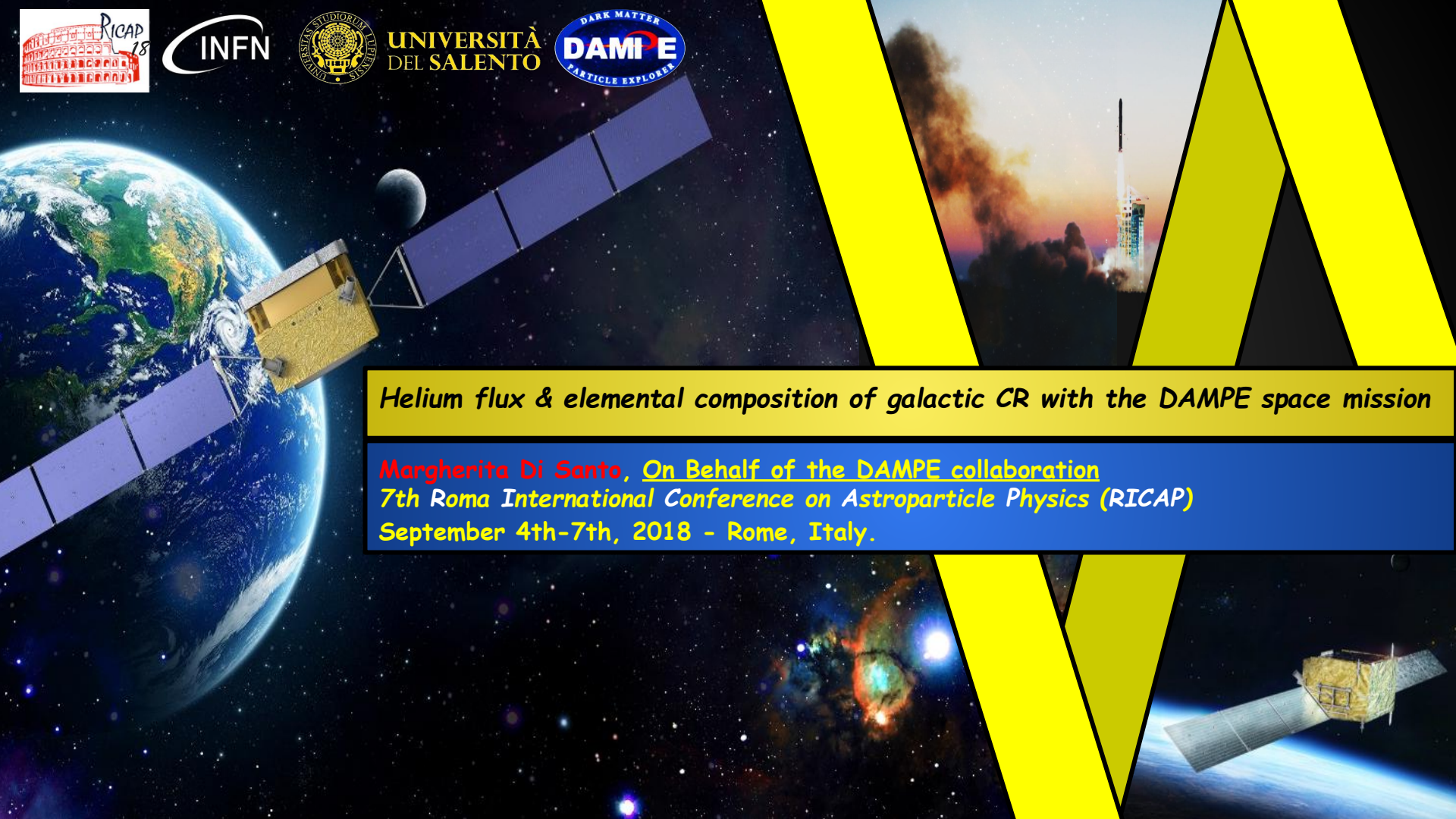
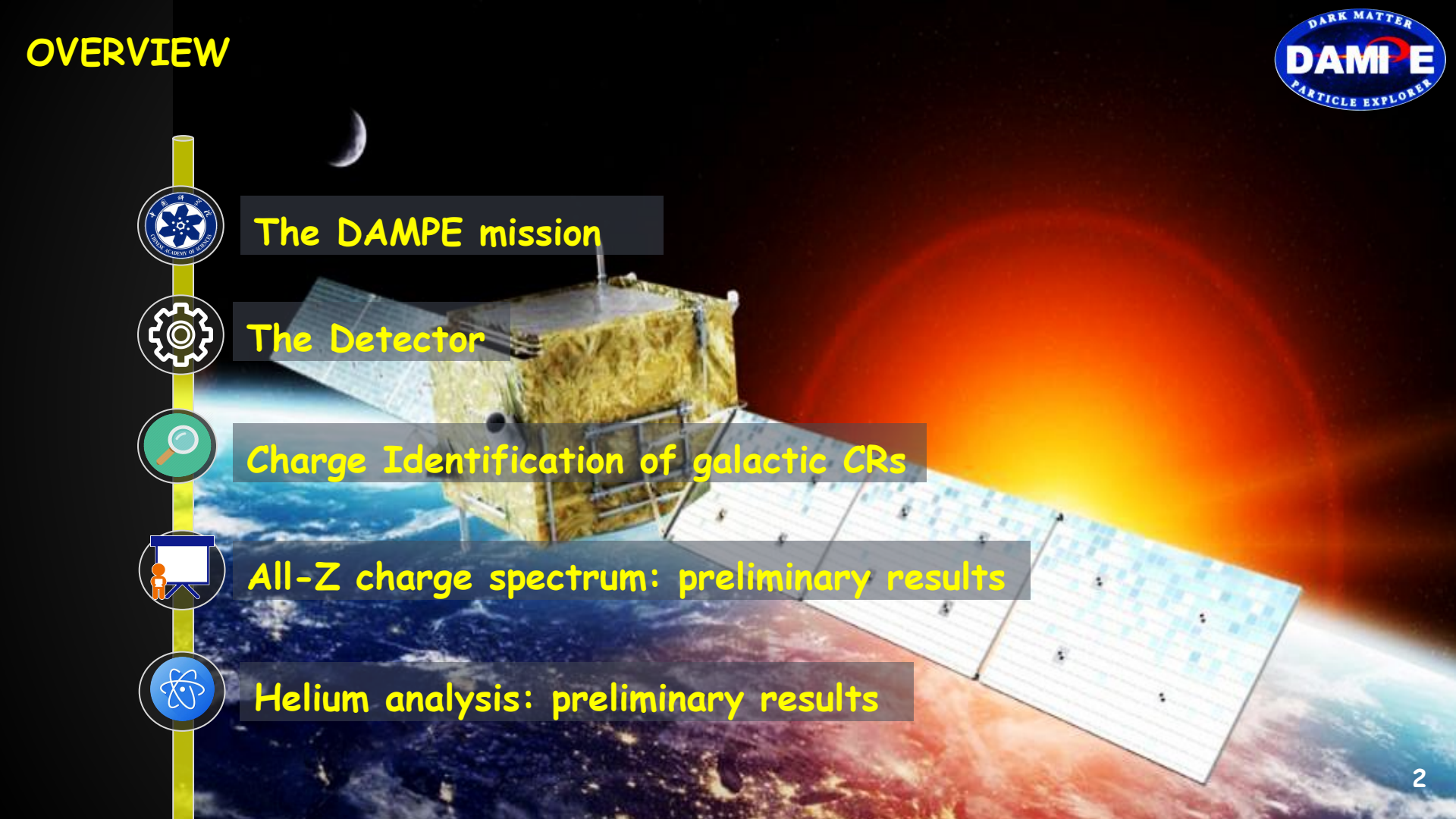


Helium flux & elemental composition of galactic CR with the DAMPE space mission

Margherita Di Santo, On Behalf of the DAMPE collaboration

7th Roma International Conference on Astroparticle Physics (RICAP)
September 4th-7th, 2018 - Rome, Italy.

OVERVIEW



- The DAMPE mission
- The Detector
- Charge Identification of galactic CRs
- All-Z charge spectrum: preliminary results
- Helium analysis: preliminary results

DAMPE MISSION: the collaboration

China

- Purple Mountain Observatory
- University of Science and Technology of China
- Institute of High Energy Physics
- Institute of Modern Physics
- National Space Science Center

Italy

- INFN Lecce and University of Salento
- INFN Bari and University of Bari
- INFN Perugia and University of Perugia
- INFN LNGS and Gran Sasso Science Institute

Switzerland

- University of Geneva

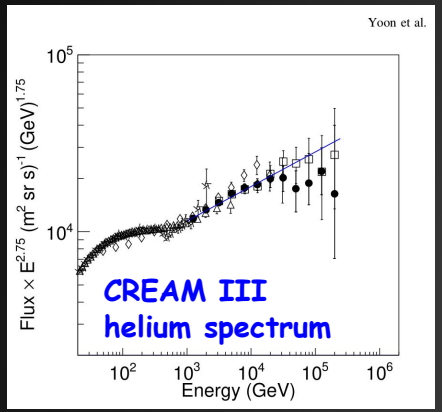
DAMPE MISSION: Scientific goals

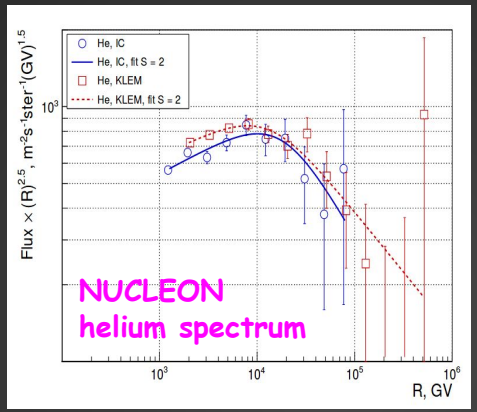
DAMPE (DArk Matter Particle Explorer) is a satellite-borne particle detector, one of the five projects of the *Strategic Pioneer Program on Space Science*, the space exploration program of the Chinese Academy of Sciences (CAS). It is smoothly collecting data in a stable sun-synchronous orbit lasting 95 minutes at an altitude of about 500 km since December 17th, 2015, day of its launch from the Jiuquan Satellite Launch Center, in the Gobi Desert.

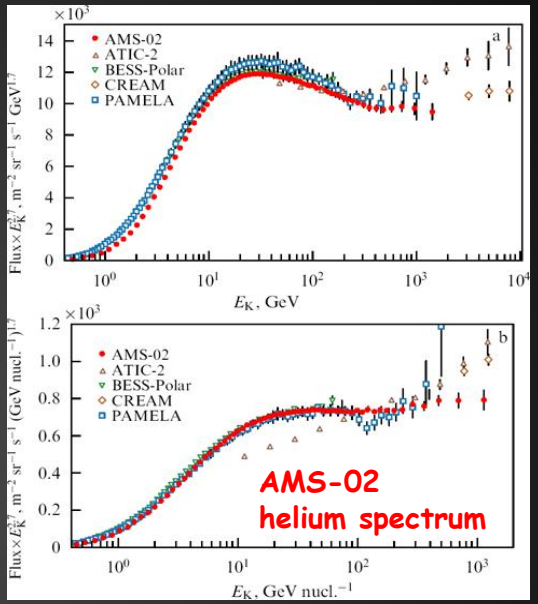
- indirect search of Dark Matter, looking for signatures in the electron and photon spectra ;
- analysis of the flux and composition of primary cosmic rays with energies up to hundreds TeV;
- high energy gamma-ray astronomy.

e/γ	1 GeV — 10 TeV
p/nuclei	50 GeV — 100 TeV

DAMPE MISSION: Scientific goals







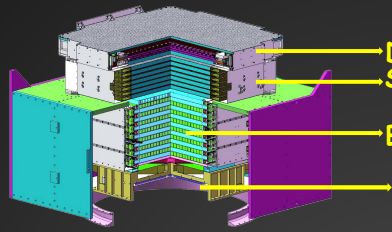
analysis of the flux and composition of primary cosmic rays with energies up to hundreds TeV;

HARDENING IN THE CR SPECTRA

HOW TO EXPLAIN THIS HARDENING?

- CRs coming from different galactic sources?
- different acceleration mechanisms that we should understand?
- different propagation effects?

THE DETECTOR



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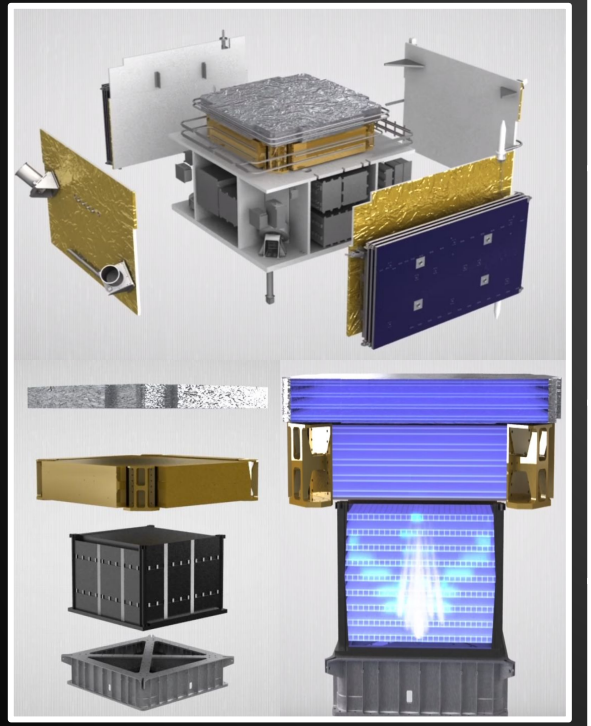


PSD	• 2 planes with double layer configuration • 82 bars of plastic scintillator ❑ CHARGE MEASUREMENT ($Z < 28$, $Z \propto \sqrt{E}$) ❑ γ-RAYS VETO
STK	• 6 planes with 2 single-sided silicon layers • 3 thin tungsten layers (for γ conversion in e^+/e^-) ❑ TRACK RECONSTRUCTION ❑ spatial resolution <80 μm for CR ($\theta_{inc} < 60°$) ❑ angular resolution ~0.2° for γ at 10 GeV ❑ CHARGE MEASUREMENT ($Z \propto \sqrt{ADC}$)
BGO	• 14 layers, each one with 22 bars of $Bi_3Ge_4O_{12}$,~32 X_0 ❑ ENERGY MEASUREMENT ❑ 1 GeV - 10 TeV for electrons and γ ❑ 50 GeV - 100 TeV for nuclei
NUD	• 1 layer, 4 boron-doped plastic scintillator ❑ detection of neutrons generated in the BGO for hadron/e.m. showers discrimination

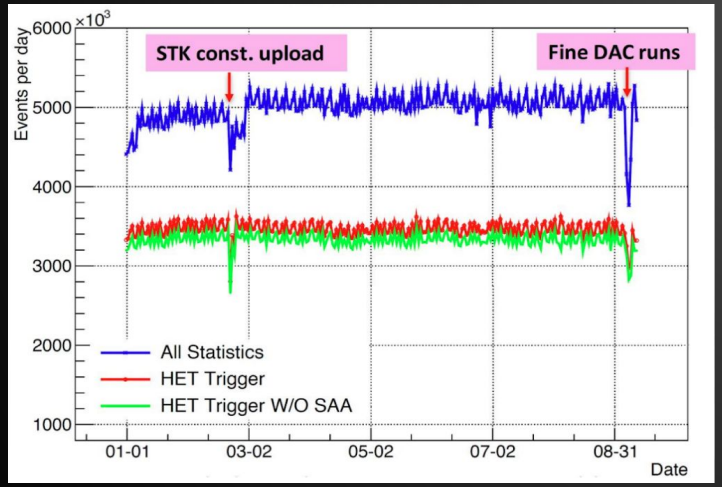
DAMPE DATA TAKING

High Energy Cosmic Rays of Galactic Origin

ENERGY RANGE : 20 GeV-100 TeV
GEOMETRICAL ACCEPTANCE : ~ 0.29 m^2sr

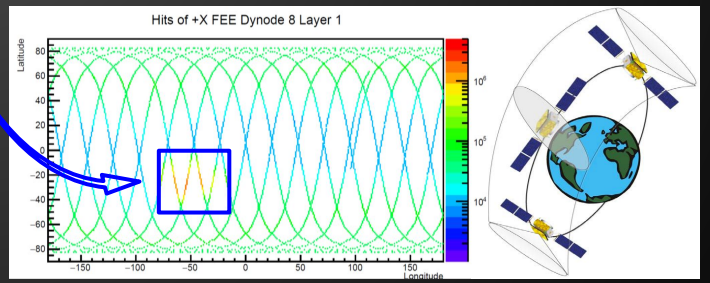
TRIGGER RATE = ~50 Hz on average
(*VERY STABLE since DEC.30, 2015*)

- ~5 M events recorded / day
- ~100 GB/day transferred to ground



DEAD TIME due to three contributions:

- South Atlantic Anomaly (SAA) region (~ 4.5% of the operation time),
- on-orbit calibration data-taking (~ 1.5% of the operation time),
- instrumental dead time (~18.5% of the operation time).



EVENT SELECTION

TRIGGER

High Energy Trigger (HET):
E_{rel}>10 MIP (1 MIP= 23 MeV) inside the first 4 layers of the BGO

PRE-SELECTION

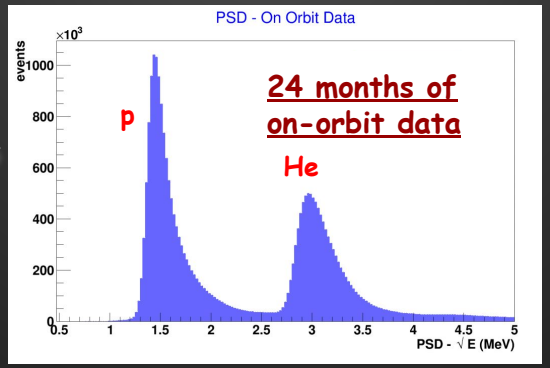
- E_{dep}> 20 GeV inside the BGO calorimeter
- SAA region events excluded
- side tracks excluded

GEOMETRY

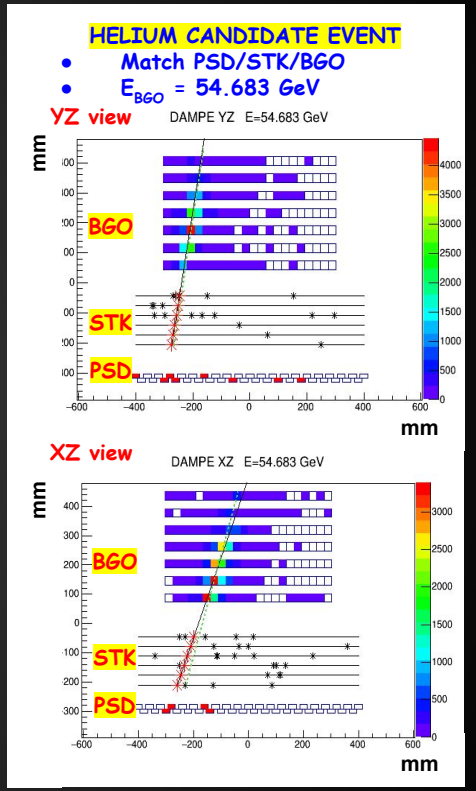
- at least one reconstructed track in the STK
- match STK track direction/hit position on the PSD bars
- match STK track direction/BGO shower direction

CHARGE

- match PSD charge measurement/1st STK layer charge measurement
- Proper PSD range to select Z



p&He events after all the selection cuts.
Number of events as a function of the square root of the arithmetic mean calculated for the energies in the two views XZ and YZ of the PSD.



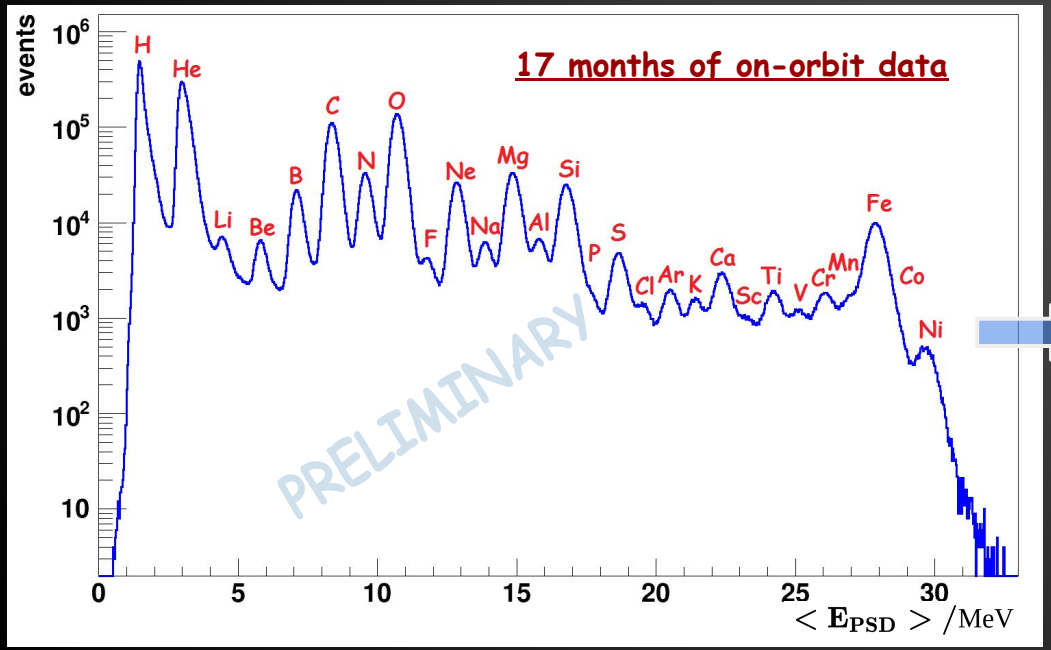
ALL Z charge spectrum: preliminary results

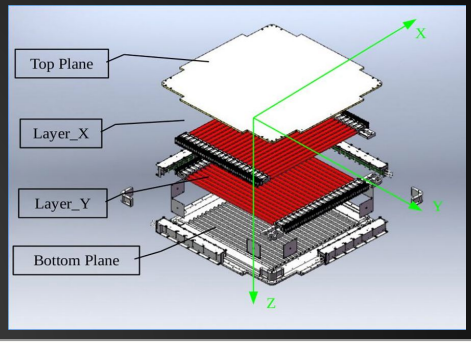
Method of charge reconstruction by using the PSD:

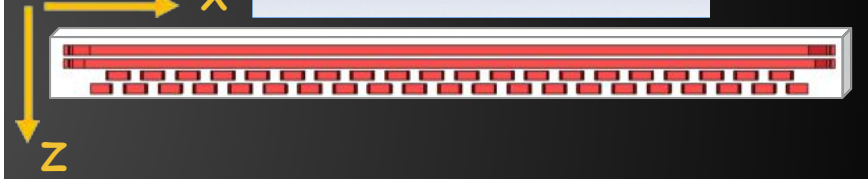
$$Q^{Rec} = \sqrt{\frac{E}{E_{MIP}}}$$

$$Q^{corr} = f(Q^{Rec})$$

- Q^{Rec}: reconstructed charge
- E : reconstructed energy
- E_{MIP}: energy deposition of a MIP per cm equals to 2 MeV
- Q^{corr}: corrected charge
- $f(Q^{Rec})$: correction function (Birk's Law)





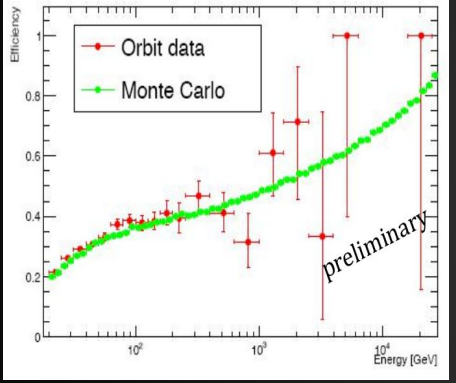


Number of events as a function of the square root of the arithmetic mean calculated for the energies in the two views XZ and YZ of the PSD.

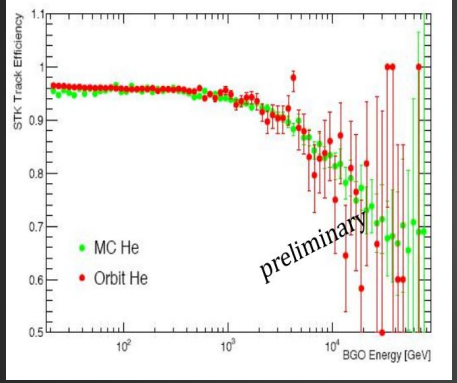
Charge resolution ≤ 25% for Z

Helium analysis: : preliminary results
HET, STK track selection & PSD charge reconstruction efficiencies

HET efficiency

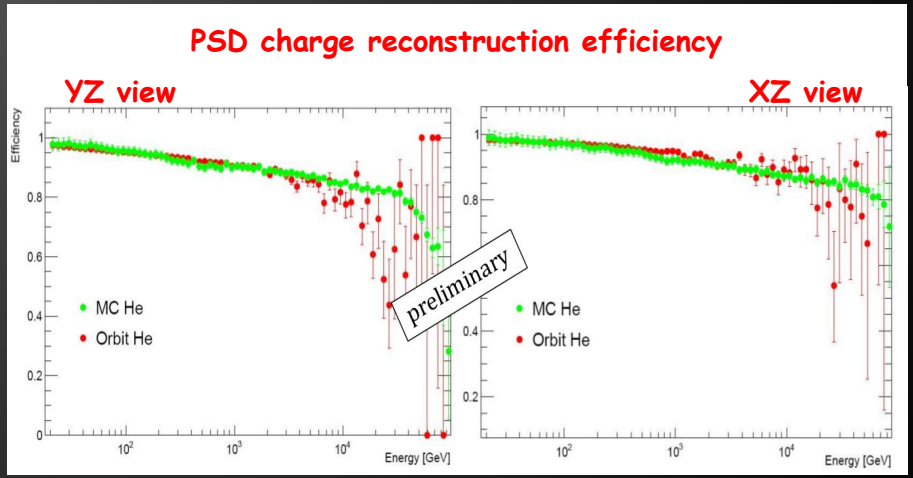


STK track selection efficiency



- $\varepsilon_{HET} = \dfrac{N(HET|unbias)}{N(unbias)}$
- $\varepsilon_{track} = \dfrac{N(track|shower-axis)}{N(shower-axis)}$
- For the PSD charge reconstruction efficiency we use the STK selected Helium sample (1st STK layer).

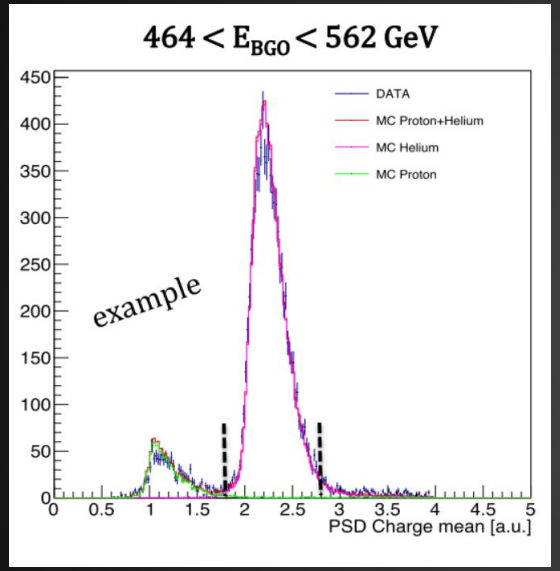
PSD charge reconstruction efficiency

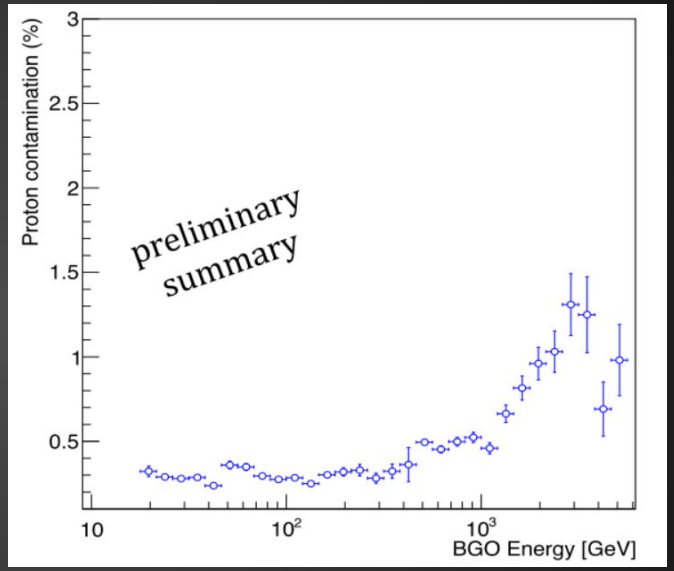


Systematic errors have been evaluated by considering the differences between on-orbit DATA and MC.

- ~5% due to HET
- ~2% due to the STK track selection
- ~10 % due to the PSD lay1 charge reconstruction
- ~4 % due to the PSD lay2 charge reconstruction

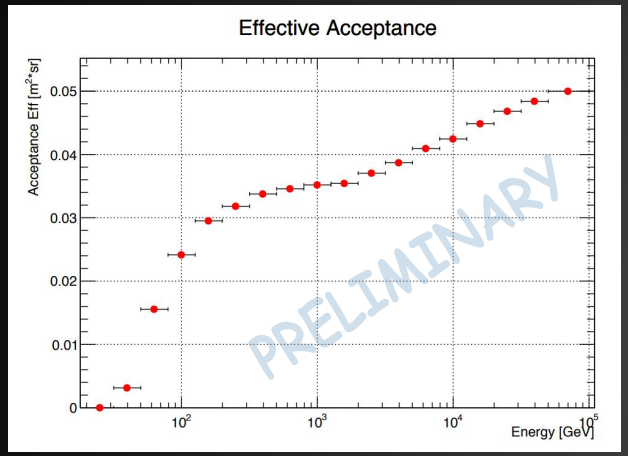
Helium analysis: preliminary results
Background estimate





- proton contamination in the Helium sample very small (< 1.5 %)
- Lithium pollution at low energies has been studied and it results negligible

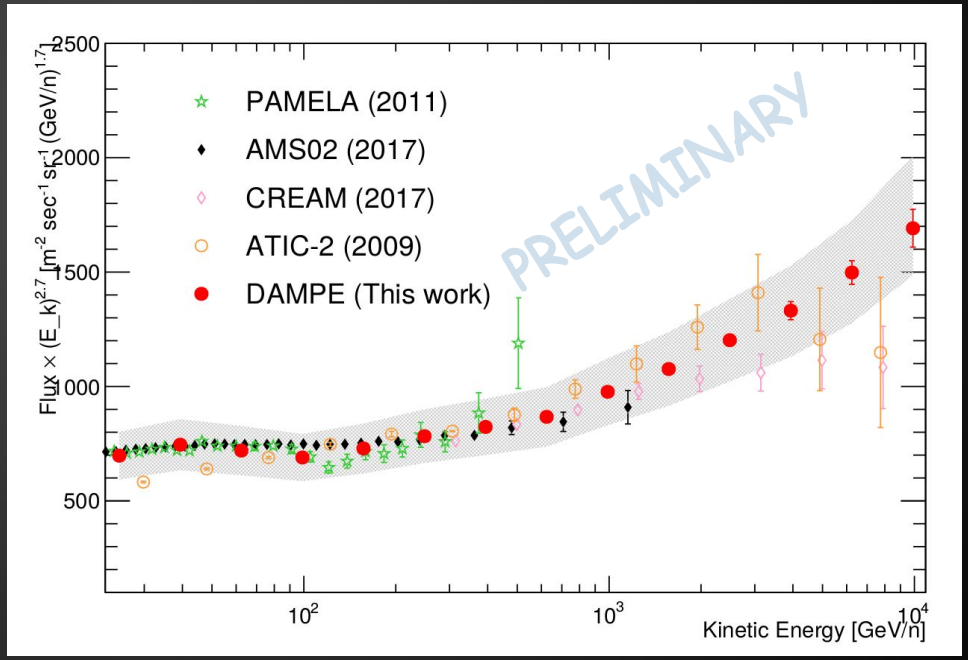
Helium analysis: preliminary results
Acceptance & Flux



HELIUM ACCEPTANCE: $A_{EFF} = A_{GEN} \frac{N_{SURV}}{N_{GEN}}$

$$\sigma_{eff} = \sqrt{\sigma^2_{HET} + \sigma^2_{track} + \sigma^2_{charge}}$$

- Systematic uncertainty ~15%
- Unfolding method used
- Energy and interaction model uncertainties to be estimated
- HARDENING after ~100 GeV/n



CONCLUSIONS

- The DAMPE detector is in a stable data-taking at 500 km of altitude since December 17, 2015
- The Helium flux has been measured in the energy range 20 GeV/nucleon – 10 TeV/nucleon
- The hardening in the Helium flux has been observed
- The evaluation of all the systematics and other uncertainties (energy scale, unfolding, ..) is in progress
- In next future the He-flux measurement will be extended up to 50 TeV/nucleon

THANK YOU FOR YOUR ATTENTION!