

14th International Workshop on the Physics of Excited Nucleons
York, UK, Jun 17-21, 2024

NSTAR2024

J-PARC E45: N^* Spectroscopy in $\pi p \rightarrow \pi\pi N$ Reactions

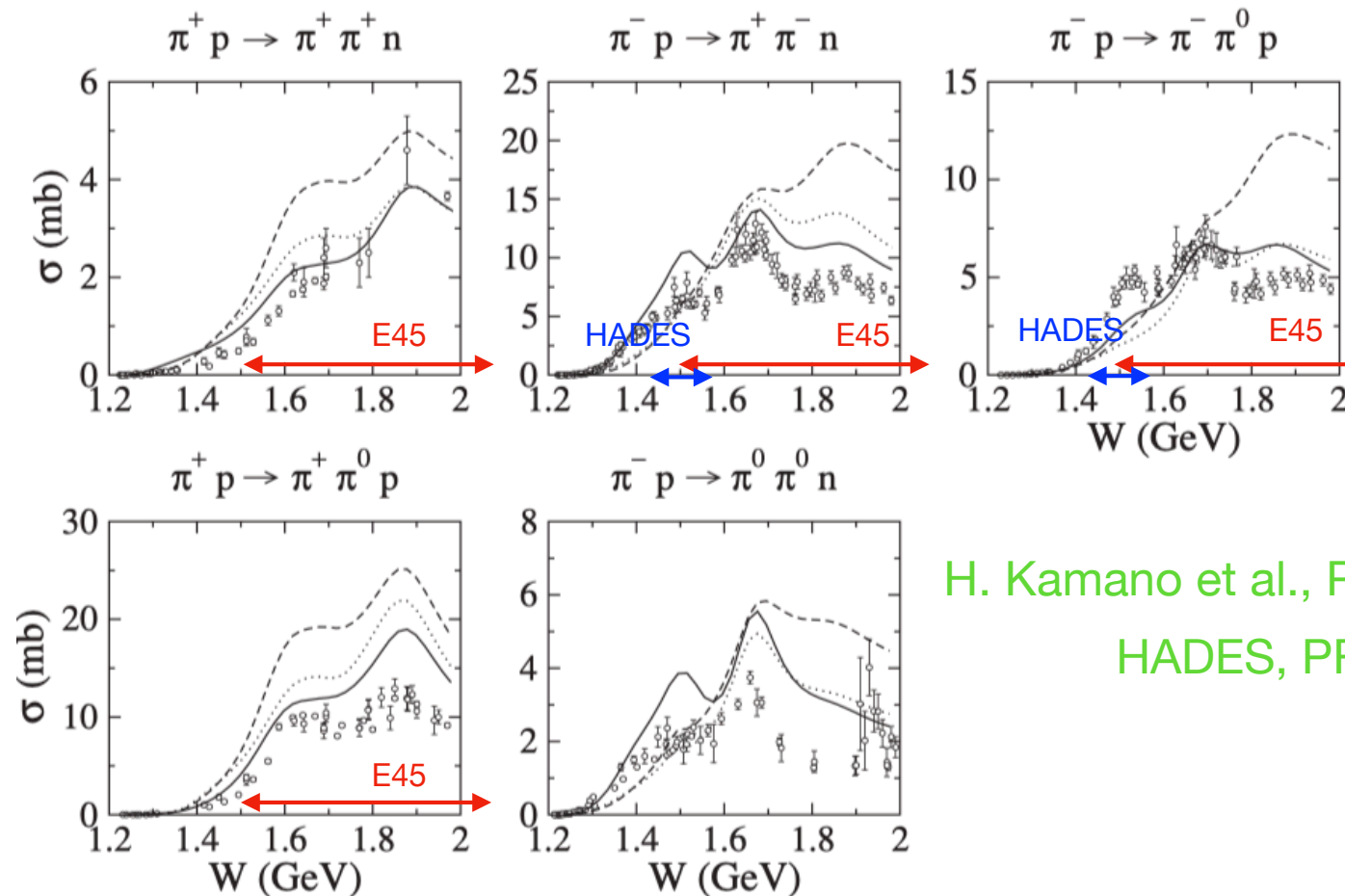
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for the J-PARC E45 Collaboration



J-PARC E45: N^* Baryon Spectroscopy

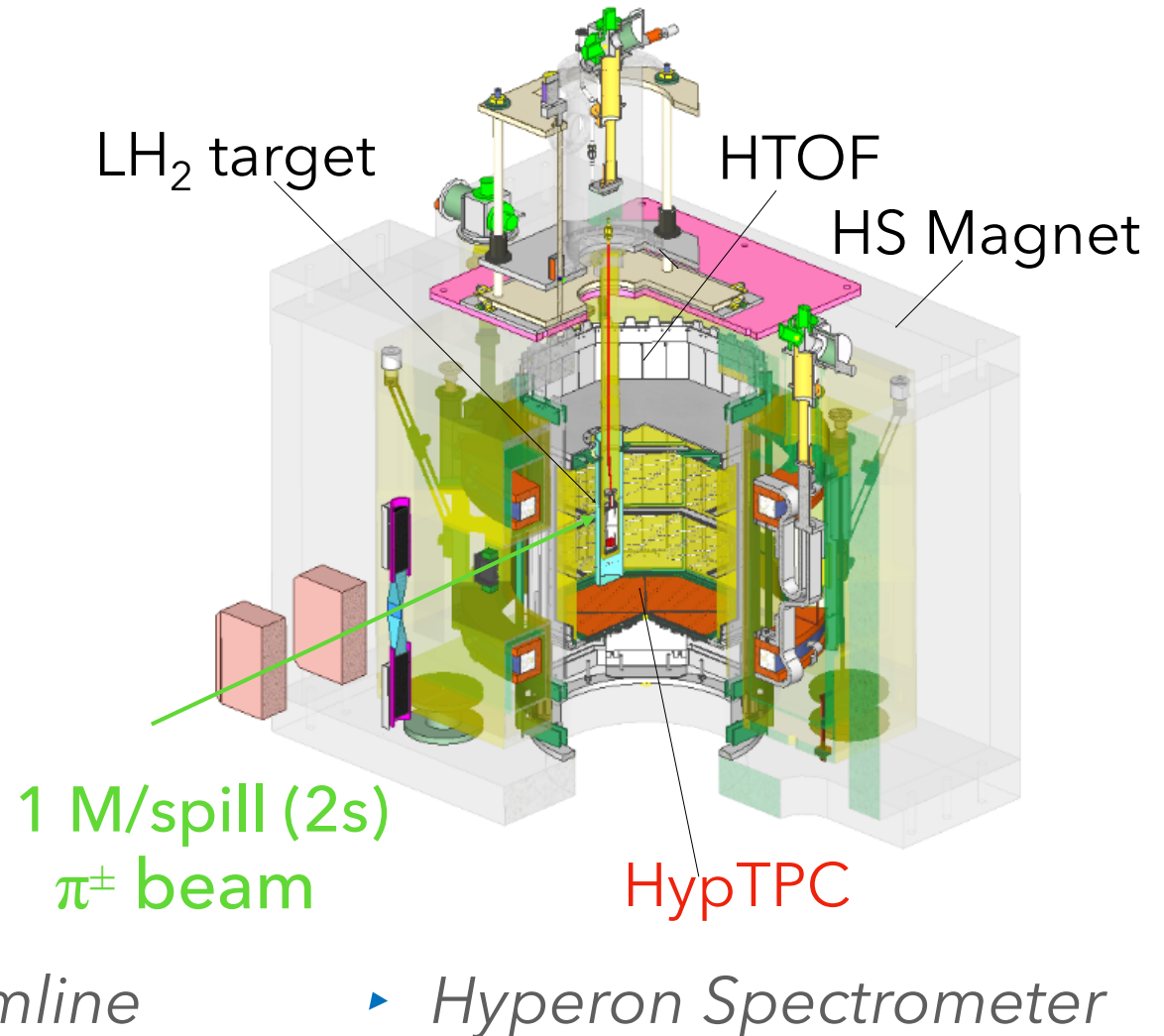
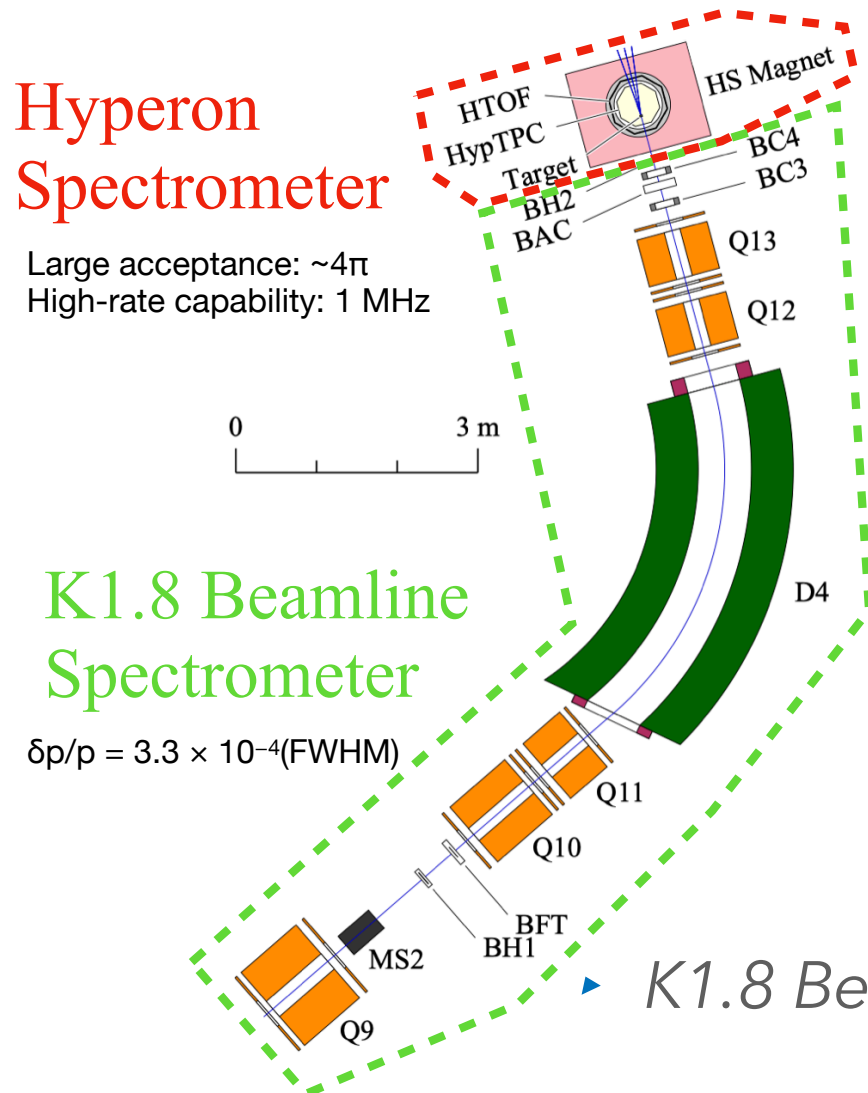
- ▶ N^* spectroscopy with the $\pi p \rightarrow \pi\pi N$ reactions in the wide energy range of 1.5 - 2.15 GeV ($p=0.73 - 2.0$ GeV/c) using high intensity beam at J-PARC.
- ▶ Updates on the world database ($\pi p \rightarrow \pi\pi N$)
 - ▶ 240k events measured in 1970's \rightarrow $\times 100$ higher statistics



H. Kamano et al., PRC 79, 025206 (2009)
HADES, PRC 102, 024001 (2020)

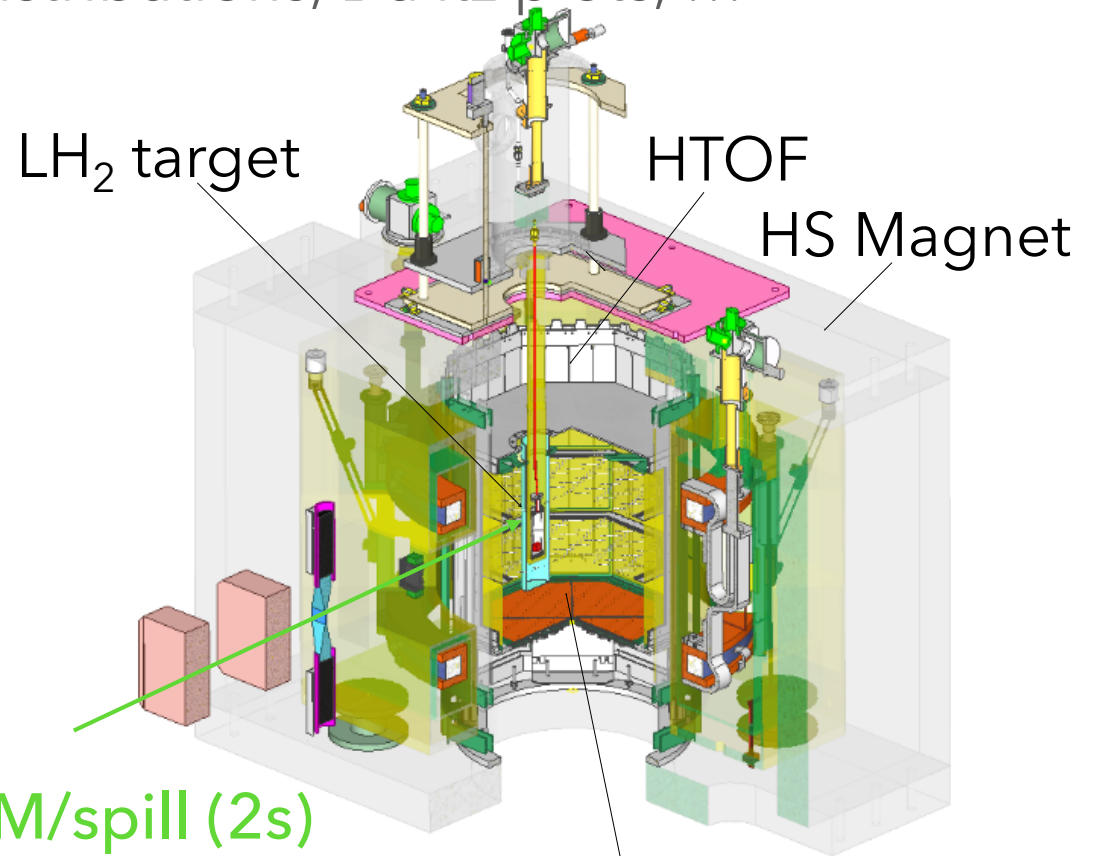
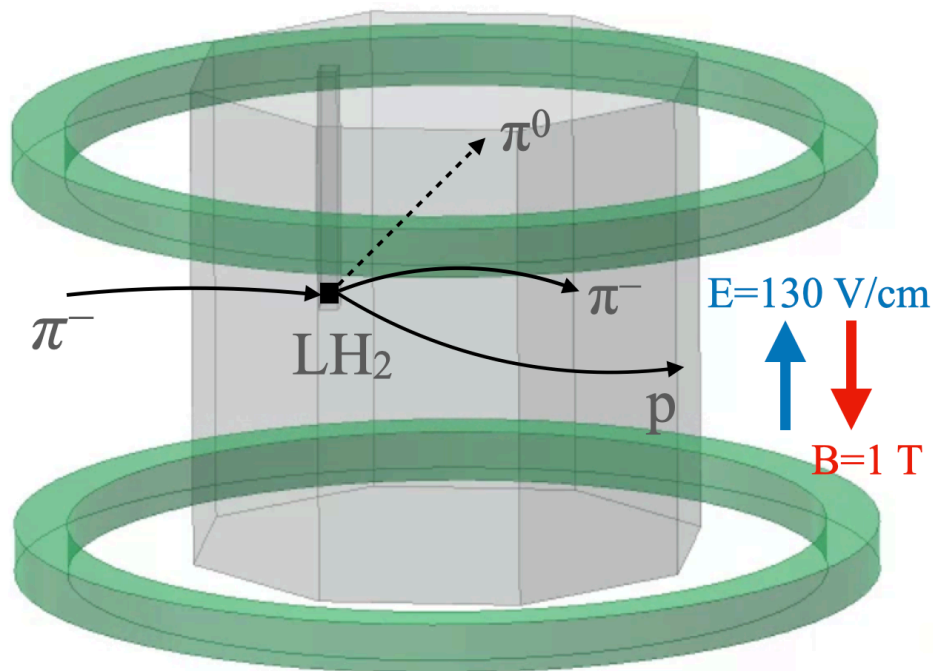
J-PARC E45 Experimental Setup

- ▶ N^* spectroscopy with the $\pi p \rightarrow \pi\pi N$ reactions in the wide energy range of 1.5 - 2.15 GeV ($p=0.73 - 2.0$ GeV/c) at J-PARC.



Hyperon Spectrometer

- ▶ Detect all charged particles' trajectories in 3D from the $\pi^\pm p$ reactions.
 → angular distributions, mass distributions, Dalitz plots, ...



- ▶ Large acceptance ($\sim 4\pi$)
- ▶ High rate capability ($\sim 10^6$ cps)
- ▶ High resolution ($\sigma \sim 1$ MeV)

1 M/spill (2s)
 π^\pm beam

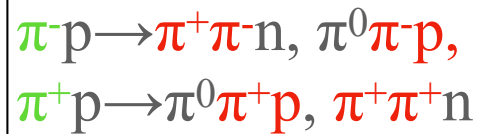
HypTPC

▶ *Hyperon Spectrometer*

J-PARC E45 Multiplicity Trigger

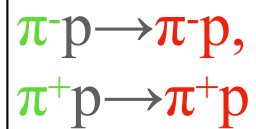
- ▶ Trigger: **HTOF multiplicity-2** from $\pi^\pm p$ reactions at 1.5 - 2.15 GeV ($p=0.73 - 2.0$ GeV/c)

- ▶ $\pi p \rightarrow \pi\pi N$ reactions

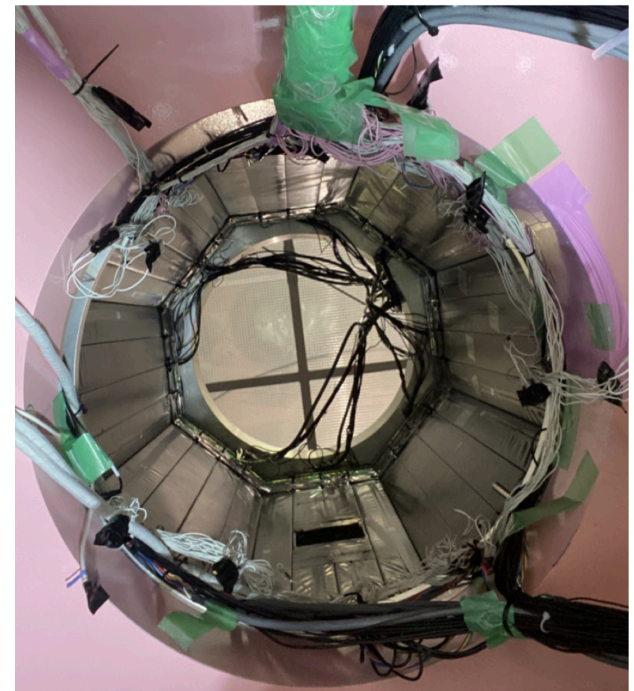
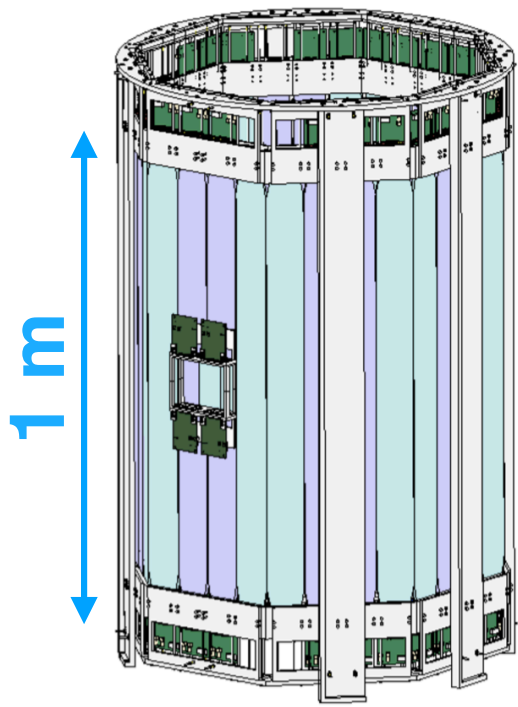
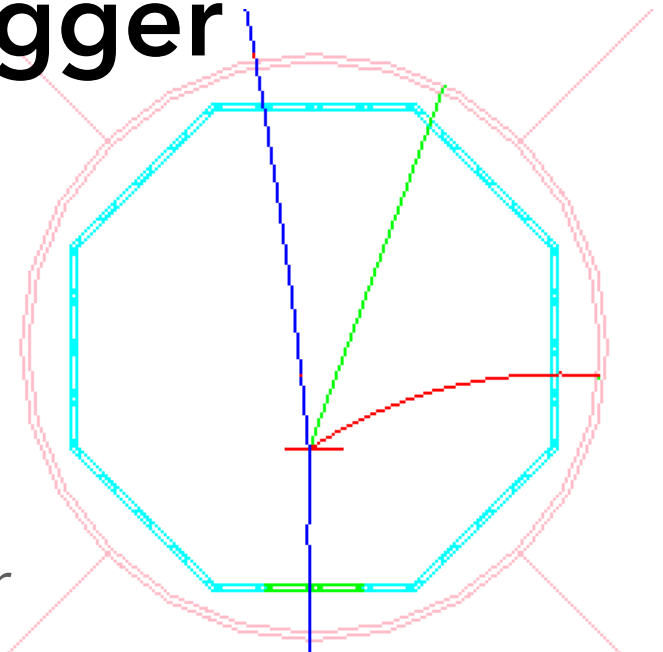


- ▶ *HTOF detector*

- ▶ $\pi p \rightarrow \pi p$ reactions



- ▶ $\pi p \rightarrow KY$ reactions



E45 Yield Estimation and Run Plan

$$N = \sigma \times \frac{\rho \times L \times N_A}{A} \times N_{beam} \times Acc,$$

π^\pm Beam: $N_{beam}=1$ M/spill

LH₂ Target: $\rho L=0.45$ g/cm² ($\phi 8$ cm), $N_A=6.022 \times 10^{23}$, $A=1$

Detector Acceptance: $Acc=0.4$

- ▶ $\sigma \sim 2$ mb ($\pi^+ p \rightarrow \pi^+ \pi^+ n$) $\rightarrow N \sim 220$ events / spill (5.2s)
In order to achieve **$\sim 30k$ events/bin** with
24 energy bins (1.50 - 2.15 GeV) \times **20 angle bins**
 $\rightarrow \sim 4$ hours for each beam energy setting is required.
- ▶ Considering all $\pi\pi N$ reactions with both π^\pm beams,
a total of **15-day** beam time is required.

