

Physics Opportunities with a Secondary K^0_L Beam at



Moskov Amaryan



ODU Nuclear Physics Seminar, May 18, 2015

A Letter of Intent to Jefferson Lab PAC-43.

Physics Opportunities with a Secondary K_L^0 Beam at JLab.

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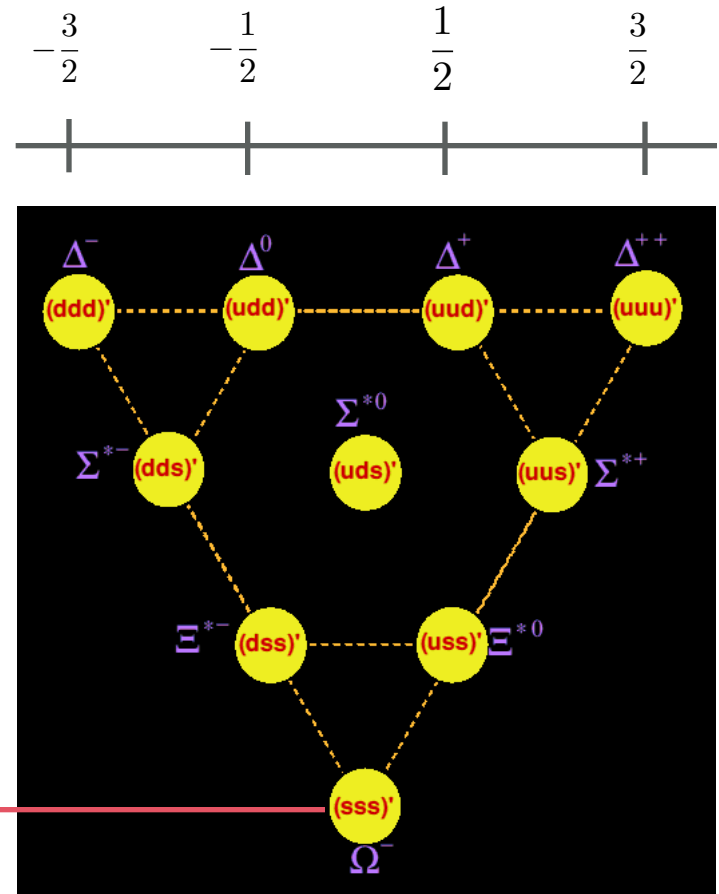
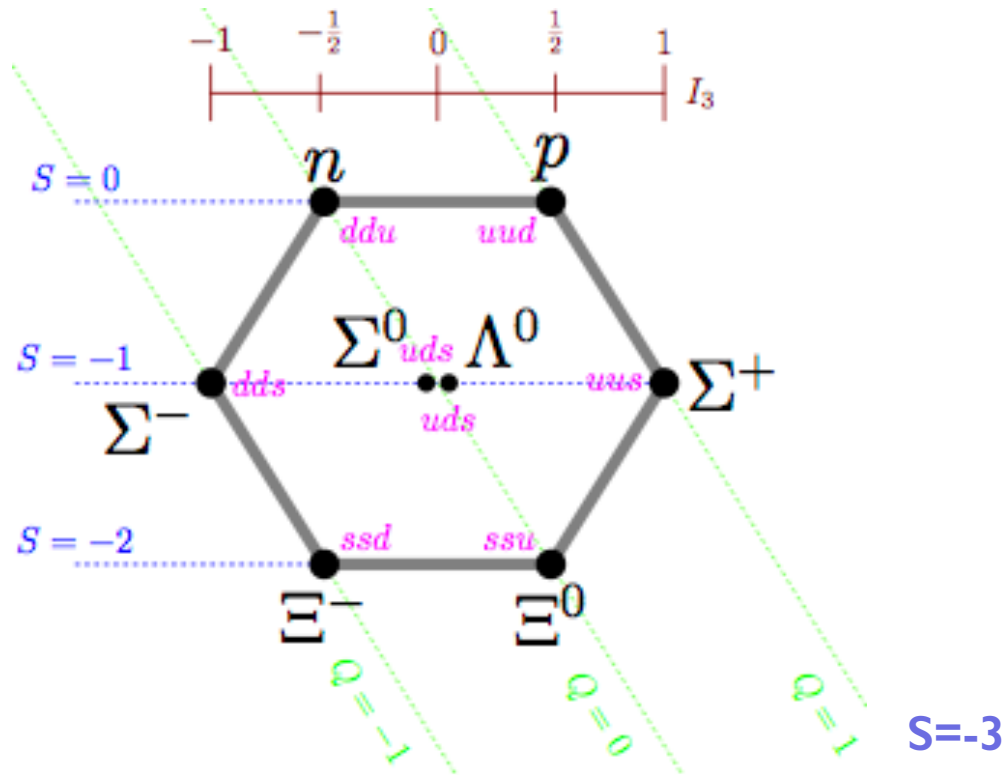
(Dated: May 15, 2015)

Outline

- Introduction
- Baryon Multiplets
- Reactions with K_L^0 beam on proton target
- Experimental Arrangement
- K_L^0 Beam at GlueX
- Expected rates
- Summary

Octet

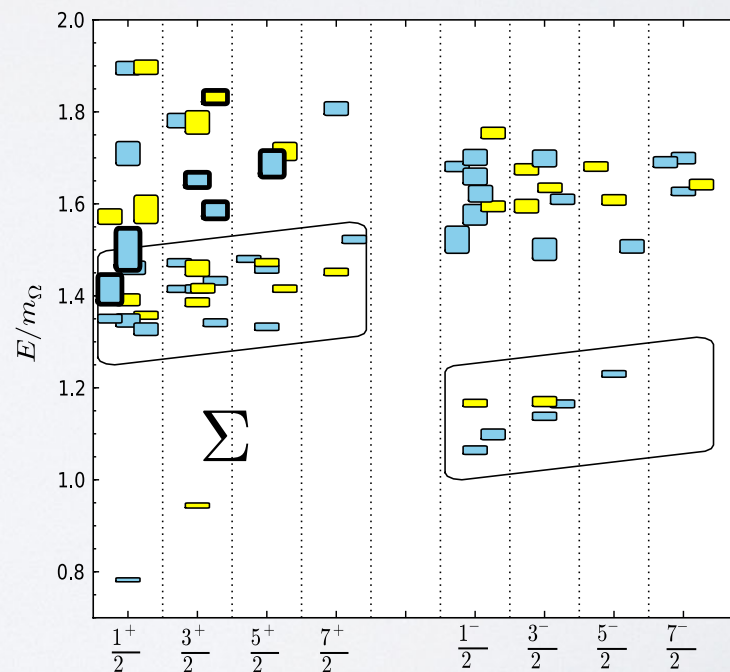
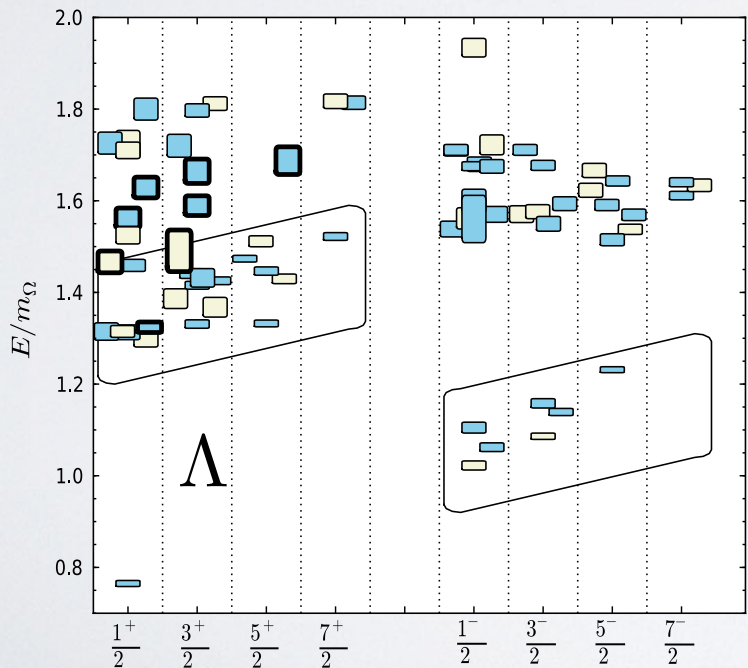
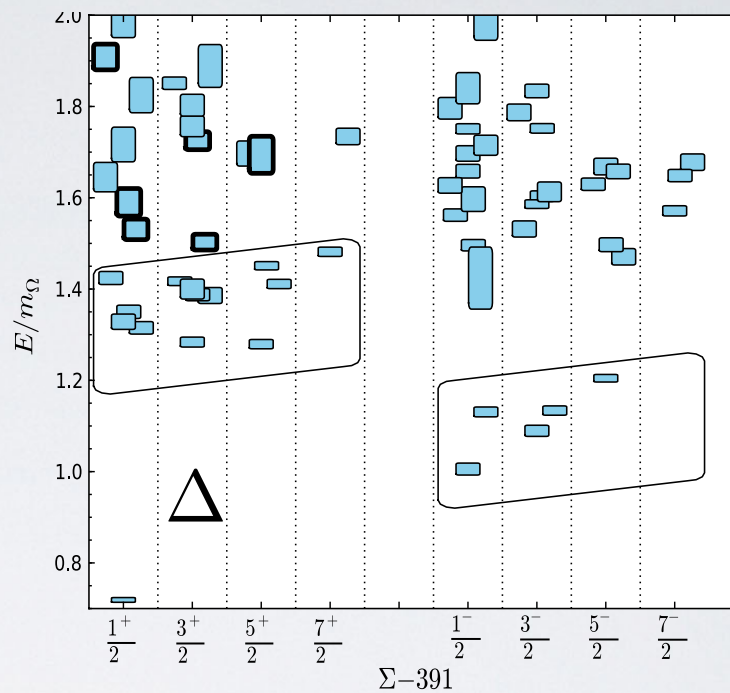
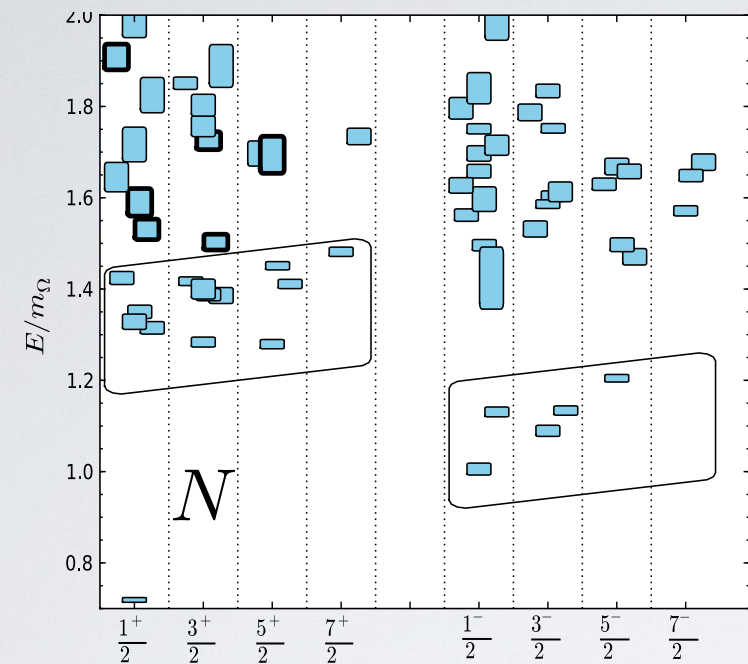
Decuplet



Gell-Mann
Nishidjima

$$Q = I_3 + \frac{B + S}{2}$$

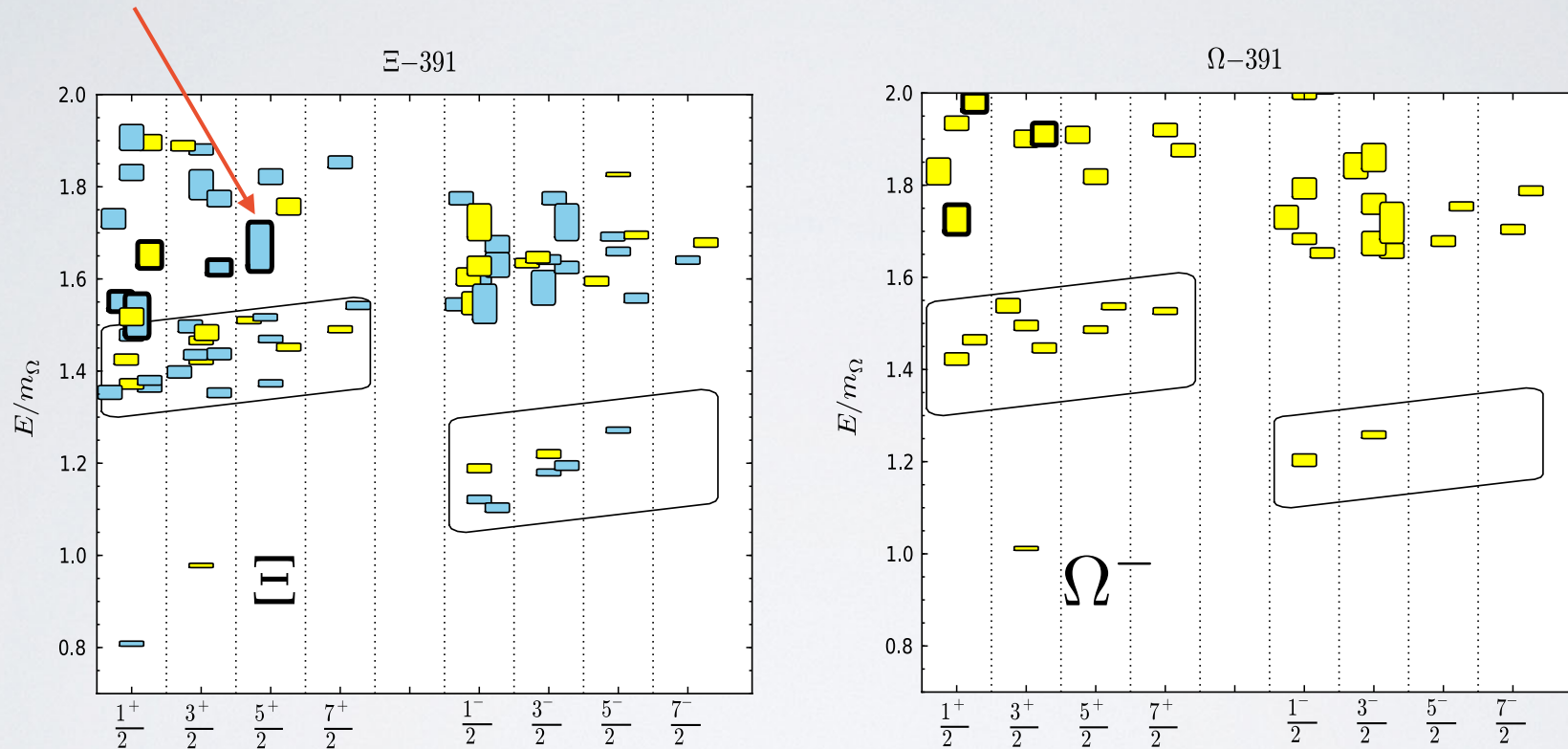
Lattice QCD calculations



$\Sigma-391$

Lattice QCD calculations

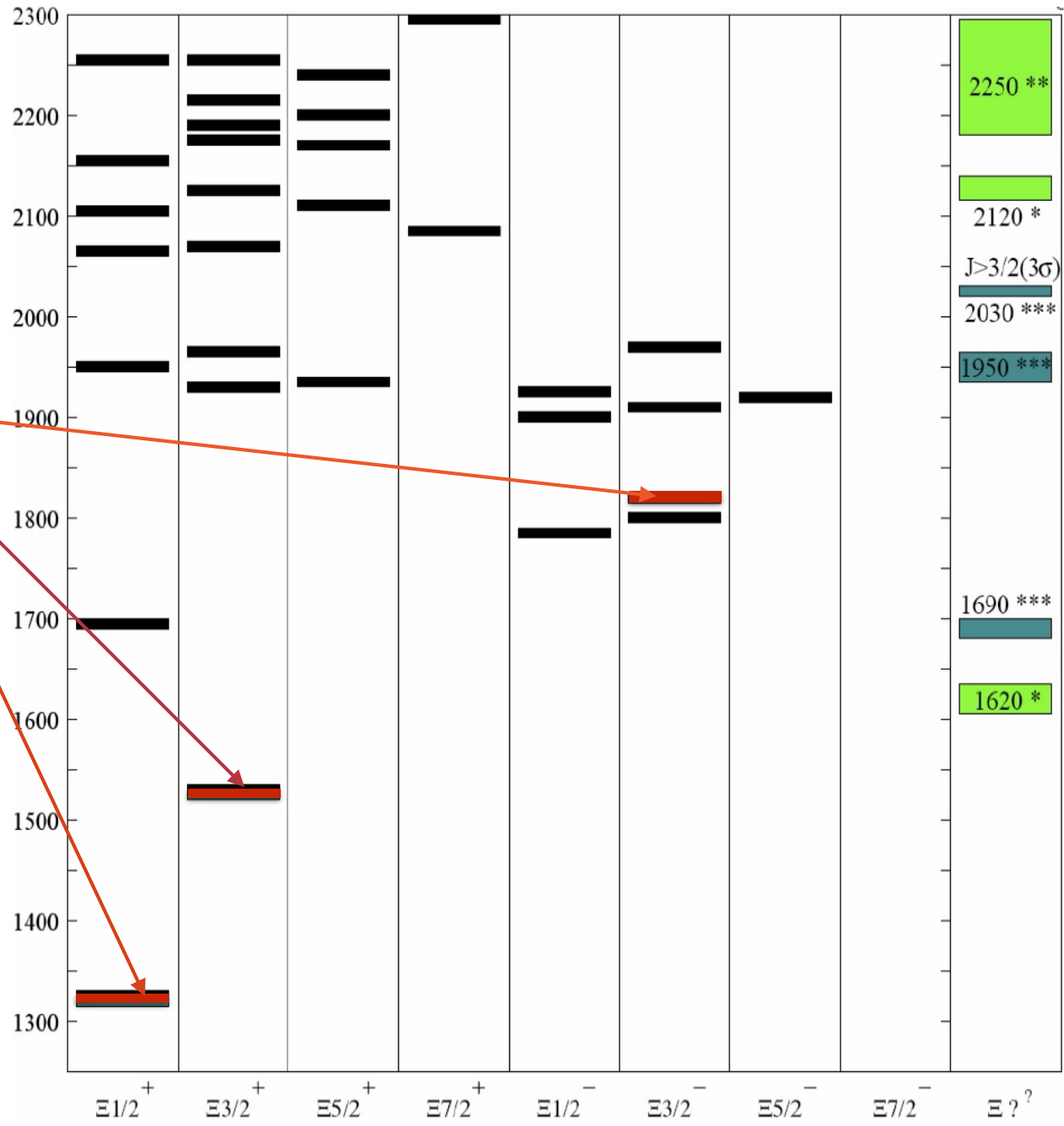
Thick borders: Hybrid states



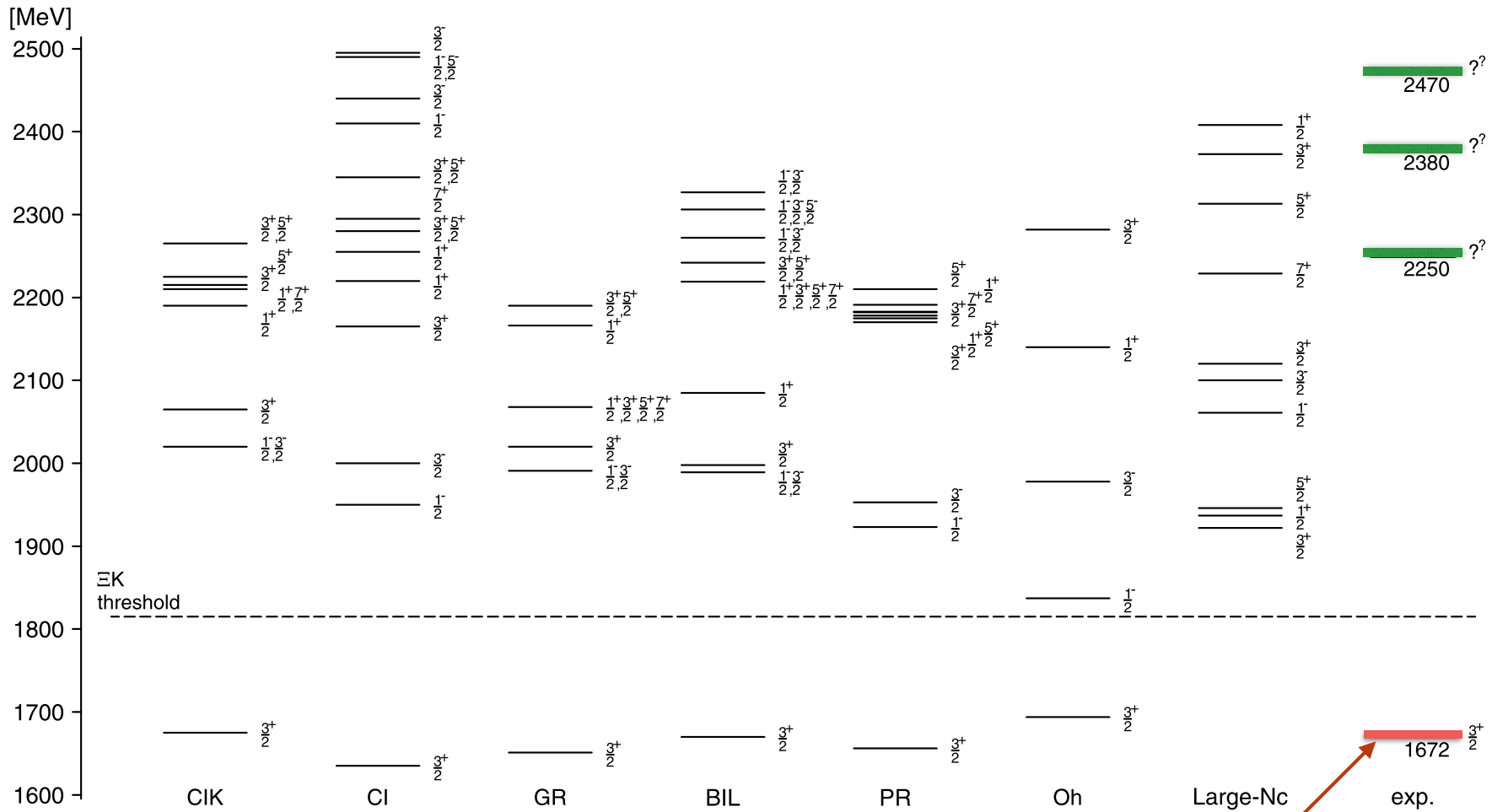
Edwards, Mathur, Richards and Wallace
Phys. Rev. D 87, 054506 (2013)

Status of $[I]^*$

well known



Status of Ω^{-*}

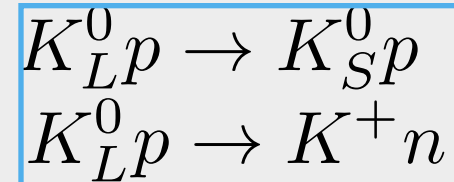


only one well known state?

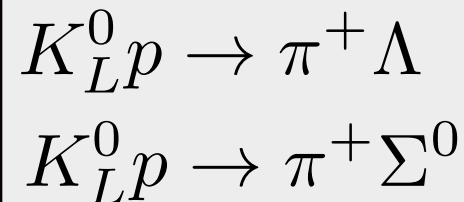
What if we have a K^0_L beam ?

List of reactions:

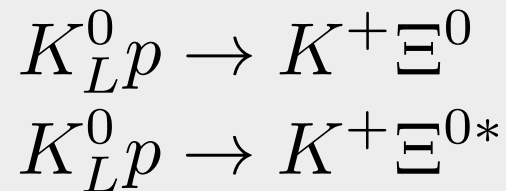
Elastic and charge-exchange



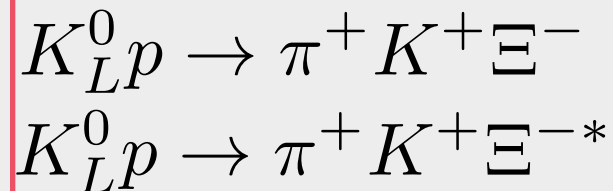
Two-body with $S=-1$



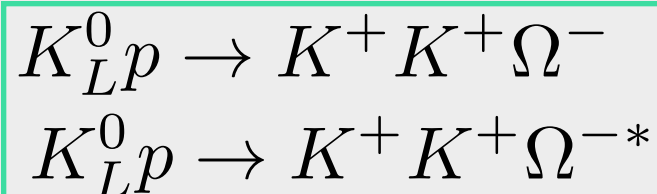
Two-body with $S=-2$



Three-body with $S=-2$



Three-body with $S=-3$

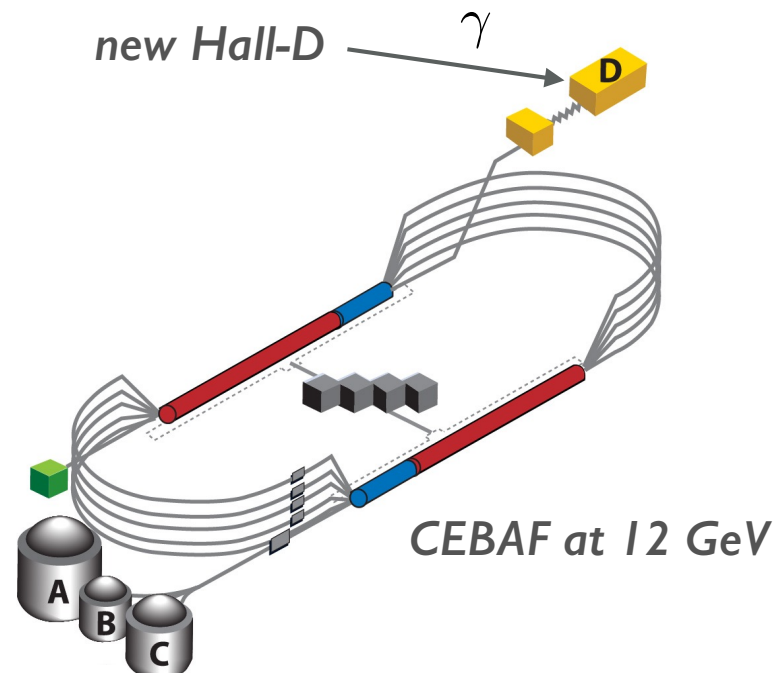


How to make a kaon beam?

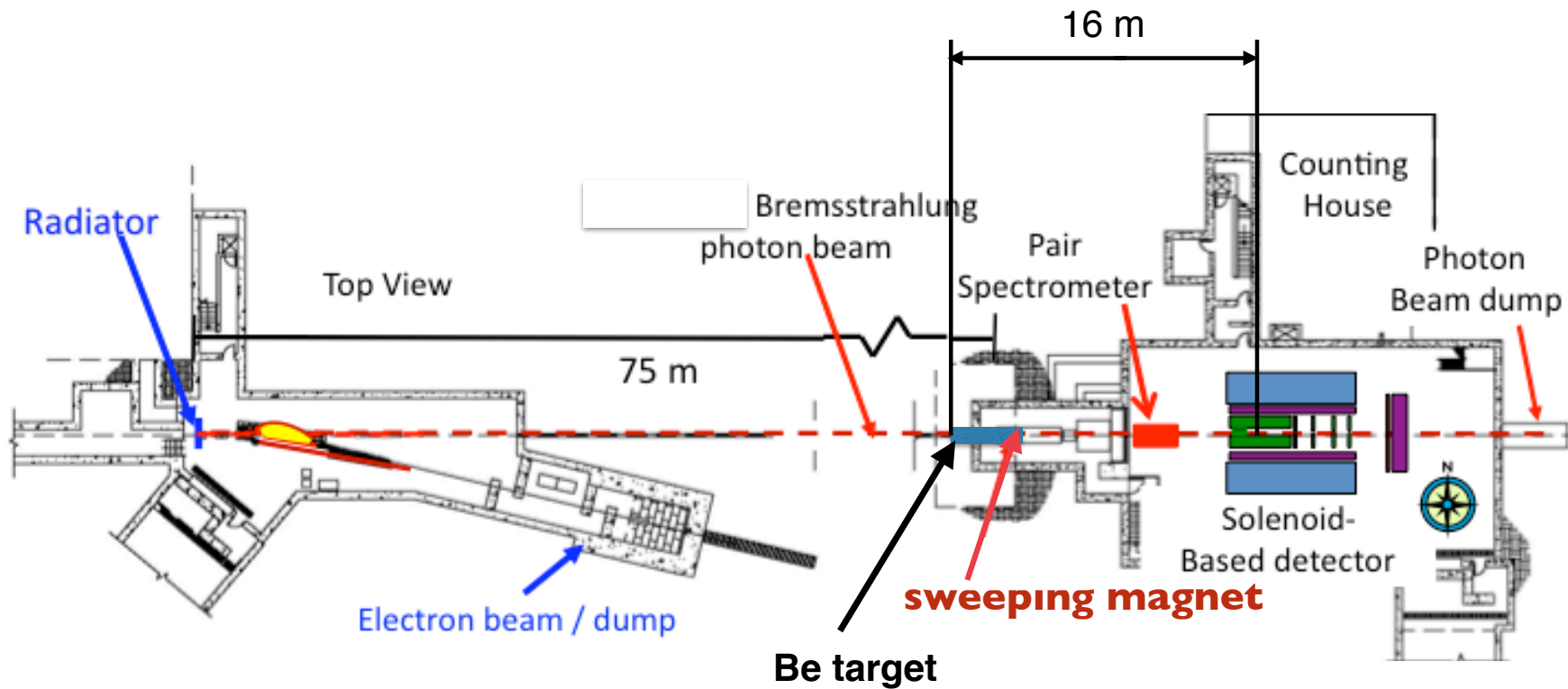
Thomas Jefferson National Accelerator Facility



Aerial View



GlueX Beamline for K^0_L



Main components:

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

K_L^0 beam

Electron beam

$$E_e = 12\text{GeV}; I_e = 5\mu\text{A}$$

Radiator (rad. length)

5%

10%

Be target (R=4cm)

$$L = 40\text{cm}$$

$$L = 60\text{cm}$$

LH2 target(L=30cm)

$$R = 2\text{cm}$$

$$R = 3\text{cm}$$

Distance Be-LH2

$$16\text{m}$$

$$16\text{m}$$

K_L Rate/sec

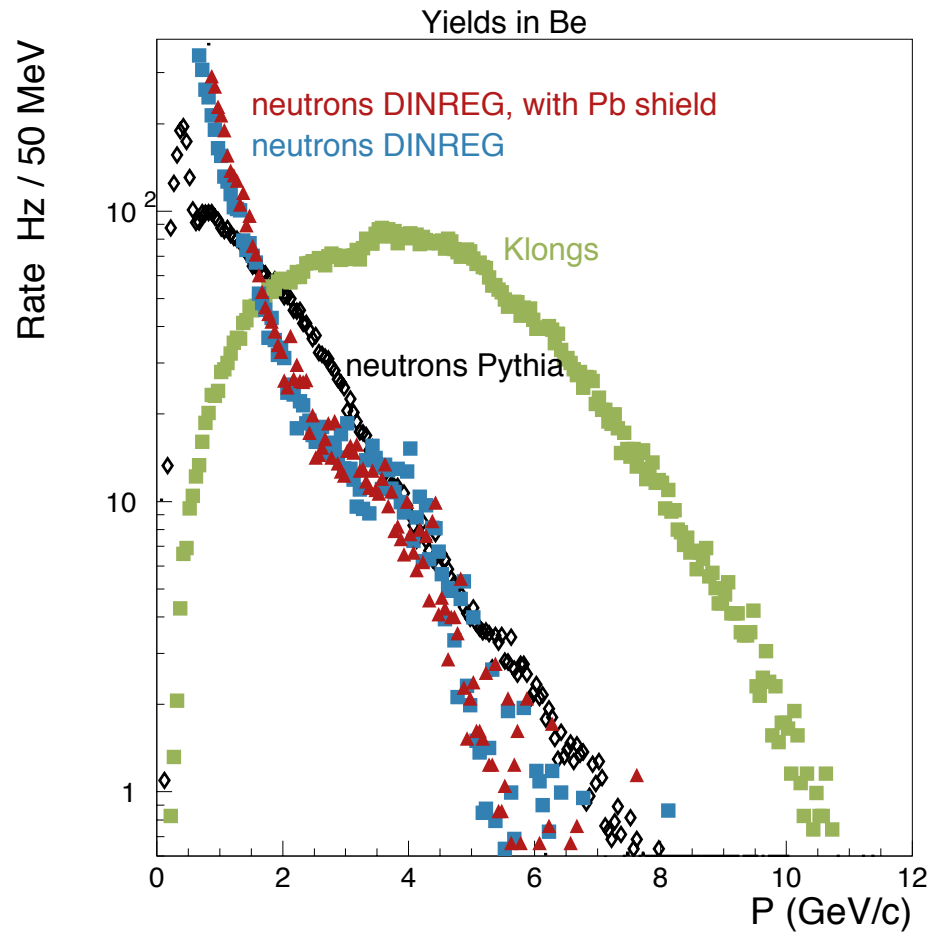
$$2 \times 10^3$$

$$10^4$$

K^0_L beam (continued)

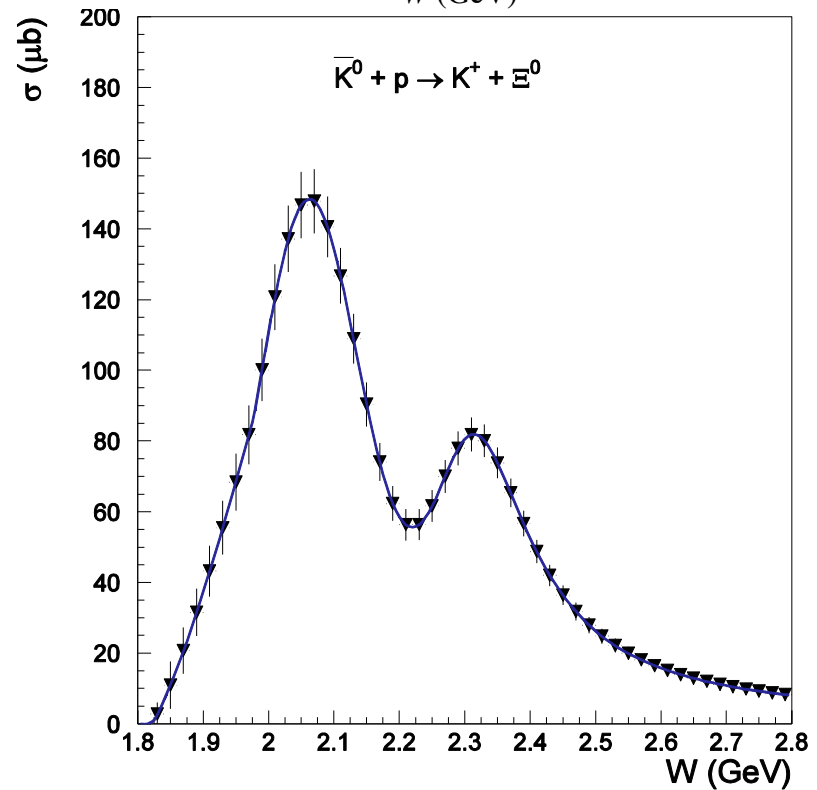
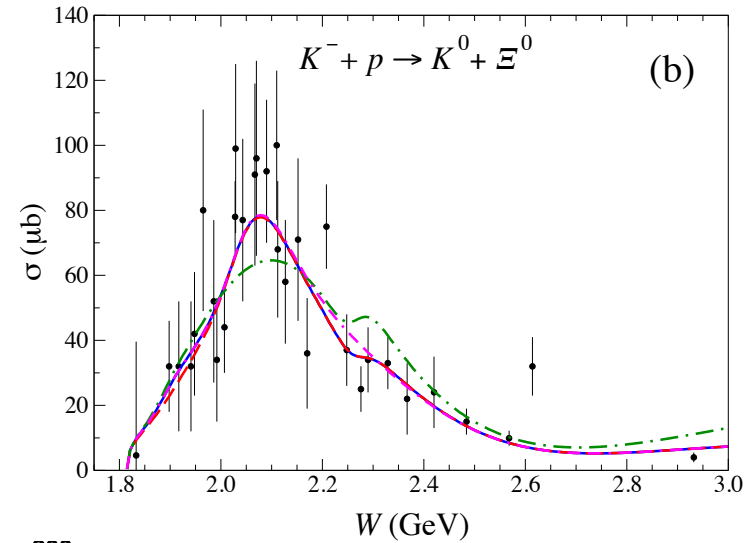
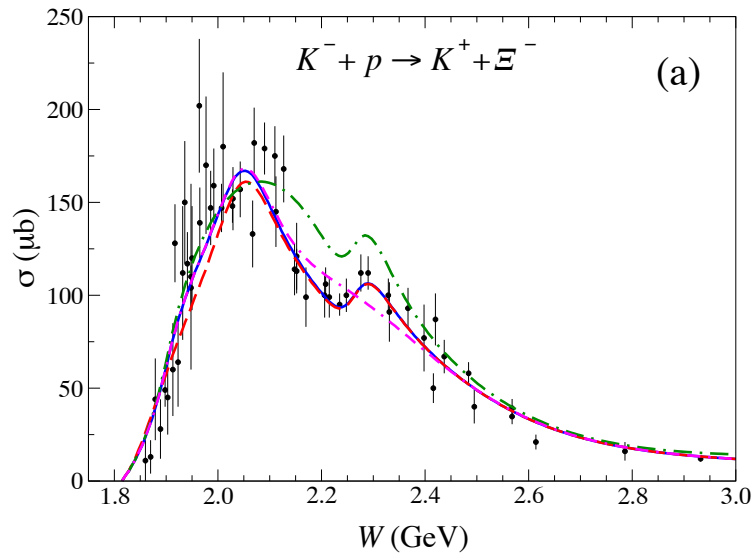
- Electron beam with $I_e = 5\mu A$
 - Delivered with 40ns bunch spacing avoids overlap in a range of momenta $P > 0.35 \text{ GeV}/c$
 - Momentum measured with TOF $\Delta p/p \sim 0.5\%$
 - K^0_L flux measured with pair spectrometer
- Side remark: Physics case with polarized targets is under study*

Rate of neutrons and K_L^0 on GlueX target



- With a proton beam ratio $n/K_L = 10^3-10^4$

World Data on Ξ



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

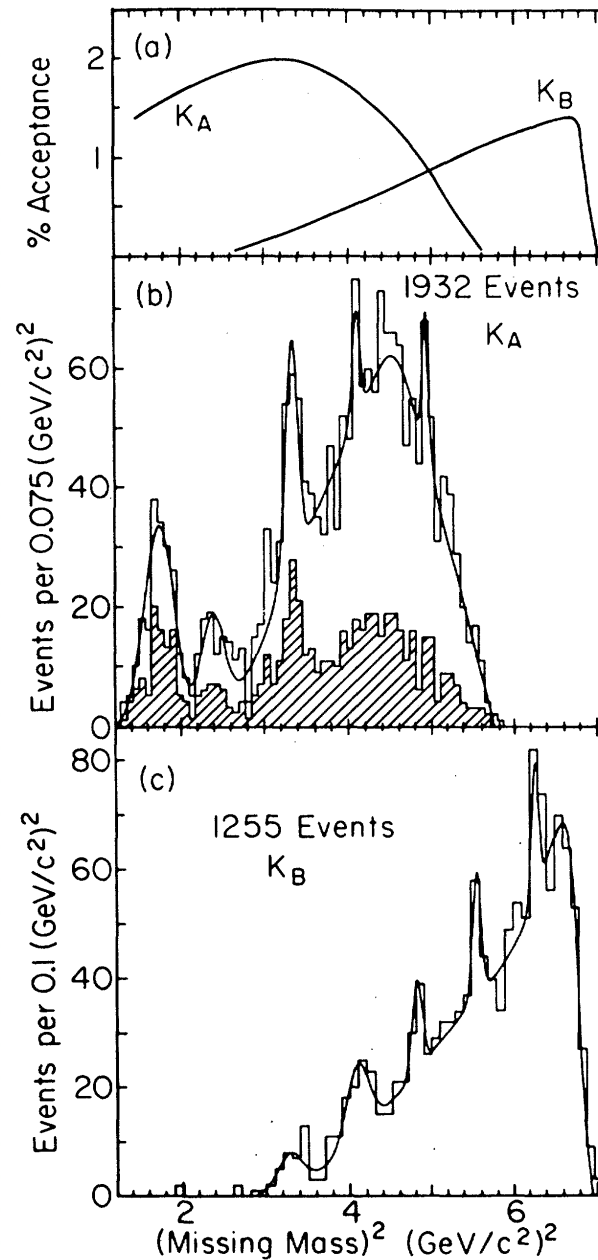


Jackson, Oh, Haberzettl, Nakayama
arXiv: 1503.00845

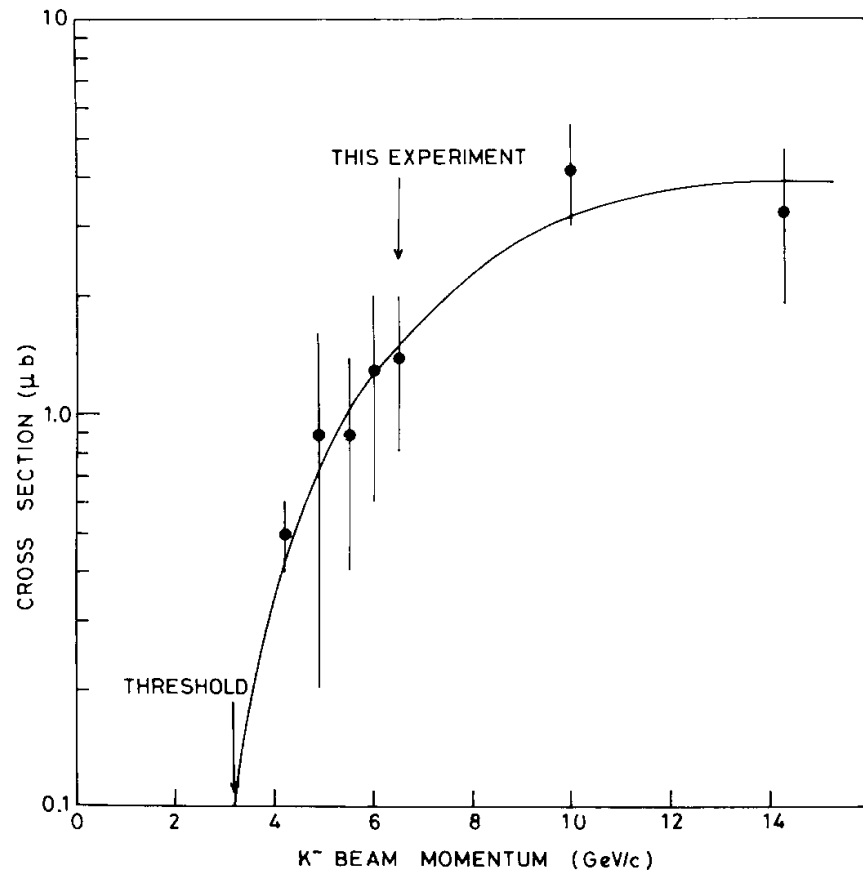
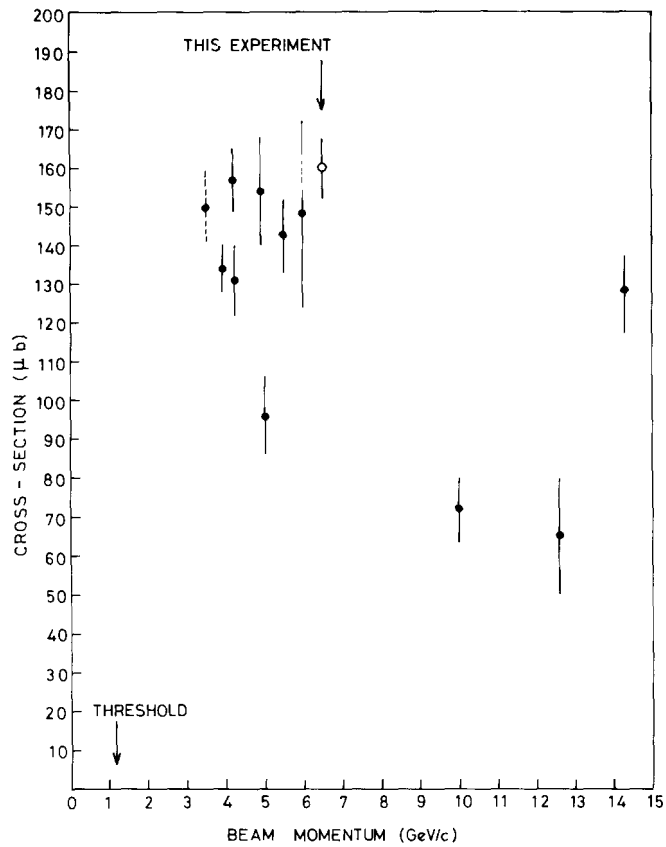
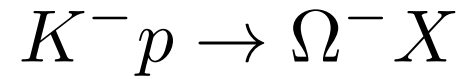
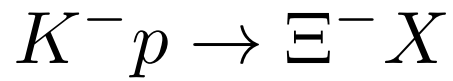
Status of $[I]^*$

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)

Expected rates

Production	J-PARC*	Jlab (this proposal)
flux/s	$3 \times 10^4 K^-$	$10^4 K_L^0$
$\Xi^*/month$	3×10^5	2×10^5
$\Omega^{-*}/month$	600	4000

* [H.~Takahashi, NP A 914, 553 \(2013\)](#)
[M.~Naruki and K.~Shirotori, LOI-2014-JPARC](#)

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
two orders higher than that in LASS (SLAC)
- Data obtained at Jlab will be complementary to future data with charged kaons at J-PARC

Backup

