MOLLER ERR JLab July 28-31, August 1 - 2025

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S1 – 30-Sept-2025 - Answered

Provide the schedule for the upstream spectrometer and how any further delay will affect the overall installation and commissioning. Who is responsible for the US enclosure design and fabrication? What are responsibilities of MIT and JLab? How the lessons learned from the DS enclosure are incorporated in this design?

Mike Dion/Klaus Dehmelt

See spreadsheet in MOLLER docDB1475(v1 or later) for US schedule activities. The P6 schedule has logic links from Spectrometer to Assembly. Any further delays will be realized in P6 and mitigation will be developed as needed.

JLab, Bartoszek Engineering, and MIT have worked together to finalize the US Enclosure design. MIT developed the original design. Bartoszek Engineering modified the design based on conversations with JLab engineering. Some of these changes (including increases to plate thicknesses and bolt sizes) were based on lessons learned from the DS Enclosure testing. The US Enclosure has not been awarded so fabrication has not begun. JLab Engineering is responsible for analyses and calculations to conform with JLab Pressure Systems guidance. The US Enclosure has "passed" these tests and requirements, and the team is proceeding with fabrication drawings.

The current scope of MIT's contract is in the SOW in MOLLER docDB1475(v1 or later).

JLab is responsible for fabrication and assembly of all components of the US Spectrometer. JLab has also completed some of the design and engineering for ancillary components; including the electrical busbars, and P&ID for Collimator and Coil cooling.

Some plate components of the US Enclosure were oversized based on FEA results. In addition, more bolt holes and larger bolts were used for the mating surface of the Top Hat to the Baseplate. The largest lesson learned was not fixing bolted joints and using a conservative coefficient of friction between mating surfaces to model worst case scenarios. The US Enclosure has passed all JLab Pressure Systems Analyses needed.

S2 – 31-Aug-2025 - Answered

Develop and present the risk mitigation plan for any further delay in DS enclosure delivery.

Klaus Dehmelt:

Any further delay of the DS enclosure will delay the mounting of TM1, TM2, TM3 and TM4 onto the enclosure baseplate, and final delivery to the hall which is currently scheduled for June 2026.

Mitigation Plan

There is potential to utilize overtime for the engineering and technician teams within the Test Lab to accelerate the assembly of TM1 to TM4 on the enclosure baseplate, as well as the consolidation and re-sequencing of some assembly activities.
The current project plan has a duration of 60 days, i.e. 3 months (from 11-Jun-2026 to 08-Sep-2026) to assemble the DS torus in the hall.
MOLLER project management will plan to utilize overtime during the assembly phase in the hall to reduce the assembly time duration.

S3 – 31-Oct-2025 - Answered

The consequences and decisions after one magnet is turned off, should be evaluated before making the decision of switching off all other power supplies and switching off the beam. The analysis should be done and presented in the form of a technical note to the management.

Krishna Kumar

The spectrometer subcoil assemblies take the scattered flux that exit the defining apertures of collimator-2 and direct it to the detector assemblies. The resulting flux distributions span the entire radial region from 60 cm to 1.1 m, 28 meters downstream of the target. Within these distributions, “hot spots” are generated which focus quite a large flux of charge particles into regions that are no more than 10 cm^2 in area.

The most intense of these are 7 regions, uniformly spread apart in the azimuth, which hit “Ring-2” quartz tiles that sit approximately 70 cm from the radial axis.

Were one of these hot spots be directed into material in the surrounding apparatus and fully absorbed, it would result in over 10 W of power deposited. The biggest concern when one subcoil assembly is no longer energized when the beam is on and the hydrogen target is in position is that these hot spots might be directed on to surrounding beam pipes and shielding material. Even without this, there is a danger that the hotspots move to neighboring tiles that have been tuned to accept far less scattered flux, which would result in saturating the output of these detectors and potential damage to the readout electronics.

For these two primary reasons i.e. potential damage to equipment and to the readout chain, we recommend that the beam shutoff be triggered as soon as any subcoil power supplies is turned off (for example from a trip) or the operating current goes outside of the 10 sigma envelope from the operating setting; where sigma is defined as the typical RMS from slow drifts.

Once the beam is shut off, we don't see any issue with continuing to keep the other 4 subcoil assemblies energized. We therefore recommend that the interlocks of all 5 subcoild power supply chains be independent of each other.

S4 – 31-Oct-2025 and ERR3(Aug 2026) – Initial response complete

Finalize the preventive and scheduled maintenance required for all the subsystems including all LOTO procedures. By the end of October 2025, start making a list of required preventive and scheduled maintenance and complete/Finalize before ERR3 (August 2026).

Probir Ghoshal

The list of preventive and scheduled maintenance can be found on MOLLER docDB1475(v2 or higher).

S5 – ERR3(Aug 2026)

Consider procuring and installing a 2nd chiller in parallel with primary collimator chiller to facilitate the reduction in beam loss time and improve ALARA.

Mike Dion

S6 – 31-Aug-2025 - Answered

Finalize the field mapping plans in the test lab, make sure the testing TM4 at 1/3 of the operating current and only in the part of the length of the coil is acceptable by the physics.

Krishna Kumar

- Field mapping plans: Firm plans exist for TM1, 2 and 3. A plan has been conceptualized for TM0 and no technical problem is anticipated in its implementation. For TM4, the same hardware will be used as for TM1, 2 and 3, so a plan exists with the caveats addressed in the following bullets.
- From the physics point of view, testing TM4 at 1/3 operating current is acceptable for two reasons: the configuration is completely iron-free and the magnetic forces at full current are not the dominant forces on the coils.
- The current mapping plan will ensure that first 0.8 m and last 0.8 m of TM4 will be mapped similar to TM1 thru 3. This is acceptable except for one caveat, which is as follows: when TM1 thru 3 are measured, it will be determined whether the measured fringe fields are compatible with the survey results on magnet placement. Assuming this is the case, then the partial mapping of TM4 is acceptable since it is primarily a verification of the survey. If there are poorly understood discrepancies in the TM1 thru 3 mapping results, then the limited survey option for TM4 will have to be reassessed.

S7 – ERR3(Aug 2026)

Complete all the required documentations and procedures for testing, commissioning and operation.

Probir Ghoshal

O1 – ERR3(Aug 2026)

The degraded beam during a Moller polarization measurement has the potential to generate a halo in the apparatus downstream of it. We recommend that an evaluation of the various measuring configurations be carried out to assess whether the degraded beam can make it to the dump without deleterious effect on the MOLLER experiment or beamline apparatus.

Kent Paschke (work with Don Jones and Eric King)

O2 – 30-Sept-2025 - Answered

The design of the trigger scintillator system is not yet final. The baseline design with the embedded WLS fibers does not provide sufficient light output for a fast trigger scintillator with a well-defined rise time and pulse shape. The alternative designs mentioned (with faster WLS fibers or without the embedded fibers) should be pursued, prototyped, and tested by early fall to enable the design to be fixed and to allow procurements to begin.

Kent Paschke and TB group (work with David Armstrong)

An alternative design for the trigger scintillators, utilizing integrated light guides with dual PMT signal collection, has been prototyped and tested. This design produces sufficiently large and uniform signals. The design has been checked in a mock assembly and is being integrated into a full CAD model to check for mechanical interferences and incorporate cable management. Several options for improving the WLS fiber have been explored, but no updated prototype has yet been deployed for testing. Subject to the final integration into the tracking detector rotator mechanical design, the collaboration is expecting to employ the light-guide design matching the prototype. A Technical Board meeting to discuss this plan is scheduled for October.

Oct 2025 update:

The design of the light guide option has been adopted, reviewed by the Technical board, and finalized. Procurement has started.

O3 – 30-Sept-2025 - Answered

Assign a person who can dedicate a considerable fraction of their time over the next 18 months to coordinating a coherent design and implementation of controls for the components of the MOLLER experimental setup.

Kent Paschke:

Sanghwa Park and Jiwan Poudel have been assigned for this task for this task as Slow Control leads for the collaboration.

O4 – 30-Sept-2025 - Answered

The scope of the slow controls requirements needs to be clearly defined. The workforce and clear responsibilities also need to be defined.

Kent Paschke (work with Sanghwa Park and Jiwan Poudel)

The requirements for the various MOLLER systems are still being fleshed out, with decisions to be made by the slow control leads on the specific systems and implementations to be used. When that work is complete, specific tasks and responsibilities will be assigned within the collaboration.

- There is a semi-weekly meeting which coordinated online monitoring shift tools and slow controls.
- Detector HV/LV controls will use CS-Studio (Phoebus). Work is currently underway (by Jiwan Poudel) to implement the HV control for Moller GEM. This system is currently being used at the test lab. The Phoebus implementation will be extended to other systems. The next step will be testing for the MPOD LV controls shortly.

- Phoebus also provides framework for alarm handler. Jiwan is currently testing this capability. Following those tests, a decision will be taken whether to employ MOLLER-apparatus alarms in Phoebus or in the MEDM-based system currently in use.
- The Slow Control leads have polled SME from the various systems and produced a draft list of required controls. The current status of this list is posted on the MOLLER wiki, and this is updated as needed.
- The current to-do list from this working group
    - Implement low level GUI for LV modules
    - Implement HV controls using CAEN crate and HV cards to be used for MOLLER (working with spare create send from W&M).
    - Display (GUIs) for subsystem: Overview/main (Jiwan), Subsystem (Sanghwa will start with one subsystem and distribute tasks for others)
    - Survey on channel and detector maps, initial list of alarm list (experts input needed, we will prepare a basic format to get this information and send it out to people)

Oct 2025 update:

First tests for the detector HV/LV controls and an Alarm handler using CS-Studio (Phoebus) have been performed.

The Slow Control leads have polled SME from the various systems and produced a draft list of required controls. The status of this list is posted on the MOLLER wiki, and this is updated as needed.

O5 – 1-Apr-2026

The collaboration needs to develop and implement appropriate engineering and administrative controls for safe testing, installation, and operation of any detectors that might start moving while people are in the vicinity.

Robin Wines (work with Larry Bartoszek and Whit Seay)

O6 – regular updates starting Sept 2025 (last updated Oct 2025)

The Hall A beam chopper slit and laser attenuator system is not optimized for producing 150 pA. It is very likely that current leakage from the other lasers at the chopper or 5th pass extraction will cause a halo in the nAmp range. Furthermore, beam position stabilization is not possible without the use of a “witness beam,” which requires another hall to be running in the main machine. Qweak had such a witness beam to the BSY

dump, which has since been decommissioned. We recommend that the collaboration engage with accelerator operations to find a solution to this.

Kent Paschke, Caryn Palatchi, David Armstrong

Sept 2025 Answer:

The Counting Mode Analysis working group is reviewing calibration, alignment, optics and background studies to better define the requirements for maximum beam current and beam instrumentation of current and position. This work will complete in October, and will be followed in November by discussions with Accelerator Division to determine the optimal machine configuration.

Oct 2025 Answer:

The collaboration has defined parameters for low current running, including a lowest required current to be used during flux distribution measurements, the range of currents needed over the period of the calibration studies, and beam monitoring needs during this period. These needs have been discussed in a BTeam meeting. An updated list of all beam requirements will be presented for discussion with Physics division.

O7 – Dec 2025 / ERR3(Aug 2026) – Answered Dec 2025

The collaboration needs to do accounting of the required workforce for the installation, commissioning, several years of data taking, and analysis. This should include taking shifts (2-3 persons per shift), on-call experts, run coordinators, and DQM personnel.

Krishna Kumar, Mark Pitt – work with IB

During the assembly: For each subsystem (Main detector, GEM tracking detectors, trigger scintillators, shower max detectors, pion detectors, scanners and scattered beam monitors, slow controls, data acquisition, beamline monitoring, Compton polarimetry, Moller polarimetry, slow controls) the collaboration aims to have at least 2 people on site working to ensure each subsystem is configured according to the collaboration needs and to provide support to JLab SMEs. Additionally, the collaboration spokesperson, Krishna Kumar, will be on site to help coordinate the collaboration efforts throughout the calendar year 2026.

During the commissioning: Beyond the personnel described above the collaboration will provide additional experts to ensure that all subsystems are functioning and data from them is processed in timely.

During data taking: The collaboration expects that data taking shifts will be composed of 2 people (target operator and shift leader). The collaboration aims to provide approximately 80 shift taking personnel (to include grad students, post-doctoral researchers, and PIs) to ensure that all those shifts are covered, including the approximately 100 RC shifts required for the duration of the whole MOLLER data taking.

Moreover, the collaboration will provide on-call experts (available by phone 24/7) for all major subsystems (including injector and beamline, modulation and fast feedback, in addition to those listed above).
Lastly, to ensure high data quality, the collaboration will provide a Weekly Analysis Coordinator (WAC) that will oversee the processing of the data, produce diagnostic plots, and provide analysis reports within 24 to 48 hours from when the data was taken.
To coordinate the efforts of the different experts, the collaboration Scientific Coordinator – Kent Paschke – has secured teaching release for the entire of calendar year 2027, and expects to me on site for most of that time. This will be followed by other senior personnel for the remainder of the data taking years.

O8 – ERR3(Aug 2026)

Submit a detailed commissioning plan for each detector system to achieve the required performance targets, including the polarimetry and the list of the necessary software and control tools. Present what challenges are anticipated, and how they will be addressed during the commissioning phase.
The presented run plan (Run I, Run II, and Run III) does not account for scheduling challenges, and includes significant inefficiencies of beam running after Run I. The run plan for full running must be presented and discussed with the physics division scheduling committee to ensure optimum beam operations.

Krishna Kumar, Ciprian Gal, Kent Paschke

O9 – regular updates (last updated Dec 2025)

Provide updates on the progress of development and commissioning of the monitoring software according to the presented milestones and timeline.

Kent Paschke (work with Ole Hansen)

Sept 2025 Answer:

A semi-weekly meeting focused on shift tools for online monitoring and slow controls has been started. This supplements the weekly Integrating Mode and Counting Mode analysis development meetings. The online monitoring framework is being tested, and the panguin display GUI has been shown to function with the required Japan analysis suite outputs. A more efficient data output format (RNTuples) is currently being tested, with both JAPAN and panguin, as an alternative to the previously used TTree format.

Dec 2025 Answer:

The MOLLER integrating mode monitoring software is expected to use the JAPAN analysis framework for computation and Panguin Graphical User Interface (GUI) for visualization. JAPAN is expected to read and analyze live data via the CODA Event Transport (ET) mechanism in one or more continuously-running background process.

The performance and exact configuration of these real-time analysis jobs is currently being studied and under design. We aim to reach 100% analysis efficiency. The interface between JAPAN and Panguin has been extensively tested and works, meeting the proposed milestone. Further development is under way, such as improving performance. A detailed list of plots to be generated by this real-time analysis chain is being developed; this milestone is expected to be reached in 2026-06, as estimated. We are also in the process of developing suitable alarm indicators within Panguin and the overall MOLLER alarm handler system to alert shift crews to anomalies. The alarm design is in the early stages and estimated to be complete by 2026-09. Several pieces of software used in prior parity-violation experiments, specifically PREX, are being studied with the aim of reusing their functionality in the MOLLER online software system.

For counting mode analysis, a similar real-time analysis and display system has been envisioned, feeding data from ET into the counting mode analyzer, Podd, and from Podd into Panguin, although achieving true real-time performance, especially with 100% efficiency, is not critical for monitoring the counting mode performance. The interface between ET and Podd works at this time: Podd has gained an ET input class for CODA data meeting the 2025-12 milestone. Further testing will continue to ensure this system works without issues on day one of data taking.

O10 – ERR3(Aug 2026)

Complete documentation before ERR3.

Ciprian Gal

T1 – 30-Sept-2025 - Answered

The project needs to come up with a contingency plan if the Moller target requires more power than expected.

Krishna Kumar

It is first noted that, even with conservative assumptions about potential heat losses, it was concluded that ESR2 capacity should be able to handle the MOLLER power load. Additionally, unexpected heat leaks in insulation over the full system can be addressed during the commissioning before the first beam on target. If the power is still found to be inadequate for operation at full beam power after commissioning, the collaboration’s options are:

1) Tweak the operational parameters of the target, which have some built-in “room" to achieve our required density fluctuation goals, to reduce overall power consumption

2) If that still doesn't allow us to run at the nominal production running conditions, then the Collaboration would negotiate with Lab management to reduce load from other ESR2 customers for the first run and prepare plans to modify target to reduce heat load during the long shutdown

3) If the capacity still isn't sufficient after 1) and 2), the collaboration would find a new operating beam current to collect physics data. In this option, the experiment would need proportionally more beam time to achieve the full statistics.

T2 – 15-Sept-2025 - Answered

Develop a list of critical spares and other equipment necessary for successful operation of the Moller experiment and procure these critical spares.

Klaus Dehmelt

The Project Manager (Klaus Dehmelt) and Dave Meekins have developed a list of critical spares by Sept 12th 2025 and they will use it to get approval to procure these spares from DOE.

T3 – N/A

Expedite the process for the on-boarding of new employees in the Target group.

JLab

T4 – N/A

The Target Group is to provide lab management with a detailed staffing profile needed to support experimental operations leading to and extending beyond the MOLLER installation.

Target group