Roger's Affair with ALICE

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Cashmorefest

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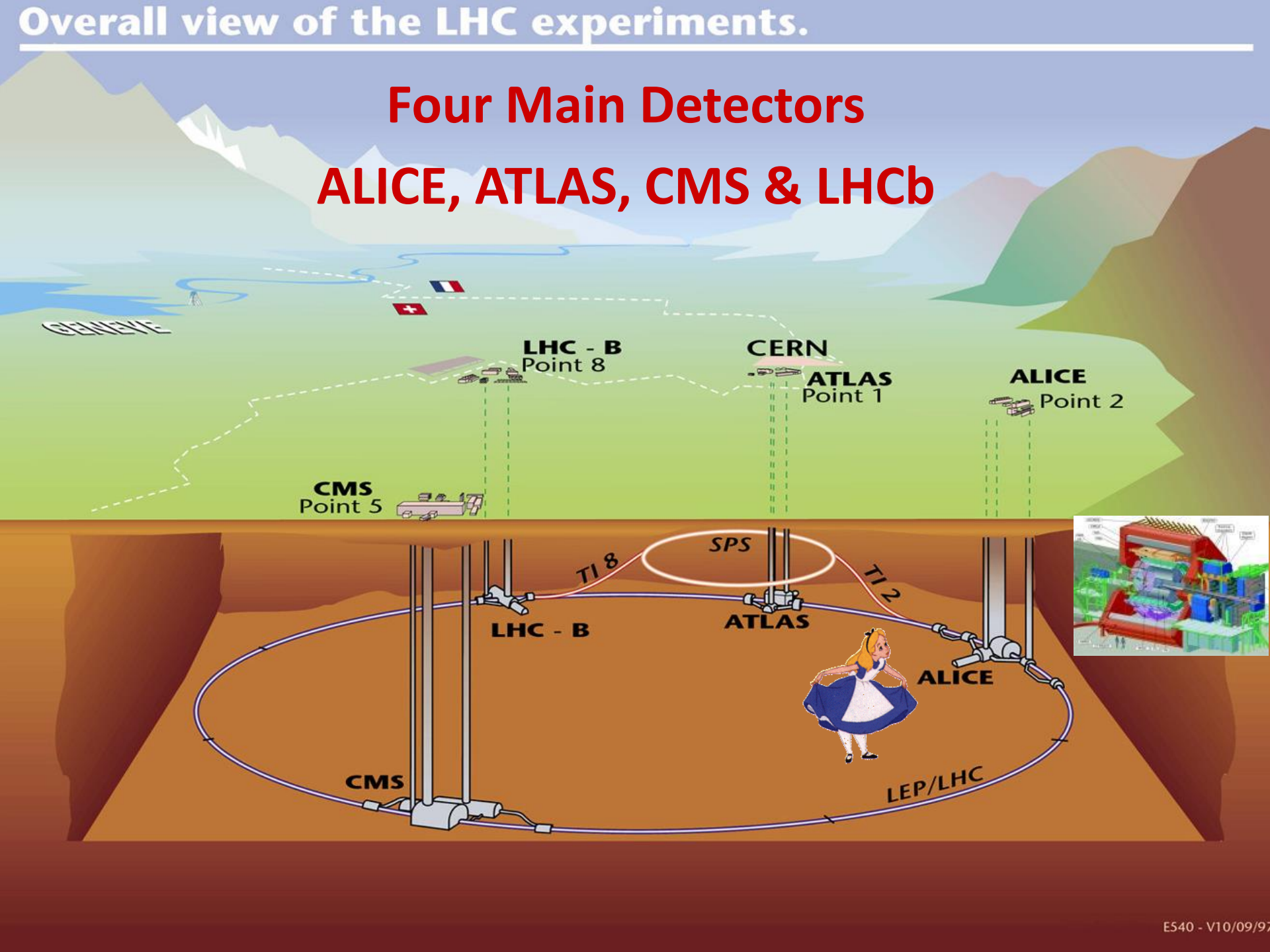
Overall view of the LHC experiments.

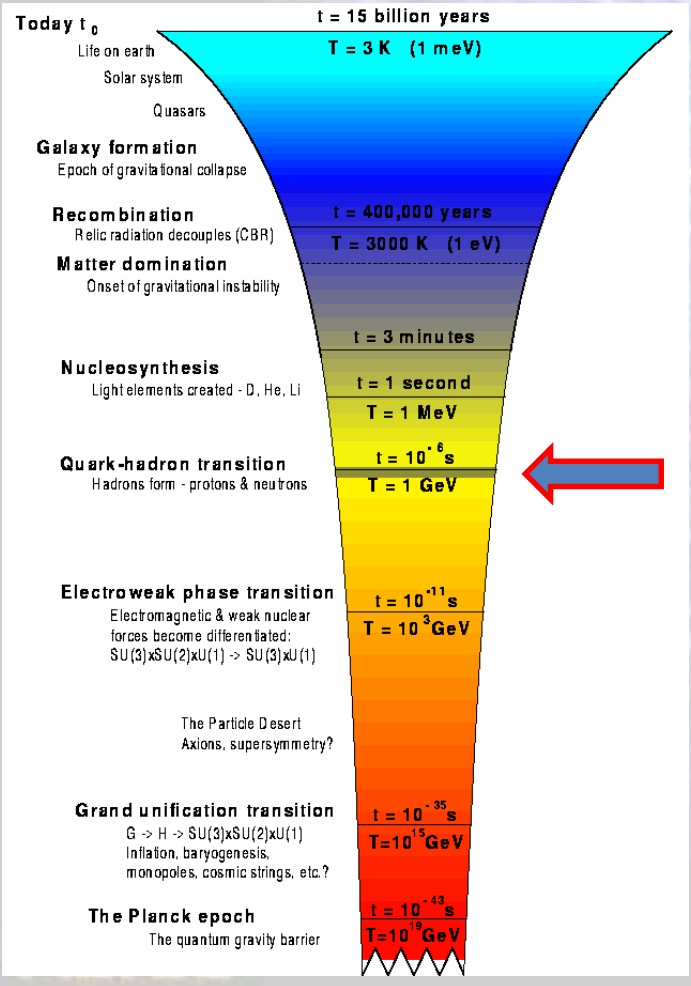
Four Main Detectors

ALICE, ATLAS, CMS & LHCb



Aims of ALICE

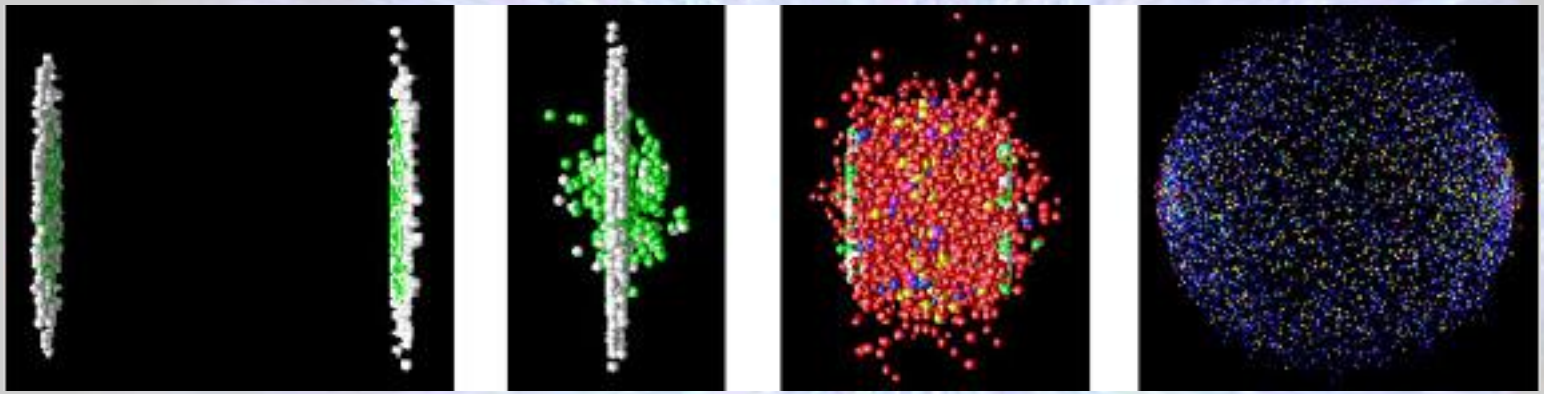
- **We collide lead ions (& p-p, p-Pb) to study QCD at extreme energy densities over large volumes and long time-scales.**

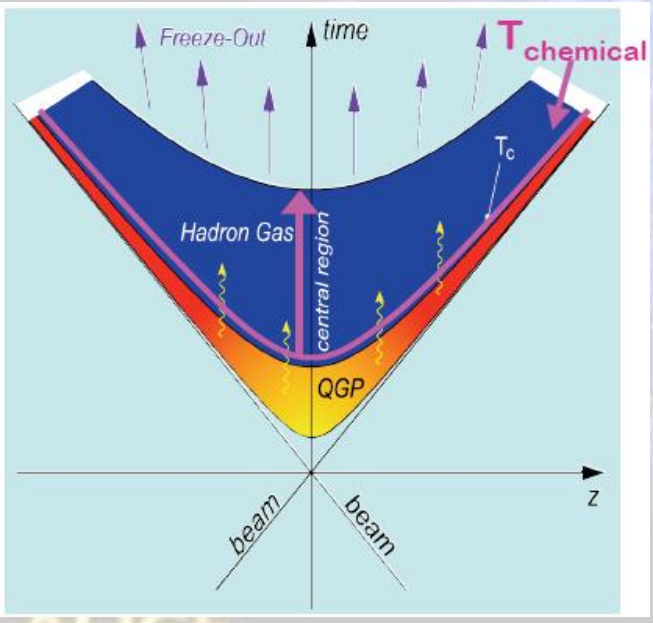


- **Study the QCD phase transition from hadronic matter to a deconfined state of quarks and gluons - The Quark-Gluon Plasma.**
- **Study the physics of the Quark-Gluon Plasma (QCD under extreme conditions).**
- **Gain insight in to the role of chiral symmetry in the generation of mass in hadrons (accounts for ~ 99% of mass of nuclear matter).**
- **and the nature of quark confinement.**

Heavy Ion Collisions

Create QGP by colliding ultra-relativistic heavy ions





pre-equilibration ⇒ QGP ⇒
hadronisation ⇒ freeze out

Colliders: AGS, SPS, RHIC, LHC

$\sqrt{S_{NN}}$ (GeV) = 5.4 19 200 2760 (5130)

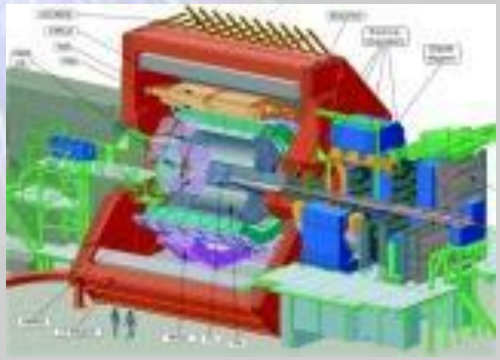
UK and ALICE

- Our task: to design, build, commission, and maintain the ALICE Trigger System.
  - And do physics of course
  - Gives us a high profile within collaboration
- UK (Birmingham) approved to join ALICE in 1999 when PPARC signed the ALICE MoU.
- Since then, some voices in PPARC (and then STFC) have had second thoughts …… and third, fourth and fifth thoughts about staying in ALICE.

The Cashmore Effect

Roger was Director of Research and Deputy Director General at CERN between 1999 and 2004.
He realised the damage a UK withdrawal would cause and the importance of keeping a UK finger in this pie.

So he worked to convince PPARC to continue to support ALICE.



Still here and some Highlights of Run 1 include

- We have measured many of the global features
  - **Phase transition temperature** - Agrees with theory **T_c ~ 164 MeV**
  - **Energy density** - Over 10x critical energy density, **ε > 15 GeV/fm^3** (> 3X RHIC)
  - **size & lifetime** of system ~ **5000 fm^3, τ ~ 10-11 fm/c**
  - **Highest temperature ever measured (from low p_T photon spectrum)**

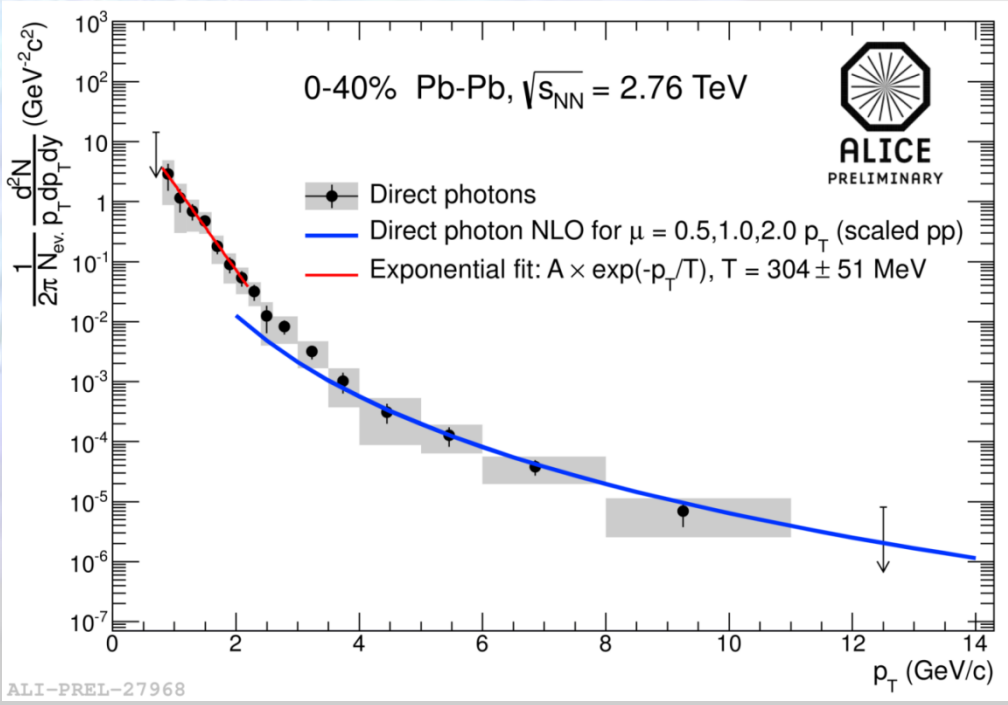
Started to measure dynamical features

Very strong radial flow, $\beta \approx 0.66$

Strong elliptical flow – ideal liquid

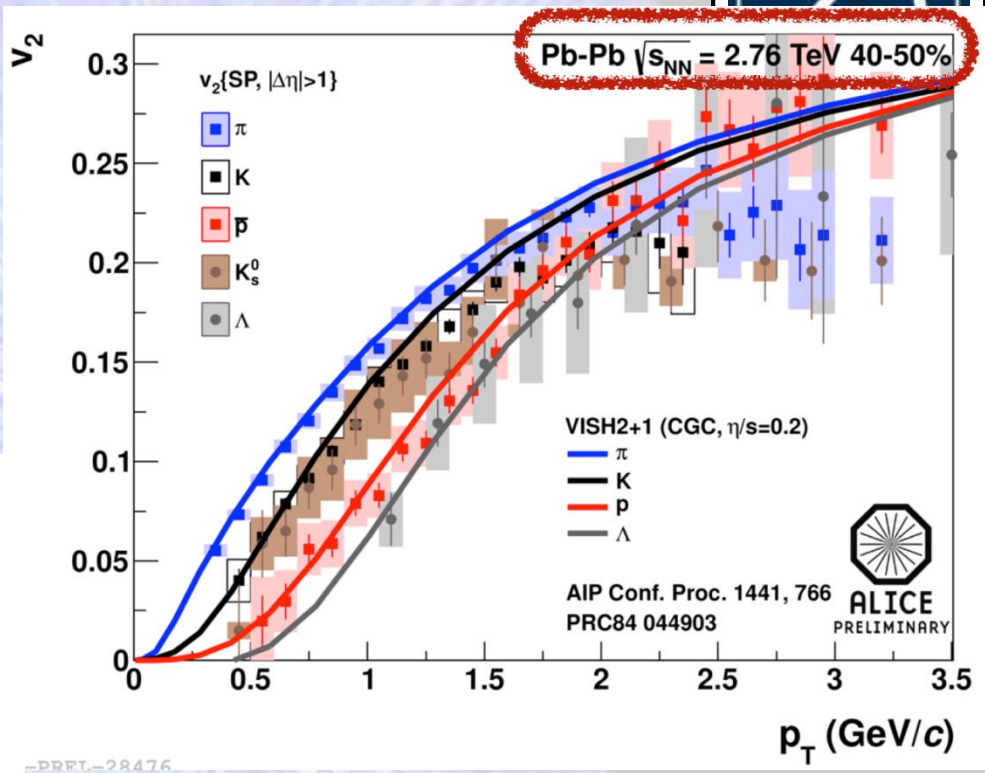
Strong suppression of jets and high p_T particles

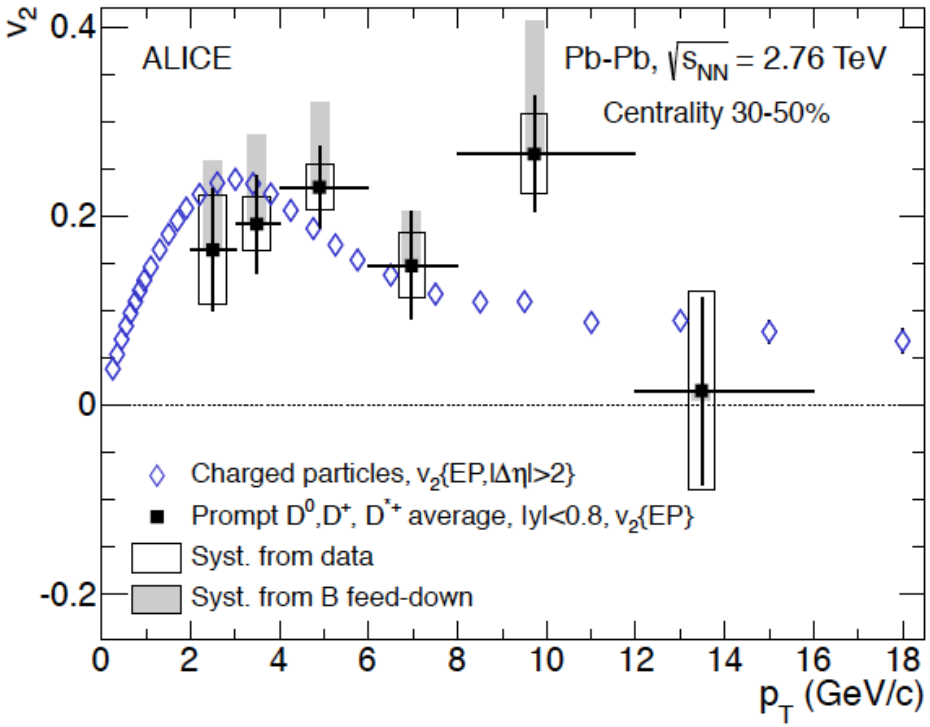
First hint of quark mass dependence on energy loss



Flow – Ideal Liquid

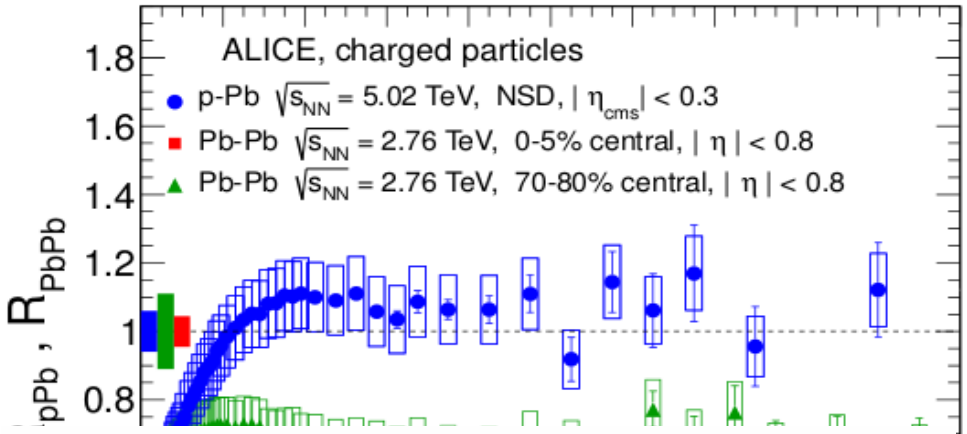
V_2 = elliptic flow
Collective effects of data fit hydro-dynamical models
→ **Most ideal liquid ever created**

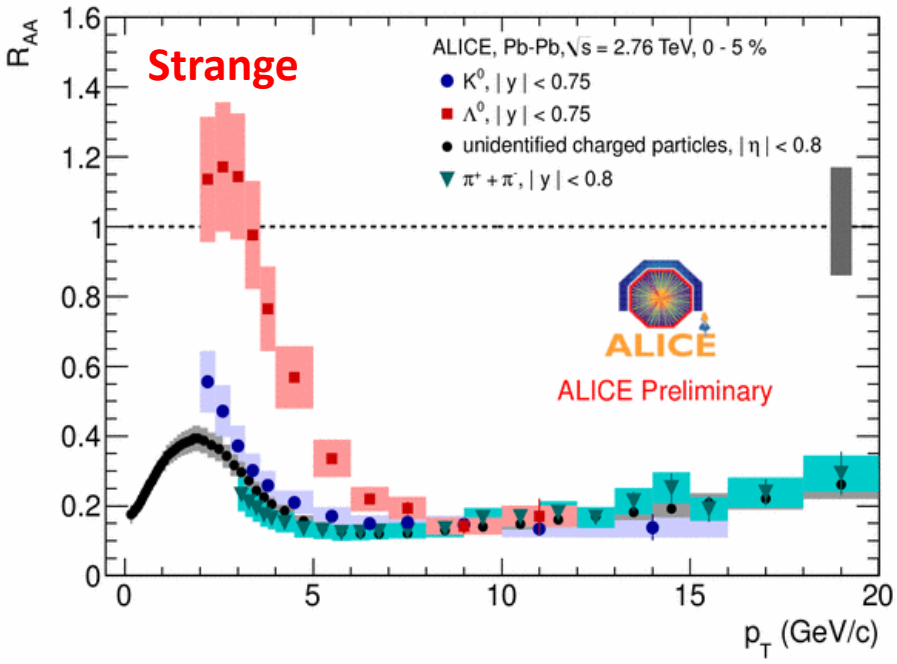




Evidence for flow from D-mesons suggests collective effects from charm.
→ **More data needed (Run 2)**

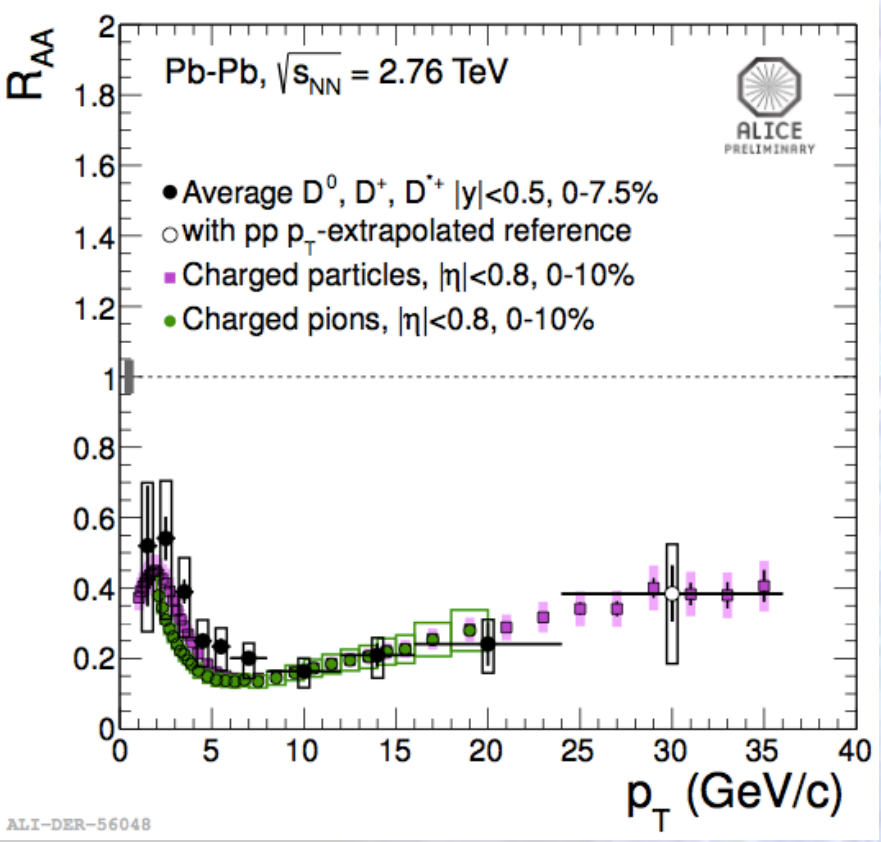
Jet & High p_T Suppression



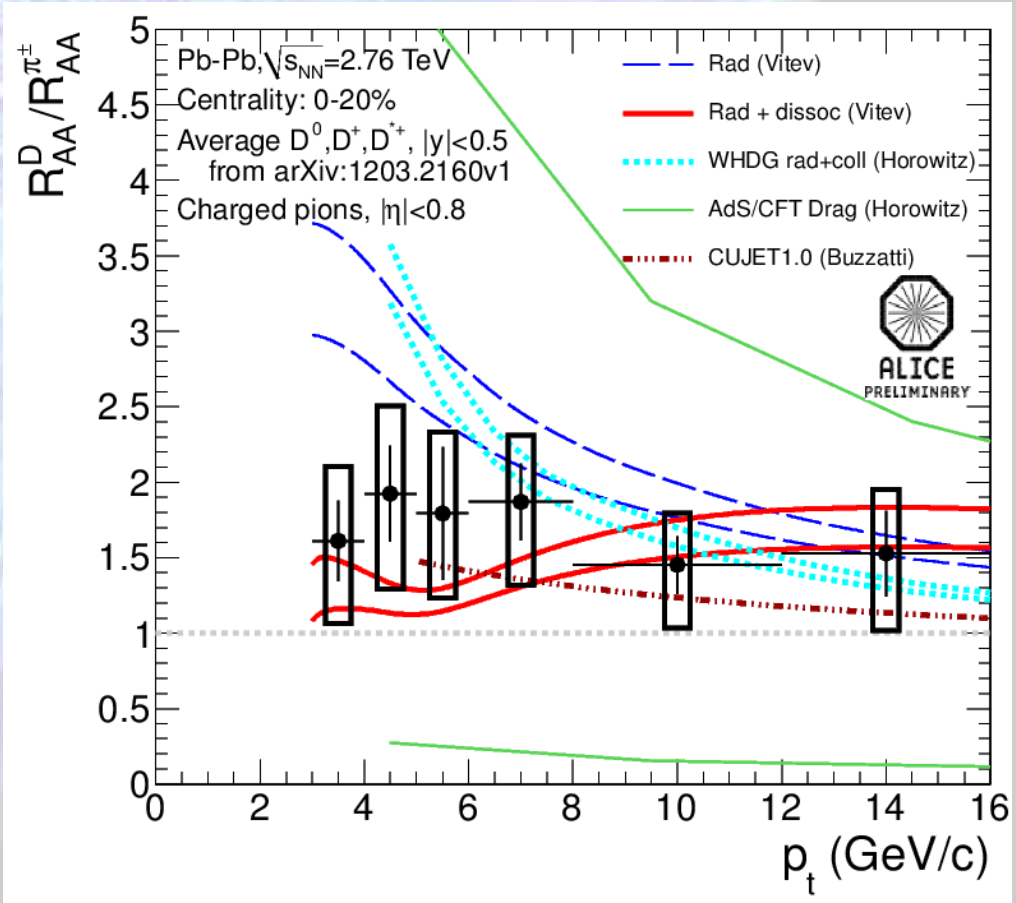


- High p_T particles supressed by factor 7 in central Pb-Pb w.r.t. *weighted* p-p data
- p_T reach high enough to see minimum & then rise (seen for the first time by ALICE).
- No such suppression seen in p-Pb
- Strangeness suppressed by equal amount as lightest flavours (unlike predicted mass dependence)

Jet & High p_T Suppression



- Charm high p_T suppression similar to lighter flavours



- Hint of flavour dependence
  - More stats required (RUN 2)
  - And B physics from Run 3

ALICE and the Future

- Many more results, of course.
  - Indeed, after the 4 Higgs discovery papers the next **three** **highest cited LHC physics papers come from ALICE.**
- Plan to take 10x data in Run 2
- Major upgrade for run 3 (new ITS, Trigger etc) – rare probes and b-physics.
- ALICE has an exciting future and the UK are playing a leading role in that.
- *Thank you Roger*