Physics Opportunities with a Secondary K^0_L Beam at

Moskov Amaryan

XVI International Conference on Hadron Spectroscopy

September 13-18, 2015, 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)

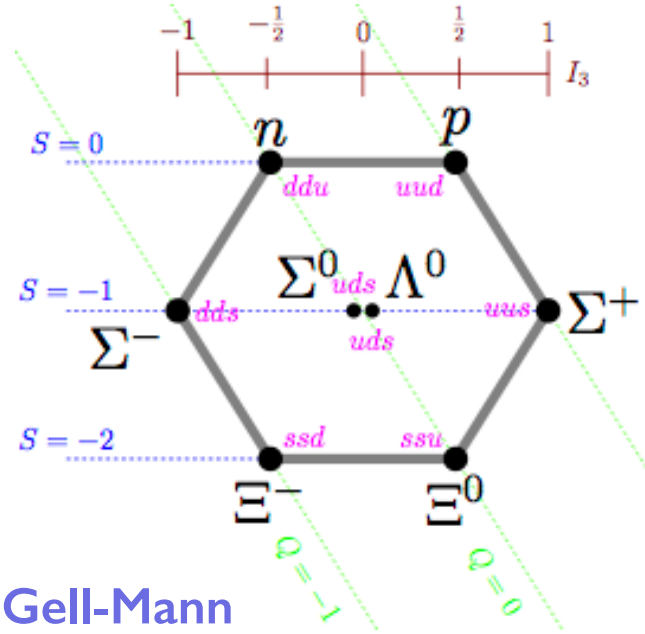
Outline

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

„Nel mezzo del cammin di nostra vita
mi ritrovai per una selva oscura
ché la diritta via era smarrita.“ La Divina Commedia, Dante Alighieri

SU(3)

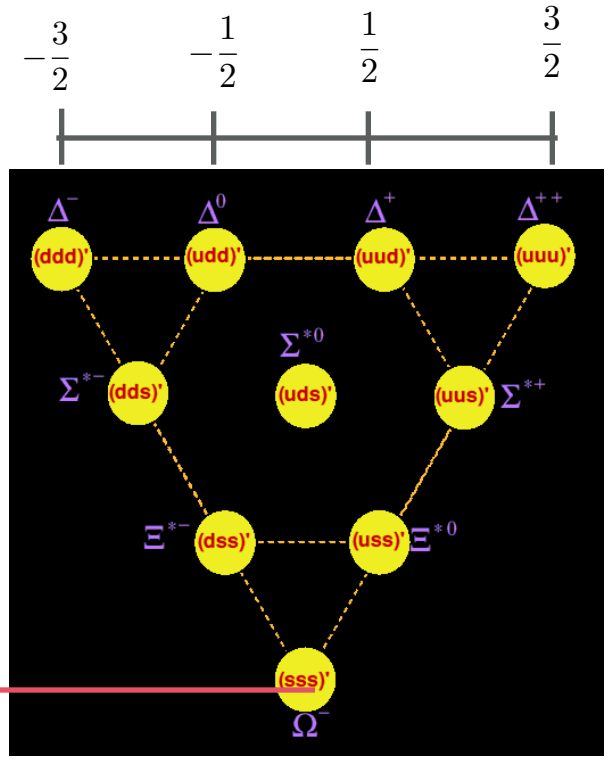
Octet



Gell-Mann
Nishidjima

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

Decuplet



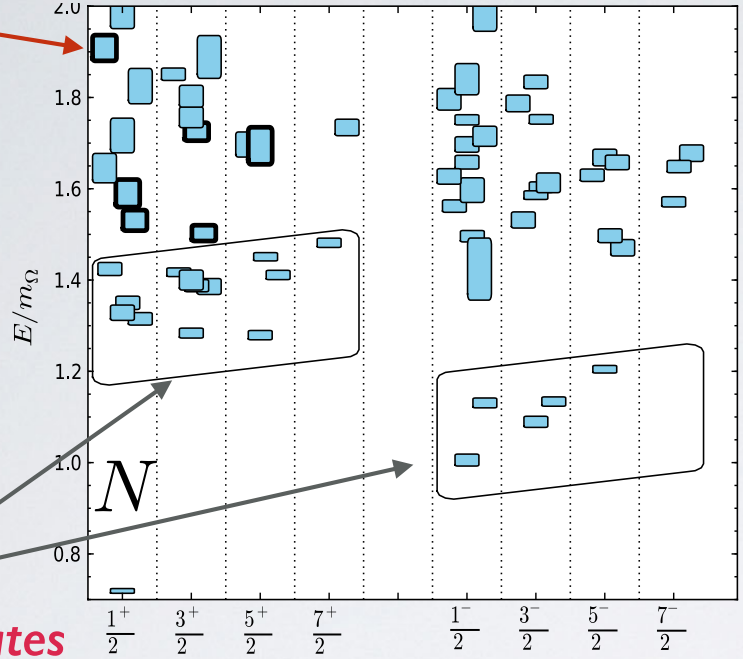
S=-3

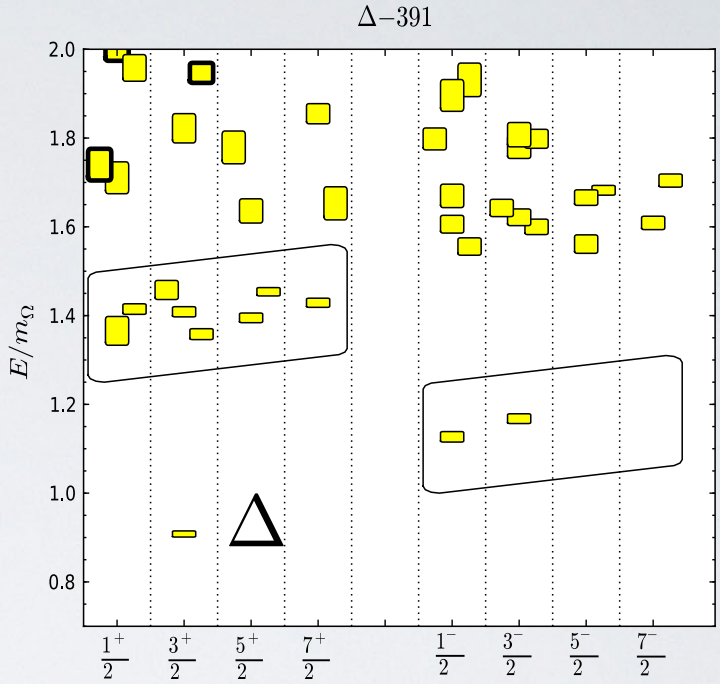
But there are many more states predicted, where are they?
Where are hybrids, glueballs, multiquark states ?
Were past efforts sufficient? □-Yes; ■-No

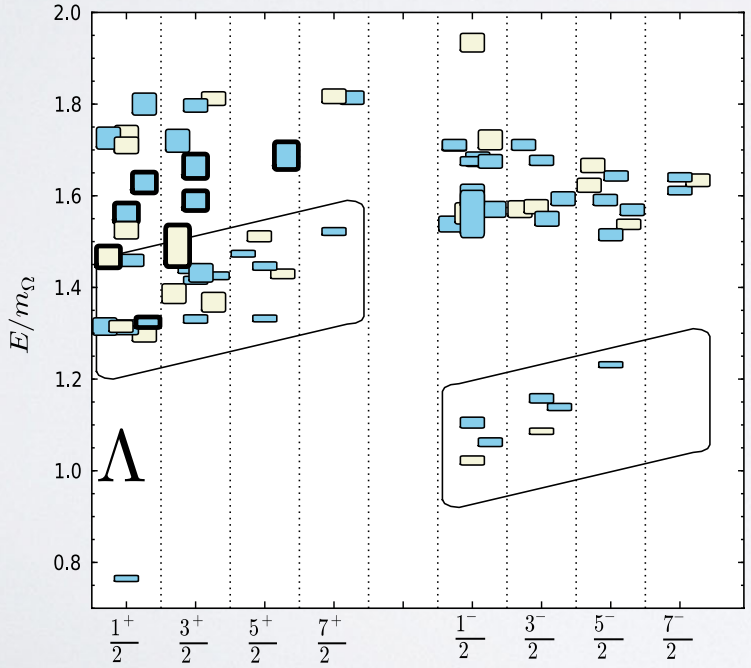
Lattice QCD calculations

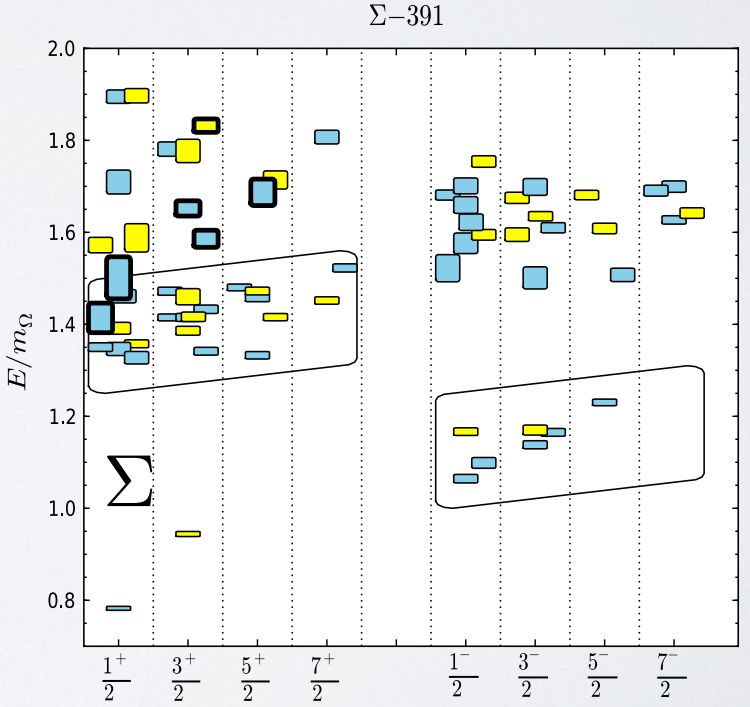
Thick borders: Hybrid states

Low Lying states



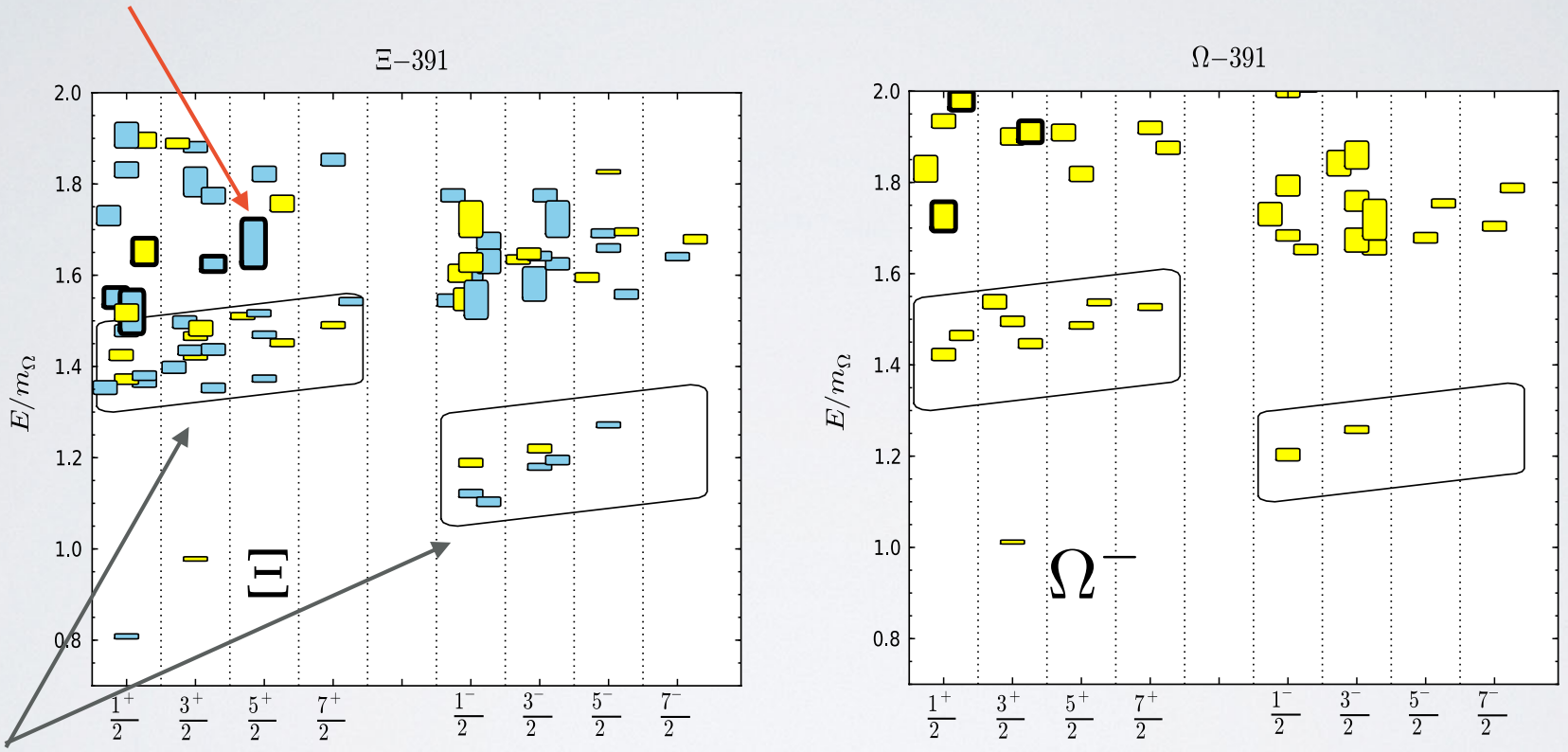






Lattice QCD calculations

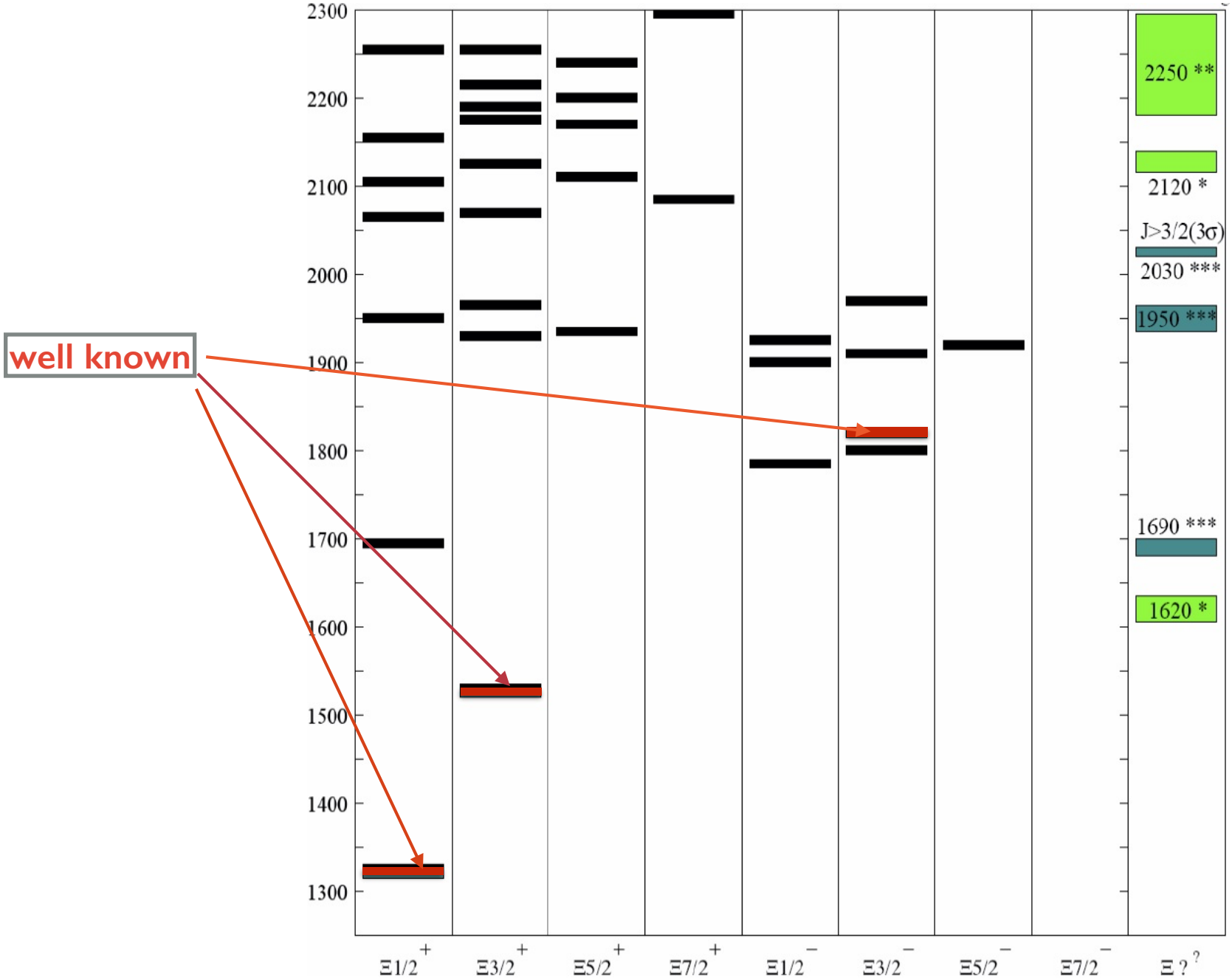
Thick borders: Hybrid states



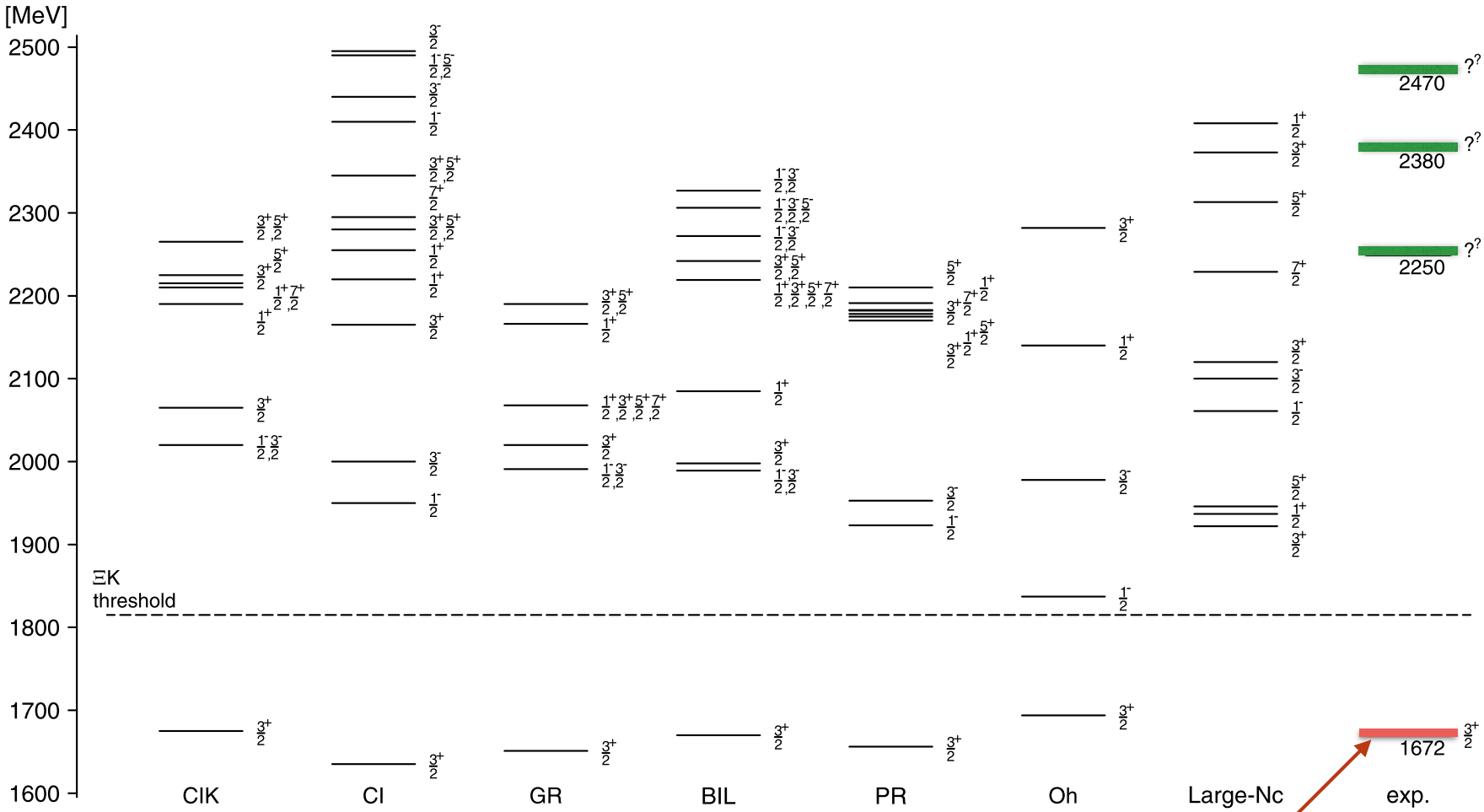
Low Lying states

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

Status of Ξ^*


well known
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
2250 **
2120 *
J>3/2(3σ)
2030 ***
1950 ***
1690 ***
1620 *
Ξ1/2+
Ξ3/2+
Ξ5/2+
Ξ7/2+
Ξ1/2−
Ξ3/2−
Ξ5/2−
Ξ7/2−
Ξ ?

Status of Ω^{-*}



only one well known state?

What if we have a K^0_L beam ?

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

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

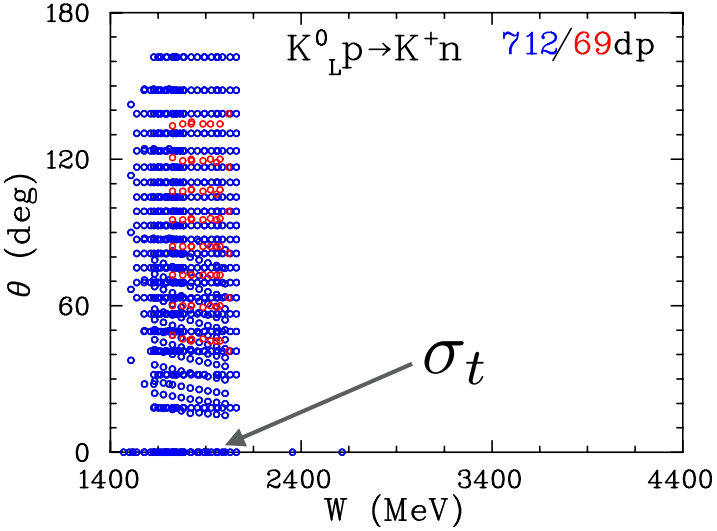
Three-body with S=-3

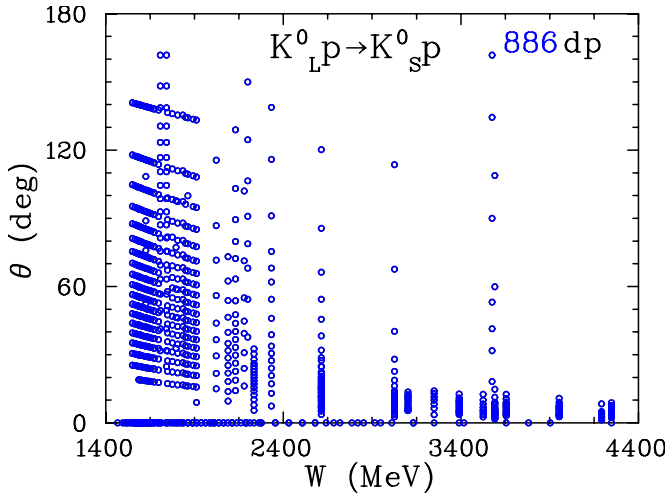
$$K^0_L p \to K^+ K^+ \Omega^-$$
$$K^0_L p \to K^+ K^+ \Omega^{-*}$$

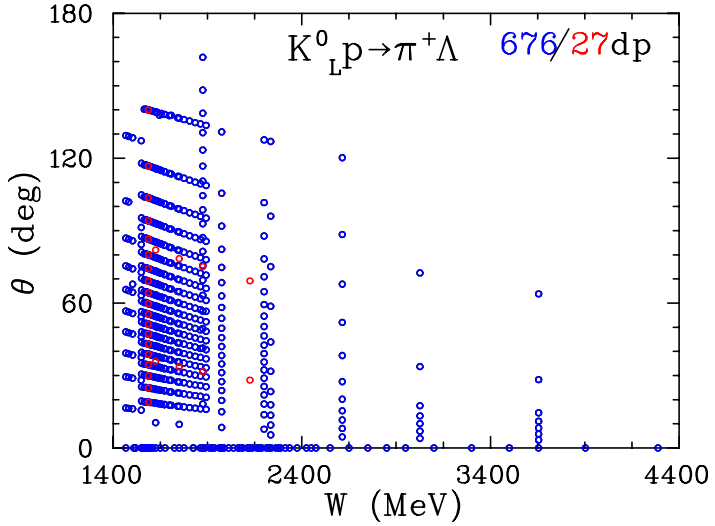
Very Limited World Data with K_L beam

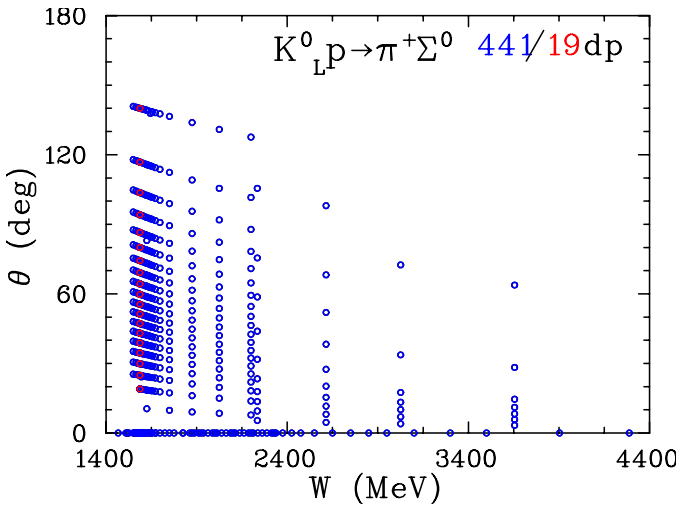
(mainly low stat. bubble chamber data **compilation by I. Strakovsky)**

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







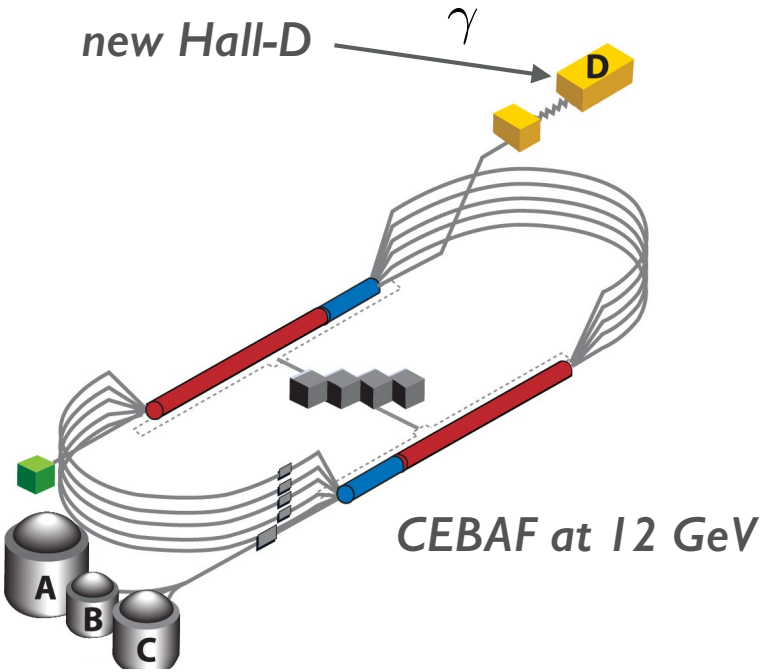


we are not aware of any data on Neutron target

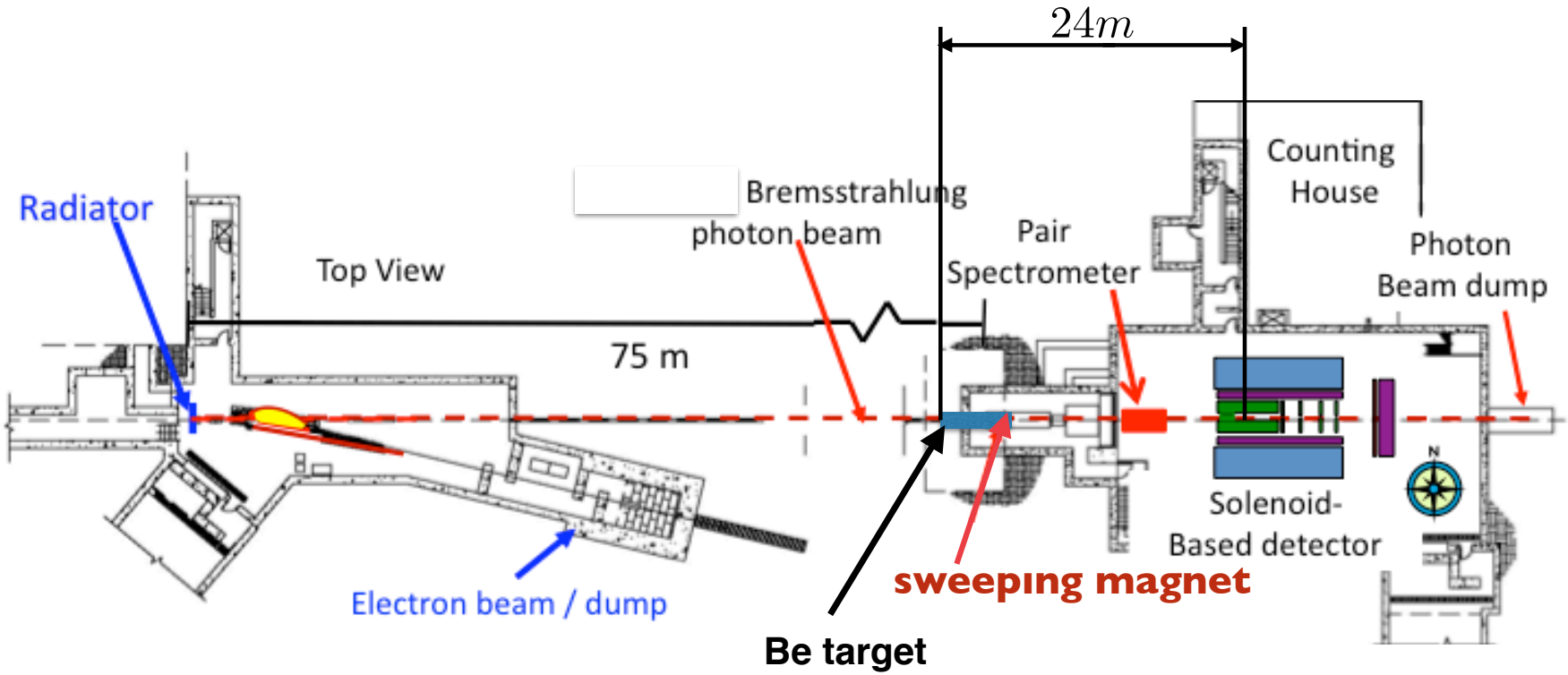
How to make a kaon beam?

Thomas Jefferson National Accelerator Facility

Aerial View



GlueX Beamline for K^0_L



Main components:

Photon Radiator

Be target

Lead absorber

Sweeping Magnet

Pair spectrometer

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 $I_e = 5\mu A$

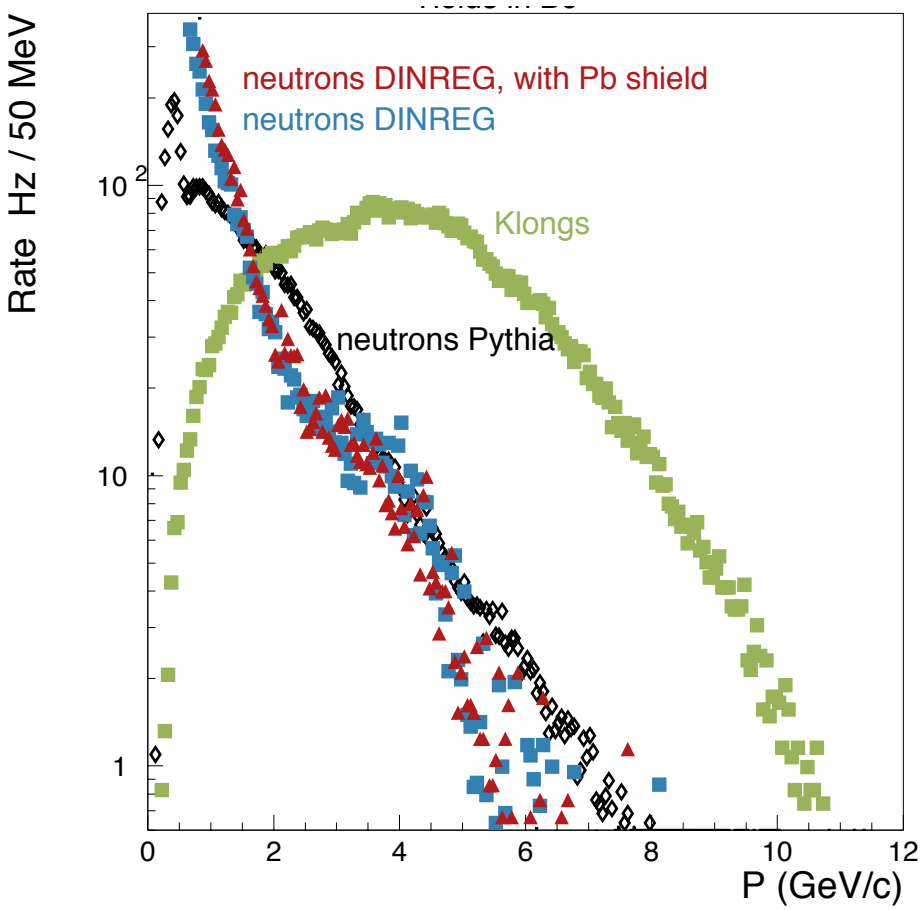
-Delivered with 60ns bunch spacing avoids overlap in the range of P=0.35-3.0 GeV/c

-Momentum measured with TOF

-K^0_L flux mesured with pair spectrometer

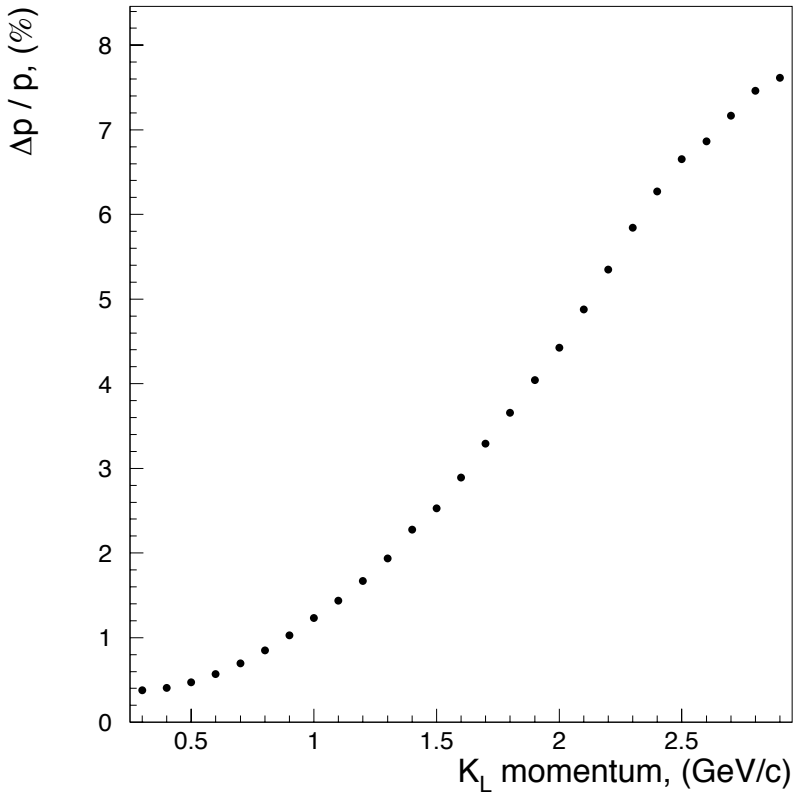
-Side remark: Physics case with polarized targets is under study

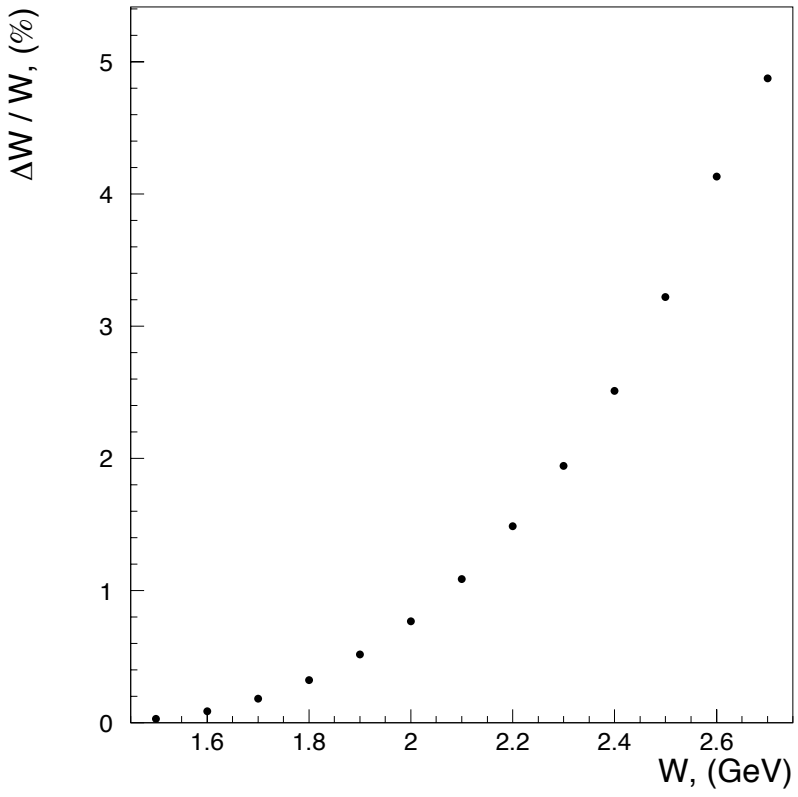
Rate of neutrons and K^0_L on GlueX target



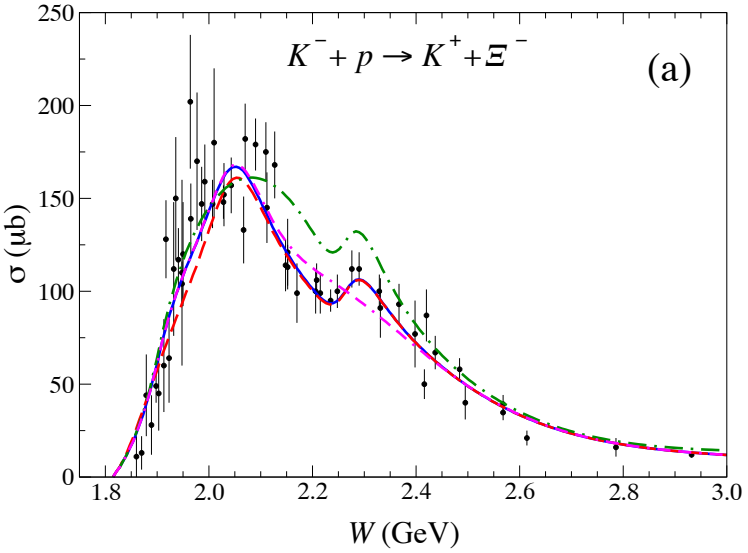
- **With a proton beam ratio $n/K_L = 10^3$-10^4**

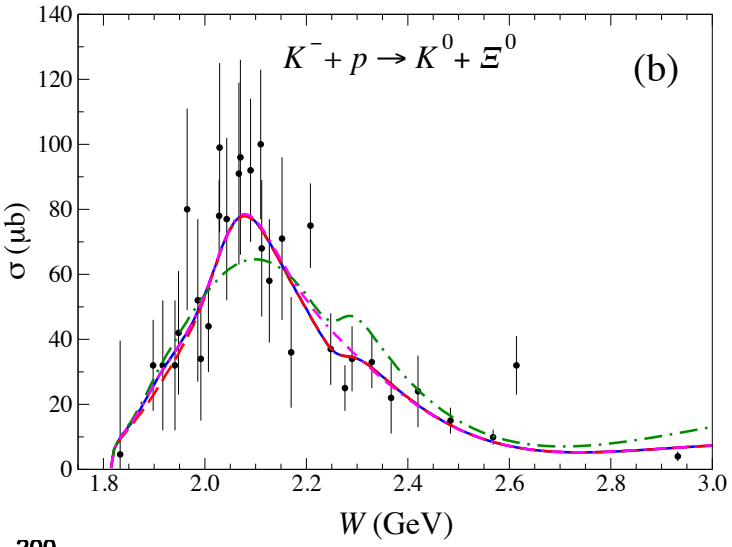
Momentum and W Resolution





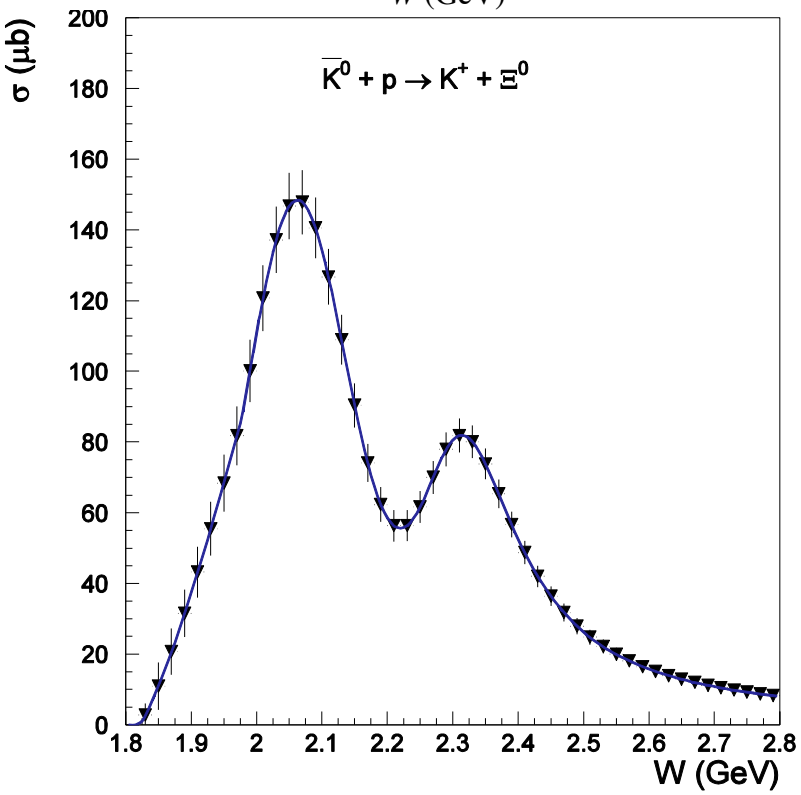
World Data on Ξ





Simulated with GlueX

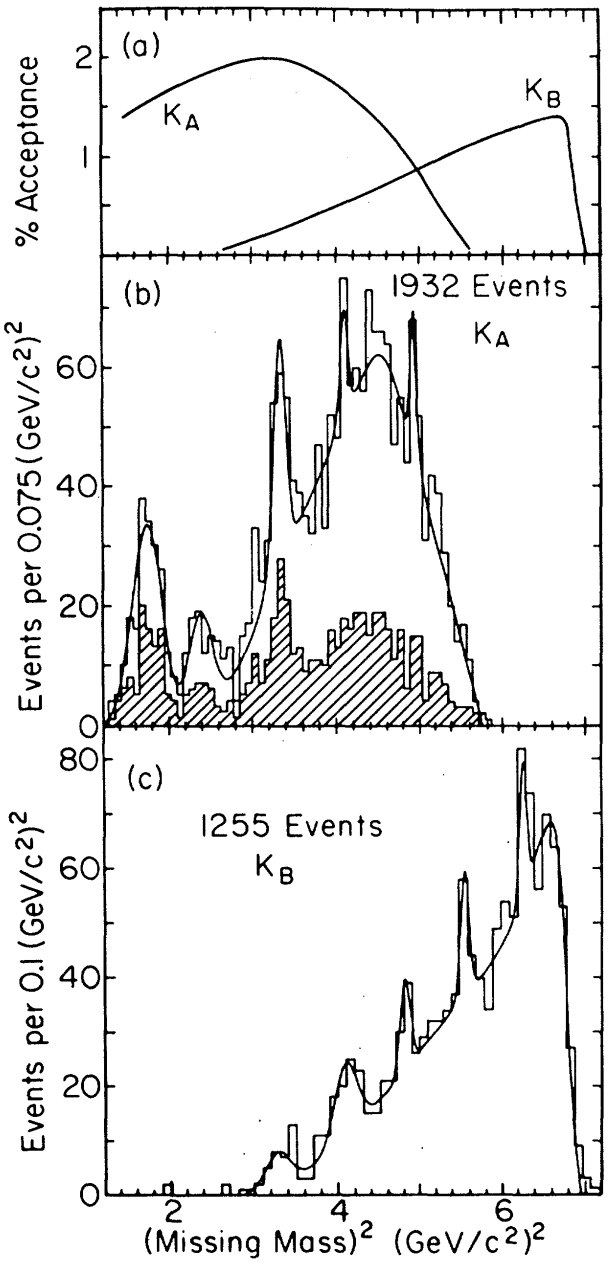
10^4 K_L/sec, one day of running



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

Status of Ξ^*

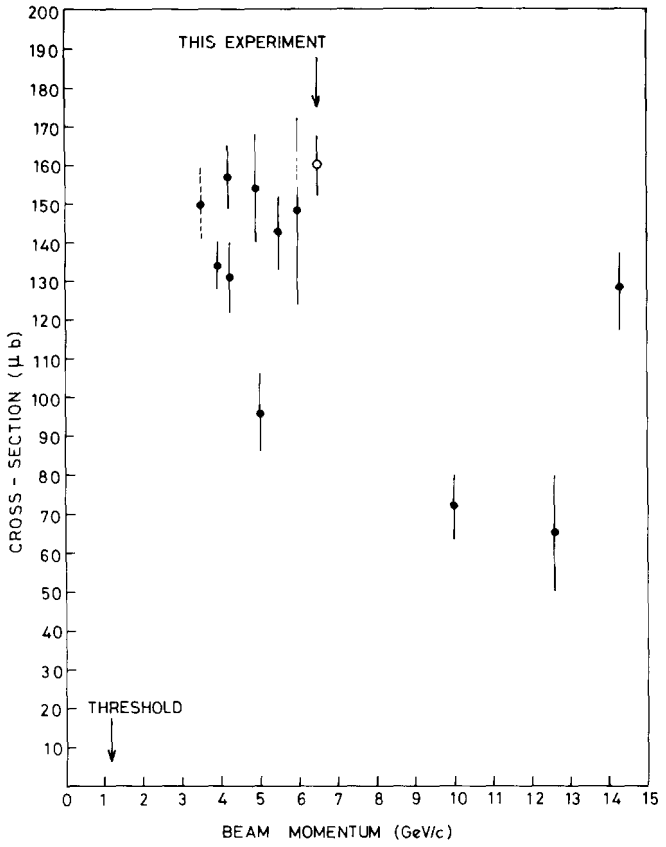
Very poorly measured at AGS (BNL) 32 years ago



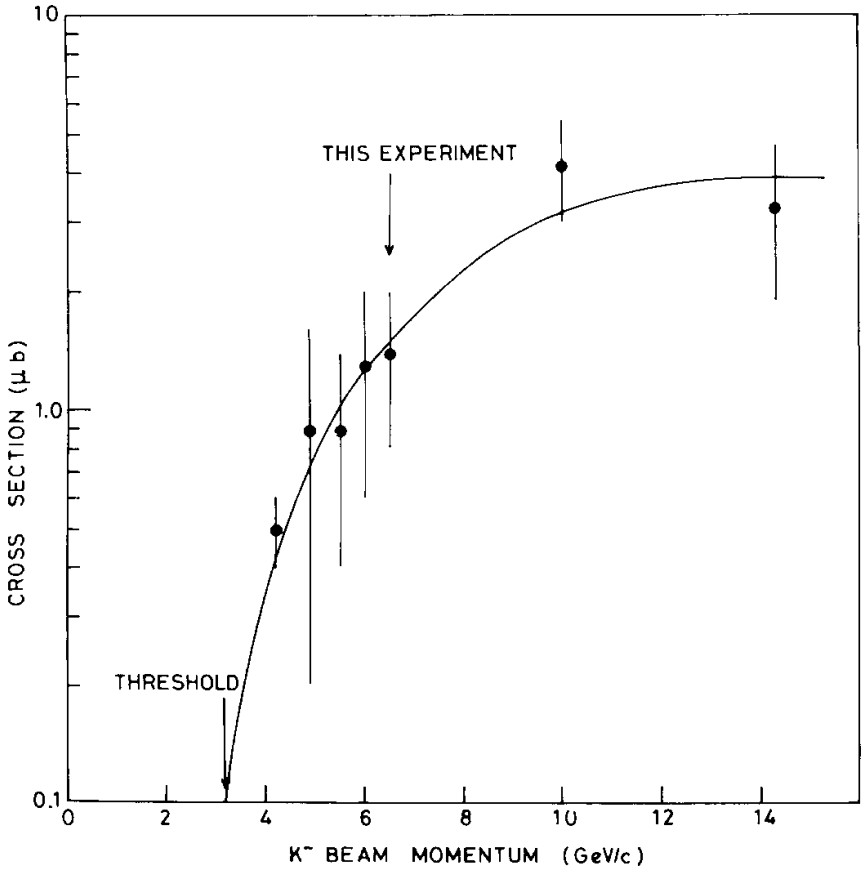
. C.M. Jenkins et al., Phys. Rev. Lett. 51, 951 (1983)

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*

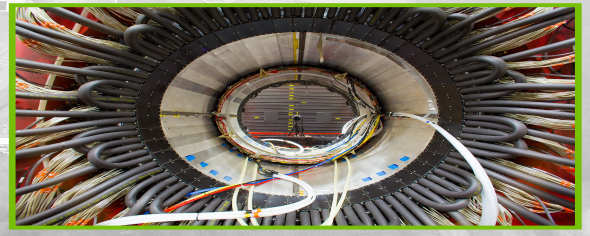
-*Data obtained at Jlab will be unique and partially complementary to charged kaon data*

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

PHYSICS WITH NEUTRAL KAON BEAM AT JLAB

KL2016

FEBRUARY 1-3, 2016
JEFFERSON LAB
NEWPORT NEWS, VIRGINIA



SCOPE

The Workshop is following LoI12-15-001 "Physics Opportunities with Secondary KL beam at JLab" and will be dedicated to the physics of hyperons produced by the kaon beam on unpolarized and polarized targets with GlueX set up in Hall D. The emphasis will be on the hyperon spectroscopy. Such studies could contribute to the existing scientific program on hadron spectroscopy at Jefferson Lab.

The Workshop will also aim at boosting the international collaboration, in particular between the US and EU research institutions and universities.

The Workshop would help to address the comments made by the PAC43, and to prepare the full proposal for the next PAC44.

ORGANIZING COMMITTEE

Moskov Amaryan, ODU, chair
Eugene Chudakov, JLab
Curtis Meyer, CMU
Michael Pennington, JLab
James Ritman, Ruhr-Uni-Bochum & IKP Jülich
Igor Strakovsky, GWU

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https://www.jlab.org/conferences/kl201index.html

You are welcome to take part!

Thank You!