Contribution ID: **772** Type: **Poster**

Measurement of the mass spectrum of vector mesons in nuclei at J-PARC

Tuesday 5 September 2023 17:30 (2h 10m)

The mass spectrum of hadrons in finite-density QCD matter is believed to reveal the effects of partial chiral symmetry restoration. However, despite the importance of understanding QCD at finite density, decisive evidence linking the mass spectrum and chiral symmetry is still lacking.
The J-PARC E16 experiment aims to fill this gap with high-statistics measurements of vector mesons (ρ, ω, ϕ) in nuclei. The experiment will measure the momenta of electron-positron pairs from vector meson decays and reconstruct their invariant mass.

To obtain large statistics,
we use a new beamline at J-PARC that provides 30 GeV-proton beams with an intensity of 1×10^{10} protons/spill.
The maximum hit rate reaches $15\,\mathrm{kHz/mm^2}$ and $5\,\mathrm{kHz/mm^2}$ at two innermost detectors, necessitating an innovative spectrometer for high-rate environments.

Since the experiment commenced in 2020, three commissioning runs have been conducted
with a limited number of detectors.
Partial results were reported at QM2022.
The next run, scheduled for June 2023, aims to improve beam microstructures
detected in the last run.
Eight modules of detectors will be operated, as proposed for the first physics run.
In the commissioning runs so far,
our detectors were successfully operated under the high-counting environment.
Tracking is performed using a layer of the Silicon Strip Detector and three layers of thin gas chambers with different sizes, all employing the Gas Electron Multiplier (GEM).
Calibration is ongoing, but the current tracking resolution is sufficient to observe changes in the mass spectrum of vector mesons.
For the ϕ mesons, we anticipate a mass resolution of $5.8\,\mathrm{MeV/c^2}$, while a mass change of $35\,\mathrm{MeV/c^2}$ was observed in the preceding experiment, KEK-PS E325.
Electron identification is carried out using the Hadron Blind Detector and the Lead Glass Calorimeter installed outside the trackers.
We achieved electron efficiency and pion rejection power consistent with the design values, at 57% and 99.97% , respectively.

In this presentation, we will report the result of the run in June, including the detector performance
and improvement of the beam microstructure, and discuss
the anticipated outcomes for the physics run planned in 2024.
In the physics run, we aim to collect 15000 phi mesons, representing six-fold
improvement compared to the KEK-PS E325 experiment.

Category

Experiment

Collaboration (if applicable)

for the J-PARC E16 Collaboration

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Session Classification: Poster Session

Track Classification: QCD at finite density and temperature