AMS-02 Trento

TIFPA - Gr 2 -2024

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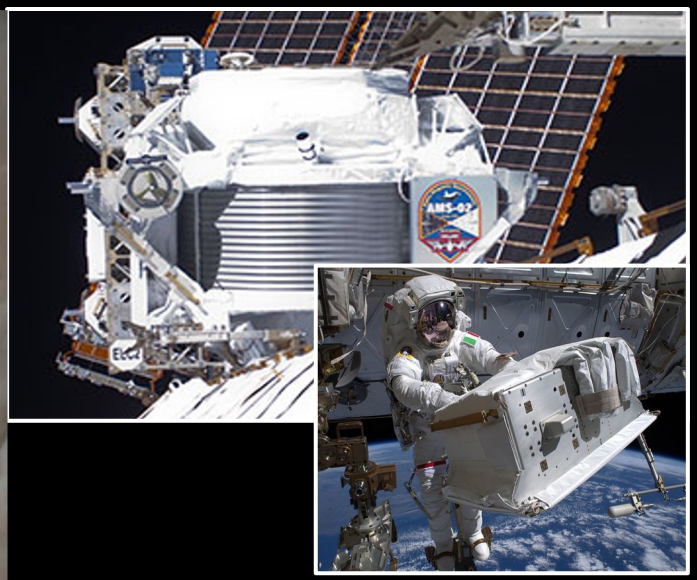
TIFPA
Trento Institute for Fundamental Physics and Applications

UNIVERSITÀ DI TRENTO

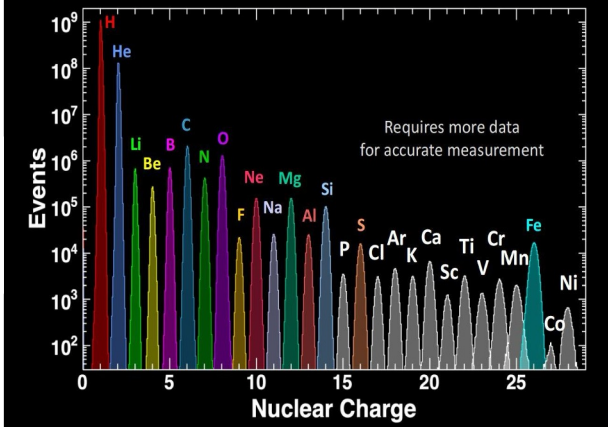
AMS - 02

AMS was installed on ISS in May 2011.



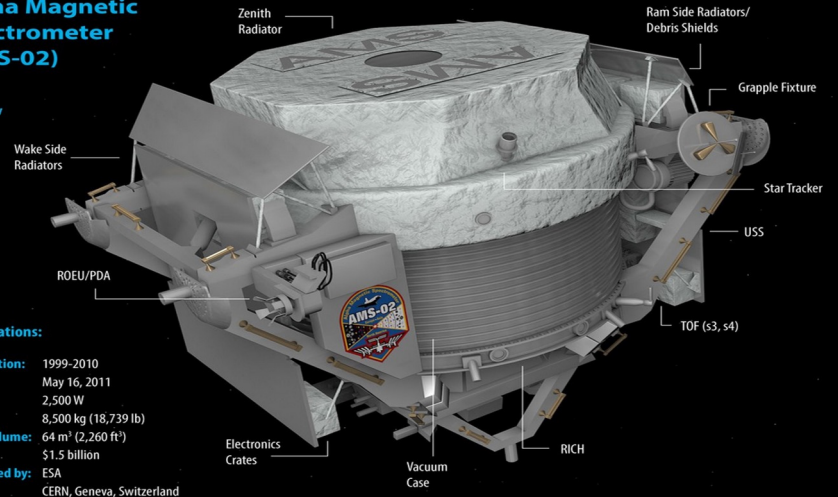
AMS determination of Cosmic Ray Nuclei

AMS will provide complete and accurate spectra for the 29 elements and provide the foundation for a comprehensive theory of cosmic rays.



Alpha Magnetic Spectrometer (AMS-02)

Port view

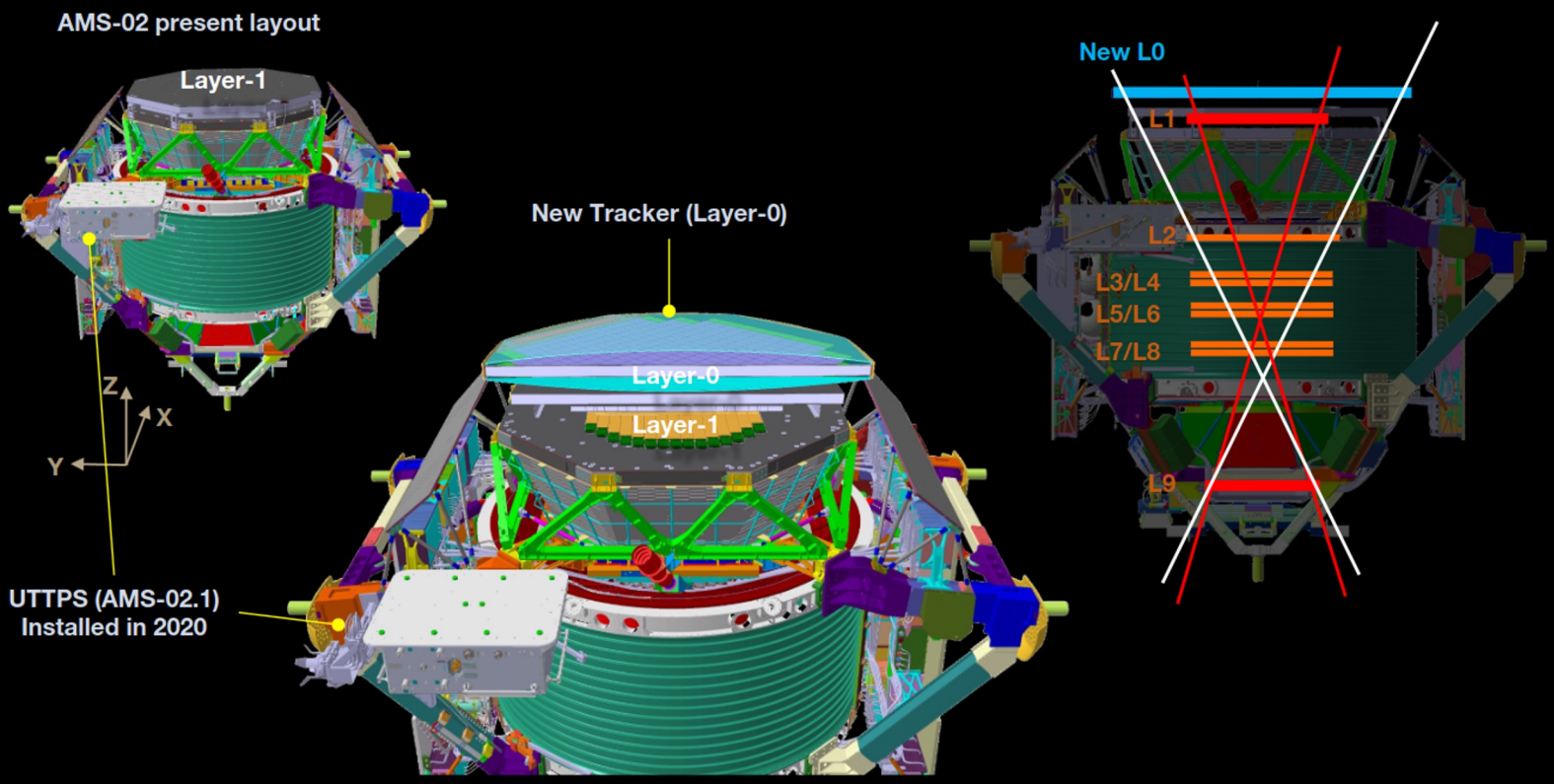


Specifications:

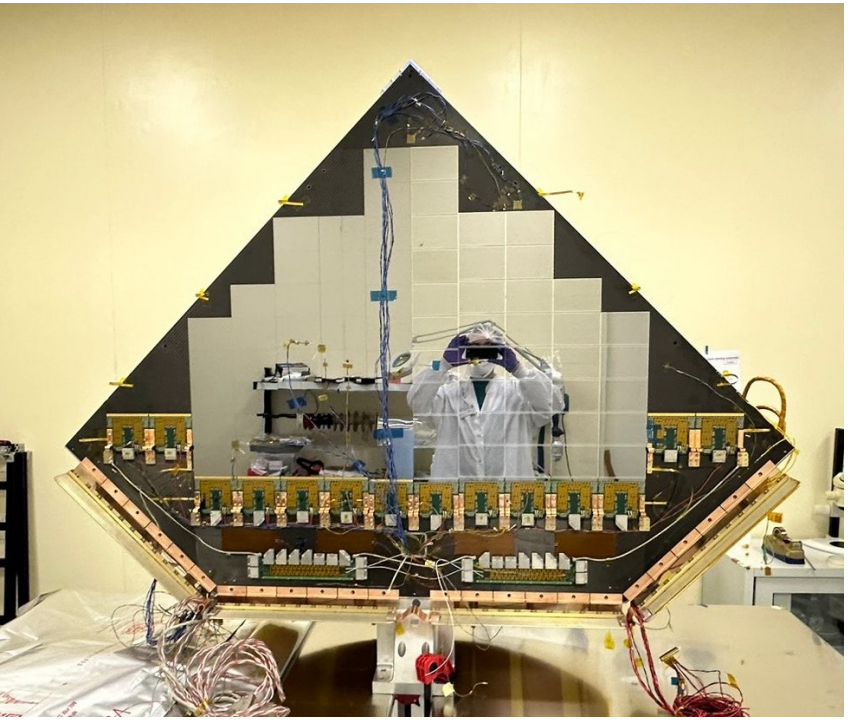
Construction:	1999-2010
Launch:	May 16, 2011
Power:	2,500 W
Mass:	8,500 kg (18,739 lb)
Press. Volume:	64 m³ (2,260 ft³)
Cost:	$1.5 billion
Contracted by:	ESA
Built by:	CERN, Geneva, Switzerland

AMS-02 Upgrade: L0 Layer to Increase Acceptance(2026)

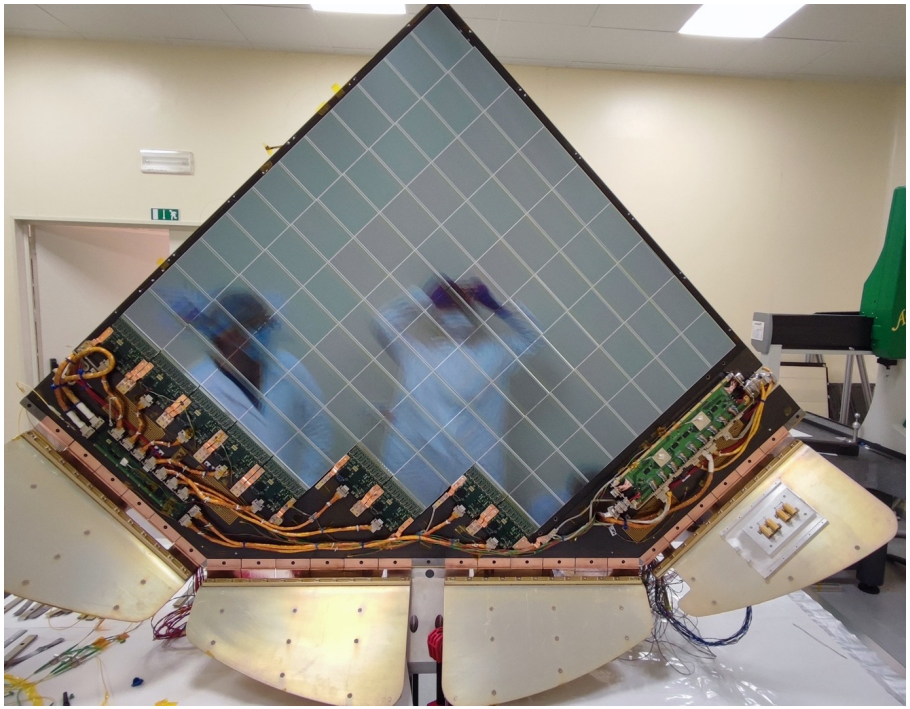
The increase of 300% in the acceptance will allow for the best use of the time left on the ISS, allowing higher rate in data collection for many analysis channels (positrons, nuclei, …).



¼ plane fully integrated

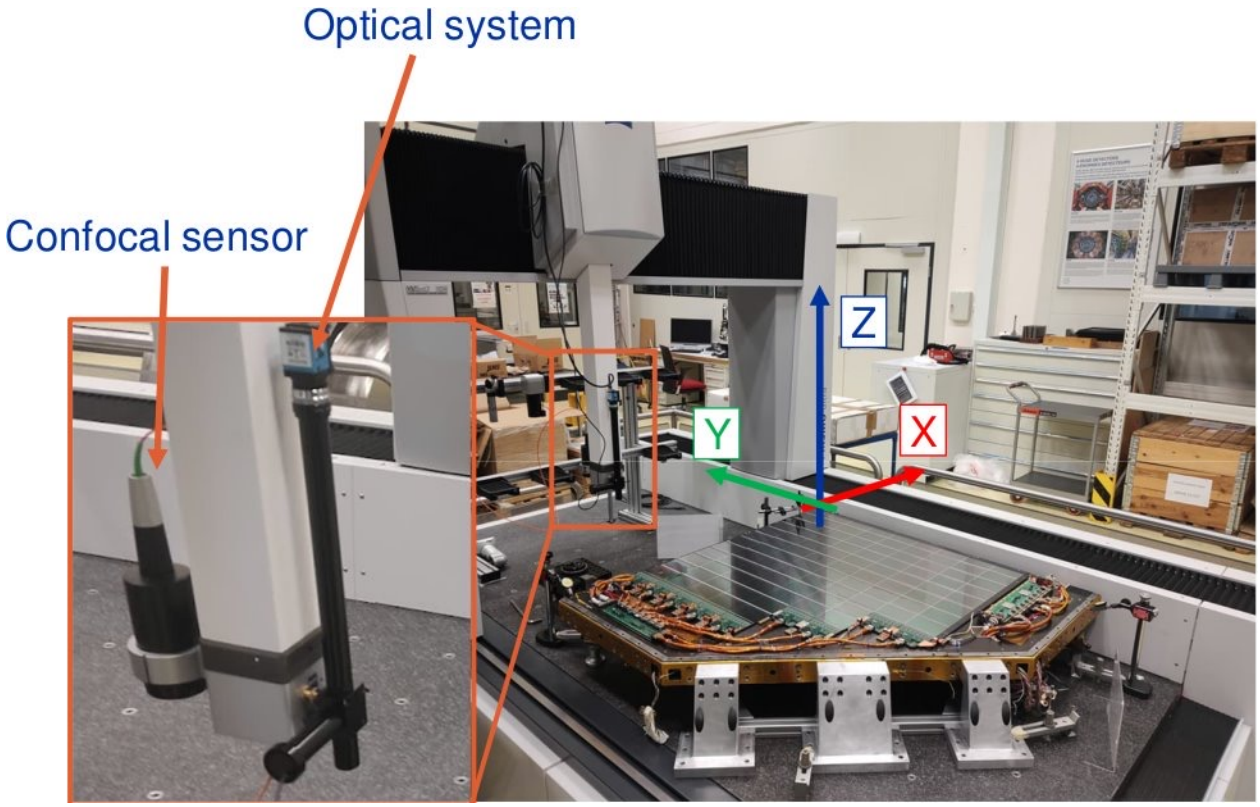


mechanical and dummy ladders

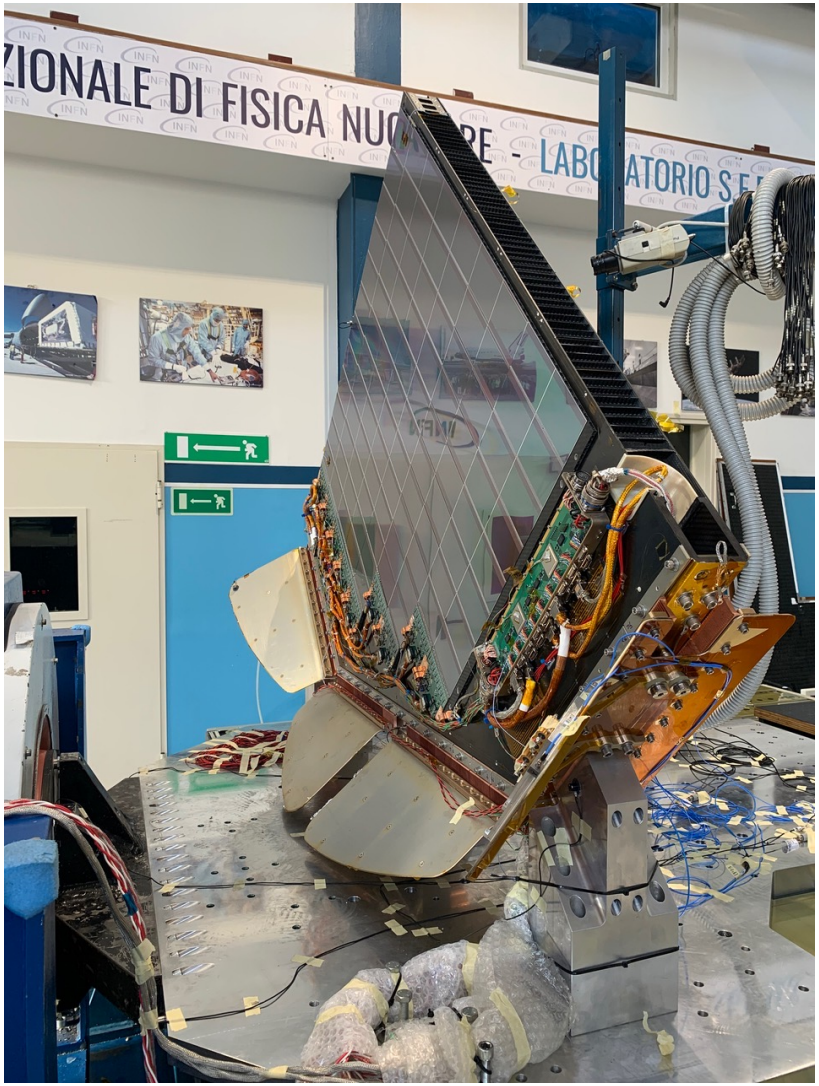


QM ladders and electronics

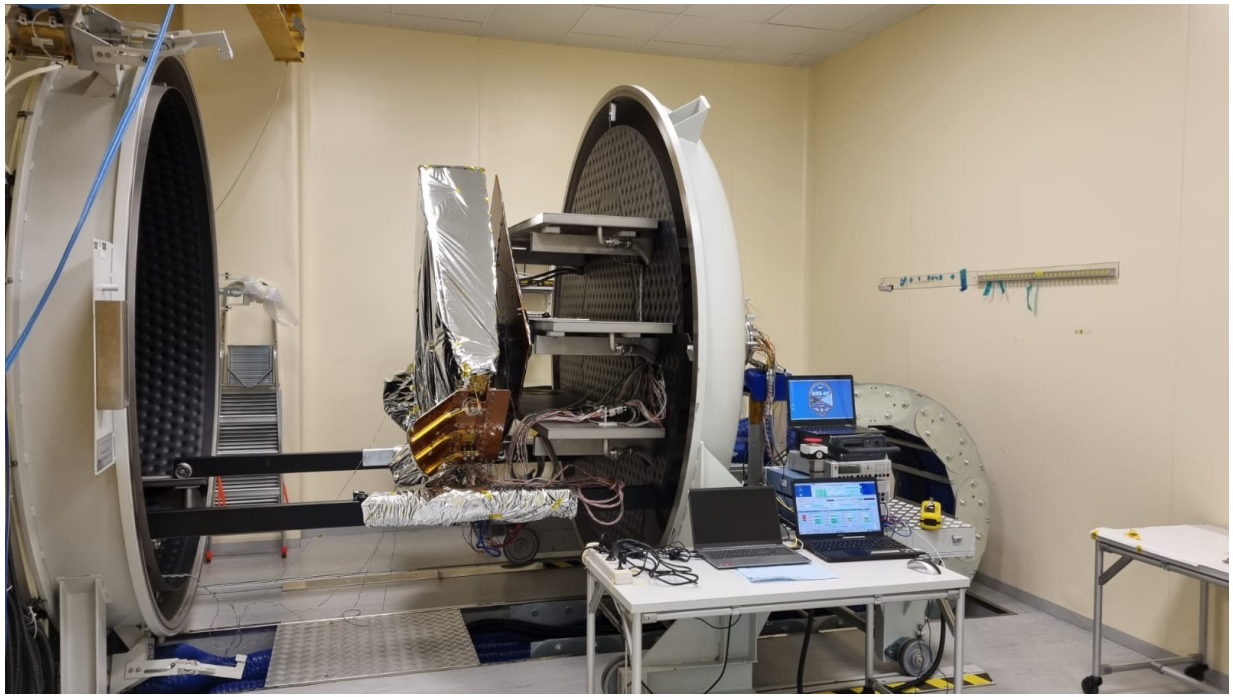
QL metrology at CERN



¼ plane after thermal vacuum and vibration test



Thermal Vacuum test



AMS-02 In Trento

William J. Burger

Francesco Nozzoli Loc. Resp.

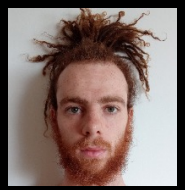
Paolo Zuccon

Roberto Battiston

Francesco Dimiccoli (RTD-A)

Abi Dass (student, departing)

Ignazio Lazizzera (senior professor)

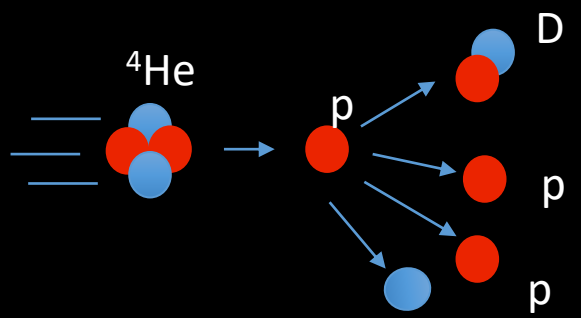


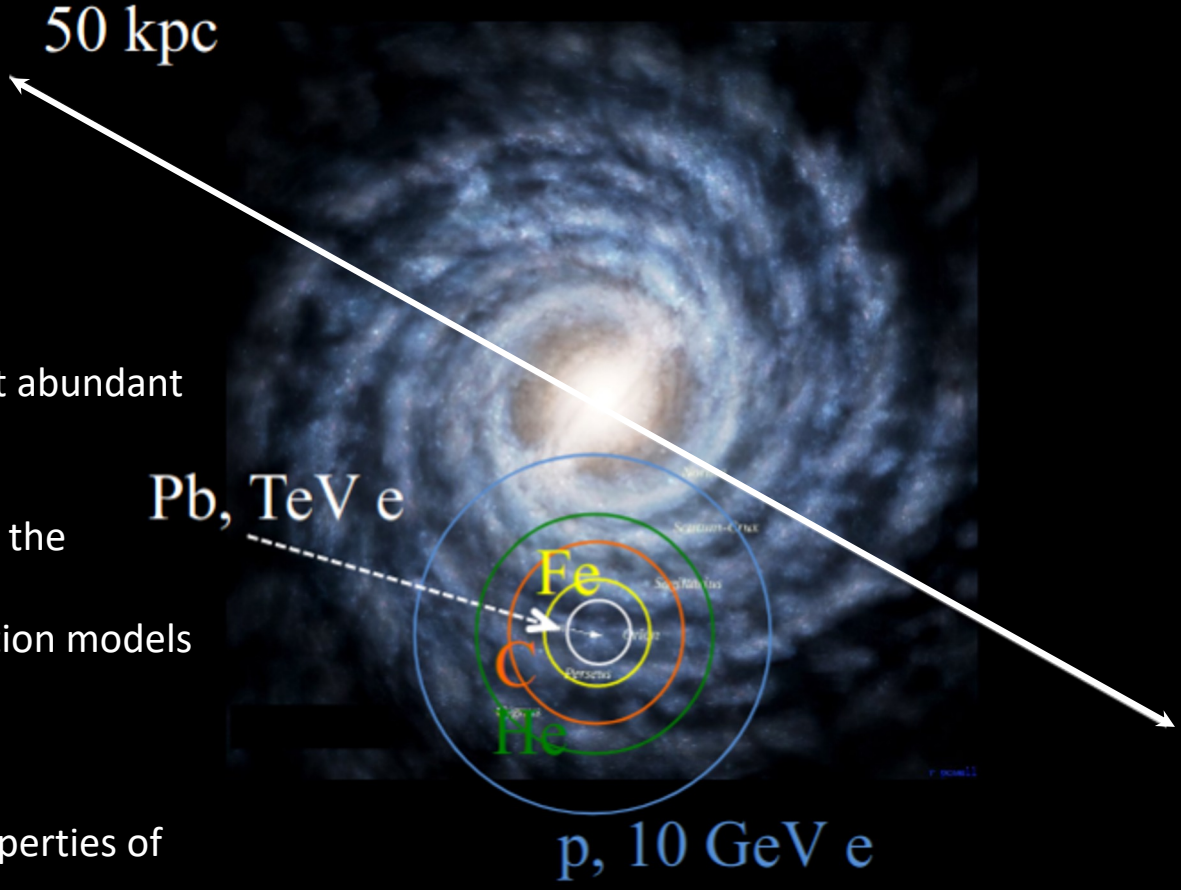
Francesco Rossi – (student)
Leo Cavazzini – (student)
NEW PHD Student

Main Tasks

- AMS Operation
  - Trento covers about 11 shift cycles per year, and it is usually in charge during the Christmas period
  - We cover between 1/3 and 1/4 of the duty of tracker expert
- Data Analysis
  - Deuterium and ^{3}He analysis
  - Beryllium isotopes analysis
  - Search for anti-He

Why Z=1&2 isotopes?





- Helium nuclei are the second most abundant nuclei in cosmic rays.
- D and ^{3}He are mostly produced by the fragmentation of ^{4}He:
  simpler comparison with propagation models wrt heavy nuclei
- Smaller cross section of He:
  D/^{4}He and ^{3}He/^{4}He probe the properties of diffusion at larger distances

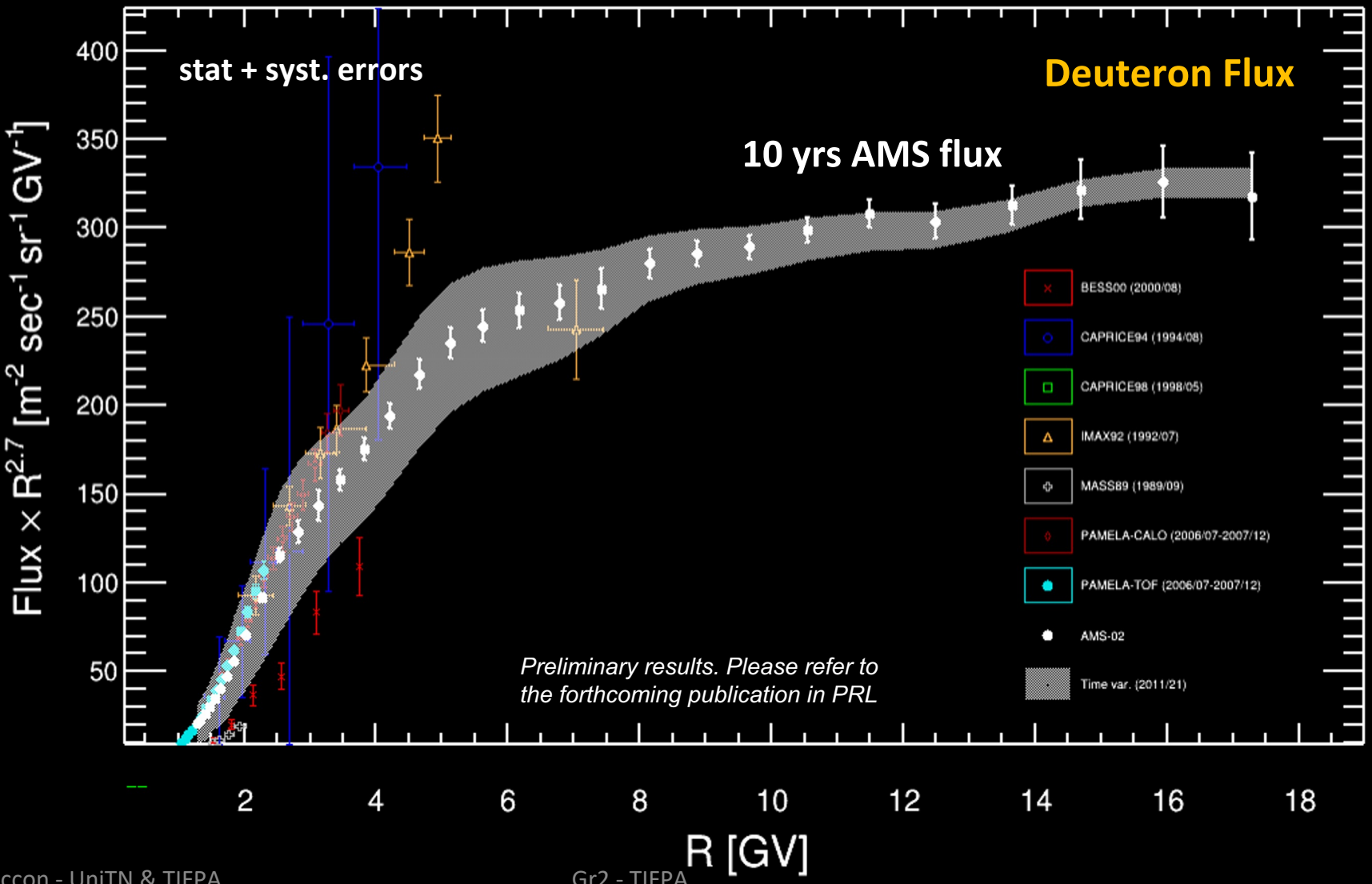
- Different A/Z ratios of D and ^{3}He allow to disentangle kinetic energy and rigidity dependence of propagation.

Deuteron Fluxes

MC templates carry informations about:

- Detector Efficiency
- Bin-to-bin migration

It is possible to directly use them to calculate **Acceptance** and **Unfolding factor** to normalize the counts and obtain **fluxes**

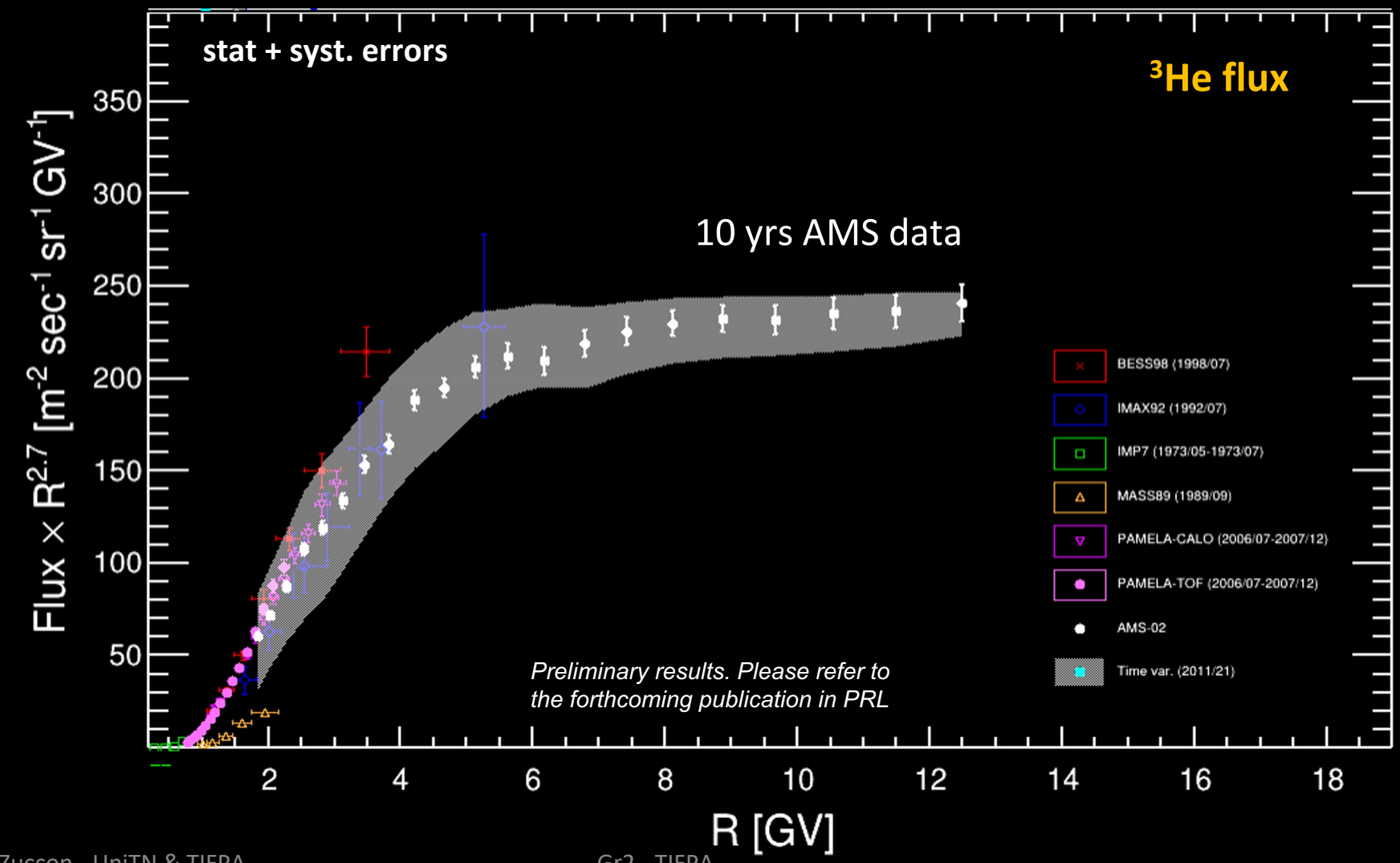


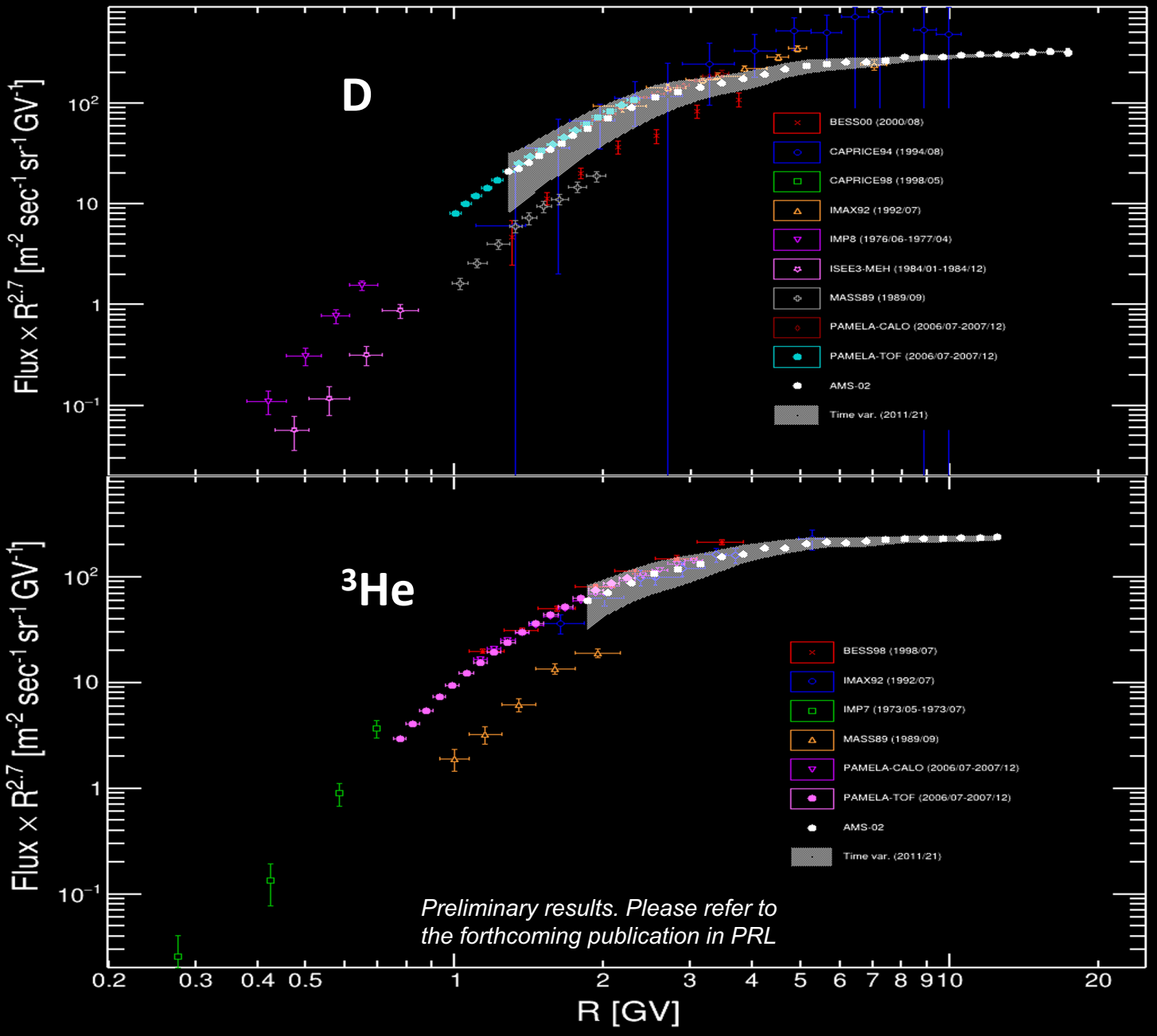
Helium-3 Flux

MC templates carry informations about:

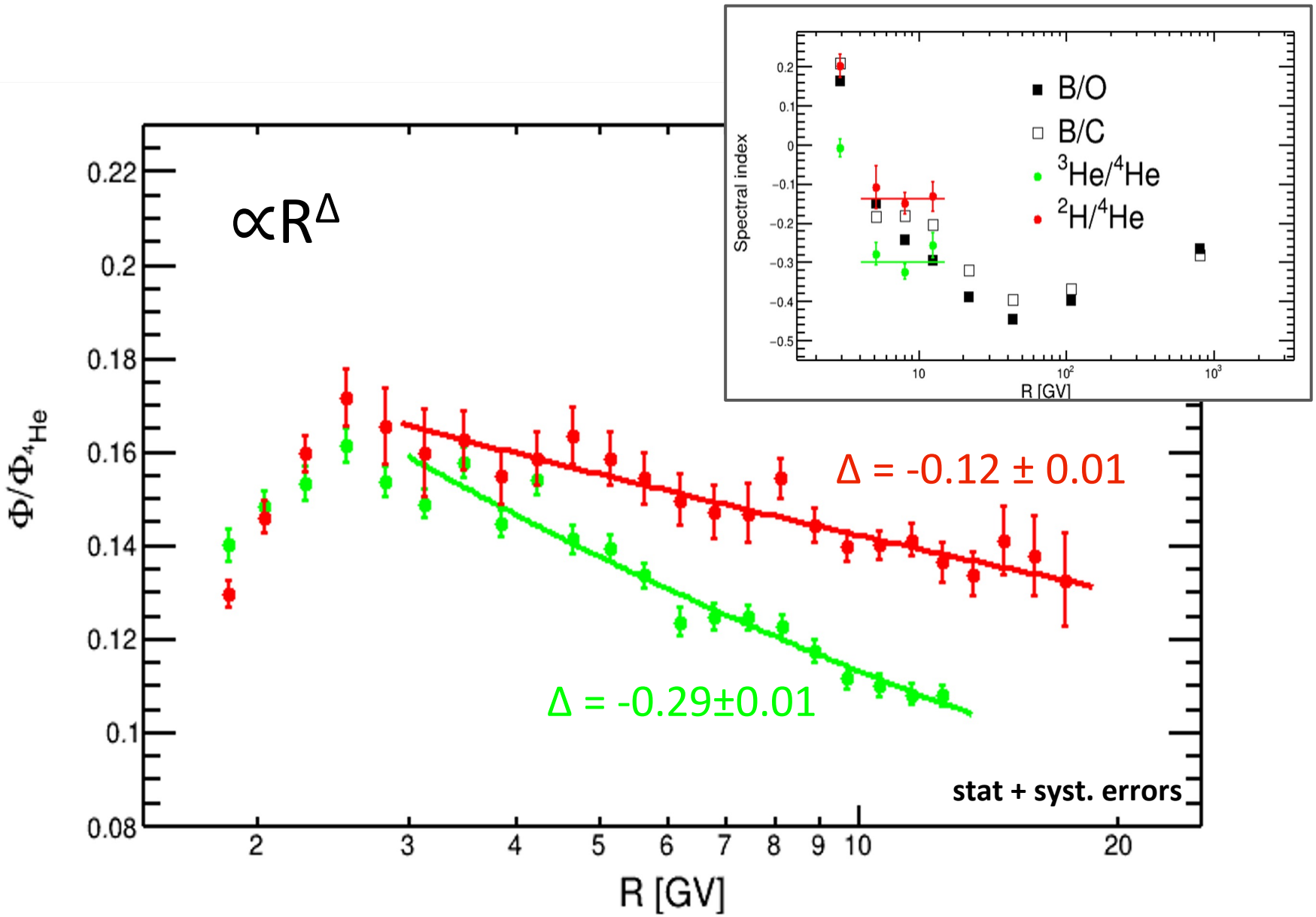
- Detector Efficiency
- Bin-to-bin migration

It is possible to directly use them to calculate **Acceptance** and **Unfolding factor** to normalize the counts and obtain **fluxes**

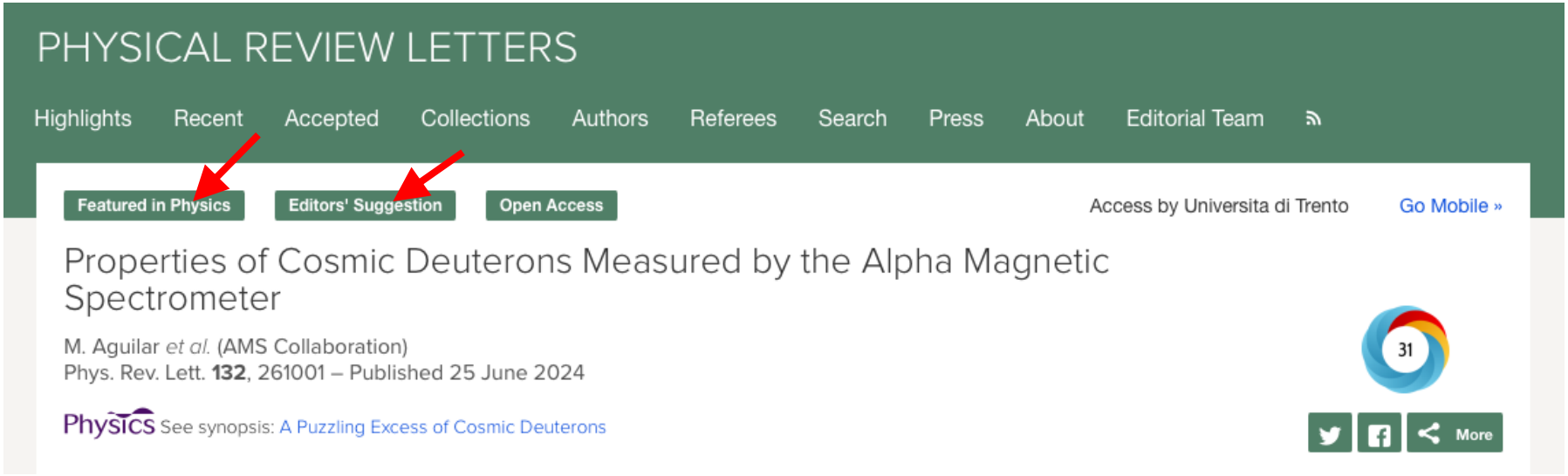



D
BESS00 (2000/08)
CAPRICE94 (1994/08)
CAPRICE98 (1998/05)
IMAX92 (1992/07)
IMP8 (1976/06-1977/04)
ISEE3-MEH (1984/01-1984/12)
MASS89 (1989/09)
PAMELA-CALO (2006/07-2007/12)
PAMELA-TOF (2006/07-2007/12)
AMS-02
Time var. (2011/21)
Flux × R^2.7 [m^-2 sec^-1 sr^-1 GV^-1]
3He
BESS98 (1998/07)
IMAX92 (1992/07)
IMP7 (1973/05-1973/07)
MASS89 (1989/09)
PAMELA-CALO (2006/07-2007/12)
PAMELA-TOF (2006/07-2007/12)
AMS-02
Time var. (2011/21)
Preliminary results. Please refer to
the forthcoming publication in PRL
R [GV]

D/^{4}He vs ^{3}He/^{4}He Spectral index



Pubblicazione su PRL



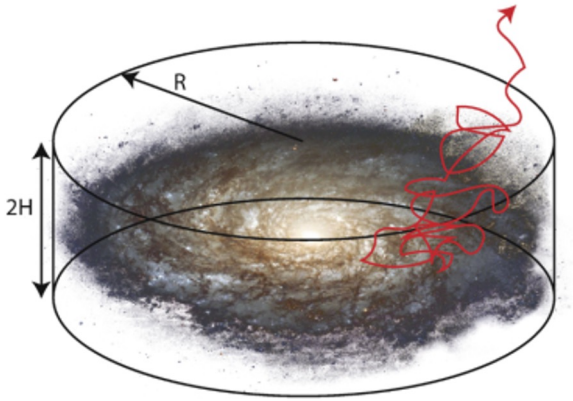
Beryllium Isotopes as a Probe for Astrophysics

Secondary/Primary CR species. E.g. **B/C**

$$\frac{I_s}{I_p} \propto \frac{H}{D}$$

Unstable Secondary/Stable Secondary. E.g. **^{10}Be/^{9}Be**

$$\frac{I^*}{I_s} \propto \frac{\sqrt{D}}{H}$$



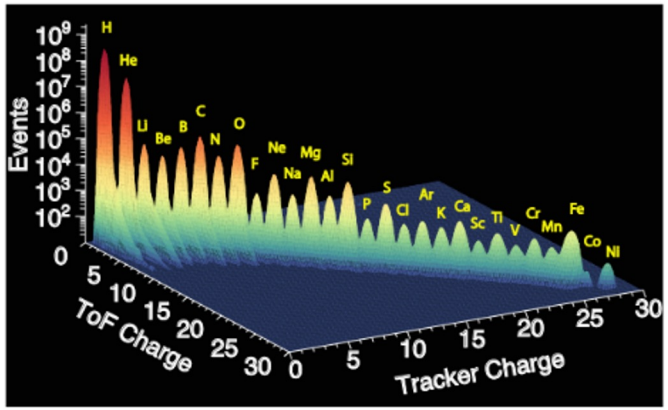
CRs assumed to be magnetically confined within the galactic disk

H- Halo Half-Size
D- Diffusion Coefficient

Constrain confinement time **H^2/D** and removes degeneracy between parameters

Importance of Beryllium isotope Studies

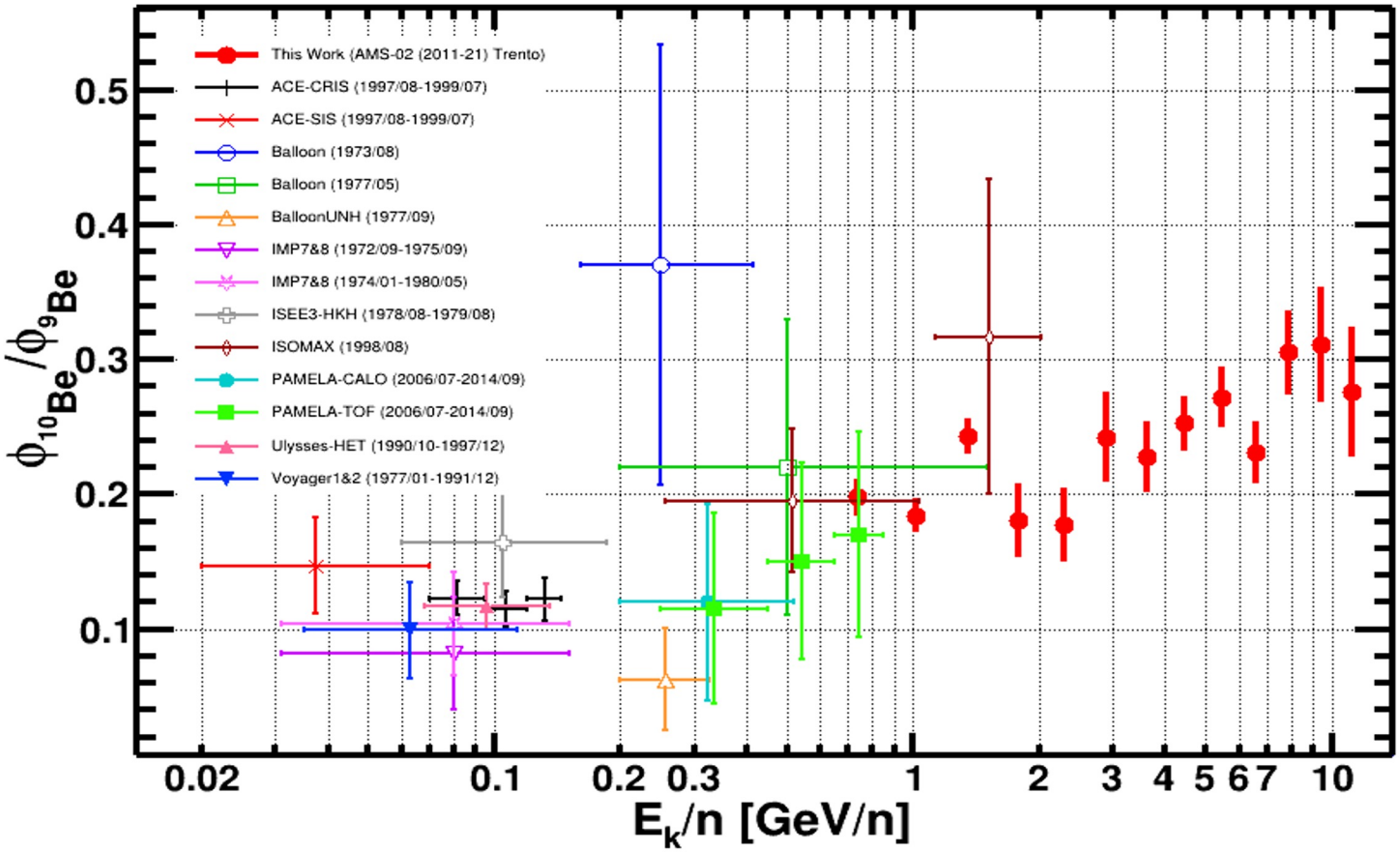
- Beryllium (**Be**) is produced in the spallation reaction of **B**, **C**, **N**, **O** with ISM
- Isotopes of Be that are found in cosmic rays: **^{7}Be, ^{9}Be and ^{10}Be**



- ^{7}Be: stable as bare nuclei, decays through e^{-} capture. Half-life: $T_{1/2} = 53.2\,\text{days}$
- ^{9}Be: Stable secondary
- ^{10}Be: β - radioactive-> half-life: $T_{1/2} = 1.39 \times 10^{6}\,\text{years}$

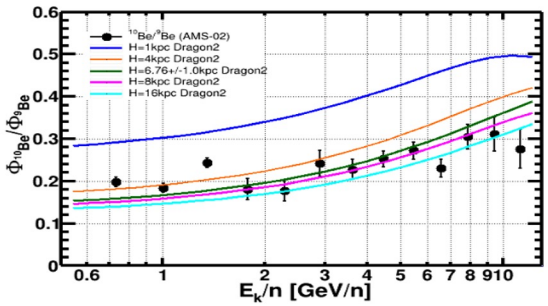
Abhinandan Dass — University of Trento

$^{10}Be/^{9}Be$ Flux Ratio Comparison

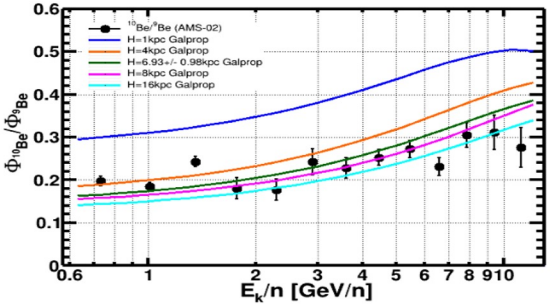


Abhinandan Dass — University of Trento

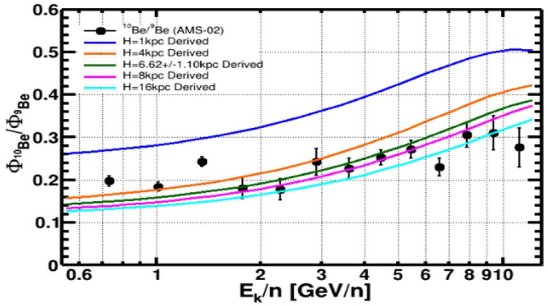
First Look into Halo Sizes



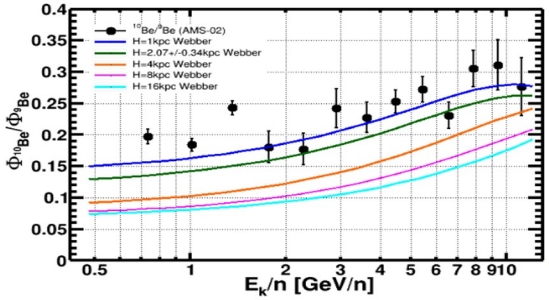
(a) Dragon Model



(b) Galprop Model

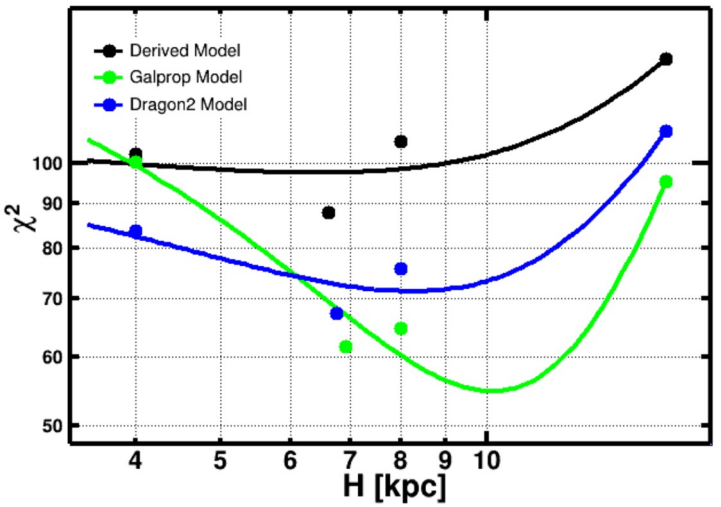


(c) Derived Model



(d) WEBER Model

AMS-02 precision measurement of ^{10}Be/^{9}Be extended to a never before explored energy range provides the possibility of constraining the halo size.



Models from P De La Torre Luque *et al Journal of Cosmology and Astroparticle Physics*, 2021(03):099, 2021

Future projects

- Continue the anti-He analysis (F. Rossi, P.Z.)
- Bring Be Isotopes analysis to publication (P. Zuccon)
- Start a new analysis on B and N isotopes (new PhD, F.D.)

- AMS- UPGRADE Certify data reduction algorithms for the new AMS silicon layer (P. Zuccon + x)

Personale per il 2025

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cognome	Nome	Posizione	FTE AMS		Sinergie
Nozzoli	Francesco	Ric. INFN	0,95		0,95
Zuccon	Paolo	PA UniTn	0,45		0,15
Battiston	Roberto	PO UniTn	0,3		0,15
Cavazzini	Leo	PhD	0,65		0,15
Rossi	Francesco	PhD	0,5		0,15
Ghezzer	Luigi Ernesto	PhD	1		1
Giovanazzi	Gregorio	Ass. UniTn	1		1
Shledevitz	David	Ass. INFN	1		
Gamba	Sara	PhD	0,5		
Totale			6,35		3,55
Senza sinergie			2,8		

Richieste per il 2025

- Consumo 2 kE
- Missioni 37 kE
  - Turni di presa dati 12 kE
  - Esperto oncall tracker (1/3) 16 kE
  - Meeting di collaborazione 6 kE
  - Meeting nazionali 3 kE
- Inventario 2 kE
  - Rinnovo postazioni di lavoro
- Servizi 5 kE
  - Mobilita' al CERN