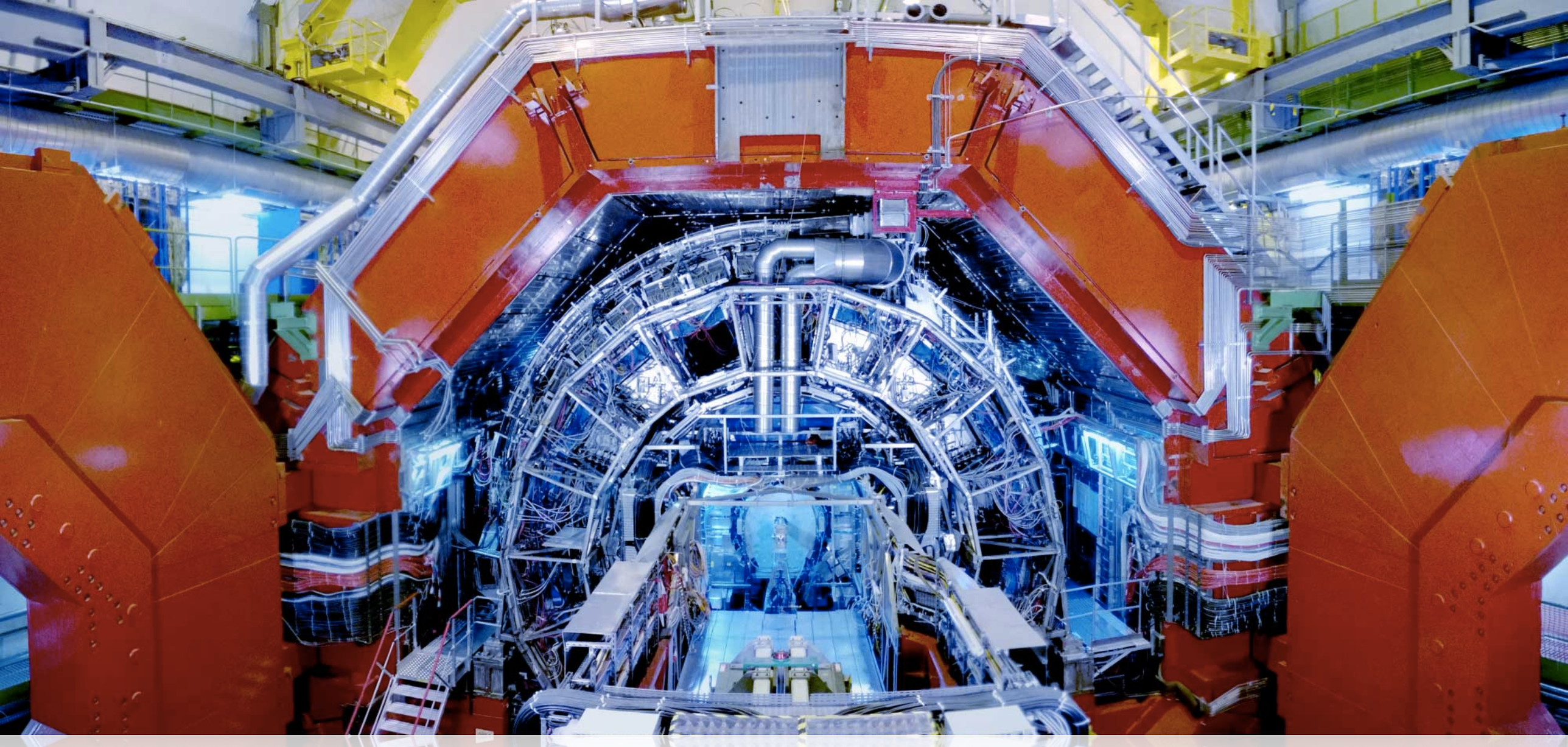


Produzione di deutone e anti-deutone a LHC con l'esperimento ALICE

Maximiliano Puccio

on behalf of ALICE collaboration

Università & INFN Torino

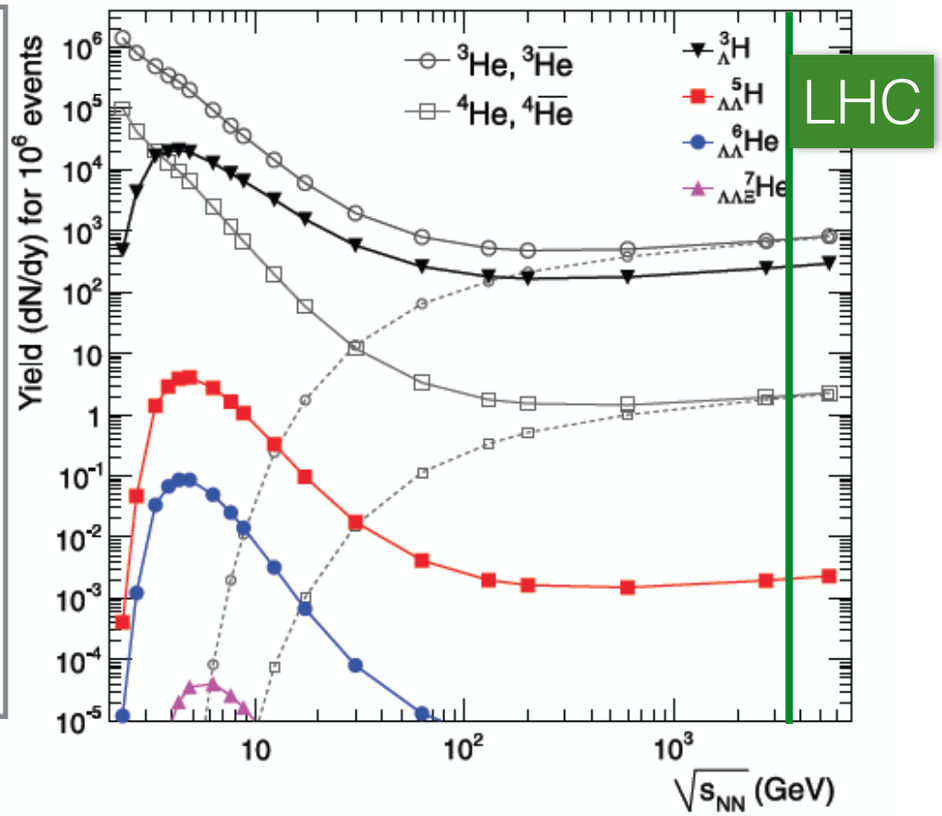
Incontri di Fisica delle Alte Energie Tor Vergata 8-10 Aprile 2015

Nuclei production: theoretical approaches

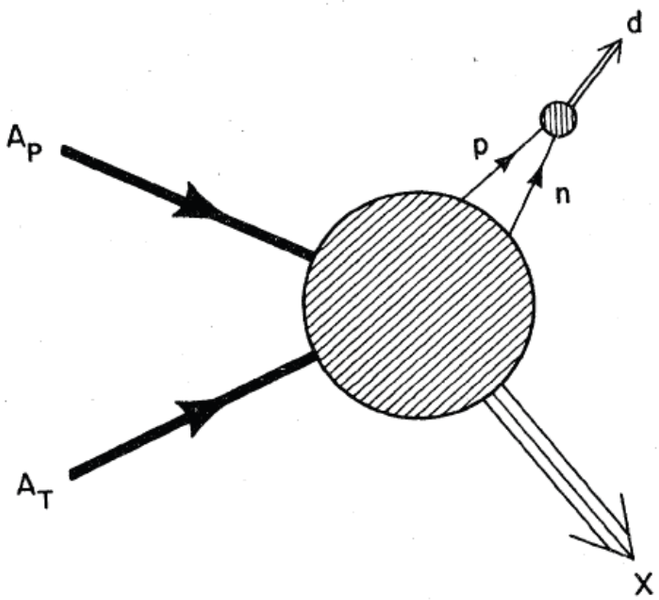
Thermal models

- Hadrons emitted from the interaction region in the statistical equilibrium when the fireball reaches limiting temperature
- Abundances fixed at chemical freeze-out
- Freeze-out temperature T_{chem} is a key parameter
- Abundance of a species $\propto \exp(-m/T_{chem})$:

➡ For nuclei (large m) strong dependence from T_{chem}



A. Andronic, P. Braun-Munzinger, J. Stachel and H. Stoecker, Phys. Lett. B607, 203 (2011), 1010.2995



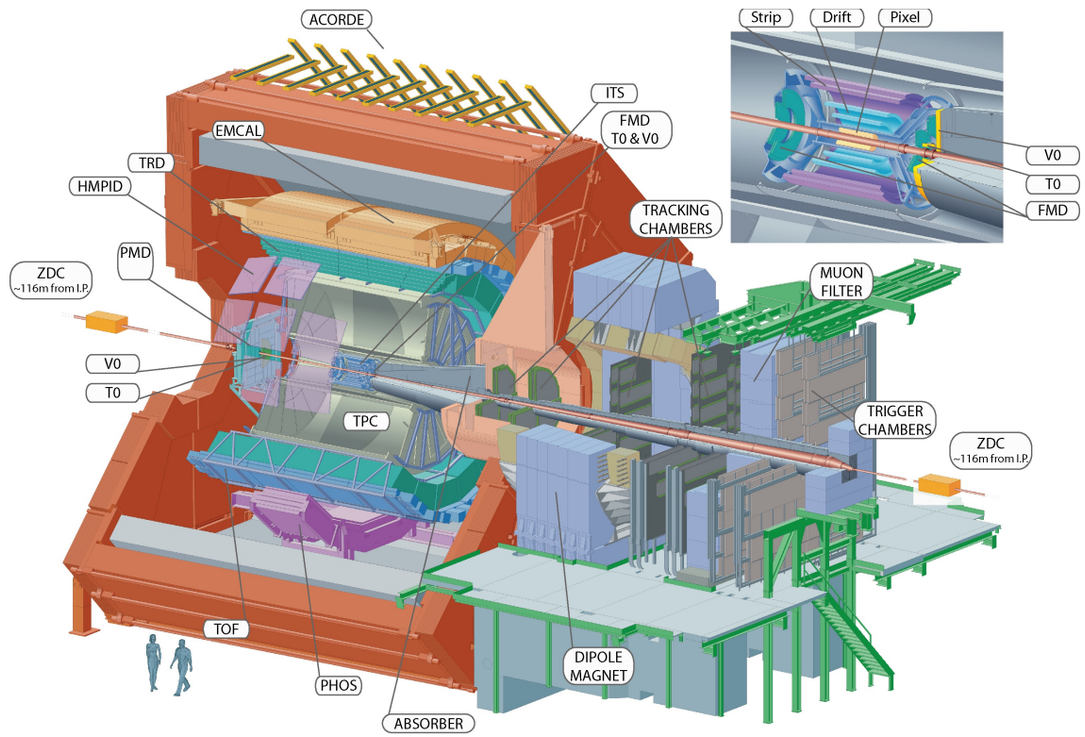
Coalescence models

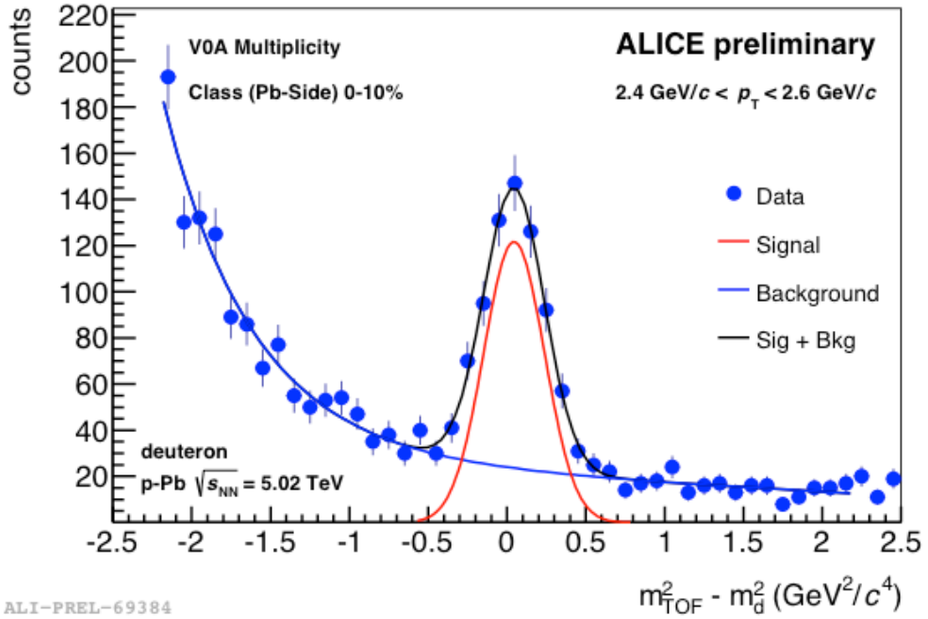
- If (anti-)baryons are close in the phase space after the kinetic freeze-out they can form a (anti-)nucleus
- (Anti-)nuclei produced at the chemical freeze-out might break during re-scattering and re-form at kinetic freeze-out

J. I. Kapusta, Phys.Rev. C21, 1301 (1980)

ALICE PID performance

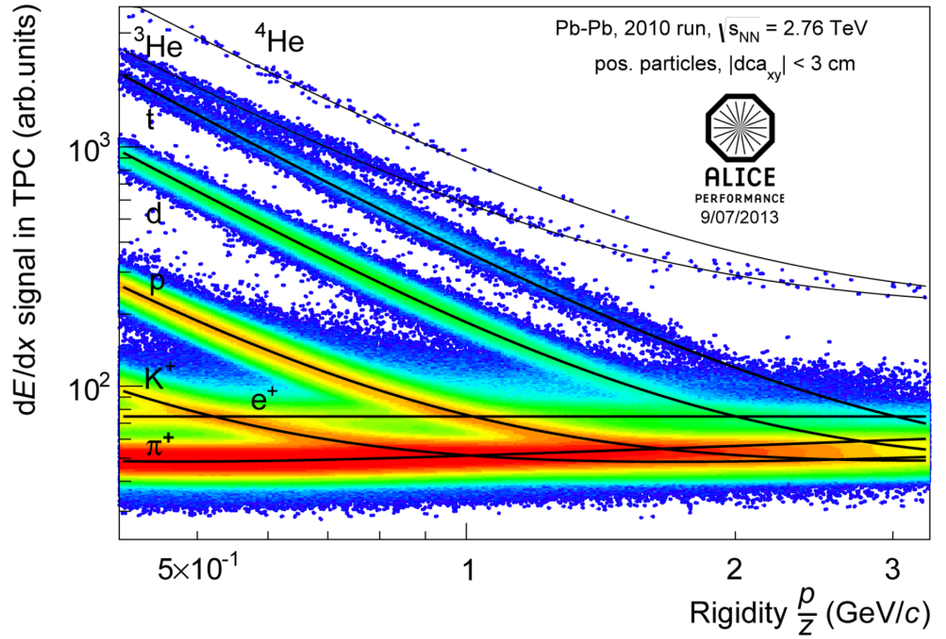
- General purpose heavy ion experiment
- Excellent PID capabilities and low material budget
- ➡ Most suited detector at the LHC for the studies of nuclei produced in the collisions





At p_T > 1.4 GeV/c the PID is done using TOF to measure the β of the particle.

- ➡ $\sigma_{\text{time-of-flight}}$ ~ 85 ps (in Pb-Pb collisions)



At $p_T \leq$ 1.4 GeV/c the TPC energy loss provides an excellent PID for deuterons

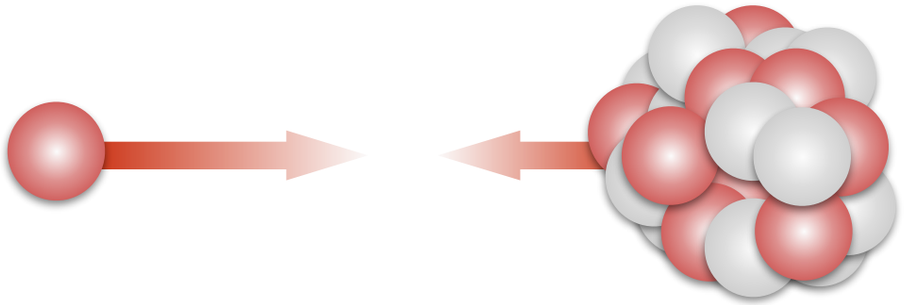
- ➡ $\sigma_{dE/dx}$ ~ 7% (in Pb-Pb collisions)

Collision systems at the LHC

p-p

$\sqrt{s}$	$\mathcal{L}_{INT}$
0.9 TeV	0.33 nb^{-1}
2.76 TeV	46 nb^{-1}
7 TeV	**5.4 pb^{-1}**
8 TeV	9.7 pb^{-1}

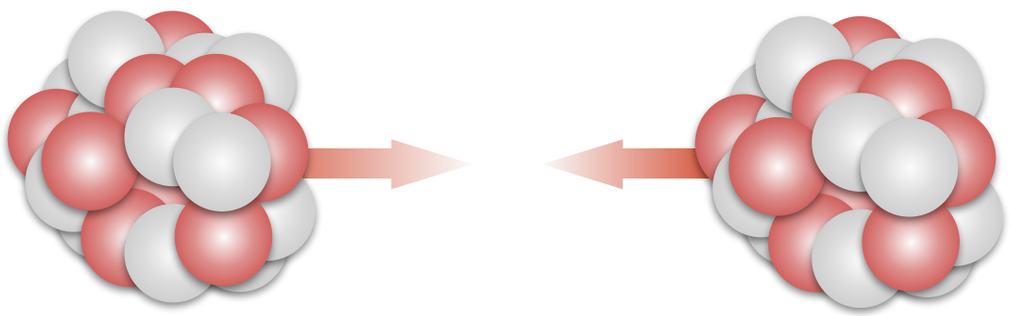
Reference for measurement in other systems



p-Pb
Pb-p

$\sqrt{s_{NN}}$	$\mathcal{L}_{INT}$
5.02 TeV	**15 nb^{-1}**
5.02 TeV	**17 nb^{-1}**

Study of nuclear matter effects



Pb-Pb

$\sqrt{s_{NN}}$	$\mathcal{L}_{INT}$
2.76 TeV	**155 μb^{-1}**

Study of hot and dense QCD matter

Three collision systems: unique opportunity to probe our knowledge of hadronisation and strong interaction at extreme regimes of energy density

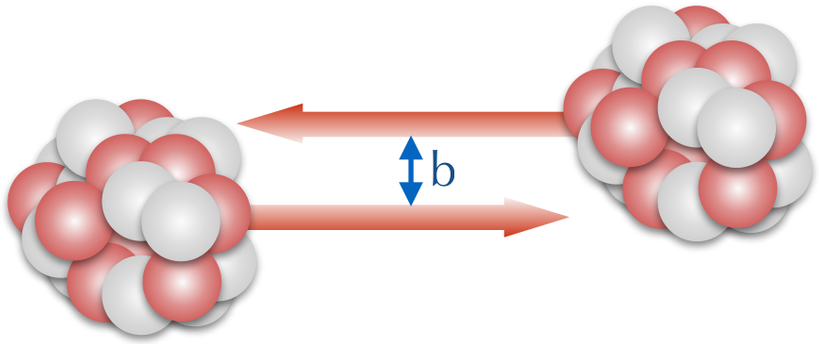
Centrality of a collision

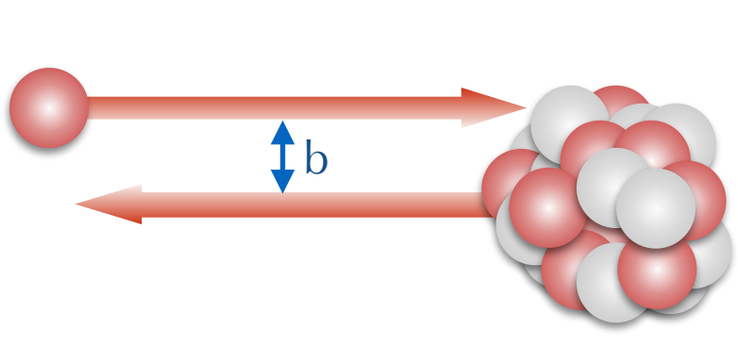
The centrality of a collision is defined by the impact parameter vector ***b***:

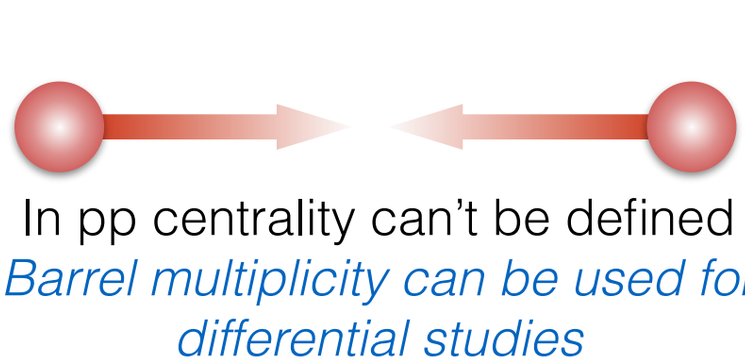
Most central collision ⇔ *Smallest* ***b***

Experimentally it is possible correlating the track multiplicity to an impact parameter value by fitting data with predictions from Glauber model.

Correlating track multiplicity with impact parameter in p-Pb is a non-trivial task.

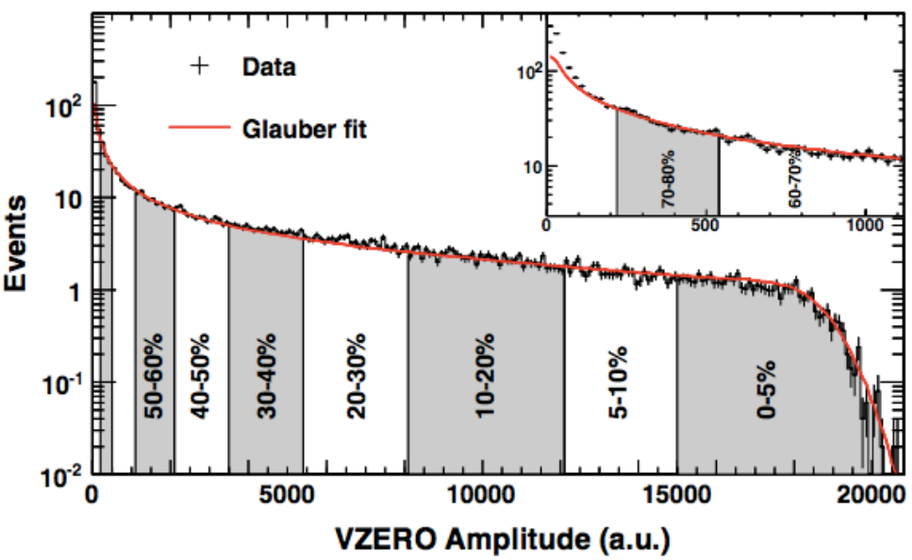




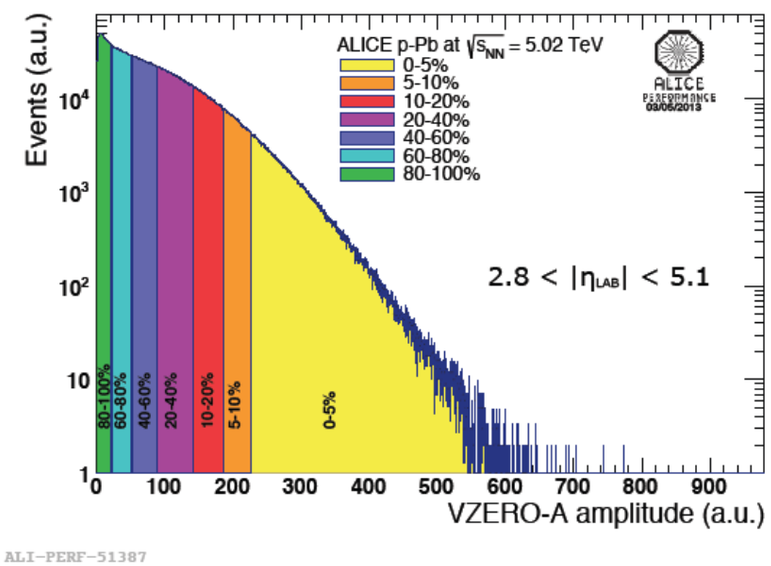


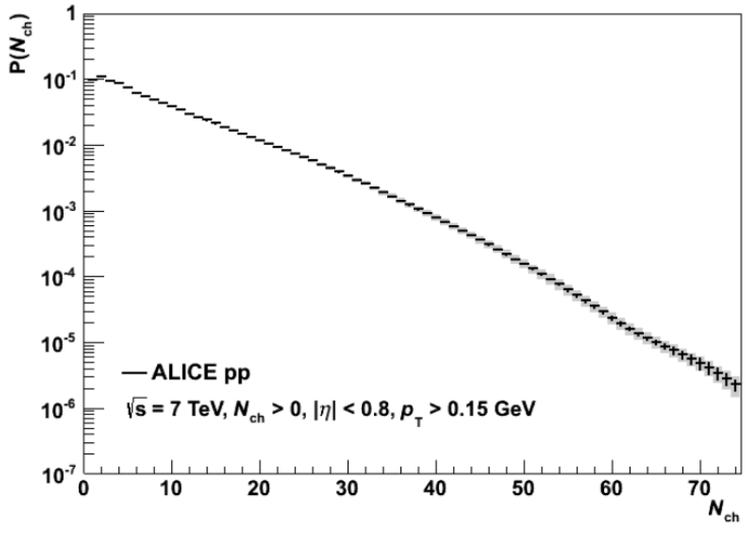
In pp centrality can't be defined

Barrel multiplicity can be used for differential studies



Phys. Rev. Lett. 106, 032301

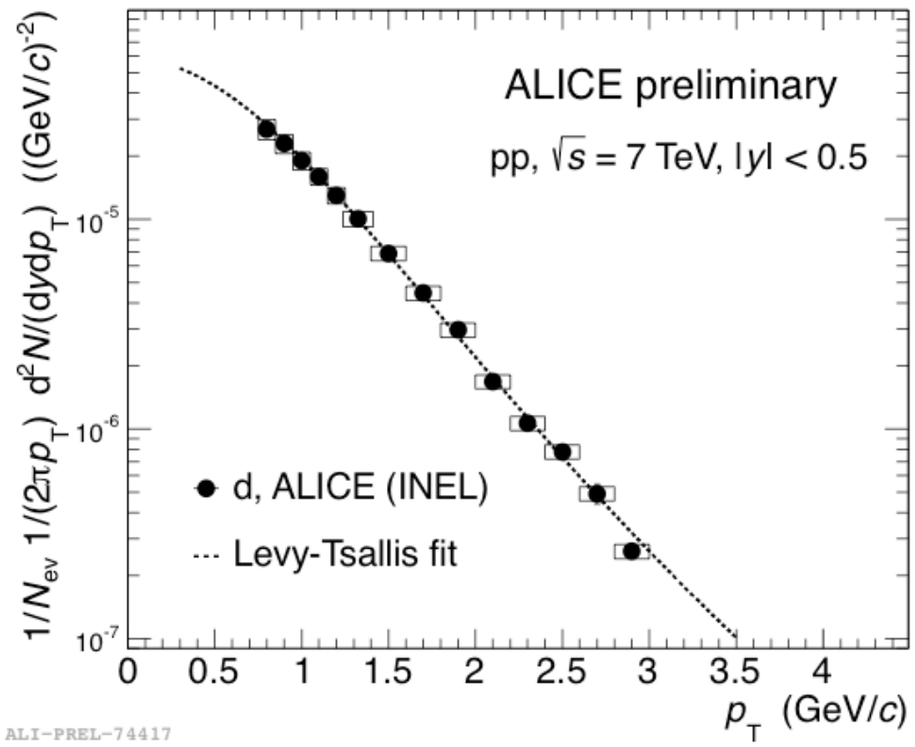




ALICE-PUBLIC-2013-001

V-ZERO is a scintillator hodoscope used for centrality estimation

Deuteron production in pp and Pb-Pb



pp

Invariant production spectrum is well fitted by the Levy-Tsallis function in p-p

$$\frac{\mathrm{d}^2N}{\mathrm{d}p_\mathrm{T}\mathrm{d}y} = p_\mathrm{T}\frac{\mathrm{d}N}{\mathrm{d}y}\frac{(n-1)(n-2)}{nC(nC+m_0(n-2))}\left(1+\frac{m_\mathrm{T}-m_0}{nC}\right)^{-1}$$

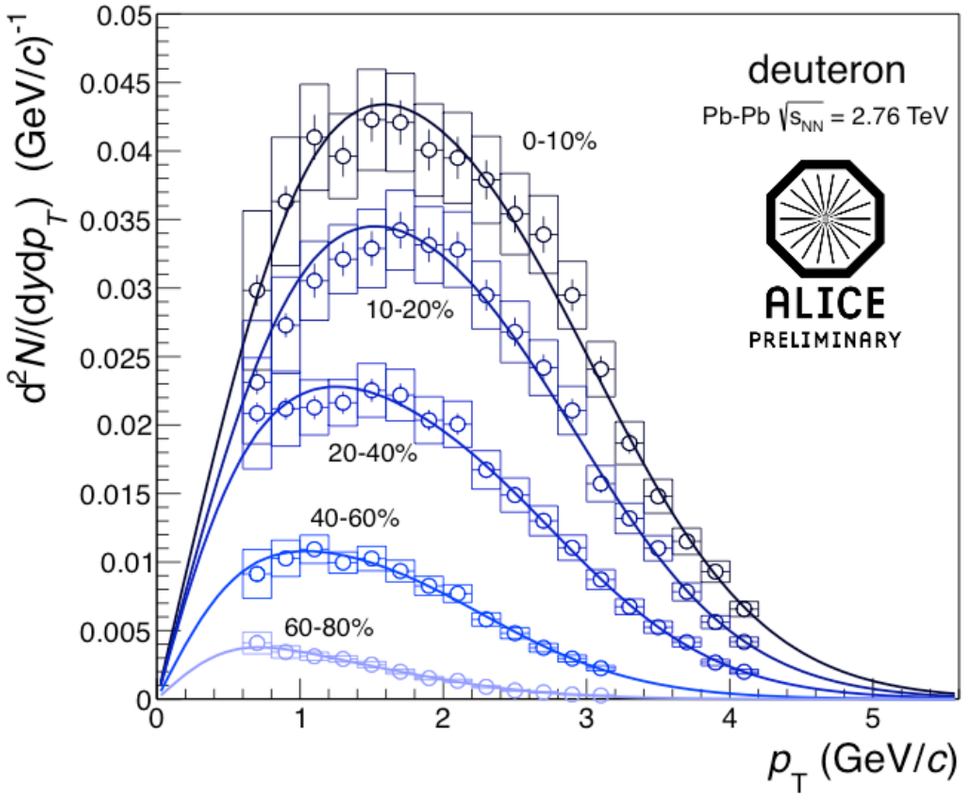
where m_0 is the reference mass of the deuteron and n,C are fit parameters.

C. Tsallis. Journal of Statistical 505 Physics, 52:479–487, (1988)

Pb-Pb

- The Blast Wave function fits well the data.
- Characteristic hardening of the spectrum with increasing centrality.
- These fits are used for the extrapolation of the yield to the unmeasured region at low and high p_T.

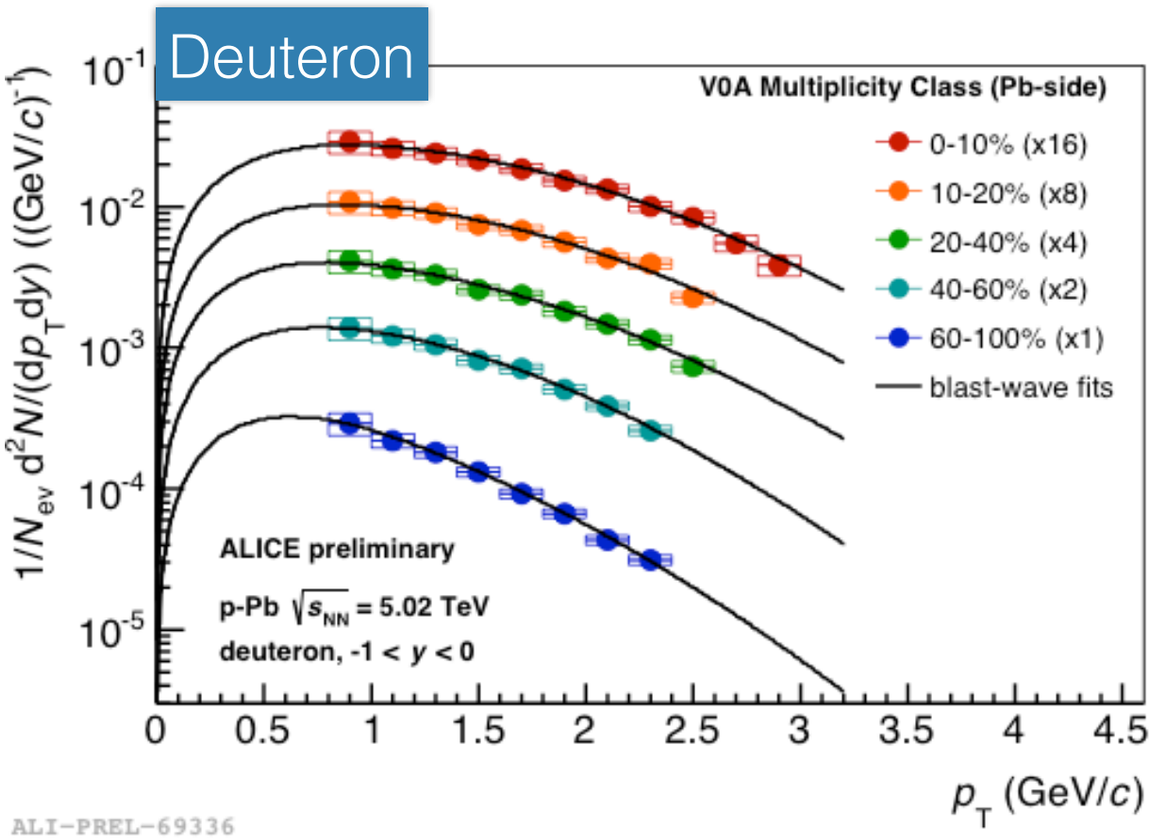
Blast wave model: E. Schnedermann et al., Phys. Rev. C48, 2462 (1993)

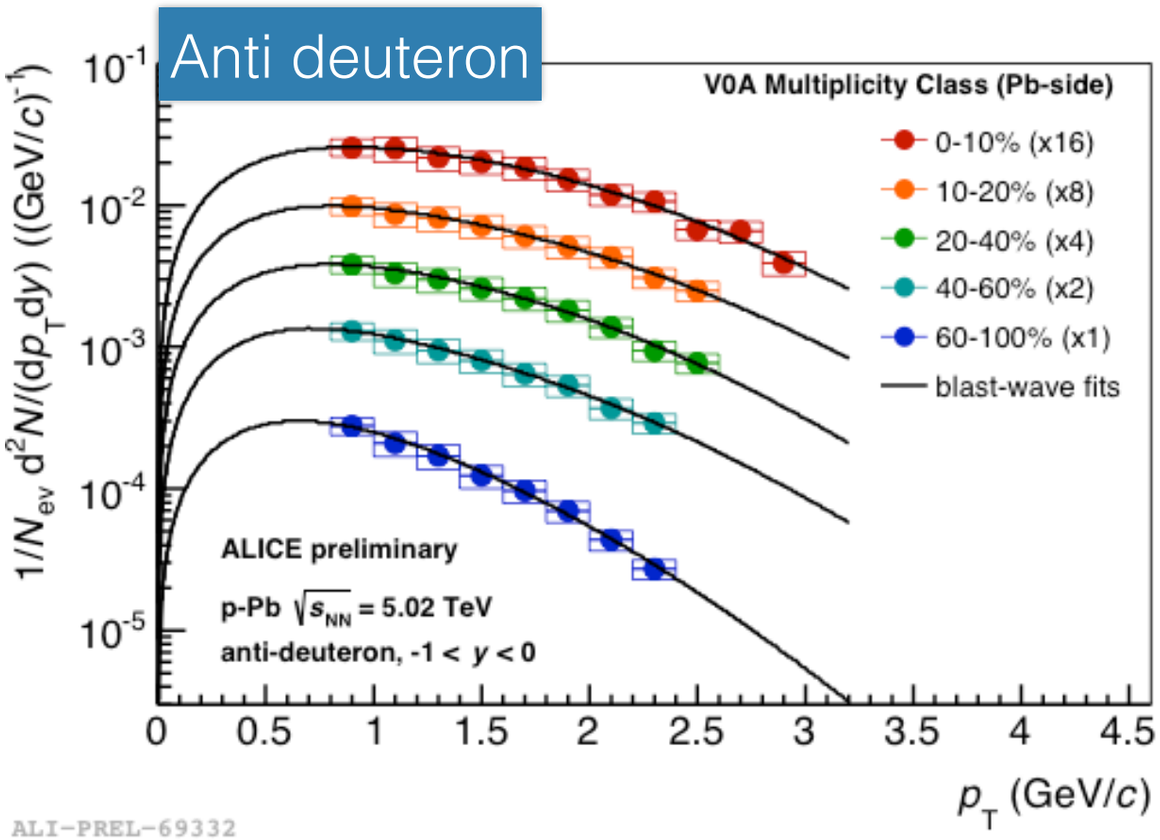


(Anti)deuteron production in p-Pb

The Blast-Wave function fits well the data also in this case.

It provides a satisfactory description of the thermal part and the radial flow visible in p_T spectra.

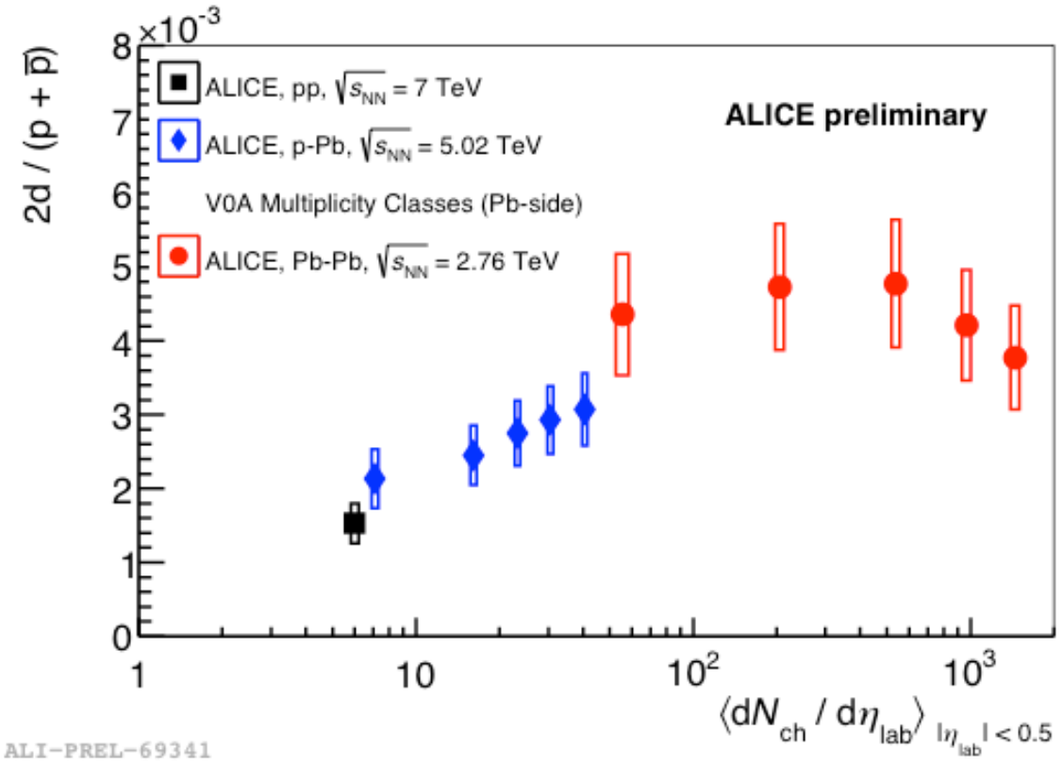




The spectra become harder with increasing multiplicity

d / p ratio and coalescence parameter

B_2 parameter: R. Scheibl and U. Heinz, Phys.Rev. C59, 1585 (1999)



- Rise with multiplicity
- No further increase in Pb-Pb collisions within errors

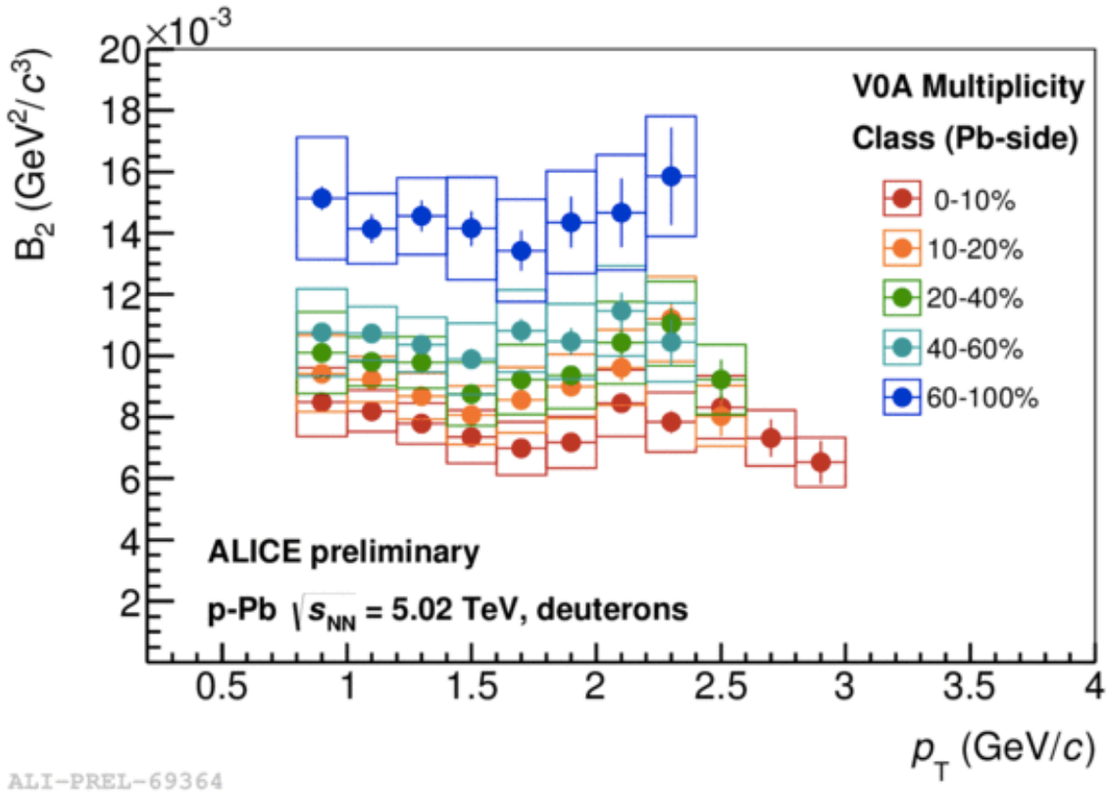
The increase of the d/p ratio with charged particle multiplicity is consistent with the coalescence picture

The coalescence parameter, defined as:

$$B_2 = \frac{E_{\mathrm{d}}\frac{\mathrm{d}^3N_{\mathrm{d}}}{\mathrm{d}p_{\mathrm{p}}^3}}{\left(E_{\mathrm{p}}\frac{\mathrm{d}^3N_{\mathrm{p}}}{\mathrm{d}p_{\mathrm{p}}^3}\right)^2}$$

is predicted to be p_T independent by the coalescence model.

This is observed in p-Pb and in peripheral Pb-Pb collisions.

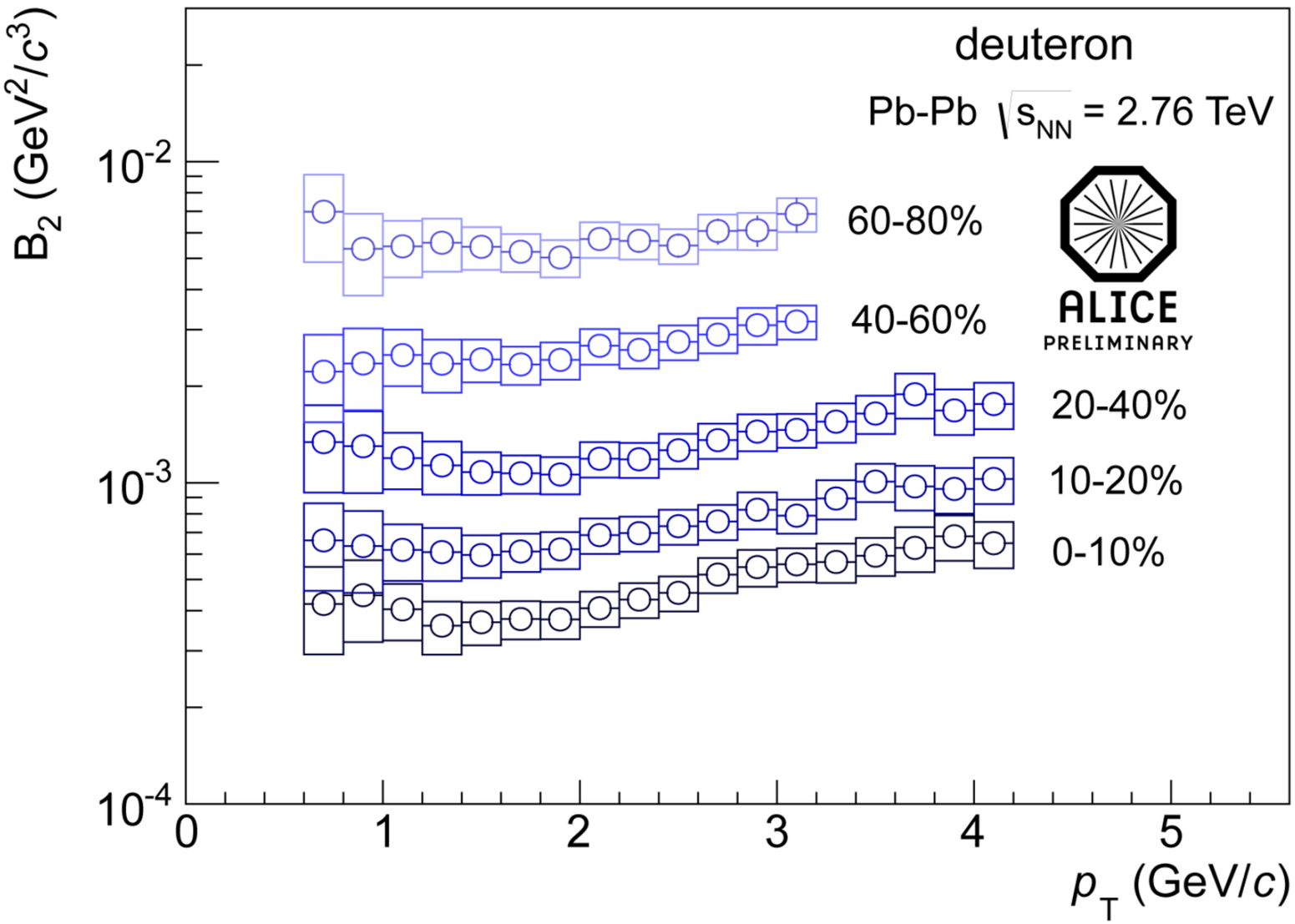


Conclusions and perspectives

- The shapes of deuteron production spectra can be understood in the coalescence model framework.
- Blast-Wave fits are used to extrapolate the yields to the unmeasured p_T region.
- Measured deuteron yields are in agreement with expectations from thermal model with a temperature of $T_{chem} \approx 156$ MeV (see backups)
- Also the d/p ratio increasing with charged particle multiplicity is consistent with the coalescence predictions.
- ALICE is looking forward to LHC Run 2 to extend the current measurement and put tighter constraints on theoretical models.

Backup

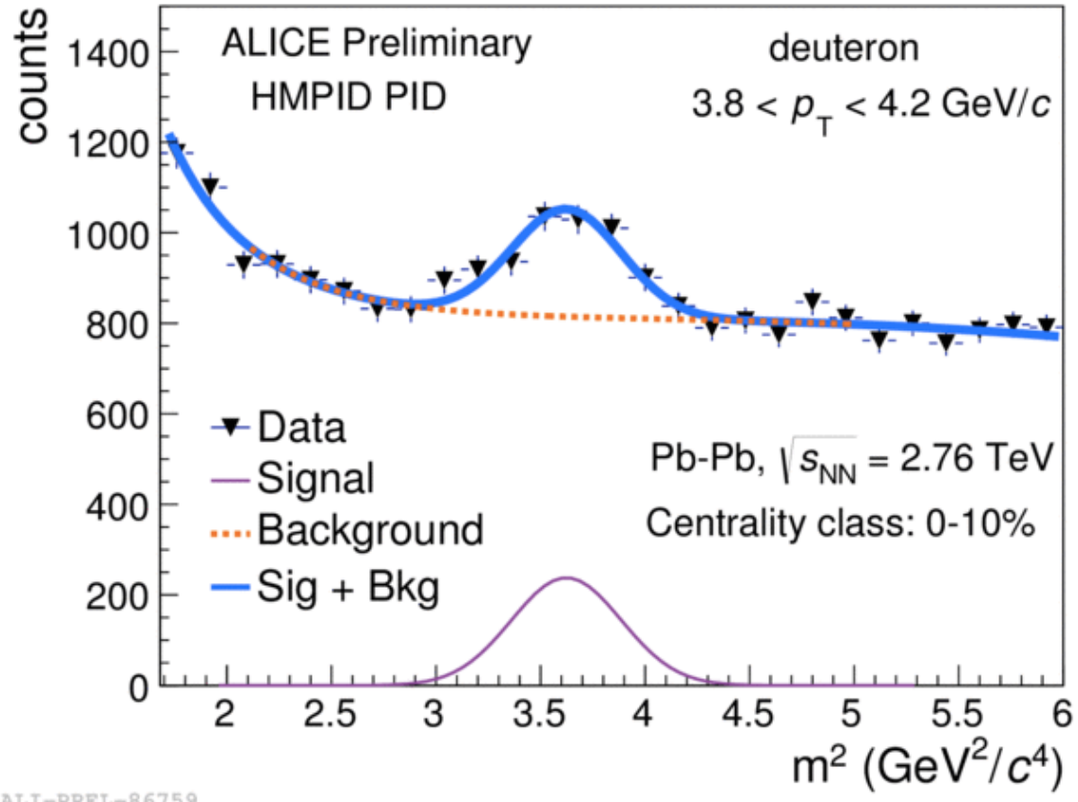
B_2 in PbPb collisions

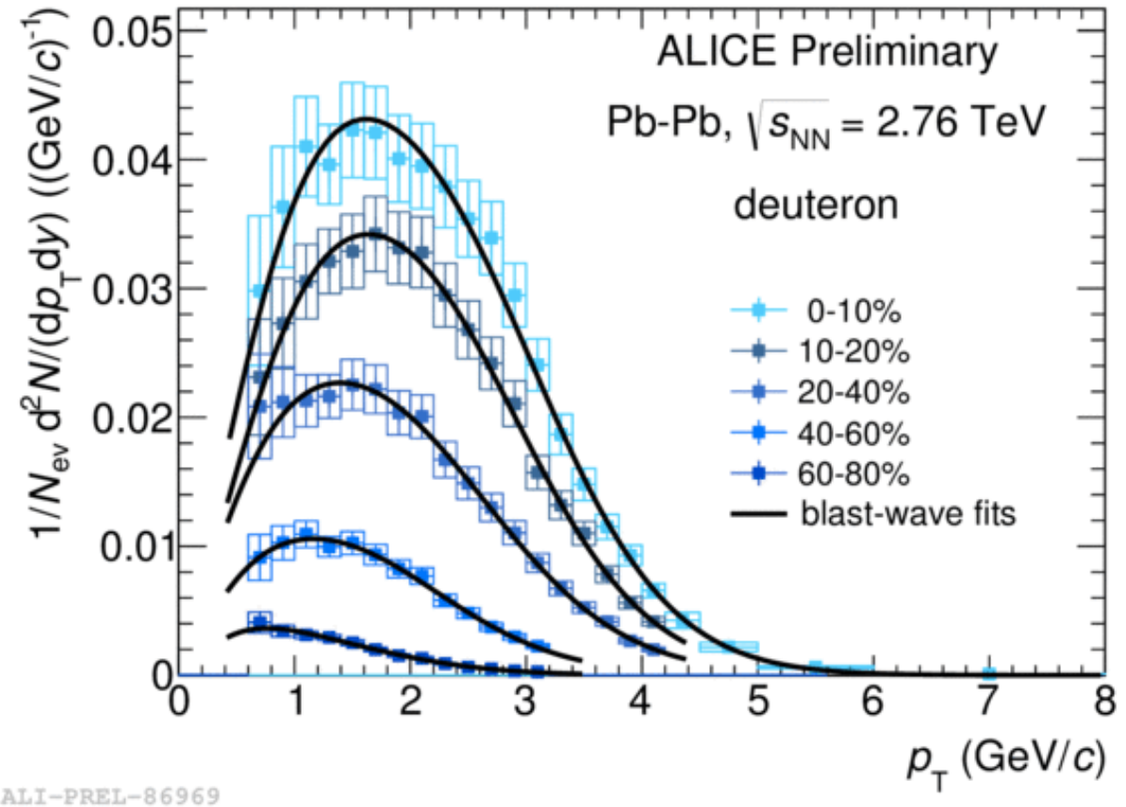


B_2 of deuterons in PbPb collisions is transverse momentum independent for peripheral collisions, while for central collisions a trend is visible.

HMPID performance

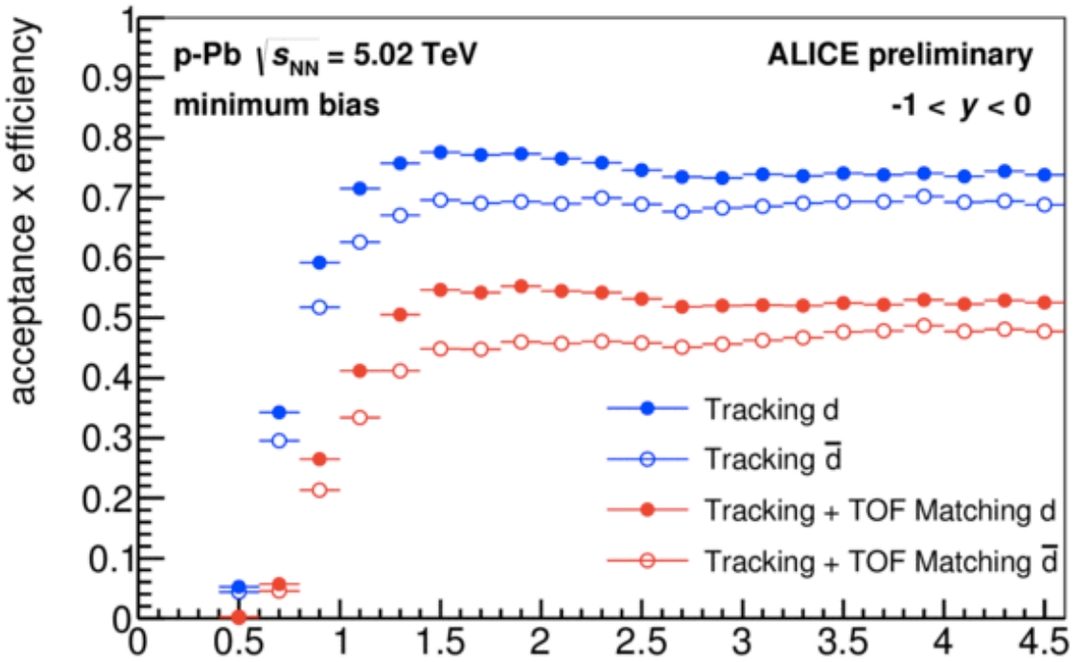
With HMPID Cherenkov detector has been possible to extend the measurement up to 8 GeV/c in the first bin of centrality.

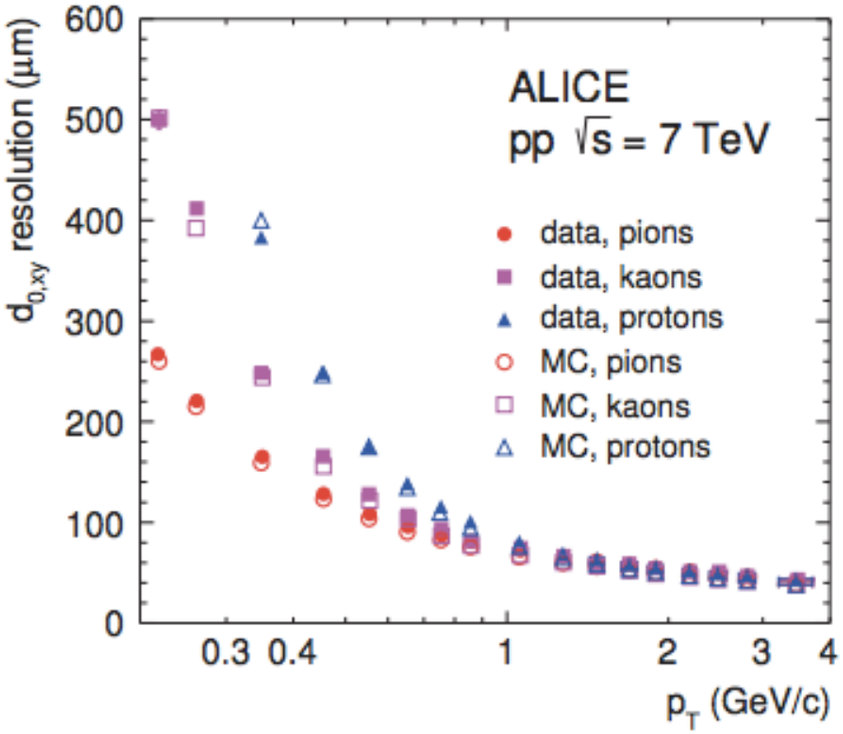


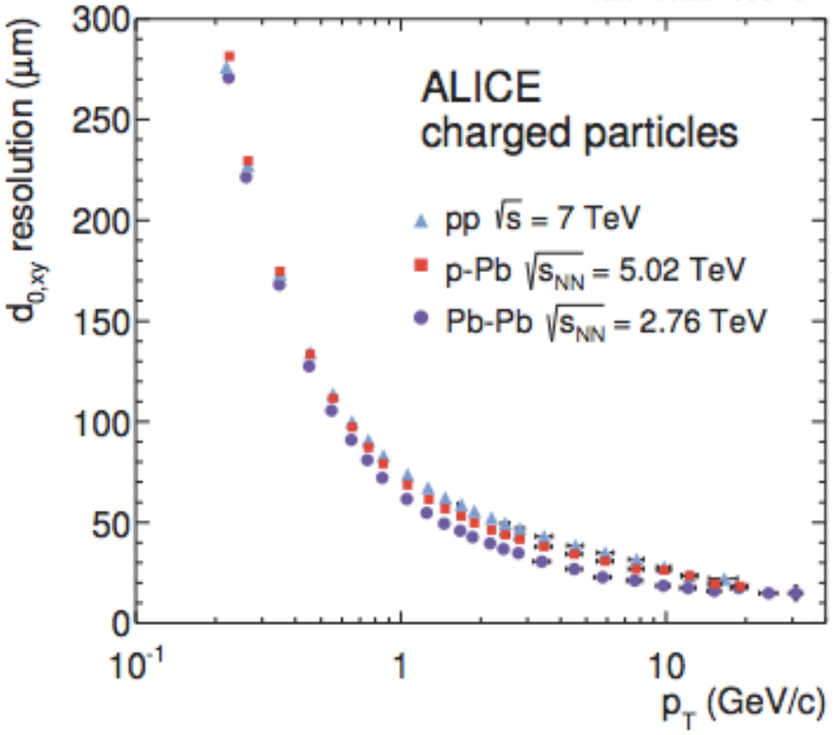


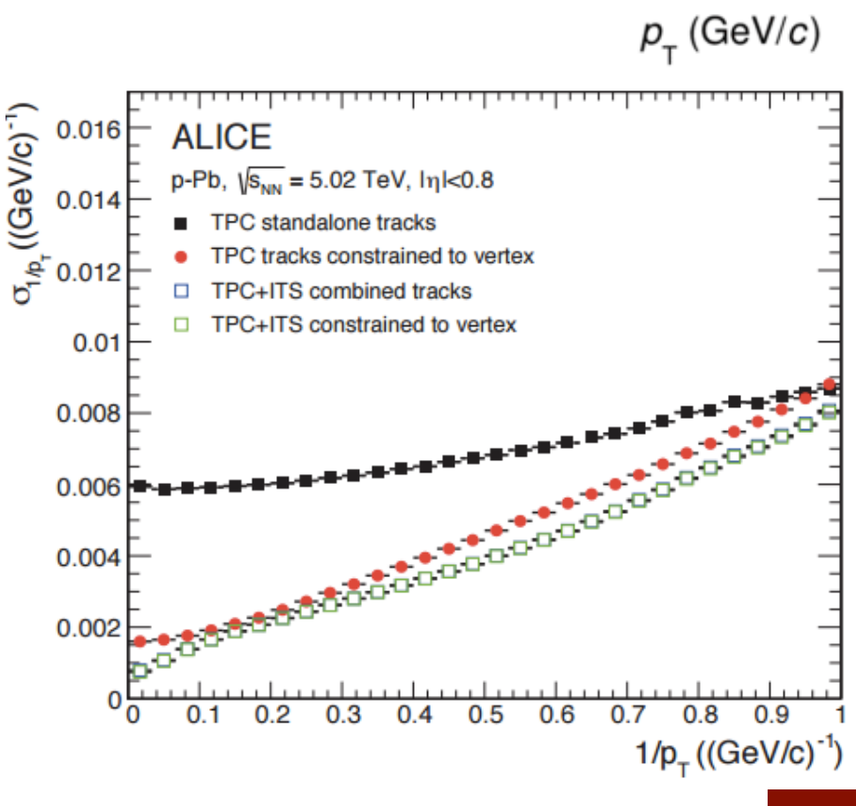
Tracking performance of ALICE

- Tracking efficiency x acceptance is fundamental to measure the production spectra of charged particle.
- Tracking efficiency depends on charged particle multiplicity.



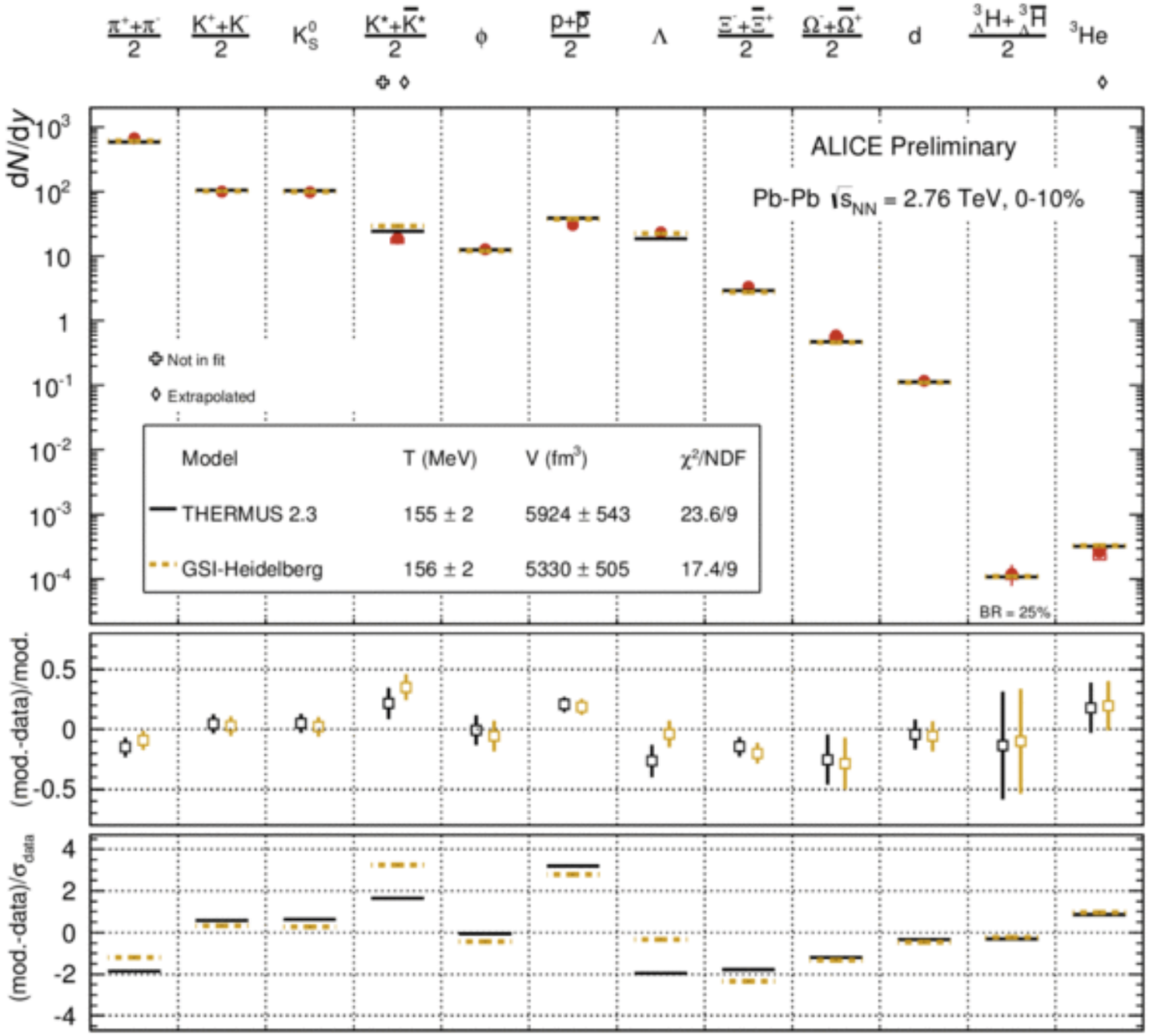






The ALICE Collaboration, Int. J. Mod. Phys. A 29, 1430044 (2014)

Thermal model



Grand canonical thermal fit for 0-10% central Pb-Pb collisions, with GSI and THERMUS models. Both models fit all the abundances with T ≈ 156 MeV.
The predictions of both models miss the yield of protons.