Intermediate Silicon Tracker For STAR HFT Upgrade

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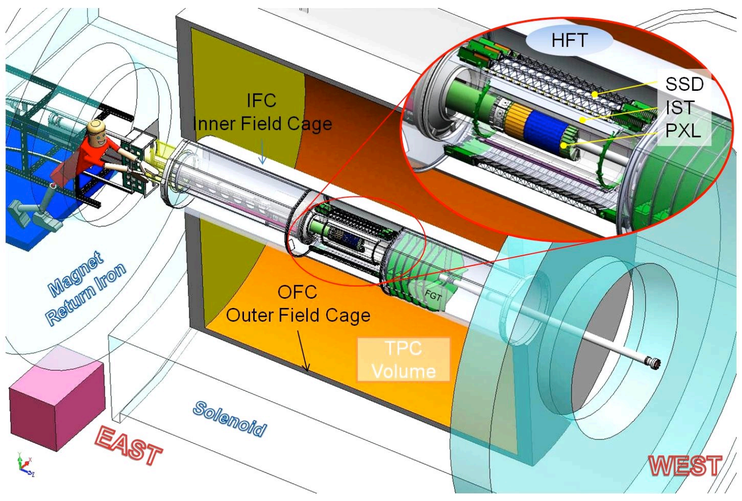
Abstract

A Heavy Flavor Tracker (HFT) has been installed in the STAR experiment at the Relativistic Heavy Ion Collider since January 2014. It greatly enhances the capability for heavy flavor studies by measurements of displaced vertices and direct topological reconstruction of open charm hadrons. The HFT consists of two inner layers of silicon pixel detectors, an intermediate layer of silicon pad detector and an outer layer of silicon strip detector. The Intermediate Silicon Tracker (IST) is the third layer made of silicon pad sensors, which have a position resolution of about 180 (1800) microns in the r-φ (z) direction. In this poster, we will present the design of the IST detector system, and its performance in the cosmic ray tests and ongoing physics data taking with Au-Au collisions.

Physics Motivation

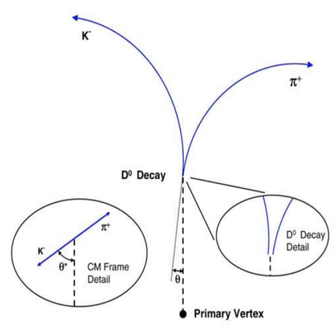


Detector	Radius (cm)	Hit Resolution R/φ - Z (μm - μm)	Radiation length
SSD	22	20 / 740	1% X_0
IST	14	170 / 1800	<1.5% X_0
PIXEL	8	12/ 12	~0.6% X_0
	2.5	12 / 12	~0.4% X_0

IST (Intermediate Silicon Tracker)

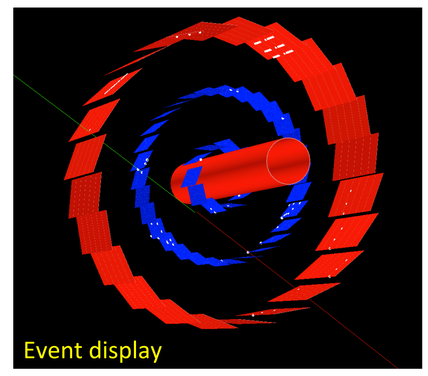
- 1 layer of silicon pad sensors
- Guiding tracks from the SSD to the PIXEL
- Operate without significant event pile-up for 200 GeV Au+Au

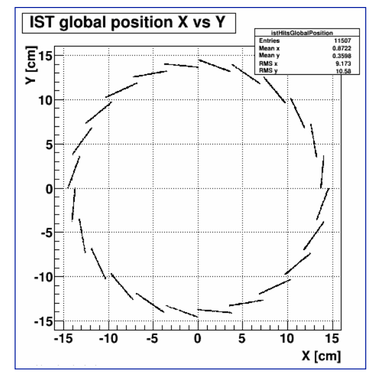
Heavy Flavor Tracker (HFT) will greatly enhance the capability of STAR for heavy flavor studies (energy loss mechanism and partonic thermalization), allowing identification of displaced vertices and direct topological reconstruction of open charm hadrons.



$D^0 \rightarrow K^- \pi^+$, $c\tau \sim 120$ μm

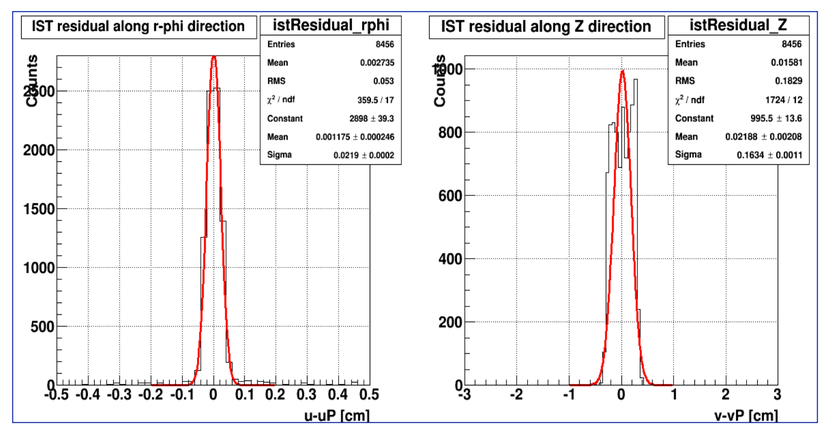
Performance of IST in Cosmic Run

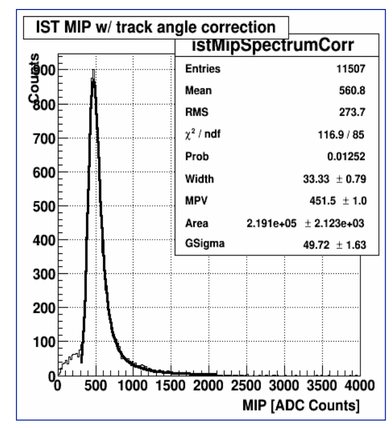




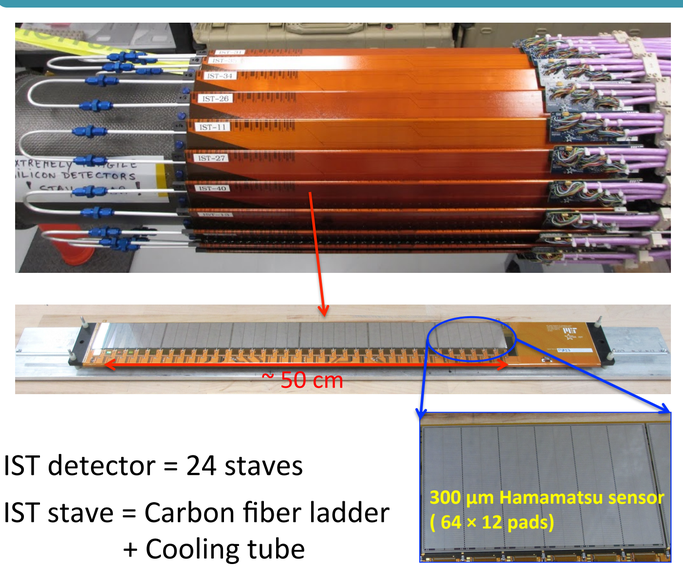
IST detector performance:

- Residual resolution (calculated by line projection with zero-Field data):
  - on r-ϕ direction: 220±2 μm
  - on Z direction: 1634±11 μm
- Signal-to-Noise ratio (after track angle correction): 9~10 (MPV and Sigma obtained by Convoluted Landau and Gaussian Fitting Function)





Technical Design

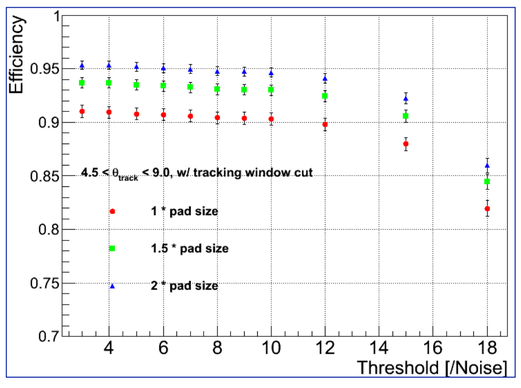


IST detector = 24 staves

IST stave = Carbon fiber ladder
+ Cooling tube
+ Kapton flex hybrid + Passive components
+ 6 silicon pad sensors +
+ 3 x 12 APV25-S1 readout chips

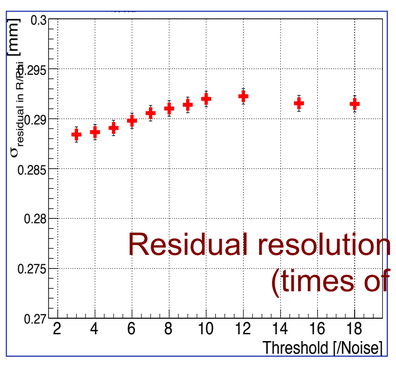
Radius	14 cm
Length	50 cm
ϕ-Coverage	2π
|η|-Coverage	⩽1.2
Number of Ladders	24
Number of hybrids	24
Number of sensors	144
Number of readout chips	864
Number of channels	110592
r-φ resolution	172 μm
Z resolution	1811 μm
Z pad size	6275 μm
R-φ pad size	594 μm

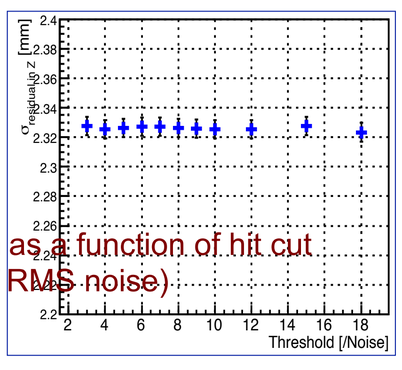
Performance of IST Prototype in Cosmic Ray Tests



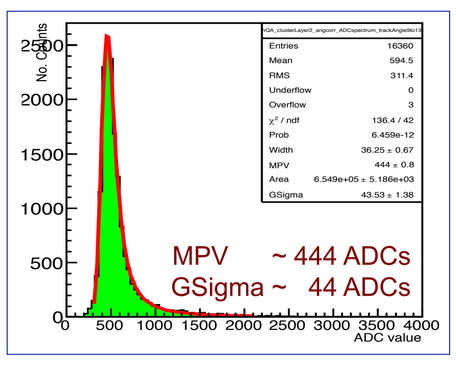
IST prototype performance:

- Residual resolution (calculated by line projection method):
  - on r-ϕ direction: 291 ± 1 μm
  - on Z direction: 2326 ± 6 μm
- Signal-to-Noise ratio (after track angle correction): 10 (MPV and Sigma obtained by Convoluted Landau and Gaussian Fitting Function)
- Efficiency decreases vs threshold (times of RMS noise), ~95% with 2 pad size tracking window cut

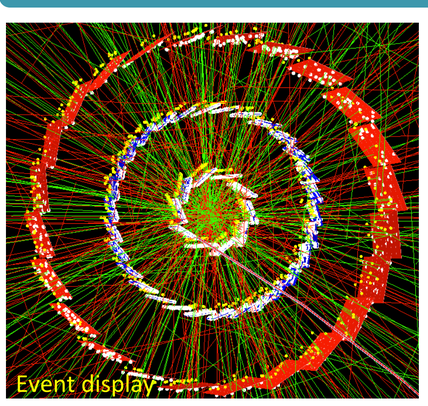




Residual resolution as a function of hit cut (times of RMS noise)



Performance of IST in Au+Au@200 GeV



Calibration (pedetal/ rms vs channnels)

IST residual deduced by alignment

IST tracking efficiency

Summary