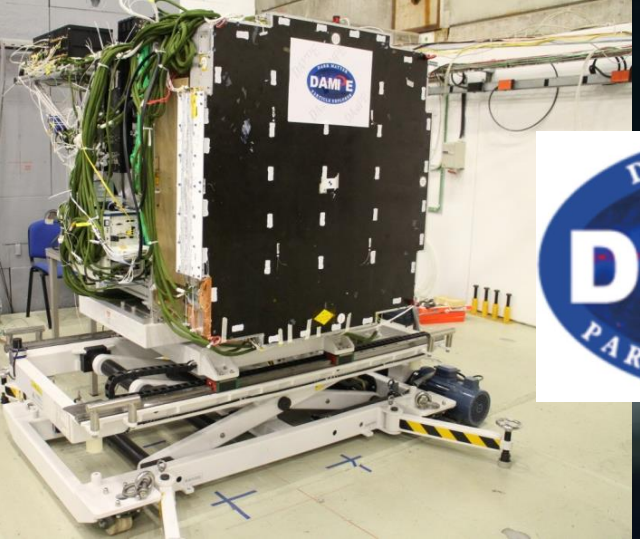


DAMPE: first data from space

Jin Chang

Purple Mountain Observatory

(on behalf of DAMPE collaboration)

The physics goals

High energy particle detection in space

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

Detection of
GeV - 10 TeV e/γ
50 GeV - 500 TeV protons and nuclei
with excellent energy resolution , tracking precision and particle identification capabilities

- Exotica and “unexpected” , e.g. GW e.m. counterpart in the FoV

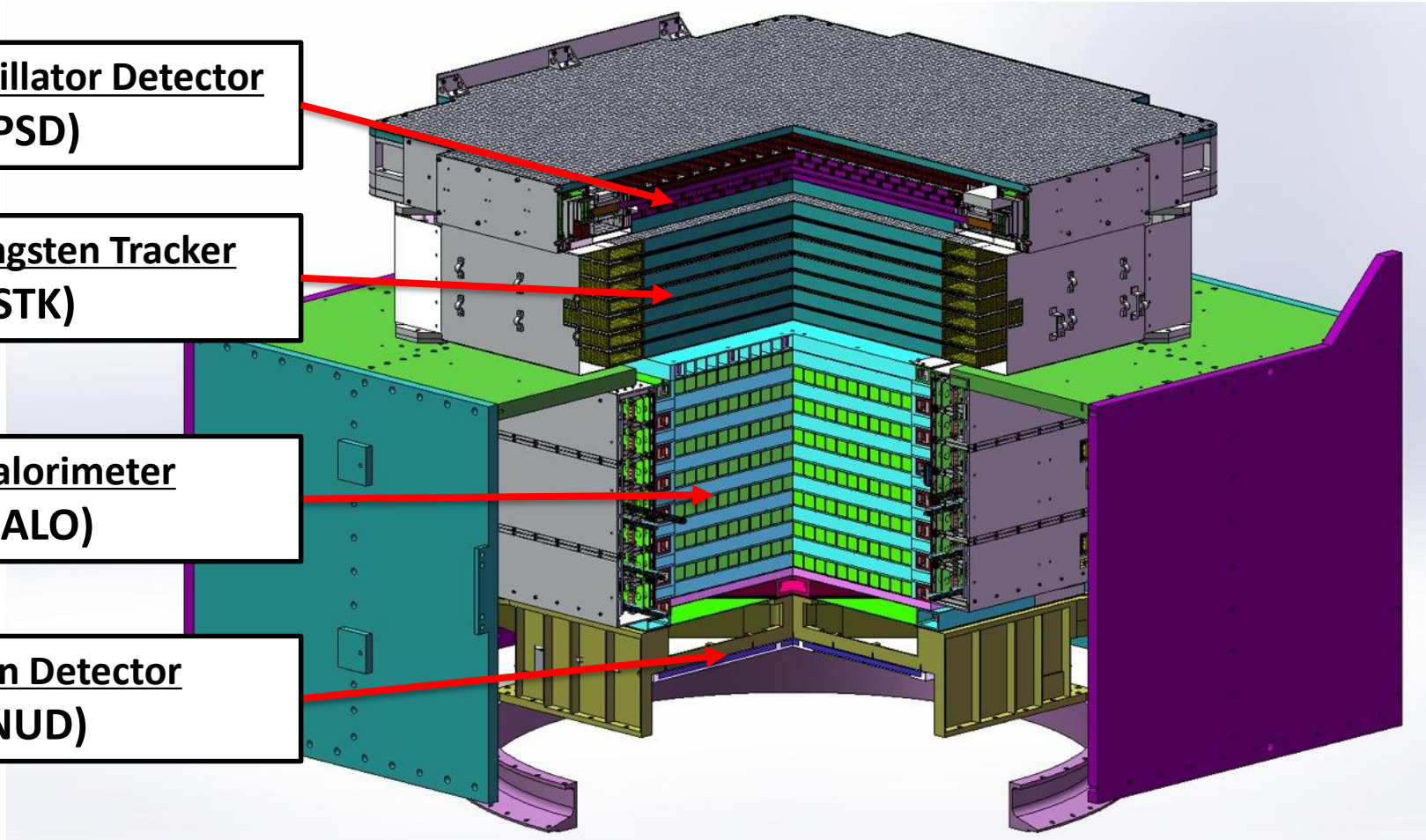
The collaboration

- **CHINA**
  - Purple Mountain Observatory, CAS, Nanjing
  - Institute of High Energy Physics, CAS, Beijing
  - National Space Science Center, CAS, Beijing
  - University of Science and Technology of China, Hefei
  - 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

- **SWITZERLAND**
  - University of Geneva

The detector

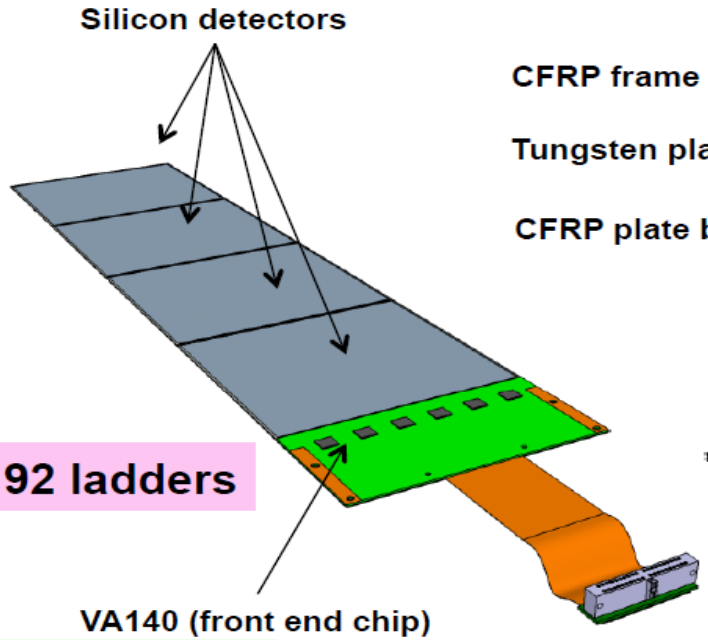


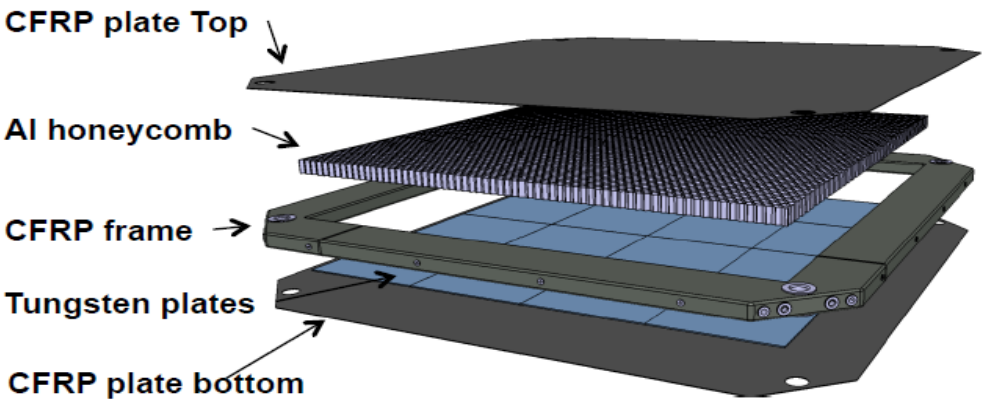
- **Charge measurement (dE/dx in PSD , STK and BGO)**
- **Tungsten converter (pair production)**
- **Precise tracking (silicon strips)**
- **Thick calorimeter (BGO bars)**
- **Hadron rejection (neutron detector)**

high energy
γ-ray, electron and cosmic ray
telescope

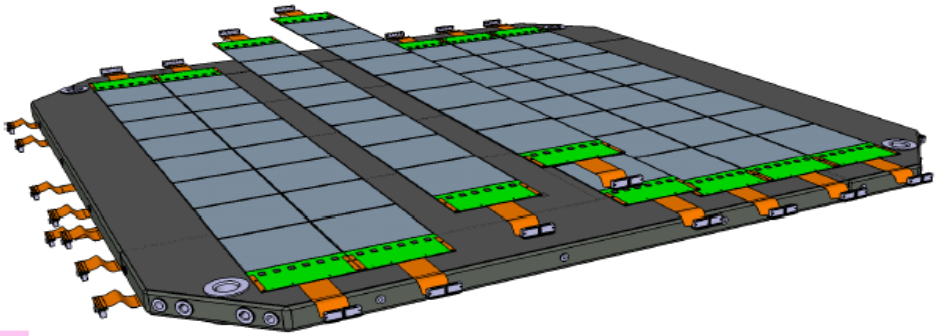
The Silicon TracKer (STK)

768 silicon sensors





12 layers, 6-x and 6-y



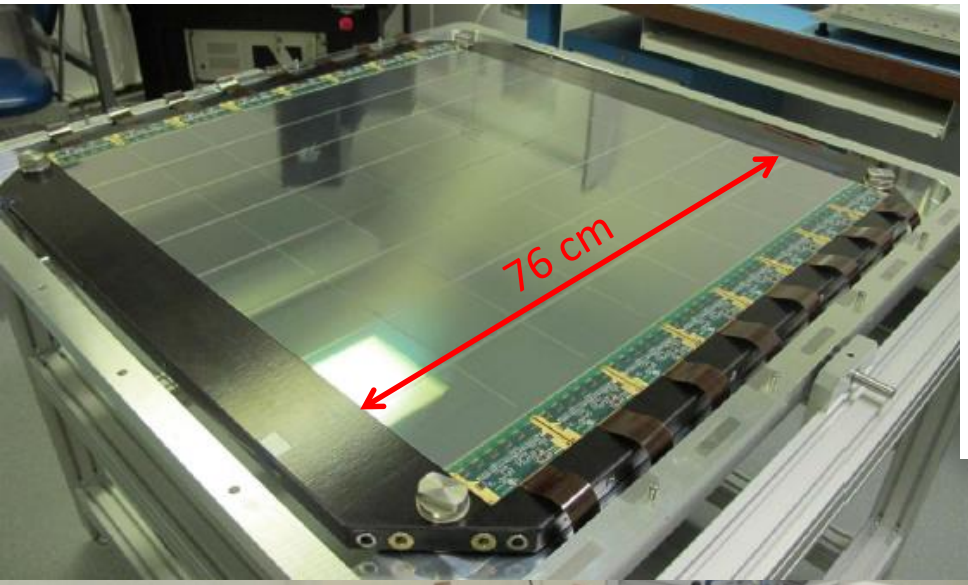
1152 ASICs

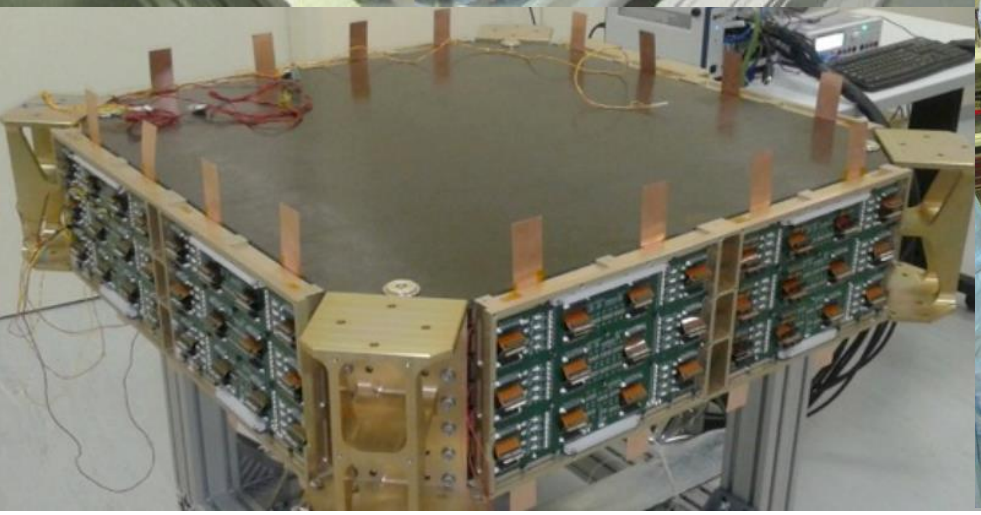
73728 channels

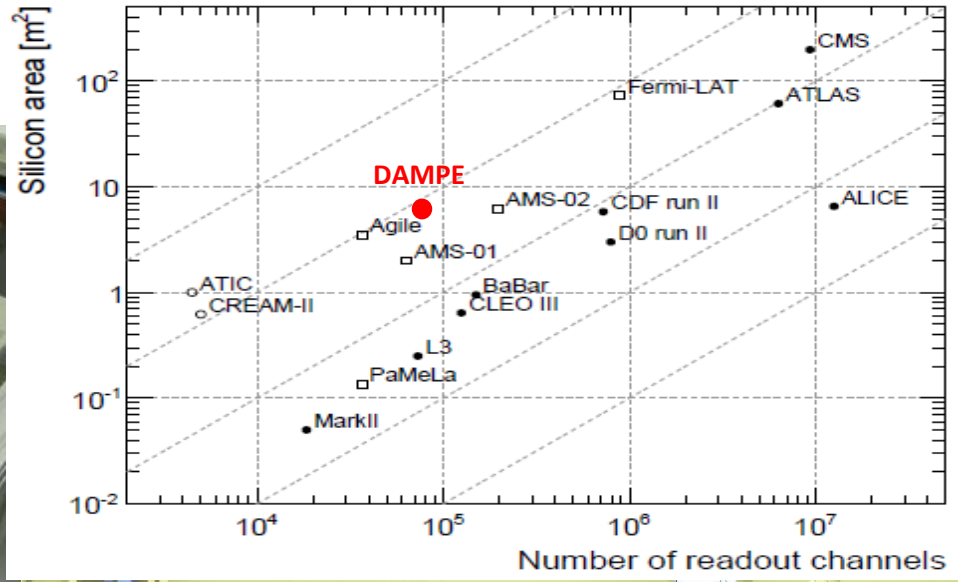
- 48 μm wide Si strips with 121 μm pitch
- (95 × 95 × 0.32 mm^3) Silicon Strip Detectors (SSD) with 768 strips
- One ladder composed by 4 Silicon Strip Detectors (SSD)
- 16 Ladders per layer (76 cm × 76 cm)
- 12 layers (6x + 6y)

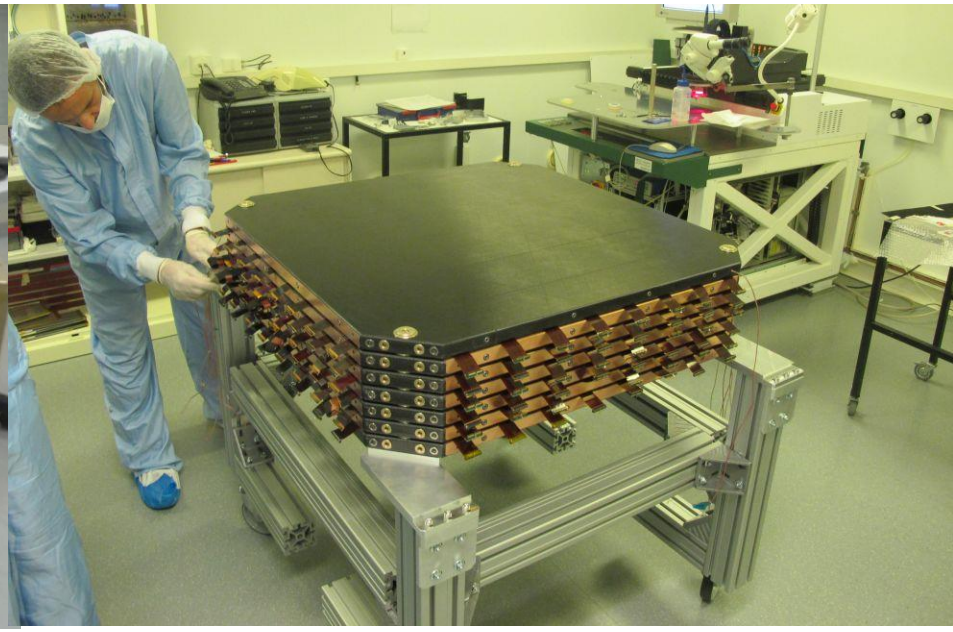
Analog Readout of each second strip:
384 channels / SSD- Ladder
Charge sharing

The Silicon TracKer (STK) - 2



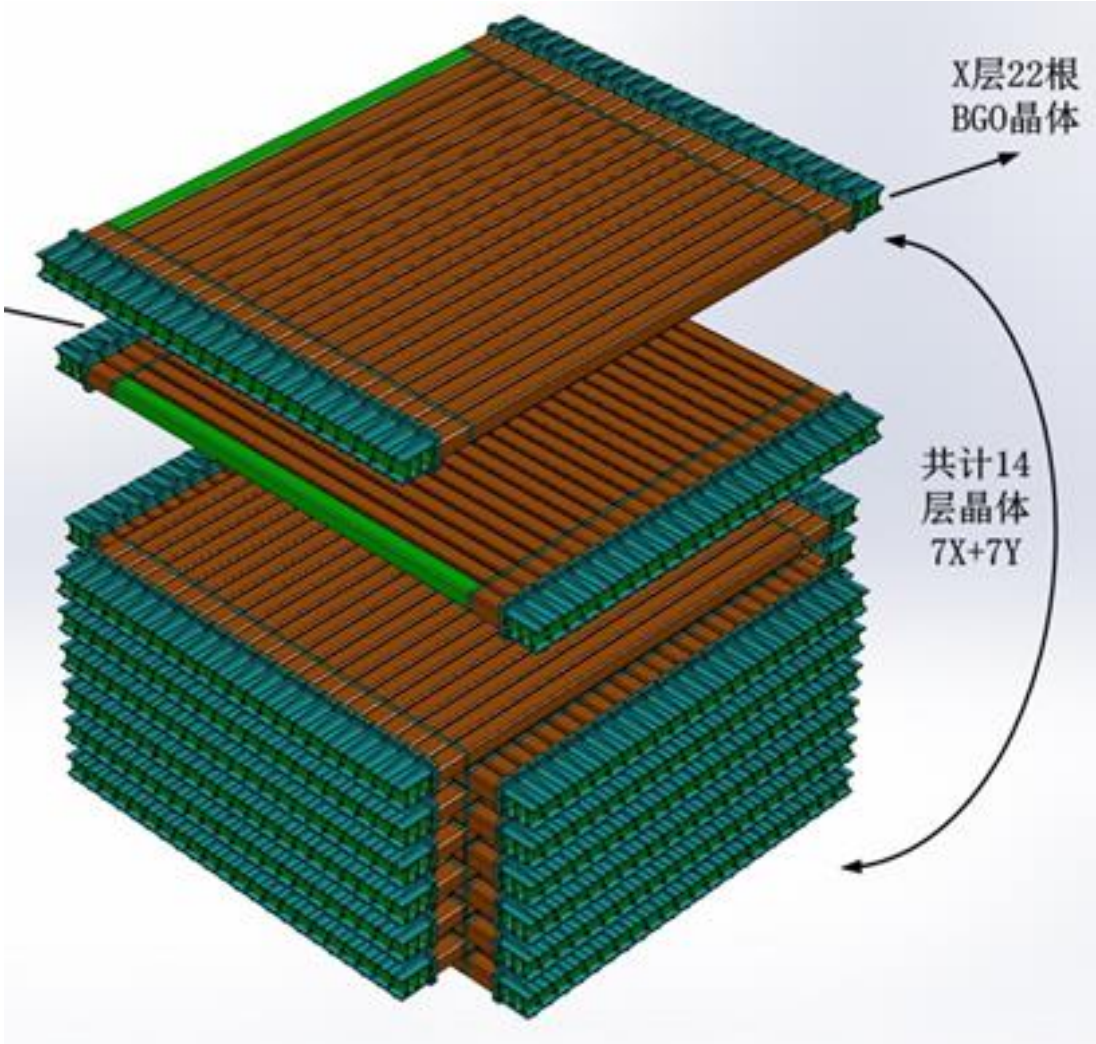






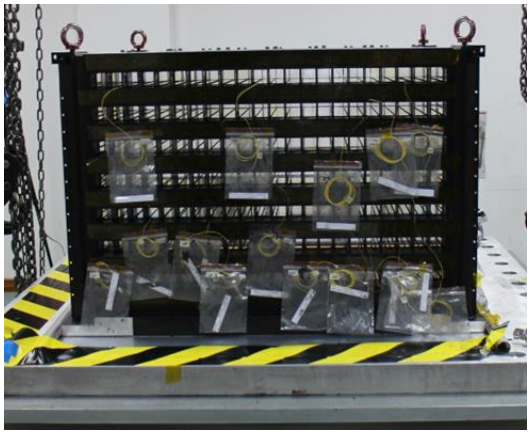
The CALOrimeter

- 14 layers of 22 BGO bars
  - Dimension of BGO bar: $2.5 \times 2.5 \times 60\ cm^3$
  - 14 hodoscopic stacking alternating orthogonal layers
  - depth ~$32X_0$
- Two PMTs coupled with each BGO crystal bar in two ends
- Electronics boards attached to each side of module



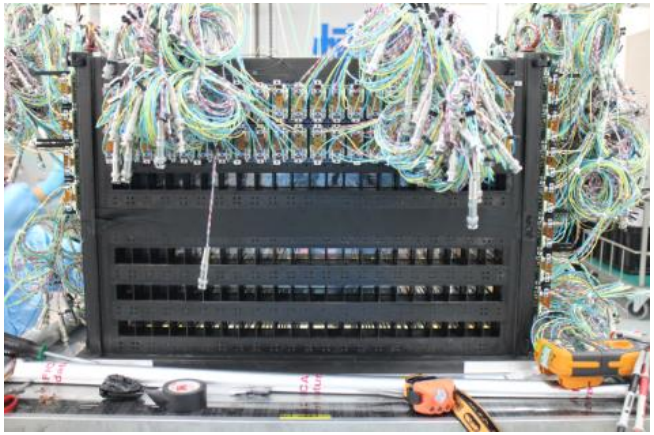
308 bars
616 PMTs

The CALOrimeter -2

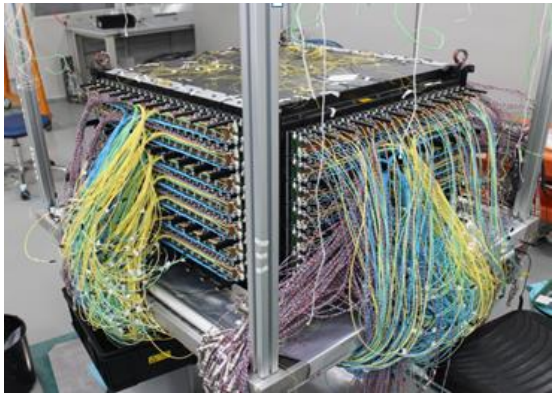


Carbon Fiber Structure

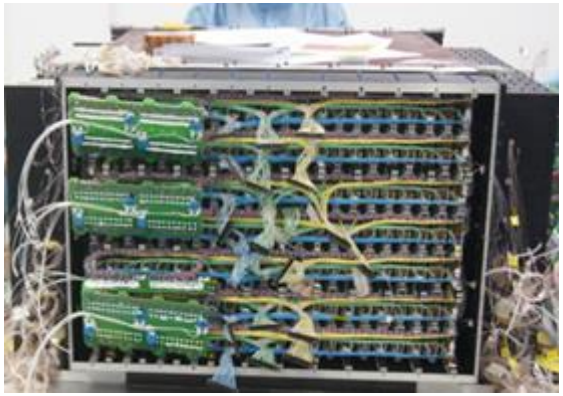
BGO crystal installation



PMT installation



Cable arranging

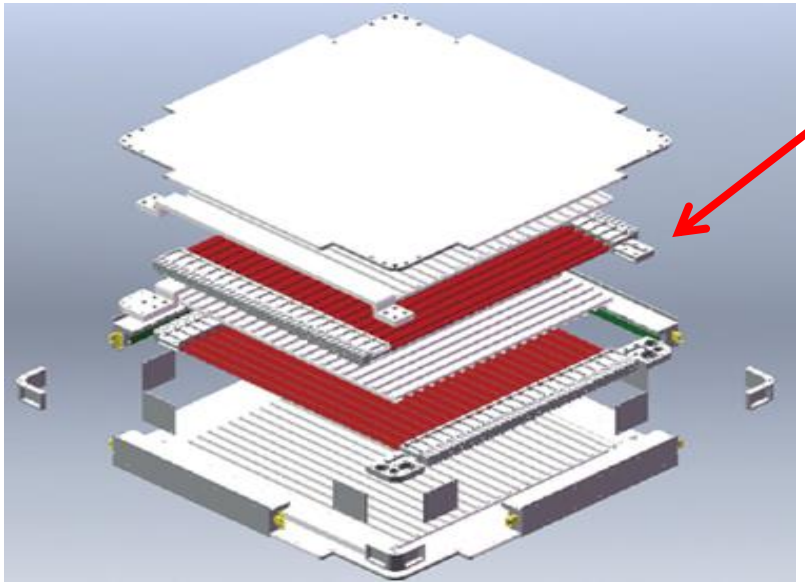


Cable connector

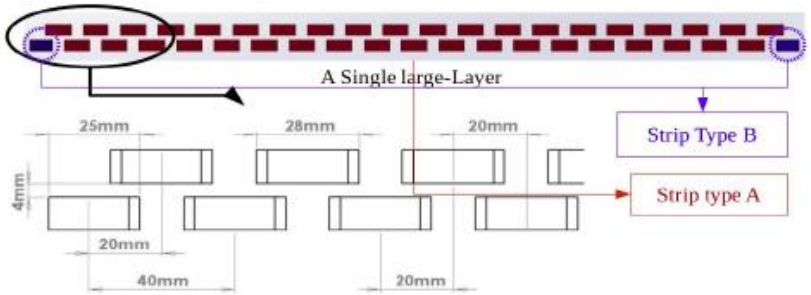
BGO Cal

The PSD and the NUD

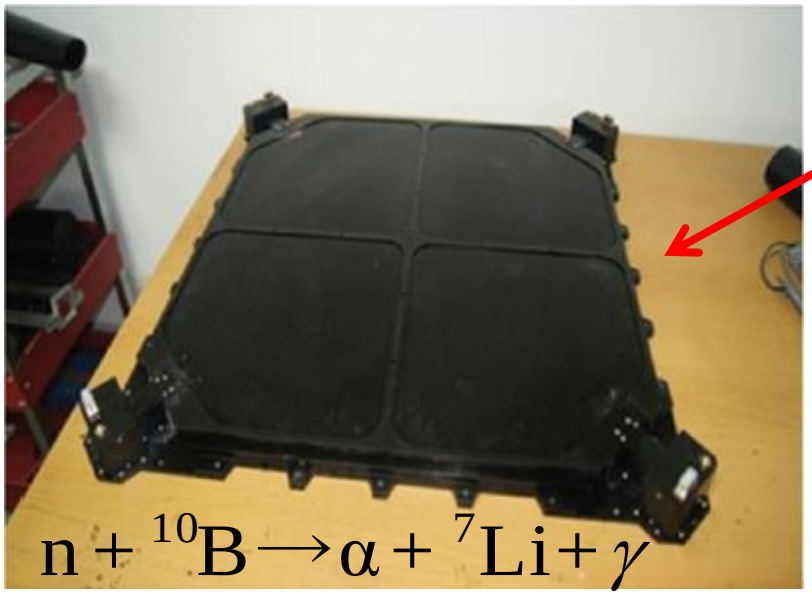
PSD



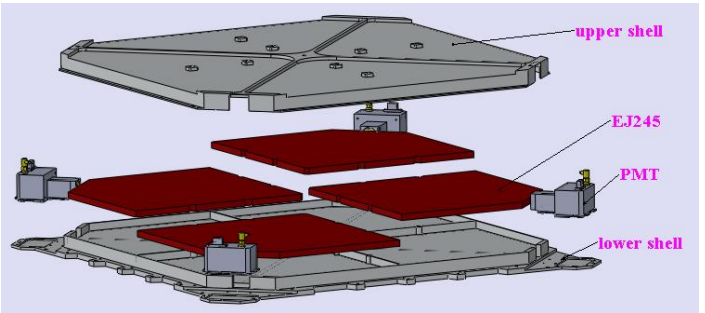
- 1.0 cm thick ,2.8cm wide and 82.0 cm long scintillator strips
- staggered by 0.8 cm in a layer
- 82 cm × 82 cm layers
- 2 layers (x and y)



NUD

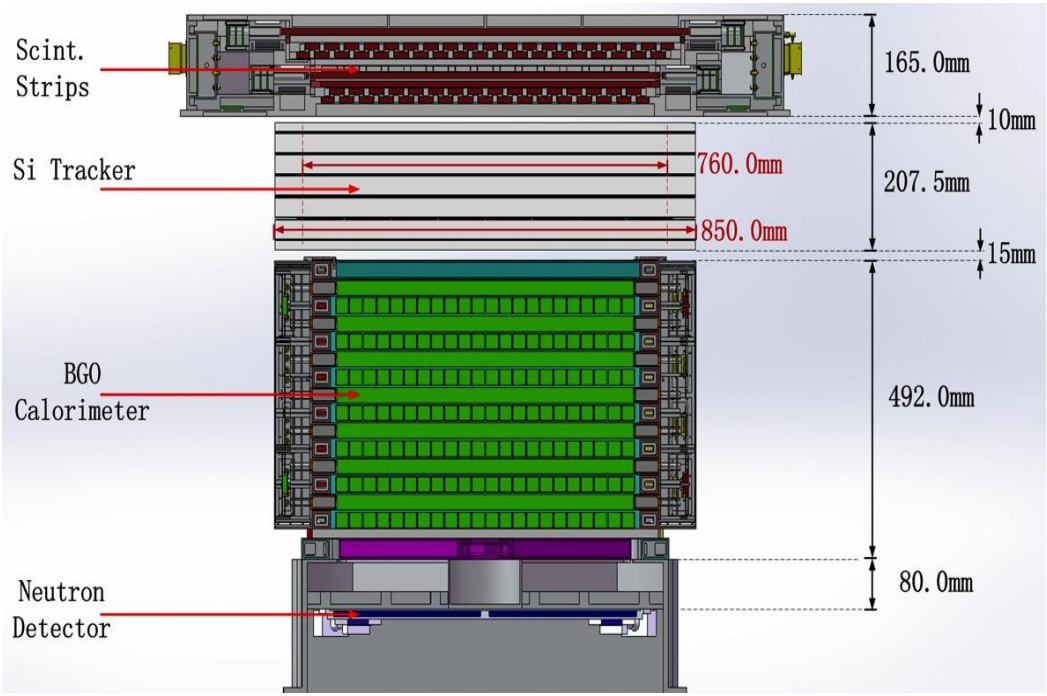


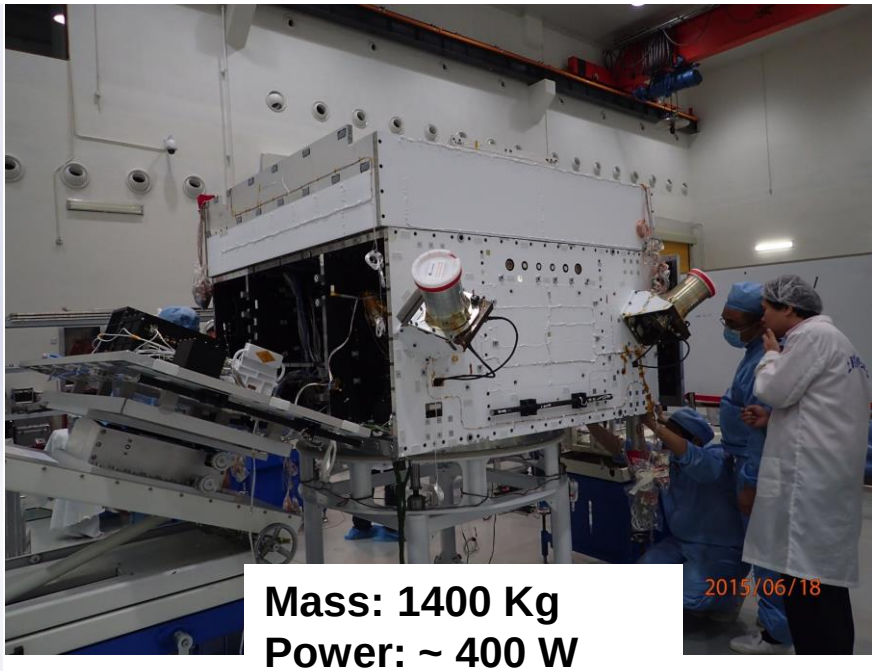
- 4 large area boron-doped plastic scintillators (30 cm × 30 cm × 1 cm)



Comparison with AMS-02 and FERMI

	DAMPE	AMS-02	Fermi LAT
e/γ Energy res.@100 GeV (%)	**1.5**	3	10
e/γ Angular res.@100 GeV (°)	0.1	0.3	0.1
e/p discrimination	10^5	10^5 - 10^6	10^3
Calorimeter thickness (X_0)	**32**	17	8.6
Geometrical accep. (m^2sr)	**0.3**	0.09	1

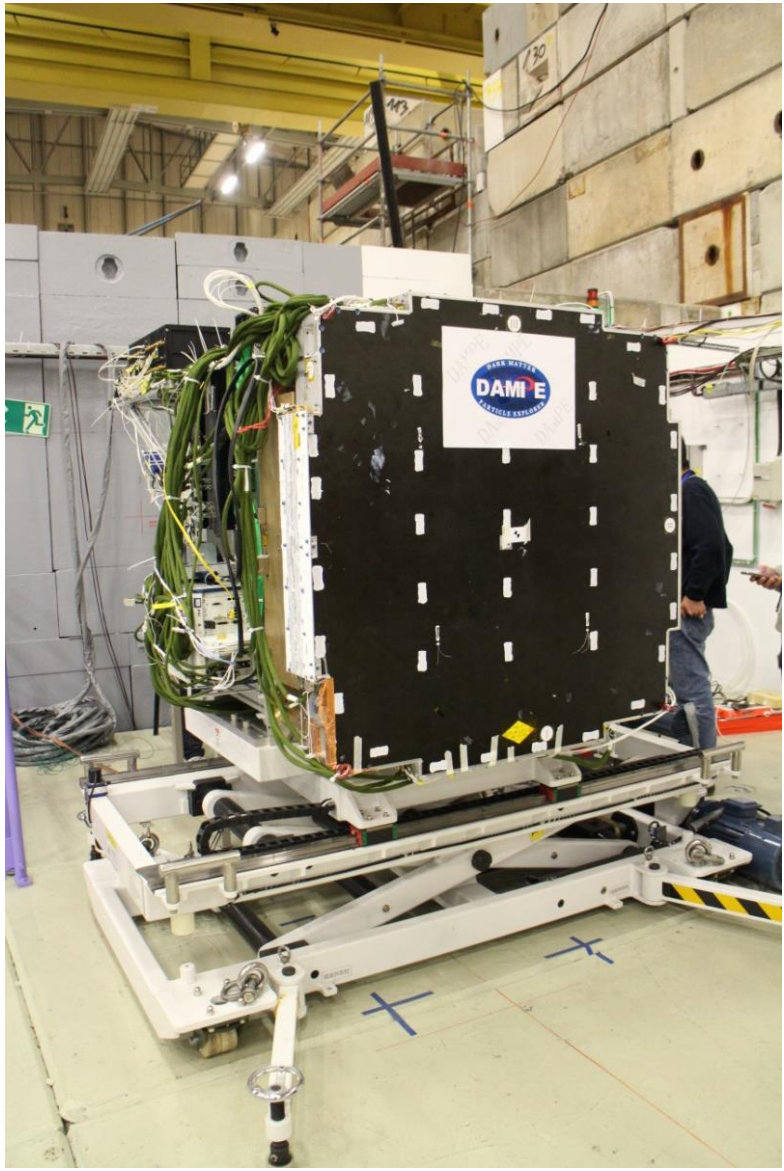




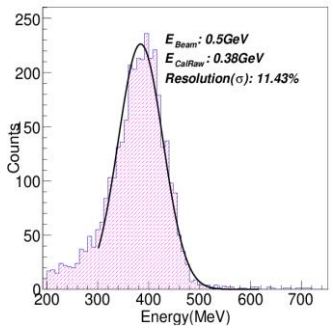
Mass: 1400 Kg
Power: ~ 400 W
Lifetime: > 3 years

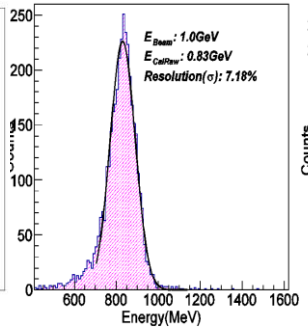
Test beam activity at CERN

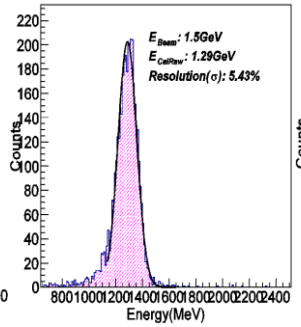
- 14days@PS，29/10-11/11 2014
  - e @ 0.5GeV/c, 1GeV/c, 2GeV/c, 3GeV/c, 4GeV/c, 5GeV/c
  - p @ 3.5GeV/c, 4GeV/c, 5GeV/c, 6GeV/c, 8GeV/c, 10GeV/c
  - π-@ 3GeV/c, 10GeV/c
  - γ @ 0.5-3GeV/c
- 8days@SPS，12/11-19/11 2014
  - e @ 5GeV/c, 10GeV/c, 20GeV/c, 50GeV/c, 100GeV/c, 150GeV/c, 200GeV/c, 250GeV/c
  - p @ 400GeV/c (SPS primary beam)
  - γ @ 3-20GeV/c
  - μ @ 150GeV/c,
- 17days@SPS，16/3-1/4 2015
  - Fragments：66.67-88.89-166.67GeV/c
  - Argon：30A- 40A- 75AGeV/c
  - Proton：30GeV/c，40GeV/c
- 21days@SPS，10/6-1/7 2015
  - Primary Proton: 400GeV/c
  - Electrons @ 20, 100, 150 GeV/c
  - γ @ 50, 75 , 150 GeV/c
  - μ @ 150 GeV /c
  - π+ @10, 20, 50, 100 GeV/c
- 10days@SPS, 11/11-20/11 2015
  - -- Pb 30AGeV/c (and fragments) (HERD)
- 6days@SPS, 20/11-25/11 2015
  - -- Pb 030 AGeV/c (and fragments）

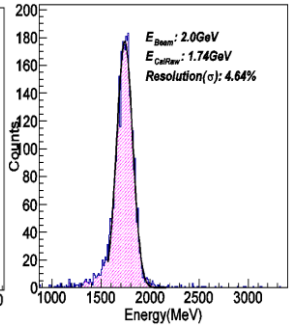


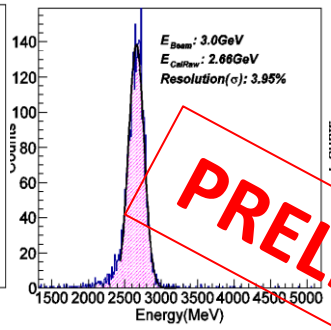
Test beam activity at CERN: electrons

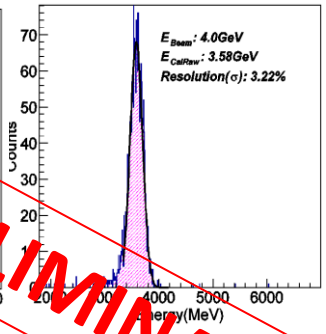




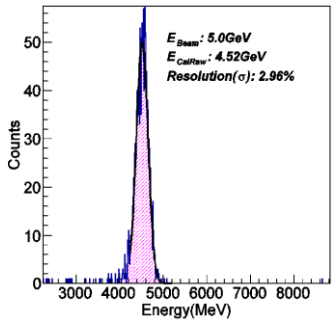


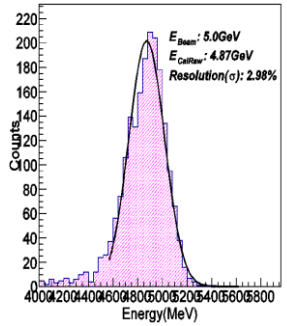


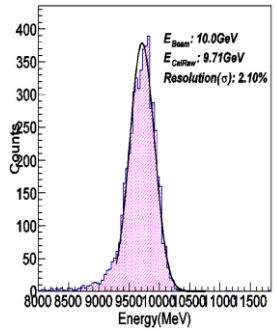


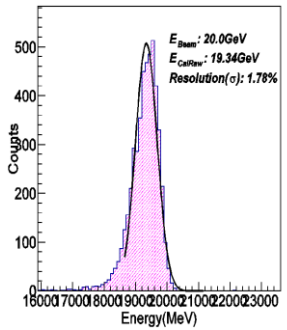


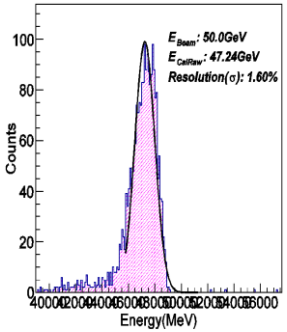
PRELIMINARY

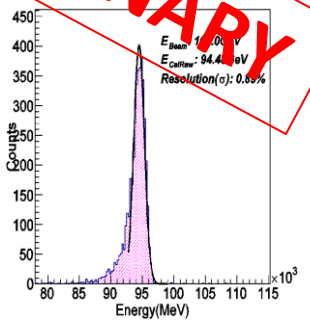


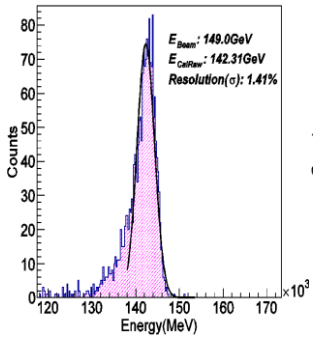


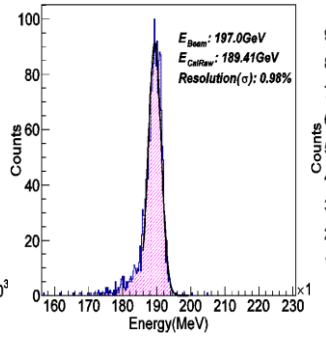


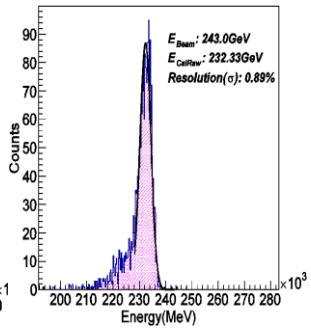


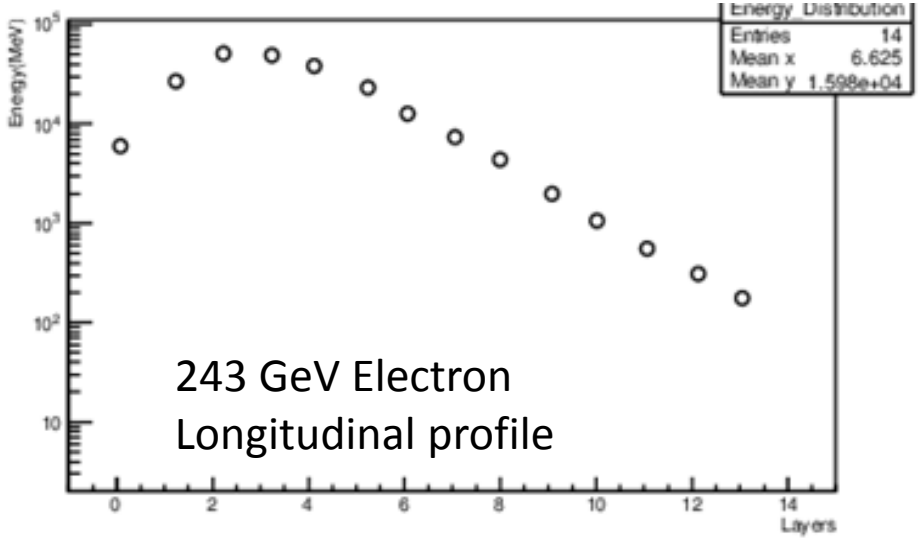












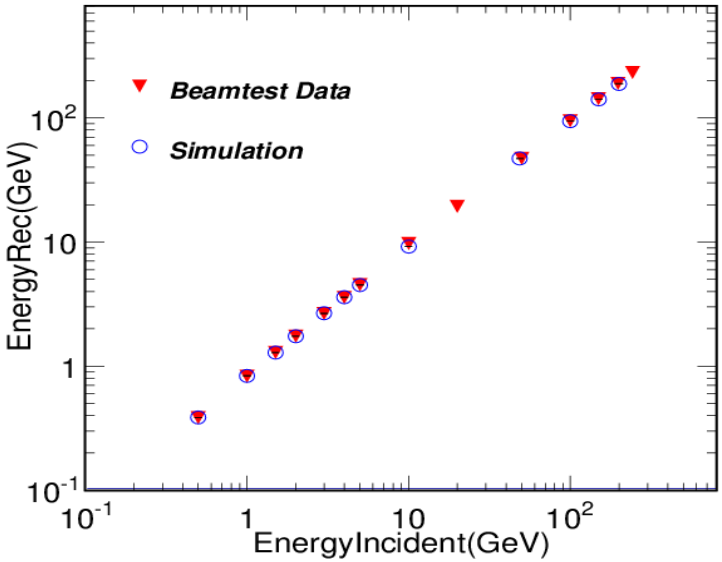
243 GeV Electron
Longitudinal profile

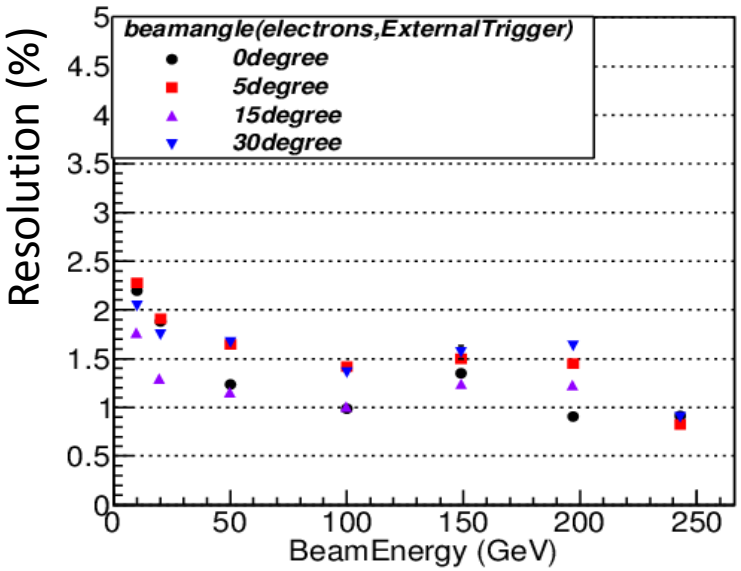
Electrons

0.5, 1, 1.5, 2, 3, 4, 5 GeV @ PS

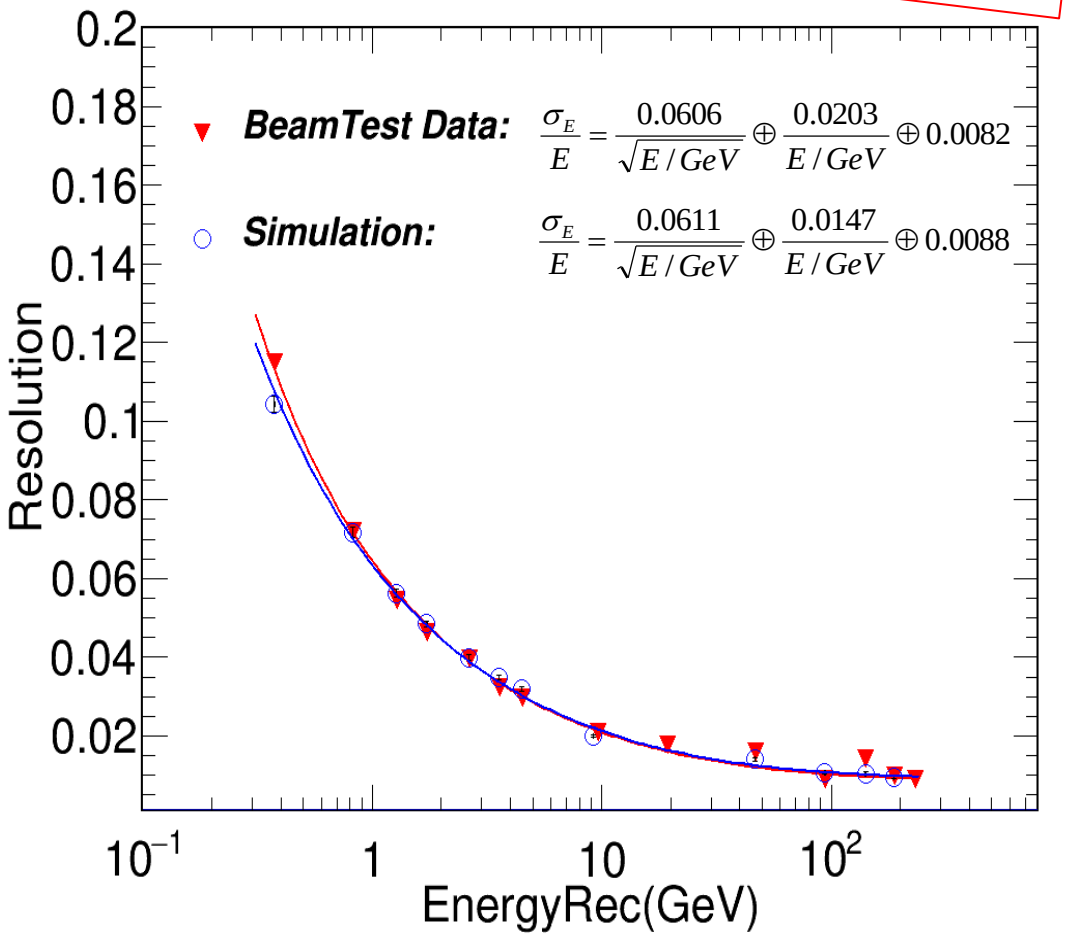
5, 10, 20, 50, 100, 149, 197, 243 GeV @ SPS

Test beam activity at CERN: electrons

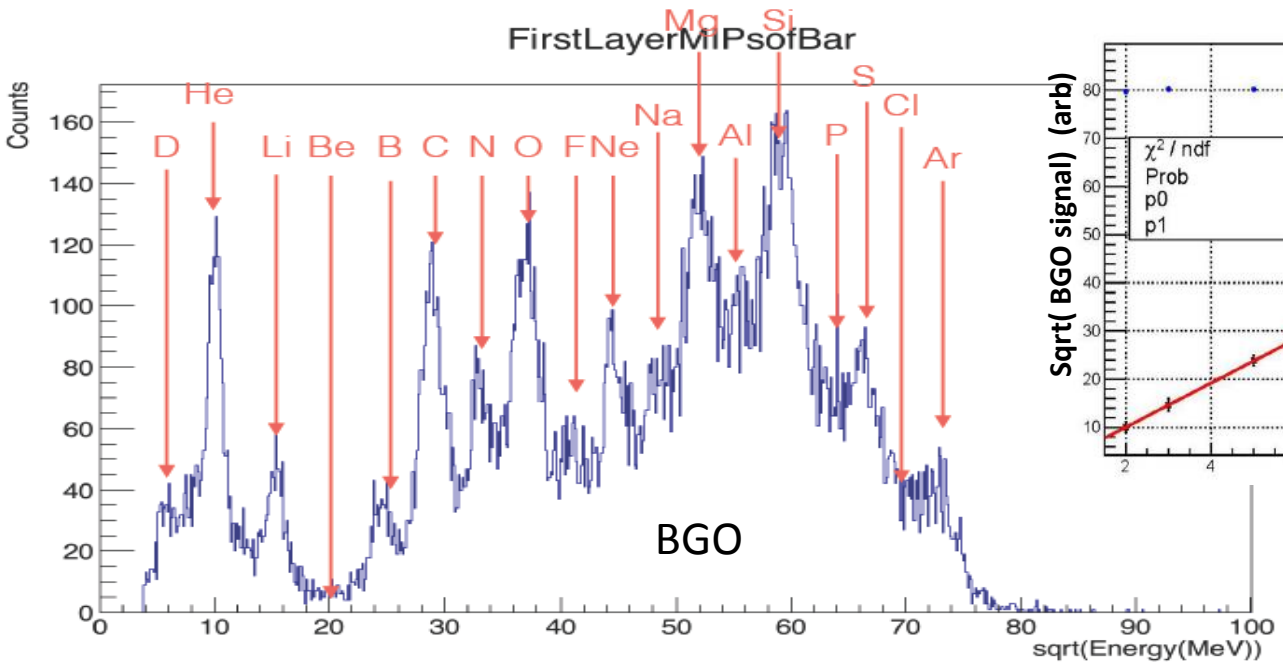


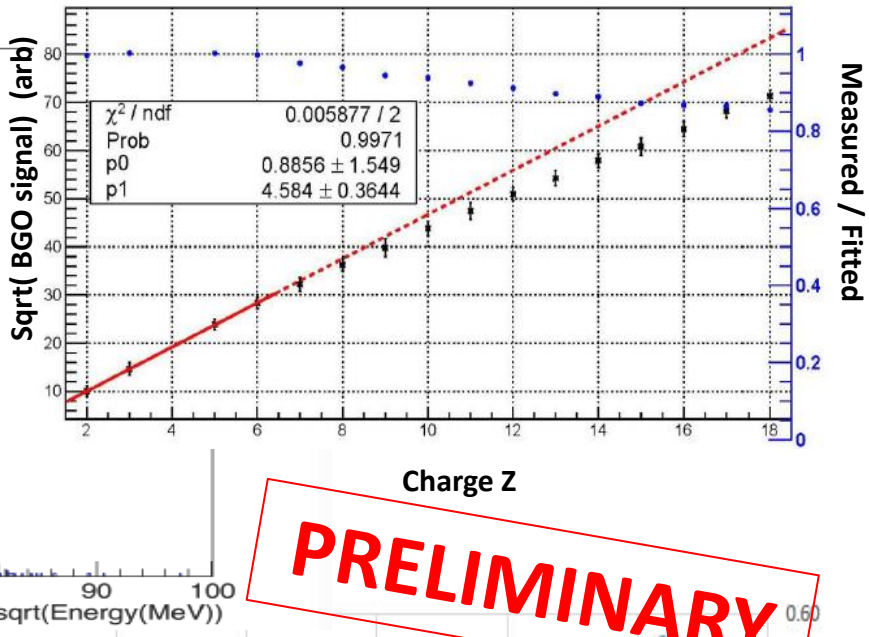


PRELIMINARY



Test beam activity at CERN: ions





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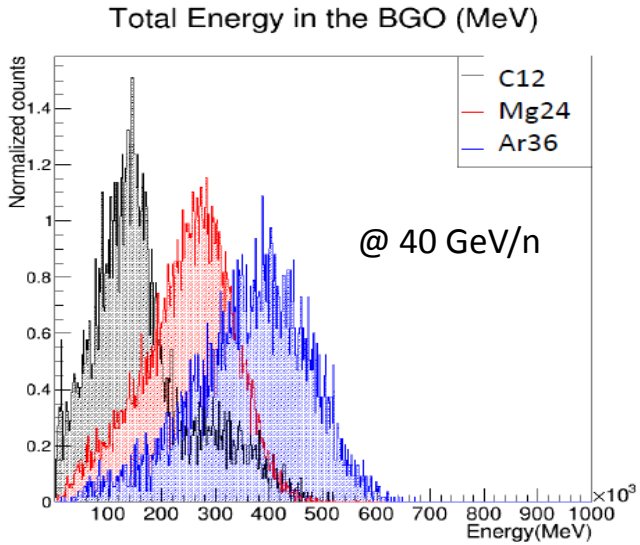
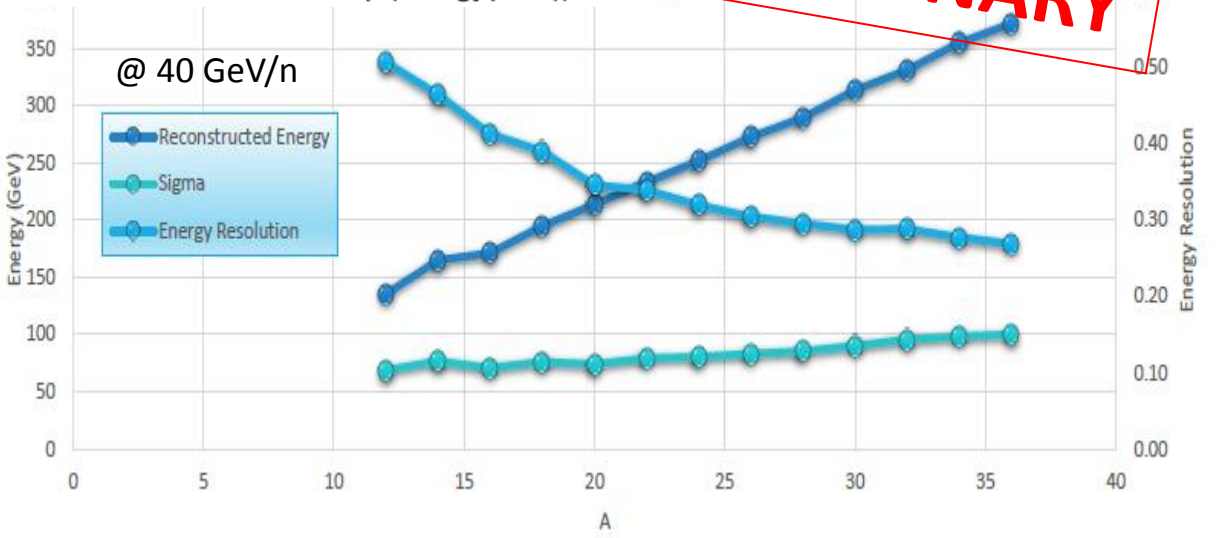




The launch: Dec 17th 2015, 0:12 UTC

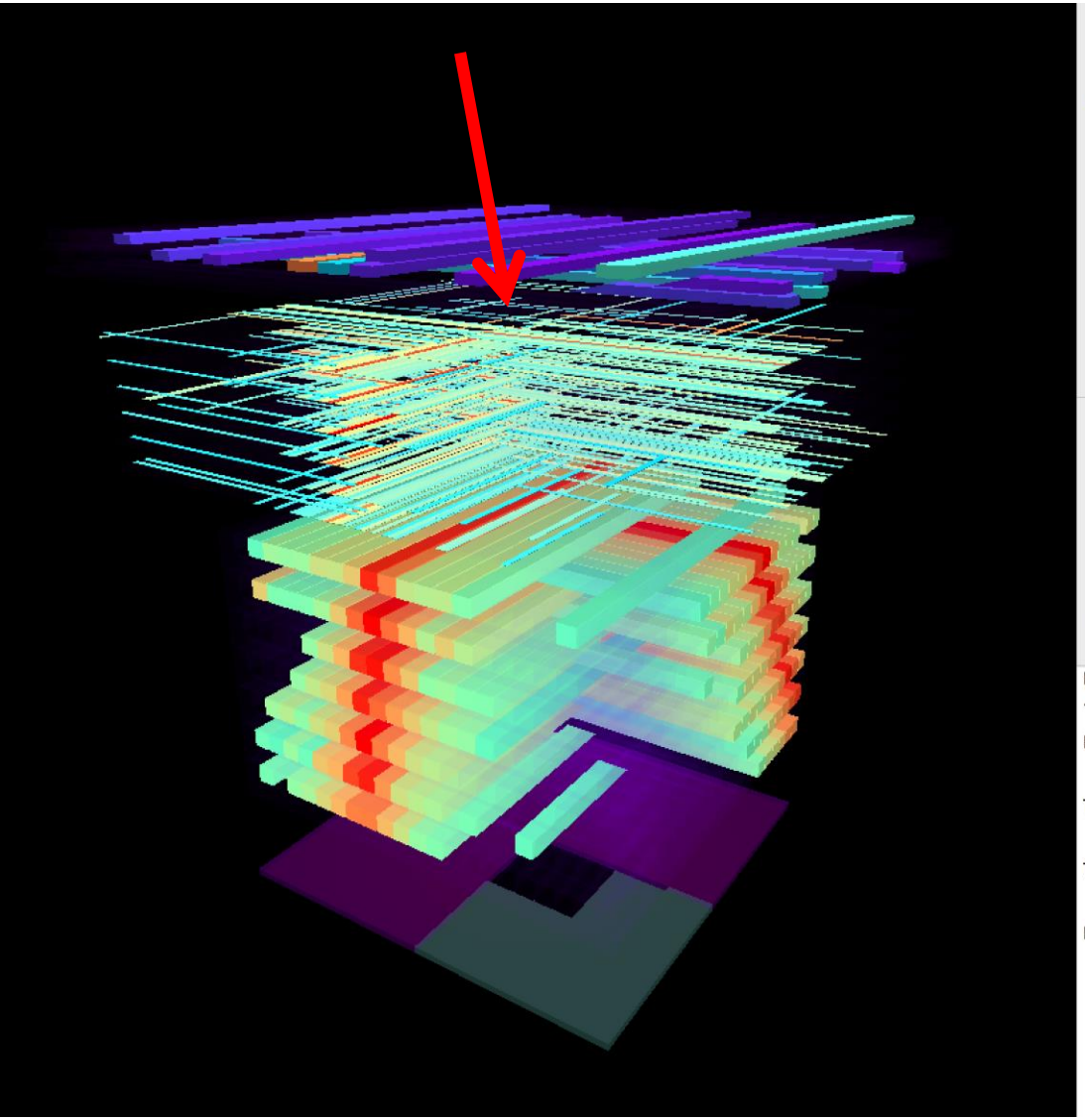
Jiuquan Satellite Launch Center
Gobi desert

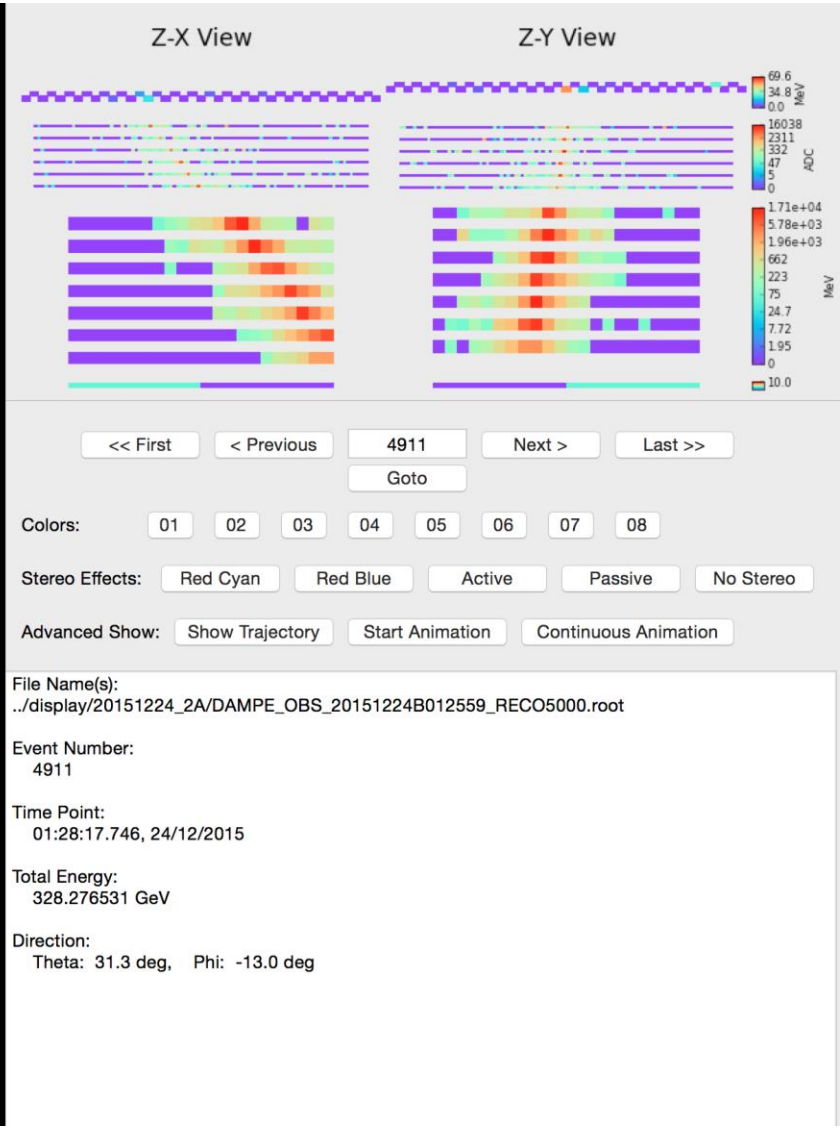
Orbit: sun syncronous , 500km

DAMPE → WUKONG

Dec 24th 2015: HV on

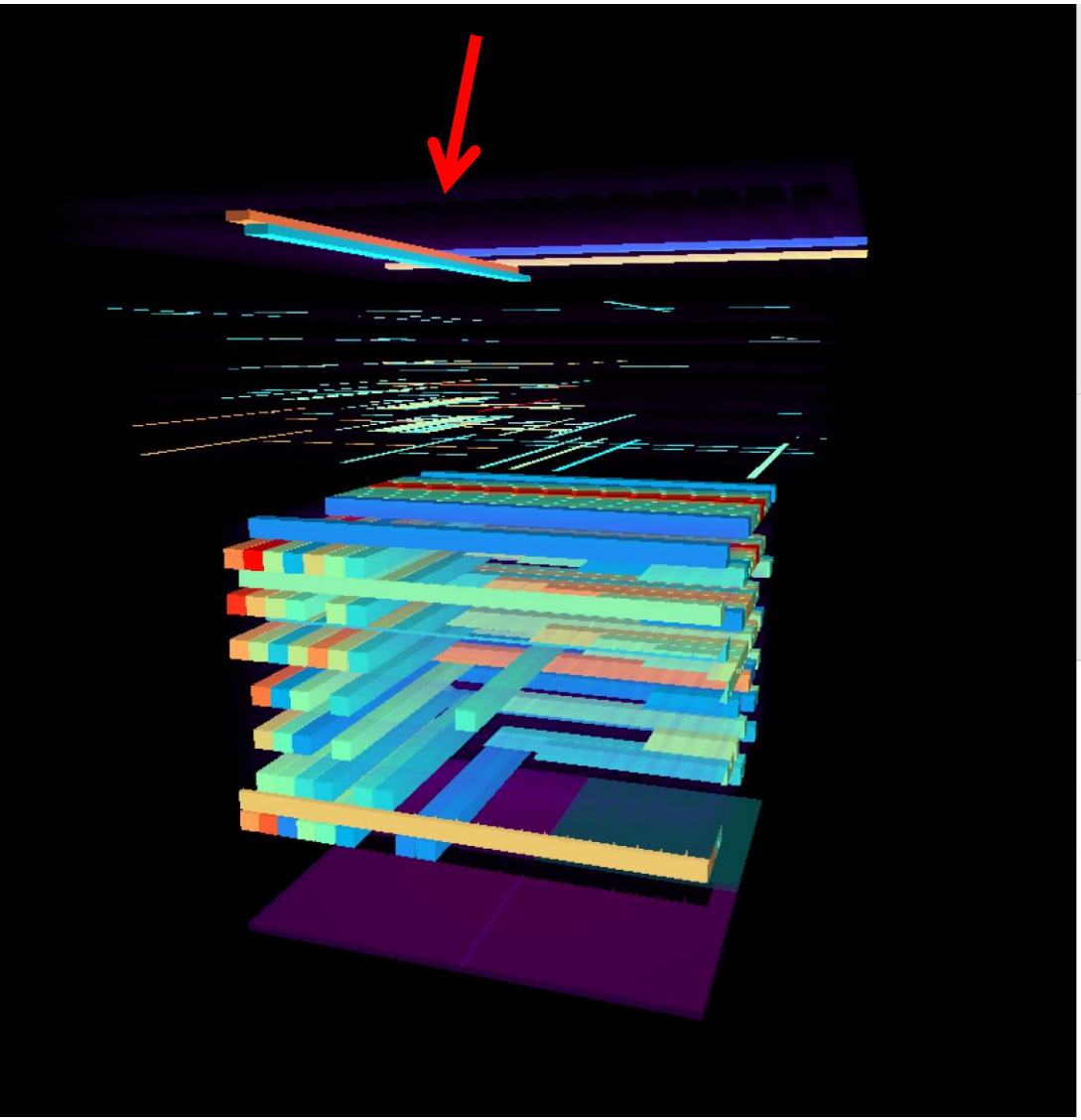
330 GeV electron

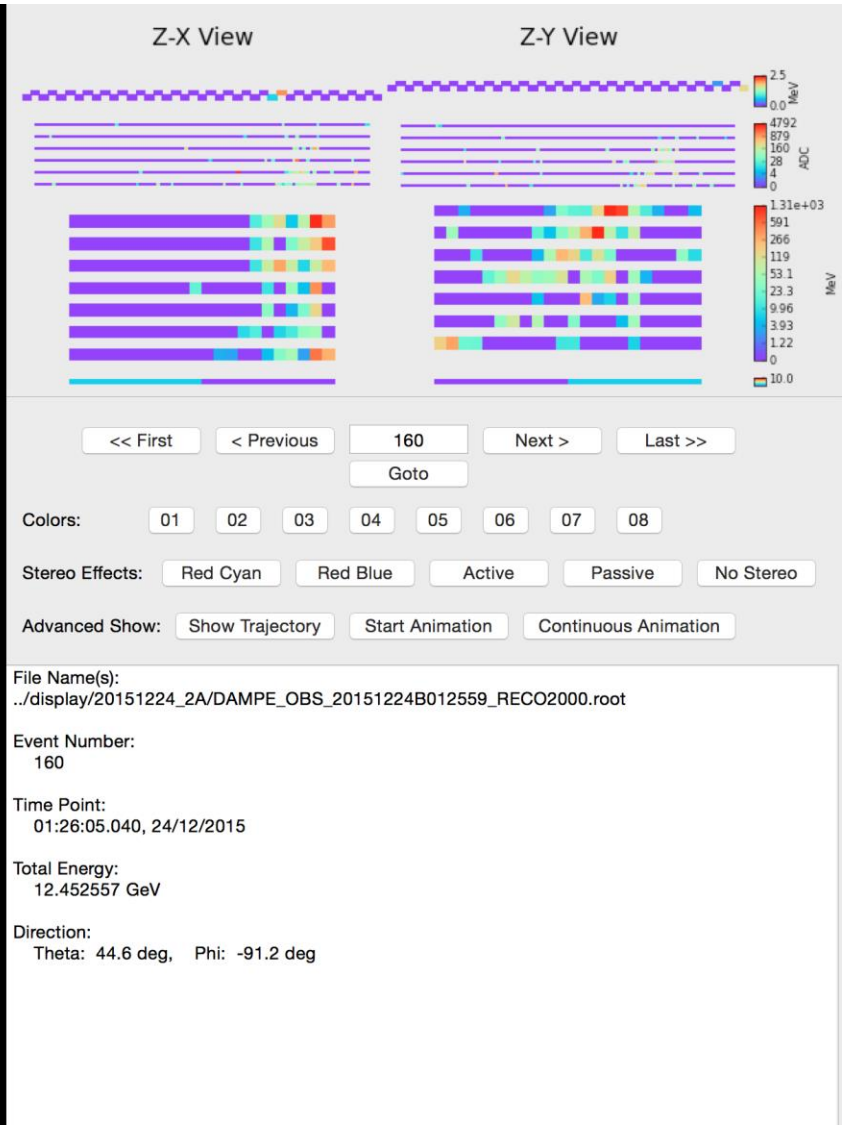




Dec 24th 2015: HV on

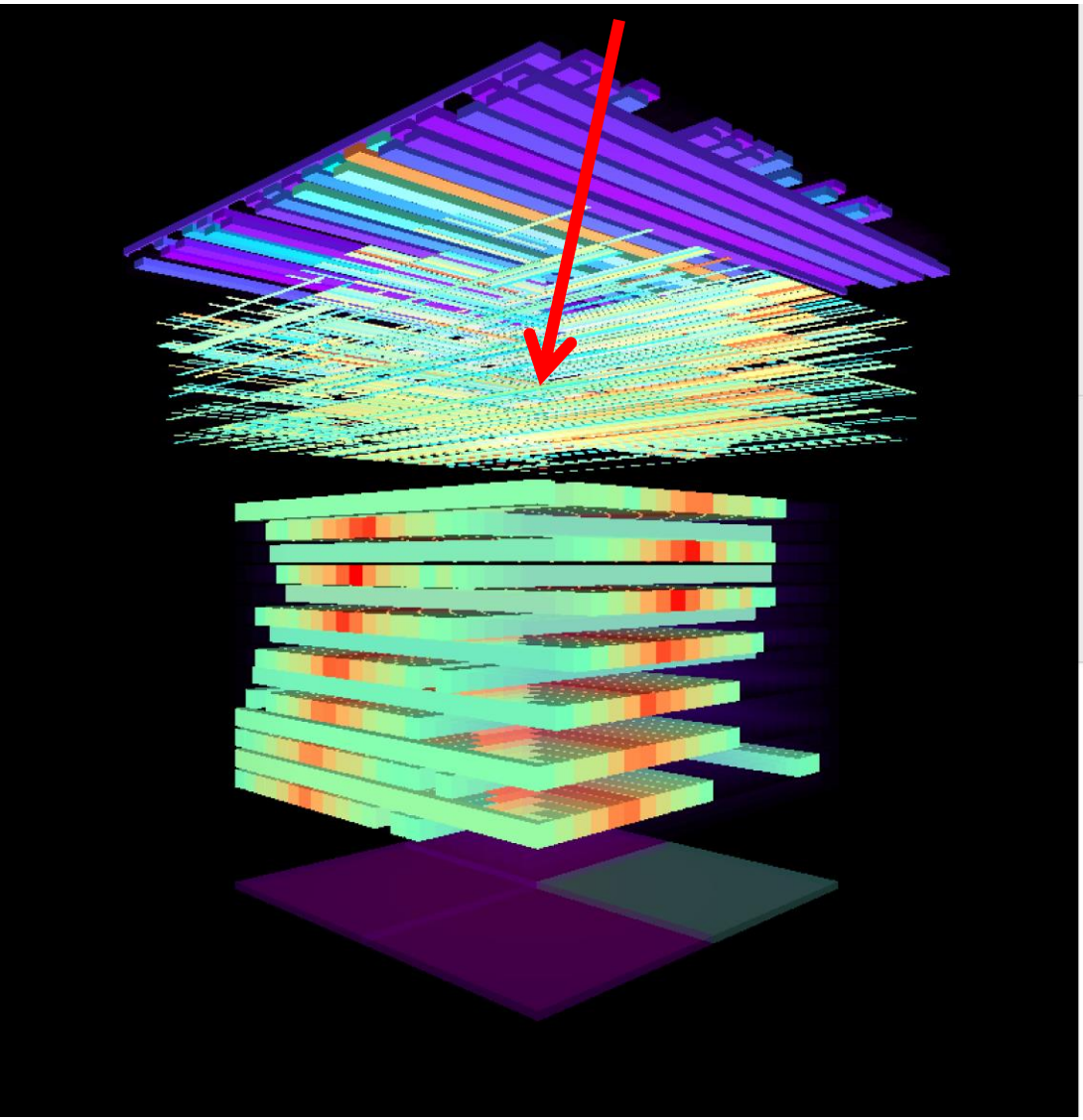
12 GeV proton

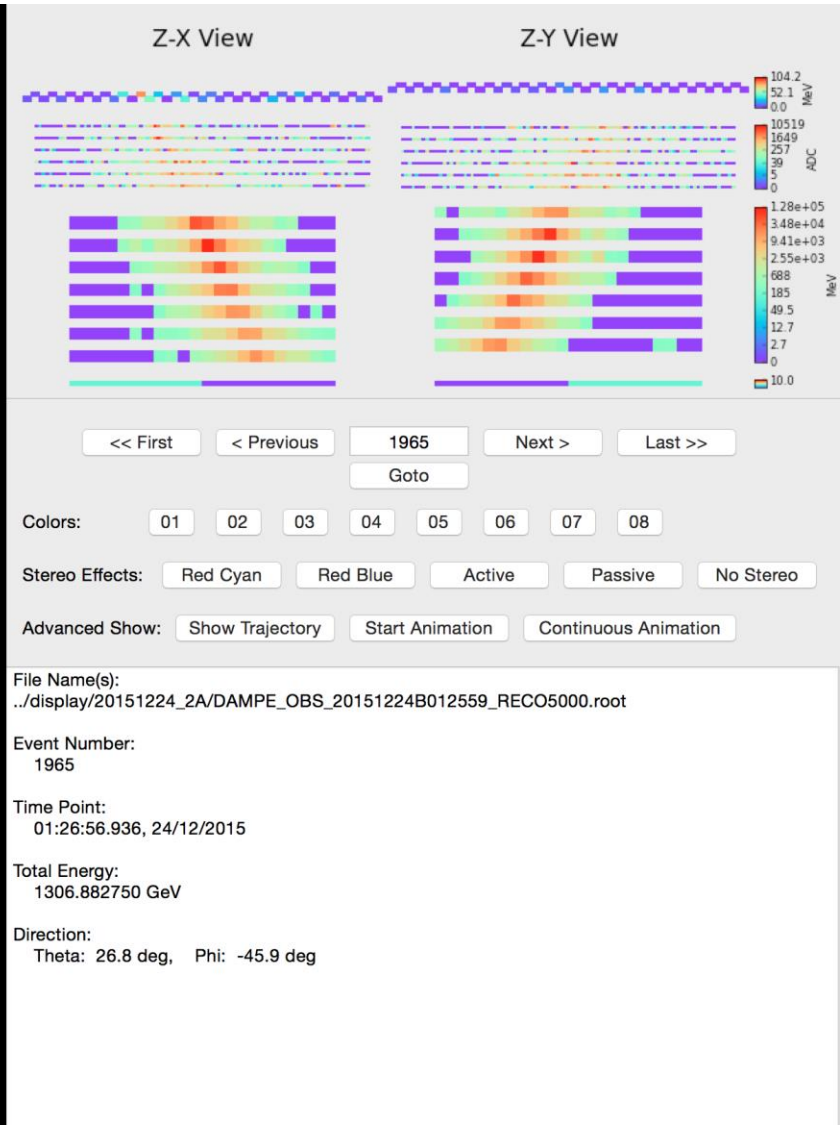




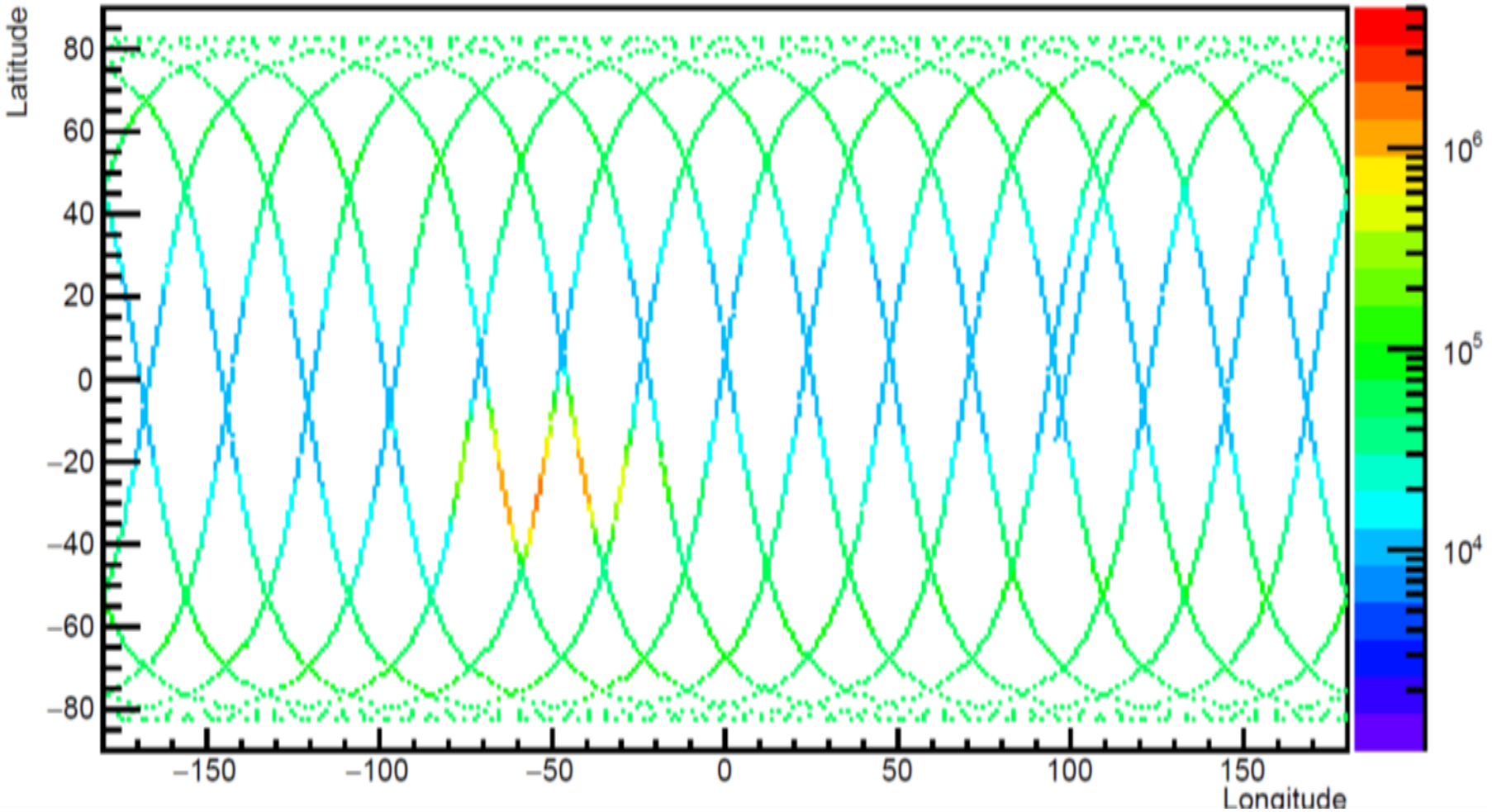
Dec 24th 2015: HV on

1.3 TeV carbon





Trigger rate in orbit

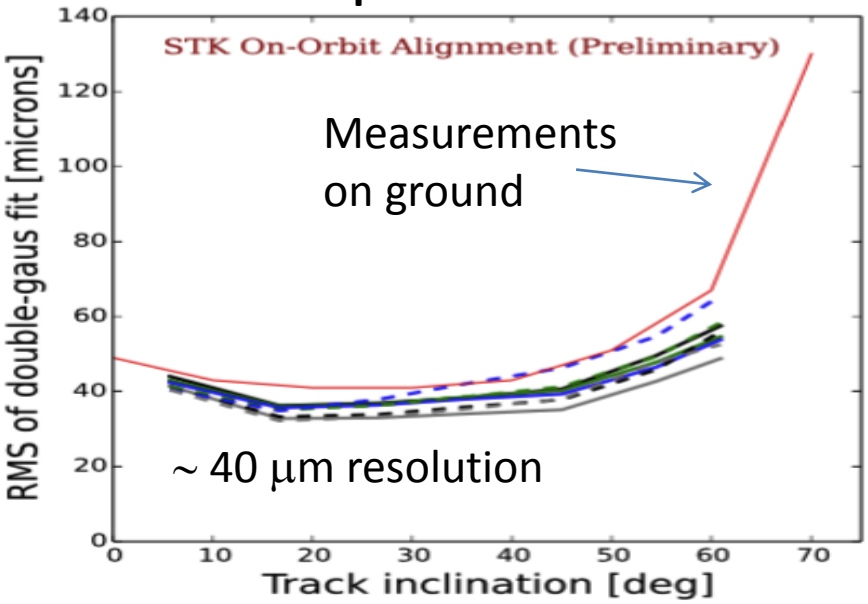


~50 Hz average trigger rate

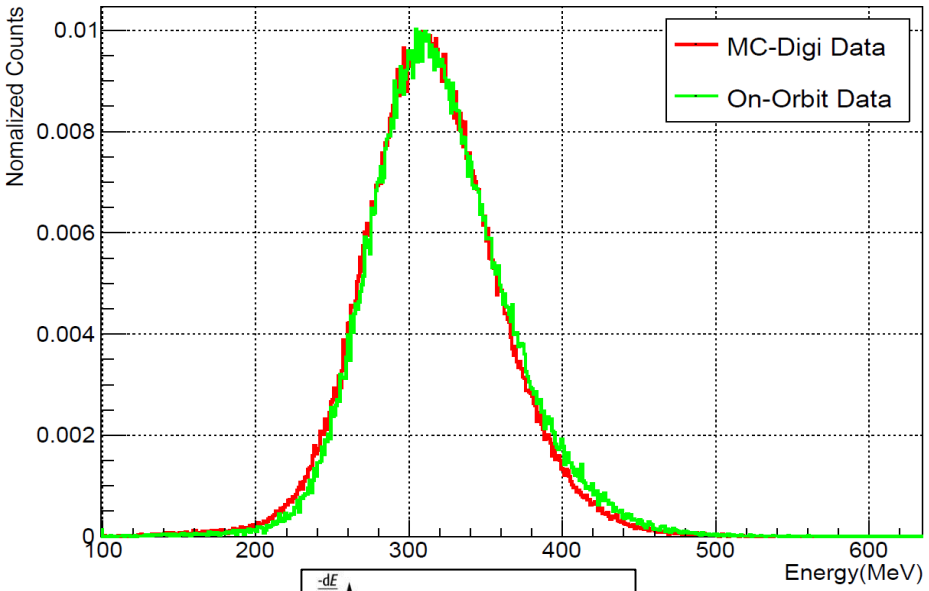
→100GB/day on ground (about 4 M events)

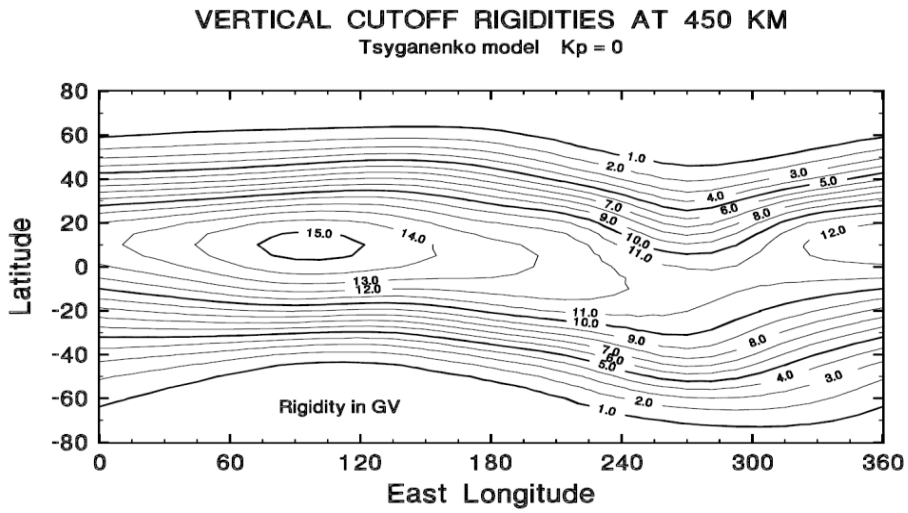
Some on-orbit performance plot

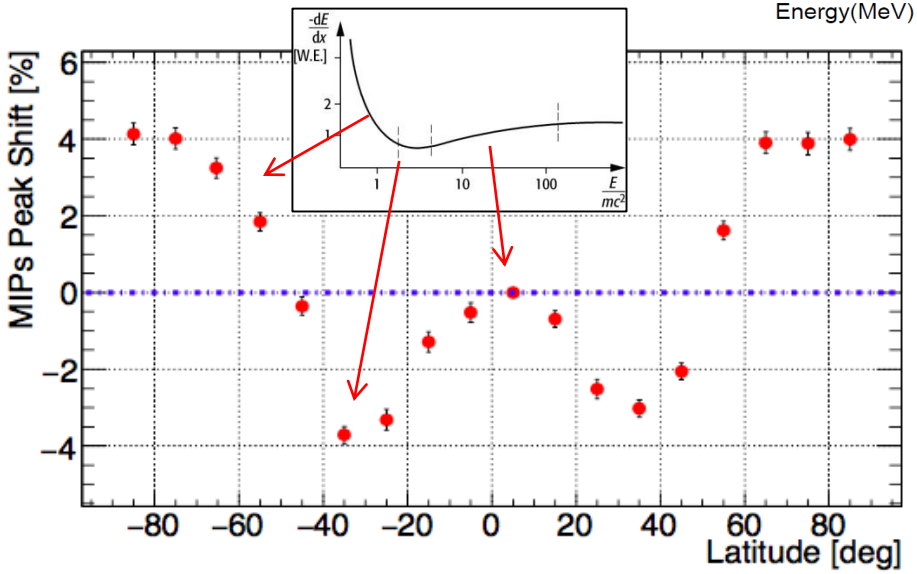
STK space resolution



BGO "mip"peak

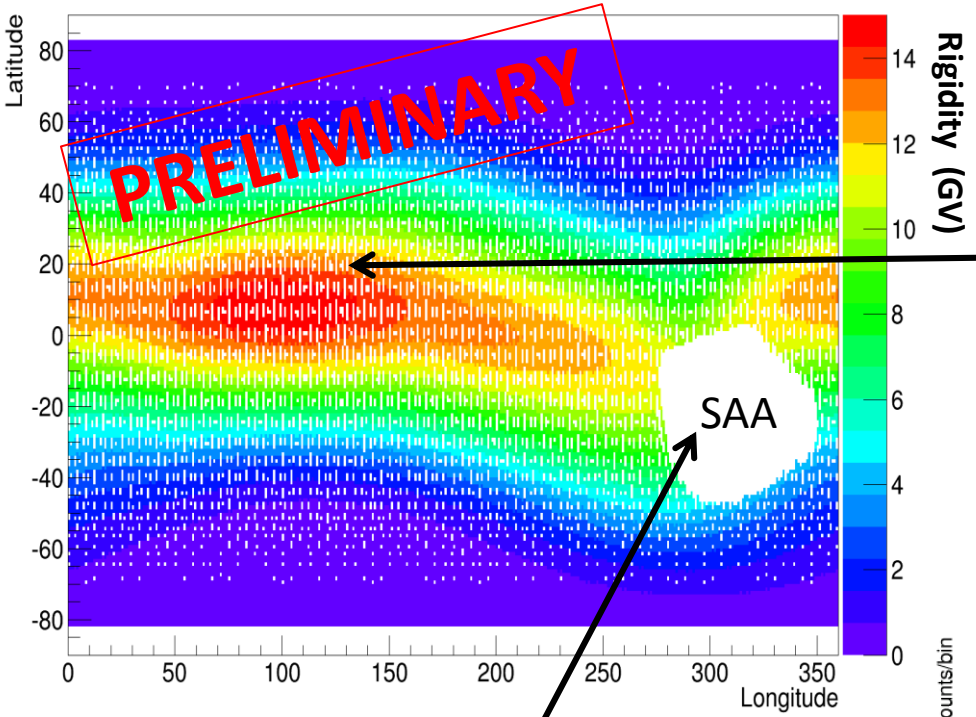


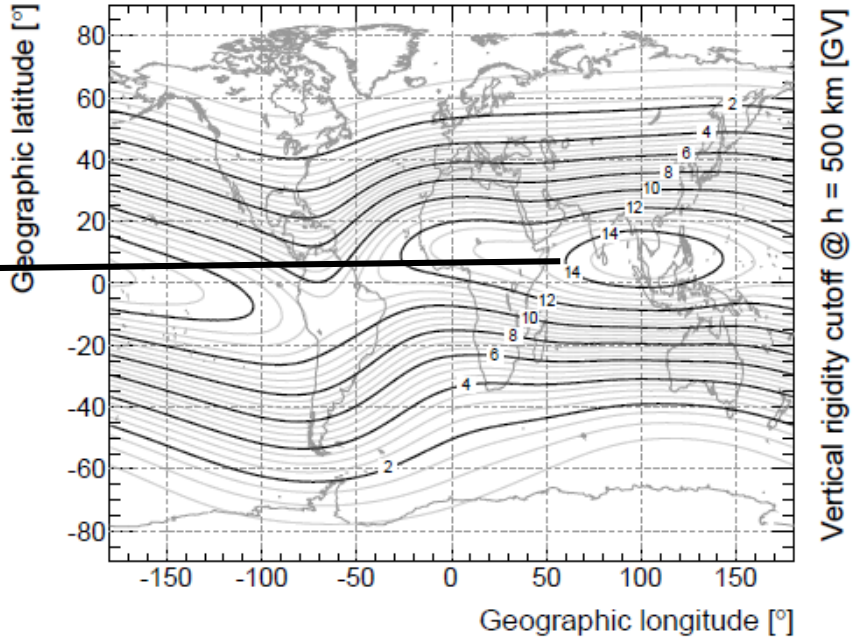


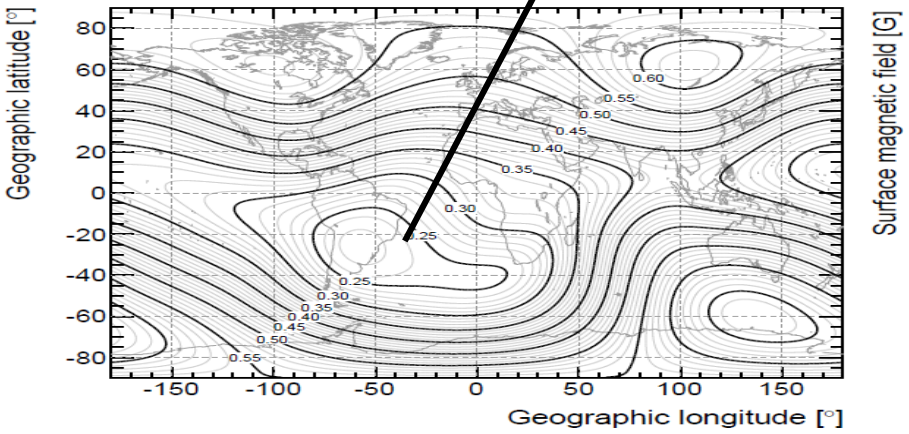


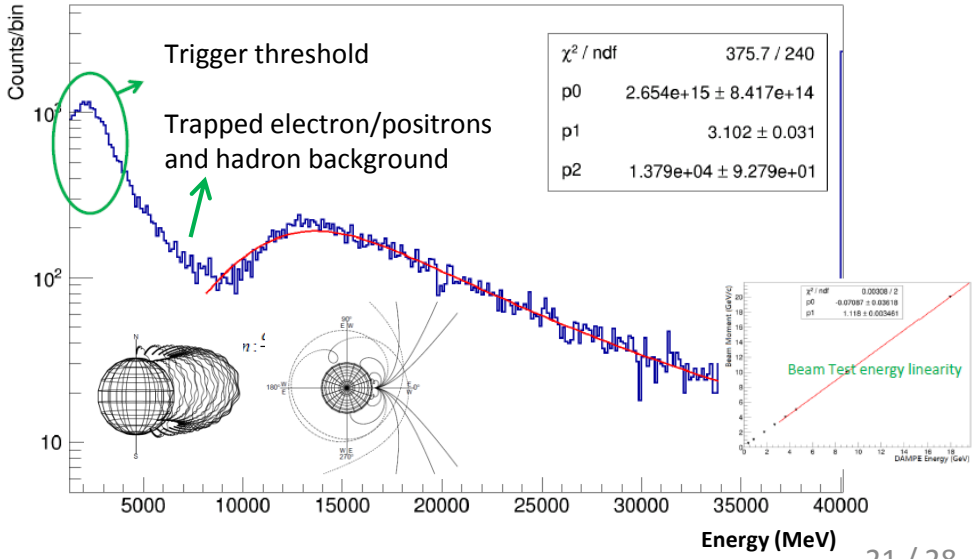
On-orbit energy calibration

$e^{\pm}$ rigidity cutoff with 1 month statistics

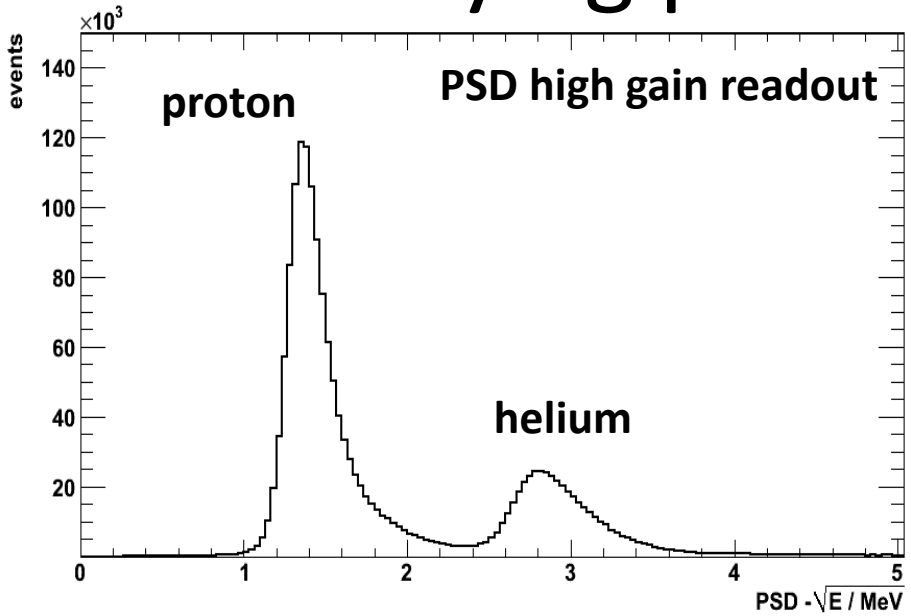


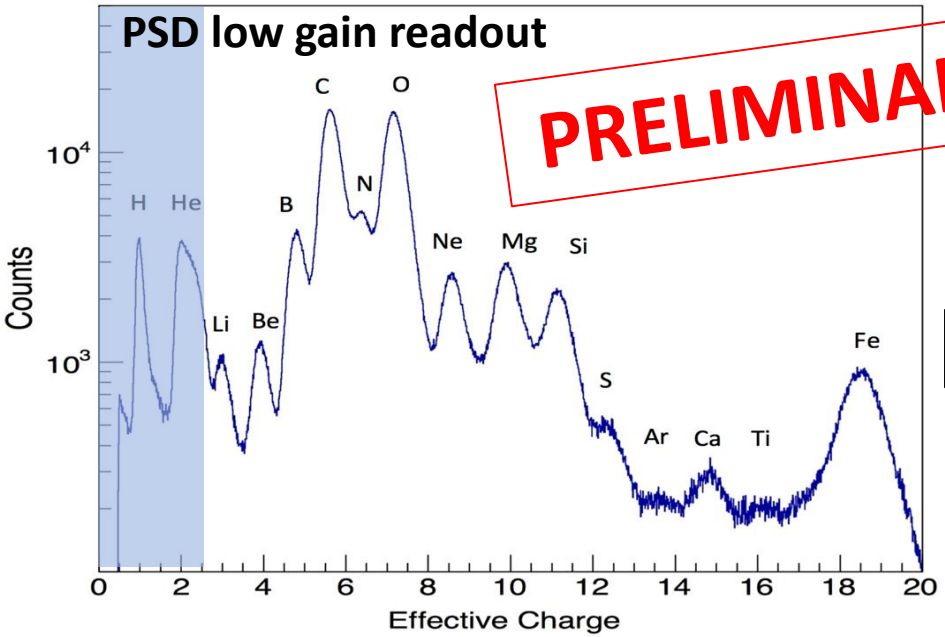




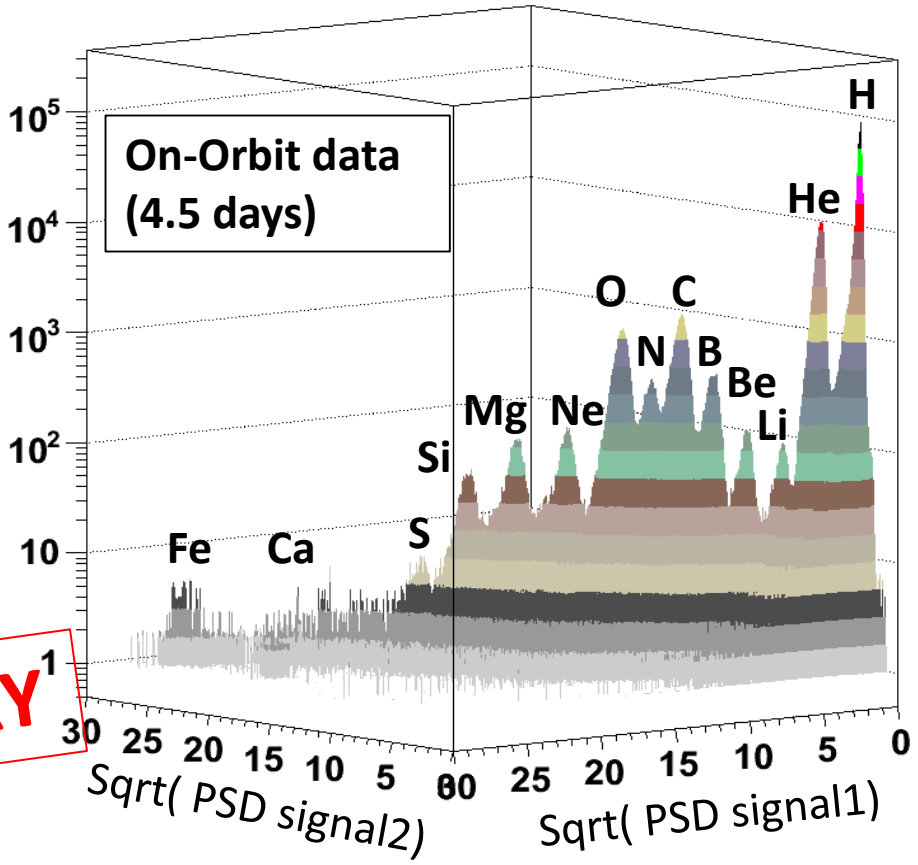


Identifying protons and nuclei





PRELIMINARY



Charge resolution ~ 0.2-0.3 e depending on Z

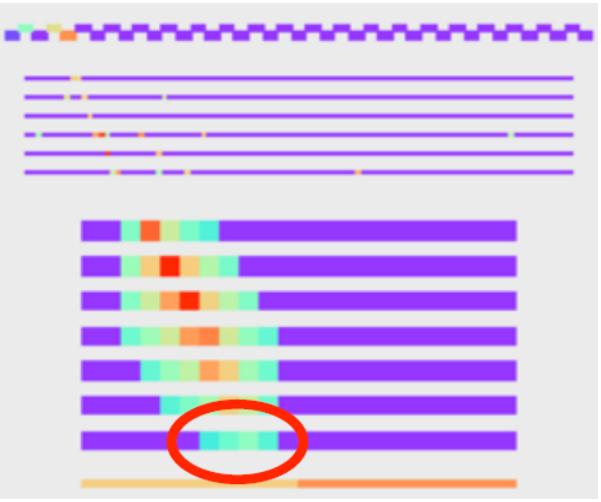
Charge measurement also given by STK and (with lower precision) by the BGO bars

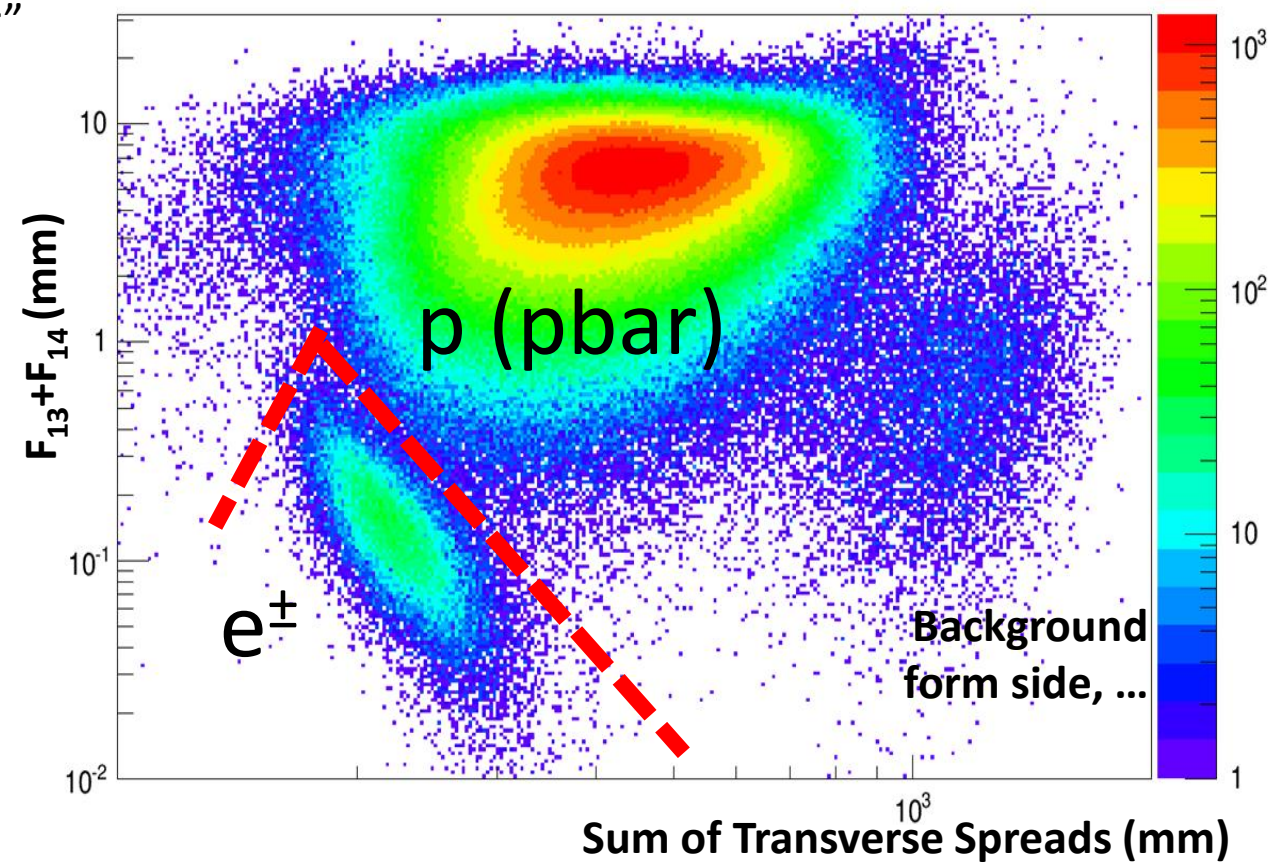
Electron indentification

One possible “shape parameter”

$$F_i = Spread_i \times \frac{E_i}{E_{tot}}$$

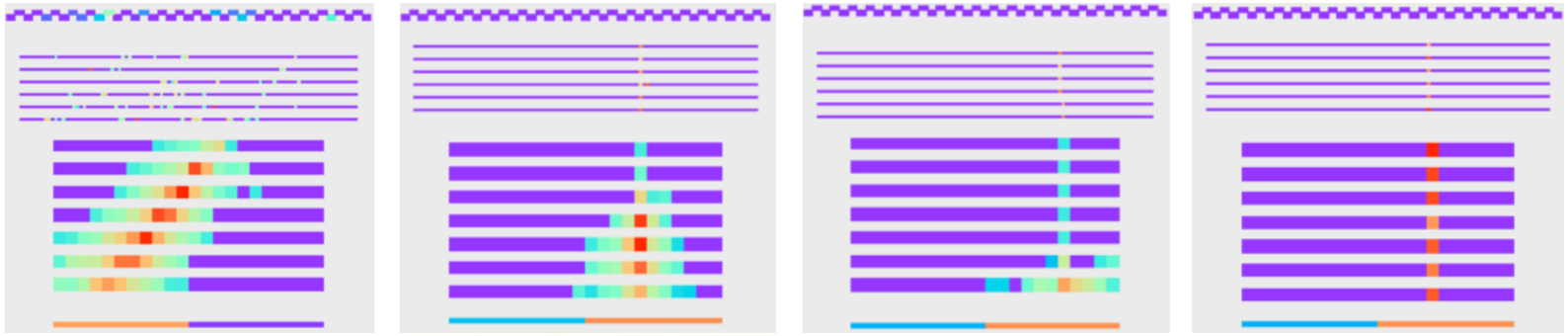
Rejection power > 10^5



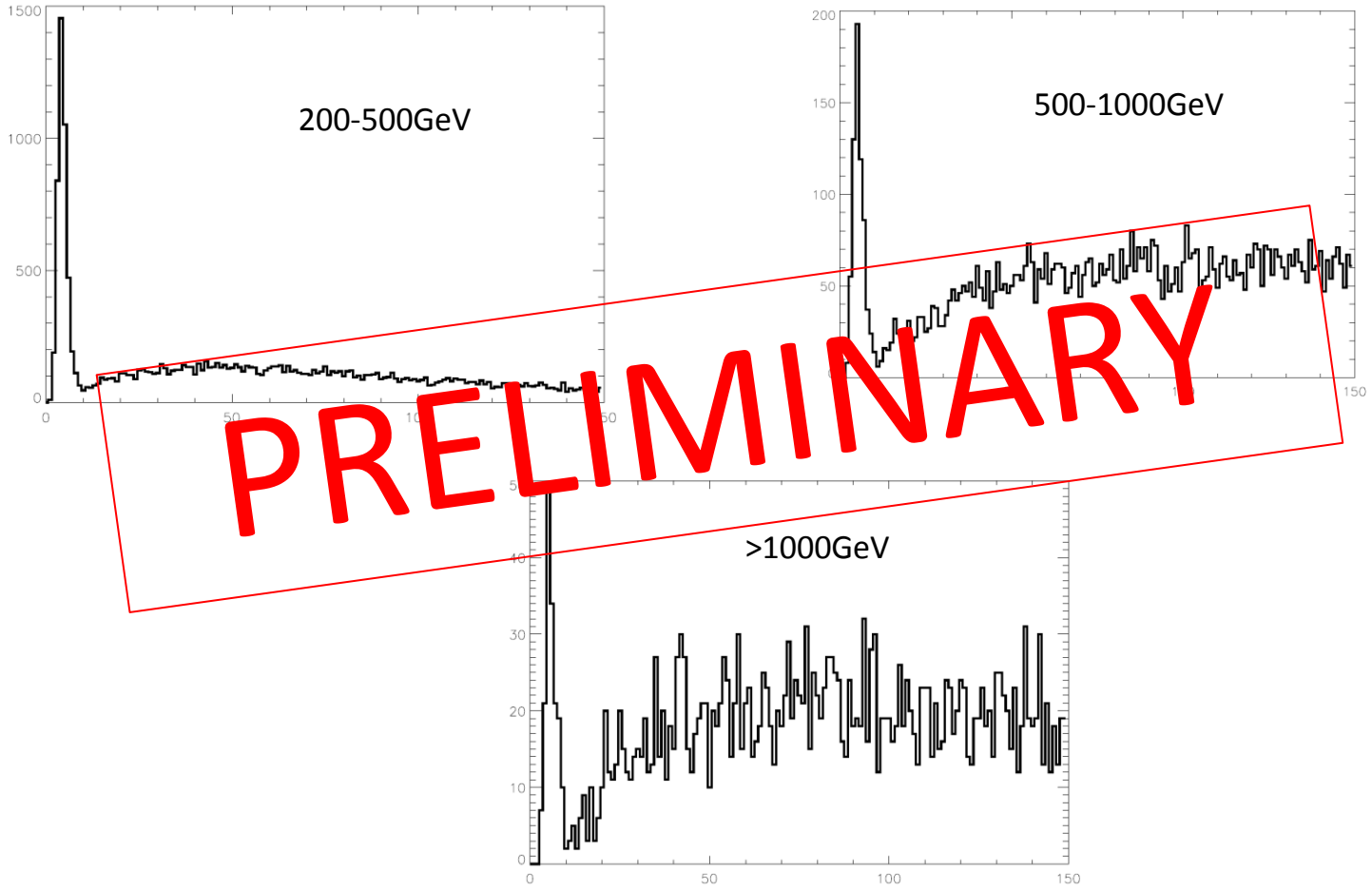


Electrons and positrons

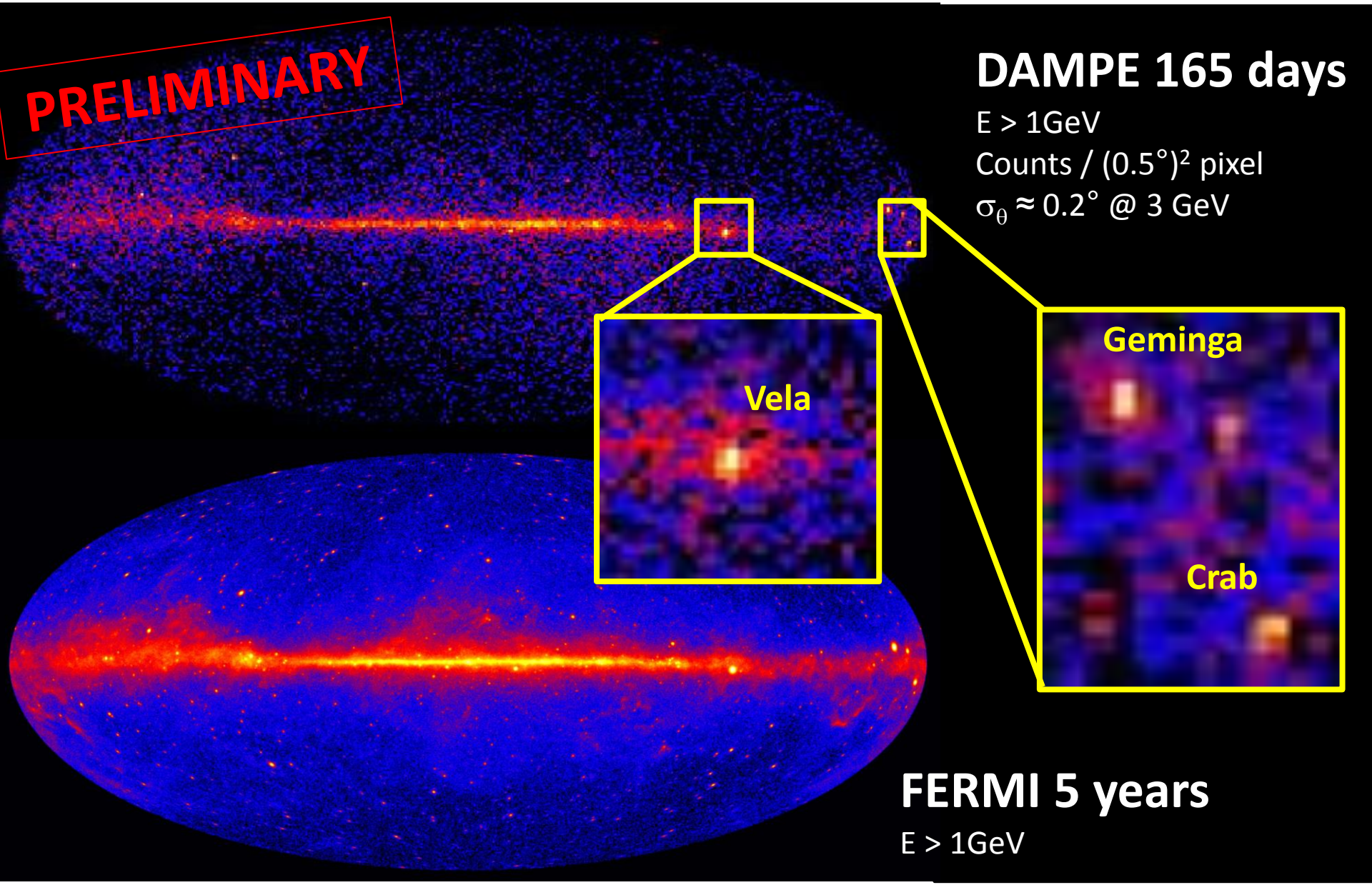
Protons and nuclei



Electron indentification

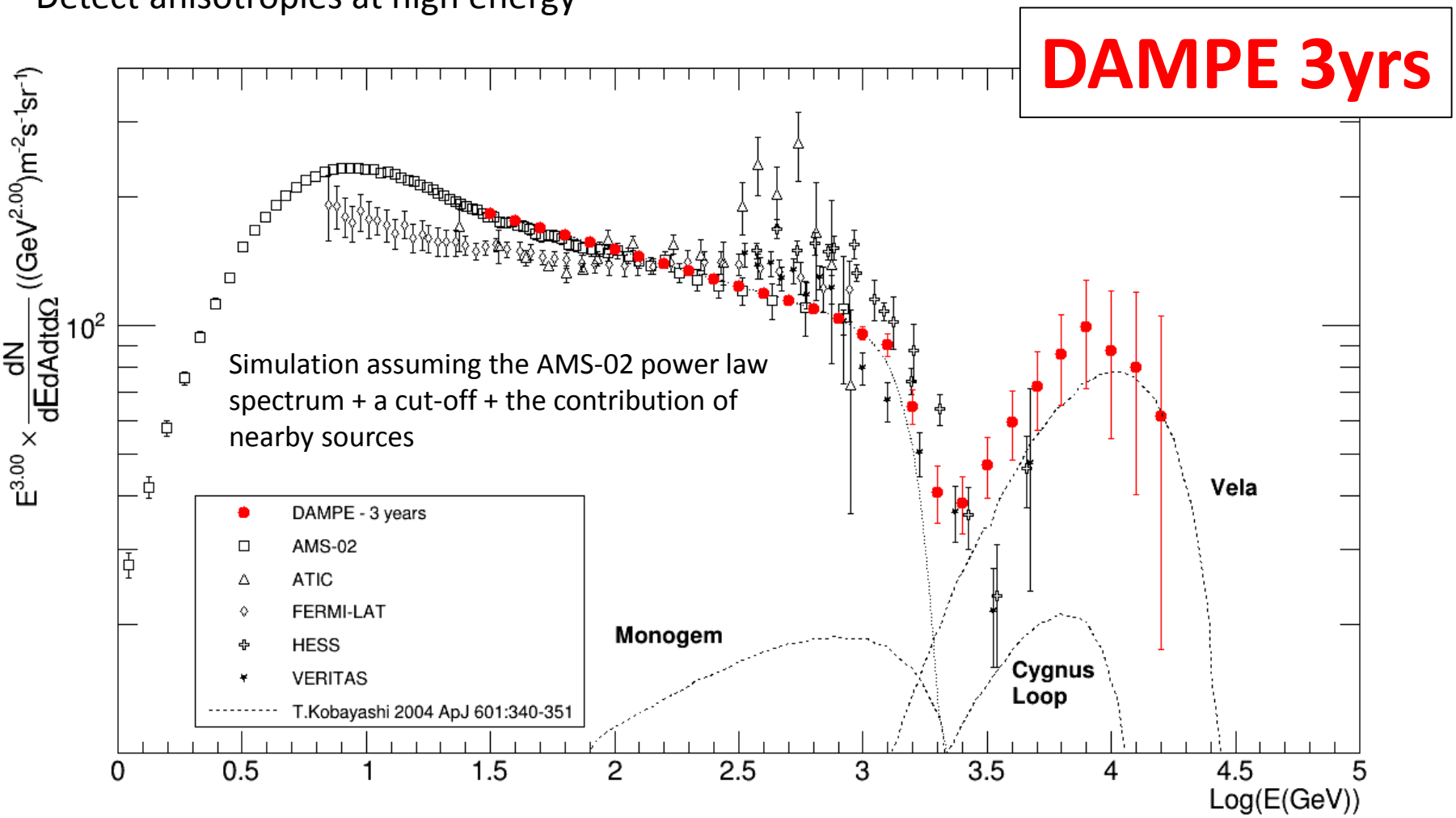


Photons

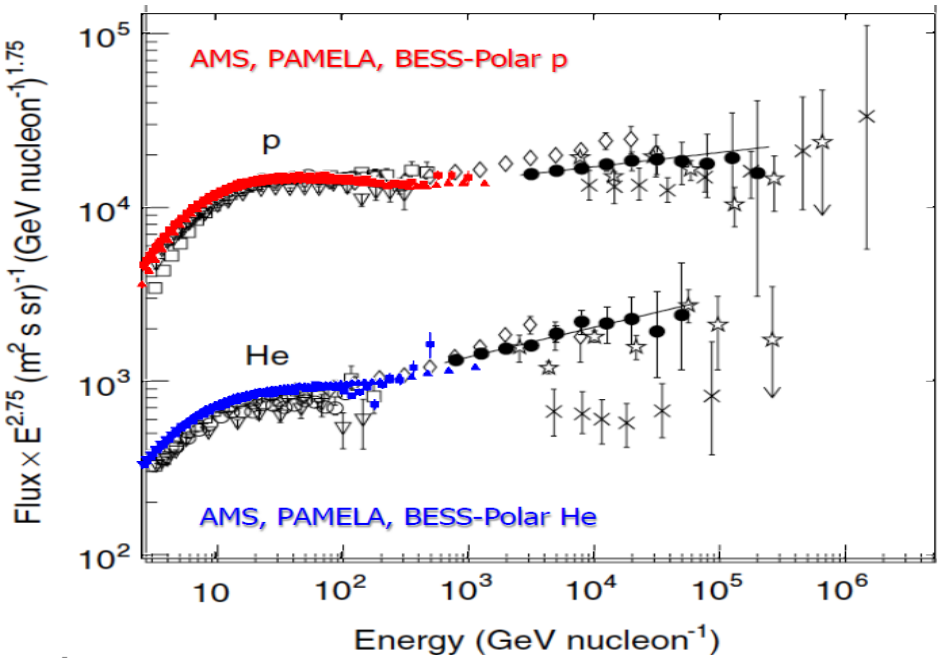

PRELIMINARY
DAMPE 165 days
E > 1GeV
Counts / (0.5°)² pixel
$\sigma_\theta \approx 0.2°$ @ 3 GeV
Vela
Geminga
Crab
FERMI 5 years
E > 1GeV

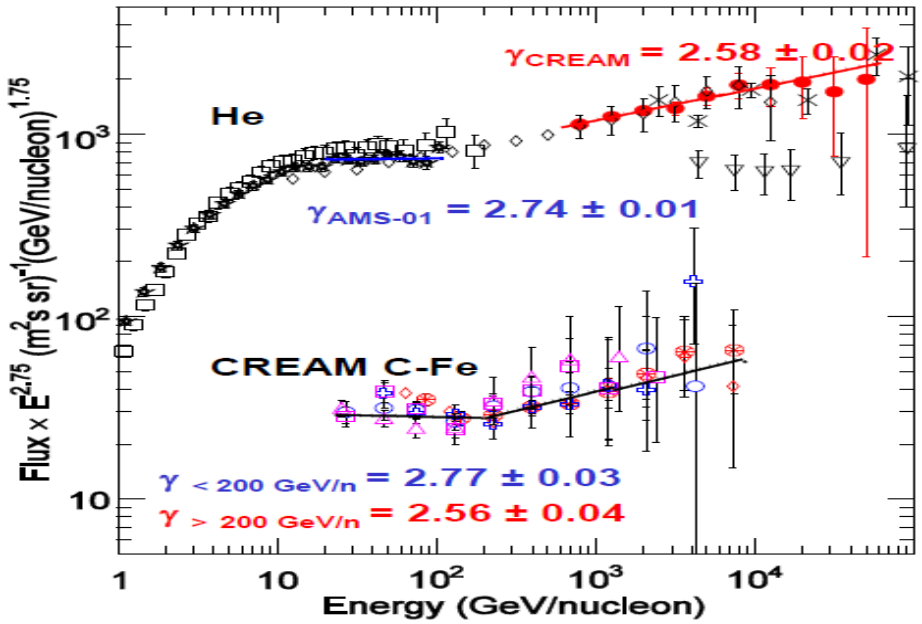
All-electron spectrum

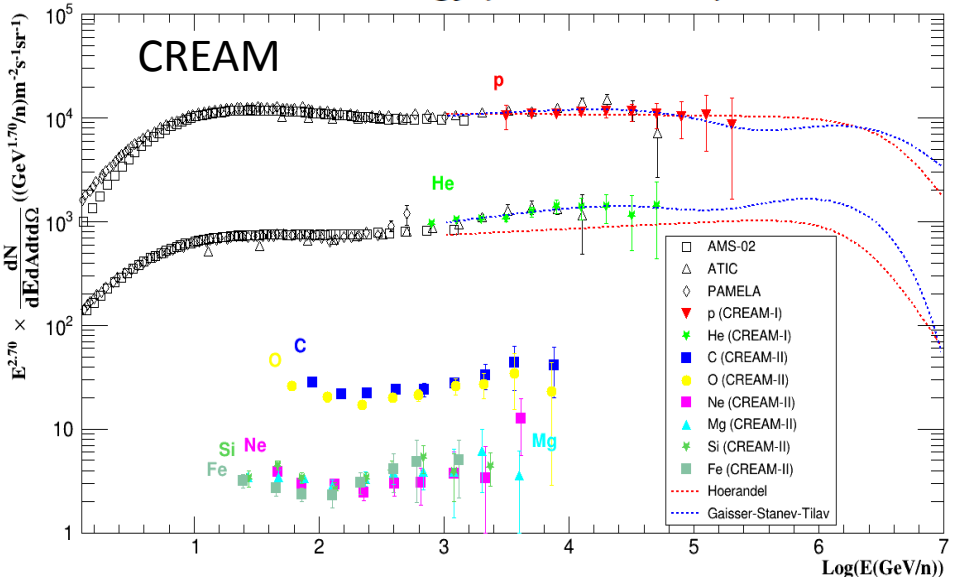
- Measure the all-electron flux up to about 10TeV
- Measure with high accuracy the sub-TeV region and the possible cut-off around one TeV
- Detect structures in the spectrum due to nearby sources and/or DM induced excesses
- Detect anisotropies at high energy

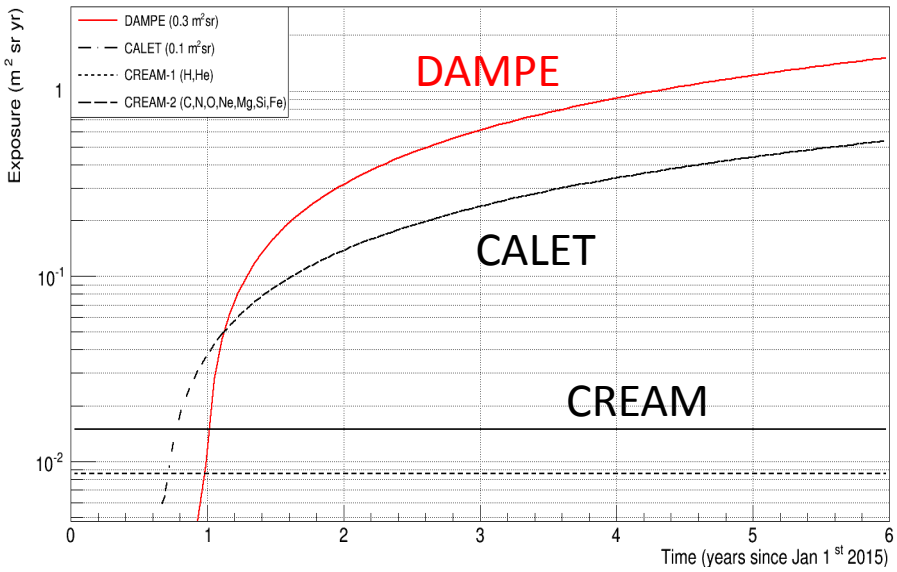


Protons and nuclei spectra

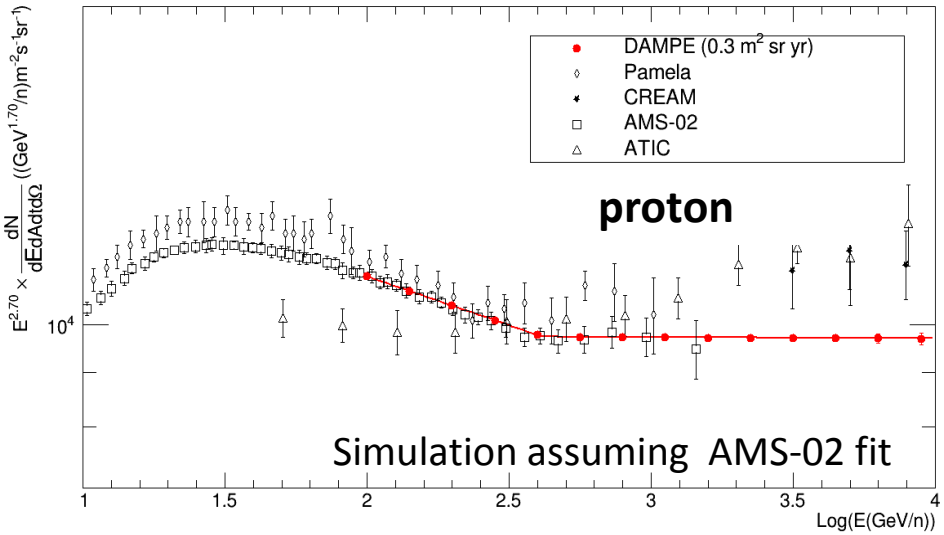


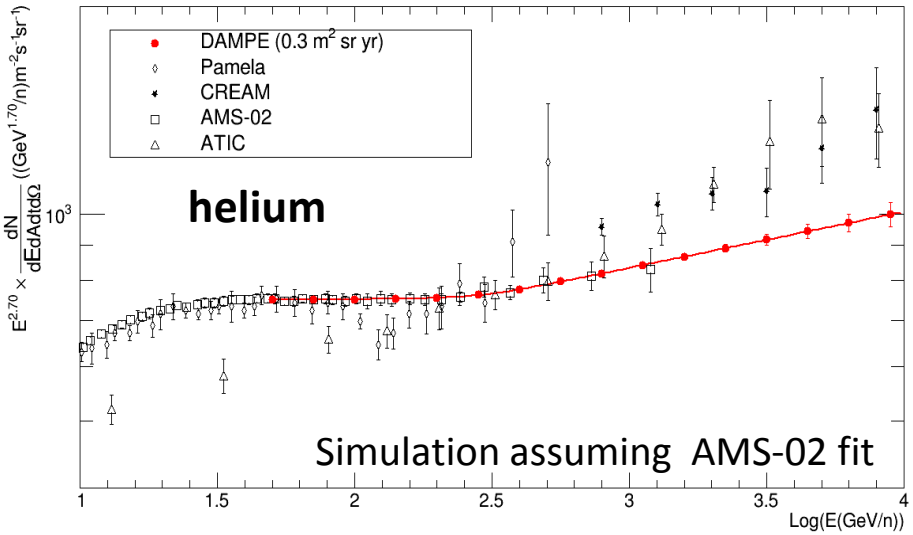


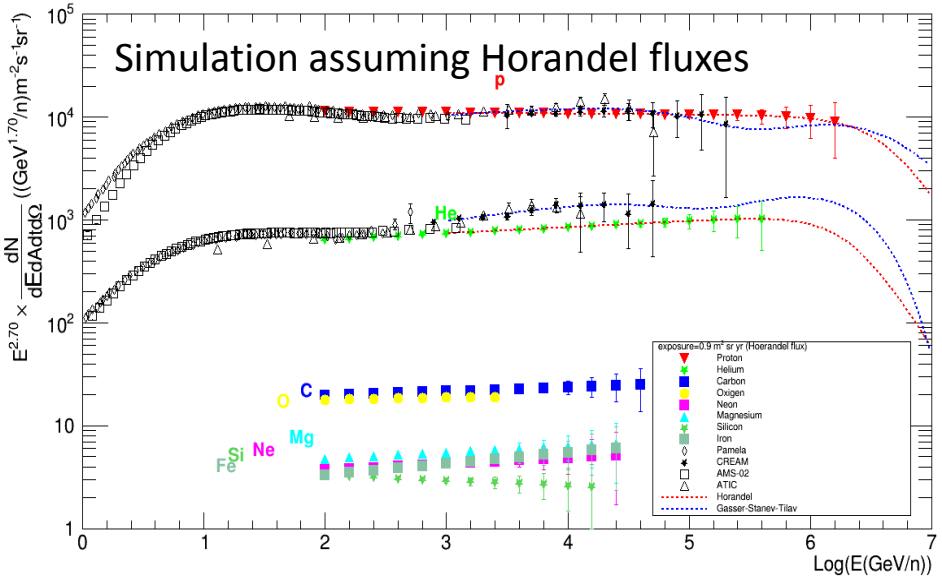


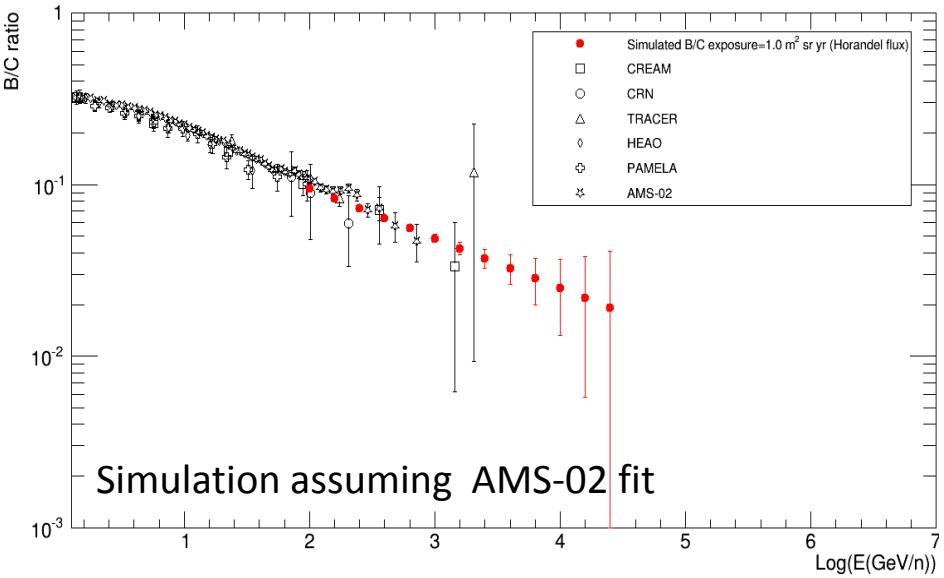


Protons and nuclei: DAMPE 3years









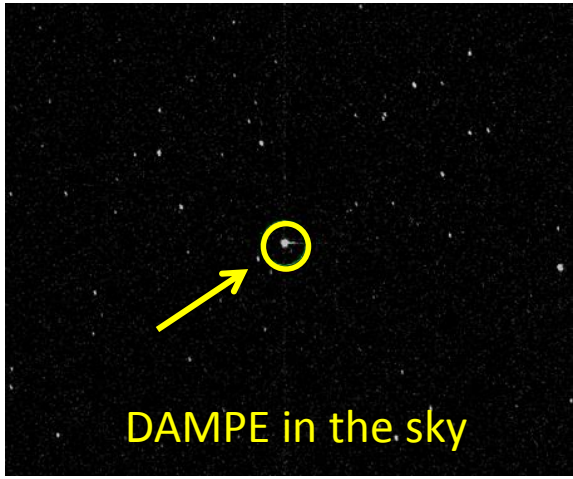
Summary

The detector

- Large geometric factor instrument (0.3 m^2 sr for p and nuclei)
- Precision Si-W tracker (40μm , 0.2°)
- Thick calorimeter (32 X_0 , σ_E/E better than 1% above 50 GeV for e/γ , ~35% for hadrons)
- "Mutiple" charge measurements (0.2-0.3 e resolution)
- e/p rejection power > 10^5 (topology alone, plus neutron detector)

Launch and performances

- Succesfull launch on dec 17, 2015
- On orbit operation steady and with high efficiencies
- Absolute energy calibration by using the geomagnetic cut-off
- Absolute pointing cross check by use of the photon map



Physics goals

- Study of the cosmic electron and photon spectra
- Study of electron anisotropy and nearby sources contribution
- Study of cosmic ray protons and nuclei: spectrum and composition
- Precise measurement of CR discrepant hardenings and spectral indexes
- High energy gamma ray astronomy
- Search for dark matter signatures in lepton spectra
- The "unexpected": GW electromagnetic follow up in FoV