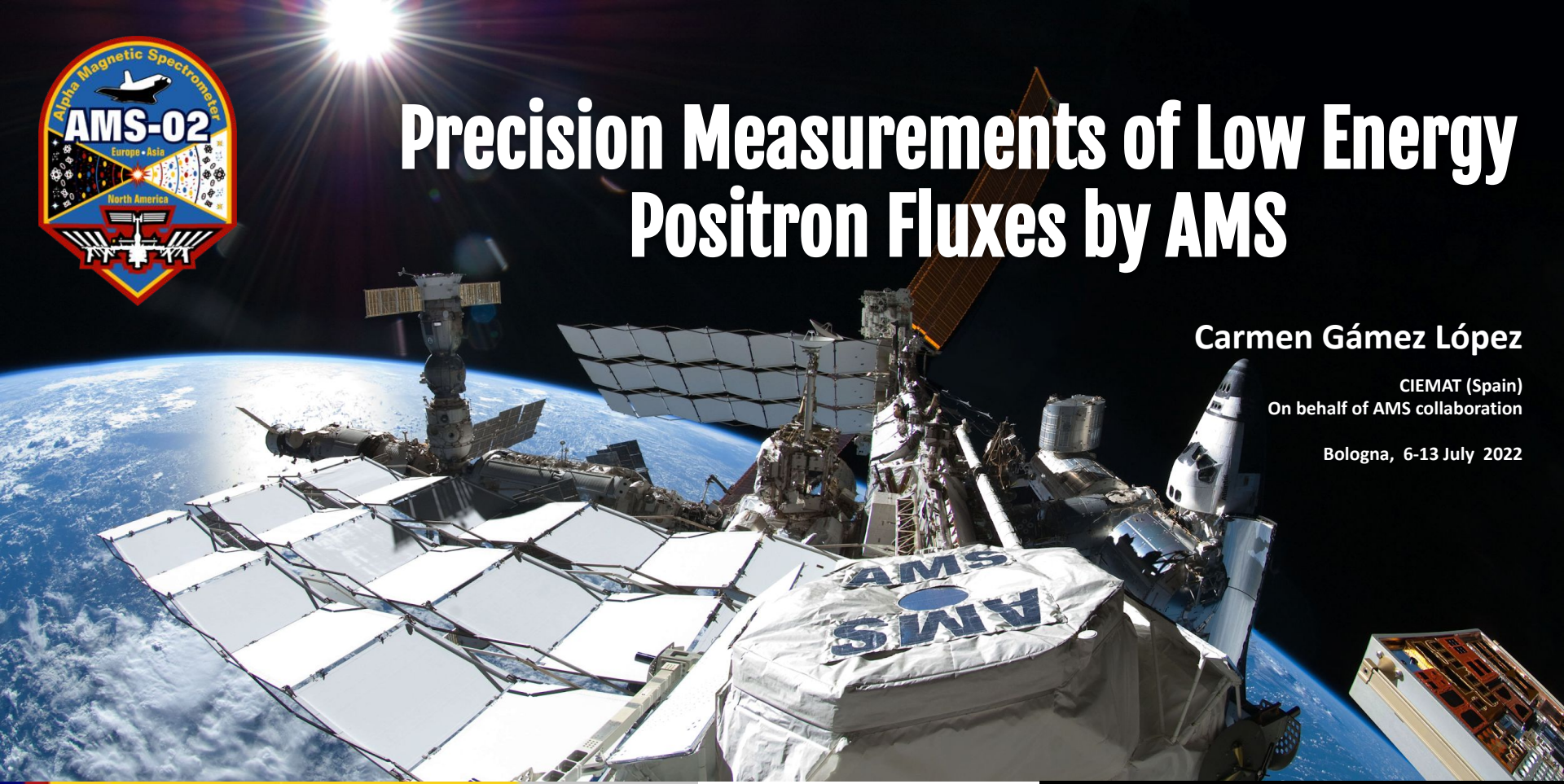

Precision Measurements of Low Energy Positron Fluxes by AMS

Carmen Gámez López

CIEMAT (Spain)
On behalf of AMS collaboration

Bologna, 6-13 July 2022

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
Ciemat
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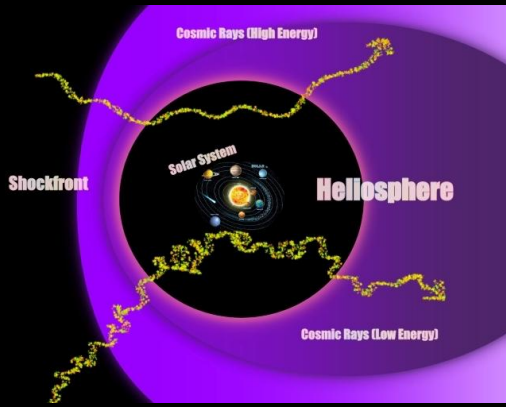
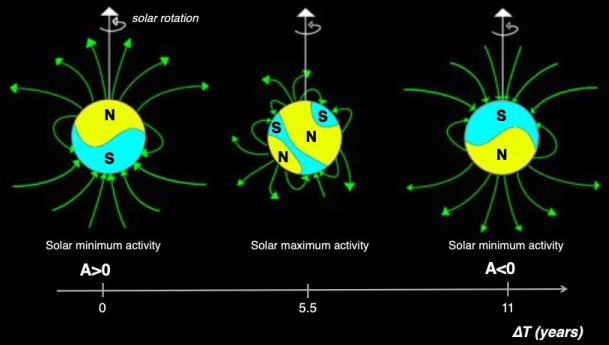
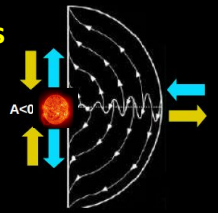
ICHEP 2022 BOLOGNA
ICHEP 2022 XLI International Conference on High Energy Physics Bologna (Italy)
6 13 07 2022

Cosmic Rays in the Heliosphere

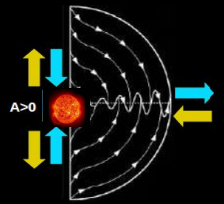
- ★ To reach the Earth, the CRs must penetrate the Heliosphere of the Solar System that is a region in the local Interstellar Medium where the solar activity dominates the environment
- ★ CR spectra measured near Earth are significantly affected by the solar activity (solar modulation)
- ★ The solar activity follows an 11-year cycle during which the configuration of the coronal solar magnetic lines changes due to the reversal of the solar dipole magnetic field
- ★ Solar modulation depends on the charge-sign of the particles
- ★ A complete model of solar modulation requires accurate measurements of particles with distinct charge sign







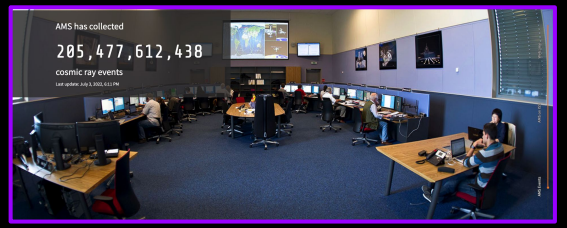
During negative polarity (A<0) negative charged particles mainly drift in the heliosphere from the poles and drift out through the equator. The opposite is true for positive charged particles

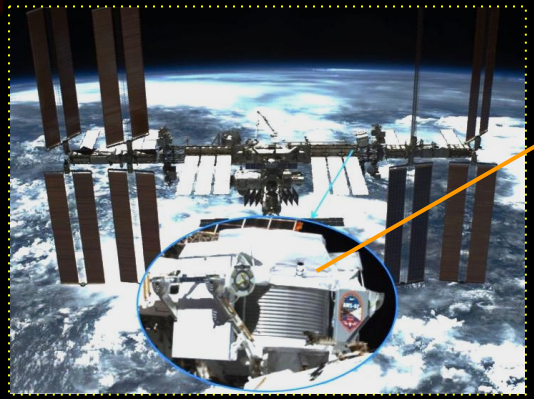


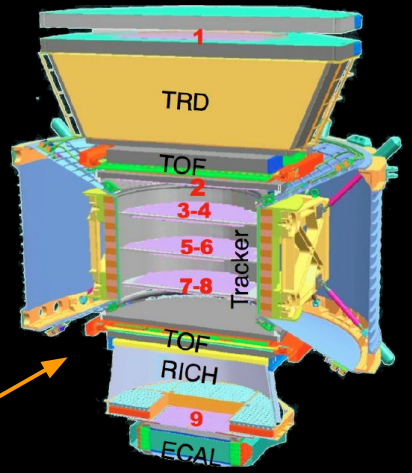
During positive polarity (A>0) positive charged particles mainly drift in the heliosphere from the poles and drift out through the equator. The opposite is true for negative charged particles

AMS-02 Experiment

- ★ AMS-02 is a multipurpose particle physics detector designed to carry out accurate measurements of cosmic ray charged particles in the GeV-TeV range
- ★ It was installed in May 2011 onboard the International Space Station and continues taking data steadily since then
- ★ So far, AMS has collected ~$2 \cdot 10^{11}$ cosmic rays particles in more than 11 years of data taking
- ★ The long duration precise measurements of AMS in the GeV range also provides new insights in solar physics
- ★ The high acceptance of AMS-02 allows measurements on very short time scales







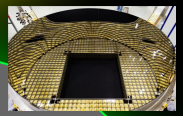
AMS-02 Experiment

TRD

distinguishes between light and heavy particles of the same charge and momentum

Silicon Tracker

provides the measurement of the particle momentum and charge with its sign



RICH

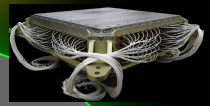
provides a precise measurement of the particle velocity

Time of Flight (TOF)

provides the measurement of the particle velocity and the trigger of the experiment

Permanent Magnet

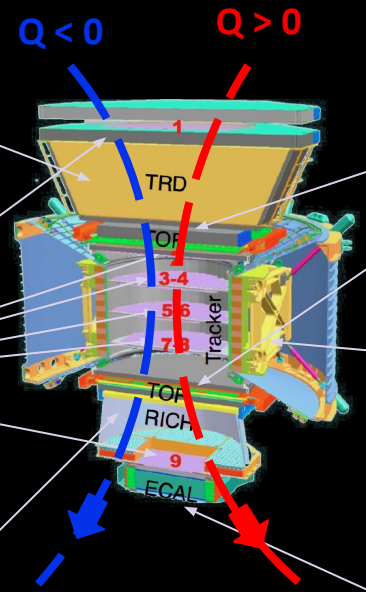
bends the trajectory of the charged particles



Calorimeter (ECAL)

measures the energy of the electromagnetic particles

separation between leptons and hadrons



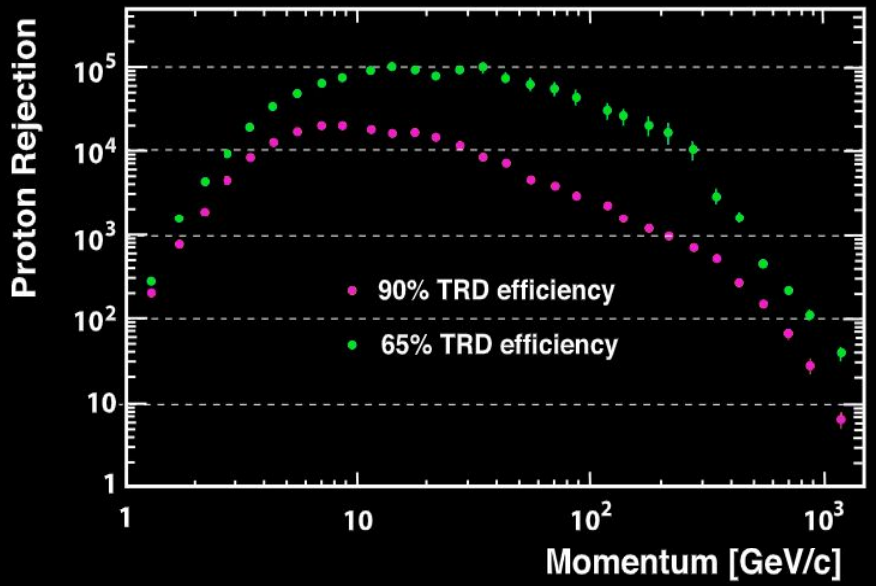
Particles are defined by their charge (Z) and energy (E ~ p)

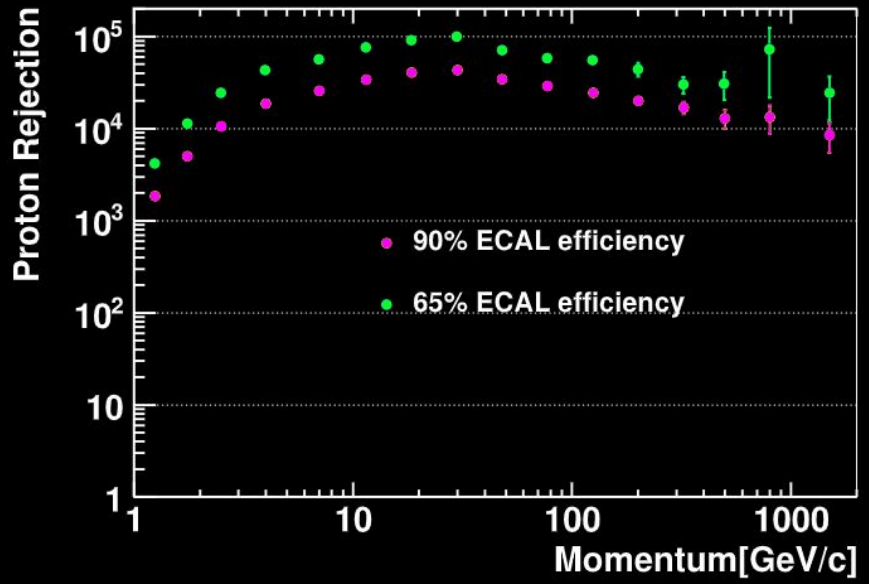
Z, P are measured independently by the Tracker, RICH, TOF and ECAL

Electron and Positron identification in AMS

– Proton Rejection –

The TRD provides a proton rejection above 10^3 up to 200 GeV for a 90% efficiency in the electron signal





The ECAL together to the consistency between E and p measurements provides a proton rejection above 10^4 up to 700 GeV with 90% efficiency in the electron signal

Physics analysis – Daily Positrons

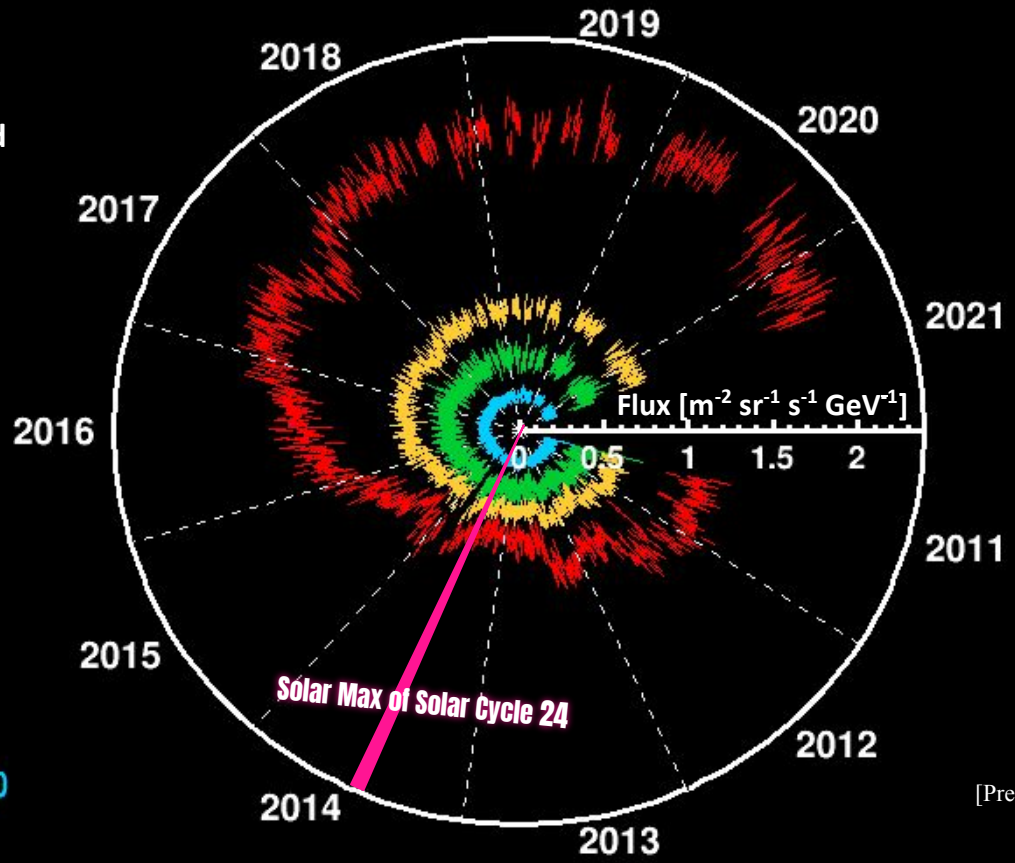
AMS provides first measurement of positron flux with 3-day granularity

Positrons collected by AMS during the first **10 years** of operation aboard the International Space Station

From May 2011 to May 2021

Positron flux exhibits variations in differents timescale

[1.00 - 2.97] GeV $\Phi_{e^+} \times 1.0$
[2.97 - 4.88] GeV $\Phi_{e^+} \times 2.8$
[4.88 - 5.90] GeV $\Phi_{e^+} \times 4.8$
[7.09 - 11.00] GeV $\Phi_{e^+} \times 10.0$



[Preliminary data, refer to the upcoming AMS publication]

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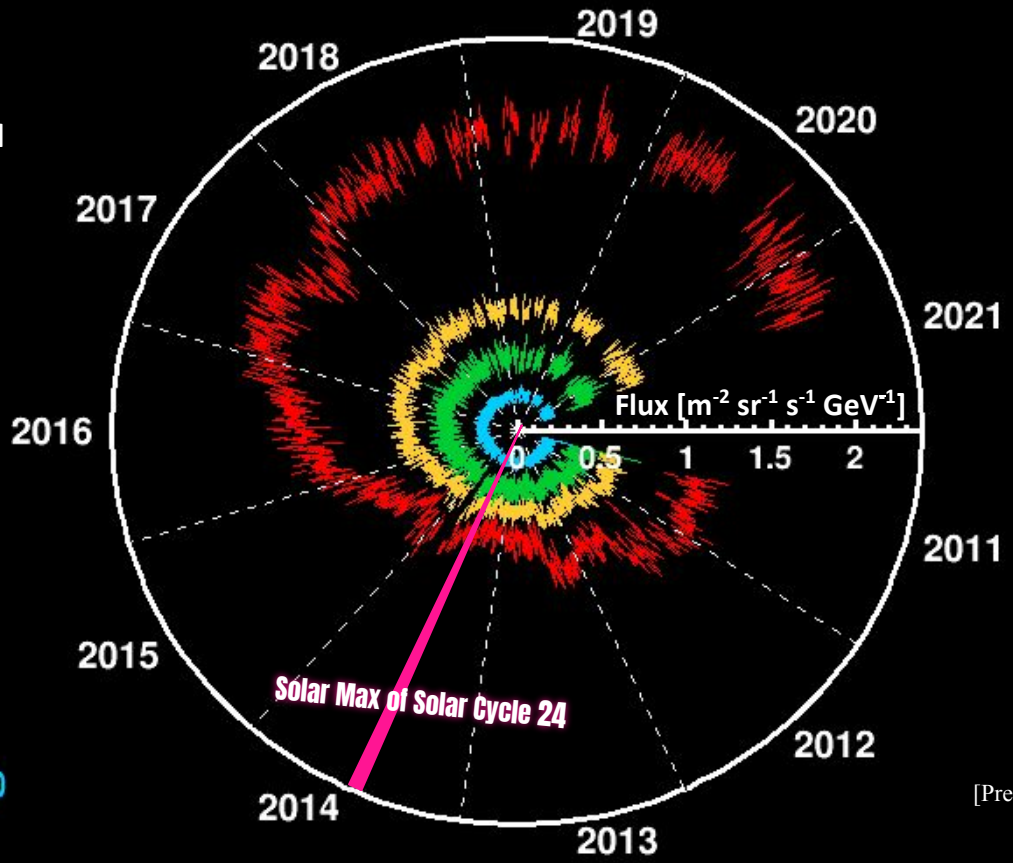


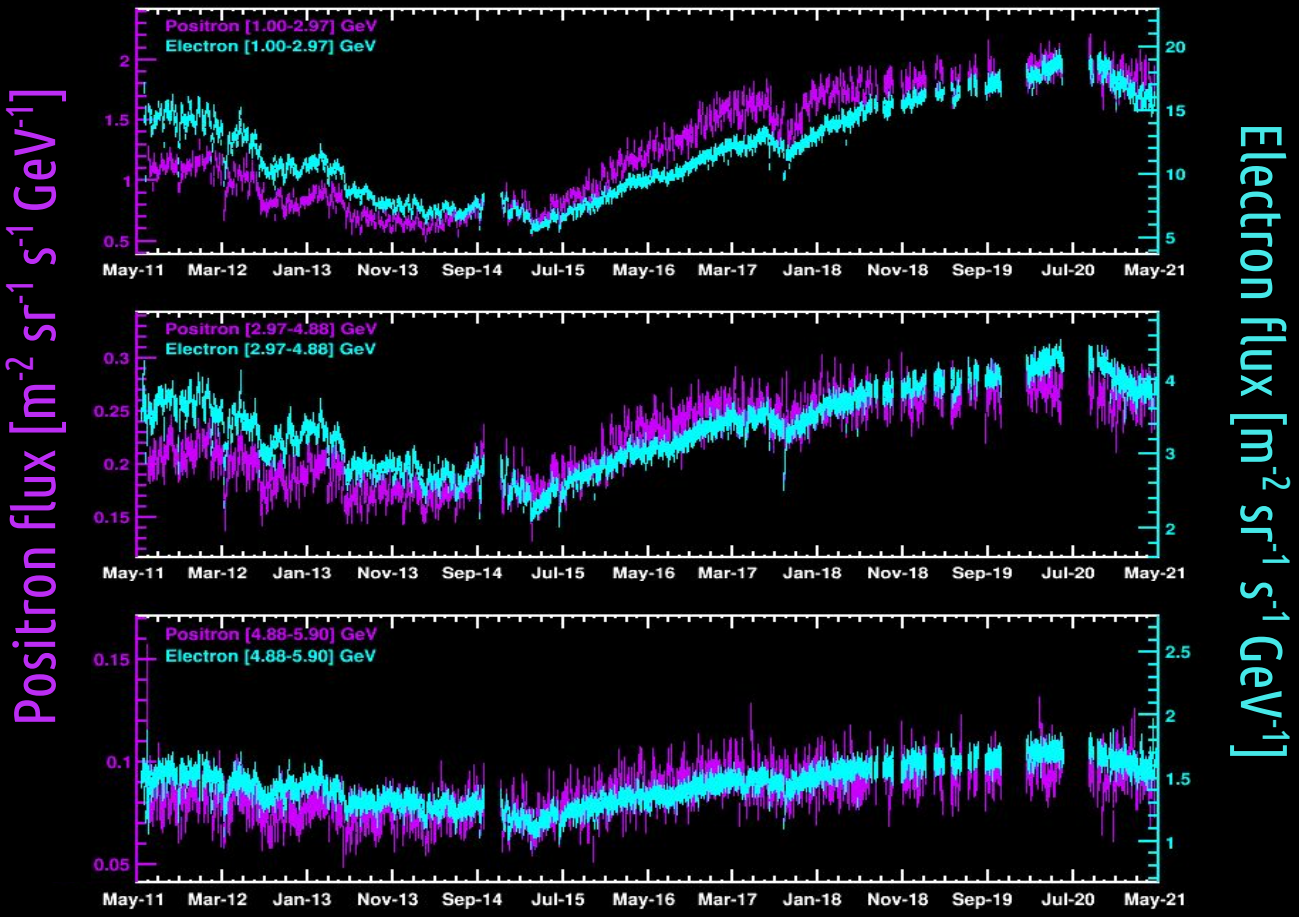
Other AMS contributions to the Low Energy CR Physics

Contribution 796.
Precision measurement of Daily Electrons Fluxes by AMS
Tong Su - Poster Session

Contribution 732.
Unique Properties of Daily Proton Fluxes up to 100 GV
Cristina Consolandi - Parallel Talk

[Preliminary data, refer to the upcoming AMS publication]

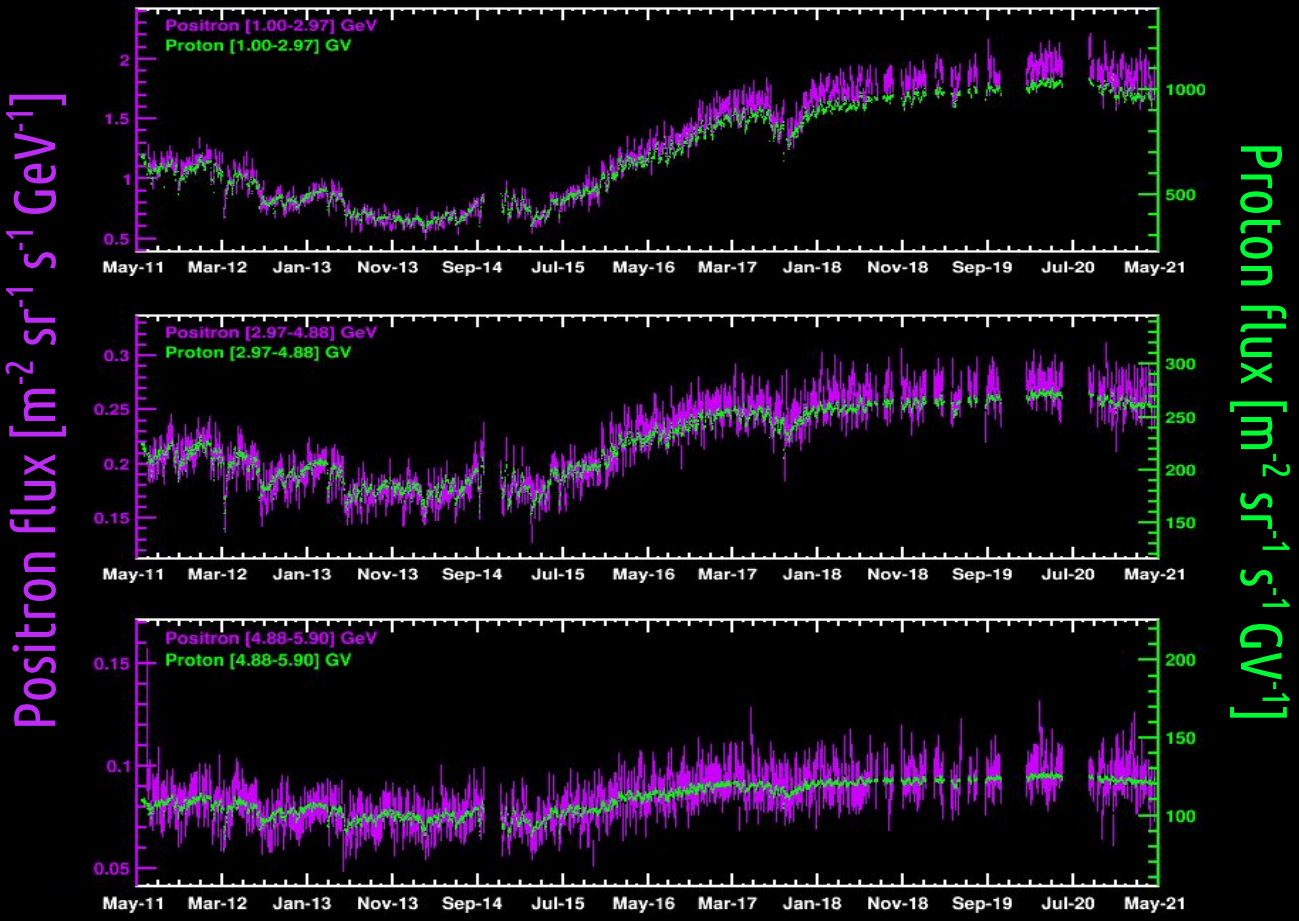
Solar polarity reversal effect – Positron vs Electron



Simultaneous measurements of positron and electron fluxes over a complete solar cycle can represent a unique test of the charge-sign dependencies in modulation models

Different behaviour before and after polarity reversal is observed for particles with same mass and different charge

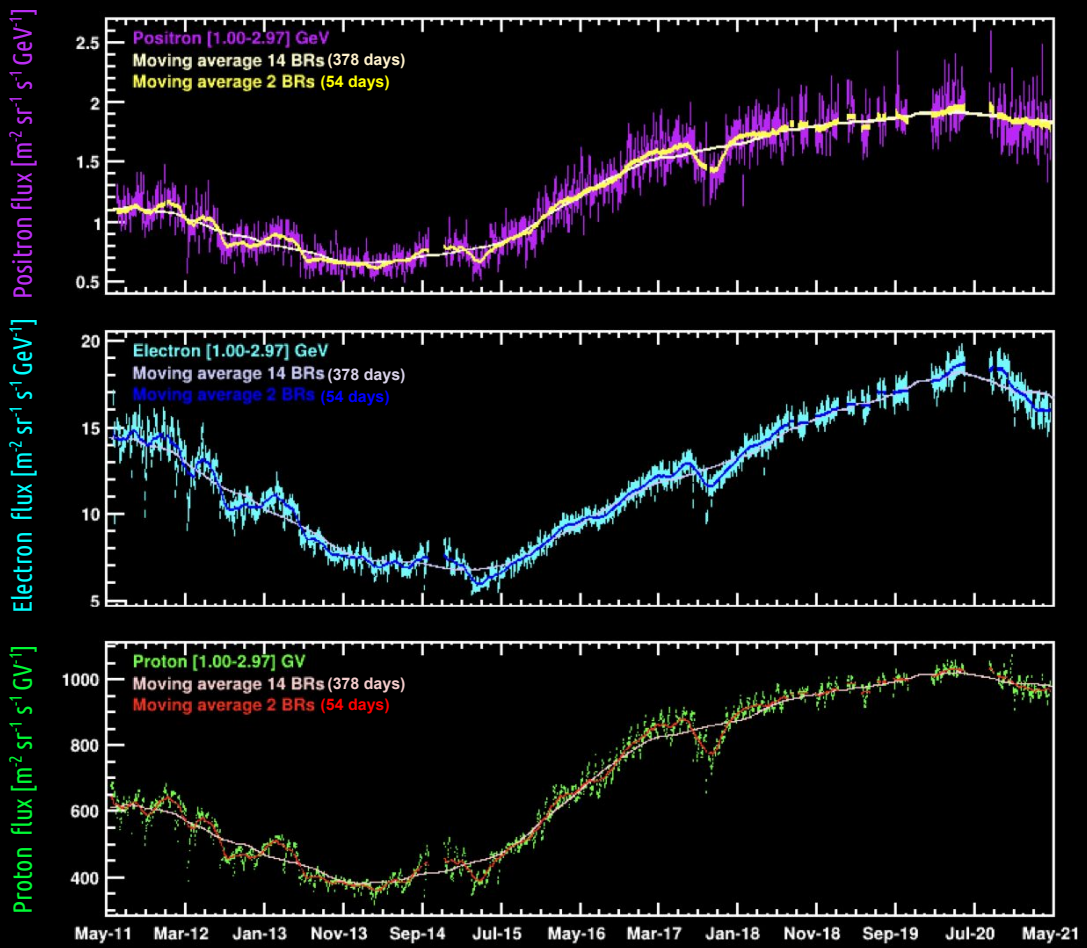
Solar polarity reversal effect – Positron vs Proton



Simultaneous measurements of **positron** and **proton** fluxes over a **complete solar cycle** can represent a unique test of the **mass dependencies** in modulation models

Similar behaviour before and after **polarity reversal is observed** for particles with **same charge** and **different mass**

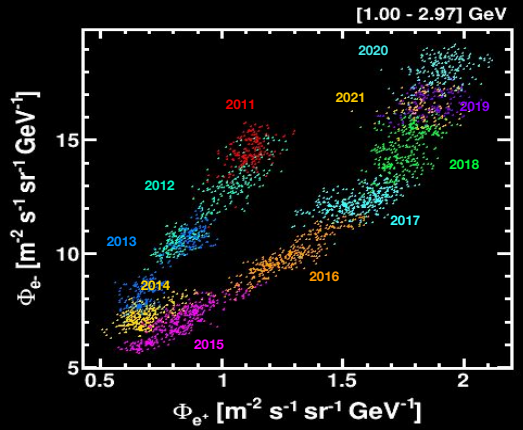
Positron Daily fluxes Smoothing –Moving average



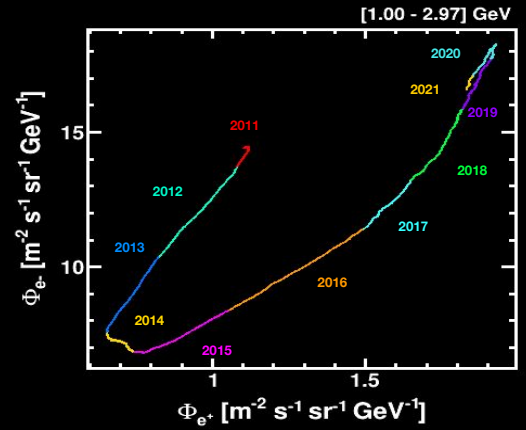
Fluxes are smoothed using a **moving average technique** for studying **short and long term structures** in detail

The size of the moving average is chosen depending on the **timescale of the structures to be studied**

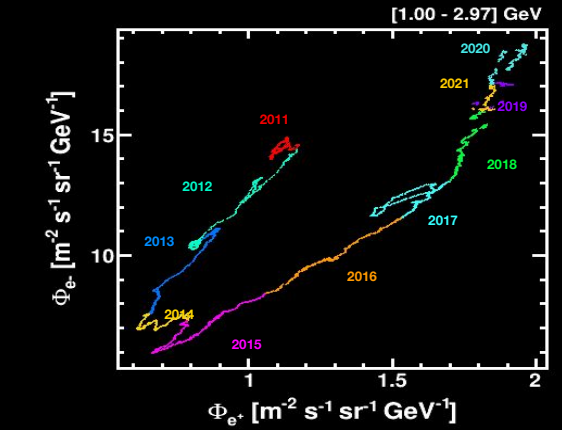
Positron flux correlations



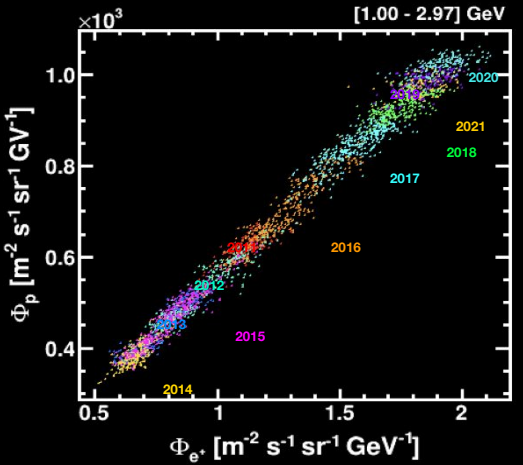
Unsmoothed daily fluxes (3-days)

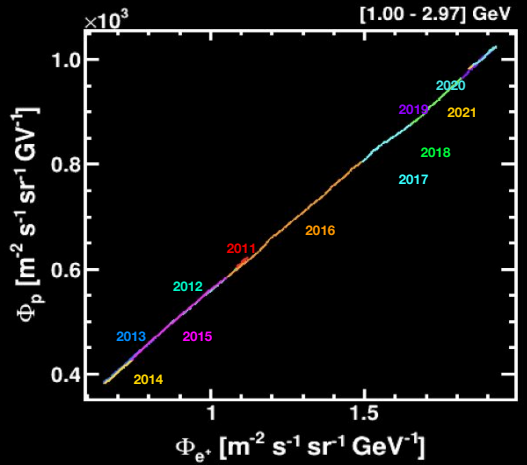


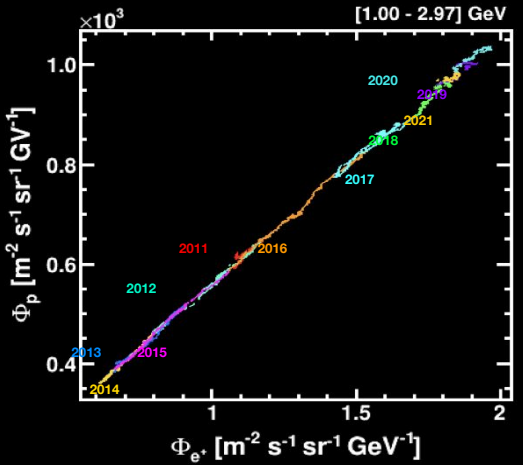
14 BRs with a step of 1 day



2 BRs with a step of 1 day

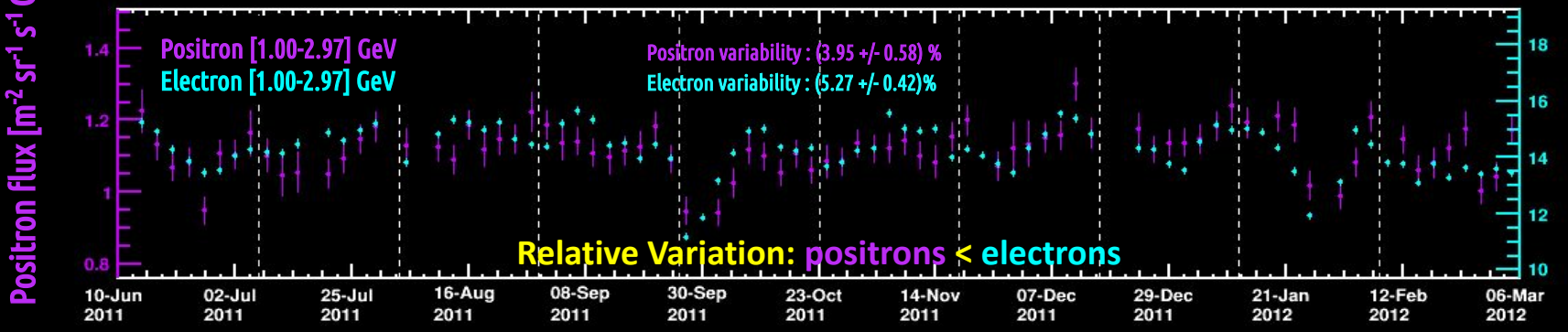


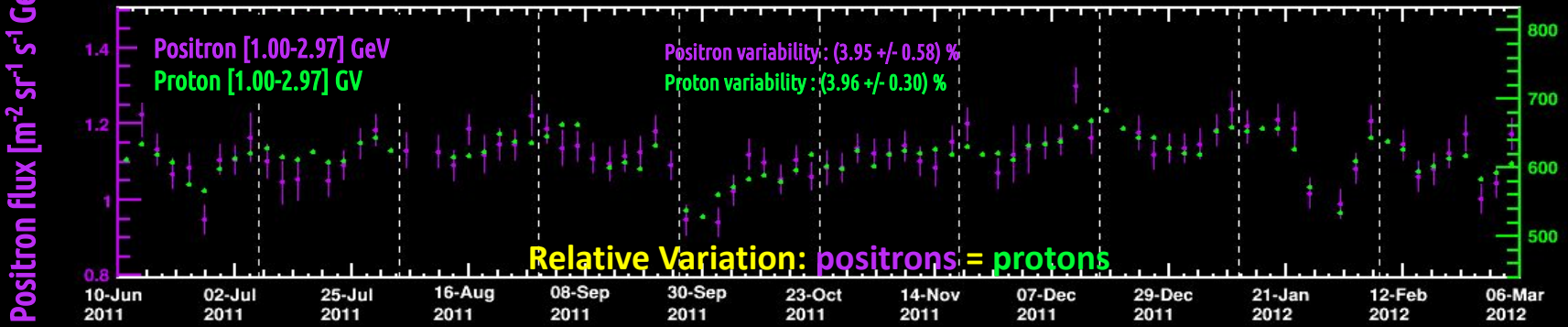




Solar Modulation Charge–Sign and Mass dependencies

2011, Solar polarity A < 0





[Preliminary data, refer to upcoming AMS publication]

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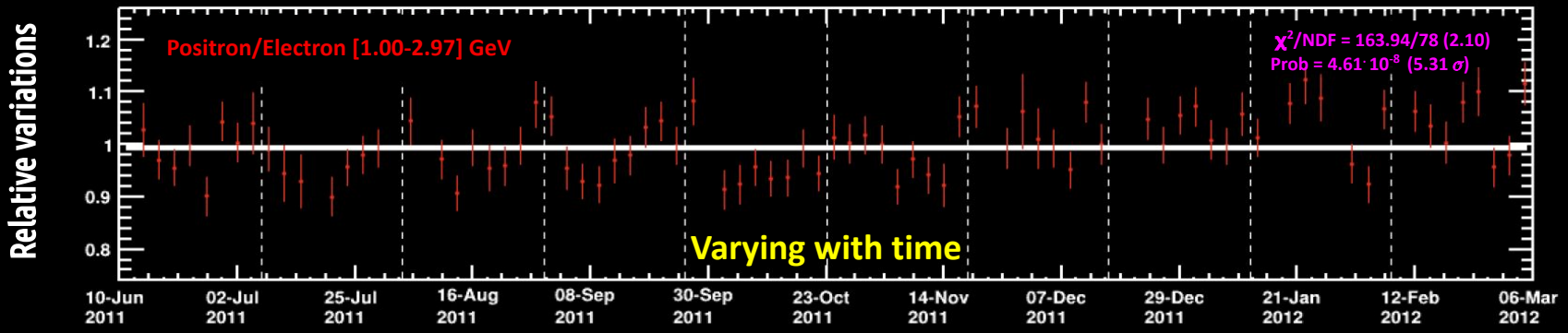

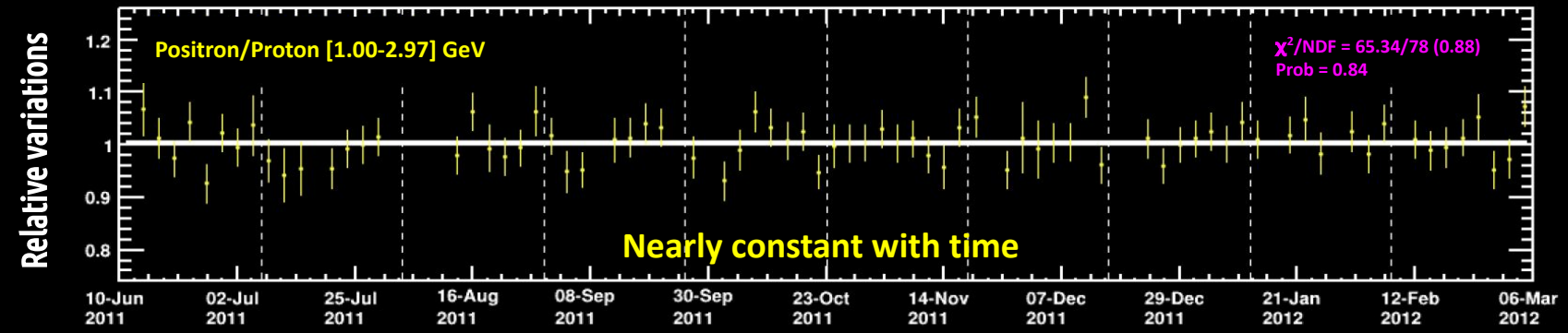

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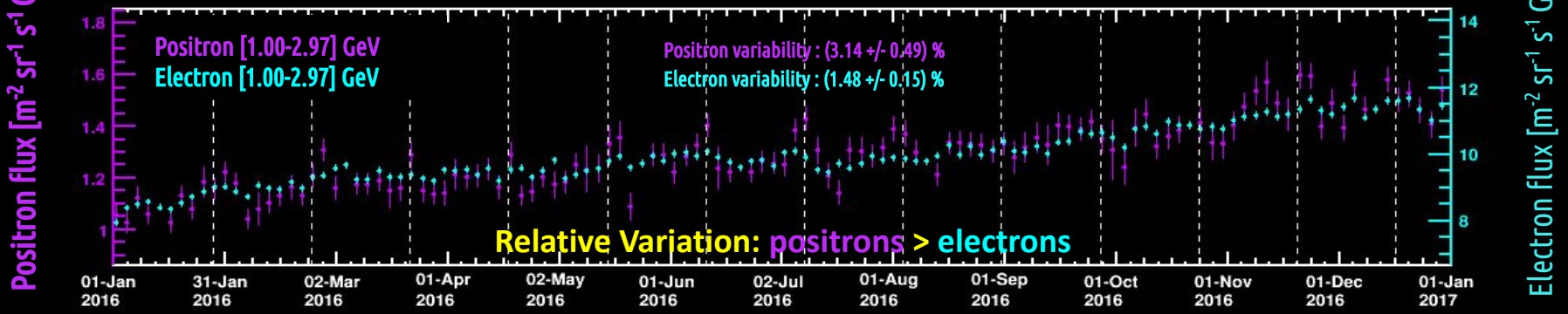
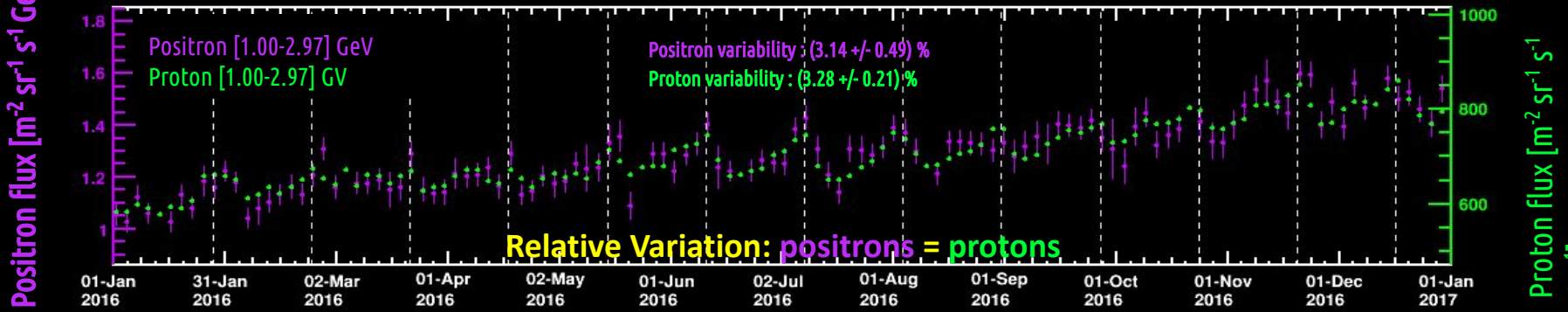
Solar Modulation Charge–Sign and Mass dependencies

2016, Solar polarity A > 0





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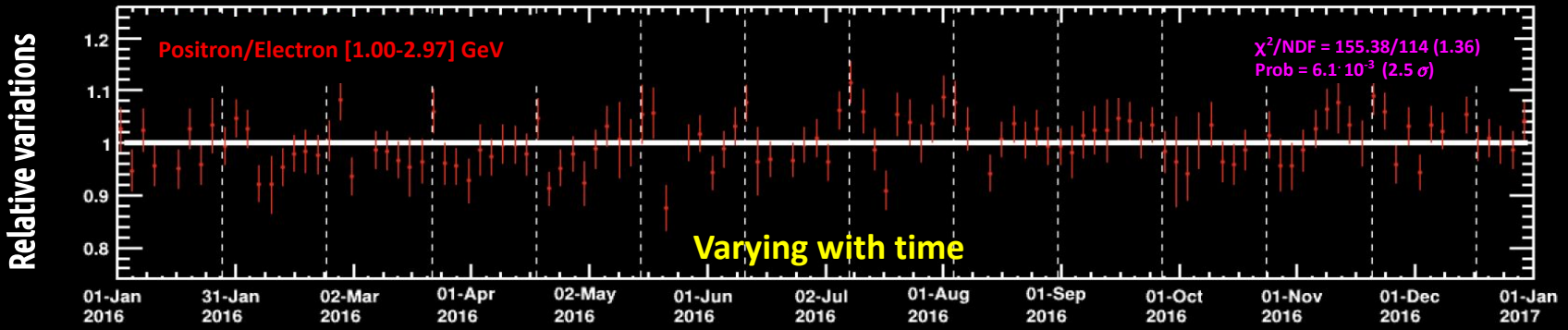
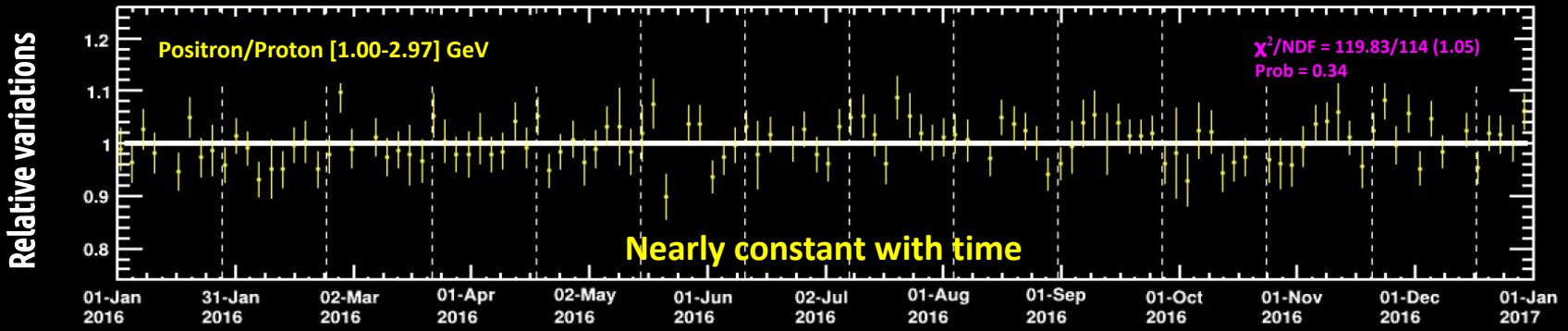




[Preliminary data, refer to upcoming AMS publication]

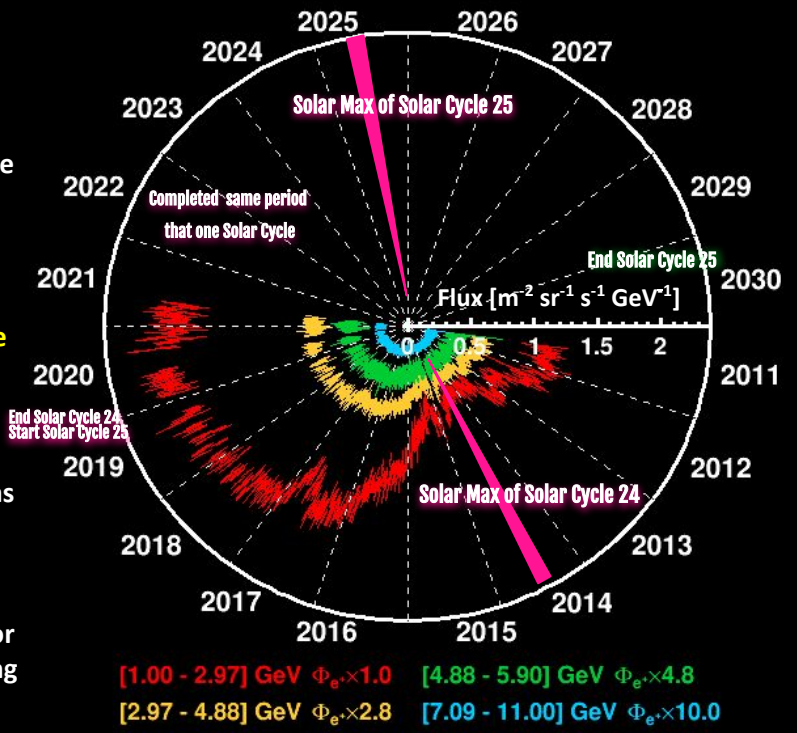
Conclusions

- ★ **The charge-sign and mass dependent** modulation during a complete solar cycle has been investigated in detail:
  - ○ **Long term scale:**

    we observe distinct behaviours between **positron** flux and **electron** flux before and after **solar polarity reversal**
  - ○ **Short term scale:**

    the **time variability** is **different** for particles with **same mass and different charge**

    the **time variability** is **similar** for particles with **same charge and different mass**
- ★ **Complex correlations** between **positron** and **electron** fluxes are observed whereas **positron** and **proton** fluxes exhibit a **linear behaviour**
- ★ **AMS** has already observed **many interesting** phenomena in the time evolution for the **positron and electron fluxes** covering part of the solar cycle 24 and the beginning of the solar cycle 25
- ★ Data collection until **2030** will allow us to extend these studies to the **complete solar cycle 25**



Thank you !