



a **P**ayload for **A**ntimatter **M**atter **E**xploration
and **L**ight-nuclei **A**strophysics



Università di Roma



PAMELA measurements of solar energetic particle spectra

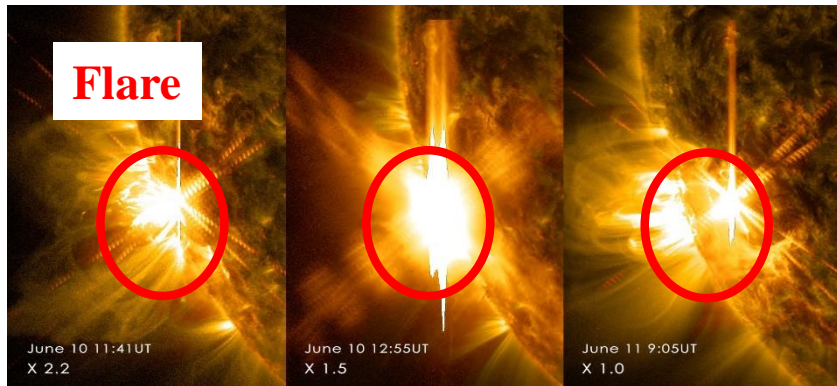
Matteo Martucci

INFN, Laboratori Nazionali di Frascati

University of Rome "Tor Vergata"

**ON BEHALF OF
THE PAMELA COLLABORATION**

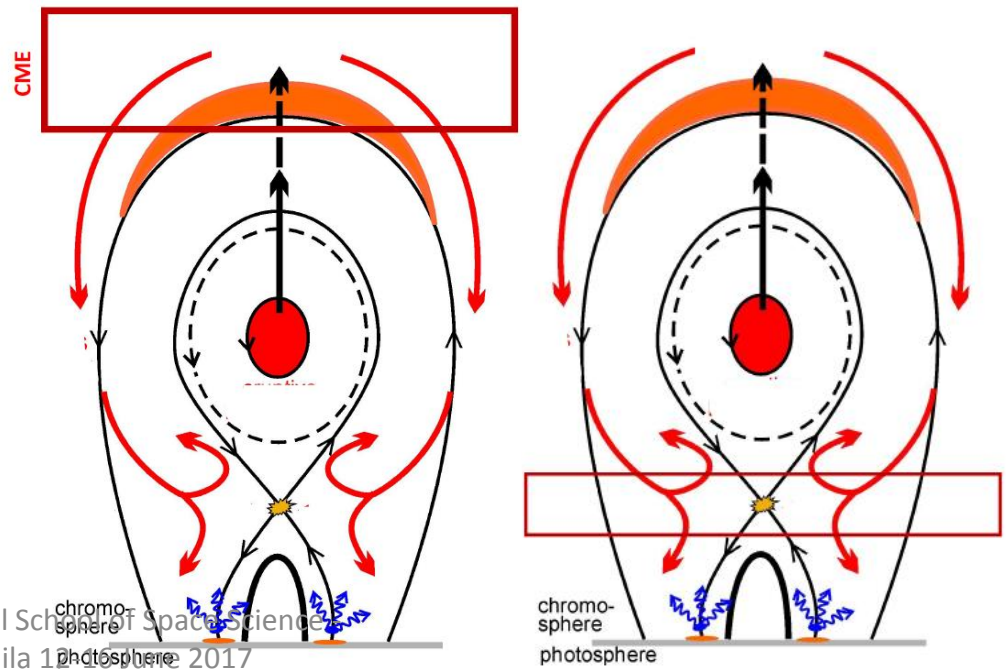
SOLAR PARTICLE EVENT



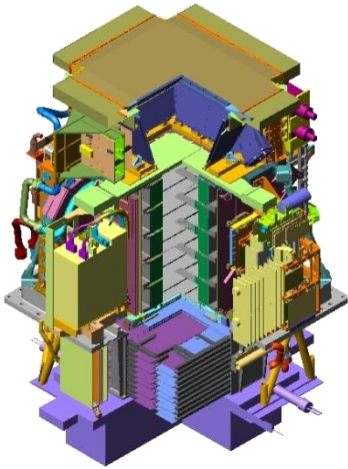
- SEPs are generated on the Sun during solar flares
- Particles are produced together with radiation (γ , radio, X etc)
- SEP change as solar flares change (position, energy etc)

SEP are accelerated by different mechanisms

- **MAGNETIC RECONNECTION:** particle are accelerated in situ after rearrangement of the magnetic field lines
- **SHOCK:** particle are accelerated by the shock caused by Coronal Mass Ejections moving in space



PAMELA INSTRUMENT



GF: 21.5 cm² sr
 Mass: 470 kg
 Size: 130x70x70 cm³
 Power Budget: 360W

Time-Of-Flight

plastic scintillators + PMT

- Trigger
- Albedo rejection
- Mass identification up to 1 GeV
- Z identification from dE/dx

Electromagnetic calorimeter

W/Si sampling (16.3 X0, 0.6 Al)

- Discrimination e^+ / p, anti-p / e^-
- Direct E measurement for e^-

Neutron detector

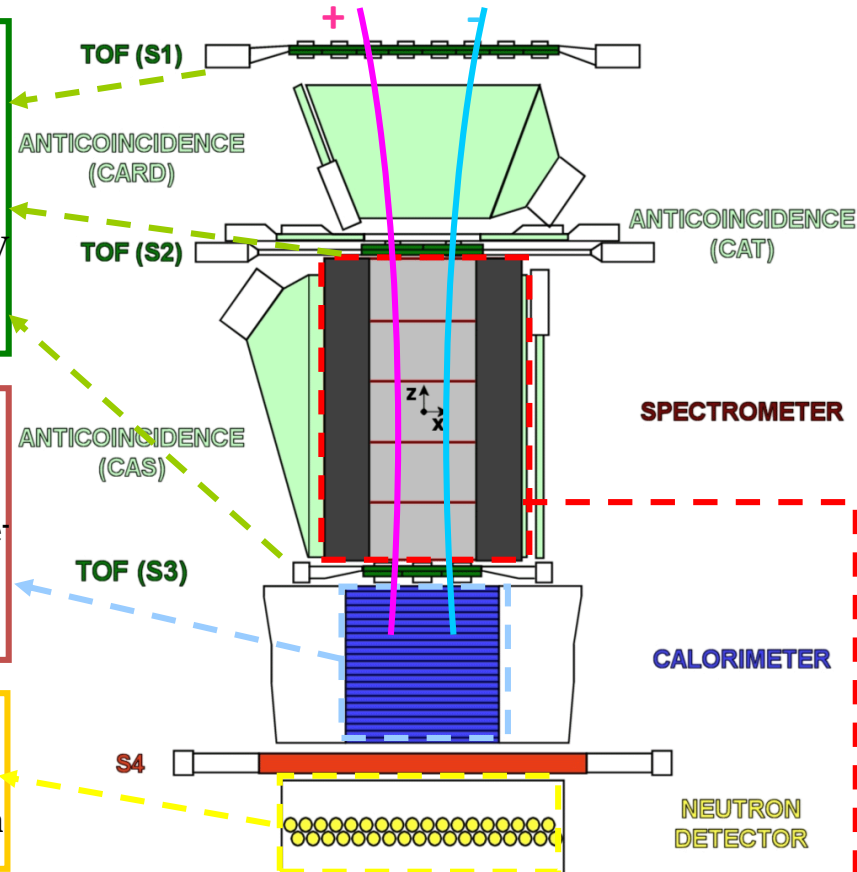
plastic scintillators + PMT

- High-energy e/h discrimination

Spectrometer

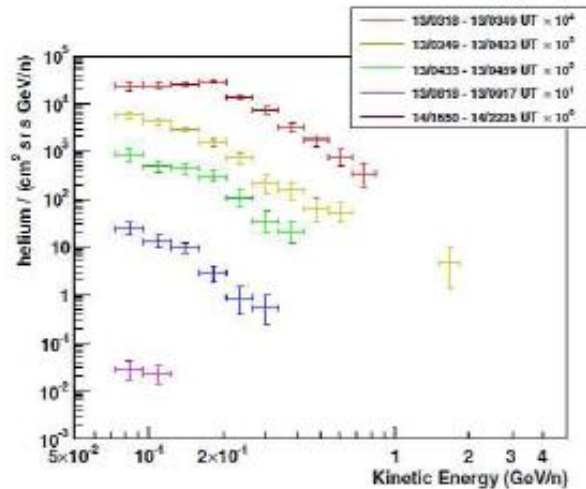
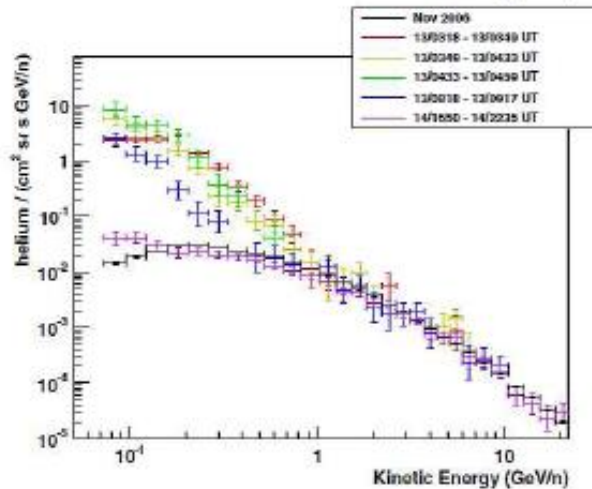
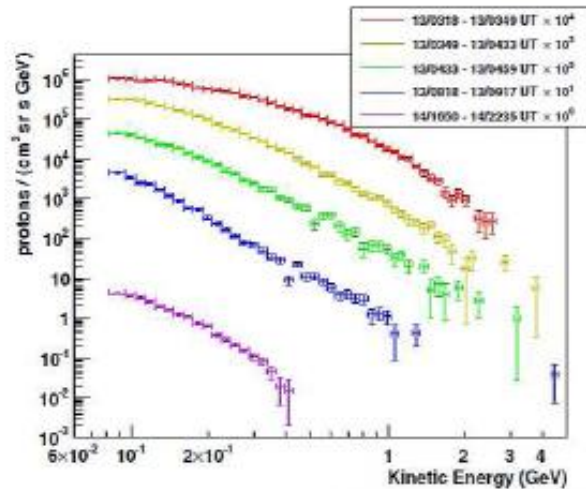
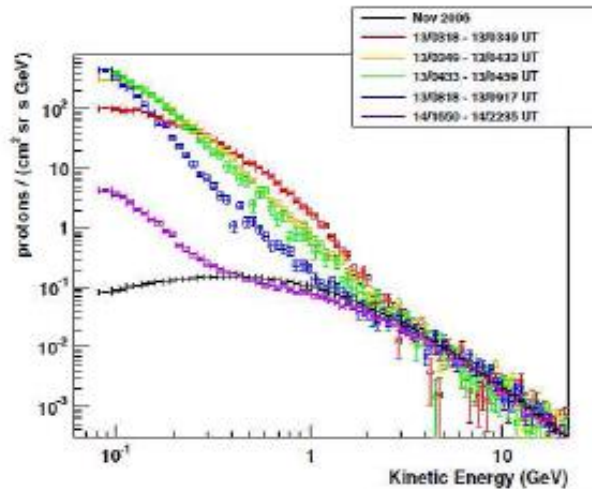
microstrip silicon tracking system + permanent magnet

- Magnetic rigidity $\rightarrow R = pc/Ze$
- Z sign
- Z value from dE/dx



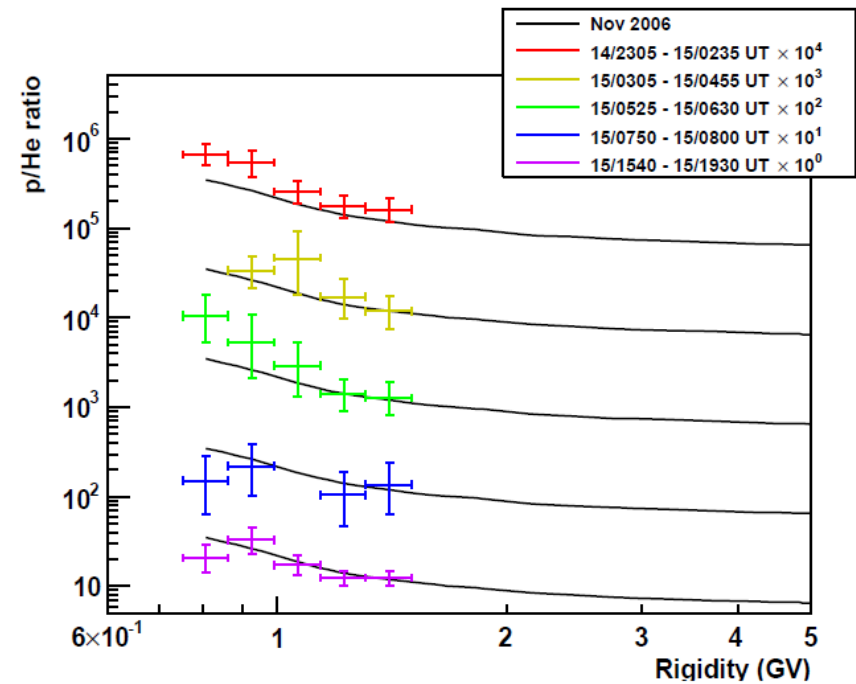
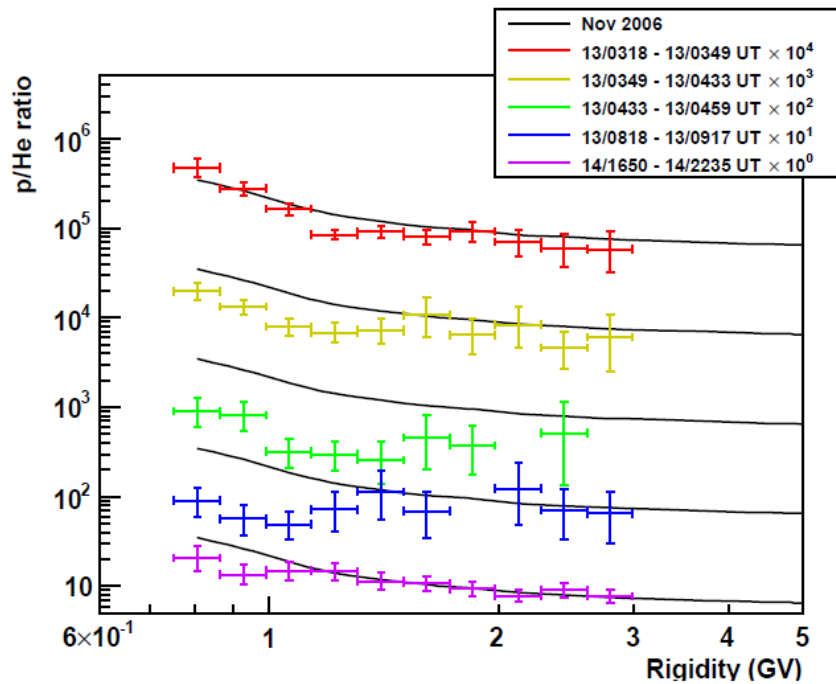
THE CAPABILITIES OF PAMELA IN SEP STUDIES

2006 December 13/14



- High performance even under high rate of particles
- Particle sensitivity to discriminate solar proton from solar helium (if present)
- Fluxes evaluated in narrow time intervals to study sudden variation of solar fluxes

THE CAPABILITIES OF PAMELA IN SEP STUDIES



LIST OF SEPs

Event No.	Date	Class	Location
1	2006 Dec 13	X3.4/4B	S06W23
2	2006 Dec 14	X1.5/--	S06W46
3	2011 Mar 21	M3.7/--	>W90
4	2011 Jun 07	M2.5/2N	S21W54
5	2011 Sep 06	M5.3/--	N14W07
6	2011 Sep 07	X2.1/--	N14W18
7	2011 Nov 04	?	?
8	2012 Jan 23	M8.7/--	N28W21
9	2012 Jan 27	X1.7/1F	N27W71
10	2012 Mar 07	X5.4/-	N17E27
11	2012 Mar 13	M7.9/--	N17W66
12	2012 May 17	M5.1/1F	N11W76
13	2012 Jul 07	X1.1/--	S13W59
14	2012 Jul 08	M6.9/1N	S17W74

Event No.	Date	Class	Location
15	2012 Jul 19	M7.7/--	S13W88
16	2012 Jul 23	?	>W90
17	2013 Apr 11	M6.5/3B	N09E12
18	2013 May 22	M5.0/--	N13W75
19	2013 Sep 30	C1.3/--	N17W29
20	2013 Oct 28	M5.1	N08W71
21	2013 Nov 02	?	?
22	2014 Jan 06	?	>W90
23	2014 Jan 07	X1.2/--	S15W11
24	2014 Feb 25	X4.9/B	S12E82
25	2014 Apr 18	M7.3/--	S20W34
26	2014 Sep 01	?	>W90
27	2014 Sep 10	X1.6/--	N14E02