

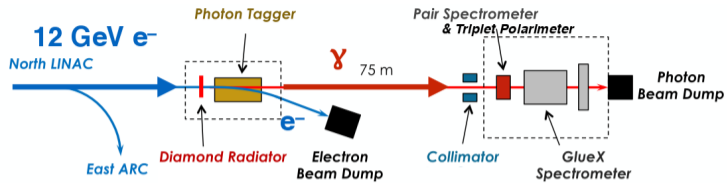
# Hall D Status

E.Chudakov<sup>1</sup>

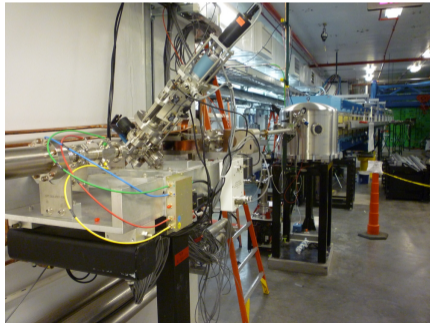
<sup>1</sup>JLab, Hall D manager

KLF Experiment ERR-1 Review, 2023 Aug 2

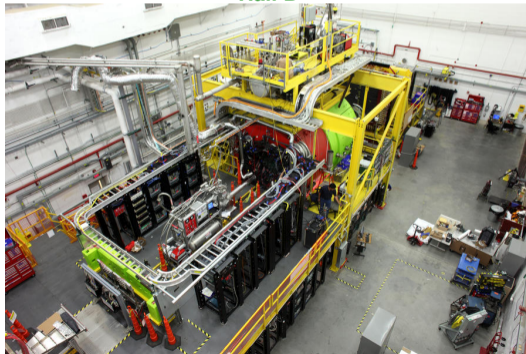
# Hall D Apparatus



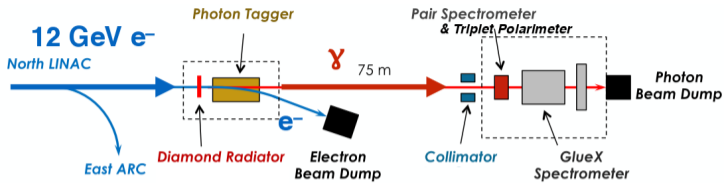
Tagger Hall



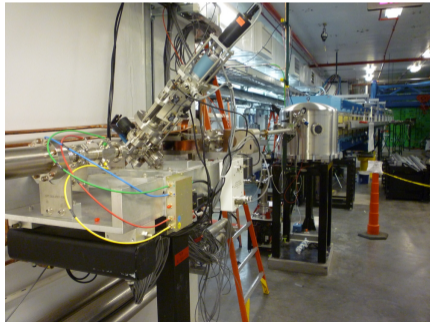
Hall D



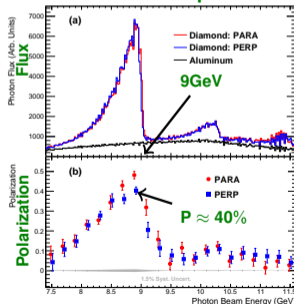
# Hall D Apparatus



Tagger Hall



Photon Beam Spectrum



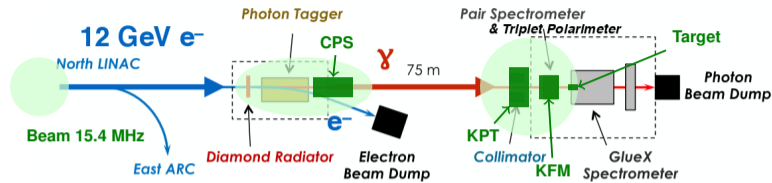
Electron beam at GlueX

- ▶  $< 500$  nA
- ▶ Focus at the collimator
- ▶ Steering: active collimator signals
- ▶  $< 5$   $\mu$ A the limit of the dump

Photon beam

- ▶ Radiator  $\approx 4 \cdot 10^{-4}$  RL
- ▶ Tagging  $\sigma E/E \sim 0.2\%$
- ▶ Linear polarization  $\sim 40\%$  peak
- ▶ Pair Spectrometer & Triple Polarimeter

# Hall D Apparatus



## KLF installation

1. CPS - Compact Photon Source
2. KPT - Kaon Production Target
3. KFM - Kaon Flux Monitor
4. Target of a larger diameter
5. Injector 4 ns  $\rightarrow$  64 ns

## Changes for KLF



### Tagger hall

- Tag. magnet off
- Detectors removed
- CPS installed
- New beam controls



### Collimator cave

- Replaced completely
- KPT installed
- activation expected
- access limitation



### Pair Spectrom.

- Removed converters, detectors, shielding
- KFM installed

## A major beamline change!

### The facility's requirements

- No irreversible impact on the existing equipment including radiation damage
- Smooth installation of KLF and re-installation of the photon beam after KLF completion

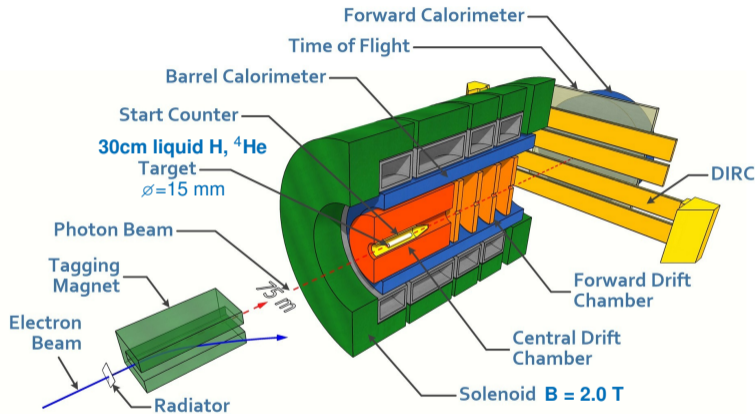
## Electron beam at KLF

- ▶ 5  $\mu$ A
- ▶ Focus at KPT - the same location
- ▶ Steering: a new active collimator?

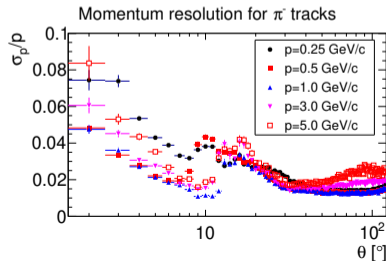
## Photon beam at KLF

- ▶ Radiator 10% RL
- ▶ Bremsstrahlung spectrum
- ▶ 6 kW power

# Hall D: GlueX Spectrometer

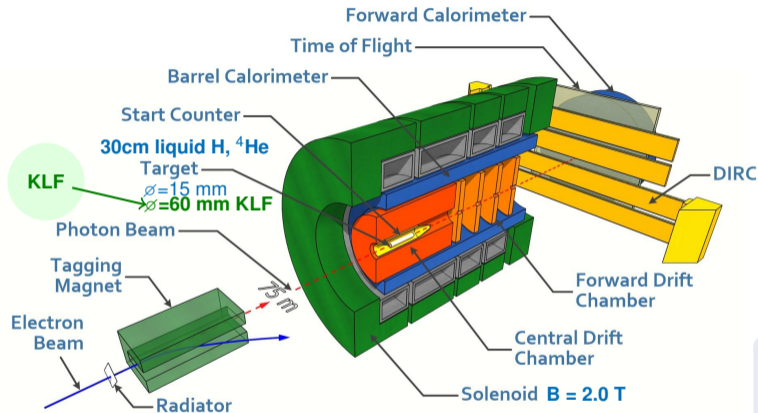


- ▶ Acceptance:  $1^\circ < \theta < 120^\circ$
- ▶ Resolutions:
  - $h^\pm$ :  $\sigma_p/p(\theta) \sim 1 - 5\%$
  - $\gamma$ :  $\sigma_E/E \sim 5.5\%/\sqrt{E} \oplus 4.5\%$
- ▶ Trigger: all photoproduction at  $E_{BEAM} > 7$  GeV  
DAQ in 2021: 85 kHz (photoproduction + EM background)



GlueX studies exclusive reactions. A good event selection and momentum/mass resolution are achieved with the help of 4C kinematic fit which uses the  $\approx 0.1\%$  energy resolution of the beam photon.

# Hall D: GlueX Spectrometer



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DAQ in 2021: 85 kHz (photoproduction + EM background)

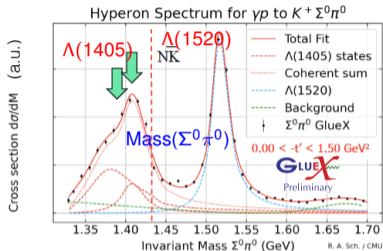
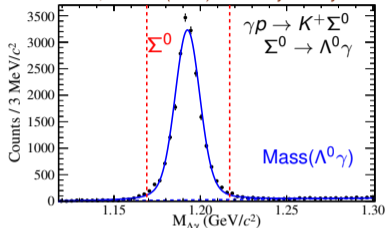
## KLF target

- $\varnothing 15 \text{ mm} \Rightarrow 60 \text{ mm}$   
will add some:
- Secondary interactions
  - Multiple scattering

GlueX studies exclusive reactions. A good event selection and momentum/mass resolution are achieved with the help of 4C kinematic fit which uses the  $\approx 0.1\%$  energy resolution of the beam photon.

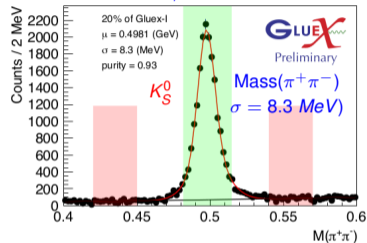
# GlueX experiment: Illustration of hyperon reconstruction

PRC 101, 065206 (2021) beam asymmetry

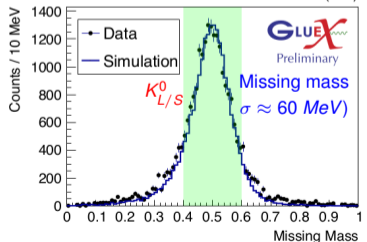
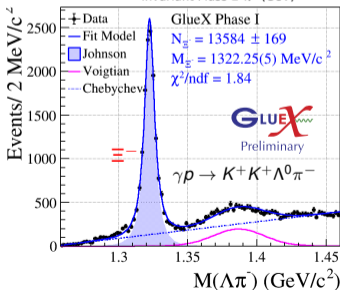
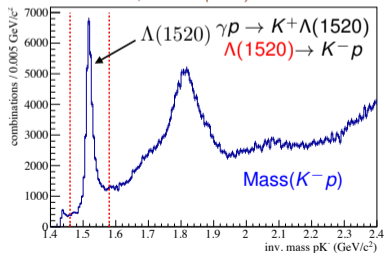


Reaction with a missing particle

$\gamma p \rightarrow p K_S^0 (K_{L/S}^0), K_S^0 \rightarrow \pi^+ \pi^-$

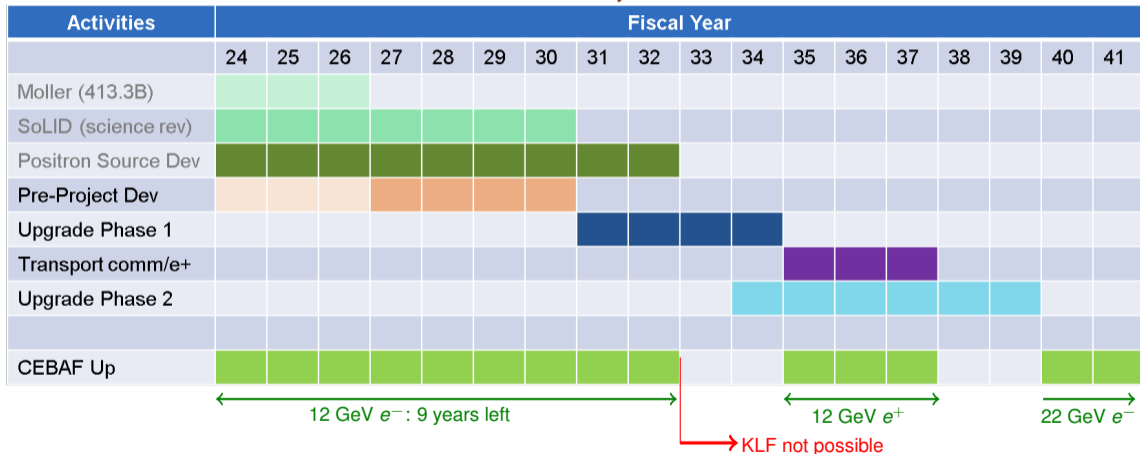


PRC 105, 035201 (2022) SDME



# JLab extended schedule, plans

From JLUO 2023 talk by David Dean





# 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
  - finished data taking
- JEF: fully budgeted, installation in progress
- KLF: partly budgeted, design in progress
- REGGE: not yet budgeted

# Physics Program in Hall D

## LOI/proposals to PAC51

- LOI: **GlueX** at luminosity frontier
- LOI: **GlueX**+TRD Spectroscopy + charmonia
- LOI: **GlueX** GDH on nuclei
- Proposal: **SRC/CT**

Exp	AC	ys	data taken
E12-0	20		100%
E12-1	20		46%
	100		0%
Eta Factory(JEF) Experiment			
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
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■ - considerable installation / new equipment required

■ - finished data taking

- JEF: fully budgeted, installation in progress
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- REGGE: not yet budgeted

Hall D physics runs

Year	Dates	Calendar days	Beam, GeV	ABU <sup>1</sup> + BANU	ABU	Experiment	PDL	Comment	PAC days <sup>3</sup>	PAC days total
2016	Feb, 3 - Mar, 23	49	12.0	?	?	E12-06-102	B.Zihlmann	Engineering run, solenoid at 1200A	3+25	25
2017	Jan, 30 - Mar, 9	40	11.7	58%	51%	E12-06-102	B.Zihlmann	Production	20	45
2018	Jan, 12 - Mar, 5	52	11.7	52%	46%	E12-06-102	B.Zihlmann	Production	26	71
2018	Mar, 29 - May, 6	38	11.7	58%	52%	E12-06-102	B.Zihlmann	Production	19	90
2018	Sep, 21 - Nov, 26	66	11.7	53%	47%	E12-06-102	B.Zihlmann	Production	33	123
2019	Feb, 8 - Feb, 21	13	11.6	45%	N/A	E12-12-002	B.Zihlmann	1/2 DIRC Commissioning	6	6
2019	Feb, 21 - Mar, 5	15	11.6	52%	37%	E12-10-011	L.Pentchev	Installation	7.3	7.3
2019	Mar, 8 - Apr, 15	38	11.2	73%	68%	E12-10-011	L.Pentchev	Production	16.1	23.4
2019	Nov, 25 - Dec, 20	25	11.4	34%	32%	E12-12-002	B.Zihlmann	DIRC Commissioning, 3. PAC days = 0.32*25	8	14
2020	Jan, 10 - Mar, 24	75	11.4	62%	56%	E12-12-002	B.Zihlmann	Production on LHe, design rate. First 2 weeks - lower rate	38	52
2020	Jul, 27 - Sep, 21	56	11.4	46%	38%	E12-12-002	B.Zihlmann	Production on LHe, DIRC at high rate	21.5	73.5
2021	Sep, 16 - Nov, 4	50	10.1	51%	45%	E12-10-011	L.Pentchev	Production on LHe, FOM=0.56 <sup>4</sup>	14	37.4
2021	Nov, 8 - Dec, 21	43	10.9	70%	60%	E12-19-003	L.Pentchev	Production on LHe, LD, C FOM=0.73 <sup>5</sup> PAC=43*0.6*0.73=19	19	19
2022	Jun, 8 - Aug, 17	71	11.6	46%	41%	E12-13-008	S.Taylor	CPP/NPP	29	29
2022	Aug, 27 - Dec, 18	113	11.6	64%	59%	E12-10-011	L.Pentchev	PrimeX-η Production on LHe, FOM=0.91 <sup>4</sup> *0.85(TAGM)	51.6	89
2023	Jan, 12 - Mar, 19	67	11.6	48%	42%	E12-12-002	B.Zihlmann	GlueX-II Production. ABU was used to calculate the PAC days	28.1	102.
23-24	Mar, 20 - Jul, 18	460						<b>FCAL2 installation</b>		
2024	Jul, 19 - Dec, 15	150	12?			E12-12-002	B.Zihlmann	GlueX-II + JEF <i>Draft schedule</i>	75 ?	177.
2025	Jan, 13 - Mar, 16	62	12?			E12-12-002	B.Zihlmann	GlueX-II + JEF <i>Draft schedule</i>	31 ?	209.
25-26	Mar, 17 - Jul, 18	460						<i>Planning:KLF installation</i>		

Runs 2022-2023  
251 calendar days  
109 PAC days

E12-12-002 GlueX-II  
E12-10-011 PrimeX-η  
E12-19-003 SRC  
E12-13-008 CPP/NPP

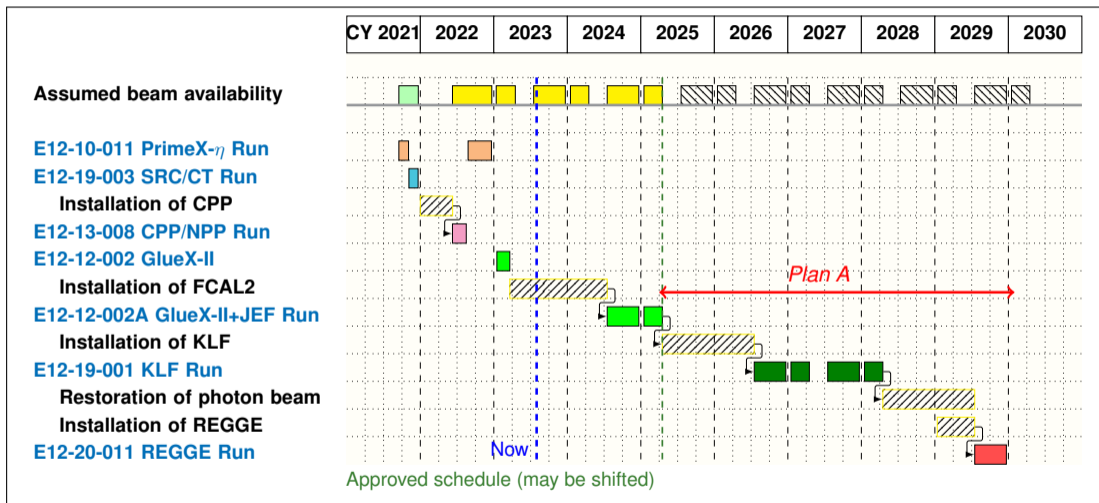
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2019	Feb, 21 - Mar, 5	15	11.6	52%	37%	E12-10-011	L.Pentchev	Installation, Production on Be, LHe, FOM=0.97 <sup>4</sup>	7.3	7.3
2019	Mar, 8 - Apr, 15	38	11.2	73%	68%	E12-10-011	L.Pentchev	Production on LHe, FOM=0.85 <sup>4</sup>	16.1	23.4
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E12-12-002	GlueX-II
E12-10-011	PrimeX-η
E12-19-003	SRC
E12-13-008	CPP/NPP

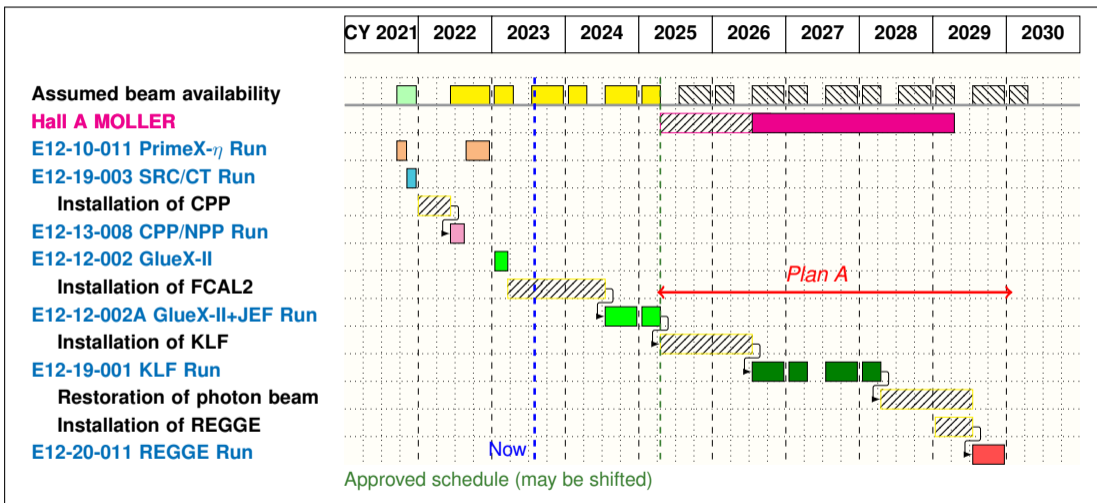
Scheduled for 2024-2025

# Hall D running schedule: outlook



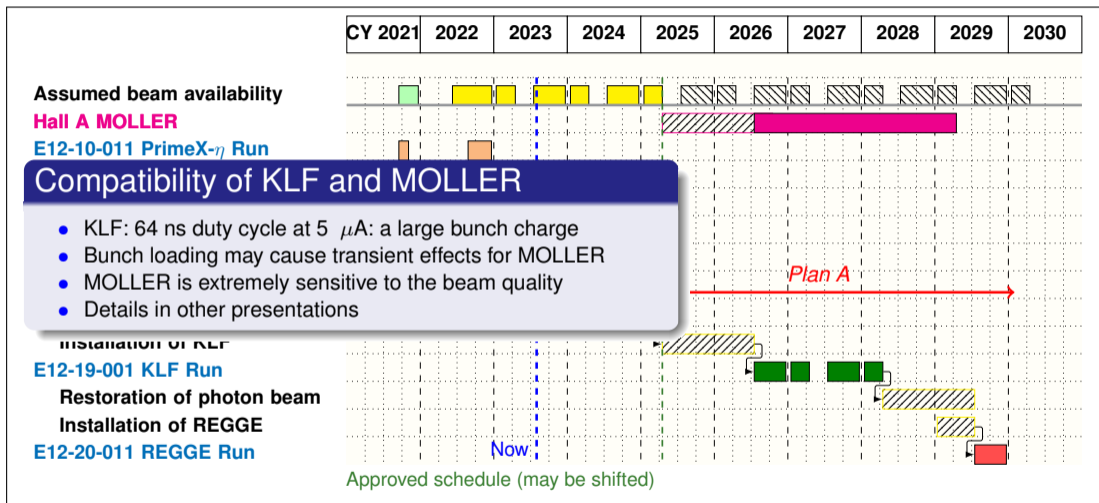
- Assuming 31 weeks/year for Hall D running in 2024/07-2025/03 and 30 weeks afterwards
- Assuming KLF compatibility with MOLLER, and timing budgeting for KLF and REGGE
- Assuming timely construction of JEF,KLF,REGGE

# Hall D running schedule: outlook



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# Hall D running schedule: outlook

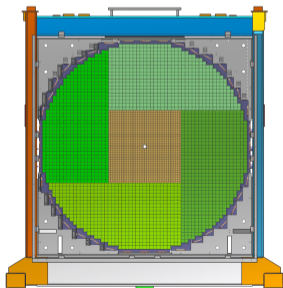


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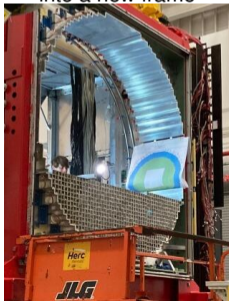
# Ongoing projects for future experiments

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

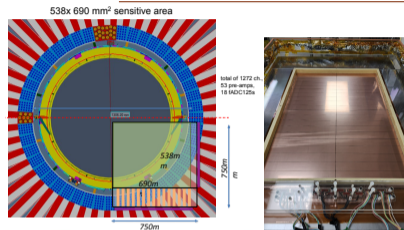
- Replacement of 400 lead glass blocks (out of 2800) with 1600 PbWO<sub>4</sub> crystals
- Twice better energy and spacial resolution, much better radiation hardness
- Required for the JEF experiment (to run with GlueX-II in 2024-2025)
- Installation on track



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)
- Electronics for the full project: VPX electronics, developed for PANDA; communication and contract with a Jülich group.
- Xe cost jumped: purification is needed

LOI to PAC51 for running of GlueX+TRD



# ENP Budget/Staff Plans for Hall D

## ● FY23 capital budget:

- ▶ FCAL Upgrade: \$130k (bases etc)
- ▶ KLF \$400k : Designer's work, procurement of materials (the collimator cave), pending on the results of the readiness review (August) and may depend on the MOLLER compatibility conclusion

## ● FY23 operation budget

- ▶ Operation costs
- ▶ FCAL2/generic equipment
- ▶ GEM-TRD project
- ▶ Supported: 3 university postdocs (at a 50% level)
- ▶ Development for future

## Hall D Staff:

- Scientific group: 13 staff scientists  
2 Hall D postdoc positions (1 is currently open)
- Technical group: 1 mechanical engineer, 1 designer and 5 techs  
1 additional ME position planned for FY24

## Expected budget for KLF

- Capital: about \$2.4 M (design and equipment/materials)  
\$53k spent so far for designer work
- More ME/MD work needed, options:
  - Engineering Dept (Capital)
  - Hall D staff (OPS)
- Operations: labor from ENP  
general purpose equipment