Reconstruction of Z0->μ+μ- with Central Barrel Detector of ALICE

For ALICE Collaboration

Chuncheng Xu
In collaboration with Daicui Zhou,
Xu Cai and Zhongbao Yin

Institute of Particle Physics
Central China Normal University

Outline

- *General Physics Motivation*
- *Strategies of Reconstruction of Z0->μ+μ-*

(I) PID between μ and e

(II) PID between μ and hadrons

- *Conclusions and Suggestions*
- *Many many Thanks*

General Physics Motivation

Z0 has 2 nice channels Z0->e+e- and Z0->μ+μ- which are very promising to be observed.

These 2 Channels can be used for detector calibration for high Pt tracks

These 2 channels can be used as a reference for other Jet Study

Measuring Mass and decay width of Z0 produced in AA might also be very interesting.

- ***But lepton momentum is high, Bremstralung of Electrons is a problem in Determining the exact property of Z0 (Mass and Decay Width…)***
- ***The Central Barrel Detector has a non-neglegible Acceptance of Z0 when Compared to Forward MUON detector.***

Electron Bremstralung and Mass Spectrum of Z0->e+e-

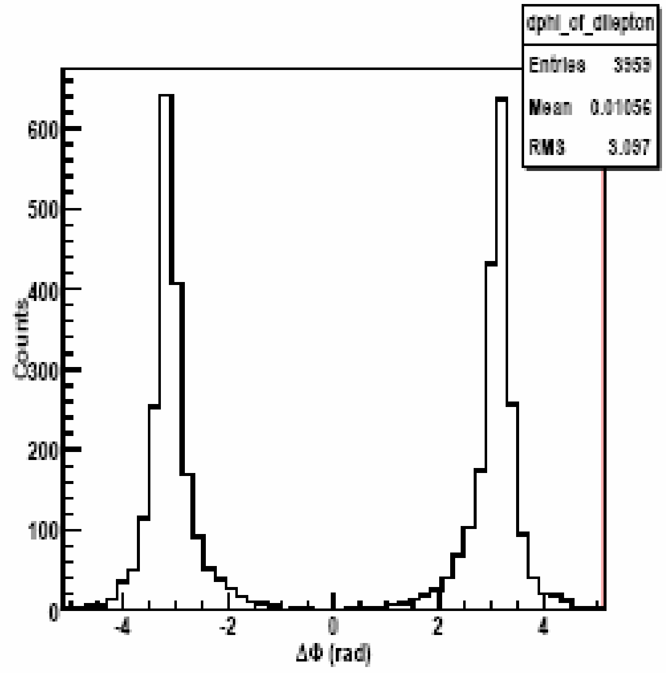


FIG. 3: The difference of ϕ between two muons decaying from the same Z^0 produced in 14 TeV pp collisions. It shows that the Z^0 leptonic decay look like a back-to-back event in ϕ direction.

Pt Spectrum of Leptons From Z0

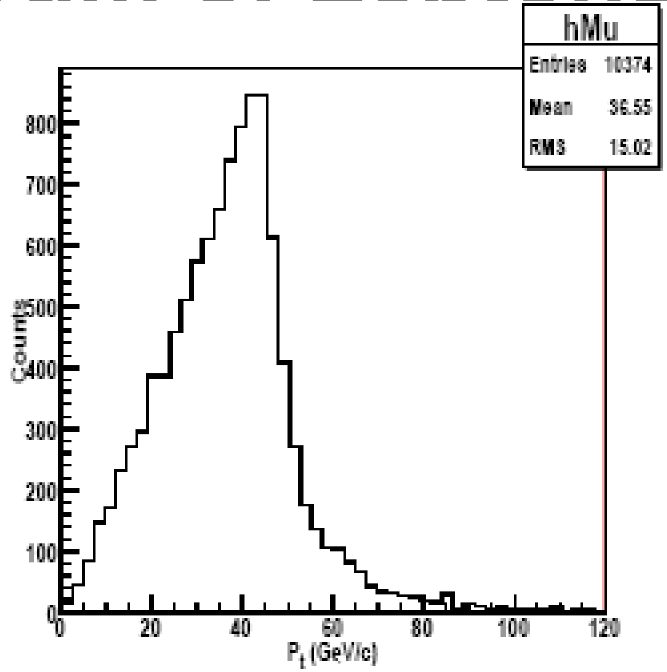


FIG. 4: The Pt distribution of Z^0 that decay into muons that both are in mid-rapidity. This shows that the Pt is in a range that the central tracking detector has good resolution. The same is true for electron channel.

Bremstralung of Electrons

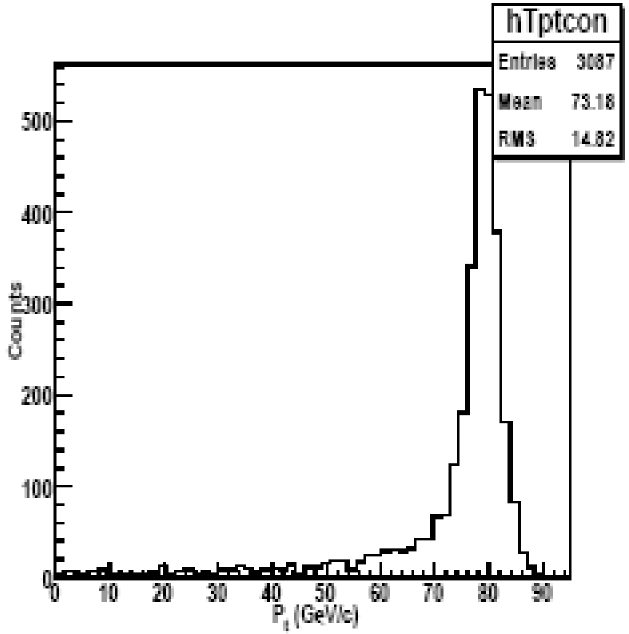


FIG. 5: Reconstructed Pt distribution of electrons generated with momentum of exact 80 GeV.The bremsstrahlung of electrons is not negligible. The same momentum of muons, the energy loss is definitely negligible within our resolution.

Mass Spectrum of e+e- Channel

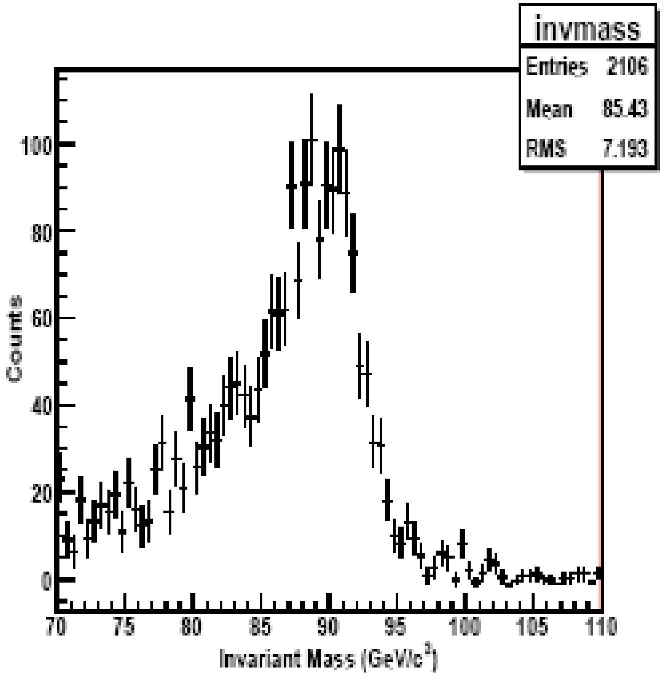


FIG. 12: Invariant mass distribution of $Z^0 -> e^+e^-$ after background subtraction in one year running at luminosity of $10^{31} cm^{-2}s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger.

Strategy of Reconstruction of μ+μ- Channel

- Back to back events
- Pt>25 GeV/c
- Both high Pt tracks should be isolated tracks (with in delta_eta and delta_phi of

[-0.1,0.1], there are no other tracks with Pt>2GeV/c

And TRD says the two tracks are not electrons.

PID of e and u

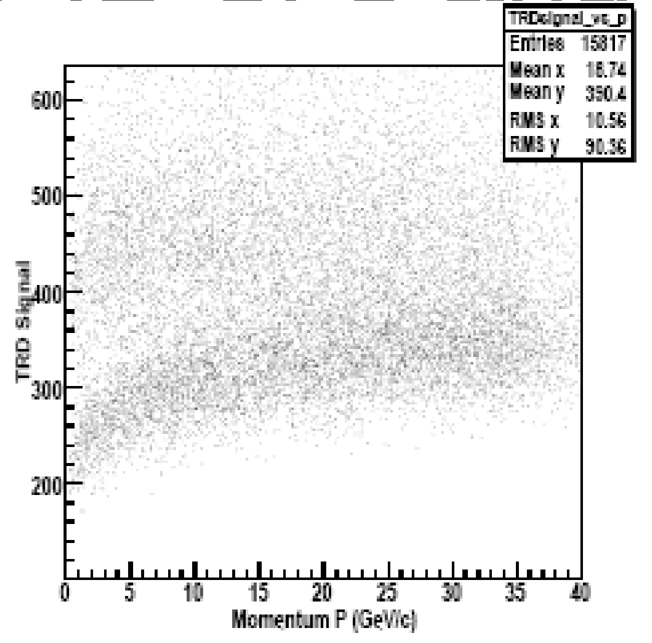


FIG. 6: TRD signal.vs. P for electrons and muons. The lower black band is mainly for muons and the upper part mainly comes from electrons. It shows that in general TRD alone still have certain power to distinguish between e and muon.

Background analysis

(1) Some leptons from D decay happens to look like a back to back event

(2) One leptons from Z0 or W and matches with another high Pt from Jets

(3) Di-Jet events --→most dangerous one

Simulation of Background from di-Jet events

each 3*10**7 min-bias 14 TeV pp events contains one Z0->μ+μ-

each 10**5 min-bias 14 TeV pp events contain one Pt>25 GeV track

Keep the above in mind we mix each Z0->μ+μ- events with 500 pp events with di-jet of Et in [100,250] GeV

One year of Z0->μ+μ- in PP

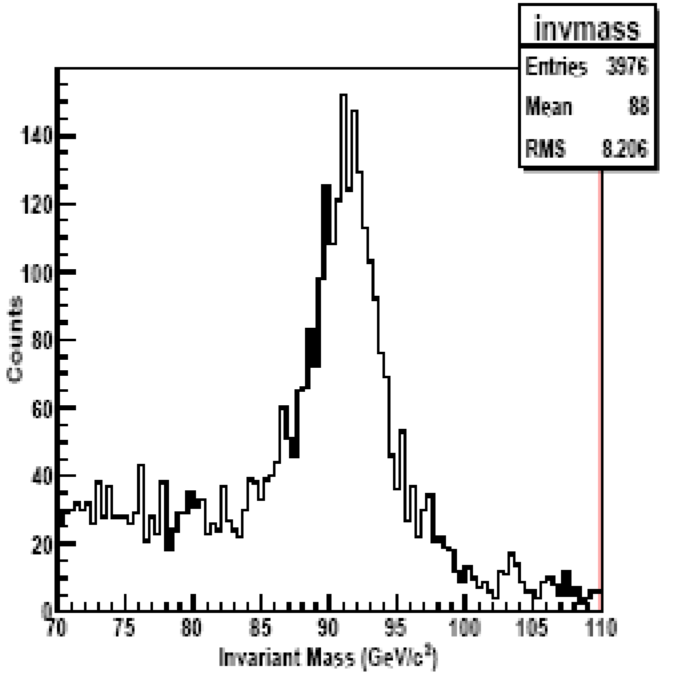


FIG. 13: Invariant mass distribution of $Z^0 -> \mu^+\mu^-$ in one year running at luminosity of $10^{31} cm^{-2} s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger.

Z0 ->μ+μ- after background subtraction in pp of 14 TeV

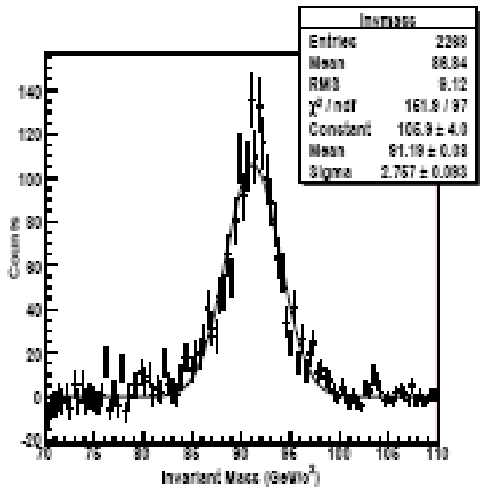


FIG. 14: Invariant mass distribution of $Z0- > \mu^+\mu^-$ after background subtraction in one year running at luminosity of $10^{31}\,cm^{-2}s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger.

Z0->μ+μ- in AA of 5.5 TeV

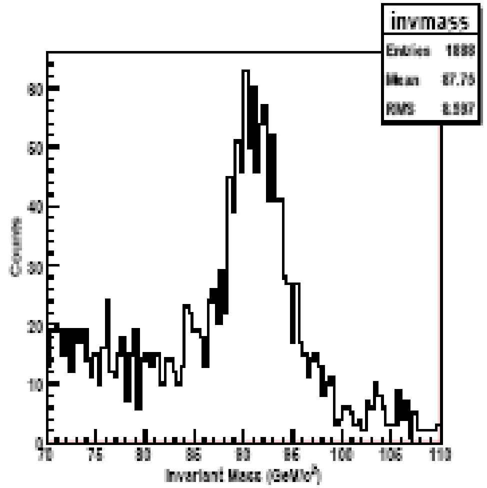


FIG. 15: Invariant mass distribution of $Z^0- > \mu^+\mu^-$ in 5 nominal year running of Pb-Pb at 5.5 TeV with L1 trigger of TRD.

Different Isolation Cut

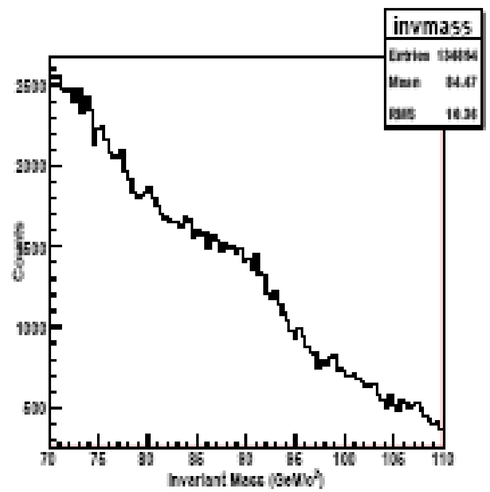


FIG. 7: Invariant mass distribution of $Z^0 -> \mu^+\mu^-$ in one year running at luminosity of $10^{31} cm^{-2} s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger and with $Pt > 25 GeV/c$ cut only.

Different Isolation Cut

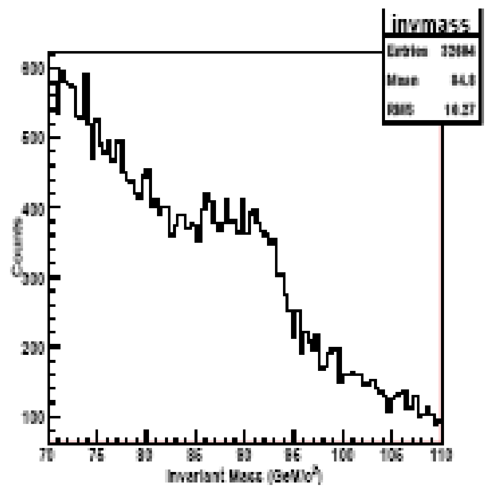


FIG. 8: Invariant mass distribution of $Z^0 -> \mu^+\mu^-$ in one year running at luminosity of $10^{31} cm^{-2} s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger and with $Pt > 25 GeV/c$ cut and with isolation cut of cone size $R_c^{threshold}$=0.03.

Different Isolation Cut

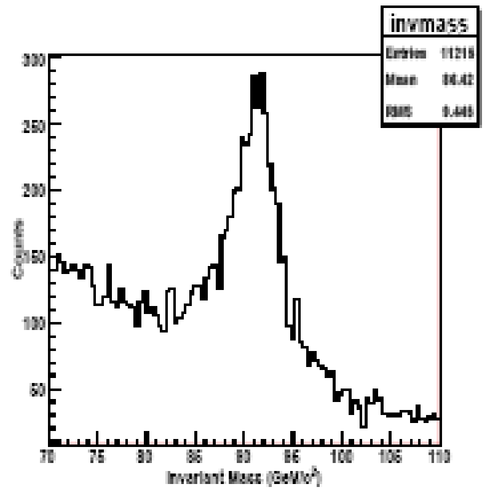
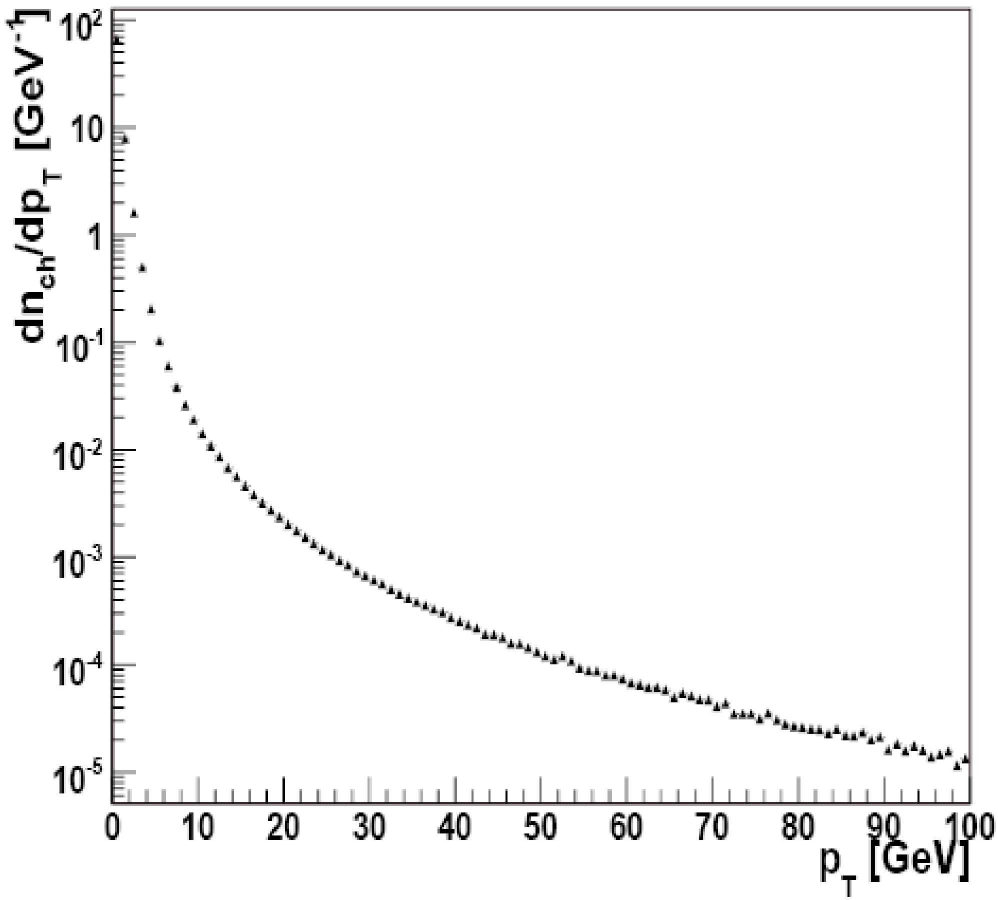


FIG. 9: Invariant mass distribution of $Z^0- > \mu^+\mu^-$ in one year running at luminosity of $10^{31}cm^{-2}s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger and with $Pt > 25GeV/c$ cut and with isolation cut of cone size $R_z^{threshold}$=0.05.

Using Tuned PYTHIA to the CDF TeV Data



Background Study Again

- Jets simulations:
  Used the tuned PYTHIA to the Tevatron data of CDF also in AliRoot (kPyJets)
  CDF Collaboration, Phys. Rev. D65 092002 (2002)
  It can fairly reproduce:
  - the size of the leading charged jets
  - the radial distribution of charged particle
  - the transverse momentum around the leading charged jet direction
  - the momentum distribution of charged particles within the leading charged jets
- Produced $b\bar{b}$ and $c\bar{c}$ per p_T^{hard} bins following the decision of the Physics board for $c\bar{c}$ at low p_T^{hard}.
  Normalised to the total cross-sections to NLO calculations taken into account the Branching ratios.
- Used also PYTHIA for $t\bar{t}$

Background analysis Again

Using the above tuned PYTHIA parameters we generated 2*108 mini-biased pp events at 14 TeV.**

We find that each 100,000 we have 1.2 entries for candidate Z0, but the isolation cut is very powerful.

It can reduce background by a factor of 500 if we choose cone-size of 0.1 and Pt Cut of 2 GeV.

One year of Z0->μ+μ- in PP With Tuned Pythia

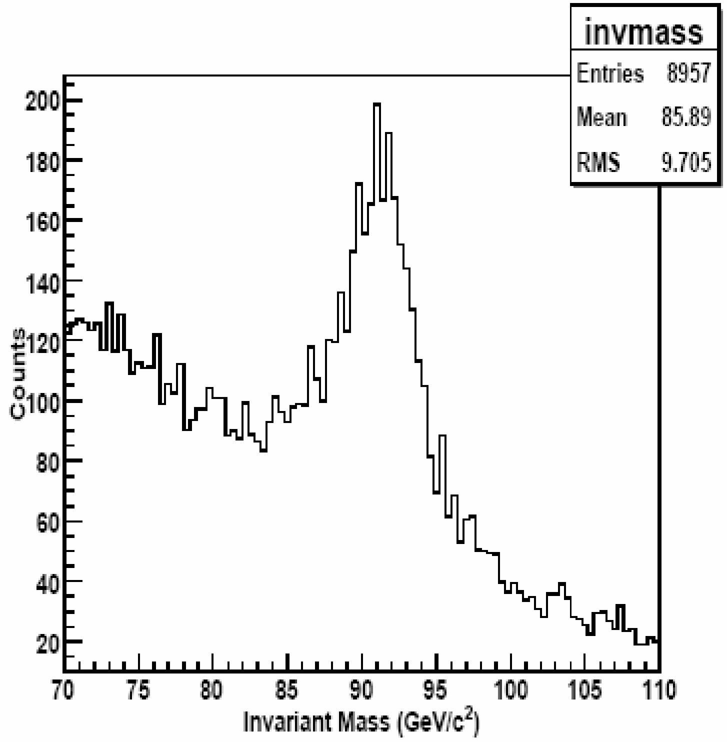


FIG. 16: Invariant mass distribution of $Z^0- > \mu^+\mu^-$ in one year running at luminosity of $10^{31}cm^{-2}s^{-1}$ in pp of 14 TeV with TRD used as L1 trigger. We use tuned pythia to CDF TeV data.$P_t^{threshold}$=1.0 and $R_c^{threshold}$=0.2

Z0->μ+μ- in AA of 5.5 TeV with Tuned Pythia

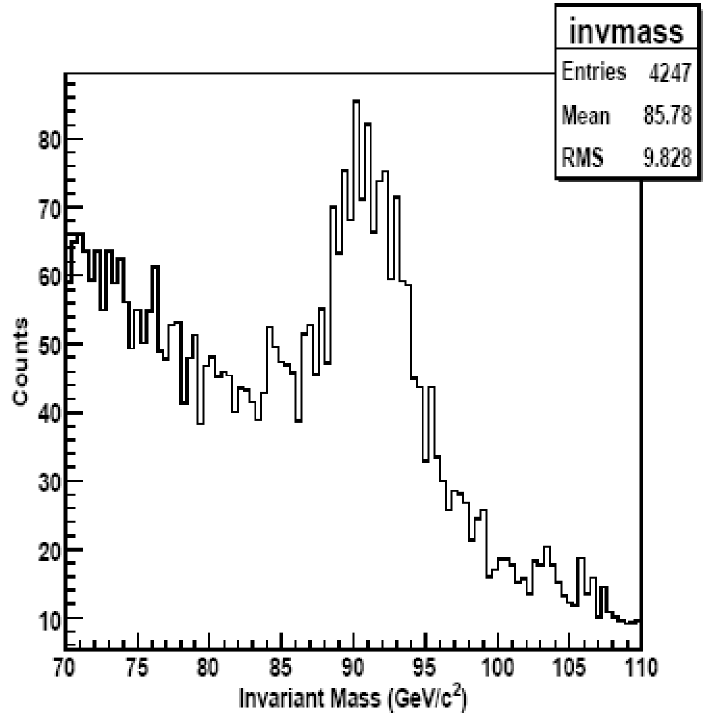


FIG. 17: Invariant mass distribution of $Z^0 -> \mu^+\mu^-$ in 5 norminal year running of Pb-Pb at 5.5 TeV with TRD used as L1 trigger. We use tuned pythia to CDF TeV data.$P_t^{threshold}$=2.0 and $R_c^{threshold}$=0.1.

Efficiency by different Isolation Cut and Different Pt threshold in AA of 5 TeV

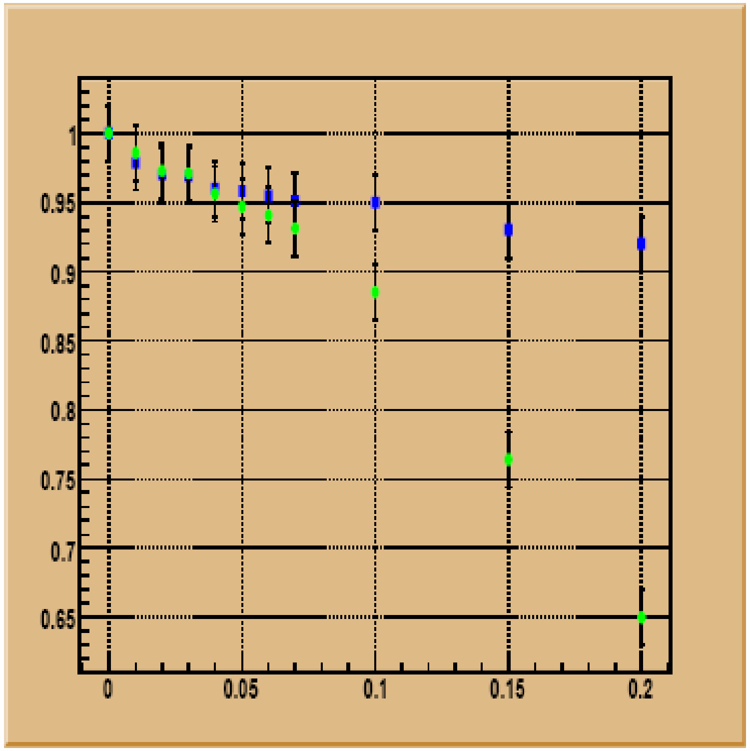


FIG. 18: Relative efficiency vs cone size $R_c^{threshold}$. Suppose without isolation cut the efficiency is 1.0. And we assume dN/dY=2000. $P_t^{threshold}$=4.0 and $P_t^{threshold}$=2.0 are studied seperately.

Conclusions

Z0->μ+μ- in Central detector seems tough

But in General we are optimistic

Triggering is necessary for statistics:2000 in pp and 200 in AA each year.

Cone size and Pt threshold still need to be optimized.

The mass of Z0 may be measured with error-bar of about 100 MeV. And decay width: a few percent.

Many thanks

- Thanks Andreas Morsch for knowledge of Jets
- Thanks Gines MARTINEZ for offering the knowledge of triggering
- Thanks Anton Andronic for offering set of

parameters of pythia tuned to CDF TeV data