Study of jet trigger with ALICE EMCAL for PbPb 5.5TeV

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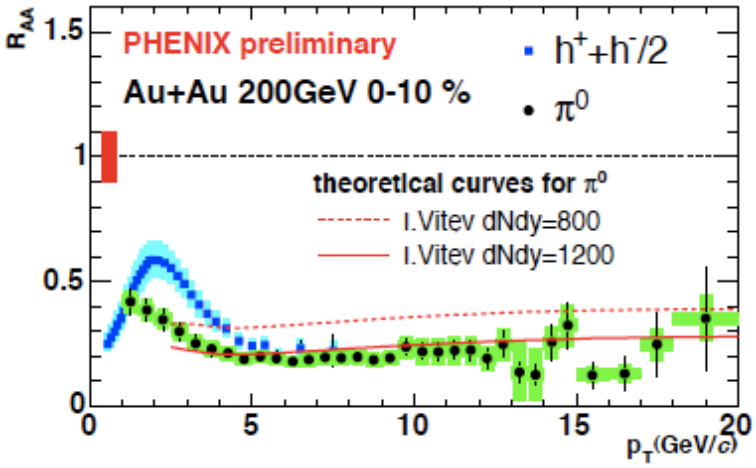
Outline

- Motivation
- ALICE Detector
- Annual jet yield with ALICE : PbPb 5.5TeV
- ALICE trigger architecture
- Jet trigger performance : PbPb 5.5TeV
- Summary

Motivation



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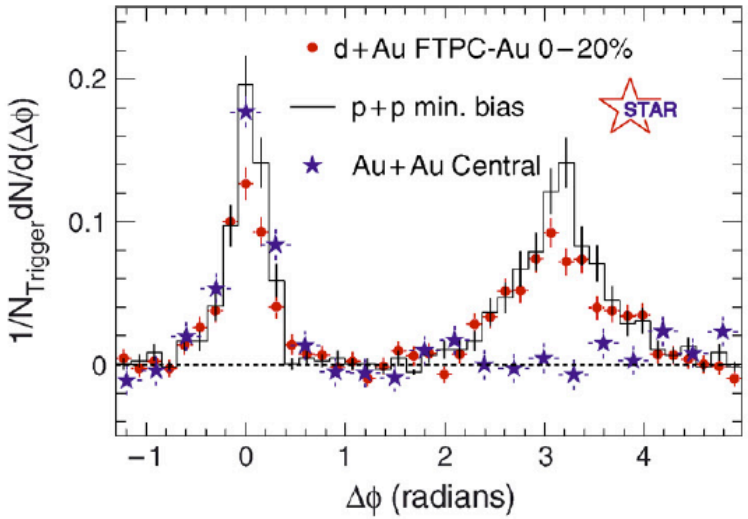
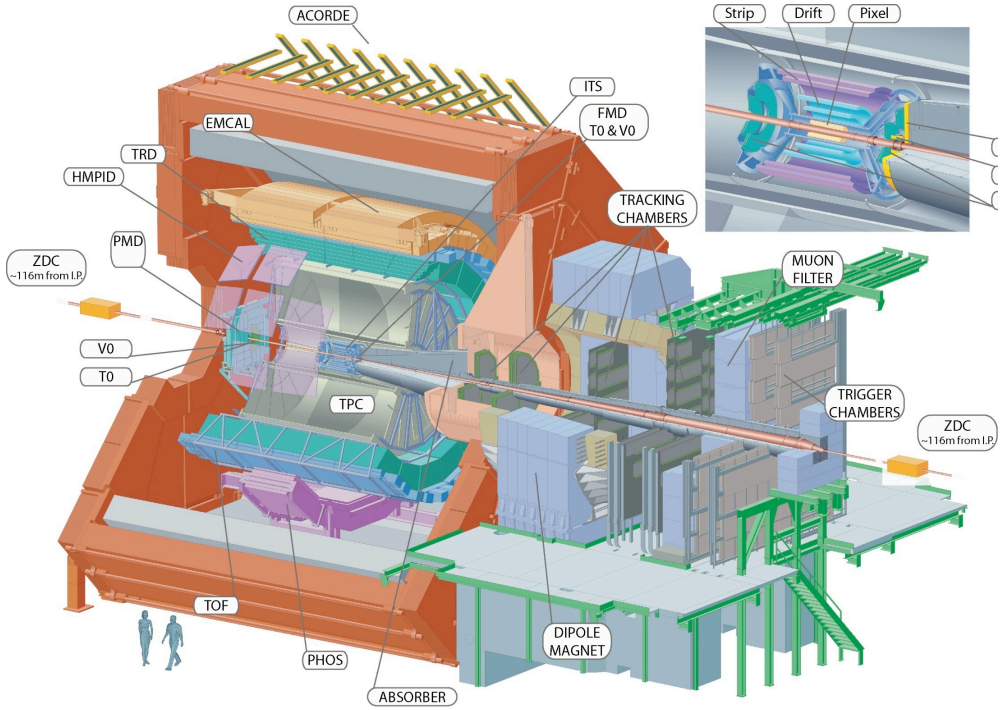
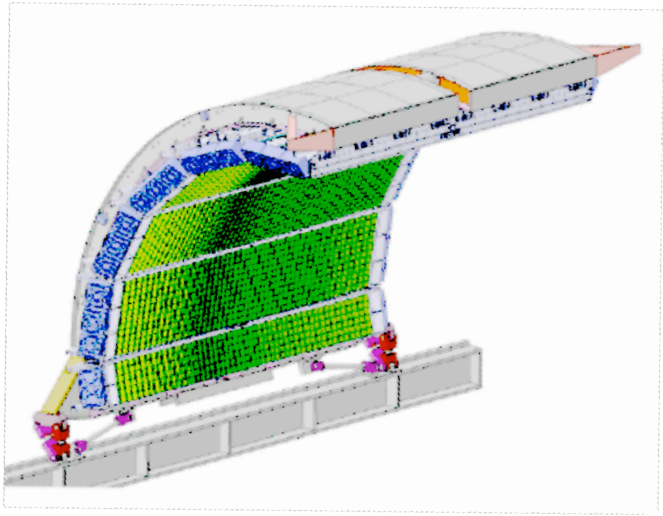


- RHIC has discovered partonic energy loss in QGP
  - These results are from the measurement of leading hadrons

- If jets can be measured in heavy ion environment, it must be more direct probe for parton energy loss and QGP property itself

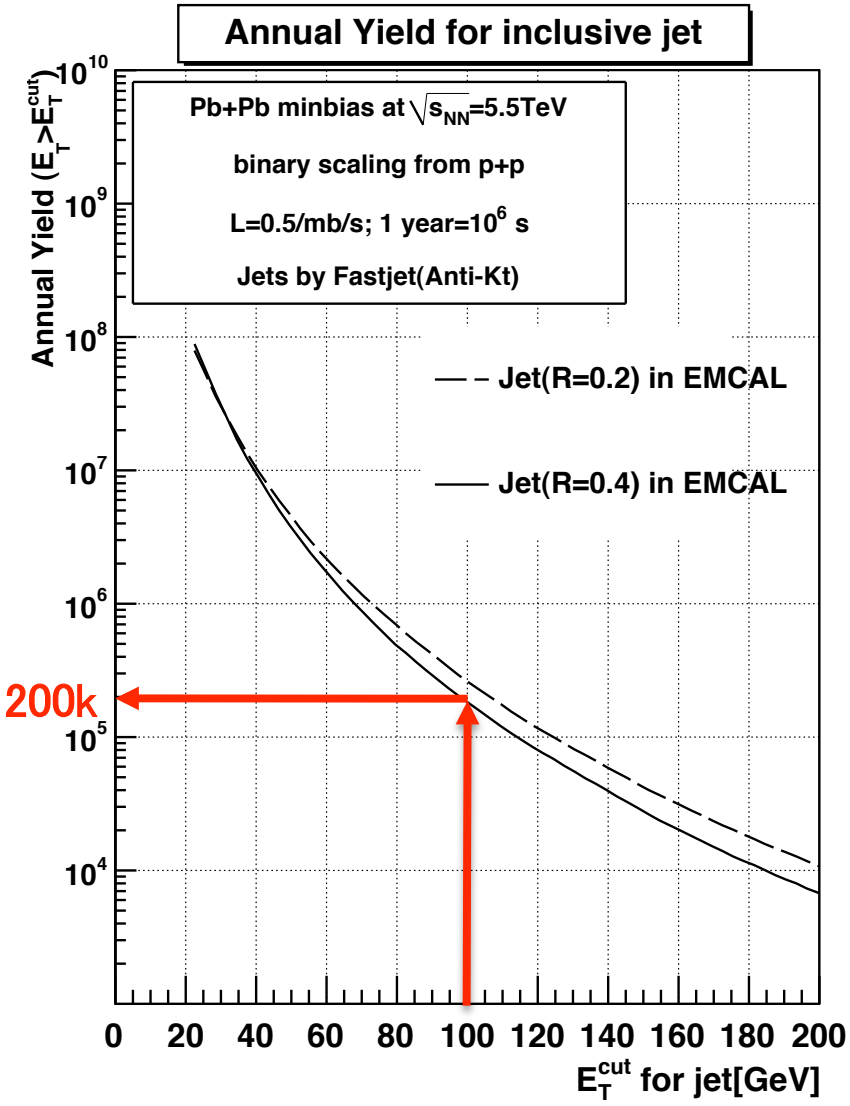
ALICE Detector





- ITS, TPC, TRD :
  - $\Delta\phi < 2\pi$ 、$|\eta| < 0.9$
  - charged particle momentum determination.
  - $\Delta p/p \sim 5\%$ at 100GeV/c
- EMCAL :
  - $\Delta\phi < 110^\circ$ 、$|\eta| < 0.7$
  - π^0 and γ measurement
  - $\Delta E/E \sim 11\%/\sqrt{E}$

Annual jet yield at ALICE



- Annual jet yield
  - Nominal PbPb luminosity
  - 1 running year
  - Binary scaling from p+p (pythia6)
  - FastJet, anti-kt algorithm is applied for jet reconstruction.
    - ➔ see next talk by D. Sakata
- Huge cross section for jet production!
  - 200k jets/year above100GeV
  - We have lots of opportunity to use jets as a probe for the properties of QGP
- ALICE can't record all events

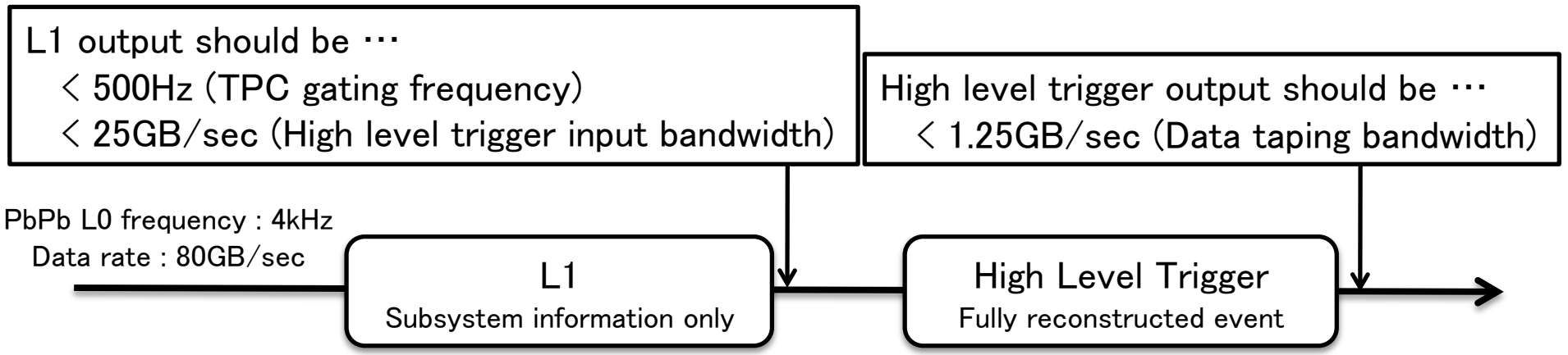
  ➔ Need to trigger

ALICE trigger architecture

- Limitations on data flow
  - TPC gating frequency (500Hz)
  - High level trigger input bandwidth (25GB/sec)
  - Data taping bandwidth (1.25GB/sec)

- We have to select the interesting event efficiently
  ➔trigger levels in ALICE (L0(1.2 μ s), L1(6.6 μ s), L2 and High level trigger)

- For heavy ion jet measurement with EMCAL, the trigger decision is at L1 and High level trigger



Jet trigger enhancement with EMCAL

System	$\sqrt{s_{NN}}$ (TeV)	L_{mean} $(cm^{-2}s^{-1})$	Time (s)	DAQ rate (Hz)	EMCal Trigger gain
p+p	5.5	$5 \cdot 10^{30}$	10^6	500	110
p+p	14	$5 \cdot 10^{30}$	10^7	100	550
p+p	8.8	$1 \cdot 10^{29}$	10^6	500	110
Pb+Pb					
cent 10%	5.5	$5 \cdot 10^{26}$	10^6	20	5.3
periph 60-80%	5.5	$5 \cdot 10^{26}$	10^6	20	53

- Trigger gain :
  - Comparison between

    Jets triggered by and reconstructed with EMCAL

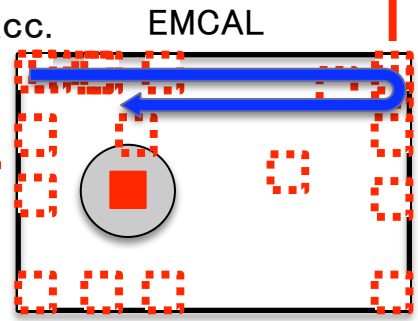
    and

    Jets by geometrical triggers and reconstructed with TPC
  - Applicable for E_T^{Jet}>100GeV
- Jet trigger with EMCAL will enhance high pt jet yield

Study of jet trigger performance : PbPb 5.5 TeV

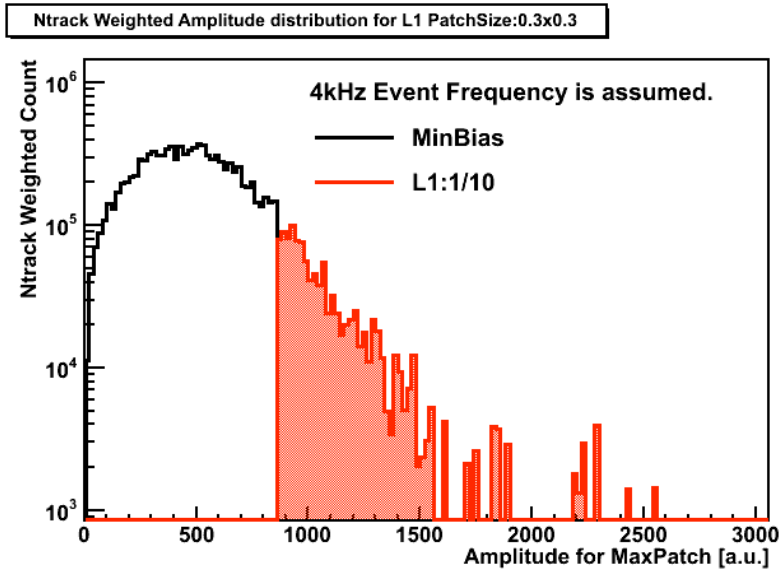
- To evaluate the jet trigger performance in PbPb collision with ALICE EMCAL, I analyzed the PYTHIA events merged with HIJING events, and applied the L1 trigger and High level trigger.

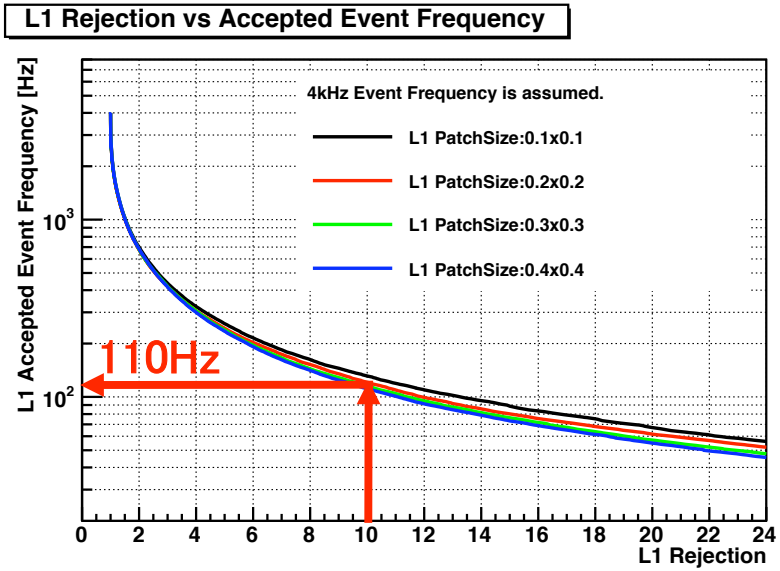
- L1 trigger
  - Patch trigger algorithm is used with subsystem information only (EMCAL, V0)
    - Search the square patch which have maximum amplitude in EMCAL acc.
    - If the amplitude is above the threshold, we accept the event



- High level trigger
  - Fully reconstructed event information (tracks, clusters in EMCAL, ⋯, etc)
  - Fastjet Anti-kt algorithm (R=0.4)
    - Search the jet which have maximum p_T inside EMCAL acc.
    - If the p_T is above the threshold, we accept the event

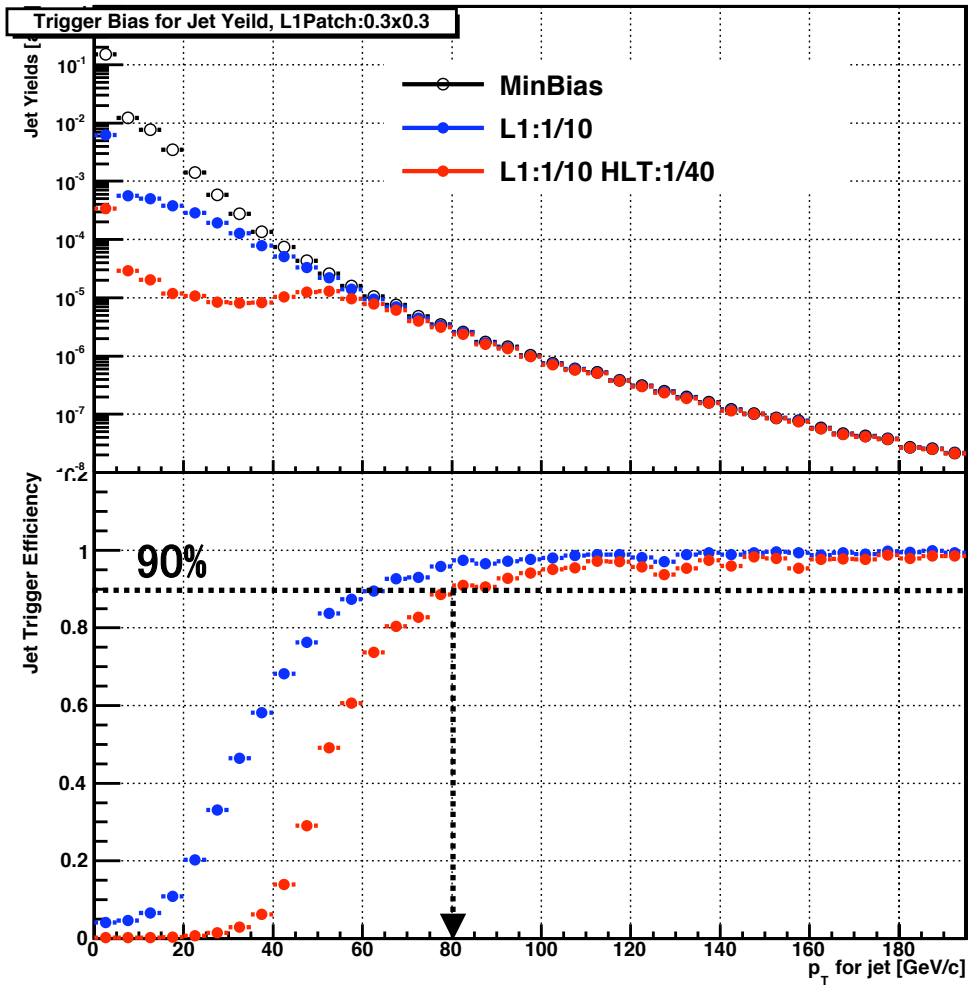
Background rejection : PbPb 5.5TeV





- Left plot :
  - Maximum patch amplitude distribution weighted by data volume
  - Background only (HIJING)
  - Applied cut to reduce data volume by factor 10
- Right plot :
  - L1 rejection vs L1 output frequency
  - Rejection 10 ➔ L1 output 110Hz, 8GB/sec

Trigger bias on jet yield : PbPb 5.5TeV



- Upper plot :
  - Jet yield as a function of jet p_T for pythia before/after trigger
- Bottom plot :
  - Jet trigger efficiency
- Rejections are 10 and 40 for L1 trigger and High level trigger respectively
  - L1 output : 110Hz , 8GB/sec
  - HLT output : 0.2GB/sec
- We have 90 % efficiency at above 80GeV/c for these rejections

Summary

- Jet Trigger performance was evaluated for PbPb 5.5TeV
- Jet trigger efficiency is greater than 90% above 80GeV/c

  with the following rejections

L1 : 1/10 HLT : 1/40	➡	L1 output : 8GB/sec, 110Hz HLT output : 0.2GB/sec

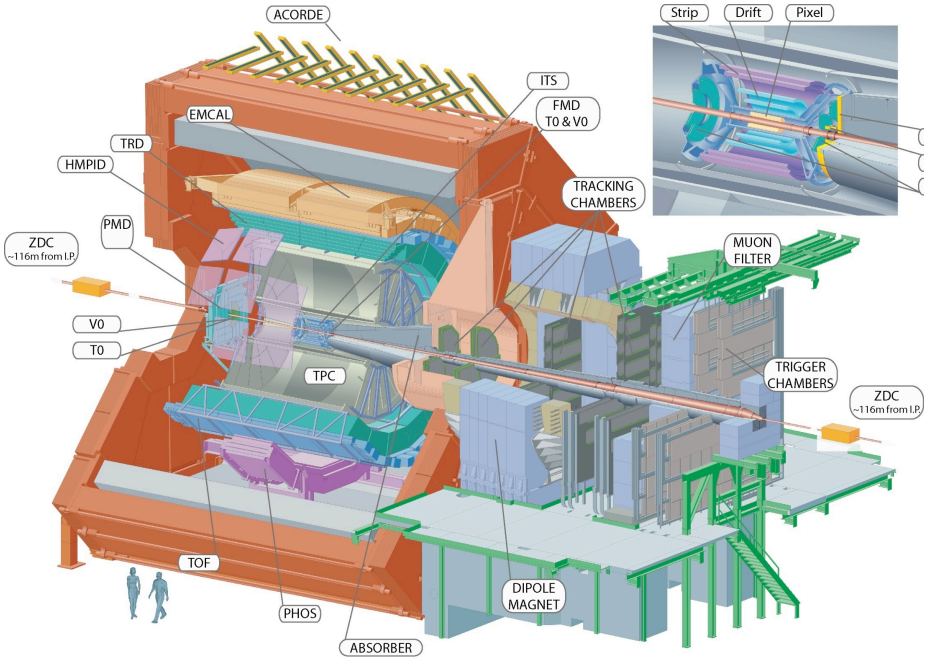
  - These output are satisfied with the requirements
    (TPC gating frequency, High level trigger input bandwidth and data taping bandwidth)

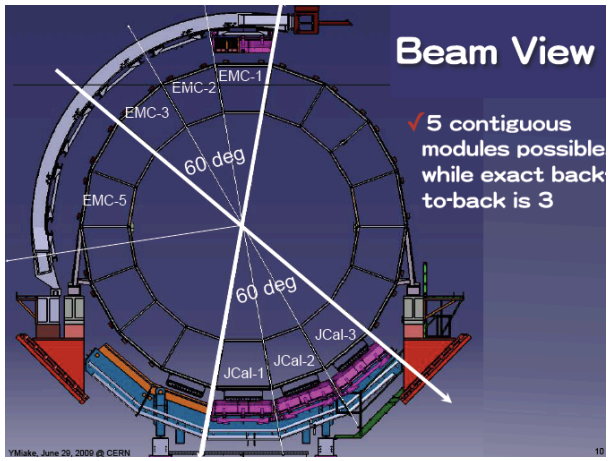
Outlook

- Centrality dependence of jet trigger performance
- Jet trigger performance with the jet quenching model
- Jet trigger performance for pp

Back up

ALICE Detector





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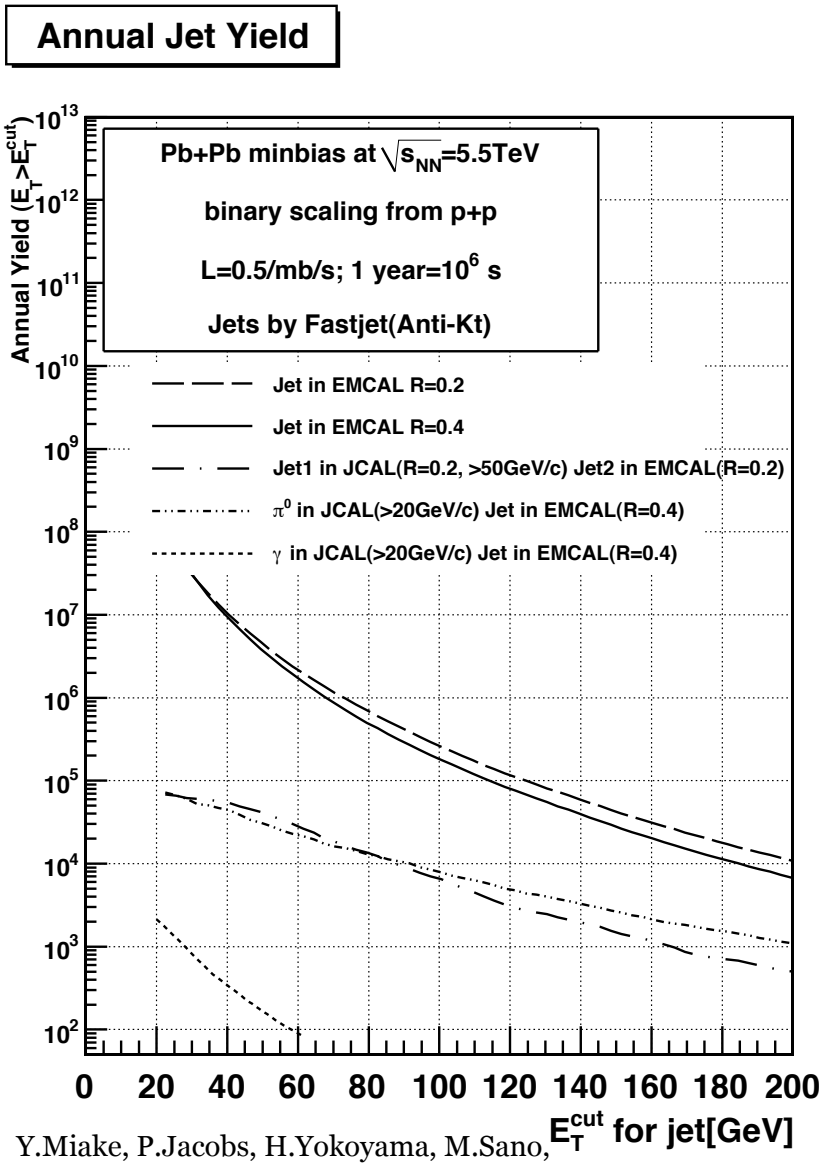
  - π^0 and γ measurement
  - $\Delta E/E \sim 11\%/\sqrt{E}$
- JCAL :
  - Upgrade of electro magnetic calorimeter in ALICE
  - Sitting on back to back side of existent EMCAL in azimuthal angle
  - $\Delta\phi < 60^\circ$, $\Delta\eta<1.4$
  - Dijet, pi0-jet, gamma-jet correlation measurement.

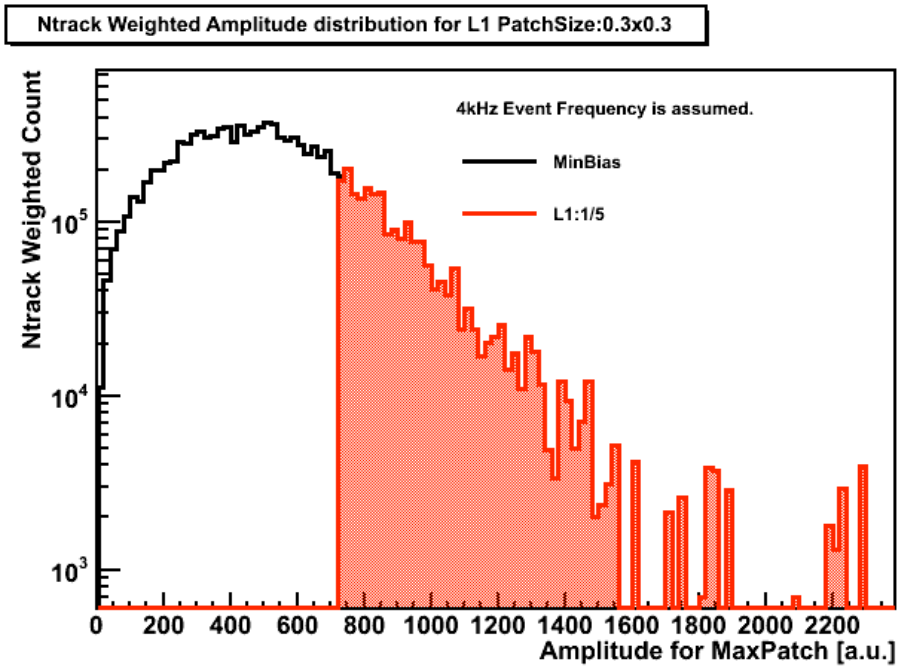
Annual jet yield at ALICE

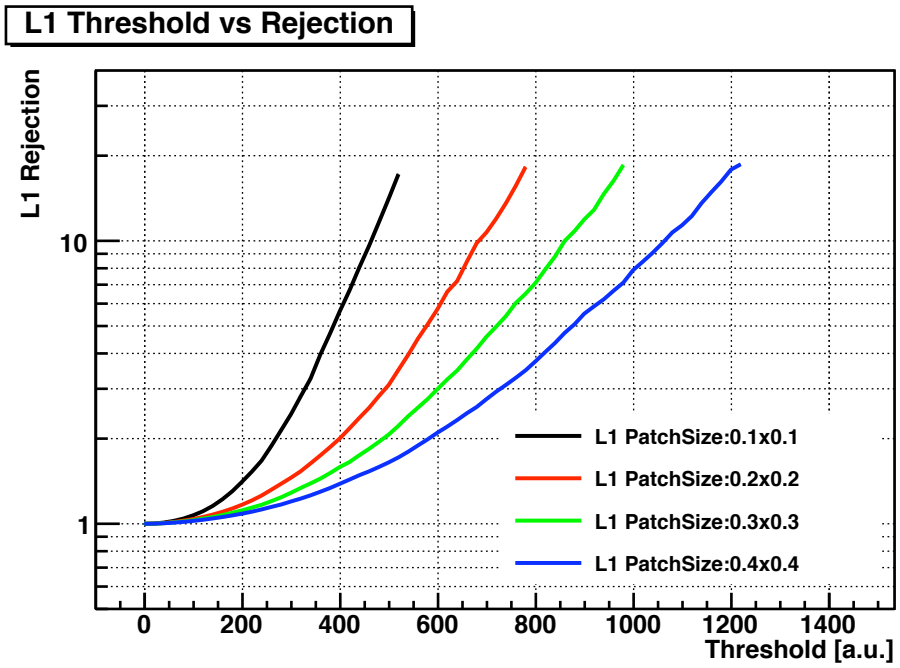


- Annual yield for various jets are calculated.
  - Inclusive jet with R=0.4 in EMCAL
  - Inclusive jet with R=0.2 in EMCAL
  - Jet1 (in Jcal) – jet2(in EMCAL)
  - π^0 (in Jcal) – jet (in EMCAL)
  - γ (in Jcal) – jet (in EMCAL)
  - Nominal PbPb luminosity for 2 months.
  - Binary scaling from p+p (pythia6)
  - FastJet, anti-kt algorithm is applied for jet reconstruction.
- We have lots of opportunity to use jets as a probe for the property of QGP !!

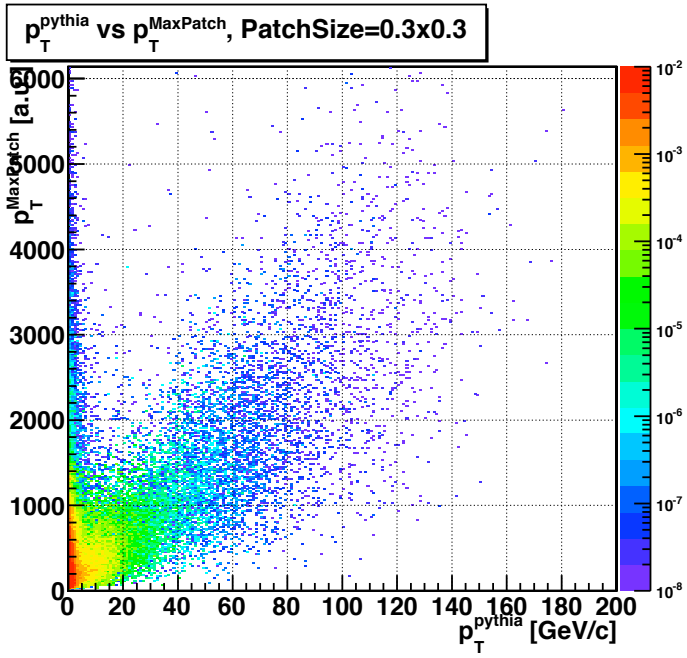
Y.Miake, P.Jacobs, H.Yokoyama, M.Sano,

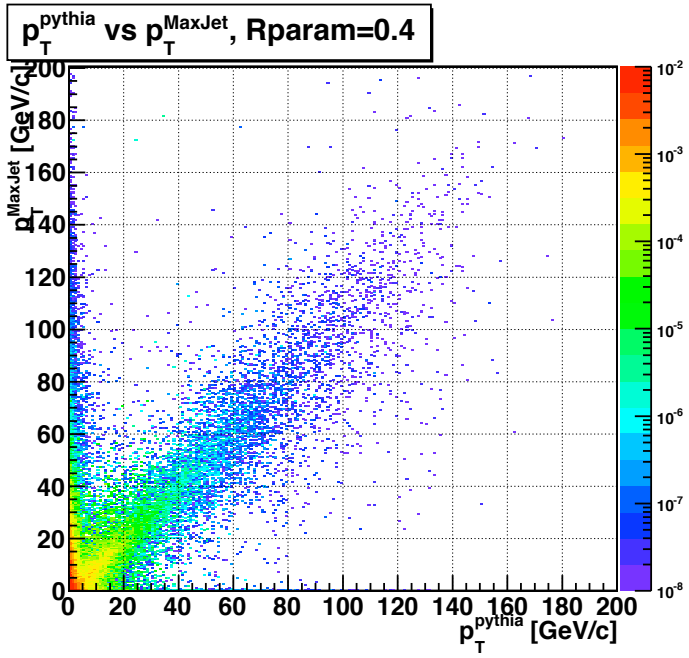
L1 rejection vs Threshold for PbPb





Response of the L1 & HLT

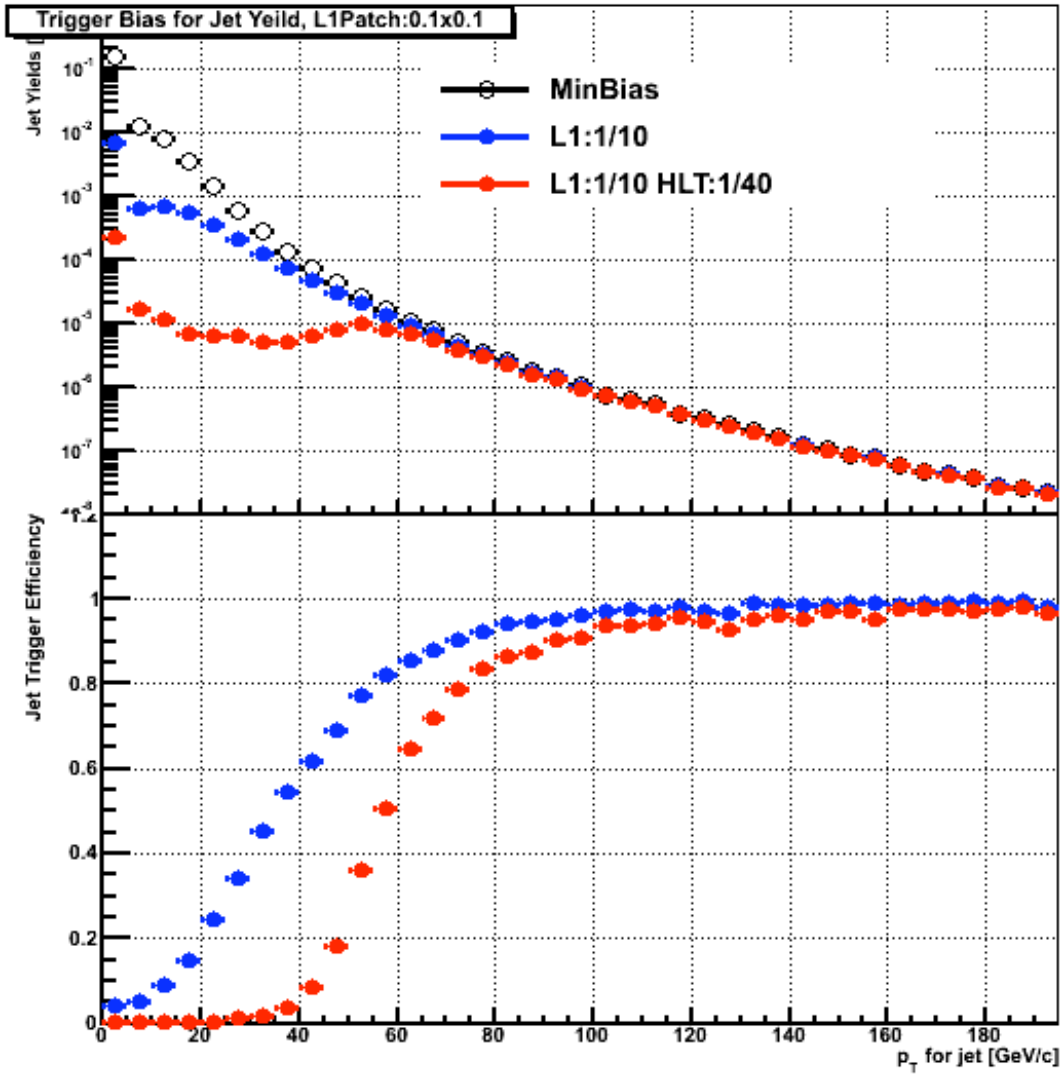




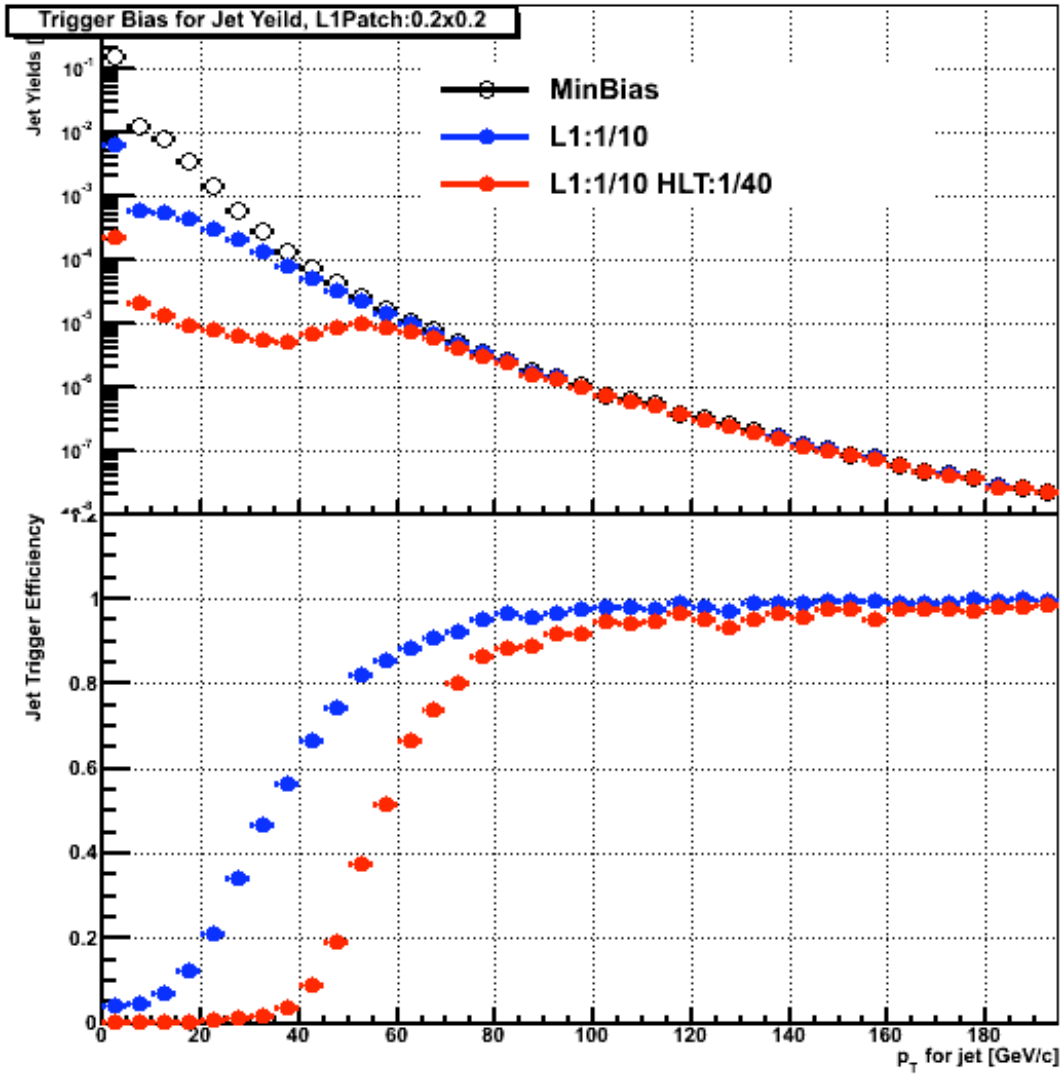
- Left plot : for L1
  - Correlation between " jet p_T in pythia(X axis)" and "amplitude of MaxPatch for L1 in pythia+Hijing(Y axis)".
  - For L1 we can use only partial information like EMCAL cell, V0 and etc. therefore broad correlation can be seen.

- Right plot : for HLT
  - Correlation between "jet p_T in pythia(X axis)" and "p_T of Maximum Jet for HLT in pythia+Hijing(Y axis)".
  - For HLT we can use the fully reconstruced information, so much sharper correlation can be seen than L1.

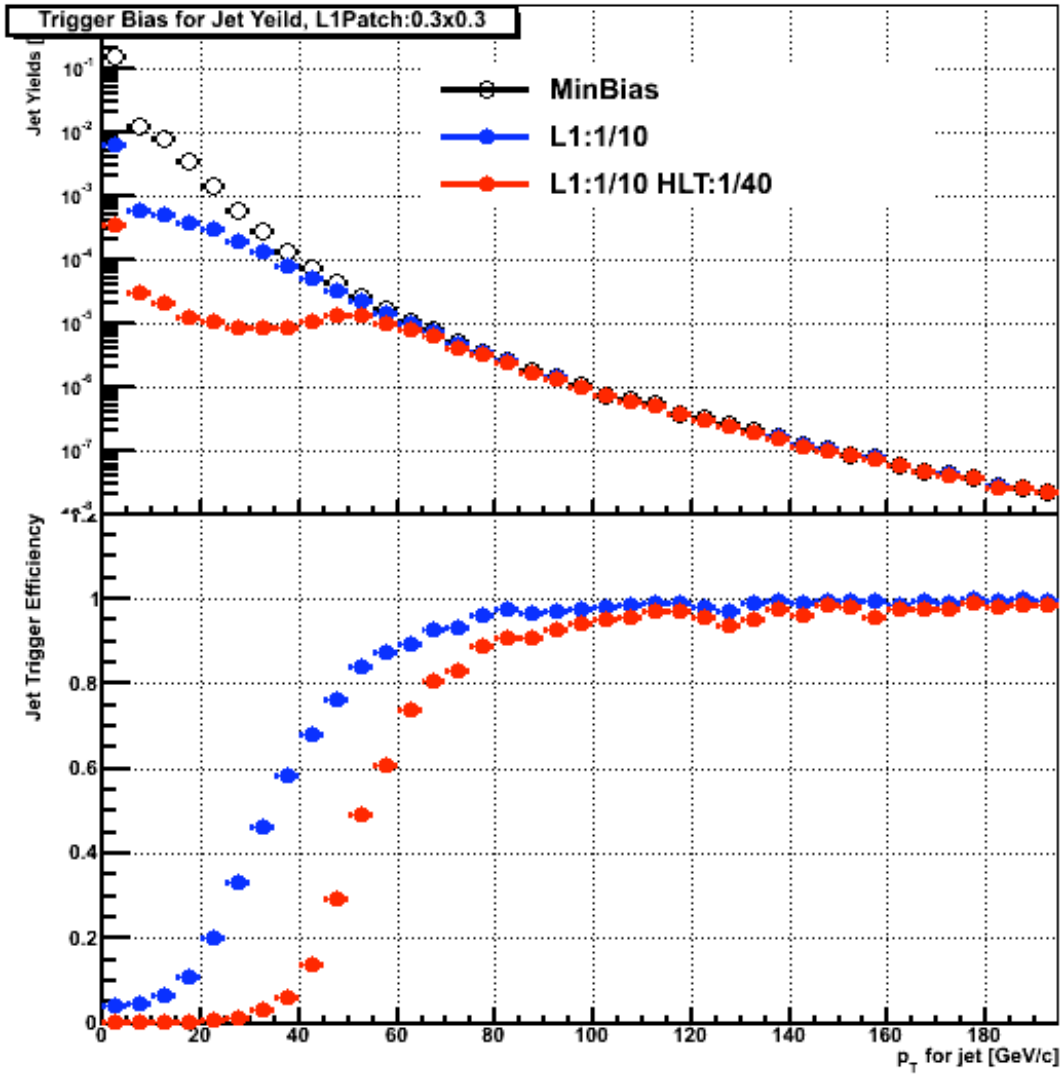
Patch size : 0.1x0.1



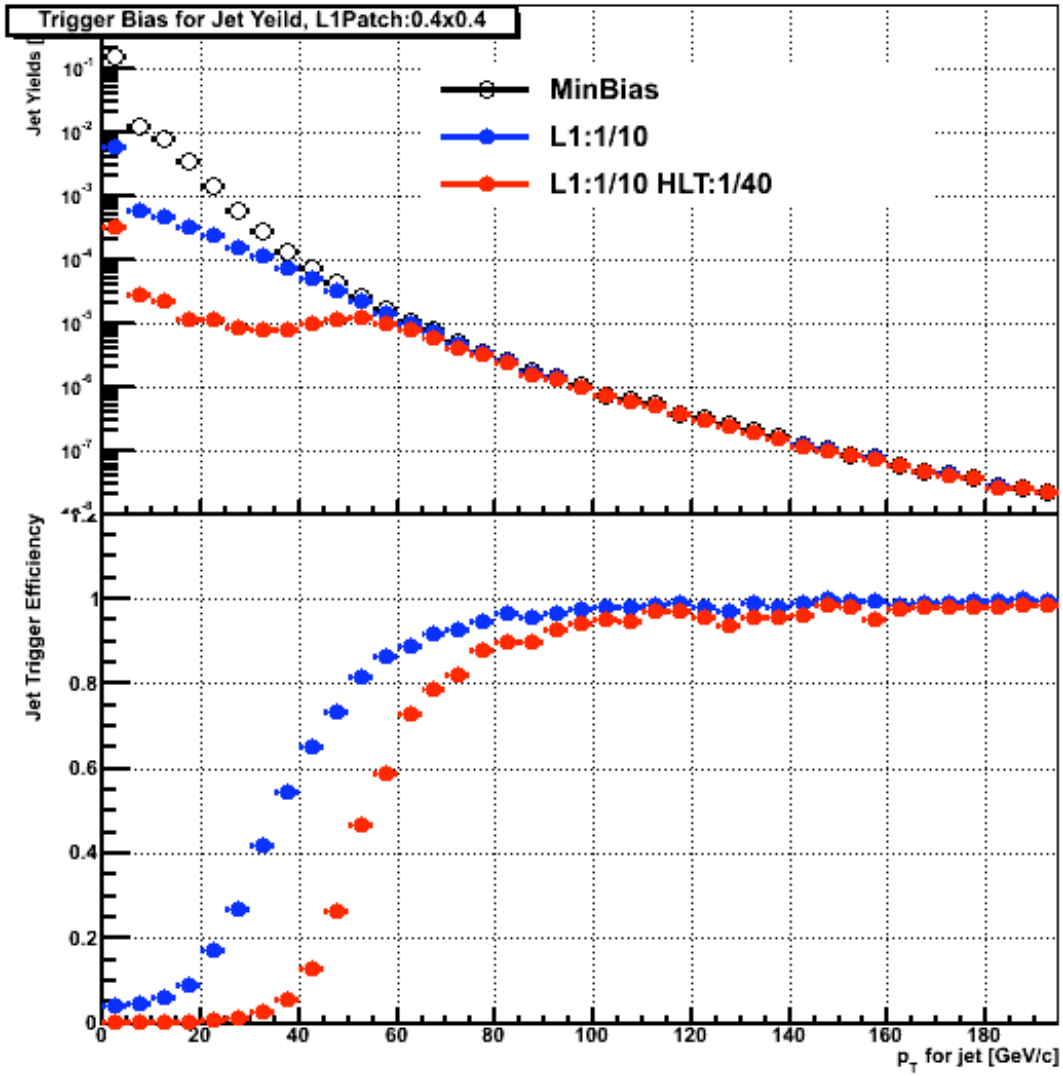
Patch size : 0.2x0.2

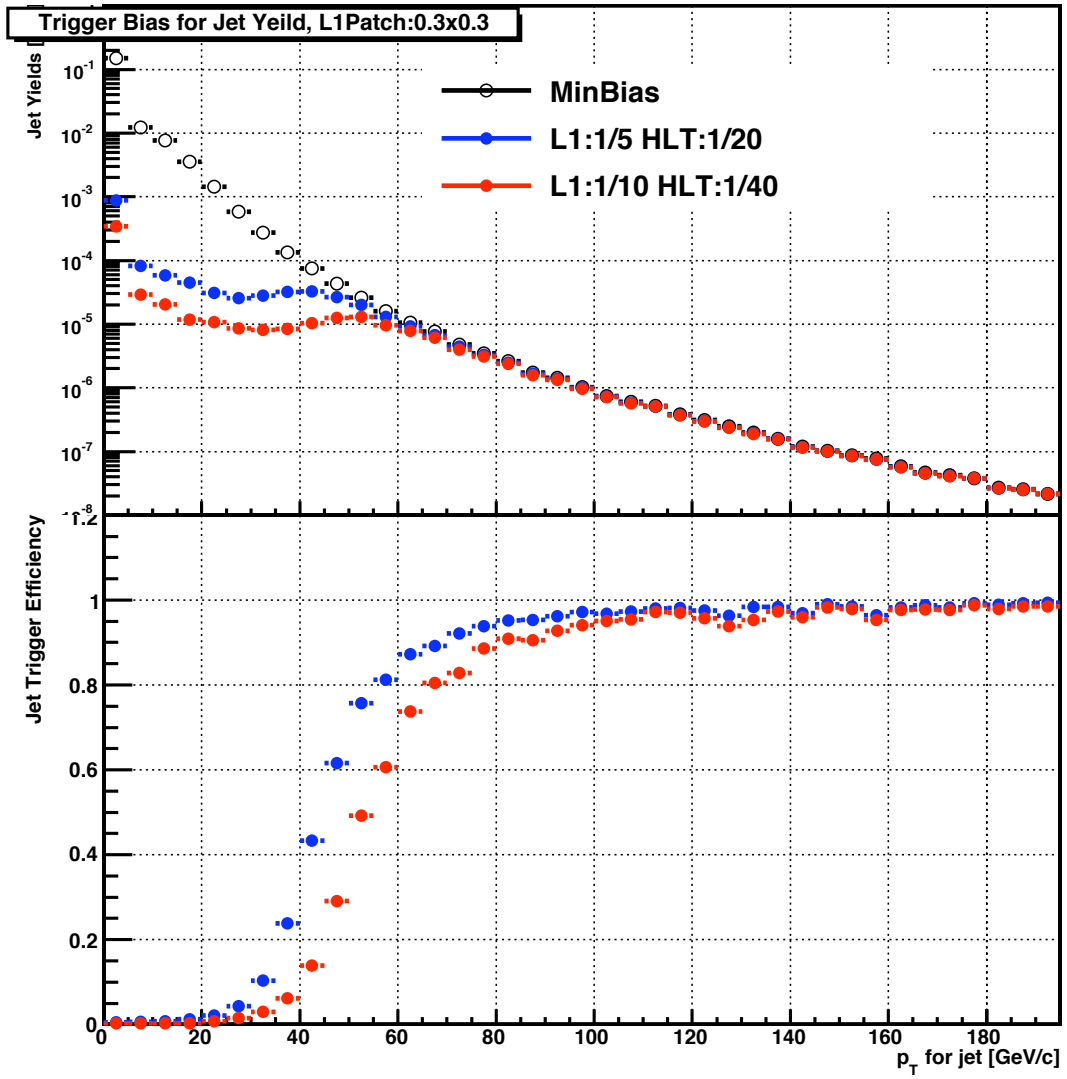


Patch size : 0.3x0.3

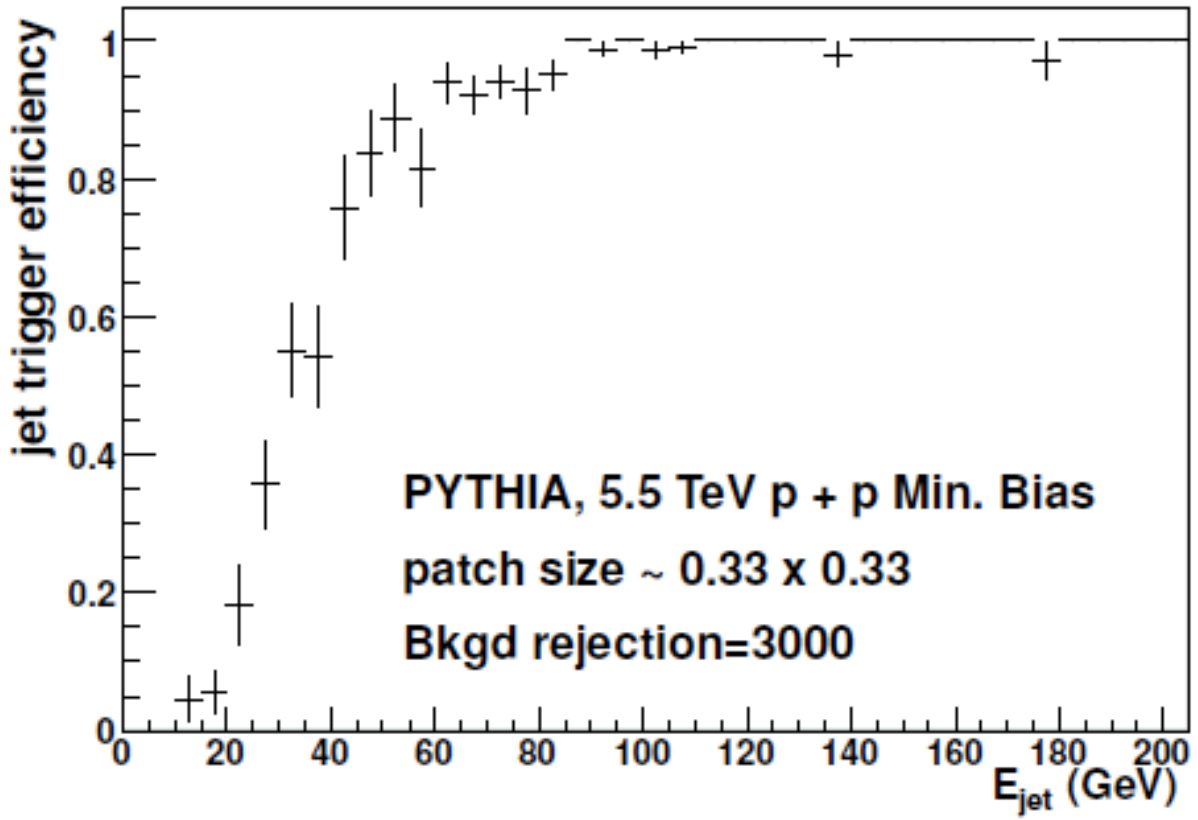


Patch size : 0.4x0.4

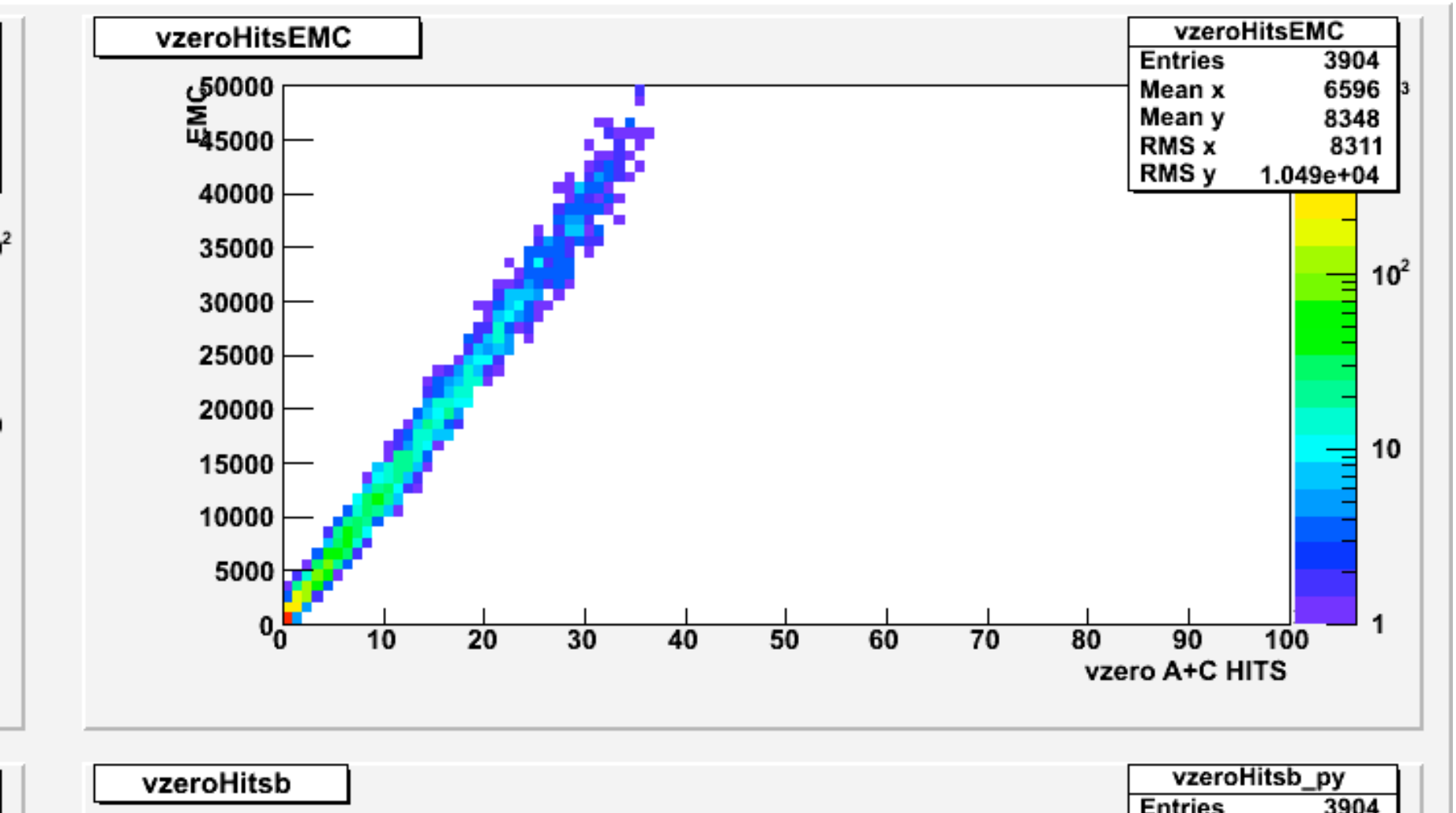



Trigger Bias for Jet Yeild, L1Patch:0.3x0.3
Jet Yields
MinBias
L1:1/5 HLT:1/20
L1:1/10 HLT:1/40
Jet Trigger Efficiency
p_T for jet [GeV/c]

Jet trigger efficiency : pp 5.5TeV



V0 hits vs EMCAL total energy : Background subtraction



Jet energy resolution

ALICE –EMCAL technical design report