Calibration of Double-sided Silicon μ-Strip Detector using intermediate energy beam of Na, Mg and Al

S. Chakraborty[1], A. Rahaman[1], U. Datta Pramanik[1]*, T. Aumann[2], S. Beceiro[3], T. Le Bleis[4], K. Boretzky[2], D. Cotrina-Gil[3], C. Caesar[2], M. Chariter[5], W. N. Catford[6], D. Gonzalez-Diaz[2], H. Emling[2], P. Diaz-Fernandez[3], Y. Dimitry[7], L. M. Fraile[8], , G. De Angelis[9], O. Ershova[2], H. Geissel[2], M. Heil[2], M. Heine[2], T. Heftrich[4], B. Jonson[10], A. Kelic[2], H. Johansson[10], R. Krucken[11], T. Kroll[4], C. Langer[2], Y. Leiffel[2], G. Munzenberg[2], A. Movsesyan[2], J. Marganiec[2],C. Nociforo[2], A. Najafi[12], V. Panin[2], R. Plag[2], H. A. Pol[3], S. Paschalis[13], R. Reifarth[2], D. Rossi[2], I. Ray[1], G. Rastrepina[2], H. Simon[2], C. Scheidenberger[2], S. Typel[2], J. Taylor[5], Y. Togano[14], E. Uberseder[2], V. Volkov[2], H. Weick[2], A.Wagner[7], F. Wamers[2], M. Weigand[2], J. Winfield[2], M. Zoric[2]

[1]*Nuclear Physics Division, Saha Institute of Nuclear Physics, Kolkata -700064, INDIA*
[2]*Gesellschaft für Schwerionenforschung (GSI), D-64291 Darmstadt, Germany*
[3] *Univ. Santiago Compostela, E-15782 Santiago de Compostela, Spain*
[4]*Technical Unin. Dramstadt, Germany*
[5] *Department of Physics, University of Liverpool, UK*
[6]*University of Surrey, Guildford, UK*
[2]*Institute for Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf, Germany*
[8]*Grupo de Física Nuclear, Facultad CC. Físicas, Universidad Complutense, E-28040 Madrid, Spain*
[9] *INFN,Laboratori Nationali di Legnaro, legnaro, Italy*
[10] *Fundamental Fysik, Chalmers Tekniska Högskola, S-412 96 Göteborg, Sweden*
[11]*Technical Unin. Munich, Germany*
[12]*Kernfysisch versneller instituut, Netherland*
[13]*Lawrence Berkeley National Laboratory, USA*
[14]*The Institute of Physical and Chemical Research (RIKEN), Japan*
* *email: ushasi.dattapramanik@saha.ac.in*

Introduction: Silicon strip detectors (SST) are semiconductor sensor which can be used in a wide variety of experiments starting from large scale particle physics, astrophysics to low energy nuclear physics experiments. Recently, it has also been deployed to explore dark matter at International Space Station [1]. Due to their high position resolution they have been used in the LAND-FRS setup at GSI, Darmstadt for tracking reaction fragments and hence to achieve better invariant mass resolution. We performed an experiment using this exclusive setup to explore neutron-rich nuclei around Island of Inversion with N~20. Details of the experiment were presented last year [2]. At this stage of analysis calibrations of different detectors are going on. In this article, calibration of the SST detectors will be presented.

Experiment: A cocktail beam of neutron rich exotic nuclei ($^{34-35}$Al, $^{31-33}$Mg, $^{29-30}$Na) (Fig.1(left)) at ~470MeV/u were allowed to undergo reaction using different secondary targets. Pb targets were used for electromagnetic excitation while reaction with CH_2 target helped in understanding nuclear contribution in the reactions. Kinematically complete measurements of all the reaction products were performed using the extensive LAND-FRS setup. Eight double-sided silicon μ-Strip Detectors (SST) were installed to track the reaction fragments. The detectors enclosed the reaction target from 4π solid angle. Four detectors were placed in-beam, two each before and after the target and the other four formed a box like structure as shown in Fig. 1(right). Each detector in principle is a n-doped silicon wafer of dimension 41×72 mm^2 and thickness 300μm. The p$^+$ strip implantation on the junction side (s-side) has a pitch of 27.5μm with an effective length of 39μm. The ohmic side has n$^+$ contact segmented into strips orthogonal to p-strips with pitch 52μm and effective length 70μm. The readout pitch corresponding to s- and k- side is respectively, 110μm and 104μm. VA-hdr circuit, derived from Viking family[3] were used as frontend electronics. VA-hdr chip has 64 analog channels,

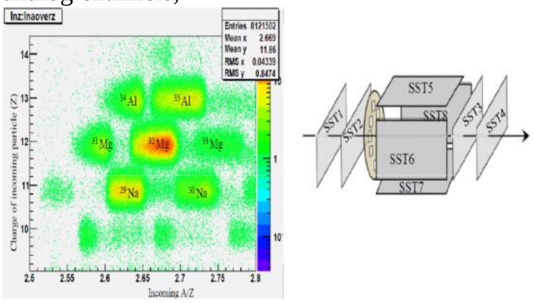

Fig. 1 (left) Incoming particle ID plot (right) Diagram showing the SSTs around the target.

each composed of a charge sensitive preamplifier, a shaper stage and a sample-and-hold circuit. Analog signals from VA-hdr are digitized for data acquisition using custom designed SIlicon DEtector REadout Module (SIDEREM).

Analysis: Data analysis is being performed using CERN-ROOT platform and *land02* framework. *land02* is an analysis tool for analyzing data from extensive LAND-FRS setup. Raw spectra of the detectors showed dead strips which were corrected. Pedestals were obtained from off-spill data with the system clock triggered. Nature of pedestal spectra showed variation in gain for the different VA-hdr circuits. This common mode shift and pedestals were subtracted from the measured charge.

When a charge particle passes through the

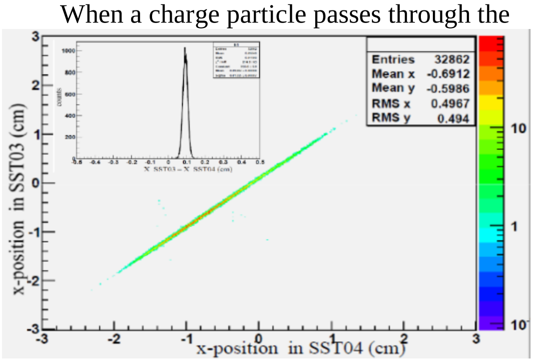

Fig. 2 Correlation plot of s-side from SSTs after target.(insight) Position resolution corresponding to s-side.

Si-wafer it generates ionization charges which are collected by a cluster of adjacent strips. Charge sharing of adjacent strips is expressed by the η-parameter , defined as

$$\eta = \frac{Q_r}{Q_l + Q_r}$$

where, Q_r (Q_l) is the charge sum of strips to the right (left) of the cluster centre calculated by centre-of-gravity. Nonlinear behavior in charge sharing was observed which reflects the geometry of the strip layout, the electric field in the wafer and the coupling with the readout circuit. This non-linearity in charge sharing was corrected using a curve fitting algorithm. A plot of profile histogram of energy distribution against η- value was made. It was then fitted with a Gaussian curve. The fitted energy value was

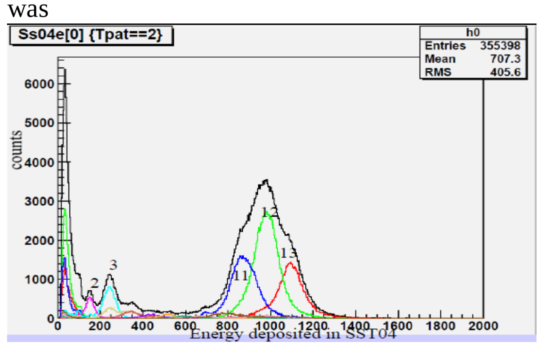

Fig. 3 Charge identification from deposited energy.

subtracted from raw energy resulting in a uniform distribution. The position of a strip cluster is derived using the observed event density in the η-distribution. Fig. 2 shows the correlation of s-position measurements from two in-beam SST detectors after reaction target. Position resolution for s- and k-side corresponding to incoming ^{32}Mg nuclei was measured to be 135.5±0.5μm (Fig.2 (insight)) and 159.1±0.6μm, respectively. Energy distribution was further corrected with the consideration of gain matching of each strip. Fig. 3 shows the energy spectra indicating charge Z=11, 12 and 13.

Conclusion: The calibration of Silicon strip trackers done so far shows reasonable performances. This position measurements will be used for tracking the reaction fragments through the magnetic spectrometer ALADIN resulting in the fragment mass.

References:

[1] B. Alpat et. al. NIM A 540 (2005) 121.
[2] http://sympnp.org/proceedings/55/C3.pdf
[3] O. Toker et. al. NIM A 340 (1994) 572.
[4] www-linux.gsi.de/~rplag/land02.