ASCI - from the COSI background measurements to the sensitivity of ASCI

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OUTLINE:

COSI (COmpton Spectrometer and Imager):

- *Instrument / Geometry*
- *Flight / Prelim. data*

COSI @ IRAP Toulouse:

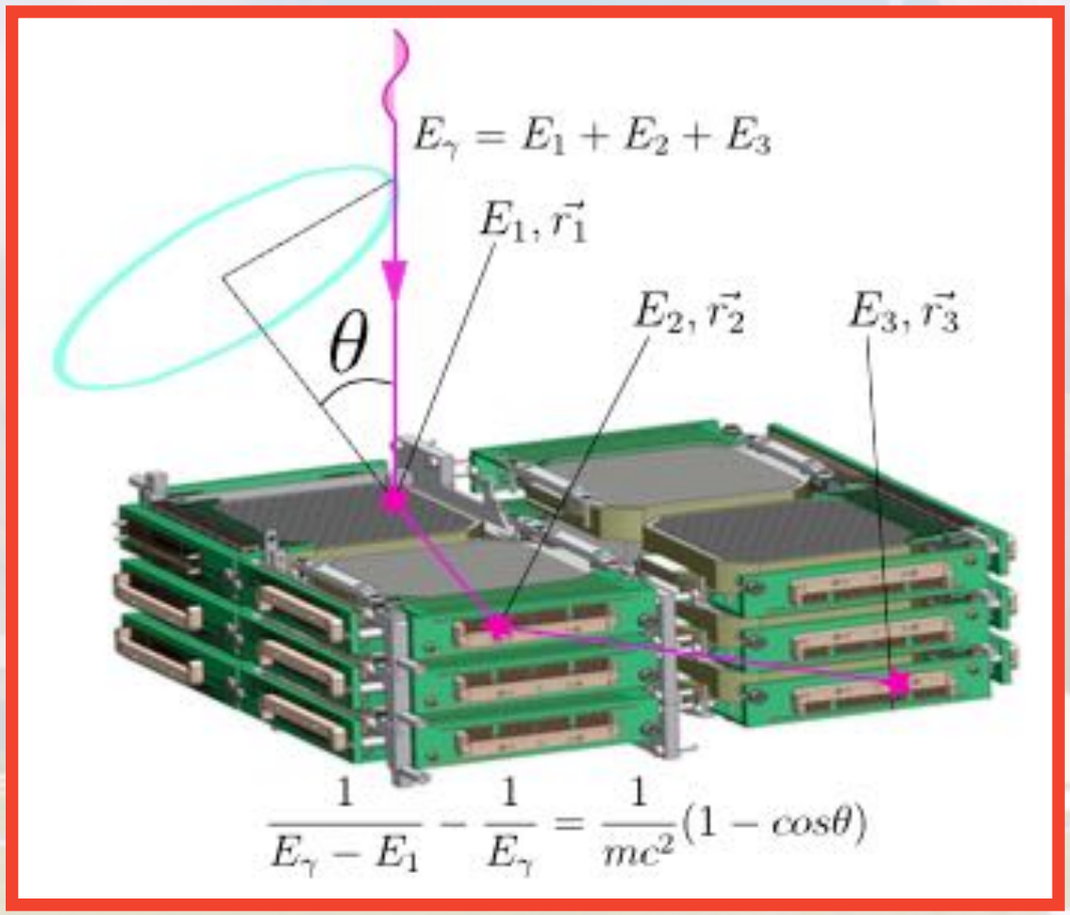
- ***ACS system design** (shield+electronics)*
- *Detected data: CO/PE / 511keV*
- *Cut-Off Rigidity estimate*
- *Data analysis*
- *Background modeling !*

COSI to ASCI (All-Sky Compton Imager):

- *Going outside the atmosphere*
- *Modeling ASCI based on COSI geometry*
- *Evaluating ASCI performance*

COSI: INSTRUMENT

- Balloon-borne telescope: 0.2 - 10. MeV
- Double-sided strip Ge detectors (GeDs)
- Geometry: 2x2 stacks of 3 GeDs
- GeD: ~ 8x8 cm^2 x 1.5 cm w/
  37 x 2 mm strips / 0.25 mm gaps
- Controlled cryostat
- ACS: CsI panels



- Energy res: 1.5-3.0 keV FWHM
- Angular res: up to ~4° FWHM
- Field-of-view: almost 1/4 of sky
- X/Y res: 2. mm or less
- Depth-of-int: ~0.2 mm RMS

COSI: FLIGHT 2016.

Balloon + gondola

Start:
New Zealand
16th May 2016.

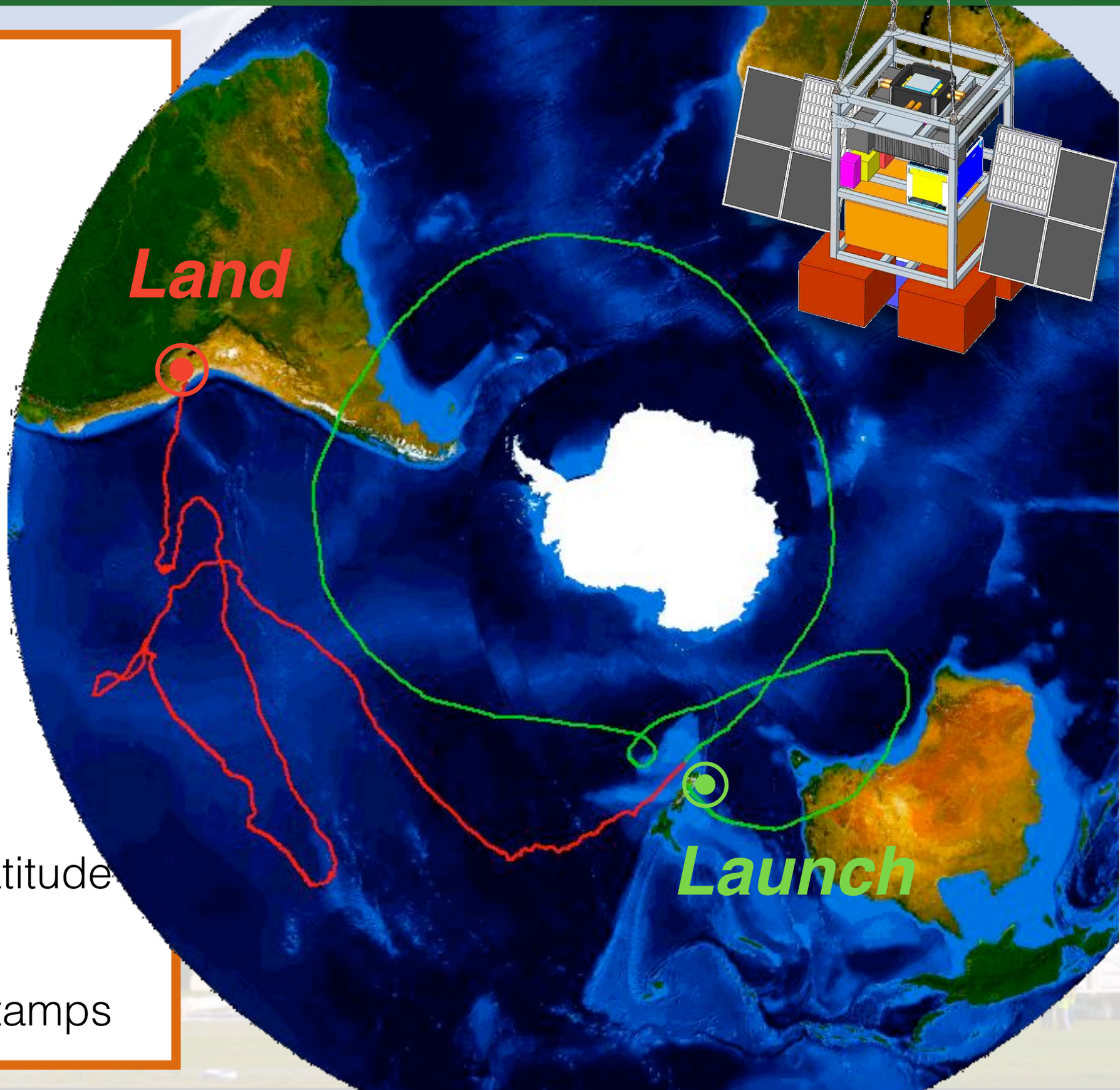
End:
South America
2. July 2016

Flight time (data):
46+ days!

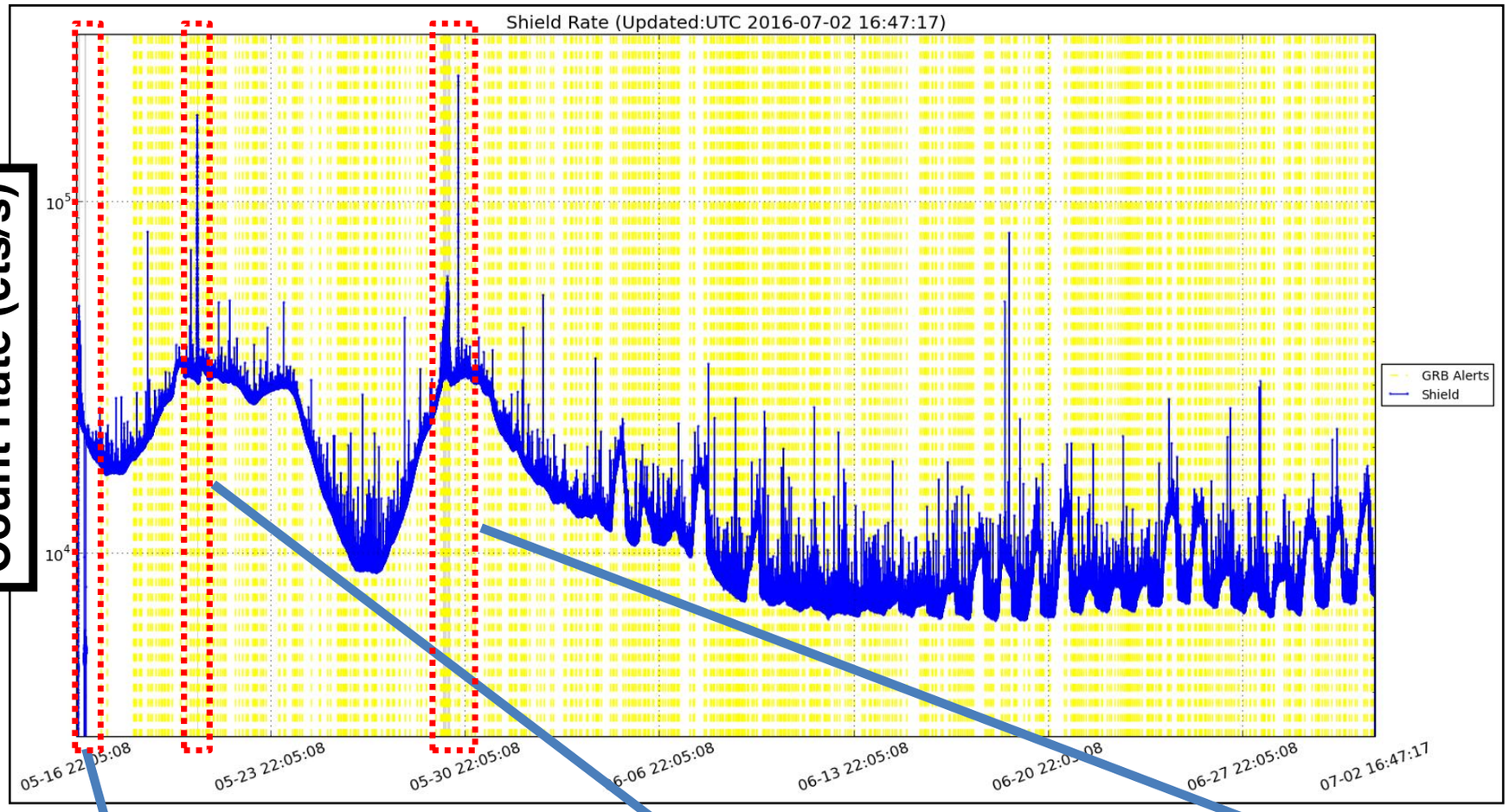
Support data:

Geolocation:
altitude, longitude, latitude

ACS count rates:
total, lifetimes, timestamps

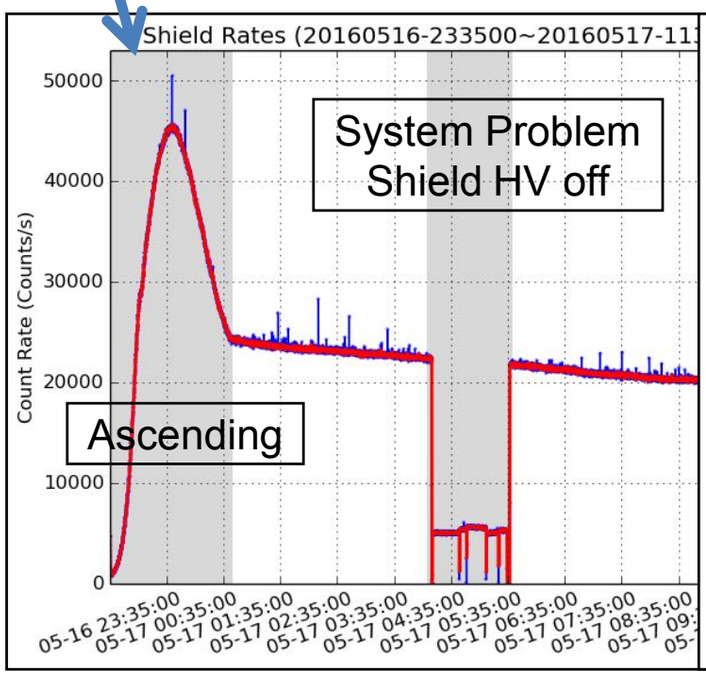


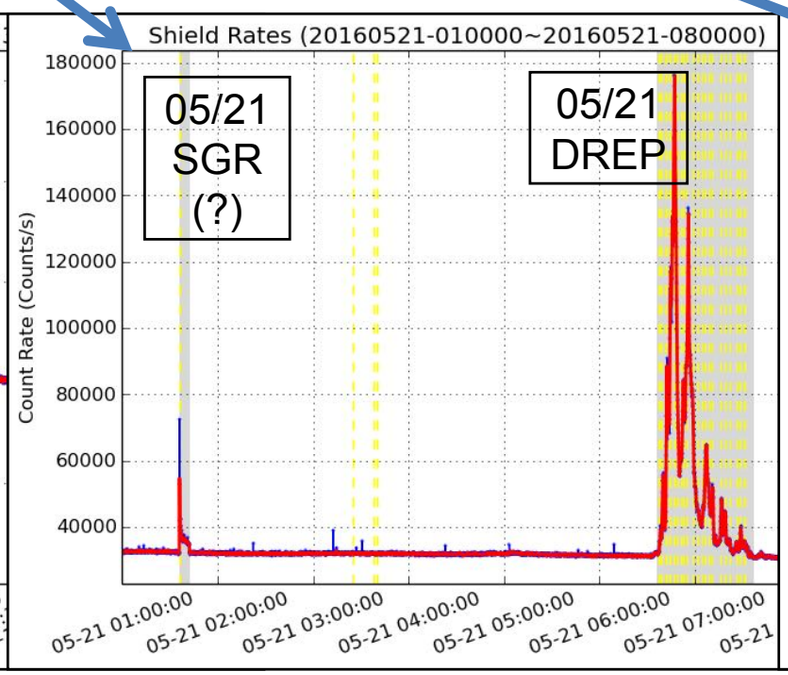
COSI: Anomaly / High Shield Rates

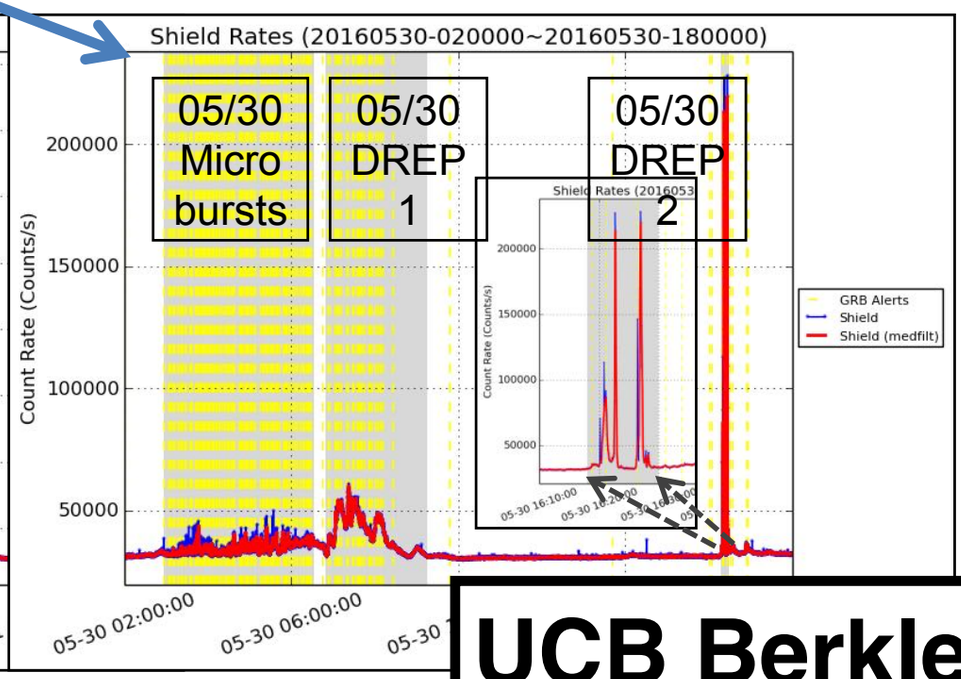



```
TYPE GTI

# Launch Time: 2016/05/16_23:35:00
# System Off : 2016/07/02_16:51:00
GT 1463441700.0000000000 1467478260.0000000000

# Include the preferred BTI files (exclusion)
IN COSI16_BeforeFloatAlt_v1.bti
IN COSI16_SystemProblems_v1.bti
IN COSI16_HighShieldRates_v1.bti
```

```
BT 1463794550.0000000000 1463794980.0000000000
BT 146
BT 146
BT 146
BT 146
```







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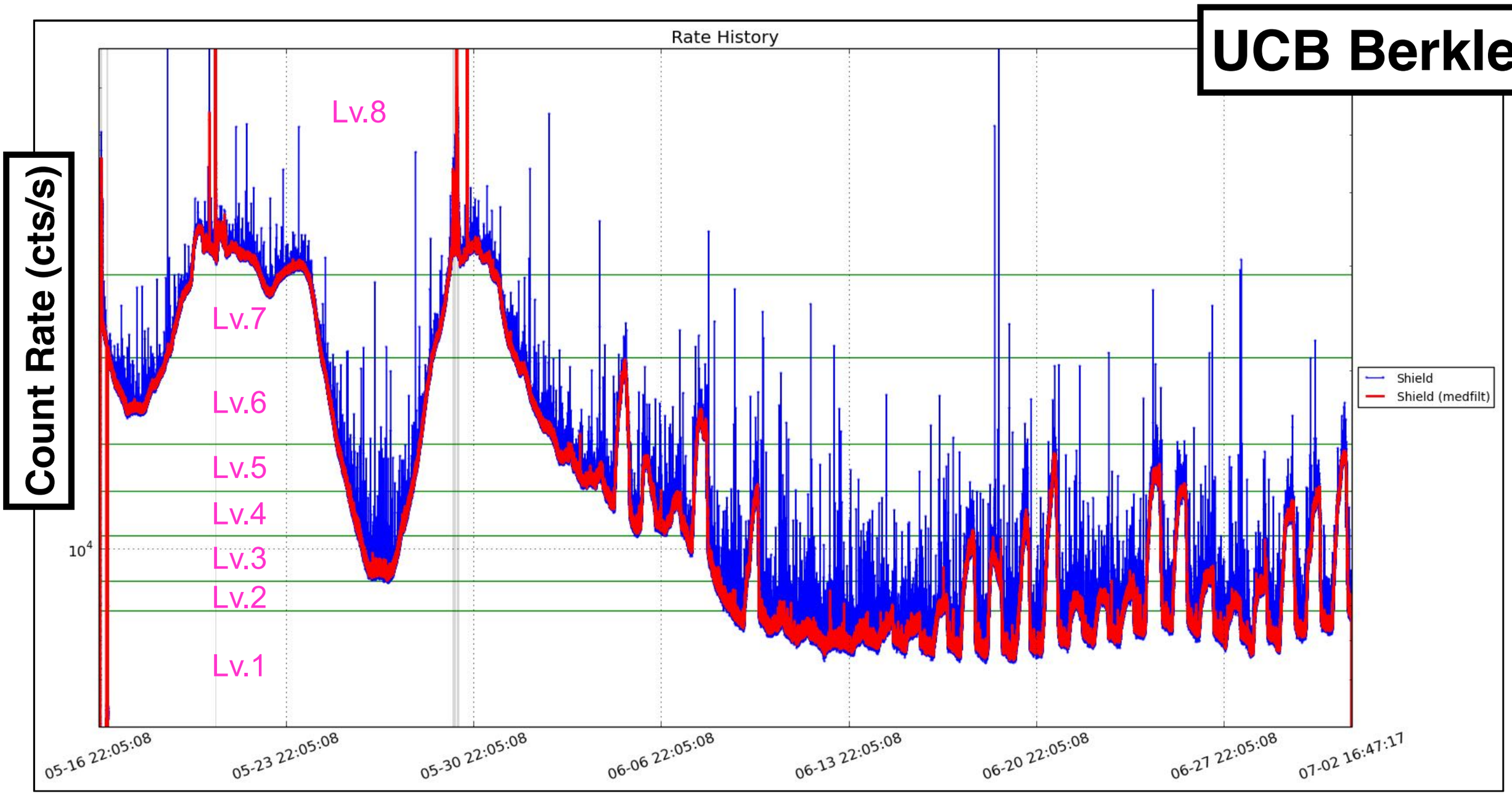
COSI: Overall Shield Rates



[Lv.8] Rate $\geqq$ 29,000 (1/sec)

[Lv.7] 21,000 $\leqq$ Rate $<$ 29,000 (1/sec)

[Lv.6] 15,000 $\leqq$ Rate $<$ 21,000 (1/sec)

[Lv.5] 12,500 $\leqq$ Rate $<$ 15,000 (1/sec)

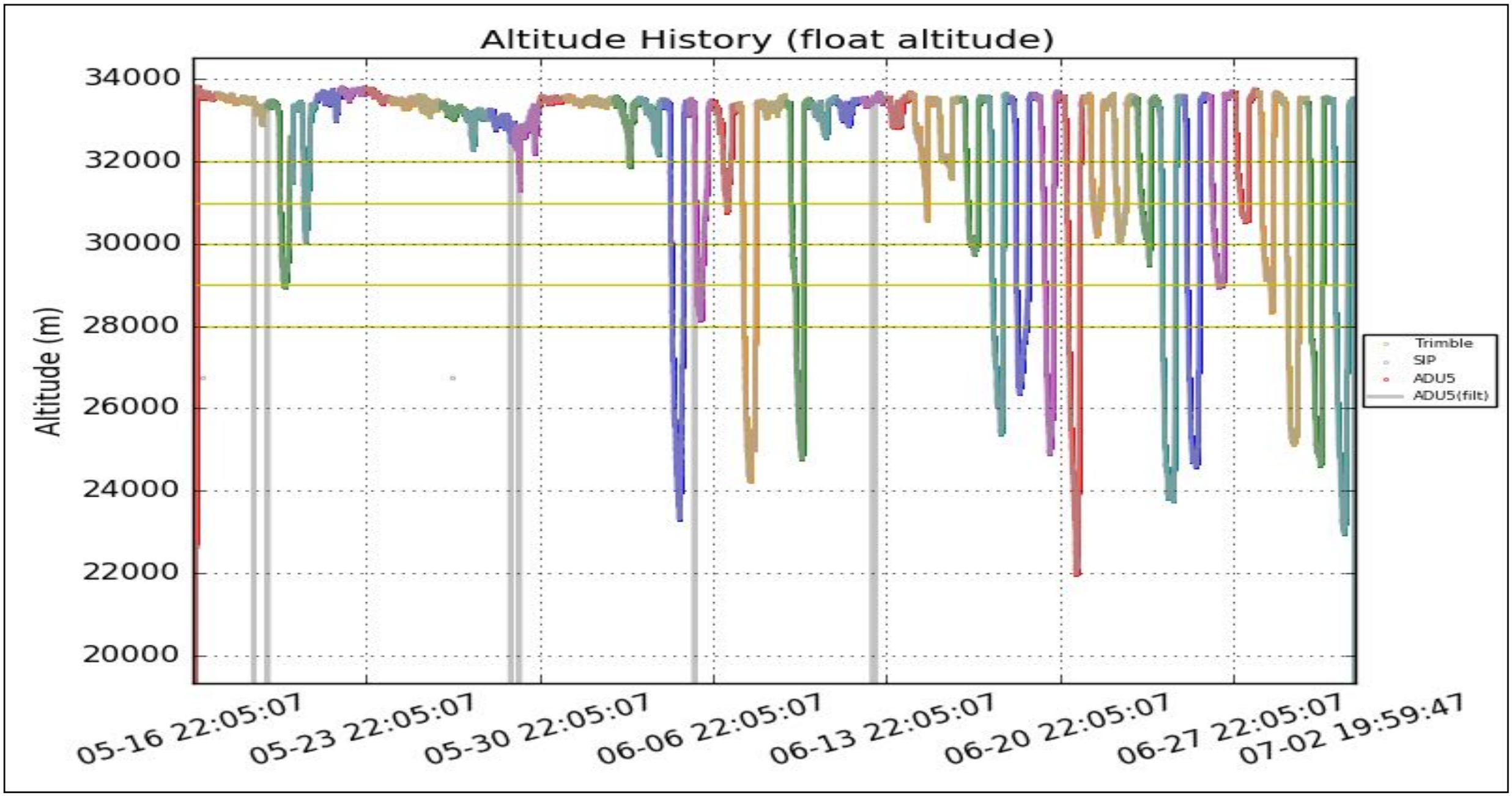
[Lv.4] 10,500 $\leqq$ Rate $<$ 12,500 (1/sec)

[Lv.3] 8,800 $\leqq$ Rate $<$ 10,500 (1/sec)

[Lv.2] 7,850 $\leqq$ Rate $<$ 8,800 (1/sec)

[Lv.1] Rate $<$ 7,850 (1/sec)

COSI: Altitude profile



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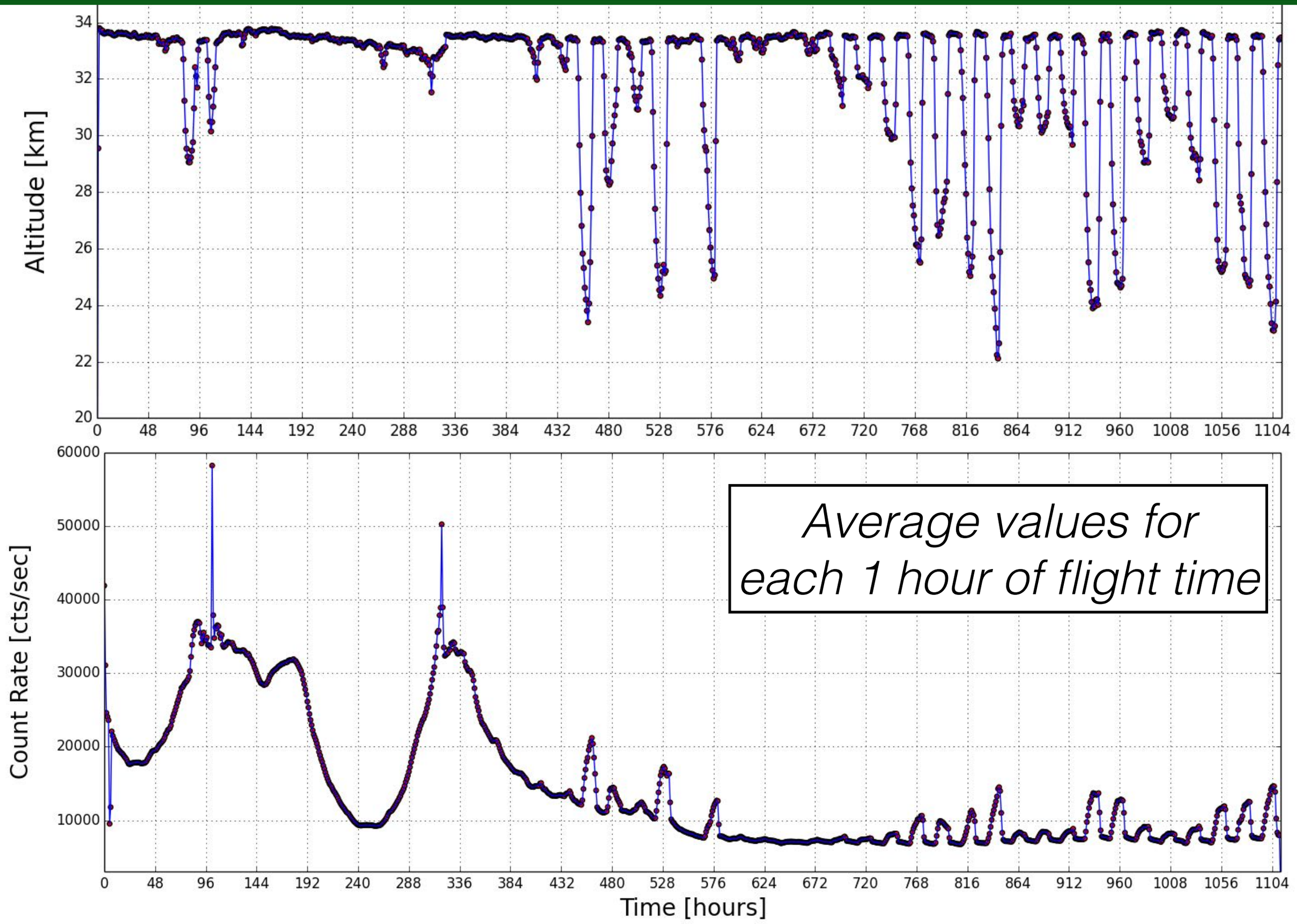
COSI @ IRAP: ACS data



COSI @ IRAP: Detected data

```
ET CO
ID 5
TI 1465517087.375969500
GX 180.849 -0.735114
GZ 270.418 30.3553
HX -58.6384 0.693535
HZ 73.8262 88.9728
CC AS -24.949472 -98.902846 238.63841 -0.6935351
-0.75773855 1465517089.800000000
CC NStripHits 4
SQ 2
CT 0 1
TL 1
TE 29.1144
CE 152.365 0.905507   29.1144 1.19019
CD 0.5816 3.62935 -4.586   0.057735 0.057735 0.42
4352   0.3816 3.22935 -4.442   0.057735 0.057735
0.0287933   0 0 0   0 0 0
LA 0.469826
```

Event type

Timestamp

E and (x,y,z) with uncertainties for the 1st and 2nd interaction

COSI data snippet:

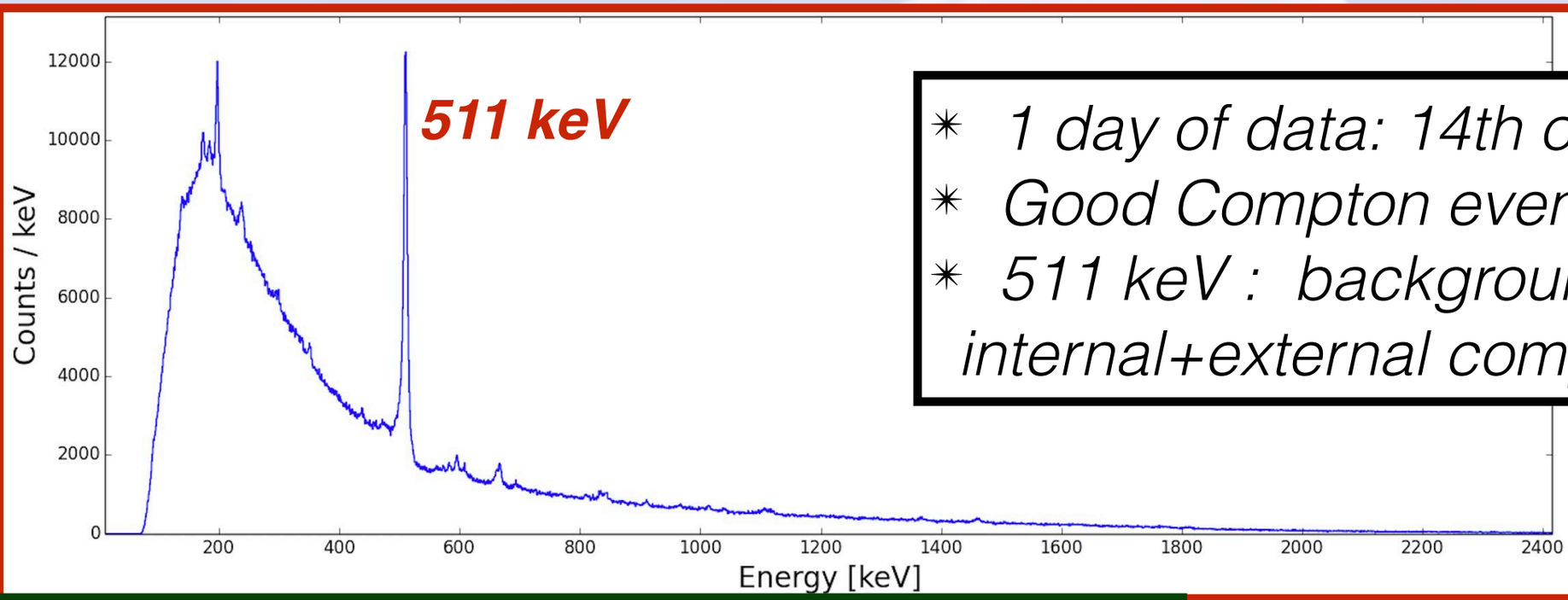
MEGAlib/Nuclearizer: Initial data reconstruction + preanalysis

Events:
Compton - CO
Single (Photoelectric) - PE
Unresolved - UN

Statistics:
~ 95% data reconstructed
~ 2:1 - Photoel : Compton

Timestamp problem < 1% in multiple files

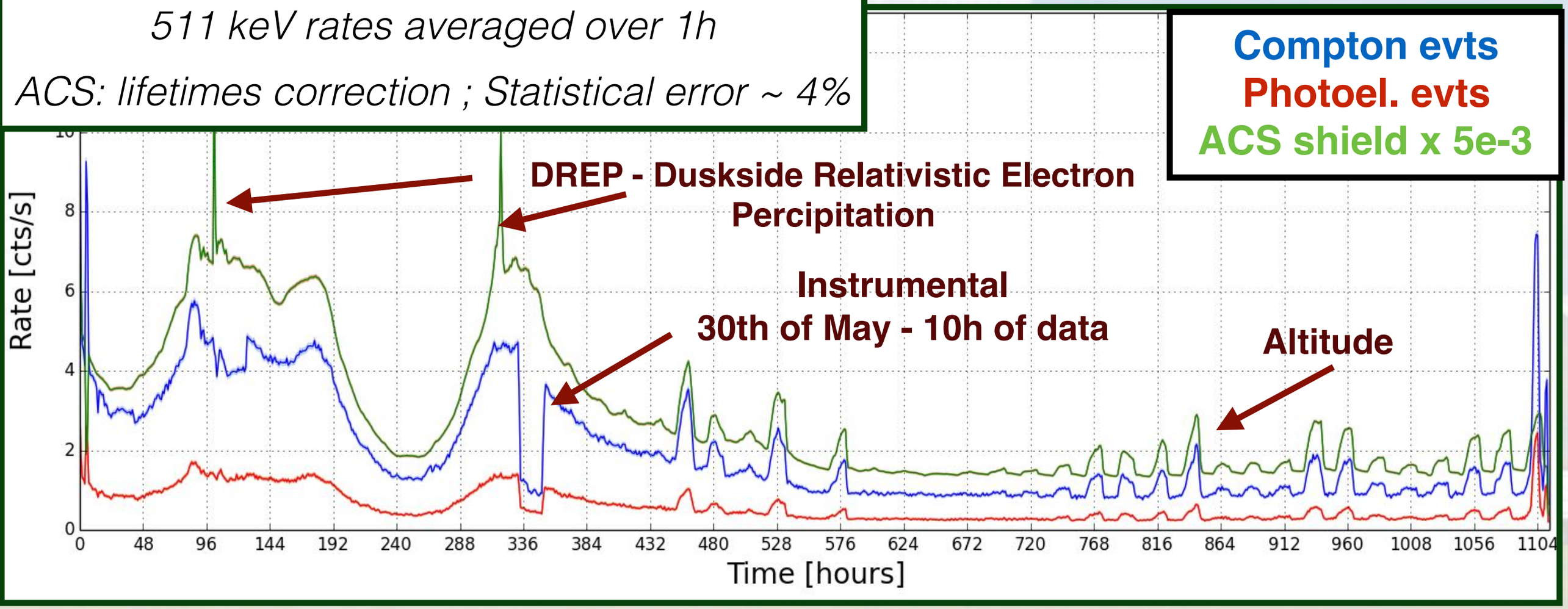
COSI @ IRAP: Detected data



- *1 day of data: 14th of June*
- *Good Compton events ~3.3M ~40./sec*
- *511 keV : background indication internal+external component; rate ~1./sec*

511 keV rates averaged over 1h

ACS: lifetimes correction ; Statistical error ~ 4%



COSI @ IRAP: Geolocation → Cut-off rigidity estim.

Estimation (rough value) of the cut-off rigidity: Shifted dipole approx.

Geographical coord. (λ, Φ) to geomagnetic (Λ, Φ, Ψ) w/ $N_m=(\lambda_p, \phi_p)$;

$$\sin\Lambda = \sin\lambda\cdot\sin\lambda_p+\cos\lambda\cdot\cos\lambda_p\cdot\cos(\phi-\phi_p)$$

$$\sin\Phi = \cos\lambda\cdot\sin(\phi-\phi_p) / \cos\Lambda$$

$$\cos\Psi = -\cos\lambda_p\cdot\sin(\phi-\phi_p) / \cos\Lambda$$

Calculating the coordinates of the dipole center and the balloon:

$$X = R\cdot\cos\phi_{dipole}\cdot\cos\lambda_{dipole} \qquad x = r\cdot\cos\phi_{craft}\cdot\cos\lambda_{craft}$$

$$Y = R\cdot\sin\phi_{dipole}\cdot\cos\lambda_{dipole} \qquad y = r\cdot\sin\phi_{craft}\cdot\cos\lambda_{craft}$$

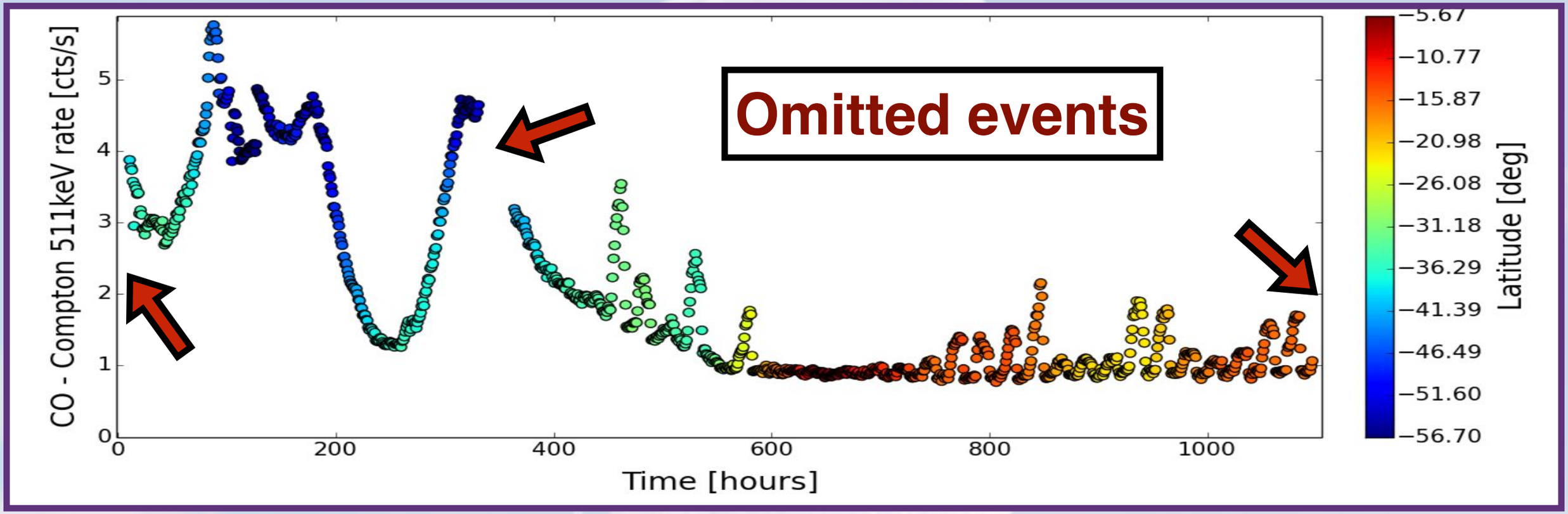
$$Z = R\cdot\sin\lambda_{dipole} \qquad z = r\cdot\sin\lambda_{craft}$$

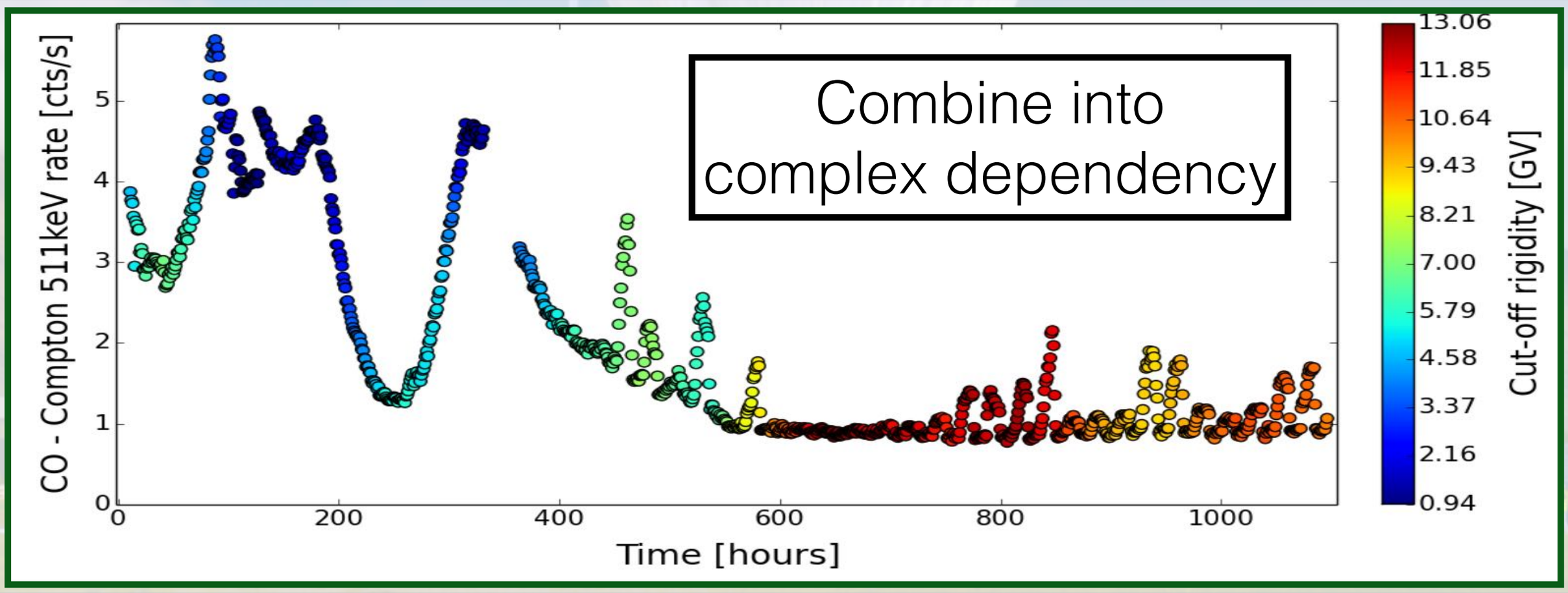
Finding the rigidity:

$$d = SQRT[\ (X-x)^2 + (Y-y)^2 + (Z-z)^2\ ]\ ;\ \ Pcut = 15\cdot(\cos\lambda)^4\ ;\ \ (\phi_{dipole},\ \lambda_{dipole}\ ,R)$$

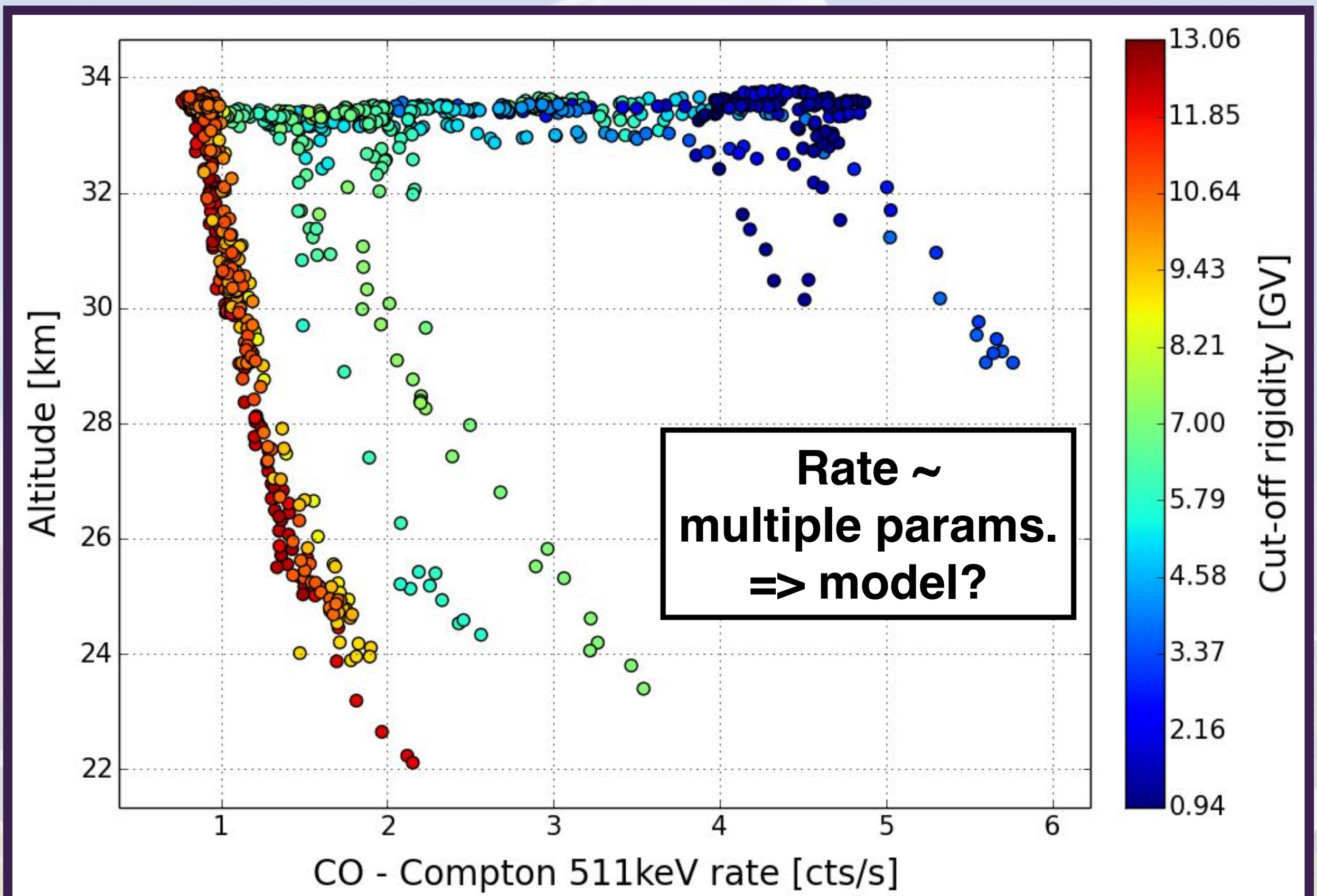
$$\Delta P / P = -3\Delta d / d \quad => \quad \text{Rigidity } P$$

COSI @ IRAP: Analysis

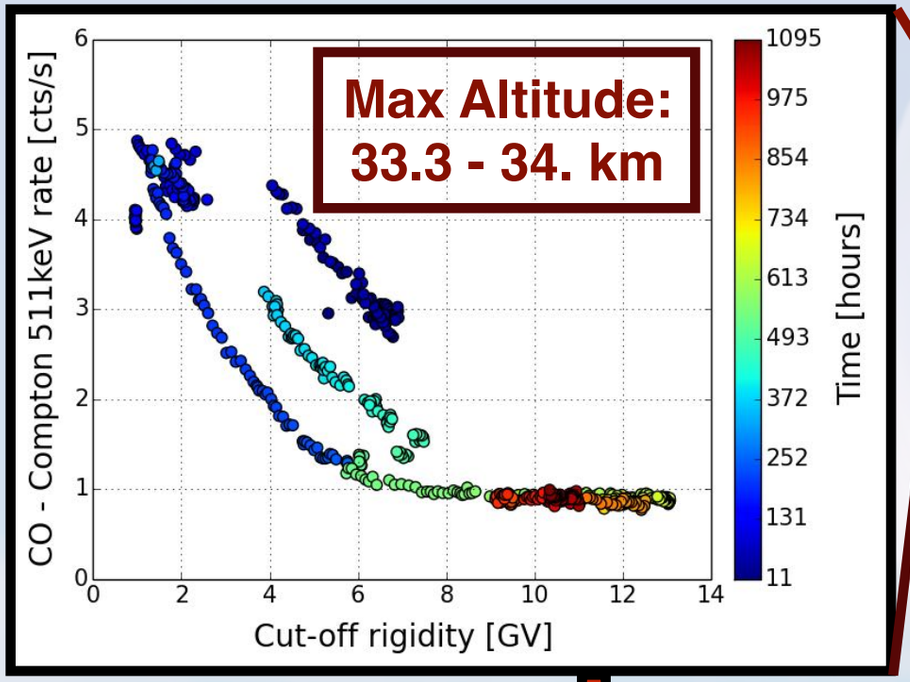


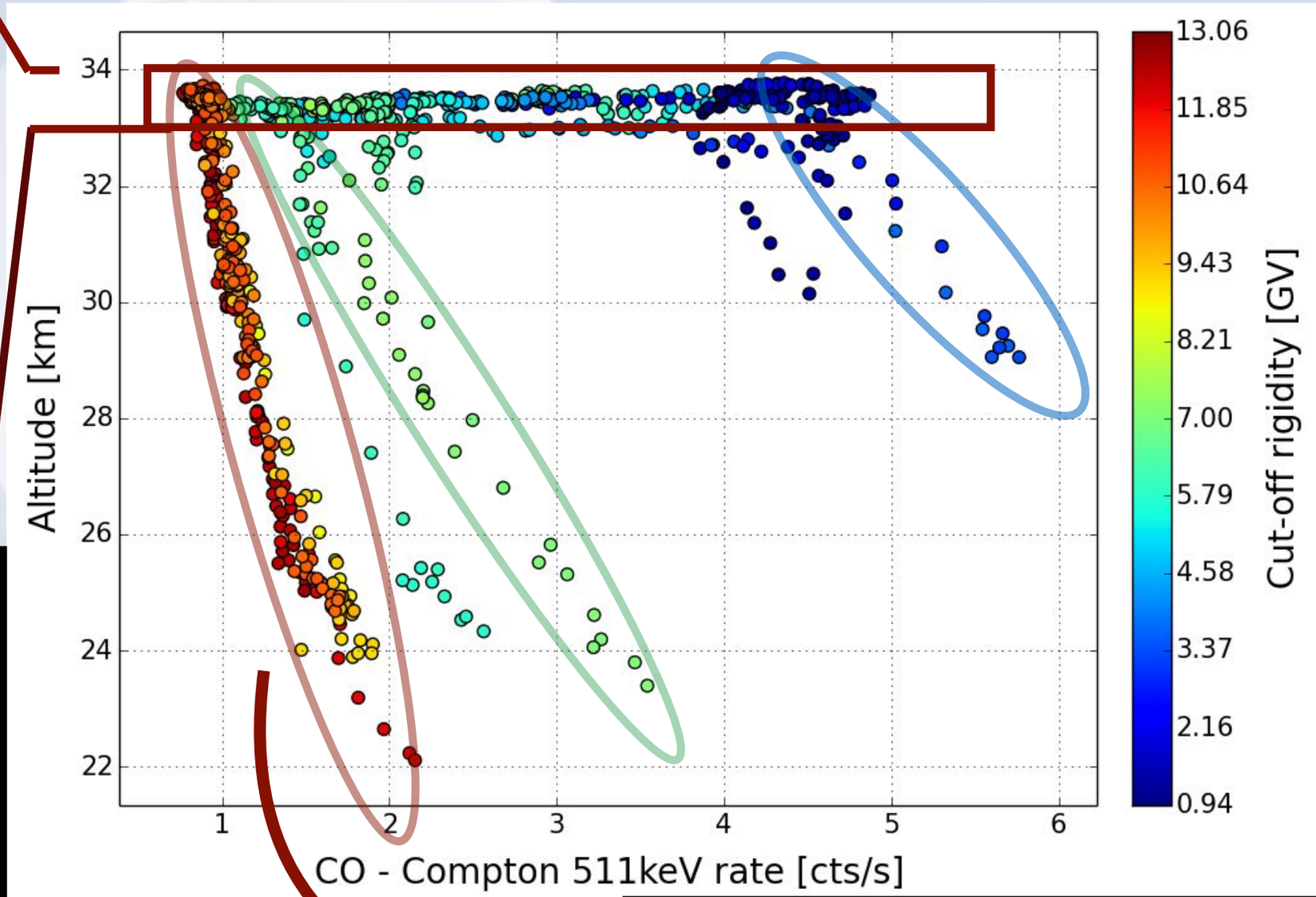


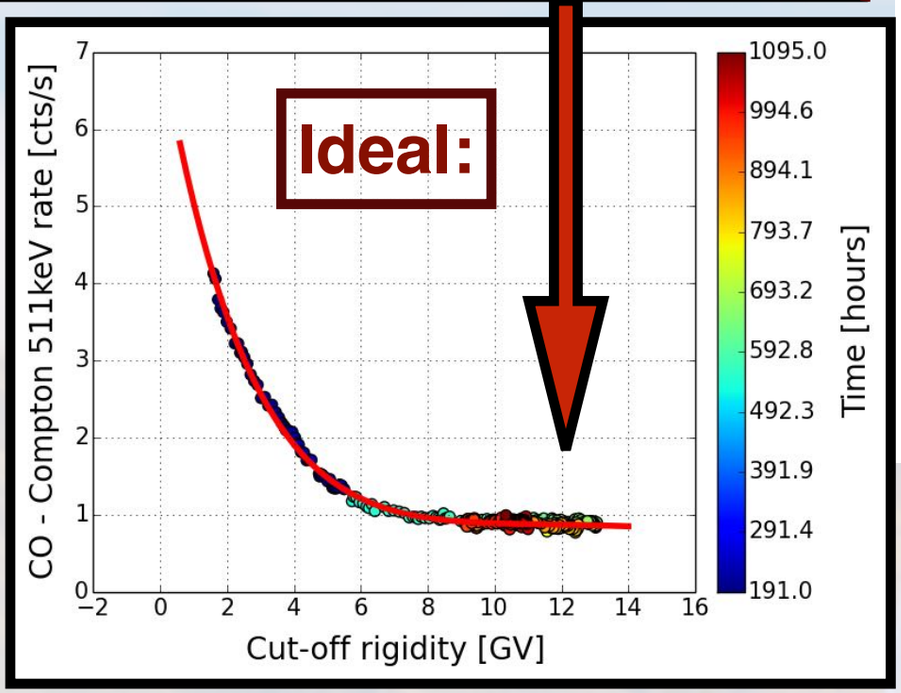
COSI @ IRAP: Background model?

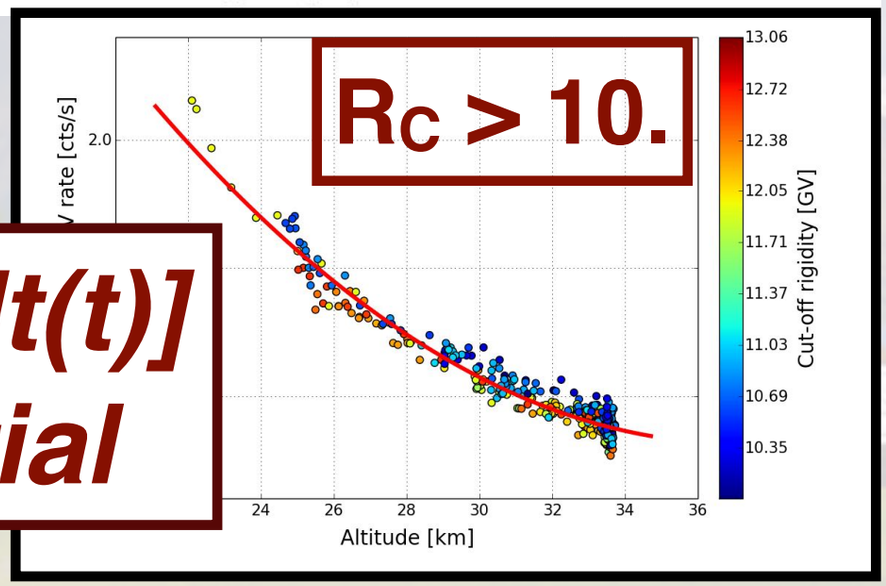


COSI @ IRAP: Background model?







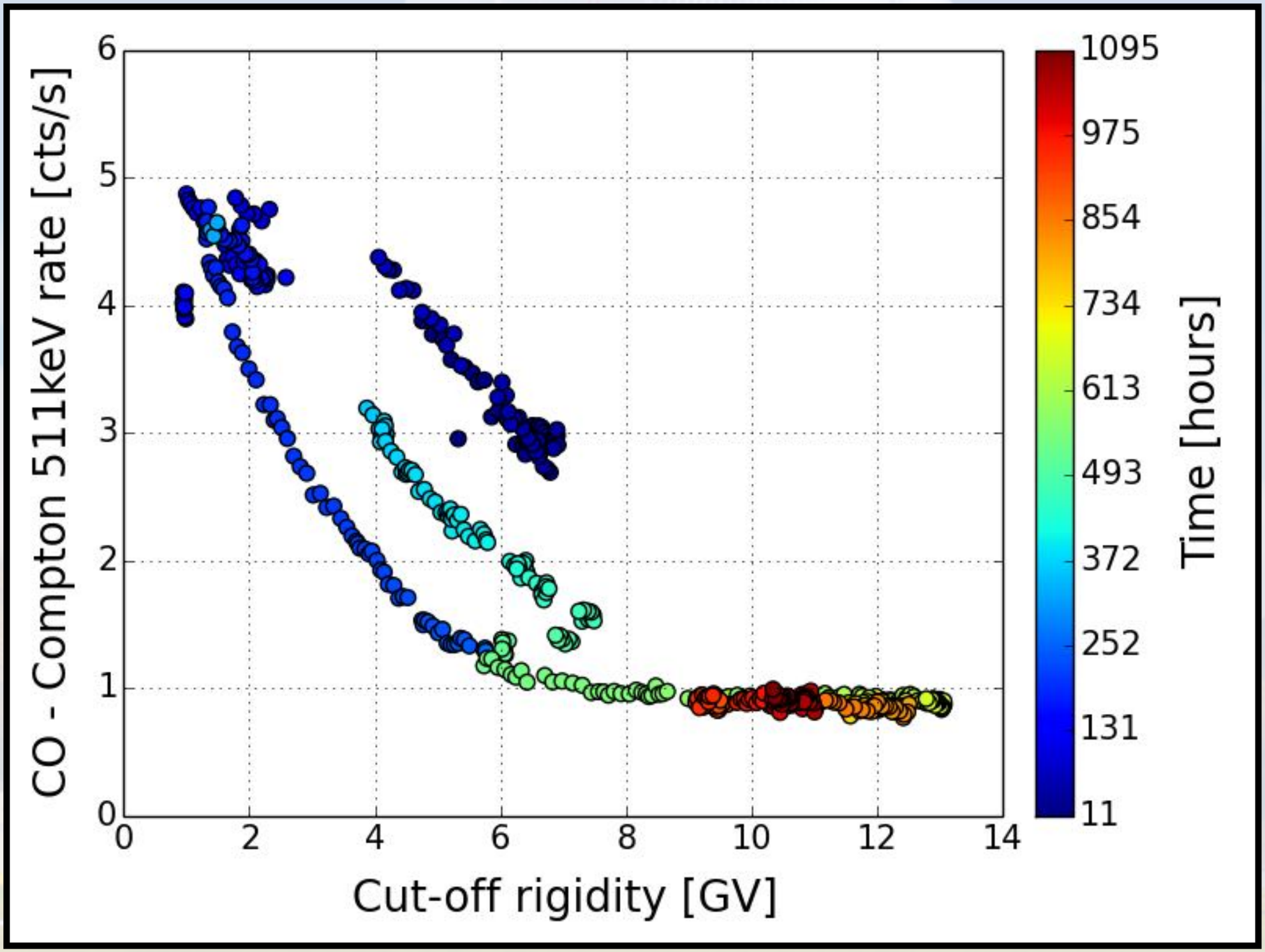


$R_{511} \sim f\,[R_{cut\text{-}off}(t)]$
power law

$R_{511} \sim g\,[Alt(t)]$
exponential

COSI @ IRAP: Background model?

Max Altitude: 33.3 - 34. km



From COSI to ASCI: Background

➡ **Final goal → have a semi-empirical model:**

$$R_{511}(t) \equiv \{ \; f\,[R_{cut\text{-}off}(t)] \times g\,[Altitude(t)] \; \} \times ??$$

➡ **Adopt the model for other energies:**

e.g. 198 keV, continuum etc.

➡ **Selection of the incoming direction of Compton evts:**

for now all are taken into account

➡ **Extrapolate the completed model to be used**

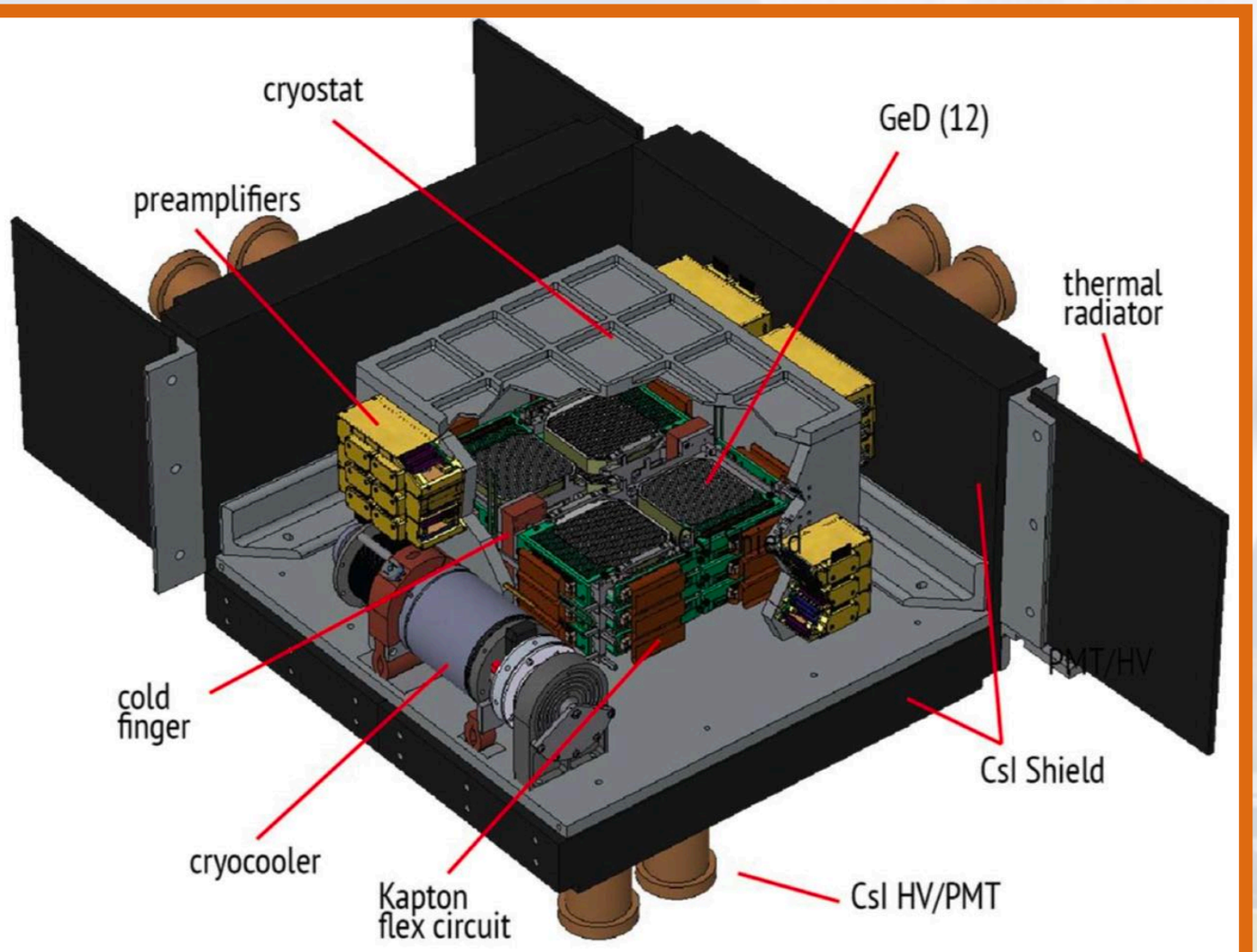
with ASCI: go outside the atmosphere, L2 orbit

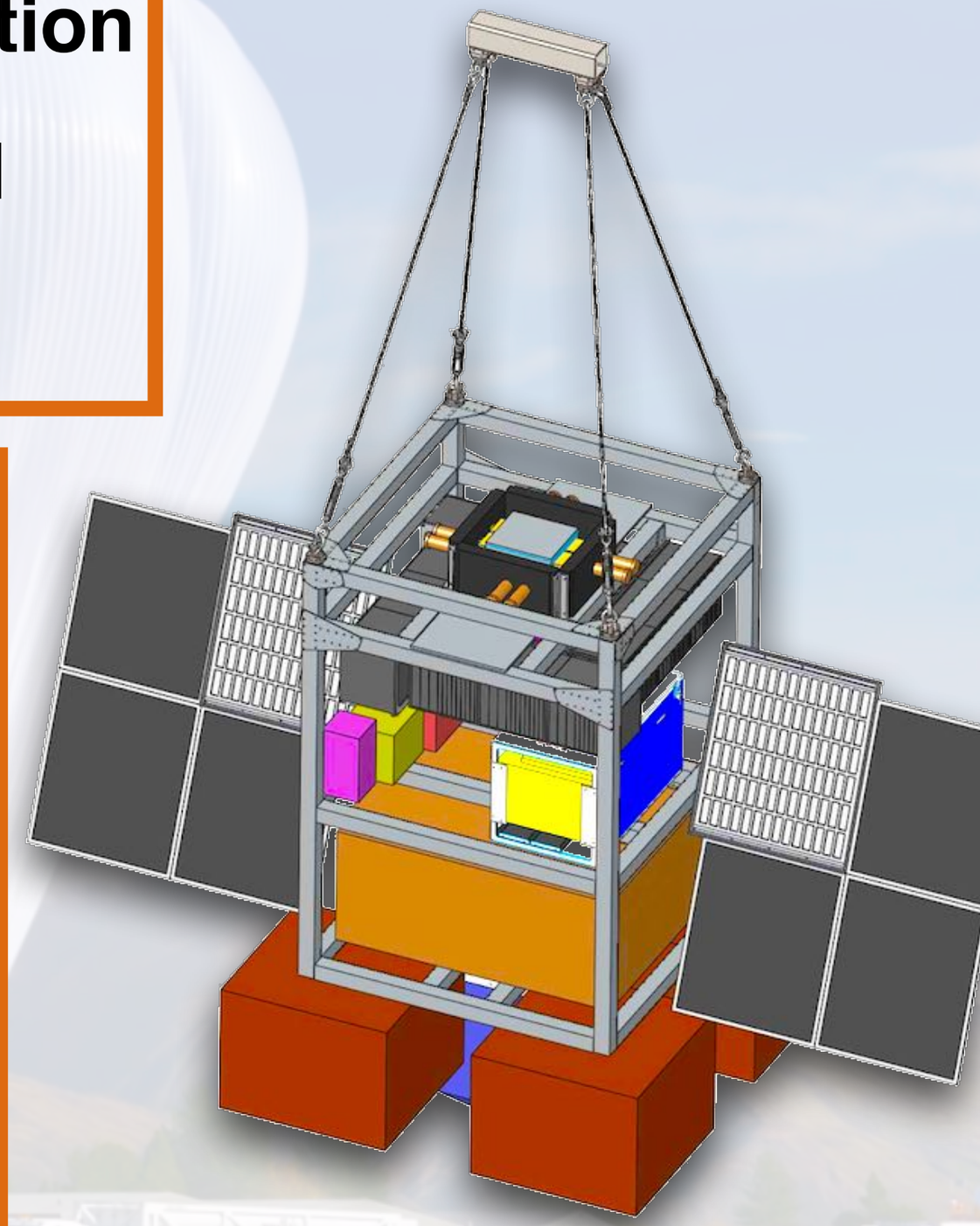
From COSI to ASCI: Simulations

Start with MEGAlib COSI simulation

Adopt the geometry for ASCI

Estimate the performance!





Thank you