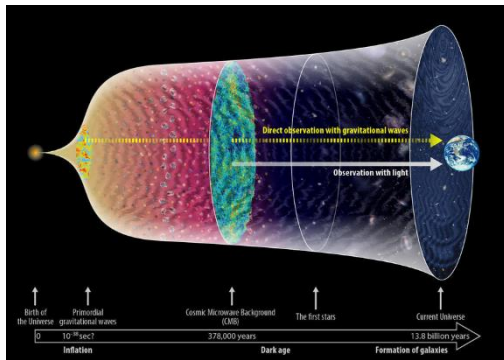# Searching for fractionally charged particles with DAMPE

Chengming Liu*, Pengxiong Ma

On behalf of DAMPE collaboration

The possible origins of FCP

There are three possible sources of FCP in cosmic rays:

- **First,** it may be produced at the early Universe after the Big Bang and remains in some bulk matter.

- **Second,** it may be produced through high-energy astrophysical processes.

- **Third,** it may be produced in the extensive air shower of cosmic-rays.
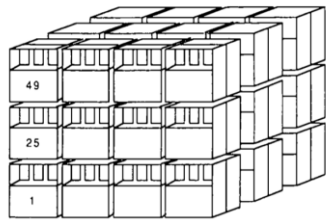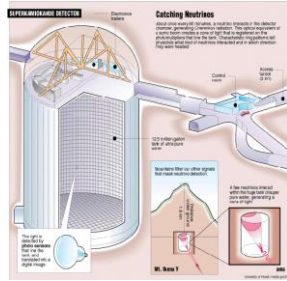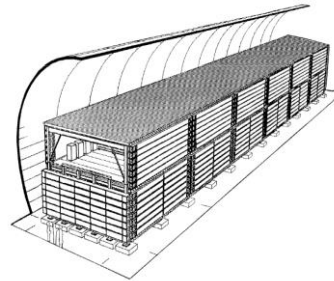
The previous experiments

LSD

Kamiokande II

MARCO
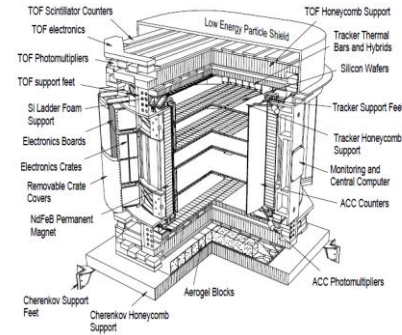
AMS01
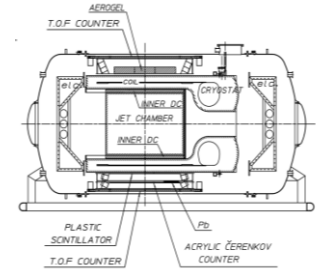
BESS

	Experiment	Upper limits$(cm^{-2}sr^{-1}s^{-1})$
Underground	LSD	2.7×10^{-13}
	Kamiokande II	2.1×10^{-15}
	MACRO	6.0×10^{-16}
In-space	AMS01	3.0×10^{-7}
	BESS	4.5×10^{-7}

Selection criteria

Plastic Scintillator Detector

Silicon-Tungsten Tracker

BGO Calorimeter

Neutron Detector
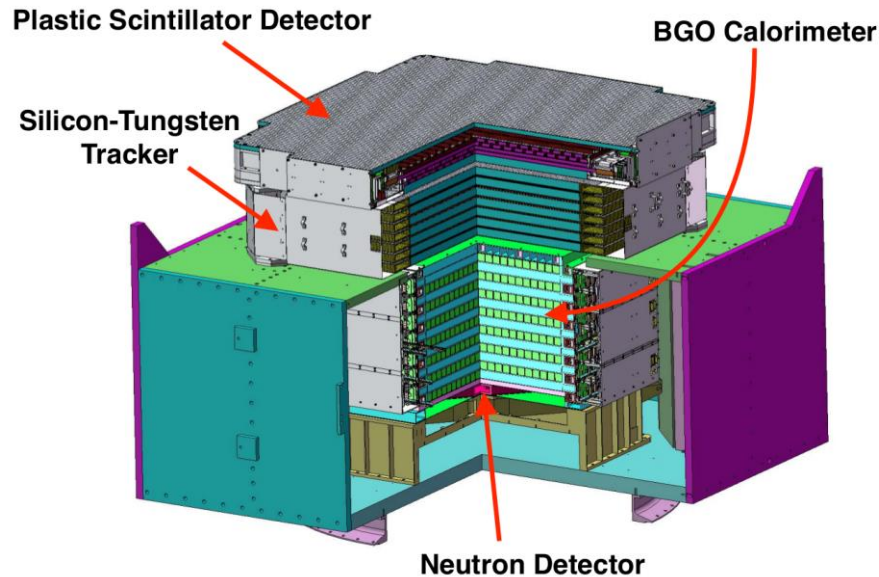
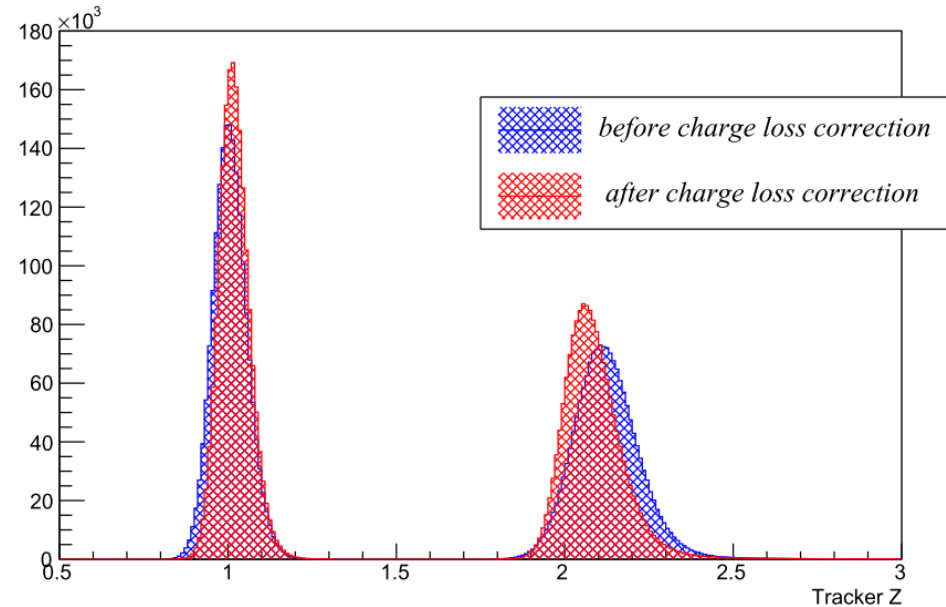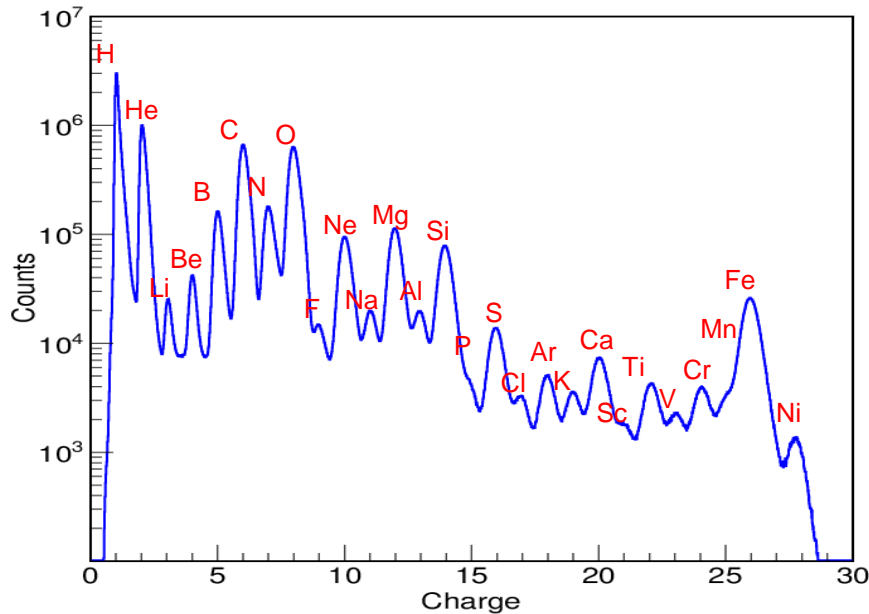- DAMPE is an orbital experiment for detecting high energy cosmic ray
- DAMPE orbit the earth at an altitude of 500 km.
- Launched on Dec. 17th 2015, CZ-2D rocket
- Period: about 90 minutes
- Life time > 5 years

Charge measurement (**PSD, STK**)
Precise tracking (**STK + BGO**)
Precise energy measurement (**BGO**)
Particle identification (**BGO + NUD**)

PSD and STK charge measurement

Left: The charge discrimination of PSD in Z from 1 to 28
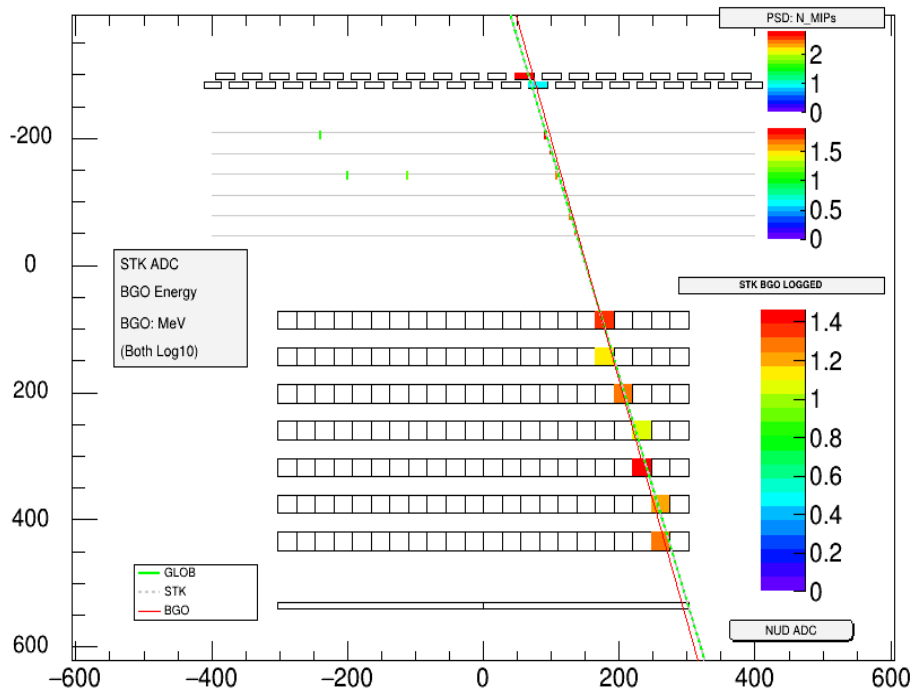**Right**: The charge discrimination of STK between proton and helium

Method of searching FCP with DAMPE

Since the designed trigger threshold of G1 G2 is 0.2 MIPs - 8 MIPs, higher than the 1/3 charged particles(1/9 MIPs), we aim to search the 2/3 charged particles.

❑**Fiducial:** Geometry angle, latitude restrictions, good track, energy deposition.
❑**Angle difference:** Remove the scattered events
❑**MIPs selections:**
- Constrain the fired detector cells in PSD and BGO
- Require the track going through the PSD strips
- Require the event penetrate the whole BGO calorimeter
❑**PSD end charge ratio:** Maintain the reliability of PSD charge reconstruction
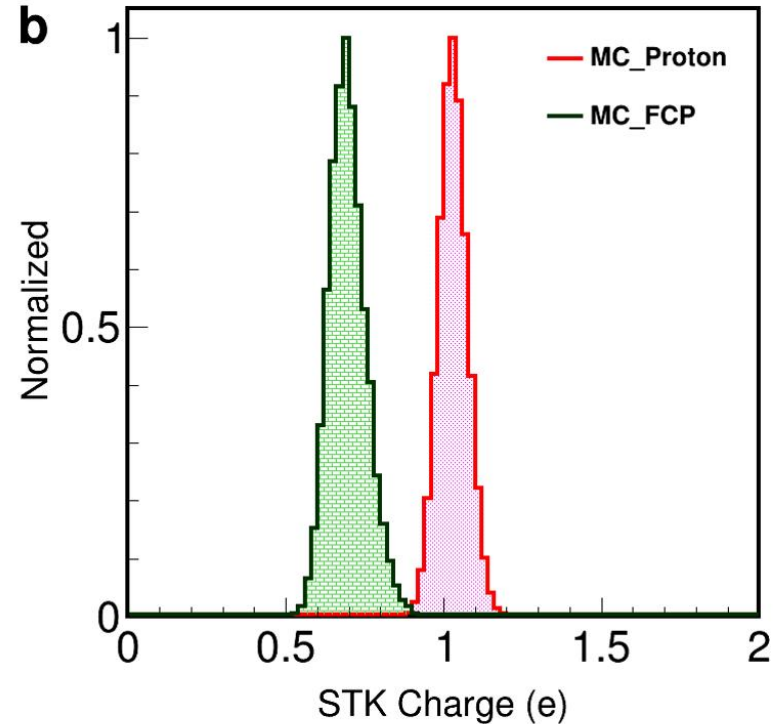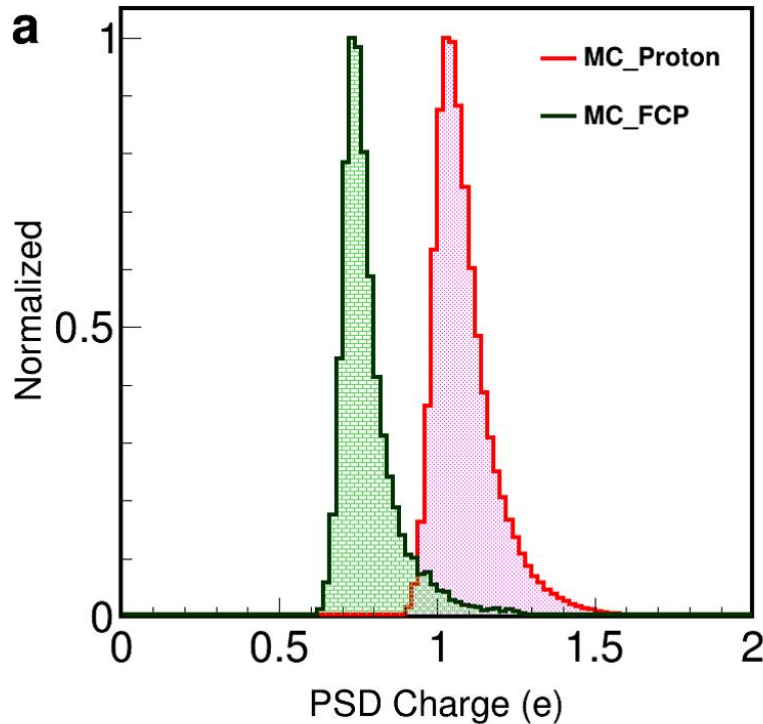❑**STK charge:** Select the good cluster to reconstruct the charge
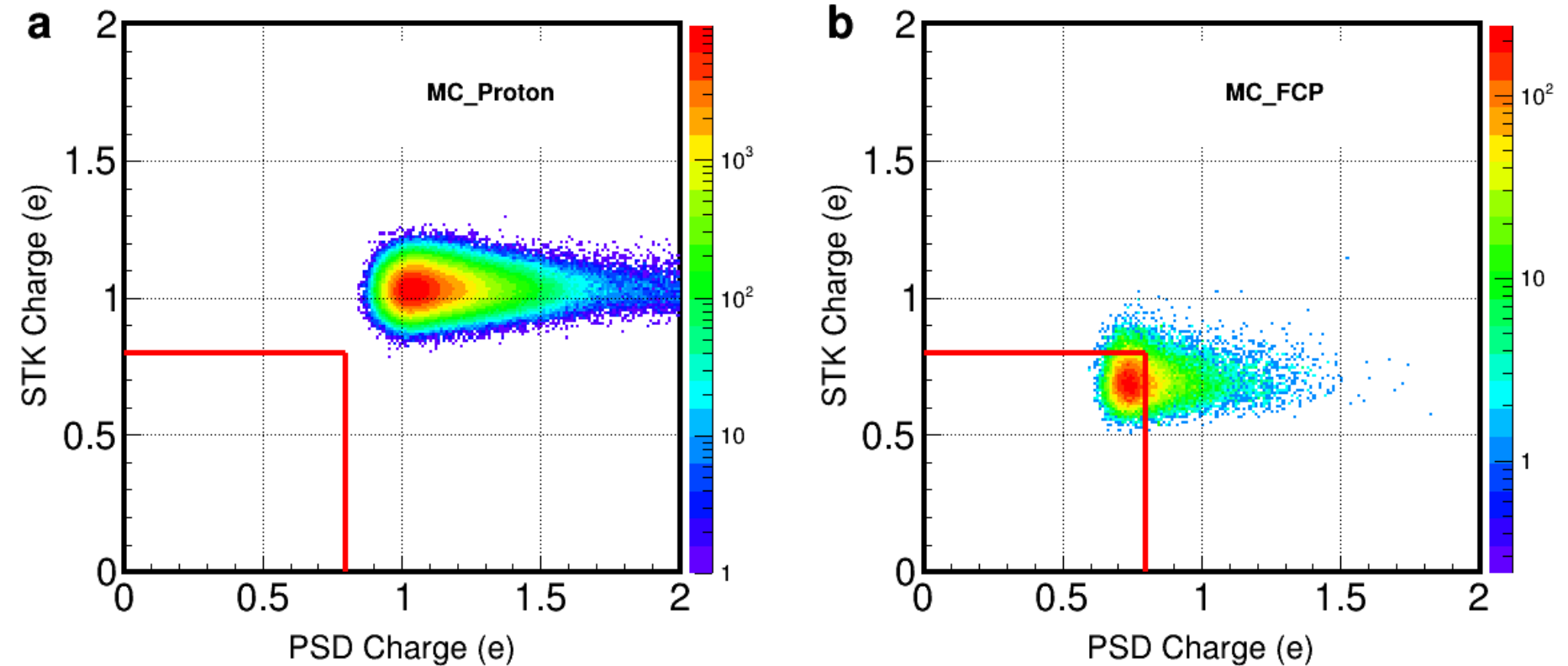
A MIPs event
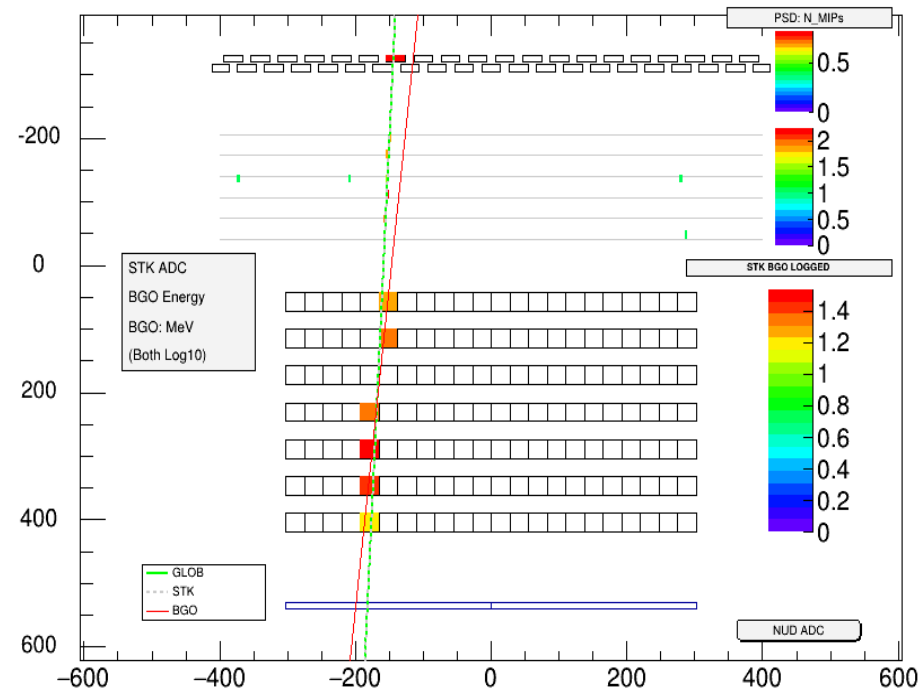
Charge reconstruction for FCP

The charges in both the PSD and STK are reconstructed. Thanks to the good charge resolution of DAMPE, a good discrimination between 2/3 FCPs and singly charged particles is possible.

Signal region for FCP

A signal region can be defined by PSD and STK MC as the red lines shows, the charge of two lines are set to 0.8. The FCP MC is simulated by creating a new particle in DAMPE software. The signal region has a 68% efficiency of covering the FCP as shown in figure d at right.

Summary

- The DAMPE has been working stably on-orbit for more than 5 years.

- The PSD and STK are used to search for Fractionally Charged Particles.

- The selection criteria to search FCP with DAMPE have been studied.

- A MC simulation has been performed and an evaluation of the search efficiency has been carried out.