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

A. Leveling - Fermilab
Begin pbars from Recycler to Tevatron
Booster improvements
MI slip stacking
Collection lens gradient increases
Old lens and smaller spot size on target
Recycler shots
Transfer Efficiency and Setup Time

Accumulator to Recycler efficiency (%)
Setup Time (minutes)


Shutdown
APO Service Building Upstream End and Target Vault Partial Elevation View

- Vacuum window
- Concrete vault shield wall
- 120 cm concrete shielding cap
- 9 steel modules 30 X 180 cm
- Beam absorber & shield
- 180 cm air gap
- 8 GeV negative secondaries bend 3 degrees into page by pulsed magnet

- 8E12 to 9E12 protons @ 120 GeV every 2.4 s
- 9 steel modules 30 X 180 cm
- Final focusing quads
- PQ9A enclosure
- PQ9B enclosure
- Air barrier
- Steel shielding
- Granular fill
- Vacuum window
- 120 cm concrete shielding cap

- 8 GeV negative secondaries bend 3 degrees into page by pulsed magnet
- Collimator
- Pulsed magnet
- Lens
- Target
- SEM
3.1E19 protons – 525 day service life
1/03 to 7/04

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

Air supply

Air exhaust
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)

3.2E19 protons – 420 day service life
7/04 to 8/05
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 (?)

2E19 Protons - 260 day service life
8/05 to 5/06
A. Leveling - Fermilab
Target 5
Three disks 2.15 X 11.4 cm
Center 10 days
Above/below center 7 days
Outer positions 4 to 5 days
A. Leveling - Fermilab

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

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

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

Target 5

Target 6

Target 7

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

A. Leveling - Fermilab
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
Target center to lens face at low gradient ~ 17 cm

9 cm
Inconel 600 Target Energy Deposition per 9E12 protons

1 sigma - 140 microns

Joules per gram

radial bin (0.004 cm/bin)
A. Leveling - Fermilab

45 cm
Target center to lens face at low gradient $\sim 14$ 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

A. Leveling - Fermilab