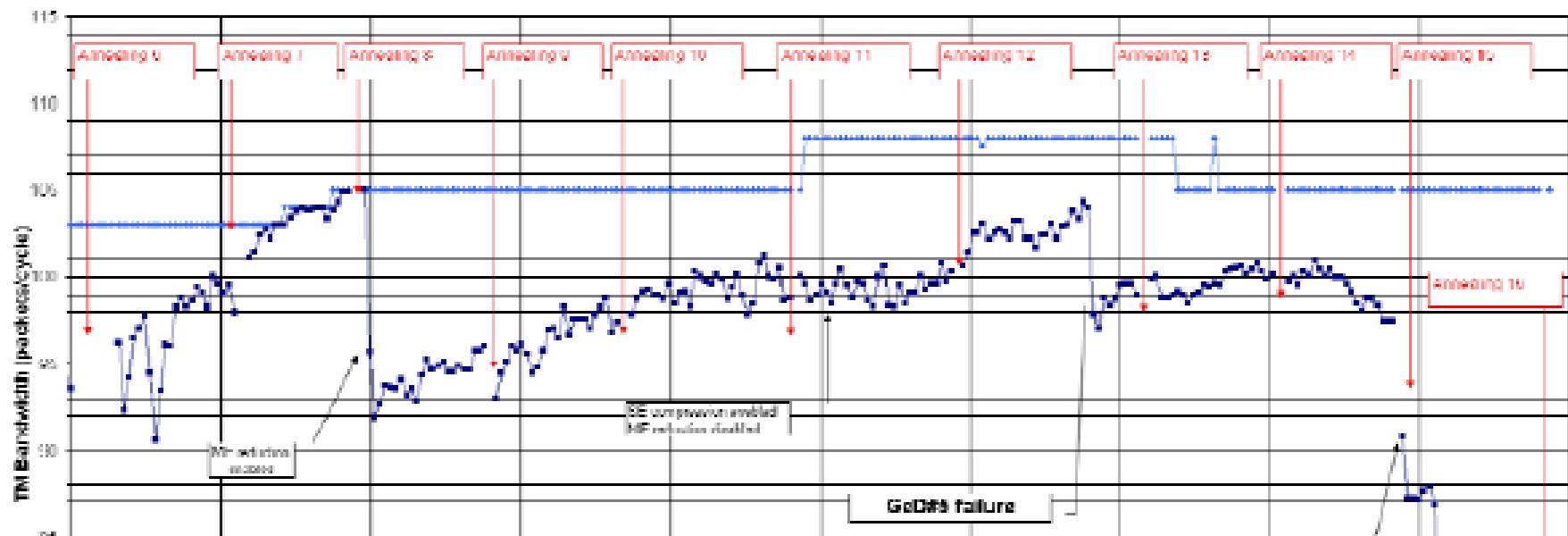
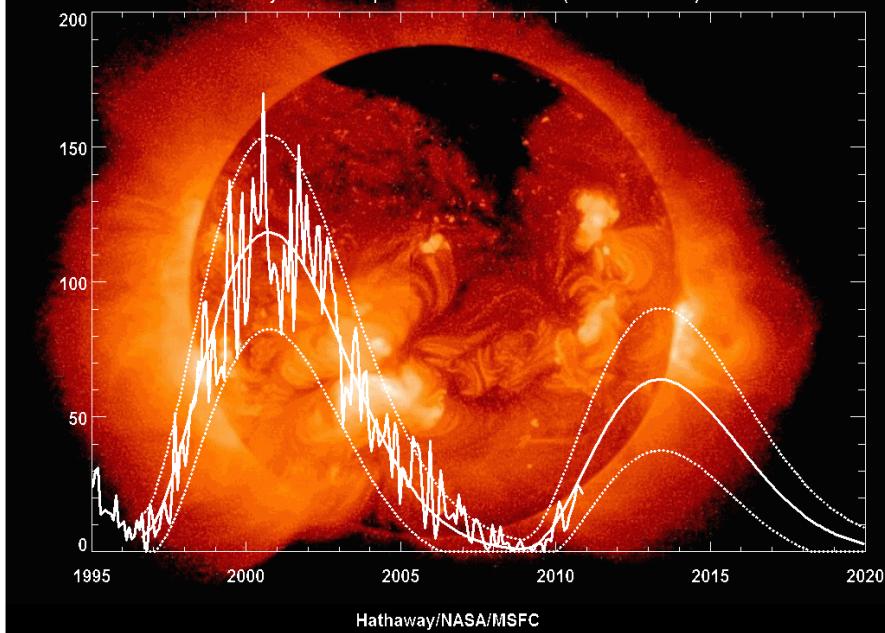


# SPI STATUS

SPI Mean TM Bandwidth Occupation in Science Mode



Cycle 24 Sunspot Number Prediction (December 2010)



Hathaway/NASA/MSFC

## GeD 1 FAILURE

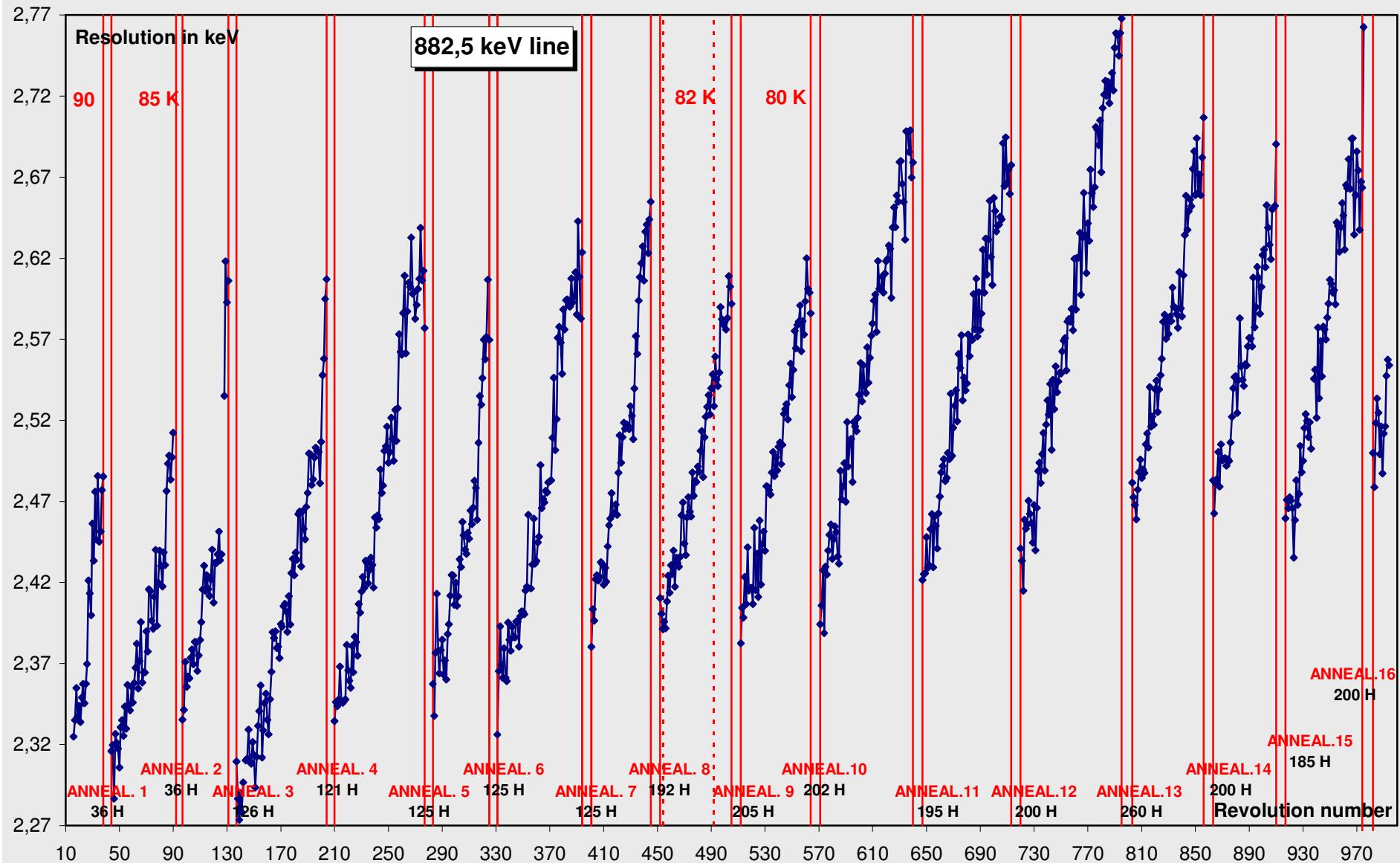
- May 25th GeD 1 stopped.
- Counting rate increase 2-3 seconds before
- Then preamp blocked with anomalous offset
- Similar to the other failures
- No clear explanation
- However seems to be linked to the HV
- **Can we reduce the risk ?**
- Yes, if we can reduce the HV

# ANNEALING: 16th SUMMARY

- Start: October 10<sup>th</sup>
- 105C on October 12th
- 200 hours at 105C
- October 23th : CDE on
- October 27th Camera switch-on at 98k
- Smooth reactivation
- Nominal HV set to 3 kV
- Recovery not perfect but “good”

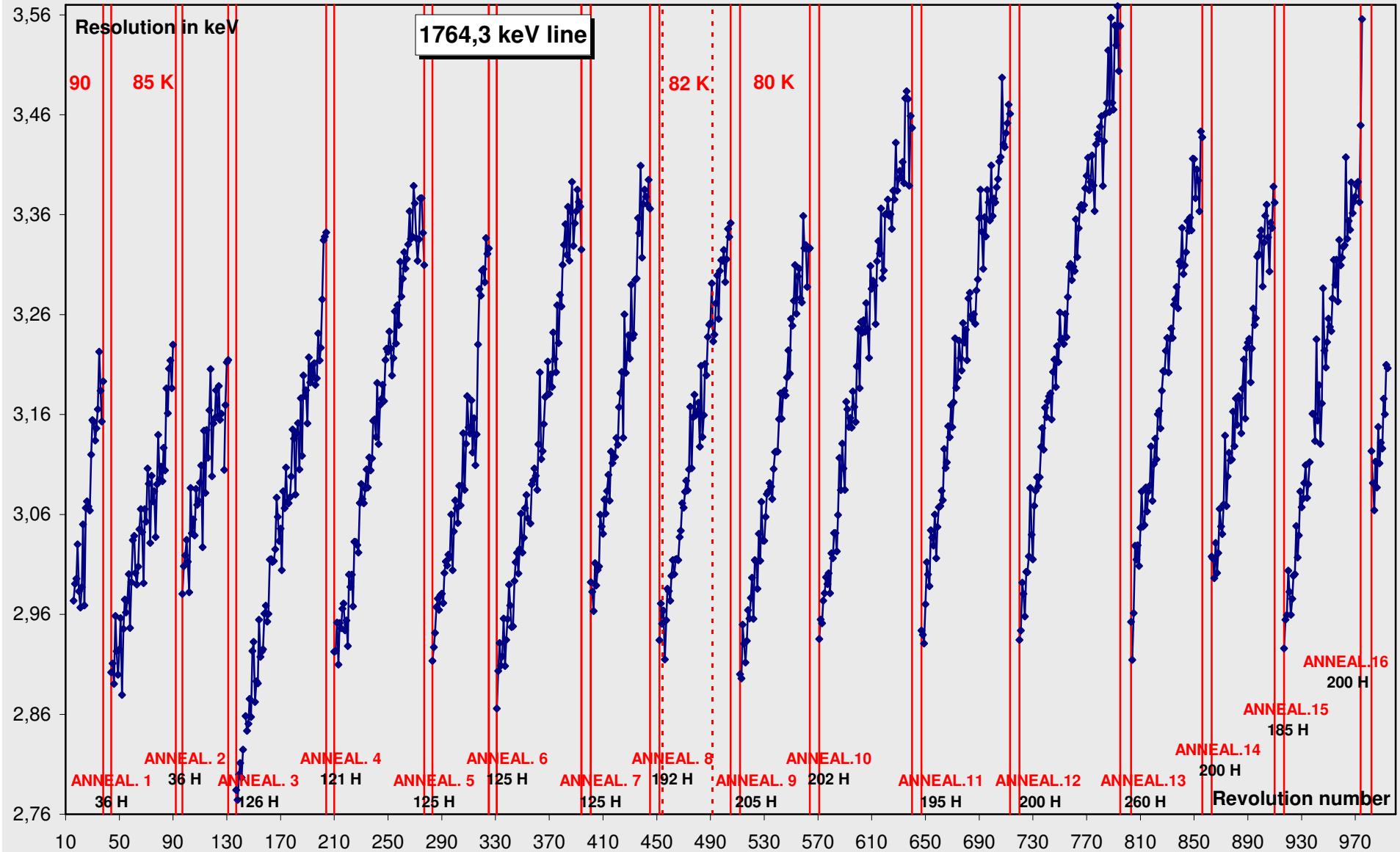
# ENERGY RESOLUTION HISTORY: 882.5 keV

- Regular annealing ( GeD at 105C) restore GeD energy resolution.



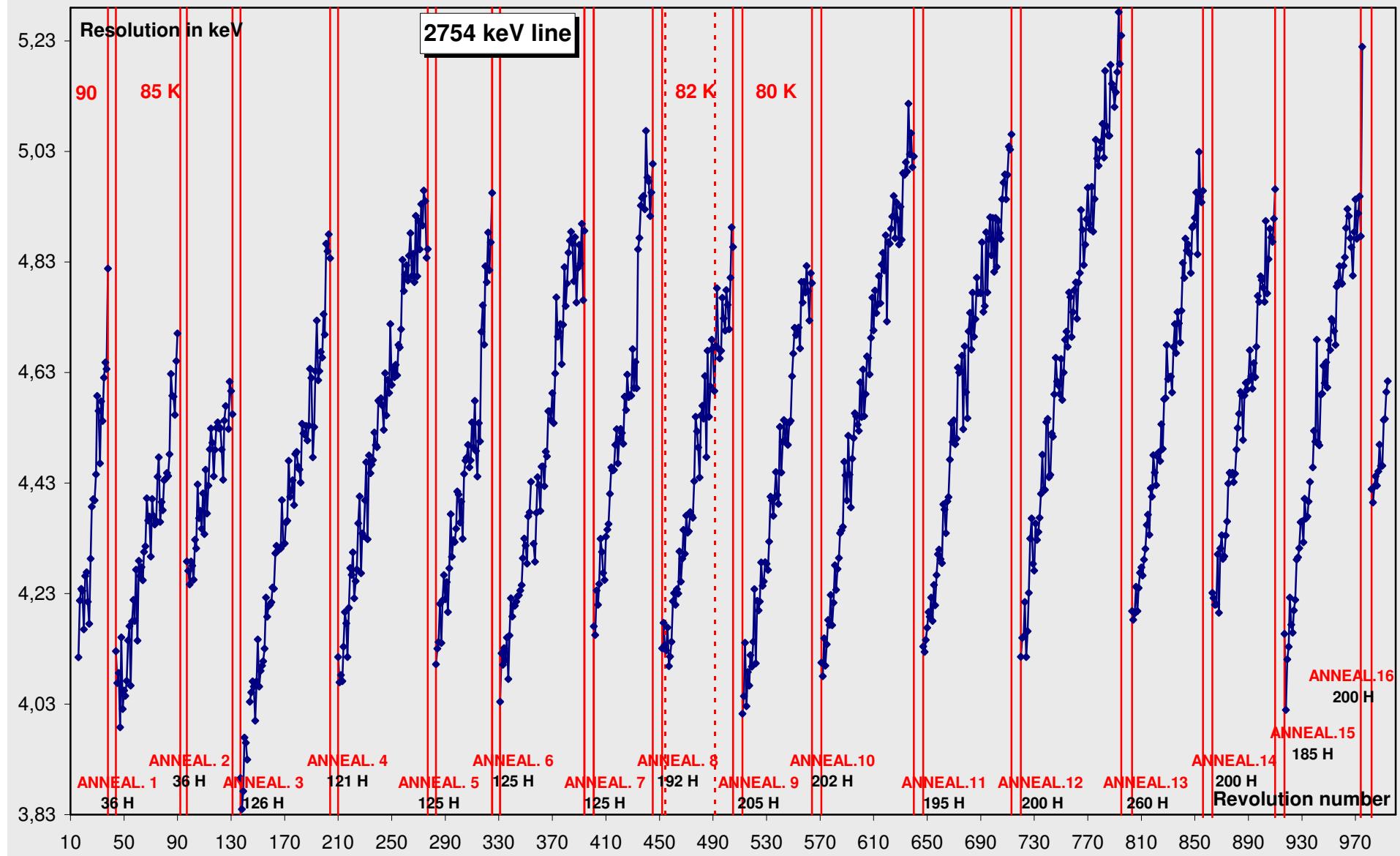
# ENERGY RESOLUTION HISTORY: 1764.3 keV

- Regular annealing ( GeD at 105C) restore GeD energy resolution.

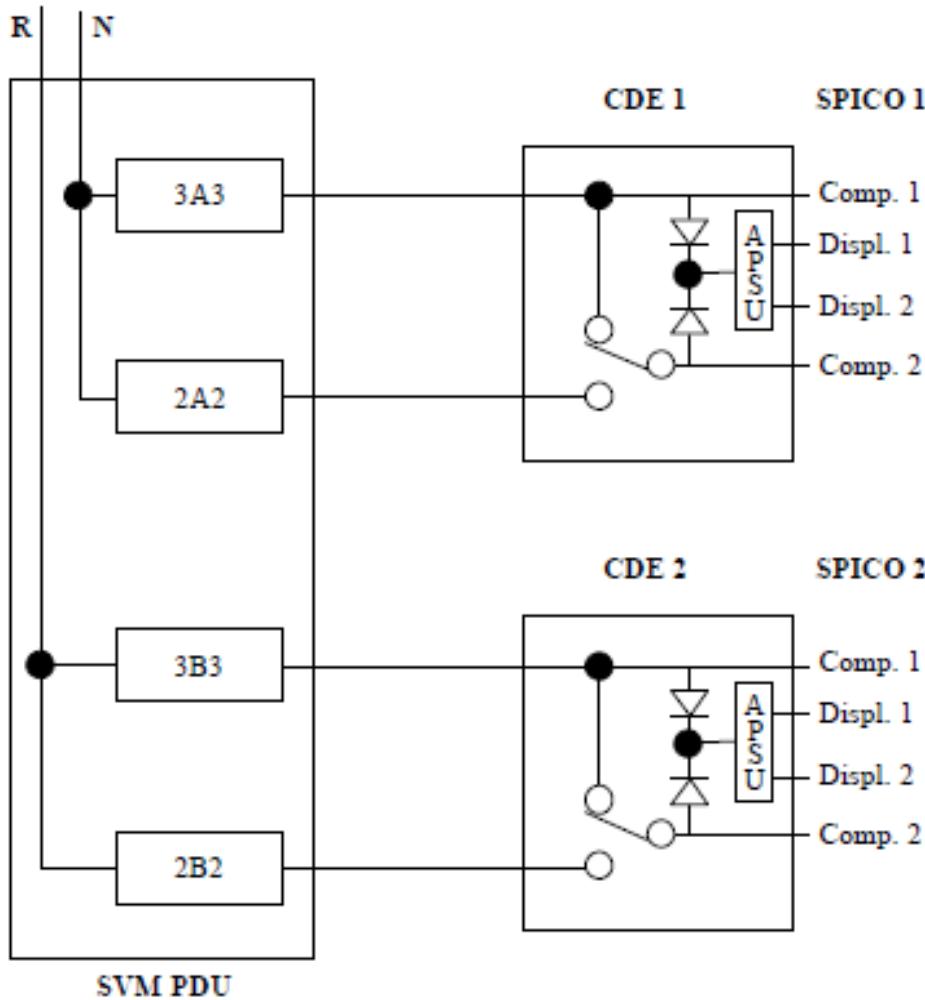


# ENERGY RESOLUTION HISTORY: 2754 keV

- Regular annealing ( GeD at 105C) restore GeD energy resolution.



# CDE “backup” configuration



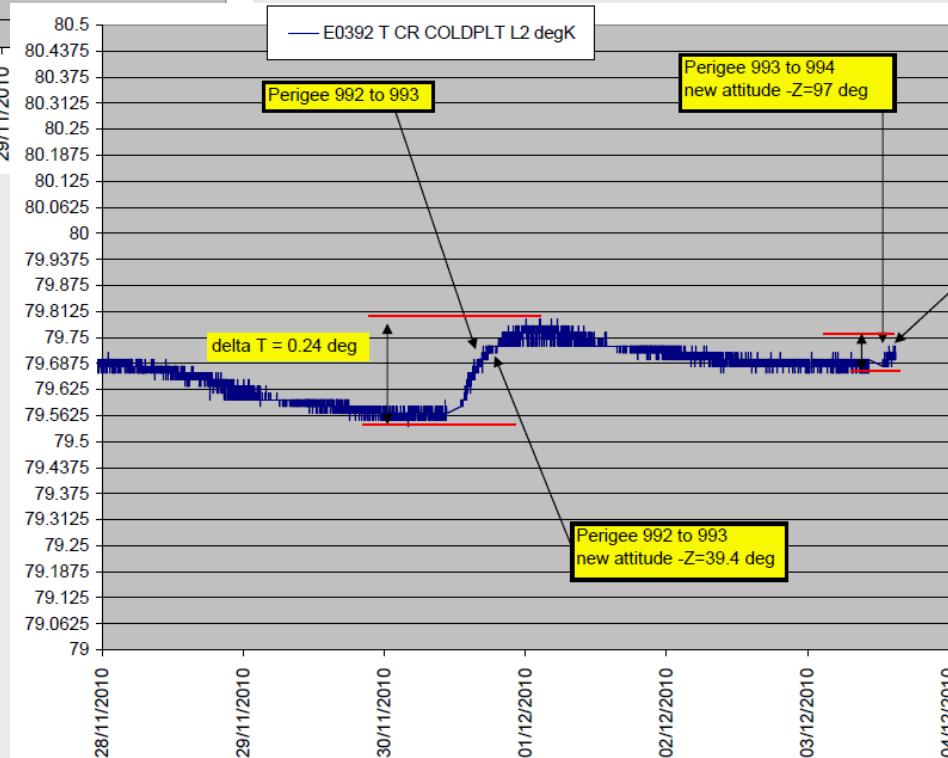
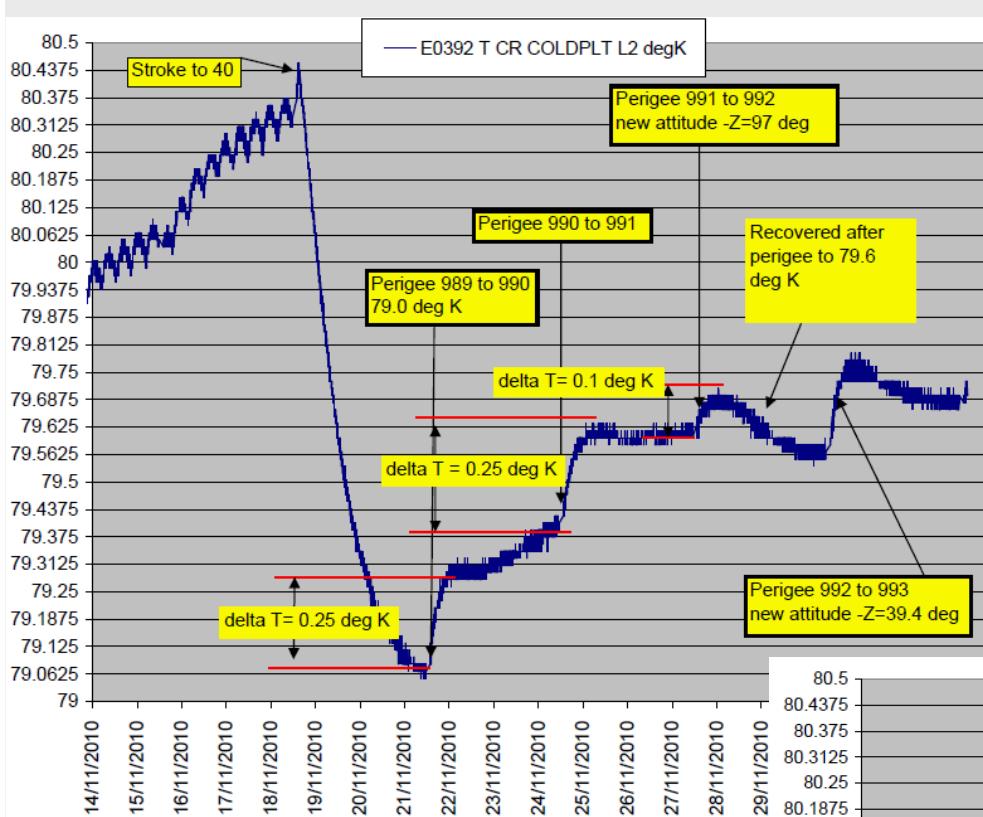
First attempt in April the relay didn't move....

Marginal design of the relay command

Test again with repeated pulses....

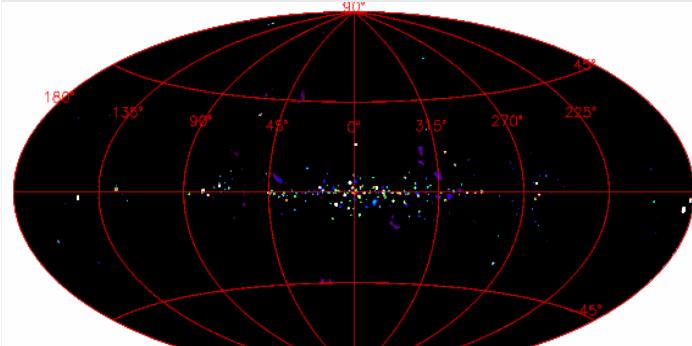
**Finally ESOC found that the relay worked but its status don't work.**

# PASSAGE AU PERIGEE: IMPACT DE L'ALBEDO TERRESTRE

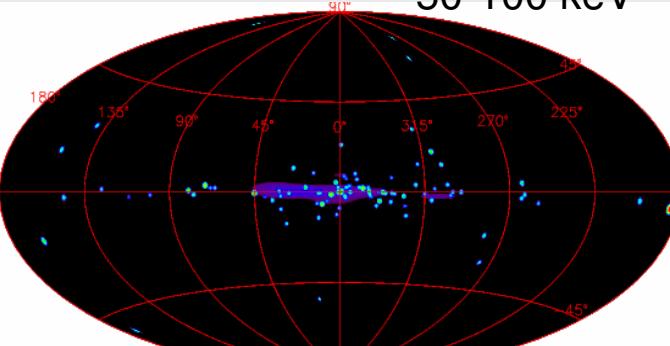


## INTEGRAL/SPI all-sky view of the Milky-way

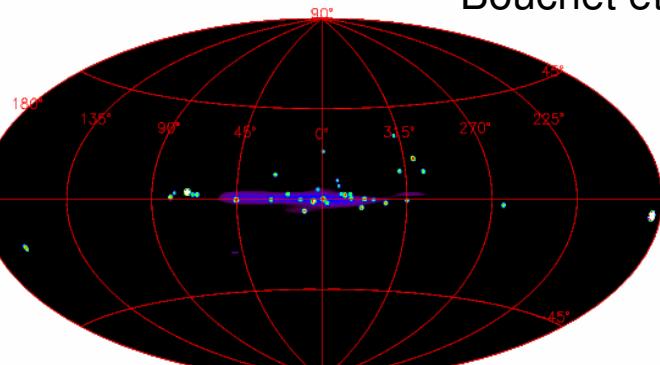
25-50 keV



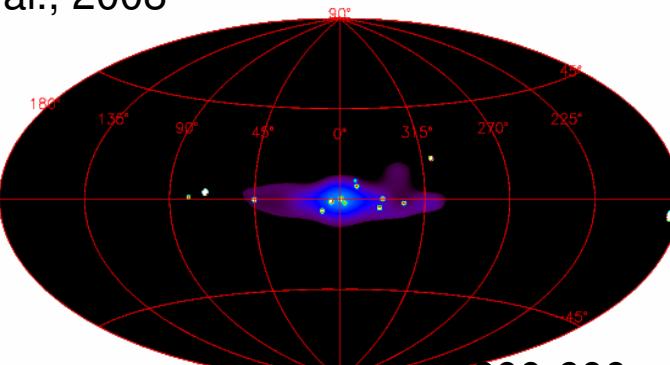
50-100 keV



Bouchet et al., 2008



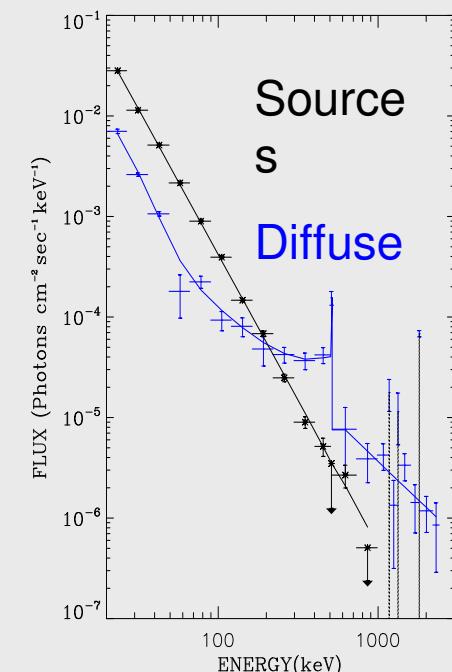
100-200  
keV



200-600  
keV

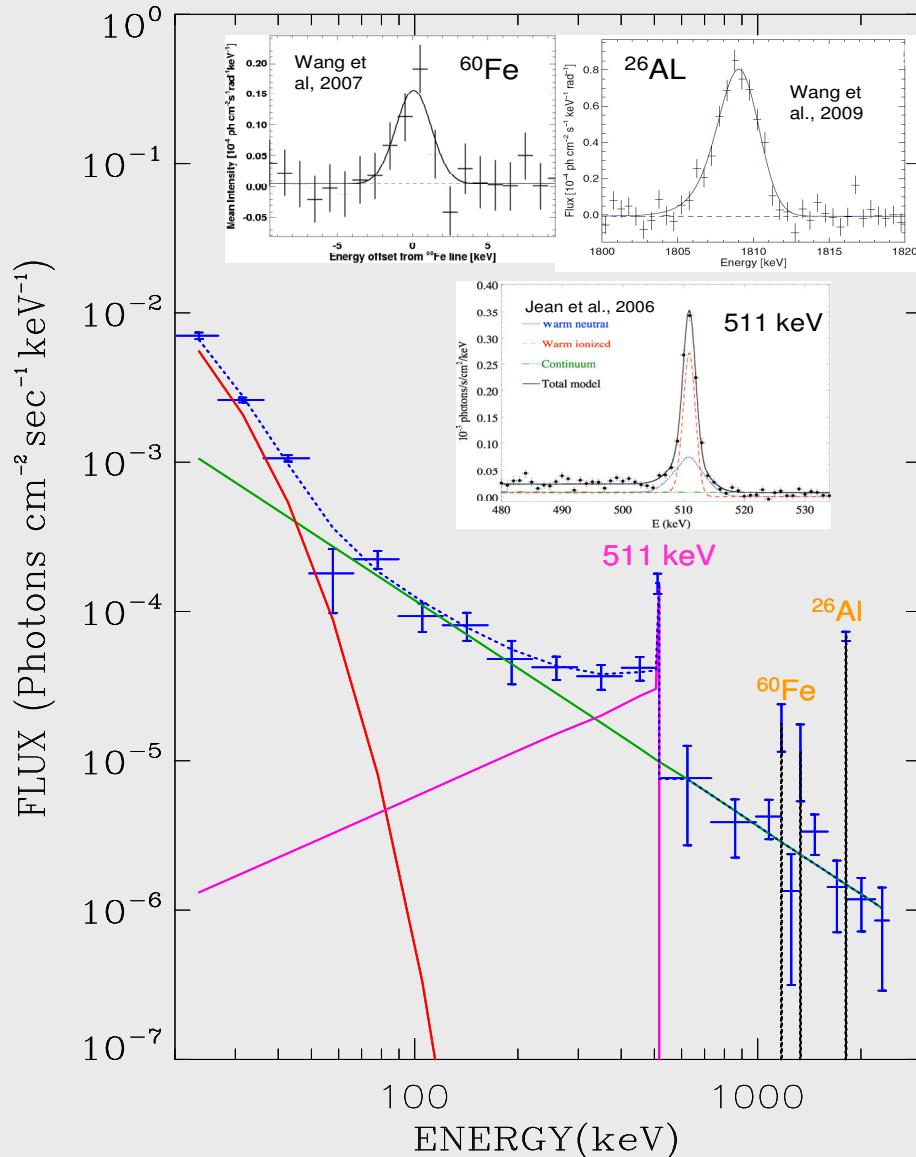
**SPI INNER GALAXY SPECTRUM**

( $|l| < 30^\circ$ ,  $|b| < 15^\circ$ )



- Point sources dominate the Milky Way (20-200 keV) emission, “diffuse” interstellar emission is weaker than previously reported (Lebrun et al., 2004, Bouchet 2008)
- The annihilation radiation dominates above 300 keV and reach a maximum at 511 keV (Bouchet et al., 2008)

# DIFFUSE INNER GALAXY SPECTRUM



## Positron Astronomy

511 e<sup>+</sup>e<sup>-</sup> keV line & positronium continuum

Morphology (Weidenspointner et al., 08, Bouchet et al., 10)

Bulge : 3° + 12° FWHM Gaussians

$F_{511} \sim 10^{-3}$  ph.cm<sup>-2</sup>.s<sup>-1</sup>

Disk :  $\sim 1.7 \times 10^{-3}$  ph.cm<sup>-2</sup>.s<sup>-1</sup>

f ~ 96 %

Spectroscopy (Churazov et al., 04, Jean et al., 06)  
Possible sources of positron ?

## Galactic radioactivities

(Diehl et al., 04, Harris et al., 07, Wang et al., 07, 09)

### Inner Galaxy

$^{60}\text{Fe}$ ,  $F_{\text{mean}} \sim 4 \times 10^{-5}$  ph.cm<sup>-2</sup>.s<sup>-1</sup> : from ISM  $\rightarrow$  SN origin?

$^{26}\text{Al}$ ,  $F \sim 3.1 \times 10^{-4}$  ph.cm<sup>-2</sup>.s<sup>-1</sup> : Ionized gas distribution

$^{60}\text{Fe}/^{26}\text{Al} \sim 18\%$

## Sources population synthesis (E < 100 keV)

↳ “Unresolved” sources population which contains mainly CV’s and coronally active stars (Krivonos et al., 07)

Diffuse continuum : interstellar particle interaction (GALPROP code)

Power law  $\alpha \sim 1.6$

# SPI SCIENCE

## Papers in Journals

Minaev, P. Yu.; Pozanenko, A. S.; Loznikov, V. M.  
Bouchet, L.; Roques, J. P.; Jourdain, E.  
Martin, P.; Vink, J.; Jiraskova, S.; Jean, P.; Diehl, R.  
Diehl, Roland et al.

Extended emission from short gamma-ray bursts detected with SPI-ACS/INTEGRAL  
On the Morphology of the Electron-Positron Annihilation Emission as Seen by Spi/integral  
Annihilation emission from young supernova remnants  
Massive-Star Nucleosynthesis: Lessons from INTEGRAL

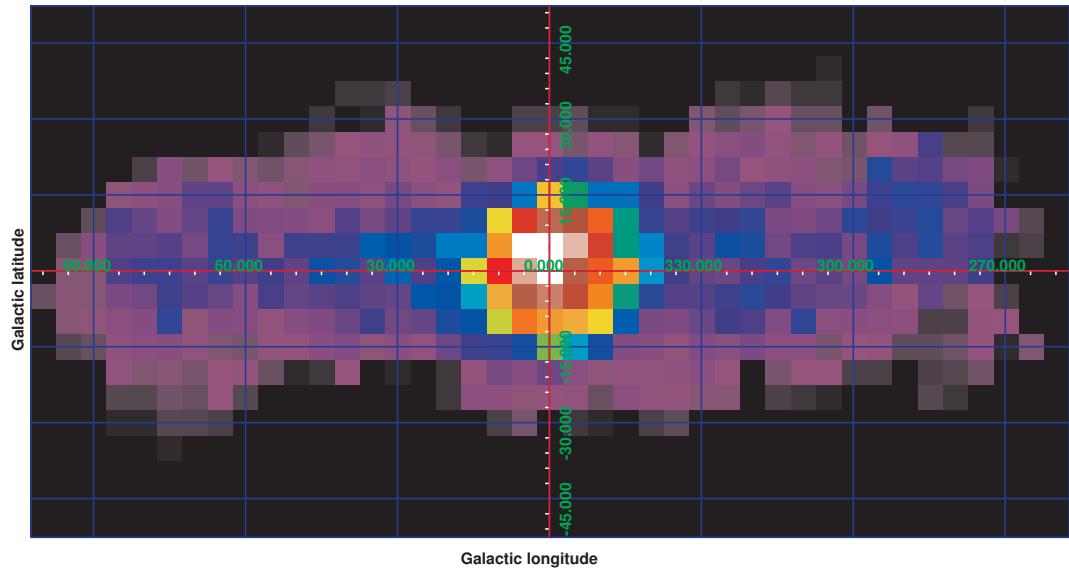
## Papers in preprint

Churazov, E. et al.  
Prantzos, N. et al.  
Bouchet, L. et al.  
Diehl, R. et al.

Positron annihilation spectrum from the Galactic Centre region, revisited: annihilation in a cooling ISM?  
The 511 keV emission from positron annihilation in the Galaxy  
On the morphology of the electron-positron annihilation emission as seen by SPI/INTEGRAL  
Radioactive  $^{26}\text{Al}$  from the Scorpius-Centaurus Association

## Picture-of-the-Month

- Dec-10 Radioactive  $^{26}\text{Al}$  from the Scorpius-Centaurus Association
- Oct-10 Doppler shift of the 1.8 MeV gamma-ray line from  $^{26}\text{Al}$  due to large-scale galactic rotation
- Mar-10 Massive Stars in the Cygnus Region

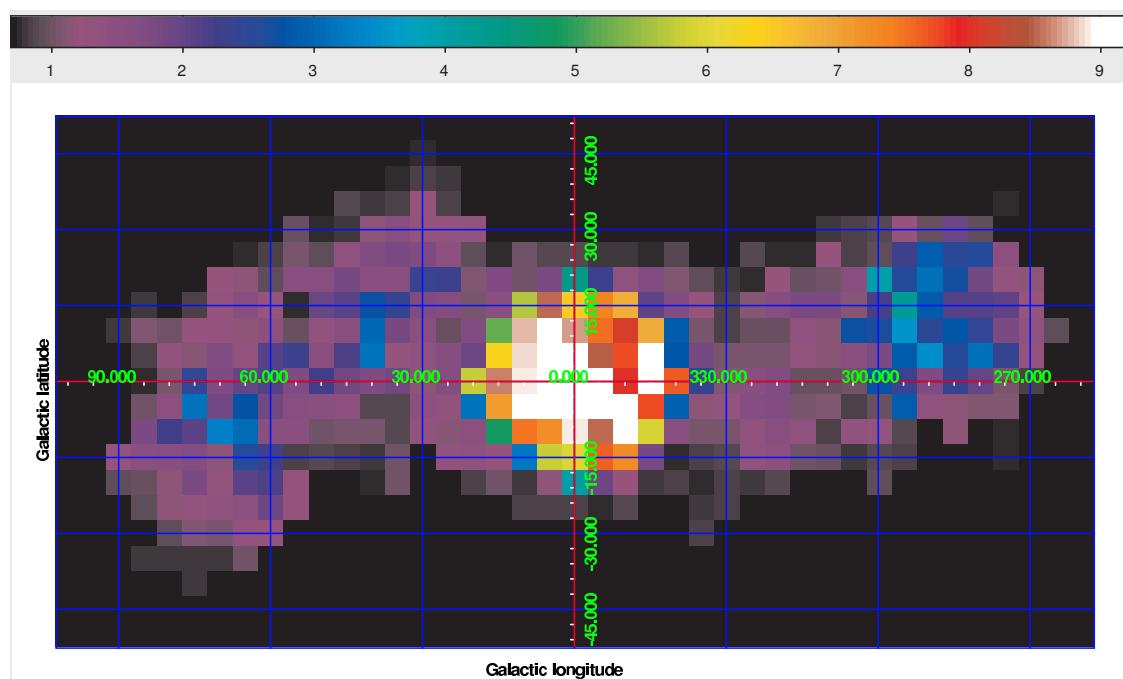


## 511 keV DISTRIBUTION MAP

508-514 maps obtained by direct system resolution. Likelihood maximization

Pixel size is  $5 \times 5$  deg.

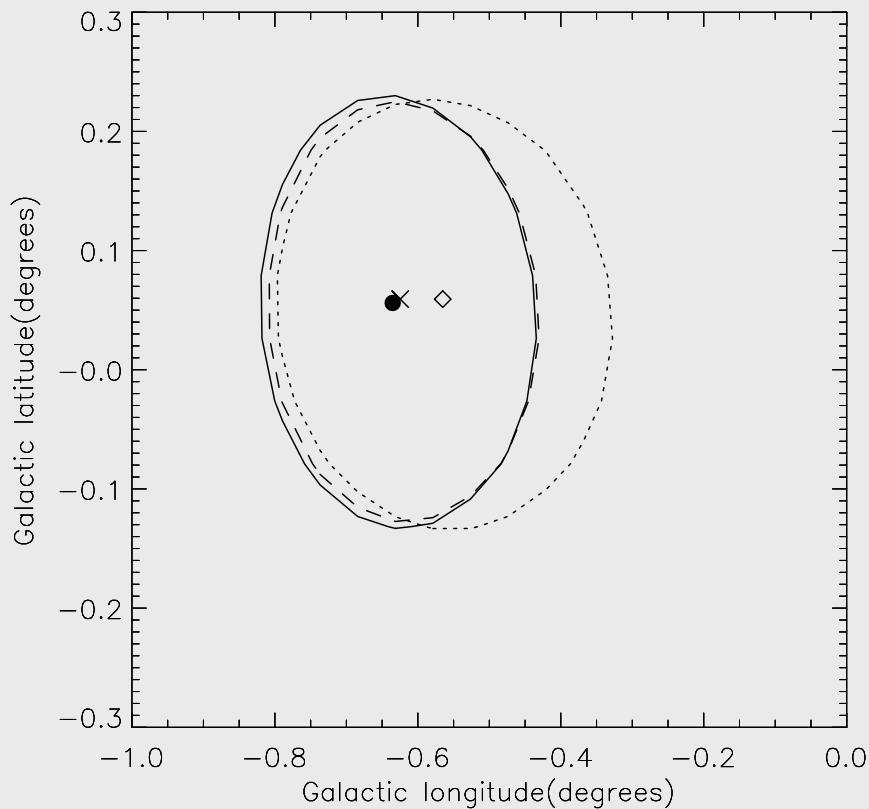
Significance map – note the low significance of disk pixels



Flux map

Bouchet, Roques, Jourdain, ApJ 2010

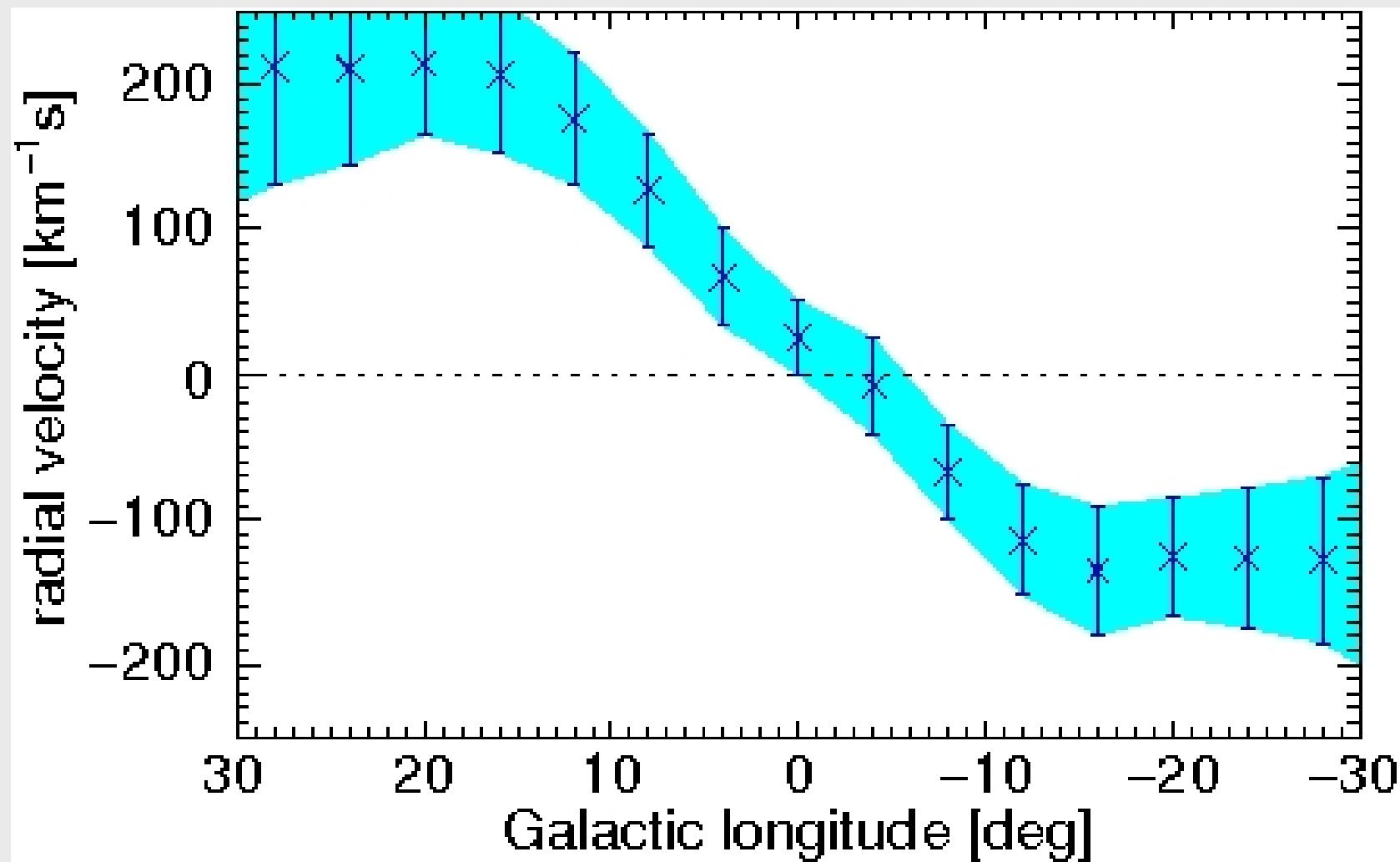
# THE BULGE EMISSION



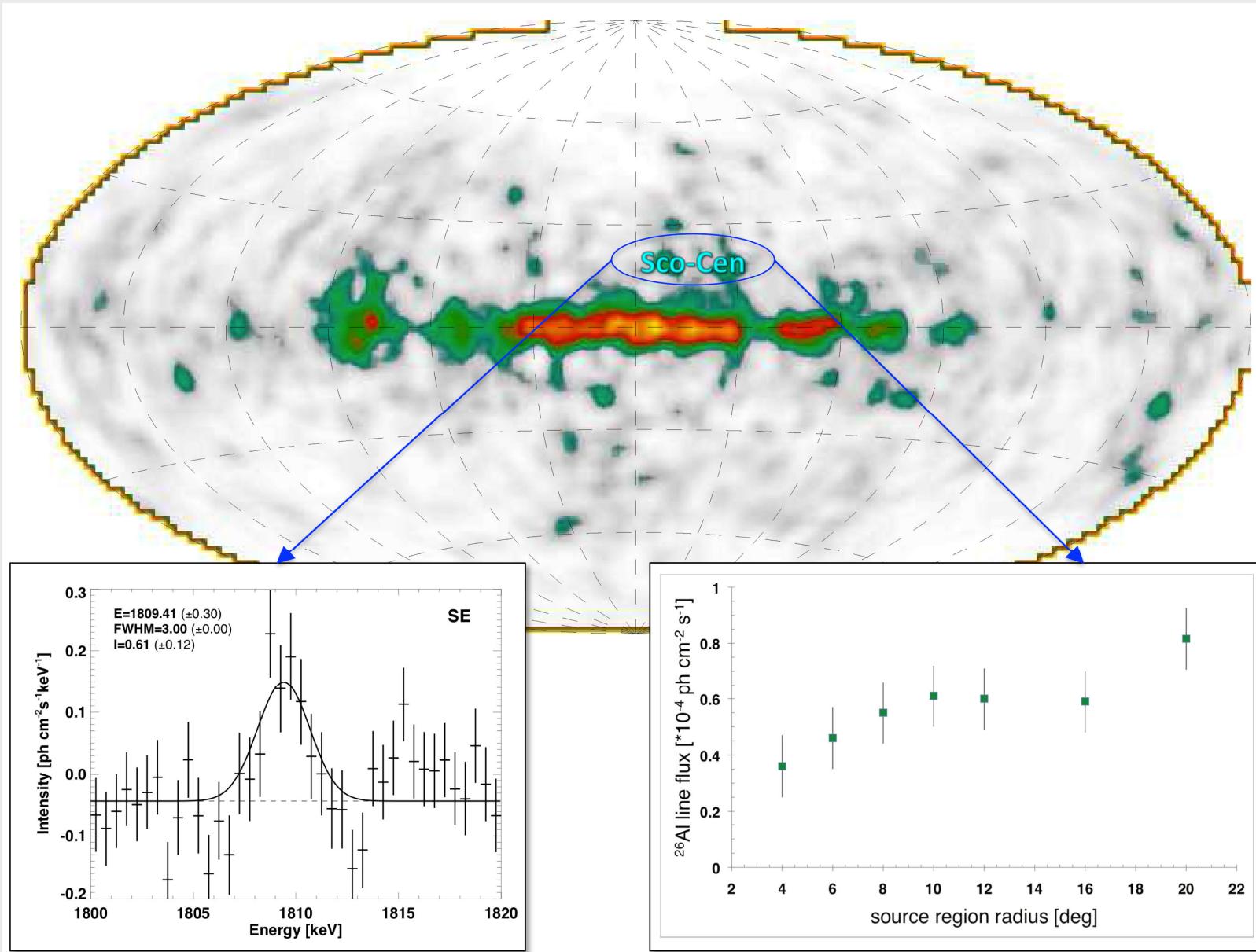
- 70  $\sigma$  detection in the data space.
- Good description of the bulge is provided by the sum of two axisymmetric gaussians:  
3.2 and 11.8 deg.
- The best centroid for this model is:  
 $l = 0.6 \pm 0.2$  deg.  
 $b = 0.06 \pm 0.2$  deg.
- Total flux is  $8 \times 10^{-4}$  ph/cm<sup>2</sup>.s

The disk component is represented by a 1-2 Gyr Robin disk

~ 220 deg. FWHM longitude, ~ 5.5 deg. FWHM latitude extension



# 26Al from Sco-Cen association



# Crab Nebula

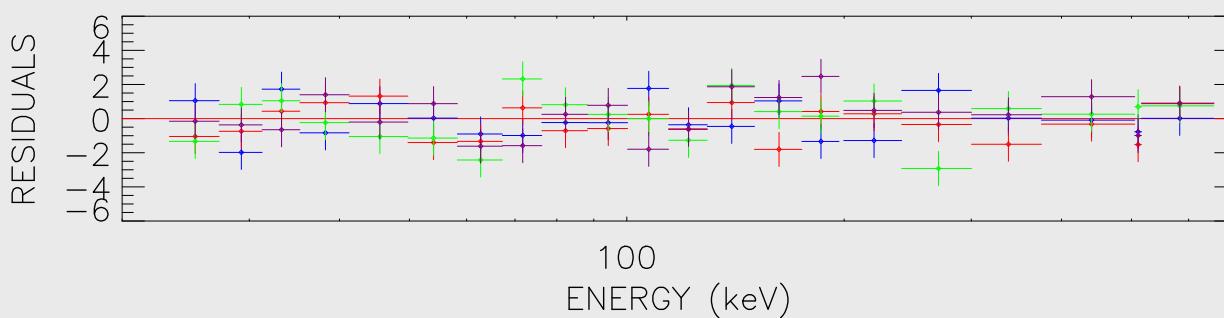
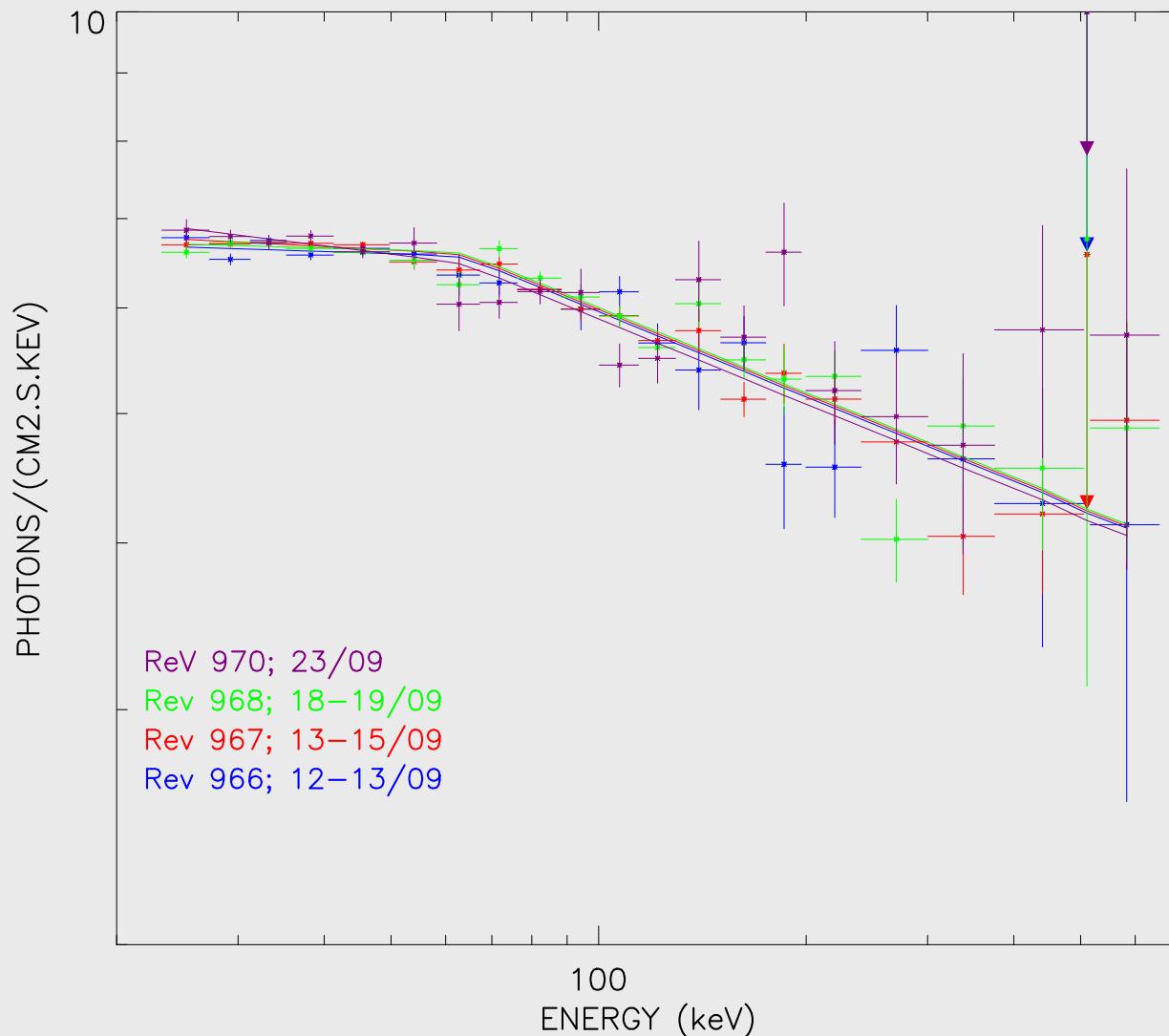
**Table 1**  
Log of the *INTEGRAL* SPI Observations Dedicated to the Crab Used in This Paper (Standard Dithering Modes)

Revolution Number	Start	End	Useful Duration ks	$F_{100\text{keV}}$ $\times 10^{-4}$ photon $\text{cm}^{-2} \text{s}^{-1} \text{keV}^{-1}$	Index1	Index2	$F_{100\text{keV}}$ $\times 10^{-4}$ photon $\text{cm}^{-2} \text{s}^{-1} \text{keV}^{-1}$
43	2003 Feb 19 16:06:05	2003 Feb 21 15:59:22	139.94	$6.3 \pm 0.2$	$2.08 \pm 0.01$	$2.25 \pm 0.03$	$6.5 \pm 0.2$
44	2003 Feb 22 04:06:15	2003 Feb 24 12:10:57	156.22	$6.5 \pm 0.2$	$2.07 \pm 0.01$	$2.24 \pm 0.03$	$6.6 \pm 0.2$
45	2003 Feb 25 03:58:54	2003 Feb 26 16:51:08	106.22	$6.5 \pm 0.2$	$2.05 \pm 0.01$	$2.24 \pm 0.03$	$6.8 \pm 0.2$
Sum 1	Rev 43	Rev 45	402.38	$6.45 \pm 0.1$	$2.07 \pm 0.01$	$2.24 \pm 0.02$	$6.6 \pm 0.1$
239	2004 Sep 29 11:12:34	2004 Sep 29 22:38:05	31.14	$6.4 \pm 0.2$	$2.07 \pm 0.02$	$2.33 \pm 0.07$	$6.6 \pm 0.2$
300	2005 Mar 29 12:00:27	2005 Mar 30 01:18:30	38.72	$6.3 \pm 0.2$	$2.08 \pm 0.02$	$2.23 \pm 0.07$	$6.5 \pm 0.2$
365	2005 Oct 11 08:33:49	2005 Oct 11 19:11:44	30.51	$6.6 \pm 0.2$	$2.05 \pm 0.02$	$2.31 \pm 0.07$	$6.8 \pm 0.2$
422	2006 Mar 28 17:28:11	2006 Mar 29 07:27:19	38.70	$6.5 \pm 0.2$	$2.07 \pm 0.0$	$2.23 \pm 0.07$	$6.6 \pm 0.2$
483 <sup>a</sup>	2006 Sep 29 01:40:14	2006 Sep 29 14:27:34	32.41	$6.5 \pm 0.3$	$2.1 \pm 0.03$	$2.26 \pm 0.08$	$6.5 \pm 0.2$
541	2007 Mar 19 13:25:14	2007 Mar 20 15:34:16	71.34	$6.3 \pm 0.2$	$2.07 \pm 0.02$	$2.27 \pm 0.08$	$6.4 \pm 0.2$
605	2007 Sep 27 00:21:34	2007 Sep 28 06:09:51	81.56	$6.4 \pm 0.2$	$2.07 \pm 0.02$	$2.24 \pm 0.05$	$6.6 \pm 0.2$
Sum 2	Rev 239	Rev 605	324.4	$6.35 \pm 0.1$	$2.07 \pm 0.01$	$2.25 \pm 0.03$	$6.55 \pm 0.1$
665	2008 Mar 24 11:57:5	2008 Mar 27 00:06:30	146.44	$6.6 \pm 0.2$	$2.07 \pm 0.01$	$2.27 \pm 0.03$	$6.7 \pm 0.2$
666	2008 Mar 27 11:40:28	2008 Mar 29 23:51:34	154.35	$6.5 \pm 0.2$	$2.06 \pm 0.01$	$2.26 \pm 0.03$	$6.7 \pm 0.2$
727	2008 Sep 25 22:34:01	2008 Sep 28 11:06:32	161.02	$6.5 \pm 0.2$	$2.07 \pm 0.01$	$2.22 \pm 0.03$	$6.7 \pm 0.2$
Sum 3	Rev 665	Rev 727	461.81	$6.5 \pm 0.1$	$2.06 \pm 0.01$	$2.25 \pm 0.04$	$6.7 \pm 0.1$

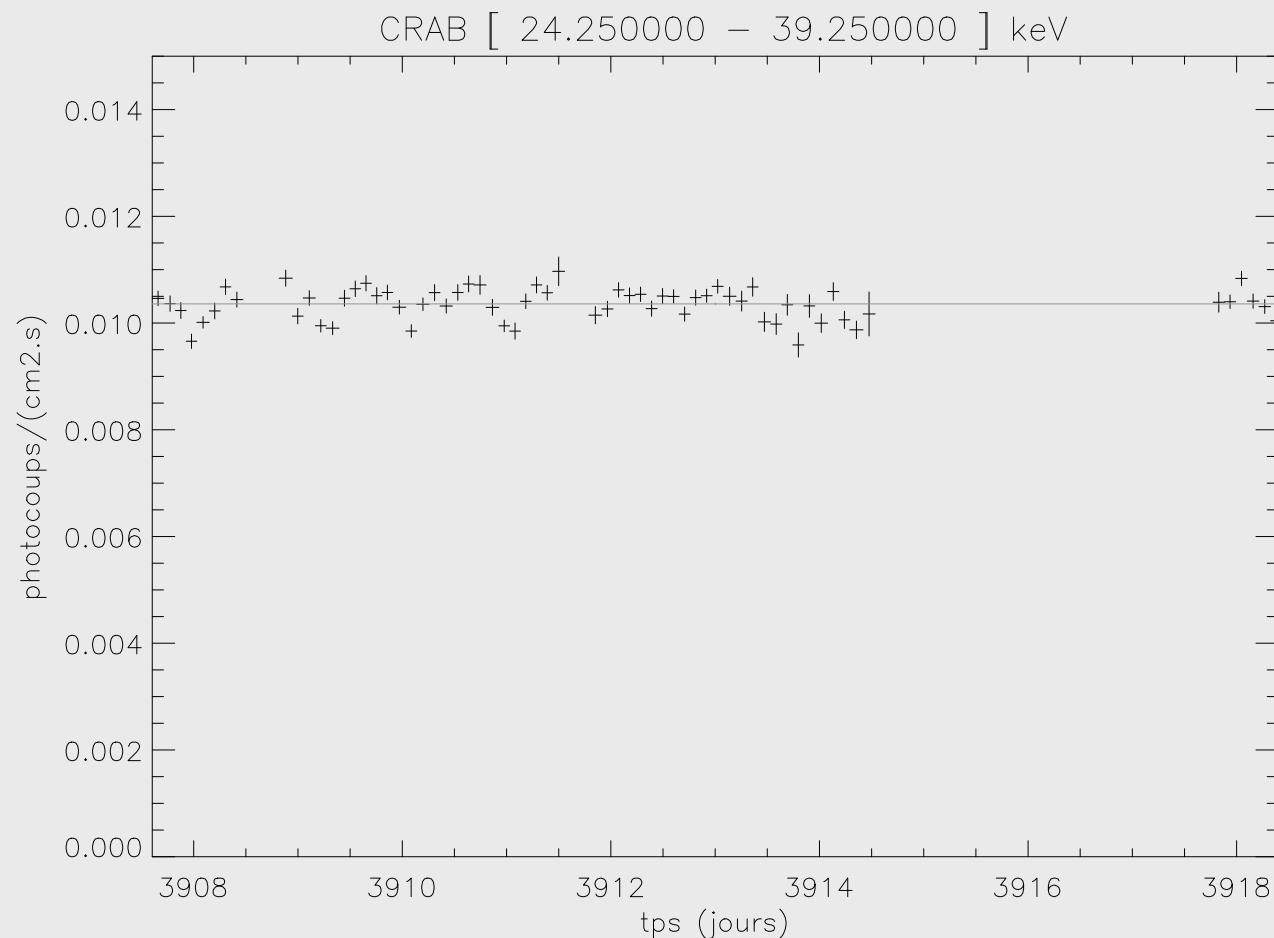
**Notes.** Columns 6–8 give the best-fit parameters for a broken power-law model with the break energy fixed to 100 keV. The data have been fitted between 23.5 and 1 MeV (6 MeV for summed spectra) with no systematic. Column 5 is the model independent 100 keV flux (see Section 3.1).

<sup>a</sup> Rev 483 has been performed with a 5×5 grid with 1° step instead of 2°.

100 keV flux for Rev 966 967 968 970 are: 6.6 - 6.6 - 6.7 - 6.5 10-4 ph/cm2/s/keV



# Crab Nebula: 966-967-968-970



## FUTURE CALIBRATIONS

ONE PATTERN (50ks) PROVIDES « ENOUGH » STATISTICS UP TO  $\sim 200$  keV

- Each annealing increases the central hole size: the high energy efficiency will necessarily decrease.
- 4 Revs allows a good control of SPI up to  $\sim 2$  MeV
- AIM is to obtain

RELIABLE DATA UP TO A FEW MEV  
IN THE STANDARD 5X5 PATTERN  
AND  
REFERENCE SPECTRA FOR CROSS-CALIBRATION

« good » cross calibration only exists for 16 ks !

IUG has accepted the principle of 4 revolutions per year on Crab