The results presented here are the outcome of almost 10year work (Integral approved as M2 in 1993, AO for instrument complement released in '94) of about 200 people that have invented, designed, built and calibrated IBIS.

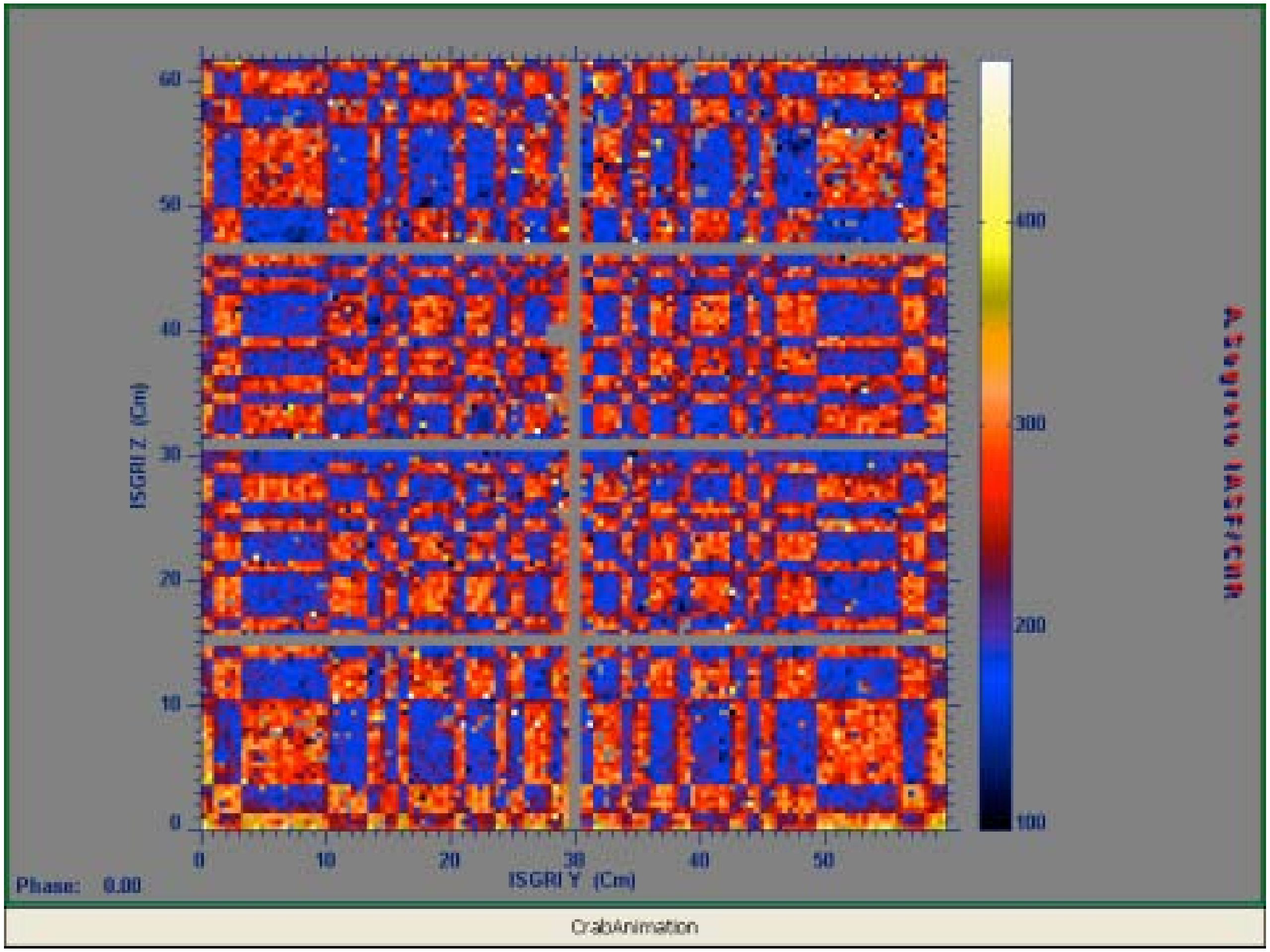
A particular credit and thanks to the few key persons that have substantially contributed to the success of the IBIS imager and in turn of the whole Integral mission.

Last but not least ASI first and all other supporting Space Agencies i.e. CNES, INTA, DARA, PPARC, NASA, CAC, UB and PSI and associated Institutes.

INTEGRAL is an astrophysical observatory that has been successfully launched from Baïkonour (Kazakistan) the 17th of October 2002 for a 2 year mission with possible extension to 5. This medium size ESA project is devoted to the observation of the gamma-ray sky in the energy range from 15 keV to 10 MeV.

After the injection in orbit and initial switch-on INTEGRAL has undergone a short Performance Verification and Calibration phase. Then the Observatory was fully operative and started to perform observations on the 3 day based orbit with real-time telemetry link.

Since the beginning of 2003 Core Programme and Open Time scientific observations have successfully started. The scientific programme comprised regular scan of the Galactic Plane, Galactic Centre Deep Exposure, Open Time standard pointing and associated ToO observations. In addition several new soft Gamma Ray sources have been discovered (last yesterday by MDS) and ~1/month Gamma Ray Bursts detected within the IBIS/SPI coded FoV.



ISGRI Z (Cm)
ISGRI Y (Cm)
0
10
20
30
40
50
60
100
200
300
400
Phase: 0.00
CrabAnimation

INTEGRAL

GLAST Workshop

P. Ubertini, IASF CNR - Roma

On Behalf of ISWT and IBIS Team

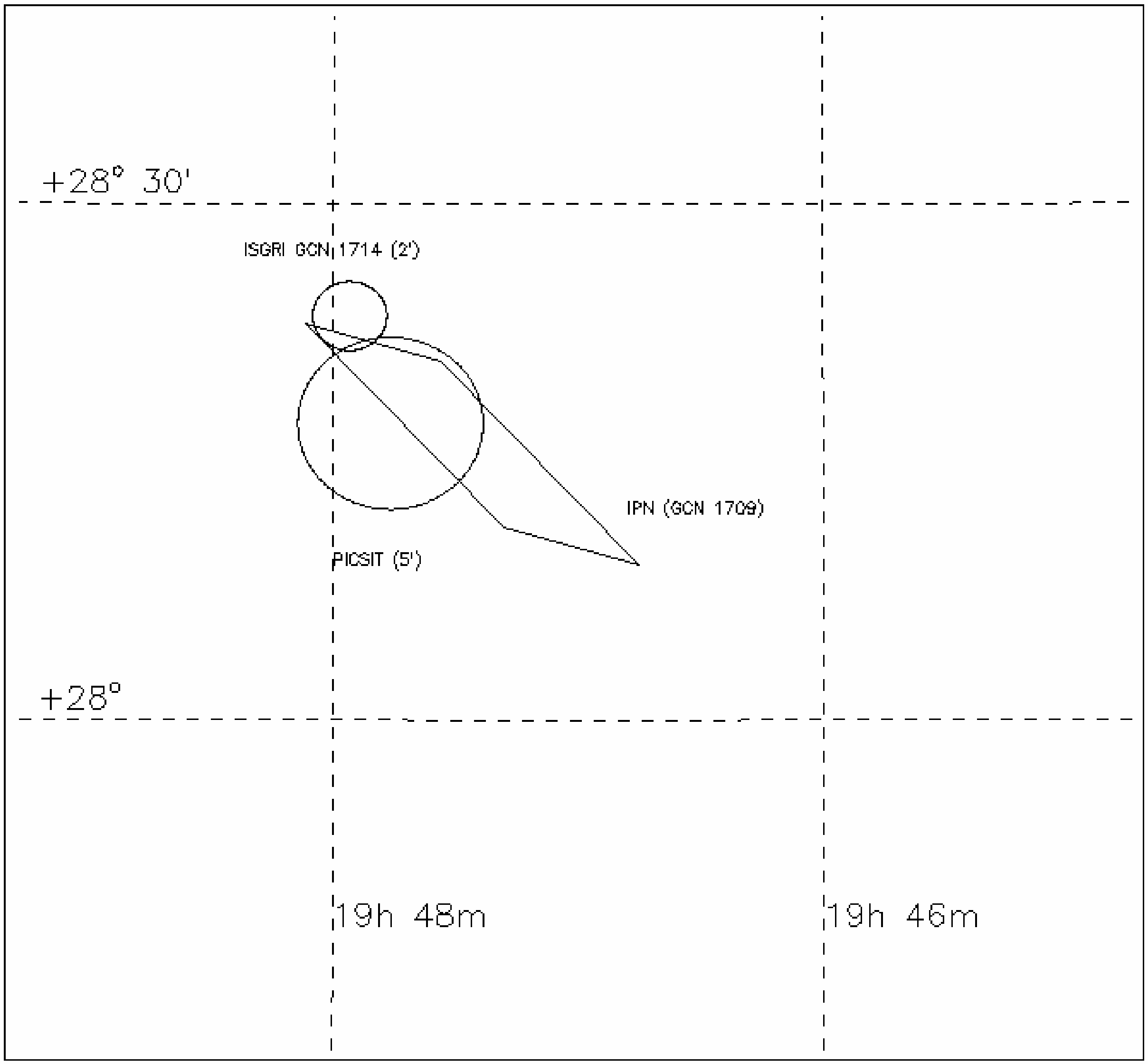
Accademia Nazionale dei Lincei, Roma, September 17, 2003

IBIS and Gamma Ray Bursts

GCN 1706 – 26 Nov.
A. Bazzano, A. Paizis and the ISWT

GCN 1714 -29 Nov
A. Gros, N. Produict and the ISWT

GRB021125



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Accademia Nazionale dei Lincei, Roma, September 17, 2003

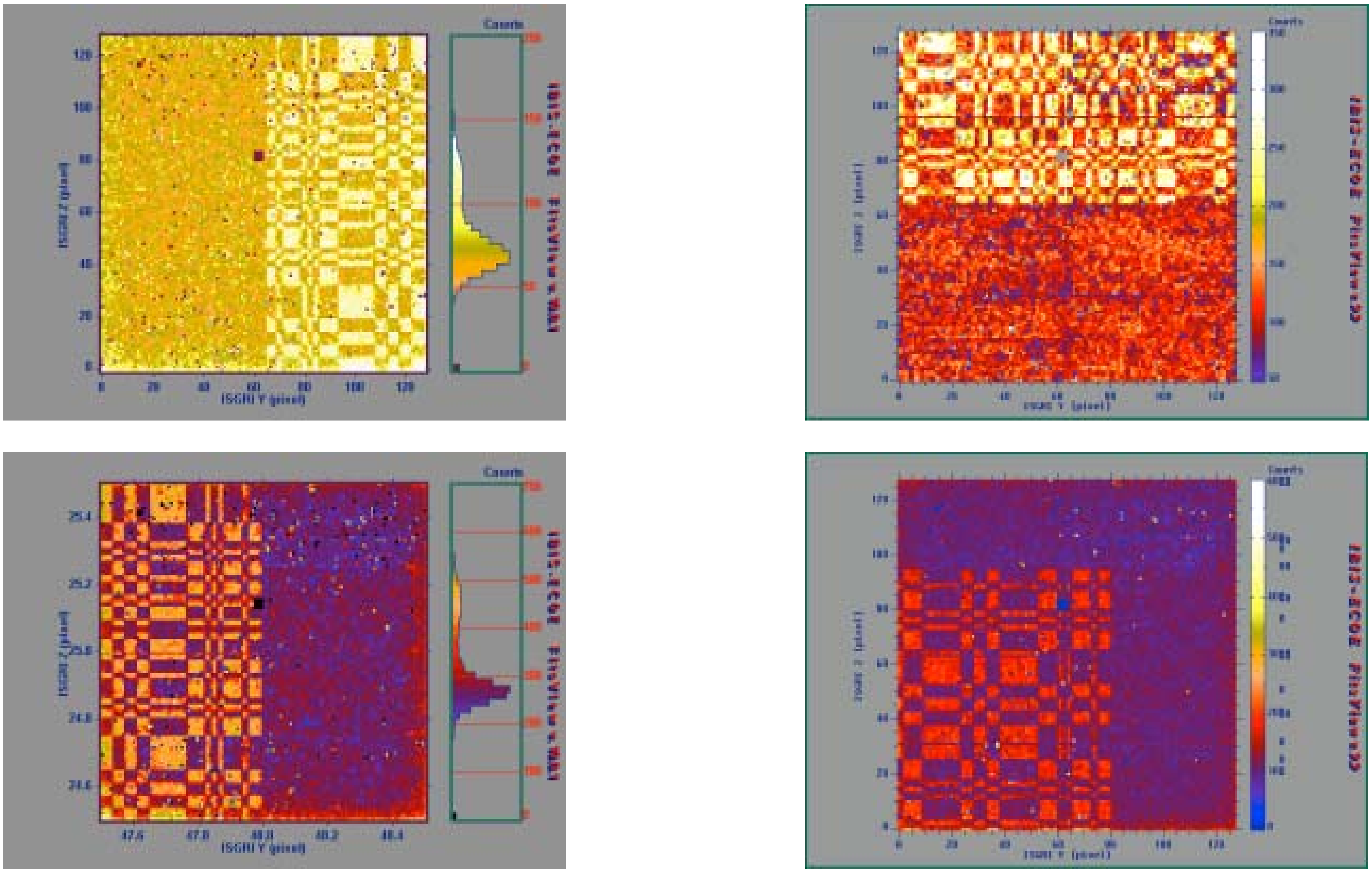
The Integral Gamma Ray Burst Discovery List!

(first discovery circular only)

Date	GRB	First Author	Reference	
25-Nov-2002	GRB021125	A. Bazzano	GCN1706	First GRB in the FOV
19-Dec-2003	GRB021219	S. Mereghetti	GCN 1766	
03-Jan-2003	GRB030131	J. Borkoski	GCN 1836	
27-Feb-2003	GRB030227	D. Gotz	GCN 1895	
20-Mar-2003	GRB030320	S. Mereghetti	GCN 1941	
27-Mar-2003	GRB030323	V. Beckmann	GCN1790	(4 day too early!)
01-May-2003	GRB030501	S. Mereghetti	GCN 2183	

Waiting for the June one!!

IBIS/ISGRI SHADOWGRAMMES during CRAB off axis pointing at 9.6 and 10.4 deg



Observation of Crab at different off-set angles was essential to characterise the IBIS large FOV response to weak sources. This is particularly relevant for low energy (E< 40 keV) affected by mask transparency

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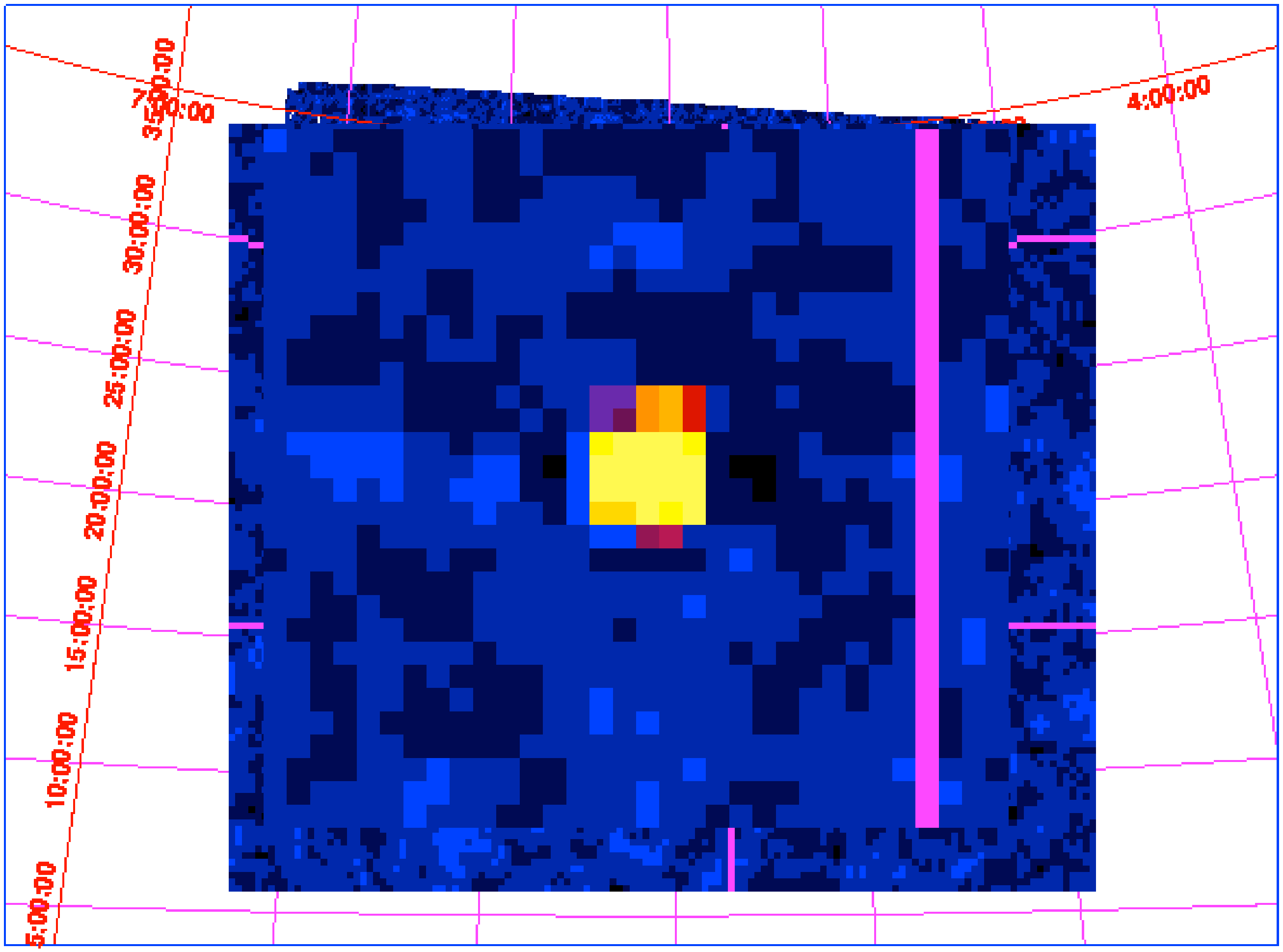
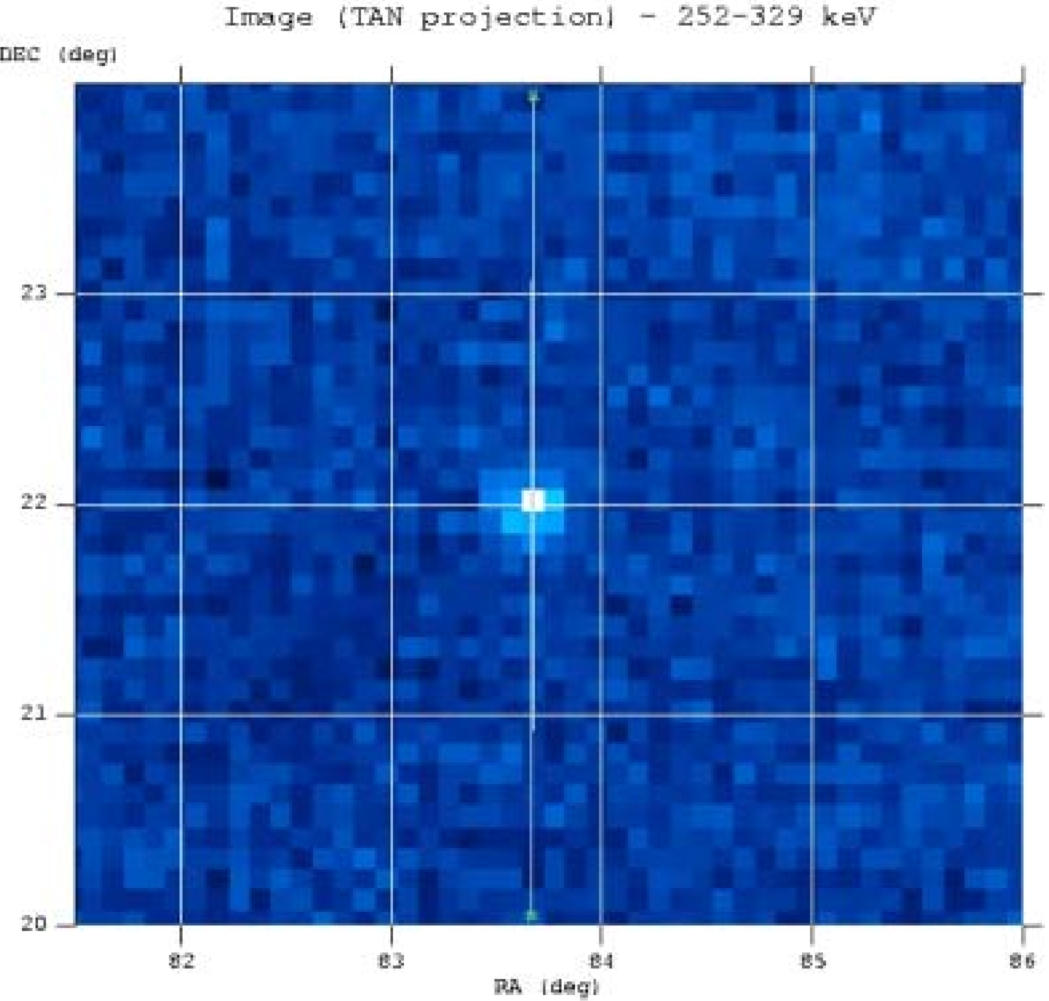


250-330keV

Images of the Crab Nebula region by the IBIS/PICsIT detector



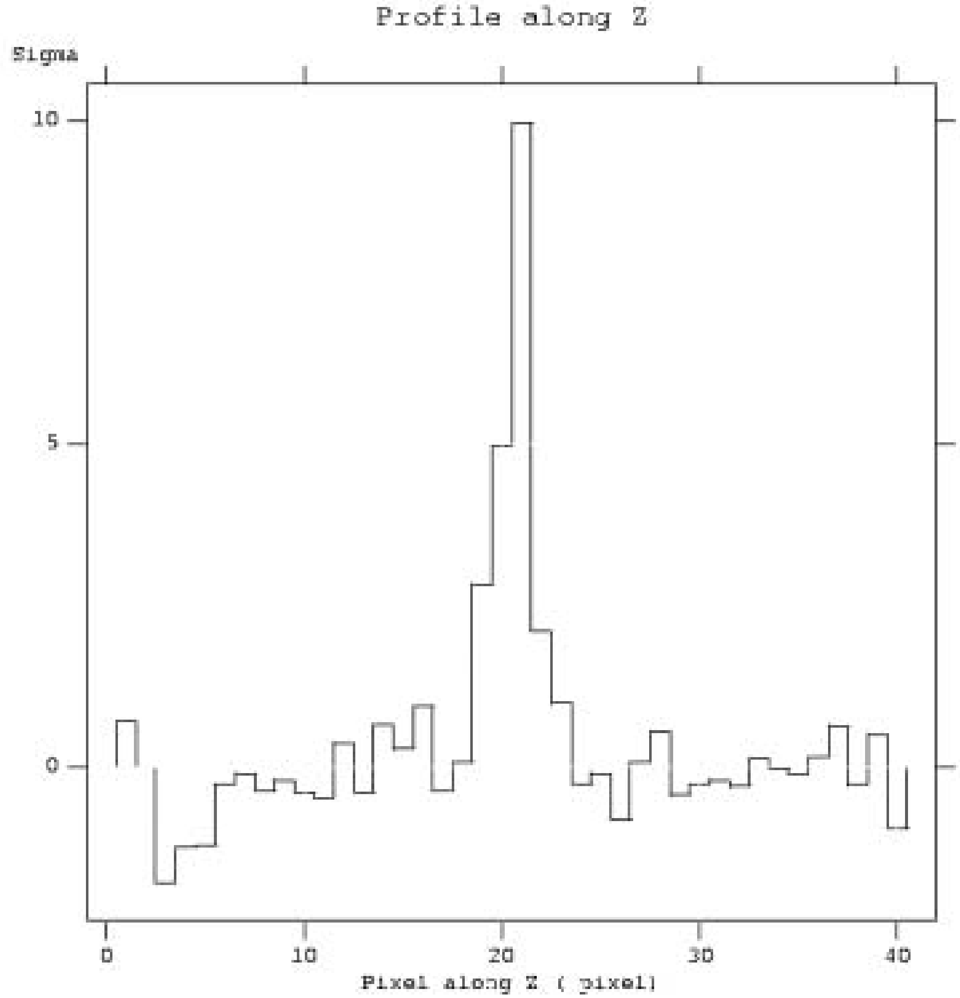
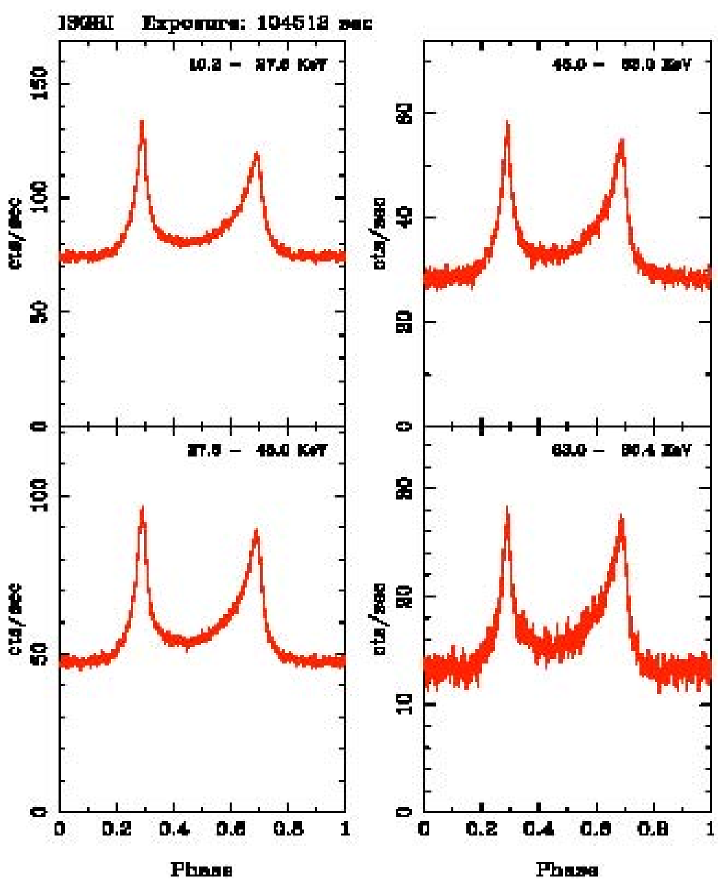


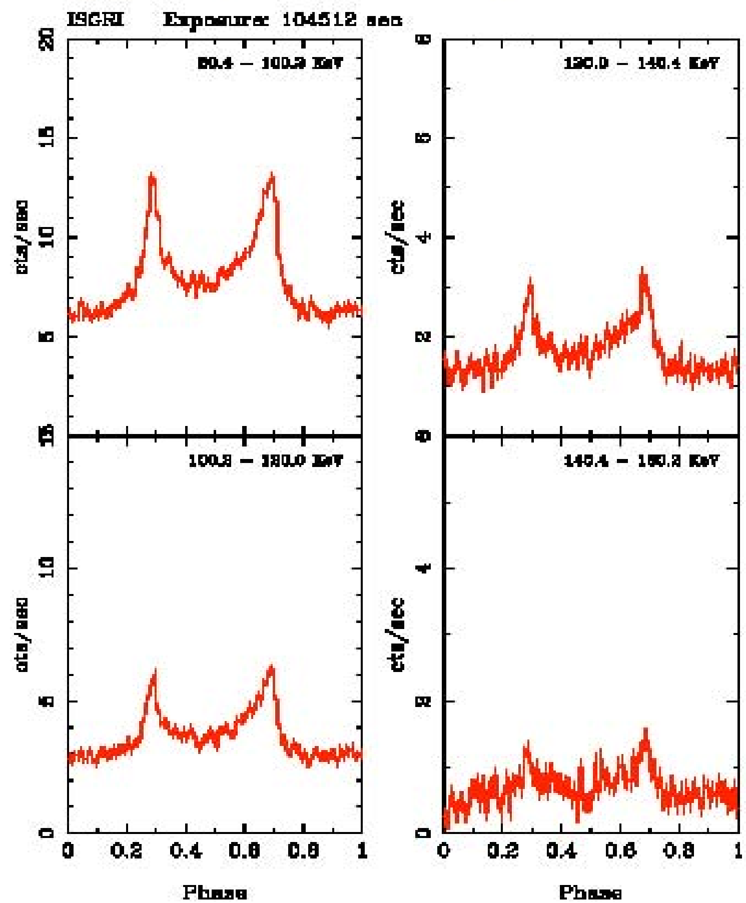
IMAGE PROCESSING. Non-uniform background and spatial structures produce unwanted systematic noise in the images. The variable background is also a serious problem, as observations at high energies require long exposure times (~10^5-10^6 s).

At high energies, background (*flat-field*) correction is necessary for source intensity and spectra reconstruction.

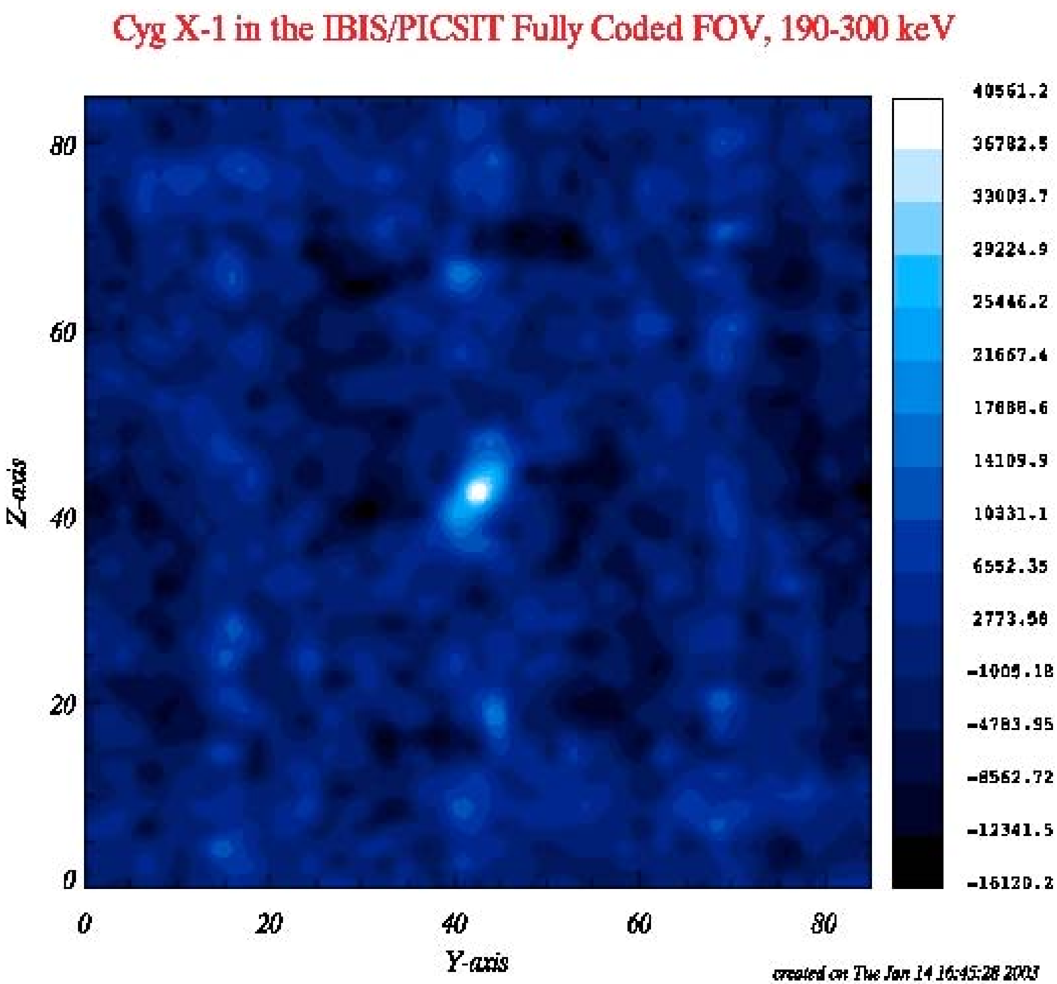
IBIS and CRAB

Background subtracted pulse profiles



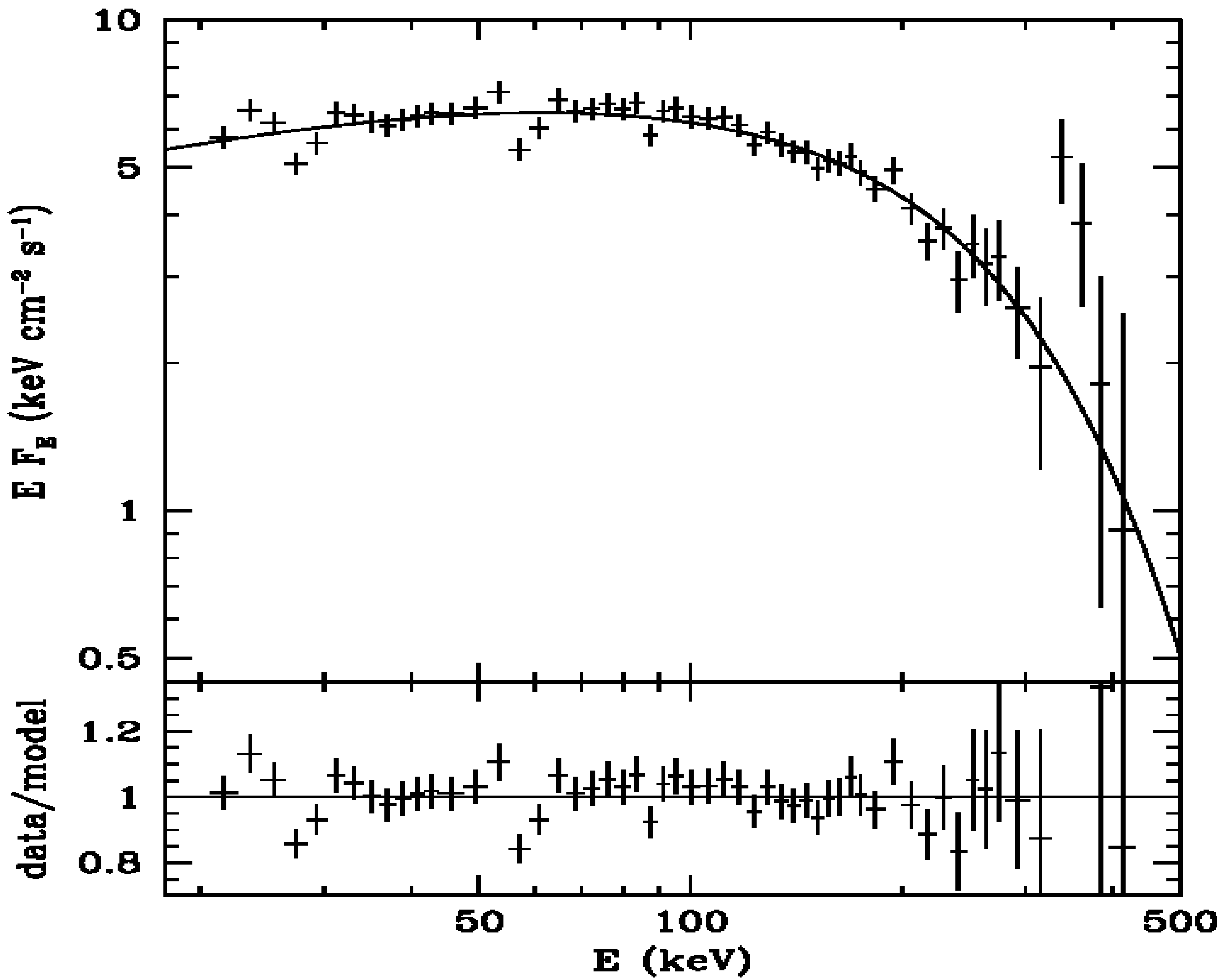


Cyg X-1 seen by IBIS/PICsIT

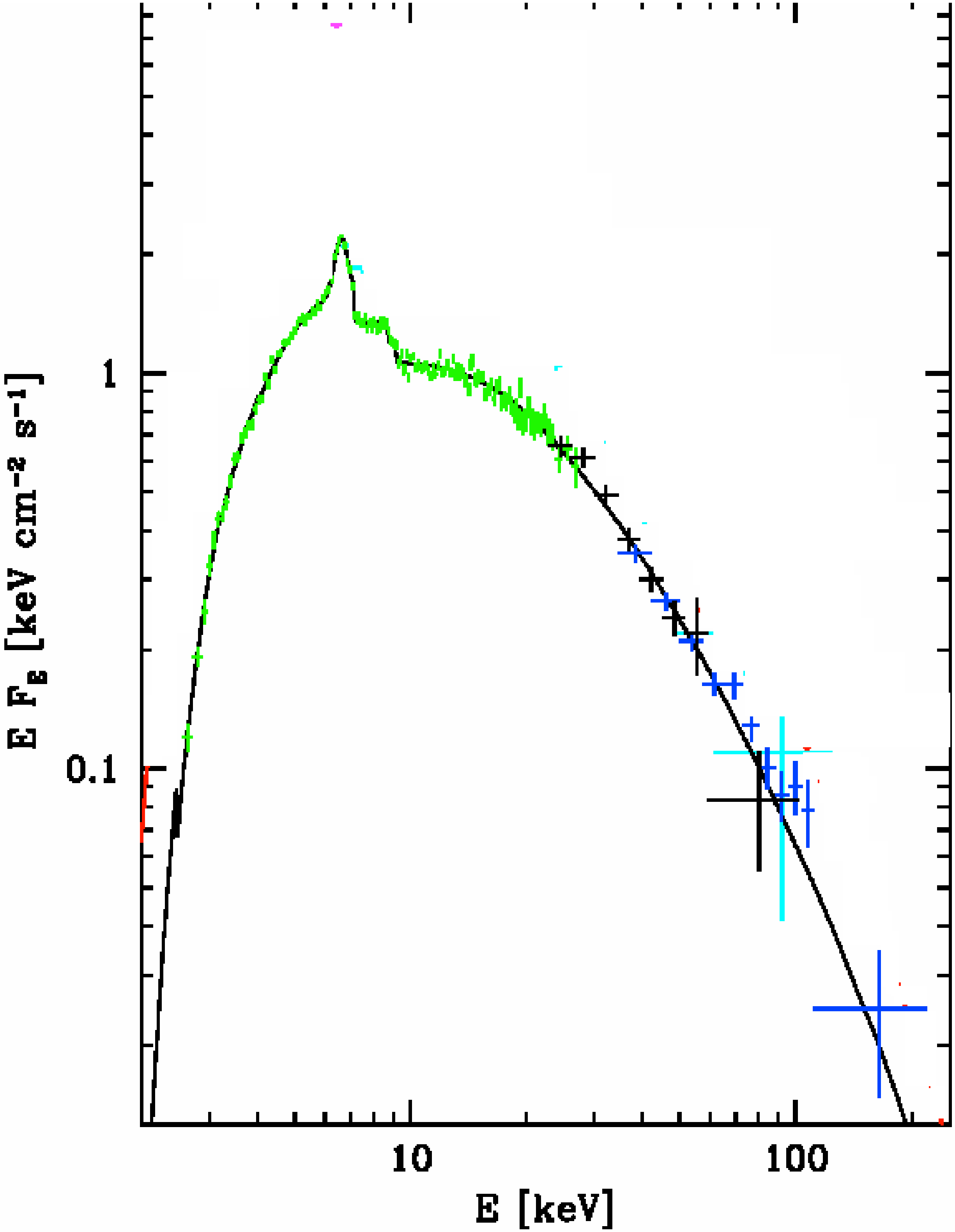


The Cygnus region has been extensively observed in Nov/Dec 2002. This image showing the bright source Cyg X-1 at the center, is integrated in the range 190-300 keV, with an exposure time of *29 ksec.*

As for Crab, the data have been corrected using previous *empty field* data, by means a background correction technique. The SNR is ~ 5_



10
5
1
0.5
1.2
1
0.8
E F_E (keV cm^-2 s^-1)
data/model
50
100
500
E (keV)

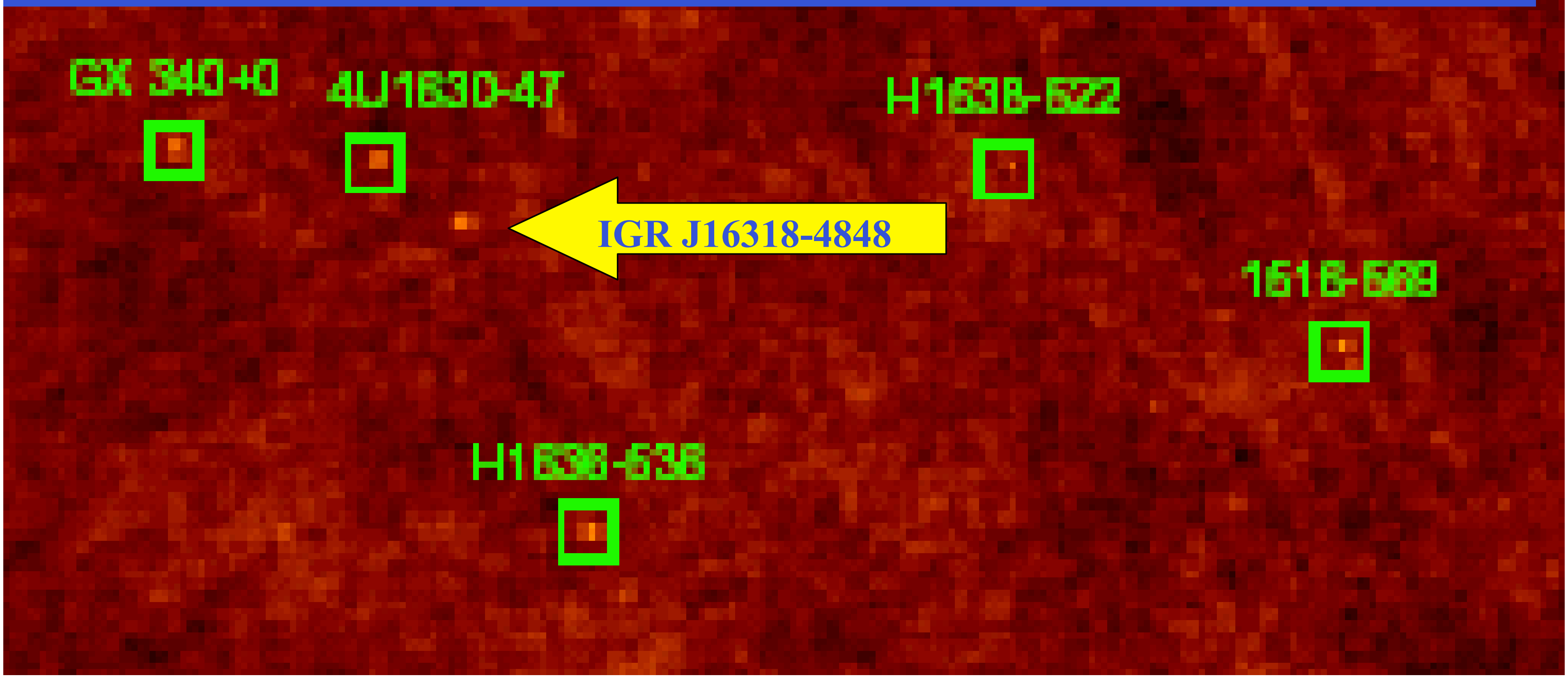


Deconvoled spectra of Cyg X-3 The green, blue and black spectra are from the JEM-X, ISGRI and SPI, respectively, with the model spectrum shown in the black curve. The ISGRI and SPI spectra have been renormalized to the JEM-X data.

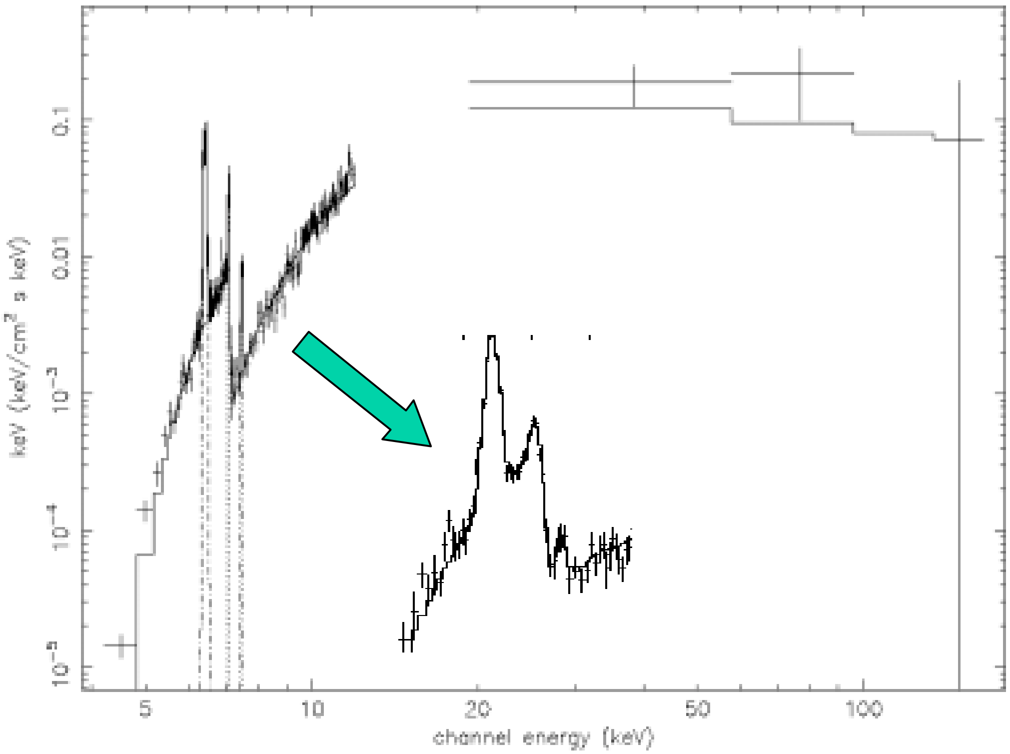
From Vilhu et al., *A&A Integral special issue*, 2003, in press

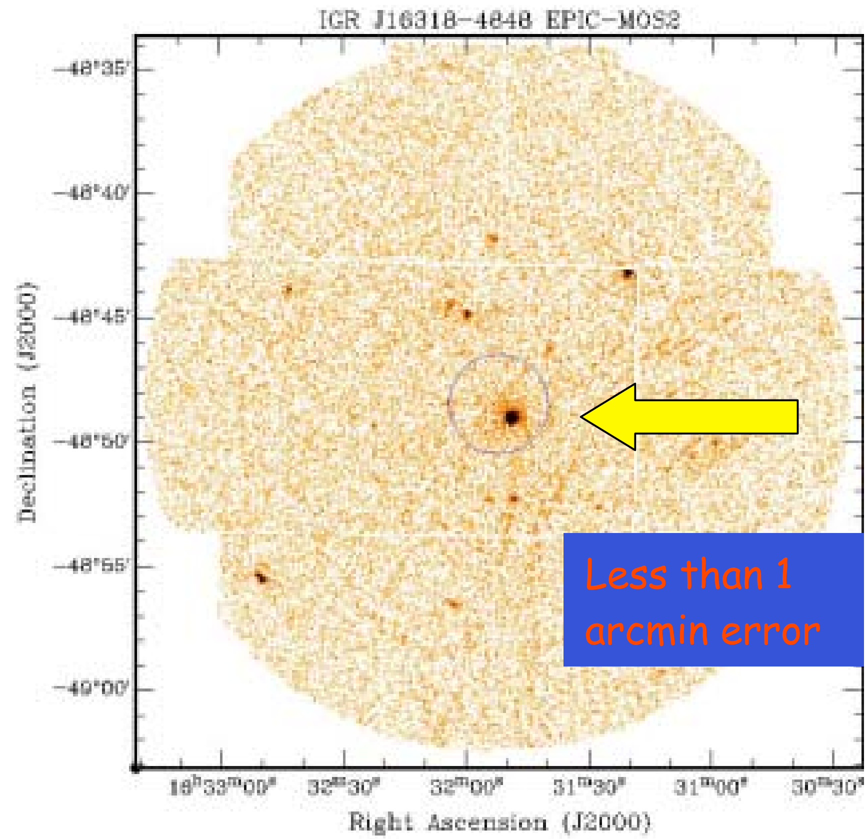
January 29th 2003…finding "plate" in gamma rays..

The First source discovered by IBIS/Integral!



INTEGRAL	**GLAST Workshop** **P. Ubertini, IASF CNR - Roma** **On Behalf of ISWT and IBIS Team** **Accademia Nazionale dei Lincei, Roma, September 17, 2003**	

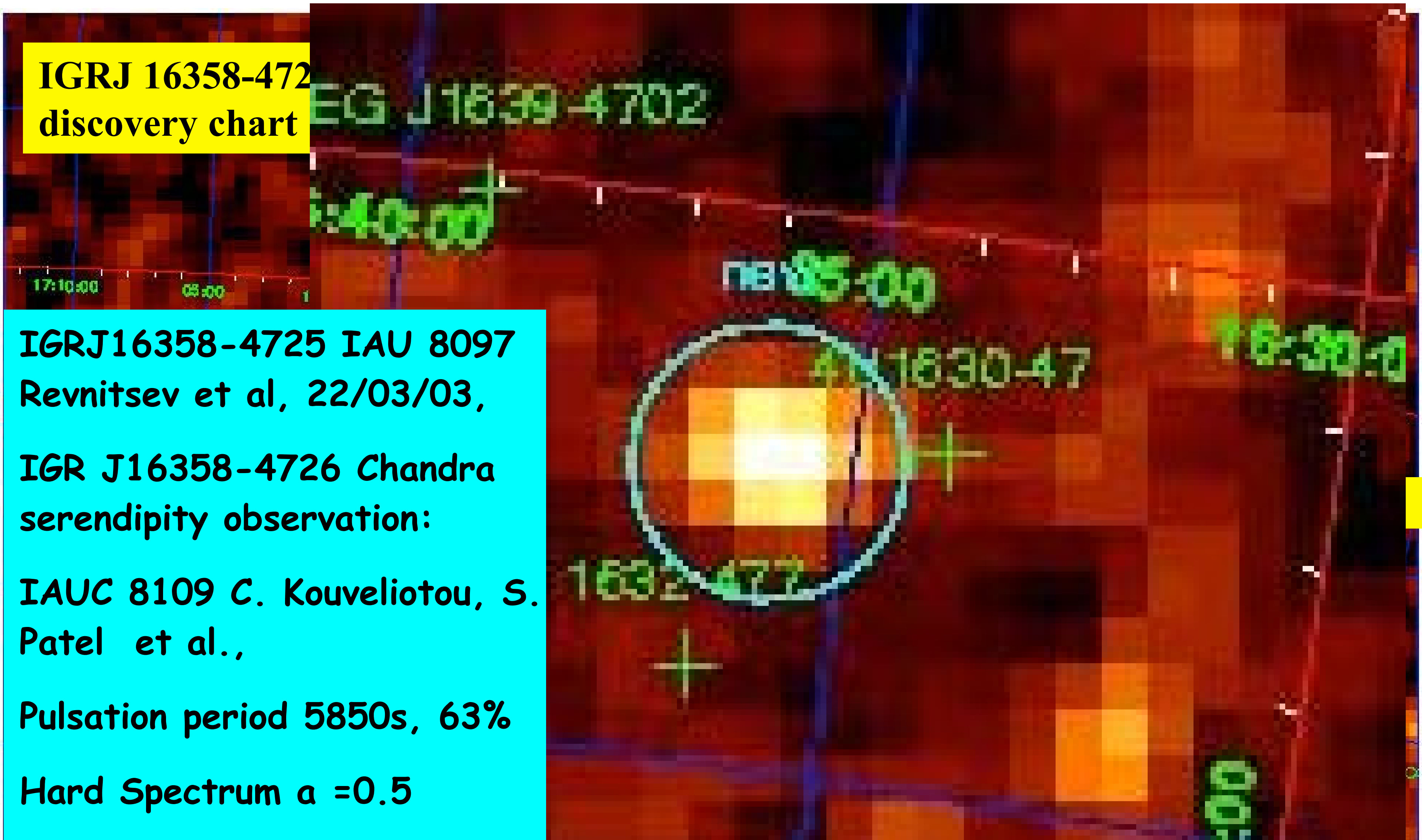




The XMM/EPIC and IBIS unfolded spectra of IGR J16318-4848. The combined spectrum is fittable with a strong self absorption and hard tail component. The IBIS spectrum is accumulated in 30 minutes.
Fe kα (6.4 keV), Fe kβ (7.08 keV) and Ni kα (7.47 keV) are present in the XMM data. Nh = $2.25 \pm 0.15\ 10^{24}\ cm^{-2}$

>>>>> suggest a new class of sources?

IGRJ 16358-472 discovery chart



IGRJ16358-4725 IAU 8097 Revnitsev et al, 22/03/03,

IGR J16358-4726 Chandra serendipity observation:

IAUC 8109 C. Kouveliotou, S. Patel et al.,

Pulsation period 5850s, 63%

Hard Spectrum a =0.5

Very intriguing source→

The Peculiar Transient IGR J16358-4726

Sandeep K. Patel (NRC)

Chryssa Kouveliotou (NASA/USRA)
Peter Woods, Mark Finger (USRA)
Allyn Tennant (NASA)
NSSTC/MSFC Huntsville, AL

Michiel van der Klis
Astronomical Institute Anton Pannekoek, U. of Amsterdam

Pietro Ubertini
Astrofisica Spaziale e Fisica Cosmica,CNR, Rome

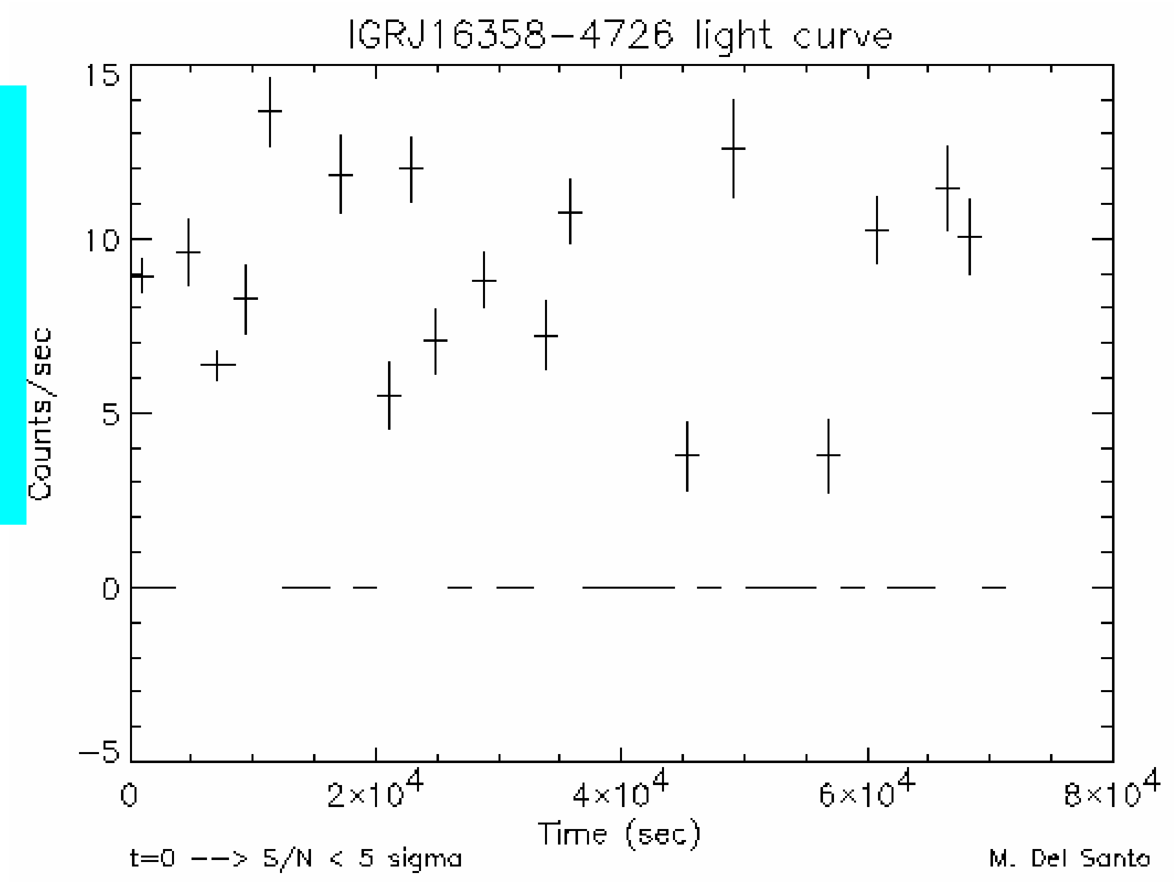
Thierry Courvoiser
INTEGRAL SDC, Switzerland

Chris Winkler
INTEGRAL SWT/ ESTEC

Stefanie Wachter
SIRTF Science Center, Pasedena, CA

From the IBIS observation it was clear the source was extremely variable.

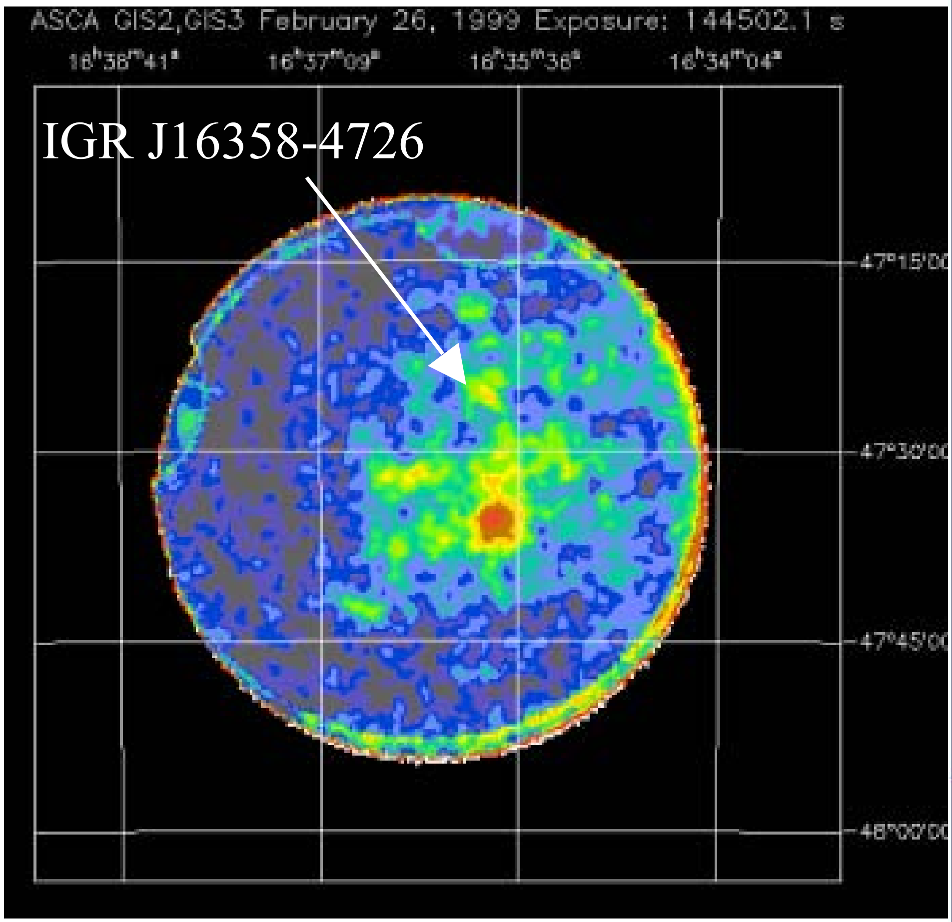
Due to the 1800 integration time it was not possible to disentangle the time variability



Light curce for single science window integration time (1800s each). Energy Range is 15-30 keV, the source intensity is: 10 ct/s ~ 70 mCrab, assuming Crab like spectrum. T=0 is 10.41.00 on March 19, 2003.

Archival ASCA and BeppoSAX Observations

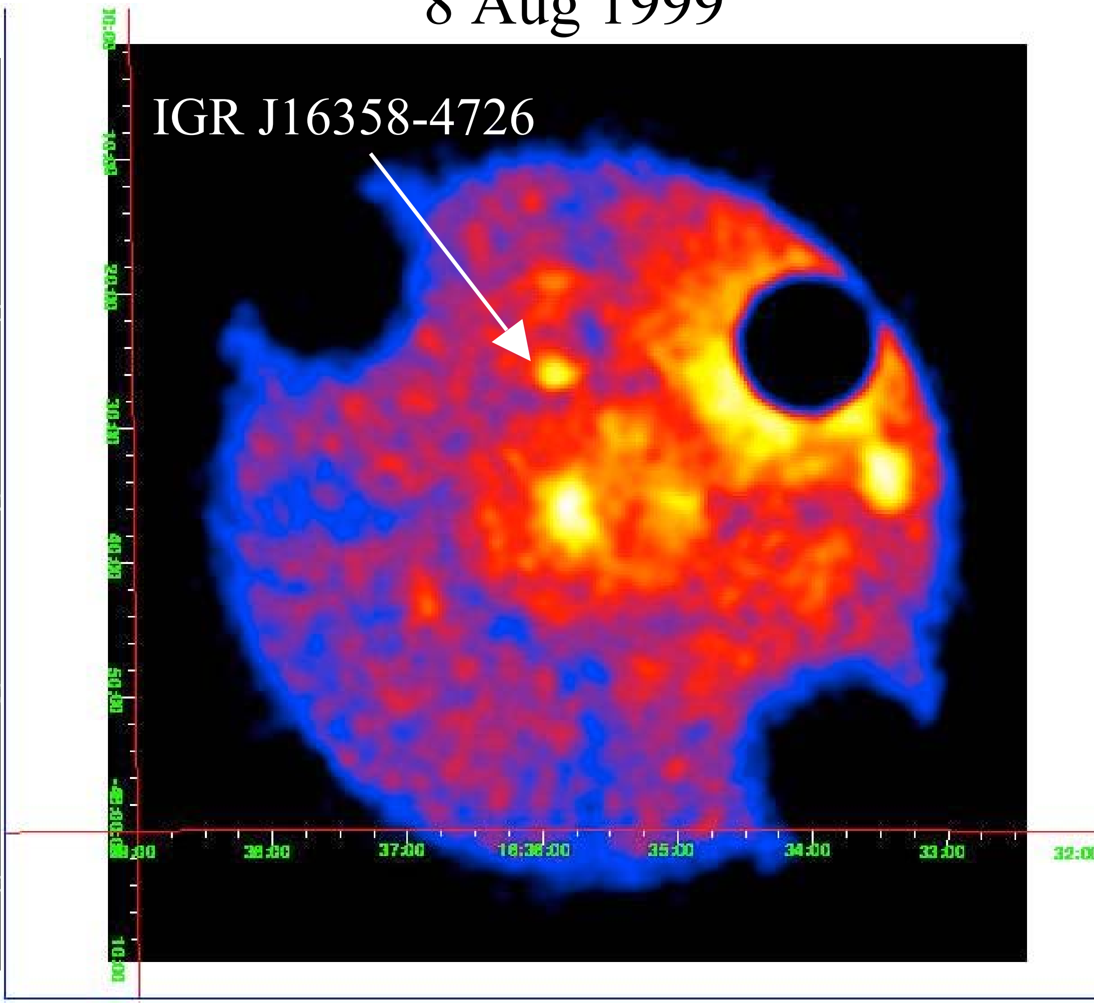
26 Feb 1999



F_{IGR}~$1x10^{-12}$ ergs cm^{-2} s^{-1} (2-10keV)

(Revnivtsev et al. ATEL #131)

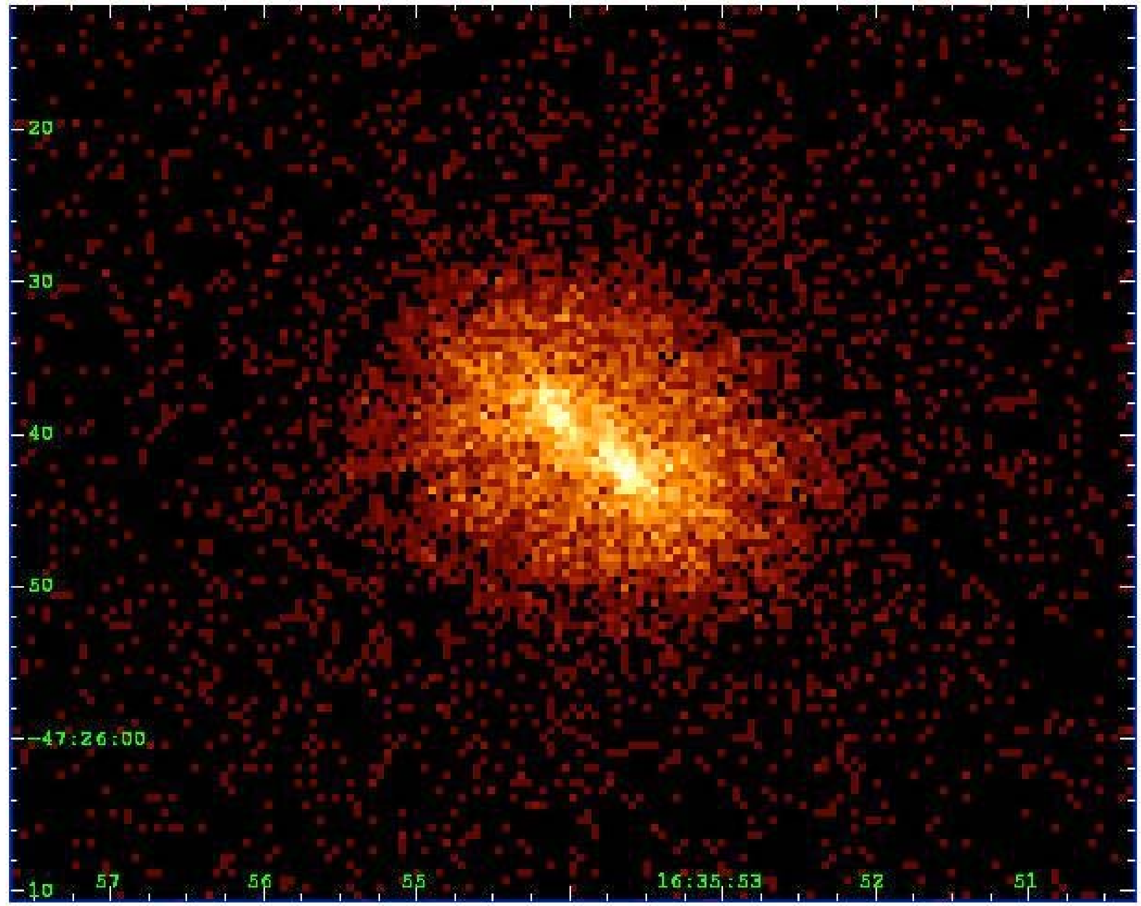
8 Aug 1999



F_{IGR}~$1x10^{-12}$ ergs cm^{-2} s^{-1} (2-10keV)

(Patel et al. 2003)

Chandra Observation: 24 March 2003

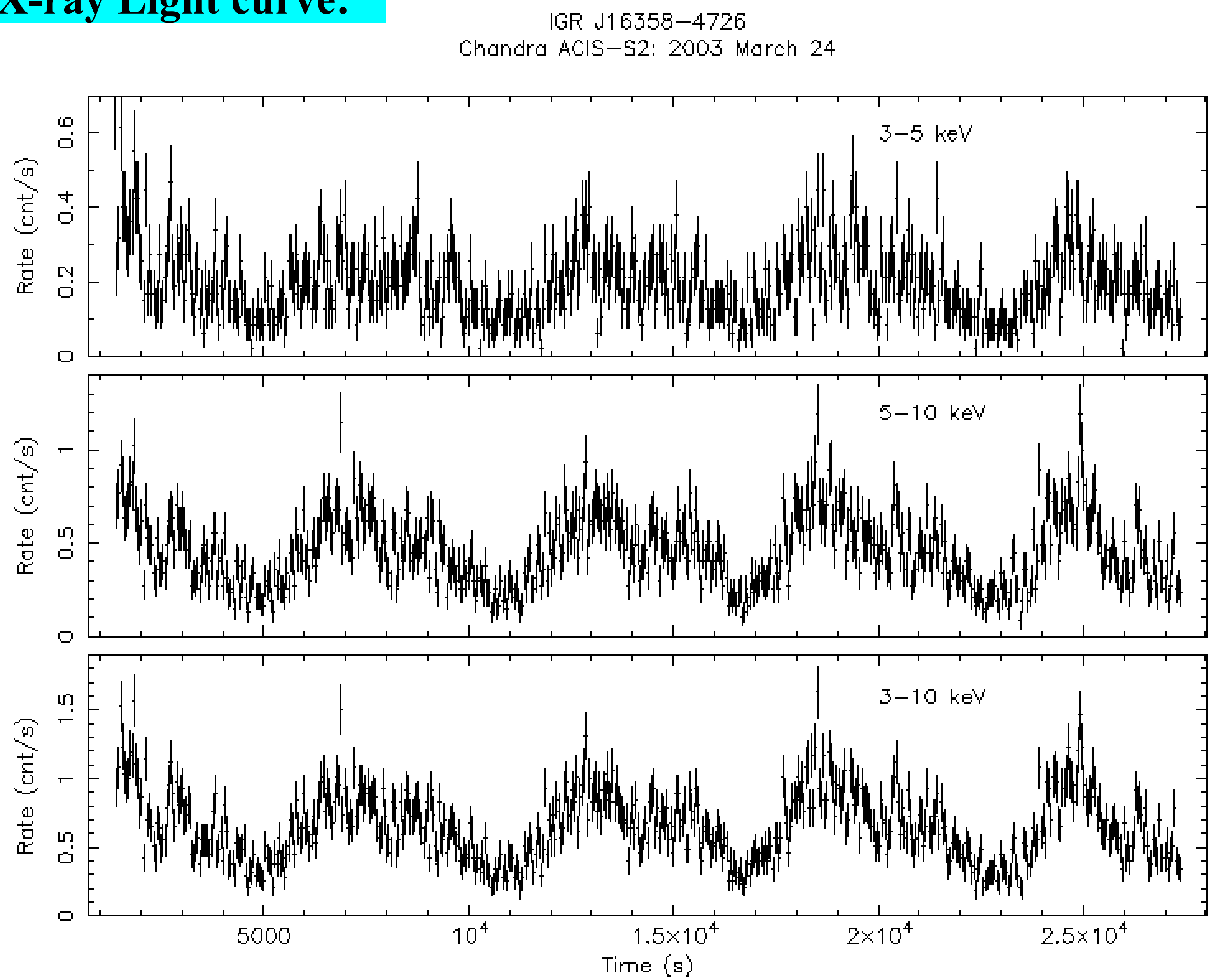


<u>IGR J16358-4726 Location</u>

We observed the transient serendipitously for 25.7 ks with Chandra ACIS-S2 during a scheduled observation of SGR 1627-41 on 24 March 2003.

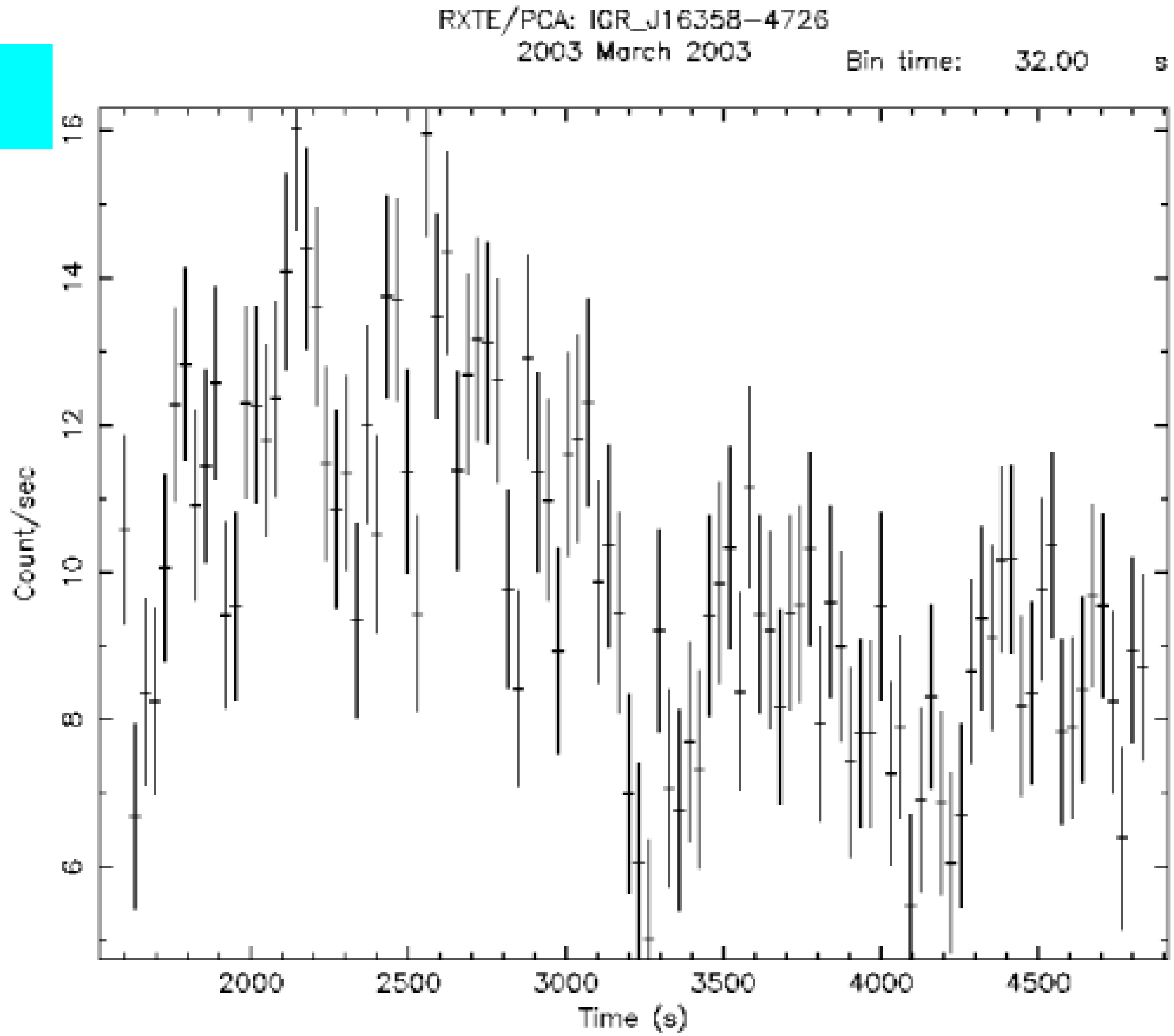
A fit to the off axis image was found to be consistent with the PSF. We derive the location of the transient to be RA = $16^h\ 35^m\ 53^s8$, DEC = -47 25' 41.1" with a 68% error radius of **0.6"** (9.7' away from SGR 1627-41).

CHANDRA X-ray Light curve:



Pulsations with a period P=5860(50) s are directly visible in the X-ray light curve with an energy dependent amplitude ; the pulse fraction between 2-10 keV is 63(6)% (peak-to-peak), which is atypical for X-ray pulsars. It is unclear whether these pulsations reflect a spin or orbital period, or a highly coherent quasi-periodic oscillation. *(Kouveliotou et al. 2003 IAUC 8109)*

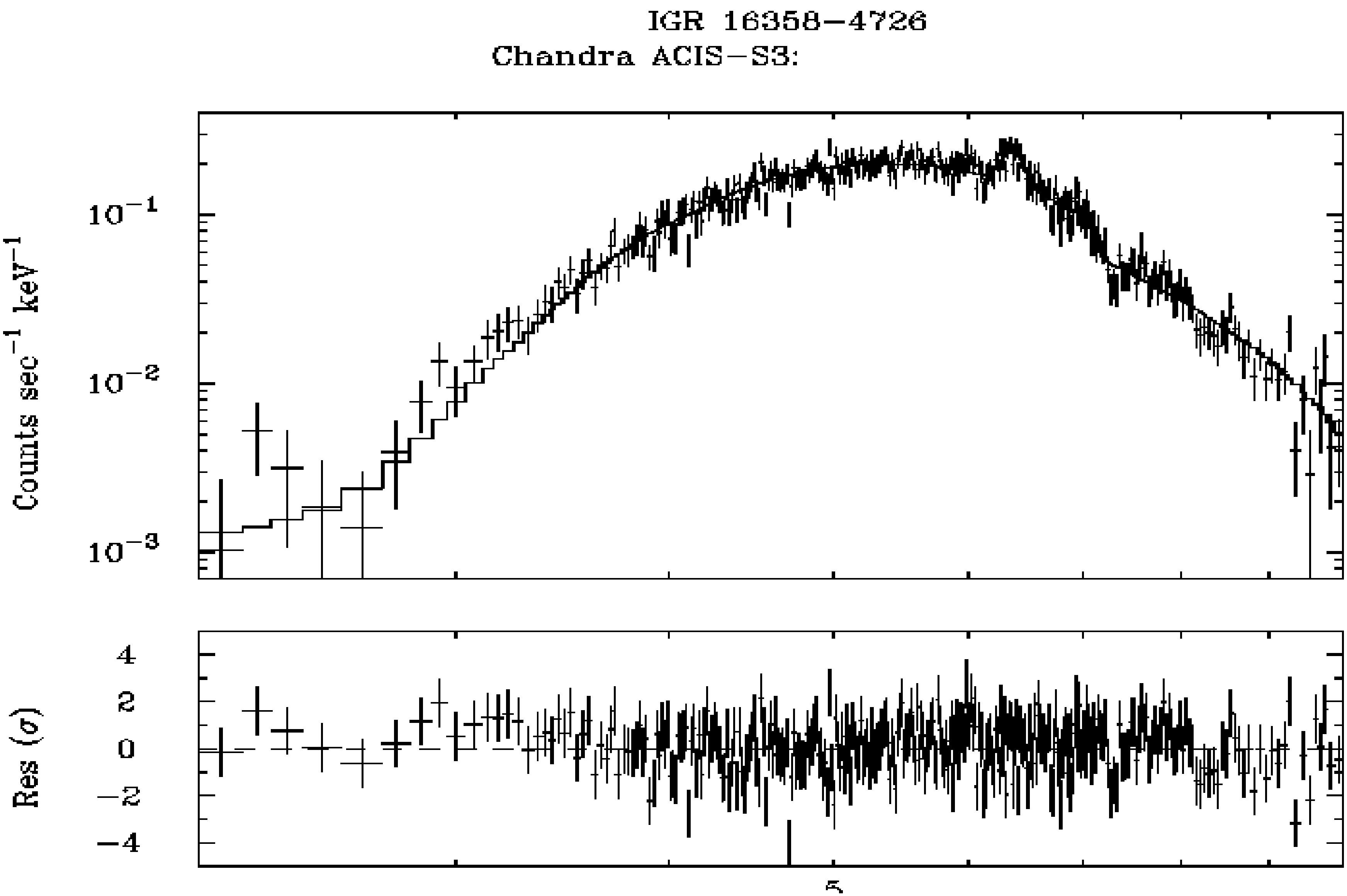
RXTE



RXTE observed the source on 25 March for 3 ksec. The power spectrum of the RXTE observations exhibits no significant peaks out to 4000 Hz. The 2-20 keV source flux decreased by a factor **~5 during the ~1.8 days** after our CXO observation. A second RXTE observation, on 11 April 2003 (11ksec), did not detect the transient above the Galactic ridge emission.

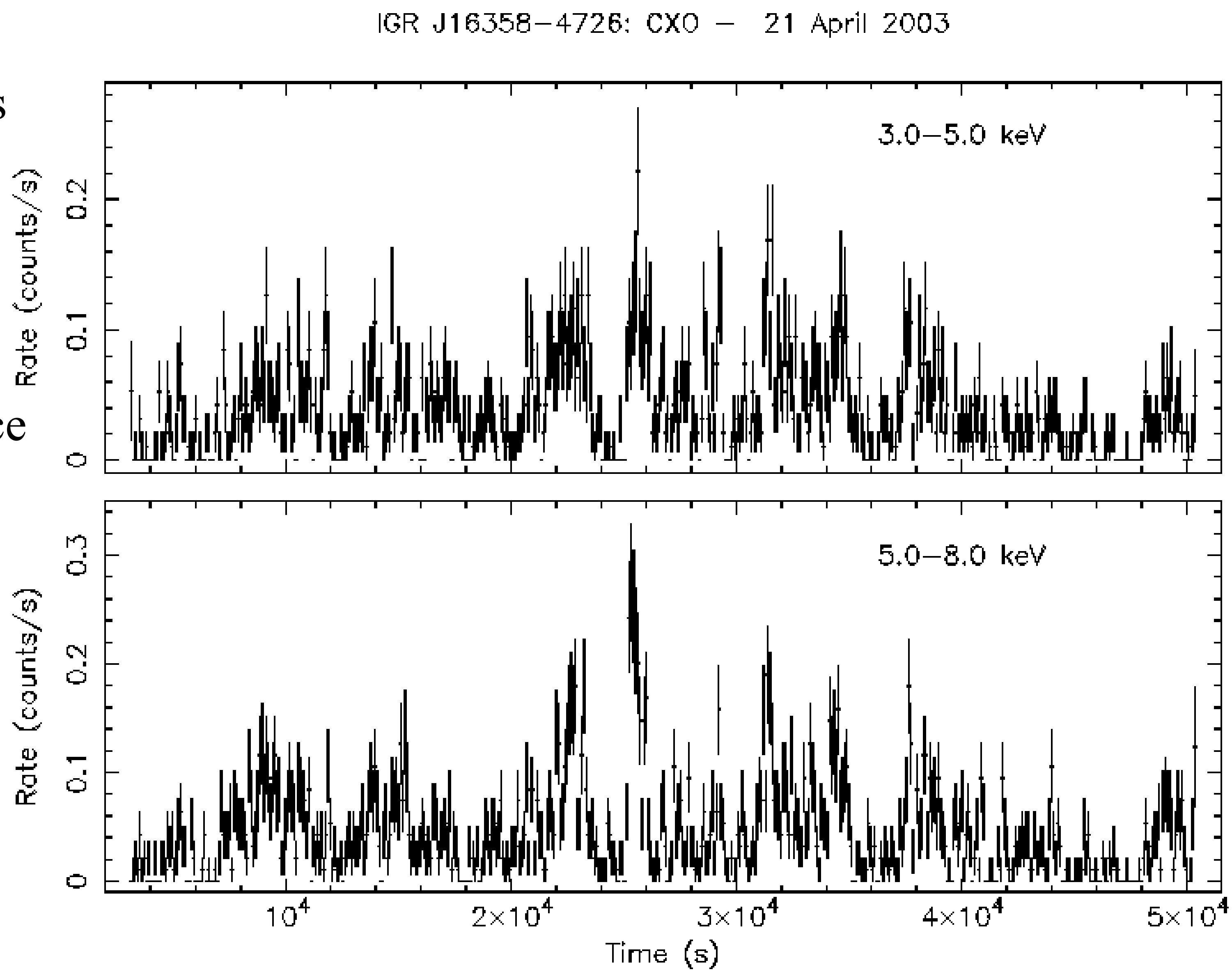
CXO Spectral Analysis:

The phase averaged source spectrum is found to be hard and highly absorbed; it is consistent with a **photon power law of index of 0.5(1)** plus a highly significant line feature at **6.4 keV** (EW=136 eV) and a column density of **N_H= 3.3(1) x 10^{23} cm^{-2}**. The unabsorbed source flux is 1.7 x 10^{-10} ergs cm^{-2} s^{-1} (2-10 keV).



21 April 2003
Chandra CC-Mode Lightcurve

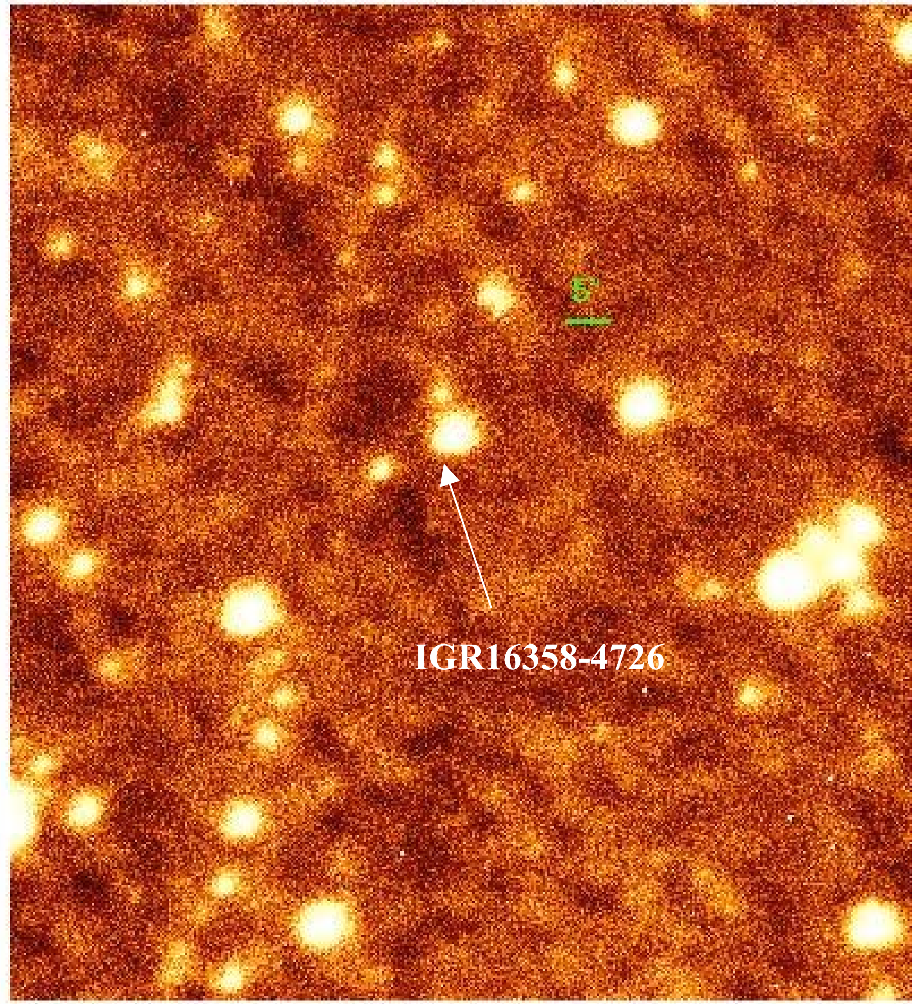
Epoch fold search of the lightcurve reveals a modulation of ~5875s, consistent with our previous measurement. Enhanced flickering (~1000s) of the source is also evident.



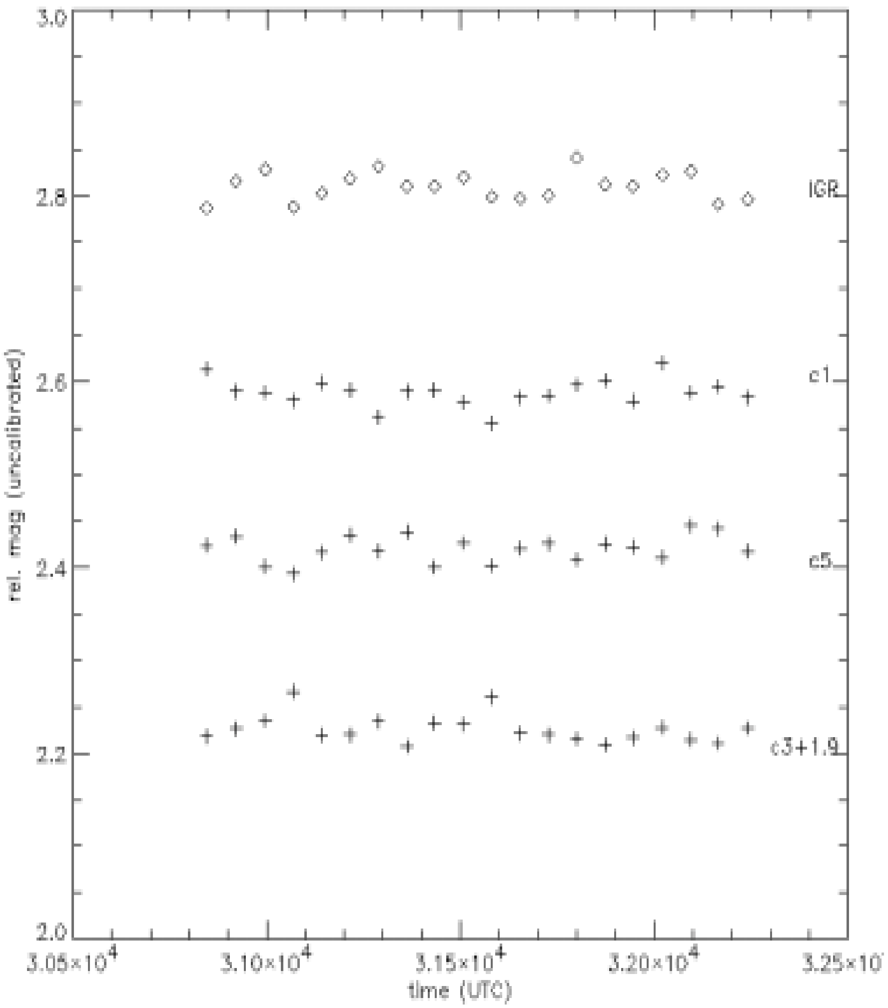
IR Observation of the IGR J16358-4726 Field

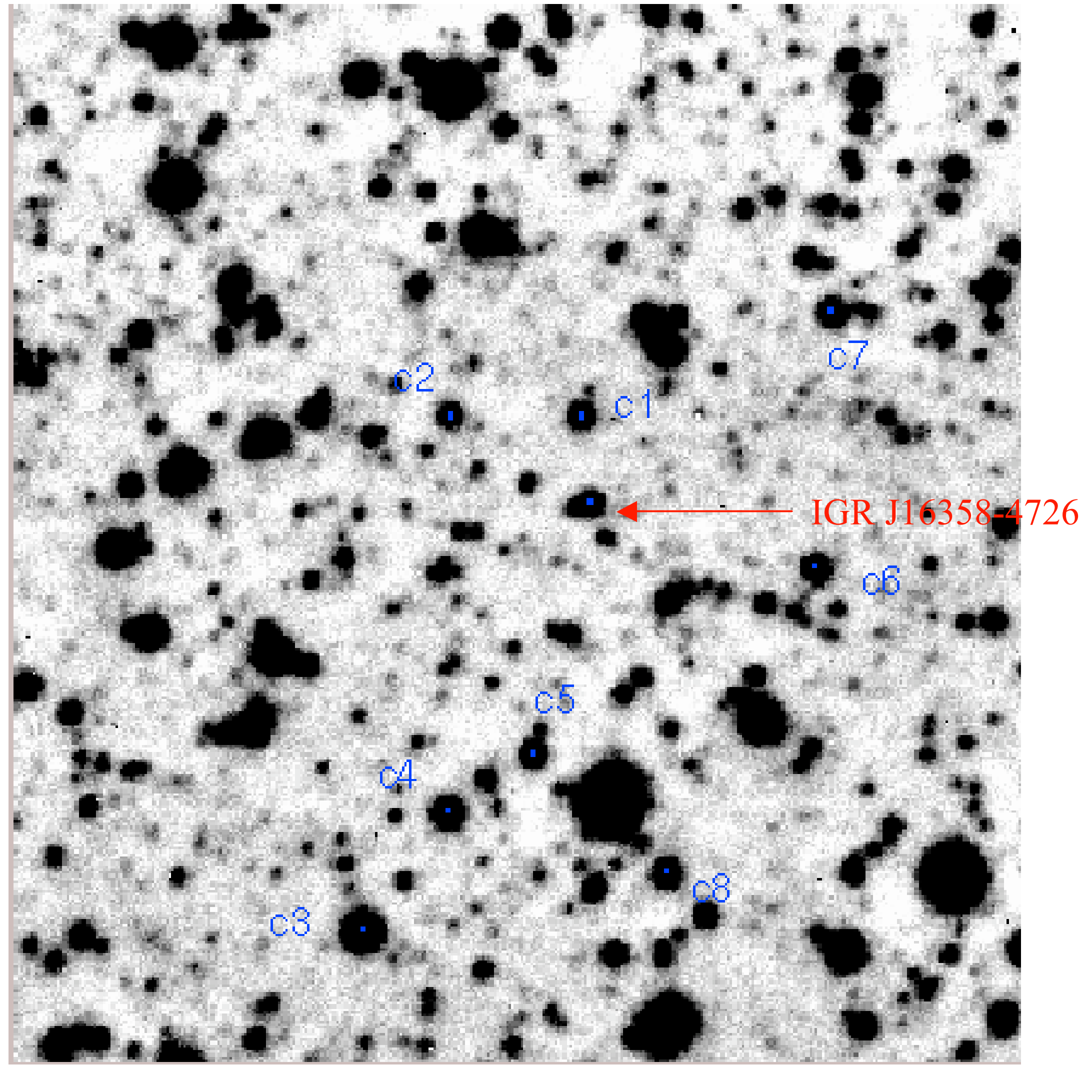
CTIO: 4 April 2003

A search for an infrared counterpart in the 2MASS All Sky Catalog revealed a relatively bright source 1".7 from the Chandra position of IGR J16358-4726 (2MASS J16355369-4725398, with J = 15.41, H = 13.44, K = 12.59). However, our 2003 April 4 observation of this field with the CTIO 1.3m telescope detected no new source at the transient location down to Ks=17. We detected the 2MASS source at Ks=12.64(5), consistent with the 2MASS catalog. The possibility that this source is the counterpart to IGR J16358-4726 cannot yet be completely ruled out.



ESO-NTT/SOFI IR Observations: 17 April 2003





We are currently analyzing observations obtained with the ESO NTT/SOFI (K band), but due to the poor seeing (1.8-2.8 arcsec) during the observation, it is doubtful that we will be able to resolve the bright 2MASS source from another source detected closer to the precise CXO location. We are currently re-proposing to observe with the CTIO 4m/ISPI.

What is IGR 16358-4726?

Some possibilities…

Cyg X-3 (HMXB)

AM Her (Magnetic CV)

4U 1822-37 (5.57h LMXB)

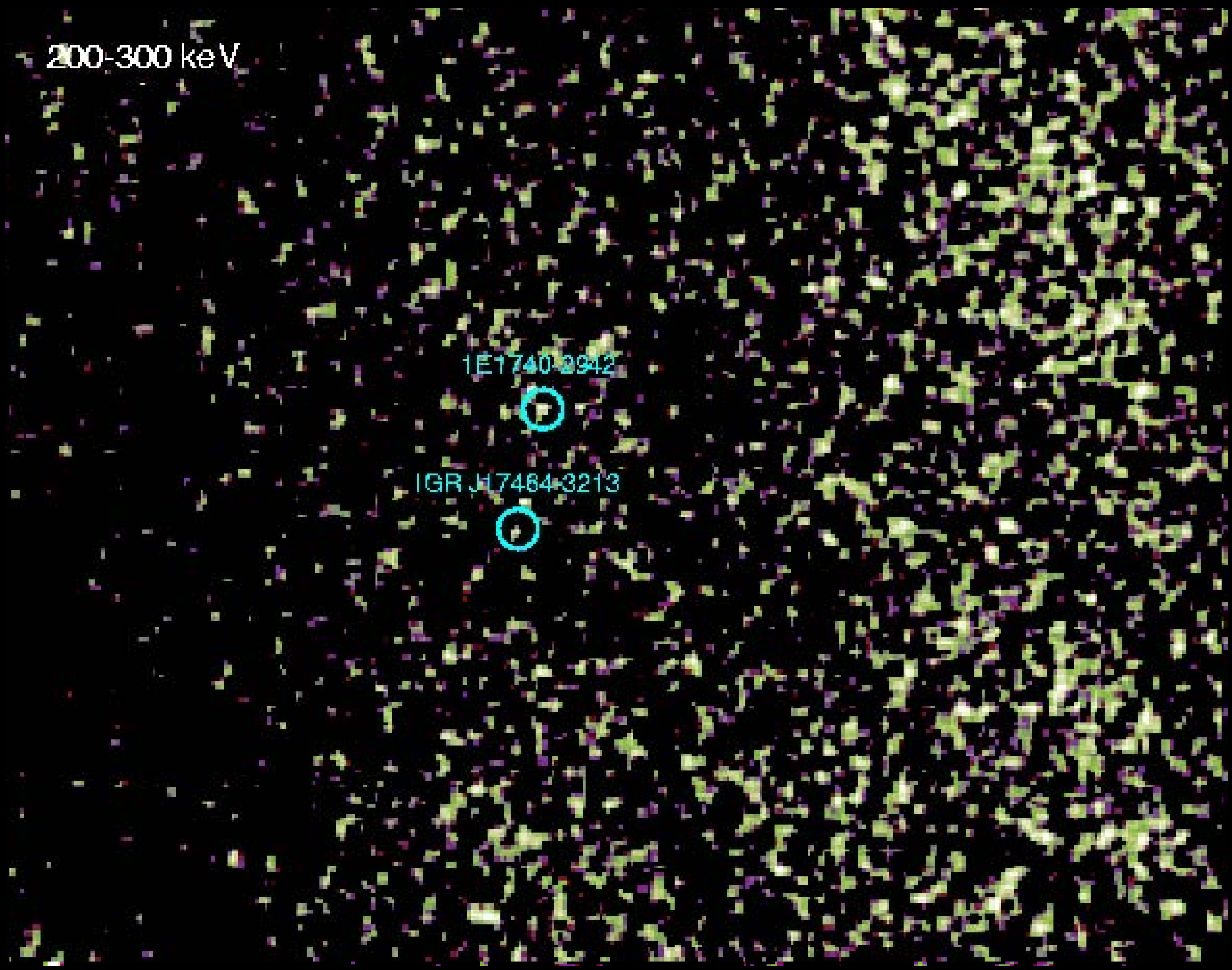
ADC

Millisecond Pulsar

GRS 1915+105 (Galactic Microquasar)

IGR 17464-3231=H1746-32 and 1E 1740-2942, both sources show a hard spectrum, BHCs?

(GCDE observation, Courtesy of A. Bazzano, F. Capitanio)



IGRJ 17464-3213

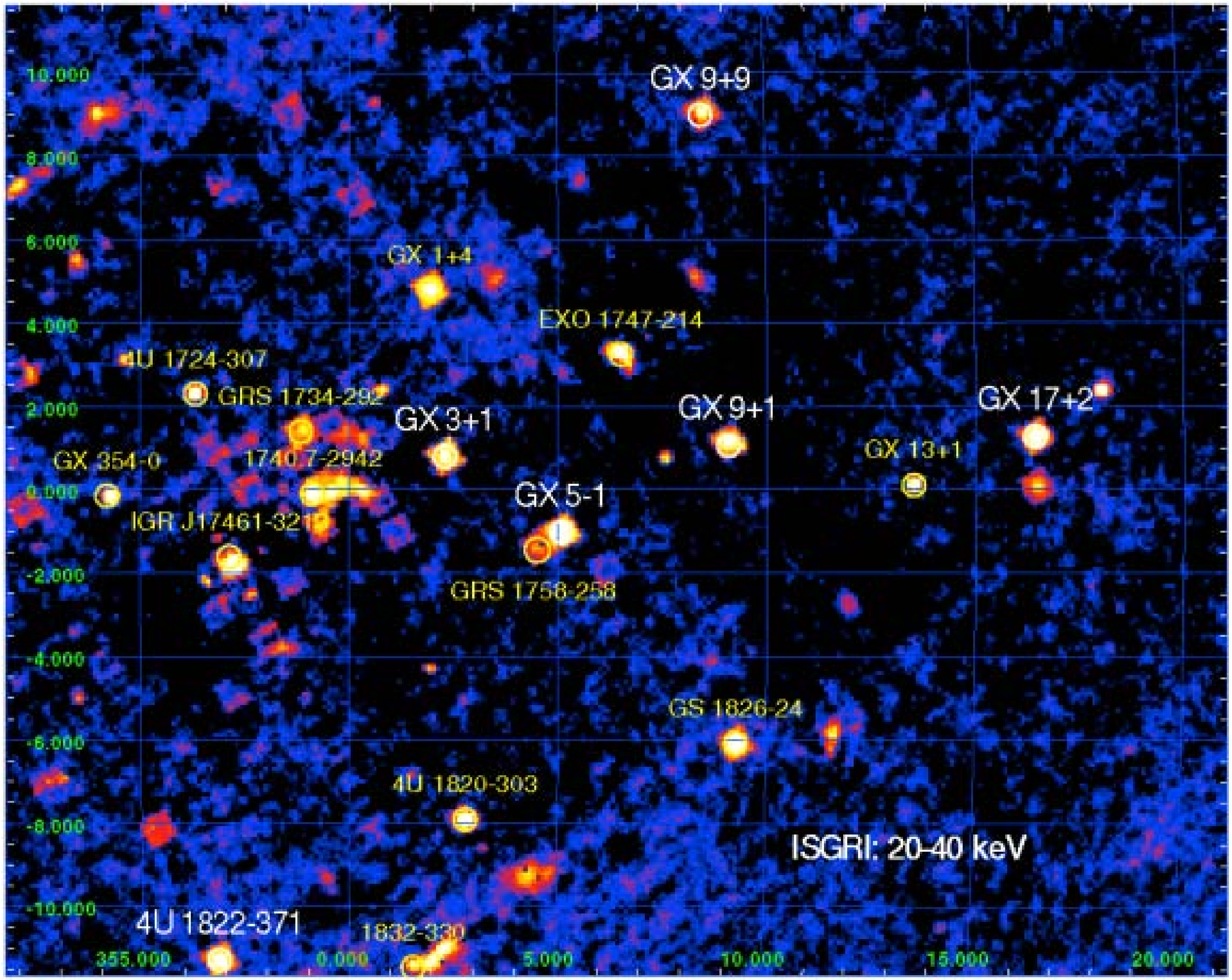
Source Fluxes:

March, 24-25 2003 Average

15-40 keV	**60 mCrab**
40-100 keV	**60 mCrab**
100-200 keV	**70 mCrab**

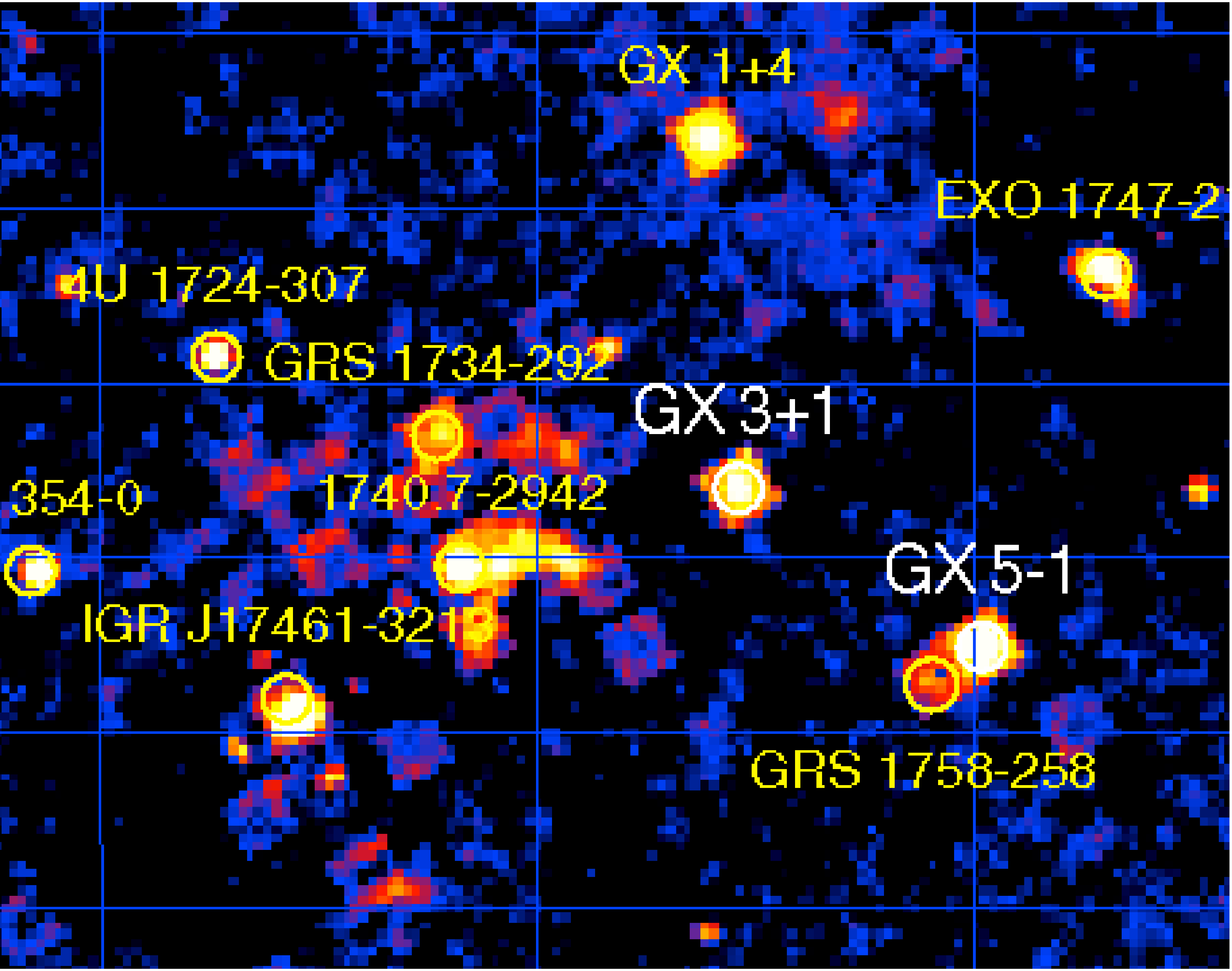
Work in progress to derive the light curve, spectrum etc

Energy range: 15-40, 40-80, 80-120, 120-200, 200-300 keV, Data Set: 21 March 2003, Exp. Time ~ 141ks



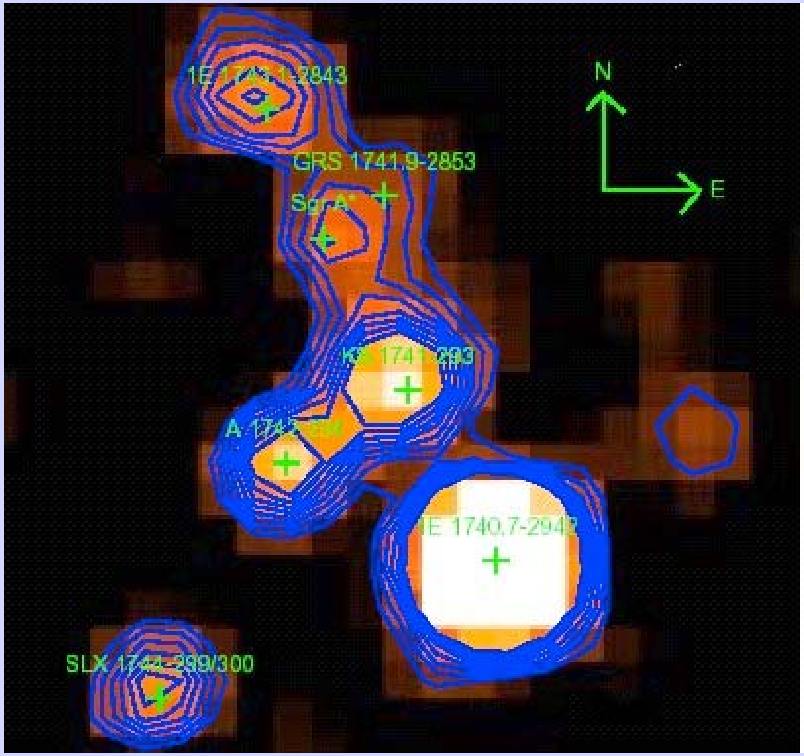
IBIS/ISGRI image of the Galactic Centre in the 20-40 keV band. The analysis of IBIS/ISGRI data is based on GCDE and GPS data from revolution 30 to 64 i.e. January 11th to April 22nd, 2003 for a total of one tousand pointings (about 2 Msec exposure).

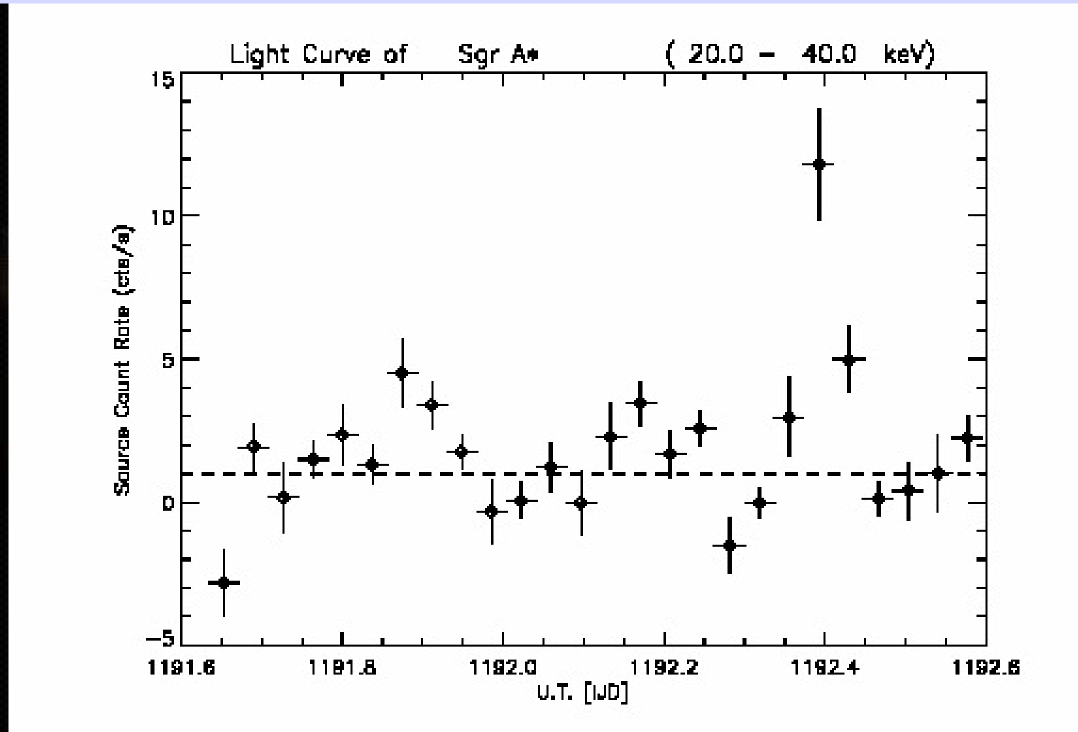
Credit A. Paizis


GX 1+4
EXO 1747-2
4U 1724-307
GRS 1734-292
GX 3+1
354-0
1740.7-2942
GX 5-1
IGR J17461-3219
GRS 1758-258

High energy emission from the SMBH
coincident with SGR A*?

A recent long IBIS exposure has revealed several high energy sources including a excess in the range 15 – 100 keV
< 1 arcmin off SGR A*





Exposure time 1.13 Ms, one sky pixel is 5 arcmin, Intensity 6mCrab

INTEGRAL

GLAST Workshop

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On Behalf of ISWT and IBIS Team

Accademia Nazionale dei Lincei, Roma, September 17, 2003

How much the Galactic Binaries can contribute to the diffuse background?

Basic facts from the presentation at the Como conference, Villa Olmo, 12 Maggio 1999

THE FIRST GALACTIC BULGE UN-BIASED LONG TERM MONITORING PERFORMED BY BEPPOSAX:

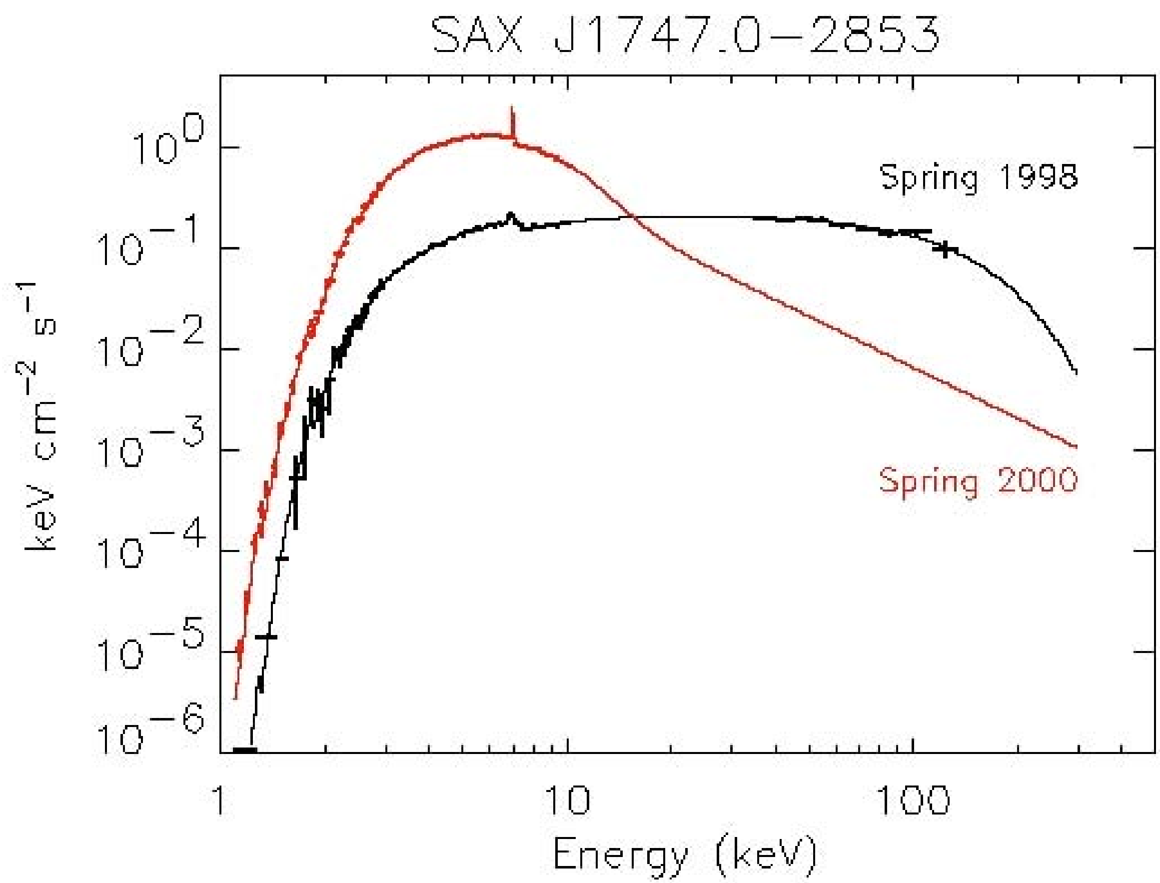
~5 million seconds were spent on the Galactic Bulge

The result is the first accurate evaluation of the ratio between Neutron Stars and Black Holes in the Central part of the Galaxy (40x40 squared degree)

$0.16=(7/45) \leq NBHC/NNS \leq 0.30=(10/42)$

This result was INCONSISTENT with previous estimations: IBIS will solve this puzzle extending the survey to the γ-ray range with a capability similar to the WFC anda factor of 10 better sensitivity than SIGMA

The first indication from IBIS/INTEGRAL looks very similar!!



The unfolded spectra measured by the BeppoSAX/NFI showing two different spectral states of SAXJ1747.0-2853. The best model spectra derived from the two observations of 1998 and 2000 are also shown in the energy range 1-200 keV. For the softer spectrum model, the high energy tail is the extrapolation of the power law measured below 10.5 keV.

(see Natalucci et al., in preparation, to be submitted to A&A)

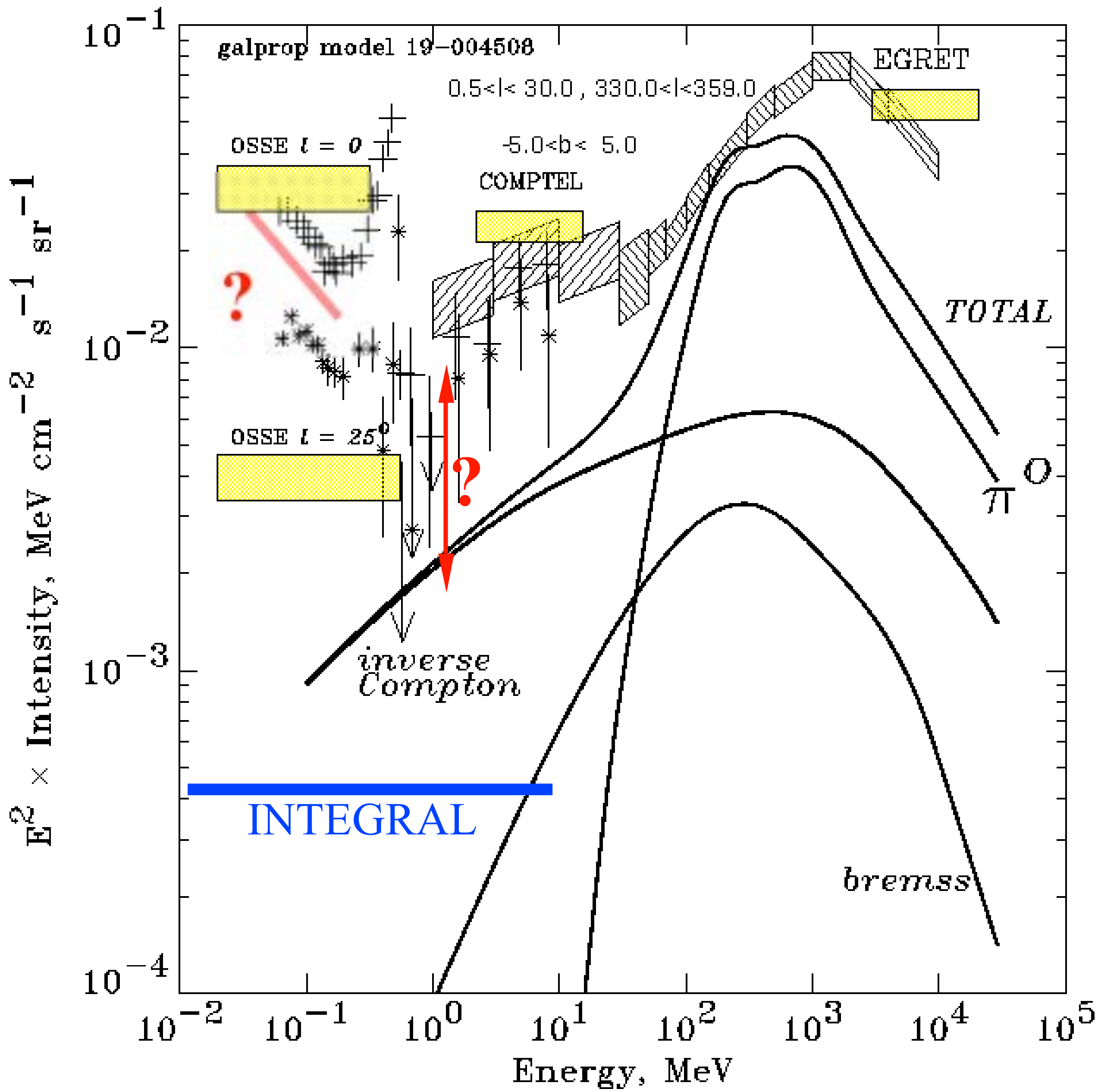
OSSE observations

The overall galactic emission observed by OSSE between 50 keV and 10 MeV can be accounted for with a three components model:

- A cosmic-ray induced component based on an extrapolation of the processes at work at higher energies
- An annihilation line and a positronium continuum
- An unknown low energy component well represented by an exponentially-absorbed power law spectrum or a thermal Comptonization spectrum (Kinzer et al. 1998).

The last component has a rather flat longitude distribution, similar to that observed at higher energies, but has a wider latitude distribution (5° FWHM) and exhibits a sharp maximum in the galactic centre direction..

Galactic gamma-ray emission spectrum



"conventional" model

Strong, Moskalenko et al. (2000)

Origin of the diffuse emission < ~1 MeV

- **Ion** inverse bremsstrahlung : NO

  because (i) pion production (EGRET)

  (ii) _-ray line production (3-7 MeV limits; OSSE)

  (iii) excessive ^{9}Be production

- Inverse Compton : NO

because radio emission ~100 MHz (electron synchrotron ~ 0,1-10 GeV)

- X- _ non-thermal SNR emission

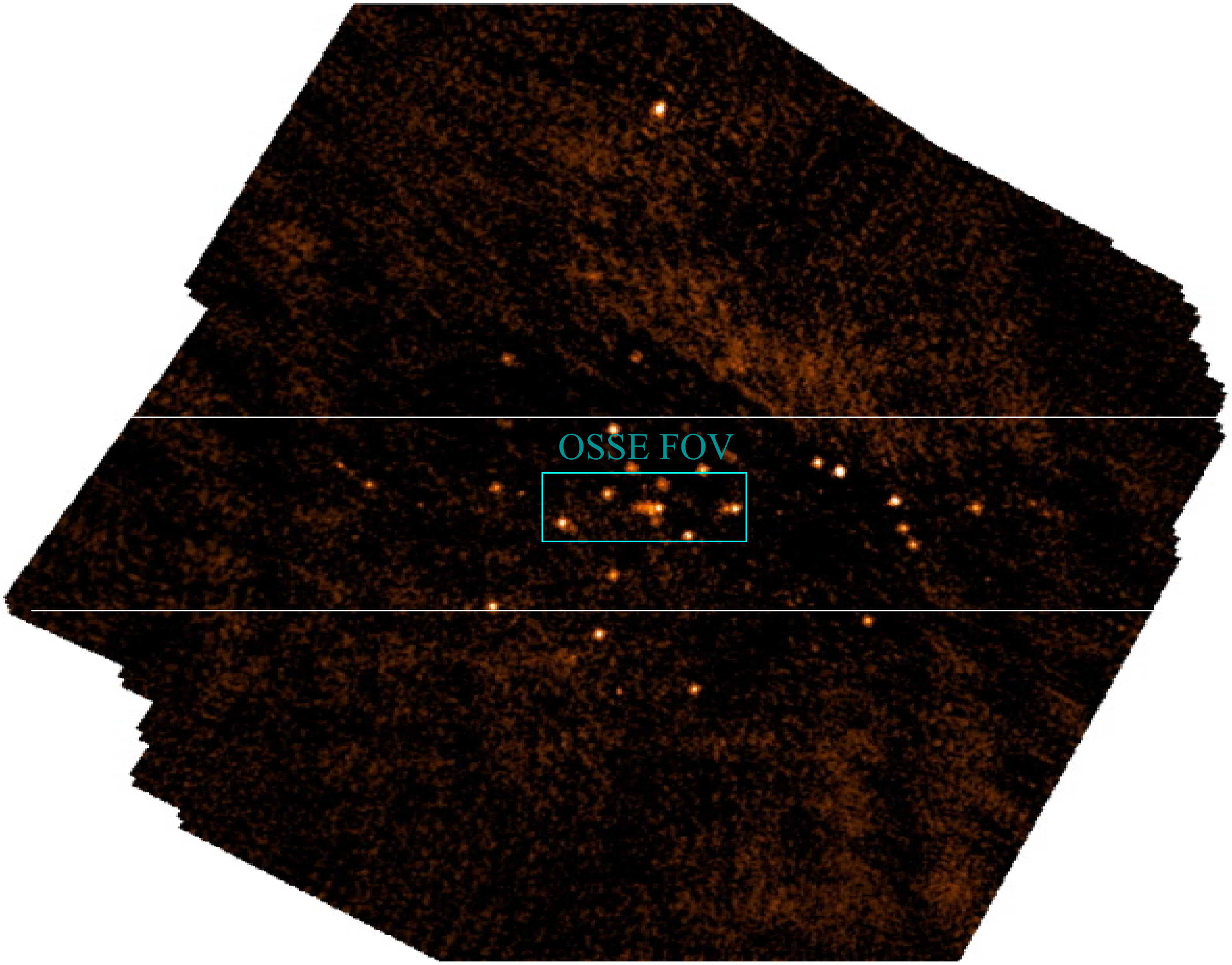
  - suprathermal electron bremsstrahlung (Cas A ?)
  - Electron synchrotron > 10 TeV (e.g. SN1006)

- Suprathermal electron bremsstrahlung

  cosmic-ray reacceleration (Schlickeiser 1997) ?

  Required power : 10^{41}-10^{42} erg/s (⇒ power supply, ionisation ?)

IBIS/ISGRI survey (20-40 keV)



F. Lebrun, CEA - Saclay

On going work

- Image background structure correction
- Image mosaics building in various energy bands
- Mosaic flat-fielding (filtering)
- Point-source extraction from the central radian and within 10° of the Galactic disc.
- Source spectra estimates
- Source spectra summation → global contribution to the galactic emission
- Comparison with OSSE measurements (Kinzer et al. 1999)

F. Lebrun, CEA - Saclay

Galactic hard X-ray/soft γ-ray diffuse continuum:
intense emission
2 10^{38} erg s^{-1}

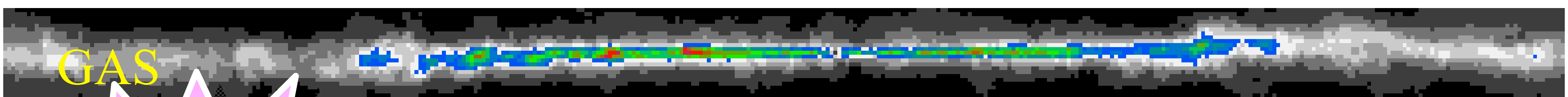
Observed by RXTE, OSSE, Ginga, ASCA, COMPTEL
Not compact sources – no known population
Chandra: shown to be *truly diffuse* (not resolved into sources)

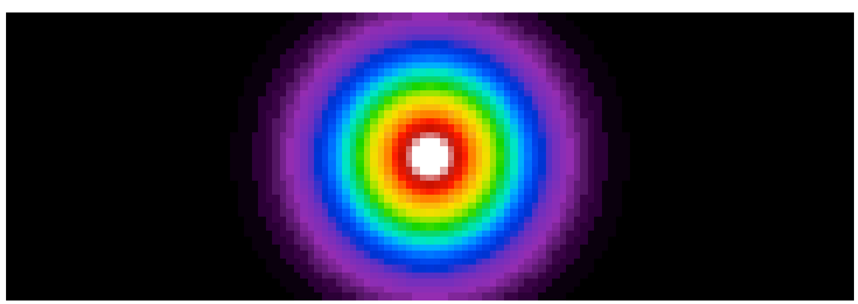
Energy problem: if bremsstrahlung from
CR electrons, most of energy lost by ionization
Power required 10^{41} erg s^{-1}
comparable to total SN energy input of Galaxy!

Various proposals, eg
- in situ electron acceleration : quasi thermal electrons (Dogiel)
- MHD hot plasma - high magnetic fields- reconnection (Tanuma &Shibata)

Diffuse emission from Galactic ridge

Energetic electrons bremsstrahlung

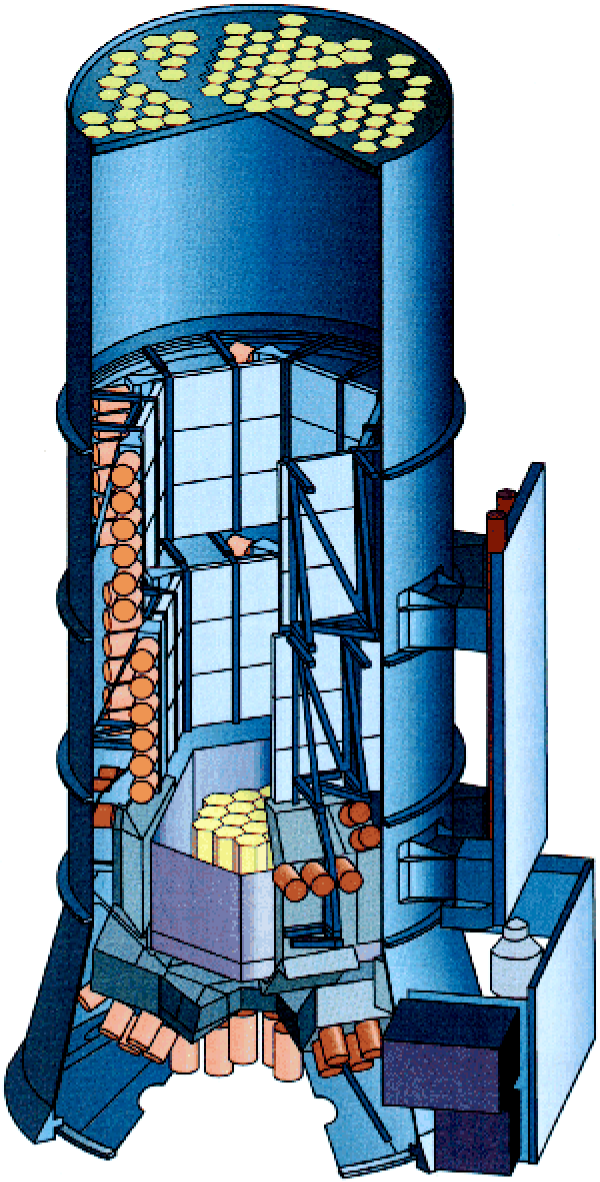


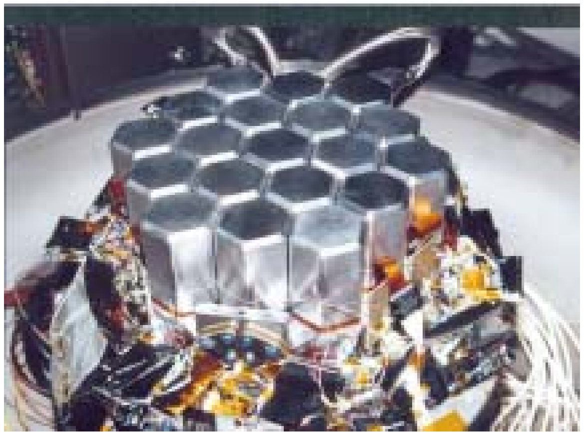


Annihiliation

A. Strong, MPE

INTEGRAL /SPI





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Diffuse Galactic continuum: a major goal of INTEGRAL

Observations and data:

Core Time:

Galactic Centre Deep Exposure : $4\ 10^6$ s yr^{-1}

$-30^o < l < 30^o$, $-20^o < b < 20^o$

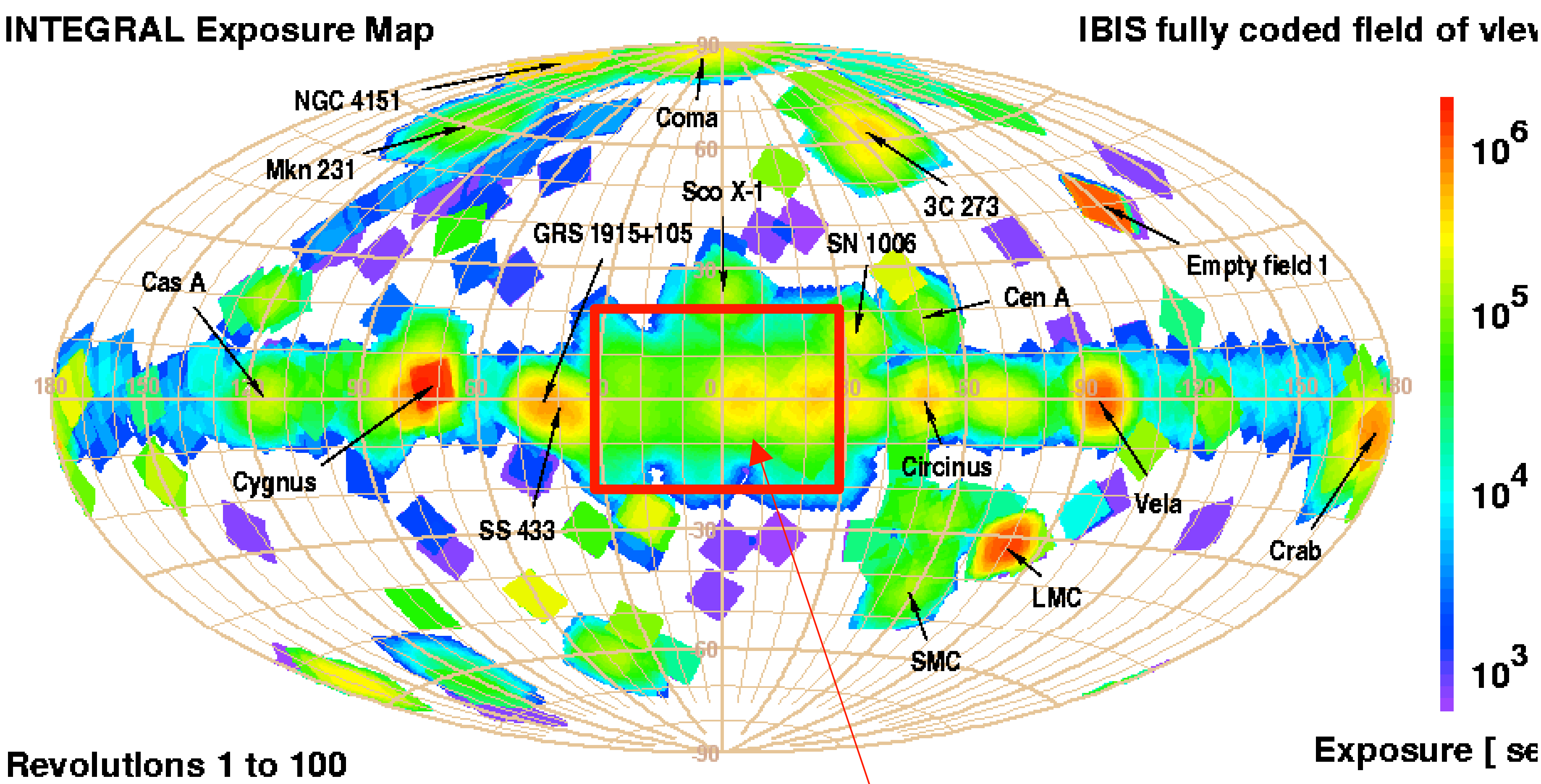
+ Galactic Plane Scans

+ all Open Time data after 1 year

Advantages of SPI

- wide energy coverage (20 keV – 8 MeV)
- high energy resolution (~2.5 keV @ 1 MeV)
- imaging capability: removal of sources, recognition of spatial structures
- large-scale coverage cf earlier missions which observed only restricted regions

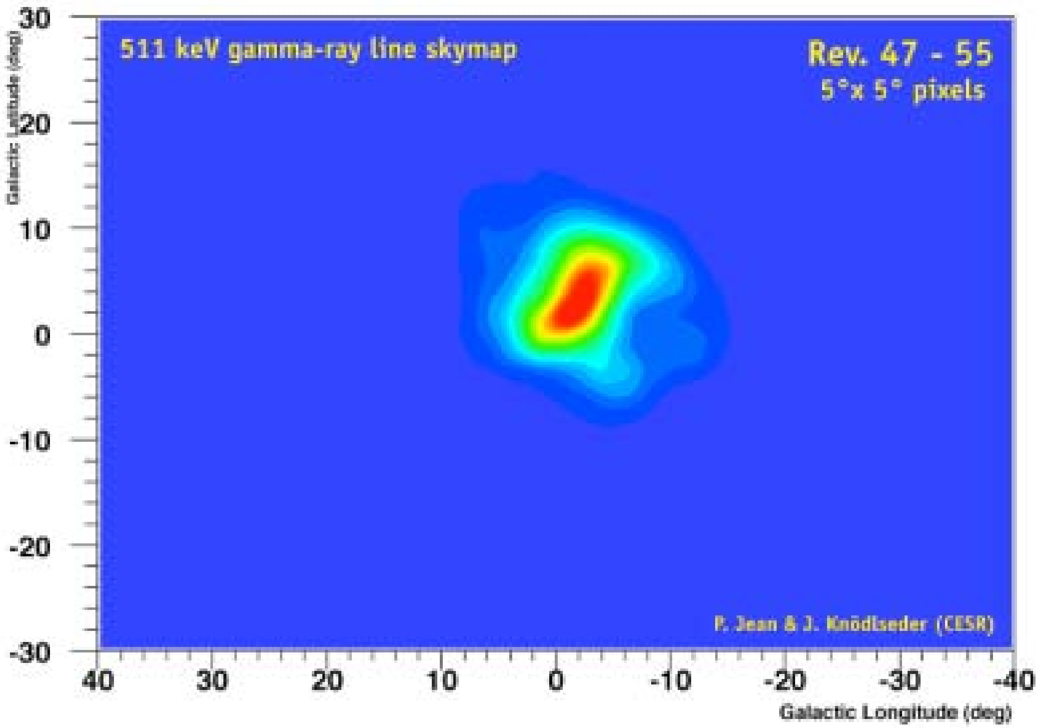
Exposure after ~1 Jahr in Orbit (including Open Time)

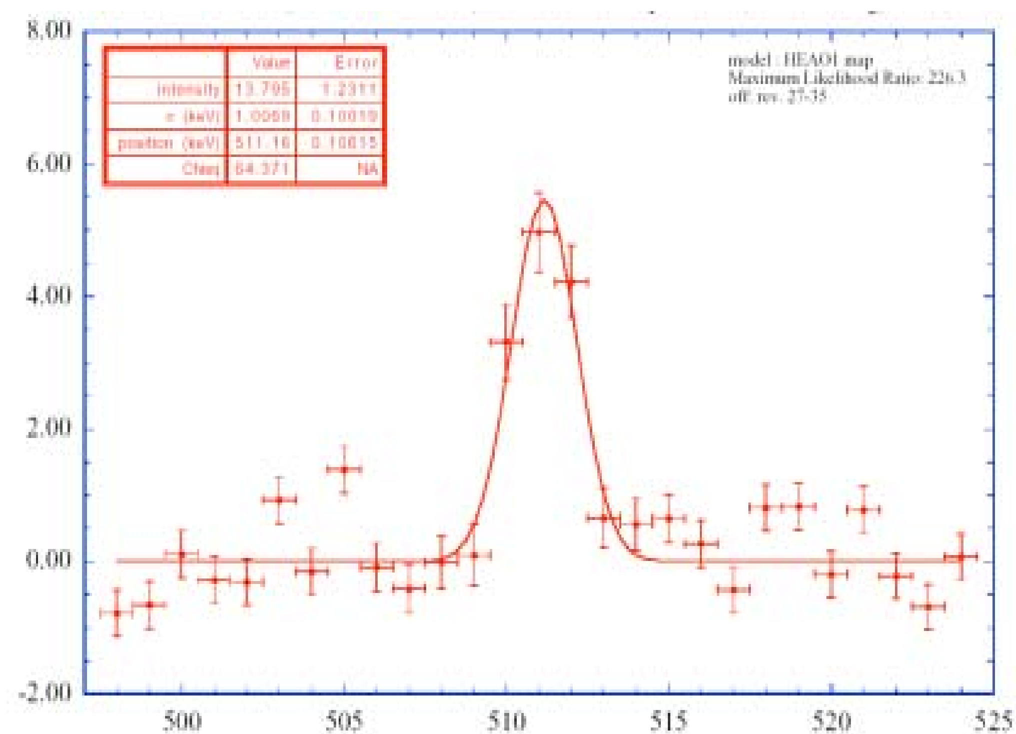


GCDE used here

THE GALACTIC CENTER

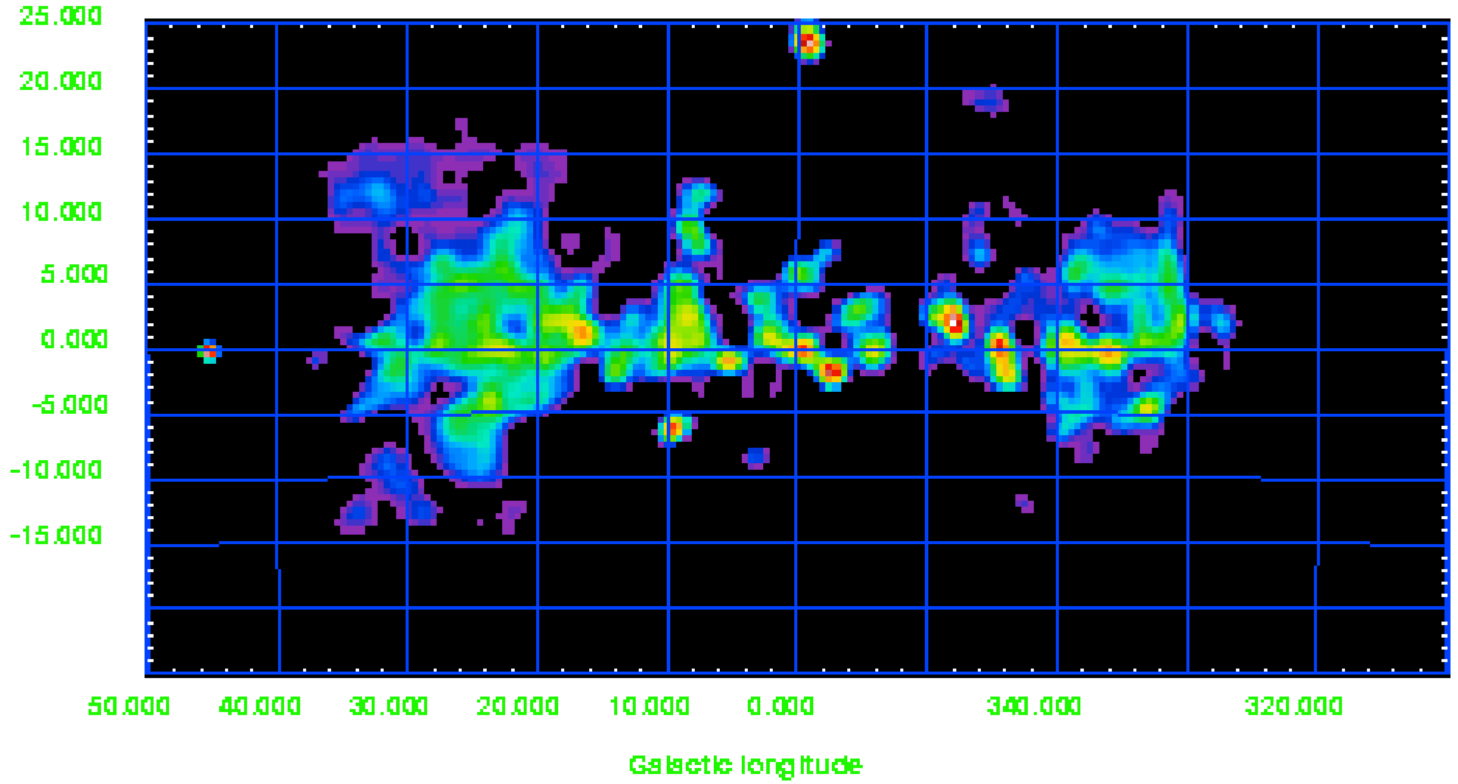
Electron-positron annihilation





Just one beautifull SPI result on the diffuse GC 511 keV emission (Courtesy of JPR) >> more to come!

Image of inner Galaxy with SPI
GCDE 18 – 40 keV



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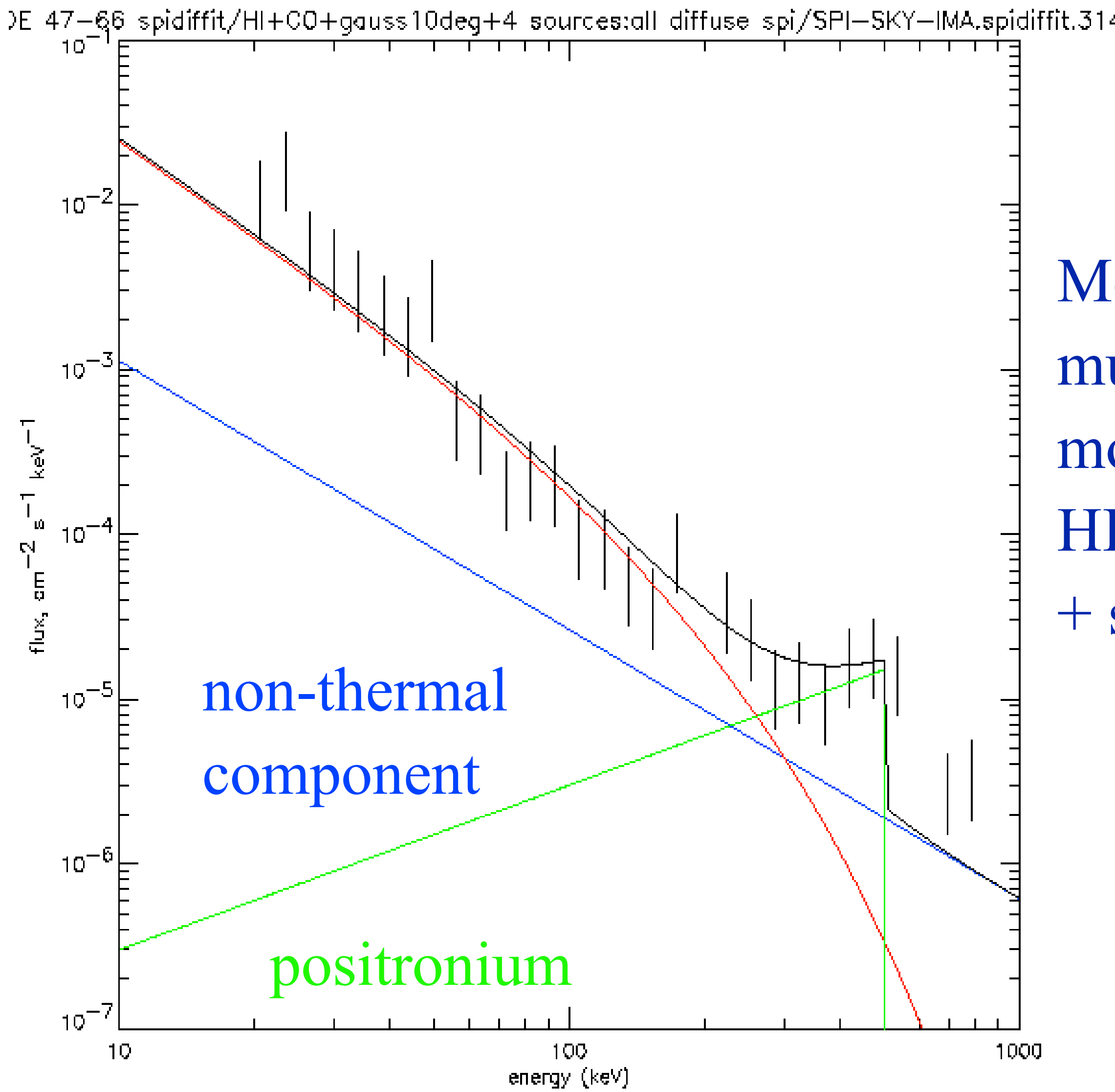
First SPI continuum spectrum of inner Galaxy

Strong et al. (2003) A&A INTEGRAL Special Edition



Method:
multicomponent
model fitting
HI, CO, Gaussian
+ sources

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Scaled components based on OSSE model at l = b = 0

CONCLUSION

first SPI result on continuum: consistent with early missions

future : complete GCDE, GPS and (after 1 year) Open Time

Exploit high energy resolution of SPI

skymaps of diffuse emission

reveal true nature of continuum

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IBIS and SPI

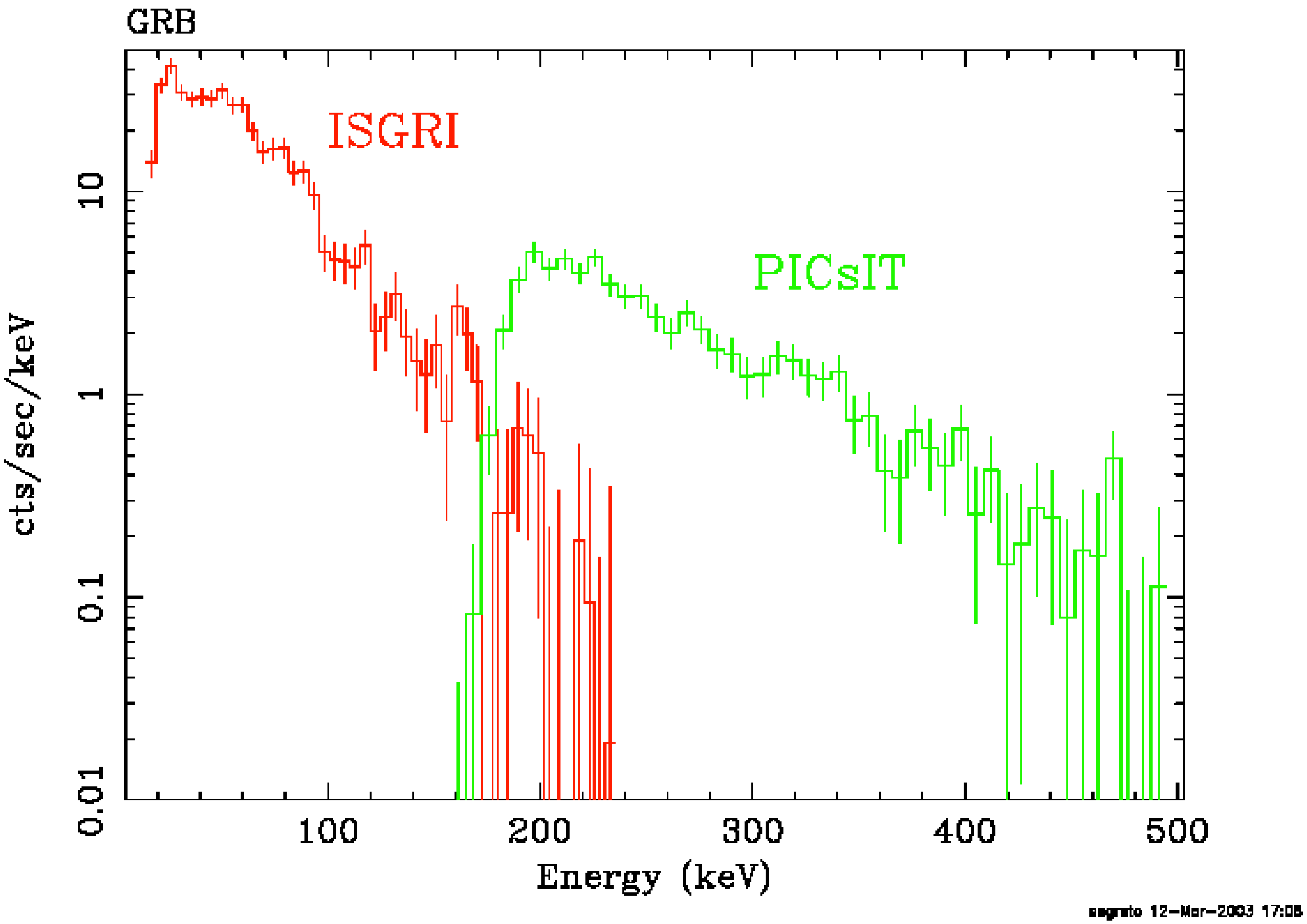
WILL (!)

solve at least the contribution of the point sources in the range

15 – 300 keV

The end

The IBIS low (Isgri 15-970 keV) and high (Picsit 0.2-10 MeV) energy detectors are well matched in term of energy coverage.



Summary

- 24 March 2003:Unabsorbed $F_{x(2\text{-}10keV)}$ = 1.7 x 10^{-10} ergs s^{-1} cm^{-2}
- Strong 5860(50)s modulations seen in X-ray lightcurve.
- Hard spectrum, phase average photon index of 0.5(1)
- Significant Fe K_ line emission detected
- Photon Index and Fe line flux appears to vary with phase

- 21 April 2003:Unabsorbed $F_{x(2\text{-}10keV)}$ = 1.1 x 10^{-11} ergs s^{-1} cm^{-2}
- Similar ~5875s modulations detected. Enhanced flickering also detected on ~1000s timescales.
- Phase averaged photon index is similar[0.8(2)], whereas N_H is ~30% lower.
- NO significant Fe Kα line emission detected.

- No conclusive IR counterpart found in quicklook CTIO image.
- No significant variations in K mag of the source during ~25 min ESO/SOFI IR observation.