R&D on Large-Volume Position-Sensitive Si(Li) Detectors

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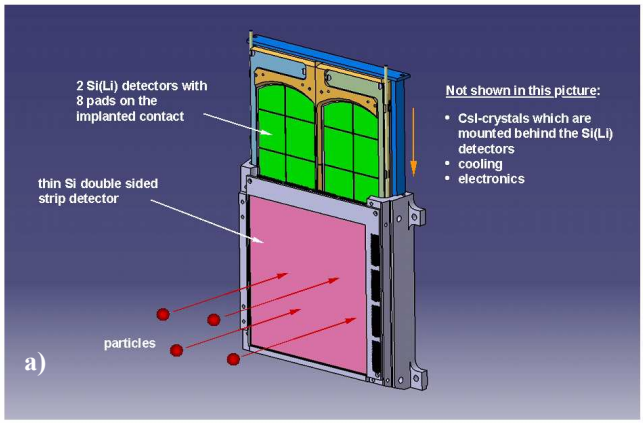
Research and development of large-volume position-sensitive Si(Li) detectors are of great importance for future activities of the EXL-Collaboration.

In the course of the work on large-diameter diodes a serious problem concerning the Li-driftability of the p-type silicon has become more and more apparent. As was feared [1], even relatively thin (4-5 mm) slices of the 5-inch p-type silicon could not be completely compensated even for 4 times longer drifting time. Unfortunately, also some of the 4-inch slices (purchased as Li-driftable p-type silicon) needed prolonged drifting time, especially in their central parts. Now, we are preparing a gettering procedure to eliminate defects inside the starting material that prevent the Li-drift process.

Each position-sensitive structure on our Si(Li) detectors are generally surrounded by an about 5 mm wide guard-ring which prevents the influence of usually high surface leakage current generated on the surface of the Li-compensated region between the detector contacts. Therefore, the area of a guard-ring is practically dead area of a contact surface. Normally, the detector user would like to have the guard-rings as narrow as possible. Concerning only the surface leakage, 1-2 mm wide guard-rings would be a possible solution. But an additional problem has been known since long time: "Surface states" on the Li-compensated region between the contacts distort the normally parallel electric field lines inside a Si(Li) detector. As a result, position and energy information for interactions several mm apart from the edge of the detector contacts could not be correct. Extensive investigations have been undertaken, applying three different methods, to explore the influence of the surface states on the detector response as function of bias voltage, temperature, shaping time constant and the time since the last surface treatment. The first results were presented in [2].

For the experiments at ESR (GSI-Darmstadt) two 7 mm thick Si(Li) diodes with a diameter of 4 inch are under preparation. To relieve the efforts for the first experiments a telescope configuration very similar to that of the MUST II experiment (Saclay, Orsay, GANIL) will be applied, as sketched in Fig. 1. Two Si(Li) detectors equipped with 8 pads on the implanted p^+-contact (the same position-sensitive structure as for the MUST II experiment) will be mounted in a frame which can be inserted in the telescope holder. For illustration, a 5 mm thick Si(Li) detector, under preparation for the MUST II experiment is shown in Fig. 1b.

An important aspect will be the development of UHV-capable detector telescopes for the ESR experiments. All these activities have been partly funded by (R II 3)-EURONS program, contract No. 506065.



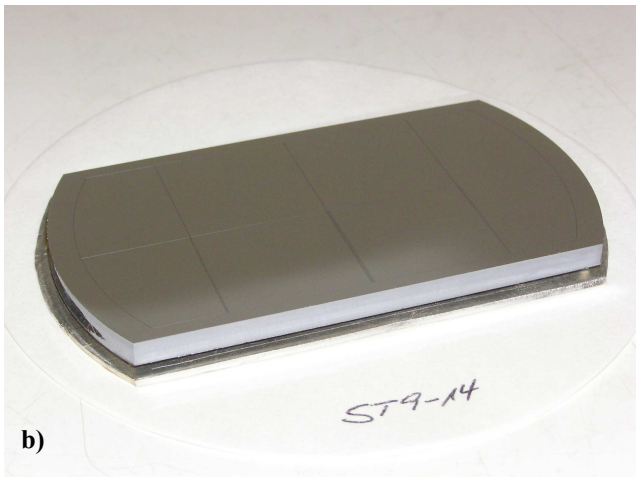


Figure 1: a) First two detector layers of a MUST II telescope for recoil particles (the sketch was made by the MUST II collaboration). Two Si(Li) pad detectors are mounted in a frame which can be inserted into the telescope holder. b) One of the transmission Si(Li) detectors, about 5 mm thick, with 8 pads on the implanted p^+-contact.

References

[1] Annual report IKP 2004.
[2] D. Protić and T. Krings, "Detection Characteristics Near Edges of Large-Volume Si(Li) Detectors", 10th European Symposium on Semiconductor Detectors, Wildbad Kreuth, 2005.