

Hall D Report

E.Chudakov¹

¹Hall D Group Leader

PAC44, July 2016

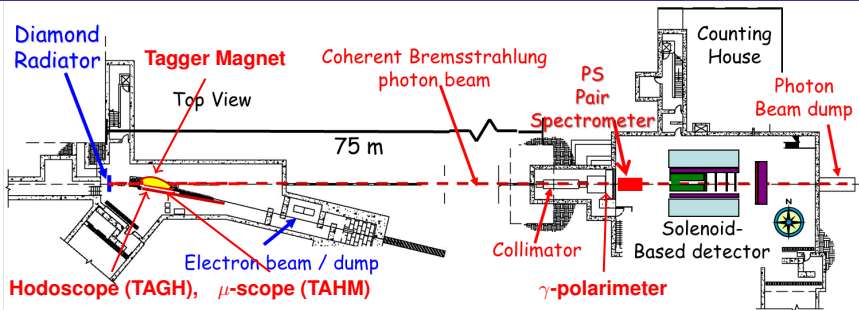


Highlights Since July 2015 ...

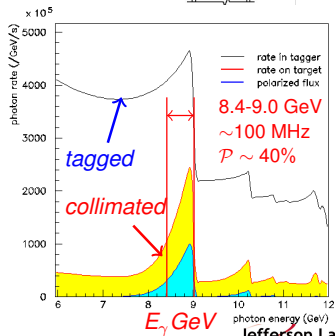
- Commissioning is complete
- Successful GlueX engineering run in Feb-Apr 2016
- Progress with calibration and data analysis
- Ready for first GlueX physics run in Oct-Dec 2016

- 1 Hall D overview
- 2 Physics program and schedule
- 3 Collaboration and staff
- 4 Commissioning results

Hall D/GlueX Beamline



- 12 GeV e^- beam 0.05 – 2.2 μA
- 20 μm diamond: coherent $< 25 \mu\text{rad}$
- Collimation $r < 1.8 \text{ mm}$ at $\sim 80 \text{ m}$
- Coherent peak 8.4 – 9.0 GeV $\mathcal{P} \sim 40\%$
2.2 $\mu\text{A} \Rightarrow 100 \text{ MHz } \gamma$ GlueX-I: 10 MHz
- Energy/polarization measured:
 - Tagger spectrometer $\sigma_E/E \sim 0.1\%$
 - Pair spectrometer: spectrum $\Rightarrow \sigma_P/P \sim 5\%$



Hall D/GlueX Spectrometer and DAQ

GLUEX

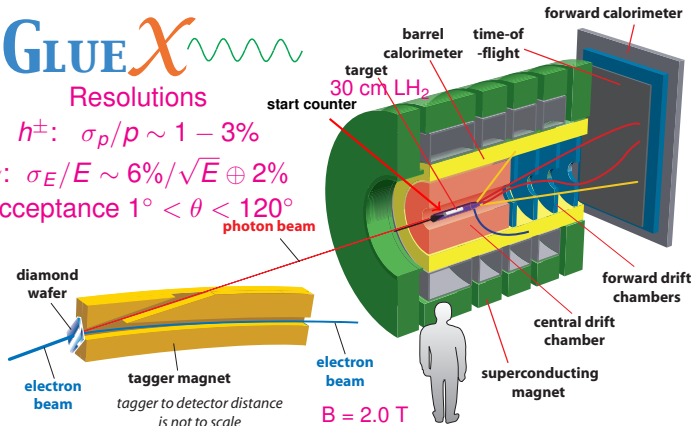
Resolutions

$$h^\pm: \sigma_p/p \sim 1 - 3\%$$

$$\gamma: \sigma_E/E \sim 6\%/\sqrt{E} \oplus 2\%$$

$$\text{Acceptance } 1^\circ < \theta < 120^\circ$$

photon beam



Detectors

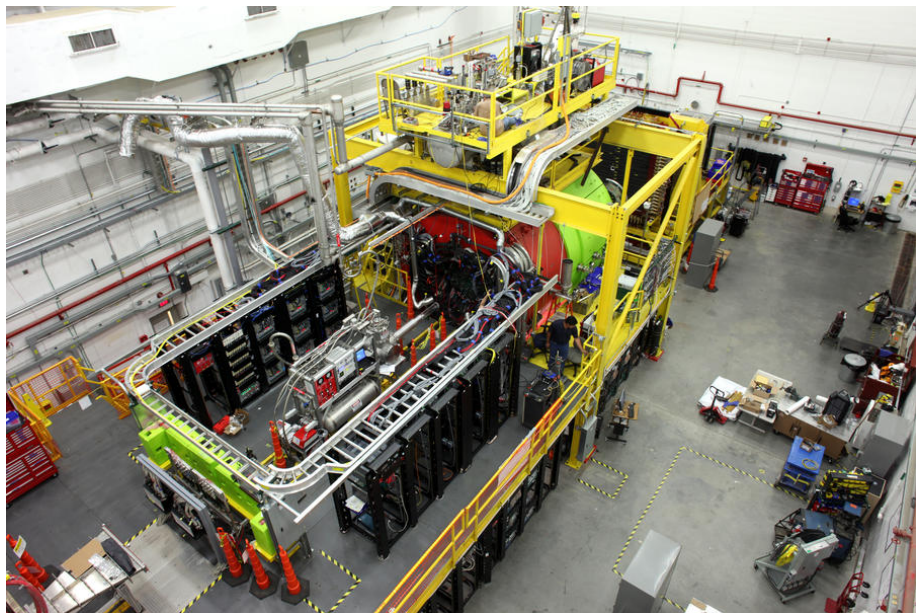
- ▶ CDC, FDC
- ▶ BCAL, FCAL
- ▶ TOF, ST

Plans to add

- ▶ 2017 L3
- ▶ 2018 DIRC

Photoproduction γp 1.5 kHz for a 10 MHz beam; Trigger $\sum E_{CAL} > X$
 GlueX-I 10 MHz/peak: trigger 20 kHz \Rightarrow DAQ \Rightarrow tape 30 kHz spring 2016
 GlueX-II 50 MHz/peak: trigger 100 kHz \Rightarrow DAQ \Rightarrow L3 farm \sim 20 kHz \Rightarrow tape

Hall D



Proposal/ experiment	Sta- tus	Title	Beam days	PAC #
E12-06-102	A	Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons	120	30
E12-10-011	A-	A Precision Measurement of the eta Radiative Decay Width via the Primakoff Effect	79	35
E12-13-003	A	An initial study of hadron decays to strange final states with GlueX in Hall D	200	40
E12-13-008	A-	Measuring the Charged Pion Polarizability in the $\gamma\gamma \rightarrow \pi^+\pi^-$ Reaction	25	40
C12-12-002	A	A study of meson and baryon decays to strange final states with GlueX in Hall D	220	42
C12-14-004	C2	Eta Decays with Emphasis on Rare Neutral Modes: The JLab Eta Factory(JEF) Experiment		42

Established schedule

Proposal/ experiment	Sta- tus	Title	Beam days	PAC #
E12-06-102	A	Mapping Mesons 2016 Fall – 2018 Spring early Polarized Photons	120	30
E12-10-011	A-	A Precision Measurement of the eta Radiative Decay Width via the Primakoff Effect	79	35
E12-13-003	A	An initial study of hadron decays to strange final states with GlueX in Hall D	200	40
E12-13-008	A-	Measuring the Charged Pion Polarizability in the $\gamma\gamma \rightarrow \pi^+\pi^-$ Reaction	25	40
C12-12-002	A	A study of meson and baryon decays to strange final states with GlueX in Hall D	220	42
C12-14-004	C2	Eta Decays with Emphasis on Rare Neutral Modes: The JLab Eta Factory(JEF) Experiment		42

Established schedule

Intention

Proposal/ experiment	Sta- tus	Title	Beam days	PAC #
E12-06-102	A	Mapping Mesons early Polarized Photons	120	30
E12-10-011	A-	A Precision Measurement of the eta Radiative Primakoff Effect	79	35
E12-13-003	A	An initial study of hadron decays to strange	200	40
E12-13-008	A-	Measuring the Charged Pion Polarizability in the $\gamma\gamma \rightarrow \pi^+\pi^-$ Reaction	25	40
C12-12-002	A	A study of meson and baryon decays to strange final states with GlueX in Hall D	220	42
C12-14-004	C2	Eta Decays with Emphasis on Rare Neutral Modes: The JLab Eta Factory(JEF) Experiment		42

Proposal/ experiment	Sta- tus	Title	Beam days	PAC #
LOI12-15-001		Physics with secondary K_L^0 beam		43
LOI12-15-006		ω -production on nuclei		43
LOI12-16-001		Lepton Universality in Bethe-Heitler production of lepton pairs		44
LOI12-16-002		Probing short-range nuclear structure and dynamics		44
LOI12-16-005		Target helicity correlations in GlueX		44

Workshops on Physics Program

- 2016 Feb 1-3: [K_L Workshop](#) - about 60 participants
- 2016 Apr 28-29: [Nuclear Photoproduction with GlueX](#) - about 30 participants

The GlueX Collaboration

Arizona State, Athens, Carnegie Mellon, Catholic University, Univ. of Connecticut, Florida International, Florida State, George Washington, Glasgow, GSI, Indiana University, ITP, Jefferson Lab, U. Mass. Amherst, MIT, MEPhi, Norfolk State, North Carolina A&T, Univ. North Carolina Wilmington, Northwestern, Santa Maria, University of Regina, and Yerevan Physics Institute.

Over 100 collaborators from 23 institutions. Others are planning to join (W&M, Wuhan Uni.(China)).

Plans for upgrades and new equipment:

- Capital equipment ($> \$0.5M$):
 - ▶ DIRC *FY16-FY18* set
- Smaller projects ($< \$0.5M$):
 - ▶ L3 farm *FY16-FY17?*

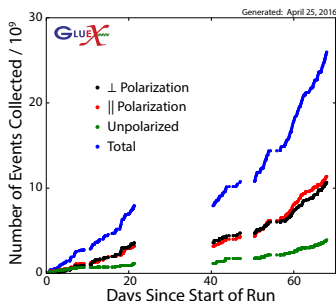
Hall D Staff:

- Scientific group: 13 staff scientists and 2 postdocs
3-rd postdoc: search in progress
Justin Stevens is leaving for W&M in Aug 2016: search started
- Technical group: 1 mechanical engineer, 1 designer and 6 techs

Hall D/GlueX Commissioning Status

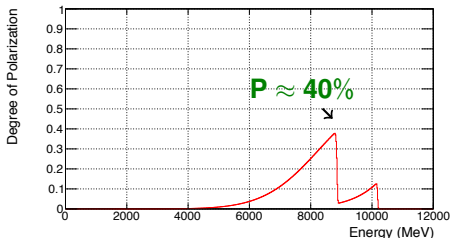
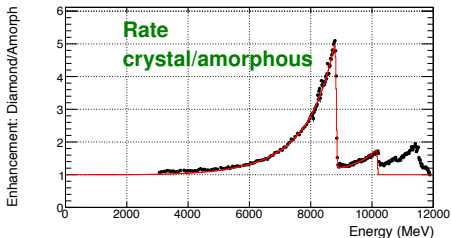
Spring 2016 run Feb 10 - Apr 25

- 12 GeV electron beam, 100-200 nA (radiator dependent)
 - Beam instrumentation commissioned (Fast Feedback)
 - Solenoid 1200 A 2.5 months
1345 A (GlueX optimum) one week
 - Diamond radiators: 50 μm - old, \sim 30 μm - new
 - DAQ: \sim 30 kHz - sufficient for GlueX-I
Data flow \sim 600 MB/s = $\times 2$ of the initial estimate
-
- Beam studies and tuning
 - Trigger studies and tuning
 - Data for early physics results
 - GlueX commissioning completed
 - \sim 24 G events recorded



Hall D/GlueX Beam: Coherent Bremsstrahlung

Run 10492: 50 μm diamond



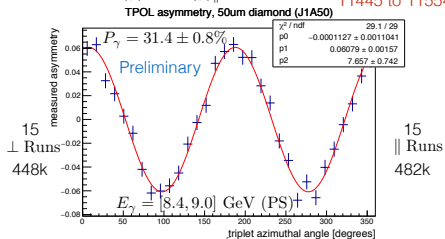
Polarization measurements

- Derived from the spectrum
- Triple polarimeter
 $\gamma e^- \rightarrow e^+ e^- e^-$
- Processes like $\gamma p \rightarrow \rho^0 p$

J1A50 (50 μm), 3 mm hole

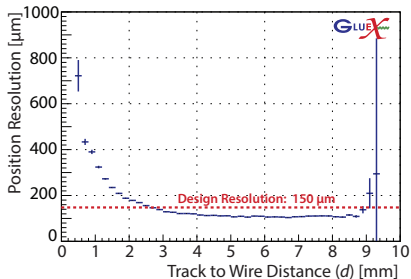
$$\frac{N(\phi)_\perp - N(\phi)_\parallel}{N(\phi)_\perp + N(\phi)_\parallel} = P_\gamma \Sigma \cos(2\phi)$$

75 μm converter PERP/PARA
11445 to 11554

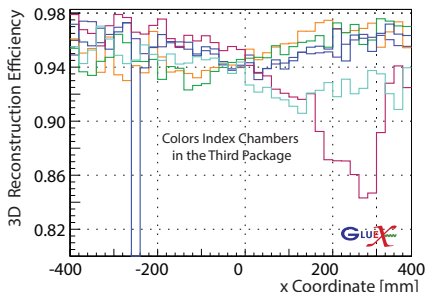
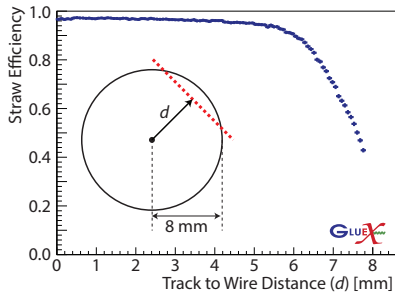
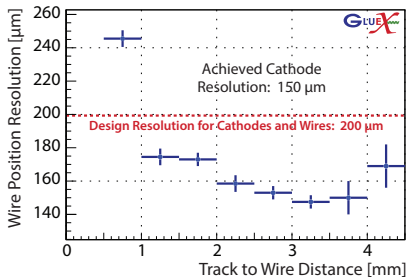


Tracking

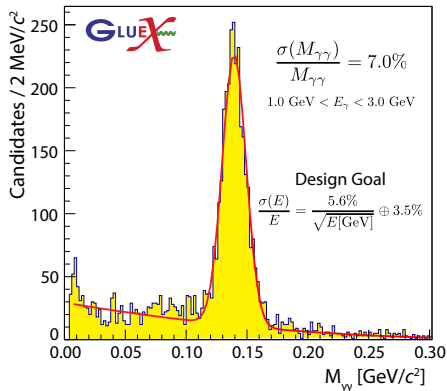
Central Drift Chamber (CDC)



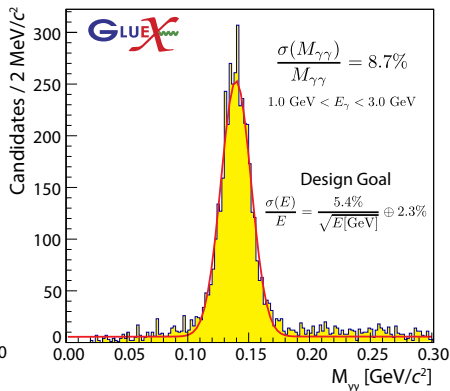
Forward Drift Chamber (FDC)



Forward Lead Glass Calorimeter



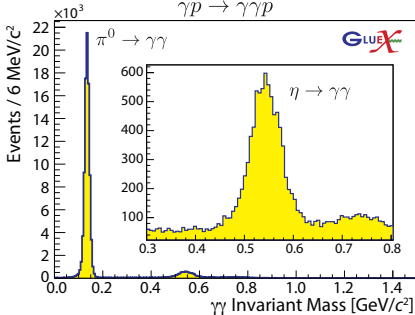
Barrel Lead-Scintillating Fiber Calorimeter



Event Reconstruction and Signals Observed

from 2015 data

$\gamma p \rightarrow \gamma \gamma p$

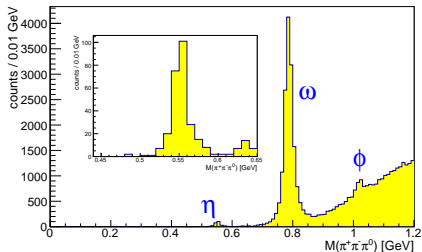


Exclusive reactions for X :

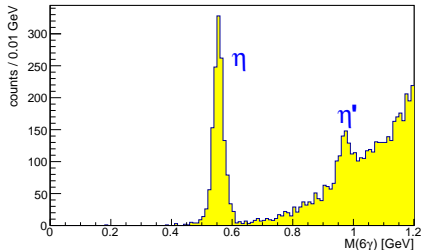


from 2016 data

$\pi^+ \pi^- \pi^0$ mass

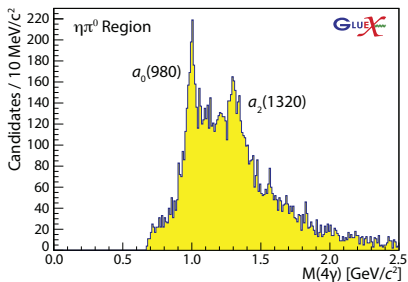
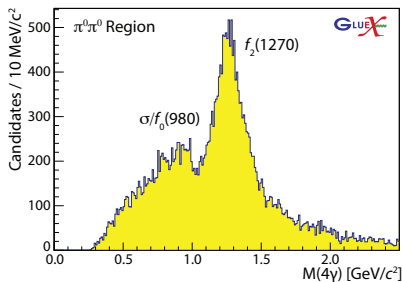
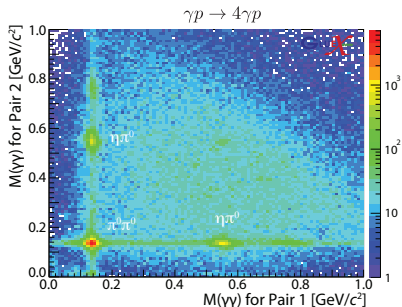


6γ mass



Event Reconstruction and Signals Observed

- Reaction $\gamma + p \rightarrow p + 4\gamma$
- Combinations $\pi^0\pi^0$ and $\eta\pi^0$

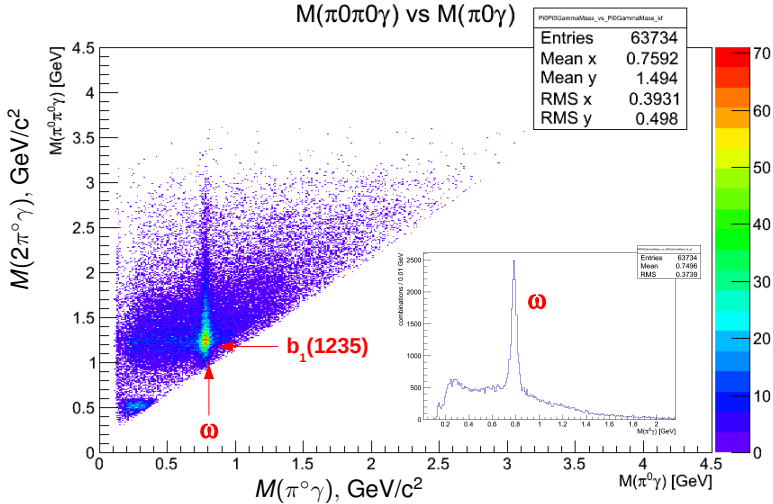


Event Reconstruction and Signals Observed

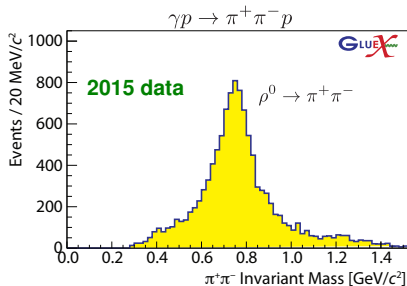
from 2016 data



$M(\pi^0\pi^0\gamma)$ vs $M(\pi^0\gamma)$

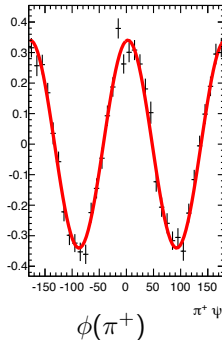


Physics With Linearly Polarized Beam



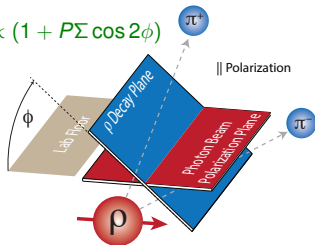
from 2016 data

- 38k (1% of total) $\gamma p \rightarrow \rho^0 p$ in $8.4 < E_\gamma < 9.0$ GeV
- 2 crystal orientations at 90°
- $\frac{N_0 - N_{90}}{N_0 + N_{90}} = P \Sigma \cos 2\phi$



$$P\Sigma = 0.341 \pm 0.007\%$$

$$\frac{d\sigma}{d\phi} \propto (1 + P\Sigma \cos 2\phi)$$



- Spring data analysis is in progress
- Early physics: asymmetries of π^0, η
- Get ready for the 2016 Fall physics (GlueX-I) run
 - Test solenoid at 1350 A in August
 - Optimization of the trigger
 - UConn group continues producing diamond radiators

APPENDIX

Future Forward Kaon Identification

Present PID: TOF, dE/dx , Kinematics

Upgrade

DIRC project, ENP capital budget

- 4 of the BaBar DIRC bar boxes
- New readout system
- Allows to study:
 - Strangeonium and hybrids
 - Hyperons
- Installation planned for 2018

