LYCCA Performance During the PreSPEC-AGATA Campaign

Pushpendra P. Singh[1,], P. Golubev[2], D. Rudolph[2], for the PreSPEC-AGATA Collaboration*

[1]Technische Universität Darmstadt, Germany; [2]Lund University, Sweden

The PreSPEC-AGATA project at GSI aims at nuclear structure studies of exotic nuclear species produced in Coulomb excitation and secondary fragmentation reactions using radioactive isotope beams at relativistic energies. This pan-European campaign is the precursor of the HIgh-resolution in-beam SPECtroscopy (HISPEC) experiment of the NUSTAR collaboration within FAIR [1]. The high-resolution γ-ray spectroscopy employs state-of-the-art detection systems, e.g., the FRagment Separator (FRS) for selecting specific radioactive ion beams, the European Advanced Gamma Tracking Array (AGATA) for the measurement of precise γ-ray energies, and the Lund-York-Cologne CAlorimeter (LYCCA) to discriminate heavy-ions produced in nuclear reactions at the secondary target. To enable event-by-event correlations of the γ rays with the reaction residues, the LYCCA array has the central role of determining both *Z* and *A* of final reaction products by itself or in conjunction with FRS. Here, we report some results of LYCCA performance numbers achieved during commissioning experiments.

The various detector components of LYCCA are: a double-sided-Silicon-strip detector (DSSSD) at the secondary target, the LYCCA wall consisting of 16 Δ*E*-*E* telescopes, and three ToF detectors [2]. Each telescope comprises a DSSSD to measure energy loss (Δ*E*) as well as the position (*x*,*y*) of the heavy ions followed by an array of nine Cesium Iodide (CsI) detectors for the residual energy (*E*). The energy loss and residual energy signals provide the *Z*-identification of the reaction products. From the target DSSSD and those of the downstream LYCCA wall the precise (*x*,*y*)-tracking of the heavy ions can be obtained which allows the impact parameter determination especially needed for Coulomb excitation experiments. Time-of-flight (ToF, Δt << 50ps) information is obtained by ultrafast plastic scintillators (BC-422Q, BC-420) in conjunction with 12 or 32 small ultrafast PMT readout. The ToF-target detector is mounted close to the secondary target, while the ToF-stop detector is situated ~3.5m downstream just in front of the LYCCA telescopes. Mass resolution for reaction products up to A ≤ 100 is anticipated. For further details see Ref. [3].

In-beam commissioning experiments for PRESPEC-AGATA were conducted in the second half of 2012. An ^{80}Kr beam at 150MeV/u was impinging on a 0.4 g/cm^2 ^{197}Au foil for Coulomb excitation and on a 0.7 g /cm^2 ^{9}Be target for a fragmentation reaction. For the ^{80}Kr+^{197}Au reaction, Fig.1 shows the correlation of the *x*-*y* position of particles hitting the target DSSSD (left), DSSSD-Wall (center), and CsI-Wall (right), respectively. It illustrates the elastic scattering distribution and three angular regions (10,20,30 mrad). This indicates that the most relevant inelastic scattering events up to the grazing angle of typically some 26 mrad can be studied.

*Email: p.p.singh@gsi.de

Fig.2 (left) shows the Δ*E*-*E* correlation of the ^{80}Kr+^{9}Be reaction at 150 MeV/u. The different nuclear charges (*Z*) are clearly separated. From the diagonal projection of the Δ*E*-*E* correlation, the *Z*-distribution on the right hand side of Fig. 2 can be extracted.

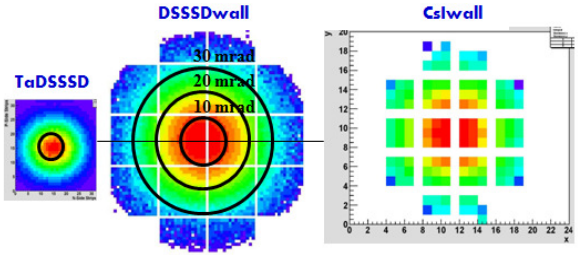

Figure 1: Correlation of the x-y position of particles hitting the target DSSSD (left), DSSSD-Wall (center), and CsI-Wall (right), respectively.

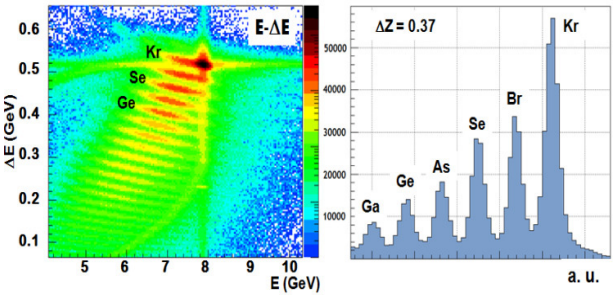

Figure 2: Δ*E*-*E* correlation measured with DSSSD-Wall and CsI-Wall (left). *Z*-distribution obtained from the diagonal projection of the Δ*E*-*E* correlation (right).

The resulting *Z*-resolution is determined to Δ*Z*/*Z* = 0.37% (an average of six peaks). This is almost identical with the value measured by the MUSIC detector of the FRS. The mass determination from the ToF measurement is described in some detail in Ref. [3], which continued optimization procedures being worked upon towards future experiments at HISPEC [4].

In the framework of the presently ongoing PreSPEC-AGATA campaign at GSI, we can show that LYCCA is able to discriminate relativistic heavy ion reaction products at typical energies of 100 – 300 MeV/u.

References

[1] PreSPEC. http://web-docs.gsi.de/~wolle/PreSPEC/
[2] LYCCA Technical Design Report (2008).
[3] P. Golubev *et al.*, submitted to Nucl. Instr. Meth.
[4] M. Reese *et al.*, this report.