Search for in-medium modifications of properties of strange hadrons

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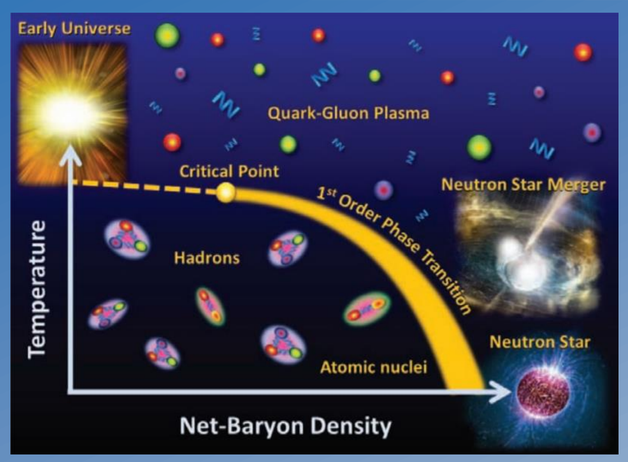
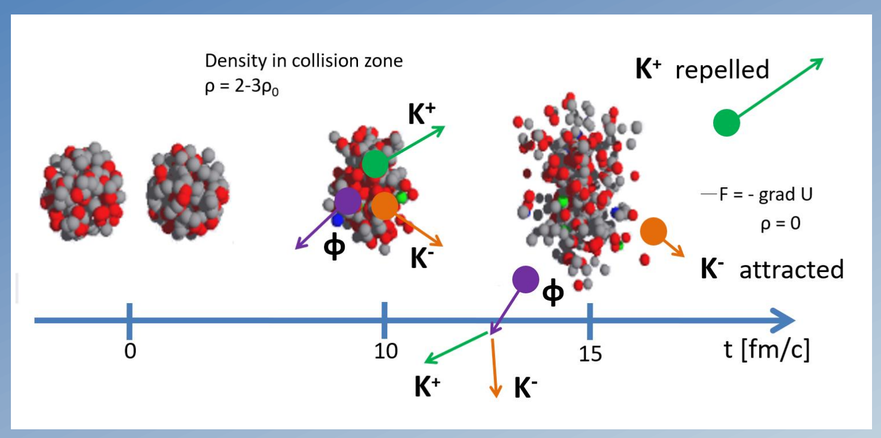


Relativistic heavy ion collisions allow to explore the phase diagram of the baryonic matter. Depending on the collision energy, the hadron gas may undergo the

- *quark deconfinement* and/or move toward
- the *partial restoration of chiral symmetry*.

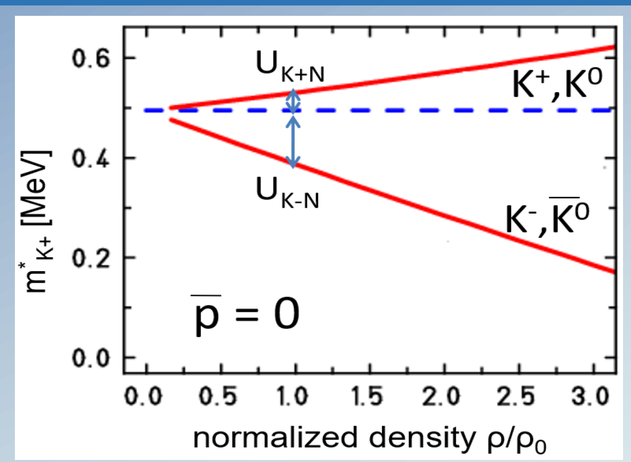
In the latter process the masses of quarks change from the constituent to current values. Thus, hadrons are expected to change mass with temperature and density of the nuclear medium.



For an extremely short time (around 10^{-22} s) the matter heats up to temperatures of about 100 MeV (10^5 × temperature of the solar core) and condenses several times compared to the density of nucleus.

The collision zone may produce new hadrons including the ones containing the strange quark, like $K^{+,0,-}$, ϕ or Λ.

At moderate energies one may produce 1 strange hadron of interest in a collision. Our aim is to infer the changes of properties of this hadron imposed by the surrounding medium.

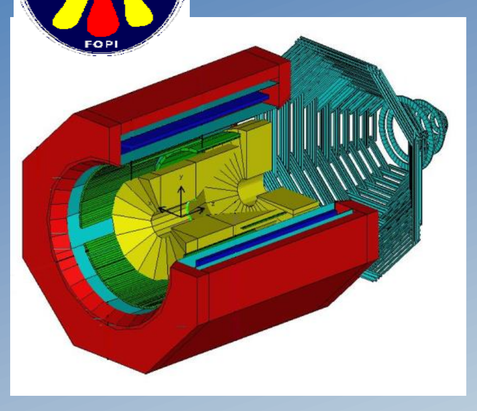


The QCD predicts that the $K^{+/0}$ produced in-medium should have the mass higher than that in vacuum. The difference between the mass at normal nuclear density from the vacuum mass, at vanishing momentum is defined as the potential U_{KN} of the Kaon – nucleus strong interaction.

Once the medium disintegrates, the release of rest energy causes that kaon to accelerate. This effect should act in the opposite way for K^- and $\overline{K}^0$.

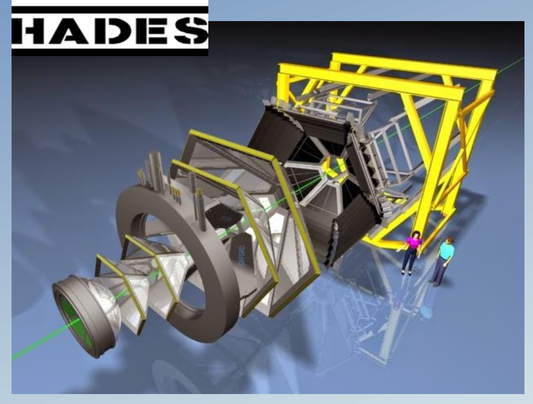
Experiments

Past



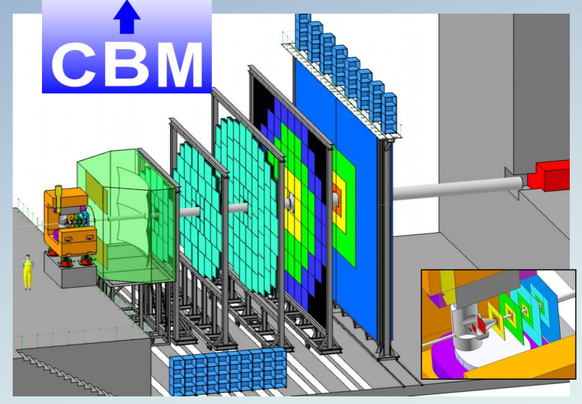
FOPI @ SIS-18 (GSI Darmstadt)
Statistics: ~10^8 events

Current

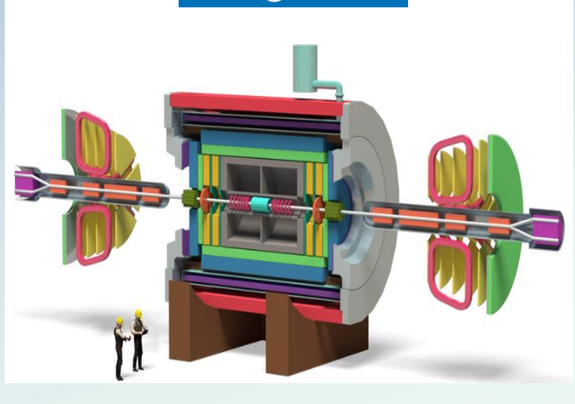


HADES @ SIS-18 (GSI Darmstadt)
Statistics: 2*10^9 events

Future



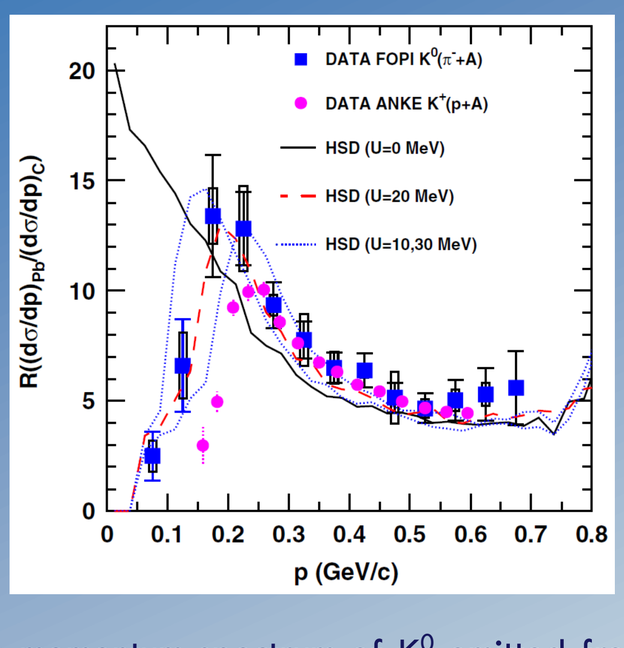
CBM @ SIS-100 (GSI Darmstadt)
Interaction rate: 10^7 Hz



MPD @ NICA (JINR, Dubna)
Interaction rate: 10^4 Hz

Results

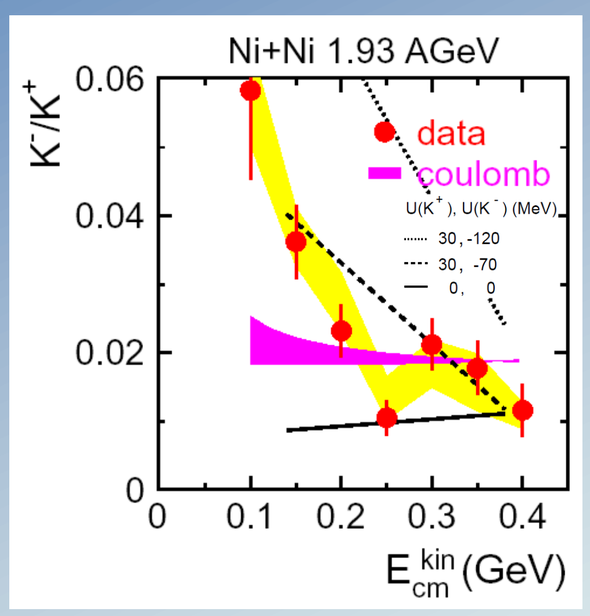
First evidence: case of K^0



M.L. Benabderrahmane et al. (FOPI), Phys. Rev. Lett. 102,182501 (2009).

The momentum spectrum of K^0 emitted from π^-+Pb (heavy nucleus) starts from higher momenta than that for π^-+C (light nucleus).
The predictions of the HSD transport model agree with the experiment if the repulsive U_{K0N} of 20 ± 5 MeV potential is added.

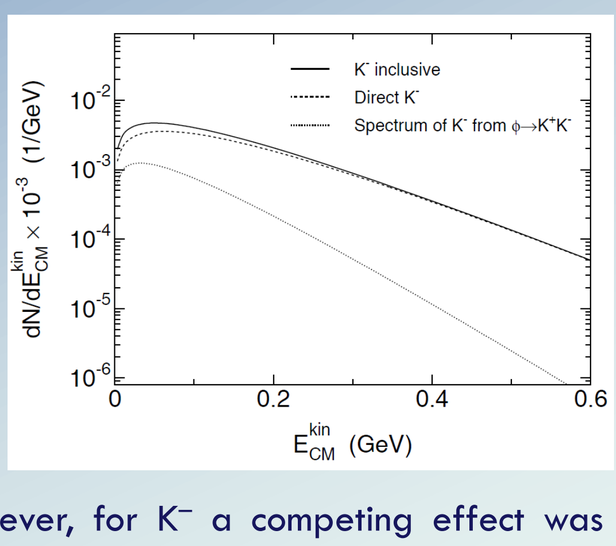
Case of K^+ and K^-



K. Wiśniewski et al. (FOPI), Eur. Phys. J. A 9, 515 (2000)

First comparisons of the K^+ and K^- kinetic energy spectra to the predictions of the transport models supported the repulsive potential for K^+ and attractive one for K^-.

Caution: influence of φ on K^-



P. Gasik et al. (FOPI Collaboration), Eur. Phys. J. A (2016) **52**: 177

However, for K^- a competing effect was found: K^- mesons emitted from decays of $\phi \rightarrow K^+K^-$ (BR ≈ 50%). Another channel, $\Lambda(1520) \rightarrow pK^-$ may also be relevant.

We plan to investigate this effect at much higher statistics and precision with help of the (current) HADES and (future) CBM and MPD setups.

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