Update on direct photon simulations with MPD ECal

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PWG4 & MPD-ECAL Meeting
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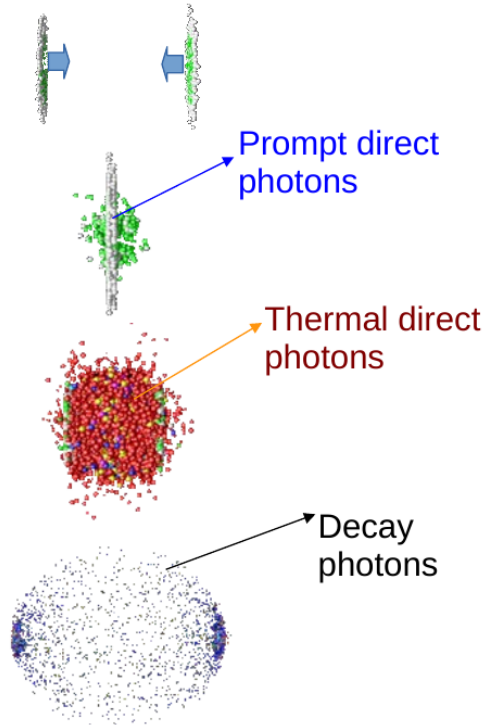
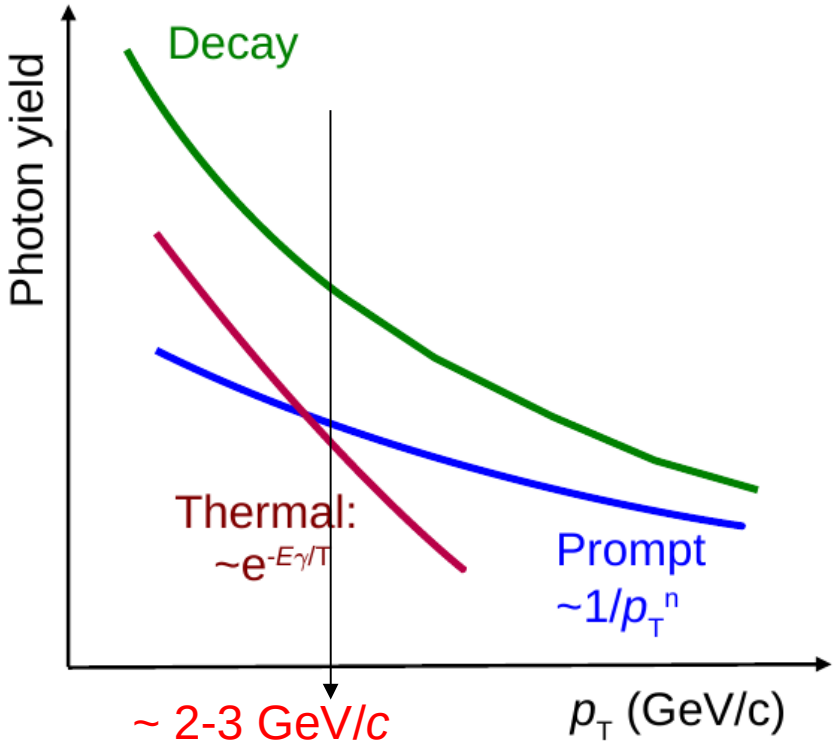
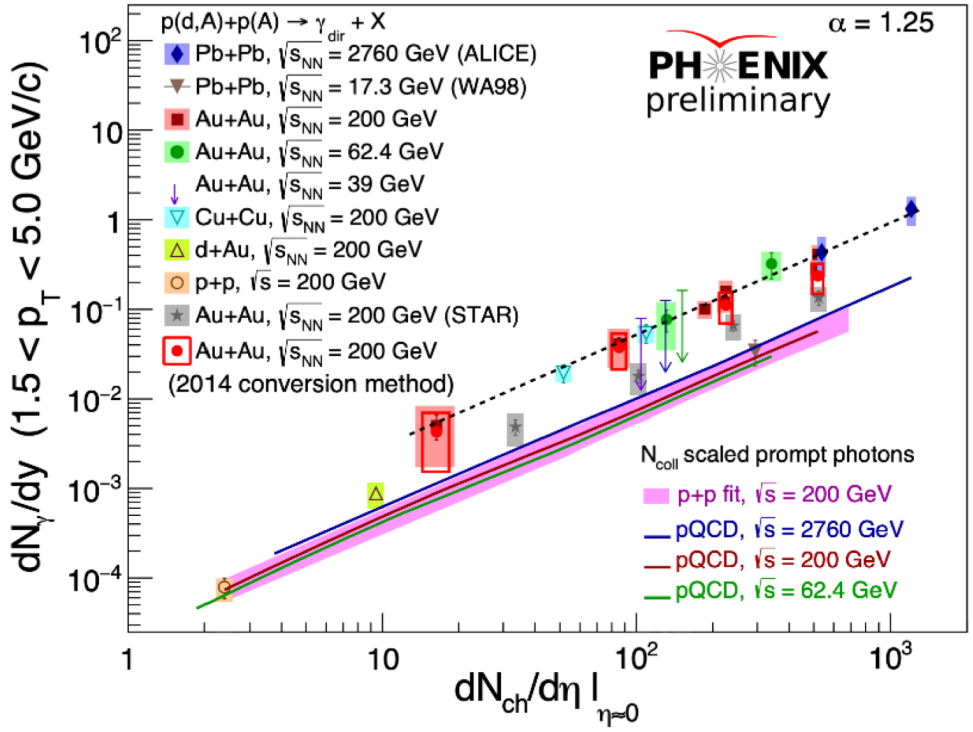
Reminder

- Direct photons is a widely used probe to study QGP (thermal properties, evolution, collective effects)
- No experimental measurements at NICA energies in AA collisions (most close measurements – WA98; PHENIX BES – large errors)
- We calculate yield of thermal and prompt direct photons in MC simulations: hydro UrQMD (thermal), JETPHOX (prompt)

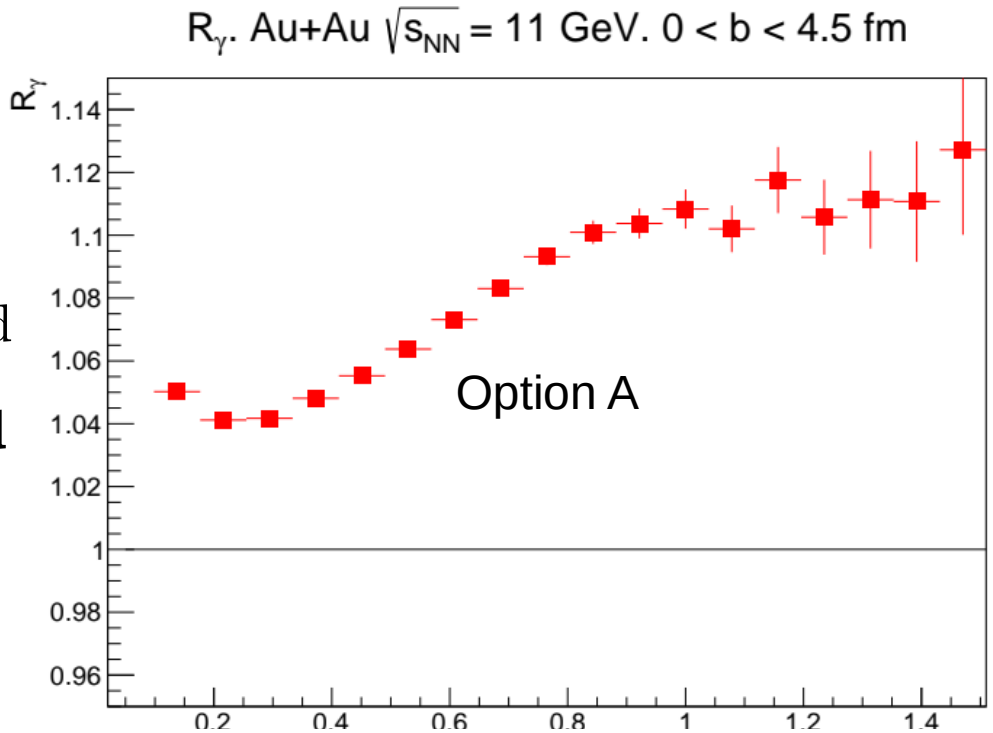


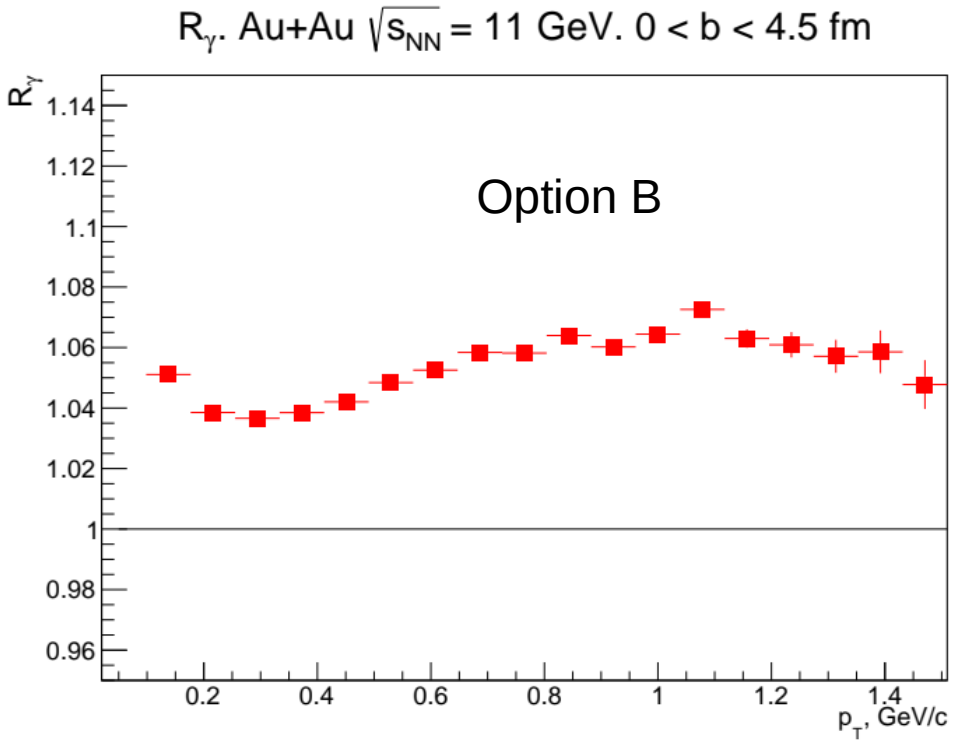


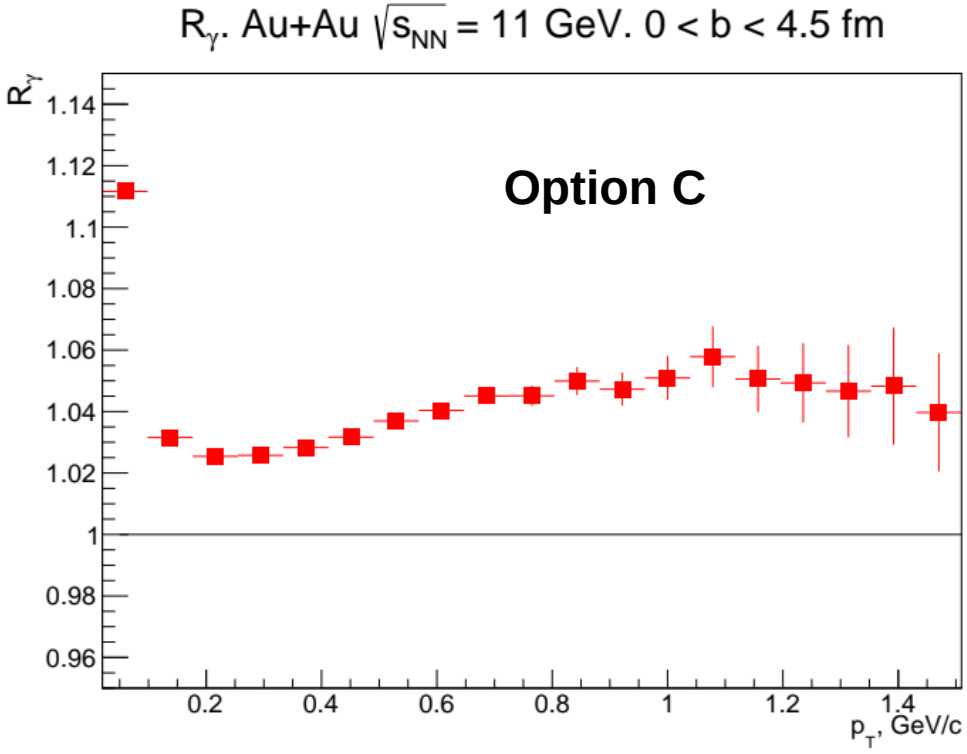


Calculations at $\sqrt{s_{NN}} = 11$ GeV

- Three options considered:
- A: direct photons from hybrid mode, pions from pure cascade, full integral
- B: direct photons and pions from hybrid mode, full integral
- **C: direct photons and pions from hybrid mode, integral only above freeze-out condition**
- Note: no prompt direct photon contribution here!

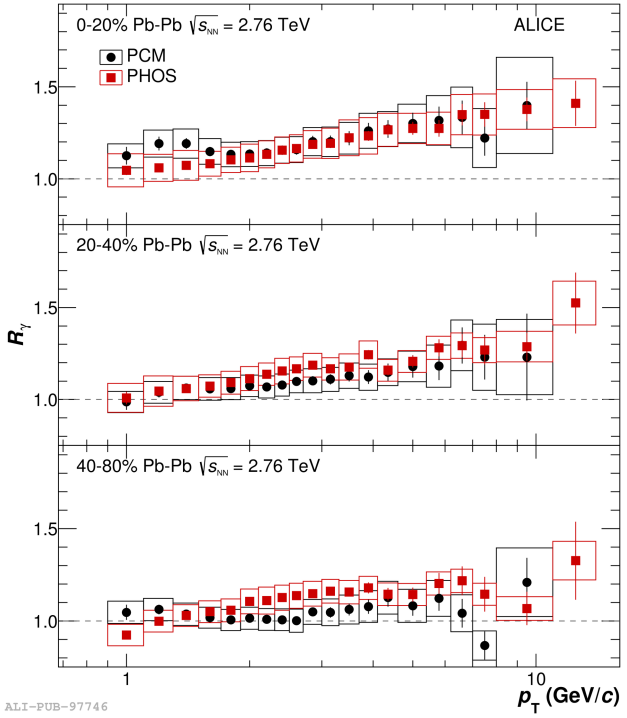


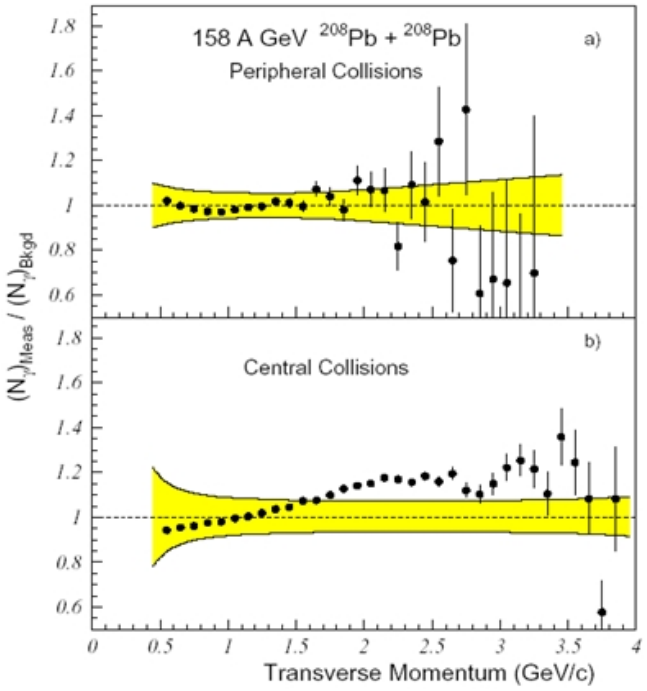




This update

- Calculate uncertainties based on ALICE measurements.
- R_γ ratio – ratio of inclusive photon spectrum to decay photons spectrum. If there is a contribution from direct photons, it is above 1
- In ALICE (Pb-Pb at $\sqrt{s_{NN}}$=2.76 TeV) R_γ is about 5-10% at 1 GeV/c [1] (note that above 3 GeV/c main contribution is from prompt photons). Syst. uncertainties on the same level
- In WA98 [2] (Pb-Pb at $\sqrt{s_{NN}}$=17.2 GeV) R_γ is about 20% at 2 GeV/c. Uncertainties about 5%



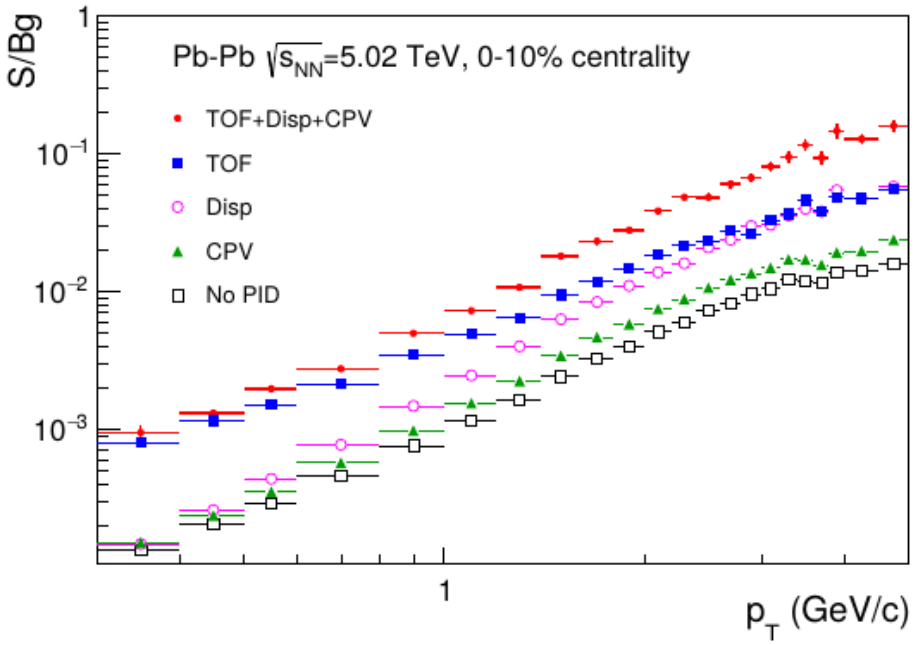


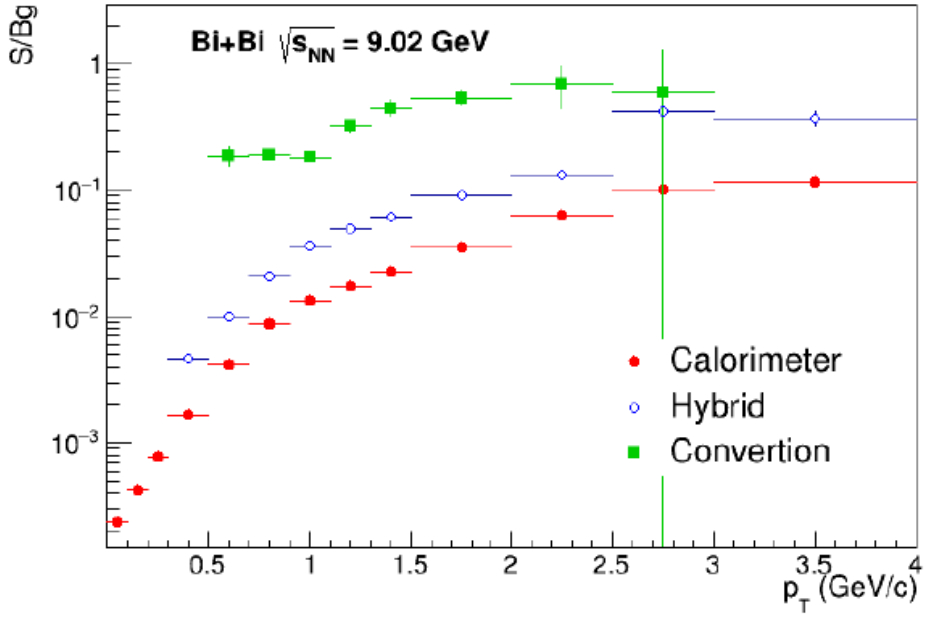
[1] J. Adam et al. (ALICE Collaboration) Phys. Lett.B 754(2016) 235-248
[2] T. Peitzmann, Pramana – J. Phys. V. 60 Issue 4 pp 651-661 (2003)

What systematic uncertainty on Rgamma consists of?

- In experiment, we calculate $R_\gamma = {}^{\gamma_{inc}/\pi^0}/_{\gamma_{decay}/\pi^0{}_{param}}$

- Main uncertainties come from:
  - **π0 extraction. Decreased by statistics, also depends on S/Bg ratio**





D. Peresunko talk
https://indico.jinr.ru/event/2100/

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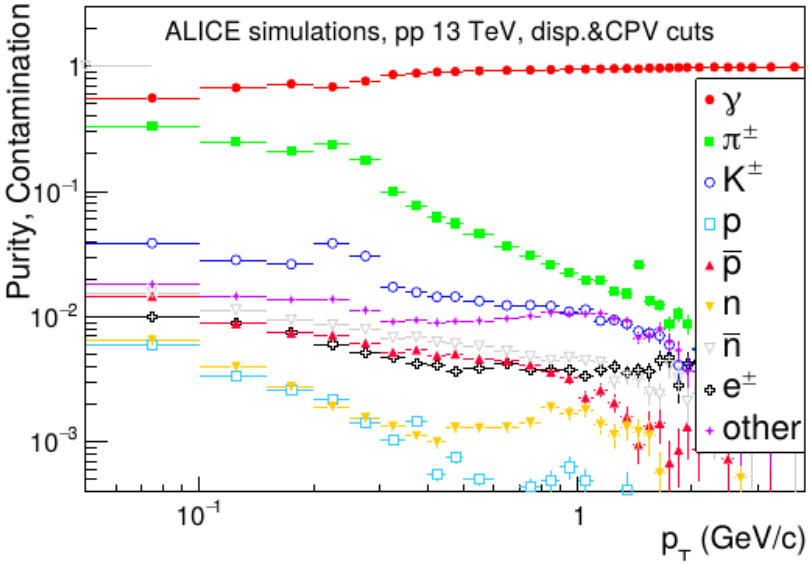
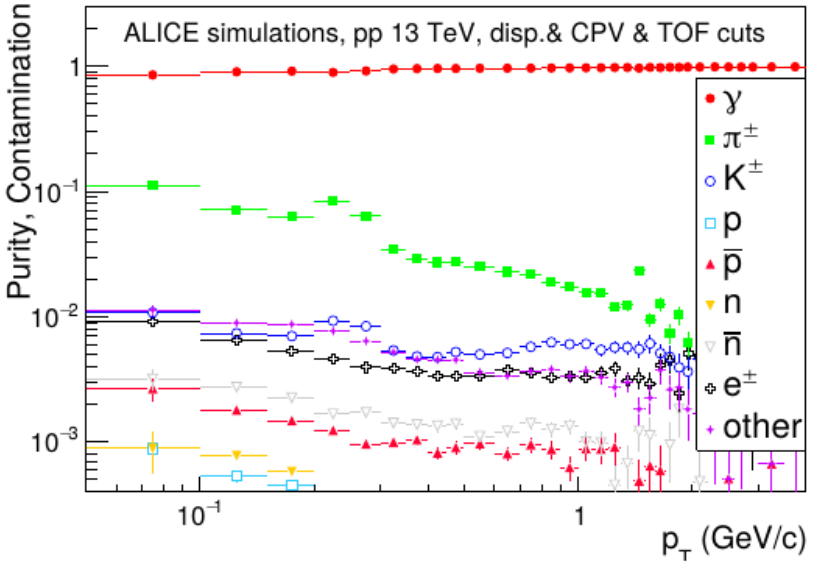
  - **Photon contamination. In ALICE – about 1% (10% uncertainty to contamination – about 10% at 1 GeV). Good Ecal time resolution can improve it about 2 times (0.5%).**





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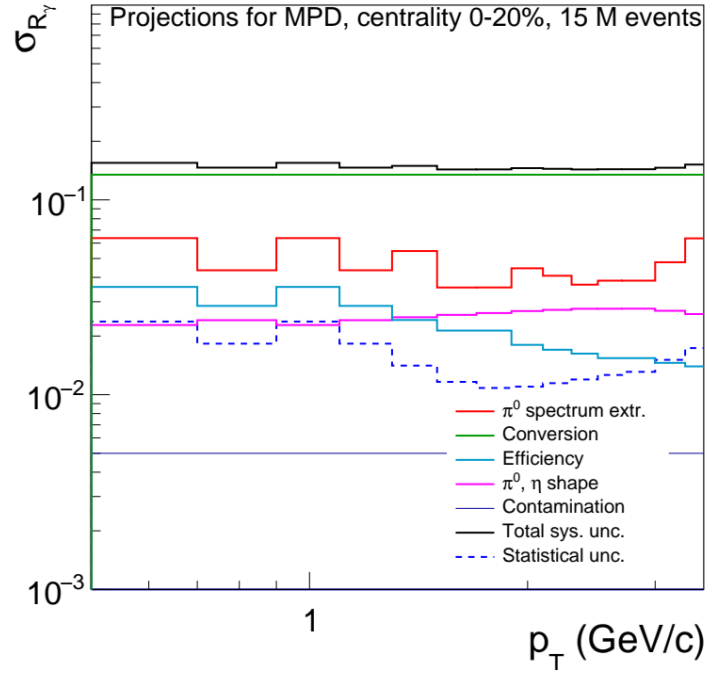
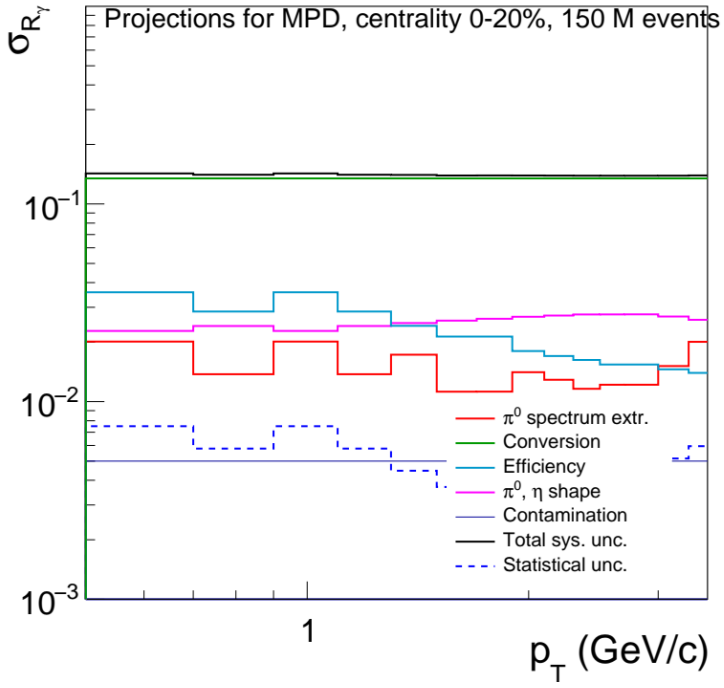
  - **Eta/pi0 ratio uncetrainty. Estimate the same in MPD and ALICE**

Results of systematic uncertainty calculation

- Statistics about 15 M central collisions, like in ALICE Run 1.
- Total error about 15%

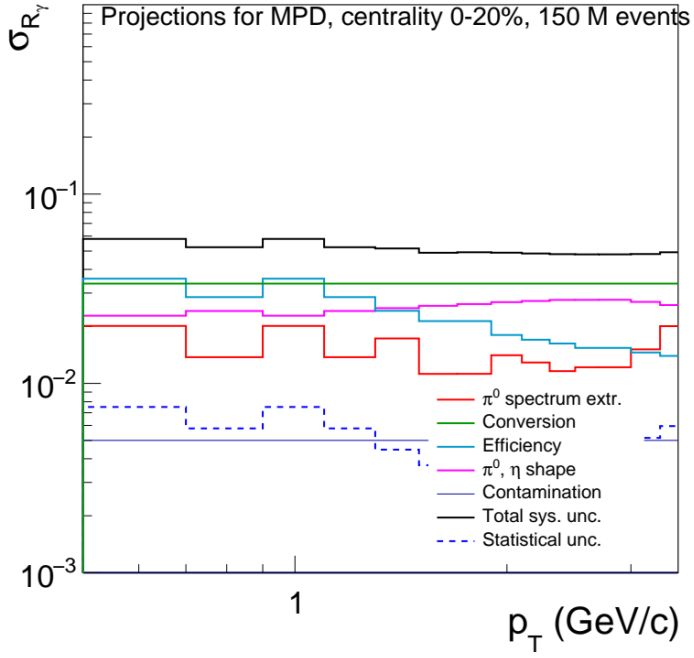


- Increase statistics 10 times.
- Total error is still dominated by conversion uncertainty

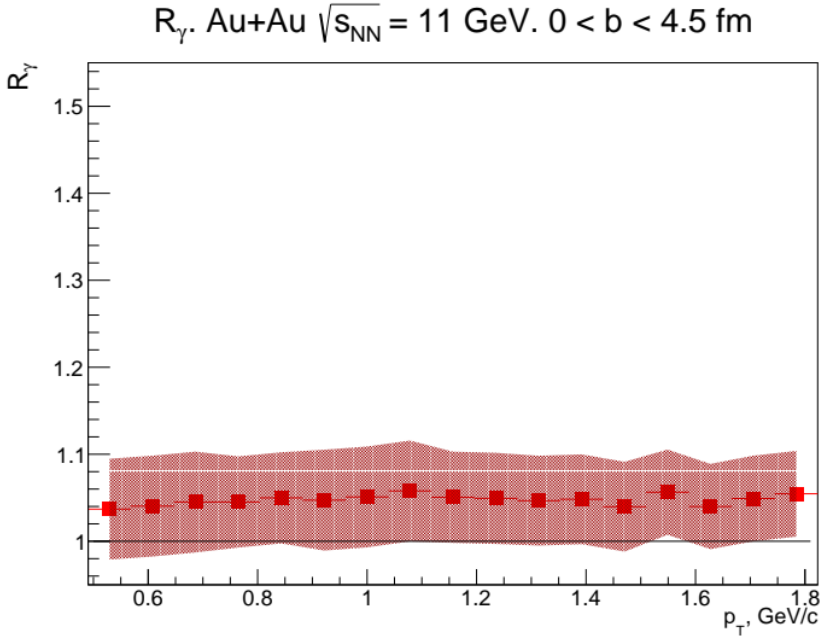


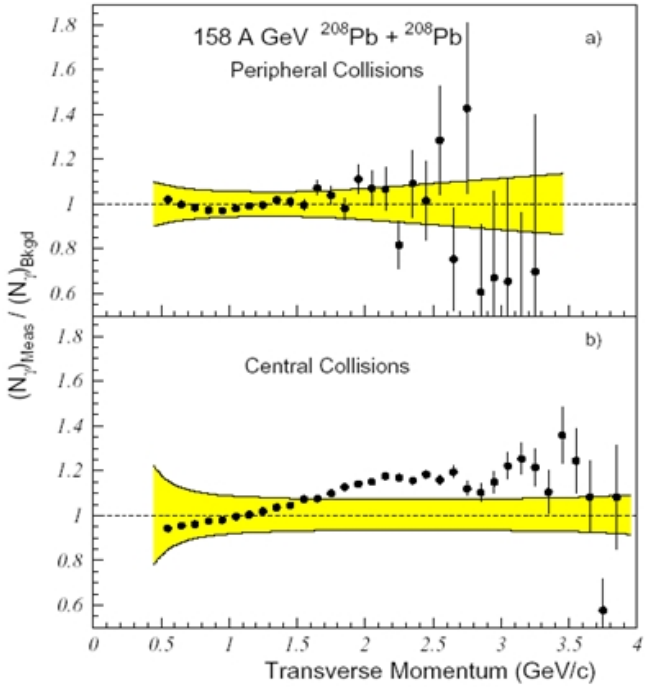
Results of systematic uncertainty calculation

- Contamination error = in ALICE
- Total error about 4-6%



- Rgamma (conservative option of calculation, centrality about 0-10%). No prompt direct photons contribution!





Conclusions

- Optimistic option (conversion error the same in MPD and ALICE) produce systematic uncertainty on the level of 4-6%, close to the conservative simulations of the thermal direct photons signal.