ATLAS at LHC

Helio Takai

takai@bnl.gov

Brookhaven National Laboratory

(for the ATLAS collaboration)

Quarkmatter 2004

Oakland, January 11-17,2004

ATLAS Heavy Ion Working Group

- S. Aronson, K. Assamagan, B. Cole, M. Dobbs, J. Dolejsi, H. Gordon, F. Gianotti, S. Kabana, S.Kelly, M. Levine, F. Marroquin, J. Nagle, P. Nevski, A.Olszewski, L. Rosselet, H. Takai, S. Tapprogge, A. Trzupek, M.A.B. Vale, S. White, R. Witt, B. Wosiek, K. Wozniak and …

$x_{FTE} \sim 1/2000 = 5x10^{-4}$

It has been active for ~2yrs and ~1year of simulation studies. Prefer full simulations due to complexity. Submission of LoI to LHCC by end of February..

Constraint: No modifications to the detector, with the exception of forward instrumentation

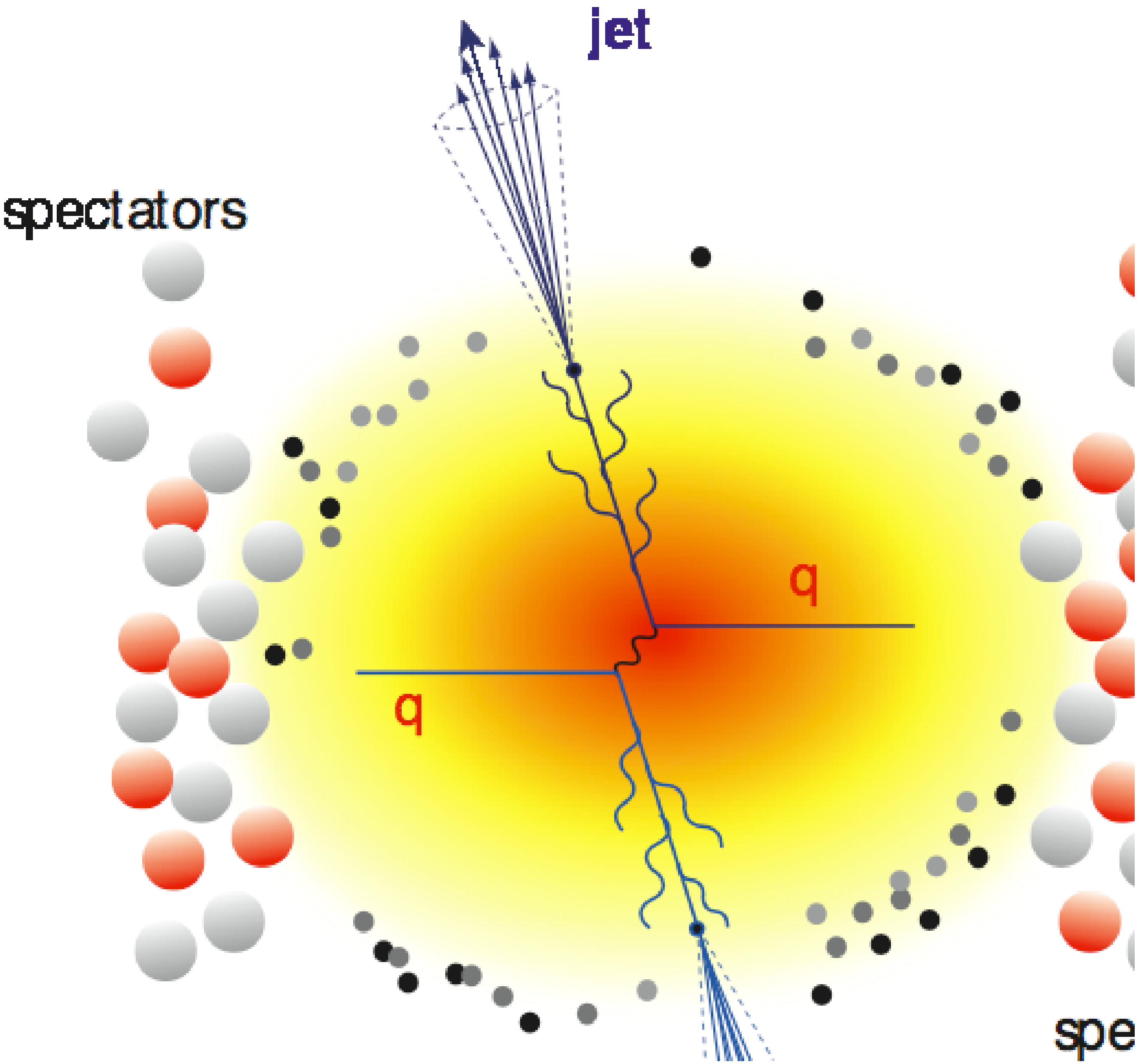
MOTIVATION

IC experiments have shown a suppression of h
hadrons - *jet quenching*

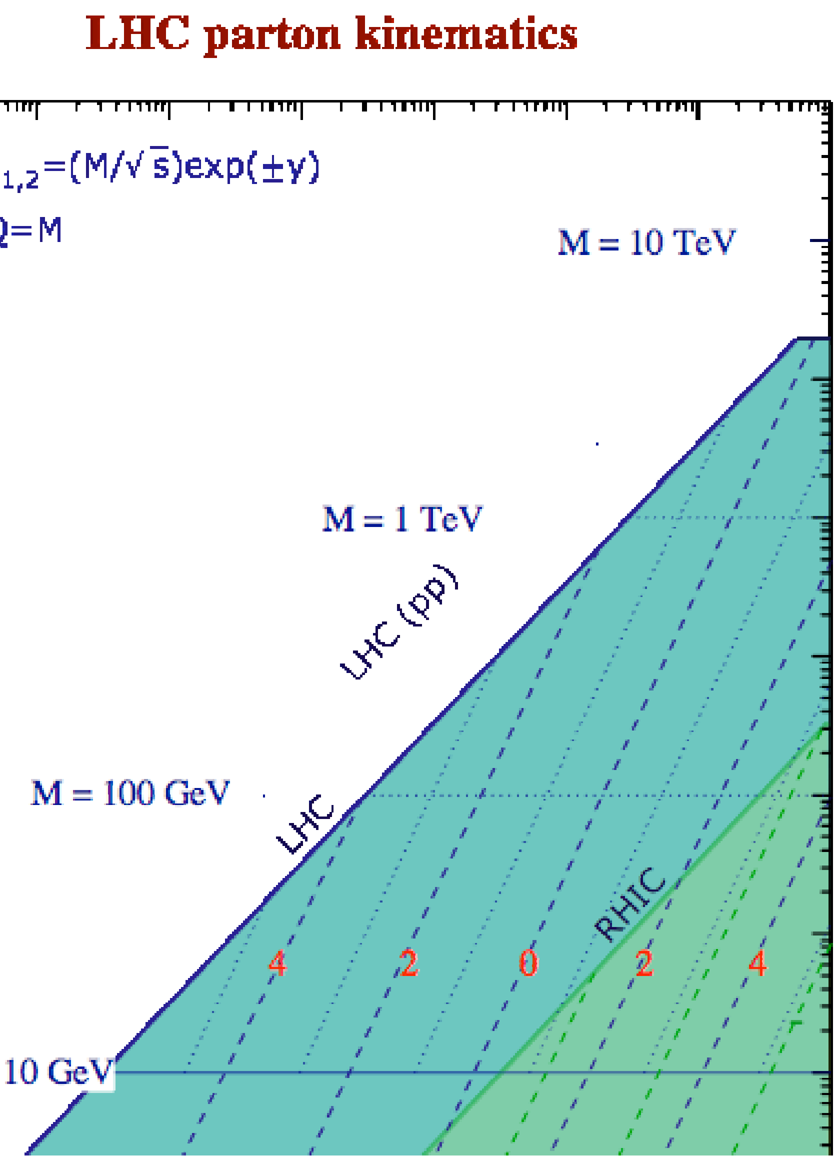
erest in learning more about QCD phase
nsition.

LAS is a detector designed for high p_T physics a
articular has excellent jet capabilities.

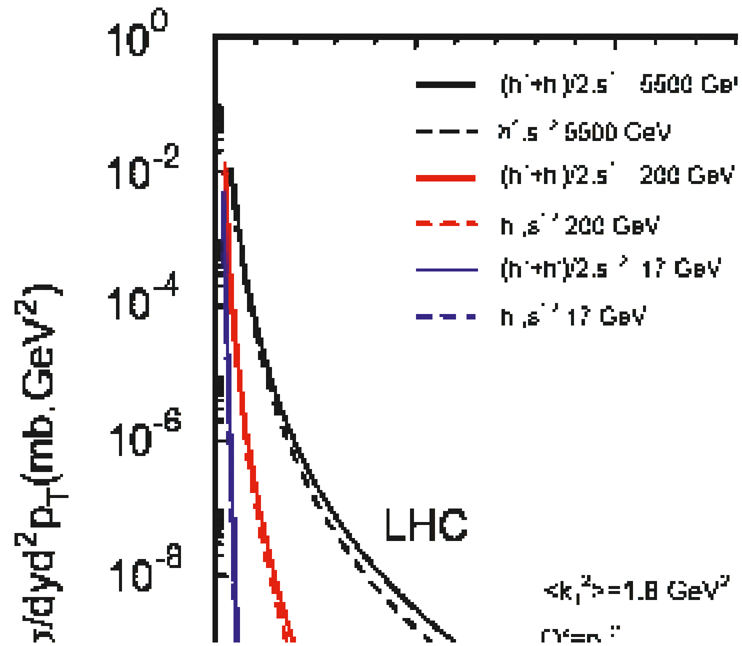
owing interest within ATLAS to study questions
ted to astroparticle physics.

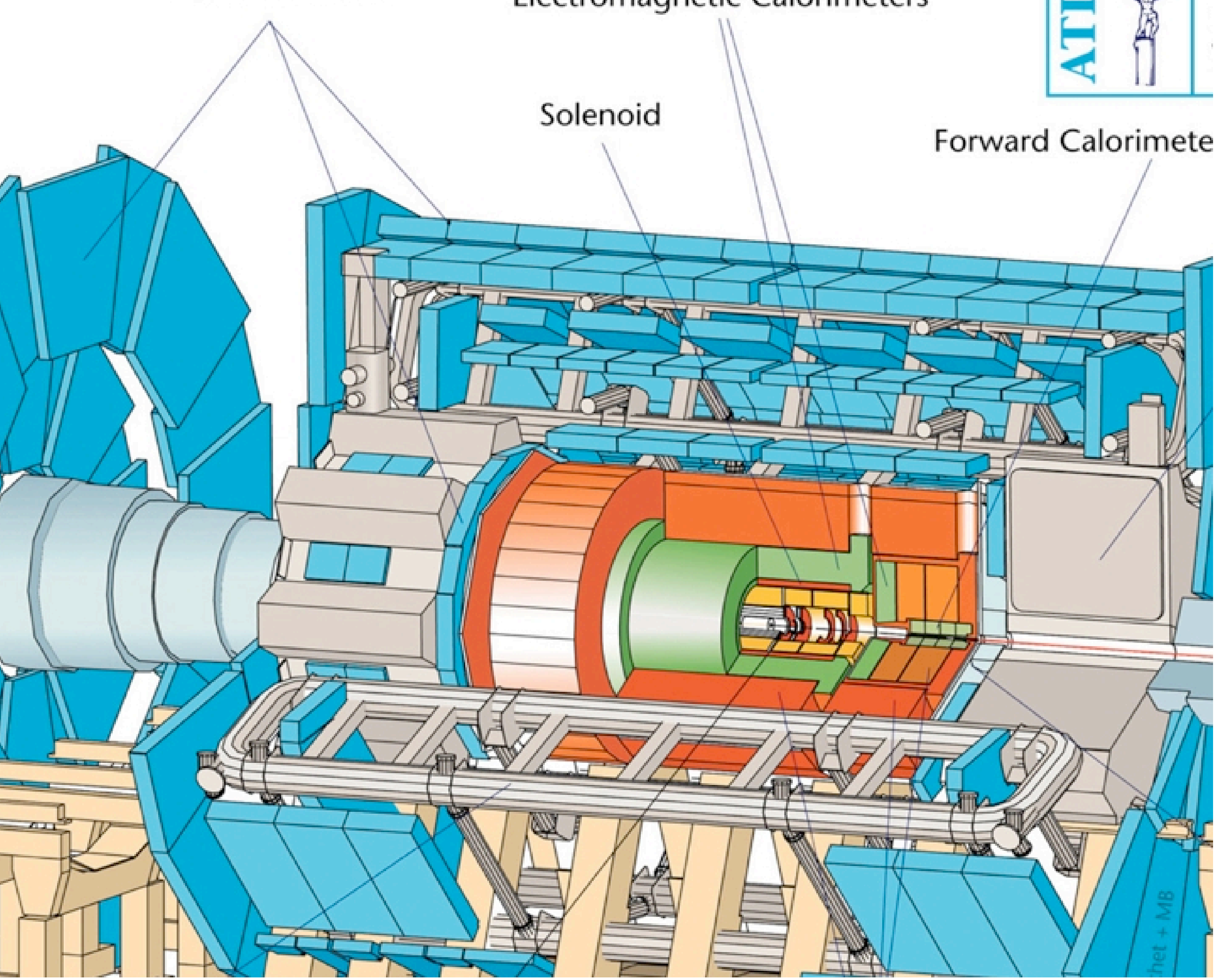

jet
spectators
q
q
spe

What changes from RHIC to LHC?



Parton kinematics, gluon density,
increase in hard scattering cross se




Solenoid
Forward Calorimete

gned to operate at full LHC luminosity of 10^{34}

rage
- Calorimeter -4.9<□<4.9
- Muon Spectrometer -2.7<□<2.7
- Inner Tracker -2.5<□<2.5

rimeter Segmentation
- EM Liquid Argon Calorimeter is finely segmented
- Hadronic Tile Calorimeter is also segmented

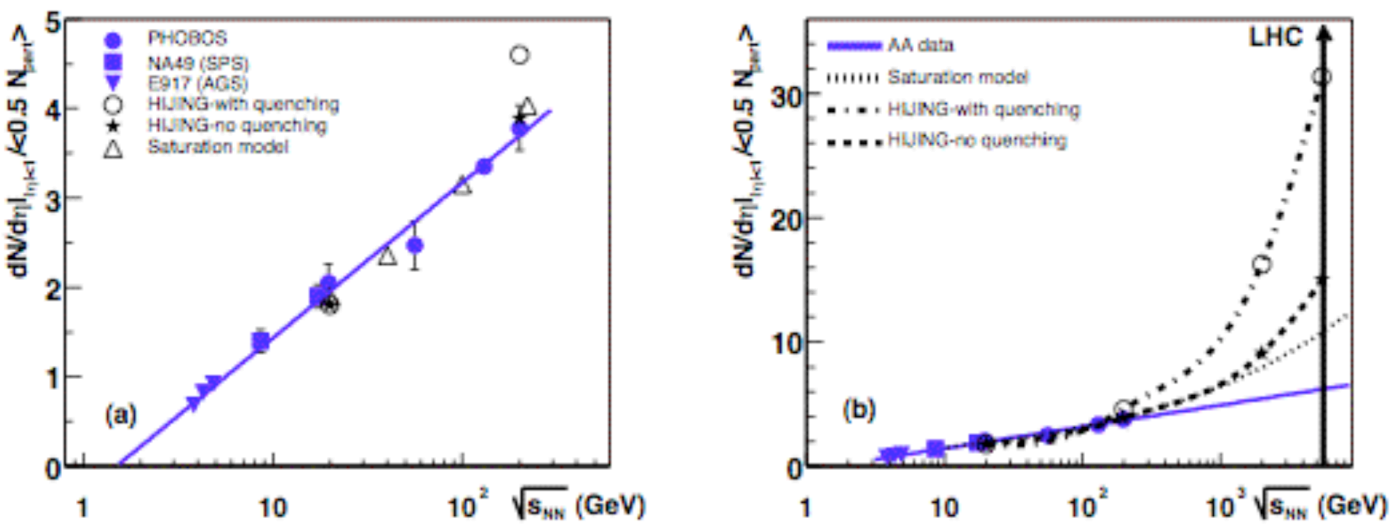
n Spectrometer
- Tracking volume behind calorimeter

Detector
- Composed of Pixel, SCT and TRT

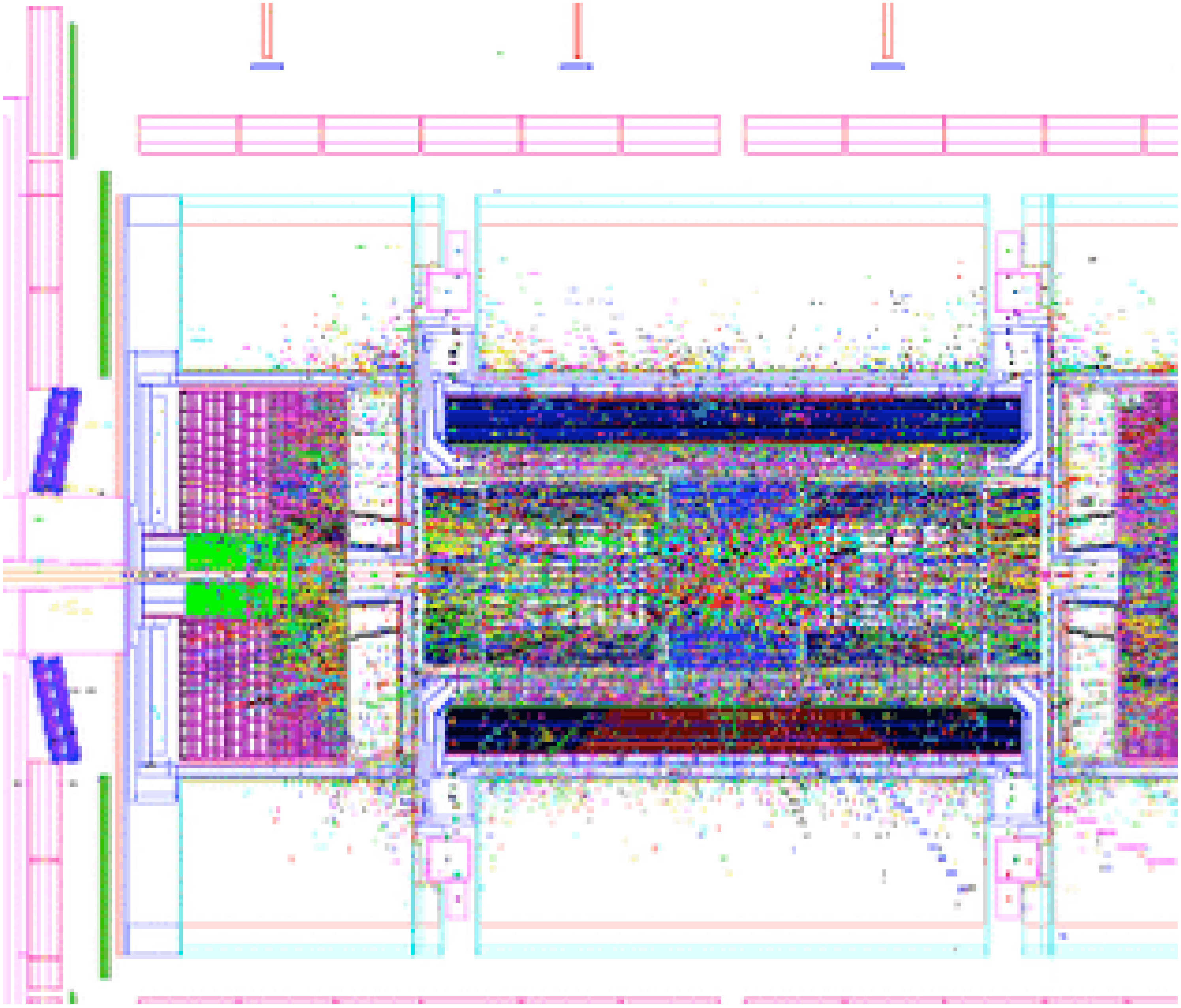
-level trigger and DAQ

nulation studies are all full simulations using a full
tector description in Geant-3.

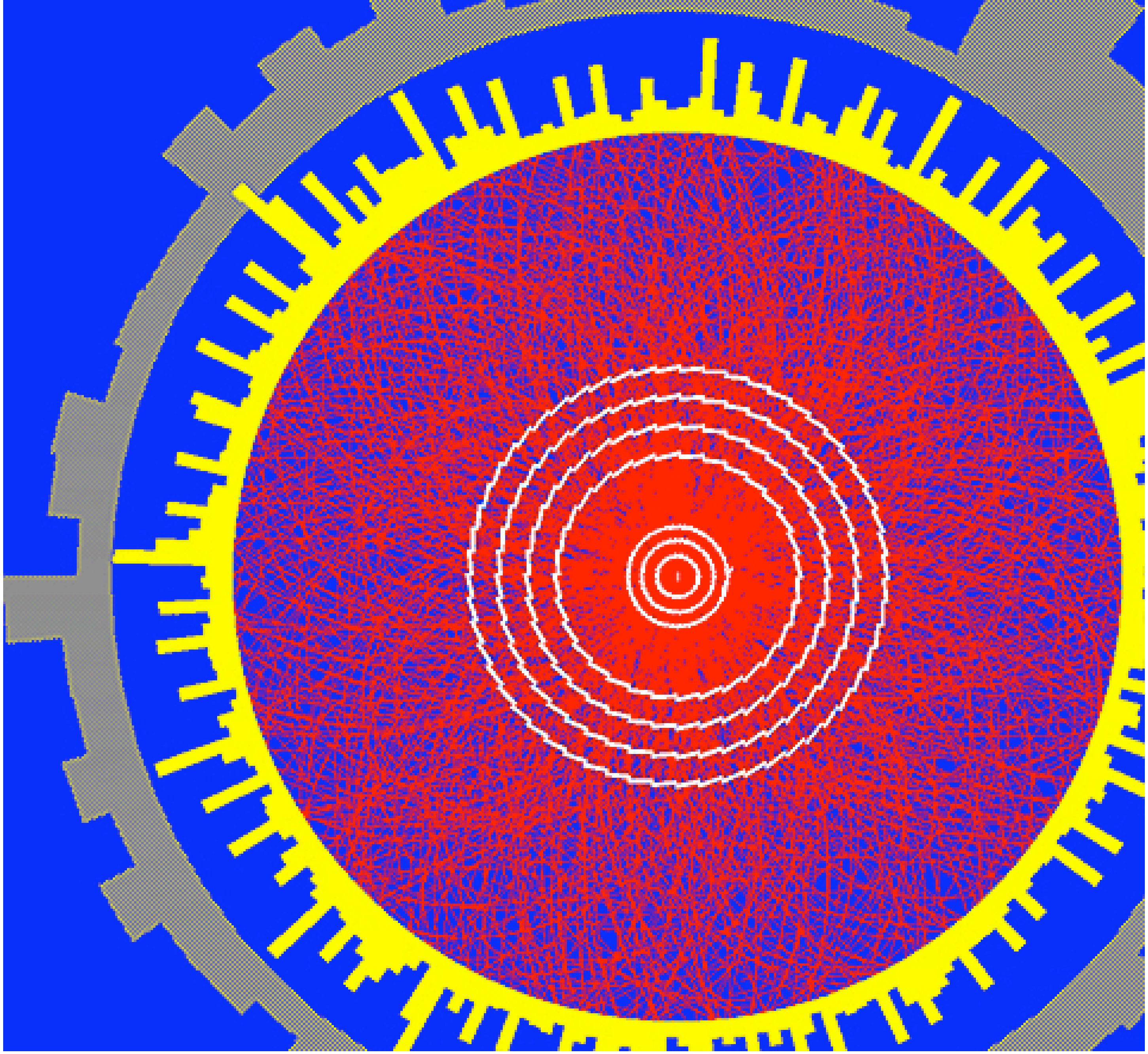
ent Generator - HIJING, no quenching, dN/d□~3500.



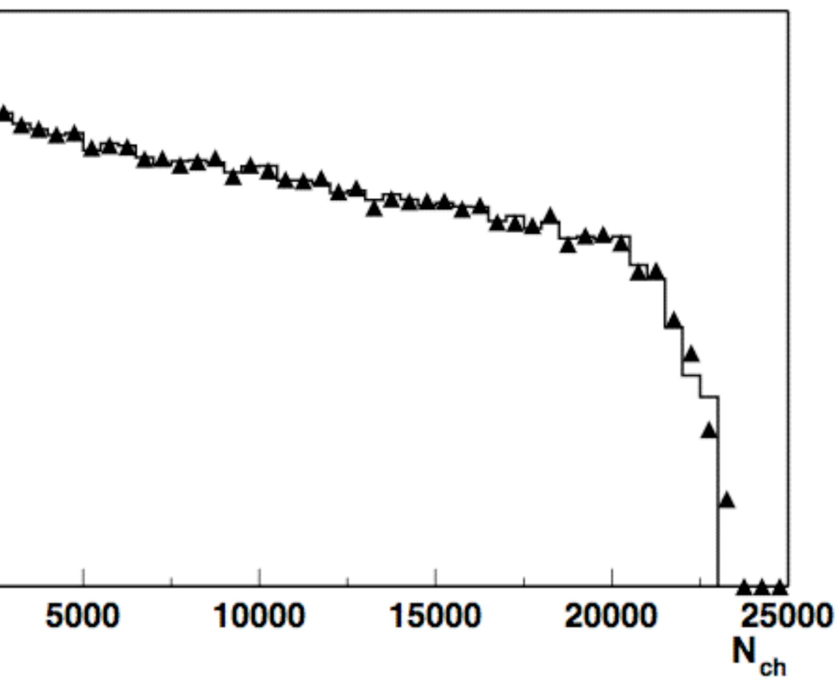
nulations are divided into two □ regions: |□|<3.2, and
2<□<4.9. It takes about 6h per event and uses the same
rameters as in pp with the exception of calorimeter
here the energy threshold is raised to 1 MeV.

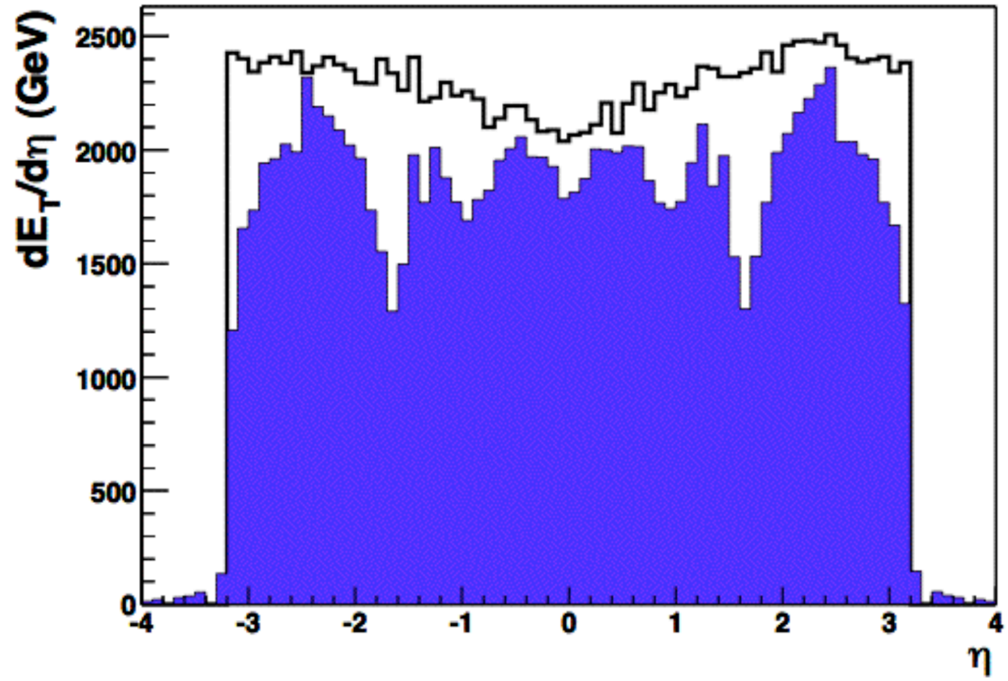


simulation

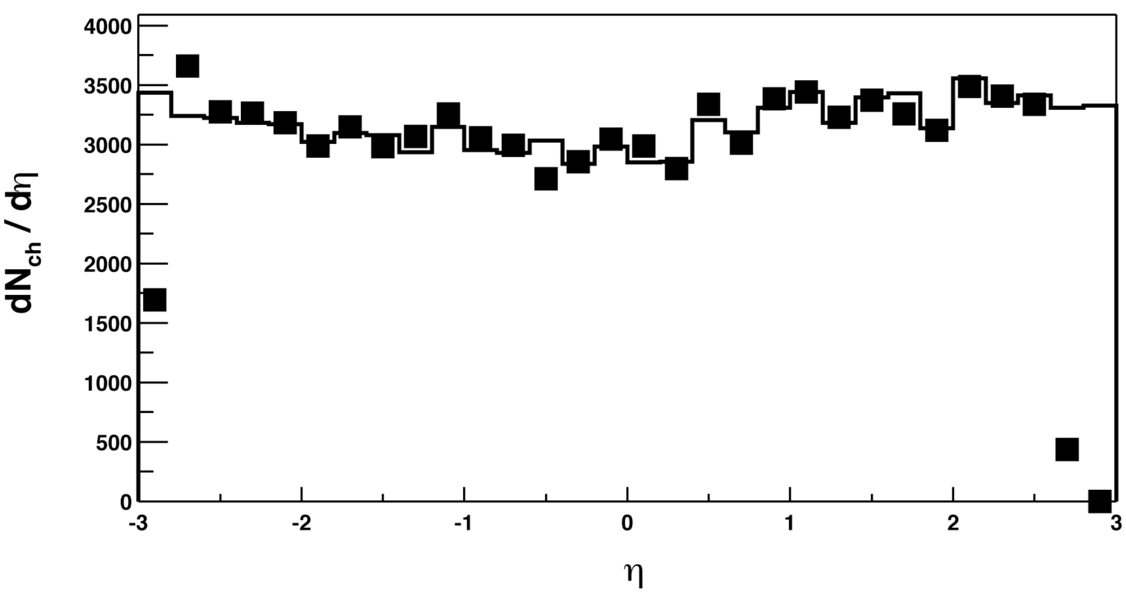


llision centrality, Impact parameter determination



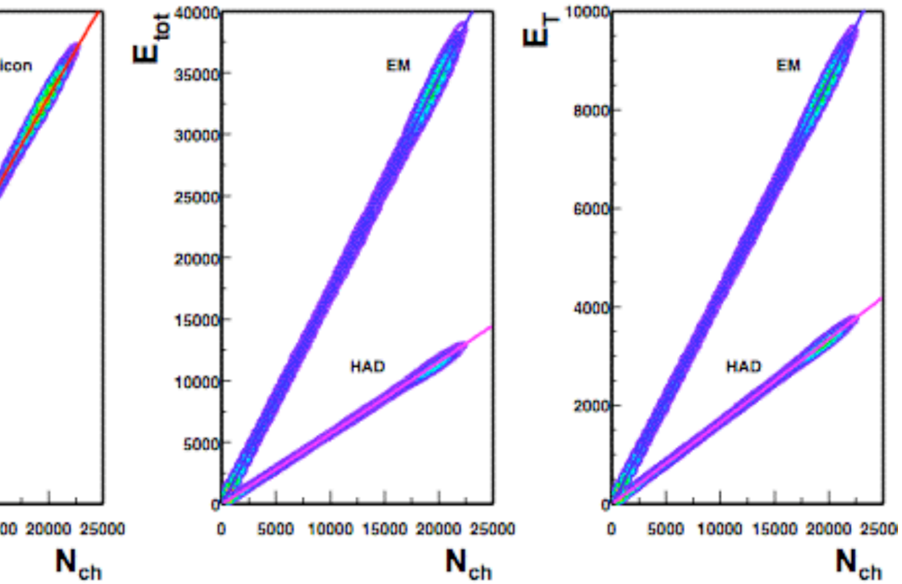


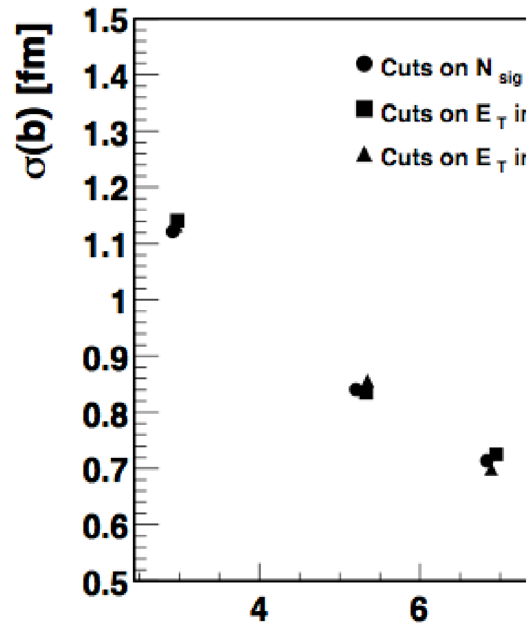
Multiplicity and dE_T/d



IMPACT PARAMETER

Use 3 detector systems to obtain impact parameter,
xel Detector, EM calorimeter and Hadronic Calorimete





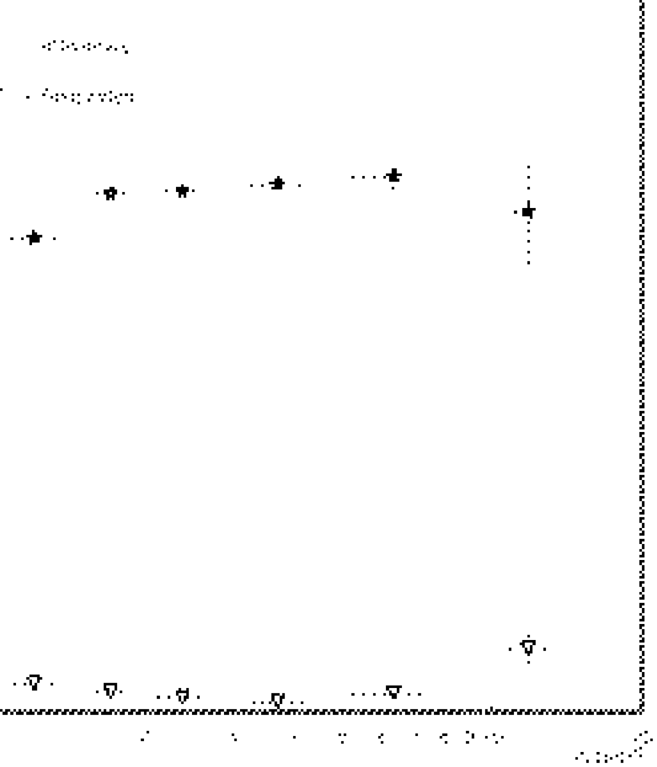
All three systems have similar performance with impact parameter resolution of ~1fm

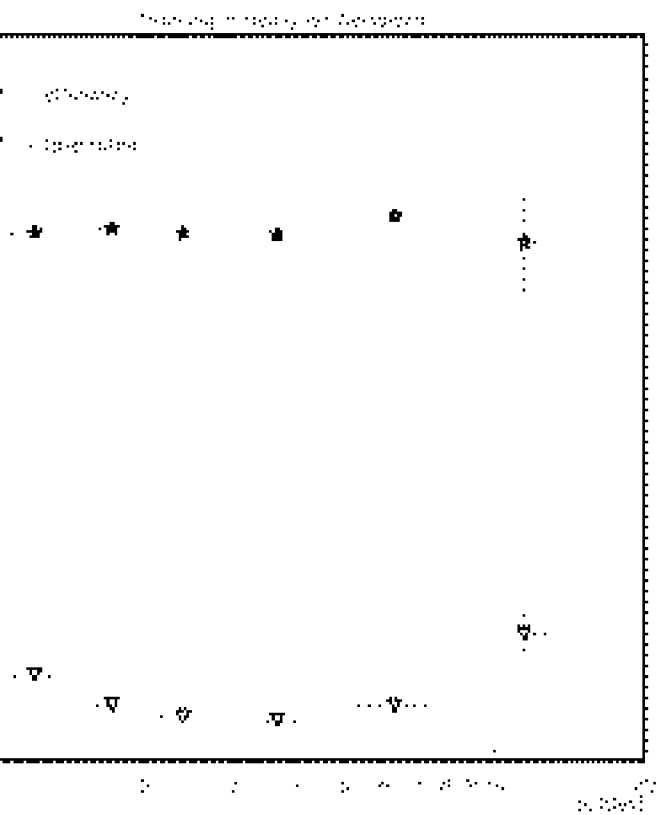
Tracking in ATLAS is accomplished by using 2 of the 3 inner detector subsystems (11 measurements):

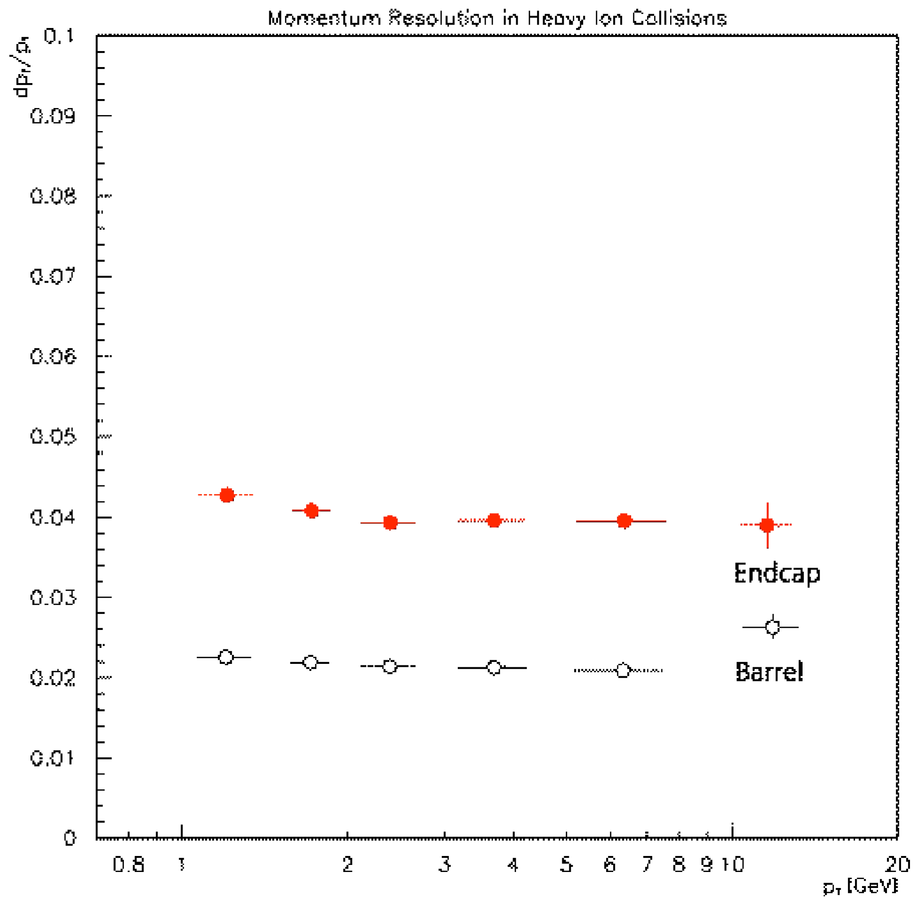
Pixel with occupancy <2%

SCT with occupancy <20%

The TRT occupancy is too large (although it will be available for pA)





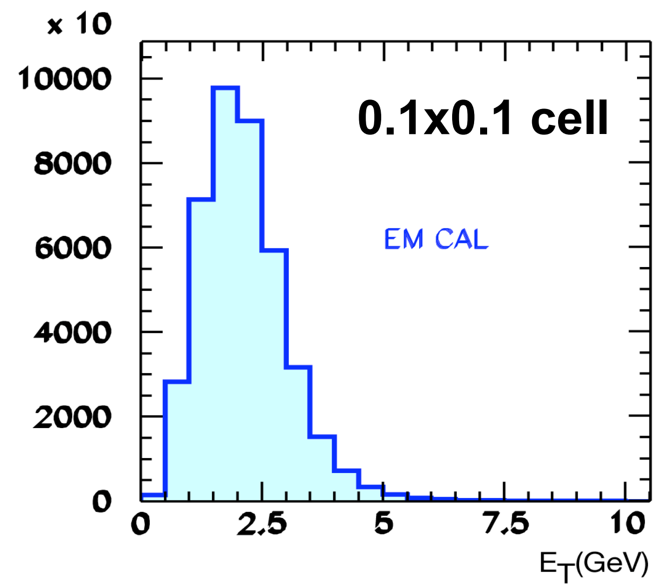


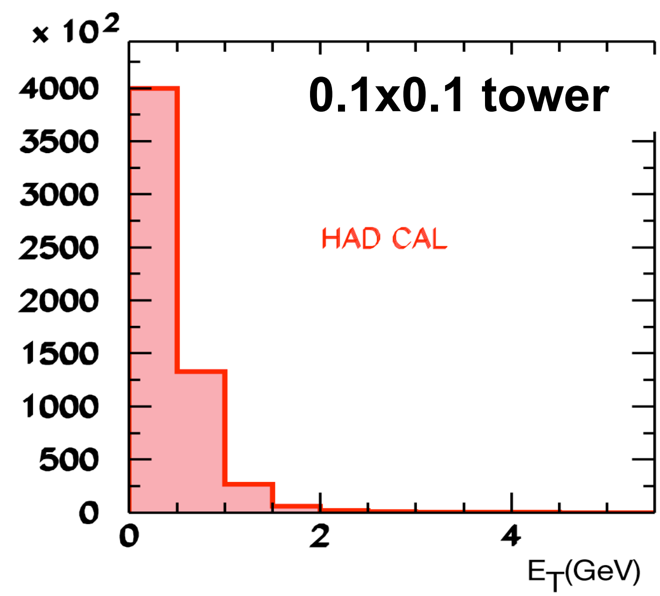
HIJING (0<b<1 fm)

Background:

~2 GeV per 0.1x0.1 tower in EM
~0.2 GeV per 0.1x0.1 tower in HAD
Soft hadrons ~ completely stop in EM
The largest background is in 1st layer

20 GeV in a cone $R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.4$
Threshold for jet reconstruction ~30 GeV
Compare to full luminosity pp ~15 GeV

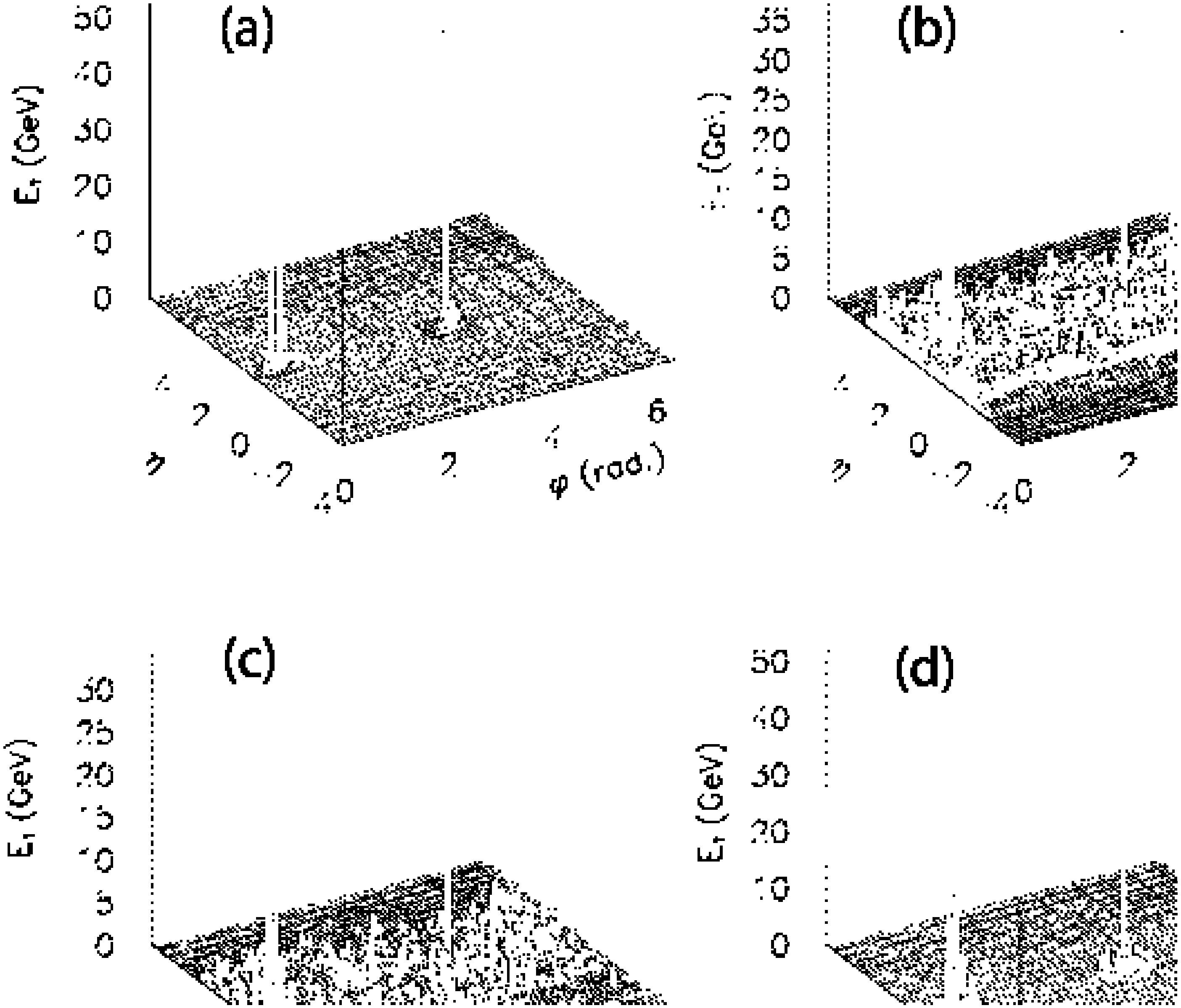




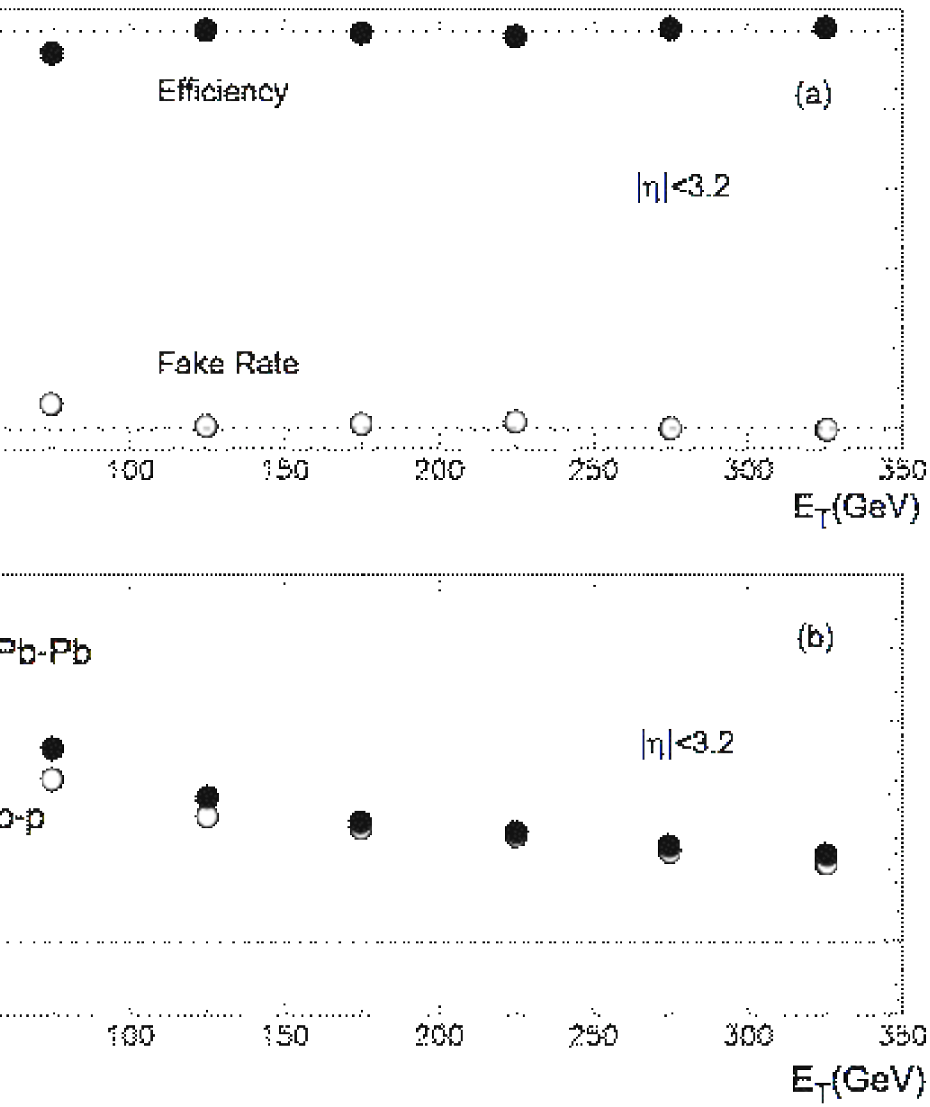
-3.2<□<3.2

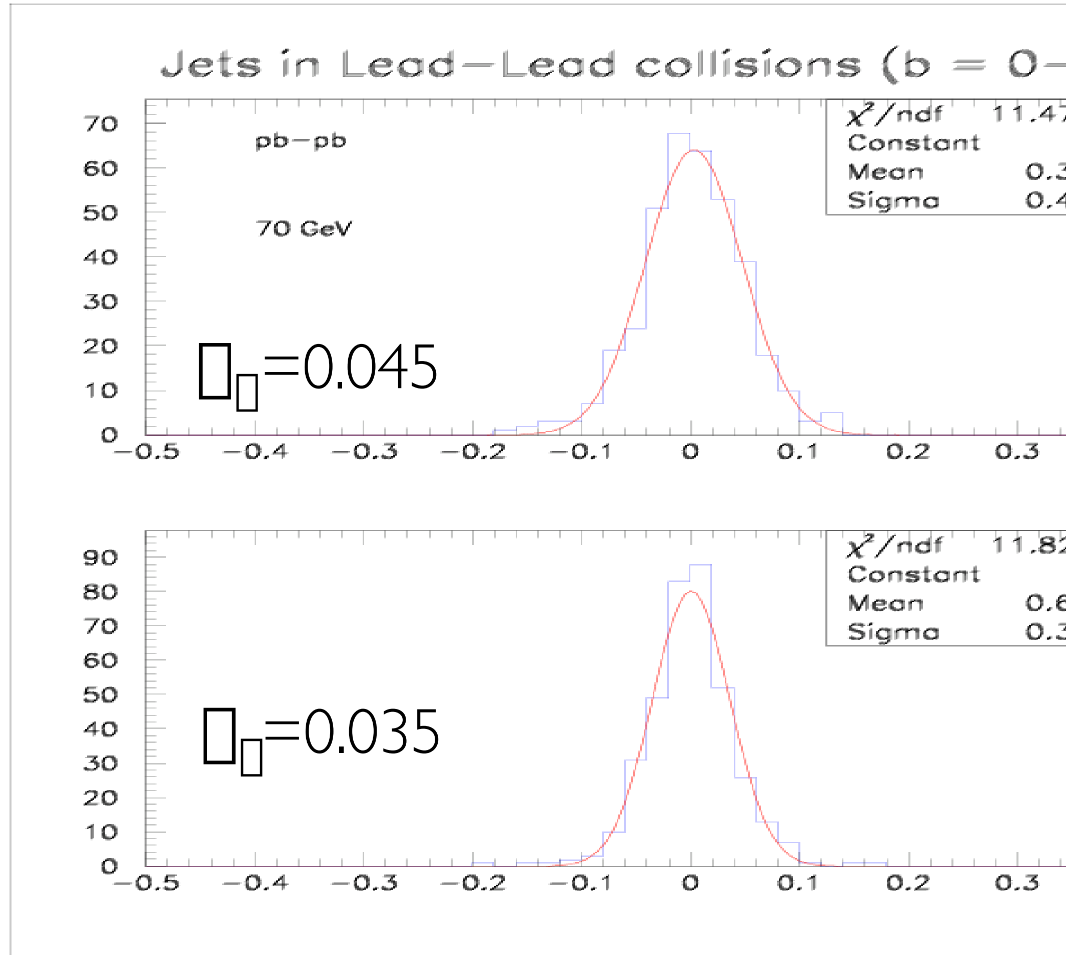
Reconstruction:

ding window algorithm with splitting/merging
fter background subtraction (average and local)
gorithm is not fully optimized.



(a)
(b)
(c)
(d)
E_T (GeV)
φ (rad.)





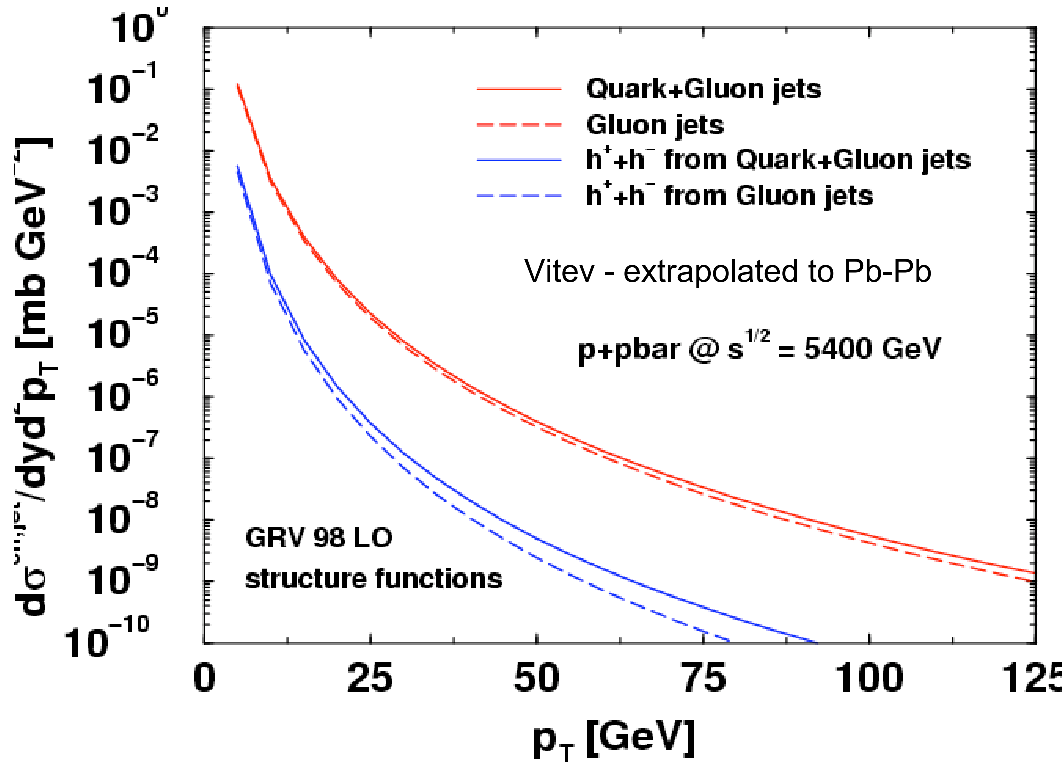
(In heavy ion environment, 70 G

calibration - Developed for the ATLAS
or based on H-1 algorithm.

Simulation indicate good performance for je
resolution, but for jets of transverse energy
~40 GeV, jet pointing resolution is also pr

ATLAS accepted jets for central Pb-Pb

Jet p_T > 50 GeV	**30 million !**
Jet p_T > 100 GeV	**1.5 million**
Jet p_T > 150 GeV	**190,000**
Jet p_T > 200 GeV	**44,000**



Every accepted jet event is an accepted jet-jet event since ATLAS has nearly complete phase space coverage !

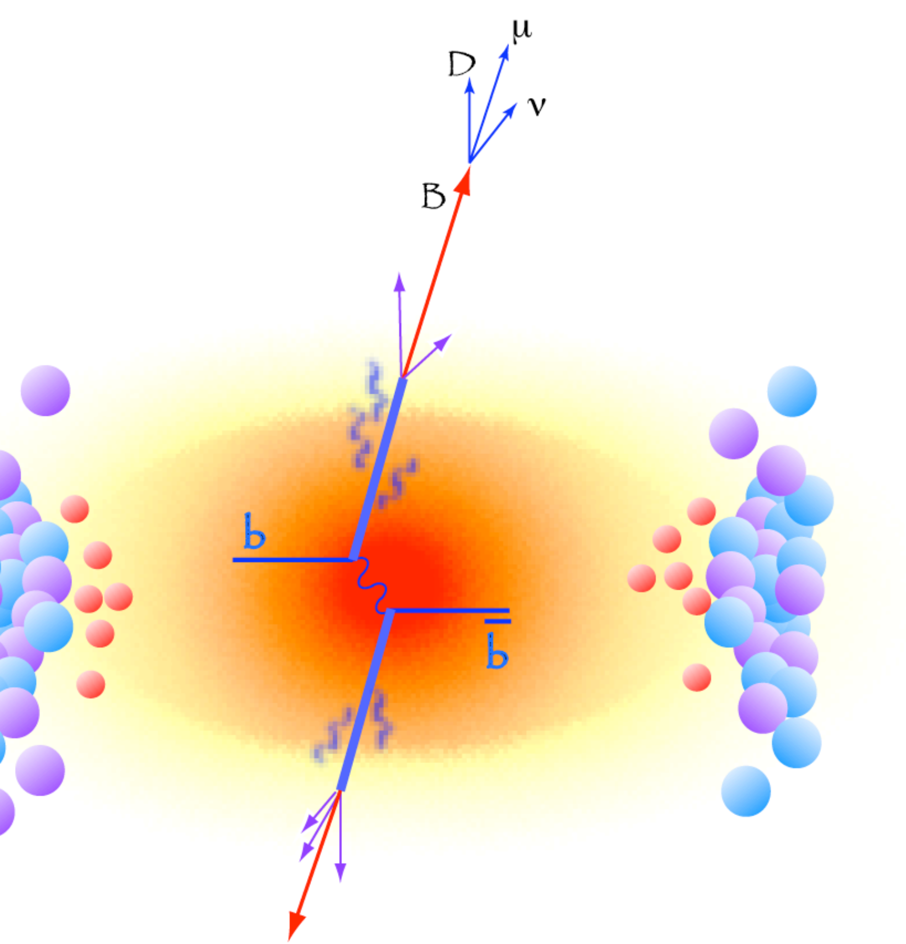
□-jet 10^6 events/month with p_T >50 GeV

□and Z^0 have no radiation !

□*-jet 10,000 events/month with p_T >50 GeV with □* □ $□^+$ $□^-$

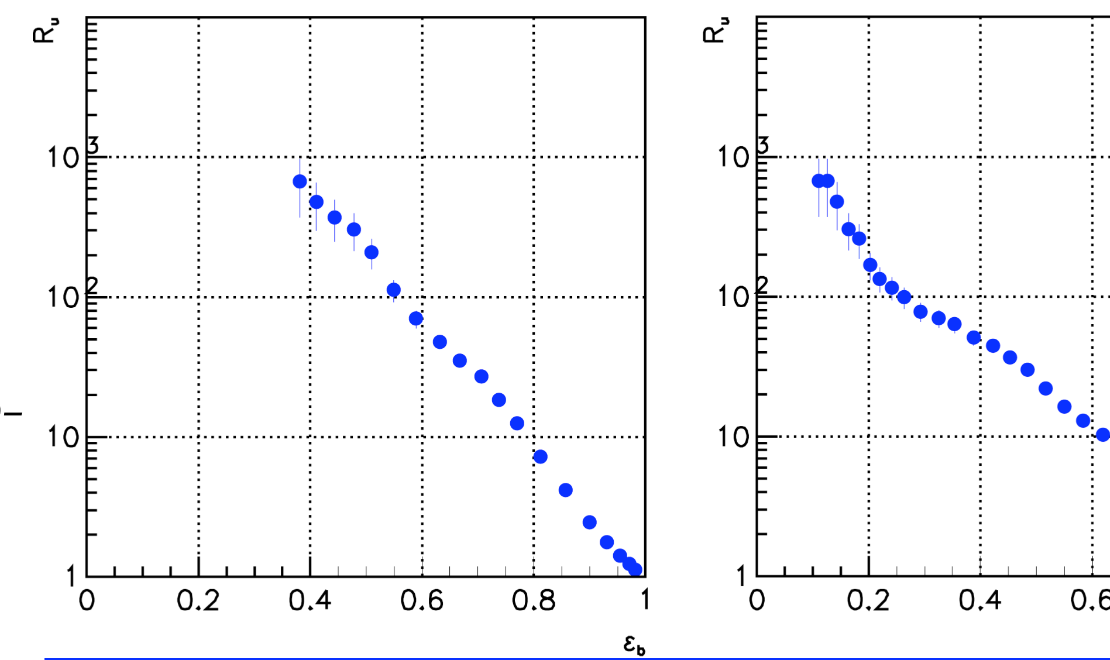
Z^0-jet 500 events/month with p_T >40 GeV with **Z^0** □ $□^+$ $□^-$

Radiative quark energy loss is qualitatively different for heavy light quarks.



ging efficiency by dislocated vertex
be possible in the heavy ion
ent. Muon tagging should improve b-
ng

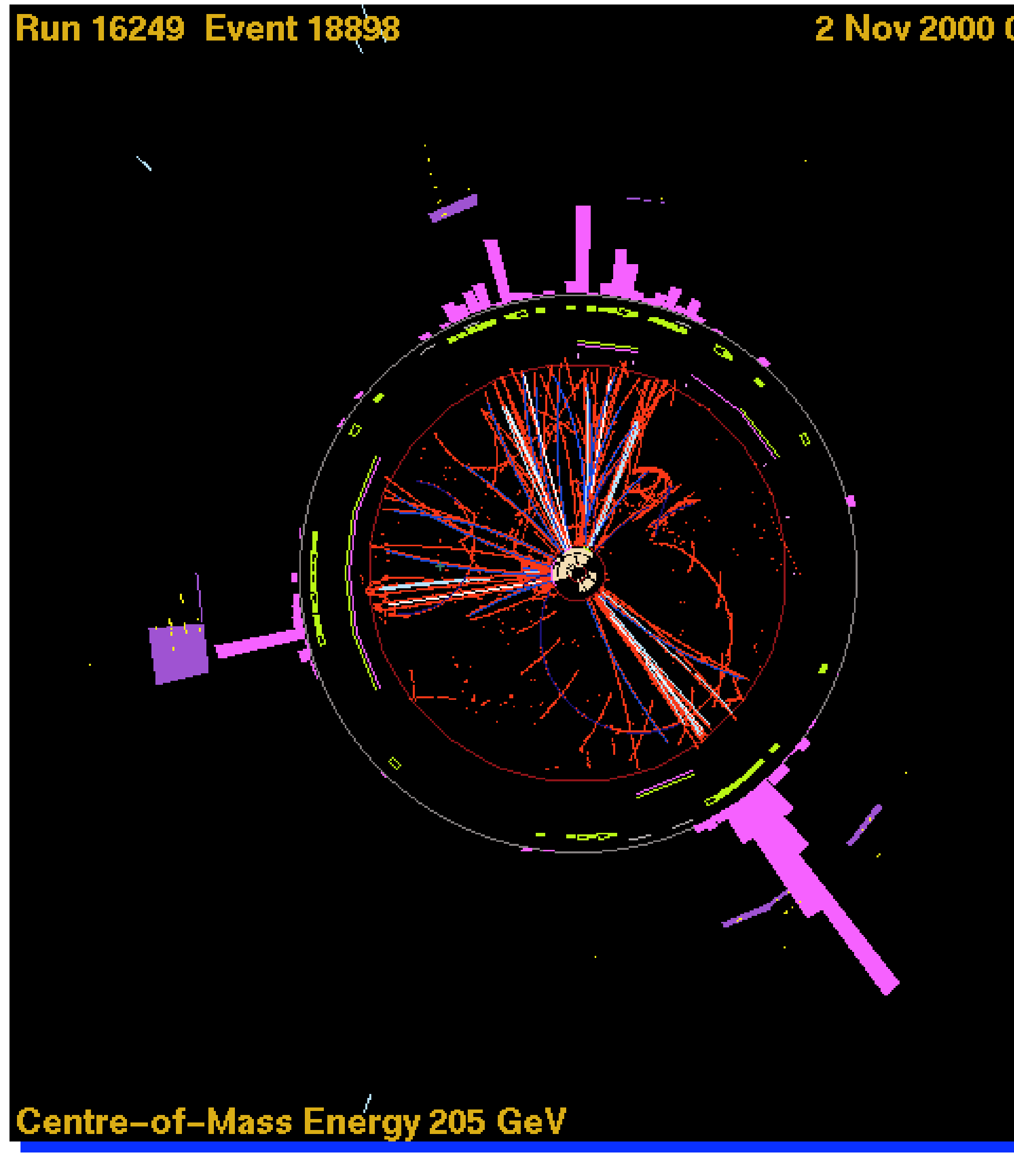
(WH events overlapped on top of HIJI



THREE JET EVENTS?

events the "third" jet is a
diated gluon. Because the
gluon plasma is a colored
the gluon should couple
tronger to the media and
re quenching should be

hould be observe?
s an enhancement in the
f 2 to 3 jet events?



obviously a LEP event!

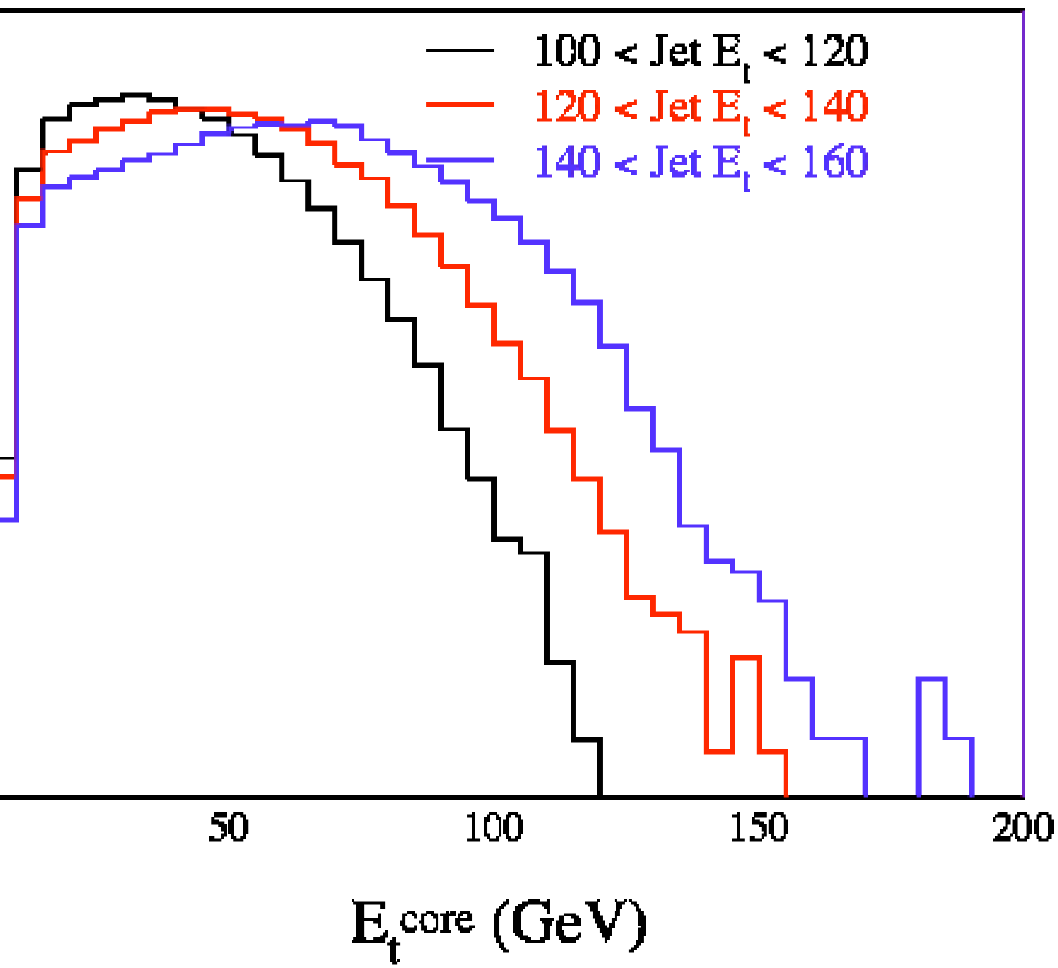
$_T$ should be balanced - either in jet+jet, 3 jet, or
Conservation of Energy

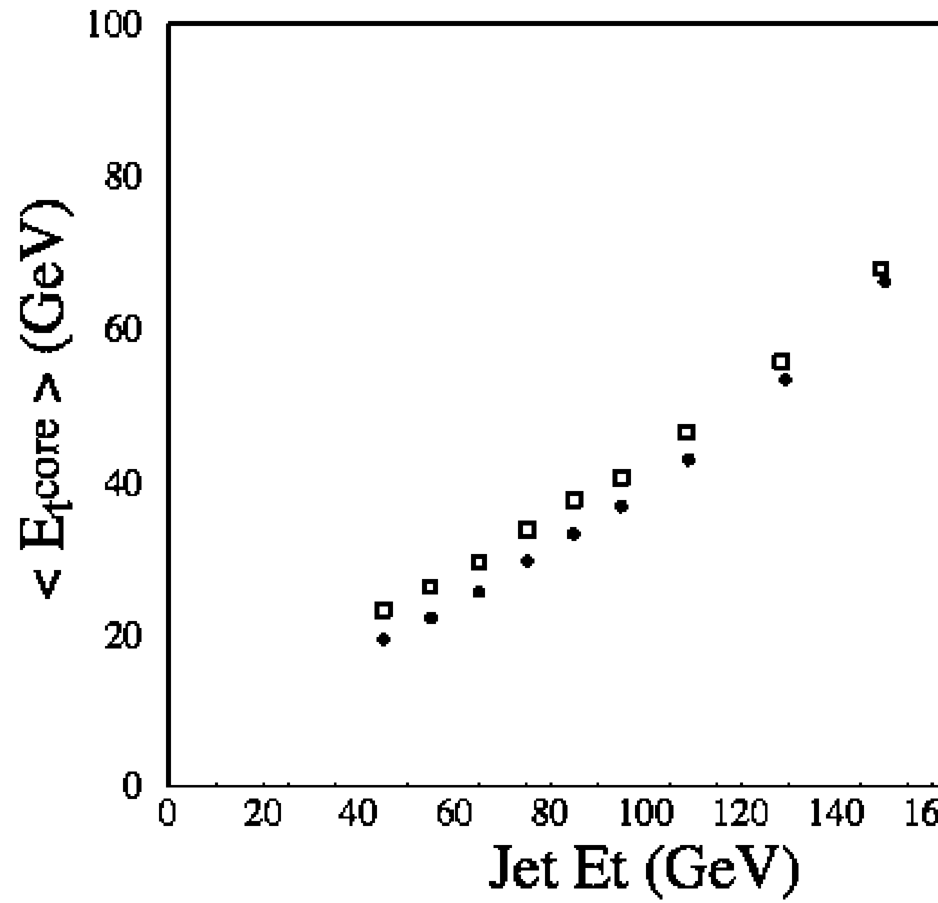
mentation function, angular distribution should be
tive to quenching - require definition of jet energ
axis based on energy flow

goal is to reconstruct jets using calorimeter
mation and inner detector tracking to obtain
mation such as dN/dz, dN/d, etc

Jet E_T Core

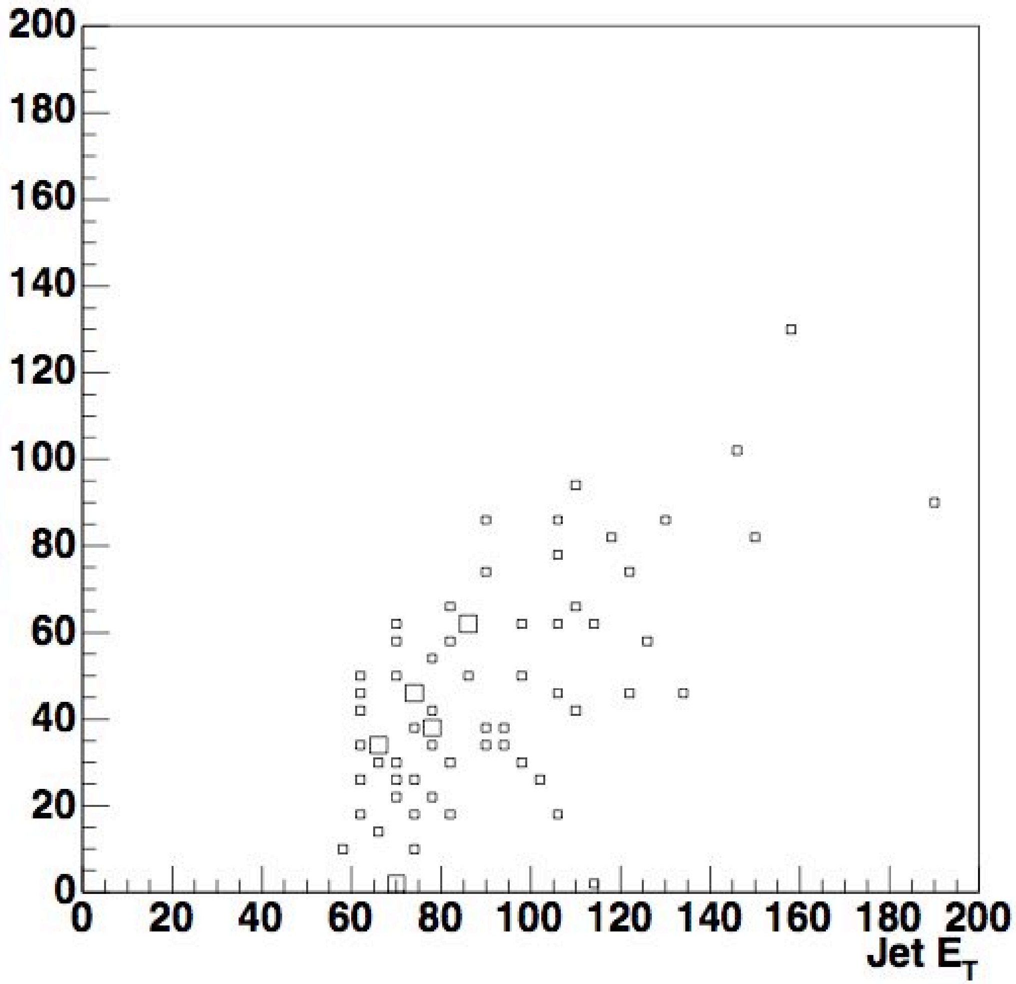
olated neutral cluster within Jets - Low yield



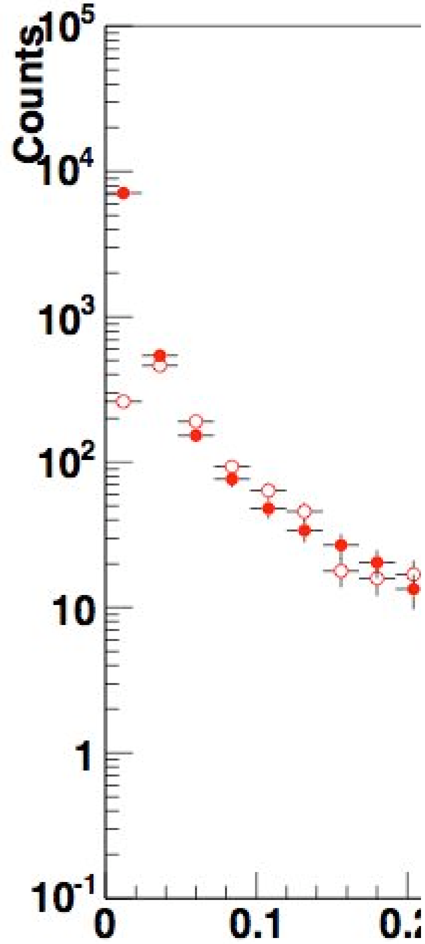


t Core E_T - ET in a narrow cone around jet axis (□R=0

(PRELIMINARY)



Jet E_T vs p_T sum (of tracks)



p_T/E_T, Pb+Pb and PYTH

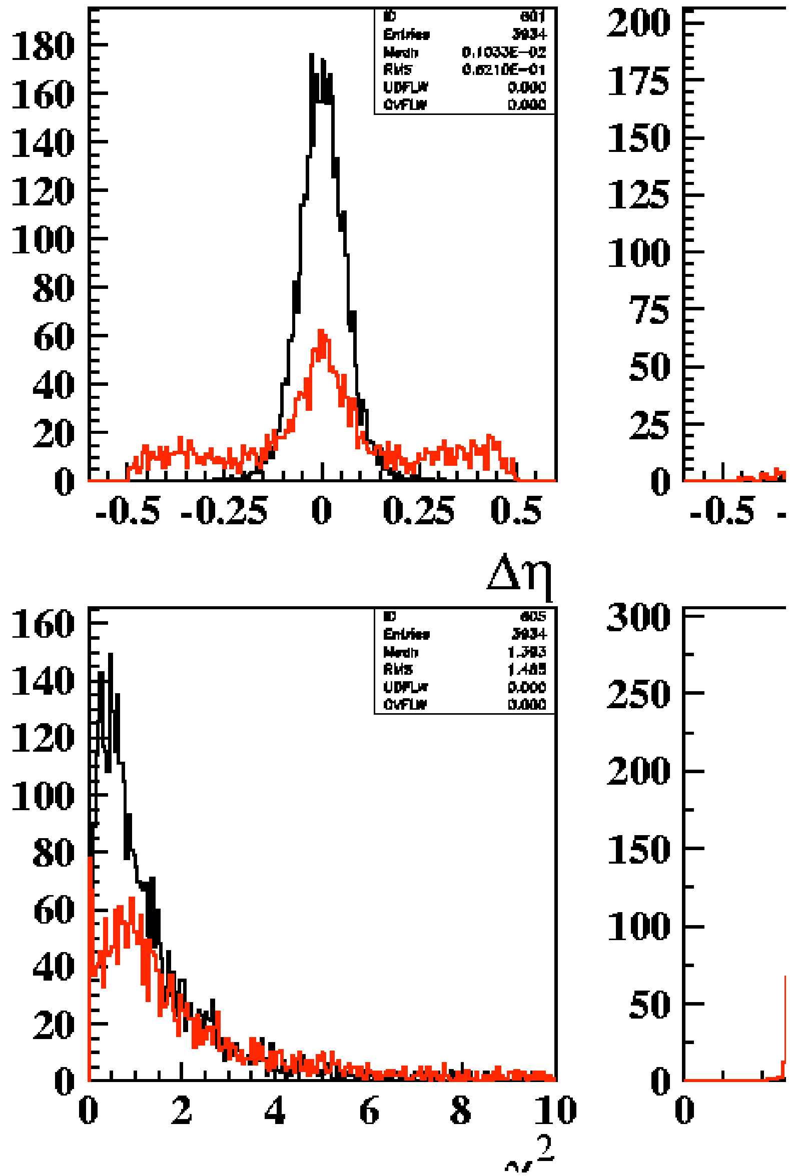
overlay upsilon decays on top of HIJING events.

Single Upsilons

HIJING background

Half □'s from c, b decays, half from π, K decays for p_T>3 GeV.

Background rejection based on □^{2} cut, geometrical cut and p_T cut.

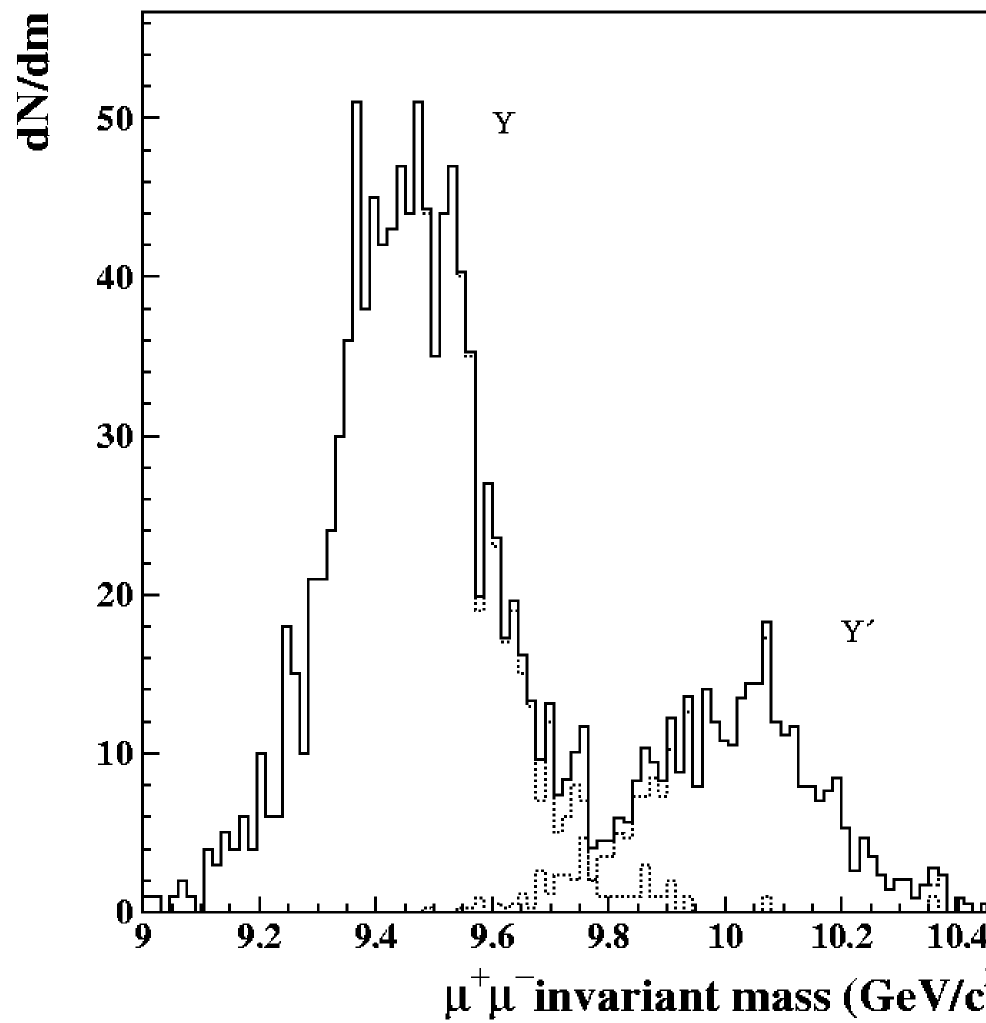


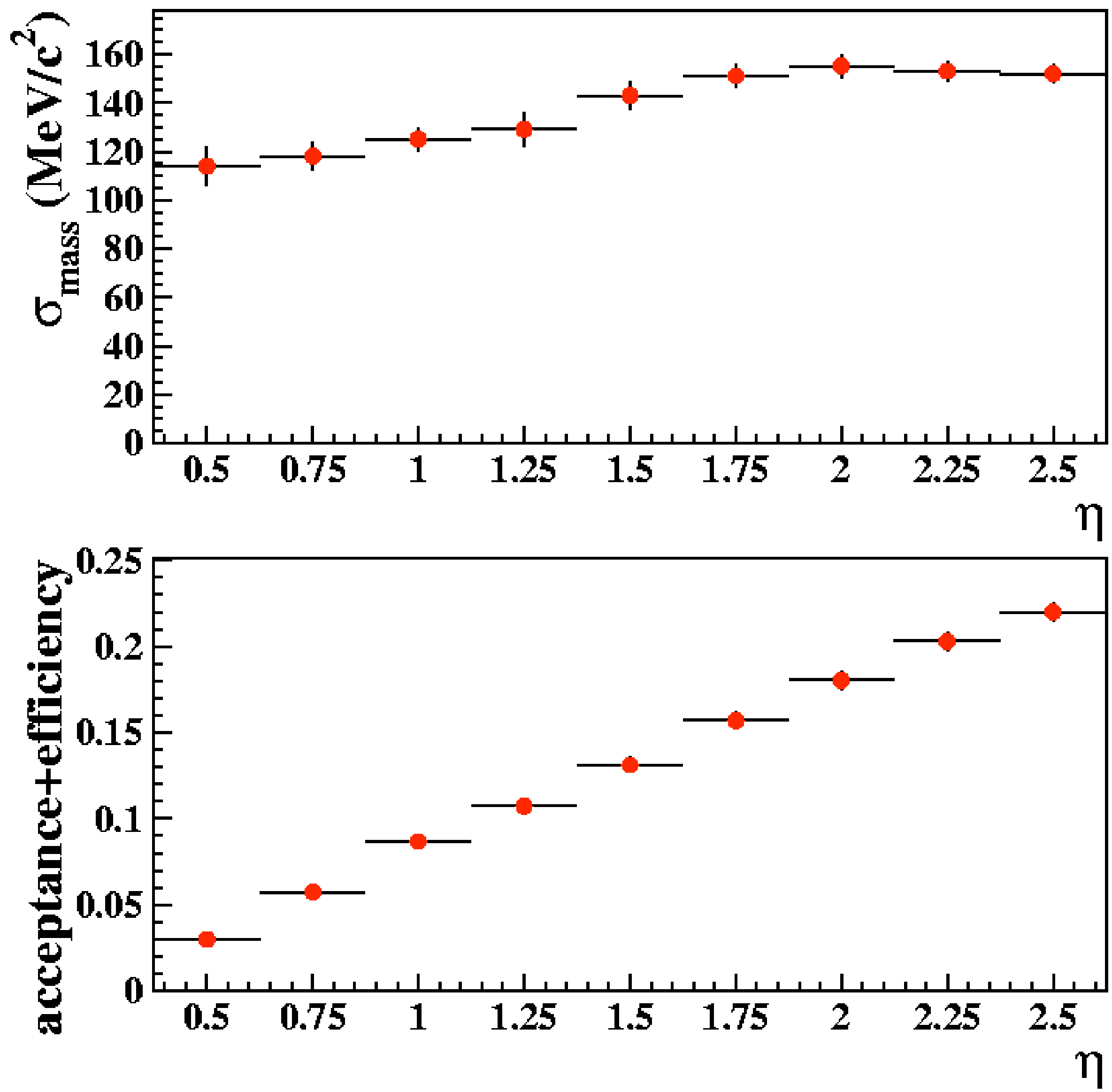
□□, □□=difference between ID and μ-spectrometer tracks after back-extrapolation to the vertex for the best □^{2} association.

and alone muon spectrometer gives a mass resolution of 460 MeV. Reconstruction uses track match to inner etectors.

arrel only (|□| <1)

cceptance efficiency	8.7%	(cf full: 22.0%)
esolution	126 MeV	(152 MeV)
/B	2.0	(0.9)
urity	94-99%	(91-95%)





A compromise has to be found between acceptance and resolution to clearly separate upsilon states with maximum statistics (e.g. 10%)

Min. p_T	3.0 GeV/c	3.5 GeV/c	4.0 GeV/c	4.5 GeV/c
Acceptance (full)	22.0%	21.5%	19.2%	7.6%
S/B (full)	0.9	1.0	1.1	0.8
Acceptance (barrel)	8.7%	8.6%	8.3%	4.0%

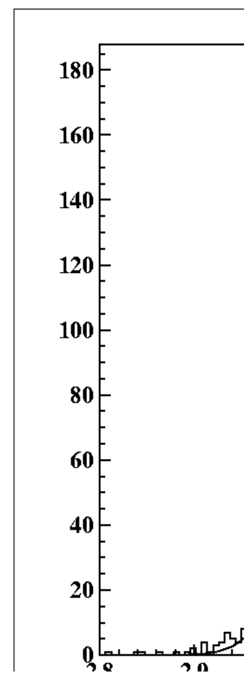
- **A di-muon trigger** using a □ p_T cut < 4 GeV **s being investigated.**

- **A J/□ study is also under way.**

□$_{mass}$=53 MeV =>easy separation of J/□ and □’

Low mass =>decay □’s need an extra p_T from the J/□ or a Lorentz boost to get through the calorimeters.

=>full p_T analysis possible only forward and backward where the background is maximum.



tudy of the modification of the gluon distribution in the ucleus at low x_F.

xg(x) enhanced by A1/3~6 in Pb compared to p

kinematical access x_F>10-5

nk between pp and AA physics

tudy of the jet fragmentation function modification

QCD in nuclear environment

Occupancy in p+Pb is lower than in full luminosity pp. Full etector capabilities will be available. L~10^{30} translates to bout 1MHz interaction rate (compare to 40 MHz in pp)

ATLAS has an excellent calorimeter/muon-
ectrometer coverage suitable for high-p_T heavy-
ns physics

jet physics (quenching) looks very promising

Upsilon is accessible

Pixel+SCT work in Pb-Pb collisions (tracking,
rticle multiplicities from hits)

p-A, Ultra-Peripheral Collisions (easier than
-Pb collisions) will be studied