Overview of KLF experiment

Moskov Amaryan
Old Dominion University

KLF Collaboration Meeting, JLab, Newport News, May 6, 2026

Auf den Bergen der Wahrhei kann man nie vergeblich klettern:
Entweder erreicht man heute einen höheren Punkt, oder man trainiert
seine Kräfte, um morgen höher klettern zu können.

Friedrich Nietzsche (1844-1900)

One can never climb the mountains of truth in vain: either one reaches
a higher point today, or one trains one's strength to be able to climb
higher tomorrow.

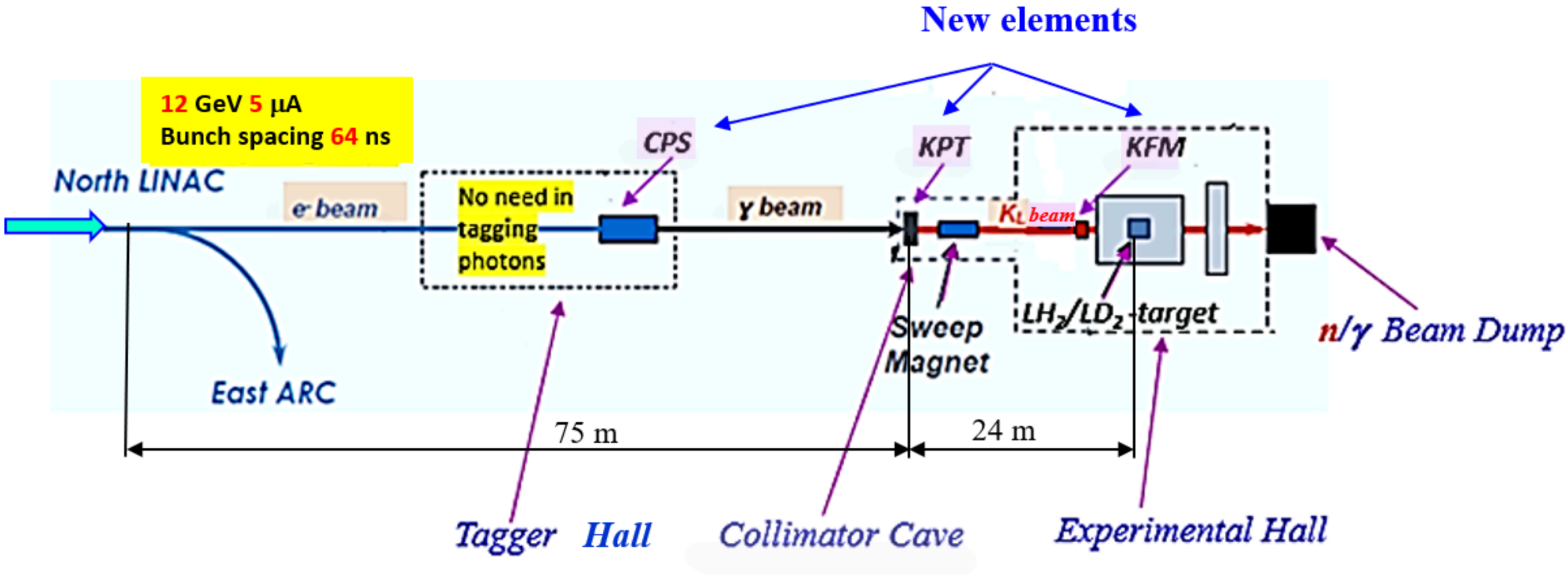
Outline:

- Introduction
- KLF beamline
- CPS
- Kaon Production target
- Flux Monitor
- Start Counter
- Software
- Summary

What is it about?

- The experiment was approved in 2020! To run for 200 days on LH2 and LD2 targets equally shared: https://arxiv.org/pdf/2008.08215
- Compared to the SLAS flux of K-long 10/sec obtained in 70’s of the last century, we can increase the flux for about ~1000 times at JLab.
- This is for the first time that we could get an access to almost all missing hyperon states both on hydrogen and deuterium data in a two-body reactions.
- This will allow to get the temperature of Universe 1\mu s after the Big Bang and compare it with the Lattice calculations which are off right now by almost 50% from data.
- Charged kaons beams can not be used for a two-body reactions.
- In addition to missing hyperon states we could measure so called kappa scalar meson with unprecedented accuracy, as well as higher K* states.

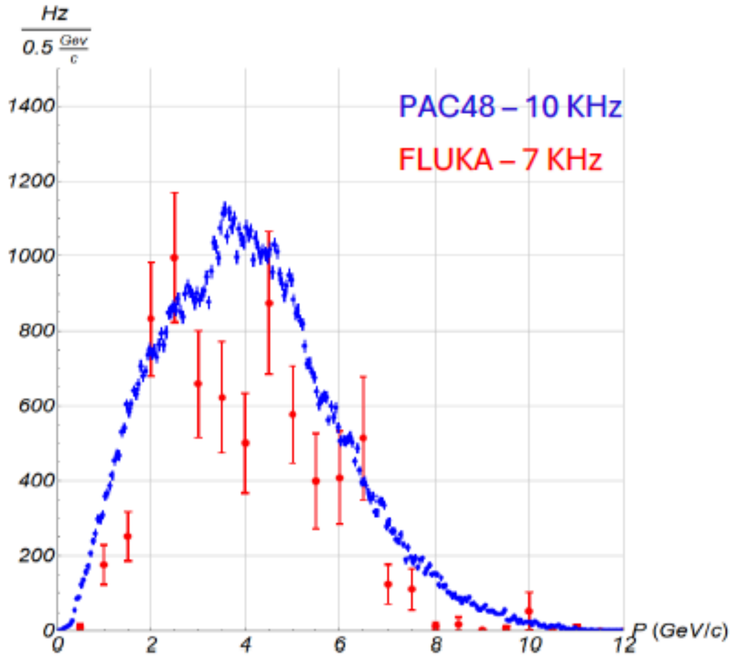
KLF Beamline



More details will be discussed in talks of H. Egiyan, M. Bashkanov and K. Itahashi

K-long Flux

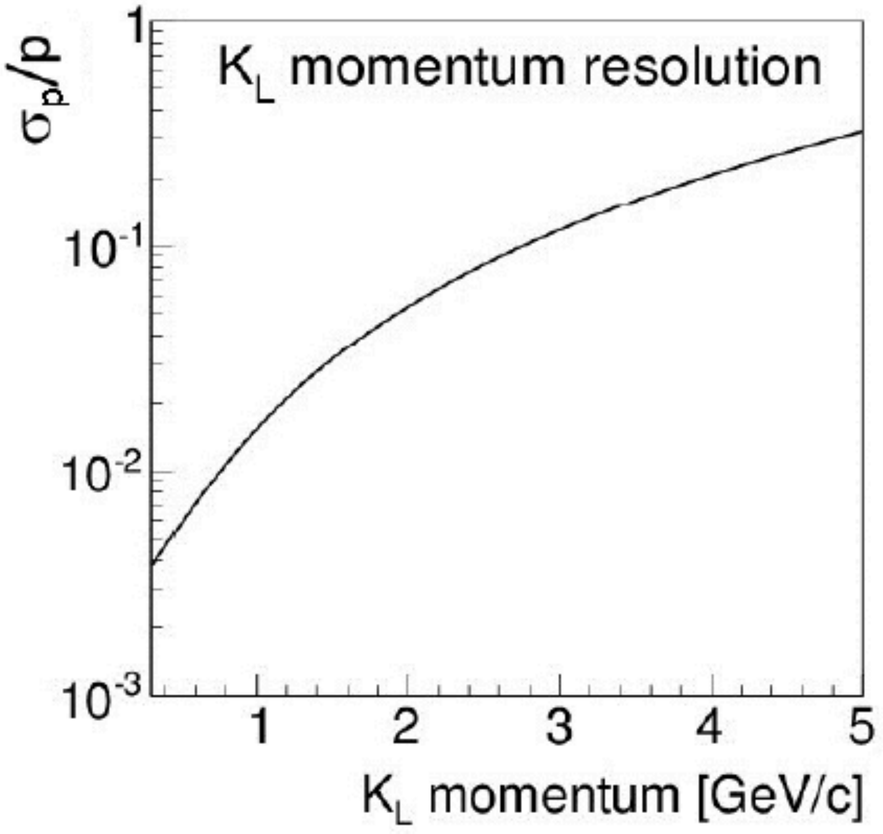
Analysis	K_L Rate (Hz) (10cm W, 10% RL)	K_L Rate (Hz) (14cm W, 20% RL)	Effective K_L Absorption length used (cm)	Comments
Ilya & Igor	10000			PAC 48
Pavel		8200	10.8	FLUKA
Eugene	3300	1900*	7.8	ϕp production only
Eugene	8500	5000*	7.8	PYTHIA, 7KHz - 10KHz range
Richard		1500	7.8	ϕp production only
Moskov		7600	6.4	Based on SLAC data
Hovanes		3100	7.1	Based on SLAC data

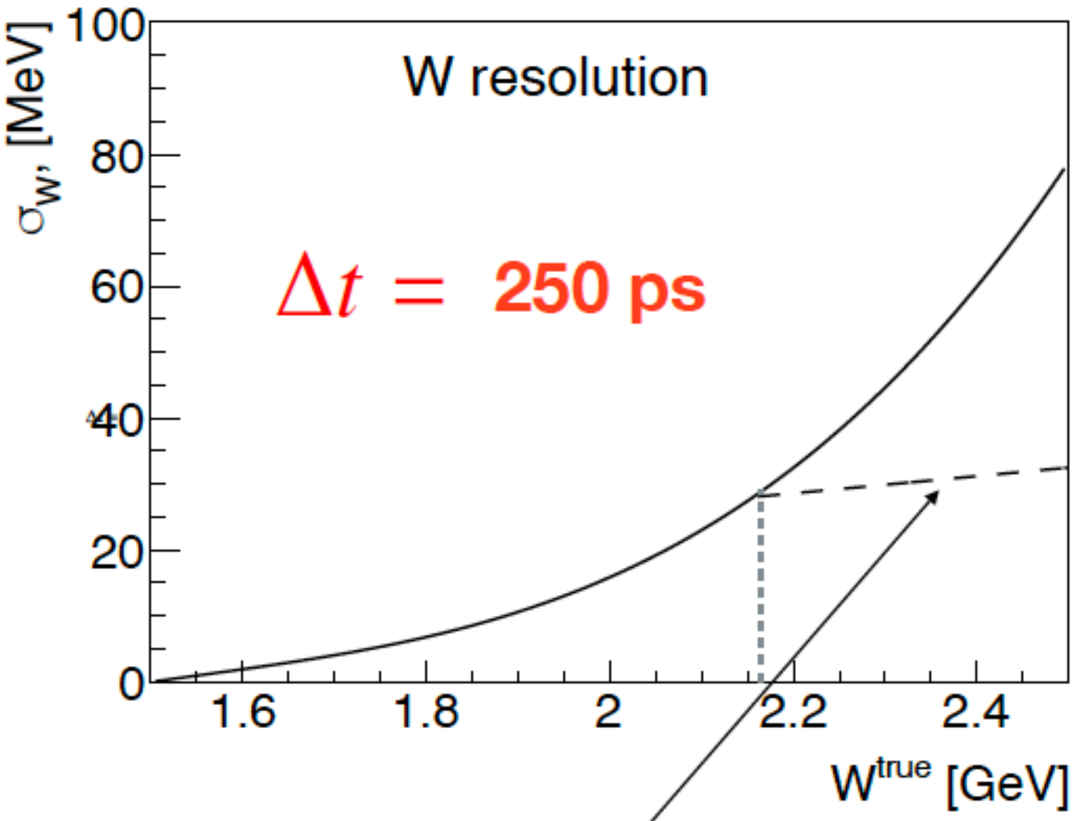


SLAC rate was 10 K_L/s

Phys. Rev. D 7, 708 (1973).

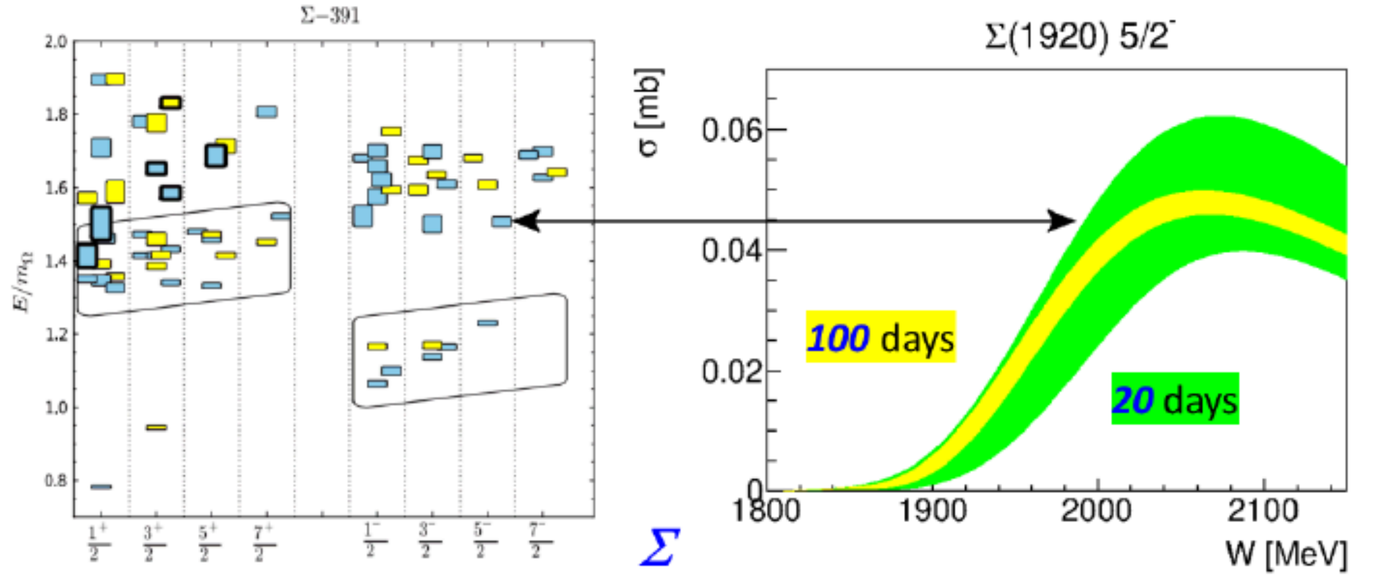
Resolutions

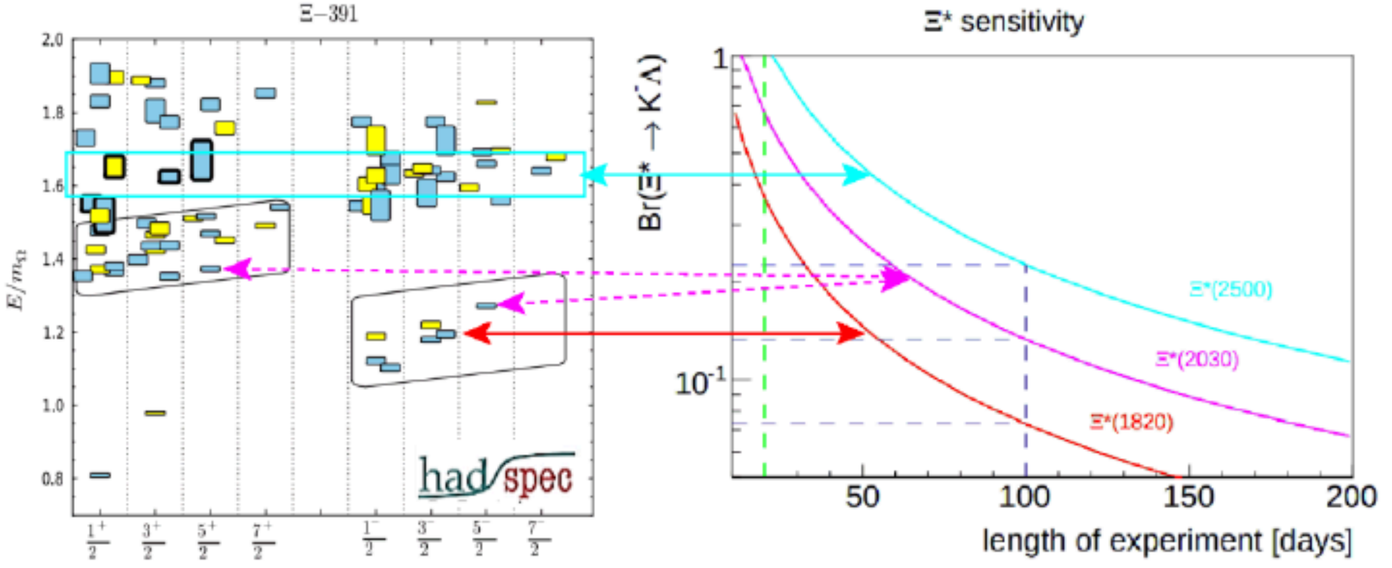




Shaded line shows region of full reconstruction

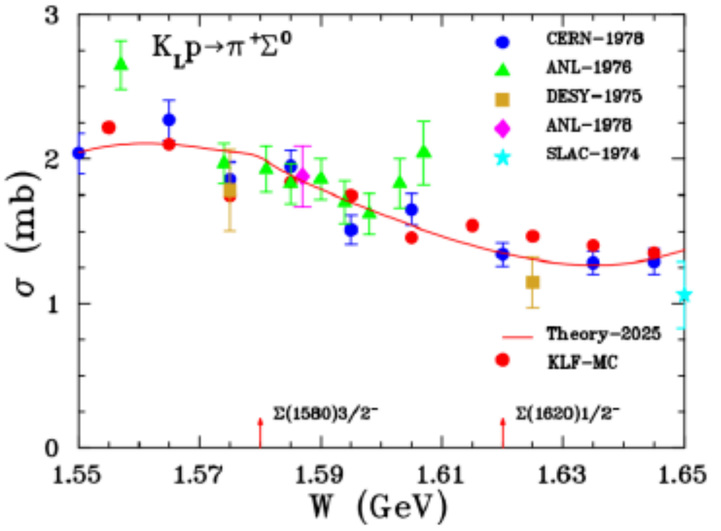
Some examples





New MC simulations with KLF

Isospin-Selective Reaction $K_L p \to \pi^+ \Sigma^0$ *Provides Clean Probe for Investigating* $I = 1$ Σ^* *Resonances*



Analysis of this reaction using effective *Lagrangian* approach for first time, incorporating well-established (4*): $\Sigma(1189)1/2^+$, $\Sigma(1385)3/2^+$, $\Sigma(1670)3/2^-$, & $\Sigma(1775)5/2^-$ states, while also exploring contributions from other unestablished states.

Dan Guo, Jun Shi, Igor Strakovsky, & Bing-Song Zou, arXiv:2504.21342 [hep-ph]

It was found that besides established resonances, contributions from $\Sigma(1660)1/2^+$ (3*), $\Sigma(1580)3/2^-$ (1*), & $\Sigma(1620)1/2^-$ (1*) improve description.

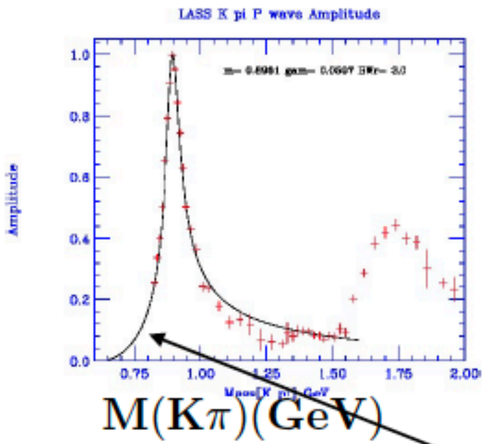
Accepted for publication in PRD

Strange Meson Spectroscopy

Proposed Measurements

SLAC

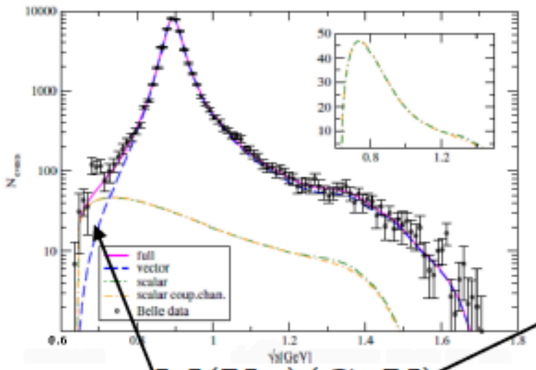
$K^-\pi^+ \to K^-\pi^+$



$\mathbf{M(K\pi)(GeV)}$

Belle

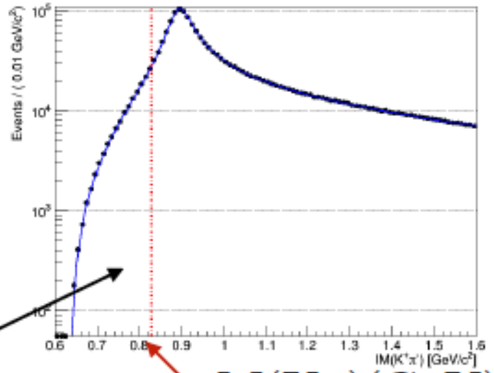
$\tau \to K\pi\nu_\tau$



$\mathbf{M(K\pi)(GeV)}$

KLF

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



$\mathbf{M(K\pi)(GeV)}$

reglon of $\kappa(800)$

SLAC Lower limit

See a talk by Keigo Miizutani and Sean Dobbs

Projected Measurements

I=3/2+1/2 *S-wave*

[redacted]

SLAC Data

$K^{\pm}p \to K^{\pm}\pi^{+}n$

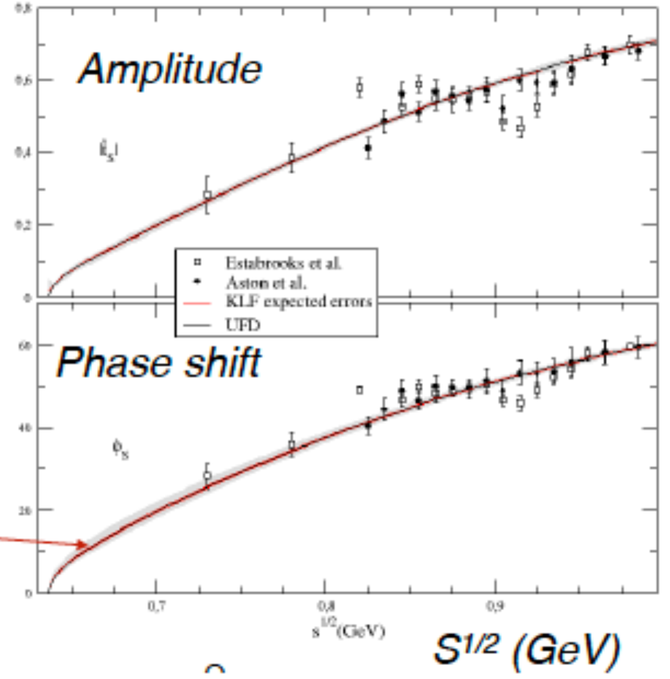
$K^{\pm}p \to K^{\pm}\pi^{-}\Delta^{++}$

Estabrooks(1978)

$K^{-}p \to K^{-}\pi^{+}n$

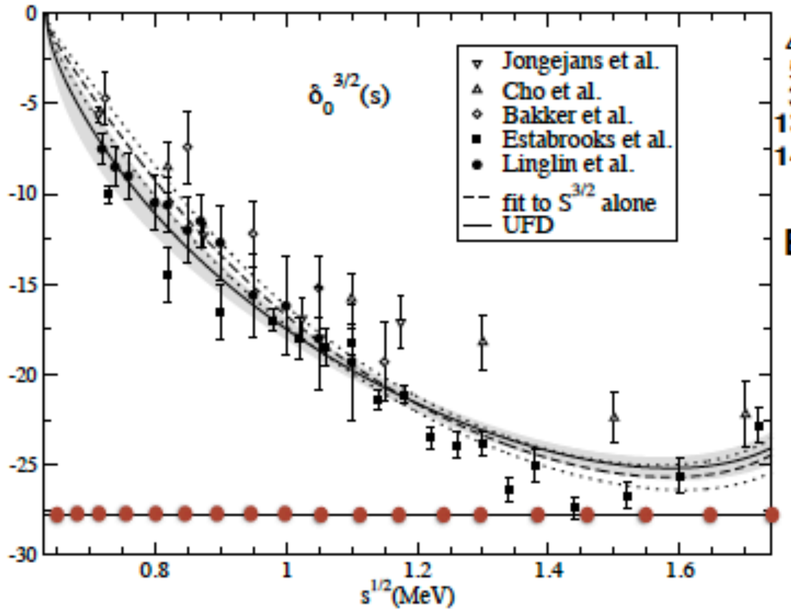
Aston(1988)

KLF (100 days)



$S^{1/2}$ (GeV)

I=3/2 *S-wave*



4.25 GeV Saclay
5.5 GeV CERN
3.0 GeV ANL
13.0 GeV SLAC
14.3 GeV CERN

Estabrooks(1978)

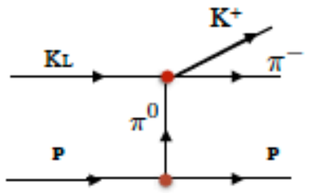
$K^{\pm}p \to K^{\pm}\pi^{+}n$

$K^{\pm}p \to K^{\pm}\pi^{-}\Delta^{++}$

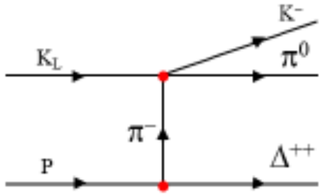
KLF 100 days

From Pelaez and Rodas paper: PRD93(2016)

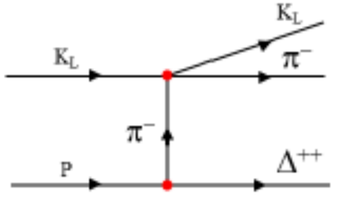
$K\pi$ Scattering



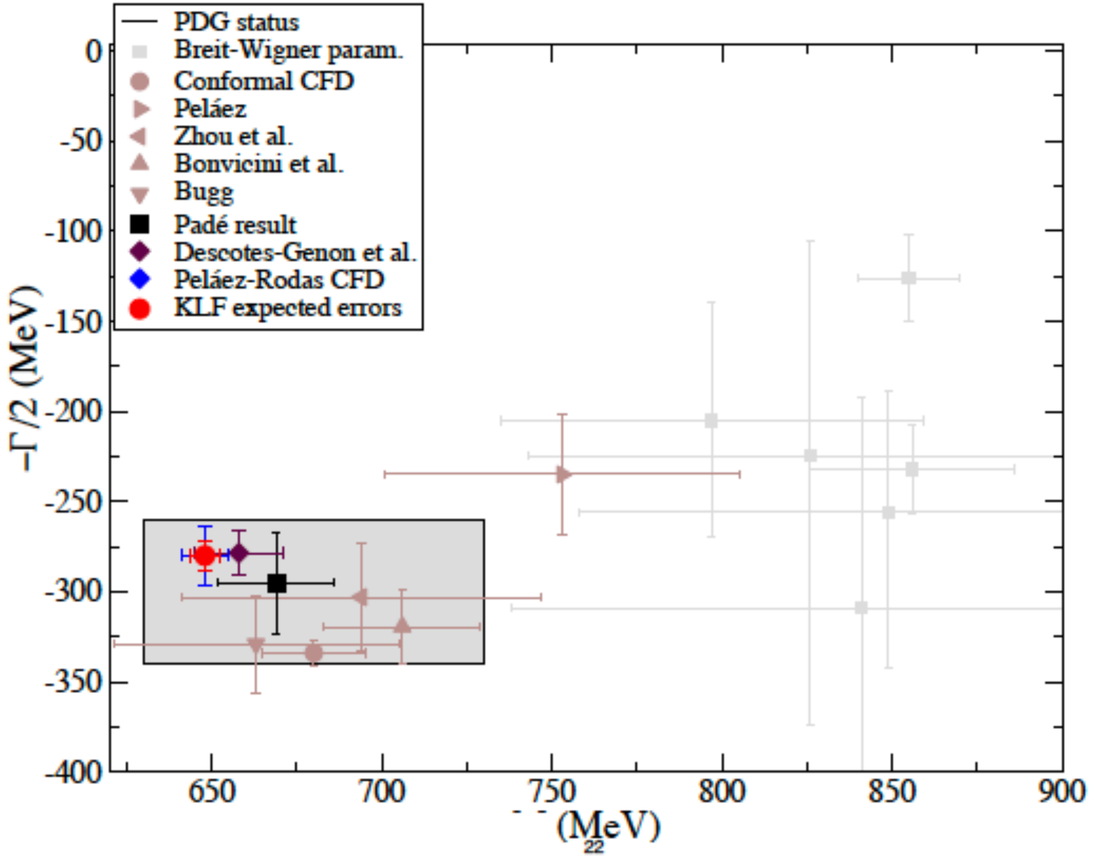
$$\frac{1}{3}(T^{1/2} - T^{3/2})$$



$$\frac{1}{3}(T^{1/2} - T^{3/2})$$

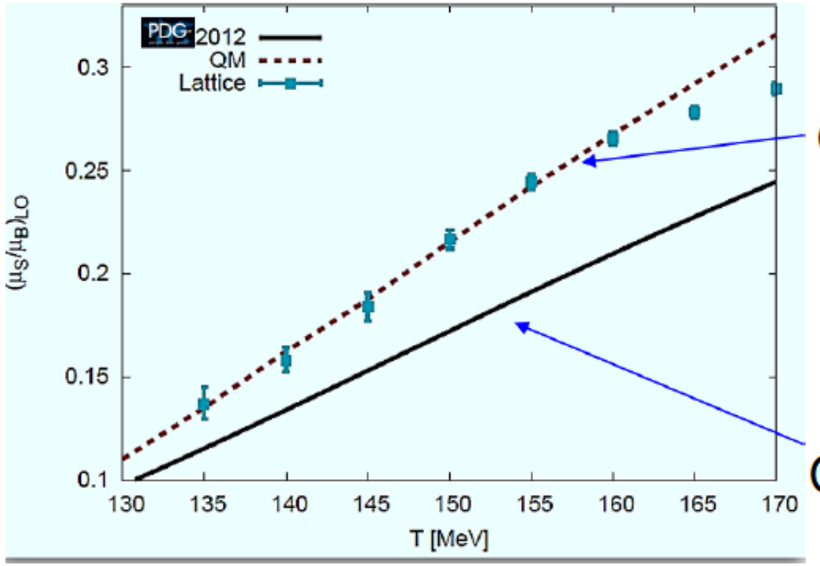


$$\frac{1}{3}(T^{1/2} + T^{3/2})$$



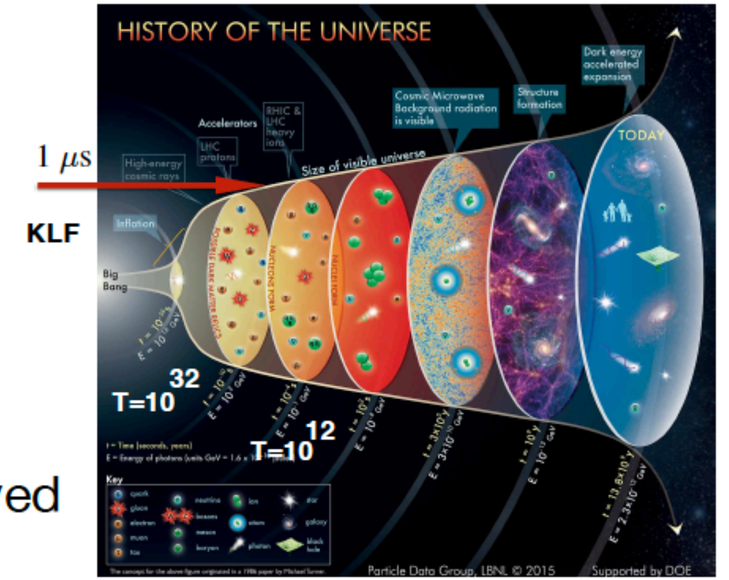
J. Pelaez and A. Rodas, Phys.Rept. 969 (2022)

Formation of Visible Matter during the Freeze-Out of the Universe after the Big Bang



QM

Observed



$1\ \mu s$

KLF

37

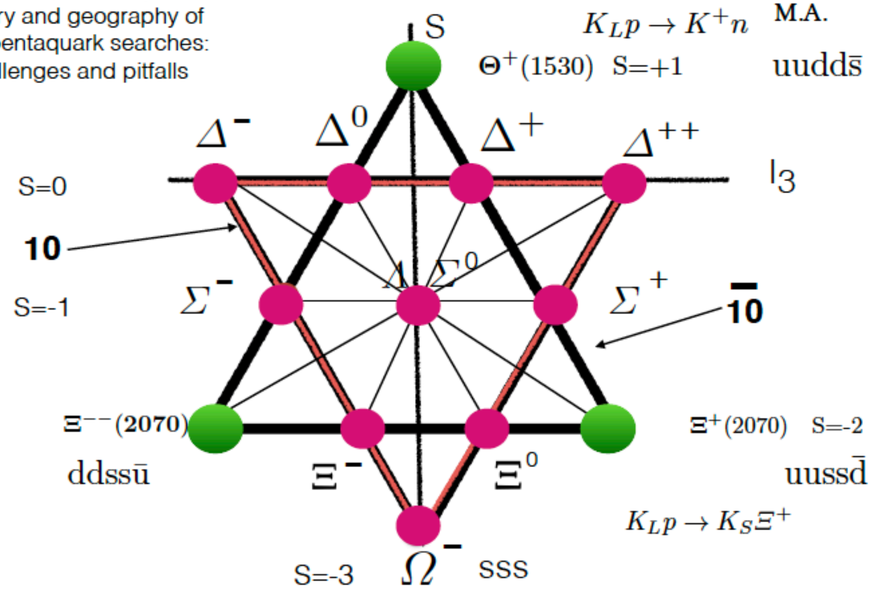
arXiv:1701.07346

Workshop YSTAR2016 Mini-Proceedings

Eur. Phys. J. Plus (2022) 137:684, M.Amaryan History and geography of light pentaquark searches: challenges and pitfalls

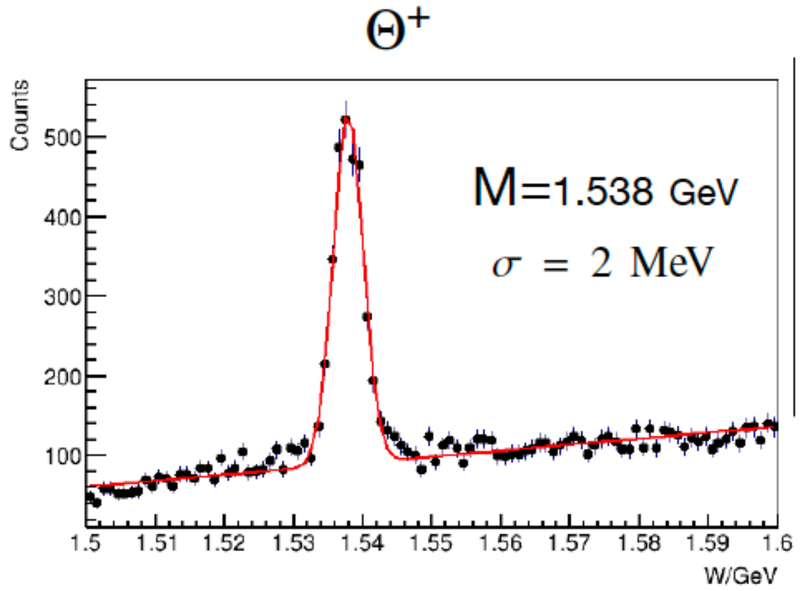
Pentaquarks

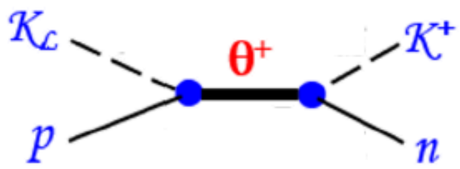
Modern Physics Letters A (2024) 2450063 D.Jido, S.Hirama, I.Strakovsky, M.A.



D. Diakonov, V. Petrov and M. V. Polyakov, Z. Phys. A **359**, 305 (1997).

Exotic Pentaquark Simulation





The figure from Geant4 simulation is for 55 days of running.

In 100 days we expect ~4000 events in the peak with

S/B= 5/1. Simulation is done for natural width of 0.5 MeV.

See the talk of Vitaly Baturin

Summary

- For the first time in the history of Particle Physics intensive beam of neutral K_L will be used for the strange hadron spectroscopy.
- In hyperon spectroscopy all excited states of Σ^*'s and Λ^*'s will be measured in the formation reactions.
- The Ξ^*'s will be measured either as a decay product of Σ^*'s in the formation reactions or via direct production mechanisms.
- The Ω^* hyperons will be measured in the production reactions.

- K-pi scattering with unprecedented accuracy.

- And more to come…