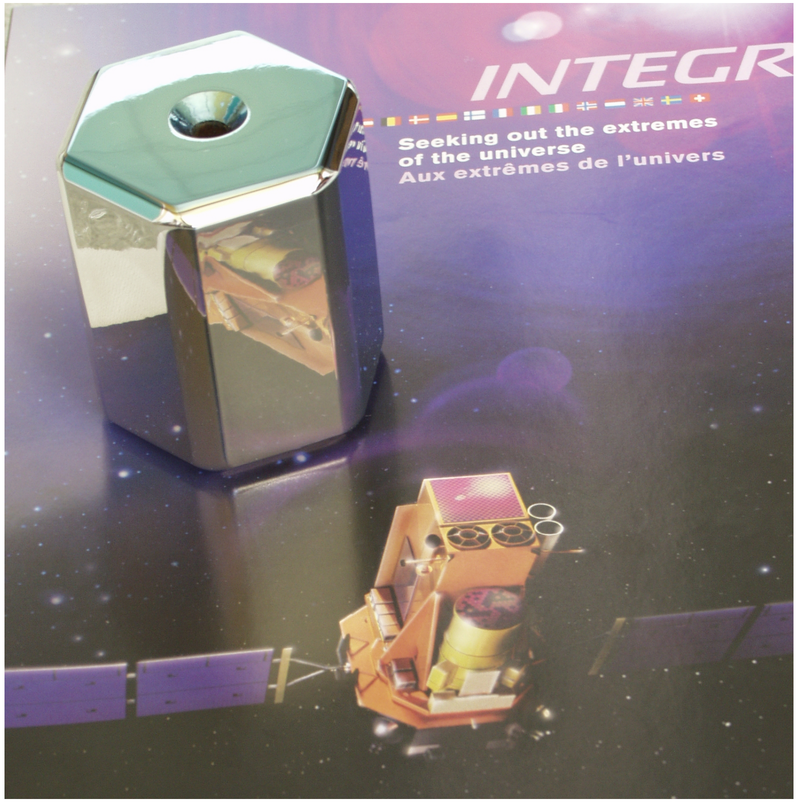
THE SPI/INTEGRAL CALIBRATION STATUS



- Some SPI specificities
- Crab nebula spectral study and results
- On-going instrumental work

E. Jourdain

IACHEC, April 2011

SPI STATUS

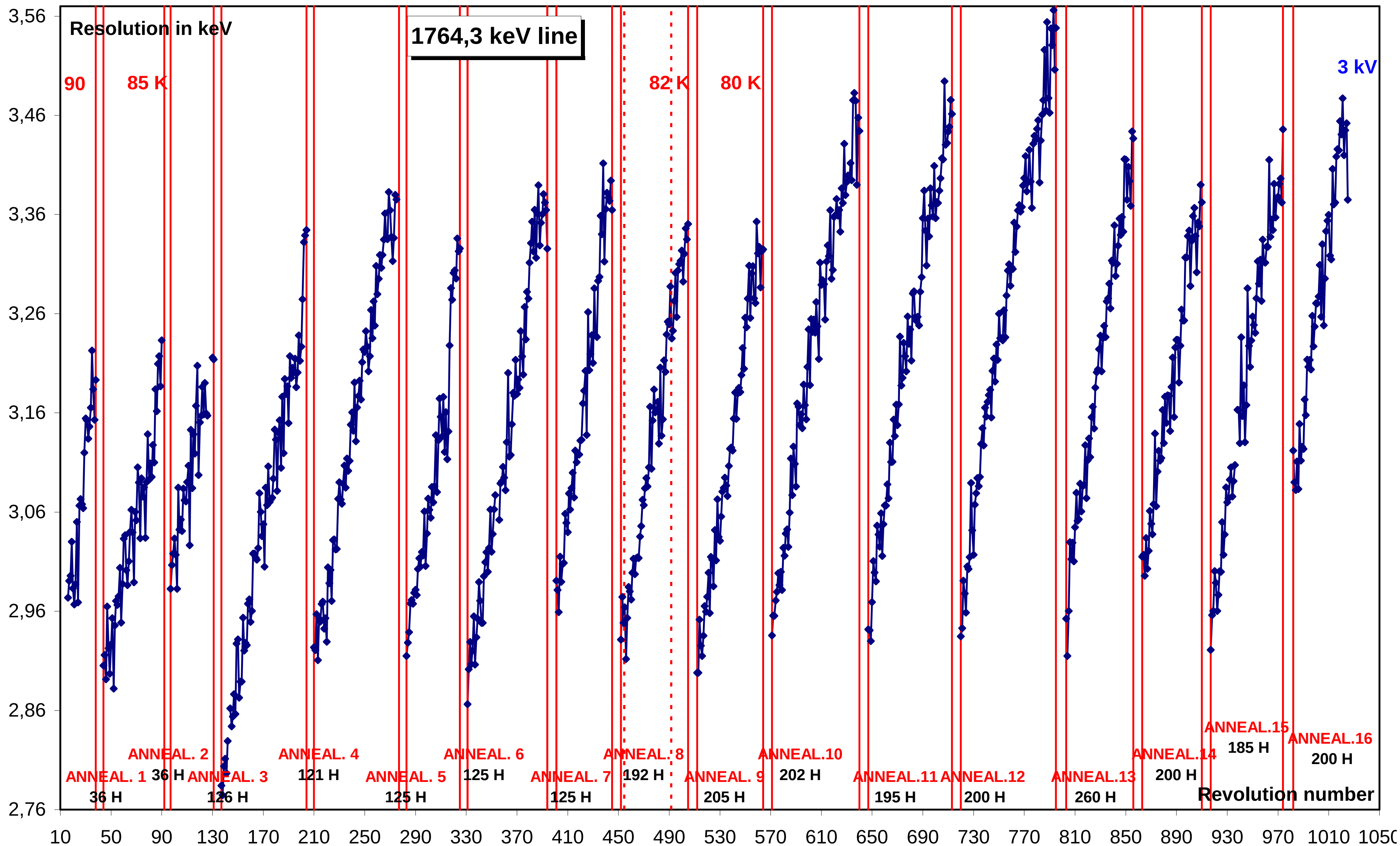
- Matrices based on ground calibrations + simulation works → Crab Nebula observations used to check performance evolution
- 4 Ged failures : Matrices correction by MC tool

  19 → 15 crystals : 15/19 ~ 0.79 of the initial area

  sqrt (0.79) ~ 0.89 of the initial sensitivity
- Regular improvements of on-board software:
  - Implementation of on-board data compression to stay into the allocated TM
- Energy resolution control
  - Regular annealings ---- each 6 months

ENERGY RESOLUTION HISTORY: 1764.3 keV

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



SPECTROSCOPY: ENERGY CALIBRATION

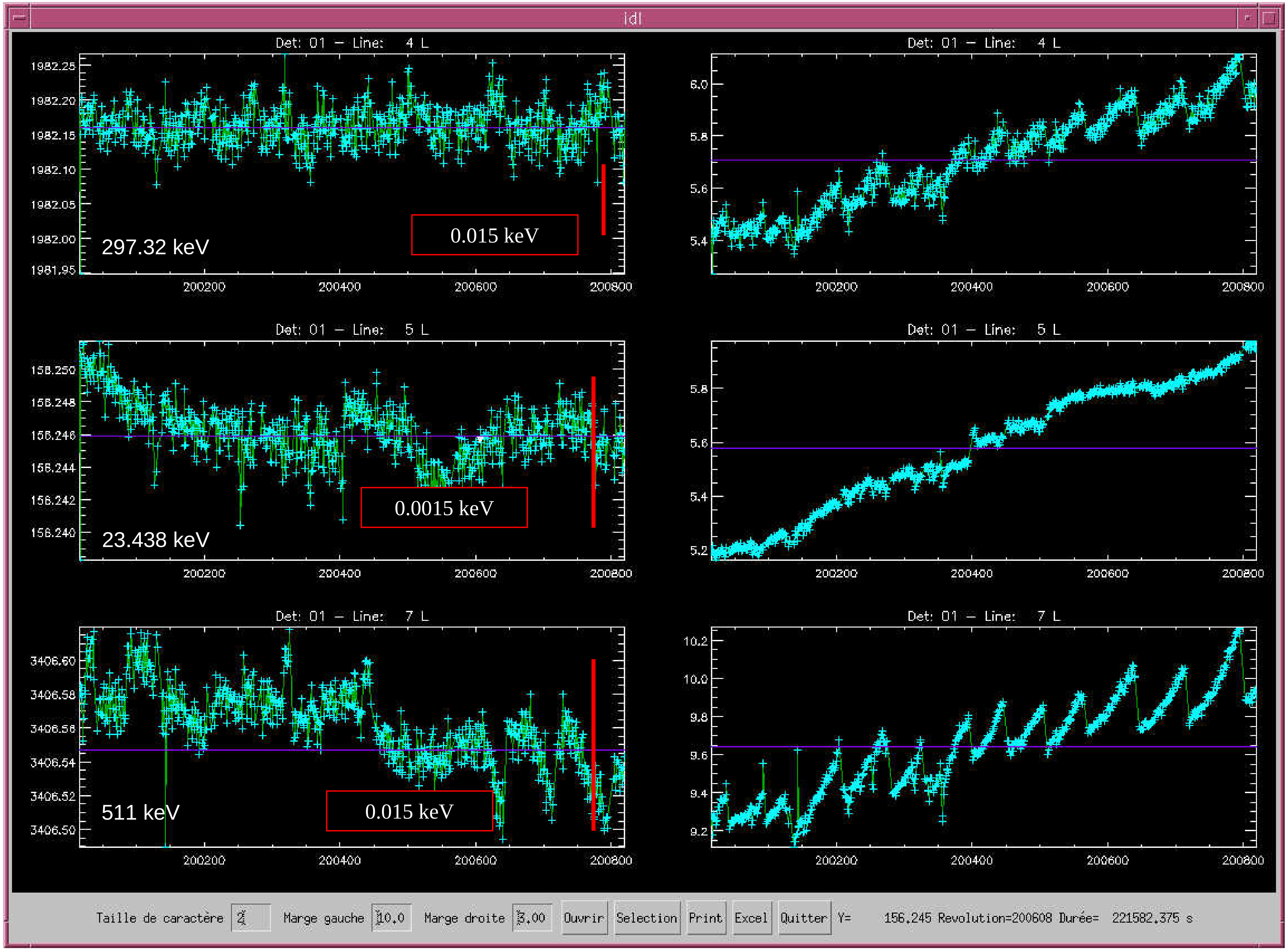
- The calibration is done on a per revolution basis
- Low energy range 20 keV – 2 MeV : 6 gamma ray lines fitted

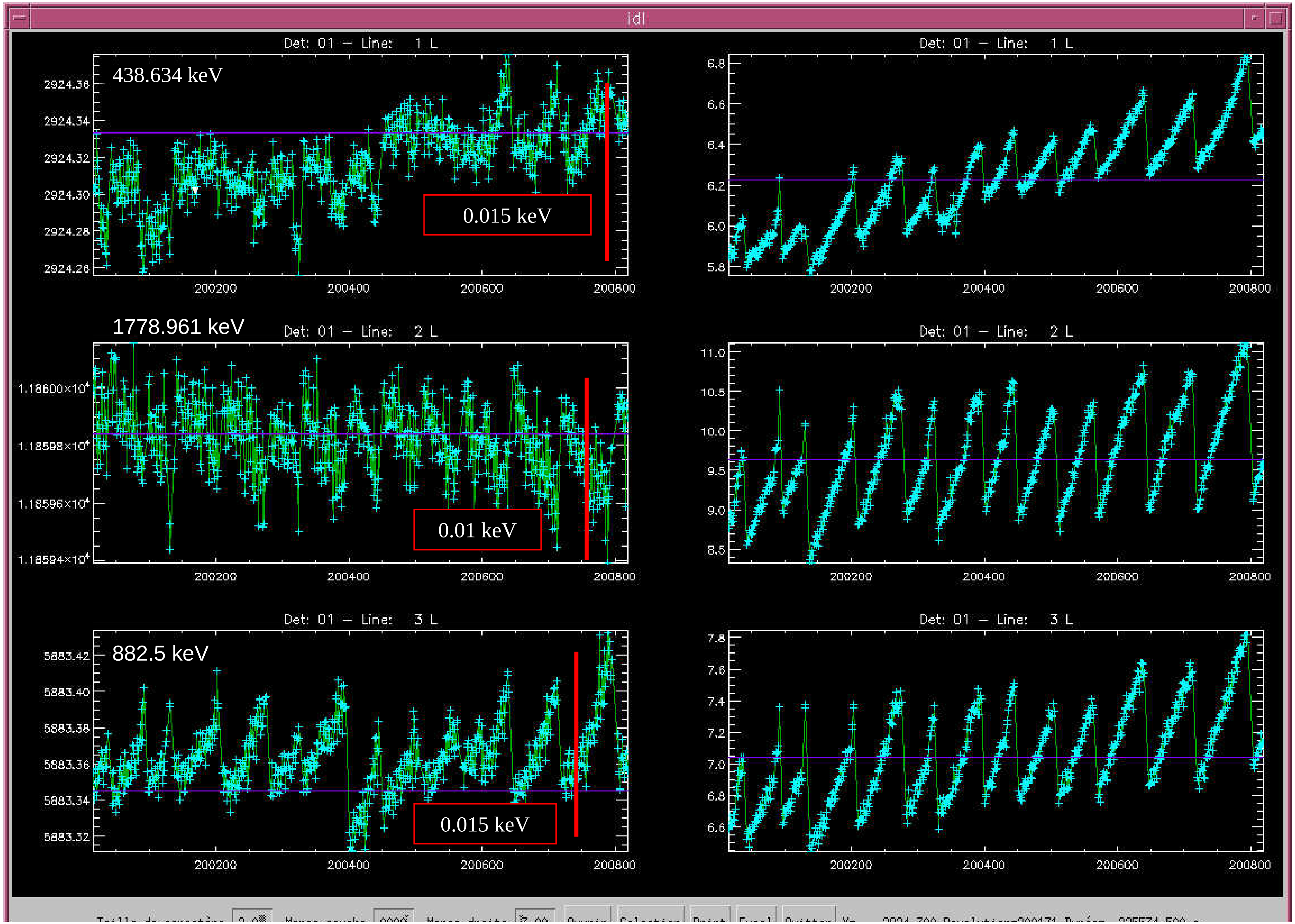
$$E = a \, Log(C) + b + c\,C + d\,C^2 + e\,C^3$$

- High energy range 2 MeV – 8 MeV : 2 gamma ray lines fitted

$$E = a\,C + b$$

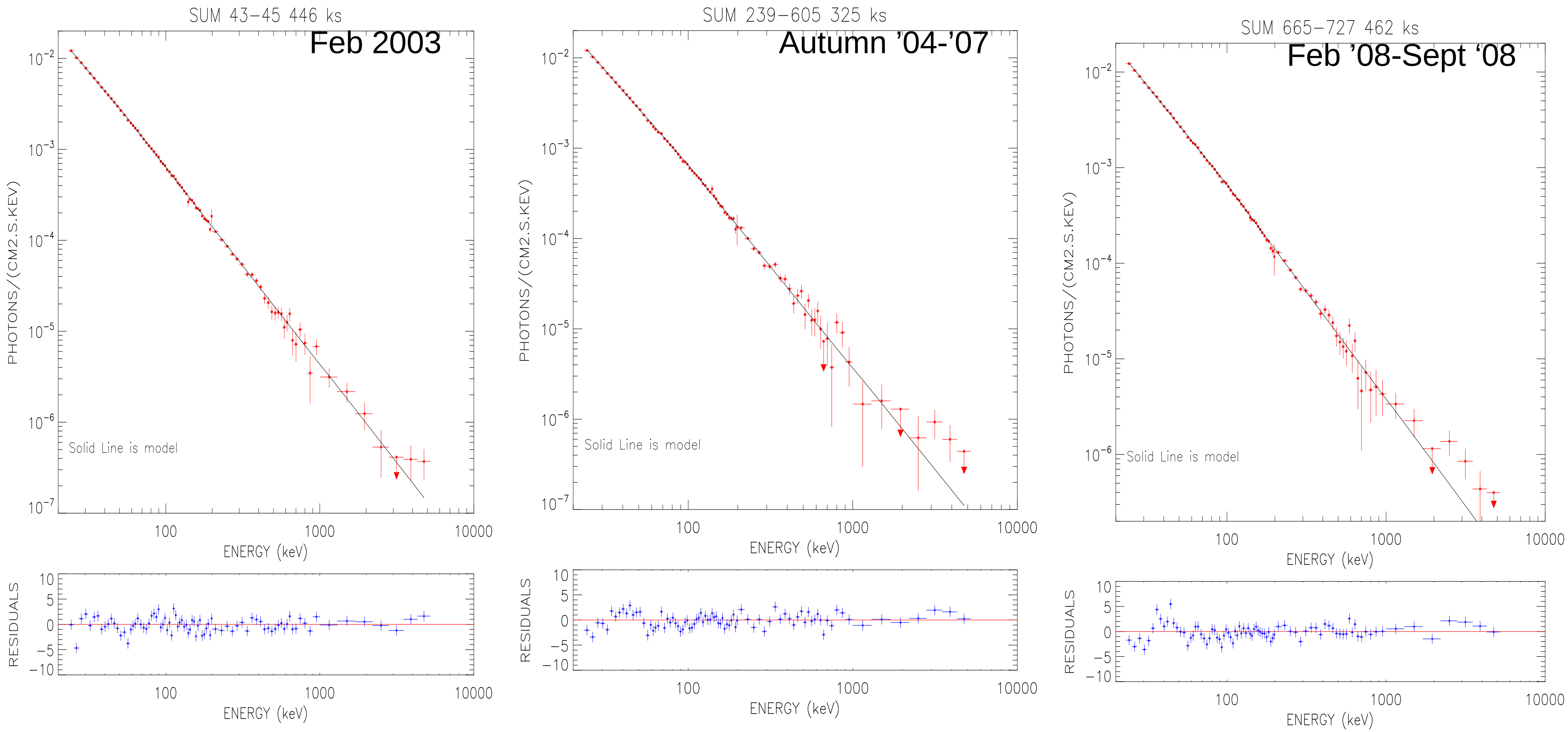
- Improvement of calibration stability (in particular above 700 keV)
  - Improves the matching between detectors and revolutions
- Coefficients will be available soon on CESR SPI web site


idl
Det: 01 — Line: 4 L
297.32 keV
0.015 keV
Det: 01 — Line: 5 L
23.438 keV
0.0015 keV
Det: 01 — Line: 7 L
511 keV
0.015 keV
Taille de caractère
Marge gauche
Marge droite
Ouvrir
Selection
Print
Excel
Quitter
Y= 156.245 Revolution=200608 Durée= 221582.375 s


idl
Det: 01 — Line: 1 L
438.634 keV
0.015 keV
Det: 01 — Line: 2 L
1778.961 keV
0.01 keV
Det: 01 — Line: 3 L
882.5 keV
0.015 keV

The Crab spectrum

(Jourdain & Roques, ApJ, 2009)



Rev #	Index 1	Ebreak	Index 2	Norme @ 100 keV
Sum 1	2.07	100 keV	2.24	6.6 10^{-4} ph/cm^2 s.keV
Sum 2	2.07	100 keV	2.25	6.55 10^{-4} ph/cm^2 s.keV
Sum 3	2.065	100 keV	2.25	6.7 10^{-4} ph/cm^2 s.keV

The Crab spectrum

- Very good stability of the spectral parameters
- A simultaneous broken PL fit on the global set of data:

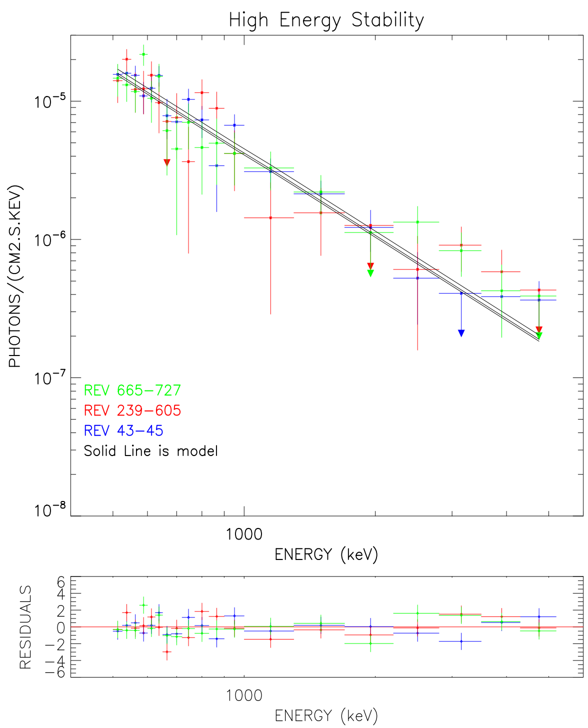
  Ind1=2.04 Ind2=2.18 Eb=62 keV

  – But spectrum is probably smoothly curved.

  Better fit with **$F(E) = N . E^{a+b.\log(E/E0)}$**

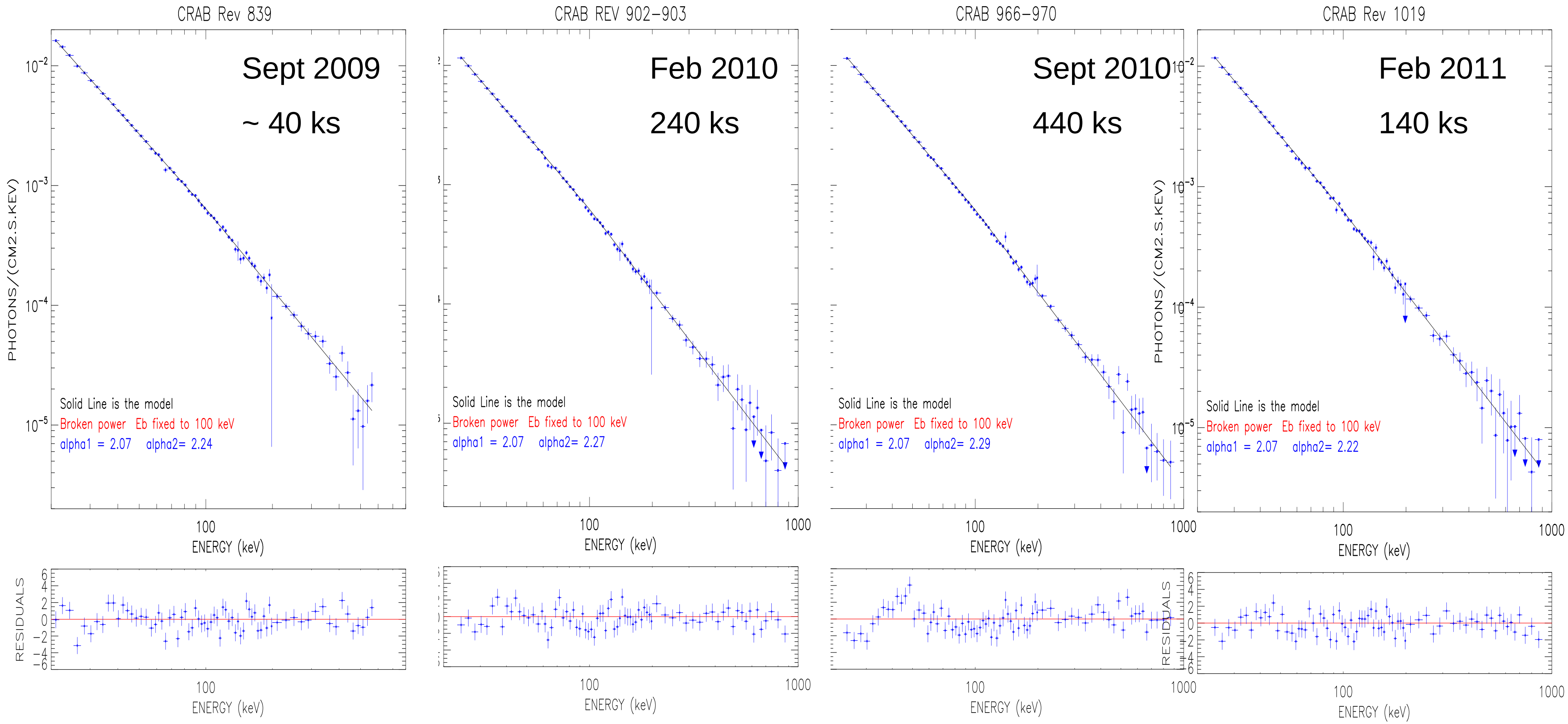
  With E0 fixed to 20 keV: a=1.79 b=0.134 N= 3.97 ph/cm²/s/keV

The high energy part



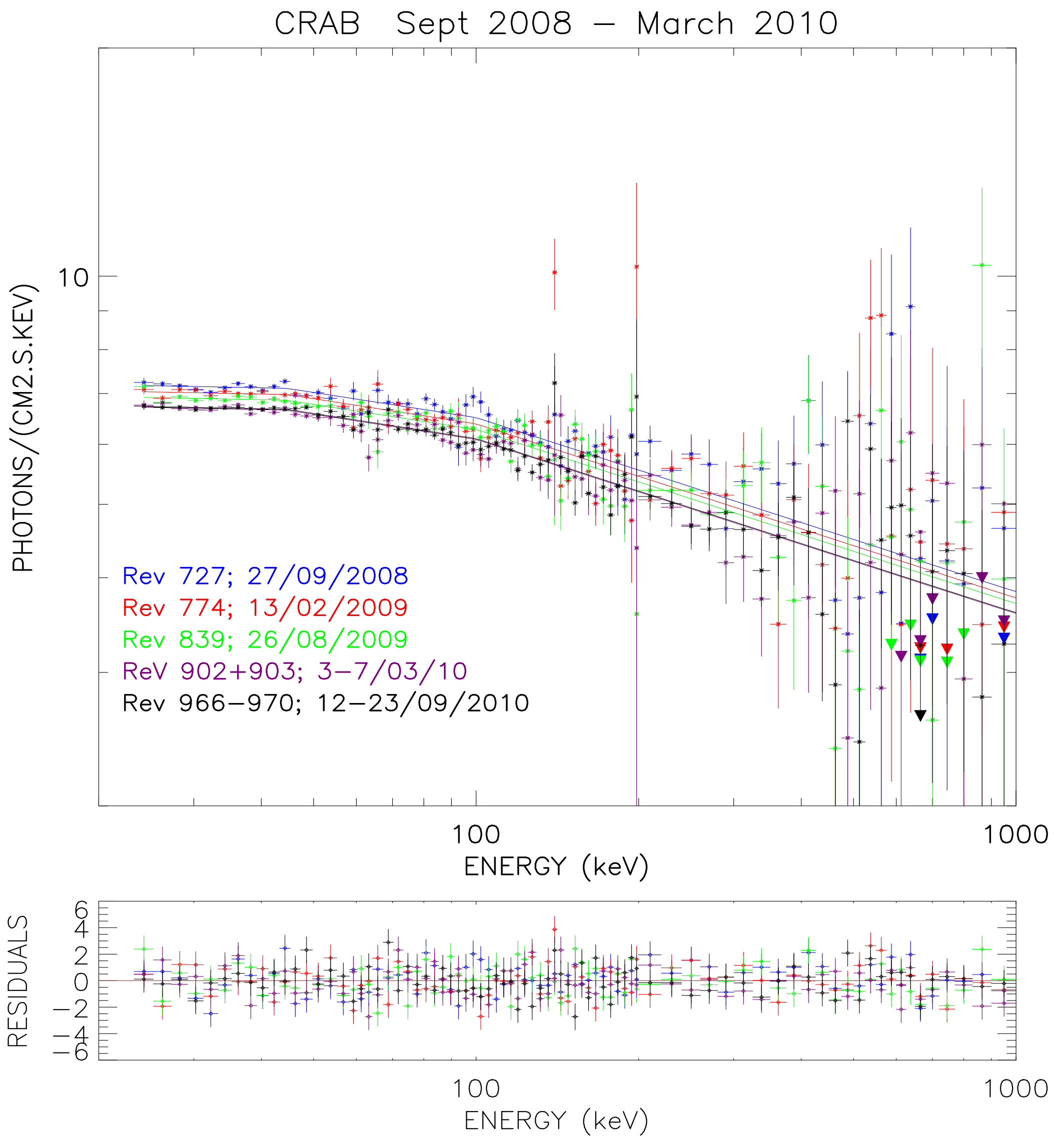
- Very good high energy stability
- Rejection of the Batse excess above 700 keV (Ling & Wheaton, 2003)
- Investigation still to be done above 3 MeV

Then



Rev #	Index 1	Ebreak	Index 2	Norme @ 100 keV
839	2.07	100 keV	2.24	6.45 10^{-4} ph/cm^2 s.keV
902-903	2.07	100 keV	2.27	6.25 10^{-4} ph/cm^2 s.keV
966-970	2.07	100 keV	2.29	6.3 10^{-4} ph/cm^2 s.keV
1019	2.07	100 keV	2.22	6.3 10^{-4} ph/cm^2 s.keV

Comparison of the spectral shapes



Simultaneous fit ;

Same spectral shape

(3 PL)

Index1 = 2.01

Break1= 44.5 keV

Index2 = 2.11

Break2 == 100 keV

Index3 = 2.23

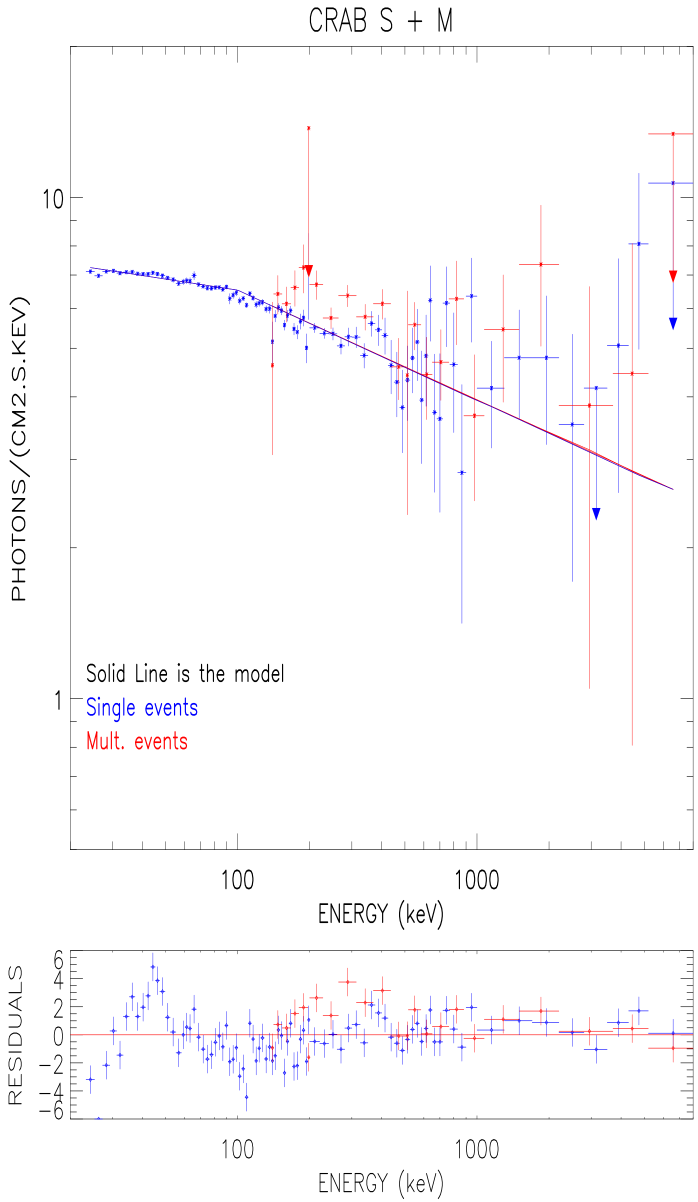
Next Step:
Multiple events

When the energy deposit concerns 2 or more detectors, we have to

- Reconstruct the total energy, attributed to
a « pseudo-detector » (42 for double events)
- Use the corresponding responses

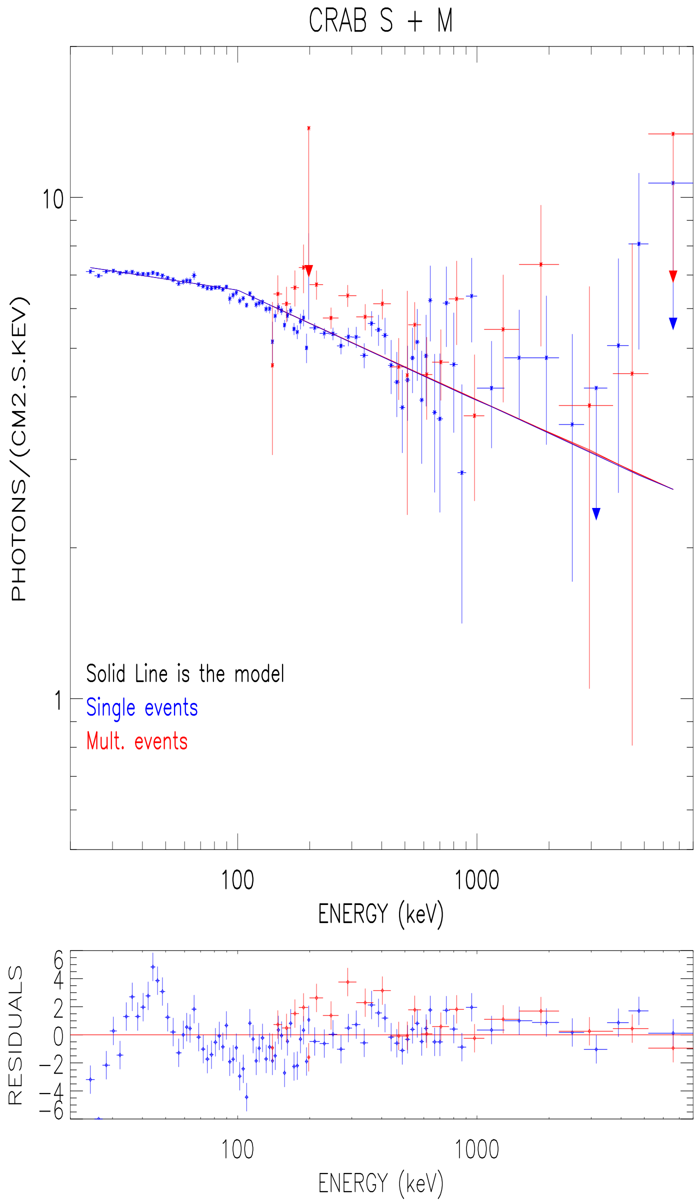
Interest:
- very low background
- Increase the SPI sensitivity at high energy

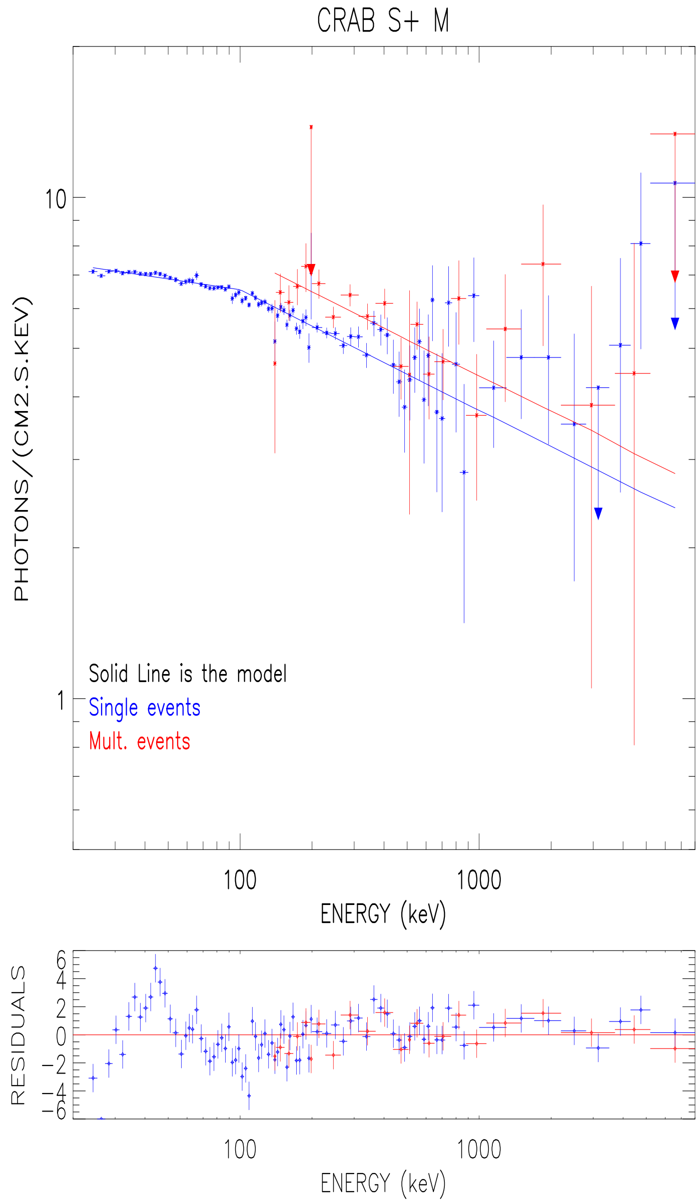
First tests



Sum 1	**2.07**	**100 keV**	**2.22**	**6.6 10^{-4} ph/cm^2 s.keV**

First tests


CRAB S + M
10
1
100
1000
ENERGY (keV)
PHOTONS/(CM2.S.KEV)
Solid Line is the model
Single events
Mult. events
RESIDUALS
6
4
2
0
-2
-4
-6
100
1000
ENERGY (keV)


CRAB S+ M
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ENERGY (keV)
PHOTONS/(CM2.S.KEV)
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RESIDUALS
6
4
2
0
-2
-4
-6
100
1000
ENERGY (keV)

Conclusions

- Crab Nebula observations allow to check the health and stability of the instrument
- Next step in the high energy part with the use of the multiple events

  Check the coherence with the single event results
- Information on the Crab nebula emission