Future plan on Investigation of ΛN Interactions by Electro-production at JLab

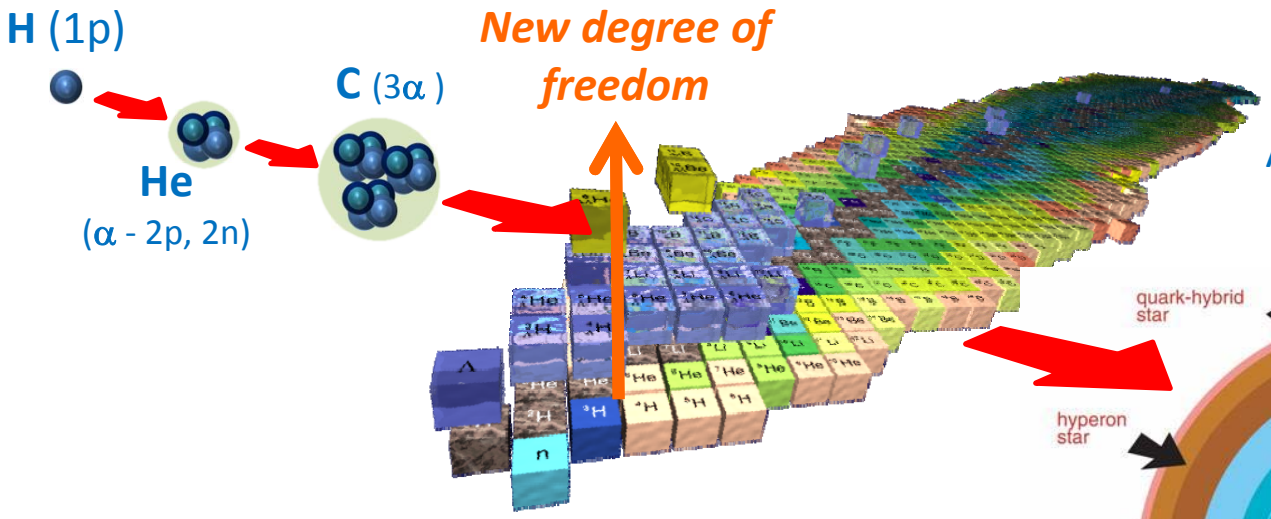
Liguang Tang
Hampton University

On Behalf of the JLab Hypernuclear Collaboration

HYP2015, Sept. 7 - 11, 2015, Sendai, Japan

Introduction – Baryonic interactions

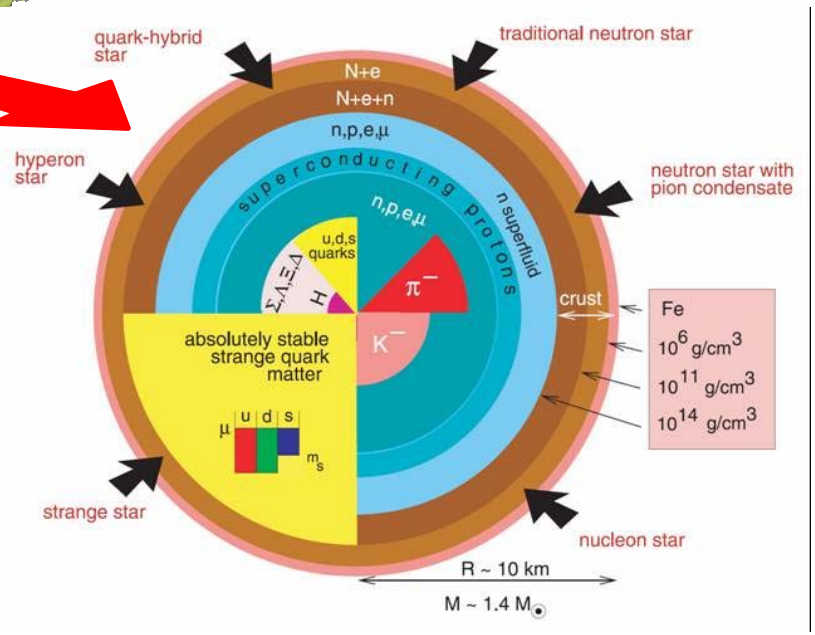
Understanding *B-B* interactions is one of the essential tasks in Nuclear Physics: *How the "world was built" by the strong interaction?*



Improved EOS

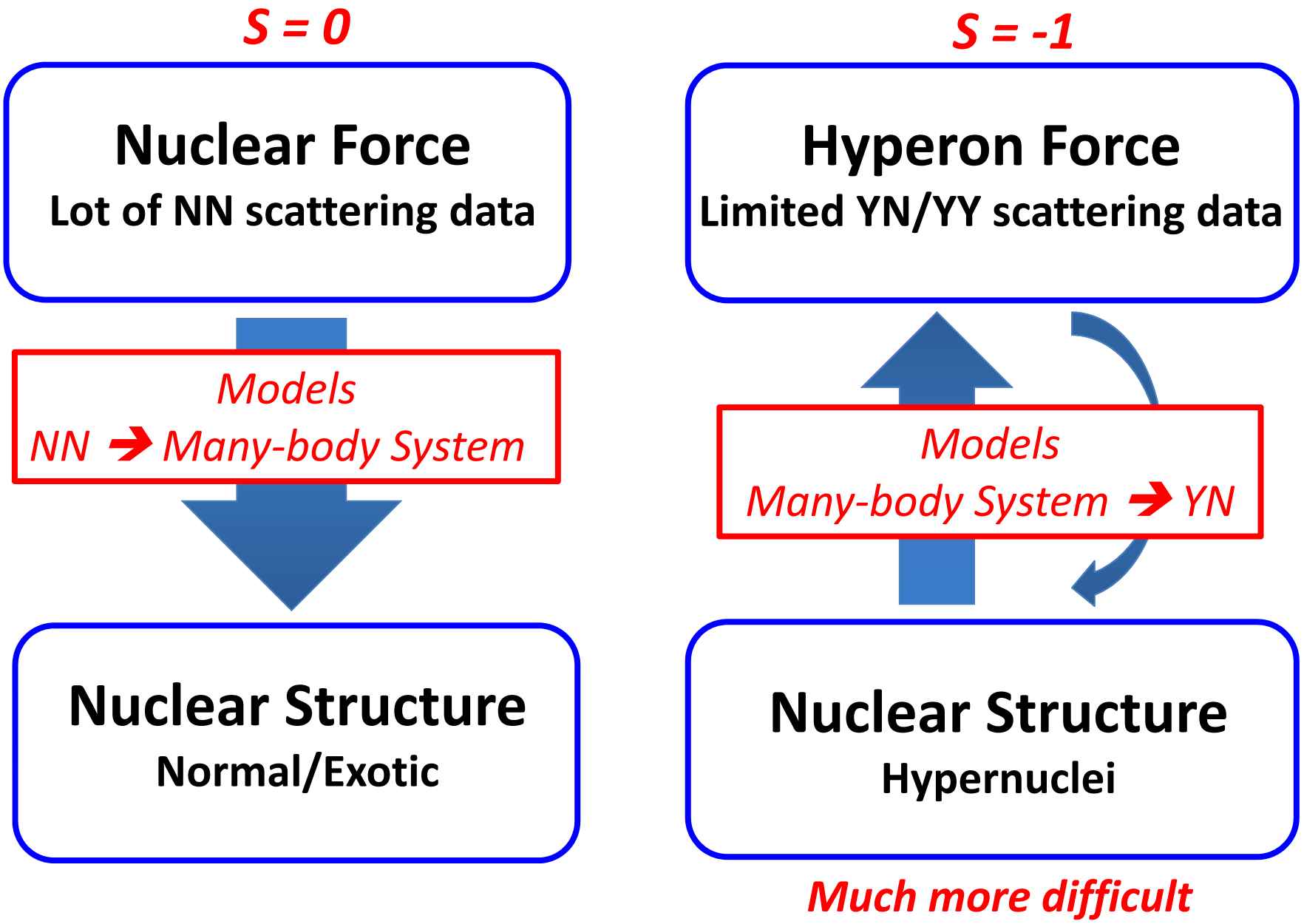
Astronomical Scale -

Neutron Stars -



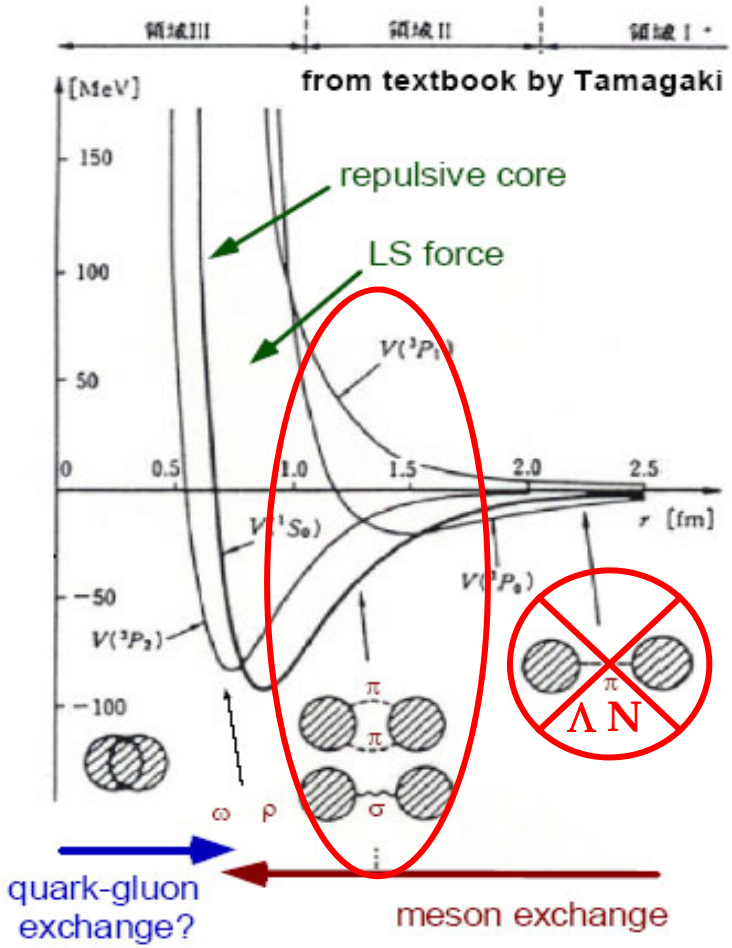
- **Hypernuclei: Study YN and YY interactions**
- **A gateway to B-B interactions beyond the strangeness**

Baryonic Interactions



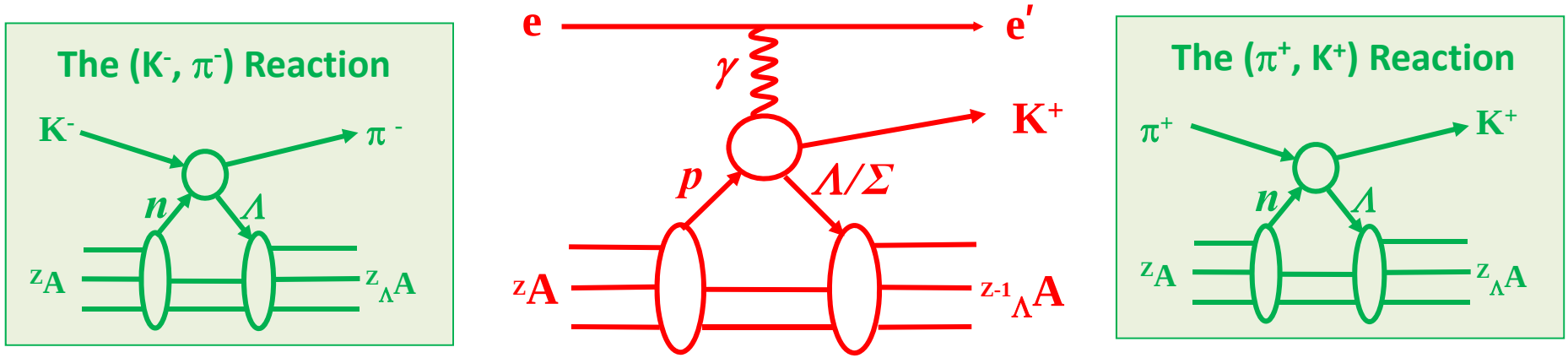
Λ Hypernuclei

- **Novel features of Λ-hypernuclei**
  - *Short range interactions*
    - *$\Lambda\Sigma$ coupling, ΛNN 3-B forces*
  - *Change of core structures*
  - *Drip line limit*
- **No Pauli blocking to Λ**
  - *Probe the nuclear interior*
  - *Baryonic property change or single particle nature of Λ in heavy baryonic system*



Electroproduction of Hypernuclei

The (e, e'K$^+$) Reaction



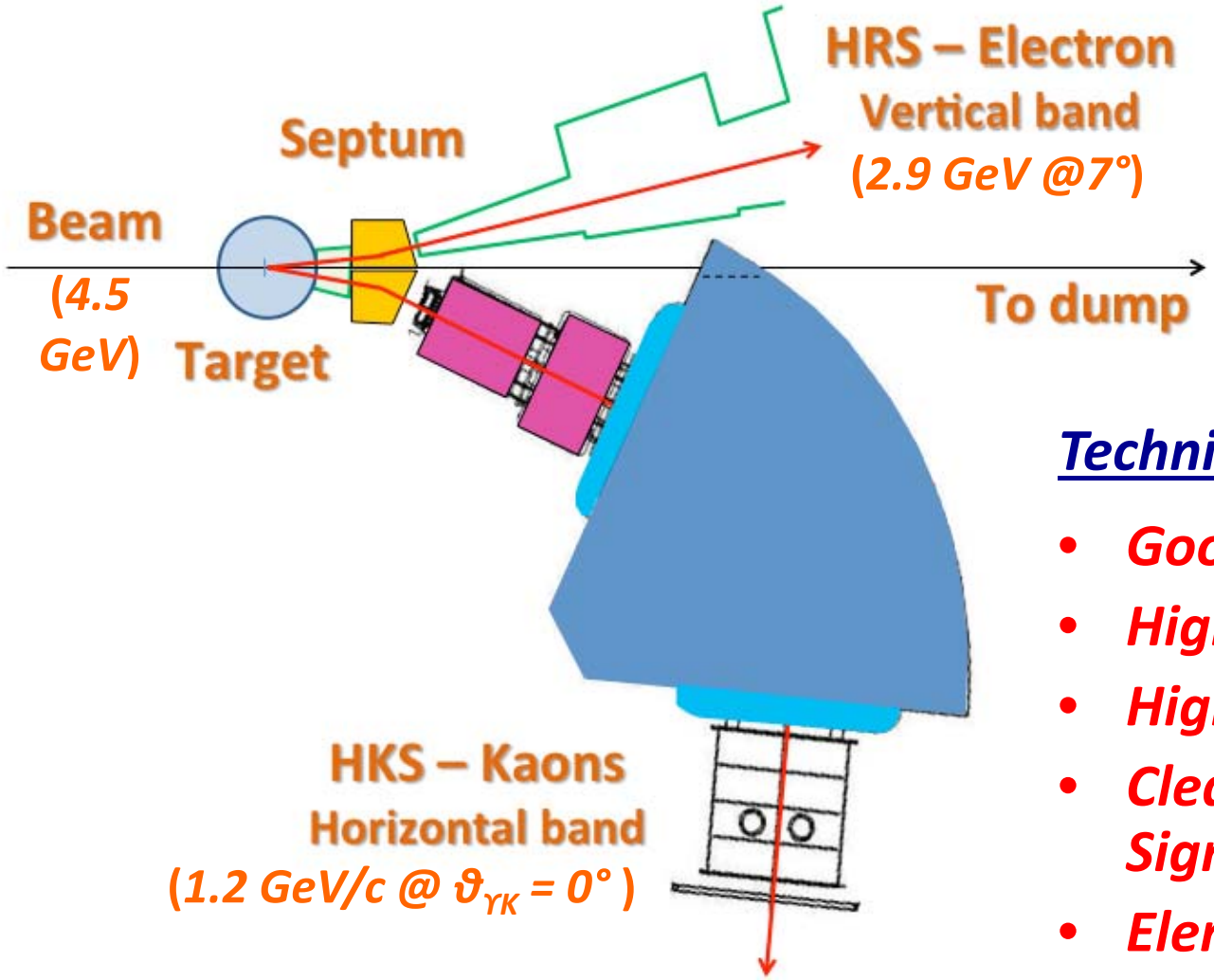
- ***High momentum transfer (~300 MeV/c)***
- ***Deeply bound, highest spin, both unnatural and natural parity states***
- ***Neutron rich hypernuclei and high iso-spin states***
- ***Capable for high precision that is important for hypernuclear spectroscopy***
- ***Small production cross section but compensated by high beam intensity***

Hypernuclear study with the (e,e'K+) reaction at JLab

- ***Well established and proven successful in the previous 4- and 6-GeV periods.***
- ***Experiments studied spectroscopy of $^{7}_{\Lambda}$He, $^{9}_{\Lambda}$Li, $^{10}_{\Lambda}$Be, $^{12}_{\Lambda}$B, $^{28}_{\Lambda}$Al, and $^{52}_{\Lambda}$V, with good resolution (~600 keV FWHM) and precision on B_{Λ}.***
- ***Achievements and status on the remaining analyses were reviewed by Prof. S. Nakamura.***

Technical Consideration of Future Program

Experimental Design

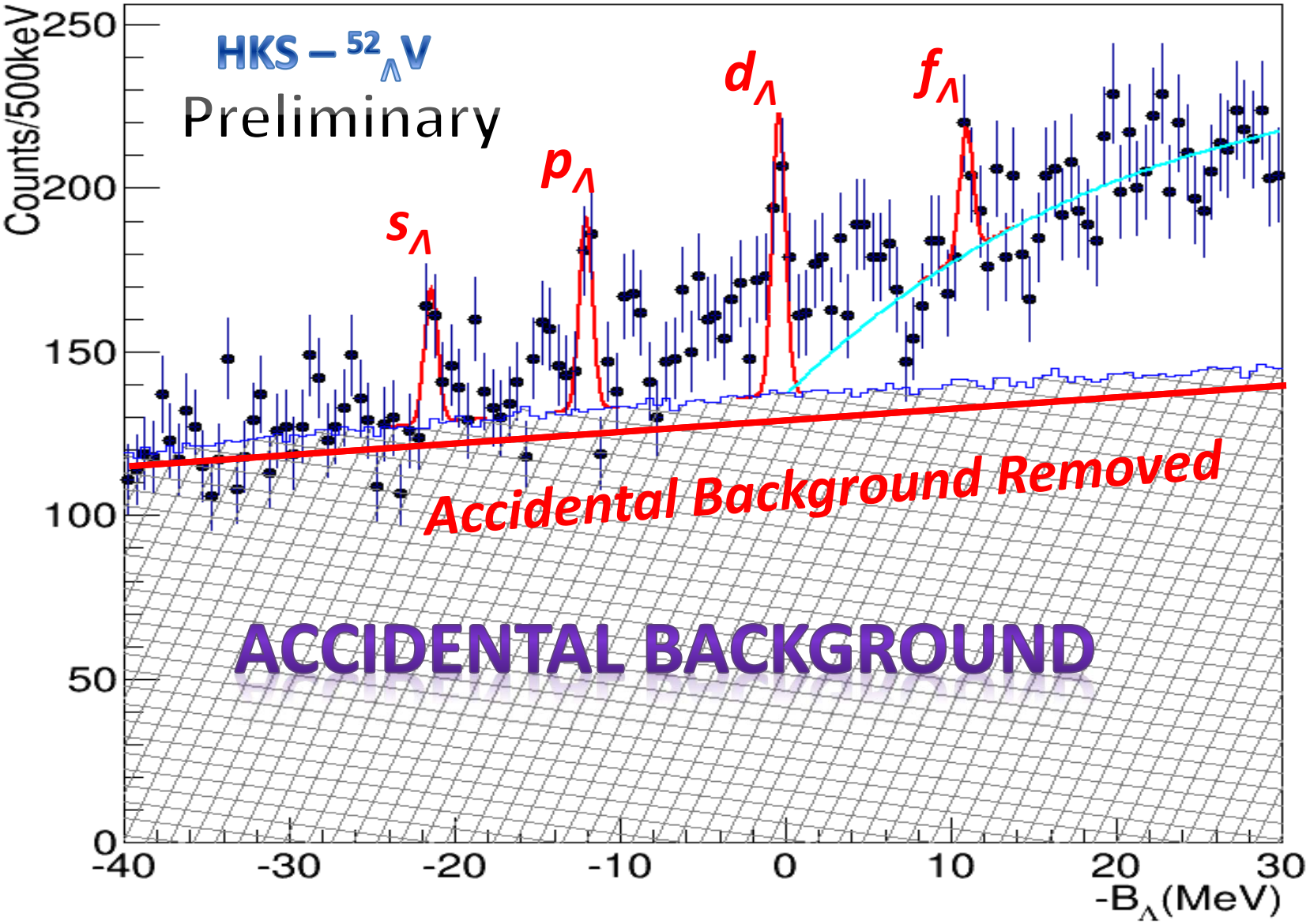


Hall A

Technical Features

- *Good resolution*
- *High yield*
- *High precision on B_Λ*
- *Clean spectra with good Signal/Background ratio*
- *Elementary to heavy system*

Key Improvement for Future Program



Physics Consideration of Future Program

Current Proposal to the JLab PAC43 (2015)

YN Interactions

Charge Symmetry Breaking

Hyperon Puzzle (Neutron Star)

Part I

Light Hypernuclei

- *$^{4}_{\Lambda}$H spectroscopy (1^{+})*
- *P(e,e'K^{+})Λ (small $\vartheta_{\gamma K}$)*
- ~~*Exotic system (Ann)*~~
- *Lightest Hypernucleus $^{3}_{\Lambda}$H*

Part II

Mid-Heavy Hypernuclei

- *Iso-spin dependence with med-heavy hypernuclei ($^{40}_{\Lambda}$K and $^{48}_{\Lambda}$K)*
- *Heaviest possible system – $^{208}_{\Lambda}$Tl (3B force)*

Total required beam time at minimum: ~1250 hours (quite long)

Status of Current Proposal
(PAC43, 2015)

- *PAC recommended to separate the current proposal with two parts in to three experiments and made review accordingly.*
- *Experiment to measure spectroscopy of $^{40}_{\Lambda}K$ and $^{48}_{\Lambda}K$ is then conditionally approved. Condition: Resubmit a proposal that focuses on $^{40}_{\Lambda}K$ and $^{48}_{\Lambda}K$ for iso-spin dependence.*
- *Few-body part of experiment was deferred. Need to be convinced for physics impact with the achievable precision.*
- *Heavy hypernuclei part was deferred. Need to be convinced on what heavy hypernuclei are the best for both experimental and theoretical achievement.*

For Future Experiments at JLab

- *Suggestions, advices, and theoretical input are more than welcome.*

For Electro-production Experiments

- *Need to work with MAMI together to achieve the best from each facility.*
- *Decay pion spectroscopy will be further evaluated and considered (regardless at MAMI or JLab). The yield rate needs to be dramatically increased, not relying on increase of beam time.*

Summary

- *JLab hypernuclear physics program with electro-production has its uniqueness in the global Strange Nuclear Physics research.*
- *Remaining results from previous periods need to be published soon.*
- *It needs to continue in the 12 GeV period. A lot of homework still needs to be done to solidly establish the new program that best utilizes the uniqueness offered by the electro-production.*

Welcome to U.S. for HYP2018

Thomas Jefferson National Accelerator Facility (JLab), Newport News, Virginia