Outline of USQCD 2018 whitepaper

Hot-dense Lattice QCD

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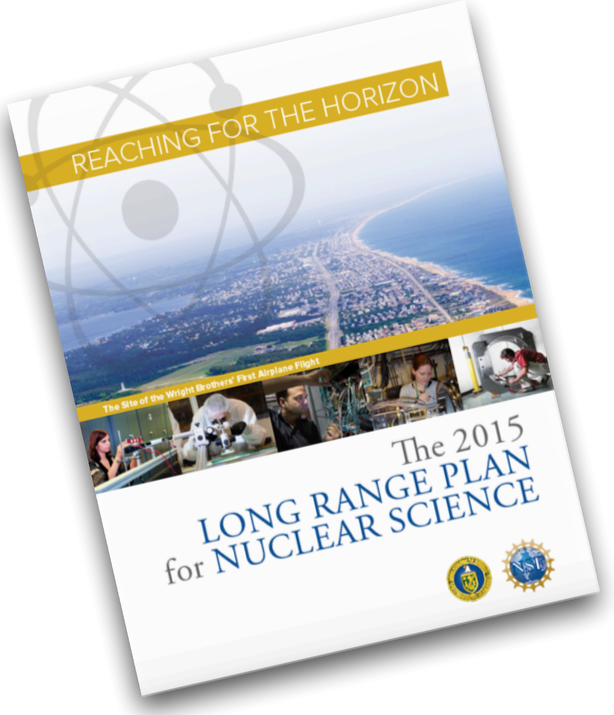
1) introduction …

- basic introduction

- big questions
  - phases of QCD under extreme conditions
    - $T > 0,\ \mu_B > 0,\ m_{u,d,s} \to 0,\ \mu_I > 0,\ \mu_S > 0,\ B > 0,\ \mu_5 > 0 \ldots$
  - properties of QCD under extreme conditions
    - understanding QGP

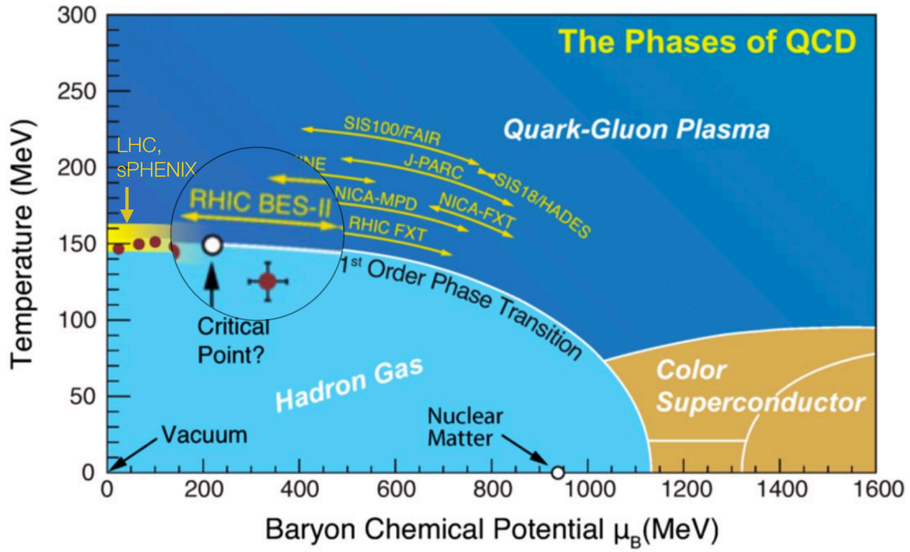


- status
  - hot-dense LQCD, heavy-ion experiment & phenomenology

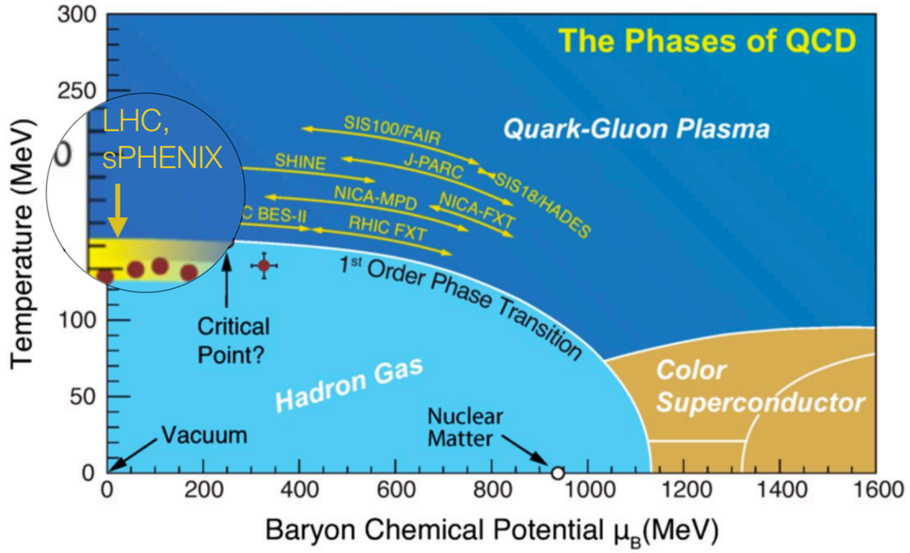
experimental drivers

- global perspective

- RHIC: BES-II (2019-2021)
  - — phases & properties at non-zero baryon density
  - — QCD critical point



- RHIC: sPHENIX (2021+)
  - — QGP at small scale: bottoming
  - — QGP in real time: electromagnetic probes
  - — anomalous QGP: chiral magnetic effect



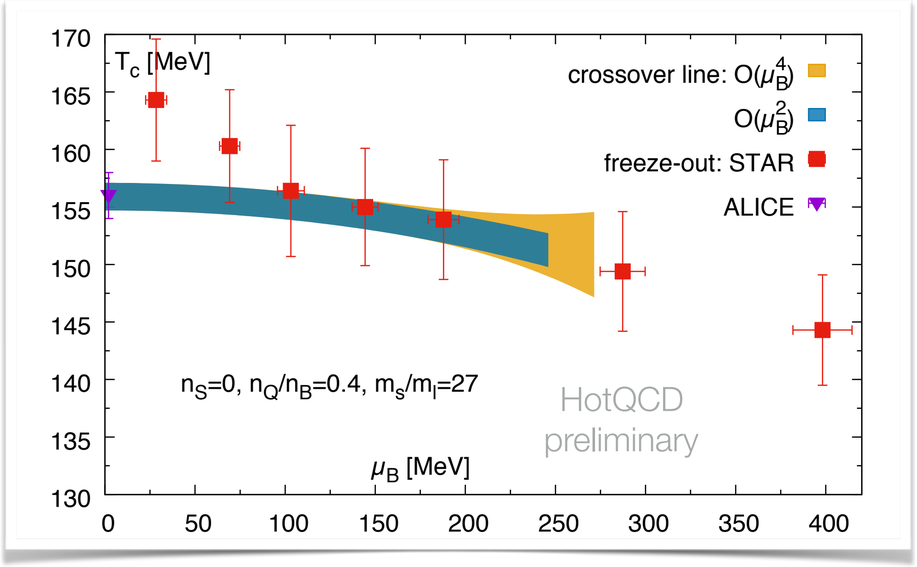
- LHC: heavy-ion program (2020+)
  - — tracers in QGP: heavy-quark thermalization & flow
  - — QGP in real time: electromagnetic probes
  - — anomalous QGP: chiral magnetic effect

the next 5 years: roles & goals of hot-dense LQCD

- phases & properties @ $T > 0,\ \mu_B > 0$
  - — BES-II, RHIC-FXT, NA49/SHINE, FAIR/CBM, NICA, J-PARK
- heavy-quarks in QGP
  - — sPHENIX, LHC heavy-ion
- electromagnetic probes
  - — sPHENIX, LHC heavy-ion
- towards chiral limit
  - — fundamental theoretical questions

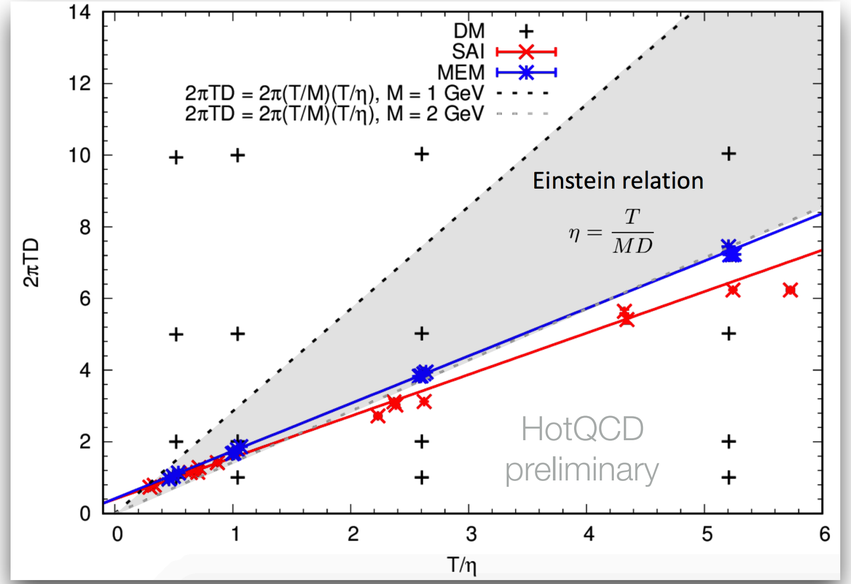
2) phases and properties of QCD @ $T > 0,\ \mu_B > 0$

- chiral crossover temperature
  — QCD phase-diagram
- equation-of-state
  — modeling of BES-II
- baryon transport
  — baryon diffusion constant
- compare with effective models
  — understand relevant interactions



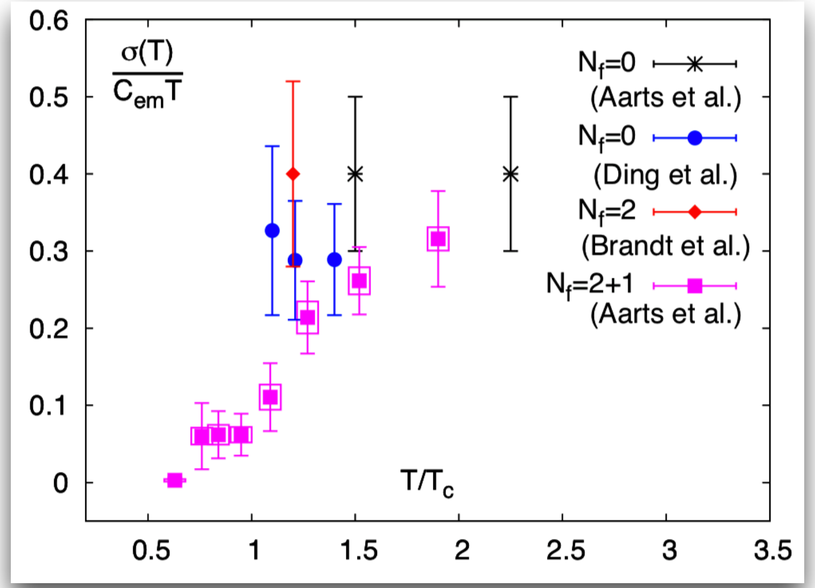
3) heavy-quarks in QGP

- quarkonia & heavy-light mesons melting
  — upsilon, J/Psi, Ds, D
- heavy-quark transport
  — heavy-quark diffusion constant
- static quark potential
  — real, as well as imaginary part



4) electromagnetic probes

- electrical conductivity of QGP
  - — lifetime of B-field & chiral magnetic effect
  - — charge diffusion in QGP
- di-lepton emission rate
- photon emission rate
  - — modeling photon flow

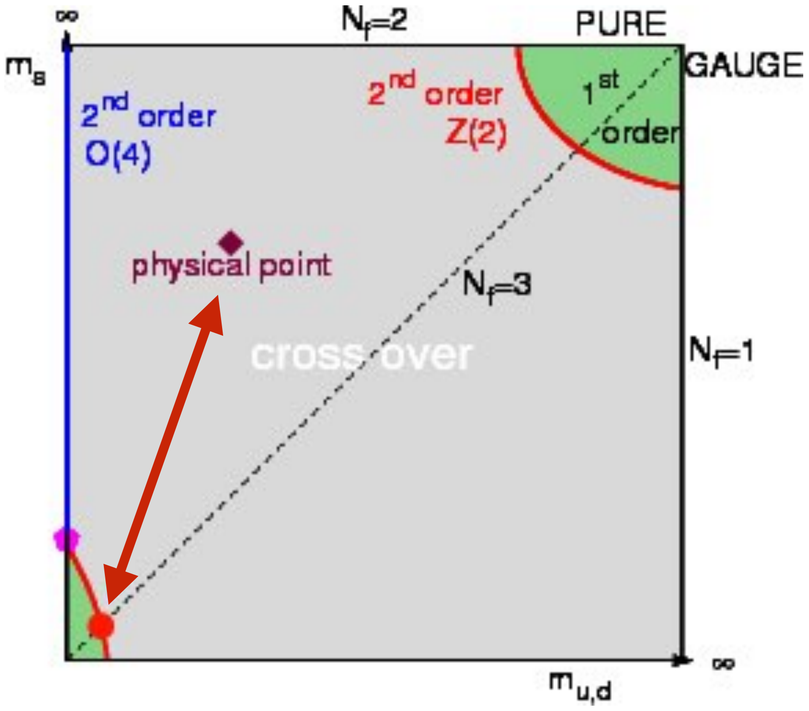


5) towards chiral limit

- chiral transition temperature
  — fundamental scale of QCD

- universality class of chiral transition
  — an open question for > 30 yrs.

- fate of axial anomaly
  — effective restoration at chiral transition ?



6) computational challenges

- phases & properties @
  — enormous statistics

- heavy-quarks in QGP
  — inclusion of dynamical light quarks for large, fine lattices

- electromagnetic probes
  — inclusion of dynamical light quarks for large, fine lattices

- towards chiral limit
  —going to very low pion masses