Physics Opportunities with a Secondary K^0_L Beam at

Moskov Amaryan

KL2016 Workshop

February 1-3, 2016, Newport News, VA

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)

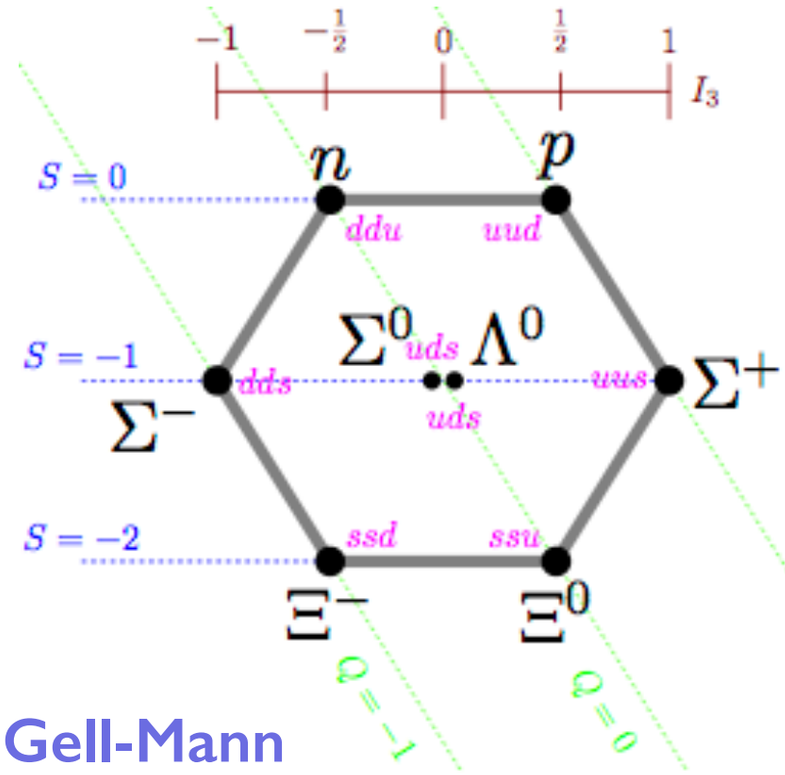
Outline

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

The nonexistent is whatever we have not sufficiently desired.
Franz Kafka

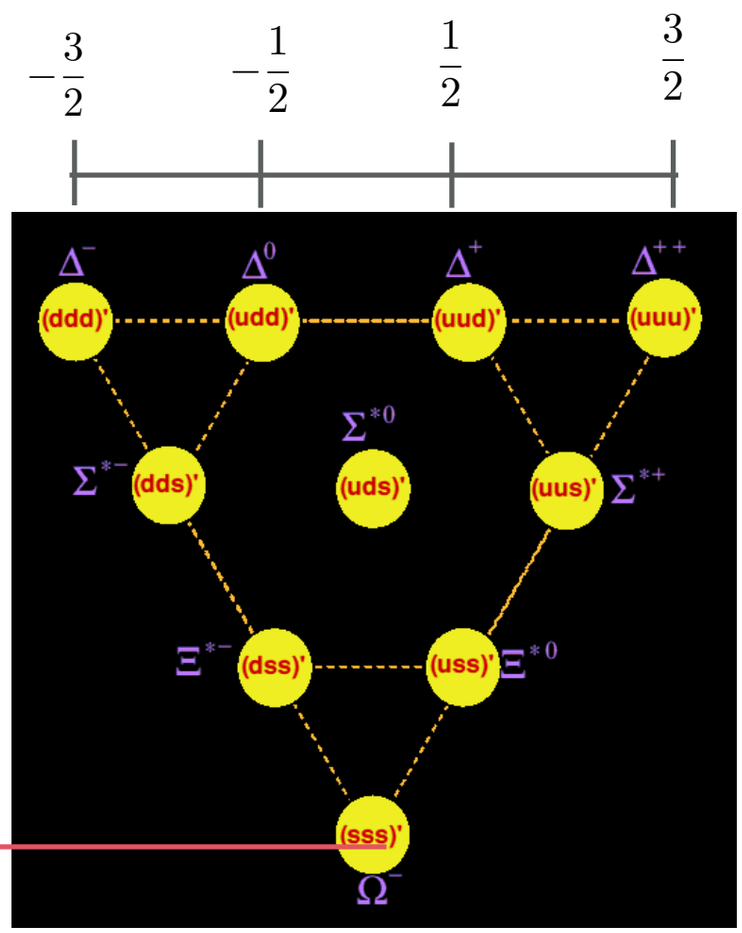
Constituent Quark Model

Octet



SU(3)

Decuplet



Gell-Mann
Nishidjima

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

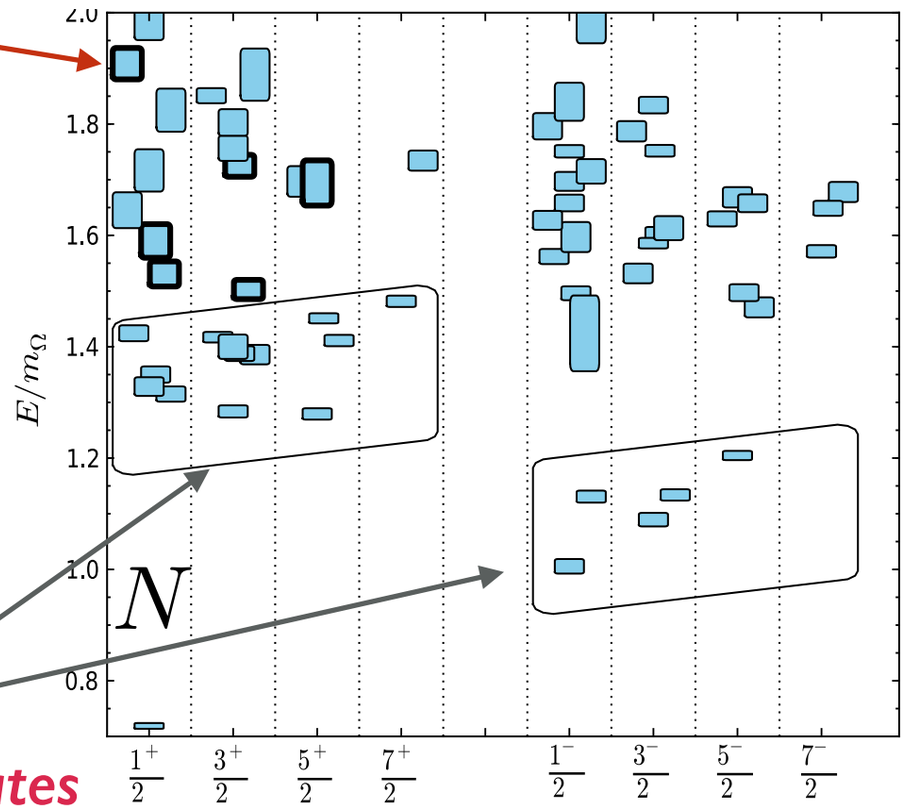
But there are many more states predicted, where are they?

Where are hybrids, glueballs, multiquark states ?

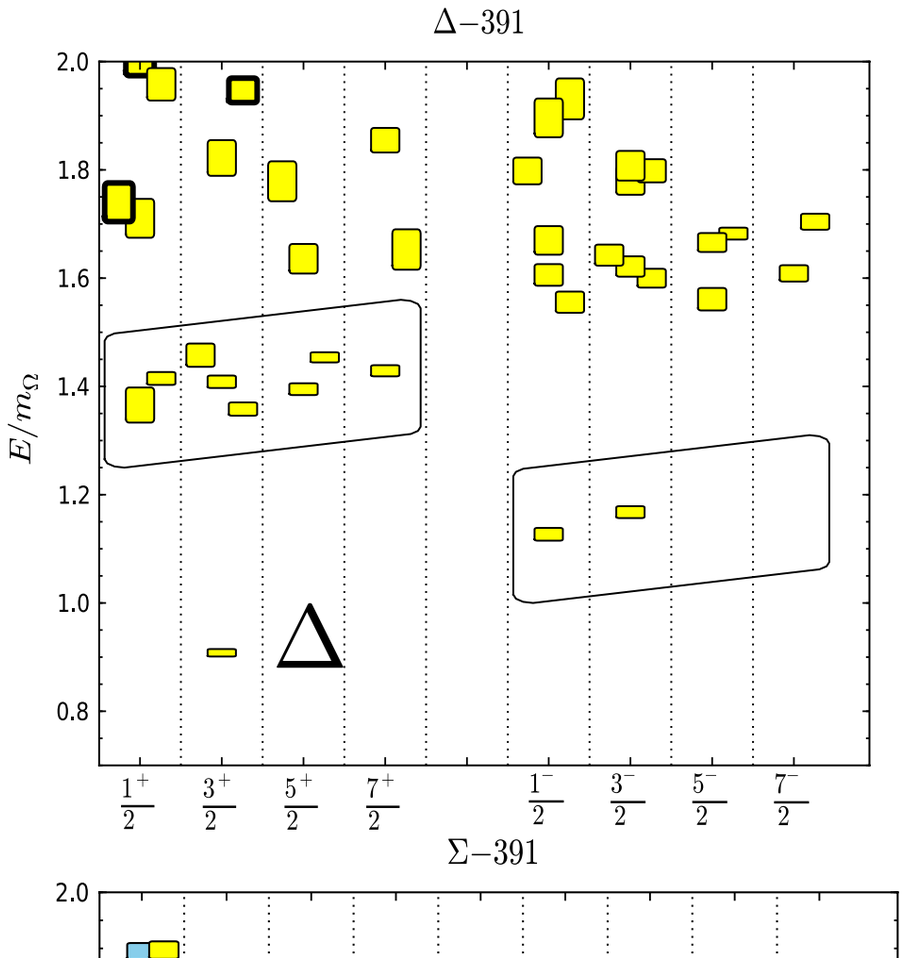
Well, some of them may already have been observed?

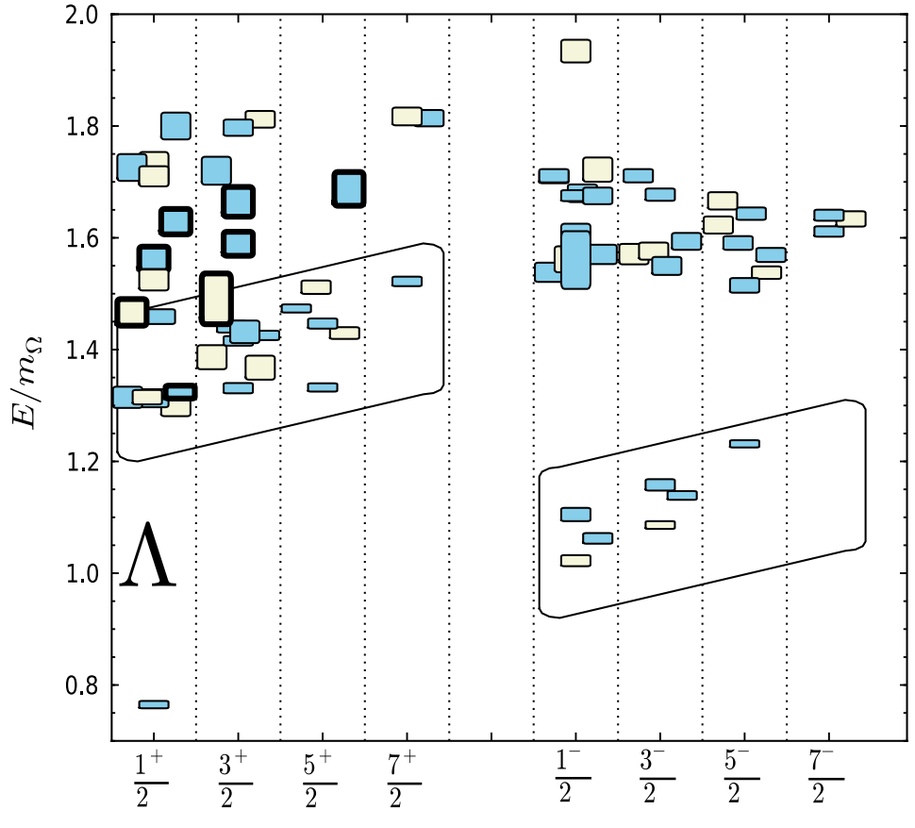
Lattice QCD calculations

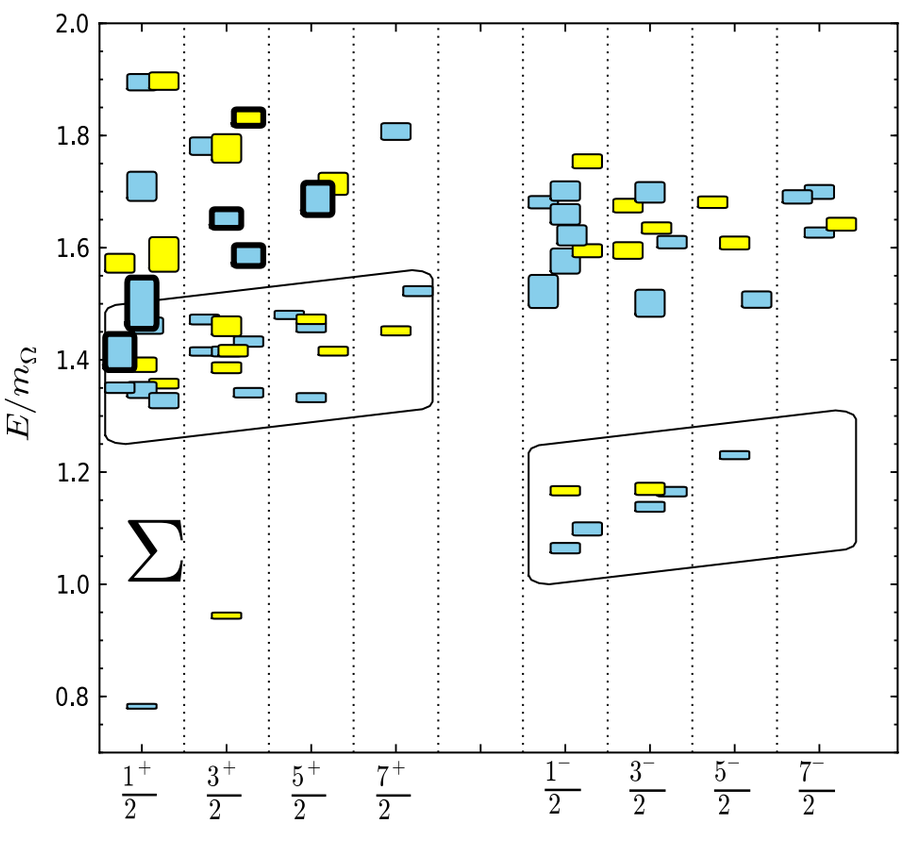
Thick borders: Hybrid states



Low Lying states

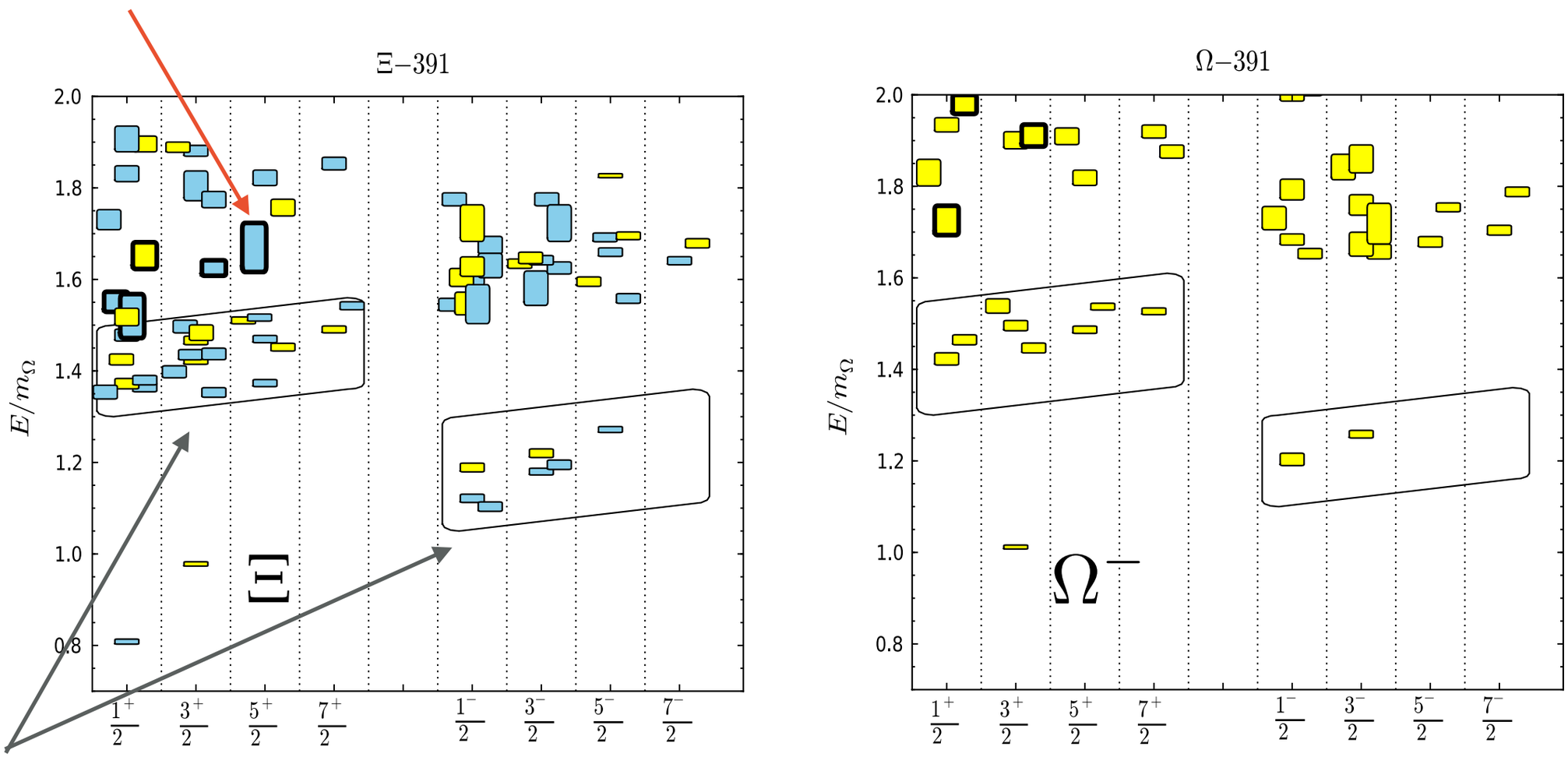






Lattice QCD calculations

Thick borders: Hybrid states

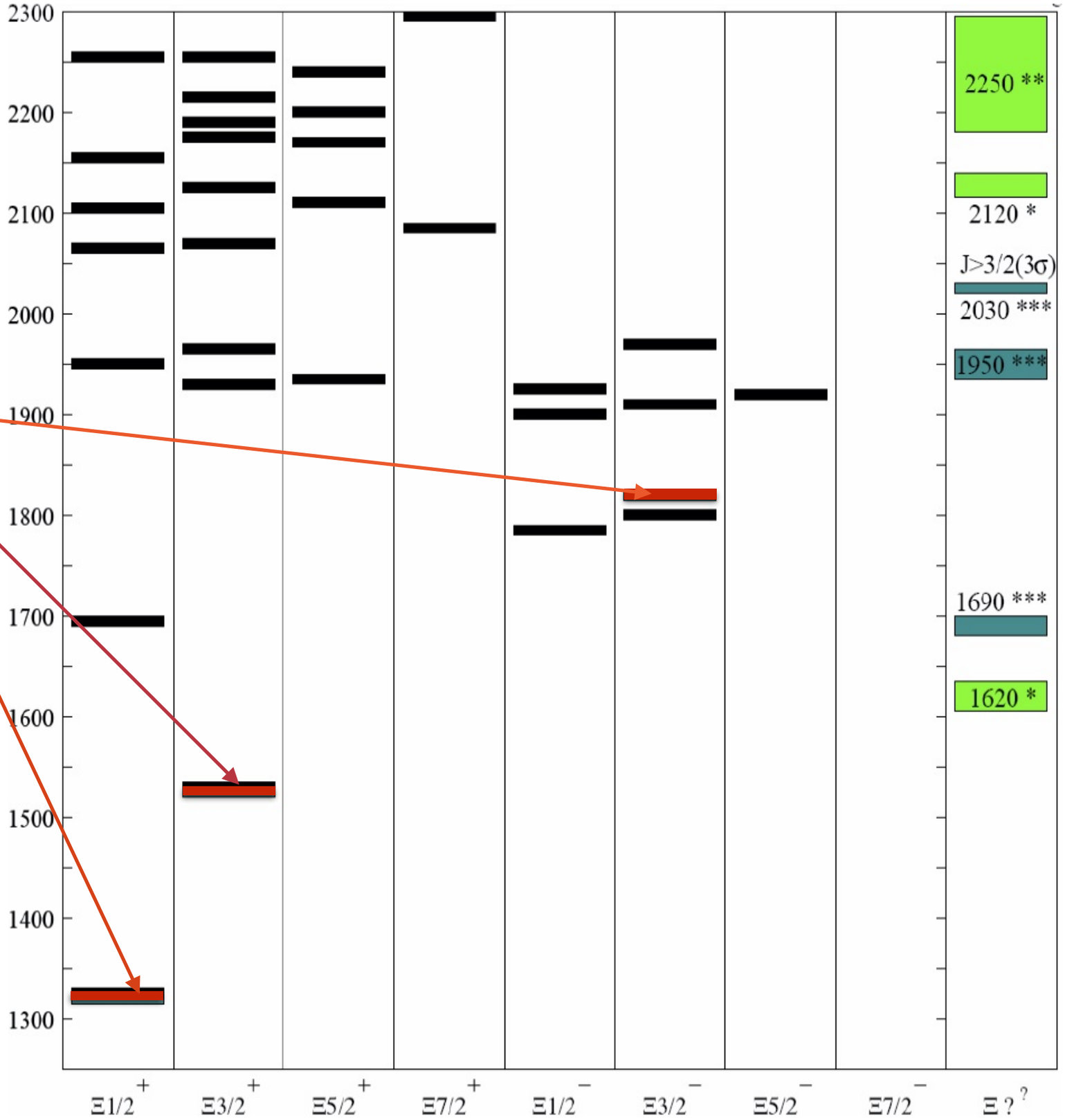


Low Lying states

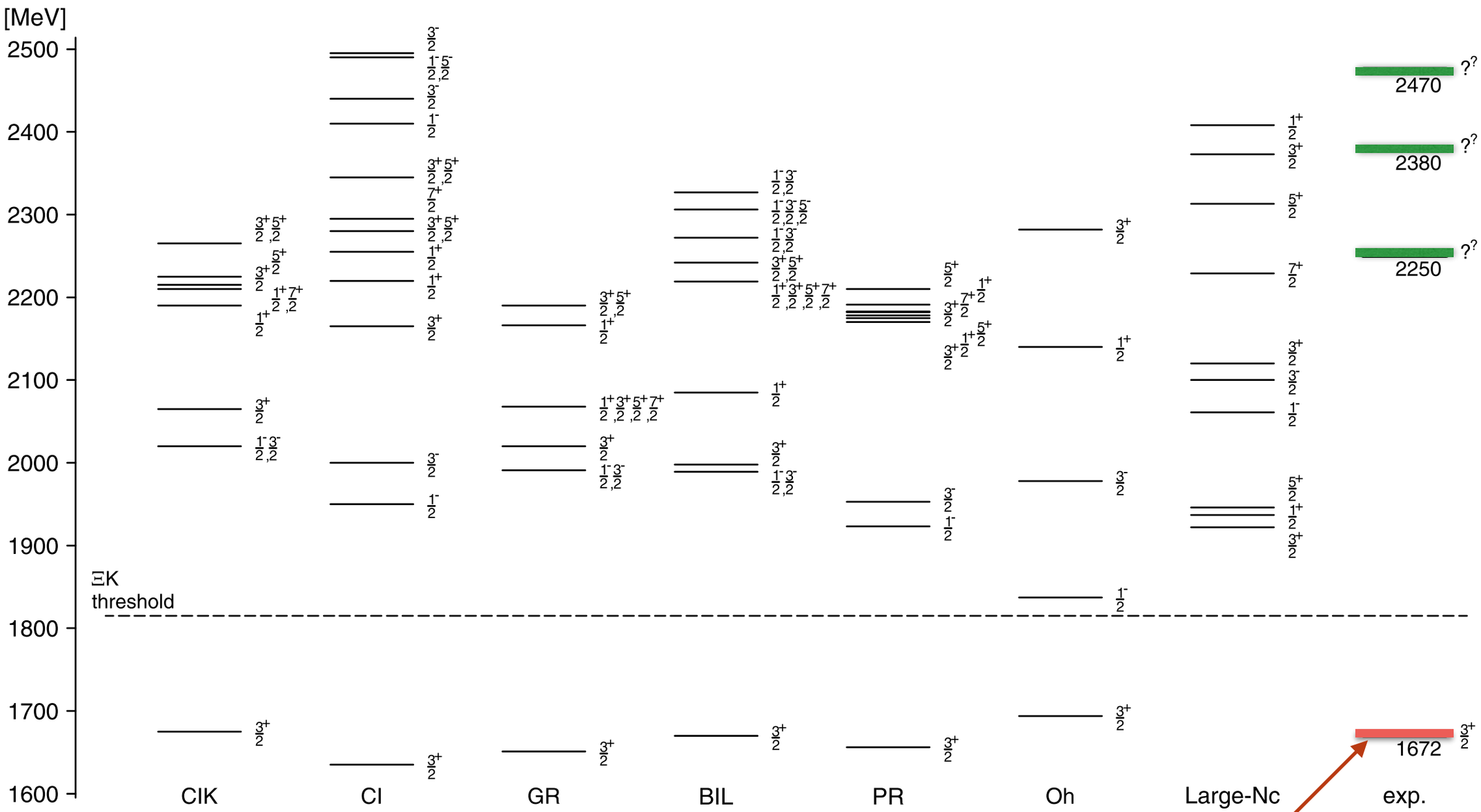
Edwards, Mathur, Richards and Wallace
Phys. Rev. D 87, 054506 (2013)

Status of Ξ^*

well known



Status of Ω^{-*}



only one well known state?

What if we have a K^0_L beam ?

see more from Mark Manley's talk

List of reactions:

Elastic and charge-exchange

$$K^0_L p \to K^0_S p$$
$$K^0_L p \to K^+ n$$

Two-body with S=-1

$$K^0_L p \to \pi^+ \Lambda$$
$$K^0_L p \to \pi^+ \Sigma^0$$

Two-body with S=-2

$$K^0_L p \to K^+ \Xi^0$$
$$K^0_L p \to K^+ \Xi^{0*}$$

Three-body with S=-2

$$K^0_L p \to \pi^+ K^+ \Xi^-$$
$$K^0_L p \to \pi^+ K^+ \Xi^{-*}$$

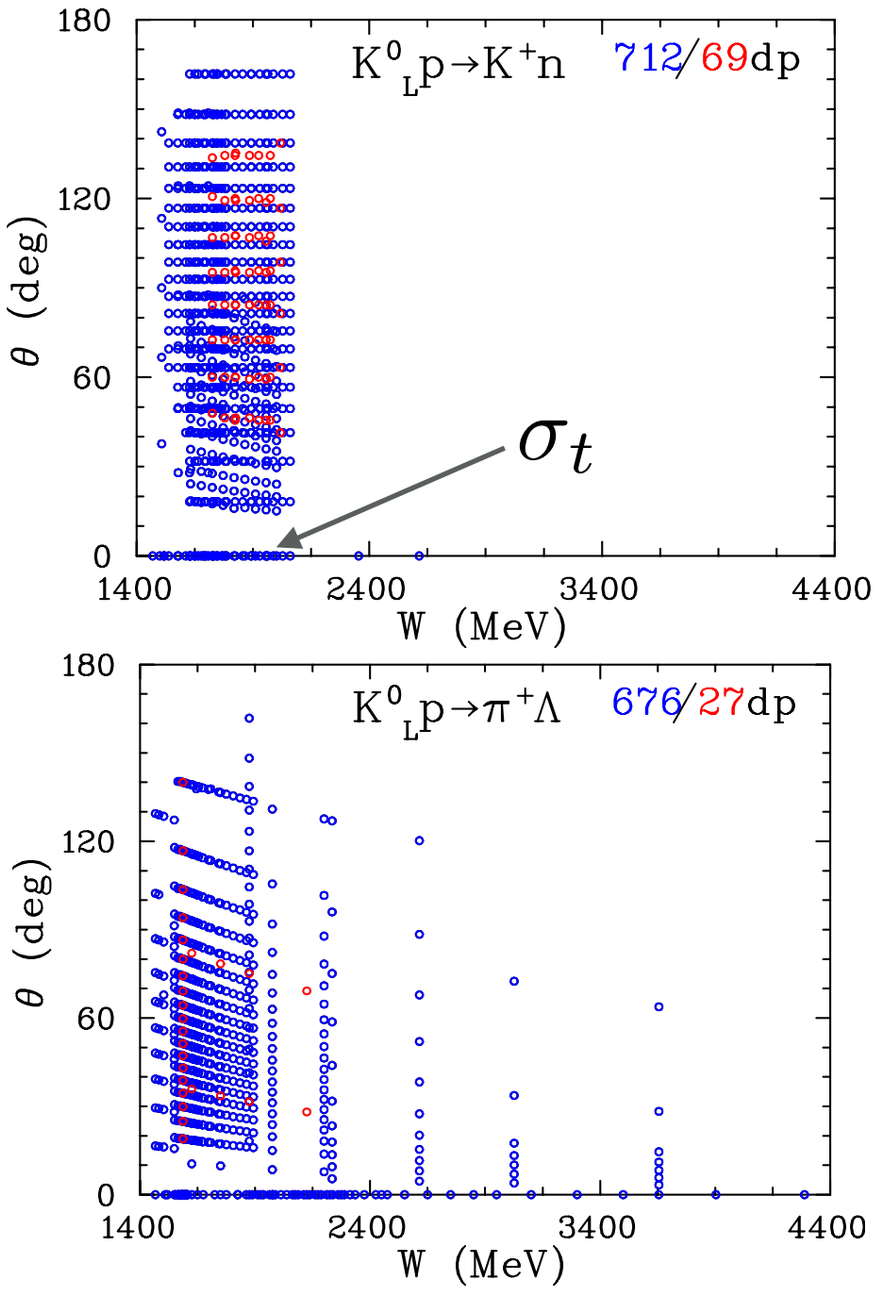
Three-body with S=-3

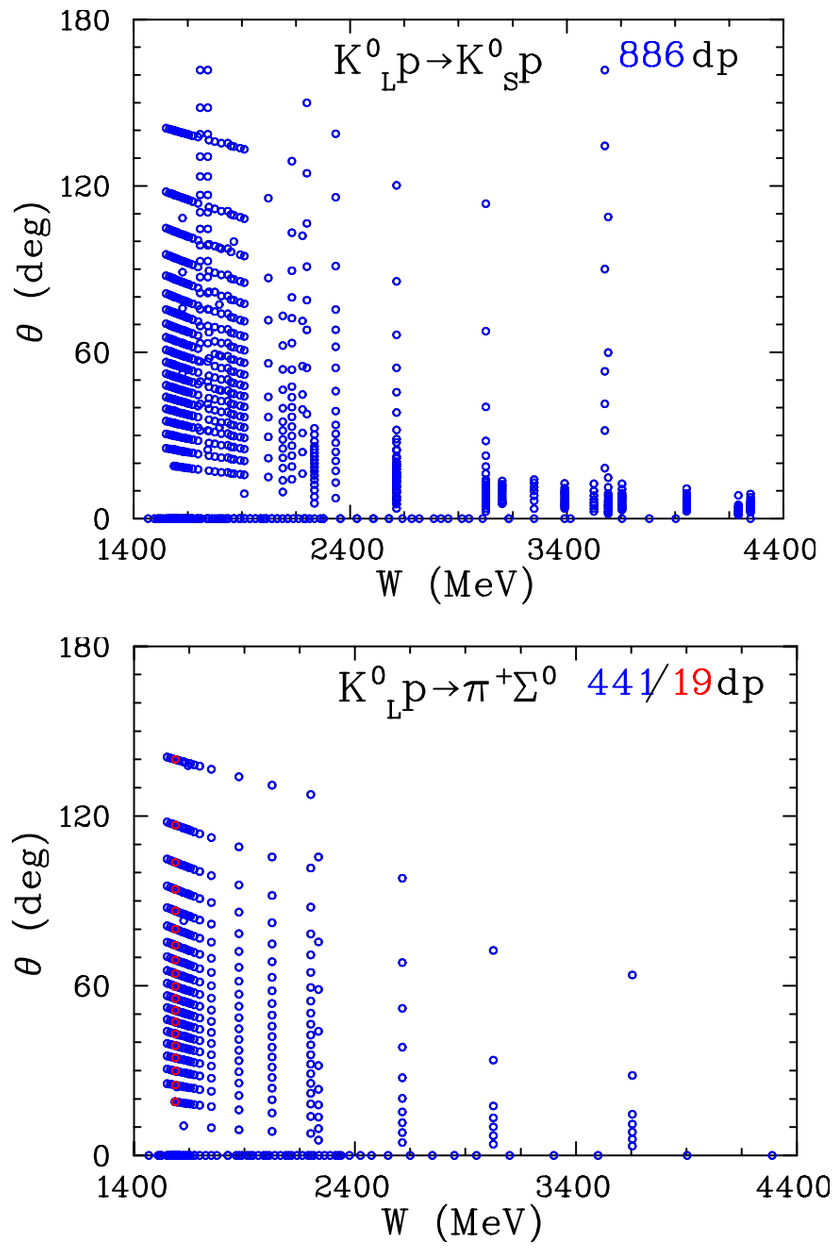
$$K^0_L p \to K^+ K^+ \Omega^-$$
$$K^0_L p \to K^+ K^+ \Omega^{-*}$$

Very Limited World Data with K_L beam

(mainly low stat. bubble chamber data **compilation by I. Strakovsky)**

blue points: $d\sigma/d\Omega$ ***red points: Polarization***



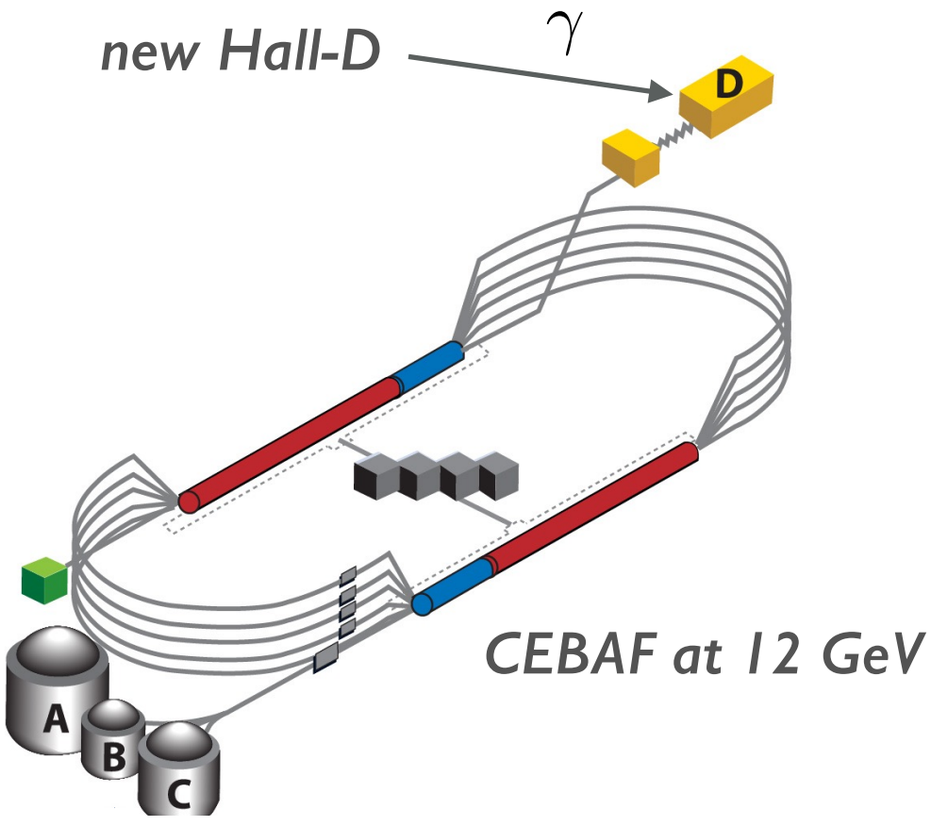


we are not aware of any data on Neutron target

How to make a kaon beam?

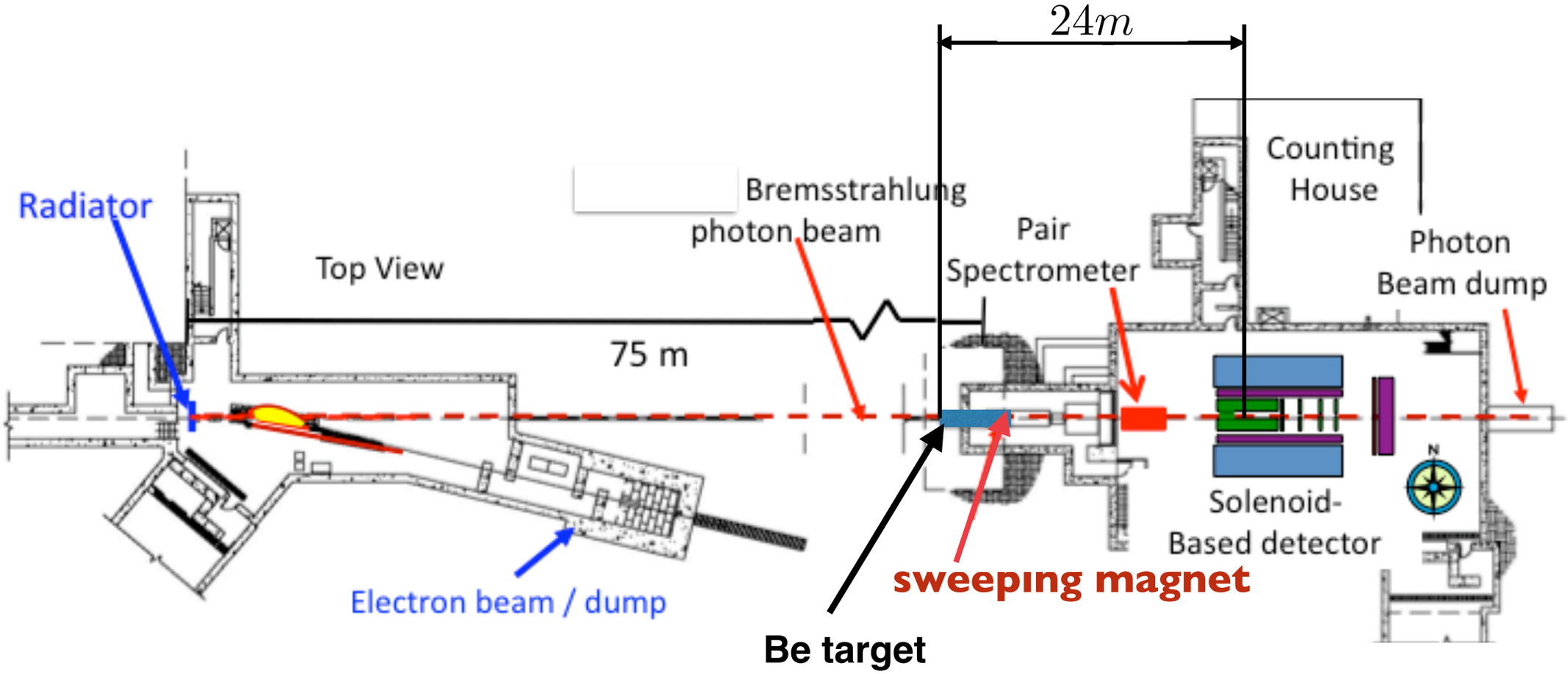
Thomas Jefferson National Accelerator Facility

Aerial View



CEBAF at 12 GeV

GlueX Beamline for K^0_L



Main components:

Photon Radiator

Be target

Lead absorber

Sweeping Magnet

Pair spectrometer

see more from
Pavel Degtiarenko's talk
on Compact Photon Source

K^0_L beam

- **Electron beam** $E_e = 12GeV; I_e = 5\mu A$
- **Radiator (rad. length)**
- **Be target (R=3cm)**
- **LH2 target(L=30cm)**
- **Distance Be-LH2**
- **K_L Rate/sec**

5%	10%
$L = 40cm$	$L = 60cm$
$R = 3cm$	$R = 4cm$
$24m$	$24m$
~10^3	~10^4

K^0_L beam (continued)

-Electron beam with $I_e = 5\mu A$

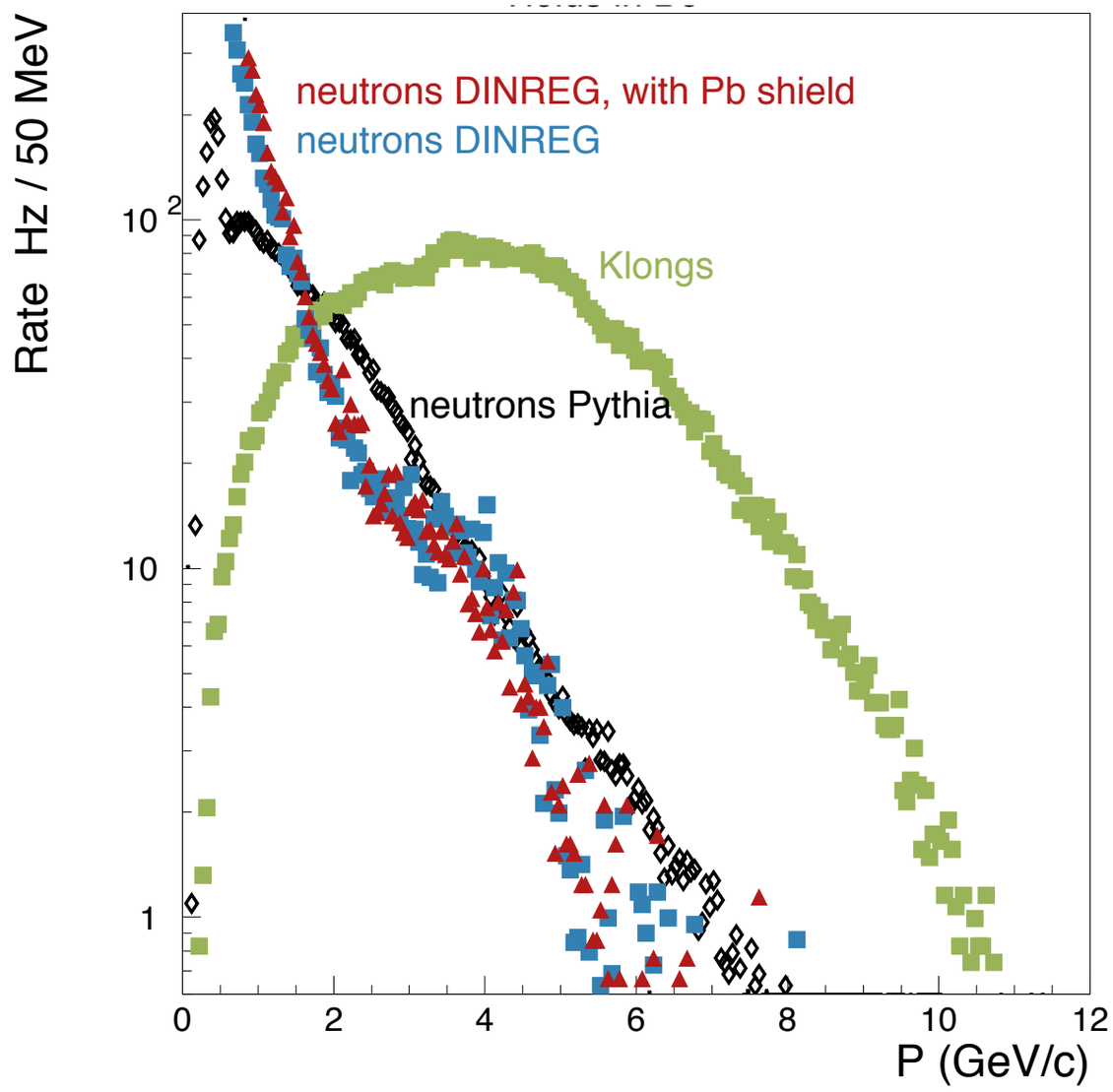
-Delivered with 60ns bunch spacing avoids overlap in the range of P=0.35-10.0 GeV/c

-Momentum measured with TOF

-K^0_L flux mesured with pair spectrometer

-Side remark: *Physics case with polarized targets is under study*

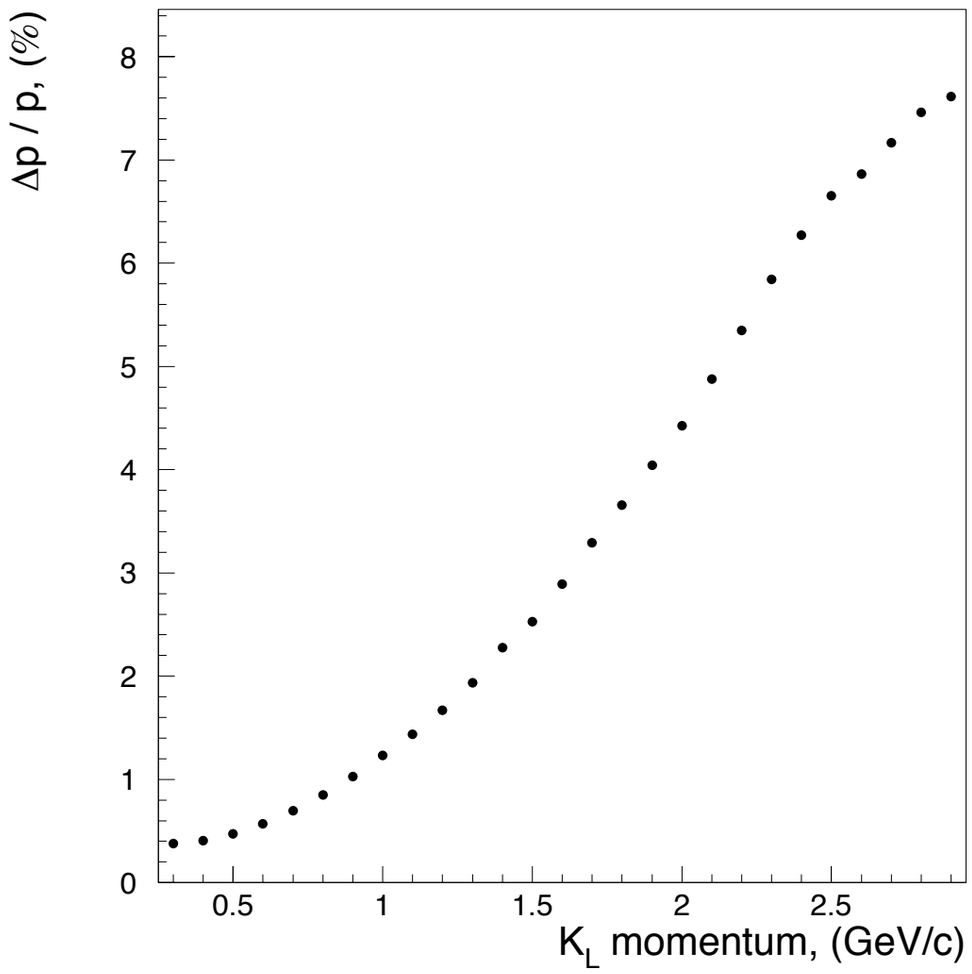
Rate of neutrons and K^0_L on GlueX target

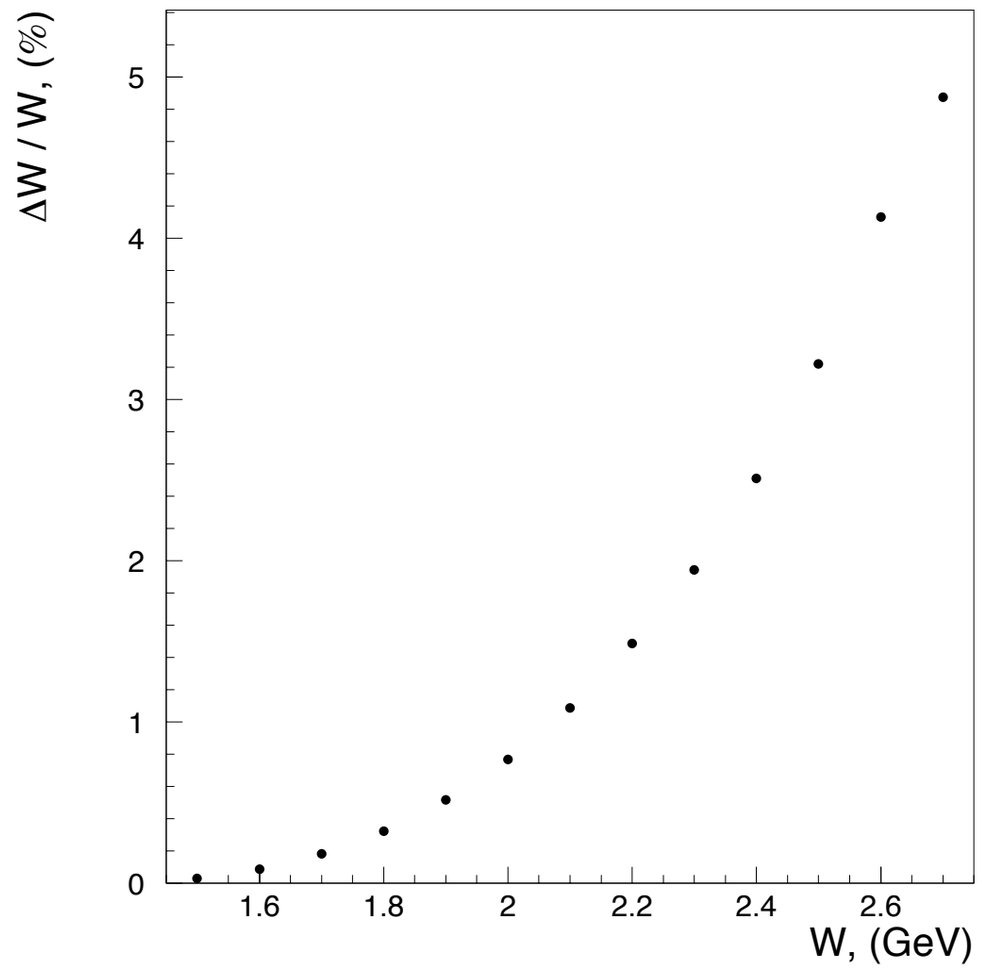


see more from Ilya Larin's talk

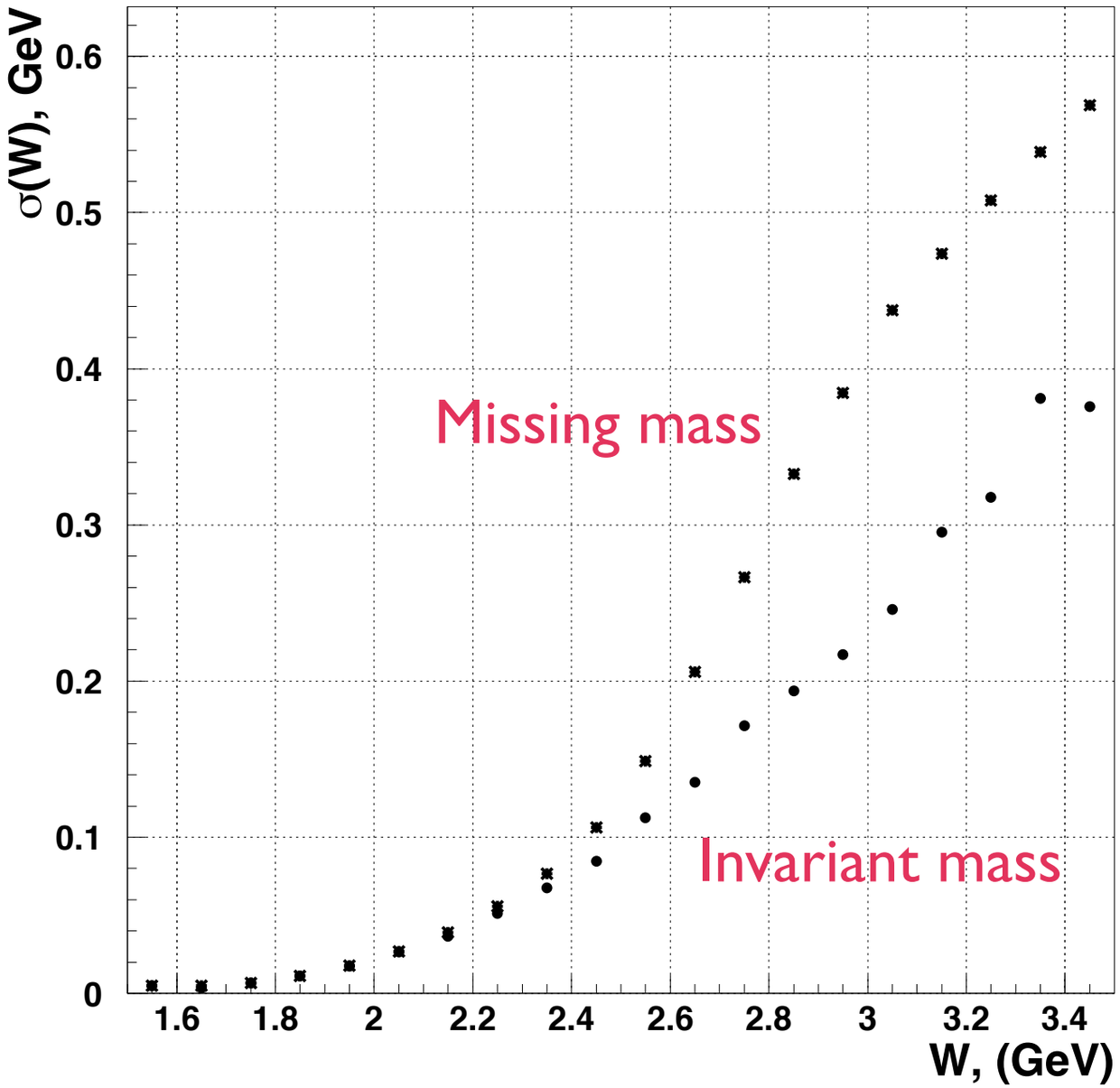
- **With a proton beam ratio $n/K_L = 10^3$-10^4**

Momentum and W Resolution



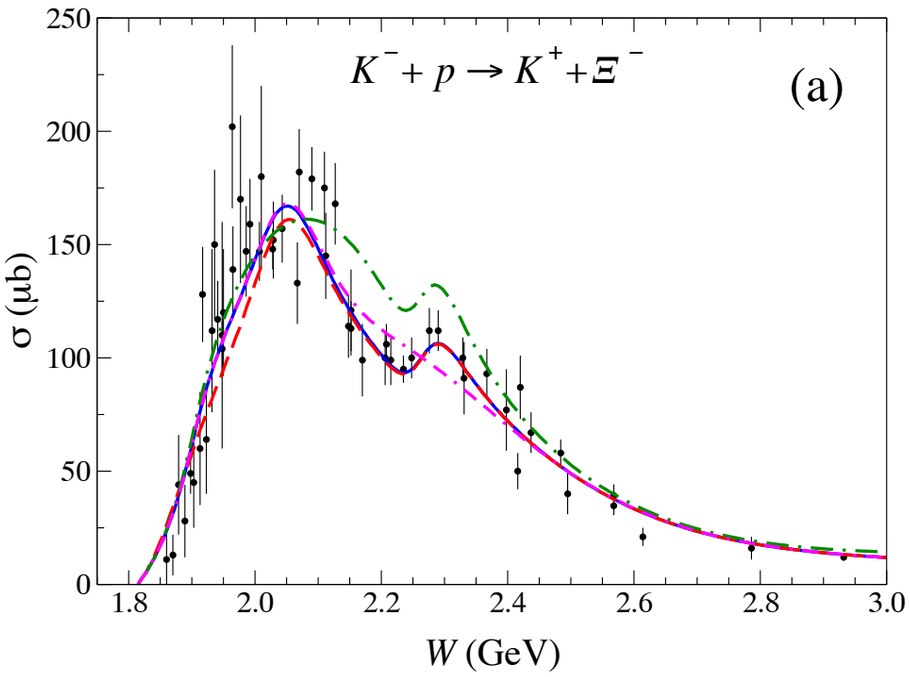


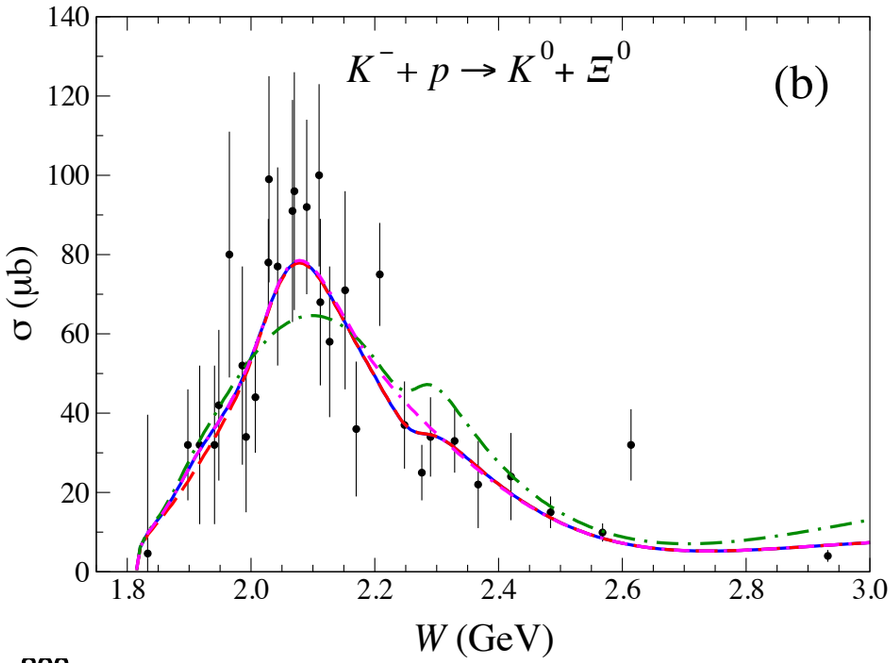
W-Resolution



see more from Simon Taylor's talk

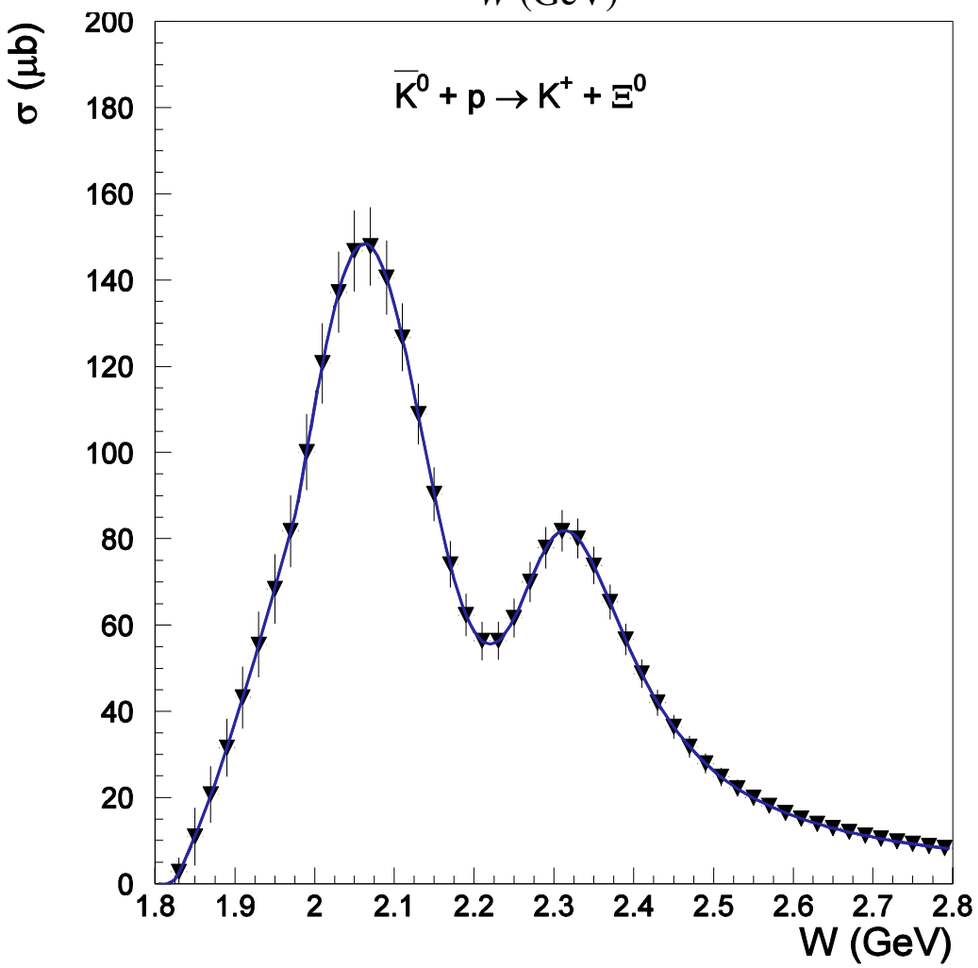
World Data on Ξ





Simulated with GlueX

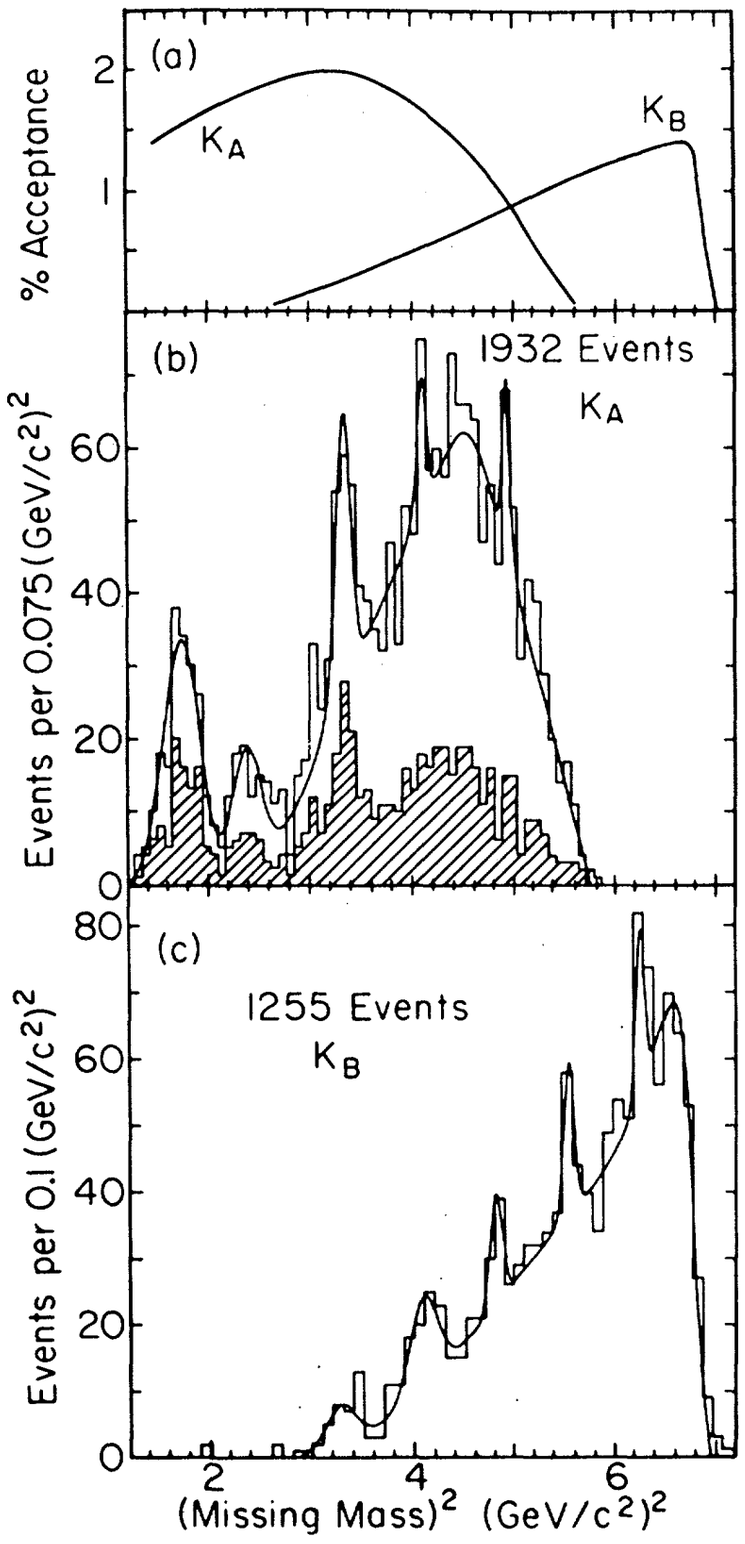
10^4 K_L/sec, one day of running



Jackson, Oh, Haberzettl, Nakayama
Phys. Rev. C 91, 065208 (2015)

Status of Ξ^*

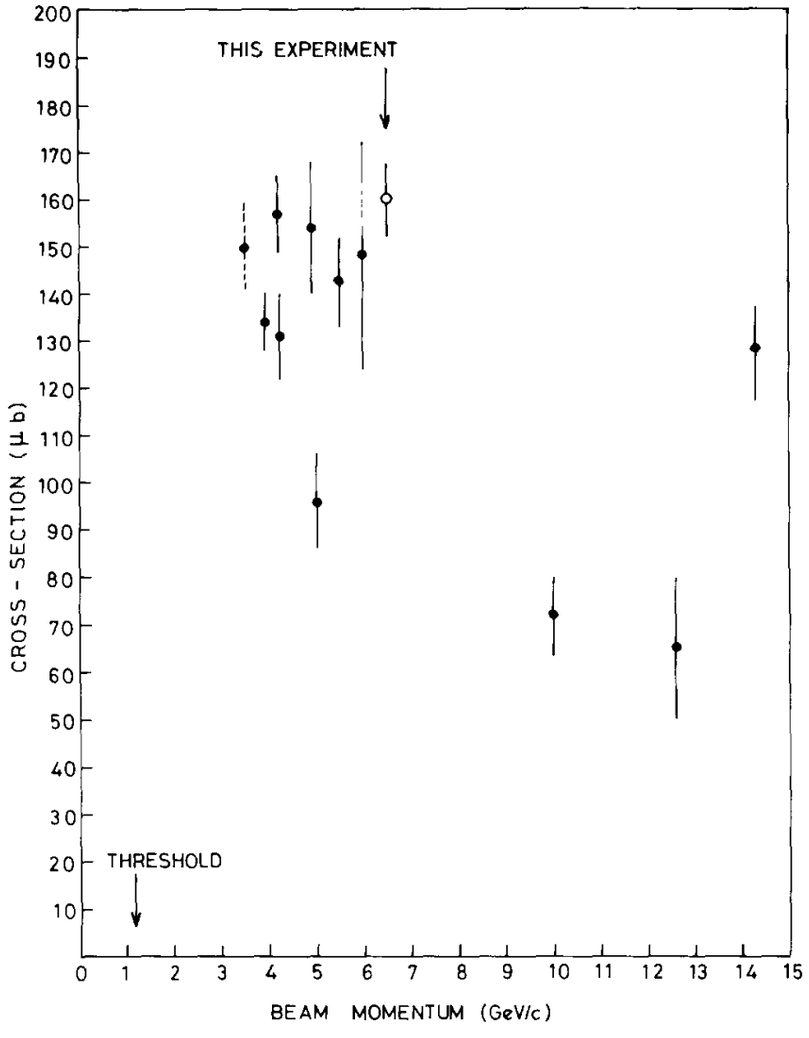
Very poorly measured at AGS (BNL) 32 years ago



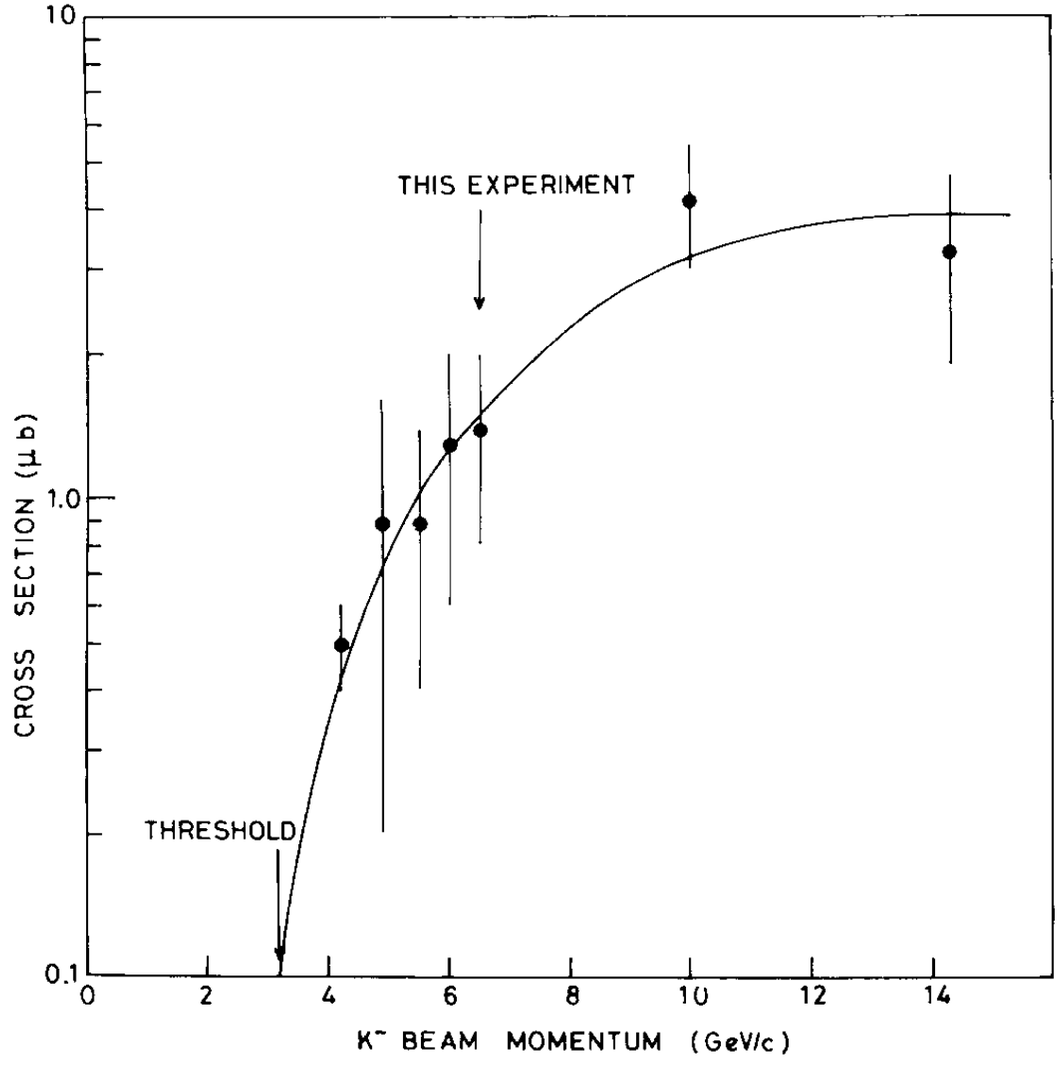
- **C.M. Jenkins et al., Phys. Rev. Lett. 51, 951 (1983)**

Cross Sections

$$K^- p \to \Xi^- X$$



$$K^- p \to \Omega^- X$$



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 studies show 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 of magnitude higher than in LASS (SLAC) experiment

-Data obtained at Jlab will be unique and partially complementary to charged kaon data

-The possibility to run with polarized H and D targets under study

Thank You!