UNIVERSITY of York

Jefferson Lab

Measuring neutron polarisation in pn production using CLAS

William Booth

The University of York

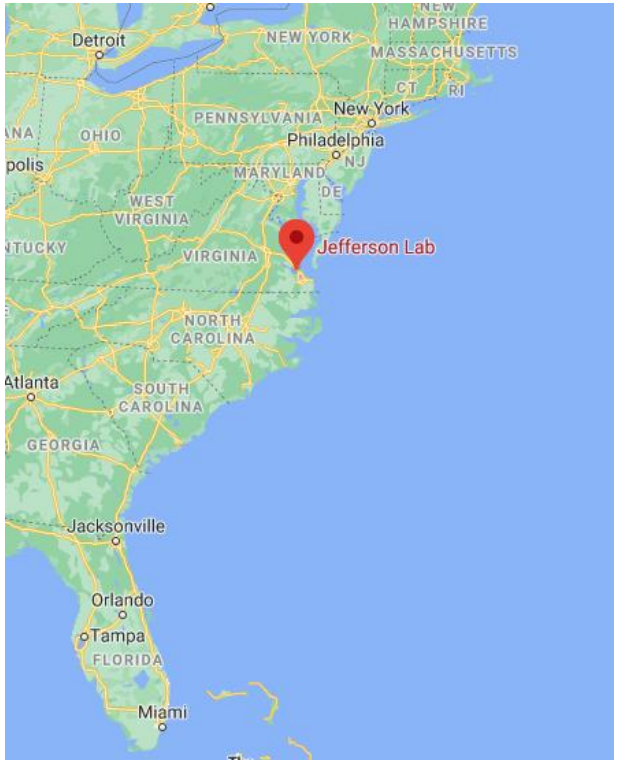
Supervisors: Daniel Watts, Nicholas Zachirou

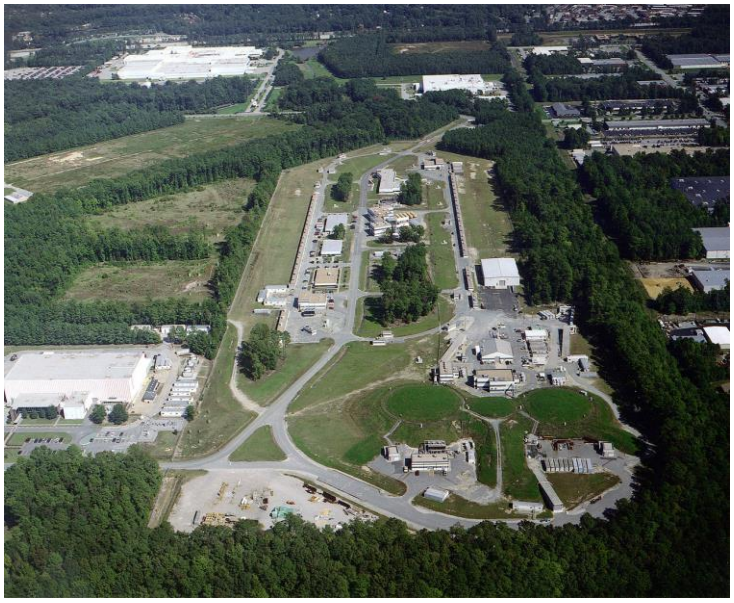
Motivation

- Determining neutrons polarisation could provide insight to:
  - the recently discovered dibaryon, d*(2380)
  - the nature of neutron stars
- Neutron polarimeters typically require dedicated equipment
- This novel utilization of the CLAS's Start Counter provides the opportunity to measure neutron polarization in the 6GeV energy regime and at wide angles, using existing data.

Jefferson Lab

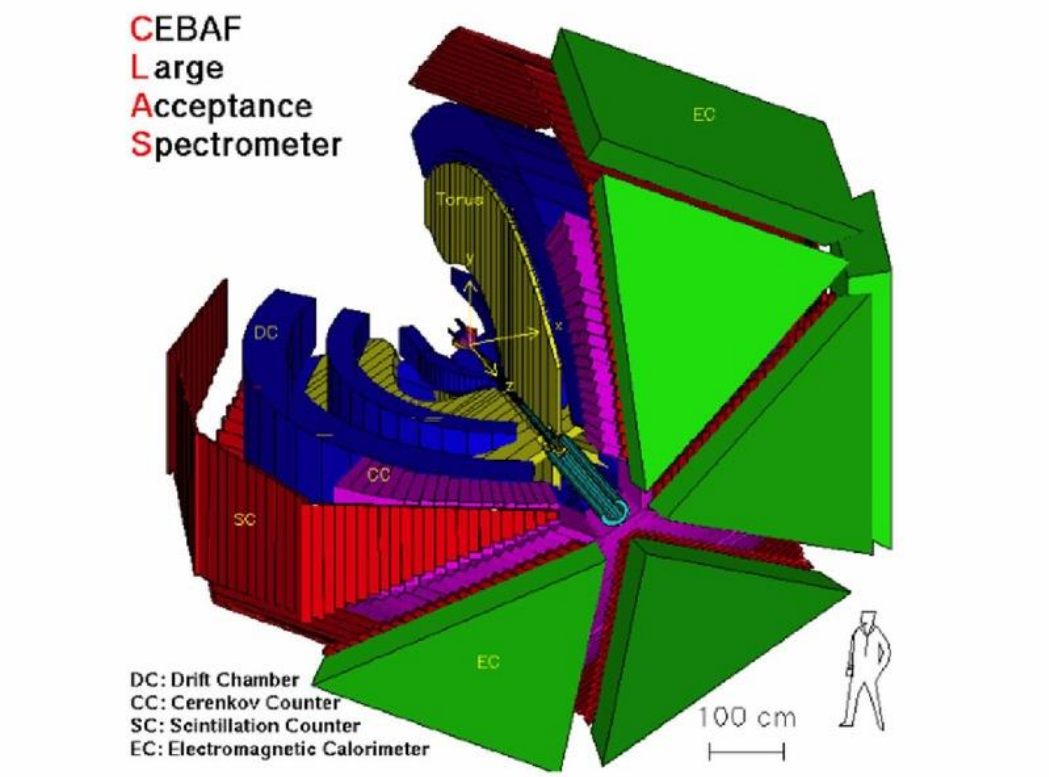
- Established 1984
- Located in Virginia, USA
- A US Department of Energy facility
- A world leading electron accelerator (CEBAF)
- Various experimental halls





The CLAS detector (1998-2012)

- CEBAF Large Acceptance Spectrometer
- A many component detector system
- Accepting beam energies up to 6GeV



The Start Counter

- A set of 3mm thick plastic scintillators surrounding the target, parallel to the beam line.
- Used to determine start time of particle events

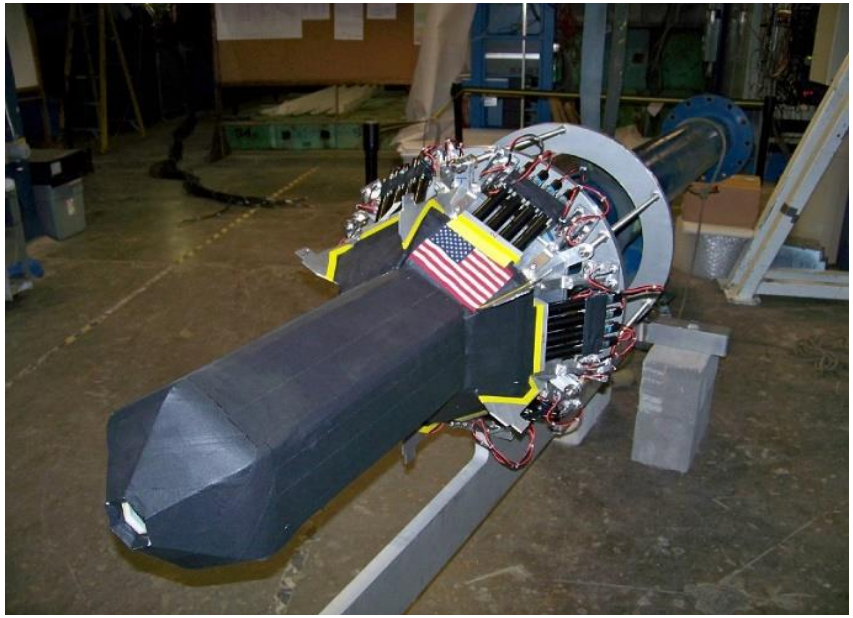
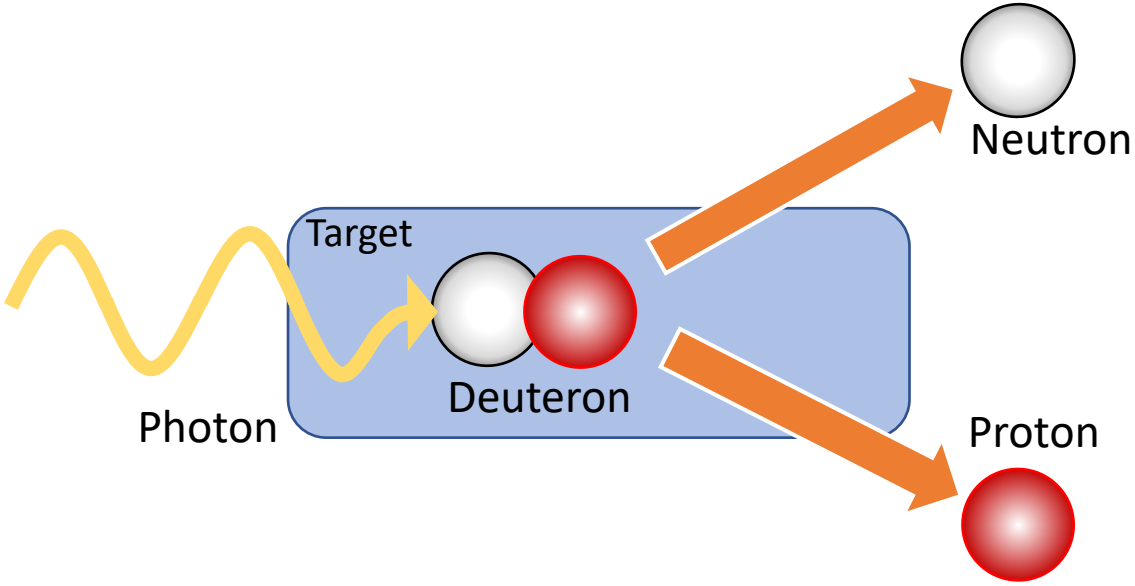


Figure 3: Photo of the start counter during CLAS's construction.
https://www.jlab.org/Hall-B/album/index.html

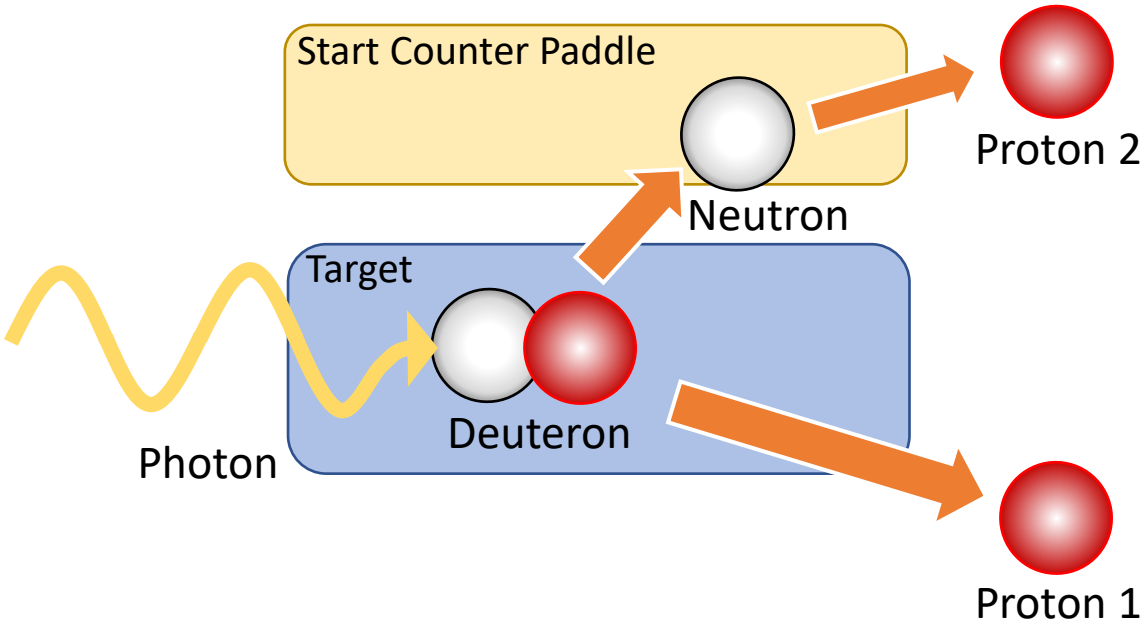
Experimental run g13a

- Deuterium target
- Circularly polarised photon beam
- Investigation of dibaryon states



Experimental run g13a

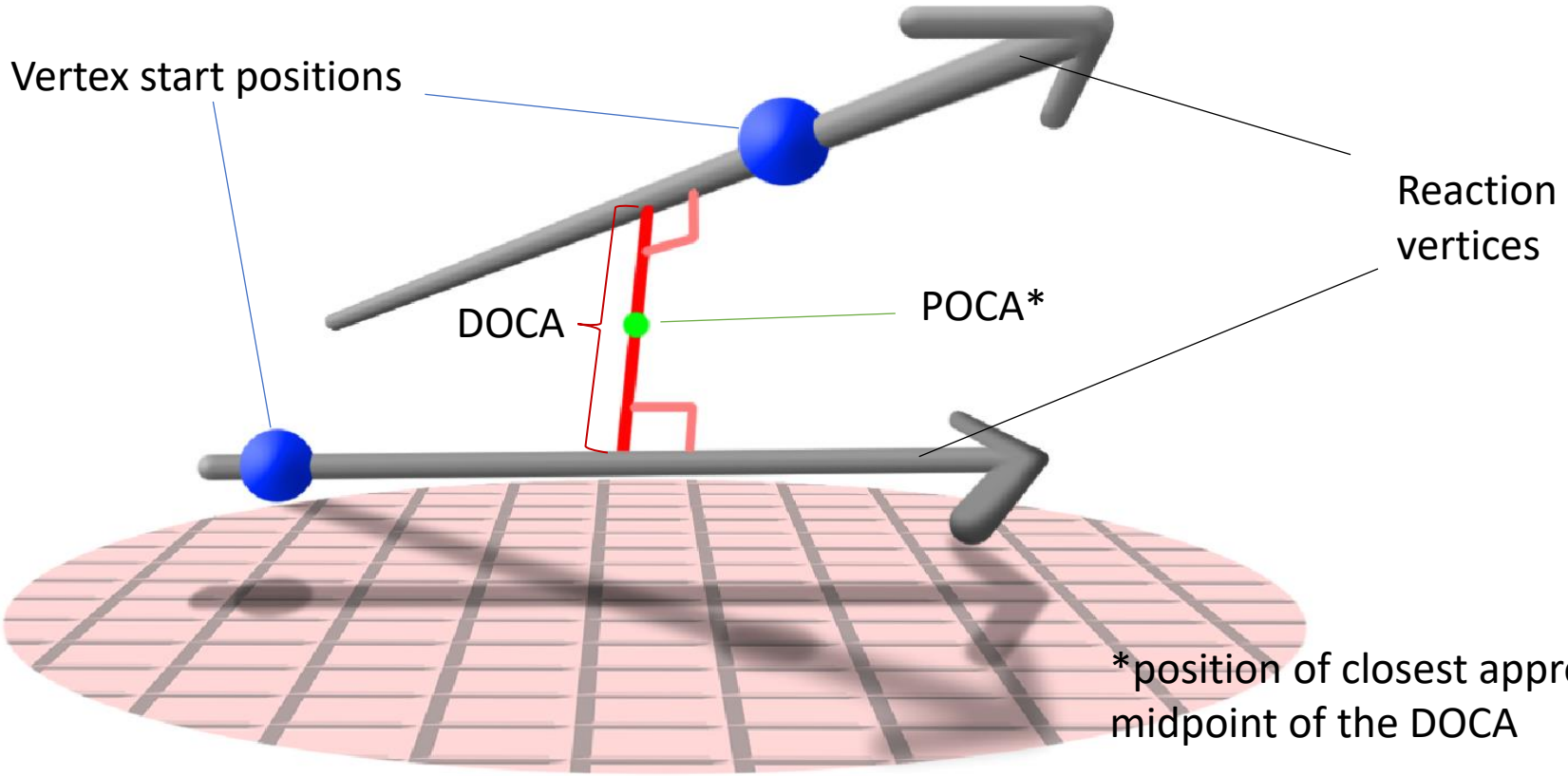
- Deuterium target
- Circularly polarised photon beam



$$I(\theta_{sc}, \phi_{sc}) = I_0(\theta_{sc})[1 + A(\theta_{sc})(P_y \cos\phi_{sc} - C_{x'} P_\gamma^{\odot} \sin\phi_{sc})]$$

Differentiating the protons

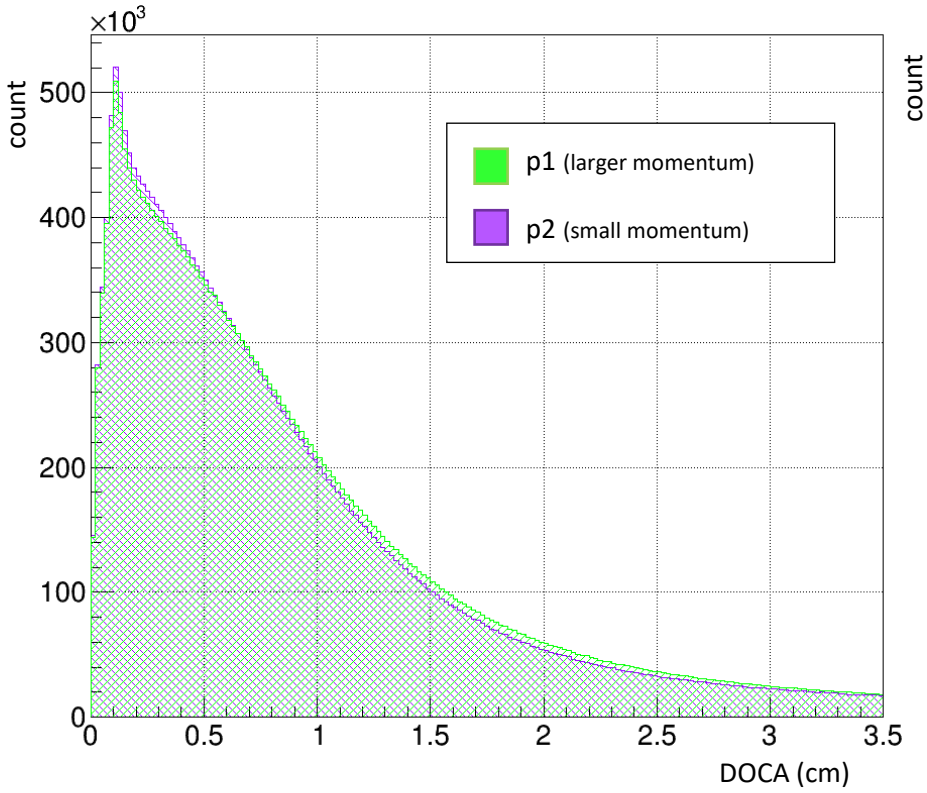
- DOCA (Distance Of Closest Approach)
- The closest distance between two vertices



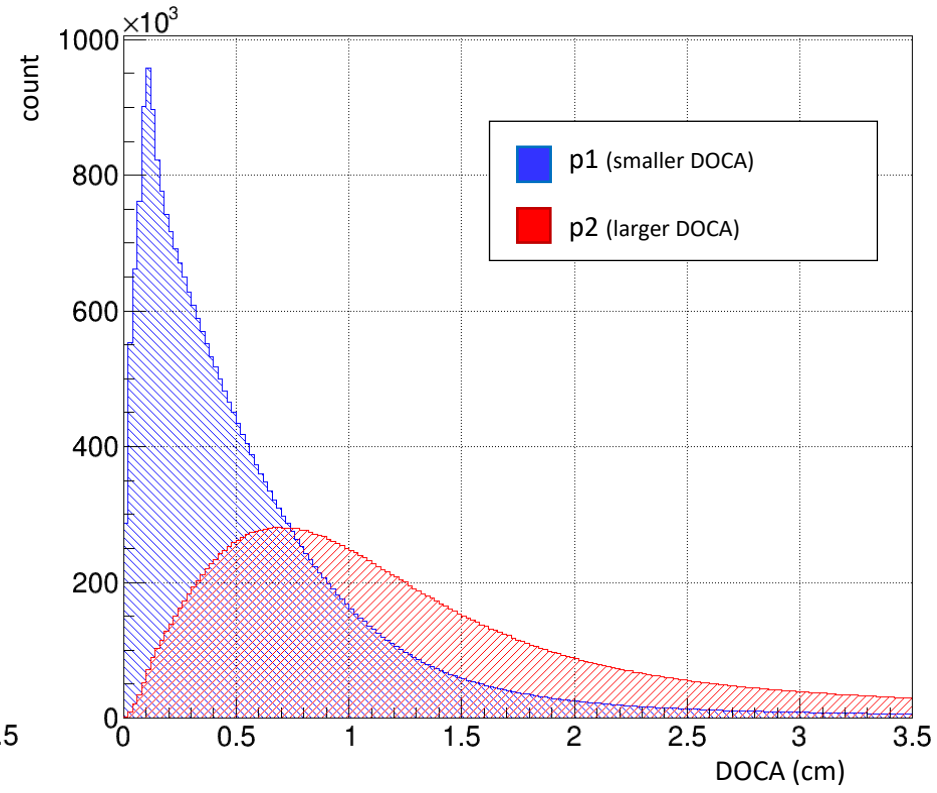
Differentiating the protons

- p1 and p2 defined by DOCA between photon and proton vertex

Before

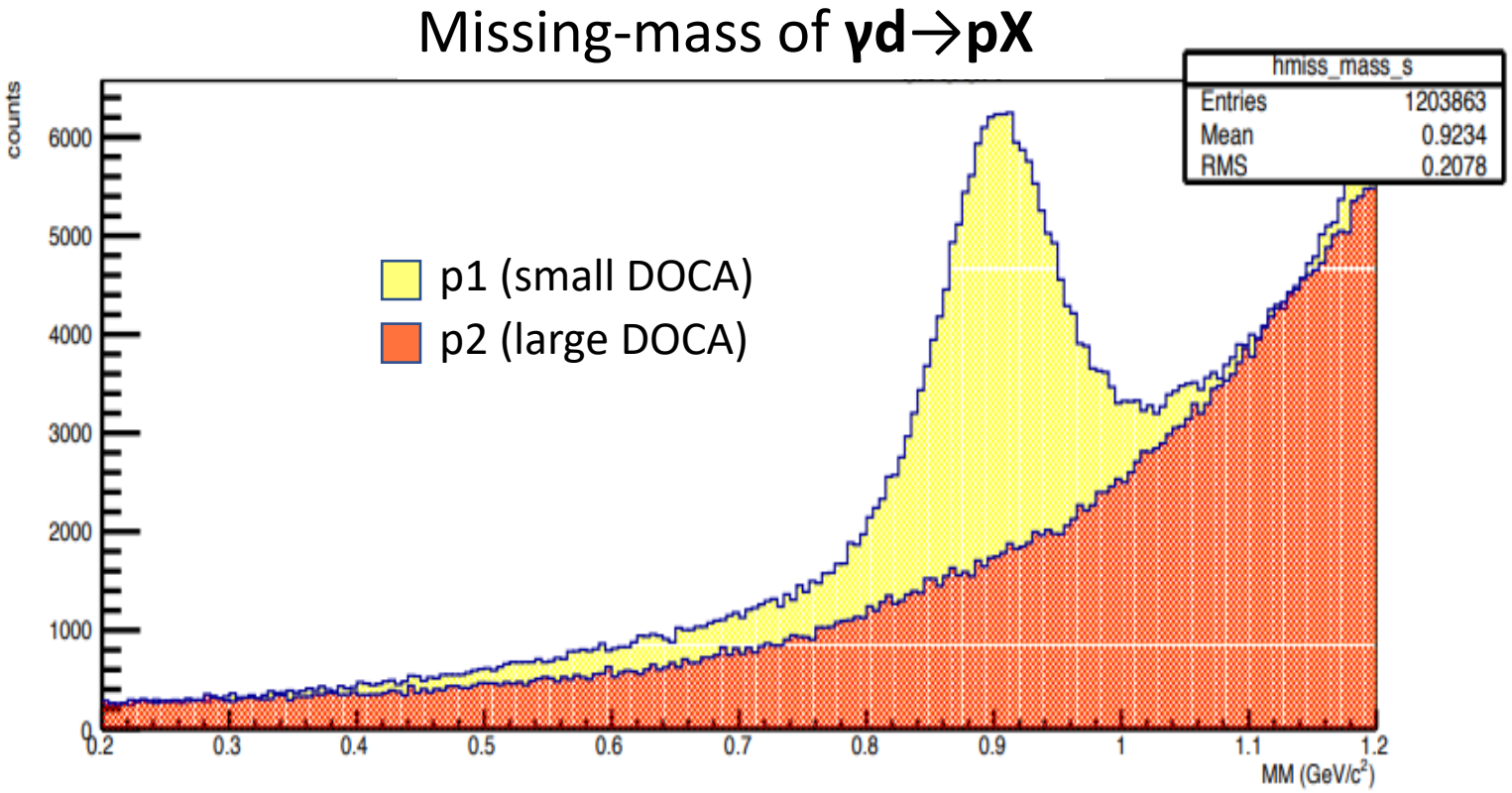


After



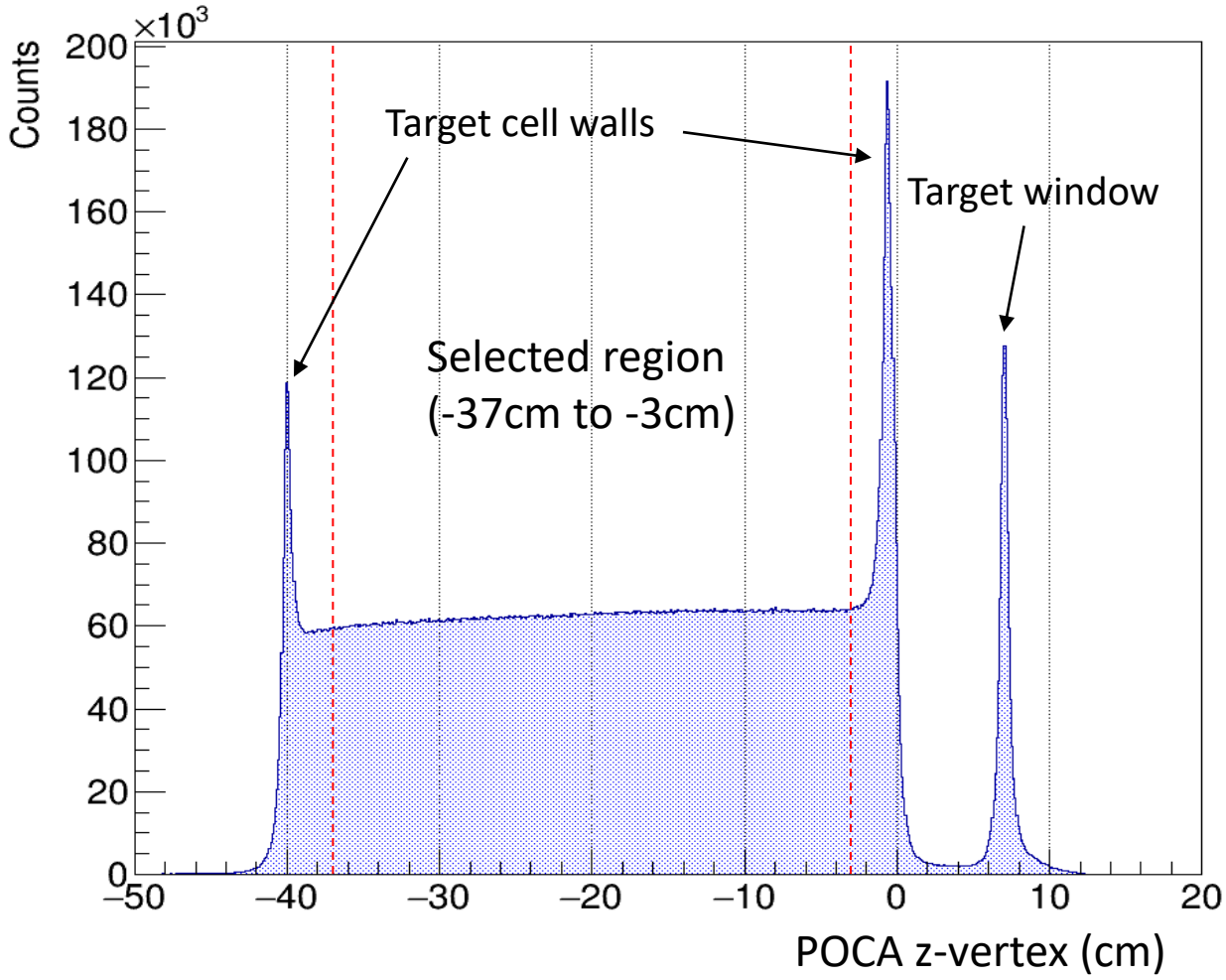
Missing mass of protons

- The distinction between p1 and p2 using DOCA is also clear in missing neutron mass

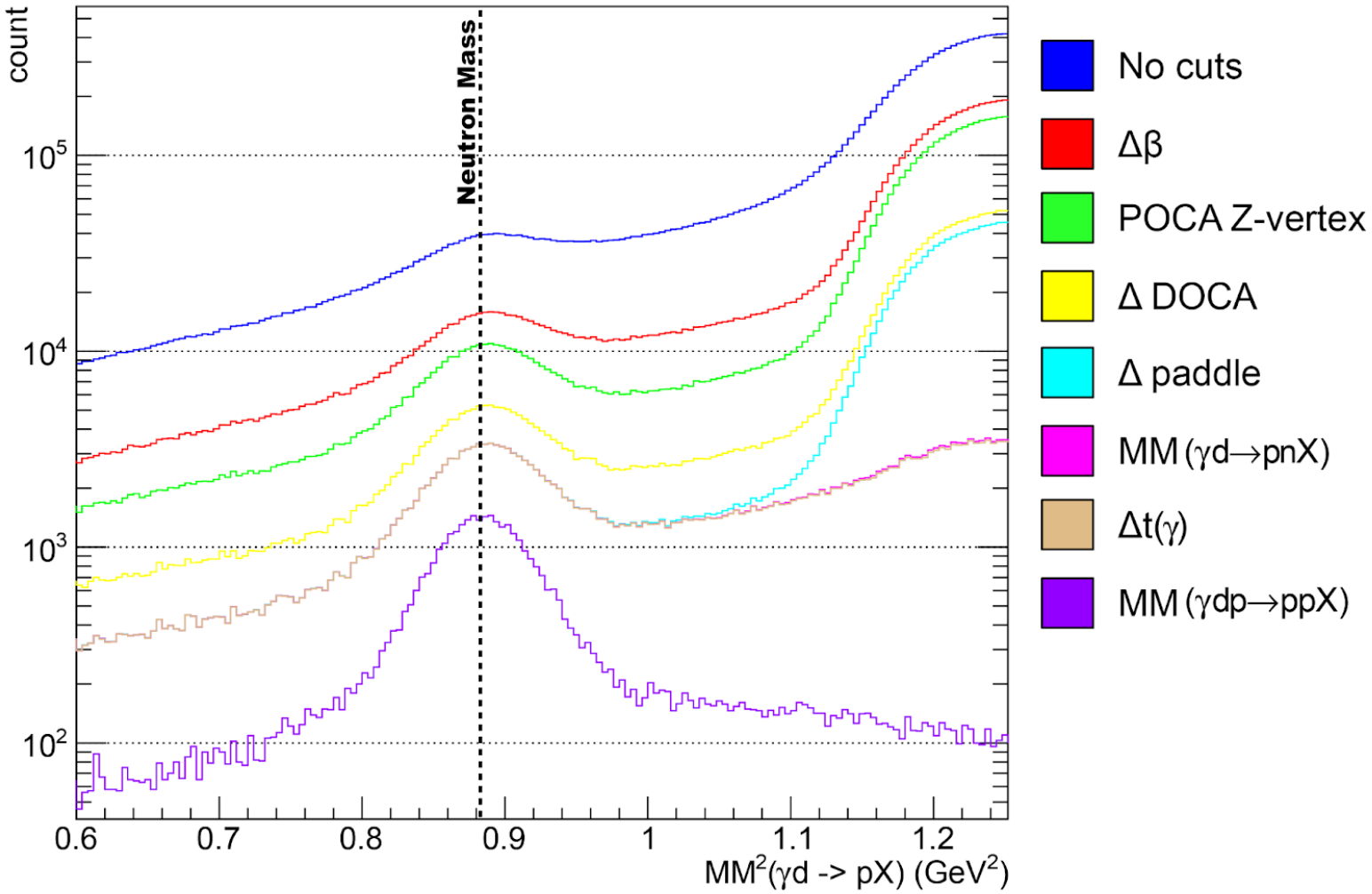


POCA cut

- Data selected to ensure event occurred in target

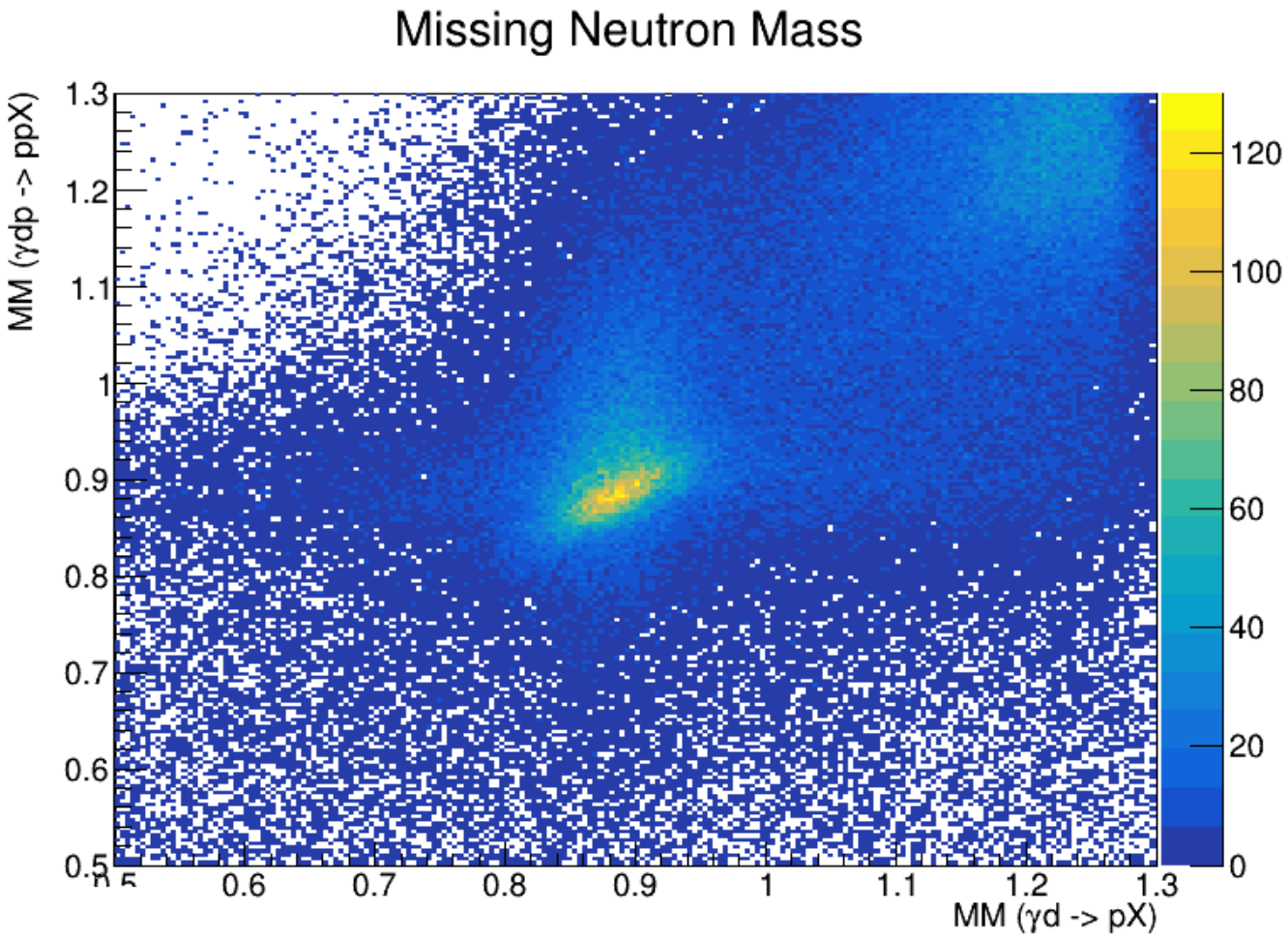


Summary of all cuts



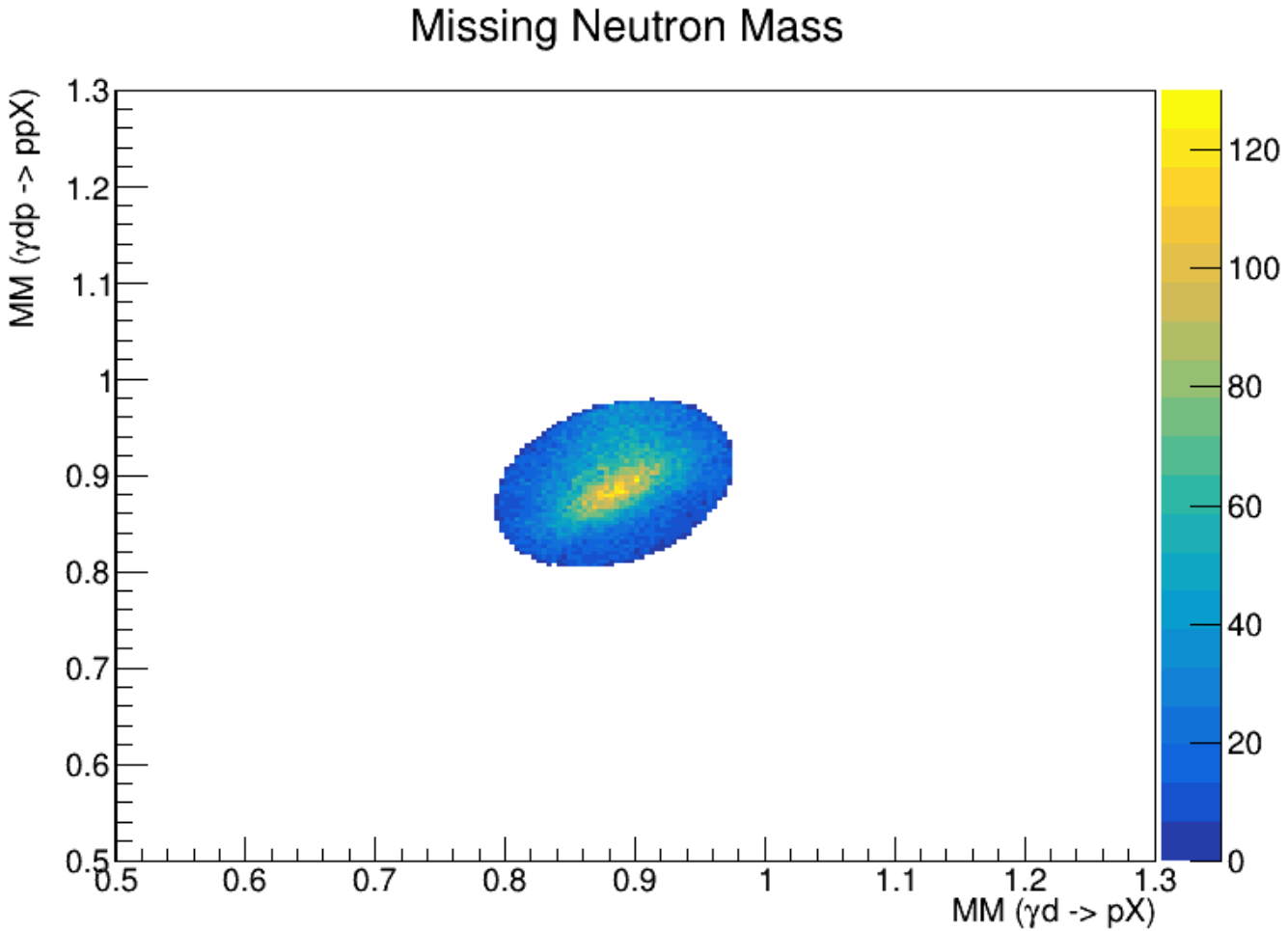
Data selection after all cuts

- Data is visible as a peak showing where two independent measurements of missing mass agree



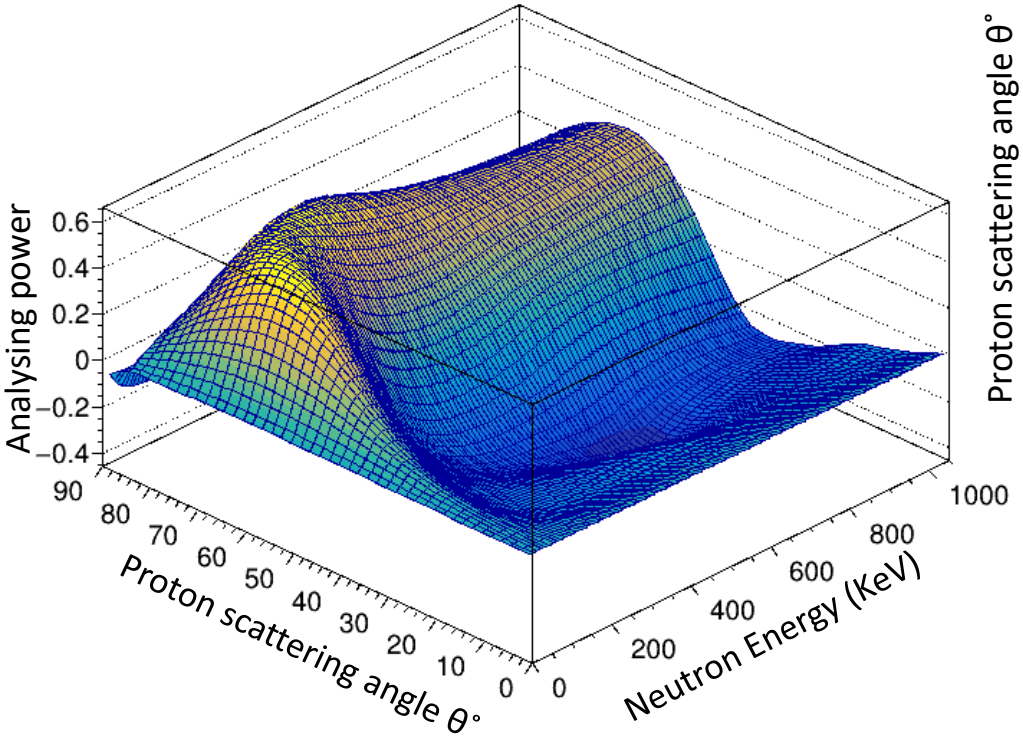
Data selection after all cuts

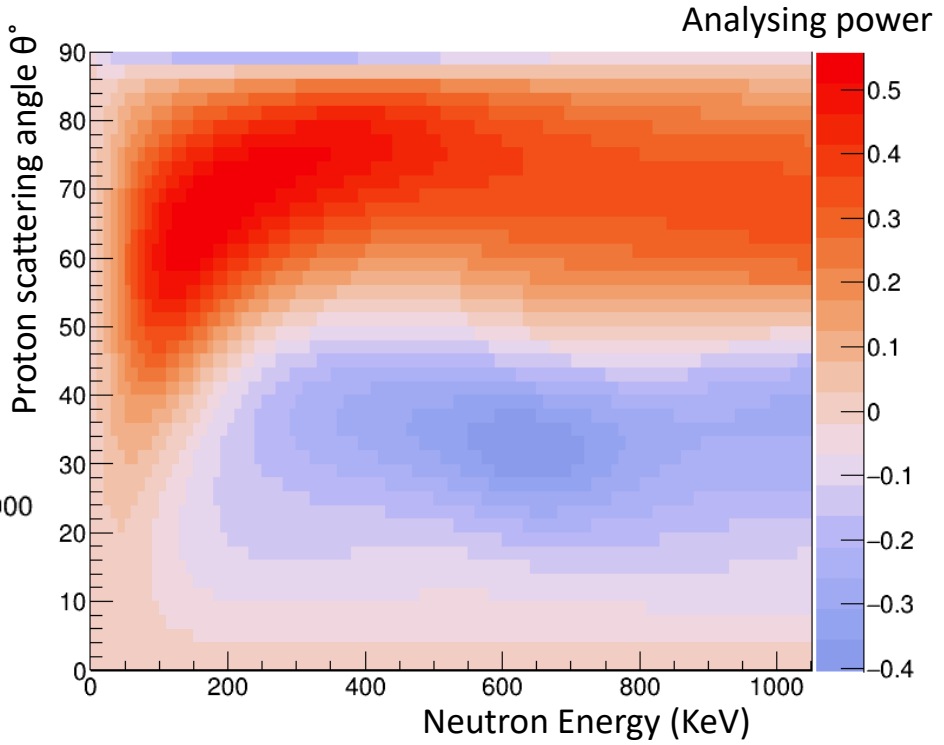
- Data is visible as a peak showing where two independent measurements of missing mass agree



SAID model

- Relates analysing power to scattering angle and energy

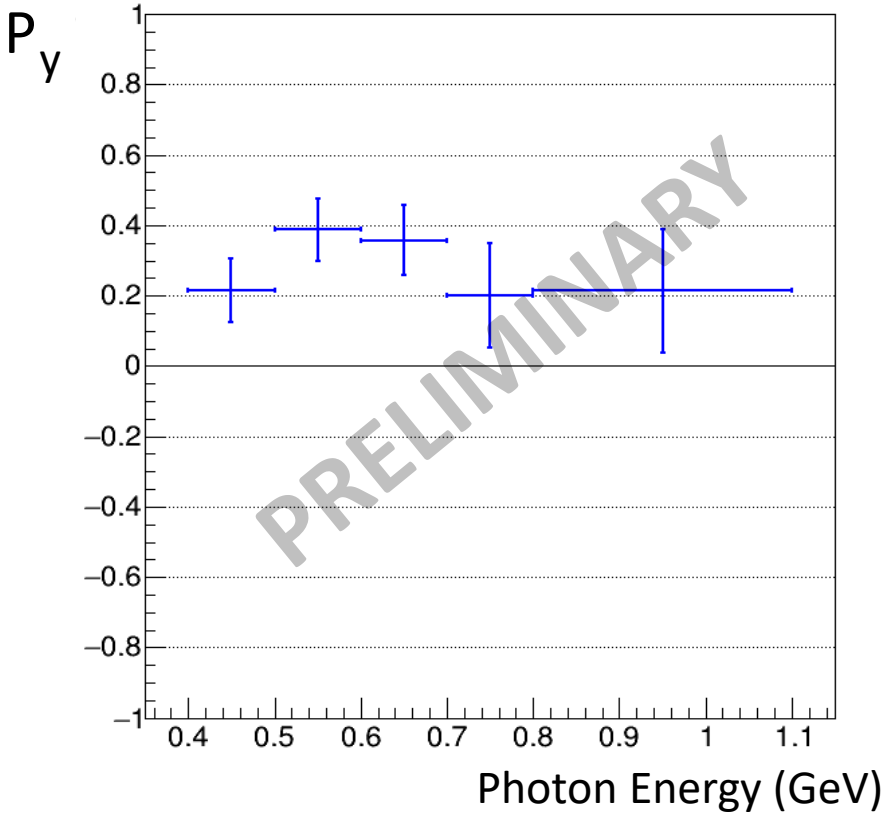




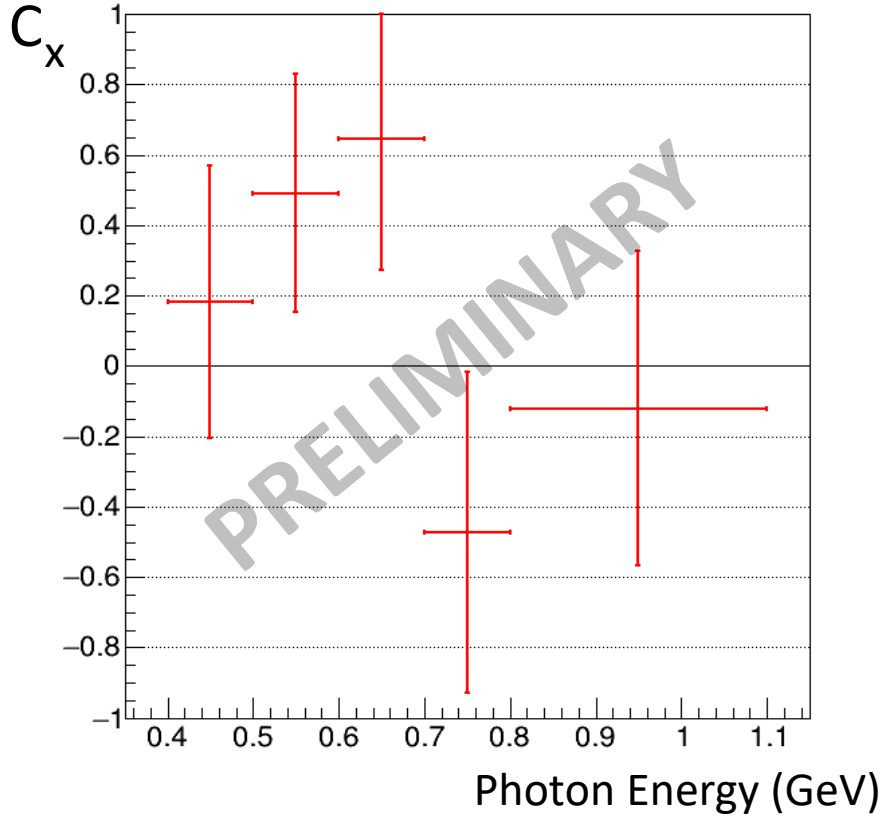
$$I(\theta_{sc}, \phi_{sc}) = I_0(\theta_{sc})[1 + A(\theta_{sc})(P_y \cos\phi_{sc} - C_{x'} P_\gamma^\odot \sin\phi_{sc})]$$

Preliminary measurements of neutron polarisation

Py – induced/transverse polarisation

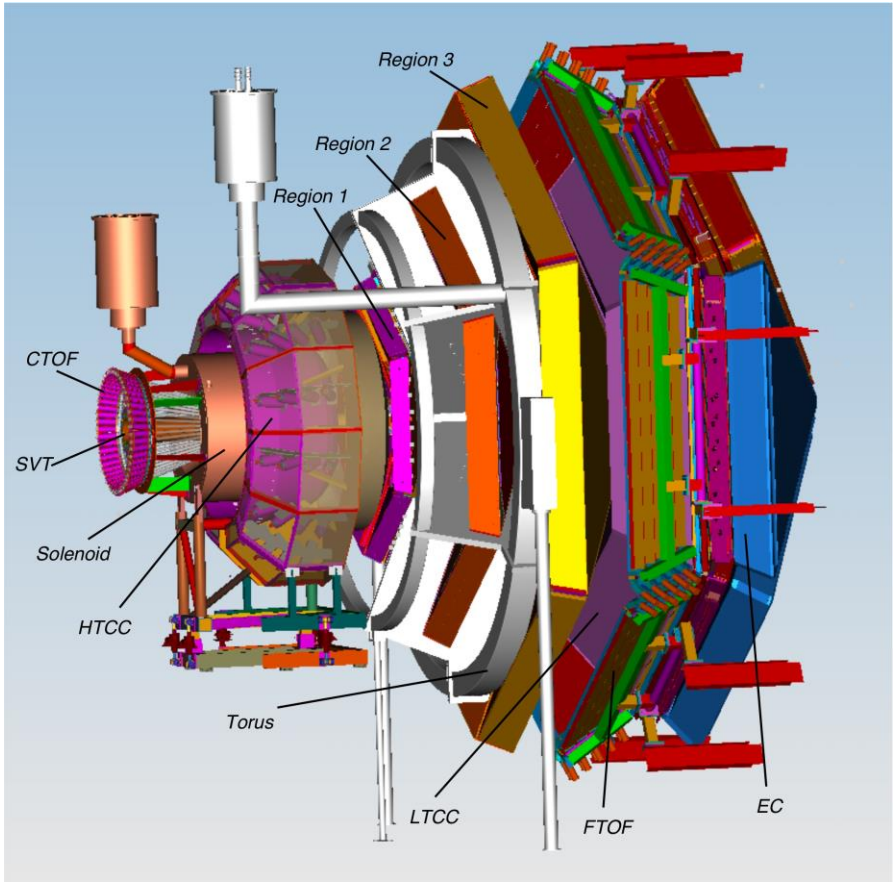


Cx – transferred polarisation



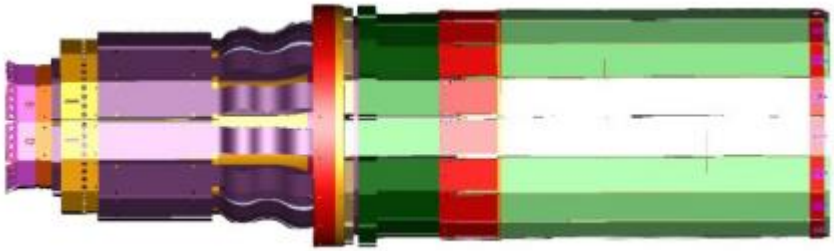
The CLAS12 detector

- New upgrade to CLAS
- Capable of beam energies up to 12GeV
- Run Group M
  - Electron scattering experiments
  - various nuclear targets
  - Will provide new SRC analysis



The silicon vertex tracker (SVT)

- Set of silicon sensors in the central detector
- Used to measure momentum and determine vertex of charged particles from the target
- Can also be utilized in the same way as the start counter as a neutron polarimeter



Summary

- g13 neutron polarisation study to be finalised
  - Process refined
  - Simulations done for comparison
- Analysis note produced
- Begin analysis on CLAS12 data with RGM
  - Provide first polarisation measurements of SRCs utilising the SVT

Thank you