



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

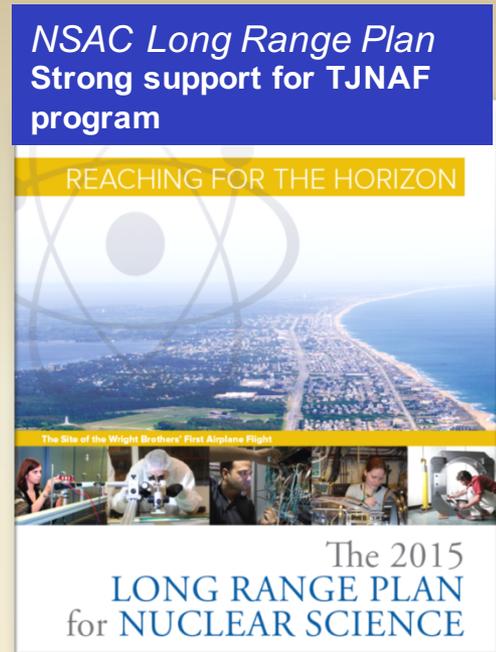


July 12, 2016

**Jefferson Lab**  
Thomas Jefferson National Accelerator Facility

# Welcome to JLAB!

- **Exciting times!**
  - **2015 NSAC long range report**
  - **Emphasizes the essential nature of computation and computing to meet the goals of near and far term scientific goals**
  - **CEBAF 12 GeV program has begun**



# CEBAF 12 GeV Upgrade Project

## **Project Scope** (~97% complete):

- Doubling the accelerator beam energy – **DONE**
- New experimental Hall D and beam line – **DONE**
- Civil construction including utilities – **DONE**
- Upgrades to Experimental Halls B & C – **~94%**
  - Halls B & C Detectors – **DONE**



Commissioned Experimental Hall D and detector

Upgrades to detectors in Halls A, B, C

Upgraded detectors will have increased output data rates

Additional detectors in the planning process

**Users compete for beam time via a peer review process.**

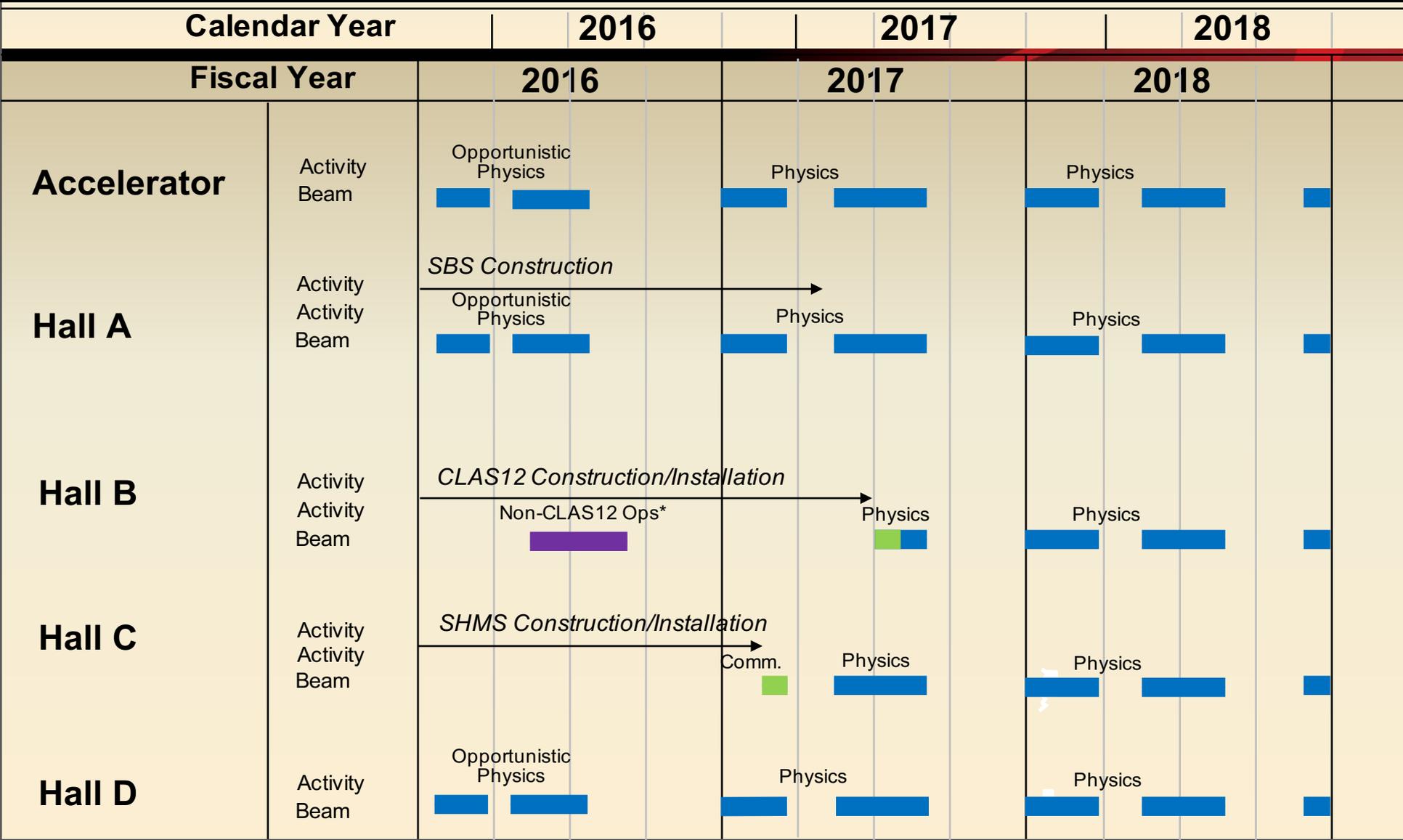
~1400 users

178 Completed Experiments to-date; 70 have been approved for the future 12 GeV program

Produces ~1/3 of US PhDs in Nuclear Physics (478 PhDs granted to-date; 193 in progress)

*The next 10 years of beam time is scheduled*

# CEBAF Three-Year Schedule



\* Potential PRad Summer 2016 run

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

# Long Range Plan: Nuclear Physics

*The JLab experimental and theoretical programs are intimately linked*

What observable states does QCD allow?

What is the role of the gluons? What about exotic matter?

*Focus of GlueX experiment & JLab 12 GeV upgrade*

How do nucleons arise?

How are quarks & gluons distributed in a proton or neutron?

*Focus of JLab 12 GeV, RHIC-spin and future EIC*

QCD must predict properties of light nuclei

Predict nuclear reaction properties, connect to effective theories

*FRIB will investigate nuclear structure and interactions*

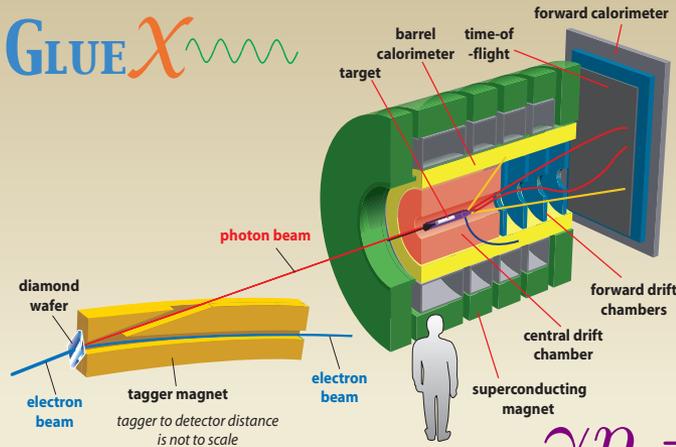
QCD under extreme temperatures & pressures - supernovae or Big-Bang

*Studied in RHIC at BNL*

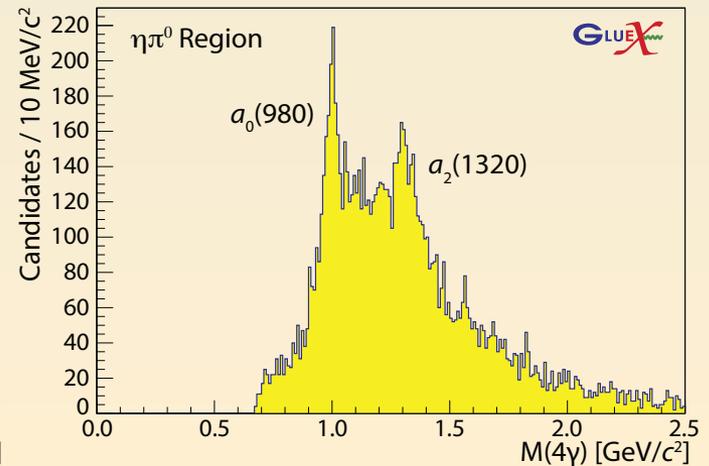
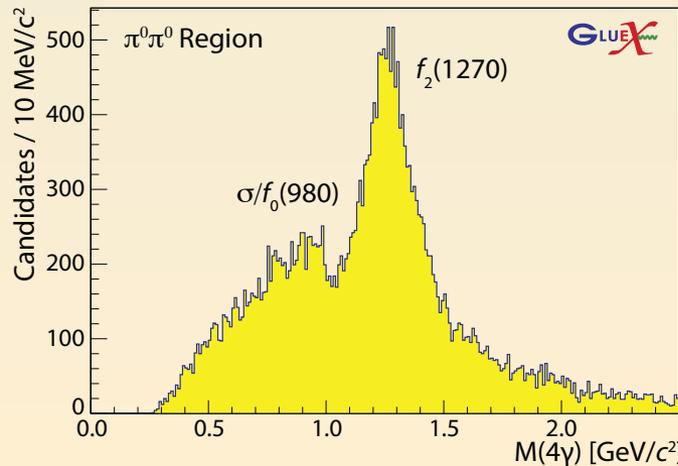
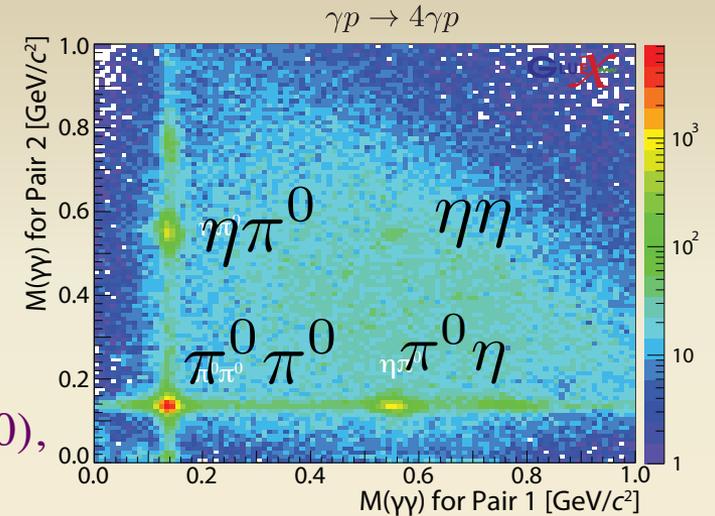
*The USQCD Facilities Project is a crucial element in realizing the scientific potential.*

# New Results from GlueX

## Four photon final states



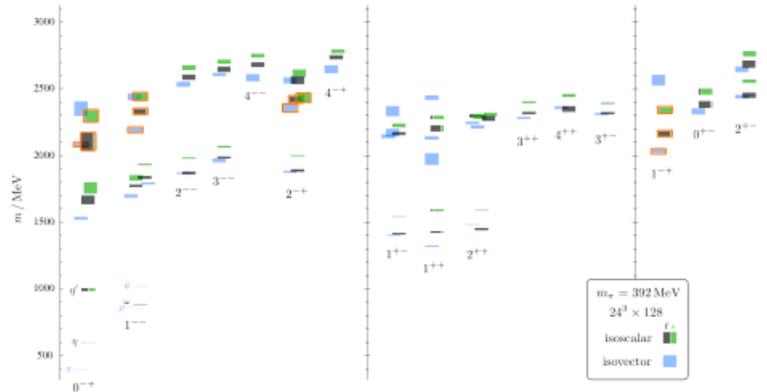
Clear signals for  $\sigma$ ,  $f_0(980)$ ,  $f_2(1270)$ ,  $a_0(980)$  and  $a_2(1320)$ .



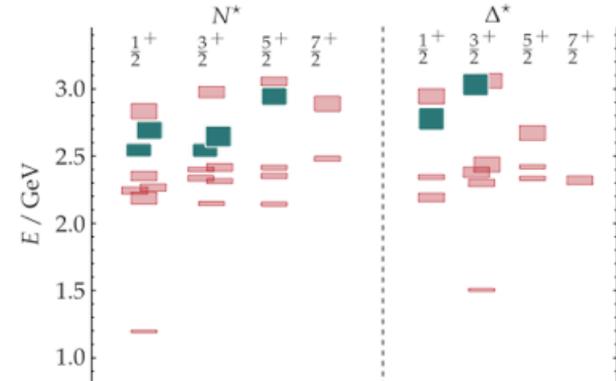
# Hadron Spectroscopy Predictions

- First glimpse of QCD spectrum - suggests rich pattern of states + gluonic excitations
  - Many states within energy range of GlueX
  - ➔ Relevant to spectroscopy campaigns at JLab, BES, LHC

Light quark meson + “exotics” & “hybrids” spectrum

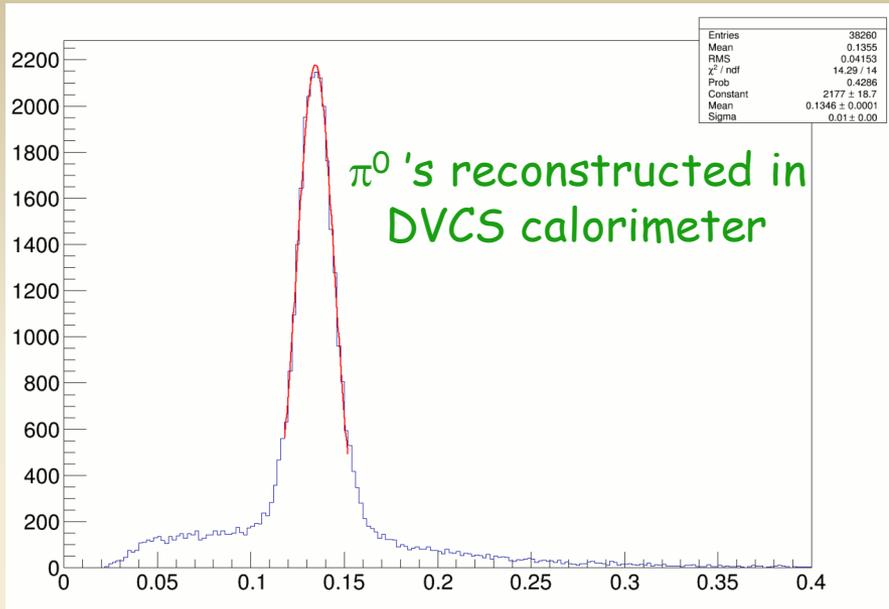


Light baryon + “hybrids” spectrum

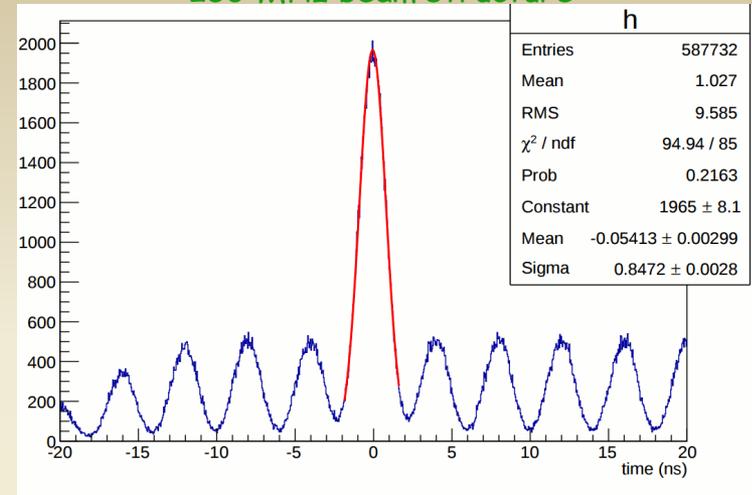


PRL 113 182001  
 PRD 91 054008  
 PRD 92 094502  
 ARXIV: 1602.05122

# E12-06-114 DVCS/Hall A Experiment at 11 GeV



Excellent coincident time resolution:  
250 MHz beam structure

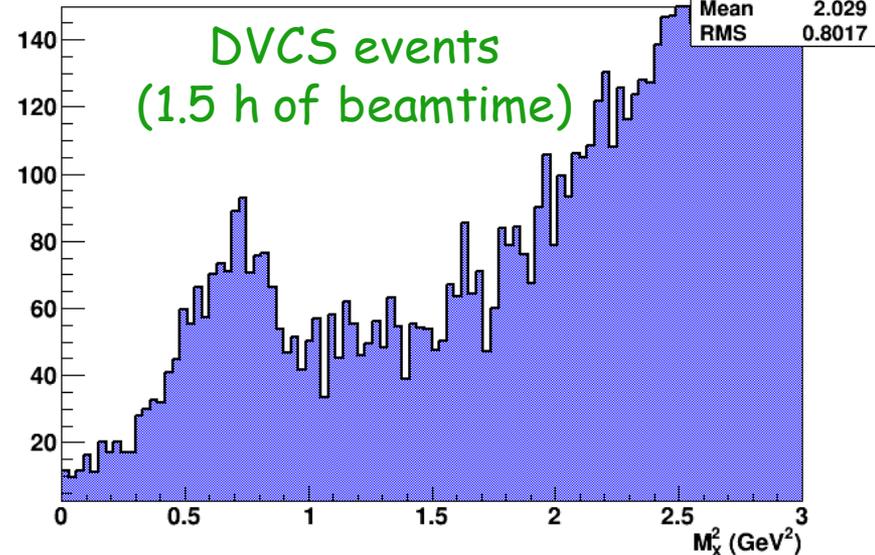


100 PAC days approved:

- High impact experiment for nucleon 3D imaging program
- High precision scaling tests of the DVCS cross section at constant  $x_B$
- CEBAF12 will allow to explore for the first time the high  $x_B$  region

16% of experiment completed in 2014-2016

$e p \rightarrow e \gamma X$  missing mass squared



# Hadron Structure Predictions

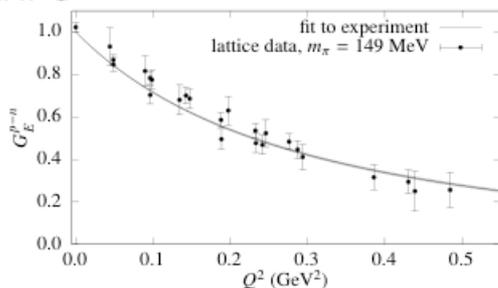
Form-factors provide a probe into the structure of a nucleon (proton/neutron)

Challenge: to control systematic errors sufficiently to resolve proton radius puzzle

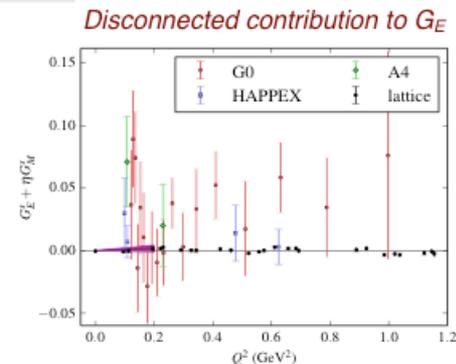
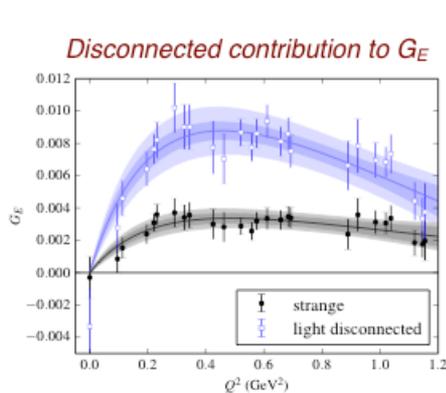
➔ Directly relevant to JLab 12 GeV & RHIC-Spin

Isovector form-factors agree with expt

LHPC *Electromagnetic Form Factor*



Strange EM form factors much smaller uncertainty than expt.



1404.4029, 1505.01803

# Thank You!