# Background Simulations with Transversely Polarized Target in CLAS12 Detector

## Zachary Meador<sup>1</sup>

Advisors: David Heddle<sup>1</sup><sup>2</sup> Latifa Elouadrhiri<sup>2</sup>

# Christopher Newport University<sup>1</sup> Jefferson Lab<sup>2</sup>

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# **CLAS12: Torus and Solenoid Magnet**

- Torus Magnetic Field:
  - Bends charged Particles.
  - Allows for momentum analysis.
- Solenoid Field:
  - Maximum central magnetic field of 5T.
  - Provides momentum analysis for polar angles greater than 35°.
  - Protection from Background electrons
  - Acts as a longitudinally polarizing field for solid state targets



- This allows the standard configuration of the CLAS12 to operate at 10<sup>35</sup>cm<sup>-2</sup>s<sup>-1</sup>.
- Standard configuration does not allow for operation with transversely polarized target.



# **Defining Occupancy**

- The main limitation to operating the CLAS12 detector with a transversley polarized target is the occupancy in the Drift Chambers (DC) subsystem.
- Number of particle interactions per detector cell per event.

CLAS12 DC Occupancy 
$$= \frac{N_{hits}}{N_{events}N_{cell}}$$



# **Transversely Polarized Target: Tasks**

• New Magnet has been designed to operate the CLAS12 detector with a transversely polarized target to replace solenoid magnet:





- To perform detailed simulations to minimize the background in order to maximize the operating luminosity of the CLAS12 detector with a transversely polarized target.
- Use Geant 4 Monte Carlo (GEMC) to simulate the passage of particles through materials.



# **Transversely Polarized Target: Configuration**

- Transverse Field.
- Target: 60% NH₃ and 40% He; (0,0,0)cm.
- Optimized shielding.
- Optimized beam angle: (10GeV, 2.15°, 0°).
- Optimized beam position: (-3.5,0,-90)cm.
- Operating luminosity ~ 10<sup>33</sup>cm<sup>-2</sup>s<sup>-1</sup>.
- Full detector.



## **Transversely Polarized Target: GEMC Screenshots**

#### 1) Beam Passing Through Target.





2) Particles passing through CLAS12 (Front).



3) Particles passing through CLAS12 (Top).



#### **Transversely Polarized Target: Simulation Results**



- 1) Region 1 is denoted by blue, Region 2 is denoted by red, Region 3 is denoted by green.
- 2) Region 1 is layers 1-12, Region 2 is layers 13-24, Region 3 is layers 25-36.
- 3) First spike is the target; the second spike is the opening of the shield



## **Transversely Polarized Target: Flux Detectors**



- CLAS12 detector replaced by flux detectors.
- Flux detectors consists of 40 planes (each plane is a particle).
- Planes have a radius of 50cm
- First plane is (0,0,10)cm from the target.
- Planes are spaced 2cm apart.



## **Transversely Polarized Target: Shield Prototypes**



### Prototype 1:

- Start position: (0,0,70)cm.
- Length of cone: 30cm.
- Total length of shield: 151.6cm.
- Inner radius of cone: 3.3cm-4.8cm.
- Material: Tungsten Alloy.



### Prototype 2:

- Same dimensions and materials as Prototype 1.
- The cone on the positive x-axis has been removed.



## **Transversely Polarized Target: Prototype Images**





#### **Transversely Polarized Target: Flux Detector Results; No Shield**





#### **Transversely Polarized Target: Flux Detector Results; Prototype 1**





#### **Transversely Polarized Target: Flux Detector Results; Prototype 2**





CLAS12 with a transversely polarized target is high impact experiment designed to study deeply virtual Compton scattering towards the extraction of nucleon orbital angular momentum.

- Status:
  - First optimization of shielding demonstrated that the CLAS12 with a transversely polarized target can operate at 10<sup>33</sup> cm<sup>-2</sup>s<sup>-1</sup>.
- Path Forward:
  - Track reconstruction and efficiency studies in background environment.
  - Continue to optimize the shielding to increase luminosity of the CLAS12 with a transversely polarized target by at least a factor of 2.

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