Energetic particle background observed in X-ray silicon detectors of SphinX experiment

S. Gburek, J. Sylwester, M. Kowalinski, M. Siarkowski, J. Bakala, P. Podgorski, W. Trzebinski, S. Plocieniak, F. Farnik, S. Kuzin, F. Reale

SRC PAS - Space Research Centre Polish Academy of Sciences Wroclaw, Poland

MECHELEN, June 2010

OUTLINE

Solar Photometer in X-rays SphinX
general description

SphinX shielding simulations
with SPENVIS

SphinX - team

SRC PAS:

Principal Investigator: **Janusz Sylwester**
Project Manager: **Mirek Kowalinski**
Project Constructor: **Jarek Bąkała**
Project Scientist: **Szymon Gburek**
Co-I: **Marek Siarkowski, Barbara Sylwester, Zbigniew Kordylewski, Piotr Podgórski, Witold Trzebiński, Stefan Płocieniak, Anna Kępa**

FIAN:

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MEPhI:

Yury Kotov, CORONAS-Photon Project Manager, SphinX Co-I

AI CzAS:

Franta Farnik, SphinX Co-I

INAFA, Palermo University:

Fabio Reale, SphinX Co-I

UCL, London:

Ken Phillips, SphinX Scientist Co-I

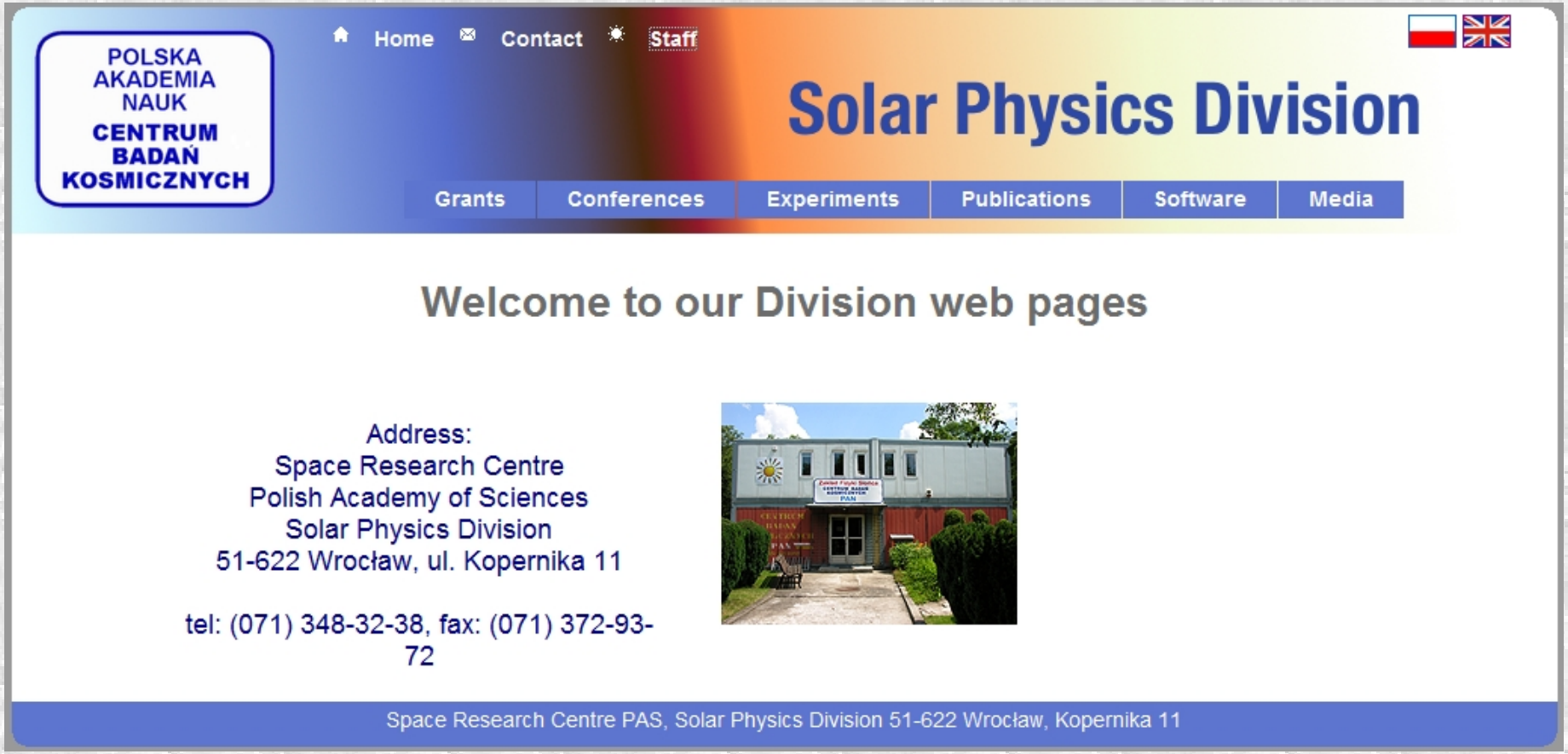
NASA GSFC:

Brian Dennis, SphinX Scientist Co-I

SPACE RESEARCH CENTER
POLISH ACADEMY OF SCIENCES
WARSAW

SOLAR PHYSICS DIVISION
WROCLAW

SOLAR PHYSICS DIVISION, SRC PAS – WROCLAW
the website



http://www.cbk.pan.wroc.pl/
http://www.cbk.pan.wroc.pl/?l=EN&act=1 English

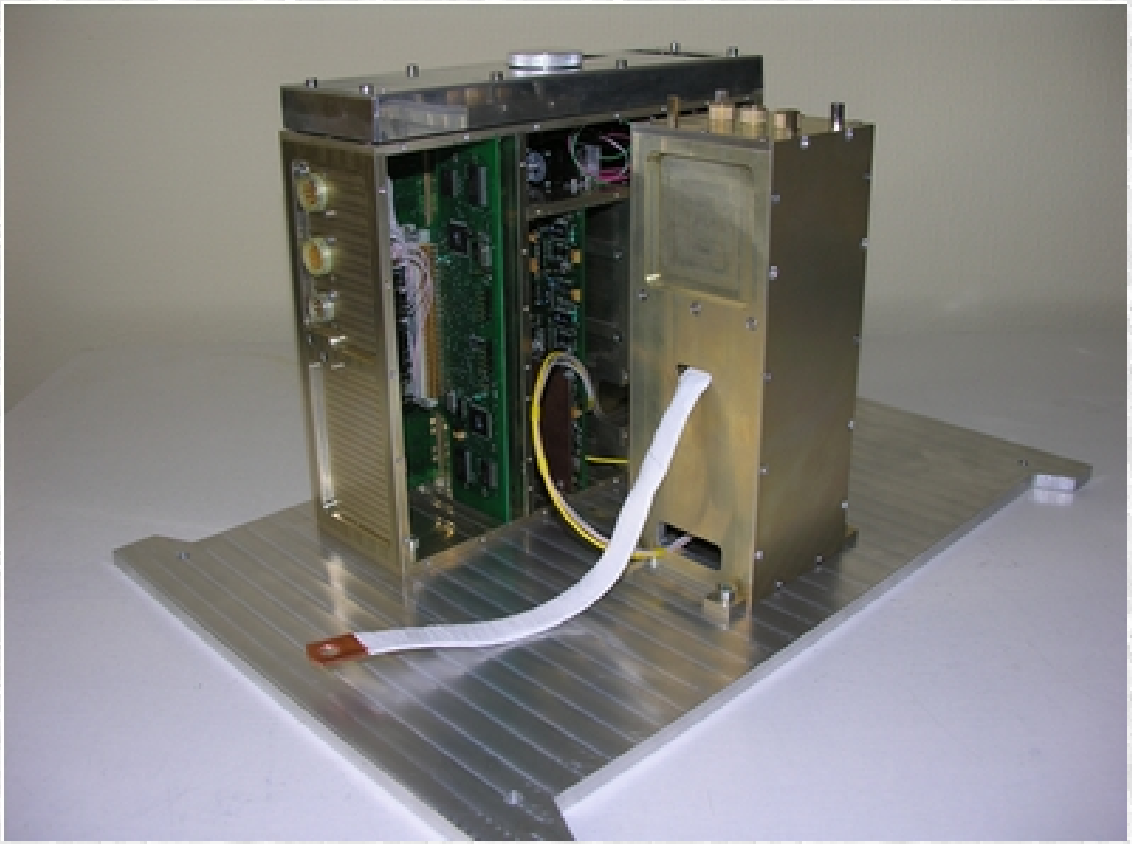
SphinX instrument

Basic characteristics

Mass 3.7 kg

Power 10 W

Telemetry – 60MB a day

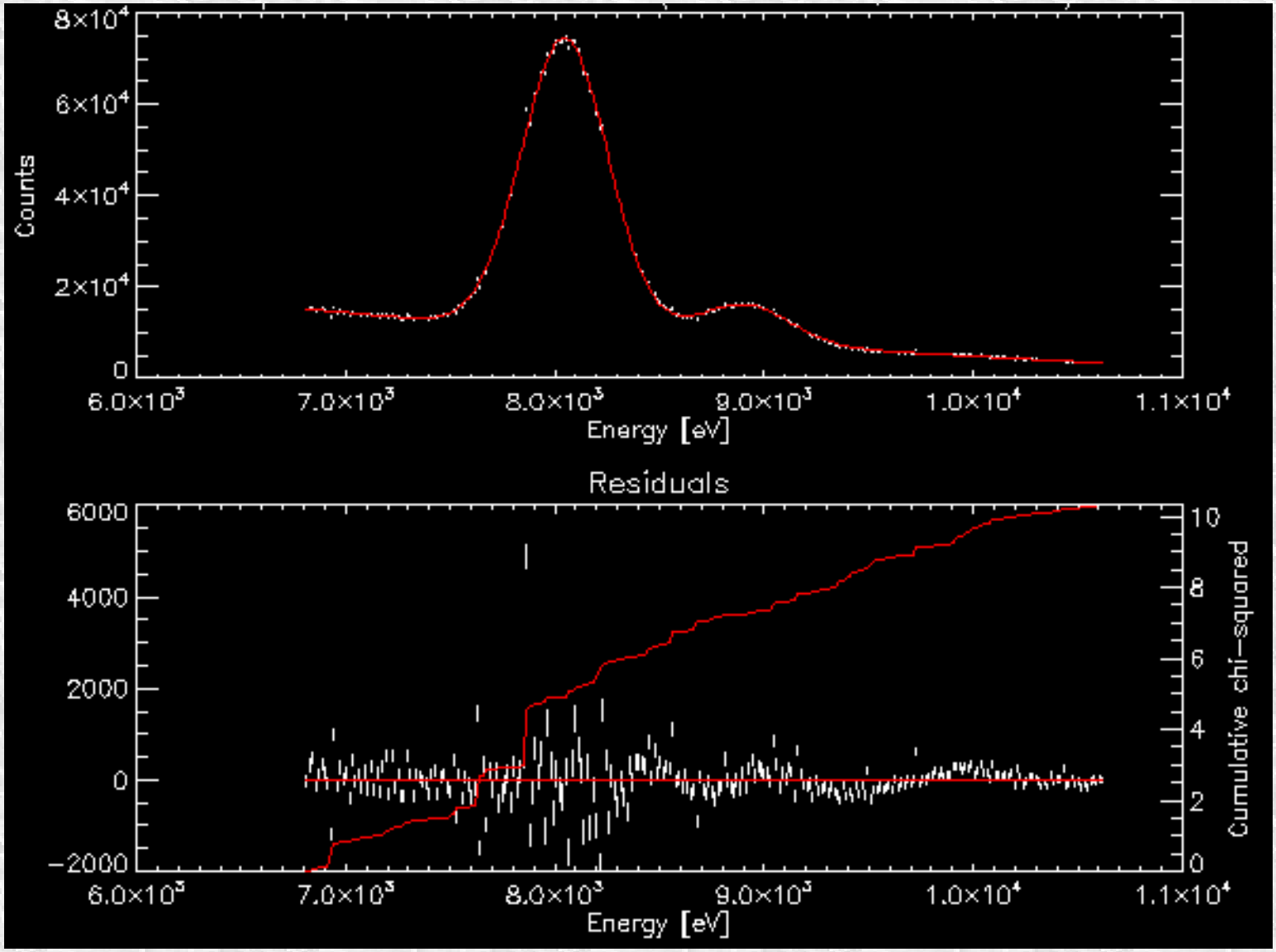


Launched on CORONAS-Photon satellite on
January 30, 2009 at 13:30 UT
from the Plesetsk Cosmodrome, northern Russia.
End of mission 29 November 2009

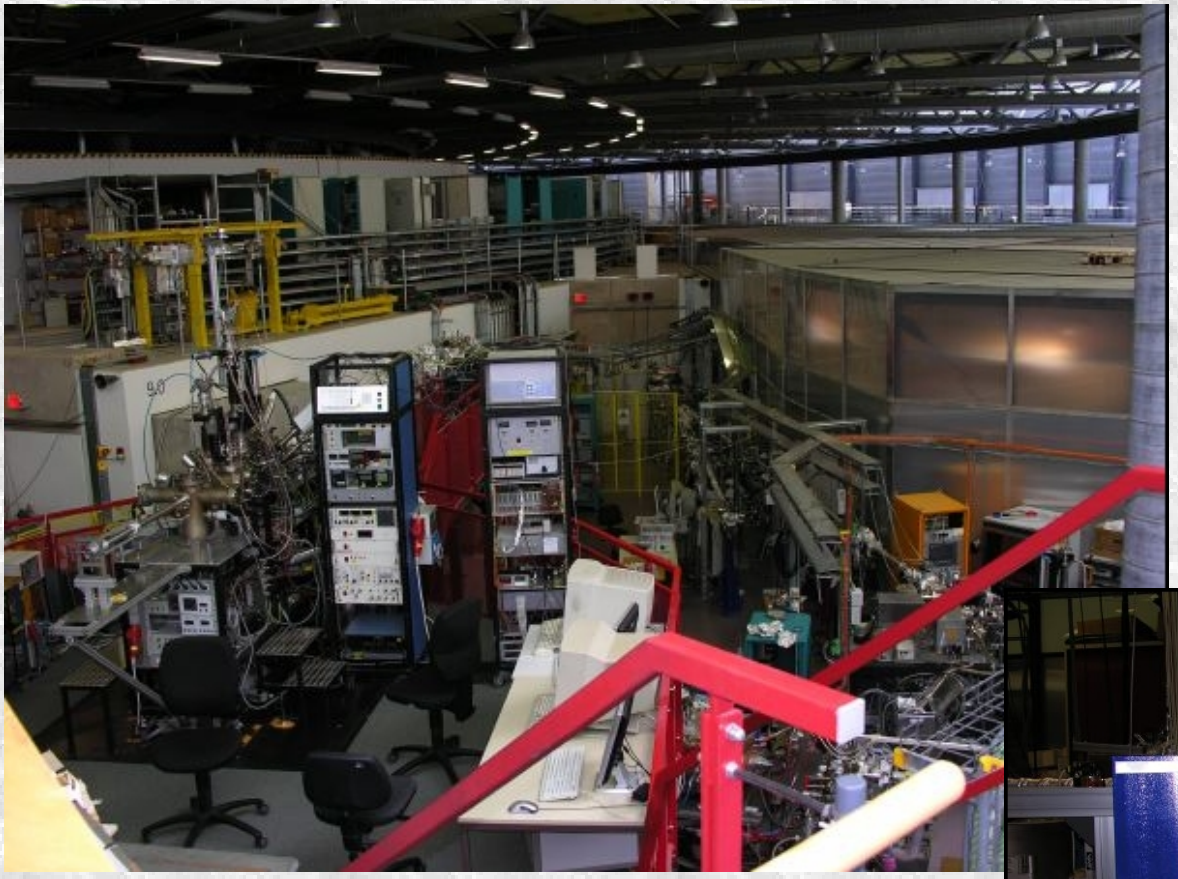
Calibration of SphinX at XACT – Palermo

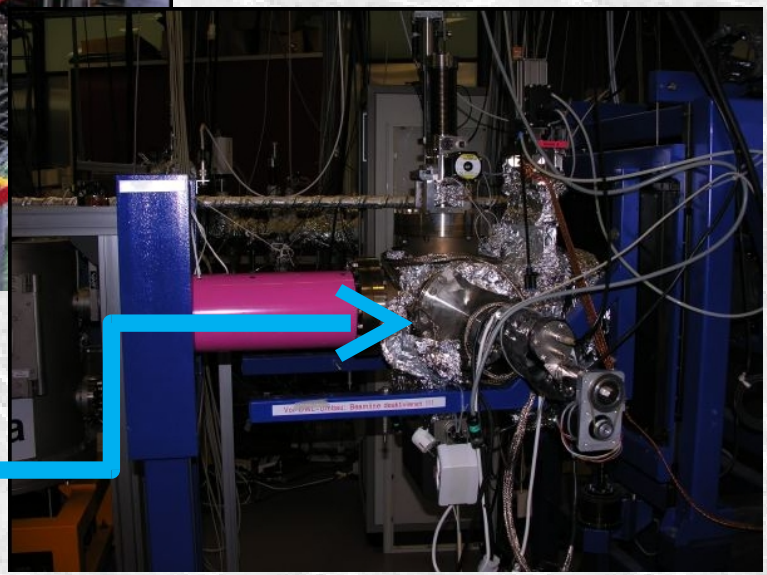
October 2007

Example of SphinX spectrum recorded at XACT



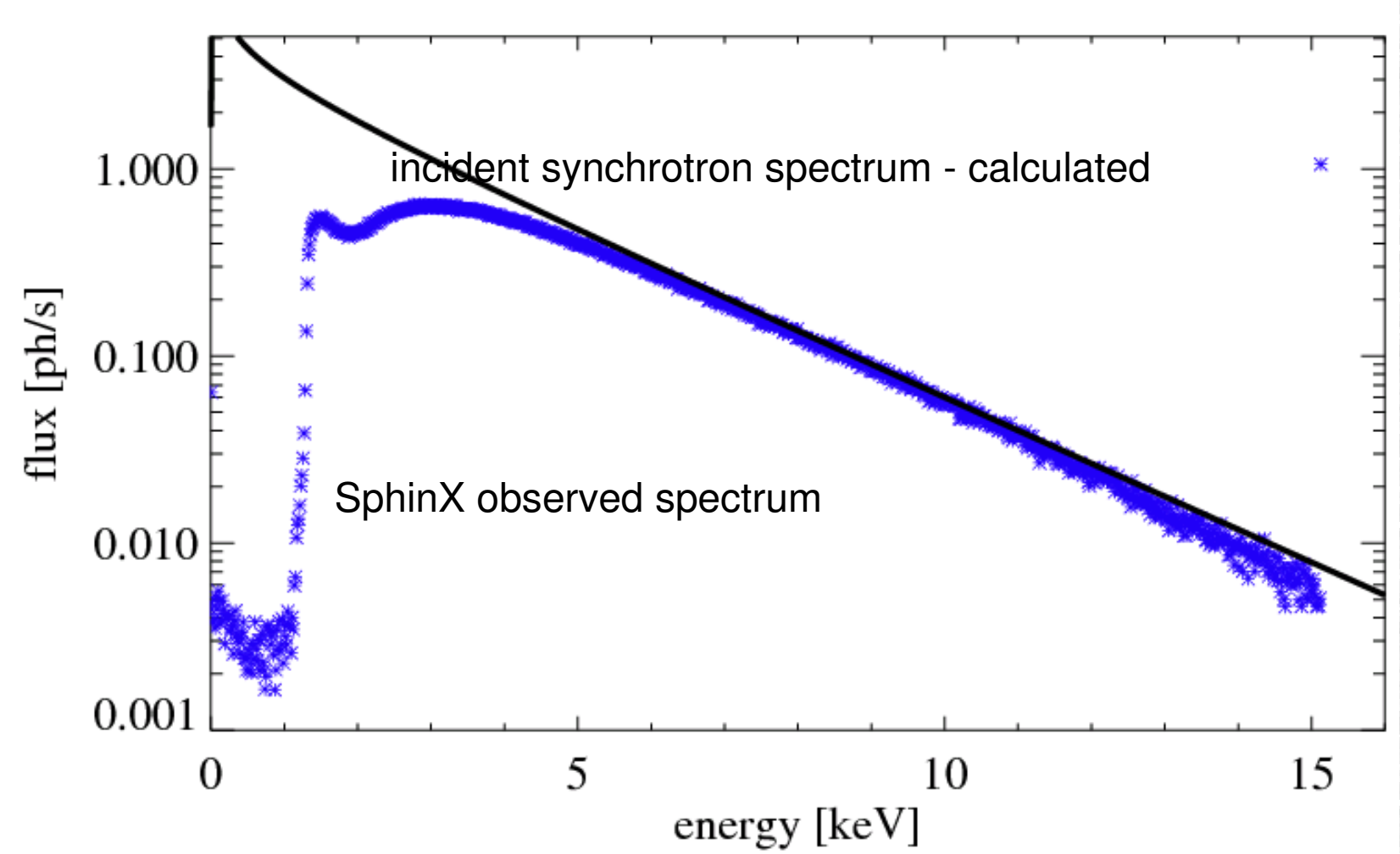
Calibration of SphinX at BESSY II – Berlin – Feb/Mar 2008



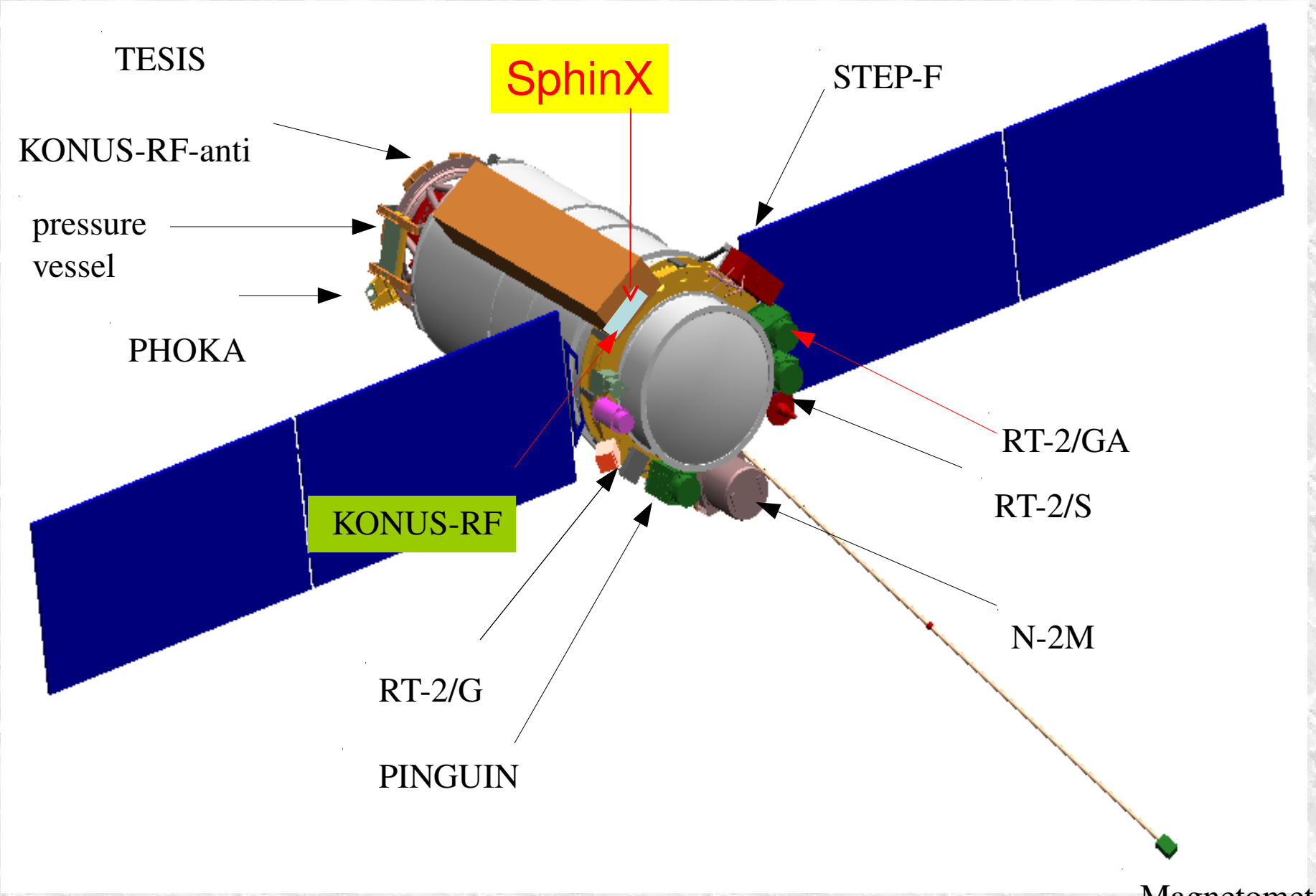


Vacuum chamber with SphinX

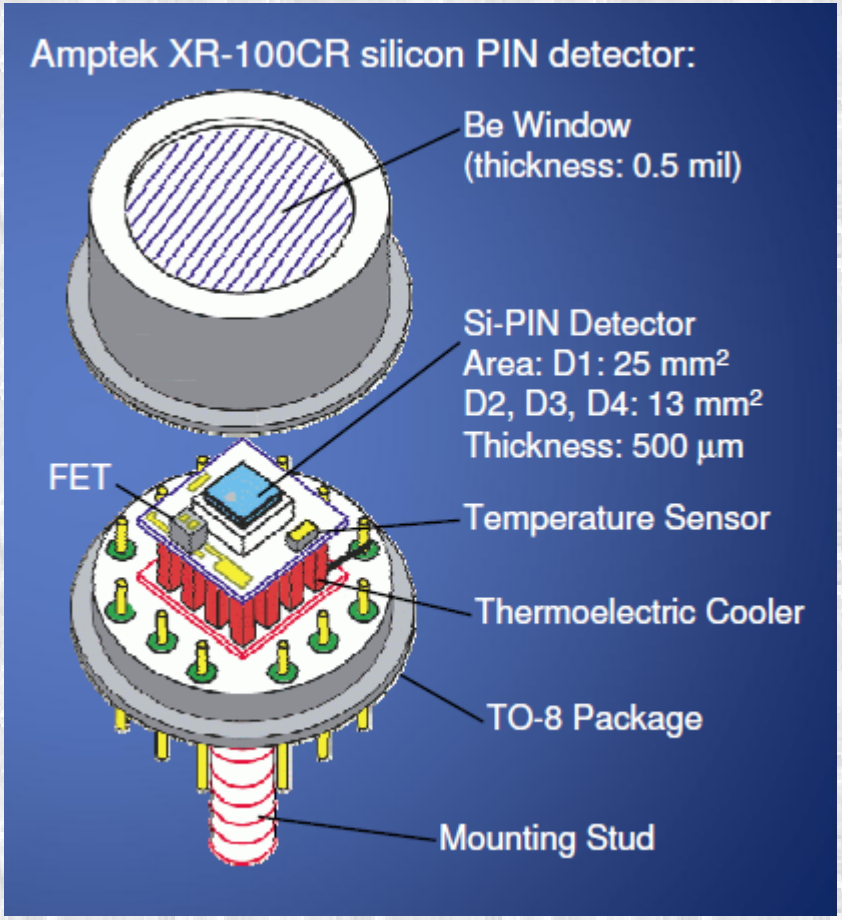
BESSY II synchrotron calibrations



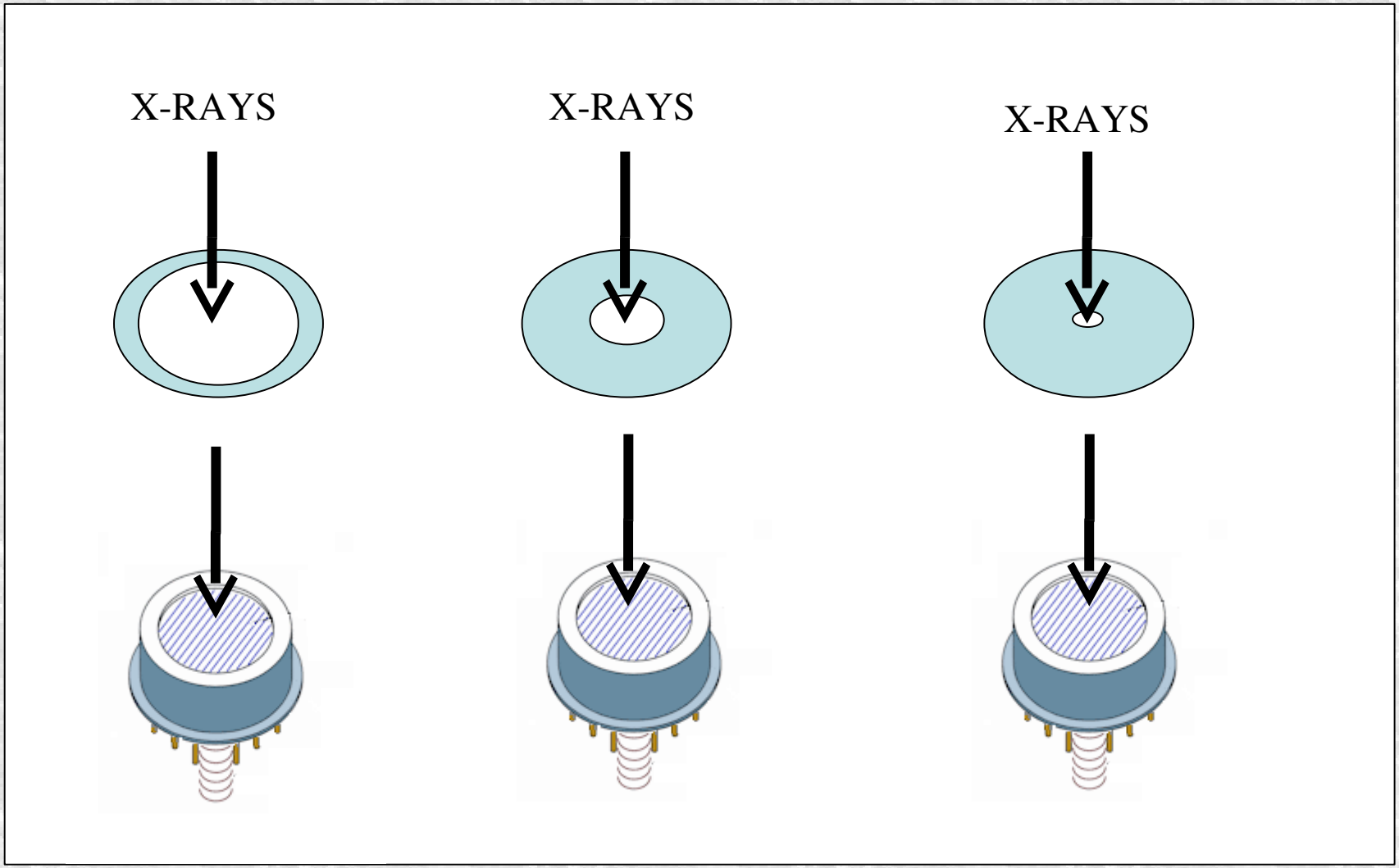
CORONAS – PHOTON satellite



SphinX detectors



SphinX main measurement channel and operation principle



Three PIN-diode detectors with decreasing appertures are used to cover 7 orders of variability of solar X-ray flux magnitude.

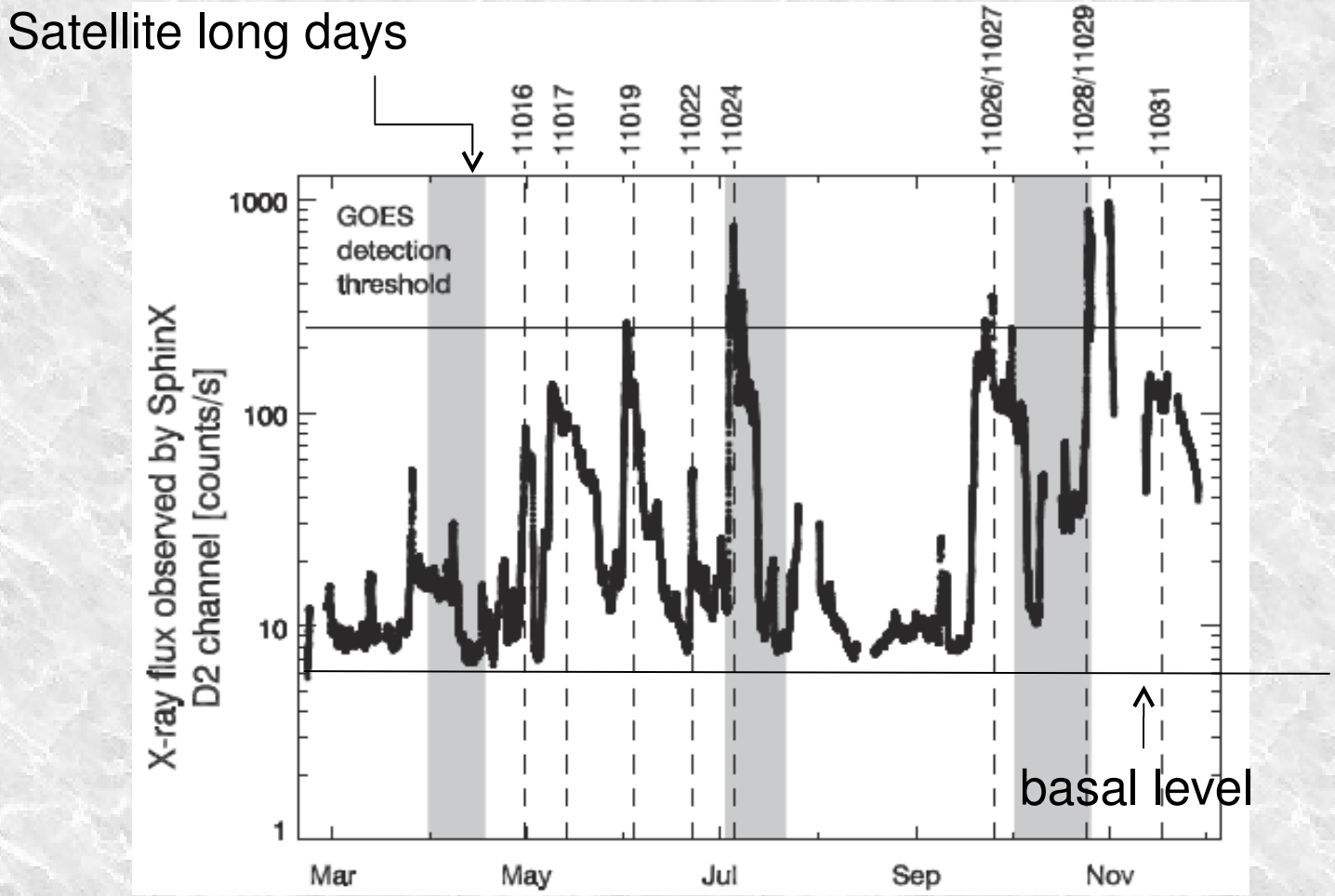
Data coverage

February 20, 2009 – November 29, 2009

Low solar activity

Data from D1 and D2 detectors only

Mission long plot of solar X-ray flux as seen by SphinX



Example of SphinX standard data product

Telemetry raw data

Level 0 data

SphinX data types

spectra
lightcurves
events sequences
0.85 keV -15 keV

Meta data

Level 1 data - FITS format

VSO, EVSO Level 1 data (FITS)

SphinX data catalogue

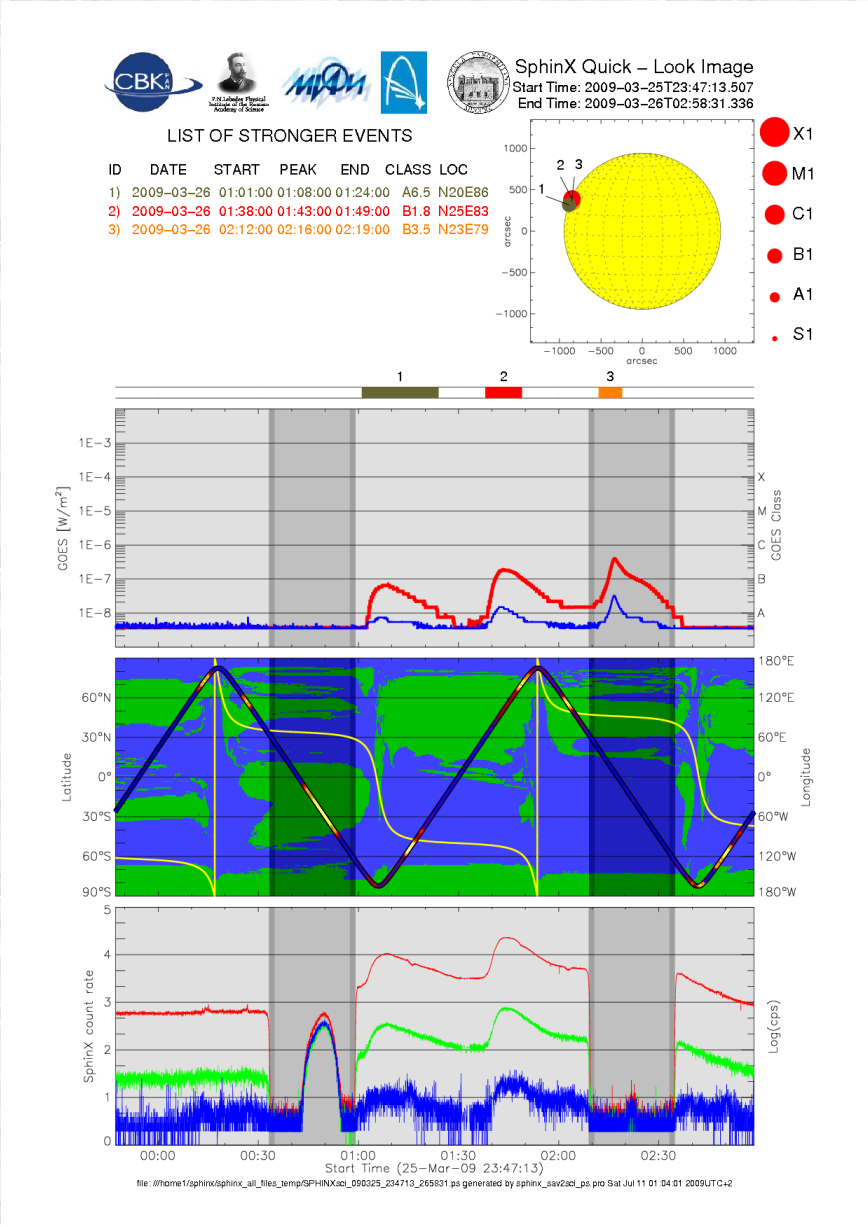
All SphinX data available here are not reduced, level 0 - telemetry data.

2009																															
January	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
February	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
March	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
April	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
May	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
July	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
October	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
December	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

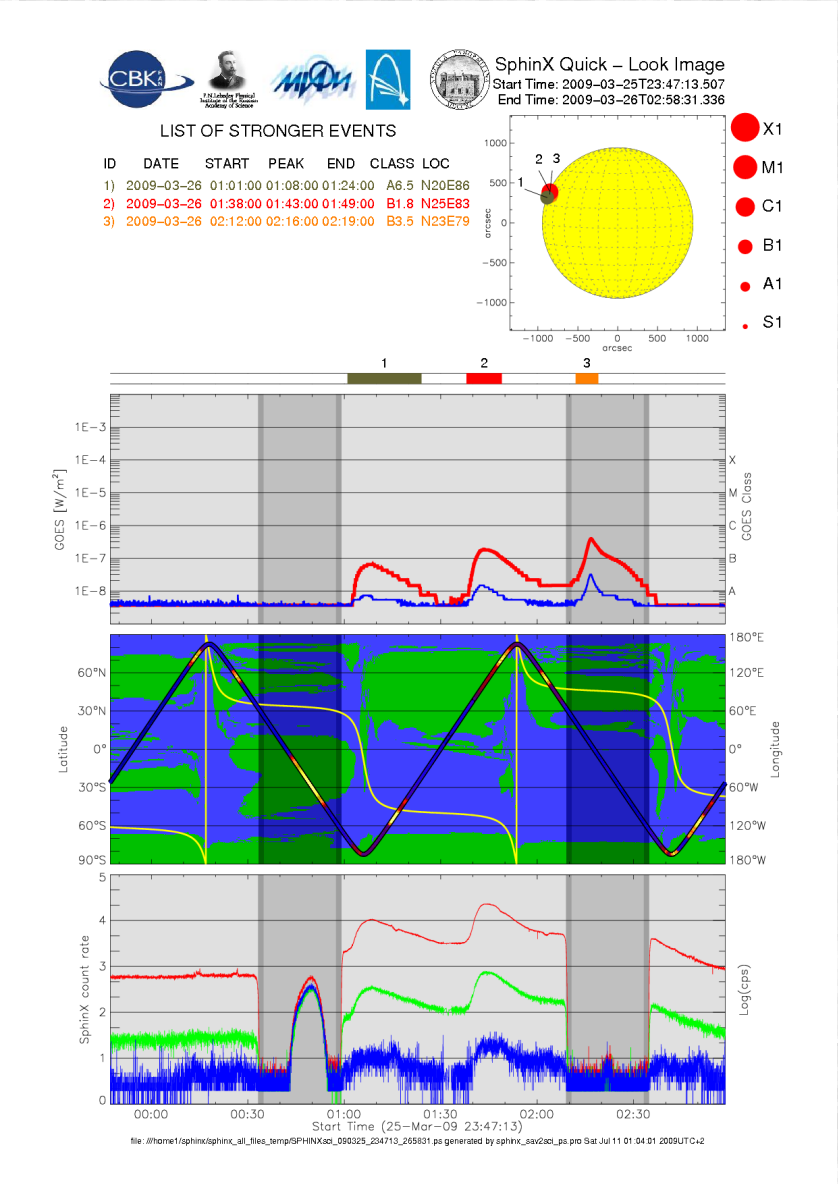
http://156.17.94.1/sphinx_catalogue/SphinX_cat_main.html
(all SphinX data can be downloaded from this site)

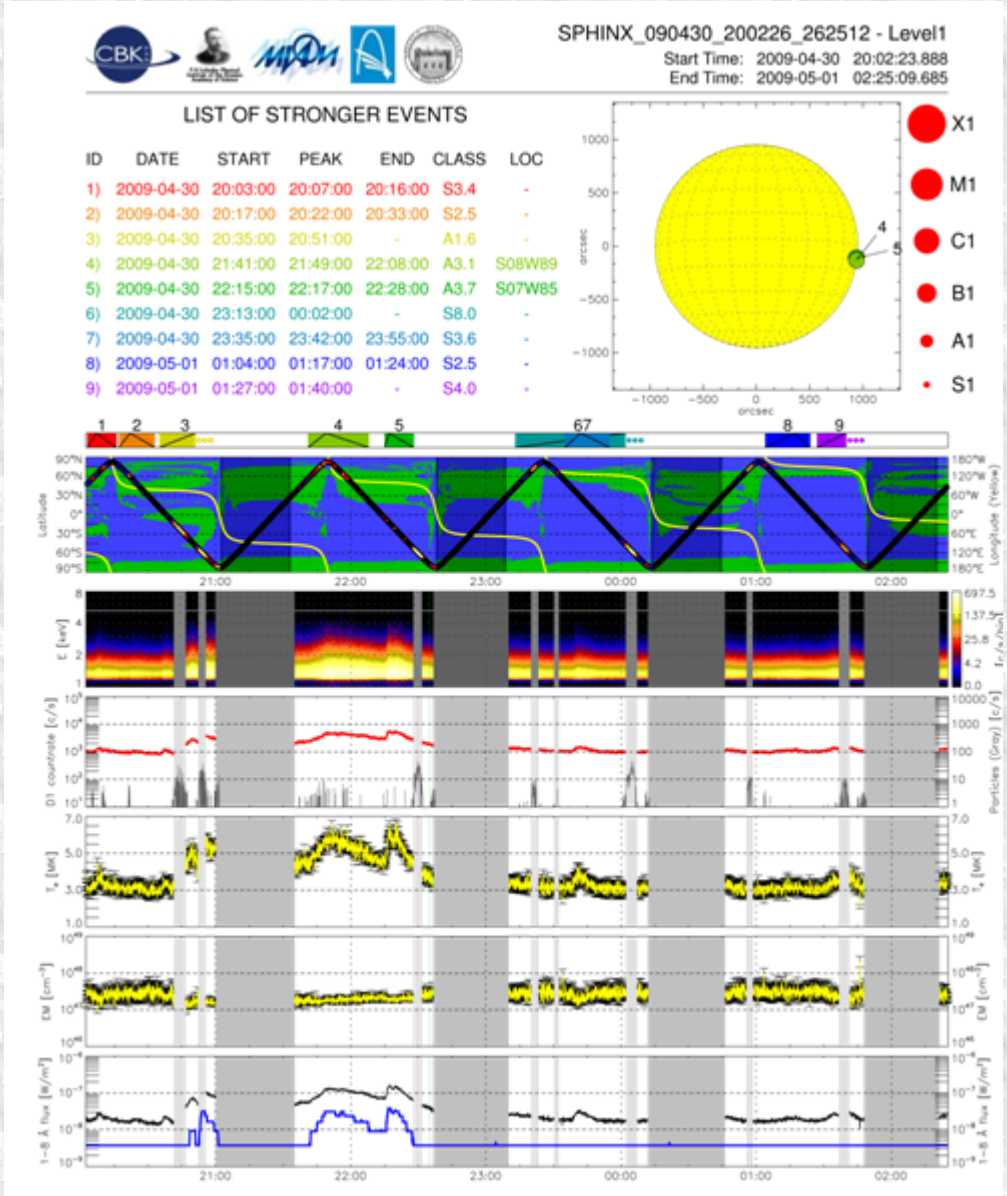
An example of plots available in SphinX catalogue

SphinX summary plot
Includes information from SphinX, GOES, orbit data and SphinX events/flare catalogue



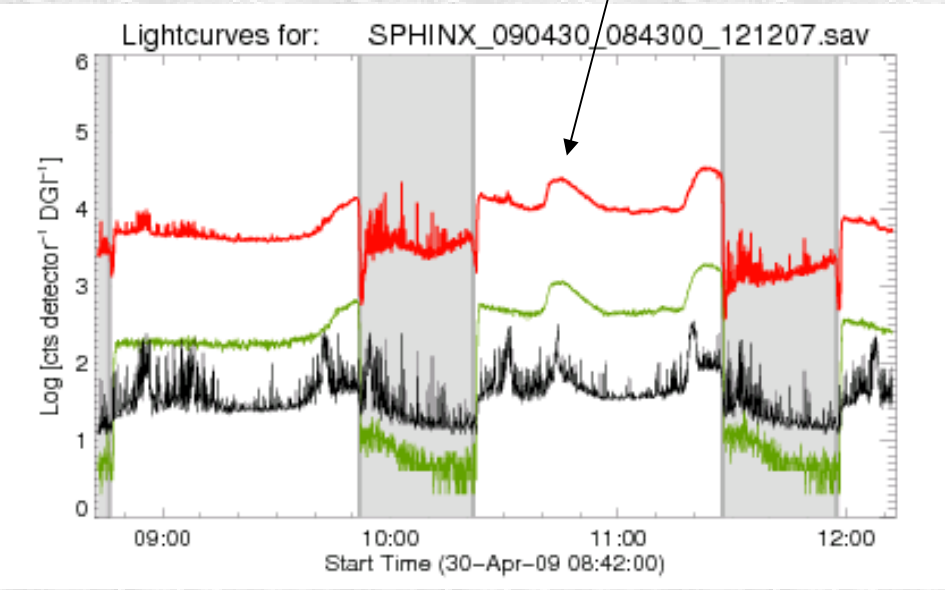
Going from level 0 to level 1 data - 40% done

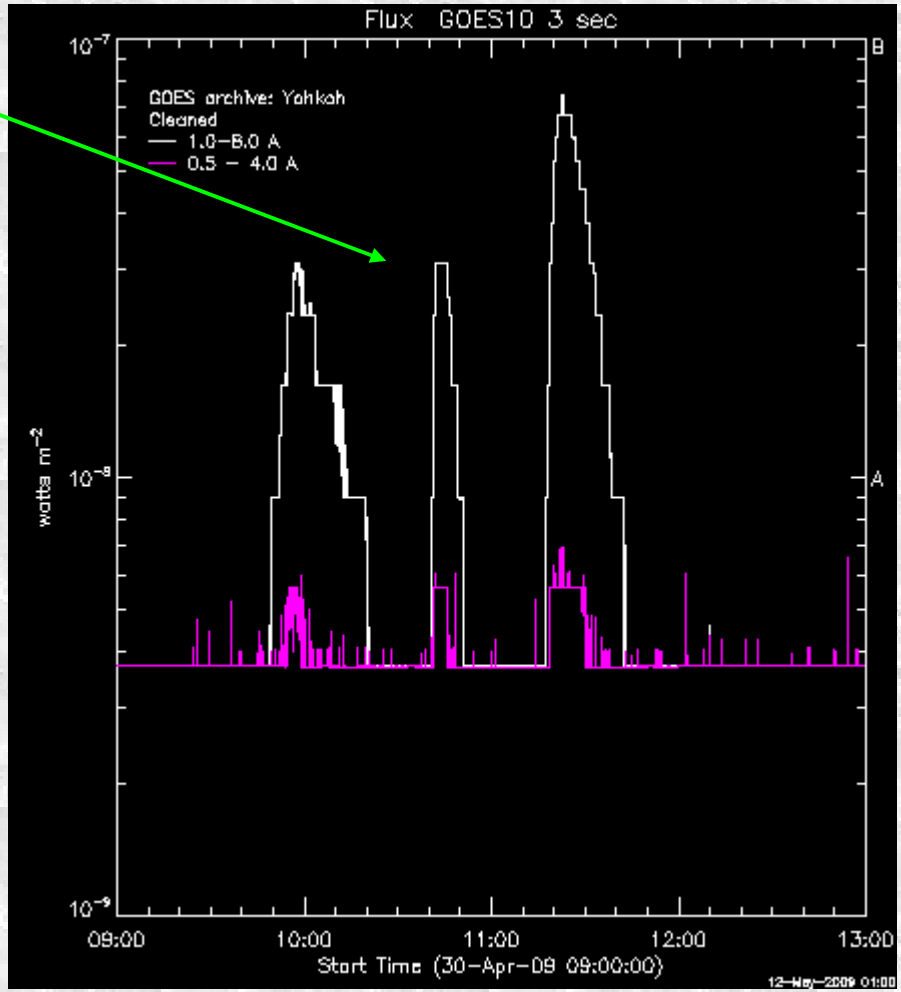




SphinX vs GOES observations

Goes A3.1





SphinX is about ~30 times more sensitive than GOES

Energetic particle contribution to SphinX observations

Particle signal – usually in the last energy channel

RB and SAA, GCR, SEPs

Depends on solar cycle phase

Effects on electronics/detectors

Cumulative effects

Ionising effects surface/volume charging of components, spourious signal increse etc...

Non ionising effects — energy deposit in component volume, changes in element structure, voltage distribution, loss of efficiency, loss of charge transfer efficiency.

Single particle hit effects

spurious signal, memory cell/procesor upsets, entire system operation failure.

SEU – single event upset temporary, reversible

SEL – single event latch-up permanent

SphinX shielding simulations with SPENVIS

Early development phase

Estimate minimum shielding necessary for an experiment

Construction details and overall geometry of the system known

Is additional shielding neccessary?

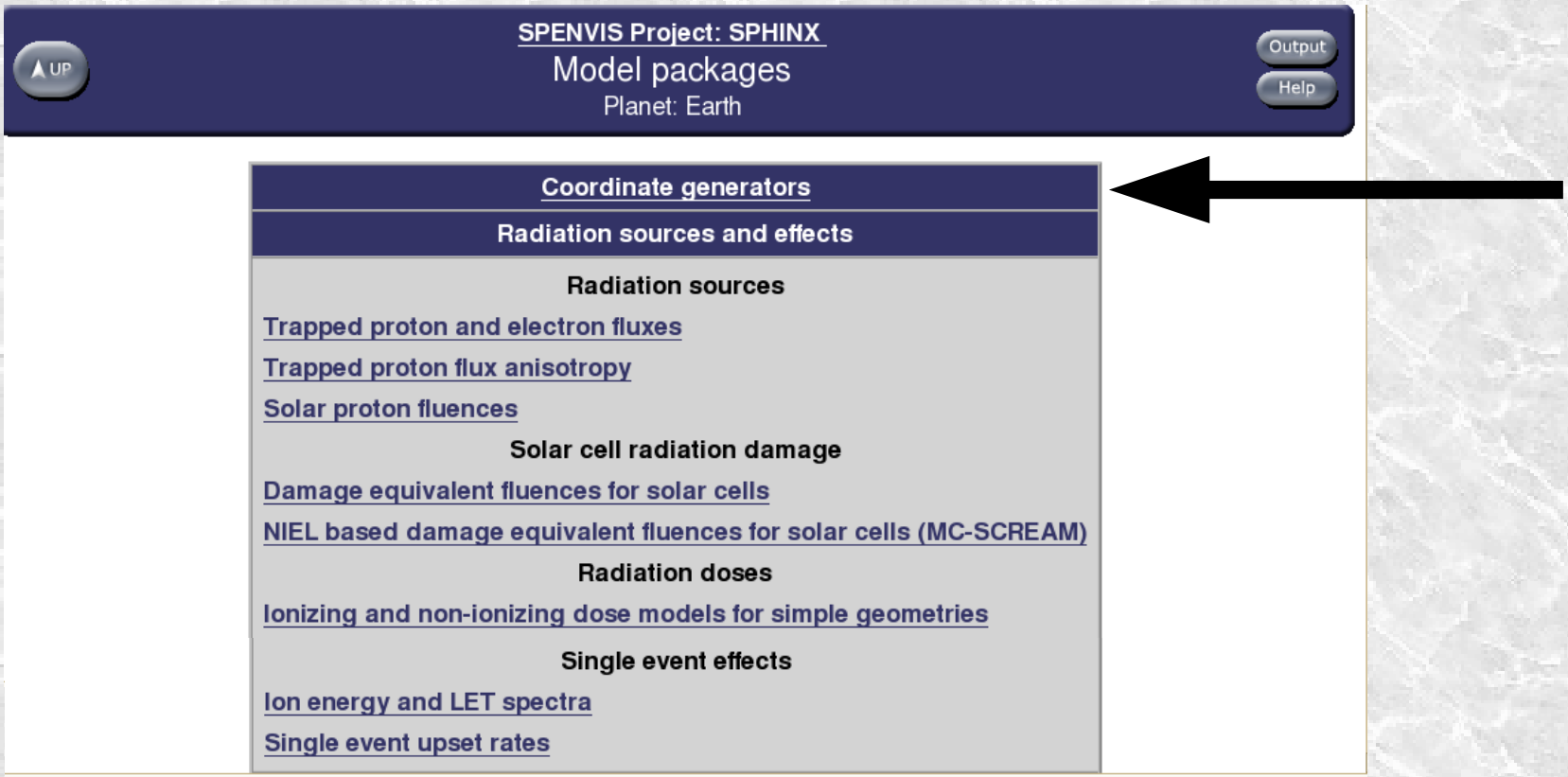
Cumulative effects

DOSES — to compare with allowable limits for componens used

Single particle hit effects

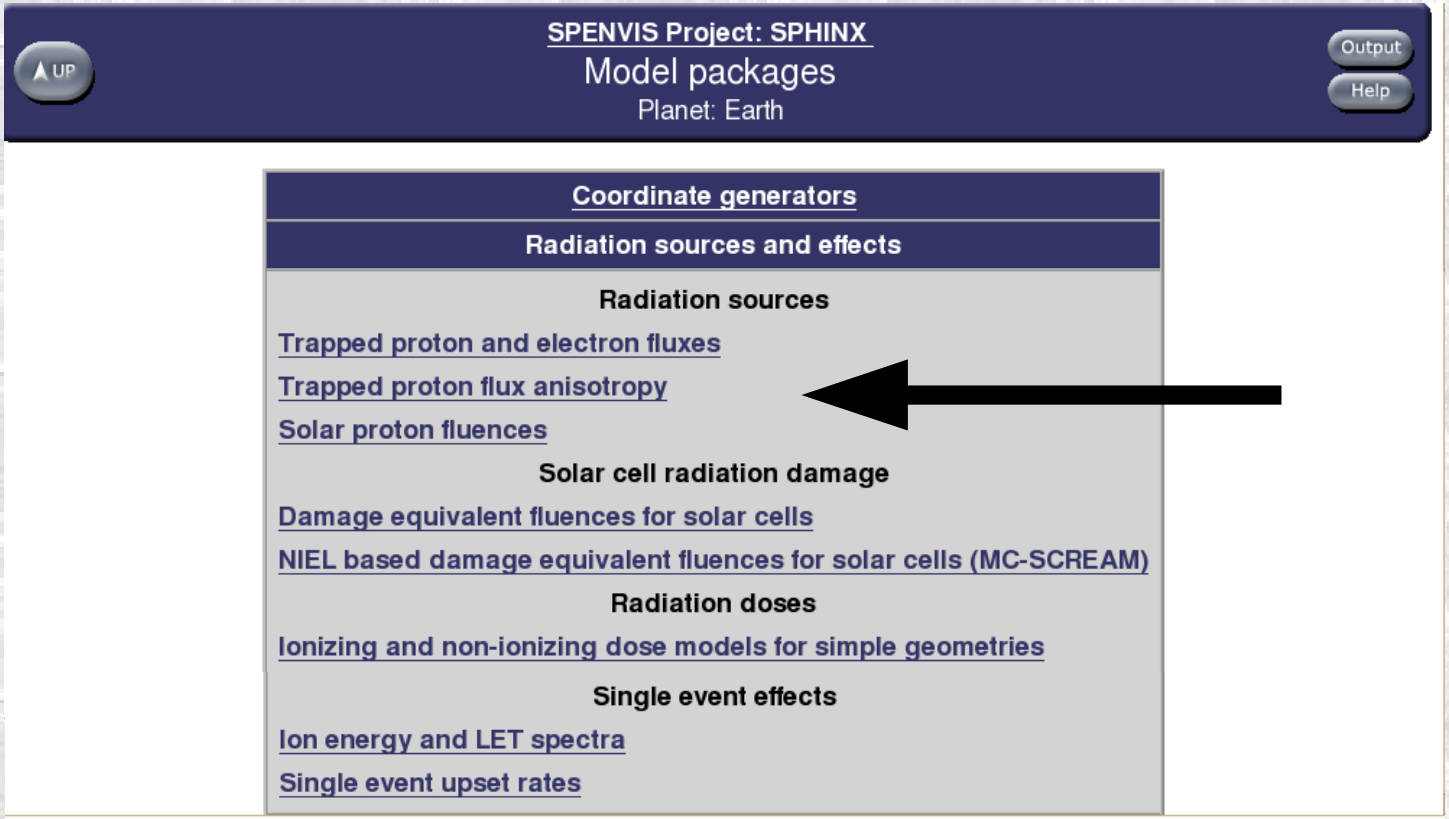
Rates/Probability of occurence

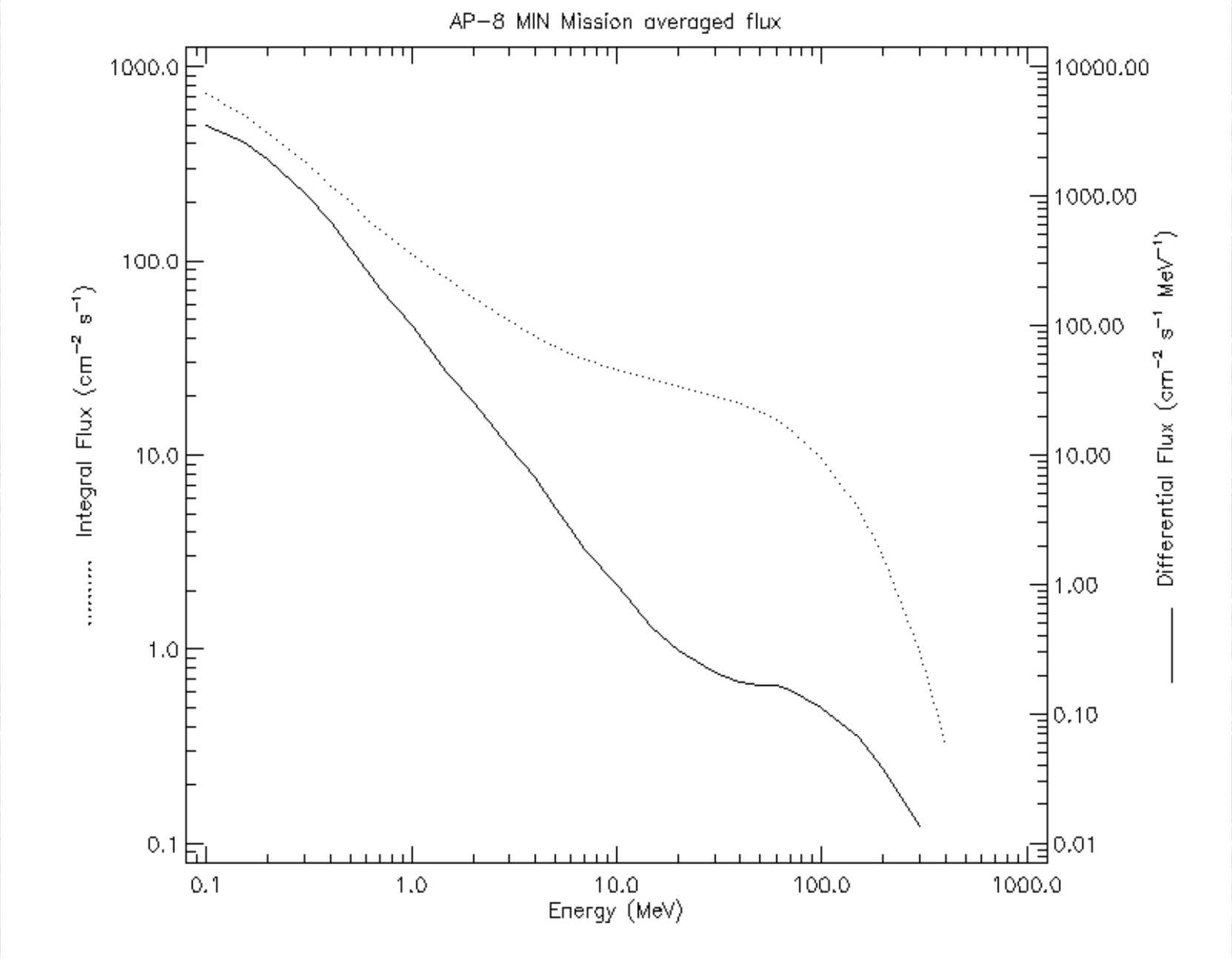
SphinX shielding simulations with SPENVIS

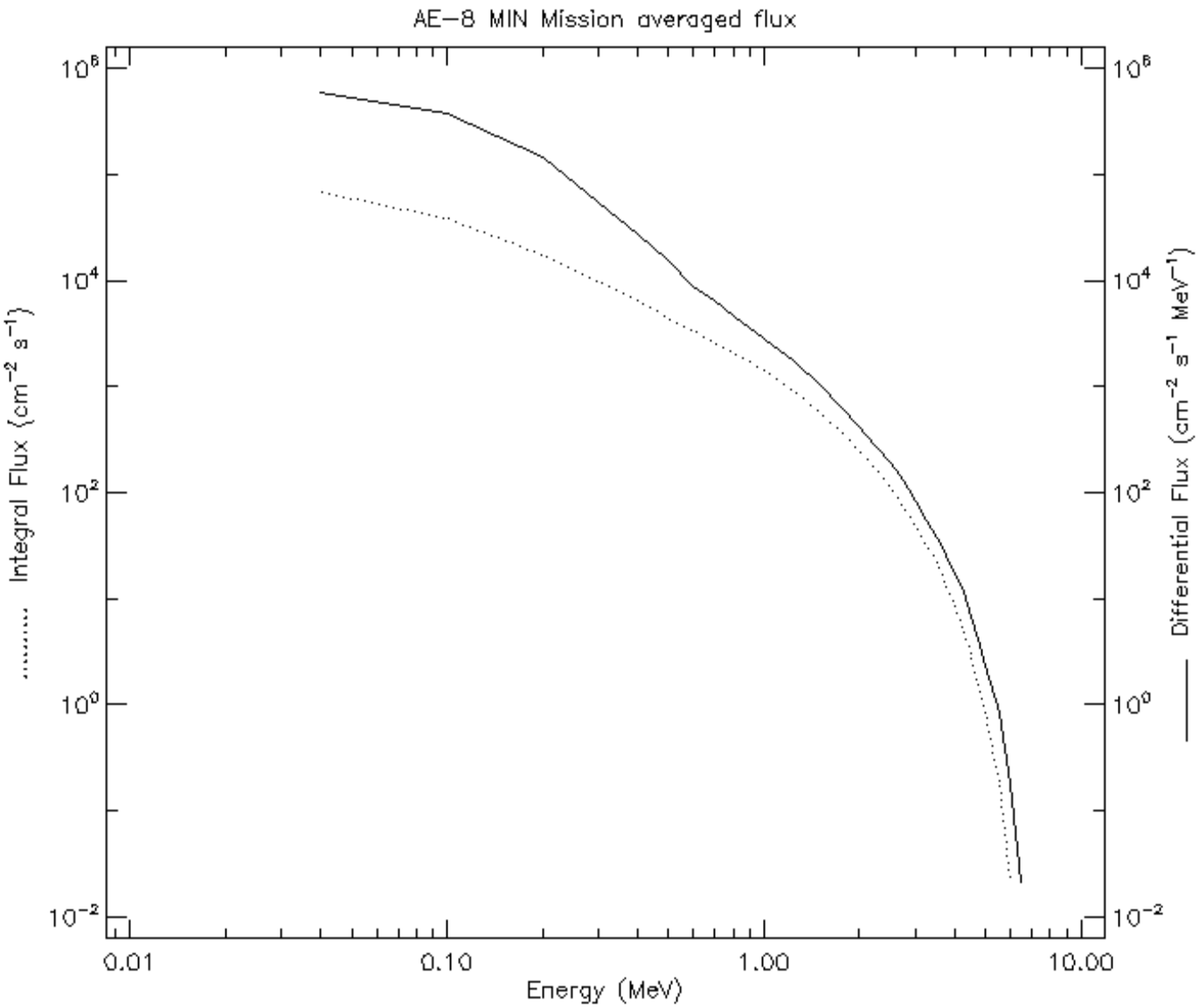


Orbit - height 500, inclination 82,5°

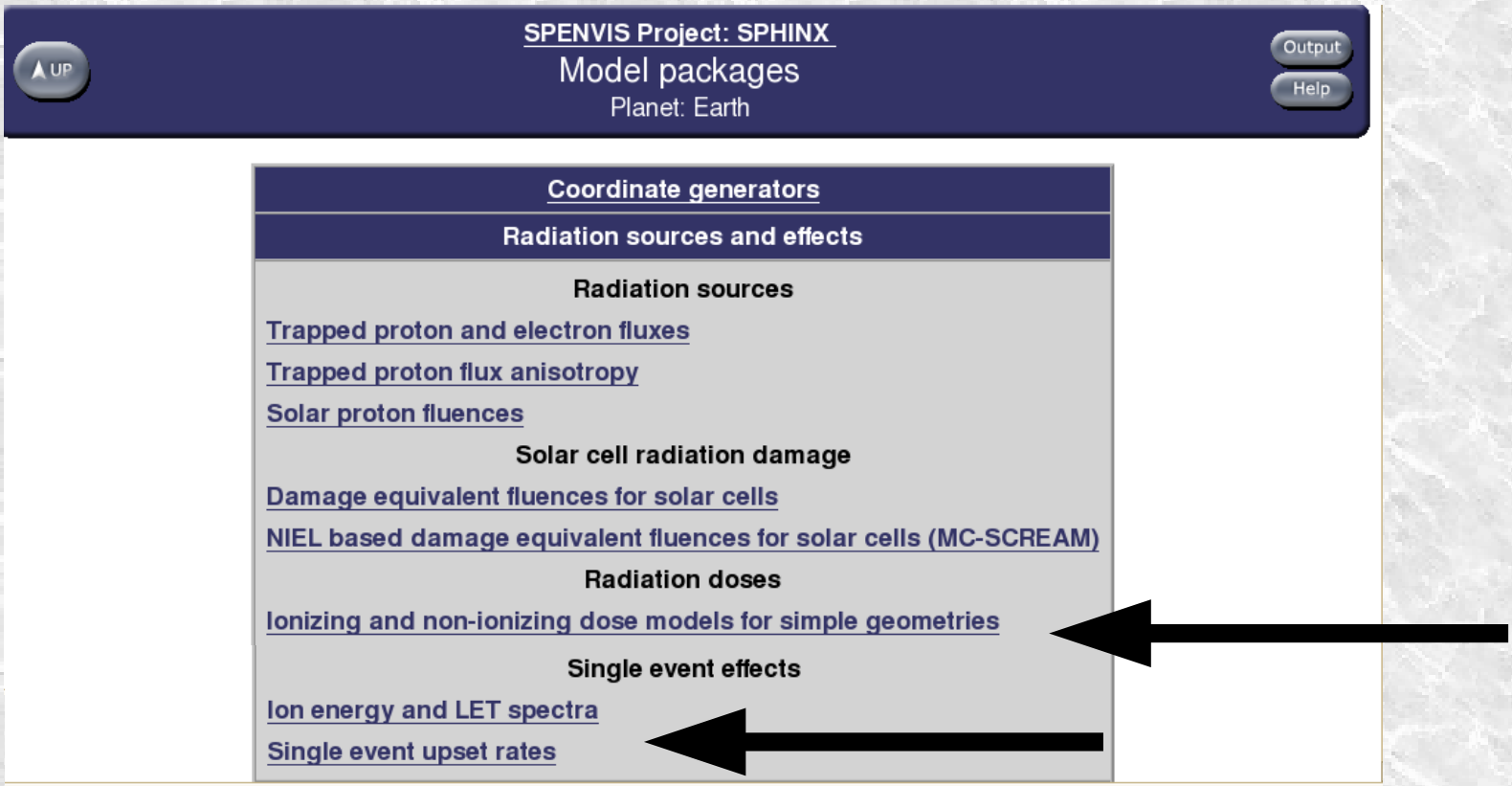
SphinX shielding simulations with SPENVIS




AP-8 MIN Mission averaged flux
1000.0
100.0
10.0
1.0
0.1
Integral Flux (cm^{-2} s^{-1})
10000.00
1000.00
100.00
10.00
1.00
0.10
0.01
Differential Flux (cm^{-2} s^{-1} MeV^{-1})
0.1
1.0
10.0
100.0
1000.0
Energy (MeV)


AE-8 MIN Mission averaged flux
Integral Flux (cm^{-2} s^{-1})
Differential Flux (cm^{-2} s^{-1} MeV^{-1})
Energy (MeV)
10^6
10^4
10^2
10^0
10^{-2}
0.01
0.10
1.00
10.00

SphinX shielding simulations with SPENVIS



DOSES

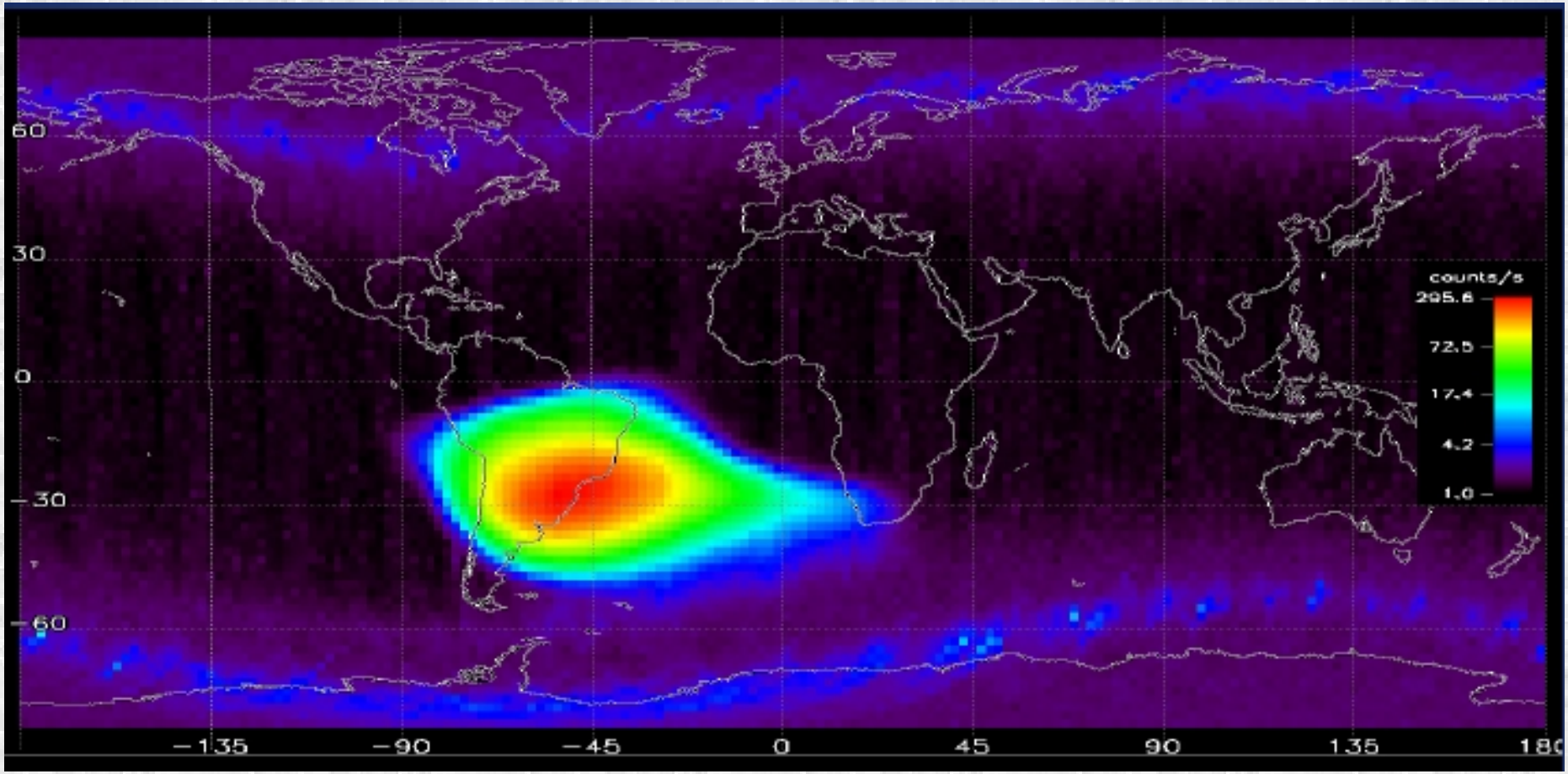
SphinX electronics component tolerance 5.10^3 - 1.10^4 rad

SPENVIS calculated doses (3years) $1.0.10^3$ rad

SEU – single event upset
Maximum two per day per instrument

Observations of energetic particle distribution at SphinX orbit

(particle signal comes from the highest energy chanell of SphinX detectors)



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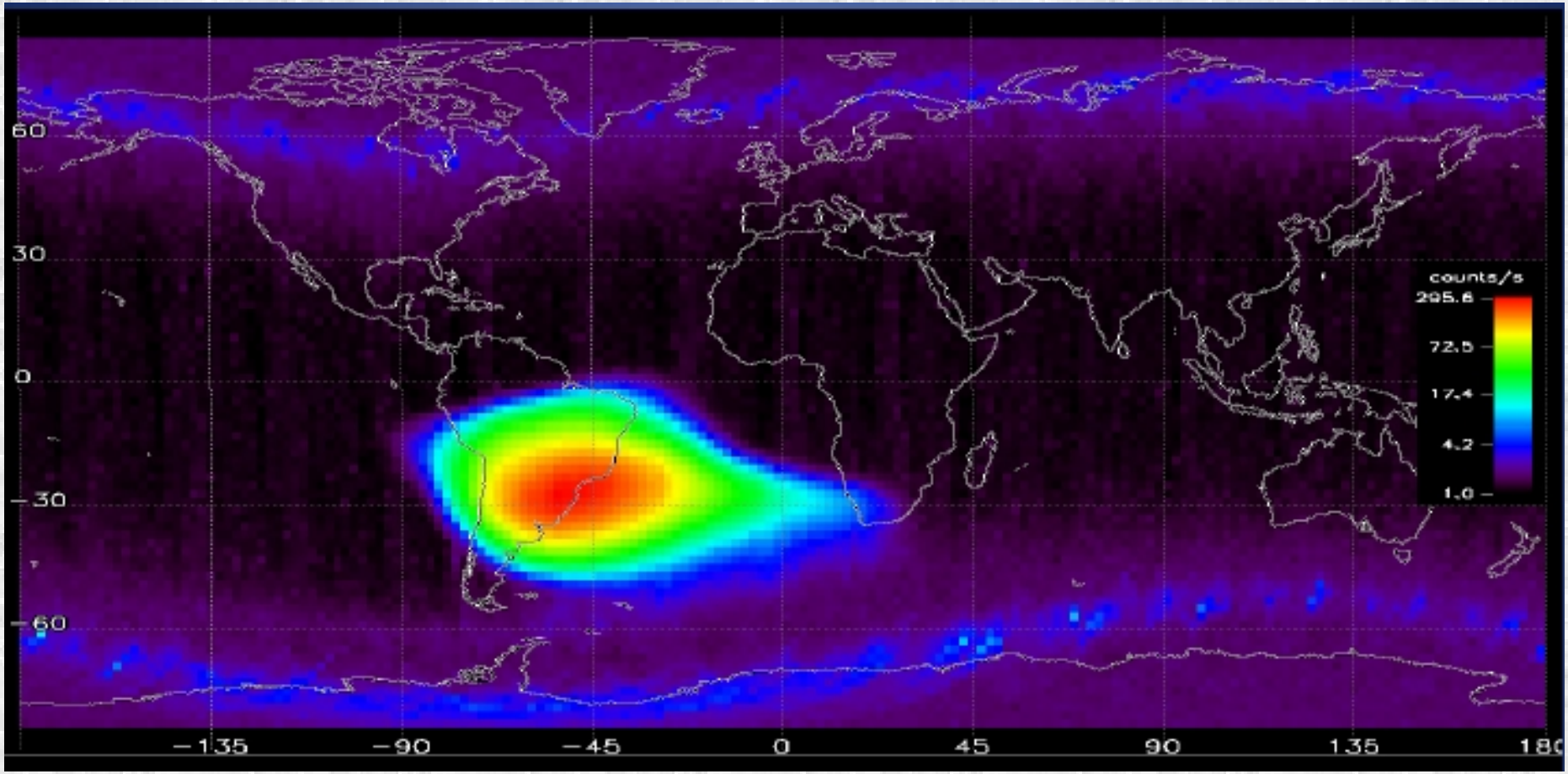

Thank you

Acknowledgement:

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