Accelerator Performance

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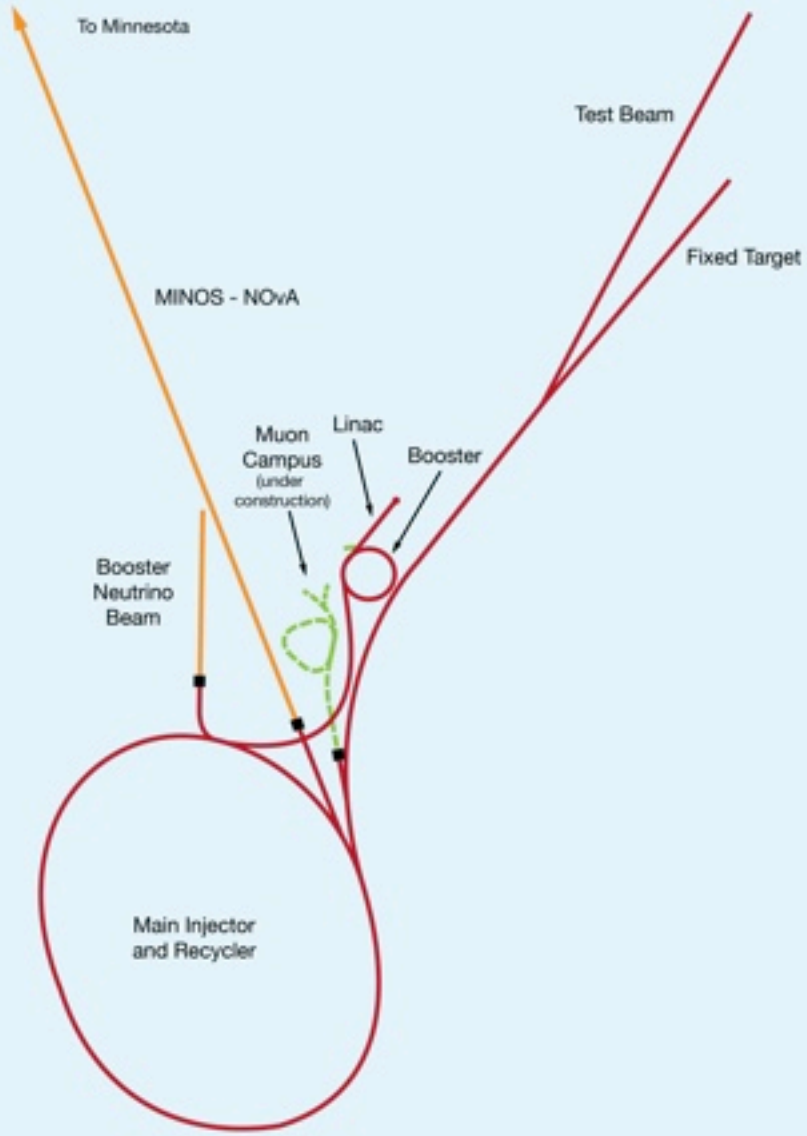
U.S. DEPARTMENT OF ENERGY

Fermilab

Operating Program

- Tevatron Shutdown
- Performance Summaries
  - Tevatron (2011)
  - Neutrino beams (2012)
  - Fixed Target (2012)
- Projections and Goals for 2013 and 2014 for
  - Neutrino
    - Target issues
- Other Fixed-Target
  - SeaQuest



Fermilab Accelerator Complex 2012

- Protons
- Neutrinos
- Muons
- Electrons
- Target

North

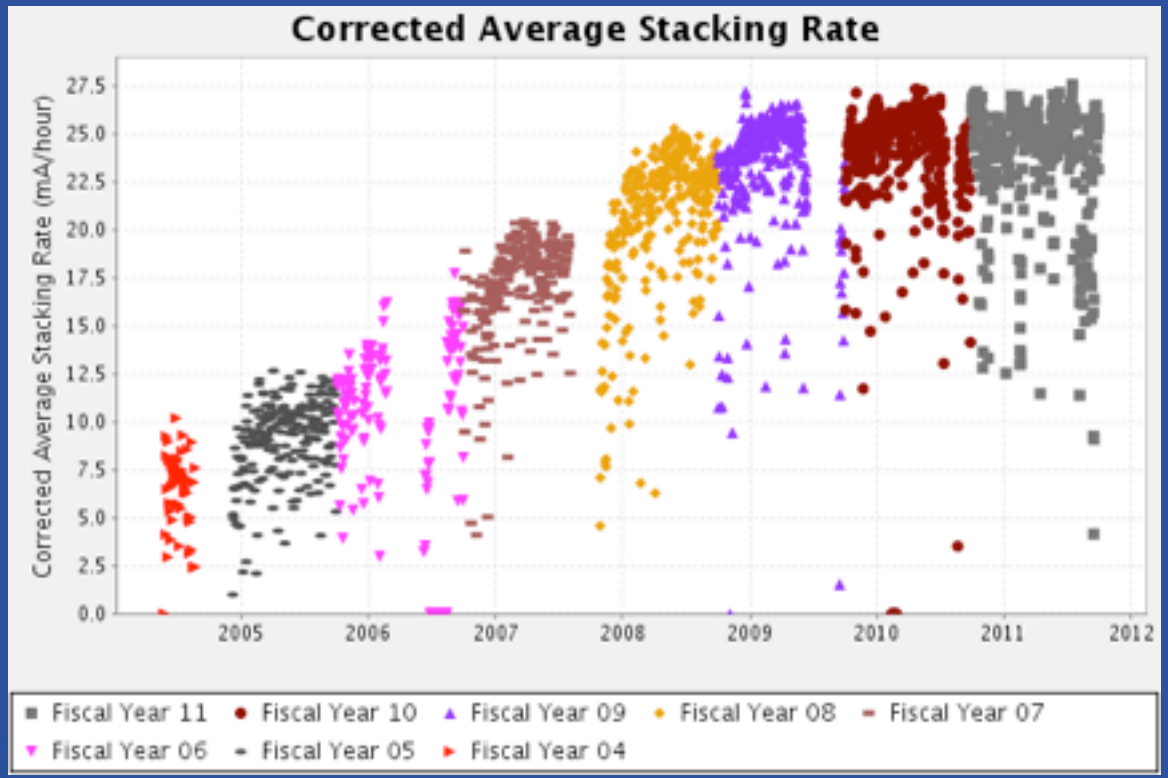
Advanced Superconducting Test Accelerator
(under construction)

Muon Test Area

(items not to scale)

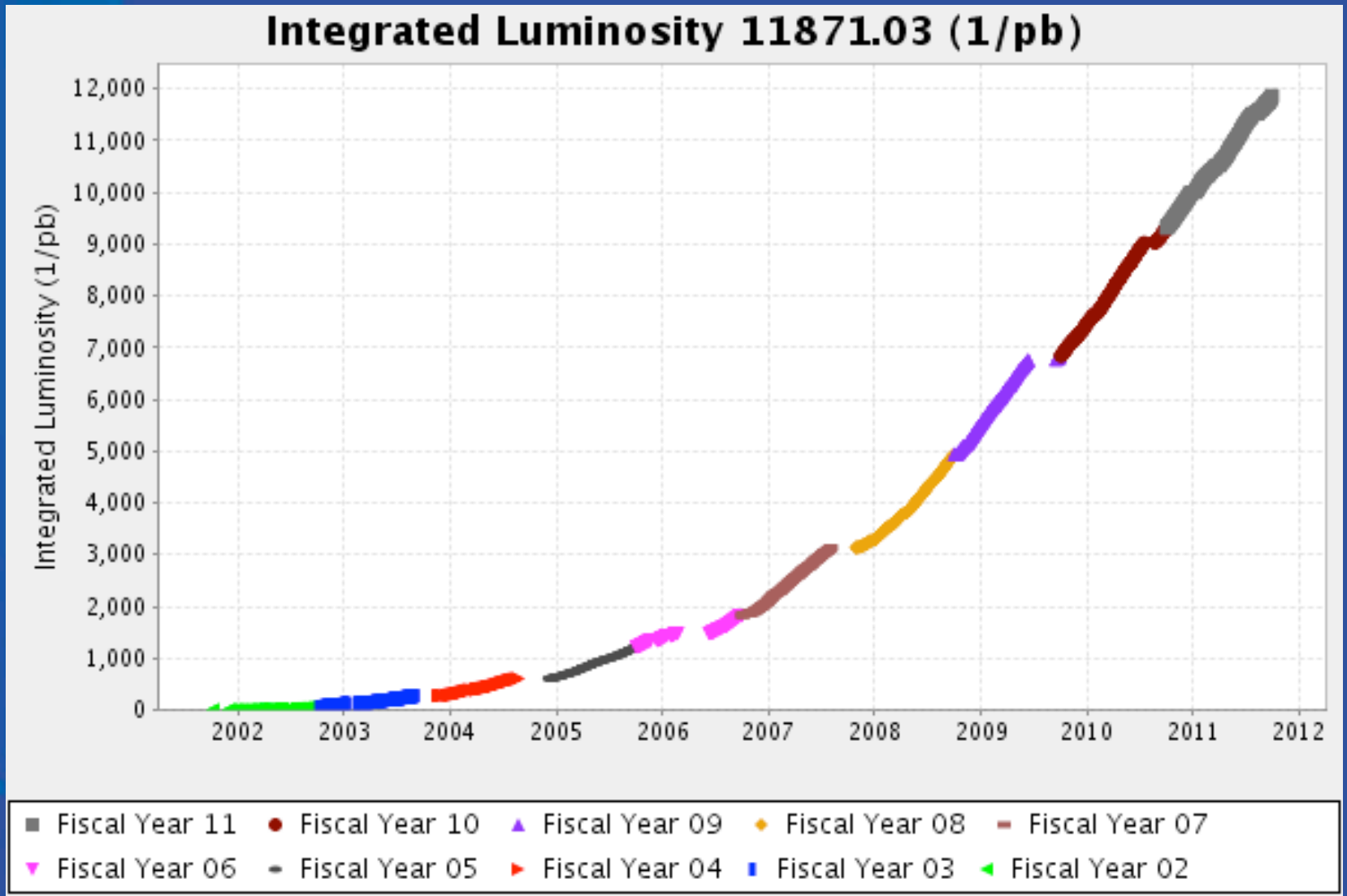

TEVATRON
RAMP
H
V

Antiproton Summary

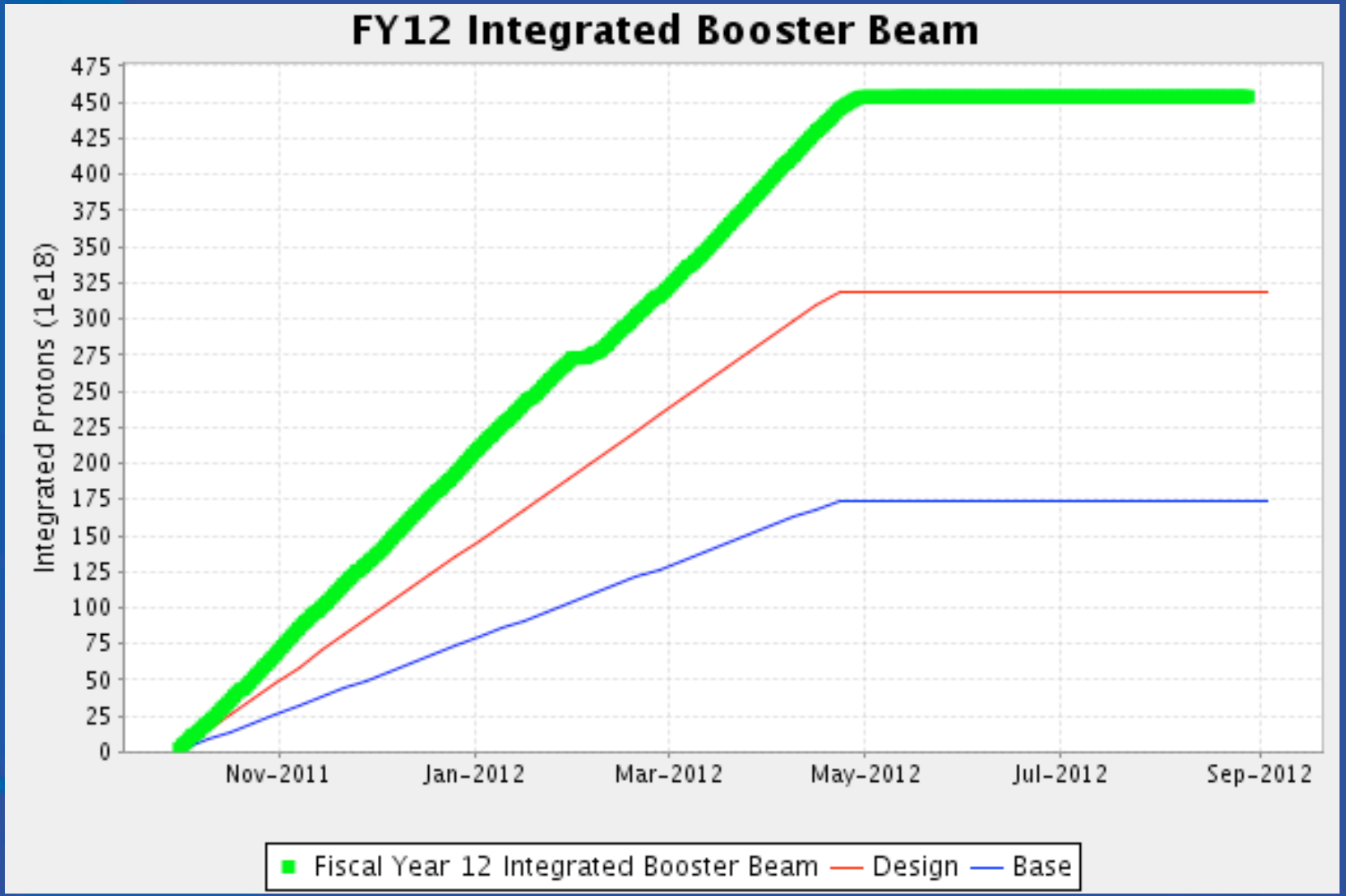


- 8.24 x 10^{15} total Run II antiprotons during Collider Running
- 8.99 x 10^{15} total antiprotons during for all antiproton Production

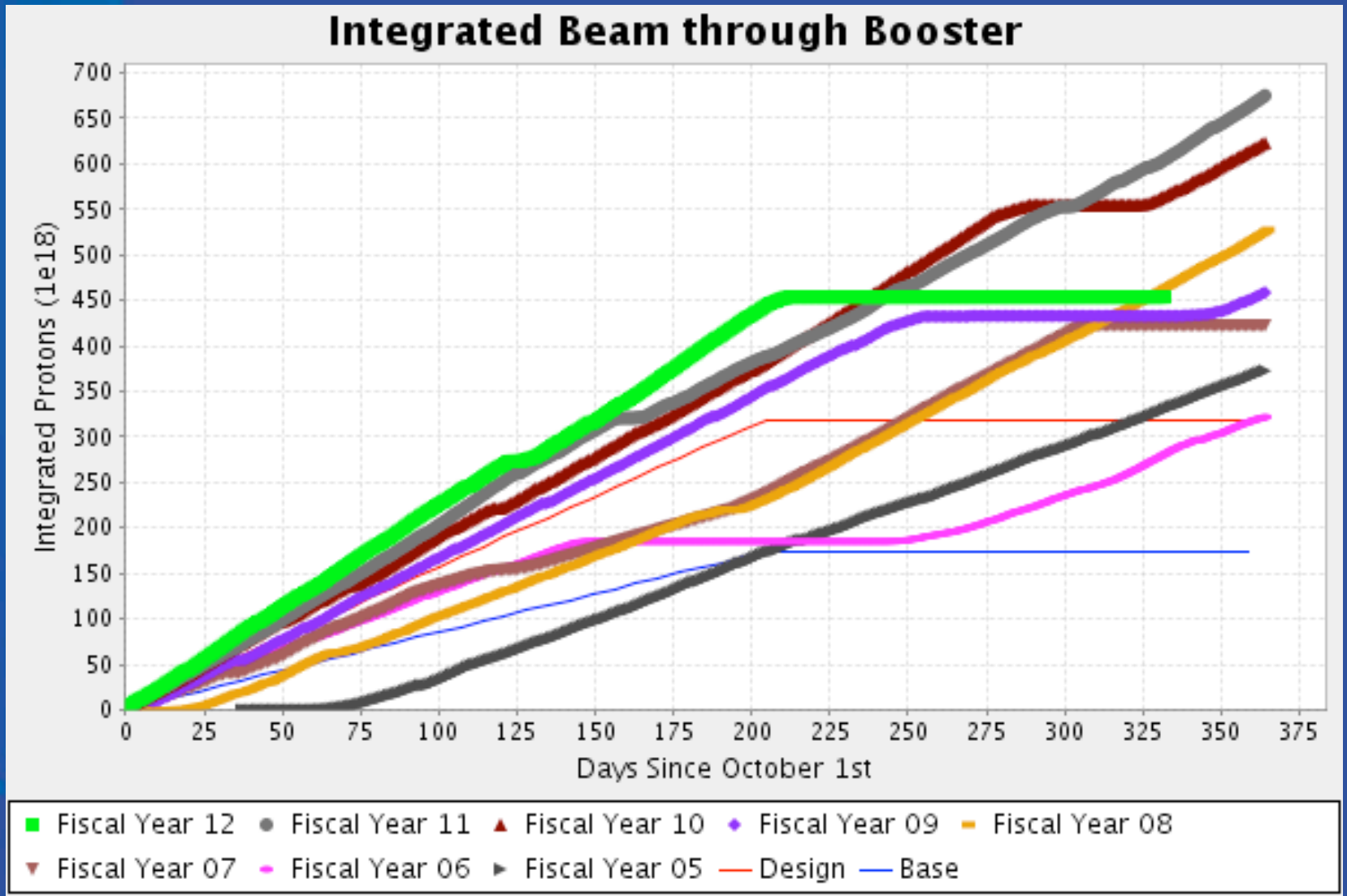
Final Tevatron Delivered Luminosity



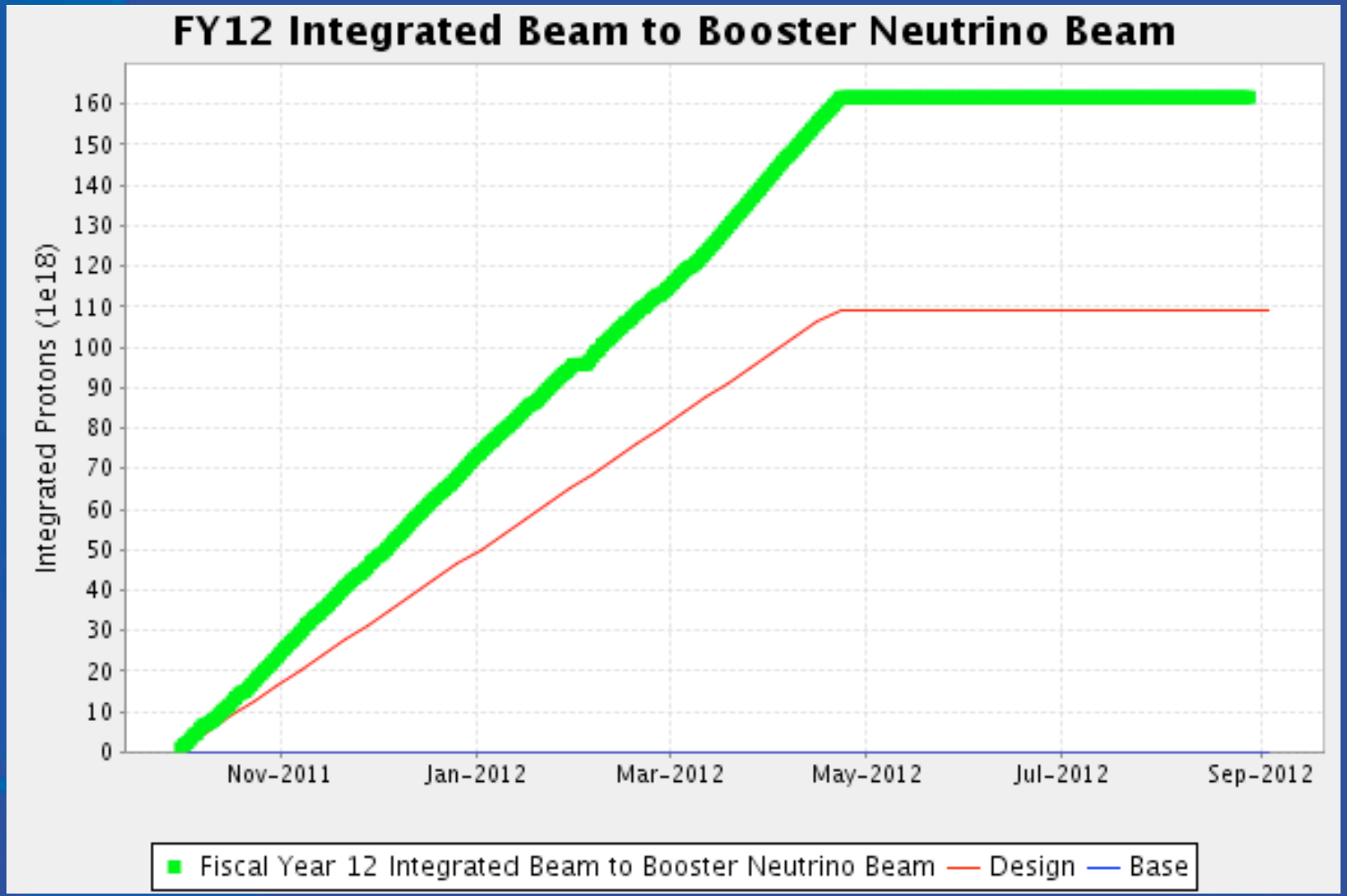
FY12 Integrated Booster Beam



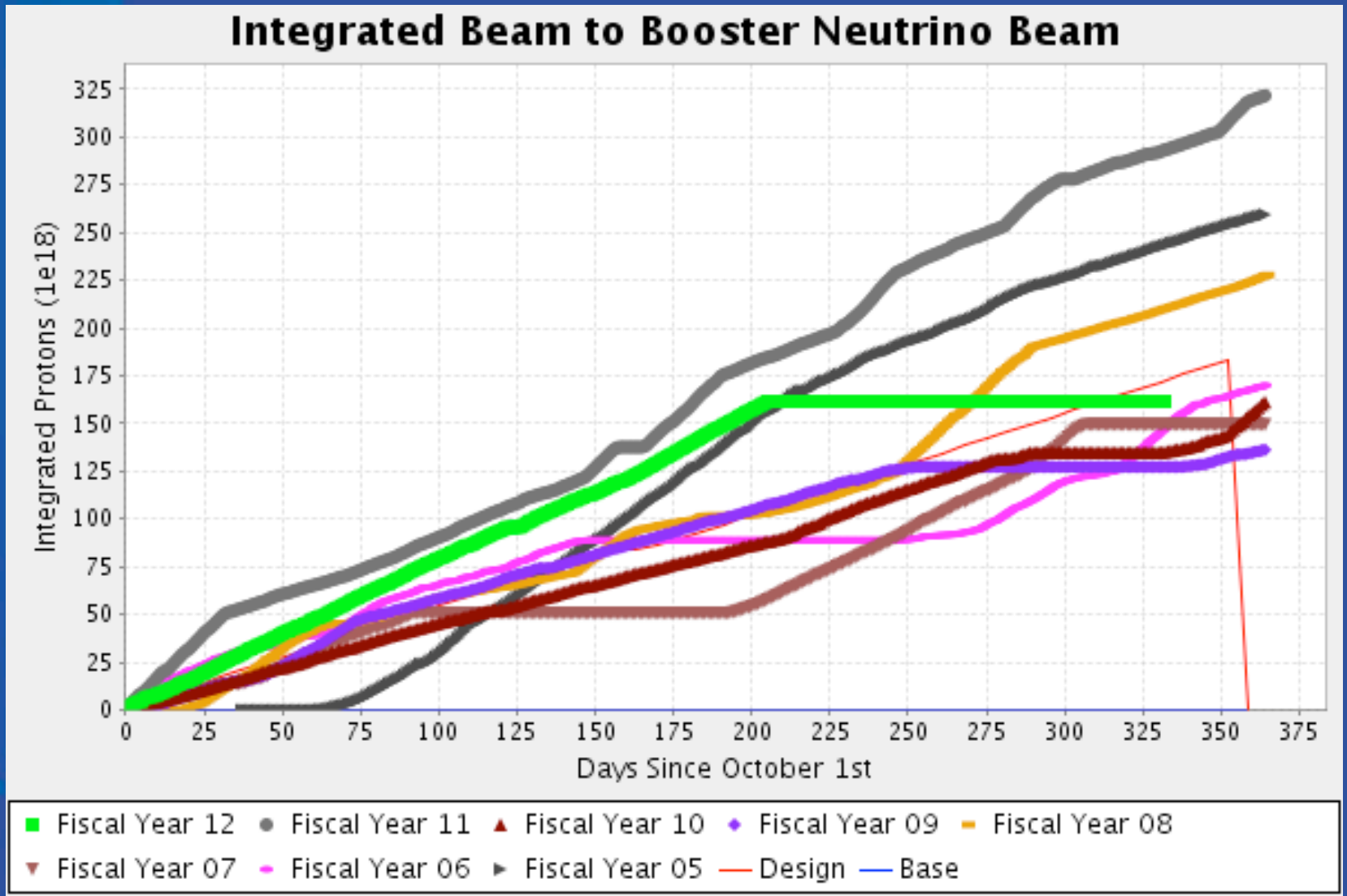
Total Booster Beam



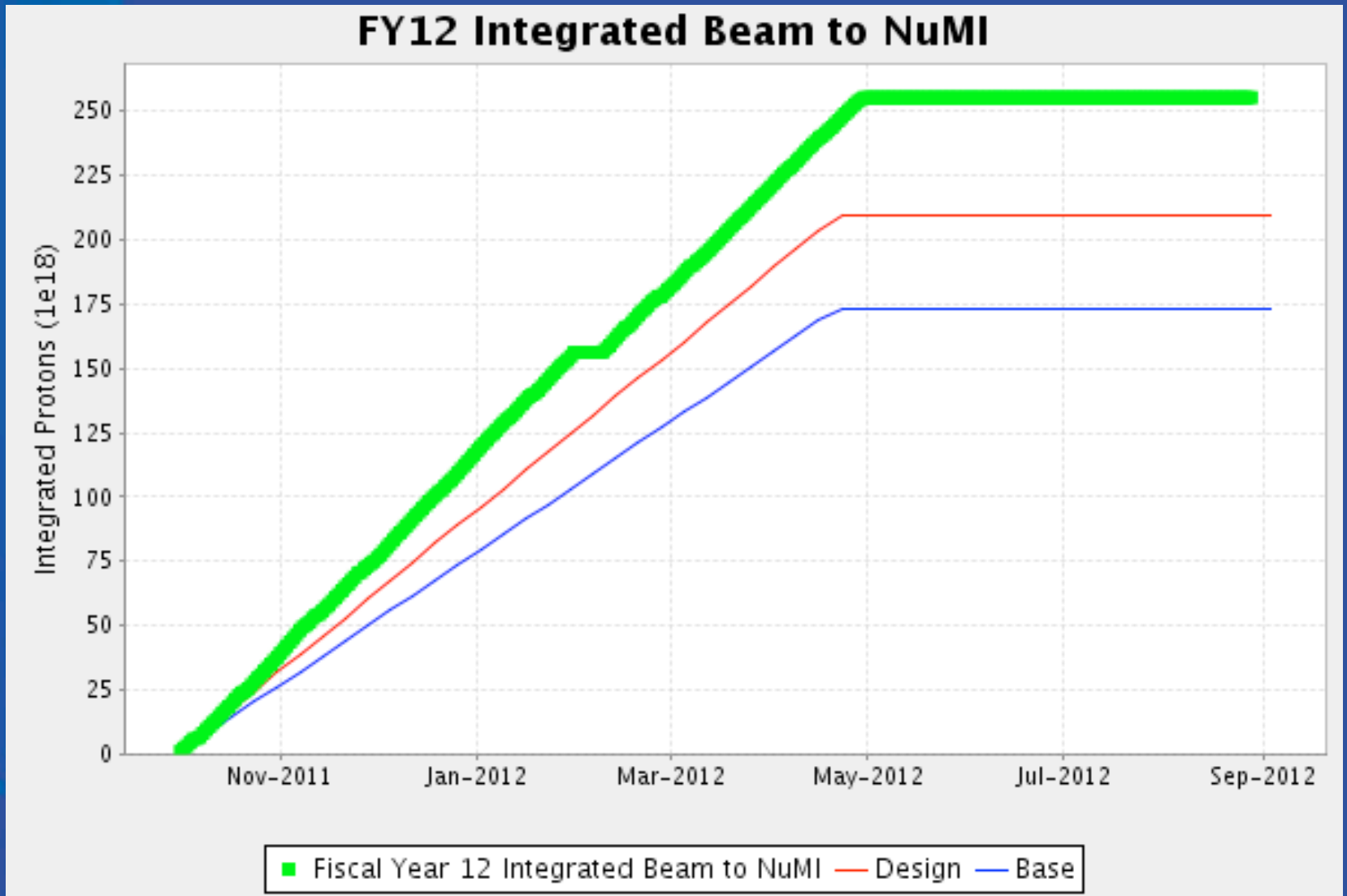
FY12 Integrated Booster Neutrino Beam



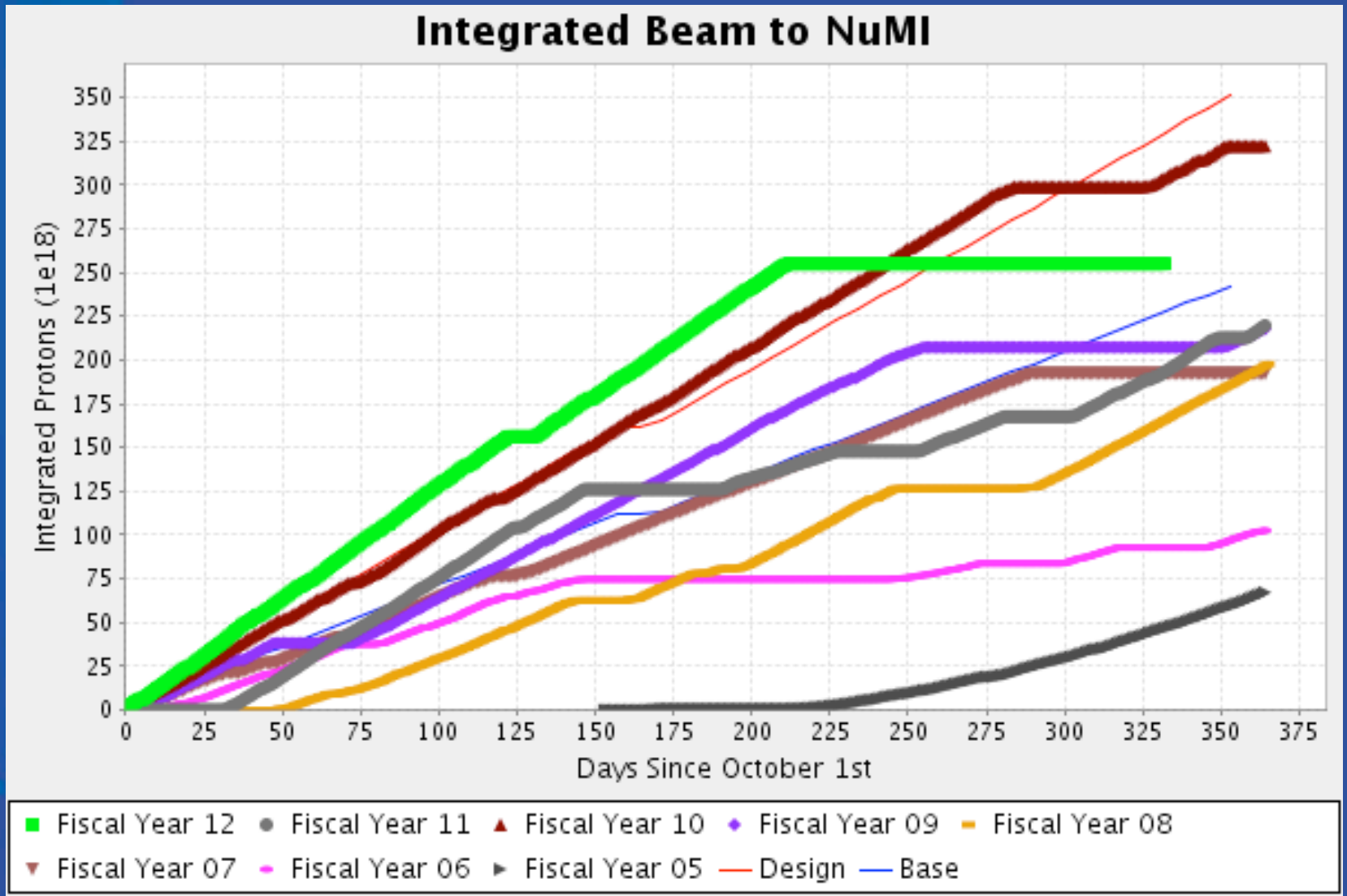
Booster Neutrino Beam History



FY12 Integrated NuMI Beam



NuMI Beam History

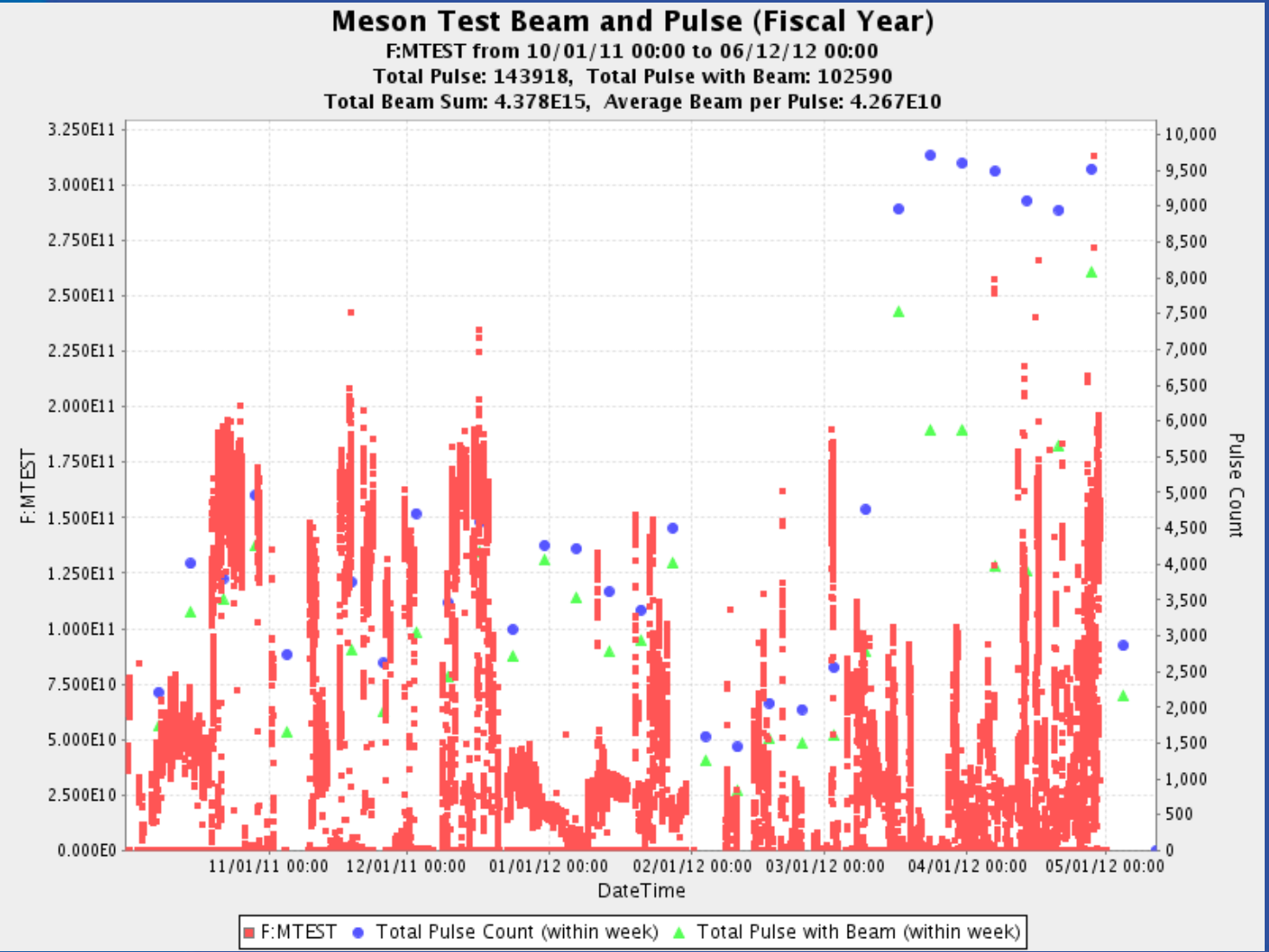


Other Fixed Target Operations

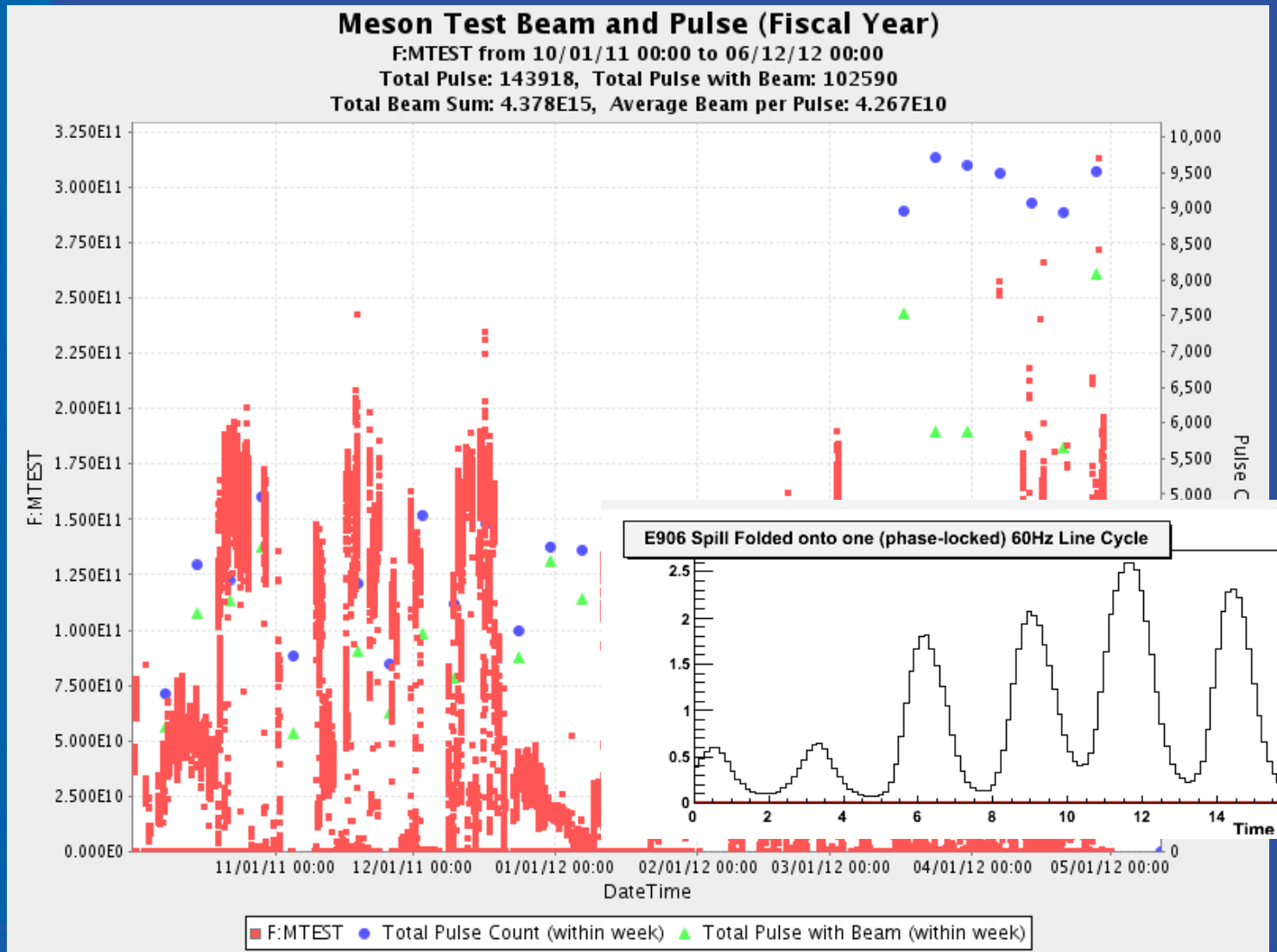
- Booster Neutrino
  - Beam
    - Tyically runs at ~ 2 Hz at 4.5 X 10^{12} Per spill
- Test Beam typically run 10^{11} protons per spill

- SeaQuest began running in March
  - Fixing buried beam pipe
    - Pipe is clear
      - Do we need to install a liner?
  - Wants 2 orders of magnitude more beam
  - Spill problems

2012 Test Beam Running



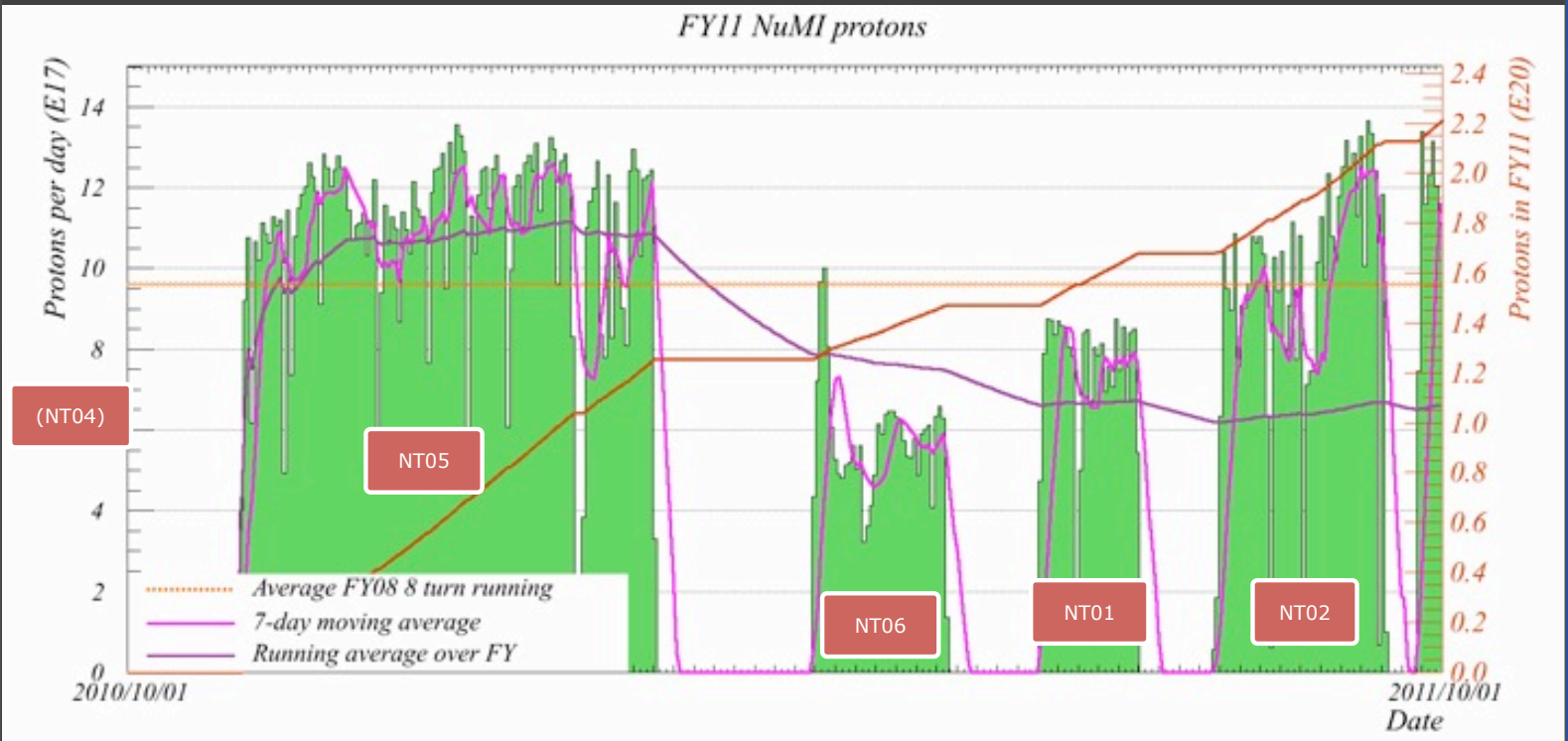
2012 Test Beam Running



Target and Horn Issues for Neutrino Beams

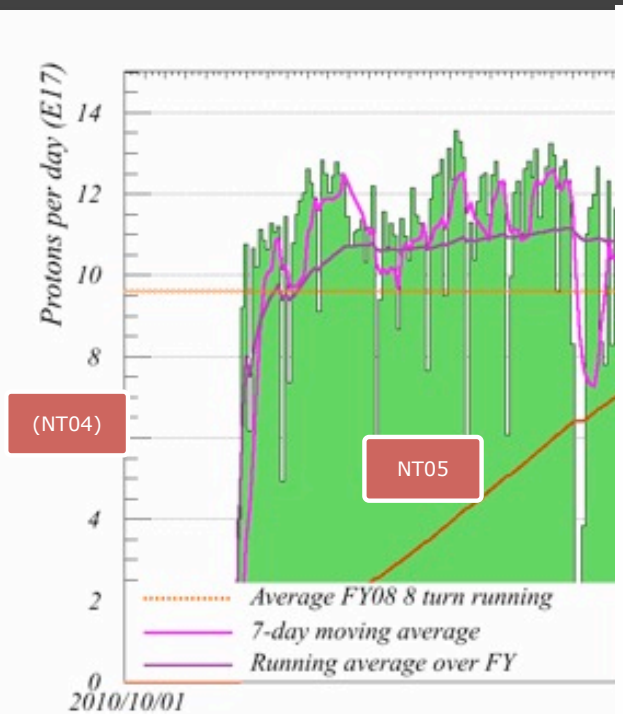
- Seven different targets were used since 2005
  - One lasted less than a month
  - One lasted for more than 2 years
  - NT01 and NT02 were repaired and used twice
- Modifications were made to the design and we believe we know how to make good targets
  - NT07 operated reliably from October, 2011 until the end of the run on until the end of the run on April 30, 2012
  - NOvA target is a completely different design

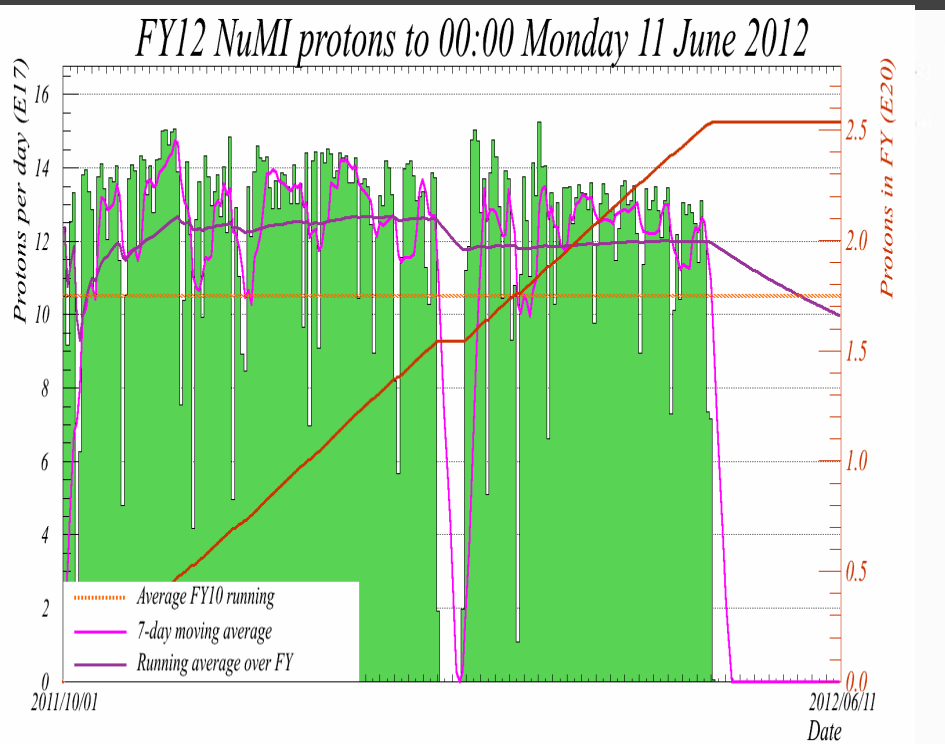
FY11: Target Problems



- Got 2.2E20 in FY11, thanks to heroic efforts from target folks (and delay to future projects)
- New target NT07 installed at end of FY11

FY11: Target Problems





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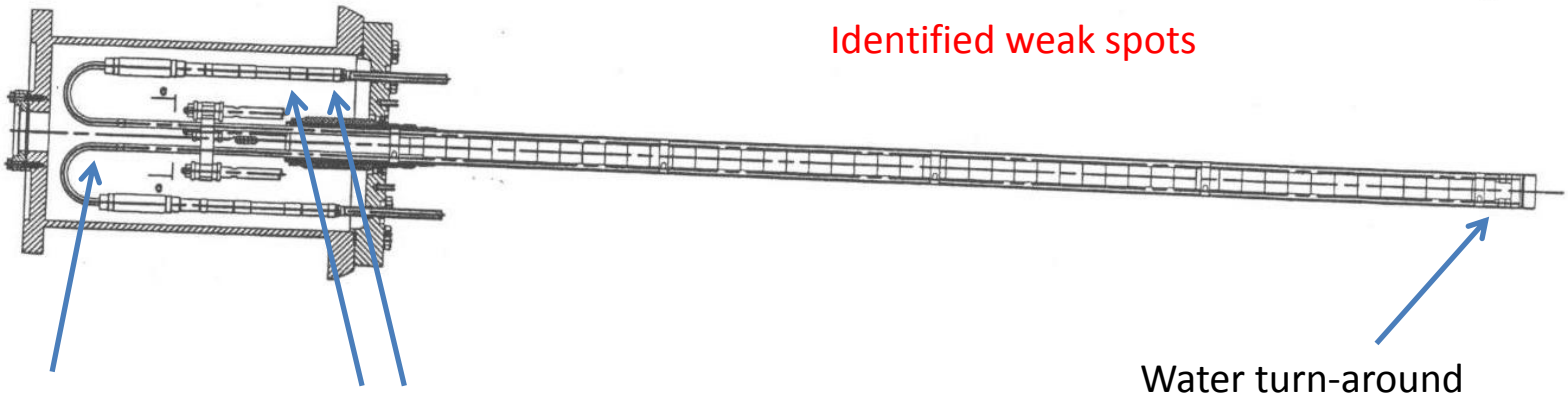
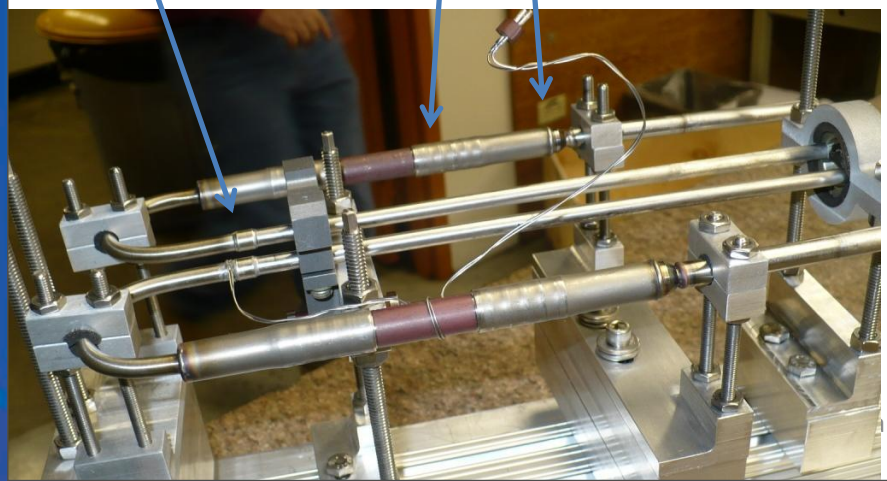
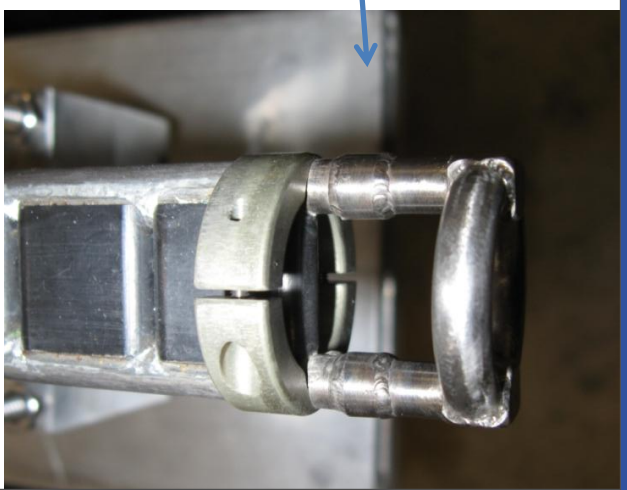
Goal of design modifications
- reduce risk of water leaks inside helium volume





- Jim Hylen



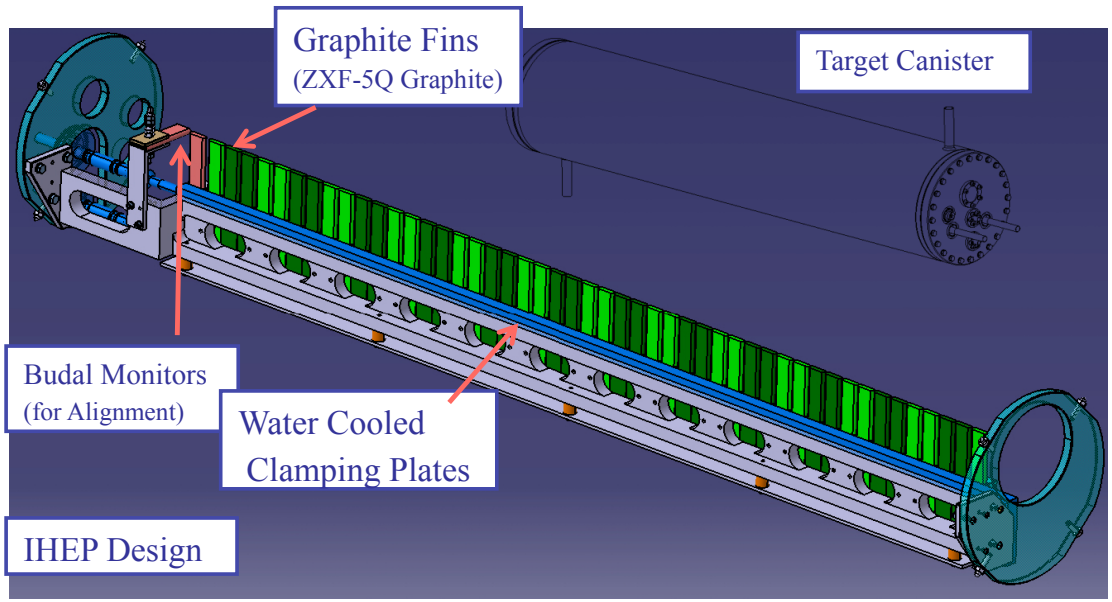
Saturday, June 16, 12

NOvA Target

- Does not have to fit inside the Horn
  - Simpler design
  - Water lines are father from the graphite
- We have one target now and will have a spare before the run begins.

Target

- Target fabrication in collaboration with RAL

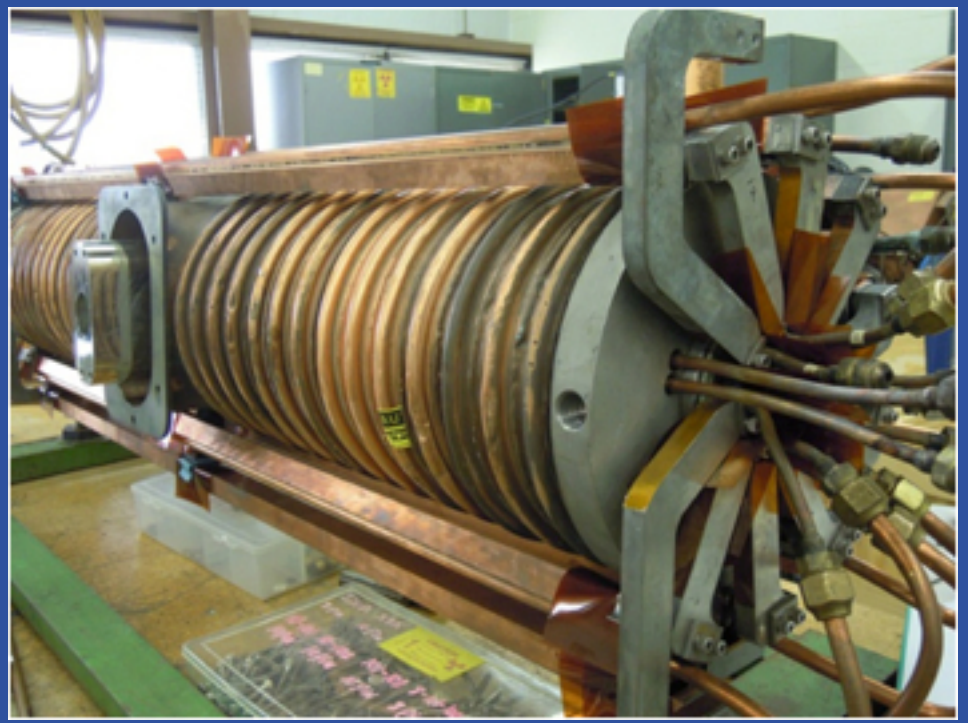


Installation Shutdown

- 12 months to change over to new mode of operations
  - Removing all pbar hardware
    - About 100 magnets, 8 cooling tanks, 2 beamlines, diagnostics for storage rings
  - Installing more than 150 magnets (dipoles, quads, trims, kickers, lambertsons)
  - Pulling nearly 400,000 feet of cable (including 300,000 ft of 3/8” heliax)
    - 2 cables to every BPM in the Recycler
  - 5 RF cavities (2 to MI, 3 to RR)
  - Opening 11 RR vacuum sectors – all of which require baking to recover 10^{-10} vacuum level
  - Alignment of new components and areas where components are removed
  - 1 target carrier, 1 new horn
  - Moving Horn 2 and rearranging the shielding
  - Maintenance and upgrades for other programs extend the length from 10 months to 12 months
- Lots of people and equipment traffic!
  - 40+ technicians and engineering staff (Accelerator Division, Technical Division, and Particle Physics Division)
  - 40+ trades (pipefitters, riggers, electricians)
  - 1 equipment access point

Proton Improvement Plan

- Linac
  - Linac Dump Repair
  - Vacuum Upgrades
  - BPM Upgrade
  - Klystron Maintenance
  - Low Energy Maintenance
- Booster
  - Solid State Upgrade
  - Booster Cavity Refurb.
  - Gradient Magnet Moves
  - Beam Absorber Install
  - LCW Upgrade
  - Possible Shielding Changes



2013 Neutrino Goals

- FY2013
  - 26 weeks scheduled commissioning plus operation
    - 6 months shutdown (Oct 1, 2012 – March 31, 2013)
    - 3 months commissioning (April 1, 2013 – June 30, 2013)
    - 3 months operation at or above pre-shutdown beam power (July 1, 2013 – September 30, 2013)
  - Assumptions for ramp-up following major shutdown
    - Assume 3 months commissioning of newly configured accelerator complex (doesn't contribute to POT)linear ramp over 3 months from previous power levels to full power (350 kW to 700 kW)
  - NOvA Design curve = 1.4E20 POT
  - Take 2B+D weighted average to get 90% confidence
  - Performance Metric: 1.1E20 POT

2014 Goals

FY2014

- 44 weeks scheduled
- Operate at nominal NOvA parameters (700 kW)
- Design curve = 6.5E20 POT
- Base curve = 4.6E20 POT
- Take 2B+D weighted average to get 90% confidence
- Performance Metric: 5.2E20 POT

Other Fixed Target Goals

- Establish “high intensity” beam to SeaQuest
- Continue Operation of the Test Beam Area with an additional test beam in MCENT

Summary

- NOvA Operations during 2012 Successful
  - Neutrino goals seem possible
- Other Fixed Target Goals are somewhat difficult
  - Booster Neutrino Beam
  - SeaQuest
    - Beam Intensity
    - Beam Quality
  - M6 Test Beam and MCENT test beam should be able to run in the background

Backup Slide

NuMI Target History

target	1st POT	last POT	weeks operation	Integrated POT	max beam power	max POT/spill	reason taken out of service
NT01	5/1/05	8/13/06	67	1.60E+20	270 kw	3.00E+13	drive stuck in high energy position
NT02	9/11/06	6/12/09	144	6.10E+20	340 kw	4.00E+13	graphite deteriorating, 10%-15% fewer nu/POT at peak
NT03	9/11/09	7/12/10	44	3.10E+20	375 kw	4.40E+13	break at ceramic tube-holder (probably water leak -> explosion)
NT04	8/22/10	9/17/10	4	2.00E+19	375 kw	4.30E+13	water leak -> explosion (blew off beryllium window)
NT05	10/29/10	2/24/11	17	1.30E+20	337 kw	4.00E+13	water leak -> eventual external water leak (water turnaround fell off)
NT06	4/7/11	5/16/11	6	2.00E+19	305 kw	3.50E+13	water leak -> eventual external water leak