

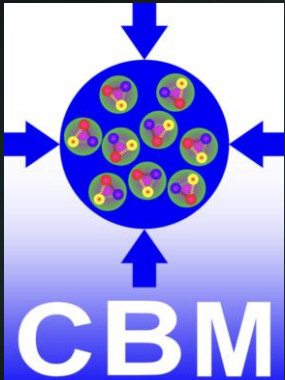
Studying QCD phase structure via event-by-event fluctuations

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MEMBER OF THE HADES AND CBM COLLABORATION

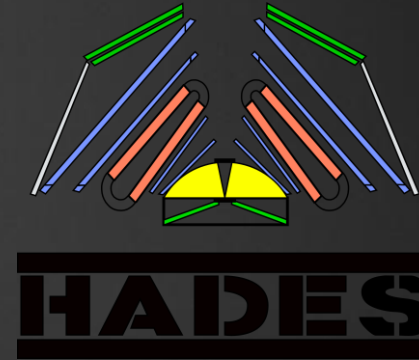


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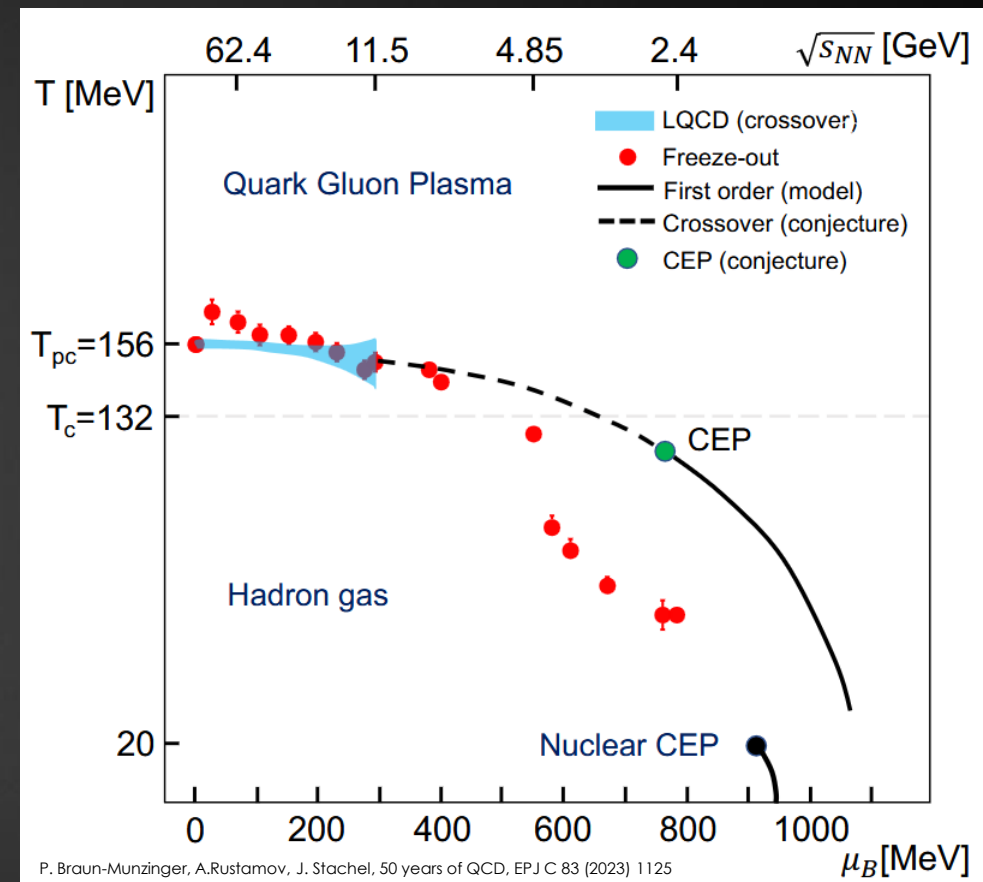
PHD PROJECT: EMISSION OF PROTONS AND
LIGHT NUCLEI IN AG+AG COLLISIONS AND THE
RECONSTRUCTION OF E-BY-E PARTICLE
NUMBER CUMULANTS



A Contemporary Phase Diagram of QCD

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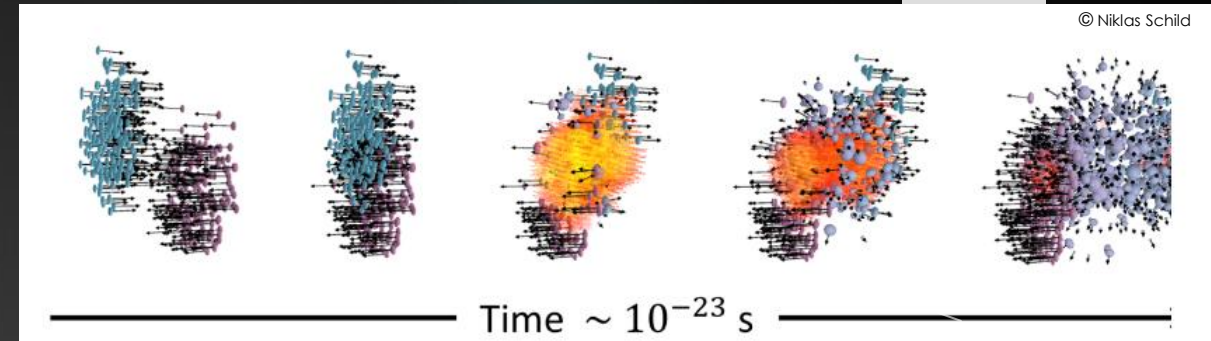
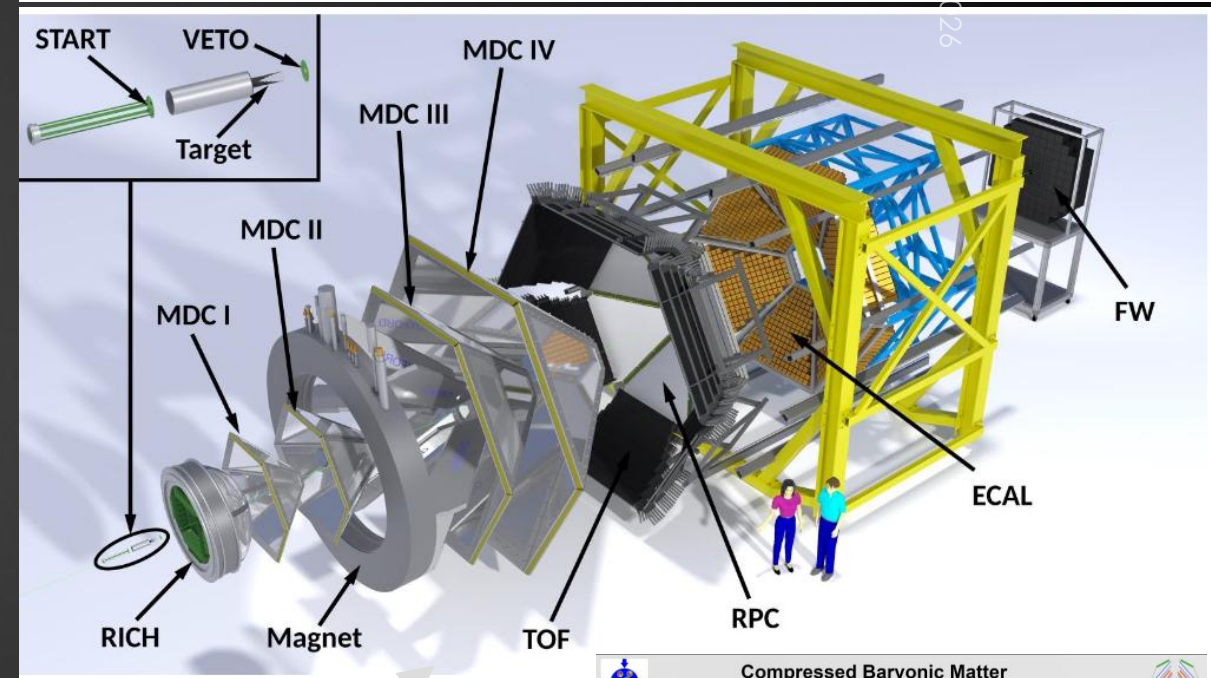
- **Confinement** and **asymptotic freedom** are fundamental features of QCD, whose thermodynamics gives rise to a **rich phase structure**
- **At vanishing baryon chemical potential**, a smooth, temperature-driven **crossover transition** is predicted by lattice QCD calculations
- **At high μ_B and moderate temperatures**, a **first-order phase transition** terminating **at a critical endpoint (CEP)** is conjectured



How to Locate the QCD Phase Transition and Critical Endpoint?

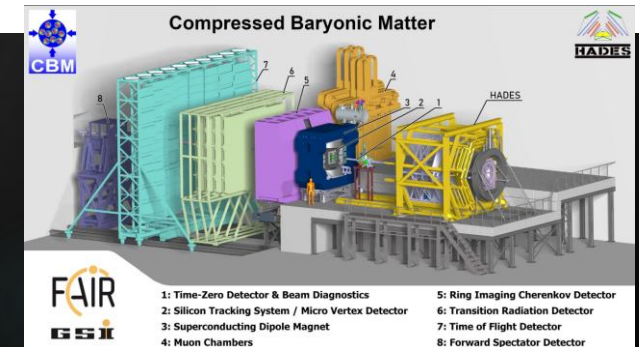
Experimental Access

- **Heavy-ion collisions (HICs)** create **strongly interacting matter** at **extreme temperatures** and/or **densities**
- **Infer the properties of matter** at high temperatures and densities **from the measured reaction products**
- **Experiments at GSI** probe strongly interacting matter **at moderate temperatures** and **high baryon chemical potentials**



HADES:
C+C, Ag+Ag,
Au+Au

CBM: In future



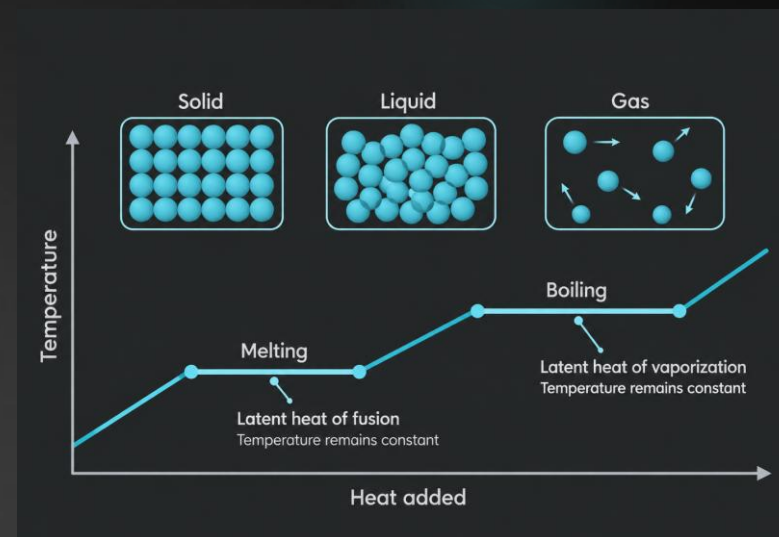
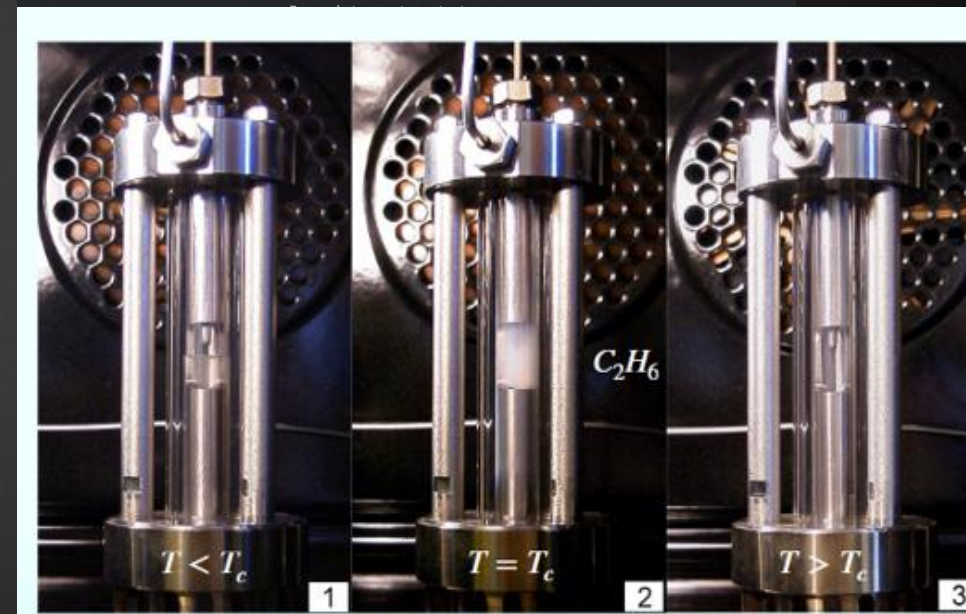
Signature of criticality

- At 1. order phase transitions: structure of binding changes, **latent heat**, **discontinuities in thermodynamic quantities**
- At the CEP (a second-order critical point): **a rapidly growing correlation length**, **critical scaling**, and **enhanced density fluctuations**
- ➔ **Critical signatures** are expected in **fluctuations of conserved charges** (e.g., net-baryon number)

$$\kappa_n(N_q) = \frac{\partial^n \ln \mathcal{Z}(T, V, \mu_q)}{\partial (\mu_B/T)^n}$$

In HICs, **net-proton fluctuations** serve as an **experimental proxy** for **net-baryon number fluctuations**

Goal: **Search for deviations of measured fluctuations from non-critical baselines**

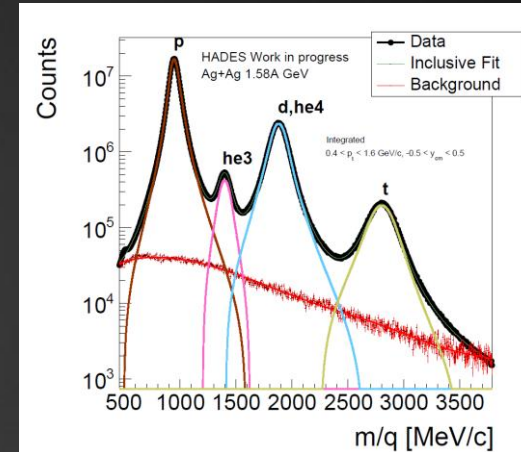
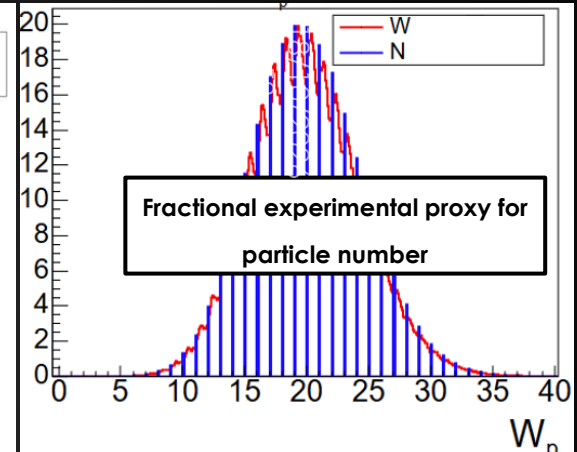
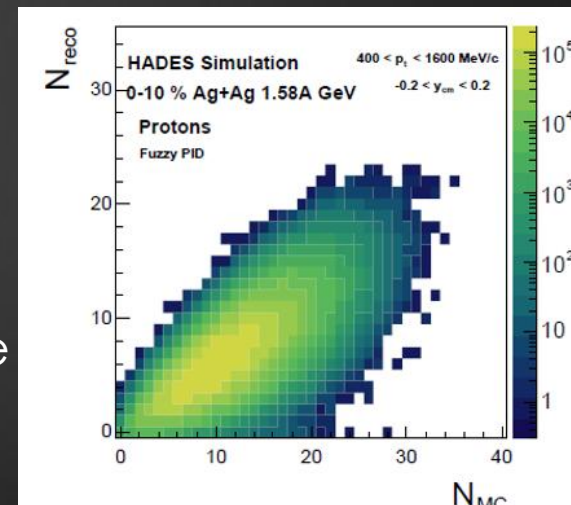
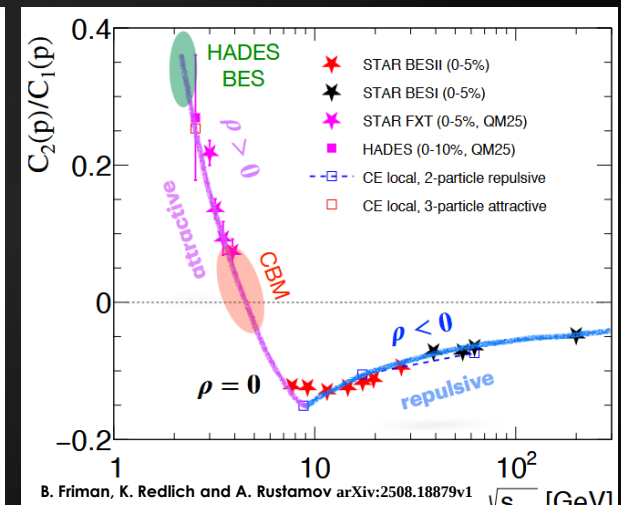


Example for C₂H₆: Critical point manifests itself in critical **opalescence** as a result of enhanced density fluctuations

Experimental Challenge: A lot of non-critical fluctuations

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- **Limited detector efficiency** which also fluctuates
- **Particle identification fluctuates** due to finite resolution
 - Method based on **Fuzzy Logic**
- **Impact parameter of collisions fluctuates**
 - Estimate fluctuations of the reaction volume from **mixed event technique**



→ Methodology and HADES results presented in my poster