

Exploring high-density baryonic matter in J-PARC-HI Project

Hiroyuki Sako¹, Kyoichiro Ozawa², and Taku Gunji³, for J-PARC-HI Collaboration

¹Japan Atomic Energy Agency (JAEA) / University of Tsukuba

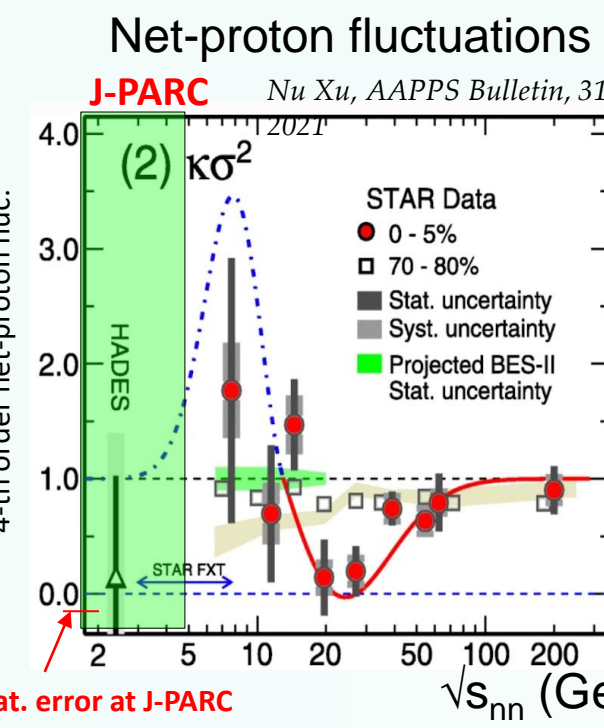
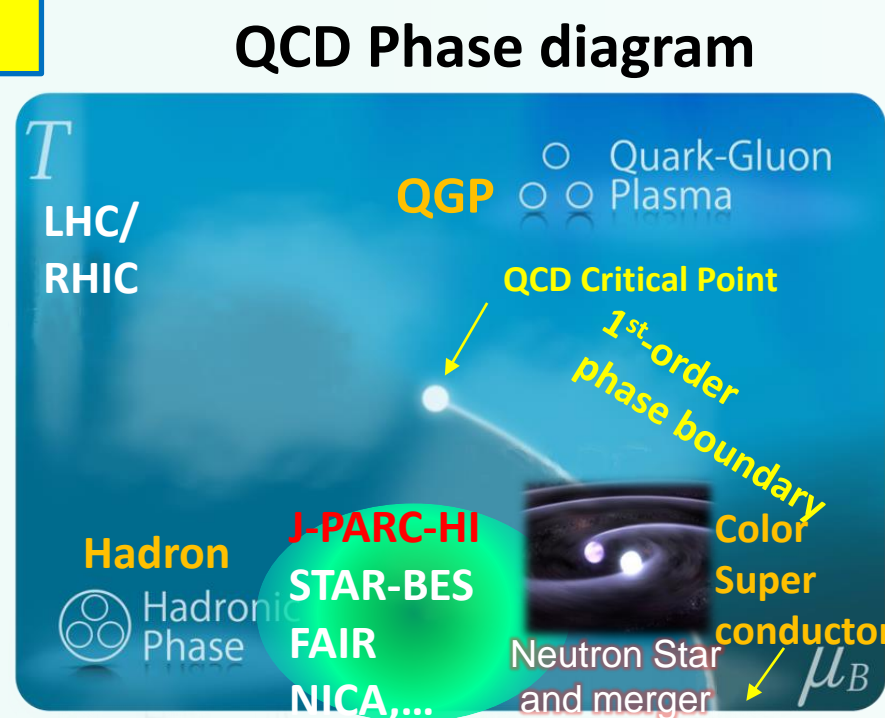
²High Energy Accelerator Research Organization (KEK)

³Center for Nuclear Study, University of Tokyo

Abstract: We are planning to accelerate world's high-intensity heavy-ion beams at J-PARC. We will build a new compact heavy-ion linac and a booster ring as an injector, while we utilize the existing RCS and MR synchrotrons to accelerate up to 10^{11} Hz heavy-ion beams at 1-12 AGeV/c. We will explore QCD phase structures in a high-density regime such as the first-order phase boundary, the QCD critical point, and color superconducting phases. We also search for various multi-strangeness particles/nuclei and study hadron interactions including strangeness. We develop a staging strategy with the existing primary proton beamline and the J-PARC E16 spectrometer (Phase 1), and with the upgraded booster ring, the extension of the proton beam line, and the construction of the new large-acceptance spectrometer (Phase 2). We show the status of the dilepton measurements in p+A at J-PARC E16, and the experimental design and physics feasibility for dilepton and hadron measurements at Phase 1 and Phase 2.

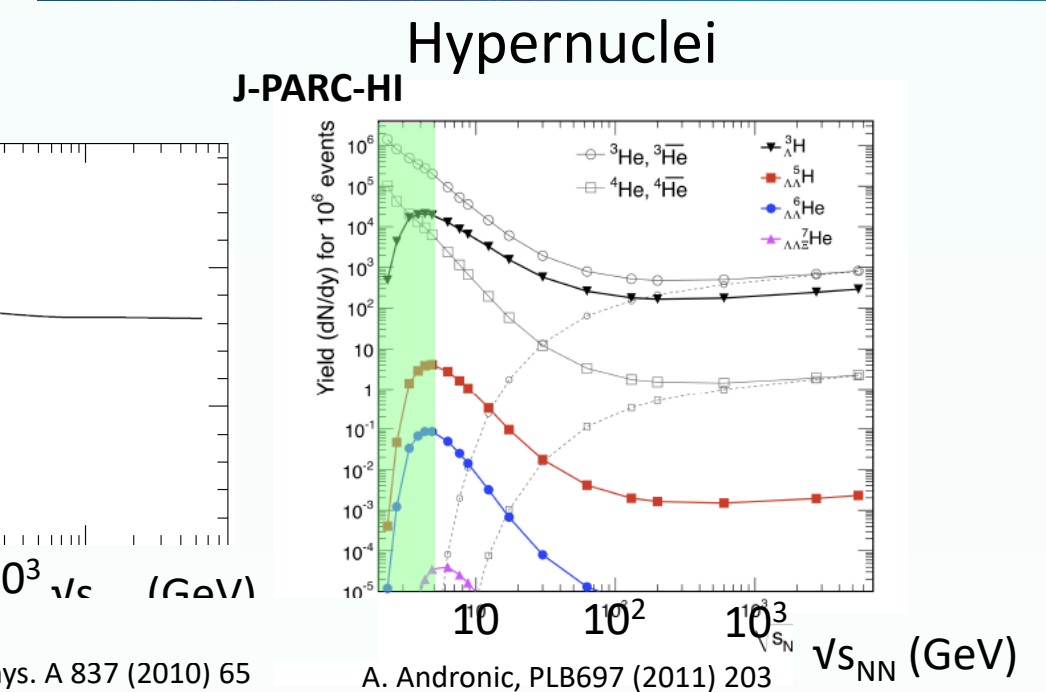
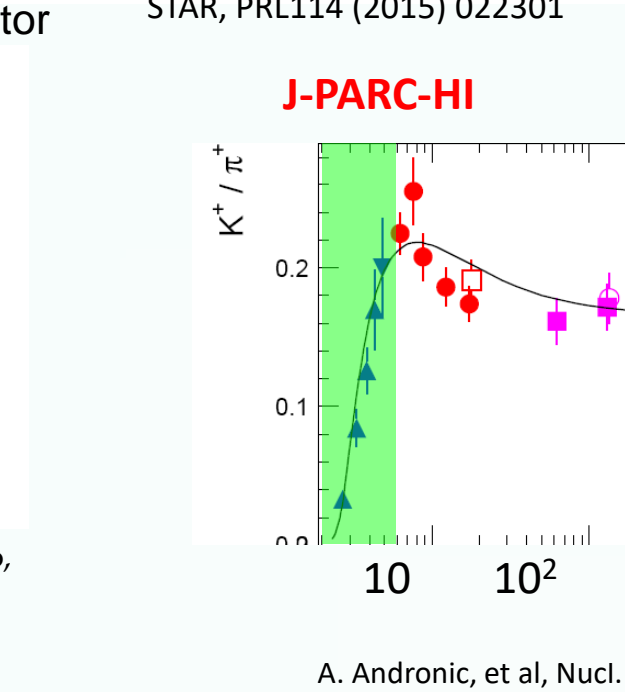
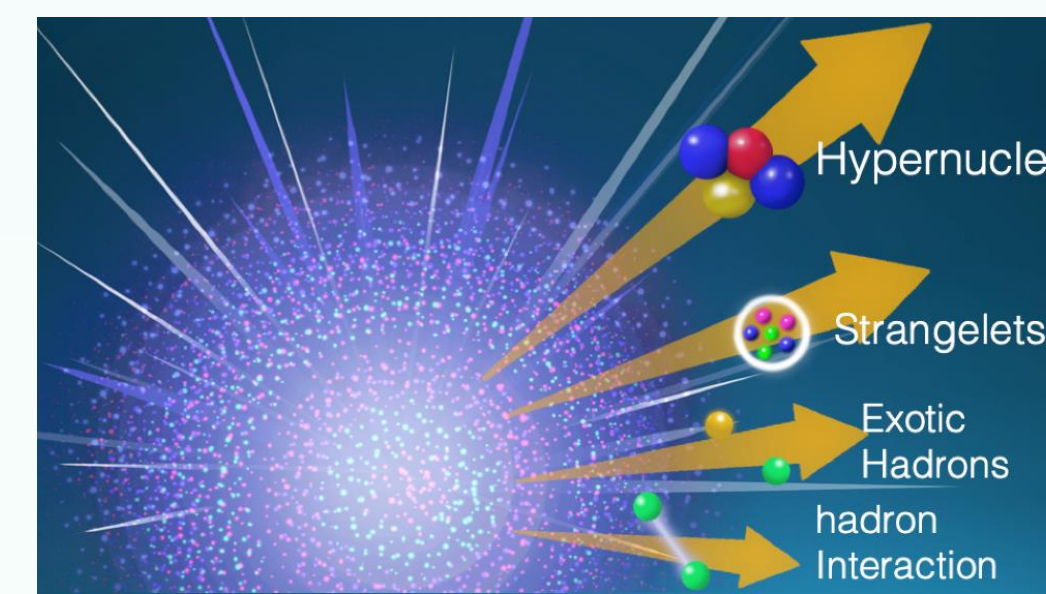
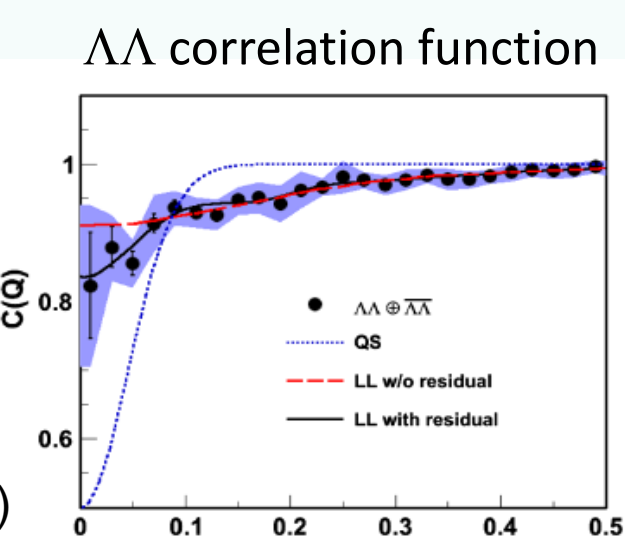
Physics Goals (1)

Exploring dense matter



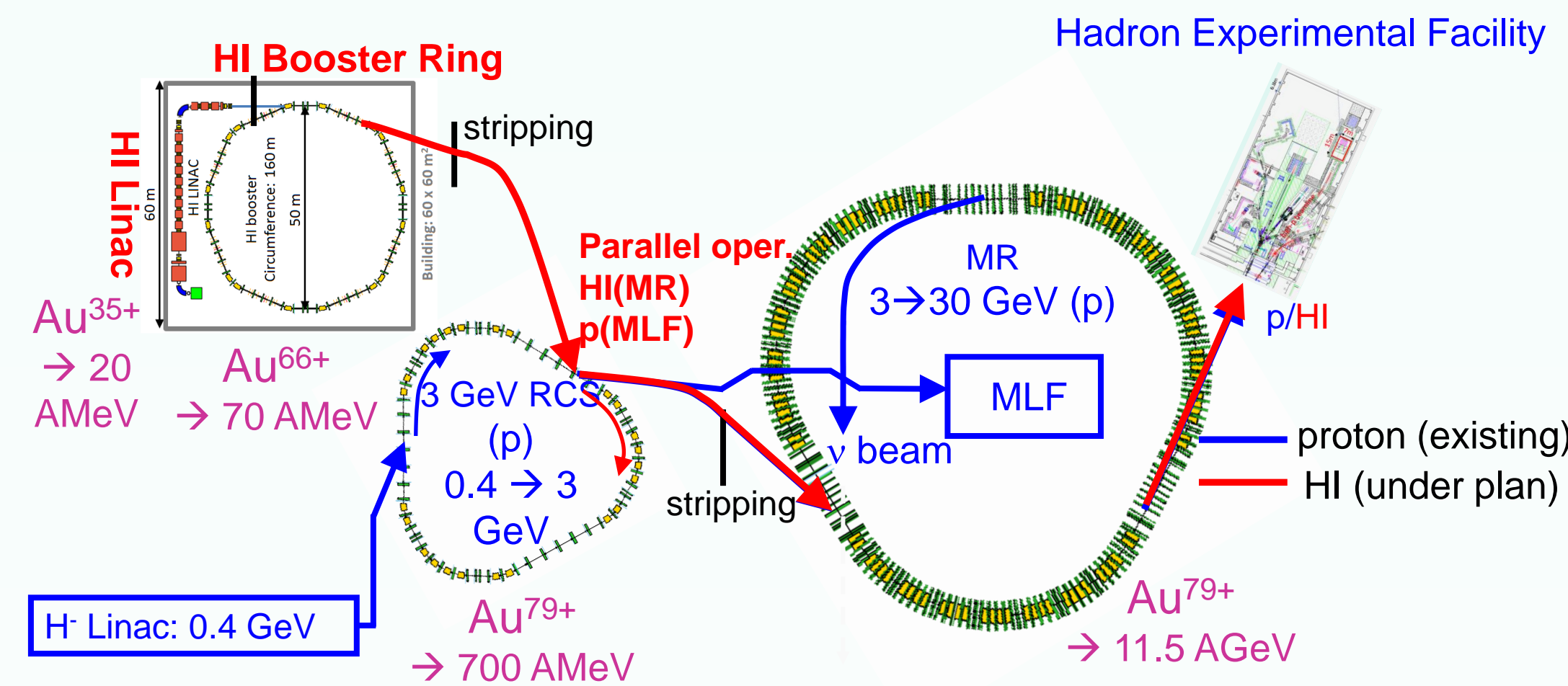
Physics Goals (2)

Studies of multi-strangeness production

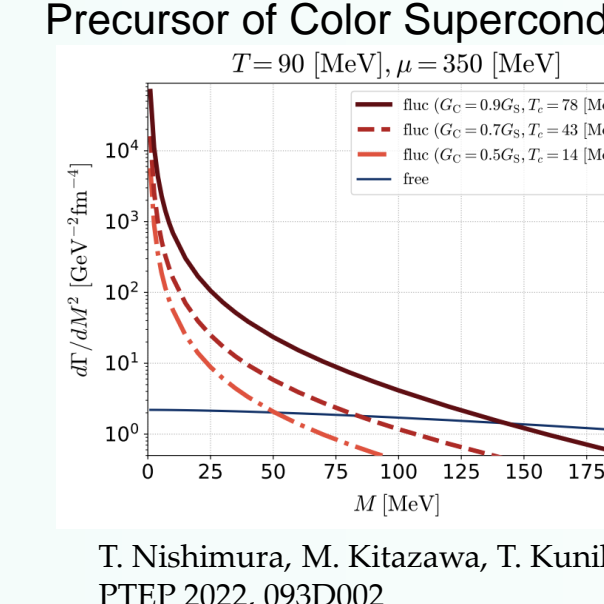
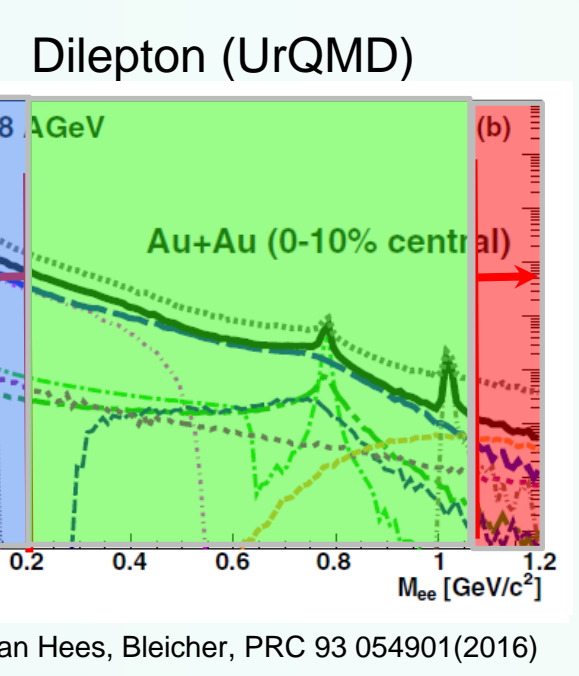
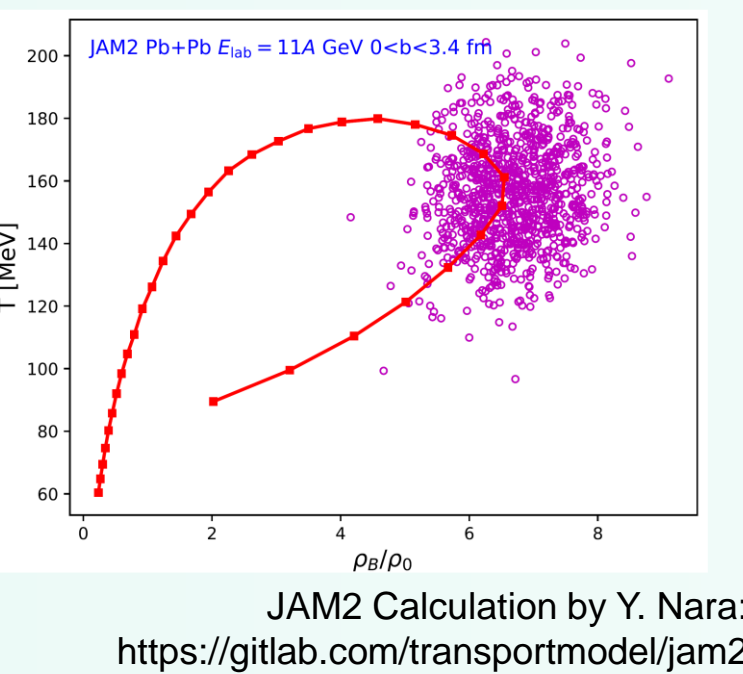


Heavy-ion Acceleration at J-PARC

- HI Beam rate $\sim 10^{11}$ Hz
- E_{lab} (Au) = 1-12 AGeV
- $\sqrt{s_{NN}}$ (Au) = 1.9-4.9 GeV



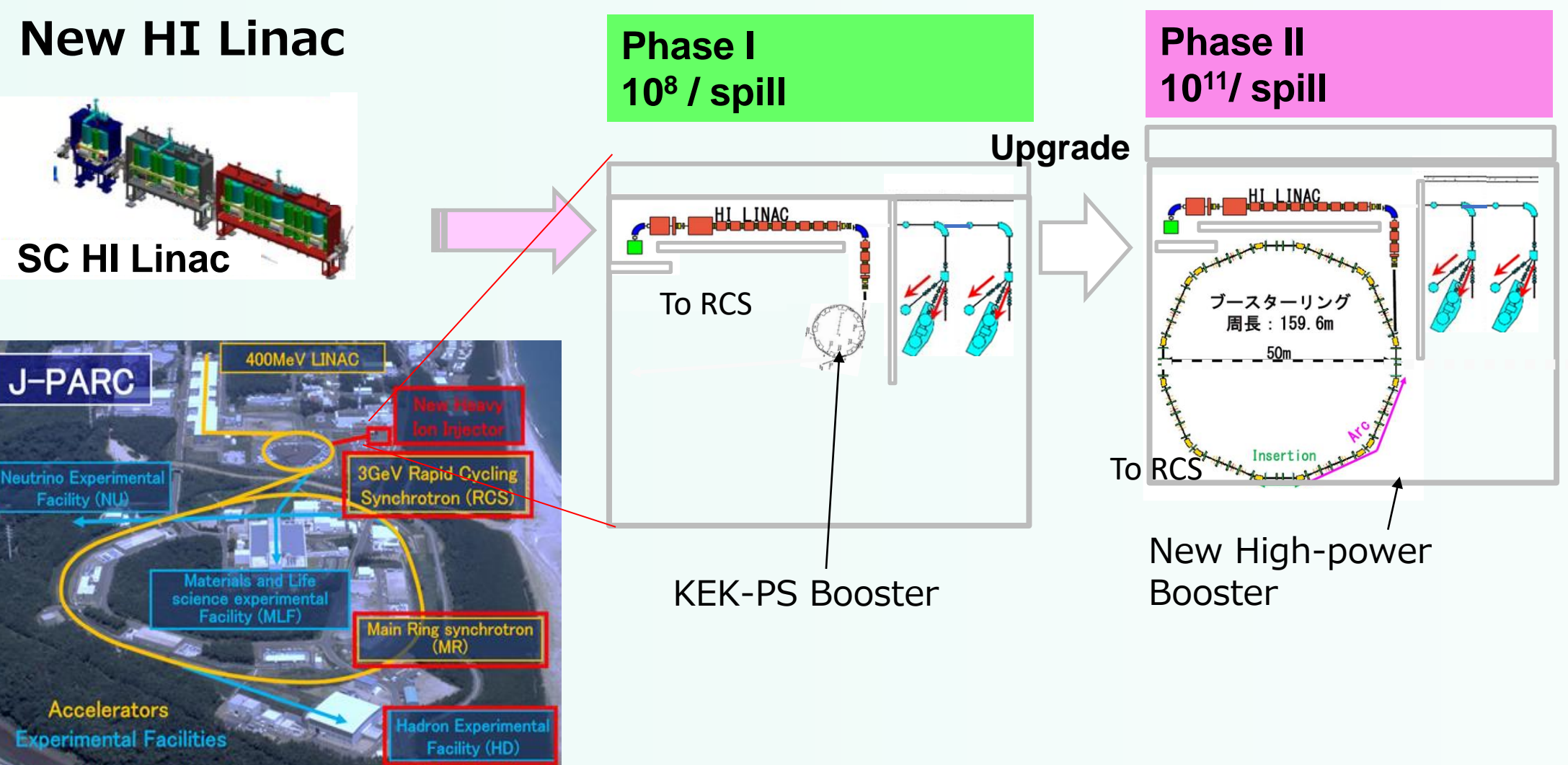
Event-by-event temperature and density



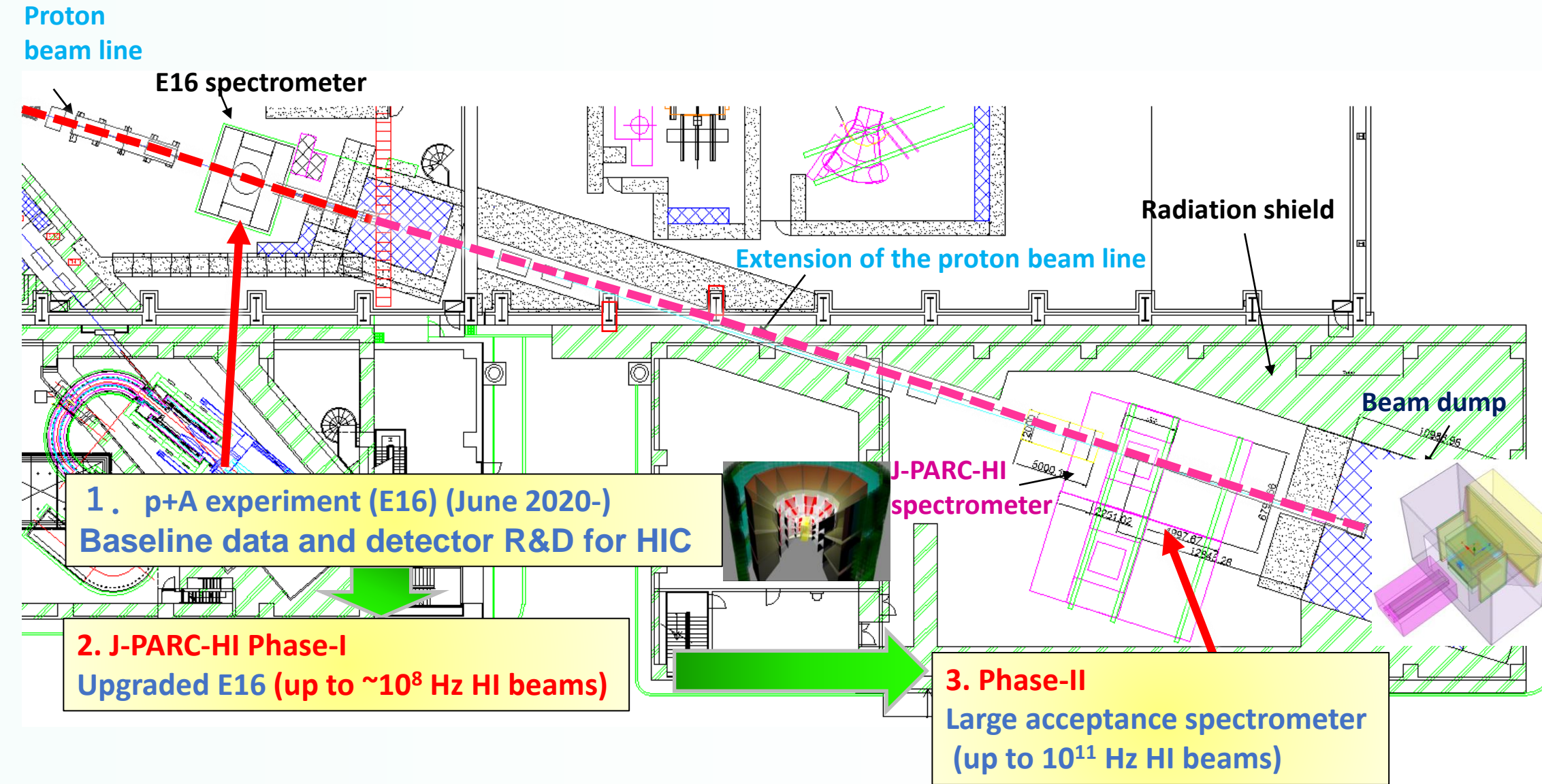
- Search for QCD Phase structures
 - 1st order phase transition, QCD Critical Point, Color superconductor
 - Event-by-event fluctuations, dileptons
- Properties of dense matter
 - Maximum density, EOS, transport properties (viscosity), etc.
 - Flow
 - Studies of neutron stars
- Chiral symmetry restoration
 - Medium modification of vector mesons
 - Dileptons

- Efficient production of strangeness at J-PARC
- Search for rare multi-strangeness systems
 - Hypernuclei, strangelet, dibaryons, etc.
- Study of hyperon interactions
 - Femtoscopy
 - EOS of strange hadronic/quark matter

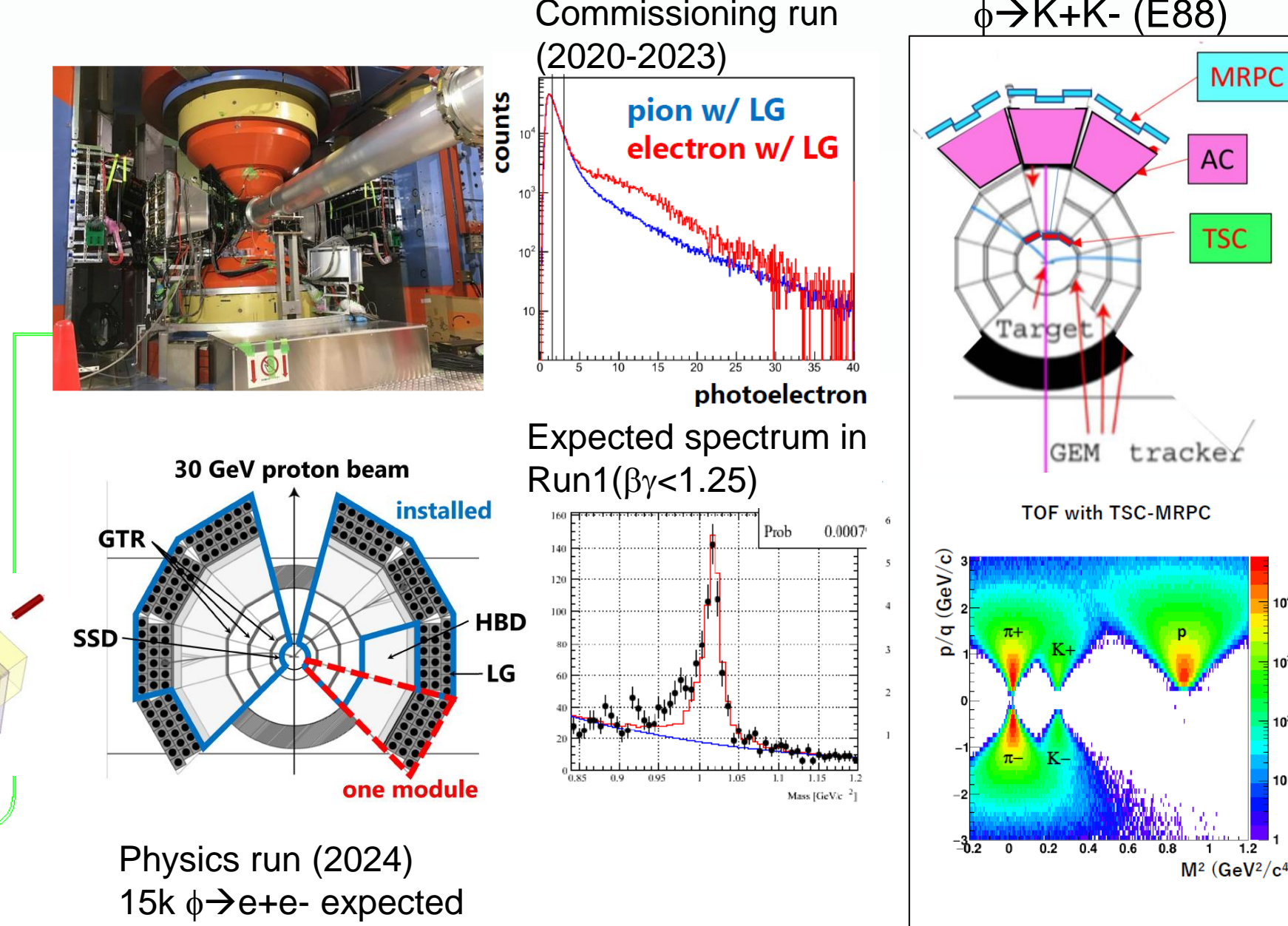
Staging Strategy (Accelerator)



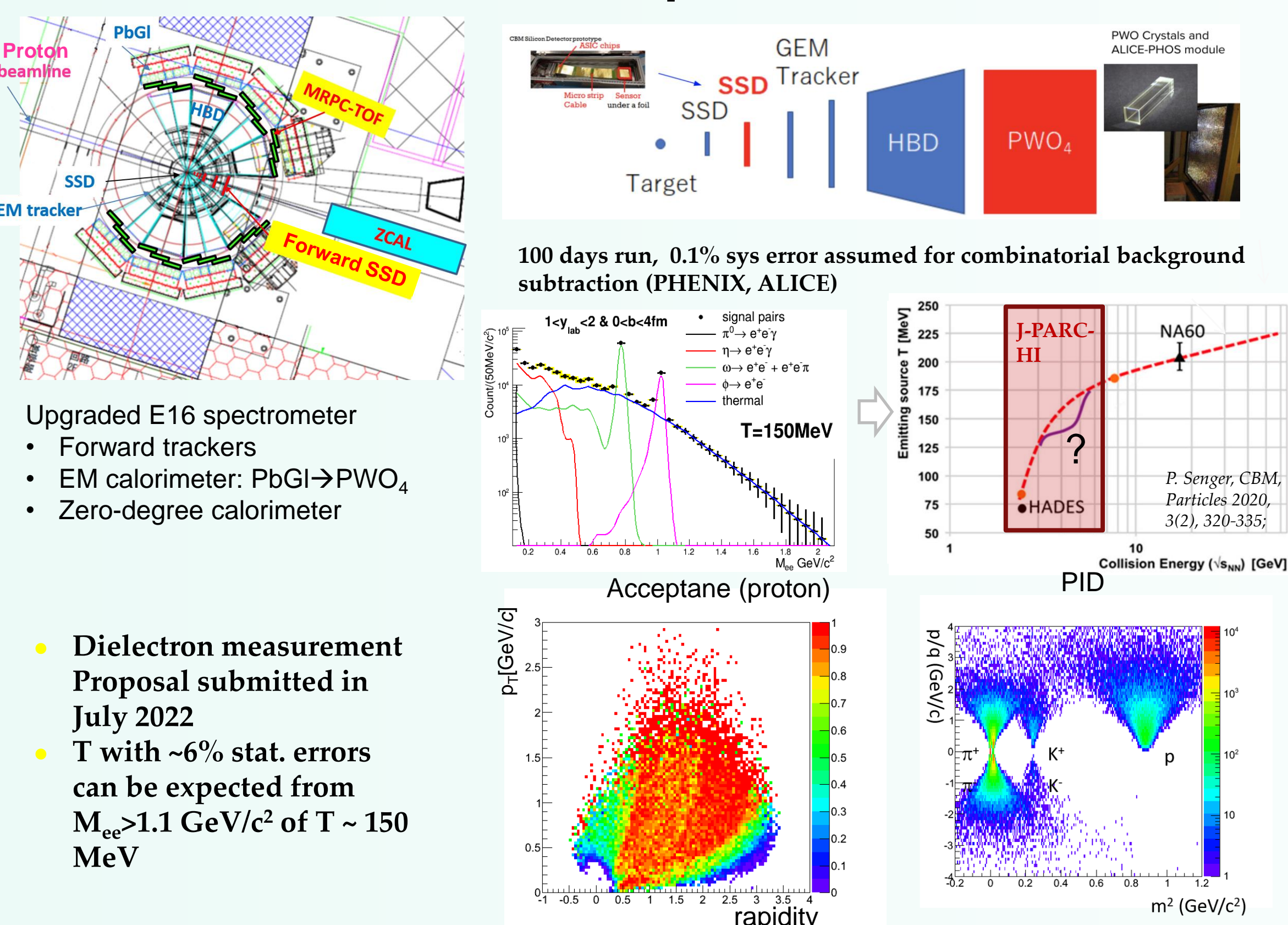
Staging Strategy (Experiment)



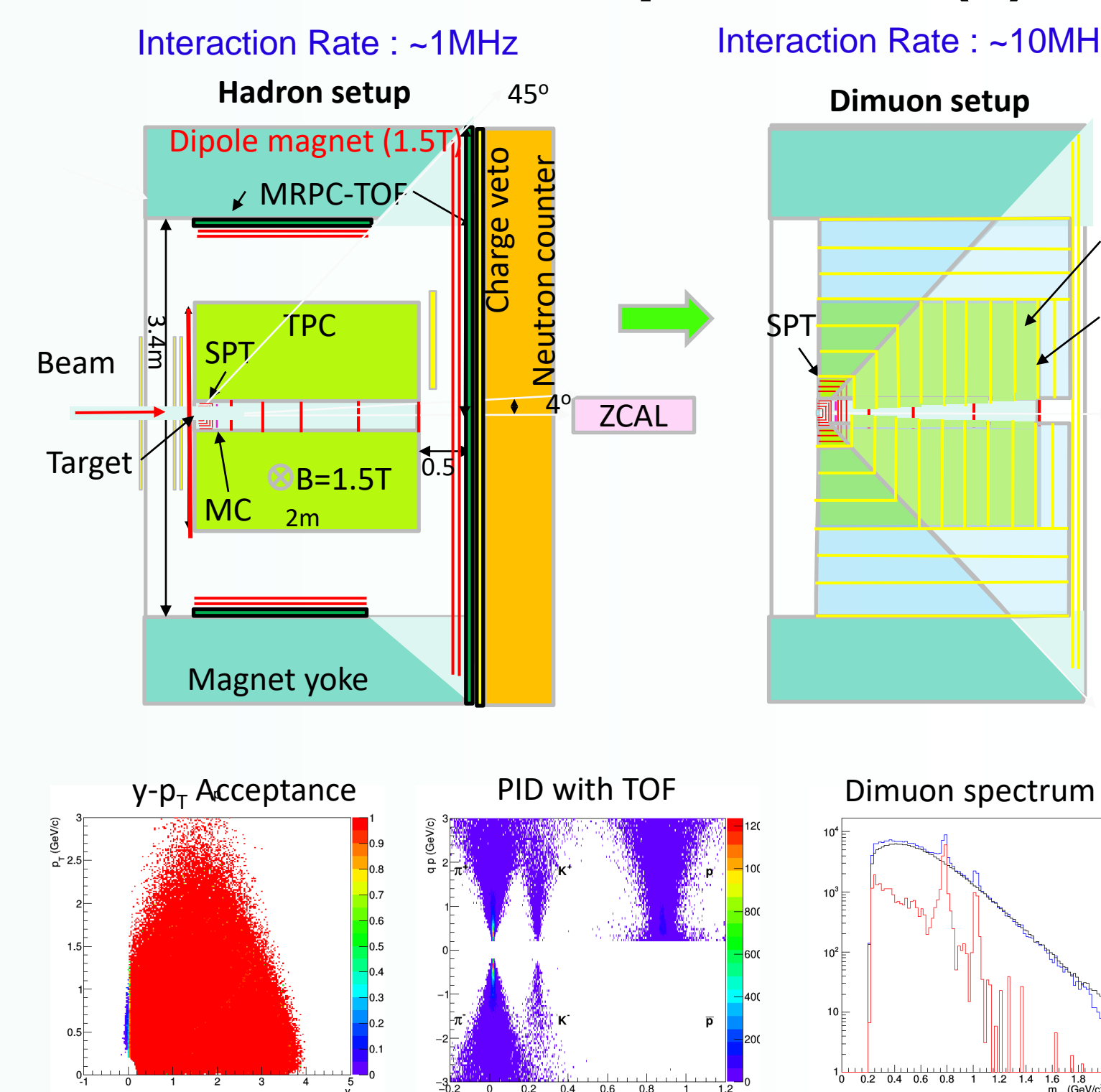
J-PARC E16/E88: ϕ measurement in p+A



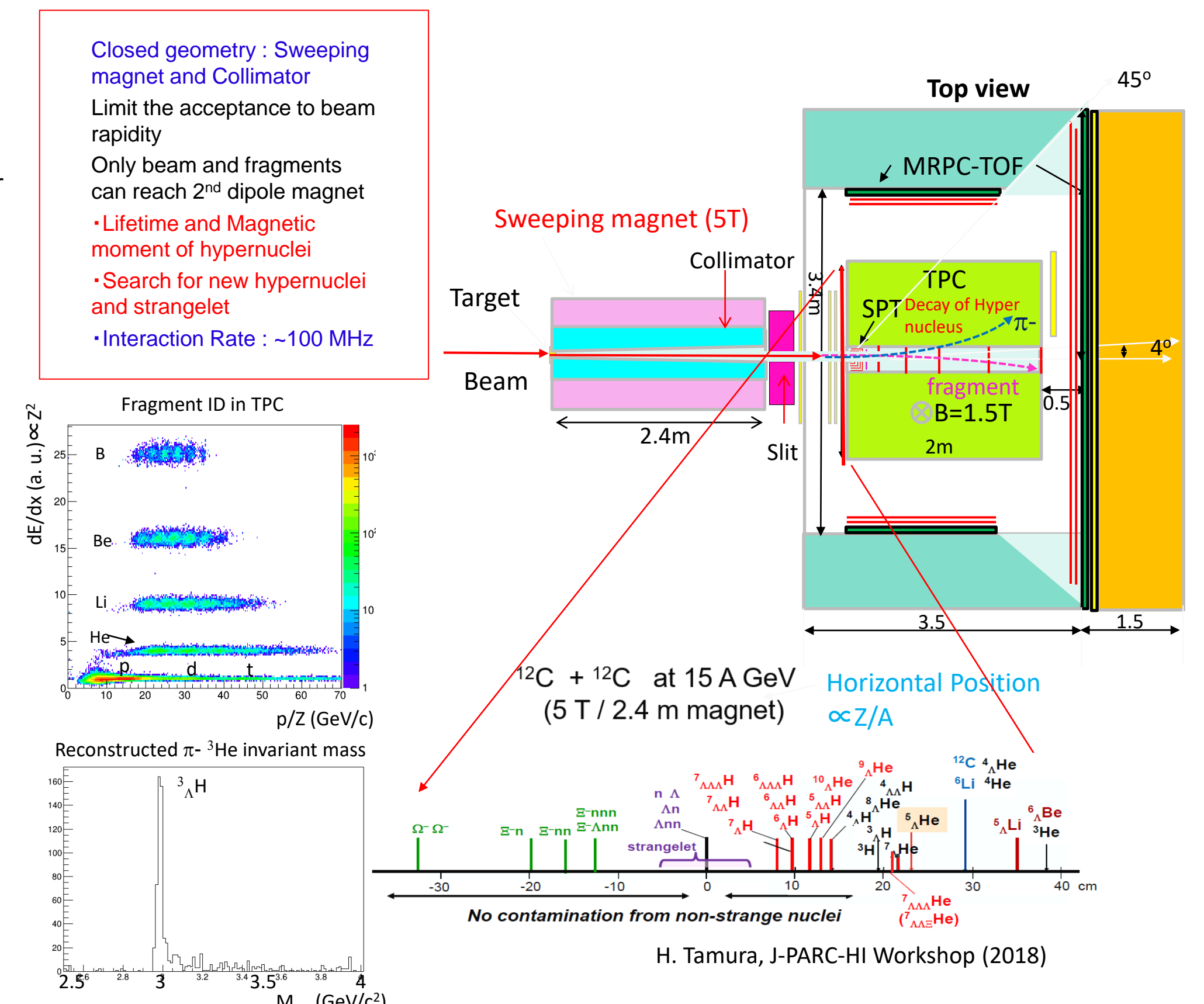
Phase-1 Experiment



Phase-2 Experiment (1)



Phase-2 Experiment (2)



Summary and Prospect

J-PARC-HI : Studies of QCD phase structures at high density and multi-strangeness systems with world's highest-rate HI beam of 10^{11} Hz

Measurements of fluctuations, dileptons, and multi-strangeness systems

Staging strategy: p+A at E16 → A+A at Upgraded E16 (Phase 1) → Large acceptance spectrometer (Phase 2)

$\phi \rightarrow e+e-$ experiment in p+A (E16) started in 2020.

$\phi \rightarrow K+K-$ in p+A (E88) proposed (July 2021)

Aiming for the start of the Phase-1 experiment after the extension of J-PARC Hadron Experimental Facility