HADRON SPECTROSCOPY

WITH HIGH-MOMENTUM SECONDARY BEAM

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MIN WORKSHOP, 2016/7/31

OUTLINE

Introduction

- overview of J-PARC Hadron Facility

Near Future Project

- Baryon Spectroscopy
  - explore hadron structure with high-momentum secondary beams
- Strange to Charm

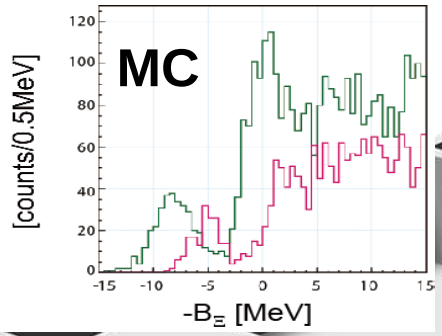
J-PARC BIRD'S-EYE VIEW

Tokai, Ibaraki, Japan

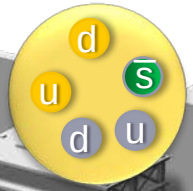
NUCLEAR & HADRON PHYSICS AT J-PARC

Strangeness Physics

Ξ hypernuclei in $^{12}C(K^-,K^+)$



Pentaquark Θ$^+$



Origin of Hadron Mass

kaonic nuclei

Λ(1405) in d(K⁻,n)

Charmed Baryon spectroscopy

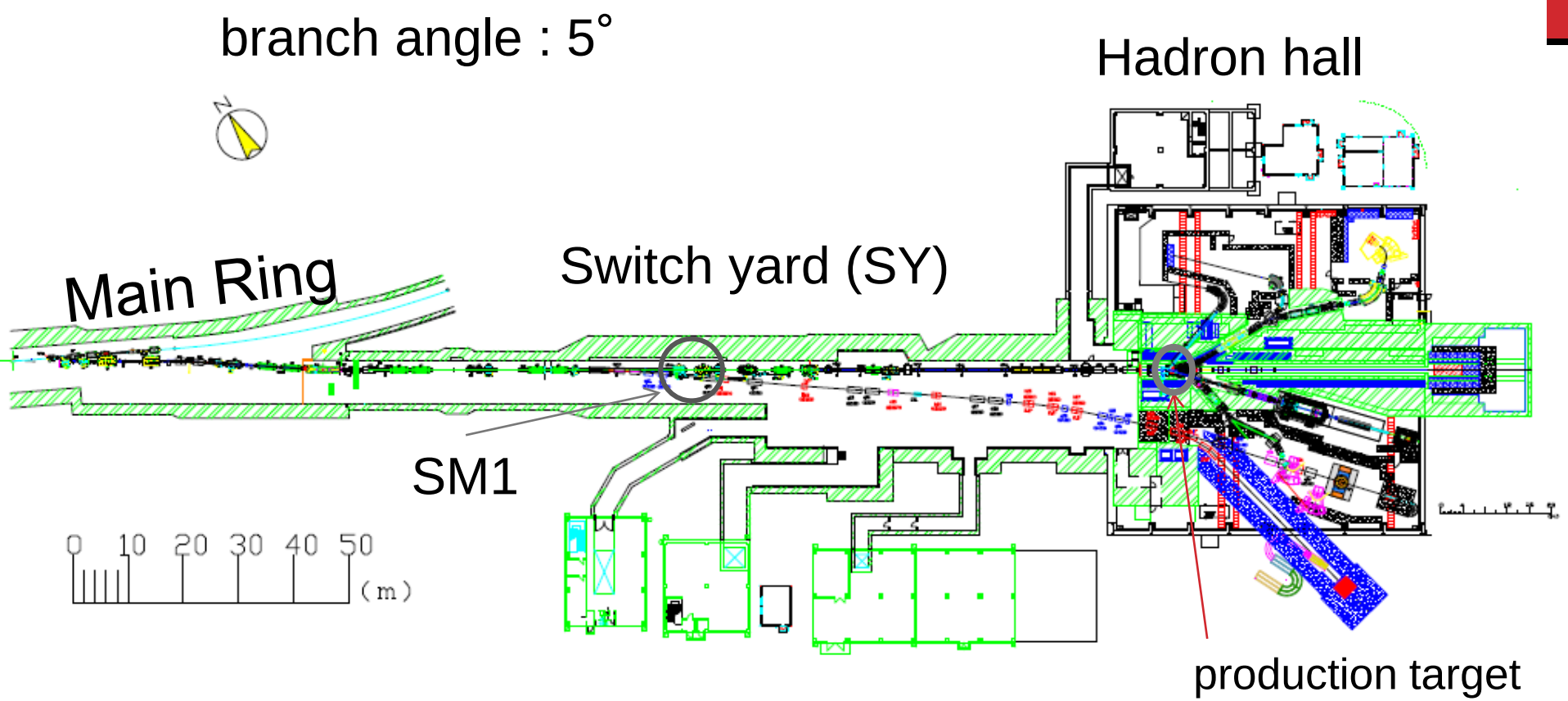
UNSOLVED PROBLEMS IN QCD

- **confinement**
- **chiral symmetry breaking**

Experimental Approaches at J-PARC

- Dilepton measurement
- Baryon spectroscopy
- Properties of Exotics

HIGH-MOMENTUM BEAM LINE



at SM1 high-p beam branches off from the primary line

- 30 GeV primary proton (10^{10}/s, 10^{12}/s)
- 8 GeV primary proton for COMET
- secondary particles (~20 GeV/c)

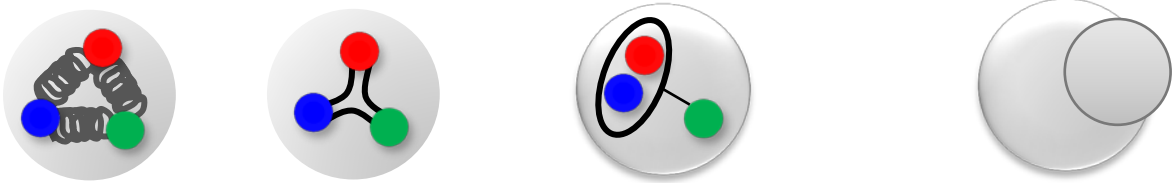
BARYON SPECTROSCOPY

Baryon : building blocks of our world

description based on QCD with spectroscopy

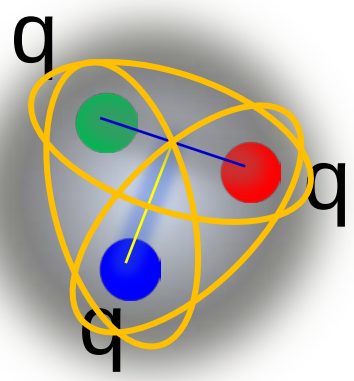
- understand underlying degree-of-freedom and interaction between them

QM flux tube diquark meson-baryon



theoretical interpretation is important to connect experimental observables to QCD.

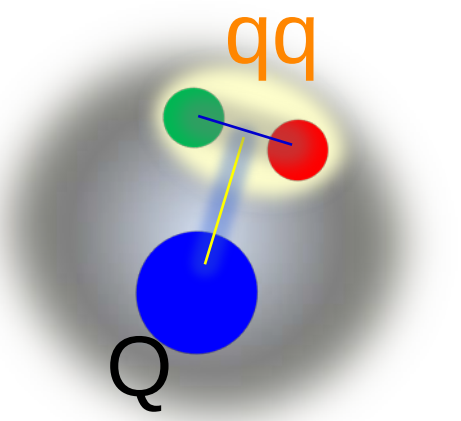
BARYON WITH HEAVY QUARK



Most fundamental question

Interaction btwn quarks

Diquark correlations



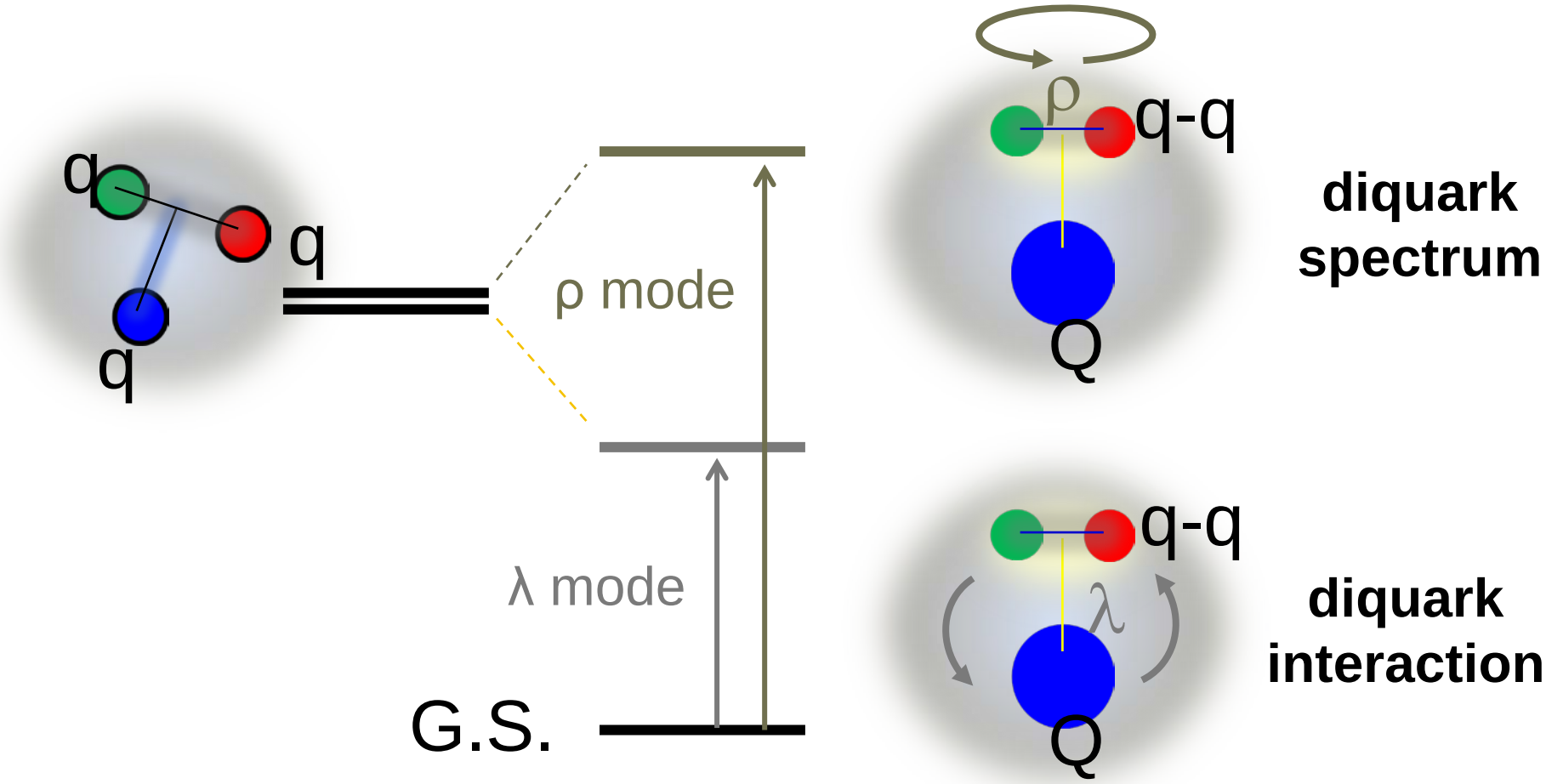
→ Charmed baryon

to close up diquark correlations

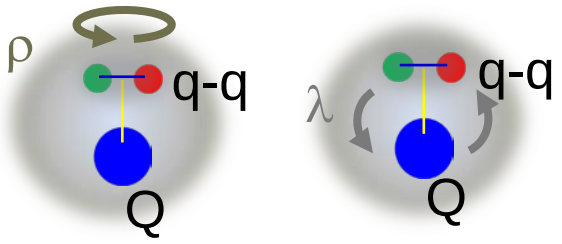
- Weak Color Magnetic Interaction with a heavy Quark

HEAVY BARYON – STRANGE TO CHARM

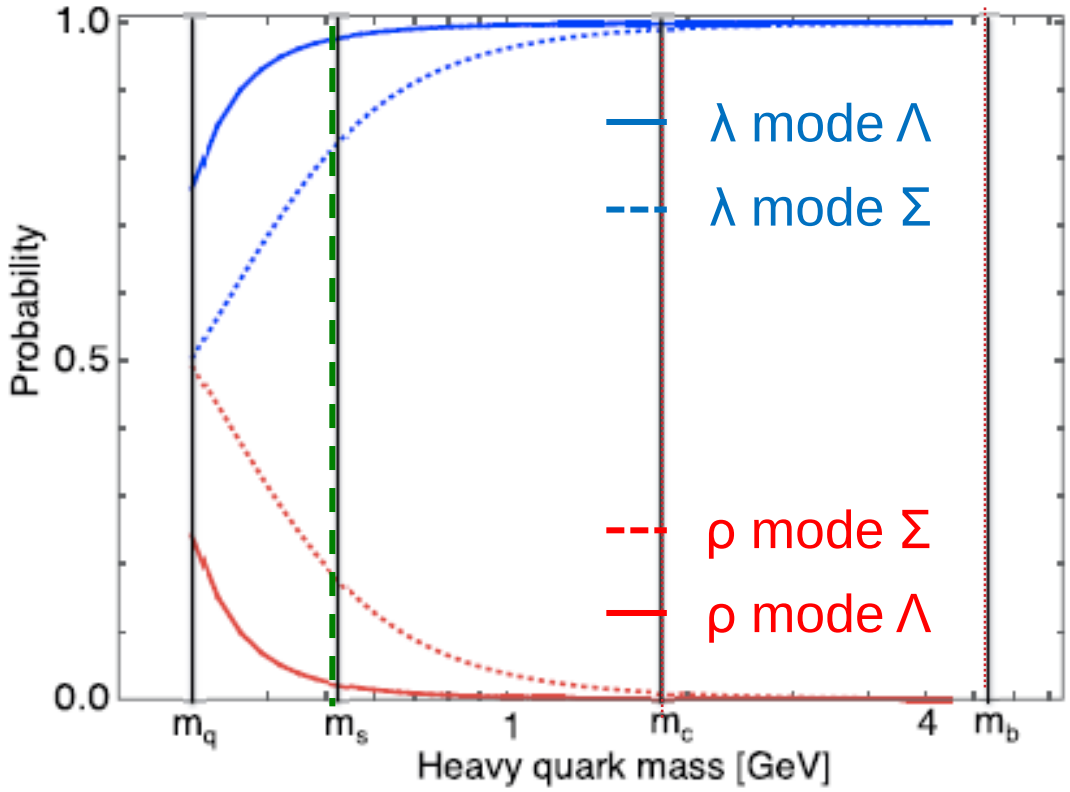
λ and ρ motions split in heavy baryons



NEGATIVE-PARITY BARYON



Yoshida, Hiyama, Hosaka, Oka & Sadato
Phys.Rev. D92 (2015) no.11, 114029

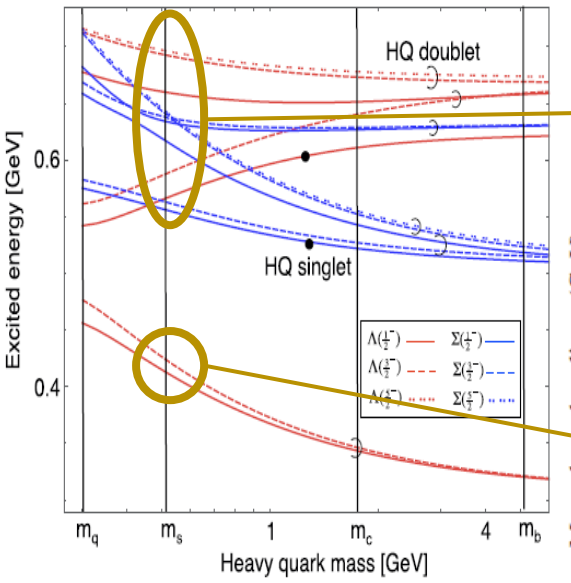


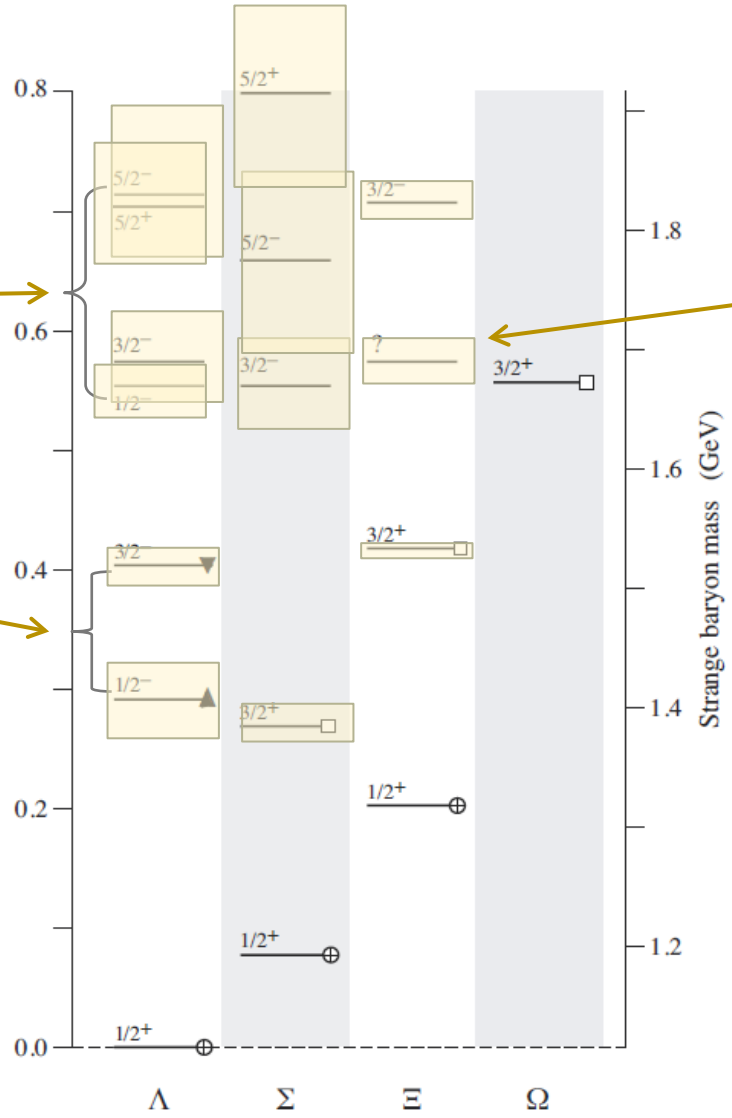
m_Q [GeV]

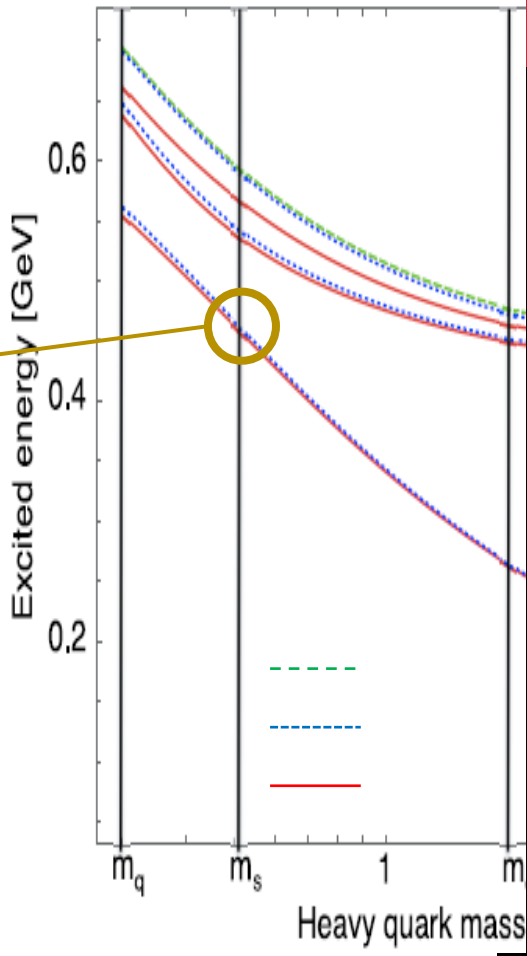
Λ_c is pure λ mode

Λ_s is almost λ mode

EXPERIMENTAL DATA







OBSERVED Ξ STATES

11 states were reported.

existence is certain : 2

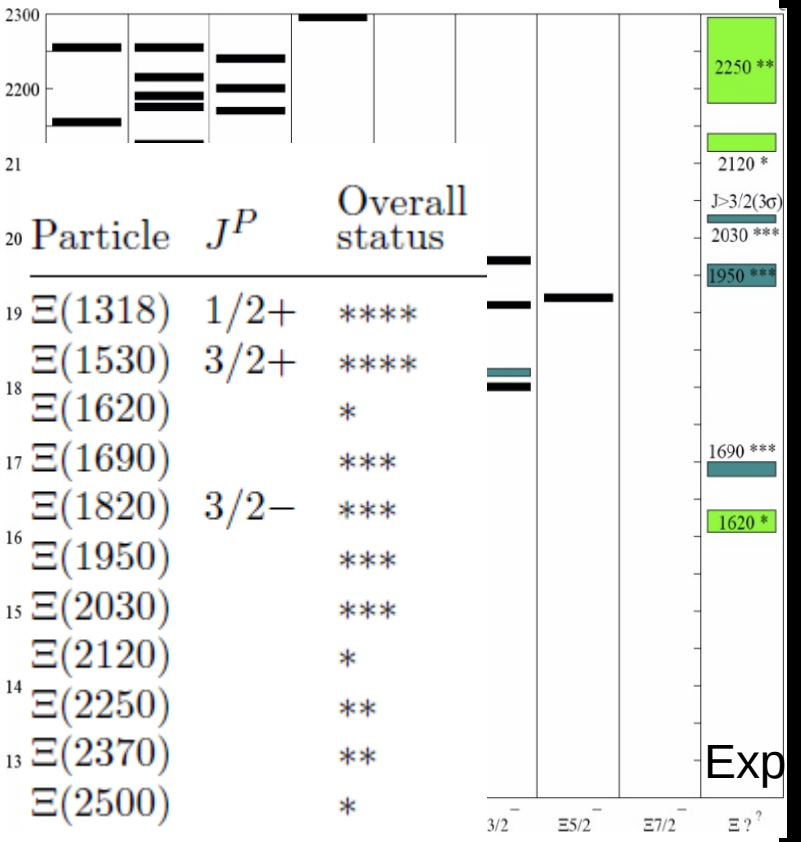
certain but need confirmation : 4

evidence is fair : 2

evidence is poor : 3

QM predicts 44 states up to 2.3 GeV

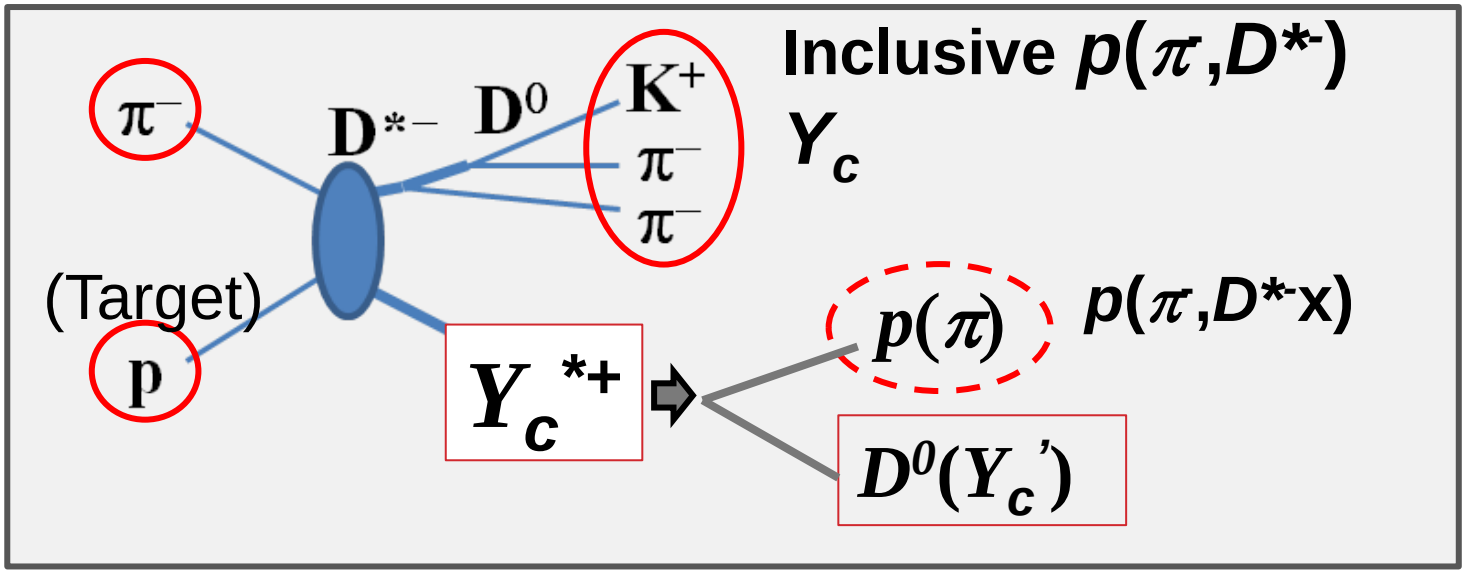
QM calc. by Chao, Isgur & Ka



Particle	J^P	Overall status
$\Xi(1318)$	$1/2+$	****
$\Xi(1530)$	$3/2+$	****
$\Xi(1620)$		*
$\Xi(1690)$		***
$\Xi(1820)$	$3/2-$	***
$\Xi(1950)$		***
$\Xi(2030)$		***
$\Xi(2120)$		*
$\Xi(2250)$		**
$\Xi(2370)$		**
$\Xi(2500)$		*

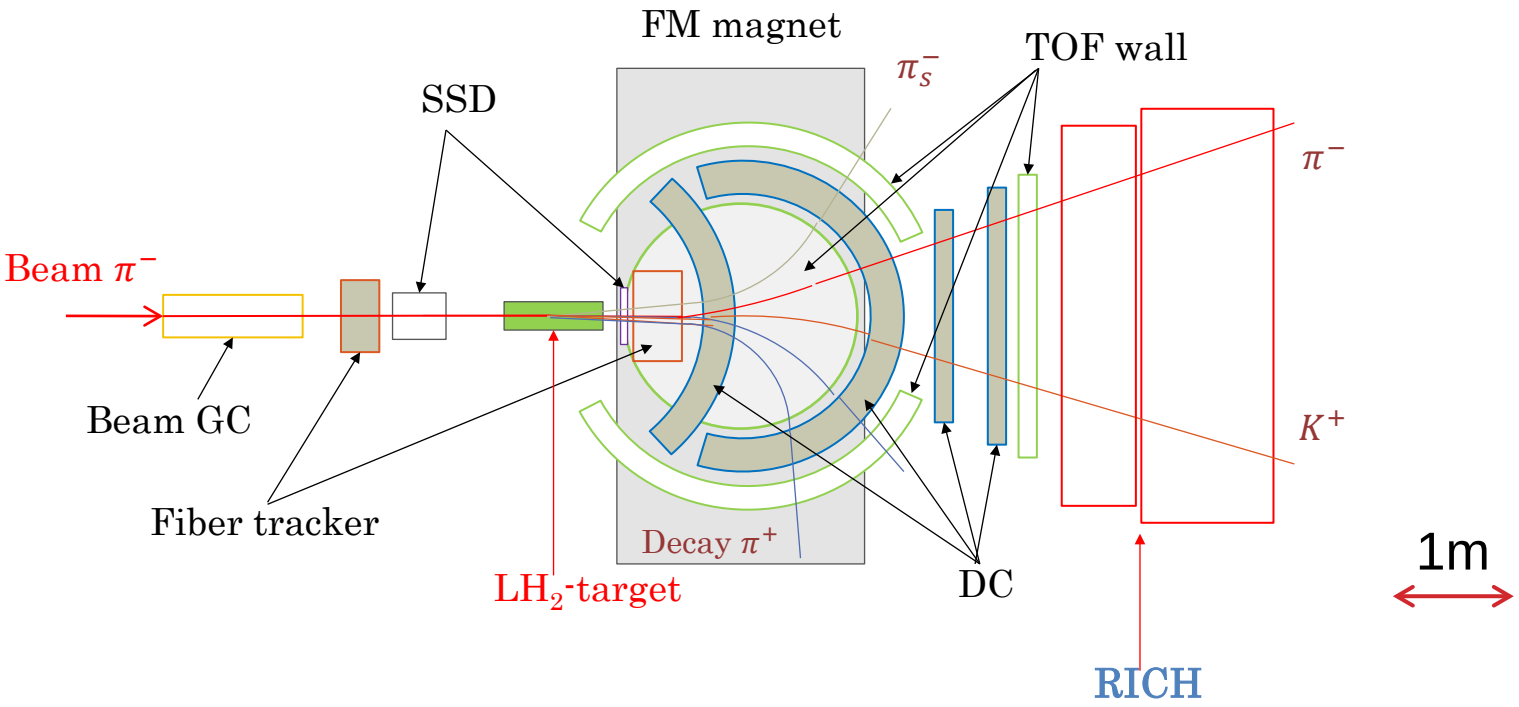
CHARMED BARYON SPECTROSCOPY

Using Missing Mass Techniques



* 20GeV/c πp→Y_c*$\bar{D}^{*-}$ with missing mass technique
* Extra tagging in coincidence w/ $p(\pi^-,D^{*-})$ to keep good S/N.
* Decay Branches:
  diquark correlation affects $\Gamma(\Lambda_c^*\text{->}pD)/\Gamma(\Lambda_c^*\text{->}\Sigma_c\pi)$.
* Angular Distribution: spin, parity

SPECTROMETER SETUP

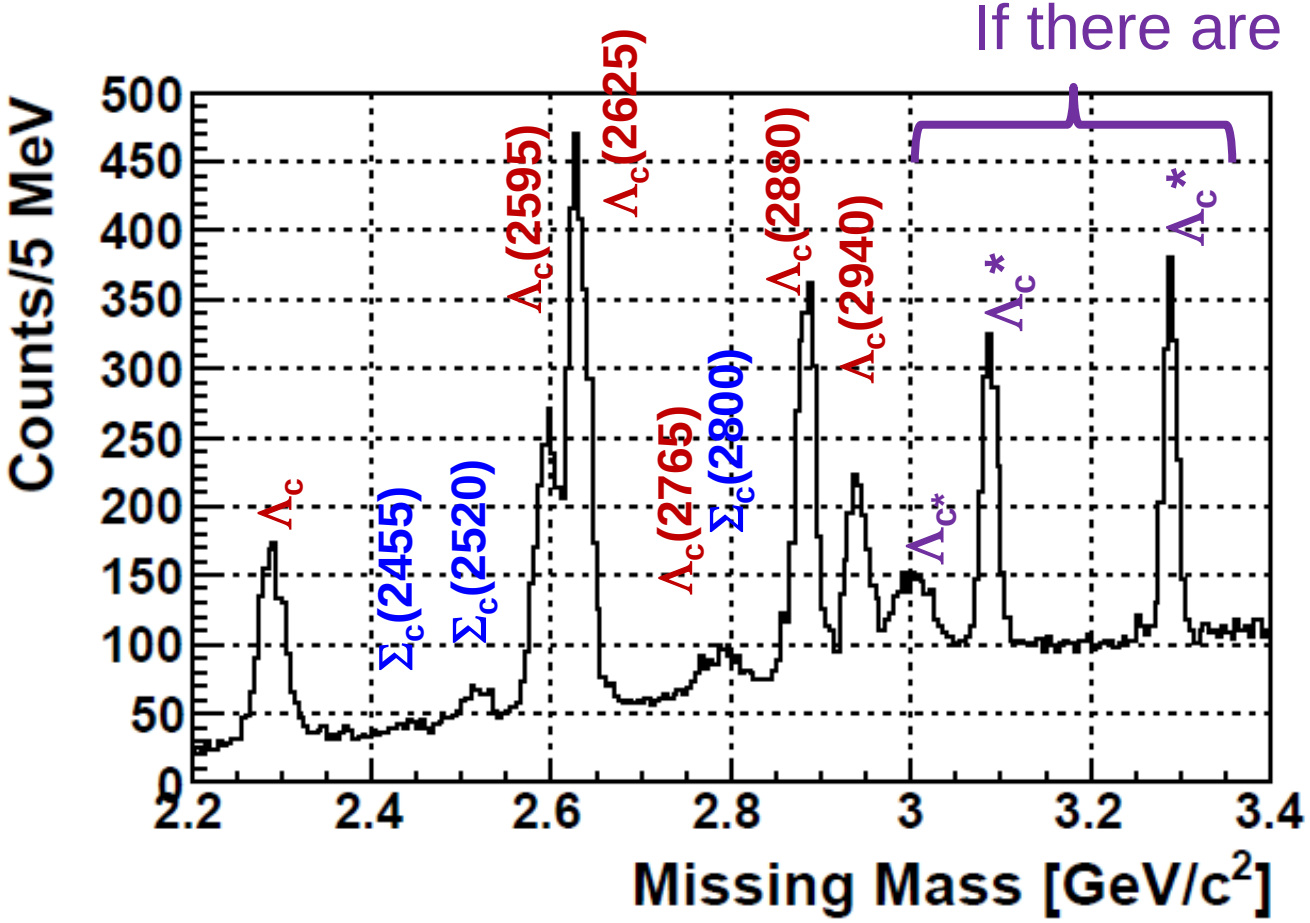


High resolution & Large acceptance spectrometer

- Larget acceptance (60% for D*)
- Detector configuration for high-resolution (dp/p=0.2%)
  - Possible decay mode measurement: $Y_c^* \rightarrow Y_c + \pi \ldots$
- Multi-particle detection in the high rate environment

EXPECTED SPECTRA: $\sigma(\Pi P \rightarrow D^{*-} Y_C)$ = 1 nB

N(Yc*)~1000 events/1nb/100 days
Sensitivity: ~0.1 nb (3σ, Γ~100 MeV)



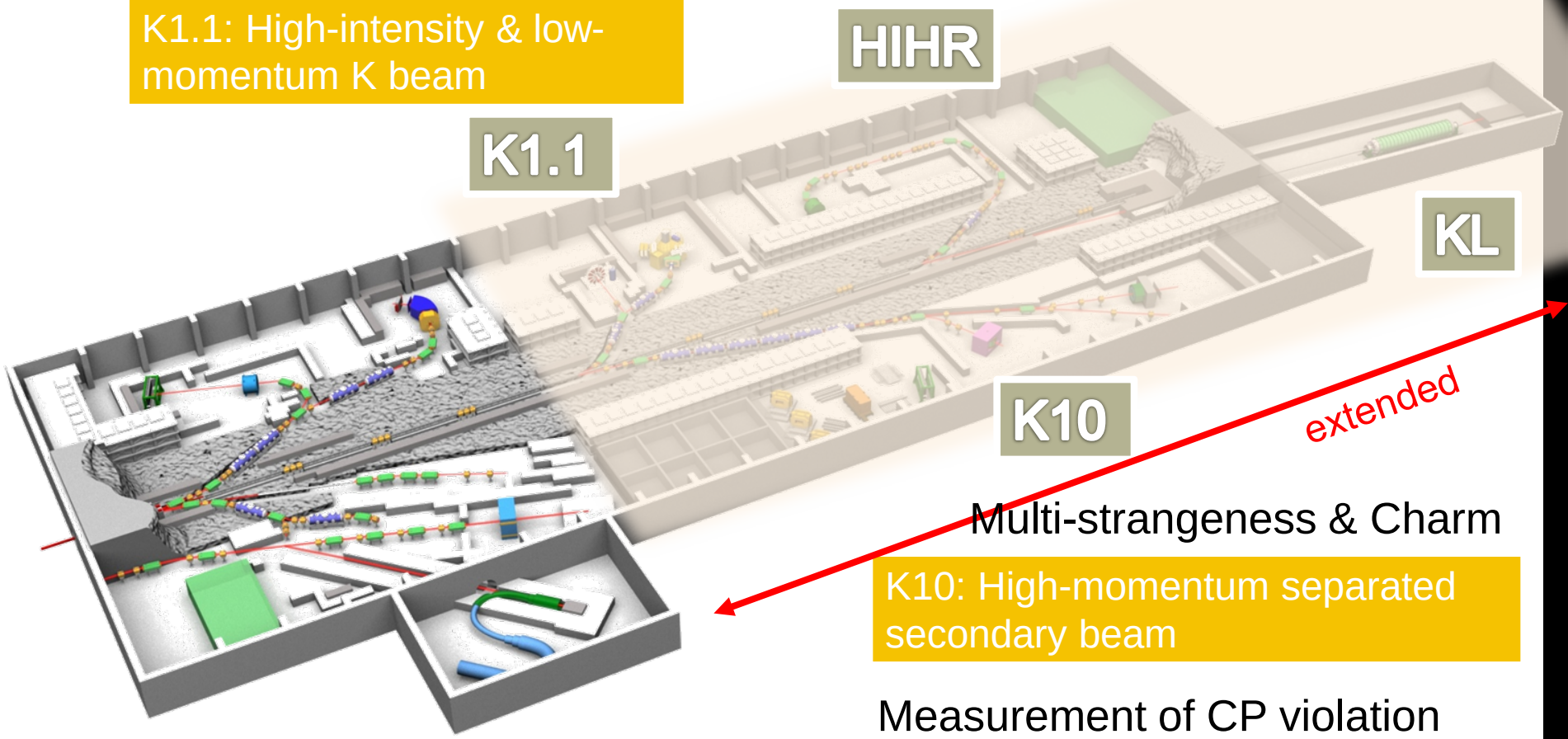
HADRON HALL EXTENSION

Precise Spectroscopy of Hypernuclei

HIHR: High resolution intense secondary beam

Systematic Study for Hypernuclei（S=-1)

K1.1: High-intensity & low-momentum K beam



Multi-strangeness & Charm

K10: High-momentum separated secondary beam

Measurement of CP violation

KL: high intensity neutral kaons