Intermediate Tracker Integration in sPHENIX

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The sPHENIX collaboration at RHIC is constructing a major upgrade to the PHENIX detector, consisting of an entirely new spectrometer based on the former BaBar solenoid magnet and the PHENIX facilities and infrastructure.[1)] The upgrade will allow for an in depth jet and beauty quarkonia physics program to address the fundamentals of strongly coupled quark-gluon plasma. The solenoid magnet is sandwiched by hadronic calorimeters (HCal) followed by an electromagnetic calorimeter (EMCal). Inward of the EMCal is a time projection chamber (TPC), INTermediate silicon strip Tracker (INTT) and MAPS-based VerTeX detector (MVTX) composing the sPHENIX tracking system. All of the subsystems have their challenges when coalescing with one another, but the INTT is of particular interest in terms of integration considerations.

The INTT design, constrained by its neighbors, has been heavily influenced by the other sPHENIX tracking components. The MVTX's active region has an outer diameter of 10.5 cm and has a service cone longitudinally starting at 25 cm from the vertex and grows to a diameter of 21.5 cm. The TPC has an inner diameter of 40 cm that spans a length of 117 cm from the vertex in both directions. The INTT has to fit between these envelopes. The INTT detector itself consists of three main components each consisting of several subcomponents as seen in Fig. 1.

The first main component is the active region containing the silicon sensors. Four sensors are wire bonded to 52 FPHX chips[1)] which are wire bonded and epoxied to two high-density interconnects (HDI) and both are epoxied to a stave for structural support. This assembly, known as a ladder, as seen in Fig. 2, covers an acceptance of pseudorapidity of ± 1.1. Several ladders arranged tangentially to a circle around the vertex compose what is referred to as a barrel. The active area of the sensors is approximately half the width of the HDI, which lends itself to a configuration where two barrels are required to obtain hermetic 2π azimuthal coverage, referred to as one layer. The detector consists of four barrels or two layers at approximate radial positions of 7.2, 7.7, 9.7 and 10.3 cm from the beam axis. The layers are held in position with a series of stave end-caps and end-rings.

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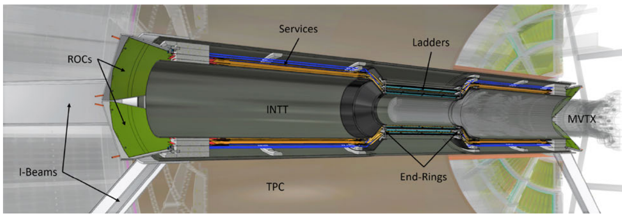

Fig. 1. INTT in sPHENIX 3D model cross section.

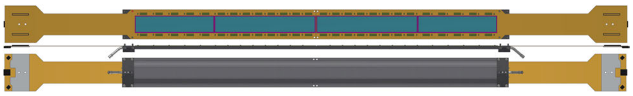

Fig. 2. INTT ladder 3D model.

The end-rings also attach the barrels to the second main component, the service barrel. The service barrel, consisting of two carbon fiber tubes and miscellaneous brackets, carries the services (cables, cooling, nitrogen, *etc.*) from the ladders to beyond the TPC volume. The cables terminate just beyond the TPC and connect to the readout cards (ROC). The cooling and nitrogen connect to manifolds beyond the TPC. From there all the services are routed to the respective racks and/or infrastructure facilities. The outside of the service barrel also has features that allow for the detector and service barrel to installed as a singular unit.

Lastly, the third main component of the INTT is its support structure. Consisting of a carbon fiber tube and aluminum I-beams, the support structure facilitates the installation and operation of the INTT and all of its services. The I-beams connect the carbon fiber tube to the inner HCal creating a direct load path for the detector and direct service routing to the INTT's racks. The I-beams also support the ROCs at an appropriate location for the HDI extension cables that have a maximum length of 120 cm.

Prototype ladders are being produced to verify the design and assembly fixtures for production.[2)] Prototype end-rings will be produced in conjunction with the ladders to verifying the barrel configurations. The service barrel and support structure designs are far along and are continuously being verified that they properly integrate with the surrounding sPHENIX detectors.

References
1) sPHENIX Conceptual Design Report (2018), `https://indico.bnl.gov/event/4625/attachments/18432/23516/sphenix-conceptual-design_051918.pdf`.
2) C. Miraval *et al.*, in this report.