K-Long Experiment @ Jefferson Lab: THREEFOLD Highlights

- project has firmly to setup secondary K_L beam line @ Jefferson Lab ,
  with *flux* of *three order of magnitude higher* than SLAC had,
  for scattering experiments on both *proton* & *neutron* (*first* time !) targets.

- *CEBAF* will remain ***prime facility*** for fixed target electron scattering @ luminosity ***frontier***.
  First hadronic facility @Jefferson Lab .

- We will determine differential cross sections & self-polarization of *hyperons*
  with ***GlueX*** detector to enable precise *PWA* in order to determine ***all*** *resonances*
  up to *2500* MeV in spectra of Λ^*, Σ^*, Ξ^*, & Ω^*.

- We intend to do *strange meson spectroscopy* by studies of π-K interaction
  to locate *pole* positions in I = *1/2* & *3/2* channels.

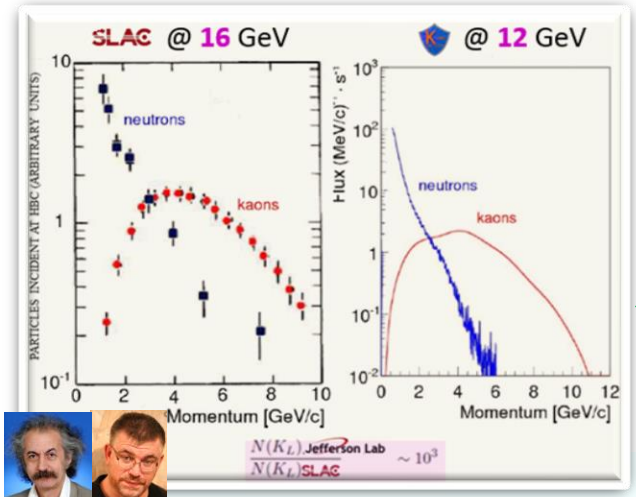
- has link to *ion-ion high energy* facilities as CERN & & will allow
  understand formation of our world in *several microseconds* after *Big Bang*.

E12-12-19-001

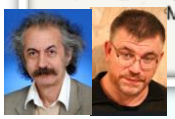
Worldwide Interest in K LONG FACILITY Physics

110 experimentalists &
42 theorists
from **68** labs
across **19** countries
worldwide

Kaon Beamline @ Hall D

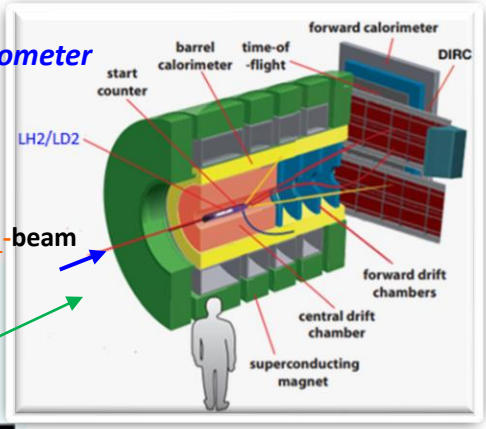


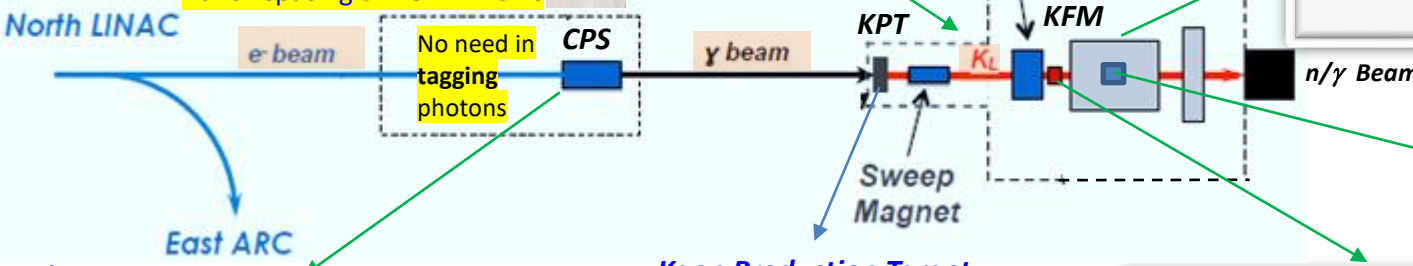
- Electrons (**3.1 x 10^{13}** e/sec) are hitting Cu-radiator @ *CPS* located in Tagger alcove.
- Photons (**4.7 x 10^{12}** γ/sec @ E > 1.5 GeV) are hitting Be-target located in Collimator alcove.
- K_L s (**1 x 10^4** K_L/sec) are hitting LH_2/LD_2 target within ***GlueX*** setting.



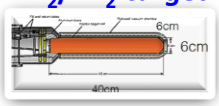
12 GeV **5** μA
Bunch spacing **64** ns → **128** ns

GlueX Spectrometer

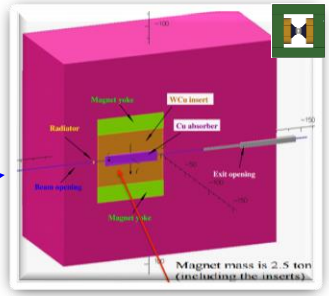




LH_2/LD_2-target



Compact Photon Source

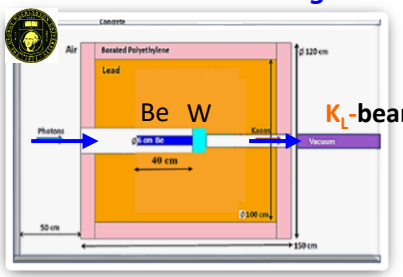


e-beam

γ-beam

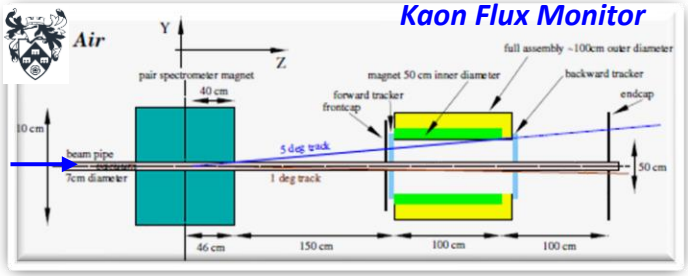
Kaon Production Target

γ-beam

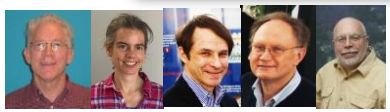


K_L-beam

Kaon Flux Monitor

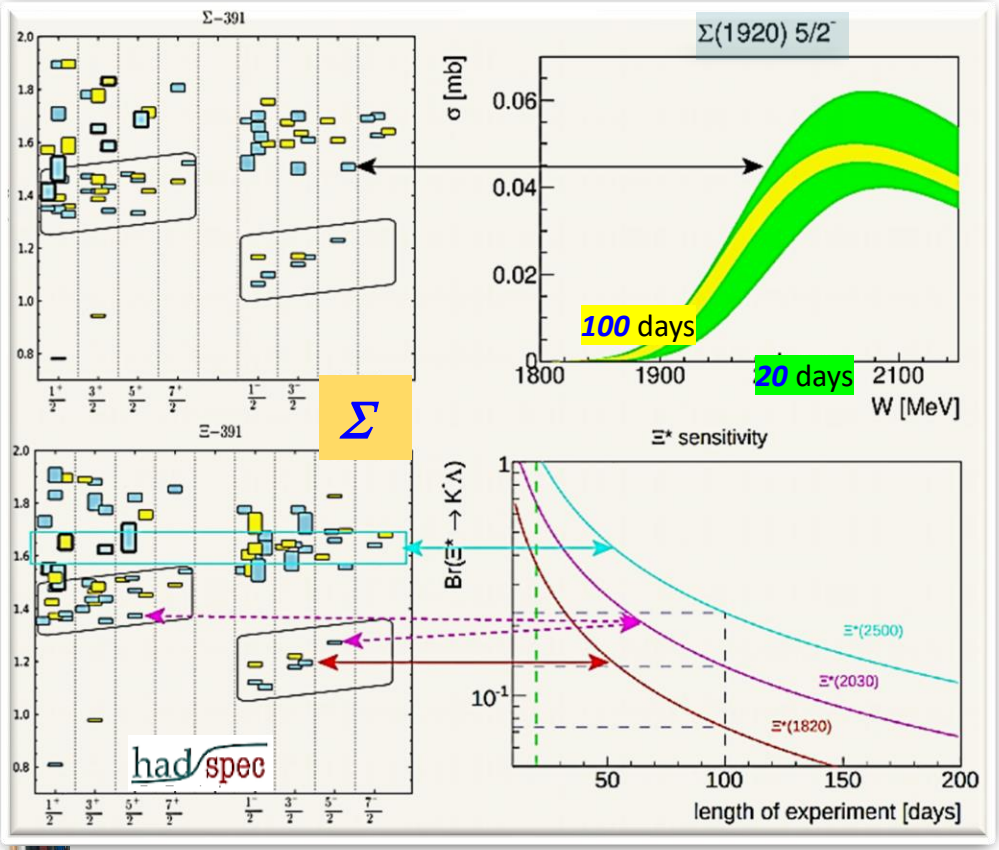


IS *et al.* [arXiv:2002.04442 [physics.ins-det]



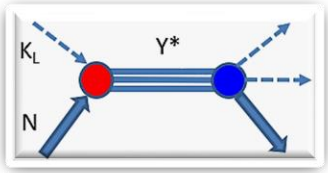
D. Day *et al.* Nucl Instrum Meth A **957**, 163429 (2020)

Summary of Hyperon Spectroscopy

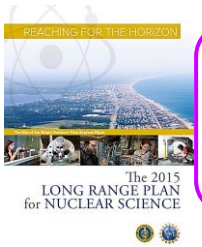


R. G. Edwards *et al*, Phys Rev D **87**, 054506 (2013)

- We showed that KL sensitivity with *100 days* of running will allow to discovery many *hyperons* with good precision.
- *Why should it be done with KL beam* ?
  This is only realizable way to observe ***s***-channel resonances having ***all momenta*** of *KL* @ once (``*tagged*'' *kaons*) .



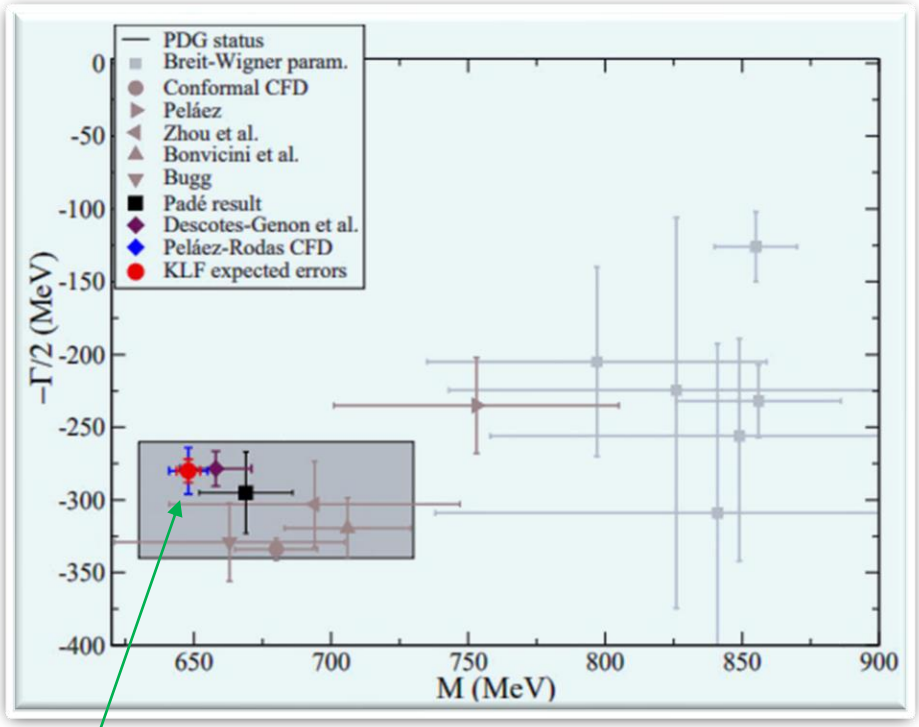
- *Why should it be done* @ Jefferson Lab ?
  Because nowhere else in existing facilities this can be done.
- *Why should we care that there are dozens of missing states* ?



…The new capabilities of the 12-GeV era facilitate a detailed study of baryons containing two and three strange quarks. Knowledge of the spectrum of these states will further enhance our understanding of the manifestation of QCD in the three-quark arena.

2015 LRP for Nuclear Science

Summary of Kπ Spectroscopy



- will have very significant *impact* on our knowledge on *Kπ scattering amplitudes*.
- It will certainly improve still conflictive determination of *heavy K*'s parameters*.
- It will help to settle tension between phenomenological determination of *scattering lengths* from data vs *ChPT* & *LQCD*.
- For *K*(700)*, it will reduce:
  - *uncertainties* in *mass* by factor of *two* &
  - *uncertainties* in *width* by factor of *five*.
- It will help to clarify debated of its *existence*, &, therefore, long standing problem of existence of *scalar* meson *nonet*.

100 days

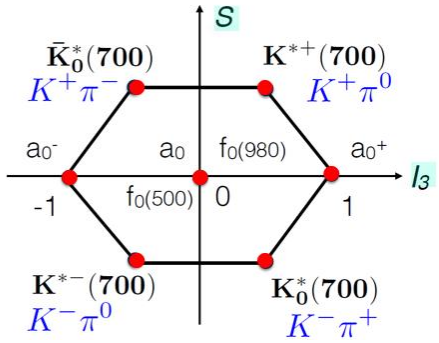
- Roy-Steiner dispersion approach

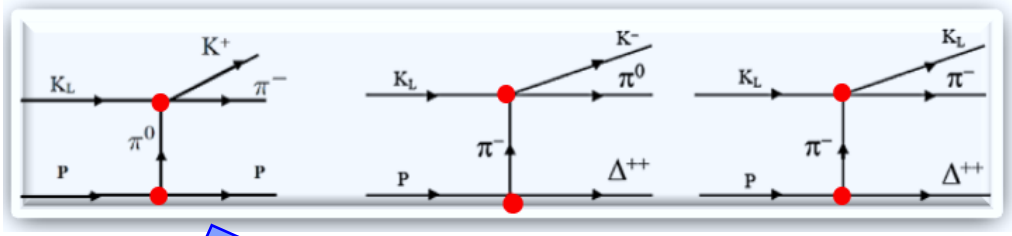
$M - i\Gamma/2 = (648 \pm 4) - i(280 \pm 8)$ MeV

J.R. Pelaez *et al* Phys Rev D **93**, 074025 (2016)

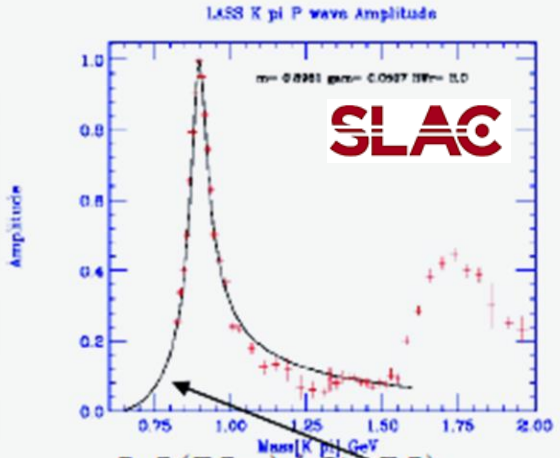
Proposed Measurements for $K\pi$ Scattering

$J^{PC} = 0^{++}$

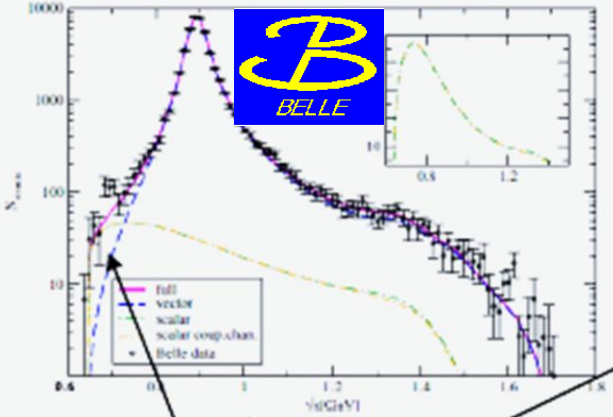




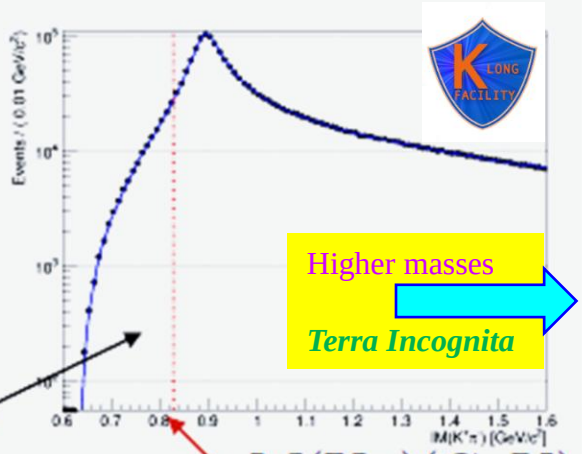
$K^-\pi^+ \to K^-\pi^+$ $\tau \to K\pi\nu_\tau$ $K_L\pi^0 \to K^+\pi^-$



$M(K\pi)(GeV)$



$M(K\pi)(GeV)$



$M(K\pi)(GeV)$

region of $\kappa(800)$

SLAC Lower limit