

# Hall D Status

E.Chudakov<sup>1</sup>

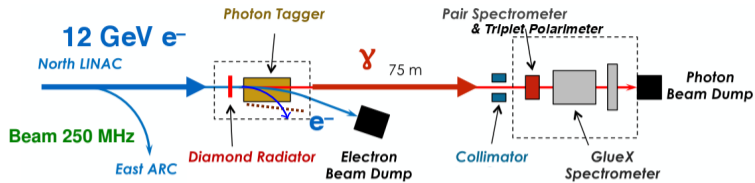
<sup>1</sup>JLab, Hall D manager

KLF Collaboration Meeting, 2023 Sept 19

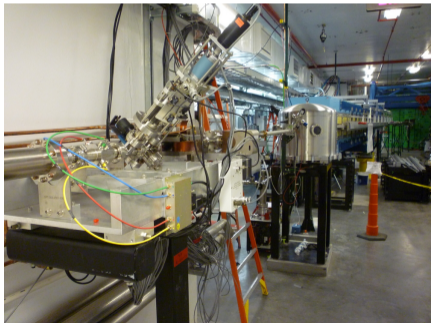
# KLF: progress since Nov 2022 - JLab perspective

- CPS conceptual design strongly advanced:  
Credit: Vitaly Baturin (ODU); Hovanes Egiyan (JLab), Tim Whitlatch (JLab), Pavel Degtiarenko (JLab)
- ENP Phase 1 Experiment Readiness Review (ERR-1) Aug 2, 2023:
  - Generally positive, no showstopper found
  - 8 recommendations, 3 to be met before October 2023

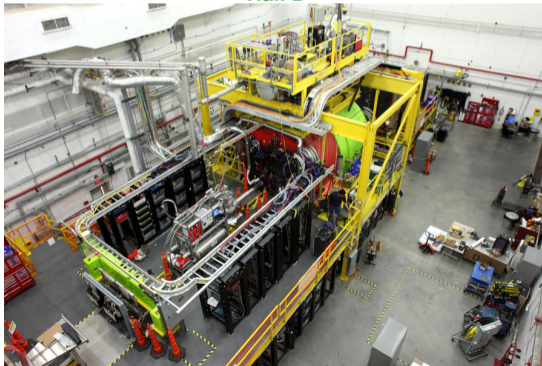
# Hall D Apparatus



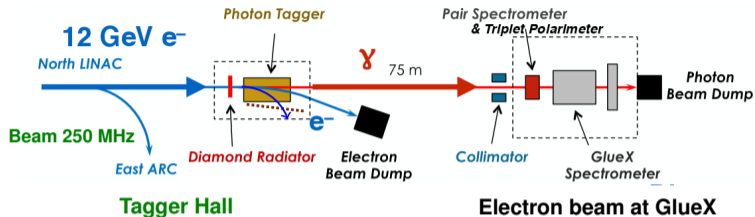
Tagger Hall



Hall D



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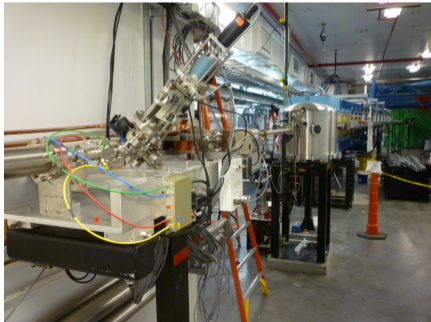


## Electron beam at GlueX

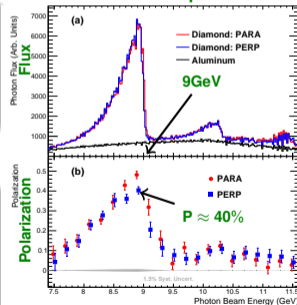
- ▶  $< 500$  nA
- ▶ Focus at the collimator
- ▶ Steering: active collimator signals
- ▶  $< 5 \mu\text{A}$  the limit of the dump

## Photon beam at GlueX

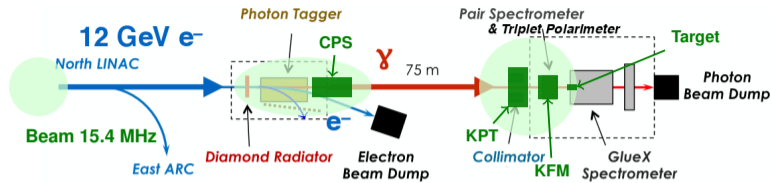
- ▶ Radiator  $\approx 4 \cdot 10^{-4}$  RL
- ▶ Tagging  $\sigma E/E \sim 0.2\%$
- ▶ Linear polarization  $\sim 40\%$  peak
- ▶ Pair Spectrometer & Polarimeter



## Photon Beam Spectrum



# 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.

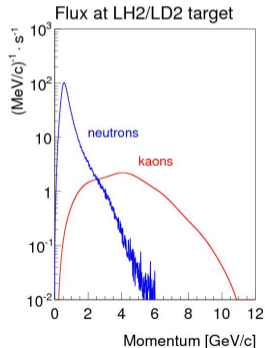
- Removed converters, detectors, shielding
- KFM installed

## Electron beam at KLF

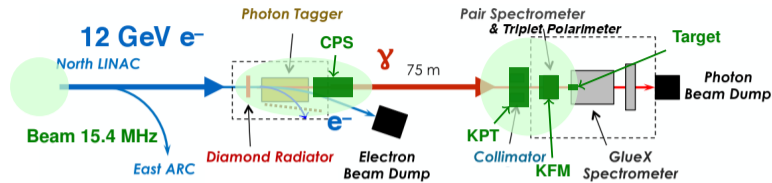
- ▶ 5  $\mu\text{A}$
- ▶ Focus at KPT - the same location
- ▶ New beam instrumentation?
- ▶ Steering: a new active collimator?

## Photon beam at KLF

- ▶ Radiator 10% RL
- ▶ Bremsstrahlung spectrum
- ▶ No tagging
- ▶ 6 kW power ( $\times$  4000 GlueX)



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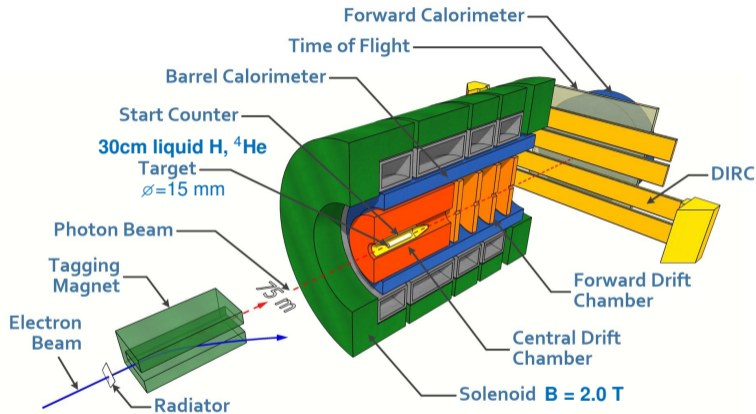
**A major beamline change!**

**High radiation and activation in Tagger Hall and Coll. Cave**

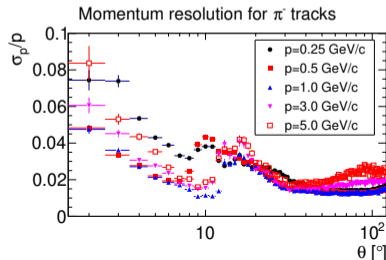
## The facility's requirements

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

# Hall D: GlueX Spectrometer

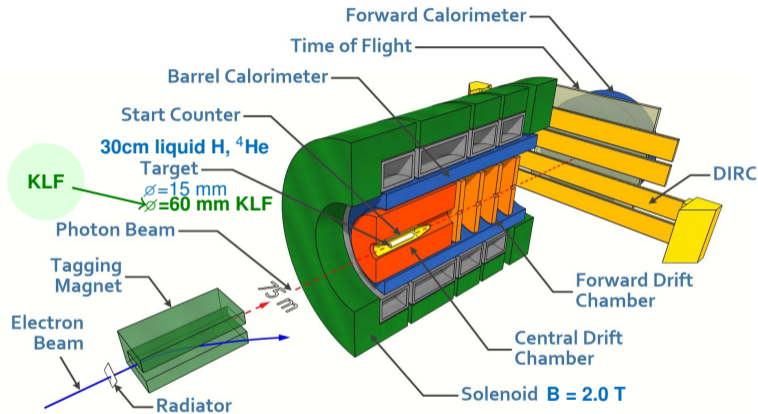


- ▶ Acceptance:  $1^\circ < \theta < 120^\circ$
- ▶ Resolutions:
  - $h^\pm$ :  $\sigma_p/p(\theta) \sim 1 - 5\%$
  - $\gamma$ :  $\sigma_E/E \sim 5.5\%/\sqrt{E} \oplus 4.5\%$
- ▶ Trigger: all photoproduction at  $E_{\text{BEAM}} > 7\text{ GeV}$   
 DAQ in 2021: **85 kHz** (photoproduction + EM background)

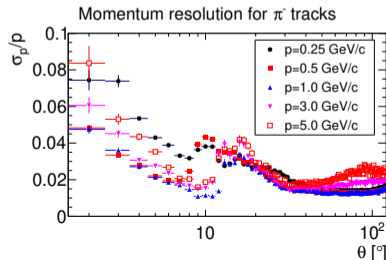


GlueX studies exclusive reactions. A good event selection and momentum/mass resolution are achieved with the help of 4C kinematic fit which uses the  $\approx 0.1\%$  energy resolution of the beam photon.

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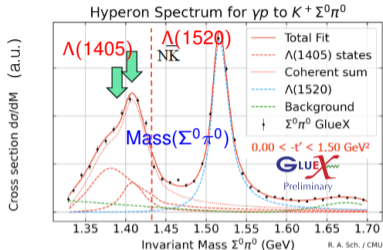
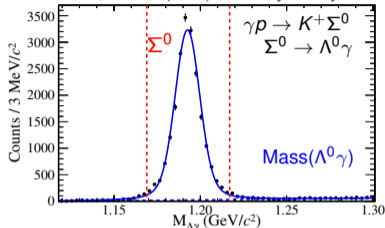


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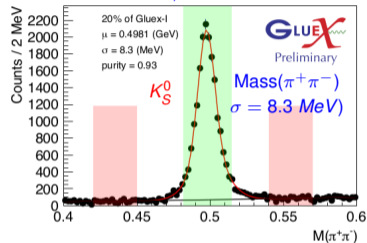
# GlueX experiment: Illustration of hyperon reconstruction

PRC 101, 065206 (2021) beam asymmetry

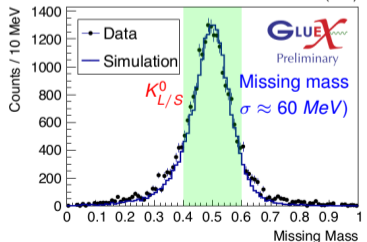
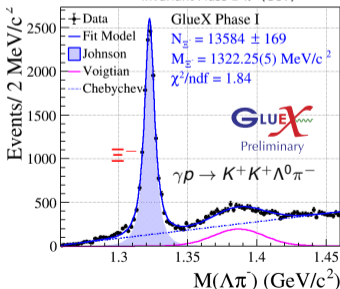
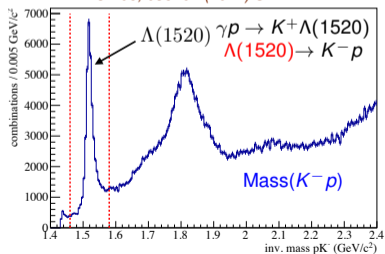


Reaction with a missing particle

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



PRC 105, 035201 (2022) SDME

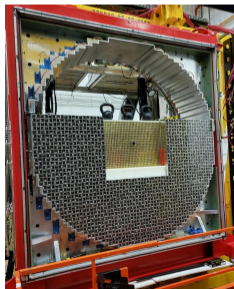
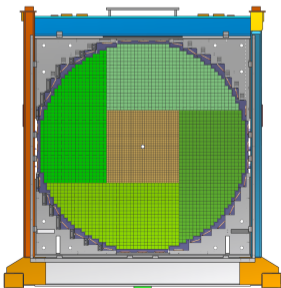


# Ongoing projects: hardware upgrades for future experiments

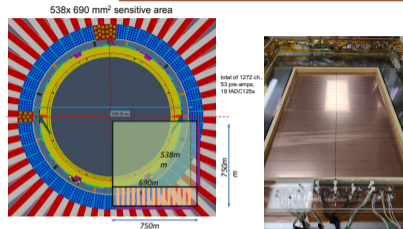
## FCAL2 PbWO<sub>4</sub> insert: Installation

- 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 is in progress

Re-stacking LG blocks into a new frame



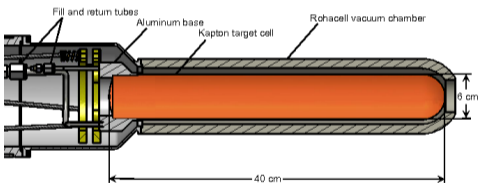
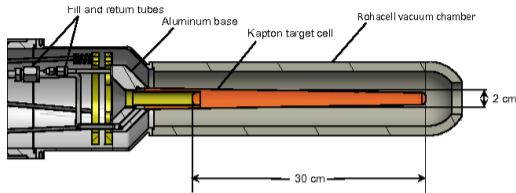
## GEM TRD: prototyping and testing



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

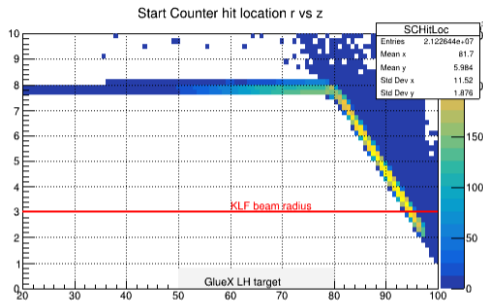
LOI to PAC51 for running of GlueX+TRD

# KLF: new development needed: target and trigger



## KLF target

- $\varnothing=15$  mm,  $L=30$  cm  $\Rightarrow$   $\varnothing=60$  mm,  $L=40$  cm
- **ST opening is  $\varnothing=40$  mm**, vac. window  $\varnothing=40$  mm
- What length can fit into ST?
- More mult. scattering, secondary interaction



## Trigger and ST

- GlueX BCAL+FCAL trigger will not cover low energies
- **What processes need to be triggered?**
- ST is probably the only detector for low energies  
**What background rate in ST is expected?**  
**50% of beam + decay products pass through ST**

# KLF: other modifications or elaboration needed

- Detector calibration

- Timing calibration:

GlueX uses photons (fixed time in a given detector with respect to the bunch)

KLF: **we need to know the timing in ST, TOF etc, for  $\beta = 1$  beam particles**, with respect to bunch timing

Would a counter at KPT help, calibrated together with ST, TOF at GlueX with the photon beam?

- BCAL, FCAL energy calibration

GlueX uses  $\pi^0 \rightarrow \gamma\gamma$

KLF: **What  $\pi^0$  statistics is expected? Is it enough for calibration?**

# 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

- Proposal: SRC/CT: conditionally approved C2
- LOI: GlueX at luminosity frontier Encouraged  $\Rightarrow$  full proposal
- LOI: GlueX+TRD Spectroscopy + charmonia Encouraged  $\Rightarrow$  full proposal
- LOI: GlueX GDH on nuclei PAC asked questions

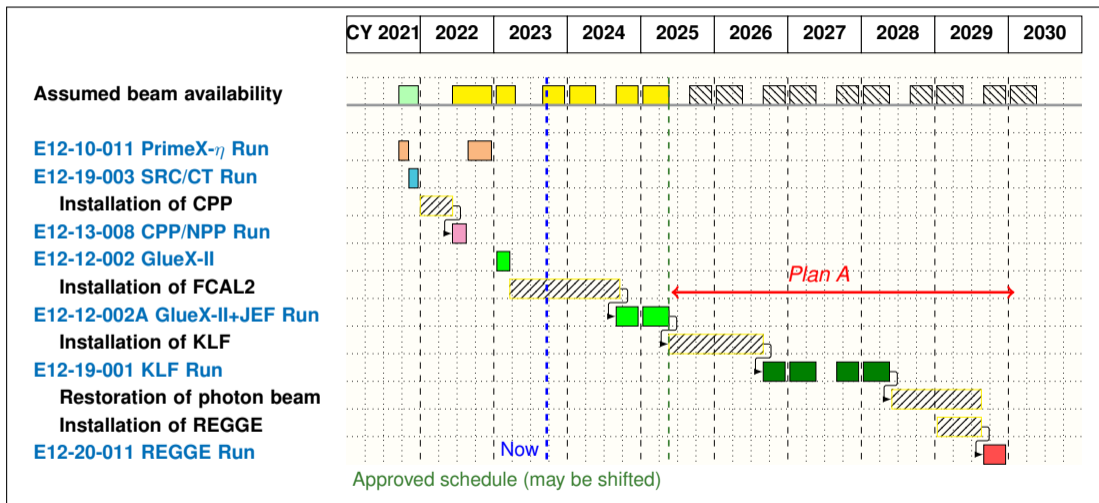
Exp	AC	ys	data taken
E12-0	20		100%
E12-1	20		46%
	100		0%
Eta Factory(JEF) Experiment			
E12-10-011	PrimeX- $\eta$	A Precision Measurement of the eta Radiative Decay Width via the Primakoff Effect	A- 79 100%
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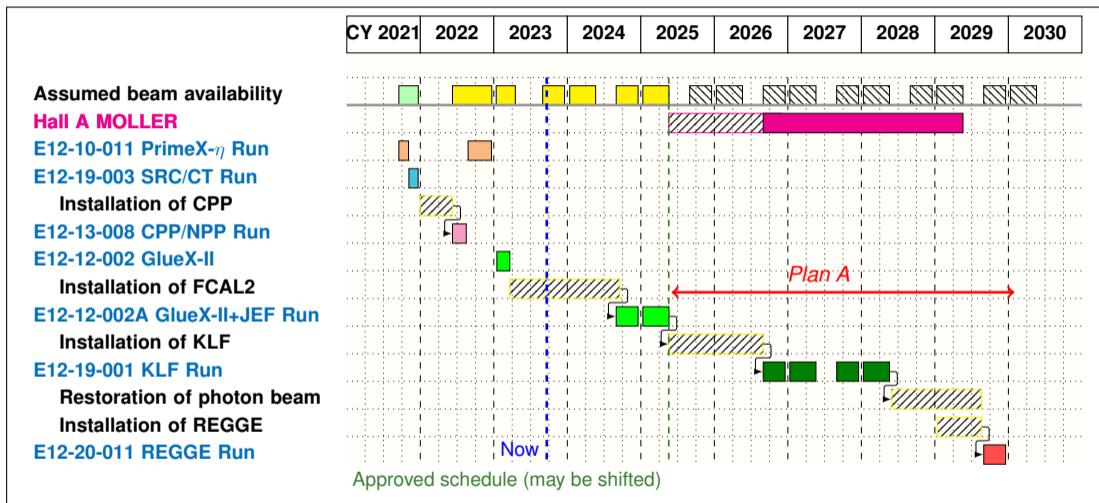
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# Hall D running schedule: outlook



- 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

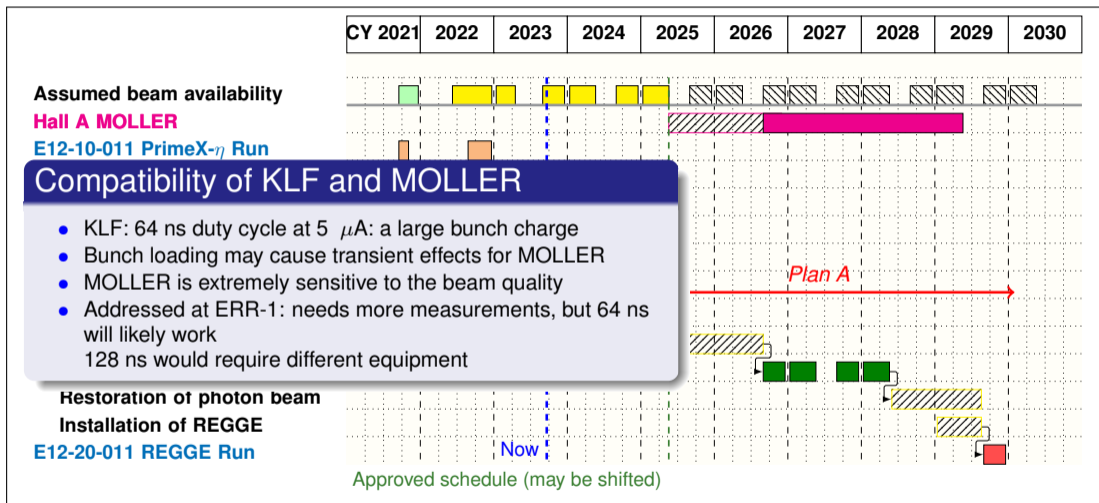
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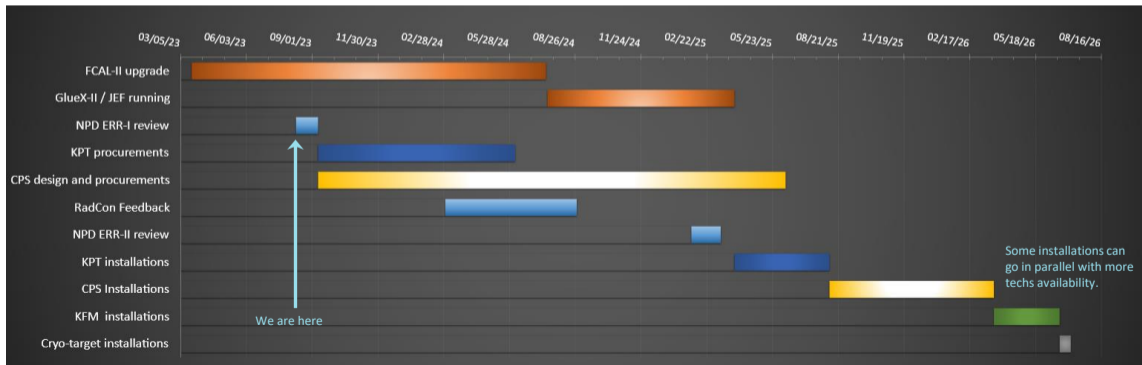
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## Timeline

- The timeline is based on the current design and preliminary estimates.
- Total cost estimate to Hall D ~\$2.3M.
  - KFM expenses are covered by University of York.
- We need to start engineering design of CPS this fall.
- We would like to start procurements for KPT this fall.



# KLF (KLONG) ERR-I Aug 2, 2023 Recommendations

- 1 Complete a bottom-up cost estimate (30% accuracy) and deliver to Physics Division management by the end of **September 2023** - prior to awarding any major procurements. **JLab**
- 2 Work with lab management, including RadCon, to document requirements for decommissioning and disposal of the KLF apparatus and incorporate this information to develop designs that are compatible with required timelines for removal and disposal of equipment. Make all efforts to obtain this guidance from lab management by the end of **September 2023**. **JLab**
- 3 Proceed with detailed engineering work.
- 4 A report of relevant beam studies results from the 2024 run period should be delivered to Physics Division management by **June 2024** (compatibility with MOLLER).
- 5 Perform time-dependent and thermal cycling (e.g. from beam trips) simulations of targets (copper and beryllium) and blockers (tungsten) that receive high (kW) power deposition to assure that thermal and mechanical performance is adequately understood. Fatigue, cracking, etc. Provide report to Physics Division management by **June 2024**.
- 6 Include residual field from dipole in beam optics calculations and determine extent of degaussing that will be required to operate KLF. Provide report to Physics Division management by **March 2024**.
- 7 Perform an FMEA including safety assessment of off-normal events, e.g. cooling system failures, power supply failures, beam excursions etc. Provide results at next ERR.
- 8 **Within 2 months**, assign a dedicated scientist or team to assess radiation tolerance of equipment, in the tagger hall in particular, and assess if any components will need to be shielded or potentially replaced to restore GlueX. **Collaboration**

# KLF: Toward the next ERR

In order to start installation in Aug 2025 KLF must pass ERR-2 (or just ERR) in the Fall of 2024. The typical requirements are:

- All new equipment has been designed to match the experimental program and either built or on track to be built
- Installation procedure and schedule have been developed and responsibilities assigned
- Commissioning procedure and schedule has been developed and responsibilities assigned
- All the tasks have been defined and responsibilities assigned (maintaining the equipment during operation, for online and offline data analysis etc)
- The plans/tasks for installation, commissioning and running should be consistent with the labs's policy (ES&H, technical specs etc)
- The collaboration has a transparent management structure, and formal documents are drafted (COO, ESAD, RSAD)
- Commitment of the collaboration to provide manpower for shift work, run coordinators, prompt data analysis.
- Readiness for expedient data analysis

# Hall D Staff/Budget

## 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

## Hall D budget:

- Operation budget \$1-1.5 M/year
  - ▶ Operation costs; installation costs: staff labor and equipment (limited)
  - ▶ Small projects (<\$2 M), development for future
  - ▶ Supported: 3 university postdocs (at a 50% level)
  - ▶ Limited support for visitors for shifts etc
- Capital budget for KLF:
  - ▶ Capital: expected about \$2.4 M (design and equipment/materials) \$53k spent so far for designer work
  - ▶ More ME/MD work needed (supported by ERR-1), worth about \$150k, options:
    - Engineering Dept (Capital)
    - Hall D staff (OPS)
  - ▶ Procurements may start after some ERR-1 recommendations are met
  - ▶ FY24 plan: \$400k: \$150k for design and \$250 for procurements