

Upgrades to the ANASEN Active Target Detector for (α ,p) reactions

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Introduction

For experiments of astrophysical interest, **reaction energies are low**, and **cross-sections are small**. There is a need for **high efficiency detectors**.

One way to achieve this is by using an **Active-Target Configuration** which allows us to achieve high efficiency in a relatively small footprint. These detectors have become quite popular in recent years with detectors such as TexAT at Texas A&M, AT-TPC at FRIB, and Encore at FSU.

ANASEN has been used in several successful experiments studying **BBN, (α, p) reactions**, as well as for the study of **the structure of light nuclei**. This poster covers the upgrades currently being worked on to improve its resolution.

ANASEN

Array for Nuclear Astrophysics and Structure of Exotic Nuclei is an active target detector designed for the study of (α, p) reactions at radioactive beam facilities.

- Capable of handling relatively high rate $\sim 10^6$ pps => can measure low cross-sections down to the mBarn scale.
- Detector consists of -
 - **24 resistive-strip SX3** Si-detectors in a barrel configuration
 - **4 forward facing annular QQQ** Si-detectors forming an endcap
 - Multi wire proportional counter (**MWPC**)

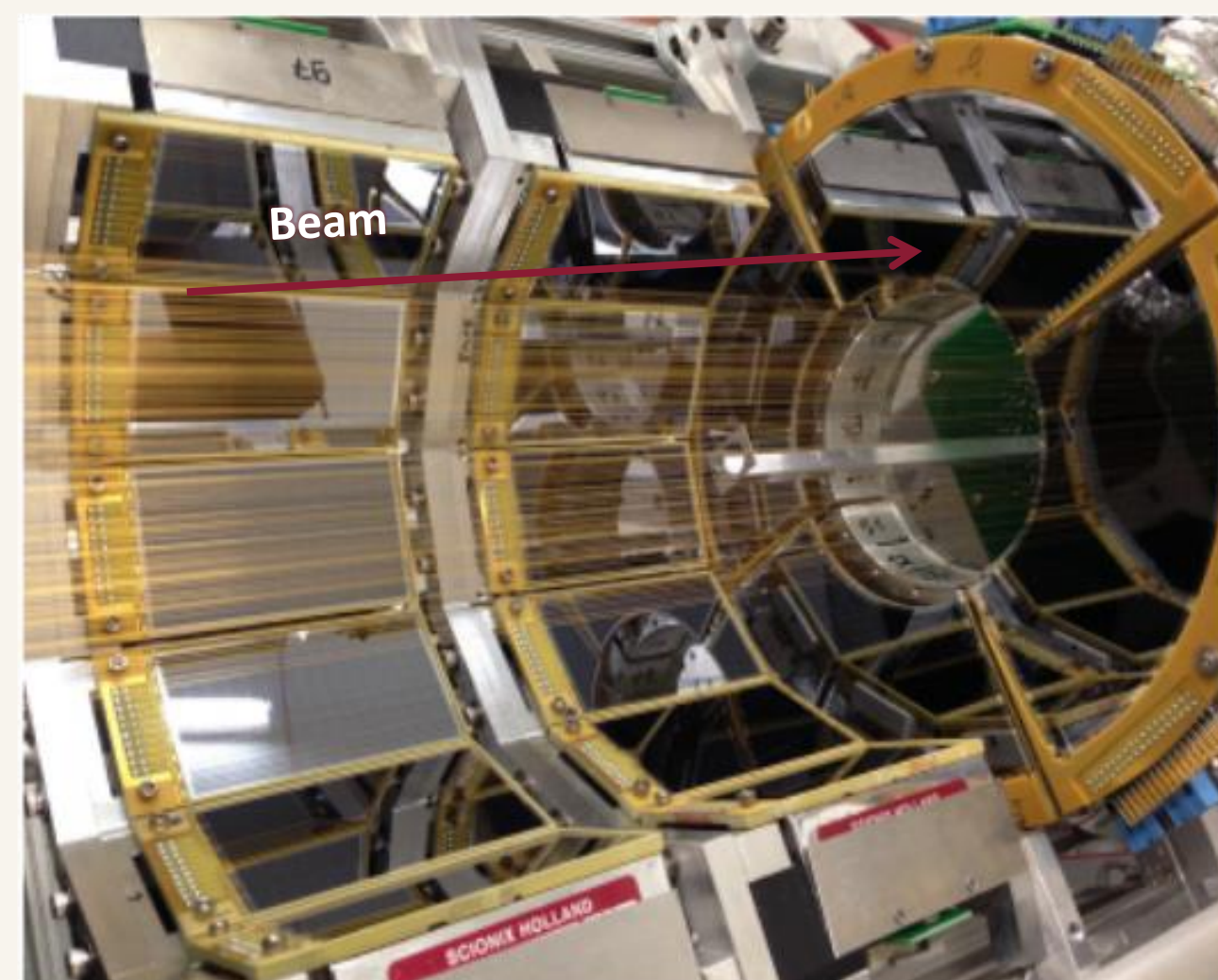


Fig 1. Image of the Anasen detector

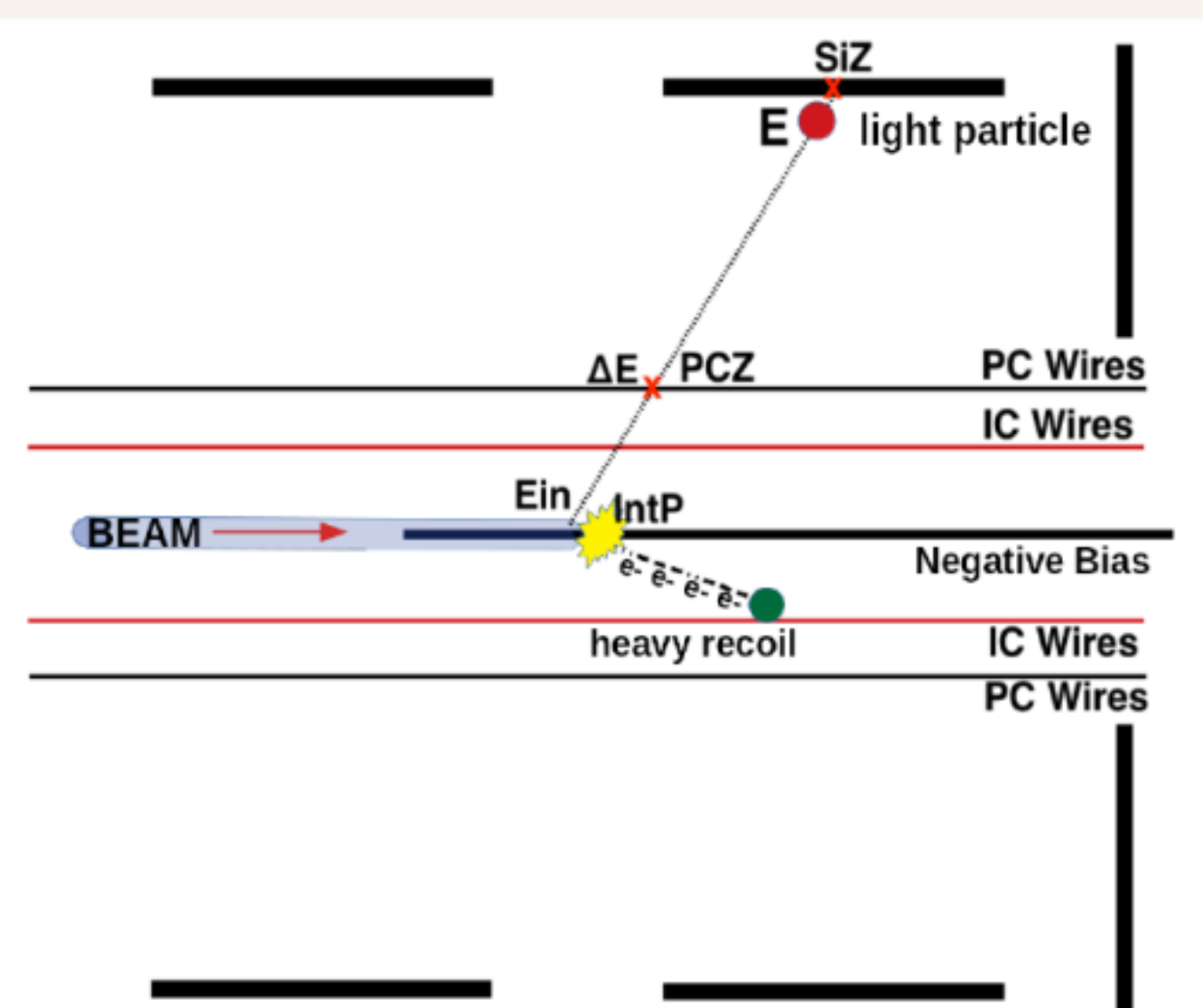


Fig 2. Schematic showing the working principle

- A combination of the **position sensitive proportional counter** and the **highly segmented Si-detectors** allow for an accurate **reconstruction of the particle trajectory** through the target gas back to the reaction vertex.

Motivation

- Excitation function information in ANASEN is extracted from the particle track reconstruction. This in turn, is determined by the position resolution of the resistive anodes.
- Reaction kinematics are dependent on the position resolution of the PC.
- The problem : **Limited position resolution for high energy protons.**

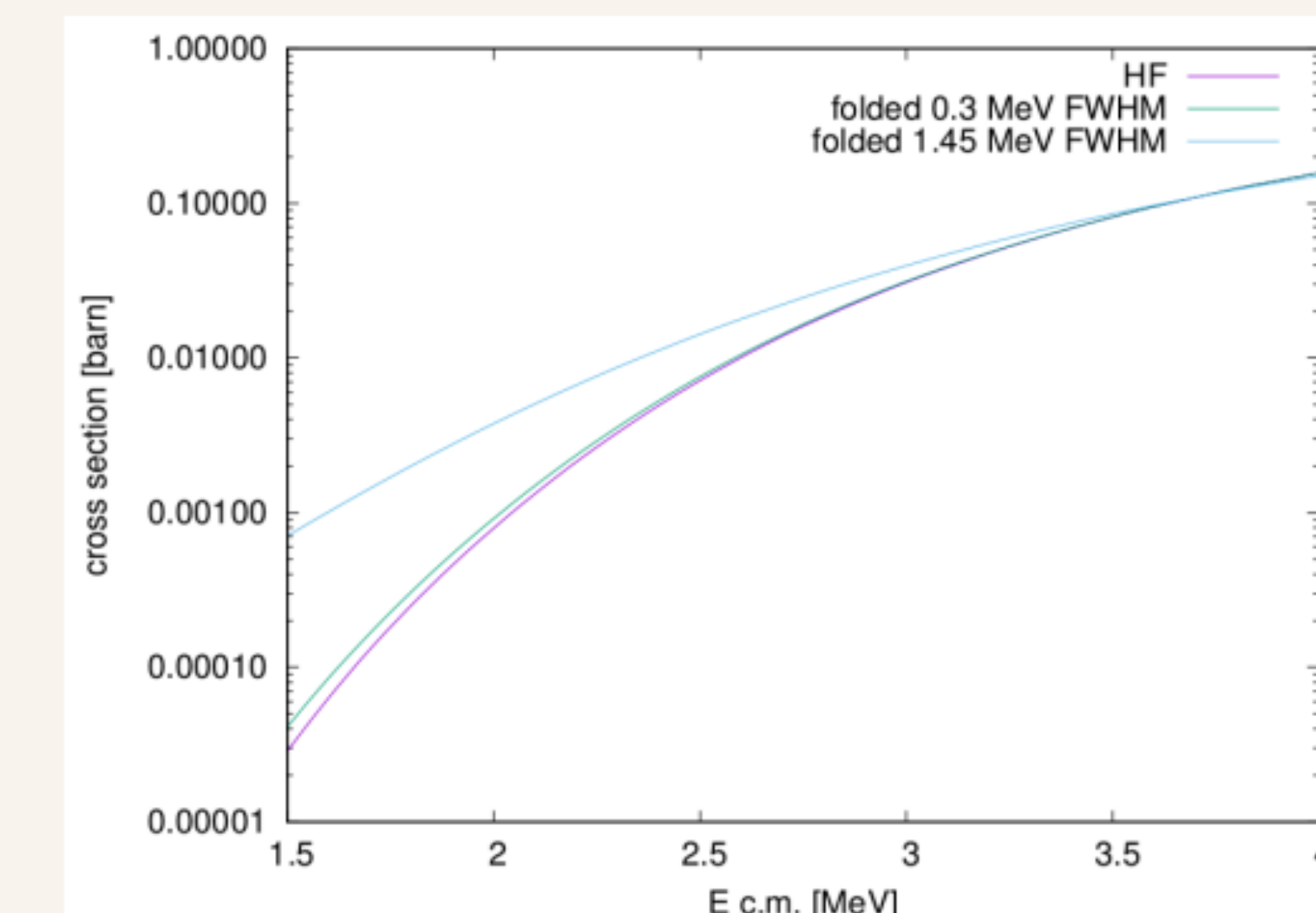


Fig 3. Hauser-Feshbach calculation providing an estimate of expected cross-sections

Upgrade

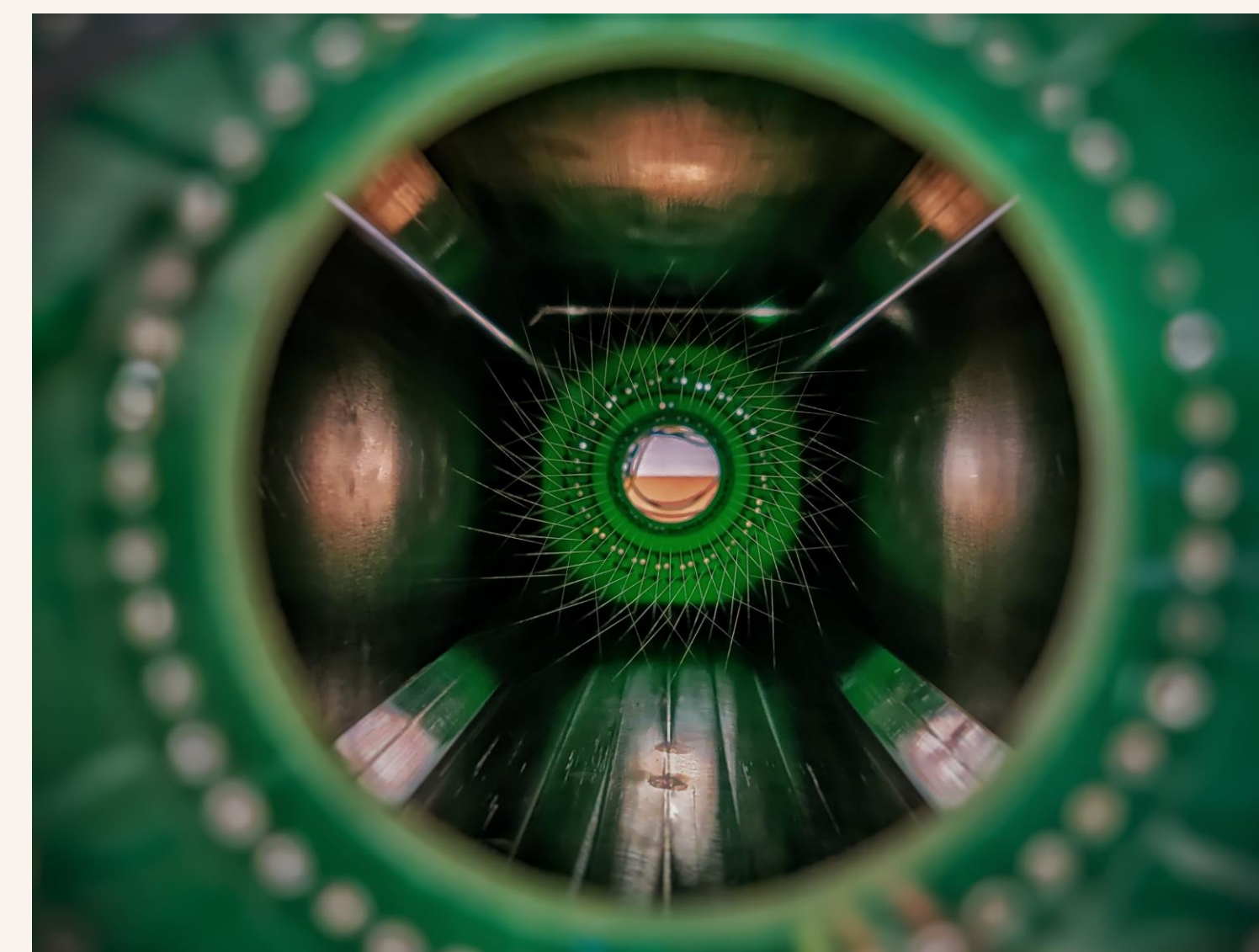


Fig 4. Front view of the Twisted Wire Proportional Counter

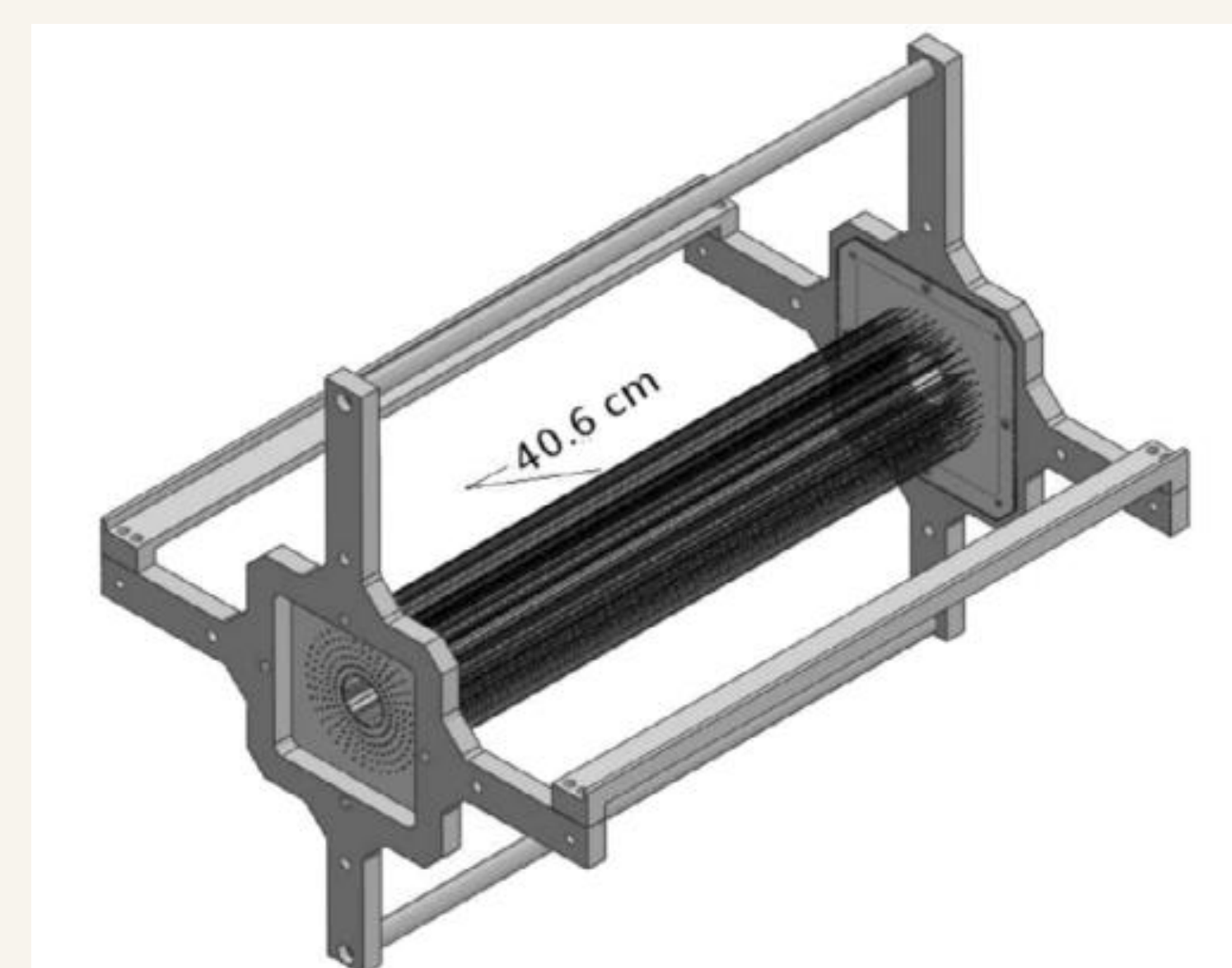


Fig 5. CAD of the changes made to the Proportional counter design

- A **twisted wire configuration** for the resistive anode, leading to **6 crossover points**, decreasing the length of charge interpolation from **38cm to ~ 6cm**.
- Position determination by **sensing the charge sharing between 2 cathodes and the closest anode**. Further precision may be achieved via weighted charge sharing calculation.

Testing Methods

- Detector testing was conducted **following the trajectory of one anode wire** while the **induced charge moves from one cathode to the next**. Monitoring changes in the cathode signal allows for an estimation of resolution.
- Estimated precision using the new configuration **~ 20mm**. Further improvement may be achieved using a **weighted charge-division algorithm**.

Testing Methods

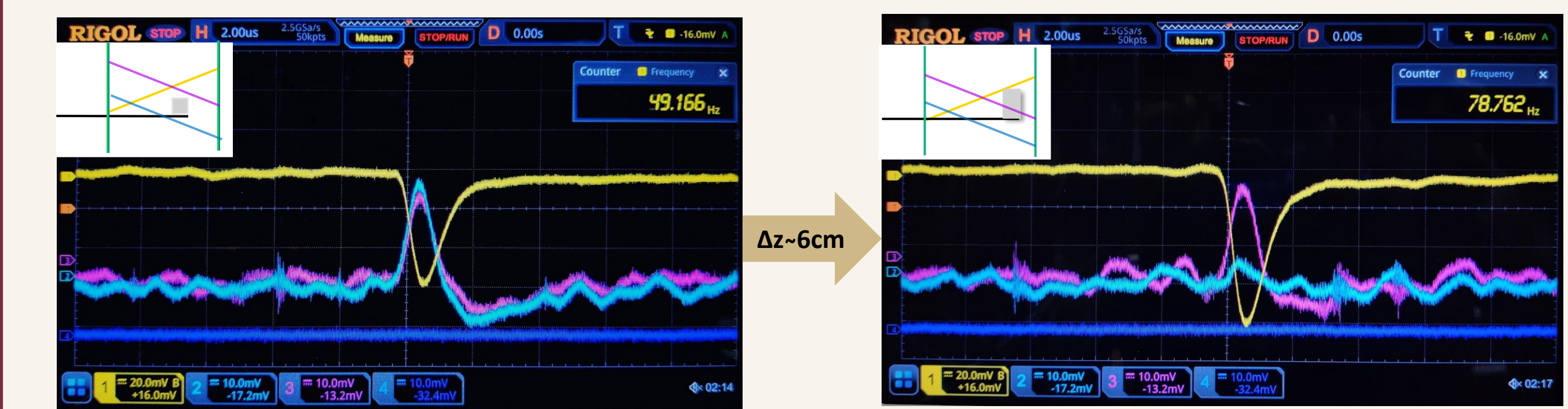


Fig 6. Change in cathode signal (pink and blue) at different source positions. Anode signal (yellow) is consistent. Inset show relative position of source.

Simulation

- The detector was studied using a Monte Carlo simulation, to better understand it's expected resolution under various conditions.
- As can be seen in the figure, there are significant aberrations in the reconstruction with only the intersection points (Fig. 7b), this is significantly improved upon using the information provided by the relative intensities of the nearest cathodes.

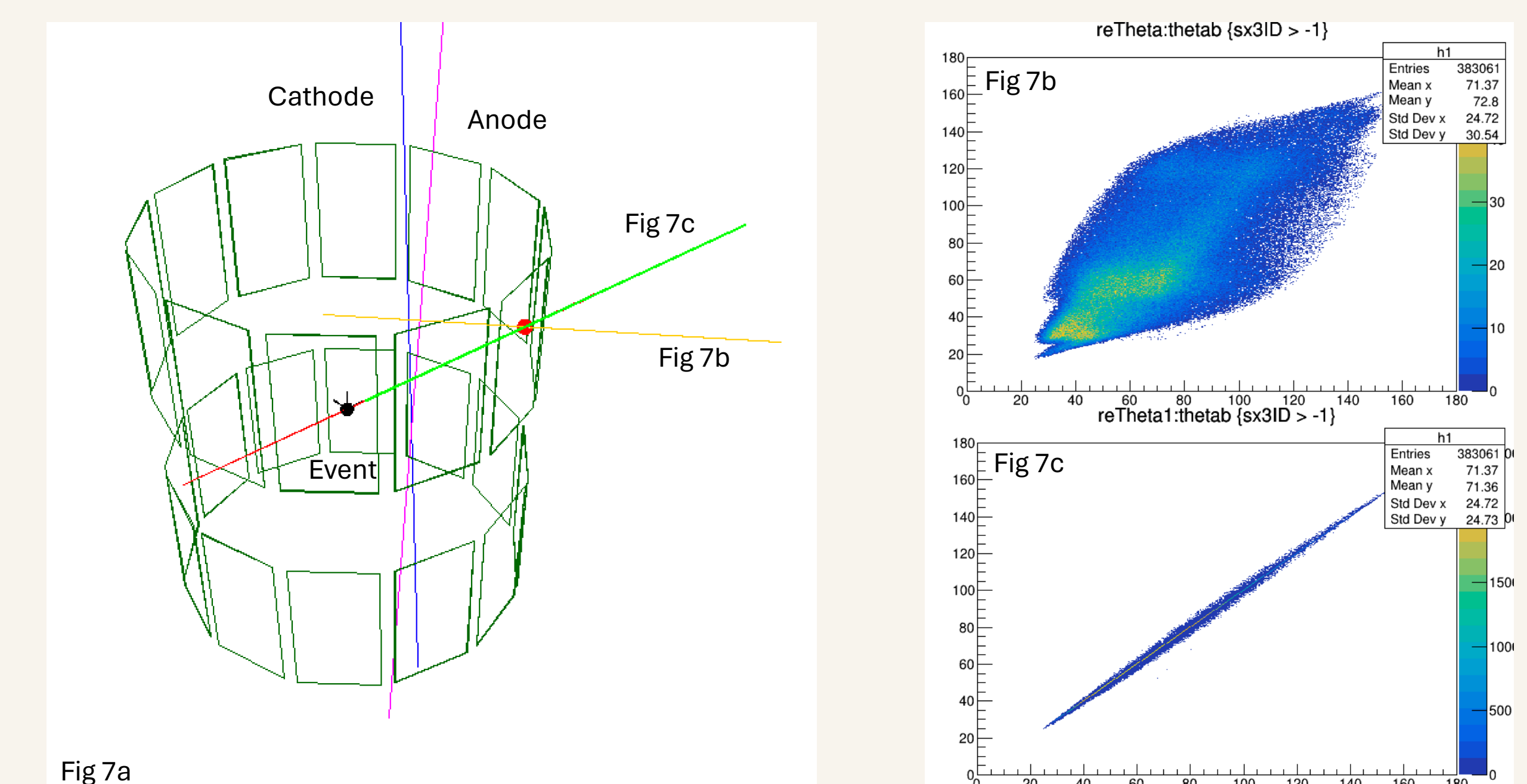


Fig 7. Event reconstruction at different detector resolutions. 7b shows the reconstruction limited to intersection points, i.e., 6cm. 7c shows an ideal case with resolution of 1mm.

Conclusion and Future Outlook

- Initial source testing and simulations display promising results with a significant improvement in resolution.
- Proton beam tests are slated to be conducted to characterise detector response for reactions of interest.
- The detector can then be used for experiments of astrophysical interest.

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