

# Spring with ALICE

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Working with  
Dr. Constantin Loizides and Friederike Bock



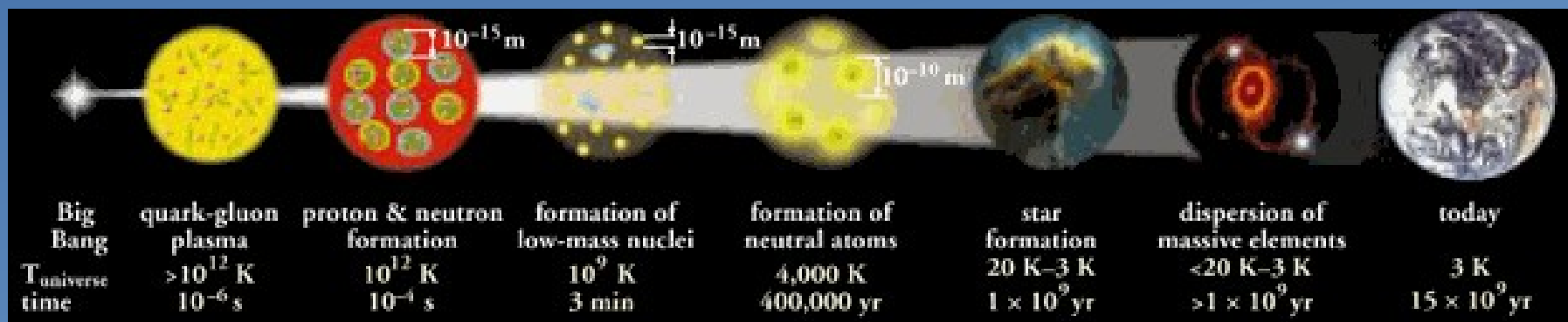
**ALICE**





# Motivation

- Looking at the very early universe
- Understanding the strong force
- Studying the interactions of quarks and gluons
- Discovering properties of the early universe matter
  - Quark Gluon Plasma (QGP)





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# Photons: most common observables

- Give a view of the quark gluon plasma
- Do not interact strongly
- Produced in a variety of ways

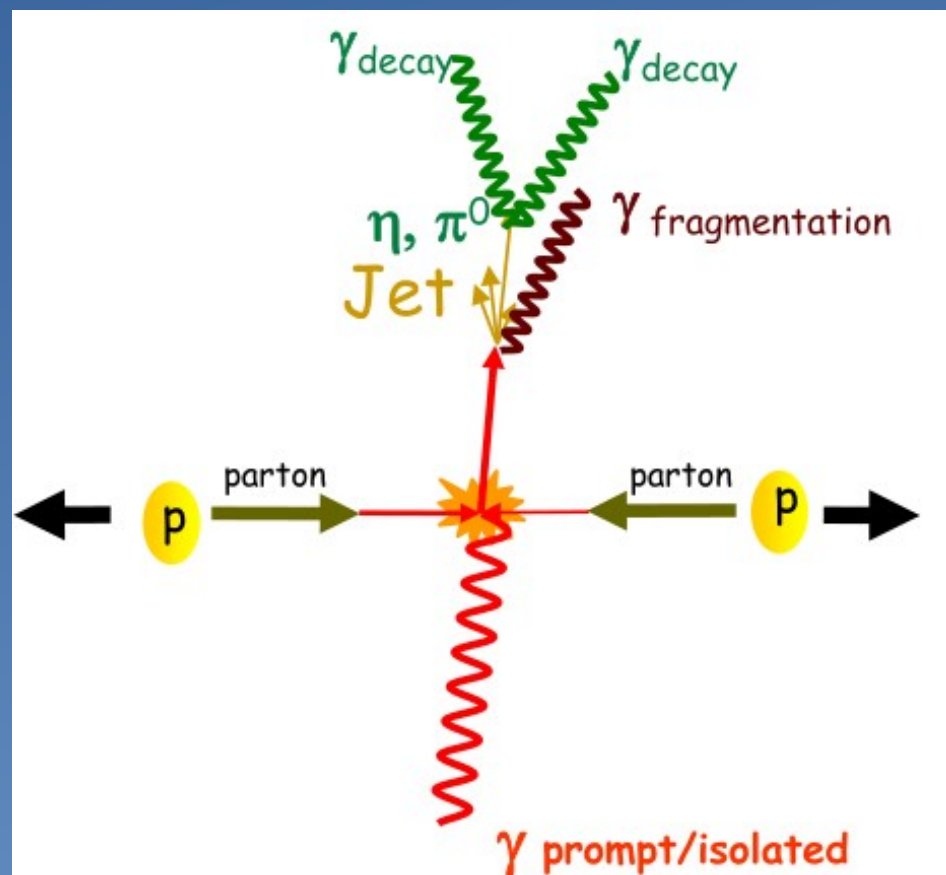


<http://images.clipartpanda.com/compound-clipart-13671574971923346275microscope.jpg>



# Sources of Photons

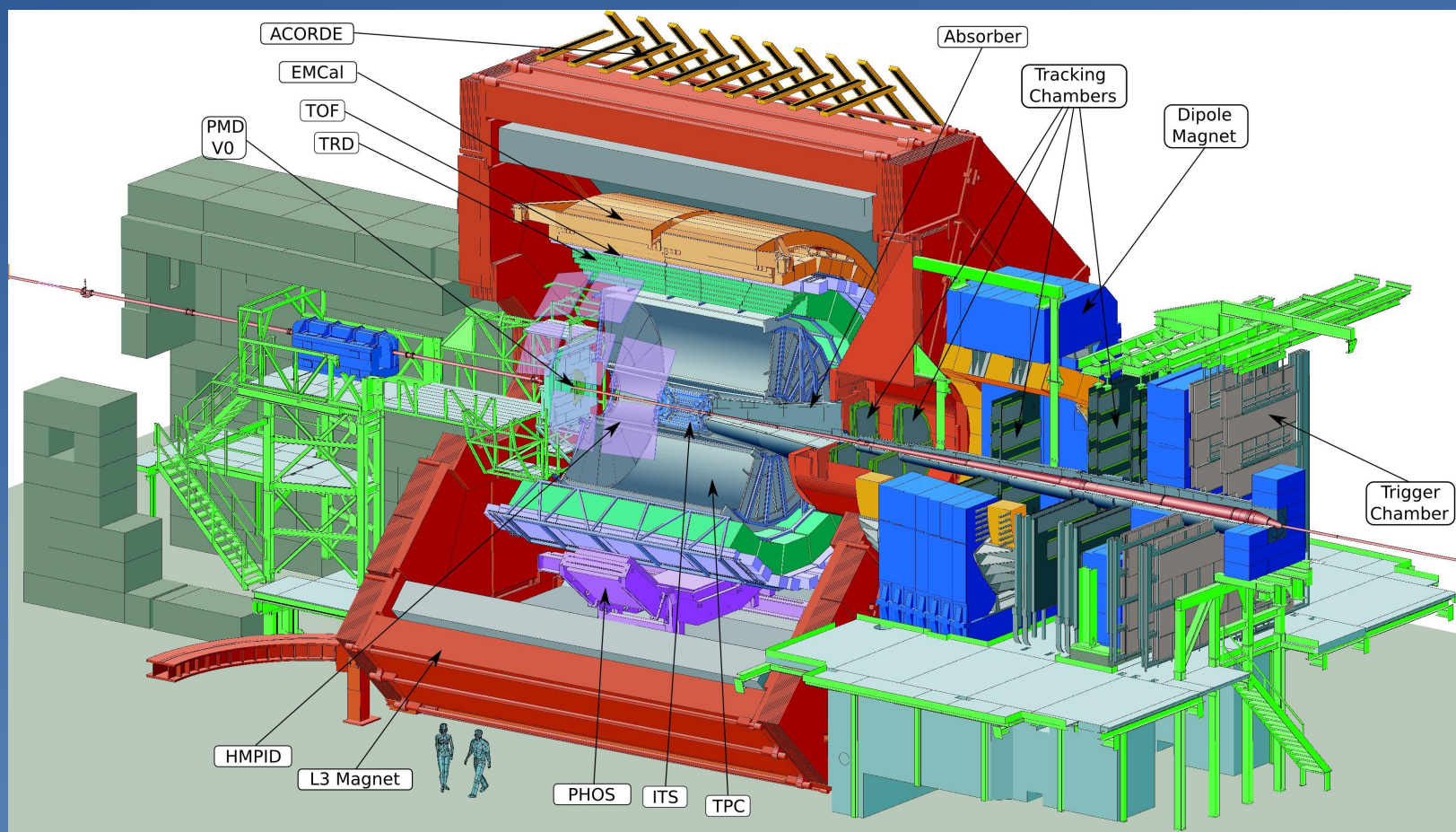
- Direct photons ← the kind we want to observe
  - Prompt photons
  - Thermal photons
  - Quark, gluon, and QGP interaction
- Background (meson decay photons)
  - $\eta$  meson
  - $\pi^0$  meson





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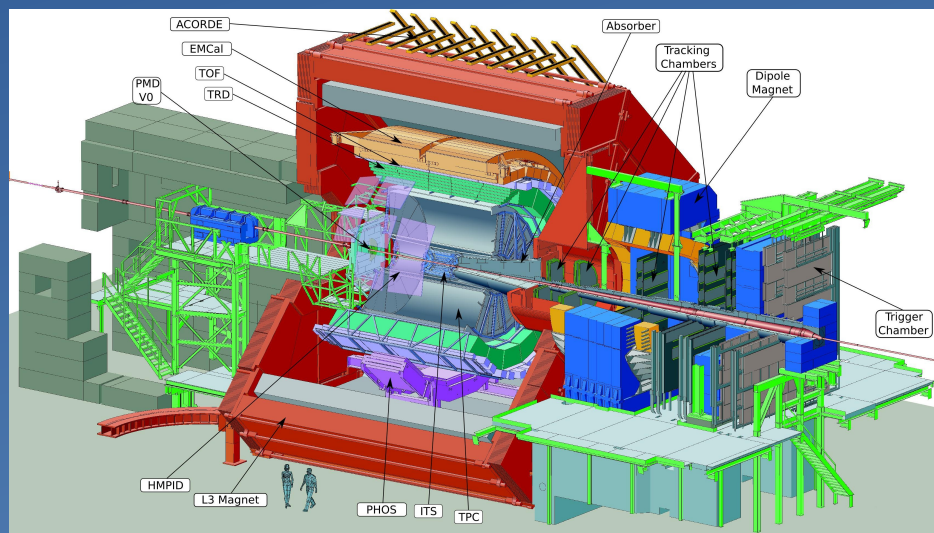
# ALICE - A Large Ion Collider Experiment



[http://inspirehep.net/record/1230338/files/figurer\\_alicepic.png](http://inspirehep.net/record/1230338/files/figurer_alicepic.png)



# Particle Tracking and Identification

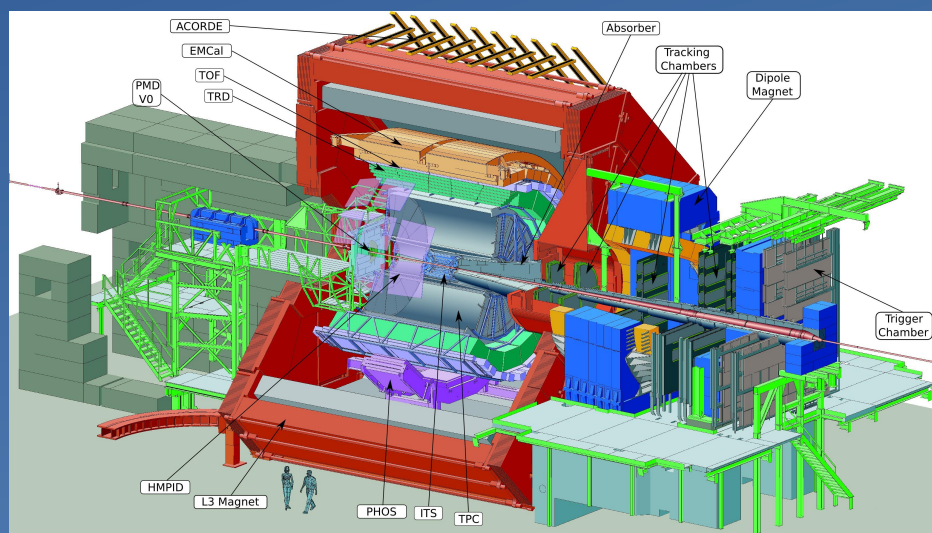


[http://inspirehep.net/record/1230338/files/figurer\\_alicepic.png](http://inspirehep.net/record/1230338/files/figurer_alicepic.png)

- Inner Tracking System
- Time Projection Chamber
- Time Of Flight
- High Momentum Particle Identification
- Transition Radiation Detector



# Particle Energy Measurement



[http://inspirehep.net/record/1230338/files/figurer\\_alicepic.png](http://inspirehep.net/record/1230338/files/figurer_alicepic.png)

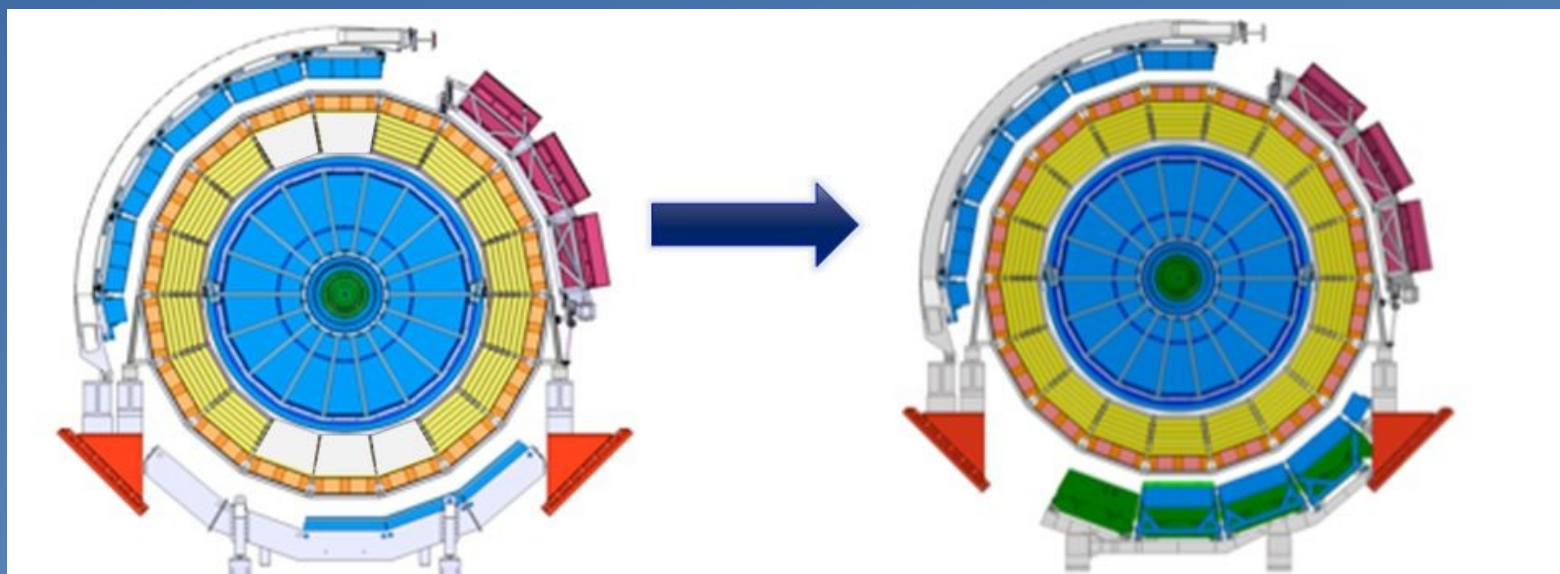
- Photon Spectrometer (PHOS)
  - $\text{PbWO}_4$  crystals
  - Higher Granularity
- Electromagnetic Calorimeter (EMCal)
  - Alternating layers
  - Sampling calorimeter
- Di-Jet Calorimeter (DCal)
  - Similar to the EMCal



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# Adding the DCal

- A smaller EMCal
- Added for LHC run 2
- Analysis framework in progress



[http://images.slideplayer.com/27/9099404/slides/slide\\_4.jpg](http://images.slideplayer.com/27/9099404/slides/slide_4.jpg)



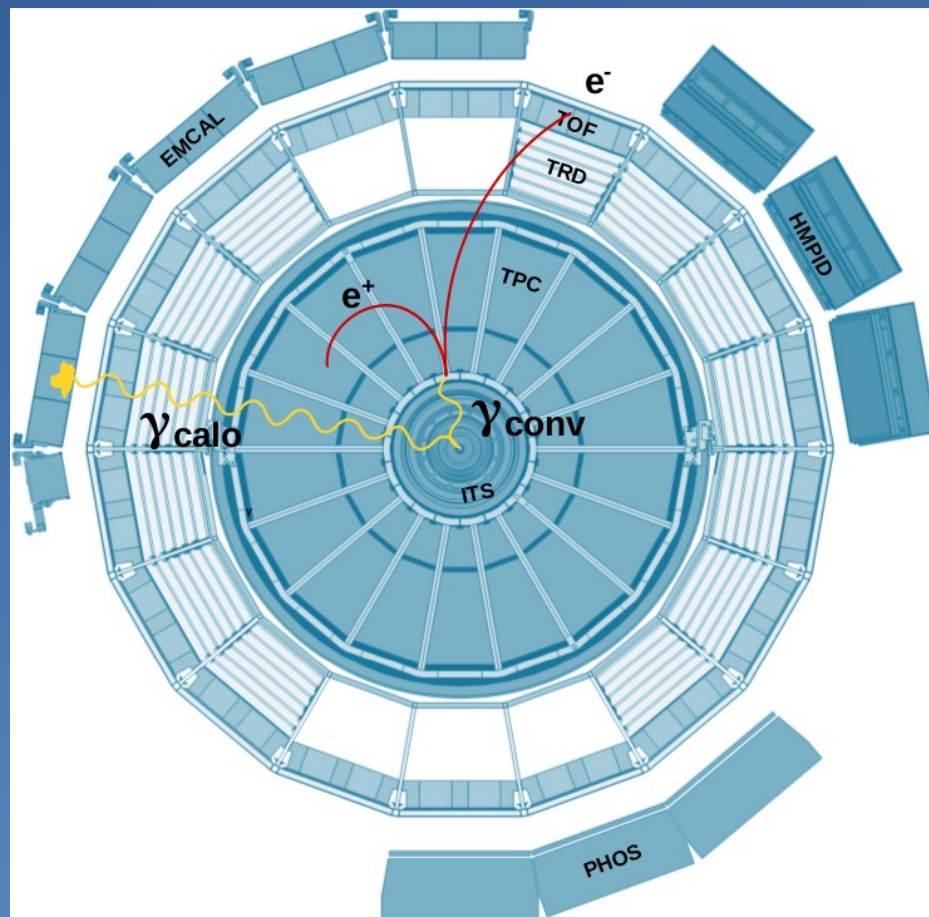
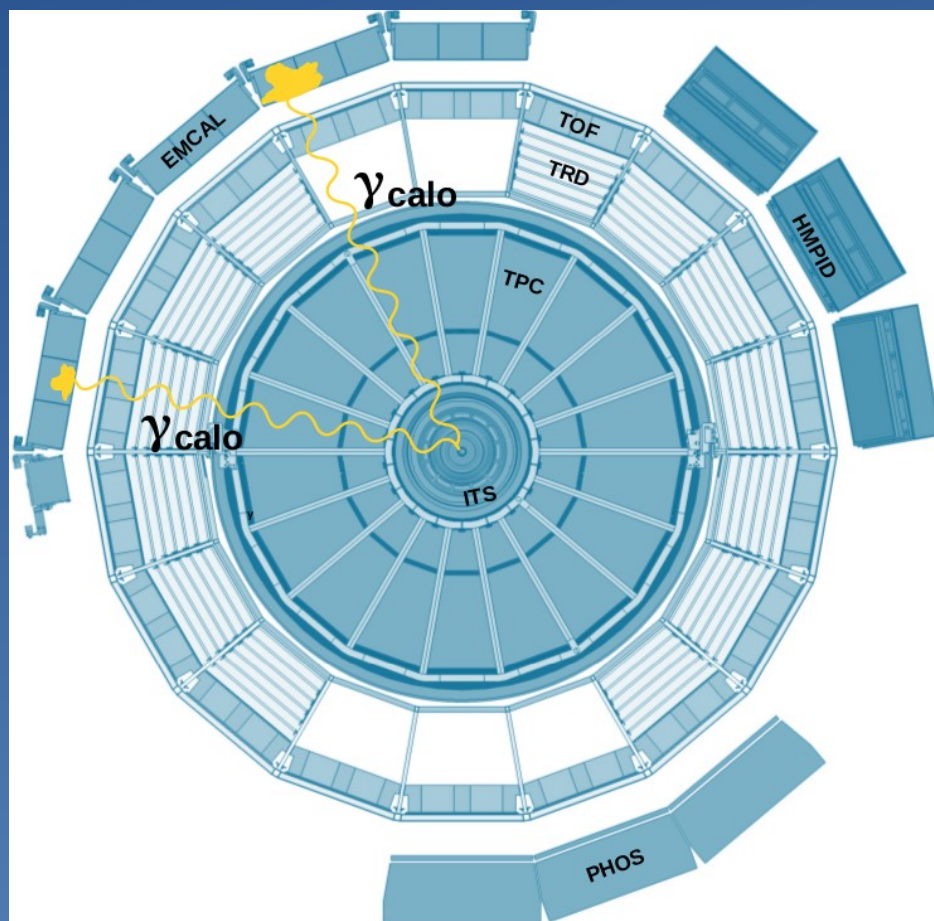


# Goals

- Photon reconstruction
- $\pi^0$  mass spectrum for EMCAL calibration
- Expand current analysis framework to include the Dcal
- Contribute to detector functionality and maintenance as EMCAL on call



# Photon Reconstruction



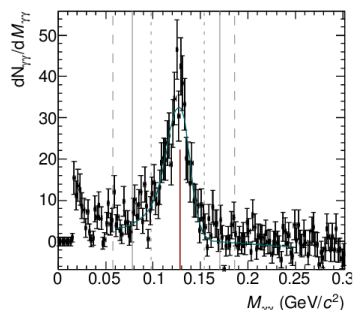
- Photon conversion method (PCM): using an  $e^+$  and  $e^-$  pair to make a photon
- Different combinations of PCM, EMCal, DCal, and PHOS
- Calorimeter and Track veto



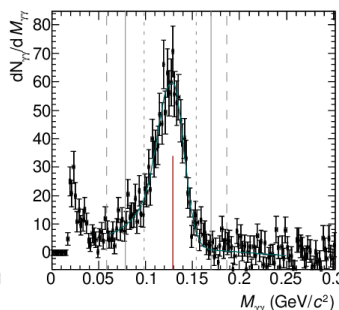
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# $\pi^0$ mass spectrum for various $p_T$

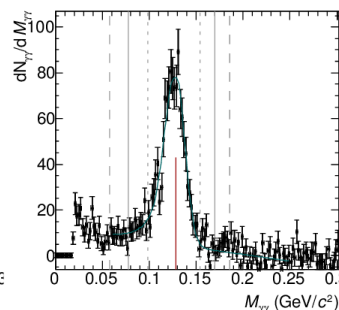
1.40 GeV/c <  $p_T$  < 1.60 GeV/c



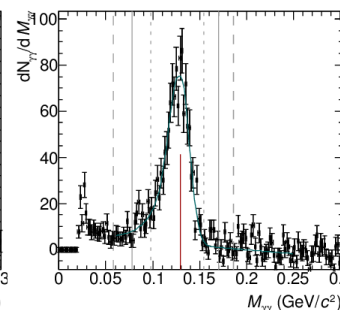
1.60 GeV/c <  $p_T$  < 1.80 GeV/c



1.80 GeV/c <  $p_T$  < 2.00 GeV/c



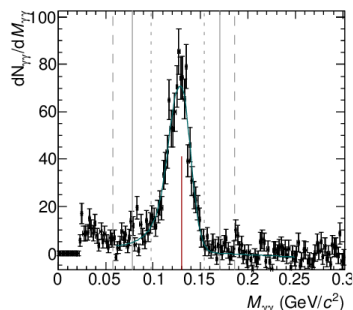
2.00 GeV/c <  $p_T$  < 2.20 GeV/c



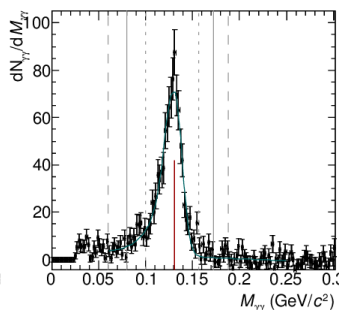
### ALICE performance

1<sup>st</sup> Mar 2016  
pp,  $\sqrt{s} = 2.76$  TeV  
 $\pi^0 \rightarrow \gamma\gamma$   
 $\gamma$ 's rec. with EMCal  
Data: 1.5e+07 events  
♦ mixed evt. subtr.  $M_{\gamma\gamma}$   
— Fit

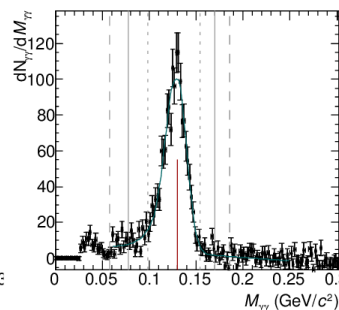
2.20 GeV/c <  $p_T$  < 2.40 GeV/c



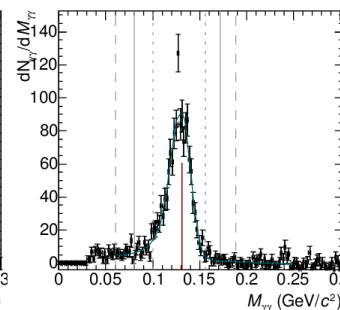
2.40 GeV/c <  $p_T$  < 2.60 GeV/c



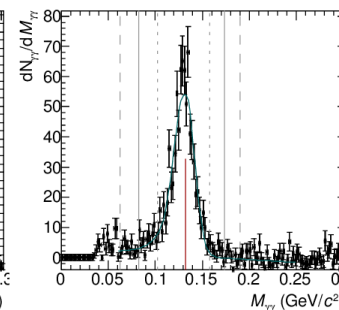
2.60 GeV/c <  $p_T$  < 3.00 GeV/c



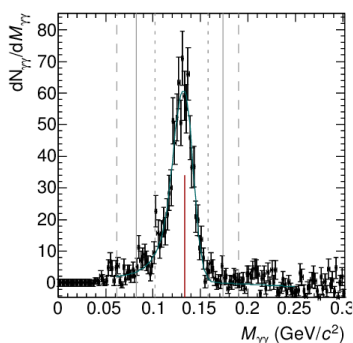
3.00 GeV/c <  $p_T$  < 3.50 GeV/c



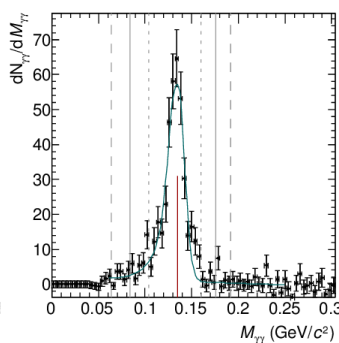
3.50 GeV/c <  $p_T$  < 4.00 GeV/c



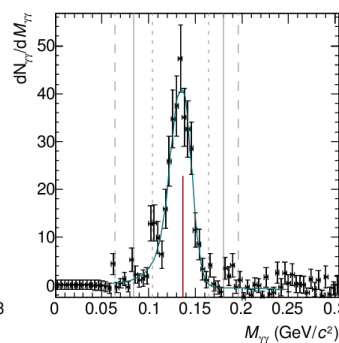
4.00 GeV/c <  $p_T$  < 5.00 GeV/c



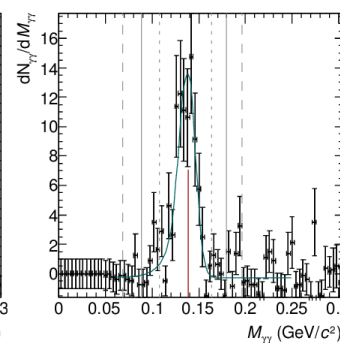
5.00 GeV/c <  $p_T$  < 6.00 GeV/c



6.00 GeV/c <  $p_T$  < 8.00 GeV/c



8.00 GeV/c <  $p_T$  < 10.00 GeV/c

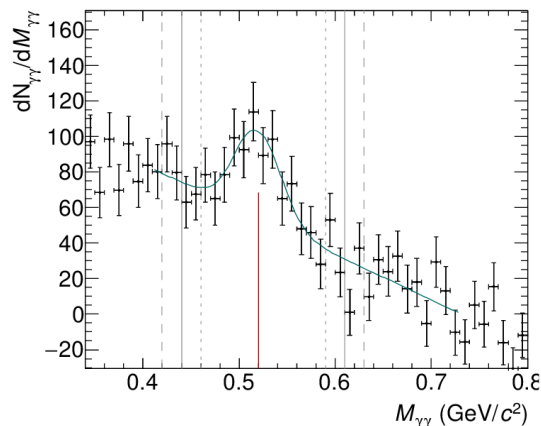


Work in progress

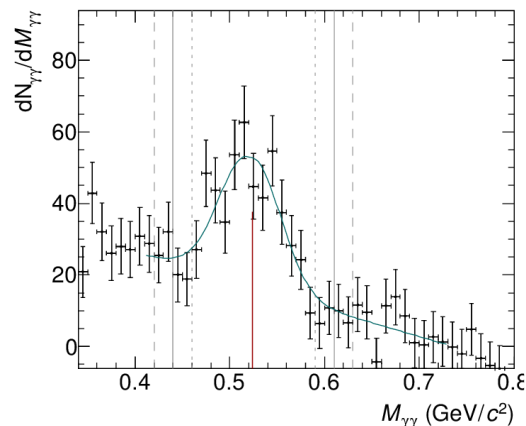


# $\eta$ mass spectrum for various $p_T$

2.00 GeV/c <  $p_T$  < 3.00 GeV/c



3.00 GeV/c <  $p_T$  < 4.00 GeV/c



ALICE performance

1<sup>st</sup> Mar 2016

pp,  $\sqrt{s} = 2.76$  TeV

$\eta \rightarrow \gamma\gamma$

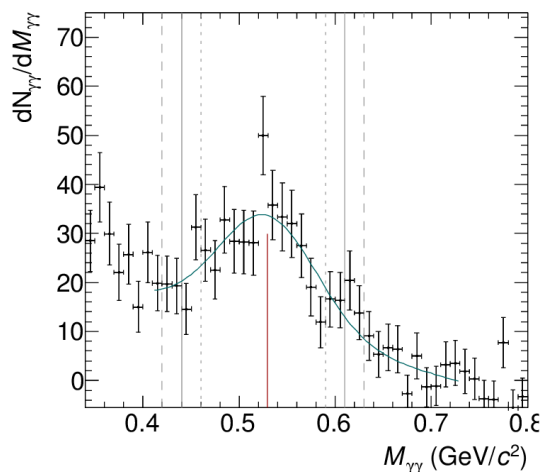
$\gamma$ 's rec. with EMCal

Data: 1.5e+07 events

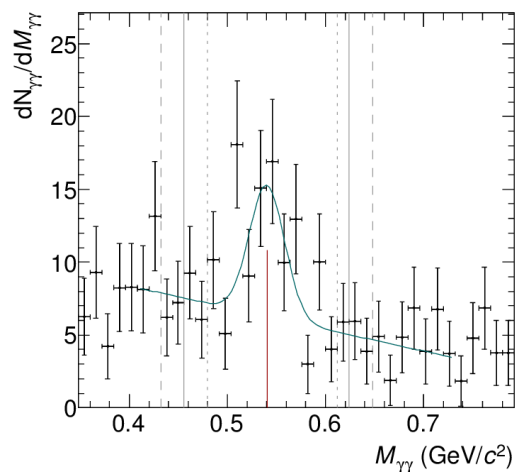
♦ mixed evt. subtr.  $M_{\gamma\gamma}$

— Fit

4.00 GeV/c <  $p_T$  < 6.00 GeV/c



6.00 GeV/c <  $p_T$  < 8.00 GeV/c



Work in progress



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# EMCal on call shifts

- Responsible for EMCal functioning and maintenance during the run
- Resolve and assist central shifters with EMCal errors during run
- Hands on hardware experience with detector electronics



<http://alicematters.web.cern.ch/sites/alicematters.web.cern.ch/files/images/installation2.JPG>



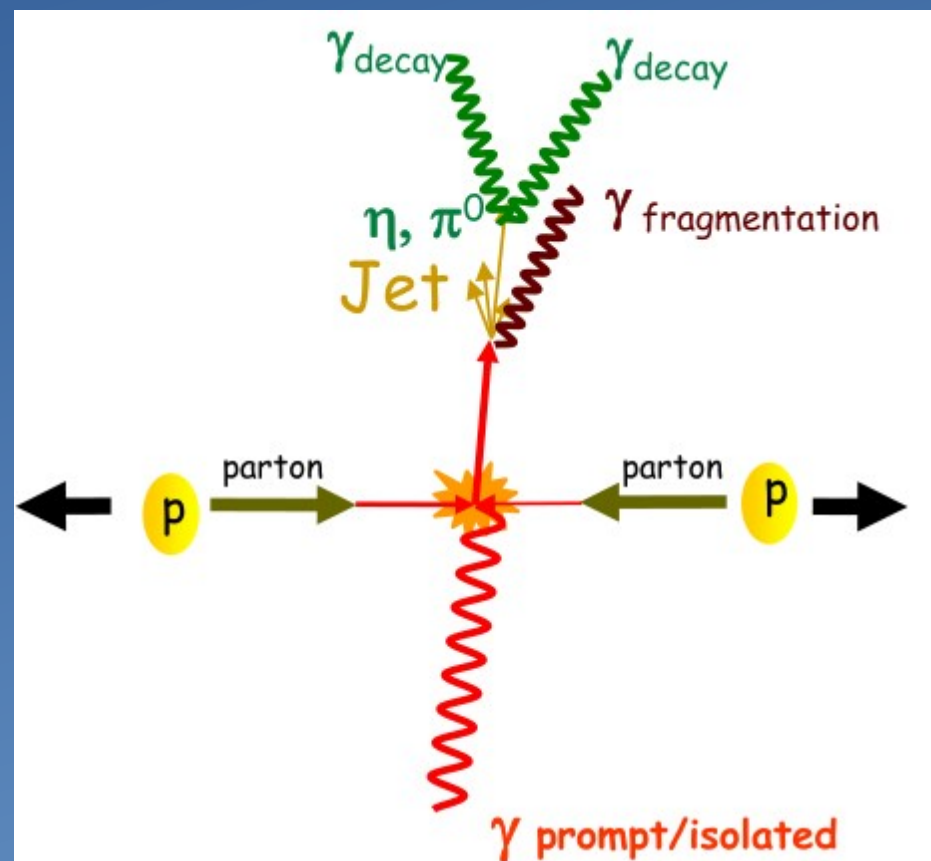
# Summary

- Learned ALICE analysis framework
  - AliRoot
  - AliPhysics
- Improved the meson and photon reconstruction
- $\pi^0$  mass extraction and background subtraction function
- Documenting EMCAL analysis framework
- EMCAL on call trainings and shifts



# Future works

- Finish DCal analysis framework
- EMCal calibrations using the  $\pi^0$  spectrum
- EMCal on call shifts
- Build towards photon-jet correlation analysis



# Other adventures

