



Jefferson Lab Status



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Deputy Director For
Science

April 2014 USQCD Meeting

Jefferson Lab
● Thomas Jefferson National Accelerator Facility

Outline

- Physics Highlights
- 12 GeV Project Status
- MEIC Planning
- Summary and Outlook

Physical Review Letter 111, 141803 (2013)

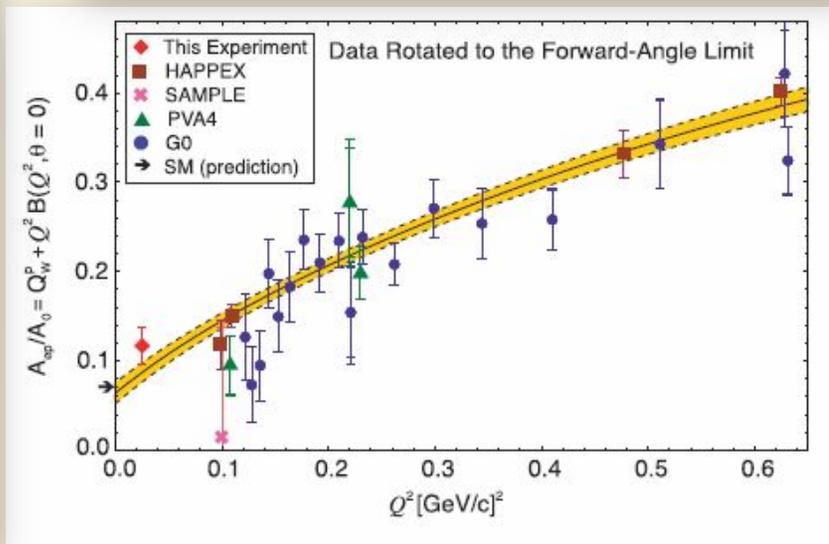
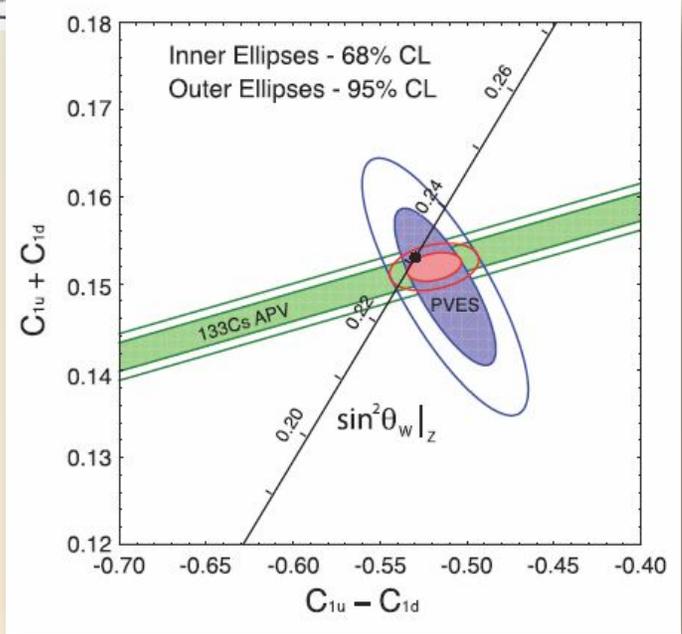
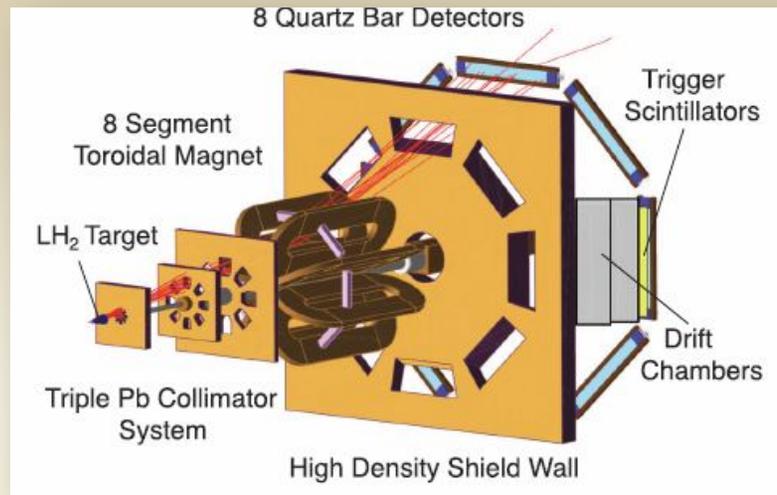
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spotlighting exceptional research

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Synopsis: The Weaker Side of the Proton

First Determination of the Weak Charge of the Proton
D. Androic et al. (Q_{weak} Collaboration)
Phys. Rev. Lett. **111**, 141803 (2013)
Published October 2, 2013

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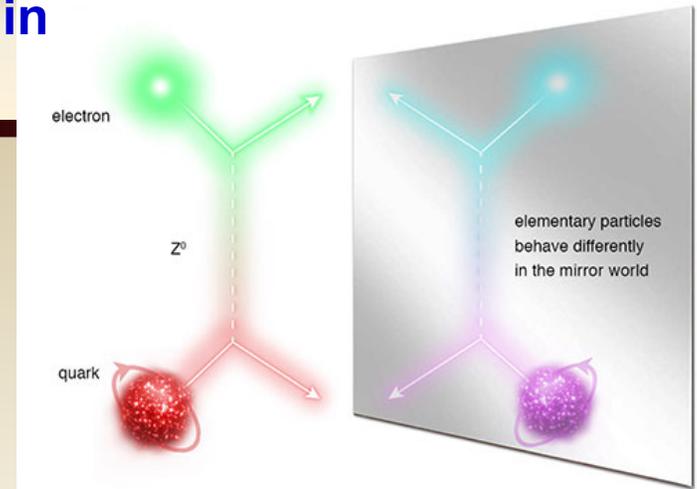
Measurement of the Parity-Violating Asymmetry in eD Deep Inelastic Scattering

Nature 506, 67–70 (06 February 2014)

The Jefferson Lab PVDIS Collaboration

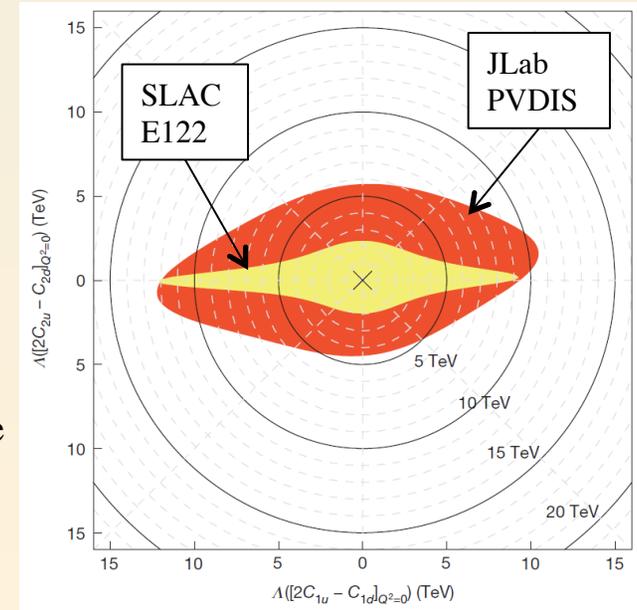
See also News & Views, *Nature* 506, 43–44 (06 February 2014)

Longitudinally Polarized Electron Scattering from Unpolarized Deuterium



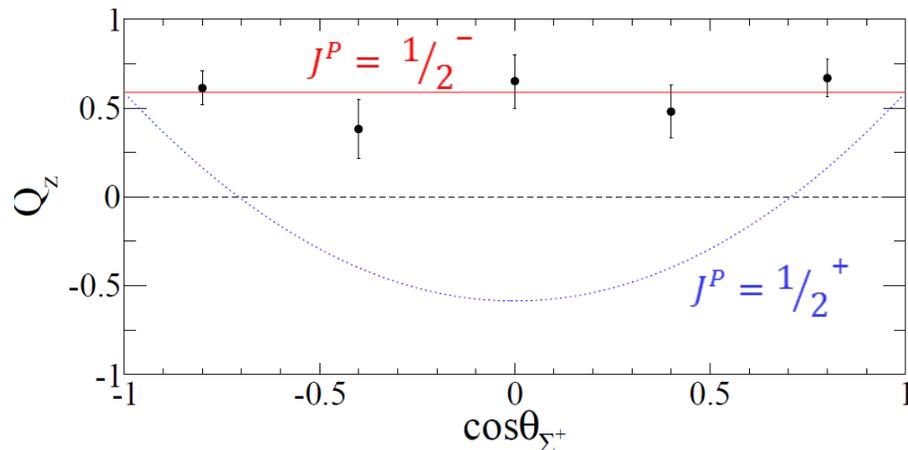
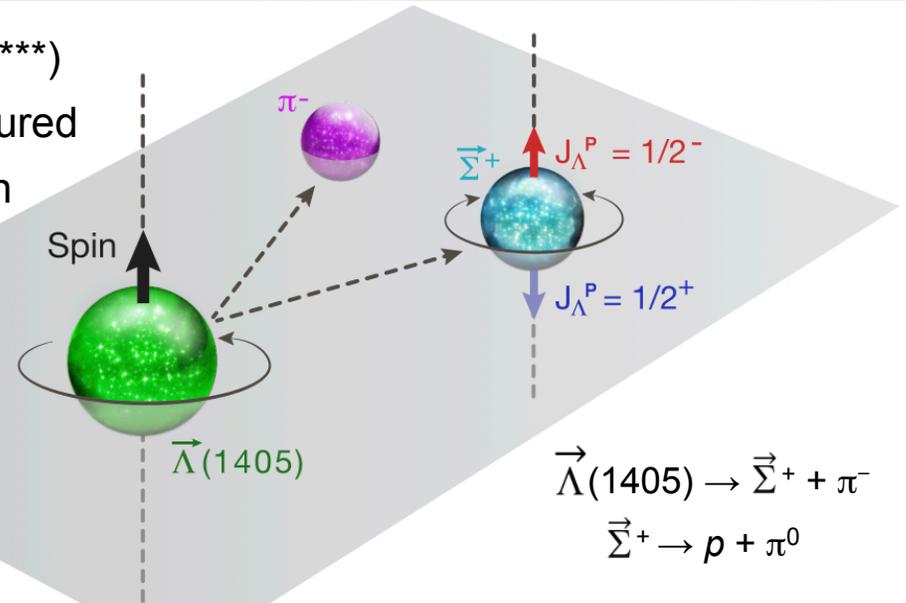
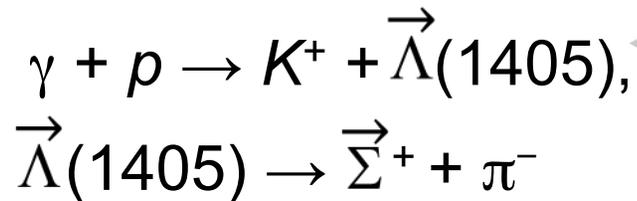
$$A_{LR} = A_{PV} = \frac{\sigma_{\uparrow} - \sigma_{\downarrow}}{\sigma_{\uparrow} + \sigma_{\downarrow}} \sim \frac{A_{\text{weak}}}{A_{\gamma}} \sim \frac{G_F Q^2}{4\pi\alpha} (\alpha [2C_{1u} - C_{1d}] + \beta [2C_{2u} - C_{2d}])$$

- Provides a determination of the effective electron-quark weak coupling combination $2C_{2u} - C_{2d}$ that is five times more precise than before.
- It is the first experiment to isolate, when combined with previous experiments like Q-weak, a non-zero C_{2q} (at 95% confidence level).
- This coupling describes how much of the mirror-symmetry breaking in the electron-quark weak interaction originates from the quarks' spin preference. The result provides a mass exclusion limit on the electron and quark compositeness and contact interactions of ~ 5 TeV.



Spin and Parity of the $\Lambda(1405)$ Baryon

- $\Lambda(1405)$ is a well-known hyperon (PDG Status: ****)
- Spin-Parity, J^P , has never been definitively measured
- $\Lambda(1405)$ created polarized via photoproduction in liquid hydrogen & detected in CLAS

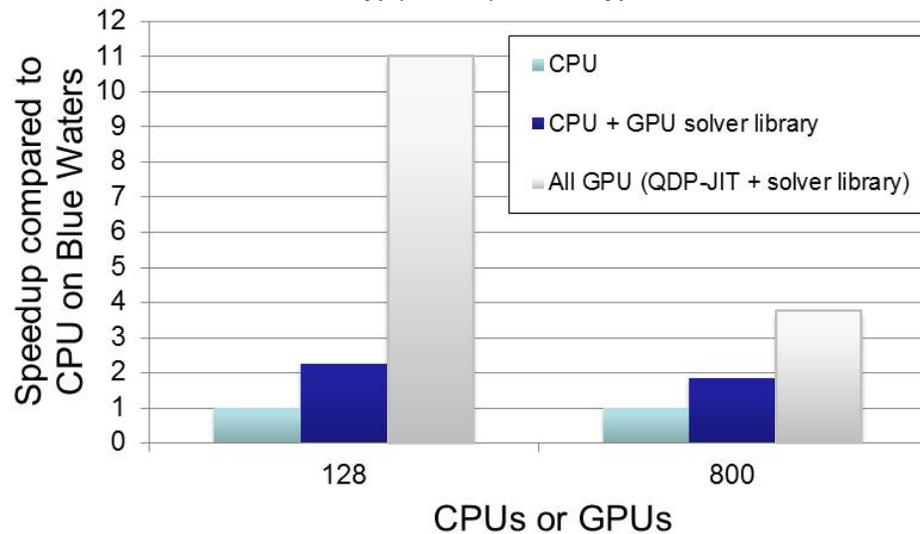


- Isotropic decay of $\Lambda(1405)$ is consistent with spin $J = 1/2$
- Polarization transfer to Σ^+ direction reveals $J^P = 1/2^-$ vs. $J^P = 1/2^+$
- Quark model expectation confirmed
- Higher spins are disfavored by the data and by theoretical expectations

K. Moriya, R. A. Schumacher *et al.* (CLAS Collaboration),
 "Spin and Parity Measurement of the $\Lambda(1405)$ Baryon." *Phys. Rev. Lett.* **112** 082004 (2014).

Accelerating Science with GPUs

Gauge Generation Benchmark Strong (Hard) Scaling



- Before: Used CPU + GPU solver library for LQCD Analysis (>95% work in solver)
- Gauge Generation uses solvers less - smaller gain from only accelerating solver
- QDP-JIT layer moves entire calculation to GPU (+ we still use GPU solver library)
- **2x-5x speedup** over GPU solver library alone, **3.7x-11x speedup** over CPU alone

Data from: F. Winter (JLab), M. A. Clark (NVIDIA), B. Joo (JLab), R. Edwards (JLab) - Accepted for IPDPS'14 conference

Applicable to leadership GPU systems
such as DOE Titan (ORNL) and
NSF Blue Waters (NCSA - University of Illinois)

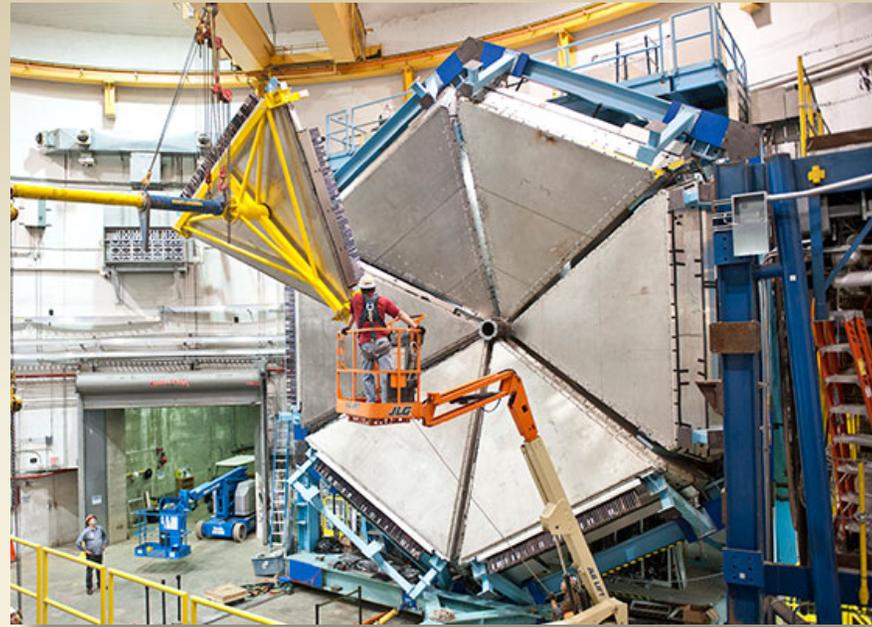
TOP 500 (#364) Supercomputer



(for only \$750K!)

12 GeV Project Highlights

Hall D



Hall B

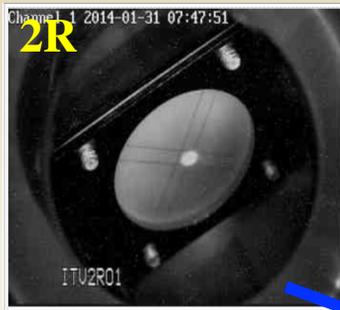


Hall C

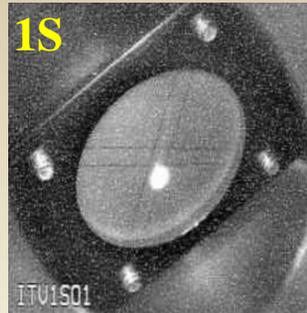
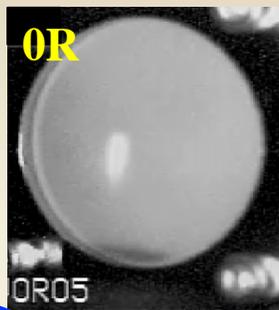


Accelerator Commissioning Progress

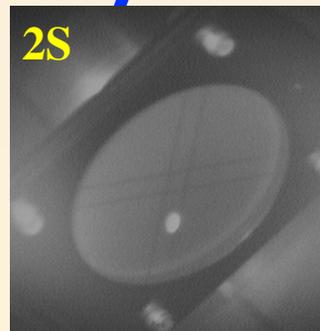
2214 MeV



34 MeV

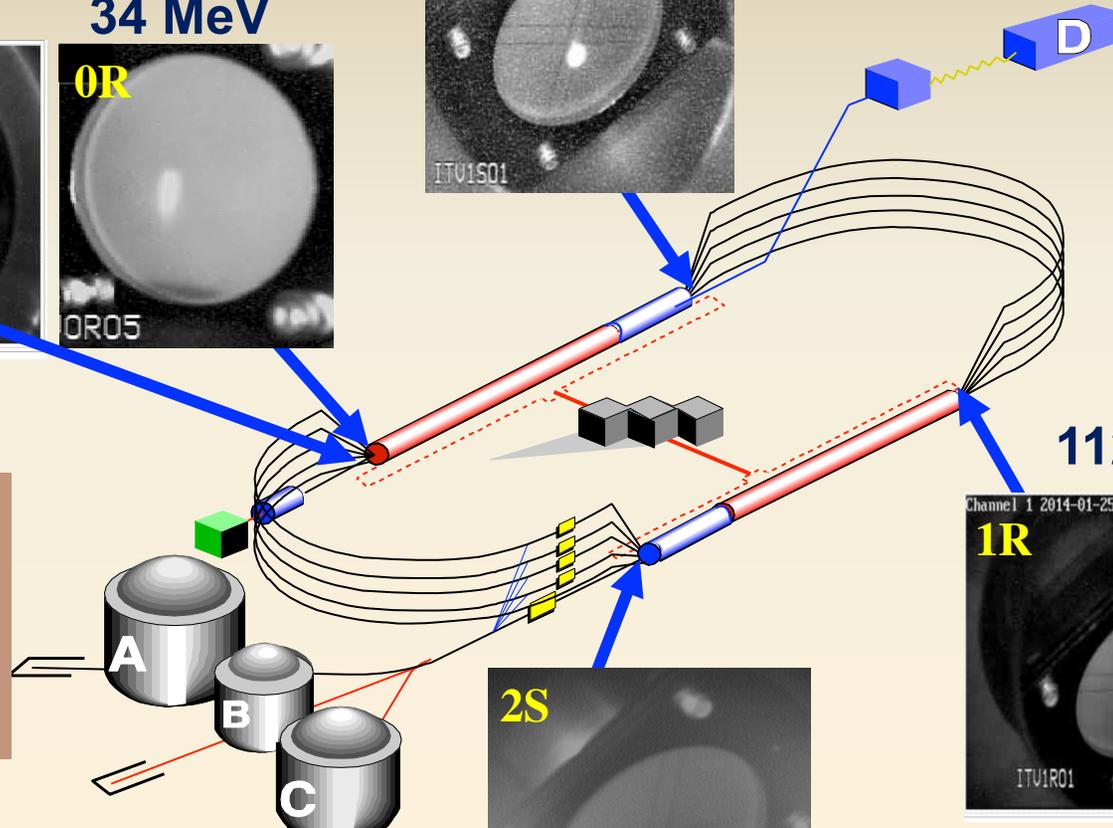


1124 MeV

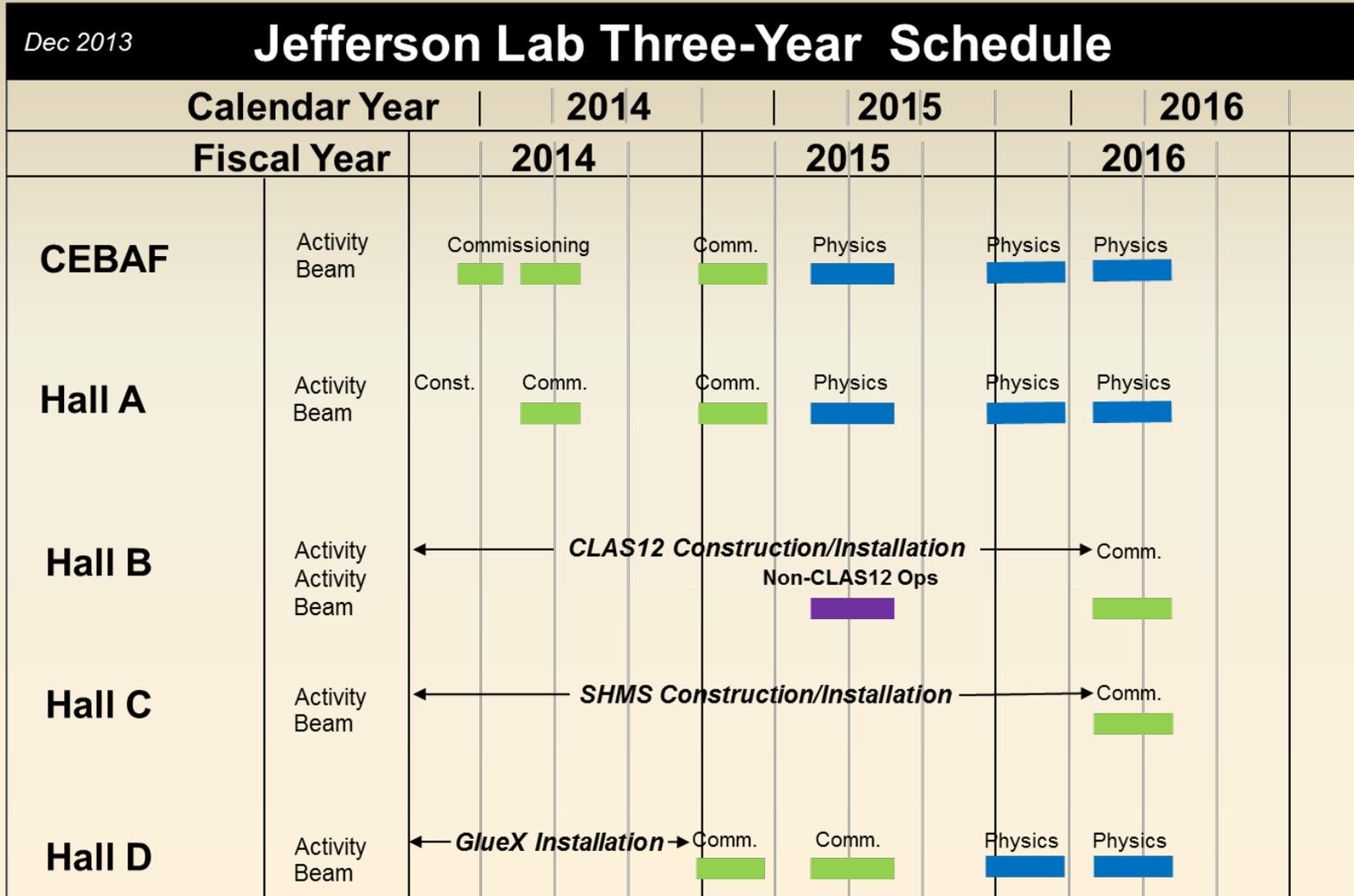


CHL1, CHL2 operational
Linacs at 2K
North Linac – 1090 MeV
South LINAC – 1090 MeV
CEBAF 2.214 GeV
Optics, Magnets great

KPP: machine capable of 12 GeV
1 pass at 2.2 GeV/pass for 8 hours
with acceptable trip rate (50% uptime)



Three year plan

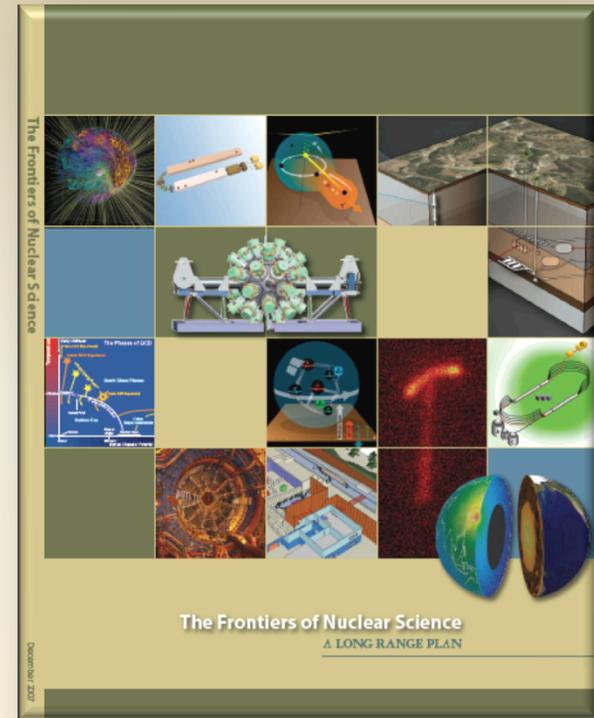


■ Beam for Commissioning
 ■ Beam for Physics
 ■ Non-CLAS12 Ops

Electron Ion Collider

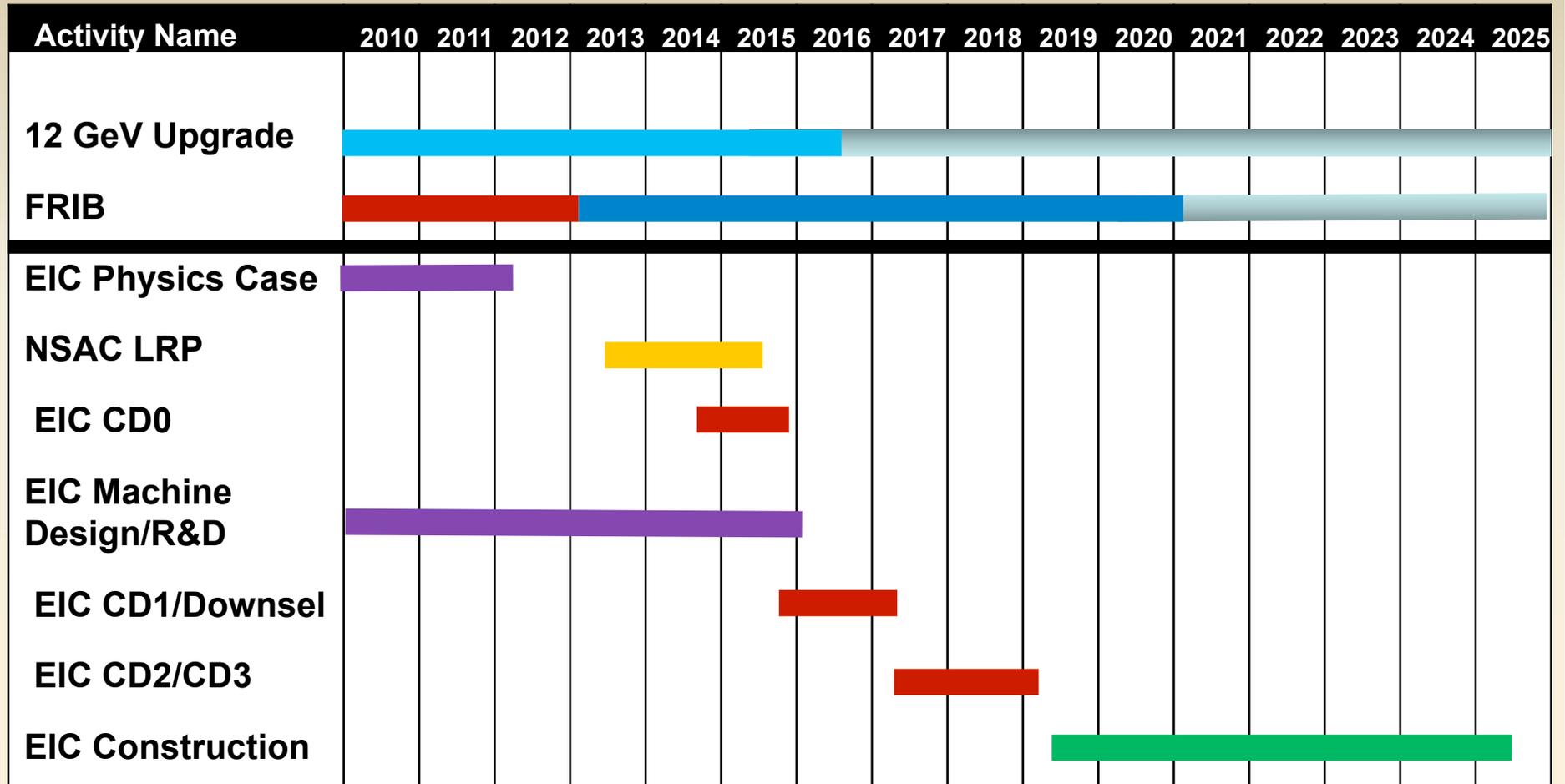
NSAC 2007 Long-Range Plan:

“An **Electron-Ion Collider (EIC)** with **polarized** beams has been **embraced by the U.S. nuclear science community** as embodying the vision for **reaching the next QCD frontier**. EIC would provide unique capabilities for the study of QCD well beyond those available at existing facilities worldwide and complementary to those planned for the next generation of accelerators in Europe and Asia.”



- **Jefferson Lab and BNL developing facility designs**
- **Joint community efforts to develop science case → white paper (2013)**

EIC Realization Imagined



*Assumes endorsement for an EIC at the next NSAC Long Range Plan
Assumes relevant accelerator R&D for down-select process done around 2016*

EIC Developments

- MEIC design review (3 external reviewers) held Jan. 2014
- Initiated MEIC Cost Review Task Force ~6 months
- EICAC meeting (2/28-3/1, BNL)
- EIC14 Accelerator workshop at JLab (Mar. 17-21)
- VA request for new \$4.6M over 2 years
 - Site assessment
 - Electron cooling test hardware
 - Project staffing
- NSAC Long Range Plan (April 2014 start?)

Summary

- Exciting Physics Results
- 12 GeV project
 - 1 pass commissioning successful
 - 3 pass operation just achieved
 - Delivered CW beam in Hall A
- Much activity to realize EIC
- NSAC LRP on the horizon