The Intermediate Tracking System of the sPHENIX Detector at RHIC

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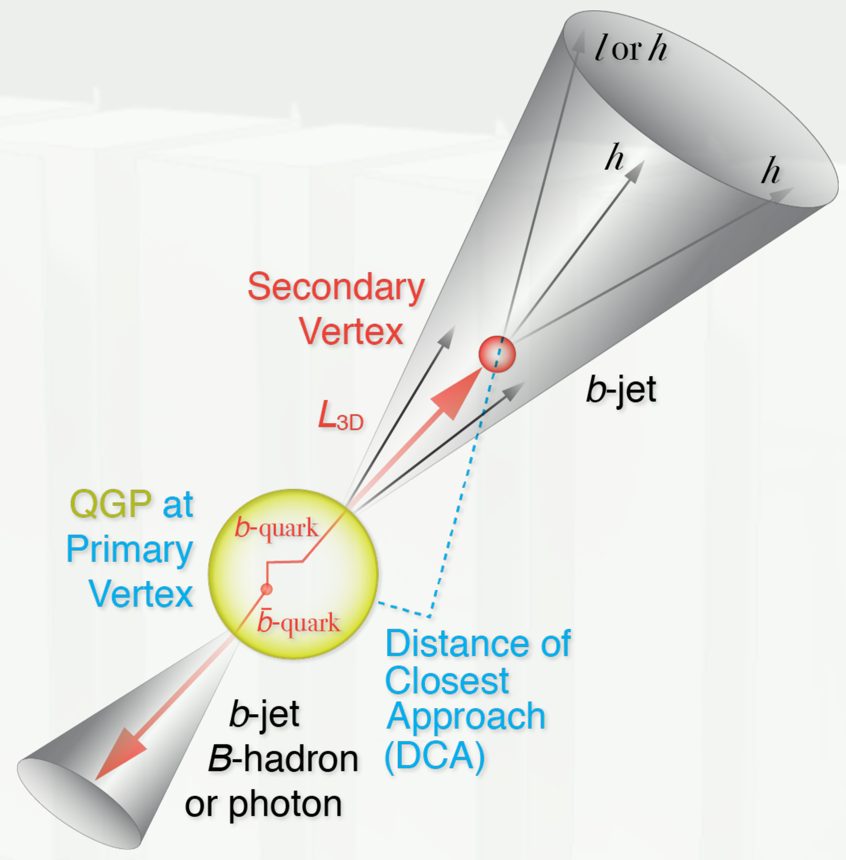
for the sPHENIX Collaboration

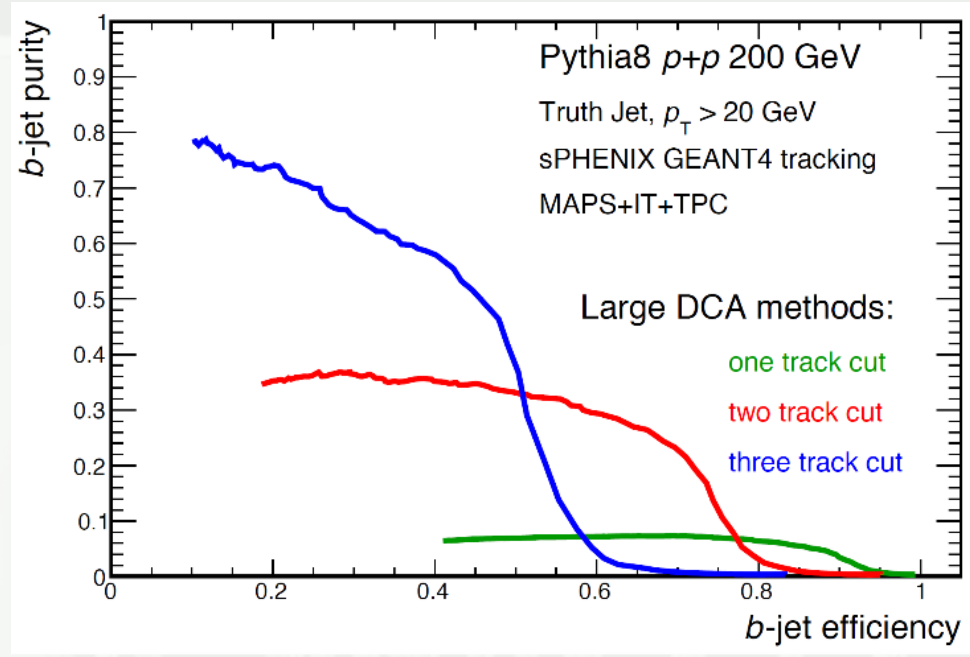
Physics motivation and requirements

The sPHENIX experiment provides data to investigate the dynamics of QGP by making use of three science drivers: jet structure, heavy-flavor jet production, and Υ spectroscopy. Each driver depends on precision tracking in a challenging environment: high luminosity, high multiplicity, and continuous readout of TPC (time projection chamber).

The sPHENIX tracker "reference" design consists of MAPS (monolithic active pixel sensors) and TPC for the inner- and outer-tracking system, respectively.



b-tag jet: efficiency vs. purity



See Haiwang Yu's poster in detail.

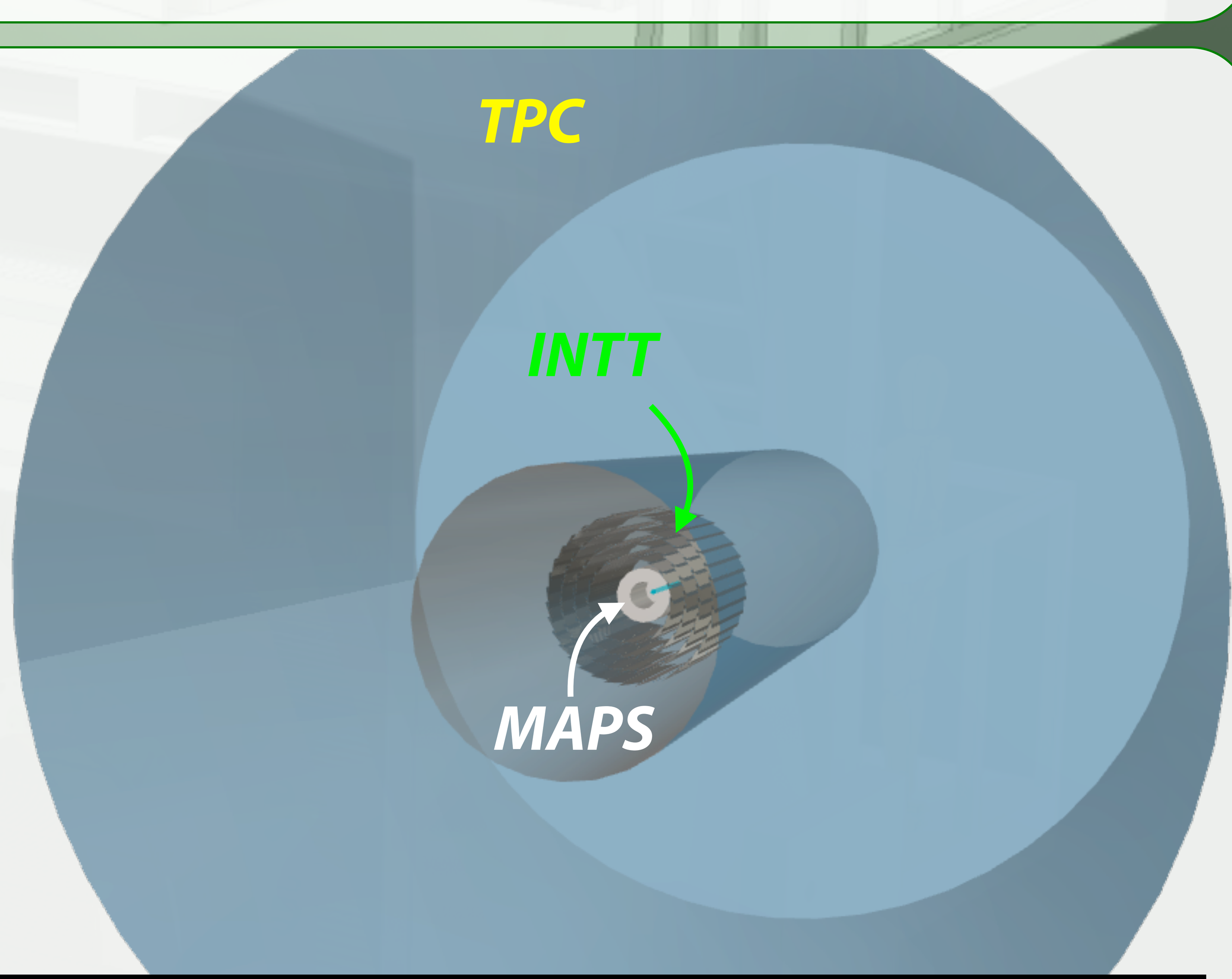
Design of the sPHENIX intermediate silicon tracker (INTT)

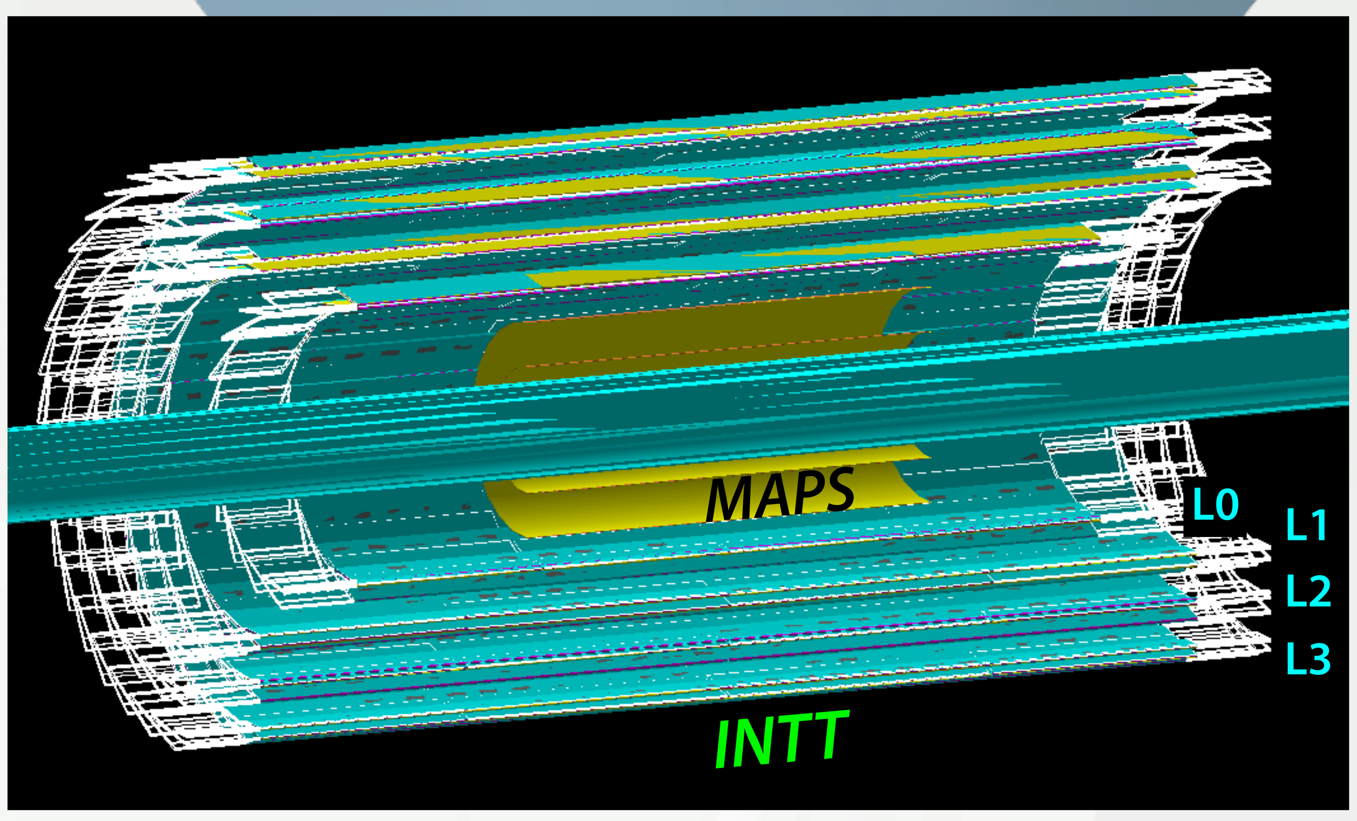
Intermediate silicon tracking (INTT) adds to the robustness of pattern recognition, momentum reconstruction, and capability of high multiplicity trigger in a challenging environment of high luminosity and high multiplicity.

Key concepts of INTT:

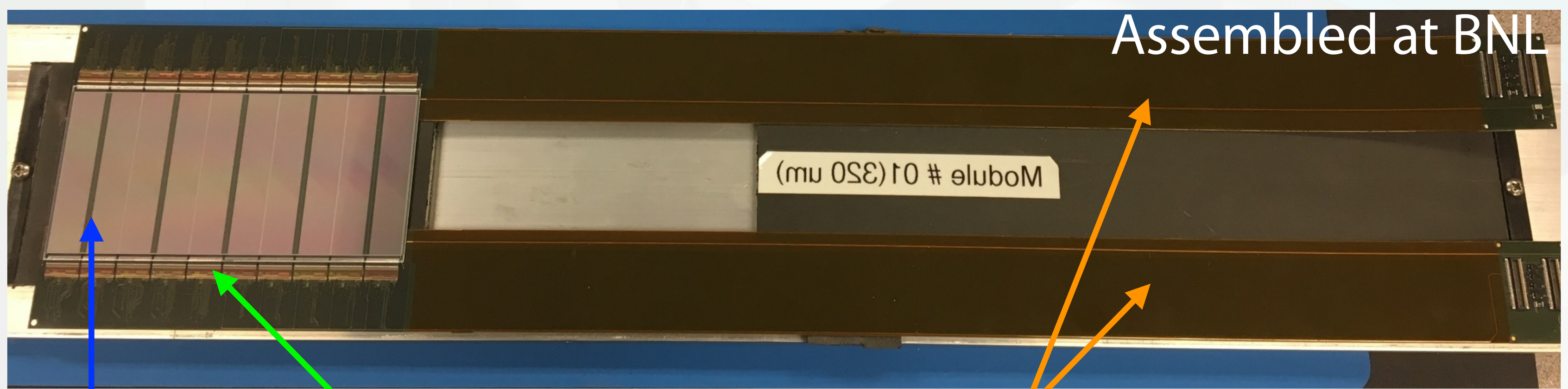
i) contribute unique association between inner and outer trackers
ii) ensure both high track reconstruction efficiency and purity
iii) azimuthal 2π and $|\eta| < 1.1$ coverages at $|z| < 10$ cm
iv) four planes of strip detectors from Layer 0 to Layer 3
 - same readout chip and electronics as used in the PHENIX forward silicon vertex detector
 - cooling by air or high-thermal-conductivity-plate (700–1950 W/(m K)) maintain low material budget (under investigation).

Layer	Radius (cm)	The number of ladders	Strip size (φ x z, mm)	Active area (m²)
0	6	20	0.078 x 18	0.144
1	8	26	0.086 x 12/20	0.261
2	10	32	0.086 x 12/20	0.321
3	12	38	0.086 x 12/20	0.381





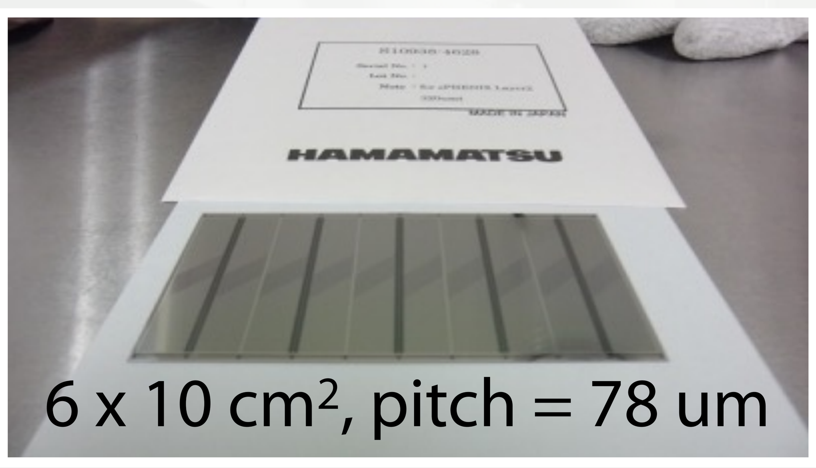
R&D of the prototype silicon-sensor-module



FPHX readout chip (128 ch / chip, 64 mW)

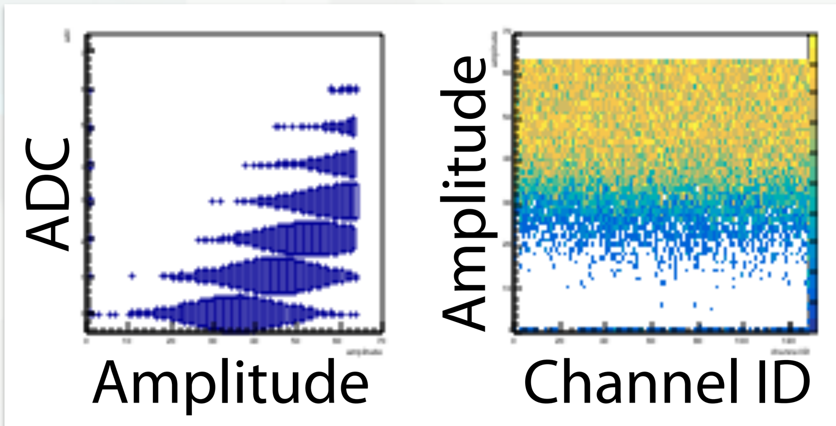
High-density interconnects (flexible printed circuits)

Prototype silicon sensor (Hamamatsu)



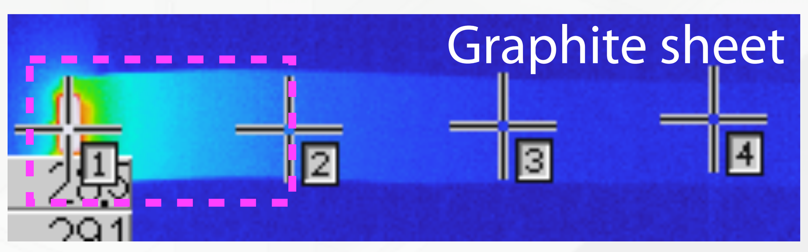
6 x 10 cm², pitch = 78 um

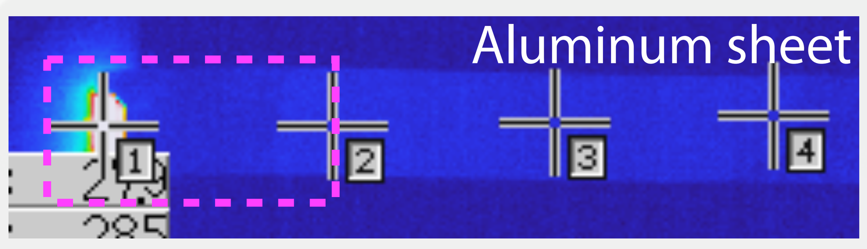
ADC readout tests using a calibration pulse generator



- Clear correlation between pulse amplitudes and ADC
- All channels (128 channels for each chip) look good.

Heat transfer tests of graphite and aluminum sheets





- Cooling by high-thermal-conductivity-plate is under test.
- Graphite sheet (Panasonic, left) indicates much better heat spread compared to aluminum plate (right).

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