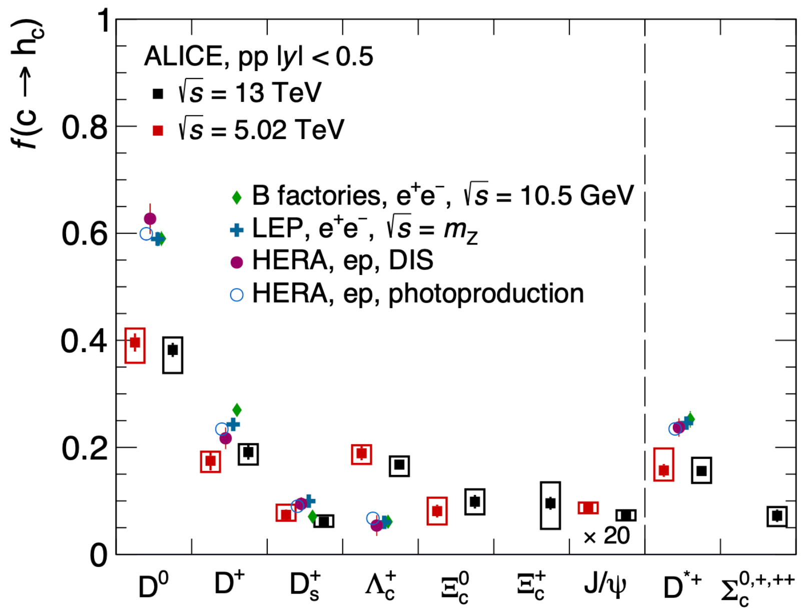
Topic 2: Cosmic Matter in the Laboratory

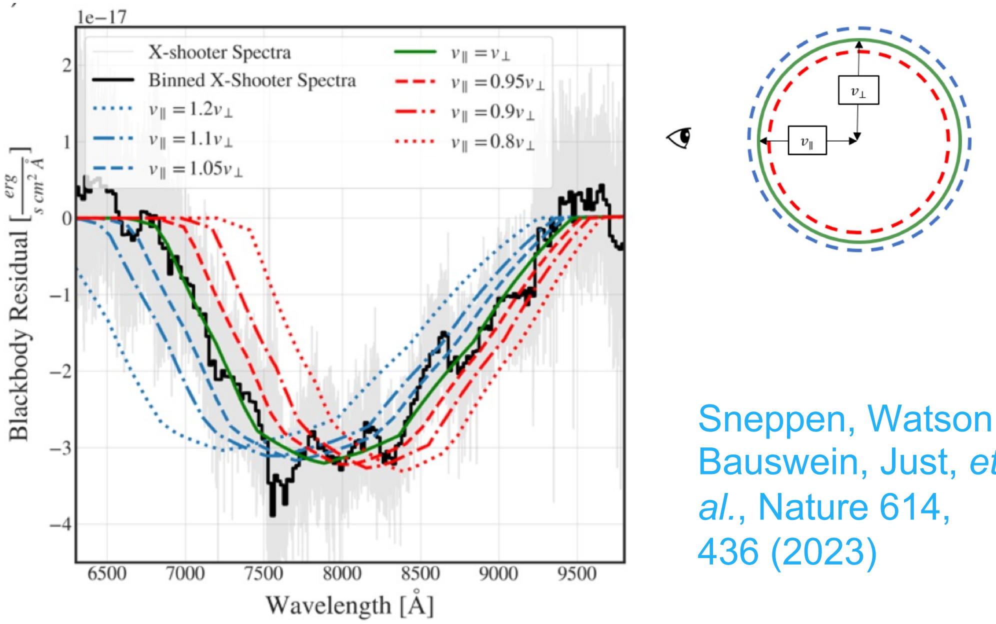
Scientific Highlights

Charm-quark fragmentation fractions at midrapidity (|y| < 0.5) in pp at ALICE



ALICE Collaboration, JHEP 12 (2023) 086

Geometry measurement of the kilonova AT2017gfo/GW170817



Sneppen, Watson, Bauswein, Just, *et al.*, Nature 614, 436 (2023)

Heavy-quark hadronisation is a universal process across different colliding systems?

Measurements demonstrate that the process of colour-charge confinement and hadron formation is still a poorly understood aspect of the strong interaction.

Suggesting high degree of sphericity

Best measured distance of GW170817 so far (45.5±0.6) Mpc

Hubble constant determined from the kilonova EPM:
$H_0 = 65.6 \pm 3.4$ km s^{-1} Mpc^{-1}

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Forschungspolitische Ziele

- *Investigate the phase diagram of hot and dense nuclear matter with their effect on the equation of state of astrophysical objects such as supernovae, neutron stars, and merging neutron stars. This may also lead to new insights into gravitational wave signals.*

- *Investigate the nuclear structure and the reaction phenomena far away from the so-called valley of stability. In particular, a better understanding of the element formation in the universe in supernovae and neutron star fusions should follow from the study of the r-process, e.g., the element abundances of the elements gold, platinum, and beyond.*

- *Test QCD predictions for exotic particle states via precision measurements of proton-antiproton collisions.*

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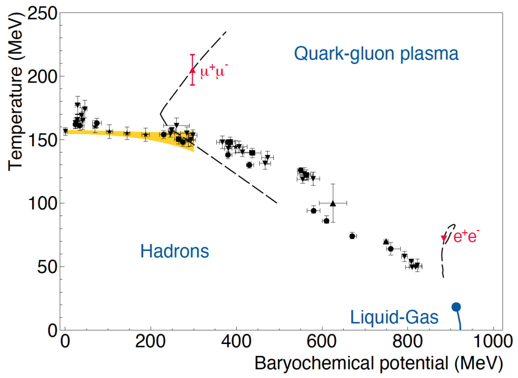
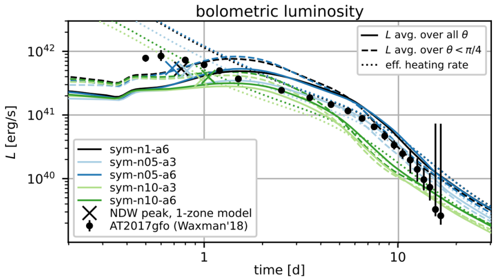
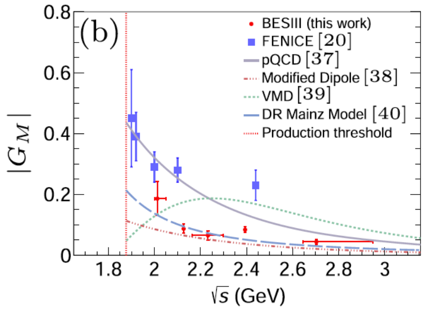
  - ALICE at CERN: study region of vanishing baryonchemical potential in recent measurements (matter in early (~10 µs old) universe)
  - HADES at GSI: explore high net-baryon densities at GSI (neutron star merger matter)
  - CBM at FAIR: unique role in studying QCD phase structure high net-baryon densities with rare and penetrating probes after 2028
- *Investigate the nuclear structure and the reaction phenomena far away from the so-called valley of stability. In particular, a better understanding of the element formation in the universe in supernovae and neutron star fusions should follow from the study of the r-process, e.g., the element abundances of the elements gold, platinum, and beyond.*
  - Continuous progress in understanding of the characteristics of exotic nuclei by ongoing measurements world wide
  - In-depth understanding of nuclear physics at work in the neutron star merger from theory
  - Super-FRS at FAIR for the discovery of neutron rich heavy exotic nuclei at the N=126 shell closure after 2028
- *Test QCD predictions for exotic particle states via precision measurements of proton-antiproton collisions.*
  - Worldwide efforts to understand the nature of the strong interaction in the 'non-perturbative' lower-energy regime (AMBER, COMPASS, LHCb, Belle II, BESIII, CLASS12, GLUEX)
  - Stored anti-proton beams at FAIR in combination with the PANDA-experiment remains unique
  - Realisation of the program requires execution of the full FAIR-MSV → POFV
  - Until then PANDA Phase-0 at various international facilities and at GSI





BESIII



HADES