Reaction studies using the MUGAST+AGATA setup at VAMOS

Letter of Intent to the AGATA collaboration

D.Beaumel, IPN Orsay
D.Mengoni, University and INFN Padova

1. Introduction

The GASPARD and TRACE high granularity Silicon arrays have been natively designed for optimal integration in new generation gamma detectors such as AGATA with the aim of performing high-resolution reaction studies. Indeed, the coupling to AGATA allows a very large gain in excitation energy resolution, in comparison with the case where the excitation energy is deduced from the recoil charged-particle measurement. The GASPARD and TRACE collaboration are now converging to build such new-generation Si ensemble in common, with a timeline of 2019-20 for completion of the final 4π array, ready for the emerging ISOL facilities, like SPES and SPIRAL1. A view of such ultimate GASPARD-TRACE setup sitting inside AGATA is shown in Fig.1.

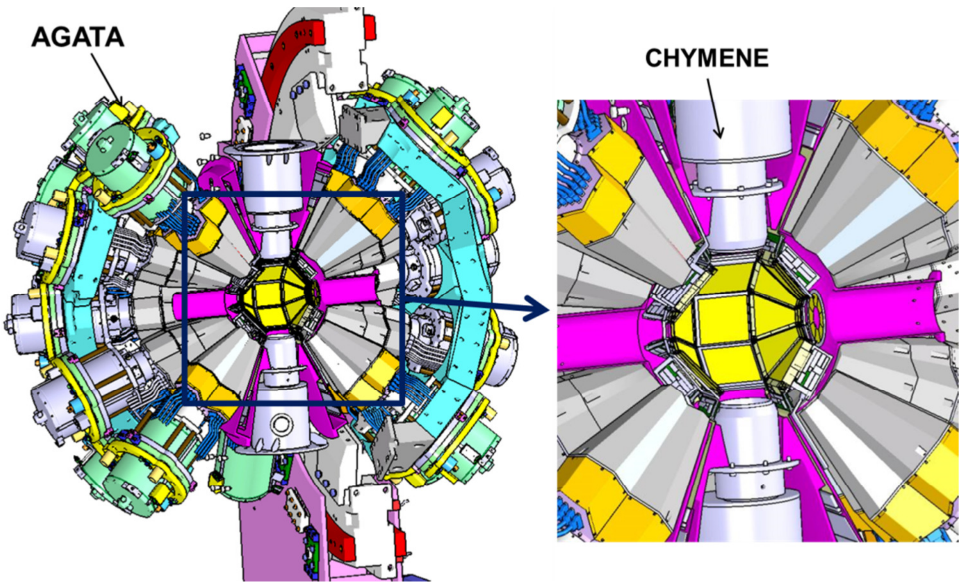

Fig1: Final GASPARD-TRACE array in full AGATA

Recently, a project of "intermediate" configuration of Silicon array (named "MUGAST" for MUST2-GASPARD-TRACE) allowing reaction studies in combination with AGATA at VAMOS has been proposed. Timeline for this project is beginning of 2017. This Letter of Intent describes briefly the MUGAST setup and the preliminary physics case.

2. The MUGAST setup

2.1 Si Detectors

In terms of detectors, this setup combines double-sided Silicon detectors (DSSD) currently developed within our GASPARD-TRACE collaboration and a few MUST2 telescopes. Granularity is identical to the MUST2 DSSDs (128x128). GASPARD is developing the trapezoid shape DSSD's while TRACE is in charge of the squared ones. In terms of detectors, the MUGAST configuration ends up as follows:

- 4 trapezoidal shape detectors placed in the backward hemisphere, complemented by an (existing) annular detectors to cover the most backward angles.
- 2 squared-shape detectors to be placed at 90 w/r
- 4 MUST2 telescopes

A sectional view of this configuration integrated in a to-be-built chamber with ~1π AGATA placed at the backward angles is presented in Fig.2.

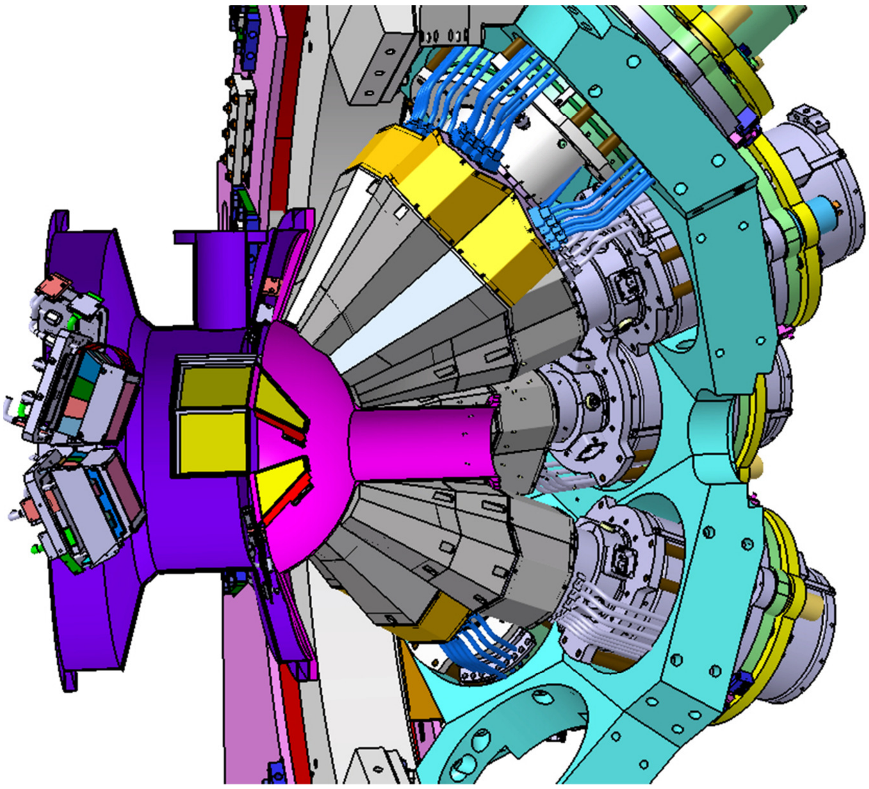

Fig2: Sectional view of the MUGAST Silicon detector configuration with AGATA modules covering the backward hemisphere

The above 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 degrees or lower, while being compatible with the present AGATA ~1π installed at VAMOS. Importantly, aside a standard simple chamber, we plan to build a new chamber designed to fit in the newly developed CHYMENE pure H/D target system. This system is based on continuous extrusion of a target film of ^{1}H or ^{2}H through a rectangular nozzle that defines the section of the film. It allows a gain of nearly 3 on the number of target protons or deuterons while suppressing the background due to Carbon in CH2 and CD2 observed in previous studies.

2.2 Electronics

Readout will be insured by the (existing) MUST2 electronics. For MUST2 telescopes, the front-end consists in two mother boards hosting the MATE ASIC's. The boards are mechanically coupled to alcohol-cooled cupper blocks placed at the back of the telescopes. For integration in the new chamber (Fig.1), new blocks made of stainless steel with optimized geometry will be manufactured. Connection of the new trapezoidal and squared DSSD's will be made by new kapton connectors. Rest of the electronics & connectics will be identical to the existing one. Number of FEE & VXI boards presently available is sufficient for the above configuration. Total number of channels (E&T) will be 5280. Coupling of the data flow to the GANIL DAQ will be straightforward through the VXI branch. The MUST2 numerical cards are controlled by the GANIL trigger module GMT. As VXI boards, they can operate in common dead-time or asynchronous modes.

3. Preliminary Physics case

Below is displayed a list of reactions of interest, with Physics theme and names of the main proponents, discussed in a recent meeting. Most of reactions make use of the new SPIRAL1 beams.

- ^{75}Kr (d,p) , ^{29}Mg (d,p), ^{60}Fe(d,p)   Shell structure evolution

(A.Matta, W.Catford, Univ. of Surrey)

- ^{56}Ni (d,p), ^{27}Na (d,p), Shell structure evolution

(O.Sorlin, GANIL)

- ^{79}Se(d,p)   Neutron cross-section by surrogate Method

(G.de Angelis, INFN LNL, D.Mengoni, UNiv. And INFN Padova)

- ^{56}Ni+^{7}Li   Shape coexistence in ^{60}Zn

(D. Mengoni, Univ. and INFN Padova, G. de Angelis, INFN LNL)

- ^{30}P(d,p) Nucleosynthesis

(N.de Séréville, F.Hammache, IPNO)

- ^{48}Cr(^{3}He,p)   neutron-proton pairing

(M.Assié, IPNO)

- ^{15}O(^{6}Li,d)^{19}Ne Nucleosynthesis

(C.Diget, Univ. of York, N. de Séréville, IPNO)

- ^{25}Al(^{3}He,d)   Nucleosynthesis

(N.de Séréville, F.Hammache, IPNO)

- Ge, Se (d,^{6}Li)   Shell Structure evolution

(F.Flavigny, IPNO)

- ^{48}Cr(d,alpha), (d,^{6}Li)   Pairing and quartetting

(M.Assié, IPNO)

- $^{45}K+^{7}Li$ Incomplete fusion

(S.Leoni, Milano, B.Fornal, Krakow)

- $^{14}O(p,p)$ Resonant gamma decay of unbound states

(I.Stefan, IPNO)

- $^{16}O + ^{27}Al$ Nuclear dynamics

(G.Verde, IPNO)

Stripping reactions, which are numerous in the proposed list , are well adapted to MUGAST+AGATA, as they requires the large angular coverage fulfilled by MUGAST.