Dilepton Measurement and Future Possibilities at J-PARC

M. Naruki (Kyoto Univ.)
at ISMD2023, Gyöngyös, Hungary
on 23th Aug. 2023

Hadron Physics at J-PARC

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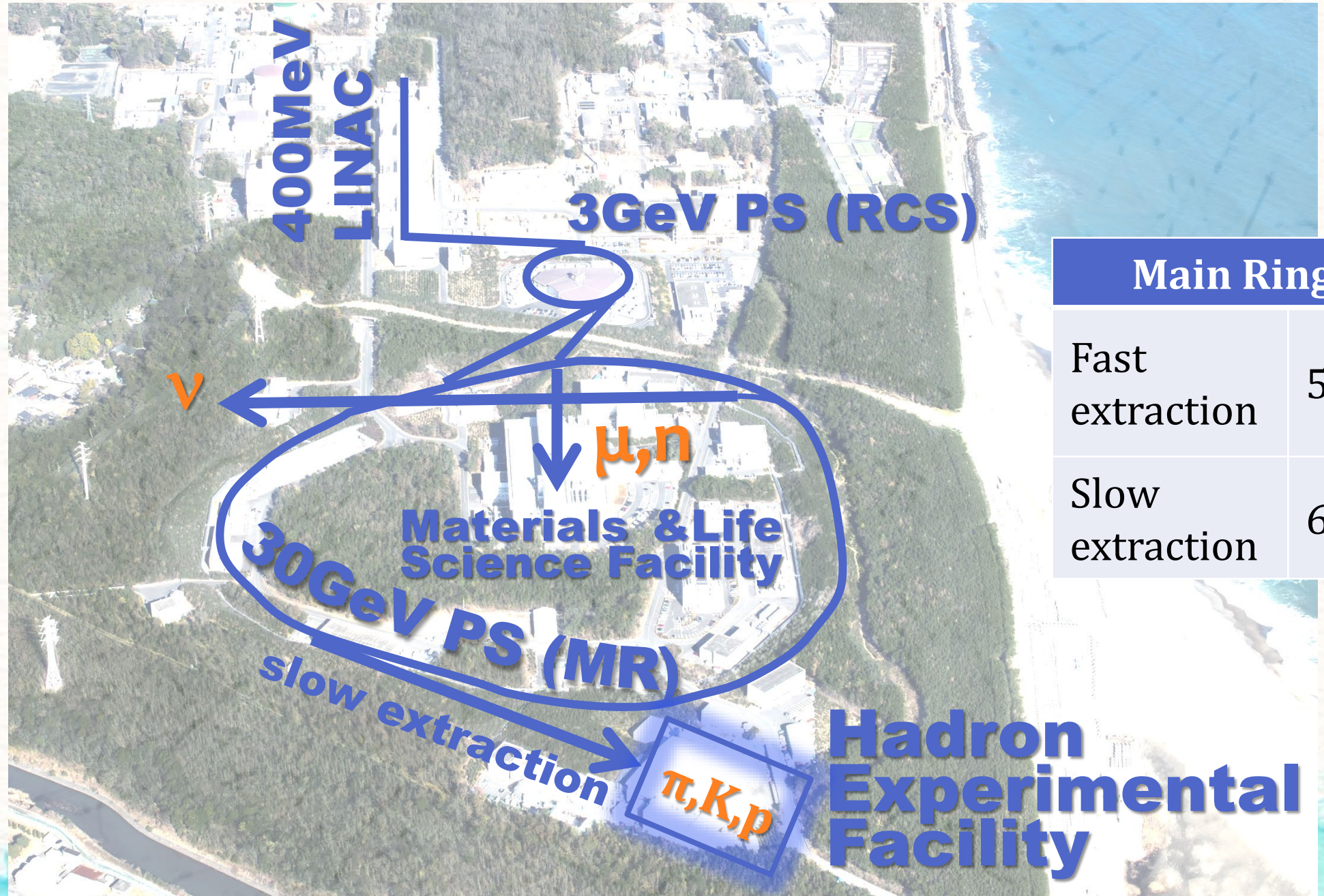
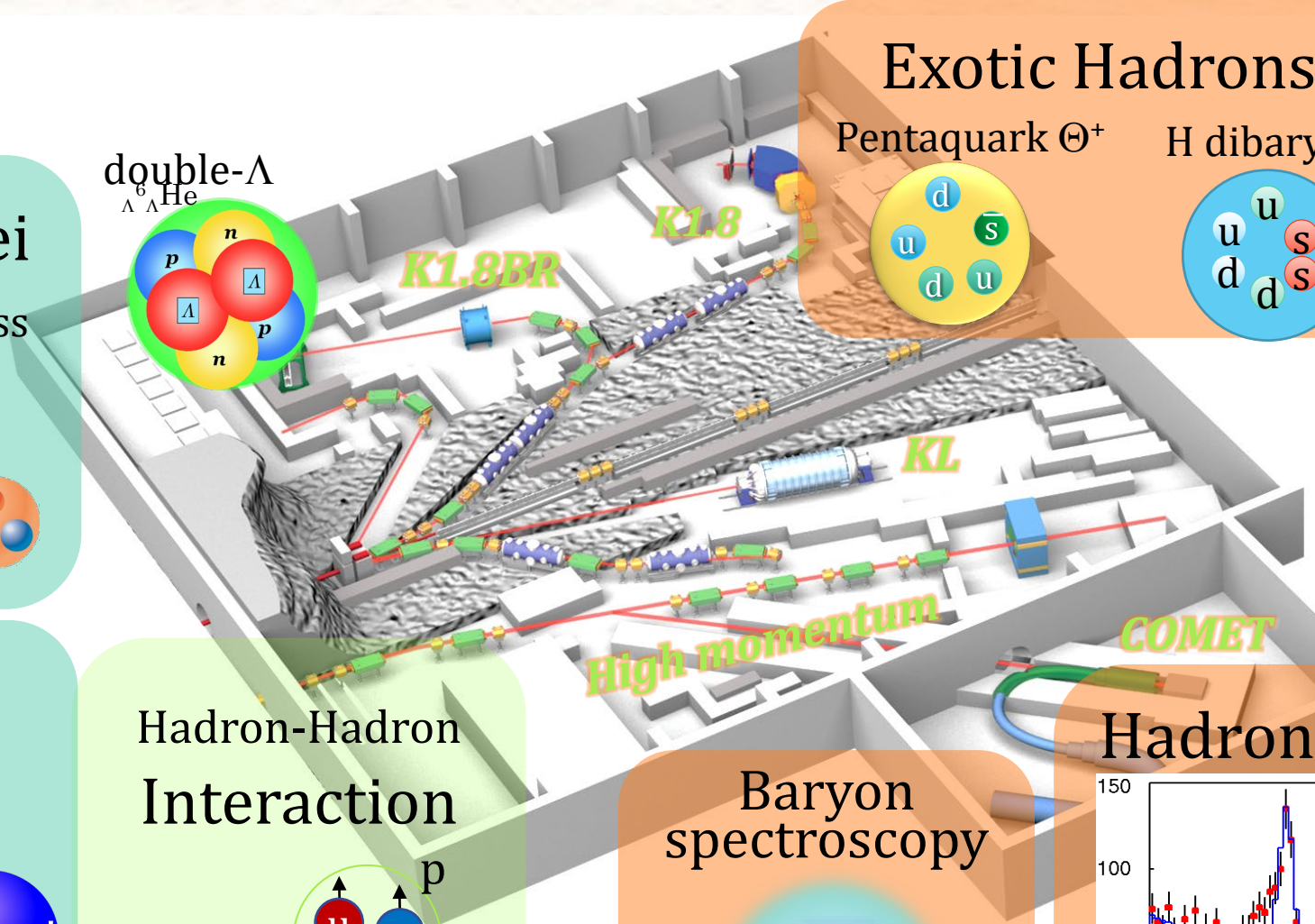
J-PARC

Tokai, Ibaraki

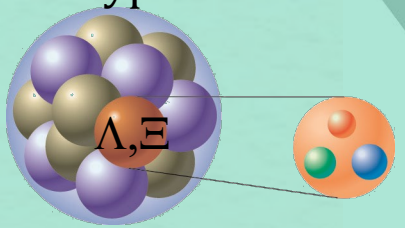


Main Ring (MR)	
Fast extraction	510kW
Slow extraction	64.5kW

Physics at J-PARC Hadron Facility
intense kaon beam

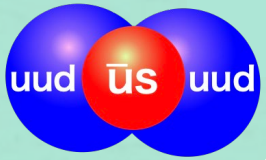


Hypernuclei
multi-strangeness hypernuclei

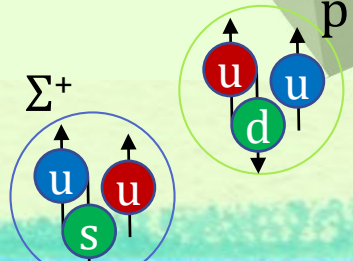


double-Λ ${}^{6}_{\Lambda\Lambda}$He

Few-body systems
K⁻pp



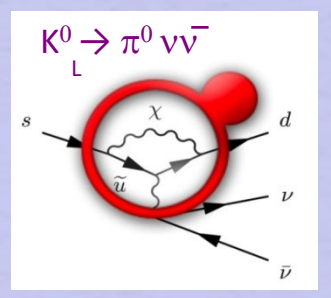
Hadron-Hadron Interaction



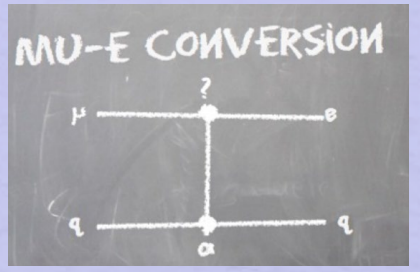
Exotic Hadrons
Pentaquark Θ⁺

H dibaryon

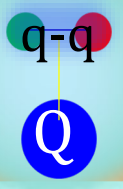
CP violation



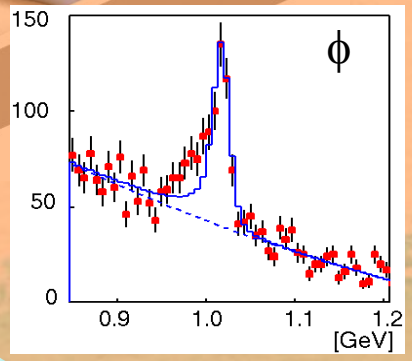
COMET



Baryon spectroscopy



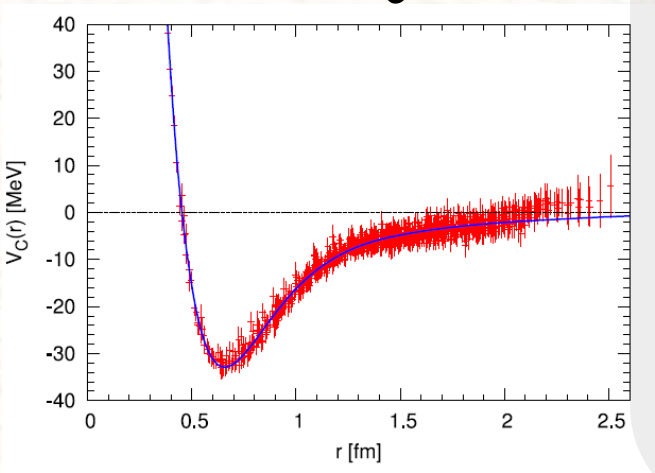
Hadron Mass



Hadron Physics at J-PARC

Quark degrees of freedom - Nuclear Force

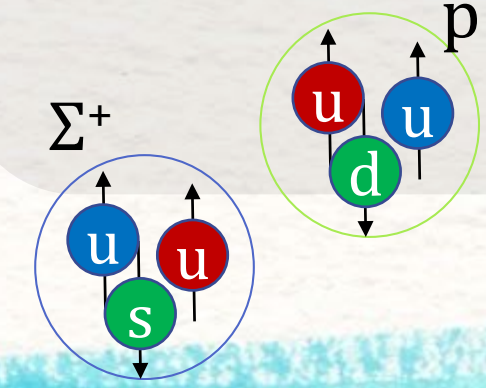
NN potential
from LQCD



N. Ishii, S. Aoki and T. Hatsuda,
PRL 99, 022001 (2007)

Hadron-Hadron
Interaction

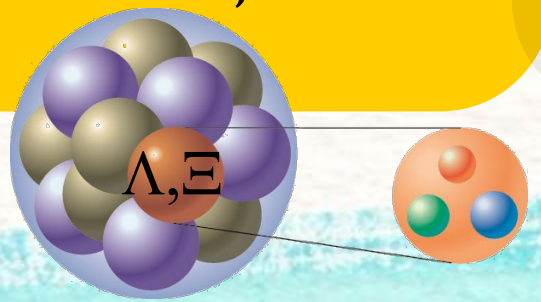
YN scattering



Hypernuclei

multi-strangeness
hypernuclei

ΞN, ΛΛ

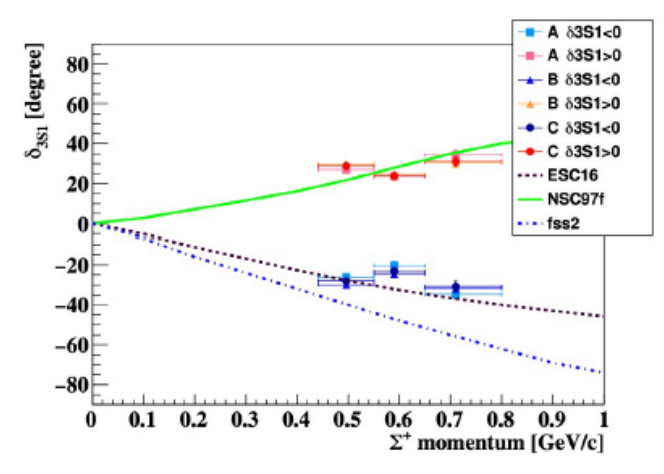


Few-body
systems

Highlights from J-PARC

Quark degrees of freedom - Nuclear Force

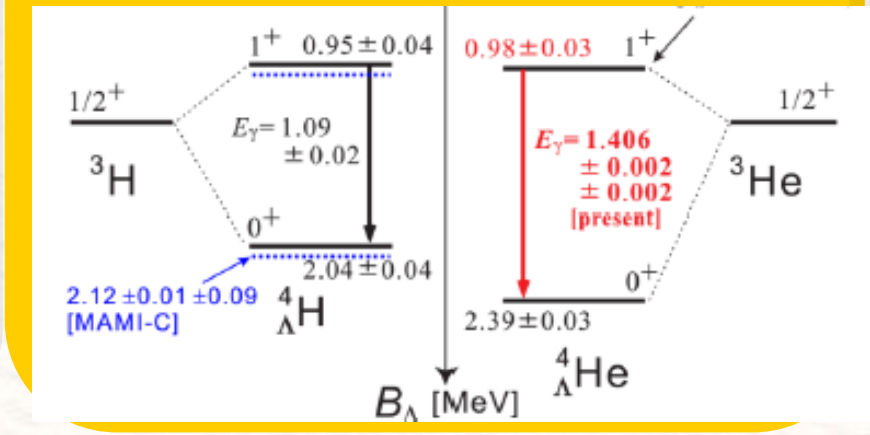
ΣN scattering



Consistent with LQCD

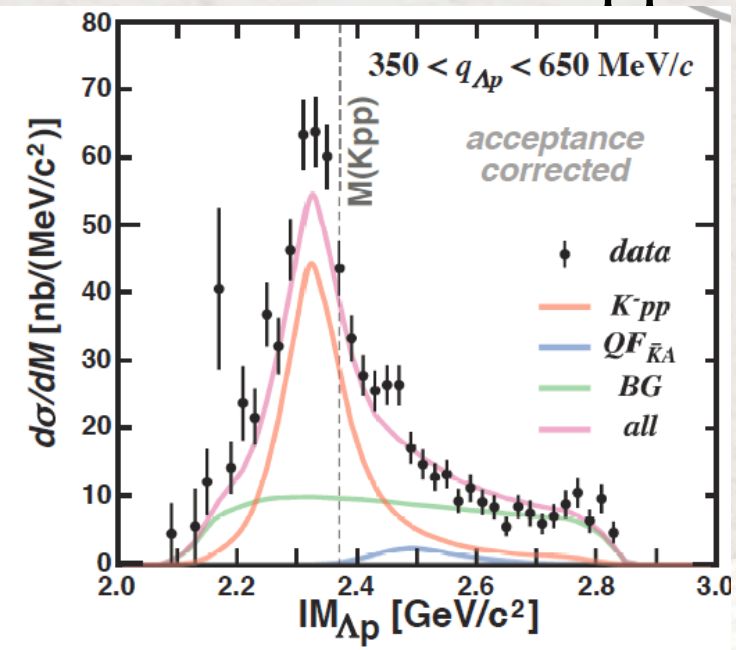
E40 collaboration,
PTEP 2022 093D01

Charge Symmetry Breaking in hypernuclei



E13 coll., PRL 115 (2015) 222501

Observation of K-pp

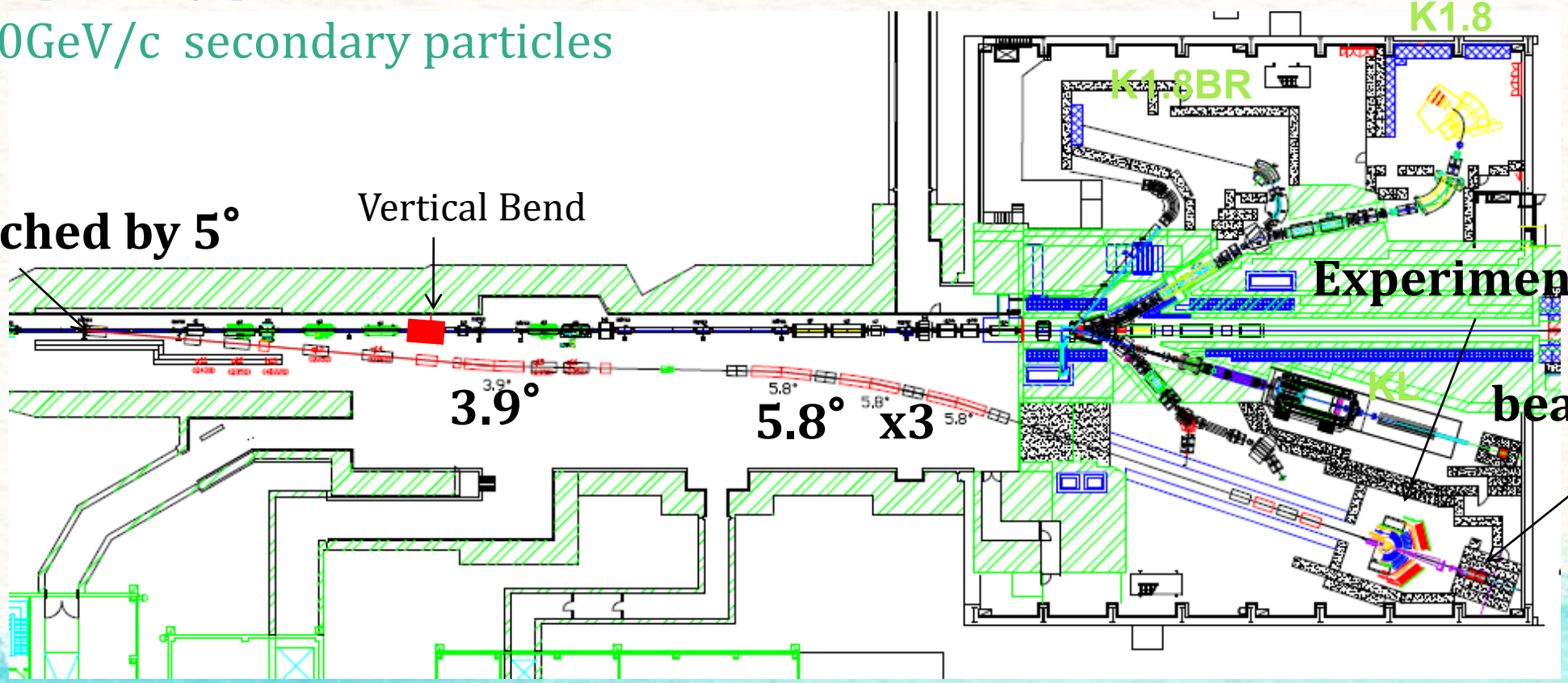


E15 coll., PLB. 789, 620 (2019)

High-momentum beamline

- at SM1 protons branches off from the primary line
- 30 GeV primary proton (10^{10}/s)
- 8 GeV primary proton for COMET
- 2 - 20GeV/c secondary particles

Name	Particles	P_{max} (GeV/c)	$I_{ntensity}$ (/spill)
K1.8	π, K	2.0	10^6 K^-
K1.8BR	π, K	1.1	10^6 K^-
KL	K^0		
High-p	**proton**	**31**	10^{10} p
High-p2	**π/K**	**20**	10^6 K^-

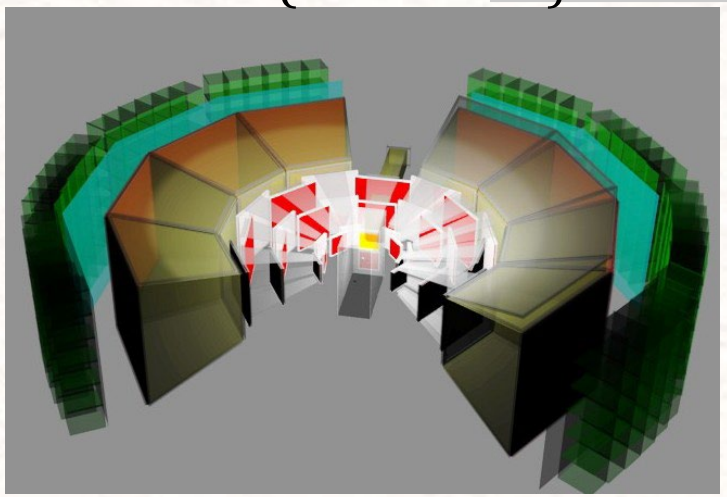


Dilepton Measurement - Schedule

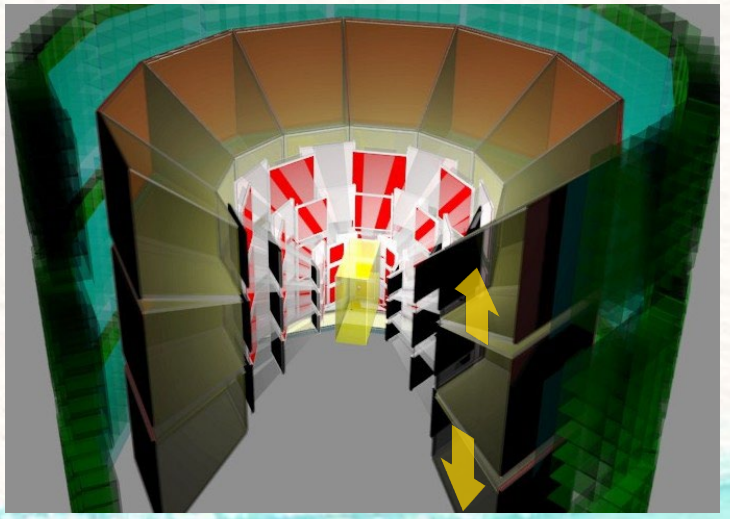
- 2020-2021 RUN0 -- 320 hours, C/Cu targets
  - Beamline / Detector commissioning
- 2023 Run0d -- 201 hours
  - Beamline commissioning, pilot run

- 2024 RUN1 -- 1280 hours, C/Cu targets
  - Physics run 15k of ϕ mesons
- 2025 RUN2 -- 2560 hours, C/Cu/Pb targets
  - nuclear size & velocity dependences
  - dispersion relation

RUN 1 (8 modules)



RUN 2 (26 modules)



Future Possibilities

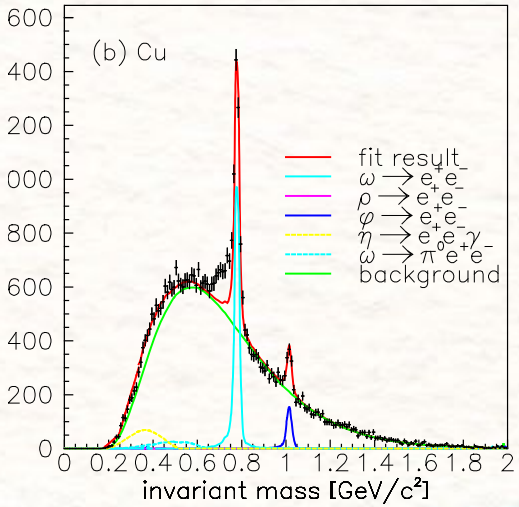
Dilepton → Dihadron Spectrometer

- $\eta \to e^+e^-\gamma$
- $\rho \to e^+e^-$
- $\omega \to e^+e^-$
- $\phi \to e^+e^-$

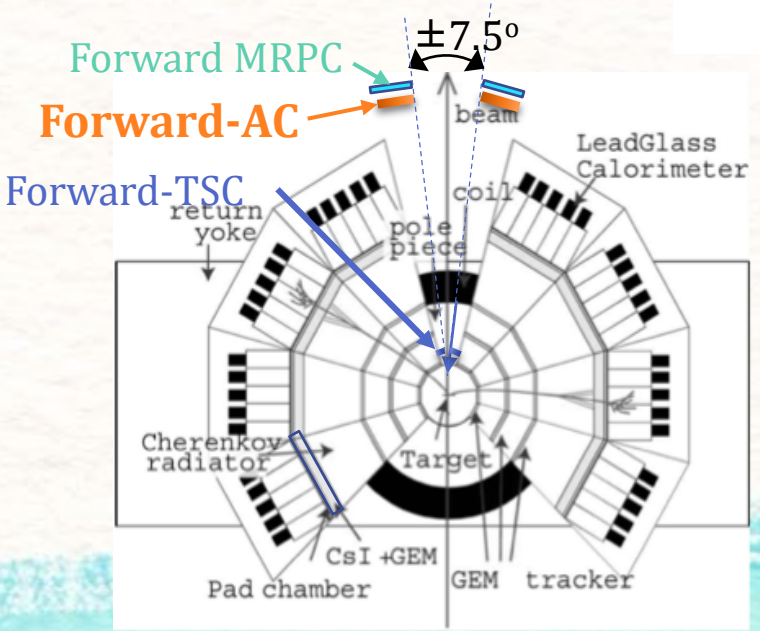
- $K_S^0 \to \pi^+\pi^-$
- $\rho \to \pi^+\pi^-$

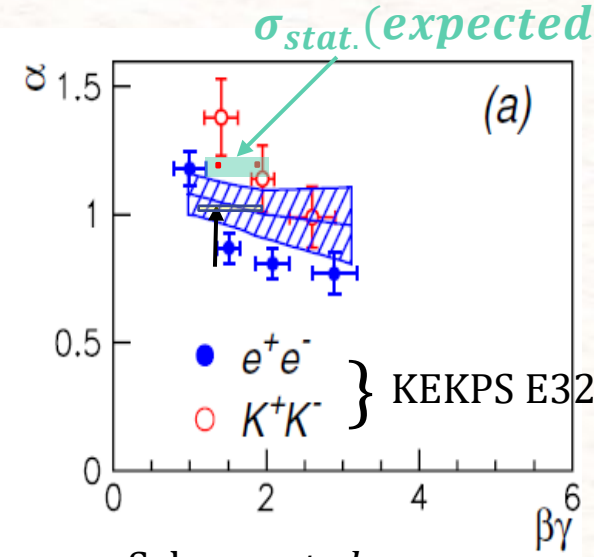
- $\phi \to K^+K^-$

E16 → E88



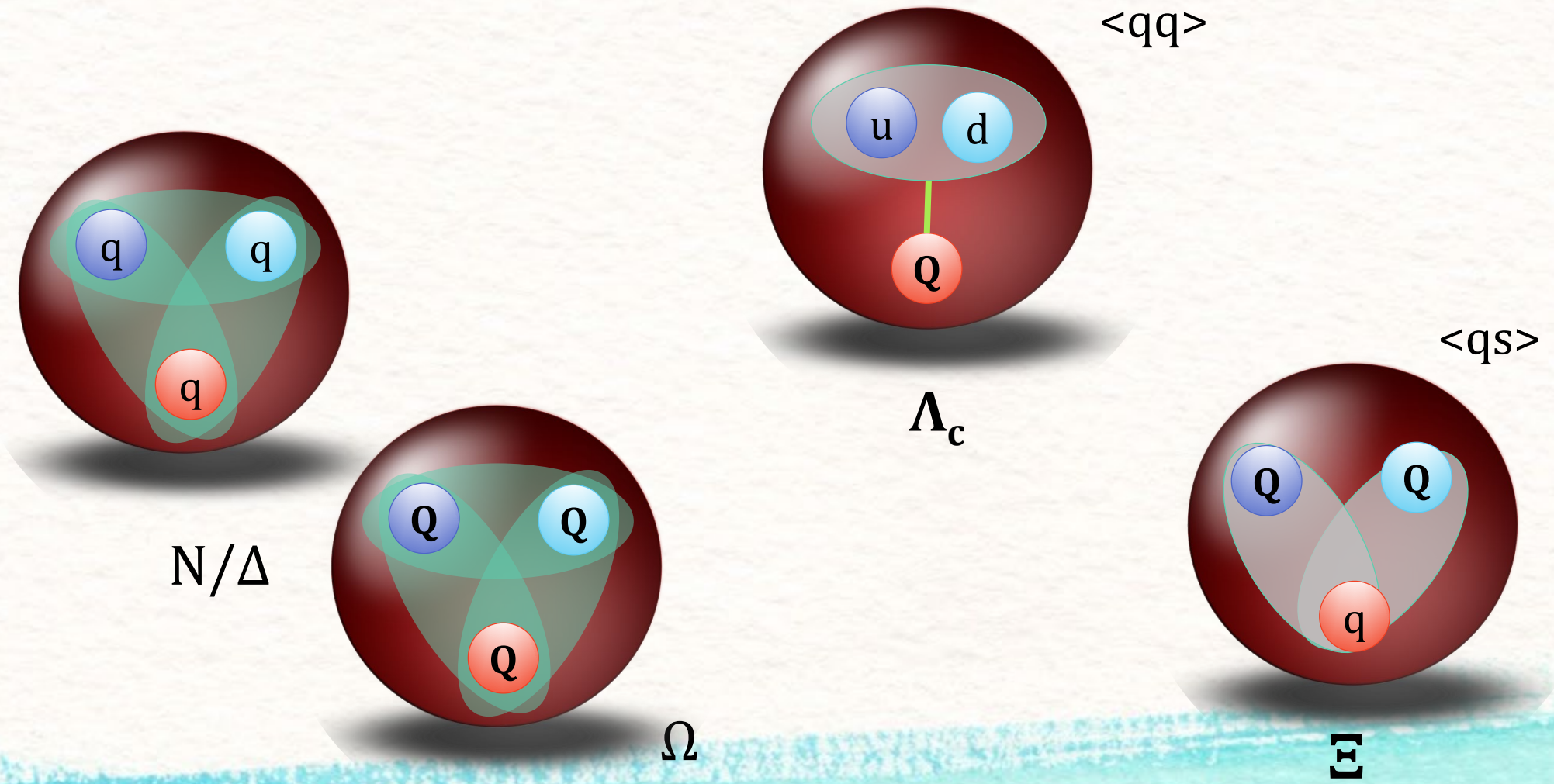
PRL**96**,(2006) 092301





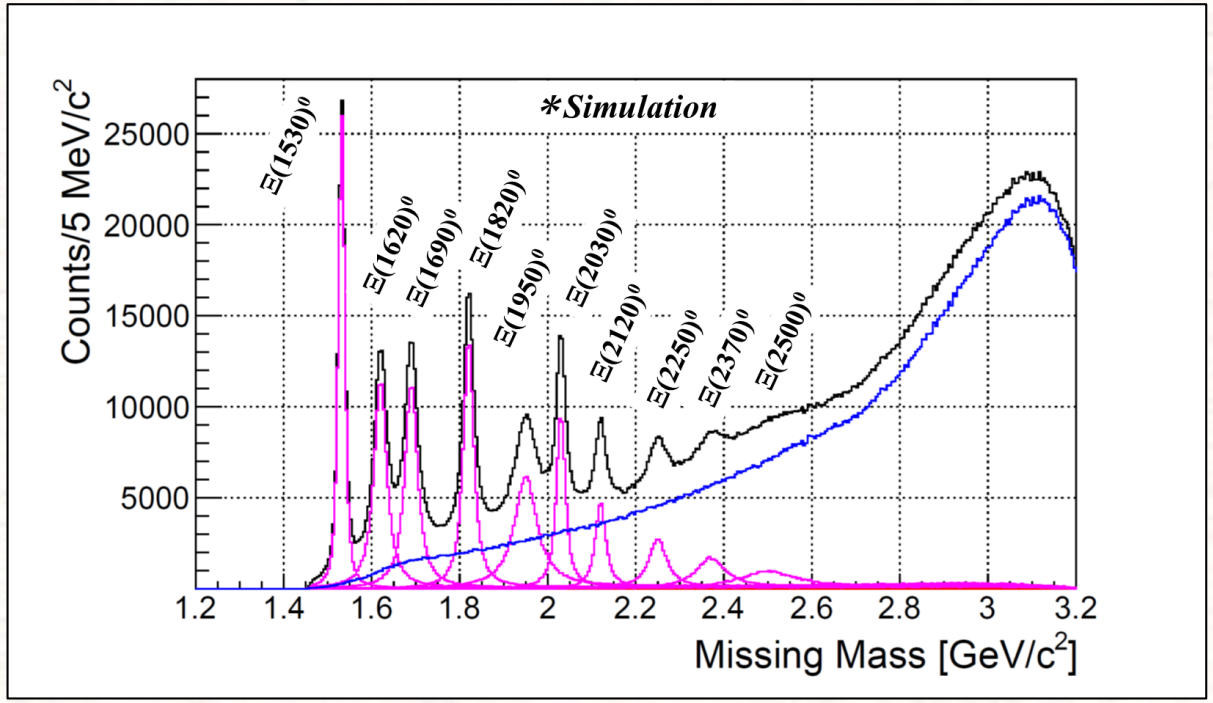
Sakuma *et al.*,
PRL 98 (2007) 152302

Strange & Charm Baryon Spectroscopy at high-p secondary beamline

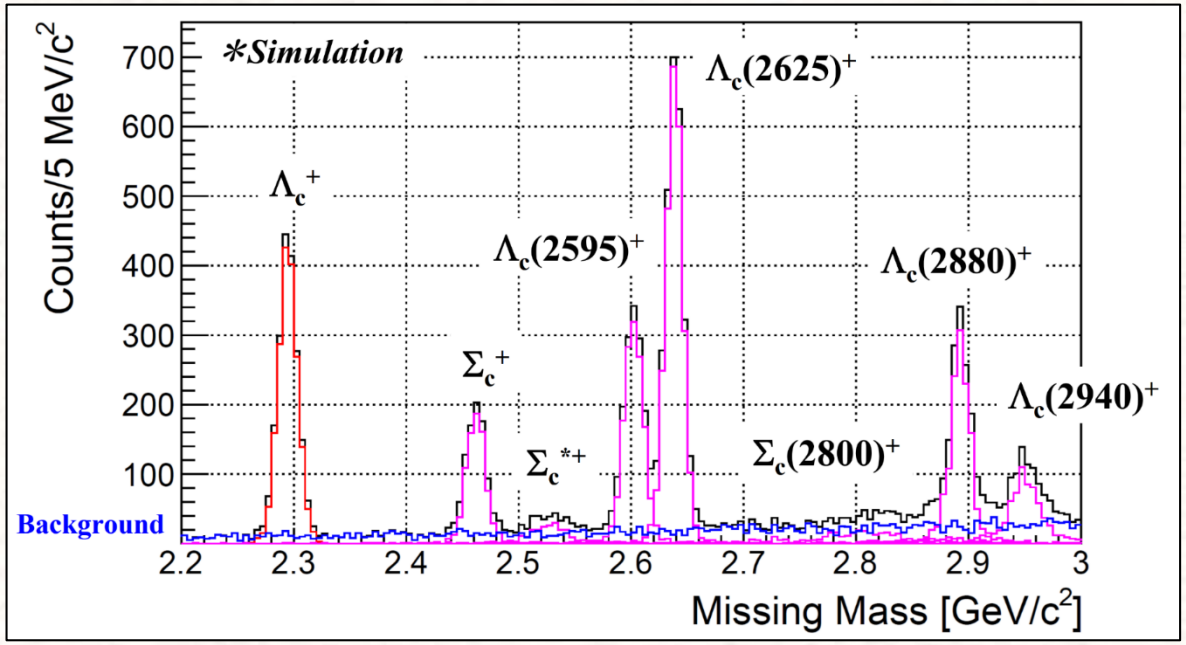


Expected spectra

E97: Ξ*



E50: Y_c^*

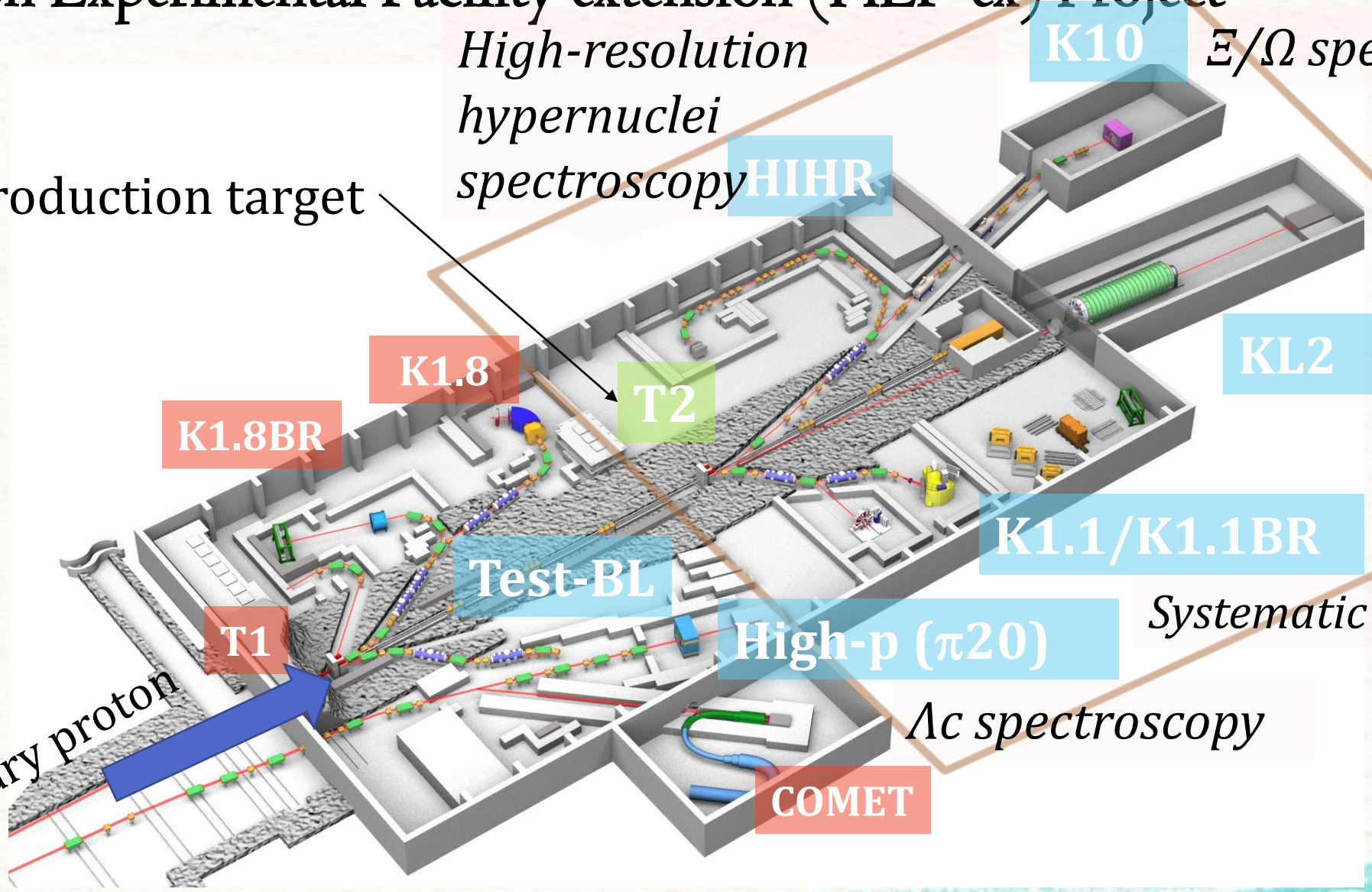


- Missing mass & decay measurements
  - ΔM of 7 MeV

$\sigma_{G.S.}$ = 1 nb in 100 days

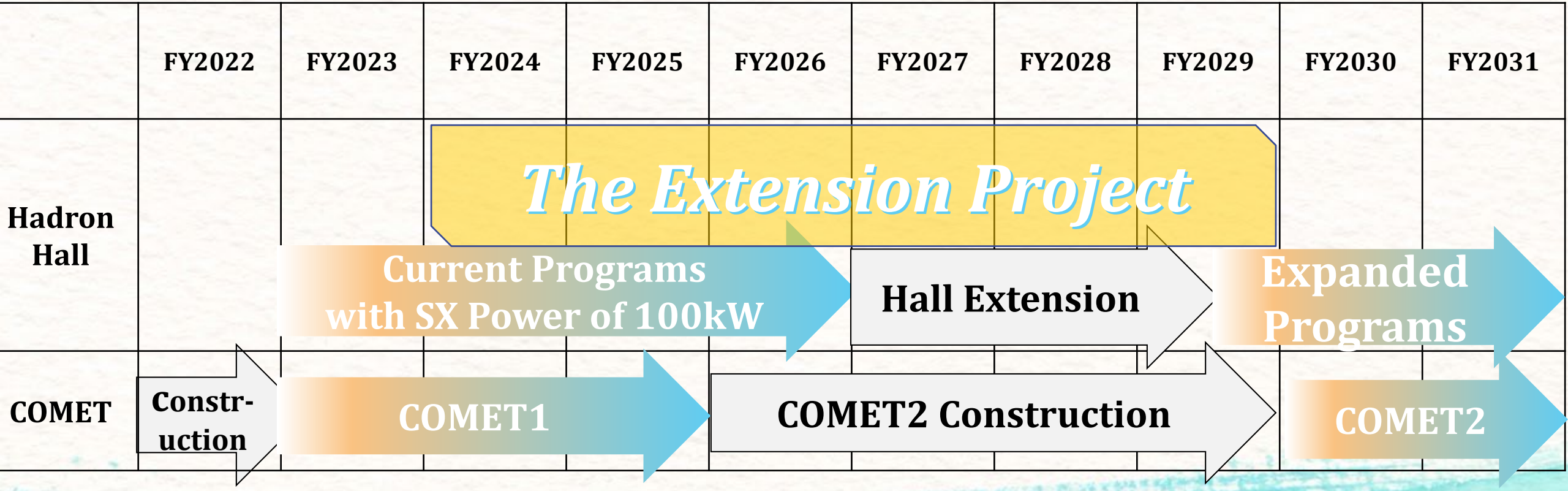
ΔM=8 MeV

Hadron Experimental Facility extension (HEF-ex) Project



Schedule

- Listed as 1st priority in KEK Project Implementation Plan 2022



Summary

- J-PARC Hadron Facility has been operated since 2009, many study findings have been published to date.
- Recently new beamline was constructed, and the dilepton measurement has been successfully launched.
- The high-momentum beamline will be utilized as the secondary beamline, and it will open to new opportunities for systematic baryon spectroscopy from strange to charm.
- The hadron extension project was selected as the first priority in the KEK long-range plan.