GRETA Service Level Description

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Revision History

Revision		Changes
R001	27 May 2026	Original Issue

Authorizing Document

None.

Authorized Documents

None.

Authorized Committees and Boards

None.

Named Program Roles

None.

Awareness Training

None.

Enabling Training

None.

1 Objective

This document describes the level of service FRIB will provide for the operation of GRETA and in support of the users of this scientific instrument.

2 Abbreviations

ANL: Argonne National Laboratory

DAQ: Data-Acquisition System

GRETA: Gamma-Ray Energy Tracking Array

GRETINA: Gamma-Ray Energy Tracking In-beam Nuclear Array

LBNL: Lawrence Berkeley National Laboratory

SLD: Service Level Description

3 GRETA Overview

The Gamma-Ray Tracking Array GRETA can provide up to full 4π coverage with 36-fold segmented Germanium detectors arranged around a target area of about 35 cm diameter. Four HPGe crystals are hosted in a common cryostat (quad) and 30 quad modules form the full sphere. GRETA provides the infrastructure to operate 30 Quad Detector Modules, including electronic chains, data acquisition system, and a computer farm performing the on-line signal decomposition.
For GRETA at FRIB two mechanical support structures are available, namely the GRETA frame consisting of two hemispheres hosting up to 15 quad modules each, and the former GRETINA frame for deployment in the S3 vault (accommodating up to 21 Quad Detector Modules). Currently, the full GRETA frame is available on the ReA beam line. The modified GRETINA frame will be used for experiments at the S800 magnetic spectrograph in the S3 vault.

This SLD is for the first FRIB campaign of GRETA and FRIB support will be provided in close collaboration with the GRETA team from LBNL. All questions on the use of ancillary detectors with respect to mechanical constraints and the merging of data streams should be directed to the FRIB GRETA Operations Lead (weisshaa@frib.msu.edu) and the GRETA LBNL team, led by Paul Fallon (pfallon@lbl.gov) and Heather Crawford (hlcrawford@lbl.gov).

4 Standard Configuration

4.1 Physical Configuration

4.1.1 GRETA Frame

The GRETA frame has a modular structure allowing to dismount whole sections of the aluminum hemispheres to provide more space around the target area. With all 30 quads deployed, the resulting sphere provides 12 pentagon openings of about 5 cm effective diameter, two of them used as beam entrance and exit and four used to support the hemisphere leaving 6 open pentagon locations.

4.1.2 GRETINA Frame for Rxperiments at the S800 Magnetic Spectrograph in the S3 Vault

The GRETINA frame consists of two solid Al hemispheres with 21 positions for the quad modules. The table below gives the available detector angles (beam axis with respect to the axis of the quad module) and number of available slots at each angle.

RING	ANGLE	SLOTS	REMARK
2	58°	4	
3	90°	8	
4	122°	4	
5	148°	5	Triplet cryostat endcap

Please note that quad modules mounted in ring 5 will constrain the beam entrance diameter to about 5 cm and which is typically not practical for fast-beam experiments. Special triple endcaps are available, allowing to double the available diameter at a loss of one crystal per impacted detector module. A new beam pipe and target mechanism for 50mm x 50mm targets will be made available to accommodate the triplet detector geometry. This will enable the configuration of 16 detector quad modules and 5 triplet modules for S800-GRETA runs, totaling 79 36-fold segmented crystals.

Note that the 6-inch diameter beam pipe that was typically used in the past for experiments at the S800 spectrograph will not fit the triplet detector configurations. If the use of a 6-inch pipe is required, 16 quad detector modules can be installed, leaving the positions of ring 5 empty. Both hemispheres can be moved perpendicular with respect to the beam axis and allow access to the target chamber area.

4.1.3 Target Chamber

For experiments with fast beams using the modified GRETINA frame, a standard target chamber with corresponding vacuum system is available. The chamber is a cylindrical, thin-walled Al beam pipe of 6-inch diameter. The standard target size is 50mm x 50mm. Targets are typically glued to a support ring and placed on a low-mass cradle. The cradle is inserted into the target chamber using a precision stick. Targets must be provided by the experimenter. Note that no quad modules can be mounted in the most upstream ring while using this chamber. A new beam pipe and target mechanism for 50mm x 50mm targets will be made available to accommodate the triplet detector geometry.

4.2 Operational Features

Experimenters can request a specific configuration for the placement of the detector quad modules over the available mounting positions in the hemispheres of the respective frames. The dynamic range of the front-end electronics is fixed at 10 MeV for the segment channels. The central contacts are converted into several dynamic energy ranges, and all ranges are recorded in the data stream simultaneously. Energy thresholds are typically set at 50-80 keV.

4.3 Electronics and Data Acquisition

GRETA is read out using a fully digital electronics and data acquisition system developed by LBNL and ANL. A software interface will be available which sends time-stamped data from FRIB-DAQ-based instruments (such as the S800 spectrograph) to the GRETA DAQ. Events will be built by the event builder of the GRETA DAQ. GRETA data is comprised of the energy and

timing of each hit segment and core electrode, and the energy deposition and spatial coordinates of each interaction point obtained from the signal decomposition algorithm.

4.4 Analysis Software and Tools

A software interface will allow access to event-built data from the GRETA DAQ. Online analysis software based on the SpecTcl framework will be made available to monitor GRETA data during the experiments.

For experiments involving the S800 spectrograph, the SpecTcl analysis will process event correlations between S800 data and GRETA. Particle-gated, Doppler-corrected gamma-ray spectra measured and reconstructed with GRETA will be available. The same software can also access event data stored on disk and so enables off-line sorting.

For other ancillary detector data, users will be supported on request to integrate their data processing in the existing SpecTcl-based S800-GRETA analysis software.

4.5 Ancillary Systems

Support of ancillary detector systems is not covered by this SLD.

5 Instrument Support Level

5.1 Support by Instrument Scientists

FRIB provides support for GRETA by instrument scientists. Setup of the instrument will be coordinated by the instrument scientists. On-site support is normally available from 9 a.m. to 5 p.m. on working days. 24-hour on-call support for critical technical assistance during the experiment outside of the normal working hours/days can be requested through the operator in charge (OIC), who will then contact the instrument scientist on call.

5.2 Additional Support

In general, opening and closing the array is done by trained FRIB GRETA operations staff. In some circumstances, if needed and on request, experimenters can be trained to open and close the array. If the target chamber as described in 4.1.2 is used, experimenters can be trained in operating the vacuum system of the target chamber and in changing targets. Experimenters need explicit approval from the FRIB GRETA Operations Lead to be allowed to perform those tasks after completed training.

Changing detector configurations is a major task and any change to a setup other than requested in the proposal shall be communicated to the instrument scientists and must be included in the spokesperson questionnaire for the Experiment Readiness Review. Changes of detector configurations outside the scope of the questionnaire will be subject to schedule and resource limitations.

6 User Responsibilities

In addition to those described in the FRIB “Responsibilities of Experimenters” document, responsibilities stated in section 6.1-6.3 should be carried out by the experimenters for an experiment with GRETA.

6.1 Prior to Start of Experiment and During Setup

Two or more experimenters shall be available one working day prior to secondary beam tuning (SDT) for the experiment. They will be trained by an instrument scientist to operate the GRETA

DAQ and online analysis software and perform source calibration measurements. The training covers:

- Start/Stop of data runs
- Analysis of online and offline data using the SpecTcl-based software
- Typical diagnostic checks for monitoring the performance of GRETA
- Procedure to hand over beam to operators
- Procedure to accept beam back from operators
- Procedure to access and secure the experimental area

Those experimenters will pass their knowledge to collaborators not attending this initial training. The training is mandatory for any person on shift as 'experimenter in charge'. Note that this allocated time does not include time needed for FRIB specific site training.

For experiments using additional equipment not supported by this SLD (e.g. the plunger target system), the spokesperson should contact the instrument scientist for coordination of the set-up.

Users are welcome to participate in the installation phase and should contact the instrument scientist to coordinate schedules.

6.2 During Experiment

The user must be familiar with routine checks of the incoming GRETA data during experiments. This includes monitoring of spectra and scaler values and of the incoming data using the analysis software provided by the instrument scientist. A check list will be provided by the instrument scientist describing the routine monitoring during data taking (e.g. run-wise check/print-out of specific spectra, scalers, etc.) and is expected to be followed by the 'experimenter in charge'.

6.3 After Experiment

No action by experimenters after the experiment is required in regards of GRETA.

7 Additional Instrument Support Not Covered in this Service Level Description

Any request for support not covered in this service level description must be submitted to the FRIB Manager for User Relations prior to the submission of an experiment proposal for review by the FRIB GRETA Operations Lead.