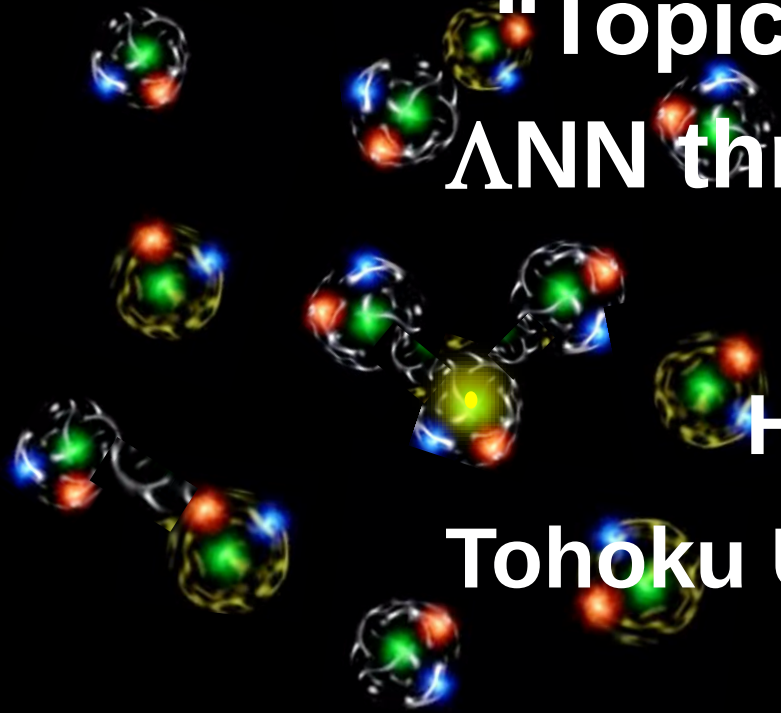
2022.6.19
HYP2022

Introduction to “Topical Session on ΛNN three-body force”

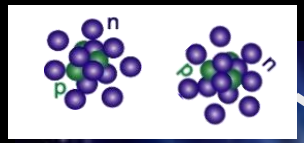


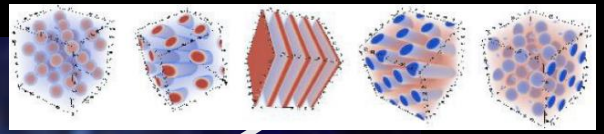
H. Tamura

Tohoku University /JAEA

Neutron star is full of mysteries

Outer crust
Neutron-rich nuclei





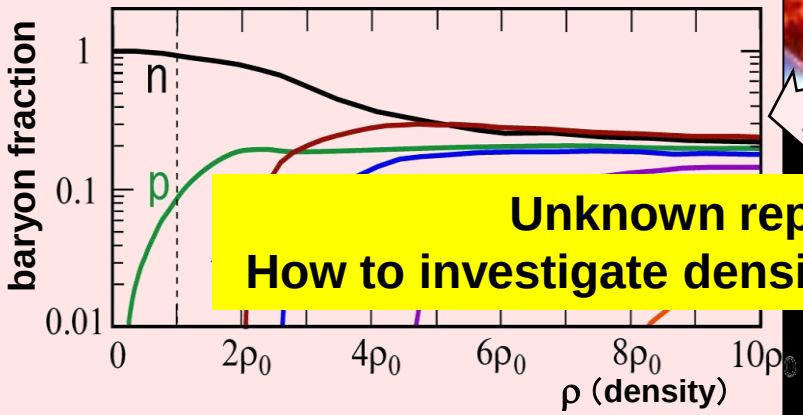
Inner crust
Pasta nuclei

Outer core
Neutron Matter

U_Λ = -30 MeV
U_Σ = +30 MeV
U_Ξ = -15 MeV

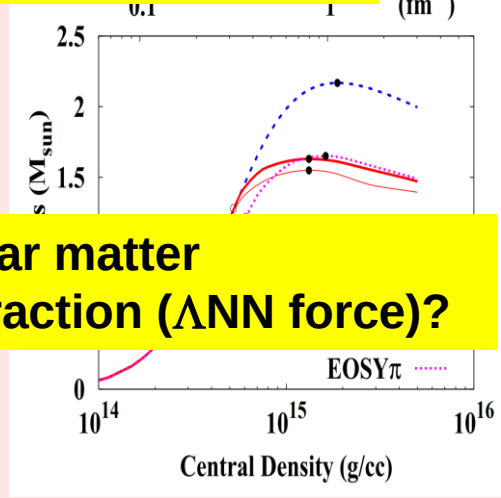
experimentally known at ρ_0

C. Ishizuka et al., J.Phys.G 35 (2008) 085201



Sensitive to YN, YY interactions

Hyperon Puzzle!



Unknown repulsion in dense nuclear matter
How to investigate density-dependent ΛN interaction (ΛNN force)?

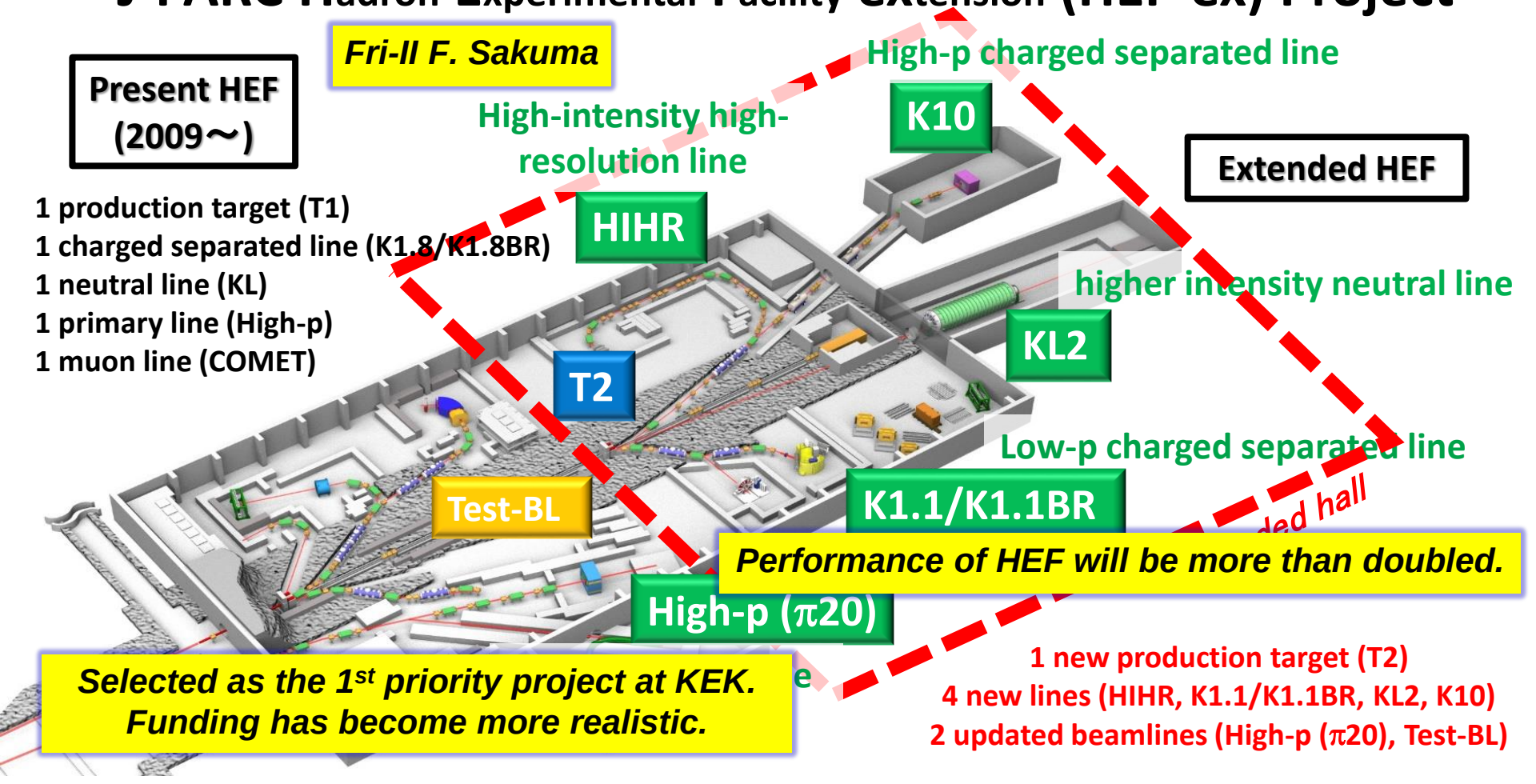
Quark Ma

J-PARC Hadron Experimental Facility eXtension (HEF-ex) Project

Fri-II F. Sakuma

Present HEF (2009～)

1 production target (T1)
1 charged separated line (K1.8/K1.8BR)
1 neutral line (KL)
1 primary line (High-p)
1 muon line (COMET)

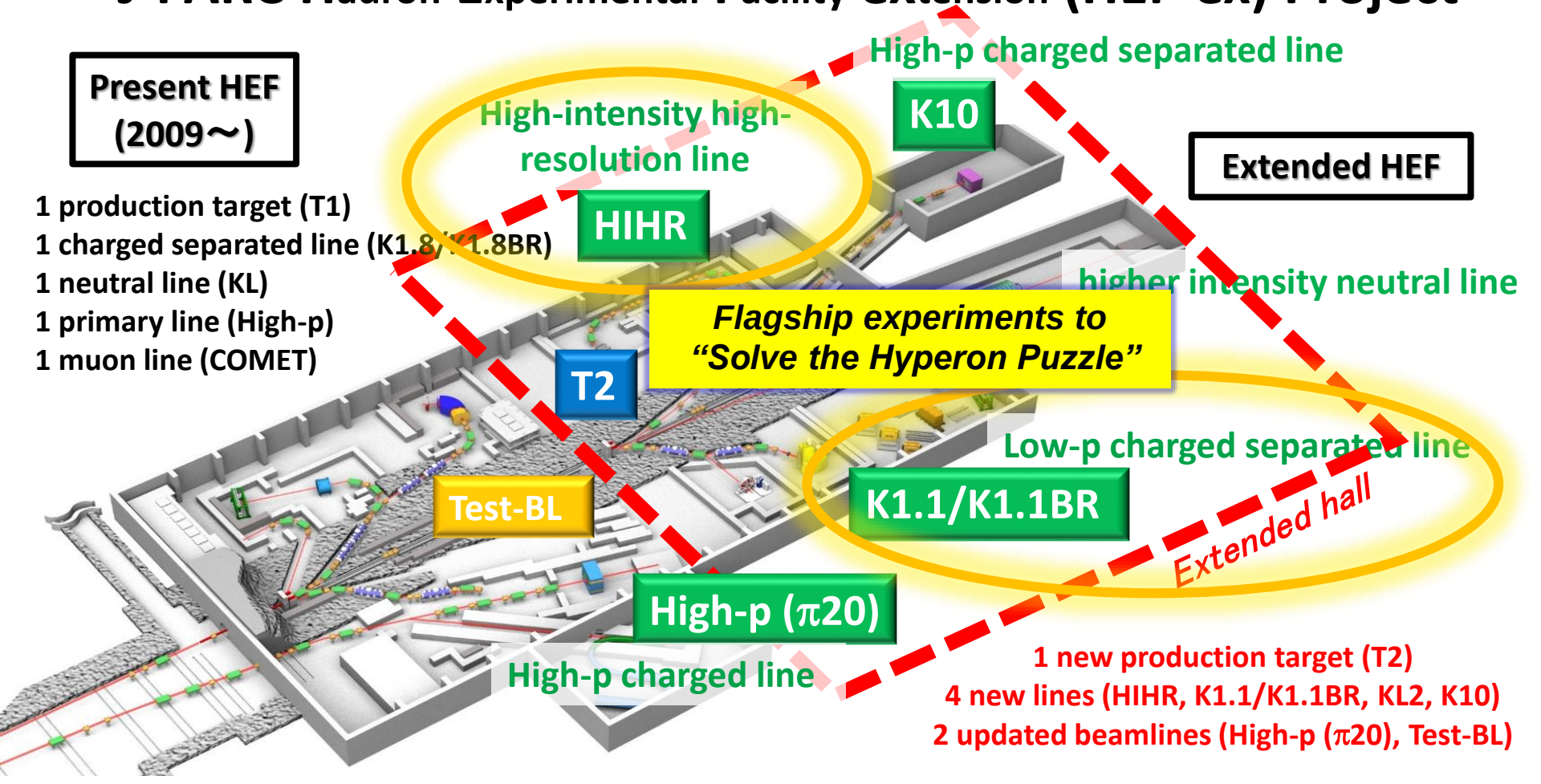


Performance of HEF will be more than doubled.

Selected as the 1st priority project at KEK. Funding has become more realistic.

1 new production target (T2)
4 new lines (HIHR, K1.1/K1.1BR, KL2, K10)
2 updated beamlines (High-p (π20), Test-BL)

J-PARC Hadron Experimental Facility eXtension (HEF-ex) Project



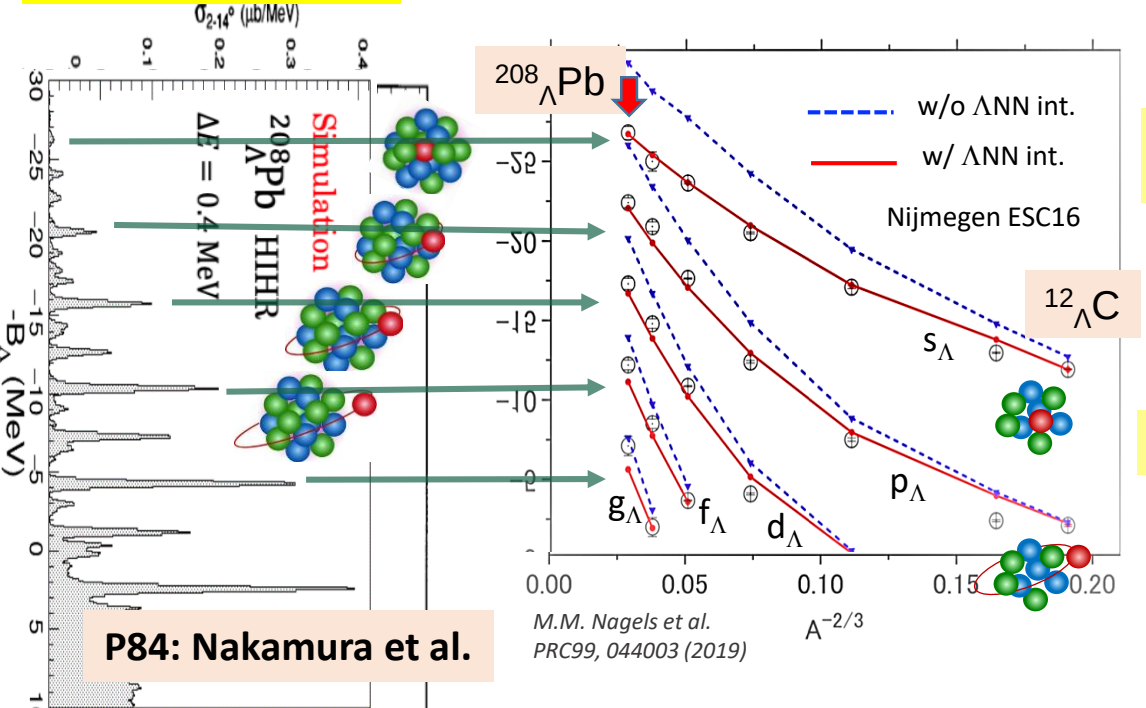
Experimental approach at J-PARC

Precise (<0.1 MeV) B_Λ values for various A and Λ s.p. orbits

+ Realistic YN interactions via high quality scattering exp.

Thu-I: Nakamura

=>Density dependence of ΛN force in matter（= ΛNN 3BF)



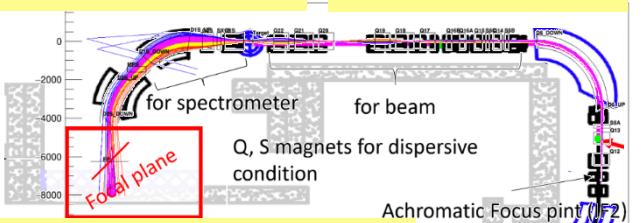
M.M. Nagels et al.
PRC99, 044003 (2019)

P84: Nakamura et al.

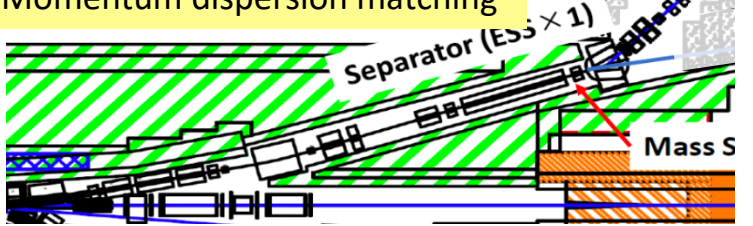
HIHR (High Intensity High Resolution line)

Pion intensity > 2×10^8/spill
limited by proton intensity

ΔM ~ 0.3 MeV FWHM
Δp/p = 1/10000



Momentum dispersion matching



Tue-II: Miwa

Σ± p Data

E40: Miwa et al.

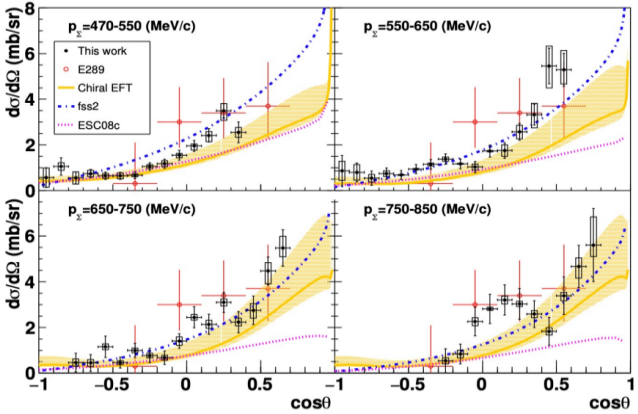
High-quality YN scattering experiments

K1.1

Λ p Simulation

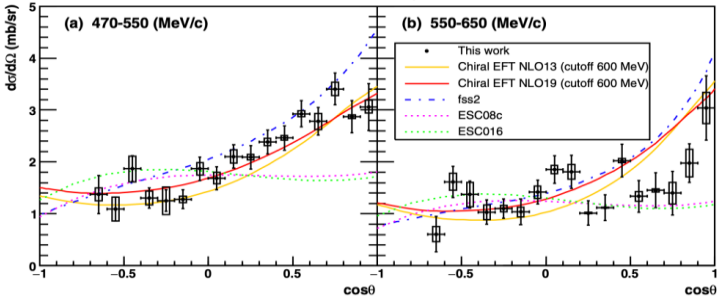
P86: Miwa et al.

Σ⁻p elastic scattering K. Miwa et al., PRC 104, 045204 (2021)



K. Miwa et al., PRL 128, 072501 (2022)

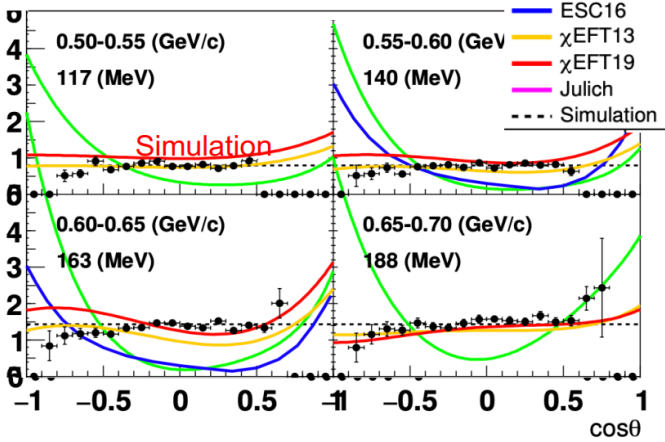
Σ⁻p→Λn inelastic scattering



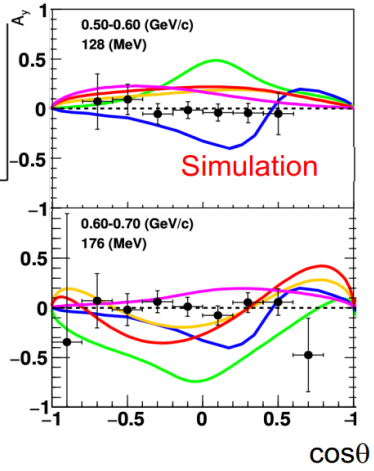
Moderate forward peaking dependence

J-PARC P86 (J-PARC EX project) at K1.1 beam line

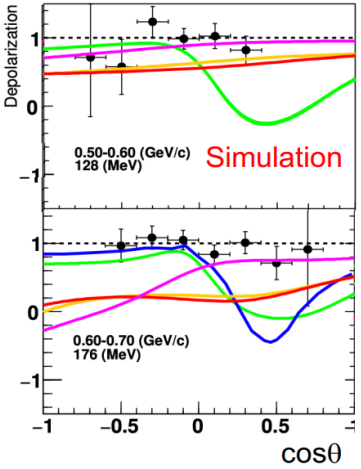
Differential cross section



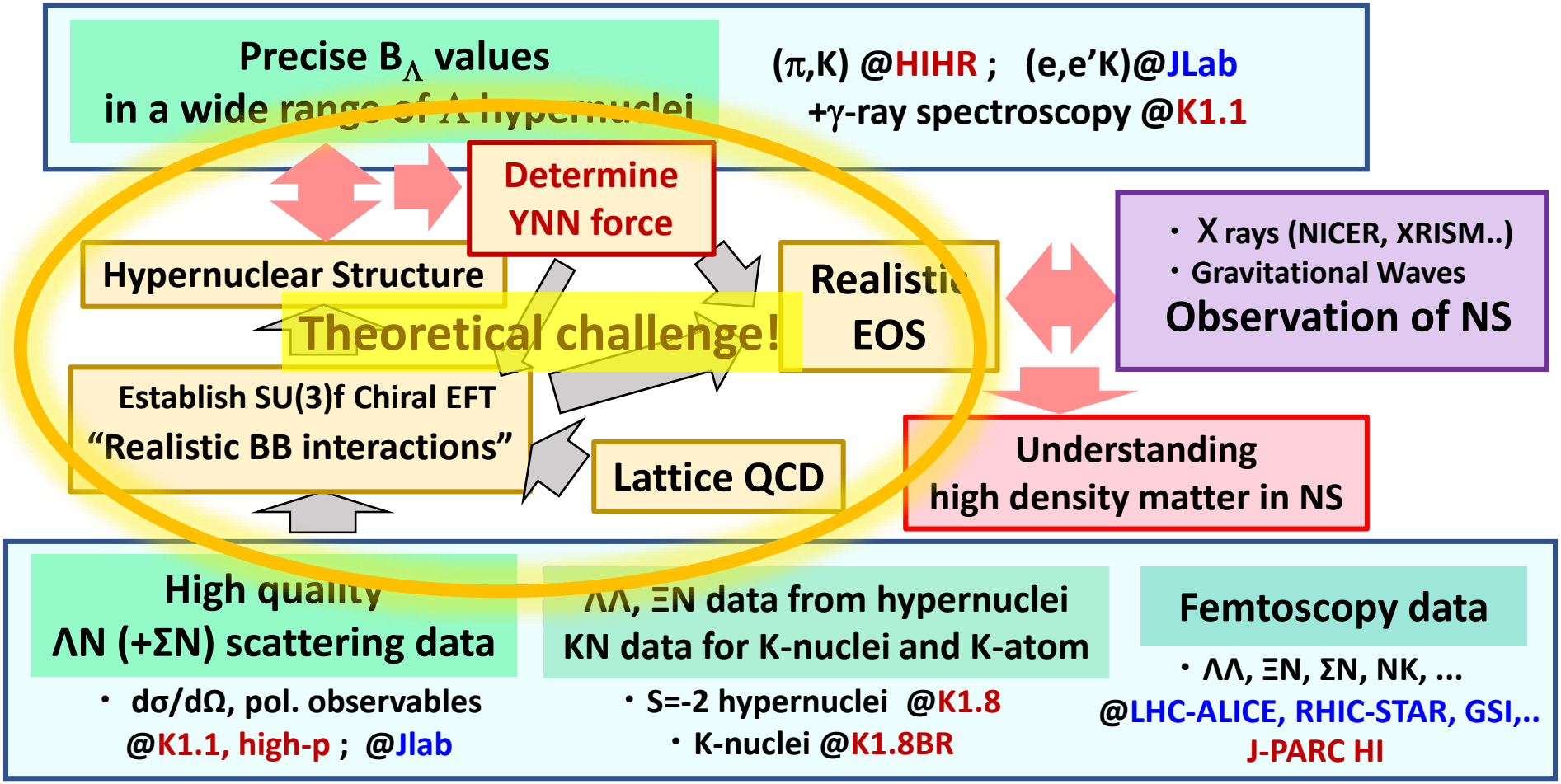
Analyzing power



Depolarization (D_y^y)



Strategy for solving the hyperon puzzle



FAQ

Even in ordinary nuclei, information on density dependent NN interaction (NNN force) cannot be easily derived from nuclear data. The YN case should be much more difficult….

- **Λ is distinguishable in a nucleus. No Pauli from nucleons.**
- **We know the local density where the Λ is located.**
- **Λ can probe various densities via various A and orbits in hypernuclei**

Nuclear data gives us info. on density dependence at
Is a reliable extrapolation to hig

- **Ch**
- **ut how well and how far?**
- **st YNN force (to determine the LEC's)?**
- **y hypernuclear structure can be calculated?**

Let us make a world-wide collaboration between theorists and experimentalists to solve the "hyperon puzzle"

High quality experimental data can be really obtained near future?

- **Yes, at J-PARC -> Nakamura, Miwa**
- **Femtoscopy approach -> Serksnyte**