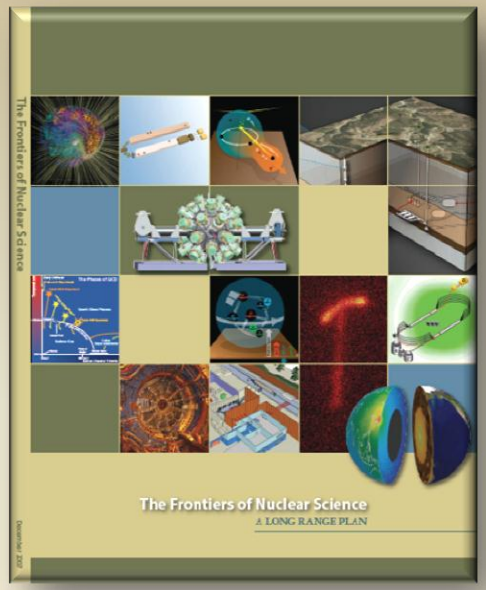
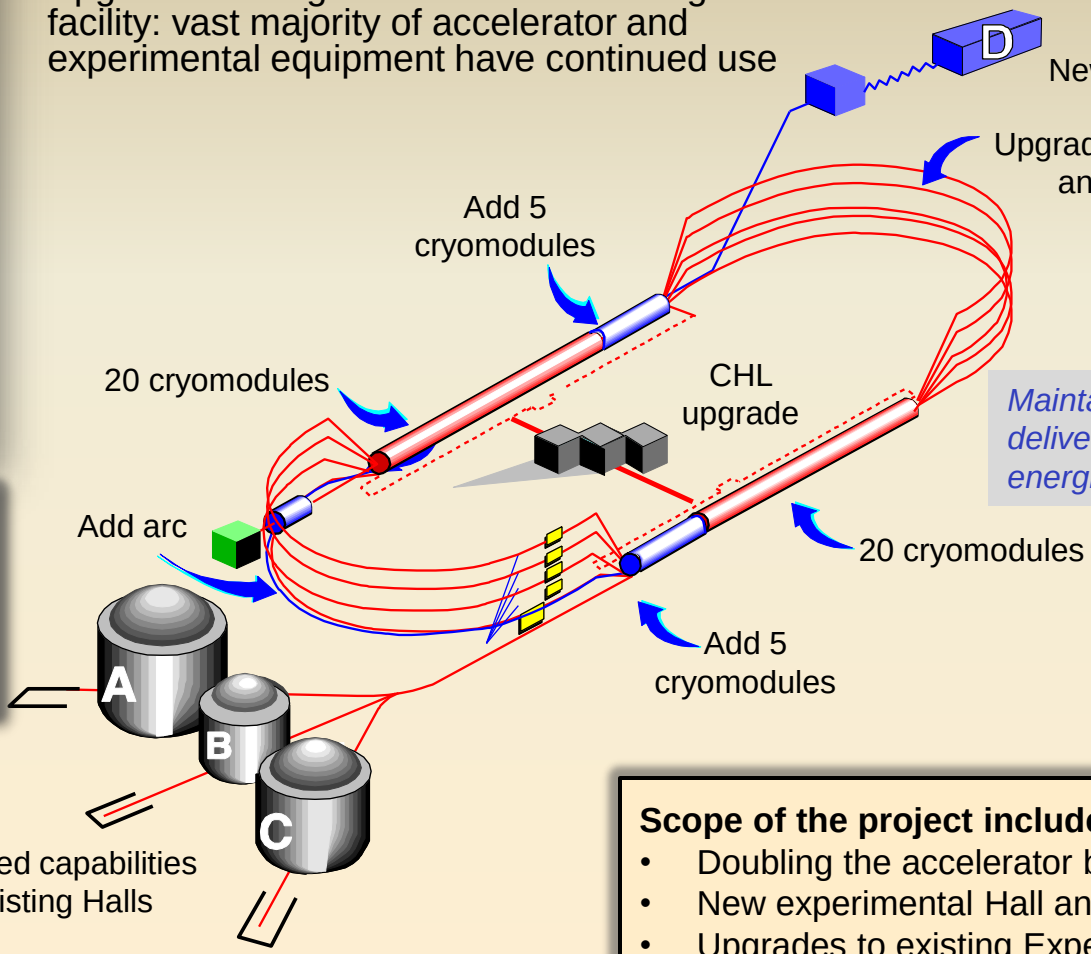
12 GeV Upgrade Project - Status

12 GeV Upgrade Project



The completion of the 12 GeV Upgrade of CEBAF was ranked the highest priority in the 2007 NSAC Long Range Plan

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



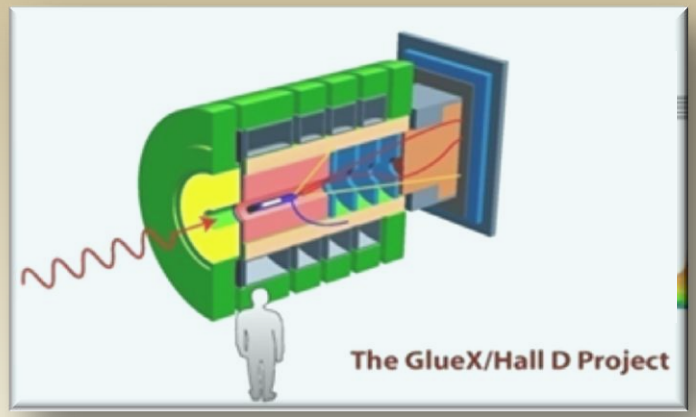
*Maintain capability to deliver lower pass beam energies: **2.2, 4.4, 6.6….***

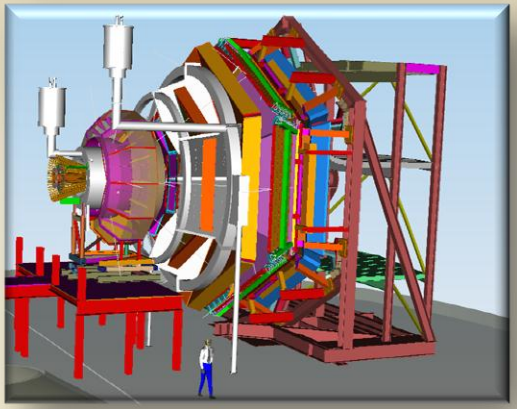
Scope of the project includes:

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

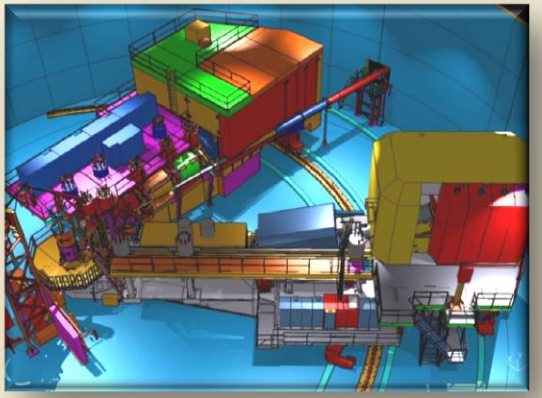
12 GeV Scientific Capabilities

Hall D – exploring origin of confinement by studying exotic mesons

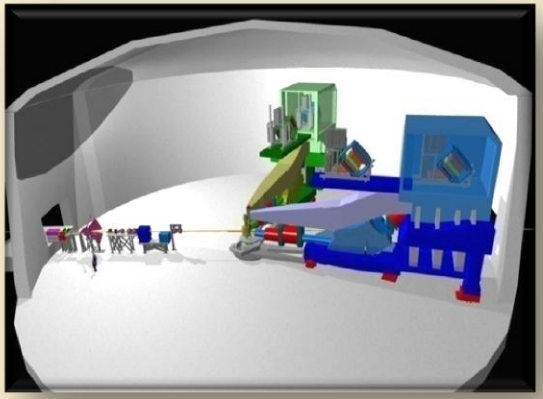




Hall B – understanding nucleon structure via generalized parton distributions



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



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

12 GeV Science

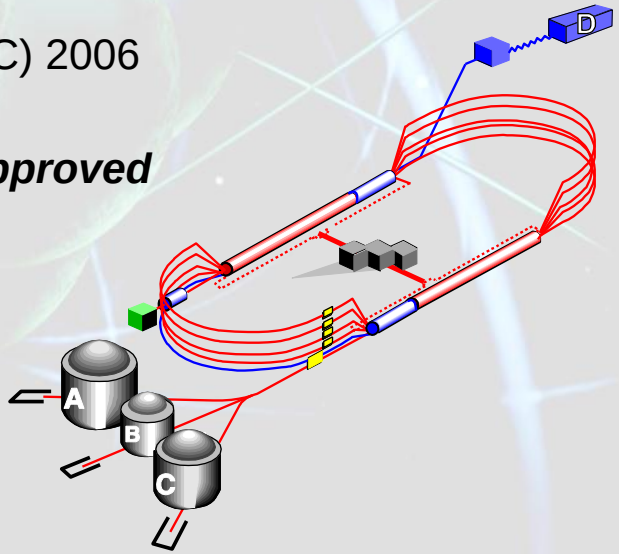
New phenomenology
techniques (theory+exp)
standard model tests

Discovery Potential

Defining the Science Program:

- **Highest priority in 2007 NSAC Long Range Plan**
- **Eight Reviews:** JLab Program Advisory Committees (PAC) 2006 through 2012
- **Results**: ***52 experiments approved; 15 conditionally approved***
- **PAC40 scheduled June 2013**
- **White paper for 2012 NSAC subcommittee published**

Experiments for 4 Halls approved for more than seven years of operation beginning in FY15



12 GeV Approved Experiments by PAC Days

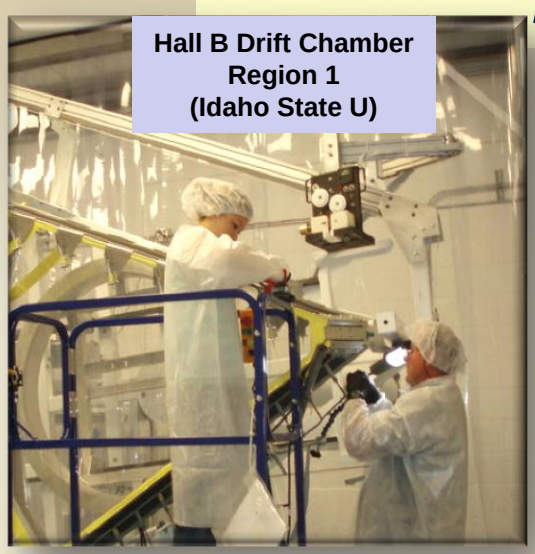
Topic	Hall A	Hall B	Hall C	Hall D	Total
The Hadron spectra as probes of QCD (GlueX and heavy baryon and meson spectroscopy)		119		120	239
The transverse structure of the hadrons (Elastic and transition Form Factors)	144	85	102		331
The longitudinal structure of the hadrons (Unpolarized and polarized parton distribution functions)	65	120	140		325
The 3D structure of the hadrons (Generalized Parton Distributions and Transverse Momentum Distributions)	409	982	108		1499
Hadrons and cold nuclear matter (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	114	120	179		413
Low-energy tests of the Standard Model and Fundamental Symmetries	513			79	592
Total	**1245**	**1426**	**529**	**199**	**3399**

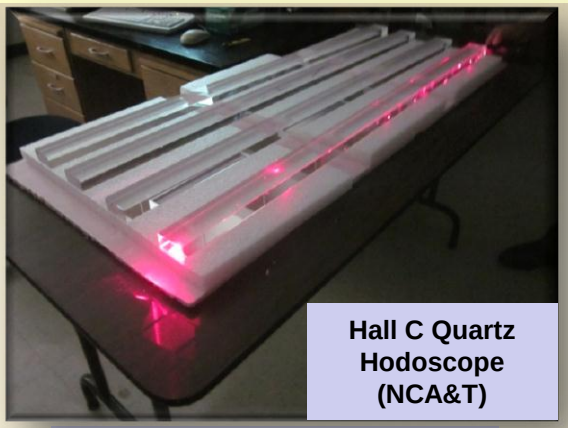
More than 7 years of approved experiments

12 GeV Upgrade – Detector Highlights

All major detector systems under construction; many undergoing testing

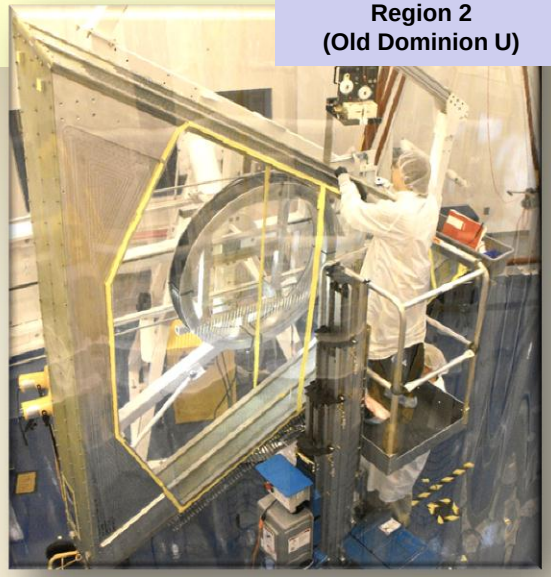
Hall B Drift Chamber Region 1 (Idaho State U)





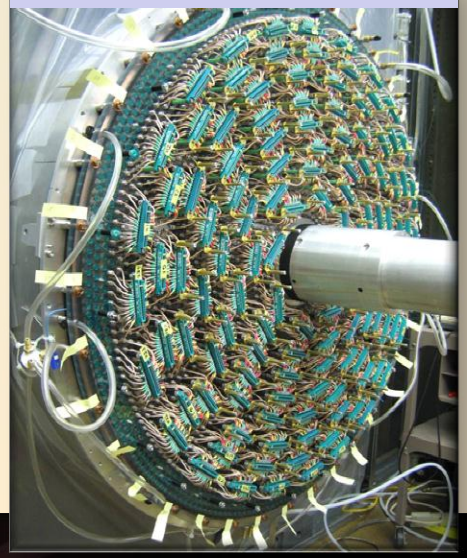
Hall C Quartz Hodoscope (NCA&T)

Hall B Drift Chamber Region 2 (Old Dominion U)



Hall B PCAL (JLab/OU)

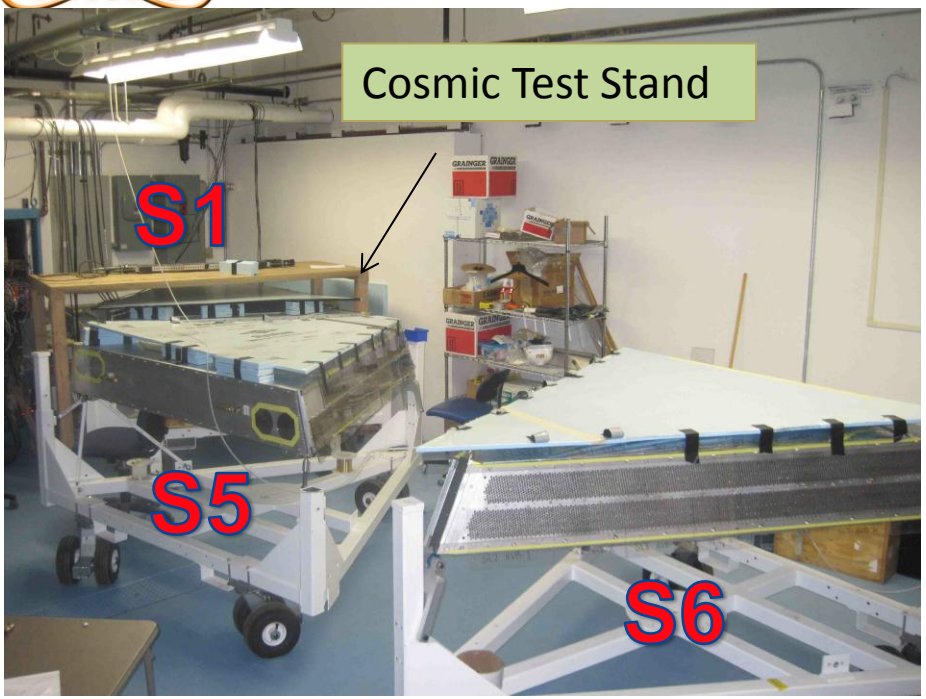
Hall D Central Drift Chamber (Carnegie Mellon)



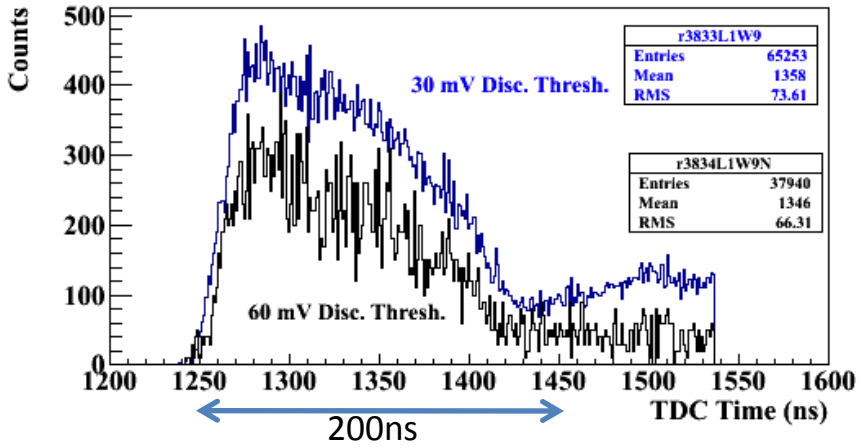
Hall D Forward Drift Chamber (JLab)

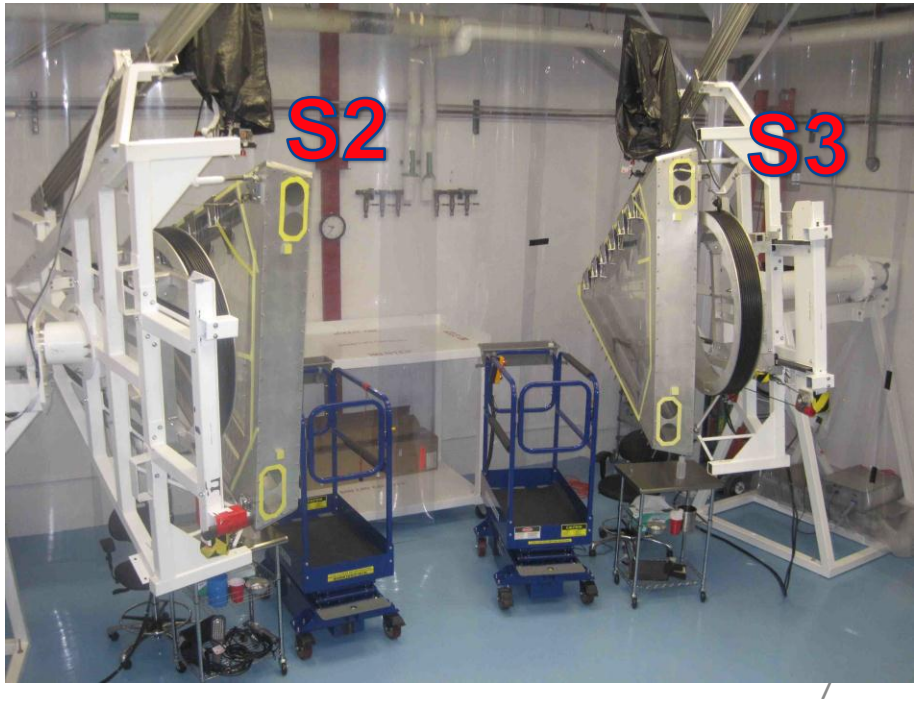
Jefferson Lab

CLAS12 Drift Chambers (DC R1)



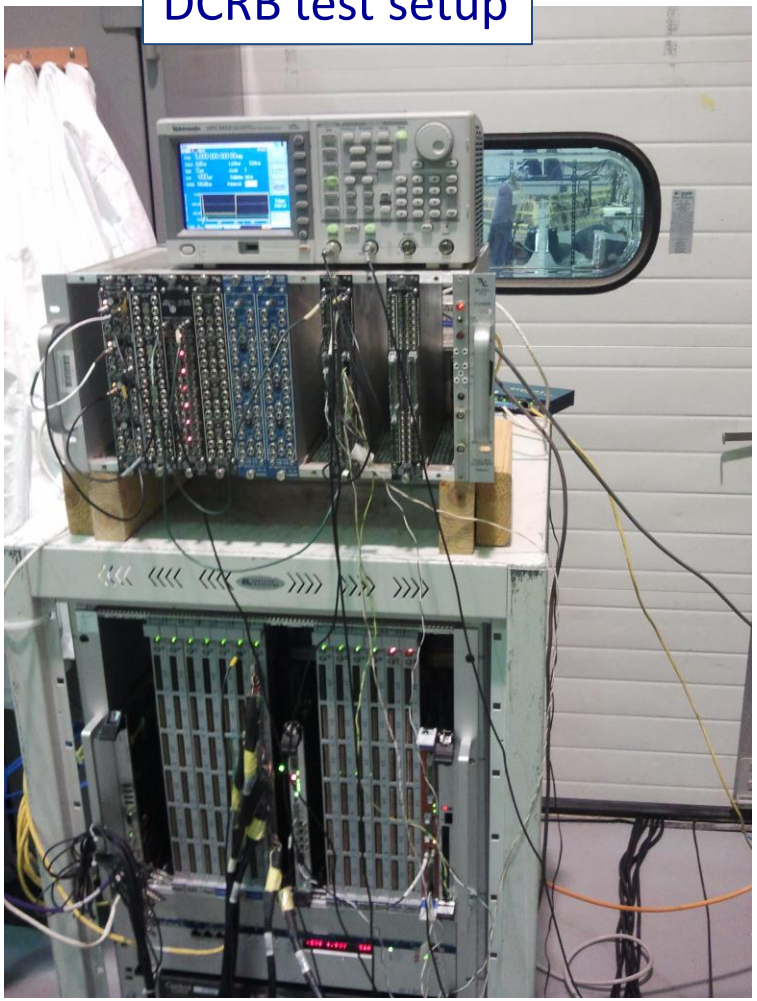
S1, S5, & S6 are strung
S1 ready for shipping
S5 & S6 ready for HV test
S2 & S3 stringing underway
Expected completion: August 2013





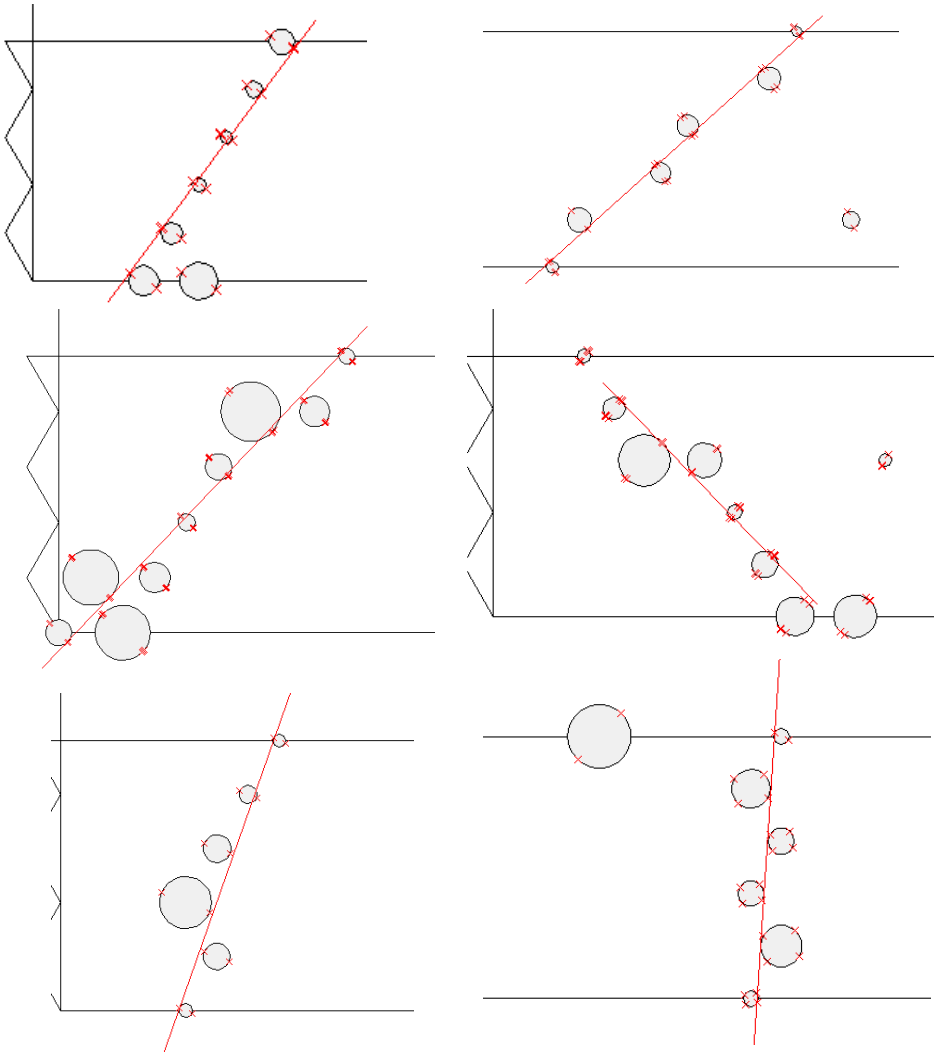
CLAS12 DC R2 - Cosmic Ray Tests

DCRB test setup



ODU – R2 sector, efficiency measured just over 98% at 2550V

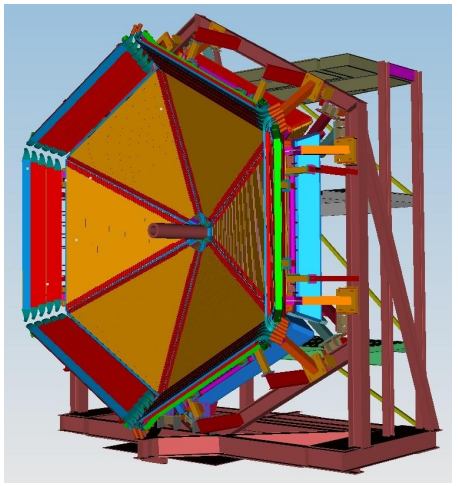
"good" events (non-typical)



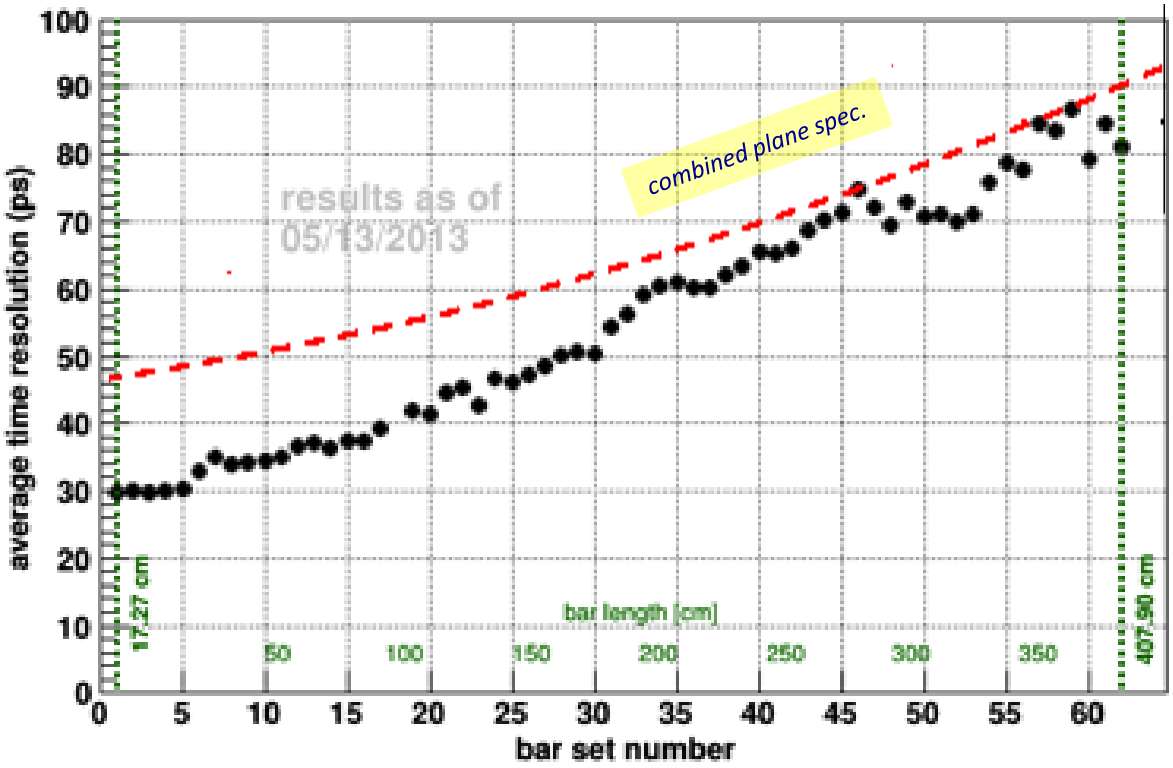
CLAS12 Forward ToF (FTOF)

- Panel 1a: Refurbishment and QA with cosmic rays completed at JLab
- Panel 1b: Project developed, constructed and all scintillator bars tested at **University of South Carolina**

Purpose: Provide timing information for charged particle id and separate pions, kaons and protons. Also used in fast trigger decision.



FTOF New Panel Time Resolution Measurements



Panel-1b arrays:

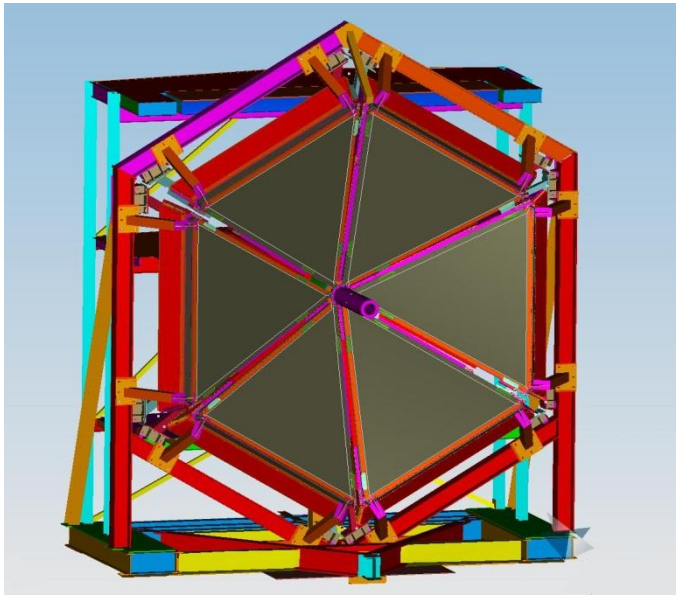
- 62 counters in 6 sectors

L = 17 → 408 cm, 6 cm x 6 cm
double-sided readout
Hamamatsu R9779 PMTs

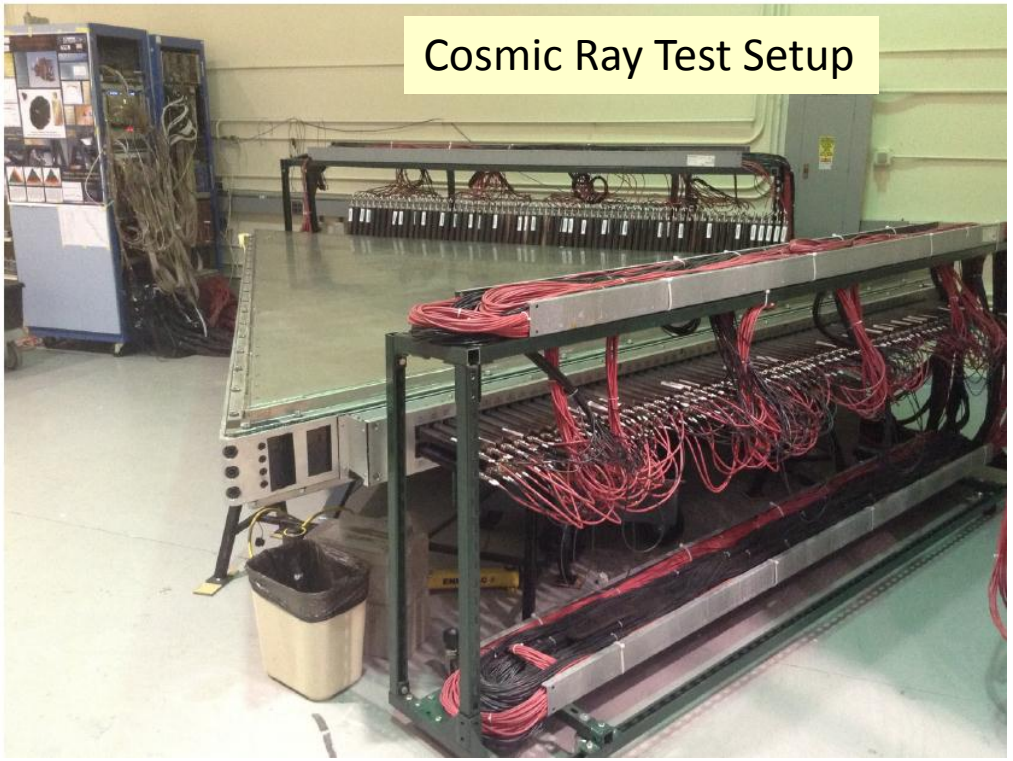
- all counters meet timing specs.

- **Transport to JLab June 2013**
- **Ready for installation Jan. 2014**

CLAS12 – Preshower Calorimeter (PCAL)



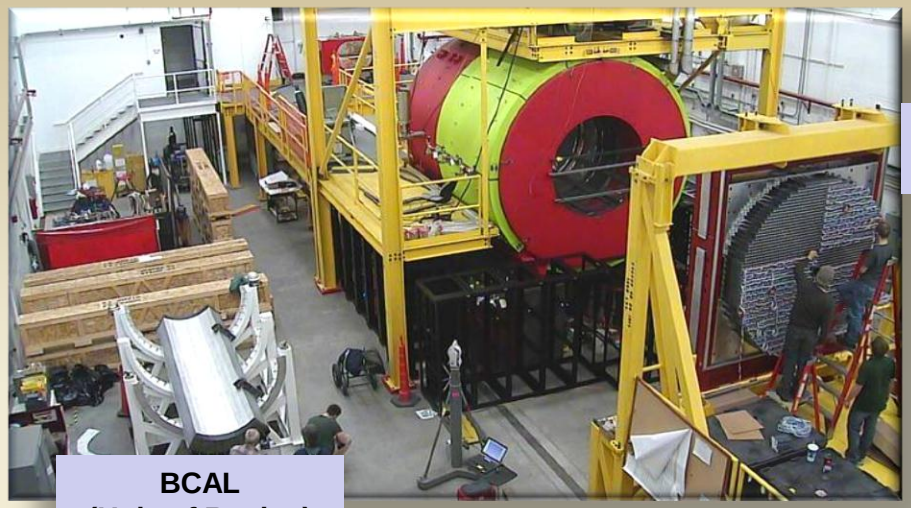
Purpose: Used primarily for id of electrons, photons, π^0->$\gamma\gamma$, and neutrons.



Status:

- All six PCAL modules are fully assembled.
- Five have been QA cosmic ray tested and are ready to be installed.
- Sixth module will be tested in June.
- It took two years and 6 months from the moment of receiving components to fully assemble and test all 6 modules of CLAS12 PCAL.

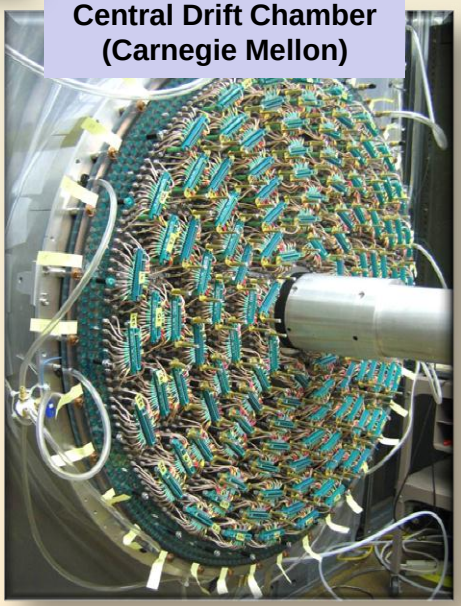
Hall D – Detector Highlights



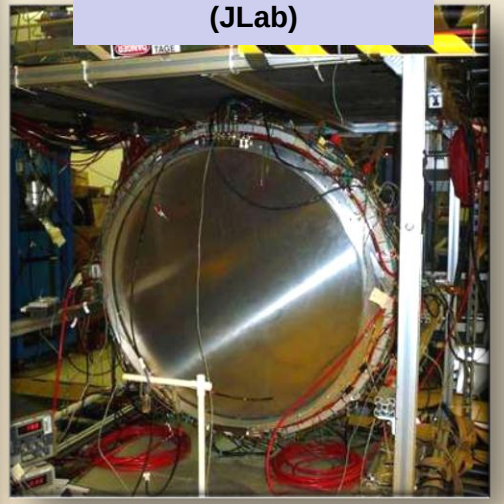
BCAL
(Univ of Regina)

FCAL
(Indiana Univ)

Central Drift Chamber
(Carnegie Mellon)



Forward Drift Chamber
(JLab)



FSU – TOF scintillators, light guides

CUA – tagger hodoscope

UConn – tagger microscope

UMass – F1TDC testing

Hall C – Highlights

DETECTORS (NSF-MRI funded):

Hampton University – past half-way point in stringing the second wire chamber assembly.

The first chamber stack is under high voltage and signals from it are being studied.

Univ of Virginia - manufacturing design detailing for the noble gas Cerenkov continues, PMTs and mirrors are ordered.

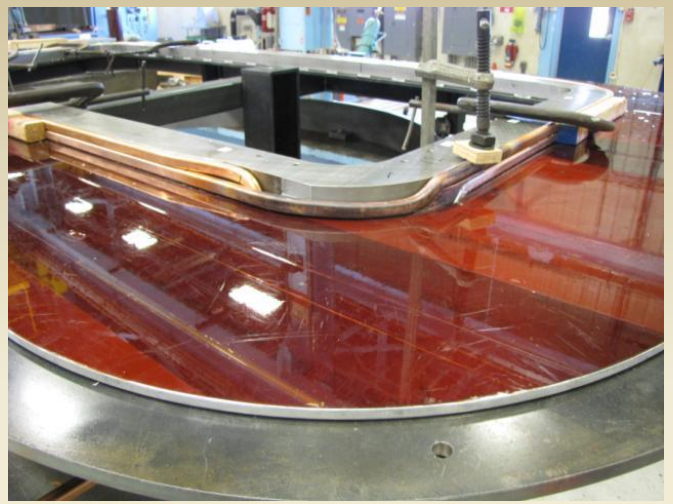
Univ of Regina - The parts for the heavy gas Cerenkov counter are being readied at for shipment to Jefferson Lab, followed by assembly on-site planned for June 2013

Q1 Magnet Yoke Stack complete at SMI, UK

12 GeV Spectrometer SC Magnets

Hall C SHMS:

- HB – Michigan State Univ making good progress
- Q1 – Scientific Magnetics, UK all 4 coils built, assembly to be done at nearby subcontractor
- D/Q2/Q3 – Sigma Phi, France coil winding procedures including conductor pre-compression under development



Hall B CLAS12:

- Torus – FNAL start of prototype coil winding this week; JLab design effort & cryostat factory making solid progress
- Solenoid – Everson Tesla, PA, Intermediate Design Review scheduled for June 26, 2013.

CLAS12 Torus coil winding table at FNAL

Hall D:

- Solenoid – successfully tested at 1500A, quench requiring re-assessment of procedures before tests start again, future refrigerator repair required

12 GeV Upgrade - Accelerator Highlights

Commissioning start – September 2013

SRF Technology: Production for CEBAF

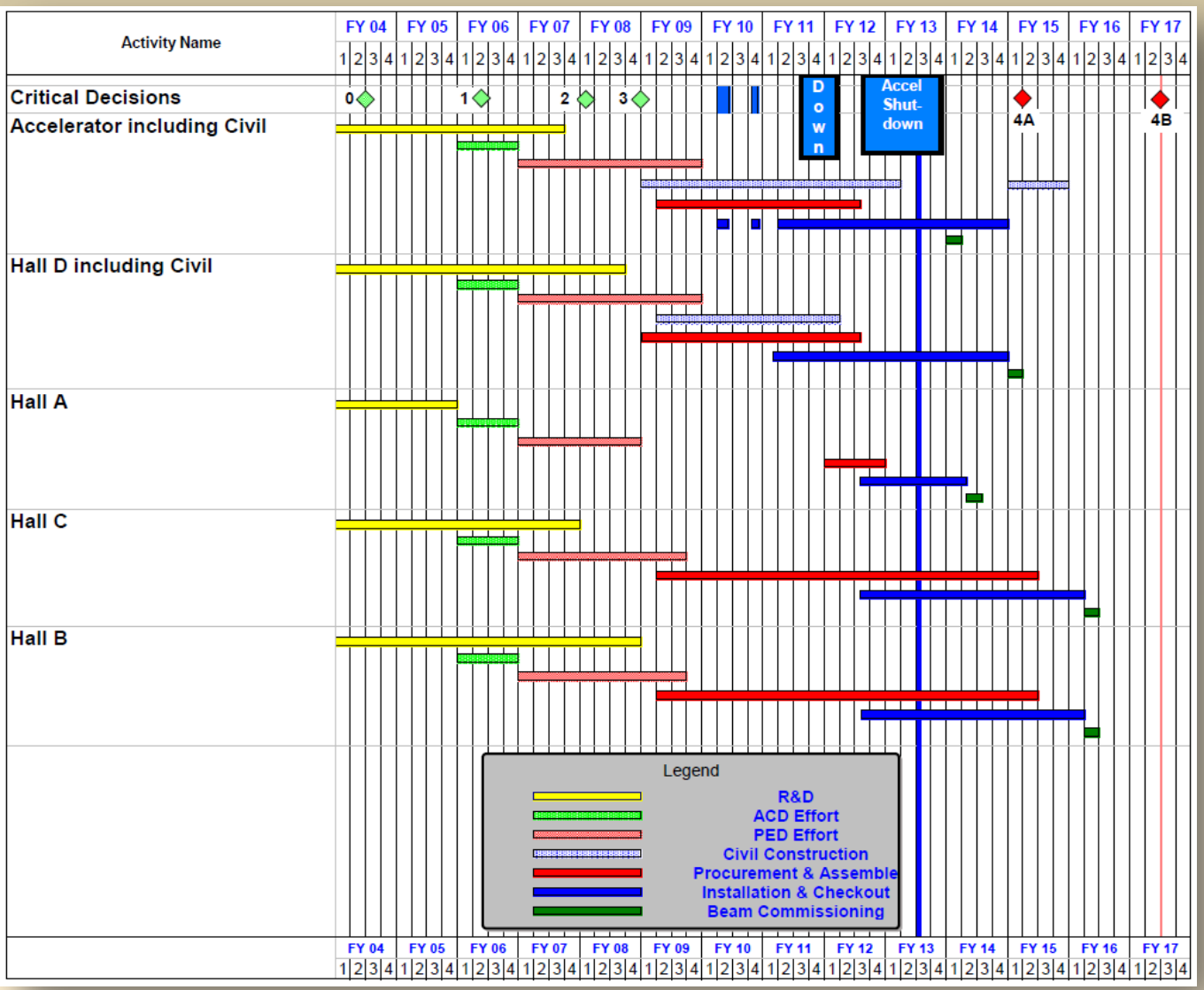
- Ten C100 cryomodule production for 12 GeV successfully completed (last 3 in the new TLA)

- C100 testing in CMTF (Cryo-Module Test Facility) completed on June 6, 2013
- All ten C100 cryomodules installed in the tunnel
- Commissioning of C100 in the tunnel progresses well, 6 done, 4 to go
- Re-commissioning of C20 and C50 (6 GeV CEBAF cryomodules) being performed in parallel with C100 commissioning
- The gradient improvement program for the C50 has started:
  - First improved C50 will be ready for commissioning with beam (start in mid Nov 2013).
  - Plan is to rework one C50/year during 12 GeV CEBAF operations.

Accelerator Status

- RF Power: ahead of cryomodule commissioning
- Magnet Power:
  - Trim PS arriving (50 of 260)
  - Box PS supplies: Arc 1 about to ship; Arc 2/Hall A about to start test
- Cryogenics: CHL2
  - Met the commissioning performance goals
- Extraction:
  - Installation of rf components underway in service building
- I&C: Controls software nearly complete; Safety systems ready for beam
- Beam Transport:
  - Arcs: East Arc final aligned; West Arc being final aligned
  - Hall A/Hall B/Hall C: HA dipole measurements complete
  - Hall D: dipoles going in

12 GeV Upgrade Project Schedule



FY12: reduction of $16M
FY13: no restoration

Present expectation (subject to rebaseline approval in August):

16-month installation
May 2012 - Sept 2013

Accelerator commissioning start
Oct 2013

Hall A commissioning start
Feb 2014

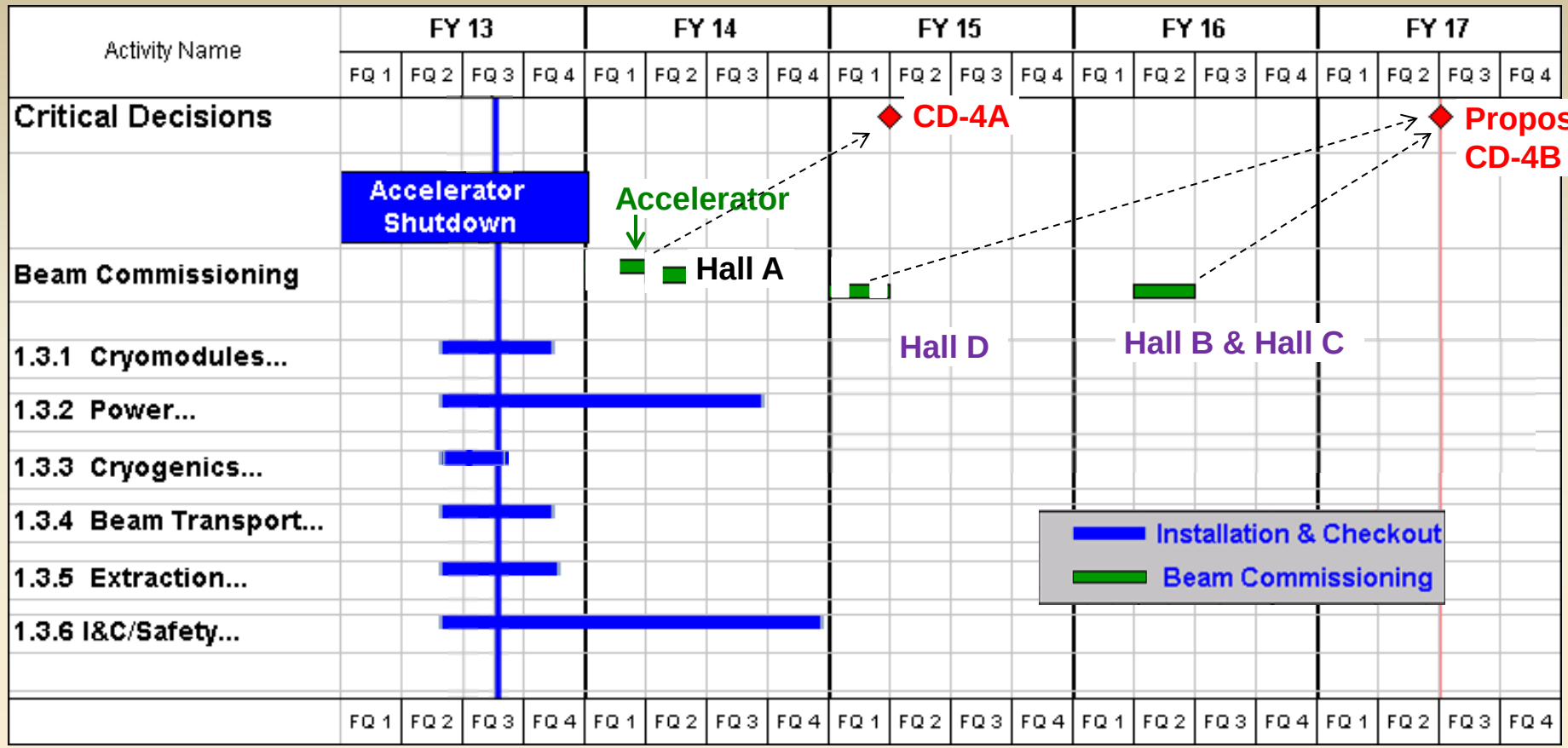
Hall D commissioning start
Oct 2014

Halls B & C commissioning start
Jan/Feb 2016

Project Completion
March 2017

Information based on DOE Project Review May 7-9, 2013

12 GeV Project Schedule



- Cryomodules, Cryogenics, Beam Transport, and Extraction will be complete in FY13
- Power and I&C deliveries extend into FY14 but will not affect commissioning schedule

12 GeV Upgrade Project Status

Hall D & Counting House

Hall D Interior

Project 77% Complete, 91% Obligated

- Civil (92%) ; Accelerator (91%) ; Physics Equip (~62%)

Challenges with spectrometer superconducting magnets

- All 7 new magnets under contract
- Refurbished Hall D Solenoid being tested

Rebaseline meeting scheduled for August 9, 2013

- Implementation date September 1, 2013
- TPC = $338M ; CD-4B March 2017

APPENDIX

CD4: Key Performance Parameters

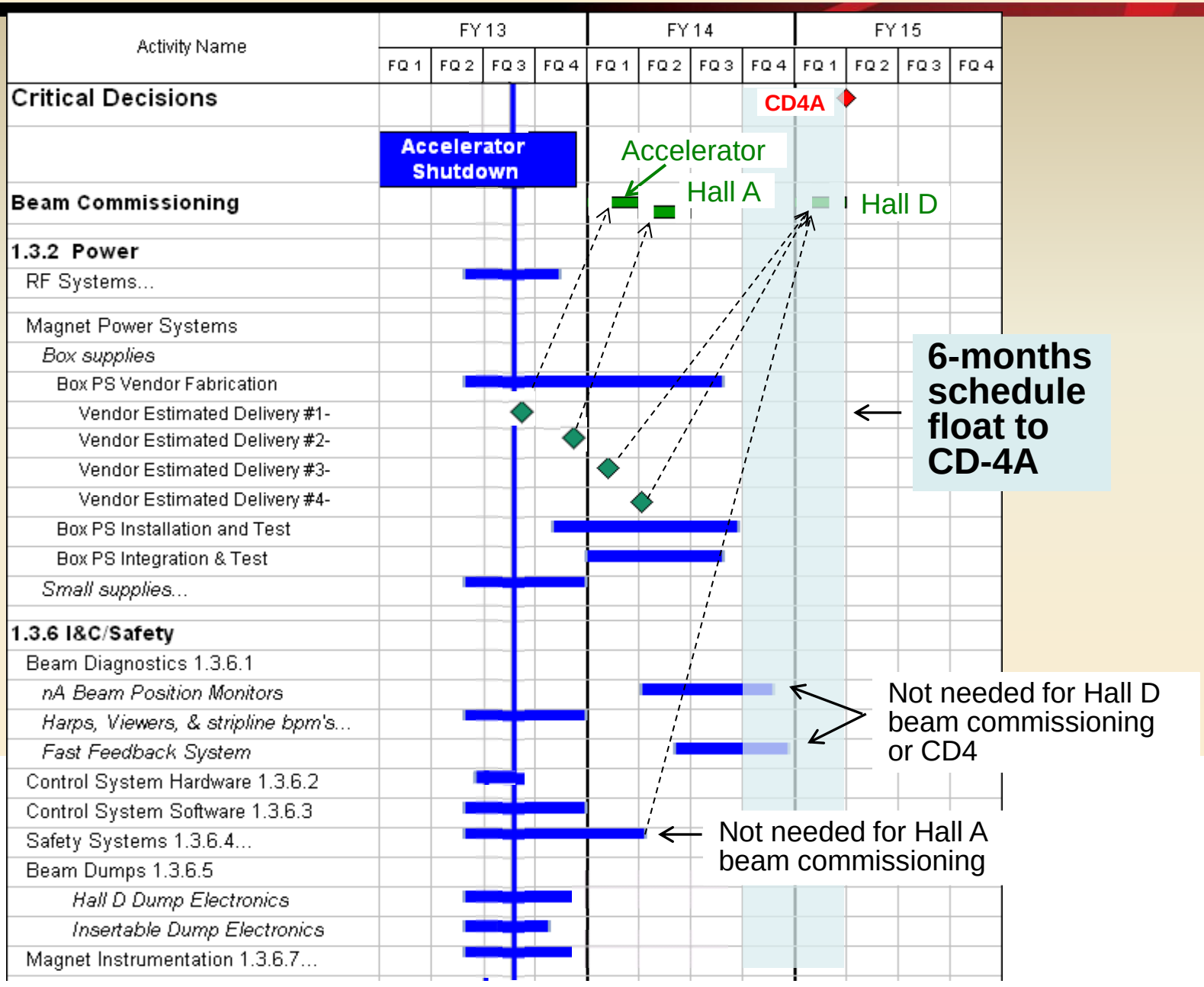
- CD-4 is phased
  - CD-4A: Accelerator and Conventional Facilities
  - CD-4B: Experimental systems

CD-4A. Deliverables / Key Parameters

Subsystem	Technical Definition of Completion
Accelerator	12 GeV capable 5.5 pass machine installed
Accelerator	11 GeV capable beamline to Halls A, B, and C installed
Accelerator	12 GeV capable beamline to Hall D tagger area installed
Accelerator	Accelerator commissioned by transporting a ≥ 2 nA electron beam at 2.2 GeV (1 pass)
Conventional Facilities	New Experimental Hall and the Counting House: ≥ 10,500 square feet

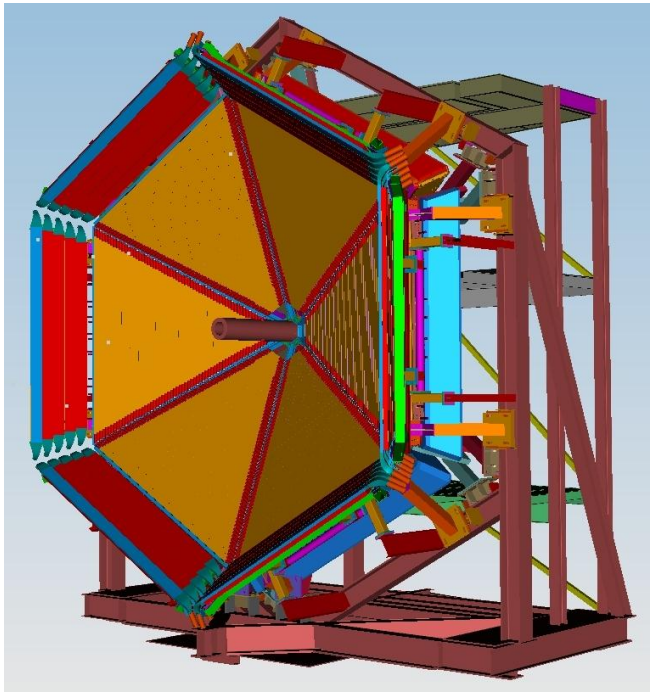
Complete

12 GeV Accelerator Schedule (details)



Forward Time-of-Flight (FTOF)

USC, JLab

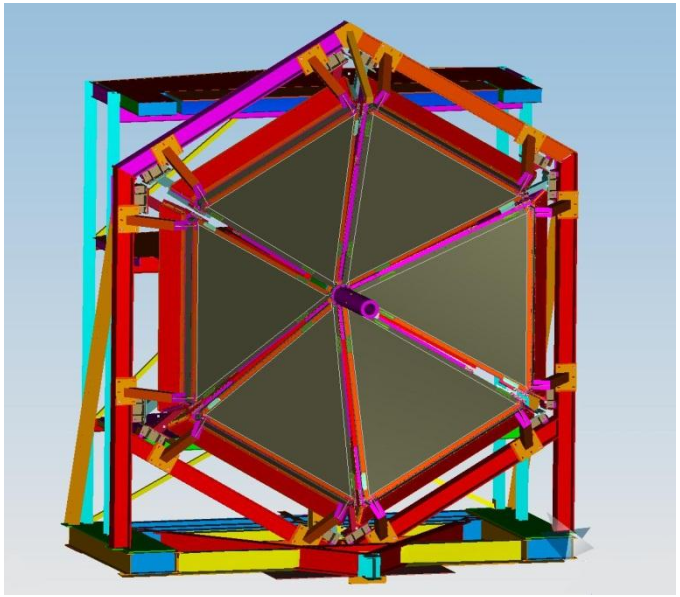


Purpose: Provide timing information for charged particle identification and separate pions, kaons and protons. Will also be used in fast trigger decision.

PARAMETER	DESIGN VALUE
Panel-1a:	
Angular Coverage	θ: 5° → 35°, ϕ: 50% at 5° → 85% at 35°
Counter Dimensions	L = 32.3 cm → 376.1 cm, w x h = 15 cm x 5 cm
Scintillator Material	BC-408
PMTs	EMI 9954A, Philips XP2262
Design Resolution	90 ps → 160 ps
Panel-1b:	
Angular Coverage	θ: 5° → 35°, ϕ: 50% at 5° → 85% at 35°
Counter Dimensions	L = 17.3 cm → 407.9 cm, w x h = 6 cm x 6 cm
Scintillator Material	BC-404 (#1 → #31), BC-408 (#32 → #62)
PMTs	Hamamatsu R9779
Design Resolution	60 ps → 110 ps
Panel-2:	
Angular Coverage	θ: 35° → 45°, ϕ: 85% at 35° → 90% at 45°
Counter Dimensions	L = 371.3 cm → 426.2 cm, w x h = 15 cm x 5 cm
Scintillator Material	BC-408
PMTs	EMI 4312KB
Design Resolution	110 ps → 150 ps
PID:	
π/K Separation	4σ separation up to 2.8 GeV
K/p Separation	4σ separation up to 4.8 GeV
π/p Separation	4σ separation up to 5.4 GeV

Status: Panel 1a: Refurbishment and QA with cosmic rays completed at JLab. Panel 1b: All counters assembled and QA cosmic ray tested at USC. Panel 2:

CLAS12 – Preshower Calorimeter (PCAL)



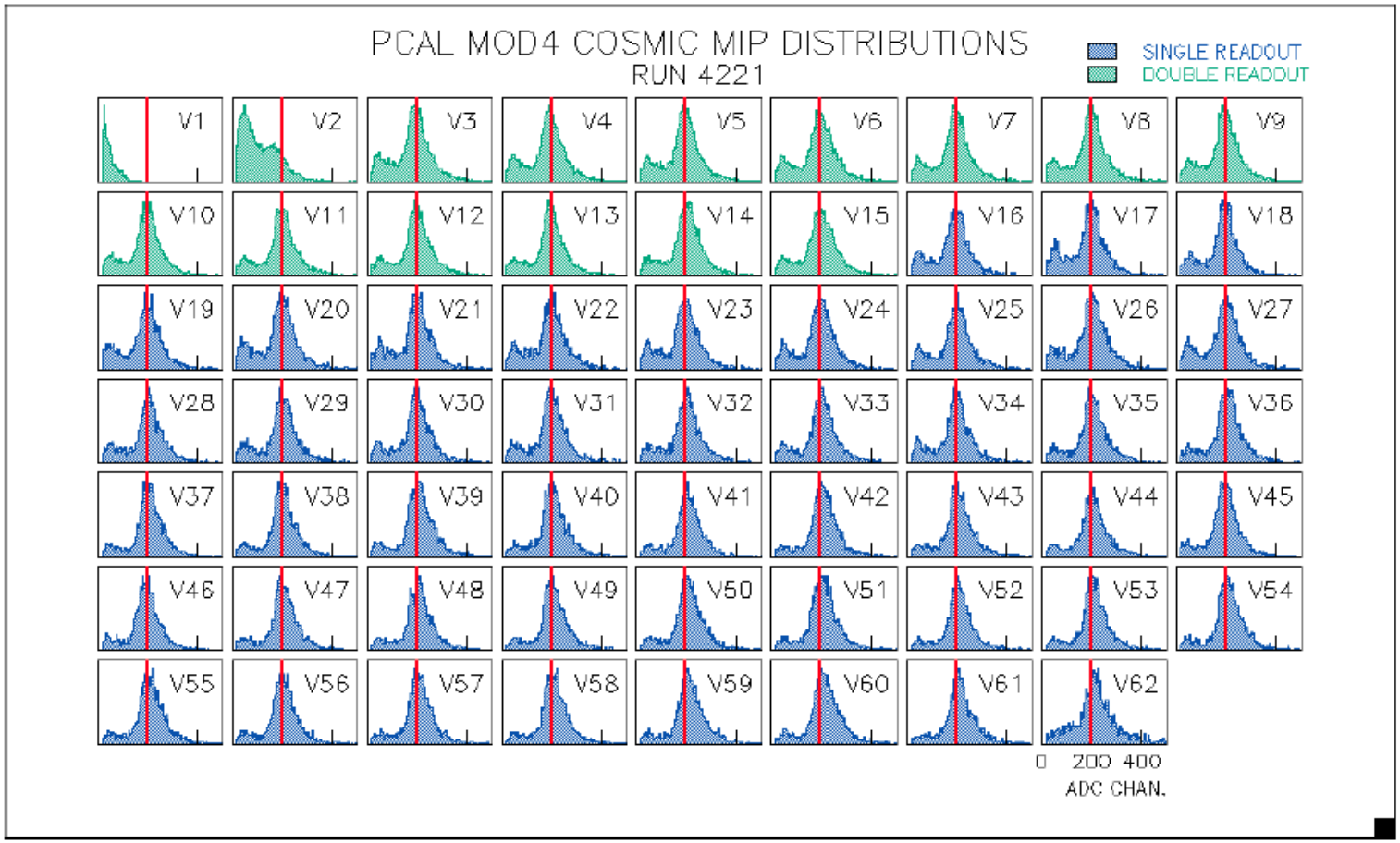
PARAMETER	DESIGN VALUE
Calorimeter type	Sampling, lead-scintillator
Number of modules	6
Coverage area	45 meter square
Distance from the target	7 meters
Angular coverage	5° to 35°
Number of scintillator layers	15 per module
Number of stereo readout views	3 (5 scintillator layers per view)
Number of readout channels	196 per module
Number of scintillator strips	1200 per module
Scintillator strips	1x4.5 cm^2 extruded (FNAL) with two holes
Lead sheets	2.2 mm thick, triangular shape (two pieces)
Scintillator lengths	2.5 cm to 432 cm
Readout via WLS fibers	1 mm diameter, 4800 fibers per module
Readout	PMT, Hamamatsu R6095
Expected Performance	**VALUE**
Energy resolution	10%/√E (with EC)
Position resolution	0.5 cm
Time resolution	500 ps

Purpose: Calorimeters in CLAS12 will be used primarily for identification of electrons, photons, $\pi^0 \rightarrow \gamma\gamma$, and neutrons.

Status: All six PCAL modules are full assembled and five have been QA cosmic ray tested and ready to be installed. Remaining sixth module will be tested in June. It took two years and 6 months from the moment of receiving components to fully assemble and test all 6 modules of CLAS12 PCAL.

CLAS12 – PCAL Cosmic Ray Test

Result of HV gain matching of light yield at fixed distance from PMT



Run 4221 (LC1881) Run 4289 (FADC)