Heavy-ion group in CERN TH

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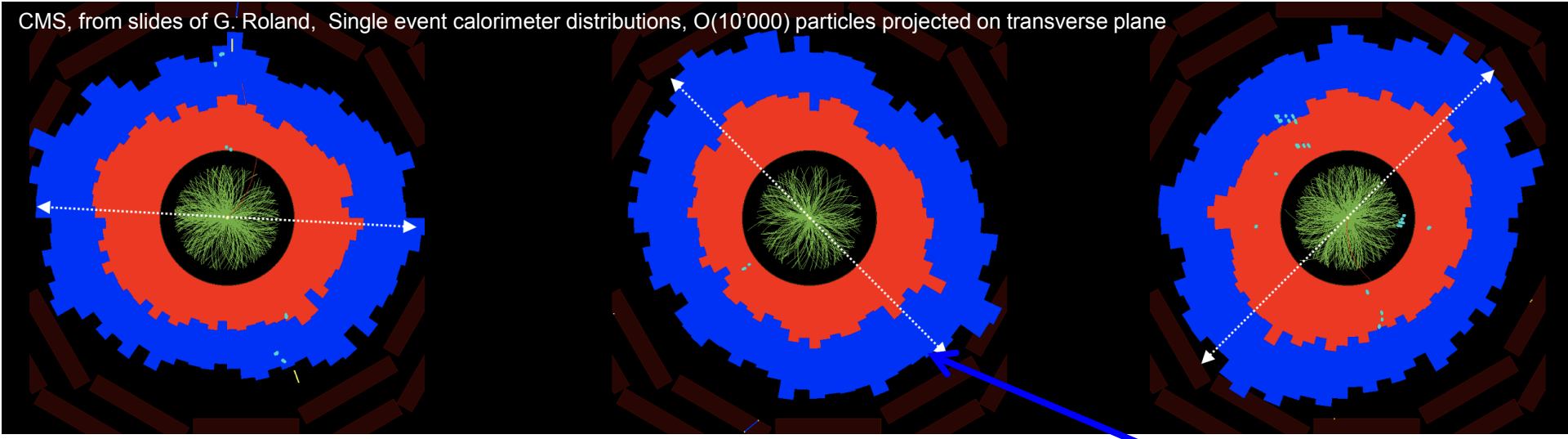
Apologies for not joining the 2019 retreat.
We were in

Heavy Ions

in 5 minutes

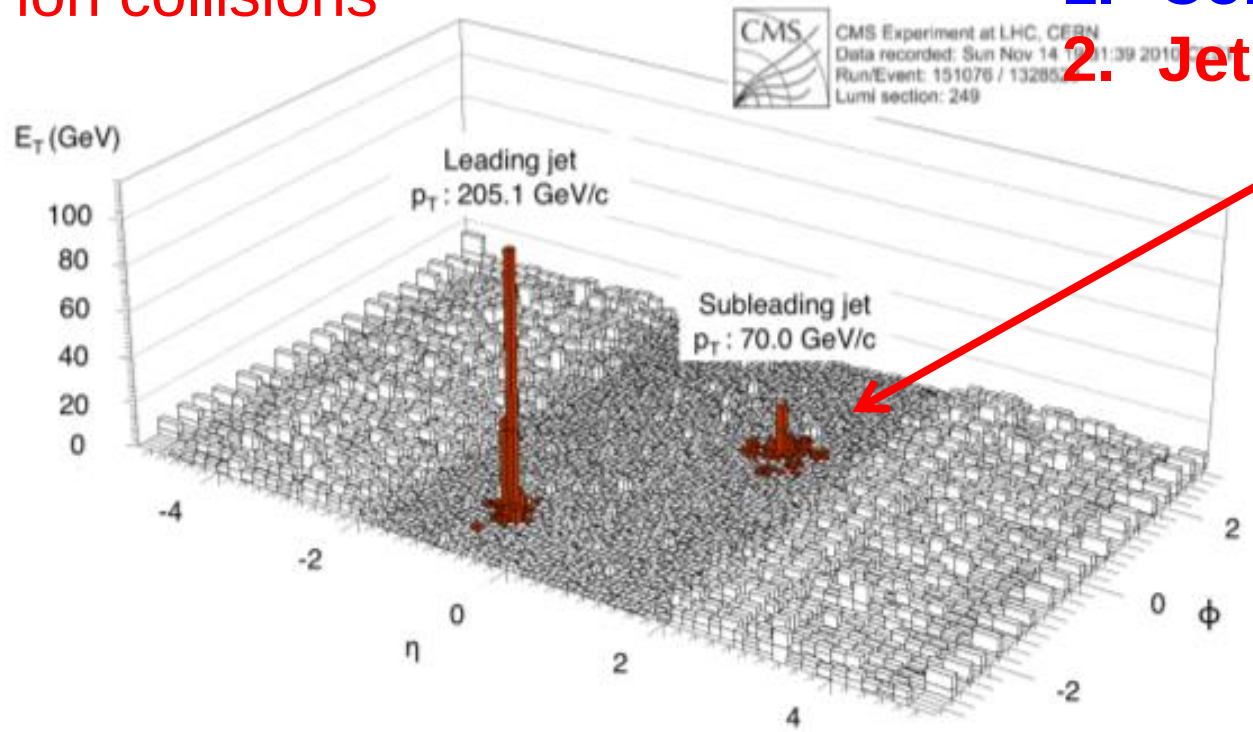
Heavy Ions at LHC

it’s one month per year



Two main characteristics of heavy ion collisions

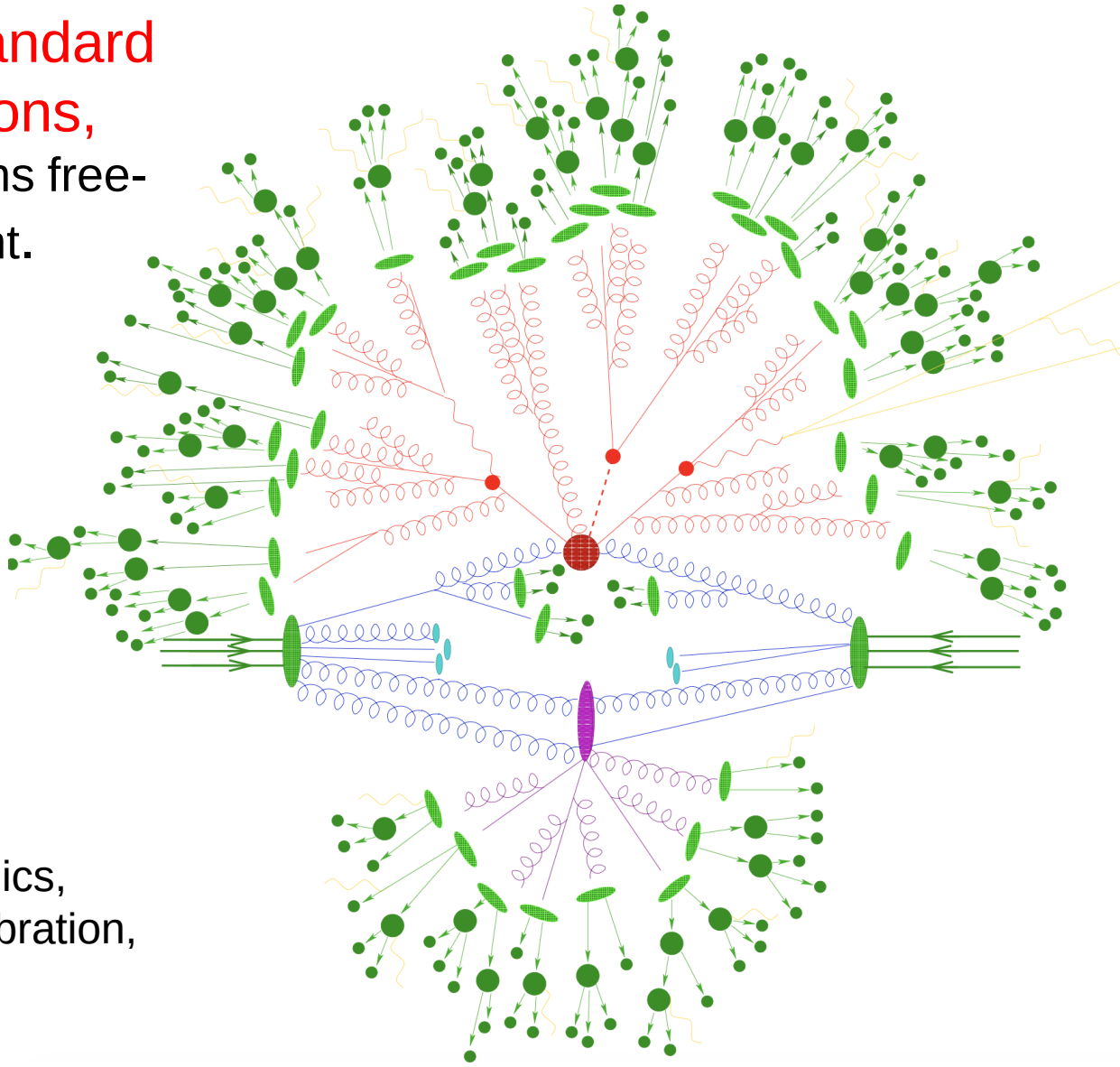
1. **Collective flow**
2. **Jet quenching**



Jet quenching and flow

do not arise in the standard picture of pp collisions,

in which final-state partons free-stream and fragment.

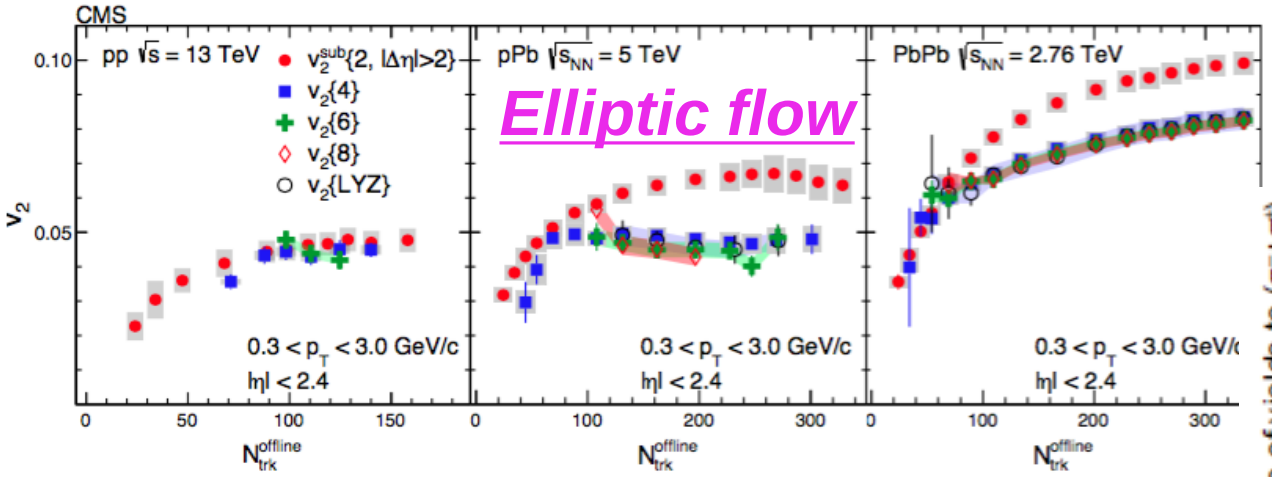


What is missing?

Re-scattering, hydrodynamics,
Kinetic and chemical equilibration,
…

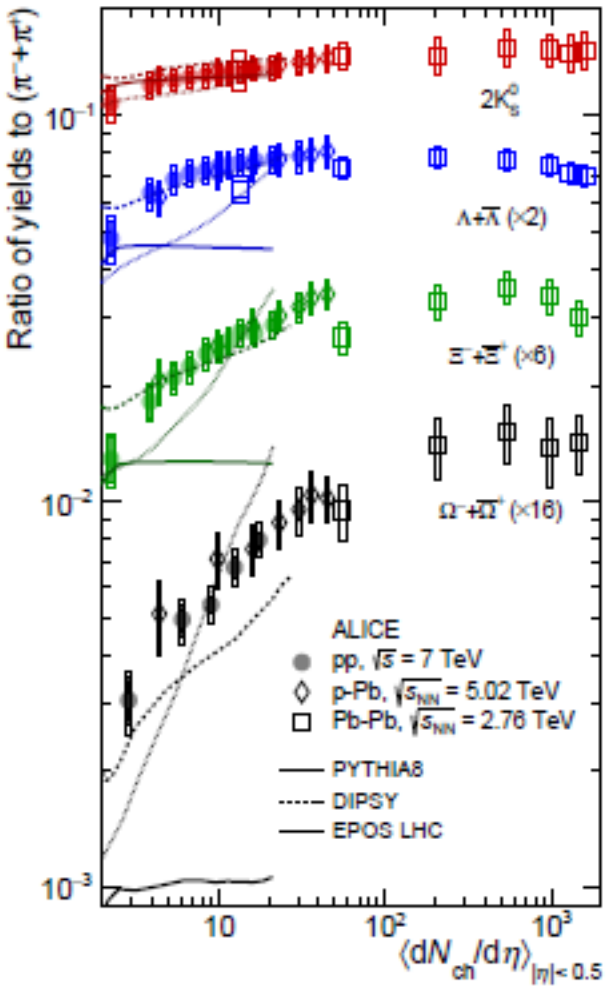
pp - pPb - PbPb @ LHC since 2016

How does collectivity emerge with system size?

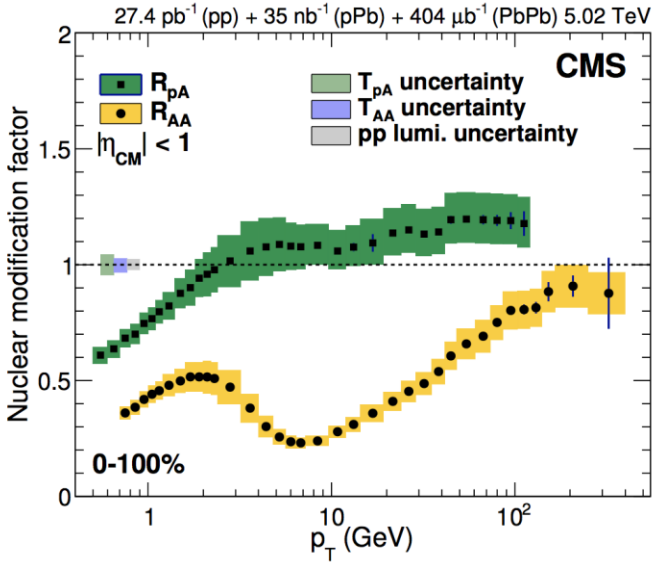


Elliptic flow

Hadrochemical abundances

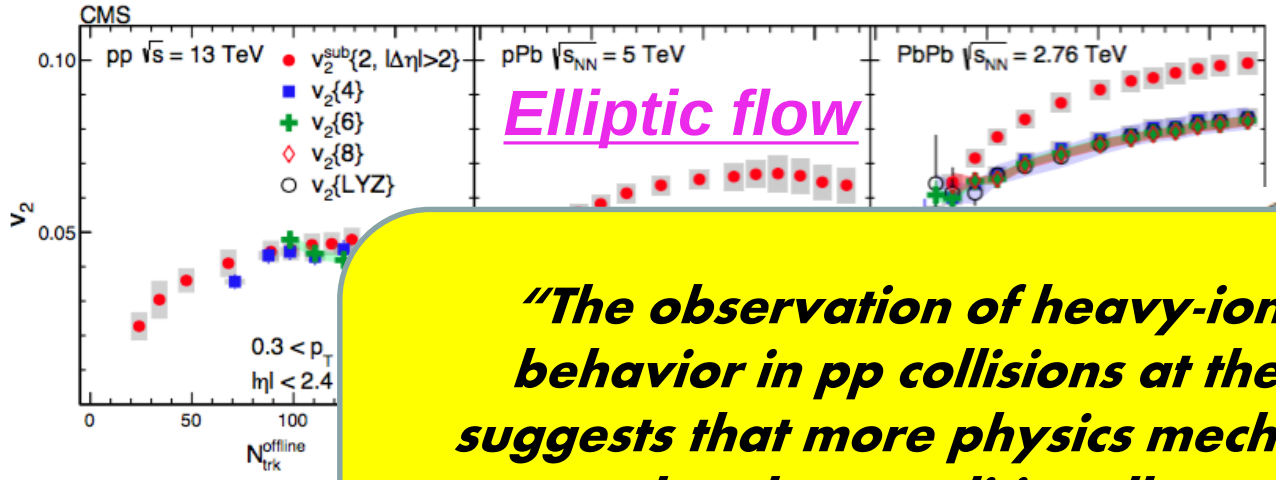


Jet quenching not (yet?) seen in pPb



pp - pPb - PbPb @ LHC since 2016

How does collectivity emerge with system size?



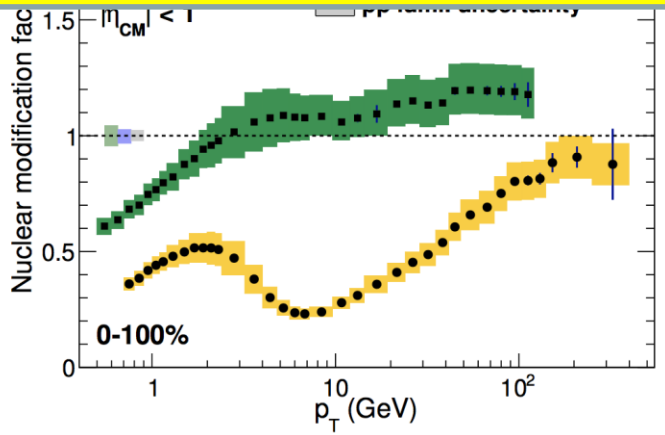
Elliptic flow

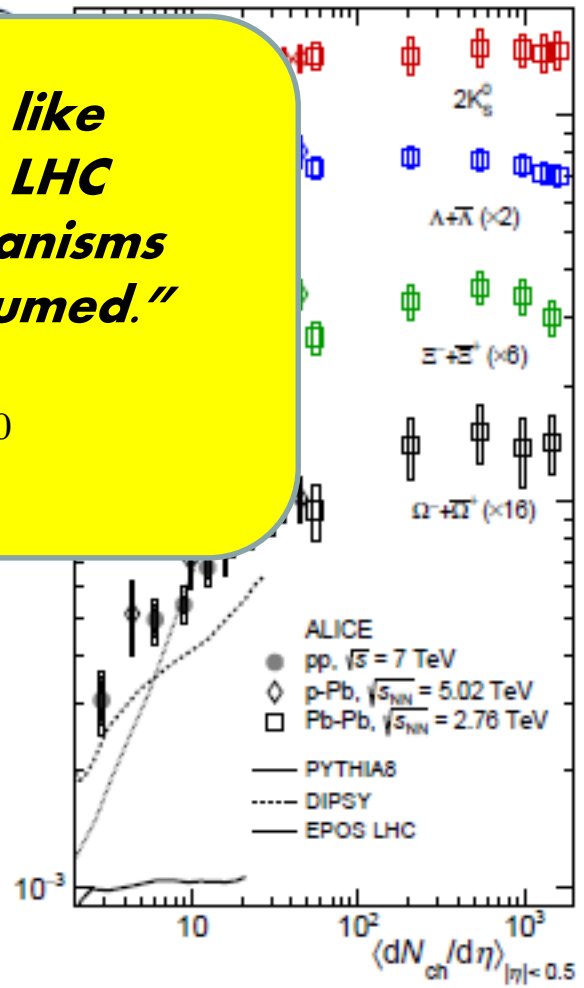
Hadrochemical abundances

"The observation of heavy-ion like behavior in pp collisions at the LHC suggests that more physics mechanisms are at play than traditionally assumed."

Fisher & Sjostrand, JHEP 01 (2017) 140

Jet quench (yet?) seen in pPb





Heavy-ion physics = New physics

= physics yet to be explained

= challenge for theory

Observed phenomena are - numerically large

(above typical QCD-related uncertainties)

- abundant

(multiple phenomenological constraints)

Largest not yet understood phenomena seen at the LHC.

There are many

- jet quenching

- collective flow

- hadrochemistry

- production light (anti)-nuclei

- heavy flavor transport

- ...

Many commonalities with high energy physics:

- sociologically (physics done in the same collaborations)
- technically (common detectors/R&D/ theory concepts)
- future (common trajectories identified in EPPSU)
- science/theory (heavy ion physics is QCD physics)

Questions asked recently

- How does a QFT hydrodynamize and thermalize?
  - at weak coupling
  - at strong coupling

  Jasmine Brewer 1910.00021,
  Aleksas Mazeliauskas, 2005.12299
  Wilke van der Schee 1907.08101
  Maximilian Attems 1703.09681

- Kinetic theory to interpolate between free-streaming fluid dynamic evolutions?

  Bin Wu 2007.06851,
  Maximilian Attems …

- Constraining hydrodynamic models from data

  Aleksas Mazeliauskas 1909.10485
  Wilke van der Schee, 2010.15130

- Testing microscopic dynamics of jet quenching models

  Jasmine Brewer 2008.08596

- Searching for jet quenching in small systems (OO @ LHC)

  Alex. Aleksi, Aleksas, Wilke, Risto 2007.13758, 2007.13754

- Dynamics of light (anti)-nuclei in QCD matter

  Jasmine, Aleksas, Sohyun,

- Electromagnetic radiation in ALICE++

  Sohyun Park

Heavy Ion group

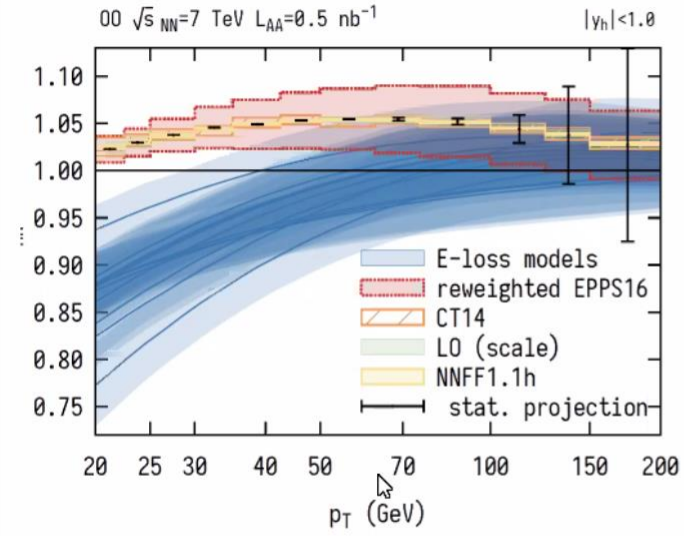
- digests the past
- prepare the future

- What can we learn from OO collisions at the LHC?

Anne Sickles @ APS DNP conf.

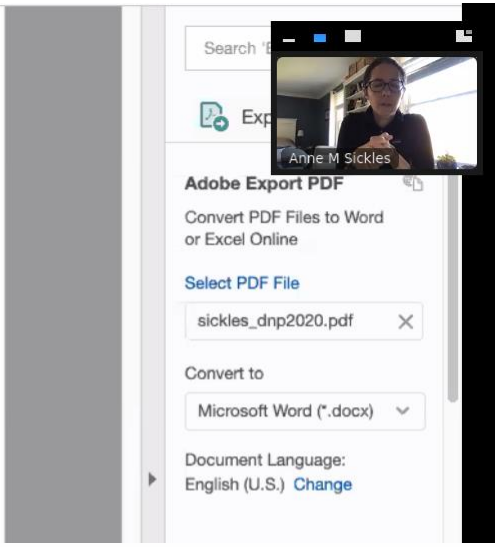
OO impact on jet quenching

2007.13754



0.5/nb → a few hours of LHC running time

light ion running has been proposed by both STAR and sPHENIX at RHIC in the 2020s



OO could provide large enough quenching to observe modifications to hadron R_{AA} at the LHC

what about RHIC?

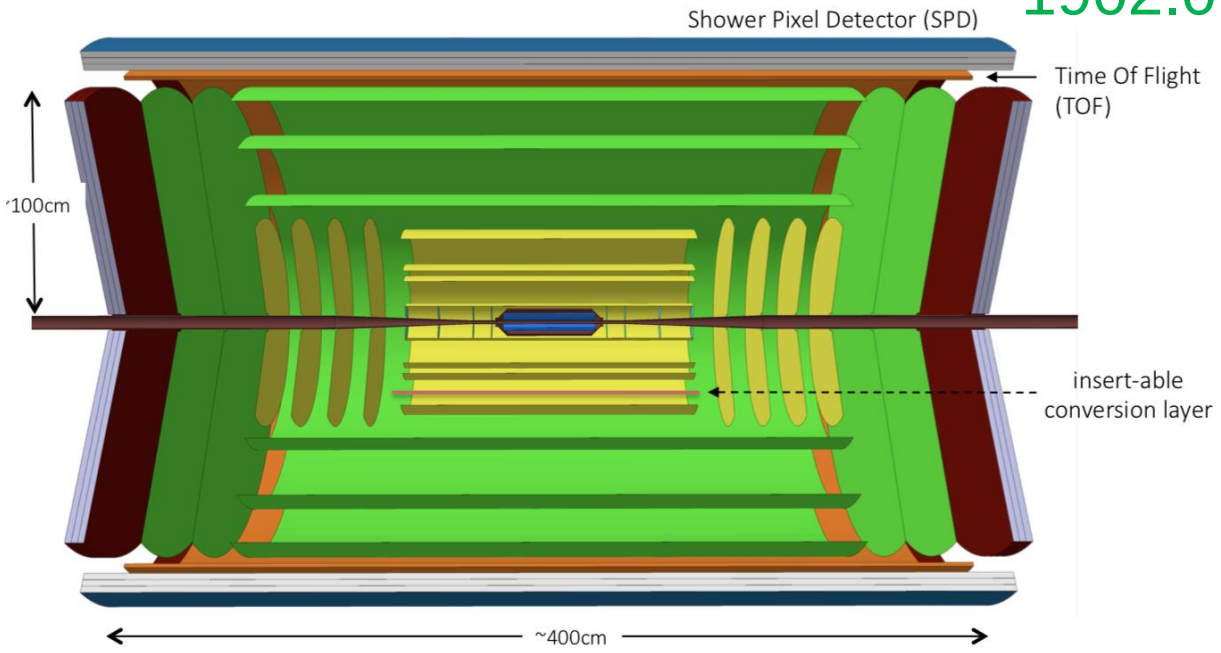
I view OO running at both RHIC (with jet sPHENIX capabilites) and the LHC as essential to understanding jets in the QGP

Heavy Ions in the 2030s @ LHC?

- Ultra-thin silicon sensors, 0.05 % X_0 per layer
- Electron/pion measurements down to pT~10 MeV ?
- …

This may open novel opportunities for heavy ion physics and for high energy physics.

1902.01211



Heavy Ion Group

Group activities in normal times…

- lunches 11:45
- seminars on Mondays at 16:00 (with follow-up at R1)
- https://indico.cern.ch/category/8607/
- Monthly lunch with local ALICE group.

During lock-down-like times:

- Virtual Coffees (irregular chats at 13:30)
- open to everyone interested (email Aleksas for details)
- Post questions on heavy-ions mattermost channel or email th-dep-hi@cern.ch
- Virtual seminars (announced to th-dep-info-seminars)