MUGAST technical document

November 3, 2015

0.1 MUGAST introduction and goal

The GASPARD and TRACE collaborations are converging to build a new-generation Si ensemble in common, with a timeline of 2019-20 for completion of the final 4π array, in view of the existing and emerging facilities, like SPIRAL1, SPES or HIE-Isolde. GASPARD-TRACE have been designed to profit of the digital PSA for measuring the light charged particles and to be transparent for the combination with gamma arrays.

In 2017-2018, the intense new SPIRAL1 beams and the gamma-tracking array AGATA coupled to the VAMOS spectrometer will be available simultaneously. This is a unique opportunity for direct reactions measurement. Given the low energies available for the new SPIRAL1 beams, it is particularly suited for stripping reactions measurement. In this purpose, high granularity and high energy resolution Silicon array is needed for light particle identification. We propose the use of a cutting edge silicon array MUGAST for particle detection. The spirit of this array is to couple a single layer of Silicon detectors for backward measurements and a 2 layer (Silicon + CsI) detection in the forward hemisphere. The coupling with the VAMOS spectrometer will give unambiguous identification of the reaction channel.

0.2 MUGAST design

The proposed highly-segmented silicon array MUGAST consists in the combination of the large area DSSSD, newly developed for GASPARD and TRACE, with the existing MUST2 detectors, see Fig. 1.

The MUGAST configuration consists in:

- 4 trapezoid-shape 500-μm nTD detectors placed in the backward hemisphere at about 15 cm from the target, complemented by an (existing) annular detector (not shown in Fig. 1) to cover the most backward angles.
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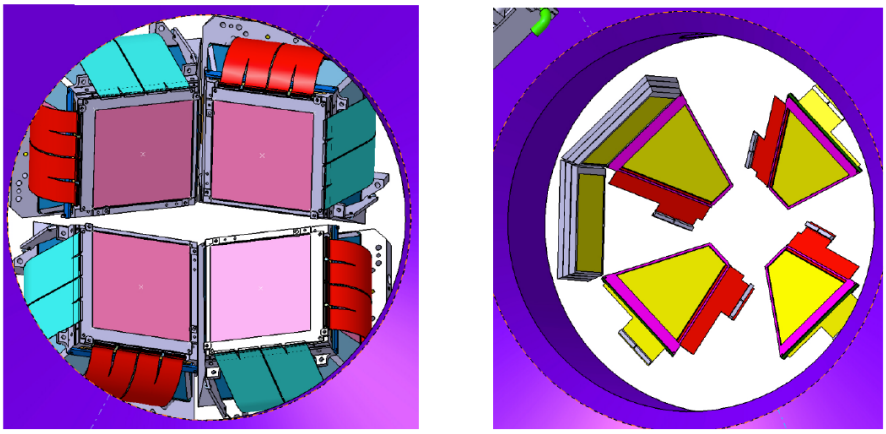

Figure 1: On the left, the MUST2 configuration, consisting of four forward telescopes. On the right, the new square (TRACE) and trapezoidal (GASPARD) detectors, at 90° and backward.

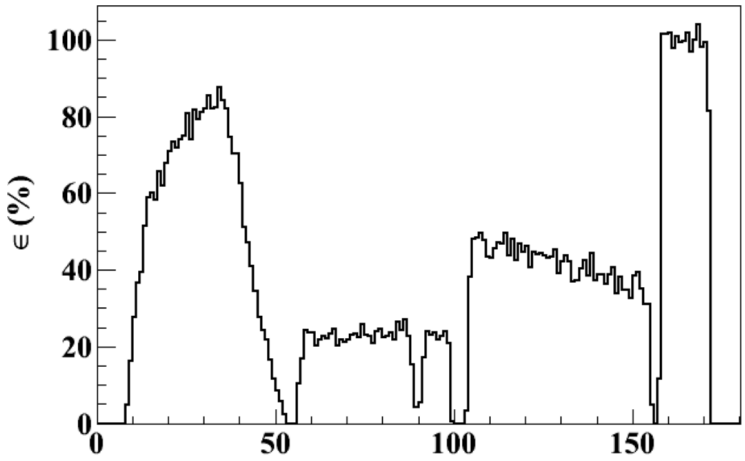

Figure 2: The geometrical angular efficiency of the proposed MUGAST configuration as a function of the polar angle.

- 2 squared-shape 500-μm detectors to be placed at 90° with respect to the beam direction and located at 8 cm from the target.
- 4 MUST2 telescopes at forward angles. The thicknesses are 300μm and they will be at 17 cm from the target. These are 10 x 10 cm^2 detectors with 128 strips on each side coupled with 16 CsI detectors read by photodiodes.

The identification of the forward emitted particle will rely on the standard δE-E technique whereas in the backward hemisphere we will rely on a single layer of Silicon coupled with the heavy residue identification in VAMOS.

A characteristic feature of this setup is the broad angular range that it offers, which is mandatory for the study of e.g. stripping reactions (such as (d,p),(^{3}He,p),(^{6}Li,d)...) because of their kinematics. The simulated angular coverage is shown in Fig. 2.

0.3 γ-ray detectors

MUGAST is meant to be coupled with highly efficient γ-ray detectors and firstly with the AGATA array. The AGATA photopeak efficiency is expected to be $\sim$10% for the 1π configuration. The available AGATA angular range covers the backward hemisphere, 90$\div$180° in the polar angle with respect to the beam direction. The expected assembly is presented in Fig. 3.

Although the MUGAST array is expected to be used in combination with the tracking spectrometer AGATA, other gamma-ray detectors such as EXOGAM or PARIS can be considered at need and accommodated in a ring at 90°.

0.4 Front-end electronics and sustainable rate

Readout will be insured by the existing MUST2 electronics. Given the short deadline, the digital electronics foreseen for the GASPARD-TRACE array will

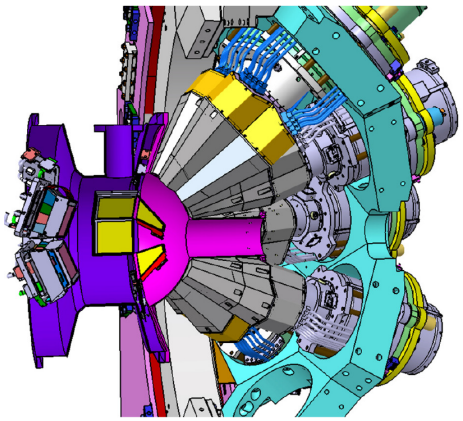

Figure 3: Vertical section of the combined setup, MUGAST plus AGATA. The silicon array is visible in the reaction chamber: the MUST2 telescopes in the forward hemisphere together with the new square (TRACE) and trapezoidal (GASPARD) detectors on the back. The AGATA array surrounds the reaction chamber in the backward hemisphere.

not be ready. The MUGAST array will be based on the existing MUST2 electronics. It is composed of 2 main parts :

- the MUFEE front end card which reads 128 channels (one side of the DSSD). They are put very close to the detectors inside vacuum with cooling.
- the MUVI back end card which is VXI type card and gathers information from 8 MUFEE cards (i.e. 4 DSSD).

The total number of channels will be 5280. In total the electronics will be composed of 11 pairs of MUFEE cards read by 3 MUVI cards. Coupling of the data flow to the GANIL DAQ will be straightforward through the VXI branch. The MUVI cards are controlled by the GANIL trigger module GMT. As VXI boards, they can operate in common dead-time or asynchronous modes. The sustainable counting rate is expected to be of the order of few kHz max. For the sync and clock distribution, the GTS and the AGAVA card will be used.

0.5 Targets

Typical targets like standard CH2 or CD2 targets will be available. It might also be possible to use the cryogenic target designed by IPN for ^{4}He and maybe ^{3}He targets. A windowless pure hydrogen H_2 film (CHyMENE) is under development. The thickness is within the range of 50-200 μm. However it does not fit with the present design of the Silicon array and with the chamber. The use of this target will be envisaged for the latest campaign and requires new developments.

0.6 Reactions

The proposed configuration provides a large angular coverage that allows the study of stripping reaction such as (d,p) which requires detection of the recoil particle at angles ranging from the very backward angles to 90° or lower, see Fig. 2. However, pickup, quasi-fusion, Coulomb excitation reactions and others are also feasible considering the disposable angular coverage.

0.7 Further information

A simulation package called NPTool and based on GEANT4 simulation package is available for MUGAST at the link : https://forge.in2p3.fr/projects/nptool.

A simulation package is available for AGATA at the link: http://agata.pd.infn.it/documents/simulations/agataCode.html.

The list of available SPIRAL1 beams can be download at pro.ganil-spiral2.eu/users-guide/accelerators/chart-beams.

0.8 Contacts

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