

- 1 Experiments in Hall D, accelerator Schedule for 2023-2025 and outlook
- 2 Publications
- 3 Results close to publication
- 4 Preparations for future experiments

# Physics Program in Hall D

Experiment	name	Title	PAC rating	PAC days	data taken
E12-06-102	GlueX-I	Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons	A	120	100%
E12-12-002 A	GlueX-II	A study of meson and baryon decays to strange final states with GlueX in Hall D	A	220	46%
	JEF	Eta Decays with Emphasis on Rare Neutral Modes: The JLab Eta Factory(JEF) Experiment	Grp	100	0%
E12-10-011	PrimeX- $\eta$	A Precision Measurement of the eta Radiative Decay Width via the Primakoff Effect	A-	79	100%
E12-13-008	CPP/NPP	Measuring the Pion Polarizability in the $\gamma\gamma \rightarrow \pi\pi$ Reaction	A-	25	100%
E12-19-003	SRC/CT	Studying Short-Range Correlations with Real Photon Beams at GlueX	B+	15	100%
<i>Not yet scheduled</i>					
E12-19-001	KLF	Strange Hadron Spectroscopy with Secondary KL Beam in Hall D	A-	200	
E12-20-011	REGGE	Measurement of the high-energy contribution to the Gerasimov-Drell-Hearn sum rule	A-	33	

■ - considerable installation / new equipment required

■ - data taking complete

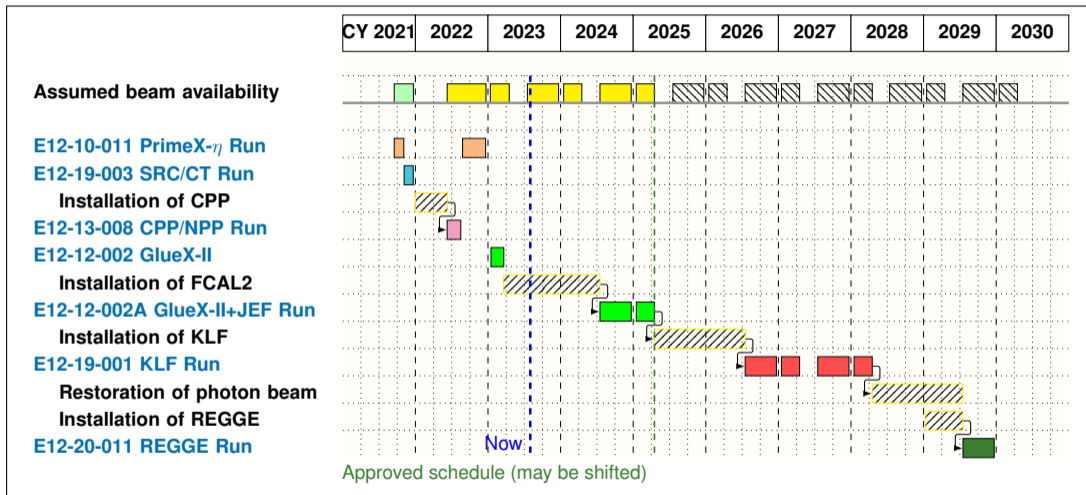
# Physics Program in Hall D

Experiment	LOI/proposals to PAC51			PAC days	data taken
E12-06-102	<ul style="list-style-type: none"> <li>• Proposal: SRC/CT</li> <li>• LOI: GlueX at luminosity frontier</li> <li>• LOI: GlueX+TRD Spectroscopy + charmonia</li> <li>• LOI: GlueX GDH on nuclei</li> </ul>			120	100%
E12-12-002				220	46%
A				100	0%
		Eta Factory(JEF) Experiment			
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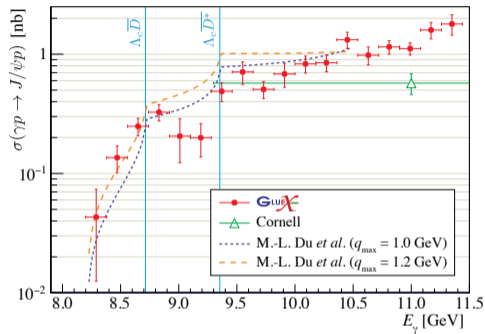
# Hall D running schedule: outlook



- Assuming 31 weeks/year for Hall D running in 2024/07-2025/03 and 30 weeks afterwards
- Assuming KLF compatibility with MOLLER, and timing budgeting for KLF and REGGE
- Assuming timely construction of JEF,KLF,REGGE

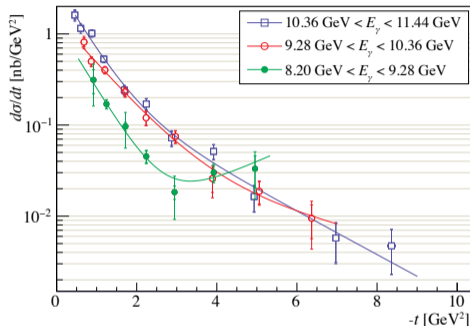
# GlueX E12-06-102: $J/\psi$ production $\gamma p \rightarrow J/\psi p$ ( $J/\psi \rightarrow e^+ e^-$ )

PRL 123 (2019) 7, 072001 25% of data, >160 citations; new arXiv 2304.04924 (2023) accepted at PRC full GlueX-I data



Interpretation is based on the production mechanism

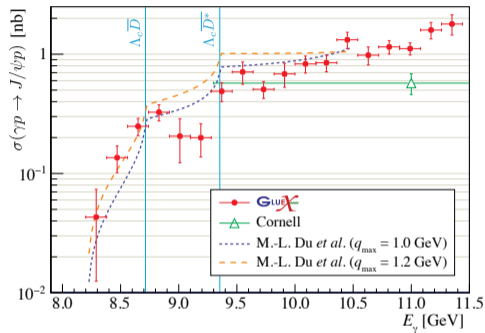
- 2-gluon exchange, factorization
  - ▶ Relation to *gravitational formfactors*, *EMT trace anomaly* - nucleon mass
  - ▶ Relation to nucleon mass radius
- Other possible mechanisms: open charm exchange



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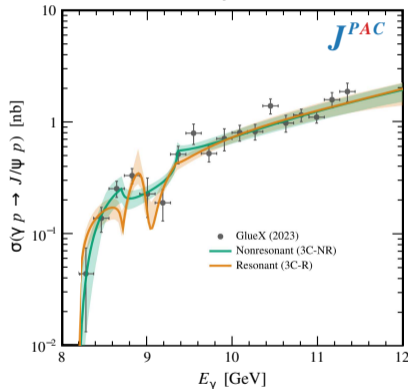
New GlueX results are used:



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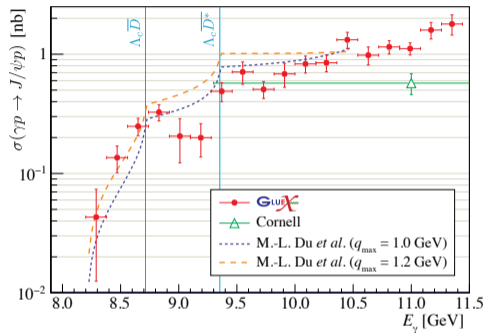
JPAC: D.Winney et al arXiv 2305.01449 (2023)



More data are needed, in particular around the “cusps” at  $\sim 9$  GeV in order to disentangle different production mechanisms

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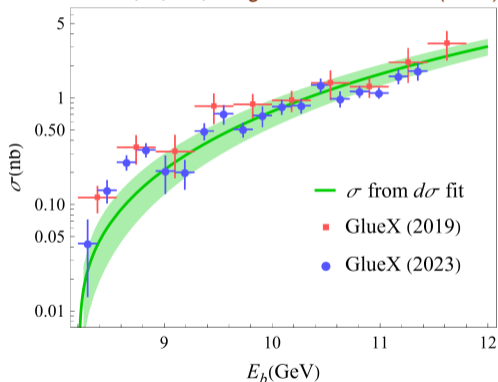


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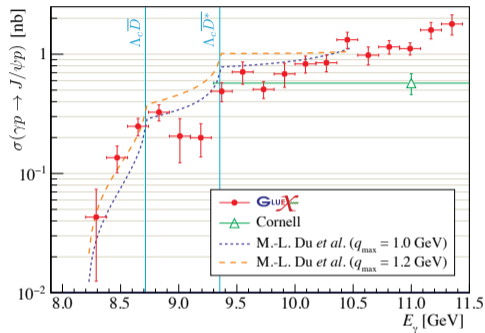
Guo, Ji, Liu, Yang arXiv 2305.06992 (2023)



Gravitation formfactors were calculated using  $d\sigma/dt$   
More quality data at high  $|t|$  and high “skewness” are needed

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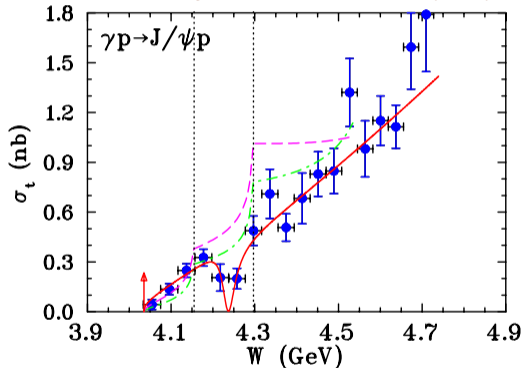


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**New GlueX results are used:**

*I. Strakovsky et al arXiv 2304.04924 (2023)*



The structure can be caused by destructive interference between the continuum and a LHCb  $P_C$  pentaquark. More statistics is needed!



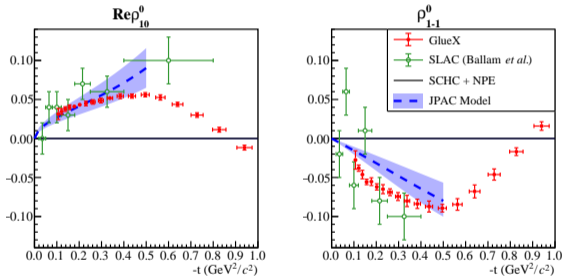
# GlueX E12-06-102: Recent results on SDMEs

arXiv 2505.09047 (2023), submitted to PRC

Measurement of SDME in  $\rho(770)$  production by linearly polarized photons at 8.2-8.8 GeV

$$\gamma p \rightarrow \rho^0 p, \rho^0 \rightarrow \pi^+ \pi^-$$

2 SDMEs shown, out of 9



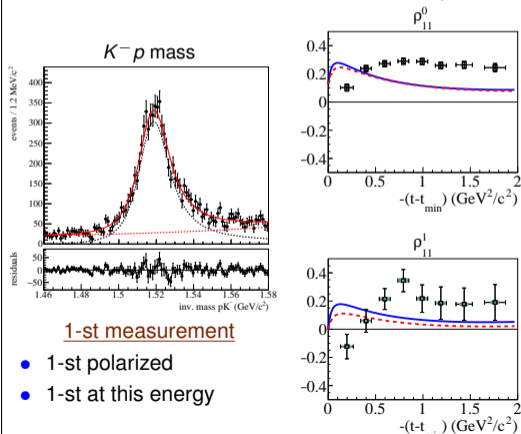
- Greatly supersedes the old data in this energy range
- Good matching of the SDME analysis results and amplitude analysis results: foundation for hybrid meson search
- Enables modeling of production of known resonances

PRC 105, 035201 (2022)

Measurement of SDME in  $\Lambda(1520)$  Photoproduction at 8.2-8.8 GeV

$$\gamma p \rightarrow \Lambda(1520)K^+, \Lambda(1520) \rightarrow K^- p$$

2 SDMEs, out of 9



1-st measurement

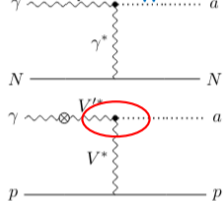
- 1-st polarized
- 1-st at this energy

# GlueX E12-06-102: Results of exotics

PRD 105, 052007 (2022)

Search for photoproduction of axion-like particles at GlueX

Primakoff process  $\gamma\gamma \rightarrow a$  coupling

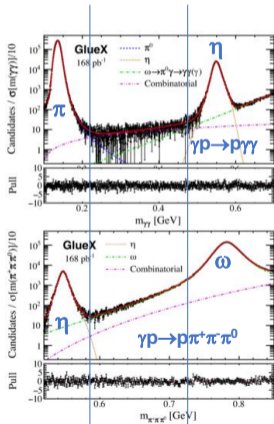


Photopr. process  $gg \rightarrow a$  coupling

Search for peaks in the mass spectra of the final states:

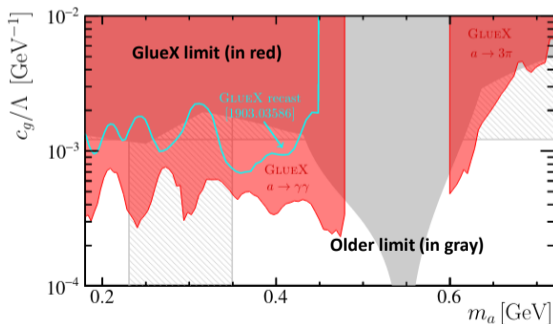
$\gamma\gamma$  and  $\pi^+\pi^-\pi^0$

Search range



Search for Axion-like particles

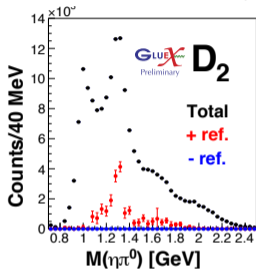
- Recent interest to ALP at  $\Lambda_{\text{QCD}}$  mass scale
- Such ALP would solve the CP problem in QCD
- $m_a > \Lambda_{\text{QCD}}$  is robust against UV contributions
- Measured limit on the ALP coupling with gluons  $c_g/\Lambda$



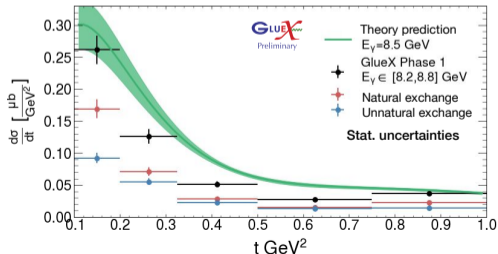
# GlueX E12-06-102: Results close to publication

## Photoproduction of $a_2(1320)$ at 8.2-8.8 GeV

$$\gamma p \rightarrow a_2(1320)p, a_2 \rightarrow \eta\pi$$



- Full amplitude analysis
- The dominant D-waves for 2 reflectivities
- A milestone for hybrid search



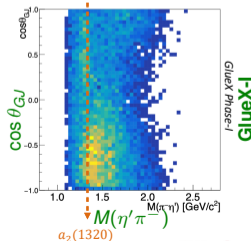
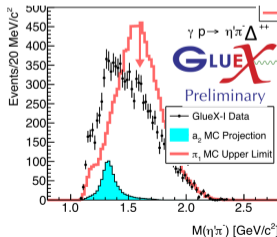
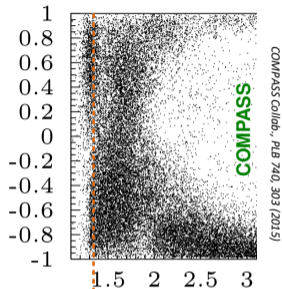
## Search for $1^{-+} \pi_1(1600)$ Photoproduction at 8.2-8.8 GeV

$$\gamma p \rightarrow \omega \pi^- \pi^0 \Delta^{++}$$

- LQCD-dominant decay
- Upper limit on  $\sigma(\pi_1)$

$$\gamma p \rightarrow \eta' \pi^- \Delta^{++}$$

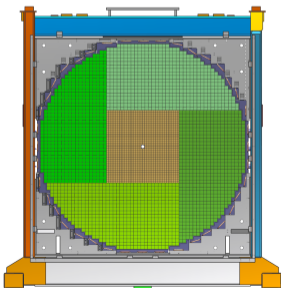
- $\cos \theta_{GJ}$  large asymmetry similar to COMPASS: odd wave interference
- Next step: amplitude analysis



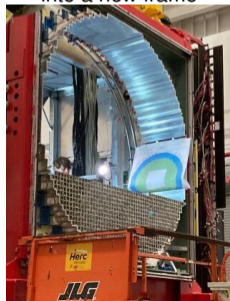
# Ongoing projects for future experiments

## FCAL2 PbWO<sub>4</sub> insert: Installation

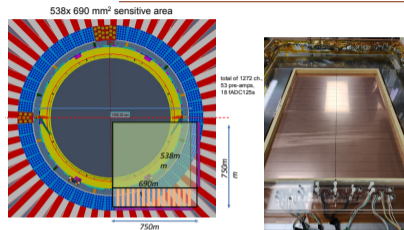
- Replacement of 400 lead glass blocks (out of 2800) with 1600 PbWO<sub>4</sub> crystals
- Twice better energy and spacial resolution, much better radiation hardness
- Required for the JEF experiment (to run with GlueX-II in 2024-2025)
- Installation in progress



Re-stacking LG blocks into a new frame



## GEM TRD: prototyping and testing



- Goal: additional PID for electrons and positrons, pion suppression  $\sim 10$  at  $\sim 90\%$  electron efficiency
- Prototype of 25% of area has been built
- Prototypes testes in test beams (JLab and FNAL)

## KLF: designing the components

- Be target and the “collimator cave” - design is complete
- Conceptual design of the Compact Photon Source (CPS) in progress
- A pre-readiness review by ENP (ERR-1) on Aug 2, 2023