Comments on systematics of corrected MB distributions

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For discussion (1)

- The event sample to normalize to
  - Sample defined by physics process
    - INEL (ALICE)
    - NSD (less well defined) (ALICE, CMS)
  - Sample defined by detector acceptance
    - INEL with at least one particle in some acceptance window
      - Published up to now:
      - ALICE in η window
      - ATLAS in both η and p_T window

For discussion (2)

- The track sample to be normalized
  - Correct down to $p_T = 0$ (used by ALICE and CMS)
  - Use a p_T cut-off defined by tracking efficiency (used by everybody)

Sample defined by physics process

- Advantage
  - Comparison with theoretical models, not necessarily a MC
  - Comparison with other experiment
- Disadvantage
  - Model dependent
    - One has to correct for the non-observed (triggered - selected) events. However, this extrapolation is not done just using the models: usually one uses constraint from ones own data and/or previous measurements.

Sample defined by detector acceptance

- Advantage
  - less model dependent, but not completely
  - for finite tracking inefficiency ε

$$N_{event} = \sum_{M} P_M \left(1 - \varepsilon^M\right)$$

$$N_{track} = \sum_{M} P_M M \left(1 - \varepsilon\right)$$

  - <*N*> depends on true multiplicity distribution at low multiplicity (*M*)

Sample defined by detector acceptance

- Disadvantage
  - This is suitable only for models formulated as Monte Carlo generators, but there are models which are not. Example: QGSM

Correction down to p_T =0

- Advantage
  - Again comparison with non-MC models and with other experiments.
  - This correction can only be used when an experiment reaches low tracking efficiency for very low p_T
    - The correction is small and very well-constrained (one measures the value on a already falling spectrum and it is constrained to zero at p_T =0
    - in ALICE conservative error of ~0.5% on mean multiplicity

Correction down to p_T =0

- Disadvantage
  - One assumes that p_T dependence is falling down monotonically with p_T from 50MeV/c (ALICE) to 0
  - However, that seems reasonable and the model dependence is very small.

Use a p_T cut-off defined by tracking efficiency

- Advantage: well suited for MC model comparison,
  - However, there are still model dependent corrections (unless one goes to very large $p_T \sim 1.5$ GeV).
  - At 500 MeV p and anti-p will have substantial energy loss (see Bethe-Bloch), one has to correct for this to get the momentum at primary vertex to do the p_T cut !
  - This correction is purely model dependent (relative amount of protons (even worse antiprotons)) their momentum spectra, and ultimately uncorrectable are dE/dx fluctuations).
  - Usually this uncertainty is much larger than the correction towards 0 (from a much lower cut-off).

Use a p_T cut-off defined by tracking efficiency

- Disadvantage
  - Comparison with non-MC models and other experiments practically impossible
  - Tuning of MC models in restricted range (1/3 of charged particles in p_T in the case of ATLAS)

Conclusions

- Event selection
  - we have to do both, events samples defined by physics processes and detector acceptance
- Track selection
  - Correction or cut-off, depends on what is more suitable for a given detector and particular reconstruction method, i.e. which gives less systematic uncertainty and larger coverage.