MB & possible MPI studies at ALICE

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ALICE

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Summary

- ALICE specific detector capabilities;
- MB physics & MPI at ALICE:
  - multiplicity distribution
    - motivation
    - unfolding
    - corrections
    - sensitivity
- other possible signals for MPI@ALICE

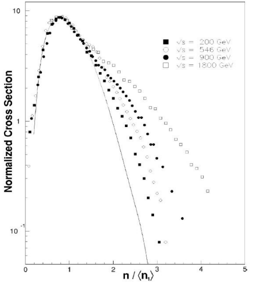
ALICE detector potential

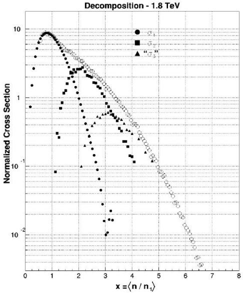
Being at LHC the HI-dedicated experiment, ALICE has some unique capabilities, complementary to those of the dedicated p-p experiments (some pros and some cons):

- wide p_T range and in particular low p_T-cutoff (down to 100MeV);
- excellent primary and secondary vertexing (σ_z^{pp} down to 50μm, $\sigma_{x,y}^{pp}$ down to 30μm);
- excellent particle identification;
- e and μ identification;
- high resolution γ-spectrometer;
- drawbacks: small luminosity, limited acceptance.

Multiplicity distribution: interest for MPI

Deviations of multiplicity distribution from KNO scaling have been observed above ISR energies (starting from 200GeV center of mass energy).





The QGSM (DPM) model has been used to explain the multiplicity distribution at high energies as the sum of different contributions corresponding to single-, double-, ... parton interactions, each obeying KNO scaling.

Similar studies could allow to measure the multi-PDFs, e.g. the probability $P(x_1, x_2)$ of finding two partons with $x_F = x_1$ and x_2.

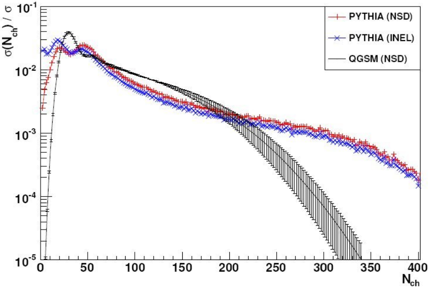
Multiplicity distribution

Grosse-Oetringhaus J.F.,2008,*ALICE-INT-2008-002*

ALICE can measure multiplicity distribution with high precision, even though it will need to extend the measurements from the acceptance ($|\eta| < 1.4$) to the full phase space.

To extract the real multiplicity distribution from the measured one:

- unfold measured distribution;
- correct for vertex bias;
- correct for trigger bias;



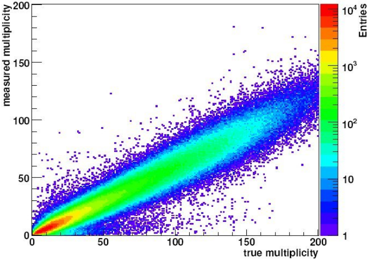
ALICE

Why unfolding

The measured distribution M depends on the true distribution T via a response matrix $\mathcal{R}$:

$$M = \mathcal{R}T$$

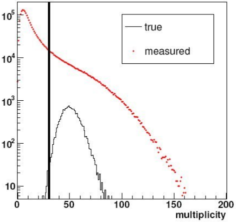
$\mathcal{R}$ can be constructed knowing the detector response.

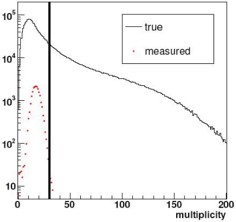


The goal is to construct T knowing M, which is not so simple as:

$$T = \mathcal{R}^{-1}M$$

- $\mathcal{R}$ might be singular
- strong fluctuations due to inversion anyway





Unfolding

using Bayesian method

$$\tilde{R}_{tm} = \frac{R_{mt}P_t}{\sum_{t'} R_{mt'}P_{t'}}$$

$$U_t = \frac{1}{\epsilon(t)}\sum_m M_m \tilde{R}_{tm}$$

New iteration:

$$U_t \rightarrow P(t)$$

until convergence.

using χ^2 minimization

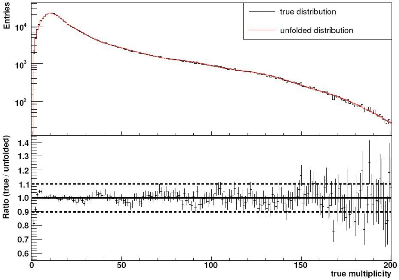
$$\hat{\chi}^2(U) = \sum_m \left(\frac{m}{e_m}(M_k - \sum_t R_{mt}U_t)\right)^2$$

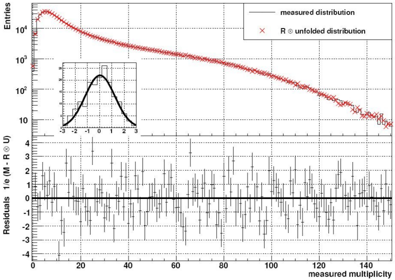
Bin size $<$ detector resolution
$\Rightarrow$ several (strongly oscillating) functions solve the eq. above
The solution is stabilized by adding a parametrized term:

$$\chi^2(U) = \hat{\chi}^2(U) + \beta P(U)$$

Validation

Both unfolding methods have been validated over a set of different input distributions (Pythia, Phojet, negative binomial, flat ...) and for each method the parameters have been set so that the result is not sensitive to the input distribution.

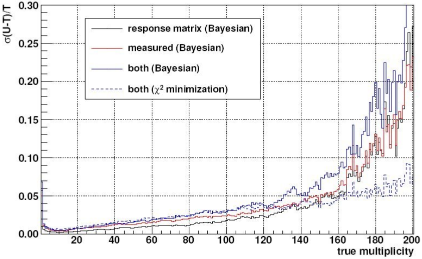


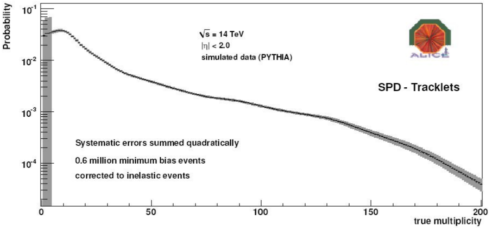


Systematic uncertainties

Detailed study of systematic uncertainties due to both

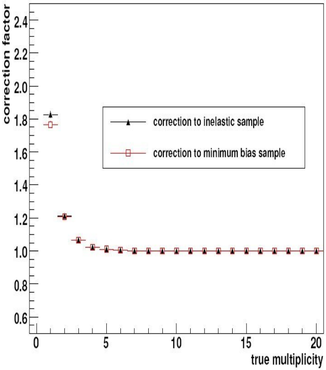
- the unfolding method itself $\longrightarrow$
- MC assumptions
  $\star$ not dependent on mult.distrib.!
  $\star$ particle composition $2-6\%$
  $\star$ relative cross-sections $< 1\%$
  $\star$ material budget $< 1\%$





Vertex reconstruction- and trigger-bias corrections

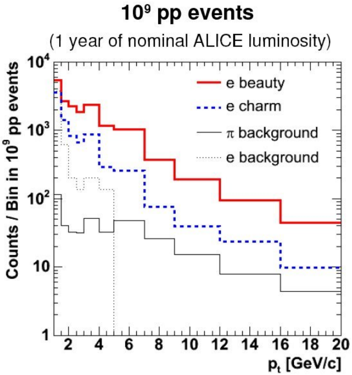
- after unfolding we get the mult.distr. for MB triggered events having a reconstructed vertex
- after vertex reconstruction bias correction we get the mult.distr. for MB triggered events
- finally we apply the trigger bias correction to get the mult.distr. for all inelastic events



The correction is different from unity only at low multiplicities (< 5).

Other possible signals for MPI at ALICE

- $b\bar{b}b\bar{b}$
- 4-jets of γ+3jets
- 2 like-sign electrons
- azimuthal distribution of 4 highest-p_T hadrons
- like-sign Ws (too low σ for our luminosity)



Investigating MPI in pA

- pN is a privileged collision system
- Predicted rate $\frac{c\bar{c}c\bar{c}}{c\bar{c}} \sim 10\%$ [1]
- Possibility to detect $c\bar{c}c\bar{c}$ by selecting events with "tagged" DD, e.g. D^0+e^+ or e^+e^+ where the background e^+ from bb events can be estimated from measured single inclusive b cross-section.
- Analysis in invariant mass of the $D^0 \rightarrow K^-\pi^+$ by tuning of set of cuts on the decay products has shown the possibility to reach a S/B$\sim$1 (from an initial S/B$\sim 10^{-4}$).

[1] Cattaruzza, Del Fabbro, Treleani, PRD 70 (2004) 034022