Search for the First Strange Hexaquark

Geraint Clash

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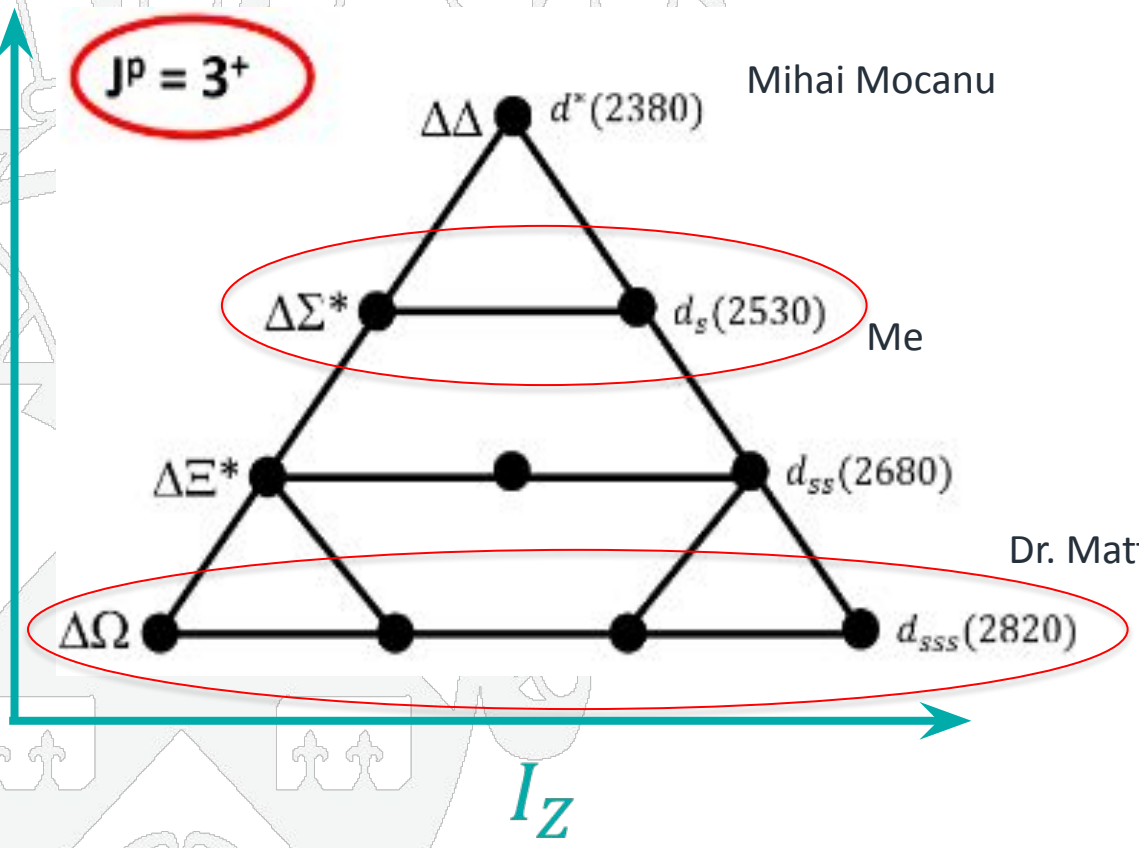
Science and Technology Facilities Council

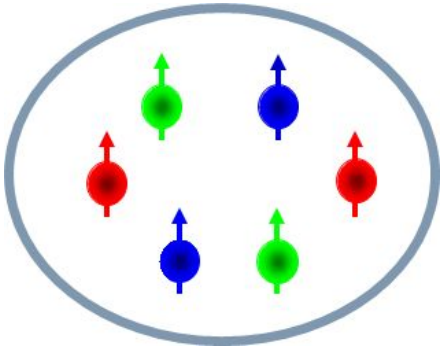
CEBAF Large Acceptance Spectrometer

What are Hexaquarks

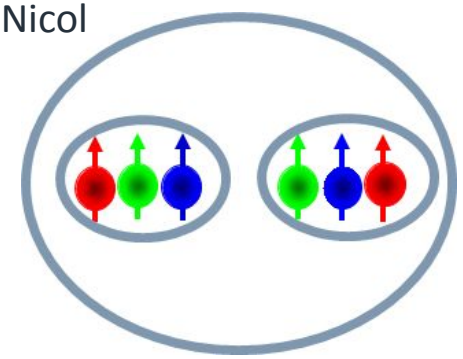


Mihai Mocanu

Me



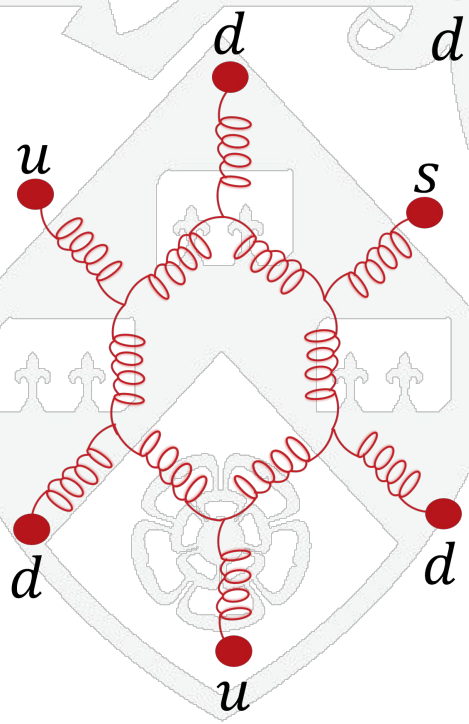
Dr. Matthew Nicol

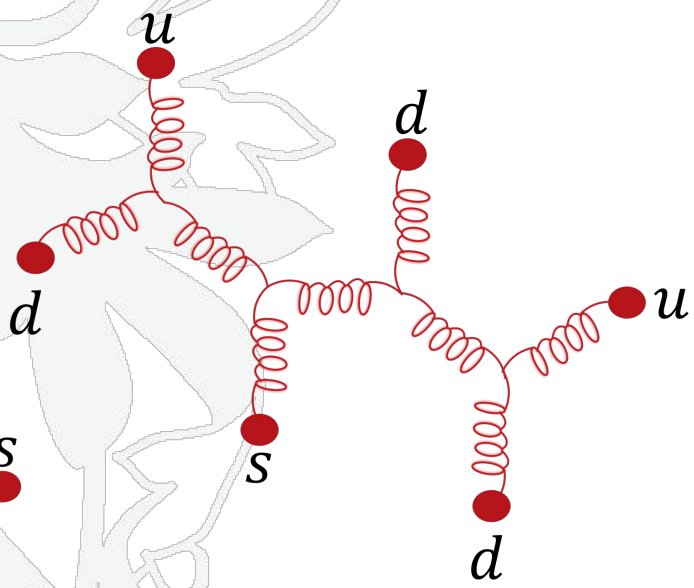


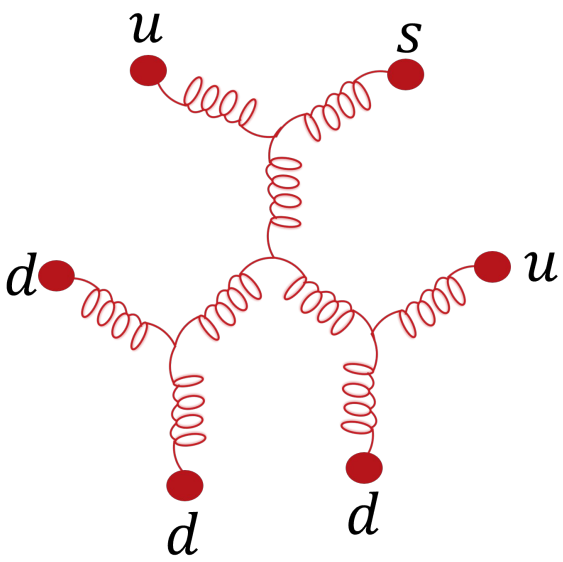
P. Adlarson et al., Phys.Rev.Lett. 106 (2011) 242302
P. Adlarson et al., Phys.Rev.Lett. 112 (2014) 20, 202301

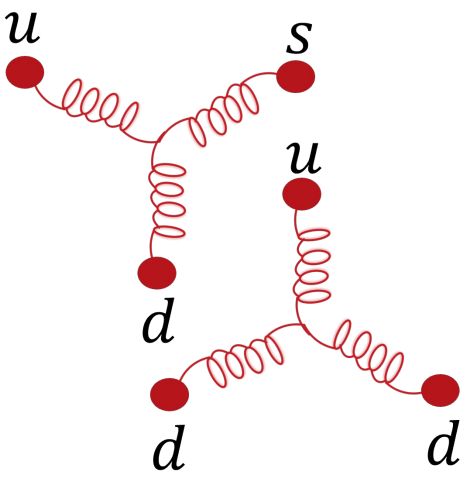
Why Hexaquarks

QCD many body effects



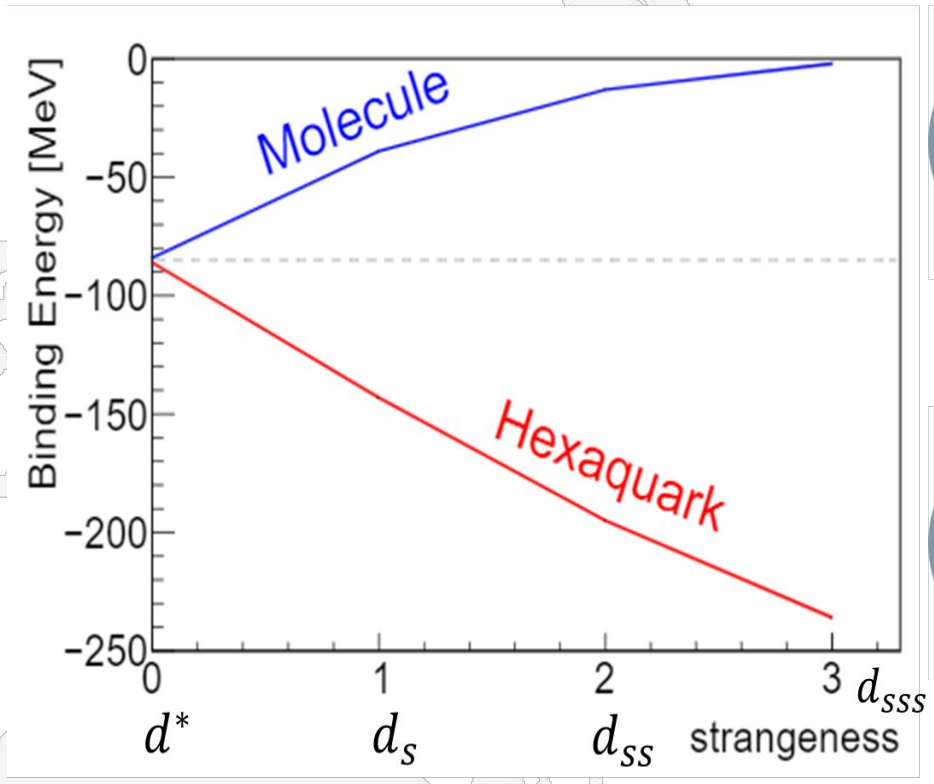


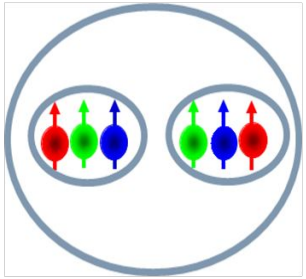


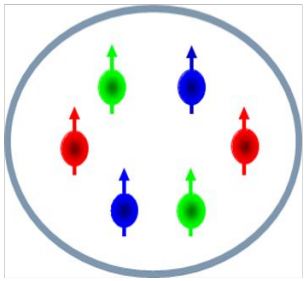


Fan Wang, arXiv:1711.01445v1

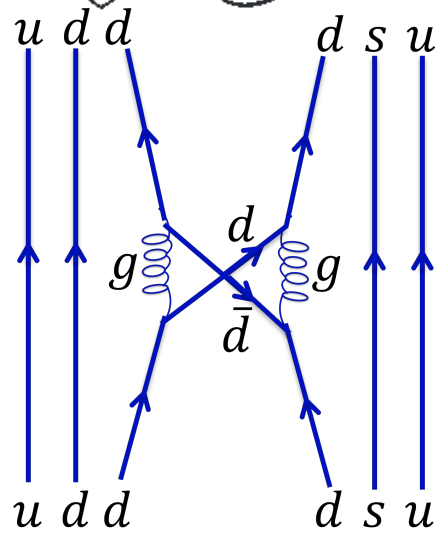
The Question of Structure

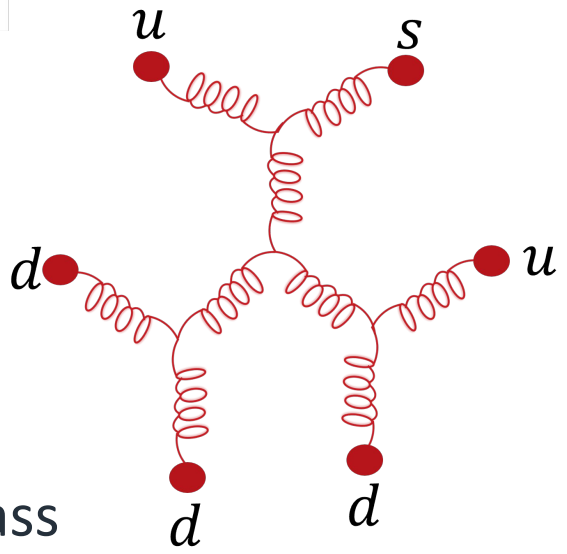






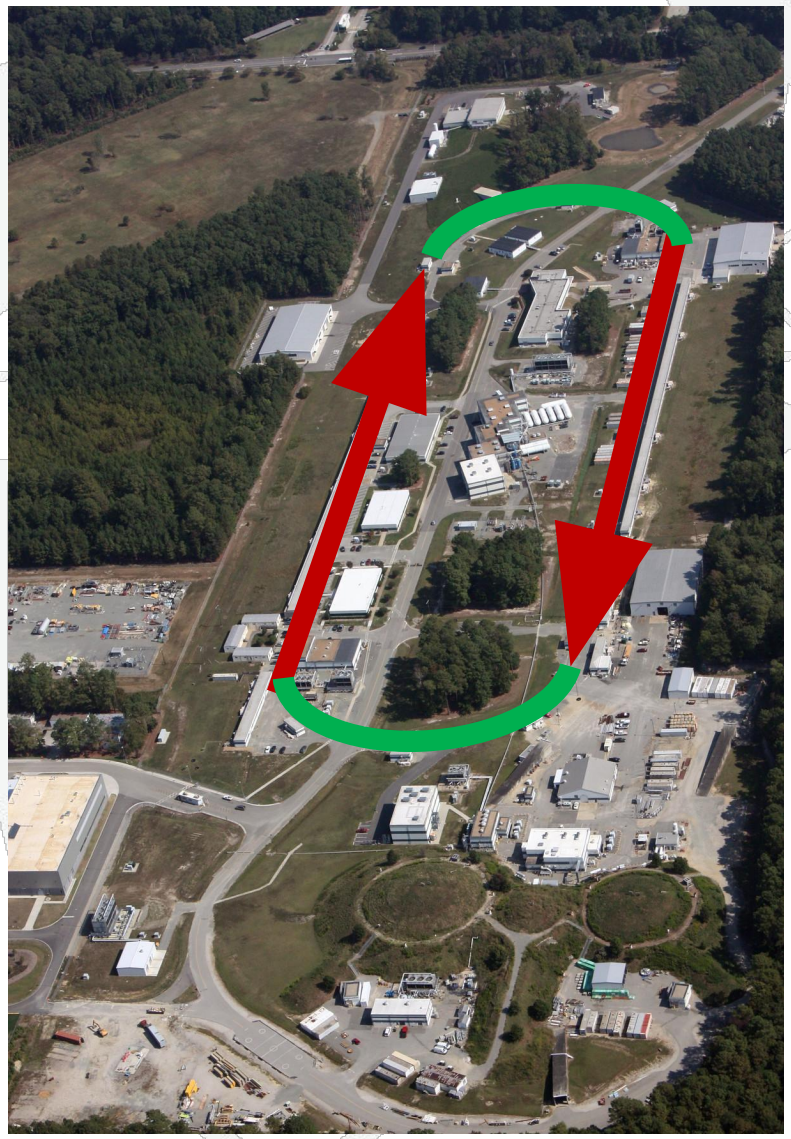
M. Bashkanov et al., arXiv:2012.11449v1





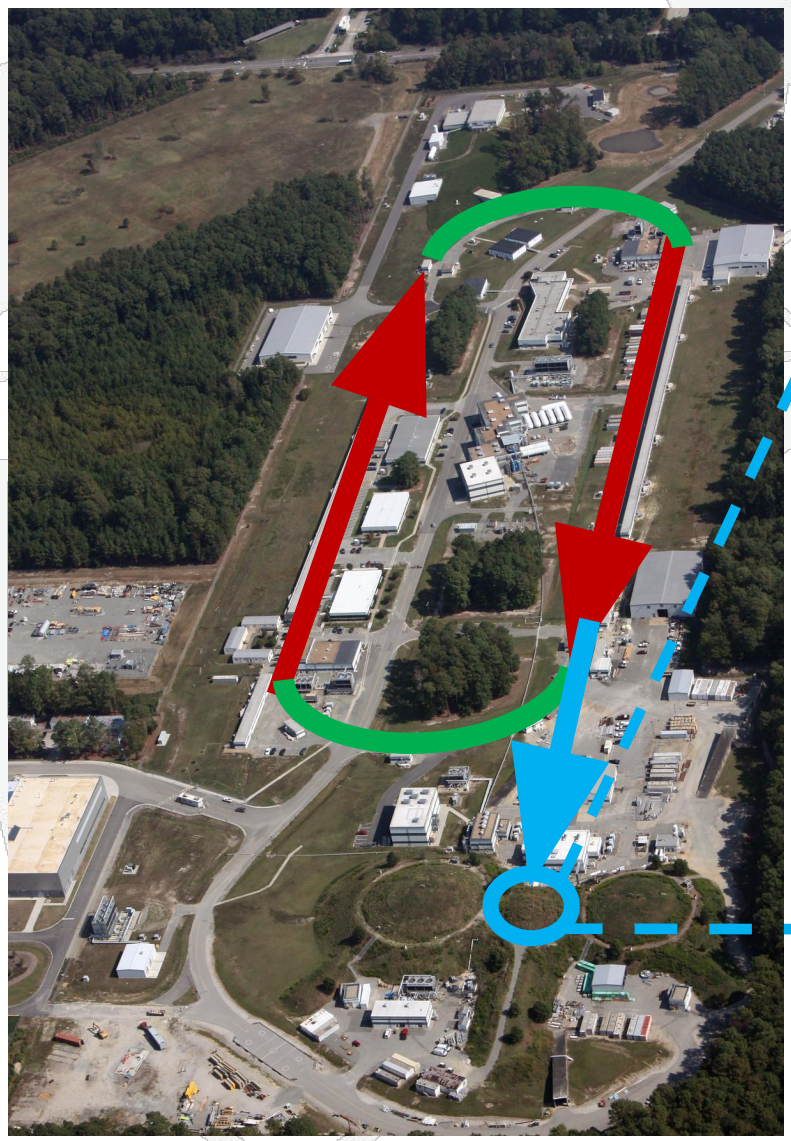
- Molecule
  - Pion exchange
  - Pion wont couple to strange quark
- Genuine hexaquark
  - Colour magnetic force scales with quark mass

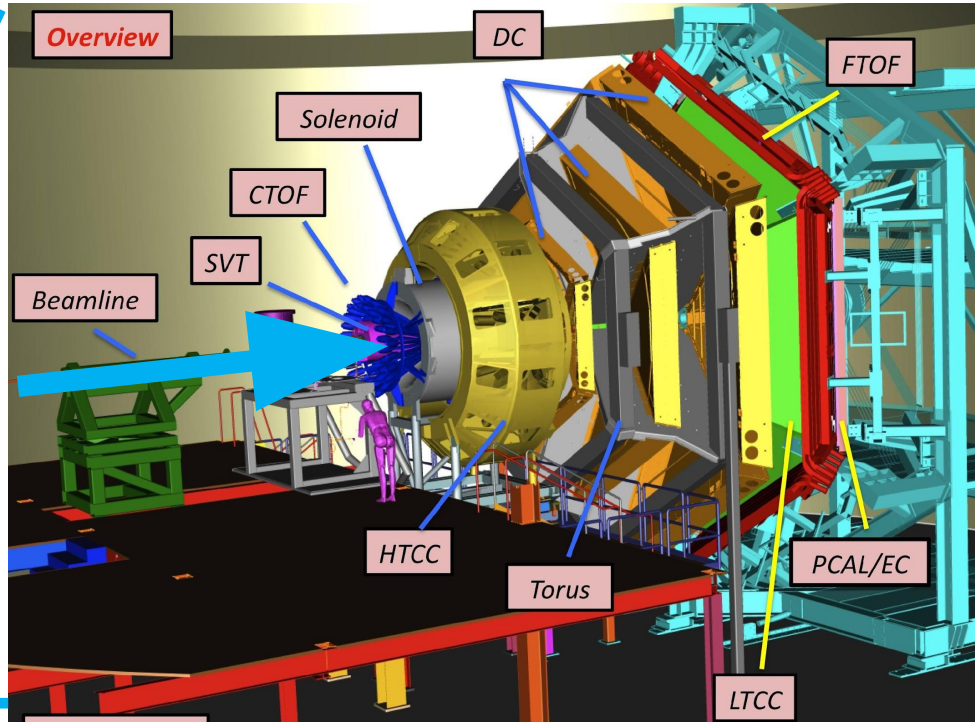
The Experiment



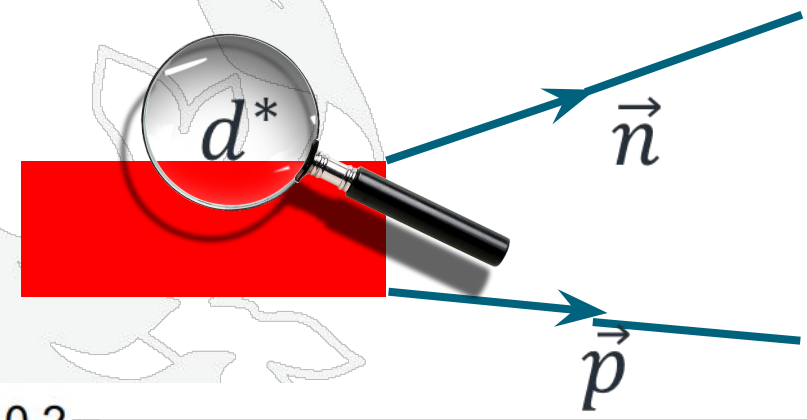
- CLAS12 JLab
- CEBAF gives electron beam
- 2 anti-parallel linacs
- At energy (10.2 – 10.6 GeV) beam enters halls
- Hall b is where CLAS12 lives

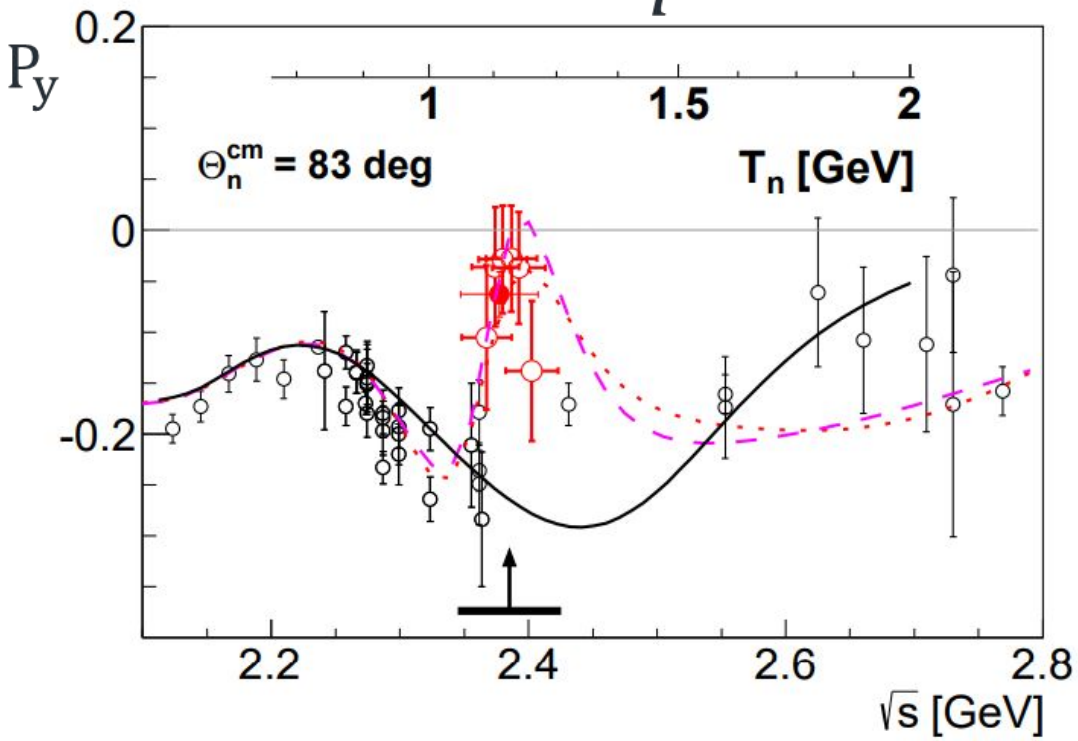
The Experiment





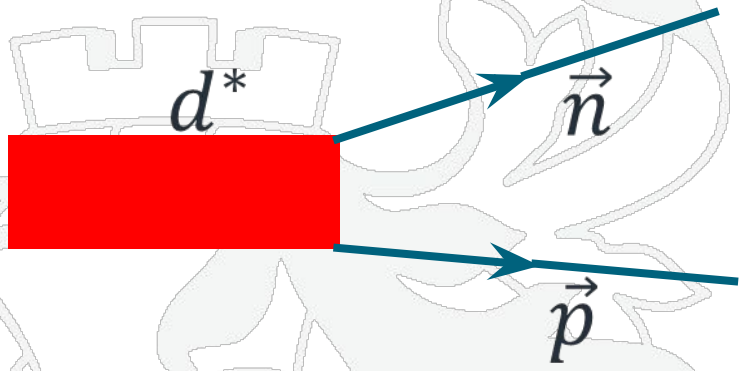
A Lens Named Polarization

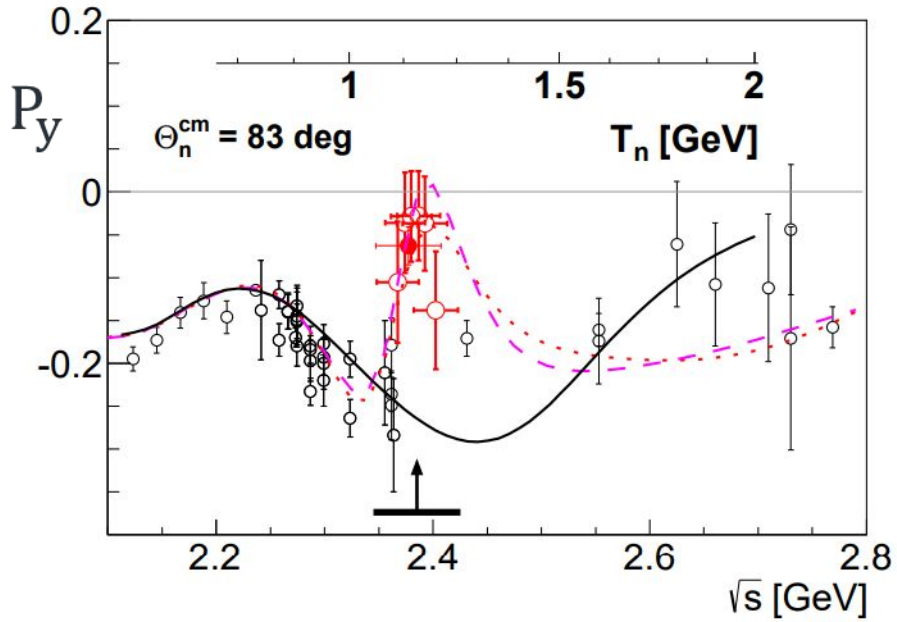


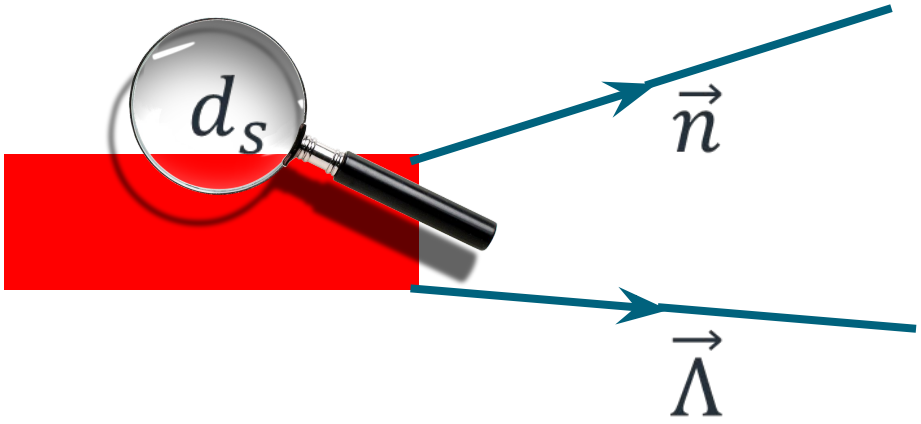


P. Adlarson et al., Phys. Rev. Lett. 112, 202301 (2014).

A Lens Named Polarization







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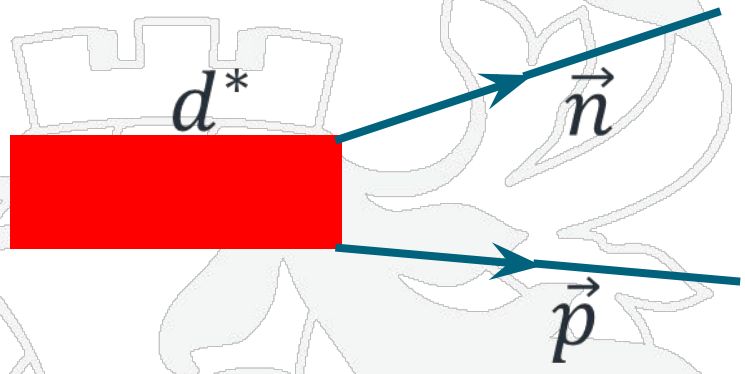
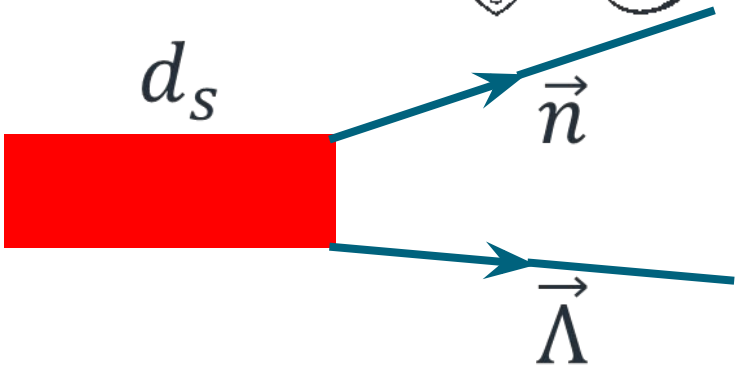
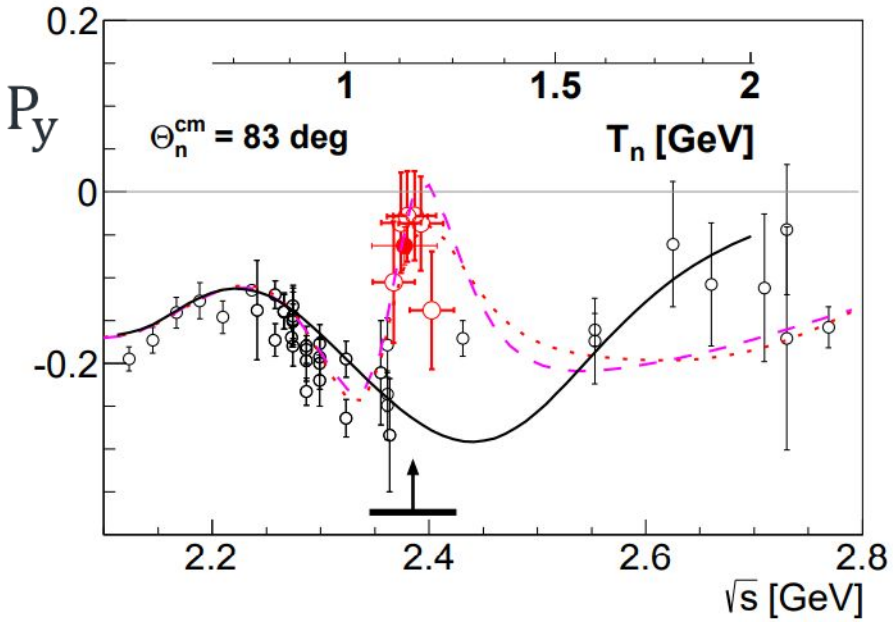




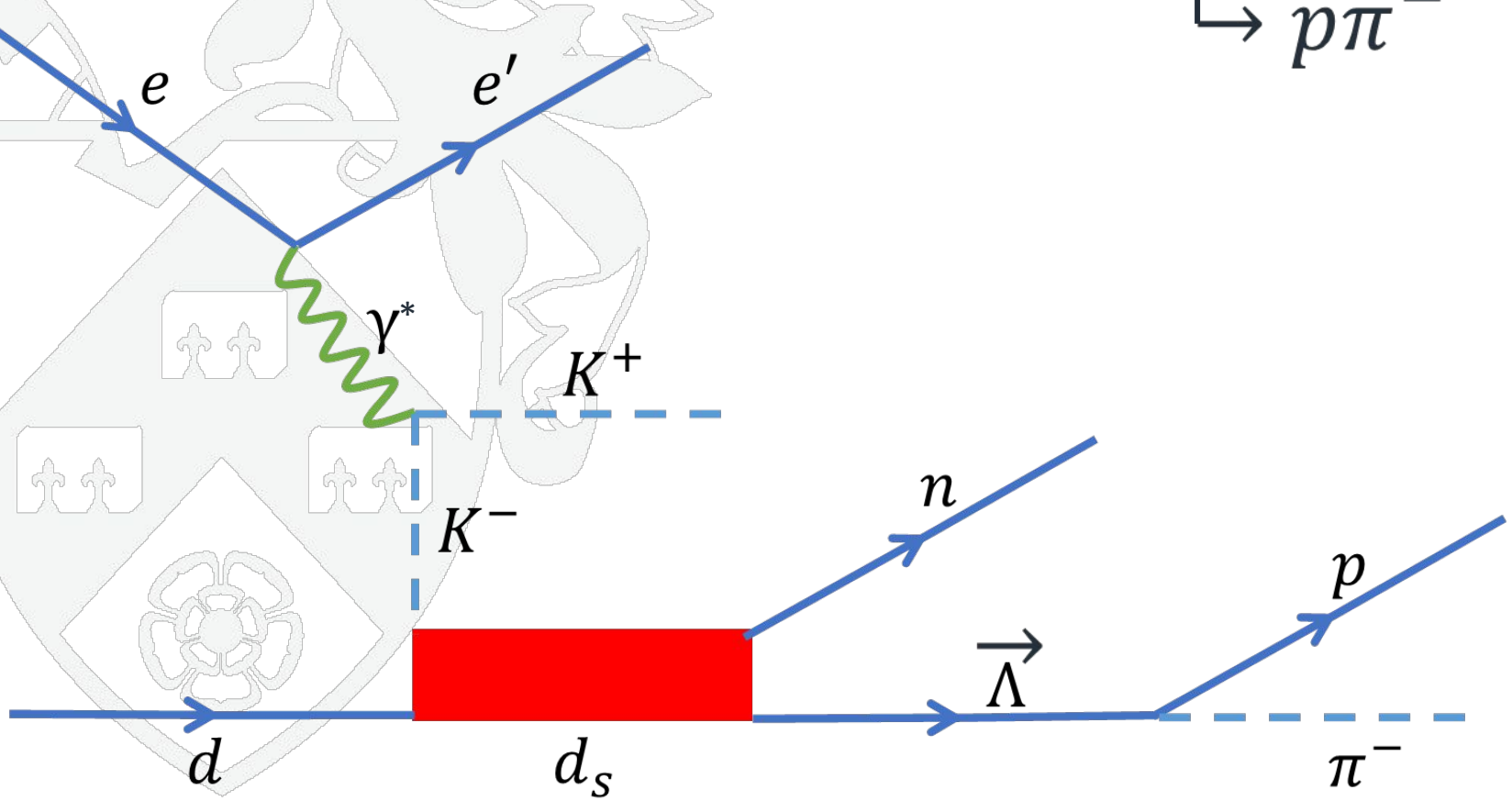


- Sensitive to polarization
- Lambda self analysing
- Lambda 100% polarized

P. Adlarson et al., Phys. Rev. Lett. 112, 202301 (2014).

Specific Channel

$$ed \rightarrow e'K^+d_s \rightarrow e'K^+\vec{\Lambda}n$$
$$\hookrightarrow p\pi^-$$



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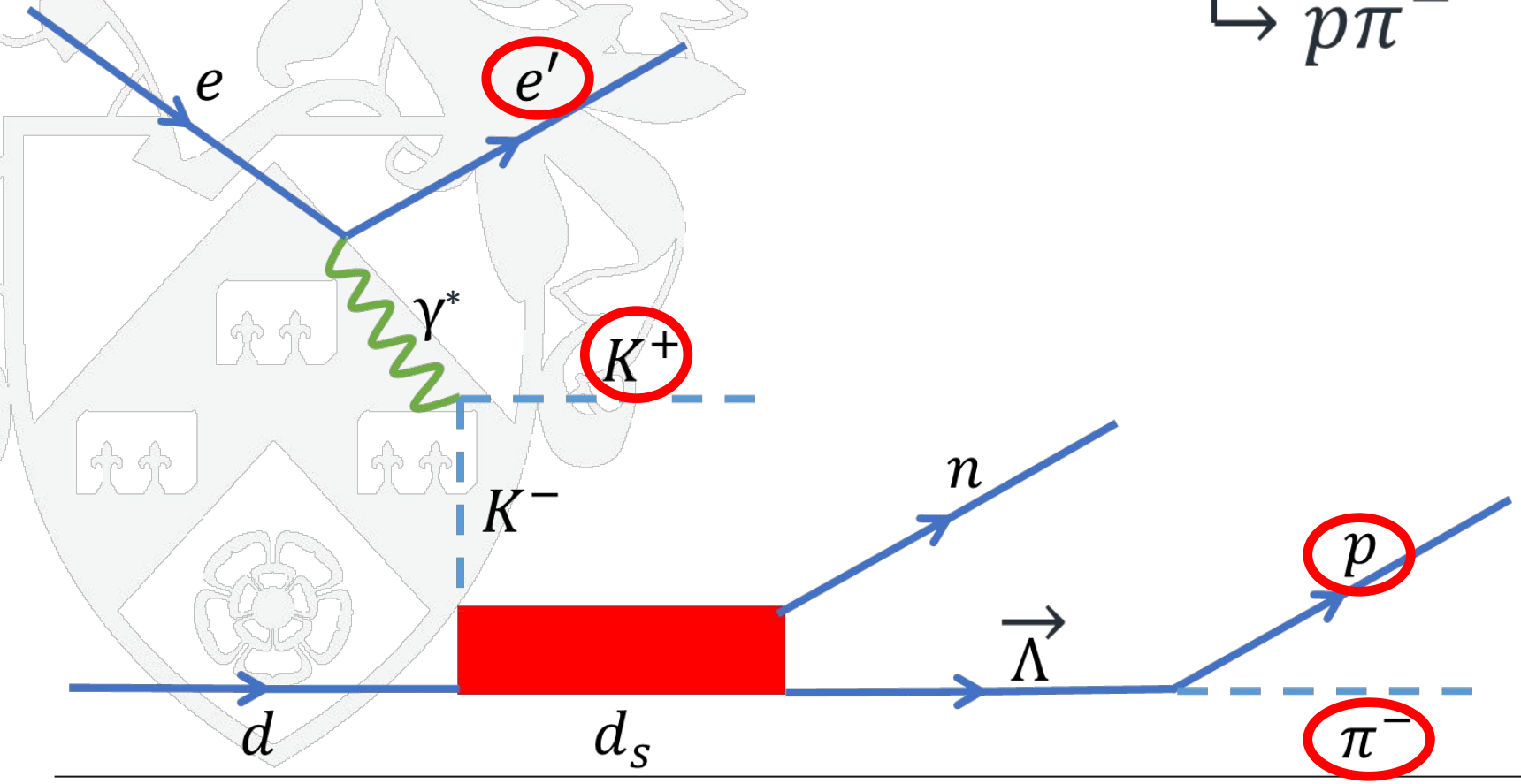
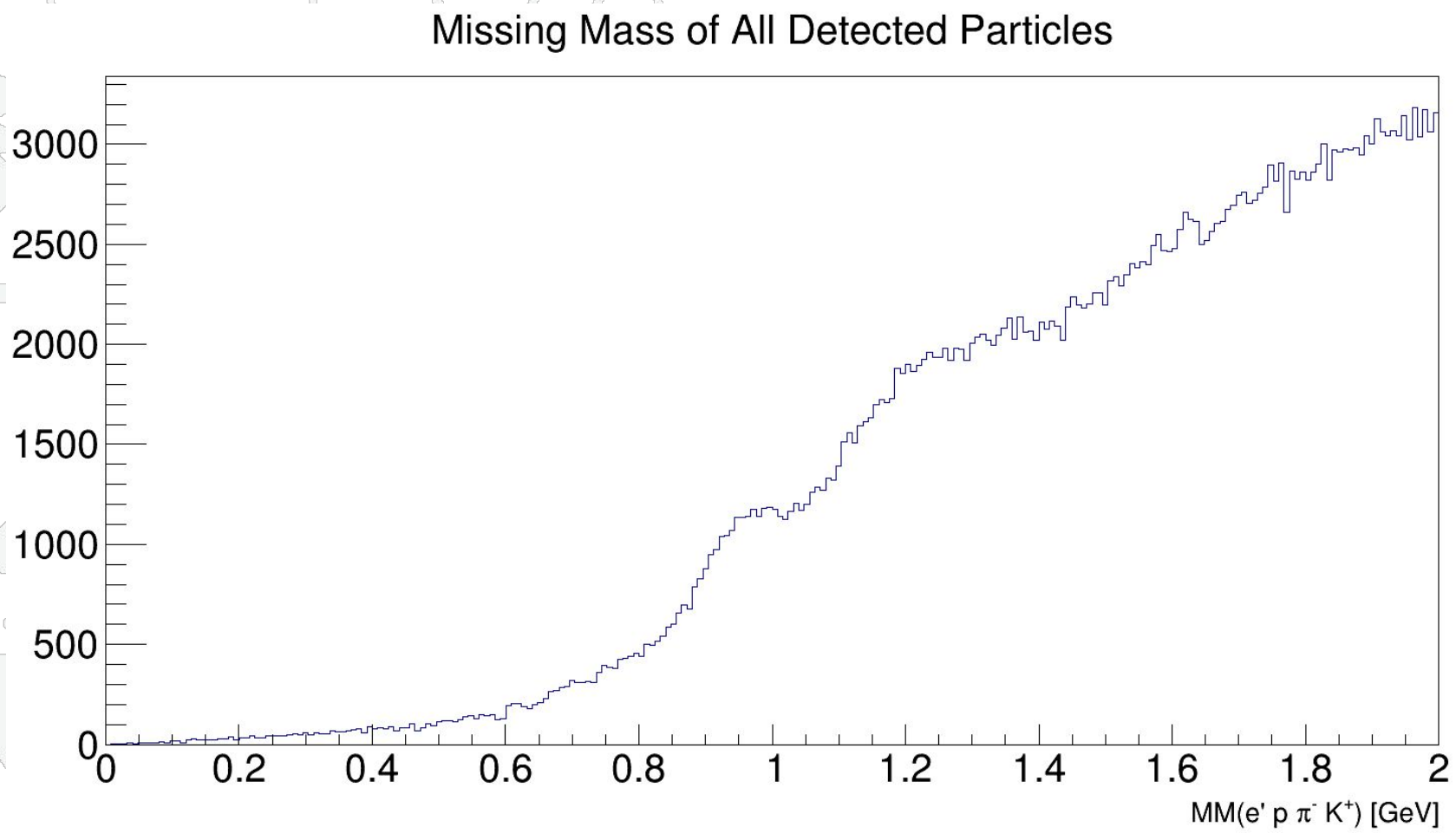
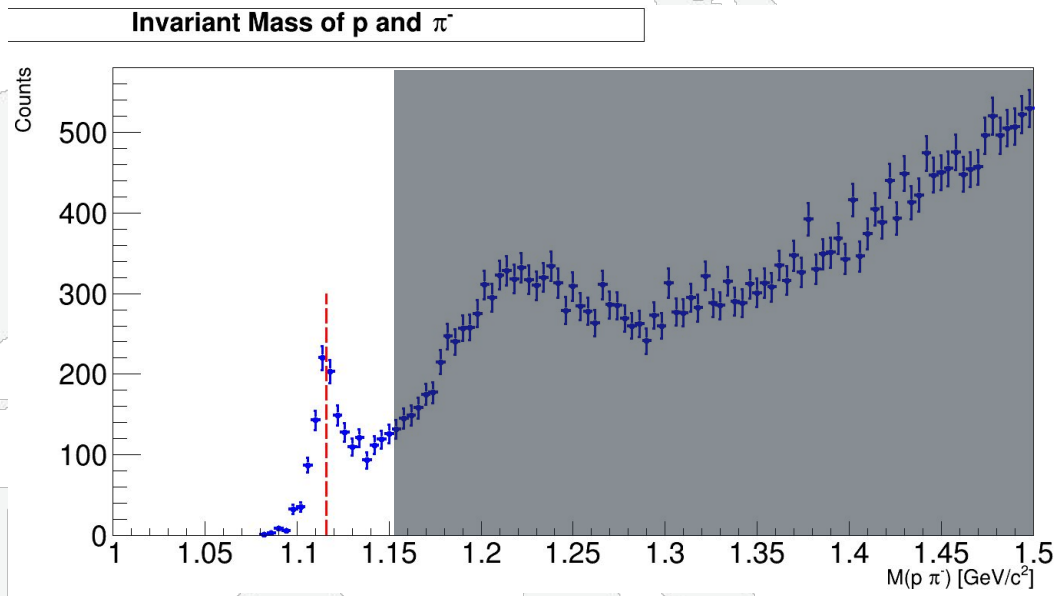


Event Selection



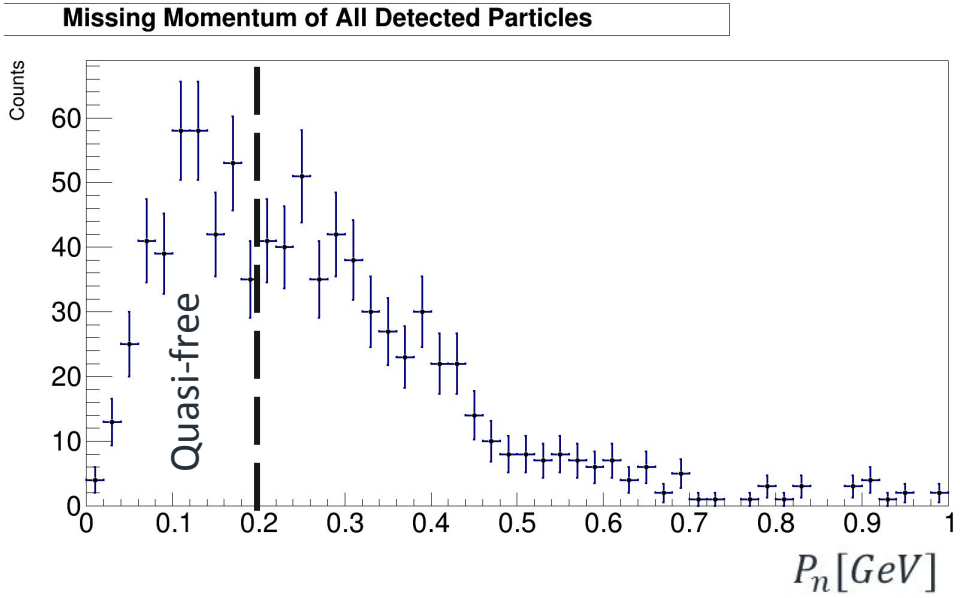
$$ed \rightarrow e'K^{+}n\Lambda$$

Event Selection

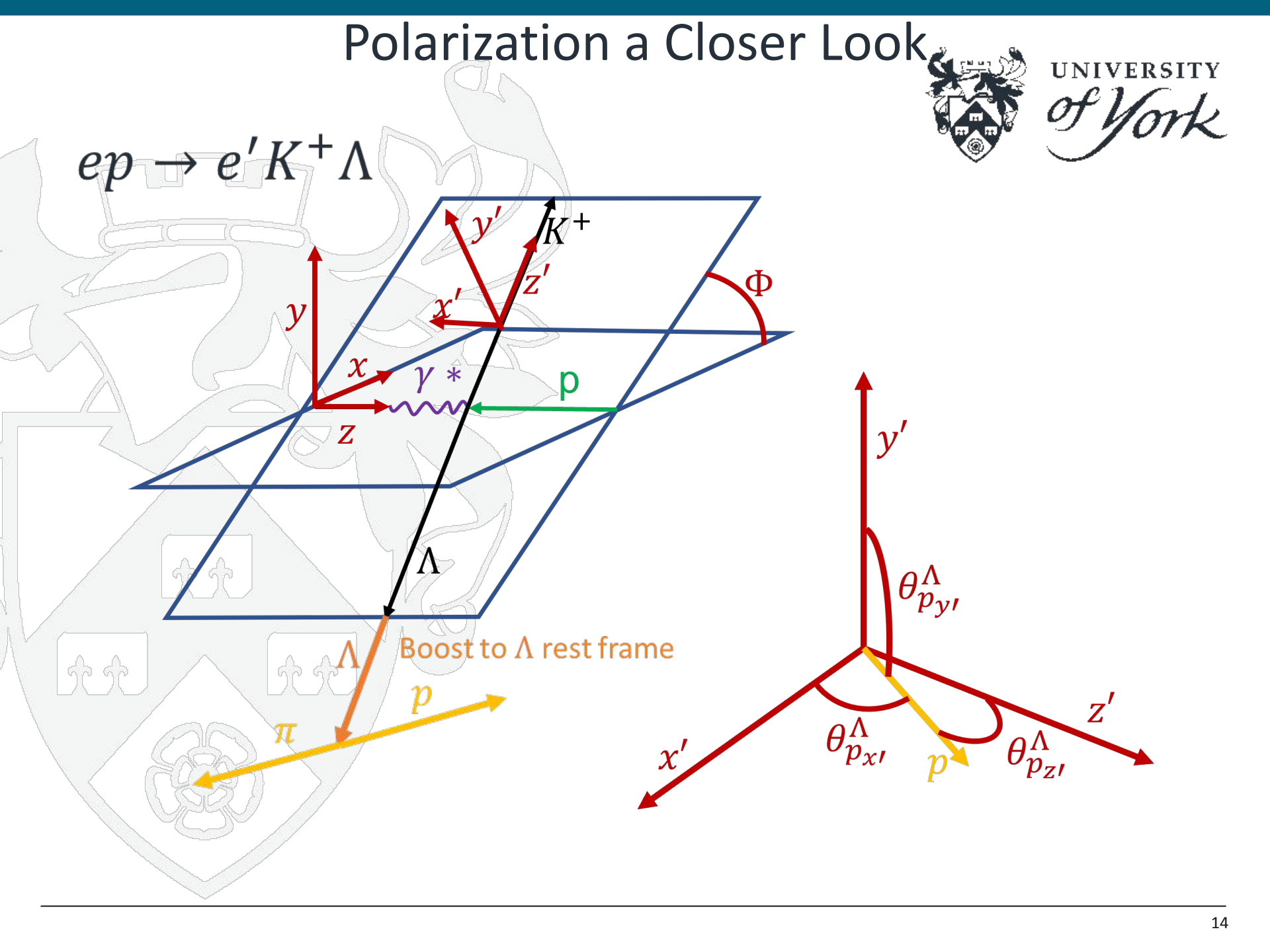


$$\vec{\Lambda} \rightarrow p\pi^-$$

$$ed \rightarrow e' K^+ n\Lambda$$

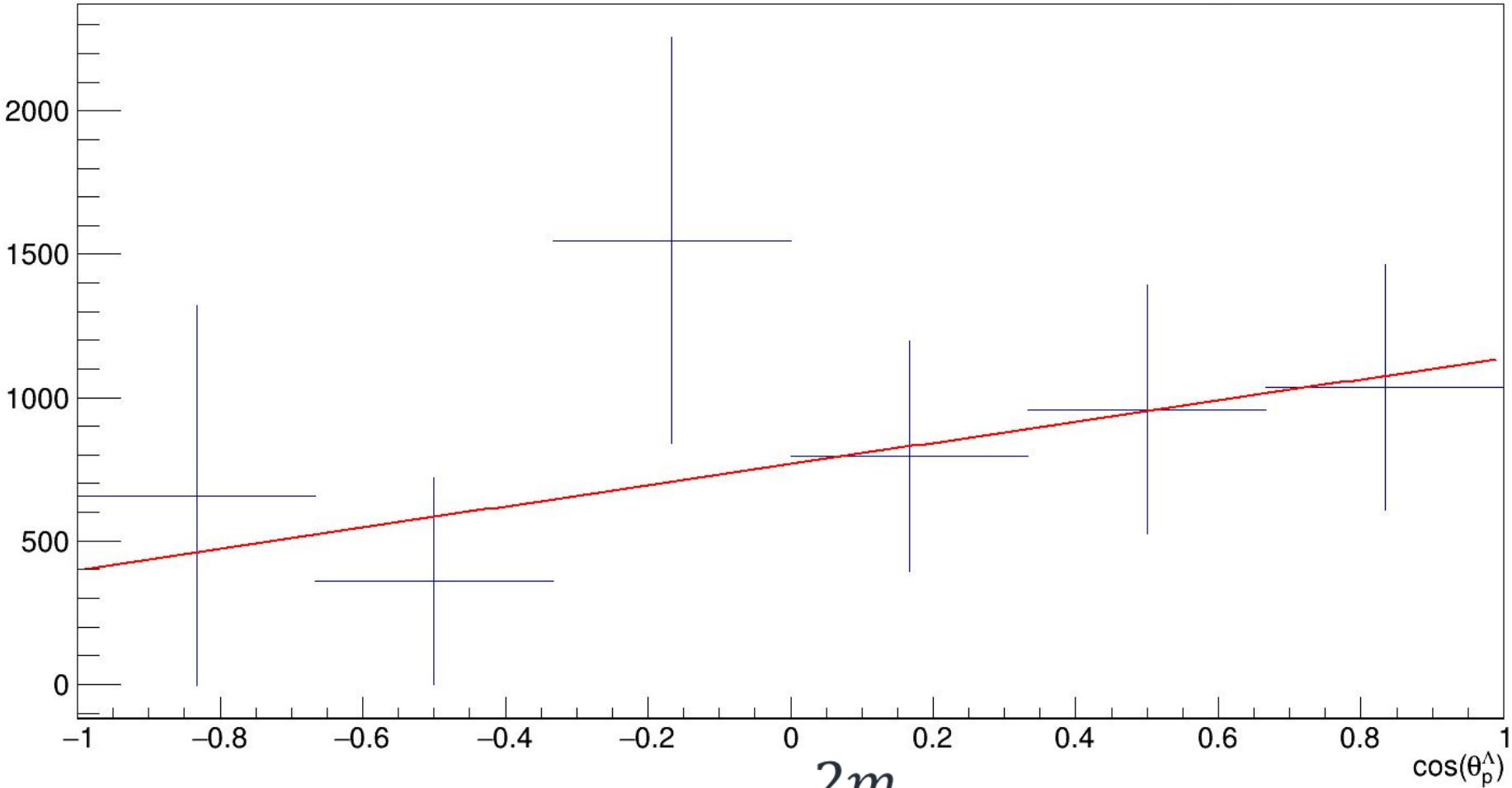


Polarization a Closer Look



Polarization a Closer Look

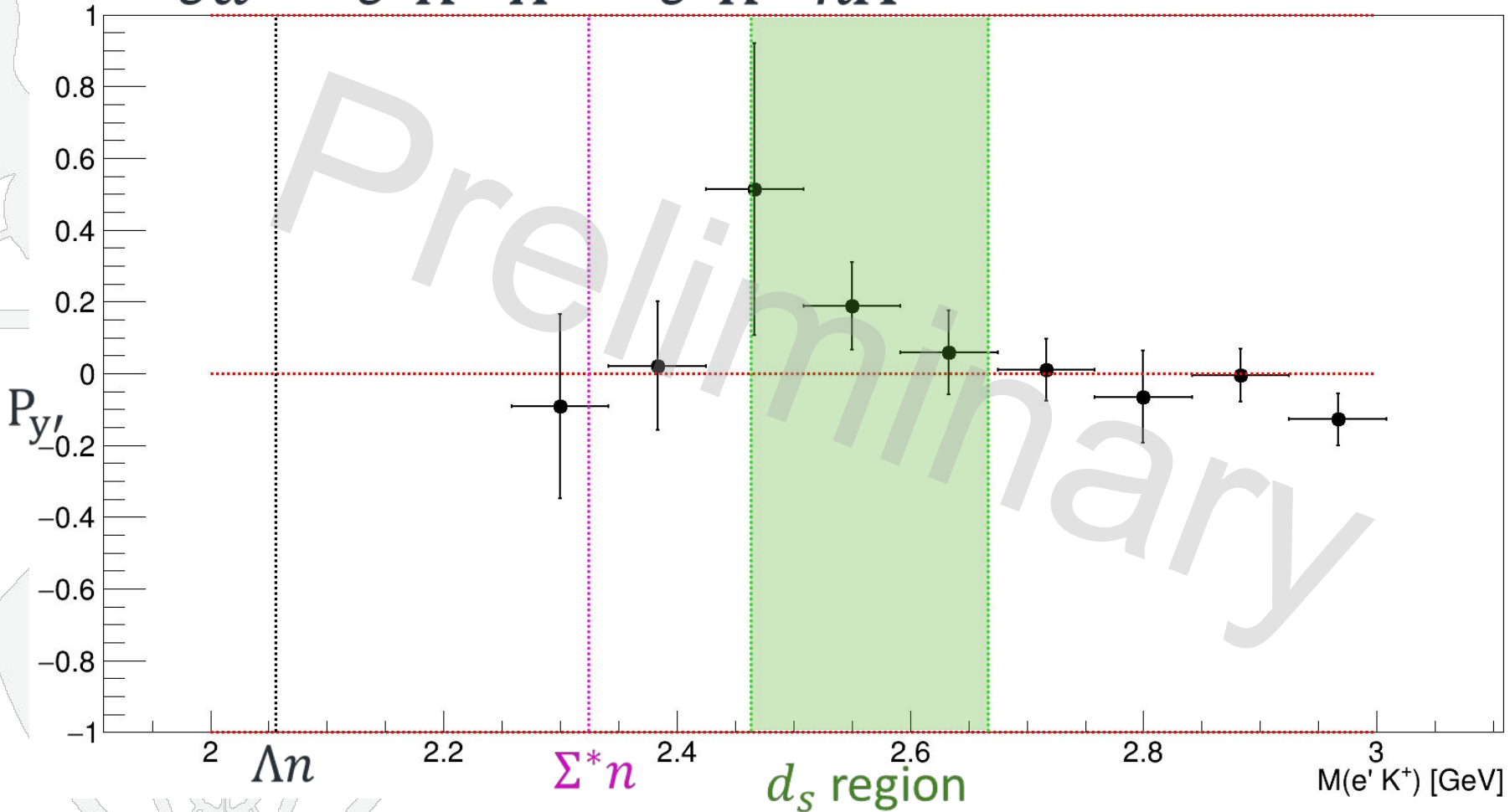
$$N(\cos\theta^{\Lambda}_{p_{y'}}) = \frac{N_0}{2}(1 + \alpha P_{y'}\cos\theta^{\Lambda}_{p_{y'}})$$



$$P_{y'} = \frac{2m}{\alpha N_0}$$

Preliminary Results

$ed \rightarrow e'K^+X \rightarrow e'K^+n\Lambda$



Mass of X [GeV]

Summary

- Exciting new data
- Benchmark reaction - done
- Polarization observables → high sensitivity for exotics (mass, width)
- More data to come
- Stay tuned

Thank you
Any Questions?

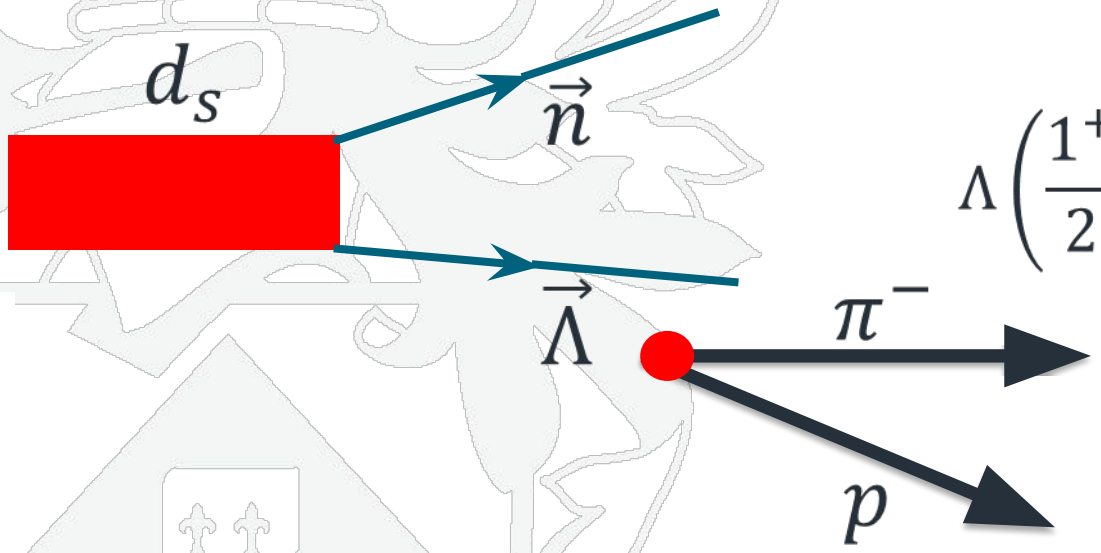
UNIVERSITY of York

Science and Technology Facilities Council

clas

CEBAF Large Acceptance Spectrometer

Polarization



$$\Lambda\left(\frac{1^+}{2}\right) \rightarrow p\left(\frac{1^+}{2}\right)\pi^-(0^-)$$

$P = (-1)^L \therefore L = 1$ for parity conservation

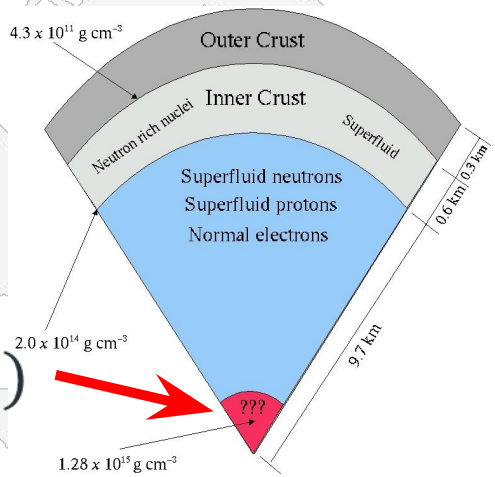
Weak decay allows parity violation

Background and Motivation

Neutron Stars

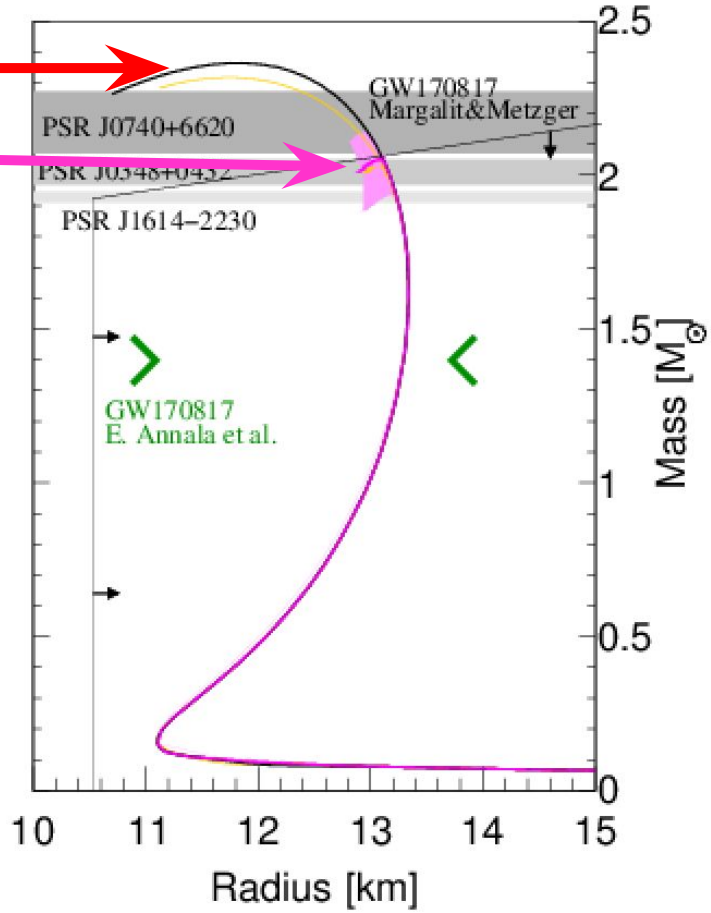
Nuclear Matter

Hexaquark Matter



Neutron Star Pizza

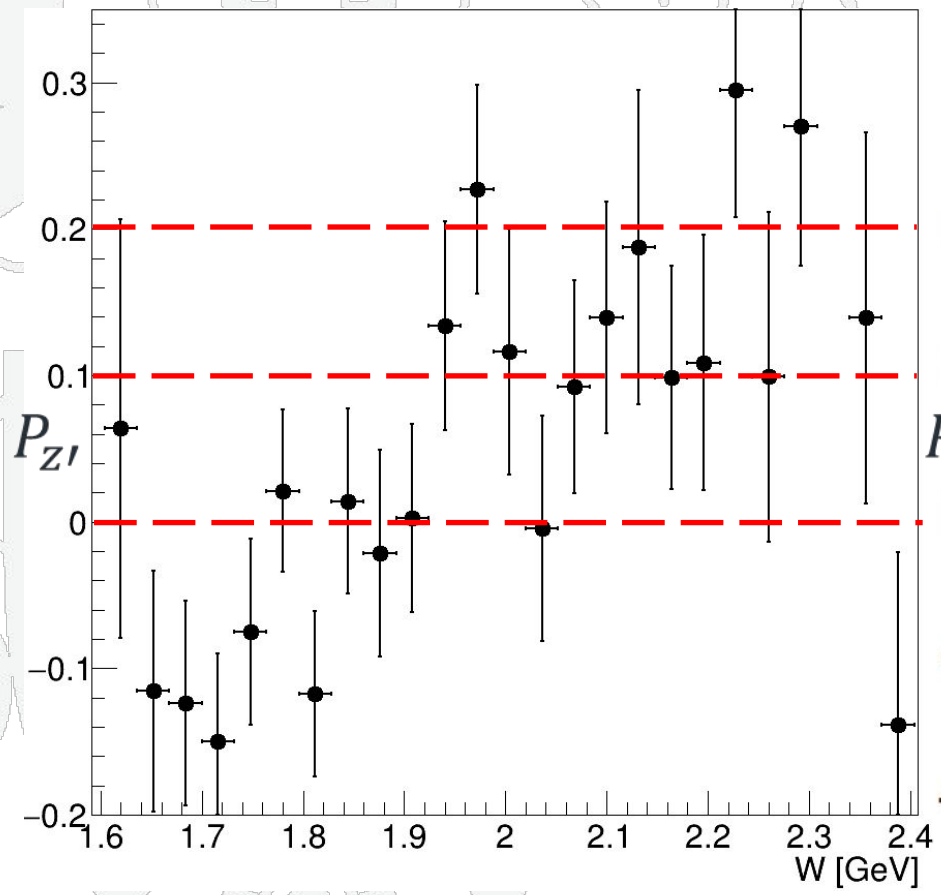
$d^*(2380)$

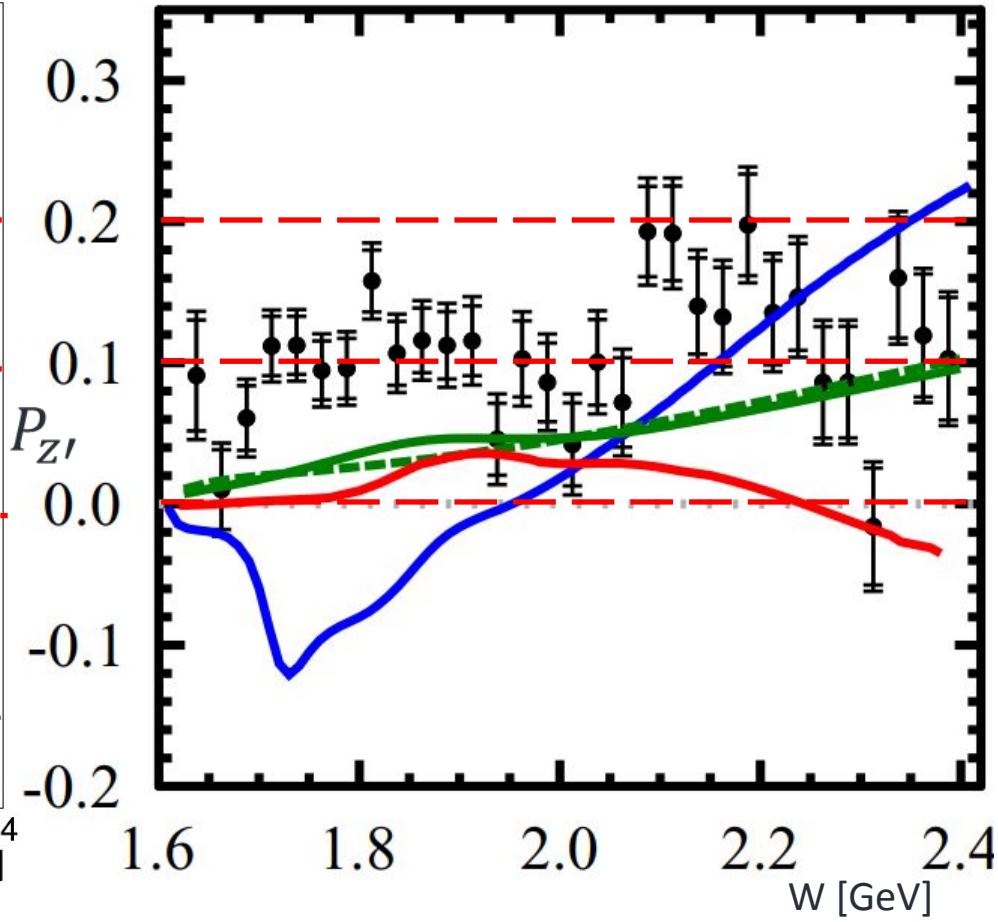


I.Vidaña et al., Phys.Lett.B 781 (2018) 112-116

Benchmark Reaction

$ep \rightarrow e'K^+\Lambda$





D. S. Carman et al. Phys. Rev. C **105**, 065201 (2022)