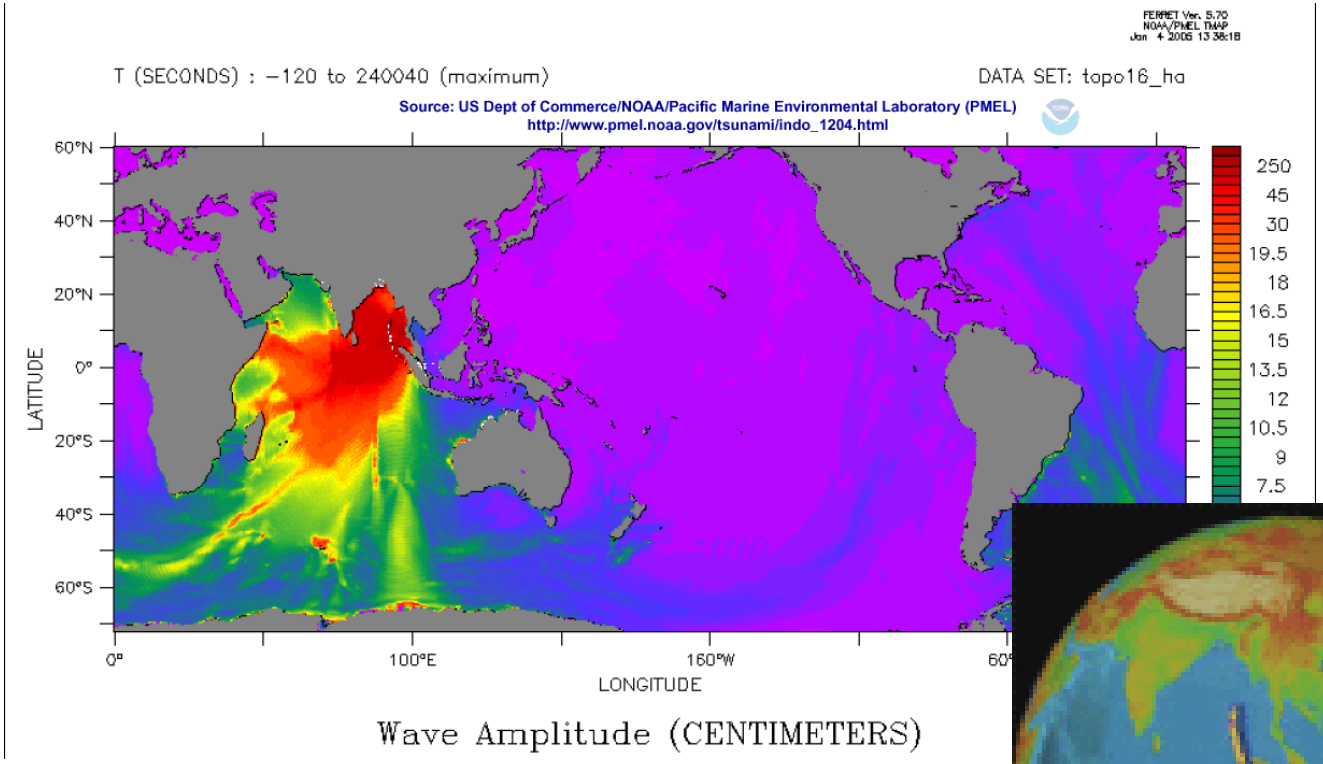
SGR 1806-20

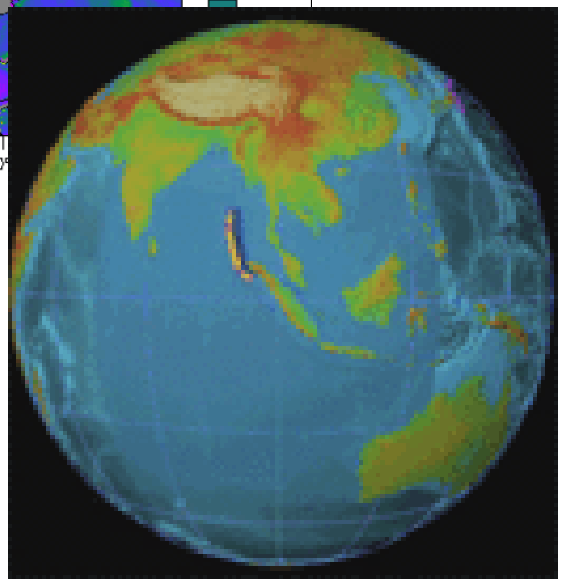
Il piu' alto campo magnetico dell'Universo

Sandro Mereghetti

Astrosiesta – 22 marzo 2007

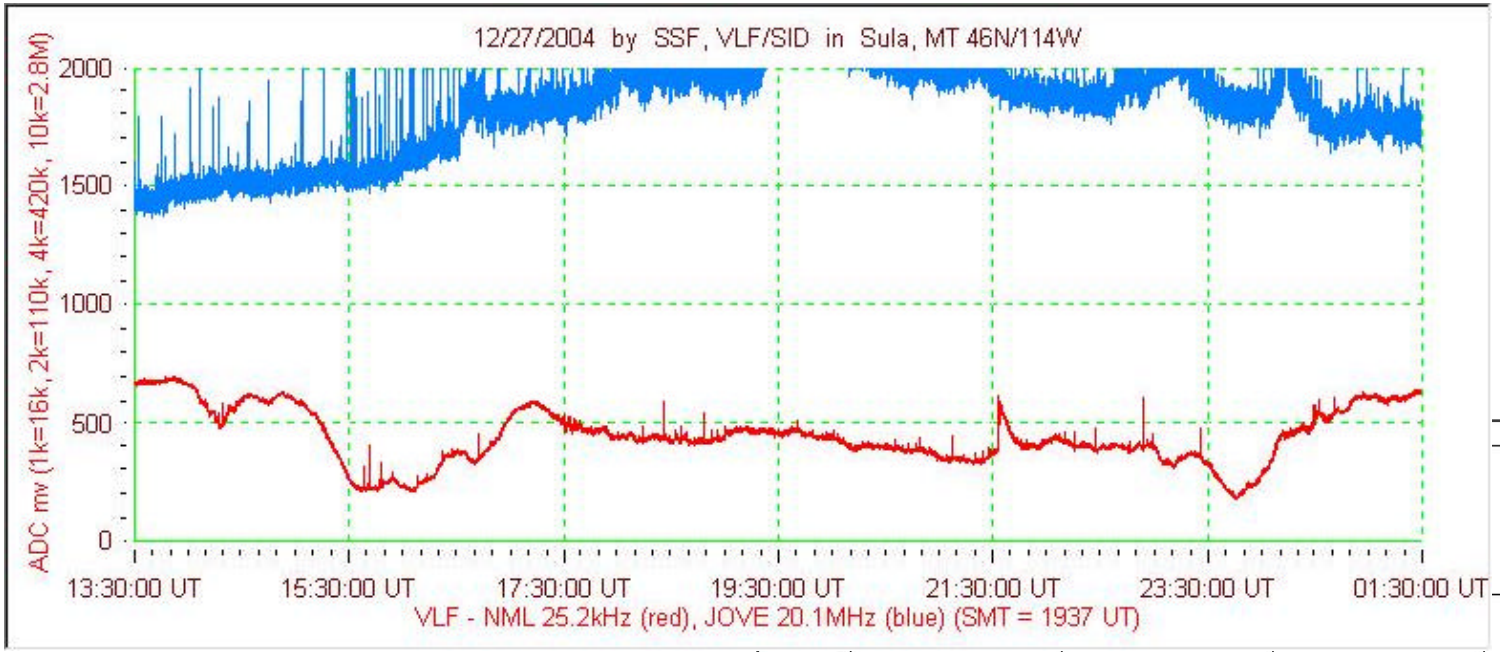
26 Dicembre 2004 alle ~00:59 UTC: Terremoto nell'Oceano Indiano e tsunami in Indonesia

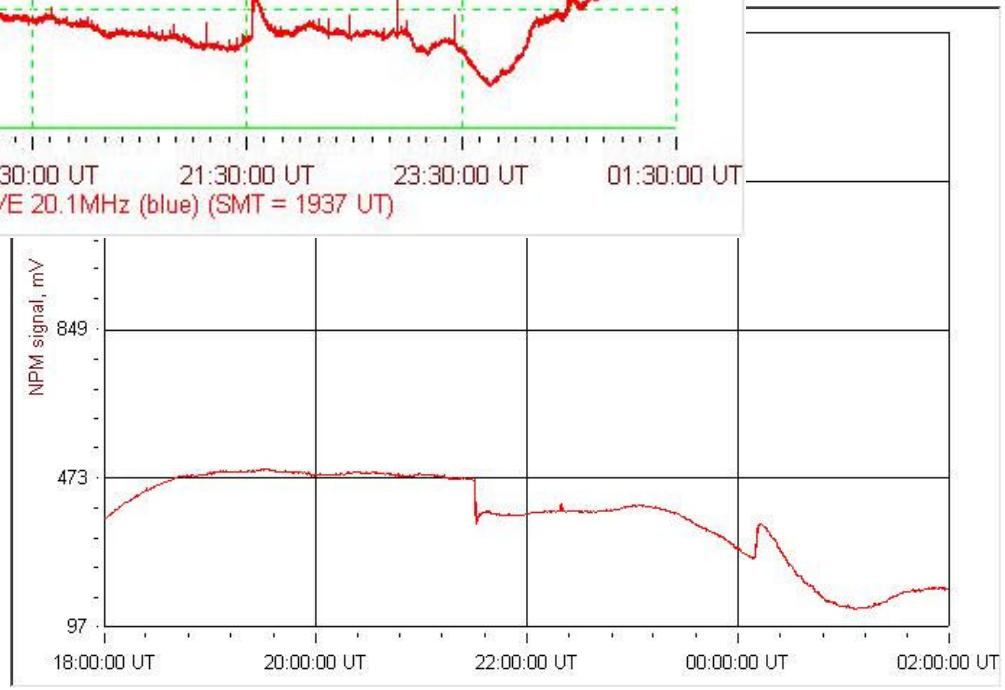


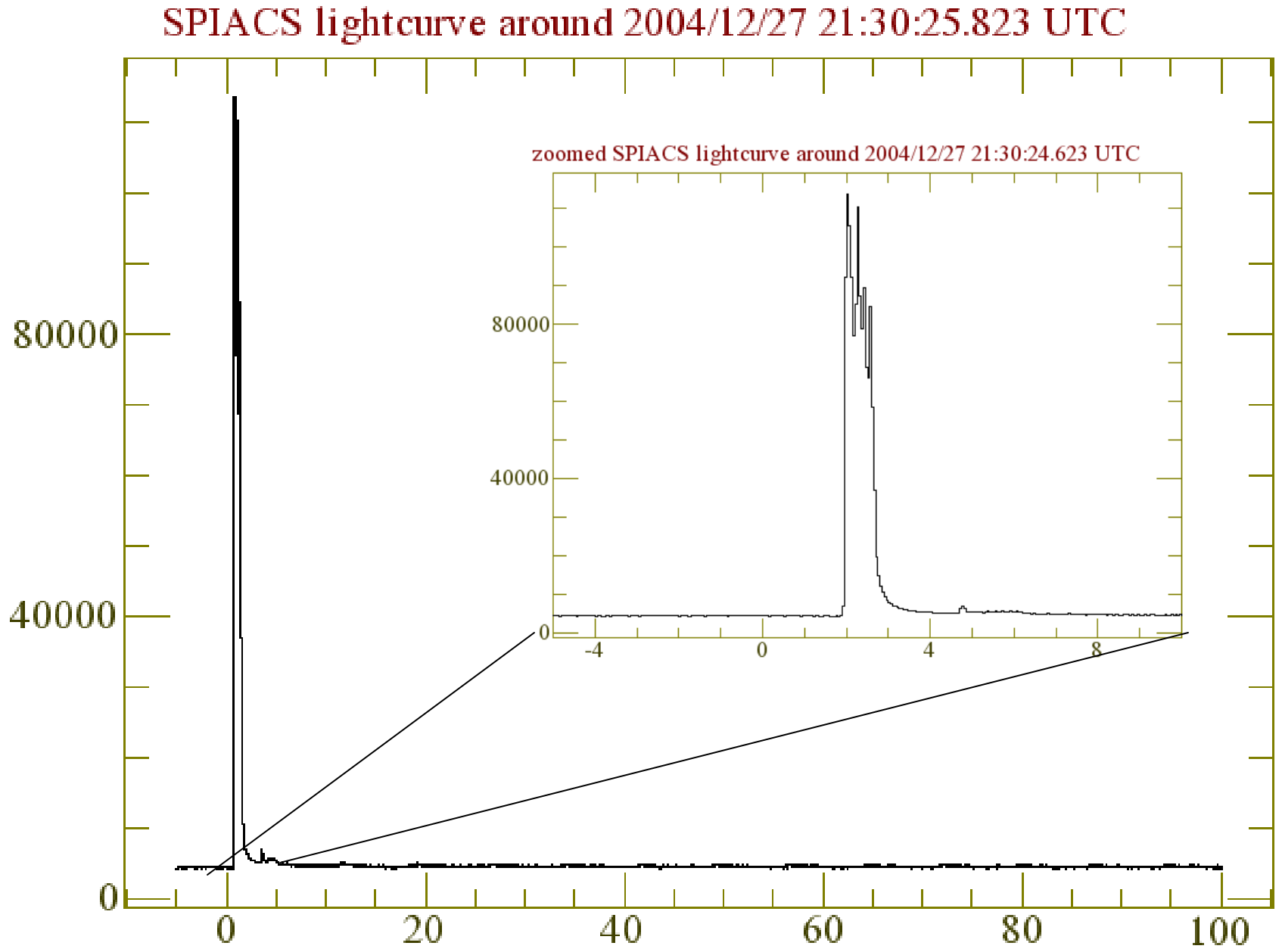


$E \sim 10^{25}$ erg

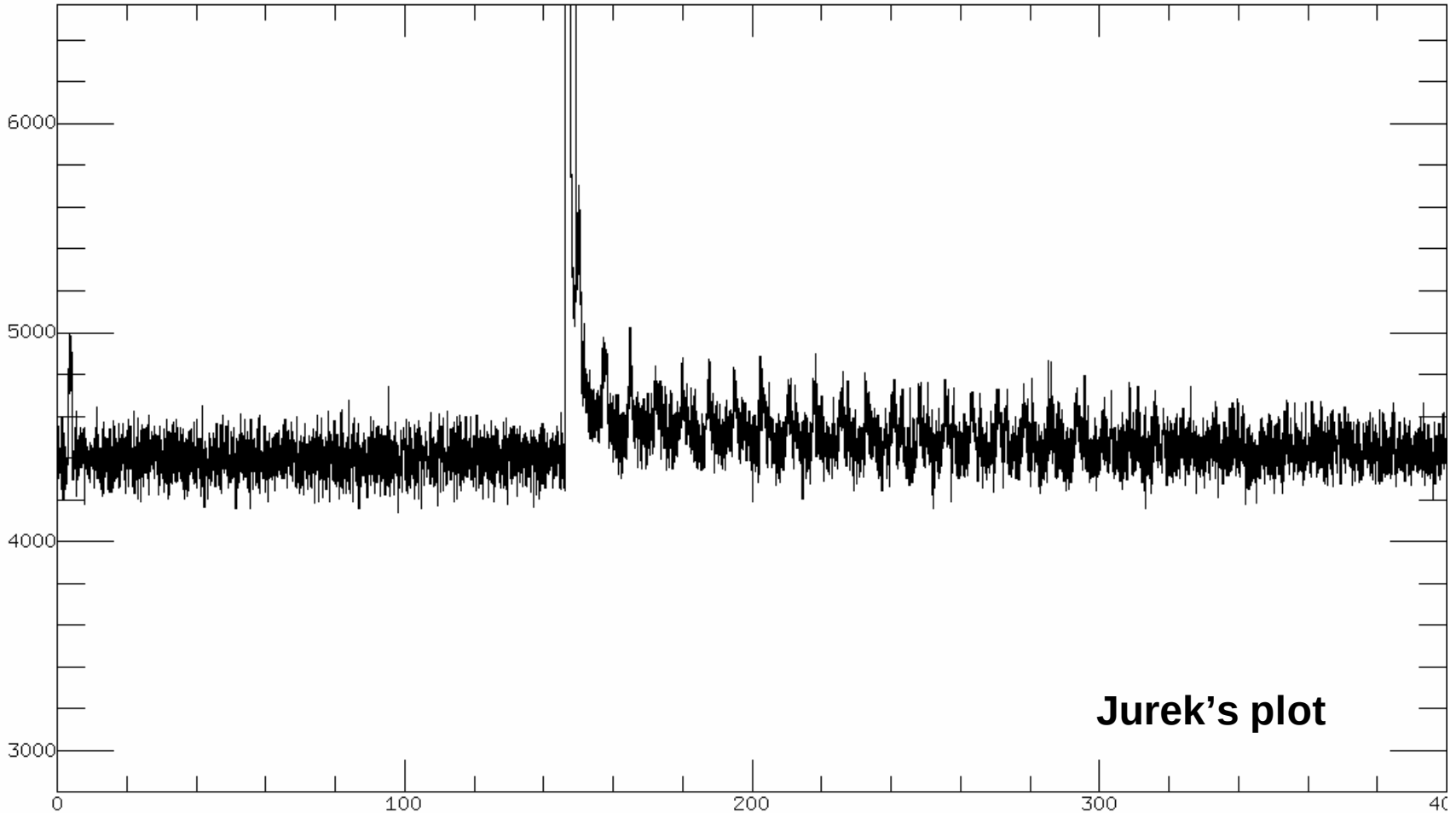
SID = Sudden Ionosphere Disturbance alle ~21:30 del 27 Dicembre 2004

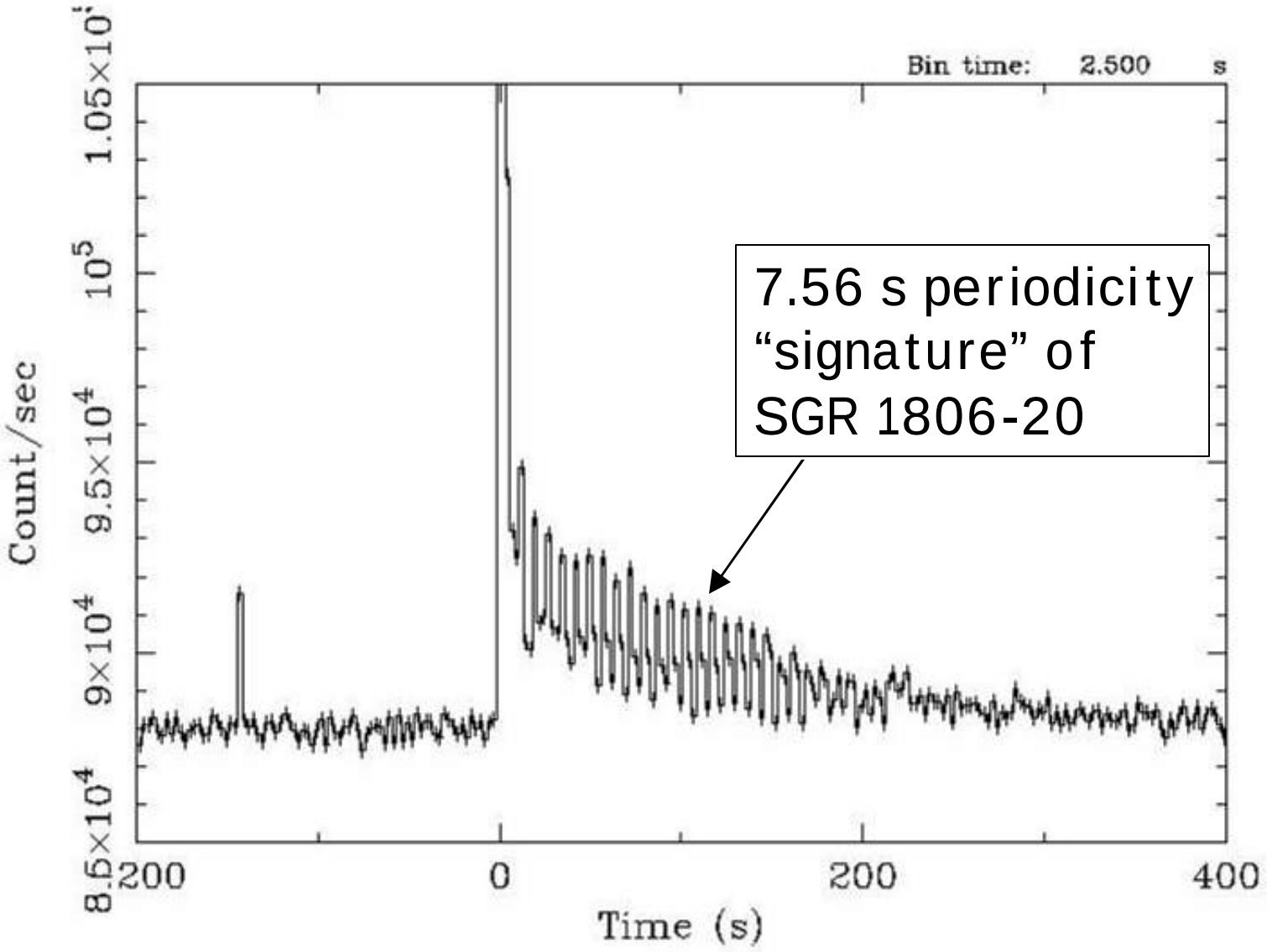


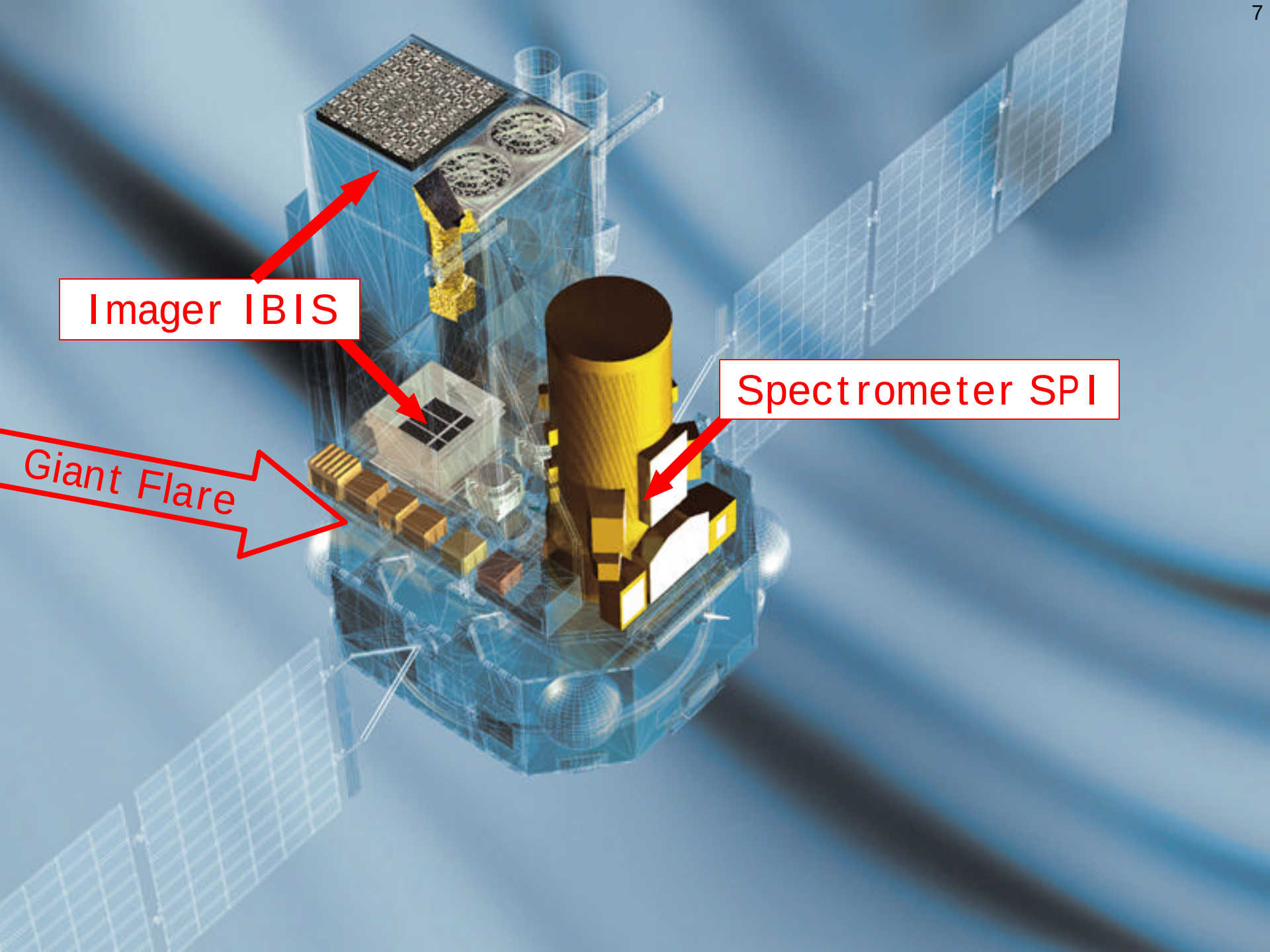




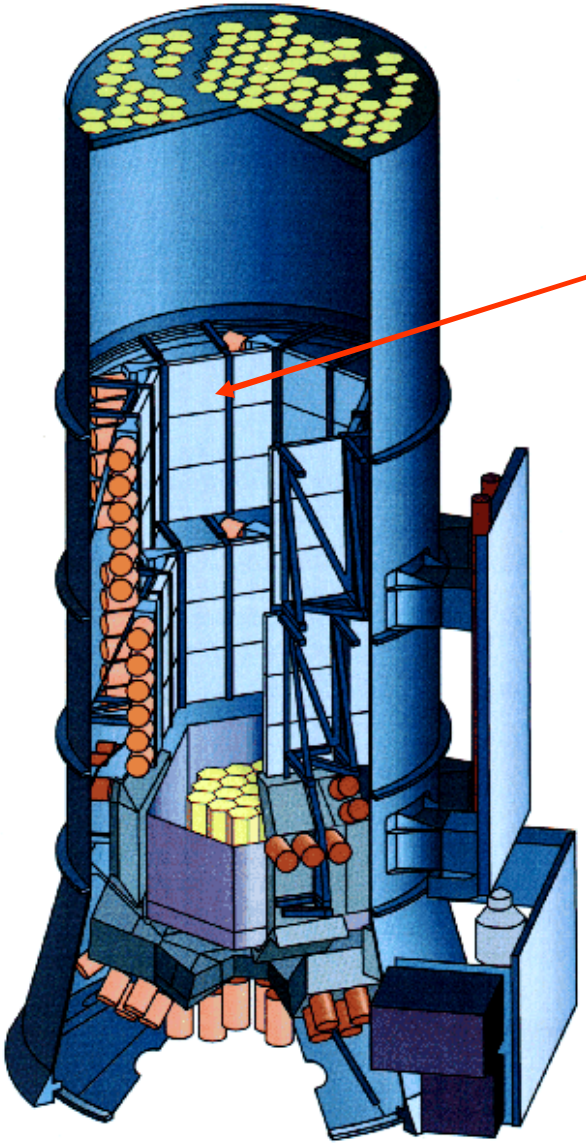
Sulle pagine web di IBAS dieci minuti dopo… http://ibas.iasf-milano.inaf.it/


6000
5000
4000
3000
0
100
200
300
Jurek’s plot


Bin time: 2.500 s
Count/sec
1.05×10^5
10^5
9.5×10^4
9×10^4
8.5×10^4
-200
0
200
400
Time (s)
7.56 s periodicity "signature" of SGR 1806-20


Imager IBIS
Spectrometer SPI
Giant Flare

INTEGRAL SPI

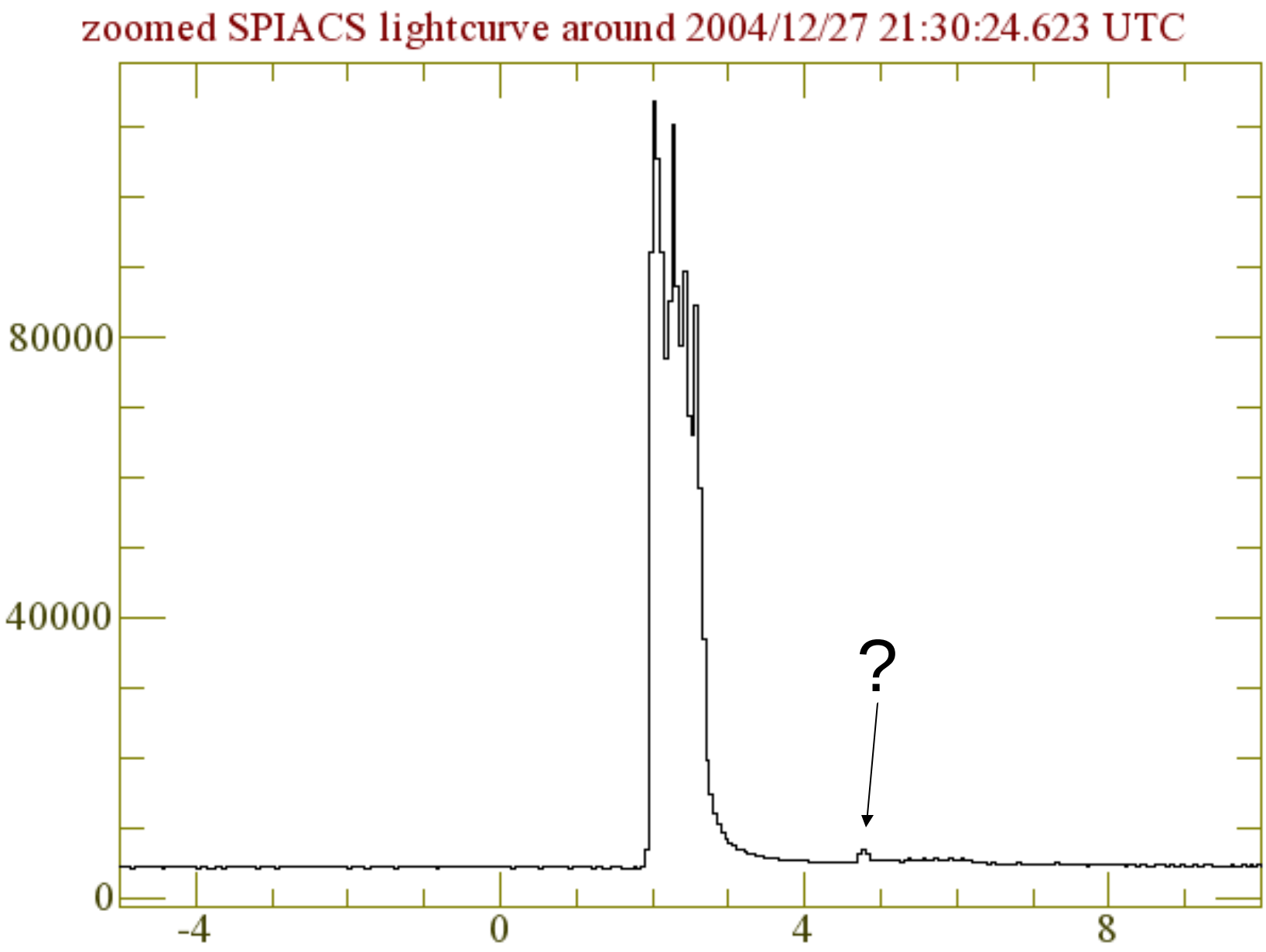


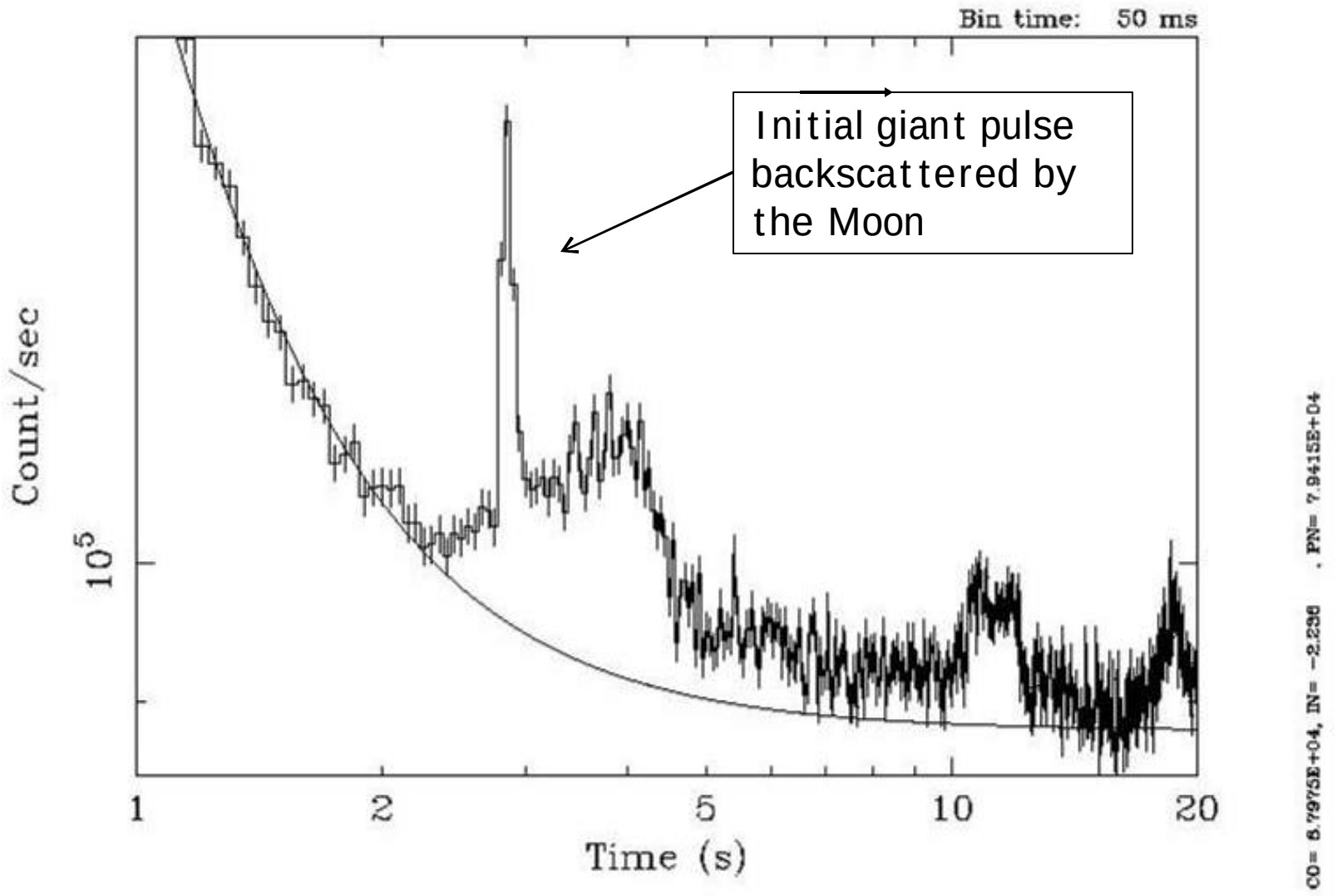
Anti Coincidence Shield (ACS)
(512 kg, 91 BGO blocks)

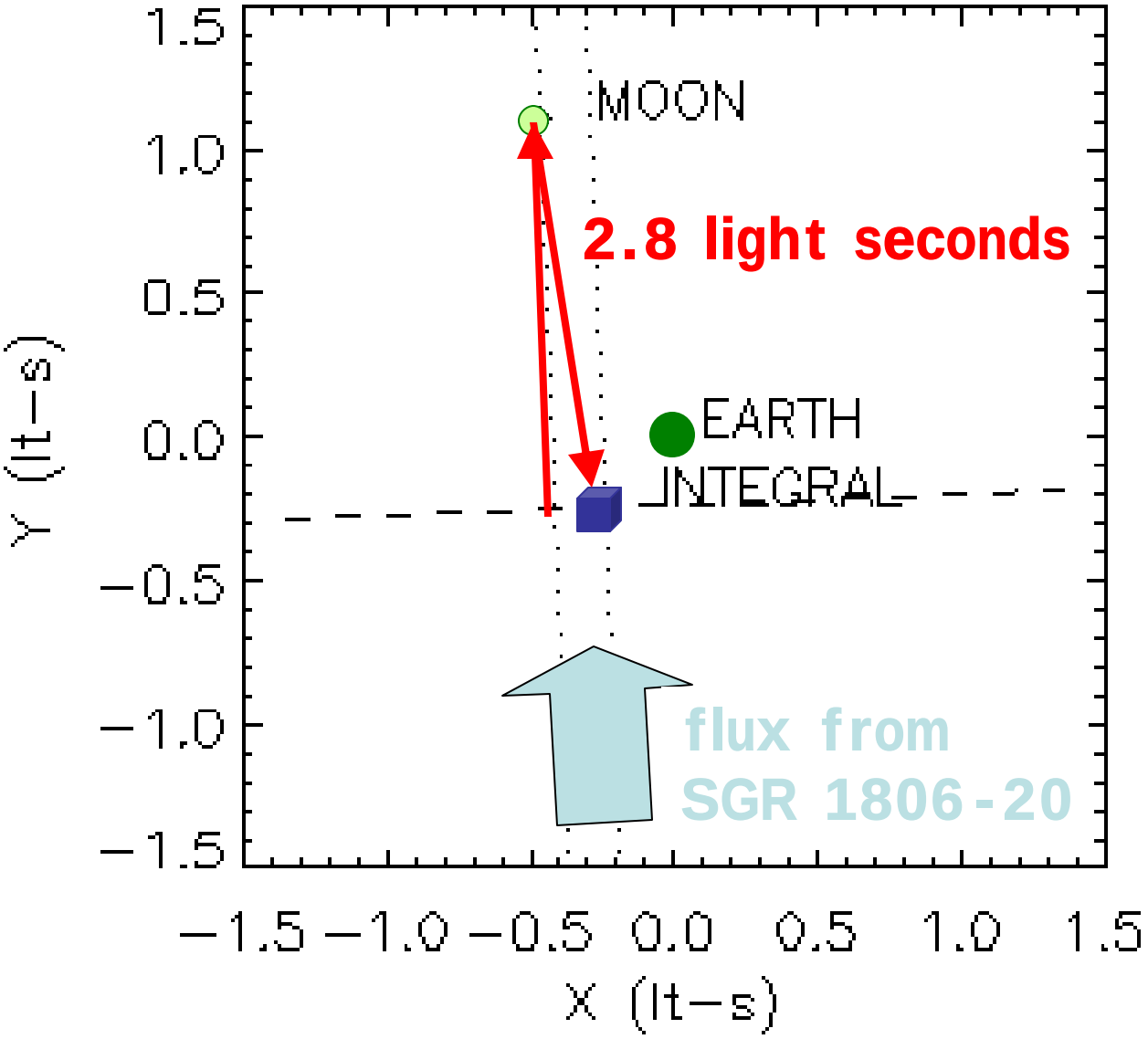
The ACS is also used as an omni-directional GRB detector (E > 80 keV)

Provides:

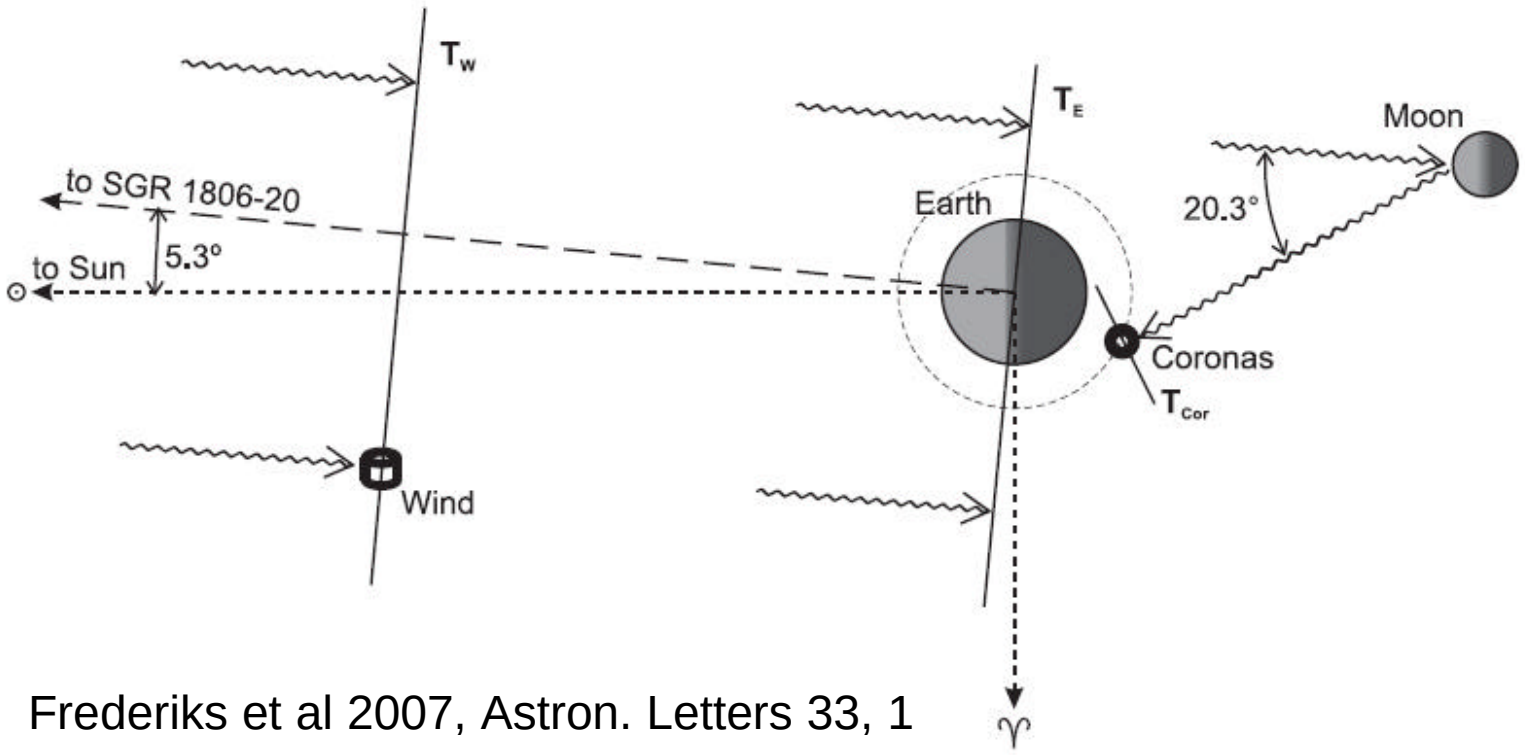
- 50 ms light curve
- No direction information
- No energy information


zoomed SPIACS lightcurve around 2004/12/27 21:30:24.623 UTC
80000
40000
0
-4
0
4
8
?


Bin time: 50 ms
Initial giant pulse backscattered by the Moon
Count/sec
10^5
1
2
5
10
20
Time (s)
CO= 6.7975E+04, IN= -2.238 , PN= 7.9415E+04


MOON
2.8 light seconds
EARTH
INTEGRAL
flux from
SGR 1806-20
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Y (lt−s)
−1.5 −1.0 −0.5 0.0 0.5 1.0 1.5
X (lt−s)

Moon reflection seen also in Helicon-Coronas-F data



Frederiks et al 2007, Astron. Letters 33, 1

Fig. 5.— Scheme illustrating the Konus-Wind and Helicon-Coronas-F observations of the giant flare. The leading edge of the flare from SGR 1806-20 arrives at Wind at time T_W, passes by the Earth at T_E=T_W+5.086 s, reaches the Moon and is reflected from it, and, finally, the reflected emission reaches the Helicon-Coronas-F detector at T_{Cor}=T_W+7.69 s.

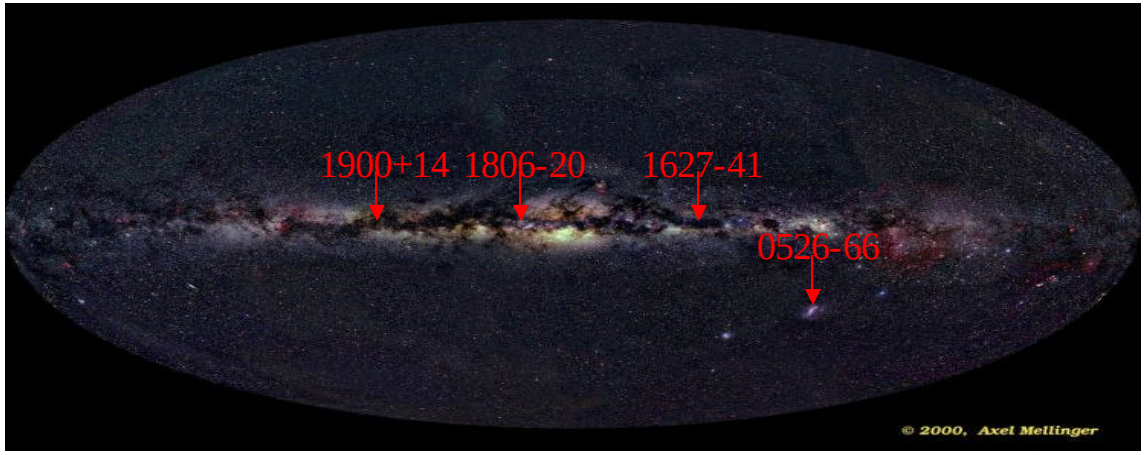
Initial spike properties

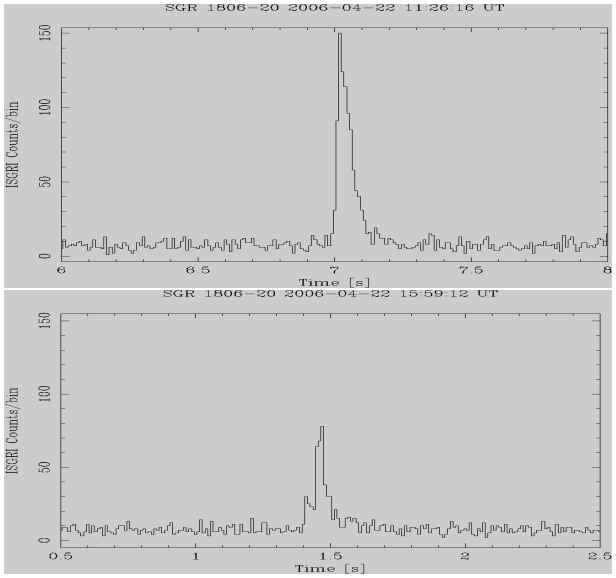
Fluence in Moon-backscattered peak ~2×10^{-6} erg/cmq at E>80 keV

→ ~ 2 erg/cmq in initial peak

- duration ~ 0.2 sec
- Peak flux ~ 10 erg/cmq/s E>20 keV
- E ~ 4×10^{46} ergs (for d = 15 kpc)

4 Soft Gamma-ray Repeaters





Stelle di neutroni isolate con campi magnetici eccezionalmente alti: 10^{14}-10^{15} G (Magnetars)

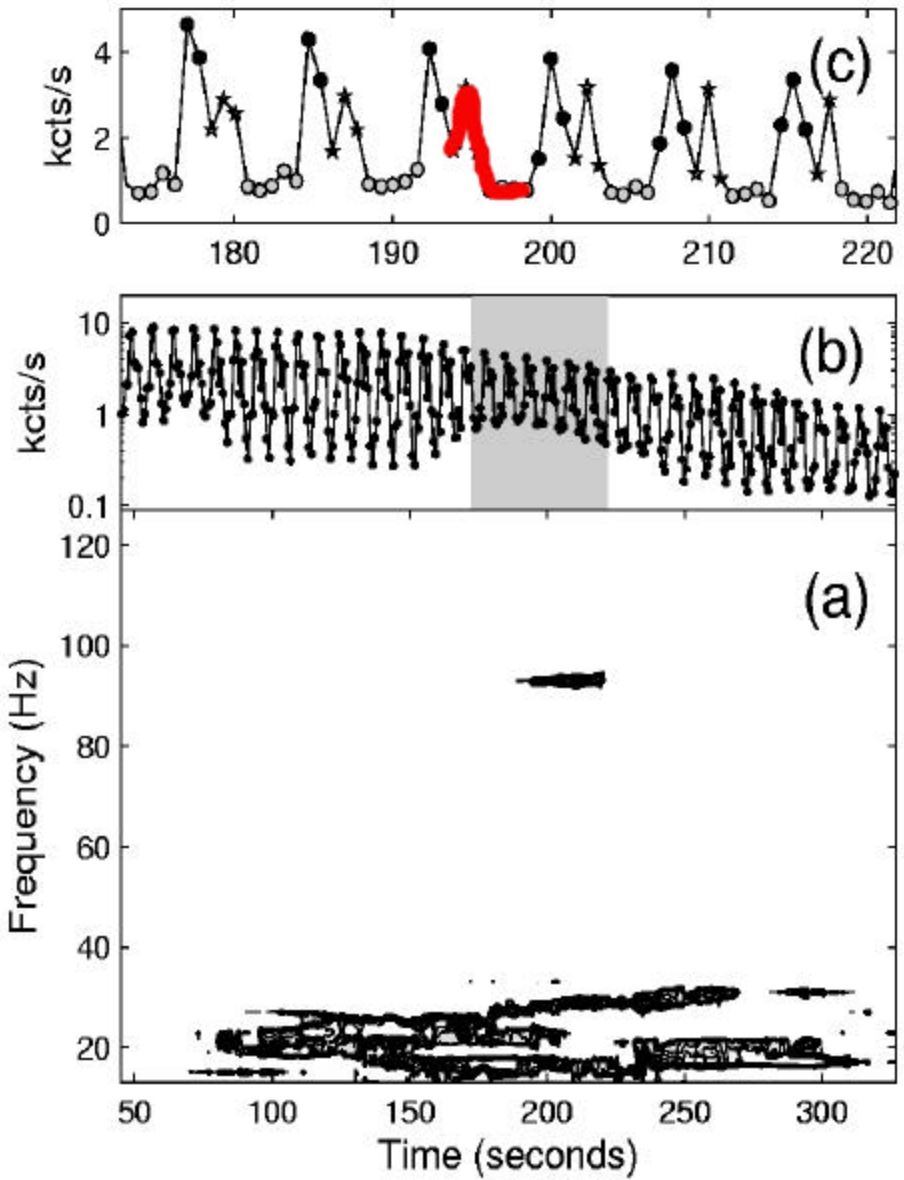
- $L_x \sim 10^{35}$ erg/s, P ~ 5-8 s, spin-down
- Burst hard X/gamma, 100-1000 x Eddington, t~0.1 s
- Giant Flares (solo 3 visti finora)

L'emissione deriva dalla energia magnetica

High Frequency Oscillations in Giant Flares

QPO (Quasi Periodic Oscillations) discovered in the tail of the Dec 27 Giant Flare

Israel et al. 2005, ApJ 628, L53



High Frequency Oscillations in Giant Flares

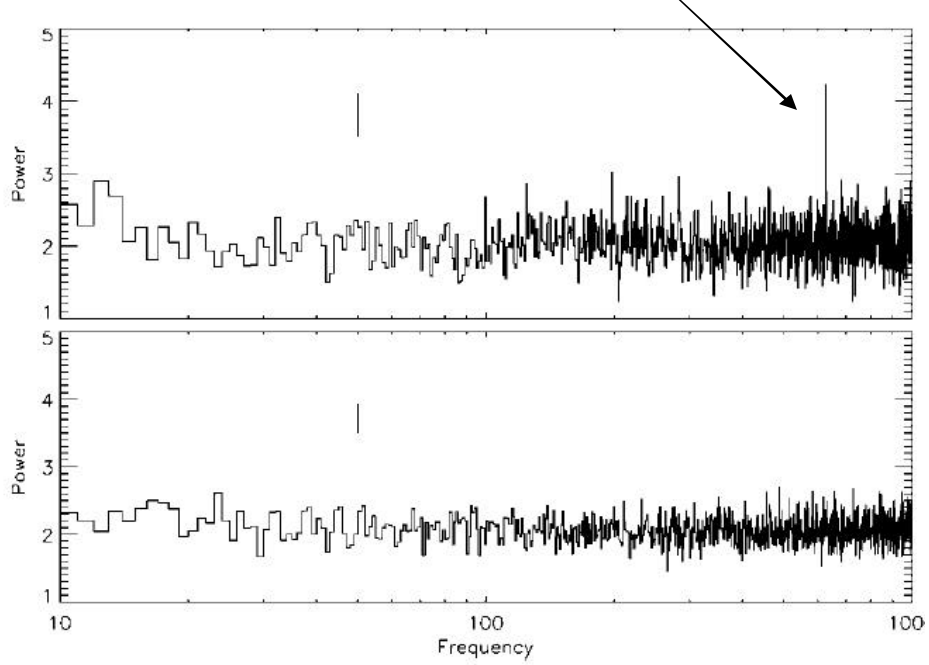
- 0526-66 – **43 Hz** (Barat etal.1983)
- 1806-20 – **90 Hz**, ~18 Hz, ~30 Hz (Israel et al. 2005)
  626 Hz (Watts & Strohmayer 2006)
- 1900+14 – **84 Hz**, 28 Hz, 53 Hz, 155 Hz
  (Strohmayer & Watts 2005)

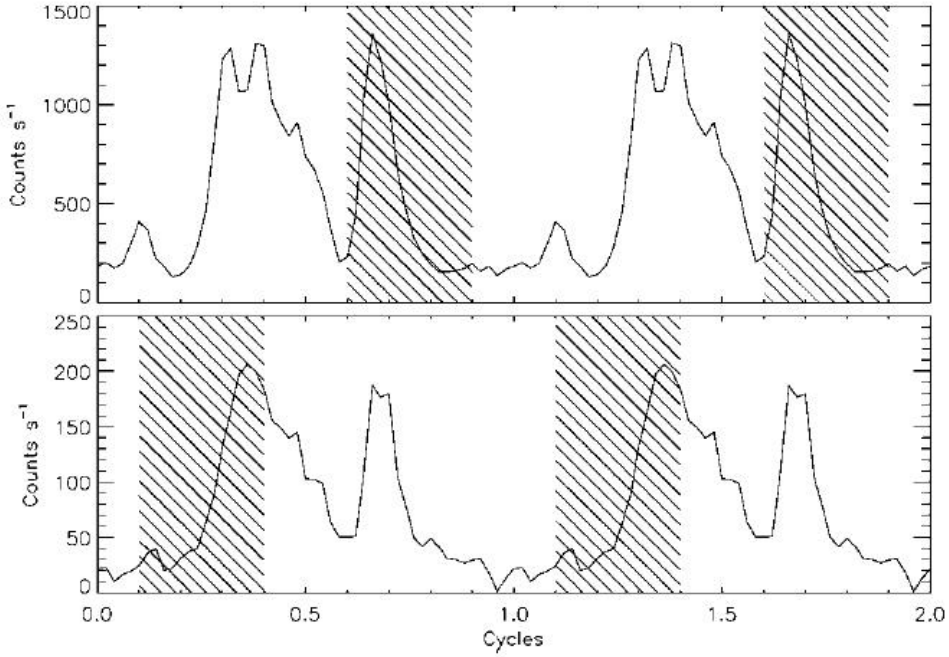
- Large scale NS crust fractures trigger global seismic oscillations (analogous to earthquakes)

- Torsional modes of NS crust → potentially important diagnostic for NS

QPO a 625 Hz nei dati RHESSI

(Watts & Strohmayer 2006)





Le oscillazioni ad alta frequenza in SGR 1806-20 implicano delle rapide variazioni di luminosita' che superano il limite di Cavallo-Rees:

$$\frac{\Delta L}{\Delta t} < e\,\frac{2p}{3}\,\frac{m_p c^4}{s_T}$$

$\Delta L/\Delta t_{QPO} \sim 2 \times 10^{43}$ erg s^{-2} >> ε 2×10^{42} erg s^{-2}

Soluzione proposta da Vietri et al. 2007, astro-ph/0702598

A causa del campo magnetico $>B_c$ la sezione d'urto dei fotoni e' ridotta di un fattore $(B/B_c)^2$

La variabilita' delle QPO implica:

$B > 1.5\ B_c\ (0.1/\varepsilon)^{1/2} \sim 6.6 \times 10^{13}$ G

(a un raggio di ~30 km)

$\rightarrow B_{surface} > 2\ 10^{15}$ G