STAR Level-3

STAR Level-3 Trigger

(Event reconstruction of HIC in realtime)

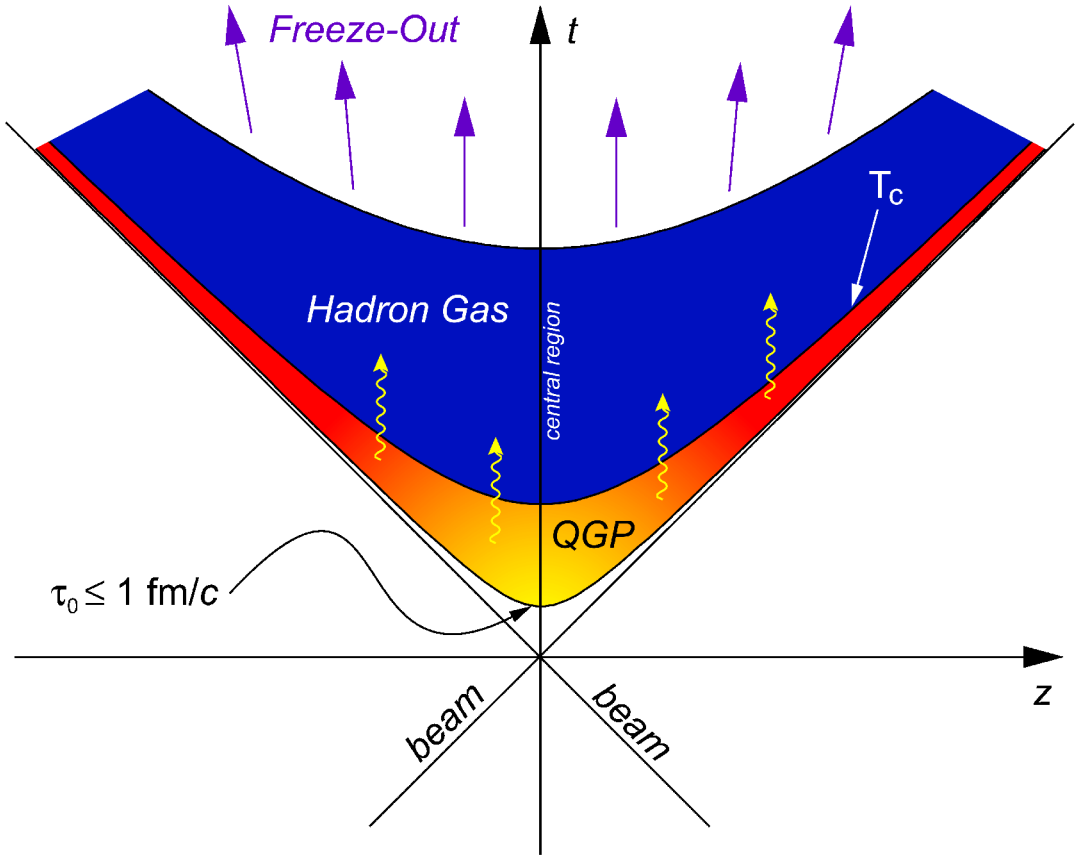
- Heavy Ion Collisions
- STAR Experiment
- Level 3 Trigger
- Physics Applications
- Plans for the 2002 run

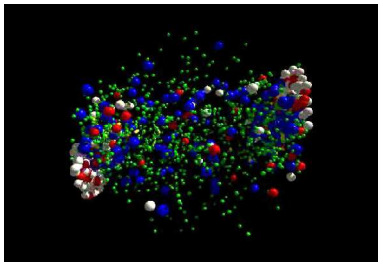
Jens Berger, IKF, Universität Frankfurt

Heavy Ion Collisions

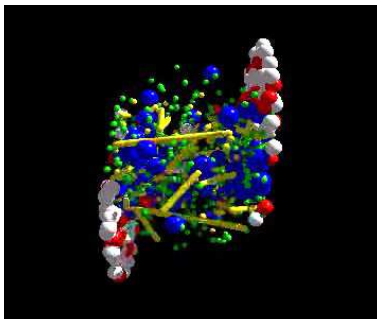
Understand the Equation of State of Nuclear Matter

Time Evolution of a Collision:

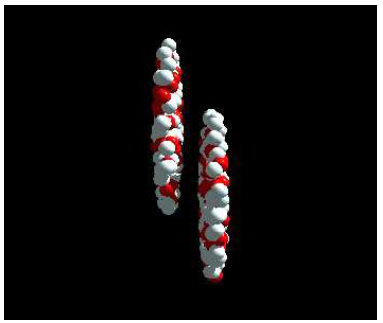




System freezes out, particles are created.



Zone of high energy density is created. QCD predicts QGP!



Lorenz contracted nuclei collide.

Particles produced in HIC

- most of the particles produced in a collision are:
π, p, k, Λ ....

study: spectra, flow, particle ratios

QGP:
Bound states of Heavy Quarks are Suppressed:

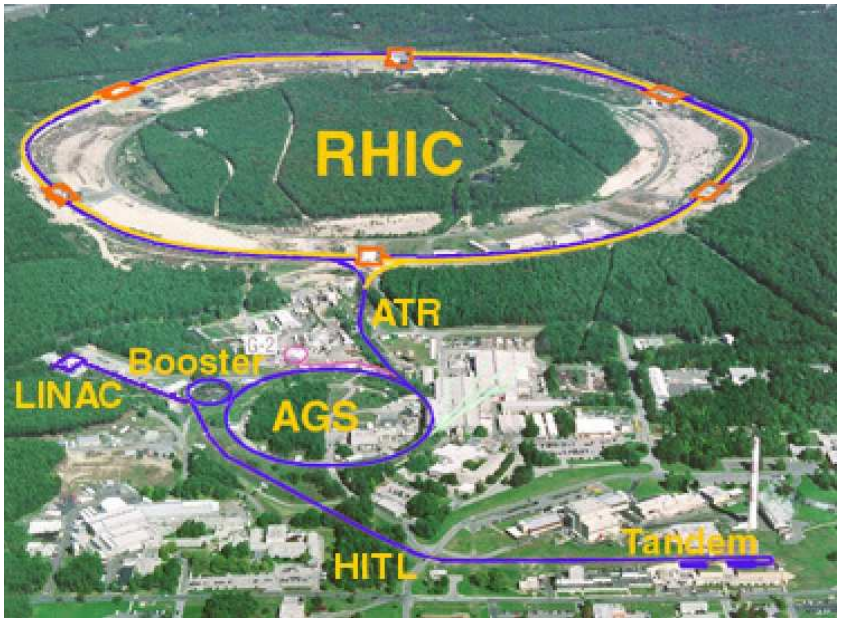
J/Ps i -> e+,e- Upsilon->e+ e-

These are rare probes (few/day): TRIGGER

STAR Level-3

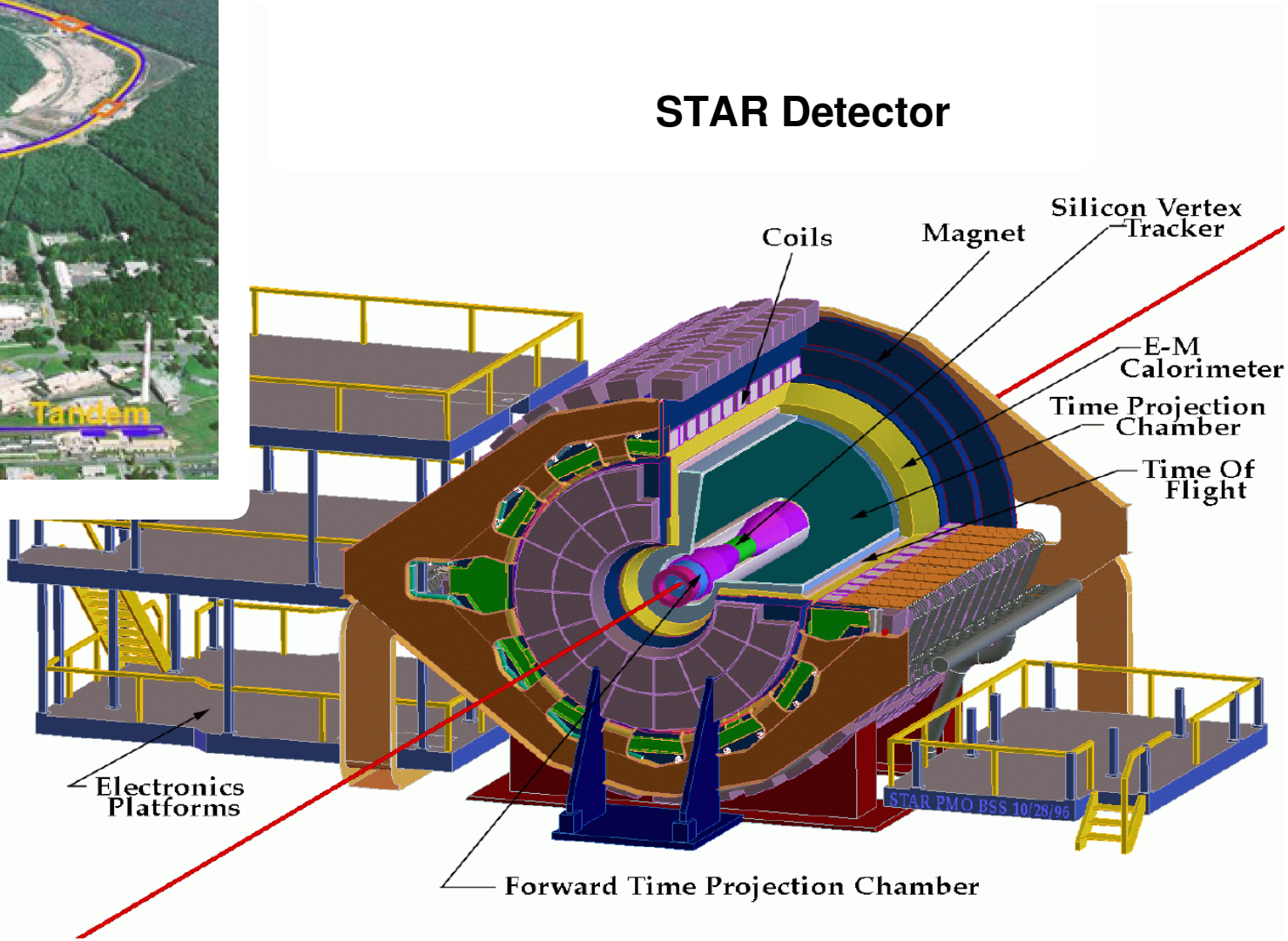
Solenoid Tracker At RHIC

Relativistic Heavy Ion Collider



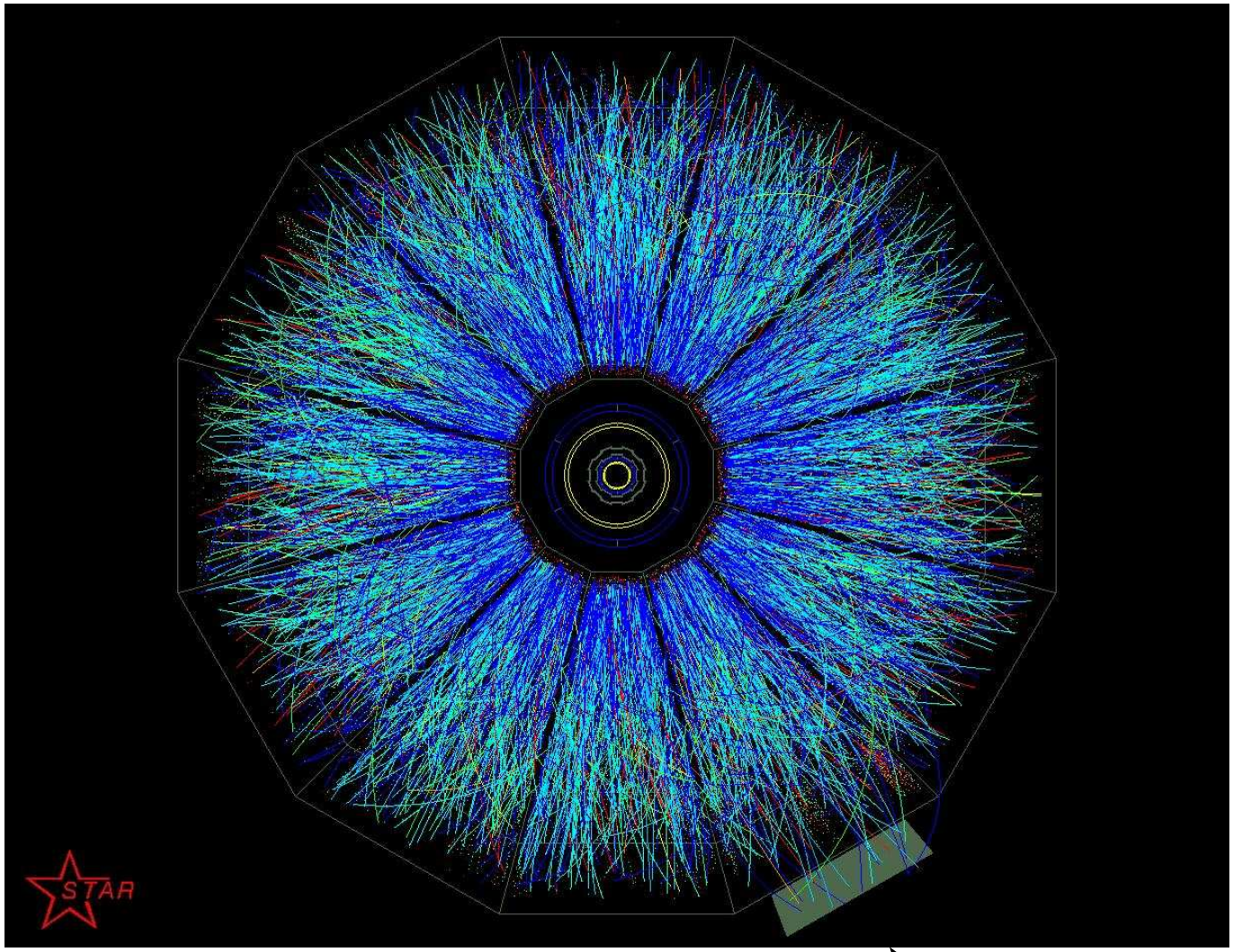
Brookhaven, Long Island, USA

STAR Detector



Au+Au Event in the TPC

Central Au+Au @ 200 GeV, front view, along beam axis:



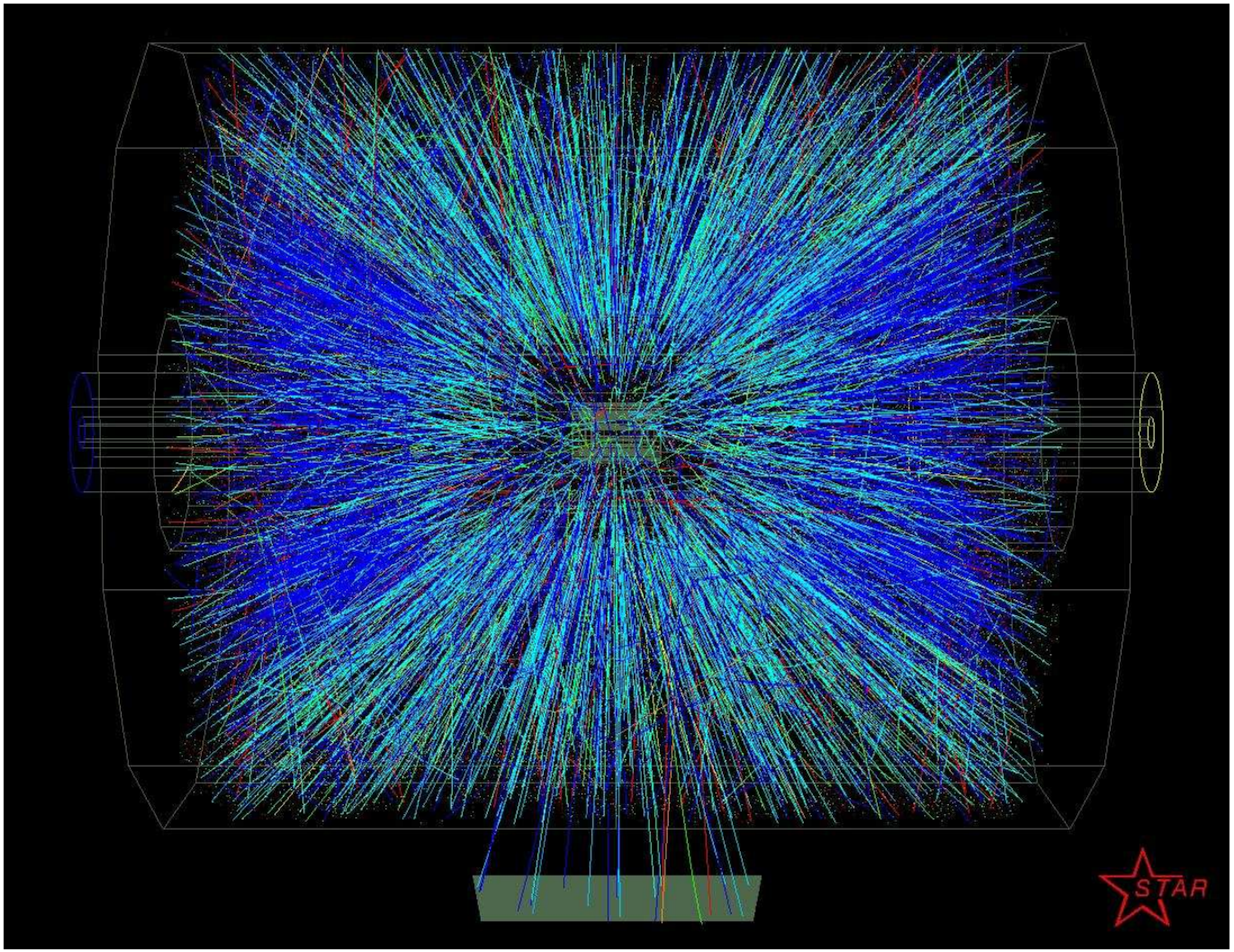
Time Projecton Chamber in magnetic Field B=0.5 T:

Trajectories of charged particles are bent : charge (q), momentum (P) determination

PID via dE/dx: Particles ionise the TPC gas along their trajectories.

Au+Au Even in the TPC

Central Au+Au @ 200 GeV, side view:



RICH Detector

$dN_{ch} / d\eta \sim 700$

STAR event Display:

- Display of events in real time during the run.
- Great tool for QA
- Events analysed by L3

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STAR Level-3 Trigger

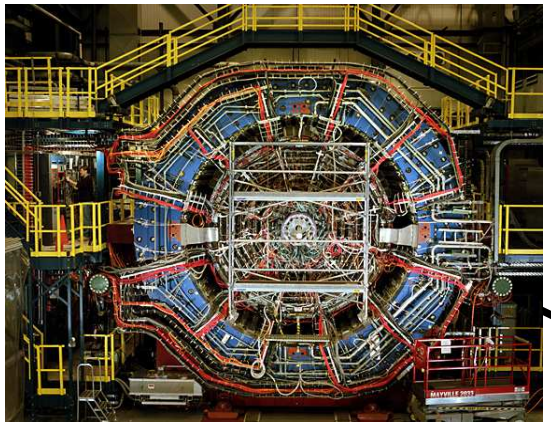
- STAR main detector (TPC) can be read out at ~100 Hz
- DAQ can write raw data at 5 Hz to mass storage.
- L3 Trigger is a processor farm that does online anlysis, (momentum determination and PID) at ~50 Hz.
- L3 Trigger is designed to trigger on rare events to enrich the event sample of e.g.:

-high Pt particles pointing to the RICH.

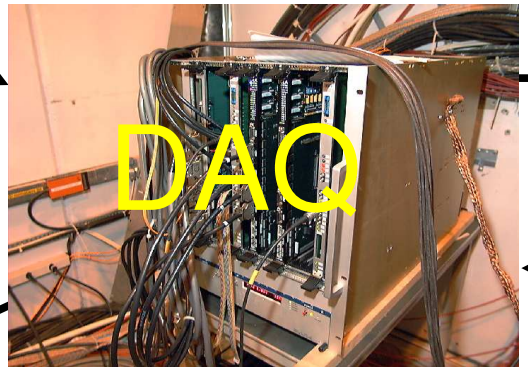
-heavy anti nucleus

-Upsilon -> e+ e-, J/Psi -> e+ e- (2002 run)

Motivation

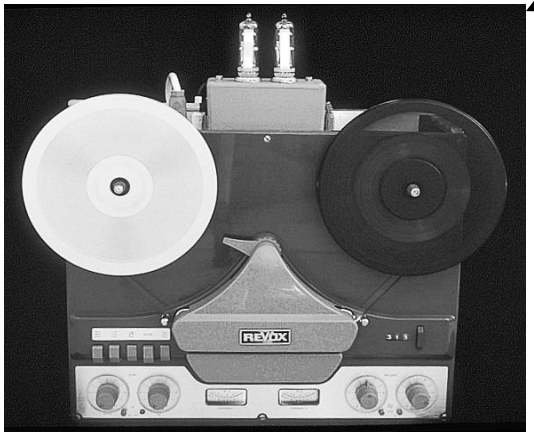


10 MB/event x 100 ev/s = 1GB/s



Data

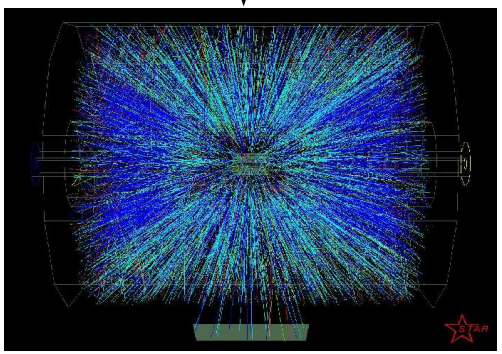
Yes/No



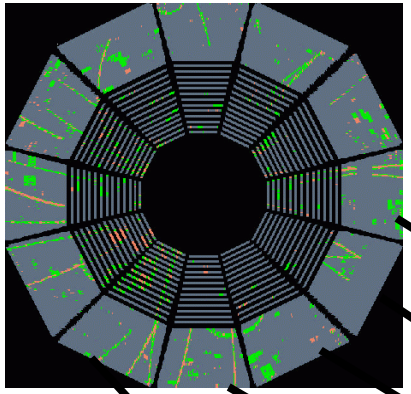
40 MB/s =~5 ev/s

Online Eventdisplay

Every 100th event



L3 Architecture



raw data 12 'sektors'

DAQ

. . . x12 VME crates

cluster finder

cluster data

Sector Level-3

. . . x48 CPUs

track finder

track data

3 CPU's

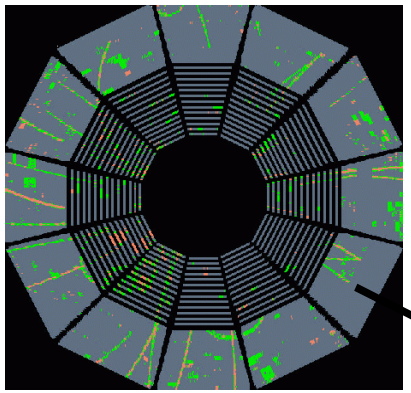
Global Level-3

GL3

physics analysis algorithm

Decision

Level-3 Processor Farm



L3 Architecture (Detail)

Rawdata

12 x Sector Crates (VME)

Cluster data

48 x Alpha CPU's

SL3

Track finder

12 Receiver Boards

3xMezzanine Card

-ASICS

❒Zero suppresion

-each 1x i960 CPU + VRAM

❒Cluster finder

→ 3x12x12=432 CPUs

Tracks

GL3

Analysis

3 Alpha/
Pentium
CPU's

Decision

Event is written/
Event is discarded

Hardware

Clusterfinder: -432 i960 CPUs
-PPC for formatting/data transfer via VME

Trackfinder: -48 Compaq Alpha workstation (DS10) 466-617 Mhz
fastest CPU at the time ~800 Mhz Pentium

OS: Linux (Redhat 6.0), 2.2.x kernel (out of the box)

Network: Myrinet
1Gb/s link (on network) ~ 70-120 MB/s
(Switch topology)

Software

Clusterfinder: - 1 dim. peak finder along drift direction
- merging in pad direction
- simple deconvolution in pad and time direction.

Trackfinder: - Conformal space tracker
+ some more tricks to make it efficient and fast

Timing: (central Au+Au collision):
Cluster finder: 10-20 ms

Track finder: ~100 ms

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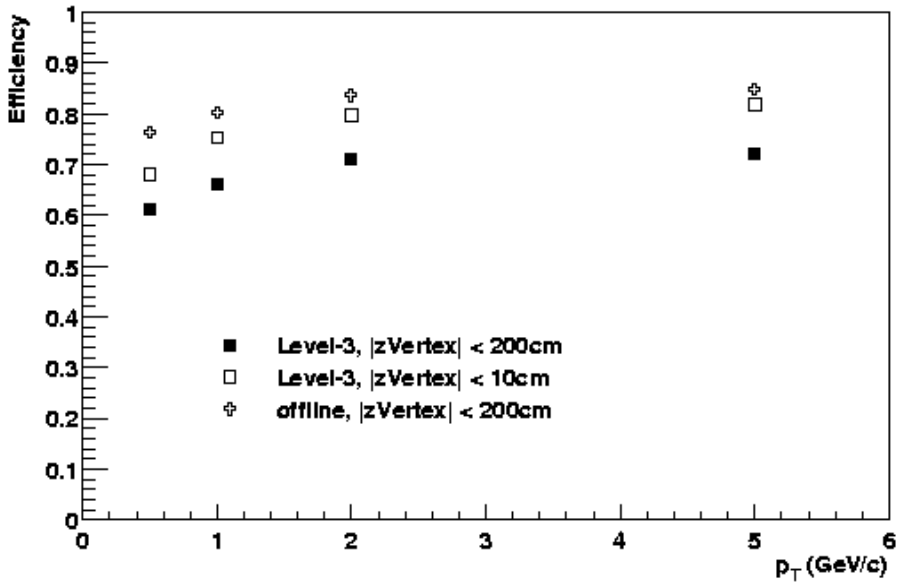
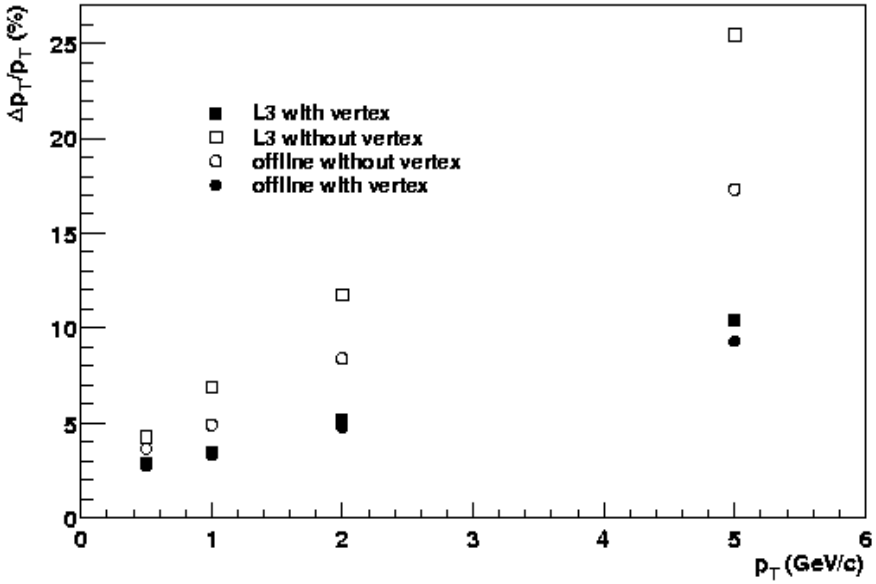
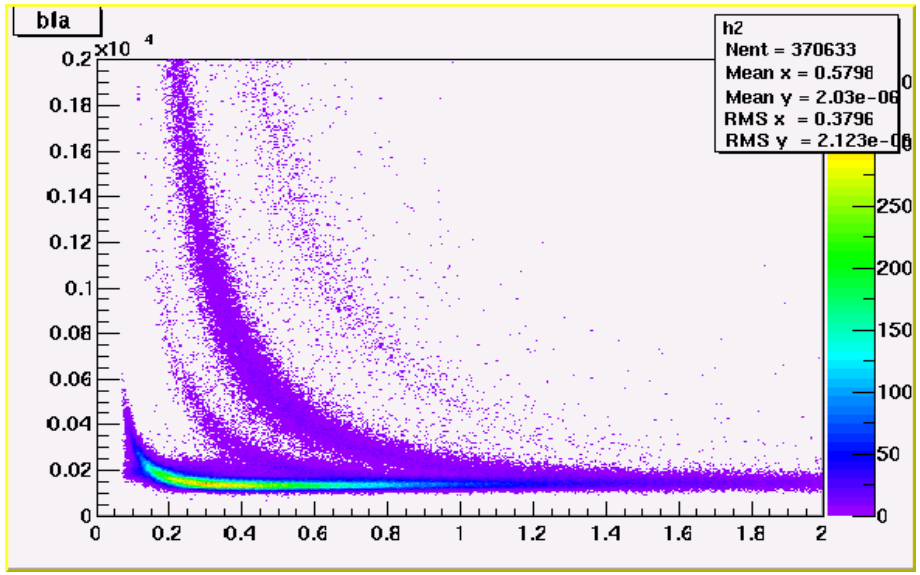
Reconstruction Quality







Efficiency 80-90 %

Pt resolution: 3% @1GeV
(half Field) 10% @ 5GeV

PID: dE/dx resolution: ~11%

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L3-Trigger Algorithms in 2001

L3 Trigger used last 3 weeks of running
for ZDC rates > 600, 1200 Hz

-high Pt (tracks pointing to RICH Detector)
momentum, geometric cuts.

-Antihelium
dEdx + momentum information of Tracks.

-Υ
invariant mass, momentum.

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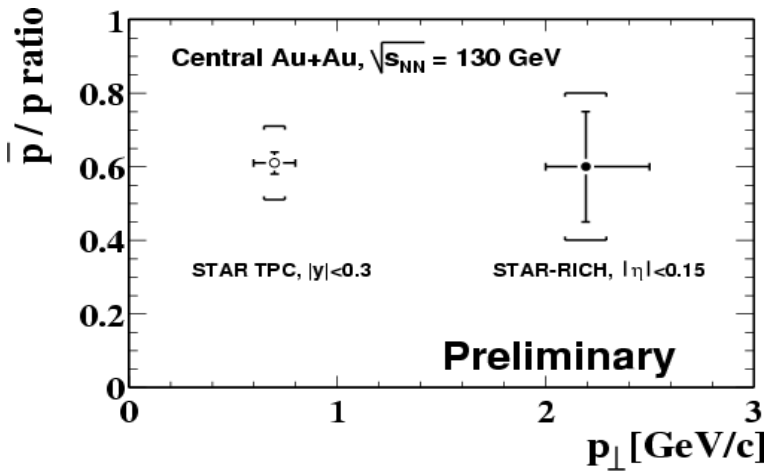
High-Pt, RICH Algorithm

Ring Imaging Cherenkov Detector:
- Identification of high Pt π, k, p.
- Small acceptance, |eta| <= 0.275, -70 < phi < -50 deg.

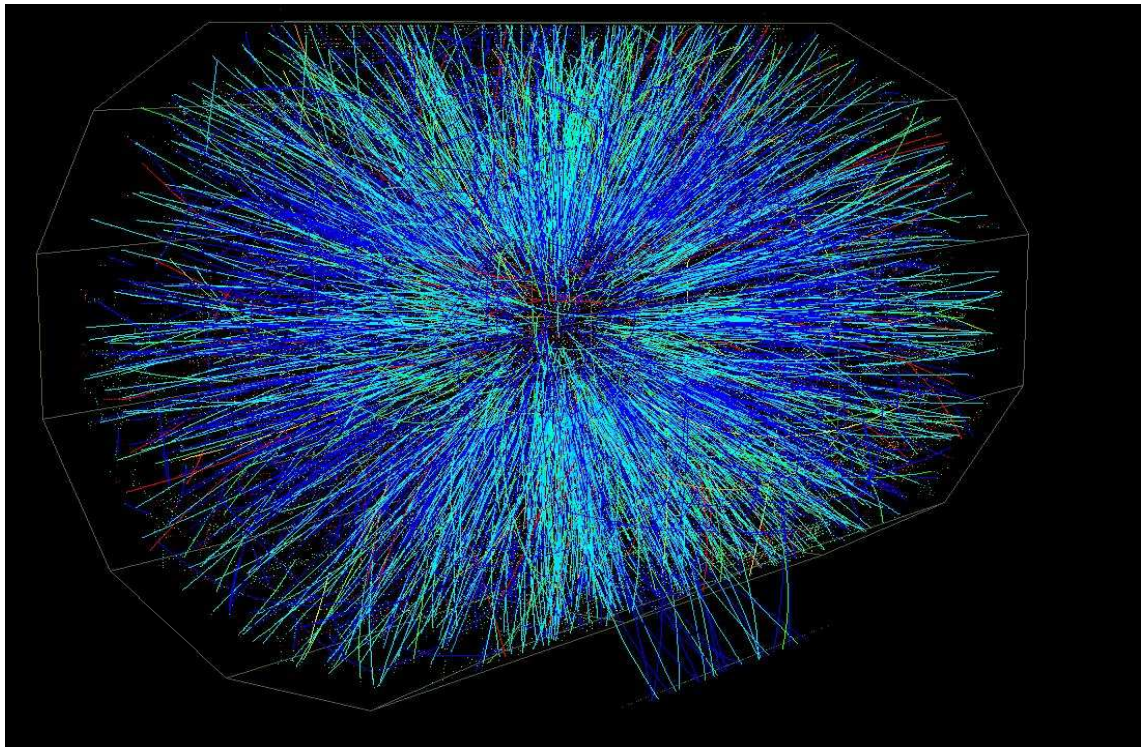
Only a small fraction of particles produced in a Au+Au collision traverse the RICH.
Every ~100th event -> particle Pt > 3 GeV/c.

L3-Trigger was used to trigger on particles with Pt > 3 GeV/c.

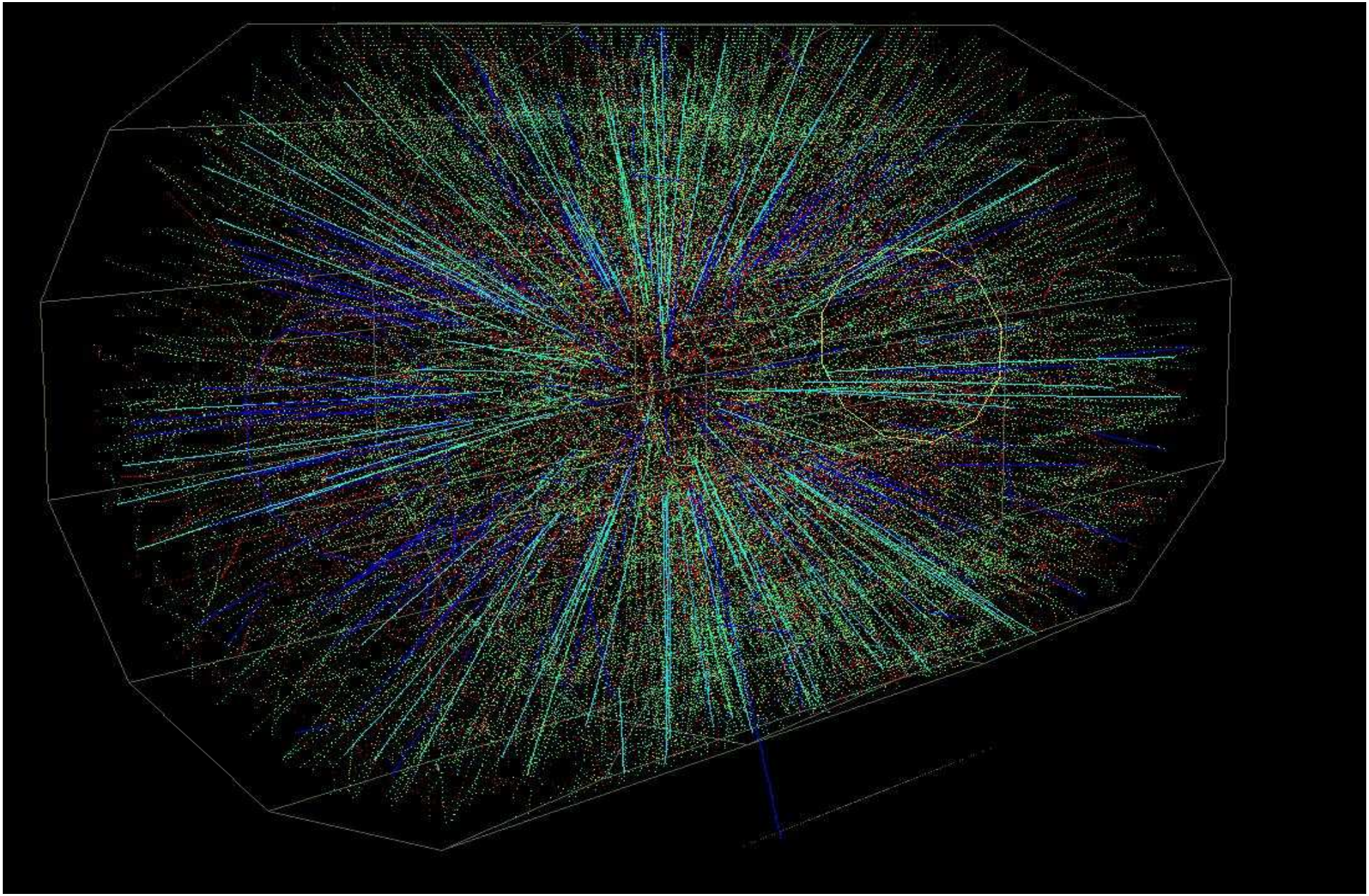
pbar/p needed to understand baryon transport



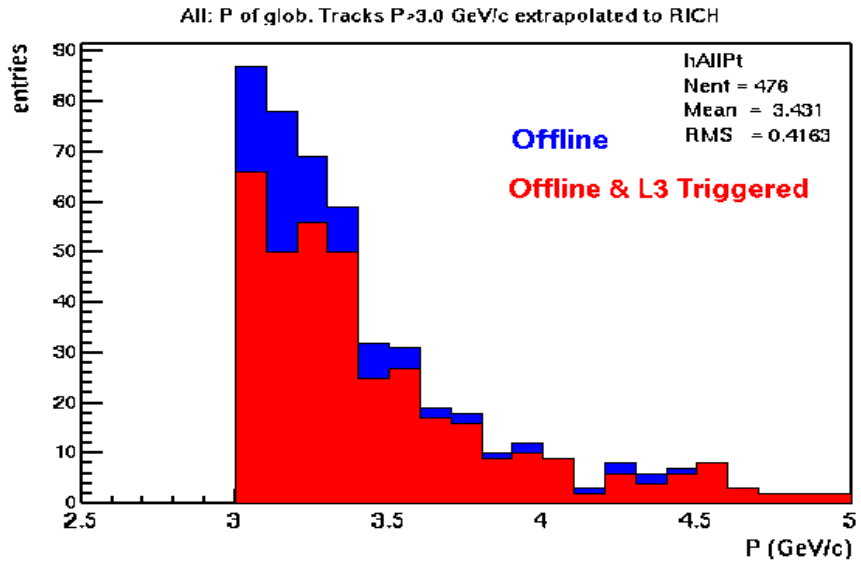
The study of flavor dependence of high momentum particle production may be sensitive to differences between quarks and gluons in propagation through matter.
X.N. Wang, Phys. Rev. C **58,** 2231 (1998)

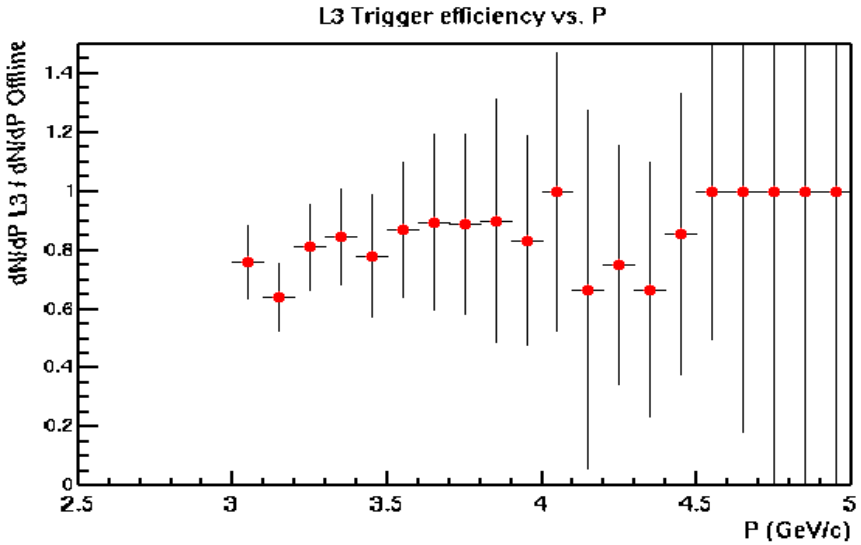


L3 tracks P>1.5 GeV/c displayed, one P=3 GeV/c pointing to the RICH



RICH trigger Efficiency, Enhancement





Rates and Enhancement

ProductionCentral:
Every 91th event a RICH candidate –> 1.1 %

ProductionCentral600 (L3 Triggered, prescale = 2):
Every 55th event a RICH candidate –> 1.8 %

ProductionCentral1200 (L3 Triggered, prescale = 5):
Every ~24th event a RICH candidate ~> 4.2 %

Hadronic central events: 3M ~> 33k RICH candidates
productionCentral600 :386k ~> 7k RICH candidates
productionCentral1200 : 93k ~> 4k RICH candidates

Year 2001: total of ~ 44,000 RICH candidates.

Watch out for RICH results at QM 2002 !

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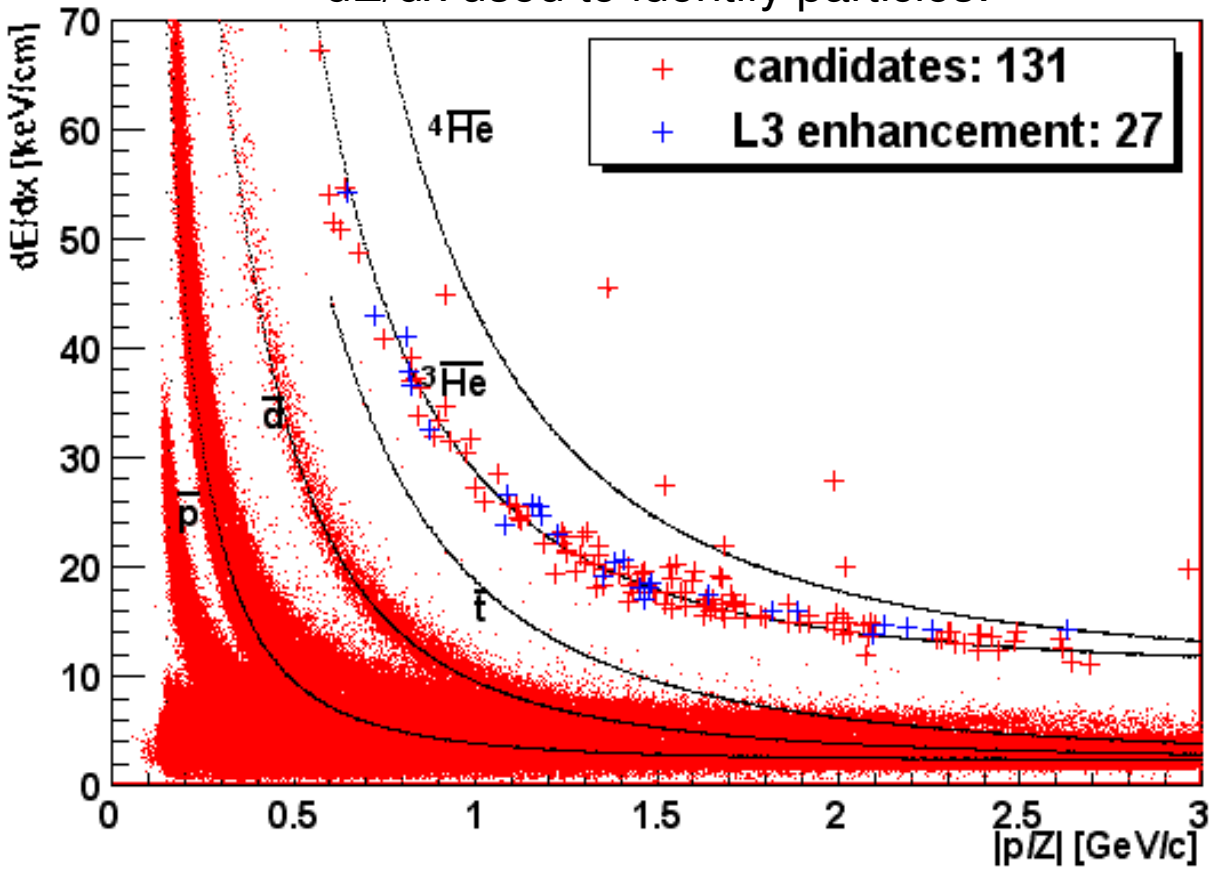
Anti-He: L3 Enhancement

10% central AuAu @ 200 GeV, full field B = 0.5 T, 2.0M events used

dE/dx used to identify particles:



L3 Triggers on high dE/dx values

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L3 Upsilon -> e+ e- Trigger

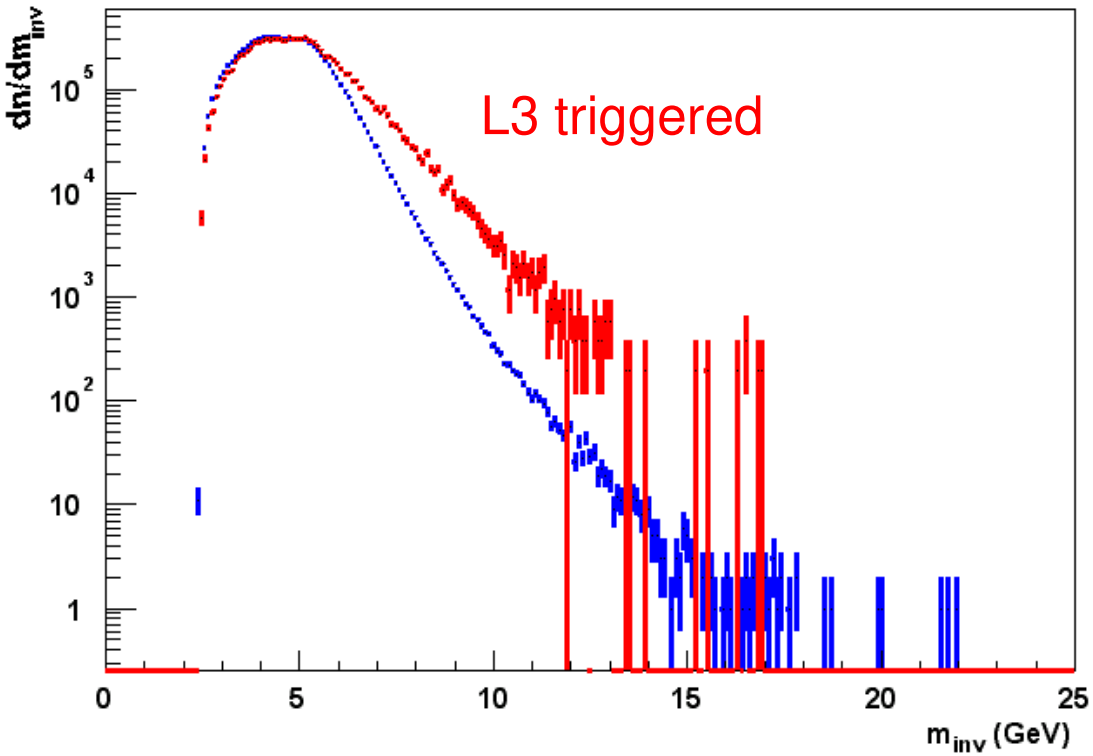
2001 testrun for Upsilon Trigger. EMC for e+, e- identification 2002!

- L3 Triggers
  Tracks : p > 3 GeV/c
  Track pairs : 7 GeV/c^2 < invariant mass < 13 GeV/c^2

- L3 trigger used after Nov 9:
  enhancement +42% (600K events/1.4M events)
  limited by luminosity, enhancement up to **factor 5** possible...

L3 Upsilon -> e+ e- Trigger

- First look on L3 trigger efficiency:



2001: High hadronic backround
no chance to extract a significant signal.

2002: Use of the EMC for e+ e- identification.

L3-Trigger for the 2002 run

- EMC (½ coverage) will be integrated in L3

- Use of the EMC for electron identification:
  trigger on Upsilon, J/Psi.

- Use L3 as a 'Strangeness' Trigger (Λ)
  trigger on events with a high number of Λ's,
  might be useful for Ω or polarized Λ measurement.
  (Strangeness group is testing right now)

STAR Level-3

Summary

-Real time reconstuction of Au+Au events works.
Max rate ~50 Hz (central collisions)

-Level-3 event display ('real time' event visualisation in 3D)
great tool for Online QA and Public Relations

-Additional detectors integrated: SVT, FTPC, ZDC, CTB, (EMC)

-First trigger algorithms switched on