Preliminary Results from PSRD

Overview

* Synchrotron Radiation Detector
  - ~ Goal
  - ~ Principle
* Prototype Synchrotron Radiation Detector
  - ~ Goal
  - ~ Setup
  - ~ Preliminary Results
* Summary

Physics behind the SRD

*Electromagnetic calorimeter measures energy (> 1 TeV)

* With the SRD one determines the sign: e^+ vs. e^-

* Fast energy loss due to synch. rad. & inverse Compton Scattering

→ Lifetime of 1 Tev e^- estimated to be : 2x 10^5 a

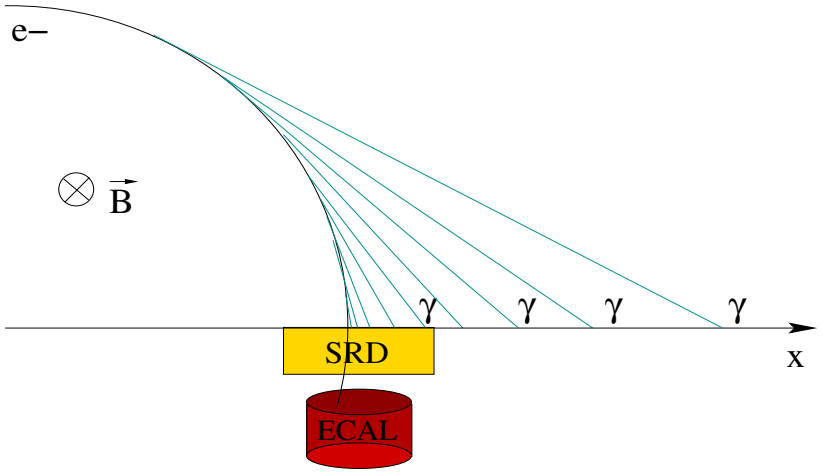
→ Source has to be within 1 kpc ≈3300 ly

→ Only few remnants of supernovae within this range

(Supernova shock fronts are assumed to be responsible for acceleration)

→ Spectra & ratio of e^+ and e^- contain info about acceleration mechanism

Principle of SRD



* Earth magnetic field taken as bending magnet for $e^{\pm}$ > some 500 GeV

→ Synchrotron Radiation

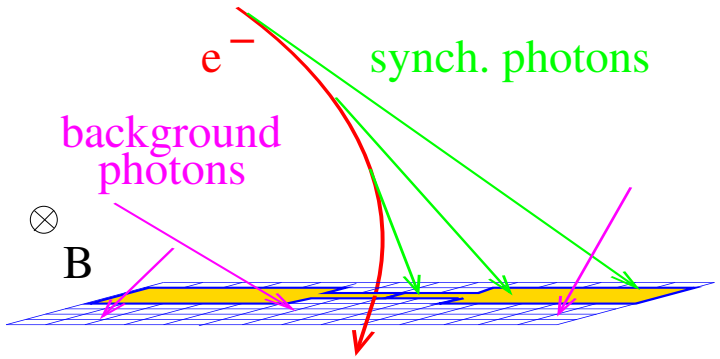
* Relative position of synchrotron photons and primary particle taken as signature for e^{+}/ e^{-}

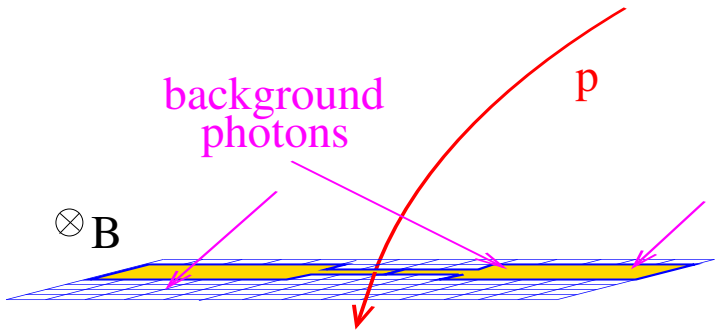
* Large proton excess: $p/e^{-} = 10^{4} - 10^{5}$

Protons in this energy region do not radiate

→ Rejection of proton flux

Background





* Energy window for synch. photons:
  2.5 keV – 100 keV

* Time resolution for primary and secondary particle : 10 ns

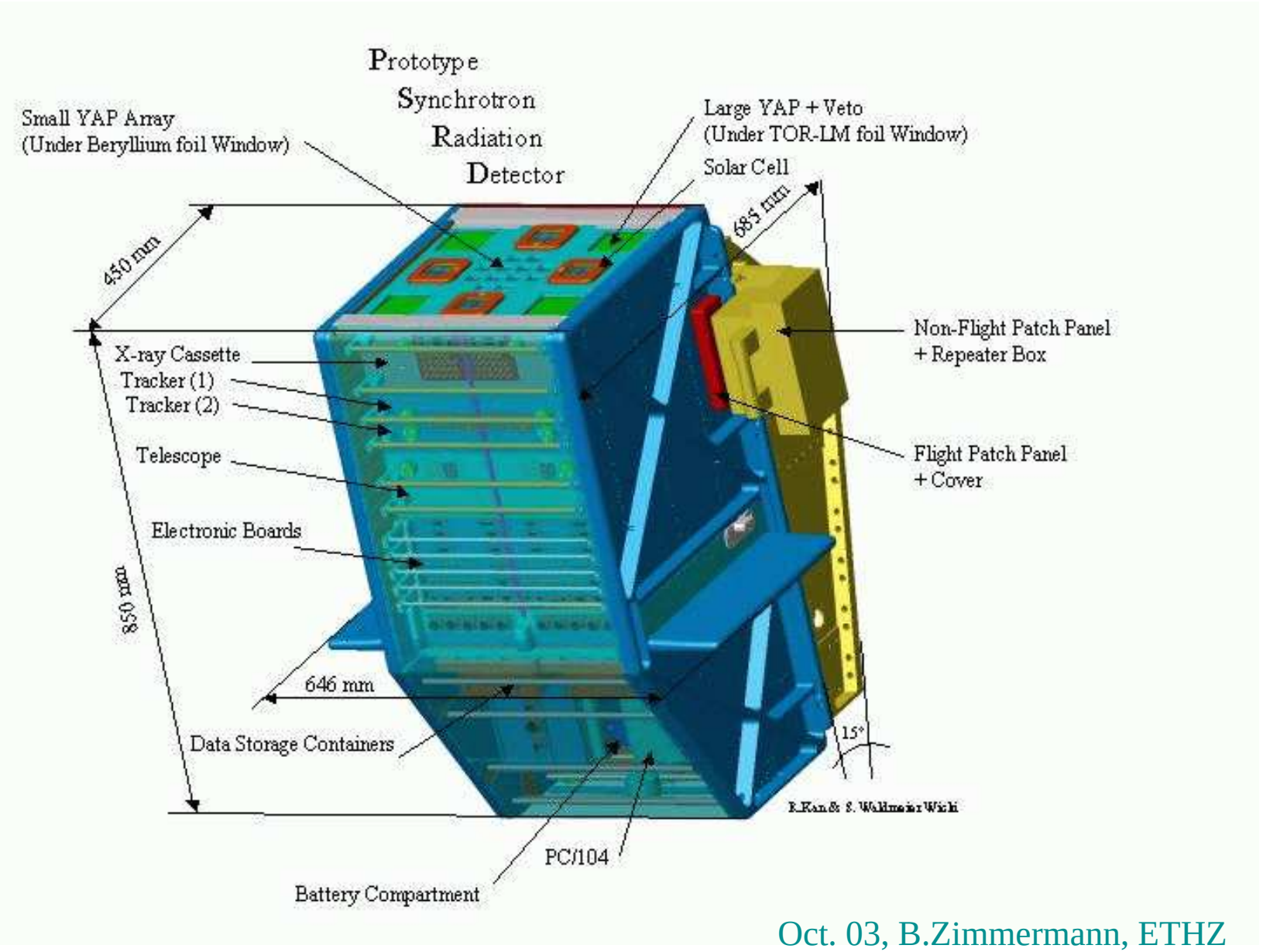
* Diffuse photons BG is known: ~ 8 /cm^{2}s sr

* Fluctuation of sun activity is very broad

* No detailed knowledge of charged particle flux in this energy region

→ PSRD

PSRD: Schematics



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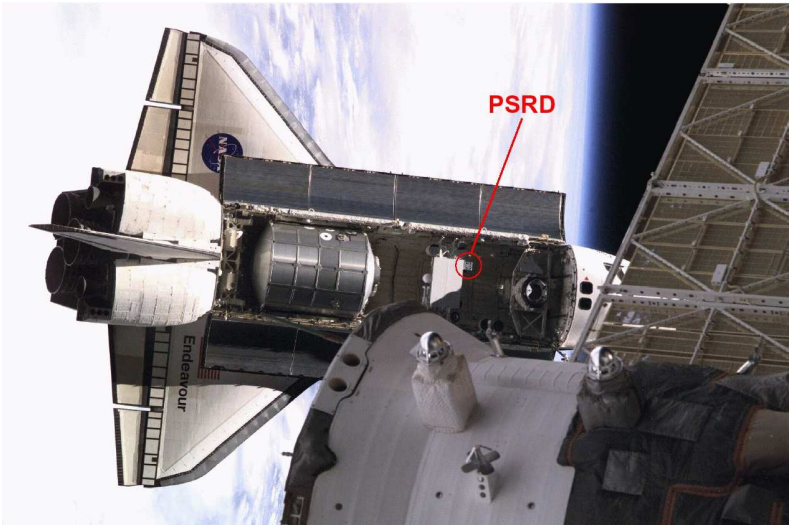
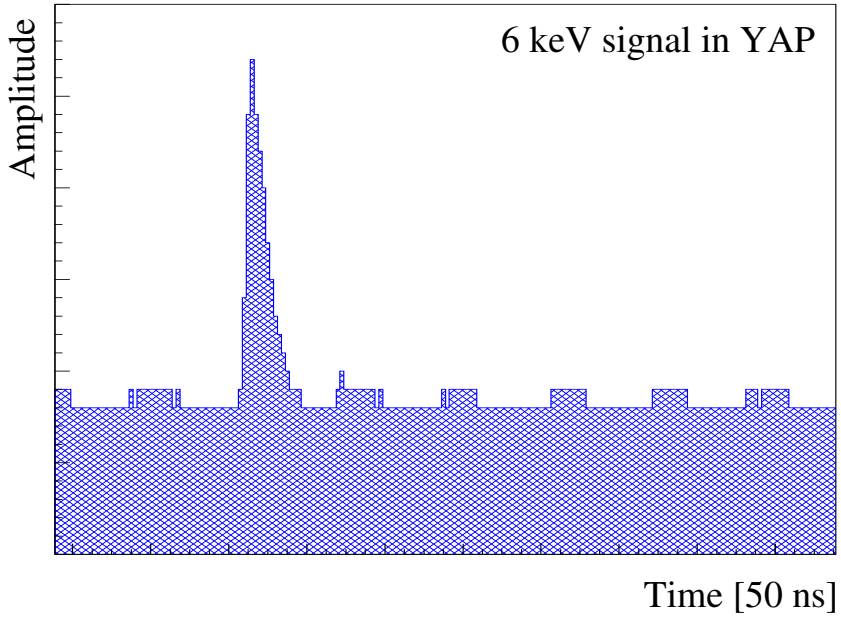
Aboard Endeavour on Flight STS–108





* Duration: 5.12. 2001 – 17.12. 2001

* PSRD running during parts of mission due to energy limitation

* Operation Times:

  ~ 38 h while docked to ISS

  ~ 37 h pointing deep space

  ~ 20 h pointing to earth

  ~ 8 h with belly to sun

  ~ 10 h at various orientations

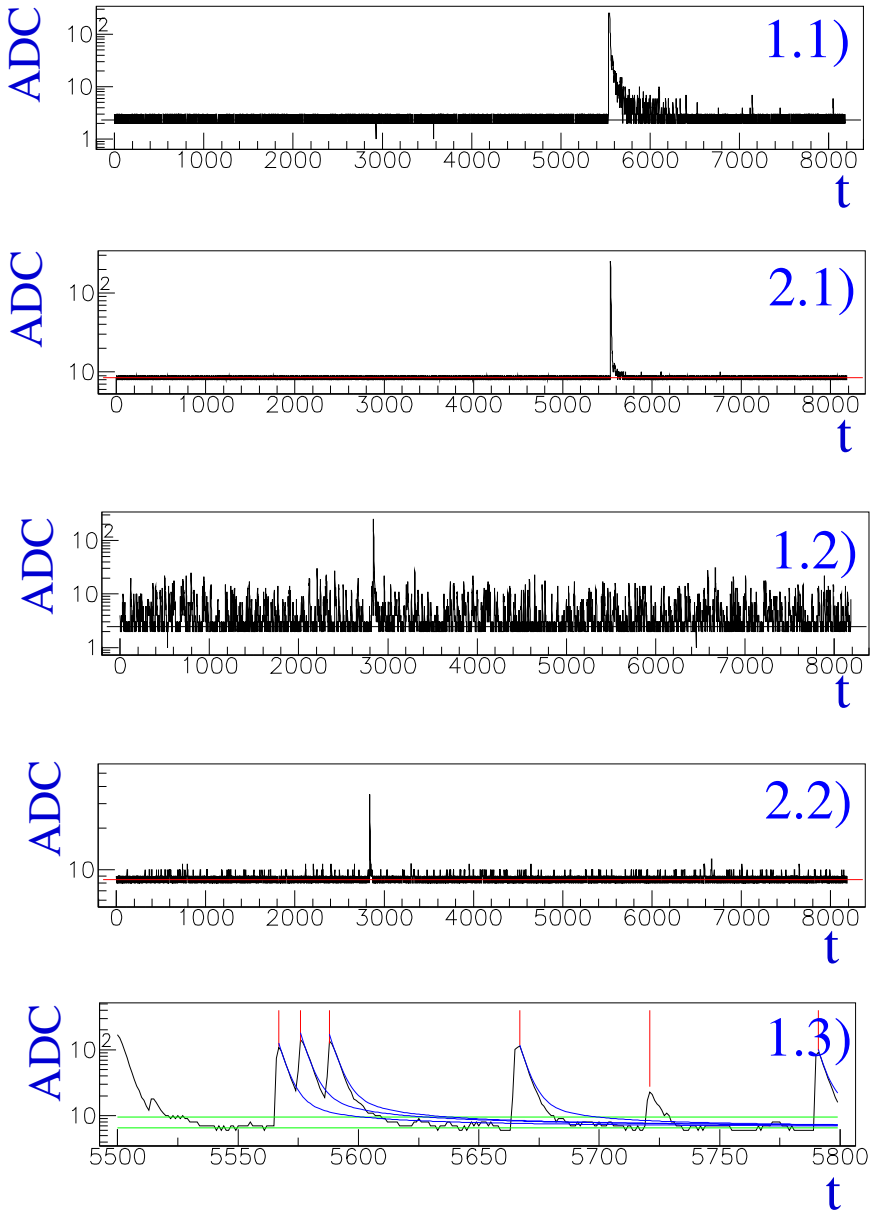
  → Total amount of 113 hours

* Data Taking:

  ~ 22 Triggers per 10 seconds

  ~ Buffer of 0.4 ms with 50 ns bins

Yap–Signals



1.*) Direct output of ADC

2.*) Attenuated output of ADC (factor 10)

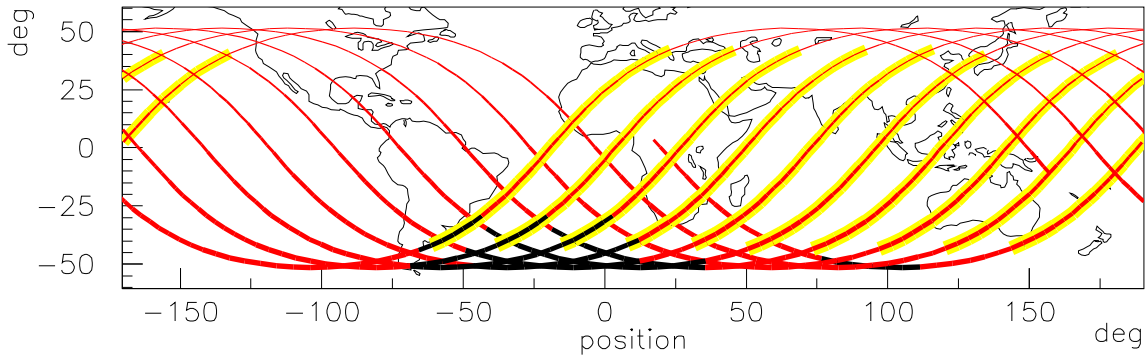
*.1) Recorded while no direct sunshine

*.2) Recorded under sun influence

~> difficulties of baseline determination

1.3) Pile–up of signals

STS–108: PSRD attitude

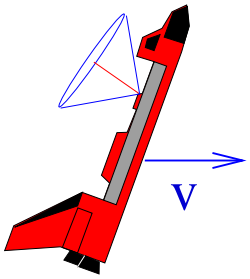


200km above ground

400km above ground

HV trip (small YAP)

direct sunlight



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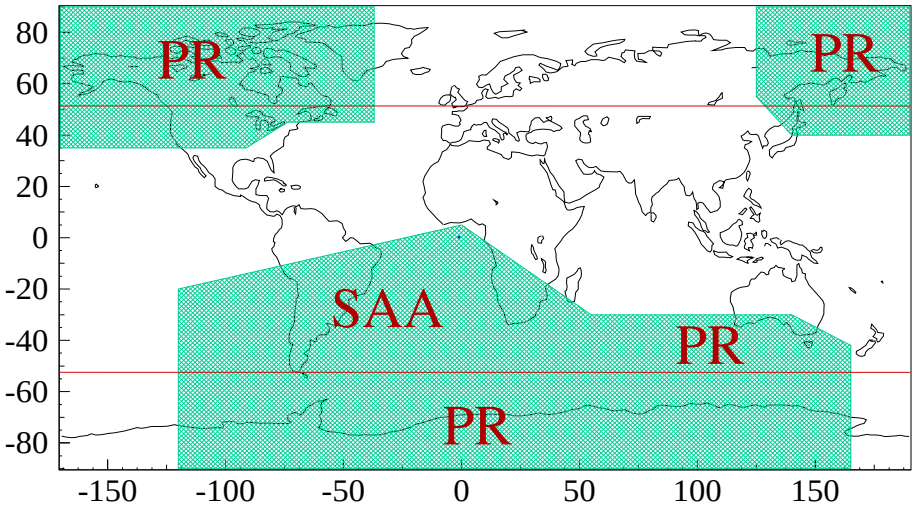
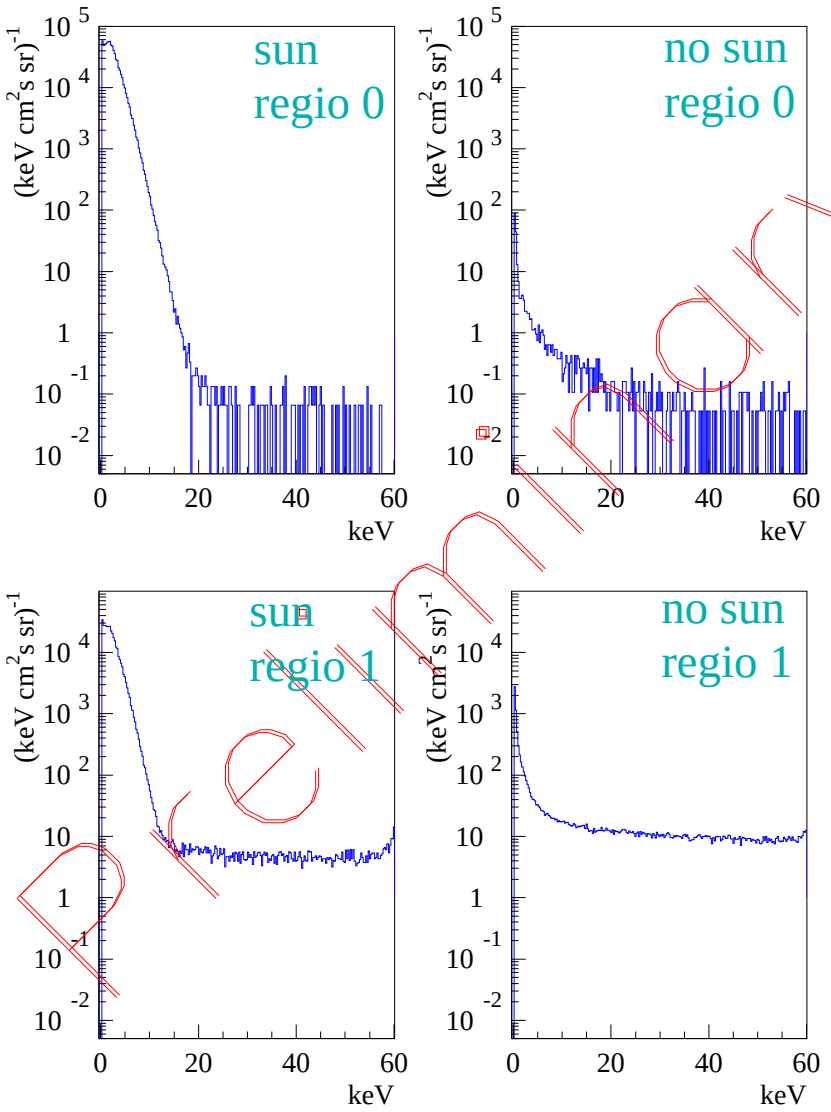
Regions of different rates



* Orbit of Shuttle between ±52 °
* Regio 0 (white): no field "anomalies"
* Regio 1 (green coloured): High rate expected due to magnetic field:
  - ~ South Atlantic Anomaly: lowered van Allen Belts
  - ~ Polar Regions: Orientation of field

Spectra under different conditions



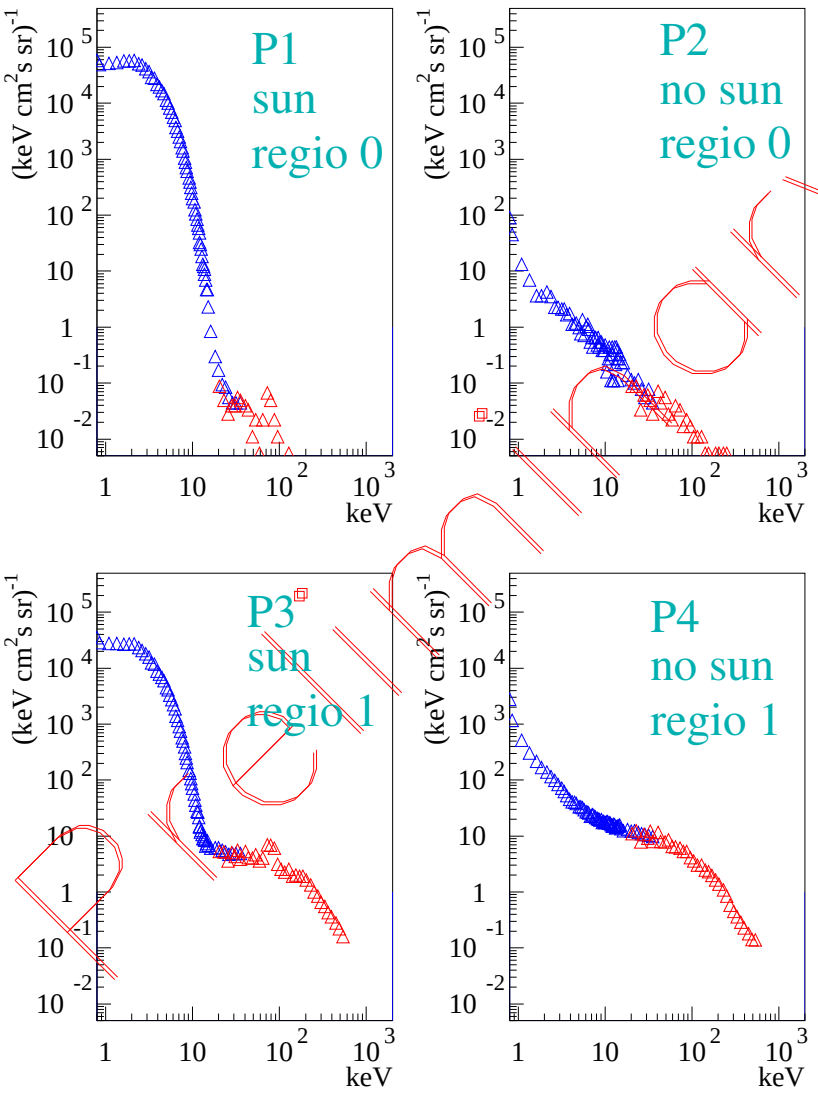
* regio 1 / 0: regions of high / low rate

* sun / no sun: detector is / is not exposed to direct sunshine

* Influence of the sun significant for energies < 20 keV; expected to be photons

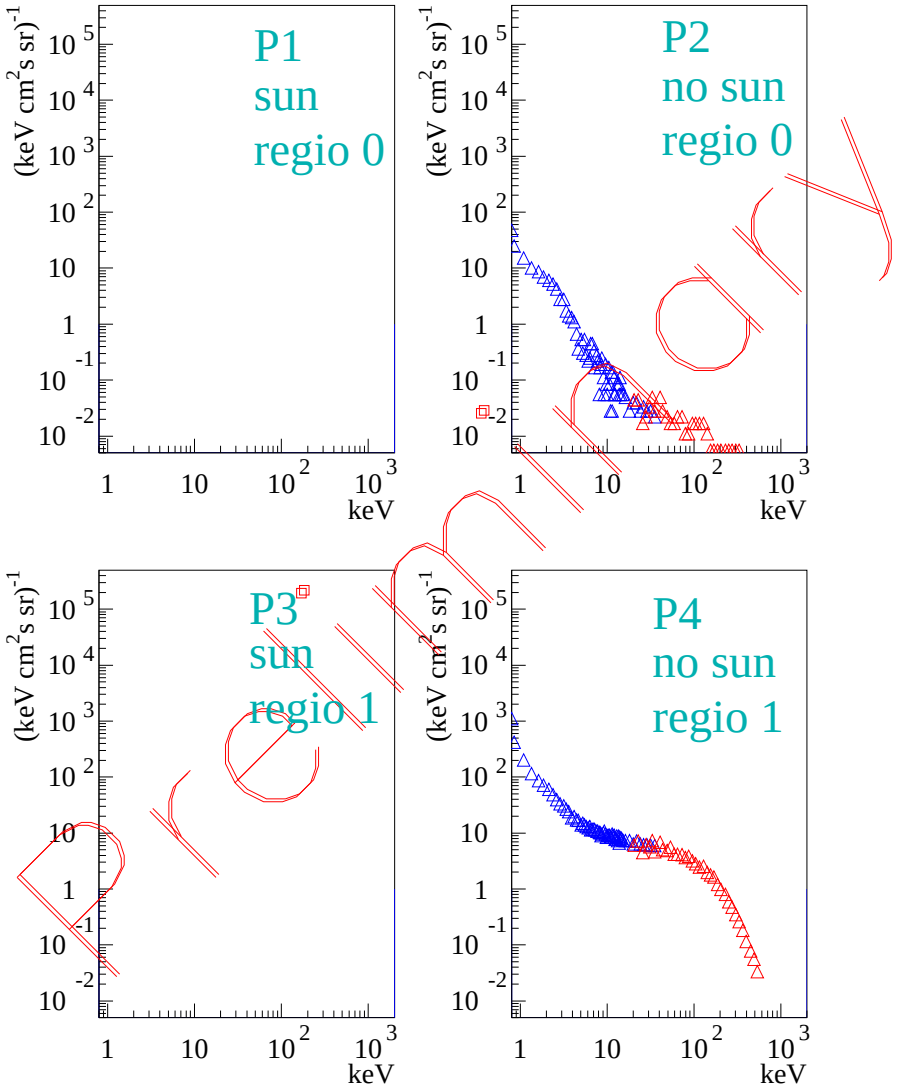
* Differences of higher energies in regio 1 are likely due to contribution of polar regions (crossed during night)

Energy Spectra: Deep Space



* Blue: Direkt ADC output
* Red: Attenuated ADC output (attenuation factor: 10)
* log–log scale to cover whole energy range
* P2: SRD background conditions
* P1: P2 + contribution from sun
* P4: P2 + contribution from polar regions
* P1: P2 + contribution from sun and polar regions
* P1 & P2: Flatness of peak due to protective Beryllium window

Energy Spectra: Bay to Earth



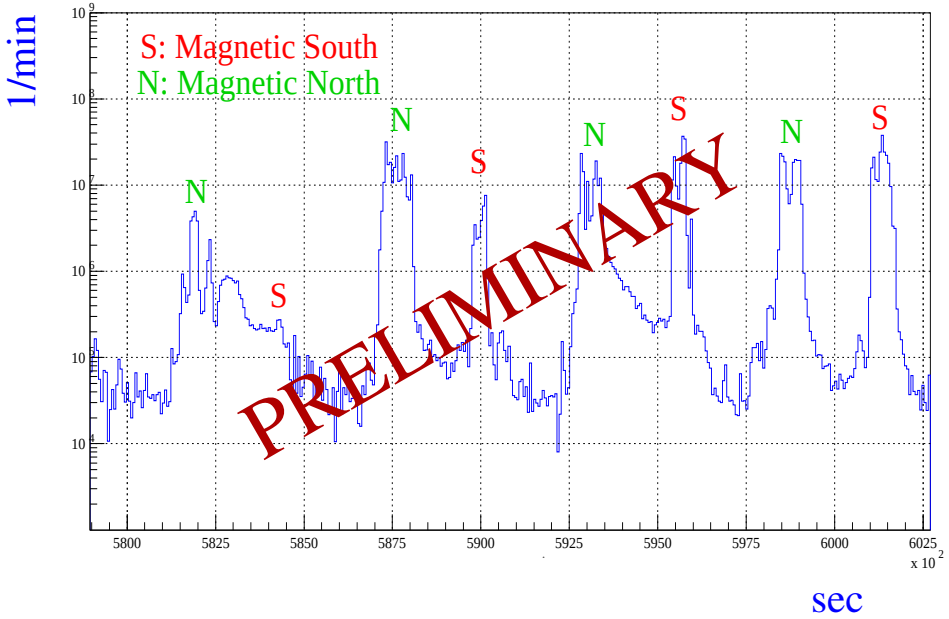
* Attitude: bay to earth

  Consequences:

  ~ no direct sunshine
  P1&P3 are empty

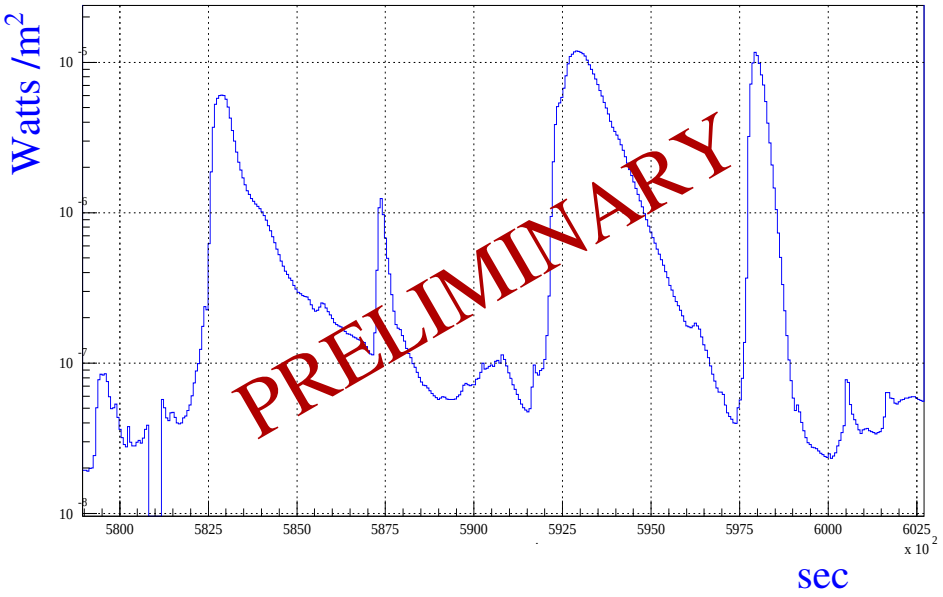
  ~ P2&P4 contain not only signals from night side of earth

Solar Activity



* Amount of signals measured by PSRD within a minute

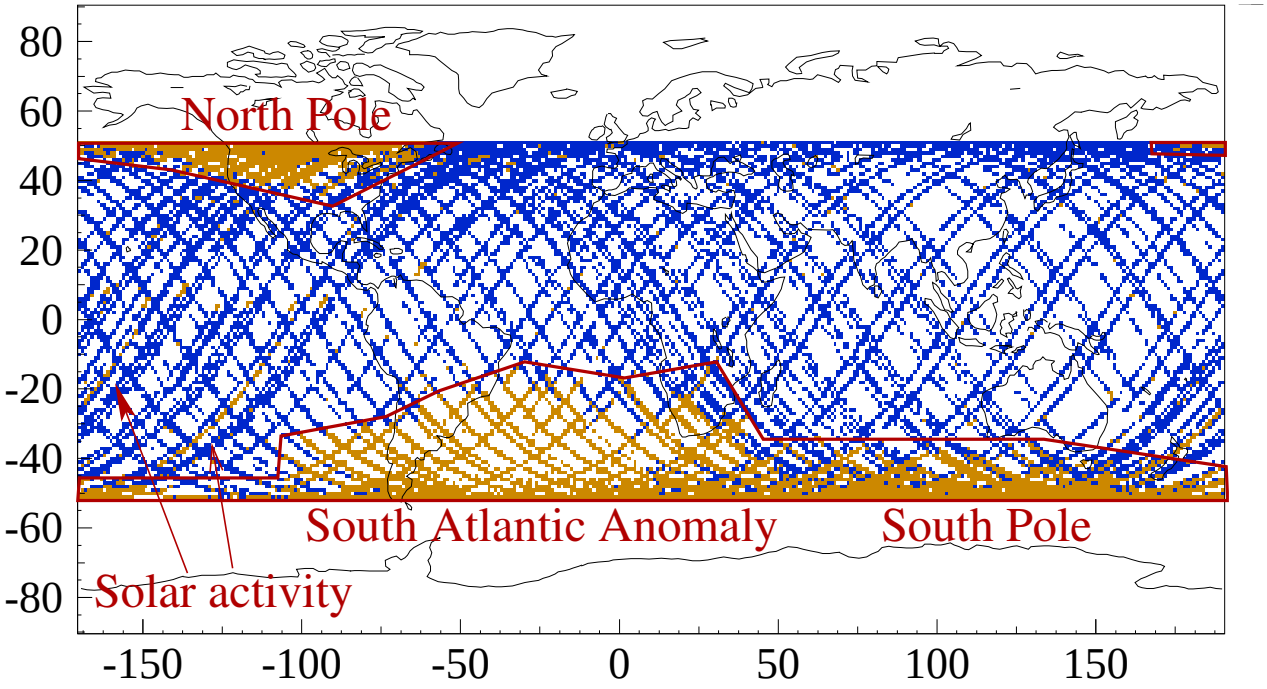
* Fluctuations of rate due to poles



* Solar X–ray flux (3–24 keV) measured by GOES satellite during same time as PSRD was operating

* Huge solar flares obsereved in PSRD data

Where does the SRD principle work?



* SRD principle works in blue coloured region

* Background is to high in the yellow parts:

  ~ near the magnetic poles

  ~ in the South Atlantic Anomaly

  ~ while exposed to sunshine

  ~ during times with high solar x–ray emission