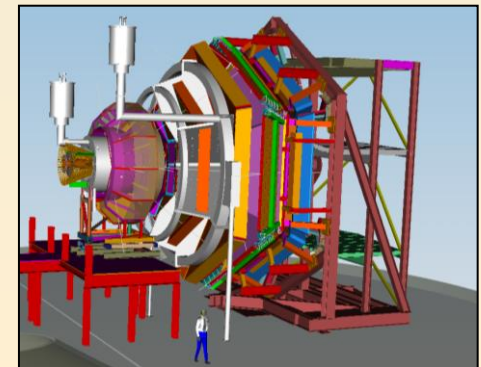
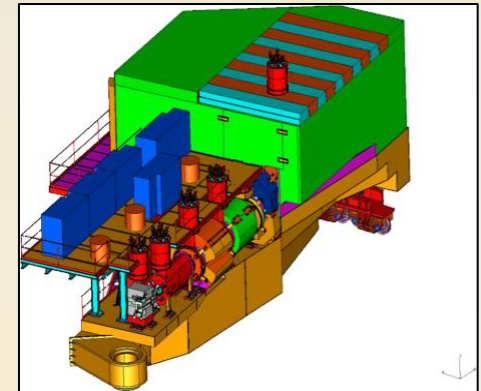
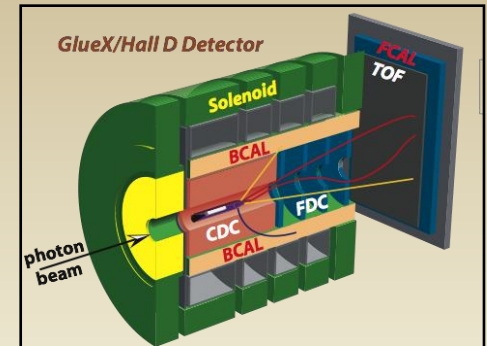




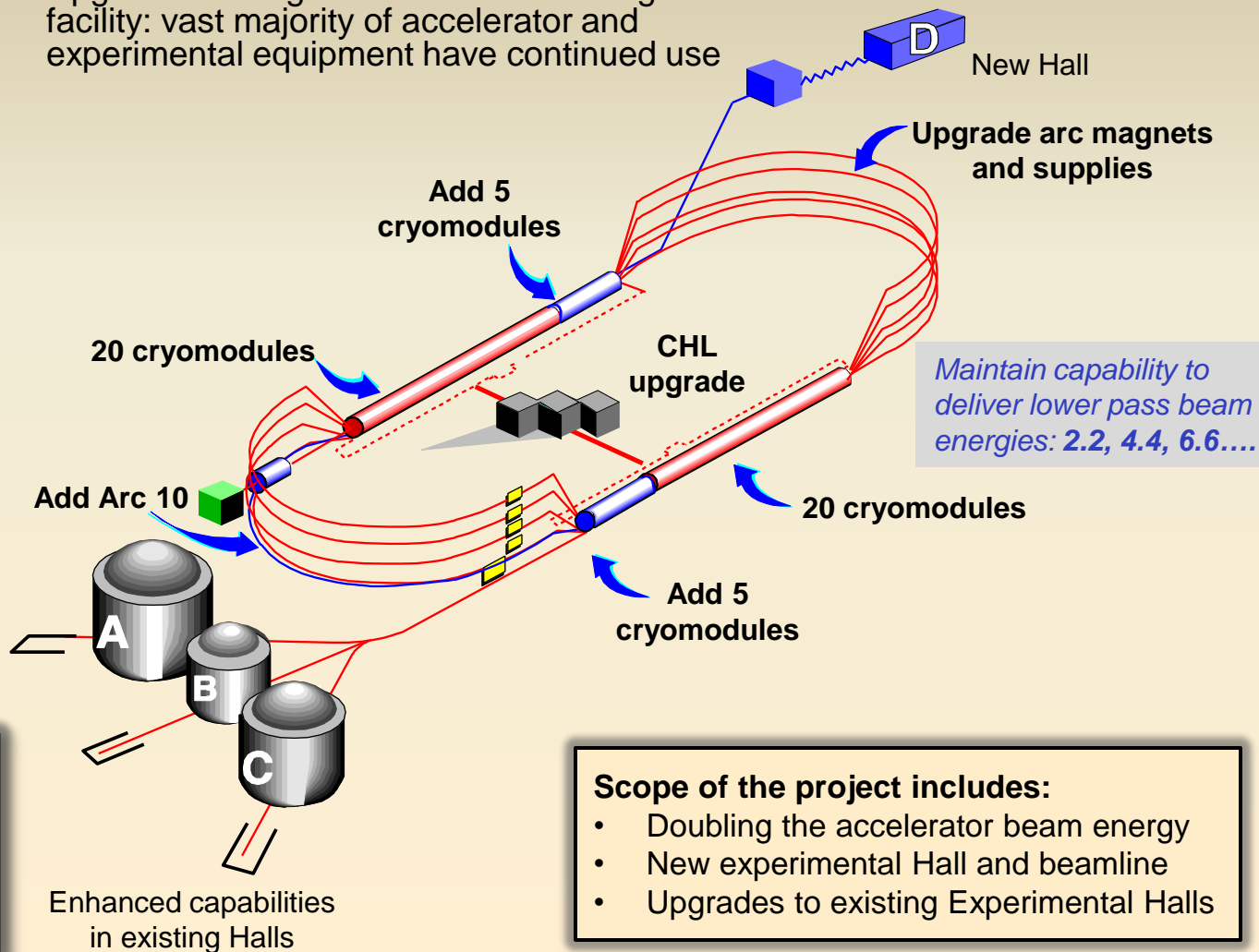
OUTLINE

- Project Description
- Science Motivation
- Civil Construction
- Accelerator
- Hall D
- Hall C
- Hall B
- Path to Completion



12 GeV Upgrade Project

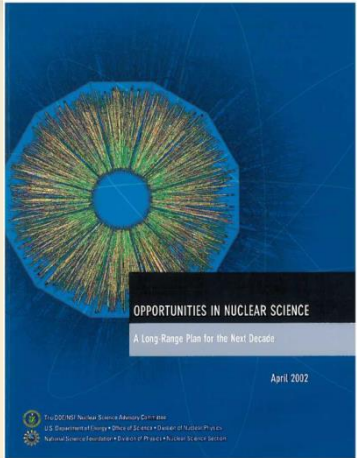
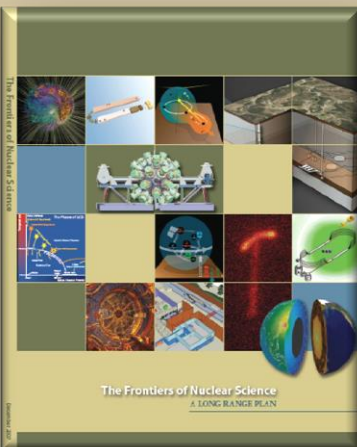
Upgrade is designed to build on existing facility: vast majority of accelerator and experimental equipment have continued use



12 GeV CEBAF Upgrade construction ranked highest priority in 2007 NSAC Long Range Plan.

Scope of the project includes:

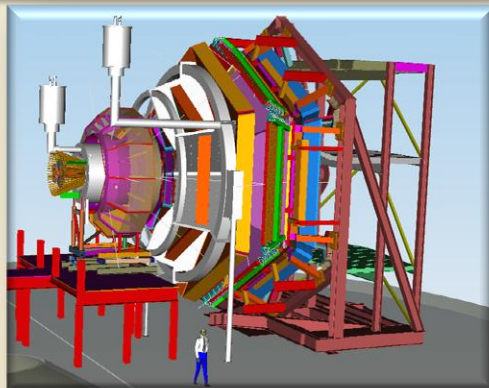
- Doubling the accelerator beam energy
- New experimental Hall and beamline
- Upgrades to existing Experimental Halls



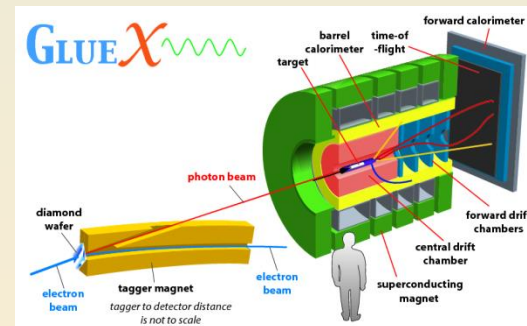
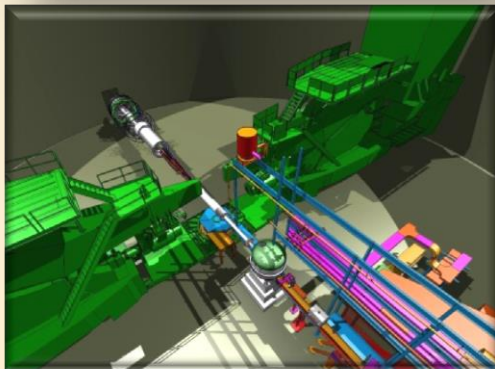
Physics Driving the 12 GeV Upgrade

- Explore the physical origins of quark confinement (GlueX)
- New and revolutionary access to the spin and flavor structure of the proton and neutron
- Discovering the quark structure of nuclei
- Probe potential new physics through high precision tests of the Standard Model

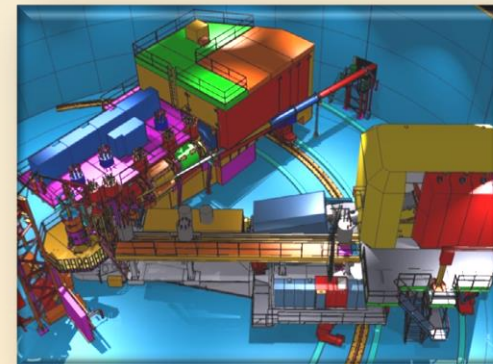
Hall B –
understanding
nucleon structure
via generalized
parton
distributions



Hall A –
form factors,
future new
experiments (e.g.,
SoLID and
MOLLER)



Hall D –
exploring origin
of confinement
by studying
exotic mesons



Hall C –
precision
determination
of valence
quark
properties in
nucleons
/nuclei

Civil Construction: Complete

CHL Building Addition



Hall D Complex



Hall D Counting House

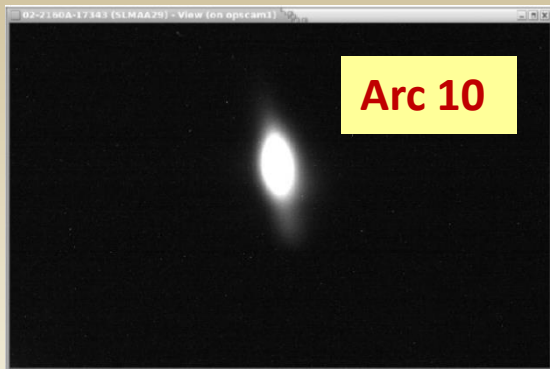


New Construction:
~10,080 sq ft

Add to Existing:
~8,400 sq ft

**Expansion of
existing utilities**

Accelerator: 5.5 Pass Commissioning



5.5 pass
10.5 GeV



Hall D Tagger Magnet/Dump



Hall D Beamline



QuickPic - BEAM ON HALL D Tagger DUMP!

Lognumber 3285622. Submitted by eforman on Wed, 05/07/2014 - 23:41.
Last updated on Wed, 05/07/2014 - 23:42

Logbooks: ELOG
Tags: Readme
Entry Makers: eforman

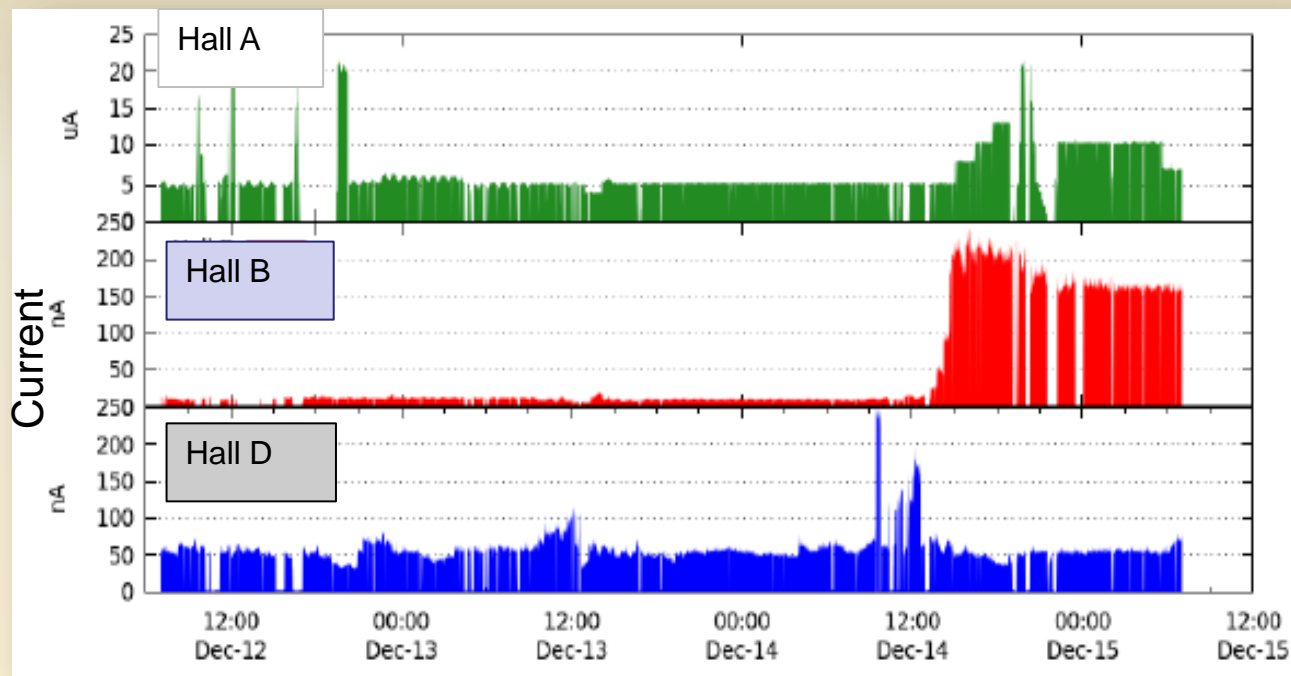
Hall D
Tagger Dump

Fig. 2 [05/07/2014 23:41:27]



Accelerator 3-Hall Commissioning

- Achieved 12 GeV Project Hall D performance parameters
- Beam delivered to 3 Halls simultaneously

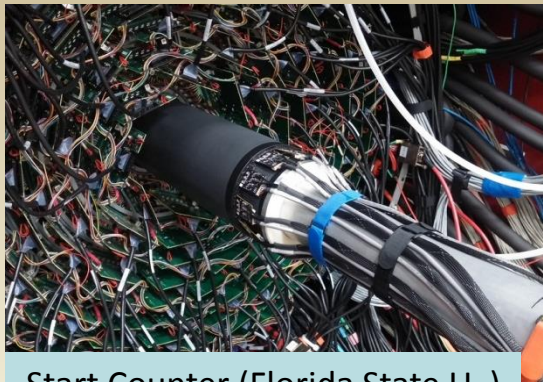


- CEBAF design has been validated
- Delivered beam quality meets the Physics requirements

Detector Technical Requirements

Hall D	Hall B	Hall C	Hall A
excellent hermeticity	luminosity 10×10^{34}	energy reach	installation space
polarized photons	hermeticity	precision	
$E_\gamma \sim 8.5-9$ GeV	11 GeV beamline		
10^8 photons/s	target flexibility		
good momentum/angle resolution		excellent momentum resolution	
high multiplicity reconstruction		luminosity up to 10^{38}	
particle ID			

Hall D: Detectors COMPLETE



Start Counter (Florida State U.)



FDC inside BCAL bore



CDC (Carnegie Mellon U.)



BCAL (U. of Regina)



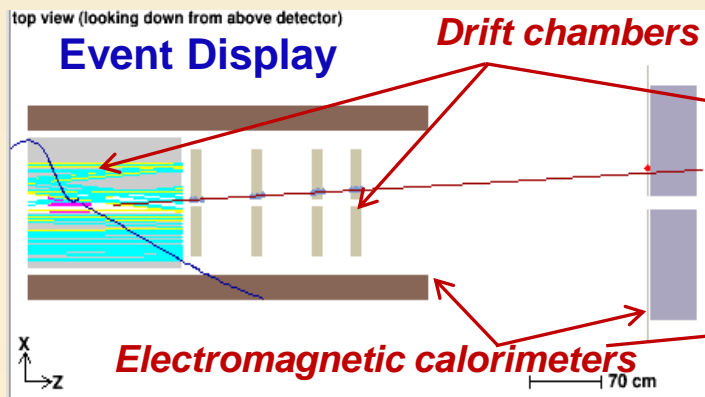
TOF



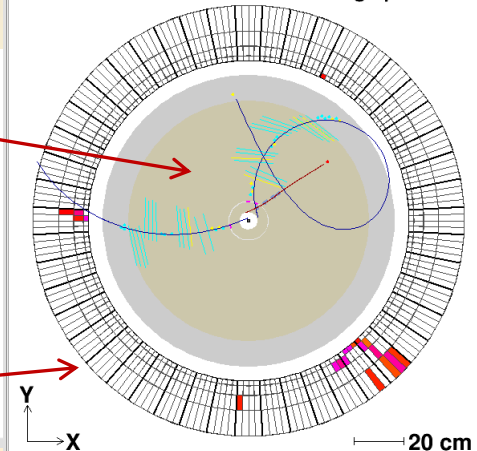
FCAL (Indiana U.)

Hall D: Commissioning

- Achieved 12 GeV Project Hall D performance parameters (December 2014)
- Delivered beam quality met the *initial years* user requirements (e, dp/p, polarization...)
- Beam delivered to 3 Halls simultaneously

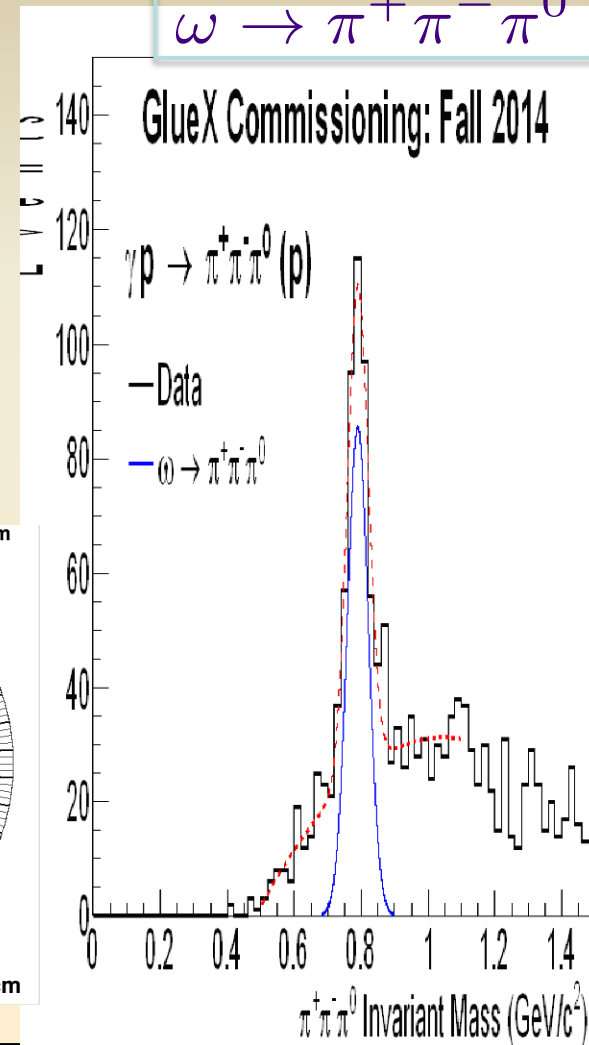


BCAL view from downstream looking upstream

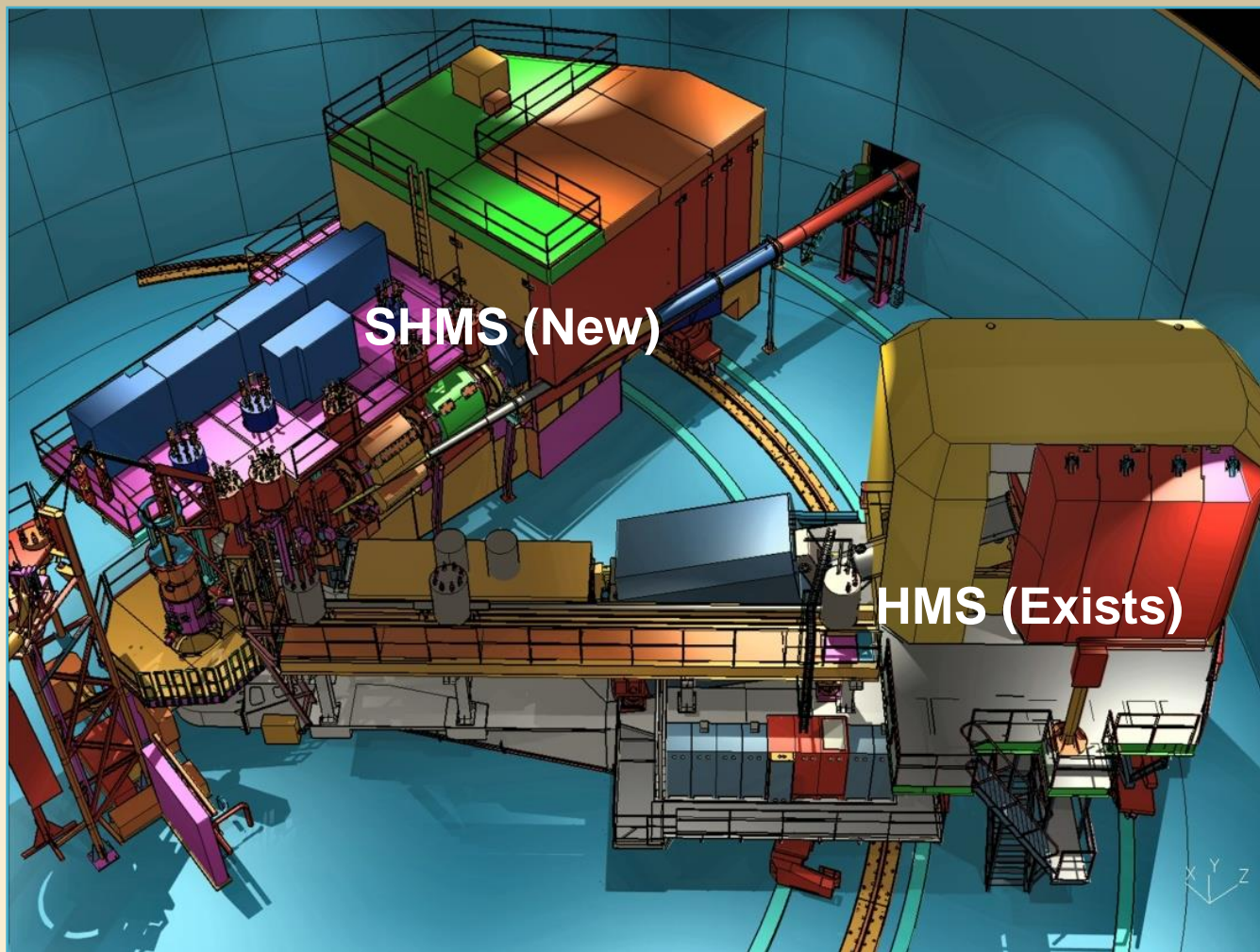


Spectrometer in solenoidal magnetic field

$$\omega \rightarrow \pi^+ \pi^- \pi^0$$



Hall C Equipment



SHMS – Super High Momentum Spectrometer ; HMS – High Momentum Spectrometer

Hall C SHMS Detectors

Noble Gas Cerenkov



Drift Chambers



Trigger Hodoscopes



•3 Planes Scintillator

•1 Plane Quartz



Heavy Gas Cerenkov*



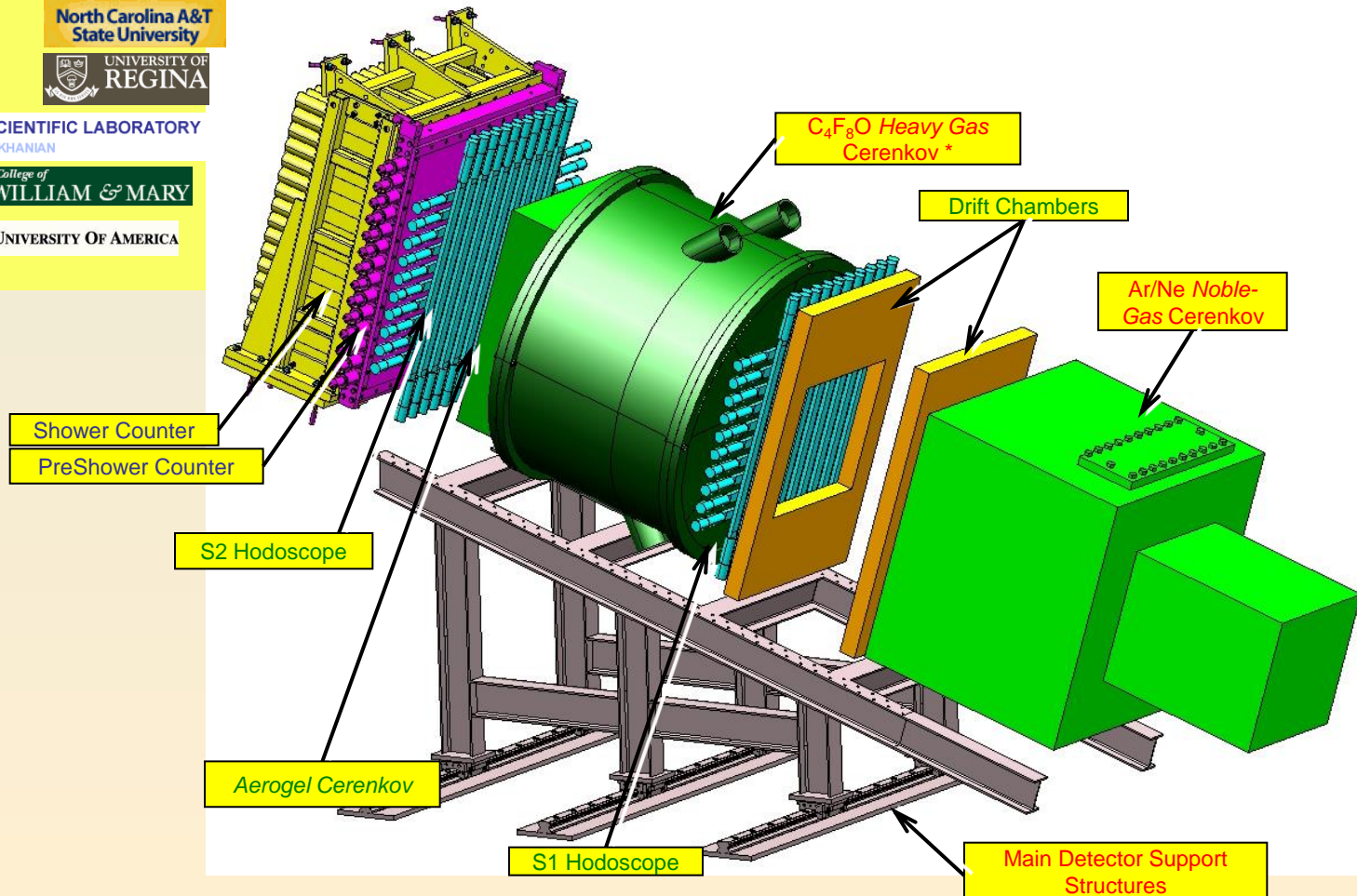
Calorimeter



Detector Frames



Aerogel



(Funding Color Codes):

12 GeV Project Funded

NSF MRI Funding

Gift from NIKHEF and NSL

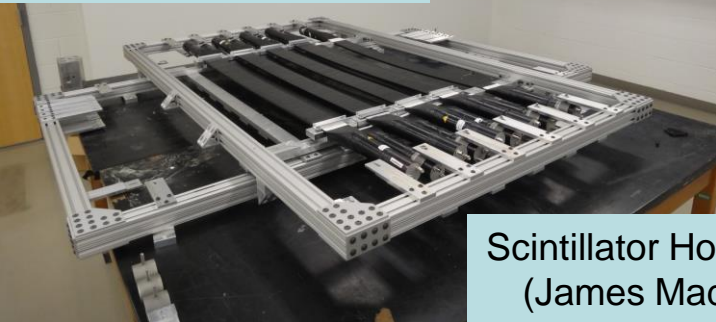
Hall C: Detectors COMPLETE



PreShower Counters



Shower Counters
(ANSL)



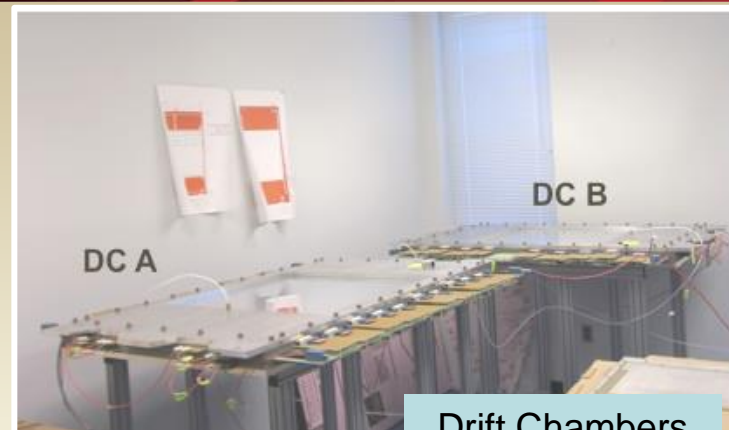
Scintillator Hodoscopes
(James Madison U.)



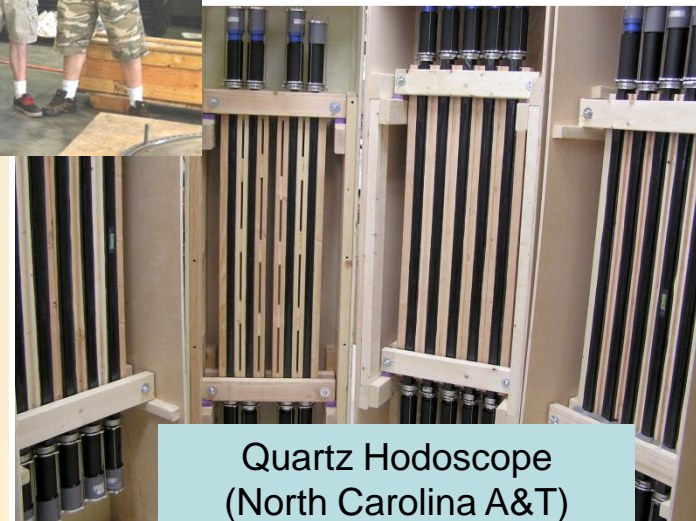
NGC
(U. of Va)



HGC Cerenkov
(U. of Regina)



Drift Chambers
(Hampton U.)



Quartz Hodoscope
(North Carolina A&T)

Hall C: SHMS Magnets

Quad 1 (Q1):

- Installed on carriage
- Cooled down
- **Power test to 110% of operational current**
- **Acceptance tests complete**

Horizontal Bend (HB):

- Installed on carriage
- Cooled down
- **Initial power test to operational current**
- **Acceptance tests complete**



HB

Q1

Hall C SHMS Magnets



Dipole
(Sigma Phi, France)



Q2
(Sigma Phi, France)



Q3
(Sigma Phi, France)

Delivery Fall 2016

Hall B Equipment

Forward Detector (FD)

- TORUS magnet
- HT Cherenkov Counter
- Drift chamber system
- LT Cherenkov Counter
- Forward ToF System
- Pre-shower calorimeter
- E.M. calorimeter

Central Detector (CD)

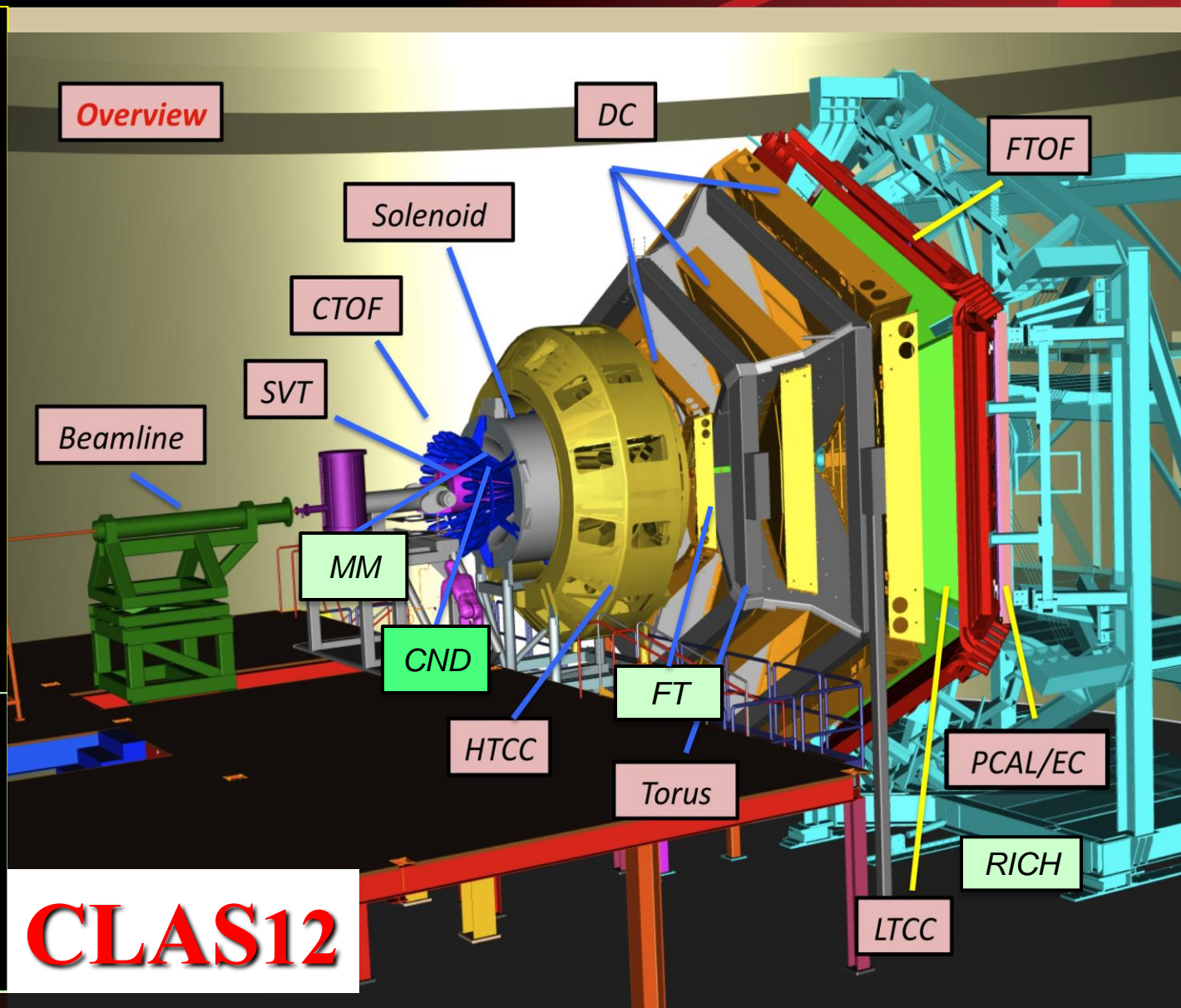
- SOLENOID magnet
- Silicon Vertex Tracker
- Central Time-of-Flight

Beamline

- Cryo Target
- Moller polarimeter
- Shielding
- Photon Tagger

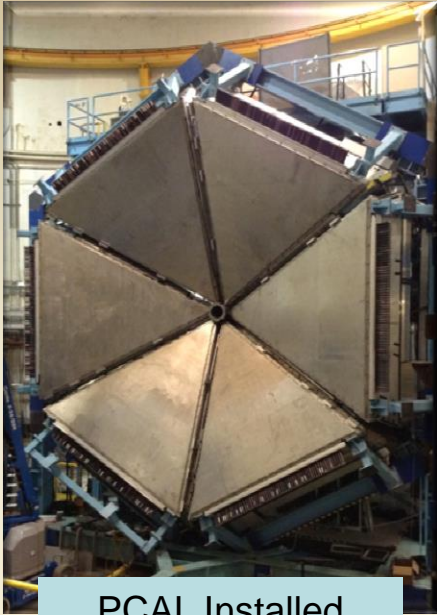
Upgrade to the baseline

- Central Neutron Detector
- MicroMegas
- Forward Tagger
- RICH detector
- Polarized target

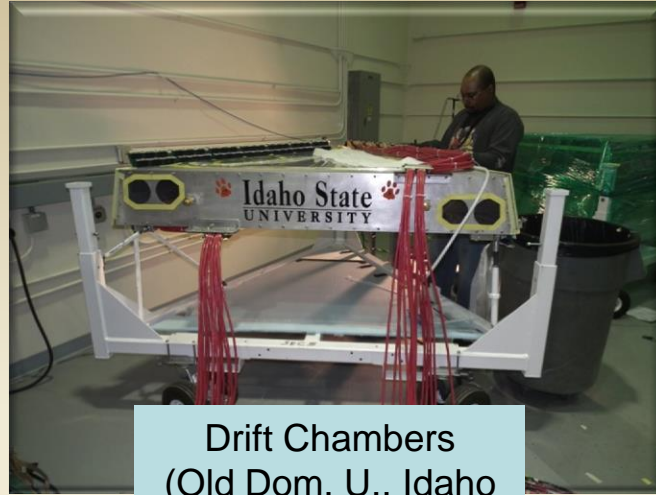


CLAS12

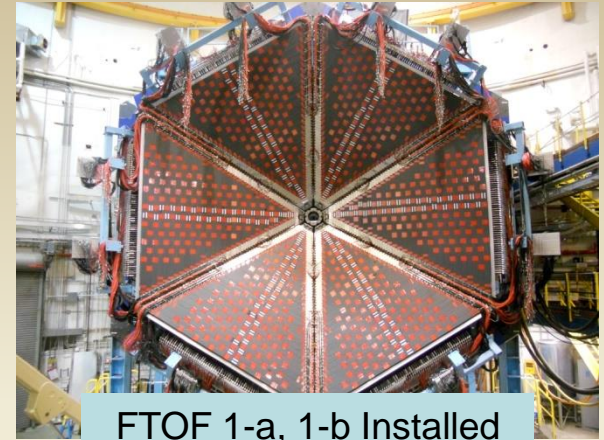
Hall B: Detectors COMPLETE



PCAL Installed
(Ohio U.)



Drift Chambers
(Old Dom. U., Idaho
State U., JLab)



FTOF 1-a, 1-b Installed
(U. of South Carolina)



LTCC-1 with First
Set of Mirrors



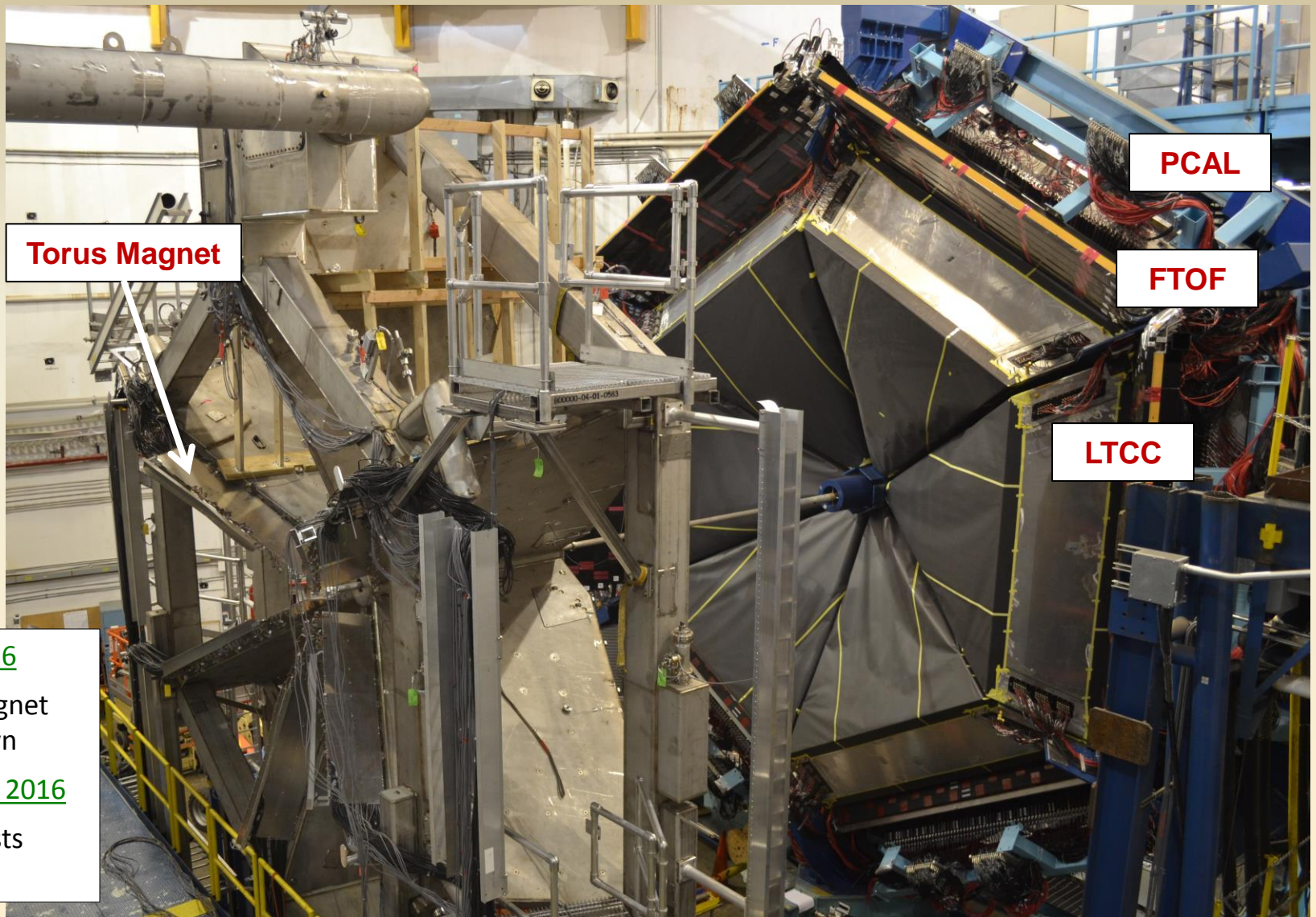
SVT Region 4 Assembled



Assembled CTOF Counters
Being Tested



Hall B – CLAS12 Spectrometer



$e^- \rightarrow$

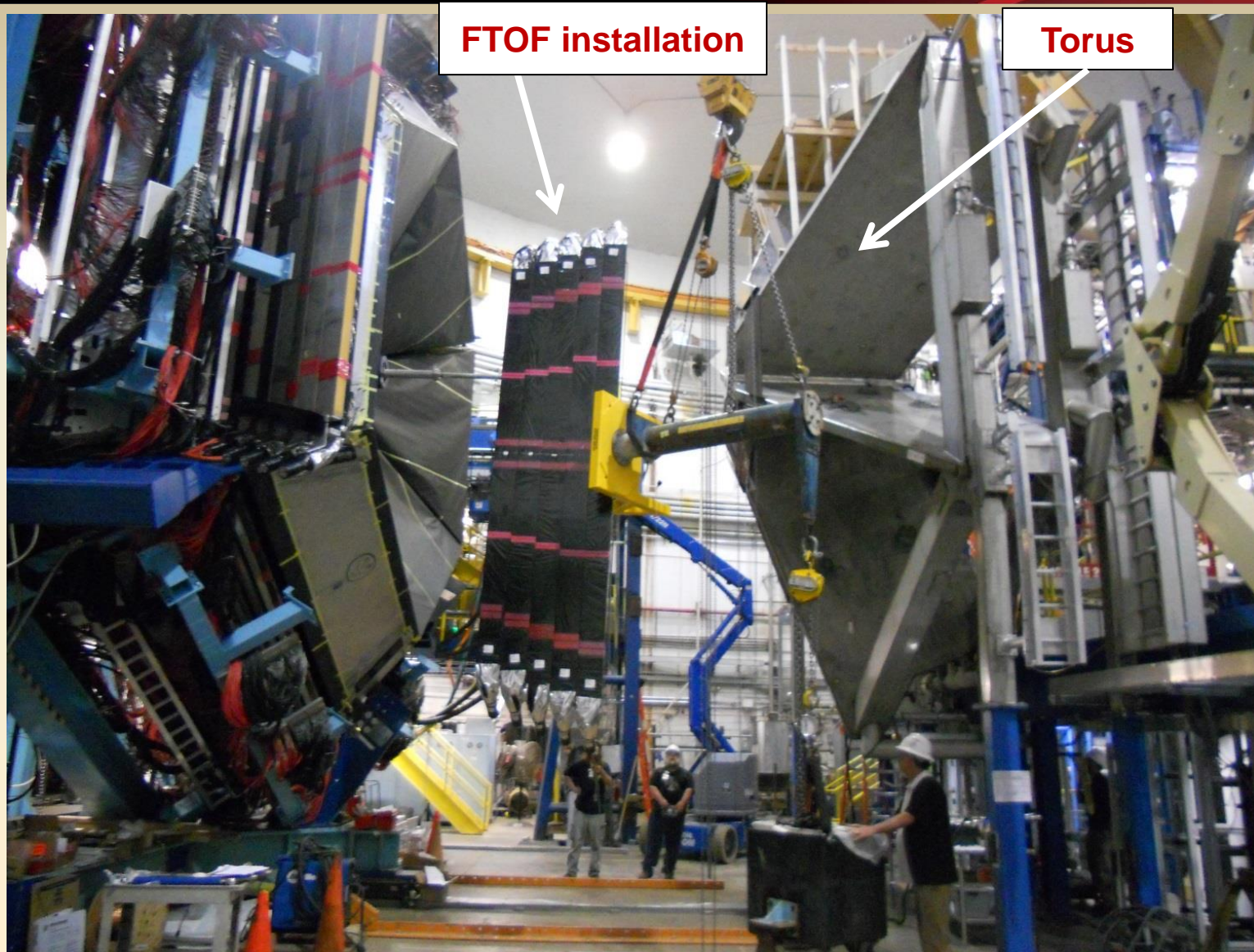
August 2016

- Torus Magnet Cool-down

September 2016

- Power tests
- Mapping

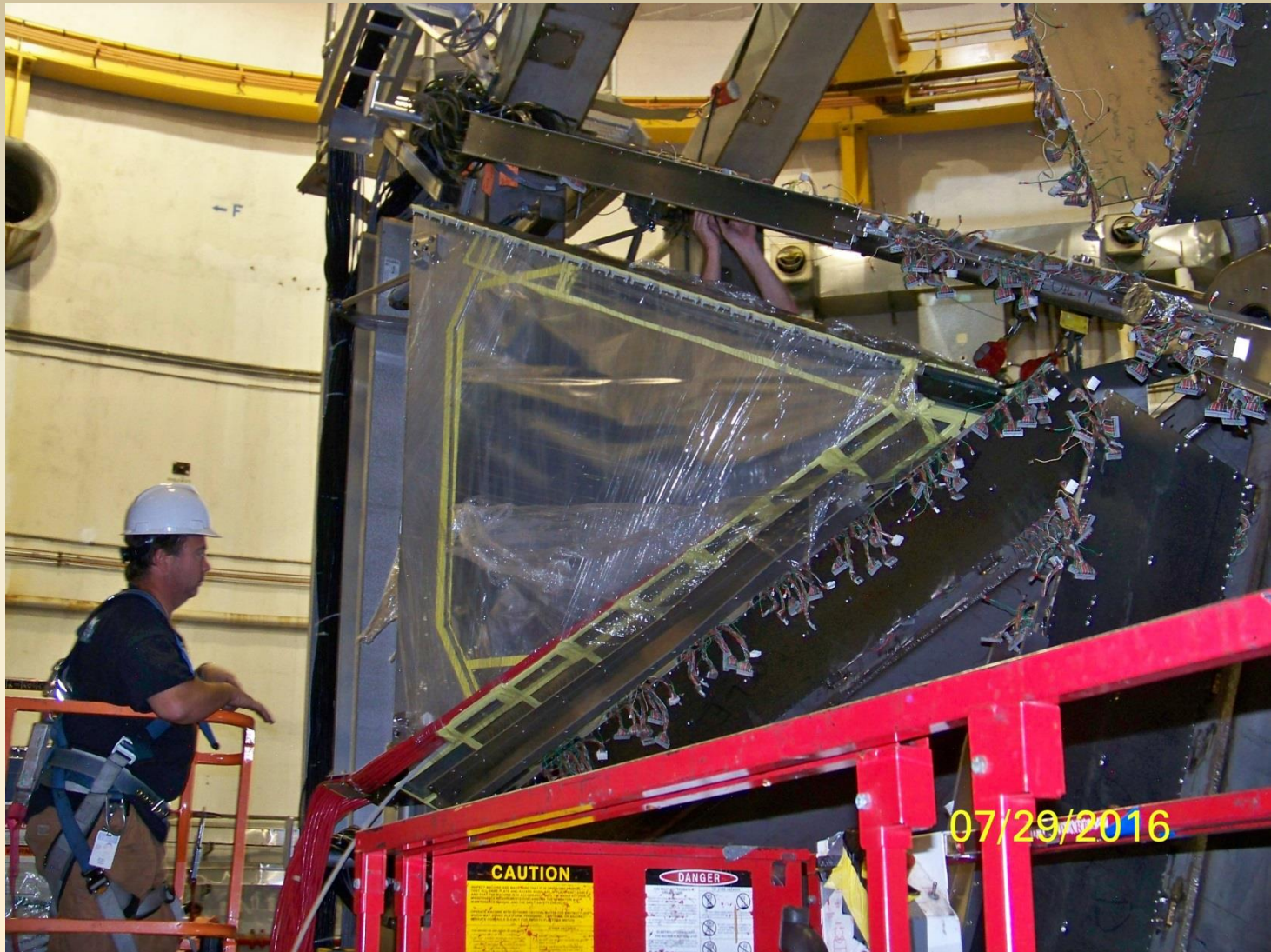
Hall B – CLAS12 Spectrometer



← e⁻

Hall B: CLAS12

$e^- \rightarrow$



Installation of first of 18 sectors of drift chambers.

Hall B: Solenoid Magnet

Coil 1 – 4 Bobbin



Delivery January 2017

Coil 5 Shield Coil



(vendor: ETI)

Jefferson Lab



12 GeV Project: University Detector Work

Hall	University	Activity	Status
B	Idaho State U	Drift Chamber	Complete
B	Old Dominion U	Drift Chamber	Complete
B	U South Carolina	TOF Counters	Complete
B	Moscow State U (RU)	SVT Testing	Complete
C	Michigan State U	HB Magnet	Complete
C	U Virginia	Noble Gas Cerenkov	Complete
D	U Athens (GR)	Monitoring BCAL, FCAL	Complete
D	Carnegie Mellon U	Central Drift Chamber	Complete
D	Catholic U	Tagger Hodoscope	Complete
D	U Connecticut	Tagger Microscope	Complete
D	Florida International U	Start Counter	Complete
D	Florida State U	TOF Counters	Complete
D	Indiana U	Forward Calorimeter	Complete
D	U Regina (CA)	Barrel Calorimeter	Complete
D	U Santa Maria (CH)	SiPM, Lightguides for BCAL	Complete
B, C, D	U Massachusetts	Electronics Testing	Complete

NSF-MRIs funded
Hall B PCAL Detector,
Long. Polarized Target

NSF-MRIs funded most
12 GeV Hall C Detectors

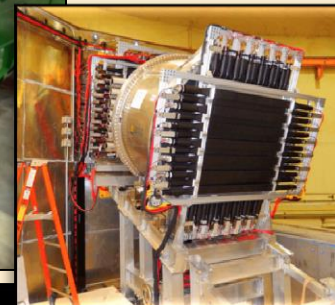
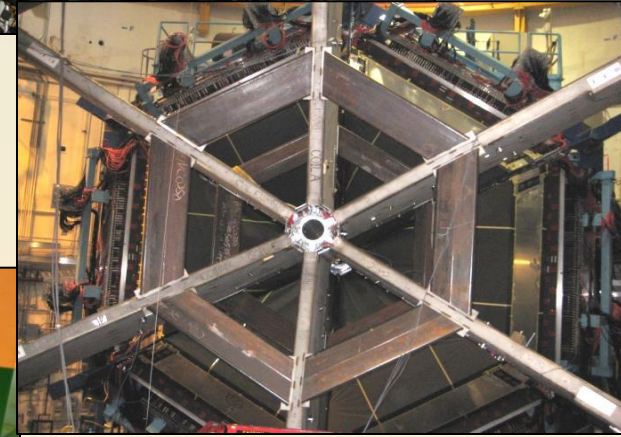
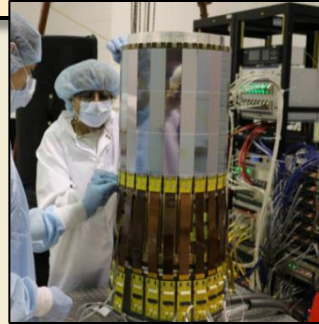
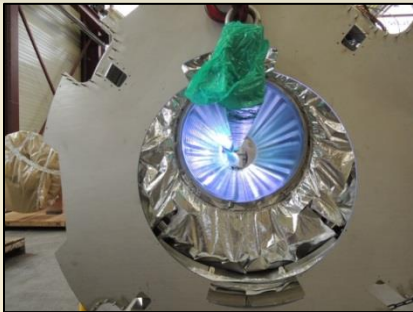
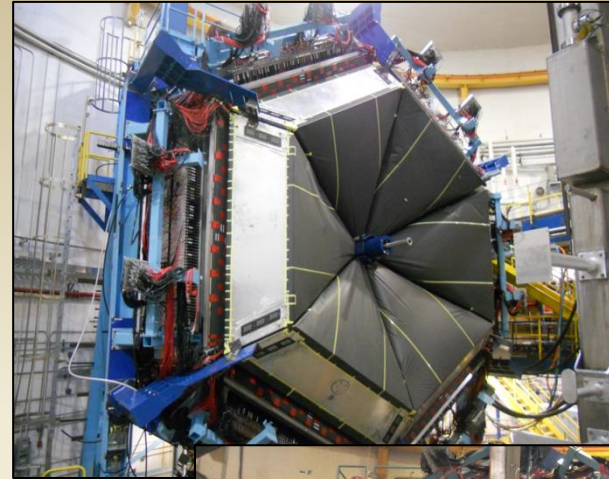
Internat'l contributions
for detectors beyond
base equipment

12 GeV Upgrade Project

TPC = \$338M
ETC = ~\$8M

Project Scope (~98% complete):

- Doubling the accelerator beam energy - **DONE**
- New experimental Hall D and beam line - **DONE**
- Civil construction including utilities - **DONE**
- Upgrades to Experimental Halls B & C - **~94%**
 - **Halls B & C Detectors – DONE**



Work Remaining - *Magnets*

- CLAS12: Torus Magnet testing and finish install/cable Forward Detectors
- CLAS12: Solenoid Magnet and then install/cable Central Detectors
 - Complete construction at ETI (January)
 - Install Solenoid (February)
 - Pump down, cool, energize magnet (March/April)
 - Install CTOF and SVT during cool-down step
 - Install HTCC and Moeller Shield
- SHMS: Magnets
 - Complete construction Q2/Q3/Dipole magnets at Sigmaphi
 - Install and test (October – March)

Key Dates – Halls B & C

Hall	Key Event	Date
B	Torus 1 st Coil Cold Mass Arrived	November 2014
B	Torus 6 th Coil in Cryostat Done	June 2015
B	Torus Installation	April 2016
B	Solenoid Coil Winding Done	March 2016
B	Solenoid Arrives	January 2017
B	Detector Commission with Beam	May 2017
C	1 st Magnet (Q1) Arrived	January 2015
C	2 nd Magnet (HB) Arrived	March 2015
C	3rd Magnet (Q2) Arrives	September 2016
C	Last Magnet (Q3) Arrives	November 2016
C	Last Magnet Tested	March 2017
C	Detector Commission with Beam	April 2017

12 GeV Upgrade: SUMMARY

- **98% COMPLETE & COMMISSIONED:**
 - Civil construction
 - Accelerator: physics quality beam delivered to 3-Halls simultaneously
 - Hall A beamline upgrade
 - Hall D / GlueX: engineering runs complete
- **Hall B:**
 - Project detectors complete; 4 installed
 - Torus installed & pumping
 - Solenoid delivery January 2017
- **Hall C:**
 - Project detectors complete; 4 installed
 - HB & Q1 magnets installed & fully tested
 - Q2/Q3/D magnet construction making excellent progress

Early physics in Halls A, B, and D*

Commissioning beam for Halls B & C in April/May 2017

*opportunistic HPS; PRad



BACK-UP

Critical Decision Schedule

LEVEL 1 MILESTONES

CD-0 Mission Need	MAR-2004 (A)
CD-1 Preliminary Baseline Range	FEB-2006 (A)
CD-2 Performance Baseline	NOV-2007 (A)
CD-3 Start of Construction	SEP-2008 (A)
CD-4A Accelerator Project Completion and Start of Operations	JUL-2014 (A)
CD-4B Experimental Equipment Project Completion and Start of Operations	SEP-2017

12 GeV Upgrade Status

- **Civil Construction complete:**
 - Tunnel Air Conditioning done
- **Accelerator Construction complete:**
 - Operation during project commissioning of Halls B & C remaining

#	System	Technical Definition	PEP Date	ACTUAL
1	Accelerator	12 GeV capable 5.5 pass machine installed	Dec 2014	June 2014
2	Accelerator	11 GeV capable beamline to Halls A/B/C installed	Dec 2014	June 2014
3	Accelerator	12 GeV capable beamline to Hall D tagger area installed	Dec 2014	April 2014
4	Accelerator	Accelerator commissioned by transporting a > 2 nA electron beam at 2.2 GeV (1 pass)	Dec 2014	Feb 2014
5	Civil	New experimental Hall and Counting House: > 10,500 sq. ft.	Dec 2014	June 2012

**Received CD-4A Approval ahead of schedule; ESAAB July 30, 2014
'Accelerator Project Complete and Start of Operations'**



Path to CD-4B: Project Complete

– Key Performance Parameters (PEP)

#	System	Technical Definition	PEP Date
1	Hall B	Detector operational: events recorded with a > 2 nA electron beam at > 6 GeV beam energy (3 pass)	Sep 2017
2	Hall C	Detector operational: events recorded with a > 2 nA electron beam at > 6 GeV beam energy (3 pass)	Sep 2017
3	Hall D	Detector operational: events recorded with a > 2 nA electron beam at > 10 GeV beam energy (5.5 pass)	Sep 2017 Dec 2014 (A)

Hall D 100% complete:

DOE-NP approval 11-Dec-2014