Isolated photon + hadron and jet correlations in p-Pb and pp collisions

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on behalf of the ALICE Collaboration

Motivation

- Serves as benchmark for Pb-Pb measurement
- Exploits ALICE unique capabilities to access a poorly explored low Q^2, low-x region

Figure from EPPS16 paper

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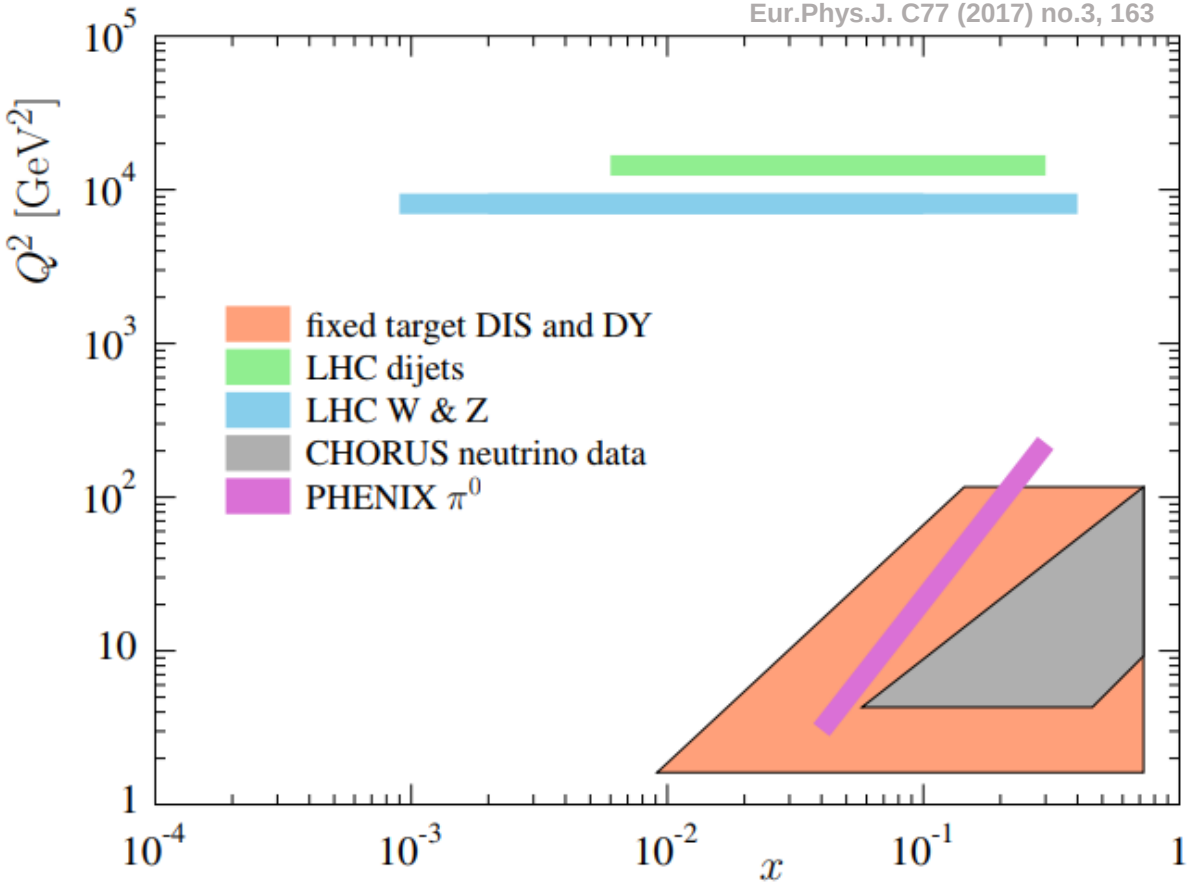
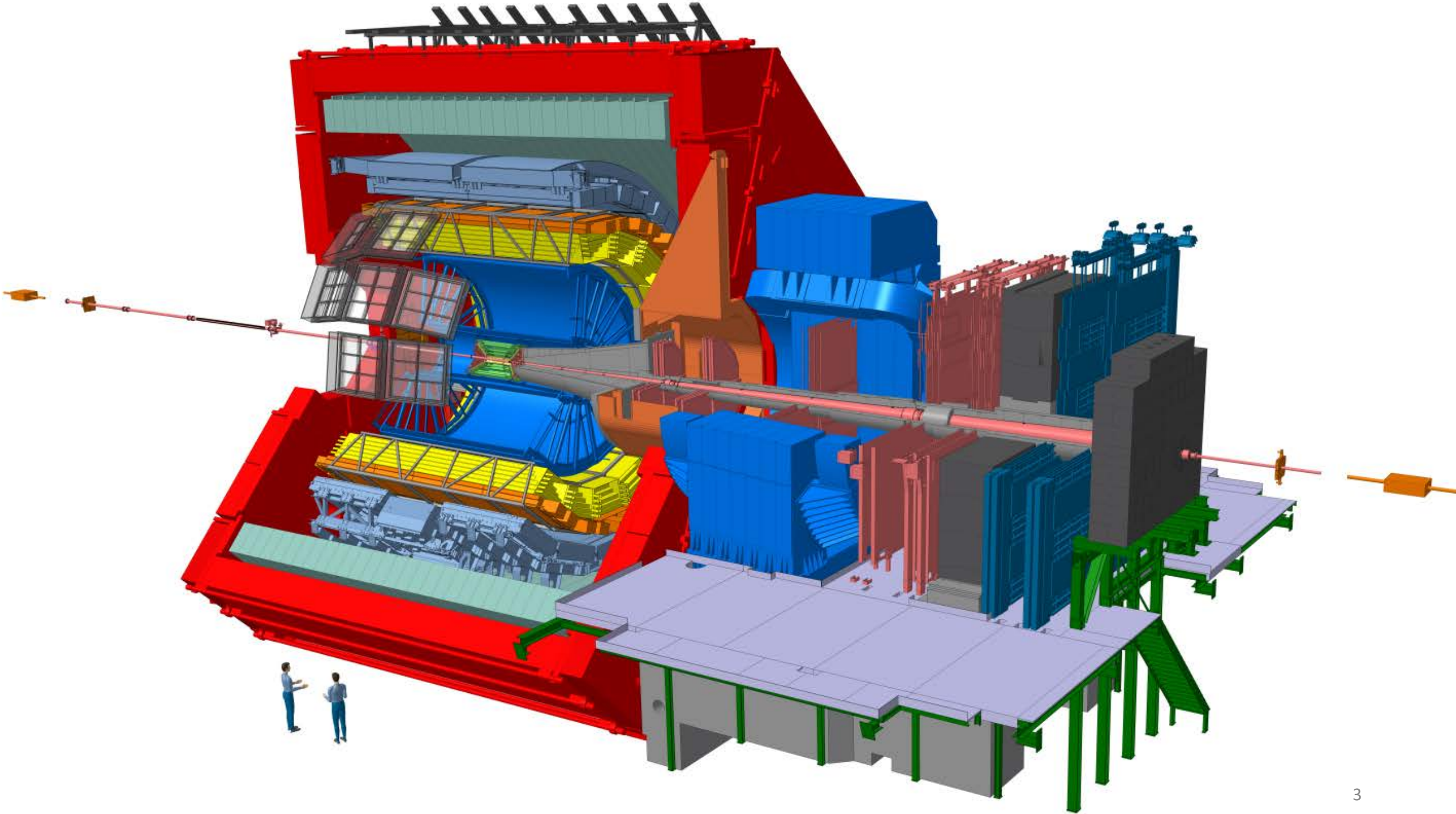
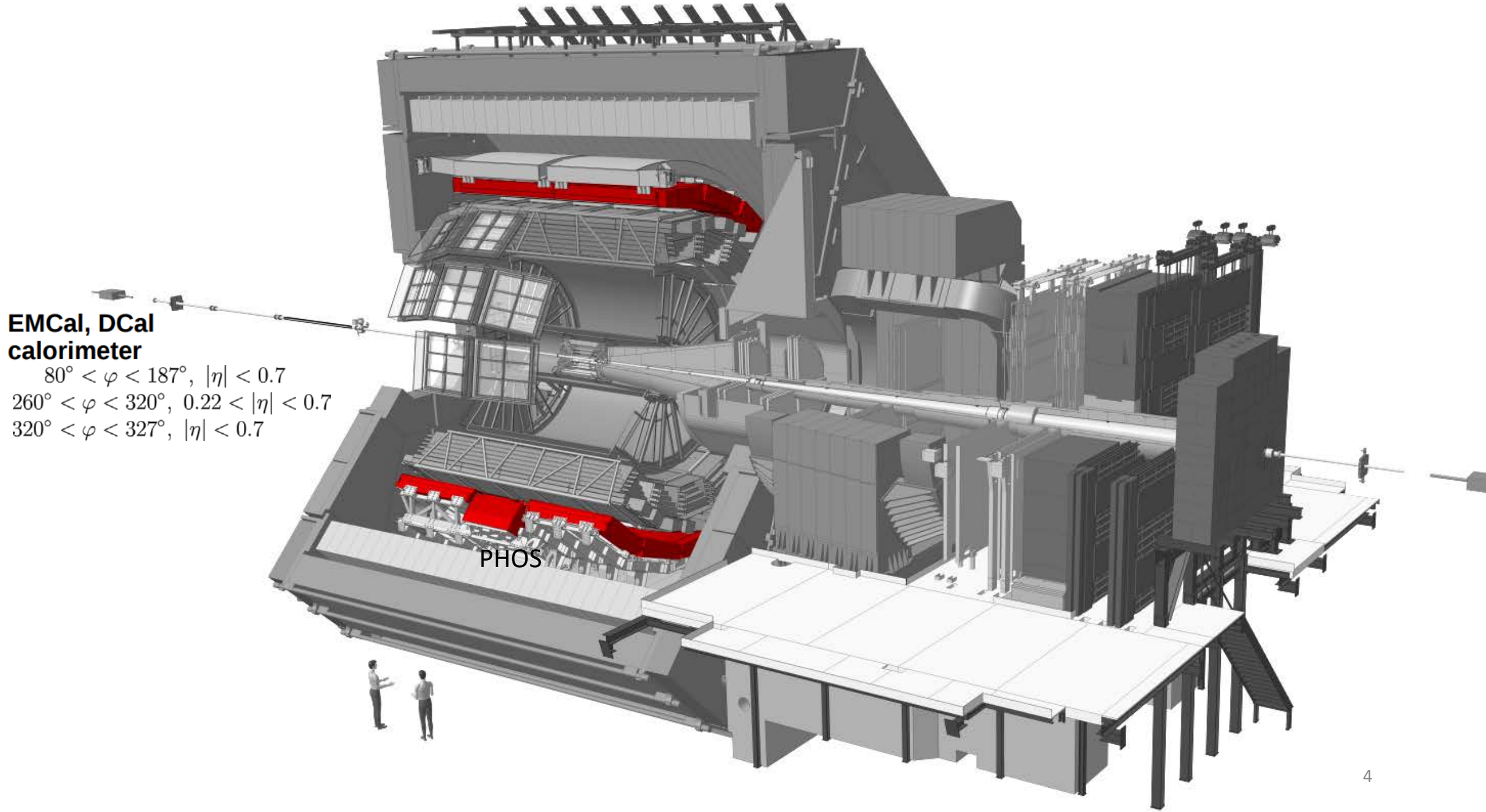
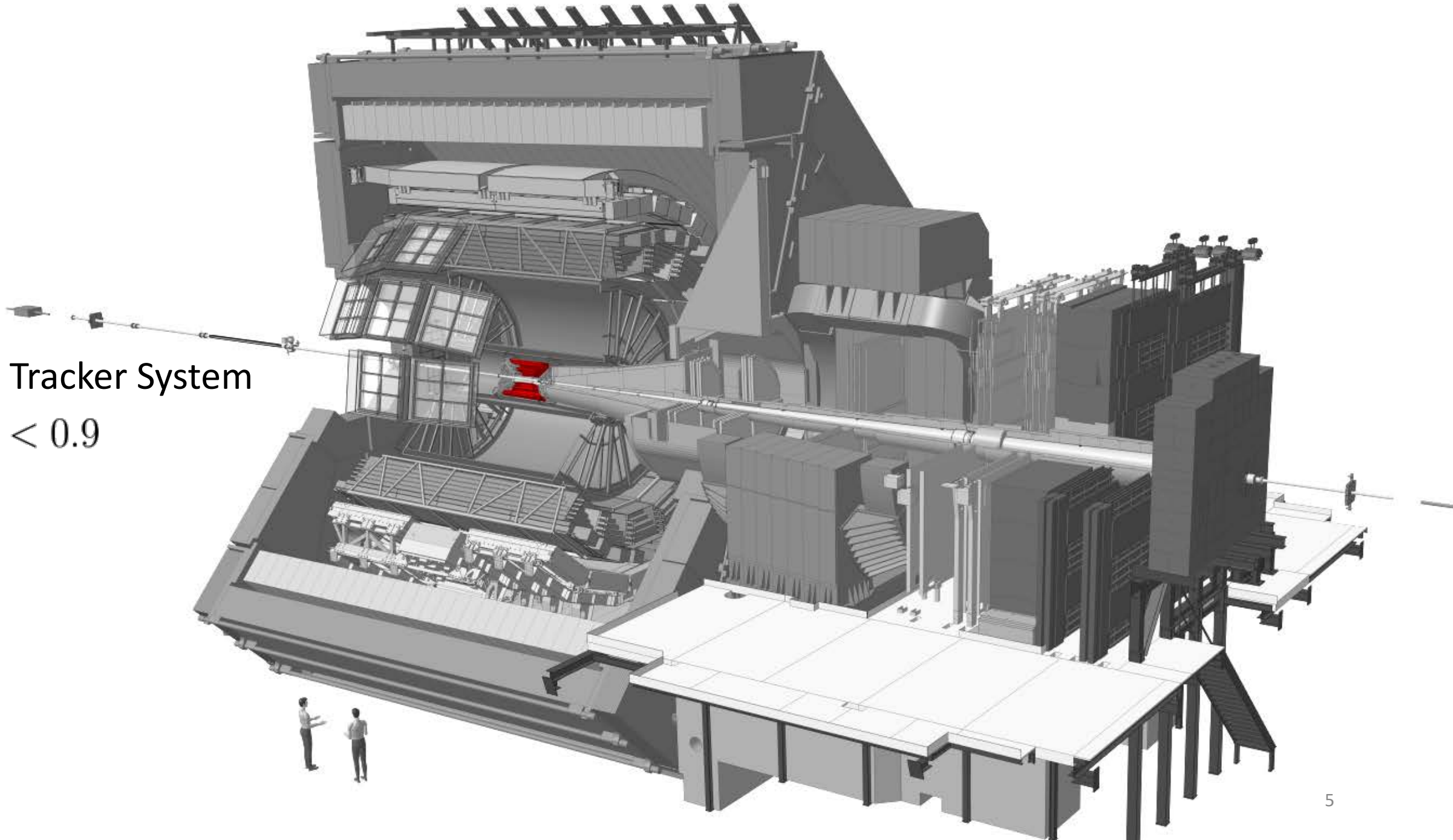





EMCal, DCal calorimeter
$80^\circ < \varphi < 187^\circ,\ |\eta| < 0.7$
$260^\circ < \varphi < 320^\circ,\ 0.22 < |\eta| < 0.7$
$320^\circ < \varphi < 327^\circ,\ |\eta| < 0.7$
PHOS

Inner Tracker System

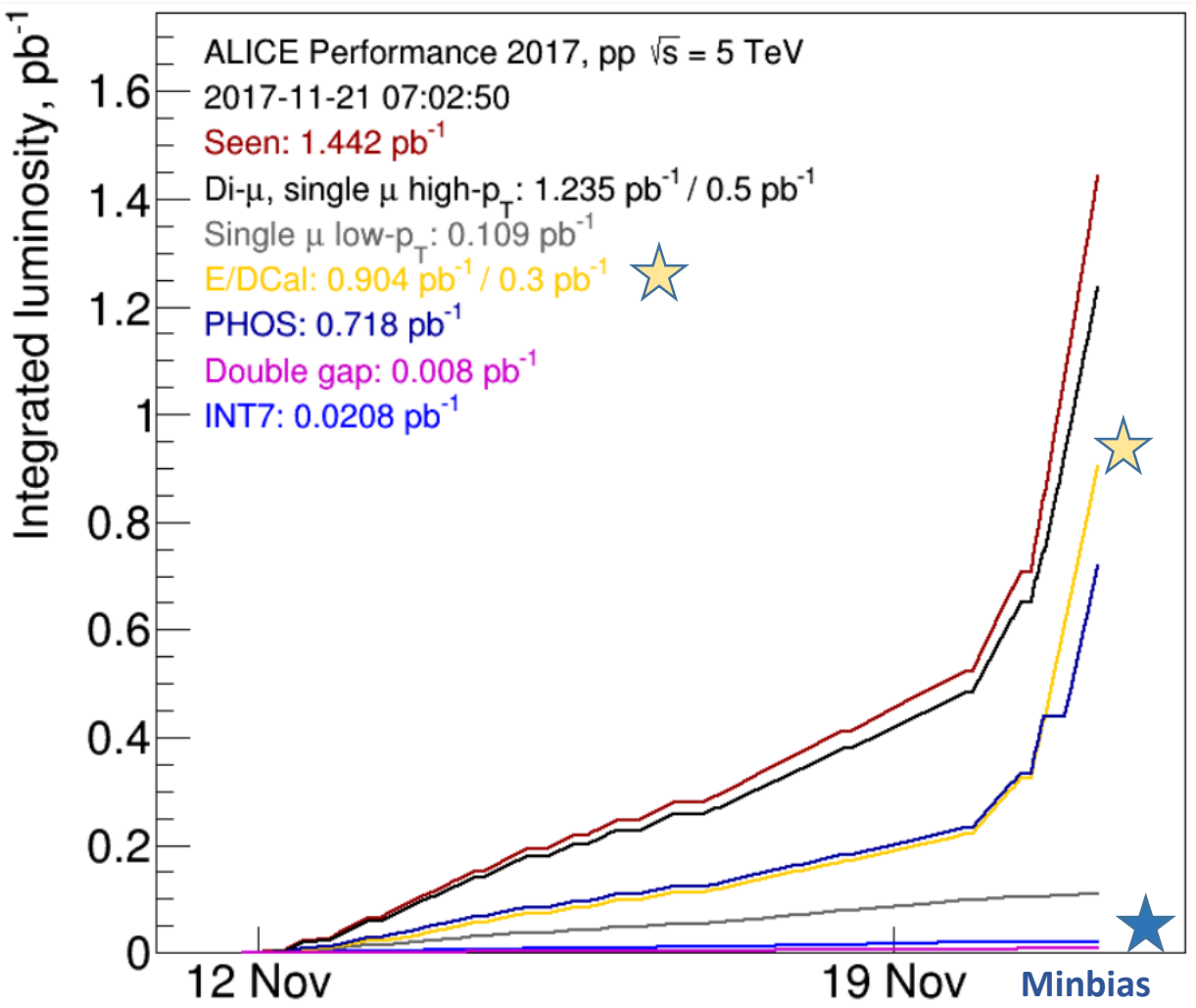
$|\eta| < 0.9$



Data samples

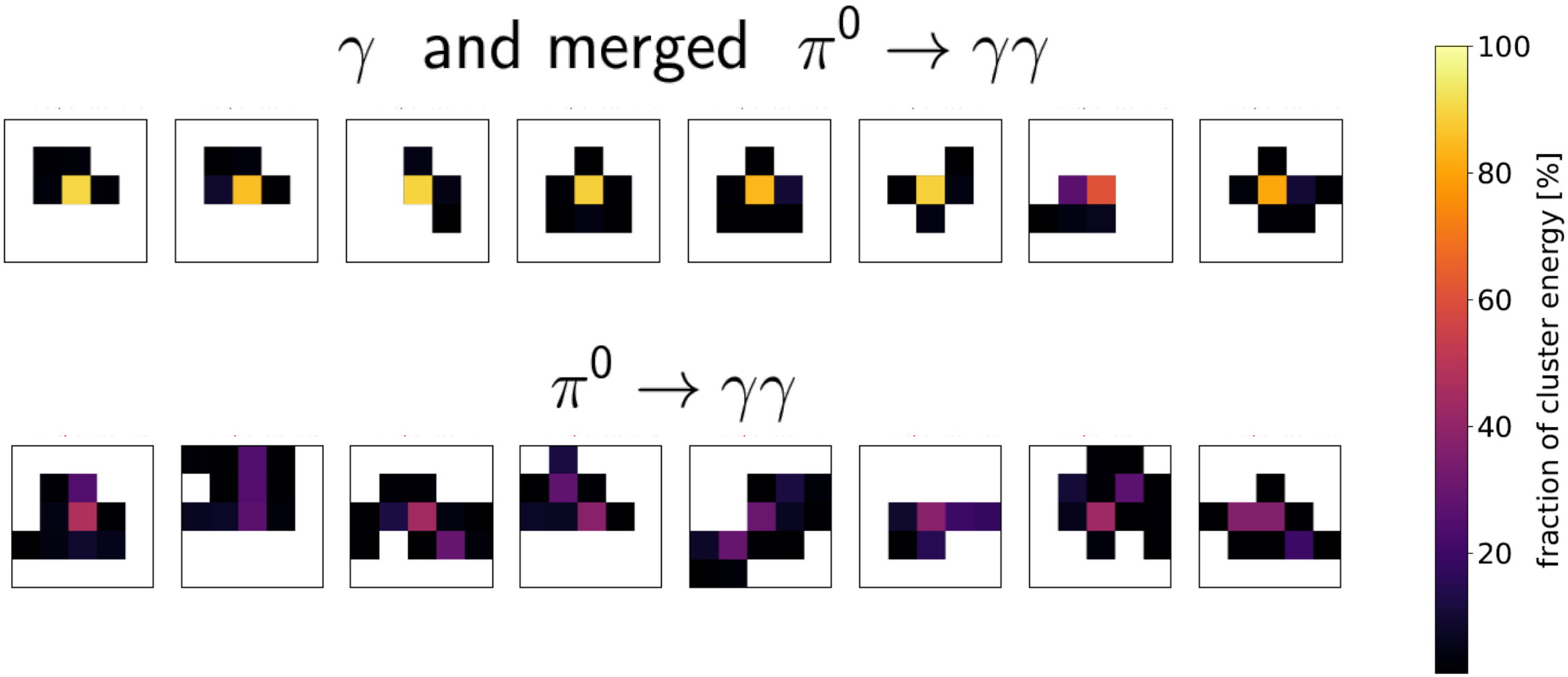
- 5 TeV pp data from 2017 run
- 5 TeV p-Pb data from 2013 run

Both collected with EMCal trigger, yielding comparable int. luminosity

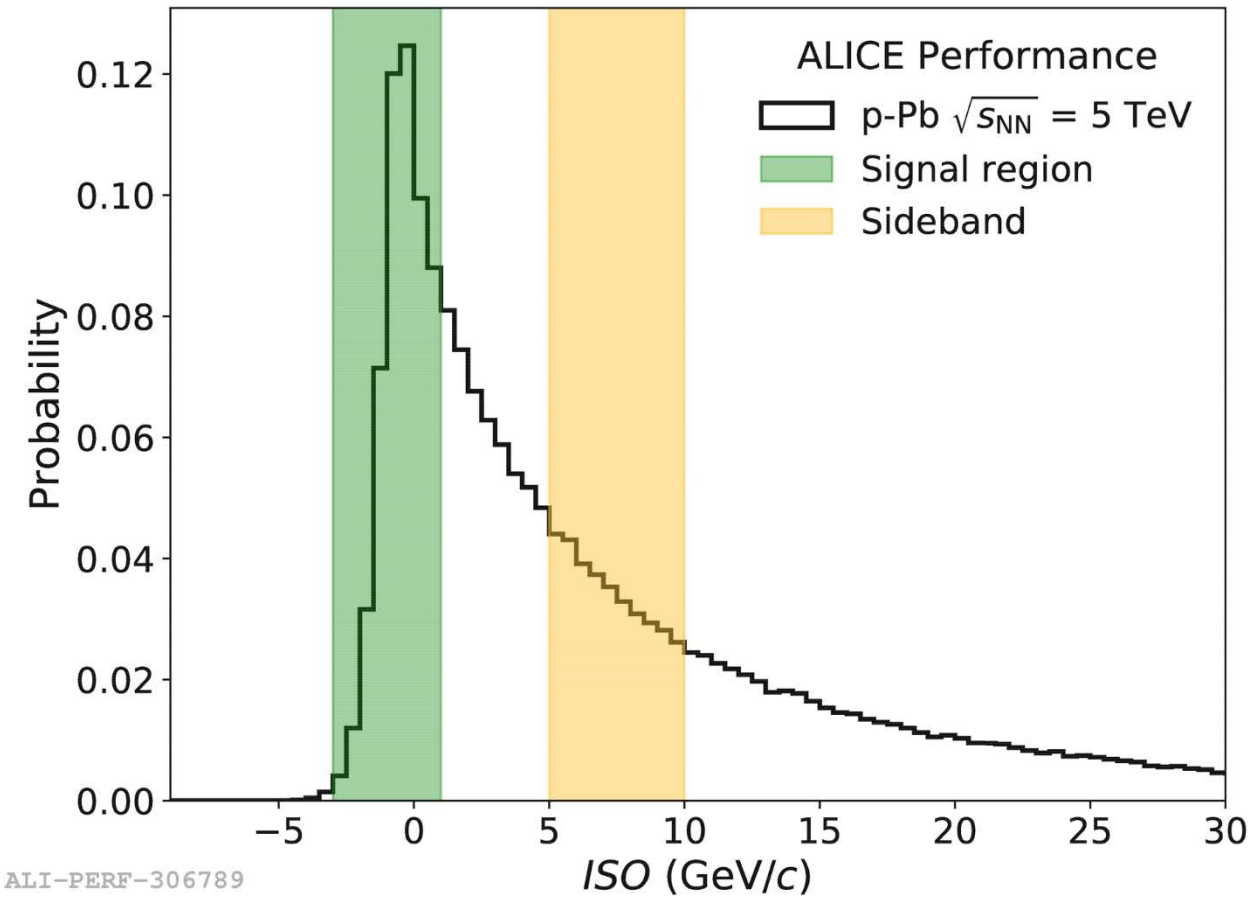


Photon identification

Photon identification with shower shapes



Photon Isolation

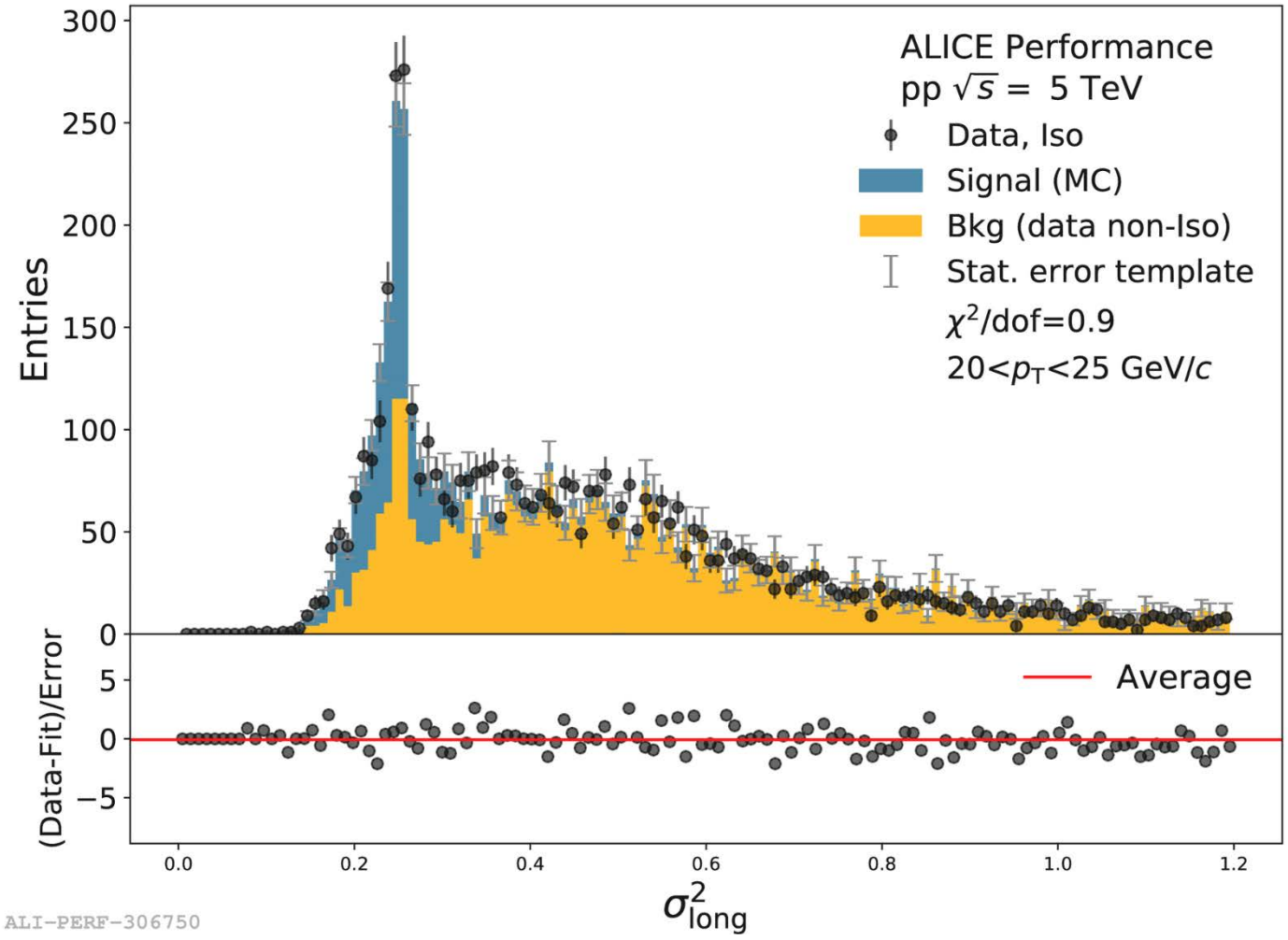


- Cluster isolated with cone R=0.4, using tracks, UE subtracted with median density:

$$ISO = \sum_{\text{track } \in \Delta R<0.4} p_{\mathrm{T}}^{\text{track}} - \rho \times \pi(0.4)^2$$

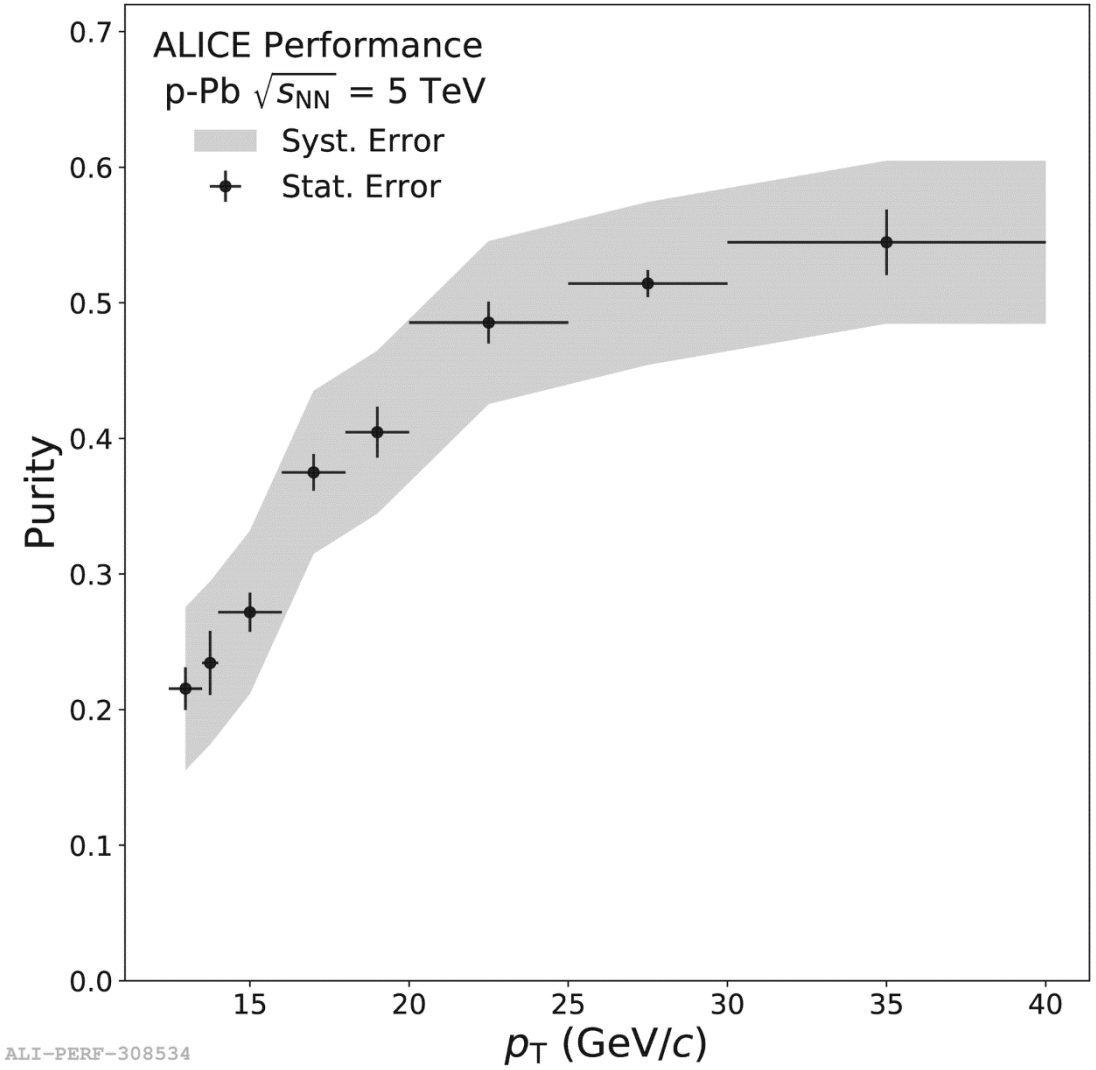
- ISO < 1.5 GeV/c selection

Template fit for purity measurement



- Data-driven background template
- Signal template from MC
- 1 free parameter

Purity measurement



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- Purity grows with p_{T} up to about 50% above 20 GeV/c
- Lower purity at low p_{T} is due to low signal-to-noise in cross-sections (percent level)

Isolated photon + hadron correlations

Correlation functions methodology

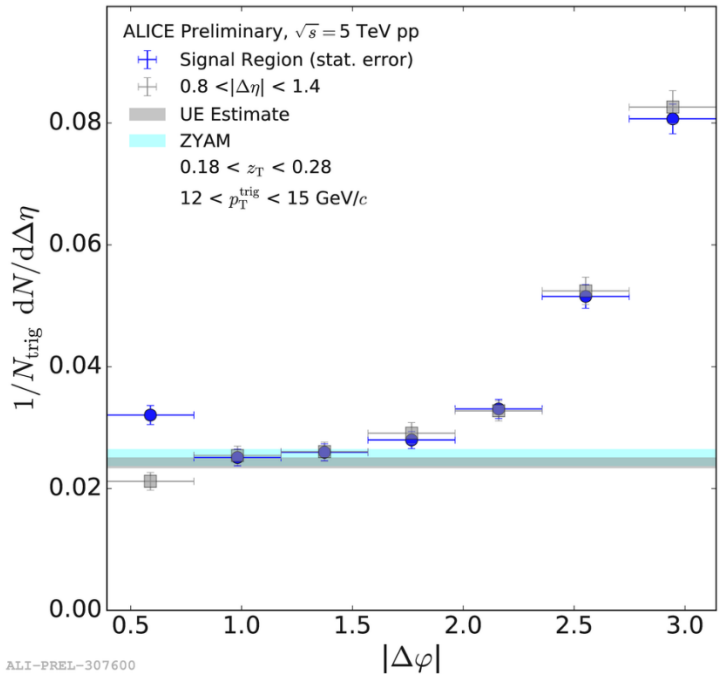
- Correlation between photons with 12—15 GeV/*c* and tracks, in different z_{T} bins. Corrected by acceptance (mixed events), efficiency and fake rate:

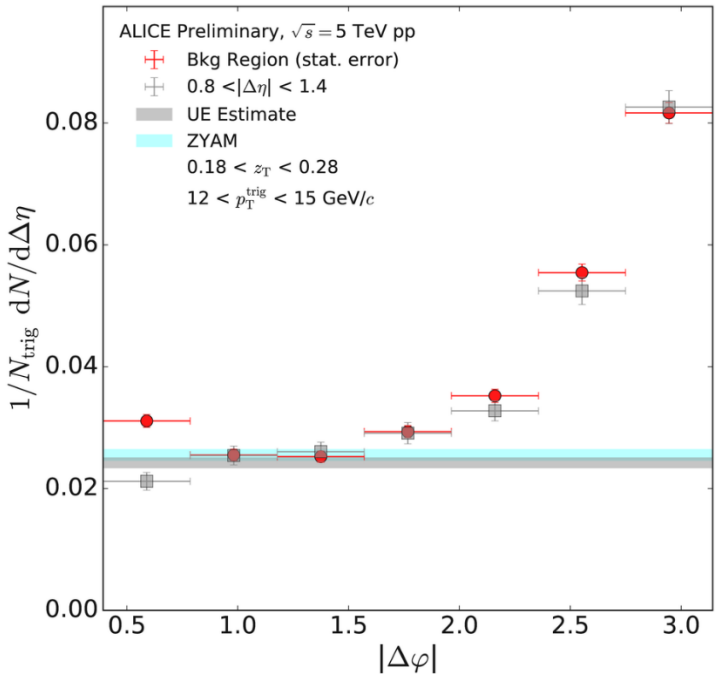
$$C(\Delta\varphi,\Delta\eta)=\frac{S(\Delta\varphi,\Delta\eta)}{M(\Delta\varphi,\Delta\eta)}\frac{1}{\epsilon}(1-f)$$

- Pedestal from underlying event, *U*, estimated with ZYAM and large $\Delta\eta$

- These are ingredients for signal correlation, obtained with measured purity (*p*) 25%:

$$C_S=\frac{(C_{SR}-U)-(1-p)(C_{BR}-U)}{p}$$

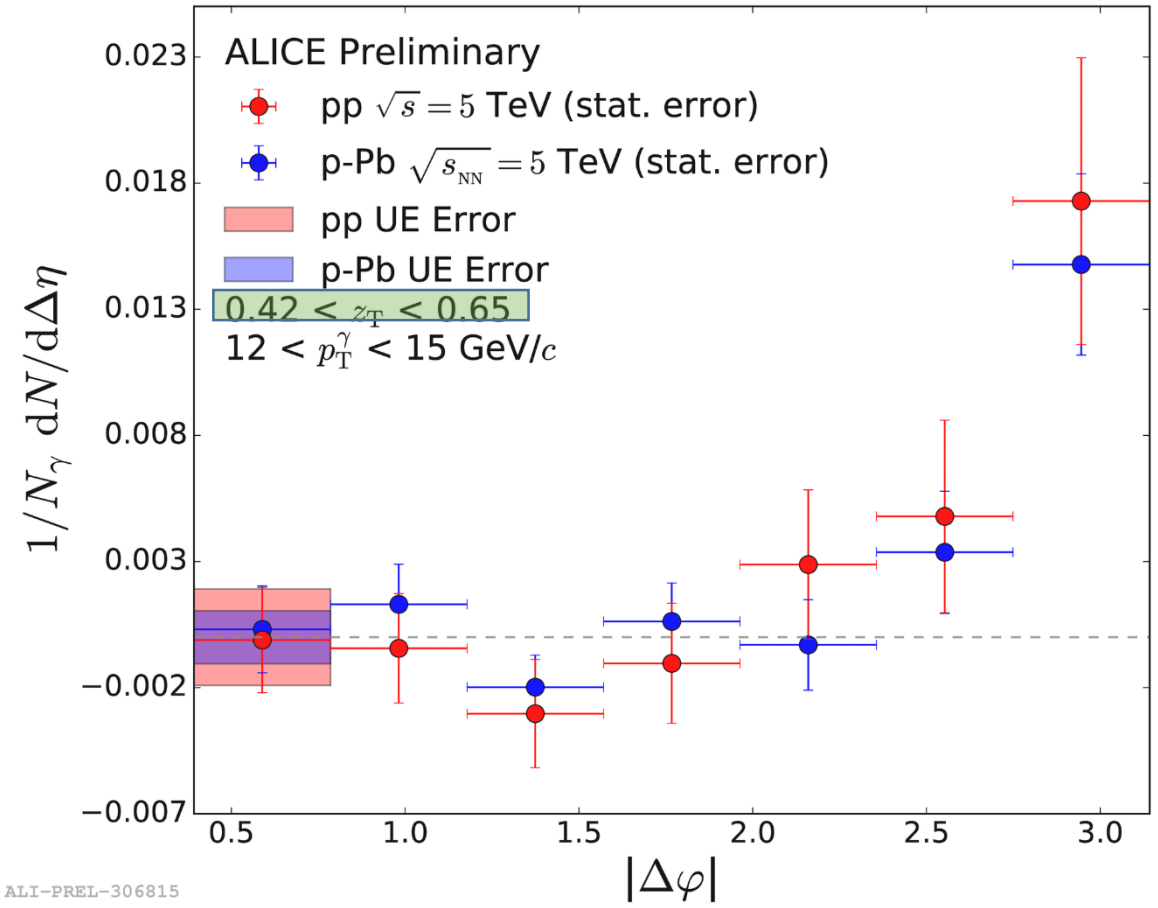


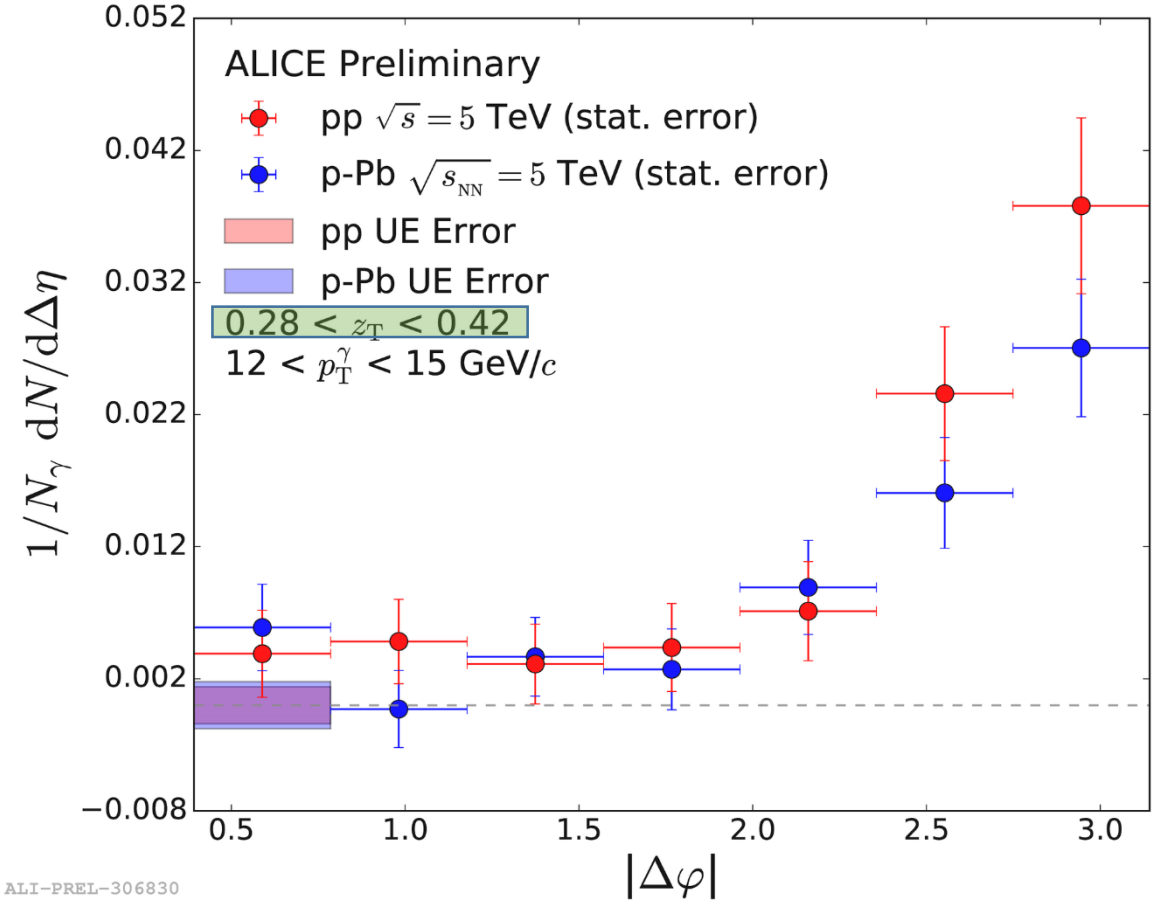


C_{SR} 

C_{BR} 

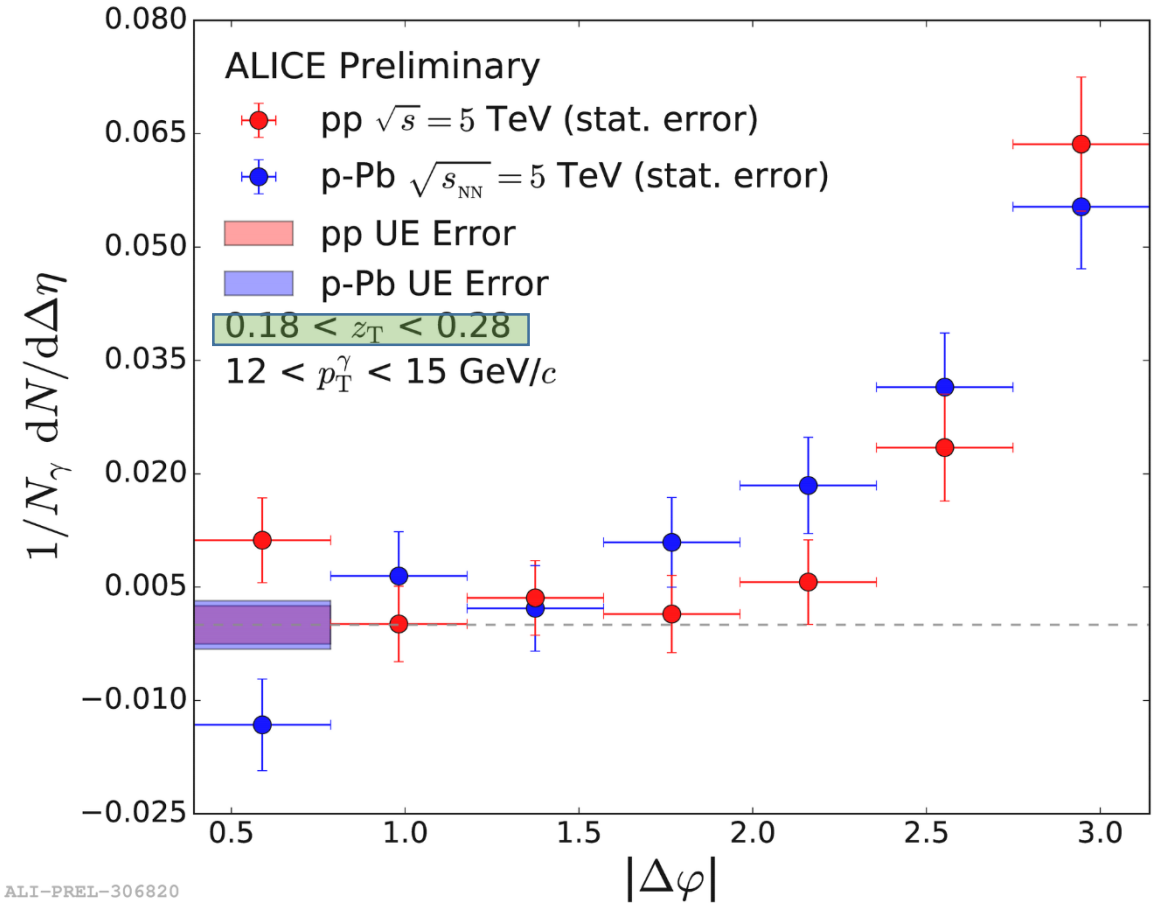
Isolated-photon + hadron correlations

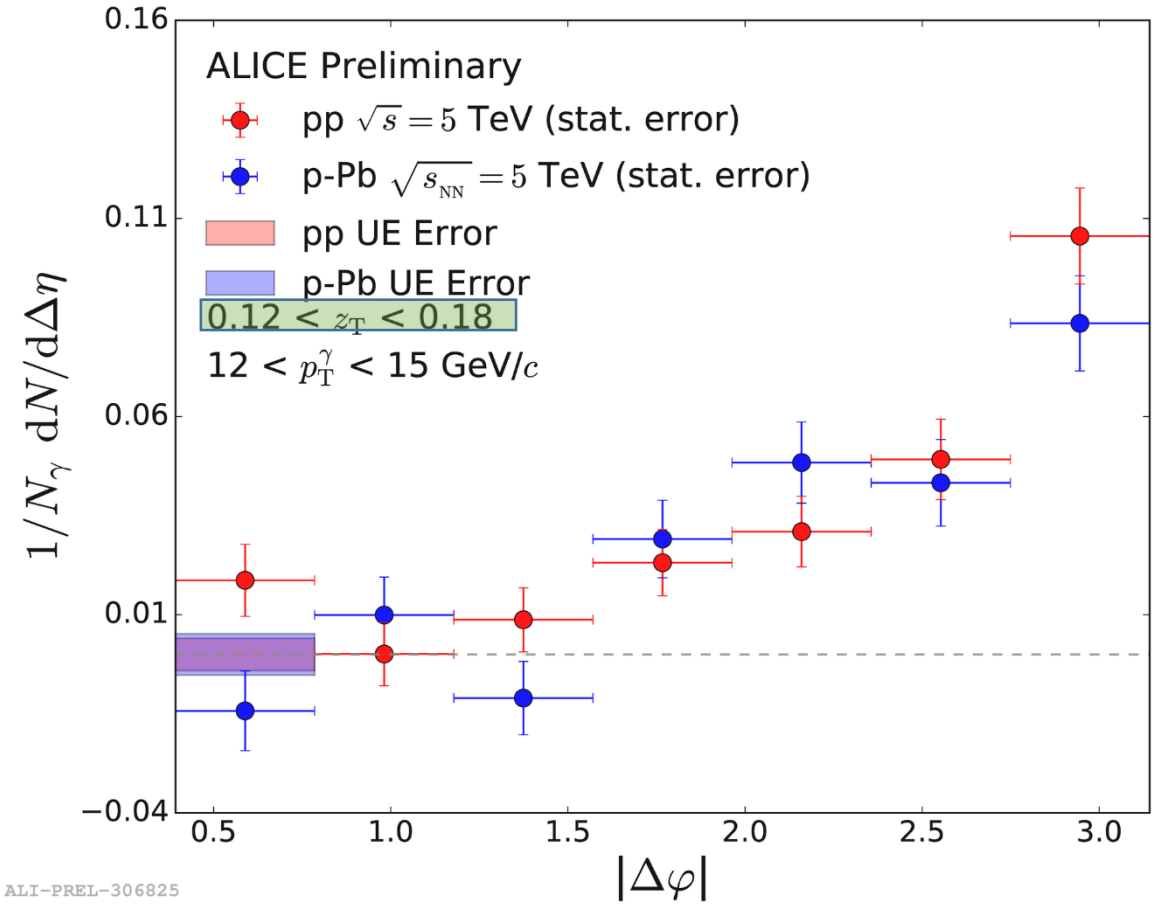




No significant difference between pp and p-Pb data

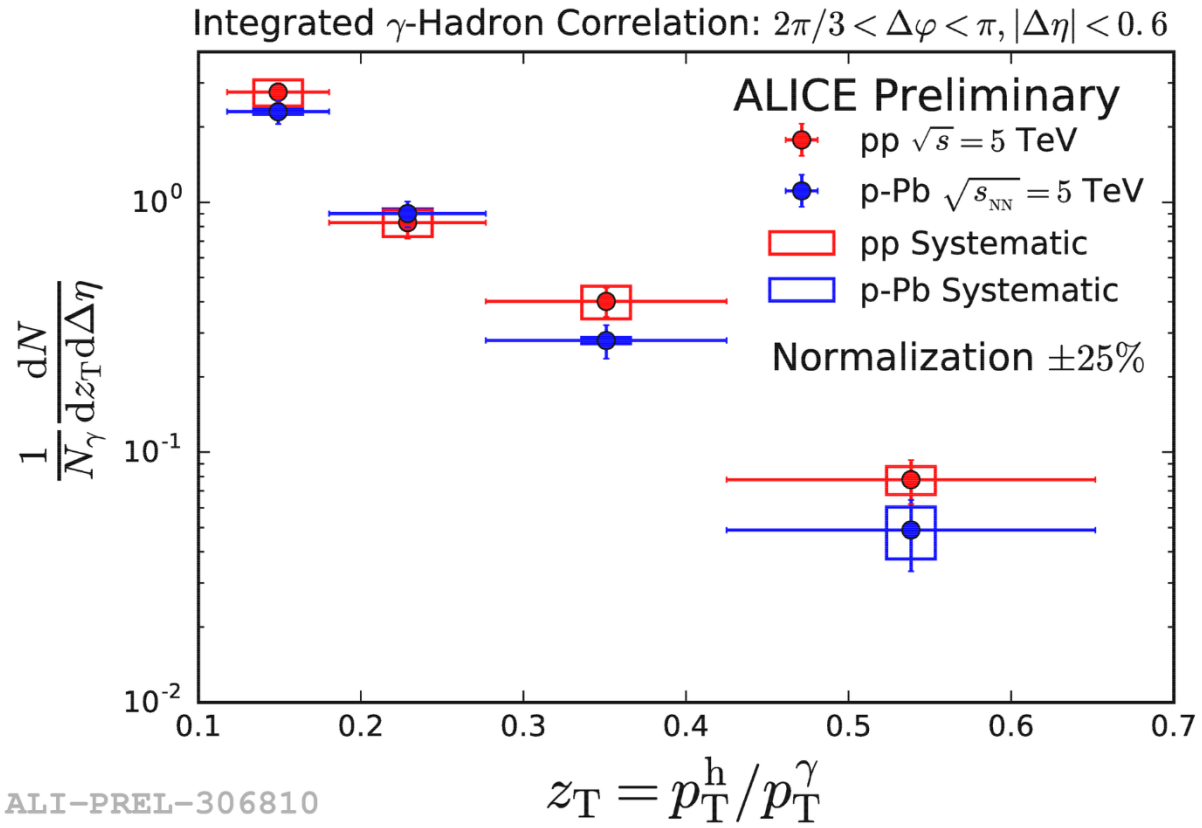
Isolated-photon + hadron correlations

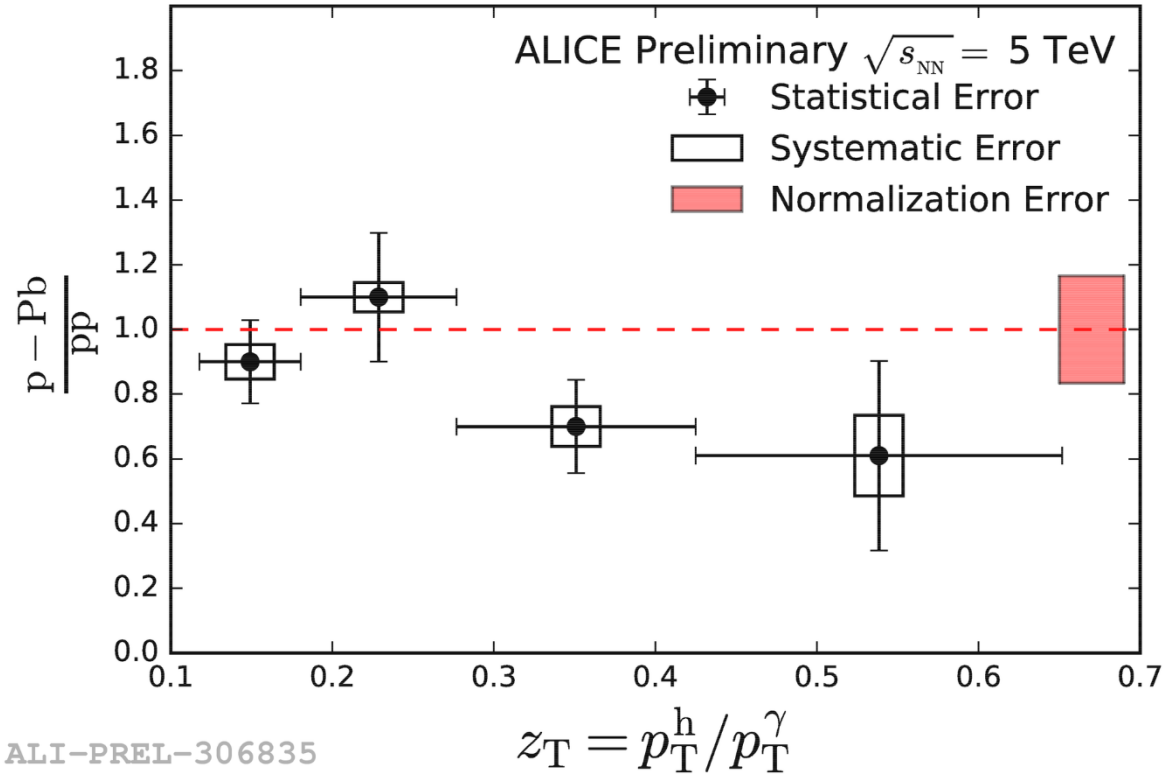




No significant difference between pp and p-Pb data

Integrated photon + hadron correlations

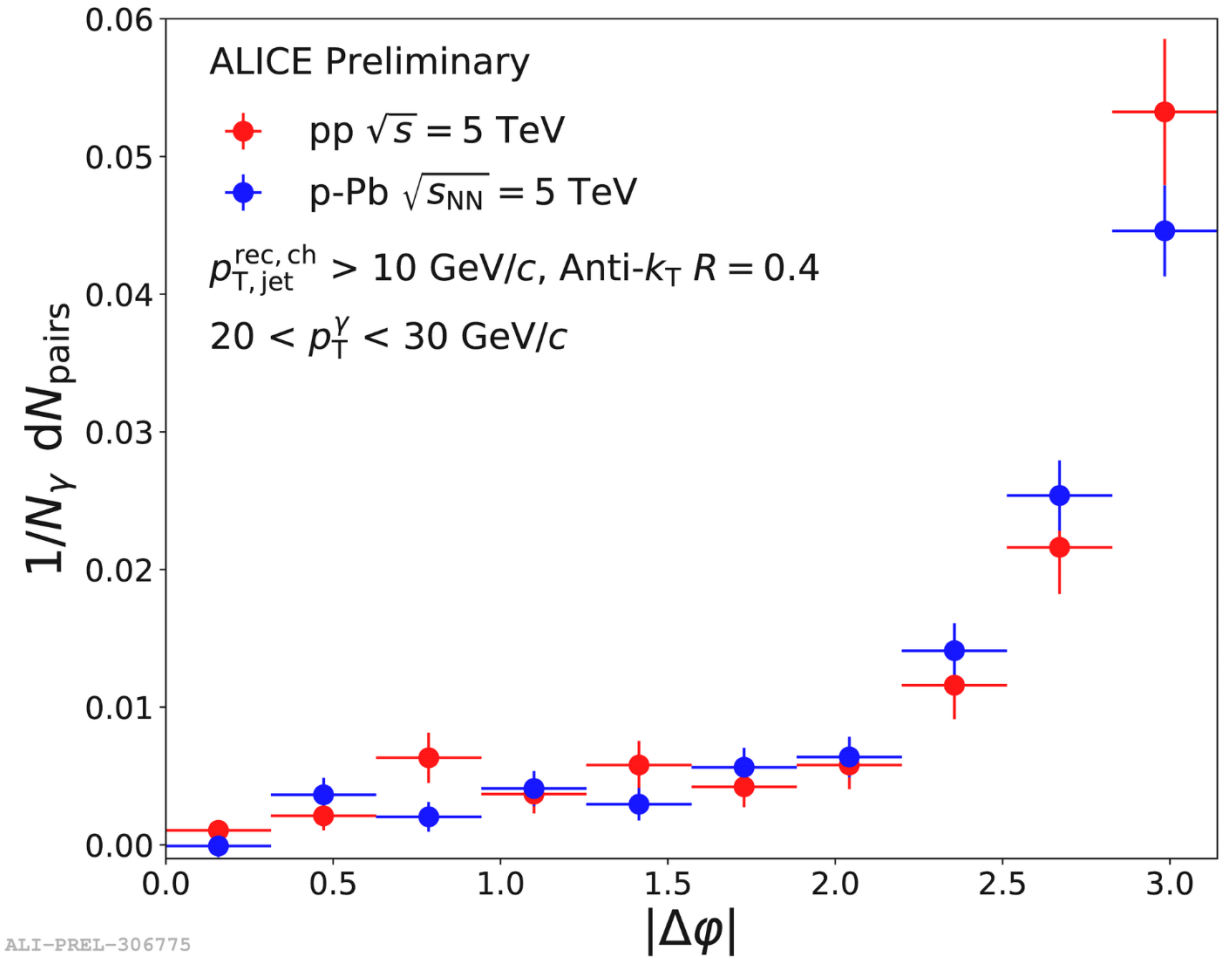




No significant difference between pp and p-Pb data

Isolated photon + jet correlations

Photon + jet angular correlation



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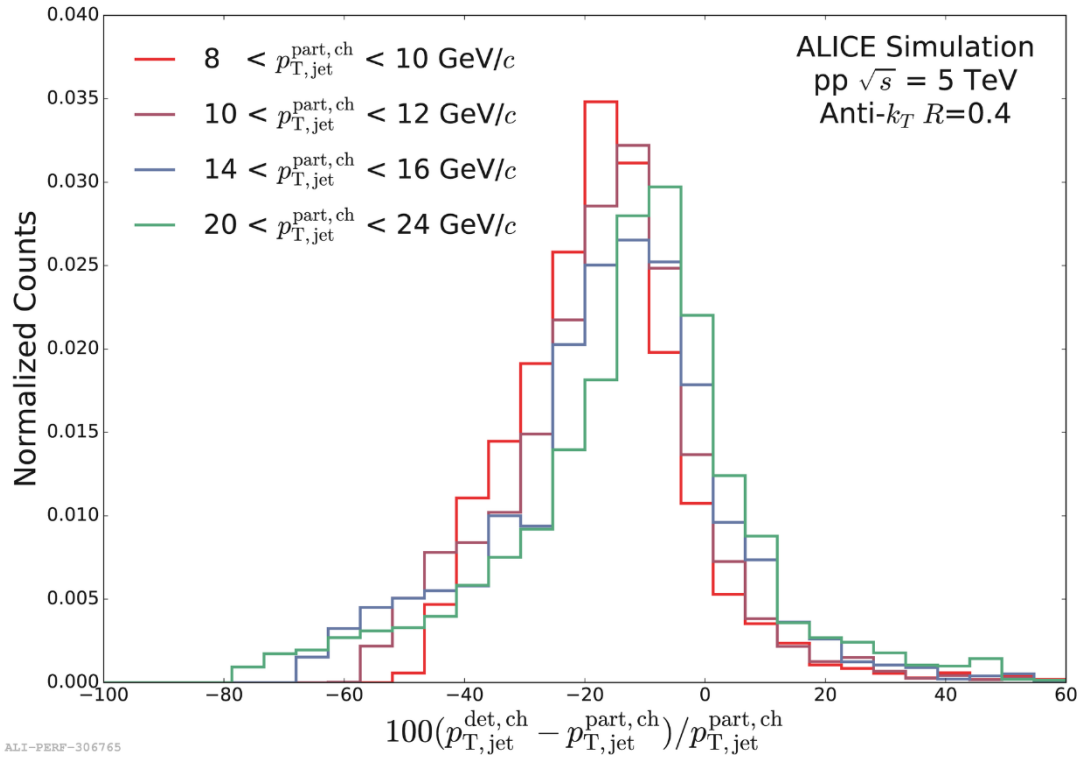
- Anti-*k*T *R*=0.4 jets. Track constituents
- Pairs with $\Delta\varphi > \pi/2$ kept
- π^0 impurity subtracted as:

$$C_S = \frac{C_{SR} - (1-p)C_{BR}}{p}$$

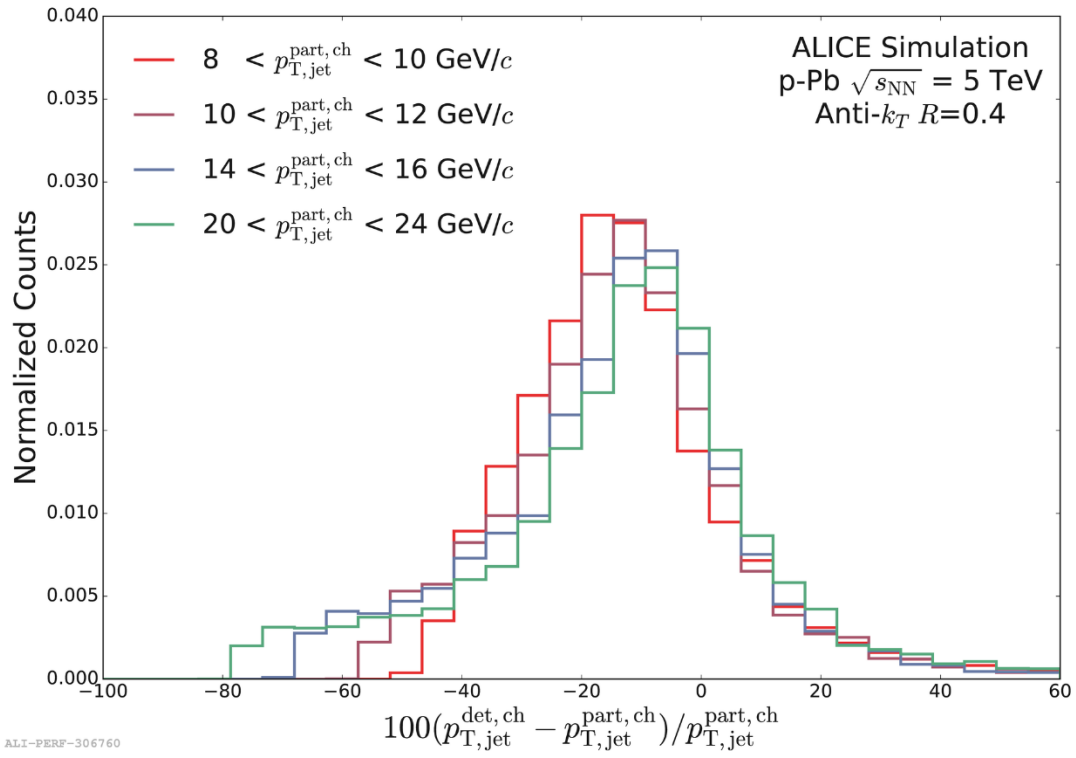
with purity (p) ~ 50%

Jet performance (new, ITS-only tracking)

2017 pp data

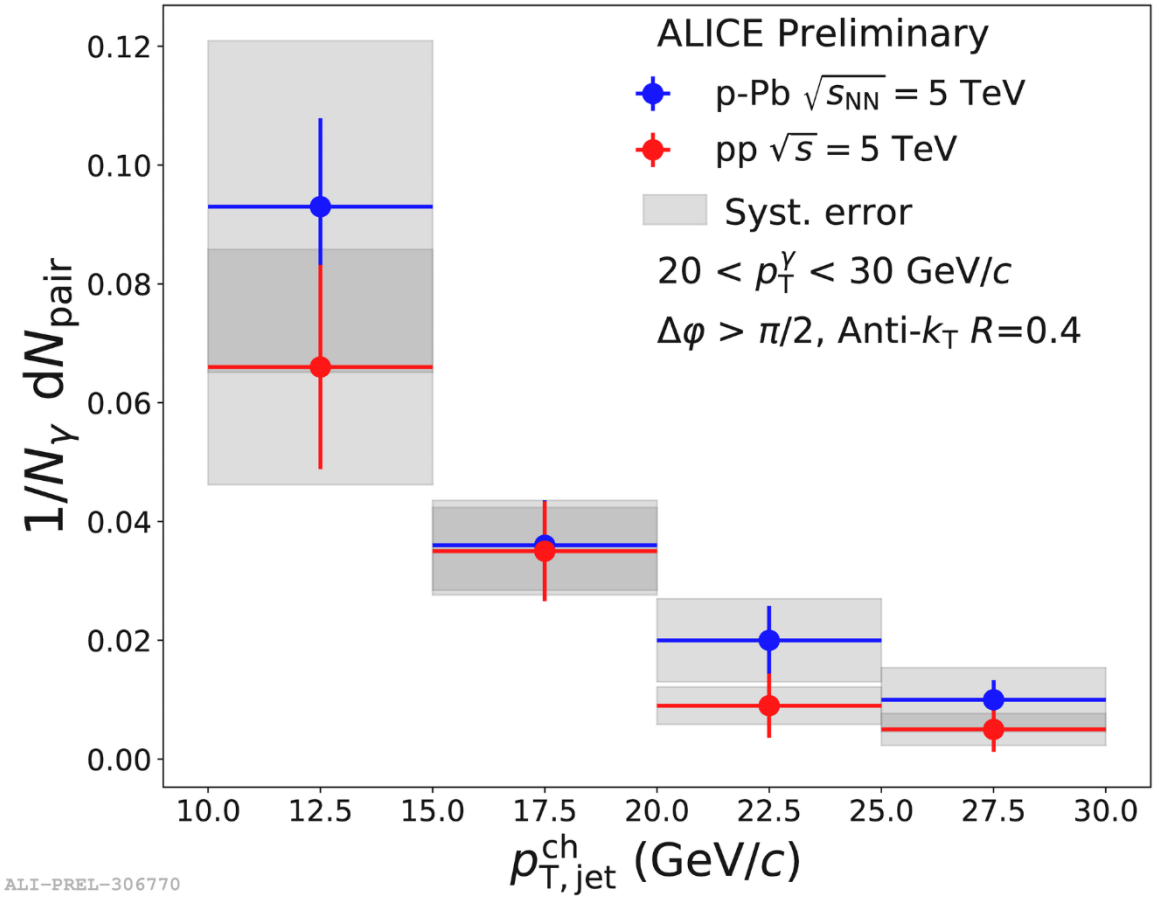


2013 p-Pb data



- Reconstructed jet unfolded to charged-particle level
- Jet energy resolution in 15—25% range
- Jet energy scale 13—16% range

Spectrum of jets recoiling to isolated photons



- No significant difference between pp and p-Pb data

Conclusions

- No significant difference is observed between pp and p-Pb measurements
- This result establishes a benchmark for photon identification and jet reconstruction for future measurements with ALICE

Future Outlook

- Measurement in Pb-Pb collisions
- Photon spectra and π^0+jet measurements (100 times more statistics)
- Exploit ALICE unique capabilities to access unexplored kinematics

Figure from EPPS16 paper

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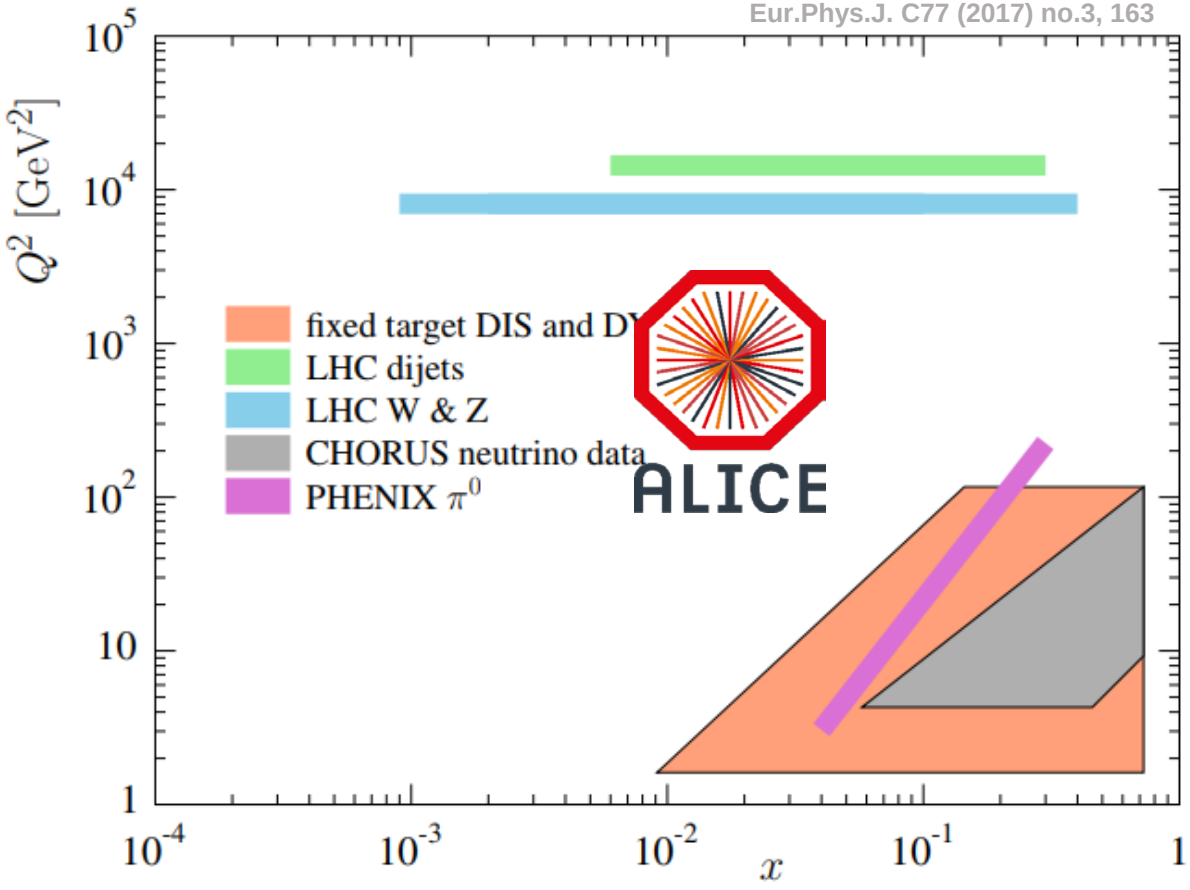
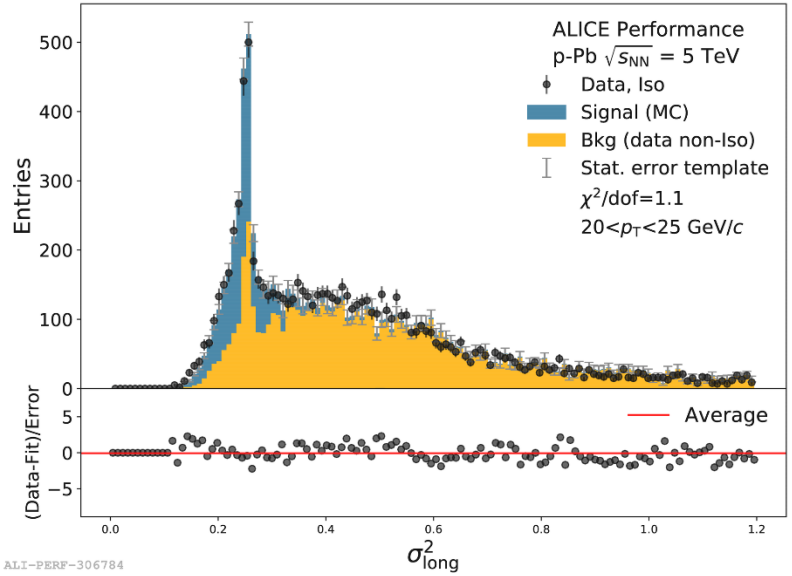
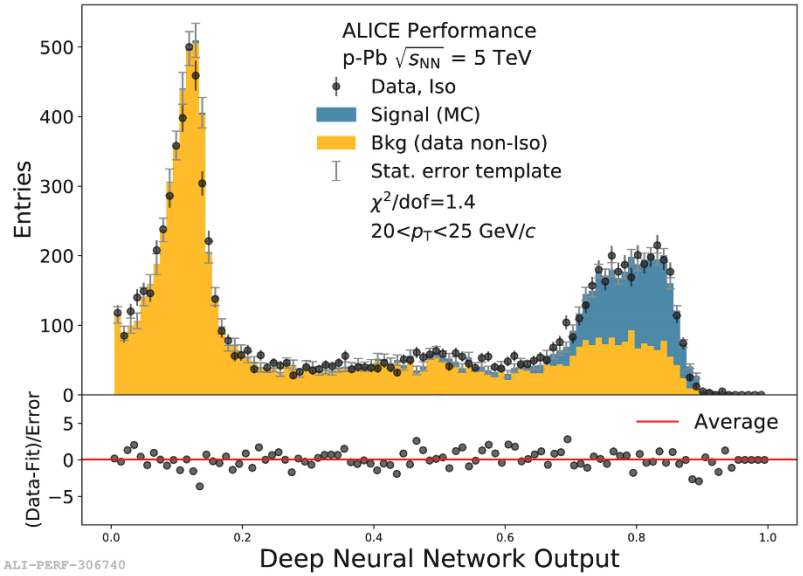
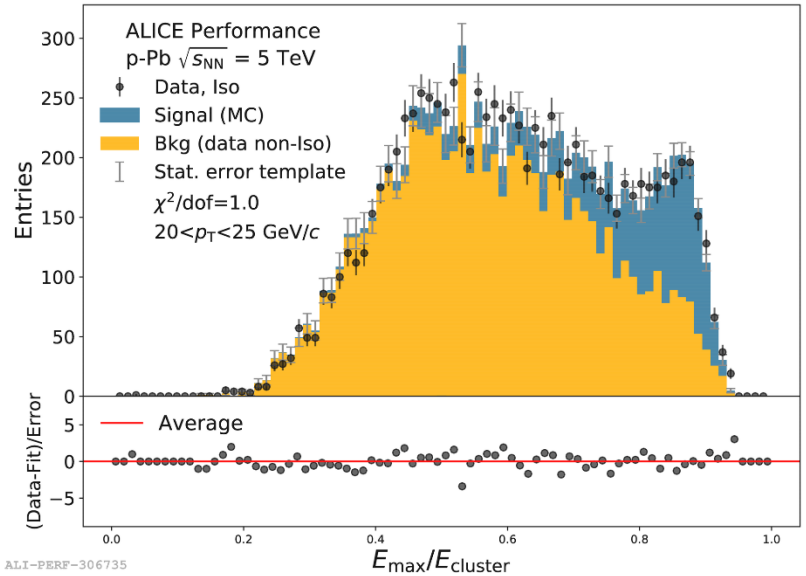
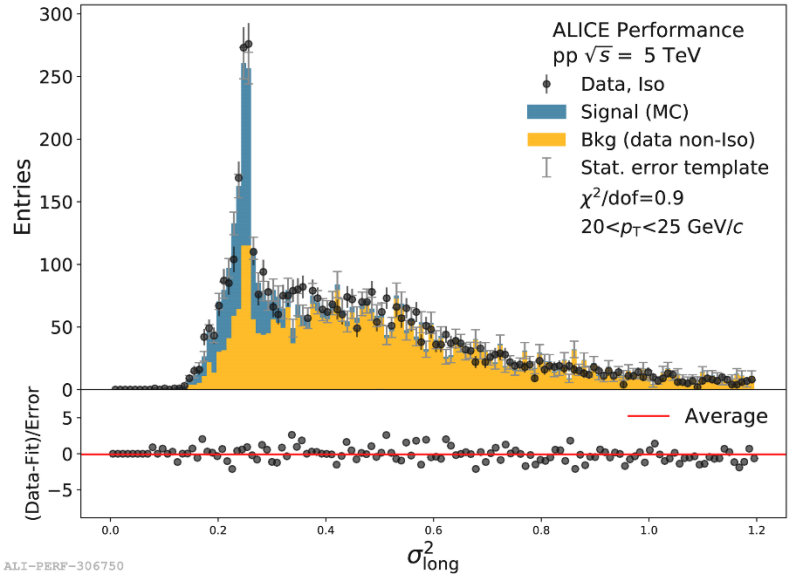


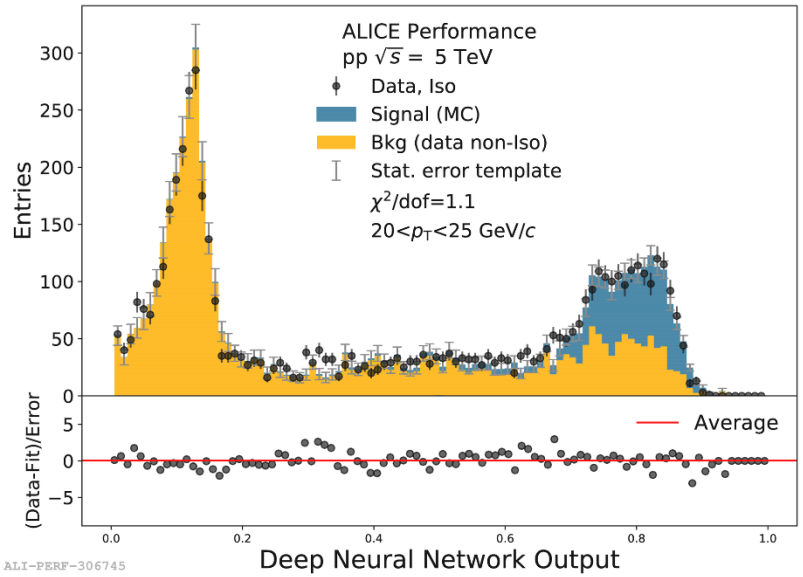
Backup Slides

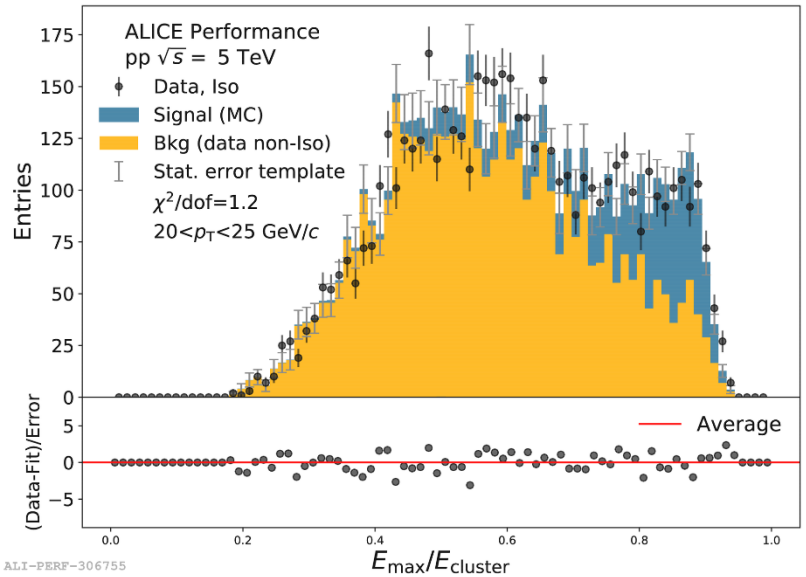

ALICE Performance
p-Pb $\sqrt{s_{NN}}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=1.1
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
σ^2_{long}
ALI-PERF-306784


ALICE Performance
p-Pb $\sqrt{s_{NN}}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=1.4
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
Deep Neural Network Output
ALI-PERF-306740


ALICE Performance
p-Pb $\sqrt{s_{NN}}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=1.0
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
$E_{max}/E_{cluster}$
ALI-PERF-306735


ALICE Performance
pp $\sqrt{s}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=0.9
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
σ^2_{long}
ALI-PERF-306750


ALICE Performance
pp $\sqrt{s}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=1.1
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
Deep Neural Network Output
ALI-PERF-306745


ALICE Performance
pp $\sqrt{s}$ = 5 TeV
Data, Iso
Signal (MC)
Bkg (data non-Iso)
Stat. error template
χ^2/dof=1.2
20<p_T<25 GeV/c
Entries
(Data-Fit)/Error
Average
$E_{max}/E_{cluster}$
ALI-PERF-306755

Fragmentation photons

Phys.Rev.D82:014015,2010