



Jefferson Laboratory 12 GeV CEBAF Upgrade

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Deputy Project Manager



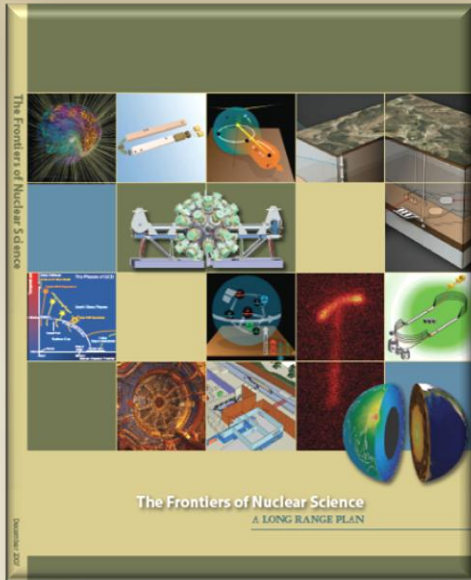
Hadron2012
Beijing, China

Jefferson Lab
Thomas Jefferson National Accelerator Facility

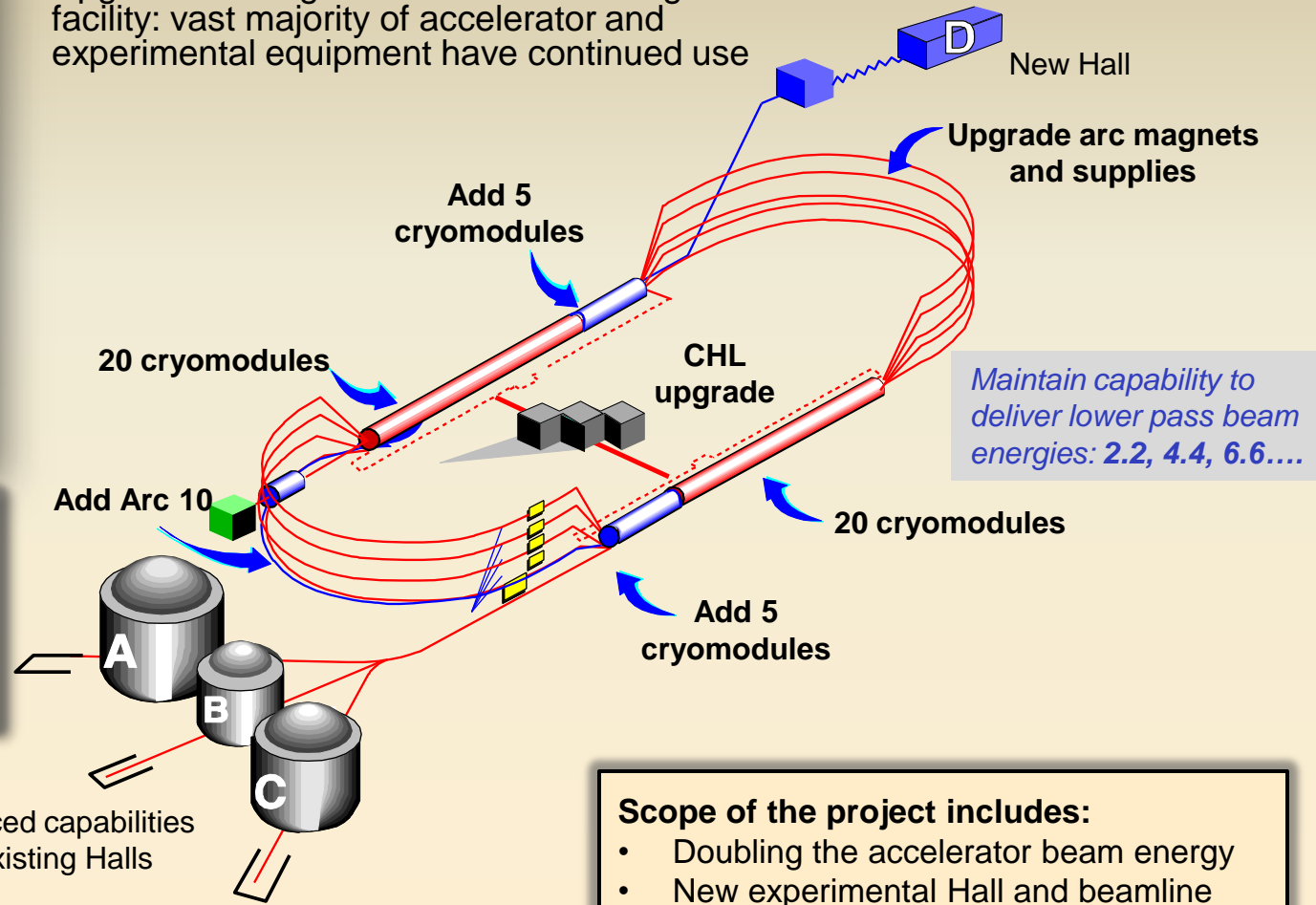
OUTLINE

- **Project Overview**
 - **Designed to Meet Science Goals**
- **Cost & Schedule Overview**
- **Construction Highlights**
- **Summary**

12 GeV Upgrade Project



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



The completion of the 12 GeV Upgrade of CEBAF was ranked the highest priority in the 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

Enhanced capabilities in existing Halls

Acceleration & Beam Transport



- Eight cavities are packaged into each cryomodule
 - 42 cryomodules in CEBAF today
 - 10 new ones will be added
 - high-performance, quadruple the gradient
- Each cavity has dedicated microwave source
 - 338 in CEBAF today
 - 80 new ones will be added
- Duplicate the existing cryogenics plant

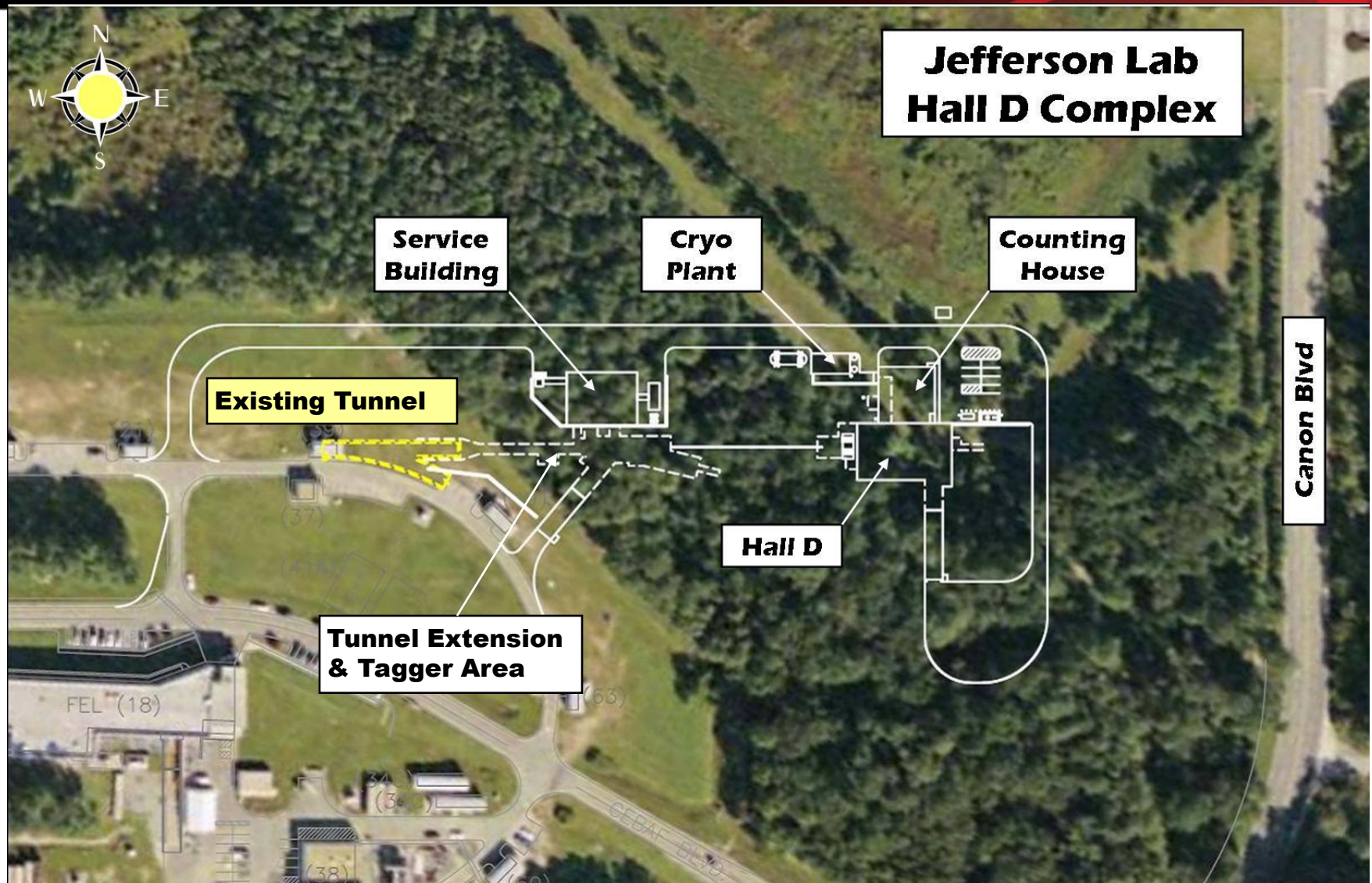


- Upgrade or replace existing recirculation & transport elements
 - 357 Dipole magnets (1-3m long)
 - 730 Quadrupoles (30x30x30cm)
 - >2000 power supplies
 - >700 beam diagnostics
 - >5 km of vacuum line
- Arc 10
 - 32 Dipole magnets (4m long)
 - 40 Quadrupoles (35x30x30cm)
 - 81 power supplies
 - 32 beam diagnostics
 - 0.3 km of vacuum line

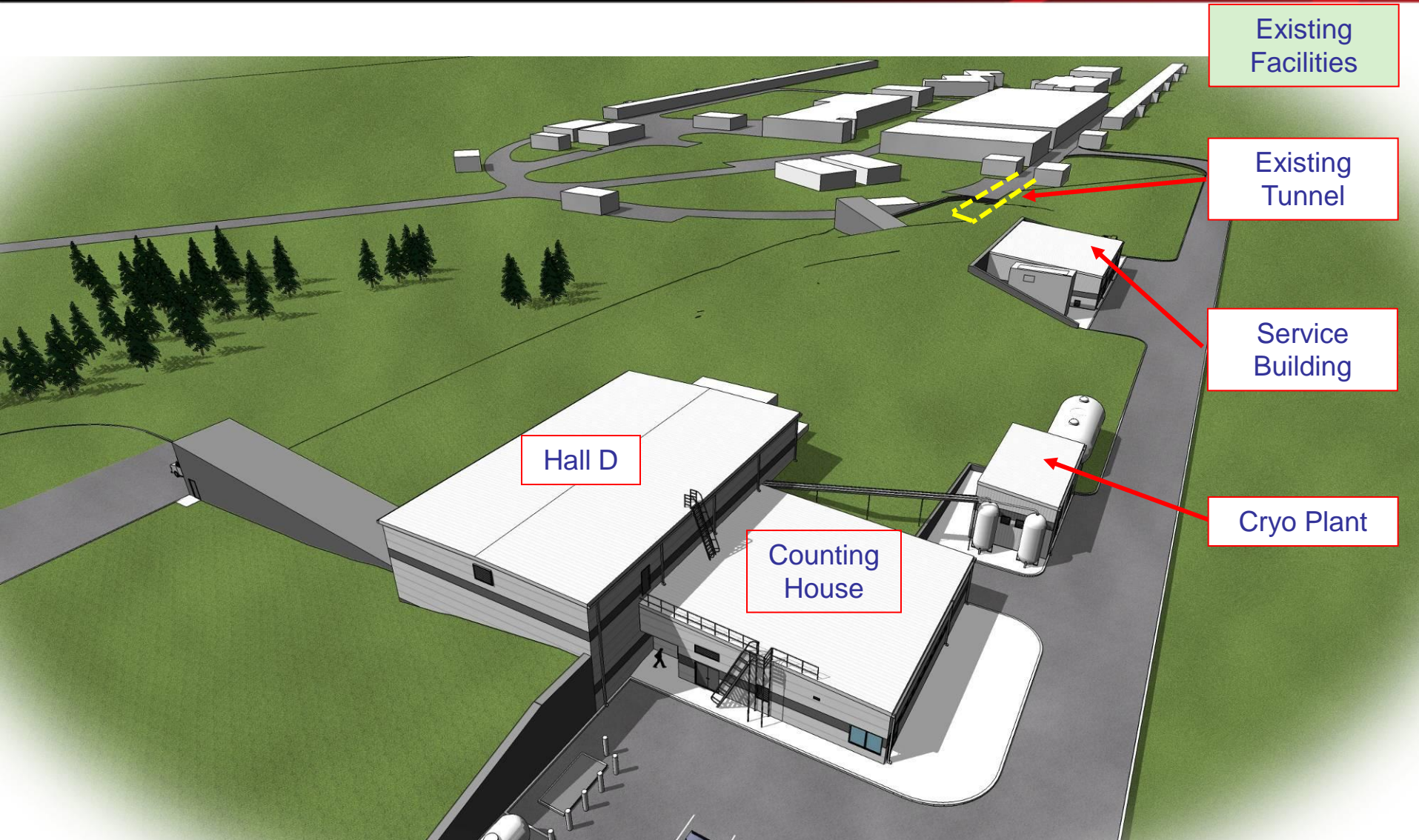
Re-use almost all

New

Hall D Complex – Civil Site Plan



Rendering of Hall D Complex – Overhead View



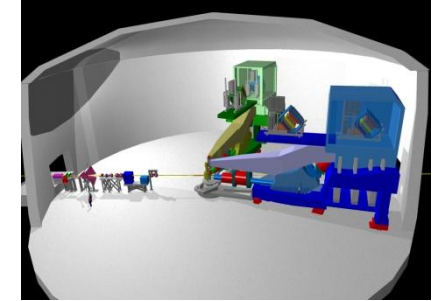
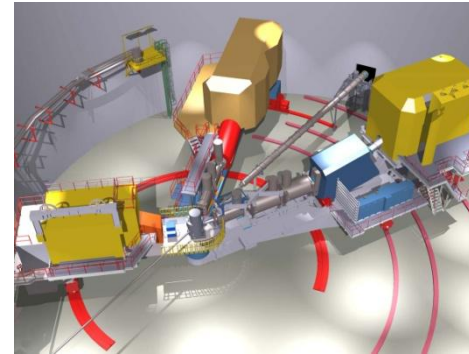
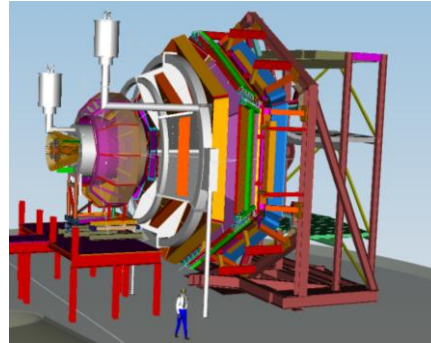
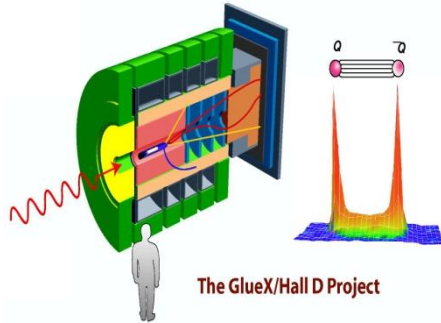
Overview of Technical Performance Requirements

new - GlueX

upgrade – CLAS12

new - SHMS

upgrade - beamline

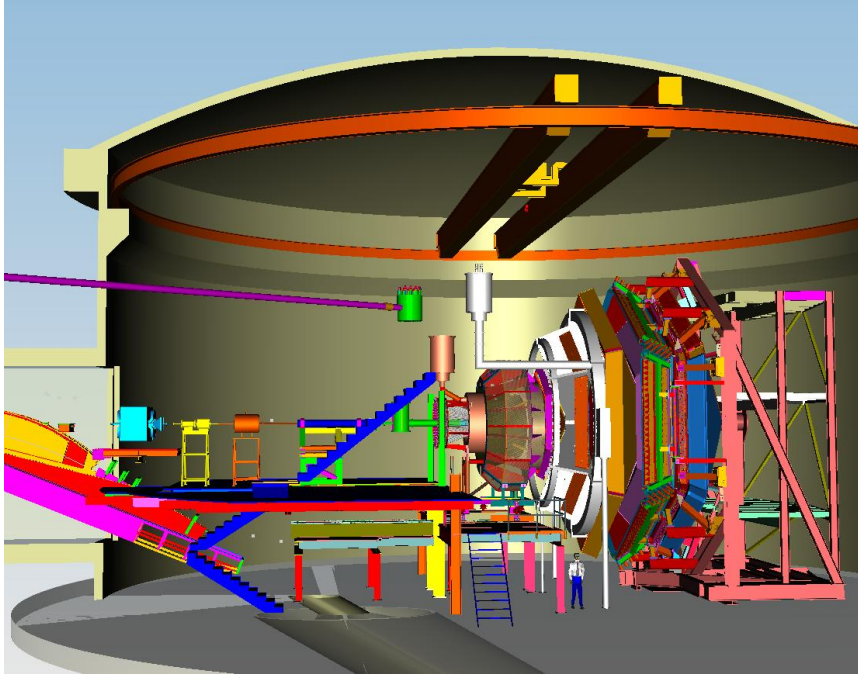


Hall D	Hall B	Hall C	Hall A
excellent hermeticity	luminosity 10×10^{34}	energy reach	installation space
polarized photons	hermeticity	precision	
$E_\gamma \sim 8.5-9$ GeV	11 GeV beamline		
10^8 photons/s	target flexibility		
good momentum/angle resolution	excellent momentum resolution		
high multiplicity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

Halls B and C

Hall B

CLAS12 = CEBAF Large Acceptance Spectrometer

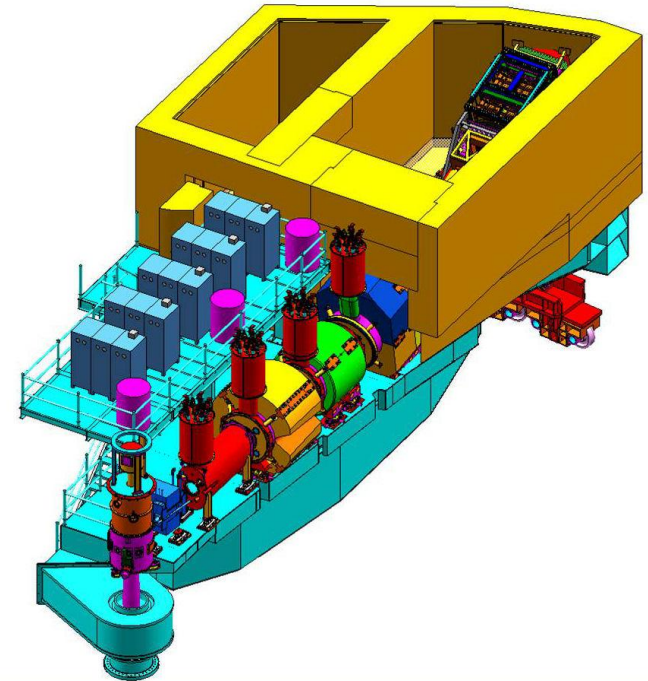


- Key Features:

- re-use some existing detectors
- 1 torus magnet, 1 solenoid magnet
- detectors: Cerenkovs, calorimeters, drift chambers, silicon vertex tracker
- hermetic device, low beam current, high luminosity

Hall C

SHMS = Super High Momentum Spectrometer

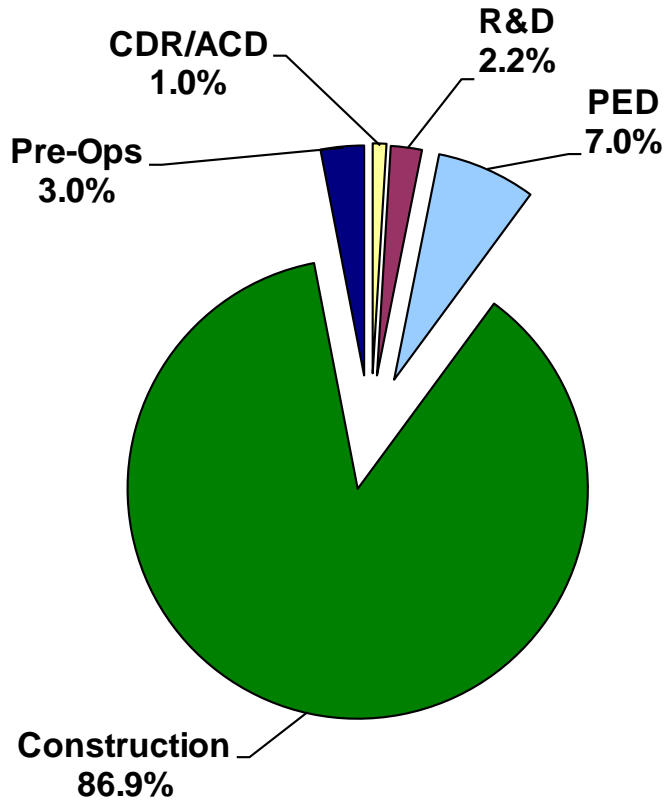


- Key Features:

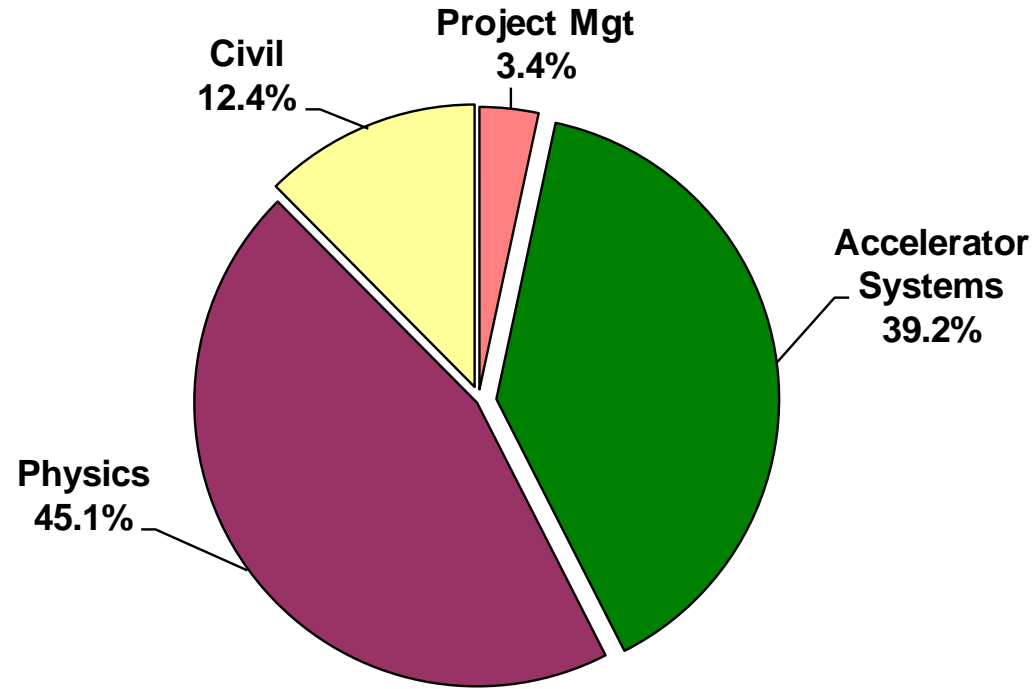
- used with existing spectrometer (HMS)
- 3 quadrupole magnets, 1 dipole magnet
- 1 horizontal bend magnet
- 6 element detector package
- rigid support structure / well-shielded detector enclosure

12 GeV Upgrade - COST

TPC

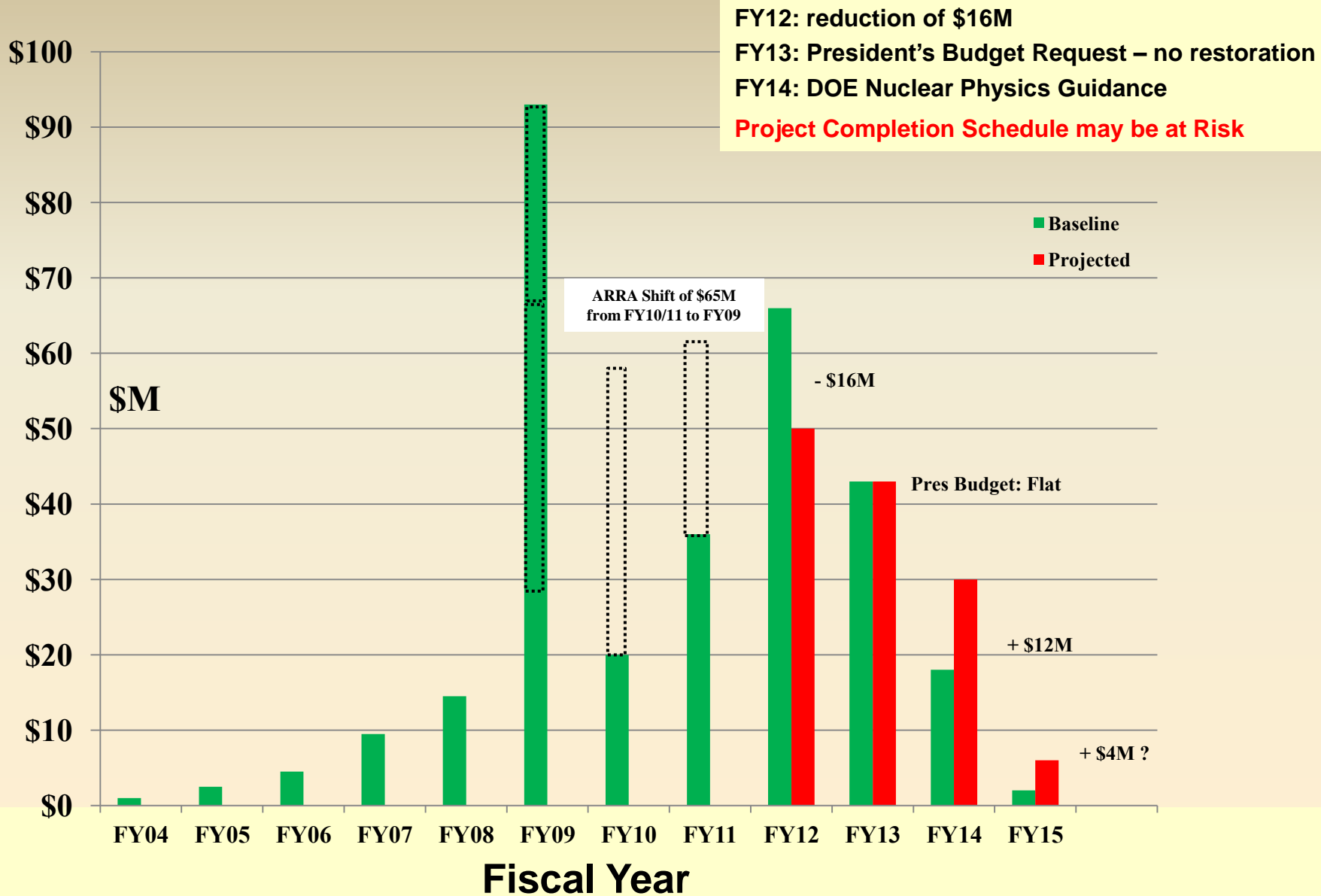


Construction



Total Project Cost (TPC) = \$310 M
Construction = \$266.5 M

12 GeV Upgrade – Funding Profile



12 GeV Upgrade - SCHEDULE

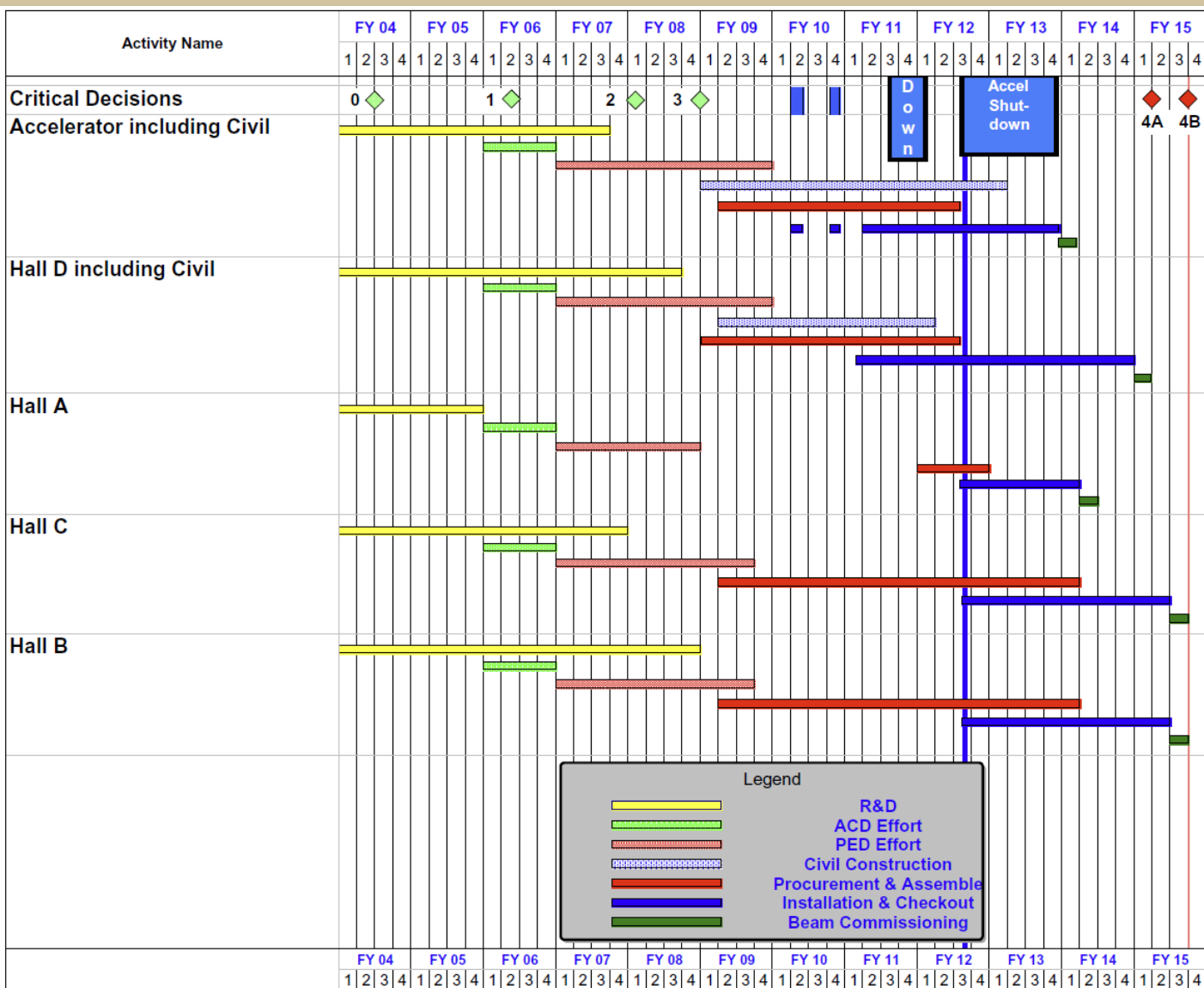
Department of Energy: CRITICAL DECISION (CD) SCHEDULE

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	DEC-2014
CD-4B Experimental Equipment Project Completion and Start of Operations	JUN-2015

~3.5 years into 5.5 year construction period

(A) = Actual date

12 GeV Upgrade - SCHEDULE



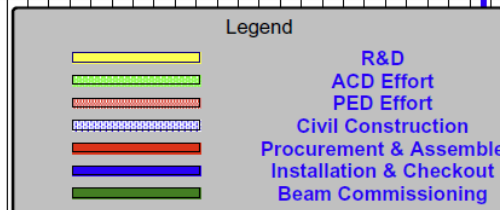
~~12~~ 16-month installation
May 2012 - May Sept 2013

Hall A commissioning start :
~~Oct 2013~~ Feb 2014

Hall D commissioning start:
~~April 2014~~ Oct 2014

Halls B & C commissioning start
:~~Oct 2014~~ Apr 2015

Project Completion June 2015??



12 GeV Cost & Schedule – “Rebaseline”

- \$16M reduction in anticipated funding resulted in:
 - Extending the duration of the accelerator installation
 - ~4 month delay in accelerator commissioning
 - ~4-6 month delay in beam to the Halls
 - Slowing of detector construction
- DOE Office of Science “rebaseline” review scheduled for late November 2012
 - Goals:
 - hold “delayed” schedule for accelerator commissioning and beam to Halls
 - add schedule “float” at end of project
 - increase funding to cover costs of delay

Accelerator Highlights – Arc magnets

6GeV CEBAF Arc with C-style dipoles



before magnet re-work

during magnet re-work

Dipoles all removed!!!! West Arc circa July 2011



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Accelerator – Arc Tunnel after rework

C→H conversion **complete**, including stretch goal of East Arcs 5,7& 9!!!



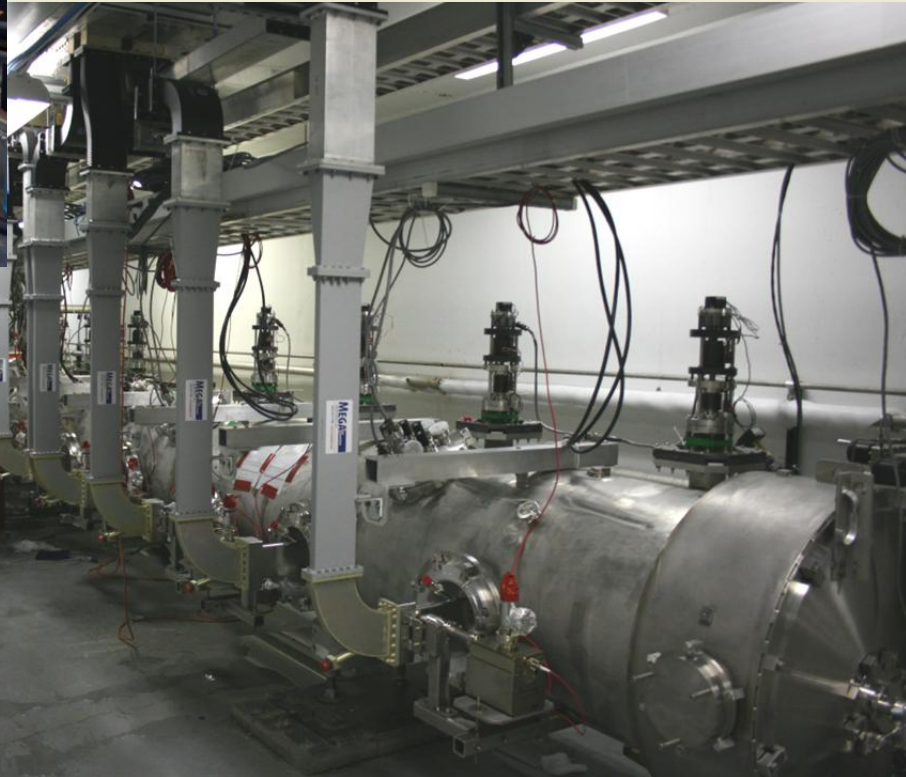
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C100 Cryomodule & New Zone Tunnel Waveguide



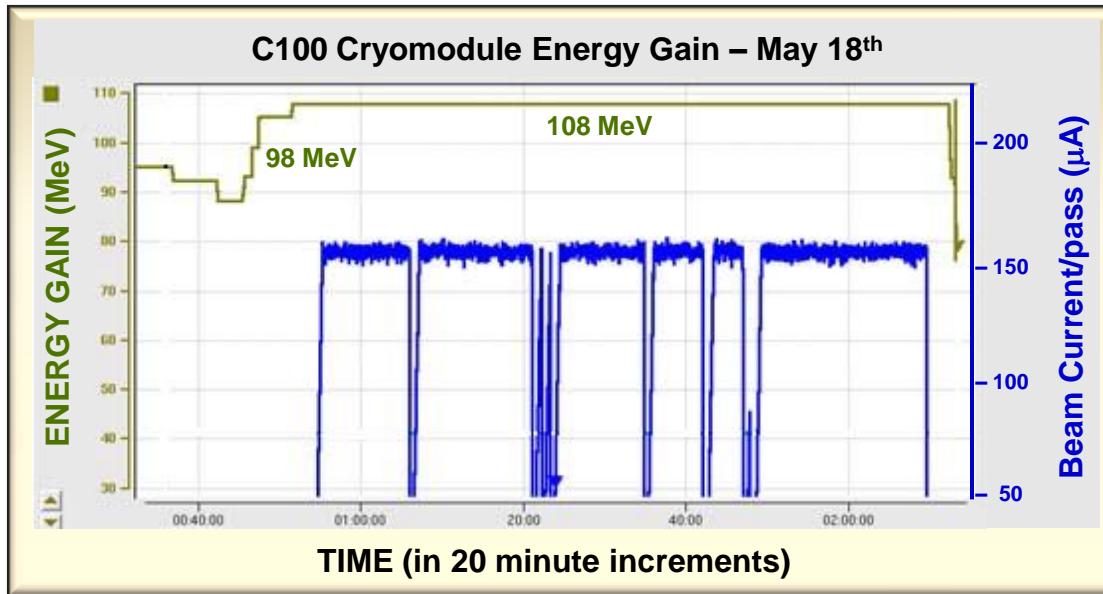
New Cryomodule – staged in Access Building prior to installation in tunnel

New Cryomodule with Waveguide installed in South Linac



12 GeV Upgrade – Accelerator Progress

- High gradient cryomodule performance demonstrated in tunnel
 - Met research beam spec. of **108 MeV @ 465 μ A**

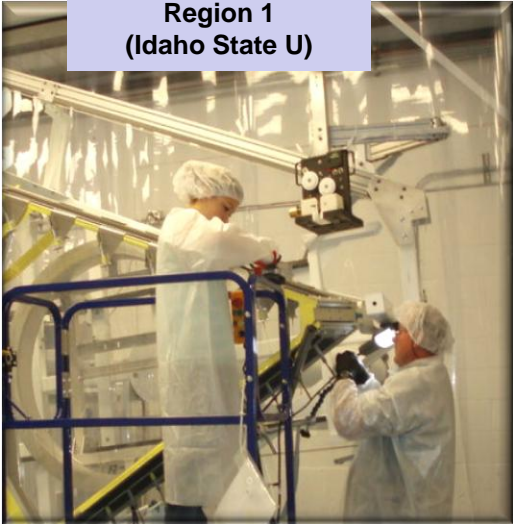


- Central Helium Liquefier-2 refrigerator in place
- Long accelerator shutdown started May 18th
- 12 GeV machine installation progressing on schedule

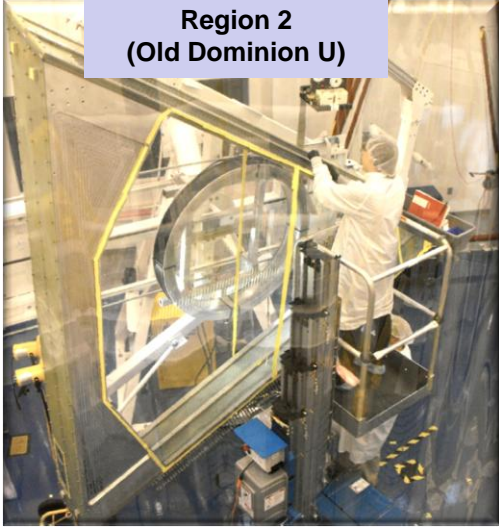


12 GeV Hall B – Detector Highlights

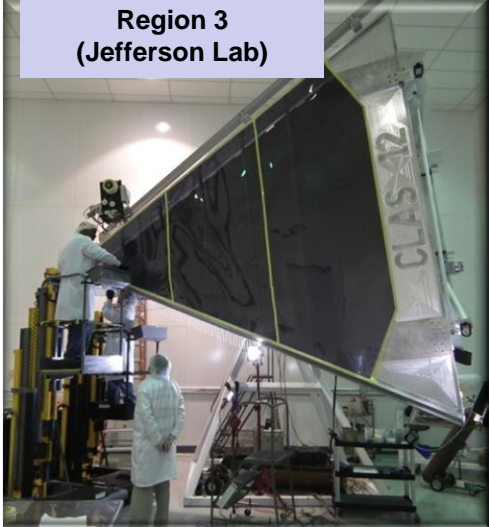
Drift Chamber
Region 1
(Idaho State U)



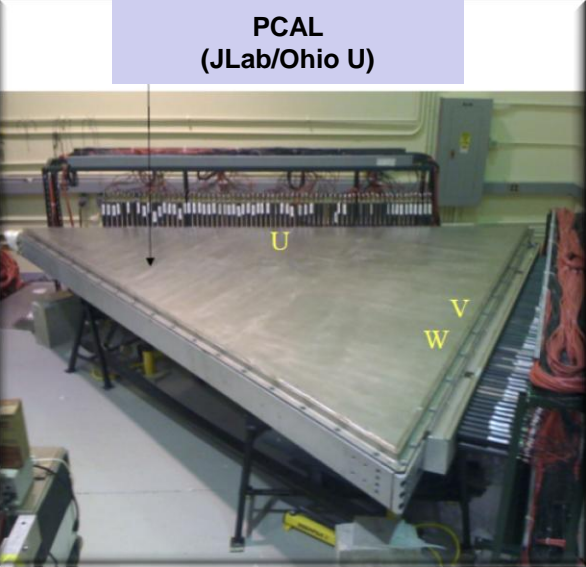
Drift Chamber
Region 2
(Old Dominion U)



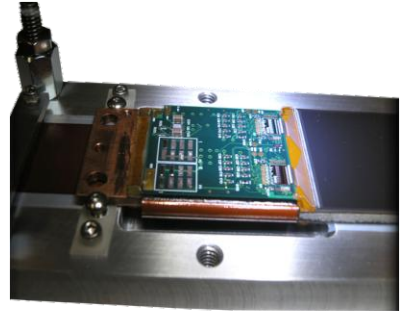
Drift Chamber
Region 3
(Jefferson Lab)



PCAL
(JLab/Ohio U)



Silicon Vertex Tracker
(JLab/FNAL/UNH)



12 GeV Hall C - Highlights

Dipole Magnet Prototype Coil
(SigmaPhi, France)

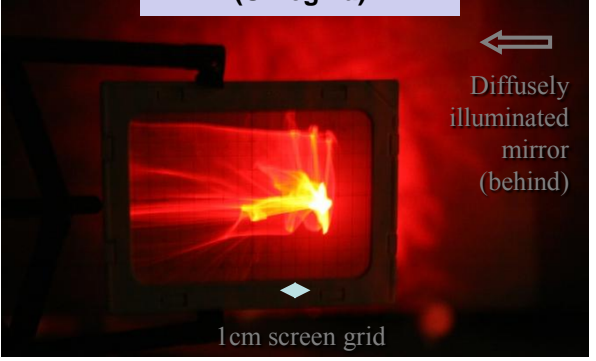


Vendor for magnet steel yokes is Ningbo Jansen in Zhejiang

Spectrometer Carriage Parts



HGC Mirror
(U Regina)



PreShower
(Yerevan/NSL)



Quartz Hodoscope
NCA&T



12 GeV Hall D - Highlights

Hall D Interior



BCAL Module
(Open House)

Mini-BCAL



Central Drift Chamber
(Carnegie Mellon U)



Forward Drift Chamber
(JLab)



CONSTRUCTION - Contributions

- National Science Foundation MRI awards:
 - *2007 Most detectors for Hall C (W&M, JMU, HU, NCA&T)*
 - *2008 Hall B PCAL detector (W&M, JMU, NSU, OU)*
 - *2009 Hall B Longitudinally polarized target (ODU, CNU, UVa)*
- Commonwealth of Virginia
 - *\$6M funding in support of Hall D*
- International contributions:
 - *Hall C lead glass calorimeter (Yerevan; NIKHEF)*
 - *Hall C heavy gas Cerenkov Counter (Canada NSERC – Univ of Regina)*
 - *Collaborations forming in support of equipment beyond the base Upgrade project, e.g. :*
 - *CLAS12 central detector*
 - *Hall A Moller experiment*
 - *Hall A SOLID experiment*

12 GeV Upgrade Summary

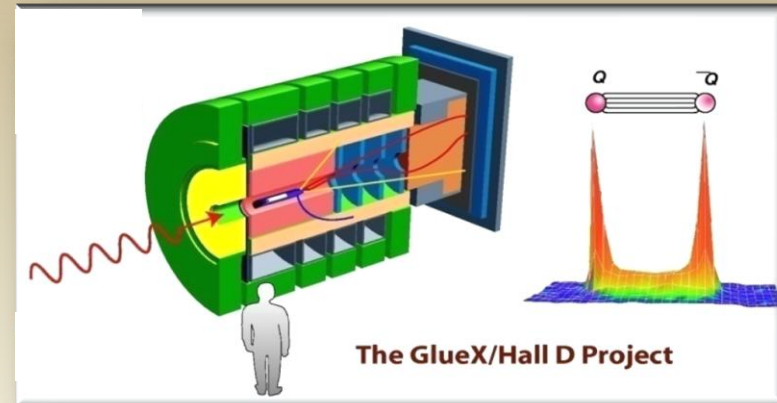
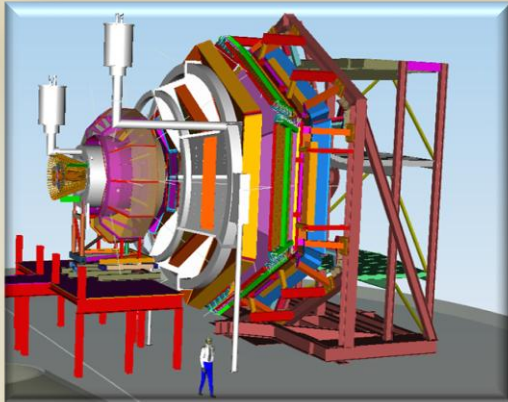
- **Very exciting times!**
- **Construction underway**
 - **Civil is ~95% complete**
 - **Accelerator ~70% complete**
 - **Physics equipment ~20 - 40% complete**
- **Strong User community involvement in detector construction**
- **Project performance well within DOE thresholds**
- **Some impact due to delayed funding**
 - **Rebaseline review planned for November 2012**
 - **Goal – Accelerator commissioning in 2014**

Great Scientific Research Opportunities Ahead

Backups

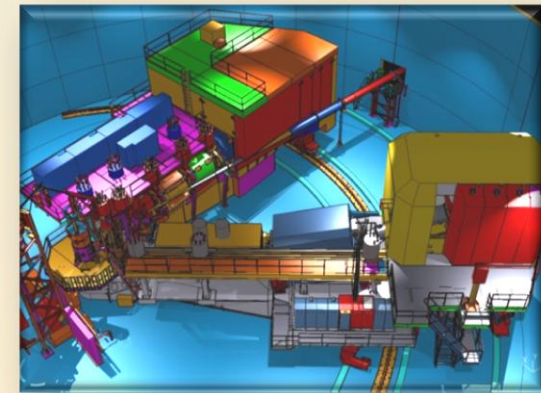
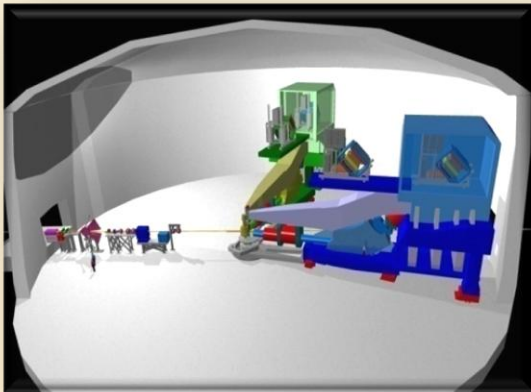
12 GeV Scientific Capabilities

Hall D – exploring origin of **confinement** by studying **exotic mesons**



Hall B – understanding **nucleon structure** via generalized parton distributions

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

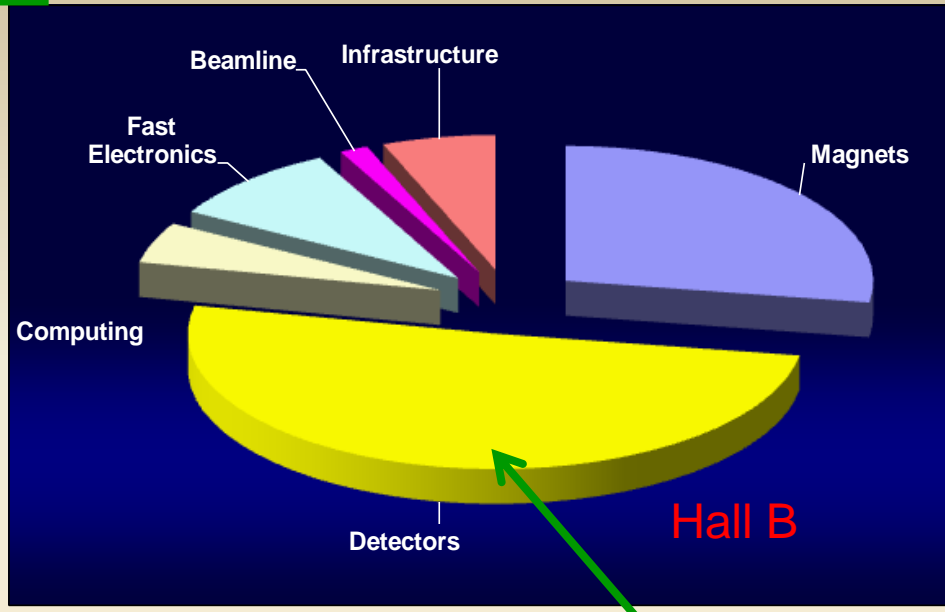
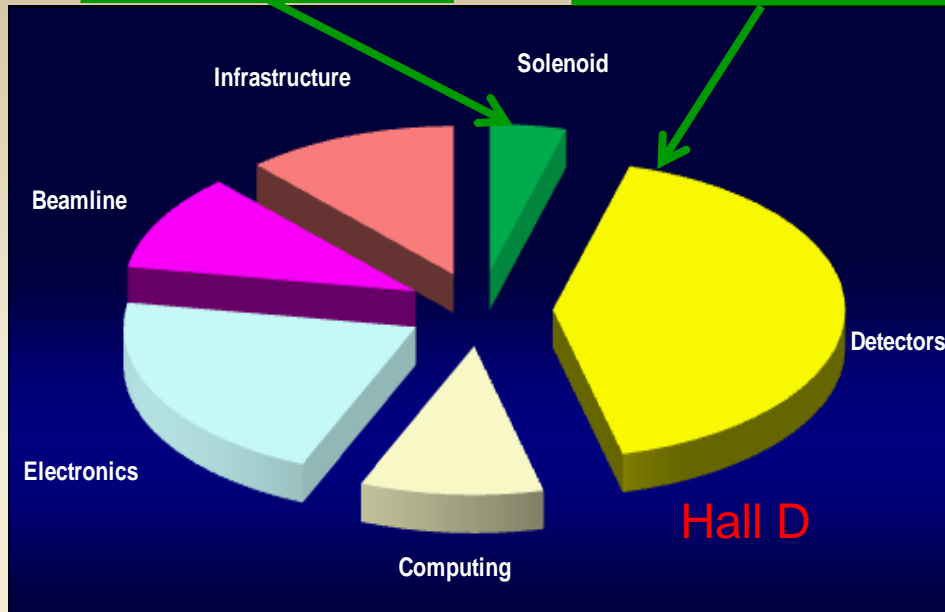


Hall A – form factors, future new experiments (e.g., PV and MOLLER)

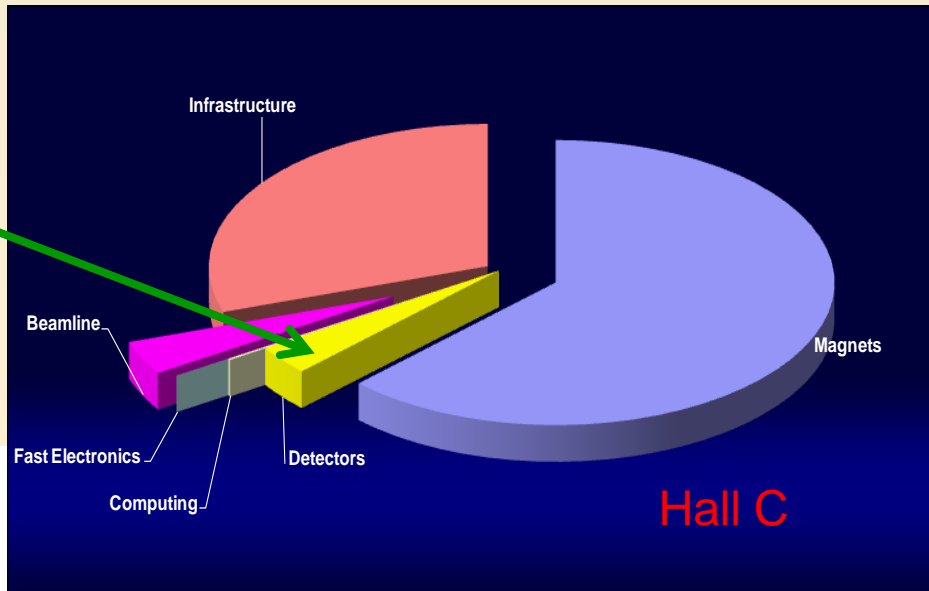
Comparison of Major Costs: Halls D, B, and C

existing magnet

Part on WFO funds

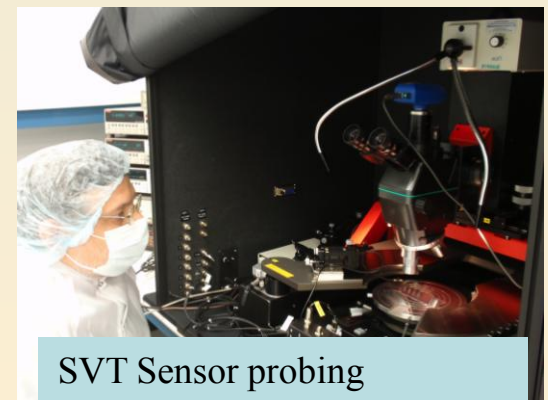
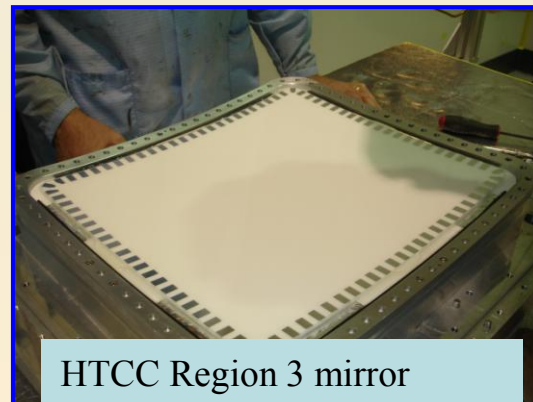


Most detectors funded through NSF/MRI grant and foreign contribution



2008 NSF/MRI grant approved for ~1/2 of PCal costs

Hall B Detector Progress



Hall D: Detector Progress

