Appreciating Radiation Environment in-situ data

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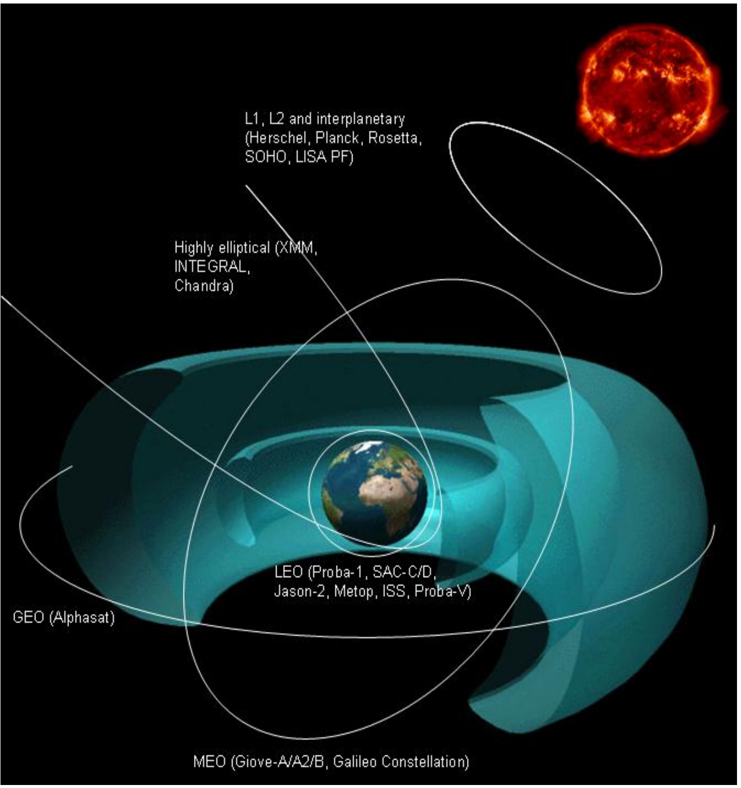
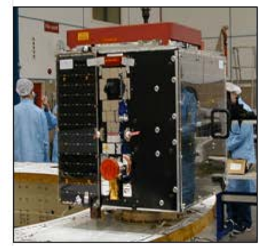
09/05/2012

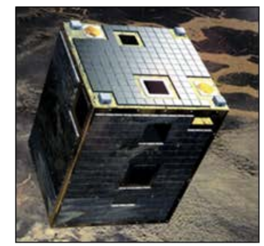


SREM – ESA's Standard Radiation Environment Monitor (1996-)

ESA, Oerlikon Contraves (RUAG), Paul Scherrer Institute (PSI)

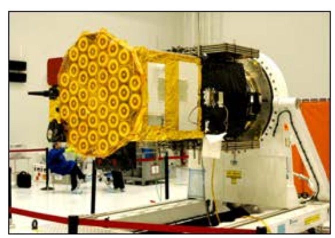


STRV-1c 2000



PROBA-1 2001

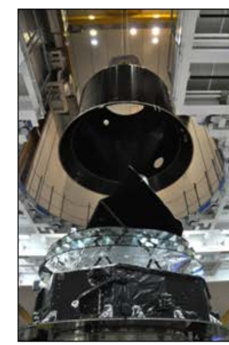
INTEGRAL 2002



Giove-B 2006

Rosetta 2004

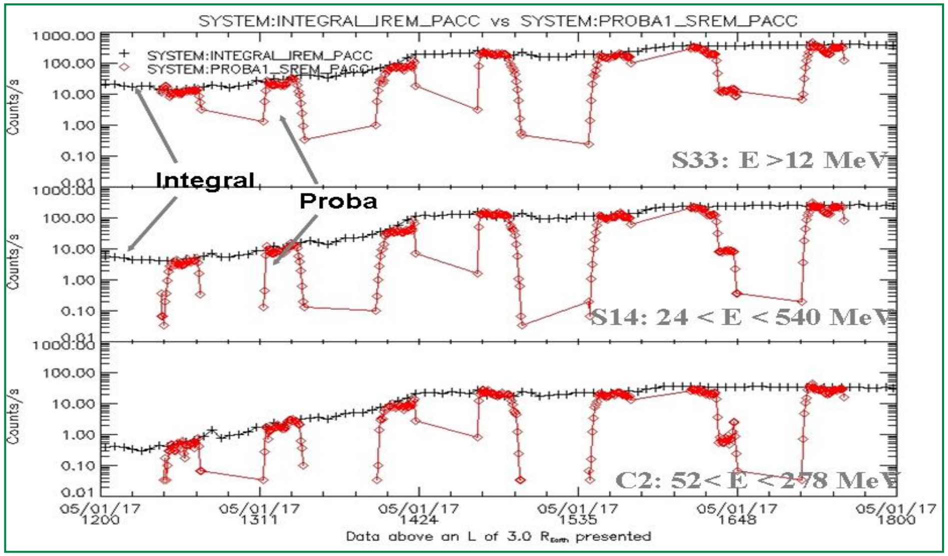
Herschel 2009

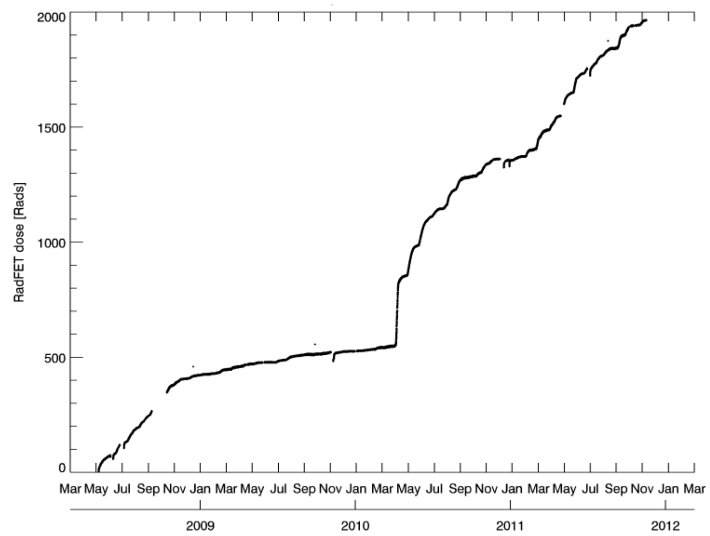


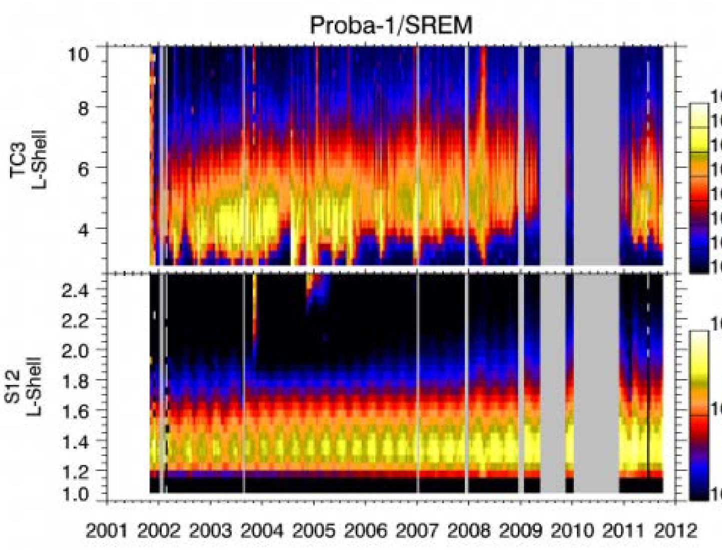
Planck 2009

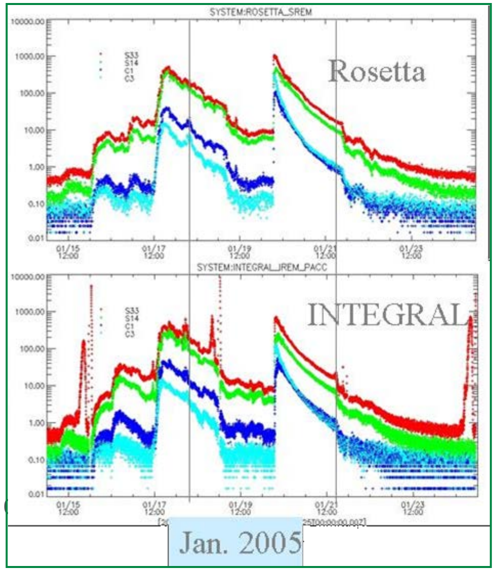
Part of a constellation of European monitors, coordinated via SEENoTC

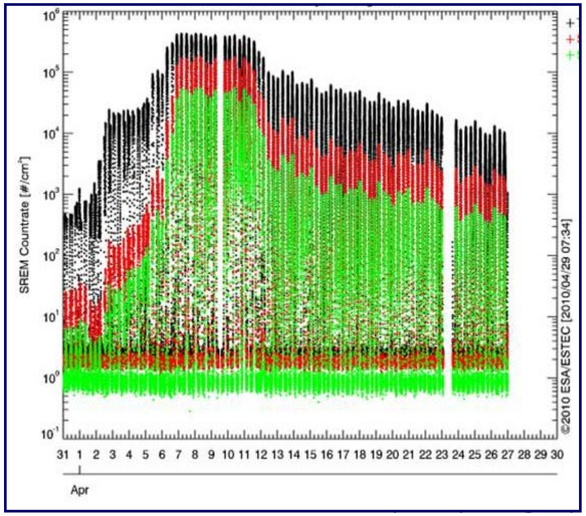
SREMs have returned a wealth of data





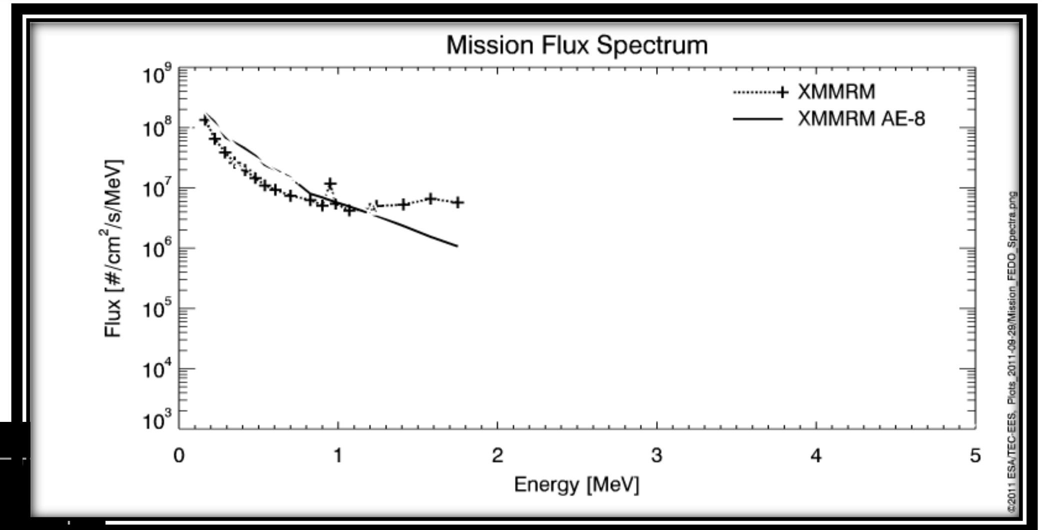


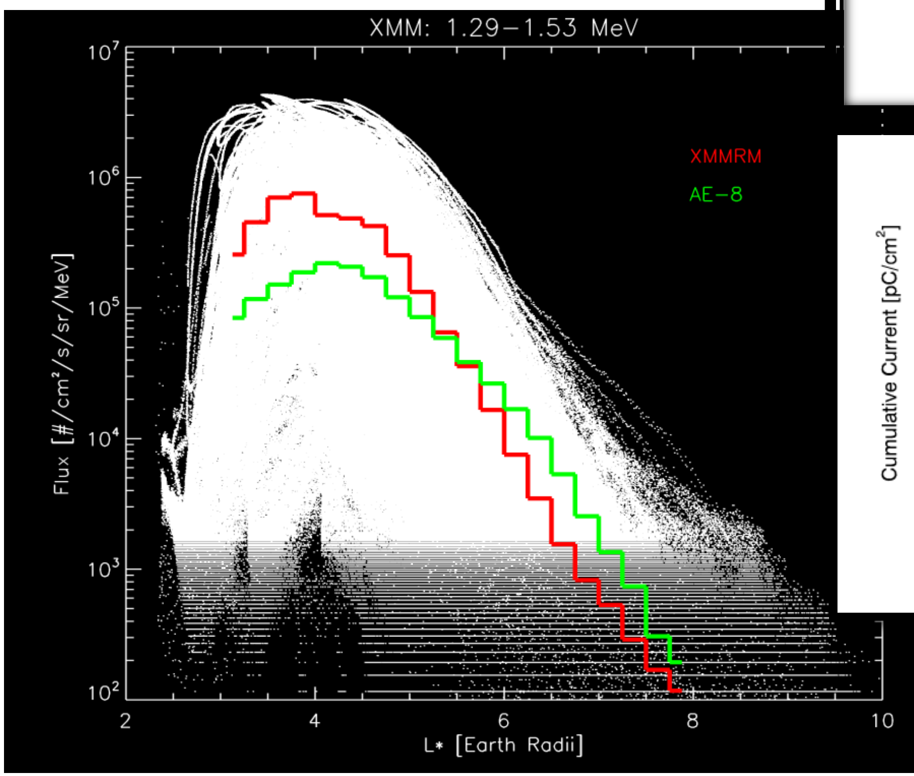


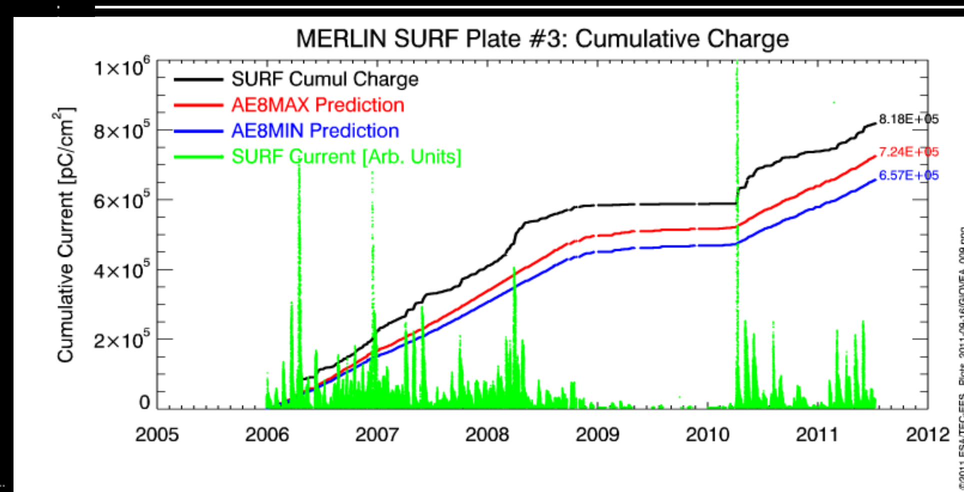


Other resources

1. XMM/EPIC-RM (ESA/CNES)
2. Giove-A CEDEX (U.Surrey)
3. Giove-A MERLIN (QinetiQ)





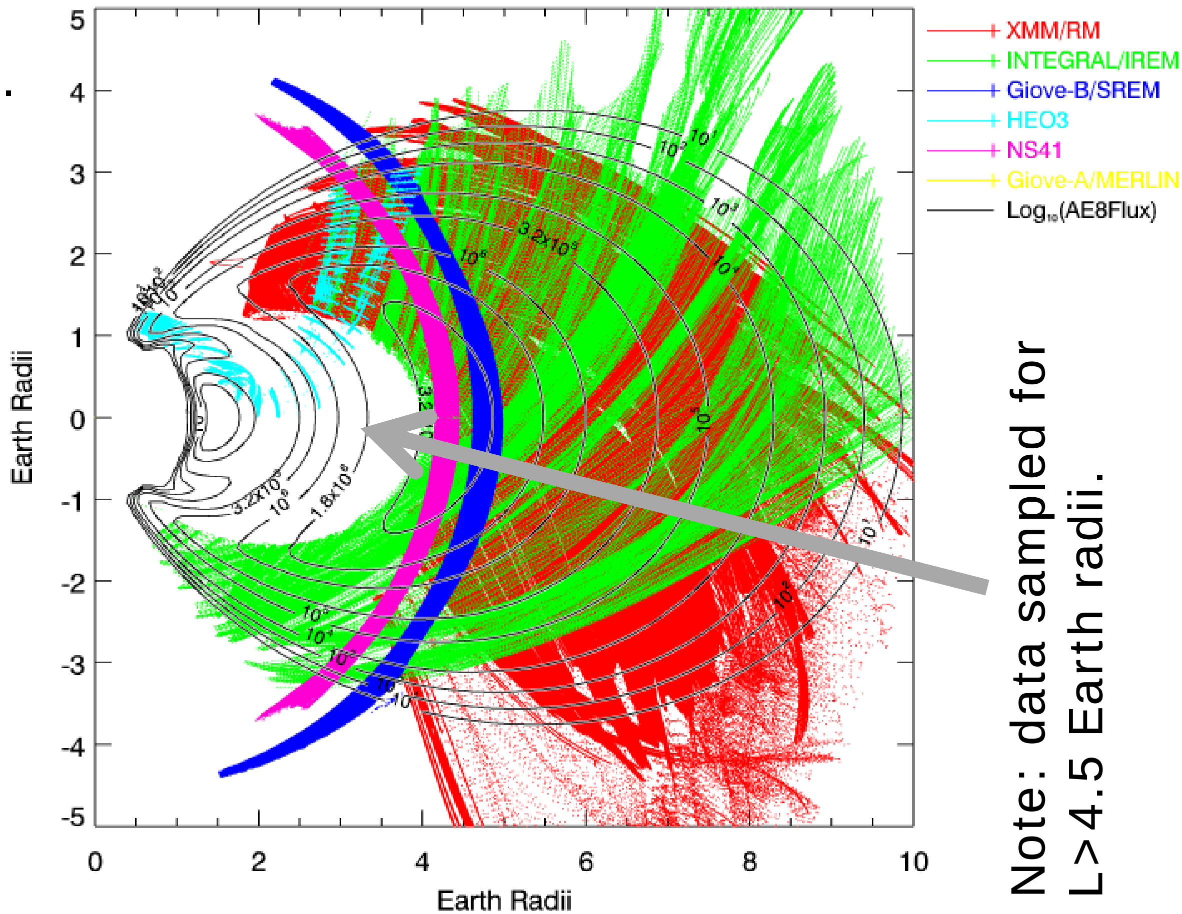


Magnetospheric Coverage

Very good coverage of the outer radiation belt.

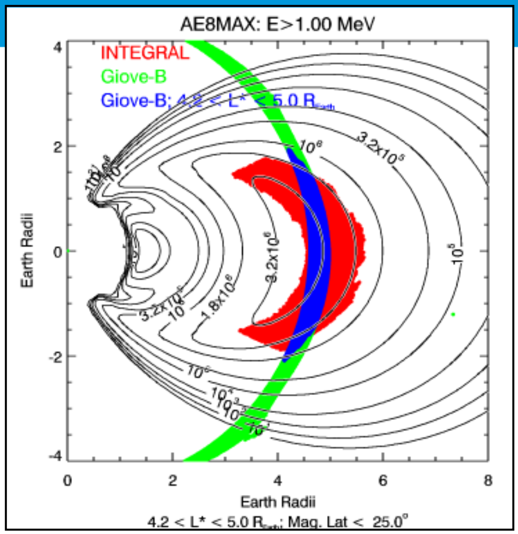
Inner proton belt coverage by Proba1/SREM, and in the last few years Integral's perigee has fallen to be within the proton belt.

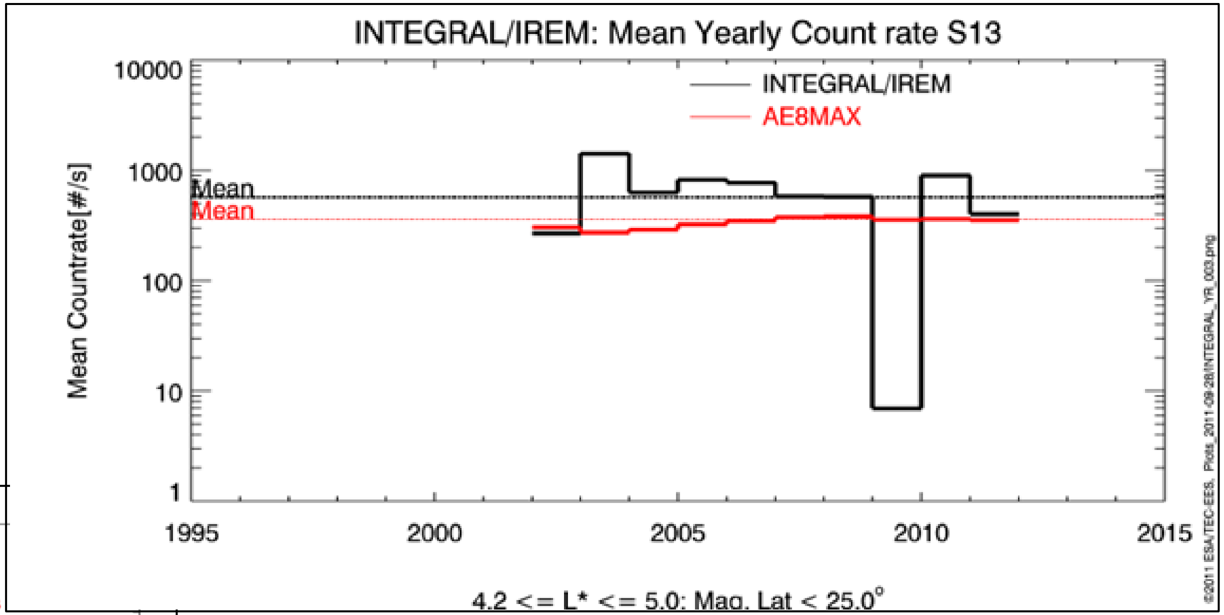
Also Herschel & Planck in L-2, and Rosetta in interplanetary space.

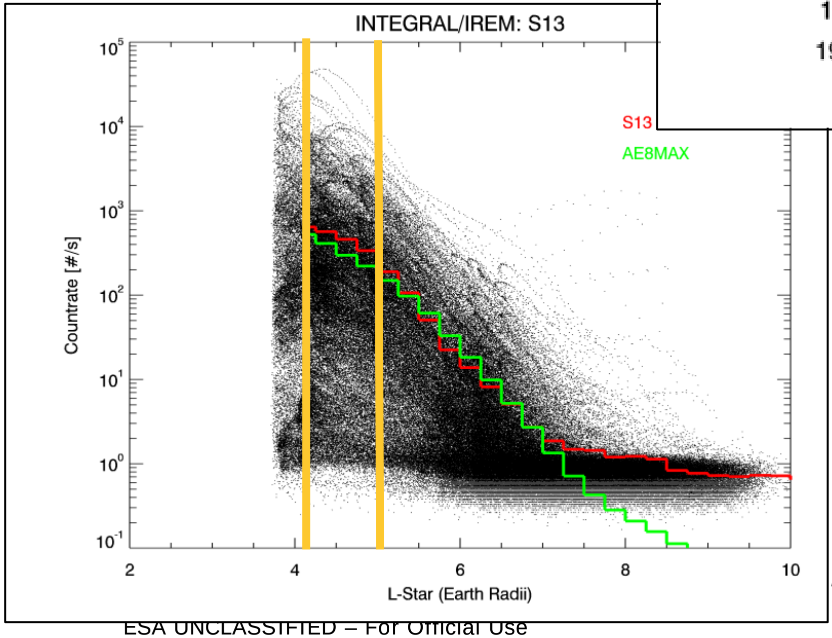


Note: data sampled for L>4.5 Earth radii.

Electron Radiation Belt Validation







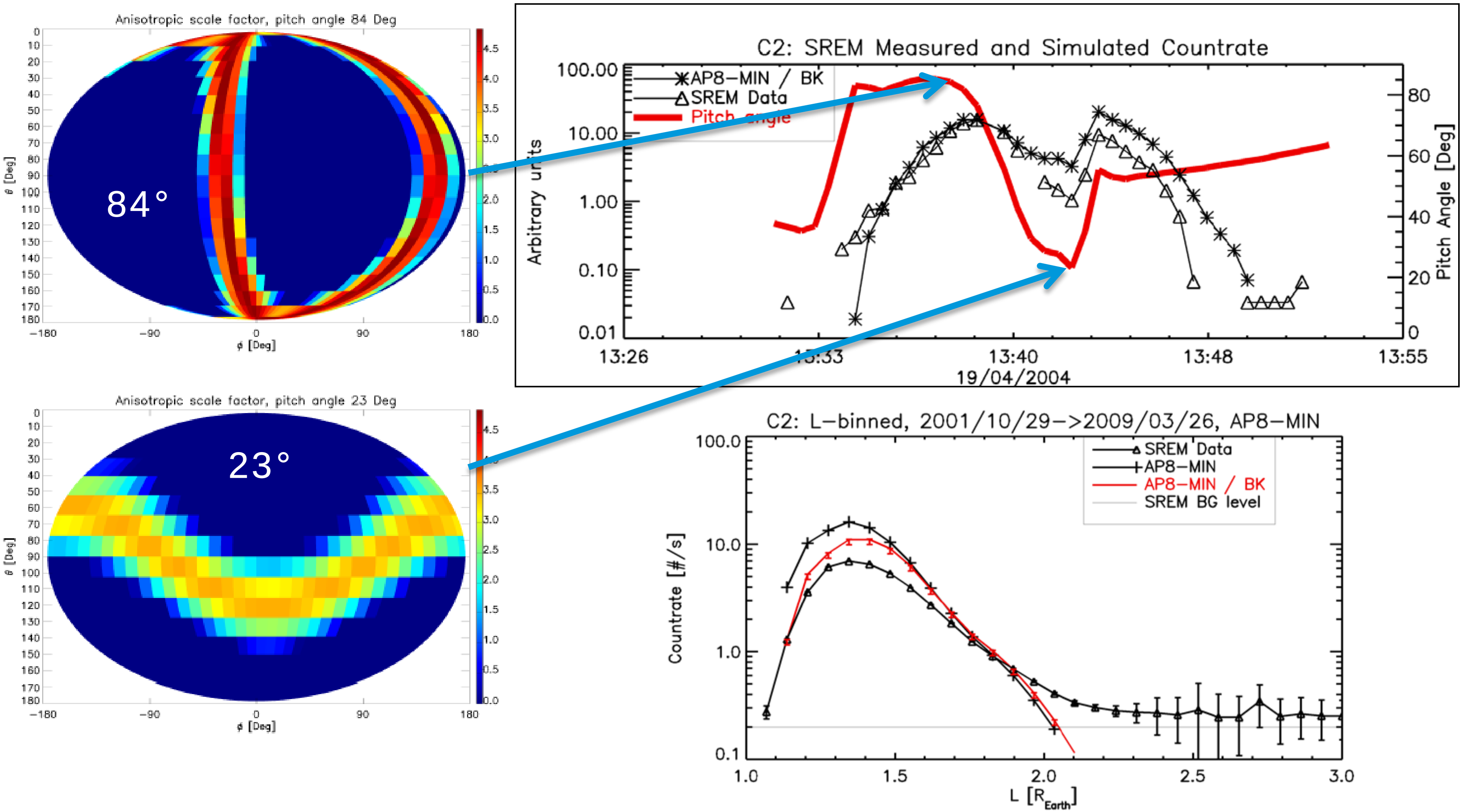
Sampled data from:

$4.2 \leq L \leq 5$ Earth Radii, and

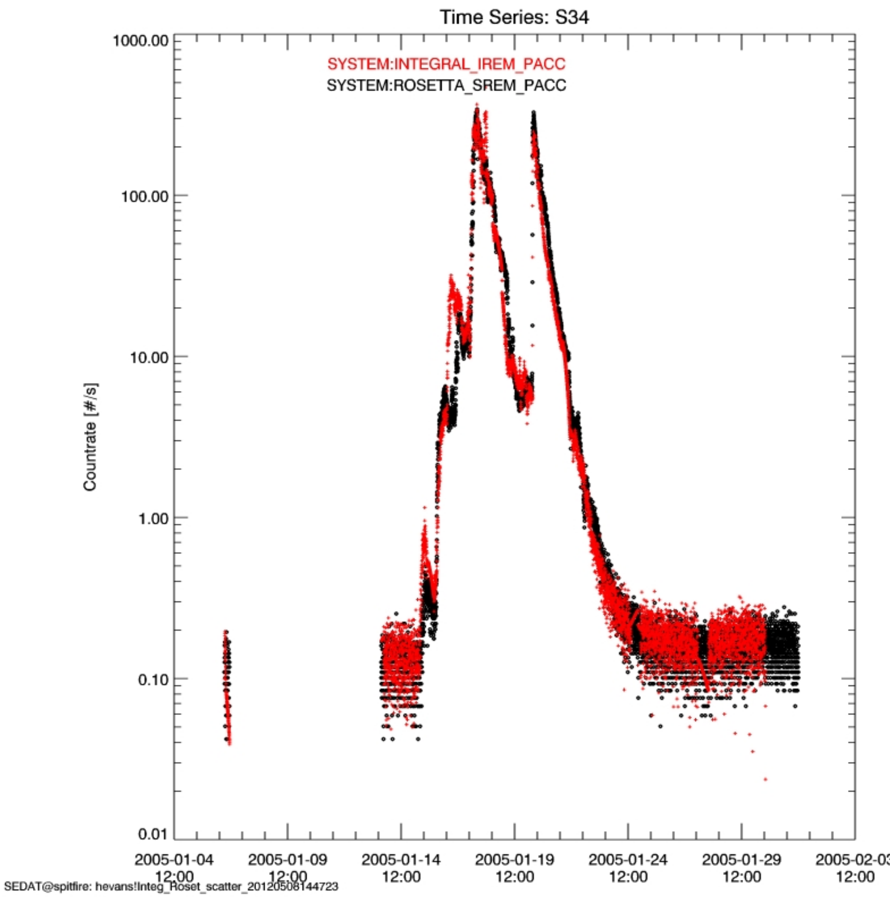
$Lat_{mag} < 25°$ (equatorial)

AE-8 MAX used to calculate equivalent count rates using IREM response function.

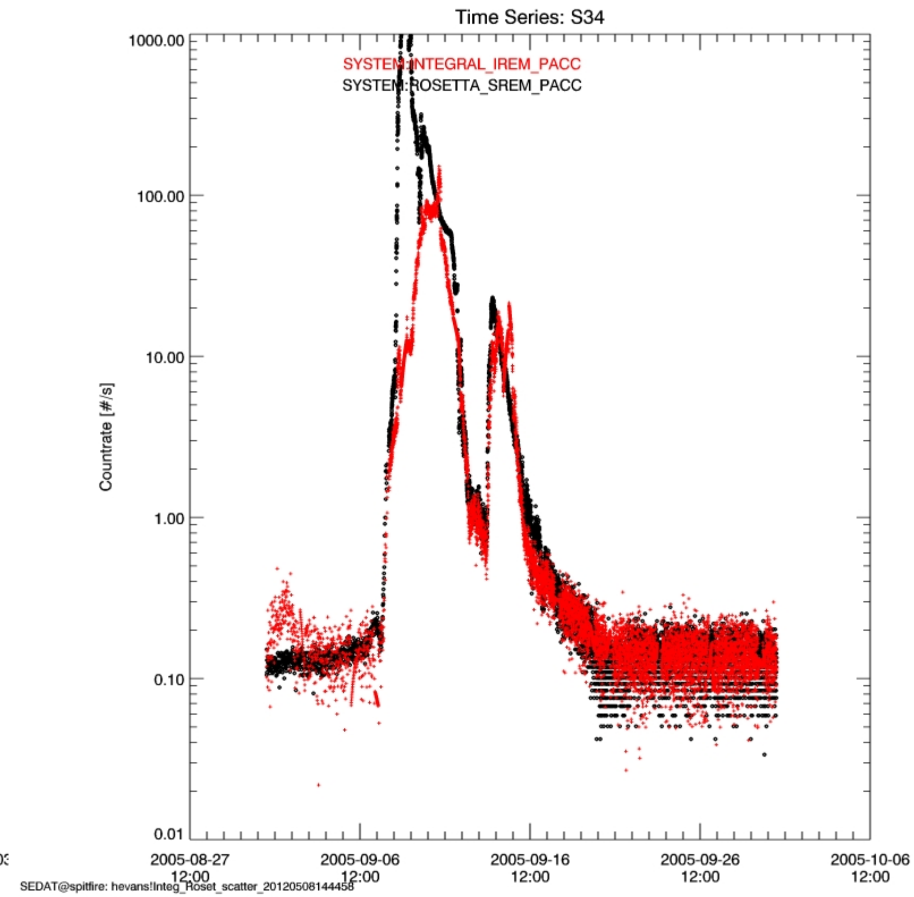
Proton Radiation Belt Validation - Anisotropy



Rosetta Experiences



Jan 2005

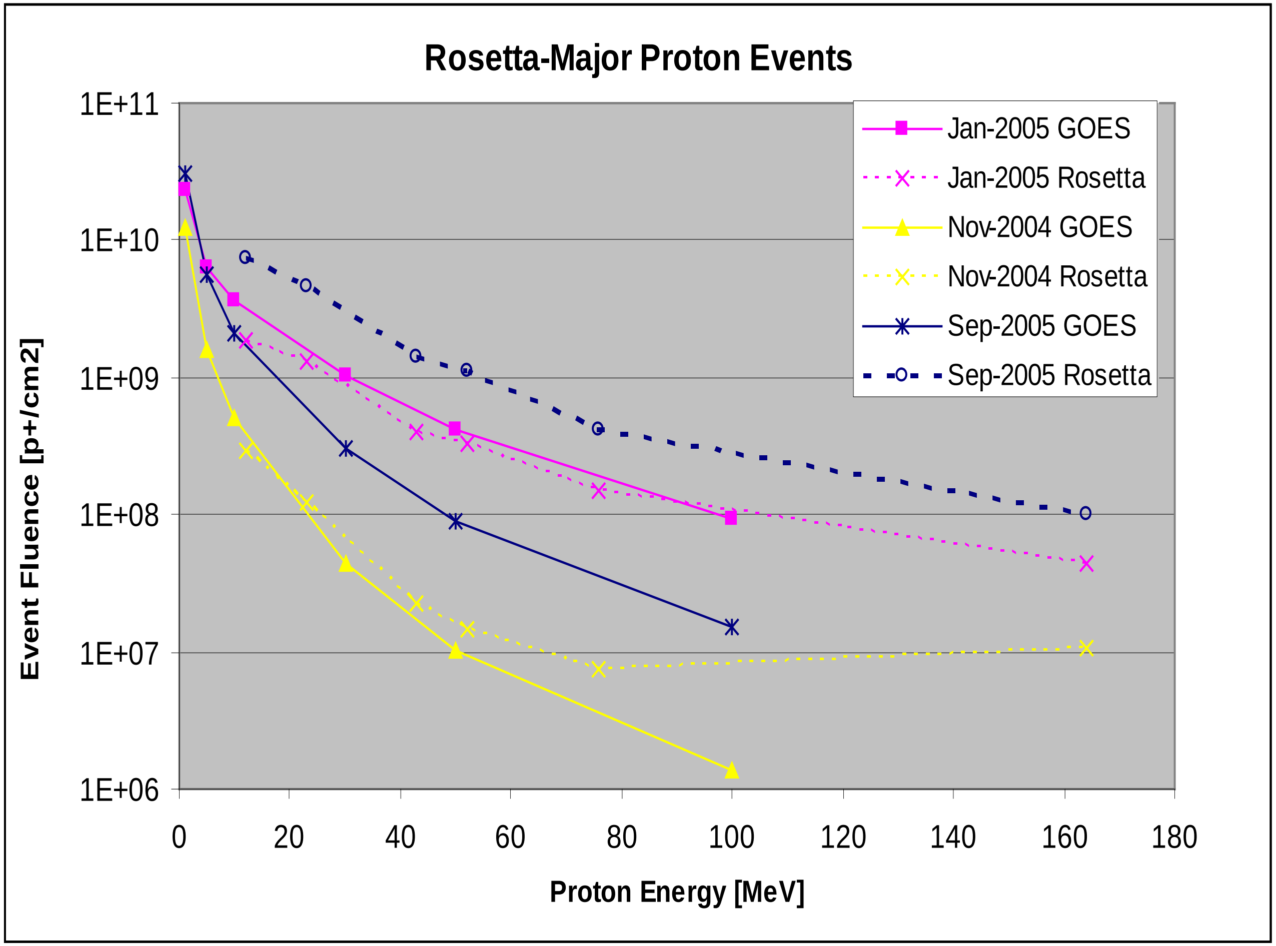


Sept 2005

Rosetta Experiences

Events in 2004 and Jan 2005 result in similar spectra for GOES and Rosetta/SREM. We can use these for cross calibration and extrapolation.

The Sept 2005 event, though shows a much harder hit at Rosetta than at Earth, demonstrating the need for in-situ measurements.

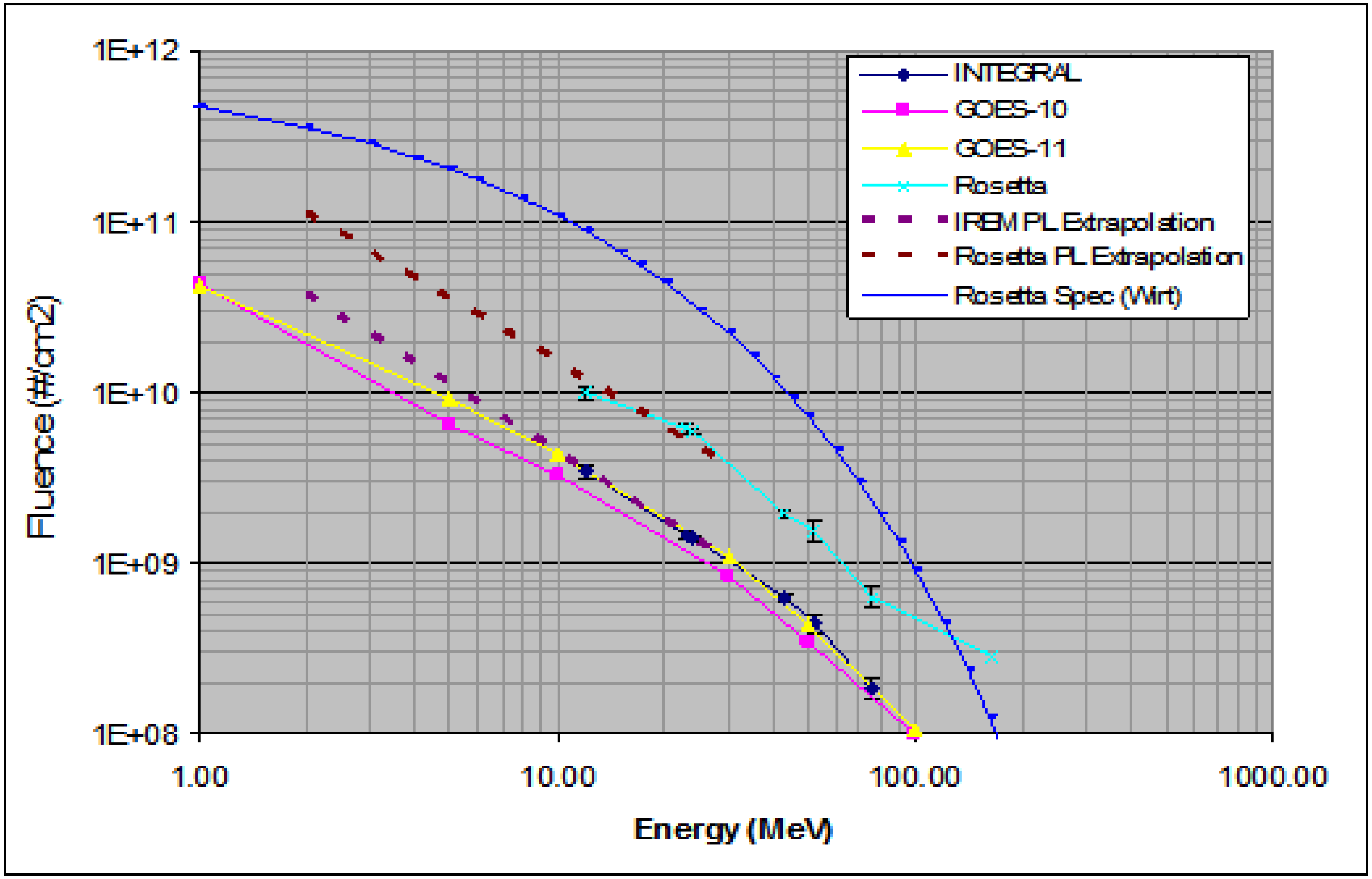


Rosetta Experiences

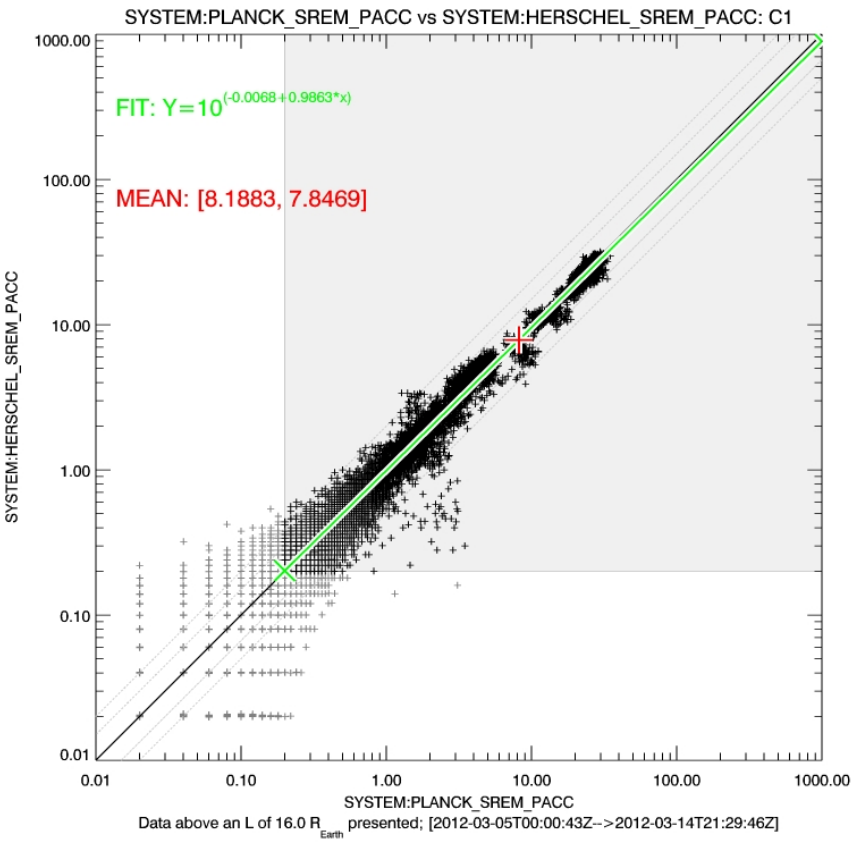
The different fluence spectra for the Rosetta Mission epoch (2004→2011).

A power law fit is used to extrapolate the Rosetta and Integral SREM data to lower energies.

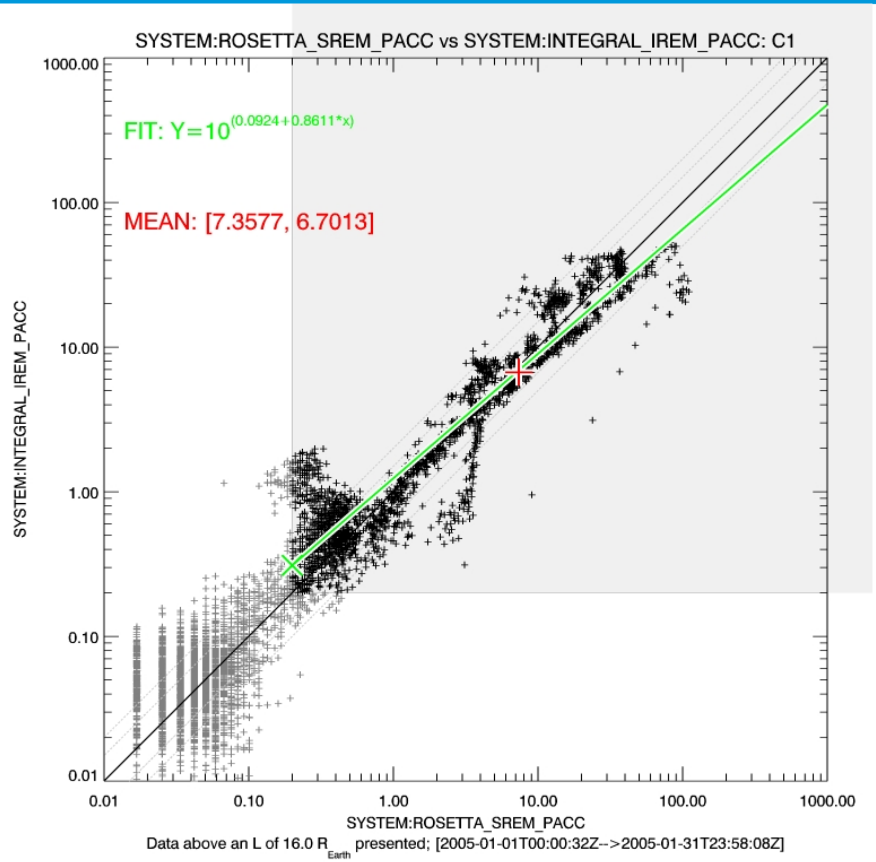
The Rosetta spectrum is ~5× higher than terrestrial measurements.



Inter calibration of Data



SEDAT@spitfire: hevans!scatterPlt_2012Mar_20120315115027



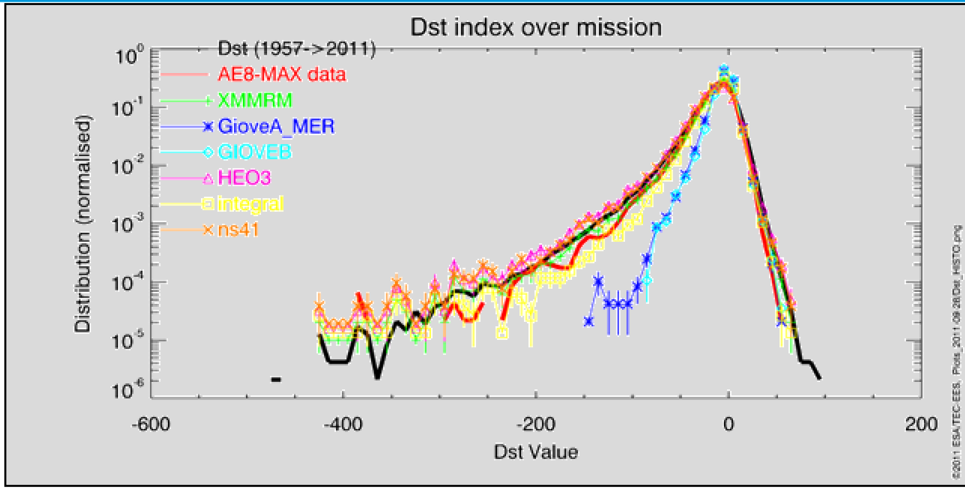
SEDAT@spitfire: hevans!Integ_Roset_scatter_20120508144723

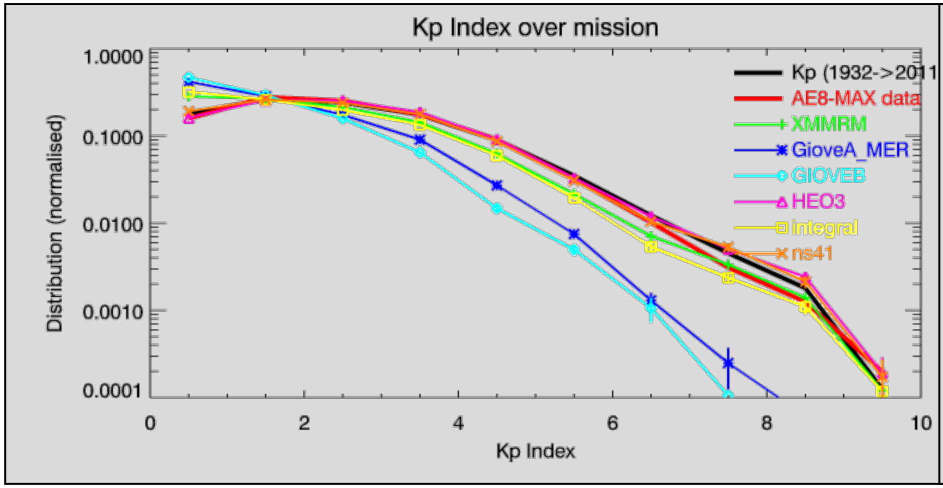
Calibrated vs Uncalibrated Data

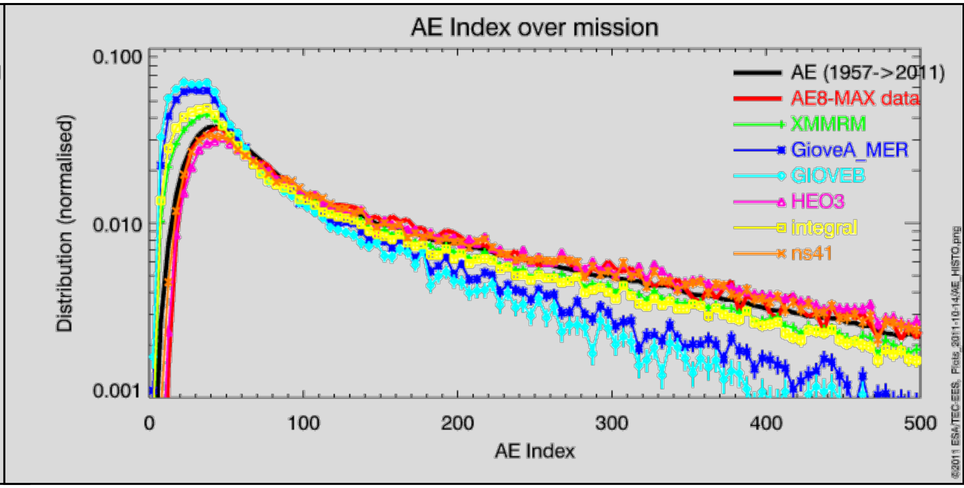
1. Raw count rate data with instrument response functions can be used for:
   a. model validation
   b. relative comparisons of the radiation environment state.
2. Calibrated data is essential for:
   a. developing radiation environment models
   b. determining derived effects
      (TID, NID, solar cell degradation, manned doses, etc.)
3. Calibrated data is essential for cross comparison of different instruments (at least one of the datasets has to be in physical units, e.g. $\#/cm^2/s$ to make use of the other instrument's response function.

Environment sample

Various datasets have been binned with magnetospheric indices to show how the magnetospheric states encountered over the dataset compares the long-term history of the magnetospheric indices.







Conclusions

1. The SREM instruments have provided a wealth of data throughout the magnetosphere and interplanetary space and have been seen to be exceptionally well inter-calibrated.
2. Use of the data has largely been with the raw count rate data, validating radiation environment models, but radiation effects have also been calculated to determine the health of spacecraft.
3. Uncalibrated data is of great use, but for full data exploitation, calibration to physical units is essential.
    a. The calibration algorithms must be comprehensively reported and available
    b. The errors in the calibrated data must be available
4. More data is always needed:
    a. For operational reasons
    b. to constantly improve the historical record of the radiation environment