Strange Hadron Spectroscopy with Secondary K_L beam in Hall D

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Norfolk, VA, USA

KLF Collaboration Meeting, May 19, 2020

Strange Hadron Spectroscopy with Secondary K_L Beam in Hall D

Experimental Support:

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Theoretical Support:

Alexey Anisovich[5,44], Alexei Bazavov[38], Rene Bellwied[21], Veronique Bernard[42], Gilberto Colangelo[3], Aleš Cieplý[46], Michael Döring[19], Ali Eskanderian[19], Jose Goity[20,49], Helmut Haberzettl[19], Mirza Hadžimehmedović[55], Robert Jaffe[36], Boris Kopeliovich[54], Heinrich Leutwyler[3], Maxim Mai[19], Vincent Mathieu[34], Maxim Matveev[44], Ulf-G. Meißner[5,29], Colin Morningstar[9], Bachir Moussallam[42], Kanzo Nakayama[58], Viktor Nikonov[5,44], Wolfgang Ochs[37], Youngseok Oh[31], Rifat Omerovic[55], Hedim Osmanović[55], Eulogio Oset[62], Antimo Palano[64], Jose Pelaez[34], Alessandro Pilloni[49], Maxim Polyakov[48], David Richards[49], Arkaitz Rodas[49], Dan-Olof Riska[12], Jacobo Ruiz de Elvira[3], Hui-Young Ryu[45], Elena Santopinto[23], Andrey Sarantsev[5,44], Jugoslav Stahov[55], Alfred Švarc[47], Adam Szczepaniak[22,49], Ronald Workman[19], Bing-Song Zou[4]

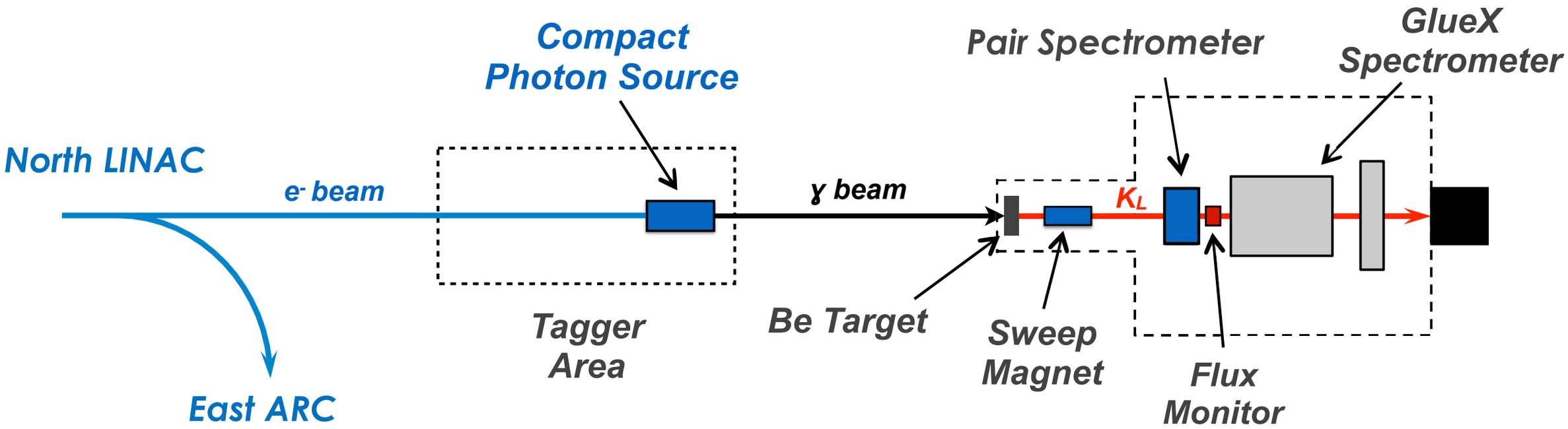
Members of 64 Universities

AGENDA

Tuesday May 19, 2020

- 09:00 (125) Session I --- Project Status.
  - 09:00 (20+5) KLF overview and addressing PAC48 report --- *Moskov Amaryan* [].
  - 09:25 (20+5) Hyperon Spectroscopy Status --- *Mikhail Bashkanov* [].
  - 09:50 (20+5) Meson Spectroscopy Status --- *Shankar Adhikari* [].
  - 10:15 (20+5) Neutron Stars -- *Nick Zachariou* [].
  - 10:40 (20+5) Discussion for PAC48 preparation.
- 11:05 Adjourn

K_L Facility in Hall D



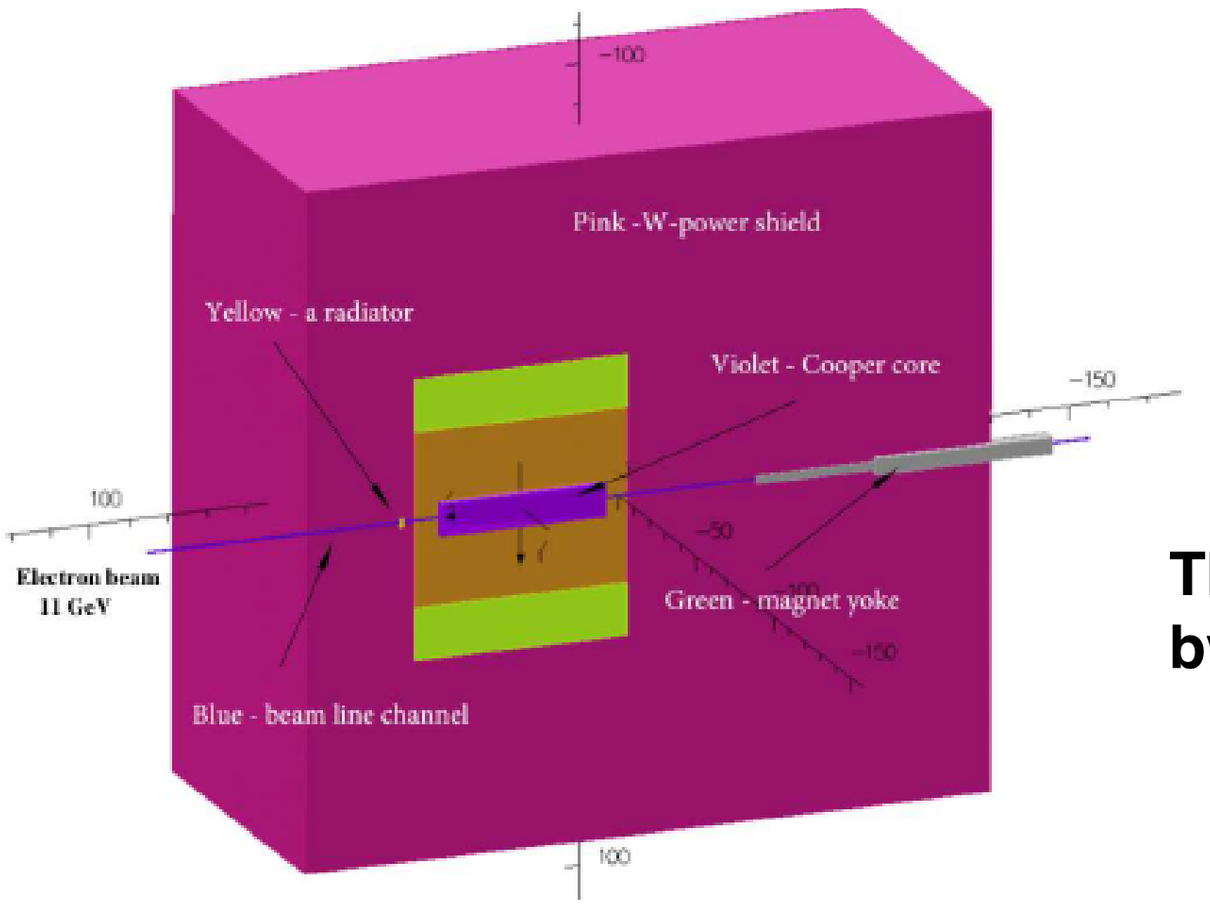
Electron Beam Parameters

$E_e = 12\ GeV$ $I = 5\ \mu A$

Bunch spacing $64\ ns$

Feasibility Confirmed by accelerator experts

Compact Photon Source



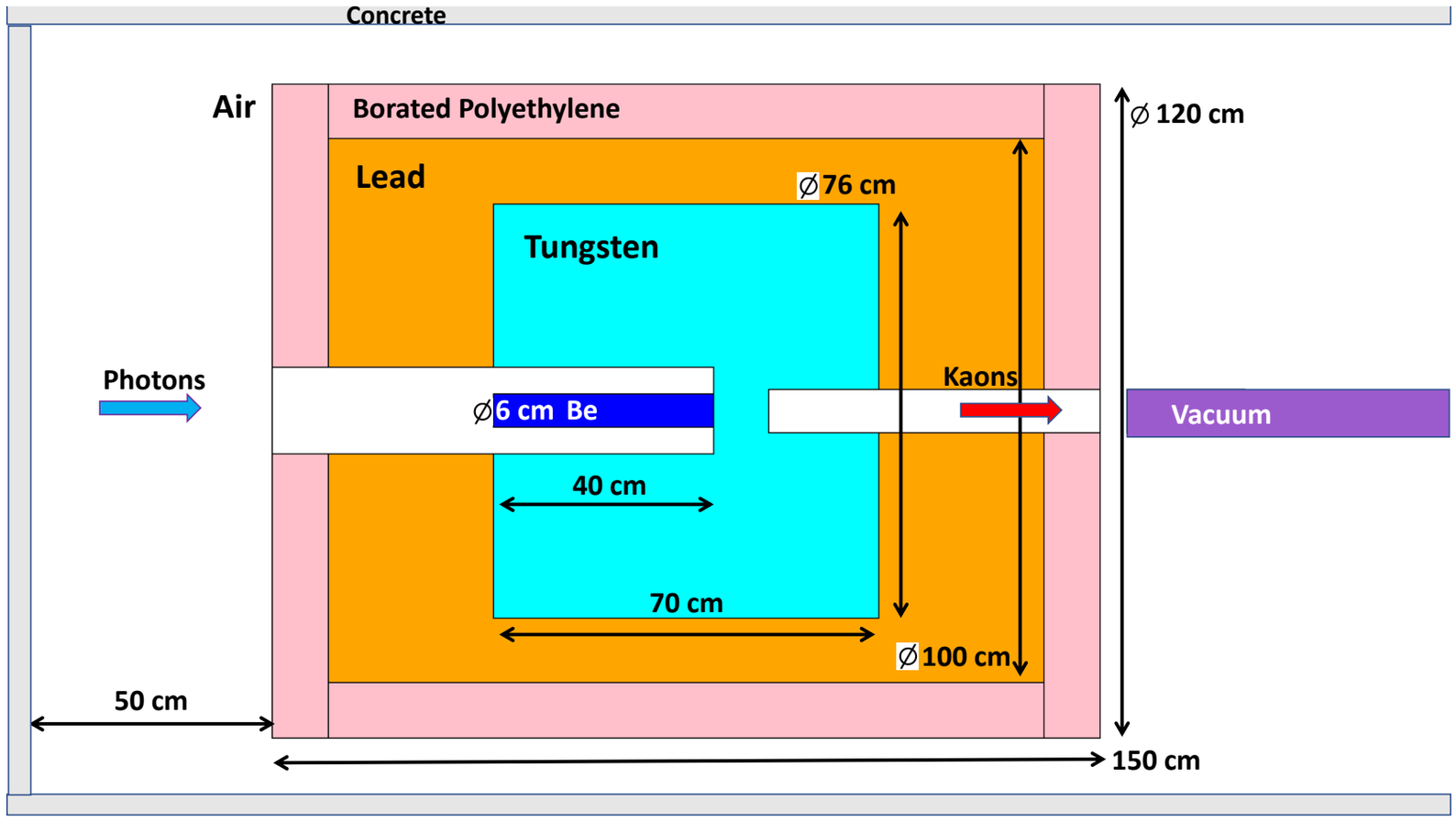
Conceptual design is completed for Halls A&C

The details of the CPS are designed by the CPS Collaboration

Meets RadCon Radiation Requirements

- **Published in: *NIM A* 957 (2020) 163429**

Be Target Assembly: Conceptual Design



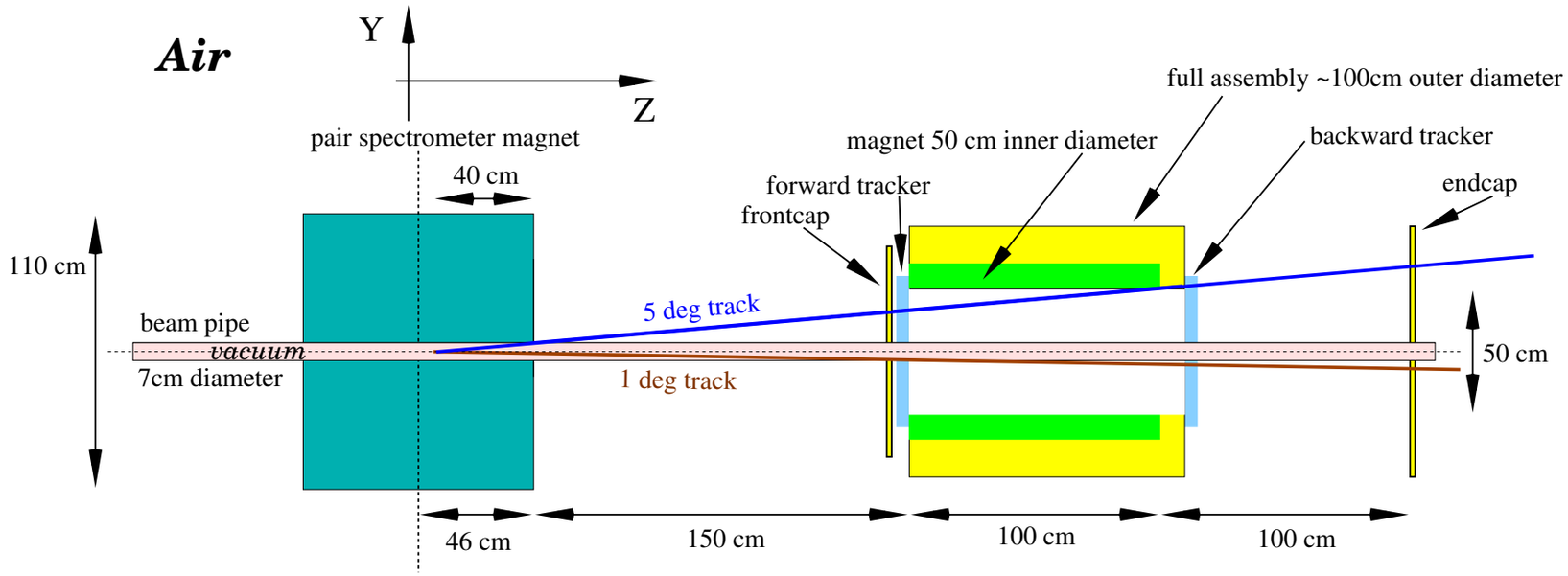
-Meets RadCon Radiation Requirements

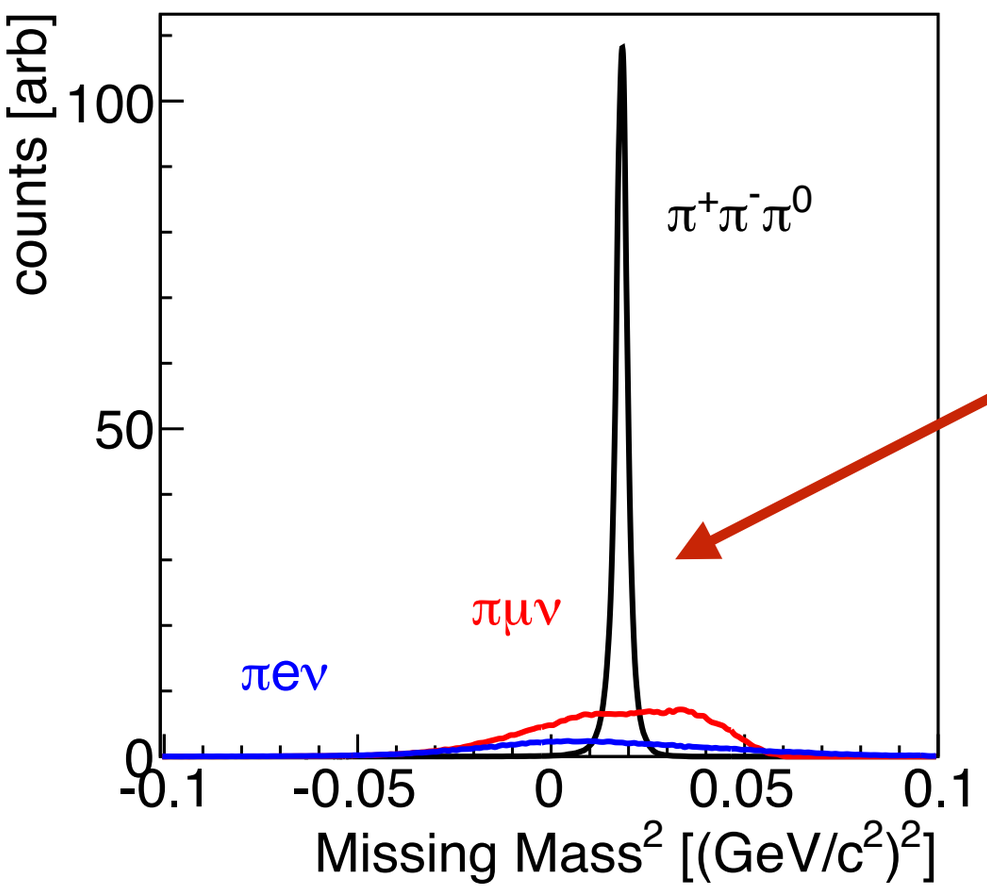
-Conceptual Design Endorsed by Hall-D Engineering Staff

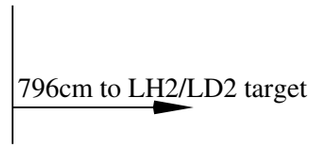
For more details consult:

https://arxiv.org/abs/2002.04442

Flux Monitor







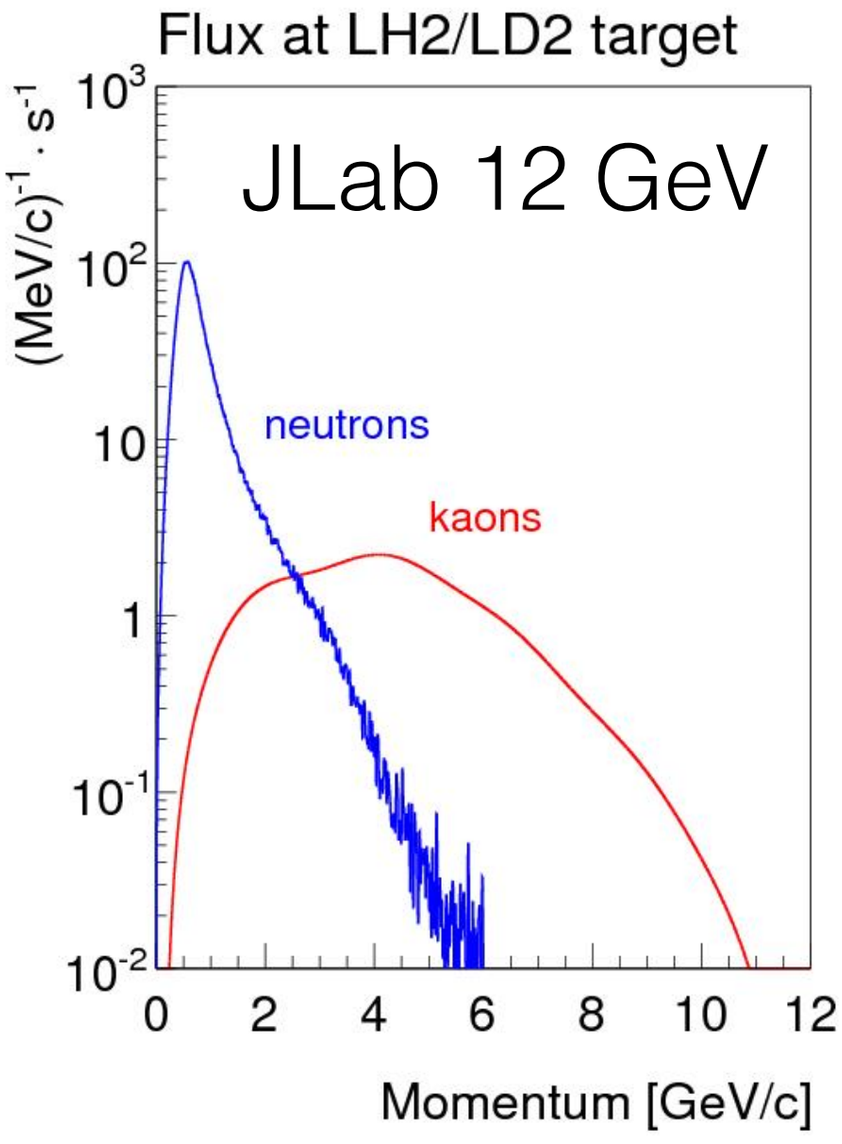
Reconstructed K_L

via missing (π^0)

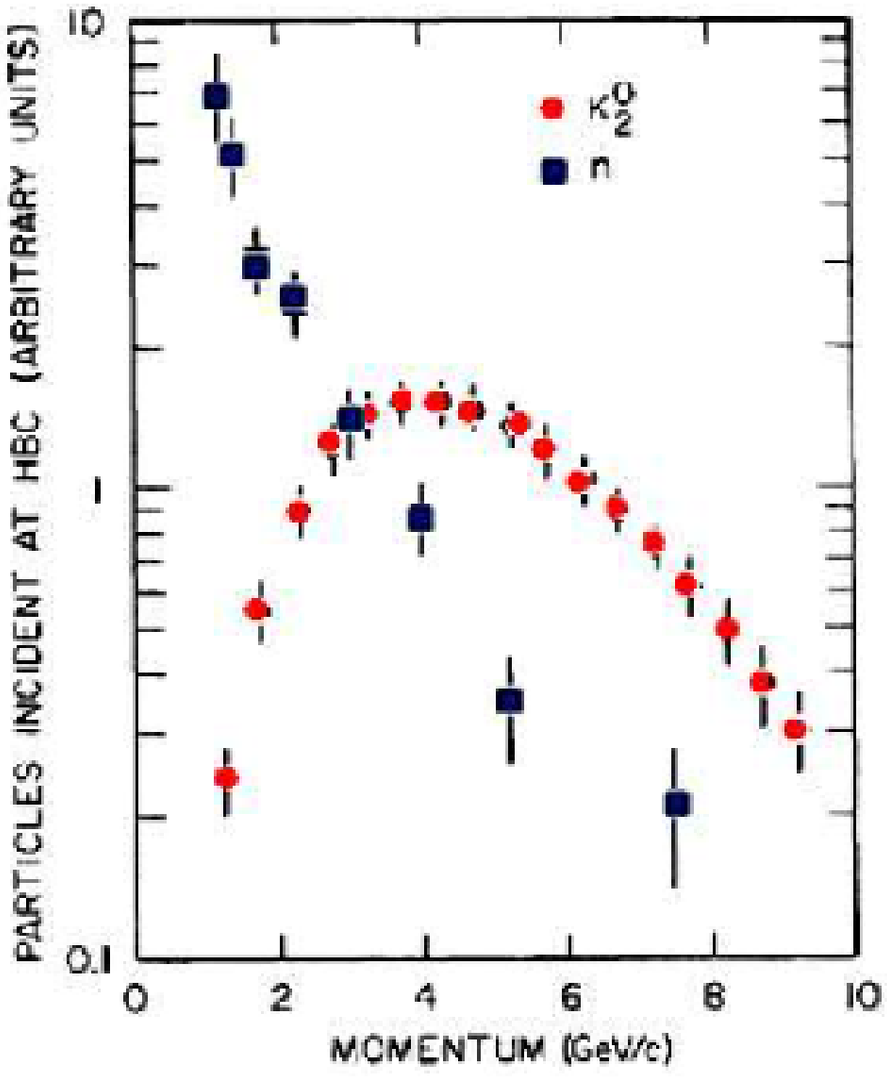
Flux measurement stat. err. <1%

Estimated syst. err. ~5%

K_L Beam Flux



SLAC 16 GeV

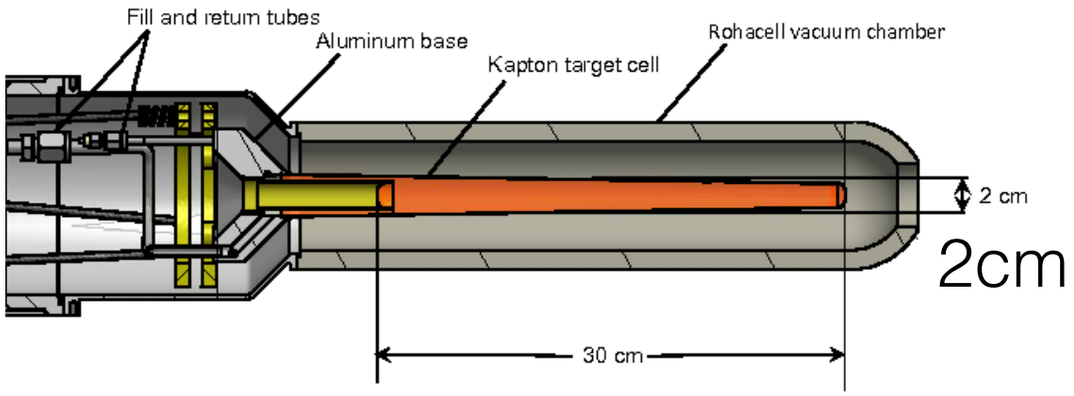


$$N(K_L)/sec \sim 10^4$$

$$\frac{N(K_L)_{JLAB}}{N(K_L)_{SLAC}} \sim 10^3$$

LH_2/LD_2 Cryogenic Target for Neutral Kaon Beam at Hall D

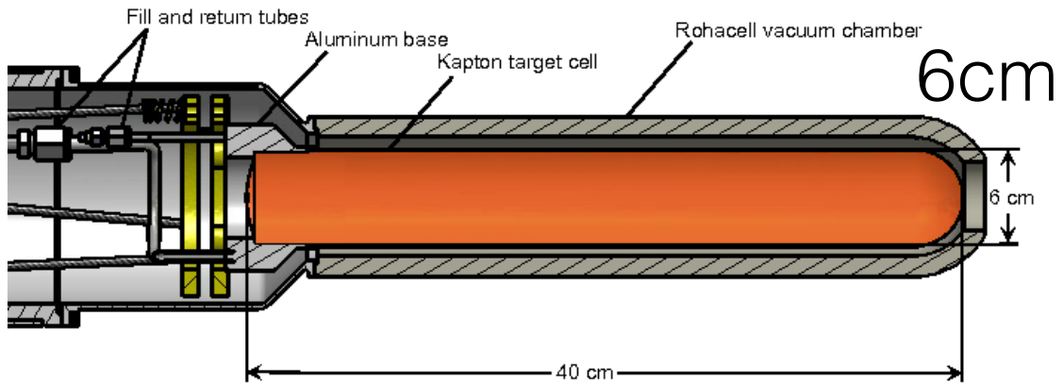
The GlueX liquid hydrogen target.



2cm

30cm

Current



6cm

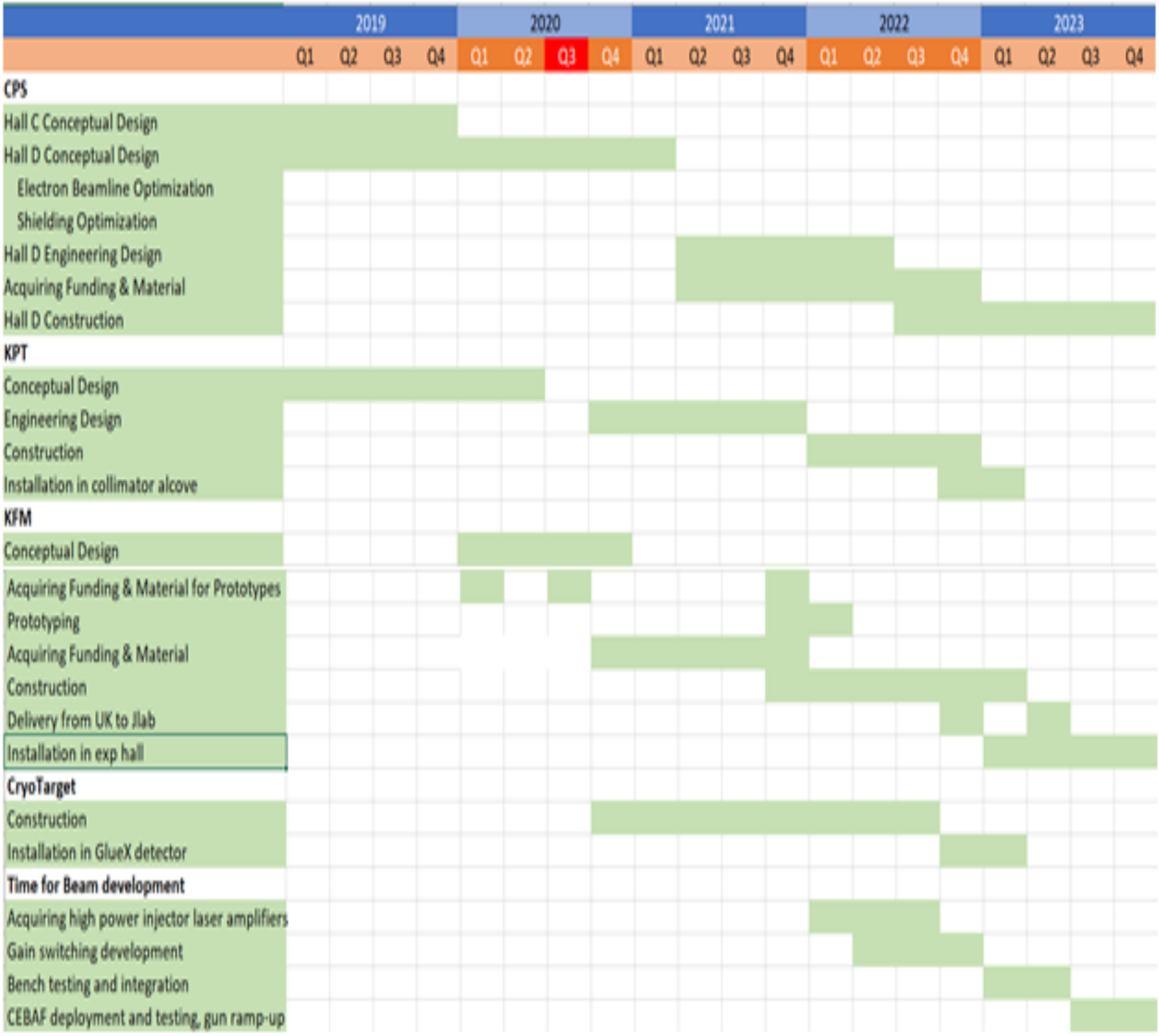
40cm

Proposed & Feasible

Longer and ticker target is needed to enhance production rate

Conceptual design has been endorsed by the JLAB target group

Timeline


2019
2020
2021
2022
2023
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
CPS
Hall C Conceptual Design
Hall D Conceptual Design
Electron Beamline Optimization
Shielding Optimization
Hall D Engineering Design
Acquiring Funding & Material
Hall D Construction
KPT
Conceptual Design
Engineering Design
Construction
Installation in collimator alcove
KFM
Conceptual Design
Acquiring Funding & Material for Prototypes
Prototyping
Acquiring Funding & Material
Construction
Delivery from UK to JLab
Installation in exp hall
CryoTarget
Construction
Installation in GlueX detector
Time for Beam development
Acquiring high power injector laser amplifiers
Gain switching development
Bench testing and integration
CEBAF deployment and testing, gun ramp-up

Wiki Page

https://wiki.jlab.org/klproject/index.php/PAC48

- **Supplemental materials for the PAC48 submission:**

- Final version of KLF_Analysis_ Report (hyperon case).

- KLF_Analysis_ Report (meson case) work in progress.

- Final version of New_Equipment.

- Final version of the Raster document.

- Final version of the KPT.

- Final version of KFM.

- Final version of the CPS.

- Final version of the timeline of the design, construction and installation of the KL beam line.

- Cover_Letter draft.

Final version of proposal will be available soon.

The KLF raison d'etre

Hyperon Spectroscopy
(talk by M. Bashkanov)

Strange Meson Spectroscopy
(talk by S.Adhikari)

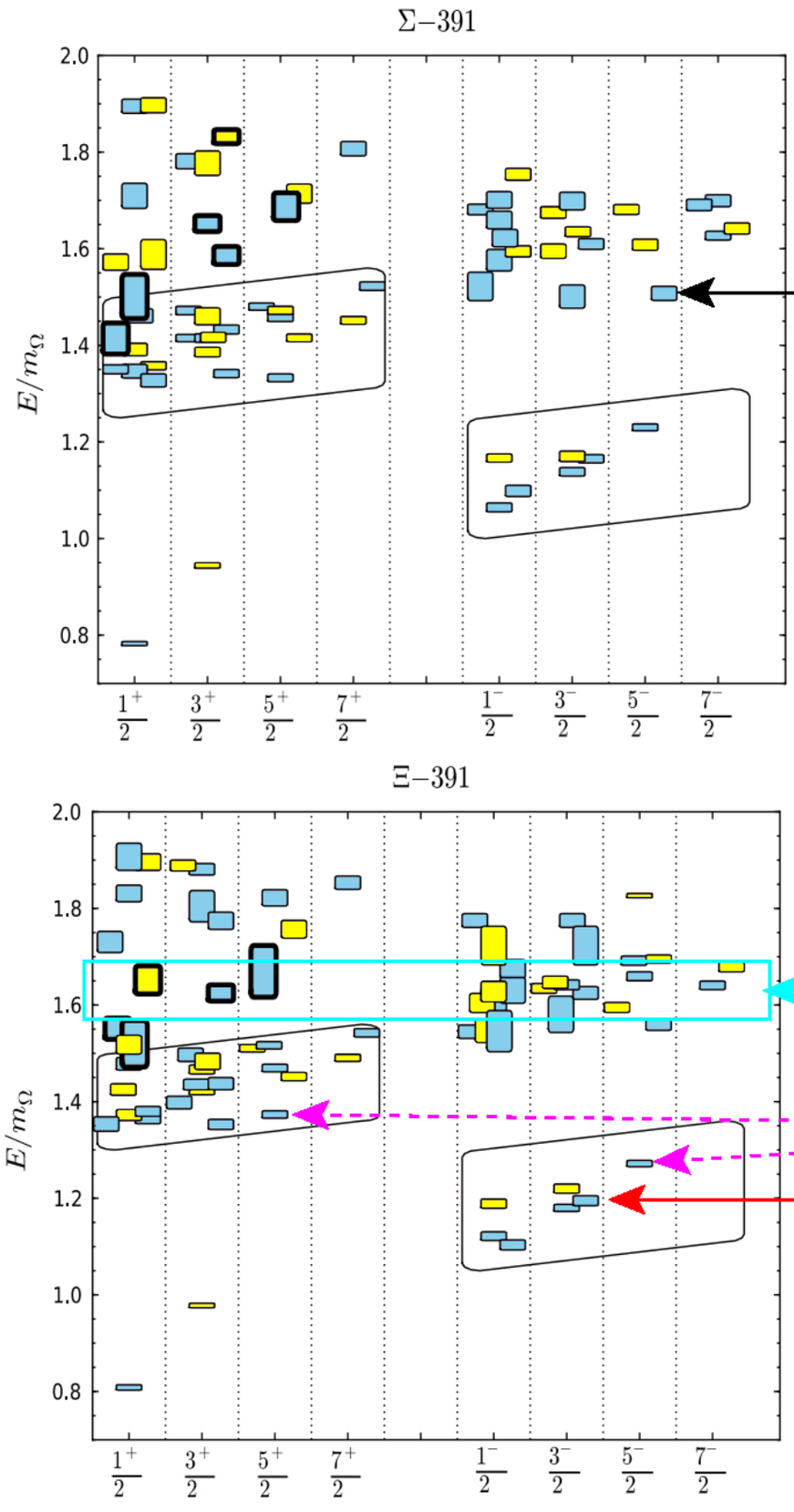
Impact on Cosmology and Astrophysics
(talk by N. Zachariu)

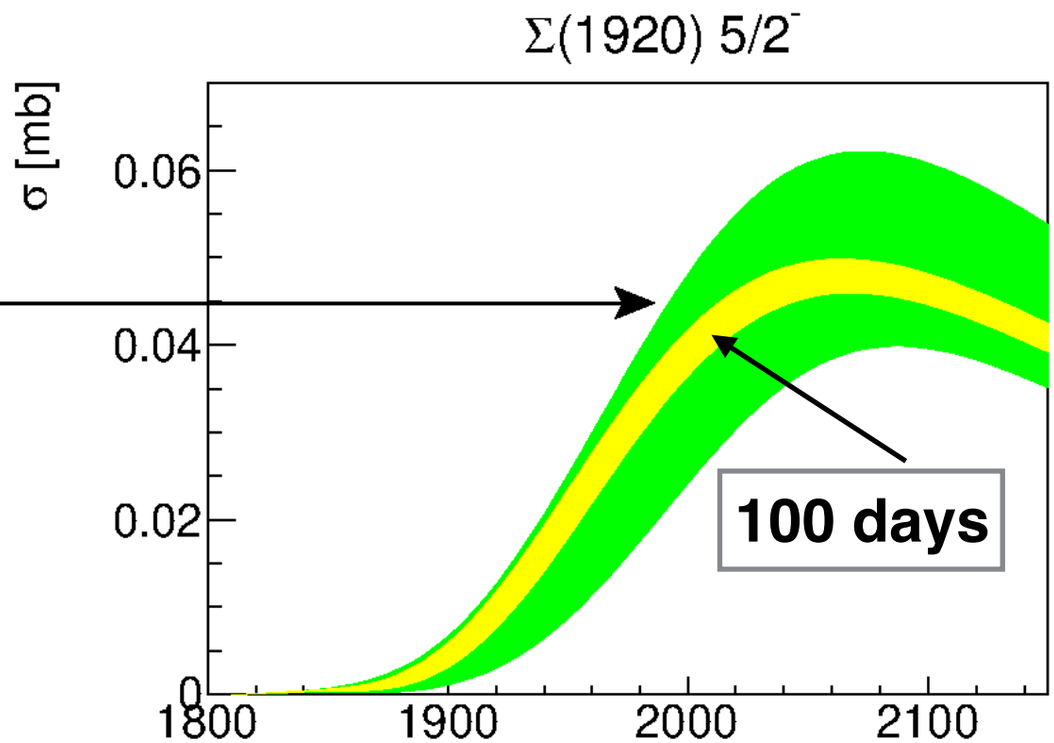
Hyperon Spectroscopy

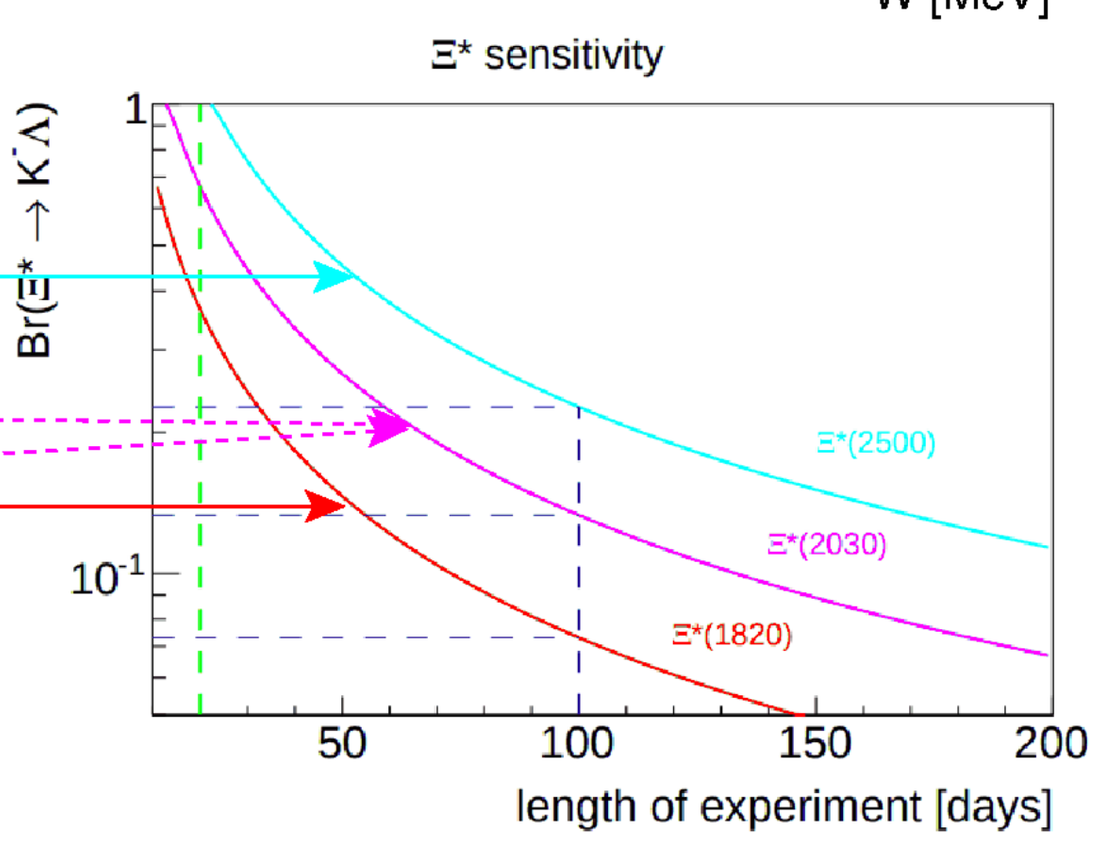
List of simulated reactions

1. $K_L p \rightarrow K_s p$
2. $K_L p \rightarrow \pi^+ \Lambda$
3. $K_L p \rightarrow K^+ \Xi^0$
4. $K_L n \rightarrow K^+ \Xi^-$
5. $K_L n \rightarrow K^+ \Xi^{*-}$
6. $K_L p \rightarrow K^+ n$

Snapshot of Hyperon Spectroscopy

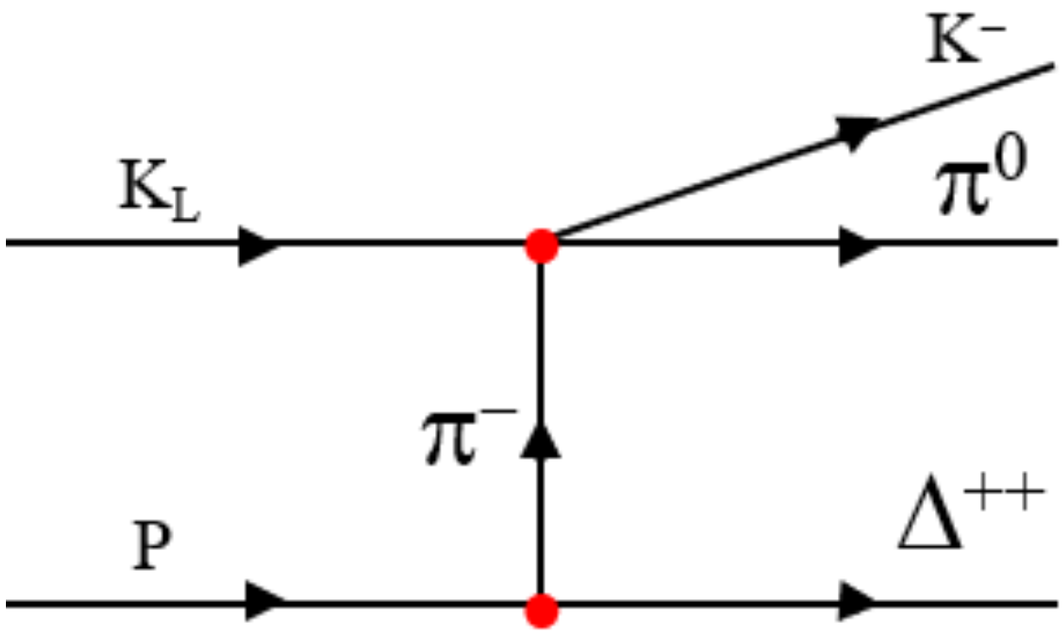


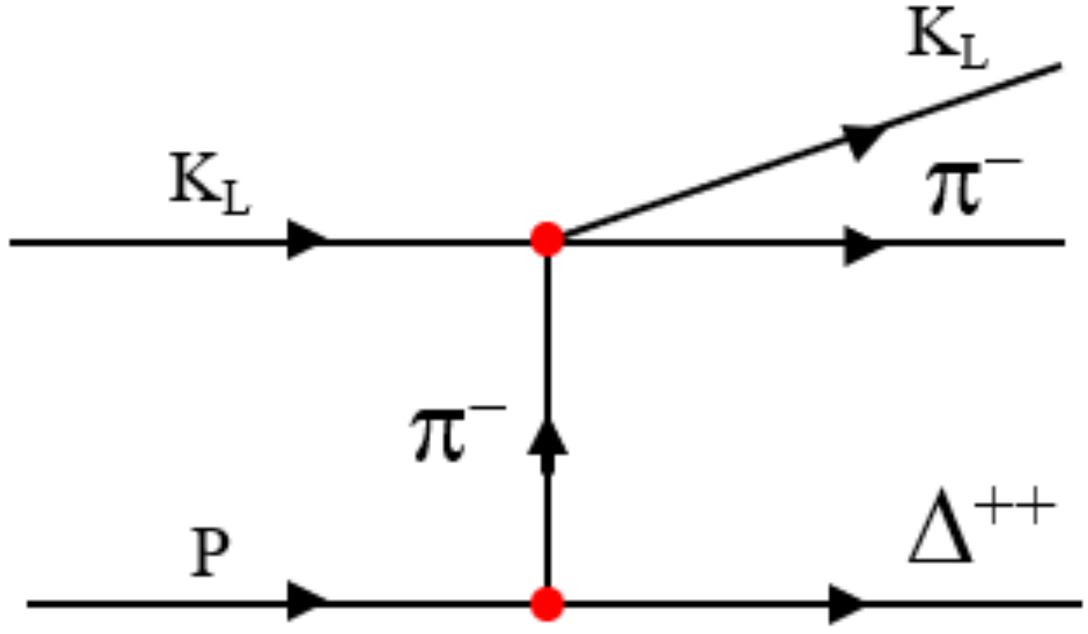




Strange Meson Spectroscopy

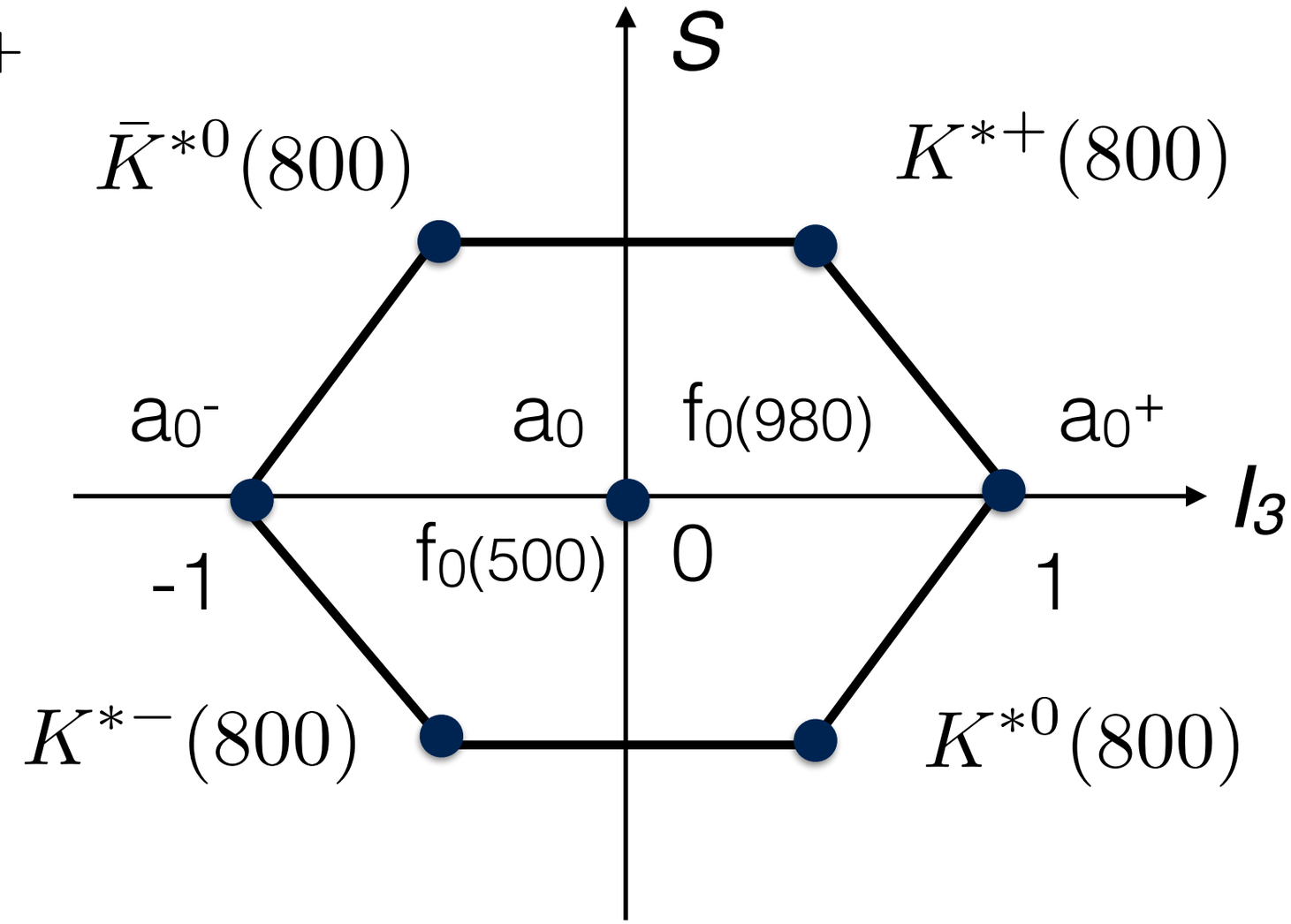
$K\pi$ Scattering





Scalar Meson Nonet

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



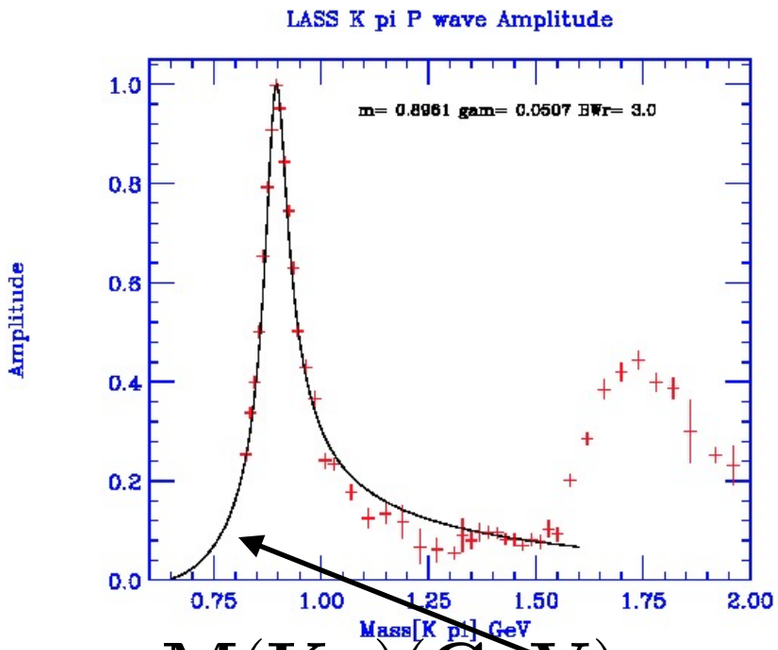
Four states called κ

still need further confirmation(PDG)

Proposed Measurements

SLAC

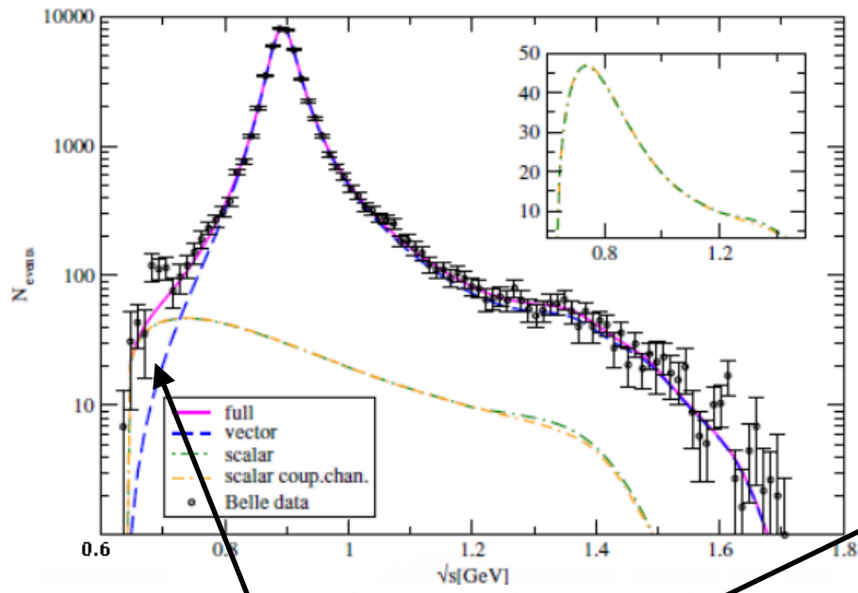
$$K^-\pi^+ \to K^-\pi^+$$



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

Belle

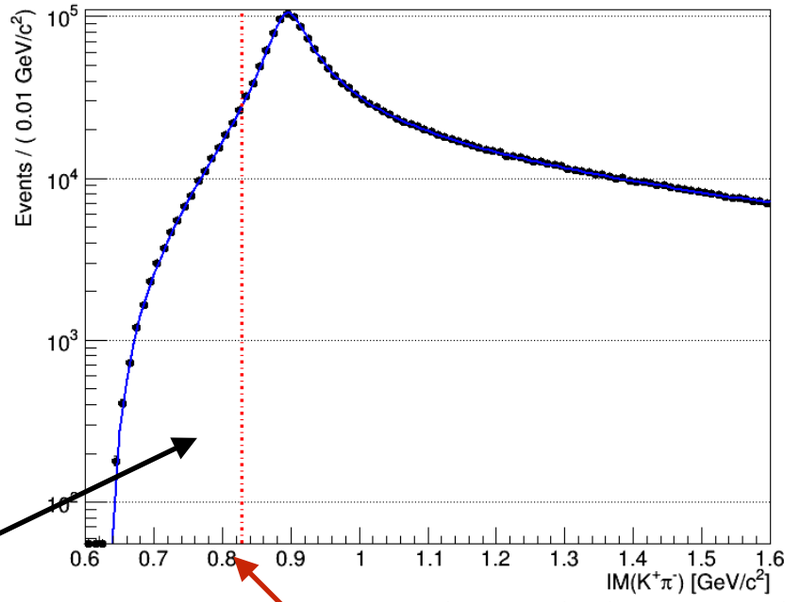
$$\tau \to K\pi\nu_\tau$$



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

KLF

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



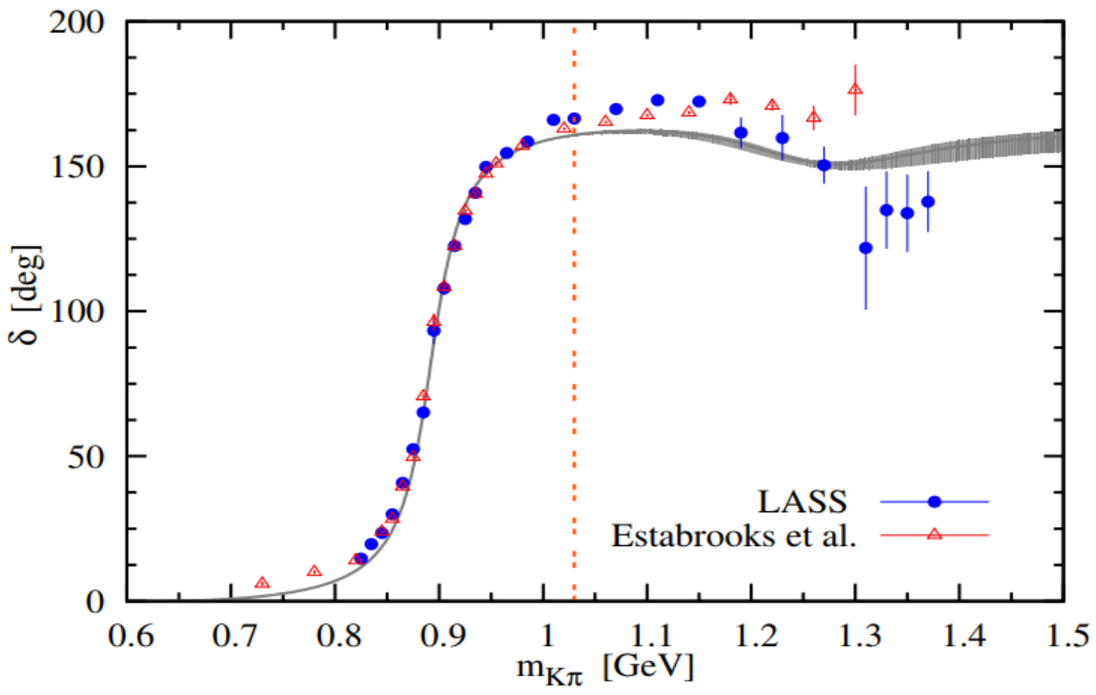
$\mathbf{M(K\pi)(GeV}$

region of $\kappa(800)$

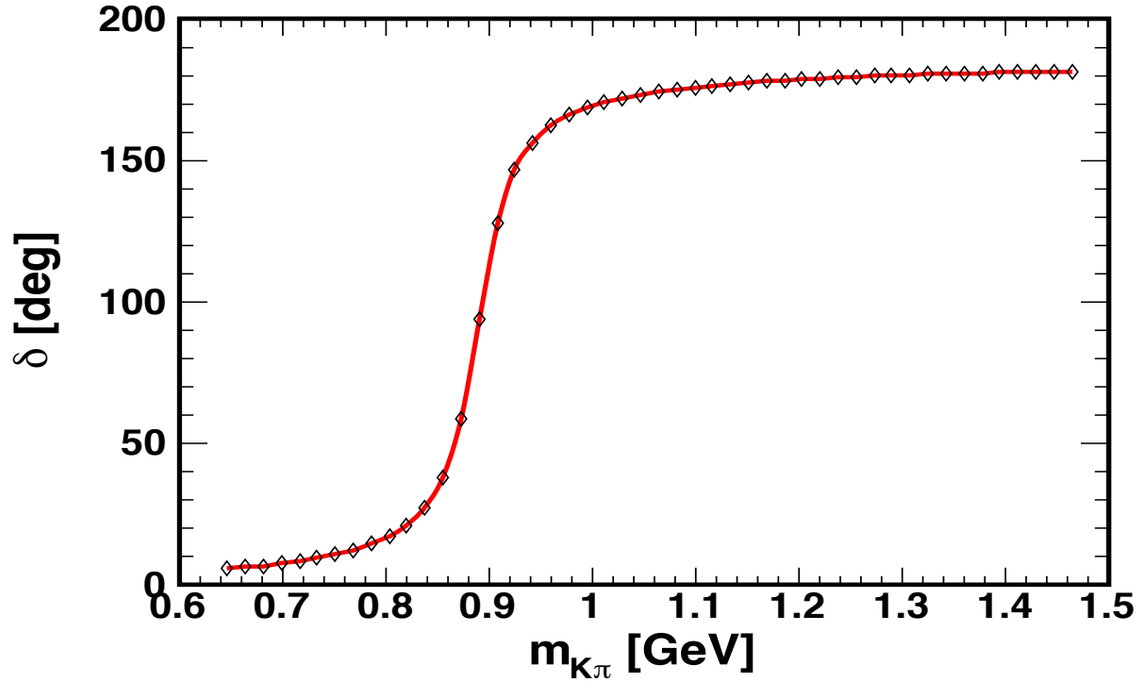
SLAC Lower limit

P-wave phase shift

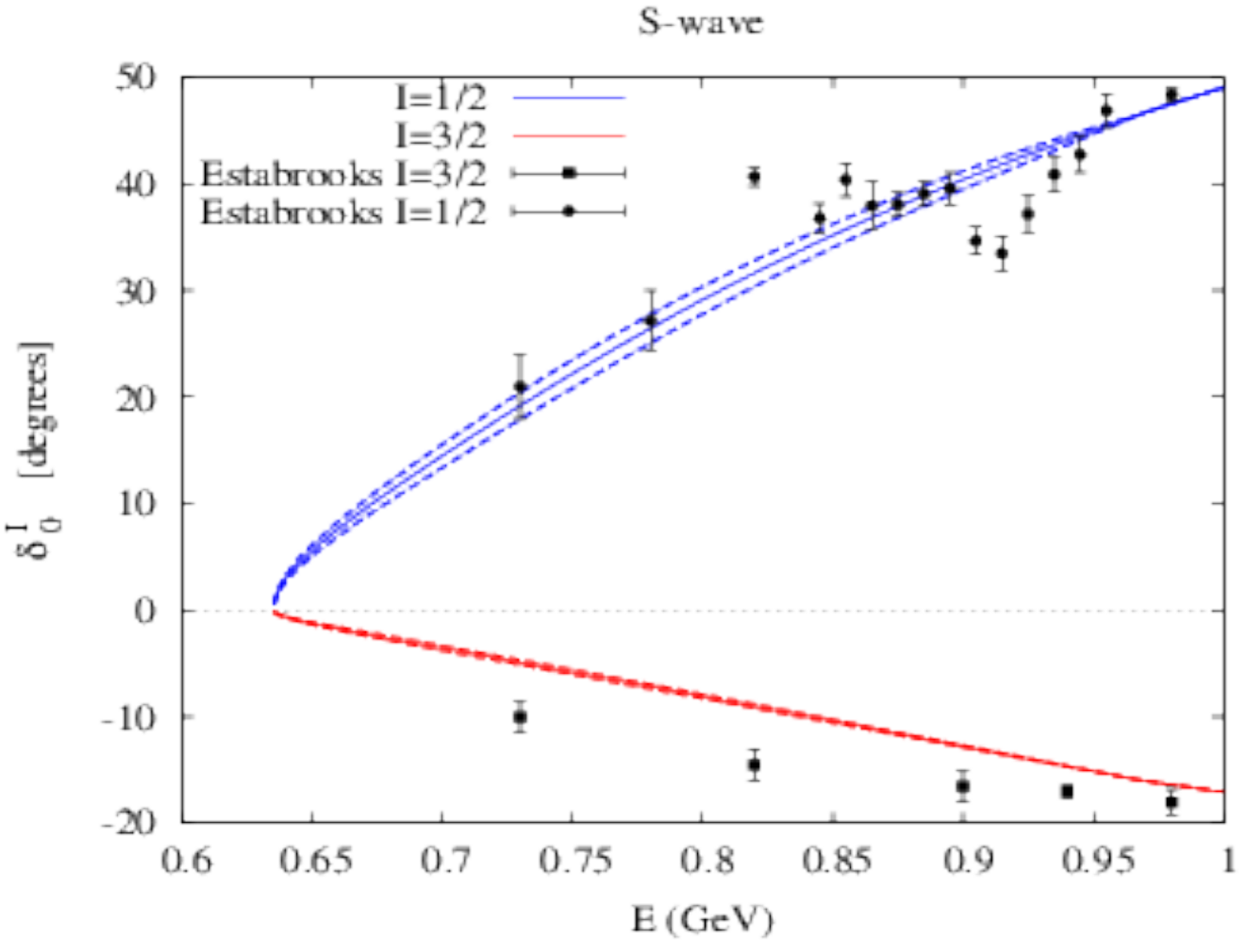
SLAC + Belle $(\mu \to K\pi\nu_\tau)$



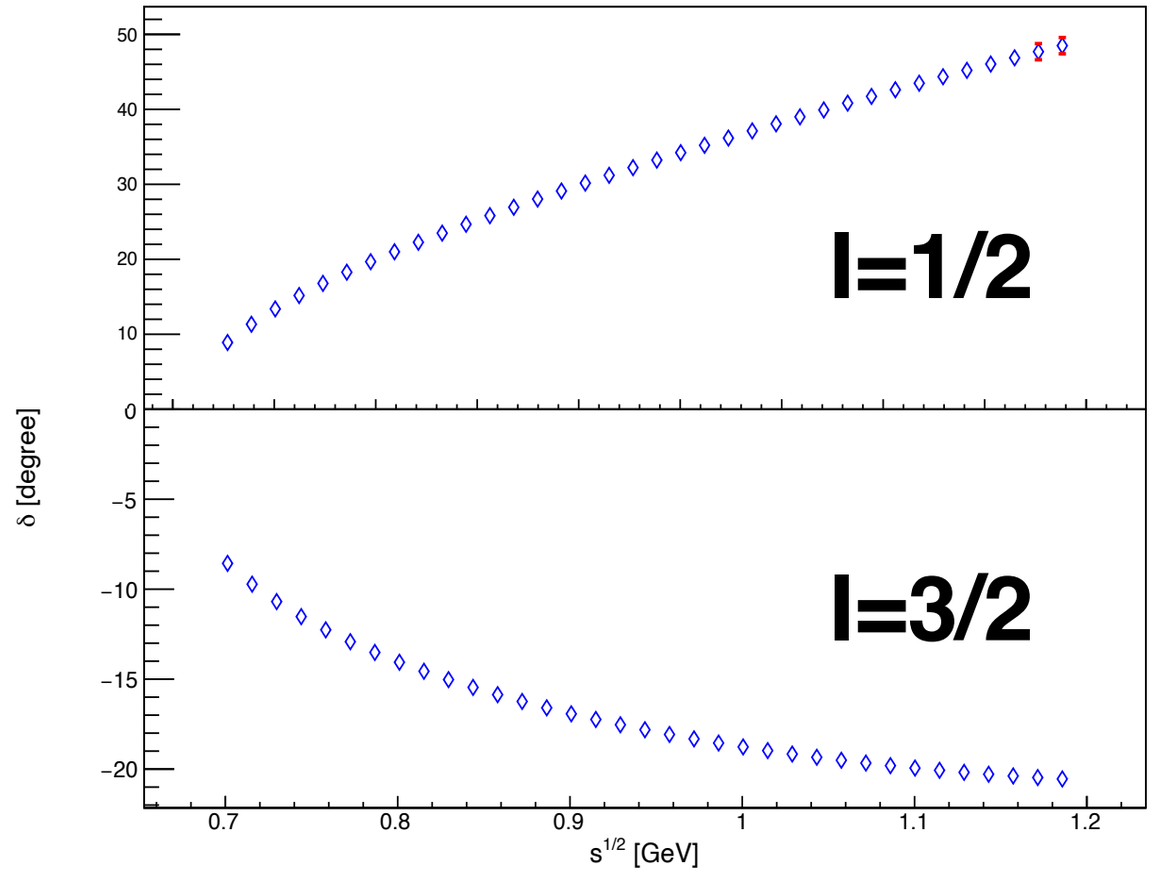
KLF 100 days



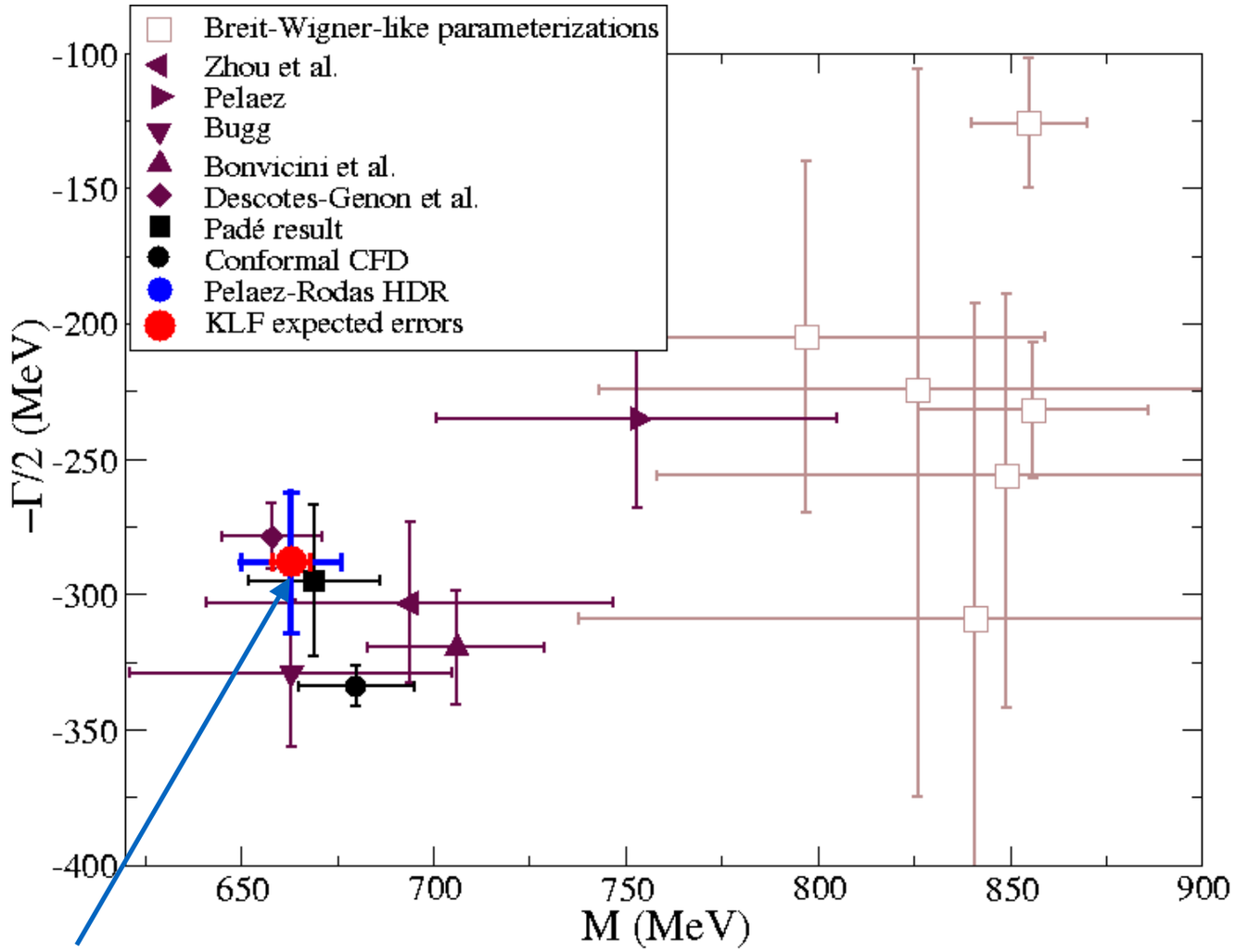
S-wave phase shift



KLF 100 days



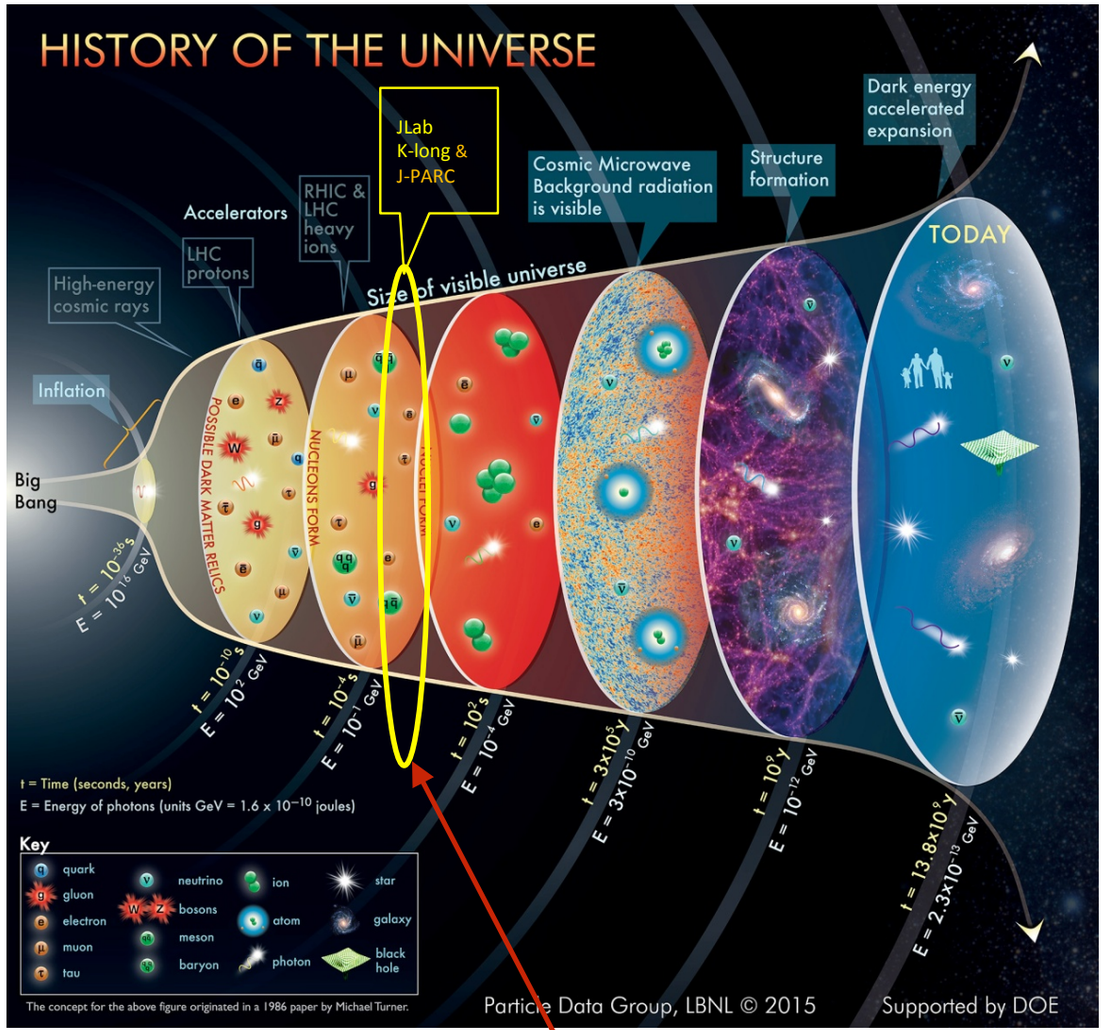
Width and Mass of κ(800)



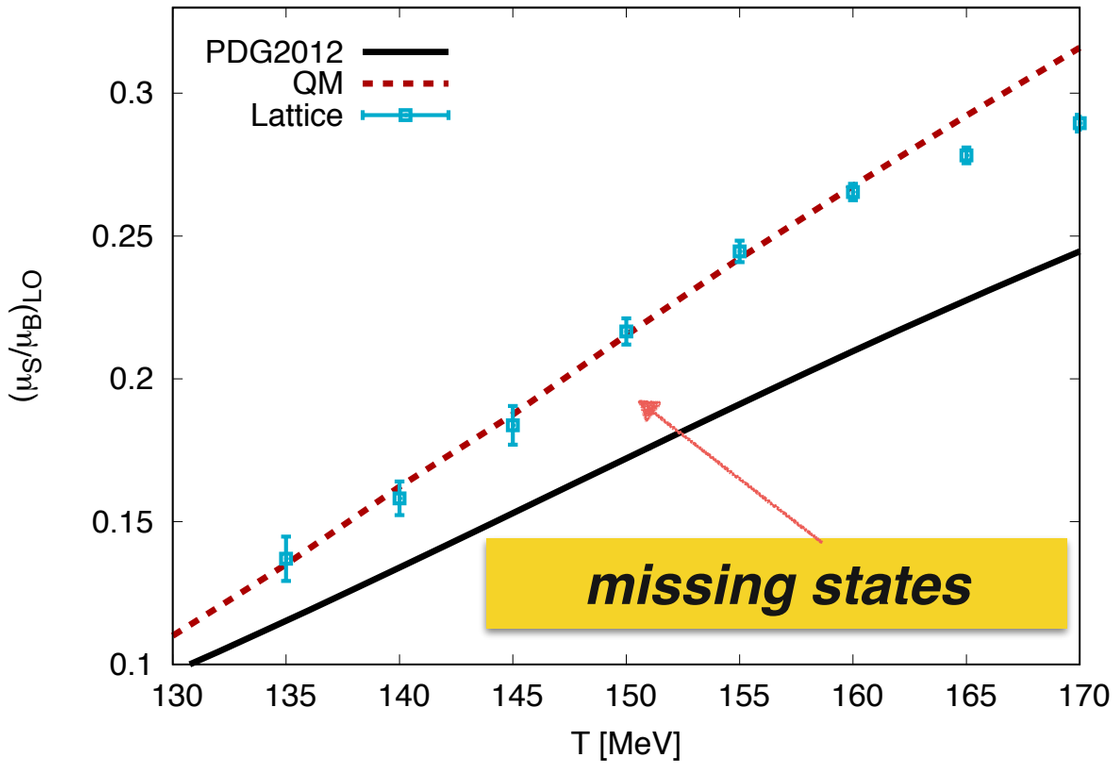
100 days of running

Measurement with KLF will reduce:
Uncertainty in the mass by factor of two
Uncertainty in the width by factor of five!

Evolution of Early Universe at Freeze-out

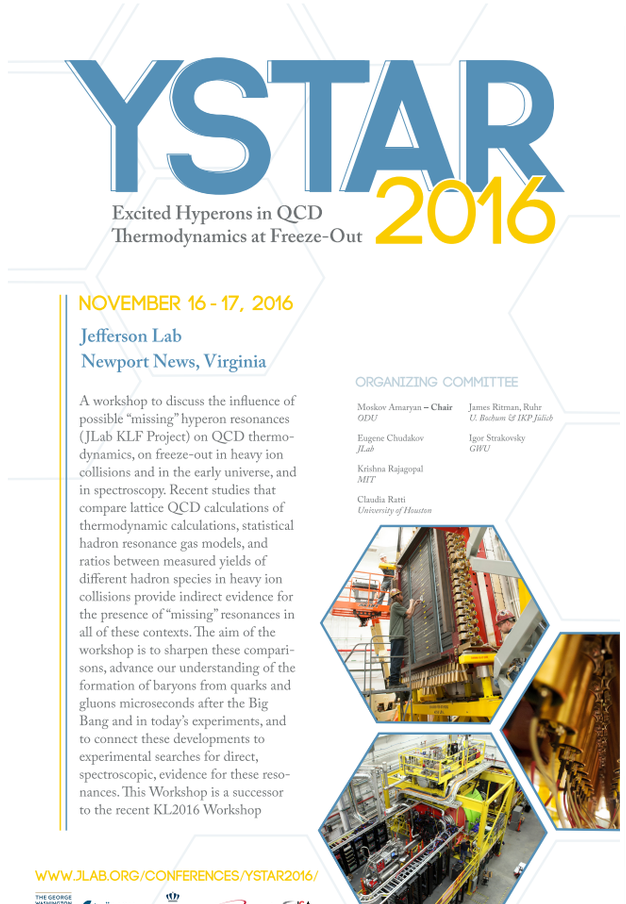


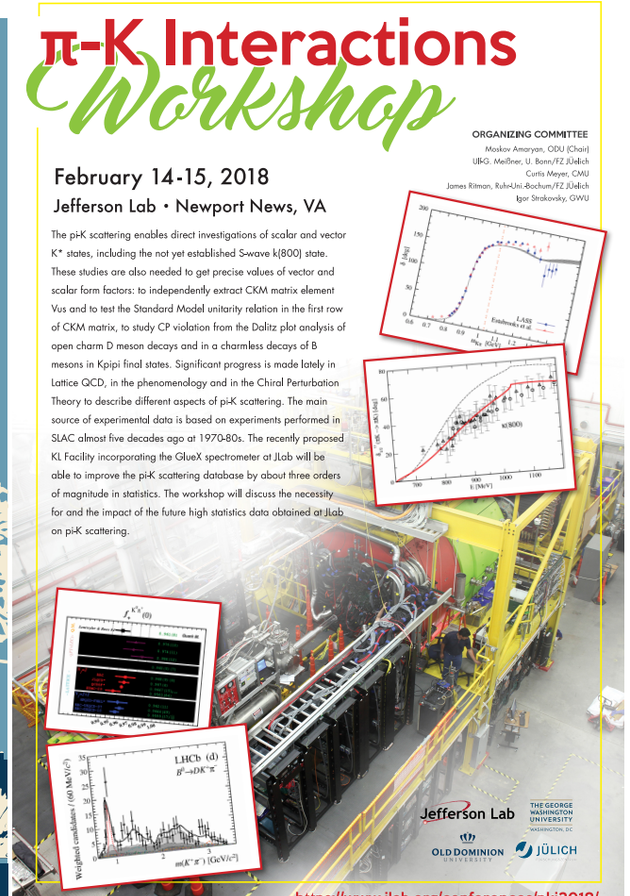
Chemical Potential



YSTAR2016 Proceedings arXiv: 1701.07346

We are here: $1\mu s$ After the Big Bang





KL2016

[60 people from 10 countries, 30 talks] ***https://www.jlab.org/conferences/kl2016/***

OC: M. Amaryan, E. Chudakov, C. Meyer, M. Pennington, J. Ritman, & I. Strakovsky

YSTAR2016

[71 people from 11 countries, 27 talks] ***https://www.jlab.org/conferences/YSTAR2016/***

OC: M. Amaryan, E. Chudakov, K. Rajagopal, C. Ratti, J. Ritman, & I. Strakovsky

HIPS2017

[43 people from 4 countries, 19 talks] ***https://www.jlab.org/conferences/HIPS2017/***

OC: T. Horn, C. Keppel, C. Munoz-Camacho, & I. Strakovsky

PKI2018

[48 people from 9 countries, 27 talks] ***http://www.jlab.org/conferences/pki2018/***

OC: M. Amaryan, U.-G. Meissner, C. Meyer, J. Ritman, & I. Strakovsky

In total: 222 participants & 103 talks

Epilogue

All questions raised by the PAC47 are addressed

The KL Facility will improve our knowledge on many topics of strange hadron spectroscopy in unprecedented way

Final version of the proposal will be sent to the Collaboration by the end of May

Thank you !