# Segmented Germanium Array Service Level Description

## I. Standard Configuration

### General

The Segmented Germanium Array (SeGA) consists of a maximum eighteen 32-fold segmented germanium detectors. The array is primarily designed to detect gamma-rays from nuclei that decay in-flight at velocities of 20 to 40% the speed of light. Position determination is made from that analysis of the energy deposition patterns of the gamma ray scattering in the segments. The central-contact energy (the full energy of the detector) is Doppler corrected based on the position determination. The detectors themselves can be arranged in several different configurations, and there are several standard frames available.

In addition to detectors for gamma-ray observations, it is typically critical to have detectors after the secondary target for scattered particle identification. The options currently available are:

- S800 (a large-acceptance high-resolution particle spectrograph)
- Fast Plastic Phoswich (particle-energy identification near zero degree)
  **This is not** an NSCL supported device. Contact Thomas Glasmacher (glasmacher@nscl.msu.edu) for the availability of this device.
- beta-counting system (stopped beam spectroscopy)
  **This is not** an NSCL supported device. Contact Paul Mantica (mantica@nscl.msu.edu) for the availability of this device.

### Array Specifications

- Minimum detectable gamma-ray energy: **100 keV**
- Maximum detectable gamma-ray energy: **10 MeV**
- Dynamic range: **0 - 8 MeV**
- Typical in-beam energy resolution: **see below**
- Energy range for which efficiencies are known: **0.1 - 3.5 MeV**
- Maximum allowed rate per detector: **3 kHz of events > 100 keV**
  (Typical beam intensities of 0.5 MHz can produce this limit on downstream detectors).
- Available configurations (see photos in Sec. V):

    - **classicSeGA** (18 (max) detectors at 20 cm from the target)
      Typical application: **High-velocity (>0.3c) in-beam**
      Typical energy resolution: **2-4%**
      See below for the efficiency

    - **plungerSeGA** (16 detectors in 2 rings [$30^o$, 30cm] and [$140^o$, 23cm] )
      Typical application: **Lifetime measurement with plunger method**


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- **miniSeGA** (6 detectors surrounding at 5 cm from the target)
  Typical application**:** **Low-velocity (<0.1c) in-beam**
  Typical energy resolution: **1.5-2%**
  See below for the efficiency

- **betaSeGA** (16 detectors in two rings surrounding at 8.6 cm the target)
  Typical application: **Stopped beam spectroscopy (e.g. beta/isomer decay) or Low-velocity in-beam**
  Typical energy resolution: **3.5 keV @ 1.3 MeV (for beta decays)**
  See below for the efficiency
  **Remark:** This setup replaces betaSeGA consisting of 12 detectors in 8.5 cm

- **deltaSeGA** (18 (max) detectors at 21 cm in nine separate angle groups)
  Typical application: **Angular dependence of gamma radiation**
  Typical energy resolution: **2-4%**
  See below for the efficiency

- Full-energy peak efficiencies (for a source at rest) for the various configurations:

| γ-ray energy [keV] | classicSeGA (17 dets) | MiniSeGA | betaSeGA | deltaSeGA |
|---|---|---|---|---|
| 100 | 8.5% | 27.6% | 20.5% | 7.8% |
| 250 | 5.5% | 17.7% | 18.6% | 5.1% |
| 500 | 3.7% | 11.7% | 11.7% | 3.4% |
| 1000 | 2.3% | 7.3% | 7.4% | 2.1% |
| 2000 | 1.4% | 4.2% | 4.6% | 1.3% |
| 3000 | 1.1% | 3.0% | 3.5% | 1.0% |

- Available vaults for operation of SeGA
  - S3: classicSeGA, plungerSeGA, betaSeGA or deltaSeGA in operation with the S800. Only 17 detectors for classicSeGA and betaSeGA and 15 detectors for plungerSeGA can be mounted at this location due to space limitations.
  - S2: betaSeGA in operation with the beta-counting station or deltaSeGA with the phoswich detector.
  - Operation of miniSeGA or other frames in other vaults are not supported.


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- Supported Target Chambers:
  - A target chamber for running experiments at the S800 target position is provided. This chamber consists of a 4" or 6" Al beam pipe with a cradle for supporting 2" targets and viewers at the center position of SeGA.
  - Additional chambers for S3 or other vaults are not supported. Interested users should contact Dirk Weisshaar for more information.

**Data acquisition and Analysis Software**

The NSCL supports a complete data acquisition and analysis software for the operation of the SeGA array. Integration of the SeGA data acquisition with unsupported devices is the responsibility of the user. A framework for combining other devices with SeGA is provided, as well as, procedures for testing SeGA with the new code.

**Analysis Software**

The analysis software is based on the event data analysis tool: SpecTcl. The framework is designed and supported by Ron Fox (fox@nscl.msu.edu). The SeGA implementation of SpecTcl allows a detailed analysis of the acquired data in near real time. At the users option the analysis package is also available to do a complete analysis of their data after the experiment.

## II. Support Level

The SeGA support level is one physicist at 50% effort, thus complete 24 hour support is not possible. Setup of the standard array configurations will be coordinated by the device physicist, however, some user participation is required during certain periods of the setup (see the Sec. III below). Prior to and during a experiment, SeGA device support is available from 9 a.m. to 5 p.m. on normal (non-vacation) working days. Evening support (5 p.m. to 12 a.m.) can be arranged with at least 24 hours notice. On call, emergency support is provided at all times by contacting the operator in charge about the problem, who will then make the decision to call the device physicist.

## III. User Responsibilities

**Required**

- It is expected that the spokesperson fill out a SeGA experiment questionnaire at the time his or her experiment is scheduled. The responses in this questionnaire will be used to setup of the SeGA electronics. It is expected that the user assist in setting gains and

thresholds, as well as, make calibrations of the array detectors prior to their experiment. **It typically takes about one day to set and calibrate the array.**

- The user should be completely familiar with the typical experimental procedures for the use of the array. This includes monitoring the array, diagnosing common problems, and preventing the unsafe operation. Extensive documentation to this end is provided on the web for the user; however, these documents are most effective when they are studied in context (i.e. when the user is at the NSCL).
  **It typically takes about one day to familiarize oneself with the operational procedures.**
- Prior to a SeGA campaign there is typically one week of intense activity to set up the array in the experimental location. One collaborator (students are particularly encouraged in this case) from each experiment to be run during the campaign is expected to participate in the setup of the array. This is often an excellent opportunity for students to learn more about the device they will be using.
  **There are typically about 2 to 3 days in which the availability of several people is most need, and this may not necessarily be directly prior to the user's experiment**.

**Recommended**

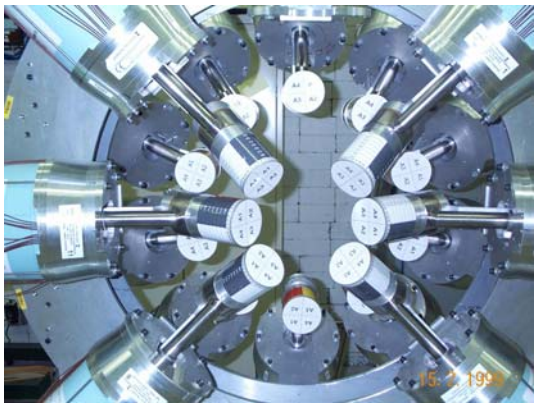
- A complete data analysis package is provided by the NSCL for the analysis of SeGA data. It is often possible to perform a near complete analysis of the data while it is being taken. While it is the user's prerogative as to how much analysis they wish to perform during the experiment, it is highly recommend that this opportunity be utilized so that the beam time can be most efficiently used.
  **It takes about one day to become familiar with the basic experimental analysis.**

From the requirements and recommendations above a spokesperson can expect that in addition to being present for the experiment at least one representative be available to visit the laboratory for 2-3 days during the set up of SeGA and that the those people who will be an "experimenter in charge" arrive at least 3 days prior to their experiment for the final setup and to familiarize themselves with the latest procedural developments.

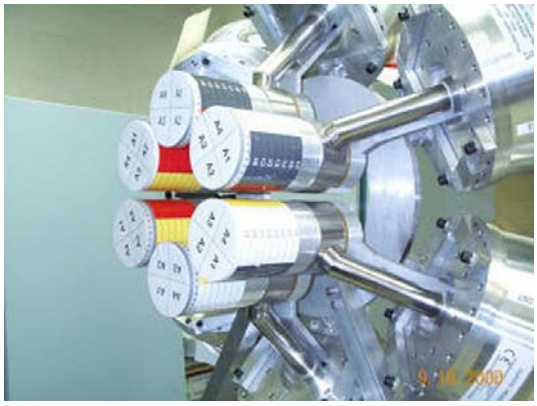
## IV. Additional Support

For questions concerning the available equipment for gamma-ray spectroscopy measurements please contact Dirk Weisshaar.

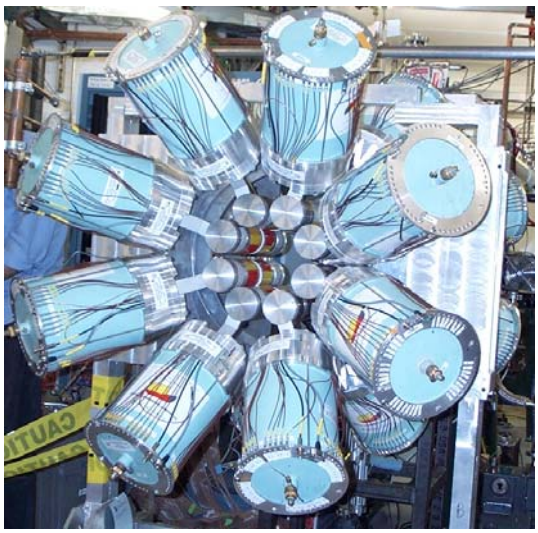
## V. Photographs of the Array Configurations



ClassicSeGA: Note that this photo only shows 6 detectors in the forward ring. The forward ring can accommodate up to 8 detectors (for 18 in the full array) except when run at the S800 target postion where only 7 detectors can be placed in the forward ring.



miniSeGA: A barrel of six close packed detectors (Inner diameter ~10.2 cm).



betaSeGA: 16 detectors in 2 rings surrounding beam line in a diameter of 17.3cm.

**PLEASE NOTE:** This setup replaces the old betaSeGA setup consisting of two rings of six detectors each (Inner diameter ~16 cm). This setup is still available if the user explicitly asks for it.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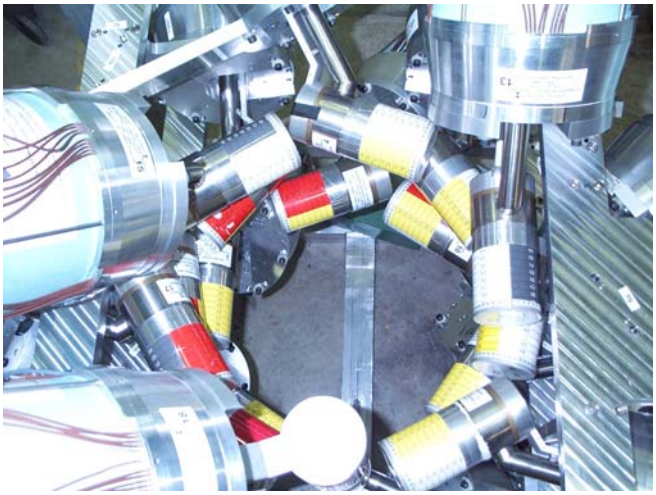
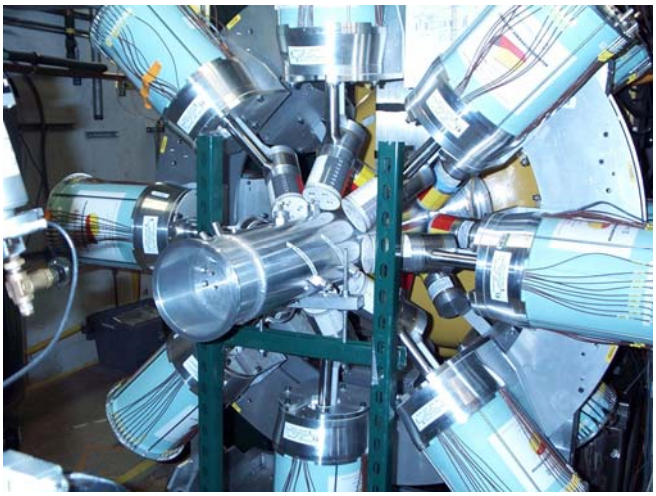


deltaSeGA: 18 detectors in nine different angle positions.



plungerSeGA: two rings of 8 detectors each at maximum forward ($30^{o}$) and backward ($140^{o}$) angle in order to obtain maximum Doppler shift of gamma lines for lifetime measurement in RDDS technique.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