



JLAB12/PANDA Collaboration

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The JLab parameters

- * Primary Beam: Electrons
- * Beam Energy: 6 GeV (12 GeV soon)
 - $10 > \lambda > 0.1$ fm
 - nucleon \rightarrow quark transition
 - baryon and meson excited states
- * 100% Duty Factor (cw) Beam
 - coincidence experiments
 - Three Simultaneous Beams with Independently Variable Energy and Intensity
 - complementary, long experiments
- * Polarization (beam and reaction products)
 - spin degrees of freedom
 - weak neutral currents



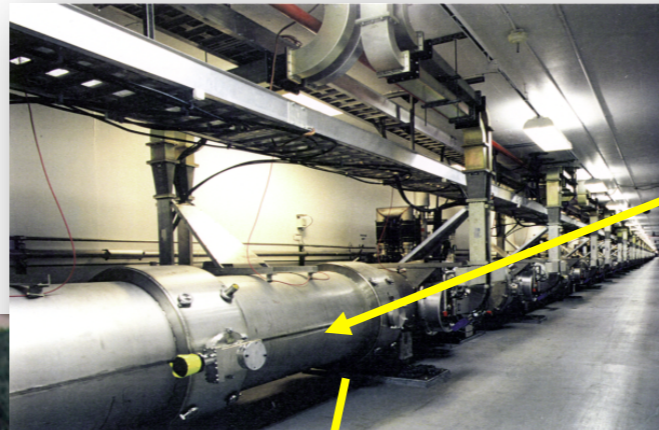
$L > 10^6$ x SLAC at the time of the original DIS experiments!
JLab 12 luminosity will increase by 10 x

The Jefferson Lab accelerator complex

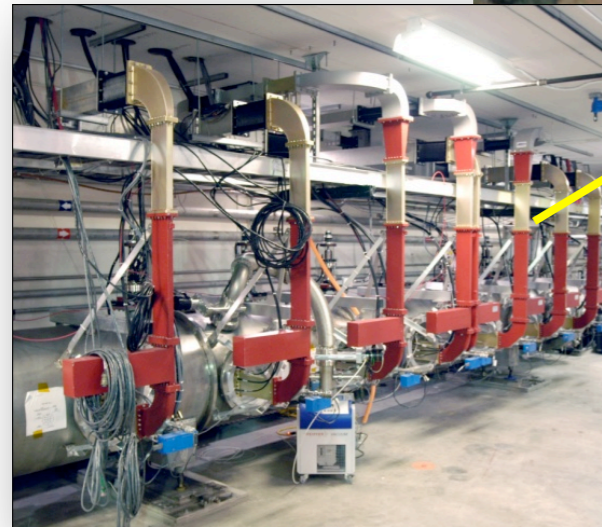
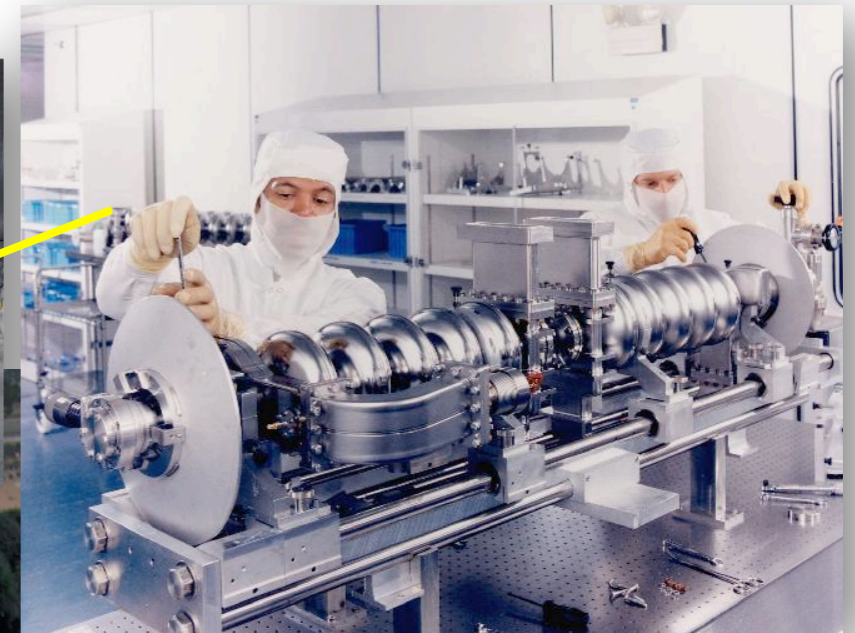


•Hall D (construction)

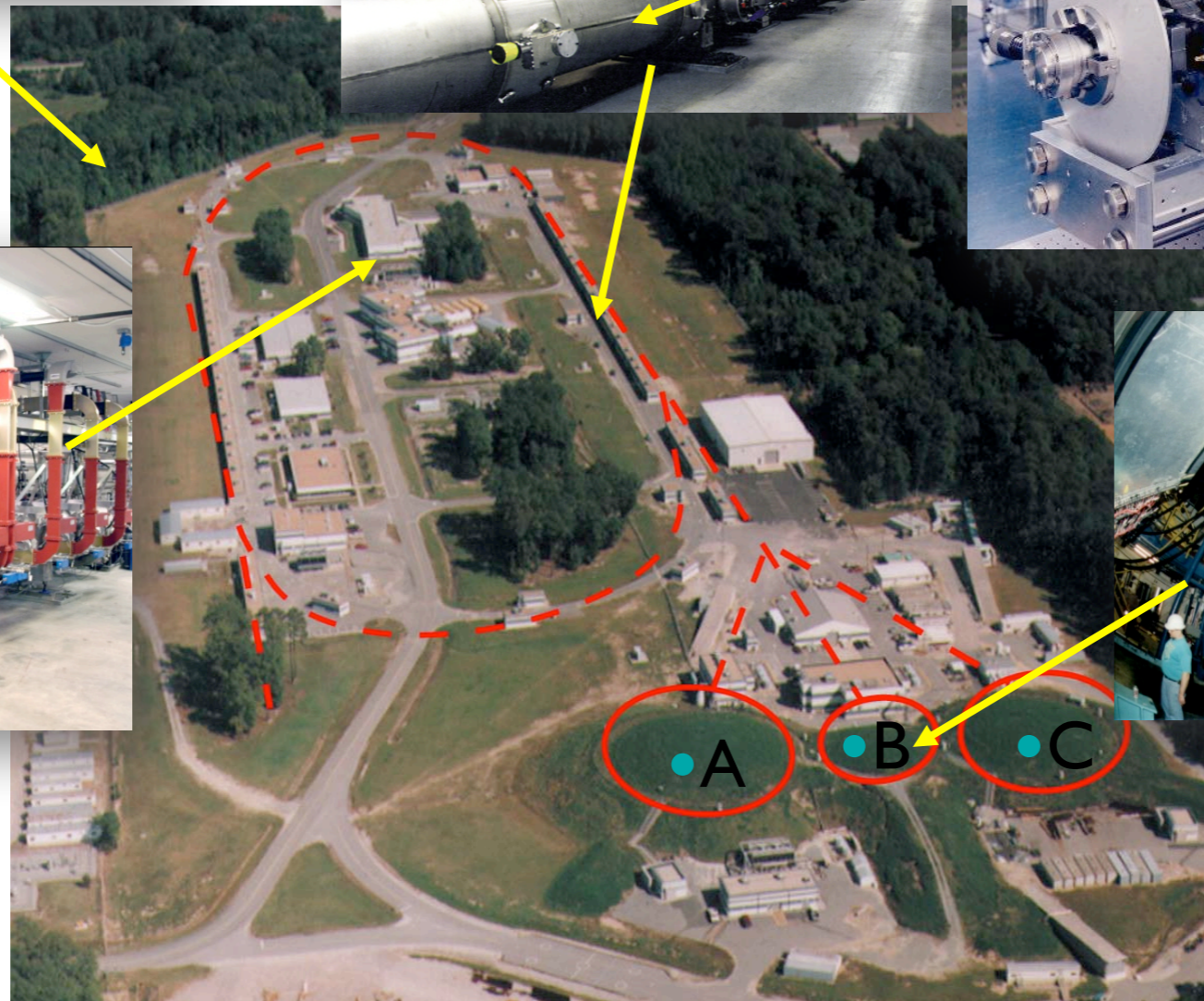
•Cryomodules in the accelerator tunnel



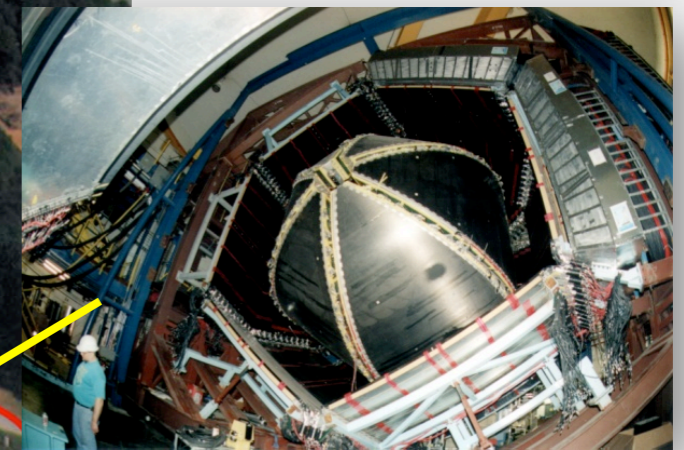
•Superconducting radiofrequency (SRF) cavities



•Free Electron Laser (FEL)



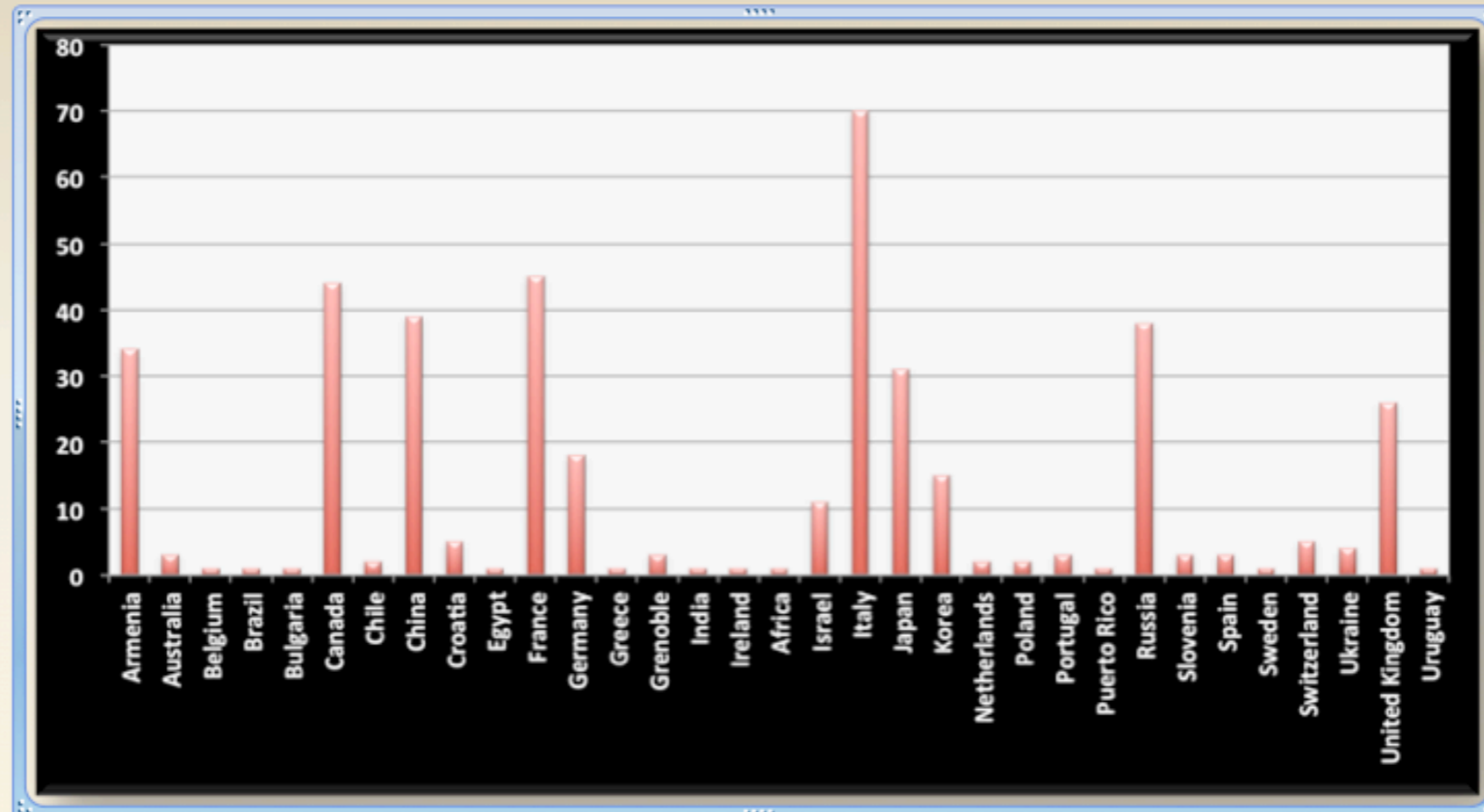
•An aerial view of the recirculating linear accelerator and 3 experimental halls.



•CEBAF Large Acceptance Spectrometer (CLAS) in Hall B

International Jefferson Lab

Non-US Nuclear Physics Users, 1/3 of total from 33 Countries



Non-US Accelerator Collaborations, 14+ Institutions from 10+ Countries

- Canada (1)
- China (1)
- France (1)
- India (1)
- Germany (3)
- Mexico (1)
- Multi-country (2)
- Russia (1)
- Sweden (1)
- Switzerland (1)
- UK (1)

The 12 GeV upgrade

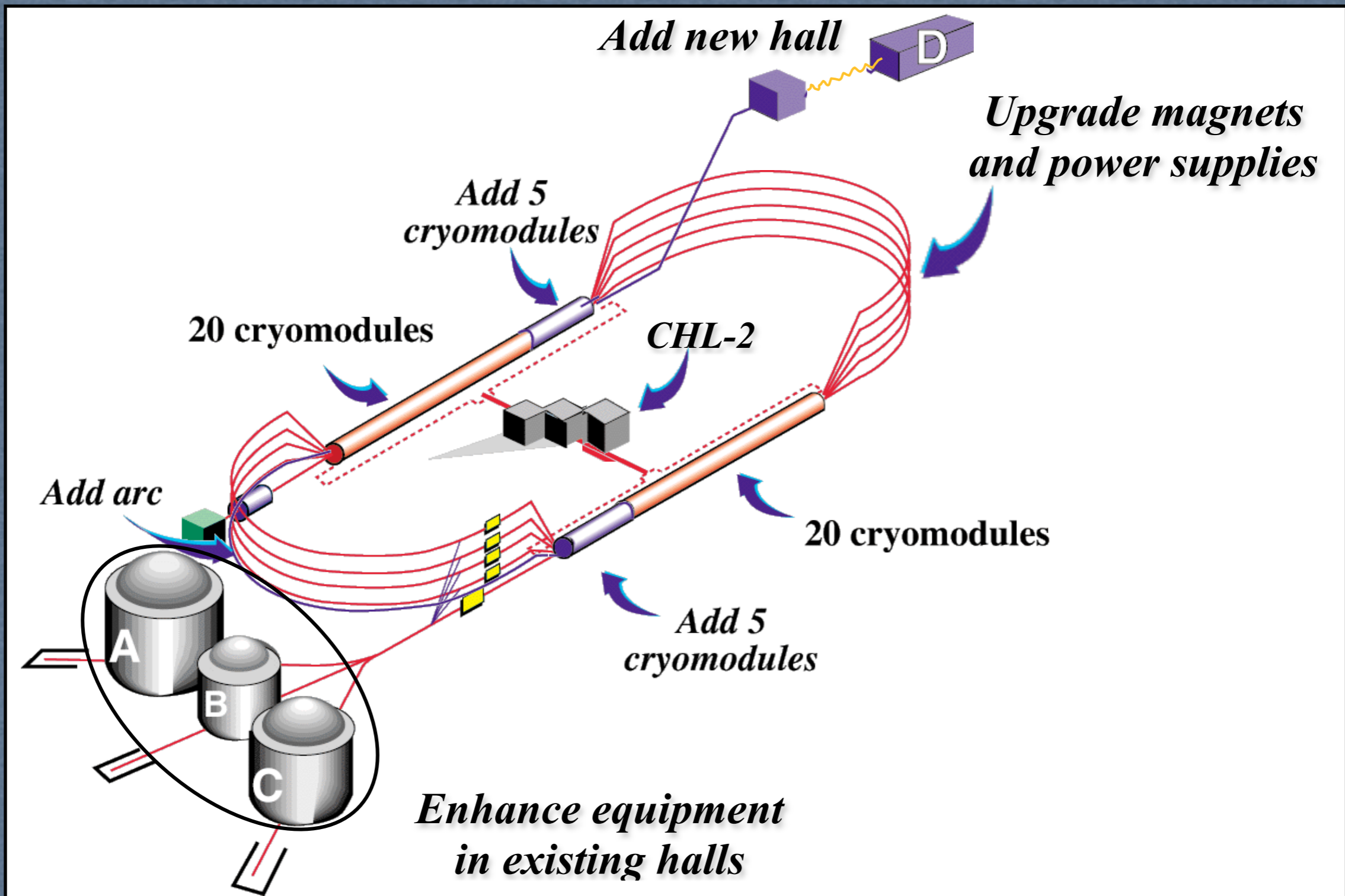
- * CEBAF design and performance make easy the energy upgrade
 - CEBAF RF cavities exceeded the designed specification by 50%
 - Maximum beam energy of 6 GeV routinely achieved (4 GeV max nominal energy)
 - ARCS can accommodate an electron beam up to 24 GeV
- * Upgrade of the accelerator
- * Construction of new equipment for Hall A, B and C
- * Construction of a new experimental hall (Hall D)

The Upgrade of CEBAF to 12 GeV (the highest priority of the 2007 NSAC Long Range Plan) is now well underway

- Project is “**on cost and on schedule**” and over half complete as of today
- Initial beam operation to begin in Hall A in **Oct 2014** and full operation by Jun 2015

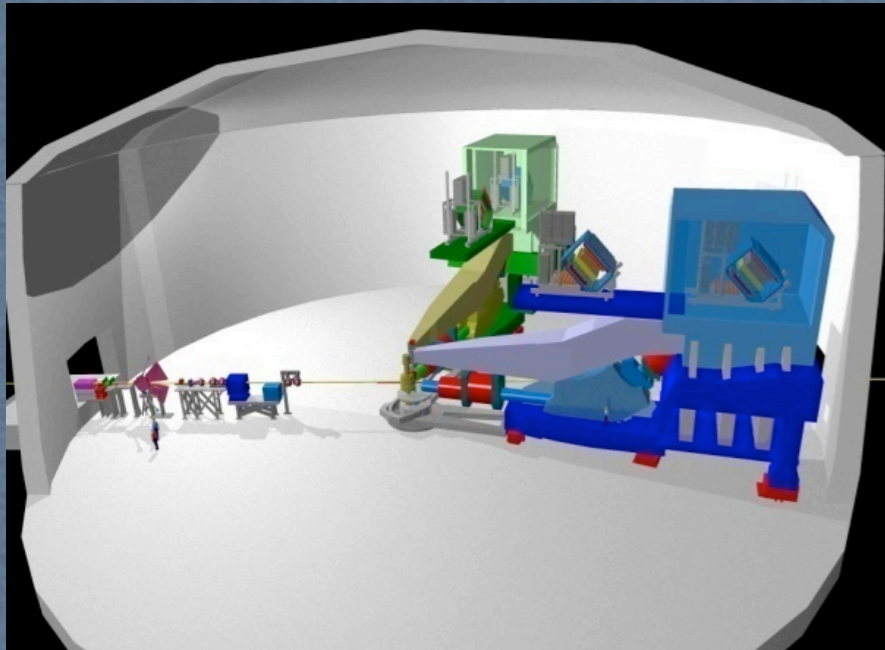
The 12 GeV Research Program is Evolving Rapidly

CEBAF @12 GeV

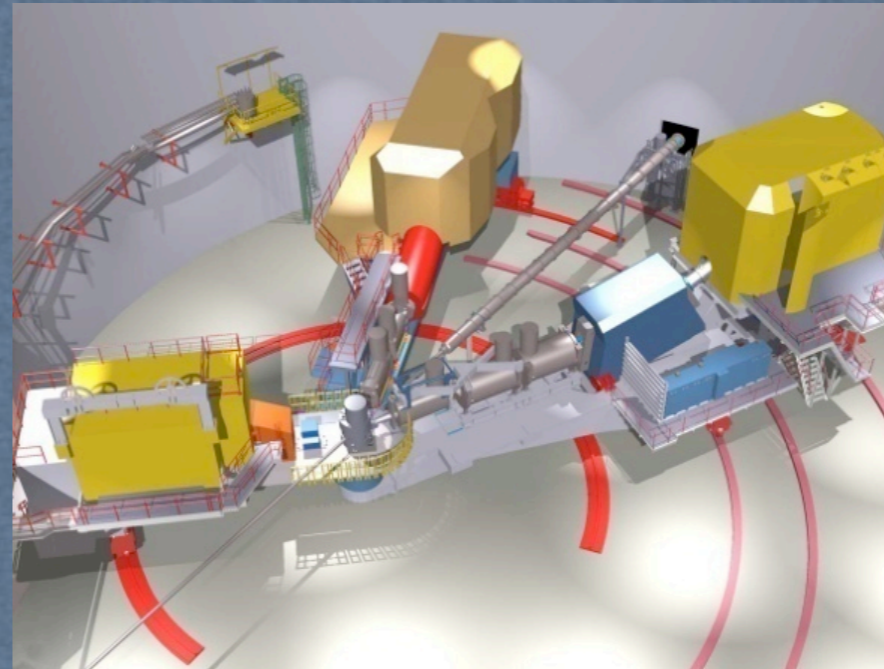


The 12 GeV equipment

Hall A – High Resolution Spectrometers and new multipurpose large acceptance detectors



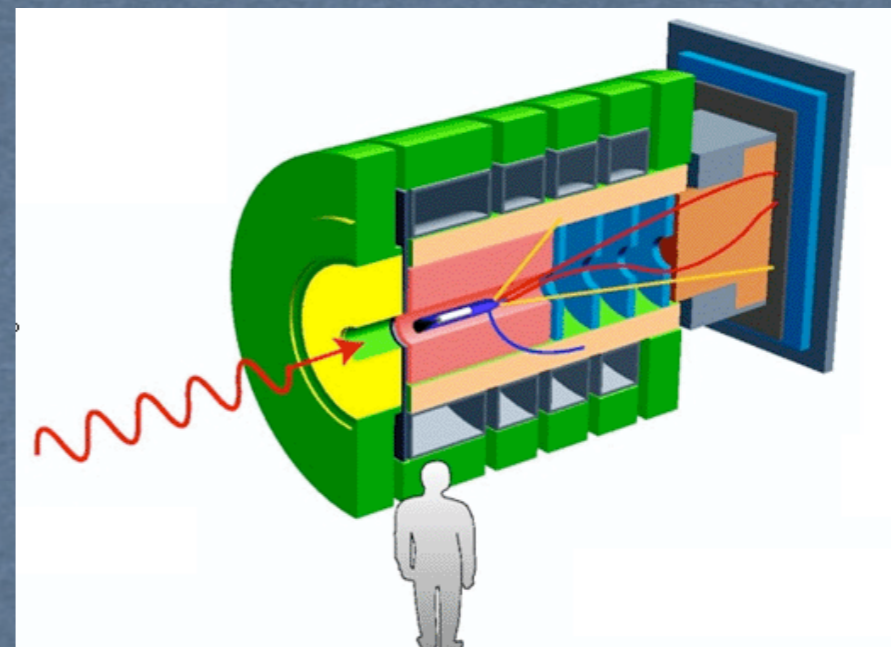
* short range correlations, form factors, and future new experiments: SOLID, MOELLER, SBS



Hall C – Super High Momentum Spectrometer (SHMS)

* precise determination of valence q properties in nucleons and nuclei

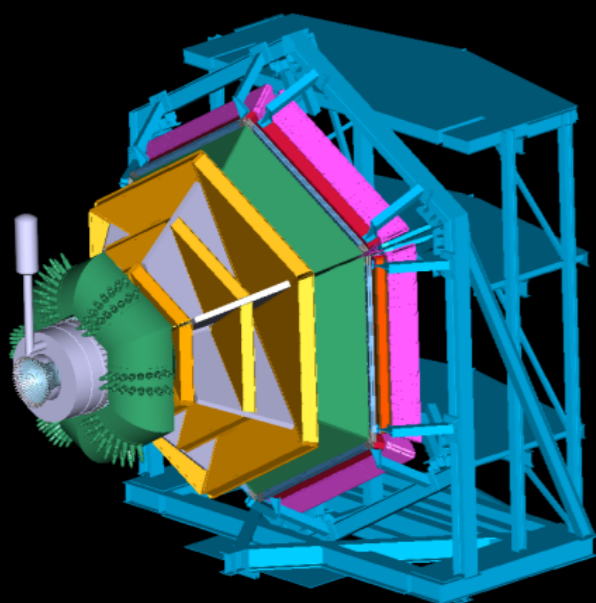
Hall D – GLUEx detector for photoproduction experiments



* explore origin of confinement by studying hybrid mesons

Hall B – Large acceptance detector CLAS12 for high luminosity measurements ($10^{35}\text{cm}^{-2}\text{s}^{-1}$)

- * Understanding nucleon structure via GPDs and TMDs and hadron spectroscopy



JLab scientific mission

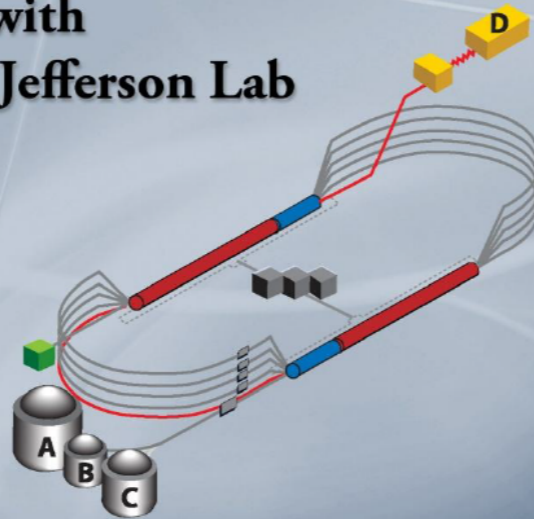
- * Understand how hadrons are constructed from the quarks and gluons of QCD
- * Understand the QCD basis for the nucleon-nucleon force
- * Explore the limits of our understanding of nuclear structure
 - high precision
 - short distances
 - the transition from the nucleon-meson to the QCD description
- * To make progress in these areas we must address critical issues in “strong QCD”:
 - What is the mechanism of confinement?
 - Where does the dynamics of the q-q interaction make a transition from the strong (confinement) to the perturbative (QED-like) QCD regime?
- * Probe potential new physics through high precision tests of the Standard Model

12 GeV White Paper

Jefferson Lab

Thomas Jefferson National Accelerator Facility

**Physics Opportunities with
the 12 GeV Upgrade at Jefferson Lab**



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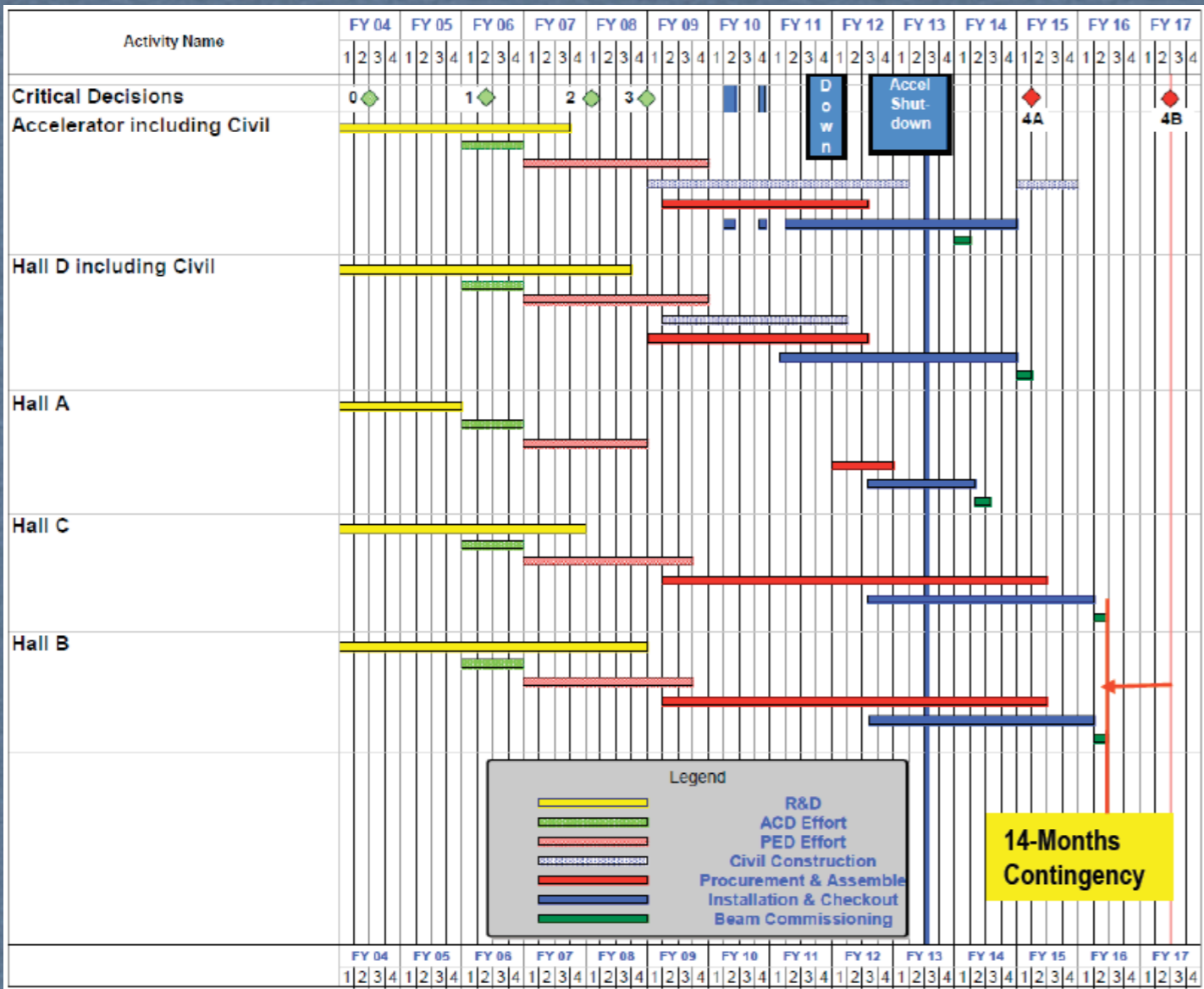
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Time schedule & Costs



May 18th 2012: 6 GeV program completed!

16-month installation: May 2012 – Sept 2013

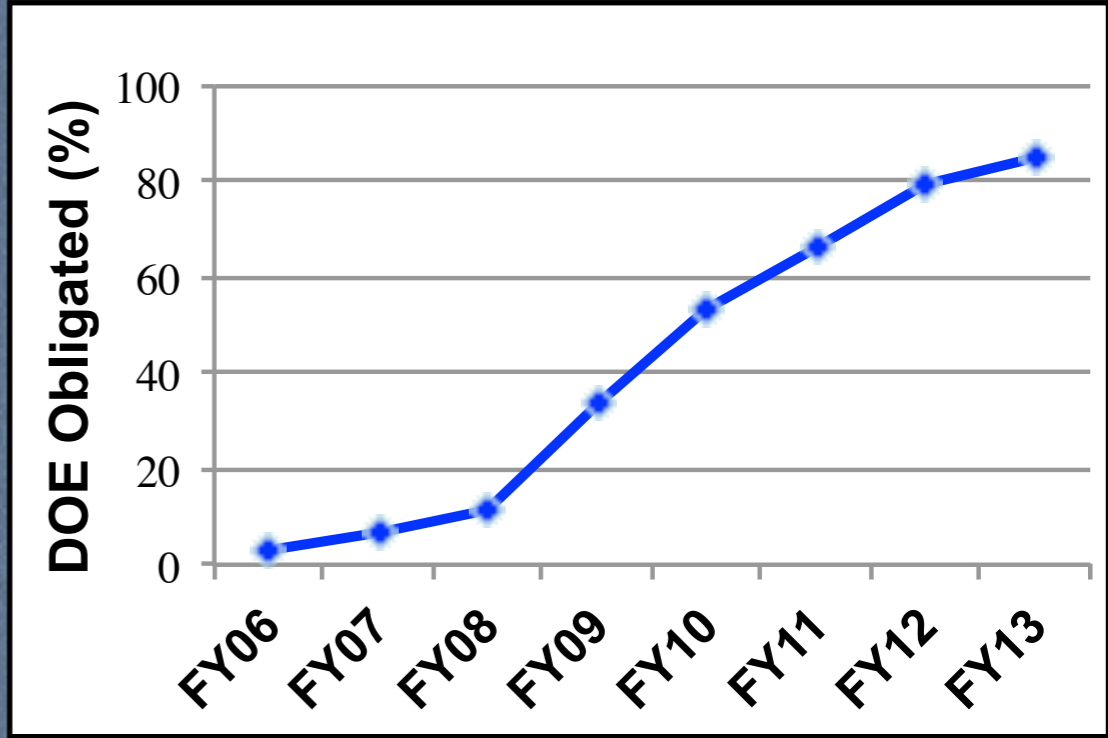
Accelerator Commissioning Oct 2013

Hall A commissioning start Feb 2014

Hall D commissioning start Oct 2014

Halls B/C commissioning start Jan 2016

Project Completion March 2017

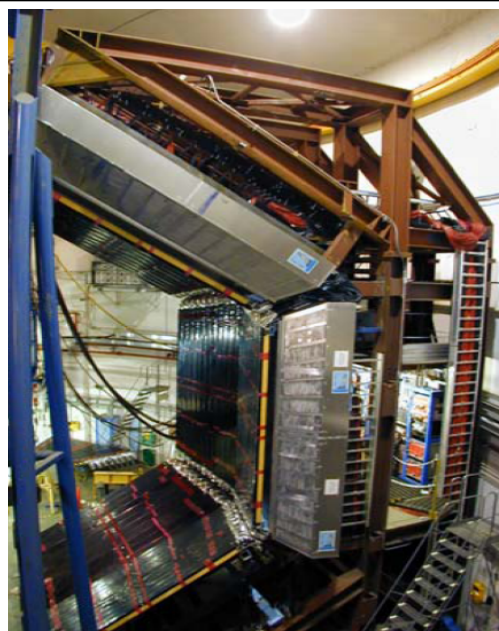
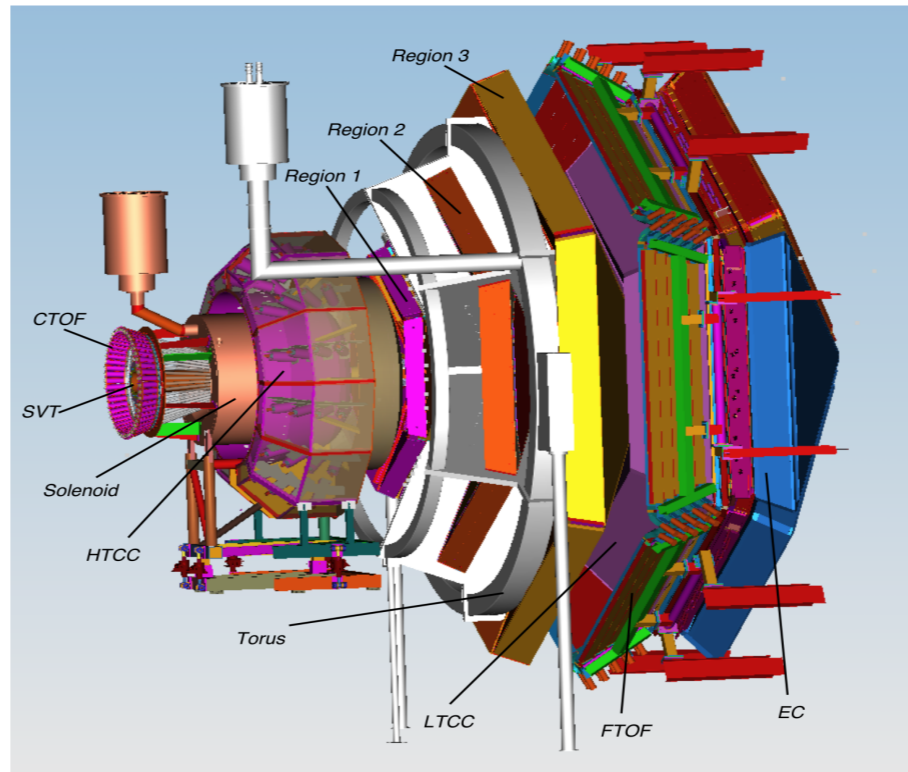
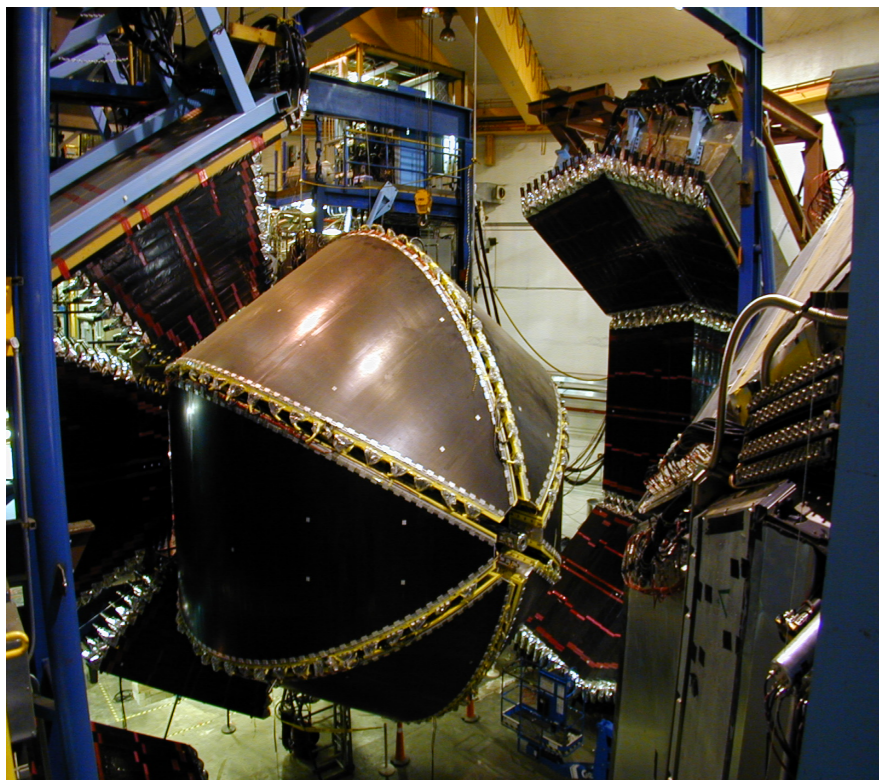


- * 12 GeV - Total project cost: 310M\$
- * ~75% completed, 88% obligated at May 2013
- * Base equipment fully funded by DOE
- * JLAB12 (Italy) contributes to extra equipment

The Hall-B

CLAS (JLab@6GeV) → CLAS12 (JLab@12GeV)

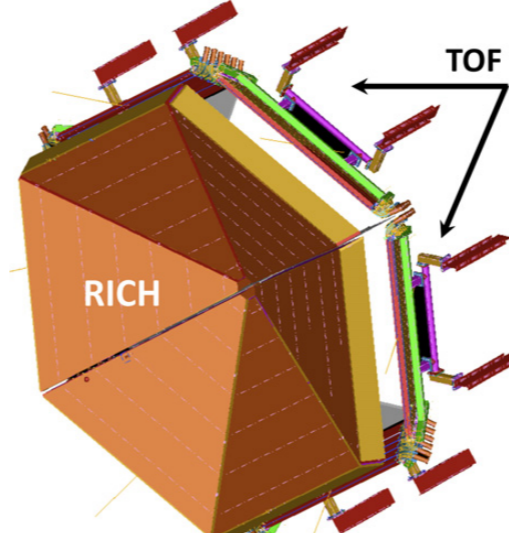
- Magnetic spectrometer based on six-coil toroidal field
- Large kinematical coverage + high luminosity (up to $10^{35} \text{ cm}^{-2} \text{ s}^{-1}$)
- Simultaneous measurement of exclusive and inclusive reactions
- Capability of polarized target experiments



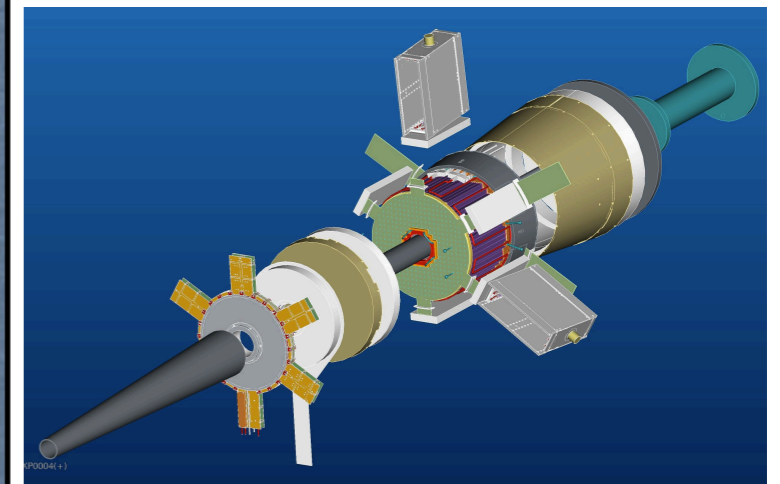
**CLAS
Large Angle
Calorimeters**

- n and γ detection at large angles
- π^0 enlarged acceptance

CLAS12 RICH detector

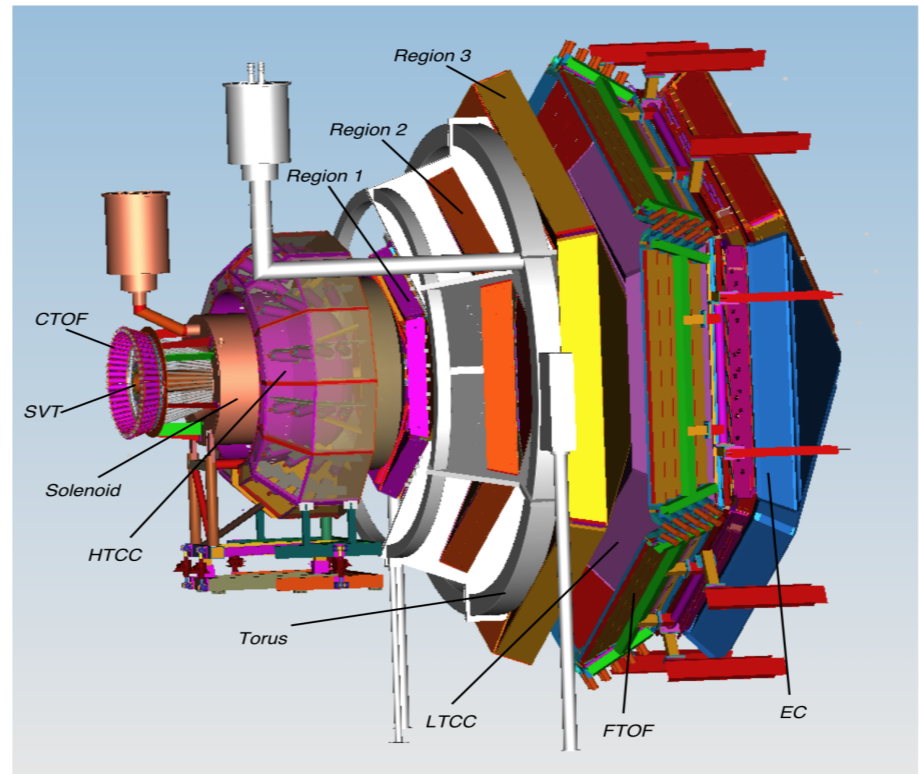
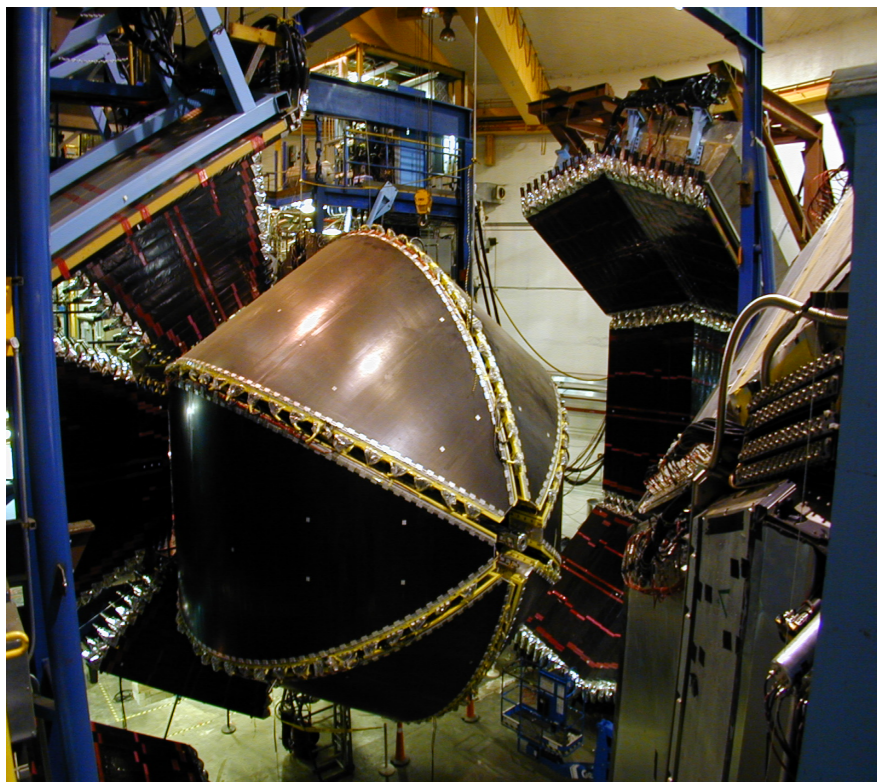


CLAS12 Forward Tagger



The Hall-B

CLAS (JLab@6GeV) → CLAS12 (JLab@12GeV)



*Nucleon Structure

- EM, EW, and Flavor-Separated Form Factors
- Structure functions
- Transverse Momentum Distributions (TMD)

*The Physics of Confinement

- Baryon spectroscopy
- Meson spectroscopy

*Nuclear Structure and the Quark Structure of Nuclei

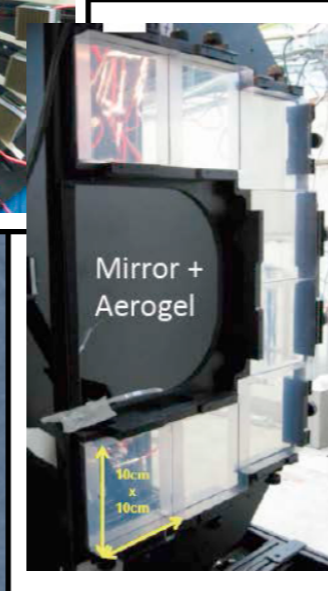
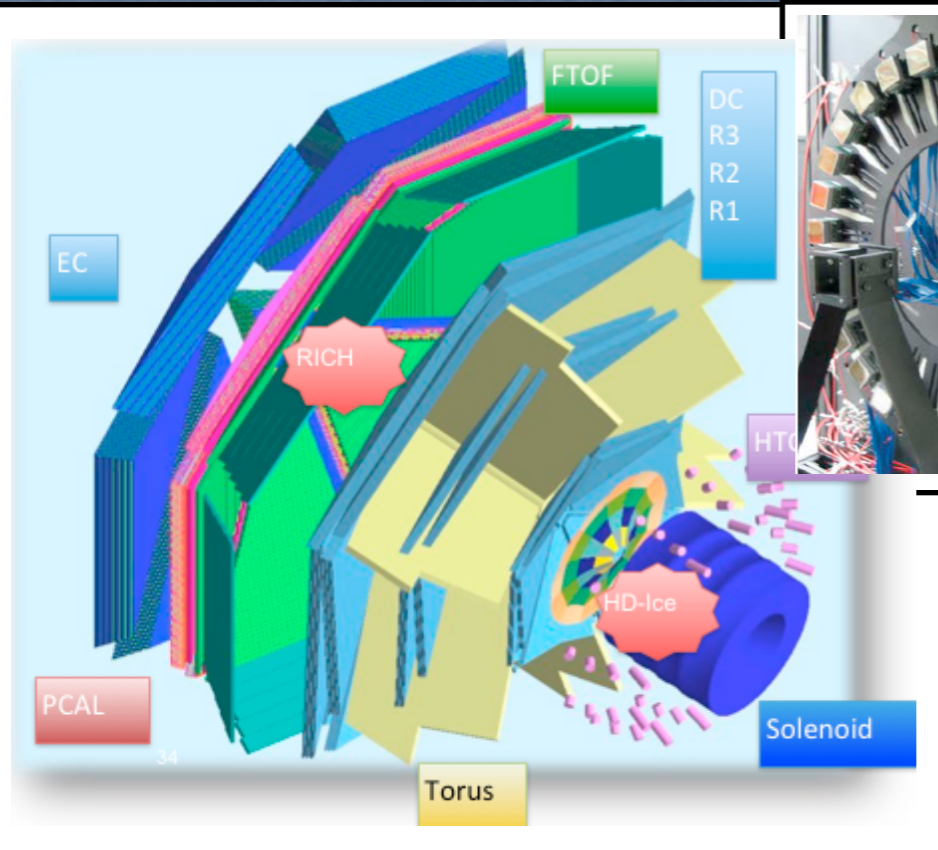
- Hypernuclear Physics

*Search for physics Beyond the Standard Model

- Dark Forces search

Nucleon structure: TMD

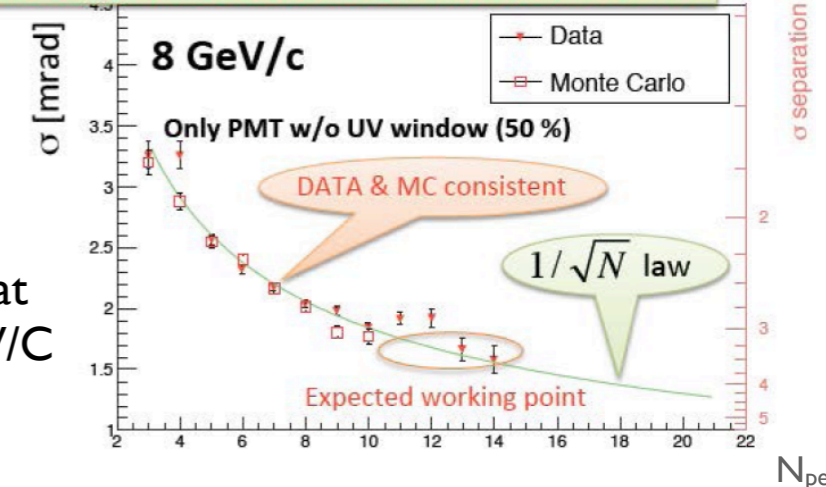
The RICH detector for CLAS12



Kaon Id up to 8 GeV/c mandatory for the TMD physics (flavor separation)
→ RICH replacing Low Threshold Čerenkov Counter

- Full $p/k/\pi$ separation in 3-8 GeV/c range
- π/k separation at $4-5\sigma$ @ $p=8$ GeV/c with $RF \sim 1000$

> 3 σ separation at 8 GeV/c with not-UV PMT



A 12 GeV Research Proposal to Jefferson Lab (PAC 34)

Studies of the Boer-Mulders Asymmetry in Kaon Electroproduction with Hydrogen and Deuterium Targets

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Studies of partonic distributions using semi-inclusive production of Kaons

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 D. H. Potterveld, P. E. Reimer, P. Solvignon

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A 12 GeV Research Proposal to Jefferson Lab (PAC 34)

Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with polarized hydrogen and deuterium targets

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Meson Spectroscopy

A CLAS Collaboration Proposal to PAC37

Meson Spectroscopy with low Q^2 electron scattering in CLAS12

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JLab MesonEx program

hunting for new configurations beyond qq and qqq

- Exotic meson search
- Hadron spectroscopy
- J/ψ threshold production
- *New equipment to detect e^- scattered at low angle
- *Distributed data analysis center: HASPECT

The Forward Tagger for CLAS12

FT-Cal- $PbWO_4$ calorimeter

electron energy/momentum

Photon energy ($\nu = E - E'$)

Polarization $\varepsilon^{-1} \approx 1 + \nu^2/2EE'$

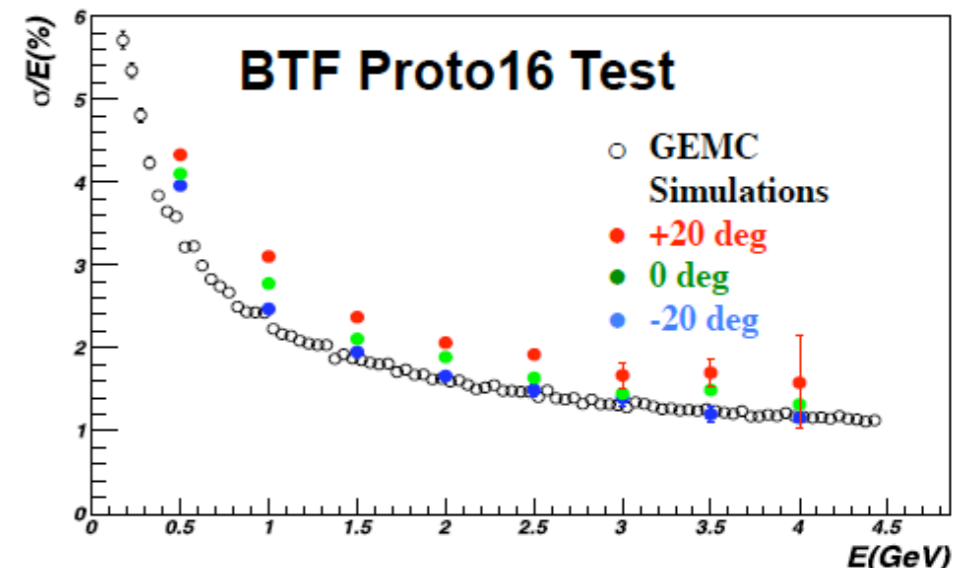
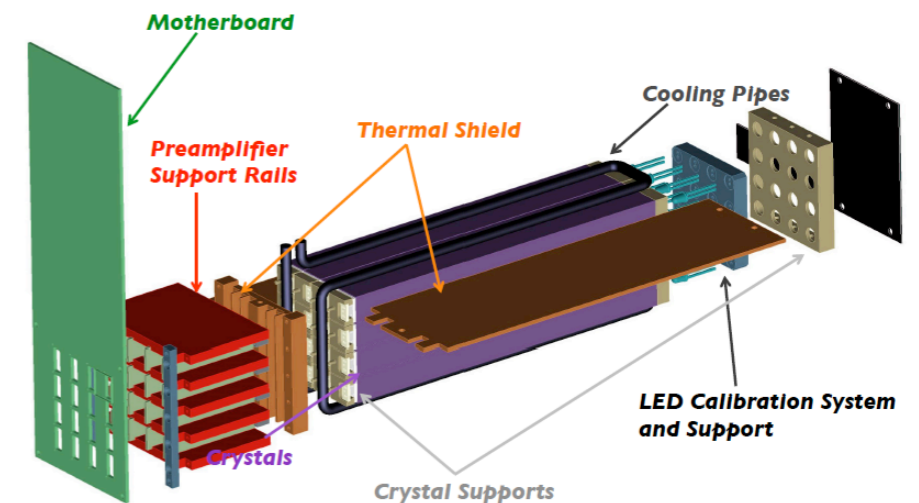
FT-Trck- MicroMegas

detectors

electron angles and polarization

plane

FT-Hodo - Scintillator tiles
 veto for photons




Meson spectroscopy: global PWA

Global strategy:

- *Creation of twin and parallel centers for both analysis and theory development
- *Collaboration and exchanges: personnel, short visits, ...
- *Coordination via JLab Pysics Analysis Center
- *Creation of a “Hadron spectrum” working group
- *Common funding plans:
 - European-FP7 (EU calls and local): HadronPhysics4, Synergy grants
 - DOE-Topical -collaboration proposals
 - Helmholtz Virtual-Institutes

**HASPECT:
Act locally
but think
globally!**



 Homepage of the Quarkonium Working Group

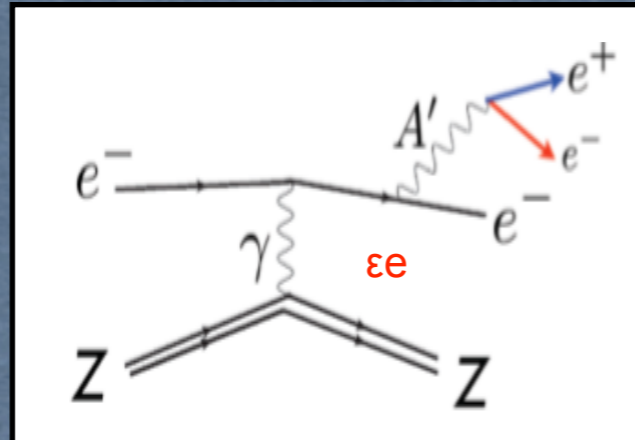
QWG Publications

- **New!** 2010: Heavy quarkonium: progress, puzzles, and opportunities [arXiv:1010.5827](https://arxiv.org/abs/1010.5827)
- 2006: Quarkonium action itmes (see the subgroups pages below)
- 2004: [CERN-2005-005 YELLOW REPORT](#) on Heavy Quarkonium

QWG Workshops on Heavy Quarkonium

- **New!** [QWG9: IHEP, Beijing, 22-26 April 2013](#)
- [QWG8: GSI, 3-7 October 2011](#)
- [QWG7: Fermilab, 18-21 May 2010](#)
- [QWG6: Nara, Japan, 2-5 December 2008](#)
- [QWG5: DESY, 17-20 October 2007 \(Photo Gallery\)](#)
- [QWG4: Brookhaven, June 27 to 30, 2006 \(Program/Slides and few photos\)](#)
- [QWG Topical Seminar School on Heavy Quarkonia at Accelerators: New Theoretical Tools and Experimental Techniques ITP Beijing, October 8 to 11, 2004](#)

Beyond the Standard Model: the HPS experiment



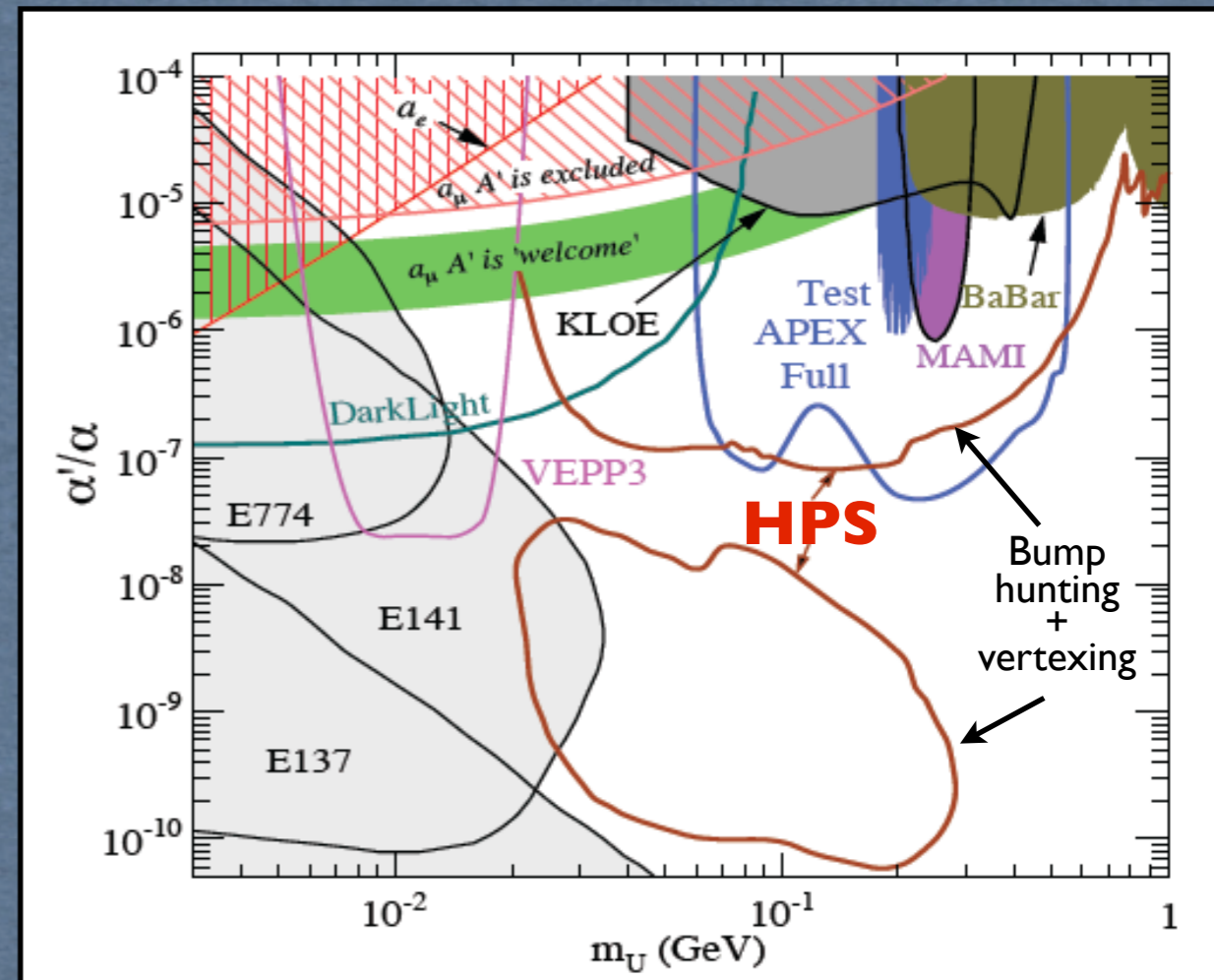
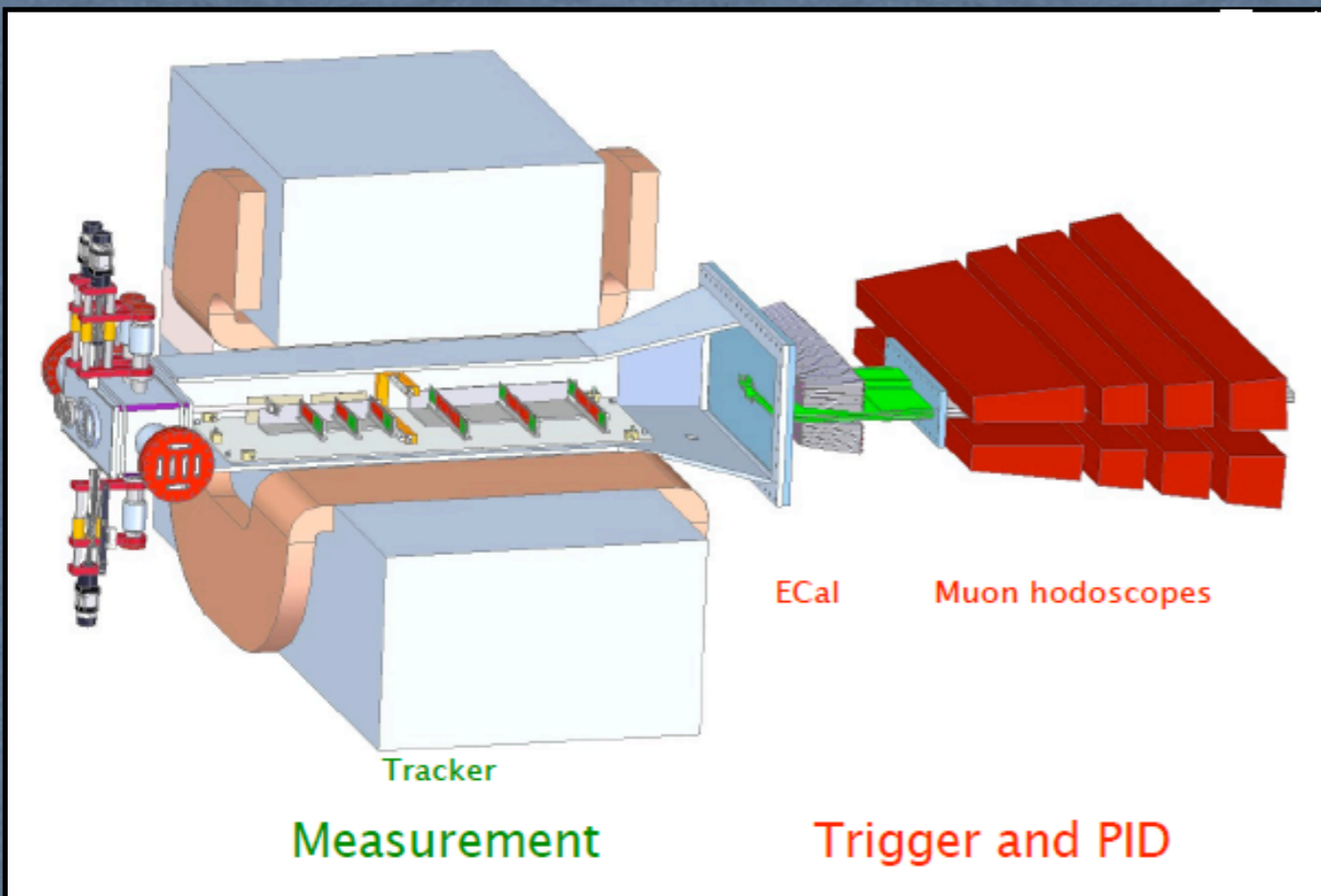
1) Bump Hunting (BH)

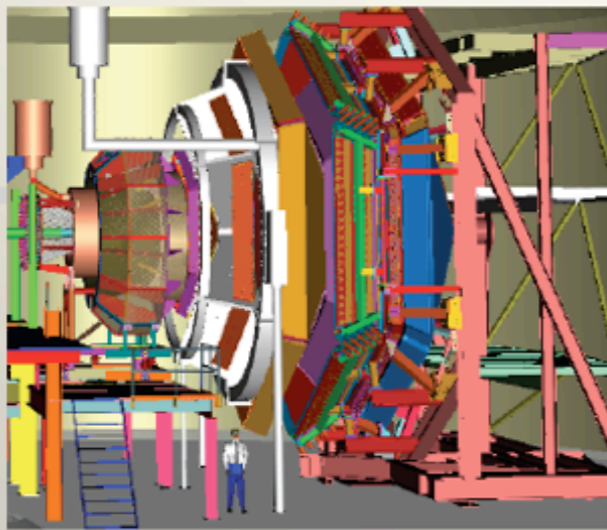
Narrow e^+e^- -resonance over a QED background
 ↳ good mass resolution: $\sigma_{A'_{\text{mass}}} \sim 1 \text{ MeV}$

2) Secondary decay vertex (vertexing)

Detached vertex from few mm to tens cm
 ↳ good spacial resolution: $\sigma_{\text{vertex}} \sim 1 \text{ mm}$

BH + Vertexing = enhanced experimental reach





Preliminary Plans for First Years of Beam in Hall B

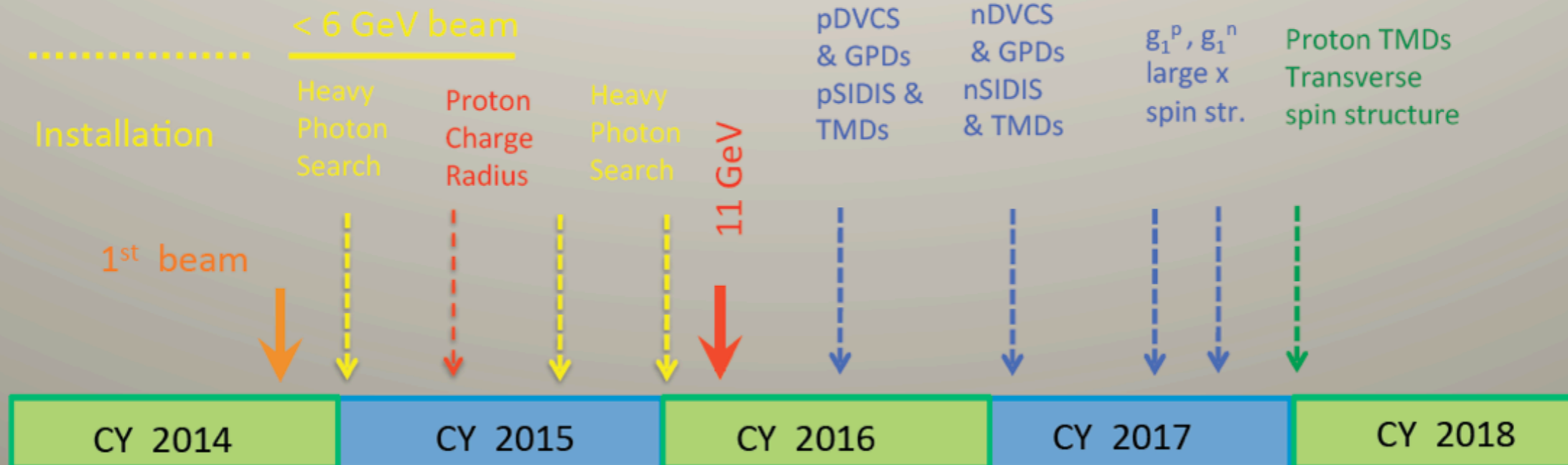
- 6 A rated experiments in first 3 years of running
- PCR, HPS, pDVCS, nDVCS, pSIDIS, g_1^p/g_1^n
- High discovery potential during first year

CLAS12

Construction

Installation

Early 11 GeV Experiments



JLAB I2/PANDA: collaboration grounds

- *Participation to the CLAS Collaboration for extract physics from collected data
 - Nucleon structure (Structure functions, GPD, form factors ...)
 - Hadron spectroscopy (Mesons & Baryons)
 - Physics of hypernuclei
- *Participation to JLAB I2 experiments (w or w/o hardware involvement)
 - Nucleon structure (hw: RICH)
 - Spectroscopy (hw: Forward Tagger)
 - Physics BSM (hw: ECal)
- *Participation to JLAB physics analysis within EU/Local projects
 - Nucleon structure: TMD-network
 - Spectroscopy: HASPECT