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High multiplicities (Small Systems)

WG4 summary and discussion

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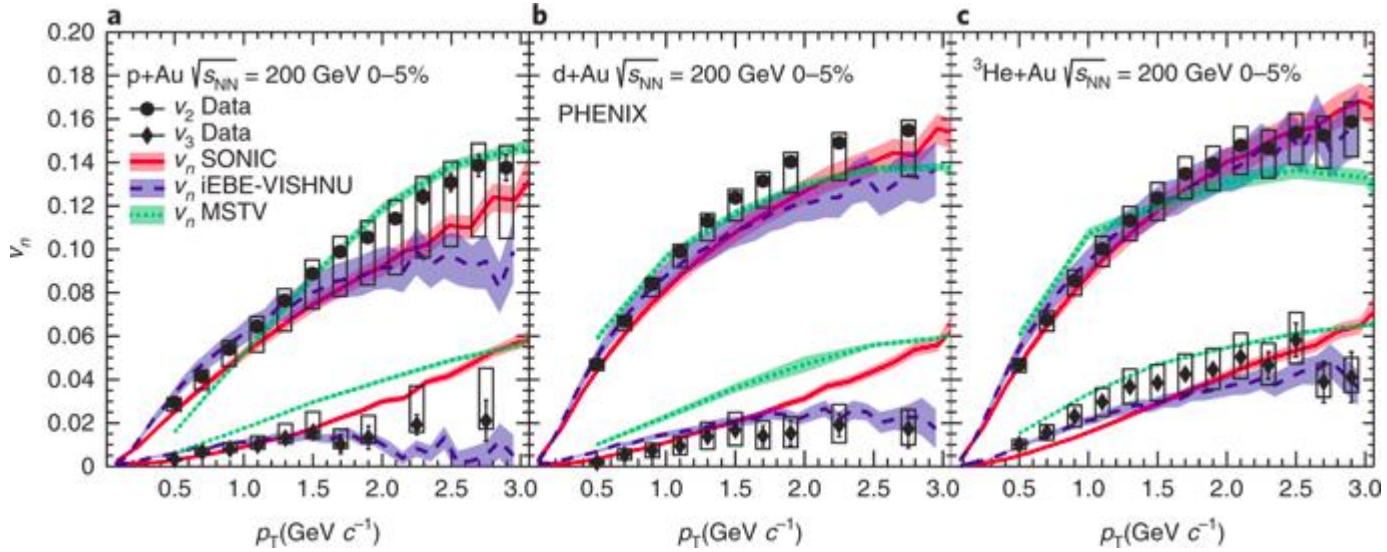
Collectivity? Hydro? QGP droplet?

this Tuesday:

"Creation of quark–gluon plasma droplets with three distinct geometries"
PHENIX Collaboration, Nature Physics (2018)



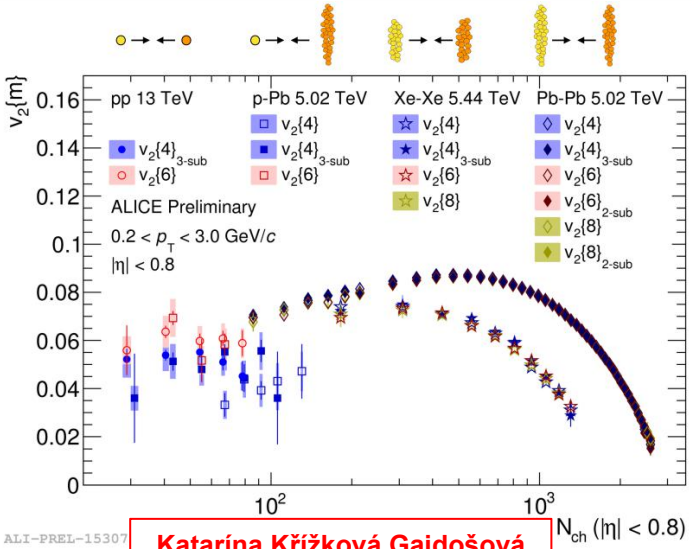
- Ordering of v_n across systems is according to hydro predictions
- ...contradicting (some?) other scenarios (color flux tubes)

$$v_2^{\mathrm{p+Au}} < v_2^{\mathrm{d+Au}} \approx v_2^{^3\mathrm{He+Au}}$$

$$v_3^{\mathrm{p+Au}} \approx v_3^{\mathrm{d+Au}} < v_3^{^3\mathrm{He+Au}}$$

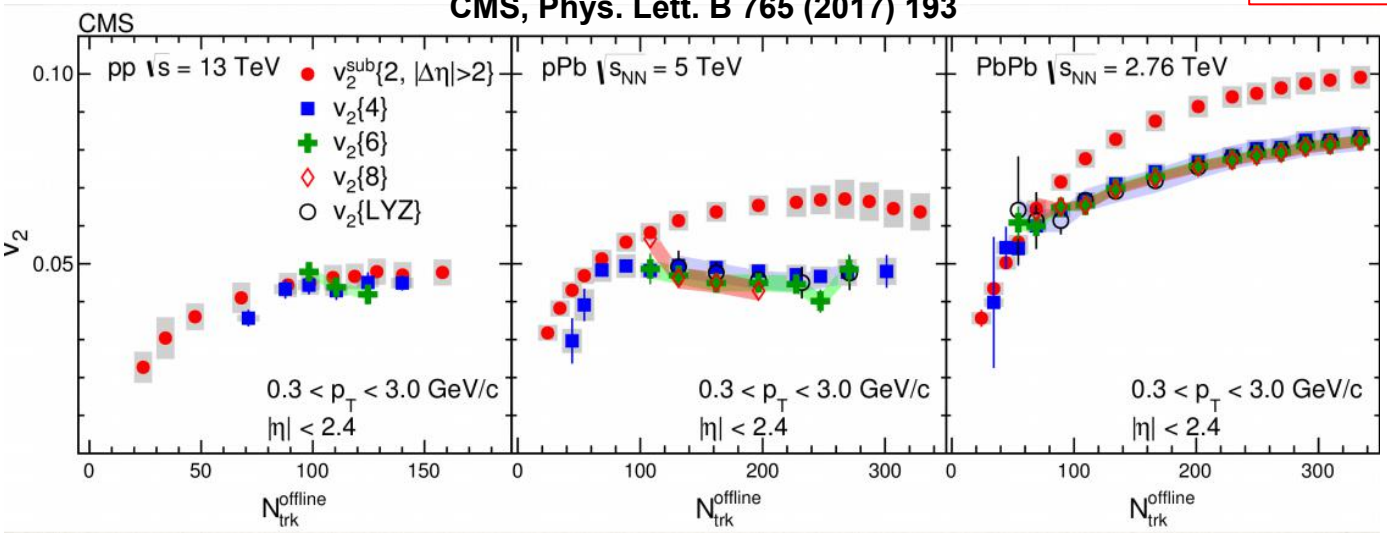
Multi-particle correlations > collectivity

- Long-range multi-particle correlations in small systems!
  - subevent methods
  - m-particle correlations
  - ...all the same



Katarína Křížková Gajdošová

CMS, Phys. Lett. B 765 (2017) 193

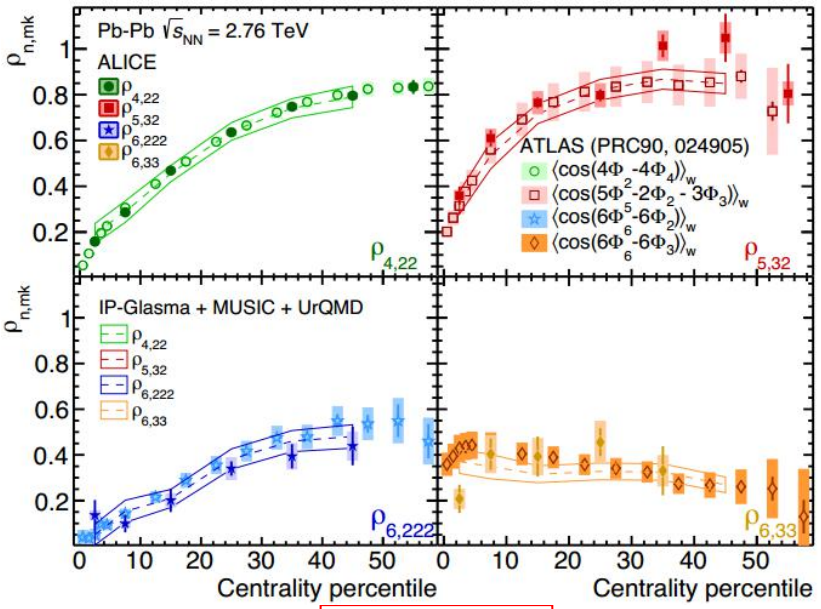


Arthur Moraes

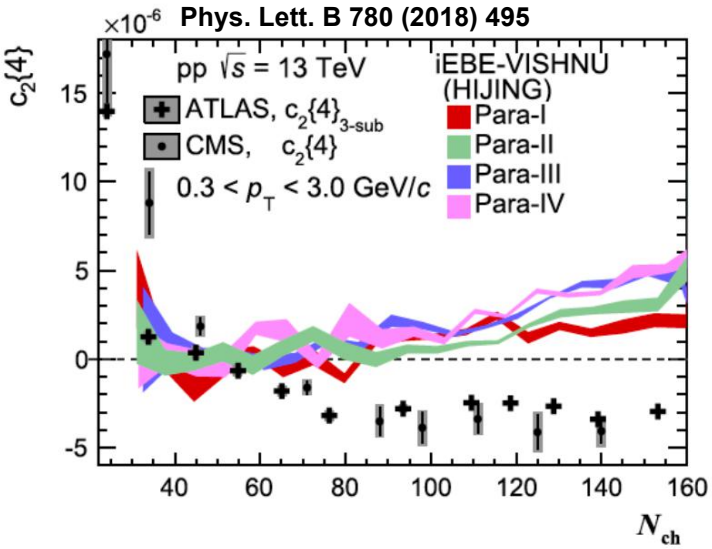
- So there's hydrodinamic evolution then. Or is there?

Precision to constrain models

- Several observables and measurements, high precision
- We can access initial conditions, η/s
- Eg. Symmetry plane correlations
  - statistical / classification methods to make use of the most info simultaneously



You Zhou



- BUT: Hydro in small systems
- Cumulants:

$$v_n\{2\} = \sqrt{c_n\{2\}}$$

$$v_n\{4\} = \sqrt[4]{-c_n\{4\}}$$

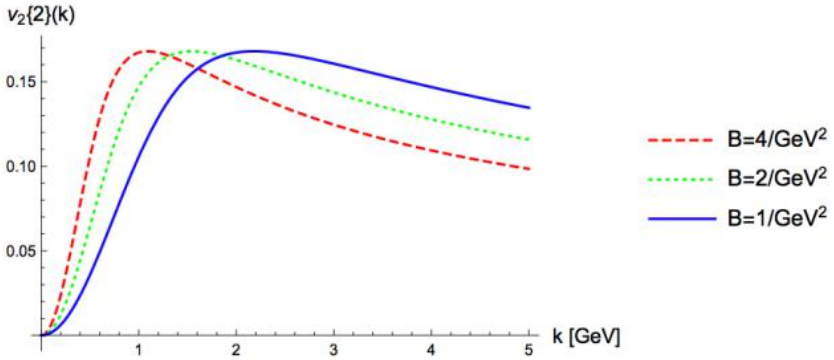
...

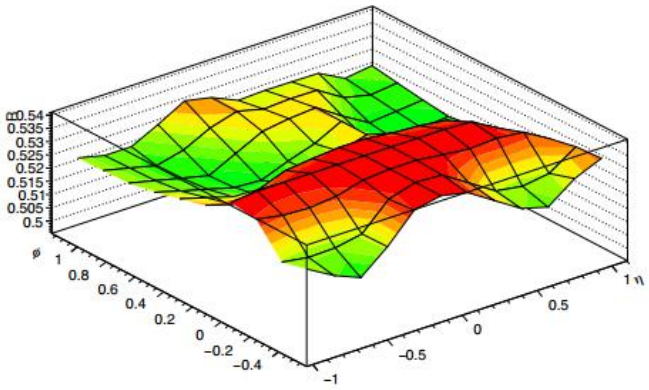
Hydro models predict wrong sign of $c_2\{4\}$!

Early origin of flow?

- Quantum interference between MPIs may lead to large flow coefficients
  - To resolve tension between requirement of strong FSI and missing signatures in other observables. arXiv:1812. 04113

Boris Blok





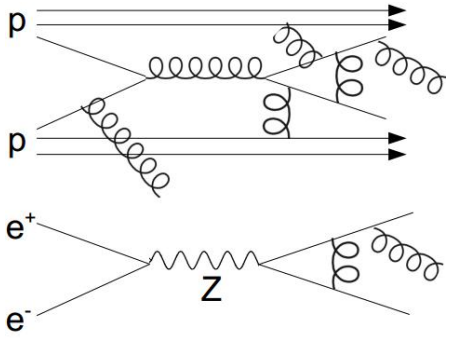
- Initial correlations of a QGP droplet may cause the ridge structure

Irais Bautista Guzmán

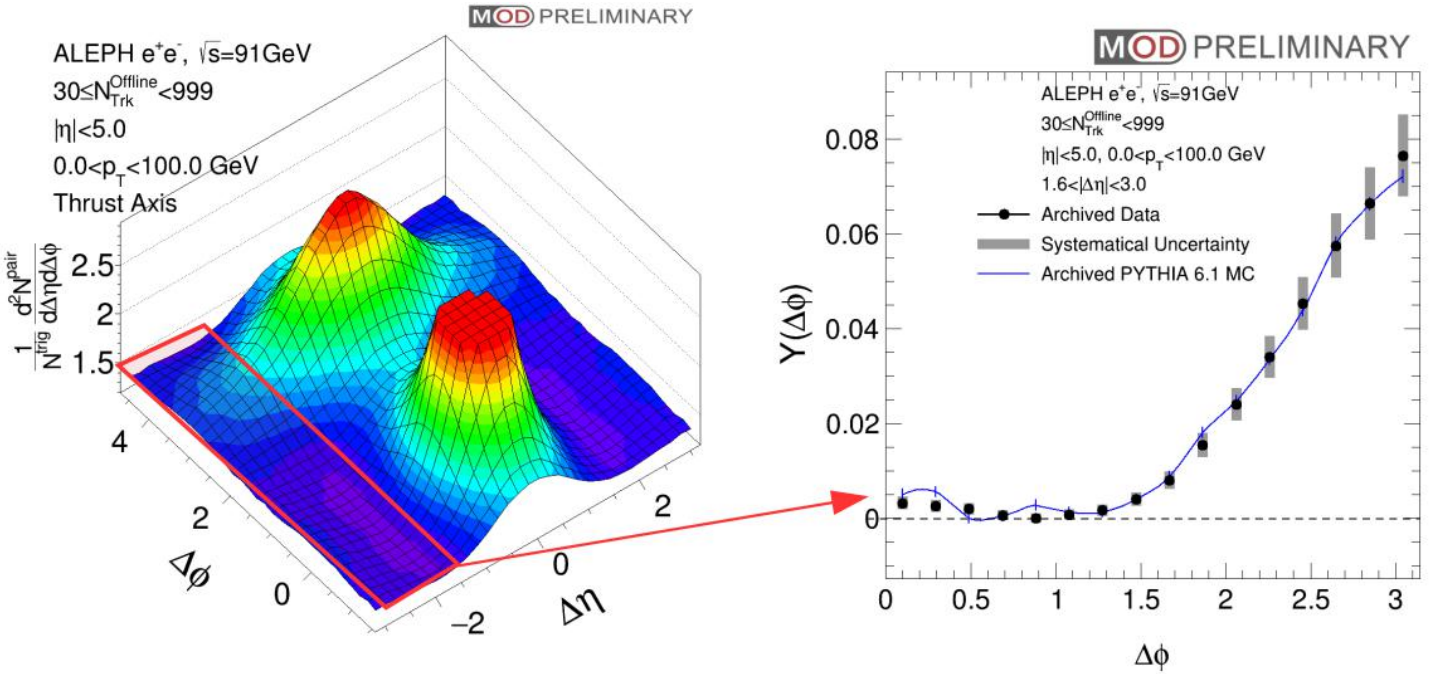
- So far these models lack quantitative understanding

Correlations in LEP1 e+e-

- No significant ridge
  - Consistent with Pythia6
  - Thrust axis coordinates

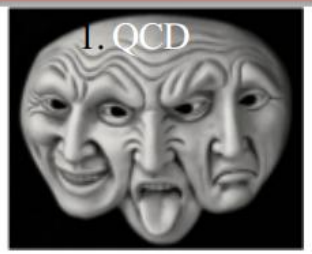


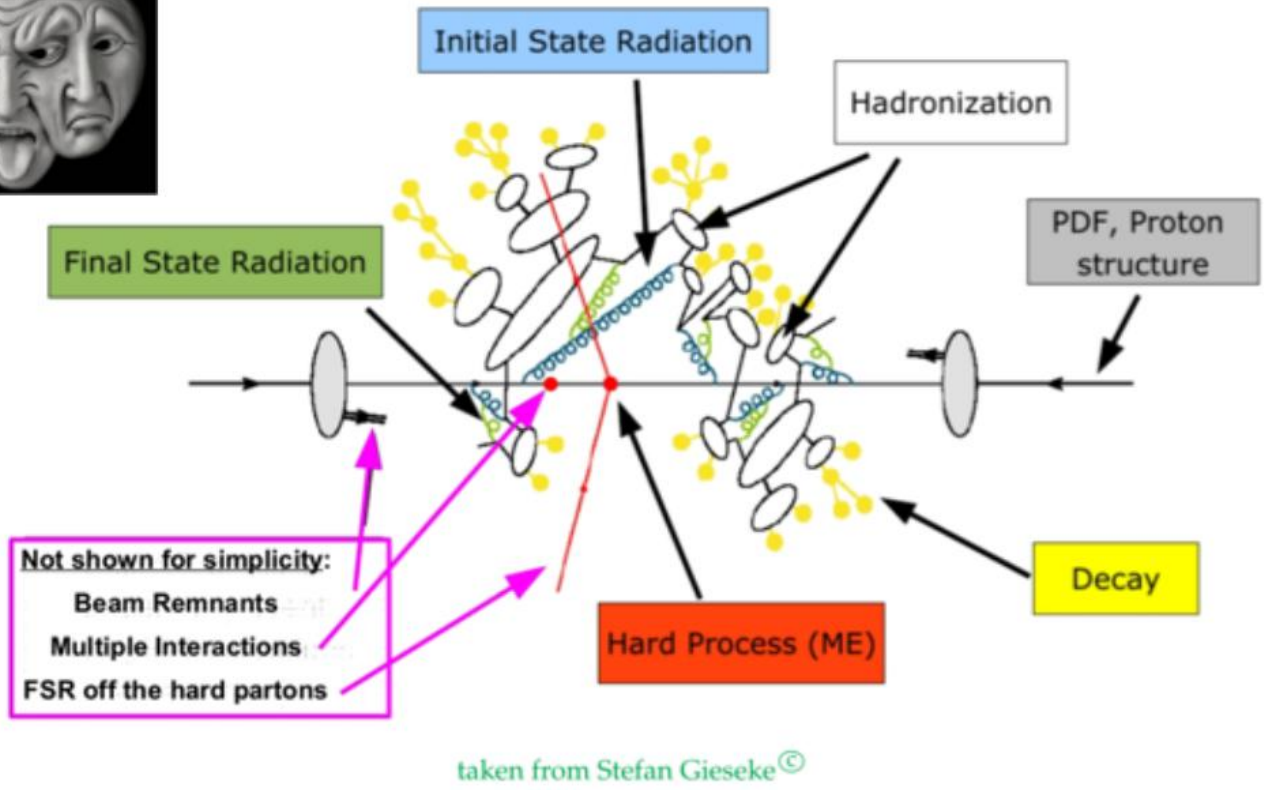
Austin Baty



Multiplicity-differential: vacuum-QCD?

1.Monte Carlo Event Generators (all QCD faces)



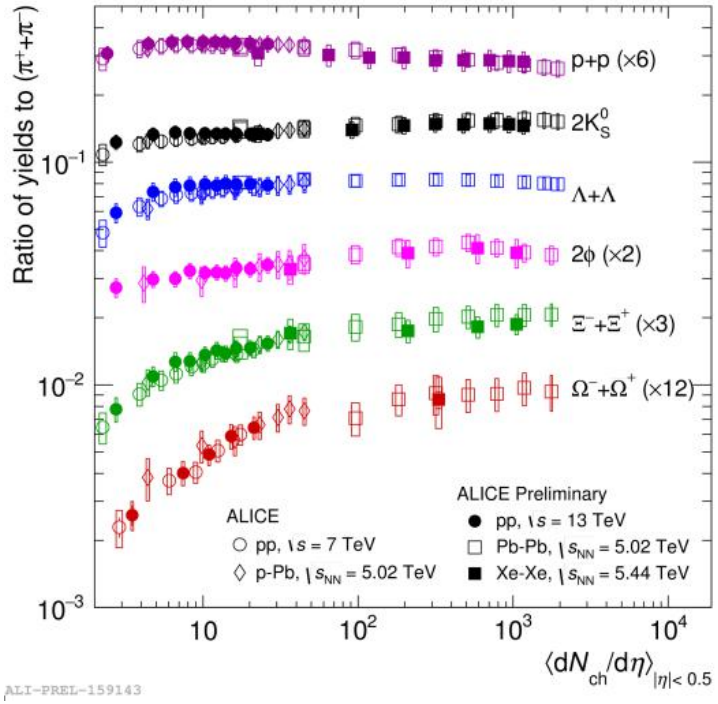


taken from Stefan Gieseke©

The general approach is the same in different programs but the models and approximations used are different.

(c) Mark Strikman

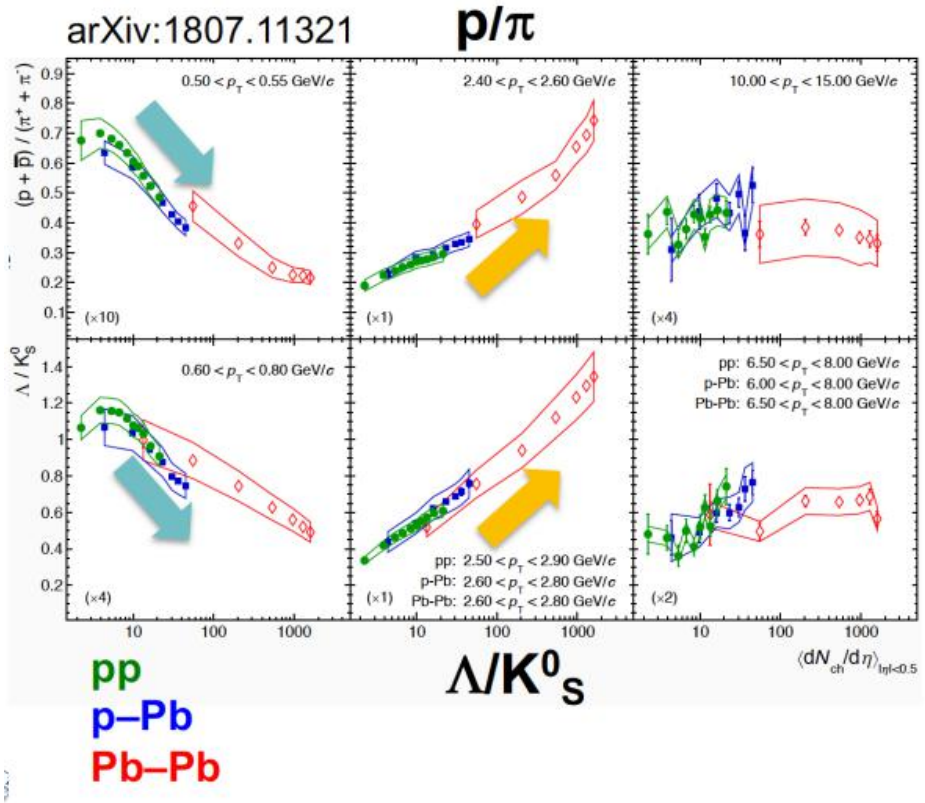
Hadrons vs. multiplicity



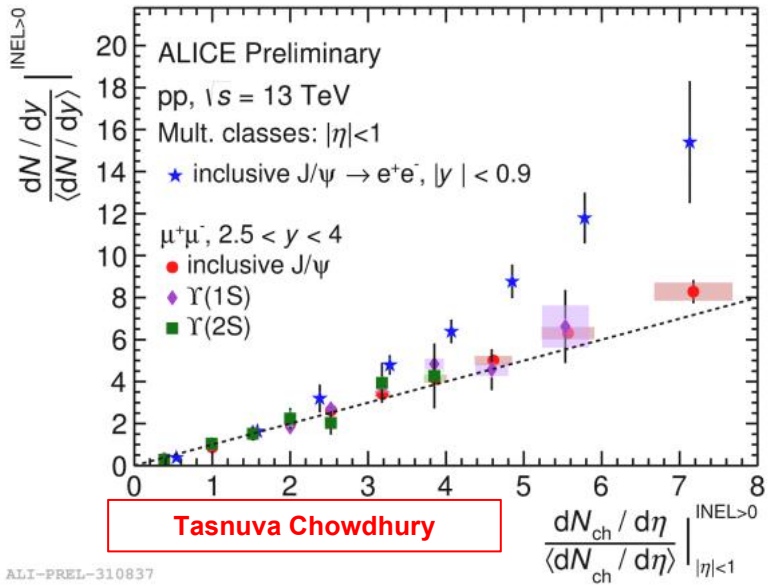
- Baryon to Meson ratio at high Nch
  - Less production at low-pT
  - More at high pT
- *No quantitative understanding*

- Strangeness enhancement
  - no energy dependence,
  - driven by resulting system size

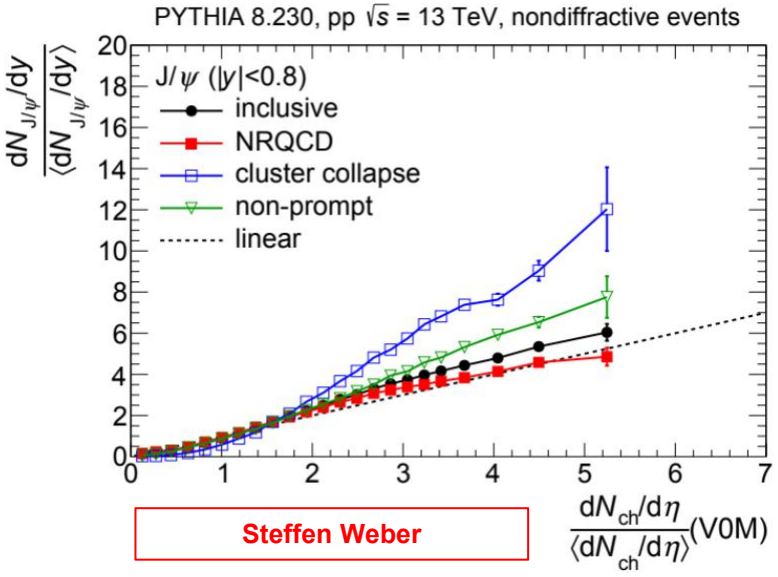
Stefania Bufalino



Enhanced HF production at high mult

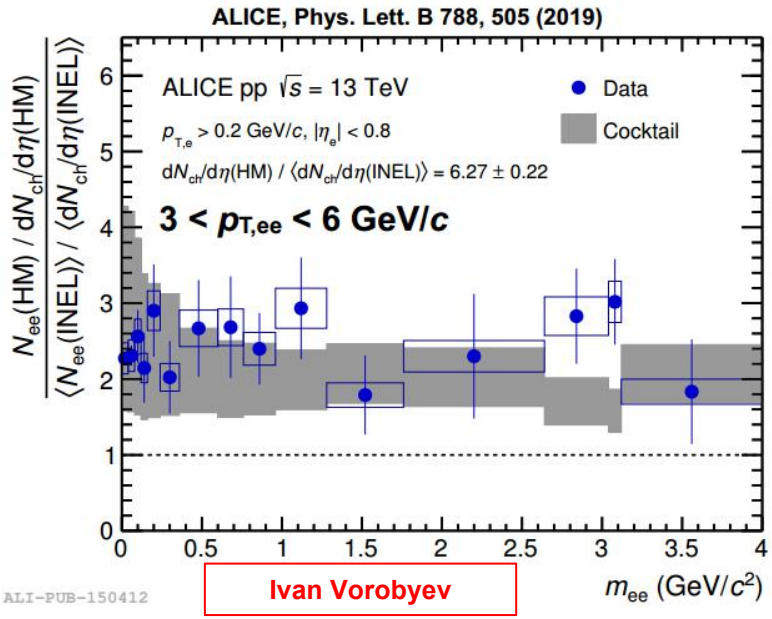


Tasnuva Chowdhury



Steffen Weber

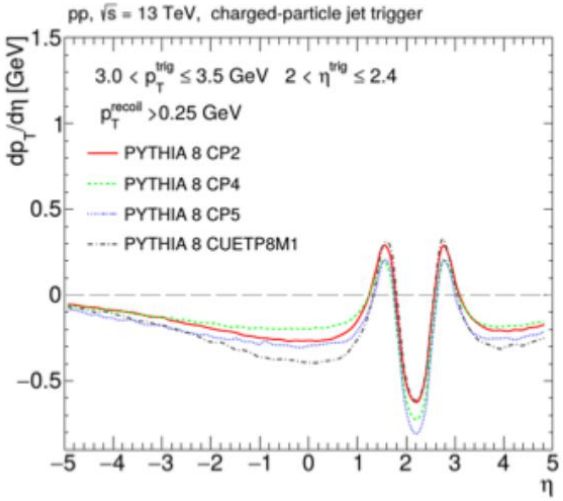
- Data prefers MPI-like mechanism
  - Universal (open/hidden, b/c, c.m.s. E)
  - Detailed modelling to understand different components
  - Beware: auto-correlations
- ***Lack of quantitative understanding!***
- New dielectron measurement
  - Attests to the universal b/c behavior



Ivan Vorobyev

Seeking new observables

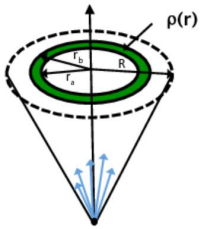
- Minijet correlations:
  - trigger on hadrons production
  - look how pT is balanced, vs. rapidity

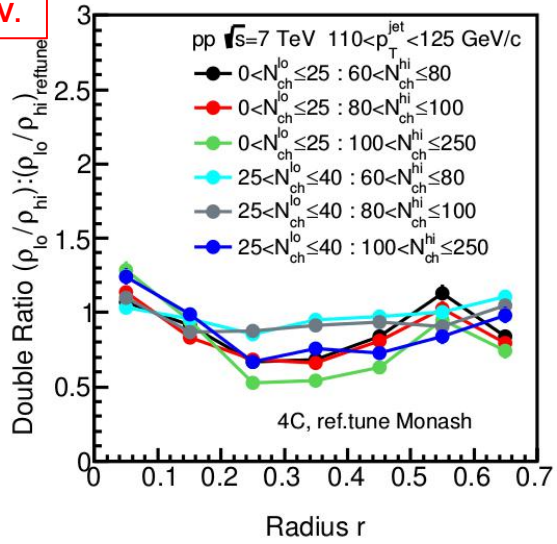


Mark Strikman

- Jet structure vs. Nch

R. V.

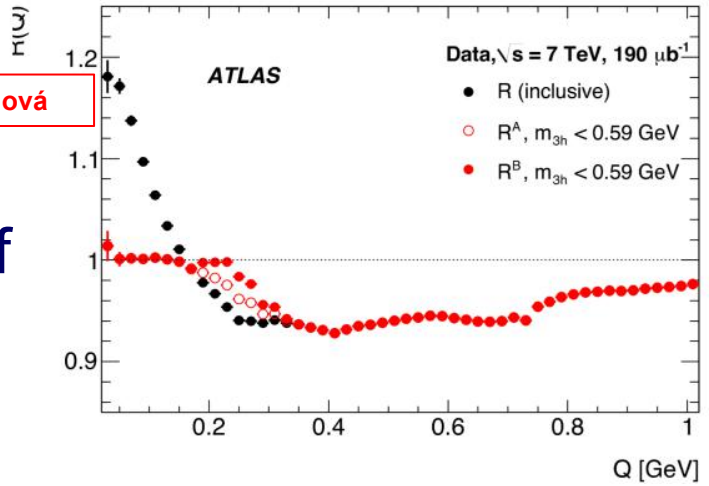




-> Help fine-tuning particular models

Šárka Todorova-Nová

- Alternative approach to BEC: helical QCD string fragmenting into a chain of ground-state hadrons
  - Observables sensitive to predictions



Discussion

- Do we have hydrodynamic evolution in small systems?
- If yes: what effects do the initial conditions have?
- Is there a QGP droplet? What are the best tests to figure it out?
- Or can we describe small systems with vacuum QCD?
- Can we gain fundamental knowledge just from refining models for MPI/CR/fragmentation?
- ...