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Construction and Performance of a Double-Sided Silicon Detector Module using the Origami Concept

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The APV25 front-end chip with short shaping time will be used in the Super-Belle Silicon Vertex Detector (SVD) in order to achive low occupancy. Since fast amplifiers are more susceptible to noise caused by their capacitive input load, they
have to be placed as close to the sensor as possible. On the other hand, material budget inside the active volume has to be kept low in order to reduce multiple scattering. We currently construct a low mass sensor module with double-sided
readout, where thinned APV25 chips are placed on a single flexible circuit glued onto one side of the sensor. The interconnection to the other side is done by Kapton fanouts, which are wrapped around the edge of the sensor.

Summary

A major upgrade of the KEK-B factory (Tsukuba, Japan) and the Belle detector is foreseen until 2013/2014. The target luminosity is 5 to 8 x 10^35 cm^-2 s^-1, which is about 30 - 50 times the present value. In the course of this upgrade
the Silicon Vertex Detector (SVD) will be completely replaced, since the present one, particularly its innermost layer, has already reached its limit in terms of occupancy and dead time.

In order to achieve low occupancy the APV25 front-end chip (originally developed for CMS) will be used to read out the Super-Belle SVD. Thanks to its short shaping time of nominally 50 ns an occupancy reduction by a factor of ~12.5 can be
achieved compared to the VA1TA chip of the present system. However, fast amplifiers are more susceptible to noise, which is mainly caused by the capacitive load at the inputs. Hence, the APV chips have to be placed as close to the sensor as possible. On the other hand, Belle operates at comparatively low energies of 3.5 and 8 GeV for positrons and electrons, respectively, and thus the material budget inside the active volume has to be kept low to minimize multiple scattering.
In the present SVD all sensors are read out from the edge of the ladders using long flex circuits and sensor ganging in the outer layers. Regarding the huge capacitive load and the fast shaping, such construction is not feasible together
with APV25 front-end chips.

We present a concept for double-sided readout of a silicon strip detector, covering both low material budget and short connections between sensor and front-end amplifiers. In that scheme the APV25 chips of both sides are placed on a single flexible circuit, mounted onto one side of the sensor. This flex-hybrid is made of only three copper layers and contains integrated pitch adapters to connect the strips on the same side as the hybrid. The channels of the
opposite side are attached by small flexible fanouts wrapped around the edge of the sensor, hence the name Origami Concept. Thermal and electrical insulation between hybrid and sensor is given by a 1 mm Rohacell (low mass styrofoam)
layer. Arranging all front-end chips in a row allows cooling by a single aluminum pipe, which is also used as a mechanical support. To achieve lowest possible material budget, the APV chips will be thinned down to approximately 100 μm.

Presently, the design of the hybrid and the flex fanouts is already finished. A few pieces of them are currently in production and will be delivered until mid of May. After receiving them, we will start to build a module using the Origami Concept as described above. By the time of the TWEPP workshop we will be able to present results of source measurements and a beam test, which is scheduled in August 2009.

Key words:
APV25, Silicon Detector, DSSD, Chip-on-Sensor, Origami, Belle

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