Overview of silicon strip sensor detector development for sPHENIX experiment

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The intermediate tracker (INTT)[1,2] is a barrel type tracker to be implemented outside of another tracking device MVTX detector near the beam pipe and covering central rapidity region of the sPHENIX collision point as shown in Fig. 1. The development of INTT is now in the second generation prototype testing stage. Shown in Fig. 2 is the INTT ladder prototype for layers 1 to 3. Various response tests have been executed and resulting performances are found to be satisfactory.[3] Further tests will be performed using cosmic rays in the test bench. An external trigger using scintillators is under development for the measurement.[4] These prototypes are to be tested with a beam at Fermilab in March, 2018. A three-layer telescope setup is under preparation for the beam test. In parallel, the third generation silicon sensors for the layers 1 to 3 are already under manufacture and they are expected to be the pre-production version.

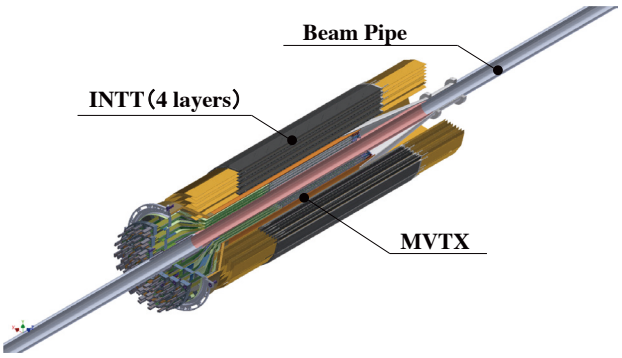

Fig. 1. Layout of inner tracking systems of the sPHENIX experiment. The beam pipe is lapped with 3 layers of MVTX and 4 layers of INTT detectors.

The study was made to optimize the design of the layer-0.[7] Due to the closest distance from the collision point, the layer-0 is designed to reduce its channel occupancy of the detector by charged particles as much as possible. As shown in Fig. 3, the first prototype for the layer-0 silicon and the high density interconnect (HDI) readout cable have been manufactured and to be tested in spring of 2018. The HDI of layer-0 is designed to be narrower than that of layers 1 to 3 since number of signal lines are fewer.

The biggest technical challenge in the R&D process of the INTT is a design of its bus extender cable. Due to the requirement of long signal transmission ($\sim$ 1.3 m) within a limited space, standard flat flexible cables can not be used. A development of a high density multi-layered flexible cable have started effectively in spring of 2017.[5] One of key developments is to make the differential signal line width as narrow as possible and achieve the higher density in order to satisfy the compactness of the cable. We are about to get to the latest technology limit of the line width for 1.3 m distance.

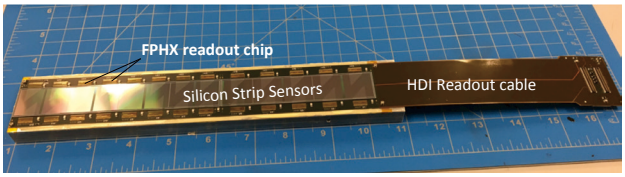

Fig. 2. The INTT ladder prototype for layers 1 to 3. The ladder consisted of silicon sensors, FPHX readout chips used for former silicon detector in the PHENIX experiment, a high density interconnect (HDI) readout cable and a support structure.

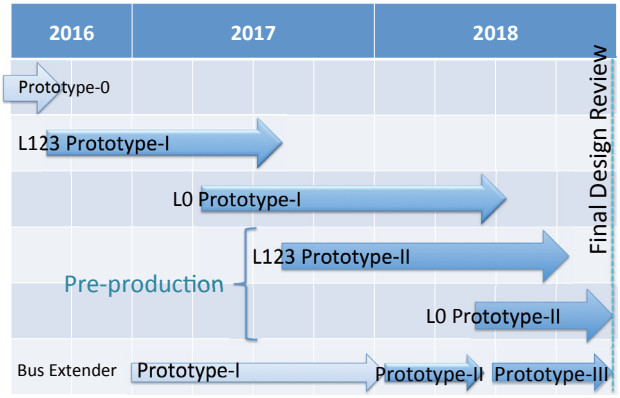

Fig. 3. R&D schedule of INTT.

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References

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