

# 12 GeV Upgrade:

## Progress & Highlights

Allison Lung  
Deputy Project Manager

DOE SC-OPA Review of  
12 GeV Upgrade Project  
Jefferson Lab  
November 18-20, 2014

# OUTLINE

- **Jefferson Lab in 12 GeV Era**
  - **Project Description**
  - **Scientific Opportunities**
- **Progress & Highlights**
  - **Civil**
  - **Accelerator**
  - **Commissioning**
  - **Critical Decision 4A**
- **Path to Critical Decision 4B**
  - **Physics Equipment**
- **Summary**
- **Appendix – DOE Review Recommendations: Summary / Map**

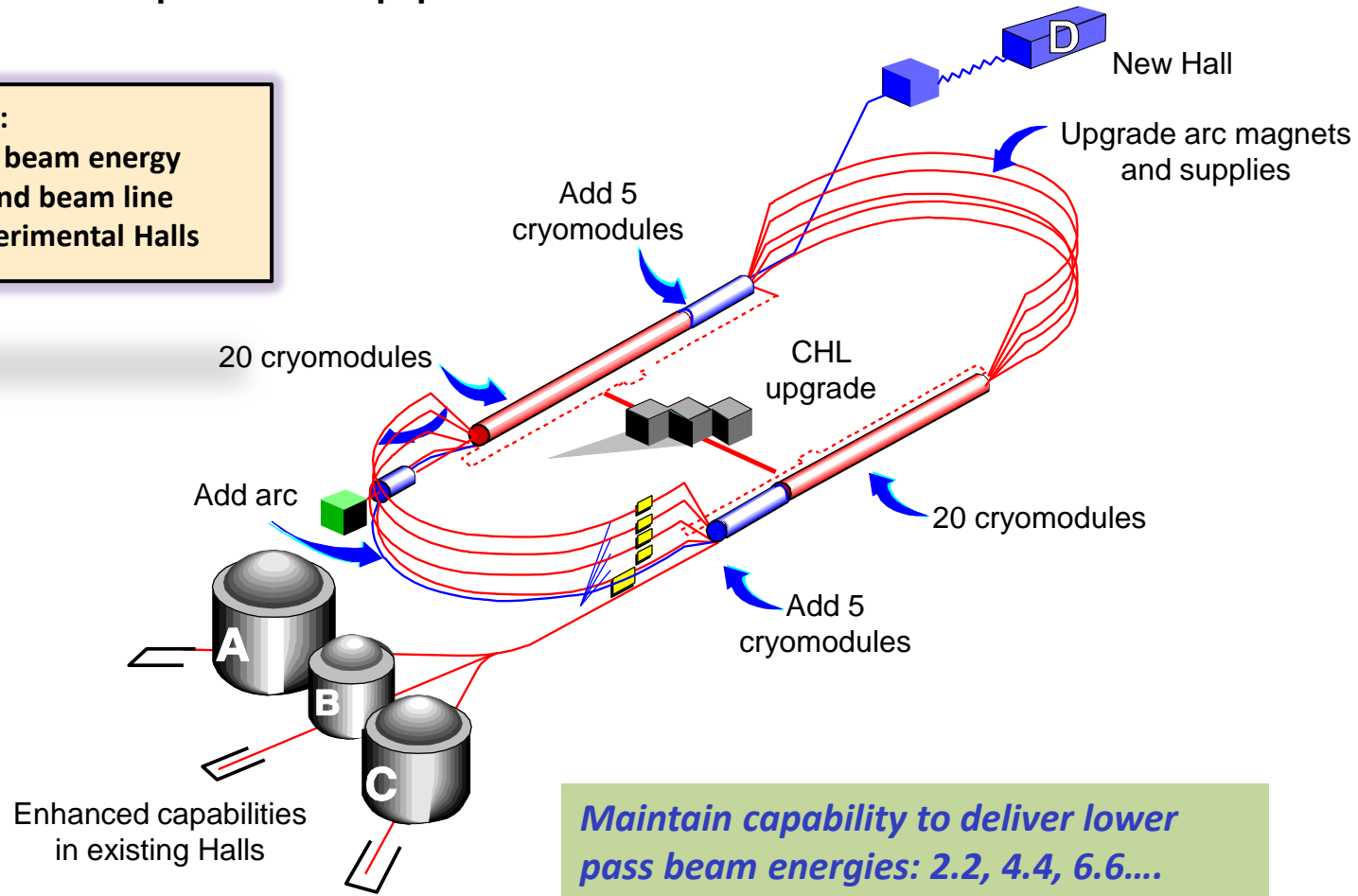


# 12 GeV Upgrade: Schematic

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

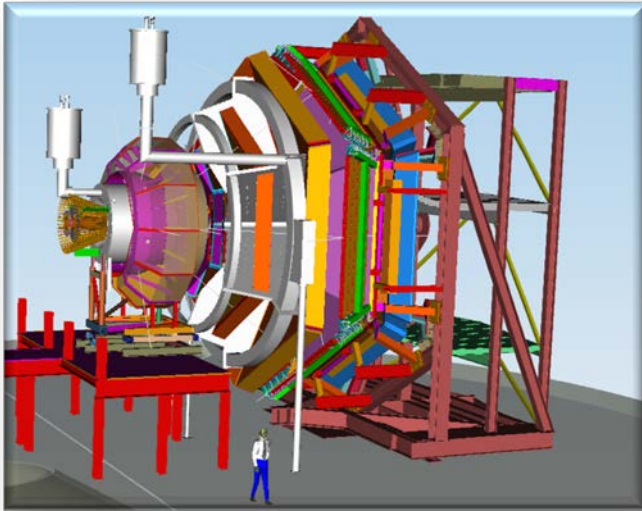
**Scope of the project includes:**

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

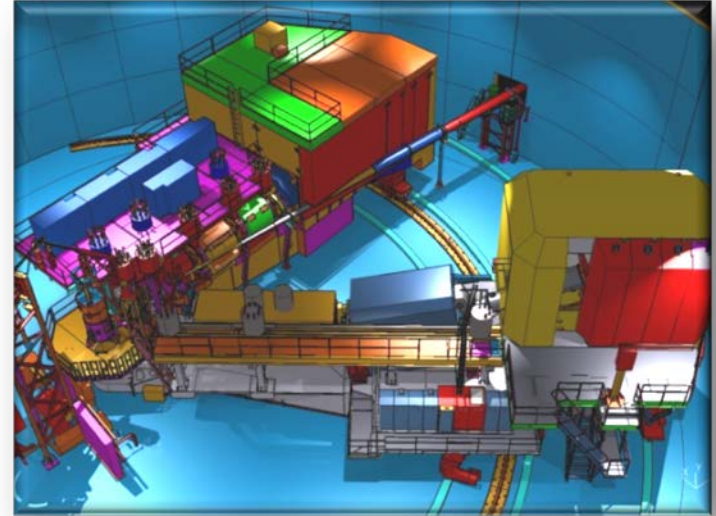


# 12 GeV Scientific Capabilities

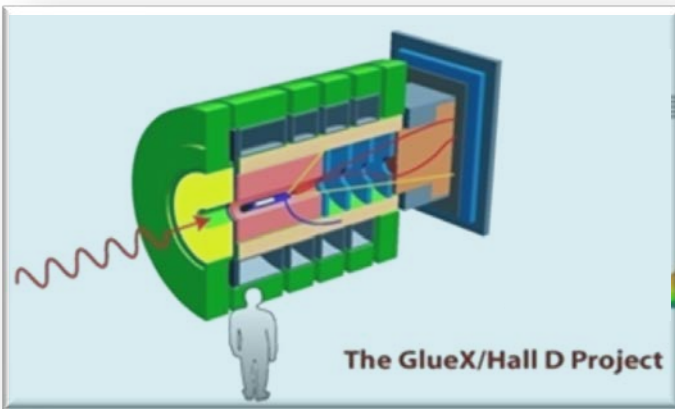
*Hall B* – understanding **nucleon structure** via generalized parton distributions



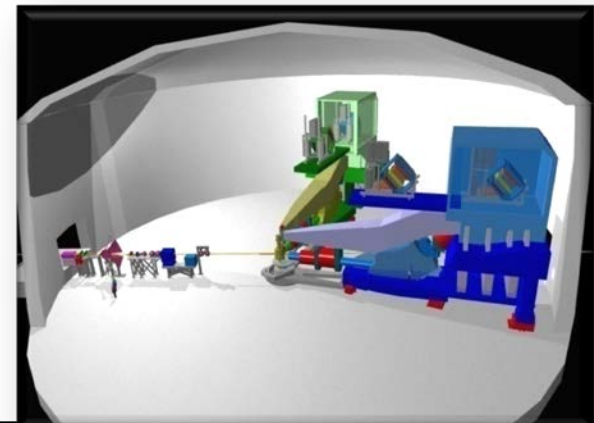
*Hall C* – precision determination of **valence quark** properties in nucleons and nuclei



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



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



# Hall B: CLAS12 Spectrometer

**CLAS – CEBAF  
Large Acceptance  
Spectrometer**

**CLAS6 – Former  
6 GeV  
Spectrometer**

**CLAS12 – New  
12 GeV  
Spectrometer**

High Threshold  
Cerenkov Counter  
(HTCC)

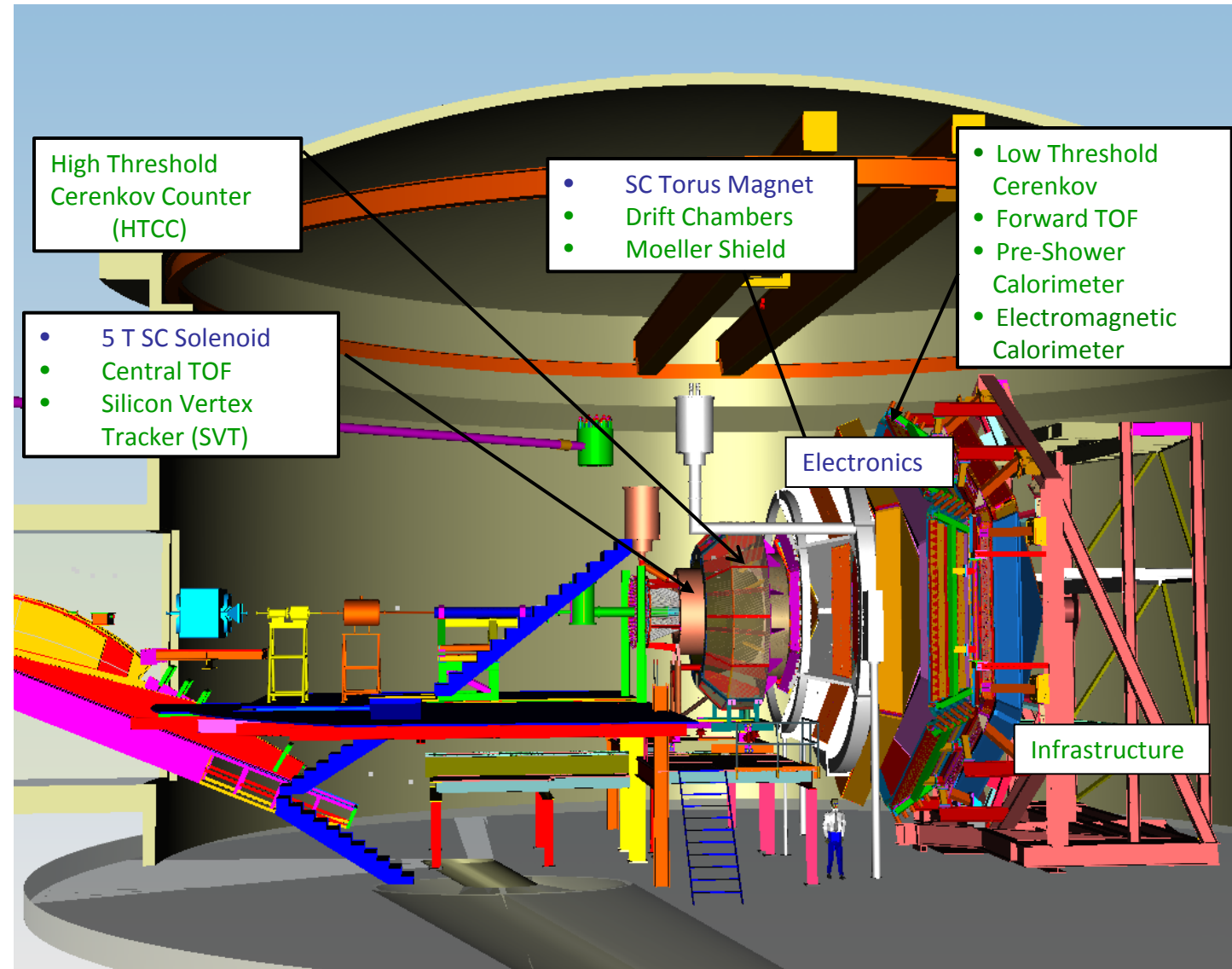
- 5 T SC Solenoid
- Central TOF
- Silicon Vertex Tracker (SVT)

- SC Torus Magnet
- Drift Chambers
- Moeller Shield

- Low Threshold Cerenkov
- Forward TOF
- Pre-Shower Calorimeter
- Electromagnetic Calorimeter

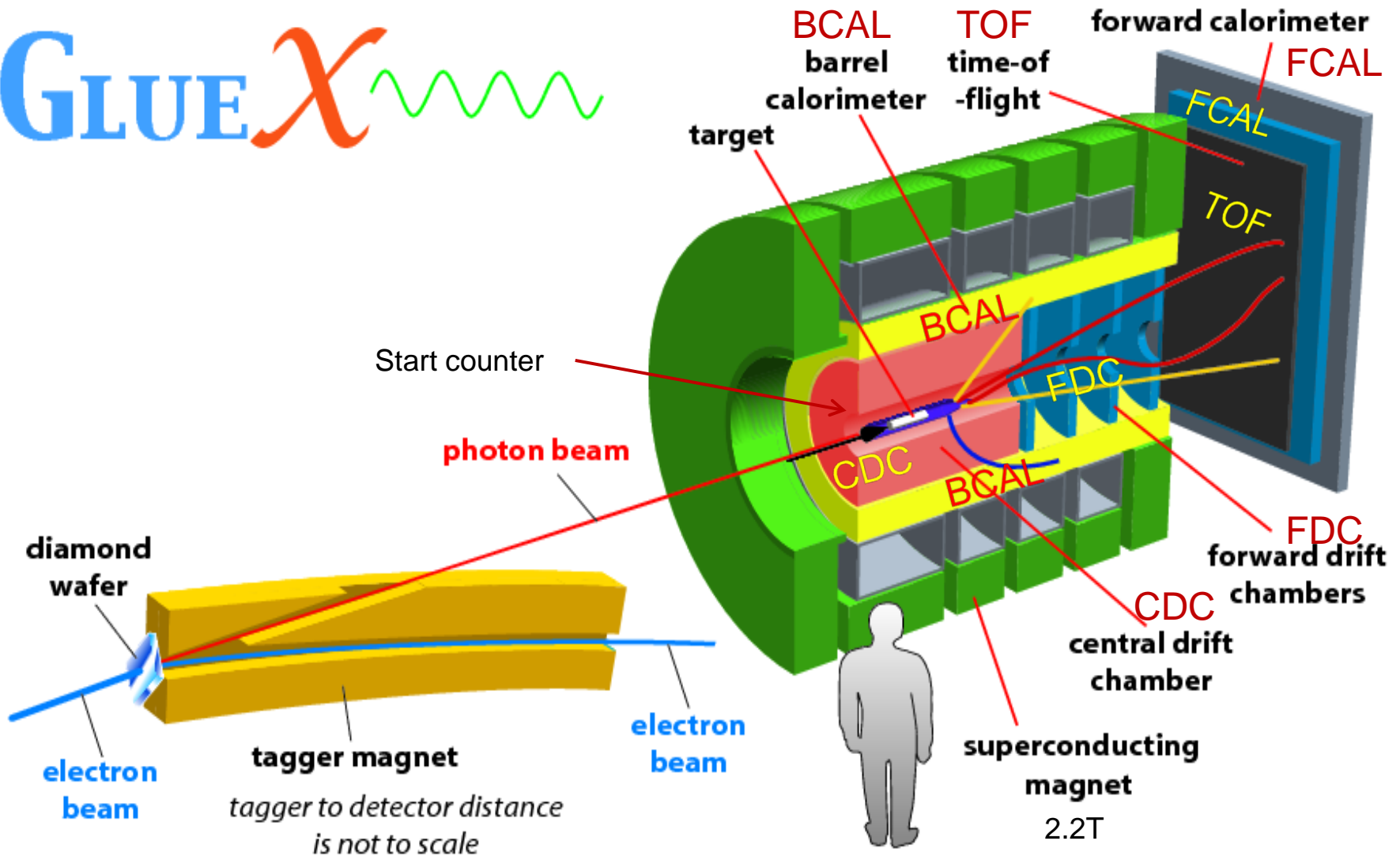
Electronics

Infrastructure

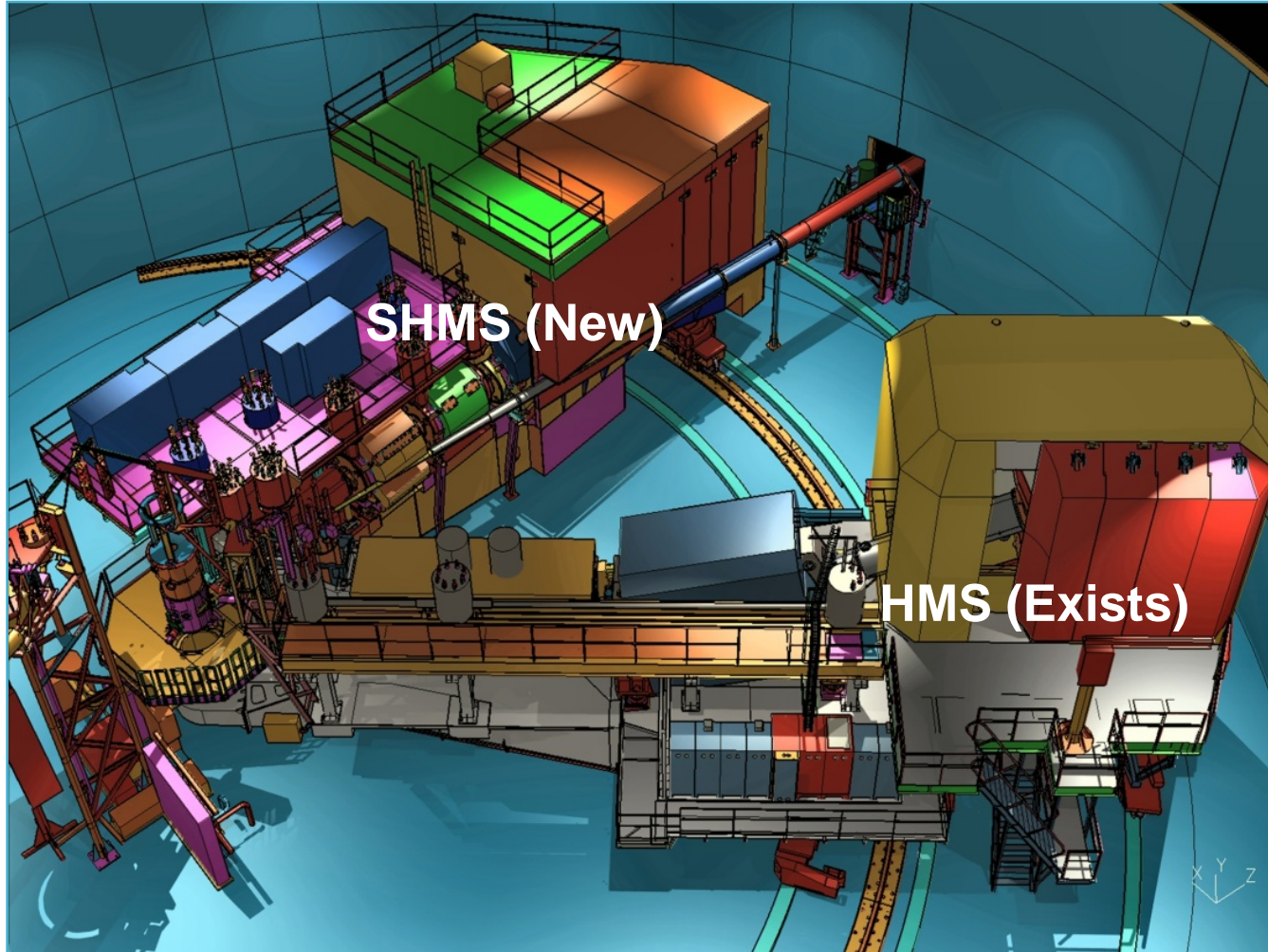


# Hall D: GlueX Spectrometer

GLUEX 

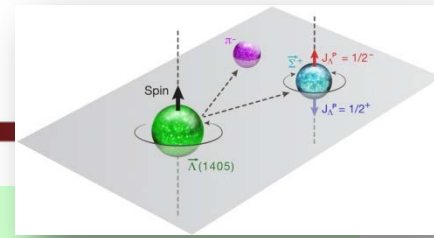


# Hall C: SHMS & HMS Spectrometers



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

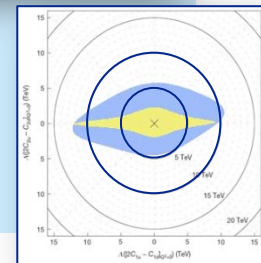
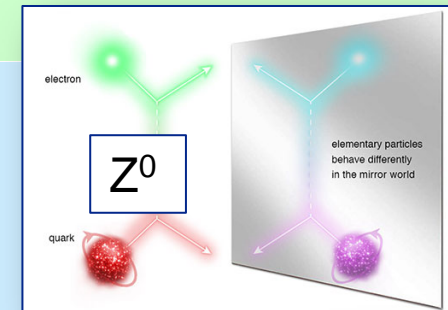
# 12 GeV Science Program



- 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

- Defining the Science Program:

- Program Advisory Committees (PAC) 2006 - 2014
- PAC41 (prioritization) held May 2014
- PAC42 in July 2014
- Results: *70 experiments approved ; 6 conditionally approved*



***Exciting slate of experiments for 4 Halls planned for first seven years of operation!***





# Critical Decision Schedule

## LEVEL 1 MILESTONES

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

*CD-4 split to ease transition into Operations Phase*

# CD-4A: Key Performance Parameters

Project Execution Plan: Table 5.1A

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

# Civil Construction: 93% Complete

## CHL Building Addition



## Hall D Complex



## North Access Building Addition



### SCOPE:

**New Construction ~10,080 sq ft**

**Add to Existing Buildings ~8,400 sq ft**

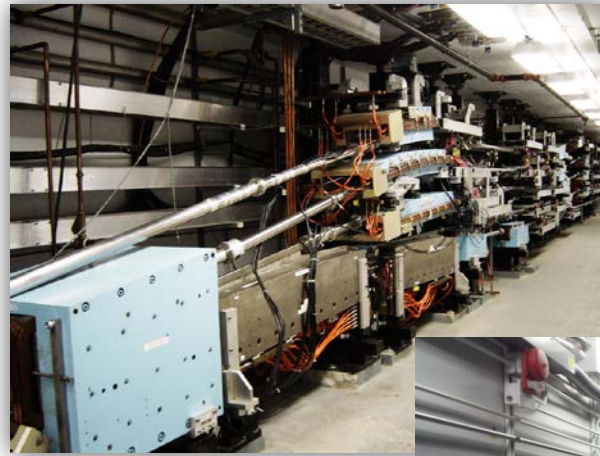
**Expansion of existing utilities**

**FY13 task complete: N&S Access Bldg AC**

**Two FY15 tasks remain:**

- **Tunnel AC; Back-up cooling towers**

# Accelerator Construction: 100% Complete



~\$104M EAC



Scope/Status in Plenary talk by L. Harwood

# Accelerator Commissioning

## Accelerator Readiness Review: Phased Approach (see P. Collins & M. Logue talks in SC-4 ESH)

- **Phase 1A (Aug 2013) :**
  - Core processes of ISM and Contractor Assurance (CAS)
  - Pre-planning of hot checkout and commissioning
- **Phase 1B (Oct 2013) :**
  - Status of processes and equipment for start of commissioning
- **Phase 2 (Jan 2014) :**
  - Verification: processes/equip in place for CW beam to Hall A and tune beam to Hall D Tagger vault
  - Review of Experimental Readiness Review Process (see P. Rossi talk in SC-4 ESH)
- **Phase 3 (August 2014) :**
  - Commissioning and operation of Hall D with multi-pass CW beam
  - Deliver multi-pass CW electron beam to Hall B and the (non-CLAS12) HPS experiment
- **Phase 4 & 5 (2016) :** CW beam to Halls B & C

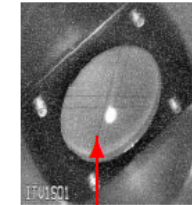
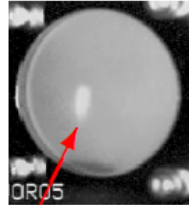
**The Accelerator Readiness Review (ARR), including the Experimental Readiness Reviews (ERR) went extremely successfully**

**This work was the basis for very successful and safe commissioning and operation**

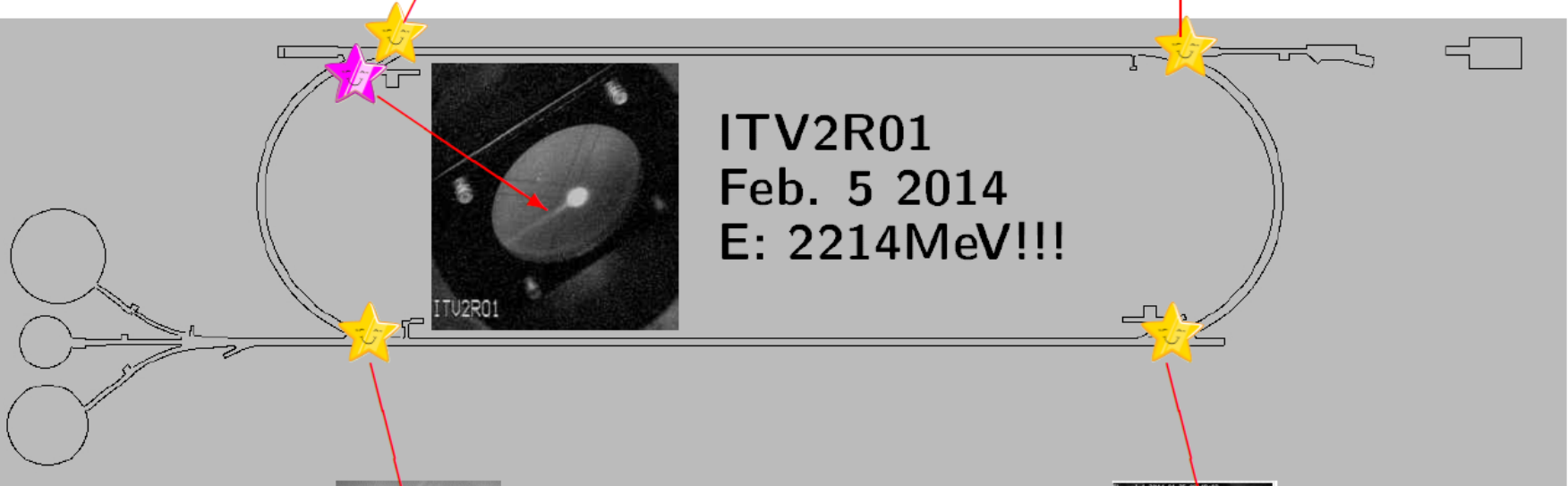
# 1-Pass Beam (KPP-4)

## Beam to 2R Dumplette: Jan 31, 2014

ITV0R05  
Dec. 13 2013  
E: 34MeV

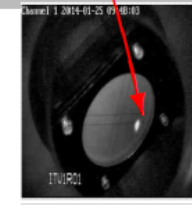
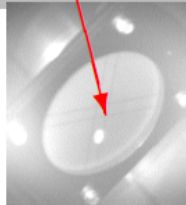


ITV1S01  
Jan. 16 2014  
E: 1124MeV



ITV2R01  
Feb. 5 2014  
E: 2214MeV!!!

ITV2S01  
Jan. 26 2014  
E: 2214MeV



ITV1R01  
Jan. 18 2014  
E: 1124MeV

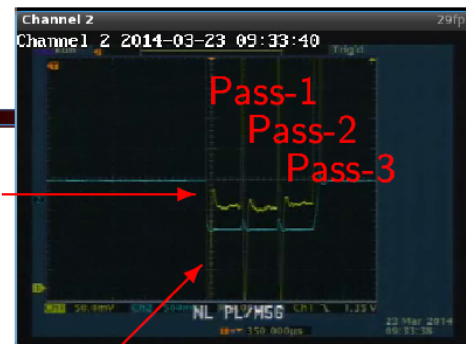
Courtesy of A. Freyberger, Head of Accelerator Operations

# 3-Pass Beam (March 15, 2014)

## Multi-pass operation

3-Pass beam to 6R!

Pathlength monitors (yellow trace) measures the phase difference of each pass to the Master Oscillator reference (10mV/degree).

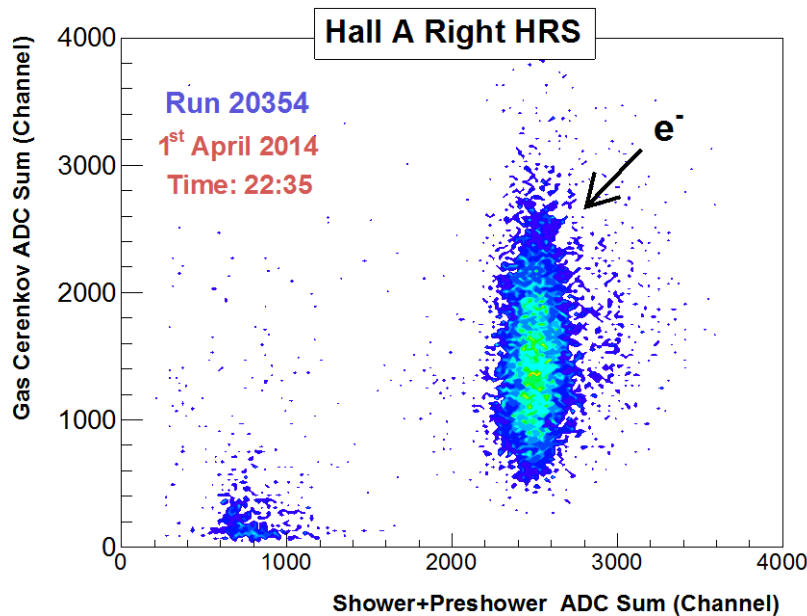


Courtesy of A. Freyberger, Head of Accelerator Operations

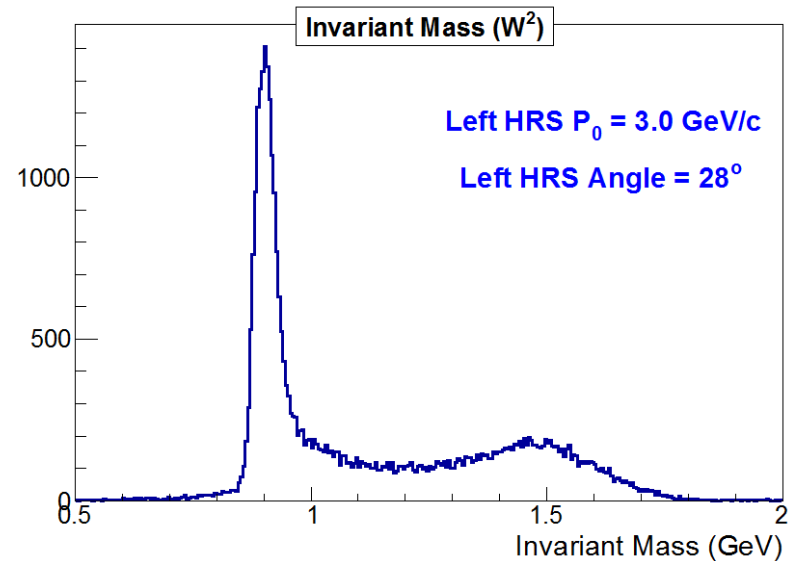


# Hall A – First Results from Beam

Electrons in Right HRS spectrometer at 2.0 GeV/c on carbon target and set beam energy of 6.1 GeV!



Electrons in Left HRS spectrometer at elastic kinematics on hydrogen target and set beam energy of 4.8 GeV – reproduces proton mass



April 1, 2014

# 5.5 Pass: 10.5 GeV to Hall D Tagger

Hall D Tagger Magnet/Dump



Arc 10

5.5 pass  
10.5 GeV



QuickPic - BEAM ON HALL D Tagger DUMP!

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

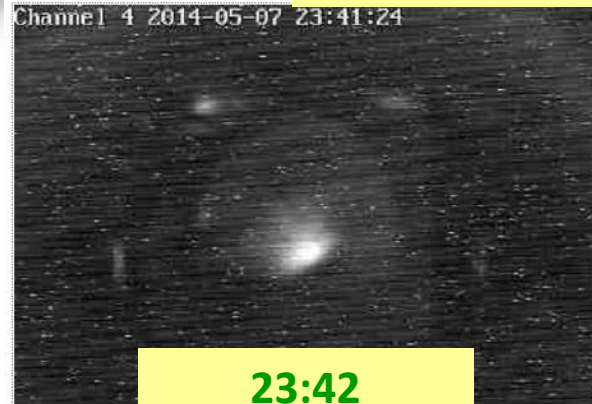
Last updated on Wed, 05/07/2014 - 23:42

Logbooks: ELOG  
Tags: Readme  
Entry Makers: eforman

Hall D  
Tagger Dump

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

Channel 4 2014-05-07 23:41:24



23:42  
May 7, 2014

Hall D Beamline



# CD-4A: Key Performance Parameters

Project Execution Plan: Table 5.1A

#	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

# CD-4A Requirements

Prior to CD-4	Demonstration	Timing	CD-4A STATUS
Verify that <u>Key Performance Parameters</u> have been met and that mission requirements have been achieved.	<p>FPD Approval Authority: Signature</p> <p>JLab to provide written summary that documents the validation of performance or completion as appropriate.</p>	CD-4A & CD-4B: As relevant to each	✓
Issue a <u>Project Transition to Operations Plan</u> .	JLab provides a TOP covering all CD-4A scope, with place holder sub-chapters to later add CD-4B scope. Document is under revision control, and requires DOE-NP, FPD, JLab signatures.	CD-4A & CD-4B: As relevant to each	✓
Conduct a formal assessment of the project's <u>Readiness to Operate</u> .	JLab provides summary of 2013/2014 ARR activities including related review reports and letters of approval.	CD-4A & CD-4B: As relevant to each	✓
Finalize the <u>Hazard Analysis Report</u> .	JLab provides the Jefferson Lab Final Safety Assessment (FSAD) Document and Accelerator Safety Envelope (ASE).	CD-4A	✓
Revise the <u>Environmental Management System</u> in accordance with DOE O 436.1.	Site Office / JLab to address within the lab's sustainability reporting requirements.	CD-4B	

# CD-4A Requirements

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

Post CD-4	Demonstration	Timing	CD-4A STATUS
Submit all <u>CD documents</u> to APM.	FPD will submit relevant documents to SC-28 for distribution to APM.	CD-4A & CD-4B: As relevant to each	✓
Finalize <u>PARS II</u> reporting.	FPD action item with JLab input as needed.	CD-4A & CD-4B: As relevant to each	✓
Within 90 days, submit <u>Lessons Learned</u> regarding project execution and facility start-up to PSO and APM.	JLab provides a draft document covering all lessons related to CD-4A scope, with place holder sub-chapters to later add more lessons related to CD-4B scope.	CD-4A & CD-4B: As relevant to each  (Lessons Learned will become part of Project Close-Out Report at CD-4B)	✓
Within 90 days, submit an <u>Initial Project Closeout Report</u> .	The OPA Template for the Project Closeout Report will be followed.	CD-4B	

# DOE Review Recommendation

## Recommendation # 2014 Apr IPR-11:

“Proceed to work with the Site Office no later than May 2014 in requesting CD-4A.”

## Status:

All CD-4A technical requirements were met as of May 6, 2014. All required documentation was completed and posted on a dedicated website for DOE review by May 31, 2014. An ESAAB was convened on July 30, 2014, and CD-4A Approval was granted by the Acquisition Executive, Dr. T. Hallman.

**Closed**

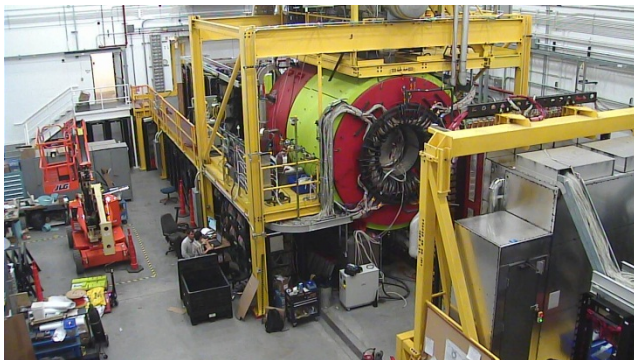
# Scope Remaining: Path to CD-4B

Project Execution Plan: Table 5.1B

#	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

(see Plenary talk by G. Young)

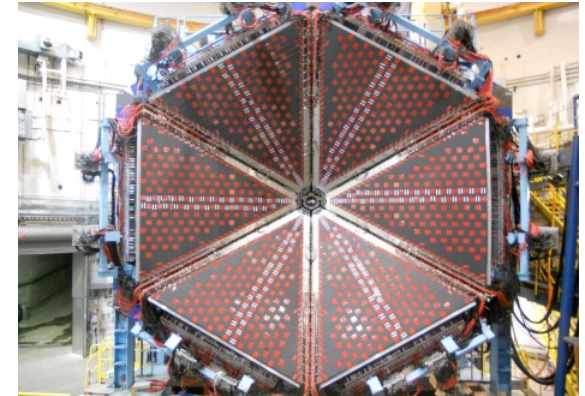
Hall D 100% complete:



Hall C 77% complete:



Hall B 76% complete:



# Highlights - Summary

- Accelerator Construction Complete: *outstanding team effort*
- Safe & Successful Accelerator Commissioning
  - based on solid ARR & ERR processes
- Led to CD-4A Approval in July 2014
- Significant progress in Experimental Equipment construction
- Exciting 12 GeV Scientific program continues to develop
  - special prioritization PAC in May 2014

***Beam Commissioning in Hall A (done) & Hall D underway!***



# APPENDIX:

Previous DOE SC-OPA Review Recommendations –  
Status 228 out of 232 Closed.

# DOE SC-OPA Recommendations - Presentations

## PHYSICS

Rec #	Recommendation	Talk	Closed
13 May IPR-03	Establish continuous onsite presence at commercial vendors of superconducting magnets with schedules near the project critical path (ETI, Sigma Phi), as soon as practical.	R. Fair, Plenary	Open
13 May IPR-12	Develop a succession plan for key project positions.	A. Lung, Breakout	Closed
13 May IPR-13	Develop and implement project lessons learned, including technical, cost, schedule, and management. Present results at the next review.	A. Lung, Breakout	Closed
13 Aug IPR-02	Hall D: In case continued analysis determines that a repair is needed, potential repair or mitigation plans should be considered, in order to determine what contingency to hold for this magnet.	C. Rode, Breakout J. Creel, Breakout	Closed

# DOE SC-OPA Recommendations - Presentations

## PHYSICS

Rec #	Recommendation	Talk	Closed
13 Aug IPR-03	Hall C: If supplies of superconducting cable limit the number of spare coils that can be fabricated to two, fabrication of two spare Dipole coils could be considered instead of one spare Dipole coil and one spare Q2/Q3 coil.	G. Young, Breakout P. Brindza, Breakout	Open
14 Apr IPR-01	Hall B Magnets: Develop a successful coil impregnation process with highest priority.	C. Luongo, Breakout	Closed
14 Apr IPR-02	Hall B Magnets: Determine if existing impregnated spare coil has voids using non-destructive testing.	C. Luongo, Breakout	Closed
14 Apr IPR-03	Hall B Magnets: Develop a contingency plan to obtain space SC conductor and other critical materials.	G. Young, Breakout	Closed
14 Apr IPR-04	Hall B Magnets: Fully qualify all production processes prior to implementation.	R. Fair, Plenary	Open
14 Apr IPR-05	Hall B Magnets: Quantify and document the impact of field quality of 100, 200, and 300 ppm on the ability of the Hall to carry out their physics program.	J. Hogan	Open

# DOE SC-OPA Recommendations - Presentations

## PHYSICS

Rec #	Recommendation	Talk	Closed
14 Apr IPR-06	Hall C Magnets: Continue vendor presence and monitoring.	R. Fair, Plenary	Closed
14 Apr IPR-07	Hall C Magnets: Develop a consistent and demonstrated VPI process and QA procedure to be implemented by vendors for the remaining superconducting magnets.	P. Brindza, Breakout	Closed
14 Apr IPR-08	Hall D: Carry out a study of the physics impact of running the Hall D solenoid at lower fields. Results should be analyzed and summarized in a document made available to Hall D experimenters. The Monte Carlo study should focus on more than one physics measurement and should address not only reductions in physics sensitivity but also potential increases in running time required to obtain a significant measurement.	E. Chudakov, Breakout	Closed
14 Apr IPR-09	Methodically resolve outstanding technical issues with magnets as soon as possible.	C. Rode, Breakout	Closed

# DOE SC-OPA Recommendations - Presentations

## Project Management

Rec #	Recommendation	Talk	Closed
14 Apr IPR-10	Continue and enhance the pro-active management approach across all elements of the Project.	A. Lung, Breakout	Closed
14 Apr IPR-11	Proceed to work with the Site Office no later than May 2014 in requesting CD-4A.	A. Lung, Plenary	Closed
14 Apr IPR-12	Conduct a DOE review in early FY15.	A. Lung, Breakout	Closed