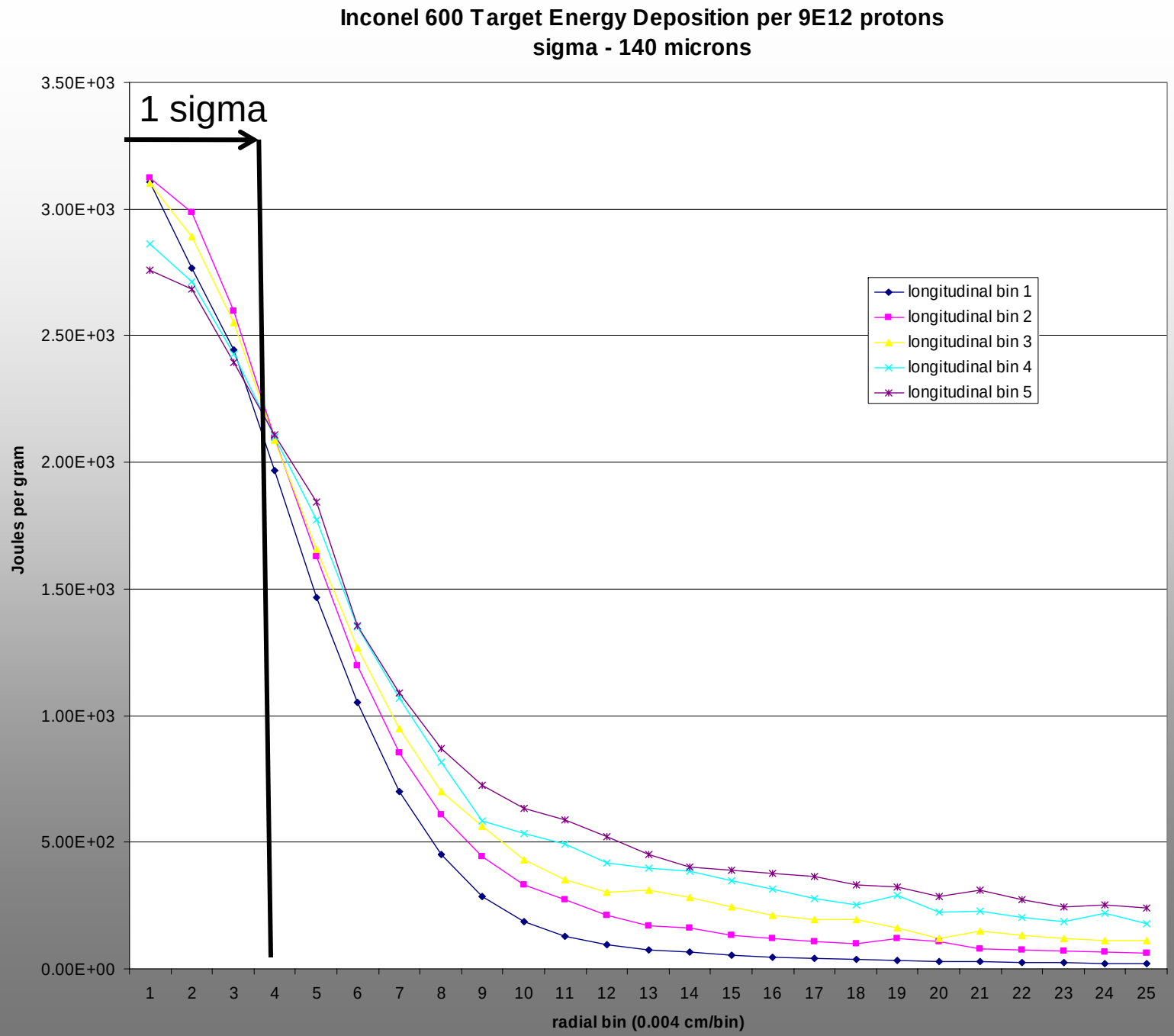
Middle disk – 140 micron beam sigma With beam sweeping radius ~0.6 mm

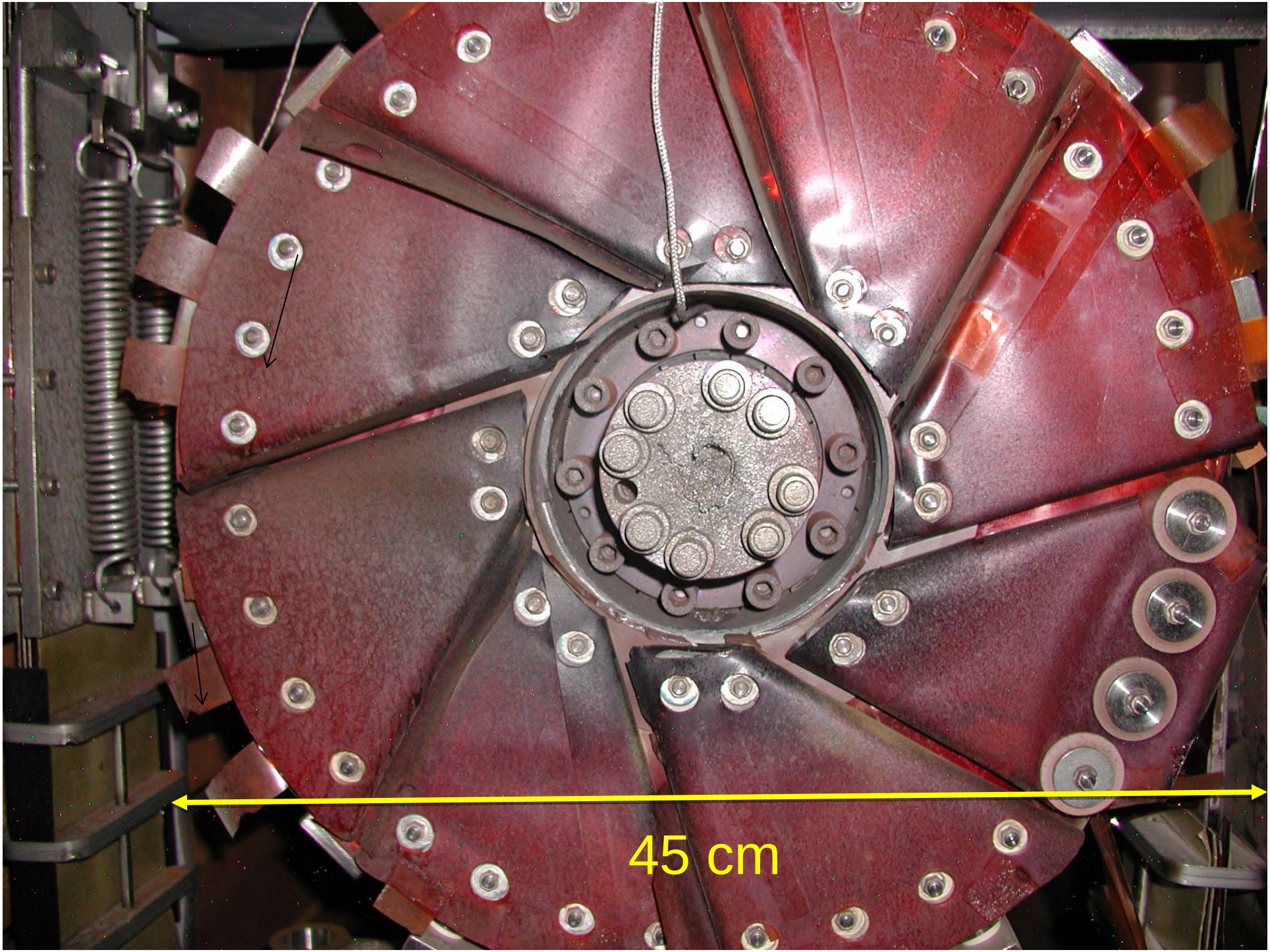
Beam sweeping system commissioned late 4/07

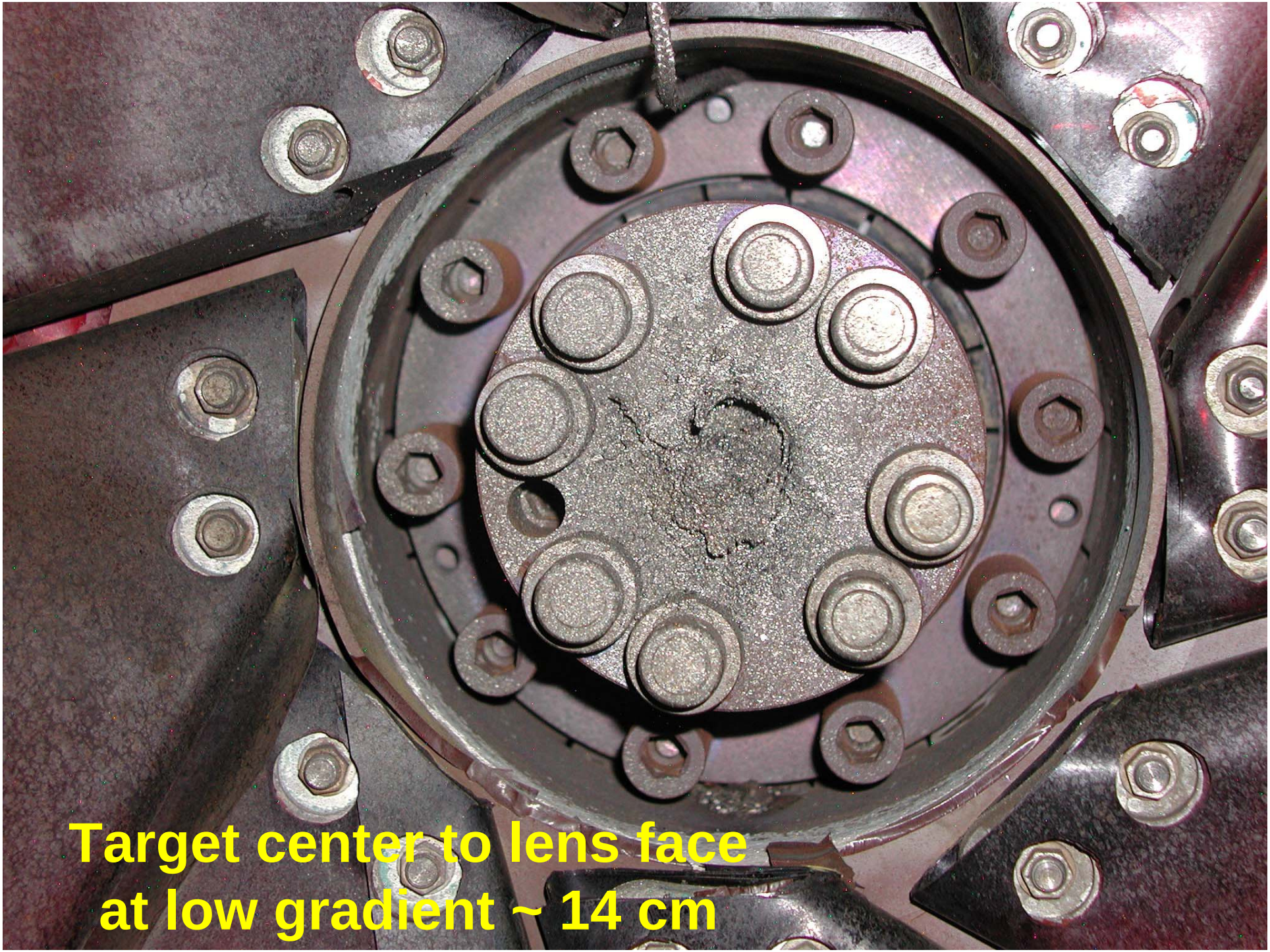
1.8E19 protons
88 days service life
5/07 to present


Inconel 600 Target Energy Deposition per 8E12 protons
sigma - 200 microns
MARS 1507 result
1 sigma
longitudinal bin 1
longitudinal bin 2
longitudinal bin 3
longitudinal bin 4
longitudinal bin 5
Joules per gram
3.50E+03
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
radial bin (0.004 cm/bin)


Target center to lens face
at low gradient ~ 17 cm
9cm

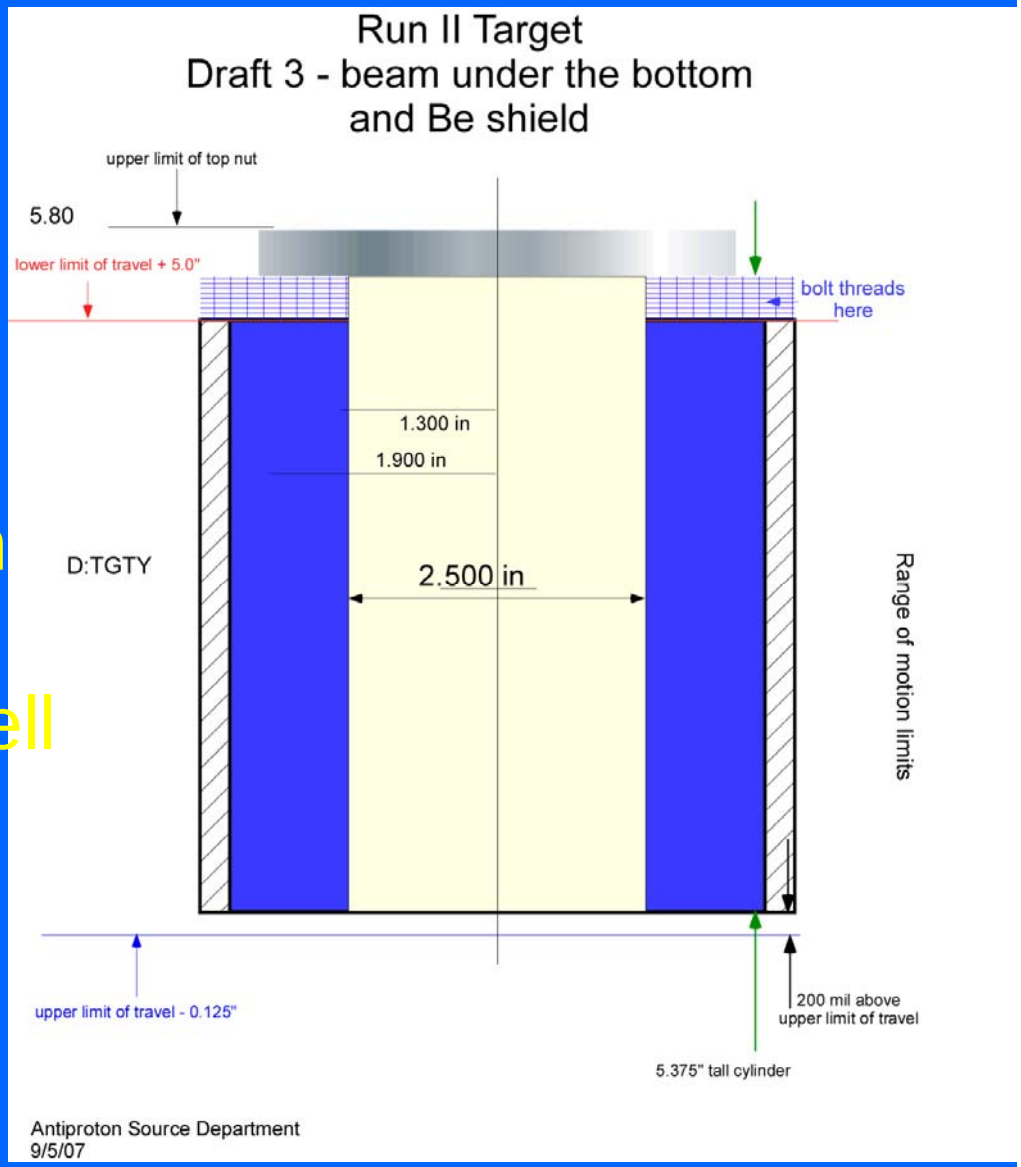

Inconel 600 Target Energy Deposition per 9E12 protons
sigma - 140 microns
1 sigma
3.50E+03
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Joules per gram
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
radial bin (0.004 cm/bin)
longitudinal bin 1
longitudinal bin 2
longitudinal bin 3
longitudinal bin 4
longitudinal bin 5


45 cm


Target center to lens face
at low gradient ~ 14 cm


Target SEM 30 cm upstream of target
Target sputtering events:
October 2005 (cone)
June through July 2007

- Inconel 600 cylinder
- Copper cooling
  - Copper pipe shell
  - 6 to 12 mm Cu balls
  - H2 brazed construction
- Be or ALBEMET outer shell
  - Interference fit
  - Excludes air at surface



The next generation target – December 2007

Pbar Target Station Summary

- Startup in October 2007
  - Install high gradient lens (to improve yield)
  - Remove damaged target SEM (BL obstacle!)
  - evaluate pulsed magnet for replacement
  - restore to larger spot size (stop sputtering)
- Build next generation target
  - Return to 140 um spot size (to improve yield)
- Build new target SEM (spot size understanding)
- Continue building spare lenses
- Run, run, run . . . and integrate luminosity