

Laboratory Outlook - 12 GeV Upgrade

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2007 Users Group Annual Meeting

Jefferson Lab

June 19, 2007



12 GeV Upgrade: OUTLINE

- Experimental Capabilities
- Project Status
 - R&D / PED progress
 - Plans for CD-2
 - Schedule
- 12 GeV PACs

Jefferson Lab Today

Hall A

Two high-resolution
4 GeV spectrometers

Jefferson Lab
CLAS Detector

Hall B

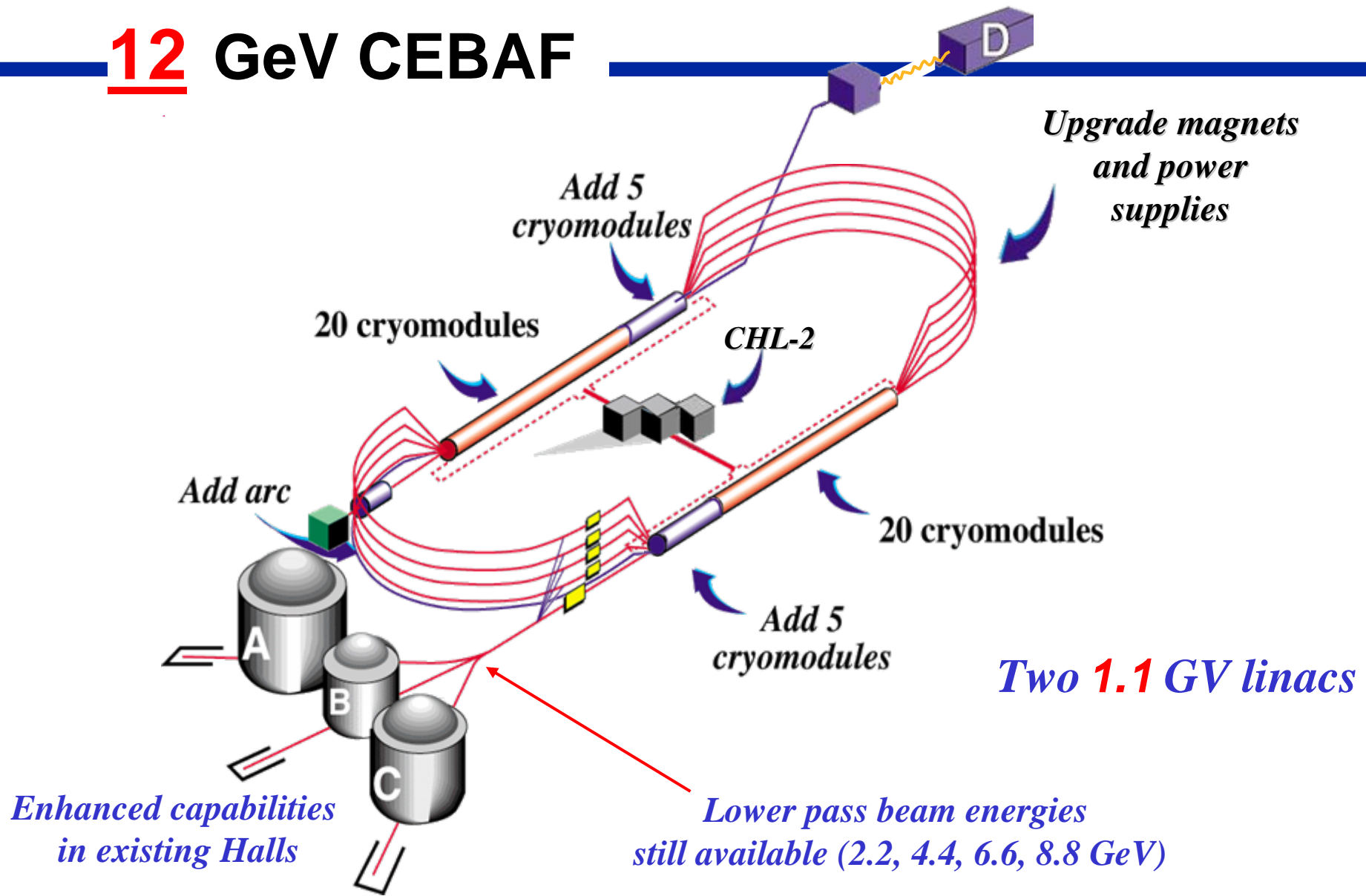
Large acceptance spectrometer
electron/photon beams

Hall C

7 GeV spectrometer,
1.8 GeV spectrometer,
large installation experiments

C

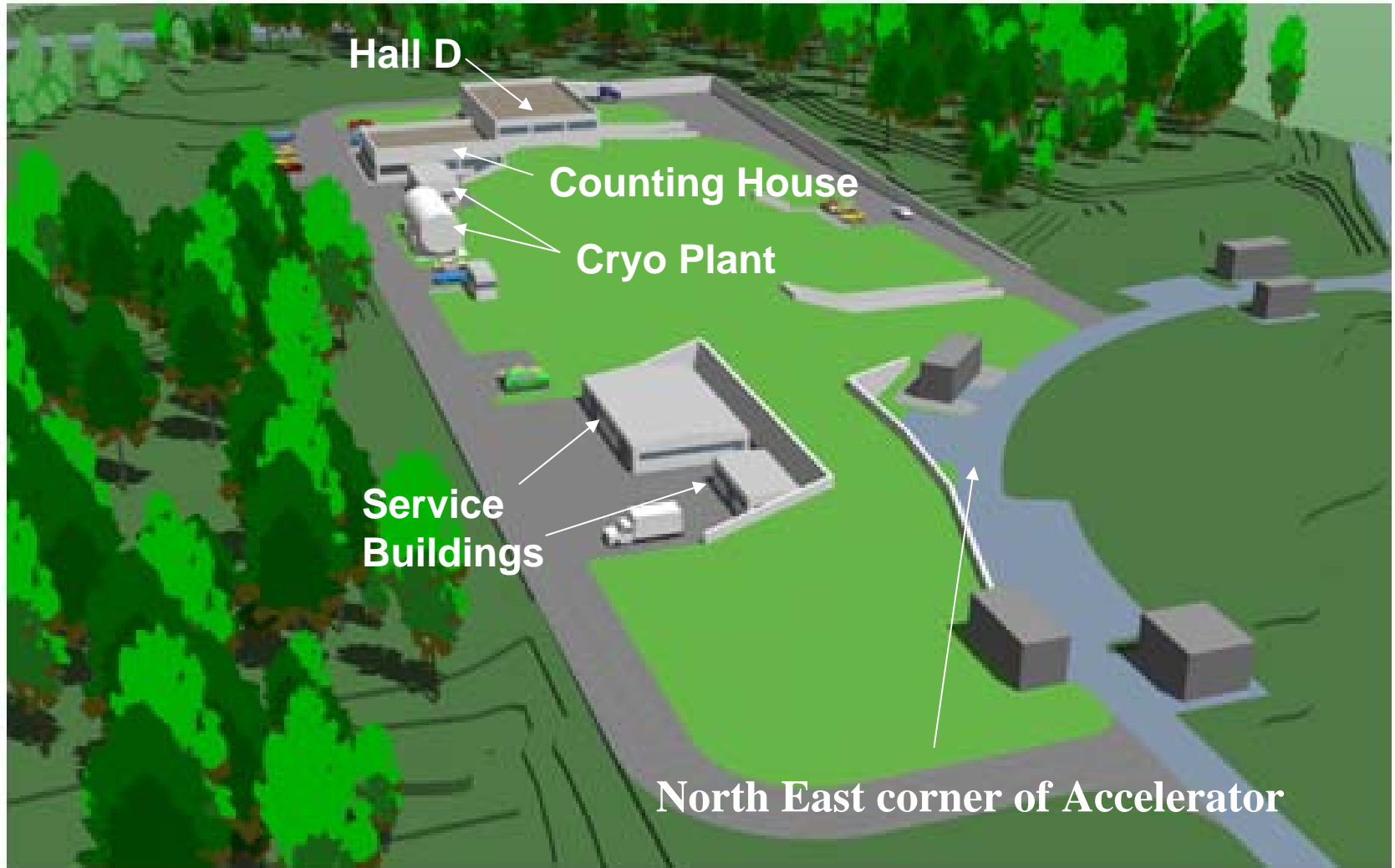
12 GeV CEBAF



Scope of 12 GeV Upgrade

Parameter	Present JLab	Upgraded JLab
Number of Halls	3	4
Number of passes Halls A/B/C	5 (for max energy)	5 (for max energy)
Max Energy to Halls A/B/C	up to ~ 6 GeV	up to 11 GeV
Number of passes to Hall D	new Hall	5.5
Energy to Hall D	new Hall	12 GeV
Current – Hall A & C	max 180 μ A combined	max ~80 μ A combined
Current – Hall B & D	(B) Up to 5 μ A max	(B, D) Up to ~5 μ A each
Central Helium Liquefier (CHL)	4.5 kW	9 kW
# of cryomodules in LINACS	40	50
Accelerator energy per pass	1.2 GeV	2.2 GeV

Architect's Rendering of Hall D Complex



Architect's Rendering of Hall D Complex



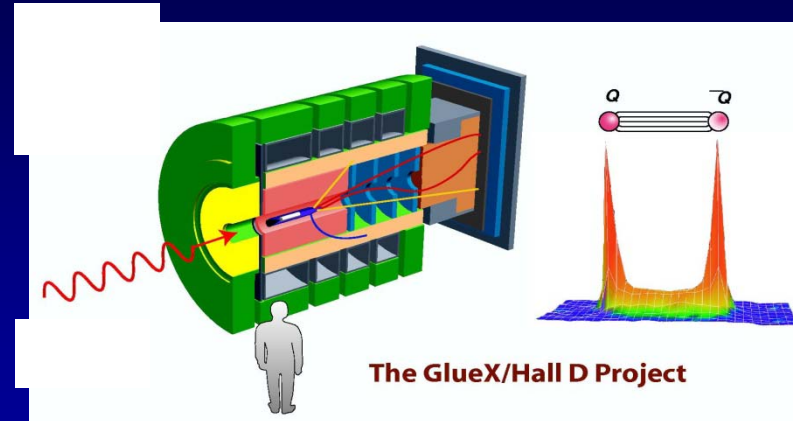
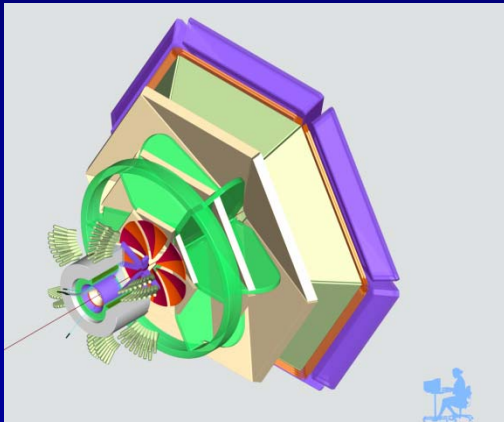
Updated Jan 2007

Highlights of the 12 GeV Science Program

- Unlocking secrets of QCD: quark confinement
- New and revolutionary access to the structure of the proton and neutron
- Discovering the quark structure of nuclei
- High precision tests of the Standard Model

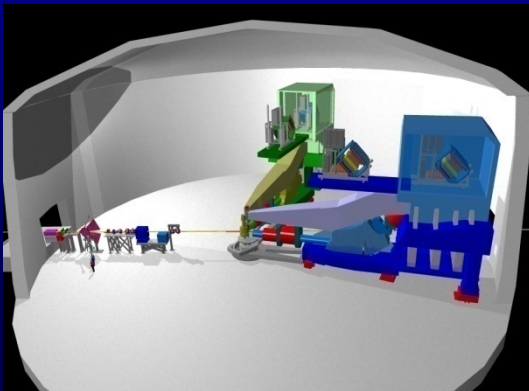
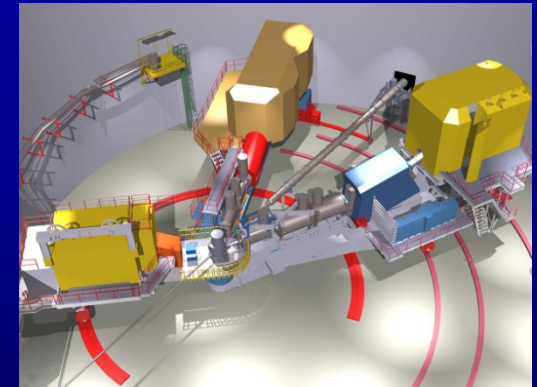
12 GeV Capabilities

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



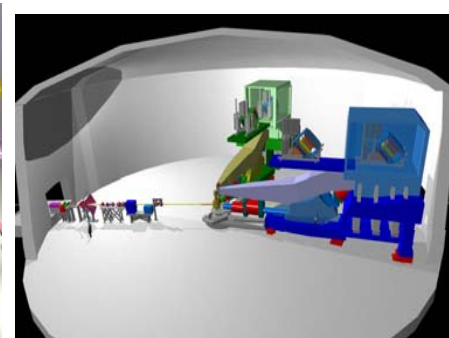
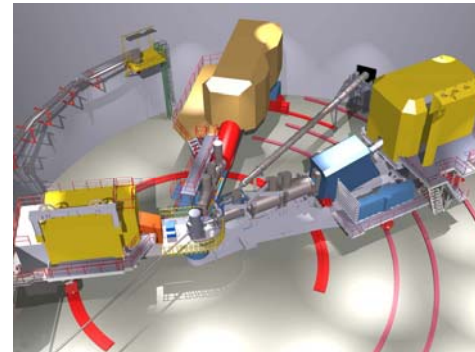
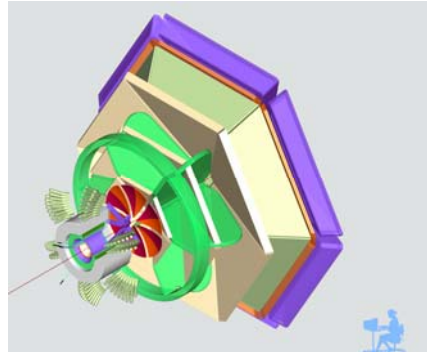
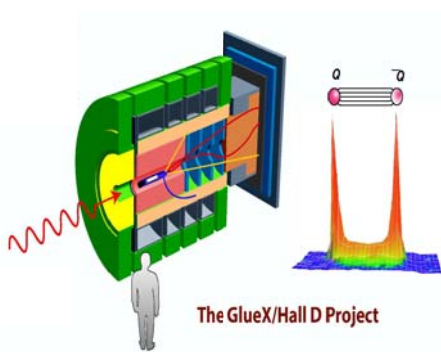
Hall B - understanding **nucleon structure** via **generalized parton distributions**

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



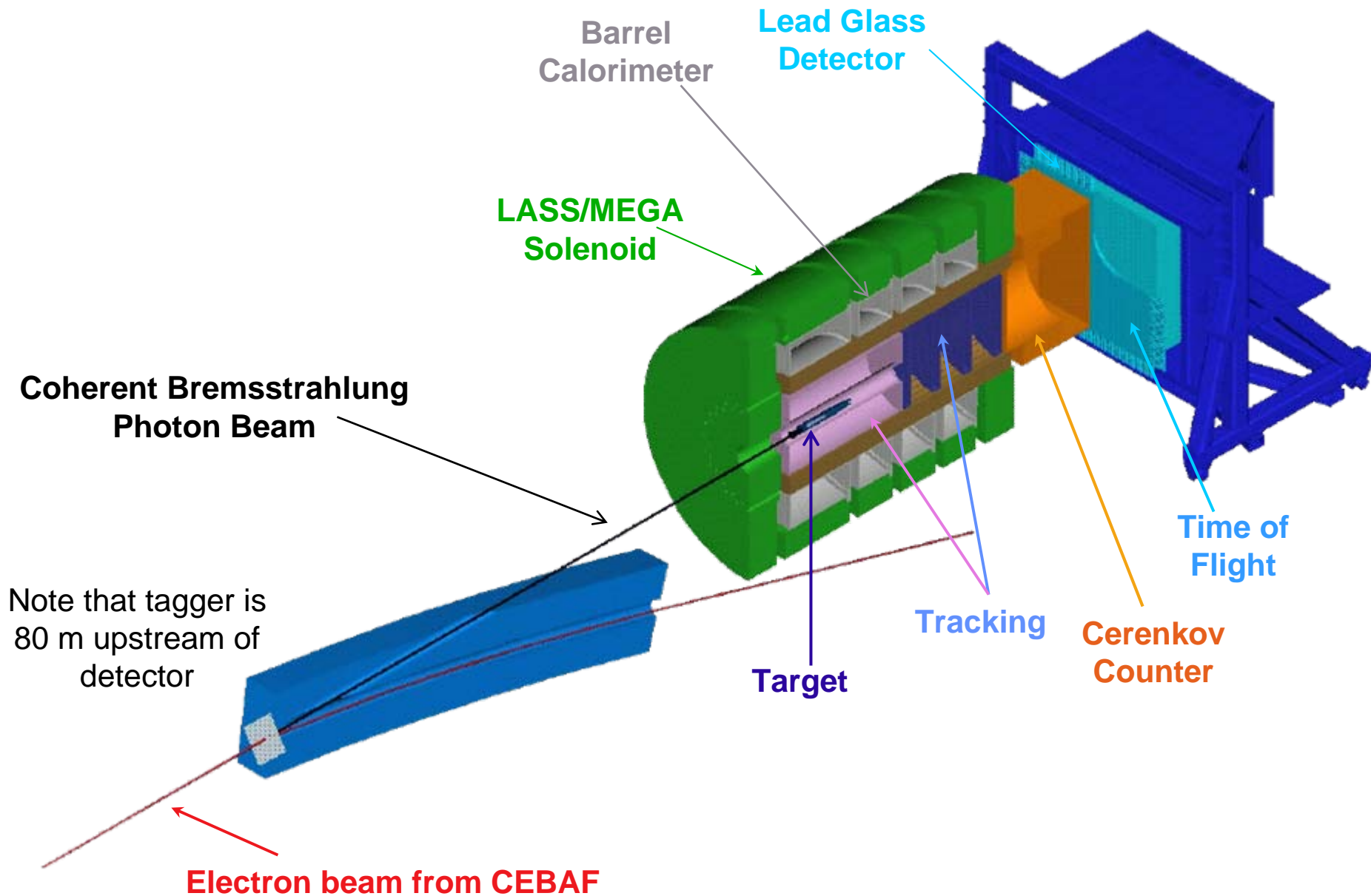
Hall A - short range correlations, form factors, hyper-nuclear physics, future **new experiments**

Overview of Upgrade Technical Performance Requirements

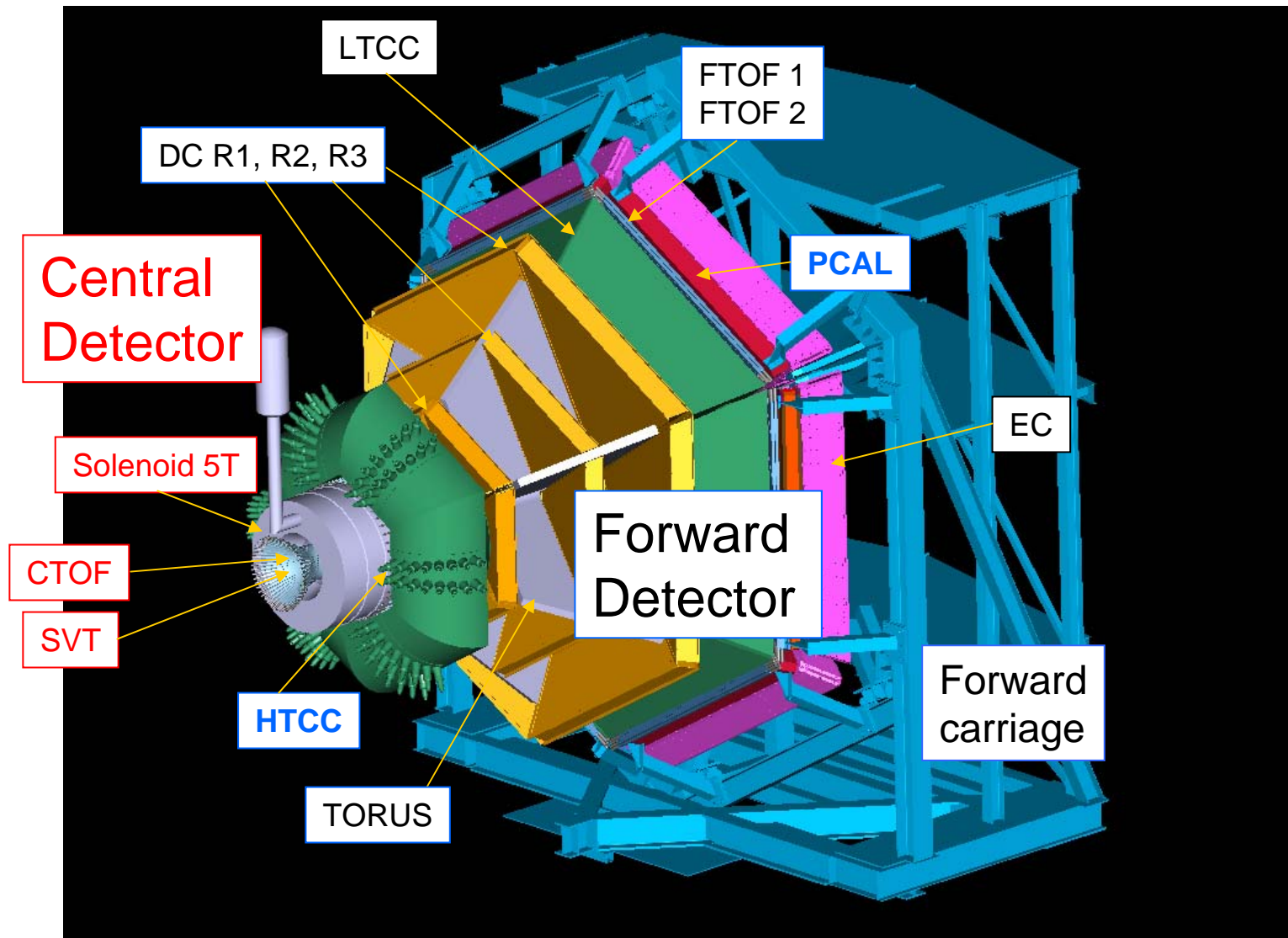


Hall D	Hall B	Hall C	Hall A
excellent hermeticity	luminosity 10^{35}	energy reach	installation space
polarized photons	hermeticity	precision	
$E_{\gamma} \sim 8.5\text{--}9\text{ GeV}$	11 GeV beamline		
10^8 photons/s	target flexibility		
good momentum/angle resolution		excellent momentum resolution	
high multiplicity reconstruction		luminosity up to 10^{38}	
particle ID			

Hall D GlueX Detector



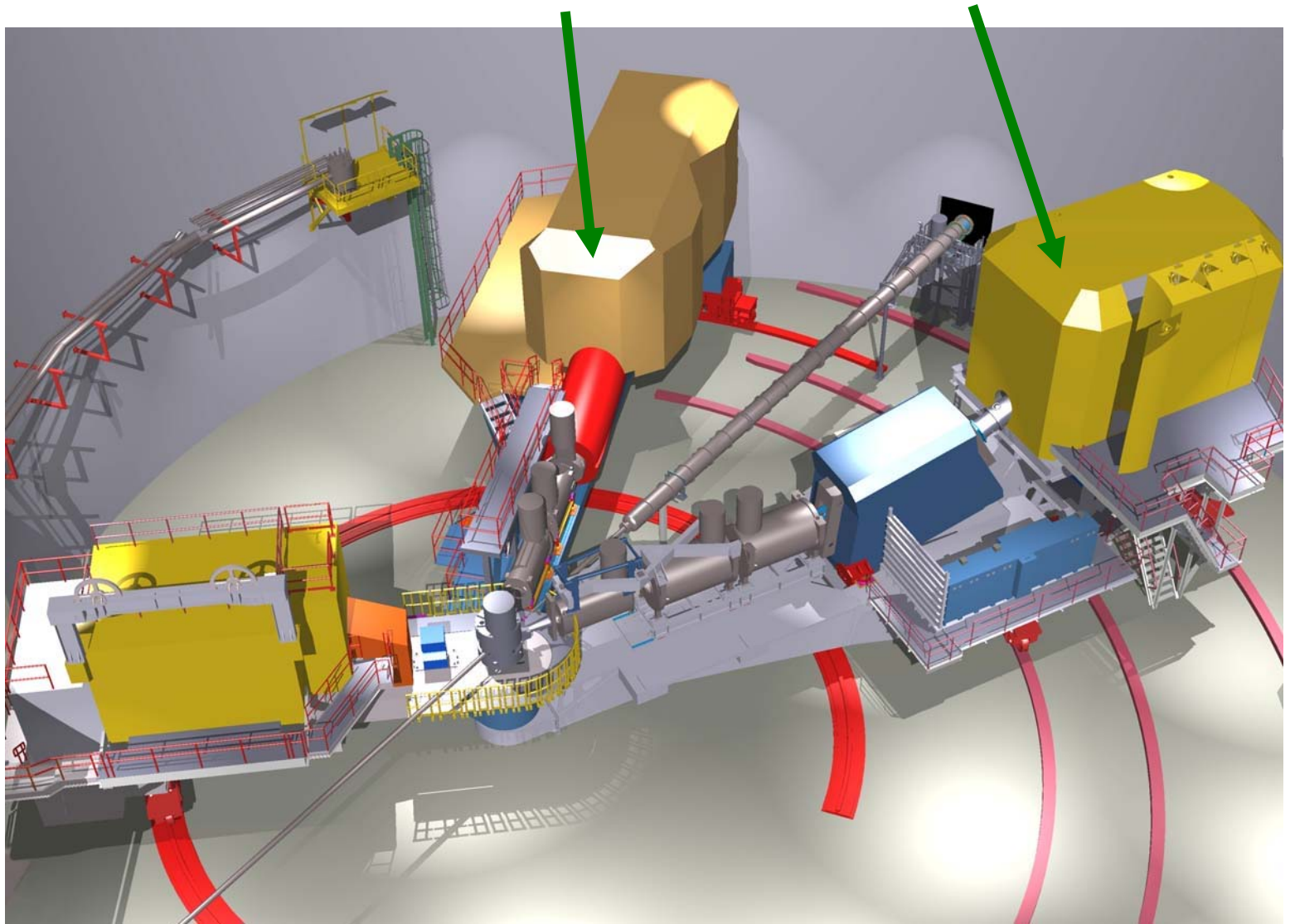
Hall B - CLAS12



Red/Blue = new equip

Black = existing equip

Hall C: SHMS and HMS



R&D Progress - examples

- Accelerator:
 - “1/4 cryomodule” assembly w/12 GeV design was successfully tested in the Horizontal Test Bed
- Hall B: **Latifa Elouadrhiri**
 - Demonstrated fabrication technique for multi-focal ellipsoidal mirror for High Threshold Cerenkov Counter **CLAS12 collaboration**
- Hall C: **Antje Bruell**
 - Studied alternate configurations of lead glass for SHMS calorimeter, finalized design with optimal performance for e- id and π rejection using HERMES blocks **Yerevan Group**
- Hall D: **Elke Aschenauer**
 - Barrel Calorimeter beam tests: both the timing (~ 150 picoseconds for 600 MeV photons) and the energy measurement ($\sim 6\%$ for 1 GeV photons) is very good **URegina and UAlberta Groups**

PED Progress - examples

- Hall A: design drawing package for Moller/Compton
- Hall B:
 - Torus and Solenoid Design Studies
 - CLAS12 Collaboration Workshops (Silicon Vertex Tracker)
 - Design/Safety Review of Drift Chambers, PreShwr, HTCC
- Hall C:
 - Magnet design studies
 - Horizontal Bend magnet in collaboration w/Michigan State
 - Collaboration meetings/workshops include 12 GeV elements
- Hall D:
 - Weekly meetings (phone confs) Hall D / GlueX Collaboration
 - Design/Safety Review of Drift Chambers

12 GeV Cost Summary

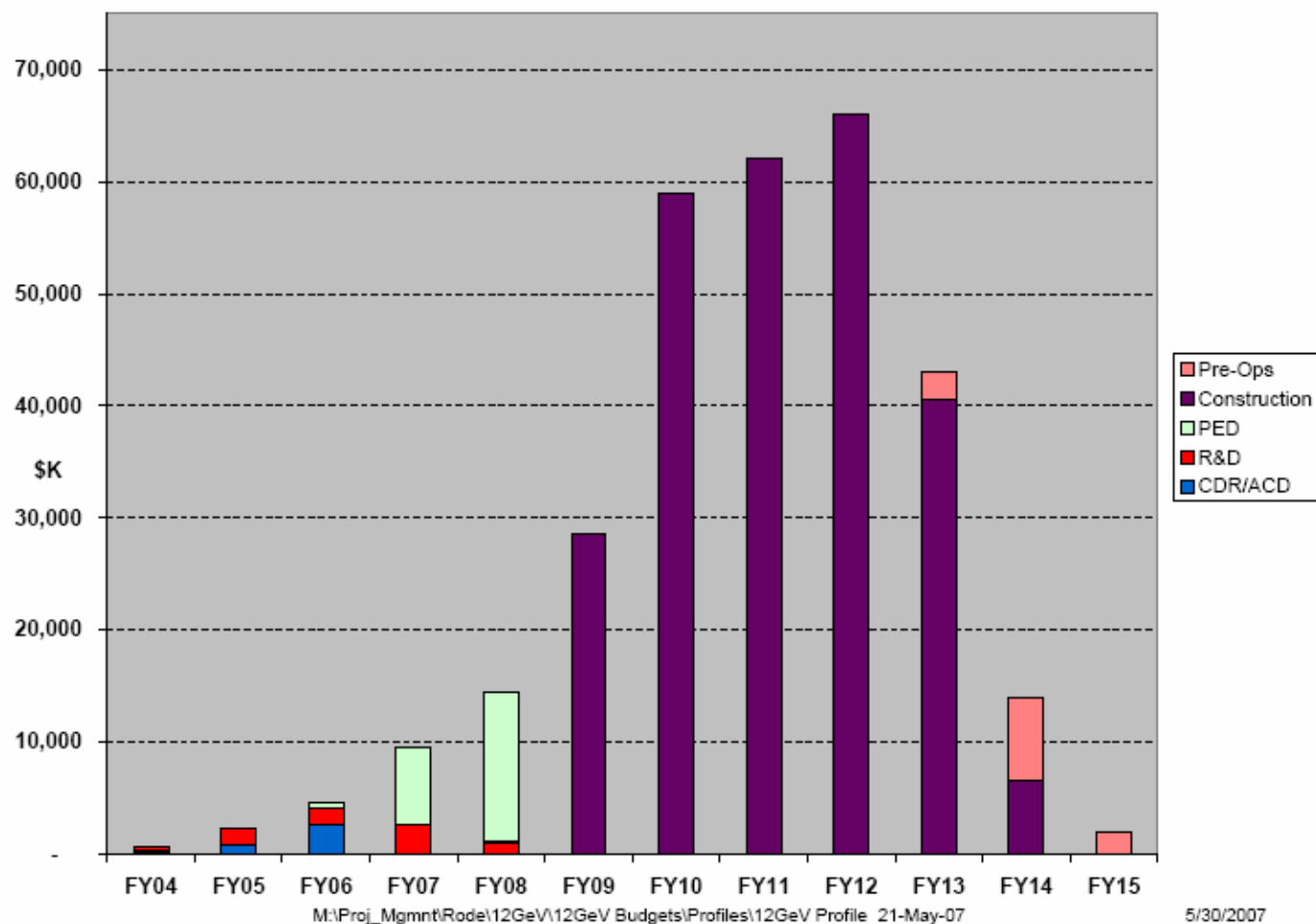
WBS	SCOPE	COST EAC FY07M\$
1.2	PED	19.1
1.3	Accelerator Systems	74.2
1.4	Upgrade Hall A, B & C	48.2
1.5	Hall D	31.0
1.6	Civil	25.4
1.7	Project Management	9.5
TEC Subtotal		207.4
Obligated		4.4
TEC Subtotal		203.1
Contingency		52.0
ETC Contingency %		26%
Escalation		24.1
TEC TOTAL		283.5
1.0/1.9	CDR/ACD	3.5
1.1	R&D	6.4
1.8	Pre-Ops	7.2
OPC Subtotal		17.1
Obligated		8.2
OPC ETC		8.8
Contingency		3.7
ETC Contingency %		41%
Escalation		1.8
OPC TOTAL		22.5
TPC TOTAL		306
TPC ETC Contingency %		26%

- Accelerator and Hall equipment are roughly equal
- Hall B/C/D equipment cost averages ~\$26M
- Civil split ~equally between Accelerator systems & Hall D

May 2007
updated for CD-2

12 GeV Funding Profile

12 GeV - \$306M Total TPC - May-2007



12 GeV Upgrade: Phases and Schedule

(based on funding guidance provided by DOE-NP in May 2007)

- ❑ 2004-2005 Conceptual Design (CDR) - *finished*
- ❑ 2004-2008 Research and Development (R&D) - *ongoing*
- ❑ 2006 Advanced Conceptual Design (ACD) - *finished*
- ❑ 2006-2008 Project Engineering & Design (PED) - *ongoing*

DOE Generic Project Timeline

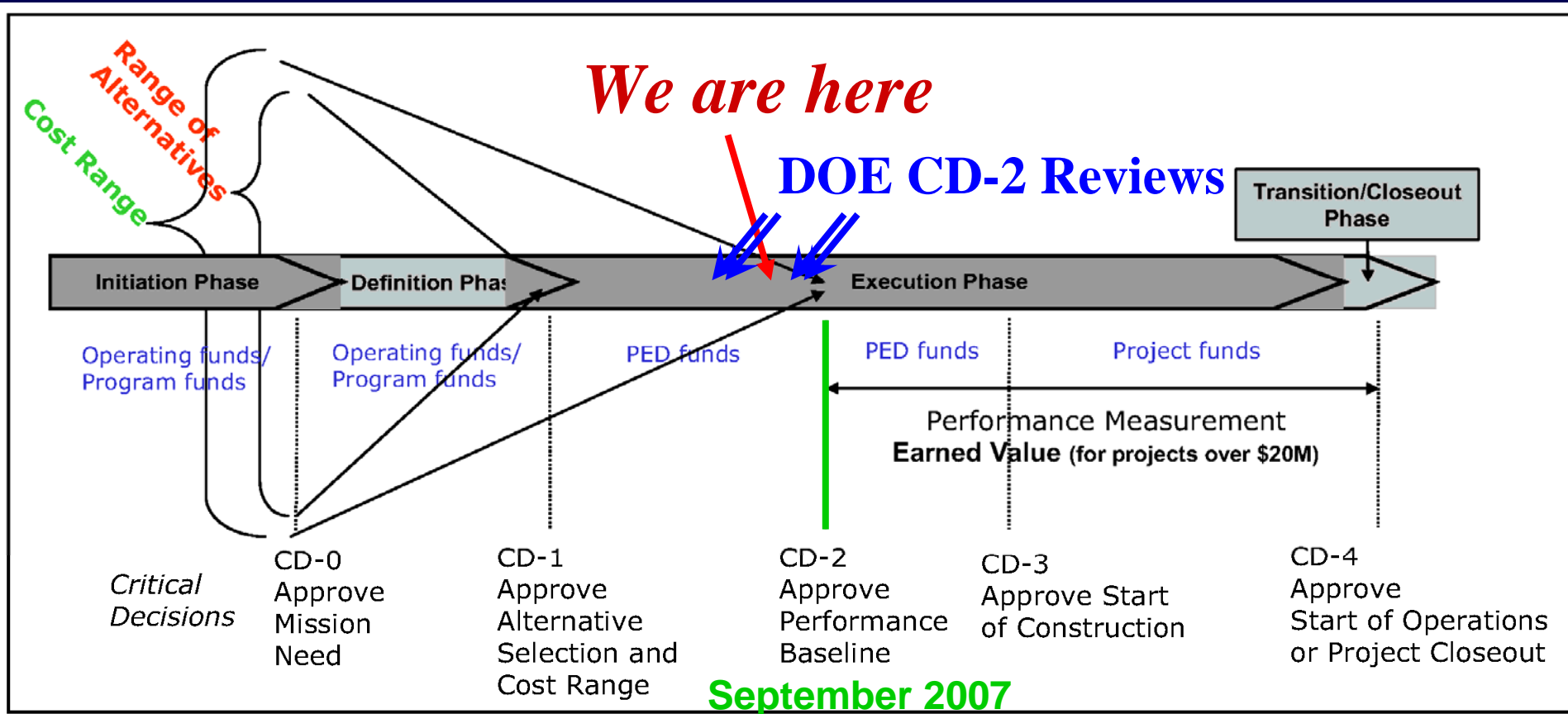
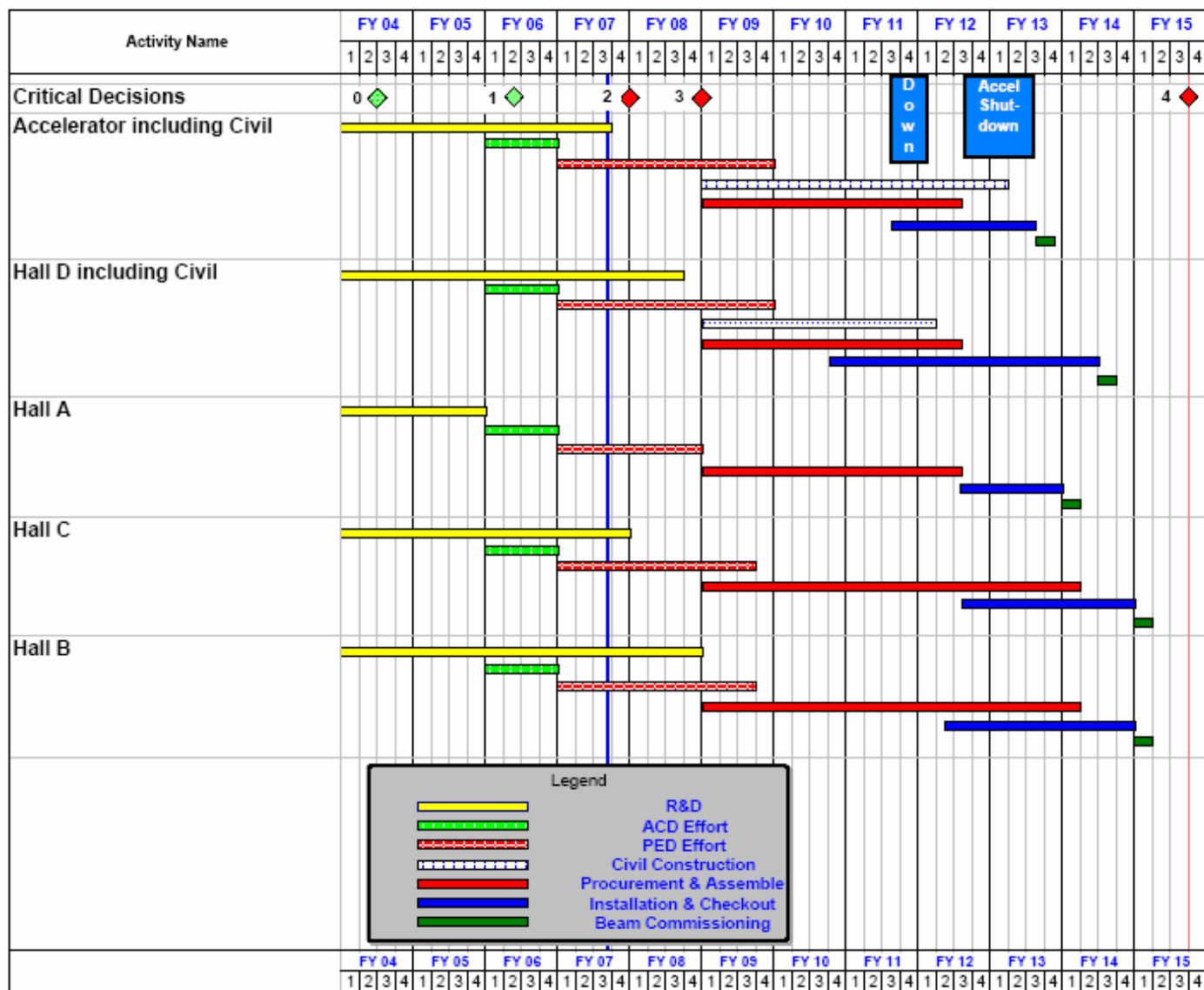


Figure 1-1. DOE Acquisition Management System.

Path to CD-2: DOE Reviews

- June 2006: DOE Project Status (Lehman) Review
 - Prepare a full resource-loaded schedule by November 2006
 - December & January: DOE Project Status Review
 - “The 12 GeV Upgrade Project is on track in their preparations and readiness for the SC IPR, OECM EIR and September 2007 CD-2 approval.”
-
- June 26-28: Critical Decision 2 Review, stage I
 - SC Independent Project Review (IPR): conducted by Dan Lehman (DOE SC Office of Project Assessment)
 - Aug 6-10 (tentative): Critical Decision 2 Review, stage II
 - External Independent Review (EIR): conducted by DOE Office of Engineering Construction Management (OECM)

12 GeV Schedule



12 GeV Upgrade: Phases and Schedule

- ❑ 2009-2013 Construction – *starts in ~18 months!*
 - ❑ *Parasitic machine shutdown – May 2011 through Oct 2011 (6 months)*
 - ❑ *Accelerator shutdown start mid-May 2012*
 - ❑ *Accelerator commissioning mid-May 2013*

- ❑ Now-2012 Challenging balance act!
 - ❑ *Expectation is to complete ~80% of approved 6 GeV program*
 - ❑ *Skill mix – lean engineering and design manpower*

- ❑ 2013-2015 Pre-Ops (beam commissioning)
 - ❑ *Hall A commissioning start ~October 2013*
 - ❑ *Hall D commissioning start ~April 2014*
 - ❑ *Halls B and C commissioning start ~October 2014*

PAC30 - 12 GeV – Aug2006

- History:
 - Science case extensively discussed at PACs 18, 23, and 27
- PAC30 Charge:
 - Begin to identify first years of commissioning experiments
 - Identify collaborations committed to securing Non-DOE contributions
- Proposals:
 - Reviewed 22 proposals and 8 letters-of-intent
 - Approved 17 experiments (4 conditionally), deferred 5

12 GeV - Hall A

PAC30 approved three experiments in Hall A:

- **PR12-06-114**, *Measurements of Electron-Helicity Dependent Cross sections of **Deeply Virtual Compton Scattering** with CEBAF at 12 GeV*
- **PR12-06-118***, *Measurement of the F_2n/ F_2p , d/u Ratios and $A=3$ **EMC Effect** in Deep Inelastic Scattering off the Tritium and Helium Mirror Nuclei*
- **PR12-06-122**, *Measurement of Neutron Asymmetry **A_1n** in the Valence Quark Region Using 8.8GeV and 6.6GeV Beam Energies and Bigbite Spectrometer in Hall A.*

* Conditional approval

12 GeV - Hall B

PAC30 approved seven experiments in Hall B:

- PR12-06-106, Study of *Color Transparency* in Exclusive Vector Meson Electroproduction off Nuclei
- PR12-06-108, Hard Exclusive *Electroproduction of π^0 and η* with CLAS12
- PR12-06-109, The Longitudinal *Spin Structure* of the Nucleon
- PR12-06-112, Probing the Proton's *Quark Dynamics* in Semi-inclusive Pion Production at 12GeV
- PR12-06-113*, The Structure of the Free Neutron at *Large x* Bjorken
- PR12-06-117, *Quark Propagation* and Hadron Formation
- PR12-06-119, *Deeply Virtual Compton Scattering* with CLAS at 11GeV with polarized and unpolarized targets

* Conditional approval

12 GeV - Hall C

PAC30 approved six experiments in Hall C:

- PR12-06-101, Measurement of the Charged *Pion Form Factor* to High Q^2
- PR12-06-104, Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Semi-inclusive Deep-inelastic Scattering
- PR12-06-105, Inclusive Scattering from Nuclei at $x>1$ in the Quasielastic and Deeply Inelastic Regimes
- PR12-06-107*, The Search for *Color Transparency* at 12 GeV
- PR12-06-110*, Measurements of Neutron Spin Asymmetry A_{1n} in the Valence Quark Region Using an 11 GeV Beam and a Polarized ^3He Target in Hall C
- PR12-06-121, A Path to “Color Polarizabilities” in the Neutron: A Precision Measurement of the *Neutron g_2 and d_2* at High Q^2 in Hall C

* Conditional approval

12 GeV - Hall D

PAC30 approved experimental program in Hall D:

- PR-06-102, *Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons, the GlueX-Experiment*
-

PAC32 - 12 GeV

Aug 6-10, 2007

- PAC32 Charge:
 - “PAC32 will continue our focus on the part of the Upgrade's physics program that can be carried out using the base equipment for the Upgrade.”
 - “Specifically, it will *only* review proposals in which the proposing scientists and institutions state clearly their intention to participate in and contribute to the construction of that base equipment.”
- Proposal Deadline:
 - June 20, 2007

Looking forward to another set of outstanding proposals for the first 5 years

12 GeV Upgrade Summary

- Essential to address key questions in hadronic physics
 - Broad and diverse scientific program
 - Unique and complementary kinematic reach and capabilities
 - Strong opportunity for international collaboration
- Construction start in ~18 months
 - Critical Decision 2 in September 2007 (baseline)
 - Critical Decision 3 in September 2008 (construction start)
 - *We are on track for accomplishing this!*
- *Physics begins in Hall A with first beam in 2013, in Hall D in mid-2014 and in Halls B and C in late 2014*
- Challenges:
 - Maintaining/building science case within political arena – Users!
 - Balancing ongoing operations with construction project – communication!

12 GeV BACK - UP

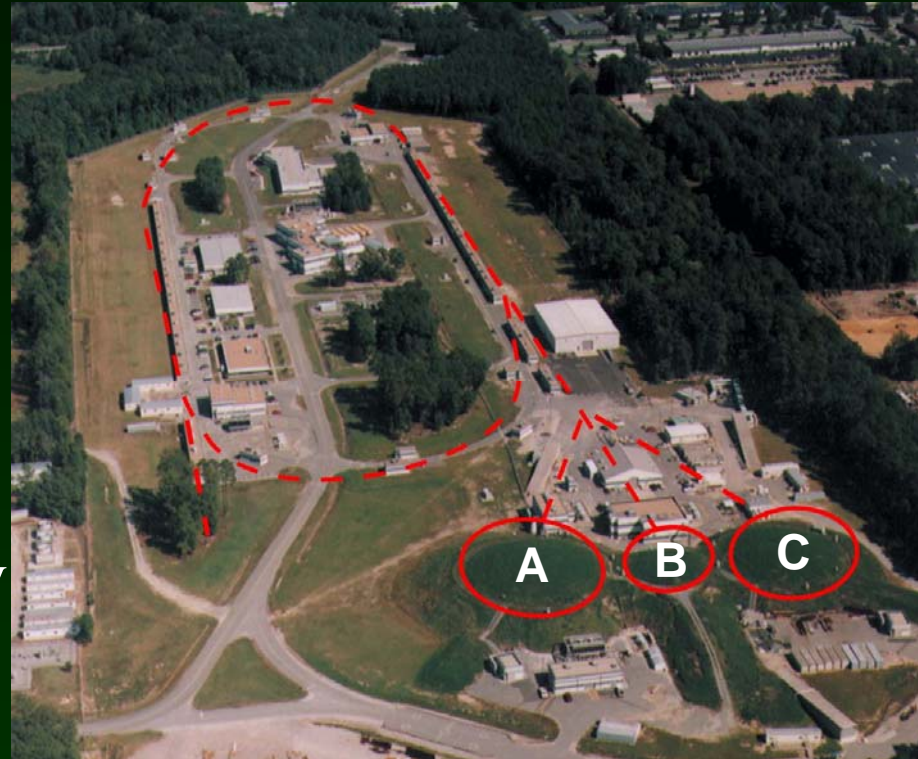
PAC32 - 12 GeV – Aug2007

- PAC32 Charge:
 - “PAC32 will continue our focus on the part of the Upgrade's physics program that can be carried out using the base equipment for the Upgrade. Specifically, it will *only* review proposals in which the proposing scientists and institutions state clearly their intention to participate in and contribute to the construction of that base equipment.”
 - “We recognize that some may require use of existing secondary devices and will accommodate such proposals *so long as the modifications needed are truly modest and the proposing scientists will undertake the funding and realization of those modifications in addition to their contributions to the base equipment construction. We will not accept at this PAC any proposal or letter of intent requiring major apparatus that is not part of the base equipment.*”

Jefferson Lab Today

2000 member international user community engaged in exploring quark-gluon structure of matter

Superconducting accelerator provides 100% duty factor beams of unprecedented quality, with energies up to 6 GeV

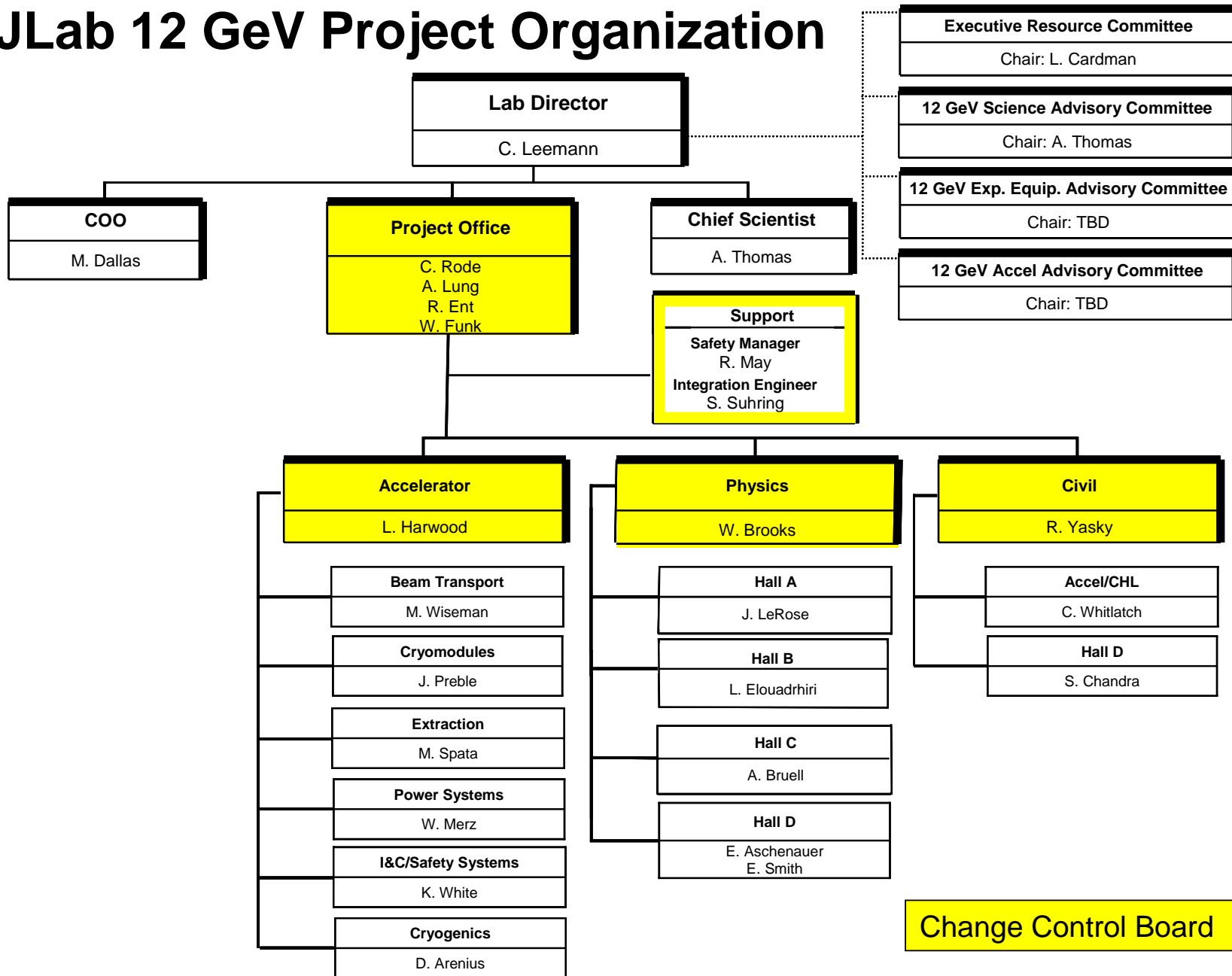


CEBAF's innovative design allows delivery of beam with unique properties to three experimental halls simultaneously

Each of the three halls offers complementary experimental capabilities and allows for large equipment installations to extend scientific reach



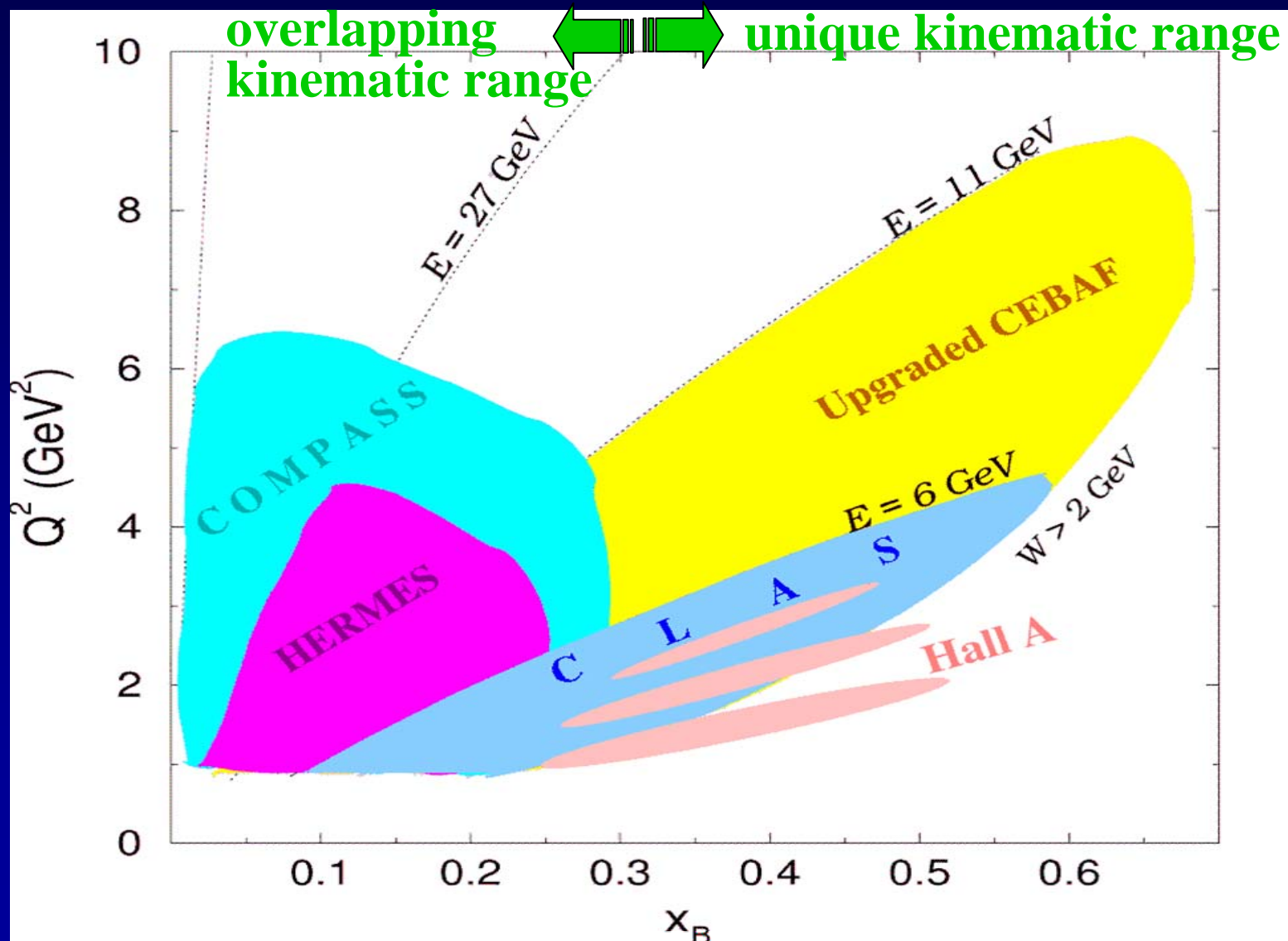
JLab 12 GeV Project Organization



High-level Parameters

Beam energy	12 GeV
Beam power	1 MW
Beam current (Hall D)	5 μ A
Emittance @ 12 GeV	10 nm-rad
Energy spread @ 12 GeV	0.02%
Simultaneous beam delivery	Up to 3 halls

Kinematics for deeply exclusive experiments



Hall B CLAS12

Preshower EC (not visible)

Low Threshold Cerenkov Counter (LTCC)

Forward EC

Forward TOF

Forward Drift Chambers

High Threshold Cerenkov (HTCC)

New Torus Coils

Central Detector

Beamline

Inner EC (not visible)

Reused CLAS element

Coil EC

