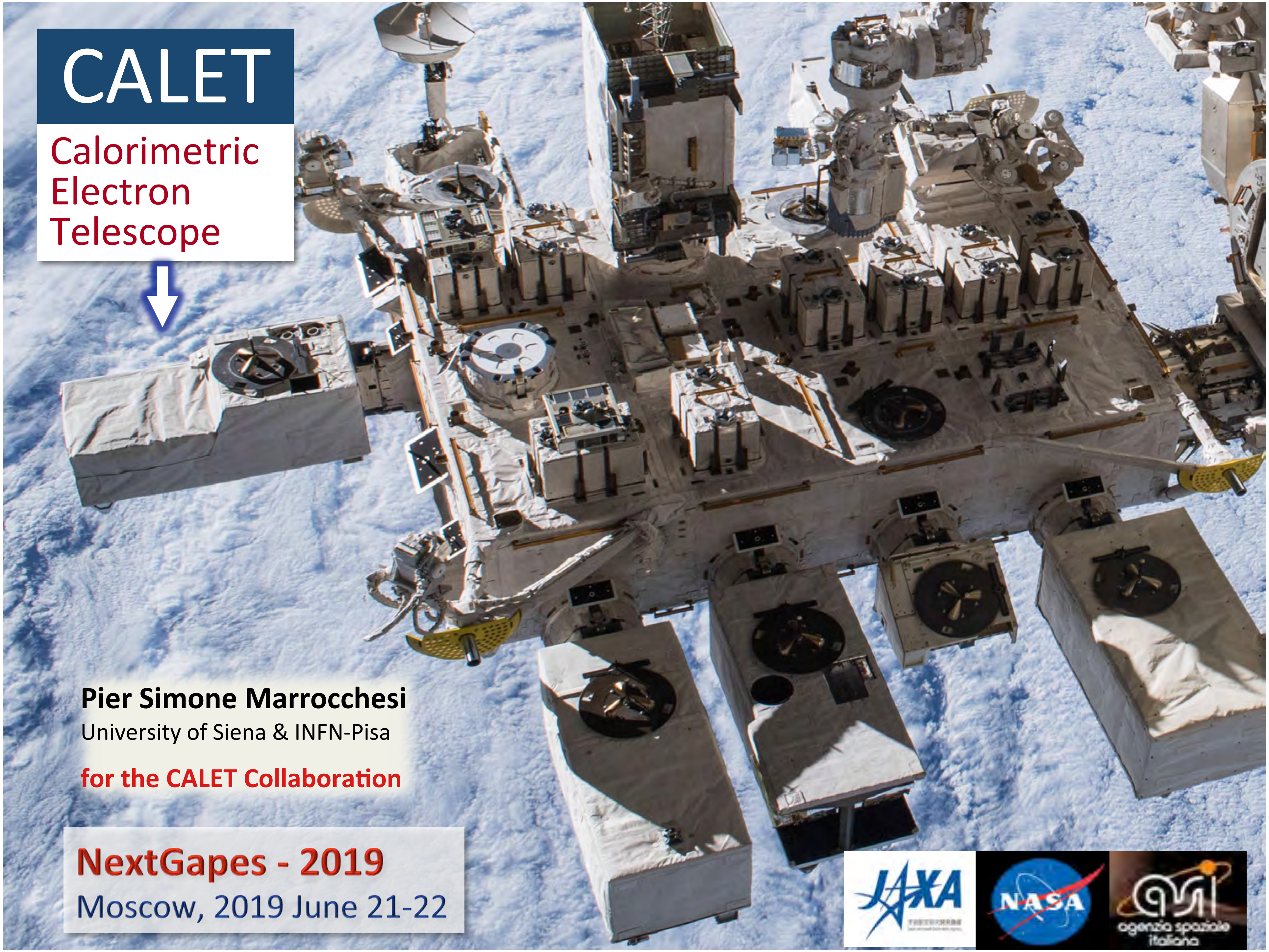
CALET

Calorimetric Electron Telescope

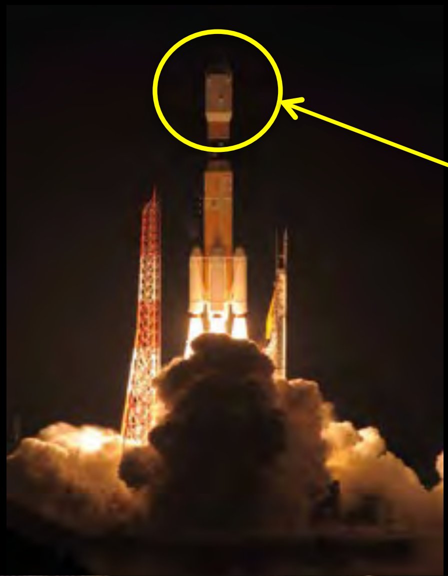


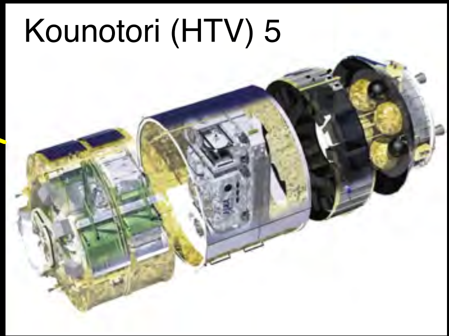
Pier Simone Marrocchesi
University of Siena & INFN-Pisa

for the CALET Collaboration

NextGapes - 2019
Moscow, 2019 June 21-22

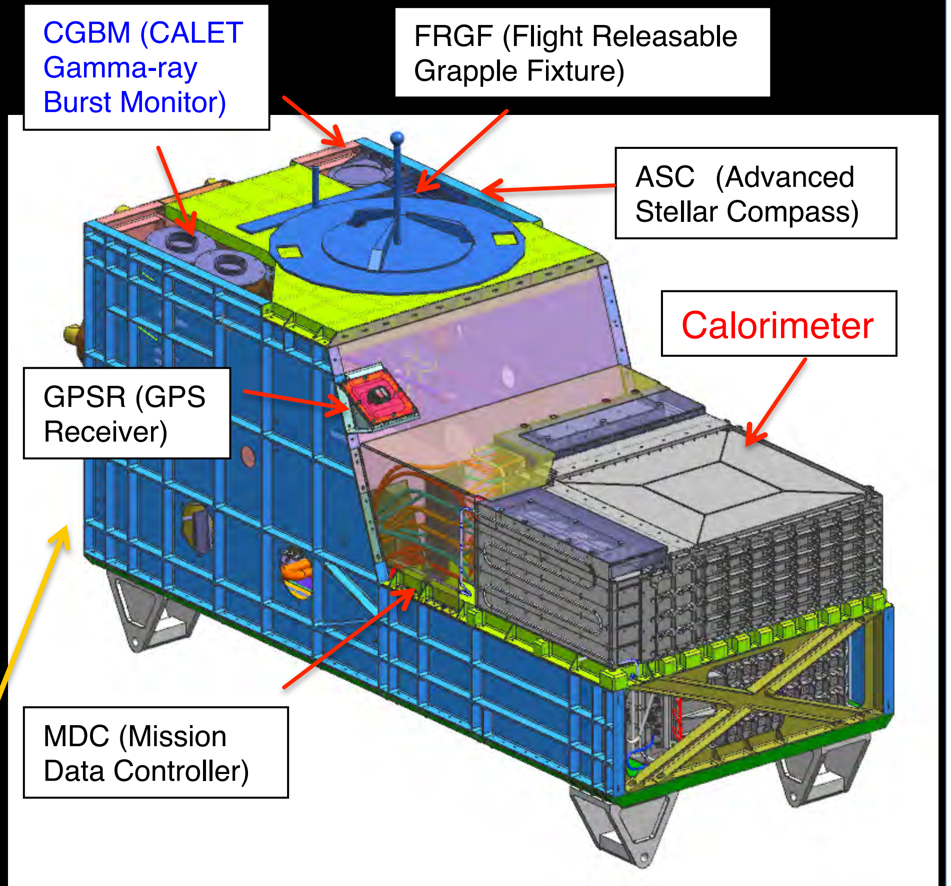
CALET Payload





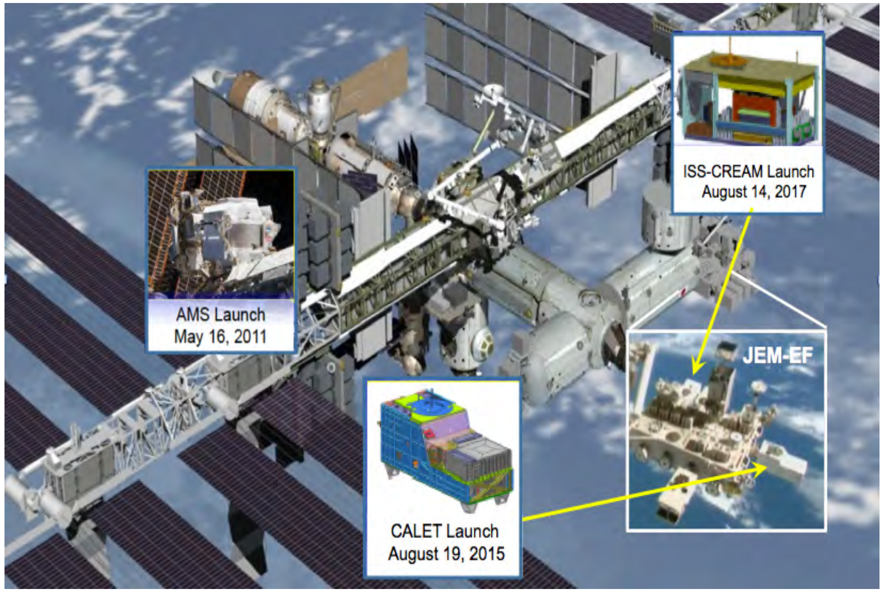
Launched on Aug. 19th, 2015 by the Japanese H2-B rocket

Emplaced on port #9 of JEM-EF (Japanese Experiment Module Exposed Facility) on Aug. 25th



- Mass: 612.8 kg JEM Standard Payload
- Size: 1850mm (L) × 800mm (W) × 1000mm (H)
- Power: 507 W（max）
- Telemetry: Medium 600 kbps (6.5GB/day)

Cosmic Ray Observations aboard the ISS and CALET program



Main CALET science objectives:

- ✧ **Electron observation** in 1 GeV - 20 TeV range. Design optimized for electron detection: high energy resolution and large e/p separation power + e.m. shower containment. Detailed study of spectral shape. Search for Dark Matter and Nearby Sources

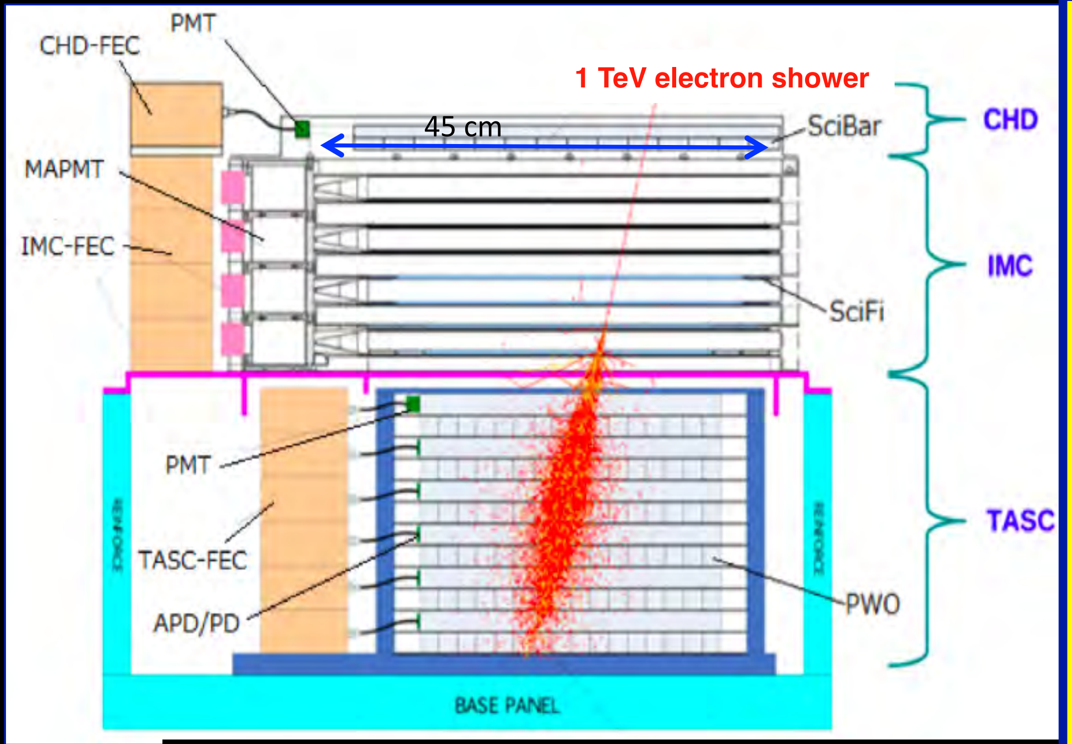
- ✧ **Observation of cosmic-ray nuclei** in the energy region from 10 GeV to 1 PeV. Unravelling the CR acceleration and propagation mechanism(s)

- ✧ Detection of **transient phenomena** in space Gamma-ray bursts, e.m. GW counterparts, Solar flares, Space Weather

Scientific Objectives	Observation Targets	Energy Range
CR Origin and Acceleration	Electron spectrum Individual spectra of elements from proton to Fe Ultra Heavy Ions ($26 < Z \le 40$) Gamma-rays (Diffuse + Point sources)	1GeV - 20 TeV 10 GeV - 1000 TeV $>$ 600 MeV/n 1 GeV - 1 TeV
Galactic CR Propagation	B/C and sub-Fe/Fe ratios	Up to some TeV/n
Nearby CR Sources	Electron spectrum	100 GeV - 20 TeV
Dark Matter	Signatures in electron/gamma-ray spectra	100 GeV - 20 TeV
Solar Physics	Electron flux (1GeV-10GeV)	$<$ 10 GeV
Gamma-ray Transients	Gamma-rays and X-rays	7 keV - 20 MeV

CALET instrument in a nutshell

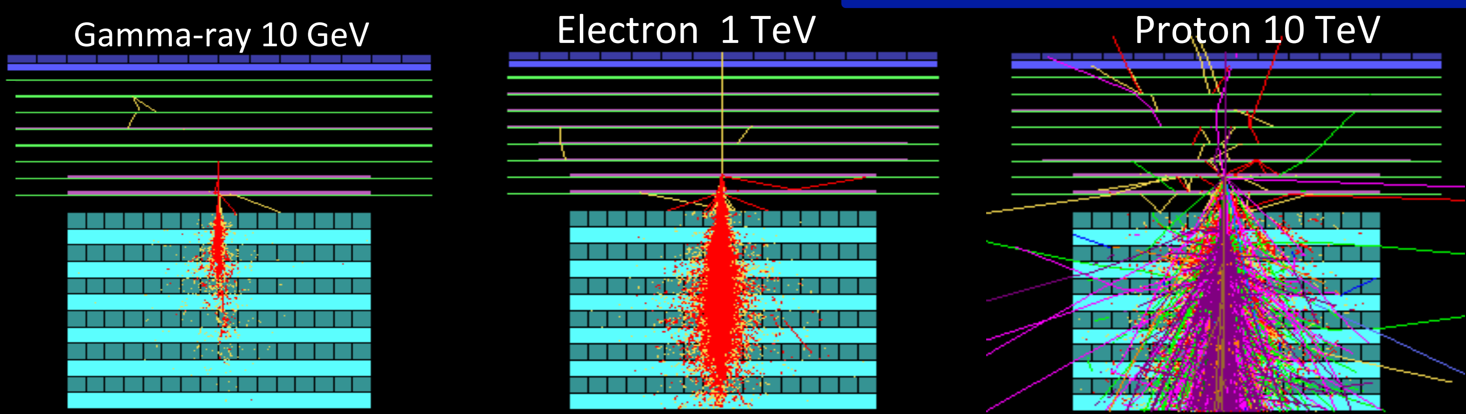
Field of view: ~ 45 degrees (from the zenith)   Geometrical Factor: ~ 1,040 $cm^2 sr$ (for electrons)



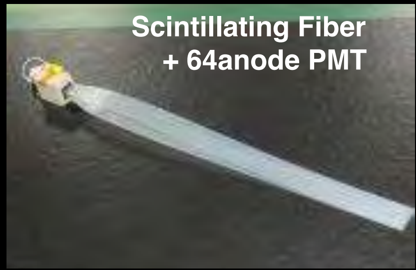
CALET: a unique set of key instruments

- **CHD**: a dedicated charge detector + multiple dE/dx sampling in the IMC allow the **identification of individual nuclear species** (charge resolution ~0.15-0.3 e).
- **IMC**: high granularity (1mm) imaging pre-shower calorimeter to accurately reconstruct **the arrival direction** of incident particles (~0.1°) and the **starting point** of electro-magnetic showers.
  Scifi + Tungsten absorbers: **3 X_0** (=0.2 X_0 x 5 + 1.0 X_0 x 2)
- **TASC**: thick (**27 X_0**) homogeneous PWO calorimeter allowing to extend electron measurements into the TeV energy region with ~2% **energy resolution**.
- **Combined** (**30 X_0, 1.2 λ_I**) they **separate electrons** from the abundant protons (rejection > 10^5).

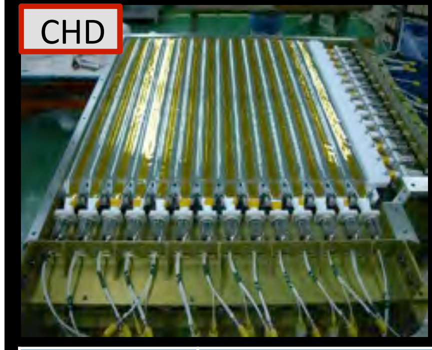
Simulated Shower Profile

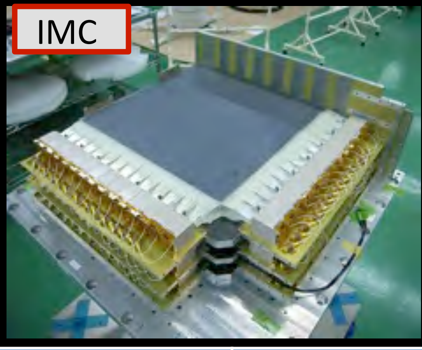


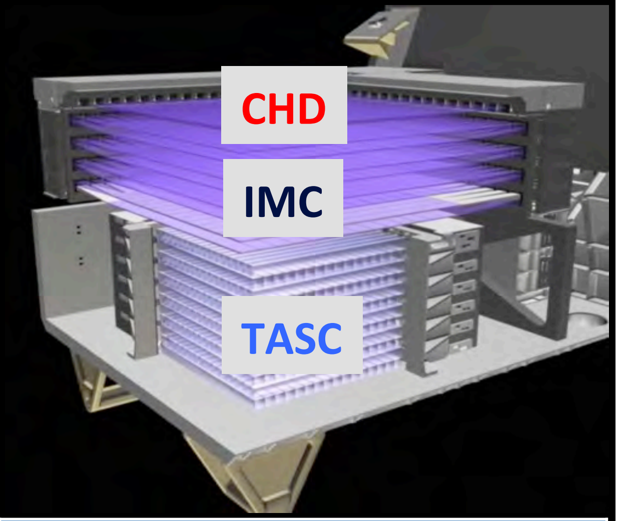
CALET Instrument overview



CALORIMETER





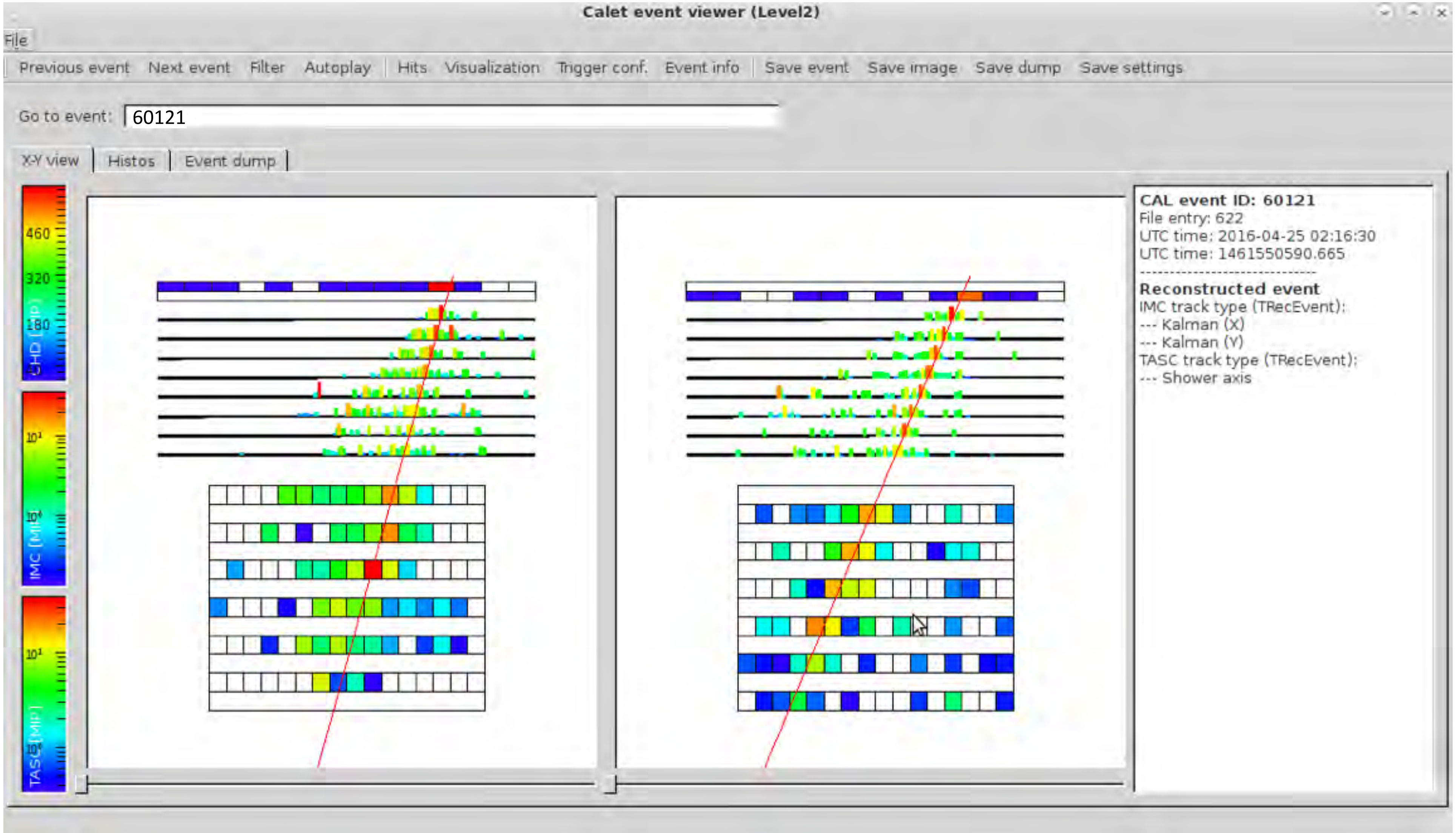


	CHD (Charge Detector)	IMC (Imaging Calorimeter)	TASC (Total Absorption Calorimeter)
Measure	**Charge (Z=1-40)**	**Tracking , Particle ID**	**Energy, e/p Separation**
Geometry (Material)	**Plastic Scintillators**: 28 paddles 14 paddles x 2 layers (X,Y) Paddle Size: 32 x 10 x 450 mm^3	**Scintillating Fibers**: 448 x 16 layers (X,Y) Scifi size: 1 x 1 x 448 mm^3 7 Tungsten layers : $0.2X_0$ x 5 + $1X_0$ x 2 Total Thickness: **3 X_0**	**PWO logs**: 16 x 12 layers (x,y): 192 logs log size: 19 x 20 x 326 mm^3 Total Thickness: **27 X_0 , ~1.2 λ_I**
Readout	**PMT+CSA**	**64-anode PMT+ ASIC**	**APD/PD+CSA PMT+CSA (for Trigger)@top layer**

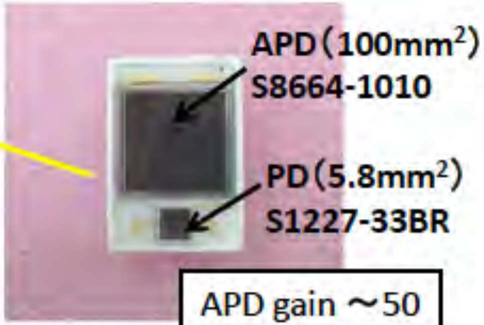
✧ CALET **tracking** takes advantage of the IMAGING capabilities of IMC thanks to its granularity of

1 mm with Sci-fibers **readout individually**

Example: A **multi-prong event** due to an interaction of the primary particle in the CHD is very well imaged by the IMC.

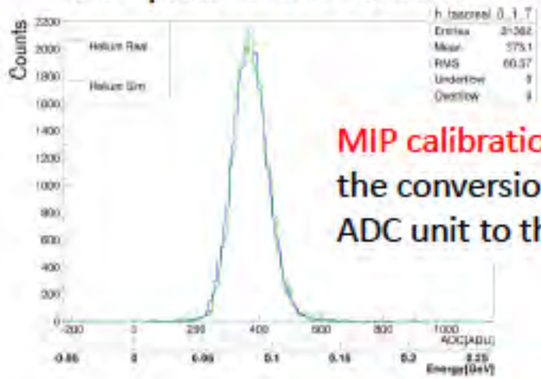


Energy Measurement in a wide dynamic range 1-10^6 MIPs

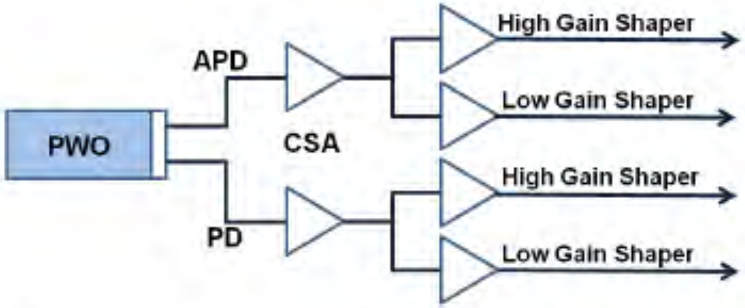


APD gain ~50

"MIP" peak in PWO: Obs. vs. MC



MIP calibration determines the conversion factor from ADC unit to the energy



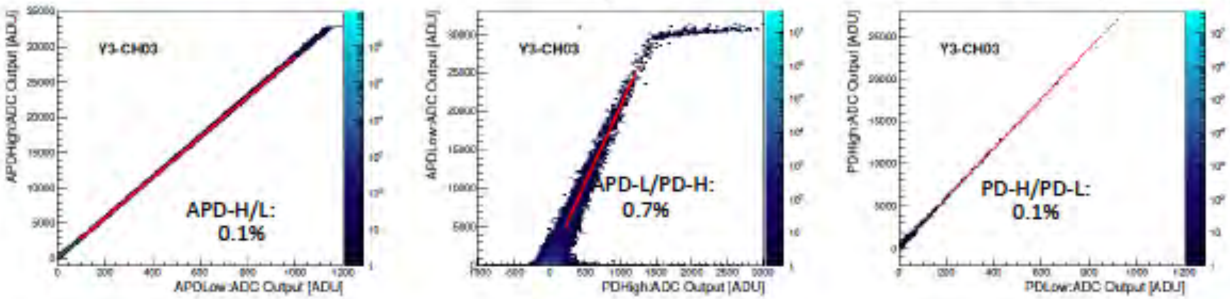
The whole dynamic range was calibrated by UV laser irradiation on ground :

1) The linearity of each gain range is confirmed in the range of 1.4-2.5 %.
2) Each channel covers from 1 MIP to 10^6 MIPs.

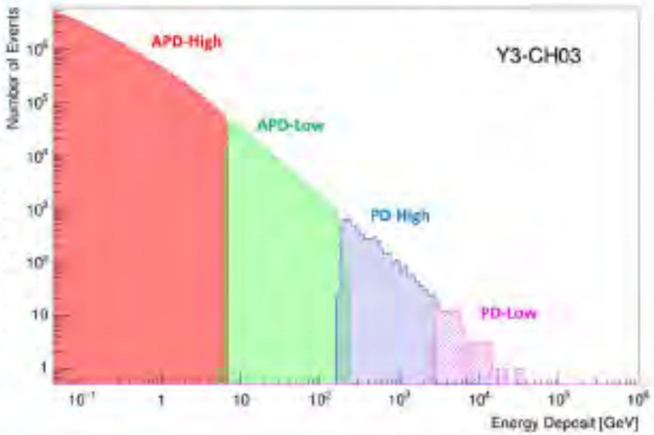
APD-H	APD-L	PD-H	PD-L
1.4%	1.5%	2.5%	2.2%

The correlation between adjacent gain ranges is calibrated by using in-flight data in each channel.

APD-H APD-L	APD-L PD-H	PD-H PD-L
0.1%	0.7%	0.1%



Example of energy distribution in one PWO log

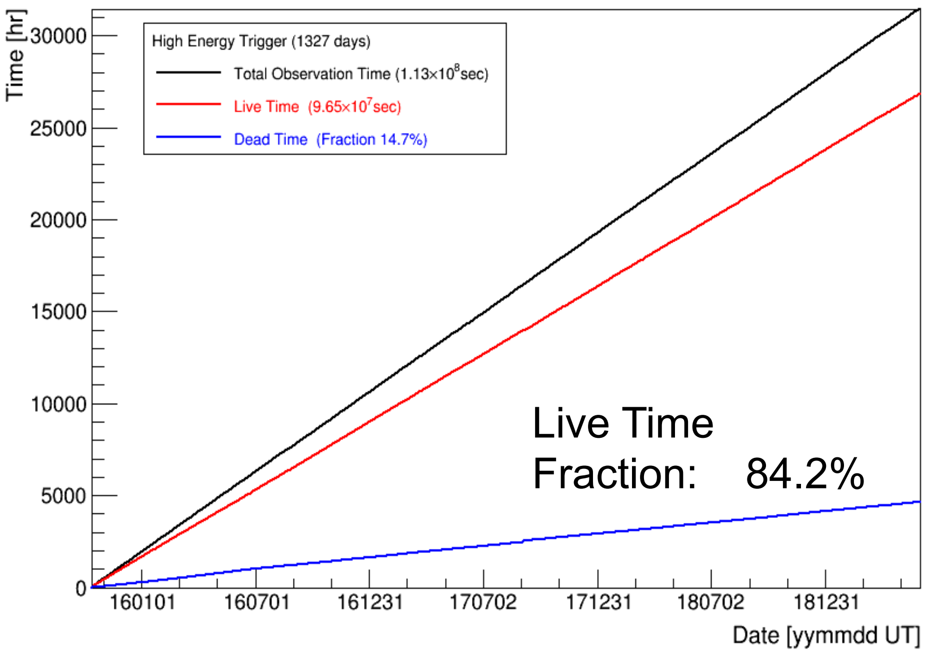


Observations with High Energy Trigger (>10GeV)

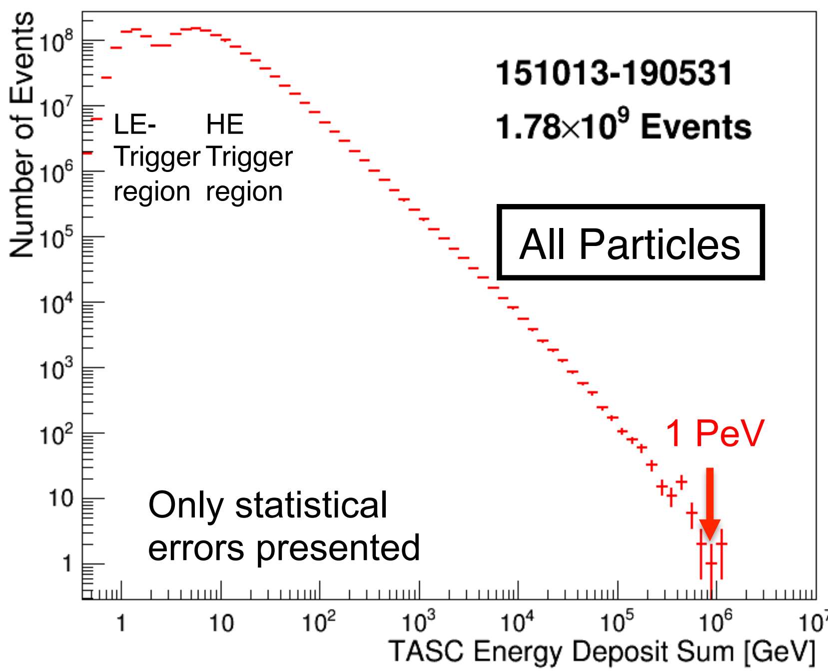
Observation with High Energy Trigger for 1327 days : Oct.13, 2015 – May 31, 2019

- The exposure, SΩT, has reached ~116 m^2 sr day for electron observations under continuous and stable operations.
- Total number of triggered events is ~1.8 billion with a live time fraction of ~84 %.

Accumulated observation time (live, dead)

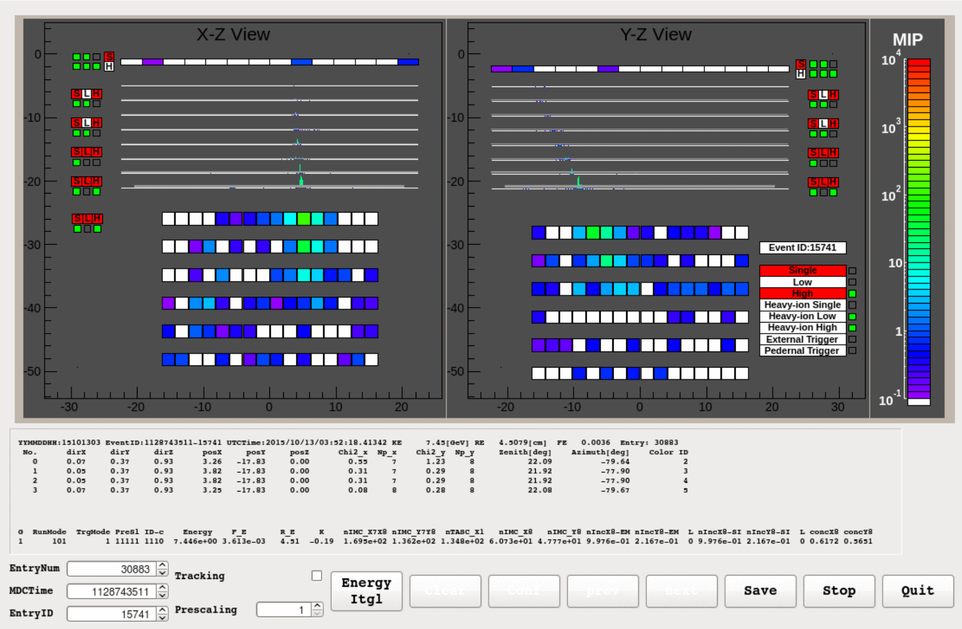


Distribution of deposit energies (ΔE) in TASC

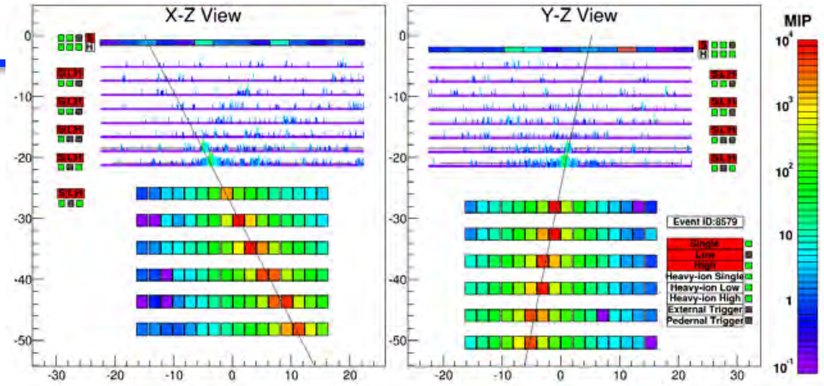


Examples of Observed Events

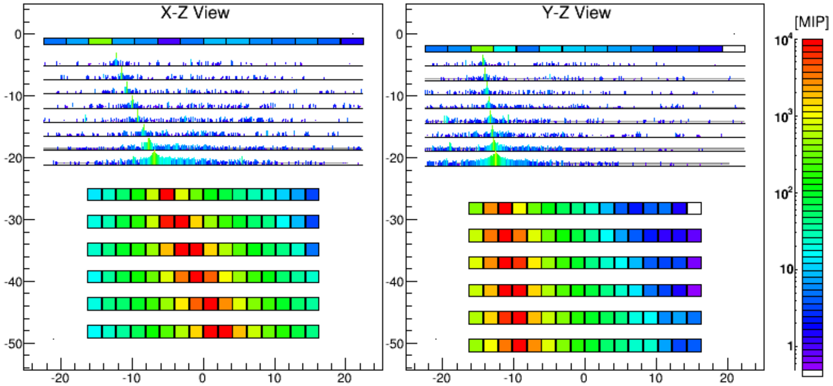
Event Display: Electron Candidate (>100 GeV)



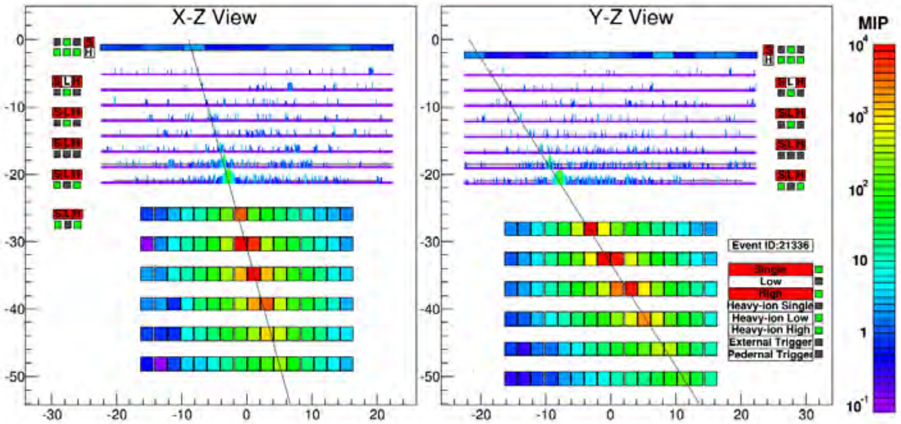
Proton, ΔE=2.89 TeV



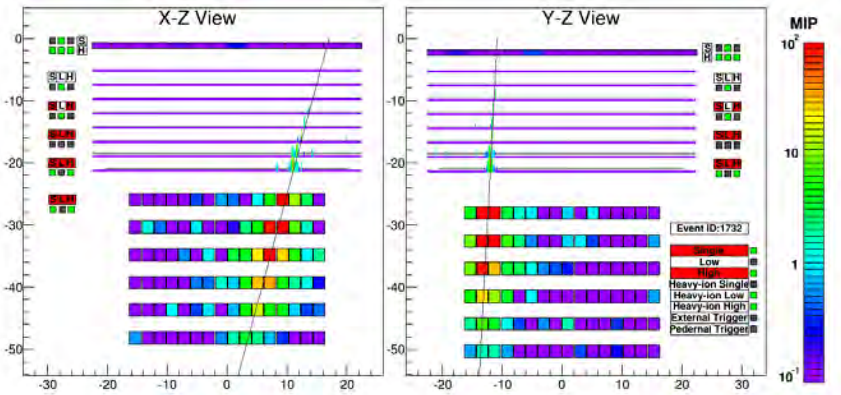
Fe, ΔE=9.3 TeV



Electron, E=3.05 TeV

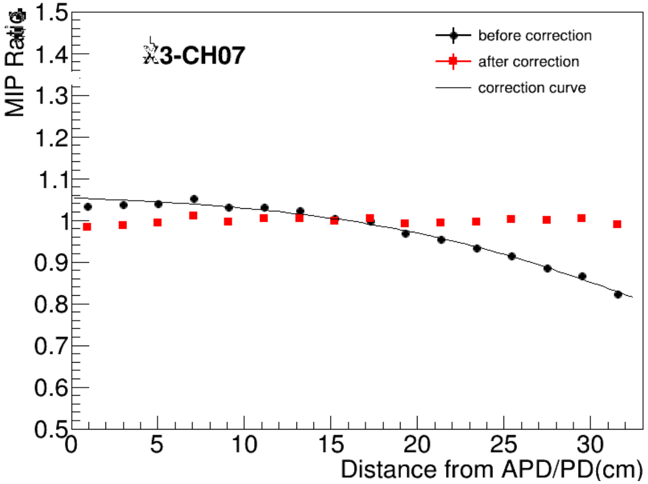


Gamma-ray, E=44.3 GeV

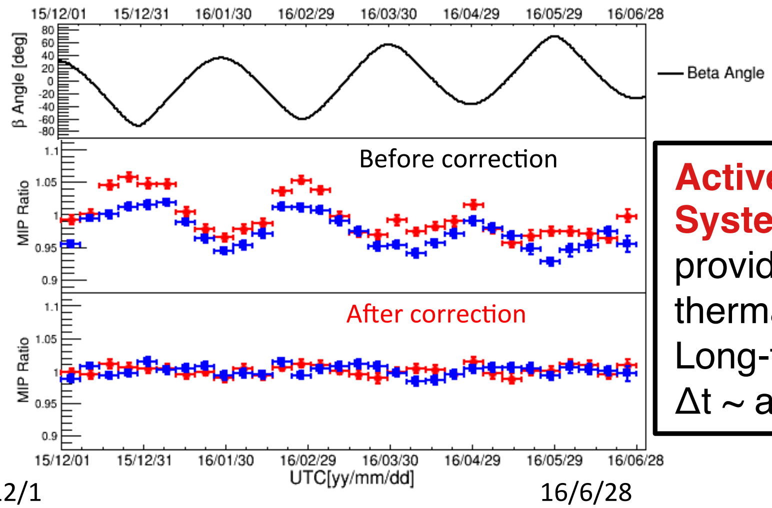


Position and Temperature Calibration + Long-term Stability

Example of position dependence correction



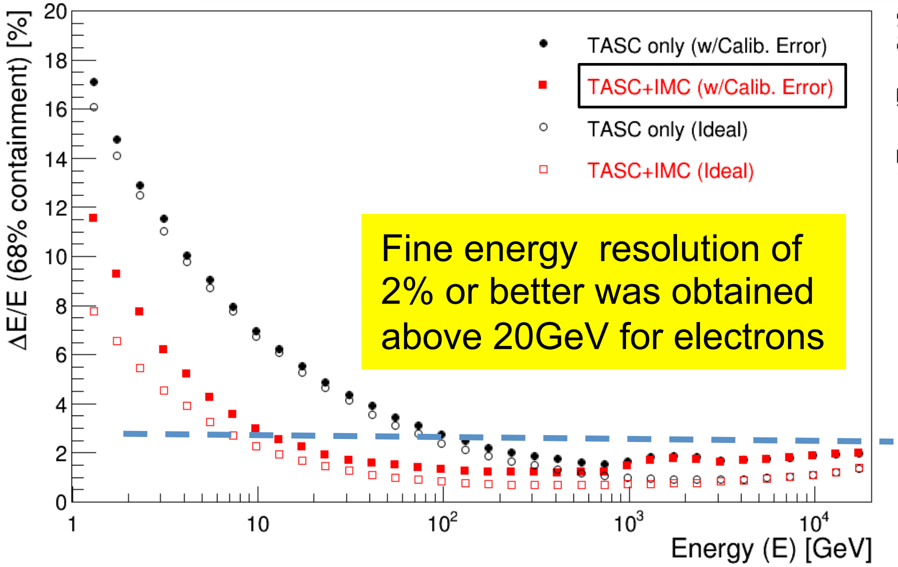
Examples of temperature change correction



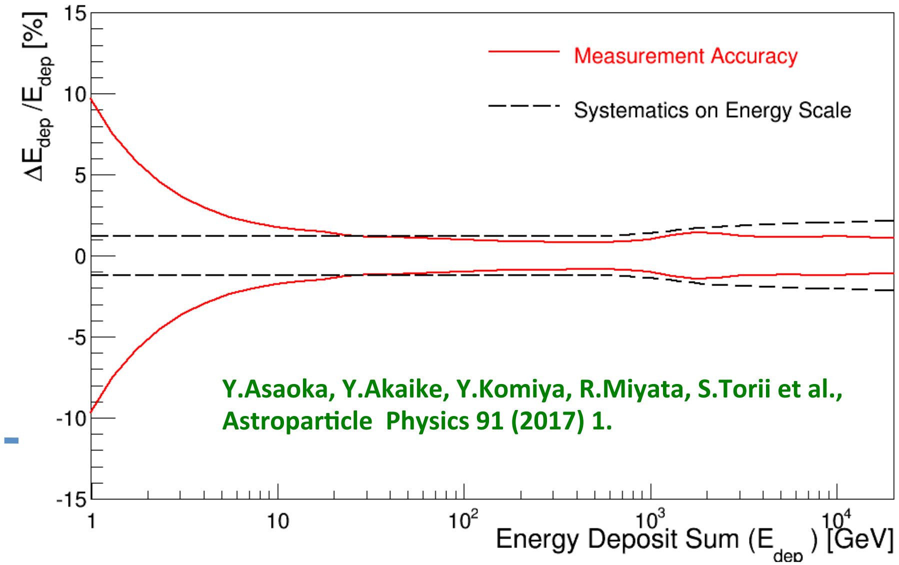
TASC

Active Thermal Control System (ATCS) on ISS provides very stable thermal condition during Long-tem observations: Δt ~ a few degrees

Energy Resolution for Electrons by On-orbit Calibration



Fine energy resolution of 2% or better was obtained above 20GeV for electrons



Y.Asaoka, Y.Akaike, Y.Komiya, R.Miyata, S.Torii et al., Astroparticle Physics 91 (2017) 1.

Electron / Proton Discrimination [Y.Asaoka, COSPAR 2108 E1.5-0023-18]

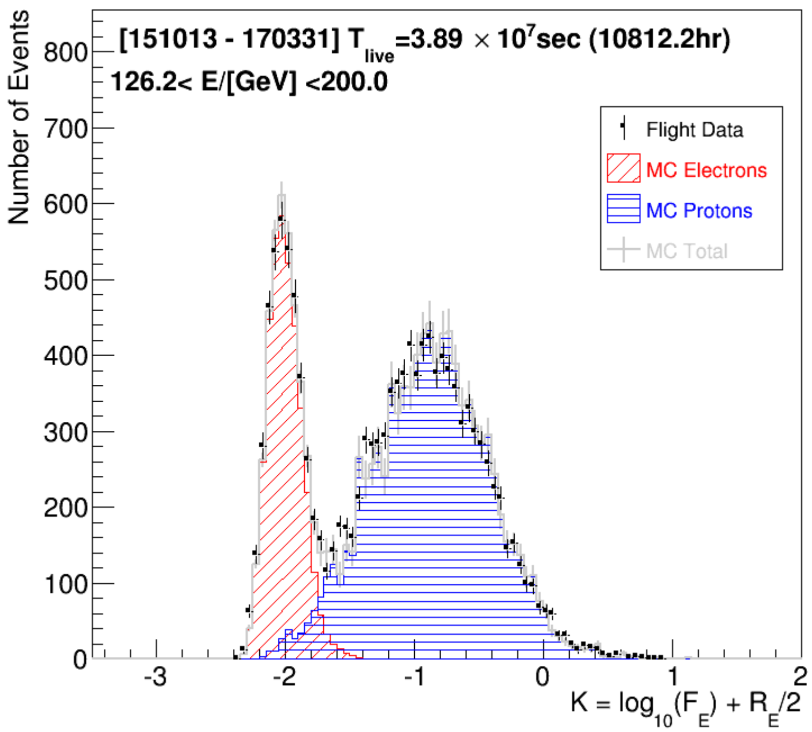
Simple Two Parameter Cut

F_E: Energy fraction of the bottom layer sum to the whole energy deposit sum in TASC

R_E: Lateral spread of energy deposit in TASC-X1

Cut Parameter K is defined as follows:

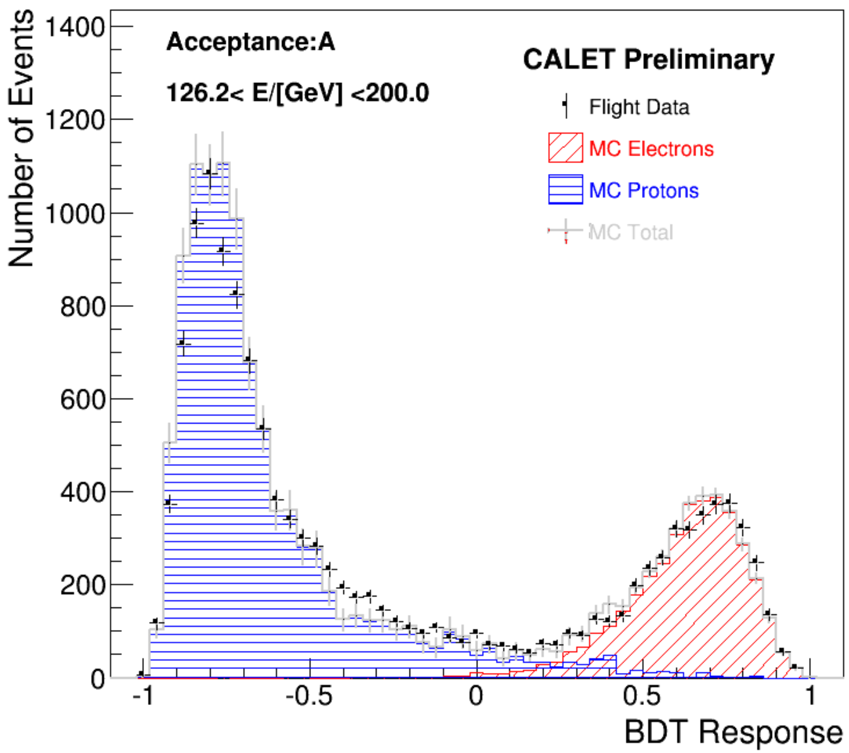
$K = \log_{10}(F_E) + 0.5\ R_E$ (/cm)



Boosted Decision Trees (BDT)

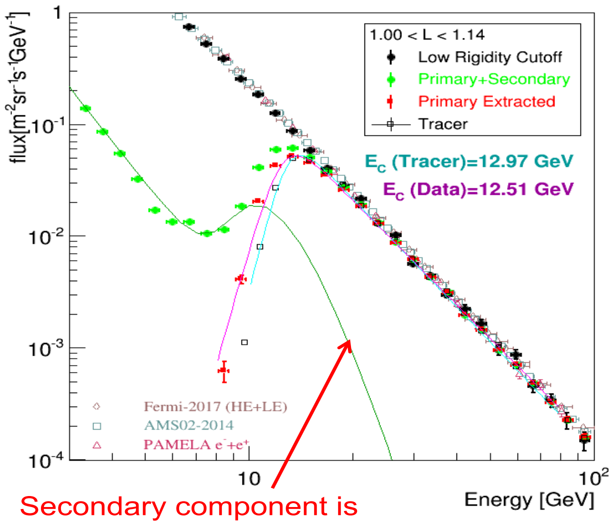
In addition to the two parameters on the left, TASC and IMC shower profile fits are used as discriminating variables

BDT Response using 9 parameters



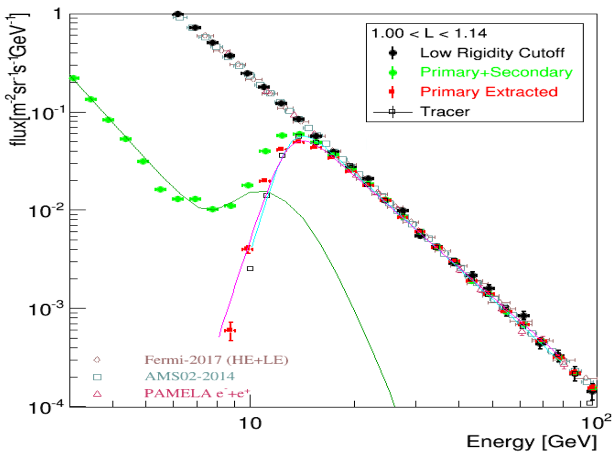
Cutoff Rigidity Measurements and Comparison with Calculation

BEFORE CORRECTION

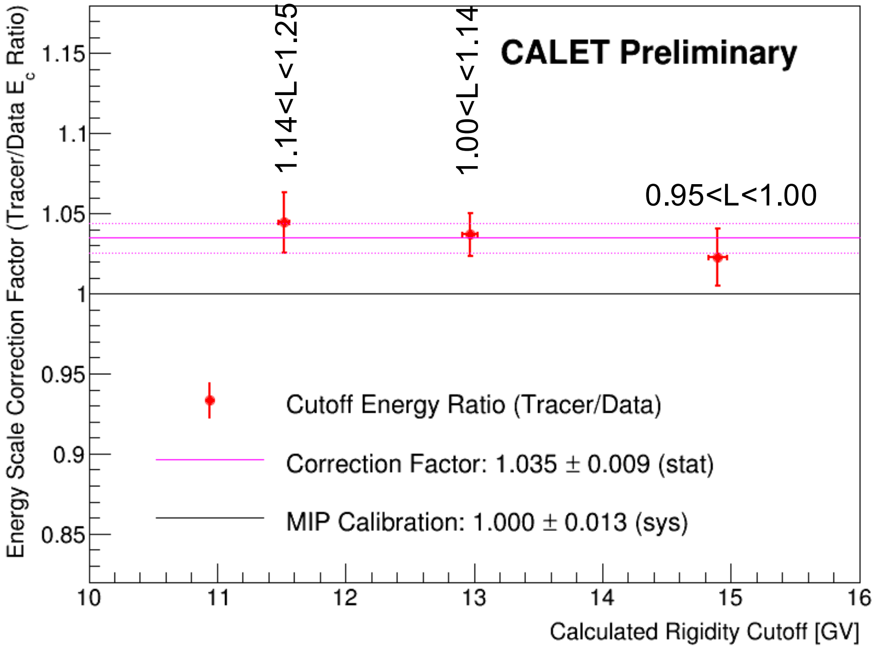


Secondary component is estimated using azimuthal distributions

AFTER CORRECTION



- Performed in three different cutoff rigidity regions.
- Correction factor was found to be **1.035** compared to MIP calibration.



[Y.Asaoka, COSPAR 2018 E1.5-0023-18]

[S.Miyake, COSPAR 2018 E1.5-0027-18]

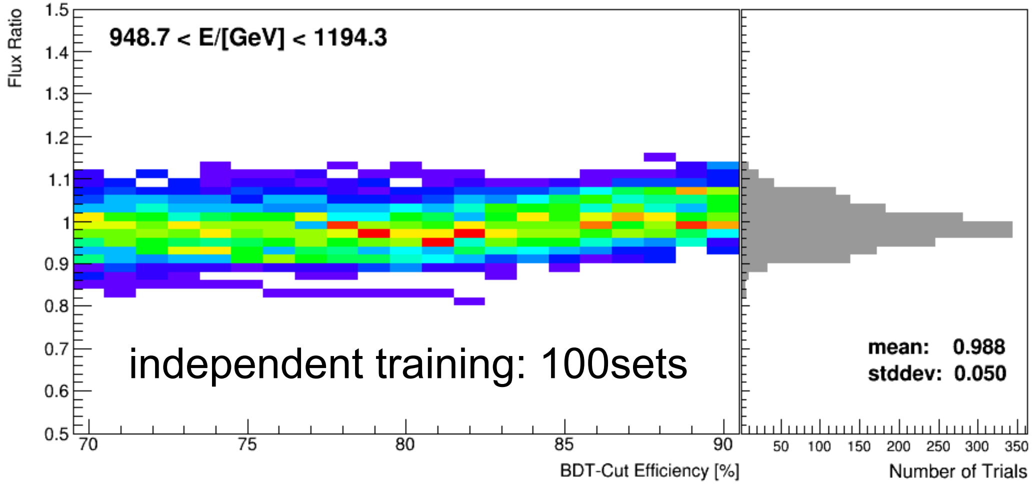
Systematic Uncertainties in Derivation of Energy Spectrum

The stability of the measured flux is intensively studied in the large parameter space of analysis selection criteria, including:

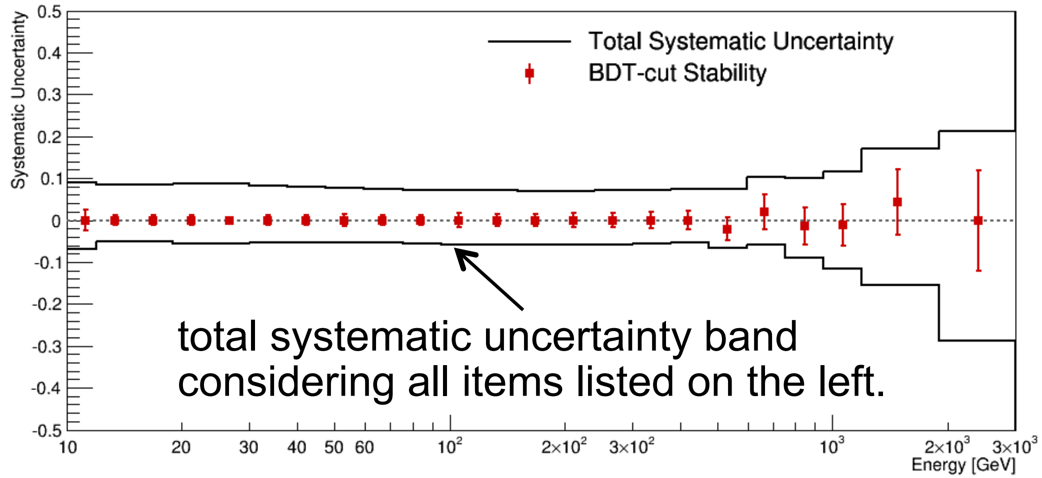
- Normalization:
  - Live time
  - Radiation environment
  - Long-term stability
  - Quality cuts
- Energy dependent:
  - Tracking
  - charge ID
  - electron ID (K-Cut vs BDT)
  - BDT stability (vs efficiency & training)
  - MC model (EPICS vs Geant4)

[Y.Asaoka, COSPAR 2018 E1.5-0023-18]

Systematic uncertainty in electron selection by BDT



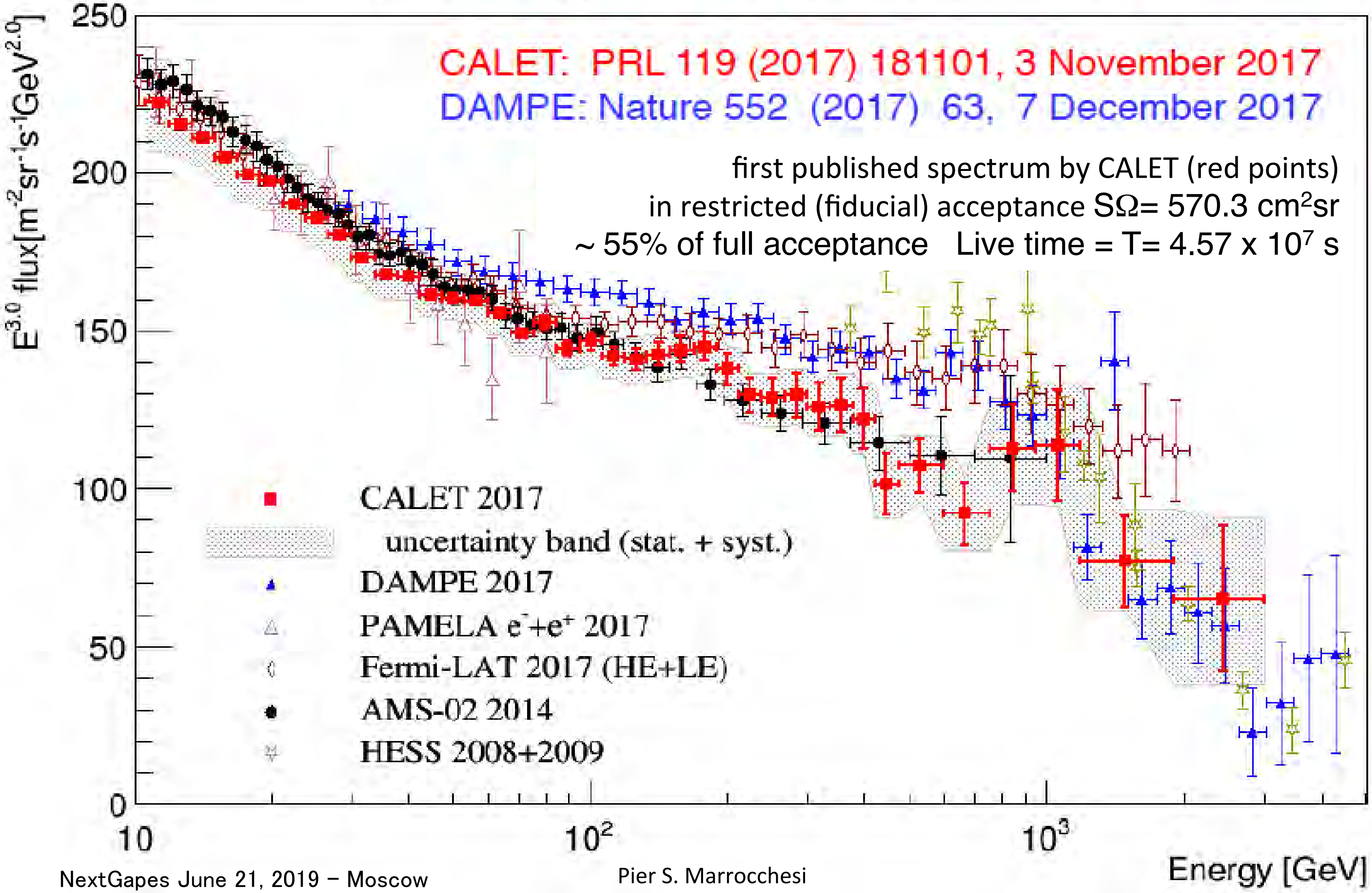
Total systematic uncertainty vs Energy



N.B. Energy scale uncertainty is not included in this analysis.

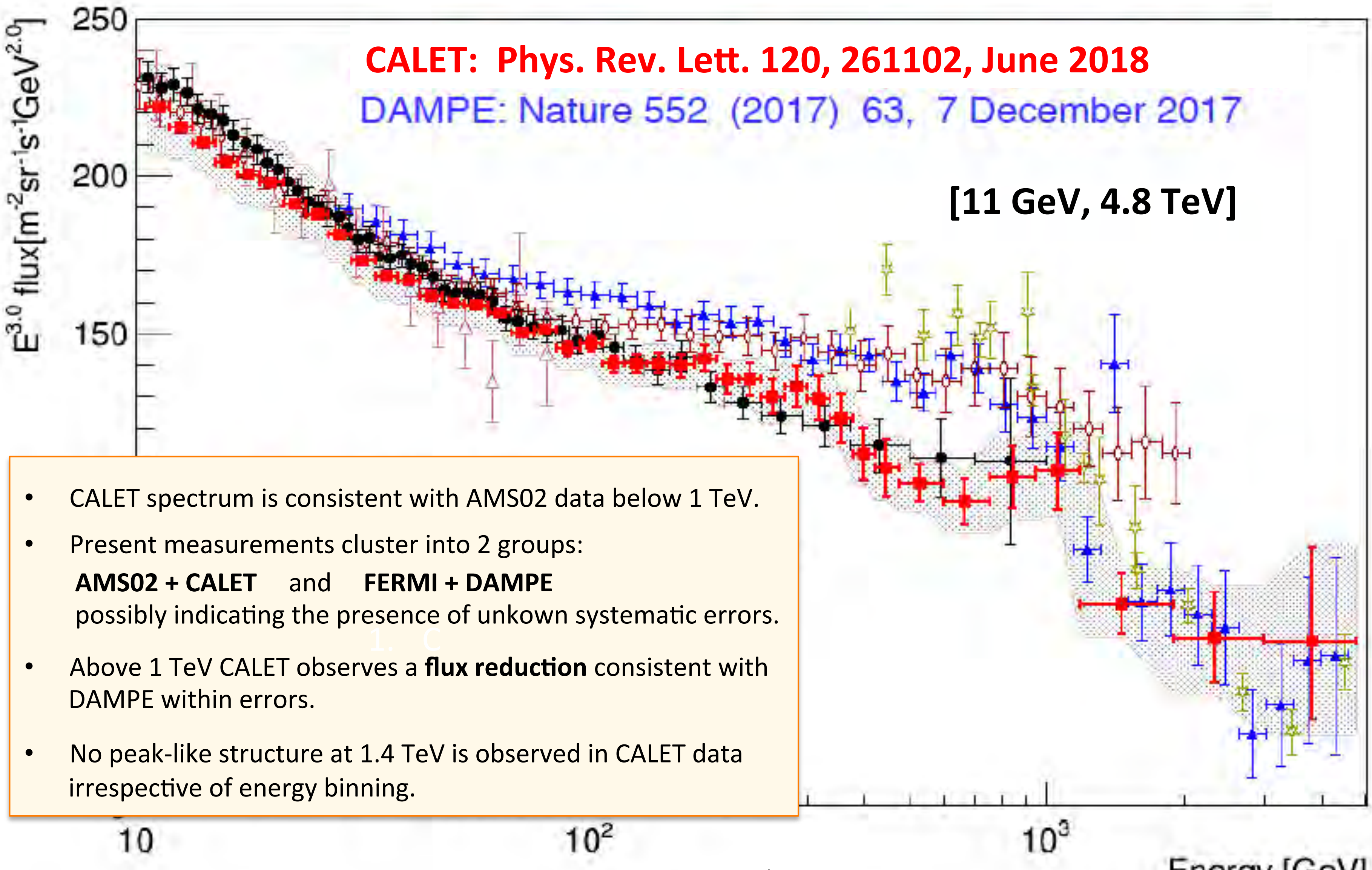
Direct measurements of the electron spectrum

Comparison of CALET with DAMPE and other experiments in space



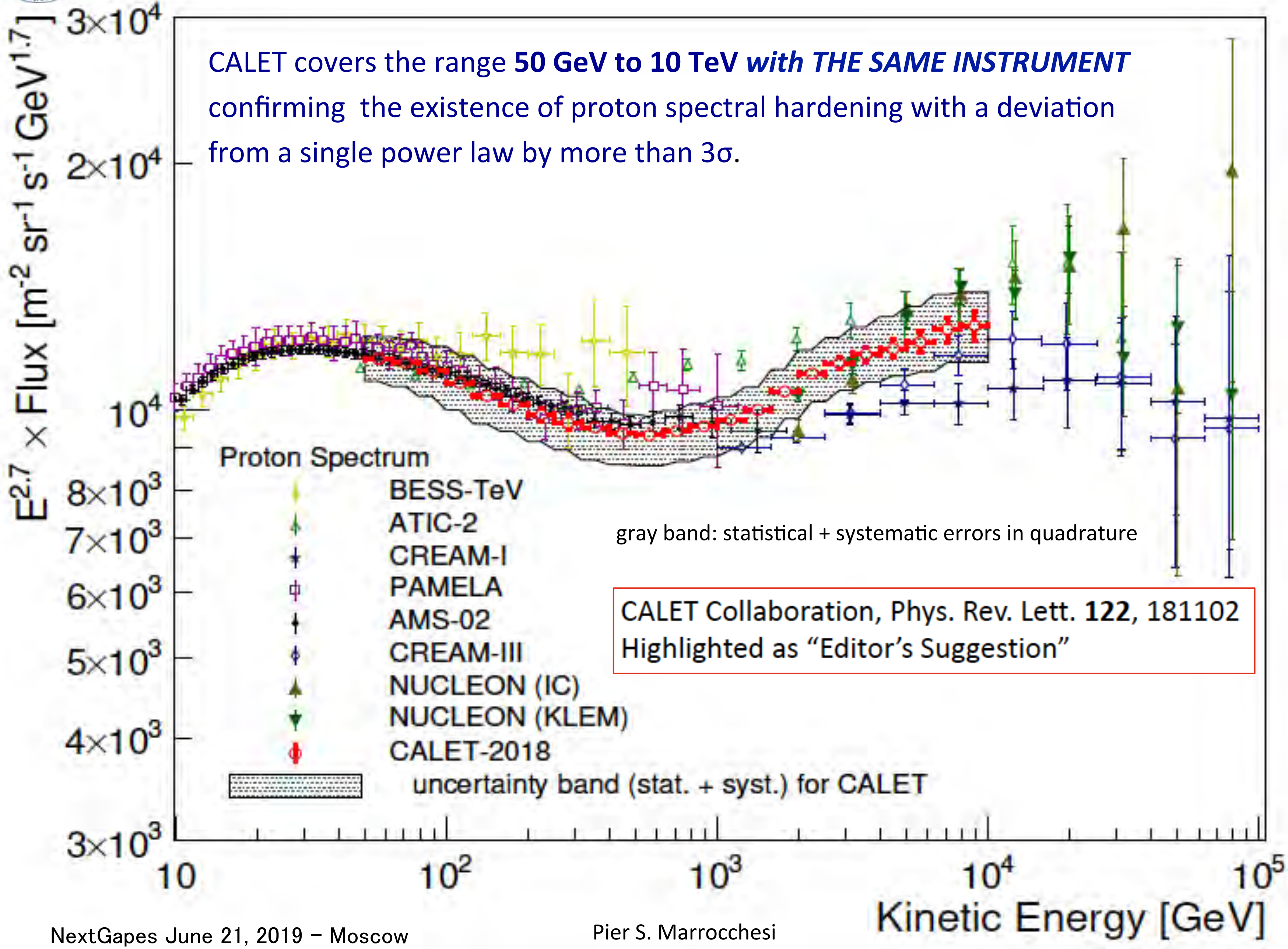
Extended CALET measurement of electron spectrum

Approximately doubled statistics above 500GeV by using full acceptance of CALET

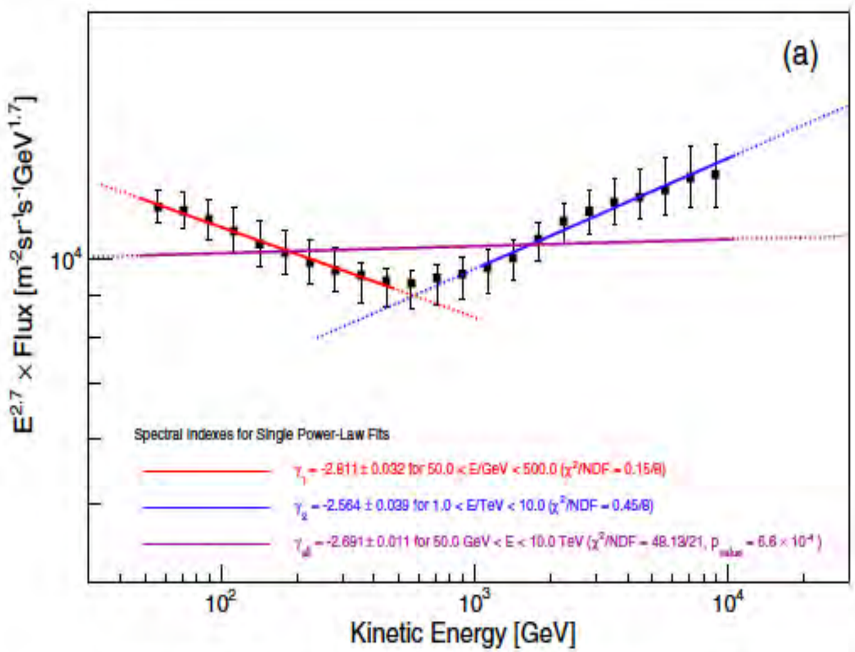


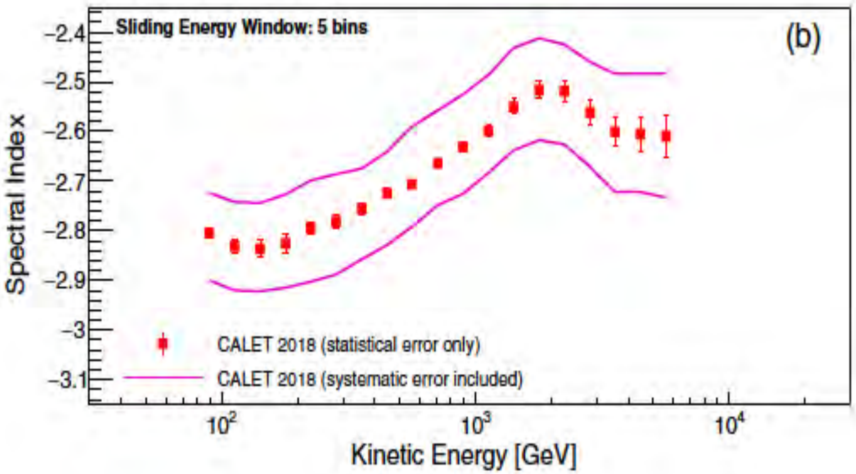
- CALET spectrum is consistent with AMS02 data below 1 TeV.
- Present measurements cluster into 2 groups:
  AMS02 + CALET and **FERMI + DAMPE**
  possibly indicating the presence of unkown systematic errors.
- Above 1 TeV CALET observes a **flux reduction** consistent with DAMPE within errors.
- No peak-like structure at 1.4 TeV is observed in CALET data irrespective of energy binning.

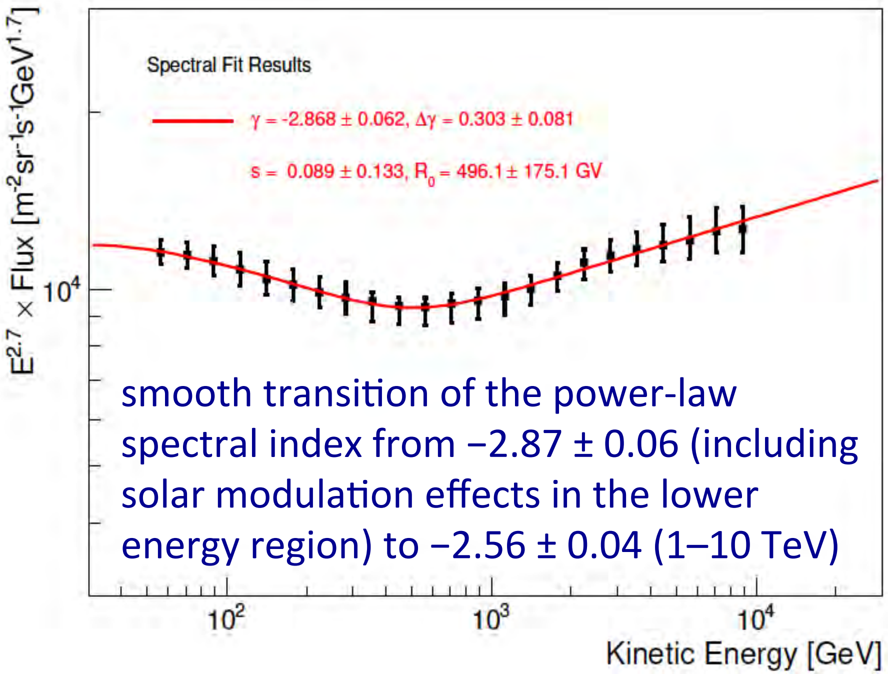
Direct measurement of proton spectrum by CALET



Spectral Behavior of Proton Flux



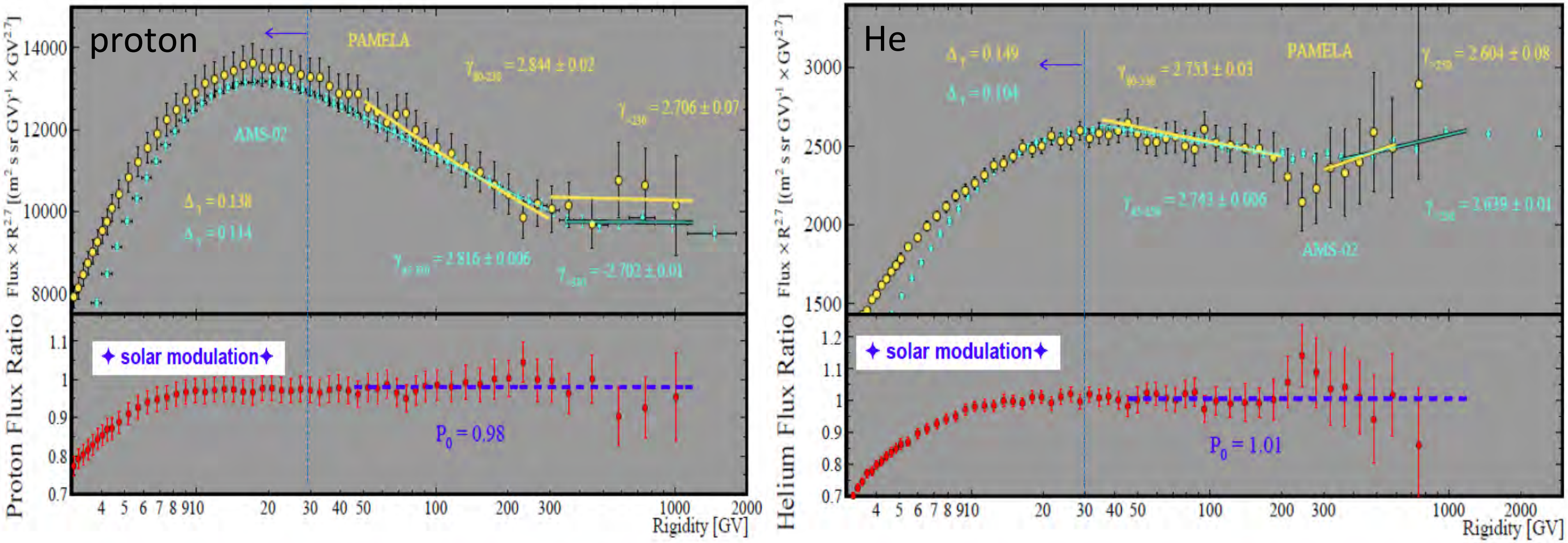




1. Subranges of 50—500GeV, 1-10TeV can be fitted with single power law function, but not the whole range (significance > 3σ).
2. Progressive hardening up to the TeV region was observed.
3. “smoothly broken power-law fit” gives power law index consistent with AMS-02 in the low energy region, but shows larger index change and higher break energy than AMS-02.

New era of precision spectral measurements:

- **p and He below 100 GeV:** % level agreement of magnetic spectrometers (BESS-TeV, PAMELA, AMS02)
- good agreement of PAMELA and AMS-02 on p and He spectra **below a few hundred GeV**



[M.Boezio @LNGS Jul 2016]

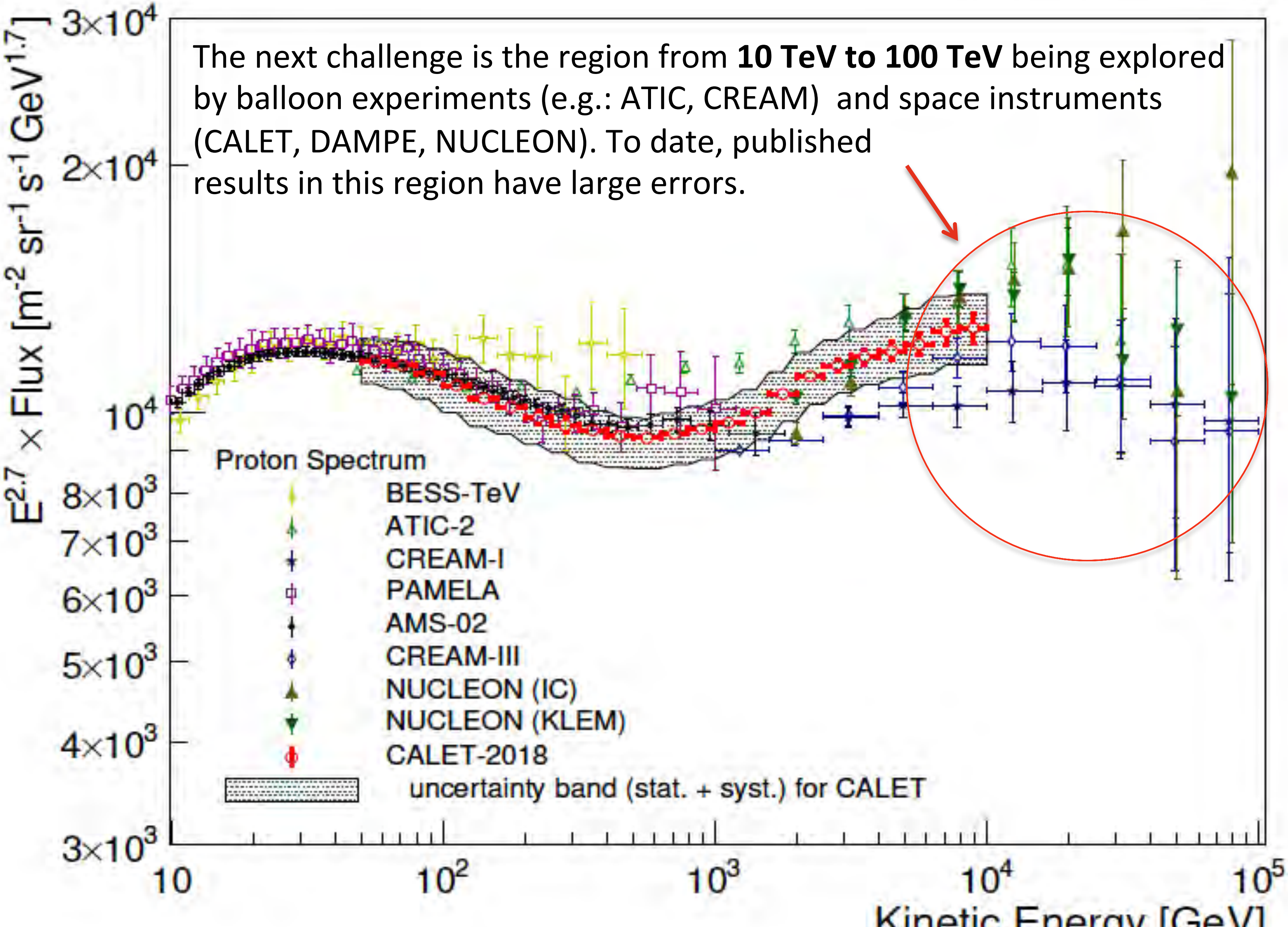
O. Adriani et al., Phys. Rep. 544 (2014) 323 ; M. Aguilar et al., PRL 114 (2015) 171103

O. Adriani et al., Science 332 (2011) 6025 ; M. Aguilar et al., PRL 115, (2015) 211101

	fit range proton	γ_p	fit range He	γ_{He}
PAMELA	80-230 GV	-2.844±0.02	80-250 GV	-2.753±0.03
AMS-02	45-330 GV	-2.816±0.006	45-250 GV	-2.743±0.006

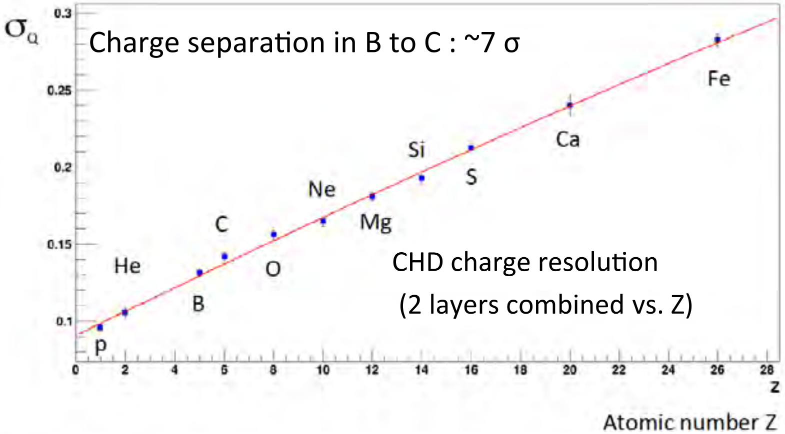
Direct measurements of proton spectrum to date

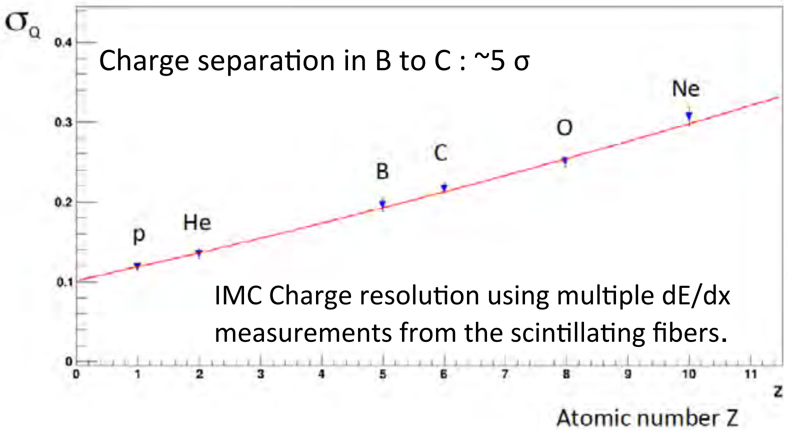
The next challenge is the region from **10 TeV to 100 TeV** being explored by balloon experiments (e.g.: ATIC, CREAM) and space instruments (CALET, DAMPE, NUCLEON). To date, published results in this region have large errors.



Charge Identification of Nuclei with CHD and IMC

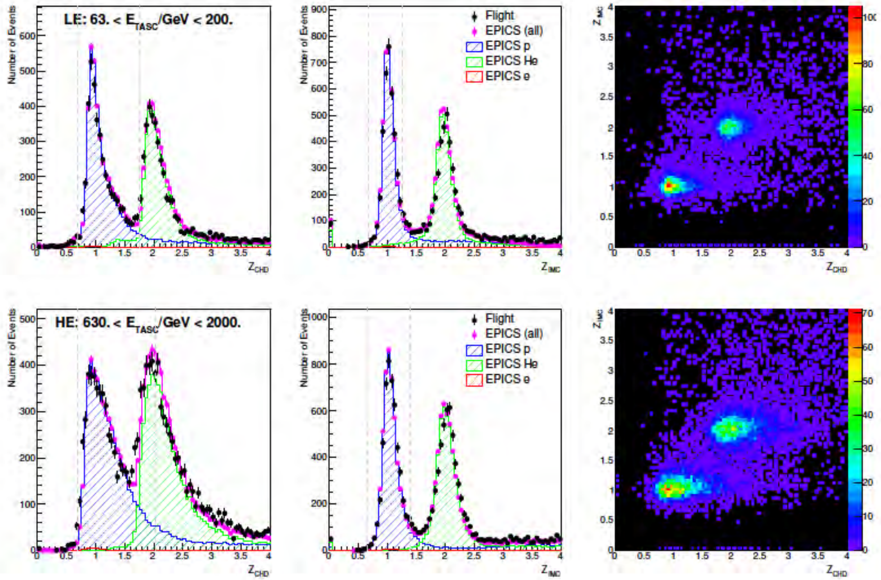
Single element selection for p, He and light nuclei is achieved by CHD+IMC charge analysis.

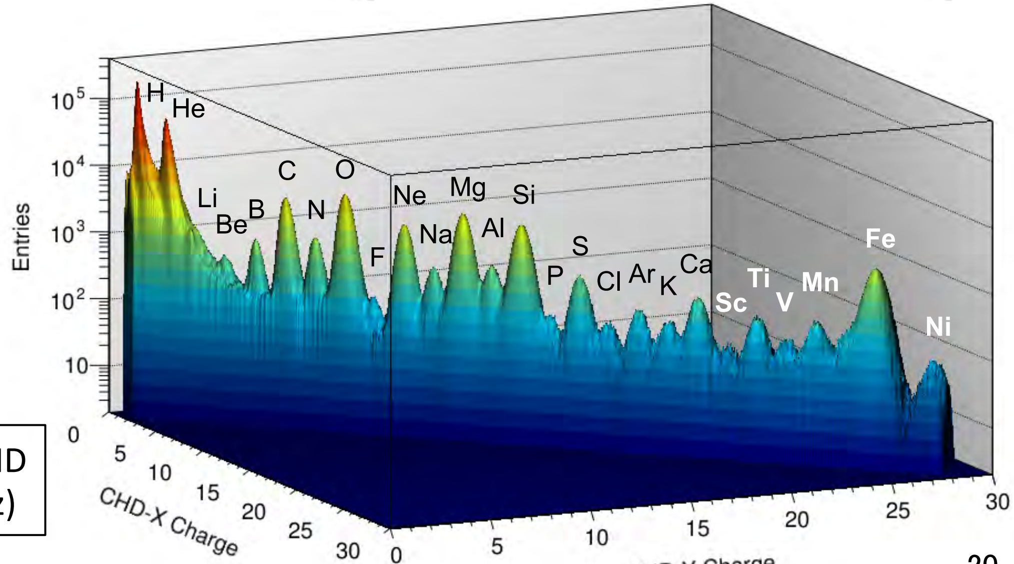




Deviation from Z^2 response is corrected both in CHD and IMC using a core + halo ionization model (Voltz)

Combined CHD-IMC proton-Helium charge-ID



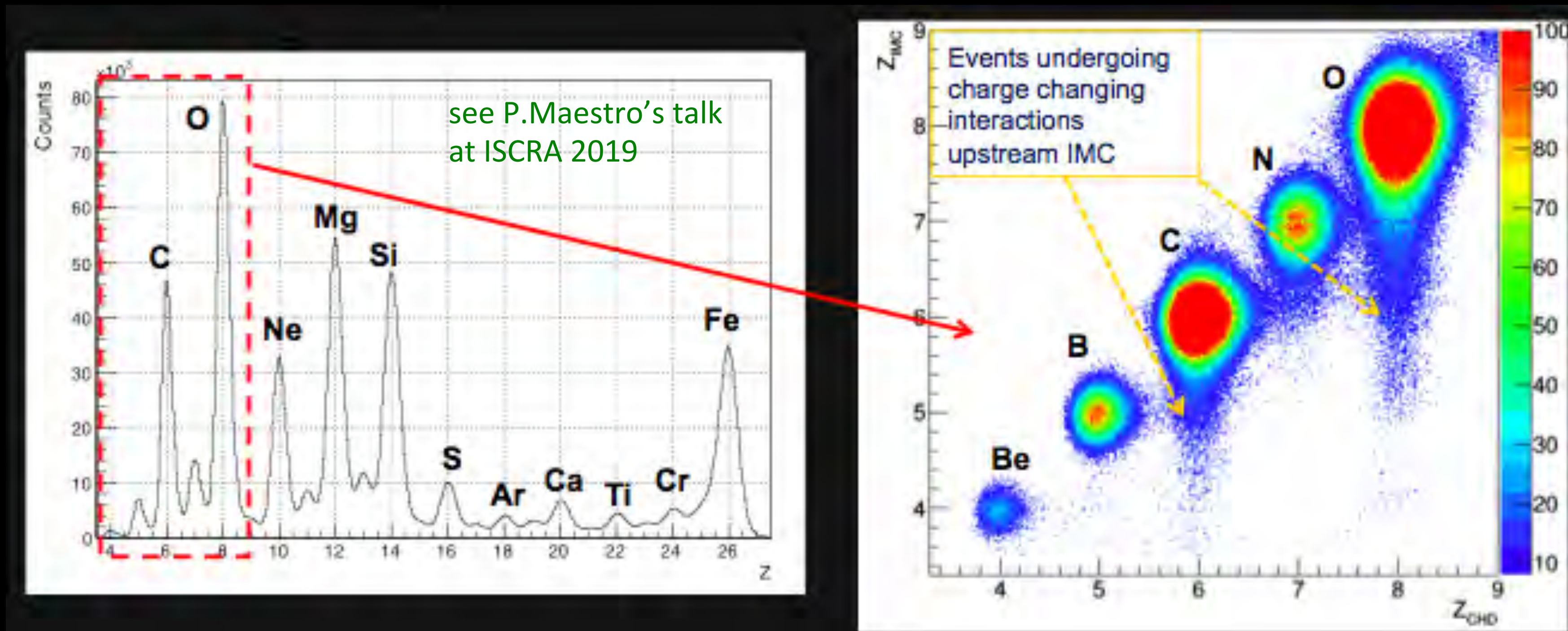


Observation of Light Nuclei

- CALET can identify individual elements thanks to the redundant charge determination in CHD and IMC and the excellent charge resolution.

Left: well resolved charge peaks from Be to Fe (all plots are in units of atomic number Z)

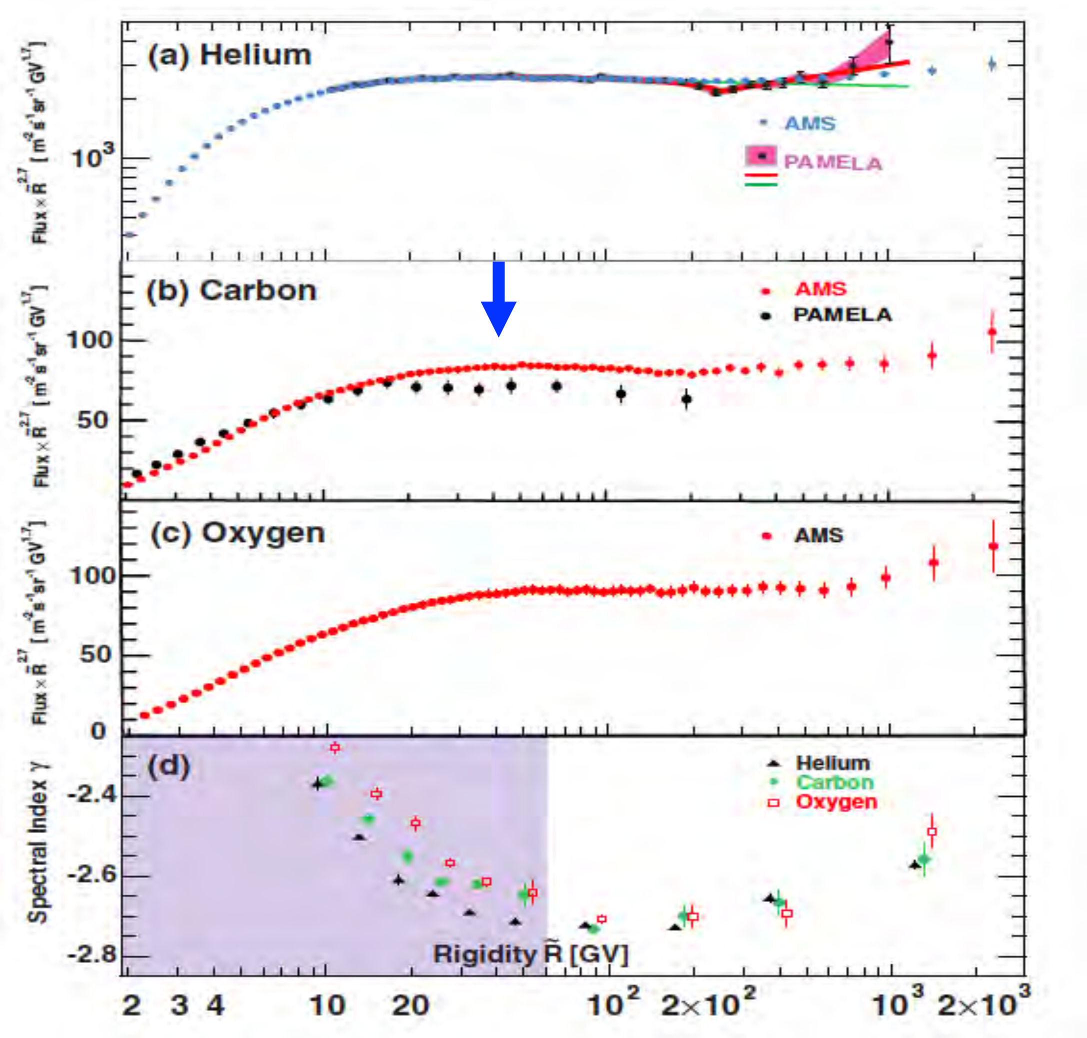
Right: Scatter plot of IMC vs CHD charge



Light Primaries: Carbon and Oxygen

fluxes vs Rigidity from PAMELA and AMS

2018

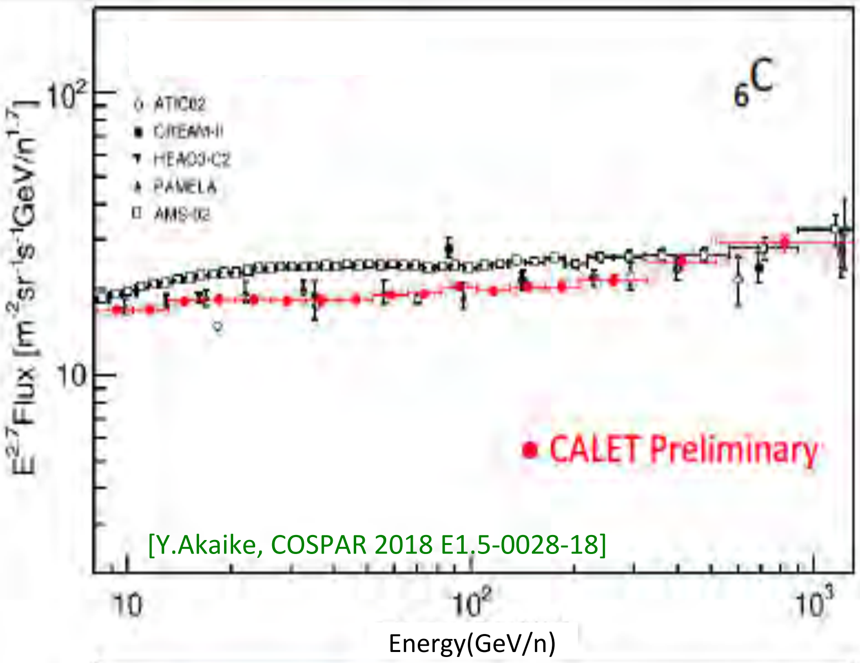


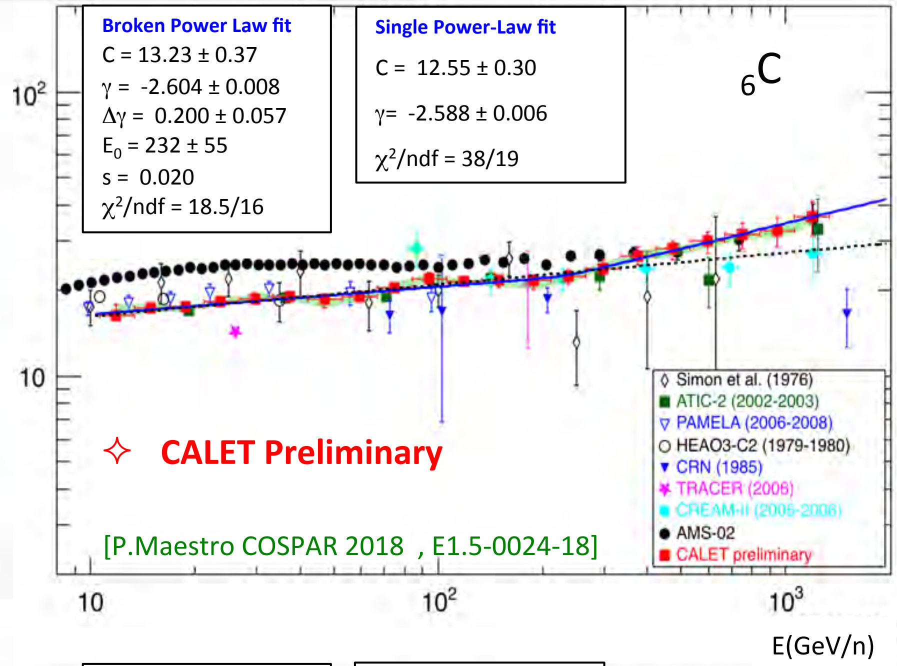
above ~10 GV AMS **carbon** flux is ~15 % higher than PAMELA

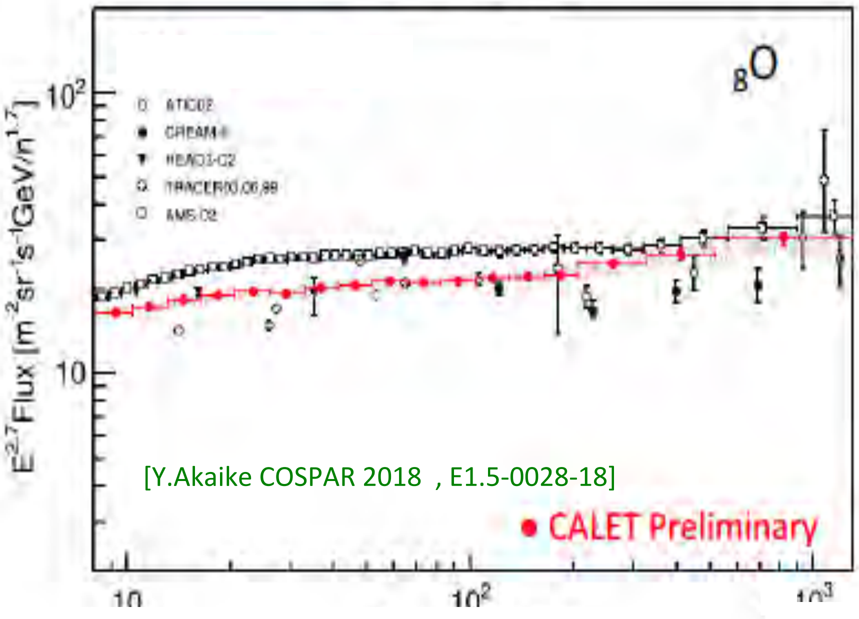
no published data for **oxygen** flux by PAMELA

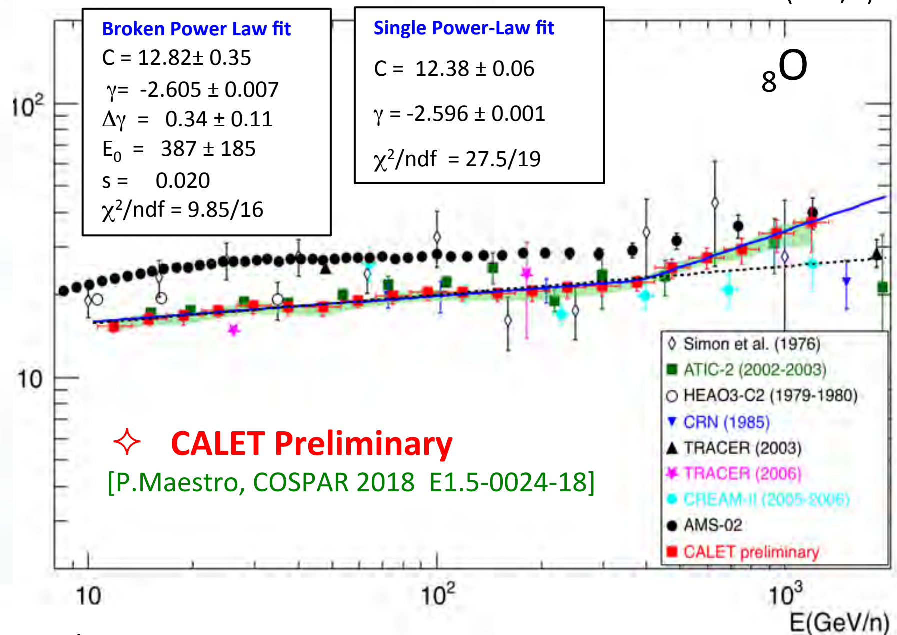
Rigidity (GV)

Preliminary Energy spectra of Carbon and Oxygen (2 independent CALET analyses)

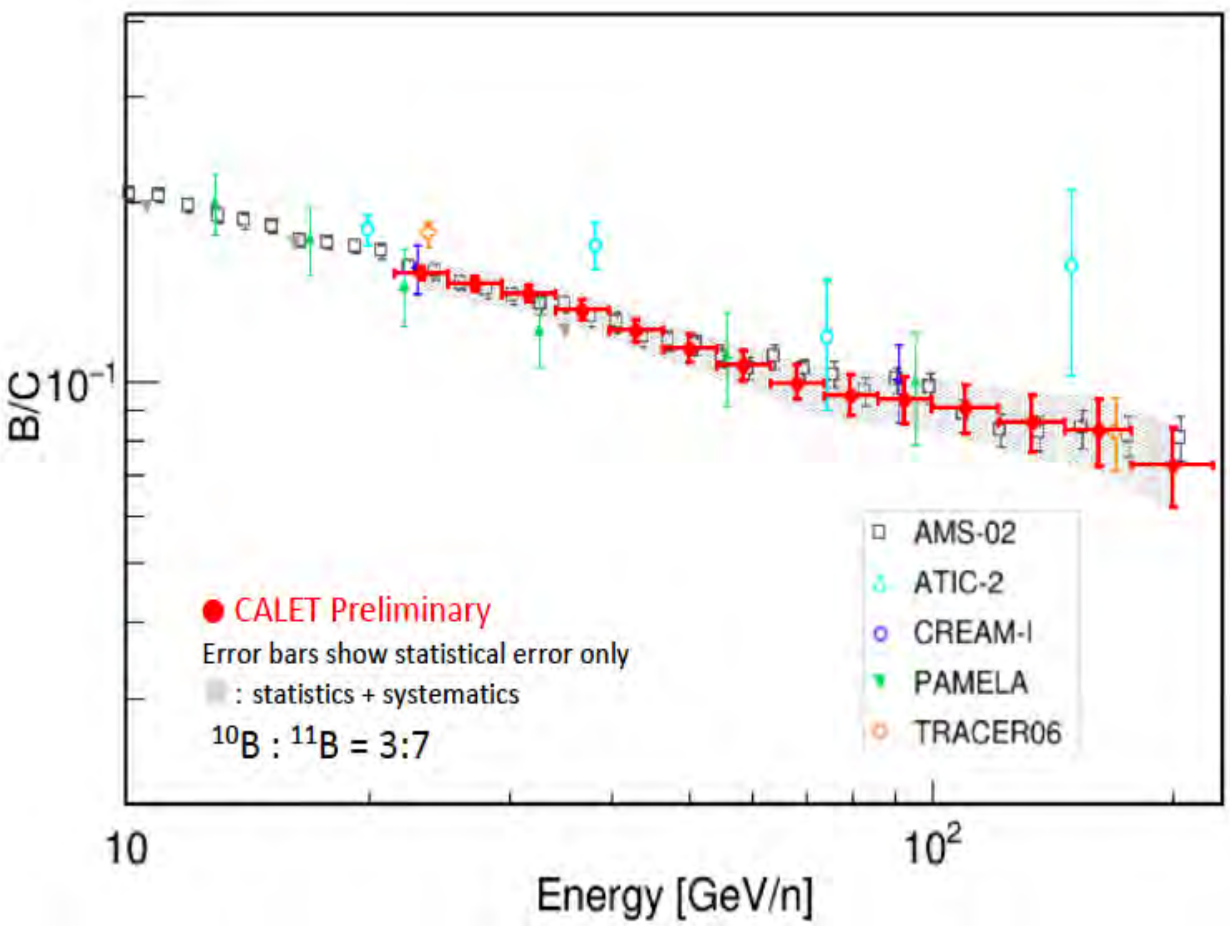








Boron-to-carbon flux ratio (Preliminary)



[Y. Akaike, APS April 14, 2019]

$^{10}B : ^{11}B = 3:7$

Source of systematic uncertainties

- Trigger efficiency
- Charge consistency cuts
- Track width selection
- Window range for charge identification
- Background model of p and He spectra
- Initial assuming spectra for energy unfolding
- Energy correction base on beam test results
- Difference of beam test model and flight model
- Long term stability

Preliminary Flux of Primary Components

Flux measurements:

$$\Phi(E) = \frac{N(E)}{S\Omega\varepsilon(E)T\Delta E}$$

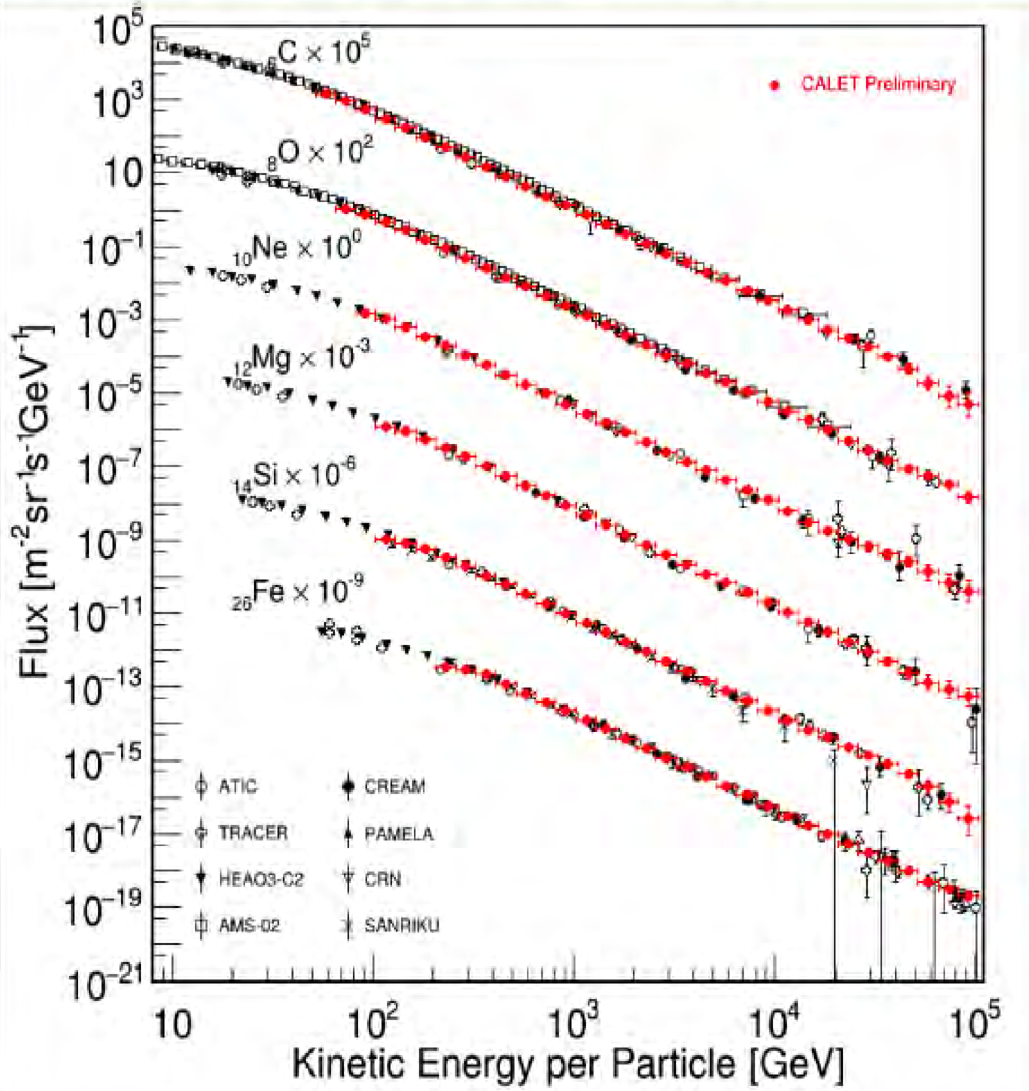
N(*E*) : Events in unfolded energy bin
SΩ : Geometrical acceptance
ε(*E*) : Efficiency
T : Live Time
ΔE : Energy bin width

Observation period:

Oct.13 2015 – May.31 2018
(962 days)

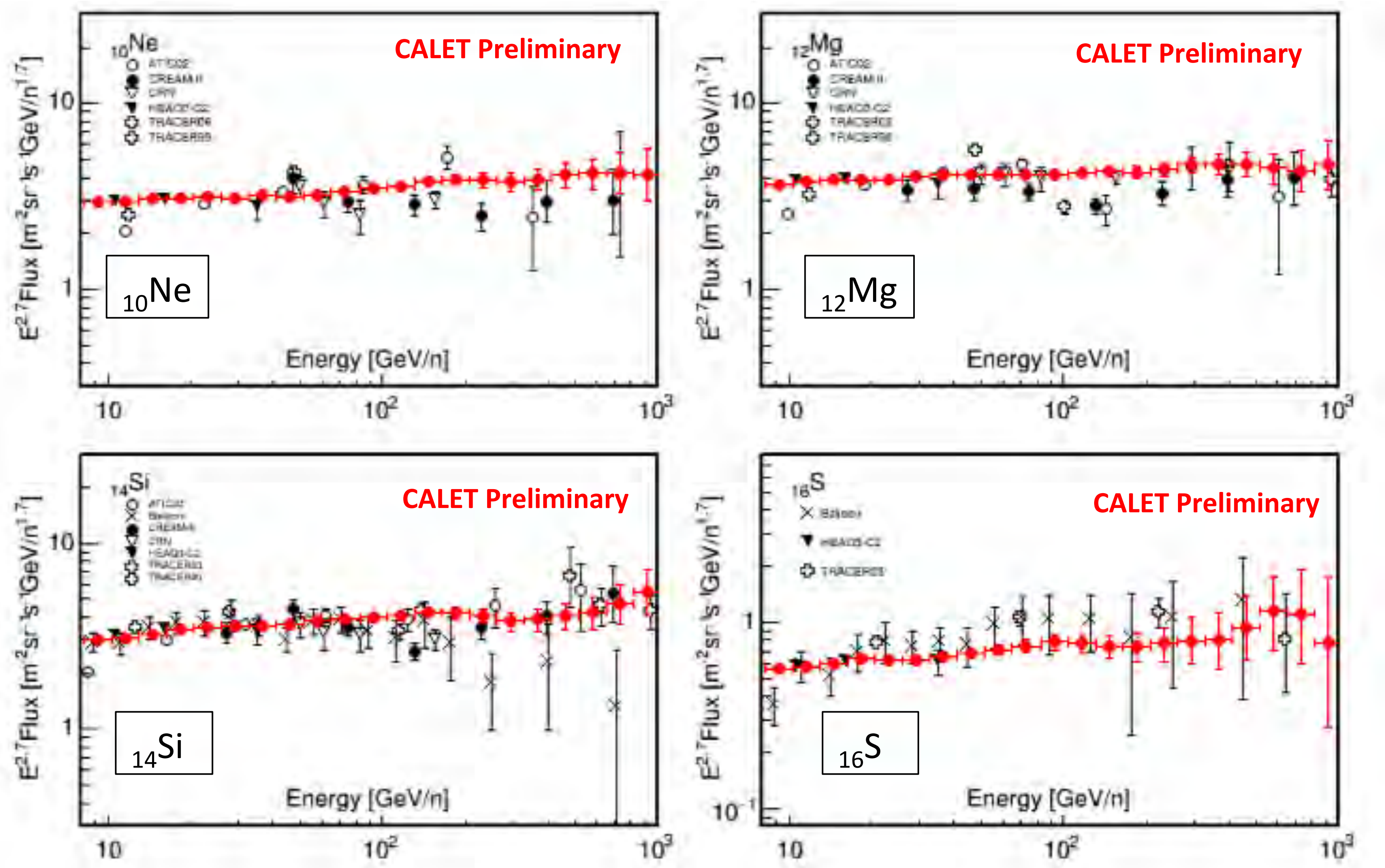
5.6 x 10^6 events (C-Fe, ΔE>10GeV)

[Y. Akaike, APS April 14, 2019]



Preliminary Spectra of Z-even Nuclei from Ne to S (Z = 10-16)

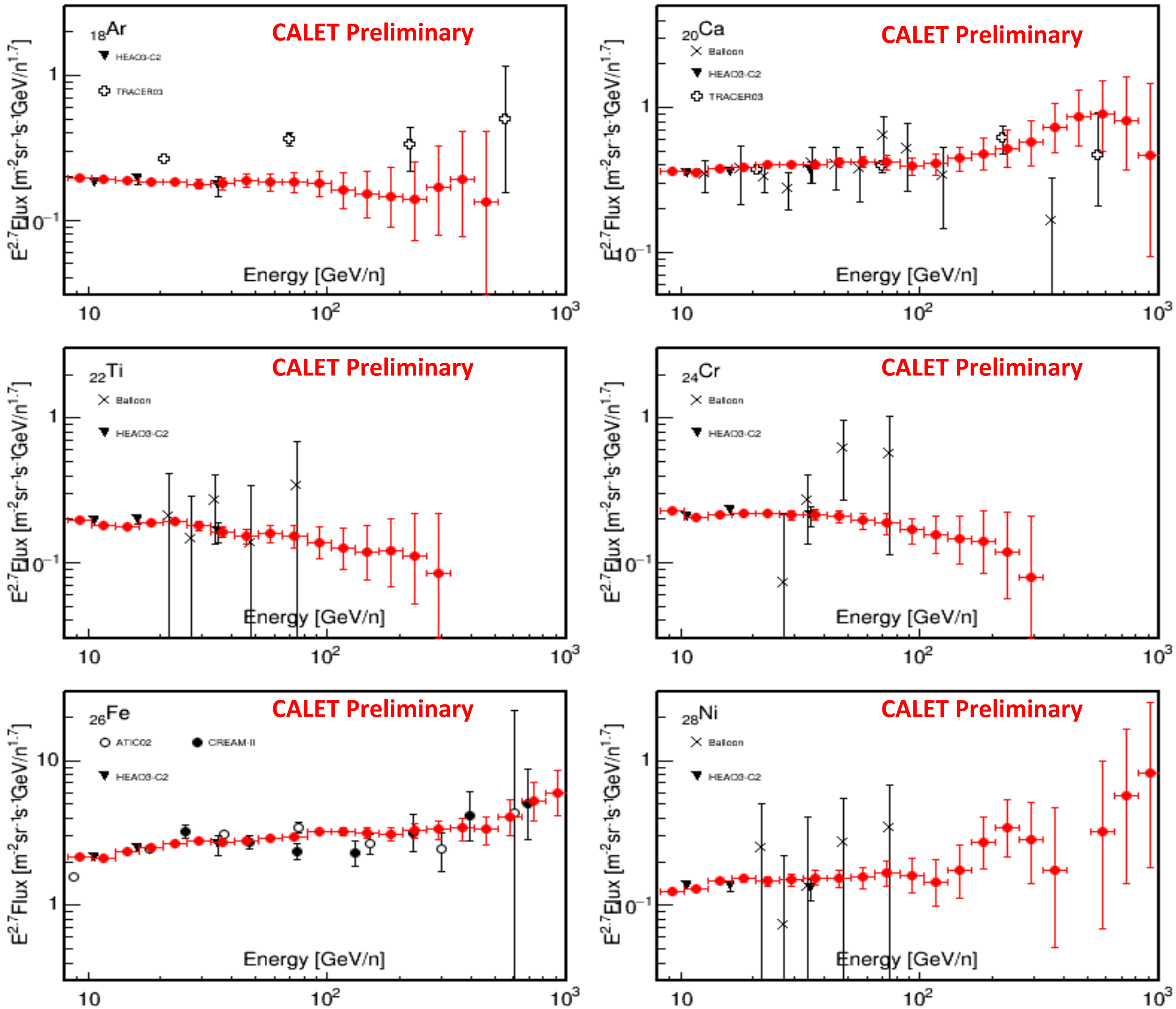
[Y.Akaike, COSPAR 2018 E1.5-0028-18]



Preliminary Spectra of Z-even Nuclei from Ar to Ni (Z = 18-28)

[Y.Akaike, COSPAR 2018 E1.5-0028-18]

$_{18}$Ar $_{20}$Ca $_{22}$Ti $_{24}$Cr $_{26}$Fe $_{28}$Ni



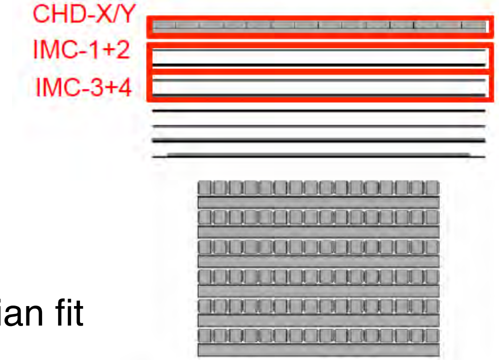
Ultra Heavy Nuclei (Preliminary Measurements for 26 < Z ≤ 40)

[B.Rauch, APS April 14, 2019]

CALET measures the relative abundances of nuclei above Fe through $_{40}$Zr

CALET has a special UH CR trigger utilizing the CHD and the top 4 layers of the IMC that:

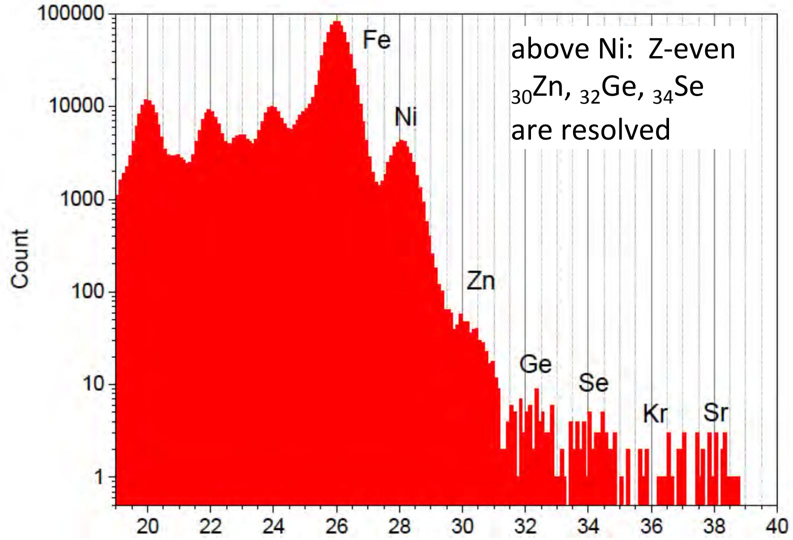
- has an expanded geometry factor of ~4000 cm^{2}sr
- has a very high duty cycle due to low event rate

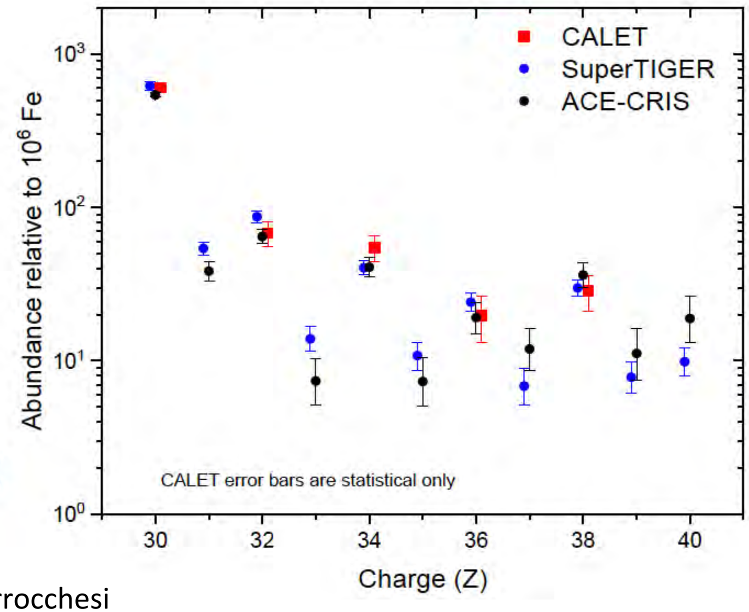


Data analysis

- ☐ Event Selection: Vertical cutoff rigidity > 4GV & Zenith Angle < 60 degrees
- ☐ Contamination from neighboring charge are determined by multiple-Gaussian fit

✧ The CALET UH element ratios relative to $_{26}$Fe show good agreement with SuperTIGER and ACE abundances.





CALET γ–ray Sky (>1GeV)

Instrument characterized using EPICS simulations

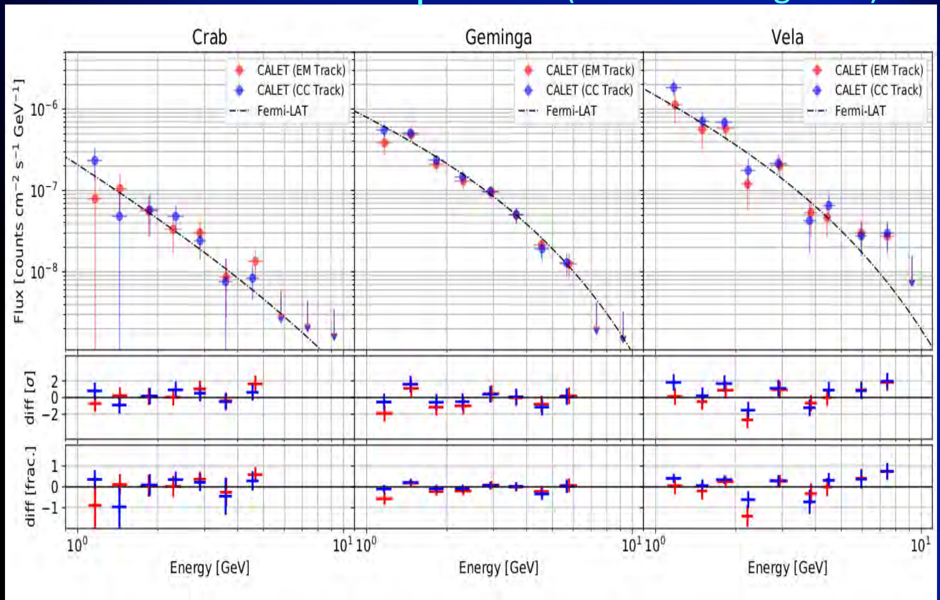
- Effective area ~400 cm^2 above 2 GeV
- Angular resolution < 2° above 1 GeV (< 0.2° above 10 GeV)
- Energy resolution ~12% at 1 GeV (~5% at 10 GeV)

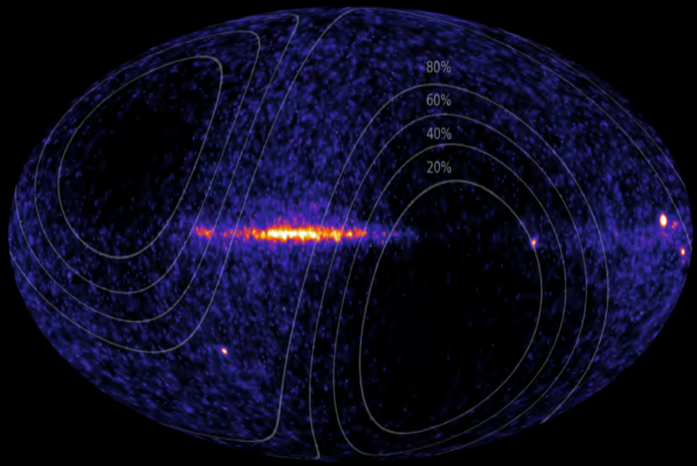
Simulated IRFs consistent with 2 years of flight data

Consistency in signal-dominated regions with Fermi-LAT

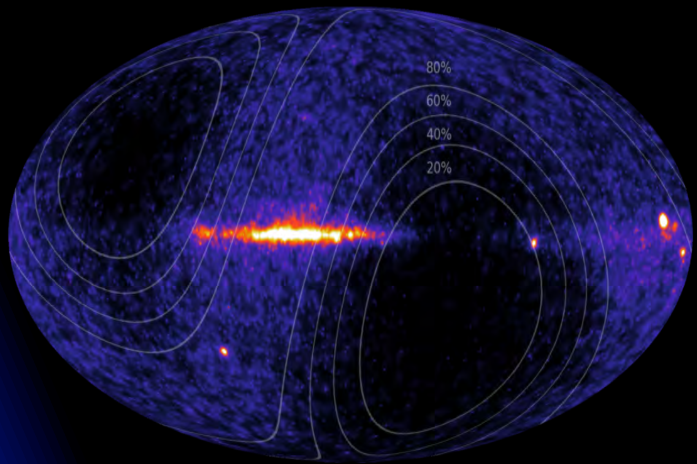
Residual background in low-signal regions

Flux validation with pulsars (under investigation)





[N.Cannady, COSPAR 2018 E1.17-0009-18]

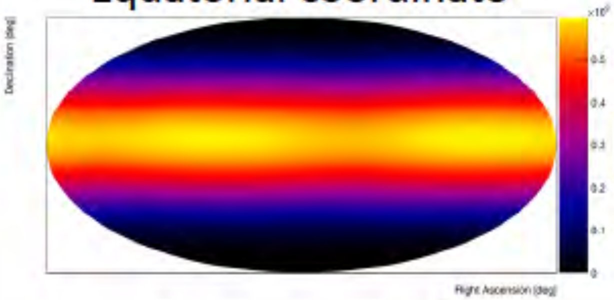


See also: **E1.17-0022-18** (Mori & Asaoka)

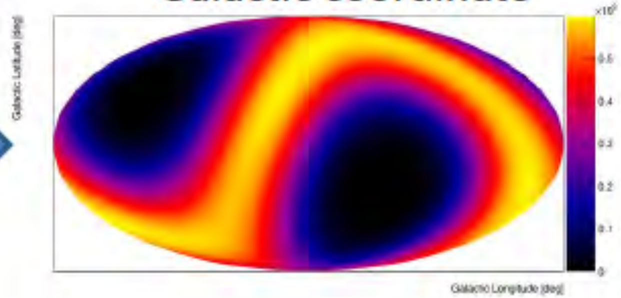
CALET Sky Map w/ LE-γ Trigger (E>1GeV)

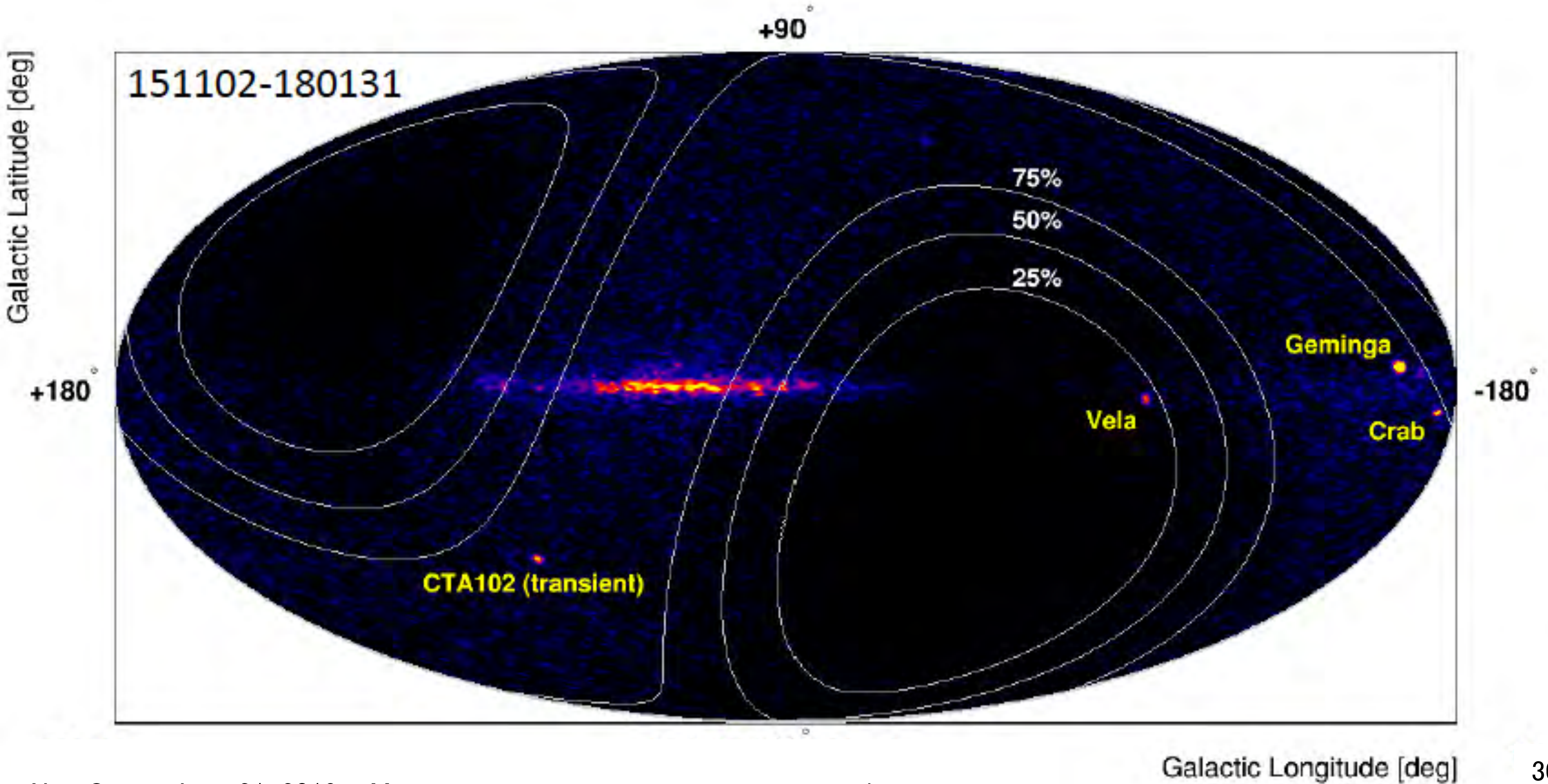
While exposure is not uniform, we have clearly identified the galactic plane and bright GeV sources.

Equatorial coordinate



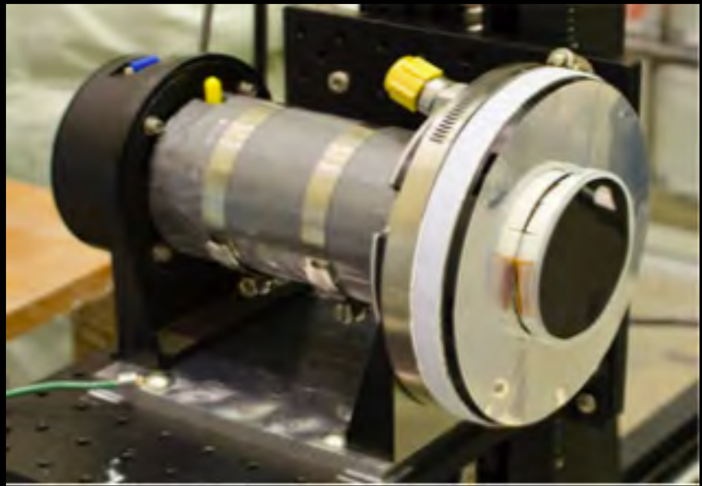
Galactic coordinate





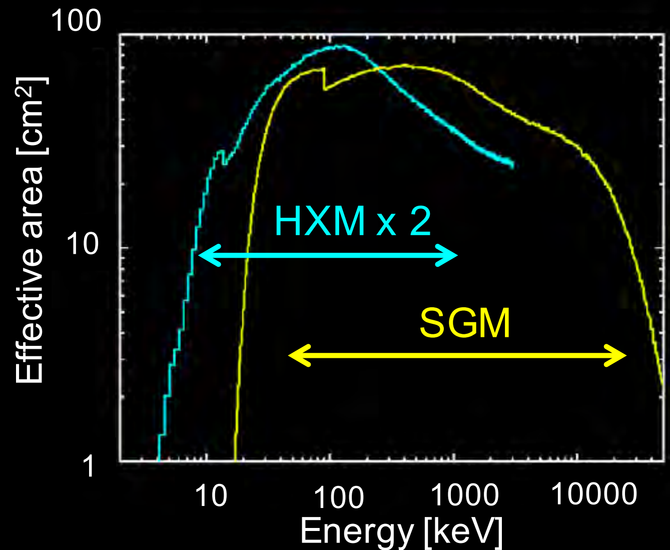
CALET Gamma-ray Burst Monitor (CGBM)

Hard X-ray Monitor (HXM)

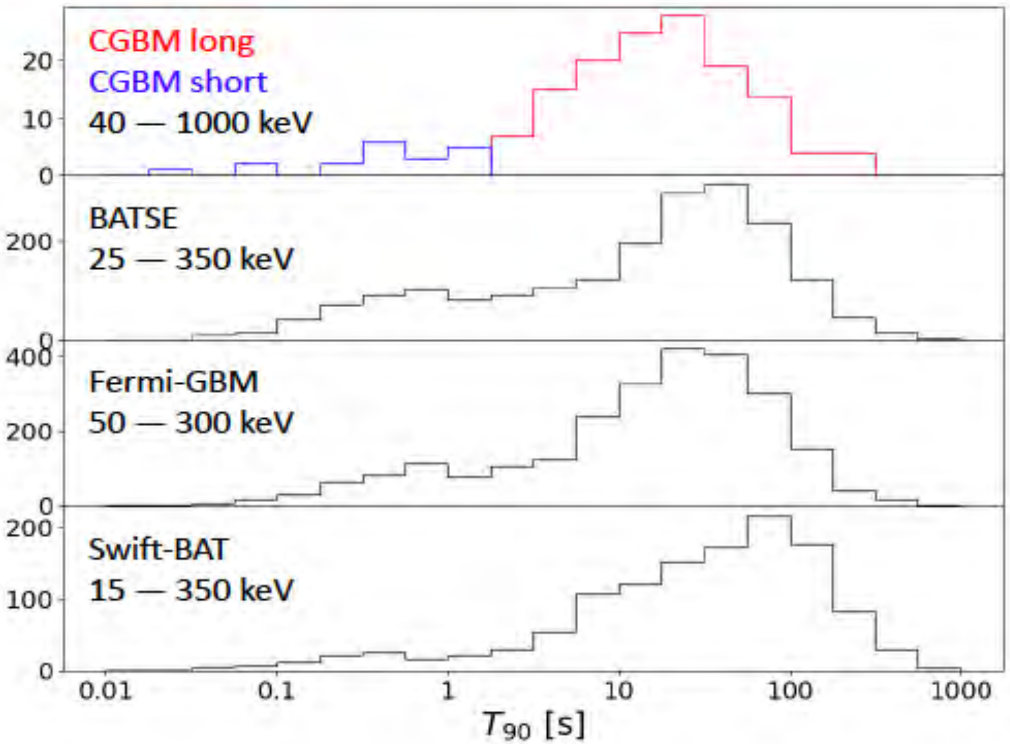


Soft Gamma-ray Monitor (SGM)

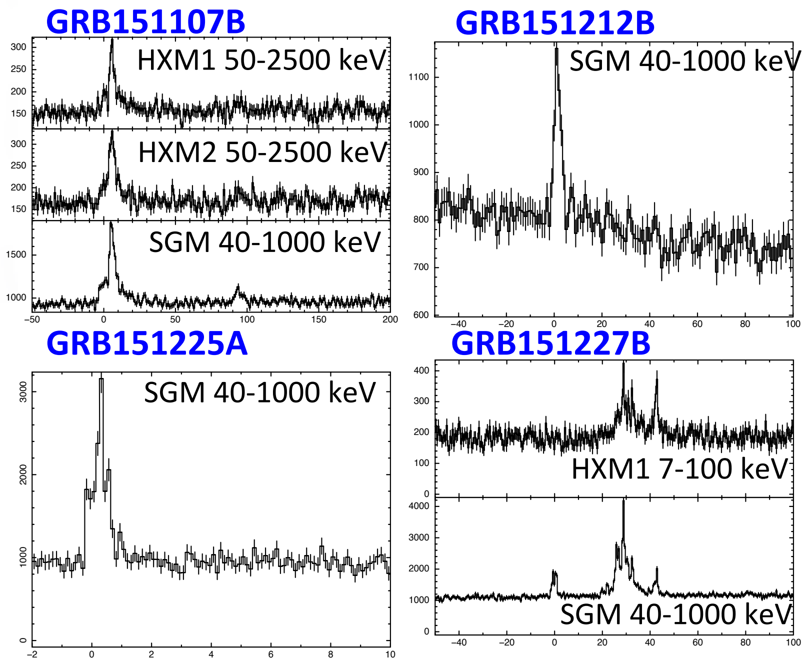
	HXM (x2)	SGM
Detector (Crystal)	$LaBr_3(Ce)$	BGO
Number of detectors	2	1
Diameter [mm]	61	102
Thickness [mm]	12.7	76
Energy range [keV]	7-1000	100-20000
Energy resolution@662 keV	~3%	~15%
Field of view	~3 sr	~2π sr



CGBM Observations Summary



Examples of LIght Curves



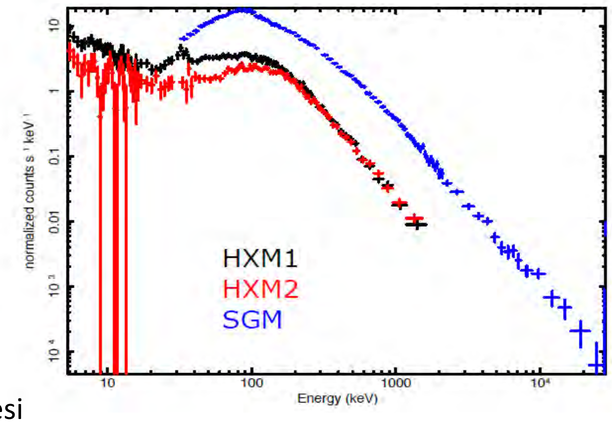
✧ As of June 2019:

159 GRBs detected

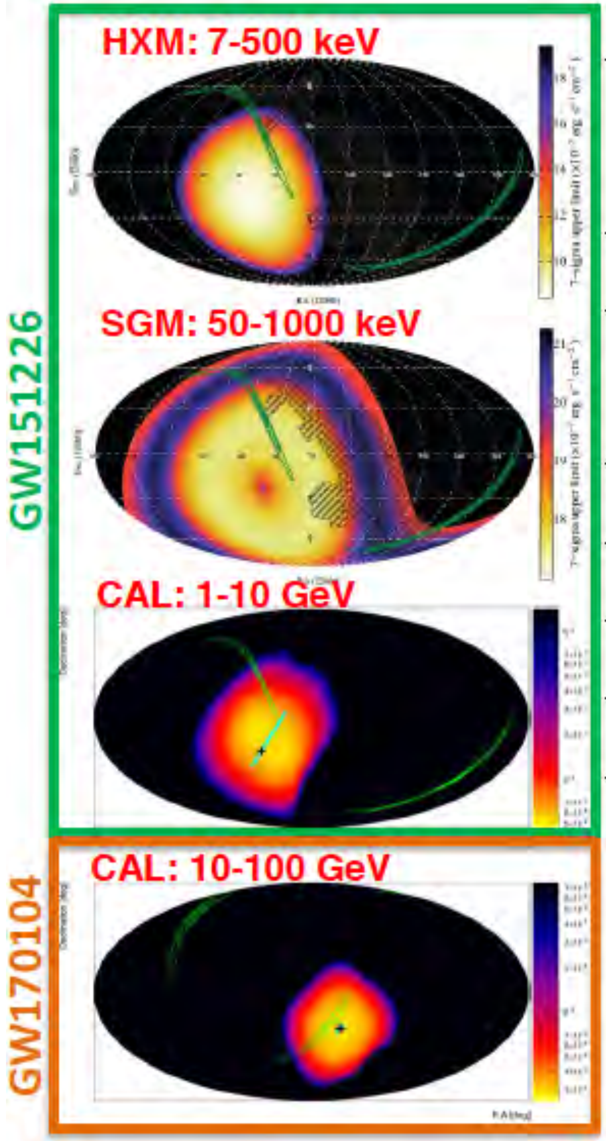
140 Long (88%) **19 Short (12%)**

Average rate ~ **43 GRBs/year**

Raw count spectra of **GRB 160625B**



Complete Search Results for GW Events during O1&O2



GW151226: O. Adriani et al. (CALET Collaboration), ApJL 829:L20 (2016).
All O1 & O2: O. Adriani et al. (CALET Collaboration), ApJ 863 (2018) 160.

Event	Type	Mode	Sum. LIGO prob.	Obs. time	Upper limits	
					Ene. Flux erg cm^{-2} s^{-1}	Lum. erg s^{-1}
GW150914	BH-BH	Before operation				
GW151226	BH-BH	LE HXM SGM	15%	T_0-525 – T_0+211	9.3×10^{-8} 1.0×10^{-6} 1.8×10^{-6}	2.3×10^{48} $3\text{-}5 \times 10^{49}$
GW170104	BH-BH	HE	30%	T_0-60 – T_0+60	6.4×10^{-6}	6.2×10^{50}
GW170608	BH-BH	HE	0%	T_0-60 – T_0+60	Out of FOV	
GW170814	BH-BH	HE	0%	T_0-60 – T_0+60	Out of FOV	
GW170817	NS-NS	HE	0%	T_0-60 – T_0+60	Out of FOV	

- CALET can search for EM counterparts to LIGO/Virgo triggers
- All O1 and O2 triggers checked – no signal in CGBM or CAL
- Upper limits set for GW151226 for CGBM+CAL in 2016 paper
- Upper limits for the CAL set using refined LE selection for triggers to-date in the 2018 paper

CALET: Summary and Future Prospects

- CALET was successfully launched on Aug. 19th, 2015. The observation campaign started on Oct. 13th, 2015. Excellent performance and remarkable stability of the instrument.
- As of May 31, 2019 total observation time is 1327 days with live time fraction to total time close to 84%. Nearly 1.8 billion events collected with low (> 1 GeV) + high energy (>10 GeV) triggers.
- Accurate calibrations have been performed with non-interacting p & He events + linearity in the energy measurements established up to 10^6 MIP.
- Measurement of electron+positron spectrum in 11 GeV - 4.8 TeV range using full acceptance Observation of a flux reduction above 1 TeV.
- Direct measurement of proton spectrum in 50 GeV – 10 TeV energy range. Spectral hardening observed above a few hundred GeV.
- Preliminary analysis of primary elements up to Fe and secondary-to-primary ratios.
- Preliminary analysis of UH cosmic rays up to Z=40.
- Study of diffuse and point sources with gamma-rays. Follow-up observations of GW events in X-ray and gamma-ray bands. CALET's CGBM detected 159 GRBs in the energy range 7 keV-20 MeV.
- After an initial period of 2 years CALET observation time has been extended to 5 years at least.

Lessons Learned in view of Next Gapes

The next generation of CR instruments should aim to fulfill (at least partially) the following:

① LARGE GEOMETRIC FACTOR

- next generation of 3-D calorimeters can reach 10 m^2 sr

② EXCELLENT CHARGE IDENTIFICATION

- *redudant* charge identifiers to cross calibrate in flight against each other
- *ad hoc granularity* to reduce ambiguities due to backscattering (gets worse at higher energy)
- VERY large *dynamic range* to cover high-Z nuclei

③ TRACKING is ESSENTIAL

- cuts down systematics on geometric acceptance
- mitigates backscattering ambiguities in charge identification
- multi-track + vertex reconstruction improve systematics related to particle interactions

④ ENERGY MEASUREMENT, SCALE ASSESSMENT & PID

- thick calorimeter for shower containment (30 X_0 or more)
- VERY large *dynamic range* to reach PeV energies (>10^6 mip)
- redundant energy measurements for cross calibration (e.g.: $\beta\gamma$ from TRD below saturation)

⑤ IMPROVEMENTS in HADRONIC MODELS and MC simulations

- CR community should foster significant improvements of GEANT4, FLUKA at high energy
- continue to push measurements of poorly known cross sections

Thank you
for your attention !

CALET Collaboration Team

O. Adriani[25], Y. Akaike[2], K. Asano[7], Y. Asaoka[9,31], M.G. Bagliesi[29], E. Berti[25], G. Bigongiari[29], W.R. Binns[32], S. Bonechi[29], M. Bongi[25], P. Brogi[29], A. Bruno[15], J.H. Buckley[32], N. Cannady[13], G. Castellini[25], C. Checchia[26],M.L. Cherry[13], G. Collazuol[26], V. Di Felice[28], K. Ebisawa[8], H. Fuke[8], T.G. Guzik[13], T. Hams[3], N. Hasebe[31], K. Hibino[10], M. Ichimura[4], K. Ioka[34], W. Ishizaki[7], M.H. Israel[32], K. Kasahara[31], J. Kataoka[31], R. Kataoka[17], Y. Katayose[33], C. Kato[23], Y.Kawakubo[1], N. Kawanaka[30], K. Kohri [12], H.S. Krawczynski[32], J.F. Krizmanic[2], T. Lomtadze[27], P. Maestro[29], P.S. Marrocchesi[29], A.M. Messineo[27], J.W. Mitchell[15], S. Miyake[5], A.A. Moiseev[3], K. Mori[9,31], M. Mori[21], N. Mori[25], H.M. Motz[31], K. Munakata[23], H. Murakami[31], S. Nakahira[20], J. Nishimura[8], G.A De Nolfo[15], S. Okuno[10], J.F. Ormes[25], S. Ozawa[31], L. Pacini[25], F. Palma[28], V. Pal'shin[1], P. Papini[25], A.V. Penacchioni[29], B.F. Rauch[32], S.B. Ricciarini[25], K. Sakai[3], T. Sakamoto[1], M. Sasaki[3], Y. Shimizu[10], A. Shiomi[18], R. Sparvoli[28], P. Spillantini[25], F. Stolzi[29], S. Sugita[1], J.E. Suh[29], A. Sulaj[29], I. Takahashi[11], M. Takayanagi[8], M. Takita[7], T. Tamura[10], N. Tateyama[10], T. Terasawa[7], H. Tomida[8], S. Torii[9,31], Y. Tunesada[19], Y. Uchihori[16], S. Ueno[8], E. Vannuccini[25], J.P. Wefel[13], K. Yamaoka[14], S. Yanagita[6], A. Yoshida[1], and K. Yoshida[22]

1) Aoyama Gakuin University, Japan
2) CRESST/NASA/GSFC and Universities Space Research Association, USA
3) CRESST/NASA/GSFC and University of Maryland, USA
4) Hirosaki University, Japan
5) Ibaraki National College of Technology, Japan
6) Ibaraki University, Japan
7) ICRR, University of Tokyo, Japan
8) ISAS/JAXA Japan
9) JAXA, Japan
10) Kanagawa University, Japan
11) Kavli IPMU, University of Tokyo, Japan
12) KEK, Japan
13) Louisiana State University, USA
14) Nagoya University, Japan
15) NASA/GSFC, USA
16) National Inst. of Radiological Sciences, Japan
17) National Institute of Polar Research, Japan
18) Nihon University, Japan
19) Osaka City University, Japan
20) RIKEN, Japan
21) Ritsumeikan University, Japan
22) Shibaura Institute of Technology, Japan
23) Shinshu University, Japan
24) University of Denver, USA
25) University of Florence, IFAC (CNR) and INFN, Italy
26) University of Padova and INFN, Italy
27) University of Pisa and INFN, Italy
28) University of Rome Tor Vergata and INFN, Italy
29) University of Siena and INFN, Italy
30) University of Tokyo, Japan
31) Waseda University, Japan
32) Washington University-St. Louis, USA
33) Yokohama National University, Japan
34) Yukawa Institute for Theoretical Physics, Kyoto University, Japan

CALET Collaboration Team

O. Adriani[25], Y. Akaike[2], K. Asano[7], Y. Asaoka[9,31], M.G. Bagliesi[29], E. Berti[25], G. Bigongiari[29], W.R. Binns[32], S. Bonechi[29], M. Bongi[25], P. Brogi[29], A. Bruno[15], J.H. Buckley[32], N. Cannady[13], G. Castellini[25], C. Checchia[26],M.L. Cherry[13], G. Collazuol[26], V. Di Felice[28], K. Ebisawa[8], H. Fuke[8], T.G. Guzik[13], T. Hams[3], N. Hasebe[31], K. Hibino[10], M. Ichimura[4], K. Ioka[34], W. Ishizaki[7], M.H. Israel[32], K. Kasahara[31], J. Kataoka[31], R. Kataoka[17], Y. Katayose[33], C. Kato[23], Y.Kawakubo[1], N. Kawanaka[30], K. Kohri [12], H.S. Krawczynski[32], J.F. Krizmanic[2], T. Lomtadze[27], P. Maestro[29], P.S. Marrocchesi[29], A.M. Messineo[27], J.W. Mitchell[15], S. Miyake[5], A.A. Moiseev[3], K. Mori[9,31], M. Mori[21], N. Mori[25], H.M. Motz[31], K. Munakata[23], H. Murakami[31], S. Nakahira[20], J. Nishimura[8], G.A De Nolfo[15], S. Okuno[10], J.F. Ormes[25], S. Ozawa[31], L. Pacini[25], F. Palma[28], V. Pal'shin[1], P. Papini[25], A.V. Penacchioni[29], B.F. Rauch[32], S.B. Ricciarini[25], K. Sakai[3], T. Sakamoto[1], M. Sasaki[3], Y. Shimizu[10], A. Shiomi[18], R. Sparvoli[28], P. Spillantini[25], F. Stolzi[29], S. Sugita[1], J.E. Suh[29], A. Sulaj[29], I. Takahashi[11], M. Takayanagi[8], M. Takita[7], T. Tamura[10], N. Tateyama[10], T. Terasawa[7], H. Tomida[8], S. Torii[9,31], Y. Tunesada[19], Y. Uchihori[16], S. Ueno[8], E. Vannuccini[25], J.P. Wefel[13], K. Yamaoka[14], S. Yanagita[6], A. Yoshida[1], and K. Yoshida[22]