

Determining the Unknown An Interaction by Investigating the Ann Resonance

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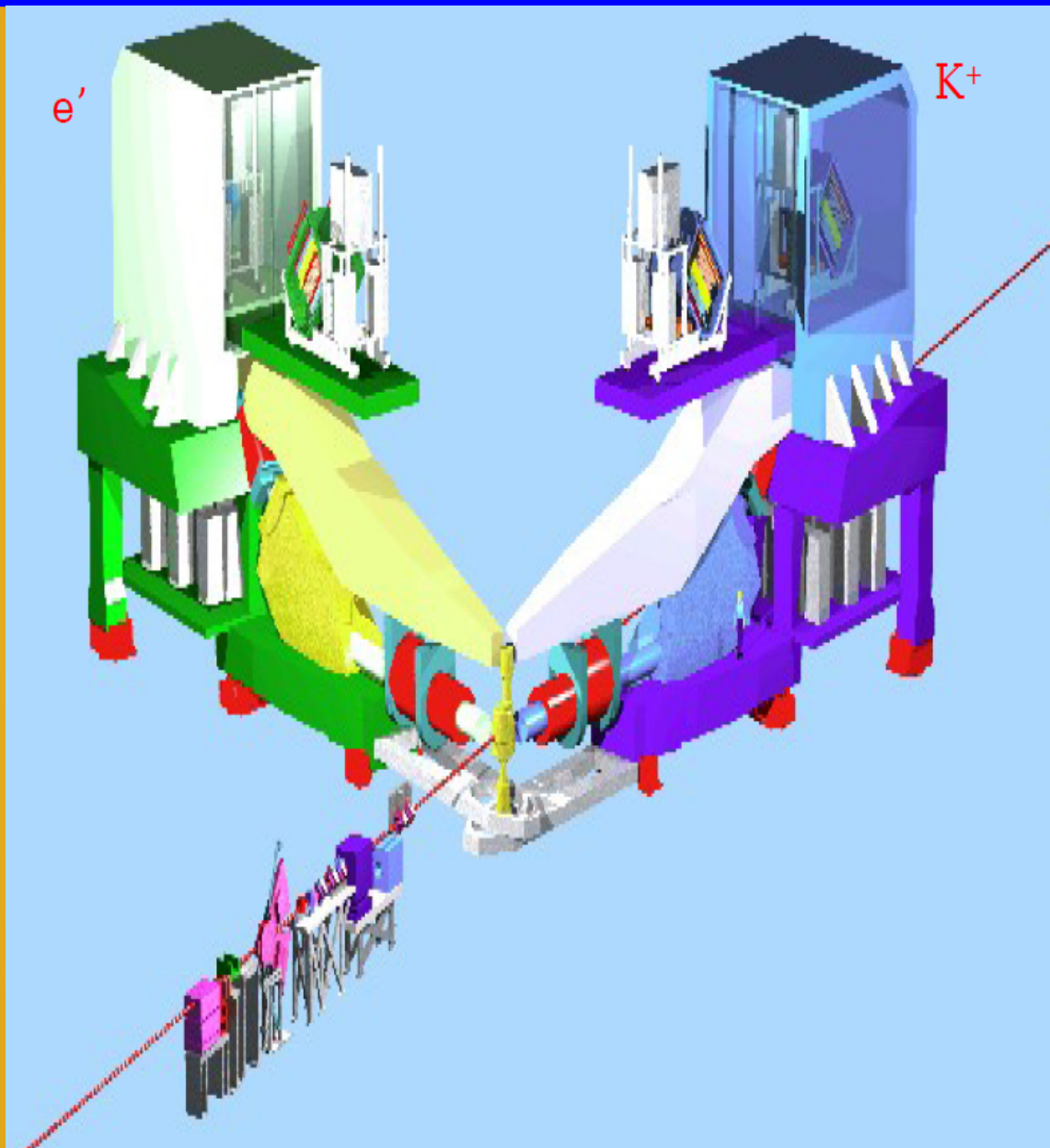
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Introduction

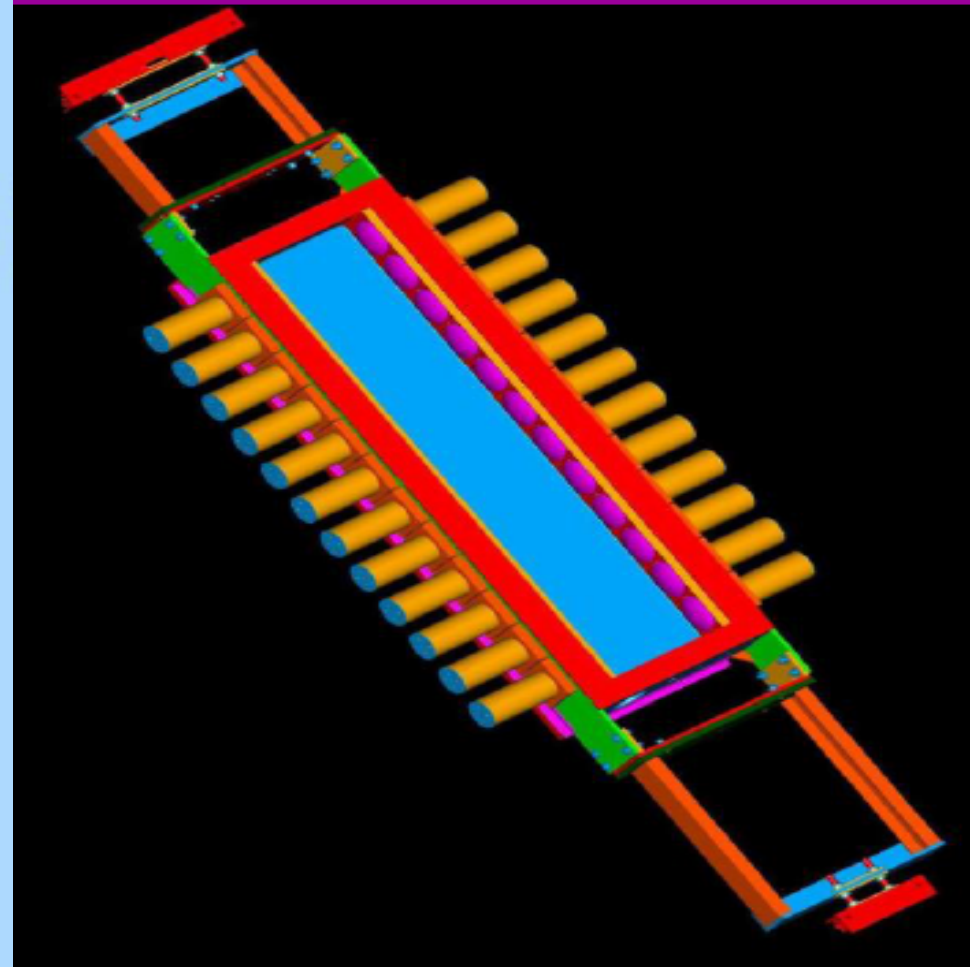
- The goal is to understand baryonic interaction with all flavors.
- Plenty of scattering data for the **NN** interaction but for **YN** and **YY** interaction the data is limited or none existing data.
- A recent precision experimental result shows that charge symmetry breaking (CSB) is much more significant in **Λ -N** interaction. Thus determining the unknown **Λ -n** interaction is critically important to understand the CSB.
- The way to investigate the **Λ nn** resonance with sufficient precision is to use the electro production of **K^+** from an existing tritium target with a high precision beam at Jlab.

Hall A Experimental Setup for E12-17-003



K^+ identification required

Time of flight



Aerogel Detector

Kinematics Configuration

Electron beam energy (2 pass, 2.0 GeV per pass)/Current	4.3 GeV/22 μ A
e' HRS central momentum (acceptance)	(2.02 & 2.18) GeV/c ($\pm 4.5\%$)
e' HRS central angle (acceptance)	12.5° (6 msr)
K ⁺ HRS central momentum (acceptance)	1.8 GeV / c ($\pm 4.5\%$)
K ⁺ HRS central angle (acceptance)	12.75° (6 msr)

B-B Interaction Model

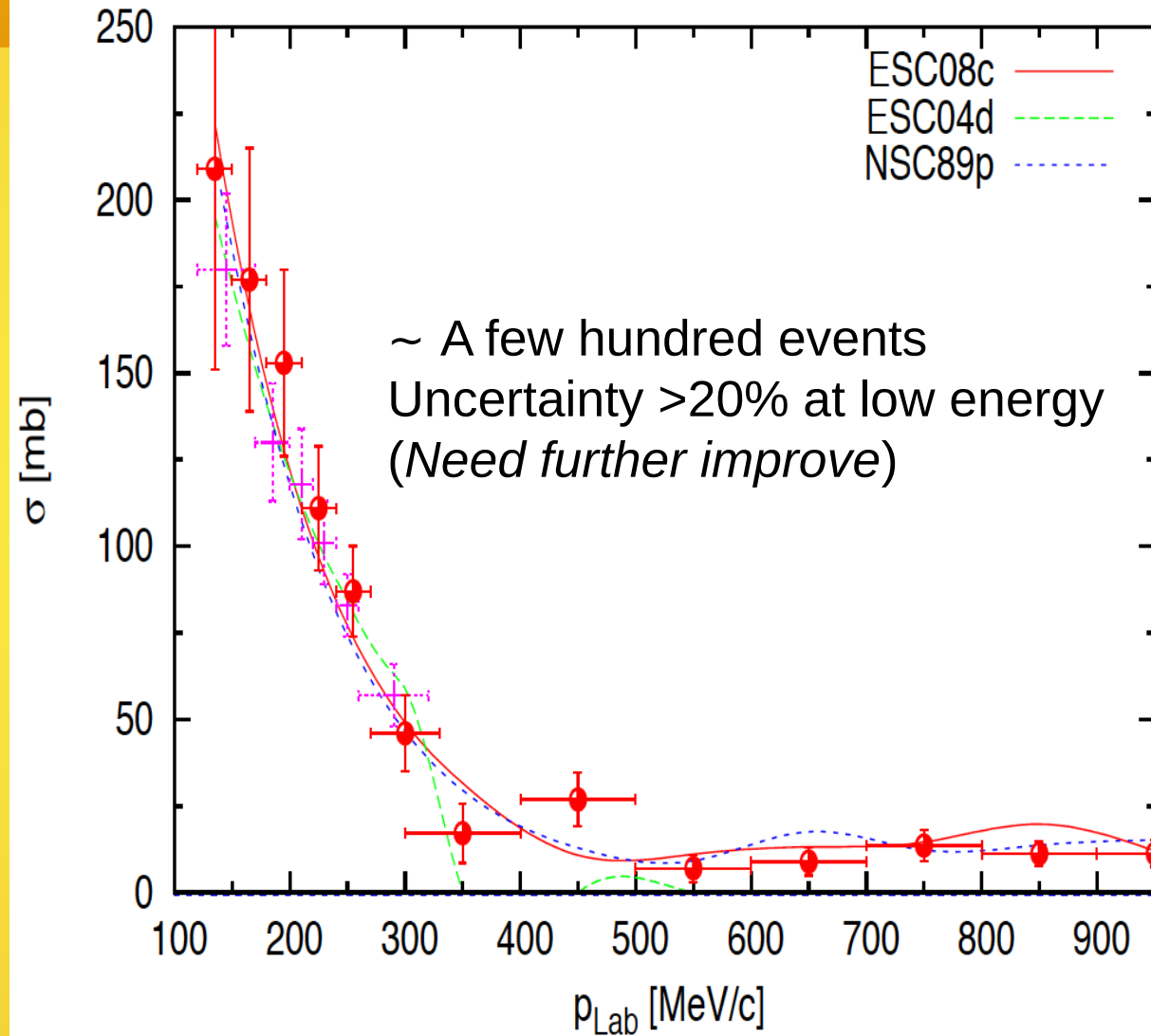
N-N Scattering

> 4000 events

*This made NN
interaction much better
understood*

Λ -n scattering non
existing data

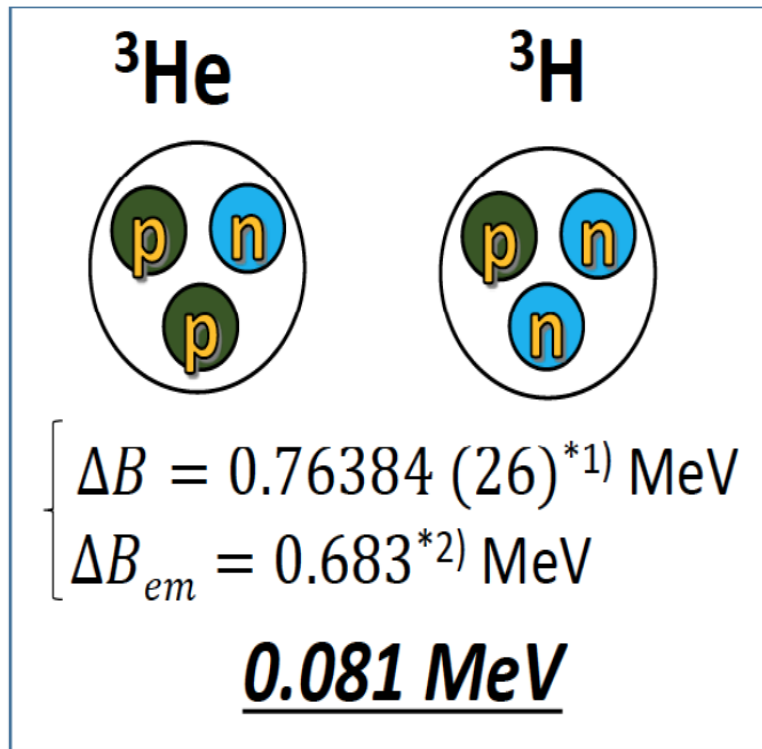
Λ -p Scattering



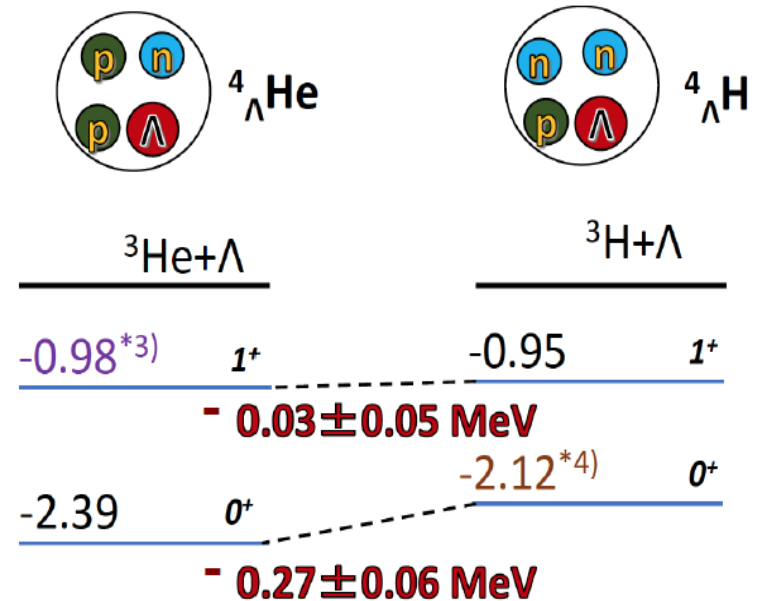
- Λ -n interaction is treated to have the same properties as Λ -p interaction

Charge Symmetry Breaking

N-N Interaction



Λ -N Interaction



*3) T.O. Yamamoto *et al.*, Phys. Rev. Lett. **115**, 222501 (2015).

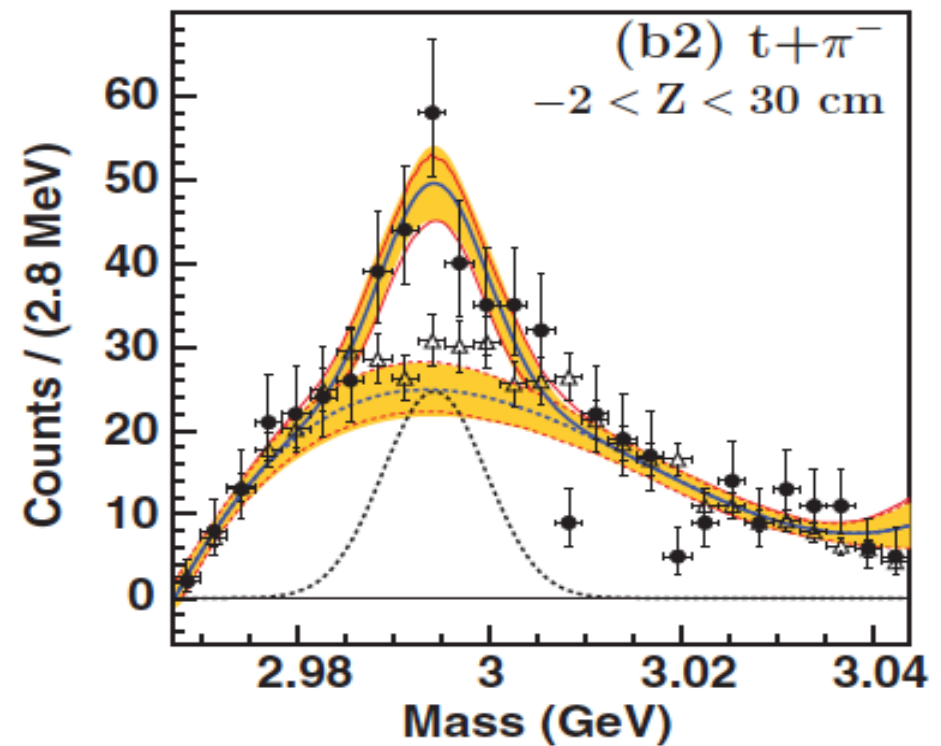
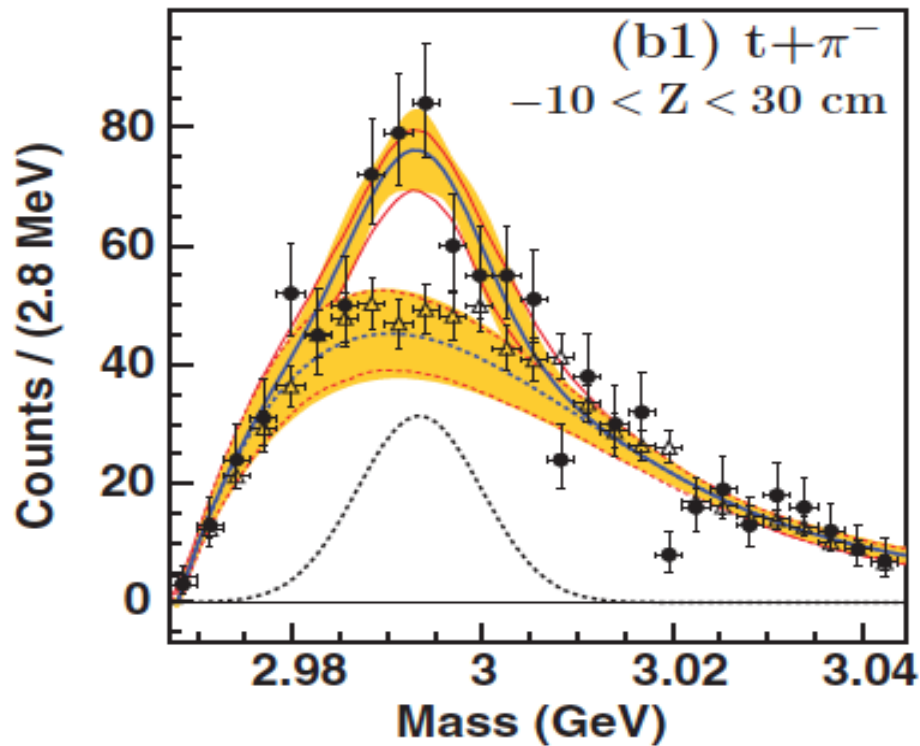
*4) A. Esser *et al.*, Phys. Rev. Lett. **114** 232501 (2015).

$\Lambda N \leftrightarrow \Sigma N$ coupling

- Experimental data on Λn interaction may shed light on the origin of CSB.

Approach to Access An Interaction

${}^6\text{Li}$ (2A GeV) on ${}^{12}\text{C}$ target and study the invariant mass of final state particles

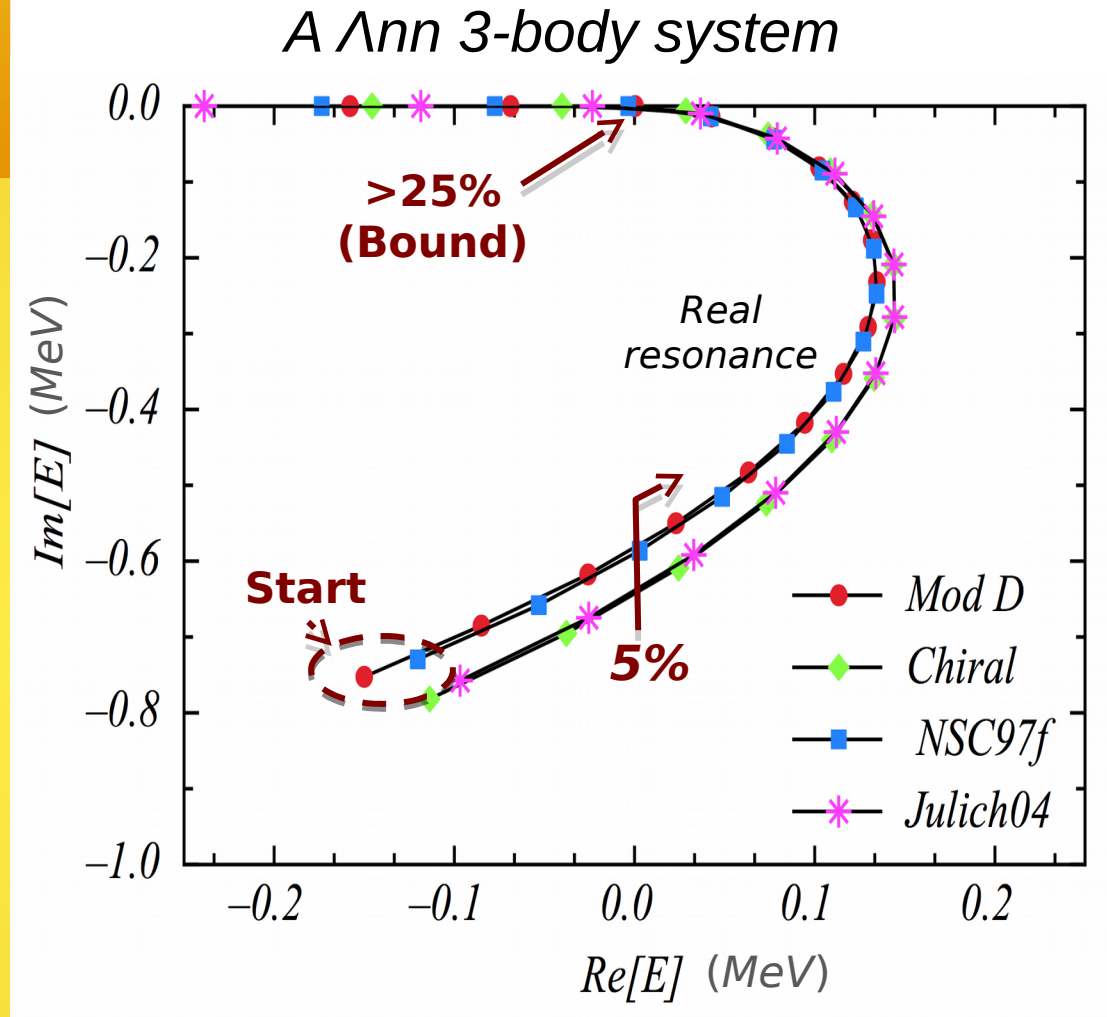


C. Rappold et al., *Phys. Rev. C* **88**, 041001(R) (2013)

- It was claimed to a bound state.
- All the theoretical analyses applying the current **YN** interaction models ruled it out.
- Question: Can it be a physical resonance and does it provide the information about Λ_n interaction?

Model Describing the Λnn Resonance

- Four different baryonic potential models were used to fit for the effective range parameters of the nn and Λp interactions from the existing scattering data.
- They solve the Λnn Faddeev equations into second complex energy (E) plane in the search of resonance.
- Continuously scaling up the Λn strength by 2.5 % in each step to obtain the eigenvalue spectrum.

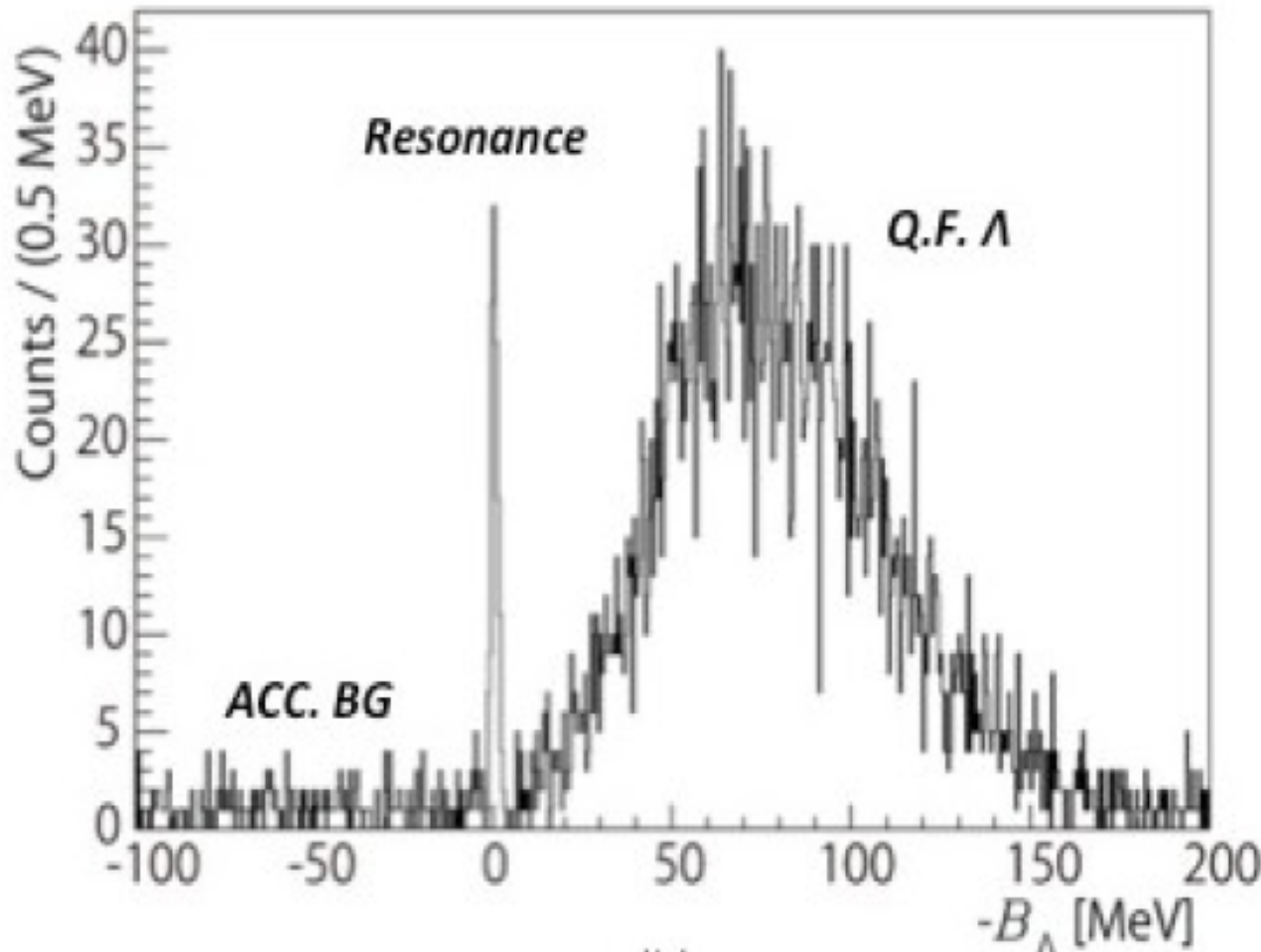


Iraj R. Afnan and Benjamin F. Gibson,
Phys. Rev. C 92, 054608(2015)

The Observed Λnn system is likely to be a pure $T = 1$, 3 body resonance.

Expected Result From Simulation

At the level of ~ 120 counts

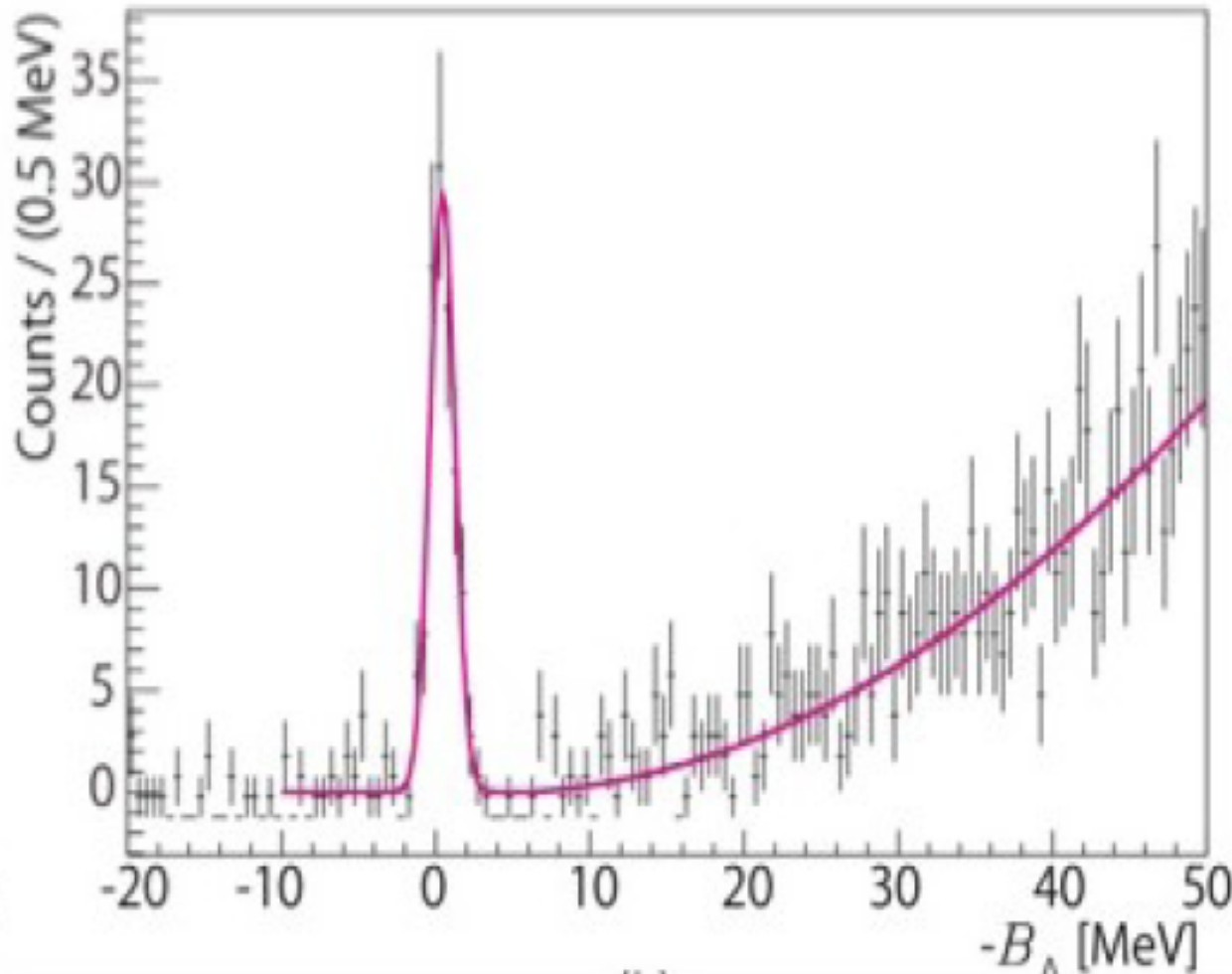


Assumptions: Gaussian peak @ $B_\Lambda = 0.5$ MeV, $\Gamma = 0.5$ MeV, energy resolution 2 MeV FWHM

- The experiment is approved for 10 PAC days.
- For 120 counts, a solid determination on B_Λ and Γ can be achieved with reasonable uncertainty.

Statistical Uncertainties

At the level of ~ 120 counts



Uncertainty	δB_Λ	$\delta \Gamma$
120 counts	± 0.09 MeV	± 0.07 MeV

Summary

- $\Lambda n n$ resonance is the unique way to understand the unknown Λn interaction.
- The Jlab experiment **E12-17-003** will investigate the Λn interaction for the first time.
- The experiment is scheduled for December 2018.

Thank you