

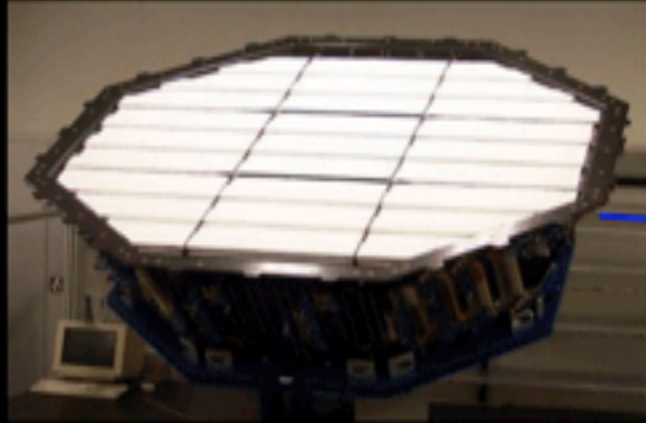
AMS

(ALPHA MAGNETIC SPECTROMETER)

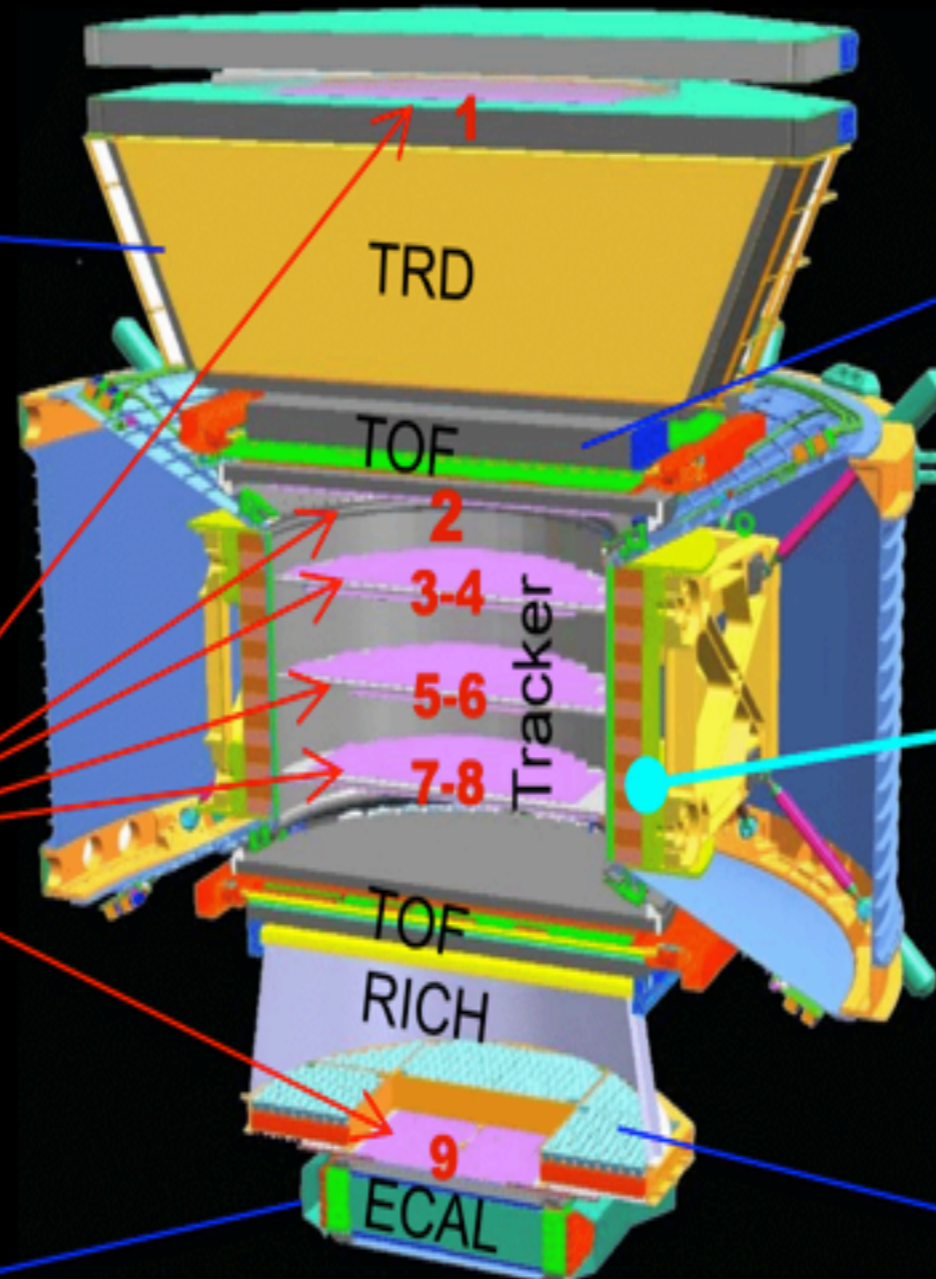
VALERIA DI FELICE

A HEP particle Detector in space

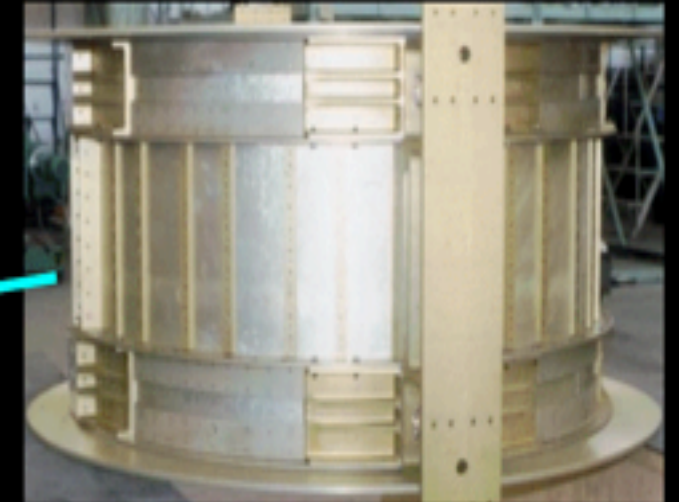
Transition Radiation Detector (TRD)



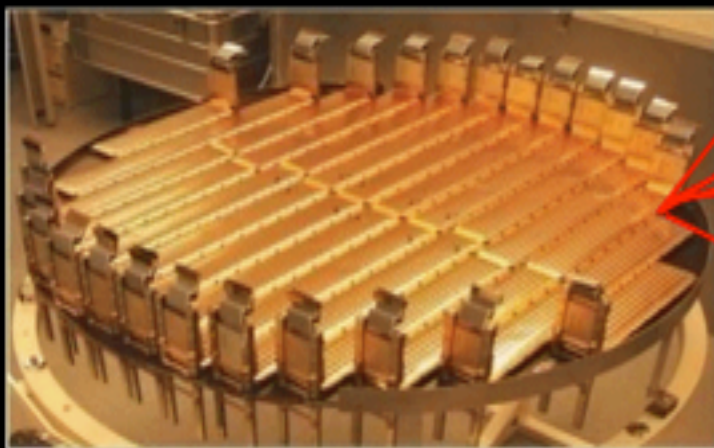
Time of Flight Detector (TOF)



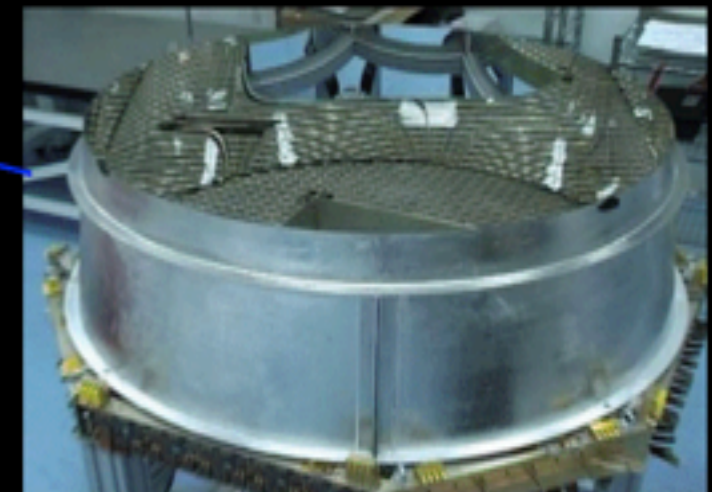
Magnet



Silicon Tracker



Ring Imaging Cherenkov (RICH)



Electromagnetic Calorimeter (ECAL)



300,000 electronic channels,
650 fast microprocessors
size: 5m x 4m x 3m weight: 7.5 tons



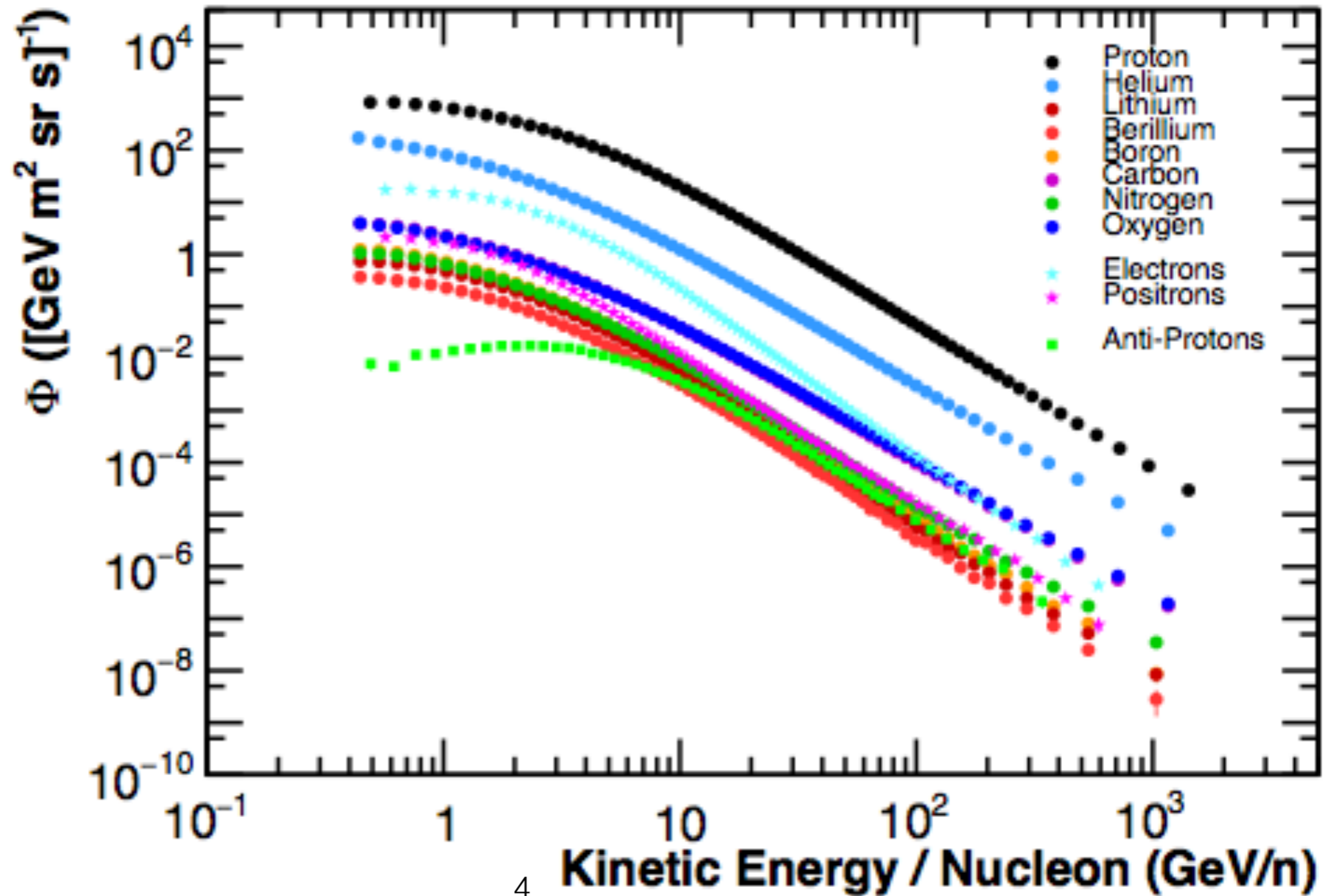
AMS

**WAS INSTALLED
ON THE ISS
MAY THE 19TH 2011
IT WILL CONTINUE
THROUGH THE LIFETIME OF
ISS (2024)**

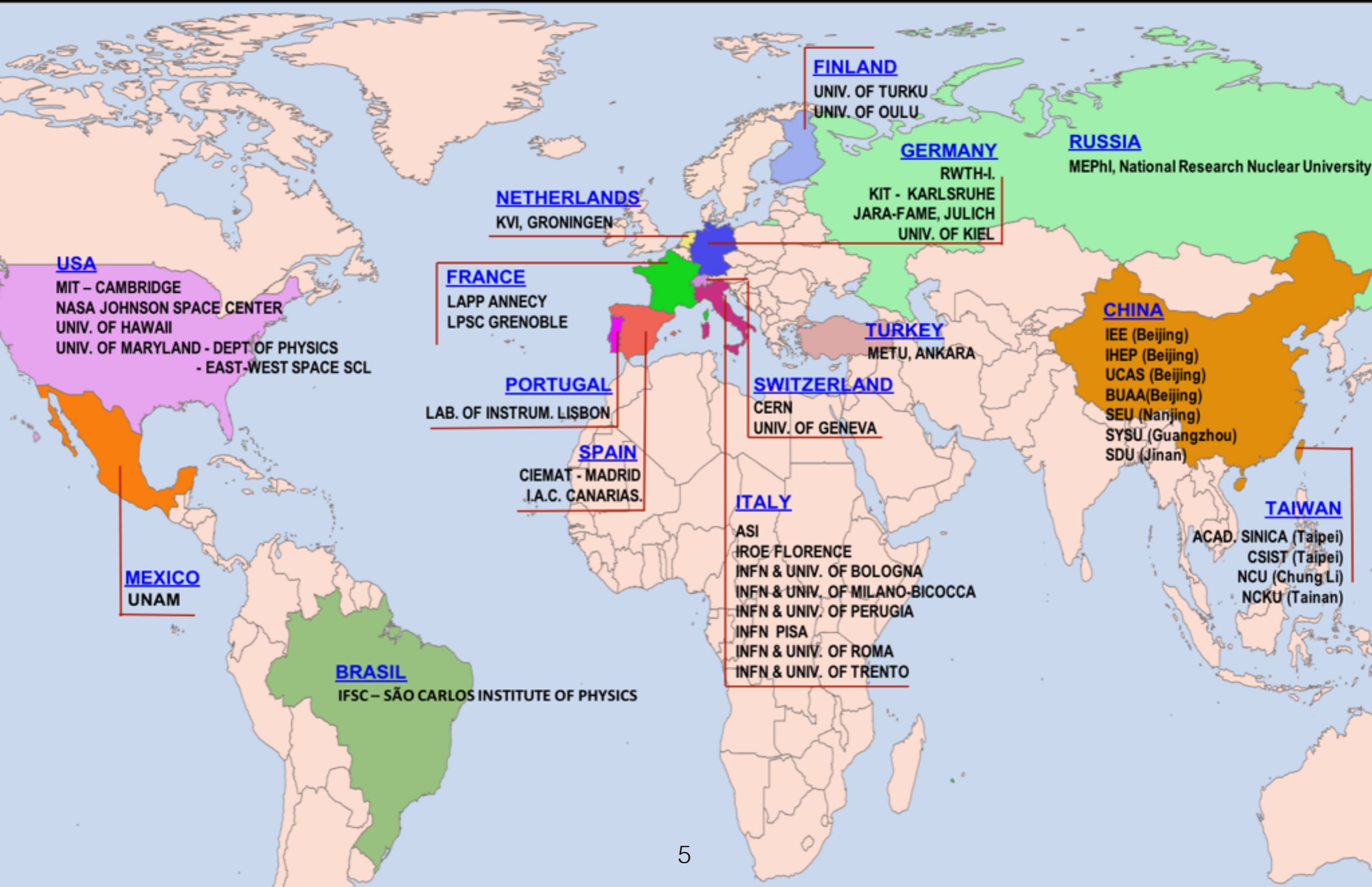
**OVER
140 BILLION
CHARGED
COSMIC RAYS
HAVE
BEEN MEASURED**

COSMIC RAY DETECTION:

- ANTIPARTICLE COMPONENT
- CHEMICAL AND ISOTOPIC COMPOSITION
- SPECTRAL FEATURES
- HELIOSPHERIC EFFECTS



AMS-02 INTERNATIONAL COLLABORATION



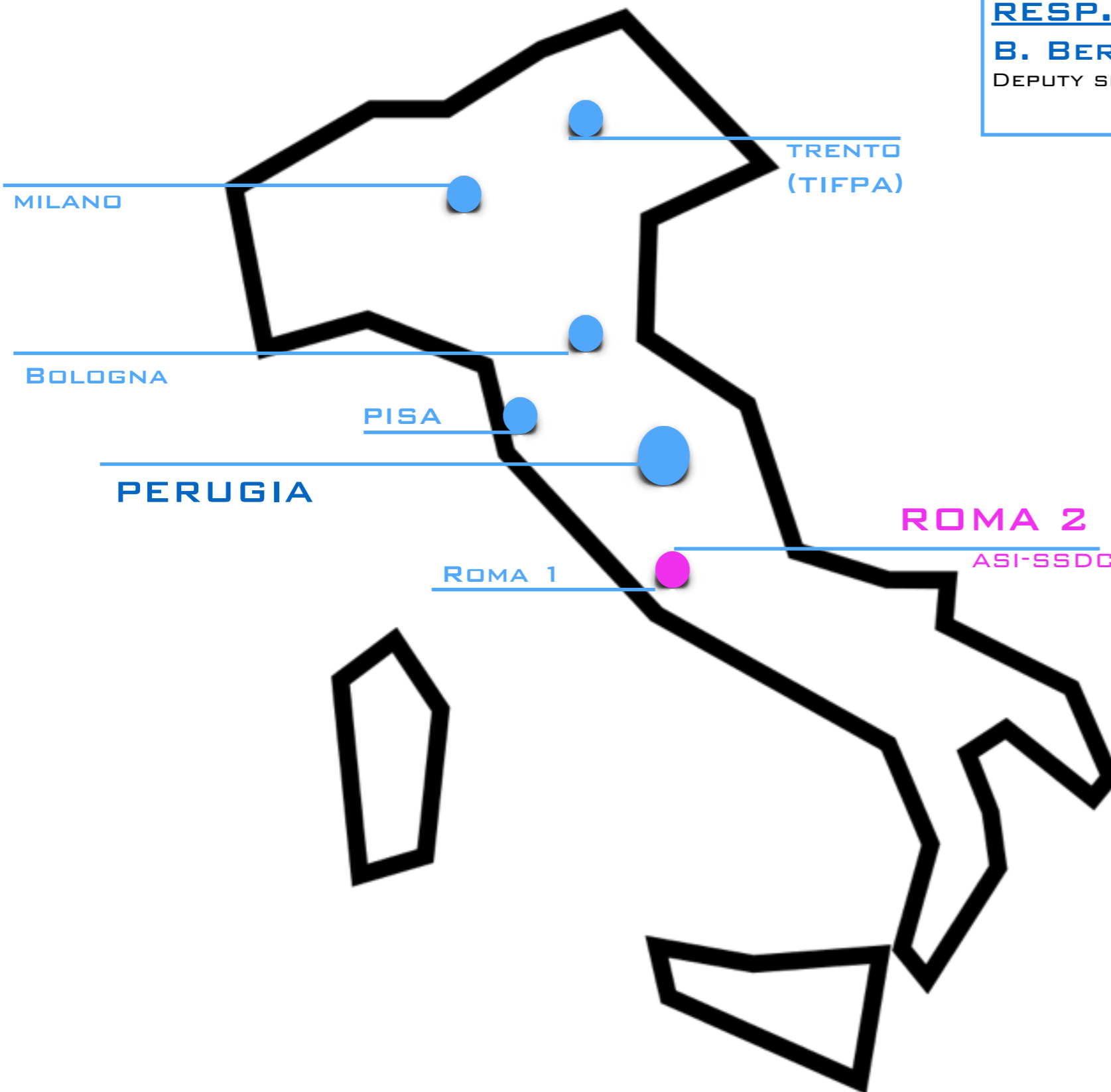
AMS-02 ITALY

FTE ~30

RESP. NAZIONALE

B. BERTUCCI - PERUGIA

DEPUTY SPOKESMAN



ANAGRAFICA (PG → RM2):

- **DI FELICE V.**
RESP. LOC.
RESP. DB @ASI-SSDC
TIME DEPENDENT ANALYSIS
- **DONNINI F.**
IONS ANALYSIS
- **FORMATO V.**
RESP. IT. NUCLEI ANALYSIS
INTERFACCIA AMS-ITALY CNAF
- **KHALI B.**
IONS ANALYSIS
- **NARICI L. (UTOV)**
PI ALTEA

ACTIVITIES:

- DATA ANALYSIS!
- DATA ANALYSIS!
- DATA ANALYSIS!
- DATA TAKING SHIFTS @CERN
- COMPUTING
- ASI AND SSDC (V. VAGELLI @ASI)



Published on: 2019-03-13

Towards Understanding the Origin of Cosmic-Ray Electrons

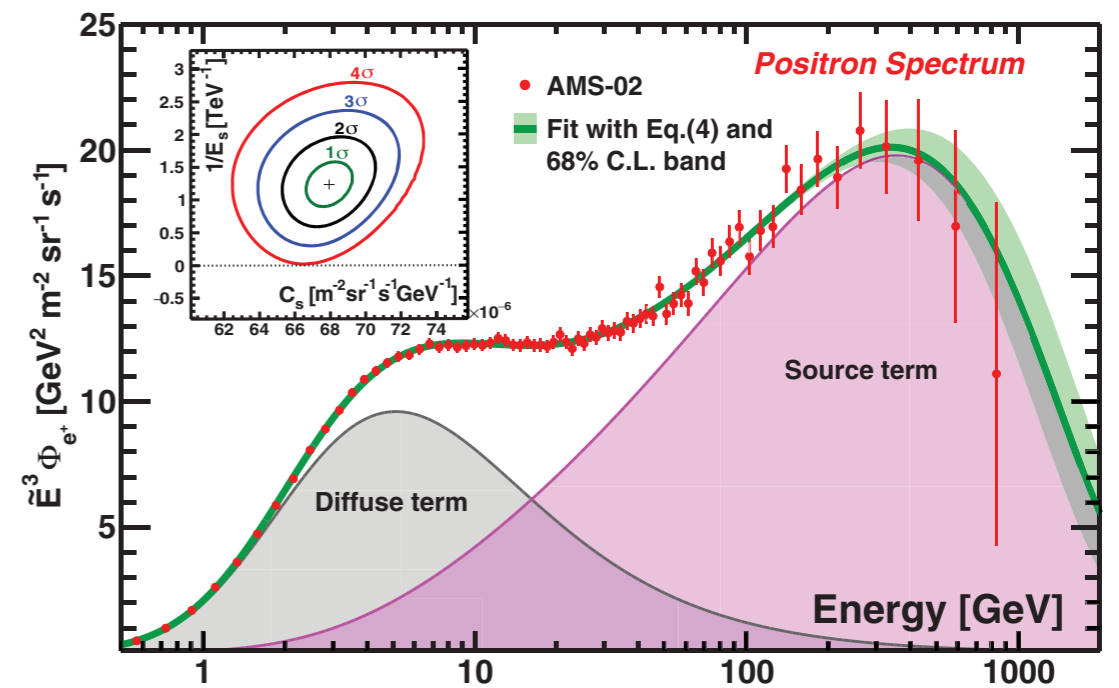
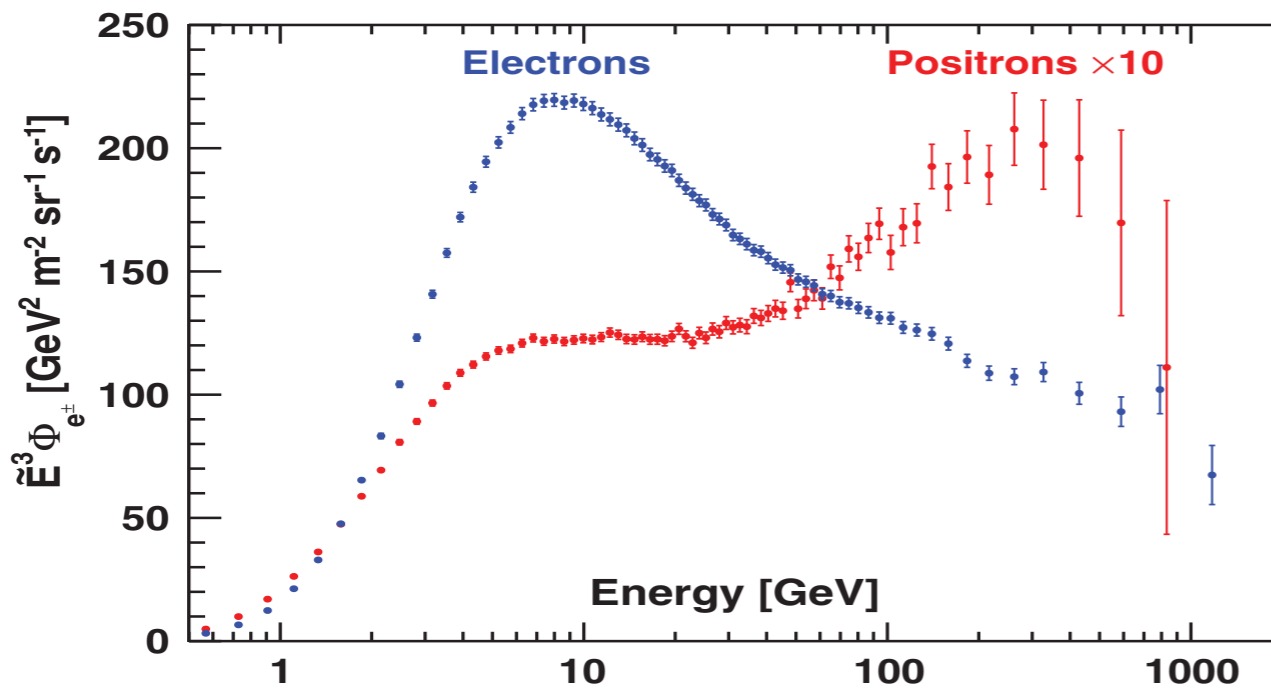
Phys. Rev. Lett.122, 101101 (2019) , Citations: 1 , View supplemental material and data

Published on: 2019-01-29 Editors' Suggestion

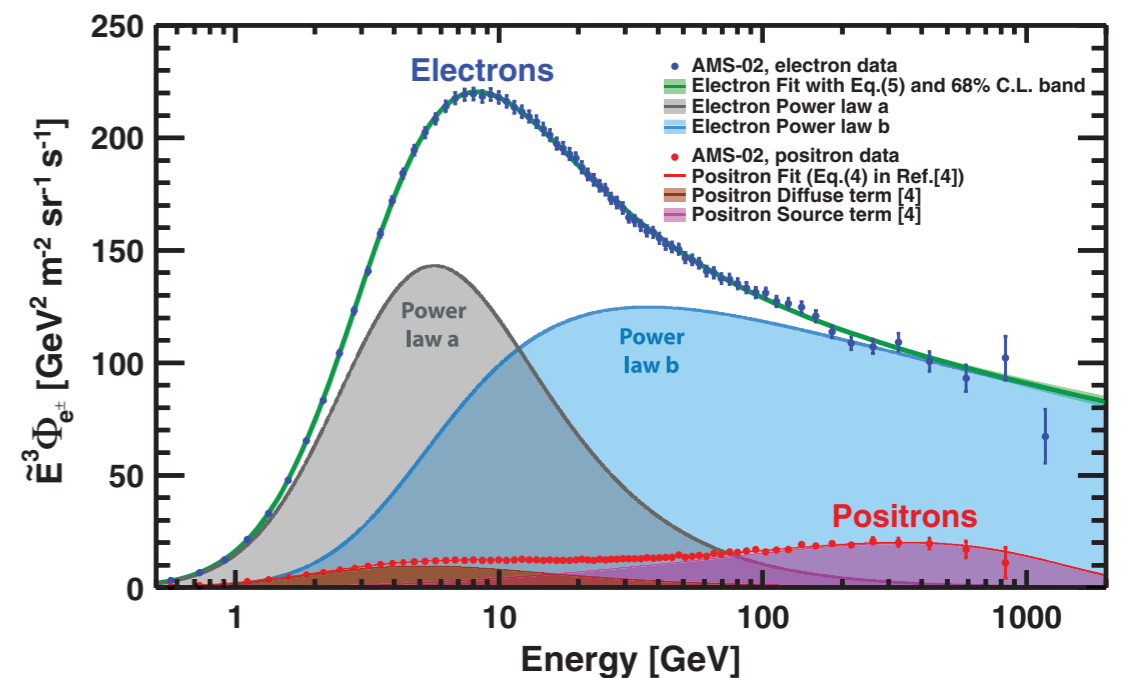
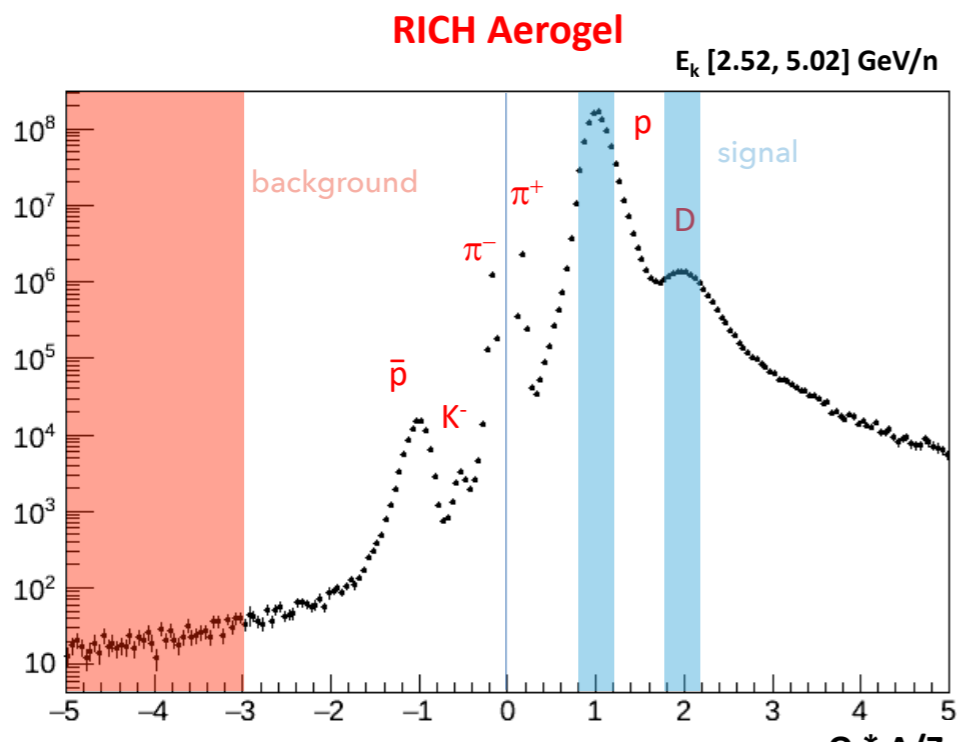
Towards Understanding the Origin of Cosmic-Ray Positrons

Phys. Rev. Lett. 122, 041102 (2019) , Citations: 18 , View supplemental material and data

MATTER & ANTIMATTER



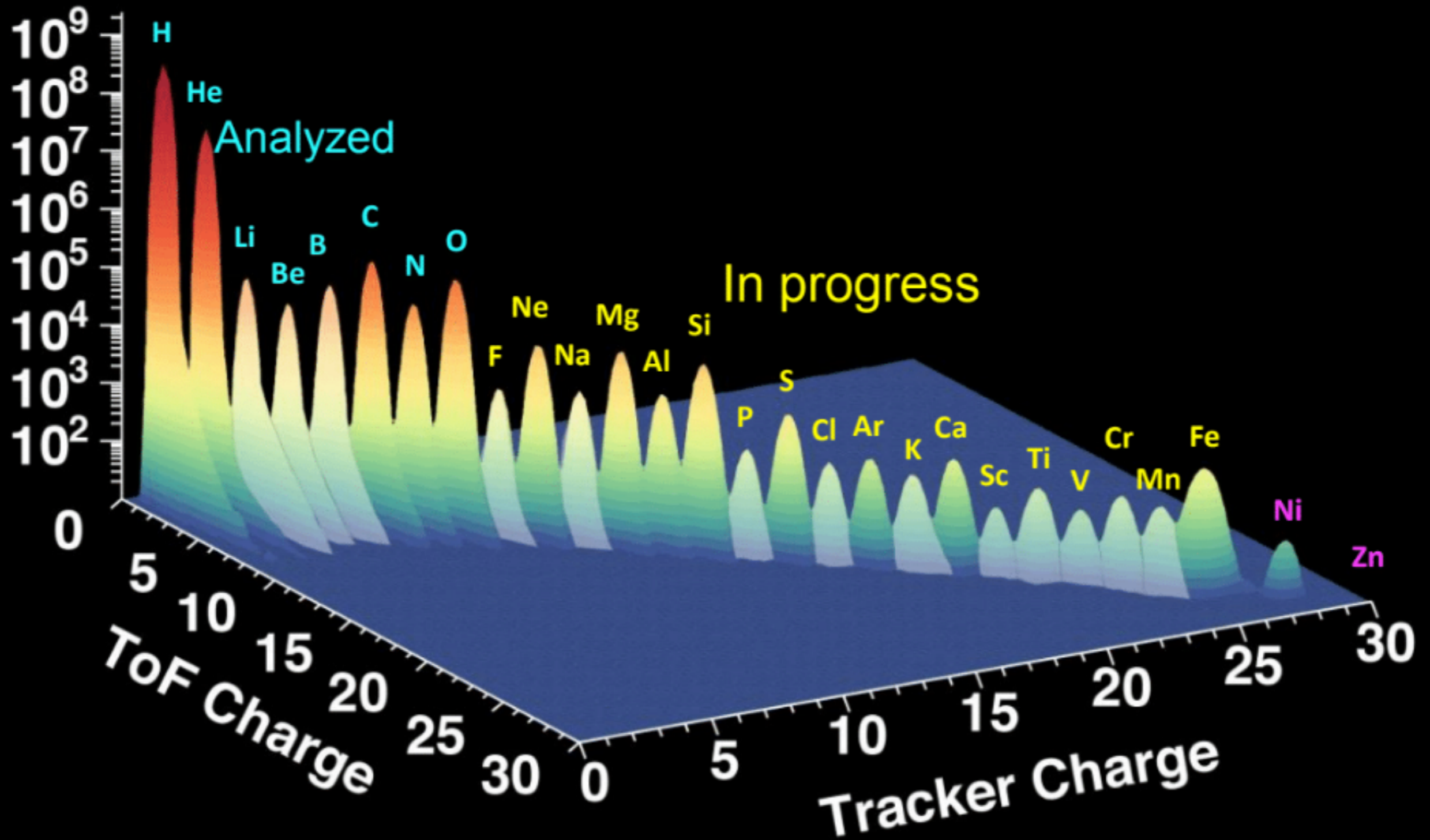
ANTIDEUTERIUM





DATA ANALYSIS

COSMIC RAY NUCLEI



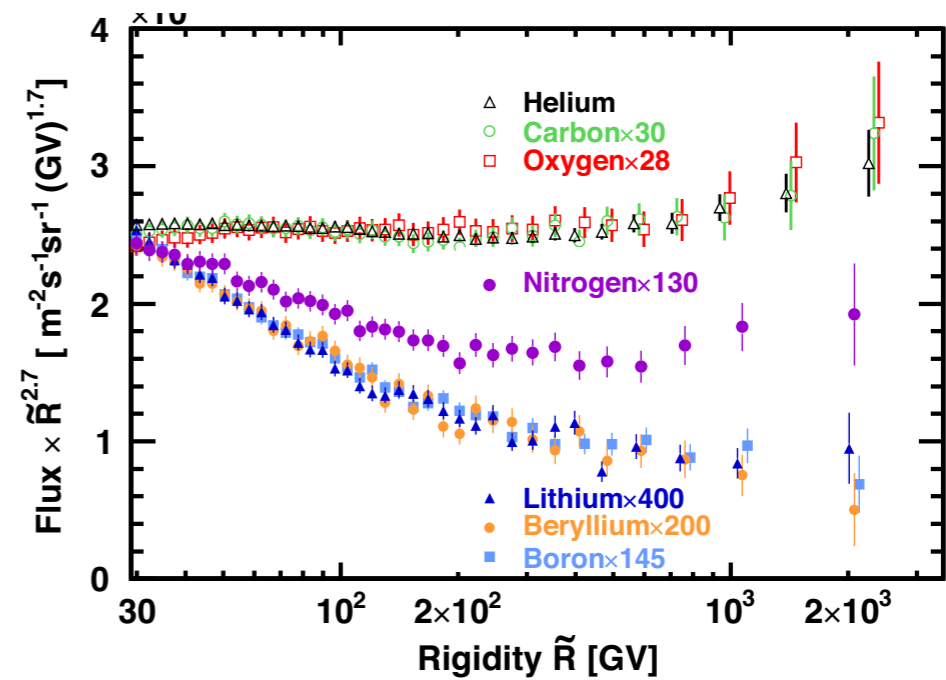
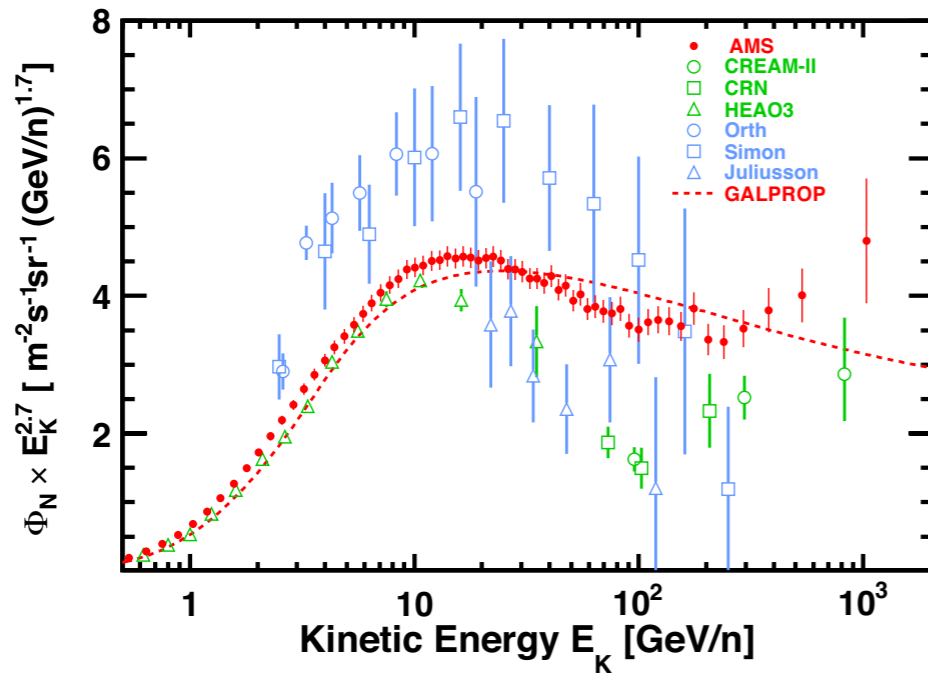


COSMIC RAY NUCLEI - RECENT AMS MEASUREMENTS

Published on: 2018-07-31

Precision Measurement of Cosmic-Ray Nitrogen and its Primary and Secondary Components with the Alpha Magnetic Spectrometer on the International Space Station

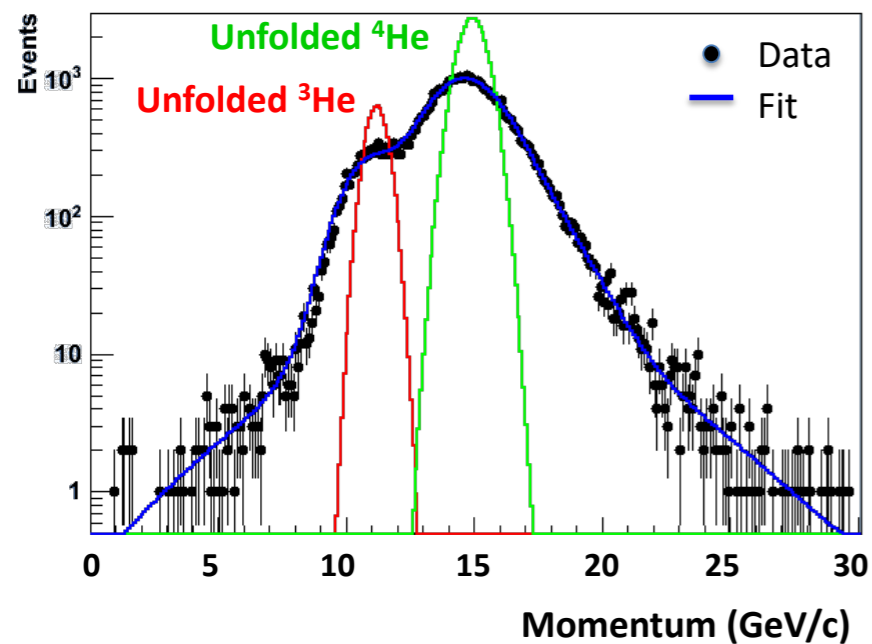
Phys. Rev. Lett.121, 051103 (2018)



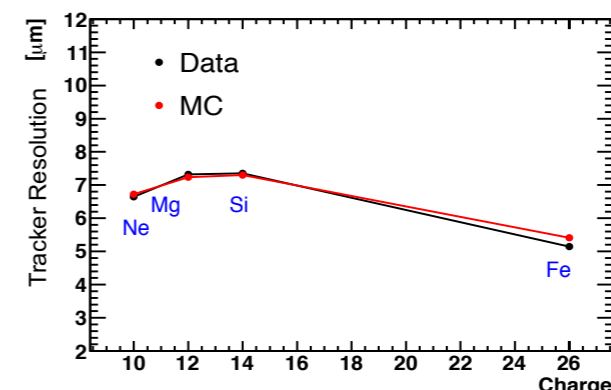
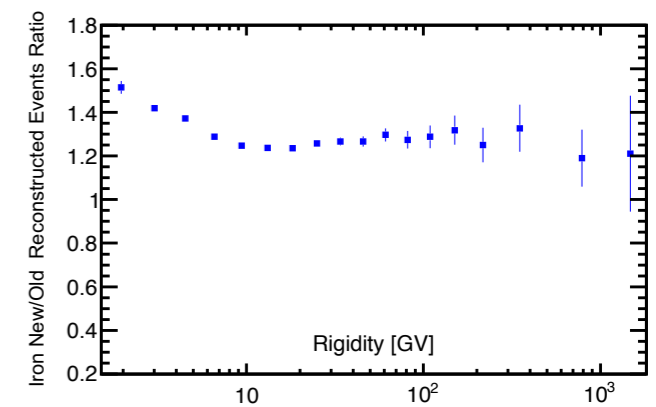
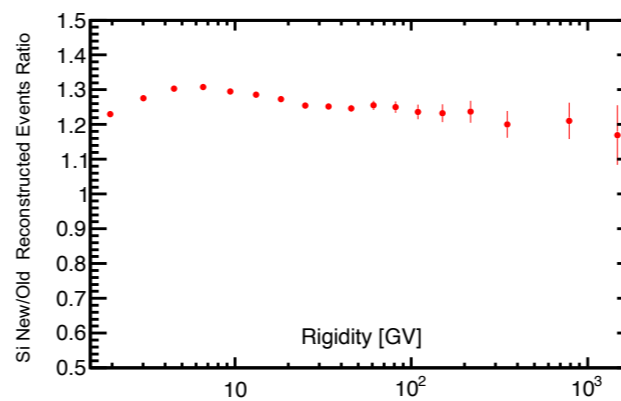
IN PREPARATION:

$^3\text{He}/^4\text{He}$ (TO BE SUBMITTED TO PRL)

$\beta = 0.97$



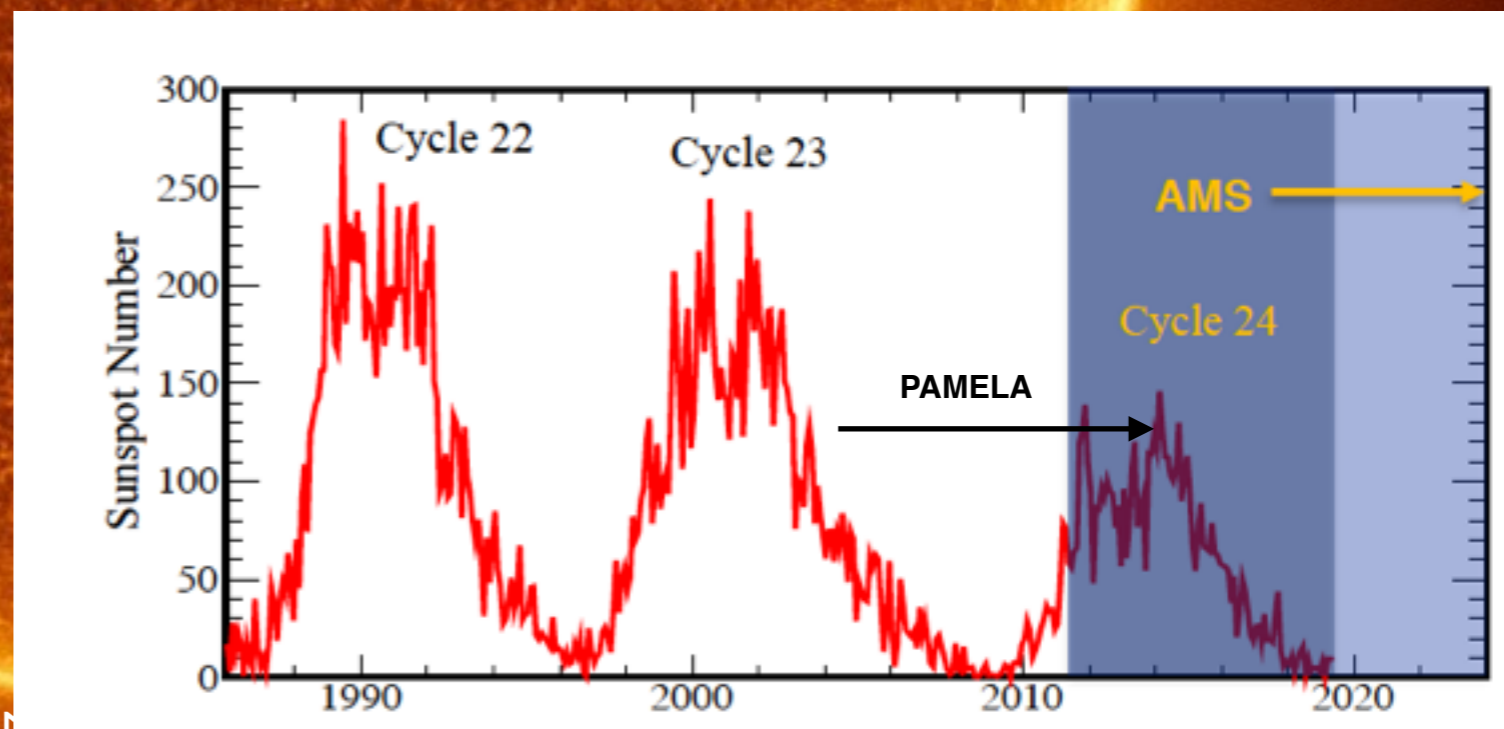
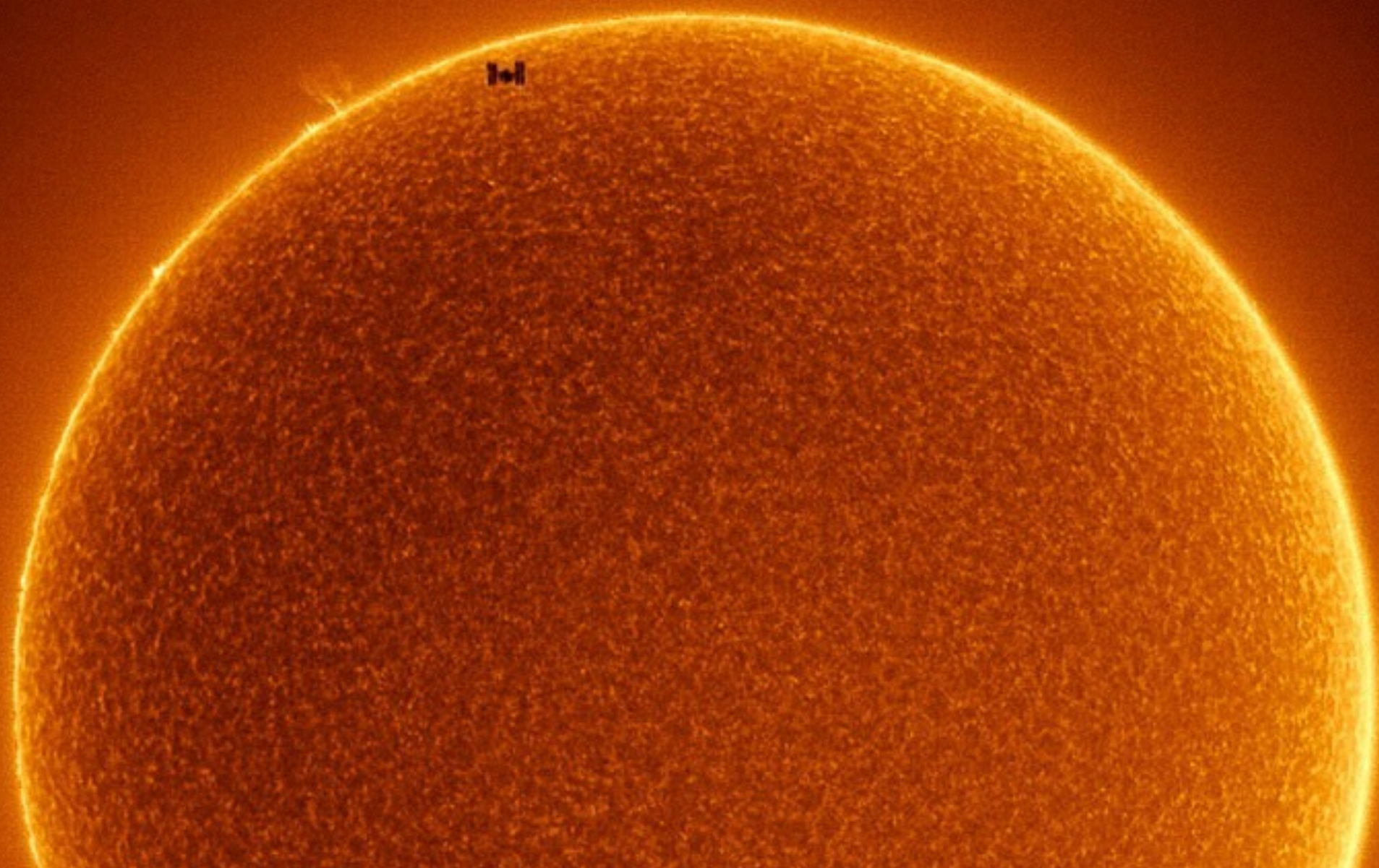
HIGHER Z NUCLEI



COSMIC RAY - VARIATION IN TIME



COSMIC RAY - VARIATION IN TIME



THE SPACE STATION CROSSES A SPOTLESS SUN

IMAGE CREDIT & COPYRIGHT: RAINEE COLACURCIO



COSMIC RAY - VARIATION IN TIME

Published on: 2018-07-31 **Editors' Suggestion**

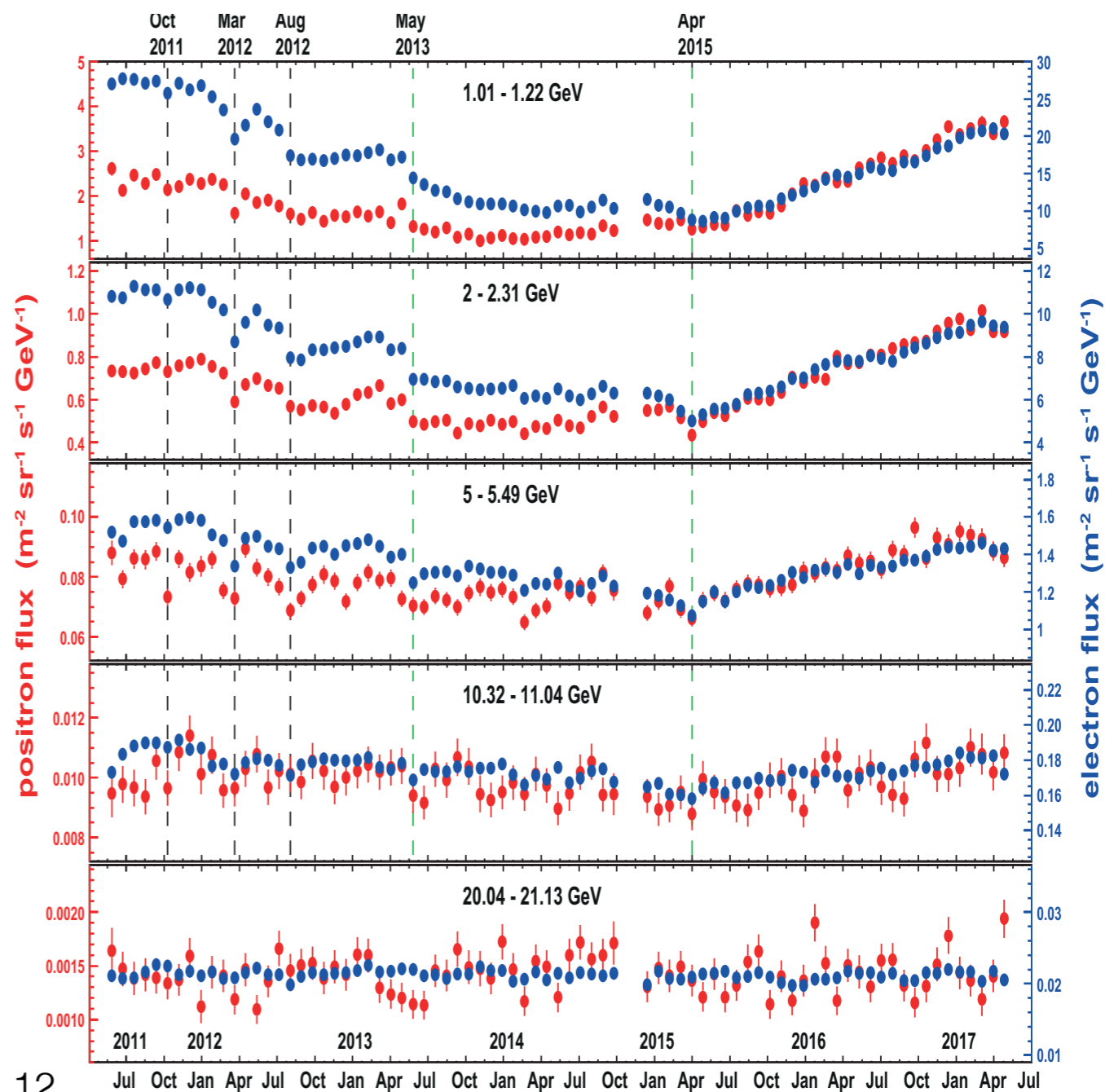
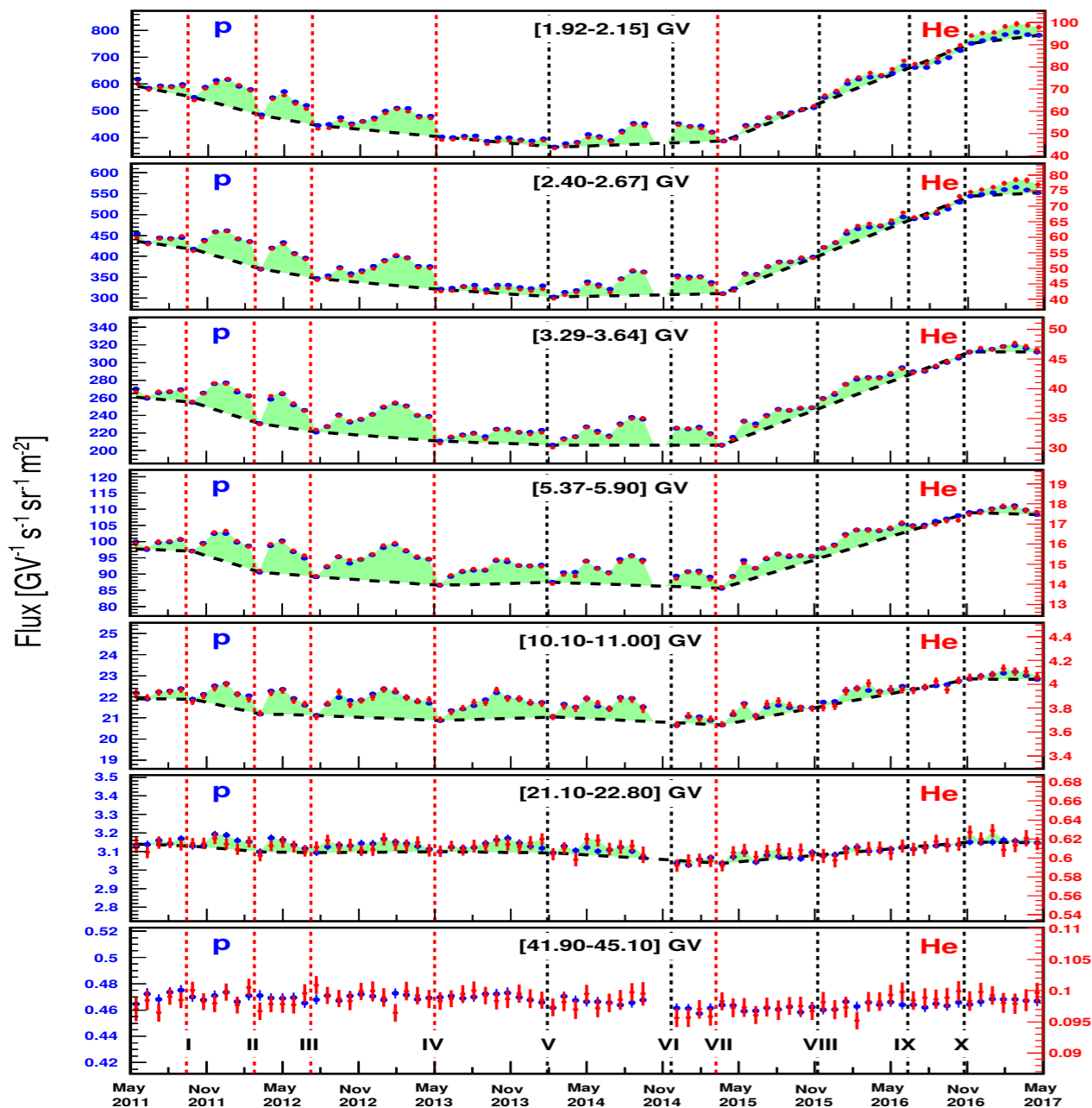
Observation of Complex Time Structures in the Cosmic-Ray Electron and Positron Fluxes with the Alpha Magnetic Spectrometer on the International Space Station

Phys. Rev. Lett. 121, 051102 (2018) [DOI](#), Citations: 14 [DOI](#), [View supplemental material and data](#)

Published on: 2018-07-31

Observation of Fine Time Structures in the Cosmic Proton and Helium Fluxes with the Alpha Magnetic Spectrometer on the International Space Station

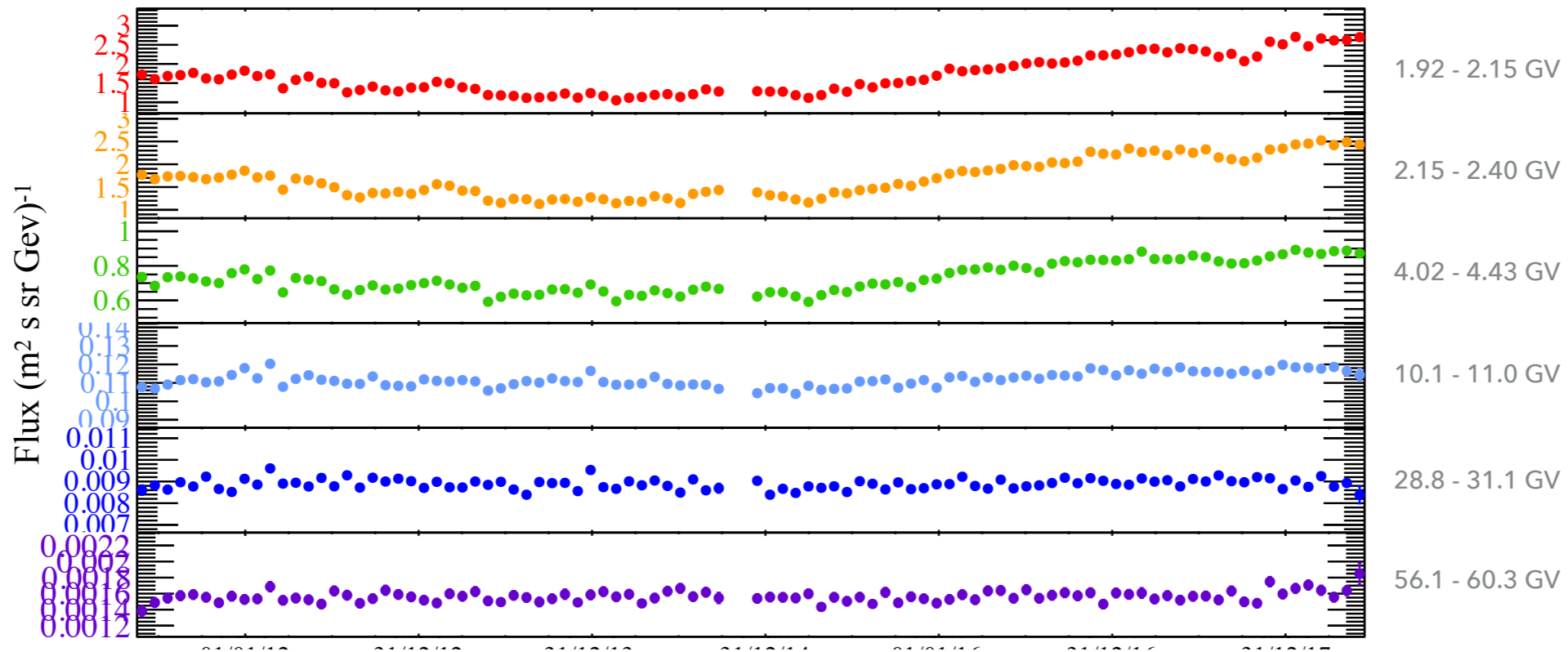
Phys. Rev. Lett. 121, 051101 (2018) [DOI](#), Citations: 14 [DOI](#), [View supplemental material and data](#)



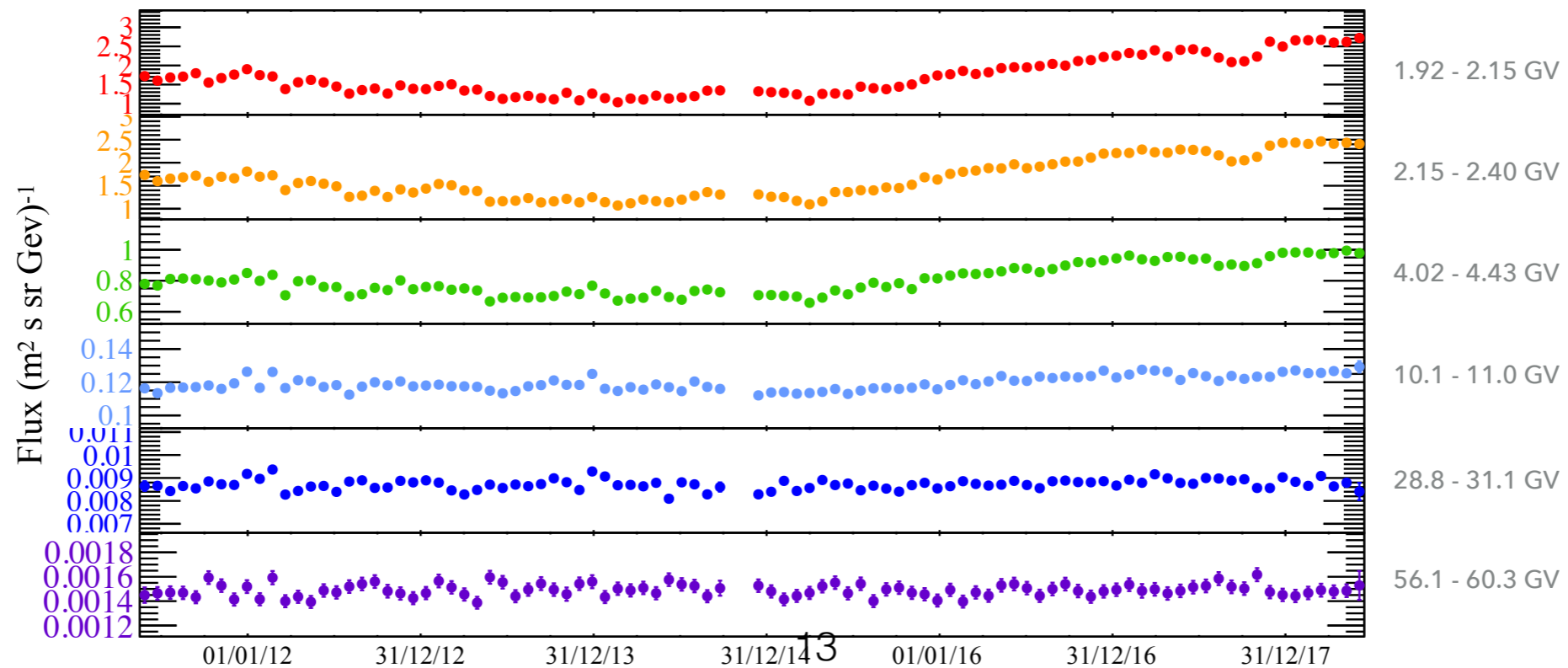


HIGHER Z TIME VARIATION - ANALYSIS BEING FINALISED

LOW ENERGY FLUXES (OXYGEN)

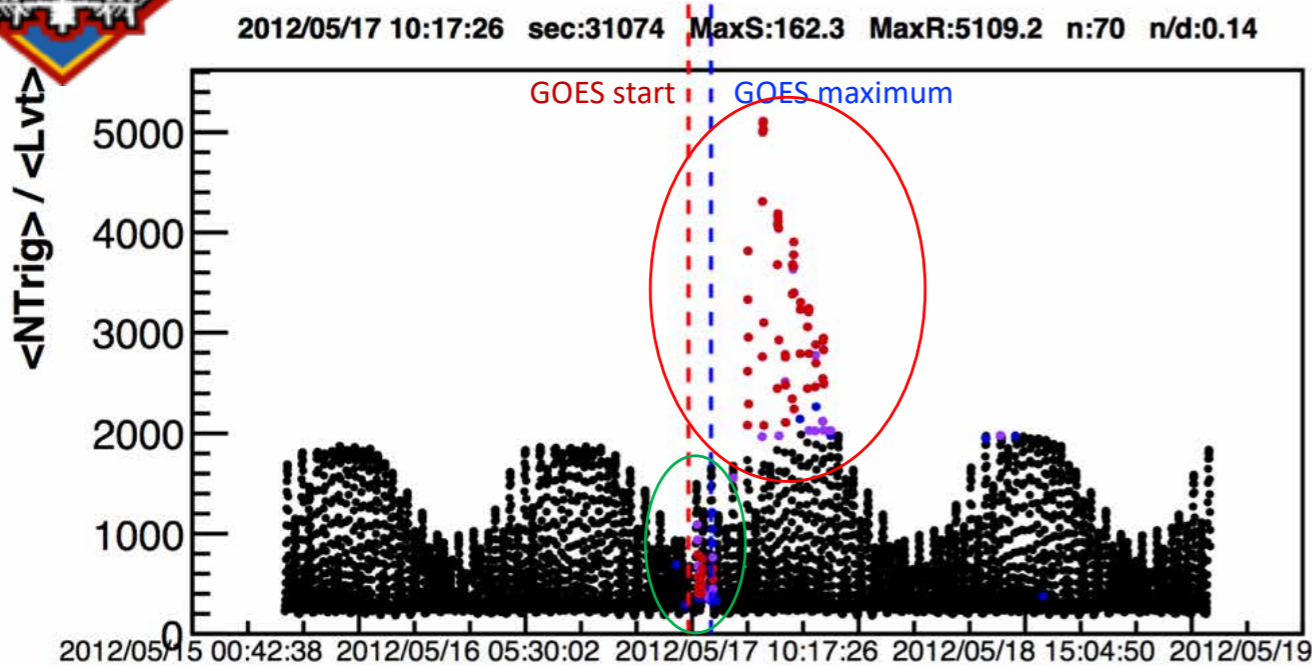


LOW ENERGY FLUXES (CARBON)





SPACE WEATHER STUDIES



New tool – currently under development

Aim:

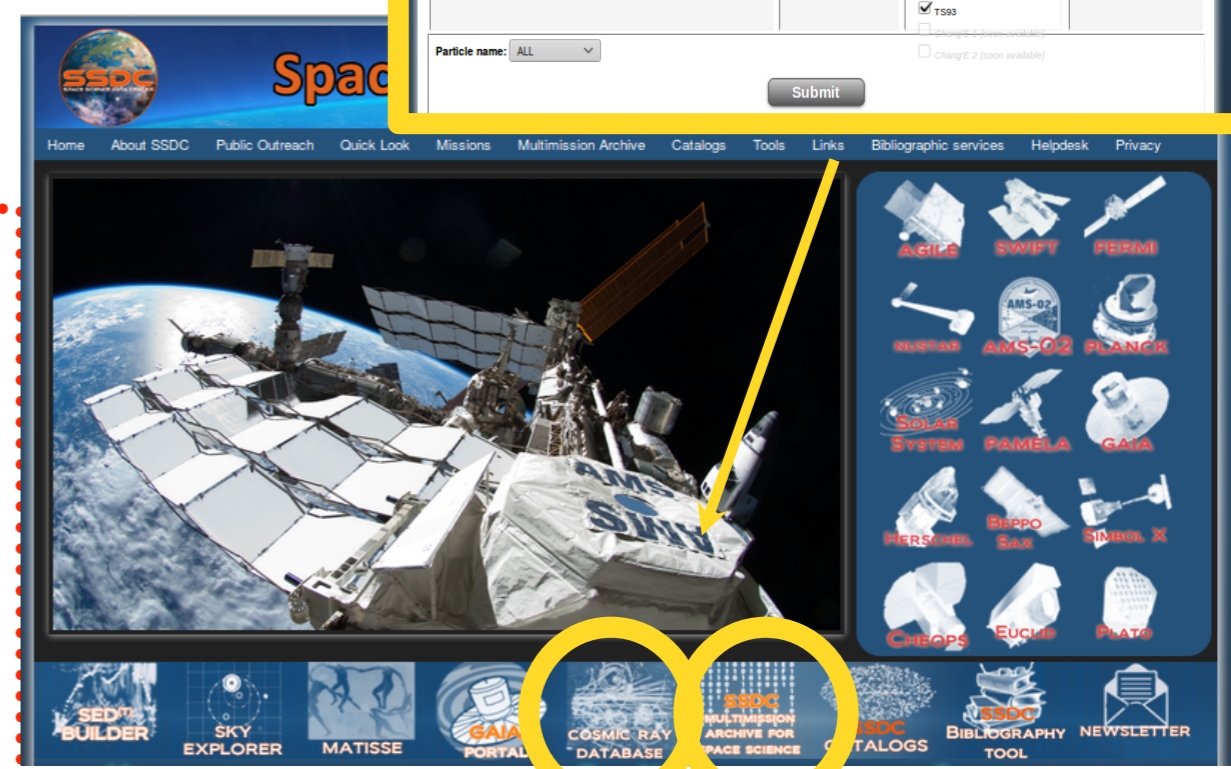
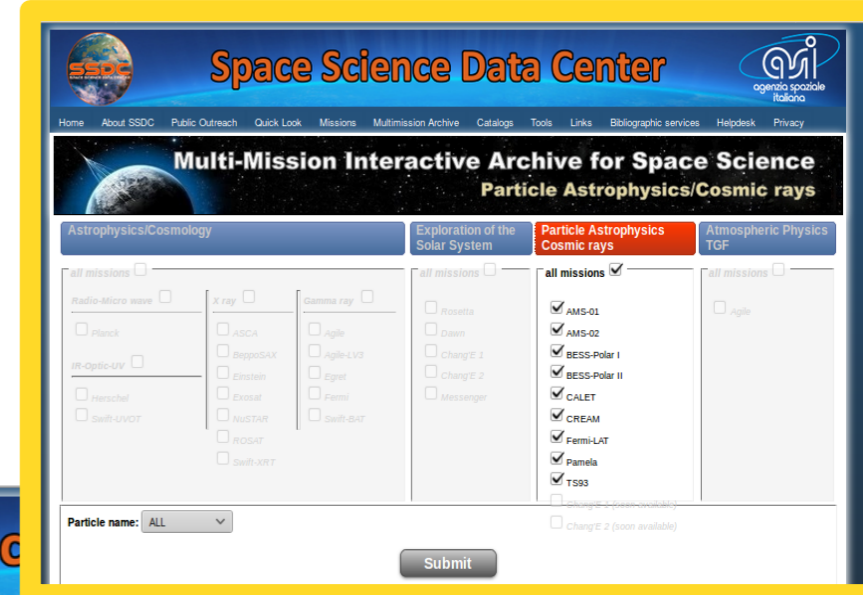
providing basic information about the radiation environment encountered by several cosmic ray missions

User selection:

- orbital parameters (altitude, latitude, longitude)
- magnetic parameters (B, L shell)
- missions
- temporal periods

Output:

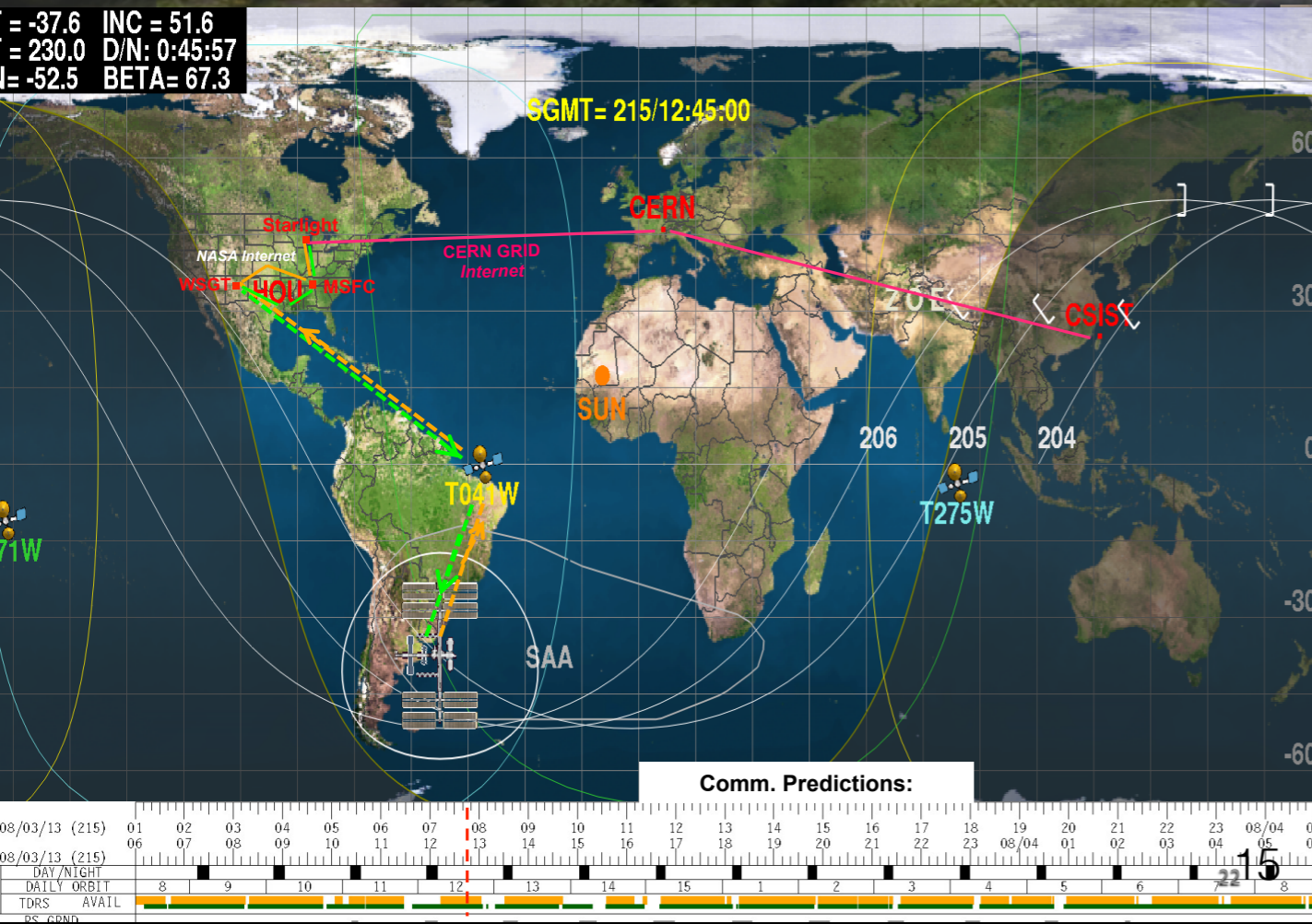
Raw count rate counts along given orbit
No particle ID



Use "low level" AMS (but not only) data to monitor the space weather

SHIFTS @ CERN

PAYLOAD OPERATIONS AND CONTROL CENTRE



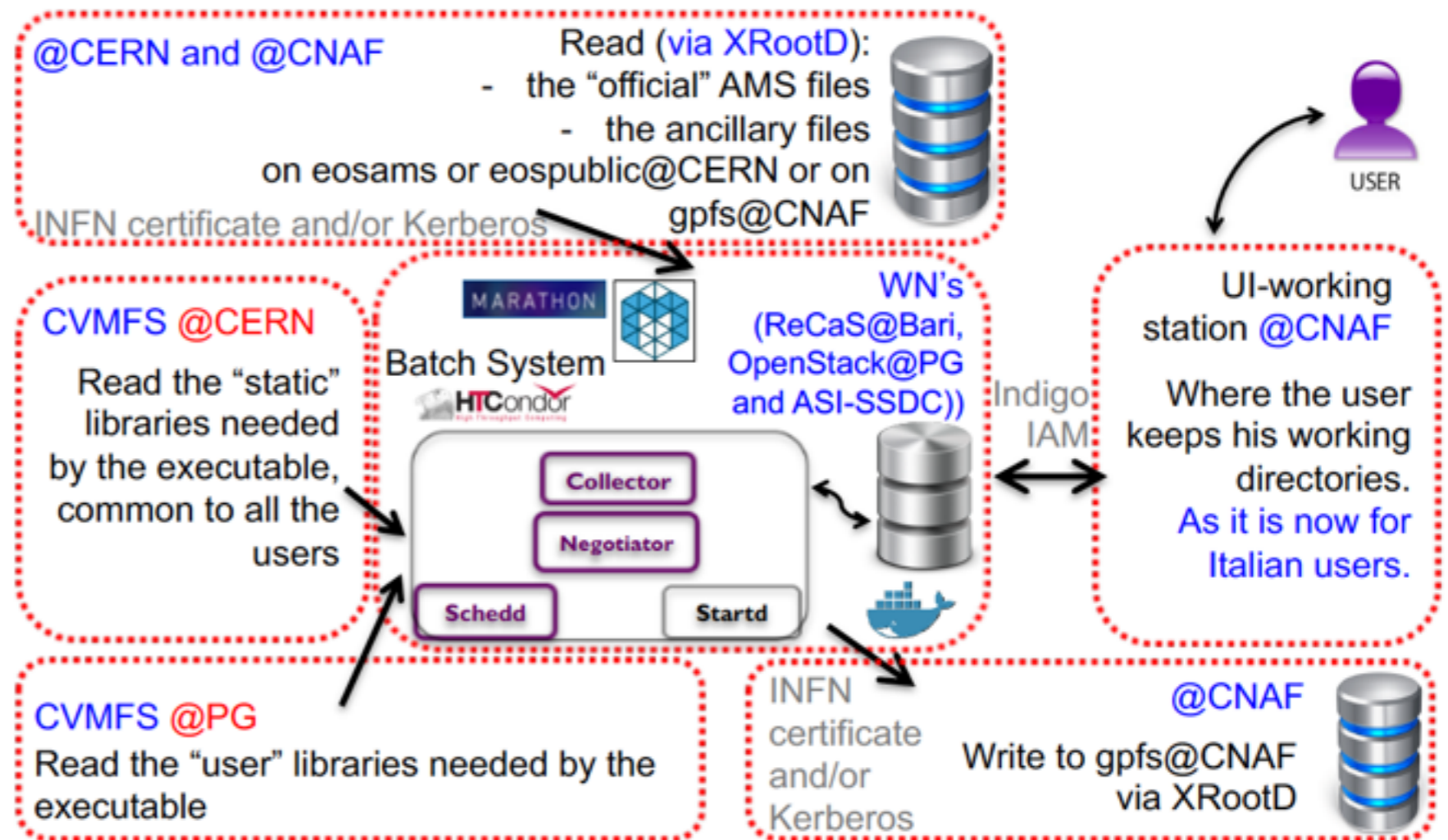
DODAS

Dal 2017 stiamo investigando la possibilità di sfruttare risorse di calcolo aggiuntive (risorse cloud, farm INFN in ASI-SSDC) in maniera armonica e congiunta alle risorse già disponibili a livello di collaborazione italiana (CNAF).

Questo verrà realizzato tramite l'utilizzo del progetto DODAS (Dynamic On Demand Analysis Service) che permette la creazione di un cluster di calcolo ad hoc basato sulle richieste e i bisogni dell'esperimento.

Questa attività ha richiesto di:

- ▶ Definire e creare un container docker per l'analisi dati di AMS-02
- ▶ Sottoporre il cluster a test ripetuti con esempi di lavoro tipici dell'analisi dati in AMS-02





ANAGRAFICHE E RICHIESTE 2020

| Ricercatori | | | | | |
|---------------------------|-------------------|-----|------------|--------------------|----------|
| | Nome | Età | Contratto | Qualifica | % |
| 1 | Di Felice Valeria | | Dipendente | Ricercatore | 80 |
| 2 | Donnini Federico | | Associato | Assegno di Ricerca | 100 |
| 3 | Formato Valerio | | Dipendente | Ricercatore | 80 |
| 4 | Khiali Behrouz | | Dipendente | Assegno di Ricerca | 100 |
| 5 | Narici Livio | | Associato | Prof. Associato | 30 |
| Numero Totale Ricercatori | | | | 5 | FTE: 3.9 |

3.9 FTE/ 5 RICERCATORI

RICHIESTE 2020 @CSN2 = 36.5 K€

- MISSIONI 29.5 K€ (CONFERENZE NAZ.-INTERN., MEETING ANALISI DATI, SHIFTS CONTROLLO PRESA DATI)

- CONSUMO, INVENTARIO E SPSERVIZI

BACKUP



COSMIC RAY Database

Database for Charged Cosmic Ray measurements.

Version 3.2

[Login](#)
[Feedback and contacts](#)

Looking for cosmic ray data?

The present Cosmic Ray DataBase (CRDB) provides access to published data from missions dedicated to charged cosmic-rays measurements. Have a look to our current (not comprehensive but in expansion) [data-set here!](#) Data are organized in a SQL database and can be searched through **queries** based on particle species, measurement of interest and/or name of the mission. A refined search is also available. **Query results** are accessible through a table, ready to be plotted, exported and downloaded in various formats. The set of returned information comprehends the published data points with associated uncertainties, and some meta-data. When, aside original data, more information are provided (e.g. the corresponding data obtained after some manipulation, as energy-rigidity conversion, change of units or similar), this is reported in the output file. Please, always consult the original publication before using the data. Feel free to contact us for any comment, query, suggestion, for adding new data or signalling any possible inaccuracy. **Thank you for citing us** when using the CRDB for your works!

Search parameters:

Particle: ALL

Plot: Flux vs Rigidity

Refined Search:

Time: from 2006-07-07 00:00:00.0 to 2017-05-09 23:59:59.0 GMT

Experiments:

All selected (19)

- Select all
- Balloon flights
- ATIC-2
- BESS-Polar I
- BESS-Polar II
- CREAM
- HEAT
- Juliusson
- Orth

SEARCH

RESET

Special datasets:

- SEP events
- trapped

- **Ulteriori DB**

- **Ambiente di radiazione spaziale**

Alla fase di sviluppo e test del prototipo basato sui dati di PAMELA è seguita una fase di dialogo con parte della comunità scientifica, utile al fine di espandere il tool ed ottimizzarlo. Dunque:

- sono stati prodotti plot relativi al cutoff geomagnetico (IGRF model) utilizzando dati di PAMELA per orbite compatibili con quella dello strumento cinese **HXMT per la astronomia X**. Questo al fine di consentire la reiezione del fondo con maggiore accuratezza. Come si vede, la disponibilità ed il facile accesso a tale tipo di informazioni è di interesse per diversi settori della comunità scientifica;

- è stato sviluppato del software per la creazione di nuovi tipi di grafici di output per il tool di monitoring;

- nuovi test sono stati effettuati, in seguito a modifiche resesi necessarie per rendere il database adatto alla molto maggiore mole di dati di **AMS**. Tali modifiche sono legate al tempo di integrazione del dato sperimentale, e non apportano cambiamenti nelle performance;

- sviluppo prosegue in una direzione che consente di interfacciare, od unire, questo DB con il DB di dati e metadati per missioni sulla ISS

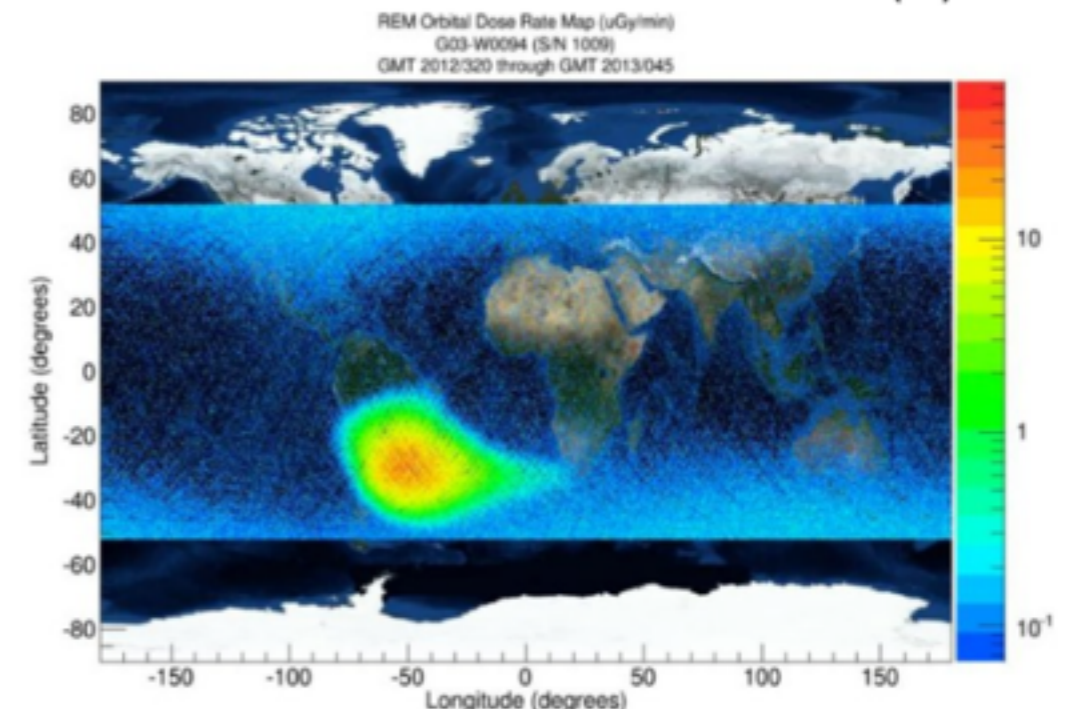
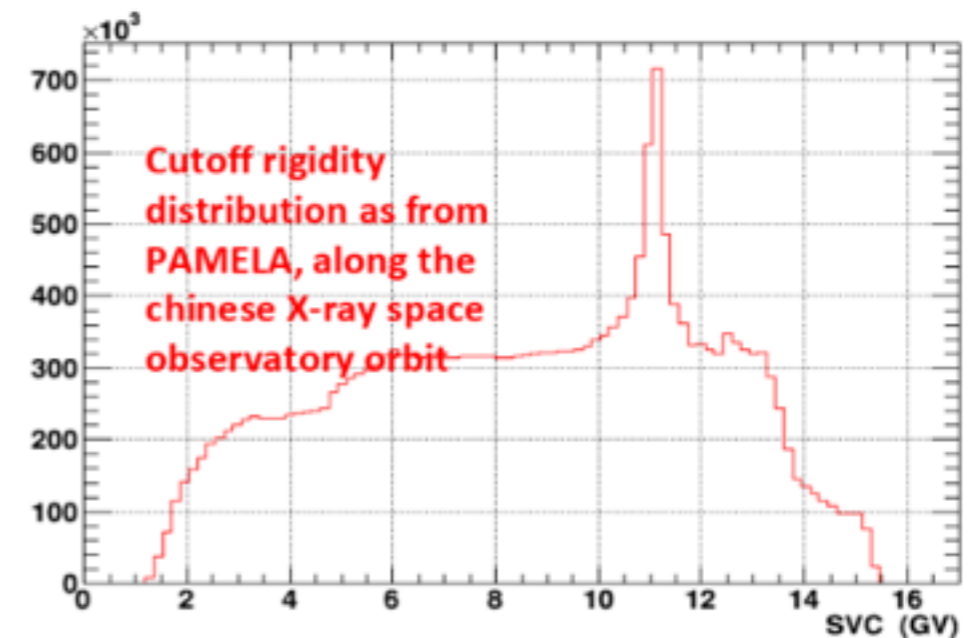
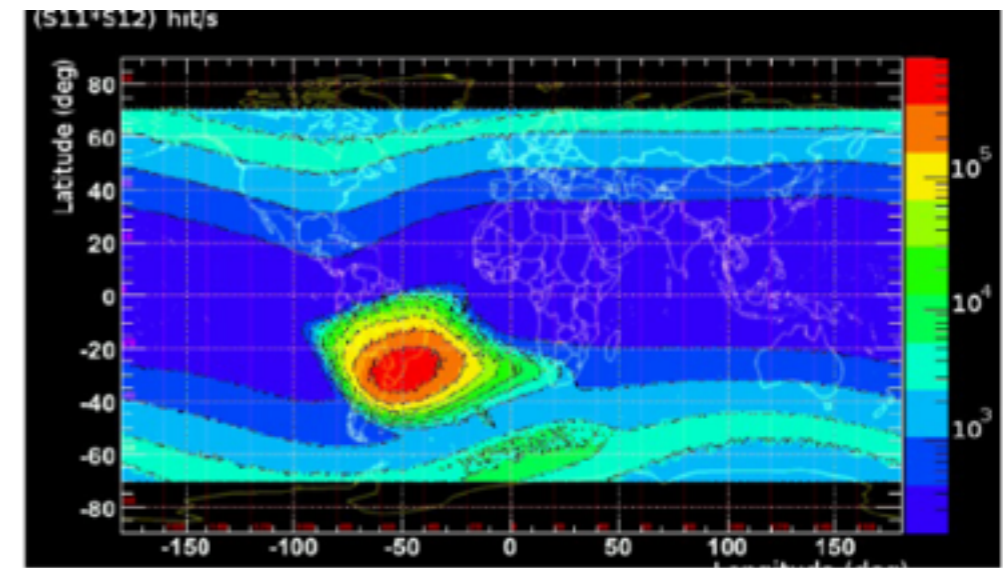
- **Metadati e dati di missioni sulla ISS**

- riunioni presso l'Università di Roma Tor Vergata per definire alcuni dettagli del progetto [1];

- studio dei dati attualmente disponibili da strumenti per la dosimetria su ISS, e del formato dei metadati e dati da inserire.

-

[1] L. Narici, (2015) doi: 10.3389/fonc.2015.00273



Esempio di mappa orbitale di dose su ISS
10.13140/RG.2.2.27789.84966

Published on: **2019-03-13**

Towards Understanding the Origin of Cosmic-Ray Electrons

[Phys. Rev. Lett.122, 101101 \(2019\)](#), Citations: **1**, [View supplemental material and data](#)

Published on: **2019-01-29** **Editors' Suggestion**

Towards Understanding the Origin of Cosmic-Ray Positrons

[Phys. Rev. Lett. 122, 041102 \(2019\)](#), Citations: **18**, [View supplemental material and data](#)

Published on: **2018-07-31**

Precision Measurement of Cosmic-Ray Nitrogen and its Primary and Secondary Components with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett.121, 051103 \(2018\)](#), Citations: **13**, [View supplemental material and data](#)

Published on: **2018-07-31** **Editors' Suggestion**

Observation of Complex Time Structures in the Cosmic-Ray Electron and Positron Fluxes with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 121, 051102 \(2018\)](#), Citations: **14**, [View supplemental material and data](#)

Published on: **2018-07-31**

Observation of Fine Time Structures in the Cosmic Proton and Helium Fluxes with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 121, 051101 \(2018\)](#), Citations: **14**, [View supplemental material and data](#)

Published on: **2018-01-11** **Editors' Suggestion** **Featured in Physics**

Observation of New Properties of Secondary Cosmic Rays Lithium, Beryllium, and Boron by the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett.120, 021101 \(2018\)](#), Citations: **50**, [View supplemental material and data](#)

Published on: **2017-12-18**

Observation of the Identical Rigidity Dependence of He, C, and O Cosmic Rays at High Rigidities by the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 119, 251101 \(2017\)](#), Citations: **49**, [View supplemental material and data](#)



Published on: **2016-11-28** **Editors' Suggestion** **Featured in Physics**

Precision Measurement of the Boron to Carbon Flux Ratio in Cosmic Rays from 1.9 GV to 2.6 TV with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett.117, 231102 \(2016\)](#), Citations: **145**, [View supplemental material and data](#)



Published on: **2016-08-26**

Antiproton Flux, Antiproton-to-Proton Flux Ratio, and Properties of Elementary Particle Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett.117, 091103 \(2016\)](#) , Citations: **236** , [View supplemental material and data](#)



Published on: **2015-11-17** **Editors' Suggestion**

Precision Measurement of the Helium Flux in Primary Cosmic Rays of Rigidities 1.9 GV to 3 TV with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett.115, 211101 \(2015\)](#) , Citations: **240** , [View supplemental material and data](#)


Published on: **2015-04-30** **Editors' Suggestion**

Precision Measurement of the Proton Flux in Primary Cosmic Rays from Rigidity 1 GV to 1.8 TV with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 114, 171103 \(2015\)](#) , Citations: **436** , [View supplemental material and data](#)



Published on: **2014-11-26**

Precision Measurement of the ($e^+ + e^-$) Flux in Primary Cosmic Rays from 0.5 GeV to 1 TeV with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 113, 221102 \(2014\)](#) , Citations: **218** , [View supplemental material and data](#)


Published on: **2014-09-18** **Editors' Suggestion** **Featured in Physics**

Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station

[Phys. Rev. Lett. 113, 121102 \(2014\)](#) , Citations: **412** , [View supplemental material and data](#)

Published on: **2014-09-18** **Editors' Suggestion**

High Statistics Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5 – 500 GeV with the Alpha Magnetic Spectrometer on the International Space Station

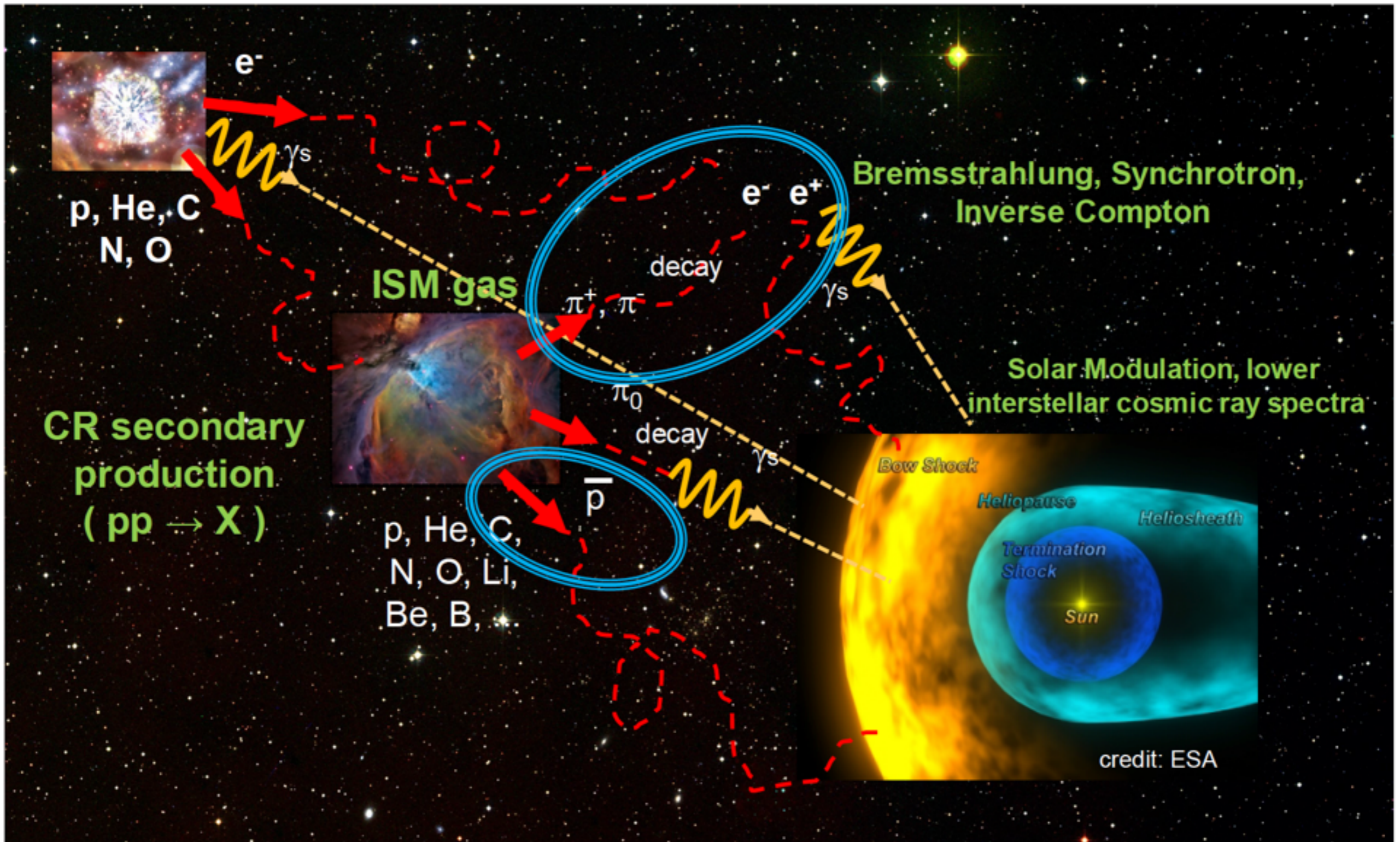
[Phys. Rev. Lett. 113, 121101 \(2014\)](#) , Citations: **450** , [View supplemental material and data](#)

Published on: **2013-04-03** **Editors' Suggestion** **Featured in Physics** **Physics Viewpoint**

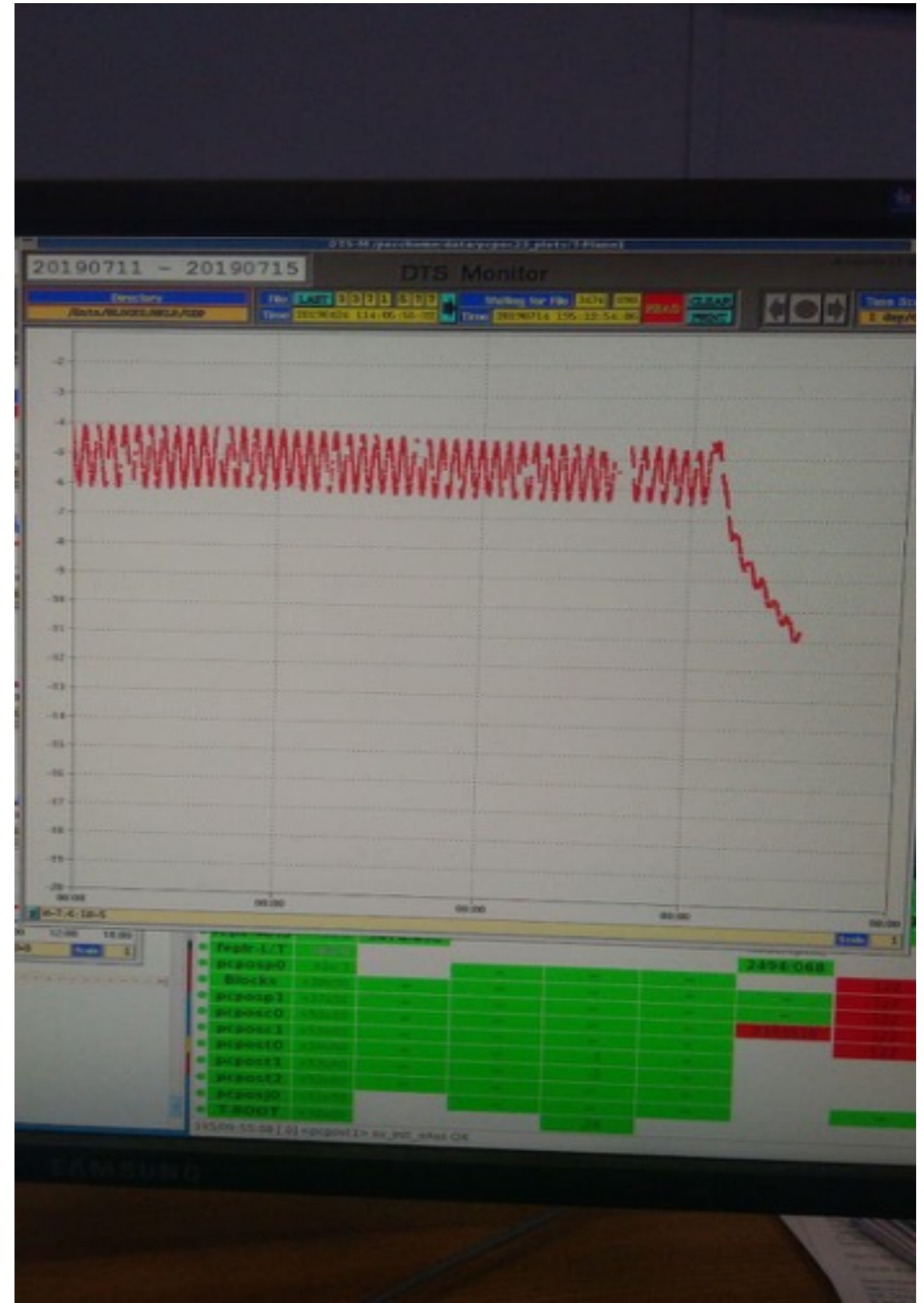
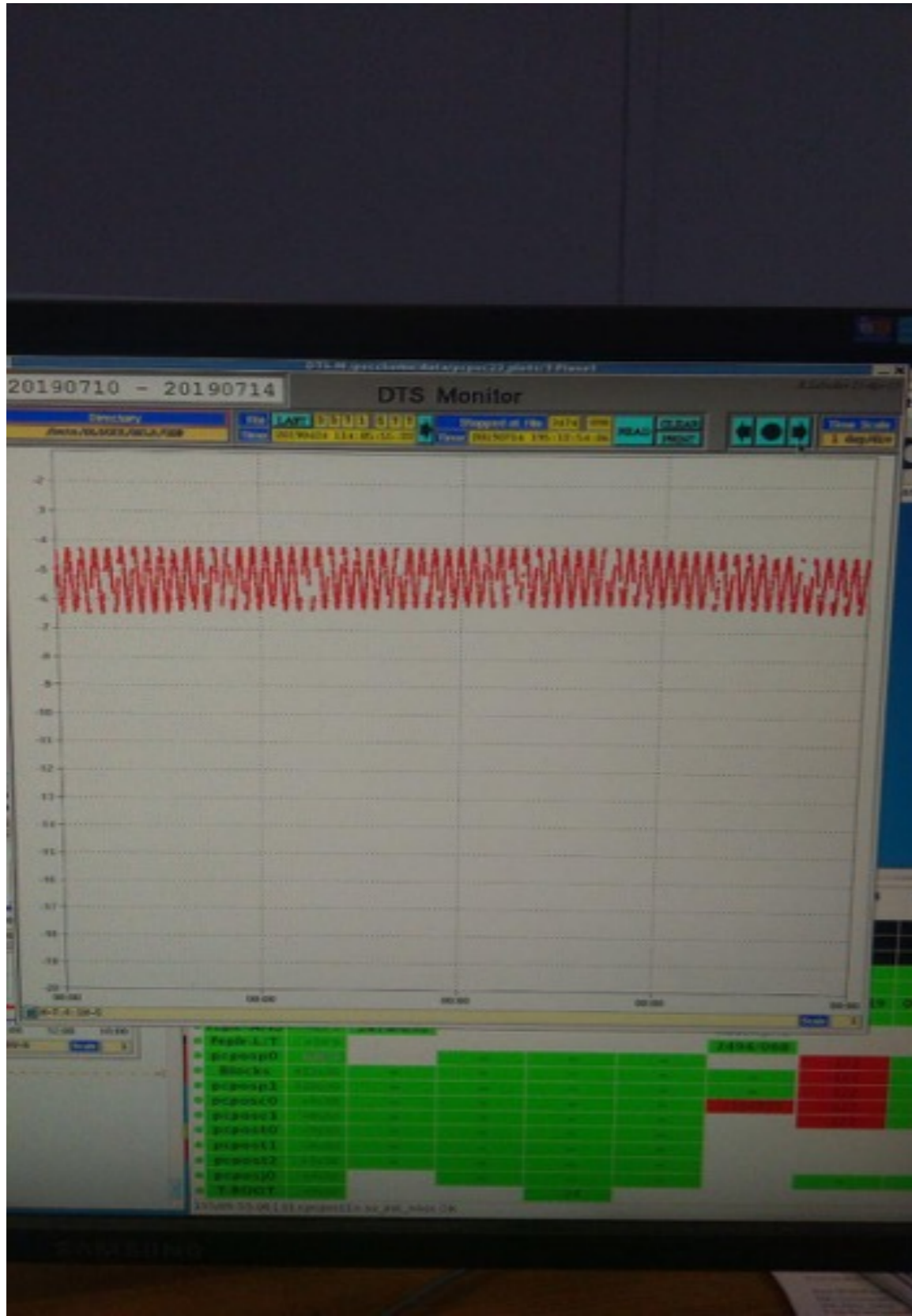
First Result from the Alpha Magnetic Spectrometer on the International Space Station: Precision Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5–350 GeV

[Phys. Rev. Lett. 110, 141102 \(2013\)](#) , Citations: **918** , [View supplemental material and data](#)

Cosmic Rays and Anti-Particles



EXAMPLE: TEMPERATURE VARIATION WITH ISS CHANGING ATTITUDE



AMS in Figures

7.5 t
Weight

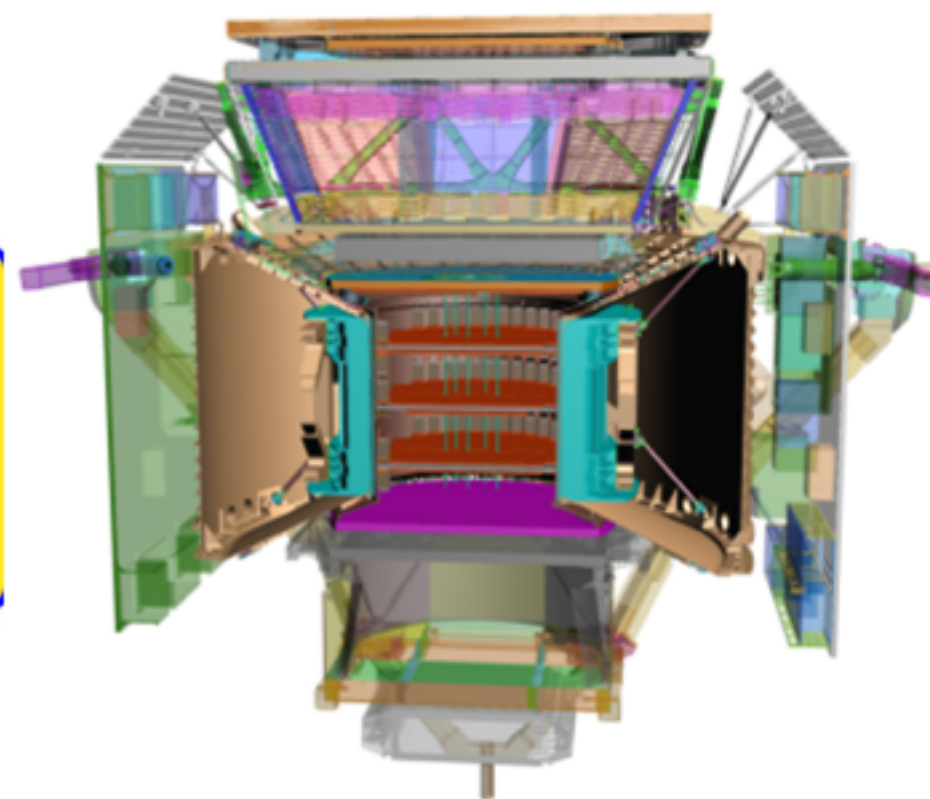
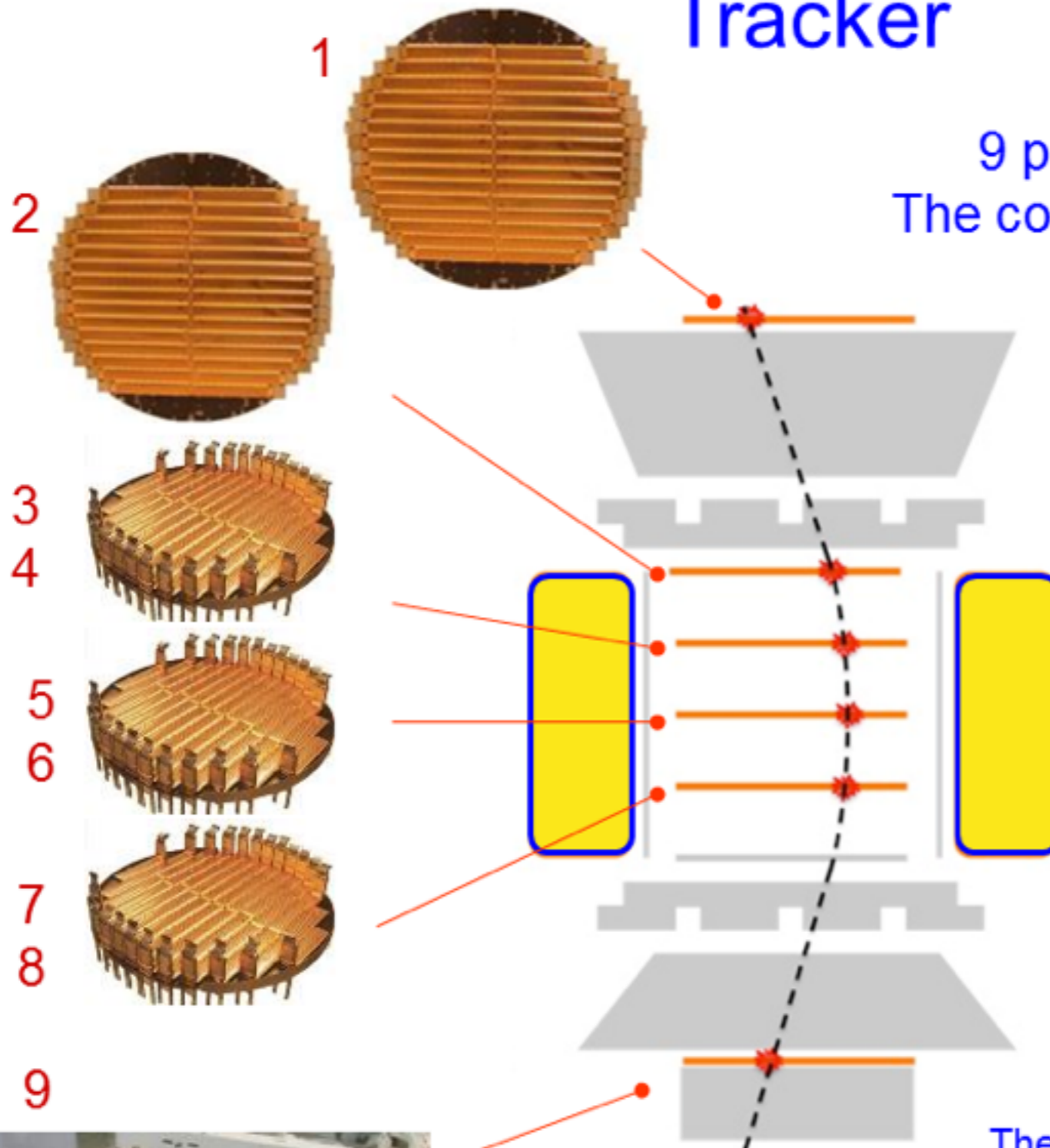
5×4×3 m³
Size

0.14 T
Magnetic Field
Intensity

16/05/2011
08:56 AM
EDT
Launched

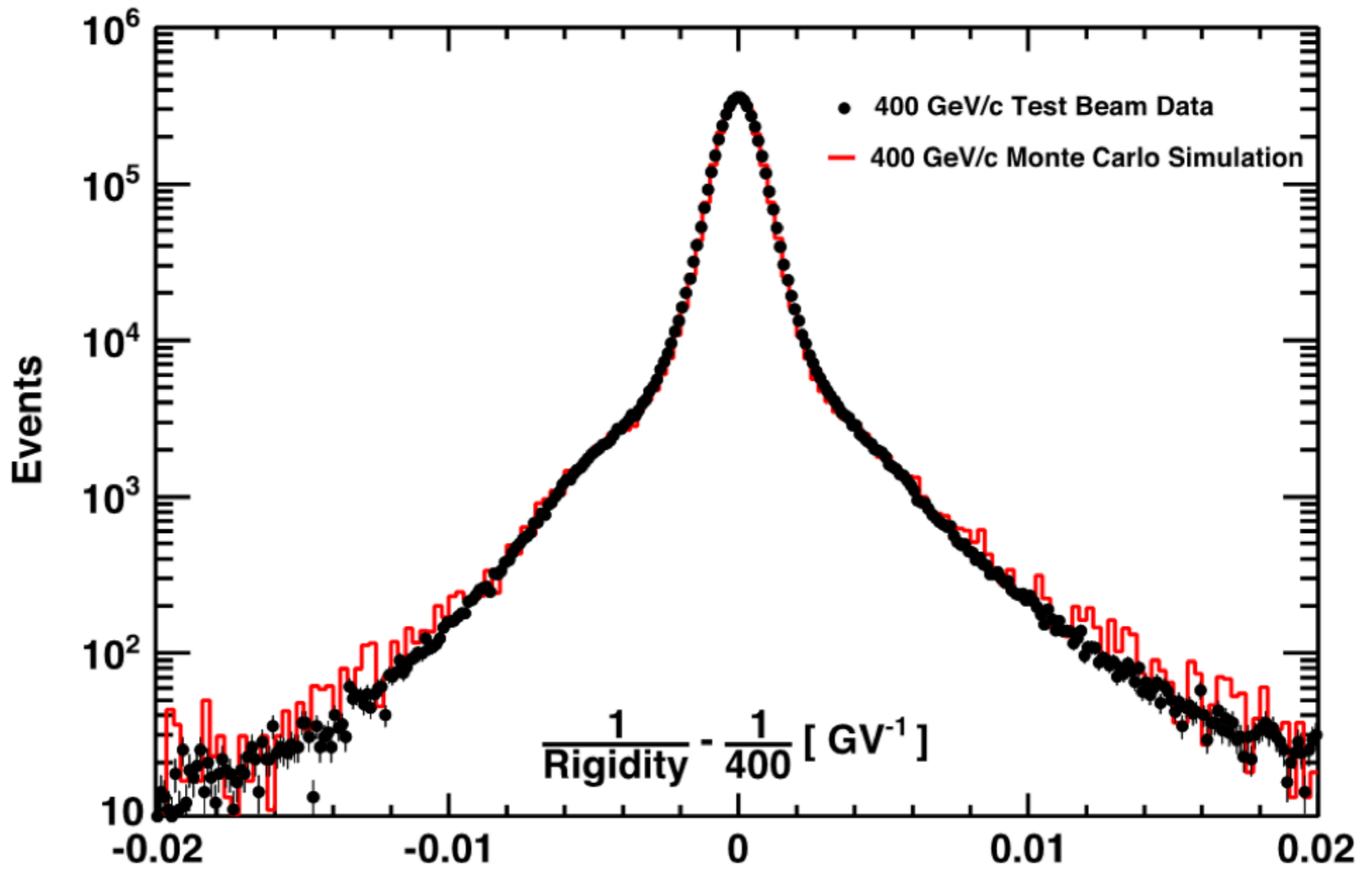
Tracker

9 planes, 200,000 channels
The coordinate resolution is 10 μm.

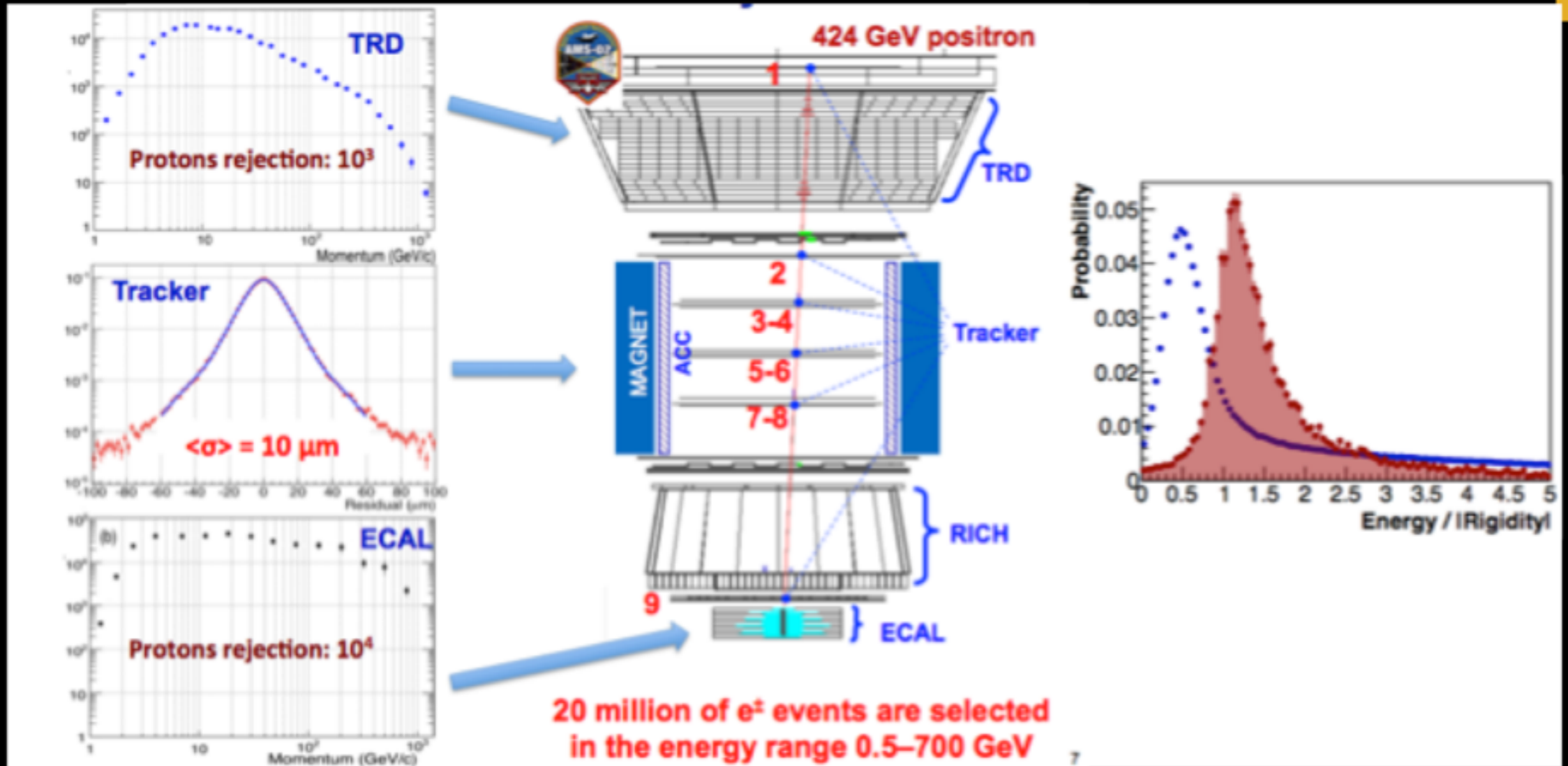


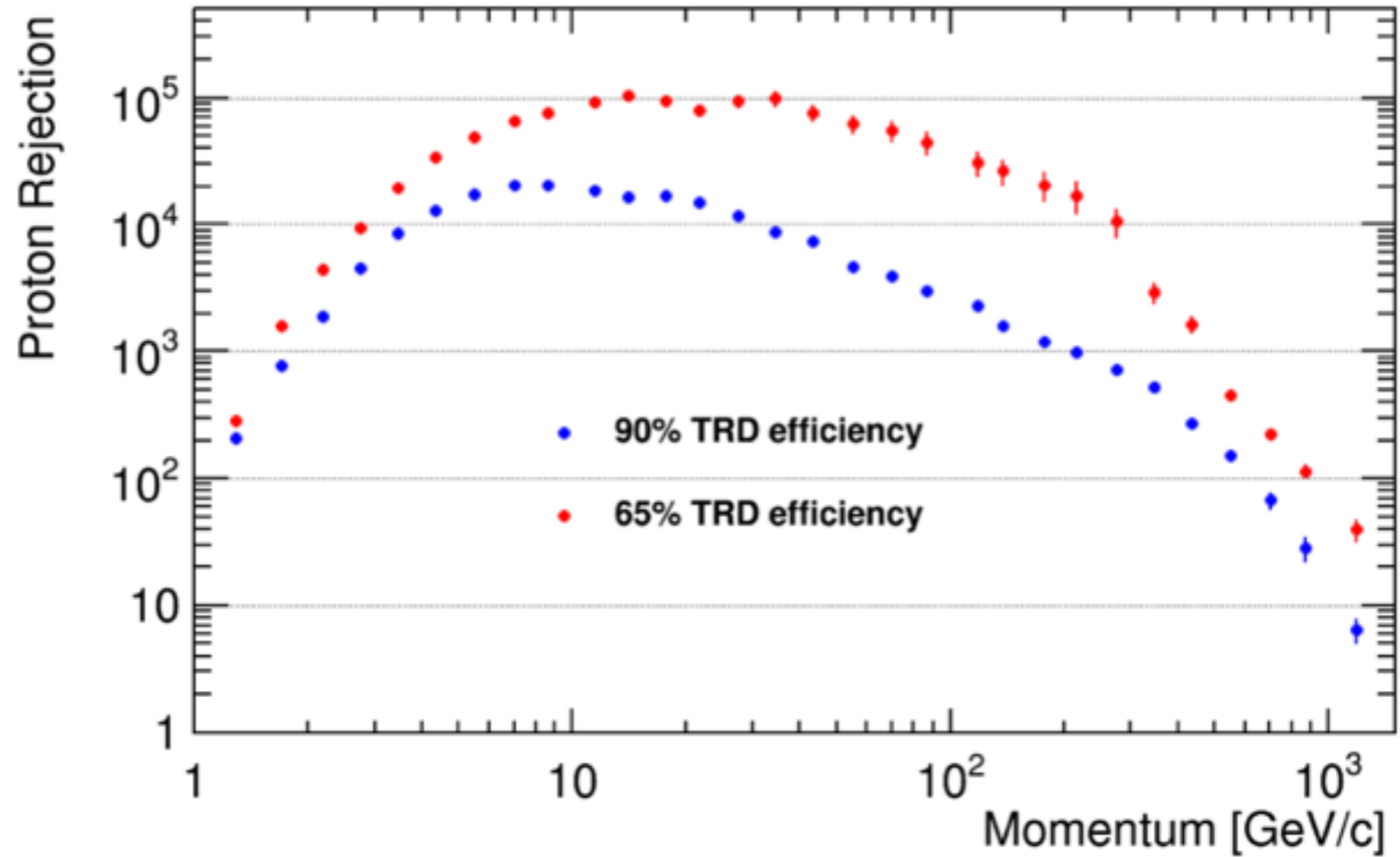
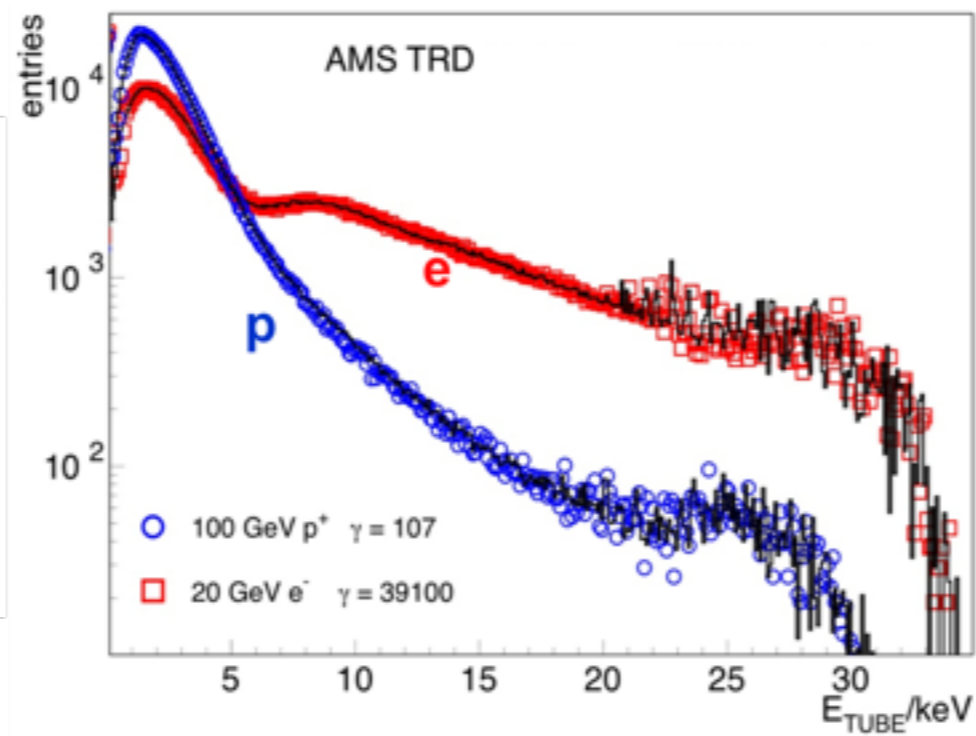
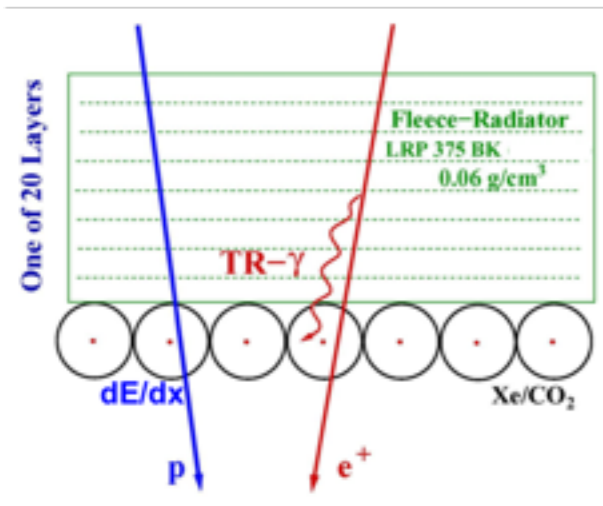
Inner tracker alignment stability monitored with IR Lasers.
The Outer Tracker is continuously aligned with cosmic rays.

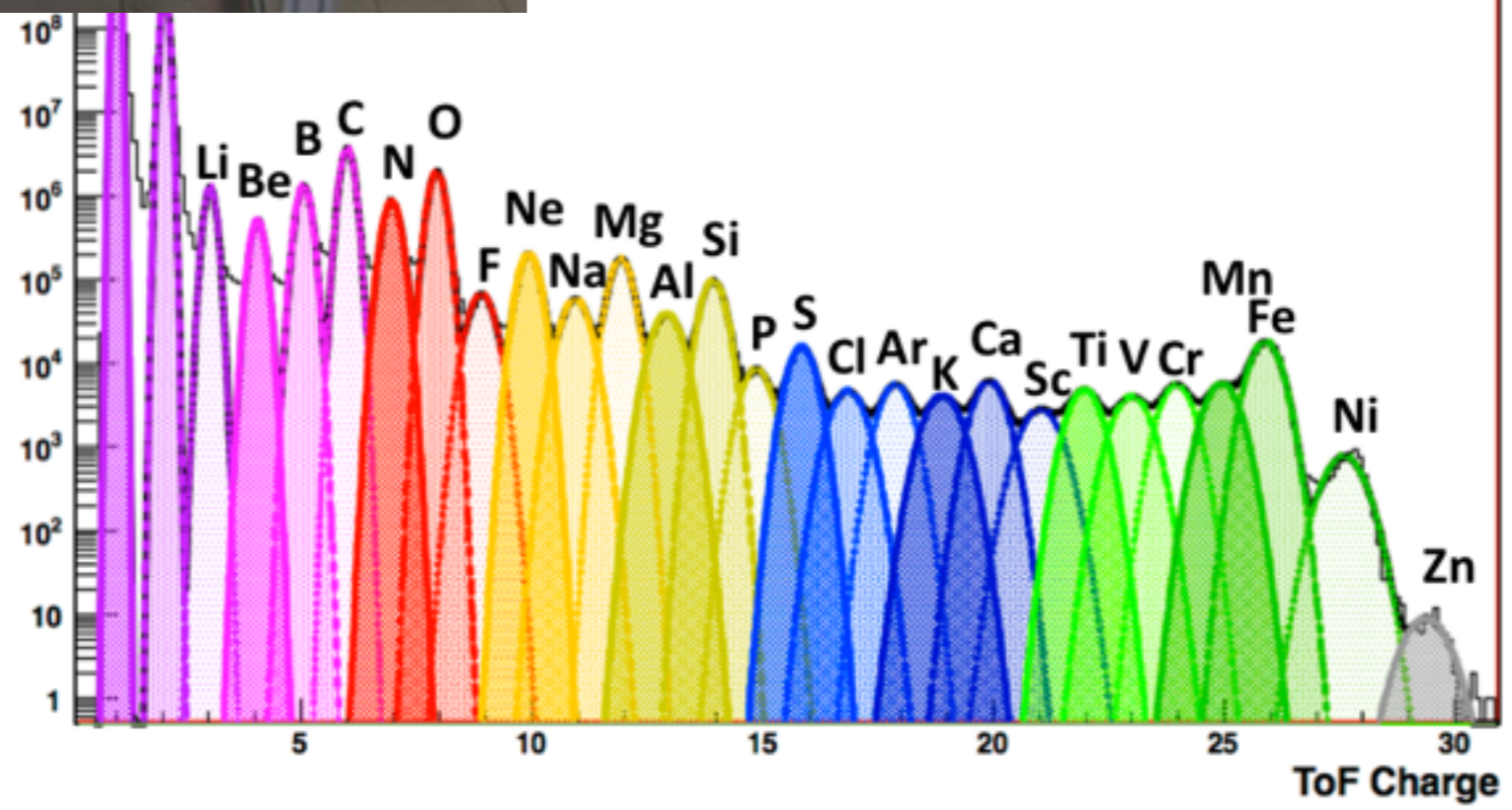
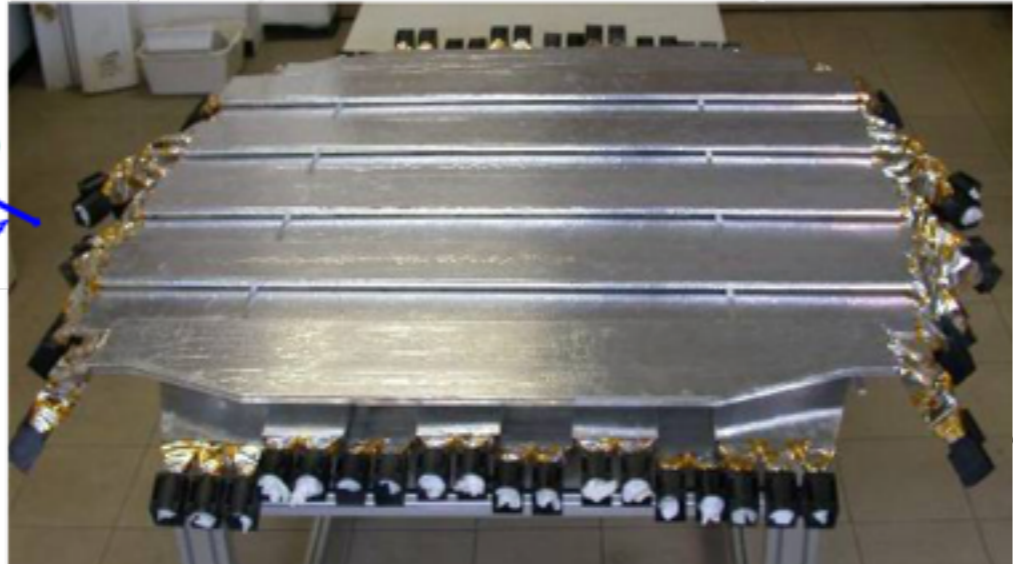
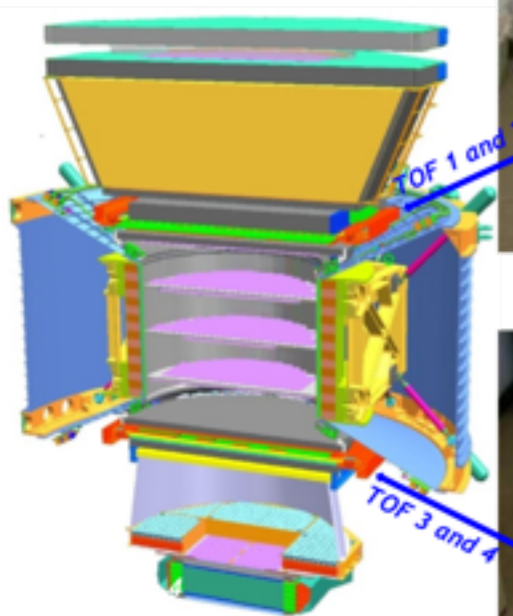


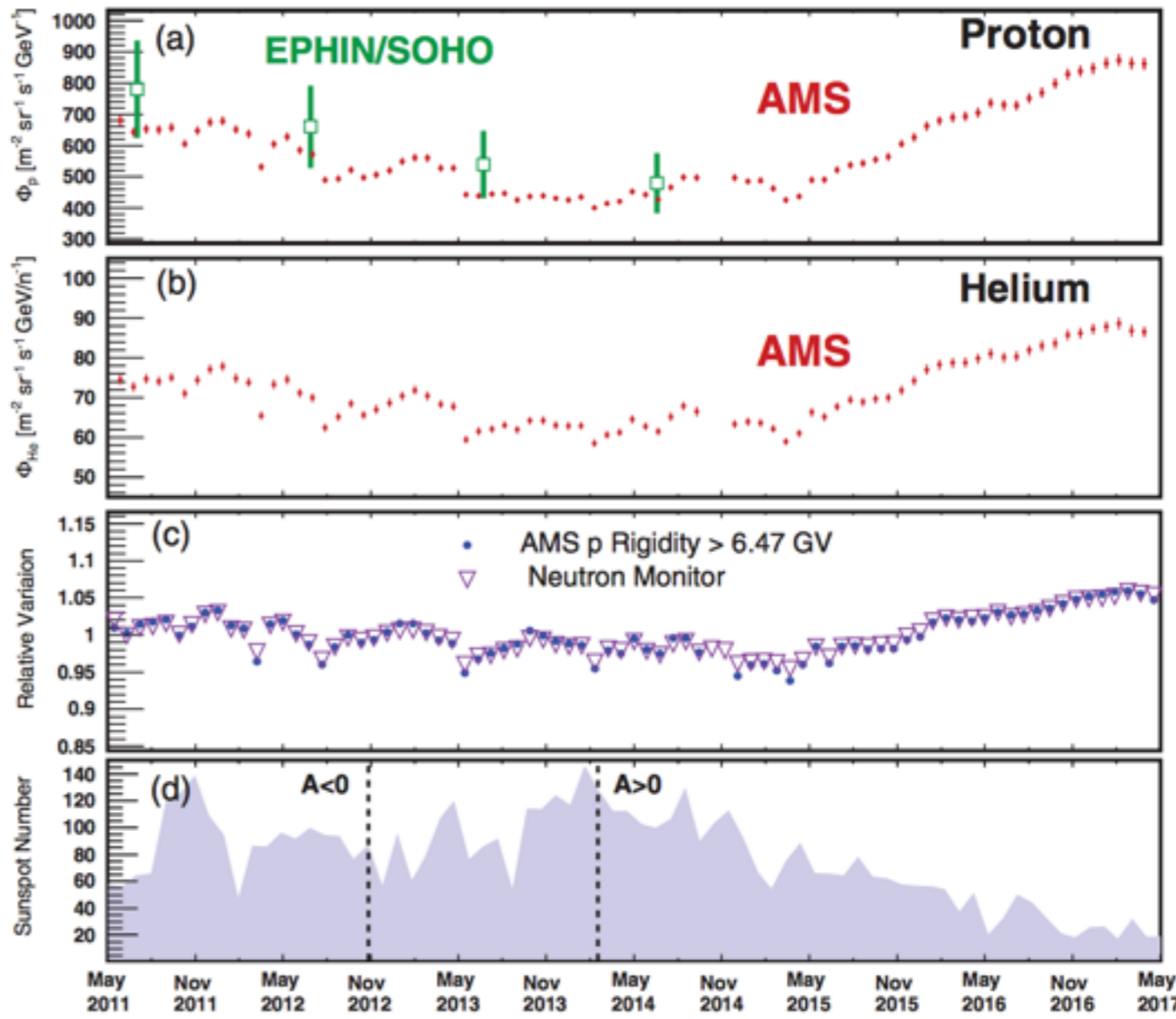
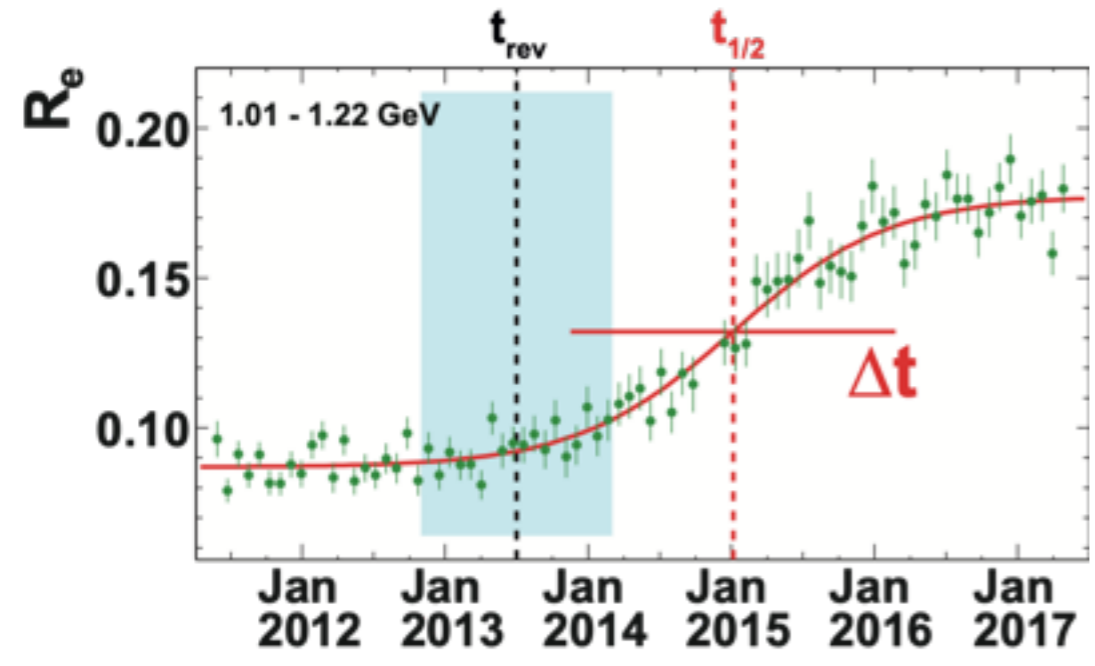


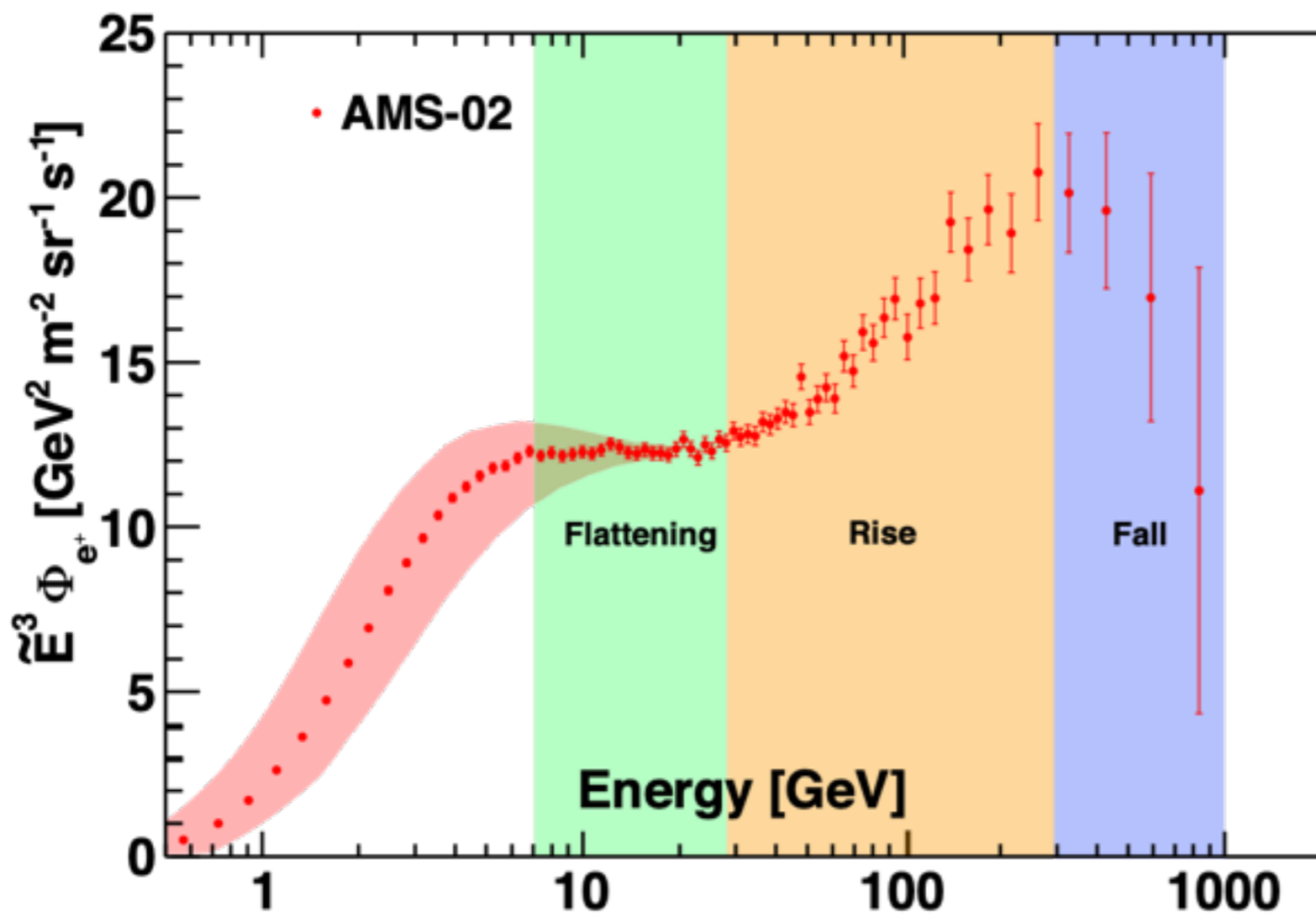
e/p separation











The positron flux exhibits complex energy dependence. Its distinctive properties are:

1. a significant excess starting from 25.2 ± 1.8 GeV compared to the lower-energy, power-law trend;
2. a sharp drop-off above 284^{+91}_{-64} GeV;
3. in the entire energy range the positron flux is well described by the sum of a term associated with the positrons produced in the collision of cosmic rays, which dominates at low energies, and a new source term of positrons, which dominates at high energies; and
4. a finite energy cutoff of the source term of $E_s = 810^{+310}_{-180}$ GeV is established with a significance of more than 4σ .

ANTIDEUTERIO

Dopo positroni e antiprotoni, i nuclei di antideuterio sono il possibile prodotto più abbondante dal decadimento della materia oscura.

Finestra "preferenziale" a basse energie dove la produzione secondaria in collisioni di raggi cosmici è sfavorita per motivi cinematici.

L'analisi in AMS-02 viene divisa in due gruppi di lavoro (A e α). Il gruppo di Perugia entra da subito a far parte del gruppo α .

