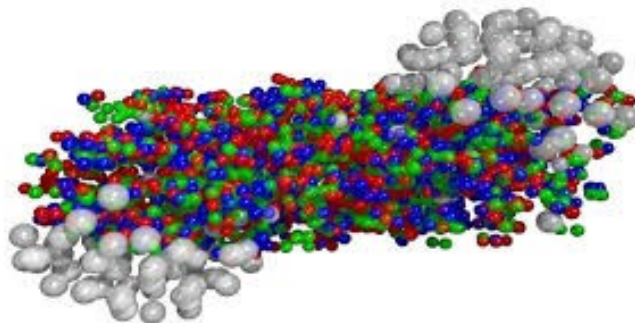


Exploring the Quark Matter with the ALICE Experiment at the CERN LHC



HUN
REN



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ALICE Budapest group

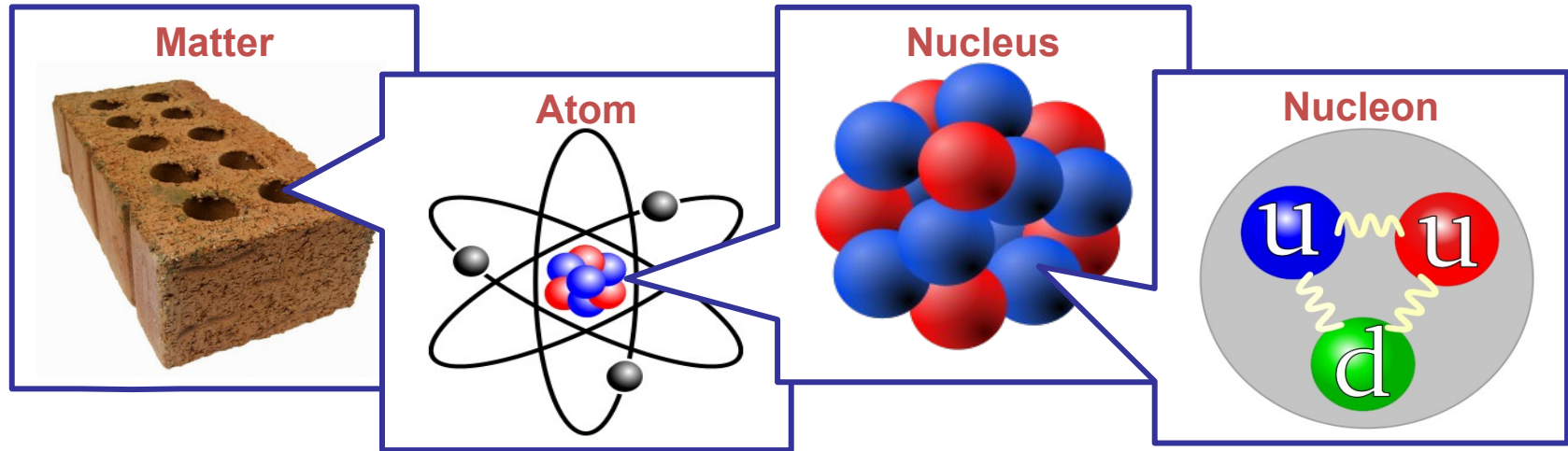
<https://alice.wigner.hu>



ALICE

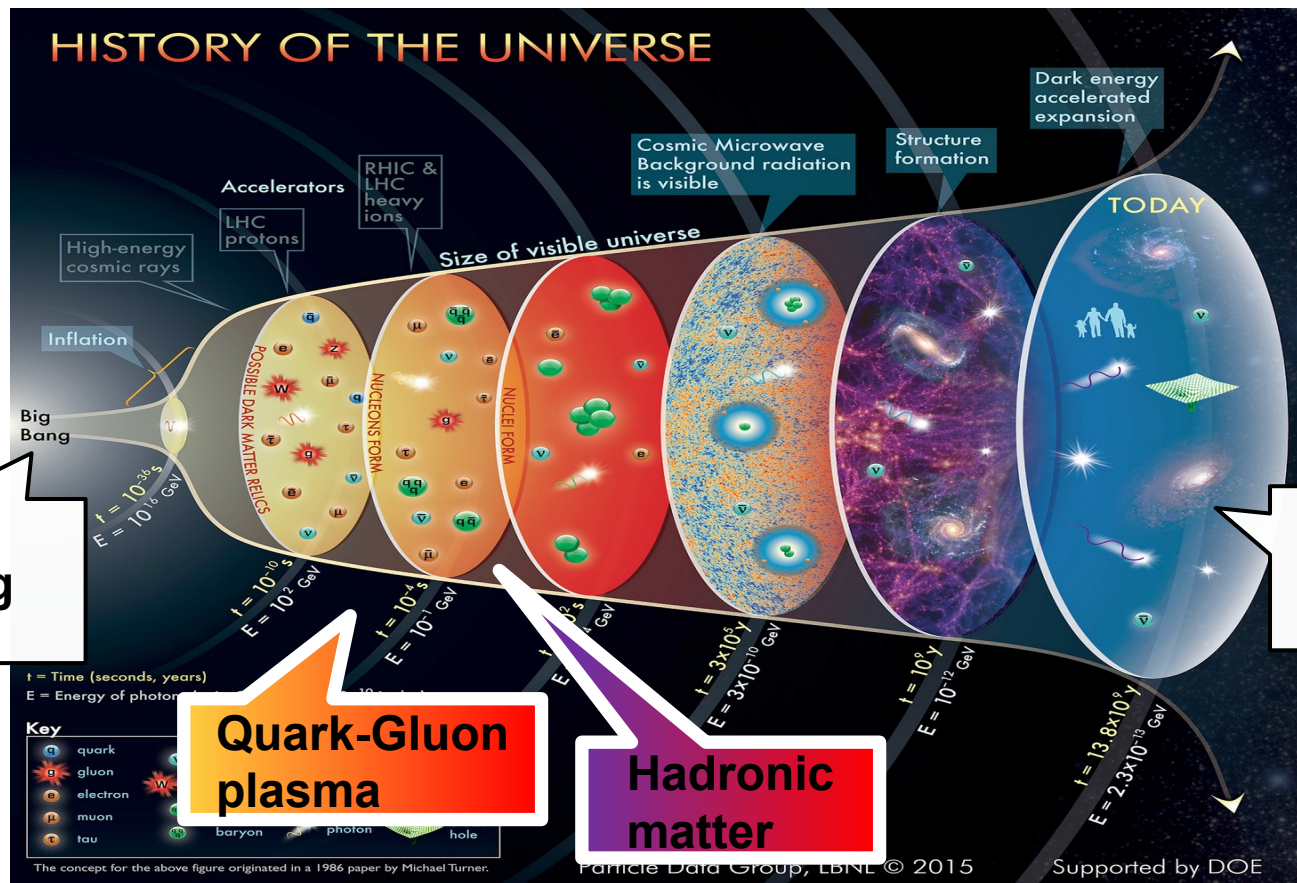


The building blocks of matter

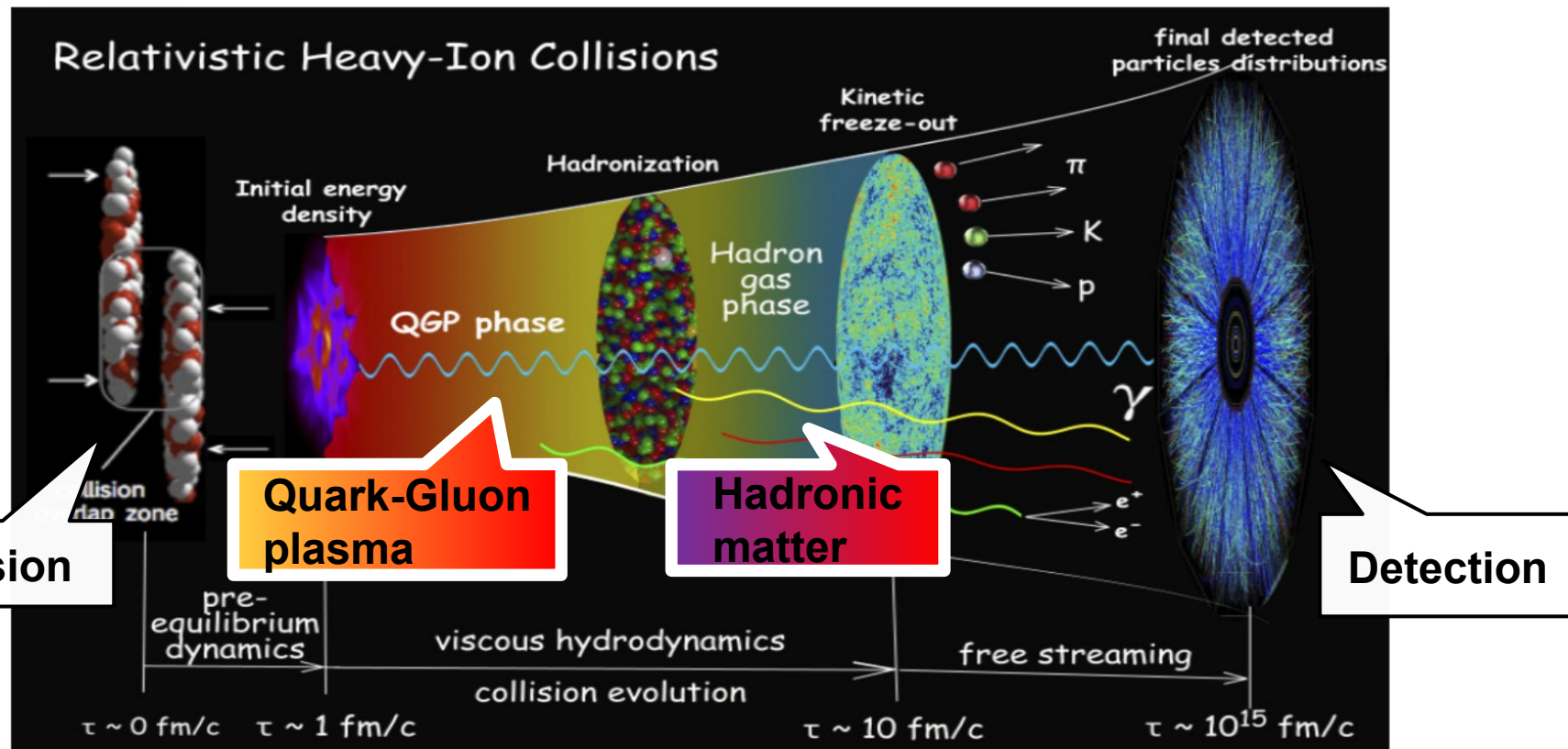


- **Quarks:** the building blocks of nucleons
- **Gluons:** mediators of the **strong interaction** holding nuclei together
- **Quantum Color Dynamics:** the theory of the strong interaction
- **Quark confinement:** lonely quarks don't exist, they form hadrons
- => How do we learn more about these?

It all started with a Big Bang



Little Bangs in the laboratory



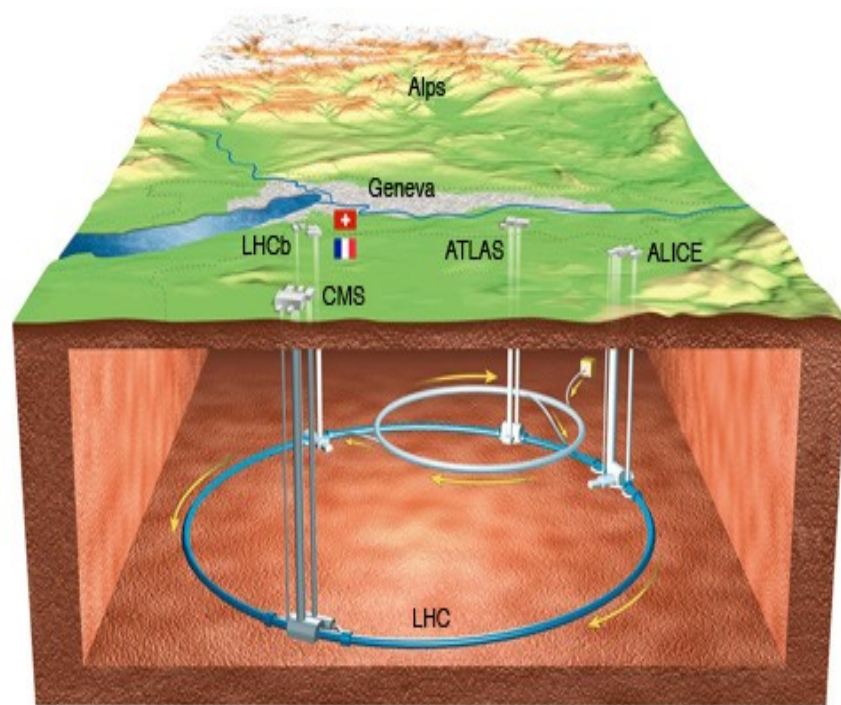
Courtesy of Paul Sorensen and Chun Shen

The Large Hadron Collider (LHC) at CERN

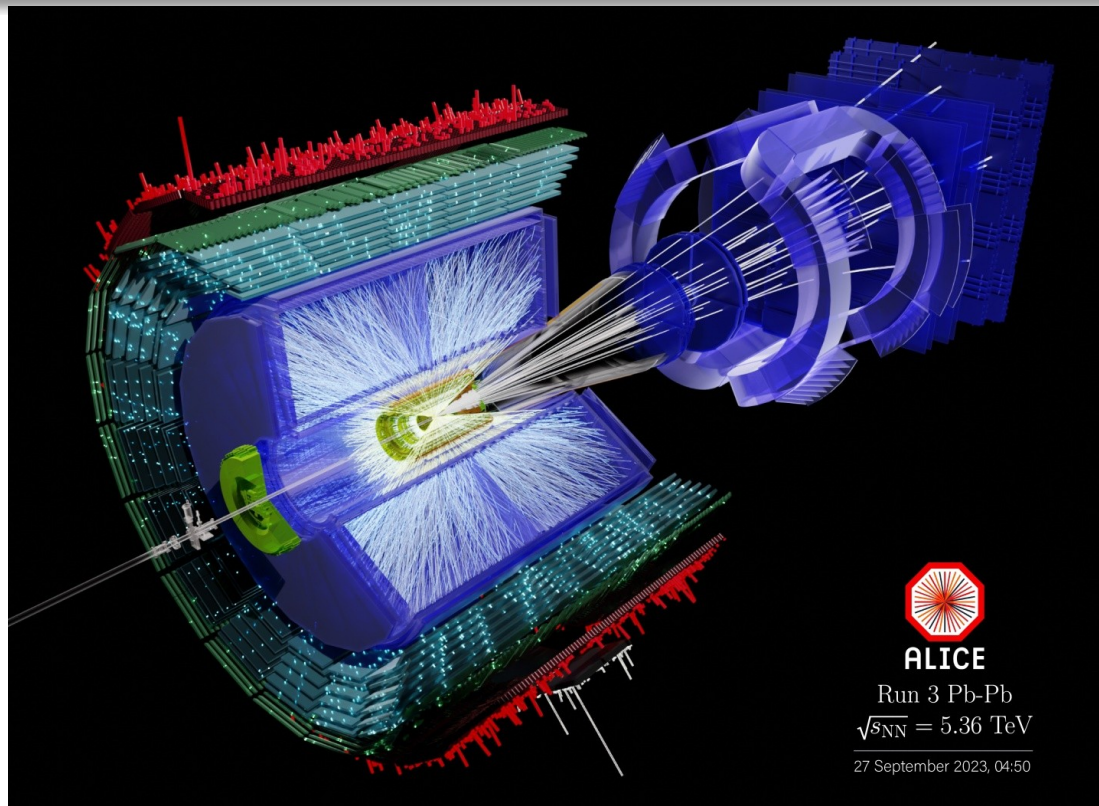


- European Organization for Nuclear Research
- 24 member countries including Hungary

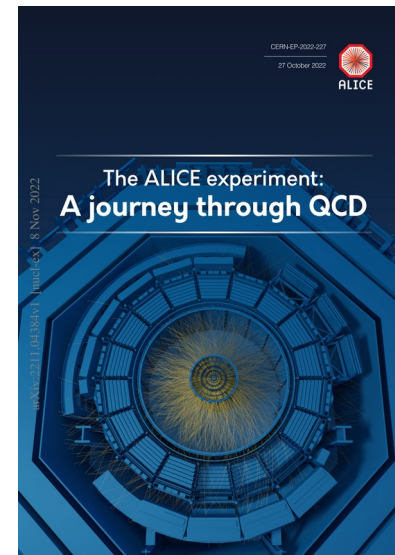
- LHC: 27 km long accelerator ring
 - Acceleration by electric field
 - Bending/focusing by magnets
- Energy frontier:
 - **pp: 13.6 TeV**
 - **Pb-Pb: 5.02 TeV**
 - **Xe-Xe, OO, Ne-Ne**



ALICE – a reconstructed Pb-Pb collision



- ALICE is dedicated to **heavy-ion collisions**
- Outstanding particle identification capabilities



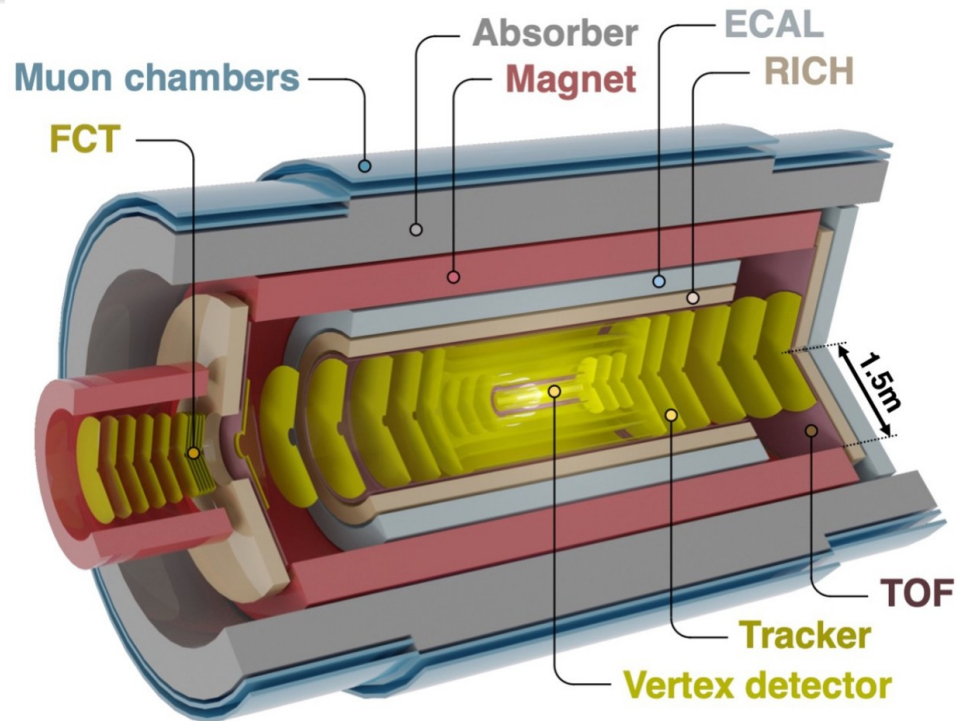
CERN-EP-2022-227, arXiv:2211.04384

ALICE 3 – from the 2030s

- **Compact silicon tracker**
- Superconducting magnet, $B = 2\text{T}$
- **Extended particle identification**
- **Precise vertexing** capabilities and great momentum resolution
- **Reconstruction of the microscopic dynamics of the quark-gluon plasma**

CERN-LHCC-2022-009

arXiv:2211.02491



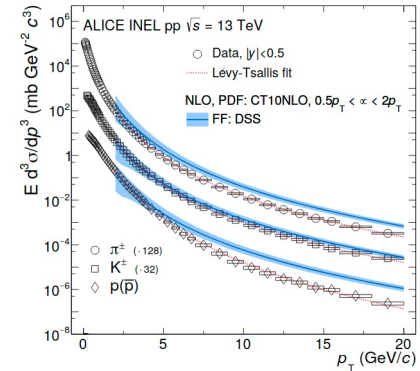
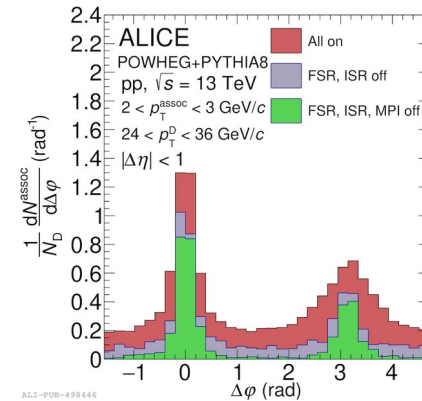
The ALICE-Budapest group – Highlights

Recent results

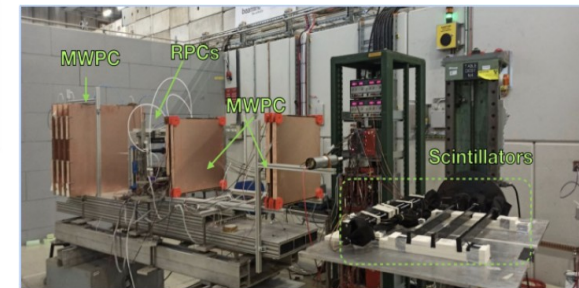
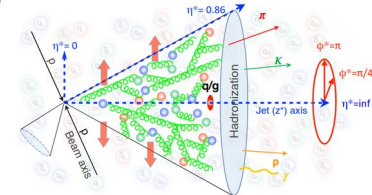
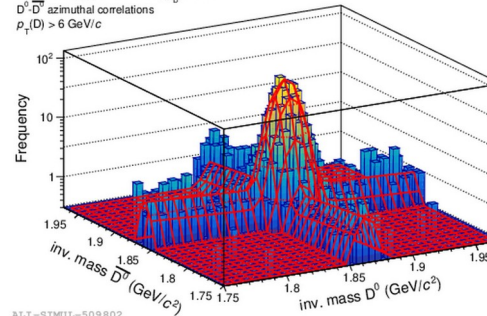
- Production of identified particles
 Eur.Phys.J.C 81 (2021) 3, 256.
 Phys.Rev.D 111 (2025) 1, 012010
- Heavy-flavor jets and correlations
 Eur.Phys.J.C 83 (2023) 8, 741
 JHEP 01 (2022) 178
 Eur.Phys.J.C 82 (2022) 4, 335.
- Development of the ALICE3 muon ID
- JINST 19 (2024) 04, T04006
 JINST 20 (2025) 09, P09015

Possible future directions

- Probing the quark matter with heavy quarks (in Run3)
- Smallest droplets of the QGP
- ALICE 3 muon ID development
- Search for Exotica in ALICE 3



ALICE 3 study, $L_{\text{int}} = 3 \text{ nb}^{-1}$
 PYTHIA 8.2, pp, $\sqrt{s} = 14$ TeV, $|y_D| < 1.44$
 D^0 - $\bar{D}^0$ azimuthal correlations
 $p_T(D) > 6$ GeV/c



The ALICE-Budapest group – People



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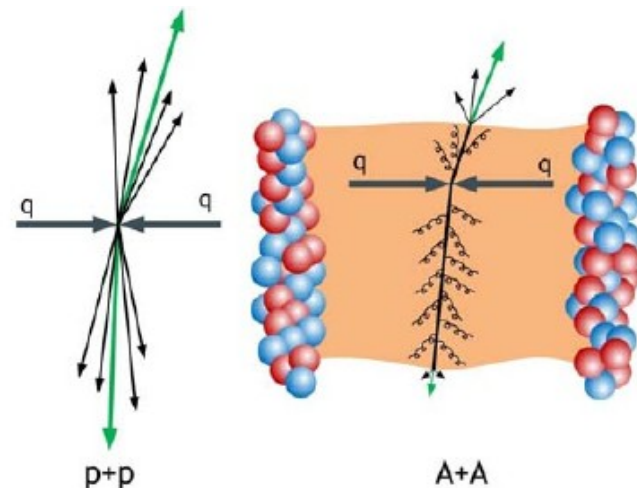
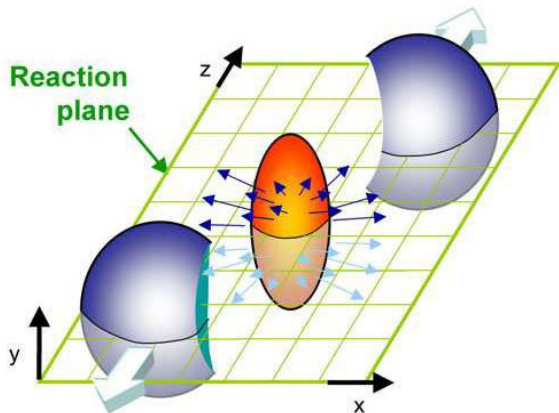
Profil: Proton CT, szimulációk,
képrekonstrukció

We are expecting You!

Backup: Probing the QGP

■ "Hard" processes

- few, high-momentum particles
- early production in well-known pQCD processes
- high permeability
- **Tomography of the sQGP, modification in the medium**



■ "Soft" processes

- Many, low-momentum particles
- From the later stages
- **Thermal behavior**
- **Collective dynamics ("flow")**