Hall D Status

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[1]JLab, Hall D manager

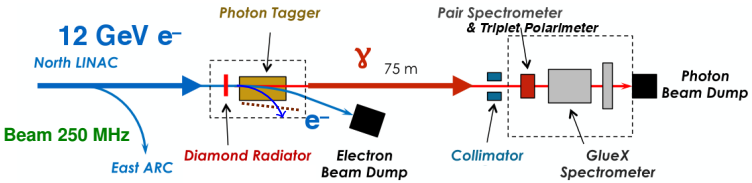
KLF Collaboration Meeting, 2026 May 6

Outline

Development since the last KLF Collaboration meeting in Sep 2023

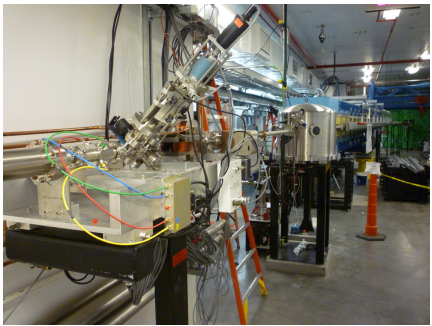
- Current Hall D setup and modifications needed for KLF
- Status of the design:
  - Development of the conceptual design and changes of some basic parameters (more by Hovanes Egiyan)
  - Next steps required to finish the conceptual design
  - Briefly on the engineering design (more by Josh Ballard)
- Early ERRs
- Budget
- Tentative schedule (details by Josh Ballard)

Hall D Apparatus: designed for photoproduction

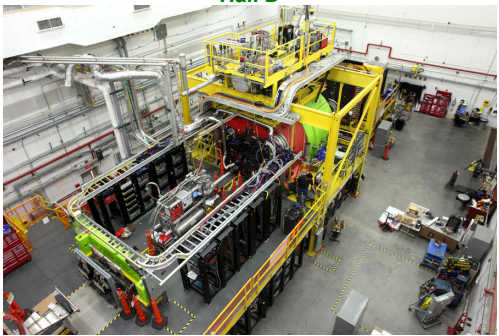


- Current used < 500 nA
- Radiator $\approx 4 \cdot 10^{-4}$ RL
- Tagging $\sigma E/E \sim 0.2\%$
- Electron dump 5 μA (60 kW)

Tagger Hall



Hall D



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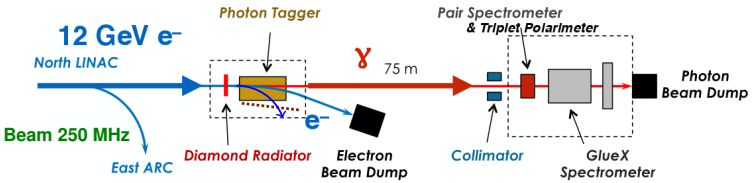
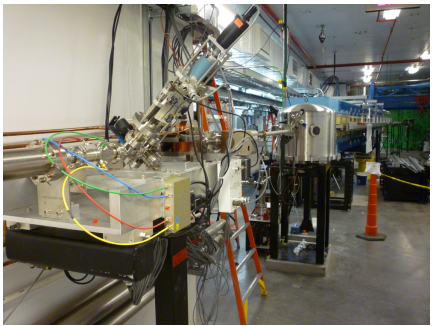
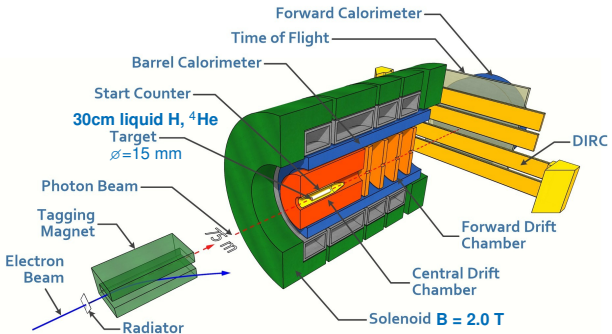


- Acceptance: $1^\circ < \theta < 120^\circ$
- Resolution: a few % for $h^\pm, \gamma$
- Trigger rate <80 kHz
- 4C fit used for exlusive reactions

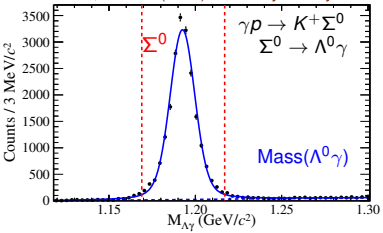
Tagger Hall



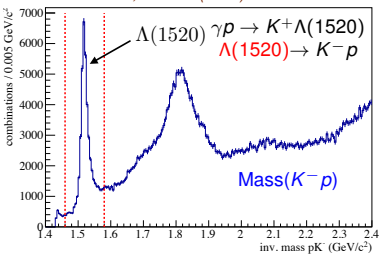


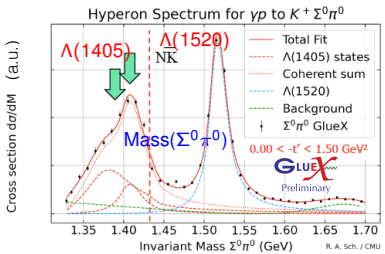
GlueX experiment: Illustration of hyperon reconstruction

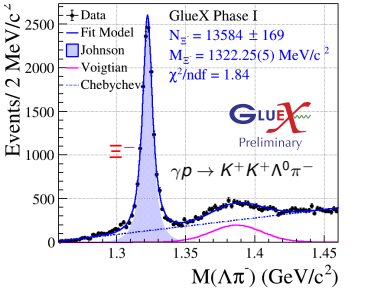
PRC 101, 065206 (2021) beam asymmetry



PRC 105, 035201 (2022) SDME

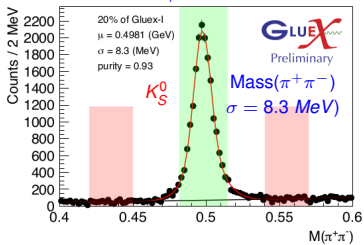


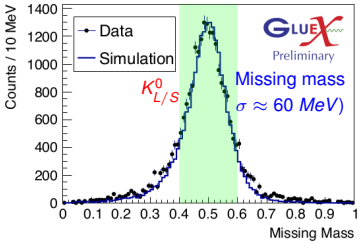




Reaction with a missing particle

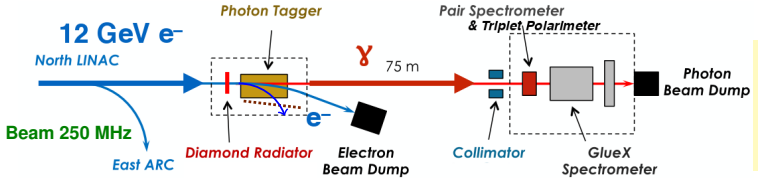
$\gamma p \to p K^0_S(K^0_{L/S}), K^0_S \to \pi^+\pi^-$





Jefferson Lab

KLF(KLONG) experiment design

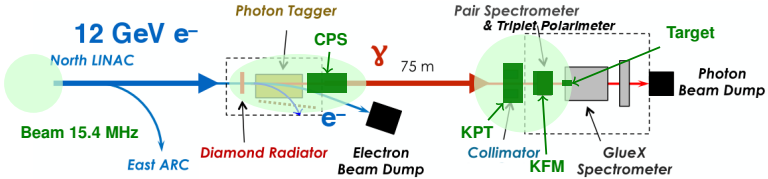


Areas in Hall D Complex

1. Tagger Hall
2. Collimator cave
3. Hall D Pair spectrometer
4. Hall D Solenoid spectrometer

Photon beam e^- 300 nA $\Rightarrow$ 0.04% RL $\Rightarrow \varnothing$=5 mm collimator $\Rightarrow \varnothing$=20 mm LH_2 target

KLF(KLONG) experiment design

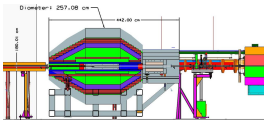


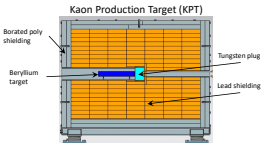
KLF Installation

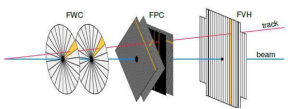
1. Injector 4 ns → 64 ns
2. CPS - Compact Photon Source
3. KPT - Kaon Production Target
4. KFM - Kaon Flux Monitor
5. LH_2 target of a larger diameter
6. New Start Counter

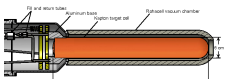
Photon beam e^- 300 nA ⇒ 0.04% RL ⇒⌀=5 mm collimator ⇒⌀=20 mm LH_2 target

Kaon beam e^- 5 μA ⇒ 10% RL ⇒⌀=60 mm, L=40 cm Be target ⇒L=10 cm W-absorber ⇒⌀=60 mm LH_2 target









CPS: new equipment

- Input: 5 μA beam
- 60 kW beam dump
- 10-20% RL radiator
- Output:12kW photon beam
- Responsibility: JLab

KPT: new equipment

- Be target ⌀,L=60,400 mm
- 10 cm W plug for photons
- Shielding
- Beam pipes to LH_2 target
- Responsibility: JLab

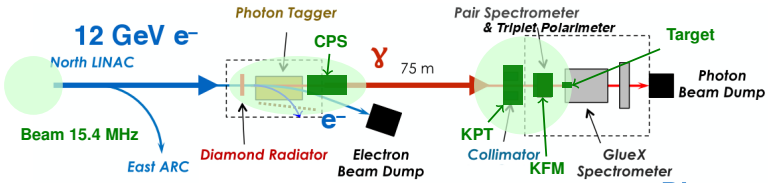
KFM: partly recycled

- Flux monitor
- Detectors from Jülich
- Detectors: Uni. of York
- Electronics/support: JLab

Target and Start Counter

- ⌀ 60 mm LH_2 target (JLab)
- New start counter (Osaka Uni)

KLF(KLONG): development of the design



KLF Installation

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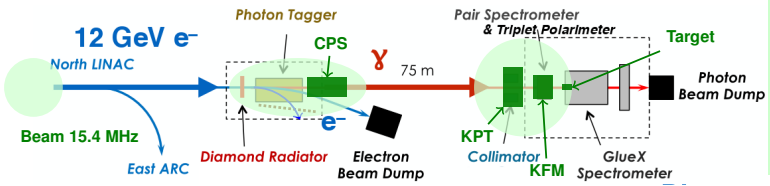
Initial design

- Initial specs:
  5 μA, 10% RL, 10 cm W plug, 64 ns
  (acceptable kaon flux)
- Initial conceptual design of CPT and KPT by Collaboration and JLab

Experimental Readiness reviews

- ERR-I Aug 2, 2023 on conceptual design
  - 8 recommendations
  - All met, but: compatibility with MOLLER (no schedule overlap anymore)
    FMEA, to prepare for ERR-II
- Intermediate ERR Aug 30, 2024 on simulation, data analysis, background etc.
  - 13 recommendations
  - I am not aware of formal responses to this ERR
  - Some recommendations on BG simulation were addressed - see next page

KLF(KLONG): development of the design



KLF Installation

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Modification of the specs

- 2024-2025: Detailed simulation of background and Kaon flux at the Spectrometer
  - Pavel Degtiarenko (JLab, ES&H) FLUKA
  - Richard Jones (UConn) GEANT
- Result: too high background from soft photons in the detectors (Start Counter, FDC, CDC)
- Change of the design (specs):
  - W plug 10 cm ⇒ 14 cm
  - Radiator 10% ⇒ 20%
  - New start counter is needed
  - Re-design of the beam pipes between KPT and LH_2 target (not finalized yet)

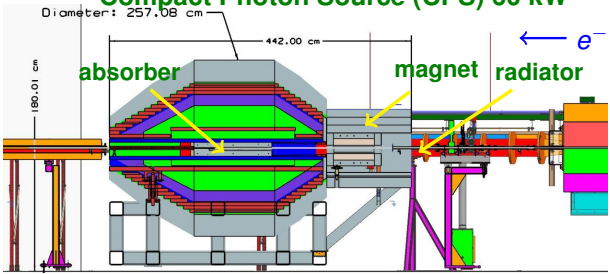
Remaining tasks on conceptual design

In order to proceed with engineering design of KPT and the beam pipes downstream certain info is needed:

- Conceptual design of the new Start Counter with all dimensions and positions
- Locations of the detectors of the Flux Monitor
- Implementation of the new Start Counter and KFM into GlueX GEANT simulation and optimization the beamline downstream of KPT
- Is a photon beam needed in Hall D for calibration of calorimeters?

KLF(KLONG): CPS status

Compact Photon Source (CPS) 60 kW



Details of engineering design

- Magnet 0.4 T·m, up to 0.67 T·m
- Decommissioning: removal of the whole activated part

Remaining design work

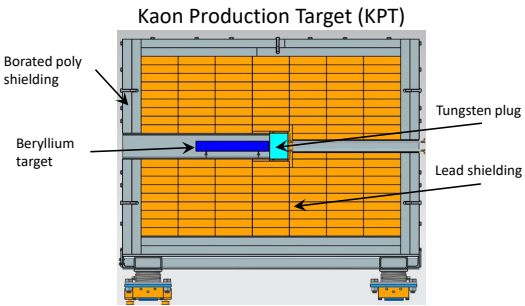
- Finalizing dimensions, assembly procedure
- FLUKA: optimization of poly absorbers
- Electron beam steering elements, monitoring, control systems and FSD

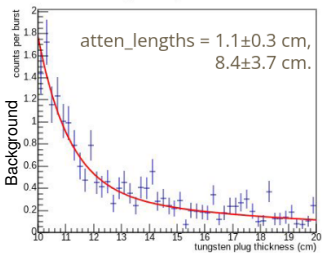
Procurement, delivered

- Magnet has been delivered ($60k KLONGB)
- 1200 new lead bricks ($68k KLONGB)
- 3100 painted old lead bricks ($60k DOPS)
- Power supply for the magnet ($187k KLONGB)

Magnet

KLF(KLONG): KPT in Collimator Cave





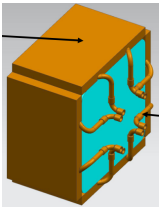
W plug thickness

10 cm: BG too high

15 cm: BG $\times 0.1$

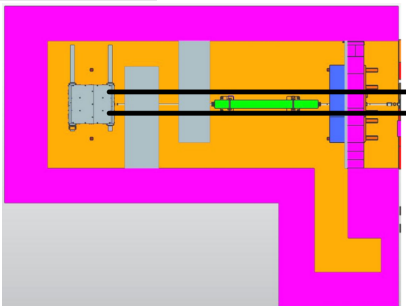
15 cm: $K_L \times 0.5$

Further optimization is in progress



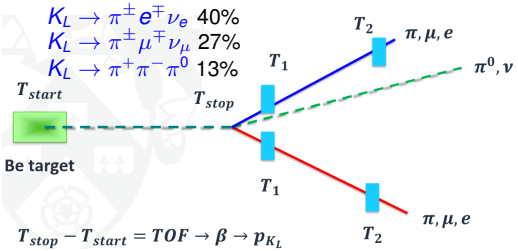
Cooling

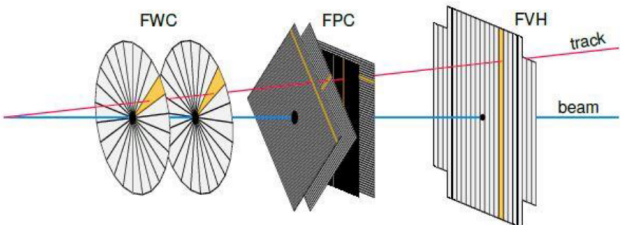
- W/Cu 80/20% 10 cm plug: $\sim$5 kW
- Water-cooled Cu plates
- Max temperature 216°C
- Extra plug downstream, movable
- Be target wrapped in Cu and cooled



To be finalized: location of the additional W plug

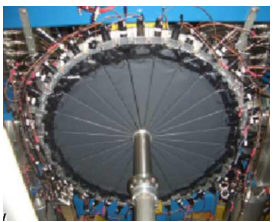
KLF(KLONG): KFM Kaon Flux Monitor





Detectors (Univ. of York)

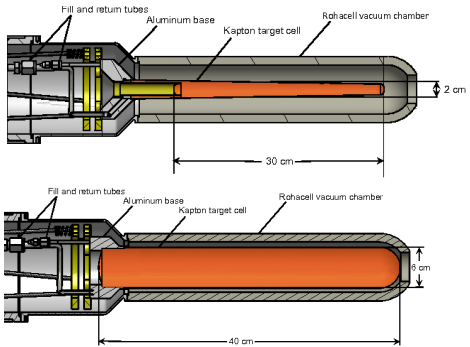
- Packed at Jülich, to be delivered to US
- Plan: testing at JLab (manpower?)



Support (JLab)

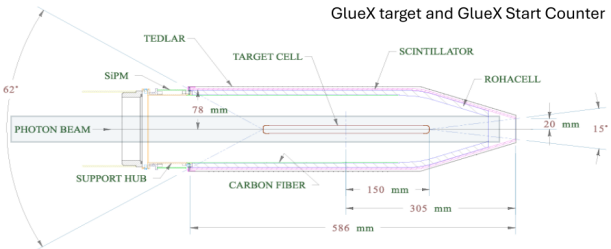
- Mechanical support: design after arrival
- Electronics and readout:
  Hodoscopes: electronics from Tagger
  Straws: plan - JLab low resol. TDC, new
  Cables: new

KLF(KLONG): Target and Start Counter



KLF target (JLab)

- ⌀=15 mm, L=30 cm ⇒ ⌀=60 mm, L=40 cm
- LH_2 and LD_2
- Target Group: requires 1 year of work



Start Counter

- The existing counter: opening ⌀=20 mm, beam ⌀=60 mm
  - too high background from soft photons
  - radiation damage in the “nose”
- New cylindrical start counter to be designed and built: a group from Osaka University
- Readout: JLab (may depend on the ST implementation)

Resources and Budget

Spent to date

- Capital funding in FY23-25
- Labor of Hall D staff not included
- Purchased (from JLab) labor 75 wks, $224k
- Purchased material, equipment: $341k

Manpower for design

- Expect capital funding resuming in FY28
- Current Hall D technical staff: 1.5 ME, 1 MD and 4 MT
- Potential support of KLF from Hall D: 0.5FTE ME next 12 months
- After resolving conceptual design details we can resume the engineering design work (need budget for 1 MD FTE)

Future resourced for building and installing

- See the presentation by Josh Ballard for details
- Total budget about $1.6 M for materials and $0.5 M for purchased labor
- Time measured since funding (typically $750/year) start
- 3.5 years to the end of installation
- 2 years for installation (assuming the existing Hall D technical manpower)
- Highly desirable to purchase more labor to reduce the installation time to 16-18 months (for losing only one running period)

Total time estimate for installation, running, de-installation is about 5-6 years

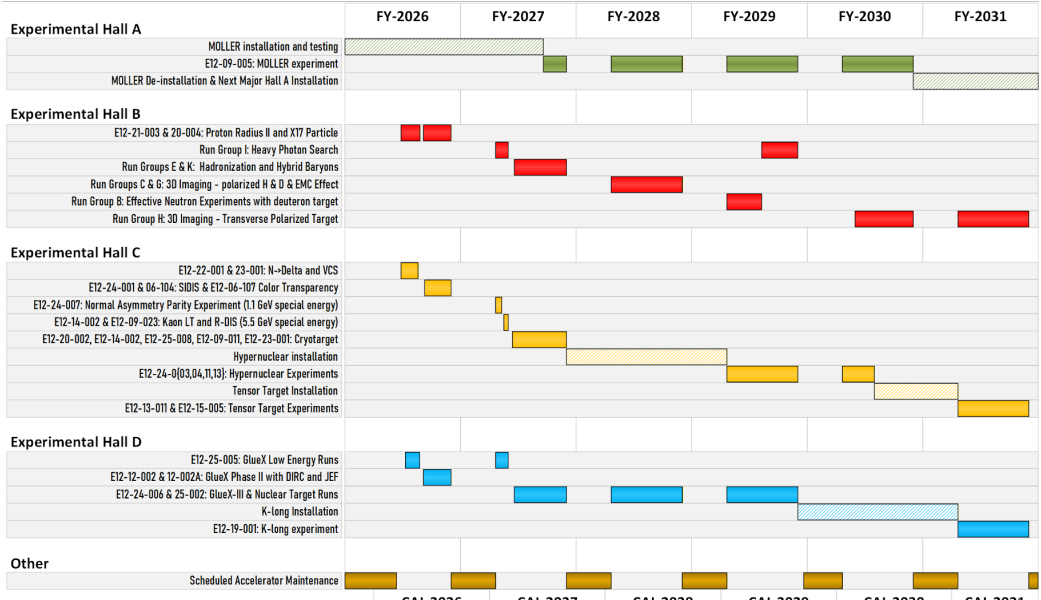
Physics Program in Hall D

Experiment	name	Collab.	Title	PAC rating	PAC days	data taken
E12-06-102	GlueX-I	GlueX	Mapping the Spectrum of ... and Gluonic Excitations	A	120	100%
E12-12-002	GlueX-II	GlueX	A study of meson and baryon decays to strange final states	A	220	80%
A	JEF	GlueX	Rare η Decays: The JLab η Factory (JEF experiment)	Grp	100	75%
E12-10-011	PrimeX-η	GlueX	Measurement of the $\eta \to \gamma\gamma$ Decay Width via Primakoff	A-	79	100%
E12-13-008	CPP/NPP	GlueX	Measuring the Pion Polarizability in the $\gamma\gamma \to \pi\pi$ Reaction	A-	25	100%
E12-19-003	SRC/CT	SRC	Studying Short-Range Correlations with Real Photon Beam	B+	15	100%
E12-25-005		GlueX	GlueX with a 1-4 GeV Photon Beam	A-	28	
			Not yet started			
E12-19-001	KLF(KLONG)	KLF	Strange Hadron Spectroscopy with Secondary KL Beam	A-	200	
E12-20-011	REGGE	GlueX	The high-energy contribution to the GDH sum rule	A-	33	
E12-24-006	GlueX-III	GlueX	Photoproduction of Charmonia at High Luminosity	A	200	
E12-25-002	Nuclear J/ψ	SRC	Photoproduction of J/ψ as a Probe of Nuclear Gluons	B+	85	
E12-25-012		GlueX	ϕ Production off Tensor Polarized Deutron	A-	65	
Remaining approved program: 700 PAC days $\approx$ 8 years of running						

- considerable installation / new equipment required

- finished data taking

JLab schedule outlook (assumes 32 weeks/year)



Outlook

My comments/recommendations:

- Aim at preparing for ERR-II before FY28 (this may be essential for funding in FY28)
- At this moment there is some schedule contingency, but not much
- The project needs more manpower soon for detailed simulation of the beamline and its final optimization

Physics with K_L beam would be an excellent extension of the Hall D program. Let us make it happen.

Backup

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**