

# FY14/15 POT Expectations

Jan 22, 2014

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U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Proton Delivery Metrics

- Define metrics with OHEP for laboratory goals
- Presented at the annual S&T Review, Nov 2013
- Two curves: Design & Base
  - Design is if all goes well, including planned improvements
  - Base is what we are confident we can deliver
  - Metric defined as:  $(D+2B)/3$

# Inputs into the calculations

- Booster operates at peak pulse rate of 7.5 Hz, intensity of  $4.3e12$  ppp
- Accelerator uptime: 80%
- NuMI Target uptime: 80%
- SY120 uptime: 90%
- SY120 fraction of cycle time: 5%
- Ramp through FY14
  - to the use of Recycler in the NuMI program
  - to increase spill intensity
- MicroBoone commissioning begins in May at low repetition rate, 1 Hz August and beyond
- Booster will reach 15 Hz operation in FY15

# Using the Booster

- Booster is a resonant machine at 15 Hz
- RF is pulsed on cycles with beam, limits us to ~7.5 Hz
  - at higher frequencies the cavities spark
  - at higher frequencies the tuners overheat
  - Refurbishment plan as part of PIP
- There is an RF pre-pulse associated with beam cycles

# Let's look at the beam cycles

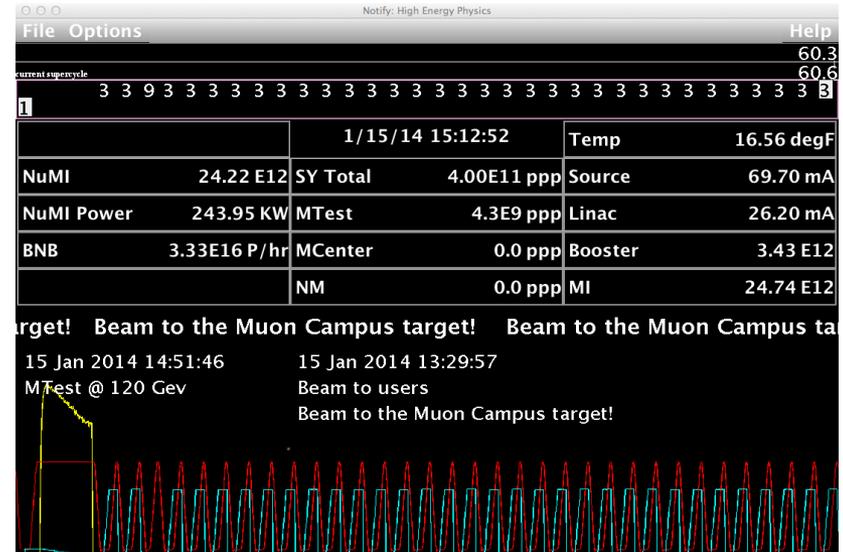
- Timeline on Ch 13: 1, 3, 9's TCLK events

- \$21: beam to SY
  - 5.867 second cycle
  - 4e11 last pulse

- \$23: beam to NuMI
  - 1.67 second cycle
  - 24.74e12 in MI
  - 243.95 kW last supercycle

- \$29: beam to Muon target (AP0 / pbar)
  - study cycle for Muon campus

- Booster Neutrino Beam: 3.33e16 P/hr





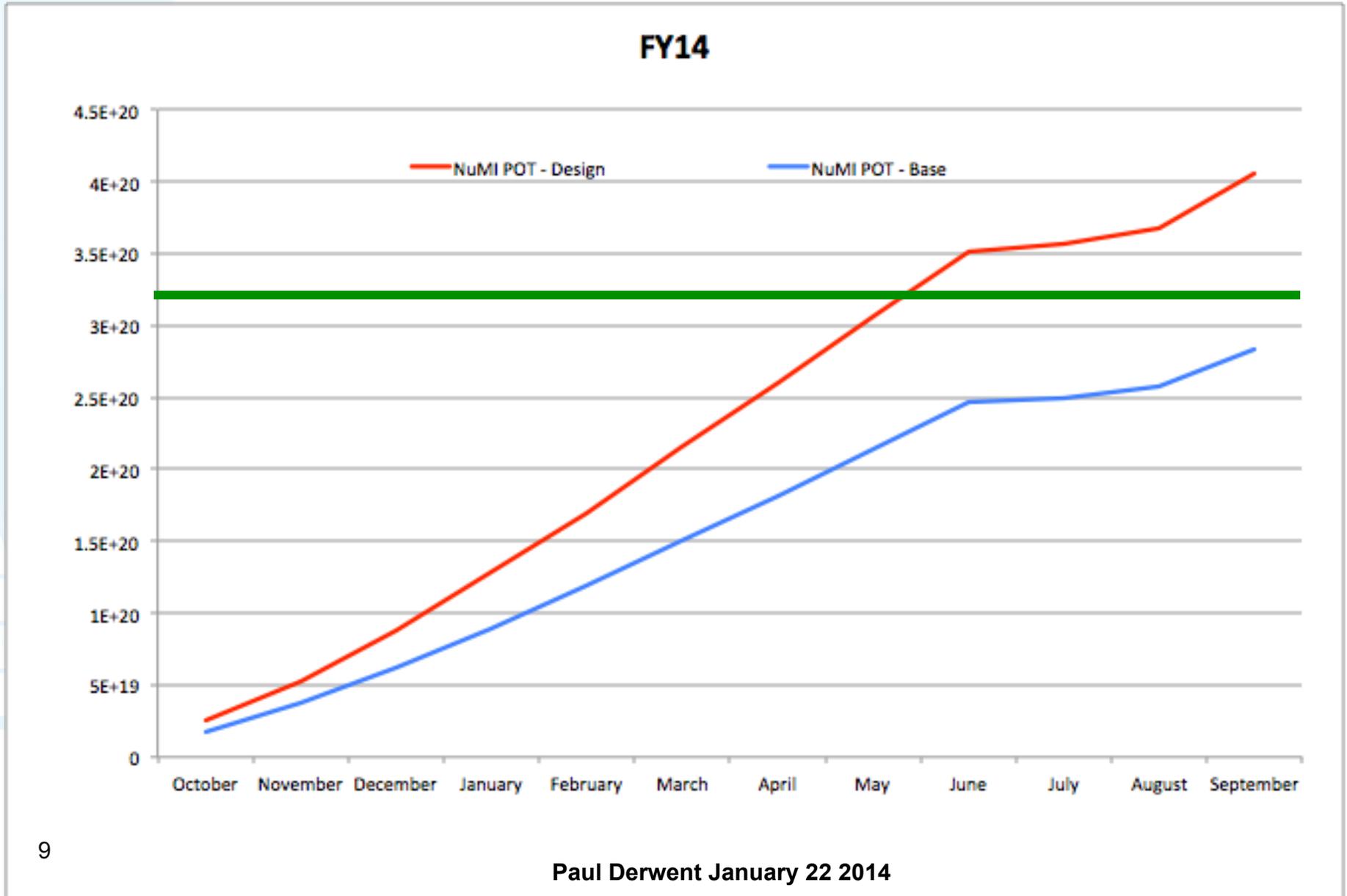
# Timeline

- \$21 cycle is 5.867 seconds
- \$23 cycle (now) is 1.667 seconds
  - 1.33 seconds for MI ramp
  - 0.33 seconds for 6 injections
  - When Recycler commissioned:
    - 1.33 seconds for MI ramp
    - 10 microseconds for injection
    - limited by 12 pulses at 7 Hz -> 1.73 second cycle
- running 1 \$21, 32-33 \$23, 0-4 \$2B, 0-1 \$29
  - approximately 1 minute in length
  - Jan 14: 1341 \$21 events -> 9.1% of timeline (1420 supercycles)
- \$21 at 5.687 seconds, can hide BNB events under the \$21 and not impact NuMI (at low frequency)

# Metrics: NuMI

FY2014	Total Design	Total Base	Total Metric
October	2.50E+19	1.75E+19	2.00E+19
November	5.31E+19	3.71E+19	4.24E+19
December	8.79E+19	6.15E+19	7.03E+19
January	1.29E+20	9.00E+19	1.03E+20
February	1.70E+20	1.19E+20	1.36E+20
March	2.16E+20	1.51E+20	1.73E+20
April	2.60E+20	1.82E+20	2.08E+20
May	3.06E+20	2.14E+20	2.45E+20
June	3.52E+20	2.46E+20	2.81E+20
July	3.56E+20	2.49E+20	2.85E+20
August	3.67E+20	2.57E+20	2.94E+20
September	4.05E+20	2.83E+20	3.24E+20
FY2015			
October	4.25E+19	2.97E+19	3.40E+19
November	8.36E+19	5.85E+19	6.69E+19
December	1.26E+20	8.82E+19	1.01E+20
January	1.69E+20	1.18E+20	1.35E+20
February	2.07E+20	1.45E+20	1.66E+20
March	2.49E+20	1.75E+20	1.99E+20
April	2.90E+20	2.03E+20	2.32E+20
May	3.33E+20	2.33E+20	2.66E+20
June	3.79E+20	2.65E+20	3.03E+20
July	3.84E+20	2.69E+20	3.08E+20
August	4.00E+20	2.80E+20	3.20E+20
September	4.52E+20	3.16E+20	3.62E+20

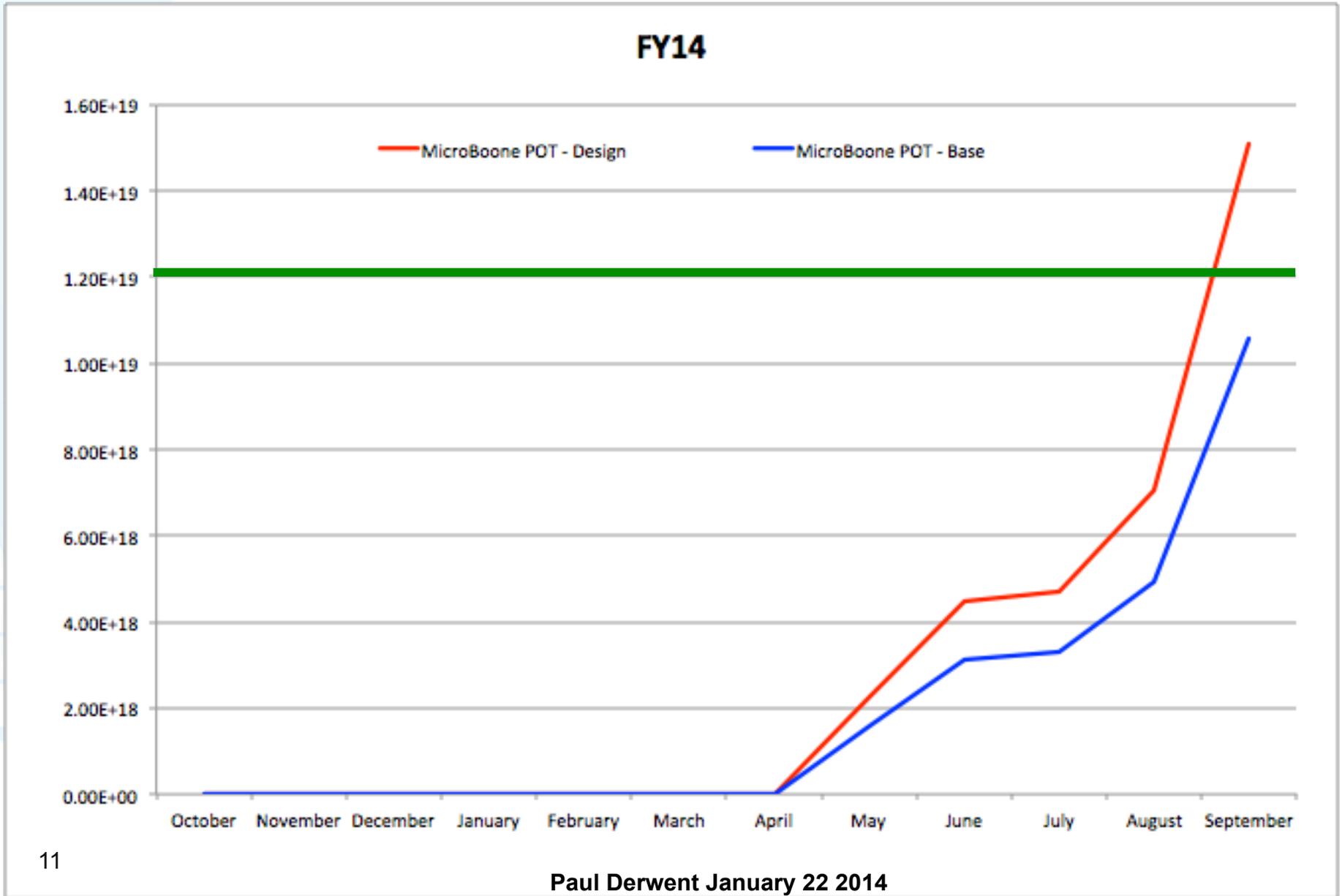
# NuMI delivery goal



# Metrics: BNB

FY2014	Total Design	Total Base	Total Metric
October	0.00E+00	0.00E+00	0
November	0.00E+00	0.00E+00	0
December	0.00E+00	0.00E+00	0
January	0.00E+00	0.00E+00	0
February	0.00E+00	0.00E+00	0
March	0.00E+00	0.00E+00	0
April	0.00E+00	0.00E+00	0
May	2.27E+18	1.59E+18	1.82E+18
June	4.47E+18	3.13E+18	3.57E+18
July	4.69E+18	3.28E+18	3.75E+18
August	7.07E+18	4.95E+18	5.65E+18
September	1.51E+19	1.06E+19	1.21E+19
FY2015			
October	9.08E+18	6.36E+18	7.27E+18
November	8.79E+18	6.15E+18	7.03E+18
December	1.79E+19	1.25E+19	1.43E+19
January	2.70E+19	1.89E+19	2.16E+19
February	3.52E+19	2.46E+19	2.81E+19
March	4.42E+19	3.10E+19	3.54E+19
April	5.30E+19	3.71E+19	4.24E+19
May	6.21E+19	4.35E+19	4.97E+19
June	7.09E+19	4.96E+19	5.67E+19
July	7.36E+19	5.15E+19	5.89E+19
August	8.07E+19	5.65E+19	6.46E+19
September	1.05E+20	7.33E+19	8.38E+19

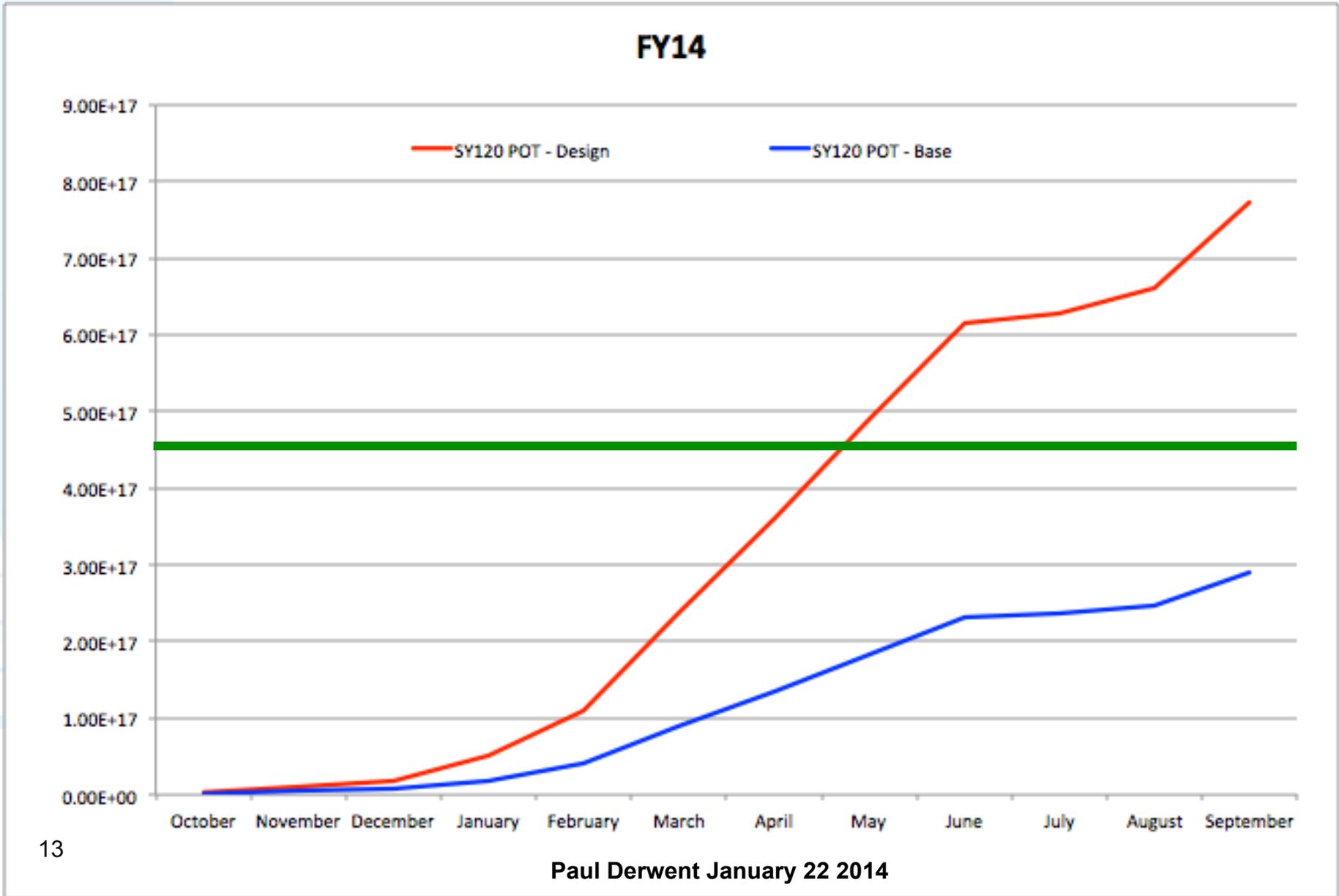
# BNB Delivery Goal



# Metrics: SY120

FY2014	Total Design	Total Base	Total Metric
October	3.21E+15	1.21E+15	1.87E+15
November	1.10E+16	4.12E+15	6.41E+15
December	1.90E+16	7.13E+15	1.11E+16
January	5.12E+16	1.92E+16	2.98E+16
February	1.09E+17	4.10E+16	6.37E+16
March	2.38E+17	8.92E+16	1.39E+17
April	3.62E+17	1.36E+17	2.11E+17
May	4.91E+17	1.84E+17	2.86E+17
June	6.15E+17	2.31E+17	3.59E+17
July	6.28E+17	2.35E+17	3.66E+17
August	6.61E+17	2.48E+17	3.85E+17
September	7.73E+17	2.90E+17	4.51E+17
FY2015			
October	1.29E+17	9.00E+16	1.03E+17
November	2.53E+17	1.77E+17	2.02E+17
December	3.82E+17	2.67E+17	3.05E+17
January	5.10E+17	3.57E+17	4.08E+17
February	6.26E+17	4.38E+17	5.01E+17
March	7.55E+17	5.28E+17	6.04E+17
April	8.79E+17	6.15E+17	7.03E+17
May	1.01E+18	7.05E+17	8.06E+17
June	1.13E+18	7.93E+17	9.06E+17
July	1.14E+18	8.01E+17	9.16E+17
August	1.18E+18	8.24E+17	9.42E+17
September	1.29E+18	9.03E+17	1.03E+18

# SY120 Delivery Goal

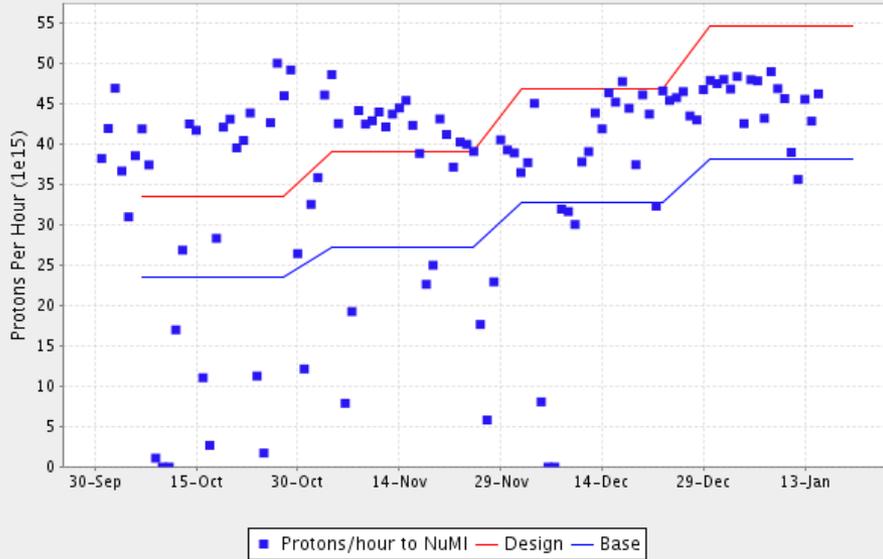


# Performance Plots

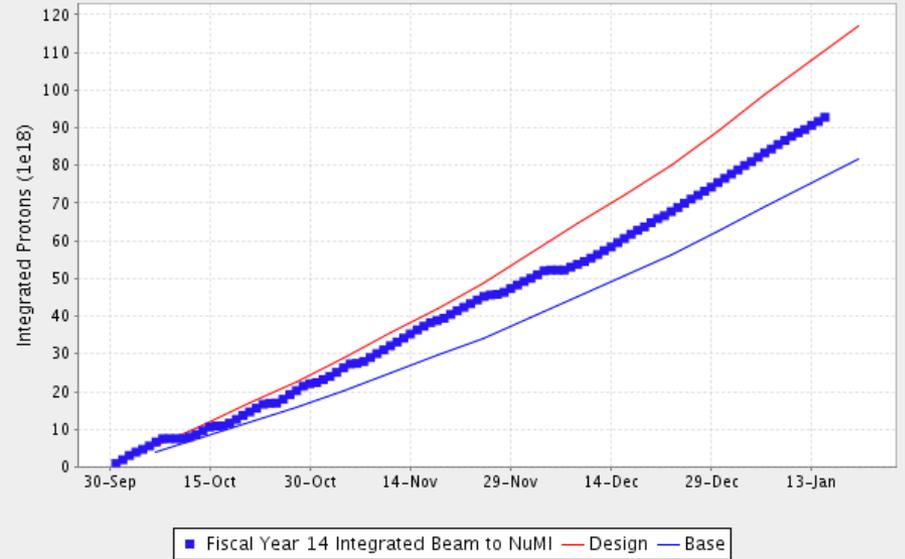
- available and updated everyday
  - <http://www-bd.fnal.gov/pplot/index.html>
  - variety of styles
    - daily, integral
    - FY14
    - all FY

# NuMI

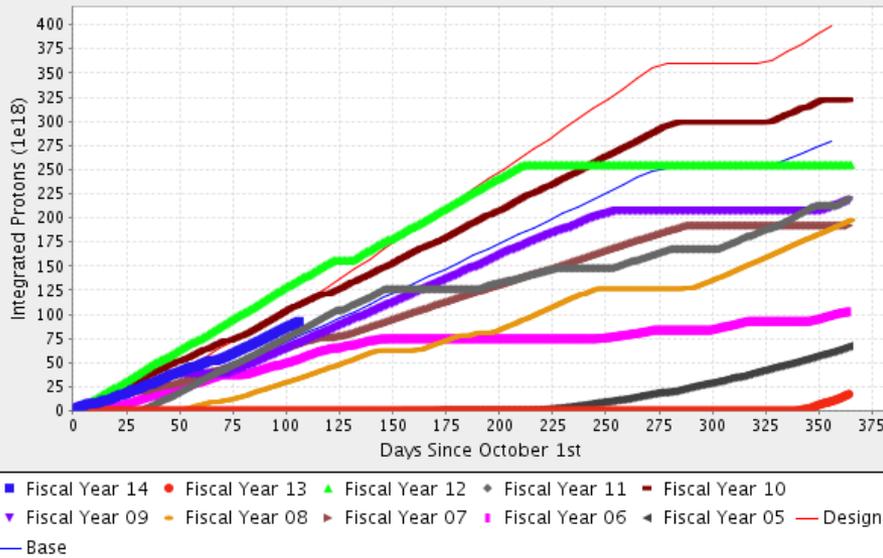
## Average Protons/Hour to NuMI



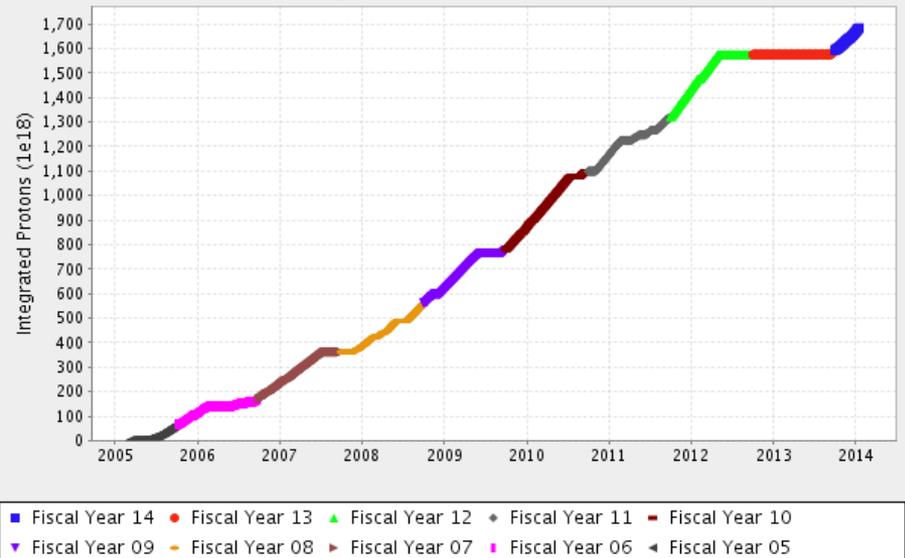
## FY14 Integrated Beam to NuMI



## Integrated Beam to NuMI

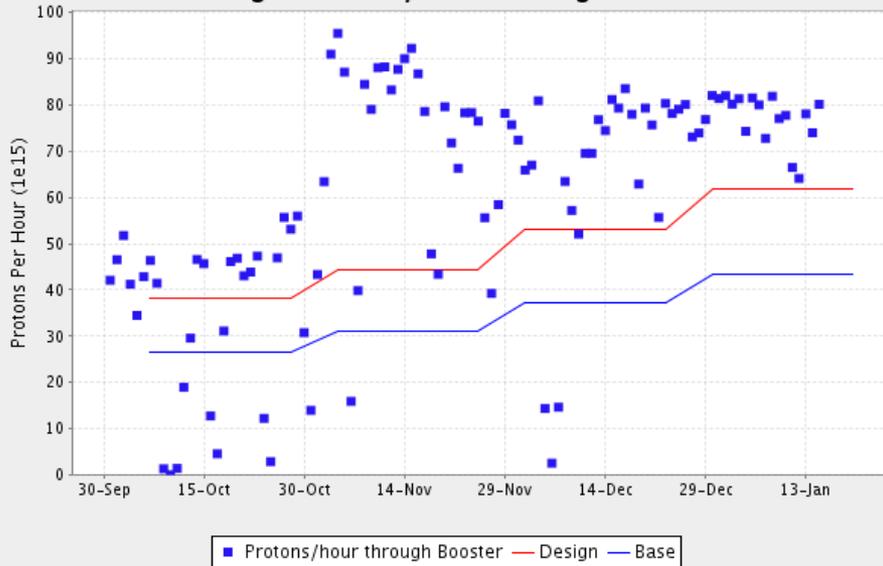


## Integrated Beam to NuMI

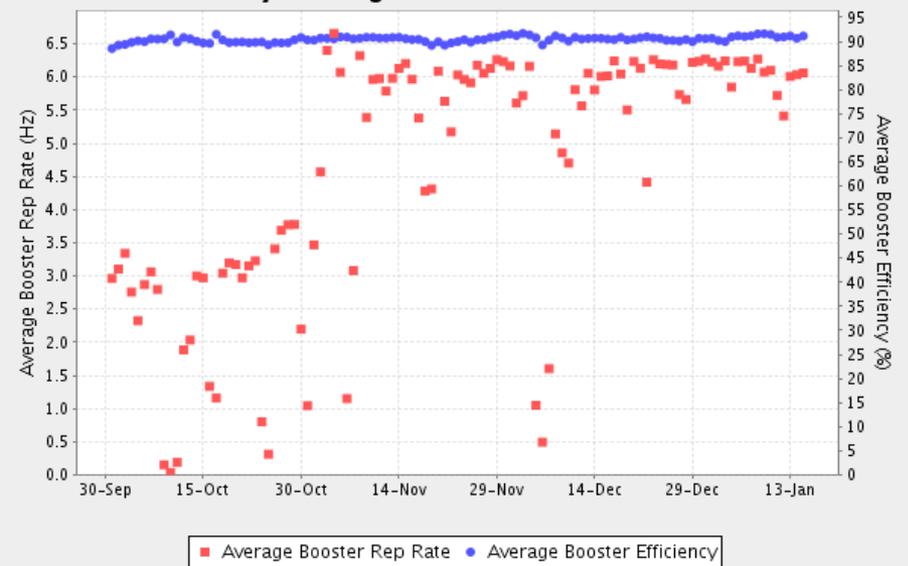


# Booster and BNB

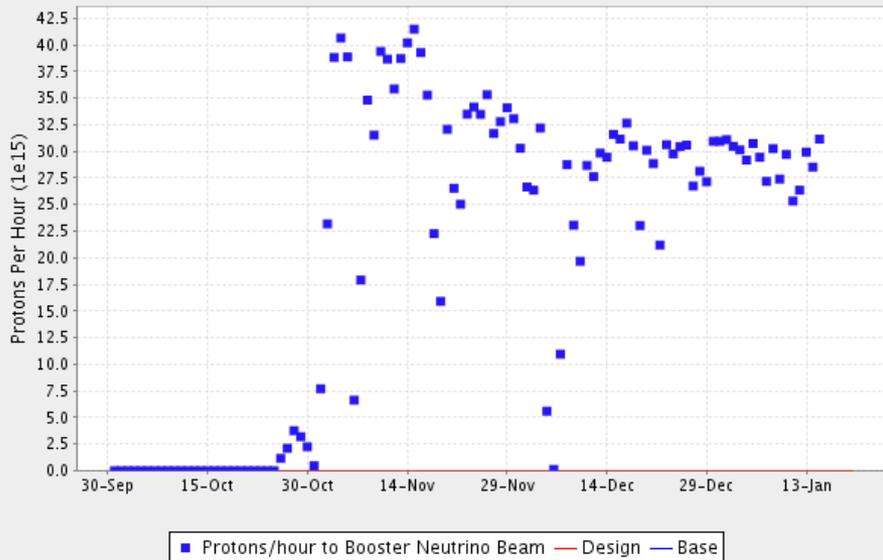
## Average Protons/Hour through Booster



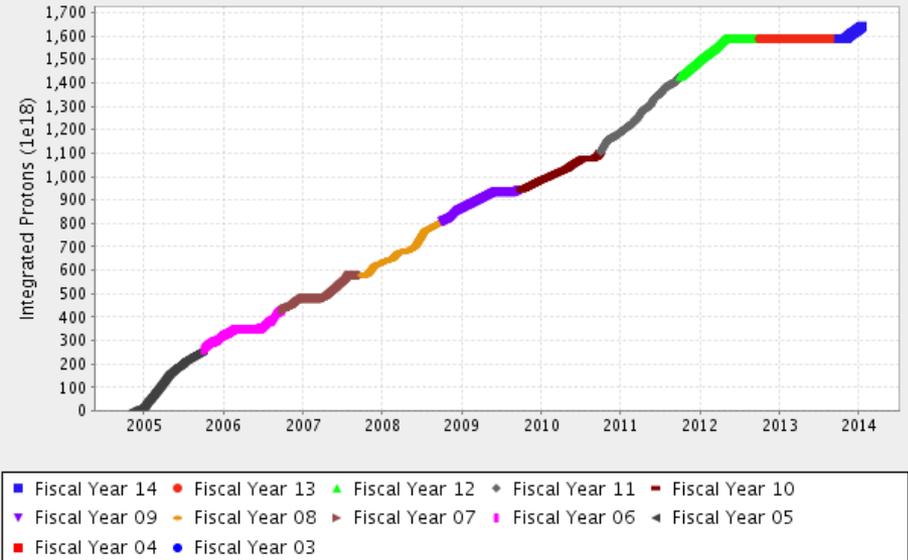
## Daily Average Booster Performance

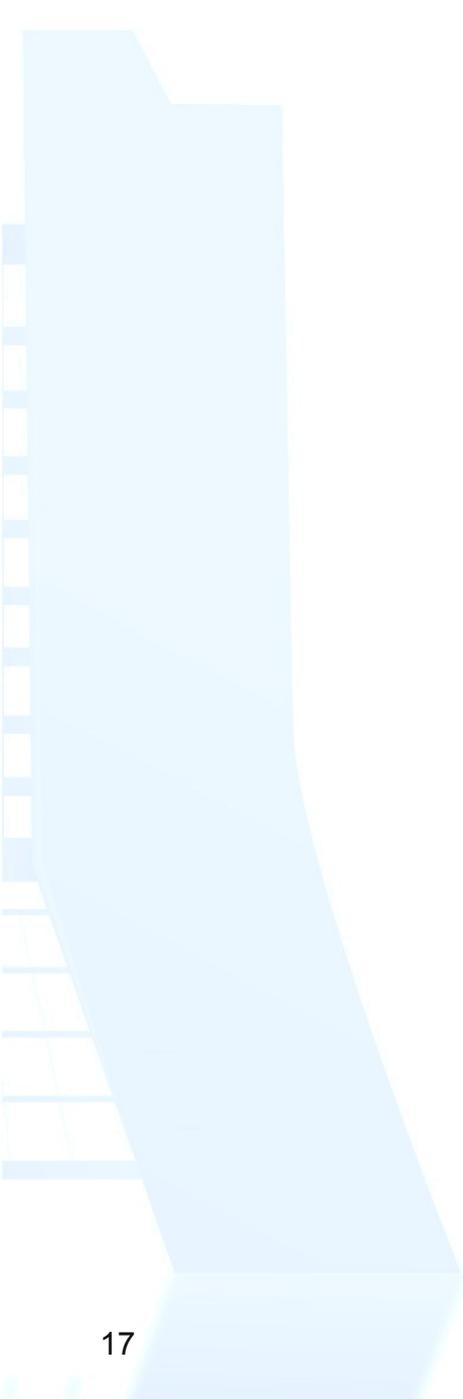


## Average Protons/Hour to Booster Neutrino Beam



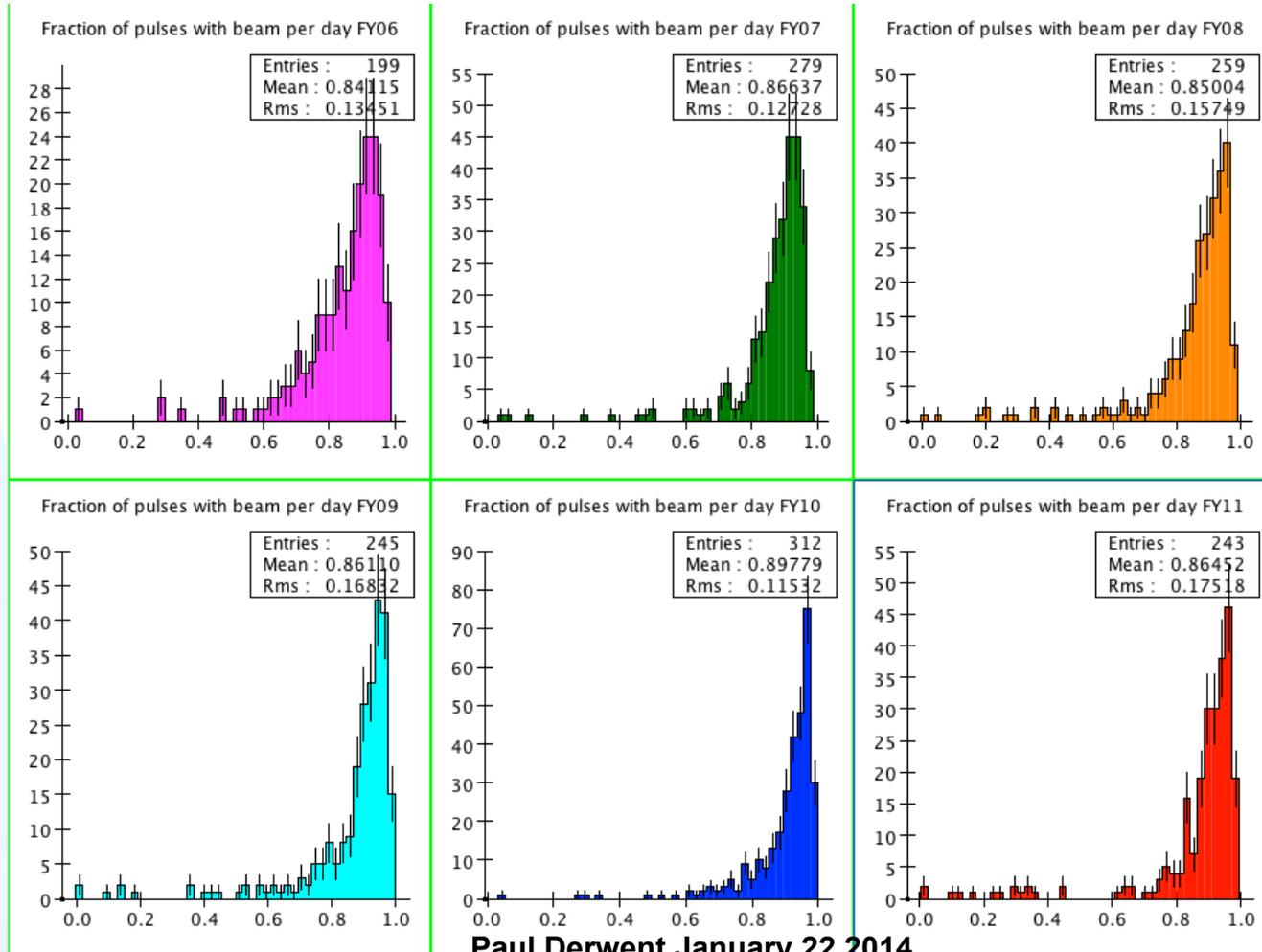
## Integrated Beam to Booster Neutrino Beam





# Uptime

- Daily basis: # Pulses with Beam (E:Tor101) / # Pulses (clock event)

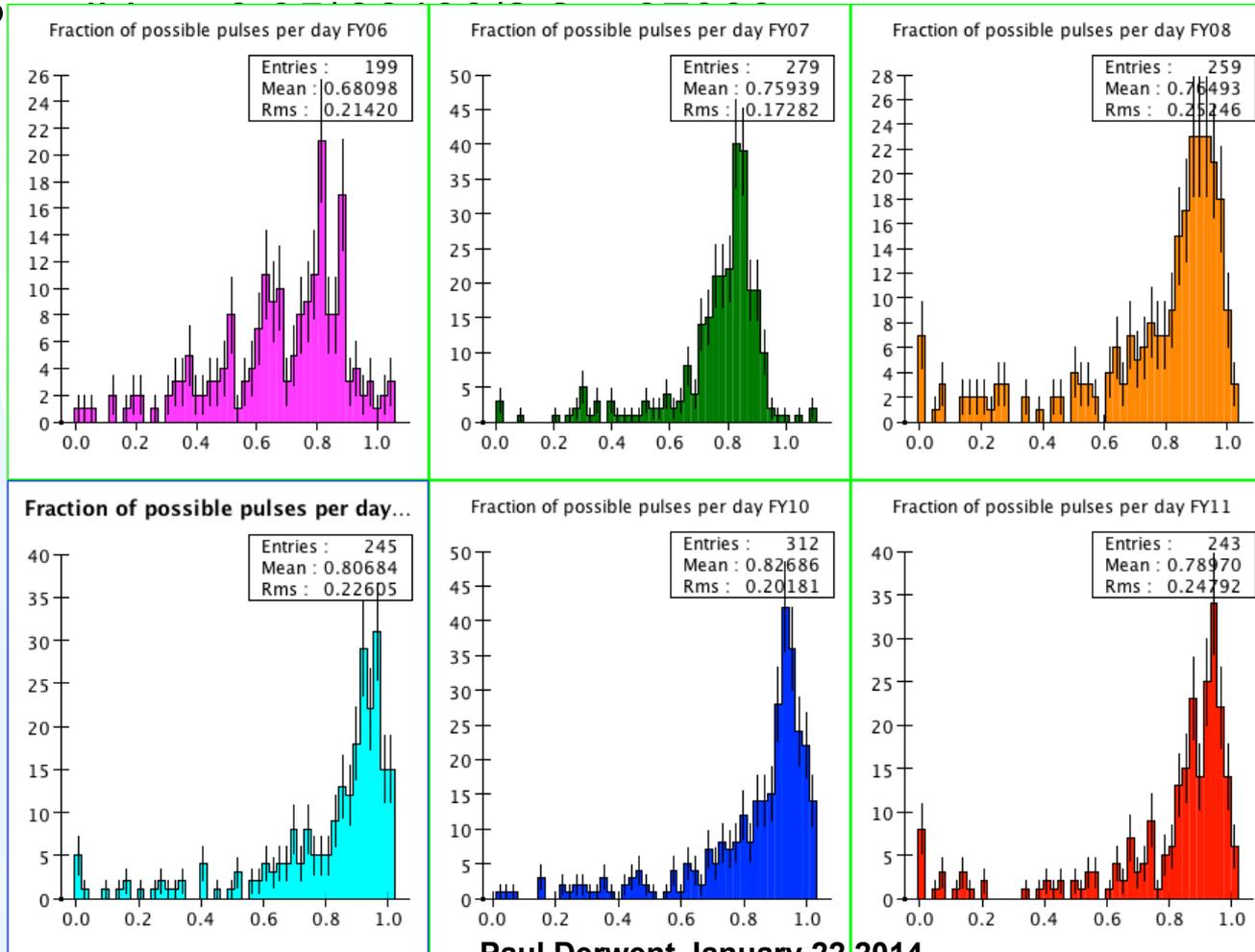


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# Uptime

- Daily Basis: # Pulses with Beam E:Tor101 / # Possible Pulses

- P



# Uptime

- Summary table for 6 years of NuMI operations

Fiscal Years	Days with >1 pulse with beam	Scheduled Days	Fraction of Scheduled days	Fraction of Possible Pulses with Beam	Fraction of Pulses with Beam	Total uptime
2006	199	267	74.5%	68.1%	84.1%	50.8%
2007	279	309	90.3%	75.9%	86.7%	68.6%
2008	259	309	83.8%	76.5%	85.0%	64.1%
2009	245	288	85.1%	80.7%	86.1%	68.6%
2010	312	323	96.6%	82.7%	89.8%	79.9%
2011	243	358	67.9%	79.0%	86.5%	53.6%
Average	256.2	309.0	83.0%	77.1%	86.4%	64.3%
RMS	38.0	31.0	10.4%	5.1%	1.9%	10.7%