a Payload for Antimatter Matter Exploration and Light–nuclei Astrophysics

INFN
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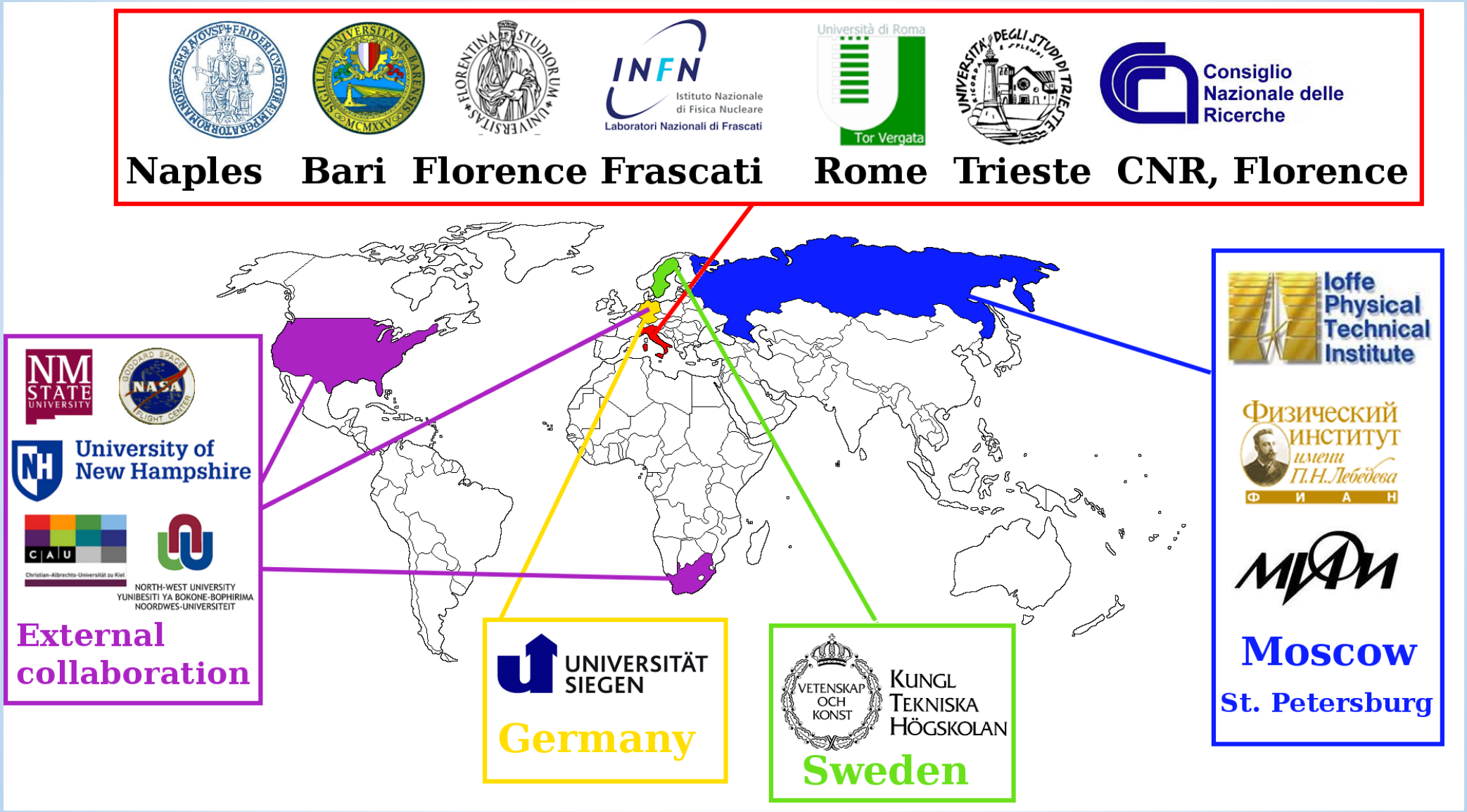
TOR VERGATA

A full solar cycle of proton and helium measurements with the PAMELA experiment

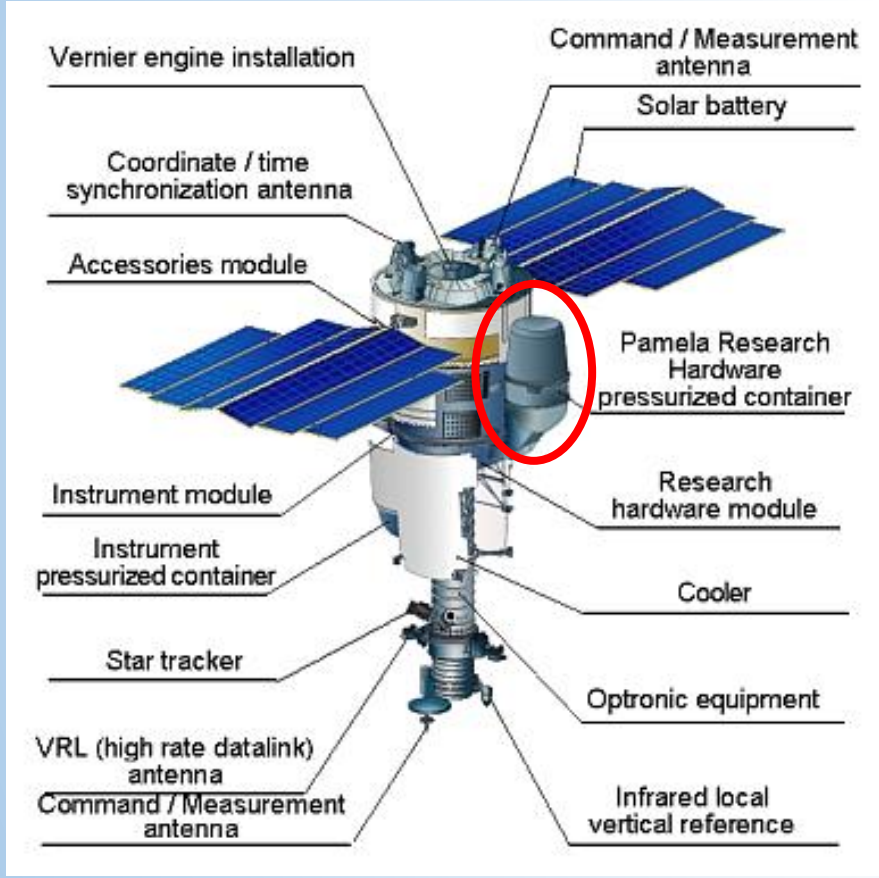
ICRC 2021, 12-23 July 2021

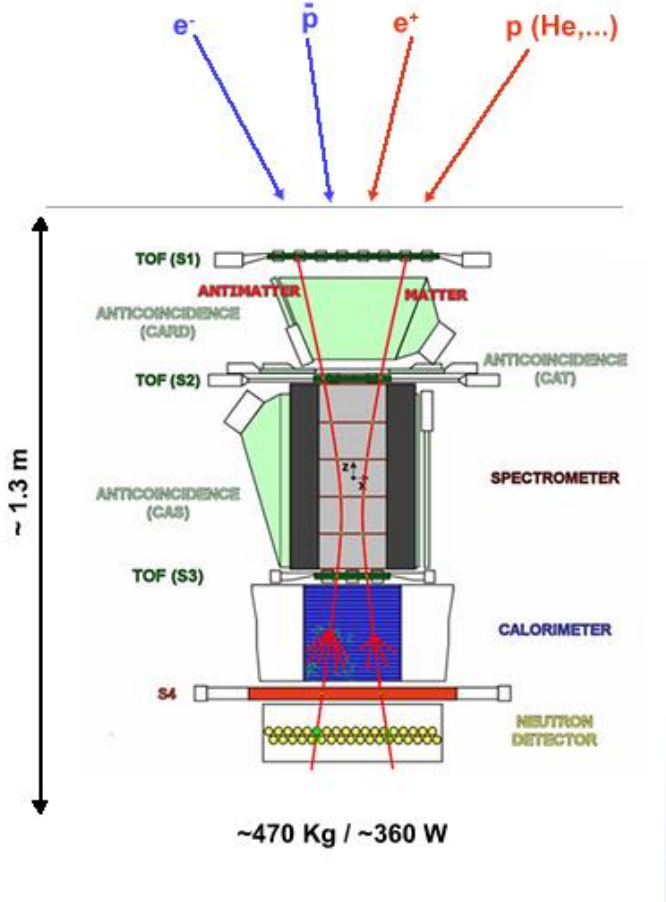
Speaker: *Nadir Marcelli*

PAMELA collaboration



PAMELA detector

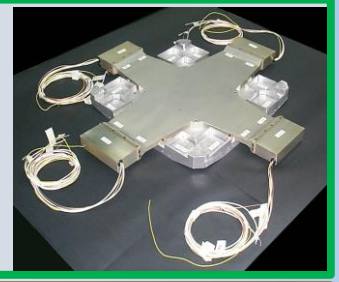




Time-Of-Fligth

Plastic scintillators:

- **Trigger - Velocity**
- **Charge identification dE/dx**



Magnetic spectrometer

Silicon strip + permanent magnet:

- **Trajectory track**
- **Sing and absolute value of the charge**

Calorimeter

Silicon Strip and tungsten:

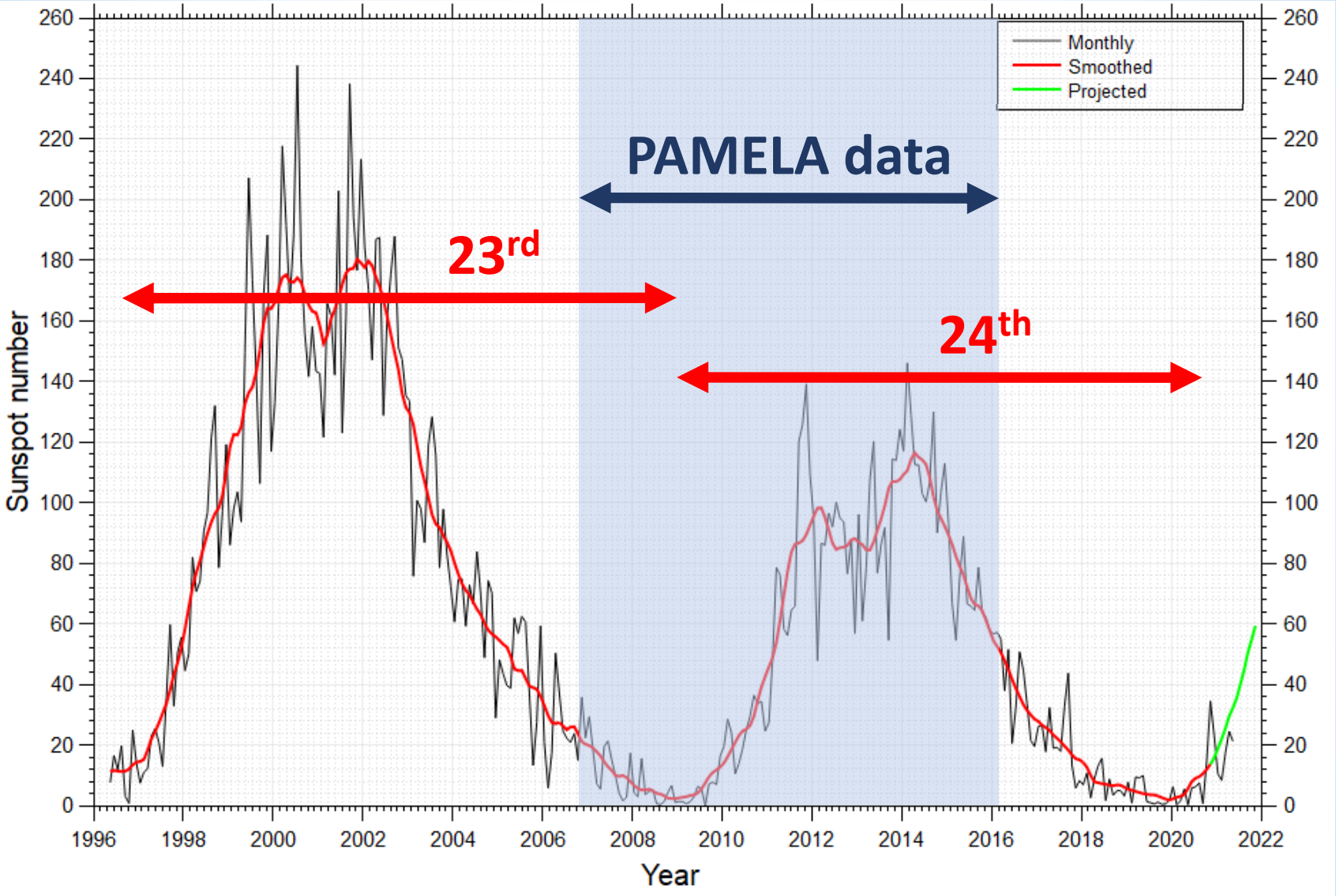
- **Electromagnetic shower energy**
- **Incident $e^{-/+}$ energy**

Neutron Detector

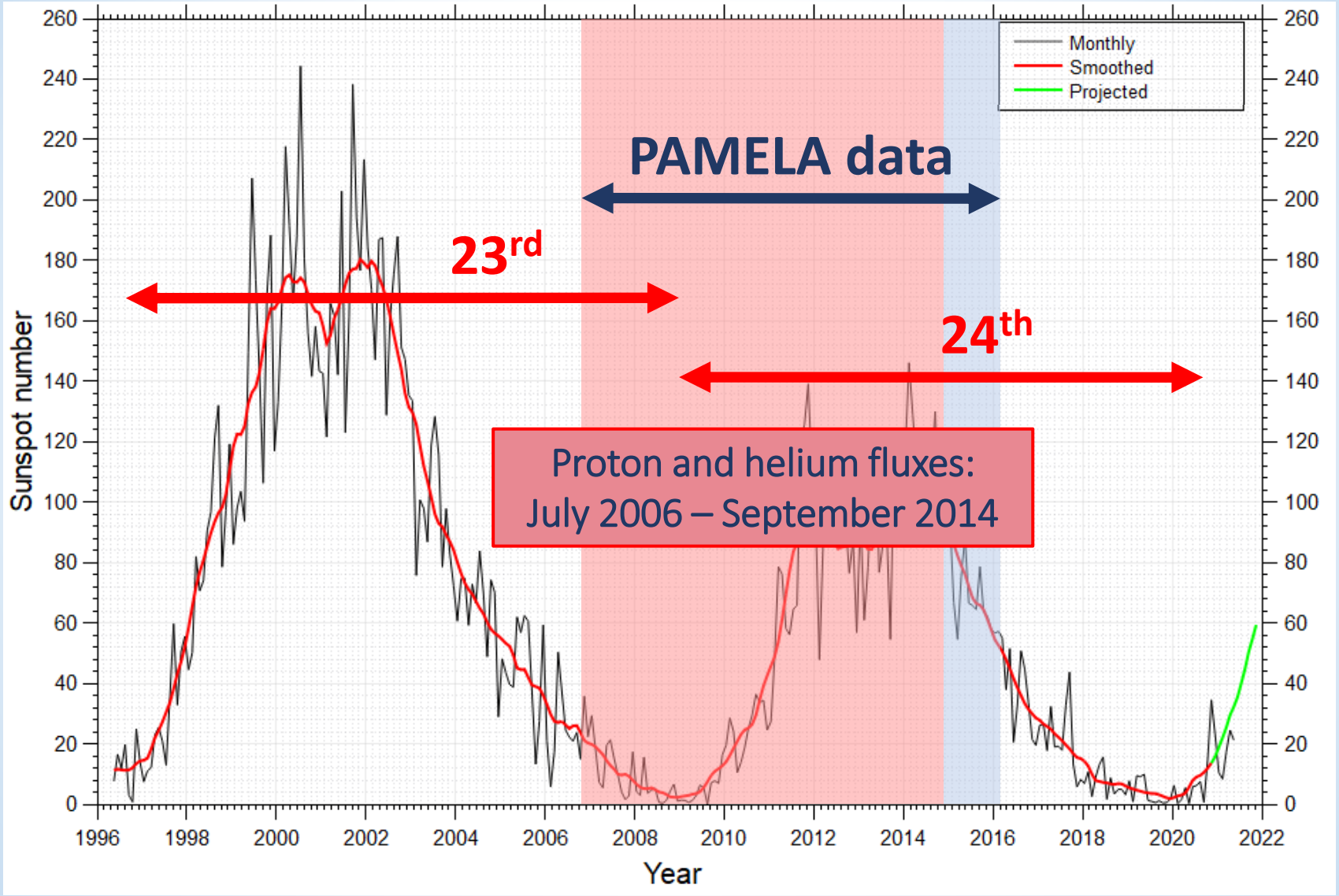
^{3}He gas cylinders:

- **Adrons and leptons discrimination**

Solar activity

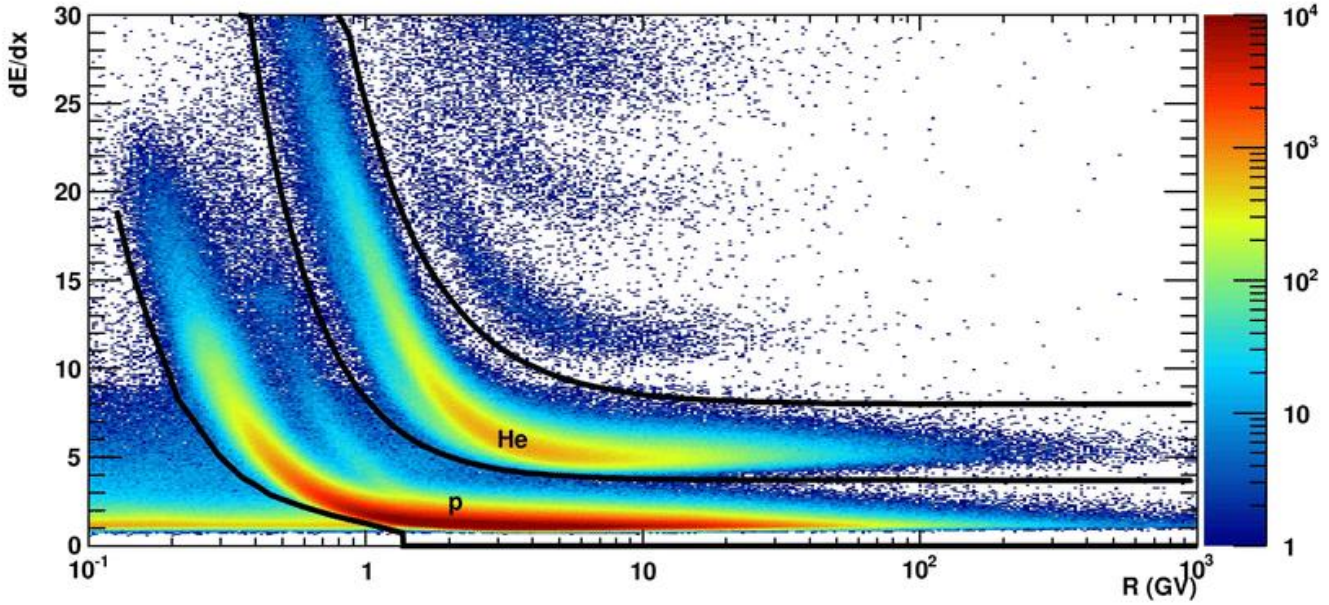


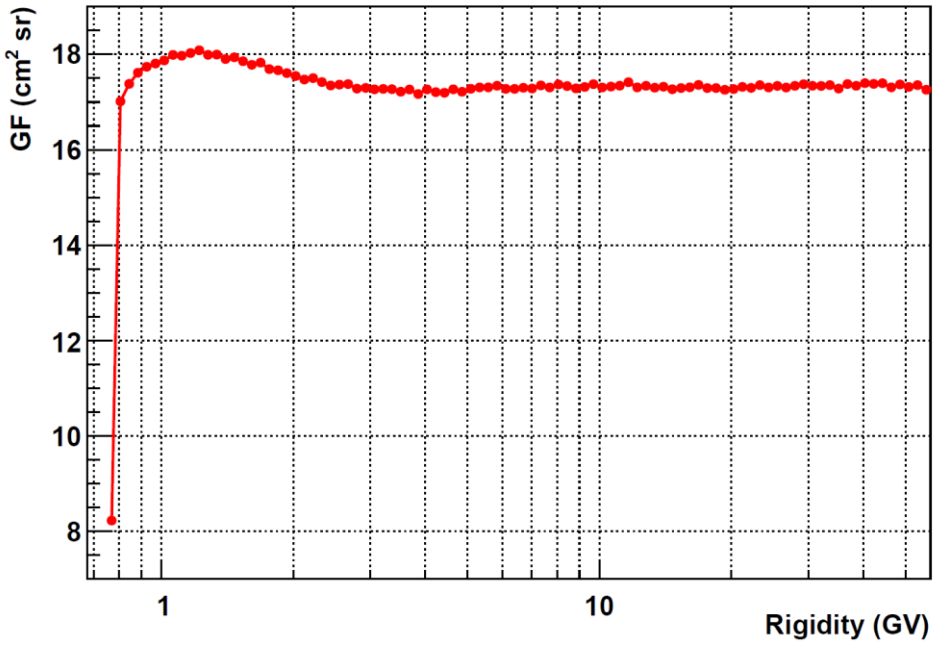
Solar activity



Flux computation

$$\phi(R_i) = \frac{N_{sel}(R_i)}{\Delta R_i} \cdot \frac{1}{GF(R_i) \cdot \varepsilon_{total}(R_i) \cdot T_{live}(R_i)}$$

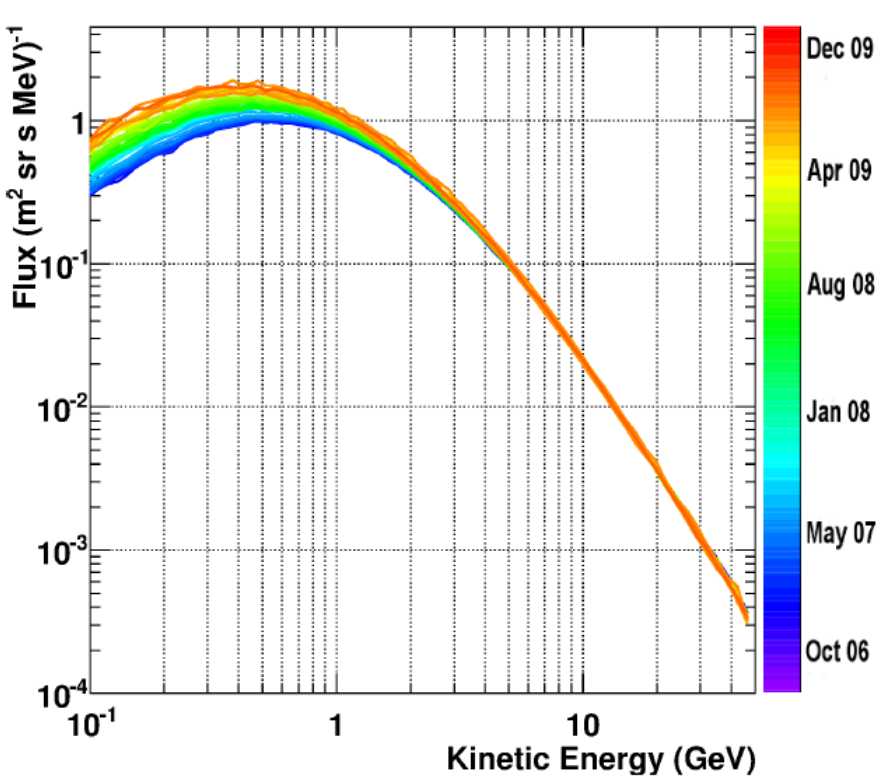


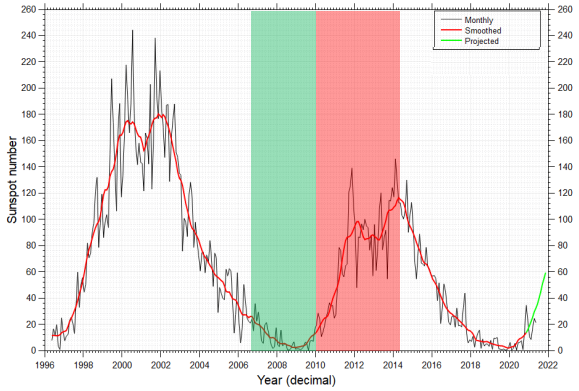


Proton fluxes

Solar minimum

From July 2006 to December 2009

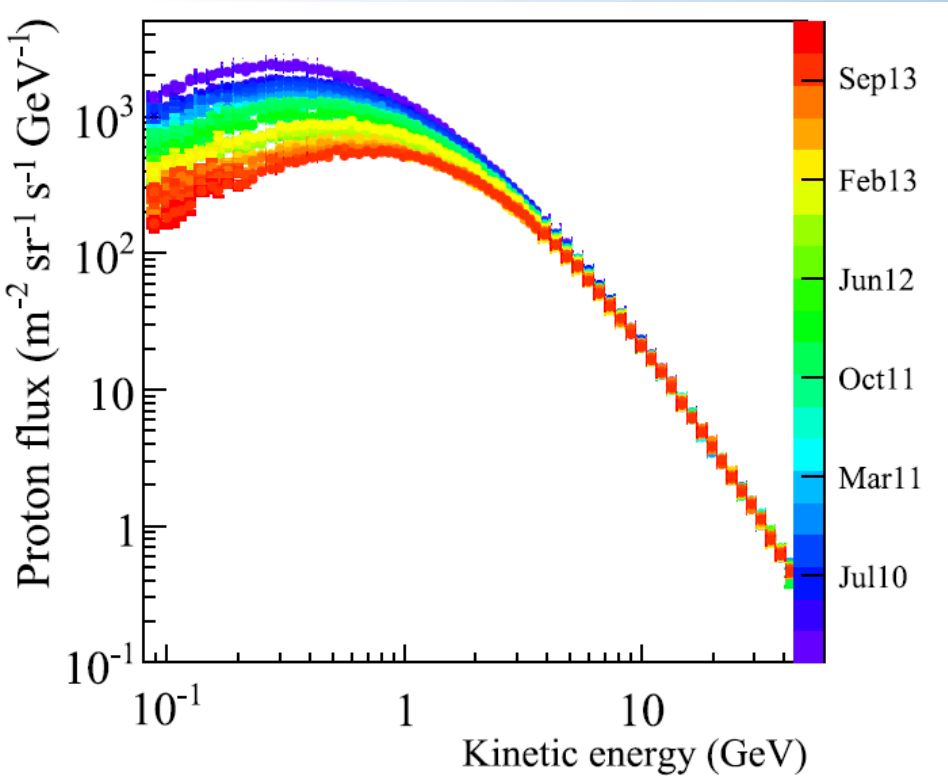




Adriani et al., 2013 - ApJ

Solar maximum

From January 2010 to February 2014

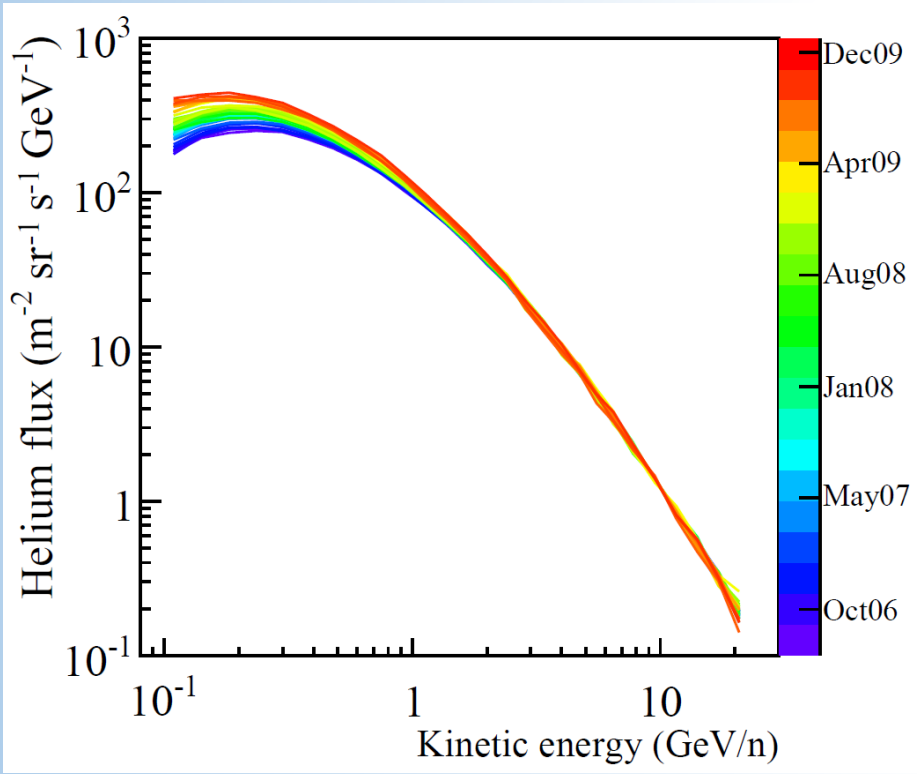


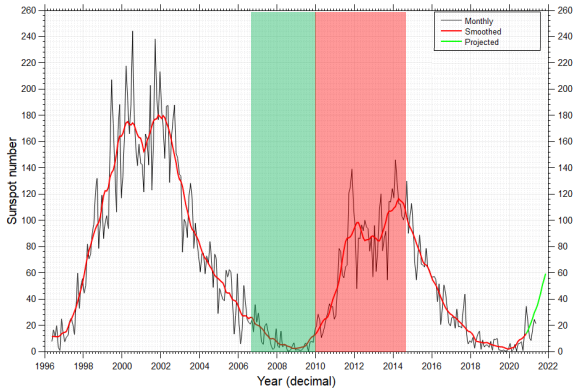
Martucci et al., 2018 - ApJ

Helium fluxes

Solar minimum

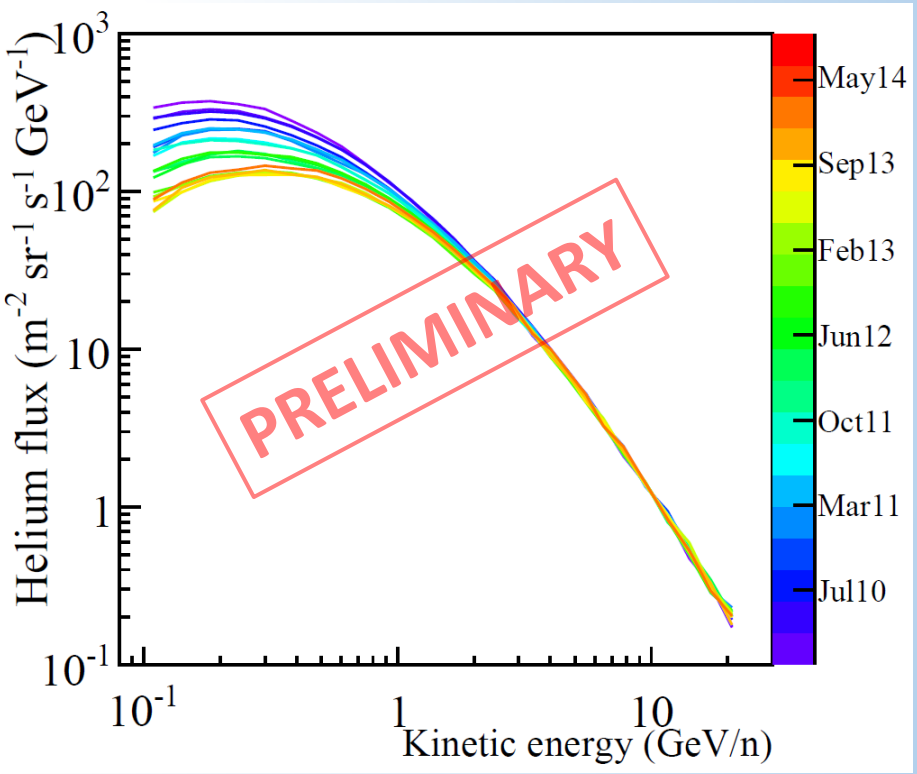
From July 2006 to December 2009





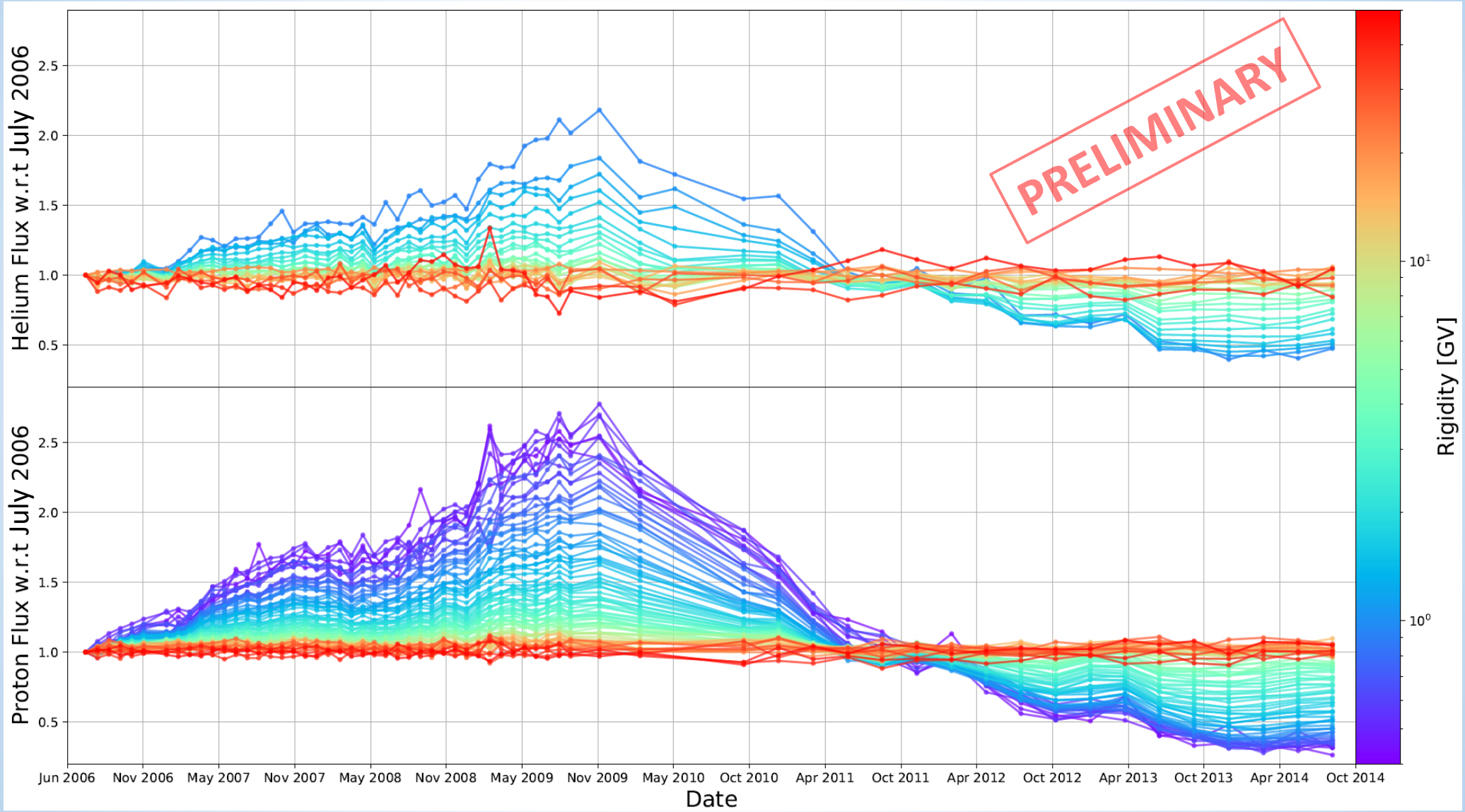
Solar maximum

From January 2010 to September 2014

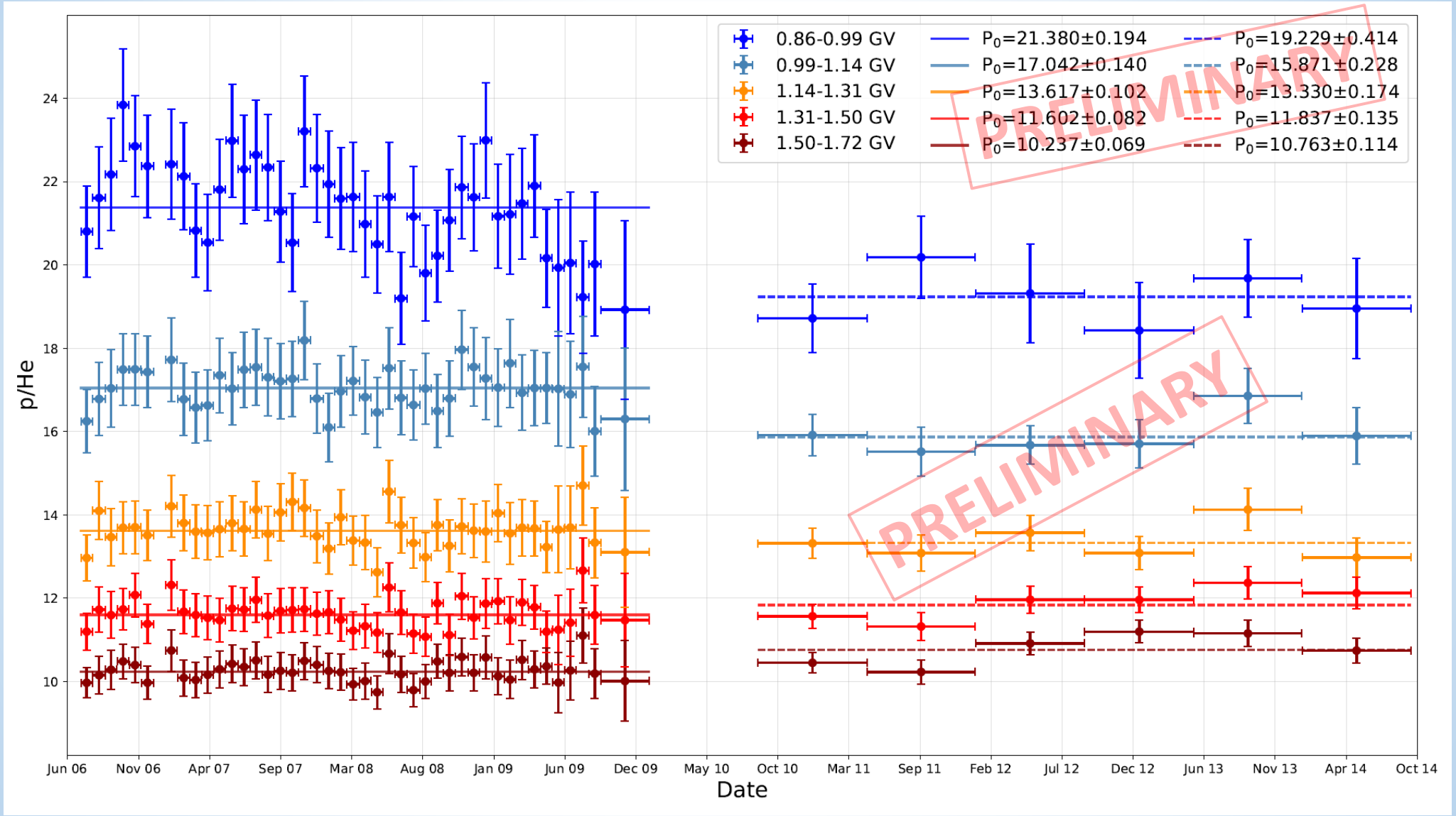


N. Marcelli et al., 2020 - ApJ

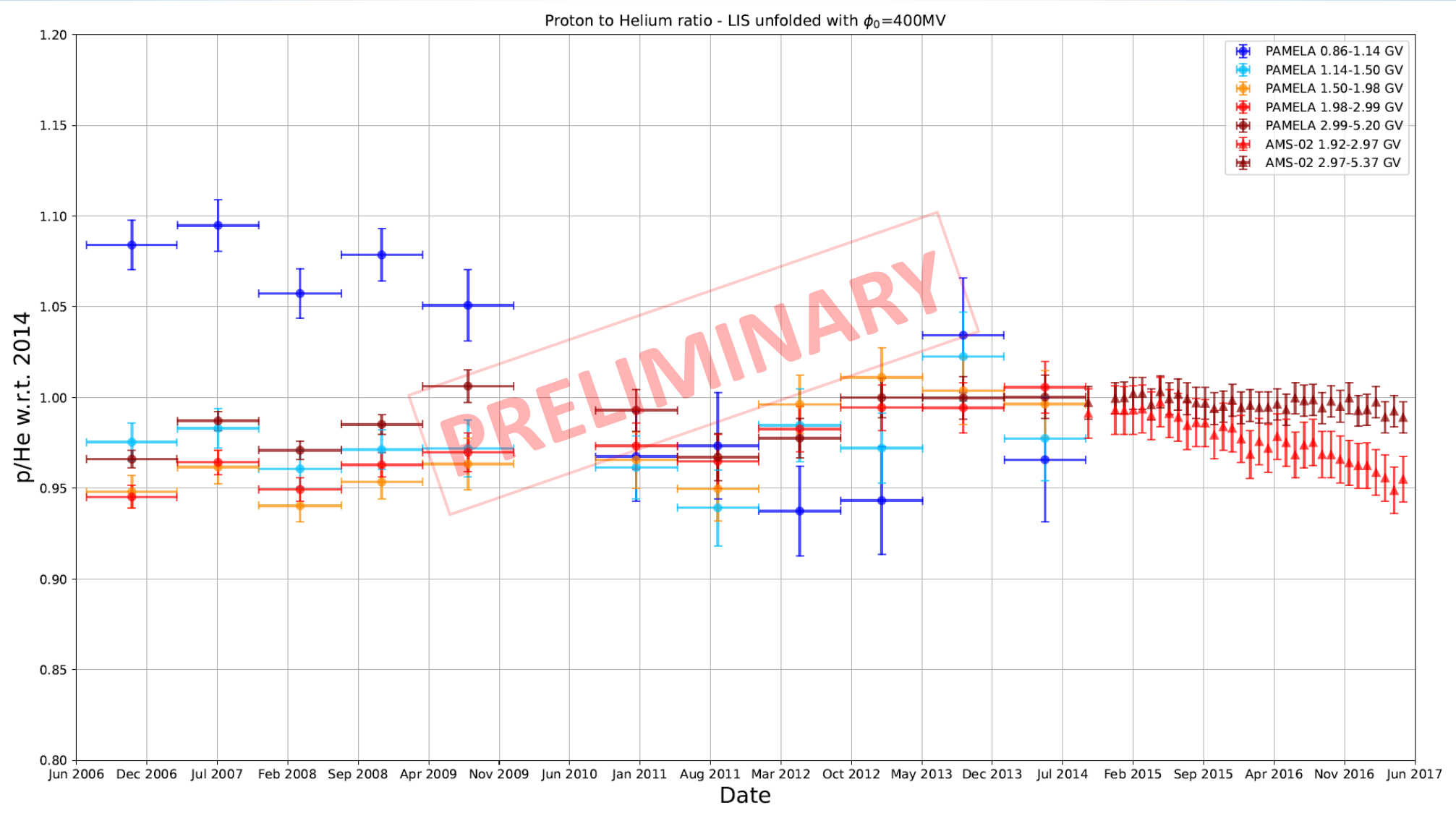
Proton and helium fluxes



Proton over helium ratio



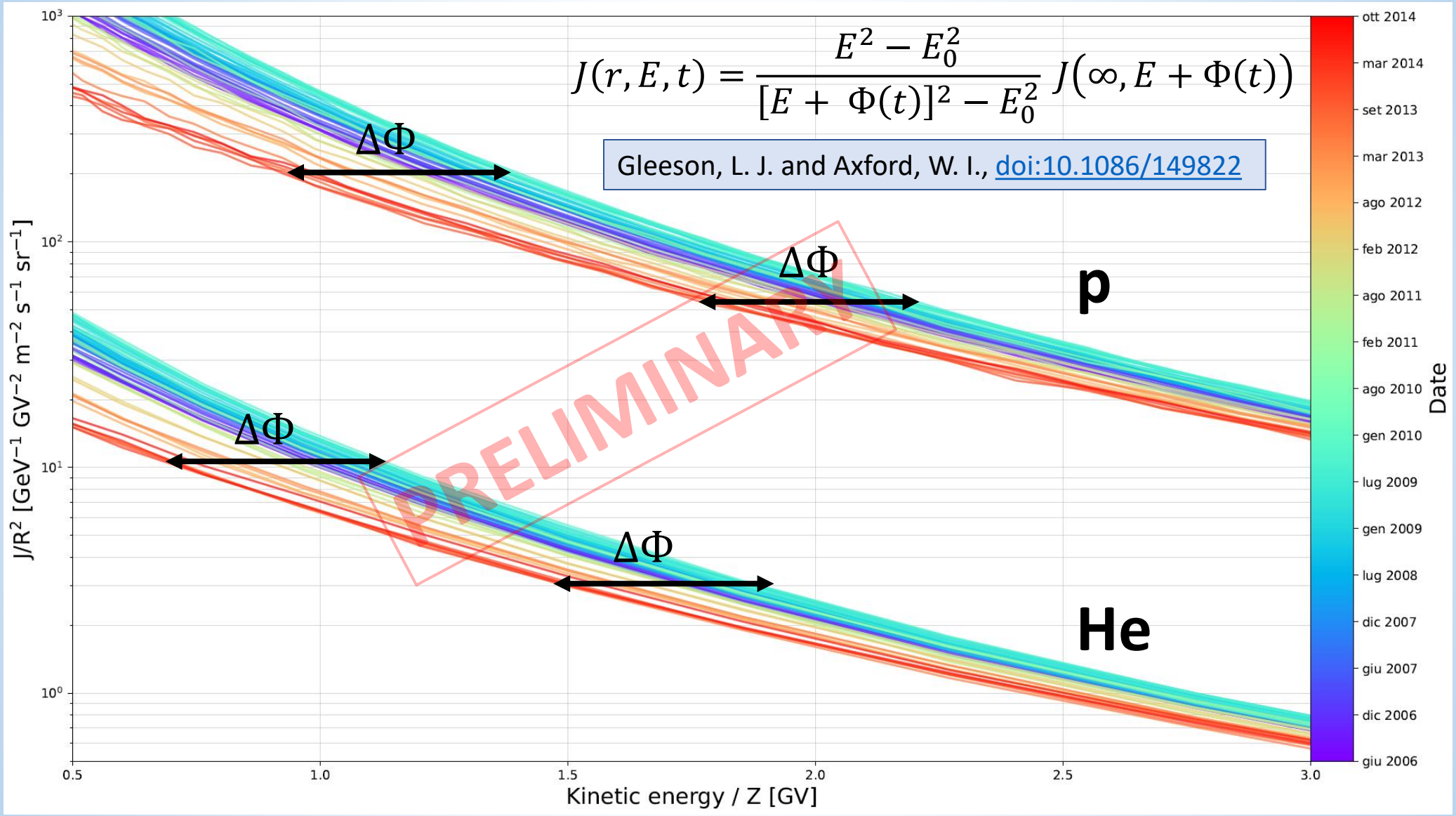
Proton over helium ratio



ΔΦ from measured fluxes

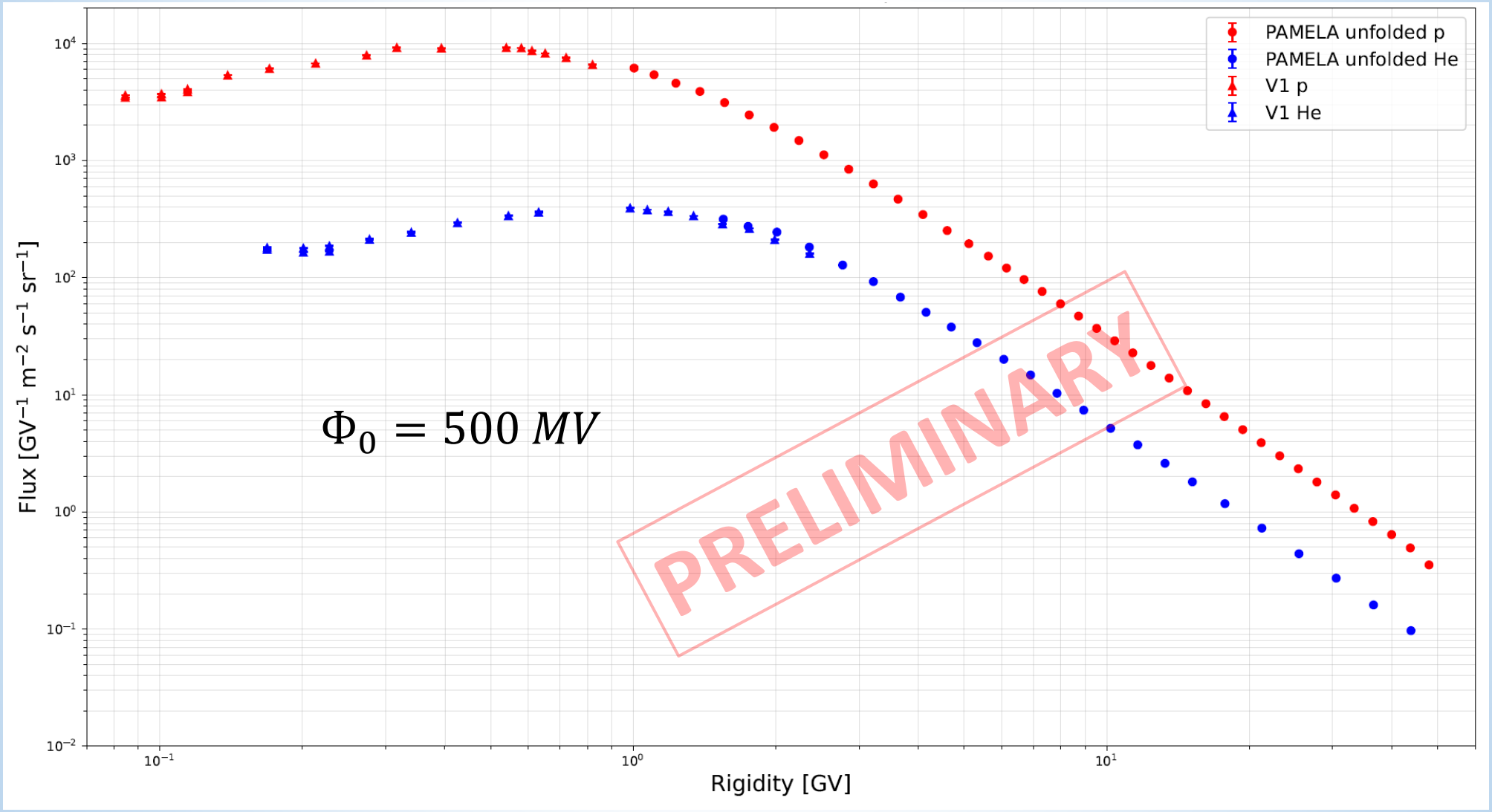
$$J(r,E,t) = \frac{E^2 - E_0^2}{[E + \Phi(t)]^2 - E_0^2} J\left(\infty, E + \Phi(t)\right)$$

Gleeson, L. J. and Axford, W. I., doi:10.1086/149822

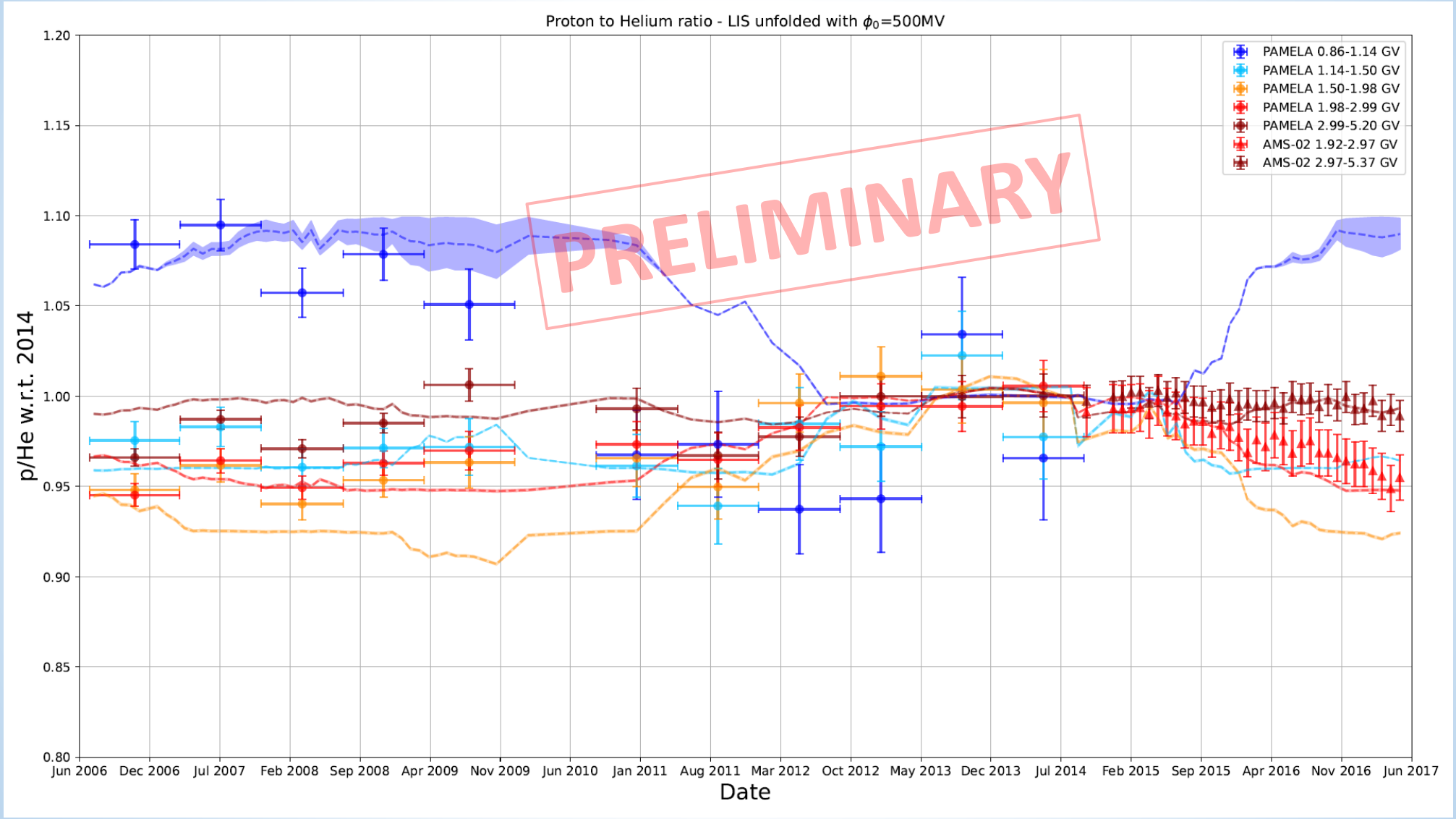


$\Delta\Phi$ from measured fluxes

Unfolded fluxes



Modeled p/He ratio



Conclusion

- The spectra for proton and helium-nuclei measured by the PAMELA experiment over a nearly complete solar cycle (July 2006 – September 2014) were presented

- An indication of time dependence in the p/He ratio is observed, suggesting either a difference in the processes involved in solar modulation effects and/or a difference in the LIS for the two species

- The force-field approximation for solar modulation was applied to relate the observed dependencies to the different shapes of the local interstellar proton and helium-nuclei spectra

- More accurate models will be developed to have a complete picture of the cause of these dependencies