ALICE

Neutral pion analysis with high energy photon trigger in pp collisions at 8TeV

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Satoshi Yano
(Hiroshima University)

広島大学 HIROSHIMA UNIVERSITY

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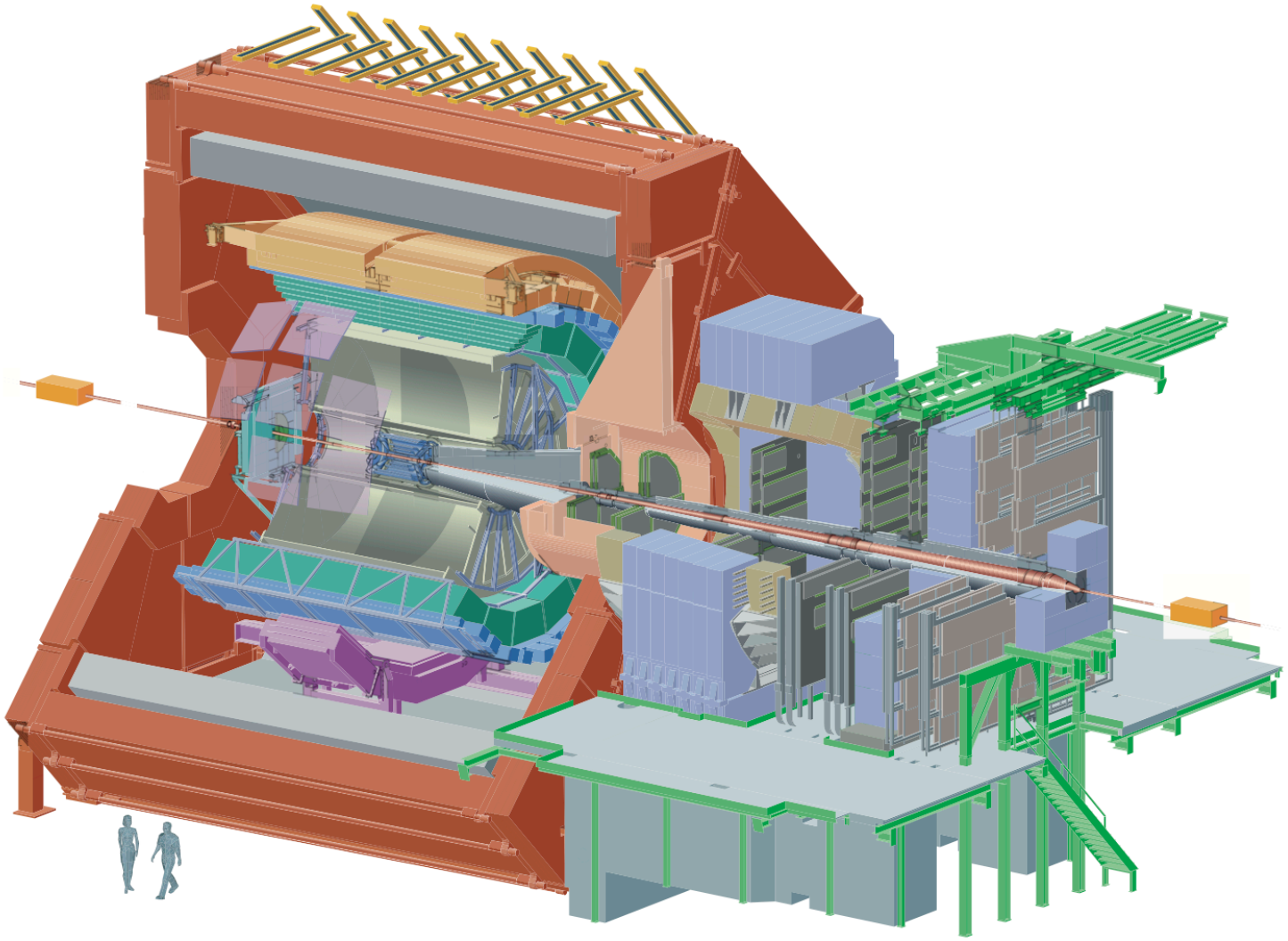
Outline

- Motivation
- How to extract neutral pion signal
- 0.9, 2.76 and 7 TeV results
- 8 TeV analysis strategy and results
- Summary and outlook

Motivation

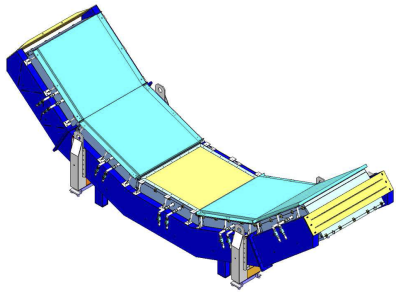
- Understanding particle production mechanisms (at low p_T) and test of pQCD cross section predictions (at high p_T).
- Constraint on the gluon to pion fragmentation.
- Reference data for Pb-Pb and p-Pb collisions.
- Main source of background of direct γ and electron from heavy-flavor.

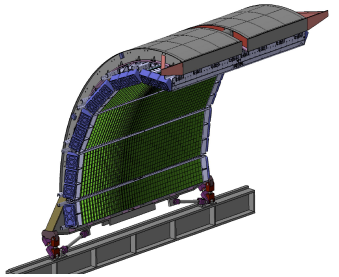
The ALICE detector

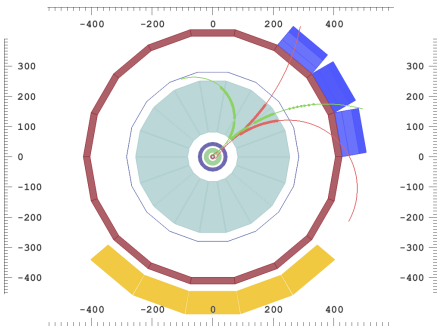


Photon detection in ALICE

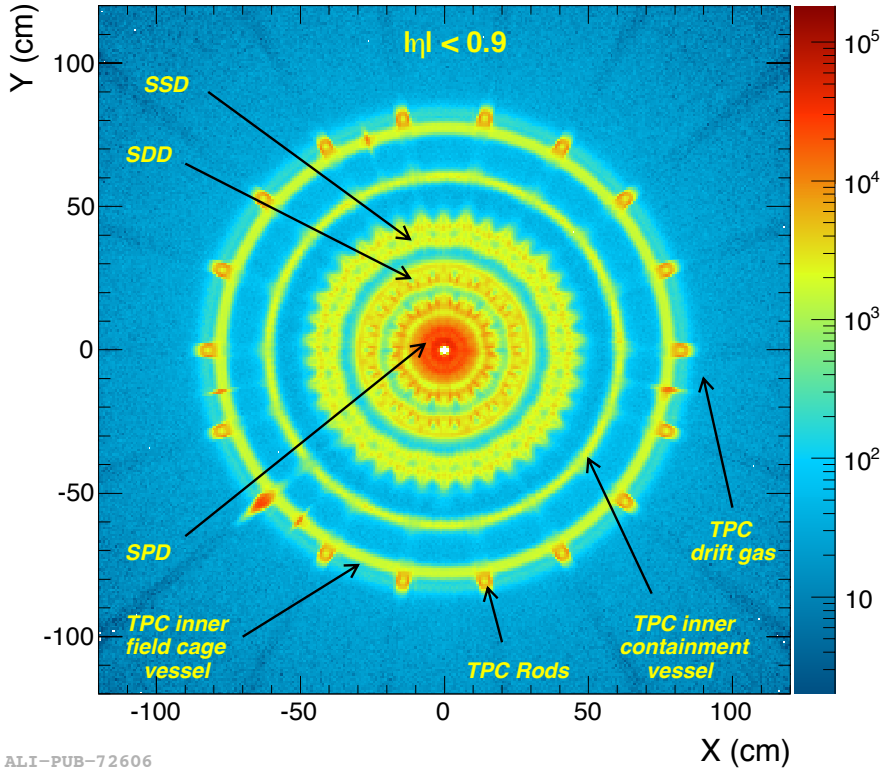
- Calorimeters
  - PHOS:
    - PbWO4 crystal
    - 3 modules at 4.6 m from the ALICE IP
    - $|\eta|< 0.13$, $260°<\varphi<320°$
  - EMCal:
    - 77 layers 1.4 mm lead + 1.7 mm scintillator
    - 10 modules at 4.4 m from ALICE IP
    - $|\eta|< 0.7$, $80°<\varphi<180°$
- Photon Conversion Method (PCM)
  - Photon conversion in detector material
  - ITS and TPC ($X/X_0 = 11.4 \pm 0.5_{sys}$ %)
  - $|\eta|< 0.9$, $0°<\varphi<360°$

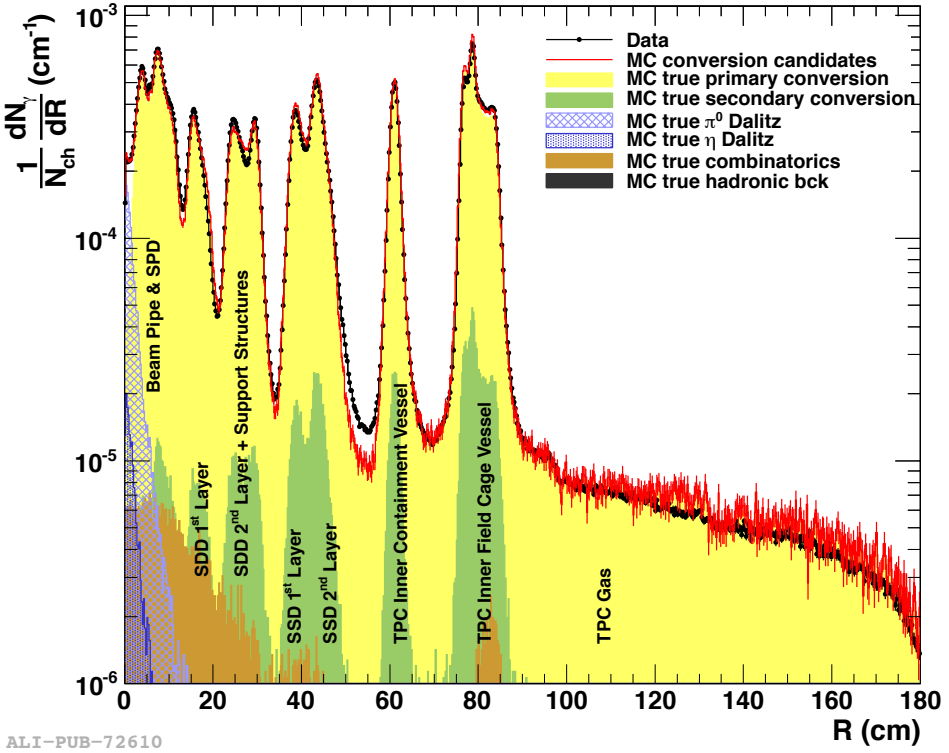






Photon conversion in material

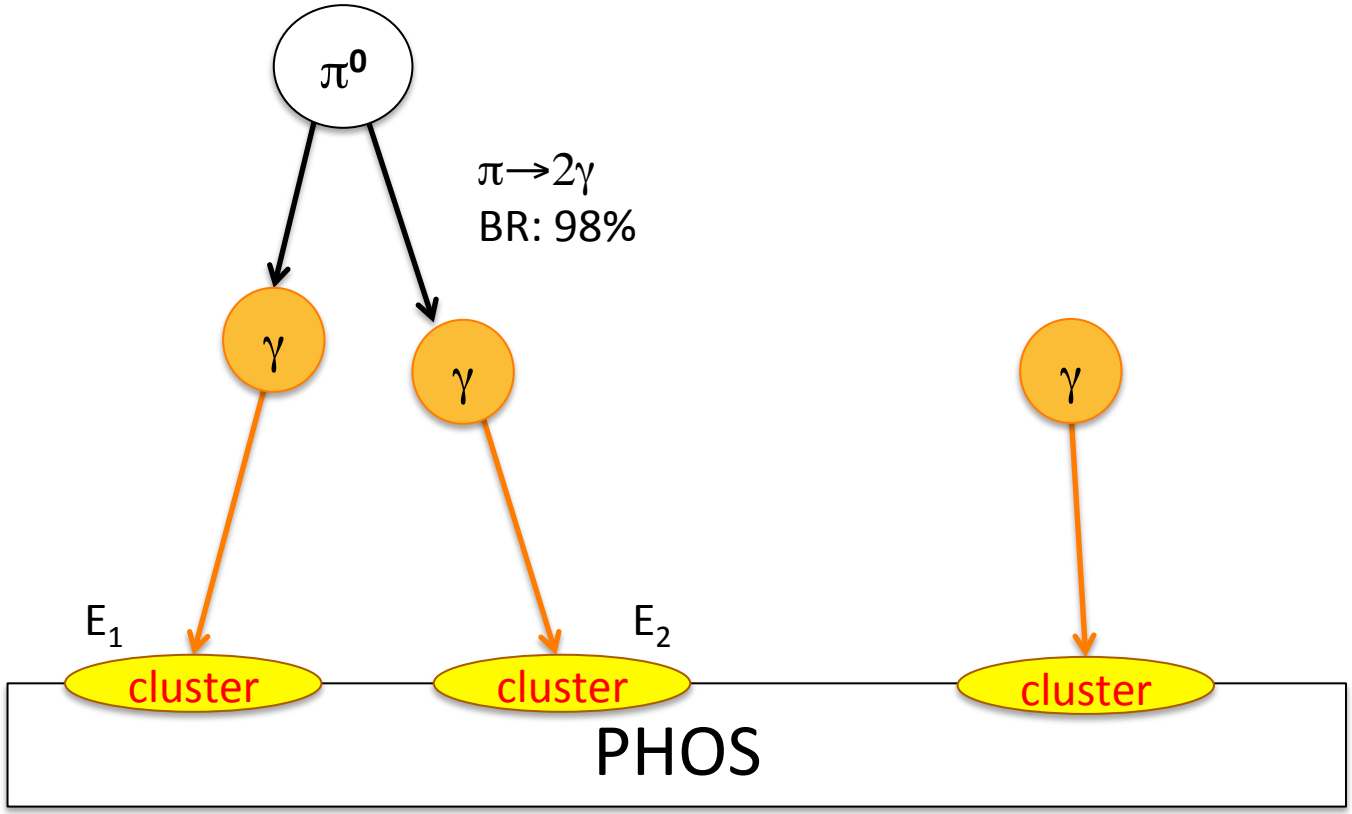




Material thickness is $X/X_0=11.4\pm0.5_{sys}$ %. ALICE material budget agrees within ±4.5% with its implementation in GEANT simulations

Invariant mass method

$$M_{\pi^0} = \sqrt{2E_1E_2(1-\cos\theta_{12})}$$



Invariant mass method

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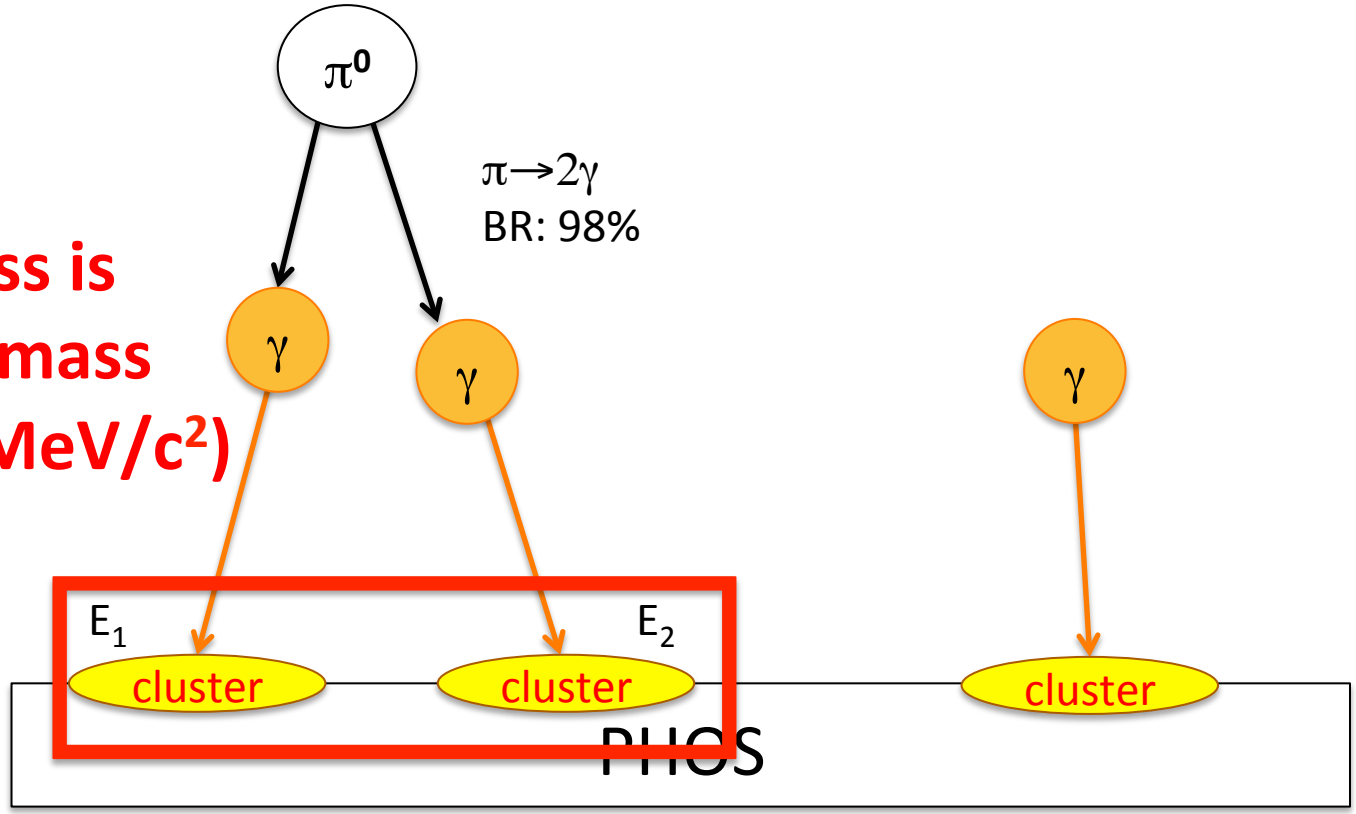
Invariant mass is neutral pion mass region! (135MeV/c^2)



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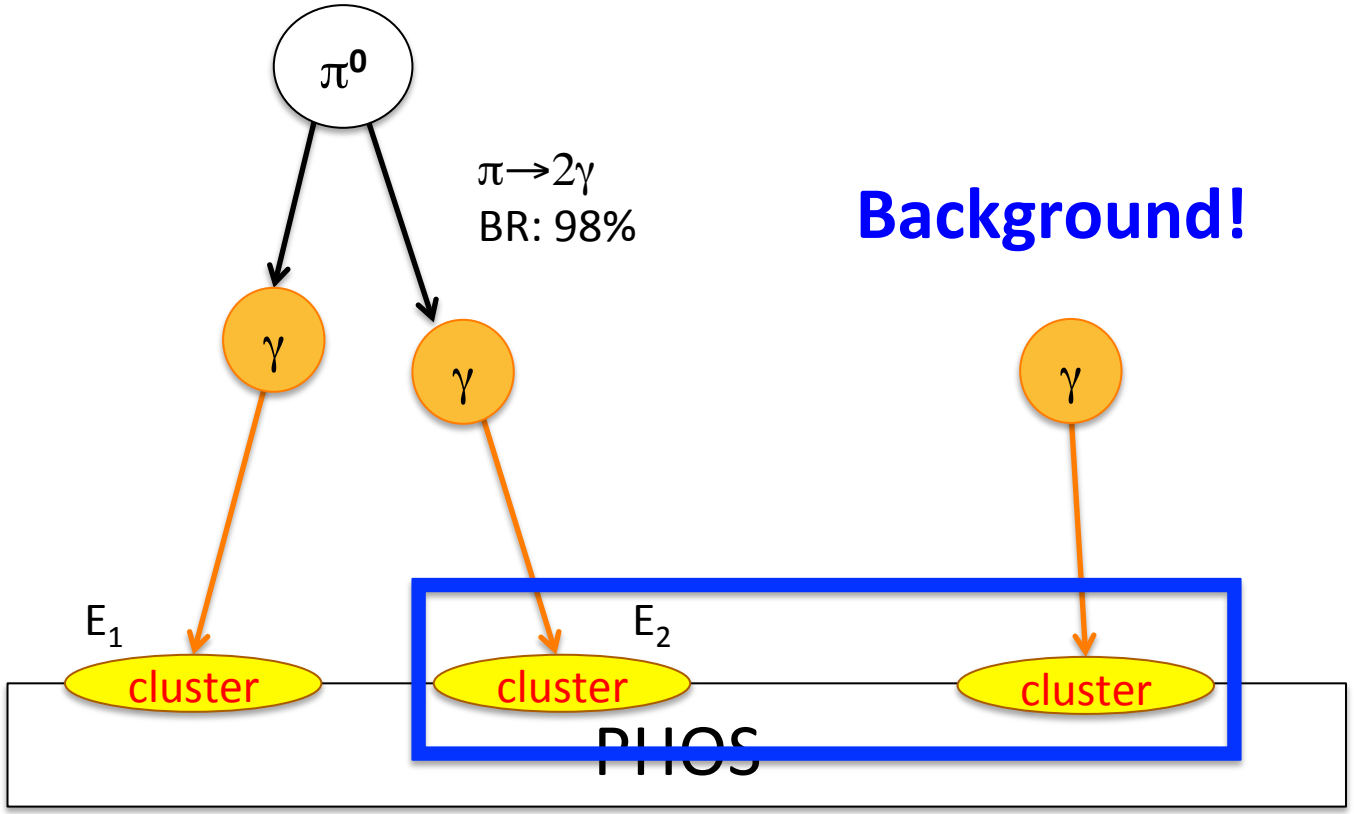

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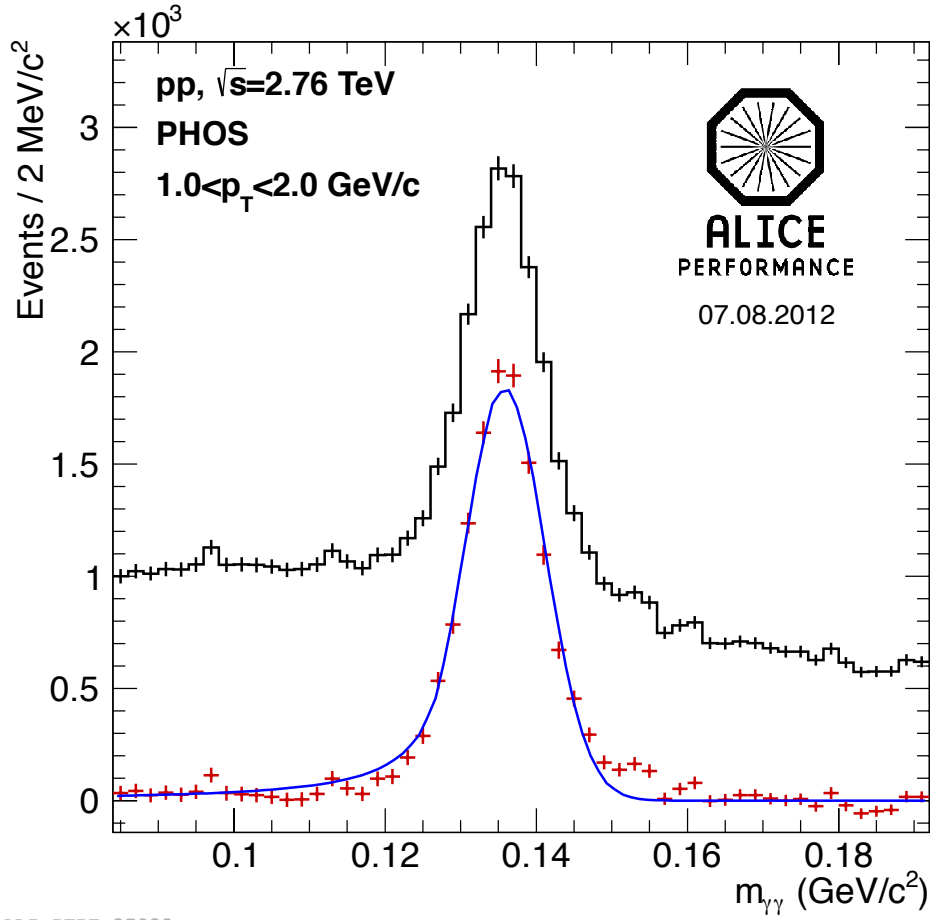

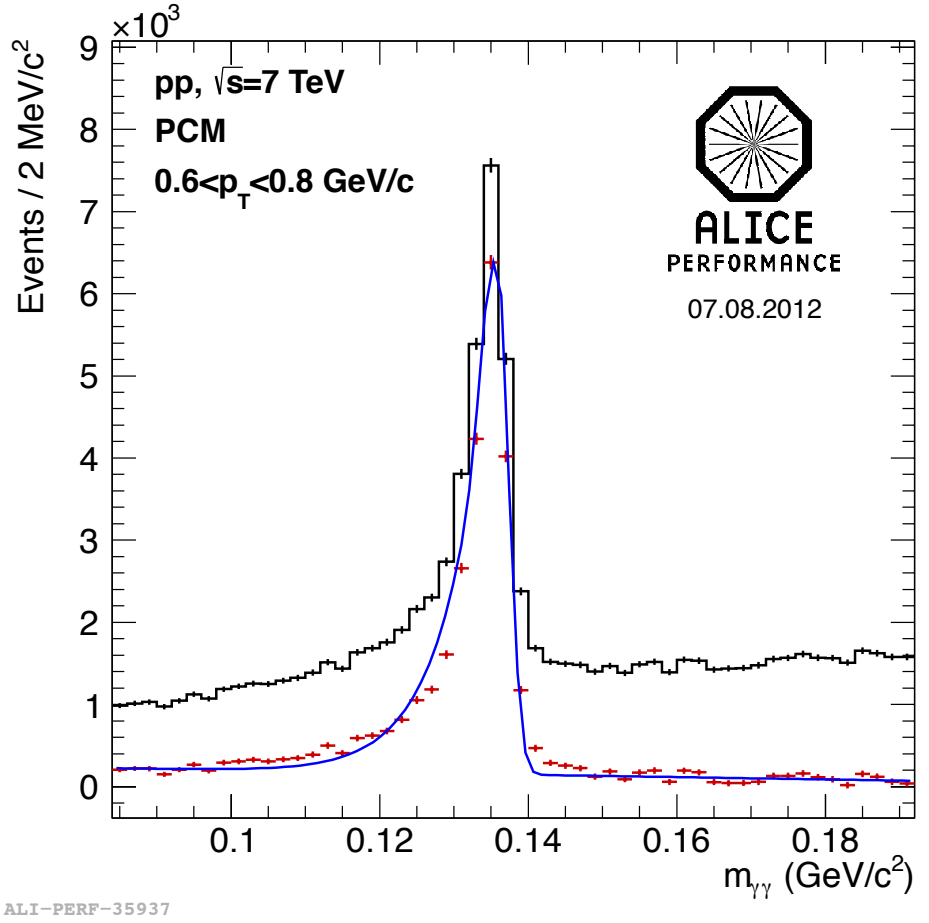

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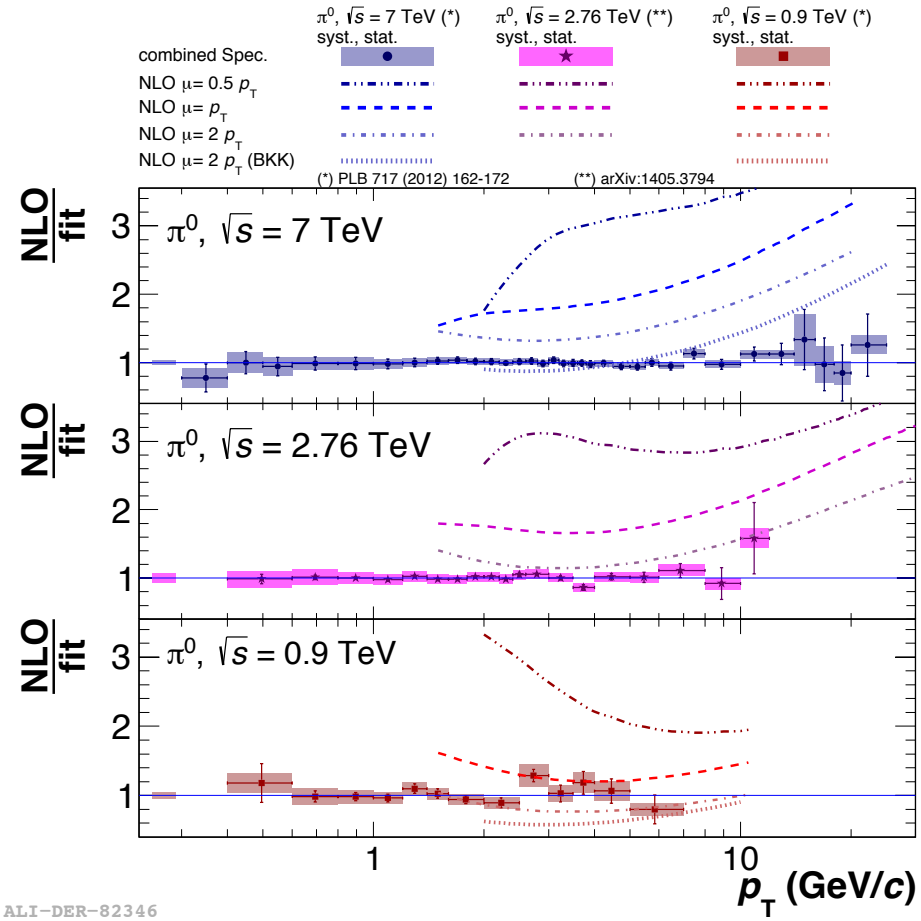
π^0 in pp: NLO pQCD calculations



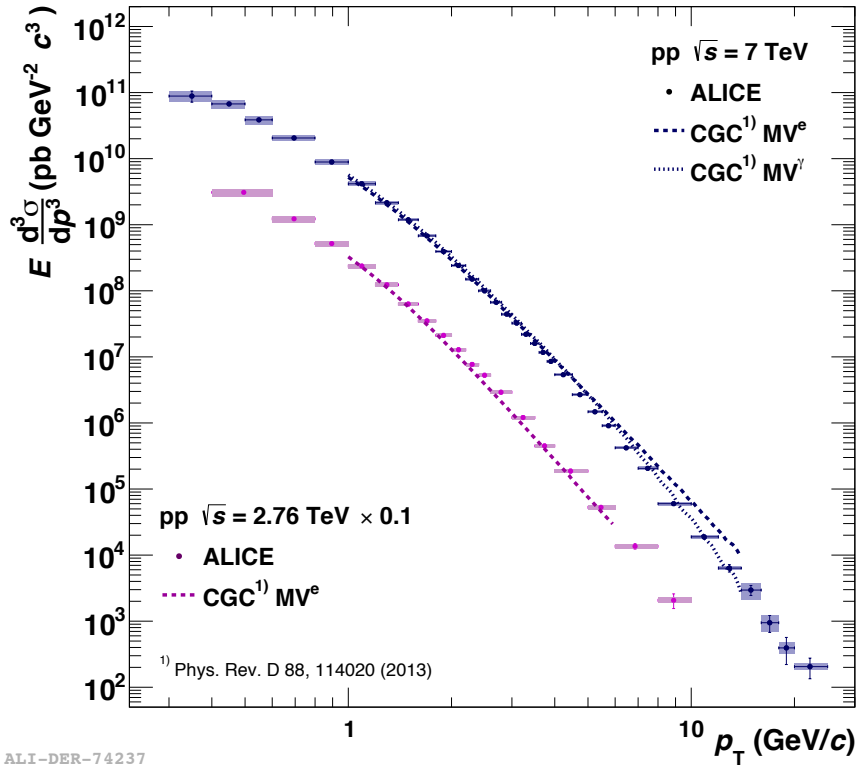
Physics Letters B 717 (2012), pp. 162-172

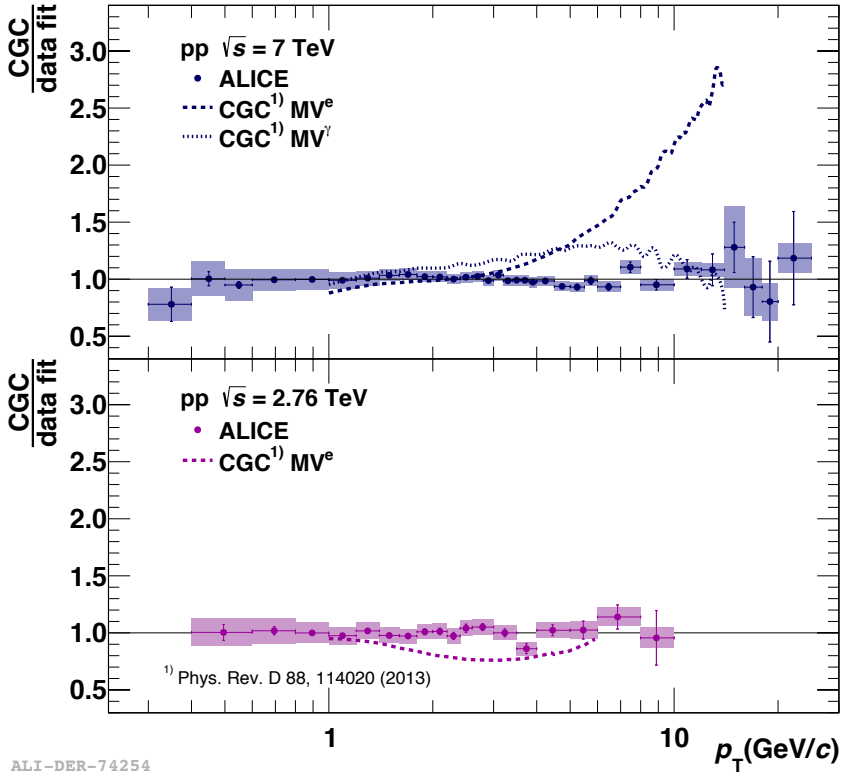
pQCD NLO:
CTEQ6M5 (PDF) and DSS (FF)
π^0 in pp $\sqrt{s}$ = 0.9 TeV reproduced
π^0 in pp $\sqrt{s}$ = 2.76 TeV and 7 TeV over estimate

Due to FF?
Discuss NLO vs $\sqrt{s}$
in Nucl. Phys. B883 (2014) 615

π^0 in pp: CGC calculations

T. Lappi, H. Mantysaari, Phys. Rev. D88 (2013) 114020

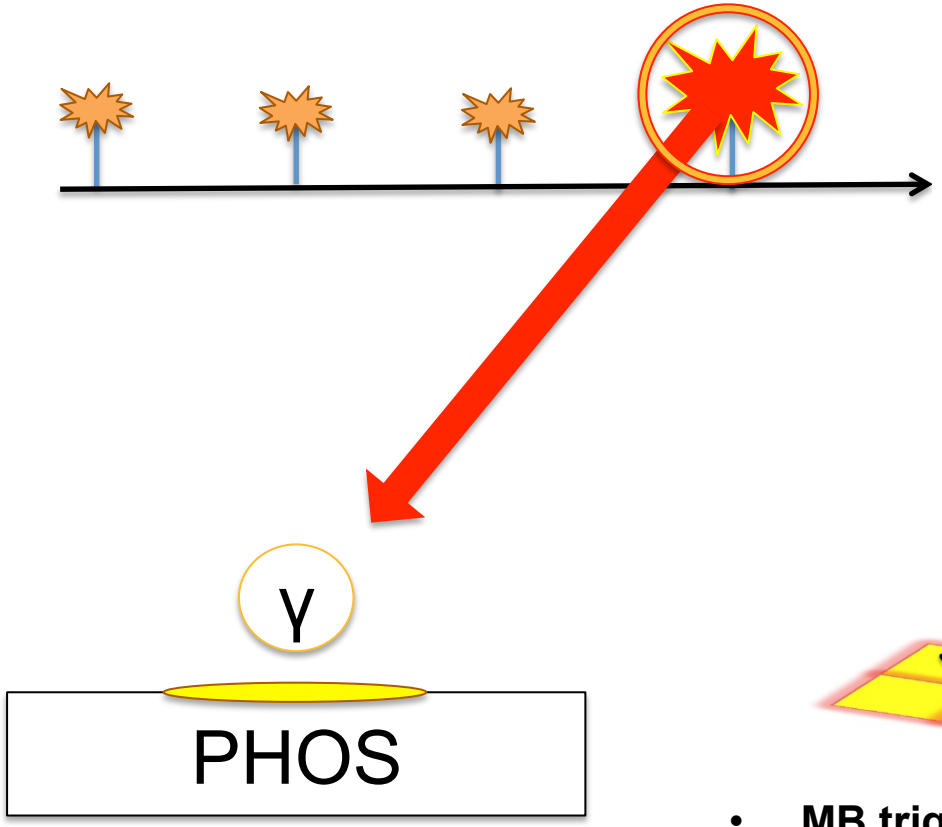


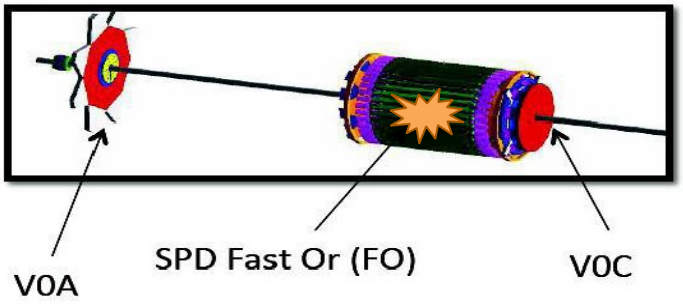


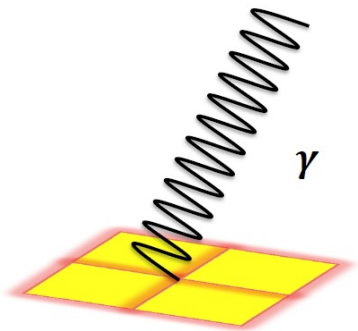
k_T factorization, MV^e and MV$^\gamma$ initial conditions
Parameters fixed to DIS data. DSS LO Fragmentation Function

High energy photon trigger (PHOS trigger)

proton-proton bunch crossing occured at interval of 50ns in 2012 at LHC-P2





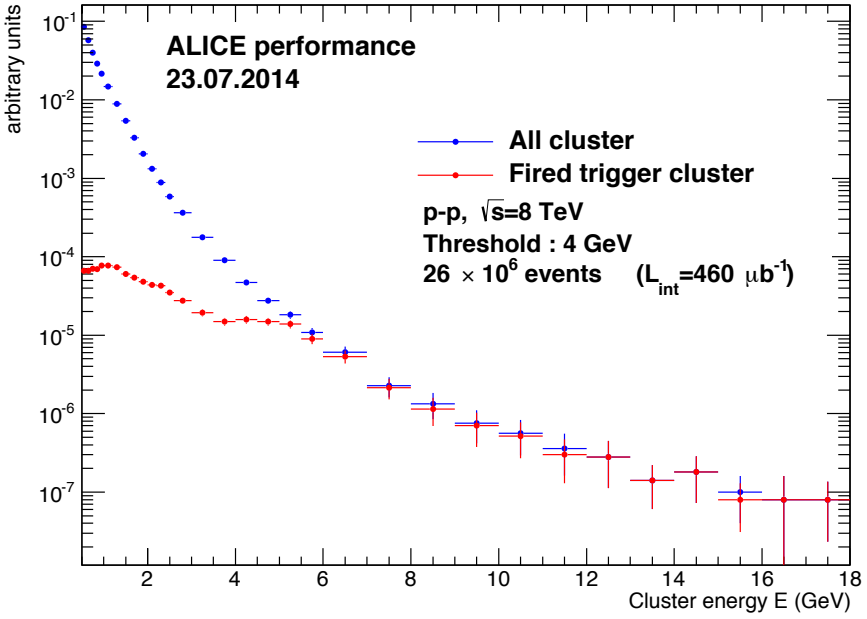


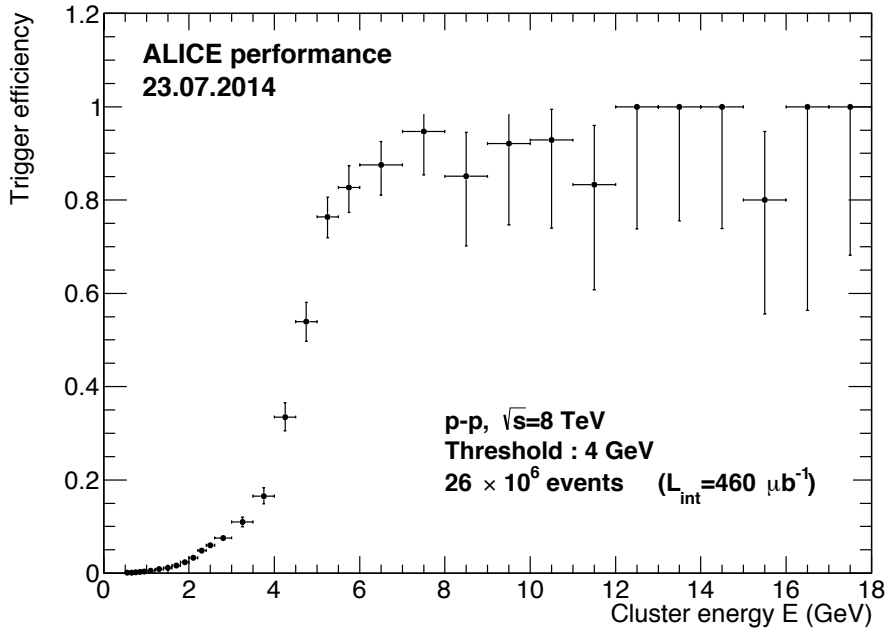
PHOS trigger (0PH0)
= 2x2-Sum E > 4GeV

- **MB trigger : V0A && V0C**
  - **For almost every events**
- **PHOS trigger : MB && 0PH0**
  - **For detection of high-energy photon events without a loss of integrated luminosity**

Trigger response for cluster energy

$$\varepsilon_{Trig} = \frac{The\ number\ clusters\ which\ fired\ trigger\ in\ \mathbf{MB-trigger}}{The\ number\ of\ all\ clusters\ in\ \mathbf{MB-trigger}}$$

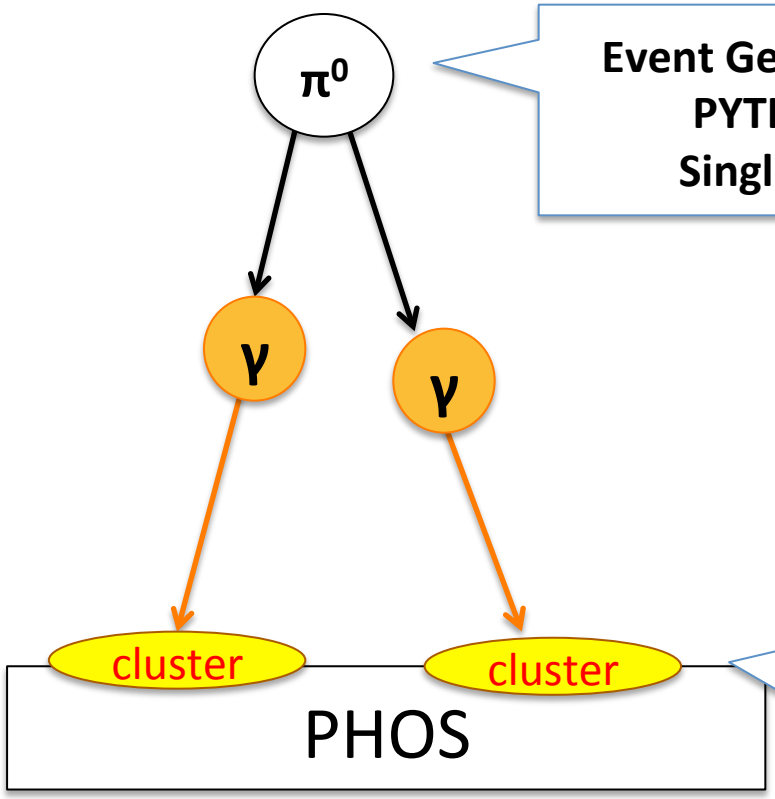




Rejection factor in pp collisions at √s = 8TeV is ~5000!

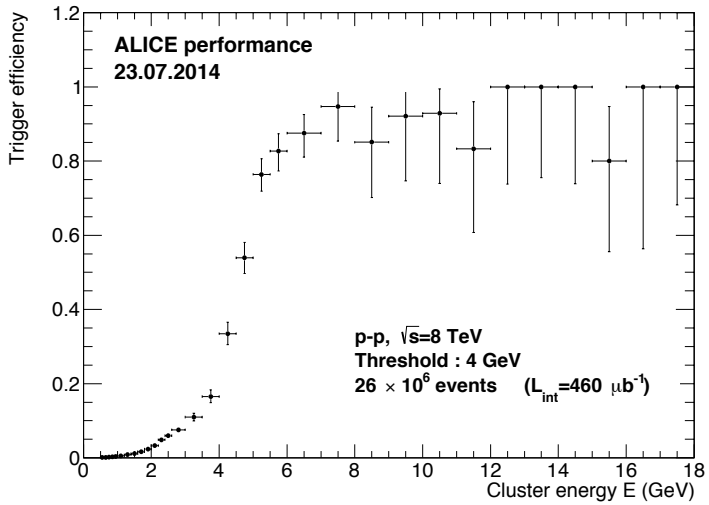
Neutral pion trigger efficiency

- **MC simulation**
- **PYTHIA6 + single π^0 + GEANT**



Event Generator
PYTHIA
Single π^0

Trigger response for cluster energy



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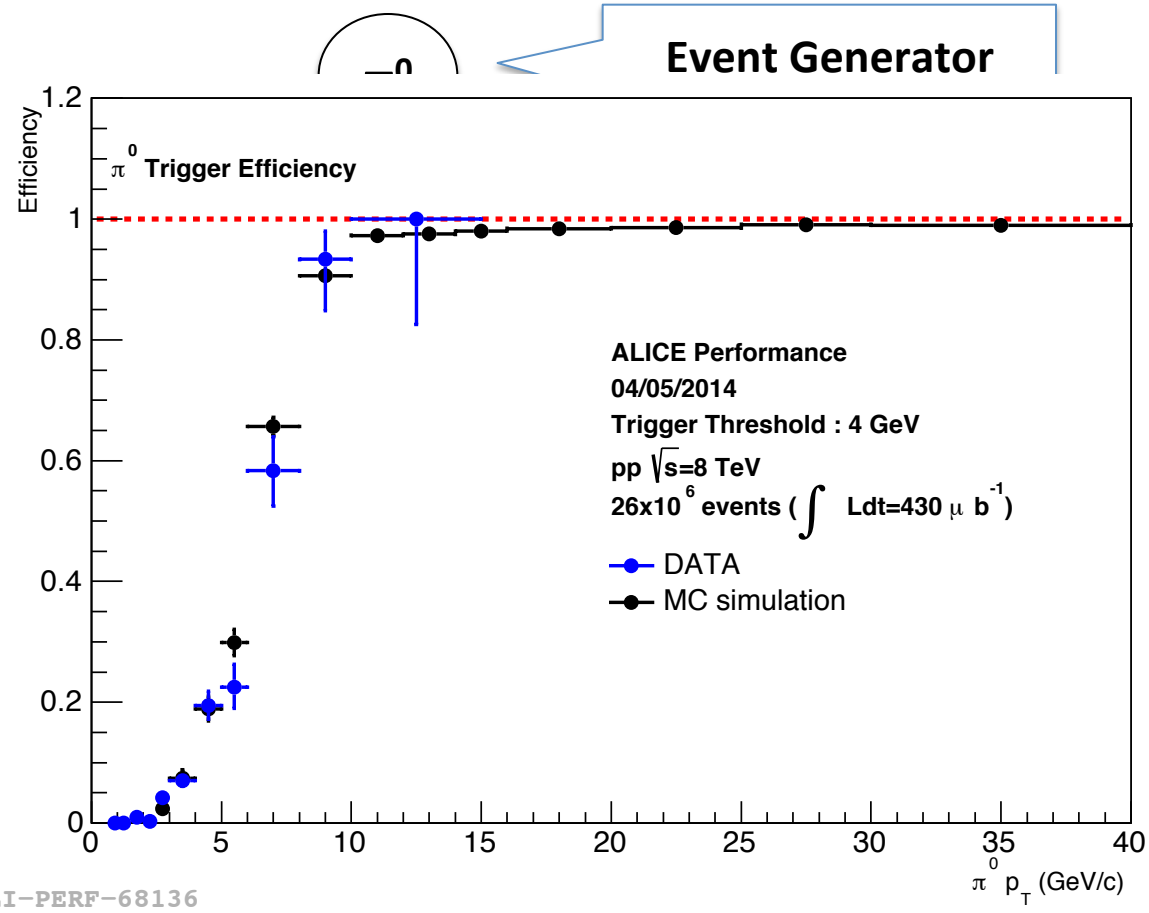
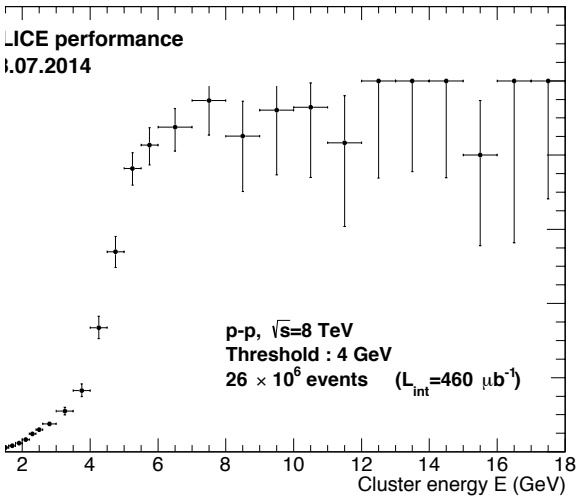


r response for cluster energy



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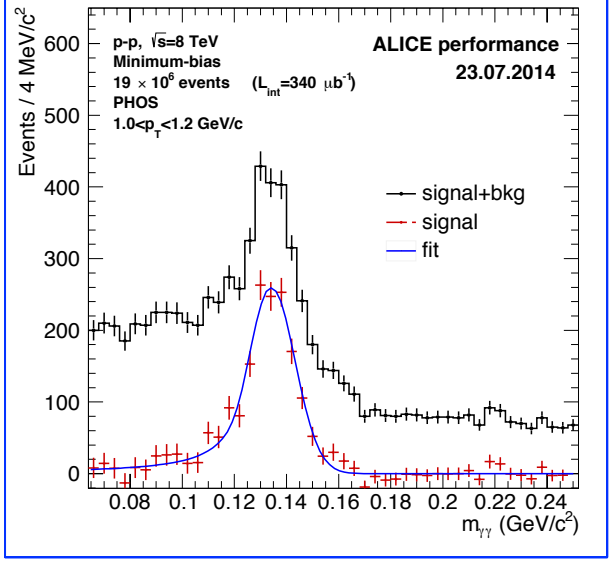
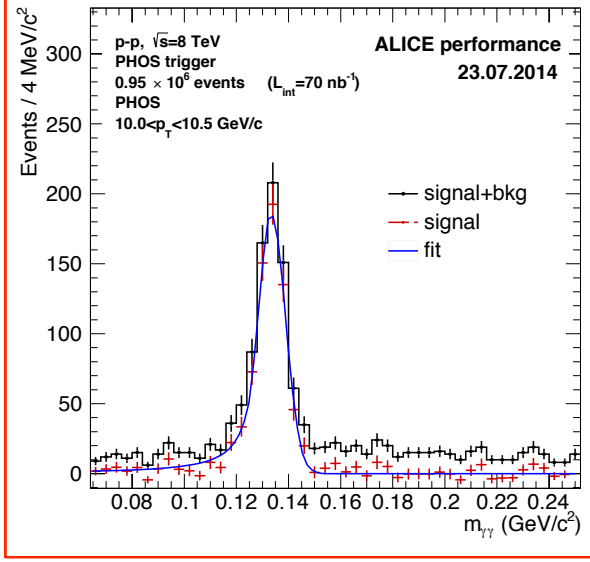
Results

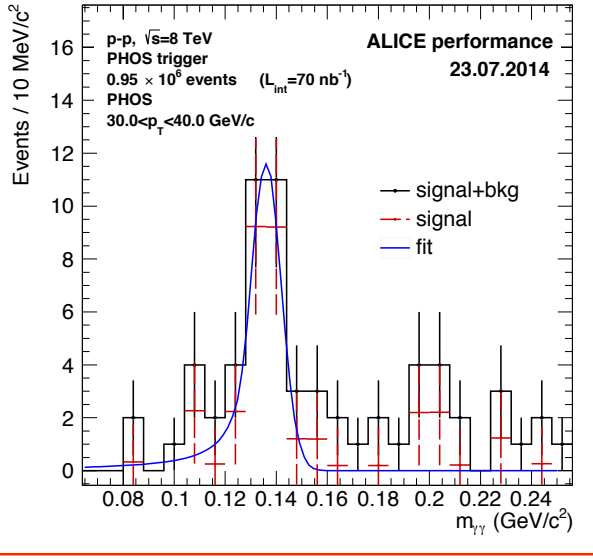
Minimum-bias data cover low p_T region.
On the other hand, PHOS trigger data covers mid to high p_T region!

Minimum-bias



PHOS trigger





Neutral pion can be measured up to 40 GeV/c with PHOS trigger!

Summary and outlook

- Neutral pion has been measured in pp collisions at 0.9, 2.76 and 7 TeV with several methods.
- 8TeV data is being analyzed with not only Minimum-bias but also PHOS triggered data.

- PHOS trigger was operated in Pb-Pb and p-Pb collisions and R_{AA} and R_{pPb} in a very wide p_T range are expected to be obtained shortly
- Other neutral mesons (η and ω) can be measured in a wide p_T range in all collision systems.