Evaluation of ALICE electromagnetic calorimeter jet event trigger performance for LHC-Run2 by simulation

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for the ALICE collaboration

Outline

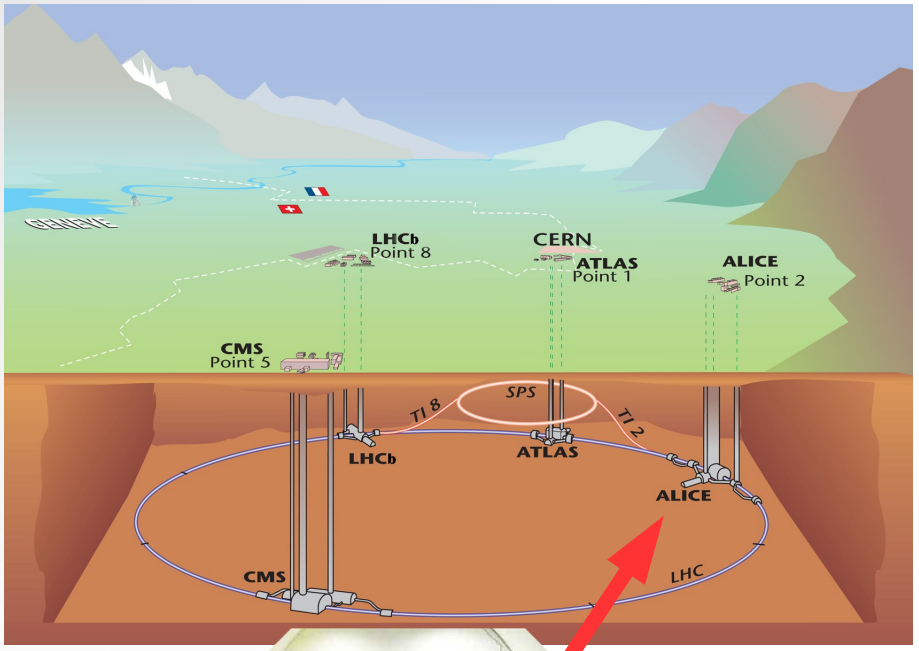
- Detector and L1 Jet algorithm over view
  - LHC Run2 and ALICE
  - ALICE electromagnetic calorimeter
  - Trigger inputs
  - L1 Jet trigger patch(EMCALside and DCAL/PHOS side)
  - L1 Jet processing flow

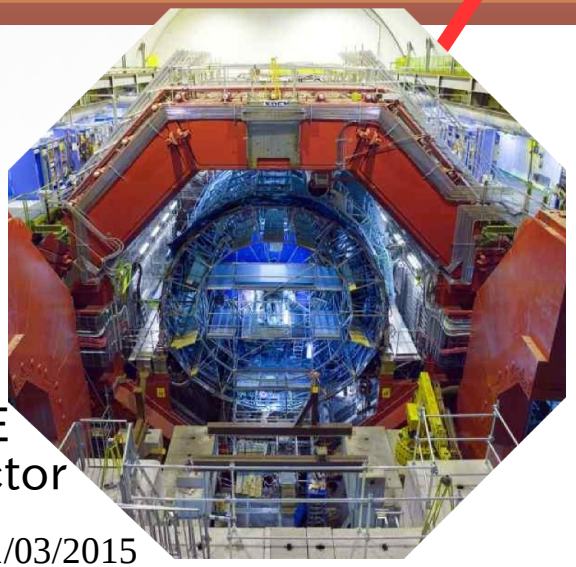
- p-p trigger performance estimation and Event by event background estimation for Pb-Pb run
  - Data set
  - L1 Jet rejection for p-p event
  - L1 Jet efficiency for p-p event
  - Background estimation for Pb-Pb event

- Summary

LHC Run2 and ALICE

LHC･･･The most largest collider in the world that is operated by CERN





ALICE detector

year

2010 • Run1

2011

2012

2013 • Long Shutdown 1(LS1)

⇨ For upgrade and tuning of accelerator and detectors

2014

2015 • Run2

⇨ $\sqrt{s_{NN}}$ = 13~14 TeV (p-p), 5.5TeV (Pb-Pb)

~2018

- LHC-ALICE

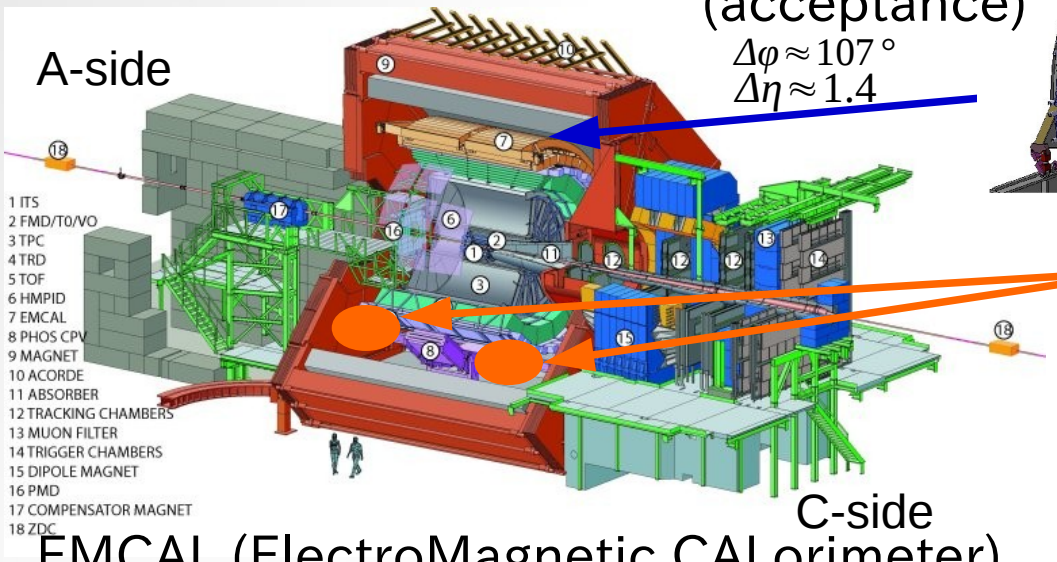
⇨ The experiment for heavy ion collision

➡ Reveals the property of Quark-Gluon Plasma(QGP)

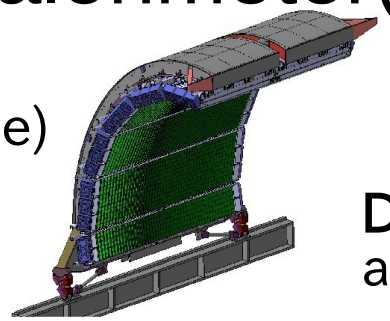
⇨ Expansion of detectors(LS1)

(DCAL/PHOS, EMCAL, TRD, TPC-RCU2 upgrade...)

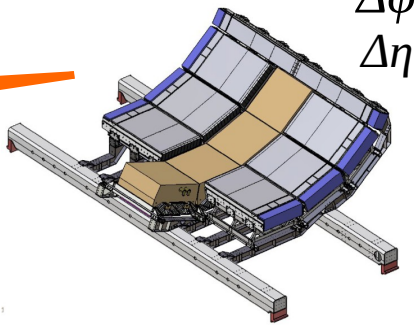
ALICE electromagnetic calorimeter(s)



EMCAL
(acceptance)
$\Delta\varphi \approx 107°$
$\Delta\eta \approx 1.4$



DCAL + PHOS
acceptance
$\Delta\varphi \approx 67°$
$\Delta\eta \approx 1.4$

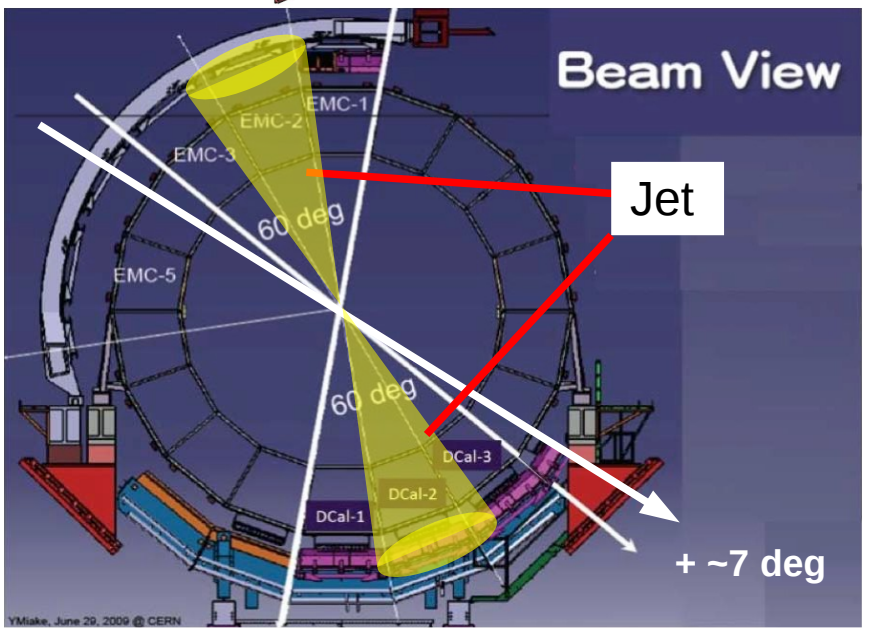


PHOS
acceptance
$\Delta\varphi \approx 100°$
$\Delta\eta \approx 0.24$

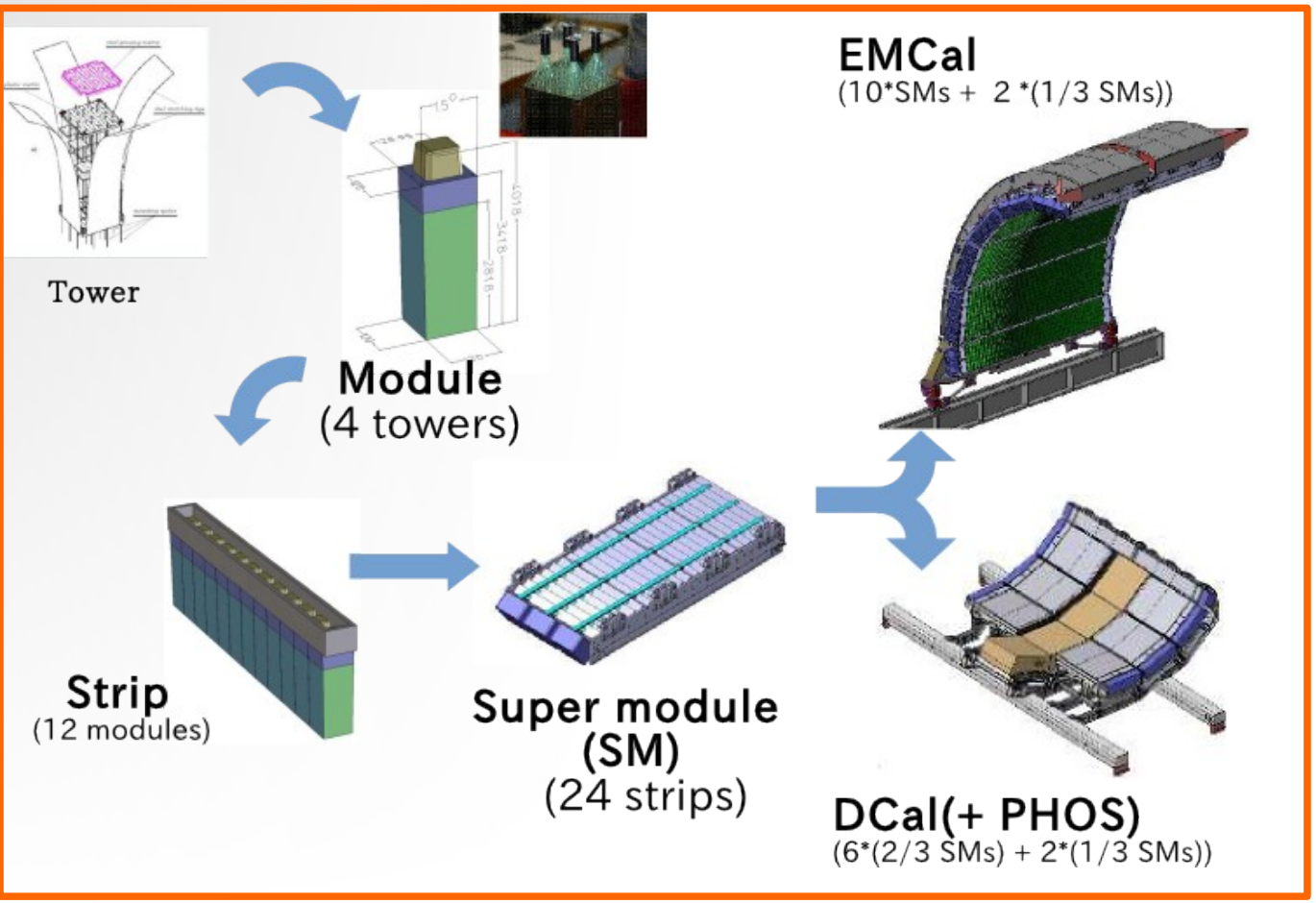
- EMCAL (ElectroMagnetic CALorimeter)
  - ⇨ Sampling type calorimeter which consists of Pb and scintillators
- PHOS (PHOton Spectrometer)
  - ⇨ Homogeneous calorimeter which consists of PbWO4

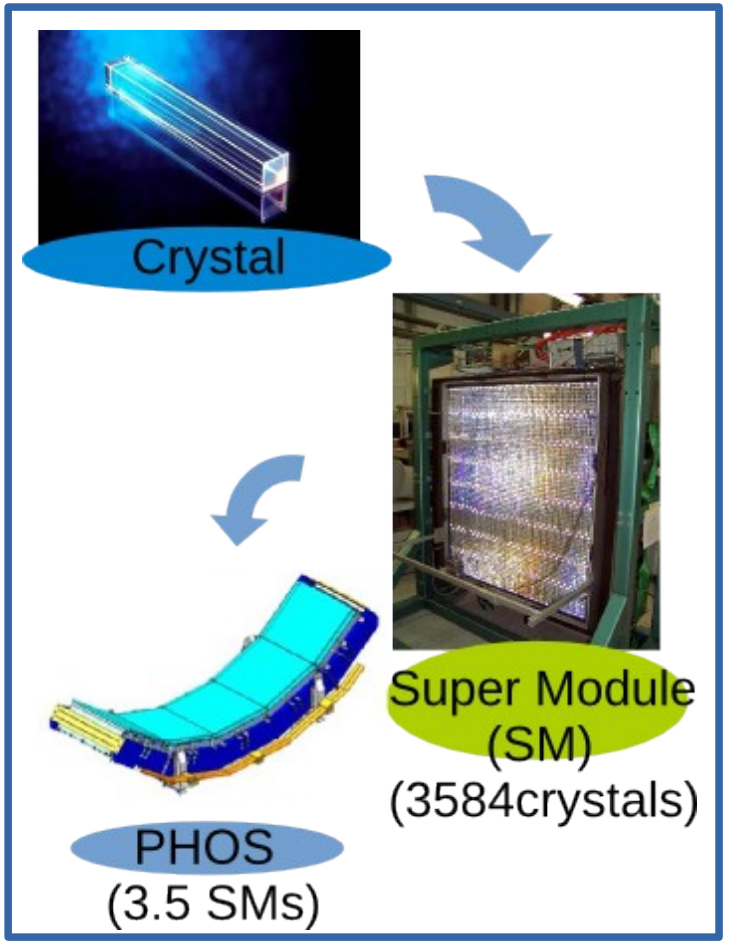
New!(Run2~)

- DCAL (Di-Jet CALorimeter)
  - ⇨ Electromagnetic calorimeter which has same structure as EMCAL
  - ⇨ Mainly, measures Di-Jet event and γ-Jet event as a probe of QGP property



Trigger inputs





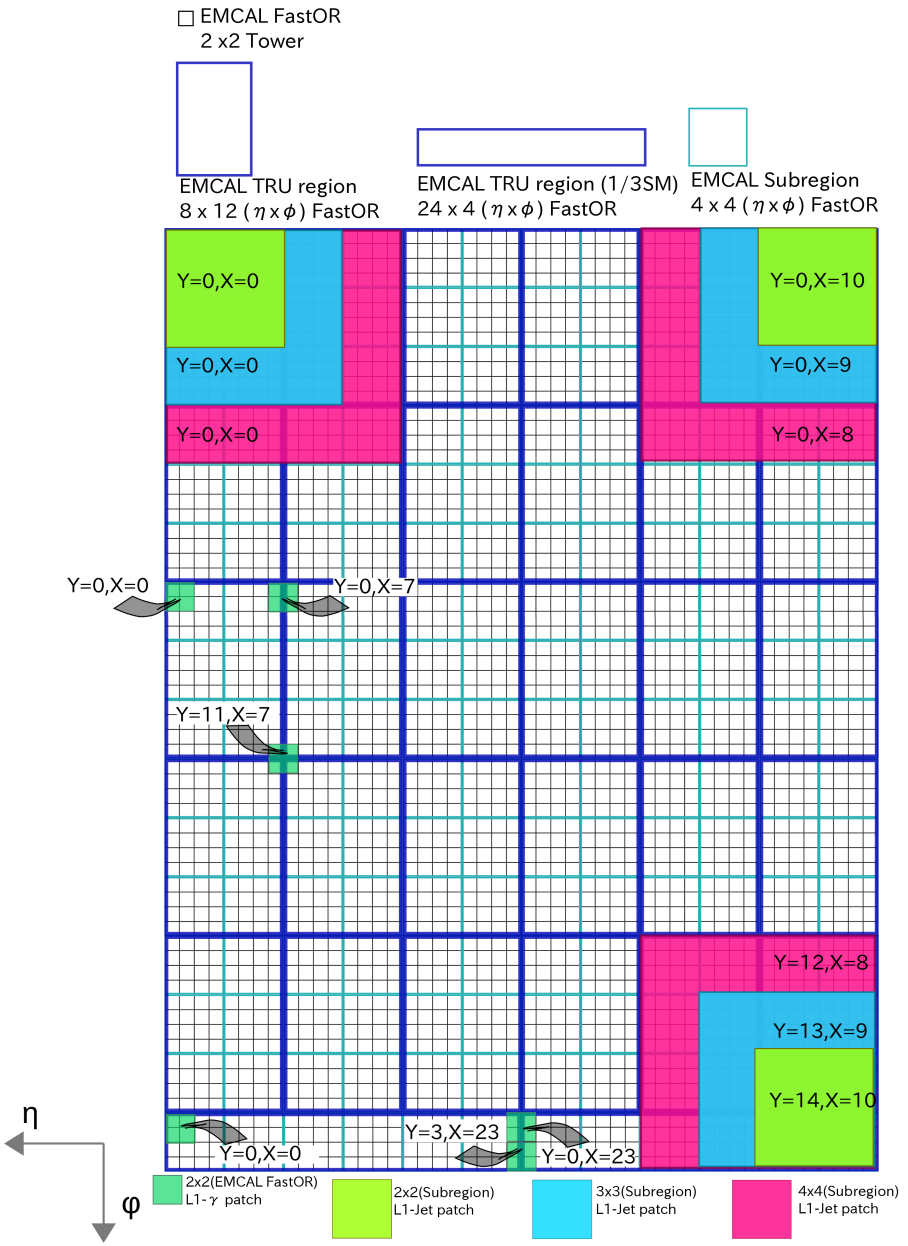
- Minimum component of L0/L1 Trigger processing (FastOR)
  - from 1 Module signal (EMCAL/DCAL)
  - from 2x2 Crystals signal (PHOS)

L1 Jet trigger patch (EMCAL side)

- 4x4 FastOR (8x8 Towers)
- Subregion
- n x n Subregions (n = 2,3,4)

  (n=4 was used at Run1)
- Jet patch

  When the Jet patch amplitude exceeds threshold, L1 is fired



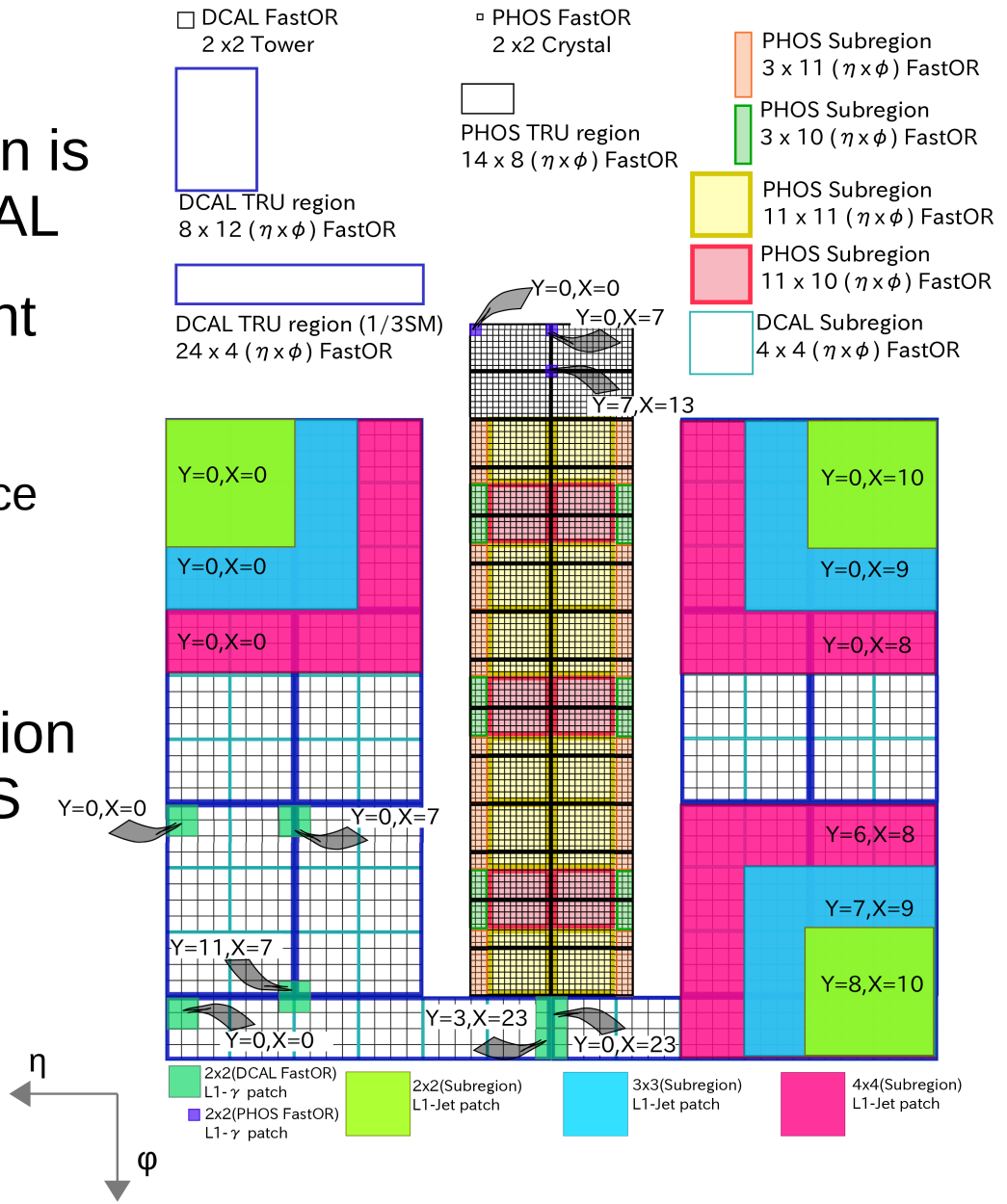
L1 Jet trigger patch (DCAL/PHOS side)

- In DCAL region, Subregion is defined as same as EMCAL
- In PHOS region, 4 different Subregion size is used

  ⇨ Because of cell size difference between DCAL and PHOS

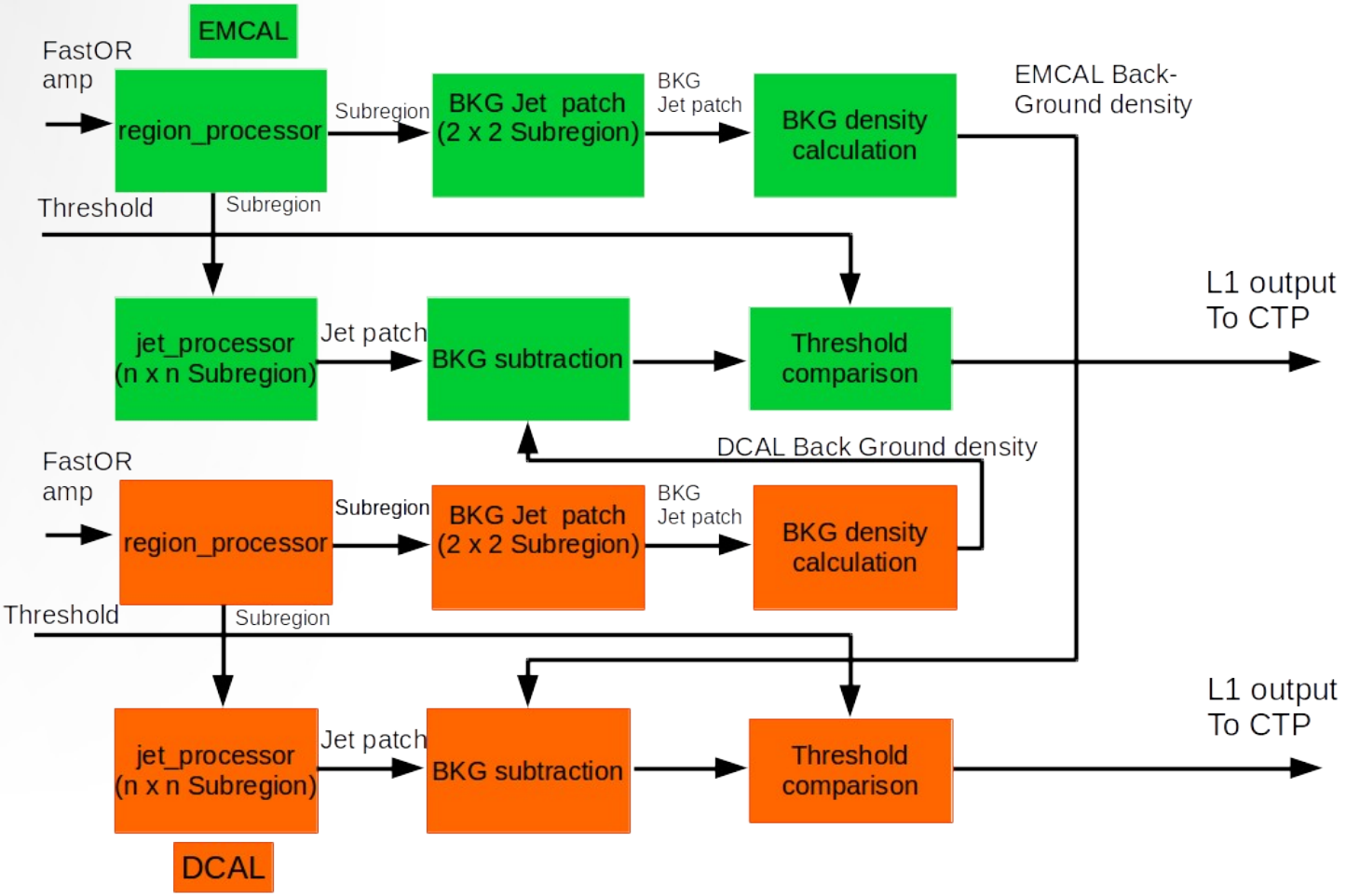
- There are about 34 cm spacial gaps on eta direction between DCAL and PHOS

  ⇨ This may make trigger performance worse



L1 Jet processing flow

- From Run2 heavy ion Run, new online background subtraction method will be used



- Run1: event by event threshold calculation by using V0 multiplicity
- Run2: event by event background subtraction by using background energy that is estimated by opposite side calorimeter

Data set

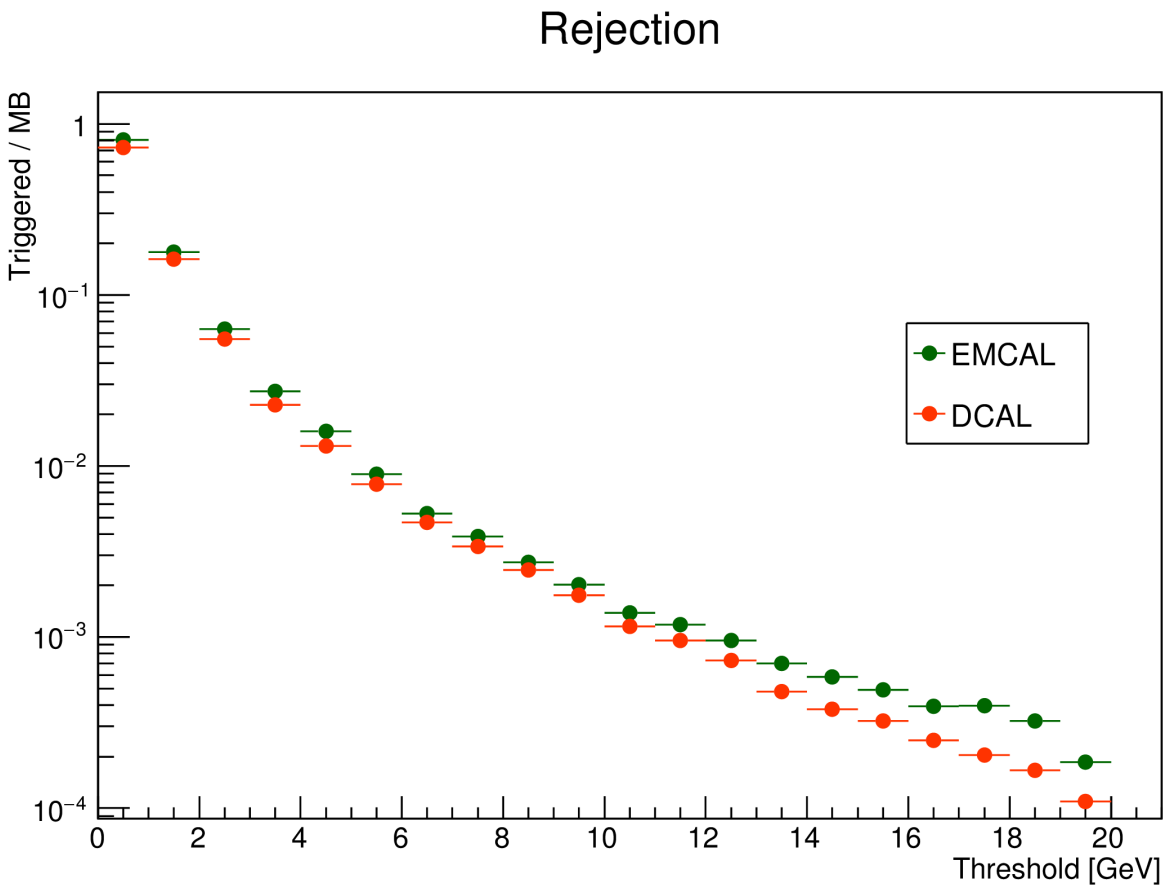
- LHC 15b1 (Pythia 13 TeV Min bias with Run2 geometry)
  - ⇨ For estimate rejection
- Pythia 13TeV p-p event with Jet event
  - ⇨ For estimate trigger efficiency
- Hijing 5.5TeV Pb-Pb event
  - ⇨ For estimate background

} generated myself

L1 Jet rejection for p-p event

- Jet patch size
  4x4 Subregions
  (32x32 Towers)

- ~1/1000 rejection
  @ Threshold = 10GeV



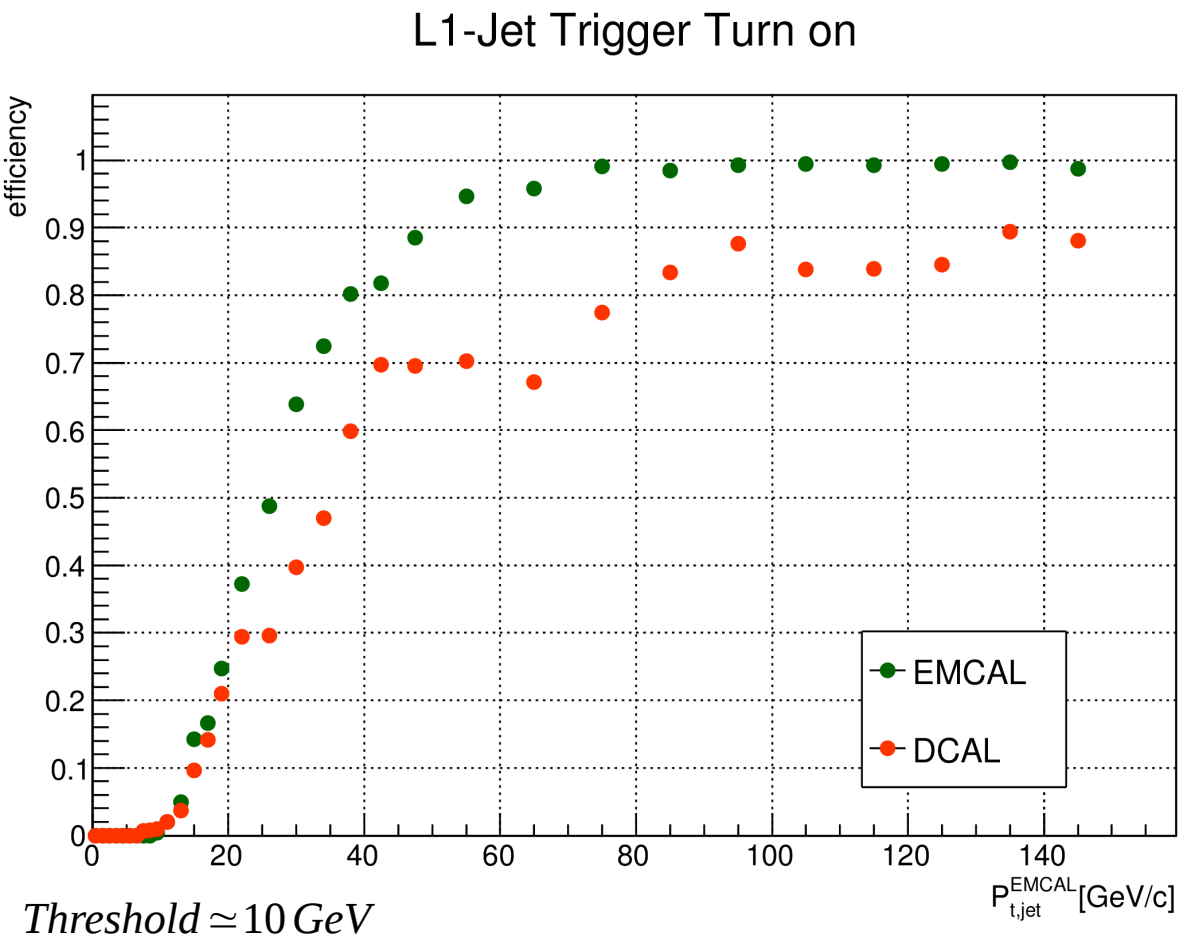
L1 Jet efficiency for p-p event

$$efficiency = \frac{Number\ of\ Triggered\ Jets}{Number\ of\ reconstructed\ particle\ level\ (MC)\ Jets\ inside\ EMCAL/DCAL\ acceptance\ (anti-kt\ ,\ R=0.2)}$$

- Jet patch size
  4x4 Subregion
  (32x32 Tower)

- > 90% @ > 50 GeV/c (EMCAL)
  ~100% @ >70 GeV/c (EMCAL)

- 80%~90% @ >90 GeV/c (DCAL)

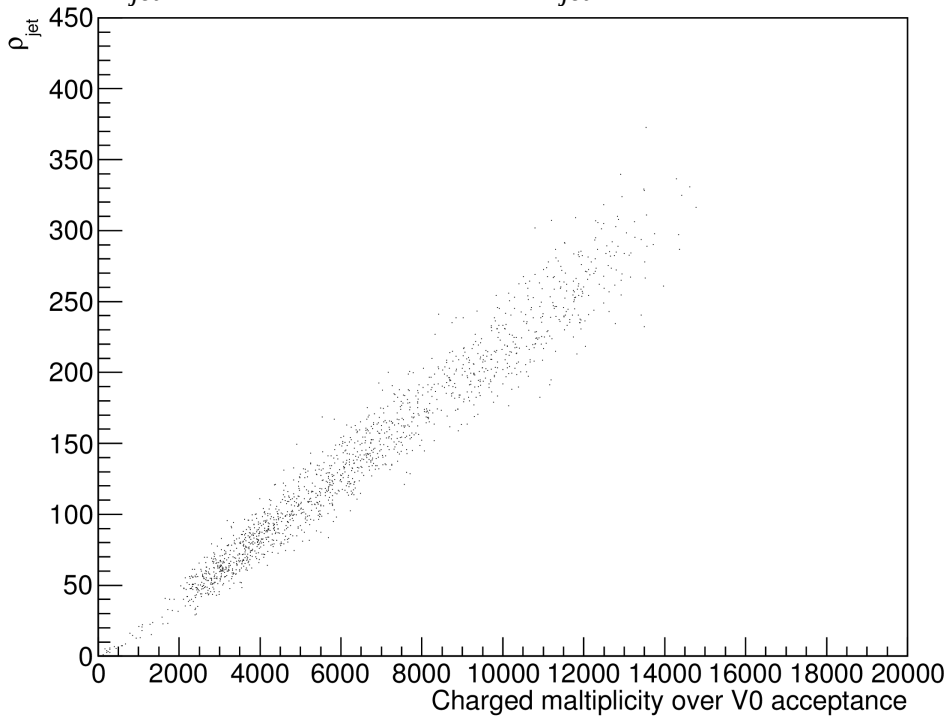


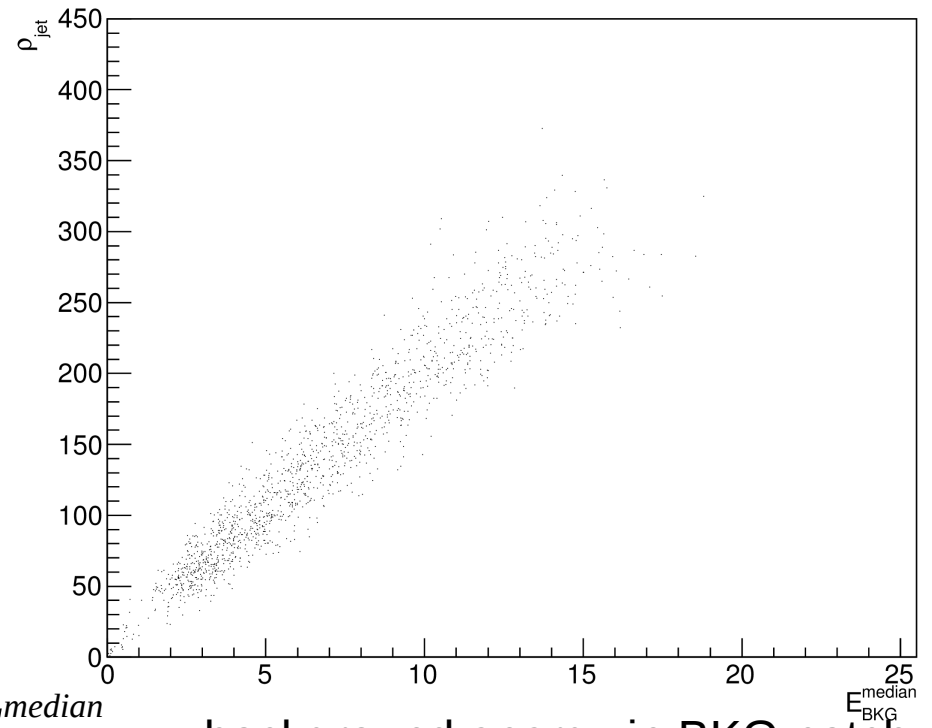
$Threshold \simeq 10\ GeV$

Background estimation for Pb-Pb event

These were estimated by using only particle level(MC) track (no detector effect)

$\rho_{jet} = median\left(p_T^{jet} / Area_{jet} \right)$





E_{BKG}^{median} ・・・background energy in BKG patch estimated by calorimeter

- Both of V0 multiplicity and background energy which is estimated by calorimeter have good relation to Jet rho
- Quantitative assessment

  ⇨ In progress

Summary

- I estimated...

  - L1 Jet rejection for p-p

    ⇨ For example,about 1/1000 rejection @ threshold 10GeV

  - L1 Jet efficiency for p-p

    ⇨ Threshold 10GeV...

    > 90% @ > 50 GeV/c (EMCAL)
    ~100% @ >70 GeV/c (EMCAL)
    80%~90% @ >90 GeV/c (DCAL)

  - Jet background for Pb-Pb

- In future

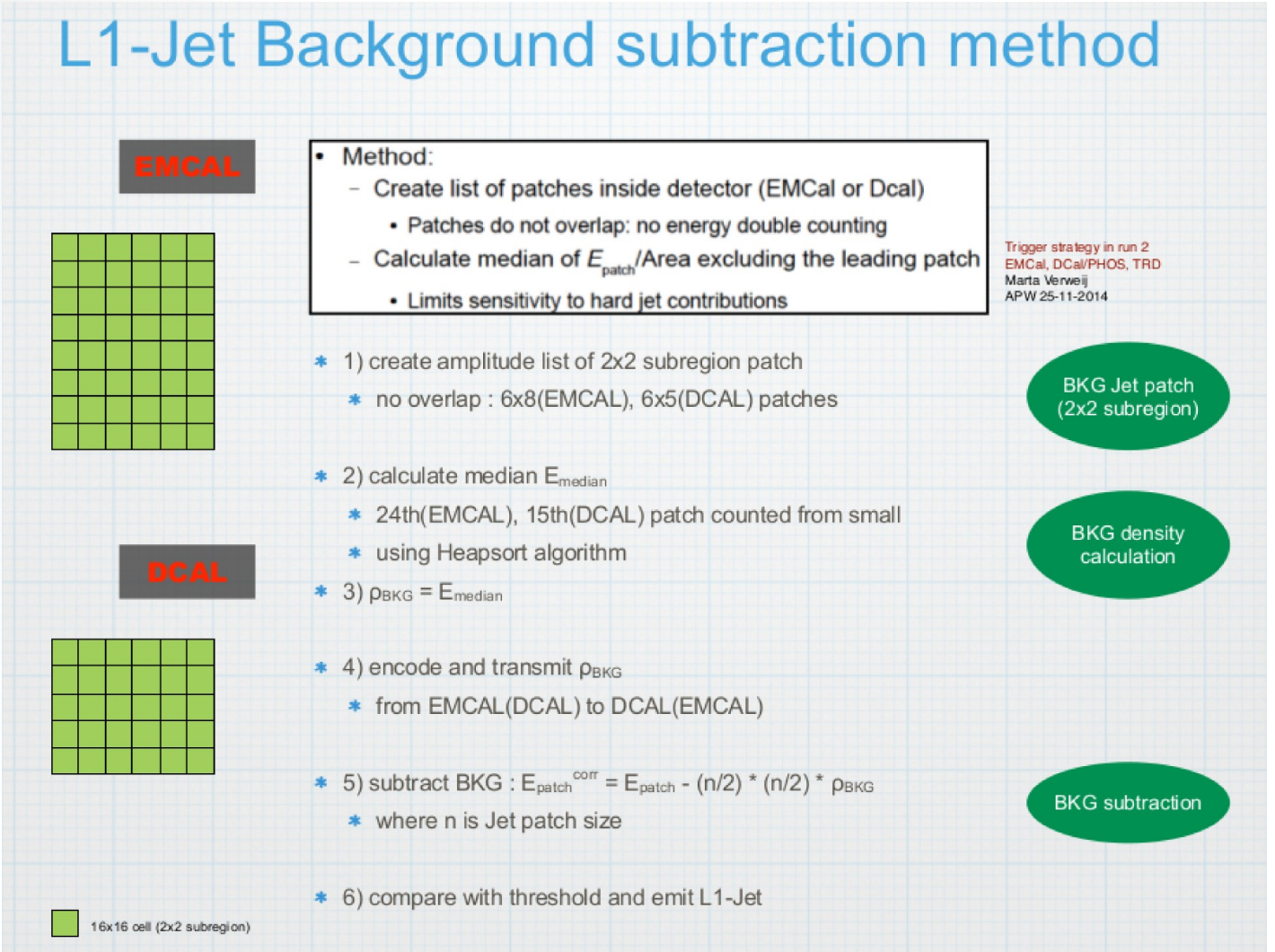
  - Quantitative assessment of background estimate accuracy of each method (V0 using method or Calorimeters using method)

  - estimate rejection and efficiency for Pb-Pb including detector effect

  - estimate purity

Backup

L1-Jet Background subtraction method



"EMCAL L1 trigger status", Hiroki Yokoyama
(Trigger meeting Tuesday, 17 February 2015)

- Pythia data

  pthardbin_loweredges=(0 5 11 21 36 57 84 117)

  pthardbin_higheredges=(5 11 21 36 57 84 117 152)

  10000 events generated per each pthardbin

- Hijing data

  0-10% Central
  10-50% Central
  50-100% Central

  } 3000 events generated per each centrality class

I took configuration from
LHC15b1

Inclusive Jet Yields

Dijet production in pp@13TeV 2015

- 'Flat scenario'
  - MB/RARE = 4 w/ 7 w = 10nb^{-1} (0.6G) / 5pb^{-1}
- POWHEG-V2 + CTEQ6M
  - NLO + PS (AliRoot)
  - Total dijet xsec 7.45mb
- Anti-k_T R=0.3