Design of the sPHENIX tracker

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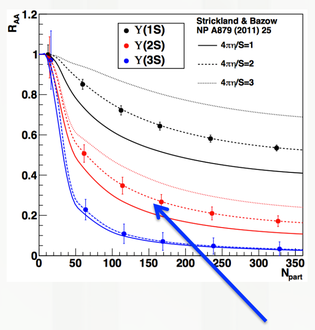
for the sPHENIX Collaboration

Abstract

sPHENIX is an upgrade to the PHENIX detector proposed to explore the quark-gluon plasma formed in heavy ion collisions through measurements of jets and upsilons at RHIC in the 2020's. The experiment will feature a 1.4 Tesla superconducting solenoid magnet which was formerly used by the BaBar experiment. sPHENIX comprises a charged particle tracking system and electromagnetic and hadronic calorimeters which have full azimuthal coverage and span 2 units of central pseudo-rapidity. The tracking system will consist of a Time Projection Chamber (TPC) with a GEM-based readout, an intermediate silicon strip tracker (INTT), and a MAPS (Monolithic Active Pixel Detector) micro-vertex detector. The design and current status of the tracker simulation studies along with key performance results are presented.

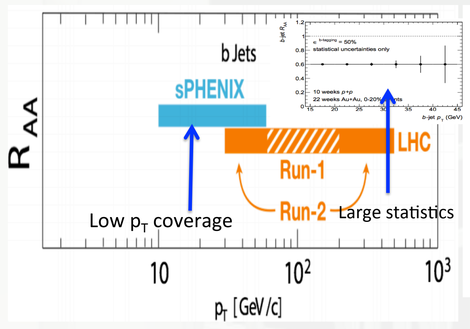
Tracking Physics Motivations

Quarkonia measurement



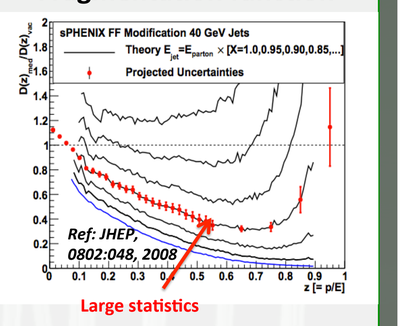
Υ(1s,2s,3s) separation require momentum resolution of ~1.2% in 4 GeV < p < 10 GeV

b-tagged jets measurement



Require measurement of displaced vertex of D or B meson decay with high precision.

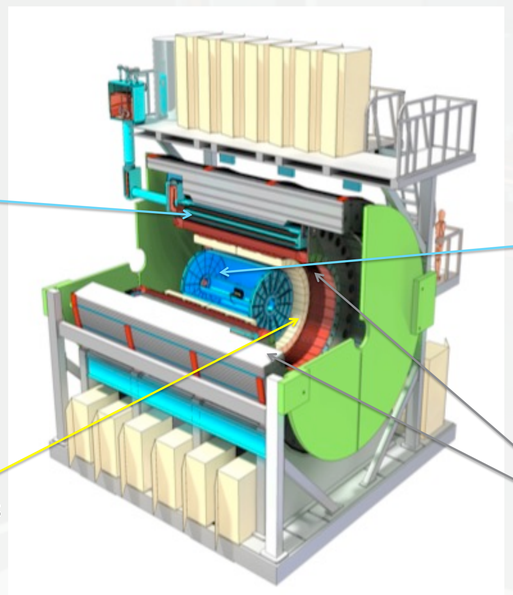
Fragmentation function



Requires momentum resolution of 1% at low z while 0.2% at high z along with uniform acceptance

Detector Overview

-1.1 < η < +1.1, ΔΦ= 2π, High rate DAQ , 15kHz



Babar solenoid, 1.4 T

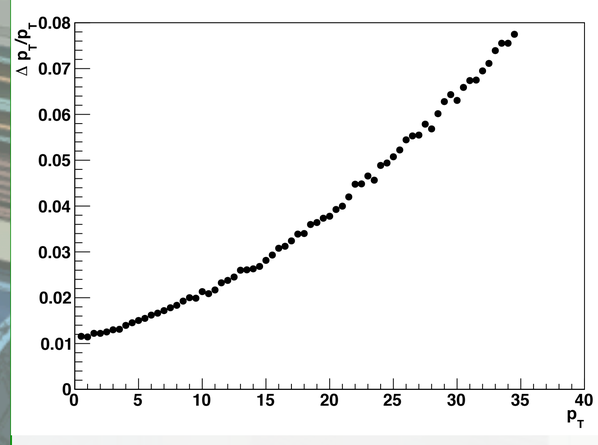
MAPS, silicon strip tracker and TPC for tracking charged particles.

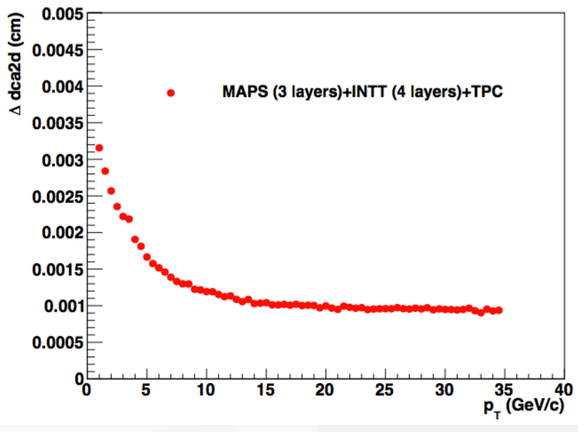
EMCal for measuring electrons and photons

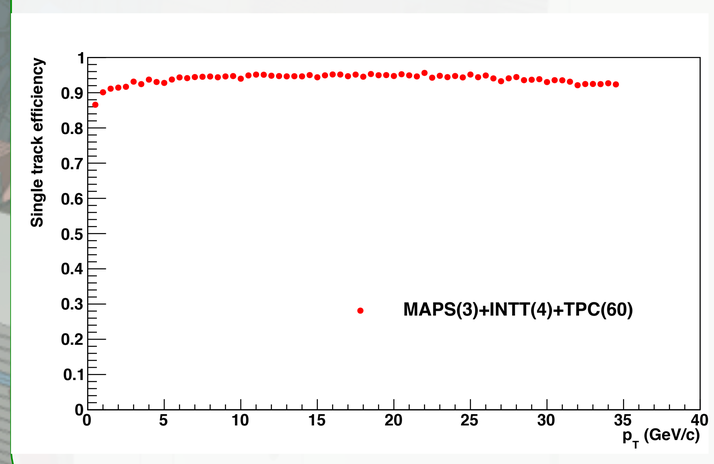
Inner & Outer HCAL for jet measurement.

Tracking performance studies

3 layers MAPS (Ladder) + 4 layers INTT (Ladder) + TPC
(pure pions sPHENIX Geant 4 simulation)





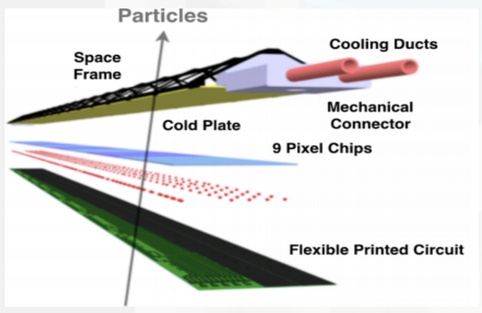


- p_T resolution well within accepted limit to resolve three states of Υ
- DCA resolution < 100 um which is good enough for b-tagged jets measurement
- Single track efficiency > 90%

Charged Particle Tracking detectors

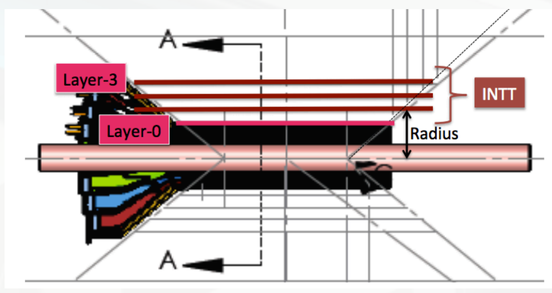
Requirements :
Excellent Momentum resolution , track pattern recognition , mass resolution < 100 MeV/c^2 and DCA resolution < 100 um

Inner pixel detector (MAPS)



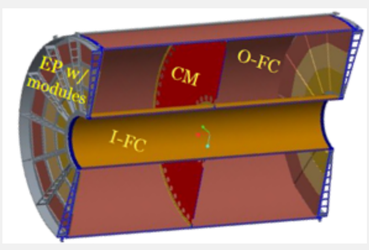
- 3-layers of pixel detector based on ALICE sensor technology
- -1.1 < η < +1.1, ΔΦ= 2π
- Precise vertex measurement and QGP b-jet Physics

Intermediate tracker (INTT)



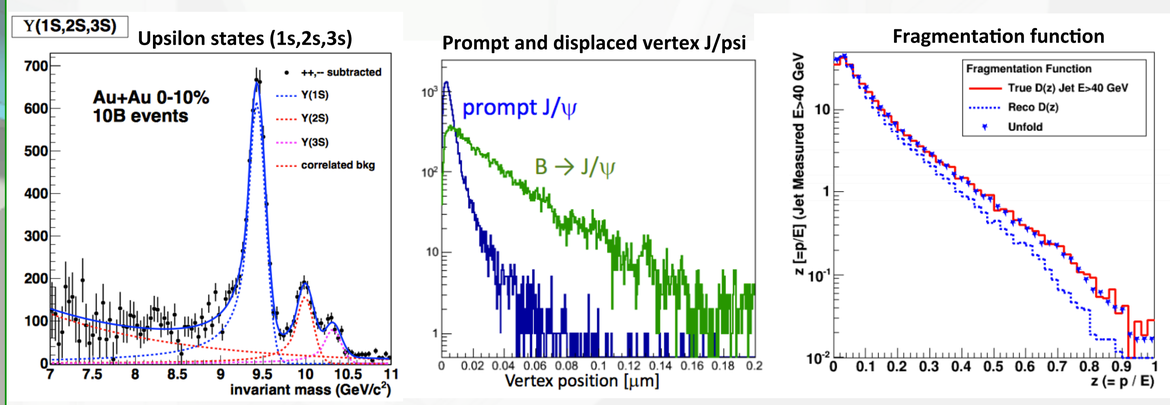
- 4-layers of Silicon strips
- |η| < 1.1, ΔΦ= 2π
- Helps TPC-MAPS matching in Jet physics, upsilon measurement

Time Projection Chamber (TPC)



- Gaseous Electron multiplier (GEM) readout based gas detector
- -1.1 < η < +1.1, ΔΦ= 2π, L = 211 cm, 20 < R < 78 cm
- Outer tracking detector providing good p_T resolution important for upsilon measurement

sPHENIX Physics simulation output



- **Excellent momentum resolution and DCA resolution by sPHENIX tracker configuration**
- **Well resolved upsilon states from Geant4**
- **Promising results in separating prompt and displaced J/psi**
- **sPHENIX tracking configuration is completely capable of delivering sPHENIX Physics goal**

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