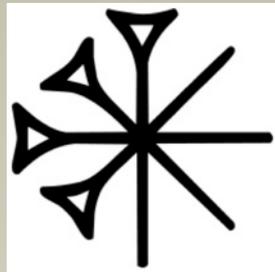


NOvA/ANU
Accelerator Sector Planning & Strategy

Paul Derwent
October 27&28, 2011



NOvA/ANU

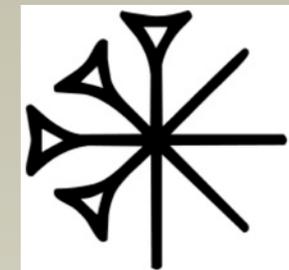
- 2nd generation neutrino mixing experiment
 - main goal is to see ν_e appearance in a ν_μ beam
- 14 kton active detector in Ash River MN
- 14 mrad off axis to get 'monoenergetic' ν_μ beam
- Critical Decision Schedule:

	Date	Review
CD-1	May 11 2007	Apr 4-6 2006
CD-2	Sep 15 2008	Oct 22-25 2007
CD-3a	Oct 24 2008	Oct 22-25 2007
CD-3b	Oct 29 2009	July 21-23 2009
CD-4	Nov 2014	

- Accelerator added to project in Dec 2006
- Project was shut down in FY2008 Omnibus bill (Dec 2007)
- Started again in Feb 2 2009, though informally in summer 2008



Goals



- Near Term: FY₁₂
 - Installation Shutdown
- Short Term: FY₁₅
 - CD-4: Nov 2014
 - Running successfully for NOvA
- Long Term: FY₂₀
 - NOvA has reached 36e20 POT

CD 4 Project Deliverable: Upgraded Fermilab Accelerator Complex and NUMI Beamline

Complete Description:

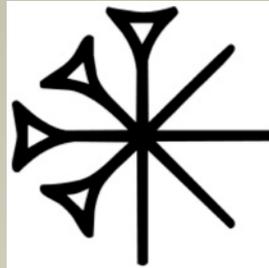
Capable of delivering a 700 kW proton beam to the NuMI target. The required capability is demonstrated when the installation and testing of the following devices is complete and all safety documentation that is required to begin beam operations is approved.

- 1 The Recycler Ring must be converted from an antiproton storage ring to a proton storage ring.
- 2 A new injection line and a new extraction line must be built using four new kicker systems.
- 3 Two new RF cavities must be added to the Main Injector.
- 4 A new target to handle the increased beam power must be designed, constructed and installed.
- 5 The second horn, including its associated power and services, must be moved downstream.

from the NOvA Project Execution Plan, Nova-docdb 130

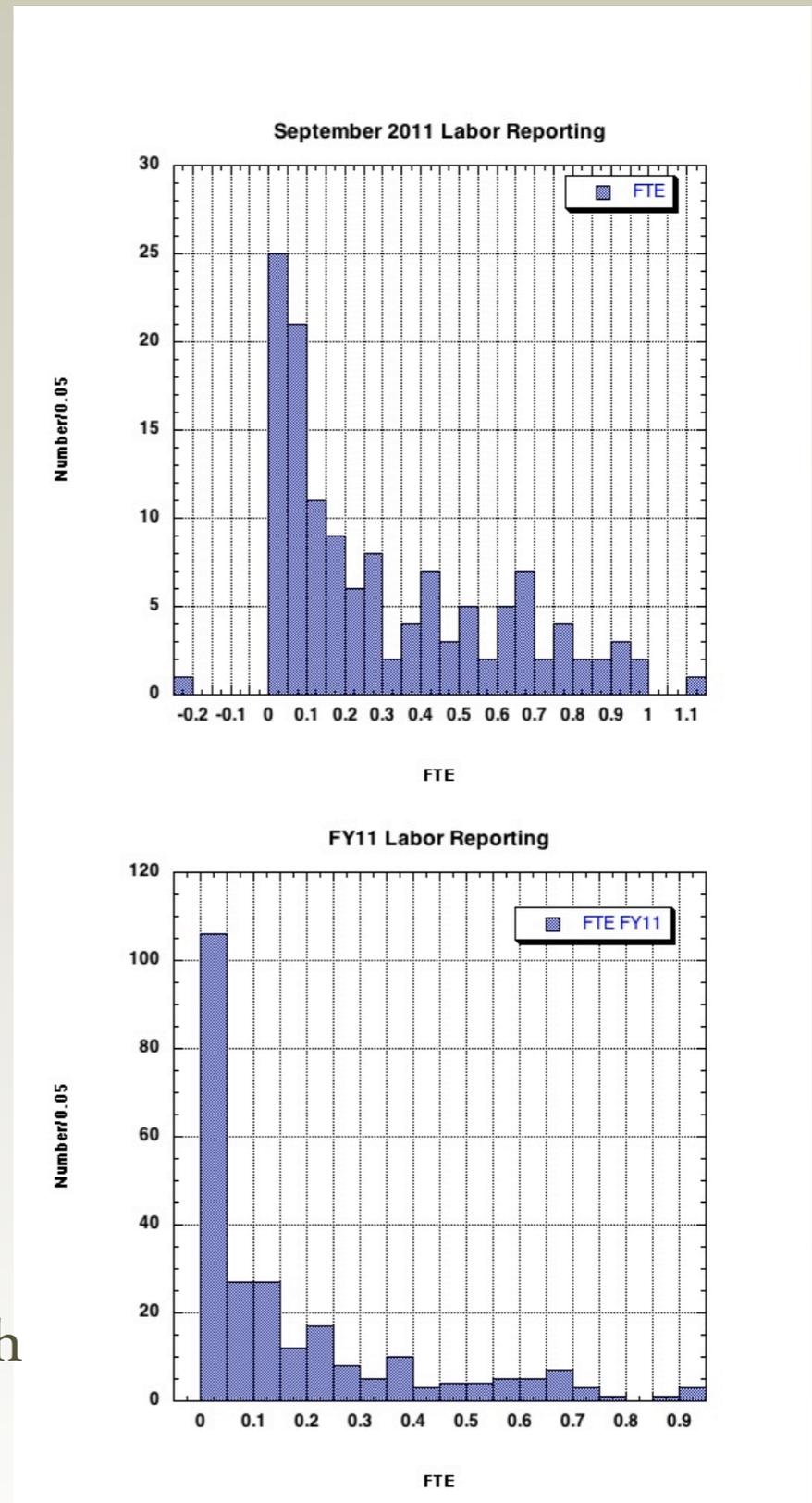


Barriers



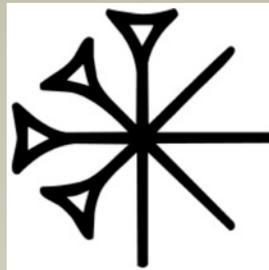
- Resource fragmentation
 - People are working on lots of things
 - September 2011: ANU
 - 40.2 FTE 132 people
 - Mean 0.3 RMS 0.3 Median 0.2
 - >0.2 in month: 35.4 FTE 65 people
 - <0.2 in month: 4.8 FTE 67 people
 - Similar distribution for 2011
- Impact on progress and efficiency

FTE = 147.3 hours/month
1768 hours/year





Barriers



- Conflicts in goals
 - Peak Performance: 700 kW on target, 80% uptime
 - Yearly Performance: 6e20 POT/year

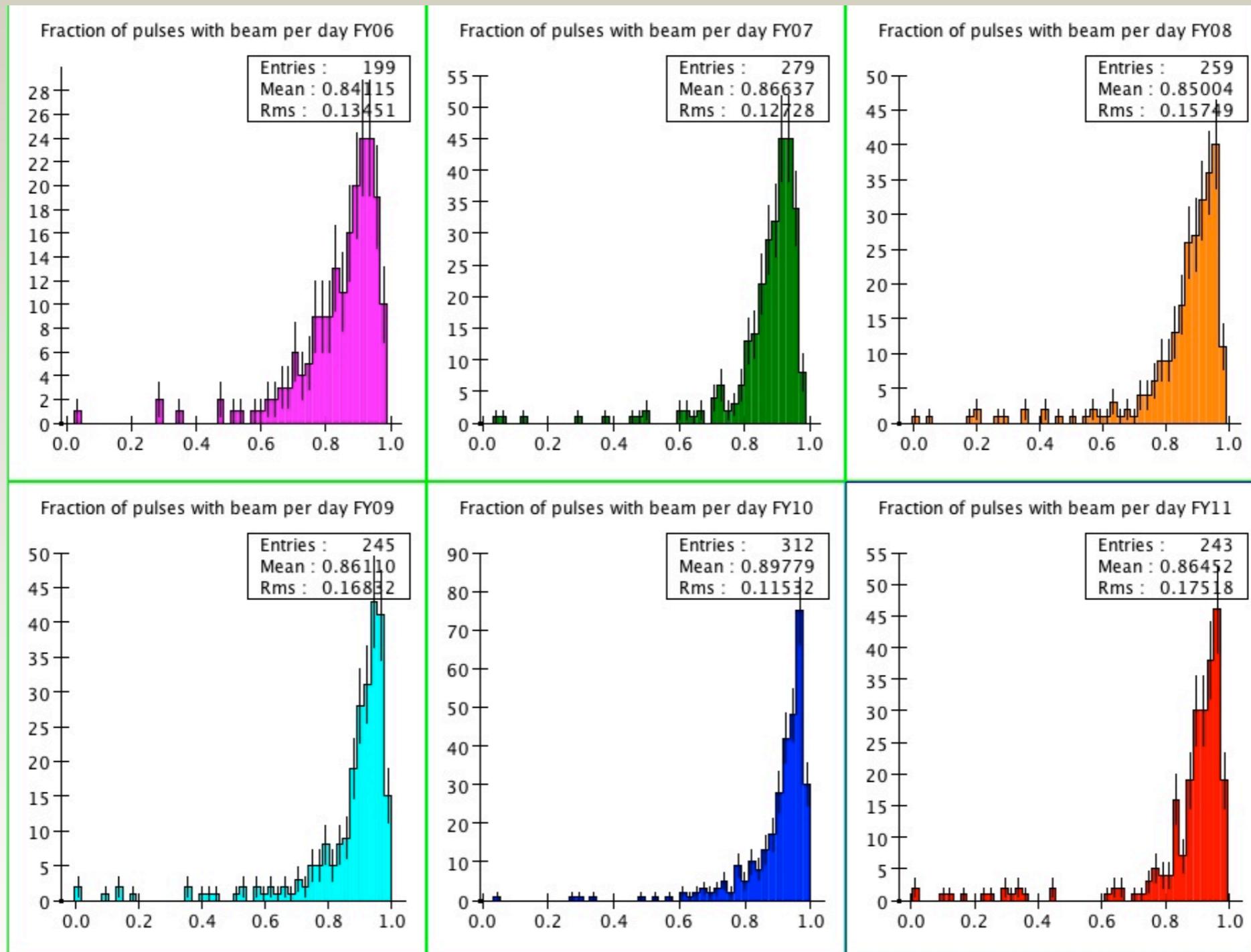
Parameter	Nominal	7.5 Hz limit	Lower Reliability 9 Hz (80%)		Using 6 year average uptime
Running Weeks/year	44	44	44		44
Average Uptime	0.8	0.8	0.64		0.642577505
MI Efficiency	0.95	0.95	0.95		0.95
MI Cycle length	1.33	1.60	1.33		1.33
Booster Batch Intensity	4.30E+12	4.30E+12	4.30E+12		4.30E+12
# Booster Batches	12	12	12		12
Seconds/day	86400	86400	86400		86400
Days/week	7	7	7		7
Protons/year	7.83E+20	6.52E+20	6.26E+20		6.29E+20
Fraction of Nominal	100%	83%	80%		80%
Fraction of NOvA Year (6e20)	130%	109%	104%		105%
Beam Power (kW)	706	588	706		706
Booster Flux (e17/hour)	1.39	1.16	1.39		1.39



Uptime

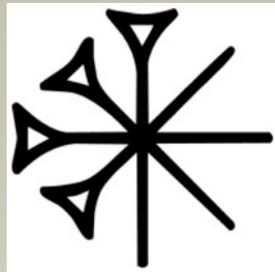


- Daily basis: $\# \text{ Pulses with Beam (E:TorIOI)} / \# \text{ Pulses (clock event)}$

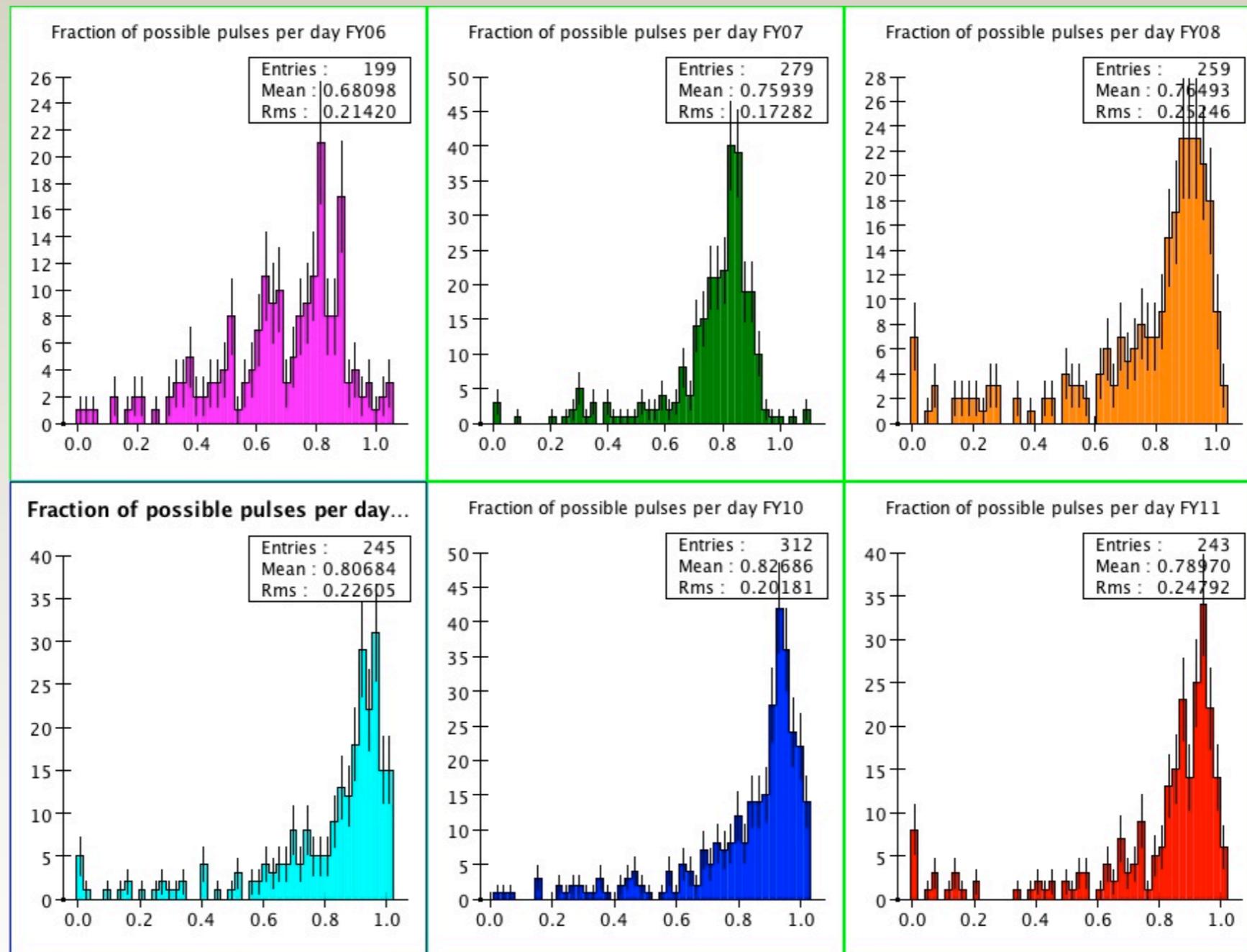




Uptime

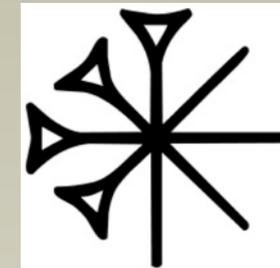


- Daily Basis: # Pulses with Beam E:Torio1 / # Possible Pulses
 - Possible = $0.95 * 86400 / 2.2 = 37309$





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%



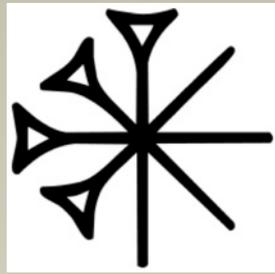
Near Term Plan



- FY₁₂: Preparation and Installation
 - Deliverables:
 - Ready for installation: hardware prepared
- FY₁₃: Installation and Documentation
 - Deliverables:
 - As built drawings for MI and RR
 - accelerator capable of delivering 700 kW on target
 - ANU subproject complete
- Note operational commissioning not included in project
 - 6 month linear ramp to 700 kW on target
- EVMS for metrics!



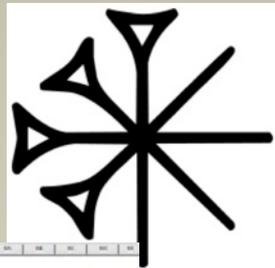
FY12: Installation Shutdown



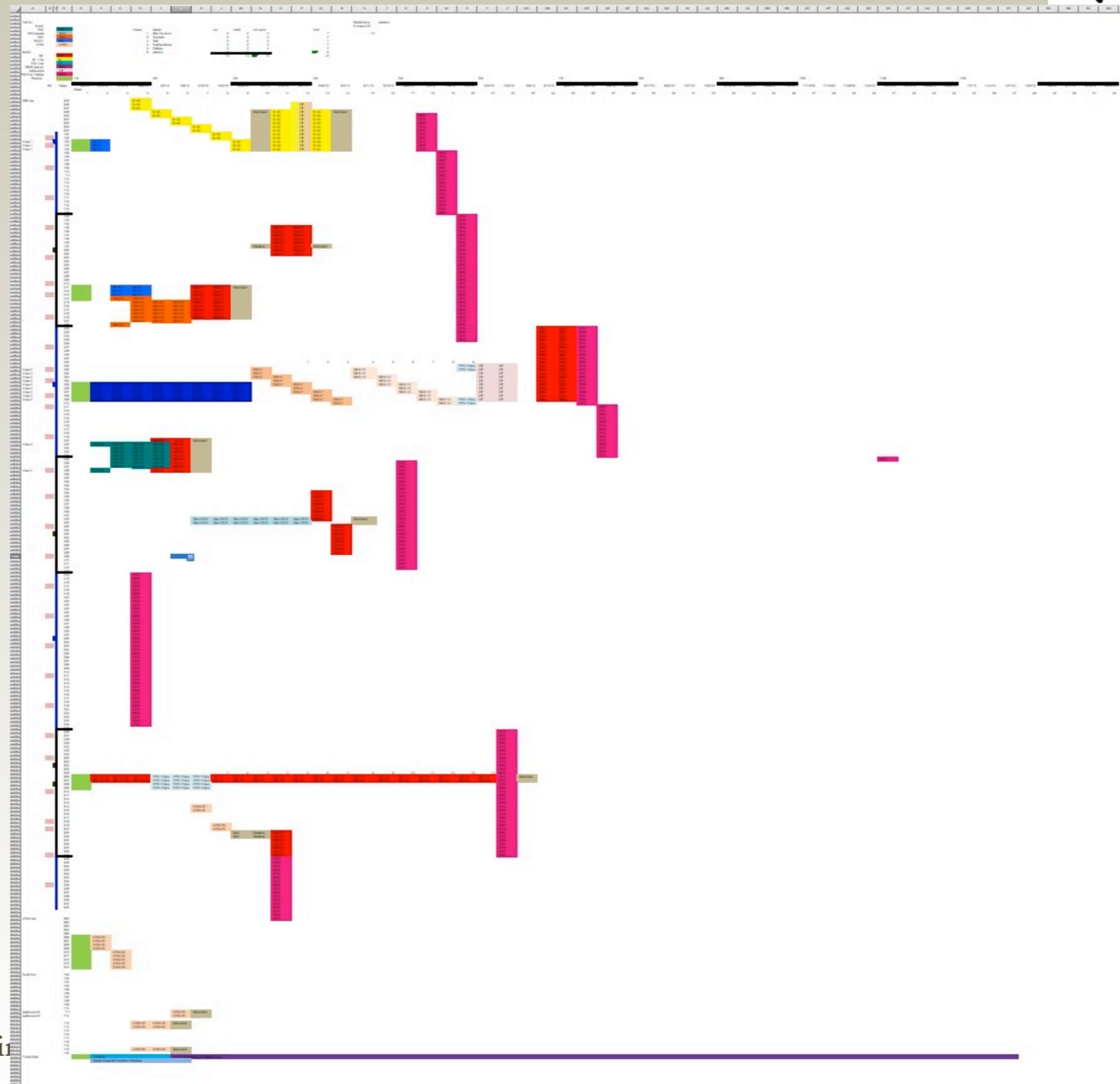
- 11 Month installation shutdown, 1 Mar 2012 - 1 Feb 2013
 - Fabrication of components: magnets, kickers, RF
 - Remove pbar devices:
 - stochastic and electron cooling
 - broad band barrier RF
 - injection and extraction lines
 - Install new transfer lines (from MI-8 to RR, RR to MI)
 - Install new RF (3 in RR, 2 in MI)
 - Install new Instrumentation (BPM cables and electronics)



Installation Shutdown

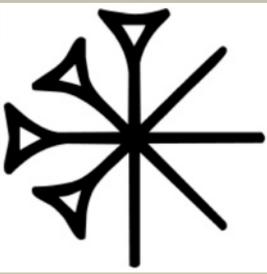


- x axis is time
- y axis is location
- color is job type
- 6 technician crews (plus welders/ pipefitters/ riggers/ electricians/ alignment)
- BPM cable pulls
- expanding to include non-NOvA jobs too





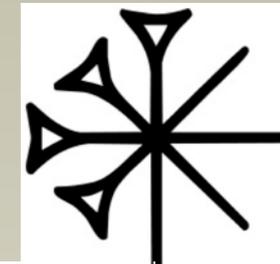
Resources



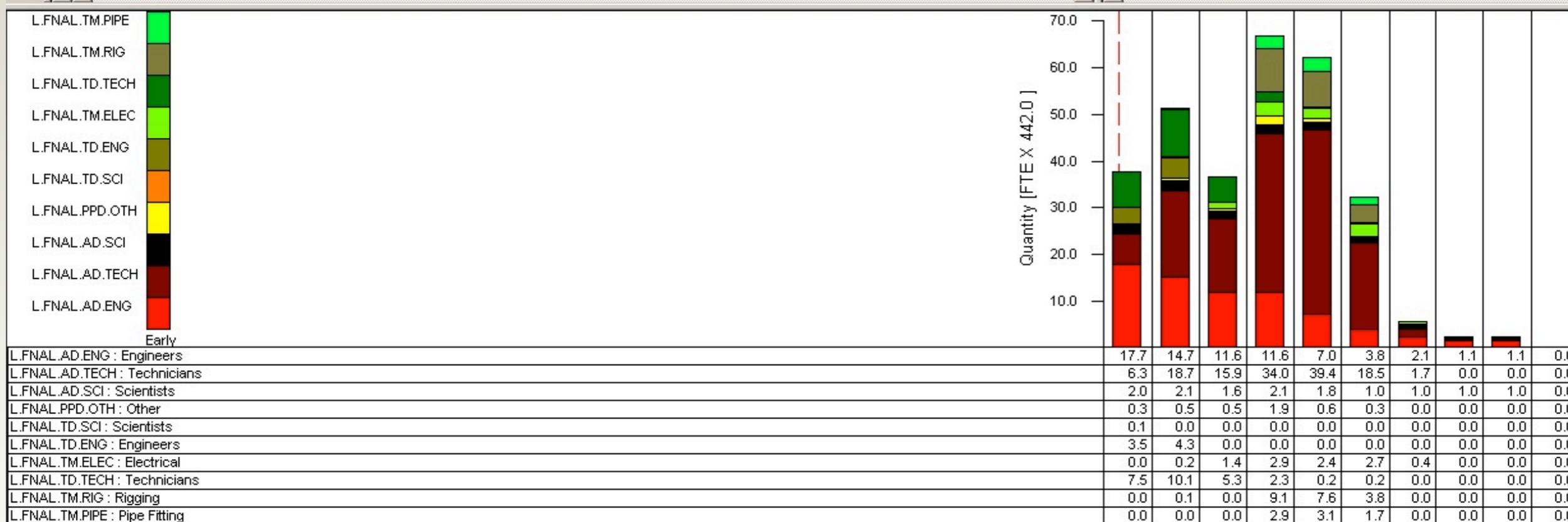
- People and money
 - Mechanical Techs: Recycler & NuMI installation
 - Electrical Techs: Service building & cabling installation
 - Alignment: experimental needs in Ash River also
- FY12 numbers defined in the budget presentations



Resources

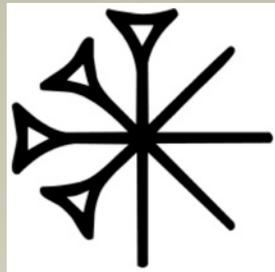


WBS	Activity Desc.	Duration	Early Dates	Baseline Dates	User Character Field 6	Status	Timeline										
							11	2012				2013					
							Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	
1	Research and Development	1790d	03Oct05 14Nov12	12Apr07 08Jan13		In Progress											
1.0	ANU Planning, Engineering & Design	1497d	01Dec06 14Nov12	30Apr07 08Jan13		In Progress											
2	Construction Project	2006d	01Dec06 26Nov14	01May07 26Nov14		In Progress											
2.0	ANU Construction	1716d	01Dec06 01Oct13	01May07 31Jan14		In Progress											
2.10	Project Management - Construction	1904d	01May07 26Nov14	01May07 26Nov14		In Progress											





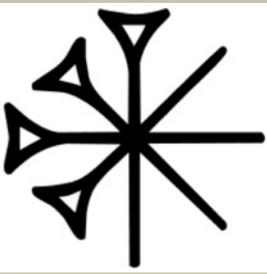
Risks



- Near term
 - Resource availability/fragmentation
 - impact on efficiency / quality / cost of work
 - radiation environment slowing down work progress
 - hot areas in MI tunnel and NuMI target hall
 - techs reaching dose limits -- finite number of people available to do work
- for 10 year goals: not so much NOvA project but NOvA experiment
 - PIP: proton demands
 - support NOvA / MicroBoone / g-2 / Mu2e at same time
 - LBNE/PX construction
 - long shutdowns for connections to tunnel



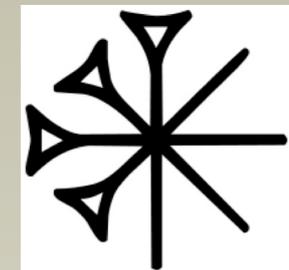
Summary



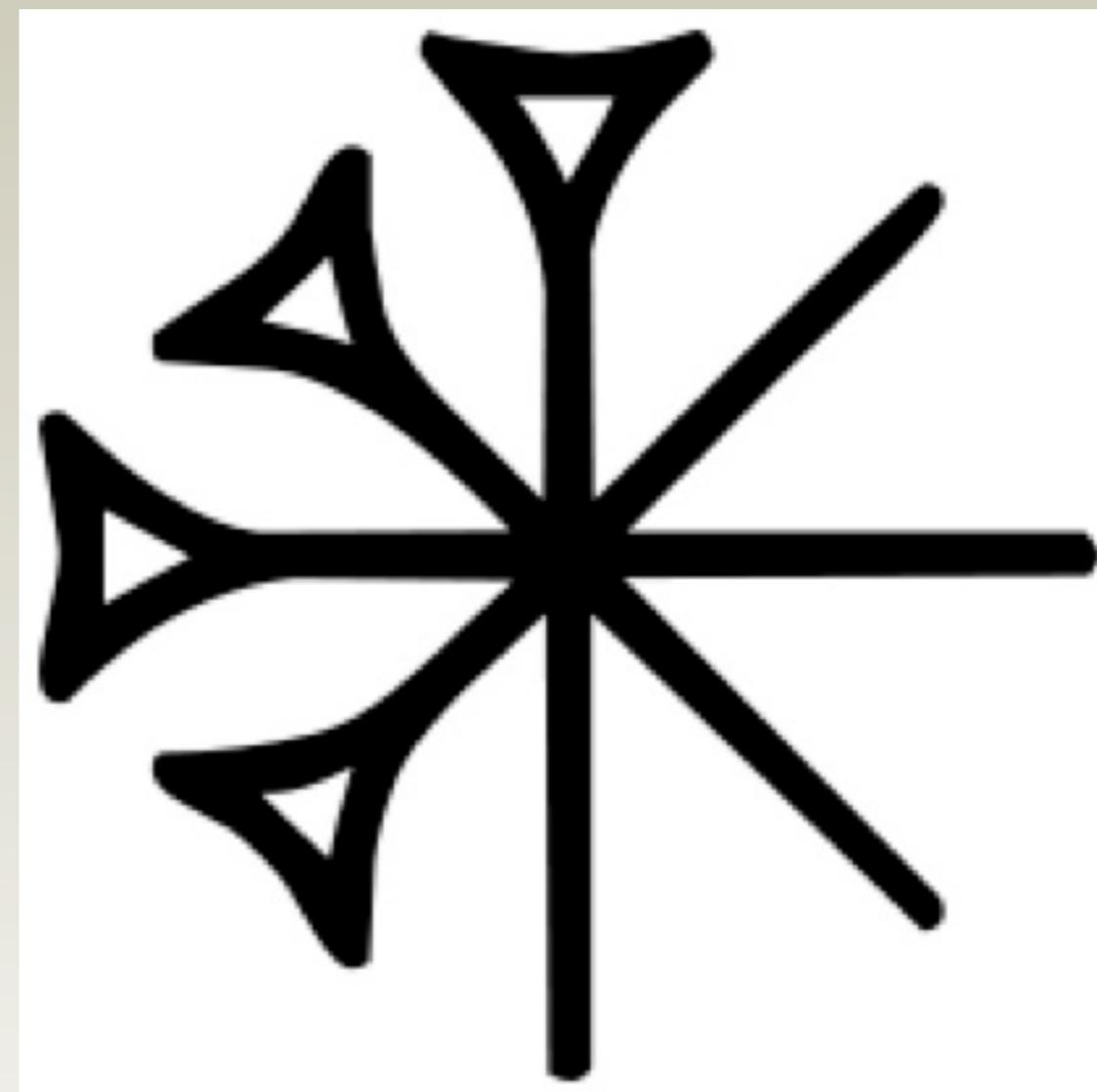
- NOvA/ANU has defined goals and schedule
 - Installation FY₁₂ - 13
 - ~55 FTEs for FY₁₂
 - fragmentation of effort
 - radiation exposure
 - demand on many more people
 - CD-4 goal: ‘accelerator capable of delivering 700 kW’



Context of ANU



- In Sumerian mythology and later for Assyrians and Babylonians, Anu (also An; (from Sumerian *An  = sky, heaven)) was a sky-god, the god of heaven, lord of constellations, king of gods, spirits and demons, and dwelt in the highest heavenly regions. It was believed that he had the power to judge those who had committed crimes, and that he had created the stars as soldiers to destroy the wicked.



Sumerian cuneiform for ANU