Measurement of Meson Electroproduction Differential Cross Sections for η', ω, and ρ^0 (E'OR) in the Threshold Region Using HKS-HES Setup

A proposal for the HKS collaboration in Hall C

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1. Context and Goal for this Presentation

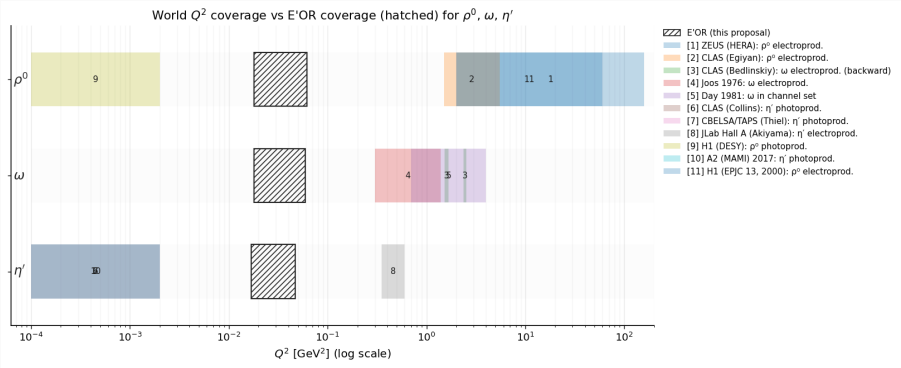
- **E'OR main concept:** HES measures the scattered electron; HKS measures the scattered proton in coincidence.
- **Exclusive final states via missing mass:** for three mesons η', ω, and ρ^0.
- **Operational model:** E'OR runs in *dedicated time blocks* (not overlapping but complementary to hypernuclear running).
- **Purpose:** to confirm E'OR feasibility within the HKS program and align on what collaboration support is needed.

Key message:

E'OR experiment is a low-disruption, valuable set of measurements that uses existing infrastructure with provided MC-based simulated projections to validate feasibility.

2. Physics Motivation: Why η', ω, and ρ^0?

- ρ^0 **and** ω**:** benchmark exclusive electroproduction channels, and help constrain exchange mechanisms and flavor structure.
- η'**:** sensitivity to singlet/gluonic dynamics and mixing systematics in phenomenological descriptions.
- **Valuable results:** limited precision coverage in low-Q^2, moderate $-t$ phase space for electroproduction, relatively unexplored region

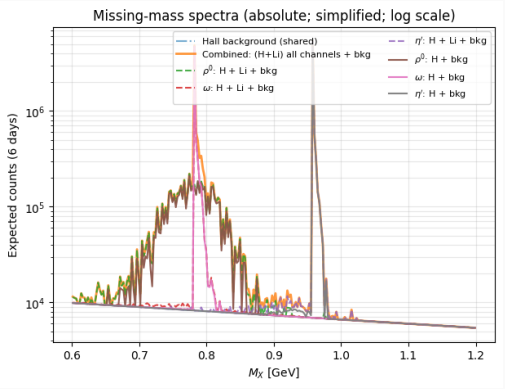


3. Experimental Concept: (e,e'p) Missing-Mass Reconstruction

- Reaction: $ep \rightarrow e'p'X$
- X reconstructed from missing mass:

$$M_X^2 = (k + p - k' - p')^2$$

- **HES:** scattered electron e'
- **HKS:** scattered proton p' (PID and proton trigger in coincidence)
- Expected shape:
  - ω, η' presents as sharp peaks
  - ρ^0 displays as a broader spectrum



Li and hall background are modeled and subtracted out for final yield extraction

4. Fit Within the HKS Program: Dedicated E'OR Running

- HKS will be normally configured for kaon (K) arm in hypernuclear running; instead E'OR uses HKS as a **scattered-proton arm**.
- **E'OR is not concurrent**, but complimentary with the other HKS experiments:
  - A dedicated proton trigger is needed.
  - proton PID via Cherenkov + TOF used for event selection.
- **Operational philosophy:** minimize interference with approved HKS program by isolating E'OR into defined blocks.

Implementation note (for data acquisition)

Trigger/DAQ changes require ability to switch between kaon trigger $\leftrightarrow$ proton trigger

5. Baseline Kinematics and Spectrometer Settings (Authoritative)

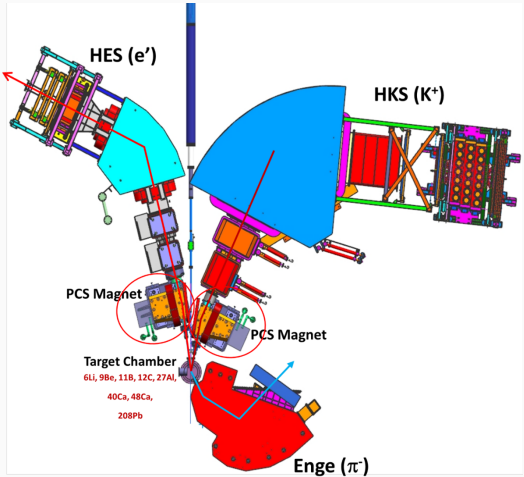
Quantity	Beam / Target	HES (electron)	HKS (hadron)
Beam energy	2.24 GeV	–	–
Central angle	–	8.5°	11.5°
Central momentum	–	0.740 GeV/c	*channel-dependent*
Solid angle	–	3.4 msr	7.0 msr
Momentum bite	–	±4%	±6%
Target (baseline)	LiH, 150 mg/cm^2, 30 μA (estimated)		

What this slide establishes

The geometry/acceptances used in MC are aligned to this intended baseline spectrometer configuration.

6. Two HKS Momentum Settings: ρ^0/ω vs η'

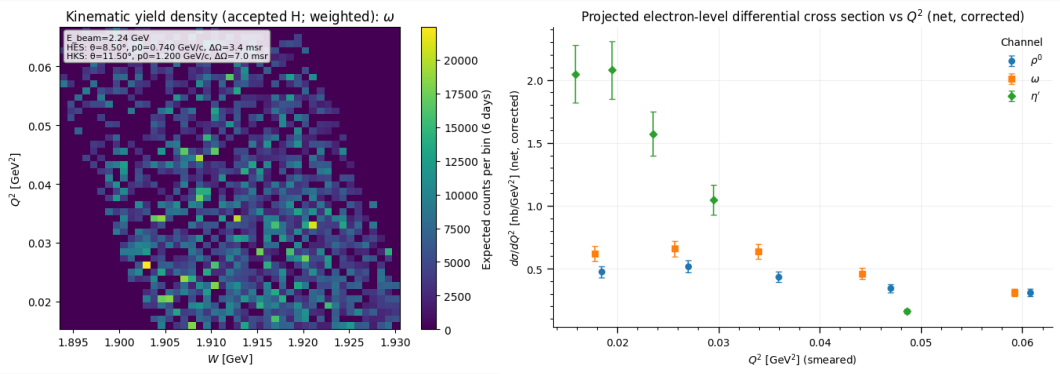
- ρ^0 and ω share a common proton momentum setting:
  - HKS $p_0 \approx 1.20\,\mathrm{GeV/c}$
  - **6 days** dedicated running
- η' requires a lower central proton momentum:
  - HKS $p_0 \approx 0.75\,\mathrm{GeV/c}$ via change in magnet current
  - **6 additional days** dedicated running
- Total E'OR request: **12 days** $(6 + 6)$, less days for beam current $>30\ \mu\mathrm{A}$.



7. MC Overview: What It Includes and What It Delivers

- **Event generation:** two-body reaction in CM frame, boosted to lab frame.
- **Acceptance modeled:** (θ, ϕ, p) windows for HES and HKS consistent with settings.
- **Detector effects:** track smearing, efficiency slightly varying with Q^2, and simple radiative tail model.
- **Physics content:** extracted differential cross sections $(-t, Q^2, W)$, subtracted out background and Li contributions.
- **Outputs used for projections:**
  - kinematic coverage plots ($Q^2 vs. W$) as heat maps
  - $-t$ ranges separated into bins with corresponding yields
  - missing-mass spectra including signals vs background vs Li contribution)
  - binned yields used to calculate projected differential cross sections, with corrections for efficiency, acceptance, bin centering, radiative tail.

8. Kinematic Coverage and Cross Sections



Example Q^2 vs W heat map for ω meson projected yields

Projected cross sections for E'OR particles, binning dependent on requested days and beam current

9. Primary Considerations Before Submission to PAC54

- **Finalize LiH target**: parameters, implementation, and production capabilities:
  - **Beam-current/areal-density:** assuming numbers for now until real target is made.
  - **Risks:** handling and chemical stability, not melting
    - LiH is water reactive and must be well sealed/handled in controlled conditions
    - Encapsulation integrity (vacuum compatibility, leak tightness),
    - Thermal conduction path to target frame, raster size and verified spot stability
- **Data Acquisition Trigger Rates**: estimates may need better verification
  - Current anticipated raw proton acceptance rate $\sim$ 500 Hz
  - Estimate total DAQ trigger rate with HKS-HES coincidence $\sim$ 300-350 Hz
- Final determination for number of requested days (target dependent), identify spokespersons, further develop simulation and analysis integration, re-write of the proposal (previous version now out-of-date)

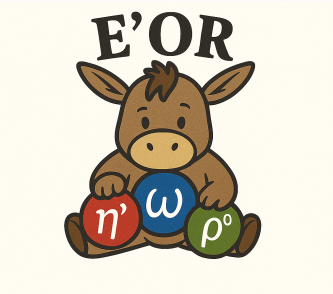
10. Run Plan, Collaboration Needs, and Next Steps

Run plan (baseline, adjustable)

- 6 days: $\rho^0 + \omega$ @ HKS $p_0 \approx 1.20\,\mathrm{GeV/c}$
- 6 days: η' @ HKS $p_0 \approx 0.75\,\mathrm{GeV/c}$

Collaboration Needs

- Contingency plans, retuning HKS magnet
- Proton trigger and proton PID using Cherenkov + TOF
- Agree on schedule and consider student theses (one per reaction channel?)



Decision and Discussion

Confirm the HKS collaboration support to proceed with E'OR submission for JLab PAC54 in April.