

The HADES Science

from GSI to FAIR

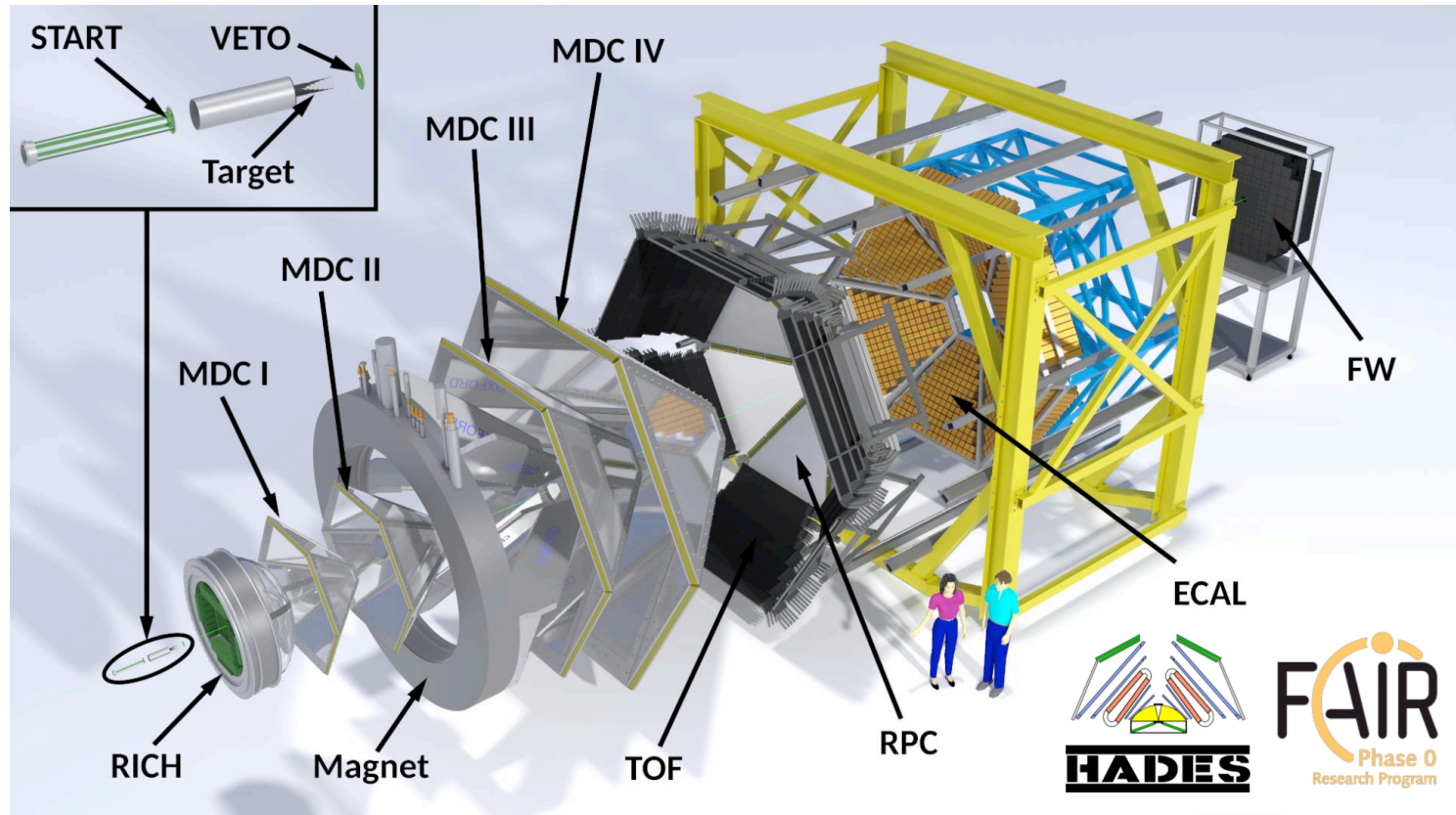
Joachim Stroth

CML Retreat, Mörfelden

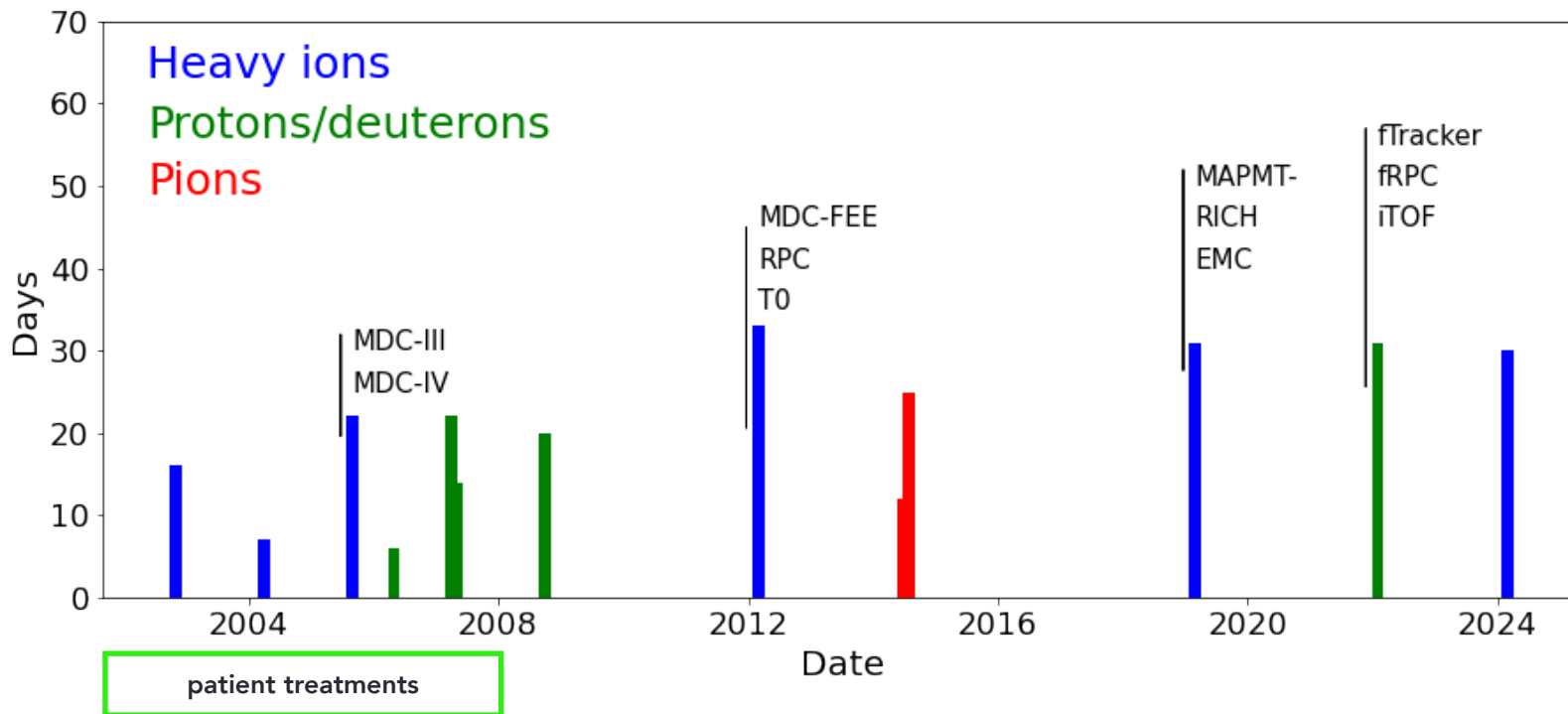
October 4, 2023



The upgraded HADES spectrometer



HADES runs until 2024



The HADES Phase-0 plans

Two of five planned runs taken, third will follow in 2024

Au+Au BES < 1 A GeV

EM transition form factors of hyperons

Cold matter effects including line shapes and SRC


Baryon resonances, meson baryon coupling in the 3rd resonance region

Iso-spin effects in dilepton production

SEARCHING FOR CRITICAL BEHAVIOR AND LIMITATIONS OF THE UNIVERSAL FREEZE-OUT LINE

Au+Au collisions at 0.2-0.63 GeV

The HADES Collaboration



Spokesperson: J. Steffens (j.steffens@gsi.de), P. Thury (p.thury@gsi.de)
 GSI contact: J. Putschke (j.putschke@gsi.de)

Subcontractors: SRH and HADES core

Beam: Au+Au collisions
 At an Au+Au $\sqrt{s_{NN}}$ of 0.2-0.63 GeV, 2×10^{11} Au ions (Pb ions)
 For Au+Au GeV, 1×10^{11} Au ions

Abstract

We will extend our exploration of the QCD phase diagram towards the location of the critical point in Au+Au collisions. This includes Au+Au runs with collision energies below the freeze-out line. The main goal is to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior.

This is a new experiment proposal.
 To be taken in 2024.

PRODUCTION AND DECAY OF HYPERONS, AND INCLUSIVE HADRON AND DILEPTON PRODUCTION

At Au+Au collisions at 4.0 GeV

The HADES and HADES/PANDA Collaborations



Spokesperson: J. Steffens (j.steffens@gsi.de), P. Thury (p.thury@gsi.de)
 GSI contact: J. Putschke (j.putschke@gsi.de)

Subcontractors: SRH, JLab, target, HADES core

Beam: protons at 4.0 GeV, beam intensity 7.5×10^{11} p/s, slow extraction

Abstract

In the RHIC Energy region, an urgent need has been to perform a series of experiments to study the production and decay of hyperons. This is a new experiment proposal. The main goal is to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior.

Successfully conducted in Feb./March 2022

STUDYING MEDIUM EFFECTS IN PHOTON INDUCED REACTIONS

p-Au collisions at 4.0 GeV

The HADES Collaboration



Spokesperson: J. Steffens (j.steffens@gsi.de), P. Thury (p.thury@gsi.de)
 GSI contact: J. Putschke (j.putschke@gsi.de)

Subcontractors: SRH, HADES core and part of the GSI/FAIR detector to measure the overall reaction

Beam: p at 4.0 GeV, beam intensity 4×10^{11} p/s, slow extraction

Abstract


We propose to investigate p-Au reactions with an improved experimental setup which enables measurements of charged particle yields in the very forward region. This is a new experiment proposal. The main goal is to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior.

This is a new experiment proposal.
 We request 10 AuAu.

BARYON COUPLINGS TO MESONS AND VIRTUAL PHOTONS IN THE THIRD RESONANCE REGION: VACUUM AND COLD MATTER STUDIES

Pb-Pb collisions on ^{208}Pb and ^{208}Pb at 0.2-0.63 GeV

The HADES Collaboration



Spokesperson: J. Steffens (j.steffens@gsi.de), P. Thury (p.thury@gsi.de)
 GSI contact: J. Putschke (j.putschke@gsi.de)

Subcontractors: SRH, core production, target and HADES core

Beam: Nitrogen at 0.2 GeV, beam intensity slow extraction

Abstract

We propose to use the GSI proton beam to probe baryon resonances in the third resonance region. This is a new experiment proposal. The main goal is to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior.

On hold otherwise A

SCRUTINIZING ISO-SPIN EFFECTS IN $N+X$ BREMSSTRAHLUNG AND DILEPTON $\mu^+\mu^-$ FORMATION IN $N+P$ COLLISIONS

Au+Au collisions at 0.2-0.63 GeV

The HADES Collaboration



Spokesperson: J. Steffens (j.steffens@gsi.de), P. Thury (p.thury@gsi.de)
 GSI contact: J. Putschke (j.putschke@gsi.de)

Beam: Au+Au collisions
 At an Au+Au $\sqrt{s_{NN}}$ of 0.2-0.63 GeV, 2×10^{11} Au ions
 For Au+Au GeV, 1×10^{11} Au ions

Abstract

We propose to investigate p-Au reactions with an improved experimental setup which enables measurements of charged particle yields in the very forward region. This is a new experiment proposal. The main goal is to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior. Au+Au runs with collision energies below the freeze-out line will be used to search for critical behavior.

This is a new experiment proposal.
 We request 10 AuAu.

Scheduled for February 2024

Successfully conducted in Feb./March 2022

On hold otherwise A

HADES physics topics – see also CBM

Explore the limit of hadronic existence – from medium-effects to novel phases of QCD matter

Conjecture after ~10 years of studies of electromagnetic probes:

- QCD matter at $\rho \gtrsim 2\rho_0$ exists as baryonic cores embedded in an entangled pion cloud
- State cannot be described as dilute resonance matter, i.e. $\lambda \neq 1/(\sigma\rho)$

Methods for further investigations

- Search for signs of criticality (First-order phase transition, remnants of liquid-gas critical point)
- Strangeness production and propagation
- In-medium properties of mesons
- Study of meson-baryon/hyperon coupling and baryon/hyperon em transition form factors

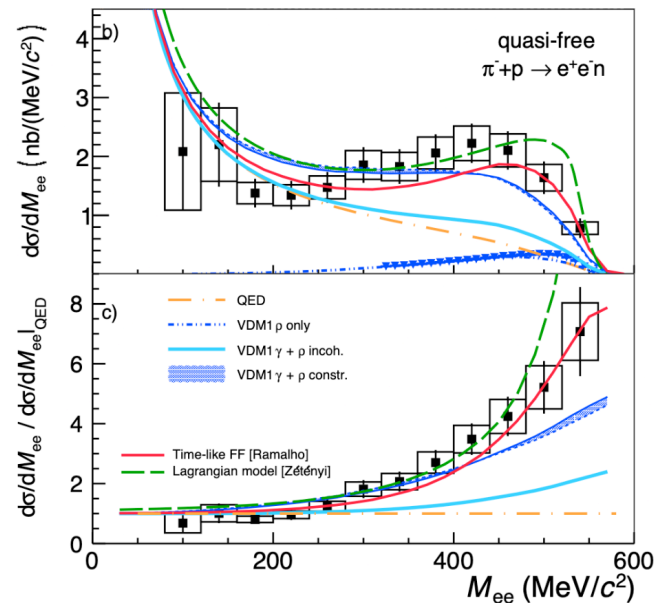
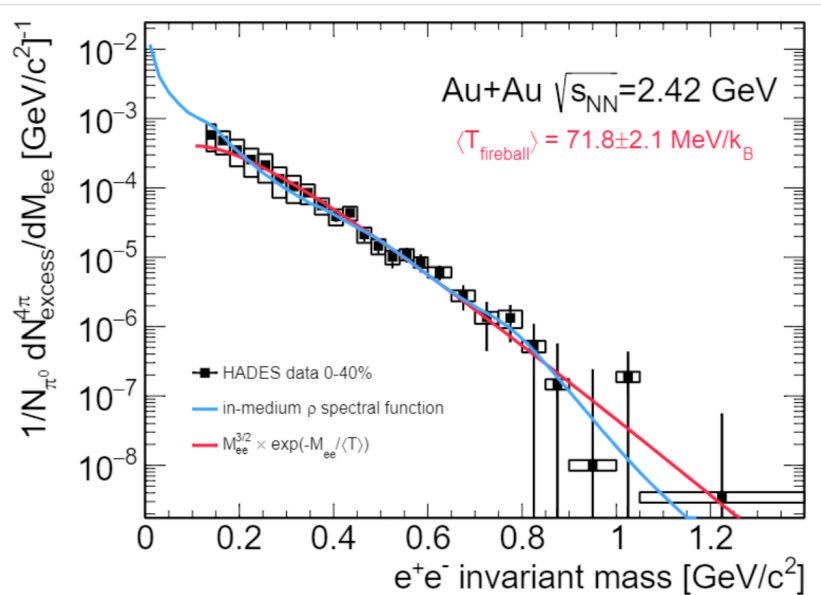
Spin-offs:

- EOS, Hypernuclei, SRC

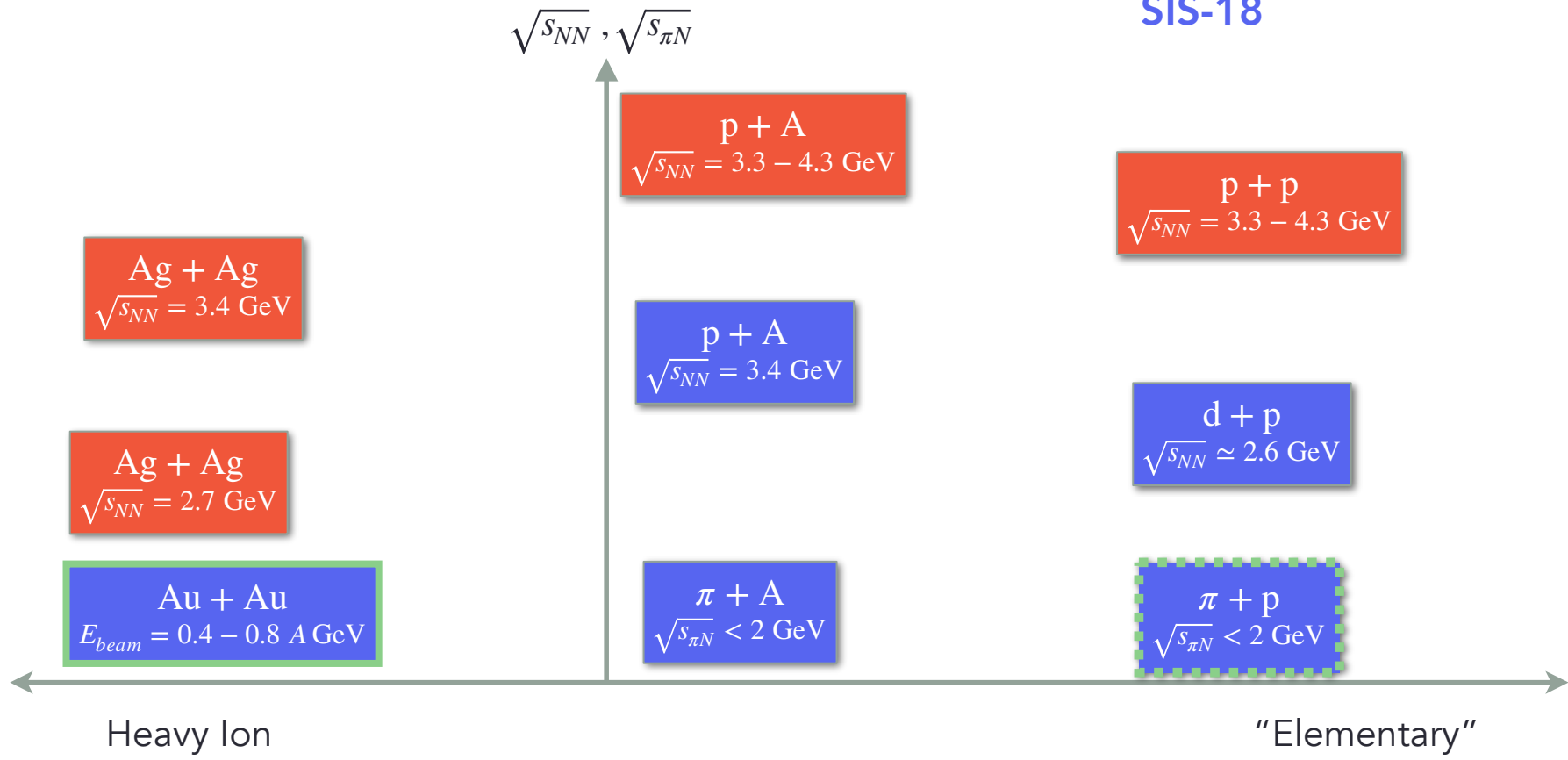
Key observations

Emissivity of compressed baryonic matter:

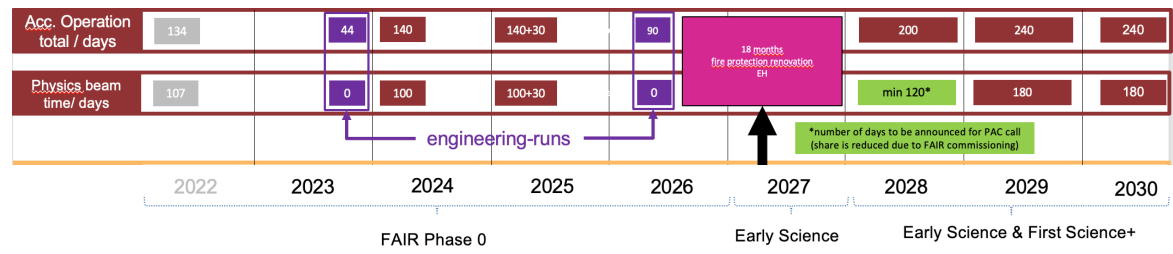
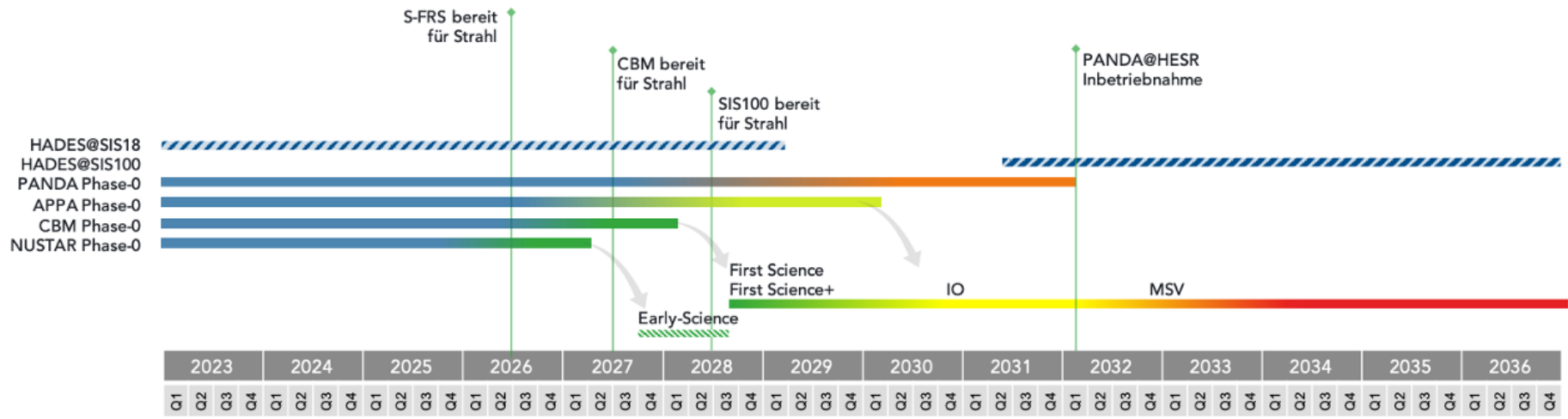
Radiation explained by decays of medium-modified vector mesons (VMD, radiation of the cloud)



HADES runs to come



HADES transfer not likely before 2031



The quest for beam time at SIS18

