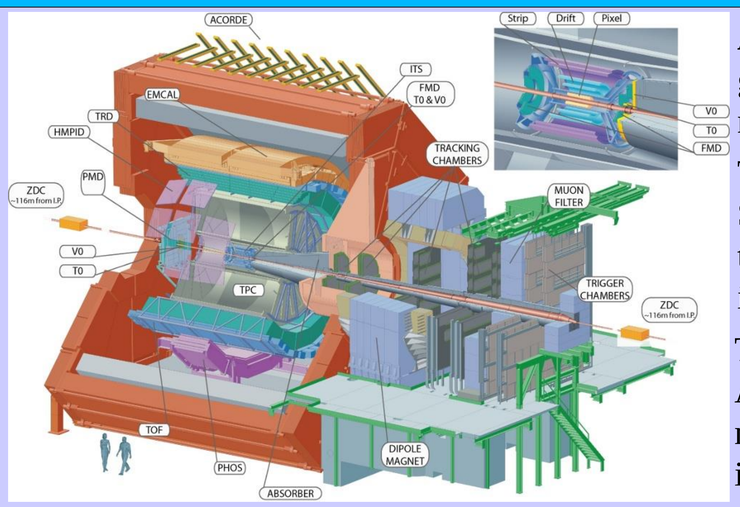
Neutral pion production in pp and Pb-Pb collisions at LHC energies

Dmitry Blau

For the ALICE collaboration

NRC «Kurchatov Institute», Moscow, Russia

ALICE experiment and PHOS spectrometer



ALICE (A Large Ion Collider Experiment) is a heavy-ion experiment at LHC (CERN). Its main goal is to study strongly interacting matter at extreme energy densities where the formation of a new state of matter, the quark-gluon plasma, is expected.

Team of NRC "**Kurchatov Institute**" lead the R&D, installation and commissioning of Photon Spectrometer (**PHOS**) at ALICE. PHOS successfully participated in Run1 of LHC (years 2009 to 2013) and collected large amount of data. One of the most interesting result built on this data is the **neutral meson production** in pp and A-A collisions at the LHC energies.

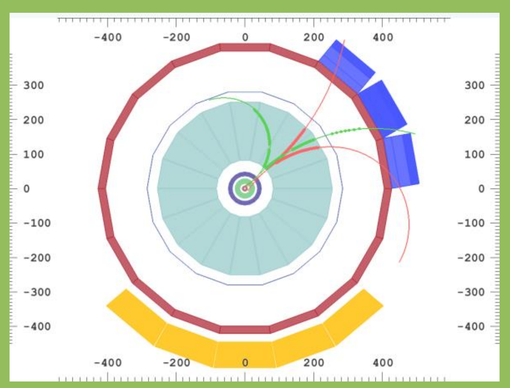
Time Projection Chamber (TPC) and The Inner Tracking System (ITS) are a parts of the ALICE tracking system developed for the measurements of charged particles energy and momentum. Together with other ALICE detectors they provide remarkable particle identification capabilities.

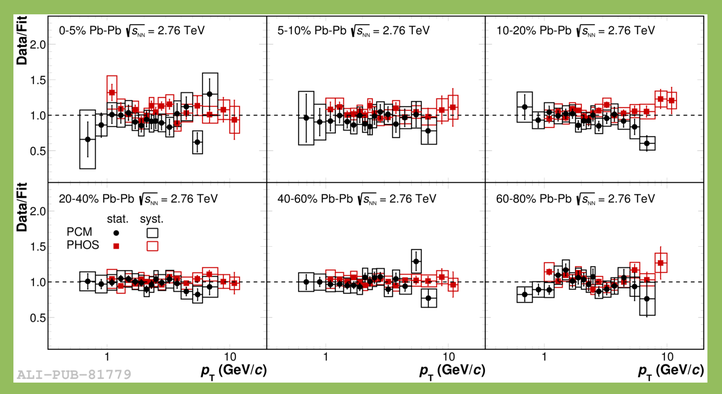
PHOS is a highly granulated electromagnetic calorimeter based on lead tungstate crystals (**PWO**). In Run1 it included 3 modules with 10752 detection channels in total. It is installed at the distance to IP equal to 460 cm and covers $\Delta\varphi$=60° in azimuth and $|\eta|$<0.13 in pseudorapidity. PHOS dynamic range is approximately 0.1-100 GeV. More information about PHOS performance in Run1 can be found in the poster "Performance of the ALICE/PHOS in the LHC Run1" by Mikhail Ippolitov.

Neutral pion analysis in ALICE

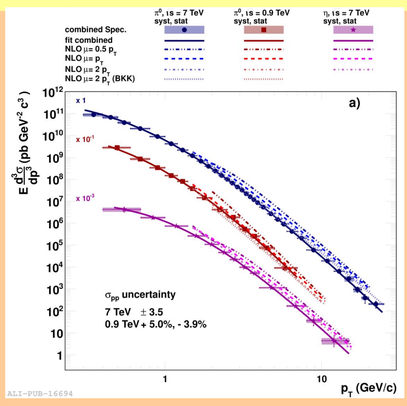
Why neutral pions?

- Inclusive spectra of identified hadrons (especially in pp collisions) are a good probe of **pQCD**:
  - ✓ π^0 can be measured in ALICE in wide p_T range via its two-photon decay
  - ✓ At LHC energies PDF and FF could be measured at x and z unavailable for previous generations of particle accelerators. This could provide new constrains for pQCD theories.
  - ✓ At LHC gluon fragmentation dominates at p_T < 100 GeV/c. Gluon fragmentation studies are possible!
- Precise measurements of neutral meson spectra are **crucial for direct photon analysis** (providing decay photon background) as well as for quarkonia spectra.
- Neutral meson spectra and R_{AA} in A-A collisions could help to test predictions of various models which describe energy losses in the hot and dense matter.

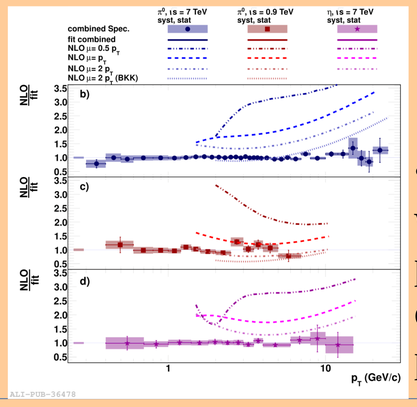




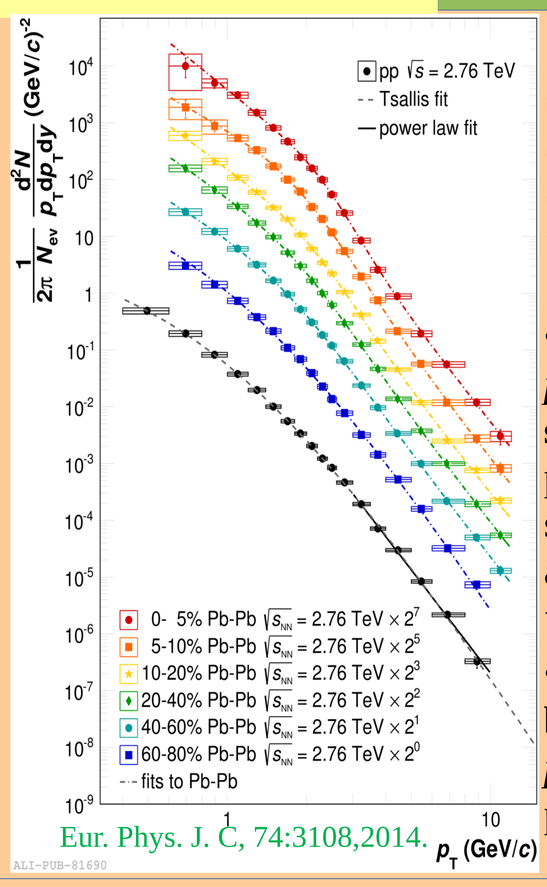
- ALICE provides two independent methods for measurement of neutral pions: with **PHOS spectrometer** and **Photon Conversion Method** using electron-positron pairs from photon conversion on central tracking system of ALICE. Neutral pion spectra measured with both methods agree within uncertainties. PCM method has better uncertainties at lower p_T while PHOS has better possibilities at high p_T.



Phys. Lett. B, 717:162–172, 2012.

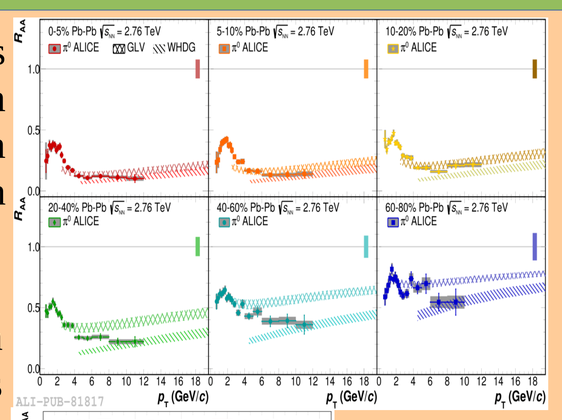


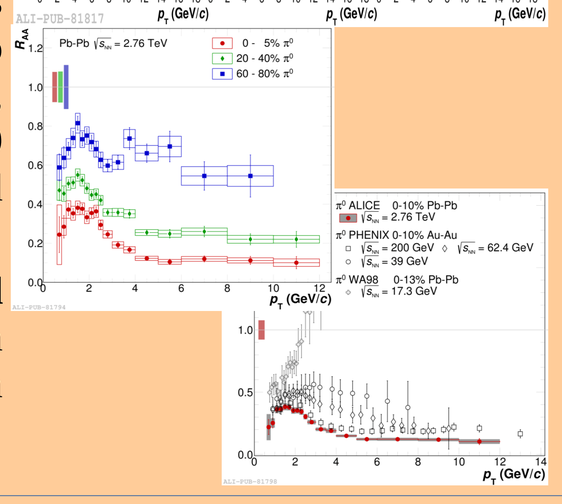
- Spectra of neutral pions measured by ALICE (combined PHOS and PCM) in:
  - ✓ **pp** collisions at **900 GeV, 2.76 and 7 TeV** (left),
  - ✓ Different centrality classes **Pb-Pb** collisions at **2.76A TeV** (right)
- Spectra were fitted with Tsallis parametrization and compared to pQCD prediction.



Eur. Phys. J. C, 74:3108,2014.

- **Nuclear modification factor R_{AA}** is defined as the ratio of particle spectrum at A-A collisions to the particle spectrum at pp collisions normalized to the mean number of binary nucleon collisions.
- π^0 spectrum at $\sqrt{s_{NN}}$=2.76 TeV at high p_T and the most central collisions is **suppressed by ~10 times** with respect to pp collisions (properly scaled), suppression is stronger than at $\sqrt{s_{NN}}$=39 and $\sqrt{s_{NN}}$=200 GeV at PHENIX and $\sqrt{s_{NN}}$=17.3 GeV at WA98.
- Experimental data are **well reproduced by GLV and WHDG models** (at high p_T) in central collisions while in peripheral the agreement is worse.





Conclusions

- Neutral pion spectra were measured by ALICE in wide p_T range with two independent methods (PHOS and PCM) in pp collisions at $\sqrt{s}$=0.9, 2.76 and 7 TeV. Theoretical predictions are consistent with data at 0.9 TeV, but overpredict yield at higher energies.
- Neutral pion spectra and nuclear modification factor R_{AA} were measured by ALICE in wide p_T range for 6 centrality classes also with two independent methods in Pb-Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV. Comparison to the results of previous experiments and to the predictions of several alternative theoretical models is made.
- Anticipating new results on neutral pion production at p-Pb collisions at $\sqrt{s_{NN}}$=5.02 TeV, results in pp collisions at $\sqrt{s_{NN}}$=8 and 13 TeV and extended p_T range at Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV based on larger statistics collected in year 2011.

The Third Annual Large Hadron Collider Physics Conference

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