

CLAS12

Hall B Run Group L (RG-L)

Radiological Safety Analysis Document (RSAD)

This Radiological Safety Analysis Document (RSAD) identifies the general conditions associated with CLAS12 Run Group L (RG-L) in Hall B, as well as the controls associated with the production, movement, or import of radioactive materials.

1. Description

The Physics Division CLAS12 RG-L run will take place during the spring/summer of 2025 in Experimental Hall B. CLAS12 is a multi-purpose detector system based on toroidal and solenoid superconducting magnets in the forward and central regions, respectively, of CLAS12. The detector system includes Cherenkov counters, drift chambers, scintillator counters, micromegas gas detectors, and calorimeters in the forward region. In the central region the experiment will employ the new ALERT detector consisting of two sub-detectors, the AHDC hyperbolic drift chamber surrounding the target and the ATOF time-of-flight detector system located radially outward of the AHDC.

During this run period, the CLAS12 Forward Detector system will be used in its standard detector and shielding configuration with the Forward Tagger (FT) ON. In the central region within the solenoid, the CVT tracker will be replaced by the new ALERT detector system (AHDC + ATOF). At backward angles the BAND neutron detector will be installed. This run will employ a high-pressure gas target cell (filled with H, D, and ^4He) placed along the beamline inside the ALERT detector. The target cell will be a 45-cm-long aluminized Kapton straw of 0.6 cm diameter and 50 μm wall thickness. It will be operated at a nominal pressure of 68 psig (4.6 atm). The straw has entrance and exit windows of 30- μm thick aluminum. The center of ALERT is defined as the midpoint of the ATOF scintillators. The ALERT detector center is positioned at the solenoid center, which is 130.3 cm upstream of the Hall center in the nominal CLAS12 coordinate system. The vacuum will be disconnected between the upstream and downstream beamlines with 1 cm of air between the upstream beam pipe window (30 μm thick aluminum) and the upstream target window. ALERT will have a helium extension tube on the downstream end with a 30 μm aluminum window. There will be a 4 cm air gap between this window and the 75 μm thick window on the downstream beam pipe.

The ALERT run will take data using 2.2 GeV (1-pass) beam for detector calibrations and both 6.6 GeV (3-pass) and 11 GeV (5-pass) polarized electron beams for production data taking. Production data collection will take place with beam currents up to 1000 nA during the 11 GeV running and with beam currents up to 500 nA for the two lower beam energies. The nominal beam-target luminosity during data taking will be $\lesssim 2.8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$. For beam tuning and Möller runs, the beam will be directed into the Hall B Tagger dipole magnet yoke as has been standard for operations in Hall B. The Hall B Faraday cup with beam blocker has been approved for 17 kW operation.

The details of all beamline and target components for ALERT are shown on the beamline drawings at: https://wiki.jlab.org/Hall-B/engineering/hallb_eng_wiki/index.php/Main_Page.

2. Summary and Conclusions

This run period is not expected to produce significant levels of radiation at the site boundary. However, radiation levels will be monitored periodically by the Radiation Control Department (RCD) to ensure that the site boundary goal is not exceeded. The main consideration is the manipulation and/or handling of target(s) or beamline hardware. As specified in Sections 4.2 and 7 below, the manipulation and/or handling of target(s) or beamline hardware (potential radioactive material), the transfer of radioactive material, or modifications to the beamline after the target assembly *must be reviewed and approved by the Radiation Control Department*.

Adherence to this RSAD is vital.

3. Calculations of Radiation Deposited in the Experimental Hall

The radiation budget for a given experiment is the amount of radiation that is expected at the site boundary as a result of a given set of experiments. This budget may be specified in terms of mrem at the site boundary or as a percentage of the TJNAF design goal for dose to the public, which is 10 mrem per year. The 10 mrem/yr design goal is 10% of the DOE annual dose limit to the public and cannot be exceeded without prior written consent from the Radiation Control Department Manager, the TJNAF Director, and the Department of Energy.

Calculations of the contribution to TJNAFs annual radiation budget that would result from running under a broad variety of conditions typical of Hall B operations, indicates that this contribution from the experiments will be negligible. With this expectation, we have not carried out calculations for the specific running conditions of this experimental group.

This expectation will be verified during the experiment by using the active monitors at the Jefferson Lab site boundary to keep up with the dose for the individual setups from Hall B and the other Halls. If it appears that the radiation budget will be exceeded, RadCon will call for a meeting with the experimenters and the Head of the Physics Division to determine if the

experimental conditions are accurate, and to assess what actions may reduce site boundary dose rates. If the site boundary dose approaches or exceeds 10 mrem during any calendar year, the experimental program will stop until a resolution can be reached.

4. Radiation Hazards

The following controls shall be used to:

- prevent unnecessary exposure of personnel
- comply with federal, state, and local regulations
- adhere to TJNAF procedures and,
- the Experimenter's home institution policies.

4.1 Beam in the Hall

When the Hall status is *Beam Permit*, potentially lethal conditions are present. Prior to going to *Beam Permit*, several actions will occur.

- Announcements will be made over the intercom system notifying personnel of a change in status from *Restricted Access* (free access to the Hall is allowed, with appropriate dosimetry and training) to *Sweep Mode*.
- All magnetic locks on exit doors will be activated.
- Persons trained to sweep the area will entry by keyed access (*Controlled Access*) and search in all areas of the Hall for personnel.

After the sweep, another announcement will be made, indicating a change to *Power Permit*, followed by *Beam Permit*. The lights will dim and Run-Safe boxes will indicate OPERATIONAL and UNSAFE.

IF YOU ARE IN THE HALL AT ANY TIME THAT THE RUN-SAFE BOXES INDICATE UNSAFE, IMMEDIATELY HIT THE BUTTON ON THE BOX.

Controlled area radiation monitors (CARMS) are located in strategic areas around the Hall and the Counting House to ensure unsafe conditions do not occur in occupiable areas.

4.2 Activation of Target and Beamline Components

The Radiation Control Department shall be notified of all radioactive materials brought to Jefferson Lab. These materials include, but are not limited to:

- Radioactive check sources of any activity, exempt or non-exempt

- Previously used targets or radioactive beamline components or,
- Previously used shielding or collimators.

The RCD inventories and tracks all radioactive materials onsite. If radioactive materials are incorporated into an experimental setup, surveys may be conducted on the setup before experiments begin.

RadCon staff will coordinate movement of all used targets, collimators, and shields. They will further assess the radiation exposure conditions and implement controls, as necessary, based on the radiological hazards.

There shall be no local movement of activated target configurations without direct supervision by the RCD. Remote movement of target configurations shall be permitted, providing the method of movement has been reviewed and approved by the RCD.

No work (e.g., drilling, cutting, or welding) that could result in dispersal of radioactive material is to be performed on beamline components. Such activities must be conducted only with specific permission and control by the Radiation Control Department.

5. Incremental Shielding or Other Measures to Reduce Radiation Hazards

None.

6. Operations Procedures

All experimenters must comply with experiment-specific administrative controls that begin with the measures outlined in the experiment's Conduct of Operations document. These controls may include radiological work permits (RWPs), ePAS permits, and/or verbal instructions from RadCon. A General Access RWP (GARWP) that governs access to Hall B and the accelerator enclosure is in place and may be found at https://misportal.jlab.org/railsForms/rad_work_permits/144648/briefing. All those who participate in the ALERT experiments must read and electronically sign the GARWP signifying that they understand and will abide by the permit. Any individual with a need to handle radioactive material at Jefferson Lab shall first successfully complete Radiation Worker Level 1 (RW-1) training.

There shall be adequate communication between the experimenter(s) and the Accelerator Crew Chief and/or Program Deputy to ensure that all restrictions on the target are well known. Exceeding these power restrictions may lead to excessive and unnecessary contamination, activation, and personnel exposure.

No scattering chamber or downstream component may be altered outside the scope of this RSAD without formal Radiation Control Department review and approval. Alteration of these components (including the exit beamline itself) may result in

increased radiation production from the Hall and a resultant increase in dose at the site boundary.

7. Decommissioning and Decontamination of Radioactive Components

Experimenters shall retain all targets and experimental equipment brought to Jefferson Lab for temporary use during the experiments. After sufficient radioactive decay time of these materials, they shall be delivered to the experimenter's home institution for final disposal. All transportation shall be done in accordance with United States Department of Transportation (Title 49, Code of Federal Regulations) regulations. In the event that the experimenter's home institution cannot accept the radioactive material due to licensing requirements, the experimenter shall arrange for appropriate funds transfers for disposal of the material.

TJNAF cannot store indefinitely any radioactive targets or experimental equipment.

The Radiation Control Department may be reached at any time through the Accelerator Crew Chief (757-269-7050).