Charmed baryon spectroscopy experiment at J-PARC

K. Shirotori

for the J-PARC E50 collaboration

Research Center for Nuclear Physics (RCNP)

Osaka University

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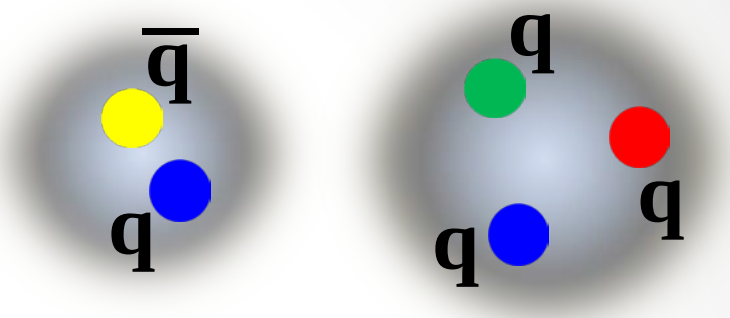
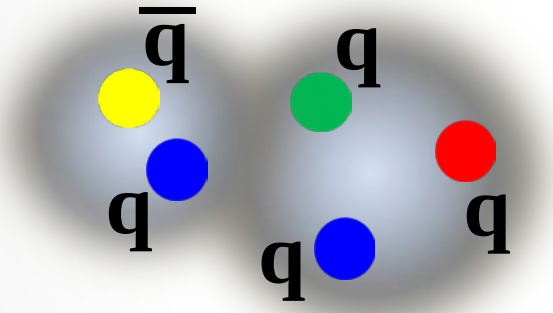
What is a building block of hadrons ?

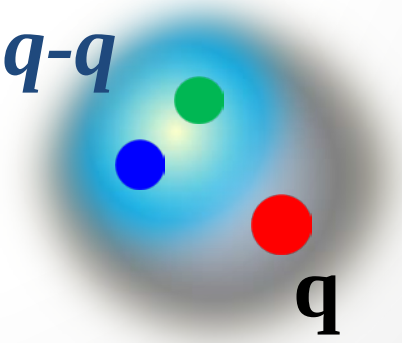
Constituent Quark





Exotic hadron

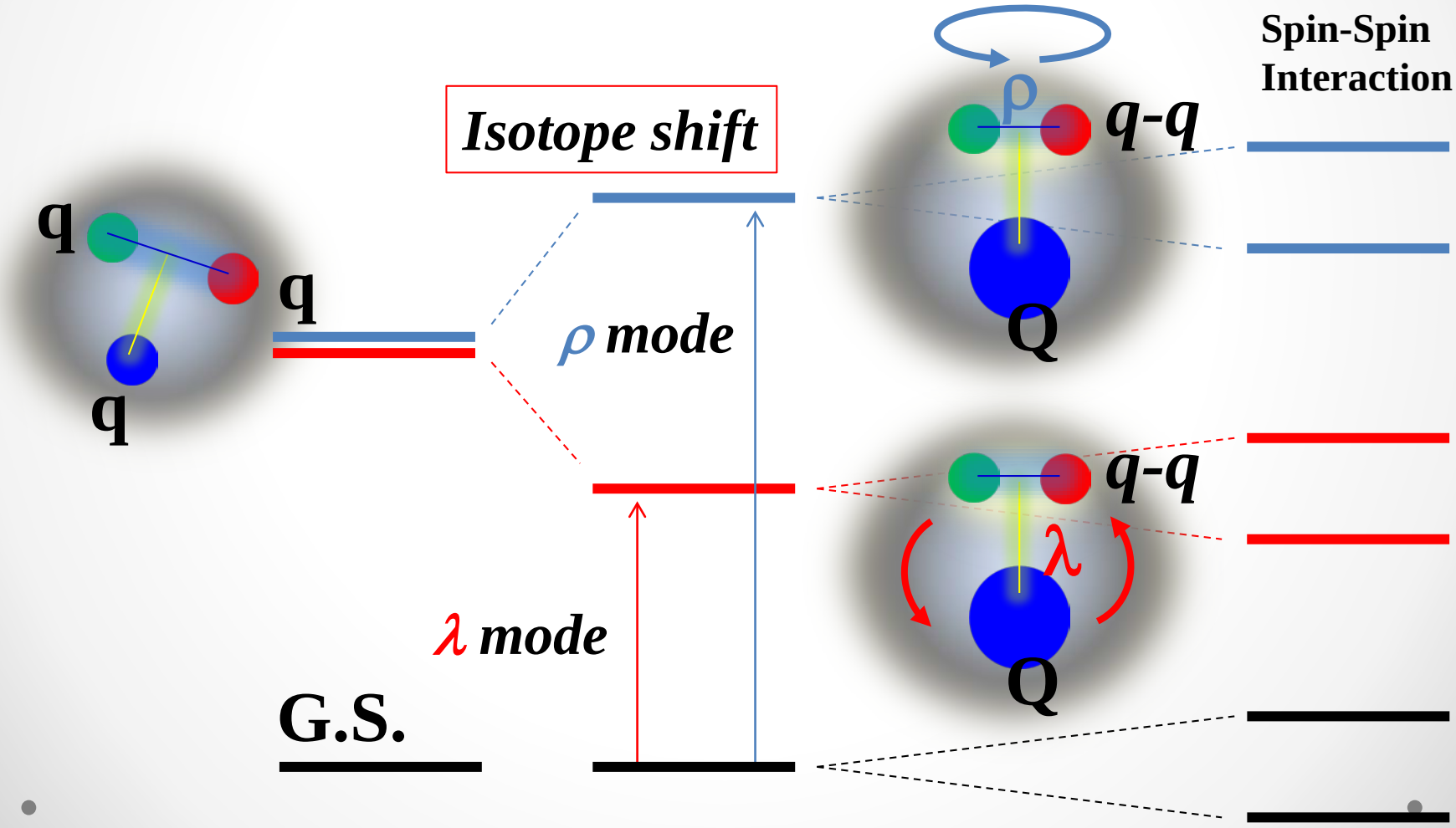
q-q correlation (diquark)



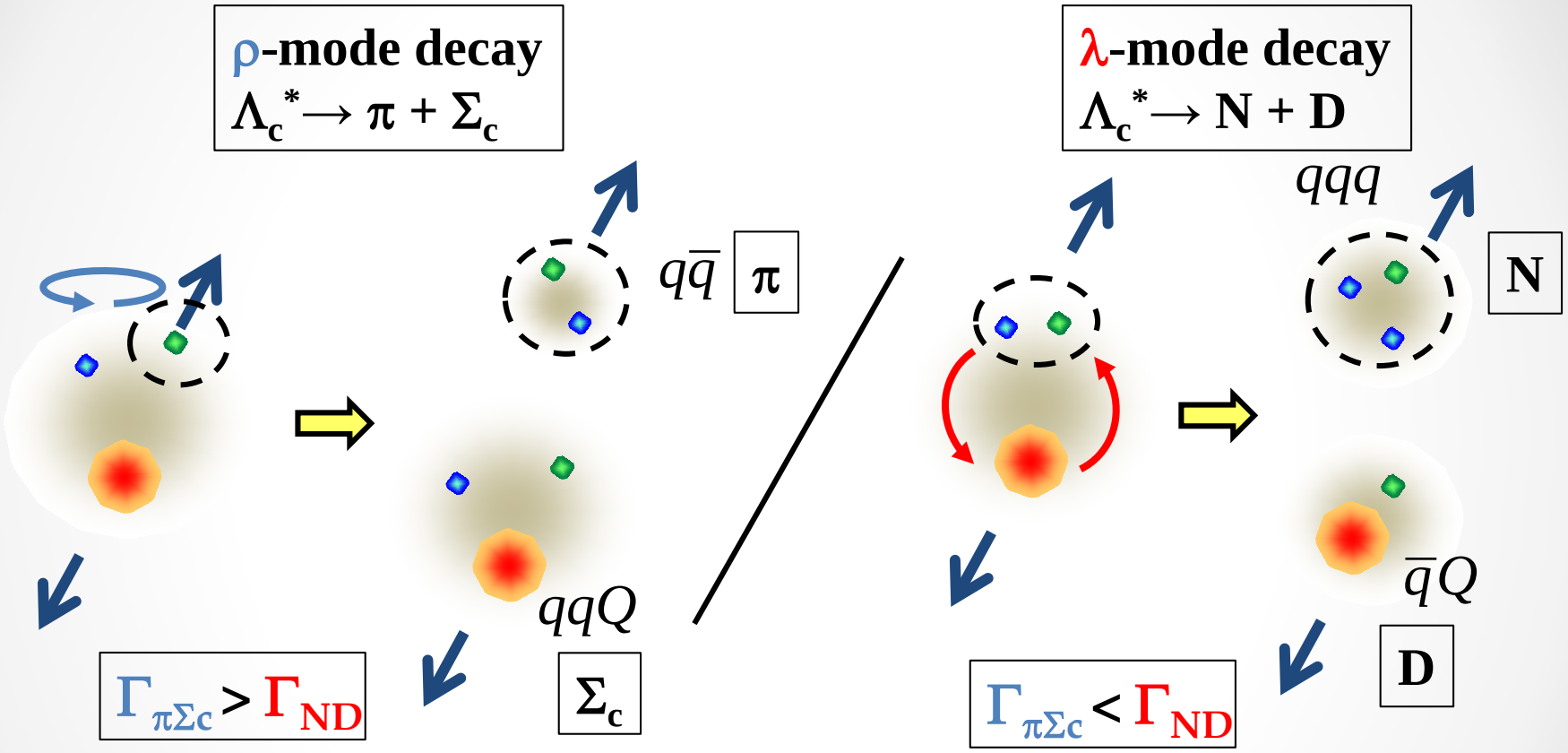
Charmed baryon spectrum: “Excitation Mode”

Heavy Quark: **Weak color-magnetic interaction**

⇒”*q-q*” **isolated and developed: “q-q + Q”**



Decay property



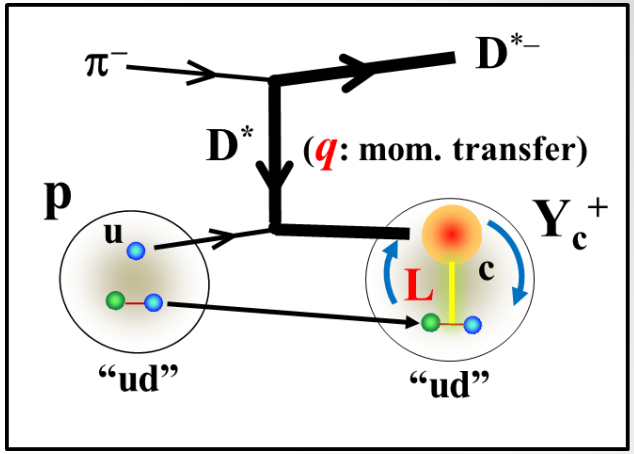
- **Decay measurement:** $\Gamma_{\pi\Sigma c} \Leftrightarrow \Gamma_{ND}$
  - $\pi^- + \Sigma_c^{++}$, $\pi^+ + \Sigma_c^0$
  - $p + D^0$

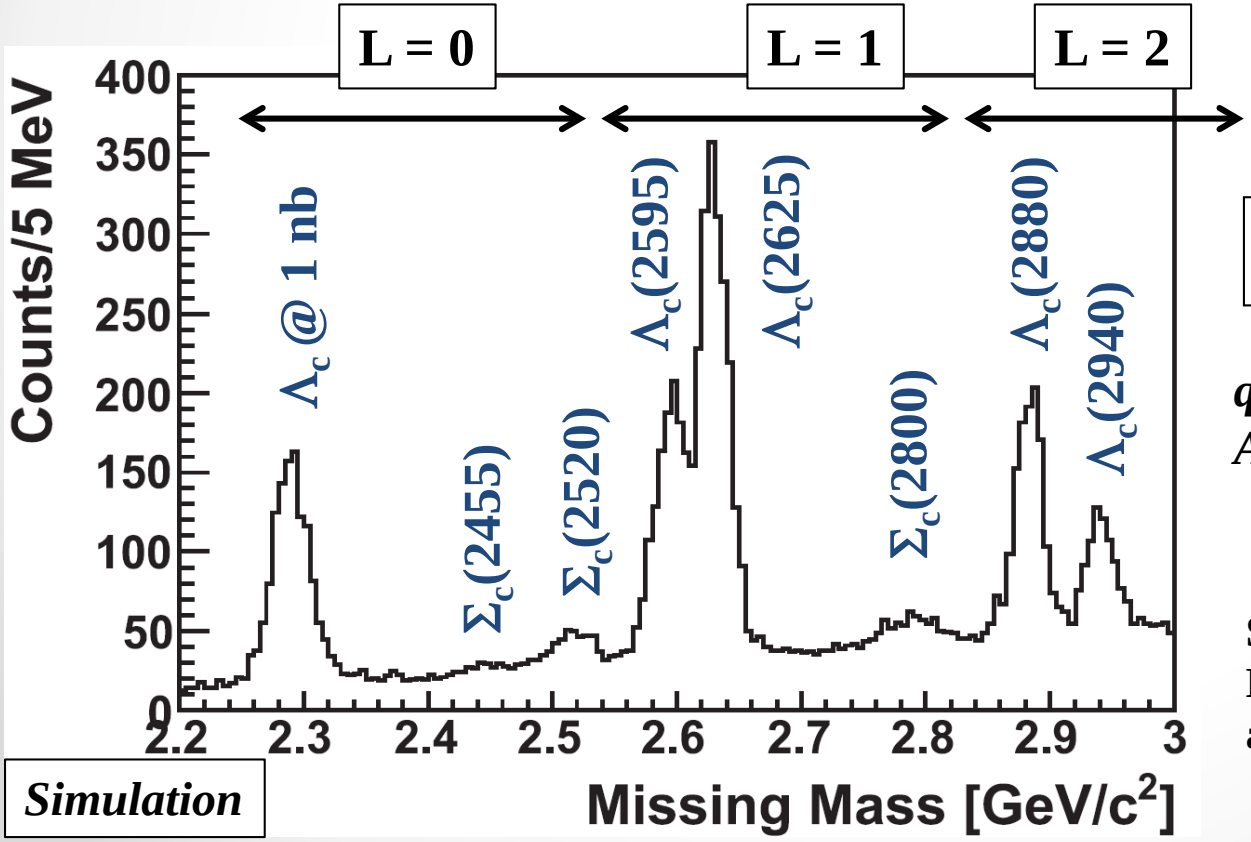
Production cross section

Hadronic production: $\pi^- + p \rightarrow Y_c^{*+} + D^{*-}$

- **Production rates ⇔ Excitation mode**
  - **Forward angles: λ mode**

⇒ Study from *"Reaction dynamics"*





$$I_L / I_{g.s.} \sim (q_{eff}/A)^L$$

q_{eff}: **Momentum transfer**
A: **(baryon size parameter)$^{-1}$**

S.H. Kim, A. Hosaka, H.C. Kim, H. Noumi, K. Shirotori, arXiv:1405.3445.

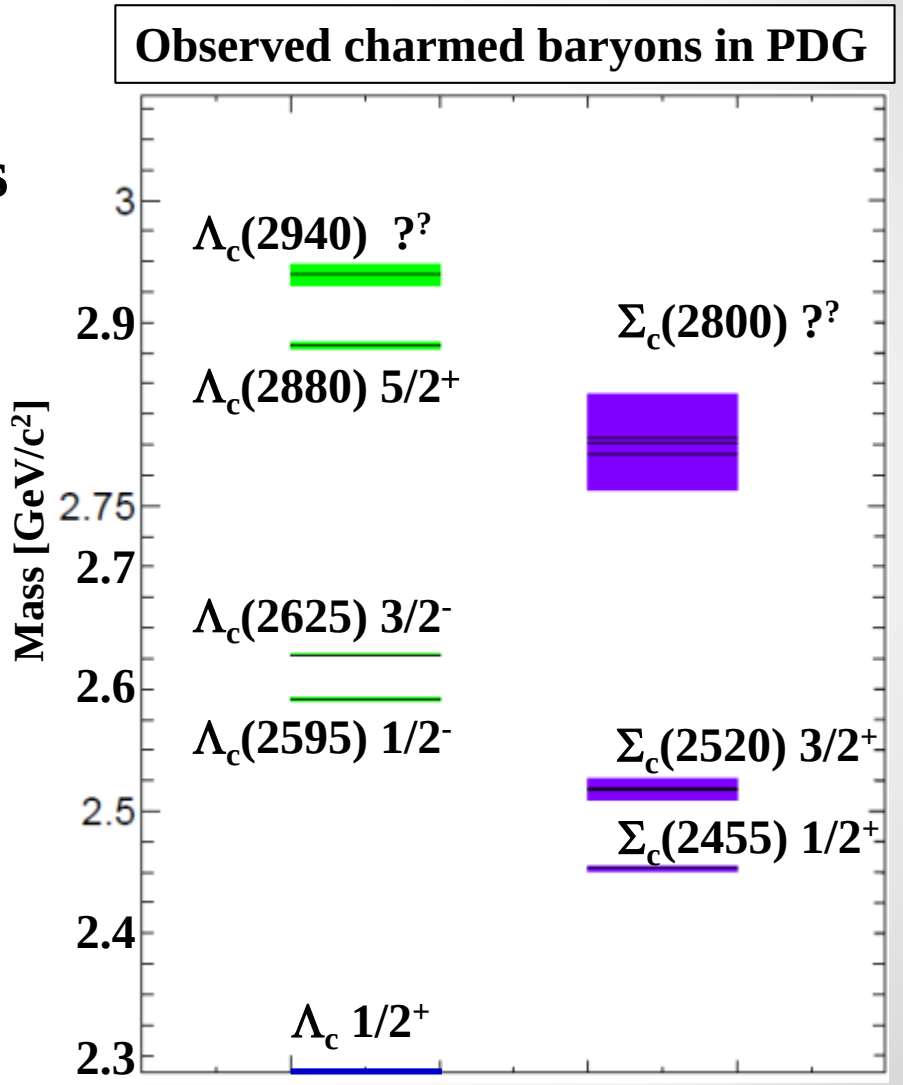
Charmed baryon spectroscopy

J-PARC E50 experiment

- **Investigate charmed baryons by Missing Mass spectroscopy**

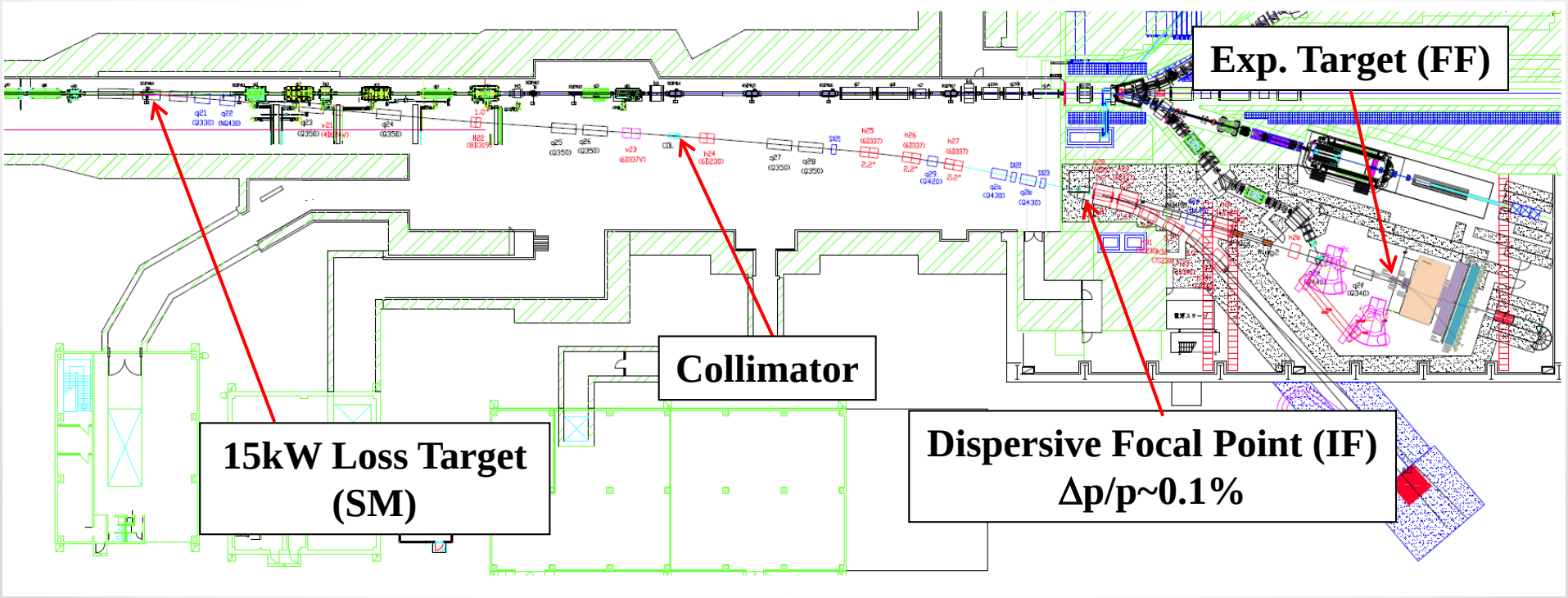
- **Systematic measurement**
  - Excited states search
  - Excitation energy
  - Decay property
  - Production cross section

⇒ **Diquark correlation**
  - Excitation mode

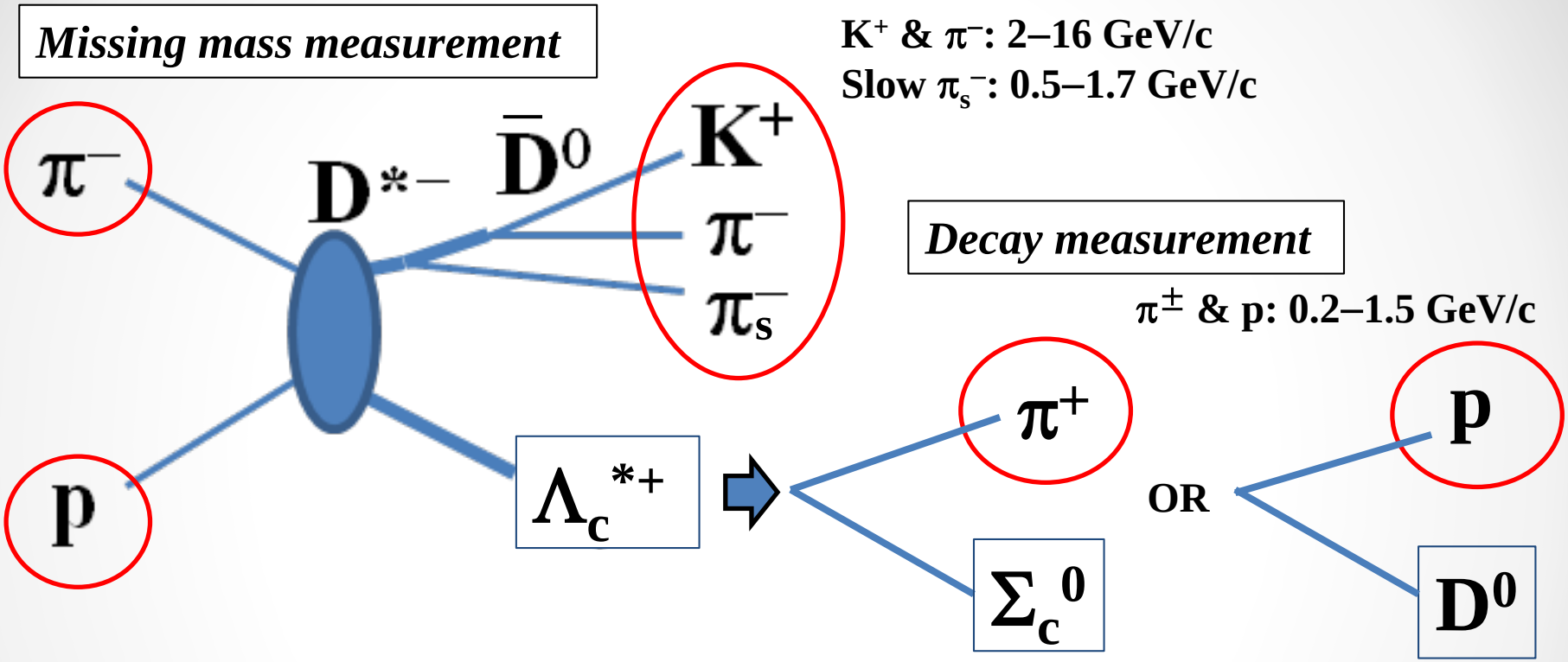


High-momentum beam line for 2ndary beam

- **High-intensity beam:** > 1.0×10^7 Hz π (< 20 GeV/c)
  - Unseparated beam
- **High-resolution beam:** Δp/p ~ 0.1%(rms)
  - Momentum dispersive optics method



Experiment

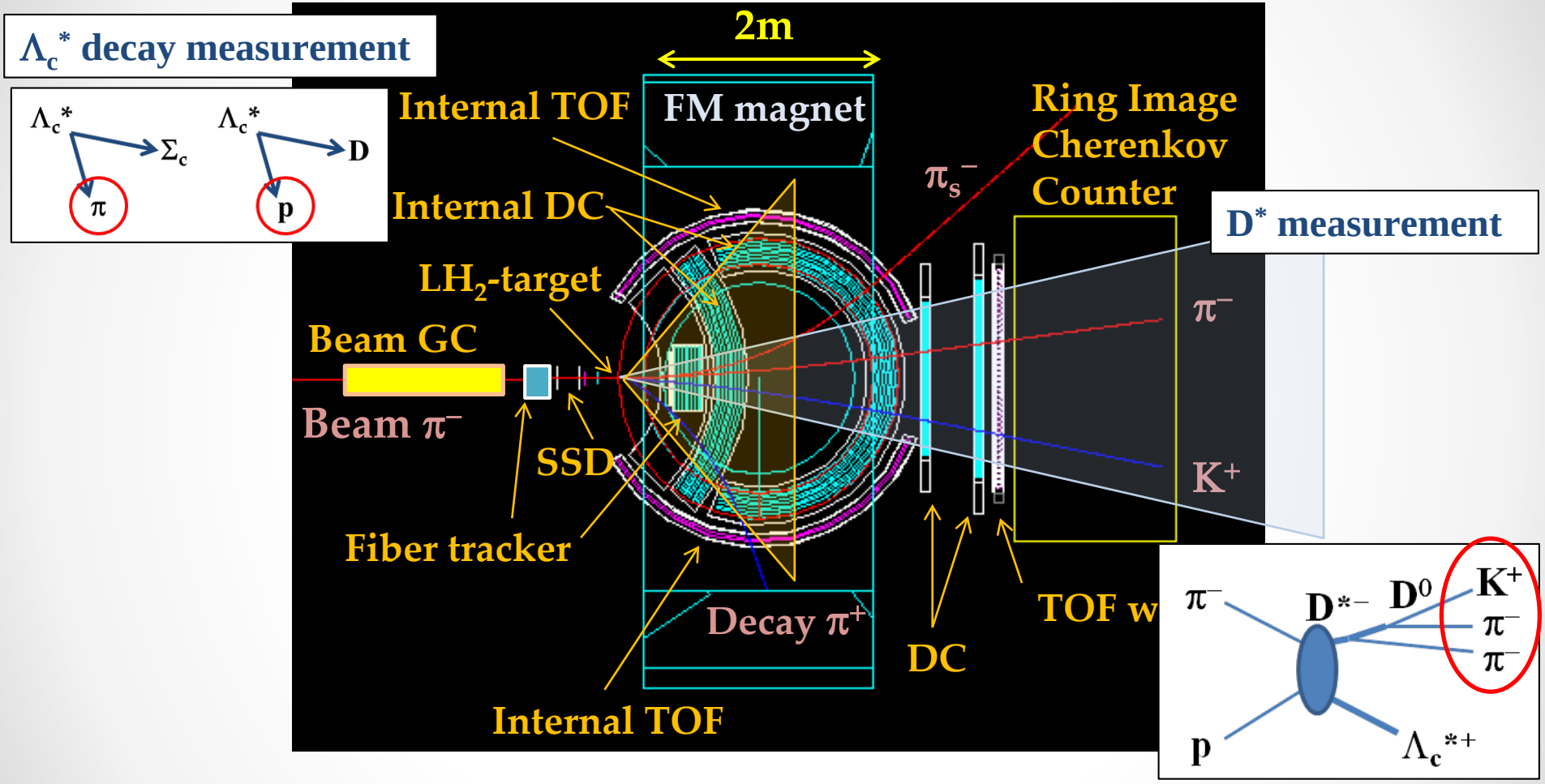


$\pi^- + p \rightarrow Y_c^{*+} + D^{*-}$ reaction @ 20 GeV/c

1) Missing mass spectroscopy
   - $D^{*-} \rightarrow \bar{D}^0 \pi_s^- \rightarrow K^+ \pi^- \pi_s^-$: $D^{*-} \rightarrow \bar{D}^0 \pi_s^-$ (67.7%), $\bar{D}^0 \rightarrow K^+ \pi^-$ (3.88%)

2) Decay measurement
   - Decay particles ($\pi^{\pm}$& proton) from Y_c^*

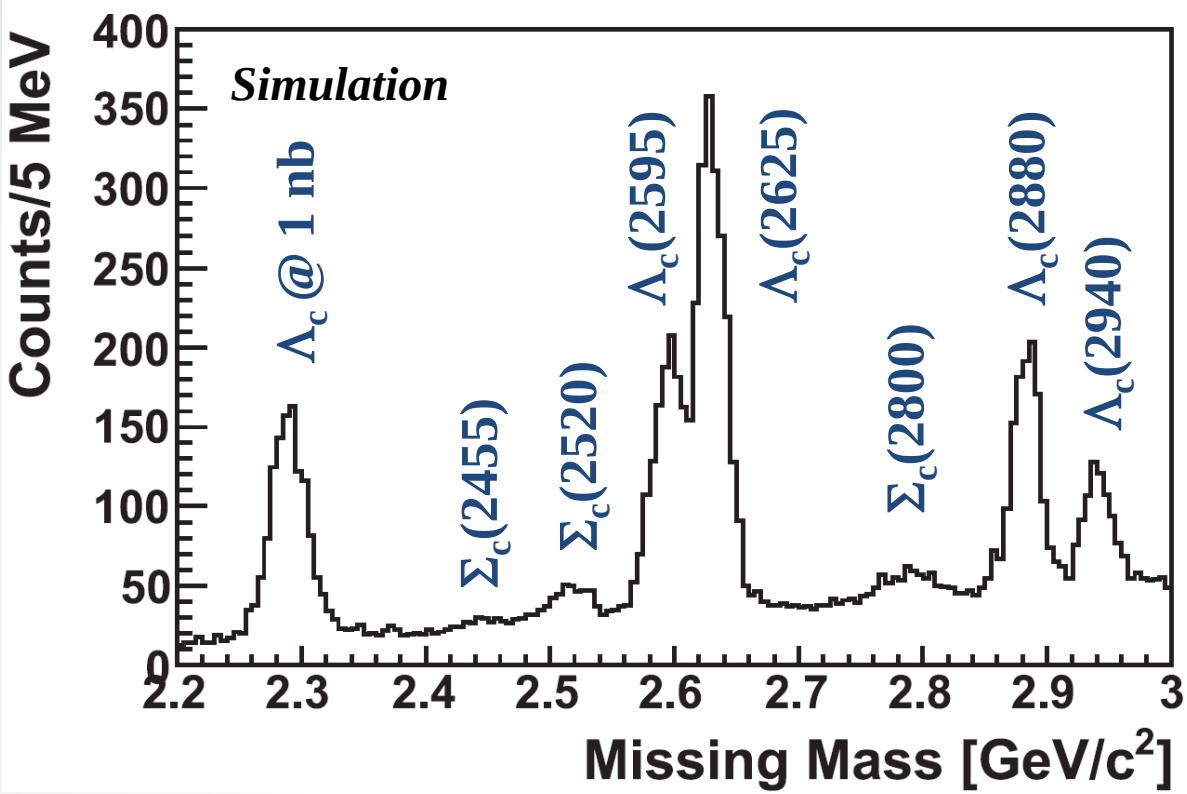
Charmed baryon spectrometer



Large Acceptance Multi-Particle Spectrometer

- Acceptance: ~50% for D^*
- Mass resolution: $M_{\Lambda c^*} = 10$ MeV(rms) @ 2.7 GeV/c^2

Expected spectra

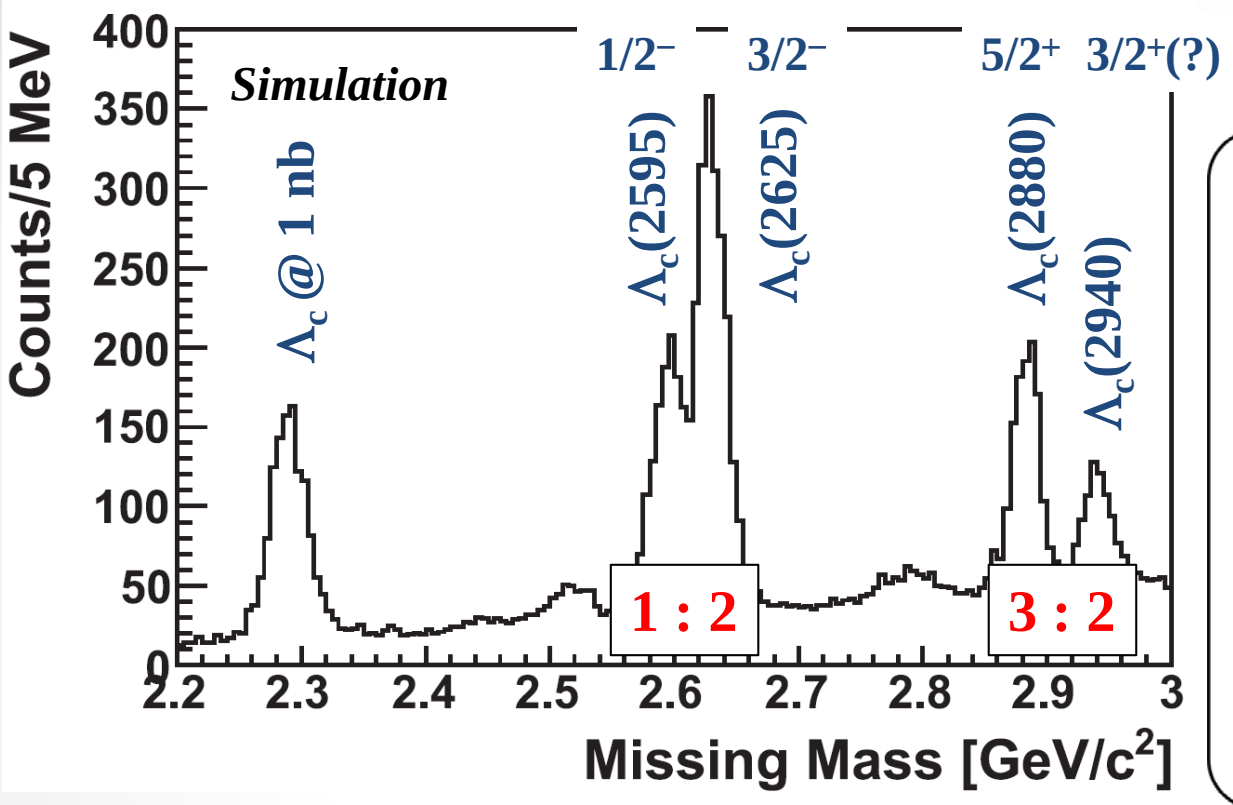


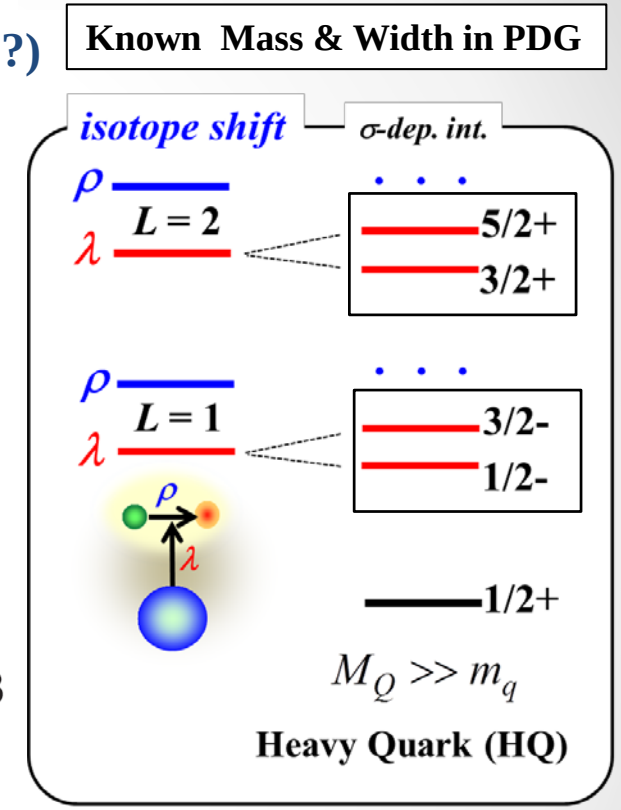
Known Mass & Width in PDG

- Λ_c: 1 nb production cross section
  - Production ration for excited states
- Background generated by the hadronic reaction code
  - Background level and reductions were precisely studied.

∗ Achievable sensitivity of 0.1–0.2 nb: (3σ level, $\Gamma < 100$ MeV)

Expected spectra





- λ-mode excitation doublets: Production enhanced

⇒ Internal structure of charmed baryons

*Diquark correlation: λ-mode excitation

Summary

- **Charmed baryon spectroscopy**
  - **Diquark correlation: λ and ρ mode excitation**
  - **Inclusive measurements by missing mass spectroscopy**

- **Experiment at the J-PARC high-p beam line**
  - **Spectrometer**
    - **Lager acceptance and high resolution spectrometer**
  - **Experimental feasibility being checked by simulation**
    - **Background study: Enough reduction**
    - **Decay measurement to help missing mass measurement**

- **Systematic study of charmed baryons at J-PARC**
  - **Excitation energy, production, decay**
  - **With strangeness sector: Y* and Ξ***

New projects at J-PARC

Hadron Experiment
at the J-PARC High-p beam line

Let's do it together !

Thank you for your attention