Prototyping of DSSD detectors for the EXL/R^{3}B collaboration

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Motivation

The EXL experiment as a part of future FAIR facility [1] will provide the means for studying many physics phenomena in unstable exotic nuclei. Reactions will be done in inverse kinematics using new storage-ring techniques and a universal detector system providing high resolution and large solid angle coverage for kinematically complete measurements. Our work focuses on prototyping and testing DSSDs as a part of EXL's Silicon Particle Array (ESPA) [2]. DSSD chips were manufactured at PTI St. Petersburg. In the course of technical development potential synergies in particular with the R^{3}B experiment is expected.

Technical Procedure And Results

Within a first stage of prototyping eight detectors were built and tested. Four of these are of 64×64 strips type and the other four of 64×16 type, respectively with the first number referring to the P$^+$ side and the second to the N$^+$ side of the detector. Detector chips of active area of 21×21mm^2 are 300μm thick and have a strip pitch of 300μm for the 64 strips side and 1250μm for the 16 strips side, respectively. The same epoxy PCB was designed for

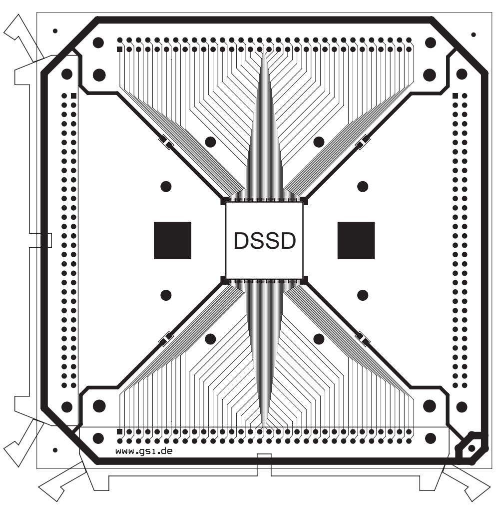

Figure 1: PCB layout for 64x64 and 64x16 DSSDs.

both types of DSSDs (see Fig.1) with standard 64-way IDC connectors enabling to read signals from both sides. The chips were glued with a special low outgasing epoxy to a small step machined on the edge of the inner opening of the PCB and manually bonded. Biasing of the detector was done with the punch-through method using a bias ring surrounding the strips. Total depletion voltage was established at -50V, but overbias of up to -200V was applied to the P$^+$ side with AC-coupled preamps. The grounding through DC-coupled preamps was used on the N$^+$ side. The readout used 16 data channels on each side with 4 strips coupled together in the case of the 64 strip sides. Measurements in vacuum of about 3×10^{-7}torr were performed using a ^{241}Am α source.

Out of 752 tested strips 97% showed good spectroscopic properties. Using P$^+$ (and N$^+$) injection we achieved an energy resolution down to 15.6 keV (and 35.3 keV) for the P$^+$ and 17.9 keV (and 44.6 keV) for the N$^+$ side. Worse resolution for N$^+$ injection is due to distorted field in between the N$^+$ strips caused by P$^+$ implants used to enhance interstrip isolation. Important part of our tests was the study of interstrip events on both sides of the detector whose induced signal is shared between two neighboring strips. Two dimensional correlation analysis of simultaneously occurring signals on both sides of the detector, i.e. P$^+$ vs. N$^+$ strips, was performed to evaluate the interstrip contribution. All events fall into four categories of: 1) strip-strip type with energy signal induced in a single strip on both sides of the detector, 2) strip-interstrip and 3) interstrip-strip type with N$^+$ or P$^+$ respectively, sharing the energy between two neighboring strips and 4) interstrip-interstrip type with both sides having the induced signal shared between two strips. The results show that for P$^+$ injection strip-strip events and those events from strip-interstrip category induced on the P$^+$ side of the detector contribute to about 95% of all events and have average resolution of 18.6 keV. The reconstructed energy E_{strip1}+E_{strip2} from interstrip events has an average resolution of 195 keV and 82 keV and relative contribution of 5% and 20% for P$^+$ and N$^+$ side, respectively. Reconstructed interstrip-interstrip events have a resolution of 336 keV and represent 1% of all events. The percentage distribution of events corresponds within the error bars with the geometry of active and interstrip areas of our detectors. Our prototyping reveals good properties of tested DSSD chips and their usability in future EXL experiment. Further detailed tests as well as a proton beam experiment at KVI, Groningen using a telescope arrangement to test the tracking and energy reconstruction properties of our DSSDs together with Si(Li) detectors are scheduled for the first half of 2009.

References

[1] **FAIR homepage:** http://www.gsi.de/fair/index_e.html

[2] **EXL homepage:** http://ns.ph.liv.ac.uk/ mc/EXL/ns-instrum-exl.html