The Heavy Flavor Tracker (HFT) for STAR

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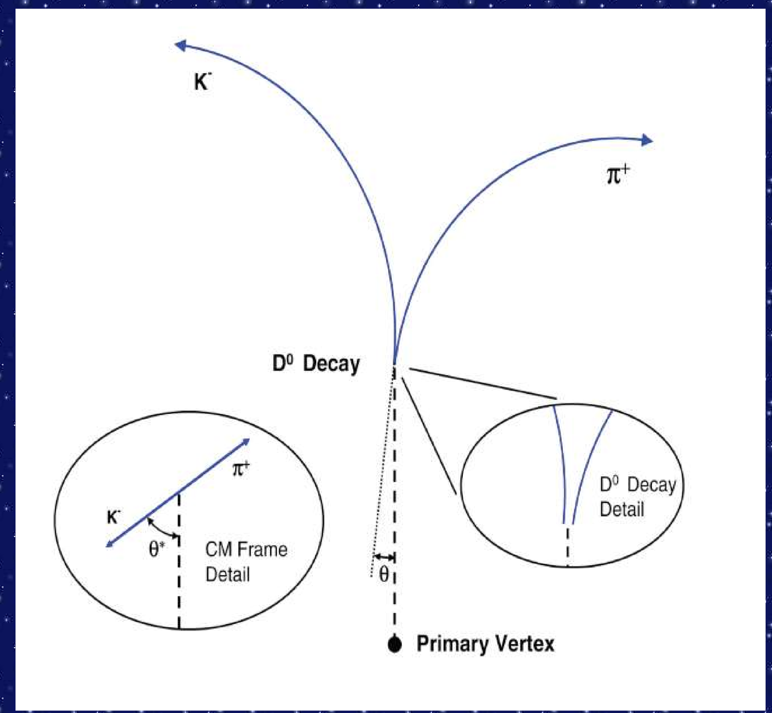
Charm at RHIC

The goal of RHIC is the identification and study of the properties of matter with partonic degrees of freedom. Previous studies have identified partonic collectivity, but have not demonstrated thermalization of the created matter. The study of the production of charm hadrons can address this issue.

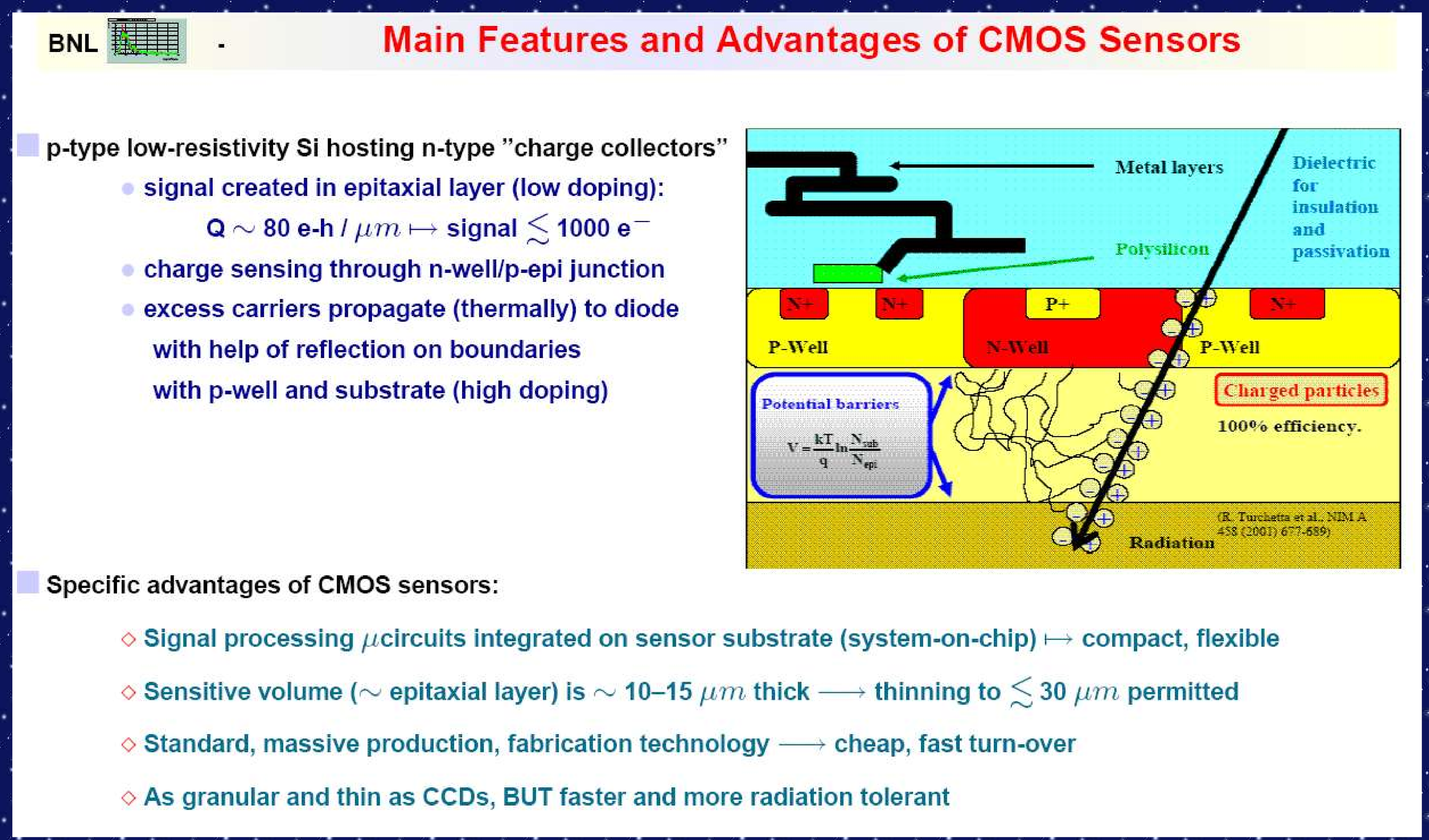


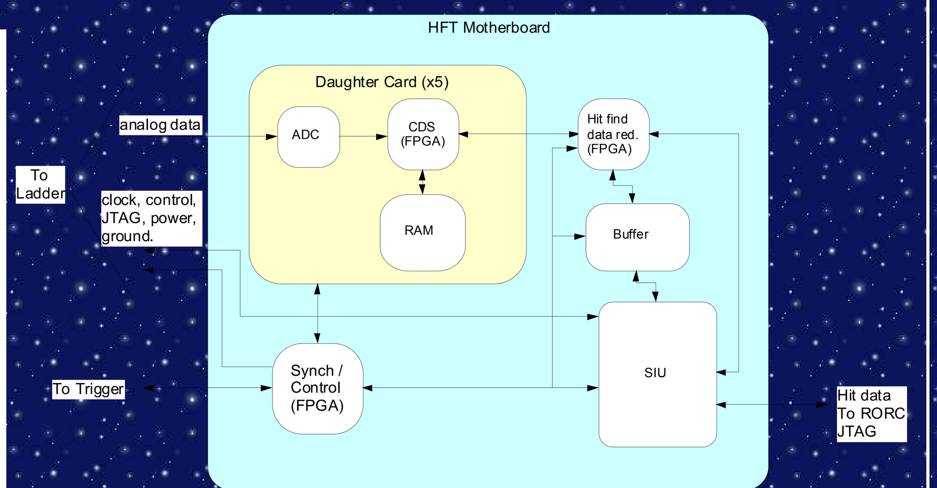
Why heavy-flavor quarks?

Heavy-flavor quarks, e.g. charm quarks, are due to their heavy mass a special probes. They are created early in the interaction and in later times maintain their characteristics developed during the early stages of the collision. Since they derive their mass from the Higgs field they stay heavy - even during chiral symmetry restoration and hence even in a QGP.

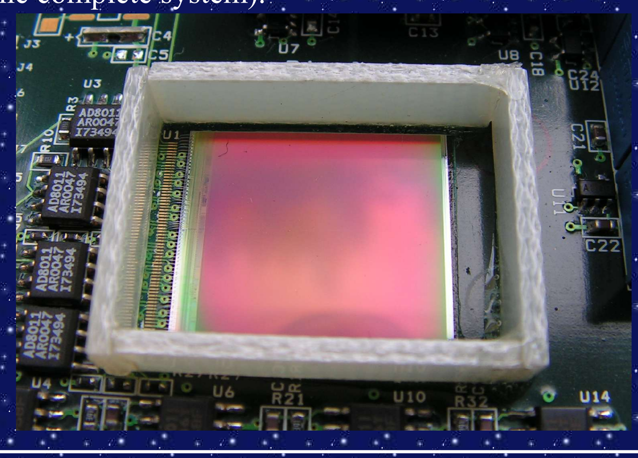
The HFT detector will allow us to identify a D^0 decay-vertex by reconstructing the trajectory of its two daughters. The picture shows the kinematics of the decay. The following selection criteria will be used to separate the D^0 signal from background: 1 - the decay length l, with l being the distance between the primary vertex and the D-meson vertex; 2 - the difference Δm between the reconstructed invariant mass and the D^0 rest mass ; 3 - the distance of closest approach $DCA_{\pi K}$, between the two daughter tracks ; 4 - isolation cuts on cos(θ), with θ being the angle between the D^0 momentum (vector sum of the two daughter momenta) and the vector joining the primary vertex to the D-meson decay vertex; 5-Isolation cuts on cos(θ*), with θ* being the angle between the kaon in the D-meson center of mass frame and the D-meson momentum.

Active Pixel Sensors





The readout system is of large parallel design. The block Readout and Data transfer diagram shown above is for one ladder (out of 24 ladder of the complete system).



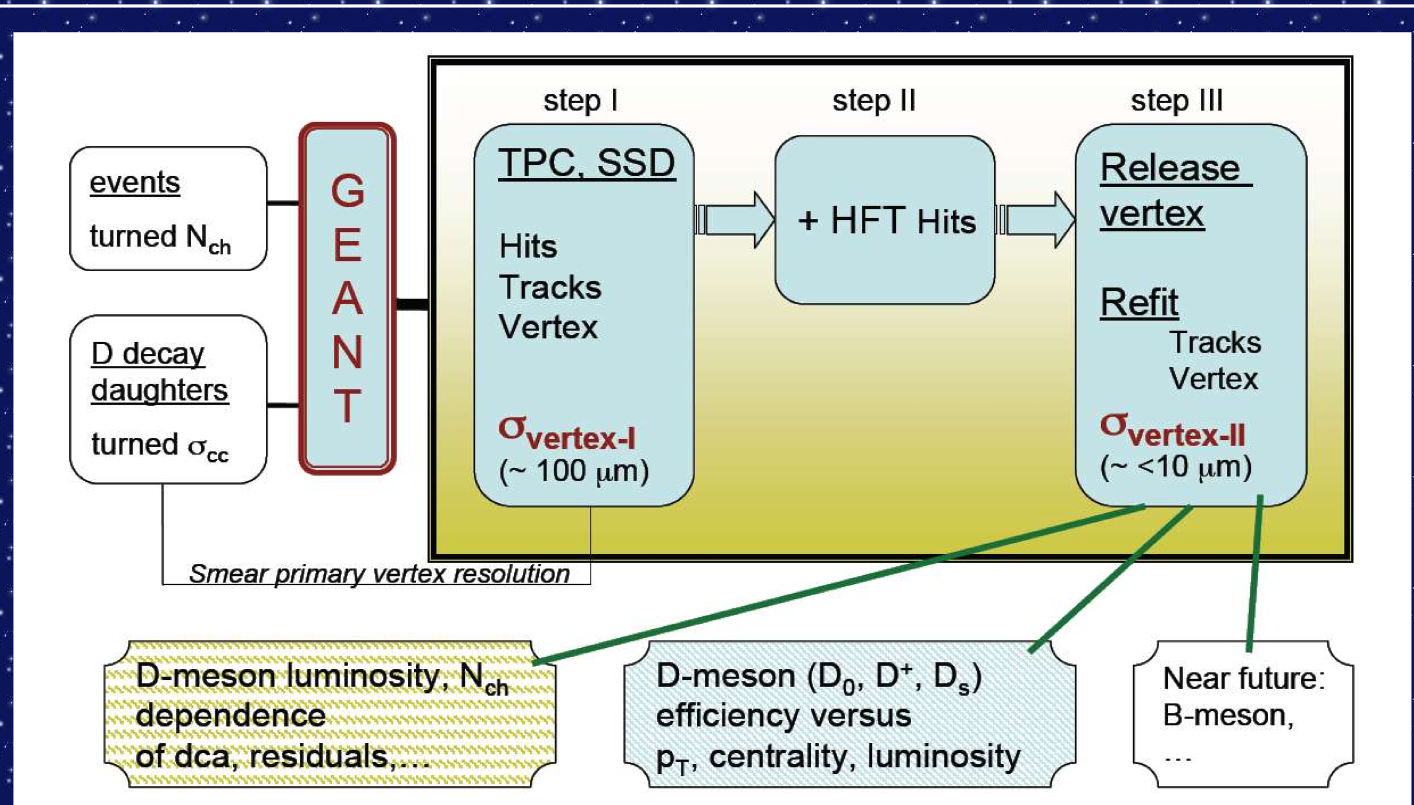
APS MIMOSTAR chip on the test board (APS developed by Institut de Recherches Subatomiques in Strasbourg (IReS) and Laboratoire d' Electronique et de Physique des Systemes Instrumentaux (LEPSI)

Event reconstruction (prototype)

Event Reconstruction Requirements:

High Purity. The track will only achieve the desired resolution if the correct hits are added.

High Efficiency. The (correct) hits must be added at sufficient rates to allow two and three body decay reconstruction.

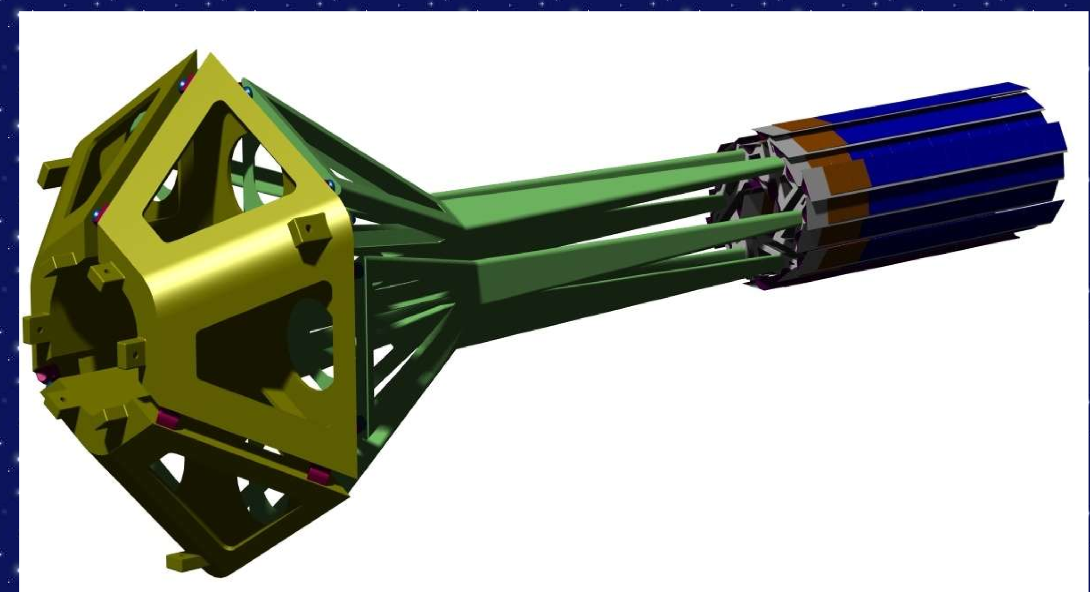


Heavy Flavor Tracker Design

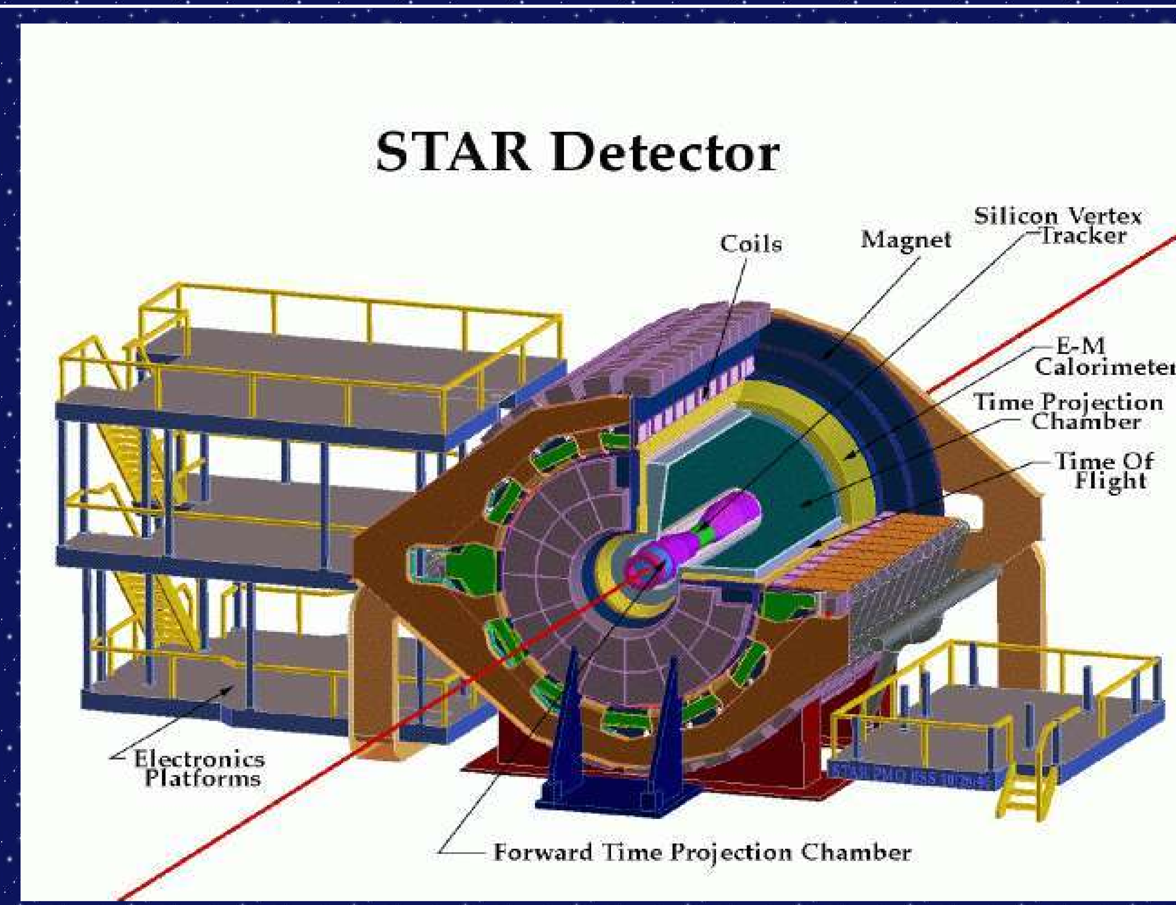
To provide the accurate track reconstruction required by the intended measurements, the detector design includes:

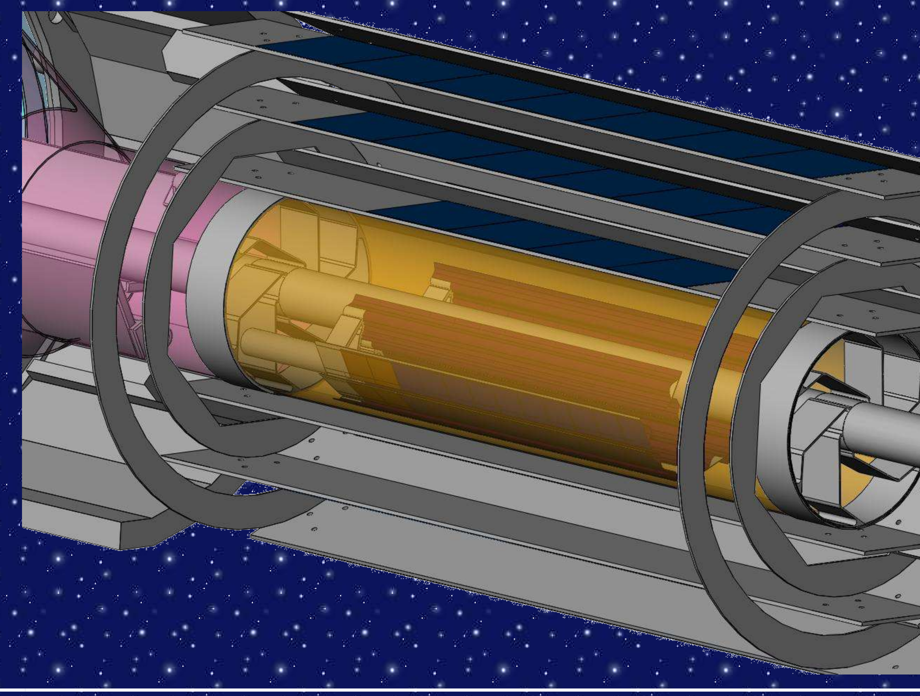
- Small radiation length to minimize multiple scattering
- Sensors positioned close to the interaction region (1.5 cm)
- High resolution (8µm) for pointing accuracy; sufficient to resolve decay vertices

Individual ladder arrangement of CMOS sensors



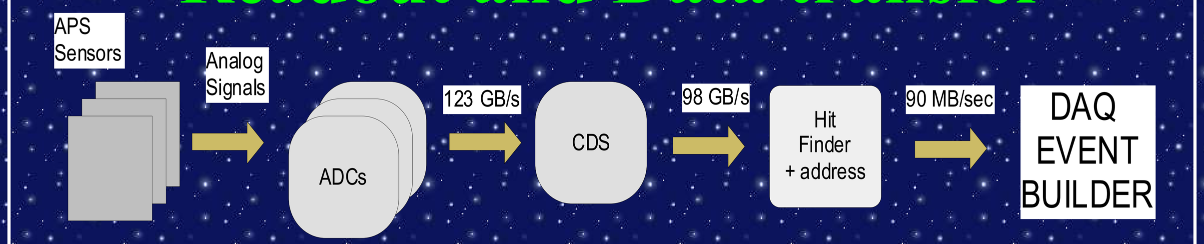
Full ladder array together with support structure



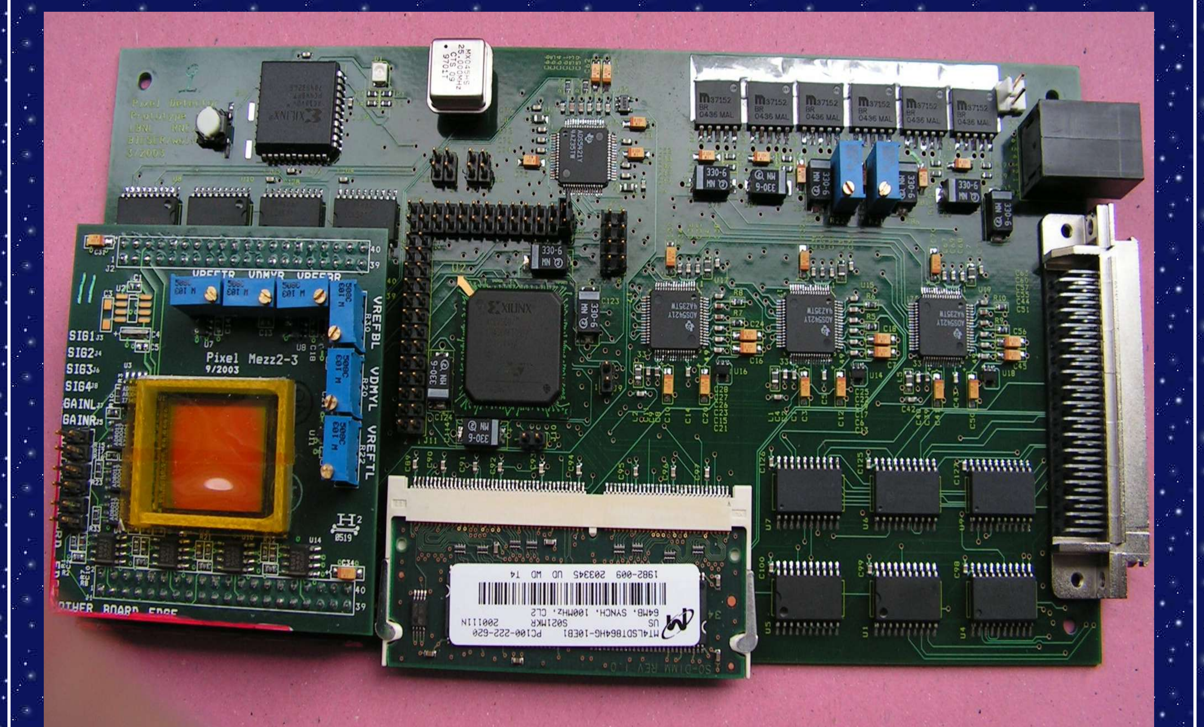


The HFT embedded within the current STAR geometry.

Readout and Data transfer



100 hits/cm² inner layer, 20 hits/cm² outer layer ($L = 10^{27}$), event size = 90 MB/sec at 1kHz



Prototype of readout electronics for laboratory tests of APS MIMOSTAR chip developed at LBNL, Berkeley, USA.

Charm reconstruction

Charmed hadrons are reconstructed through their decay topology. The effectiveness of selection cuts to suppress the background and improve the signal to noise ratio can be investigated. Result is that D mesons and Λ_c are predicted to be successfully reconstructed at significant rates, allowing the study of spectra and charm flow in an event.

Study of charmed hadrons at STAR in RHIC is a challenging measurement, which will require an upgrade to the current tracking detector suite. Current schedule includes the prototype detector installation in 2008, and full detector in 2010.

REFERENCES

[1] Z. Xu et al. "A heavy flavor tracker for STAR", LBNL-PUB-5509, http://www-library.lbl.gov/docs/PUB/5509

[2] K. Schweda for the STAR collaboration "A Heavy-Flavor Tracker for STAR", arXiv: nucl-ex/0510003.

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Z. Xu[1], Y. Chen[2], S. Kleinfelder[2], A. Koohi[2], S. Li[2], H. Huang[3], A. Tai[3], M. Sumbera[4], C. Colledani[5], W. Dulinski[5], A. Himmi[5], C. Hu[5], A. Shabetai[5], M. Szelezniak[5], I. Valin[5], M. Winter[5], M. Miller[6], B. Surrow[6], G. Van Nieuwenhuizen[6], L. Greiner[7], Y. Lu[7], H.S. Matis[7], M. Oldenburg[7], H.G. Ritter[7], F. Retiere[7], A. Rose[7], L. Ruan[7], K. Schweda[7], E. Sichtermann[7], J.H. Thomas[7], H. Wieman[7], N. Xu[7], Y. Zhang[7], I. Kotov[8]

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