High Energy Light Isotope eXperiment

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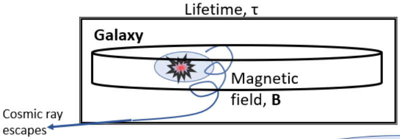
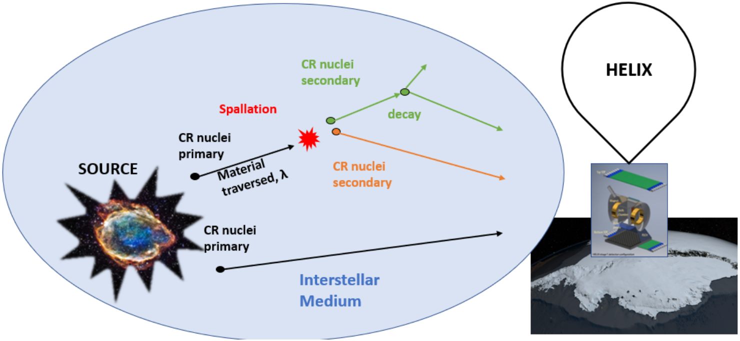
Cosmic Ray Nuclei

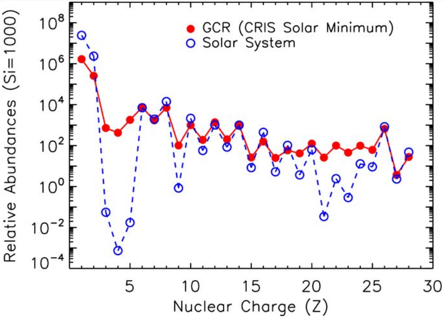
Protons, electrons, and nuclei with energies between **GeV** to 100 EeV.



$\frac{\textit{secondaries}}{\textit{primaries}}$ constrain galactic properties λ and τ.



Abundances and ratio measurements

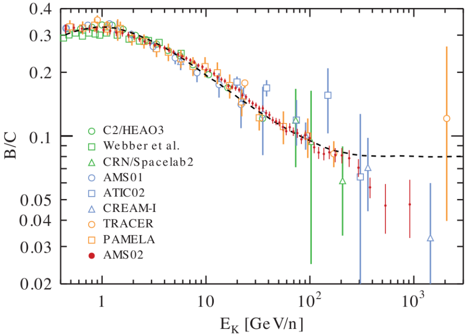


Data shows the overabundance of elements in CR spectra compared to stellar processes → Secondaries

J. S. George, et al 2009 ApJ 698, 2

Research on ratios such as this constrain the energy dependent diffusion of the galaxy or material CR traversed.

Formato, et al 2016 arxiv 1612.09160

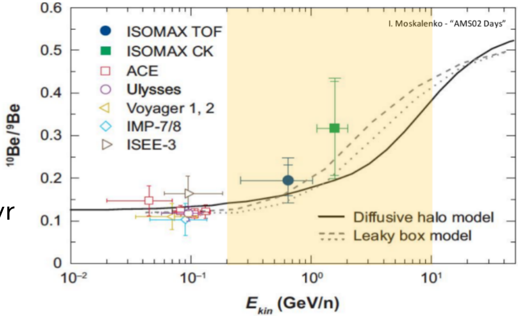


Isotopes and HELIX Goals

HELIX aims to make the following **1st** measurements:

Measurement	Energy GeV/n
*^{10}Be/^{9}Be	> 2
^{22}Ne/^{20}Ne	> 1
^{7}Li/^{6}Li	> 1
^{10}B/^{11}B	> 1

*^{10}Be has a half life of 1.4Myr



Yellow region is HELIX range

Expect to see thousands of Be events

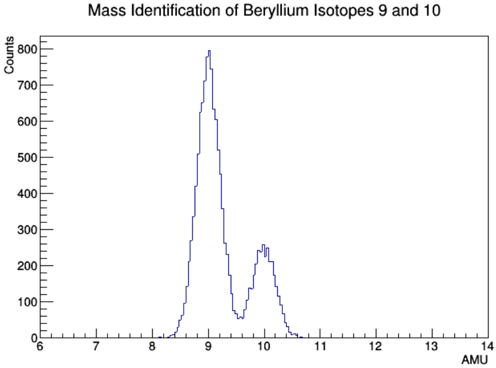
Measuring mass

Mass identification using **rigidity**, **velocity**, and **charge**.

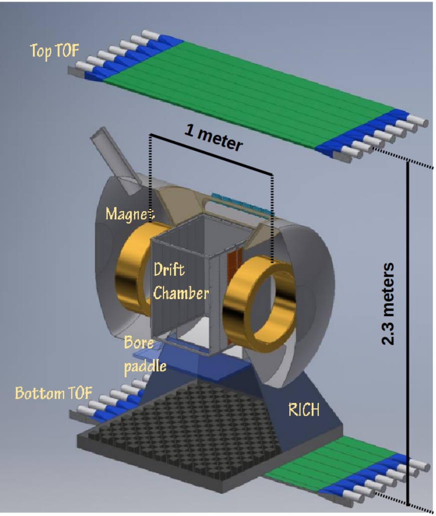
$$R \equiv \frac{p}{Ze} \rightarrow m = \frac{R(Ze)}{\gamma\beta}$$

β	TOF and Cherenkov
R	Magnet + Drift Chamber
Ze	TOF scintillator

Required resolution for 4σ separation is $\frac{\Delta m}{m} \sim 0.025$. High resolution necessary for determining the isotope ratios.



Superconducting Magnet Spectrometer

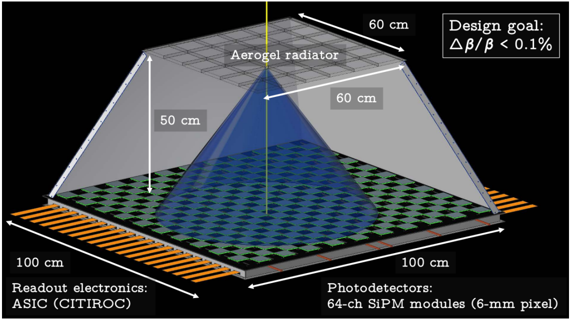


- TOF measures β with scintillator. (E< 1GeV/n)
- Bore paddle for triggering
- Drift Chamber with magnetic field $\rightarrow R = \frac{p}{Ze}$
- Magnet cooled to 4K with LHe and holds 250L. B $\approx$ 1T, I $\approx$ 100A

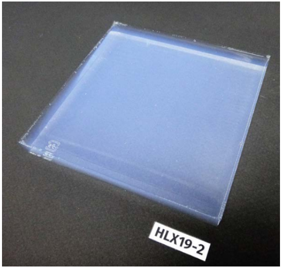
β	TOF and Cherenkov
R	Magnet + Drift Chamber
Ze	TOF scintillator

RICH or Ring Imaging CHerenkov Detector

Tabata 2018 RICH detector conference



Silica Aerogel



$$\cos\theta_C = \frac{1}{n\beta}$$

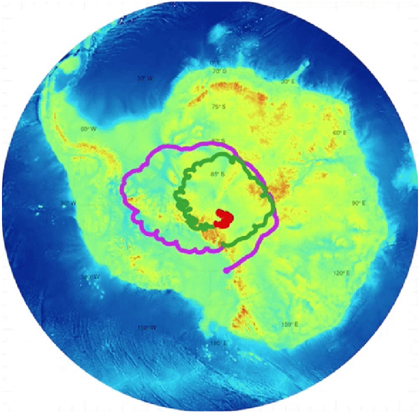
E> 2GeV/n

$$n = 1.16$$

Flight

- Polar Vortex during Austral Summer
- 30km altitude.
- Winds keep payload over continent.
- Constant daylight improves altitude stability.

ANITA-4 Trajectory 2016



30 day flight with 2 orbits

HELIX Collaboration

- In summary, HELIX is a superconducting Magnet Spectrometer to observe relativistic charged Cosmic Ray nuclei flying on a balloon the size of a football field over the Antarctic ice in Dec 2020.
- Collaboration
- University of Chicago
- The Ohio State University
- Indiana University
- Penn State University
- Northern Kentucky University
- McGill University
- University of Michigan

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