Time of Flight Calibration for HELIX

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OUTLINE

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HELIX Overview

Components of the detector.

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Specifications for the Time of Flight detector.

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Theory for the calibration procedure.

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The challenges encountered and their solutions.

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Current Status

The results to date and next steps.

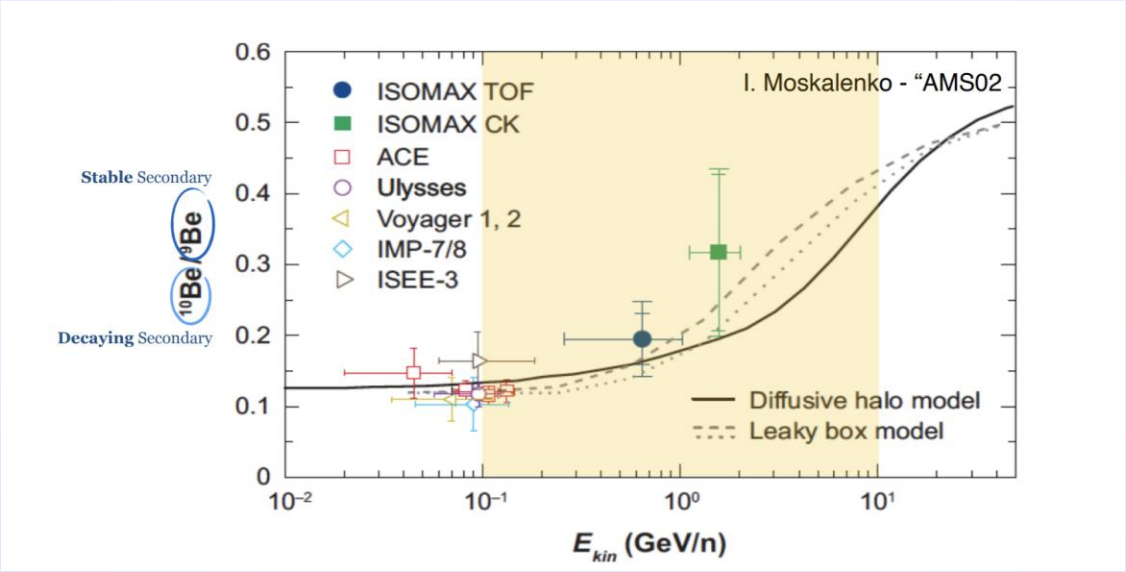
HELIX Overview

Goal: better understand the cosmic ray propagation model.

Scientific Motivation

Motivation: expand the knowledge of higher energy cosmic rays.

Measurements: momentum, velocity and charge for Beryllium-9 and Beryllium-10.



Components of HELIX

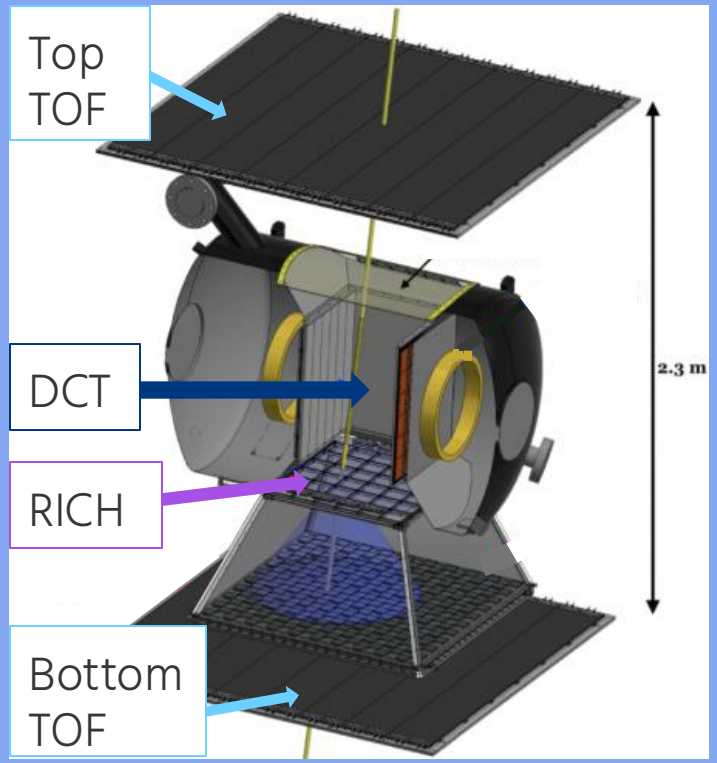
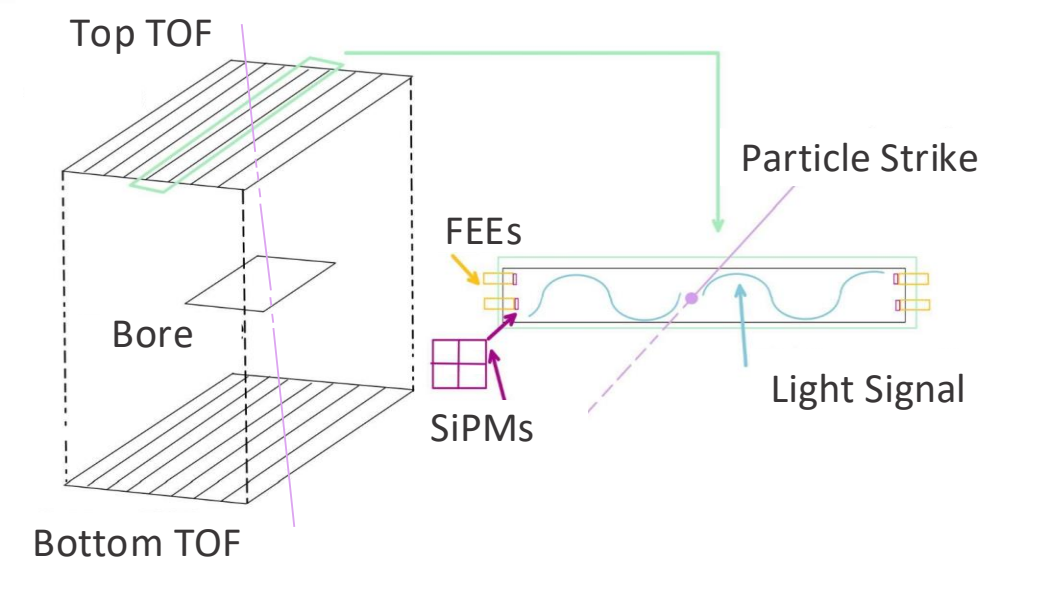


Image credit: University of Chicago, HELIX Team.

Momentum → Drift Chamber Tracker (DCT)

Velocity → Ring Imaging Cherenkov Detector (RICH)

Charge → Time of Flight Detector (TOF)



TOF Detector

Goal: Measure charge and velocity of particles.

01

Paddles

- 8 Top and 8 Bottom TOF paddles
- Strike on top triggers data taking
- Strike on all three layers saves an event

02

SiPMs

- Silicon Photo Multipliers amplify the light signal

03

FEEs

- Front End Electronics interpret the light signal
- Get charge, position and time of signal propagation

HELIX flight 2024

Flew for 6 days from Kiruna, Sweden to Ellesmere Island in Nunavut.

Image credit: HELIX launch team.

Initial Calibration

SiPMs performance varies with temperature, but ground calibrations were not perfect.

Calibration Procedure

01

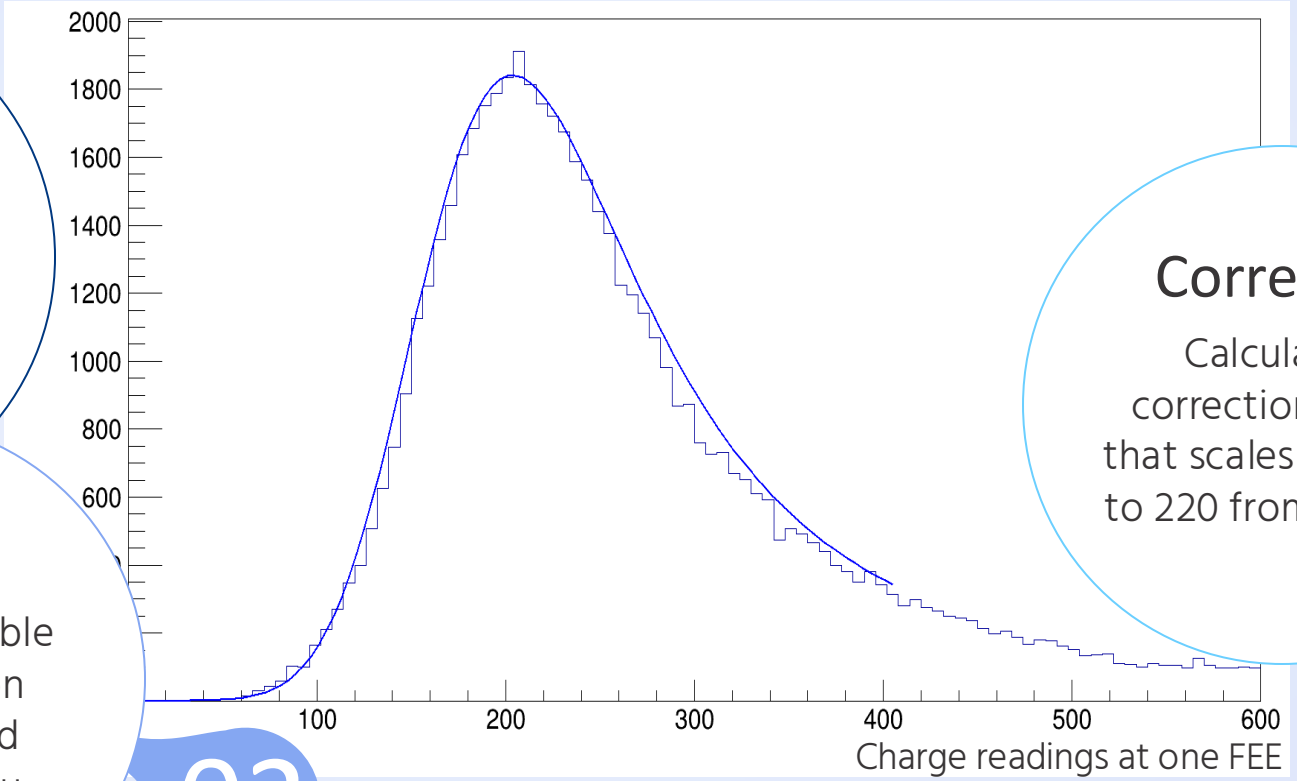
Histogram

Fill a histogram with all the charge readings from one FEE of proton events.

02

MPV

The most probable value of proton charges should follow a landau function.



03

Correction

Calculate a correction factor that scales the MPV to 220 from all FEEs.

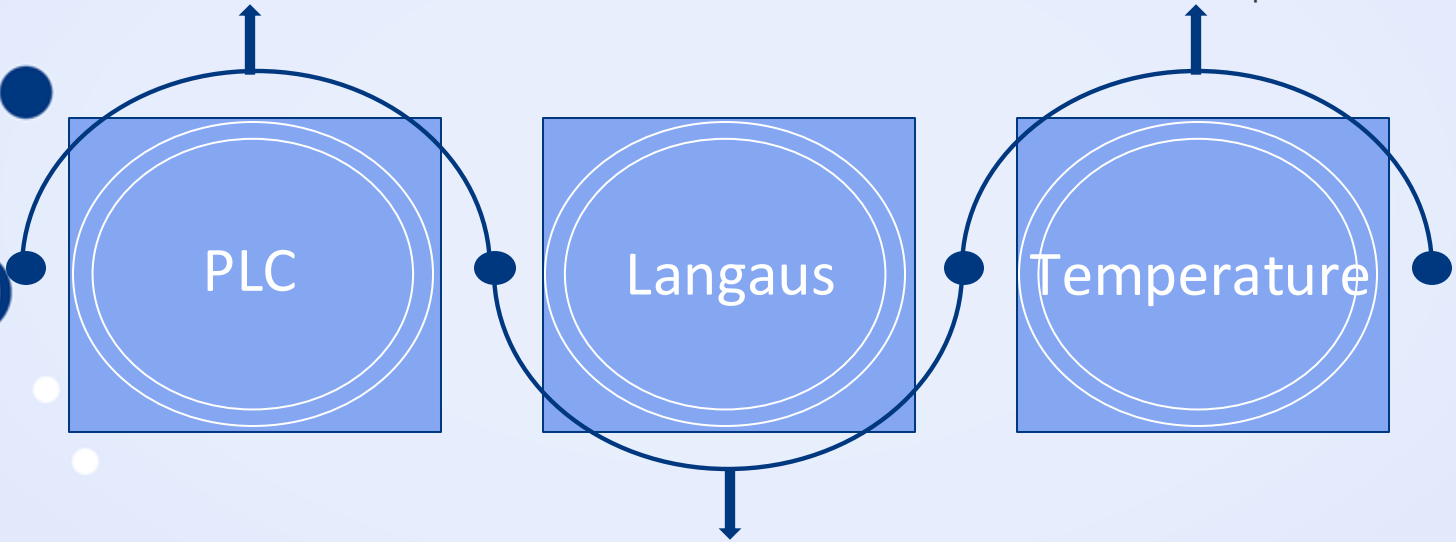
Iterations

The problems encountered and their solutions.

Improvements

There is a Path Length Correction factor, which could improve the calibration.

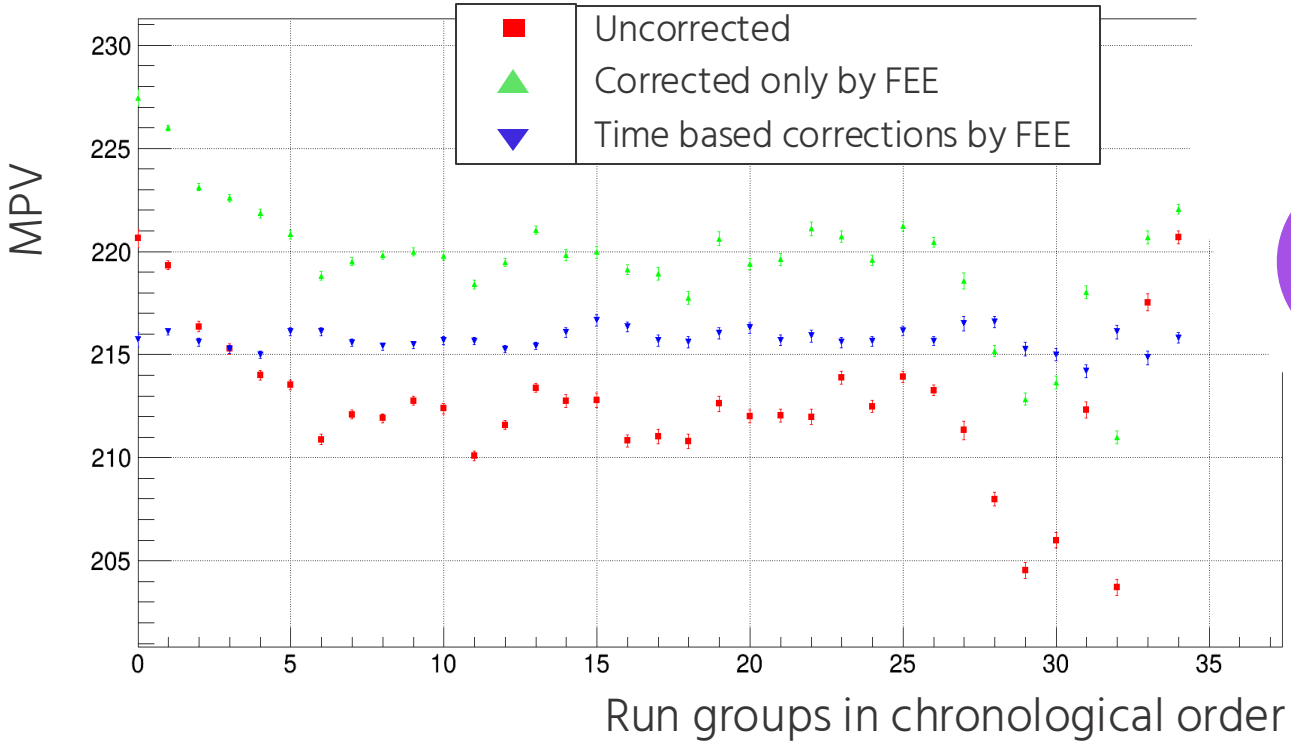
The temperature is variable within the detector. But there is no direct relationship between MPV and temperature.



The histogram fitting was done with a landau function, but the noise made the function more gaussian.

Time Based Corrections

Calculating the correction factors for separate intervals of time instead of all at once.



Current Status

The up to date corrections and next steps.

Latest Flight Data

- Iterations provided helpful insight
- The corrections have been calculated and applied to the whole flight
- Further study the small fluctuations in MPV over time

THANKS

Do you have any questions?

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