DAMPE space mission and recent results

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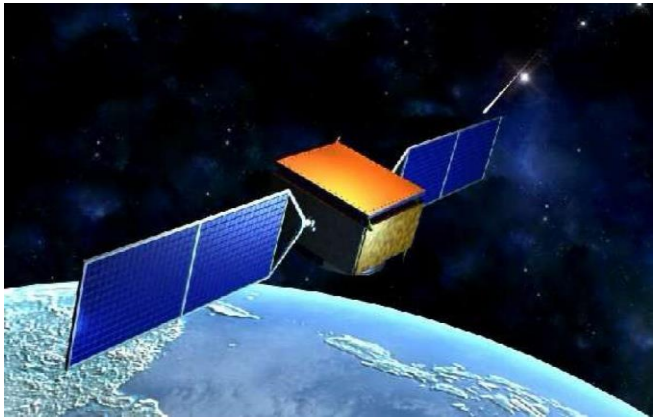
WIN2019 The 27th International Workshop on weak Interactions and Neutrinos

Overview

- Introduction of the collaboration and scientific goals of DArk Matter Particle Explorer (DAMPE)
- DAMPE structure and functionality parameters
- Recent results concerning spectra of electron, proton and helium
- Brief introduction on our analysis on proton + helium spectrum



The Collaboration

Launched on December 17th 2015, DAMPE has been collecting CR data for more than 3 years!

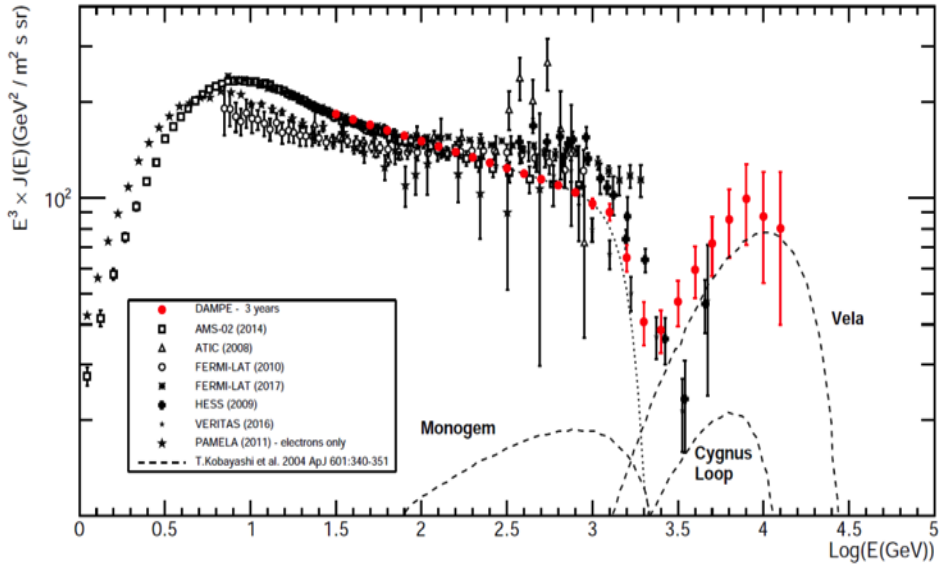
- **CHINA**
  - **Purple Mountain Observatory, CAS, Nanjing**
  - **University of Science and Technology of China, Hefei**
  - **Institute of High Energy Physics, CAS, Beijing**
  - **National Space Science Center, CAS, Beijing**
  - **Institute of Modern Physics, CAS, Lanzhou**
- **ITALY**
  - **INFN Perugia and University of Perugia**
  - **INFN Bari and University of Bari**
  - **INFN Lecce and University of Salento**
  - **INFN LNGS and Gran Sasso Science Institute**
- **SWITZERLAND**
  - **University of Geneva**

The scientific goals

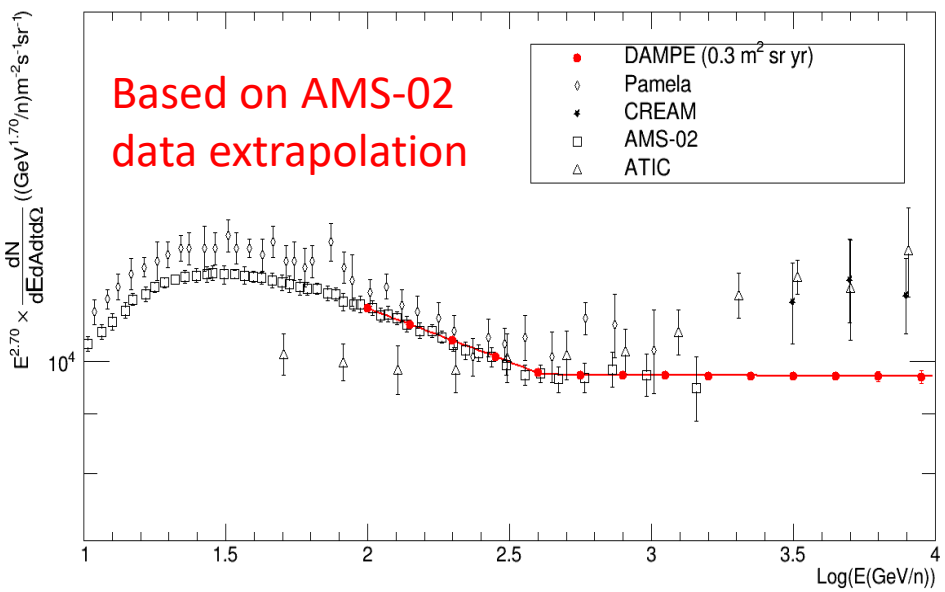
High energy particle detection in space

- Study of the cosmic-ray electron spectra
- Study of cosmic-ray protons and nuclei: spectrum and composition
- High energy gamma ray astronomy
- Search for dark matter signatures in lepton spectra

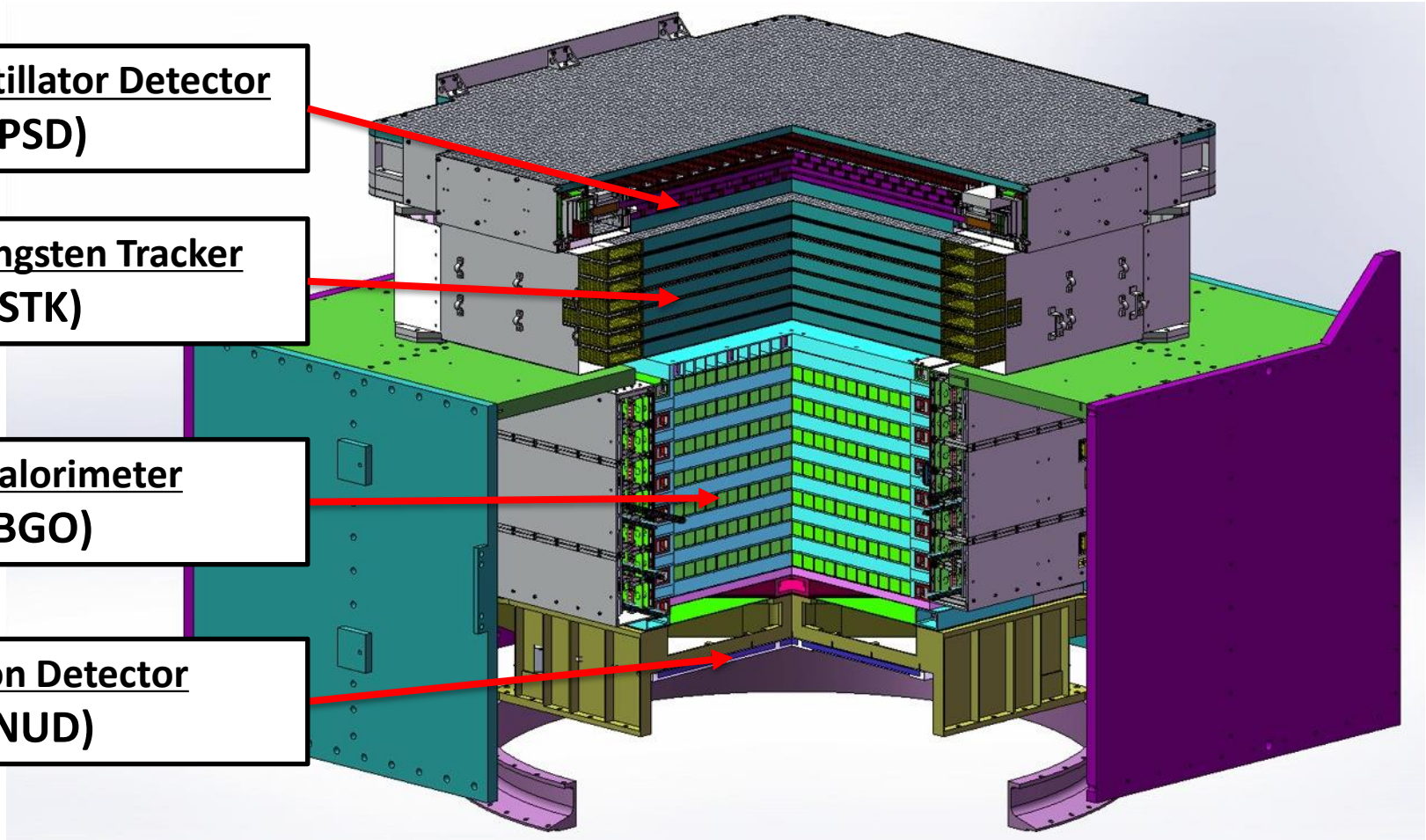
DAMPE expected electron+positron spectrum



DAMPE expected proton spectrum



The detector structure



PSD: Charge measurement; Identify electron and γ-ray;
STK: Tungsten converter (pair production); Precise tracking (silicon strips);
BGO: Energy measurement; e/p separation;
NUD: Hadron rejection;

The detector parameters

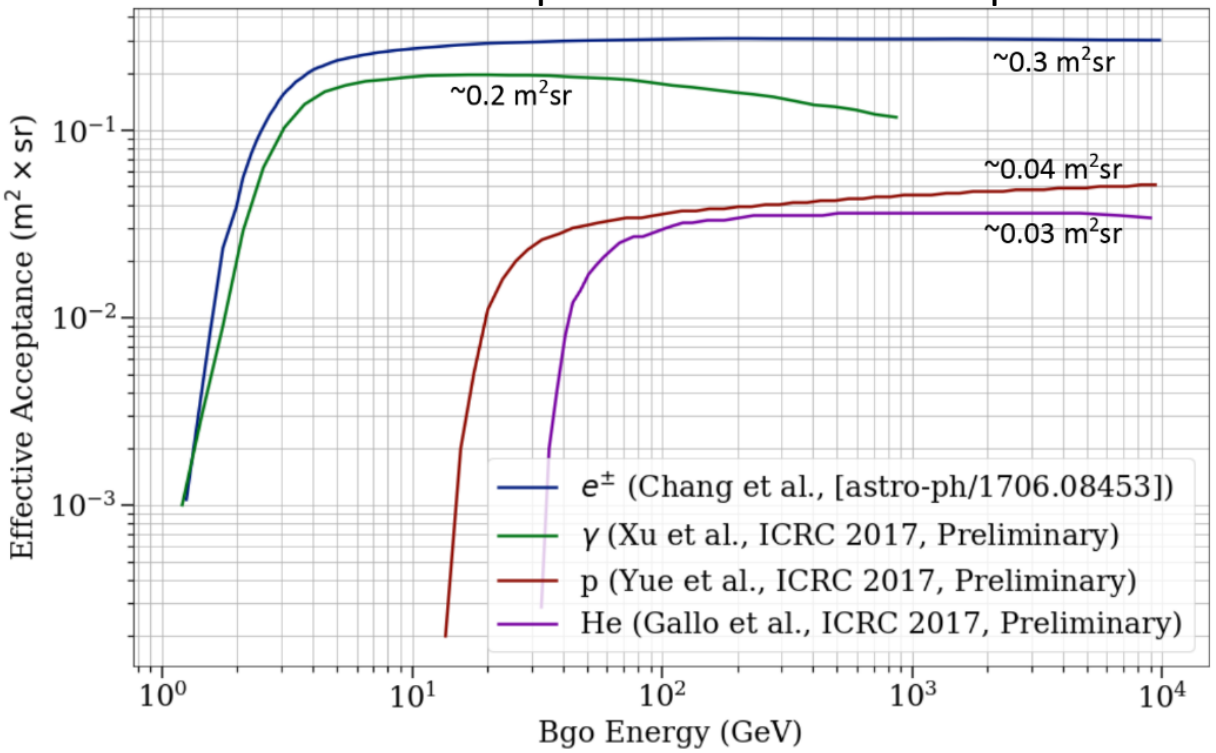
DAMPE main parameters

Parameter	Value
Energy range of γ-rays/electrons	5 GeV−10 TeV
Energy resolution[a] of γ-rays/electrons	$\leq$ 1.5% at 800 GeV
Energy range of protons/heavy nuclei	50 GeV−100 TeV
Energy resolution[a] of protons	$\leq$ 40% at 800 GeV
Effective area at normal incidence (γ-rays)	1100 cm^2 at 100 GeV
Geometric factor for electrons	0.3 m^2 sr above 30 GeV
Photon angular resolution[b]	$\leq 0.2^\circ$ at 100 GeV
Field of View (FoV)	~1.0 sr

Comparison with AMS-02 and Fermi LAT

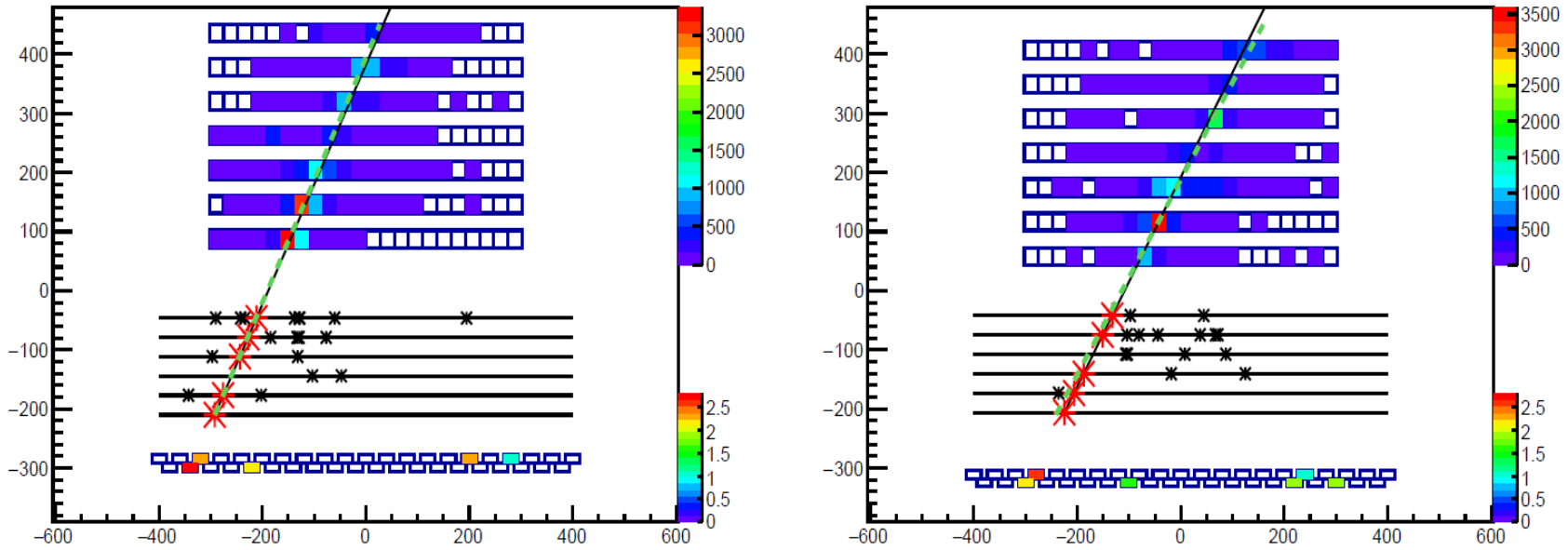
	DAMPE	AMS-02	Fermi LAT
e/γ Energy res.@100 GeV (%)	**1.2**	3	10
e/γ Angular res.@100 GeV (deg)	0.2	0.3	0.1
e/p discrimination	10^5-10^6	10^5 - 10^6	10^3
Calorimeter thickness (X_0)	**32**	17	8.6
Geometrical accep. (m^2sr)	**0.3**	0.09	1

DAMPE effective acceptance for different CR particles



An example for one trigged event

A proton event, seen from XZ (left) and YZ (right) view. The event releases 40.518 GeV energy inside the BGO calorimeter.

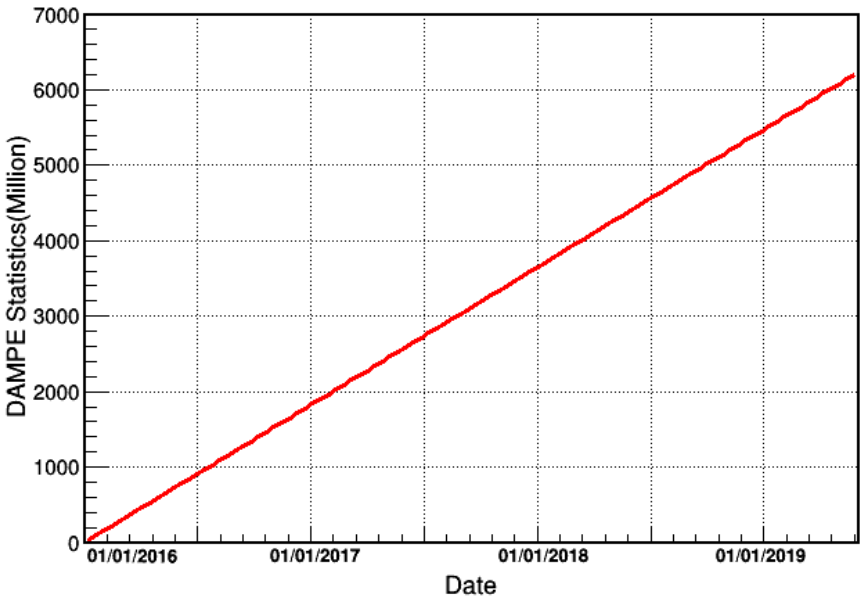


Green dash line: BGO track, Black line: STK track.

Track, energy deposition and charge measurement information are combined together to reconstruct the primary information of the events. (Including the energy, category and direction etc.)

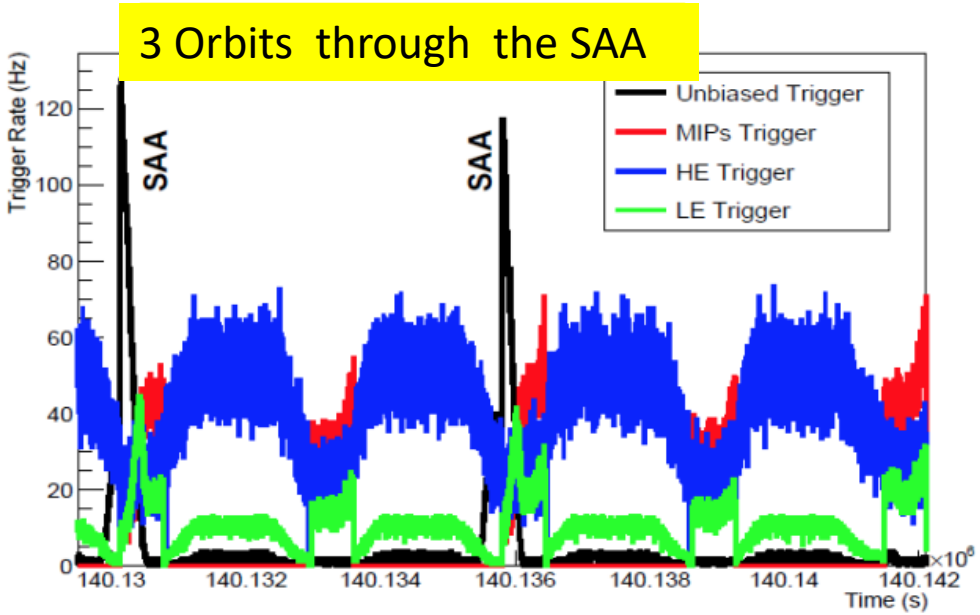
Present status

DAMPE statistics



Up to now, DAMPE has collected more than $6*10^9$ events. On average, 5 million events are collected for each day.

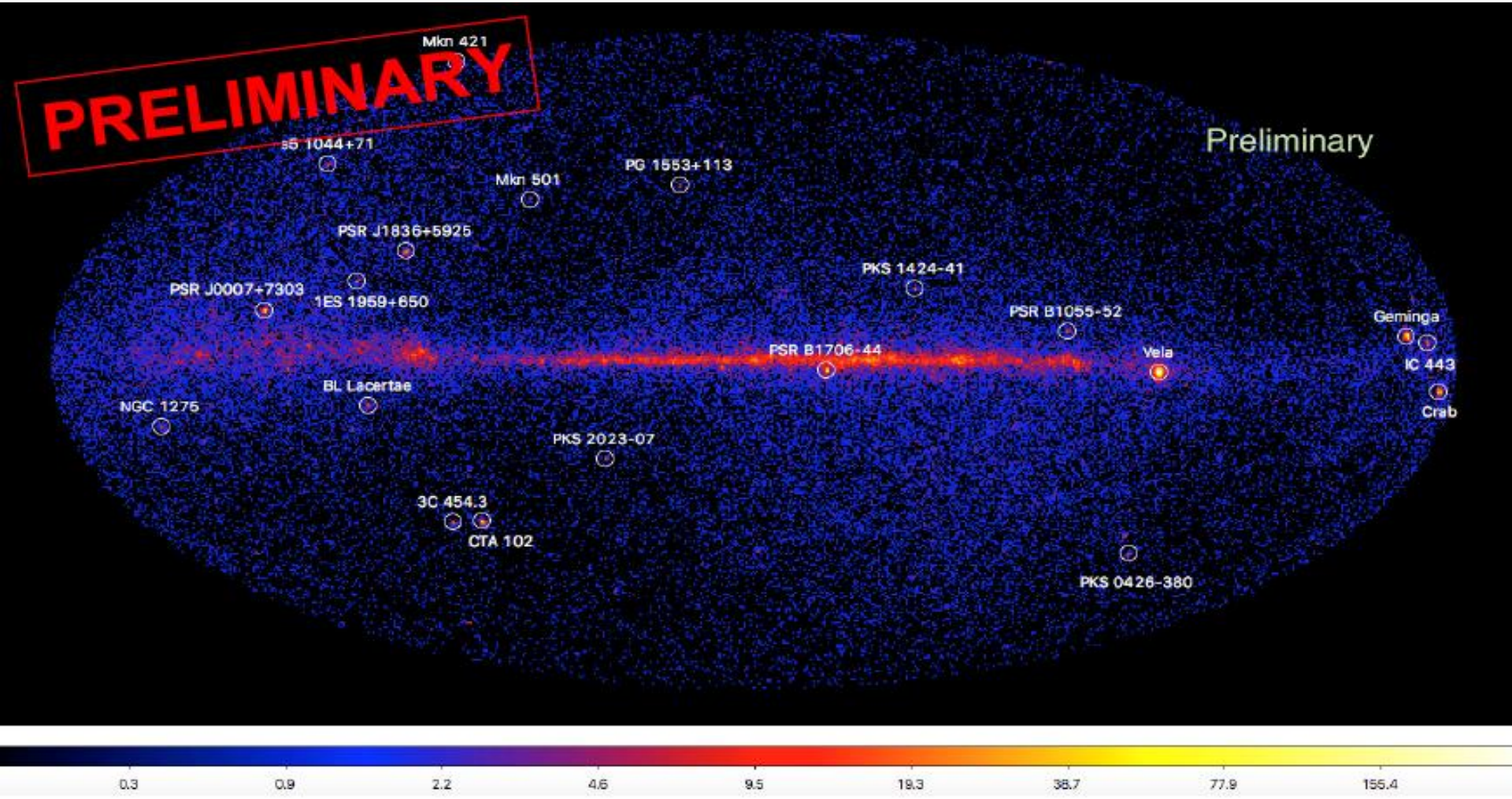
DAMPE trigger rates



High energy trigger rate: 20-60 Hz

The data taking progress is still going on steadily.

The gamma ray sky



510 days counts map. Mollweide projection, 0.5° ×0.5° pixels
E> 2GeV 90,000 events O(20) sources detected

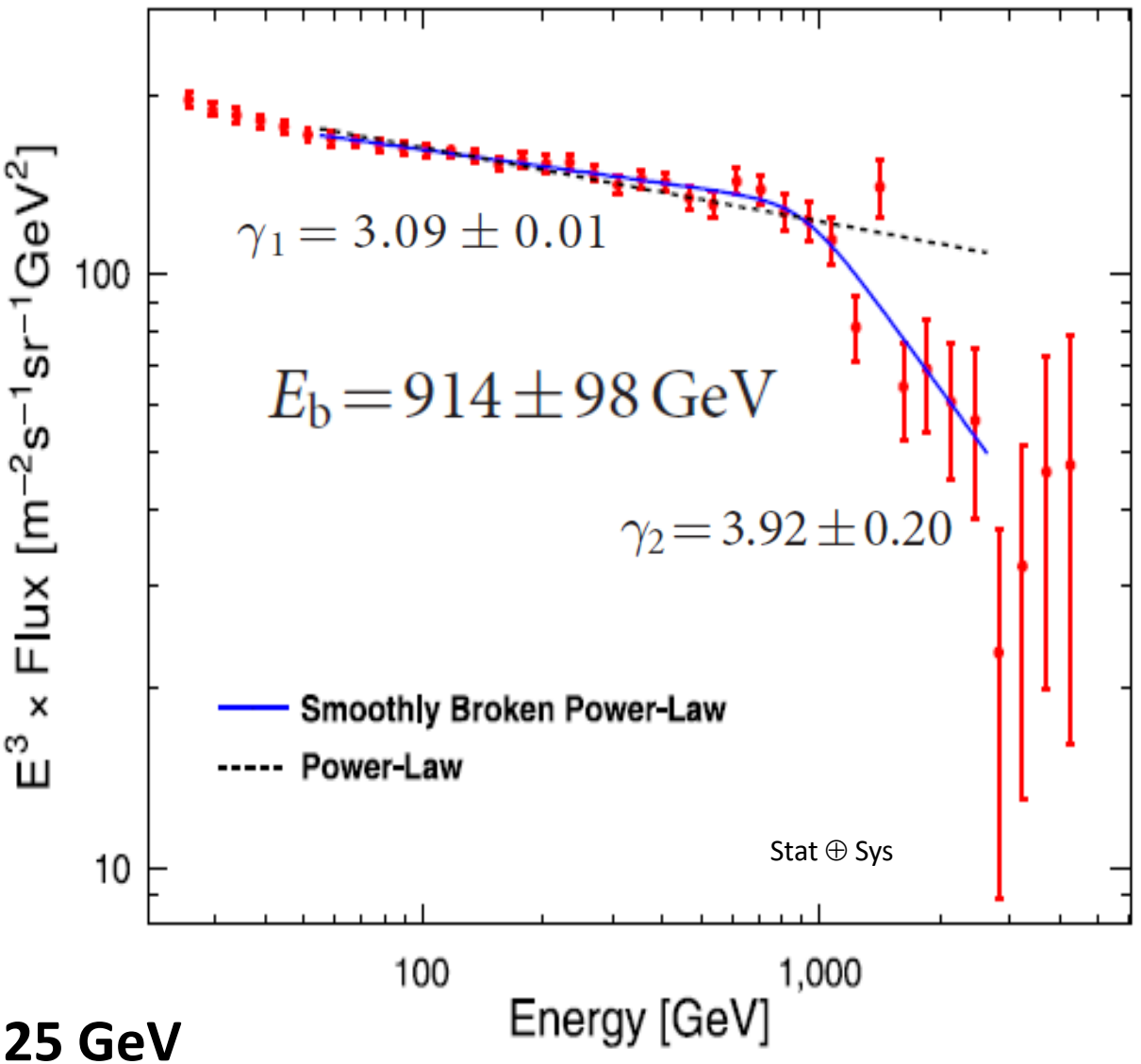
The DAMPE (e^++e^-) spectrum

LETTER nature International weekly journal of science :10.1038/nature24475

Direct detection of a break in the teraelectronvolt cosmic-ray spectrum of electrons and positrons

DAMPE Collaboration*

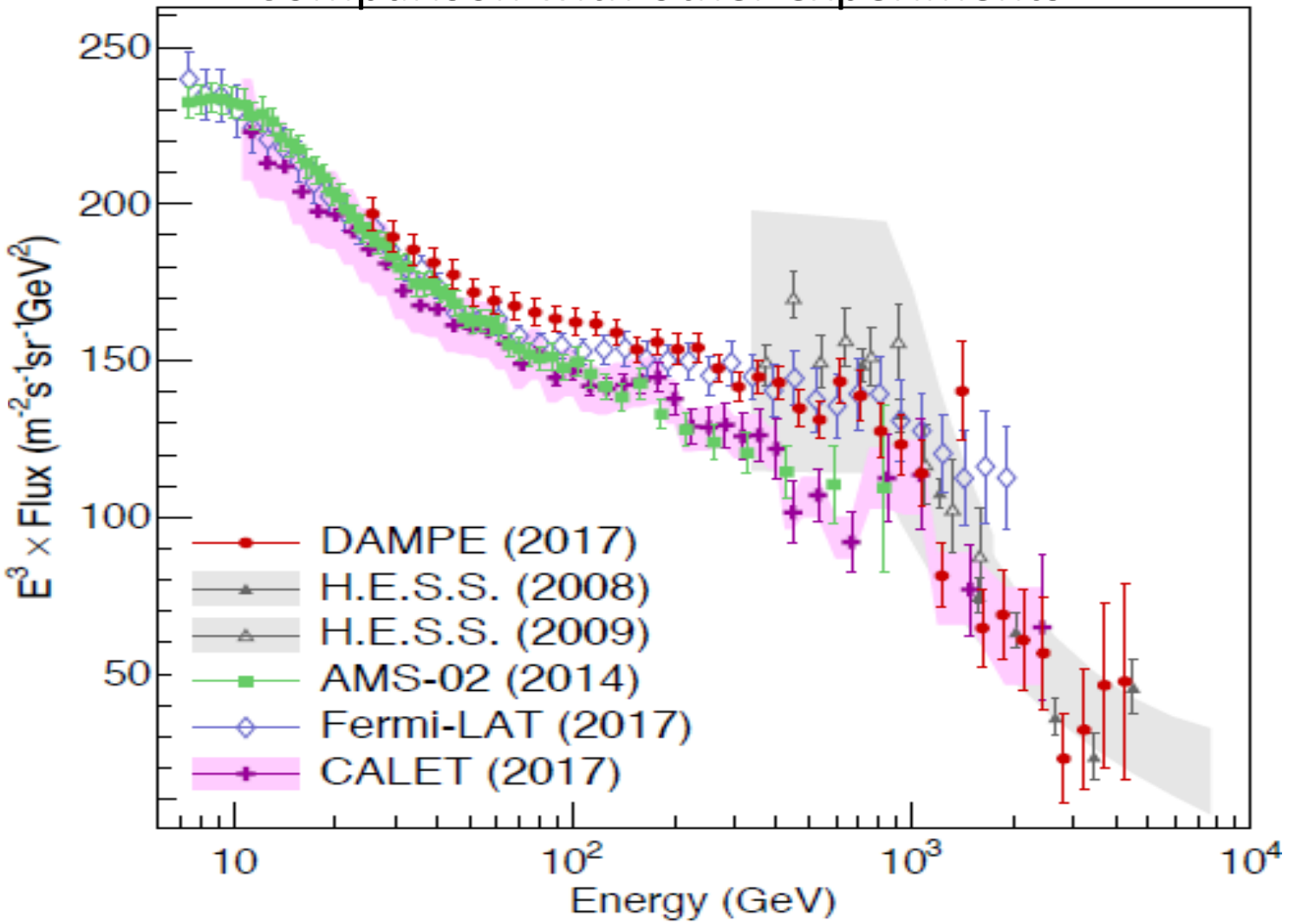
First Direct Evidence for a spectral break in the all-electron spectrum at 0.9 TeV



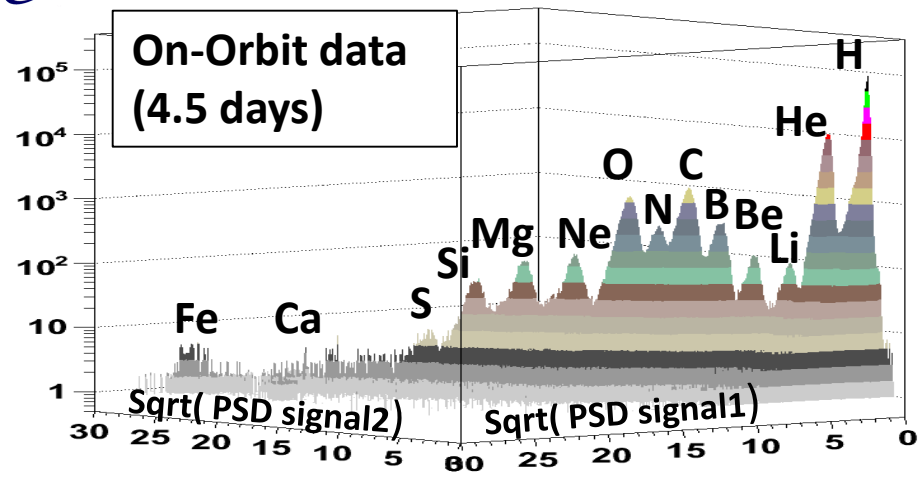
- 530 days
- 2.8 billions CR events
- 1.5 million CREs above 25 GeV

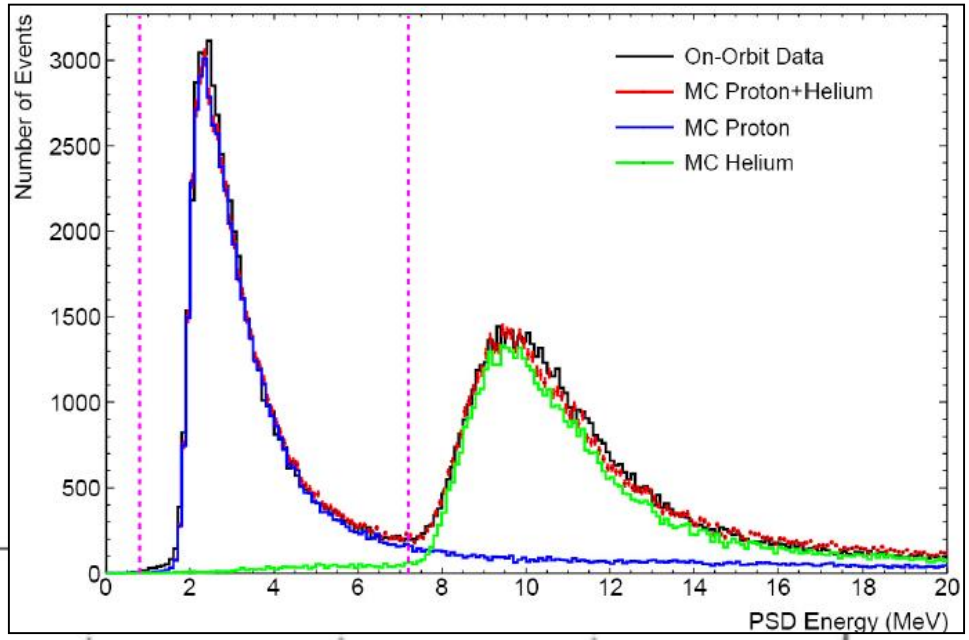
The all-electron spectrum

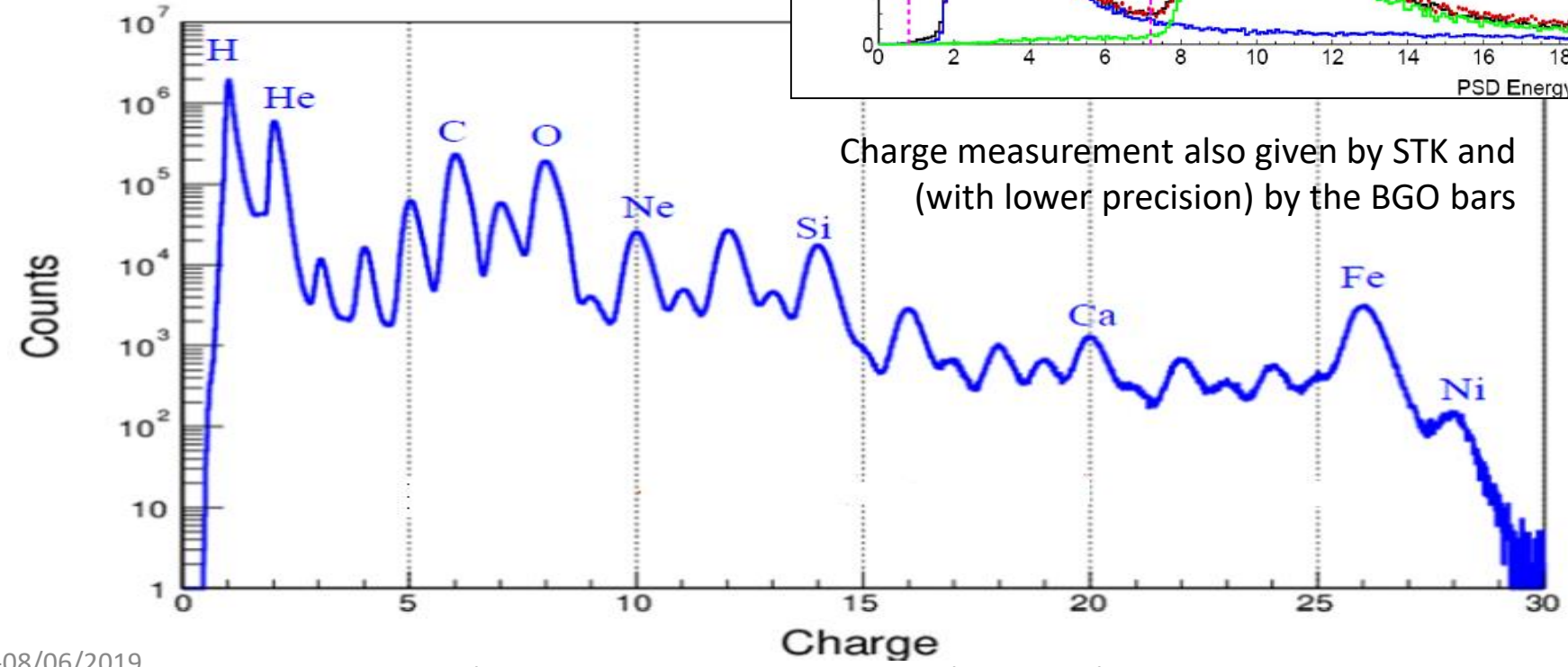
Comparison with other experiments



Nuclei ID with PSD



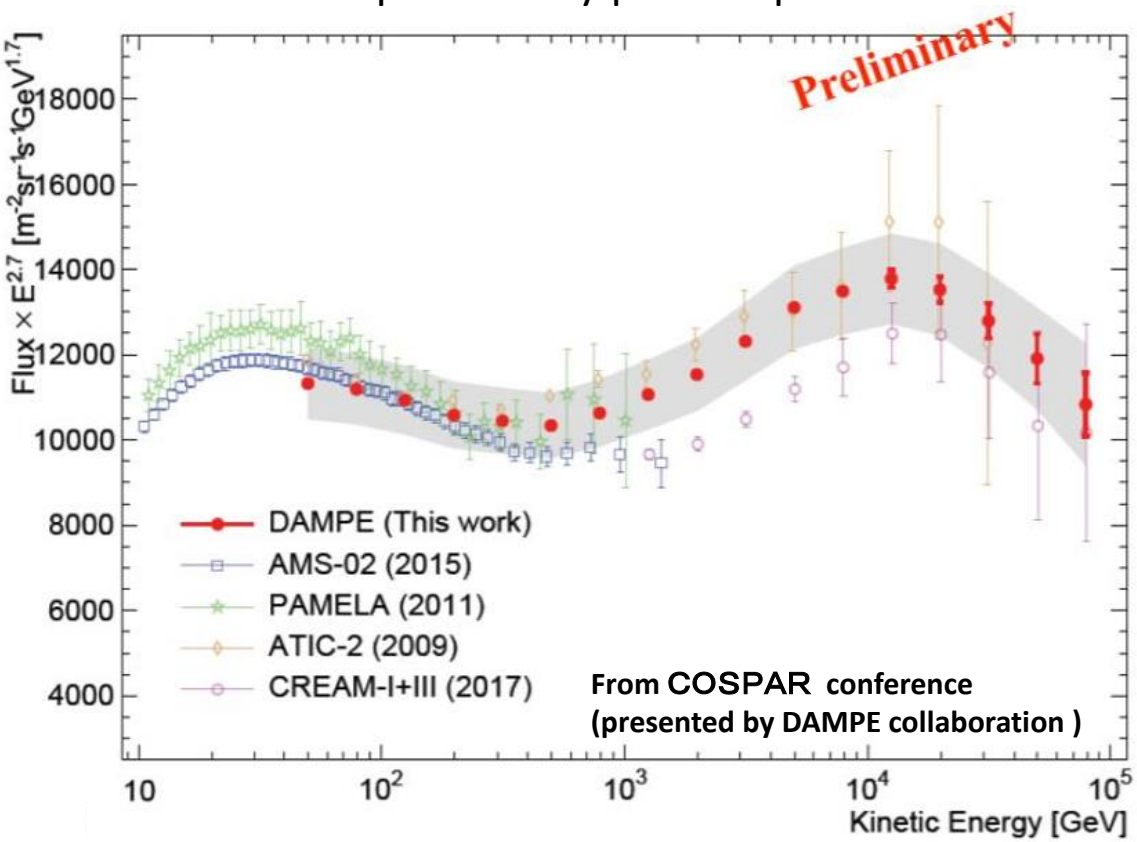


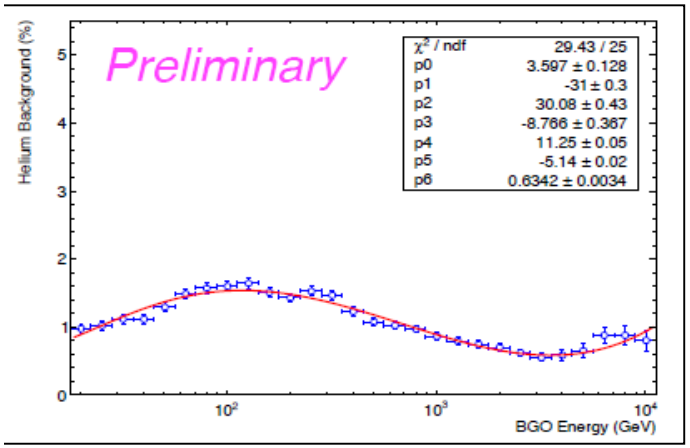


Charge measurement also given by STK and (with lower precision) by the BGO bars

Proton flux measurement

DAMPE preliminary proton spectrum





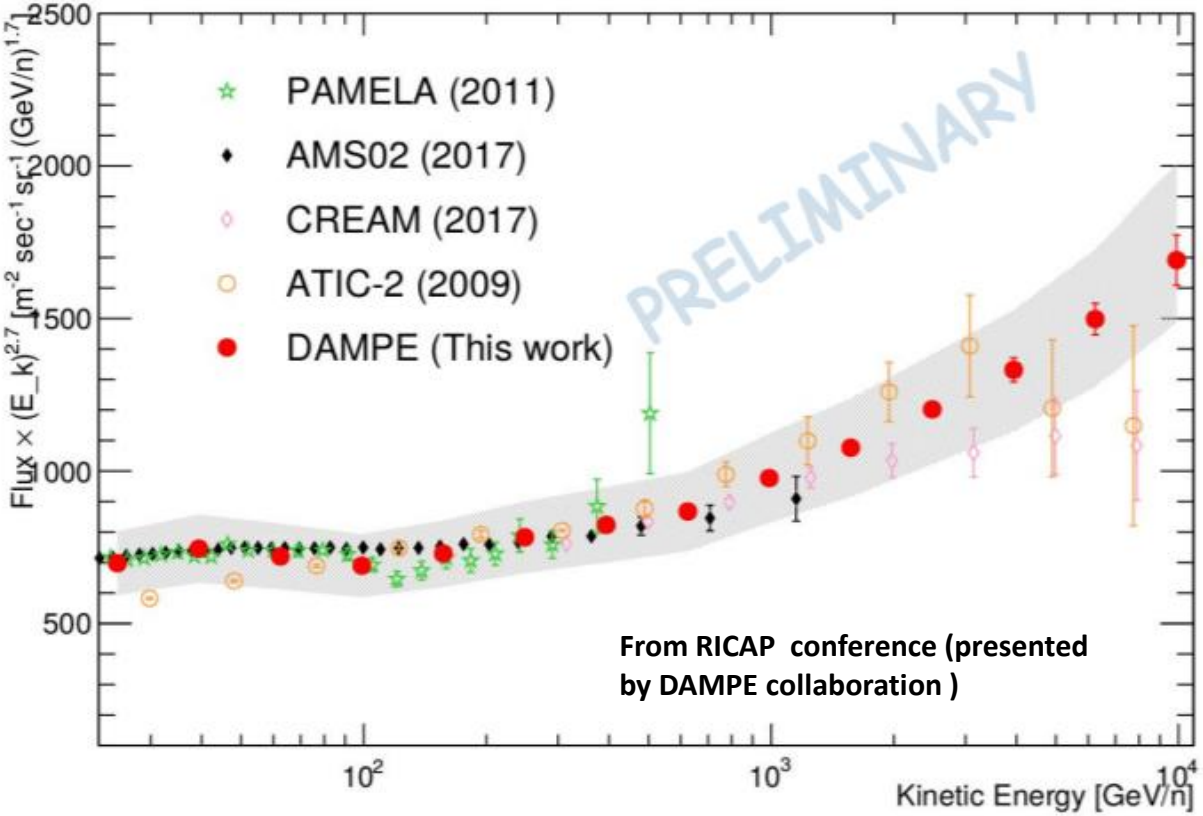
He contamination < 2%

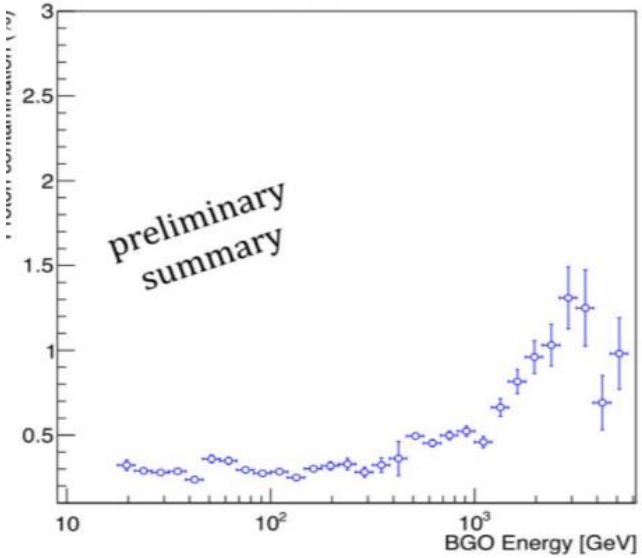
These results:

- **Confirm the spectral hardening around 300 GeV observed by ATIC/CREAM/PAMELA/AMS-02/CALET**
- **Reveal a spectral softening above~10TeV**

Helium flux measurement

DAMPE preliminary helium spectrum



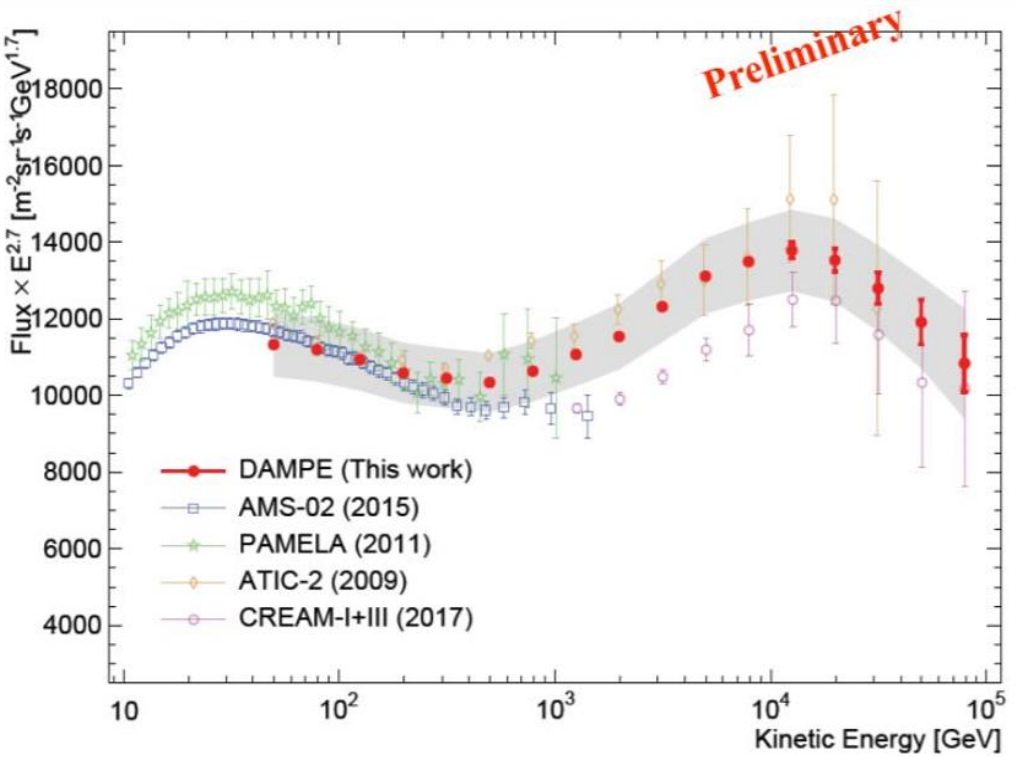


Proton contamination < 1.5%

More precise analysis on helium spectrum is in progress…

p + He spectrum

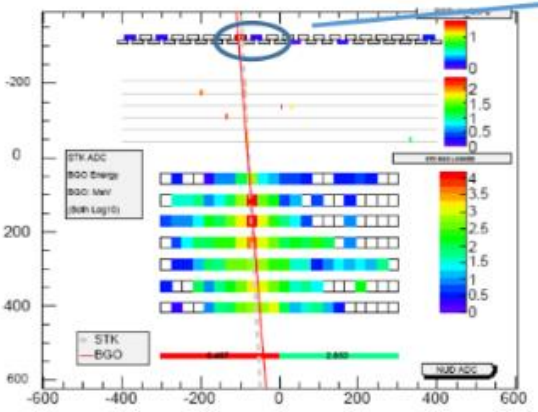
Why do we study the p + He spectrum?

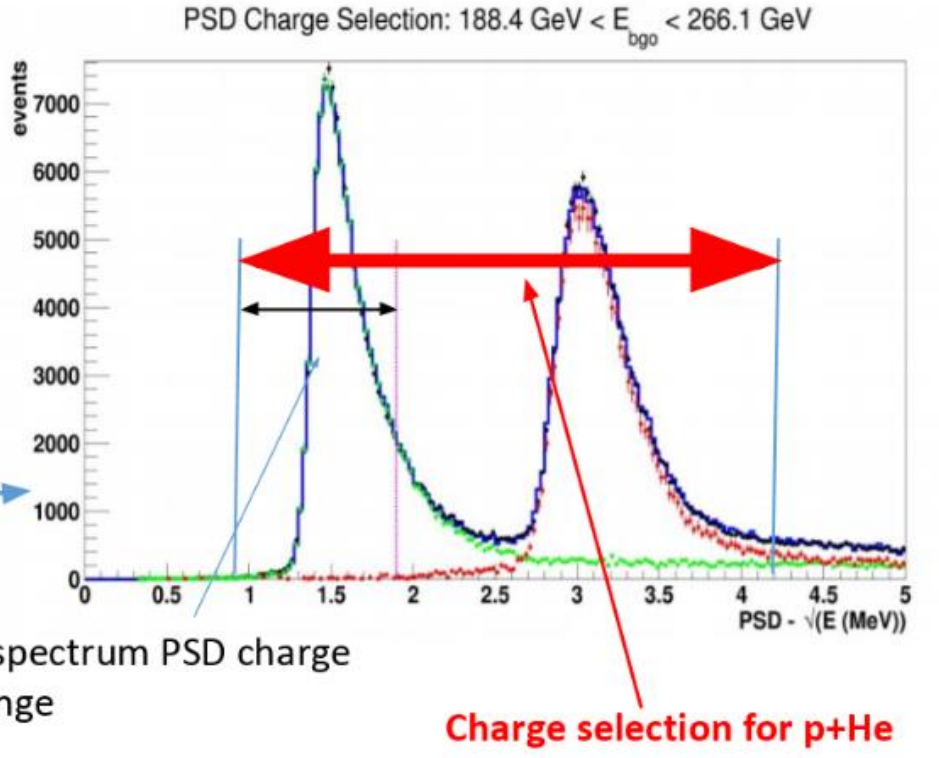


- A spectral softening at 10-15 TeV in proton spectrum?
- Crosscheck for p and He individual spectra
- Negligible background from other nuclei
- No effects of p <-> He misidentification
- Compare the p + He spectrum with measurements from ground-based experiments at the highest energies

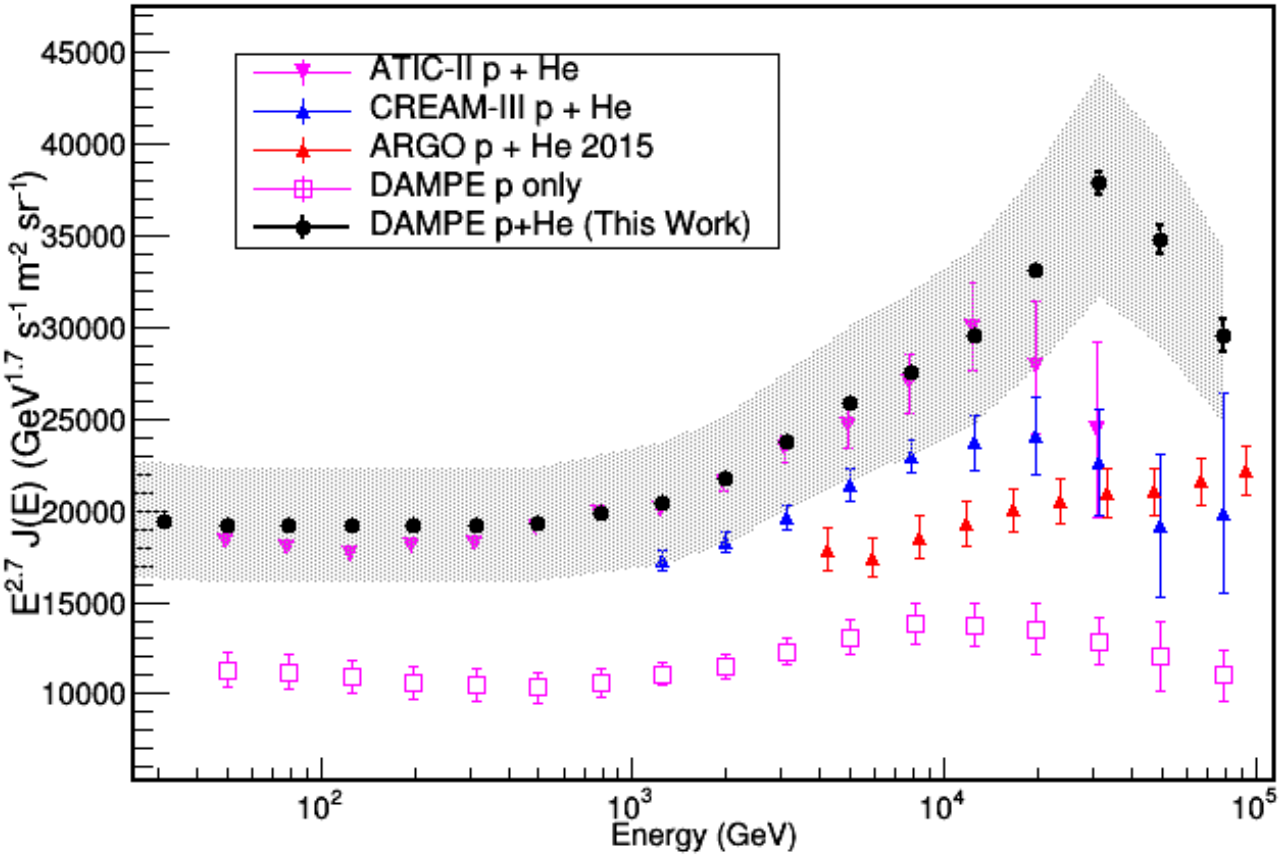
p + He spectrum

Comparing with the p spectrum analysis, the charge selection range is much "wider" in p + He spectrum analysis, which means larger statistics and less contamination from heavier nuclides.





p + He spectrum

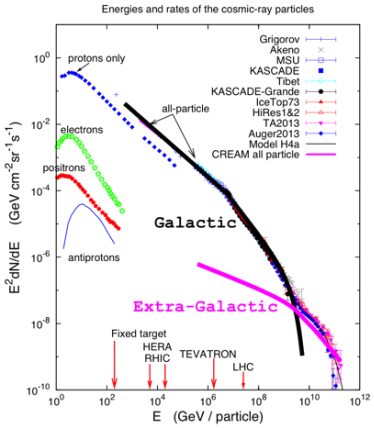


- A softening at ~30 TeV!
- Only part of the systematic errors (shadow area) are included.
- Future work on p + He spectrum will be mainly focused on the systematic error assessment.

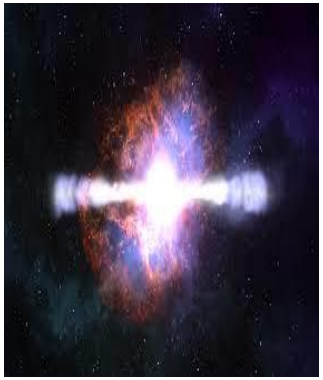
Summary

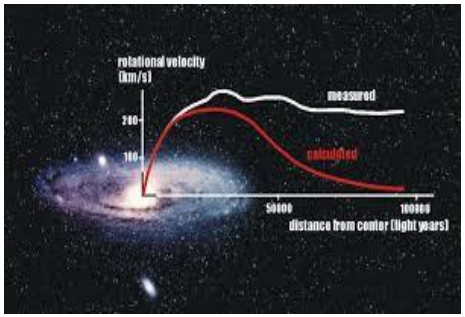
- DAMPE has been working extremely well for ~3.5 years. All the sub-detectors are in stable status.
- The electron + positron spectrum at TeV energies has been shown, together with the preliminary light nuclei spectra.
- Future works for DAMPE will focus on acquiring more precise nuclei spectra

More results are expected in the future.



Thanks for your attention!





BACK UP

CALET Proton spectrum