Measuring Temperature dependent Drift Times for the HELIX experiment

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19 August 2024

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HELIX High Energy Light eXperiment

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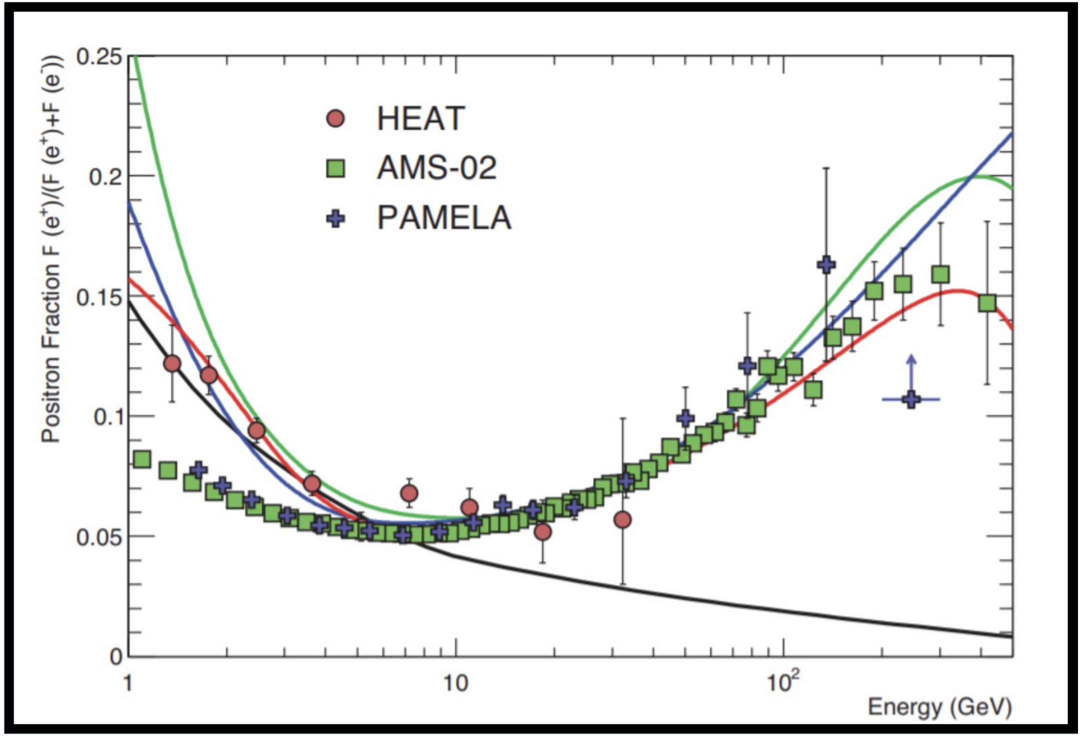
  - Hyebin Jeon, Keith McBride, Kenichi Sakai, Scott P. Wakely
- Indiana University
  - James Musser, Gerard Visser
- McGill
  - David Hanna, Ste O'Brien
- Northern Kentucky University
  - Scott Nutter
- Ohio State University
  - Patrick Allison, James J. Beatty, Lucas Beaufore, Dennis Calderon
- Pennsylvania State University
  - Yu Chen, Stephane Coutu, Isaac Mognet, Monong Yu
- Queen's University
  - Melissa Baiocchi, Avani Bhardwaj, Connor McGrath, Nahee Park (Kaan Sun, Gabrielle Barsky-Giles)
- University of Michigan
  - Noah Green, Gergory Tarle

Flew this summer!

Scientific motivation

Cosmic rays

- Particles that travel through the universe
- Close to the speed of light
- Mostly p^+, α and some nuclei
- Interact with space and the atmosphere



Rising positron fraction : traditional models in black

The life of a cosmic ray

Why are we measuring Beryllium ?

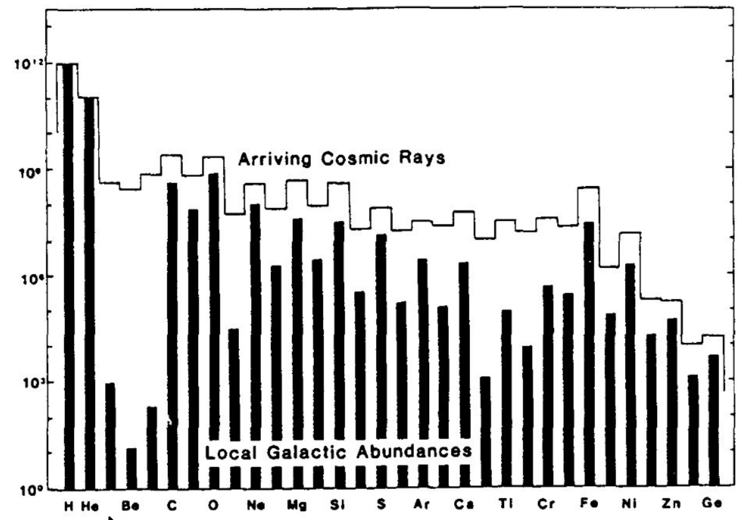


Fig. 1. Elemental abundances of arriving cosmic rays (line) compared with Local Galactic abundances (bars). The normalization is at hydrogen.

Lund, N. (1984). *Cosmic-ray elemental abundances*. Danish Space Research Institute.

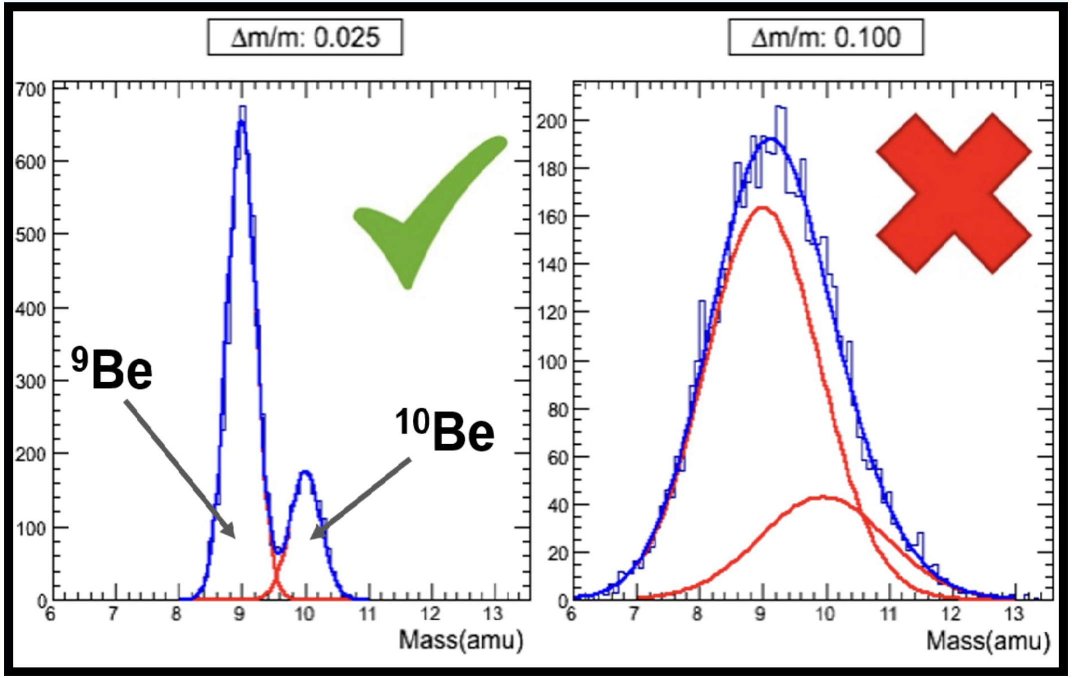
HELIX : looking for the age of cosmic rays

This will let us estimate how much material cosmic rays interact with before reaching the earth

^{10}Be vs ^{9}Be : A cosmic ray clock

How will HELIX measure this

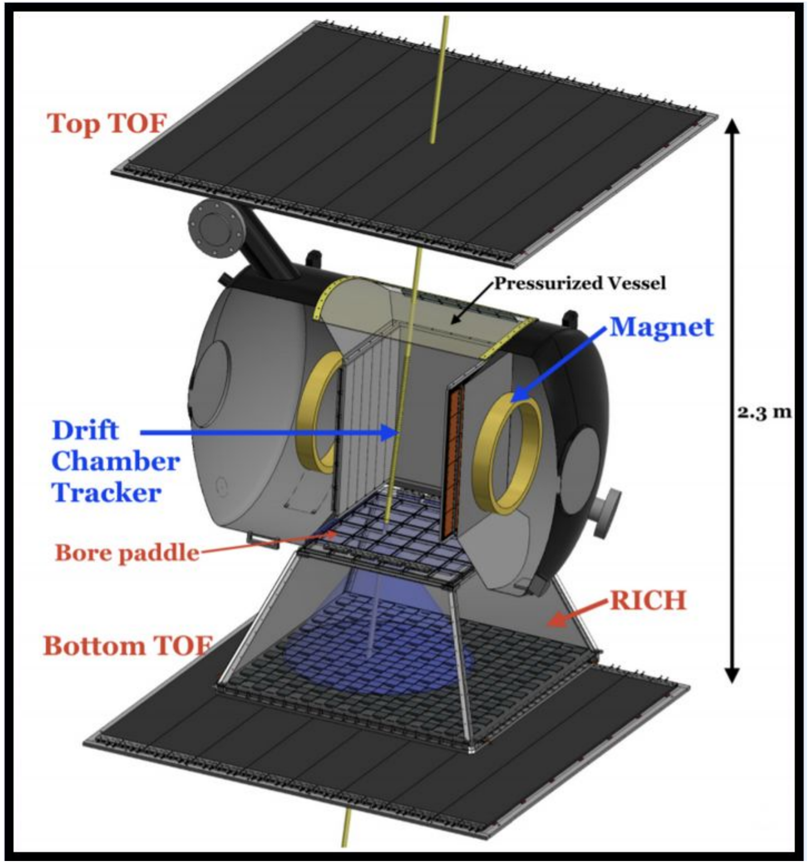
- Light nuclei form a proton (Z = 1) to neon (Z = 10)
- Energy range: 0.2 GeV/n to 10 GeV/n
- Optimized for Beryllium isotopes
- 2.5% mass resolution



HELIX detectors

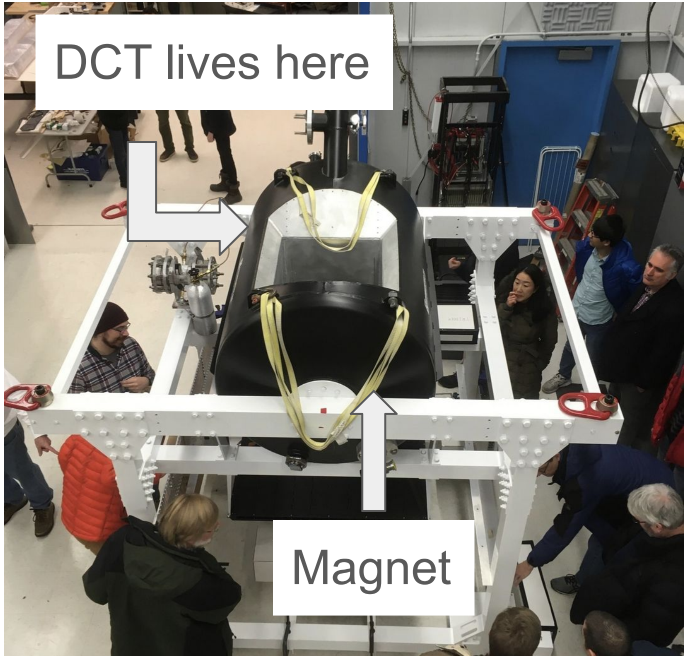
- Measuring velocity
  - Time of Flight : particles < 1 GeV/n
  - Ring-Imaging Cherenkov detector : particles > 1 GeV/n
- Drift Chamber Tracker (DCT)
  - Track particles through magnetic field
  - Momentum of particles
  - Gas chamber with sensor wires
  - 216 wires separated into 3 columns of 72 wires

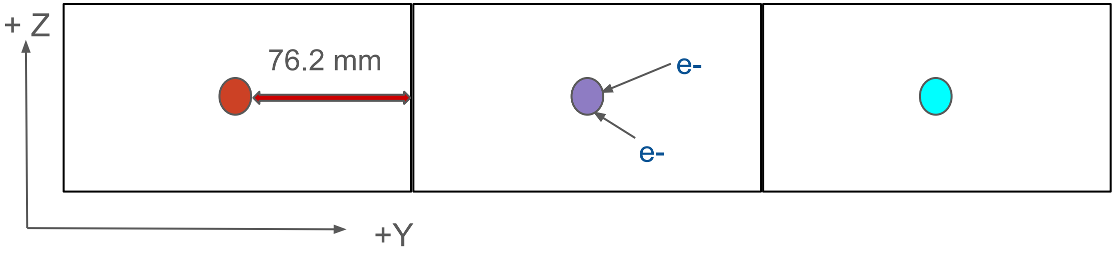
This study focuses on the DCT



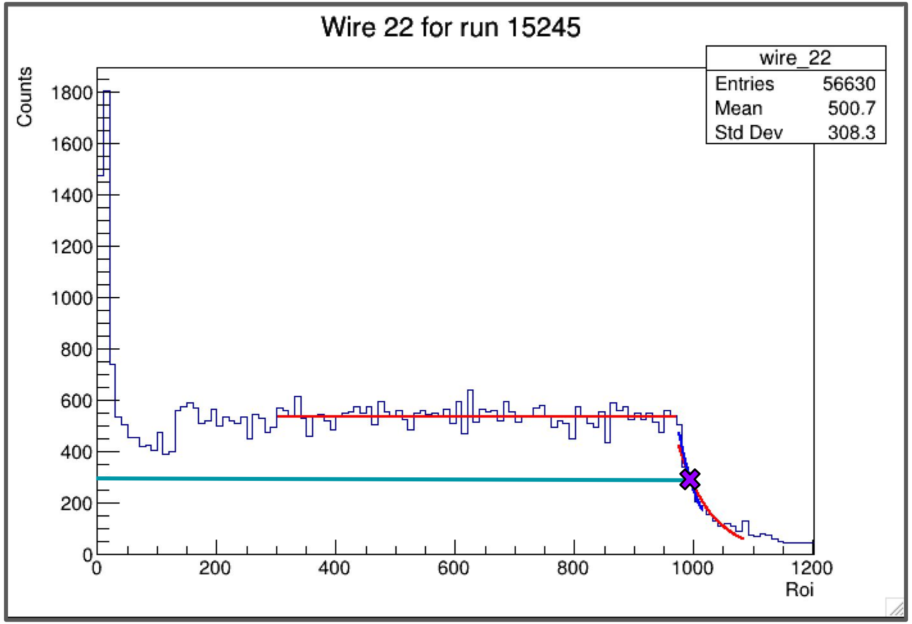
Drift Chamber Tracker (DCT) - data and geometry

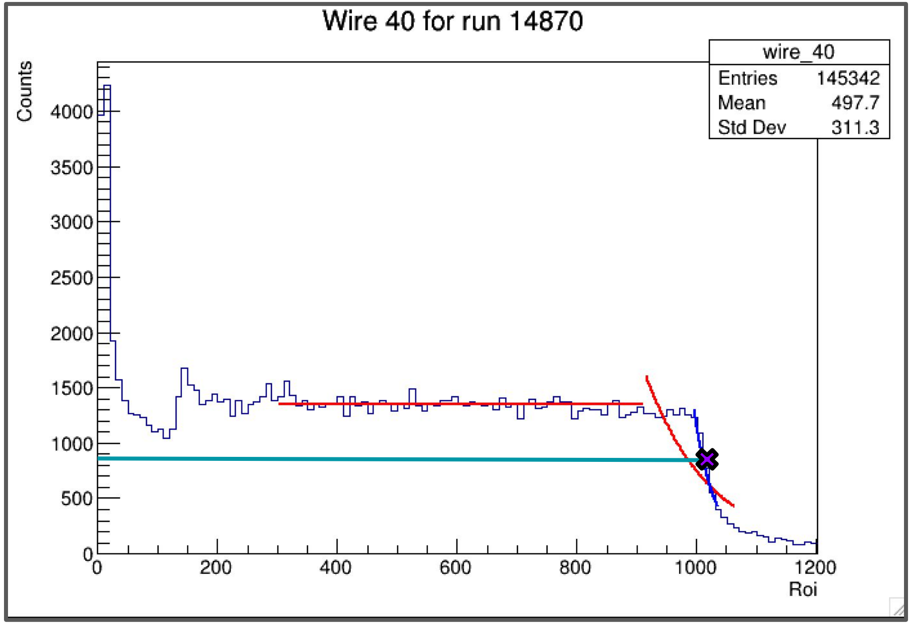
- Takes data in a Region of Interest (Roi)
  - This is at an interval of 80 Mega sample / sec
  - Takes note when signal is above a threshold of electronic noise
- Convert Roi to time
- Drift time [nsec] = Roi x 12.5 [nsec]
- Goal of the study : calibrate DCT
  - Expect temperature dependence of drift velocity





Maximum drift time - Roi Cutoff



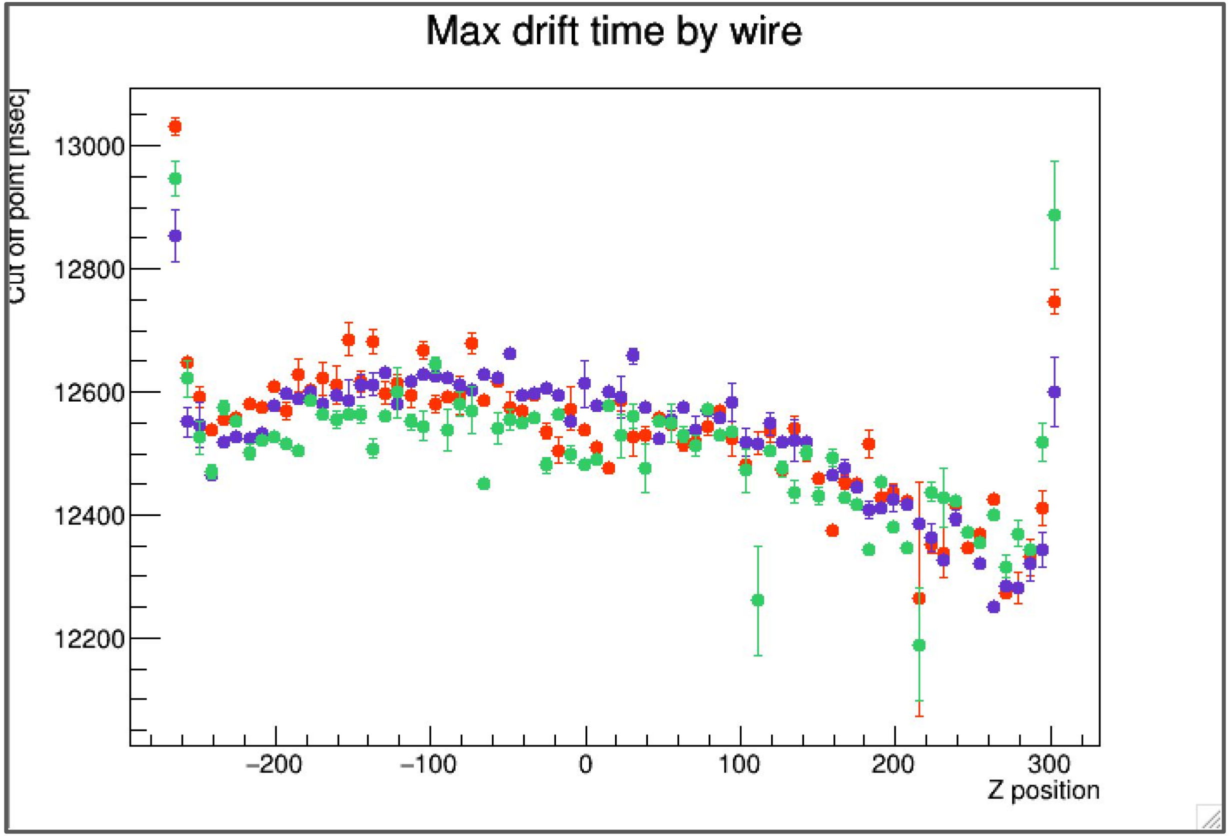


First set of fits, Second fit

Maximum drift time : the longest time it will take an electron to reach the wire

Results

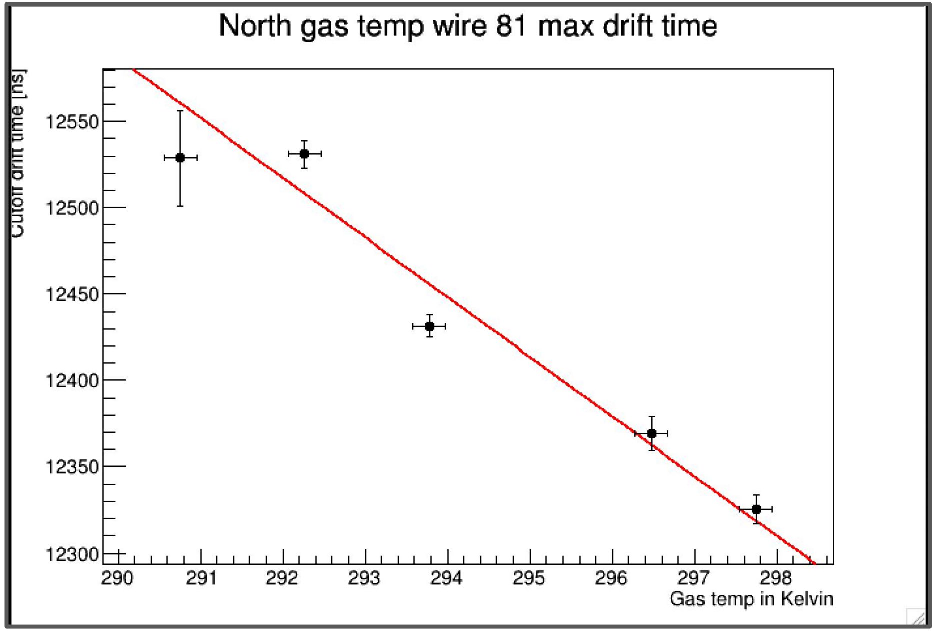
Success on average of 99.7% of wires !



Y -150, Y 0, Y +150

Gas temp mapping review

- Looking for temperature dependence of drift time
- Drift velocity depends on gas temperature
- Use maximum drift time to build map of temperature in the detector
- Predicts a range of about 10 degrees
- Compare to simulations



Fit results
Slope : -2.73 [Roi/°C]
Intercept : 1052.9

Simulation predicts slope of -2.66 [Roi/°C]

Overview and next steps

- Still waiting for full data to be recovered and be processed
- This study looked into initial temperature dependent DCT performance with small sample of data downloaded from stralink
- So far calibration works as expected
- Methods applied to full data set to develop full calibration