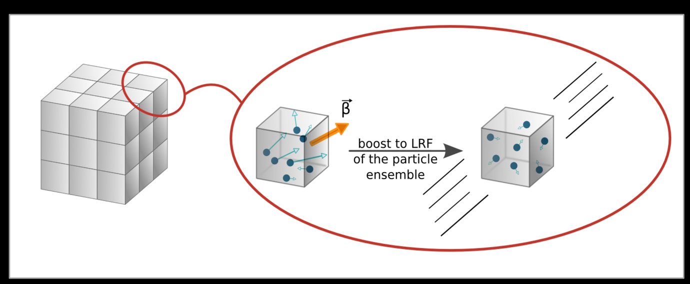
THERMAL DILEPTON RADIATION
AT LOW AND INTERMEDIATE COLLISION ENERGIES FROM A COARSE-GRAINING APPROACH

Florian Seck TU Darmstadt, Germany

in collaboration with
T. Galatyuk TU Darmstadt & GSI
R. Rapp Texas A&M University
J. Stroth Goethe-U Frankfurt & GSI

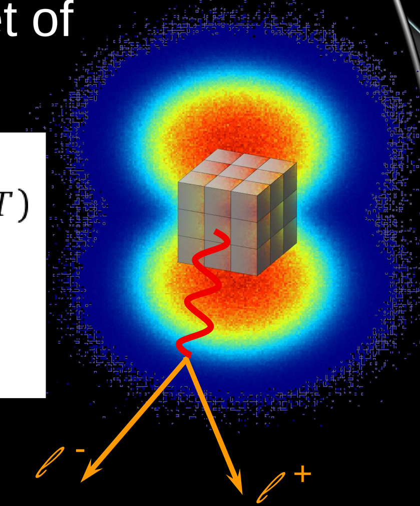
Thermal dileptons via coarse-graining of transport

- "Combine" hadronic transport with a hydrodynamic approach
- Simulate many events in a transport model and take the ensemble average → smooth space-time evolution
- Divide space-time evolution into small 4-dim. cells
- Determine for each cell that fulfills criteria for the onset of thermalization its bulk properties like T, ρ_B & v_{coll}

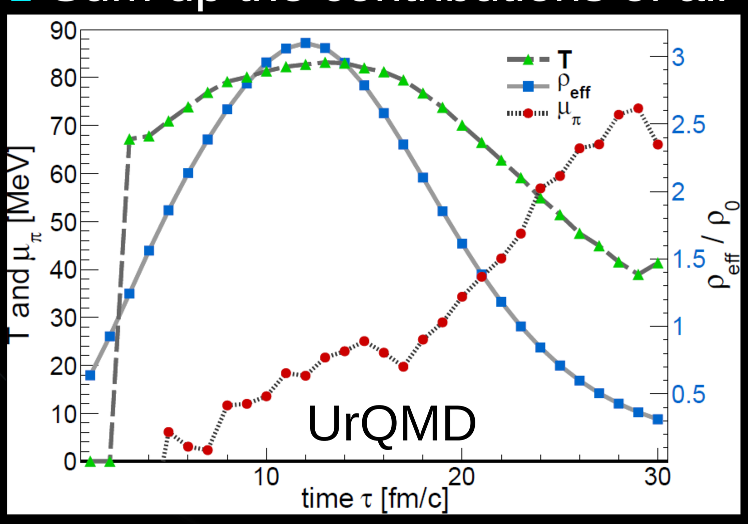


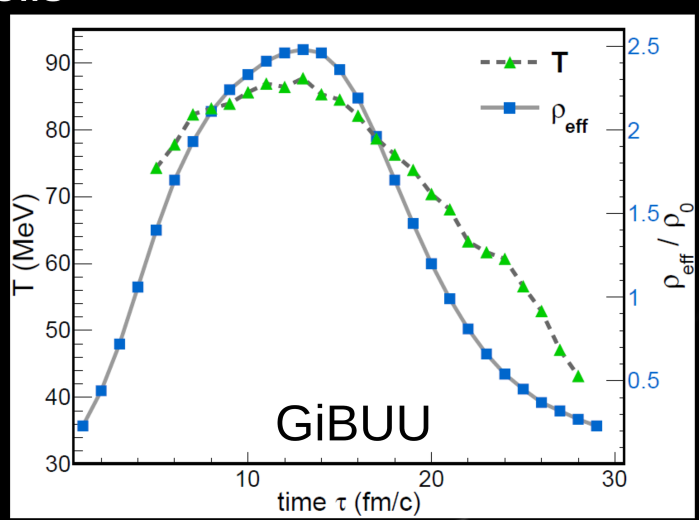
$$\frac{d^3N}{d\vec{p}} = \frac{d^3N}{dp_z\, p_t\, dp_t\, d\theta} \propto \exp(-E/T)$$

$$\frac{1}{m_t^{3/2}}\frac{dN}{dm_t} \propto \exp(-m_t/T)$$



- Calculate dilepton rates based on these inputs → parametrization of Rapp-Wambach in-medium ρ spectral function
- Sum up the contributions of all cells



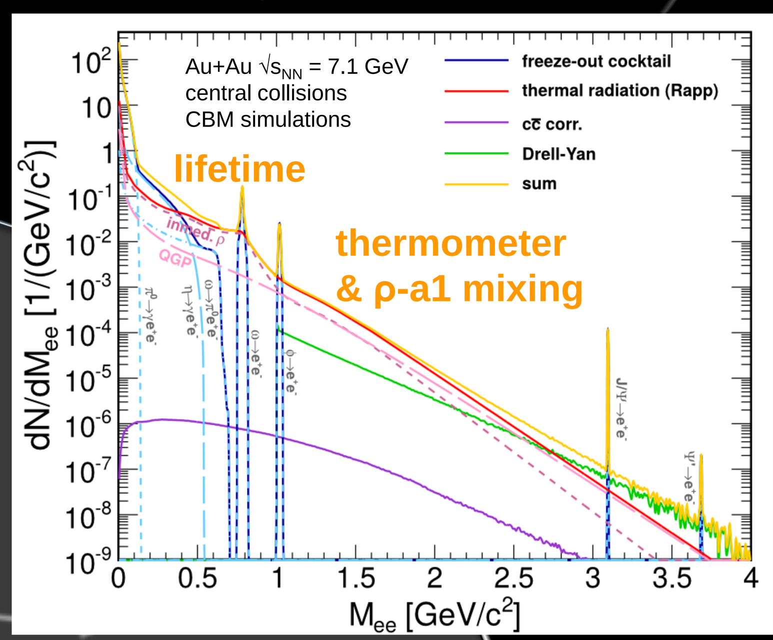


Theoretical modeling

- Thermal emission rates are given by McLerran-Toimela formula

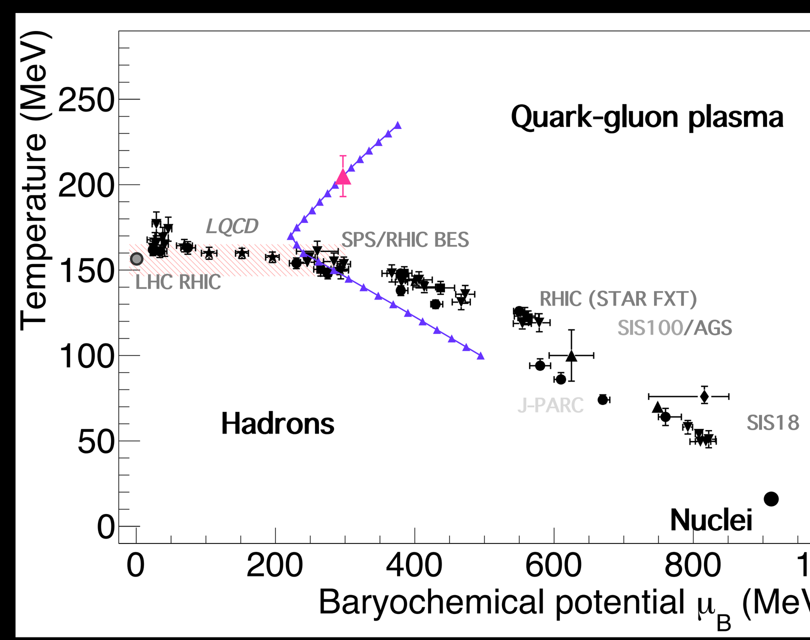
$$\frac{dN_{ll}}{d^4x\,d^4q} = -\frac{\alpha_{EM}^2}{\pi^3 M^2}\, f^B(q\cdot u;T)\, \mathrm{Im}\Pi_{EM}(M,q;\mu_B,T)$$

- Application of thermal rates in pure transport description challenging
- Pure hydrodynamic description of space-time evolution less reliable at lower collision energies



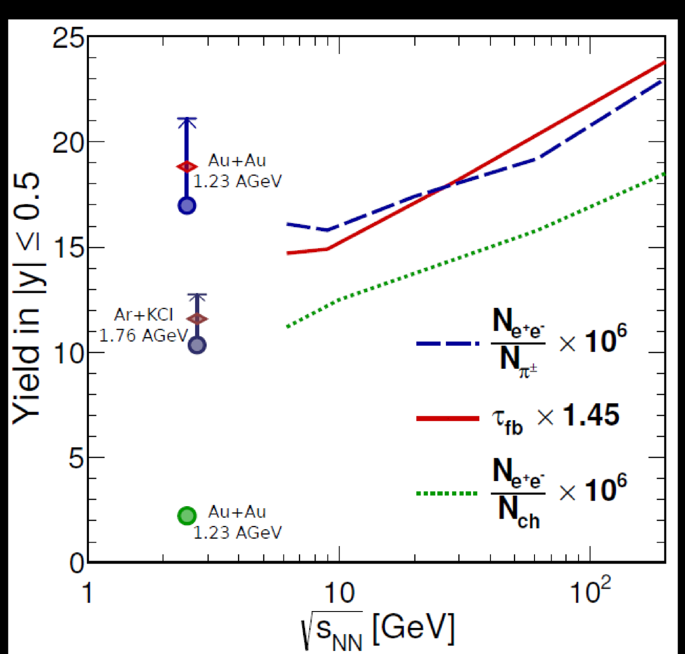
Exploring unknown territory in the phase diagram of strongly interacting matter

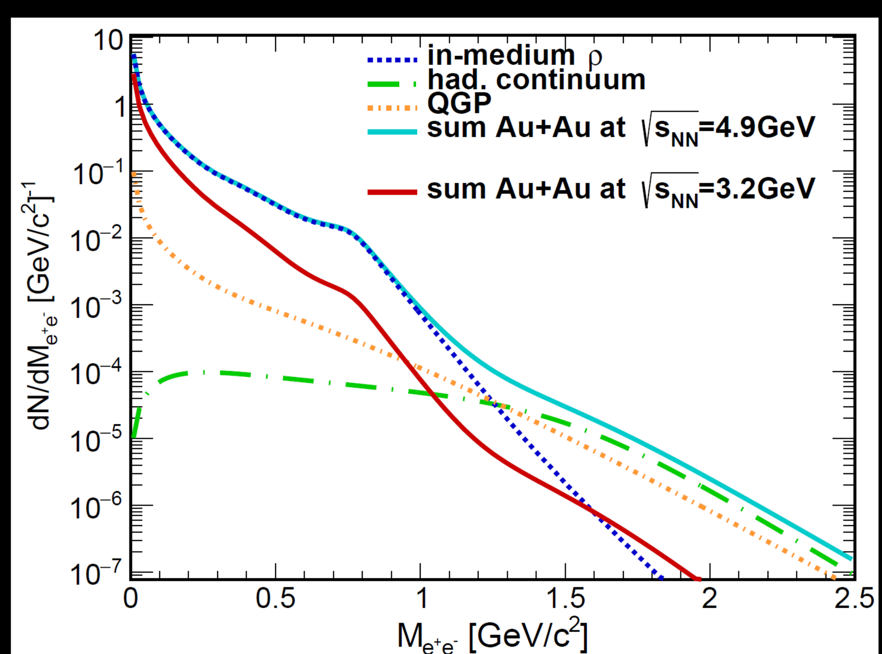
- Electromagnetic radiation emanates over entire course of a heavy-ion collision and decouples from the matter once produced
- Provides unique information about the interacting QCD medium: τ, T, v_{coll}, cos(ϑ)
- Key tool in the search for
  - In-medium modifications of hadrons
  - Chiral symmetry restoration
  - Change of microscopic degrees of freedom



Excitation functions

- Integrated yield of thermal dileptons in the mass range 0.3 to 0.7 GeV/c² normalized to the number of charged pions is rather flat as a function of collision energy
- Strong correlation with the lifetime extracted from the time interval that emits most of the thermal radiation

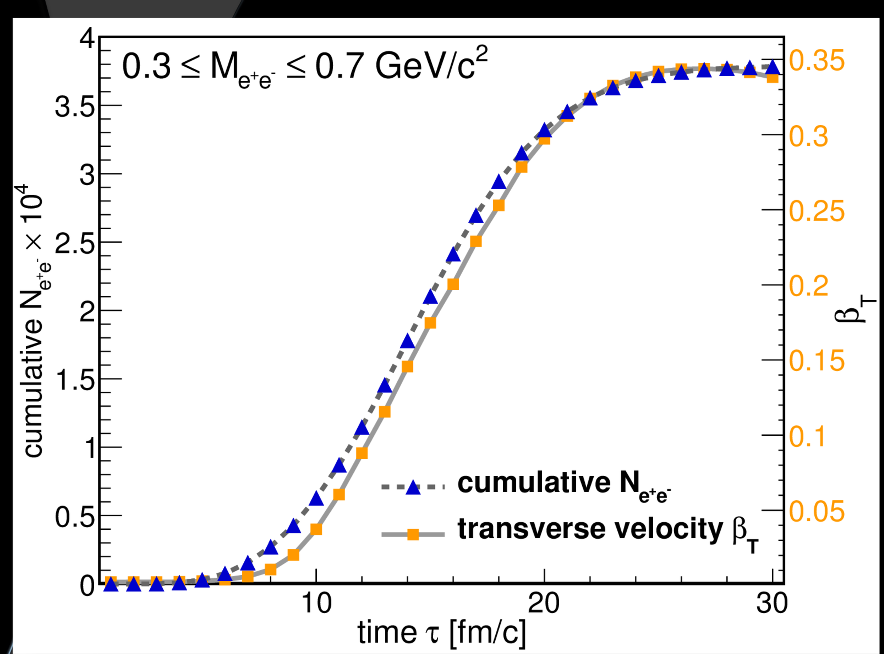




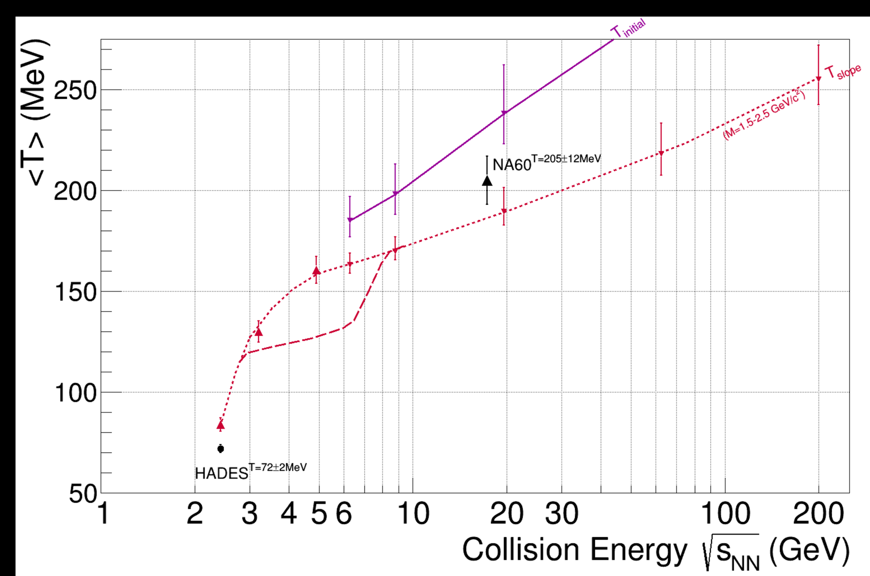
- Toy model for phase transition: let cells that cross a phase boundary shine a few fm/c longer
- Slope in the intermediate-mass range could show a plateau-like structure as a sign of critical behavior near a phase transition

Results for Au+Au collisions at $\sqrt{s_{NN}}$ = 2.4 GeV

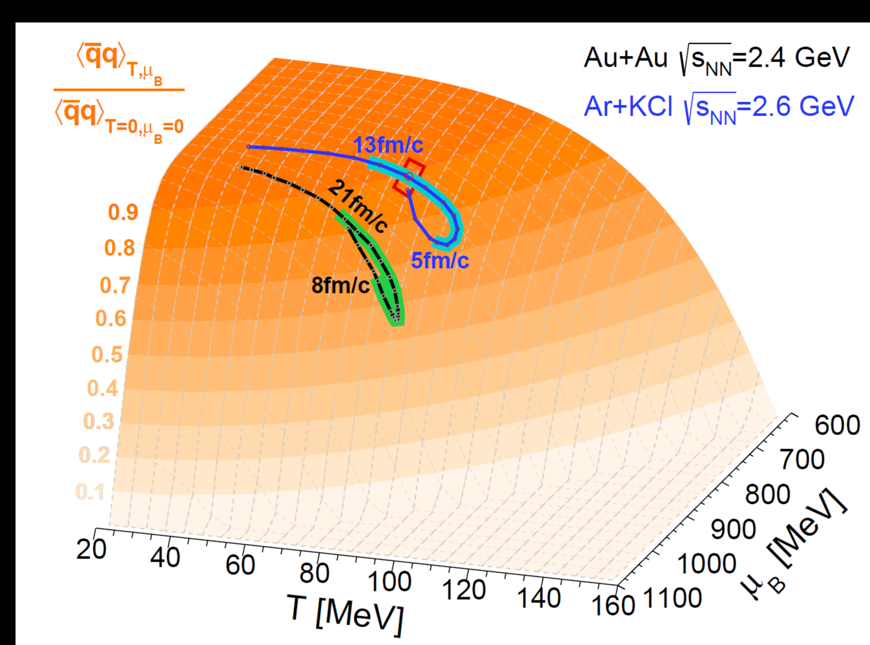
- Strong medium effects on ρ-meson → almost structureless spectrum
- Time evolution of cumulative dilepton yield follows build-up of collective flow



- ~13fm/c long radiation window → lifetime of the fireball
- Fair description of available HADES data in Ar+KCl and Au+Au collisions



- $T_{initial}$ ~ 3 times lower at SIS18 compared to SPS
- Predominance of early emission shifts from M_{ll}>1.2GeV/c² at SPS to M_{ll}>0.4GeV/c² at SIS18
- Low-mass range as thermometer
- Trajectories of central cube with chiral condensate based on a model calculation by Schaefer and Wambach



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