The Dark Matter Particle Explorer

Study of the cosmic B, C, N and O nuclei with the DAMPE space mission

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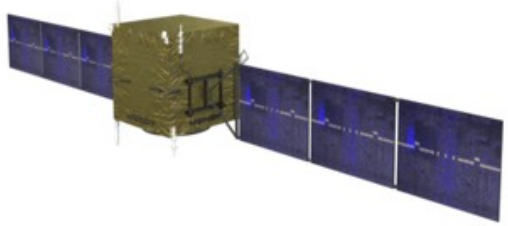
Overview

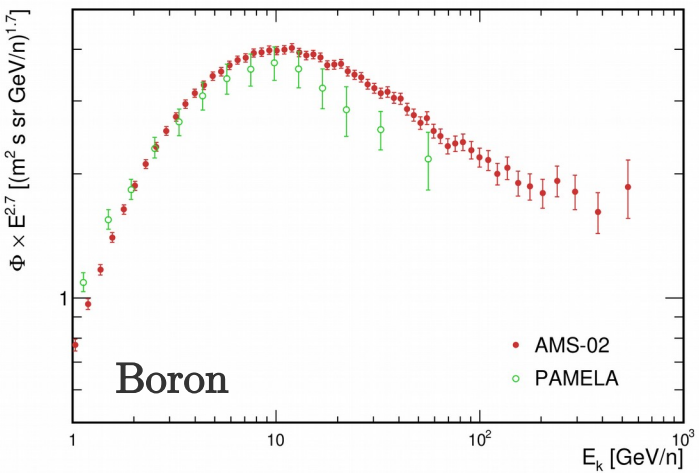
Physics perspective on BCNO nuclei

The DAMPE Space Mission

BCNO analysis study



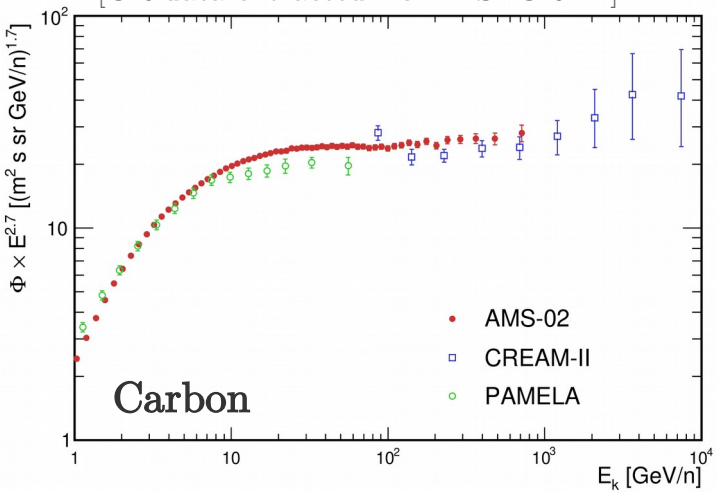
Insight on BCO physics



Available results from AMS – 02 showing:

- Identical rigidity dependence above 60 GV for He, C & O
- Progressive hardening above 200 GV

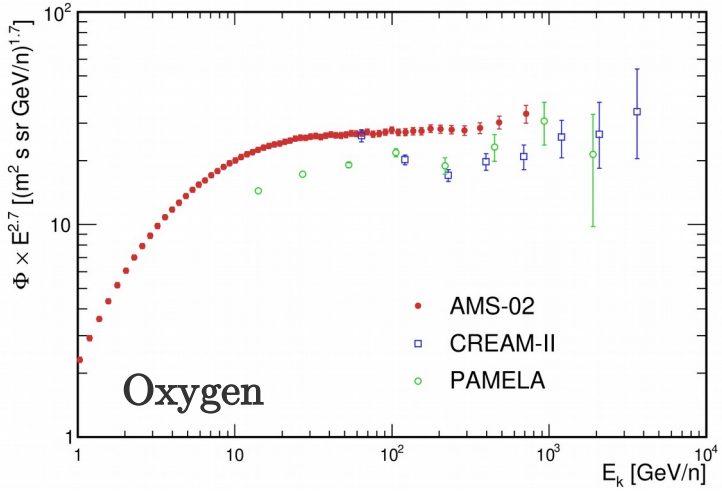
[CR data extracted from ASI CRDB]



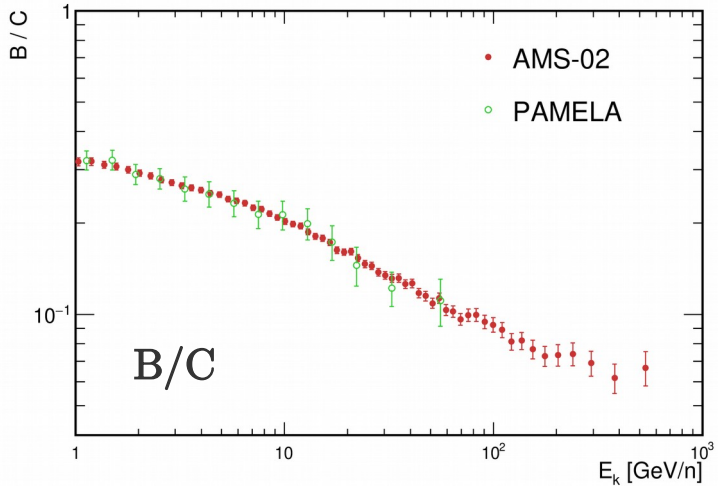
Importance of secondary–to–primary ratios:

- C & O: mainly of primary descent
- Li, Be, B: secondaries produced via spallation of heavier primaries with the ISM

Thus providing insight on the grammage traversed by CRs during propagation



B/C, B/O & C/O ratios



B/C used to quantify propagation of CRs in the Galaxy

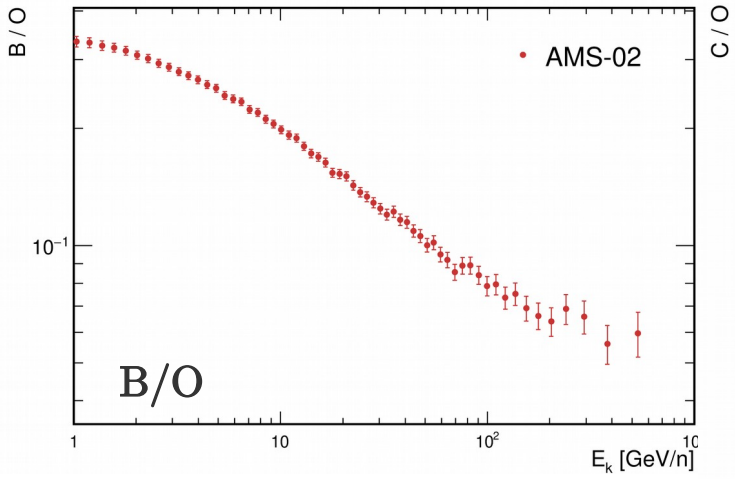
Although heavily depends on:

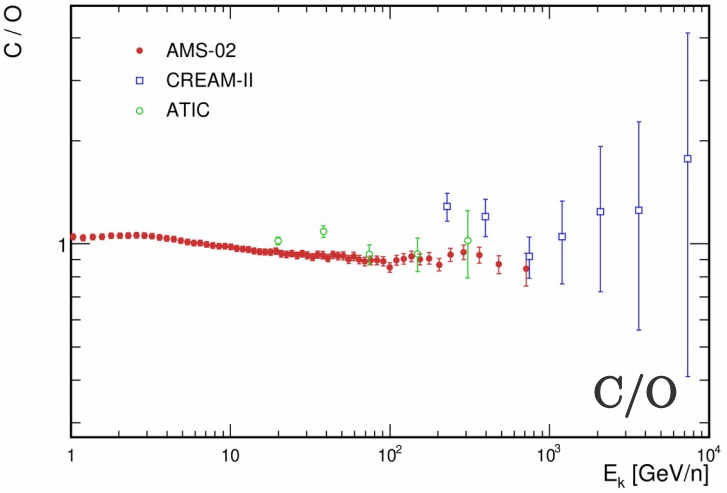
– Spallation cross sections for Boron production (~30% error).

– Flux measurements of heavier elements.

Detection of breaks in nucleonic spectra provides hints related to CR transport rather than acceleration.

Why emphasize on C/O and B/O along with B/C?





C/O departs from a flat behavior due to:

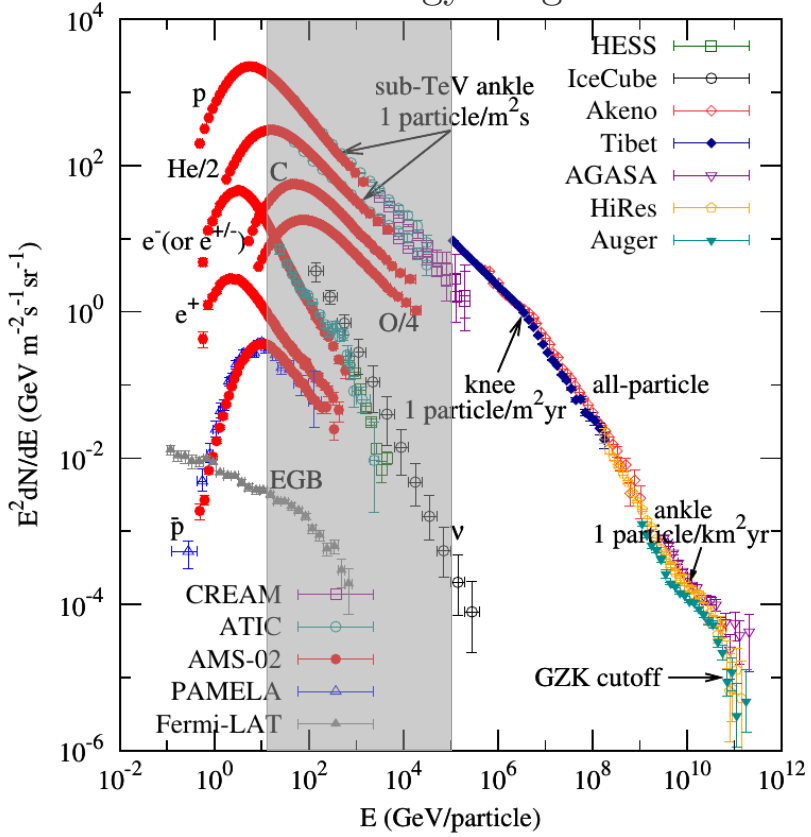
– Spallation processes being analogous to $A^{2/3}$

– 20 % of the Carbon flux at low energies is due to Oxygen spallation.

Extending the energy range for BCNO nuclei is important in understanding different aspects of the CR propagation mechanism

The DAMPE space mission

DAMPE energy range



Scientific Objectives

Particle acceleration & propagation of CRs in the Galaxy
Gamma – ray emission from galactic & extragalactic sources
Indirect Dark Matter studies

Wide energy range
Improved energy resolution
Large acceptance


Vibration tests

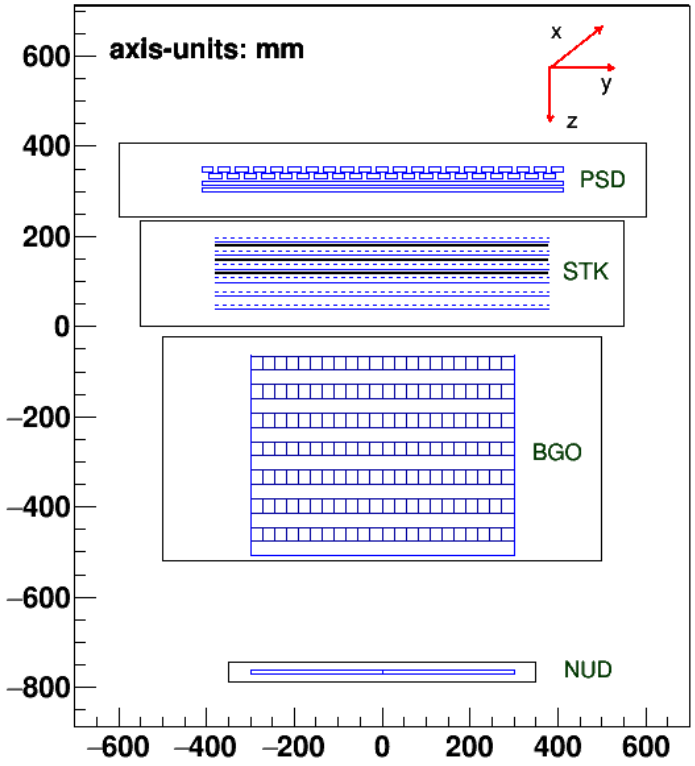

Launched on Dec. 17th 2015


DAMPE workshop @GSSI, 2018

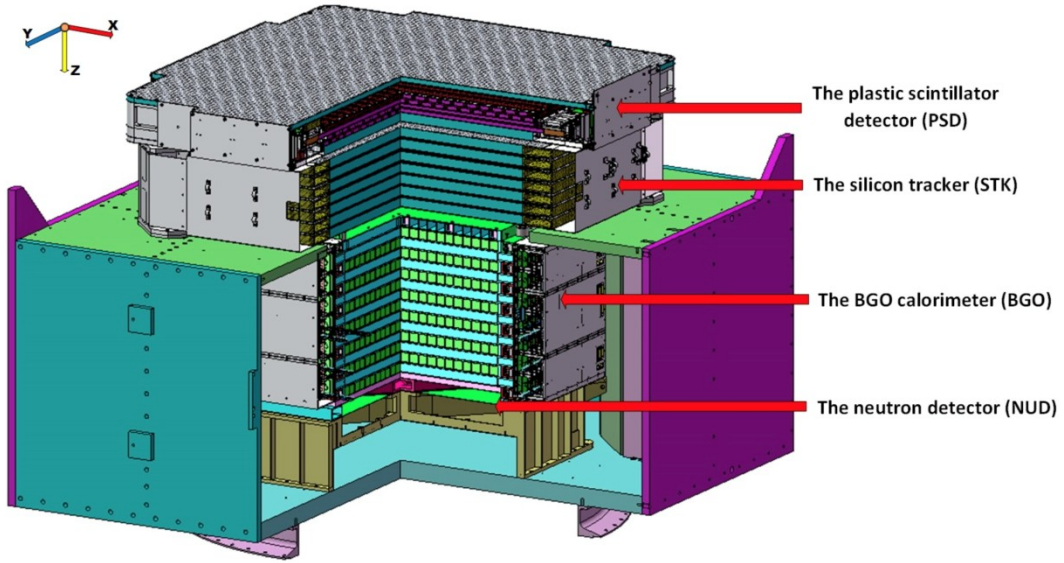
The Collaboration

The DAMPE initiative includes several institutes and universities from China, Italy and Switzerland

The DAMPE detector



Astropart. Phys., 95, 6 [2017]



PSD: Anti – coincidence detector for gammas and charge measurement

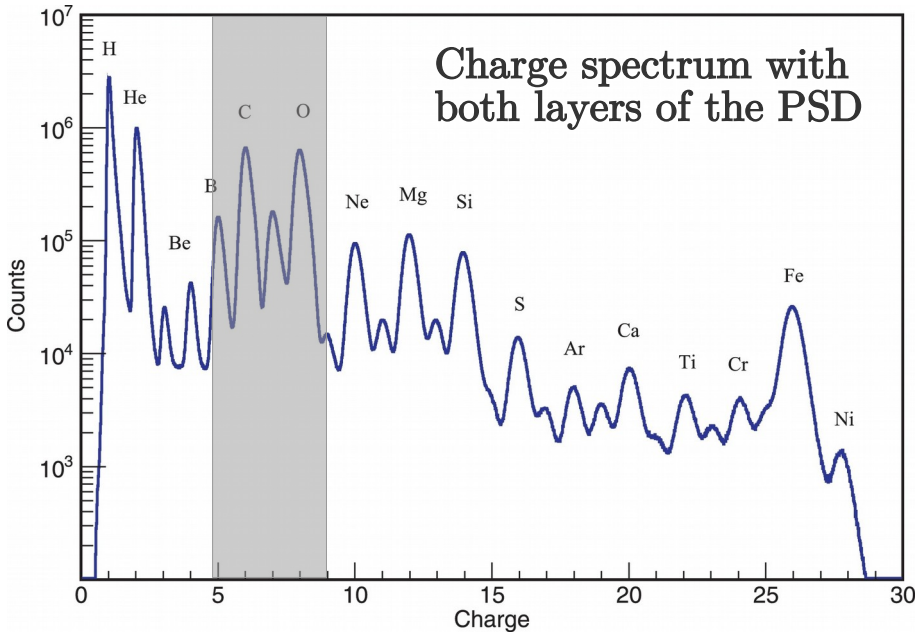
STK: Particle tracker, photon converter & additional charge measurement

BGO: Energy measurement & particle identification via shower topology

NUD: Further particle ID from electromagnetic & hadronic showers

Charge spectrum and first results

Astropart. Phys., 105, 31 [2019]



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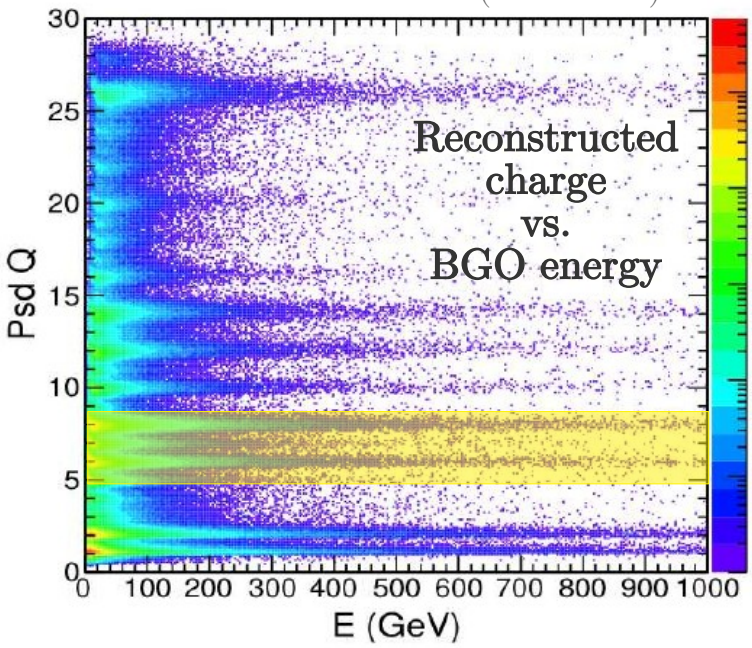
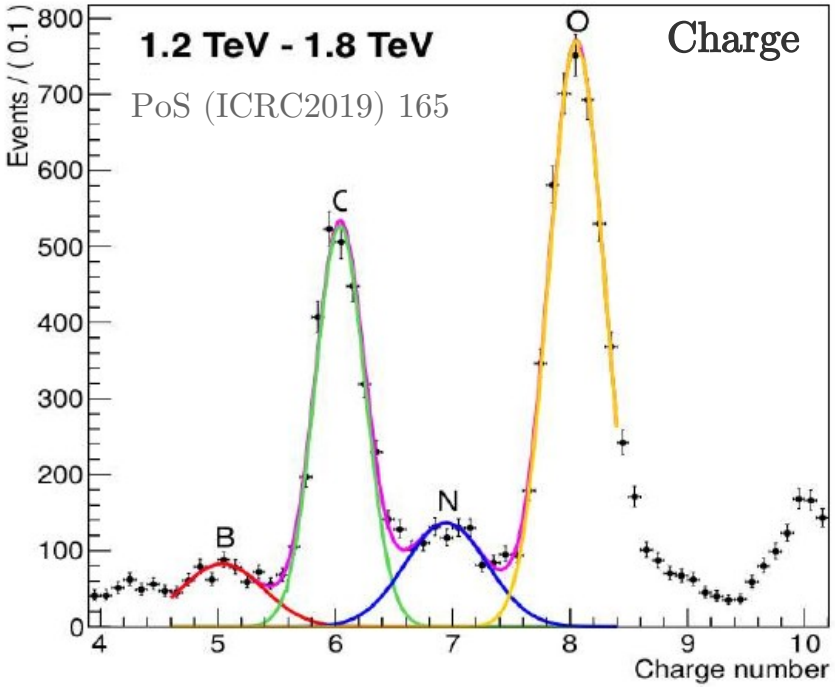
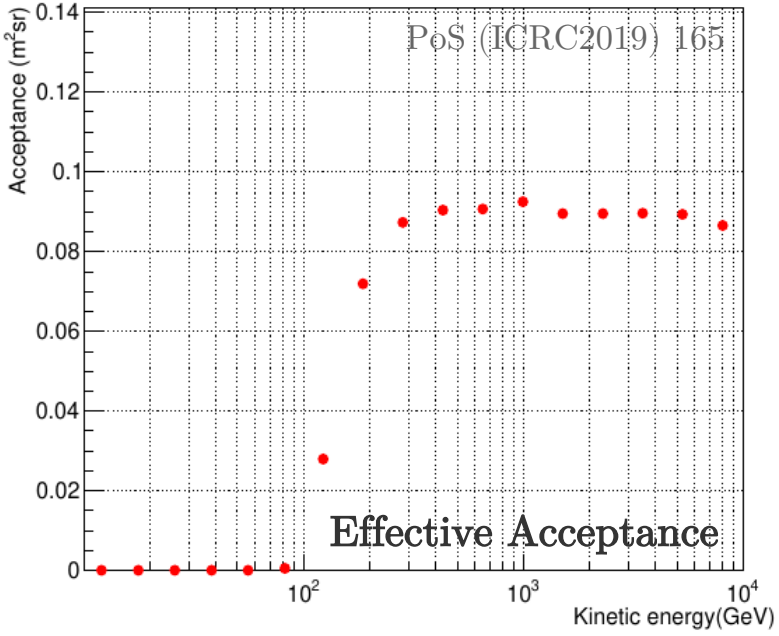


Element	Charge resolution
B	0.17
C	0.18
N	0.21
O	0.20



DAMPE results from 2 years of flight data



Ongoing Analysis

Main Goal:

Measuring the BCNO spectra from 100 GeV – 100 TeV [particle energy]

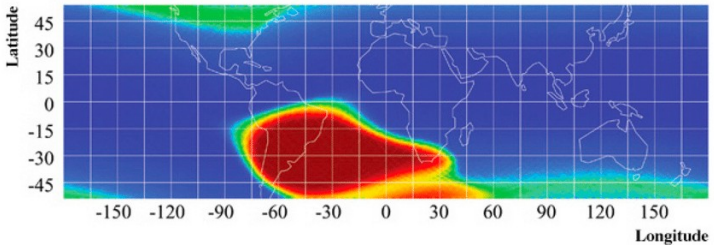
Utilizing flight data from January 1st, 2016 to August 31st, 2020 – 56 months of data

Pre–selection of events

Omitting data acquired during the passage through the South Atlantic Anomaly (SAA).

Elimination of events entering the detector from the bottom and side.

Ensuring core containment of the shower in the calorimeter.



Charge selection

CR nuclei should be found in the interval of $5 < Z < 8$ in order to optimize charge selection and performance.

Trigger selection

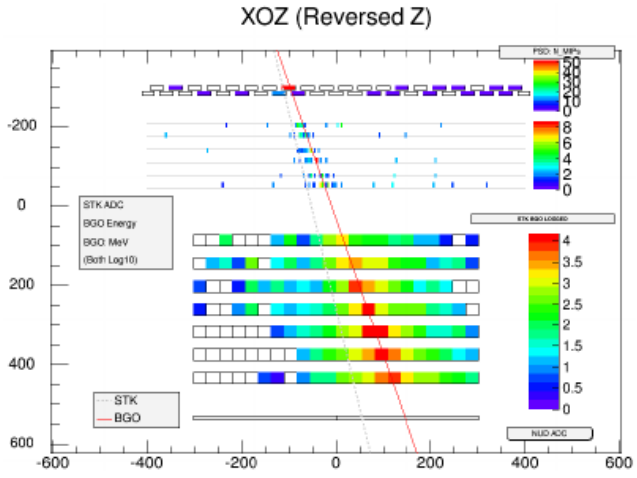
High Energy Trigger activation: Energy deposition in the first 4 calorimeter layers should exceed the threshold of ~10 MIPs for each BGO bar hit.

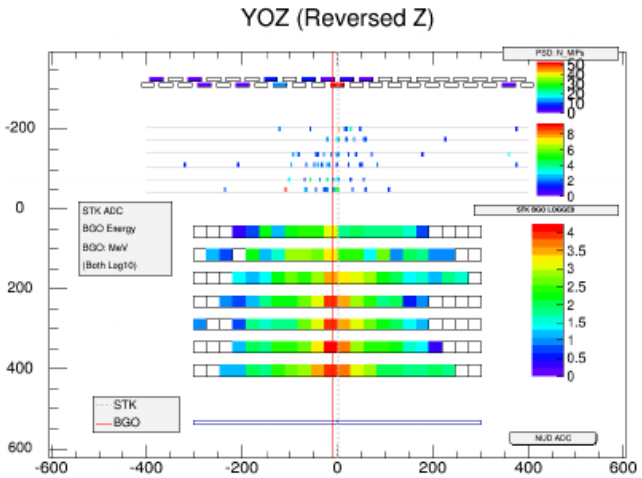
Track selection

Determining a track close to the center of the STK cluster.

Each candidate STK track should have maximum energy deposition along its path.

STK tracks should hit at least 5/6 tracker planes in X & Y dimension.





Summary

BCNO nuclei provide valuable information regarding CR propagation in the Galaxy.

Recent experimental results up to ~ 1 TeV/n are intriguing, although data at higher energies are needed.

The analysis of BCNO cosmic nuclei is carried out with DAMPE, a suitable candidate due to its wide energy range, large acceptance and improved energy resolution.

Ongoing work is focused on optimizing the event selection procedure, taking advantage of 56 months of flight data and valuable experience gained from proton and helium analyses.