Radiological Safety Analysis Document for the Spring 2019 GlueX-II (E12-02-002 DIRC commissioning), and PRIMEX-eta (E12-10-011) Runs in Hall D

This Radiological Safety Analysis Document (RSAD) will identify the general conditions, and controls with regard to production, movement, or import of radioactive materials, associated with the spring 2019 runs in Hall D.

1 Description

The spring 2019 Hall D run is scheduled from 01-30-19 to 04-07-19 with the total running time of 68 days. It will utilize up to 12 GeV electron beam. The run will be split into two parts: DIRC commissioning for GlueX-II (2 weeks) and PRIMEX-eta running.

The DIRC part of the run will be using regular GlueX-I conditions, similar to the Fall of 2018, with the regular 30 cm LH2 target, plus the DIRC installed. Two diamond radiators (already used in Sept-Oct 2018) will be used, as well as amorphous aluminum radiators. The beam current in the runs with amorphous radiators will be adjusted depending on the radiator's radiation length X_0, in order to provide a photon flux similar to the photon flux produced by the diamond radiators. Nine days of beam time are dedicated to runs at smaller beam currents below 200 nA, and five days at higher currents below 1300 nA.

Radiator	Current (nA)	Total Time	Comment
3.9×10^{-4} X_0 Diamond 1.4×10^{-4} X_0 Diamond 5×10^{-4} X_0 Al	< 200 < 300 < 200	9 days	Standard running conditions, 30cm liquid hydrogen target
3.9×10^{-4} X_0 Diamond 1.4×10^{-4} X_0 Diamond 5×10^{-4} X_0 Al	< 600 < 1300 < 600	5 days	Standard running conditions, 30cm liquid hydrogen target

Table 1. Hall D Spring 2019 run plan, GlueX-II part

The PRIMEX-eta part of the run will run in the configuration different from the previous GlueX part. The differences include: (a) the solenoid in Hall D will be turned off; (b) the vacuum pipe downstream of the FCAL will be removed (similar to the last days of running in Dec 2018); (c) only Aluminum radiators will be used; (d) the targets will be different - Liquid Helium 30cm (3.9% X_0), and Be 17.8mm (5% X_0) thick. The CompCal will be used, similar to Dec 2018 run. Total 54 days. Maximum beam current 600nA (<10h), regular beam current 320nA.

Radiator	Current (nA)	Total Time	Comment
$1x10^{-4}$ X_0 Al	< 320	47.5 days	Standard running conditions, 30cm liquid helium target
$1x10^{-4}$ X_0 Al	< 320	1 day	Standard running conditions, empty liquid helium target
$1x10^{-4}$ X_0 Al	< 320	3 days	Standard running conditions, 1.78 cm beryllium target
$0.2x10^{-4}$ X_0 Al	< 2	2 days	Standard running conditions, CompCal calibration
$1x10^{-4}$ X_0 Al	< 600	0.5 days	Standard running conditions, 30cm liquid helium target

Table 2. Hall D Spring 2019 run plan, PRIMEX-eta part

2 Summary and Conclusions

The Spring 2019 Hall D run is not expected to produce significant levels of radiation at the site boundary. However, it will be continuously monitored by the Radiation Control Department (RCD) to ensure that the site boundary goal is not exceeded. Activation of targets, collimators and beam line hardware must also be considered. As specified in Sections 4 (4.2) and 7, the manipulation and/or handling of targets and beam line hardware (potentially radioactive material), the transfer of radioactive material, or modifications to the beam line after the target assembly must be reviewed and approved by the RCD.

Adherence to this RSAD is vital.

3 Calculations of Radiation Deposited in the Experimental Hall (the Experiment Operations Envelope)

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

Comparison of the beam configuration parameters of the spring 2019 run with the previous Hall D runs, as well as with the parameters used in the "Shielding Basis for Hall D Complex" (JLAB-TN-08-033) indicate that it will have acceptably low contribution to the site boundary dose. Use of helium and beryllium targets is not standard in Hall D and it has not been evaluated in detail. Such running conditions are expected to produce noticeably larger neutron dose rates per beam current, compared with the standard. However, due to the low beam current operations planned, the contribution to the dose rate accumulation at the boundary is expected to be small. Considerations leading to this conclusion may be found in the ERR documentation:

https://cnidlamp.jlab.org/RareEtaDecay/JDocDB/system/files/biblio/2017/06/beamline_trigger_4.pdf

Running Hall D with nuclear targets, and with the 300 cm long vacuum section in the beam dumpline removed, is expected to produce noticeably larger neutron dose rates per beam current (on the same radiator), compared with the standard LH2 target. However, the maximum beam current for these runs is planned to be significantly smaller than in the standard GlueX experiment conditions, and the contribution to the dose rate accumulation at the boundary is expected to be small (a detailed simulation model for future operations under such non-standard conditions is under development in RadCon).

The expectation of the small contribution of Hall D to the boundary dose accumulation will be verified during the run using the active monitors at the Jefferson Lab site boundary. If it appears that the radiation budget will be exceeded, RCD will require a meeting with the experimenters and the Head of the Physics Division to determine if the run conditions are accurate, and to assess what actions may reduce the dose rates at site boundary. If the site boundary dose approaches or exceeds 10 mrem during any calendar year, the run program will stop until a resolution can be reached.

4 Radiation hazards

The following controls shall be used to prevent the unnecessary exposure of personnel and to comply with Federal, State, and local regulations, as well as with Jefferson Lab and the Experimenter's home institution policies.

4.1 Beam in the hall

When the Hall status is Beam Permit, there are potentially lethal conditions present. Therefore, 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 enter by keyed access (Controlled Access) and search in all areas of the Hall to check 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 that unsafe conditions do not occur in occupied areas.

4.2 Activation of target and beam line components

All radioactive materials brought to Jefferson Lab shall be identified to the RCD. These materials include, but are not limited to radioactive check sources (of any activity, exempt or non-exempt), previously used targets or radioactive beam line components, or previously used shielding or collimators. The RCD inventories and tracks all radioactive materials onsite.

The RCD will coordinate all movement of used targets, collimators, and shields. The RCD will assess the radiation exposure conditions and will 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 is to be performed on beam line components, which could result in dispersal of radioactive material (e.g., drilling, cutting, welding, etc.). Such activities must be conducted only with specific permission and control of the RCD.

5 Incremental shielding or other measures to be taken to reduce radiation hazards

None.

6 Operations procedures

All experimenters must comply with experiment-specific administrative controls. These controls begin with the measures outlined in the experiment's Conduct of Operations Document, and also include, but are not limited to, Radiation Work Permits, Temporary Operational Safety Procedures, and Operational Safety Procedures, or any verbal instructions from the Radiation Control Department. A general access RWP is in place that governs access to Hall D tagger building, Hall D proper, and the accelerator enclosure, which may be found in the Machine Control Center (MCC); it must be read and signed by all participants in the experiment. Any individual with a need to handle radioactive material at Jefferson Lab shall first complete Radiation Worker (RW I) training.

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

The radiator assembly and the downstream beam-line components may not be altered outside the scope of this RSAD without formal RCD review. Alteration of these components may increase radiation production in the Hall and subsequently increase the site boundary dose.

7 Decommissioning and decontamination of radioactive components

Experimenters shall retain all targets and experimental equipment brought to Jefferson Lab for temporary use during the experiment. After sufficient decay of the radioactive target configurations, they shall be returned to the experimenter's home institution for final disposition. All transportation shall be done in accordance with United States Department of Transportation Regulations (Title 49, Code of Federal Regulations) or International Air Transport Association 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 transfer of funds for disposal of the material. Jefferson Lab cannot store indefinitely radioactive targets and experimental equipment.

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

Approvals:

Radiation Control Department Head

1/15/2019
Date

Appendix A: Radiation Damage to the Hall D Electronics

Due to the low overall beam power planned to be delivered to the hall during the spring' 2019 Hall D run, no problems are anticipated with respect to radiation damage to the electronics, including the most vulnerable silicon photomultipliers.