

# Physics Opportunities with Secondary $K^0_L$ beam with GlueX Setup at Jlab



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*GlueX Collaboration Meeting, Newport News, May 13, 2015*

## A Letter of Intent to Jefferson Lab PAC-43.

### Physics Opportunities with Secondary $K_L^0$ beam at JLab.

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(Dated: May 11, 2015)

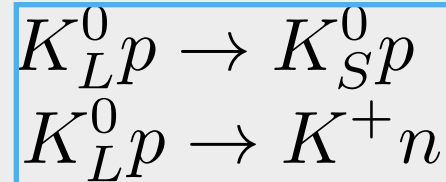


# Outline

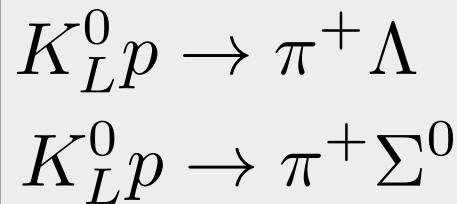
- Introduction
- Reactions with  $K_L^0$  beam on proton target
- Experimental Arrangement
- $K_L^0$  Beam at GlueX
- Excited  $S=-2$  and  $S=-3$  states
- Expected rates
- Summary

# List (not full) of reactions with $K^0_L$ beam

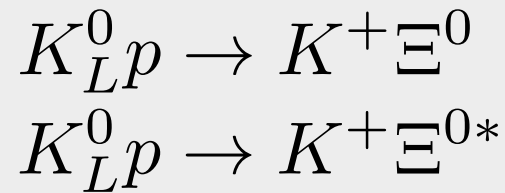
## Elastic and charge-exchange



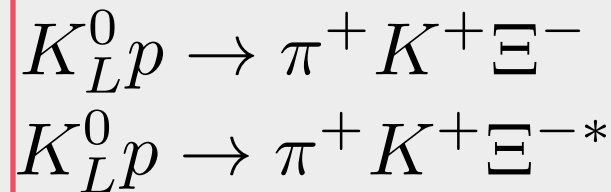
## Two-body with $S=-1$



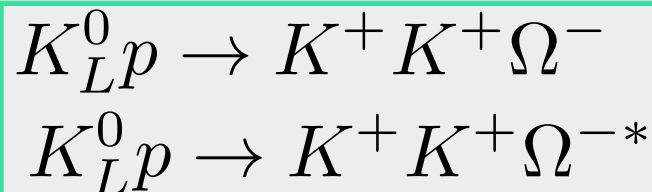
## Two-body with $S=-2$



## Three-body with $S=-2$



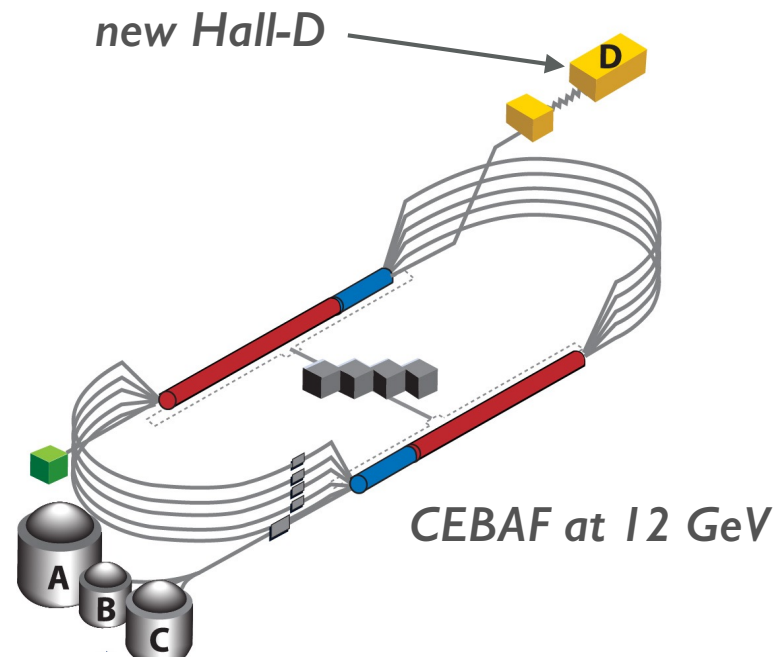
## Three-body with $S=-3$



# Thomas Jefferson National Accelerator Facility

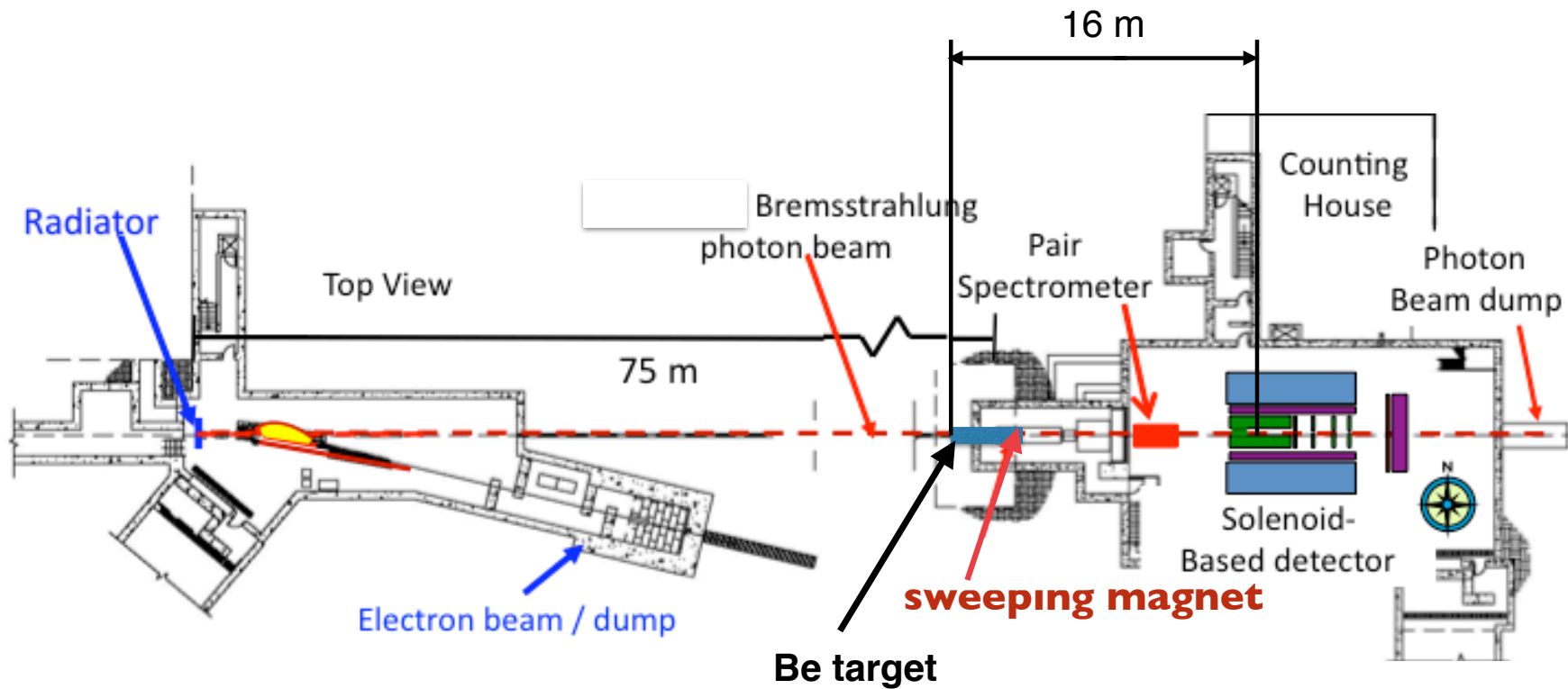


Aerial View





# GlueX Beamline for $K_L^0$



## Main components:

- Photon Radiator
- Be target
- Lead absorber
- Sweeping Magnet
- Pair spectrometer

# $K_L^0$ beam

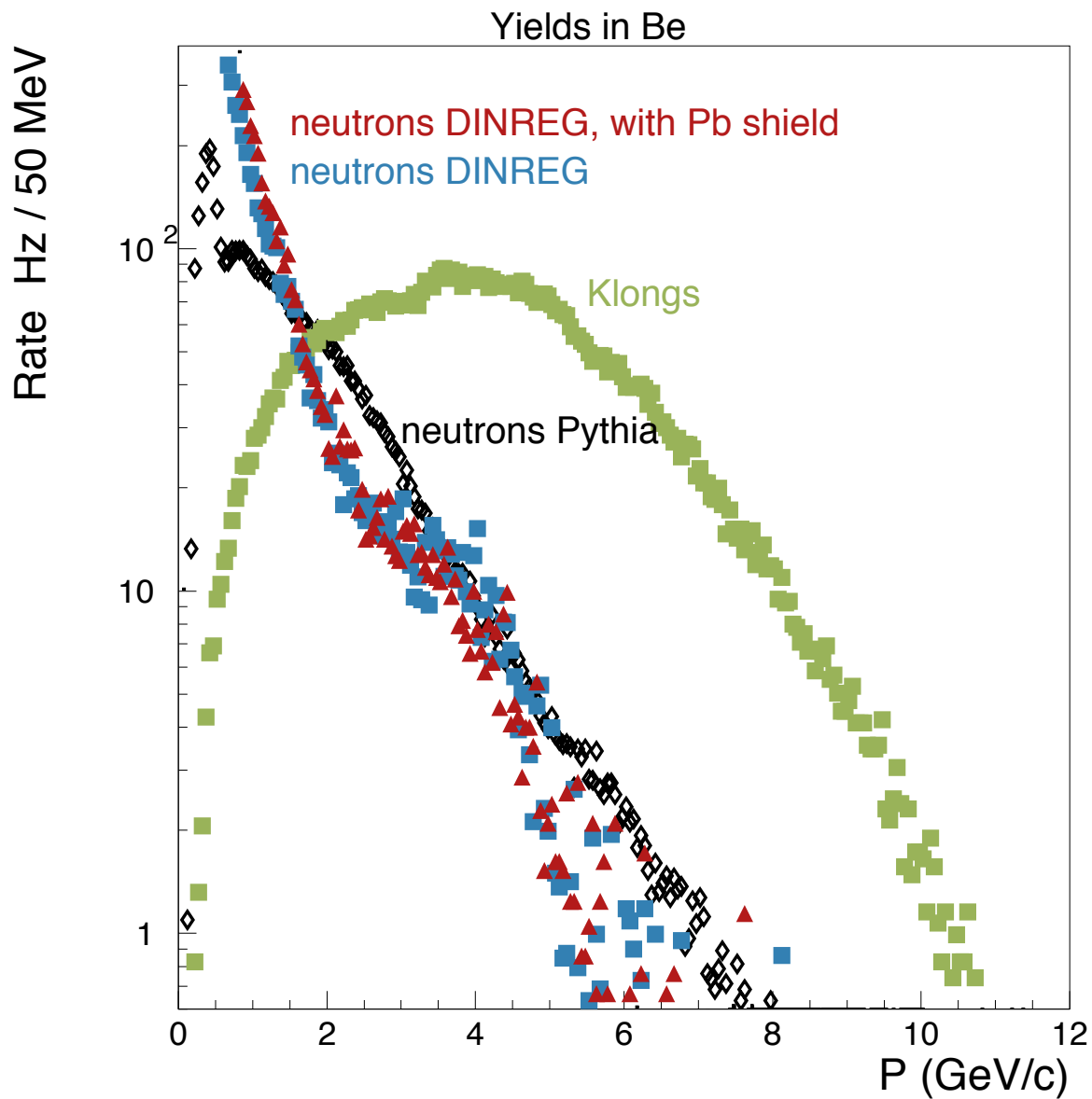
- An electron beam with energy  $E_e = 12$  GeV and current  $I_e = 5\mu A$
- A thickness of radiator 5 % radiation length (10 %).
- Primary Be target with  $R = 2$  cm,  $L = 40$  cm (60 cm).
- $LH_2$  target with  $R = 2$  cm,  $L = 30$  cm ( $R = 3$  cm).
- Distance between Be and  $LH_2$  targets 16 m.
- Flux of  $K_L^0$  mesons  $\approx 2000 K_L^0/sec$  ( $\approx 1.2 \times 10^4 K_L^0/sec$ ).

# $K^0_L$ beam

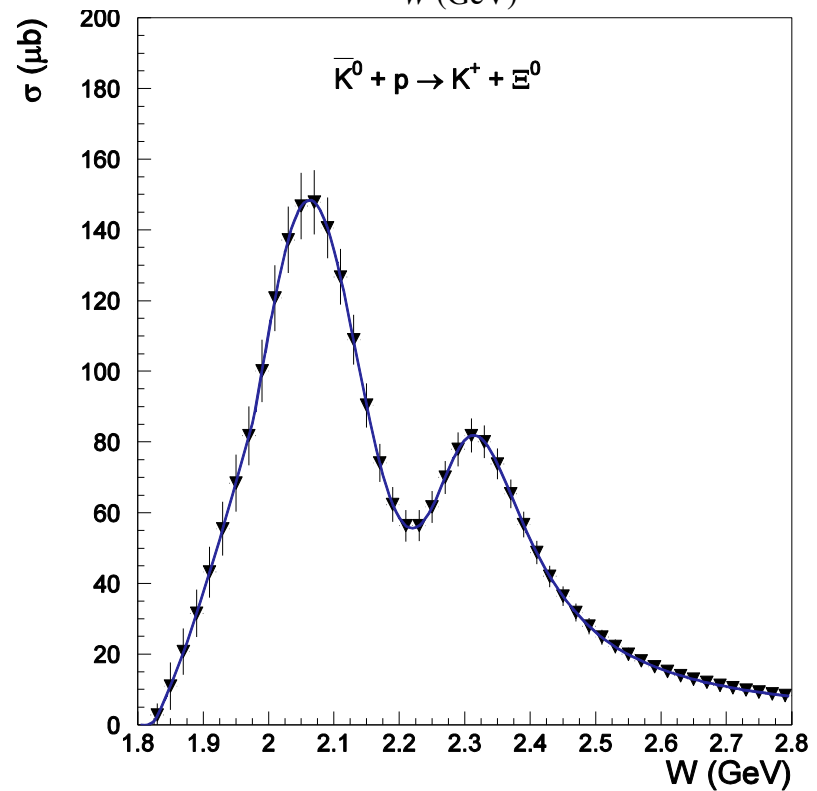
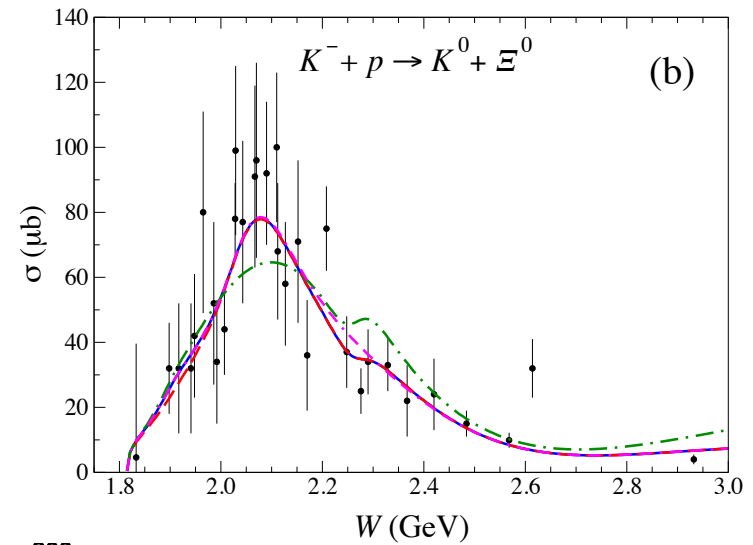
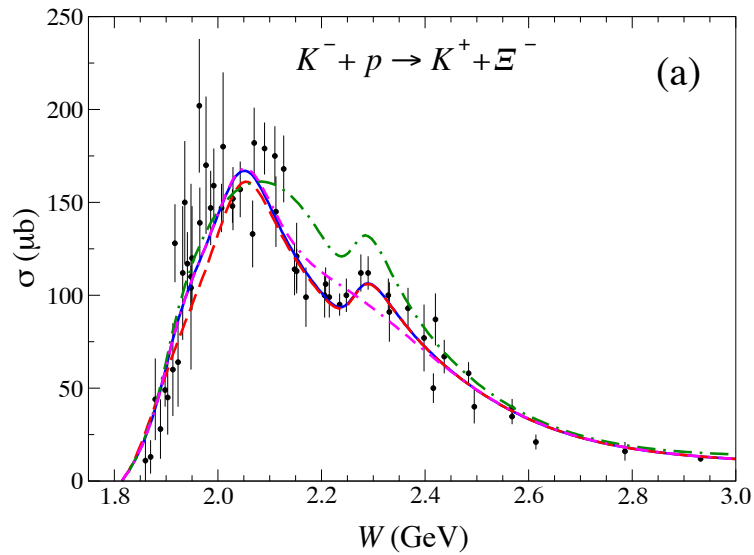
- Electron beam with  $I_e = 5\mu A$
  - Delivered with 40ns bunch spacing avoids overlap in a range of momenta  $P > 0.35 \text{ GeV}/c$
  - Momentum measured with TOF  $\Delta p/p \sim 0.5\%$
  - $K^0_L$  flux measured with pair spectrometer
- Side remark: Physics case with polarized targets is under study*



# Rate of neutrons and $K^0_L$ on GlueX target



# World Data on $\Xi$



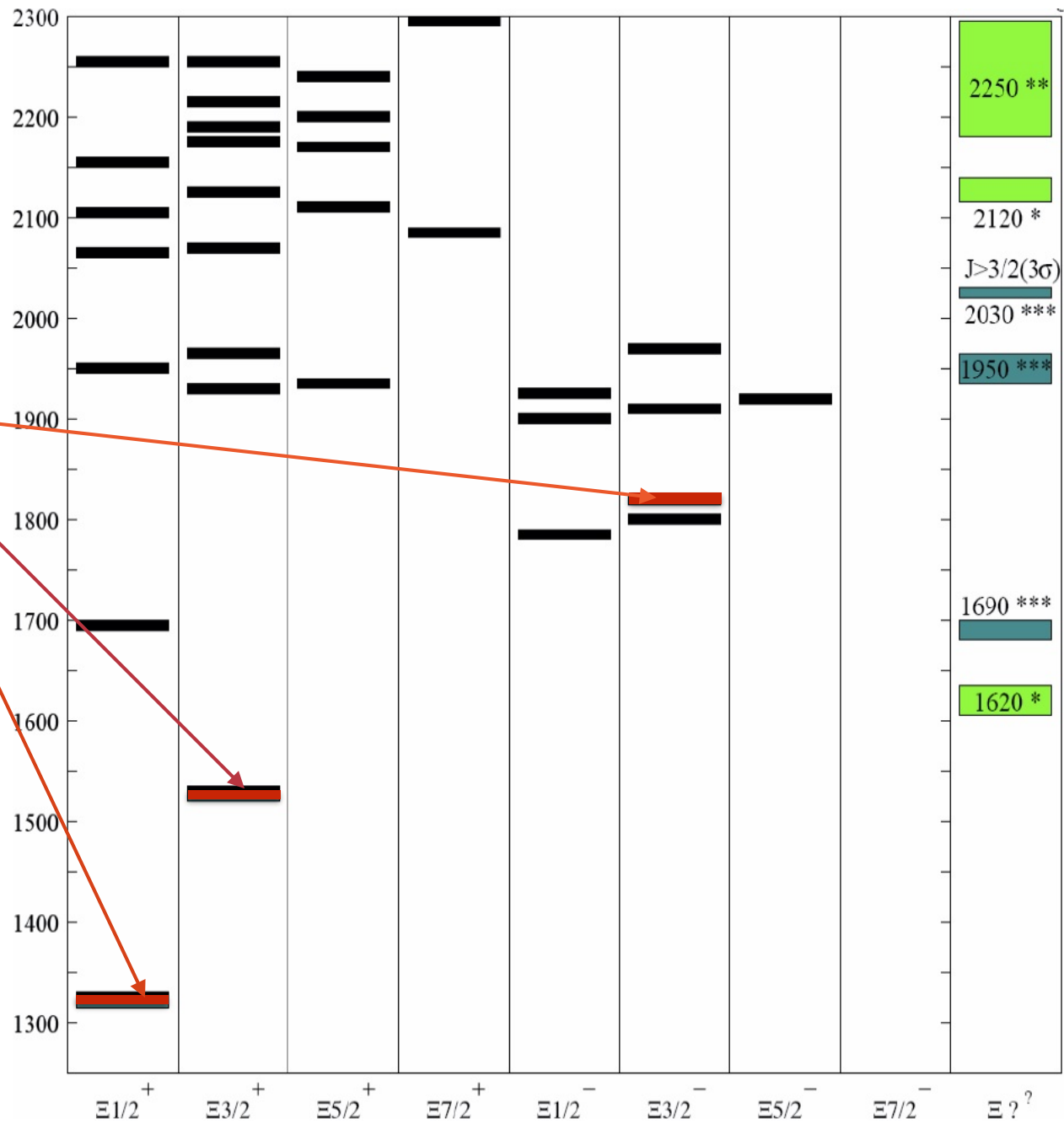
Simulated with GlueX  
 $10^4$   $K_L$ /sec, one day of running



Jackson, Oh, Haberzettl, Nakayama  
arXiv: 1503.00845

# Status of $[I]^*$

well known

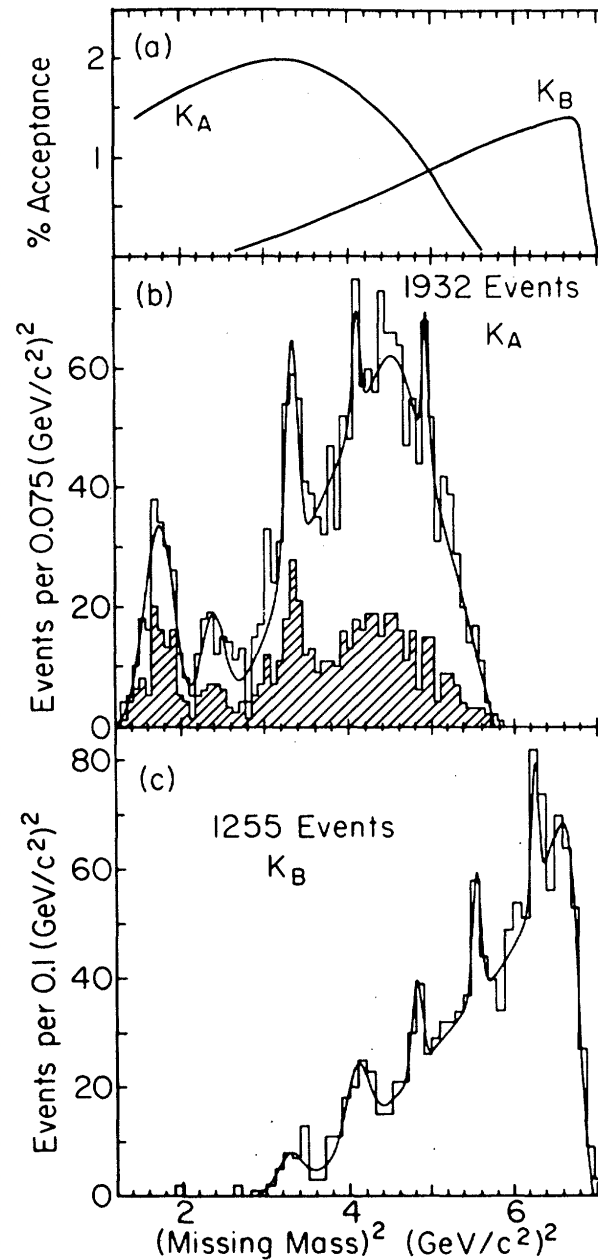




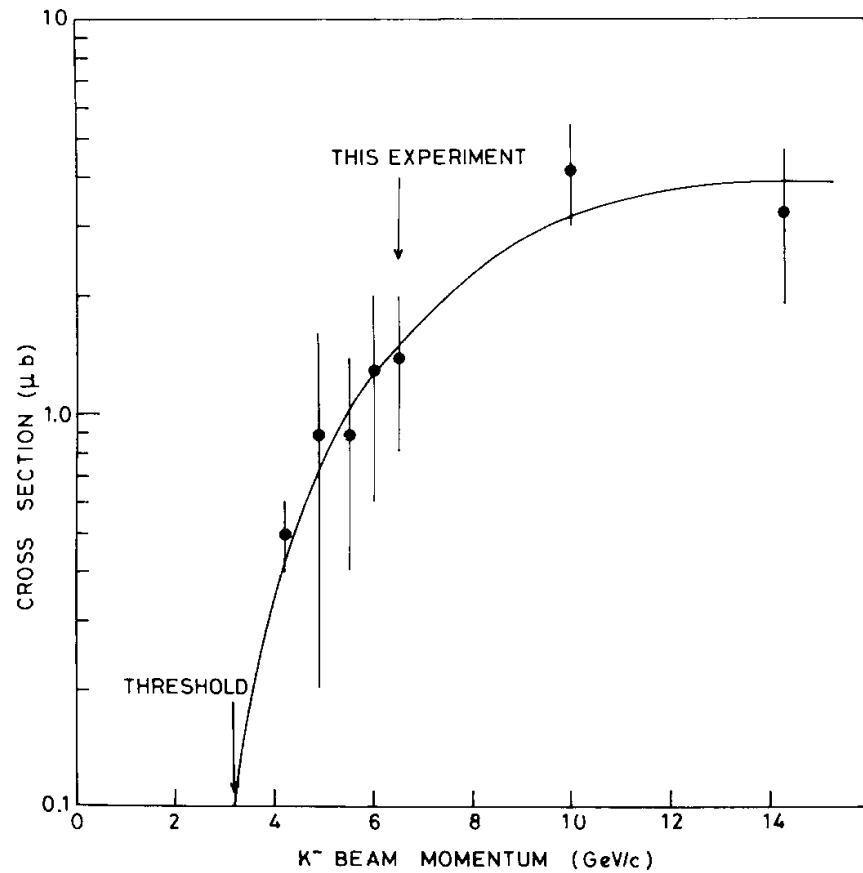
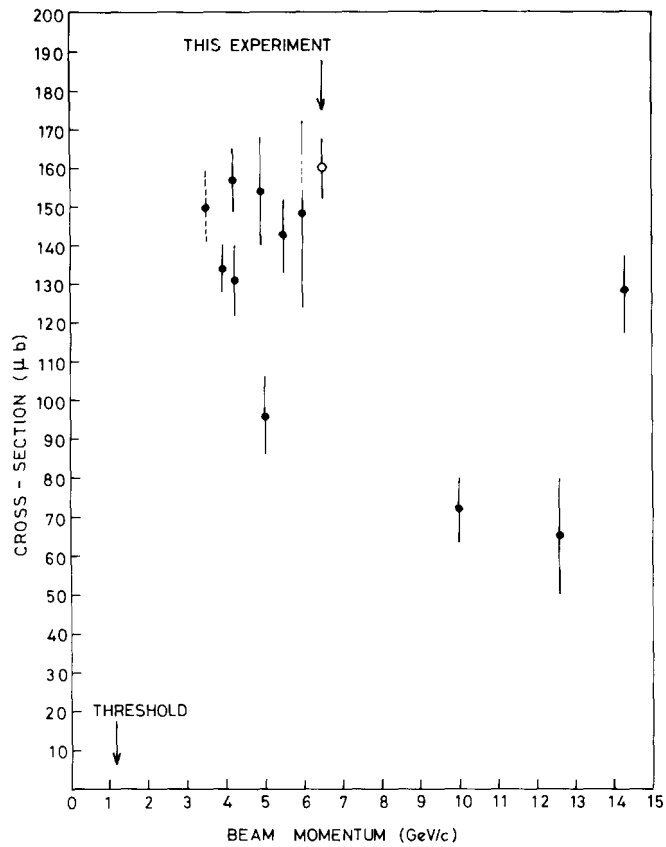
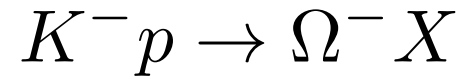
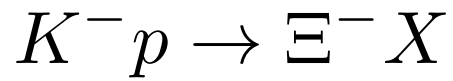
# Status of $[I]^*$

Very poorly  
measured at  
AGS (BNL)  
30 years ago

• C.M. Jenkins et al., Phys. Rev. Lett. 51, 951 (1983)

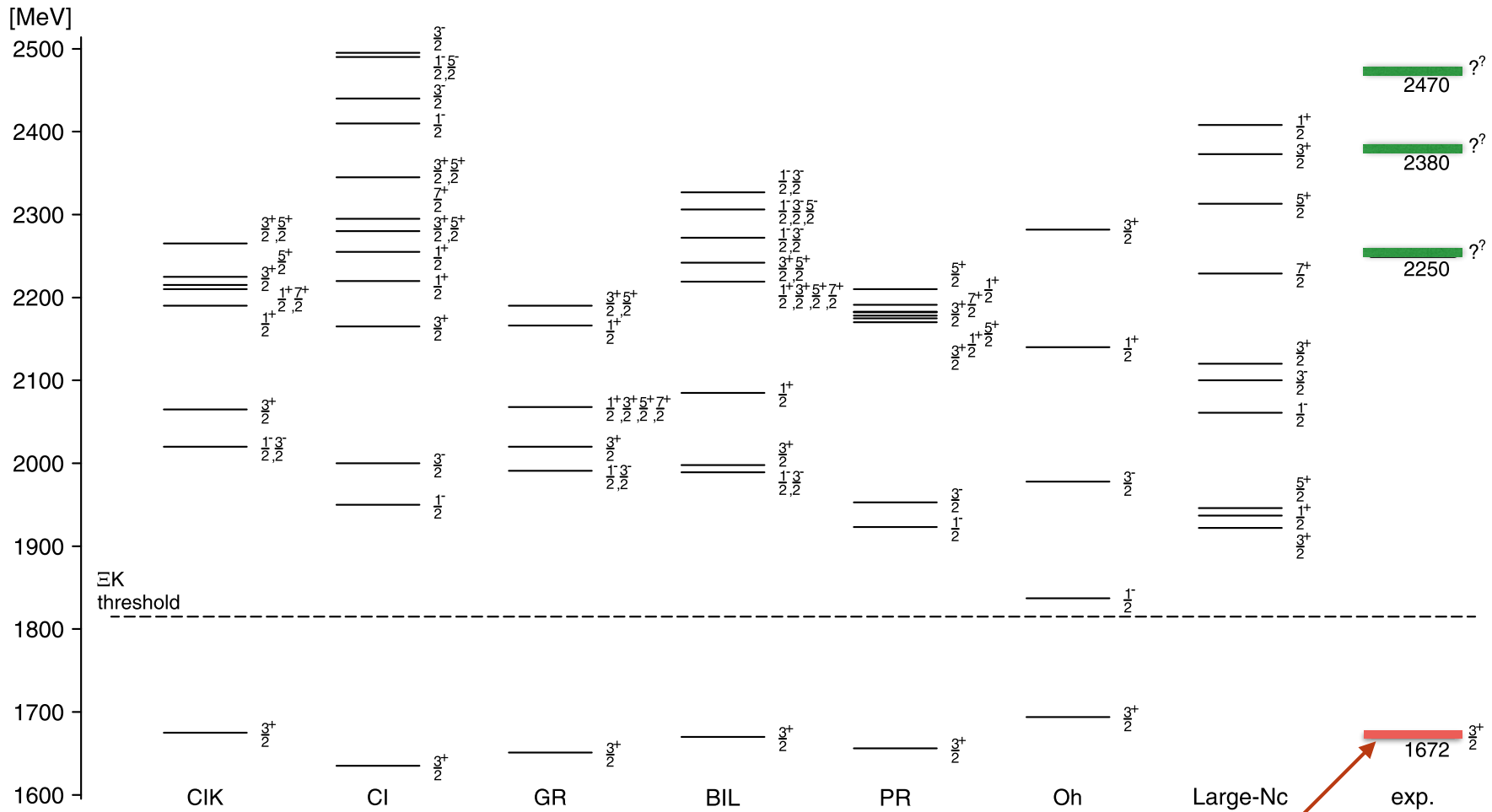


# Cross Sections



*J.K. Hassal et al., NPB 189 (1981)*

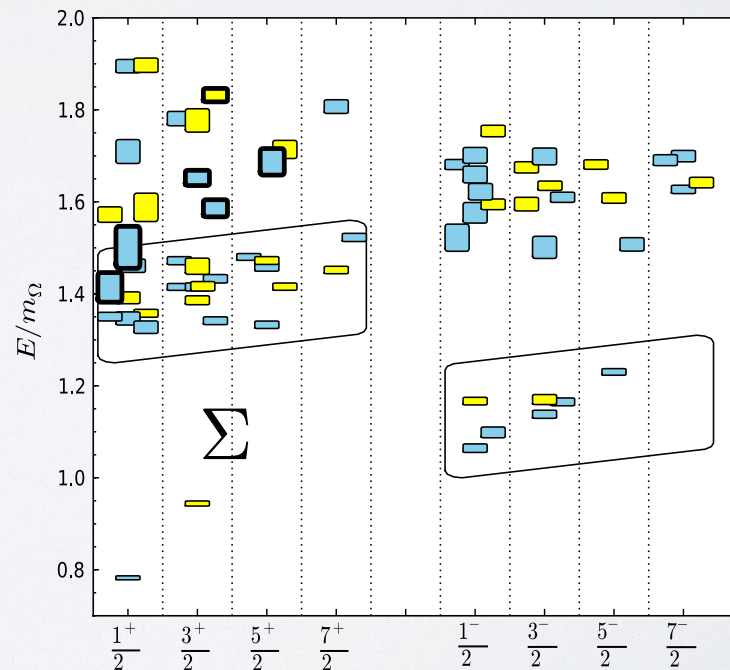
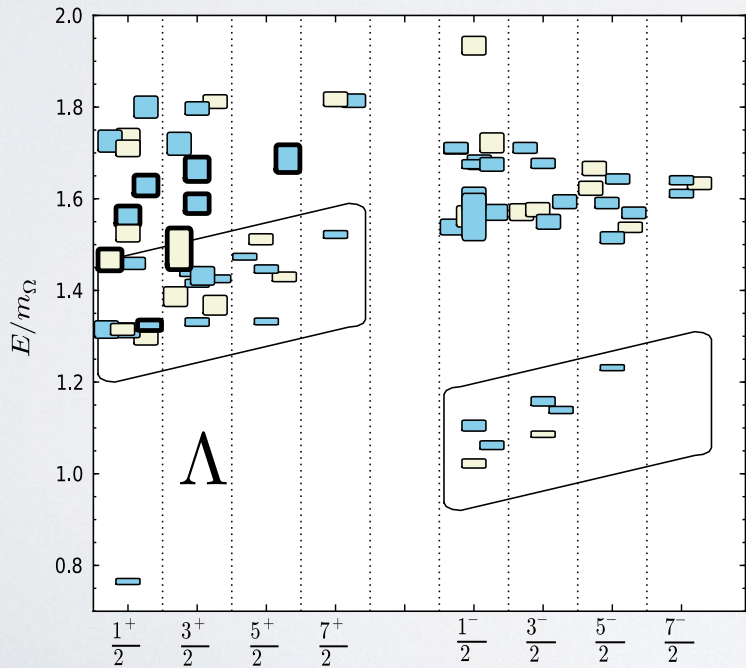
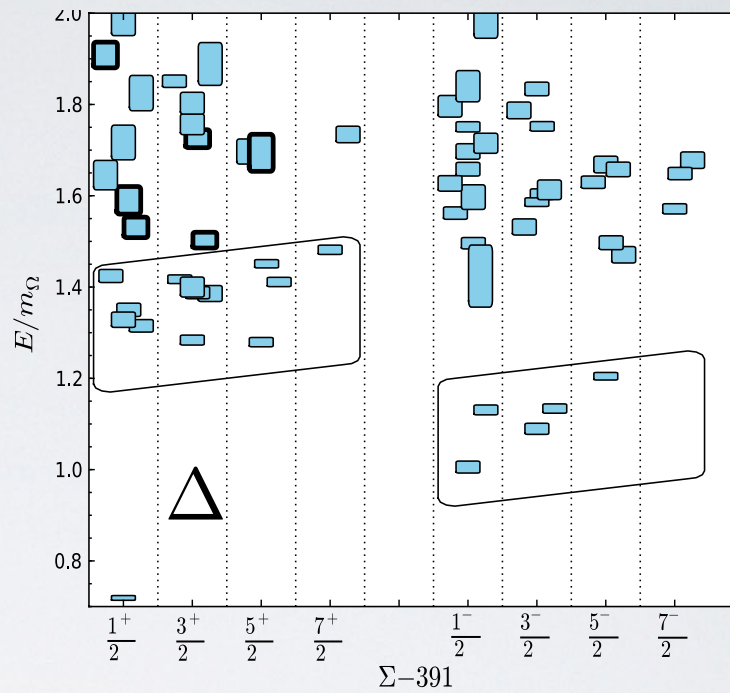
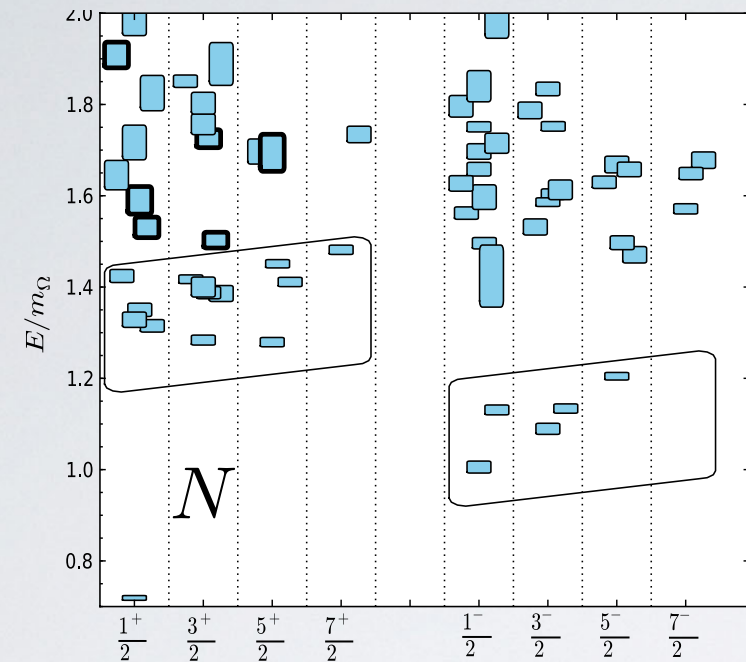
# Status of $\Omega^{-*}$



**only one well known state?**



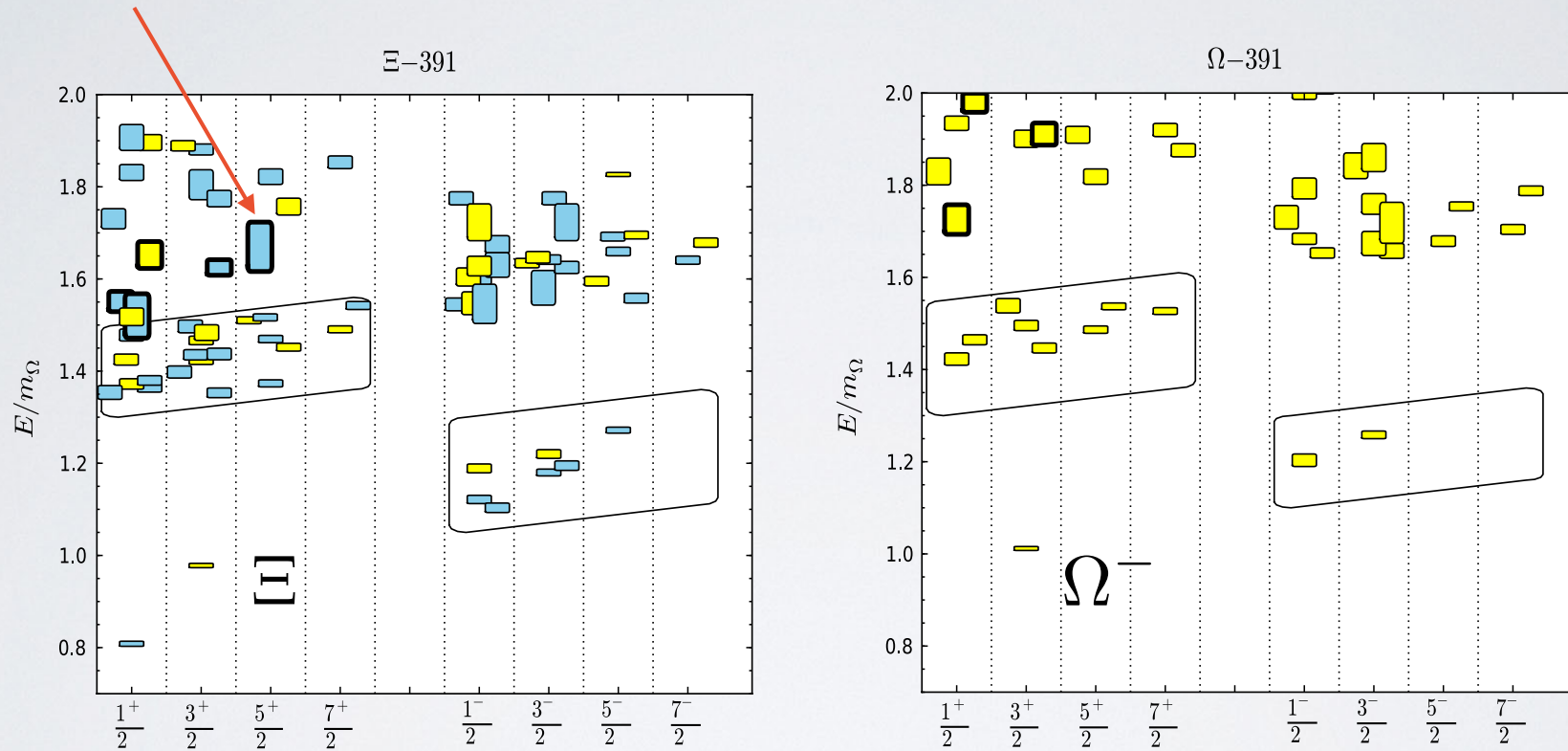
# Lattice QCD calculations



$\Sigma-391$

# Lattice QCD calculations

Thick borders: Hybrid states



Edwards, Mathur, Richards and Wallace  
Phys. Rev. D 87, 054506 (2013)

# Expected rates

<i>Production</i>	<i>J-PARC</i>	<i>Jlab</i>
<i>flux/s</i>	$3 \times 10^4 K^-$	$10^4 K_L^0$
$\Xi^*/month$	$3 \times 10^5$	$2 \times 10^5$
$\Omega^{-*}/month$	600	4000

# Summary

- KN scattering still remains very poorly studied
- lack of data on excited hyperon states requires significant experimental efforts to be completed
- Our preliminary study shows that  $10^4 K^0_L/s$  at Jlab is feasible with GlueX setup in Hall D
- Proposed setup will have highest intensity  $K^0_L$  beam ever used for hadron spectroscopy
- Data obtained at Jlab will be complementary to future data with charged kaons at J-PARC

# *Backup*



