

## Trigger Configuration for the PreSPEC-AGATA Campaign at GSI \*

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An online  $\gamma$ -ray spectroscopy campaign, PRESPEC-AGATA, was performed in 2012 using radioactive ions beam produced by the FRagment Separator (FRS [1]) and impinging on a target placed at the final focal plane (S4) of the FRS. The target was surrounded by segmented High Purity Germanium (HPGe) detectors called AGATA (Advanced GAMMA Tracking Array [2]), and by the HECTOR+ detectors (LaBr3 and BaF2) in order to detect  $\gamma$ -ray transition. The reaction products were identified after the target with the Lund York Cologne CALorimeter (LYCCA [3]).

$\gamma$ -ray spectroscopy requires to record  $\gamma$ -rays emitted in coincidence with a nucleus identified in both FRS and LYCCA. The particle trigger request was given by the signal coming from a scintillator plastic, SC41, placed before the target. An AGATA detector consist of one core and 36 segments. In order to provide a  $\gamma$ -trigger request, the gain-matched core signals were cabled to a Constant Fraction Discriminator (CFD). A logic OR of all the signals was then sent to our trigger logic module. Previous experiments done with the PRESPEC setup showed that around 50% of the events were not properly identified in LYCCA. In order to increase this ratio, we included in our trigger a coincidence with LYCCA consisting in the coincidence of the Time of Flight start plastic scintillator with the DSSD wall. For details concerning the LYCCA setup, please refer to [3].

The trigger scheme consisted of 12 different triggers fired only when the acquisition is not in dead time. Each trigger was associated with an event configuration. Trigger 12 was a *spill on* trigger fired at the beginning of the beam pulse and trigger 13, a *spill off* trigger, fired at the end of the beam pulse. Trigger 10 was a particle trigger, i.e. a trigger generated for each SC41 trigger request. It was used with a reduction factor as a normalisation, and also for the isomer tagging configuration. Physics triggers (6-9) required a coincidence with a particle (SC41 signal), a LYCCA signal and with a  $\gamma$ -ray detected in AGATA (T9) or in HECTOR(T8). The trigger 7 was generated with the coincidence of a particle and a  $\gamma$ -ray detected by AGATA. Trigger 6 was obtained with a coincidence between a particle and a  $\gamma$ -ray from HECTOR detectors. Trigger 5 was a generic FRS trigger. It was used during the setting up of the FRS, and can be switched to any FRS detector trigger. Triggers from 2 to 4 are calibration triggers used for the calibration of HECTOR (T4), AGATA (T3), and LYCCA (T2).

Trigger 1 was a scaler readout trigger. It ran at 10Hz, and was always validated (no dead time rejection, it was pending until the dead time was released).

The priority in the trigger was set to the inverse of the trigger number, e.g. trigger 10 has a higher priority than trigger 9, which assured a good normalisation trigger 10, with no missed events. The trigger scheme was implemented on a Field Programmable Gate Array (FPGA) based module developed at GSI, the VULOM4, with the help of the TRLO firmware developed by Hakan T. Johansson [4].

This system (FRS+LYCCA+HECTOR) was running under the Multi Branch System (MBS) data acquisition system and triggered as previously explained. The AGATA Germanium detectors came with their own data acquisition system (see AGATA reference paper [2] for details). Its trigger is the Global Trigger and Synchronisation (GTS) system. The latter is built as a tree, where each Germanium detector is considered as a leaf. In the tree philosophy, each leaf can send a trigger request to the trigger processor unit, the root of the tree, which takes a decision and sends it back to the leaves. Each time a  $\gamma$ -ray is detected in one detector (i.e. above the AGATA electronic threshold), it sends a request to the trigger processor which will either accept the event (record the event via the AGATA data acquisition system), or reject it. In our case, the trigger processor was divided in two partitions. One consisted in all the leaves from the Germanium detectors, the other one was the MBS data acquisition system. In this way, for each trigger from the FPGA based module, a signal was sent to the trigger processor which validated each Germanium leaf with a request in coincidence with it. The GTS system assured the time-stamping of the data which was used for the merging of an MBS event with AGATA data.

With this system, 5 experiments were performed in 2012. It allowed in-flight  $\gamma$ -ray spectroscopy, and also isomer tagging for a confirmation of the identification with the FRS. In the case of trigger 9 more than 99% of the events were validated by the GTS system, which verifies the satisfactory behavior of the coupled system.

### References

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