Ion Program of NA61/SHINE Experiment

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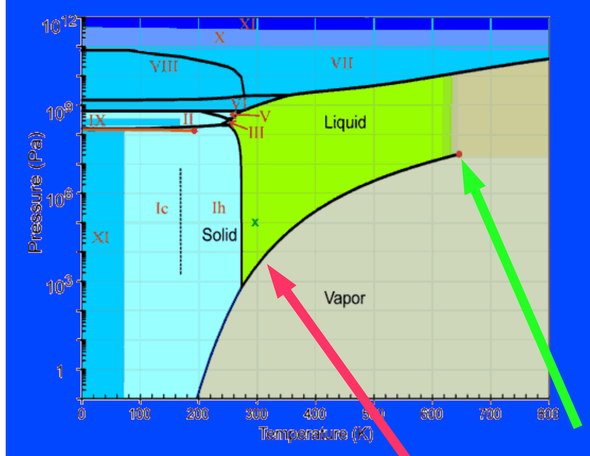
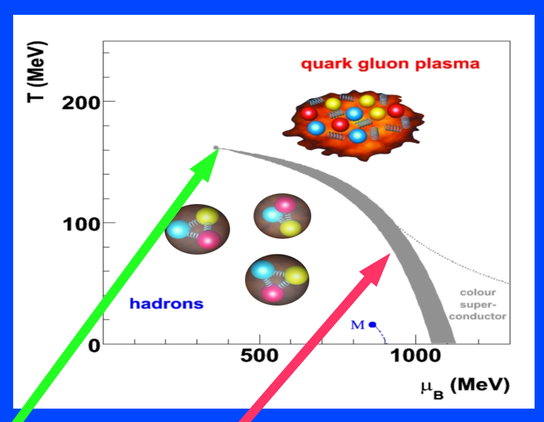
Abstract

NA61/SHINE at the SPS facility is the successor of the former NA49 experiment. The aim of the new project is to explore the phase diagram of strongly interacting matter within the range of thermodynamical variables (like e.g. temperature and baryon chemical potential) where QCD predicts the existence of a 1st order phase boundary between hadronic and partonic phases and the critical end point. The detector and data acquisition system upgrades have resulted in an increase of the data rate by factor about 10 as compared to the standard NA49 data rate. These new conditions allow to perform a 2D scan of the phase diagram by varying energy (10A-158A GeV) and size of the colliding nuclear systems (p+p, p+Pb, C+B, Ar+Ca, Xe+La). The main goal of the scan is a search for the critical point and a detailed study of the onset of QGP formation by measuring the dynamical event-by-event fluctuations, the azimuthal anisotropy as well as the inclusive pion and strange hadron production. The increase of the data rate will also give a unique possibility to measure the inclusive and correlated yields of high p_T hadrons.

Analogy between phase diagram of water and strongly interacting matter





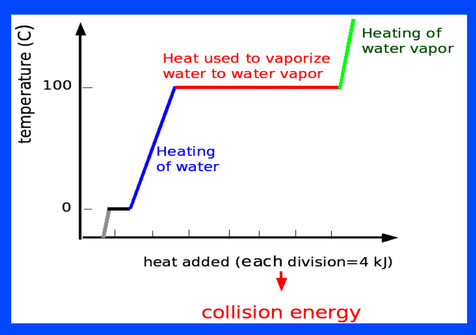
Critical Point

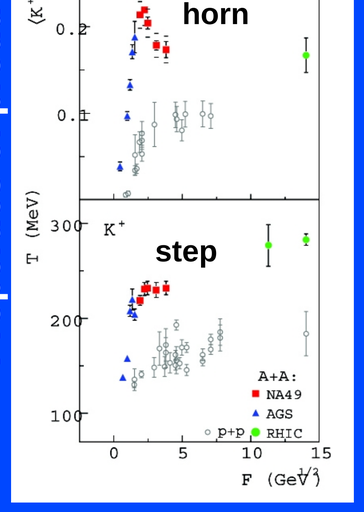
1-st order phase transition

Evidences for the onset of deconfinement

Experimentally observed rapid changes in collision energy dependence in observables like “kink”, “horn, and “step” is hard to explain by statistical and dynamical models that do not incorporate phase transition between hadron gas and quark-gluon plasma

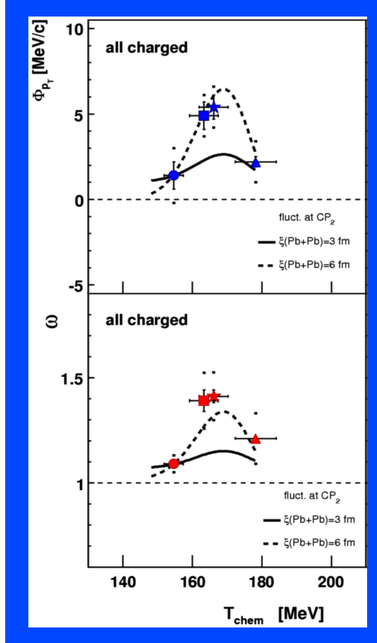
Characteristic „step” dependency of kaon effective temperature versus collision energy is in analogy to the heating (caloric) curve of water reflecting transitions between the phases of water

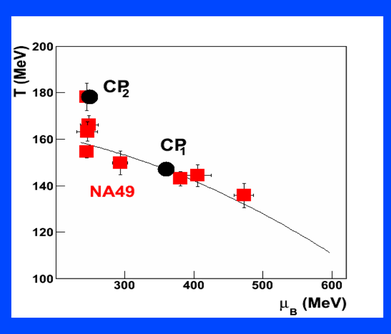




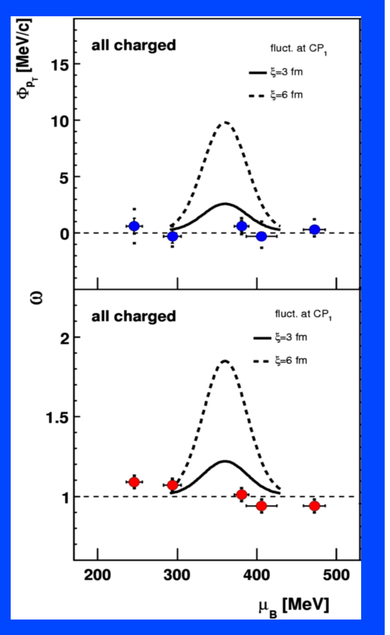
NA49 search for the critical point

System size dependence of average p_T and multiplicity fluctuations at energy 158 AGeV





Energy size dependence of average p_T and multiplicity fluctuations in central Pb+Pb

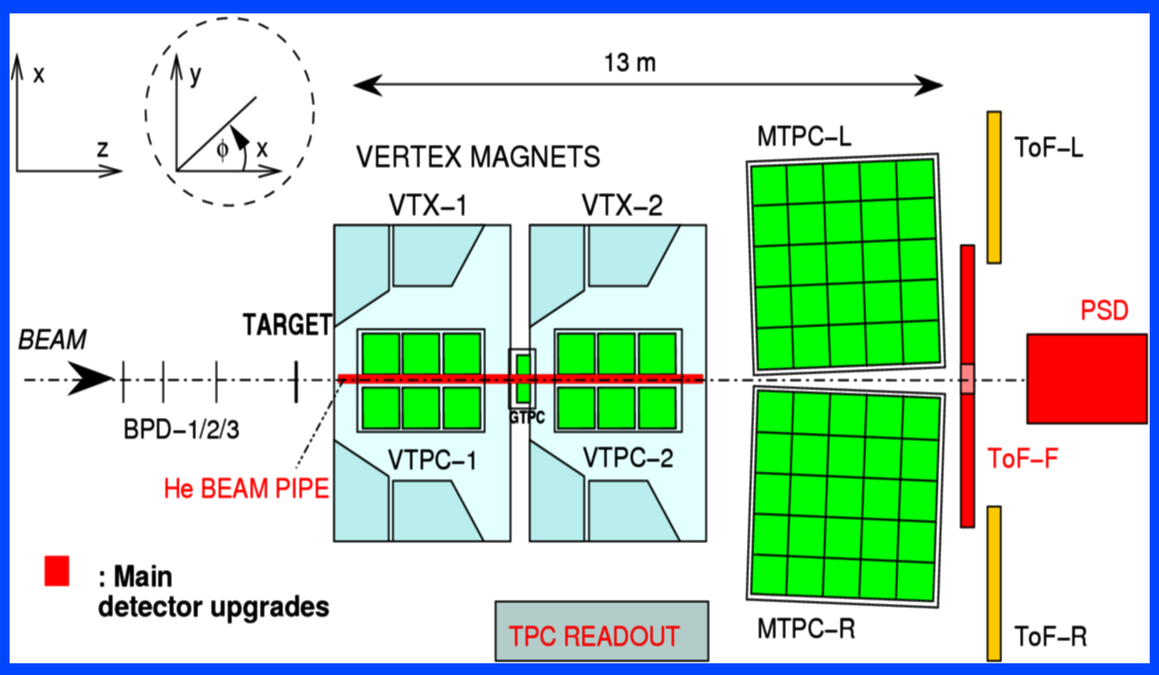


Two locations of the critical point (CP1 and CP2) considered

Maximum of Φ_{pT} and ω observed for C+C and Si+Si are consistent with CP_2 predictions

K. Grebieszkow at al. Nucl. Phys. A830, 547c and arXiv:0909.0485

Detector setup and upgrades



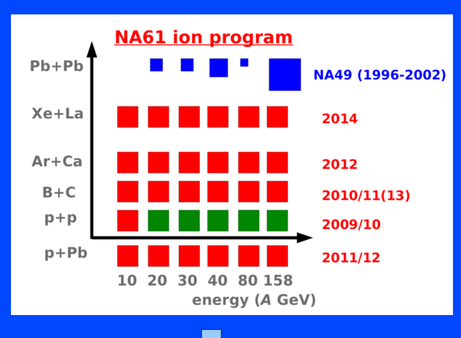
Most of the setup is inherited from NA49 experiment

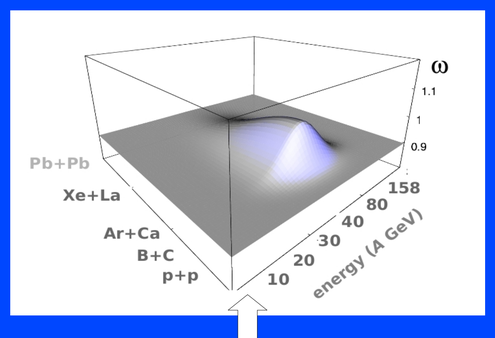
Main upgrades:

2007	**2008**	**Planned:**
ToF-F wall constructed (ToF acceptance extended to p ≈ 1 GeV/c).	TPC read-out (increase of event rate by factor of 10 in comparison to NA49)	· Projectile Spectator Detector · He-beam pipe (reduce δ-electron (x10)) · Fragment separator

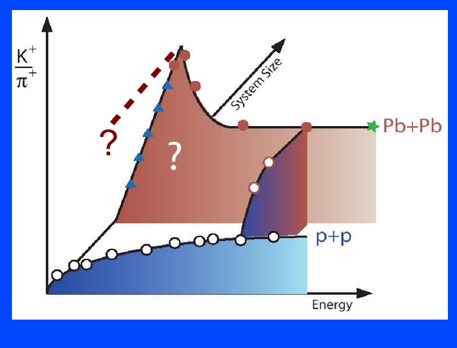
NA61/SHINE versus NA49

NA61/SHINE planes to perform a comprehensive scan in energy and size of colliding nuclei to study the properties of the transition between hadron gas and quark-gluon plasma





New data may lead to discovery of the critical point of strongly interacting matter by the observation of the hill of fluctuations



… and characterize properties of the onset of deconfinement by searching for the onset of “horn” like structure in collisions of light nuclei

Summary and Outlook

Within the NA61/SHINE ion program we plan to study:

- Spectra and yields: $K^{+/-}$,$\pi^{+/-}$, (anti-)protons, (anti-)lambdas, K^0_s, strange baryons and mesons, resonances (K*, ρ^0)
- Multiplicity and transverse momentum fluctuations
- Azimuthal fluctuations (Φ_Φ) and azimuthal correlations ($\Delta\Phi$)
- Nuclear modification factors
- Critical fluctuations (intermittency)

The NA61/SHINE has a significant discovery potential for the critical point of strongly interacting matter, if it exists.