Two-particle correlations in p-Pb collisions with ALICE

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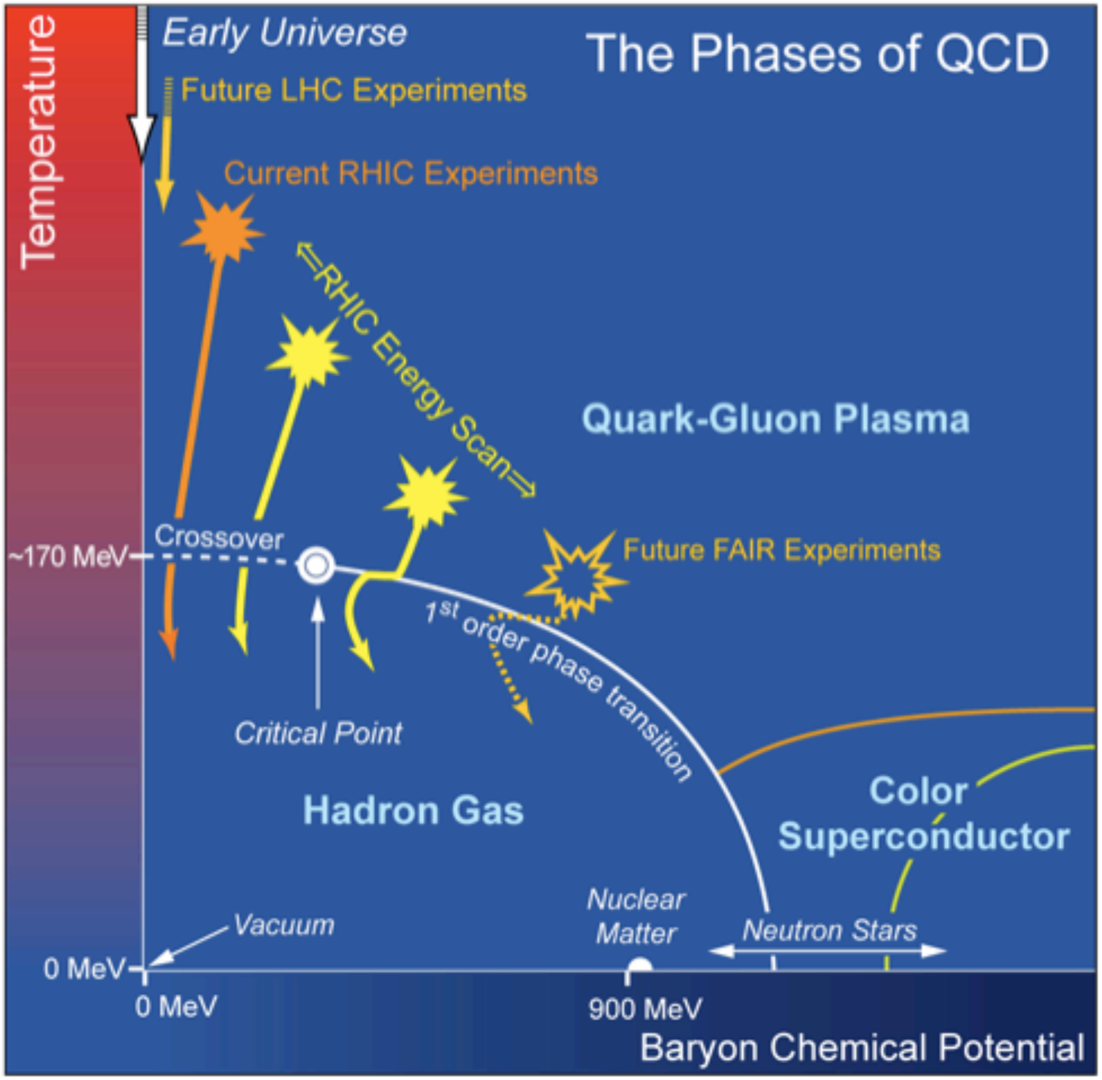
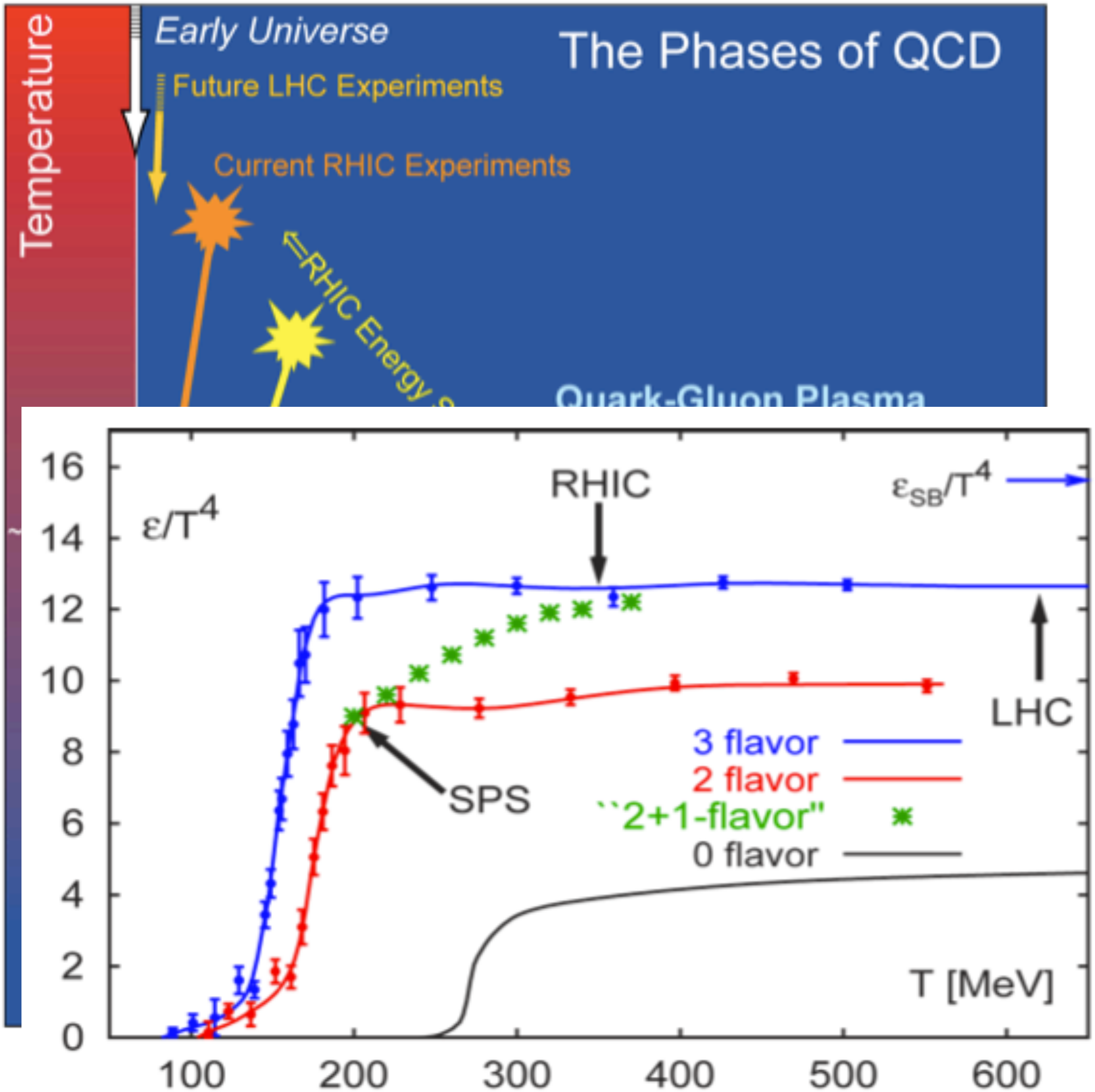
Introduction – Quark Gluon Plasma



- **Quark Gluon Plasma**, a phase of QCD, consisting of asymptotically free quarks and gluons
- Colliding nuclei at high energy to create suitable conditions for "melting" matter into the **QGP**

Introduction – Quark Gluon Plasma

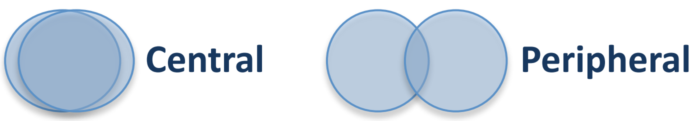


F. Karsch, et al. Nucl.Phys.B605 (2001) 579

- **Quark Gluon Plasma**, a phase of QCD, consisting of asymptotically free quarks and gluons
- Colliding nuclei at high energy to create suitable conditions for "melting" matter into the **QGP**
- Lattice QCD calculations for phase transition
- **Dynamical evolution at RHIC and LHC energies dives deeply into the "Quark-Gluon Plasma" domain of QCD**

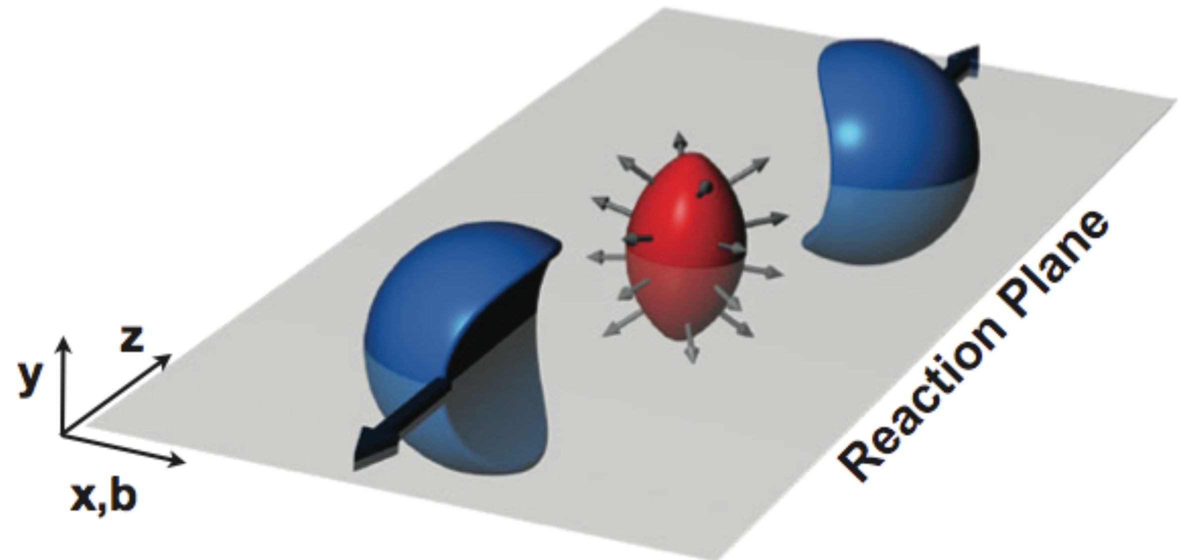
QGP – Anisotropic Flow

- Spatial Anisotropy
  - Almond shaped interaction volume after a non-central collision of two nuclei

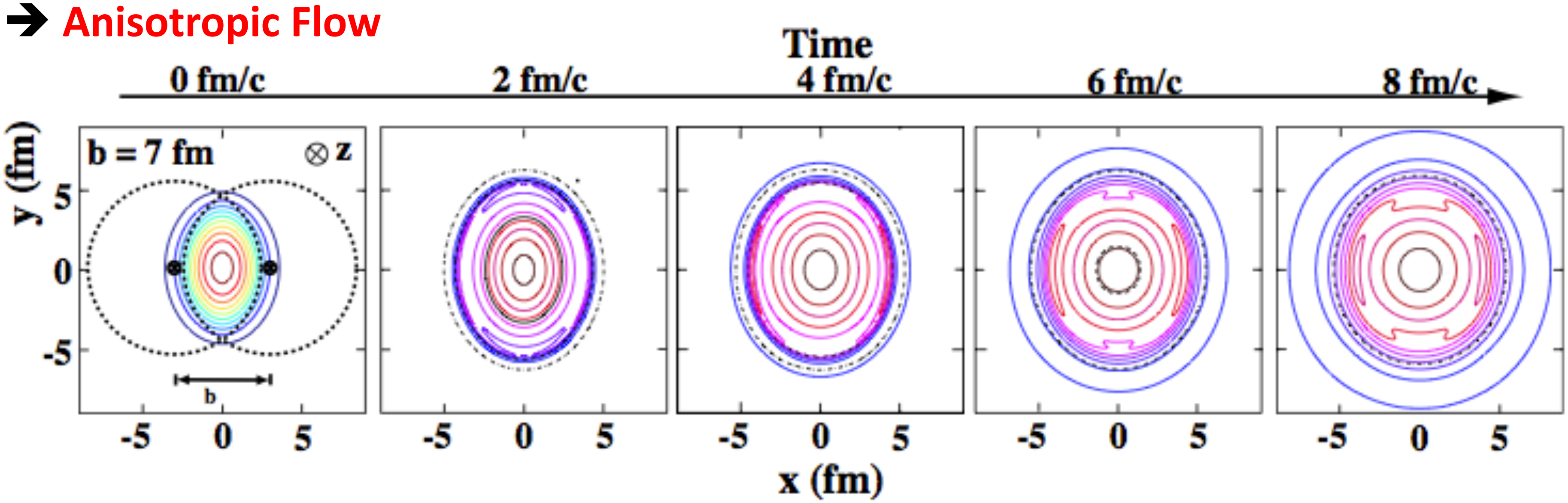


- Spatial Anisotropy translates into a momentum anisotropy of the produced particles

  → **Anisotropic Flow**



R. Snellings, New J.Phys.13:055008,2011



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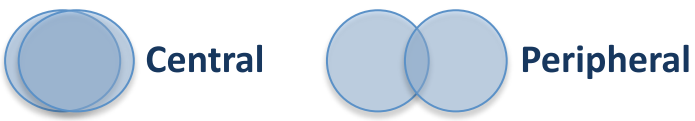

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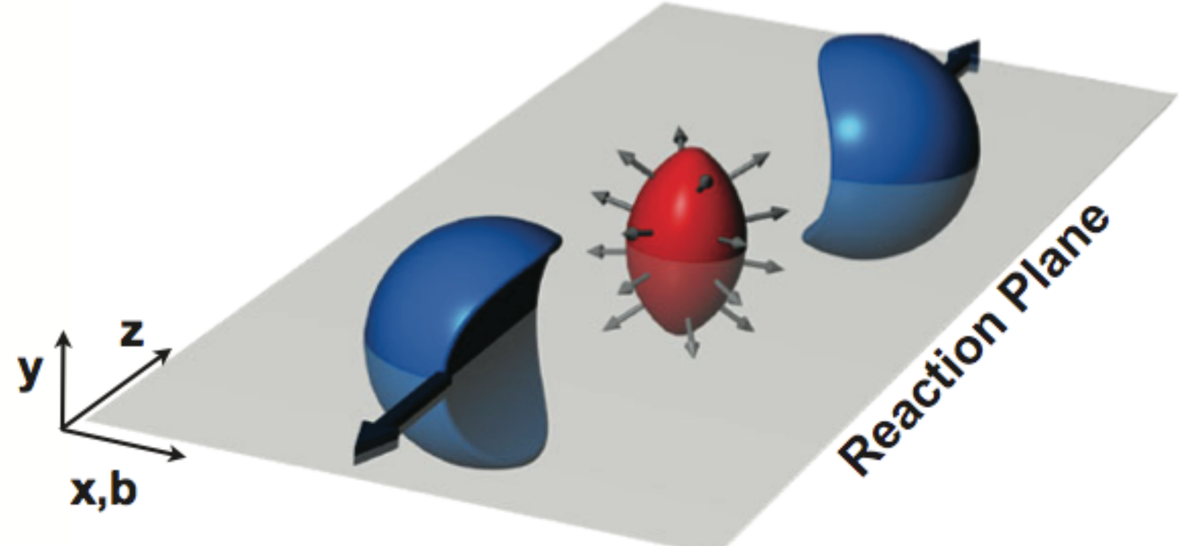
  ➔ **Anisotropic Flow**



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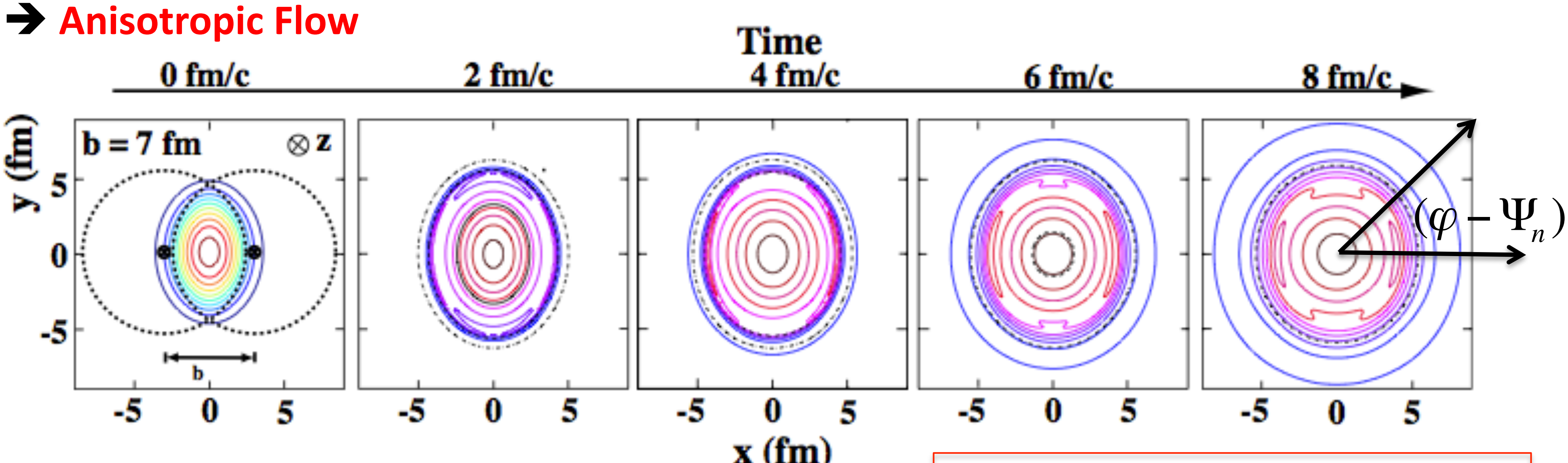
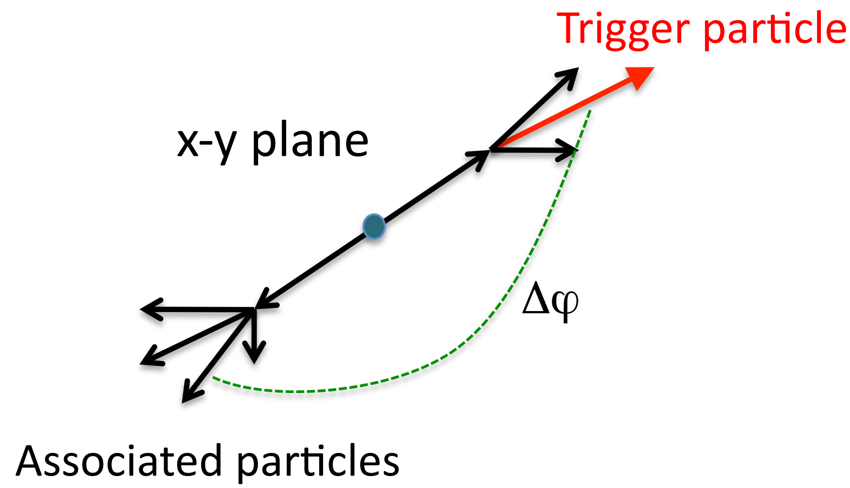
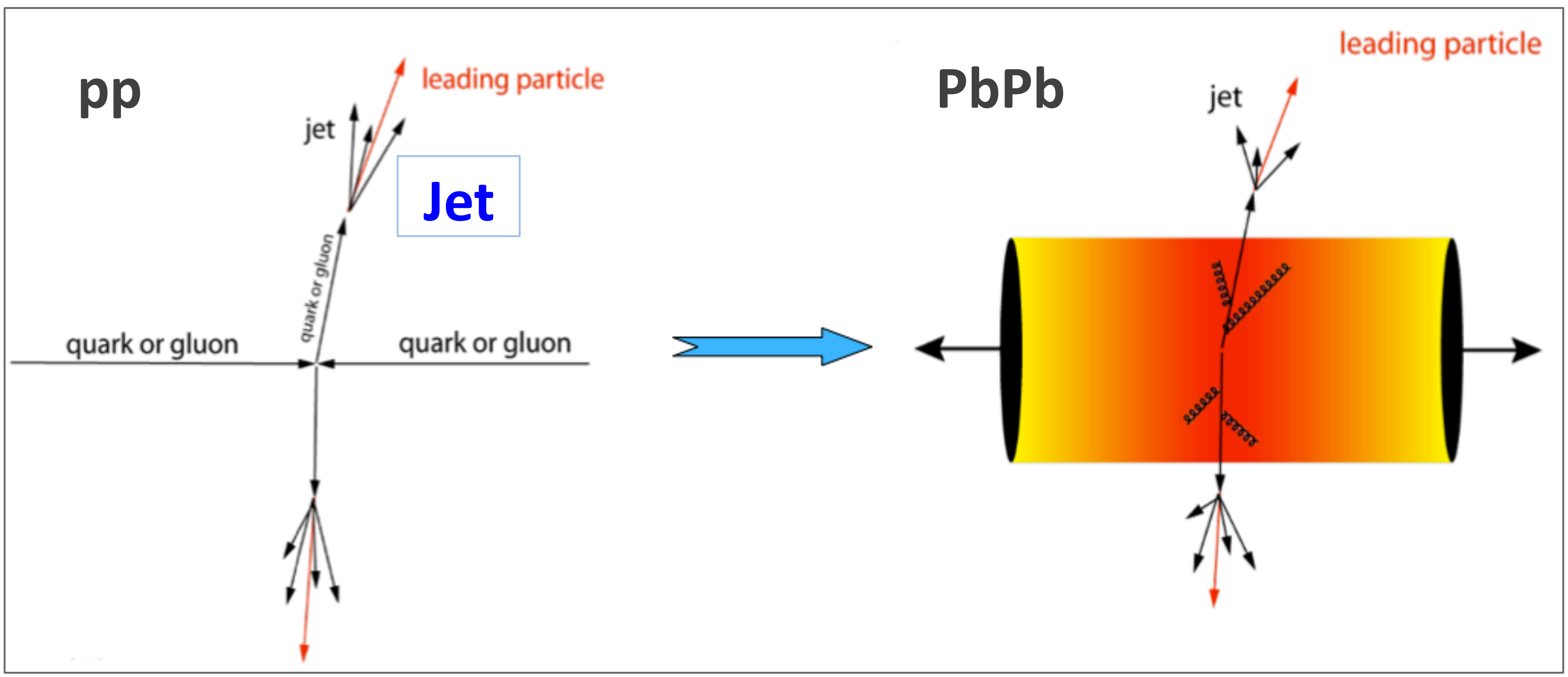


$$\frac{dN}{d\varphi} \propto 1 + \sum_{n=1}^{\infty} 2v_n(p_T)\cos(n(\varphi - \Psi_n))$$

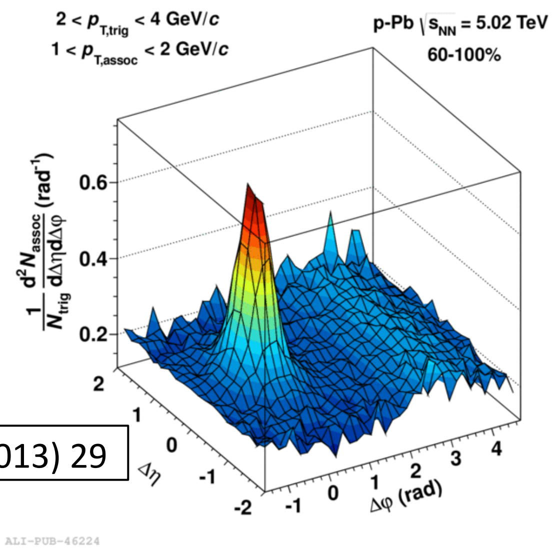
Two-Particle Correlations

- Two-particle correlations have been used as a tool to explore particle production mechanisms in collisions
- Angular correlation (Δφ, Δη) between trigger particle and associated particles



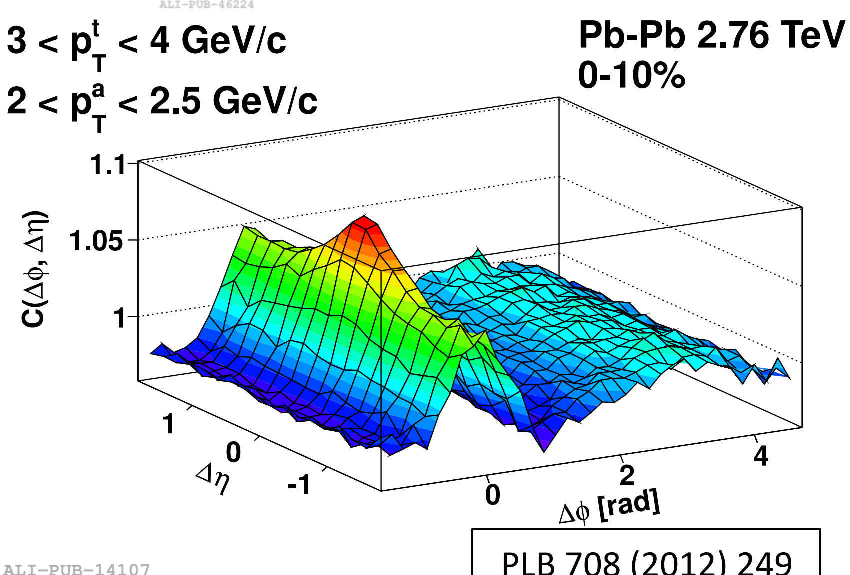


Two-Particle Correlations



PLB 719 (2013) 29

- **pp** and low multiplicity **p-Pb**
  - ✓ Dominated by near-($\Delta\varphi \sim 0$) and away-side ($\Delta\varphi \sim \pi$) jet structures



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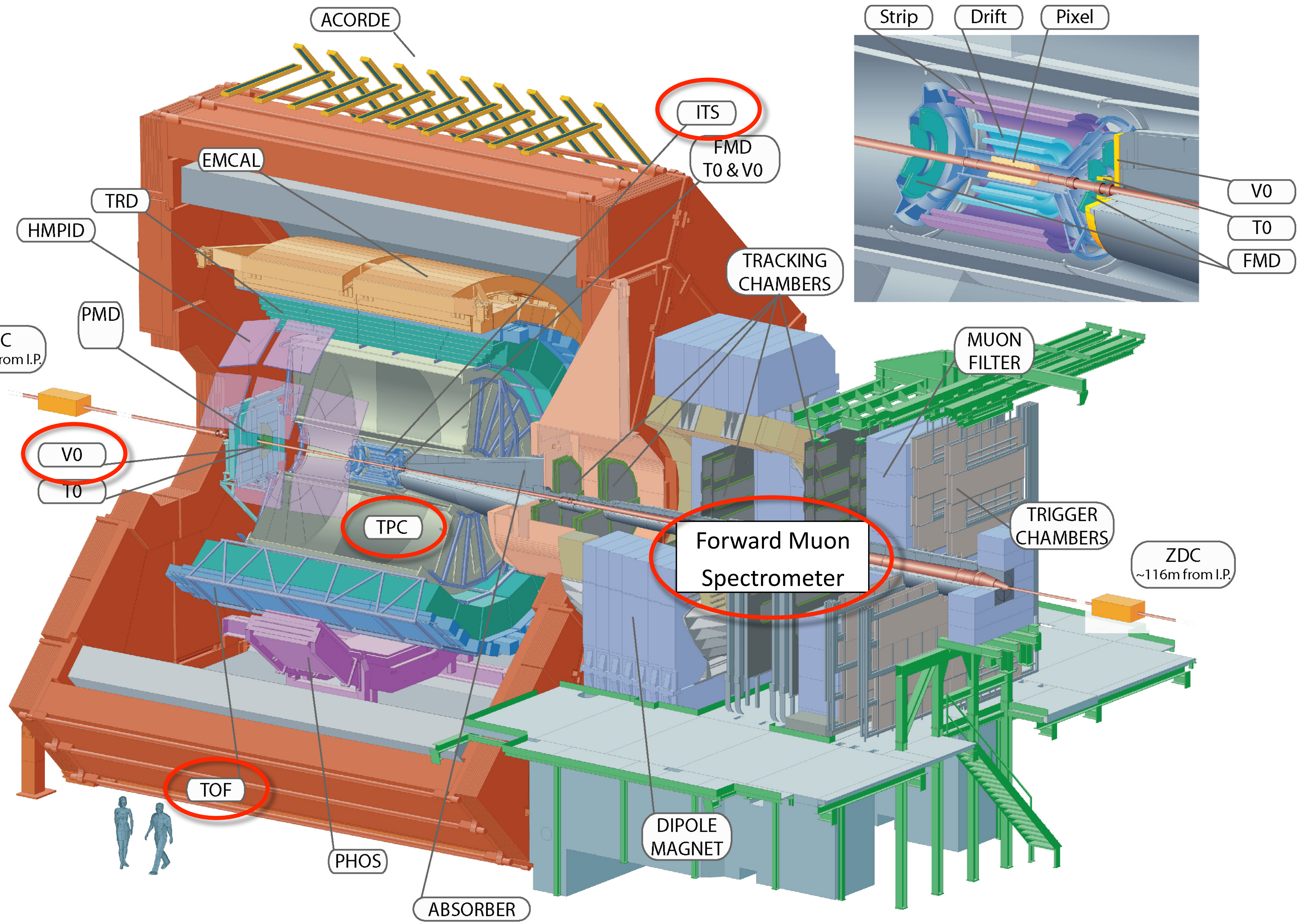
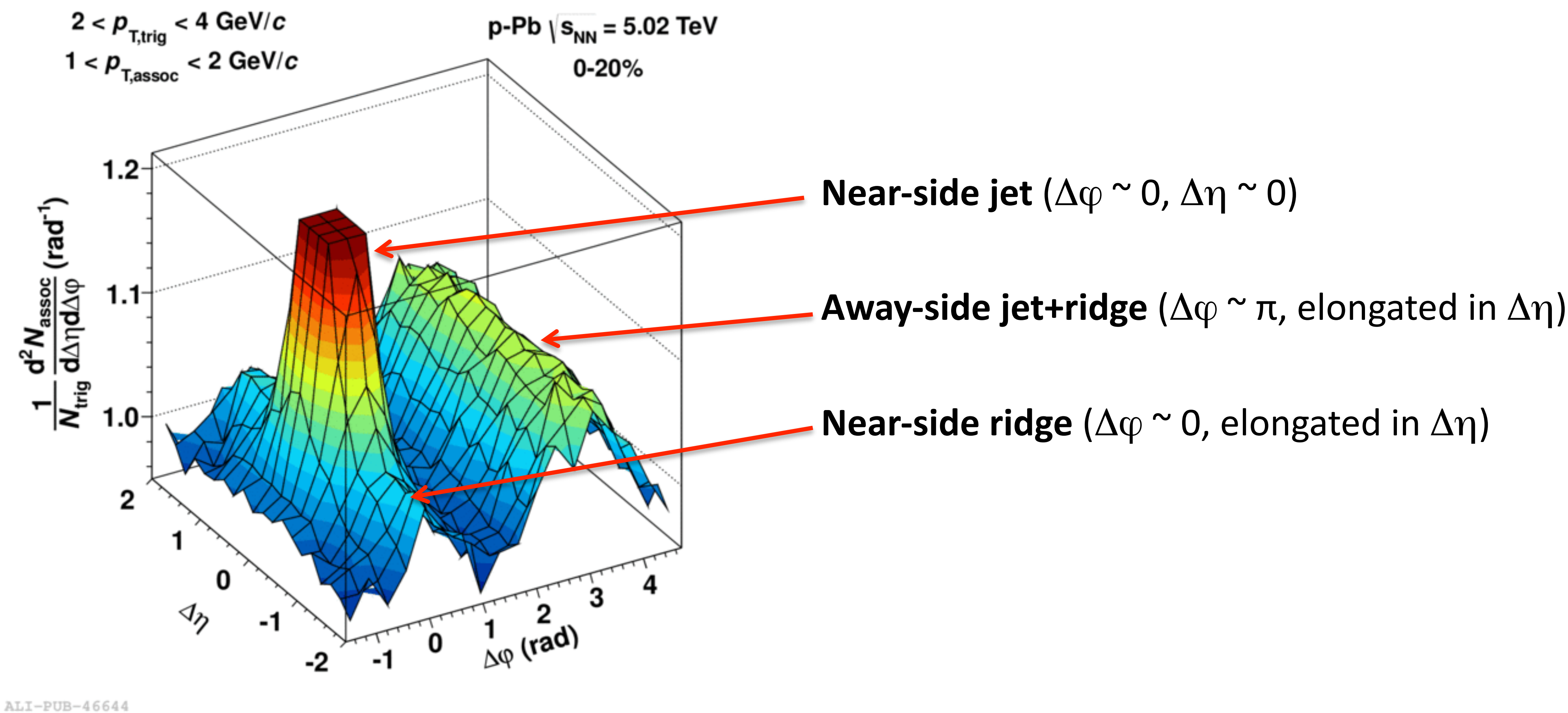
- **Pb-Pb**
  - ✓ Near-side : jets + resonances
  - ✓ Away-side jets
  - ✓ Near-side ridge and away-side structure : collective effects, e.g. anisotropic flow

p-A collisions : Access initial state effect + A reference for heavy ion studies

ALICE Detector



First Look at Correlation Function in p-Pb



- Highest multiplicity p-Pb (Zoomed in)
  - Near-side ridge appears (also, very high multiplicity pp (JHEP 09 (2010), 091))
  - Higher yields on both near- and away-side than lower multiplicity cases

Two-ridge Structure

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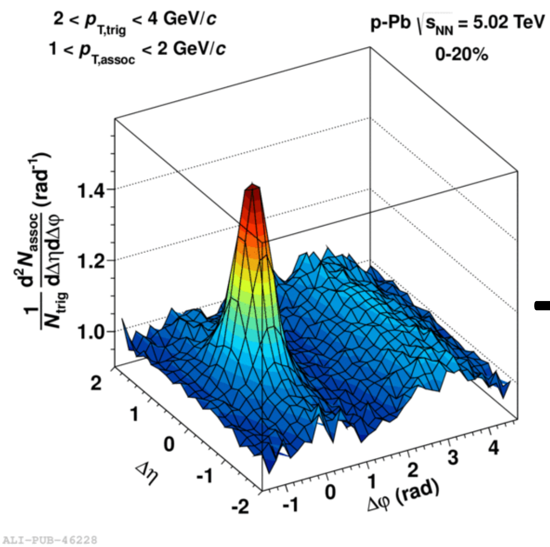
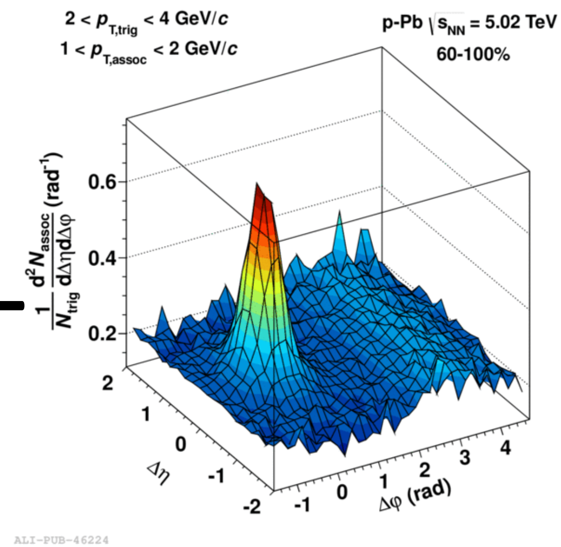


0-20% (Highest Mult.)

(Jet + Ridge)

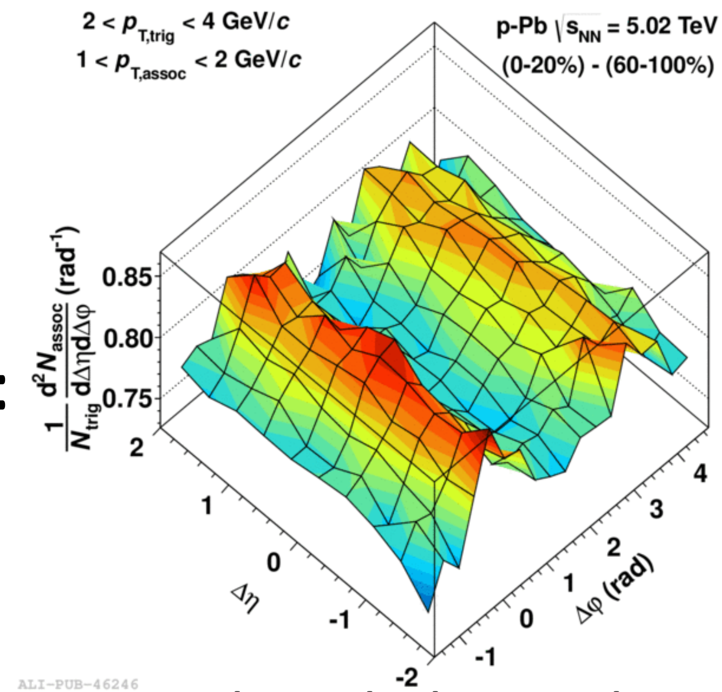
–



60-100% (Lowest Mult.)

(Jet)

=



(0-20%) – (60-100%)

Two-ridge structure

- Two-ridge structure from ALICE di-hadron correlations analysis in p-Pb

Two-ridge Structure

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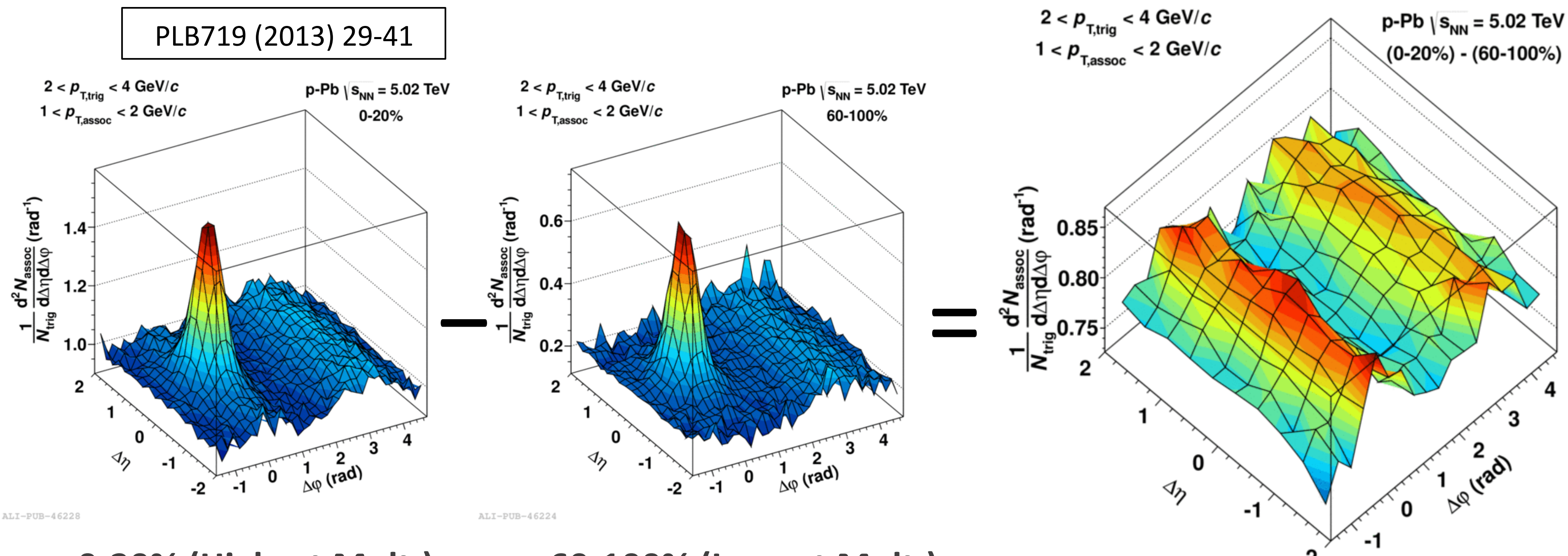

0-20% (Highest Mult.)
(Jet + Ridge)

60-100% (Lowest Mult.)
(Jet)

(0-20%) – (60-100%)
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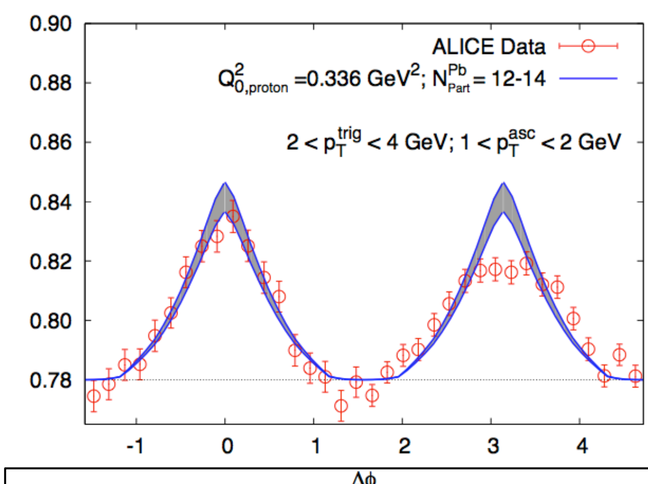


K. Dusling, R. Venugopalan, arXiv:1302.7018

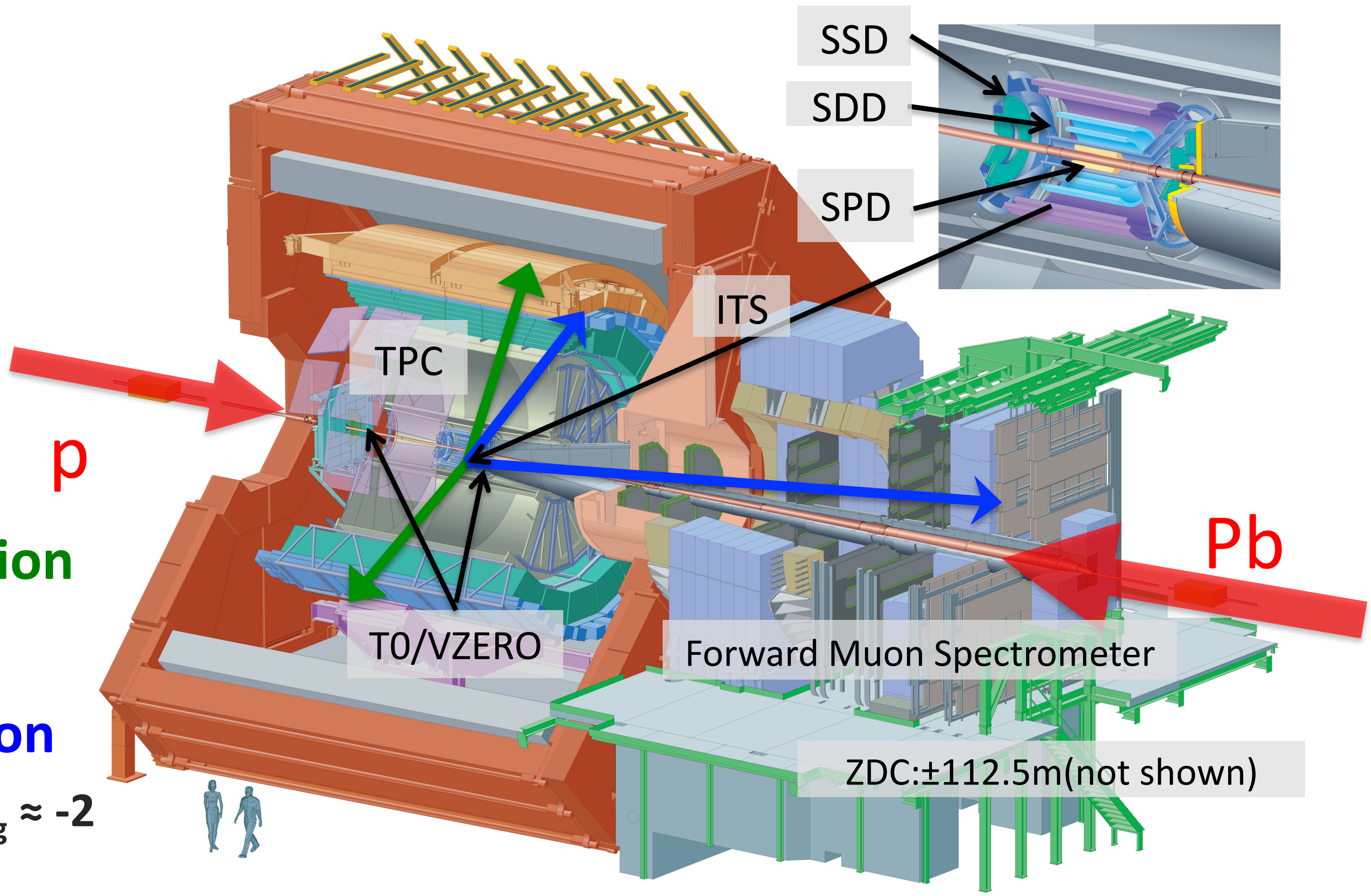
- Yield comparison, extraction of v_2, v_3 from Δφ–projection
- The origin of collective features might be
  - ✓ Initial state parton saturation in nucleus (CGC)
  - ✓ hydrodynamic expansion of high-density medium

Forward-Mid Two-Particle Correlations

η coverage

- TPC/ITS : |η| < 1.2
- Forward Muon Spectrometer : -4 < η < -2.5

3D ALICE Detector Schematics



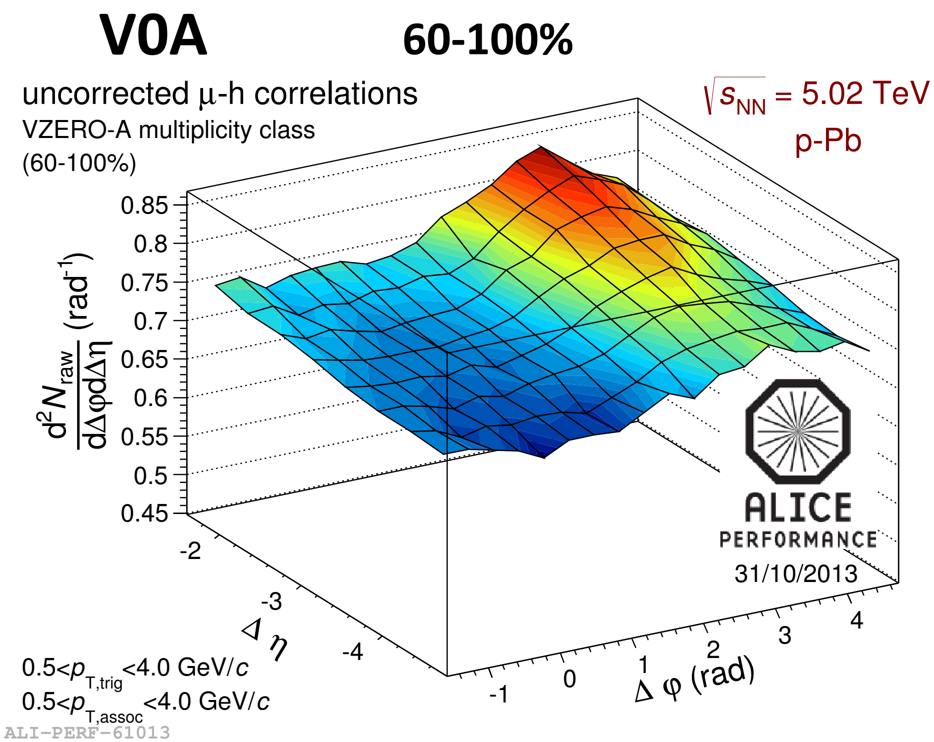
➢ **Di-hadron correlation**
  - **|Δη| < 2, $\eta_{avg} \approx 0$**

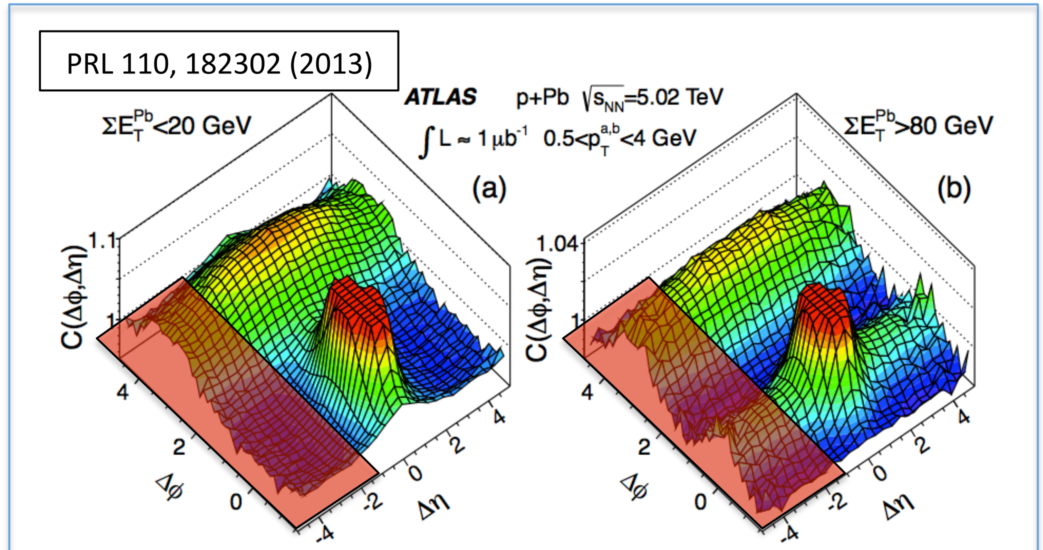
➢ **μ-hadron correlation**
  - **-5 < Δη < -1.5, $\eta_{avg} \approx -2$**

➢ One can approximately estimate parton x of Pb(p) with given **p_T, Δη** and **η_{avg}**.

➢ Access **smaller x of Pb** with **forward-mid two-particle correlations**

Forward-Mid Two-Particle Correlations



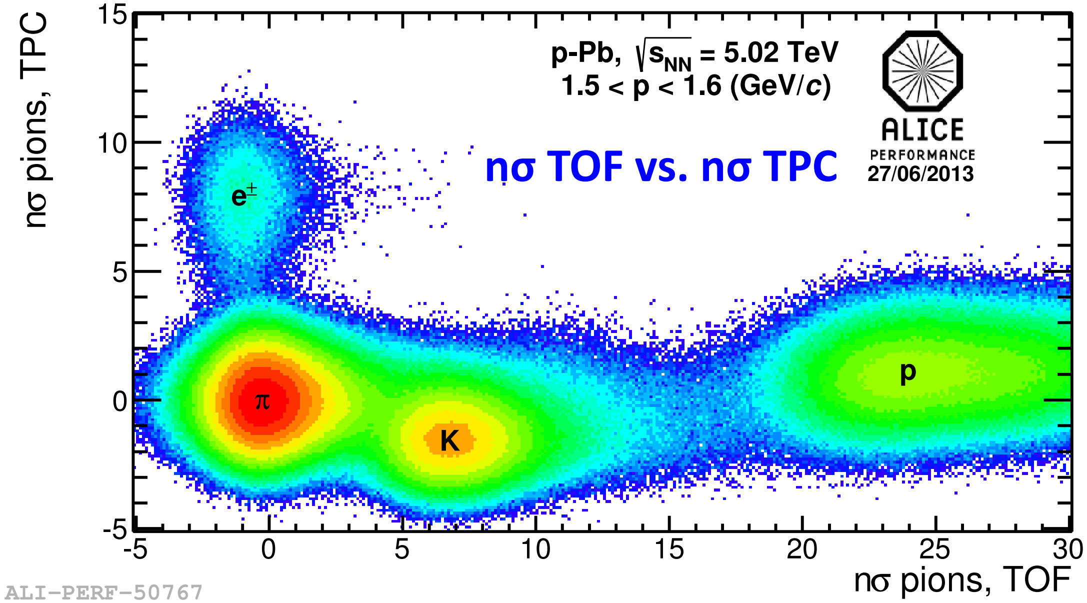


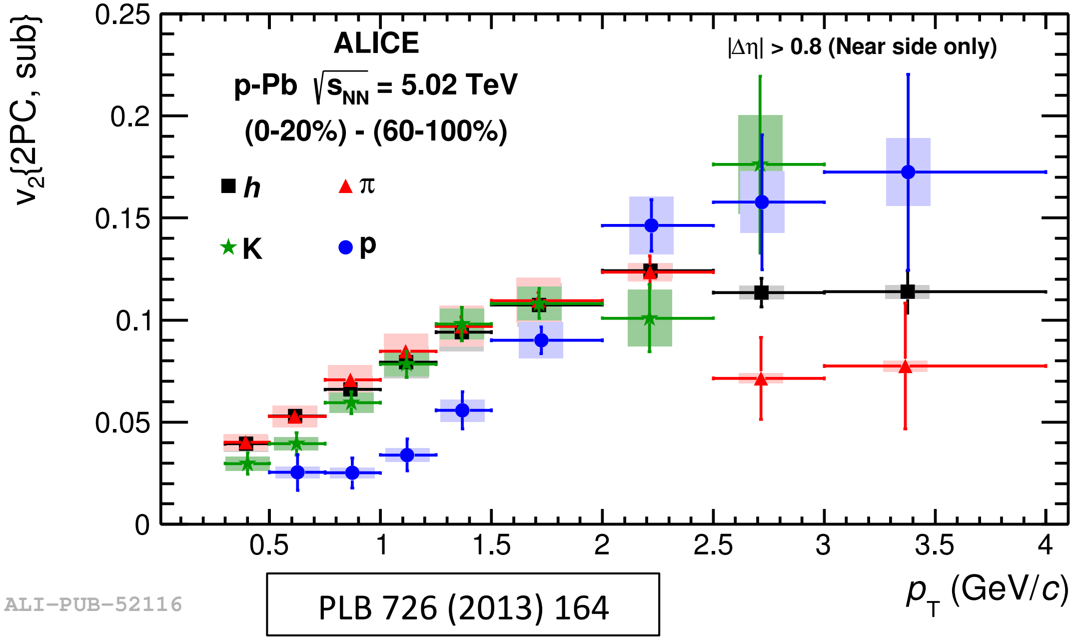
Corresponding area from ATLAS two-particle correlation

- More results coming soon
- Capabilities to distinguish models
  - ➔ Larger saturation effect with smaller parton x of Pb?

Two-Particle Correlations with Identified Particles

- ALICE detector has powerful particle identification capabilities





- h-π, h-K, h-p correlations
- Mass ordering in high multi. pPb
  - ✓ Low p_T (<2GeV/c)
  - ✓ More obvious after subtraction (left plot)
  - ✓ Qualitatively similar to PbPb
- Weak mass ordering in low multi. pPb and pp

Summary

- Two-particle correlations are a tool to study the underlying mechanism of particle production in collisions of hadrons and nuclei at high energy.
- A double ridge structure in high-multiplicity p-Pb collisions is observed
- Forward-mid correlation measurements can explore lower x-range in the nucleus than di-hadron correlations (underway!)
- Identified particle correlations in high multiplicity p-Pb show qualitative similarities to measurements in A-A collisions

Thank you.