

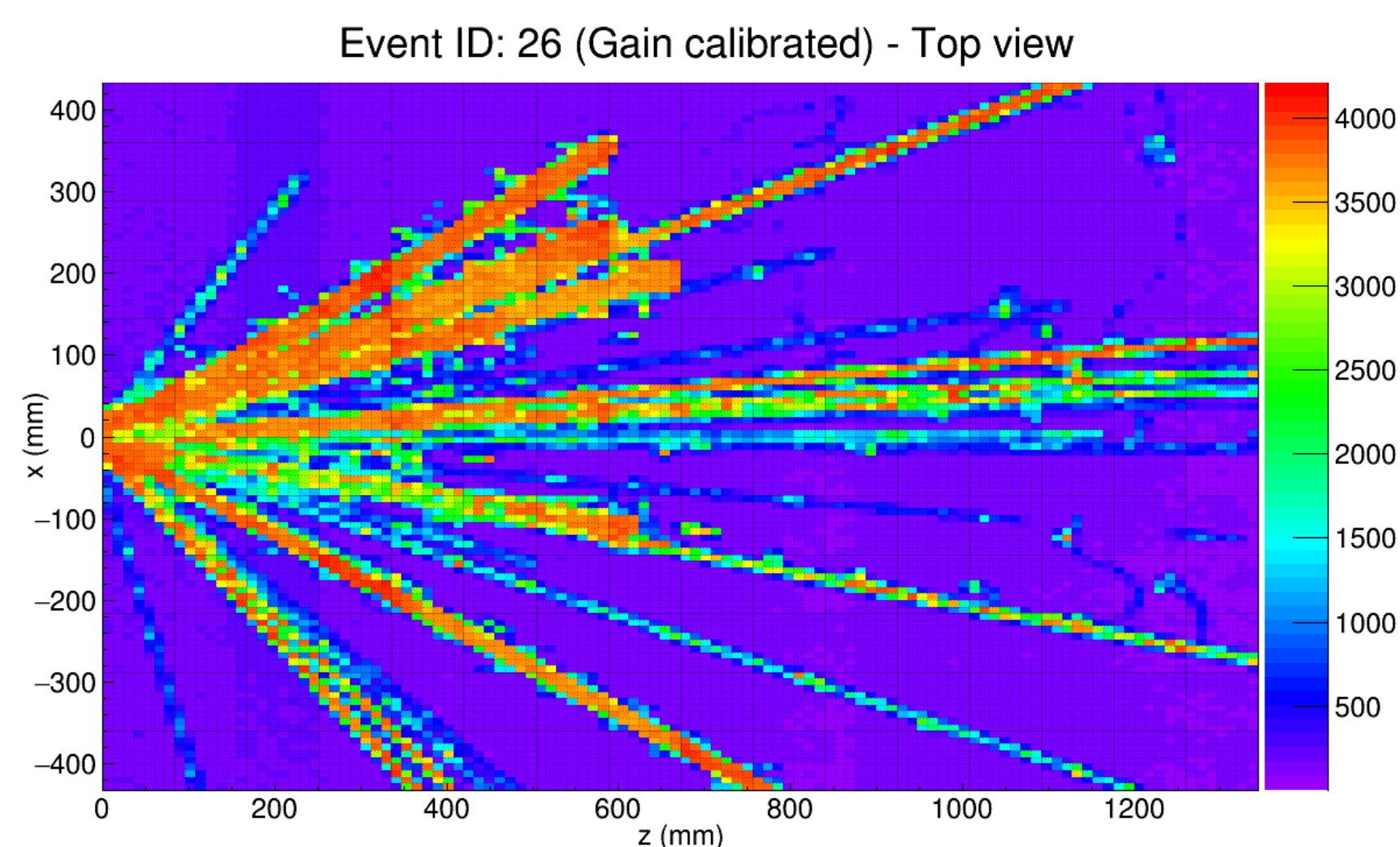
# Cosmic Rays and Showers with the $\pi$ RIT TPC

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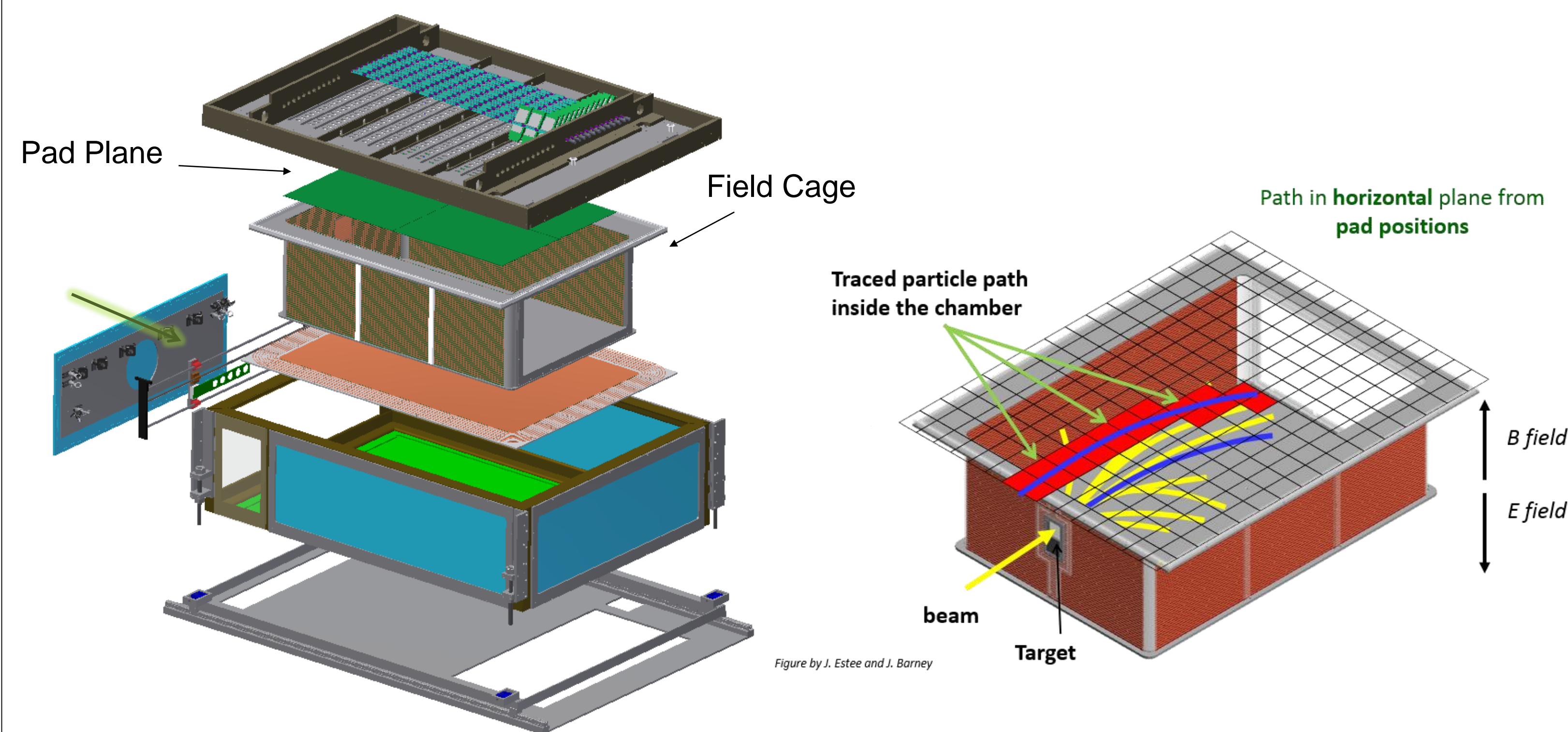
## Introduction

In the wake of **nuclear reactions** with cosmic particles, a time projection chamber can be used to reconstruct the path of the particles. The  $\pi$ RIT TPC was used to trace the paths of particles passing through a gas filled chamber with electric and magnetic fields. These traced paths can reveal cosmic **rays and showers**. The images produced were gathered for **outreach** to K-12 students on a website. The website also allows students to find **further information**.



## Nuclear Collisions

In a nuclear collision, the **collision** of an energetic particle with another nucleus can liberate **particles** in the matter, such as protons and electrons. During the collision, energized particles **transfer energy** to the liberated particles.



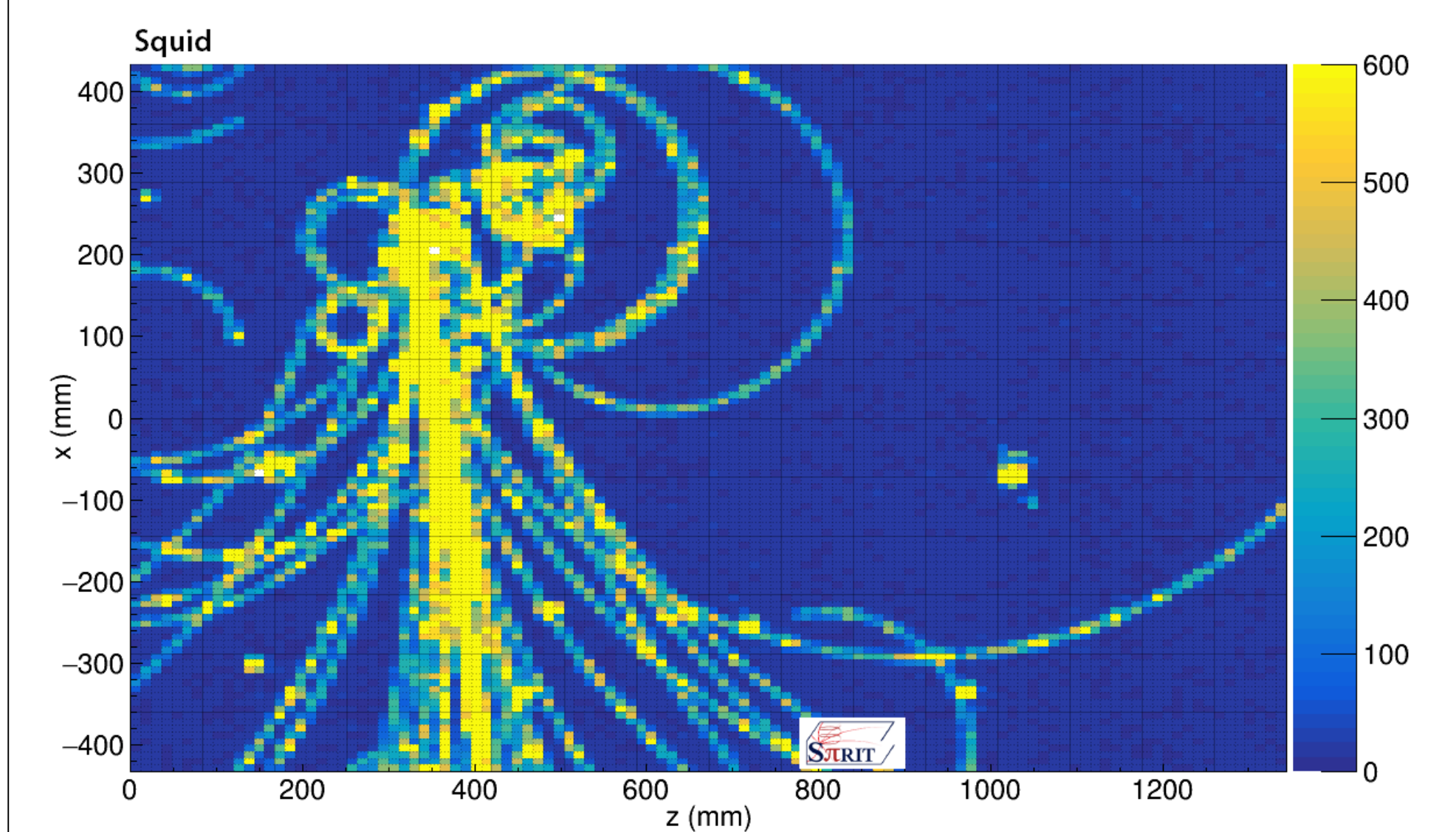
## SAMURAI Pion Reconstruction and Ion Tracker Time Projecting Chamber

$\pi$ RIT TPC: A detector built to take 3D “pictures” of nuclear collisions. Main components to creating this picture, are a **field cage** and **pad plane**. The field cage is a large box, producing a constant **electric field**, filled with gas. High energy particles flying through knock **electrons** off gas molecules leaving trails. These electrons then **drift upward** in the electric field to the pad plane. Using a two-dimensional pixel array, like a TV, the **pad plane** detects the electrons, and produces a 2D image of the electrons’ trail. Using timing information from when individual pads detect signals, a 3D image of the **trail** is then constructed.

## Outreach

An outreach **website** for K-12 **students** to gain an understanding of cosmic activity was designed. The website includes suggested **activity plans** for students in elementary through high school to use. For example, elementary students are encouraged to look at images of particle trails from the  $\pi$ RIT TPC and interpret what they think they look like.

**Website:** [groups.nsl.msu.edu/hira/cosmic/](http://groups.nsl.msu.edu/hira/cosmic/)



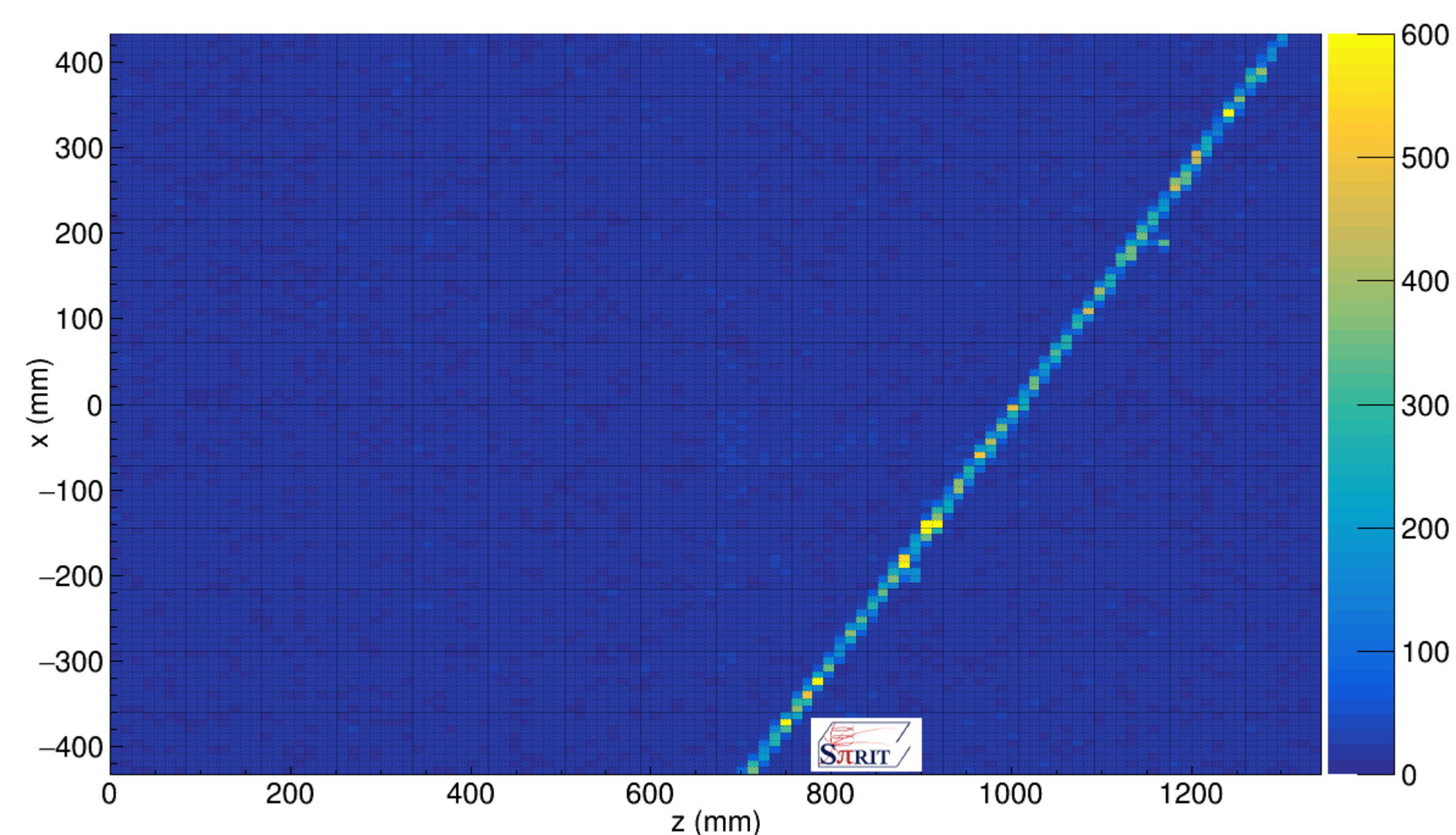
## Further Information

The website also contained links to further **information** for interested **students** to look explore, such as a link to the article “*What keeps the Neutron Star from Collapsing?*”

## Cosmic Rays

### What is a Cosmic Ray?

Cosmic rays are **high energy particles** coming mainly from **outside the solar system**. They can interact with particles in the atmosphere on Earth’s surface in **nuclear collisions**. Most examples of particles seen by  $\pi$ RIT are **single tracks** from the interaction of cosmic rays with the atmosphere.

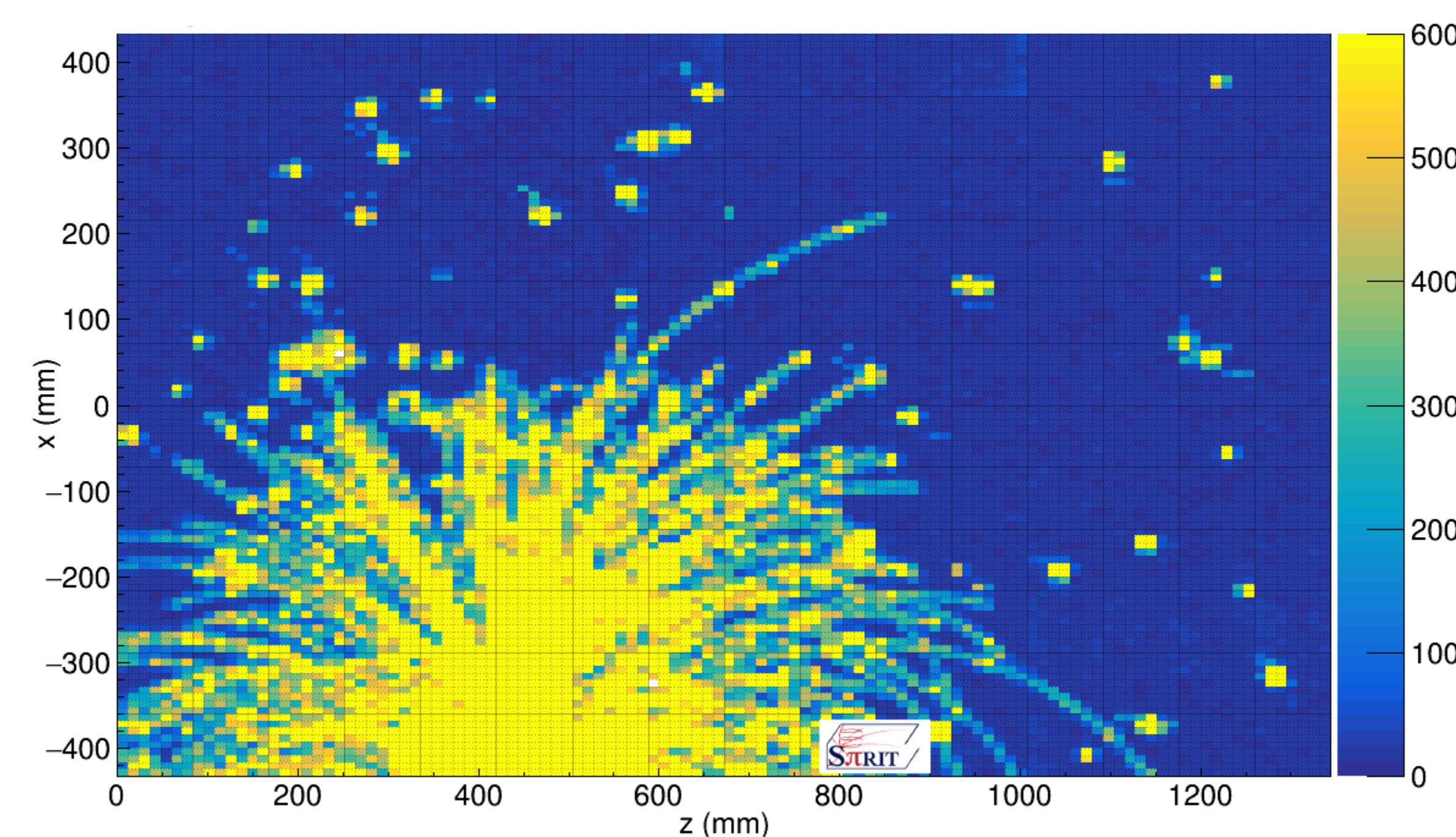


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## Cosmic Showers

### What is a Cosmic Shower?

When particles in cosmic rays collide with other particles, they can create a **cascade of particles**, by knocking-off **electrons and protons**. We can observe the particles produced as a cosmic shower of particles. In a magnetic field, protons and electrons travel in different directions due to their opposite **charge**.



## ACKNOWLEDGEMENTS:

J. Barney, M.B. Tsang, G. Cerizza, J. Estee, G. Jhang, T. Isobe, M. Kaneko, M. Kurata-Nishimura, J.W. Lee, J. Manfredi, P. Morfouace, T. Murakami, C. Santamaria, C.Y. Tsang, Y. Zhang for the  $\pi$ RIT Collaboration



This work is partly supported by the U.S. Department of Energy under Grant No. DE-NA0002923.



The NSCL is funded in part by Michigan State University and the National Science Foundation.

