Intermediate silicon tracker development for sPHENIX experiment at RHIC

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The construction of sPHENIX detector[1] has been started since the sPHENIX was approved for the Project Decision-2/3 (corresponds to DOE's Critical Decision-2/3) in May, 2019. The subsystem detectors are now under mass production. We have been developing the one of the tracking devices of sPHENIX called INTermediate Tracker (INTT), which consisted of 2 layers of a silicon strip sensor. The INTT is the only tracker which has better than 1 beam clock resolution in sPHENIX trackers. It provides thus the timing of particle trajectories. A telescope was assembled with 3 layers of prototype ladder for the first beam test in March, 2018 at Fermilab test beam facility (FTBF). The prototype detector demonstrated satisfactory position resolution as designed and about 96% detection efficiency using well focused 120 GeV proton beam.

The design of silicon sensor and the high density interconnect readout cable were finalized after the first beam test. The next prototypes were considered as pre-production versions and new silicon ladders were assembled again to be tested in the next round beam test at FTBF in June, 2019. The performance of the pre-production ladders are discussed in Ref. 2). The attempt to reproduce observed performance by a GEANT MC simulation is in progress. The very first attempt was made in this beam test to accumulate data with the full chain of the INTT readout system including the 1.2 meter long bus extension cable.[3] Technologically, it is the most challenging R&D of the INTT project.

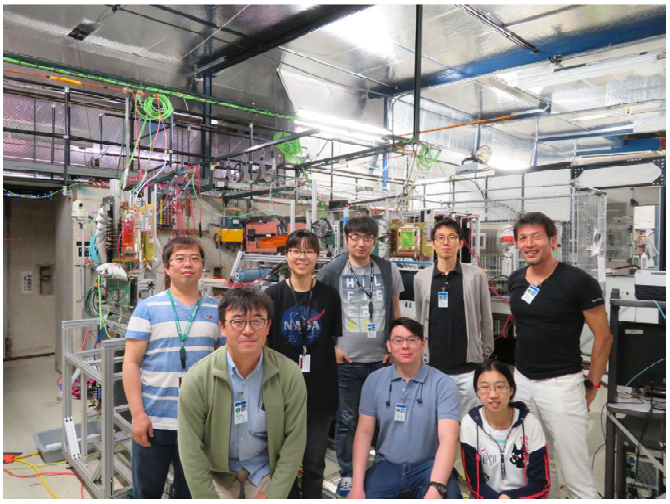

Fig. 1. The INTT collaboration at the Fermilab test beam facility in June 2019.

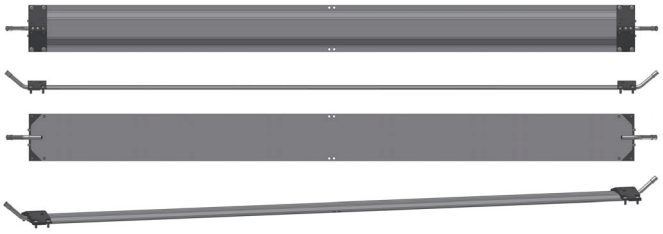

Fig. 2. The latest stave design (liquid cooling type).

The stave is the support structure of the INTT module which consisted of silicon sensors and HDI. It requires not only the stiffness, but also high thermal conductivity in order to remove heat generated from the read out chips mounted on the HDI. The stave is made of a carbon fiber reinforced plastic and its prototyping has been proceeded in Asuka Co. in Japan and Lawrence Berkley National Laboratory in parallel. The latest stave is designed to be (Fig. 2) a liquid cooling type using a carbon fiber composite tube laid out in the middle of the stave. The fabrication of the latest design has been procured in Asuka Co.

The development of the INTT detector is thus in the final stage, the preparation for the mass production is in progress. Produced all silicon sensors are to be tested and evaluated in National Central University, Taiwan.[4] The ladder assembly is to be performed in both National Taiwan University[5] and BNL.[6] The mechanical design of the INTT ladders, readout chain, and support structure is discussed in Ref. 7).

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References

1) Conceptual Design Report of sPHENIX (2018).
2) A. Suzuki *et al.*, in this report.
3) T. Hachiya *et al.*, in this report.
4) K. Chen *et al.*, in this report.
5) C. Shih *et al.*, in this report.
6) M. Connor *et al.*, in this report.
7) D. Cacace *et al.*, in this report.