

Responses for the HKS Experimental Readiness Review

JLab Hypernuclear Collaboration

May 2026

Abstract

This document summarizes the HKS Collaboration response to the comments and recommendations from the first Hypernuclear ERR held on November 18–19, 2024, and documents the current readiness status for the June 2026 ERR.

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Executive Summary

The HKS Collaboration has made substantial progress in addressing the comments and recommendations from the first Hypernuclear ERR held on November 18–19, 2024. The present document summarizes the current responses and provides the readiness status for the June 2026 ERR.

Major progress has been made in the experimental hardware configuration, beamline design, target system, magnet and power-supply preparation, detector commissioning, radiation studies, DAQ/electronics planning, and analysis software development. Several design issues identified in the previous ERR have been addressed or are being actively closed. In particular, the target system design now includes provisions to protect air-sensitive targets during maintenance activities, the target configuration and usage plan have been updated, and the beamline and shielding configuration have advanced significantly.

For the electron beam and machine requirements, dedicated beam studies have been performed to evaluate the achievable beam energy spread and stability. Additional BPMs, beam-position monitoring, and feedback-related procedures are being incorporated into the plan. The effect of stray magnetic fields on beam transport has been evaluated using the available TOSCA field maps, and the current results indicate that the beam can be transported to the dump with the corrector magnet settings. Updated field maps and full tracking studies using the refined geometry are being prepared as follow-up confirmation.

The collaboration has also made progress in detector and electronics readiness. The HKS and HES detector systems benefit from prior operational experience, while the ENGE detector package and calibration procedures are being developed and tested. The ENGE fiber detector design has been updated to use multi-anode PMT readout instead of SiPMs, thereby removing the identified SiPM radiation-damage concern from the baseline design. Electronics locations and shielding concepts have been evaluated with respect to the expected radiation environment.

Several items remain open and are being actively tracked. These include the completion of updated TOSCA field-map studies, finalization of some magnet and power-supply tests, completion of detailed documentation and procedures, finalization of manpower and responsibility tables, and continued refinement of installation and commissioning schedules. None of these items is currently identified as a fundamental show-stopper for the experiment; rather, they represent remaining work toward final readiness.

Overall, the collaboration considers that the experiment has advanced substantially since the first ERR. The remaining tasks are well identified, responsible groups are being assigned, and mitigation plans are being developed where schedule or technical risks remain. The collaboration will continue to close the remaining open items in preparation for the June 2026 ERR and subsequent installation, commissioning, and running.

1 Equipment Status and Commissioning

1.1 Comments

- The basic beamline layout is not finalized. There are concerns about shared vacuum among multiple instruments. The scattering chamber remains in the conceptual phase. The collaboration should consider a design allowing the target ladder to be isolated from the rest of the system. This would facilitate insertion, removal, and protection of reactive samples (e.g., lithium, calcium) and the alpha calibration source.
→ **Response:** This concern is addressed by the target-system design described in the response to the later comment on scattering-chamber access and shared vacuum in this section.
- The beamline vacuum is currently one system. To meet the 10^{-6} accelerator vacuum requirement, additional ion pumps may be required.
→ **Response:** An ion pump will need to be added to the girder prior to target.

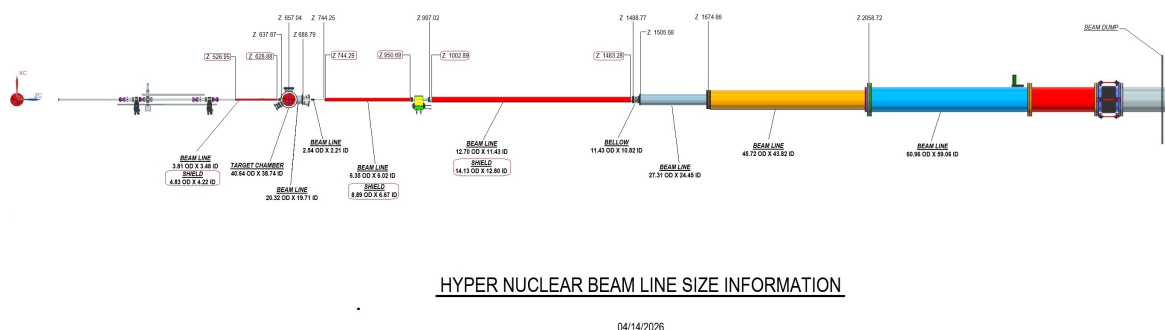


Figure 1: Beamline geometry for the HKS experiment at Hall C.

- Insufficient detail was provided on the completion/commissioning schedule for the beamline and scattering chamber. A detailed, resource-loaded (cost and manpower) schedule for design, installation, and commissioning is required.
→ **Response:** See Fig. 1 for reference. The project schedule has been completed and will be presented to the panel at ERR.
- Stray fields were estimated using TOSCA simulations. A full tracking simulation of the main electron beam through the experimental setup—including detector effects—in the presence of stray fields would significantly improve confidence in the setup.
→ **Response:** Refer to Sec. 2.1.
- Four new magnet power supplies are required. PRs (and presumably SOWs) for two were submitted, but none are on order. Specifications must be verified for required overhead. PRs should be issued promptly due to potential 1–2 year lead times.
→ **Response:** Three power supplies are at RFQ stage and will be placed on purchase order

within the next month, one power supply still requires budget office signature. This will be released as soon as that is signed. Engineering is working diligently with purchasing to maintain the priority for this to be completed on time.

- HES and HKS support structures are being reused. The PCS magnet support stand is under design and analysis and appears reasonable but is not finalized.
→ **Response:** The PCS Magnet support stand has been designed and analyzed with detailed drawings to be completed within the next month.
- The flux return path (return yoke) design presented corresponds to an older HKS/HES configuration and is being revisited. The updated magnet/yoke design documentation for the present configuration was not presented.
→ **Response:** The collaboration appreciates the comment regarding the flux return path (return yoke) design. We would like to clarify that, in the current HKS/HES configuration, there is no dedicated flux return yoke structure as part of the system. The magnet configuration remains unchanged from that used in previous experiments, and the present setup corresponds to a relocation of the existing system without modifications to the magnet structure or field configuration. For this reason, no updated return yoke design documentation was presented. If additional clarification is helpful, the collaboration would be happy to provide further details on the magnet configuration.
- Old magnet power supplies require evaluation and re-commissioning. Due to age-related risks (electronics and firmware availability), proceeding without upfront testing and mitigation planning poses significant risk.
→ **Response:** The collaboration recognizes the importance of evaluating and re-commissioning the existing magnet power supplies in order to mitigate potential risks associated with aging components. The experiment requires power supplies for both the HKS and HES dipole magnets. The HKS dipole magnet power supply has already been transferred from ESB to the Jefferson Lab test facility in April, and preparations for testing are currently underway based on a detailed test plan. For the HES dipole magnet power supply, a dedicated test and evaluation plan will be developed as the next step. These efforts are intended to ensure reliable operation and to identify and address any potential issues prior to experimental running.
- Magnet–magnet interactions—including mechanical forces, magnetic field interference, fringe fields, stability, and variability—must be documented.
→ **Response:** Magnet–magnet interactions for the PCS dipole magnets have been evaluated quantitatively using TOSCA calculations. The calculated magnetic forces at full field were studied for configurations with and without the Fe beam-line shield. The results indicate that the magnetic forces between the PCS dipole magnets are at the level of several kN ([PDF](#)). These forces have been considered in the mechanical design of the PCS magnet support structure. To mitigate possible magnet motion induced by these magnetic forces, the two PCS dipole magnets will be mechanically connected by a bridging support frame.
- ENGE calibration procedure must be written. The effect of PCS stray fields on ENGE optics must be studied. Alpha-source calibration with PCS magnets ON and OFF should be evaluated. Polarity reversal and potential nonlinear calibration effects must be assessed. An NMR probe should be installed to track magnetic field stability.
→ **Response:** The calibration procedure document is posted in the HKS wiki ([PDF](#)). The calibration will be done with all the magnetic elements fully powered. Thus, the PCS stray field effect will be included. Since the calibration is done before beam time and the PCS field

may be tuned in order to deliver the beam to the dump, the source calibration also includes a PCS field scan to obtain the momentum correction as a function of the PCS field. The ENGE field will be measured by an NMR probe and the measurement is included in the data stream, and correction can be made when it is necessary.

- The scattering chamber design does not appear to provide access for last-minute sample installation (e.g., Ca-40, Ca-48, Li-6, alpha source) / Shared vacuum among instruments presents risks. The collaboration should pursue a target design that isolates the target ladder and allows access to components.

→ **Response:** The spectrometers, beamline, and the vacuum scattering chamber containing the target system are operated as a connected vacuum system. The collaboration recognizes the potential risks associated with a shared vacuum configuration. To mitigate these risks, the target system is designed such that the target ladder can be retracted into a dedicated storage volume connected to the scattering chamber. In this configuration, the target ladder remains under vacuum and is isolated from exposure to air during maintenance activities, even when other parts of the system are vented. This approach ensures that sensitive targets, such as Ca and Li, are protected from air exposure while allowing necessary maintenance work to proceed on other components of the system.

- Detector commissioning plans are in development. While HES and HKS arms have prior operational history, ENGE detectors are new and require new calibration procedures. Detailed ENGE calibration steps were not fully presented.

→ **Response:** The ENGE calibration procedures are developed and documented and posted in HKS wiki ([ENGE calibration procedure](#)). The wire chamber is fully commissioned and is ready. The TOF counters were assembled and fully tested. However, the front layer of TOF will be replaced by the existing counters with thinner thickness based on the simulation result. One additional long counter in Y-direction will be added to minimize background trigger rate. These modifications will be completed and tested in summer 2026. The ENGE drift chamber has already been tested using cosmic rays. The Fiber Detector consists of cylindrical type scintillating fibers coupled to multi-anode PMTs. A prototype detector assembled with several fibers has been tested using beta and alpha sources, and its basic performance has been evaluated. A study using a 64-fiber configuration is currently in progress. The final design of the vacuum port for mounting the fibers is also underway. The vacuum port is scheduled to be delivered to the University of Tokyo in July, and the subsequent fiber assembly is expected to be completed in September. A subset of the multi-anode PMTs has already been delivered, and delivery of the full set is expected in November. These components will then be shipped from Japan to Jefferson Lab.

1.2 Recommendations

- Beamline magnetic shielding, shield locations, and corrector locations must be defined and reviewed prior to ERR approval.

→ **Response:** Their designs are fixed.

- PCS magnets have been built. Testing documentation and specifications must be presented and approved. Additional JLab acceptance tests are required.

→ **Response:** Documents summarizing the visual inspection, insulation test, excitation test, B-I curve, and related checks of the PCS magnet are uploaded on the Wiki. Since the

documents are written in Japanese, we prepared a translated version. PCS magnet tests are planned to take place in the Test Lab

- HKS collaboration, Hall C management, and the Target Group should agree on target configurations and schedules for the entire HKS program.

→ **Response:** The HKS collaboration has prepared an updated target configuration and usage plan, summarized in Table 1. This table reflects the current baseline target list, including the beam current, raster condition, target tilt, and the effective thickness along the beam axis. The target usage schedule depends on the detailed running sequence of the HKS program. In the present plan, physics targets will be used for production running, while calibration targets such as ^{12}C and ^6LiH will be used as needed for energy calibration. The carbon-hole target will be used to verify and ensure the beam position. A water target is included as a backup for the ^6LiH energy-calibration target. The water target will be operated at room temperature, unlike the cryogenic targets. A basic procedure for safely switching to and operating the water target has been developed. The most thermally challenging target is expected to be ^{208}Pb ; ANSYS simulations indicate that melting due to beam heating will not occur under the planned operating conditions.

Table 1: List of HKS targets.

ID	Target	Thickness (mg/cm ²)	30 deg tilt	Along beam (mg/cm ²)	Raster 2×2 mm ²	Beam (μA)	Remarks
#1	^6LiH	86.6	✓	100.0	✓	50	Proton target used for energy calibration
#2	^6LiH	86.6	✓	100.0	✓	50	z position is displaced by 1 mm
#3	^6Li	86.6	✓	100.0	✓	50	
#4	^9Be	86.6	✓	100.0		50	
#5	^{11}B	110.2	✓	127.3		50	In a form of $^{11}\text{B}_4\text{C}$
#6	nat.C	86.6	✓	100.0		50	
#7	nat.C	65.0	✓	75.0		50	
#8	nat.C	86.6		86.6		50	
#9	^{27}Al	129.9	✓	150.0		50	
#10	^{40}Ca	150.0		150.0		50	
#11	^{48}Ca	150.0		150.0		50	
#12	^{208}Pb	150.0		150.0	✓	25	
#13	^{208}Pb	150.0		150.0	✓	25	Spare
#14	Carbon hole	100.0		100.0	✓	10	φ 1 mm
#15	α source	–		–	–	–	ENGE calibration
#16	CH_2	450.0		450.0	✓	2	5-cm long
#17	Water (H_2O)	500.0		500.0	✓	10–20	Backup for ^6LiH
#18	Spare	–		–	–	–	
#19	Spare	–	✓	–	–	–	
#20	Spare	–	✓	–	–	–	

- Given concerns about acquiring another ^{48}Ca sample, pricing and delivery estimates from DOE should be obtained.

→ **Response:** A request for pricing and delivery estimates for the required ^{48}Ca sample has been submitted, and we are currently awaiting a response. Procurement planning is underway to secure the sample, with the goal of having it available in the first half of FY2027 (October 2026-).

- All magnet, detector, and target stands must incorporate access platforms with railings.

→ **Response:** The railings are incorporated in the design.

- A minimum number of spare detector components must be guaranteed. A mitigation plan is

required given the duration of the data taking.

→ **Response:** Spare components for each detector are summarized in a spreadsheet, and the mitigation plan for wire-chamber failures is documented in a PDF file posted on the HKS wiki.

Wire chambers; if a serious failure occurs and on-site repair in the installed position is judged to be difficult, the chamber will be uninstalled and repaired in the work area in the experimental hall. Based on repair experience at ESB, the required time is estimated to be three shifts, corresponding to approximately one day. A sufficient number of spare ASD cards, more than 25 boards, is available.

Scintillation detectors; several spare counters for HES and HKS will be prepared. The expected lead time is approximately one month for scintillators and approximately six months for PMTs, and the spare components are expected to be ready within this calendar year. For the ENGE TOF detector, more than ten spare counters are already available.

Water Cherenkov detectors; more than 20 spare PMTs and approximately six spare detector boxes are available.

Aerogel Cherenkov detectors; four spare PMTs and replacement aerogel tiles are available.

ENGE fiber detector; we plan to secure four spare multi-anode PMTs and one spare vacuum flange on which the fibers are mounted.

- LCW (cooling power, including concurrent Moller operation) and electrical power requirements must be clearly defined and documented, including mitigation strategies.
→ **Response:** LCW cooling has been discussed and reviewed with facilities. The currently planned Hall C flow allotment will satisfy the cooling requirements of the magnets and power supplies for the hypernuclear experiment.

2 Electron Beam Requirements

2.1 Comments

- Stray fields were estimated via TOSCA simulations. A full tracking simulation of the main electron beam through the experimental setup in the presence of stray fields is recommended.
→ **Response:** The magnetic stray field along the beamline, in particular the vertical field component (B_y), has been evaluated using TOSCA calculation. Based on the integral BdL from these studies, it has been confirmed that the electron beam can be successfully transported to the beam dump by appropriately tuning the corrector magnet. The present studies were performed using the beamline and iron shielding configuration from the previous design iteration. Subsequently, the beam pipe and iron shielding geometry were slightly modified in order to secure sufficient space for installation of the sieve slit on the PCS magnet.

An updated TOSCA model incorporating these design changes is currently under preparation. Once this updated model becomes available, a full tracking simulation, including the refined stray field configuration, will be carried out as recommended by the review committee. The collaboration expects that the updated TOSCA model, magnetic field map generation, and full tracking simulations will be completed within the next two months.

- Interaction between the Hall A beam at Pass 5 (40 μ A) and the Hall C beam at Pass 1 must be evaluated. If Hall A terminates their beam while Hall C is running, beam loading effects

in the SRF cavities may affect the centroid energy beyond $\Delta p/p = 3 \times 10^{-5}$ in σ .
→ **Response:** See details at the end of the Section 2.

- Using an NMR probe on the 9th dipole to monitor stability is beneficial; however:
 1. When Hall A runs in FFB energy mode, the BSY1C dipole string determines the energy.
 2. It may not be balanced with the BSY3C dipole string.
 3. When Hall C runs alone, the centroid may shift.
 4. Procedures must be written in collaboration with the accelerator division.
 5. Testing should verify NMR lock consistency.

→ **Response:** See details at the end of the Section 2.

- Careful target alignment on the Hall C beamline is critical. The ability to adjust the target ladder after attaching the scattering chamber to the spectrometers is important. Offsets greater than a few millimeters may be difficult to compensate.
→ **Response:** The standard target ladders in Hall C are typically installed and aligned with a precision of better than a couple mm, and this should be achievable with the simpler HKS ladder. In addition, knowledge of the target position is more critical than absolute alignment, and that will be achieved with high precision via survey.
- Failure modes and associated risks have not been fully identified. A documented risk and mitigation analysis is required.
→ **Response:** The collaboration and hall staff have been working to identify and mitigate risks and failure modes. While a single document has not been drafted summarizing these efforts, the collaboration is making progress in this area.

2.2 Recommendations

- Beam energy stability and spread requirements (3×10^{-5}) approach accelerator limits. Beam tests should evaluate feasibility, especially considering C75 and C100 SRF upgrades.
→ **Response:** A dedicated beam test at 2.23 GeV was performed at the end of the FY25 run period. The intrinsic energy spread of the beam was found to be $\delta E/E \sim 3.2 \times 10^{-5}$, determined using the horizontal beam size measured using the harp at 3C12 and the measured emittance. The Synchrotron Light Interferometer (SLI) was also used during this test to monitor the beam size non-invasively over the span of about 1 shift. The interference pattern observed in the SLI was not as expected - tests are continuing during the FY26 run period. A presentation summarizing the SLI tests can be found here:
<https://hallcweb.jlab.org/doc-private/ShowDocument?docid=1318>
- The proposal to use two additional BPMs to meet beam position and stability requirements must be supported by a design document.
→ **Response:** With the existing Hall C BPMs closest to the standard pivot/target, a precision of 0.65 mm on the beam position at the HKS target can be achieved (assuming $\sigma_{\text{BPM}} = 0.1$ mm). Adding two more BPMs closer to the HKS target (at 3.9 and 2.2 meters) improves the precision to 0.11 mm.
The collaboration has performed GEANT4 simulations which indicate a required beam position accuracy that suits for both the HES-HKS and decay pion experiments is: $|x| \leq 0.25$ mm and $|y| \leq 2.0$ mm. A note summarizing this has been posted here:
[BPM Requirements by Simulation 202605](#)

→ **Response:** Summary of beam requirements and limits, and procedures and methods to ensure the beam energy precision.

- The upper limit of both the beam energy spread and stability is $\sigma_E/E = 5 \times 10^{-5}$.
- The SLI on the Hall C line is currently under testing. With an alarm for exceeding the limit, it will be used to monitor the beam energy spread. Beam tune will be required when the energy spread becomes a problem.
- The beam energy reported by the machine via Epics (measured using Arcs and Injector) with a frequency of 1 Hz will be included in the data stream and used in the missing mass reconstruction.
- To achieve the required beam energy stability, the Fast Feedback energy lock is required to be ON for all the data taking. During the experiments, the FFB energy lock is primarily made by Hall A. In case of a planned down of Hall A exceeding an hour while Hall C is running, the FFB energy lock should be transferred to Hall C. The energy FFB has recently been recommissioned in Hall C and has been used during the FY26 run.
- The BPM signal from 3C12 (at the location with maximized momentum dispersion) will be fed into the FADC and thus included in the data stream allowing determination of the position at 3C12 on an event-by-event basis. Energy shift reported by the machine due to FFB change between Hall A and C can be used to calibrate the 3C12 (energy change as a function of position change). With FFB energy lock ON, regardless of whether it is provided by Hall A or C, the energy shift will not affect the experiments since the recorded energy defined by the machine will be used in the missing mass reconstruction.
- There will be two cases in which the FFB energy lock will be OFF. First of all, MOLLER requires dithering the beam energy with a frequency of 15 Hz and eight times per hour. The FFB energy lock will be OFF 2 minutes per hour ($\sim 3.3\%$ of one hour data taking). The second case is a short down time ($<$ an hour) of Hall A while Hall C is still running. In such cases, the machine-defined energy at low frequency will not be correct due to the noise at high frequency. Then the measured 3C12 position recorded in the data will be the backup correction to the machine reported beam energy. To make this possible, a FFB lock ON or OFF flag signal will be included in the data stream.
- Since the target point is moved about seven meters further downstream from the Hall C pivot, an additional beam girder equipped with harps and BPMs will be installed in front of and close to the target chamber. Fast Feedback position lock will be ON all the time to ensure the average beam position on the target is at the same point throughout the experiments. In addition, the measured beam positions before the target will be fed into the data stream so that corrections can be made as needed.

3 Beam Commissioning and Machine Requirements

3.1 Comments

- FSD thresholds and locations must be identified and defined before run start. Risks associated with dropping magnet current to 0 A (with inductance dominated by iron) must be assessed.
→ **Response:** See the reply to the recommendation below. If a magnet power supply trips,

once the output current is outside the allowed window in the ADC used in the FSD system, beam to the hall will be terminated.

- EES and MPS plans were not presented.
→ **Response:** See the reply to the recommendation below.
- A configuration change of this magnitude requires a new ERG and safety walkthrough.
→ **Response:** Agreed. A new ERG will be created and a new safety walkthrough will be provided to collaborators and staff near the end of the hypernuclear installation, before the run starts.

3.2 Recommendations

- Create a detailed procedure addressing machine protection systems and beamline commissioning.
→ **Response:** With the assistance of the Operations Department and Safety Systems Group, we have drafted a detailed beam setup procedure, and a document describing the FSD configuration modifications for the hypernuclear experiments.
Beam tuneup procedure: [HKS-beamline-tuneup.pdf](#)
MPS configuration: [MPS Configuration](#)

4 Manpower and Resources

4.1 Comments

- The Target Group does not believe they can meet the schedule with existing Engineering/Design staff given current workload.
→ **Response:** Updates to the long-term beam schedule and the addition of a new staff scientist to the group have improved the situation with respect to the schedule. The target group should be able to design and fabricate the targets needed for the hypernuclear experiments. However, this relies on no unexpected changes to the long-term schedule (for example, delays in the MOLLER target installation). Also, additional design support would be helpful to meet the program requirements.
- Hall C Engineering is short one engineer, and a senior designer will leave next year. This may jeopardize the schedule.
→ **Response:** Workforce challenges continue to be of some concern. However, as the work required for the MOLLER installation in Hall A winds down, design and engineering assistance from the Hall A Engineering and Design group can be allocated to hypernuclear activities. Hall A designers have already contributed to some of the hypernuclear drawings, and those contributions are expected to increase.
- The installation schedule presented appears optimistic and lacks contingency.
→ **Response:** The originally presented installation schedule was based on a completion in eight months, including two weeks for Enge alpha source calibration at the end. Now the currently planned hall installation time is 16 months, a factor of two of what the collaboration requested. This gives a significant amount of contingency, allowing a substantial amount of time to carefully check out all equipment, calibration of detectors and spectrometers, and analysis software preparation by taking and analyzing the calibration data.

- The collaboration must ensure sufficient personnel to cover shifts.

→ **Response:** The approved HKS hypernuclear program currently consists of E12-24-004, E12-24-011, E12-24-013, E12-24-003, and E12-20-013A / E12-15-008A, corresponding to a total of 149 PAC days. This corresponds to approximately 894 shifts, assuming six shifts per PAC day. With two shift takers required per shift, the total shift-person requirement is approximately 1,800 shift-persons. The collaboration considers this requirement to be realistic. More than 40 collaborators have already expressed interest in participating in the present program, and the actual shift-taking pool is expected to grow as the beam-time period approaches. Many participating PIs have also indicated strong interest in involving graduate students and young researchers in the experiment. In addition, a new Japanese KAKENHI grant, International Leading Research program, “Origins of Matter Explored through Femtoscale Quantum Many-Body Systems — Nurturing Talent in the Quantum Era,” led by S. N. Nakamura, started in 2025 for 7 years. This program is designed to promote international research experience and cross-disciplinary training of young researchers in hypernuclear physics, high-energy QCD, including activities at JLab, CERN ALICE, and the EIC. Participation in the JLab hypernuclear program is one of the central opportunities for students and young researchers to gain hands-on experience in an international experimental environment. Based on the experience of previous HKS experiments before 2009, in which more than 100 shift takers participated, it is realistic to expect a shift-taking pool of similar scale for the present program. If approximately 100 shift takers participate, the required load corresponds to about 18 shifts per person, or roughly 20 shifts per person including contingency. This is considered a feasible level of commitment for a long-duration experimental program, especially with the expected participation of graduate students, postdoctoral researchers, and young researchers supported by the broader international training framework. The detailed requirements for authorship on publications from the present program will be discussed and finalized by the Collaboration at a later stage. These requirements may include shift contributions, service work, analysis contributions, and other institutional responsibilities. The shift-manpower estimate given here is therefore intended only to assess the feasibility of experimental operation, and should not be regarded as defining the final authorship policy.
- Individuals and institutions should be assigned concrete tasks to distribute workload evenly.

→ **Response:** The collaboration has assigned coordinators and core members for the major subsystems and tasks, as summarized in Table 2. The coordinators are responsible for organizing the work within each area, tracking progress, and coordinating communication with the relevant subsystem groups. The listed core members are the primary contributors for each task. At the same time, the collaboration expects broader participation beyond the listed core members. Additional collaborators will contribute to multiple areas as needed, particularly during installation, commissioning, shift operation, calibration, and data analysis. The collaboration will also continue to expand participation and recruit additional members to strengthen coverage of the HKS program.
- The Hypernuclear Collaboration should formalize governance by defining rights and responsibilities of members through a governance document.

→ **Response:** The collaboration recognizes the importance of formalizing its governance structure and clearly defining the rights and responsibilities of its members. A draft governance document has been largely completed. The spokespersons will review and finalize the contents over approximately the next month, after which the document will be made available

to the collaboration.

Table 2: Task assignments and core manpower for the HKS program.

WG	WG Name	Coordinator	Core Workers
WG1	HKS	M. Ichikawa (RIKEN) S. Nagao (U. Tokyo) [†]	Members from WG4, 5, 6, 11 contribute to this WG.
WG2	HES	T. Gogami (Shiga U.) M. Ichikawa [†] (RIKEN)	Members from WG4, 5, 6, 11 contribute to this WG.
WG3	ENGE	S. Nagao (U. Tokyo) W. Henry (JLab) [†]	K. Higashimoto (U. Tokyo), K. Okabayashi (U. Tokyo), J. Takahashi (U. Tokyo), R. Yamakawa (U. Tokyo), and Members from WG4, 5, 6, 11 contribute to this WG
WG4	Tracking	L. Tang (Hampton U.) B. Pandey (VNI) [†]	K. Nishida (U. Tokyo)**, R. Kumaragamage (Hampton U.), Y. Ma (Hampton U.), J. Takahashi
WG5	Timing / PID	J. Reinhold (FIU) R. Marinaro (CNU) [†]	K. Higashimoto**, K. Ishido (Kyoto U.), K. Mccusker (Summer Student), K. Nishi (U. Tokyo), K. Okabayashi
WG6	Trigger DAQ	A. Camsonne (JLab) T. Gogami [†] (Shiga U.)	K. Higashimoto, K. Nishida
WG7	Target	D. Meekins (JLab) T. Gogami [†] (Shiga U.)	H. Lu (JLab)**, K. Ishido
WG8	Beamline	D. Gaskell (JLab) B. Freeman (JLab) [†]	K. Nishi**
WG9	Simulation	S. Nagao (U. Tokyo) M. Ichikawa [†] (RIKEN)	J. Takahashi**, K. Higashimoto, K. Ishido, T. Ishige (Tohoku U.), T. Gogami
WG10	Run Shift	TBD	
WG11	Analysis	S. Park (JLab)	K. Higashimoto, R. Kumaragamage, Y. Ma, K. Nishi, K. Nishida, J. Takahashi, M. Ichikawa, R. Marinaro
WG12	Safety	W. Henry (JLab)	
WG13	Publication	S.N. Nakamura (U. Tokyo) P. Markowitz (FIU)	

[†] Deputy Coordinator.

** Team Leader.

4.2 Recommendations

- Provide a realistic estimate of required FTEs, identified manpower (with names if possible), and a timeline with milestones for preparation, installation, and execution.

→ **Response:** An overall installation schedule and manpower estimate will be presented in the ERR package. See [Manpower.pdf](#).

5 Simulation and Data Analysis Software

5.1 Comments

- The reconstruction and analysis software used by the collaboration for the past experiments will have to be ported to the software framework used currently by Hall C. The work has just started. While contributors to this task are listed, it is unclear how much work will be involved in FTEs and whether this would be compatible with the other commitments these contributors may have.

→ **Response:** The analysis software has been developed based on the Hall C framework. Data decoding and reconstruction are functional and being tested using the cosmic-ray data. Further development is underway, but the major work has been largely completed. The remaining work will need approximately 0.5 FTEs for 6 months which is at the level of current commitment of the main contributors on this task. The online monitoring tool, Panguin has

been fully tested and is operational.

- No estimate of the computing resources (storage and CPU) required for offline simulations, reconstruction and analysis. Traditionally, Hall C experiments are the smallest consumers at JLab but, since the experiment involves new detector packages and requires high precision, it would be advisable to provide an estimate to ensure this is compatible with the available resources.

→ **Response:** With the expected data rate of 260 MB/s, the total data volume is estimated around 3.5 PB. The current capacity of the Hall C file server for raw data is around 30 TB with data transfer speed up to 40 Gbps which would need an additional file server. The online analysis will use the counting house computing resource (three local machines, each with 20 cores, 64 GB memory and 20 – 30 TB disk space, are dedicated to online analysis), and the offline production will use the JLab batch farm. The current Hall C fairshare allocation is 8%, and the Hall C usage is at the level of 5% on average.

The offline simulation is based on a physics Monte Carlo code using Geant4.11. At the current stage, the simulation does not require large-scale computing resources. All simulation studies performed so far have been carried out on a consumer-grade desktop machine with 16 CPUs, 32 threads, and 128 GB of memory. The total data volume produced and used for the present studies is approximately 1 TB only.

5.2 Recommendations

Provide a realistic estimate of the required FTEs and the identified manpower as well as the corresponding timeline with milestones for preparing, installing and conducting the experiment.

→ **Response:** The main workforce for the data analysis software consists of the Hall C staff (0.4 FTE) and a Ph.D. student (0.2 FTE). Detector calibrations will be carried out by groups of graduate students with and JLab staff. While additional person-power is anticipated, with the currently assumed level of workforce the milestone for getting the fully developed software is expected to be reached by the end of 2026.

The simulation development is led by one staff member with three graduate students. This level of manpower is considered sufficient for the offline simulation tasks. In previous Hall C hypernuclear experiments, similar simulation work was successfully carried out mainly by two Ph.D. students, and the present collaboration has comparable or stronger manpower available for this task. Therefore, we do not anticipate offline simulation to be a limiting factor in terms of either computing resources or manpower.

6 Radiation and Shielding

6.1 Comments

- Radiation budget was evaluated without including the full experimental package. Stray magnetic fields may scatter electrons along the beamline and increase radiation levels. Overall radiation is expected to remain acceptable.
- The new ENGE detector package includes SiPM sensors, which are susceptible to neutron damage. Neutron flux at sensor locations should be estimated and a mitigation plan devel-

oped. Having spares may not be sufficient if flux significantly shortens detector lifetime.

→ **Response:** A radiation-damage test of SiPM sensors was performed in Hall A during the 2025 physics run. The test showed that the single-photon peak resolution in the ADC spectra started to degrade at an accumulated dose of approximately 2 rem. At 200 rem, the SiPMs were still operational; however, the leakage current increased from about 10 μA to 200 μA , and the single-photon peaks were completely smeared out. The accumulated dose corresponds to approximately two days of the expected radiation level at the ENGE detector location.

This result demonstrated that the use of SiPMs for the new ENGE detector package would be difficult for the present experiment. Therefore, we decided not to use SiPMs and instead adopted a conventional 64-channel multi-anode PMT, Hamamatsu H7546. A test-bench study was performed using the H7546 coupled to scintillating fibers. The response was evaluated with ^{90}Sr beta rays and ^{241}Am alpha sources. We confirmed that the H7546-based detector provides sufficient response for the intended ENGE detector application.

Consequently, radiation damage to SiPMs is no longer a critical issue for the ENGE detector package, because SiPMs have been removed from the baseline design.

6.2 Recommendations

- Develop a realistic plan for shielding SiPMs from radiation damage.
→ **Response:** Since SiPMs are no longer used in the baseline ENGE detector design, radiation damage to SiPMs is no longer a concern.
For the updated plan of the ENGE fiber detector, including the replacement of the original SiPM-based design with multi-anode PMT readout, see Section 1.1.
- Finalize electronics location and shielding configuration in the hall.
→ **Response:** The locations of the electronics and the overall shielding configuration in the hall have been defined at the conceptual level, and their suitability has been evaluated with respect to the expected radiation environment. The VXS-based readout systems, including FADC, VETROC, and TDC modules, will be installed in the electronics racks located on the SHMS hut, where operation of such electronics in a comparable radiation environment has already been demonstrated. Additional electronics will be installed beneath the detector platforms, including signal splitters and discriminators for transmitting timing signals to high-resolution TDCs used for time-of-flight measurements. Based on the estimated radiation levels in this region, these components are expected to operate reliably. A baseline configuration of shielding blocks has been established. Any remaining gaps identified in the layout will be filled with appropriate shielding materials, such as lead blocks, to further reduce radiation-induced backgrounds in the detectors. Overall, simulations of the radiation environment and prior operational experience indicate that both the electronics and detector systems can be operated under acceptable conditions.

7 Documentation and Procedures

7.1 Comments

- What is the status of the specific documentation and procedures (COO, ESAD, RSAD, ERG, OSPs, operation manuals, etc.) to run the experiments?

7.2 Recommendations

- A draft of each of these documents needs to be developed.
 - **Response:**
 - COO: Ready for collaboration to review. Need to decide if there are any “Special Procedures” to include.
 - RSAD: Need to finalize Tosca map and then provide targets, current, and beam times to Pavel
 - Operation Manual/ESAD: Outline is complete based on the Hall C standard equipment manual. Hazards analysis and EPASes are completed for operation of drift chambers, hodoscopes, and Cherenkovs in ESB. Flammable gas system will be the same as the existing SHMS/HMS drift chambers. High Voltage operation also the same. Magnet procedures and hazards can be cloned from SBS/BigBite and NPS corrector magnets, will also use HKS power supply test in Test Lab documentation as a starting point.
 - ERG: Walk through training still needs to be developed but minimal changes to existing document will be needed. Had discussions with SSG regarding new run safe boxes.
 - All documents as well as the previous hypernuclear COO and ESAD are available on the [wiki](#)