Crab spectrum from JEM-X onboard INTEGRAL

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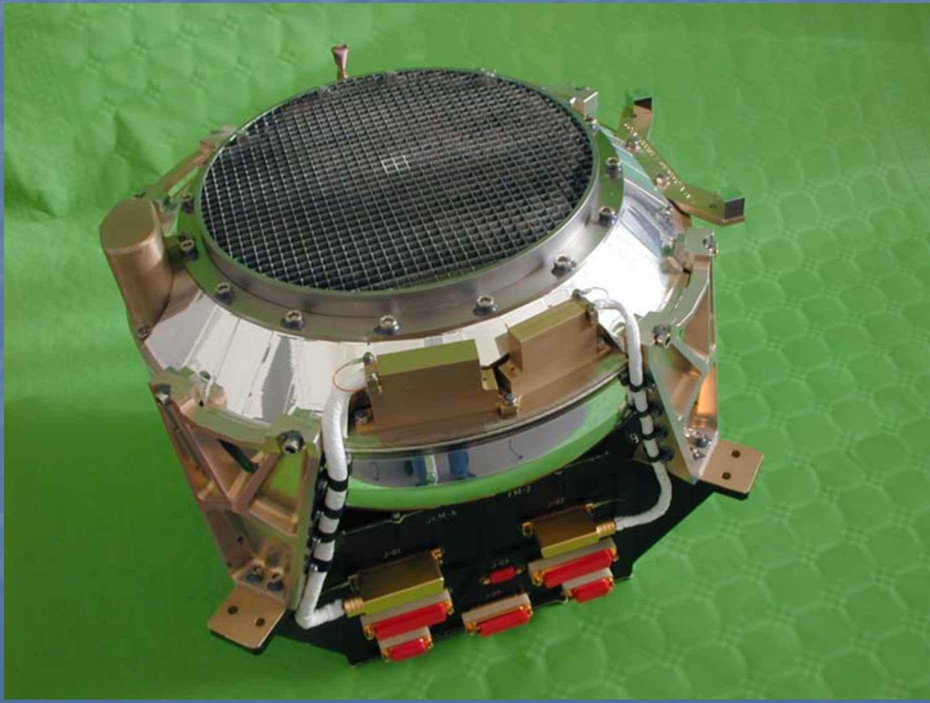
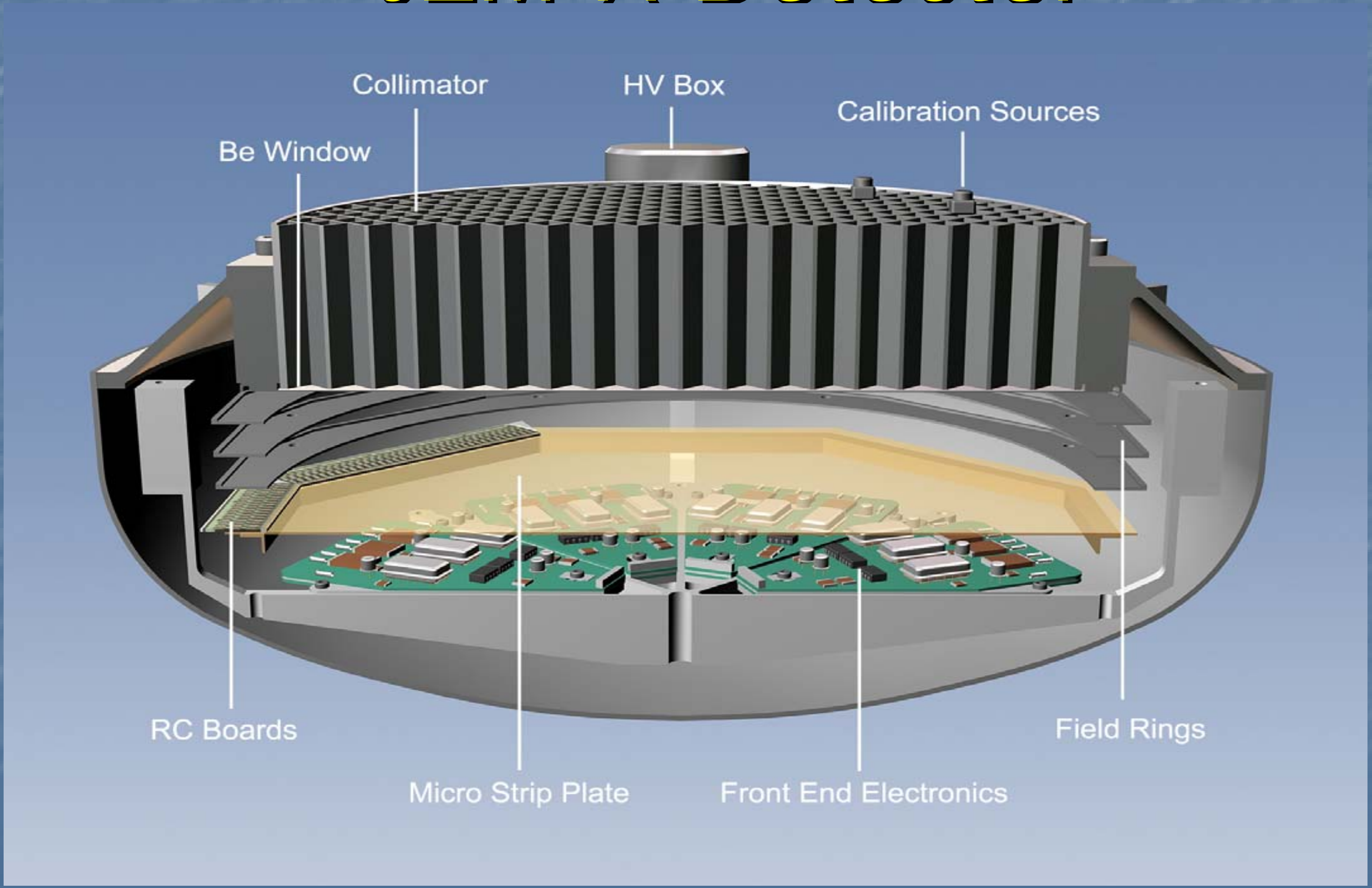
Instrument properties
Selection of detector area
Gain effects
All detector spectra and background
Results from fitting

JEM-X HARDWARE



Mask :	535 mm
Mask hex holes:	3 mm
Detector diam :	250 mm
Mask-Detector:	3401 mm

JEM-X Detector



However, soon it was discovered that we lost anodes ...

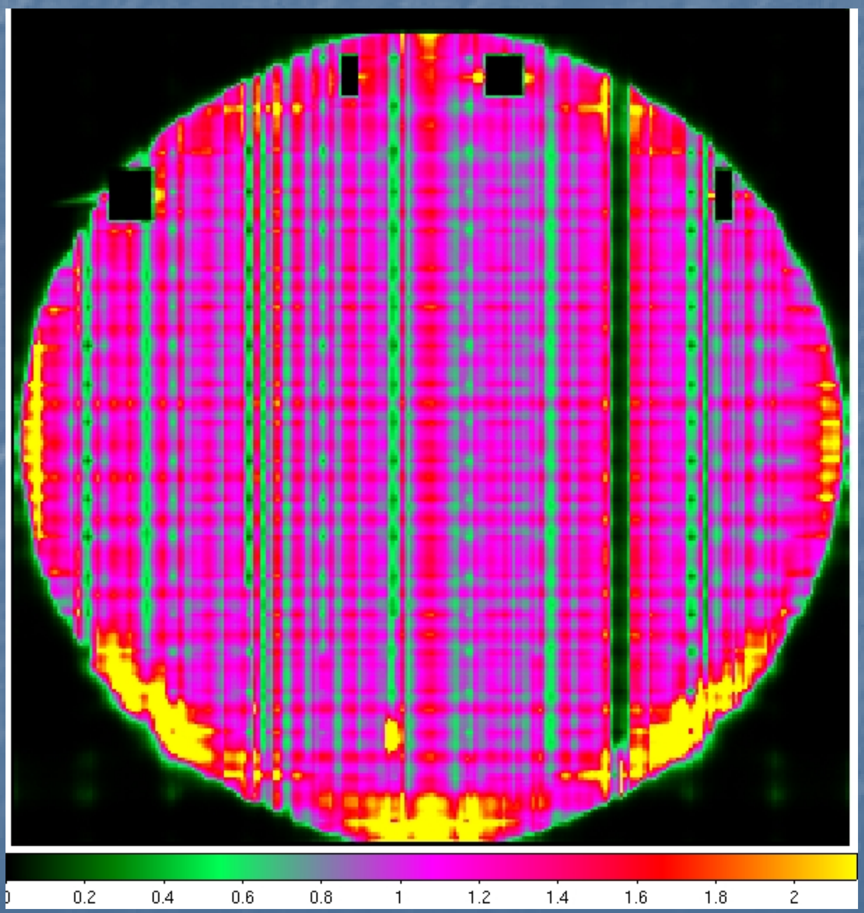
Consequences:

The high voltage was lowered → lower gain

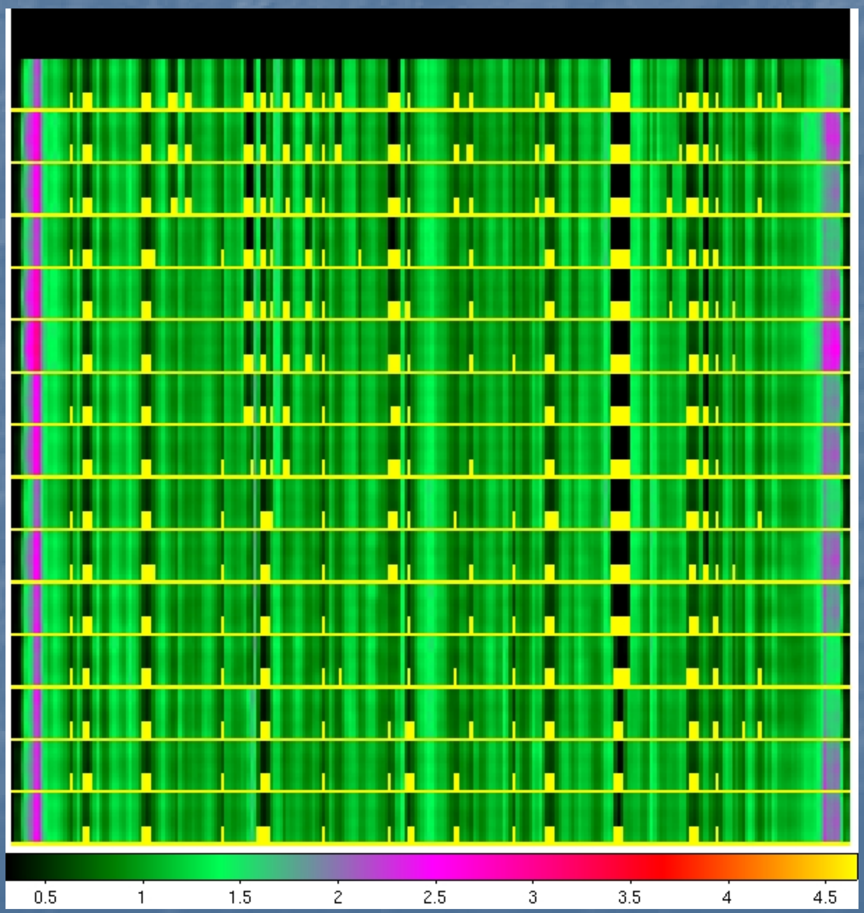
Only one instrument is used at a time

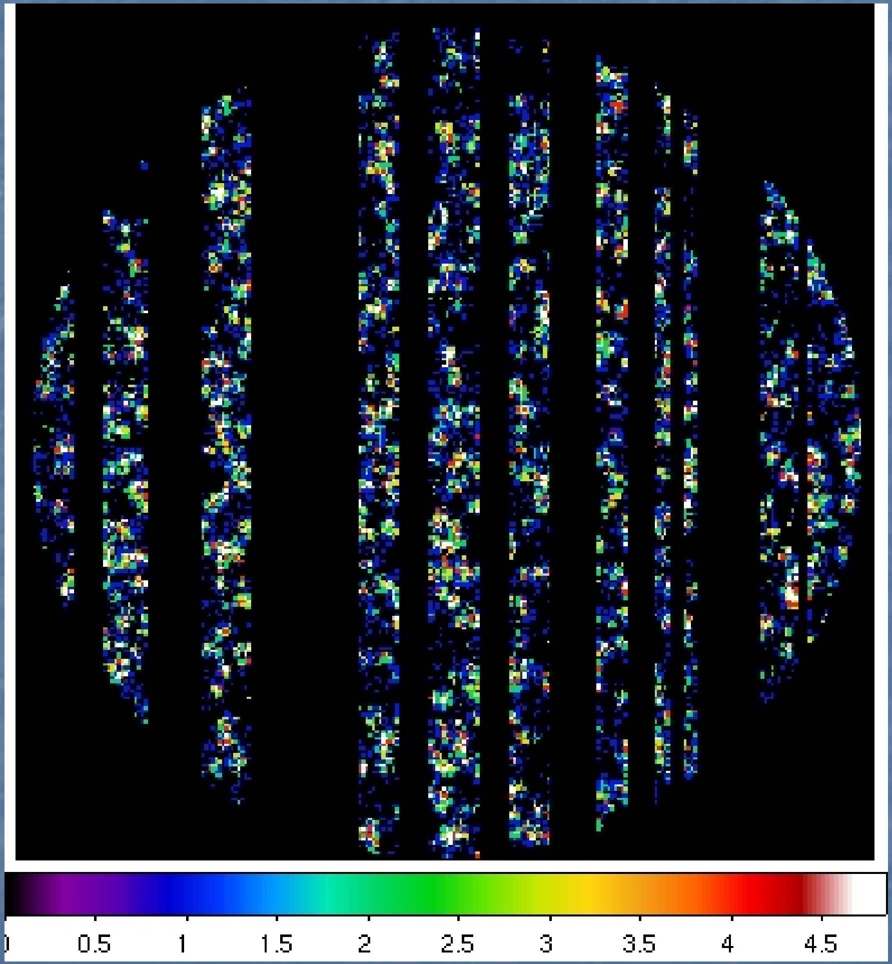
The Crab was used ’actively’ for the calibration

JMX1 shadowgram revolutions
311 – 497, 12 – 25 keV



Progression of anode deterioration





The selected detector part to minimize the effect of anode problems.

Two phenomena appeared:

1) Due to the lower high voltage the electronic threshold cuts in at energies below 10 keV

2) The gain increases slowly in the course of time with high voltage on
This is counteracted by lowering the voltage from time to time

The electronic efficiency (threshold and bkg rejection) is a function of PHA.
The ARF depends on the energy of the photon.
The absorption in the thermal foil, the Beryllium window and the detector gas (Xe) is known.
The calibration of the electronic efficiency is done by comparing the Crab spectrum with nominal and low high voltage.

JEM-X Electronic Efficiency

In the approximation where the energy resolution is disregarded:

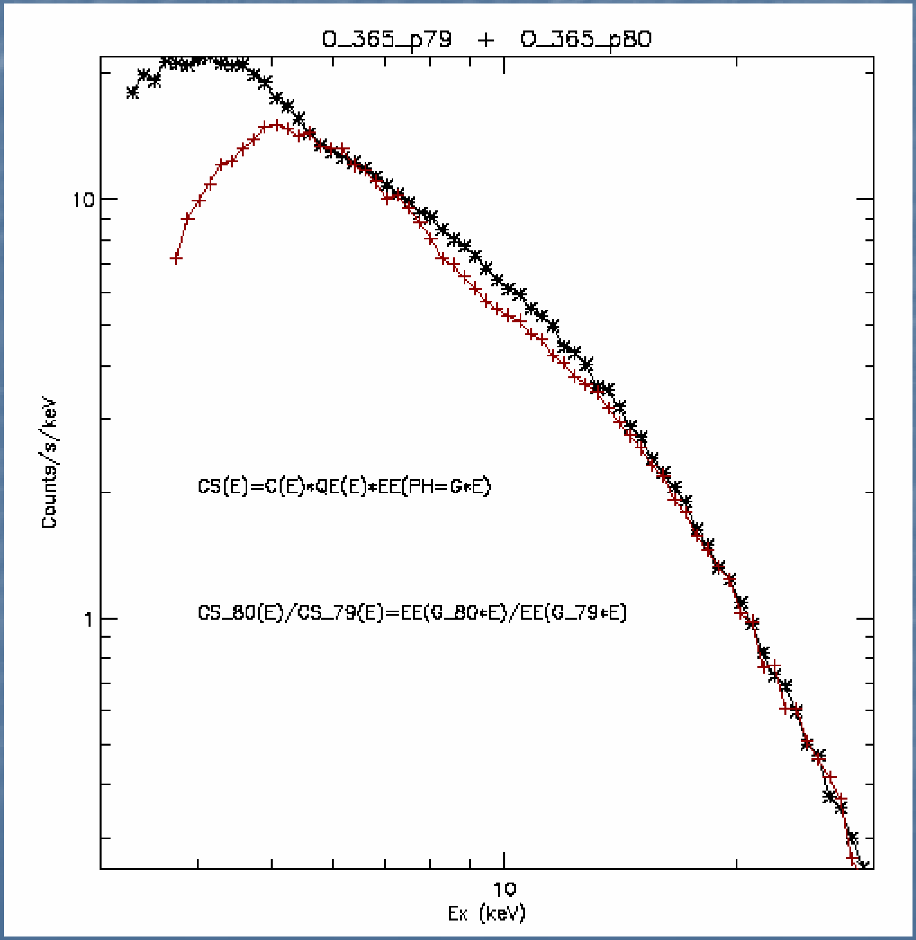
- N(E) = Flux(E)*ARF(E)*EE(PH=Gain*E)

- EE(PH=G2*E)=EE(PH=G1*E)*N2(E)/N1(E)

Solved by assuming EE = 1 for high PH; with G2 < G1 one gets EE for a lower PH.
With Enext = G2*E/G1 the next lower value is obtained – and so on ...

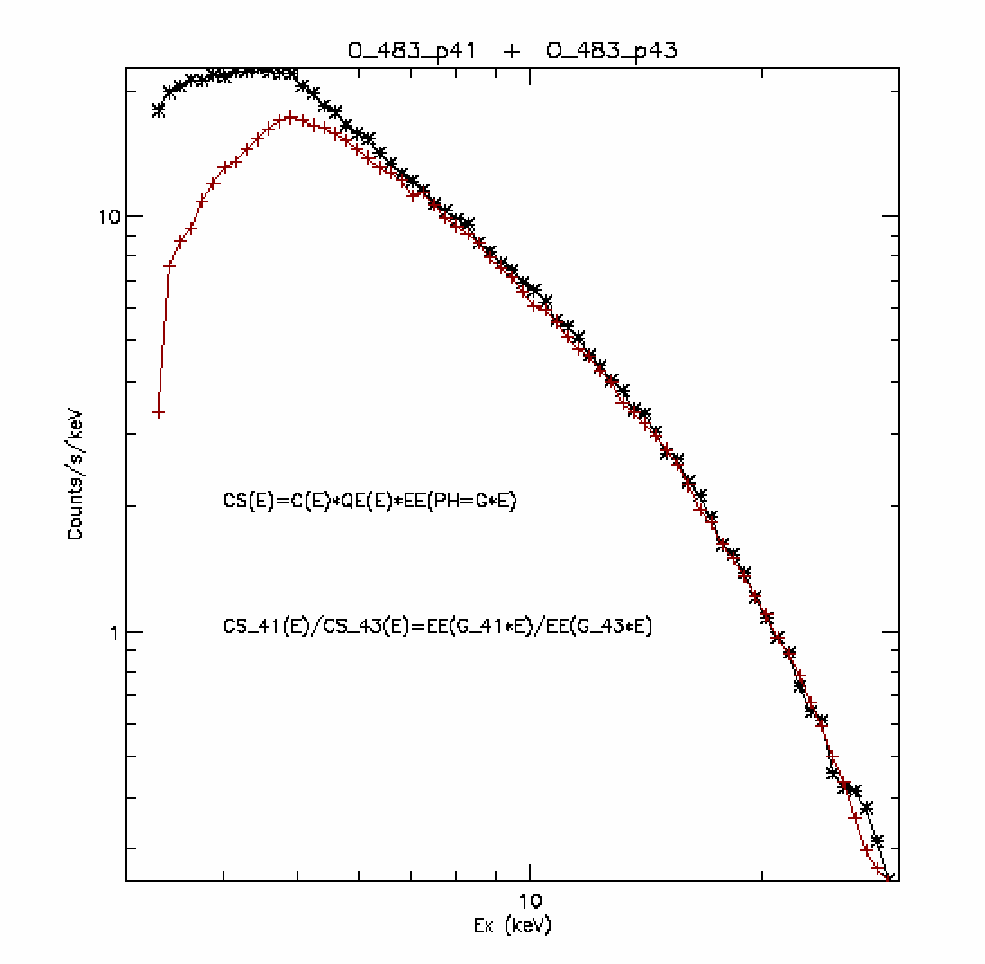
JMX1 Spectra

JMX1 spectra with event rejection that depends on pulseheight. It is open between threshold and a certain value.

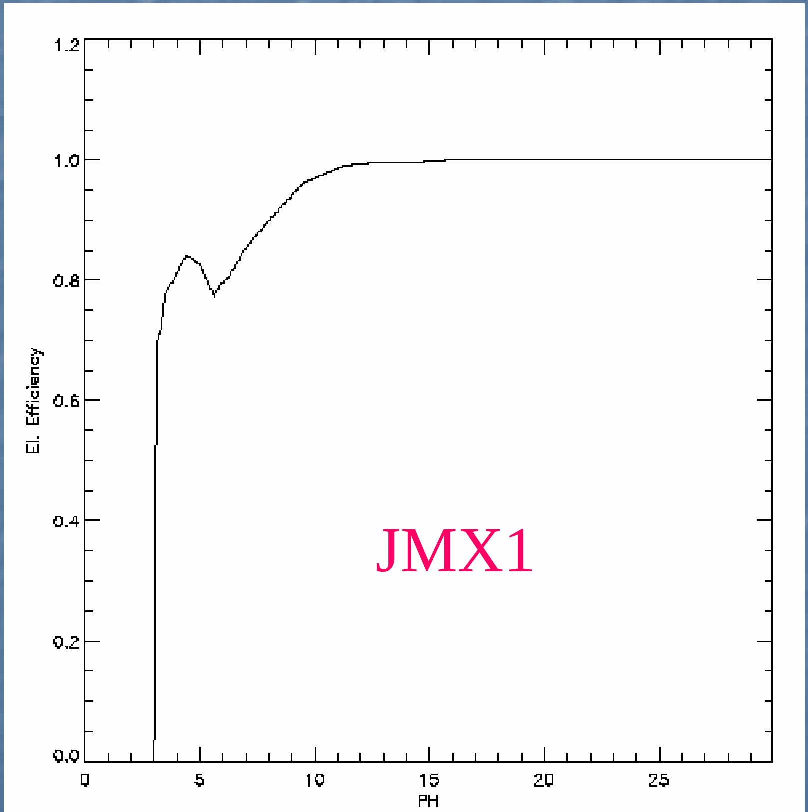


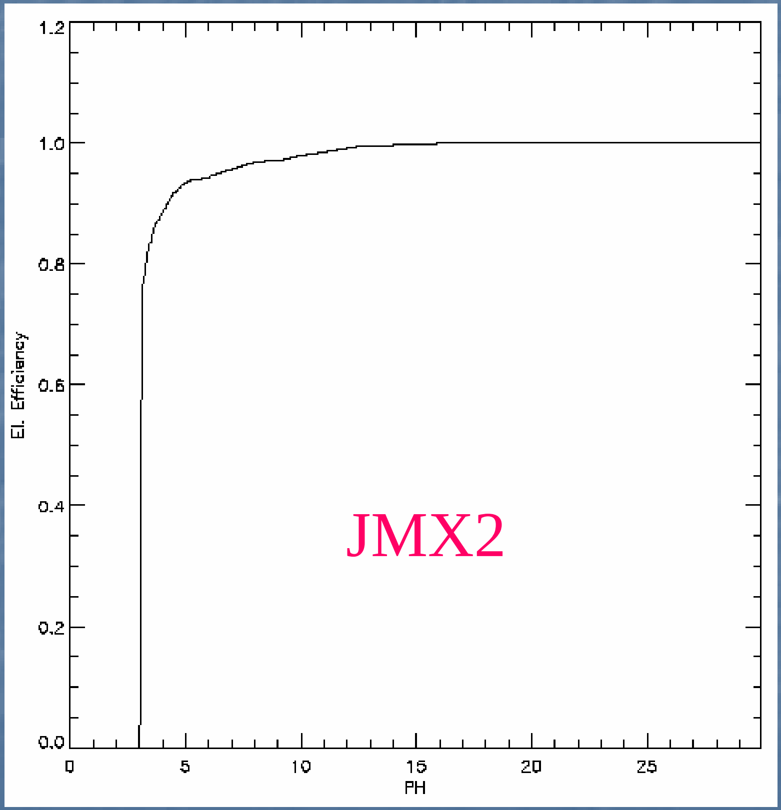
JMX2 Spectra

Spectra derived by fits to JMX2 Crab images generated (cross-correlation method) for 70 energy bins



Electronic Efficiency





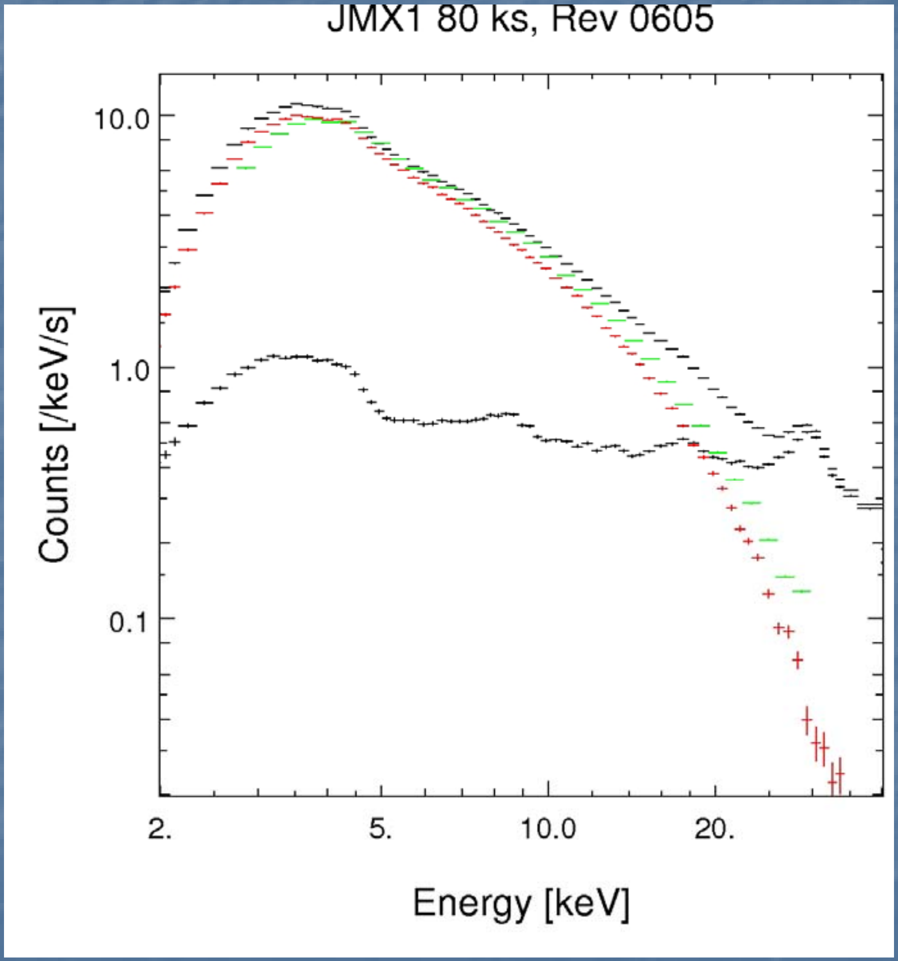
Including the gain dependence in the spectral fitting

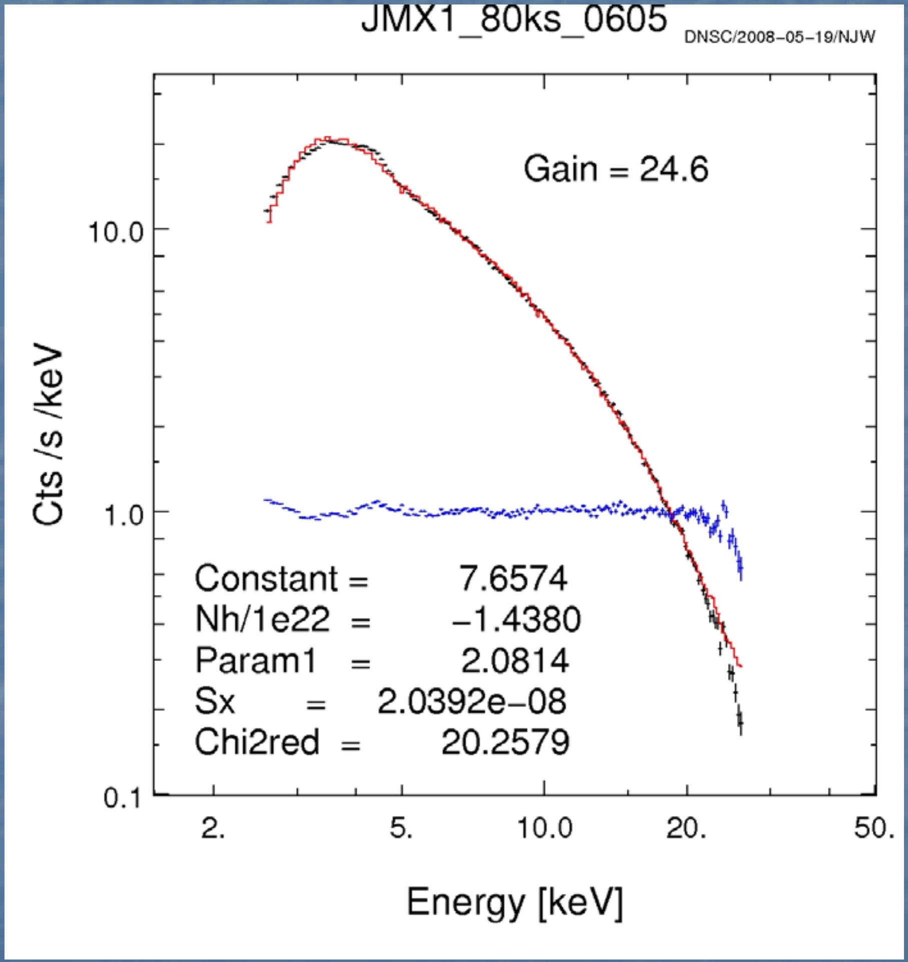
Usually we have

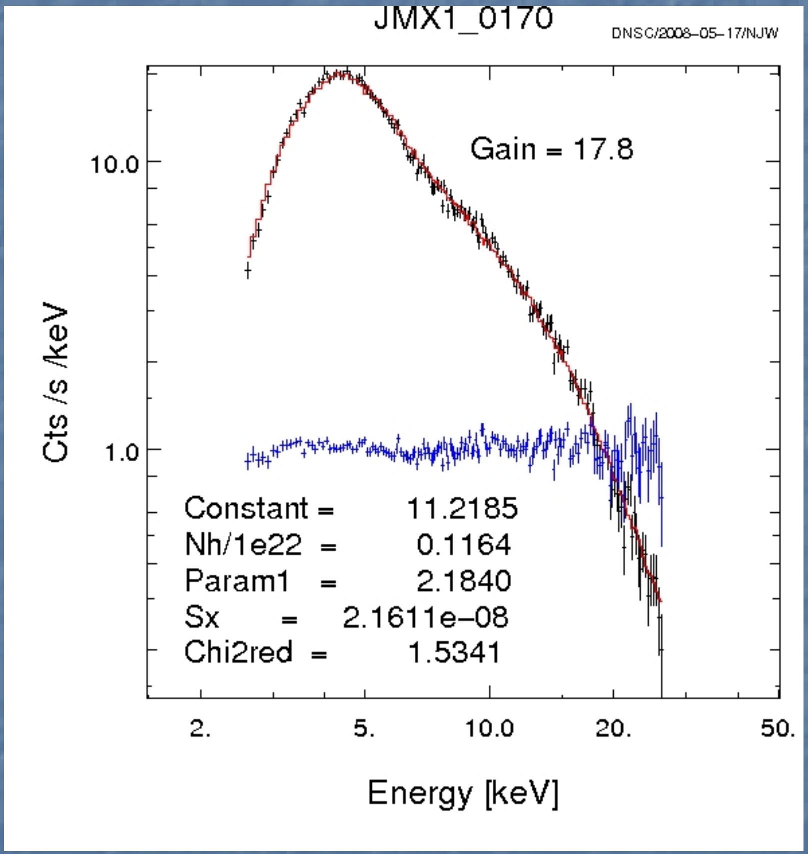
Cts = (RDM * ARF * flux)

but the electronic effects the number of counts <u>after</u> redistribution hence:

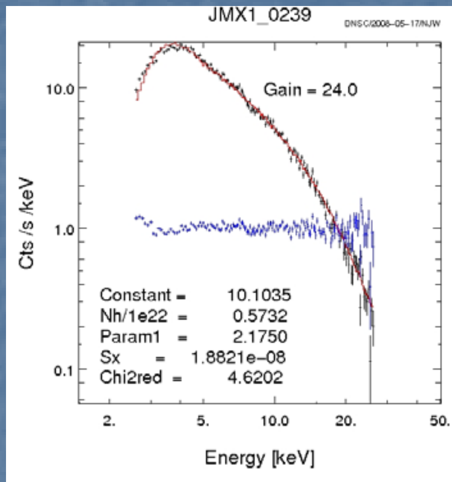
Cts = Eeff * (RDM * ARF * flux)

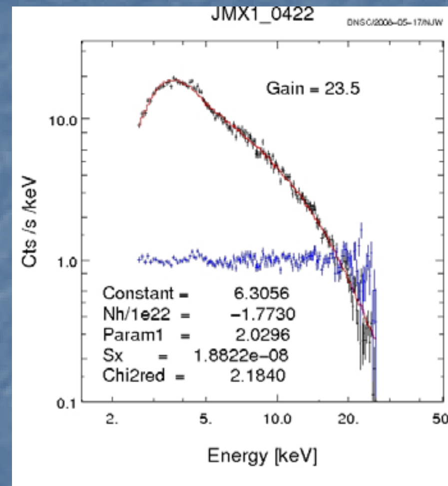

JMX1 80 ks, Rev 0605
Counts [/keV/s]
10.0
1.0
0.1
2.
5.
10.0
20.
Energy [keV]

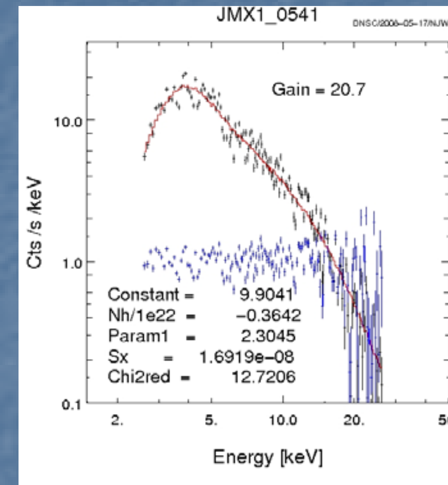

JMX1_80ks_0605
DNSC/2008-05-19/NJW
Gain = 24.6
Cts /s /keV
10.0
1.0
0.1
Constant = 7.6574
Nh/1e22 = -1.4380
Param1 = 2.0814
Sx = 2.0392e-08
Chi2red = 20.2579
2.
5.
10.0
20.
50.
Energy [keV]

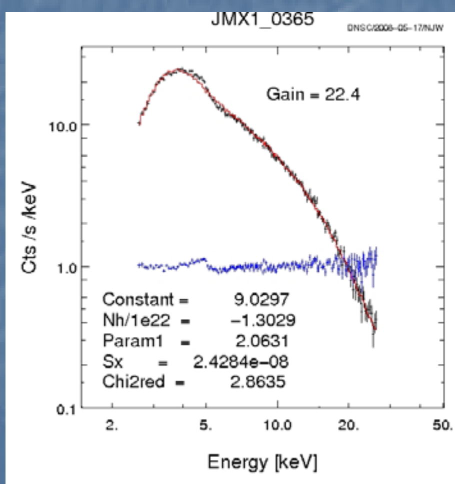


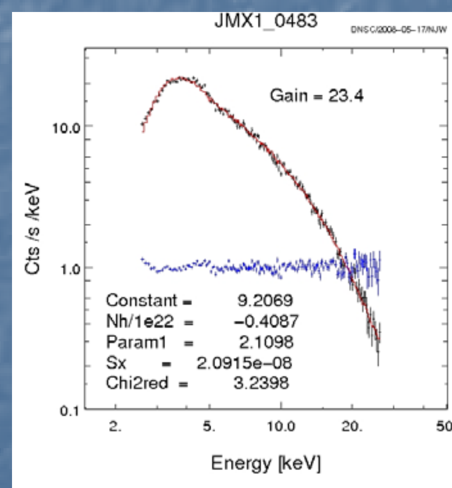
The result of fitting a powerlaw spectrum to the detector count spectrum

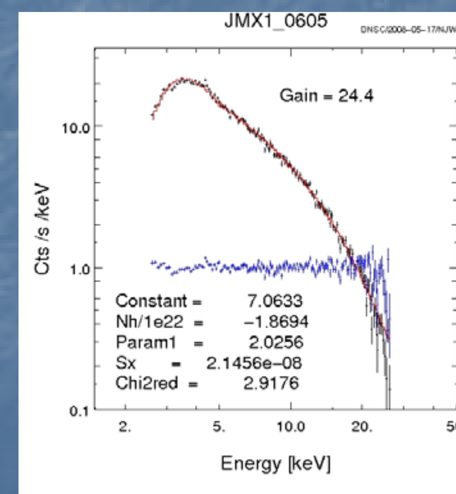

JMX1_0239
Gain = 24.0
Cts /s /keV
Constant = 10.1035
Nh/1e22 = 0.5732
Param1 = 2.1750
Sx = 1.8821e-08
Chi2red = 4.6202
Energy [keV]

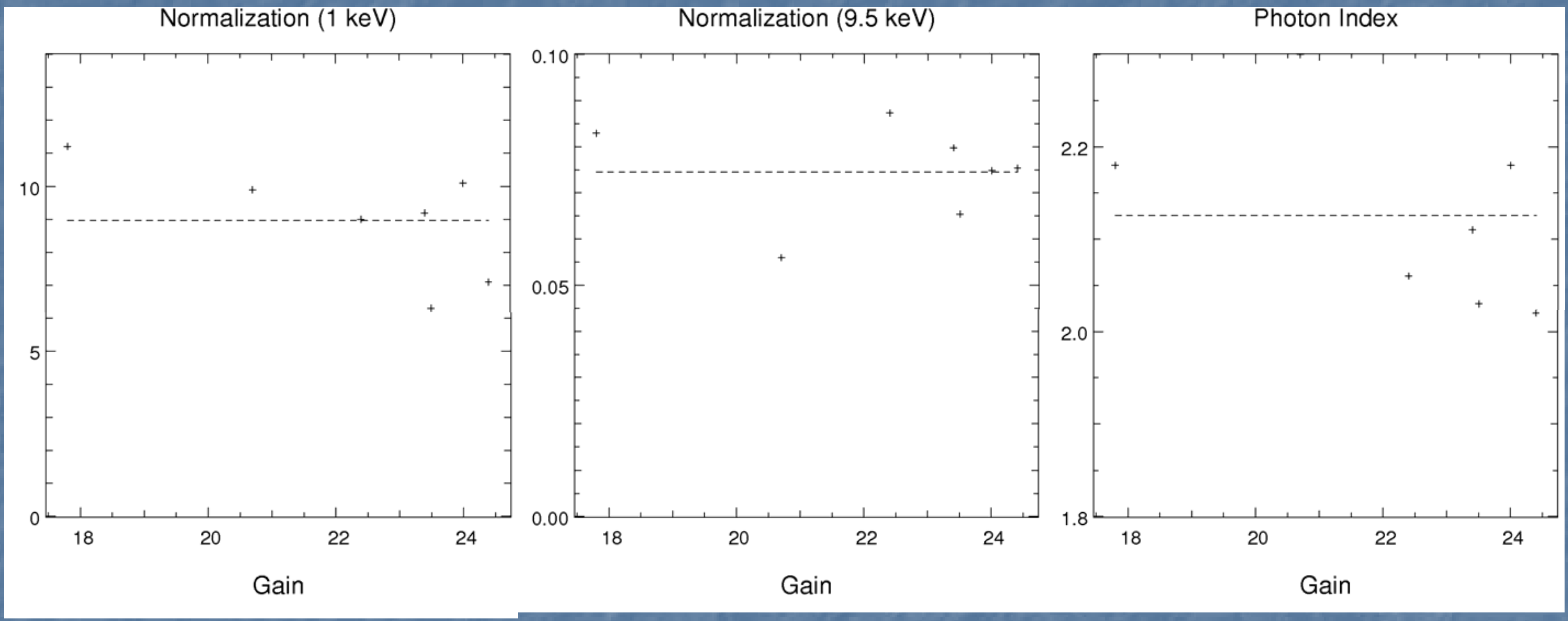

JMX1_0422
Gain = 23.5
Cts /s /keV
Constant = 6.3056
Nh/1e22 = −1.7730
Param1 = 2.0296
Sx = 1.8822e-08
Chi2red = 2.1840
Energy [keV]


JMX1_0541
Gain = 20.7
Cts /s /keV
Constant = 9.9041
Nh/1e22 = −0.3642
Param1 = 2.3045
Sx = 1.6919e-08
Chi2red = 12.7206
Energy [keV]


JMX1_0365
Gain = 22.4
Cts /s /keV
Constant = 9.0297
Nh/1e22 = −1.3029
Param1 = 2.0631
Sx = 2.4284e-08
Chi2red = 2.8635
Energy [keV]


JMX1_0483
Gain = 23.4
Cts /s /keV
Constant = 9.2069
Nh/1e22 = −0.4087
Param1 = 2.1098
Sx = 2.0915e-08
Chi2red = 3.2398
Energy [keV]


JMX1_0605
Gain = 24.4
Cts /s /keV
Constant = 7.0633
Nh/1e22 = −1.8694
Param1 = 2.0256
Sx = 2.1456e-08
Chi2red = 2.9176
Energy [keV]


Normalization (1 keV)
Normalization (9.5 keV)
Photon Index
0
5
10
0.00
0.05
0.10
1.8
2.0
2.2
18
20
22
24
Gain
Gain
Gain

Concluding remarks

The absolute calibration must be improved

A powerlaw for the Crab is supported with an index between 2.08 and 2.10 in the 3 – 30 keV range

The electronic efficiency must be better determined e.g. in the next Crab calibration campaign

The ARF is now fixed but spectra taken with different gain cannot be added. A new strategy must be defined