

Giant radio flares from Cygnus X-3

Sergei Trushkin, N. Nizhelskij

Special astrophysical observatory RAS, Russia

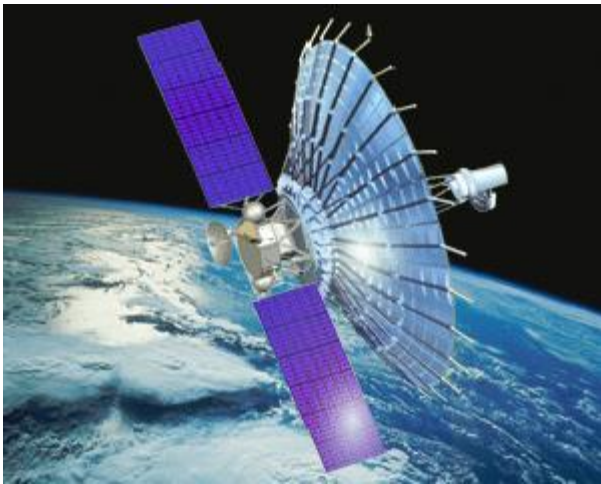
***Black holes astrophysics:
Tales of Power and Destruction***

Winchester, UK, 18-24 July 2011

19 July

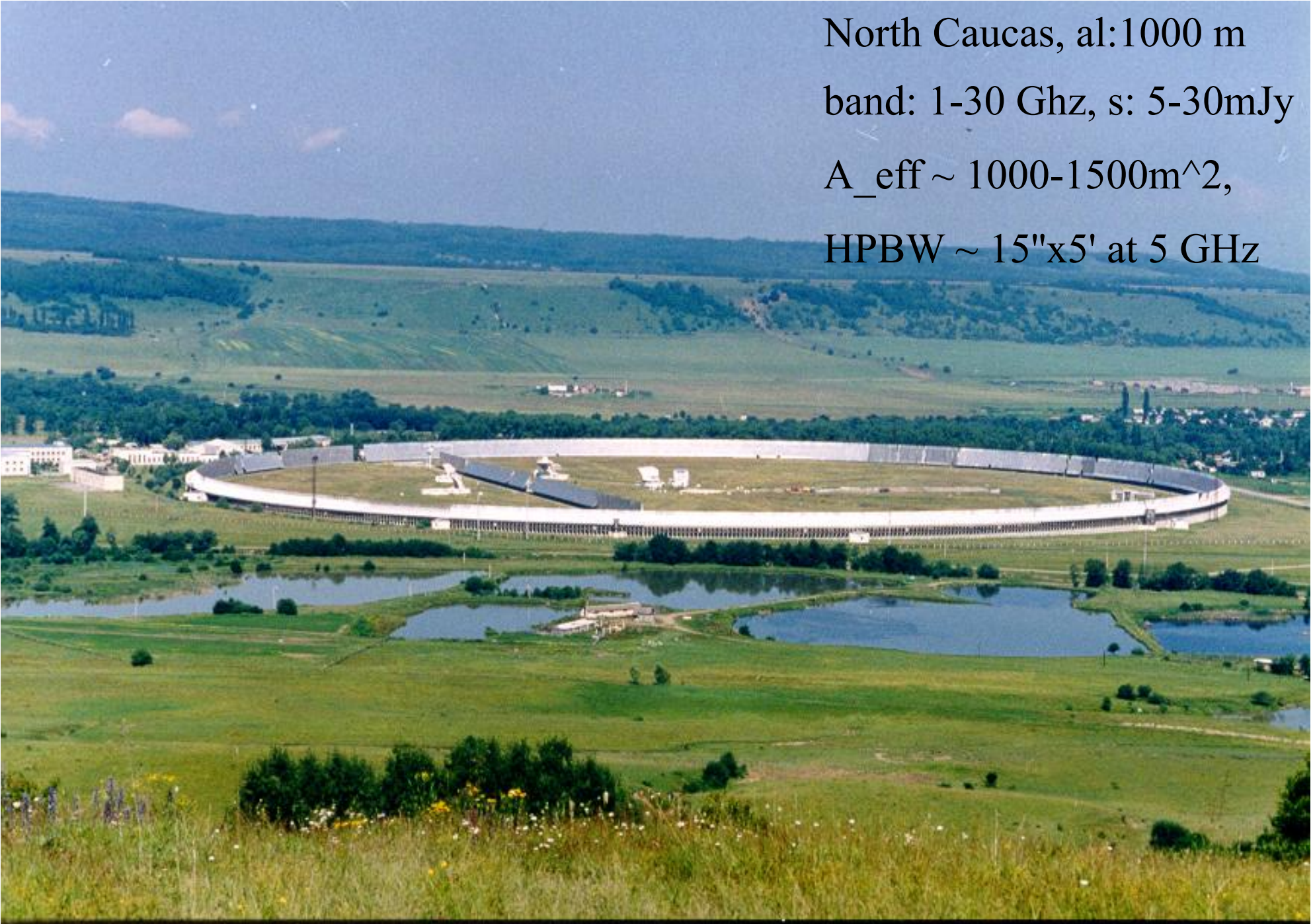
Good news for AGN/QSO fans:

**RADIOASTRON = International Space
VLBI system (10m) has been launched on
18 July from Baikonur space facility**

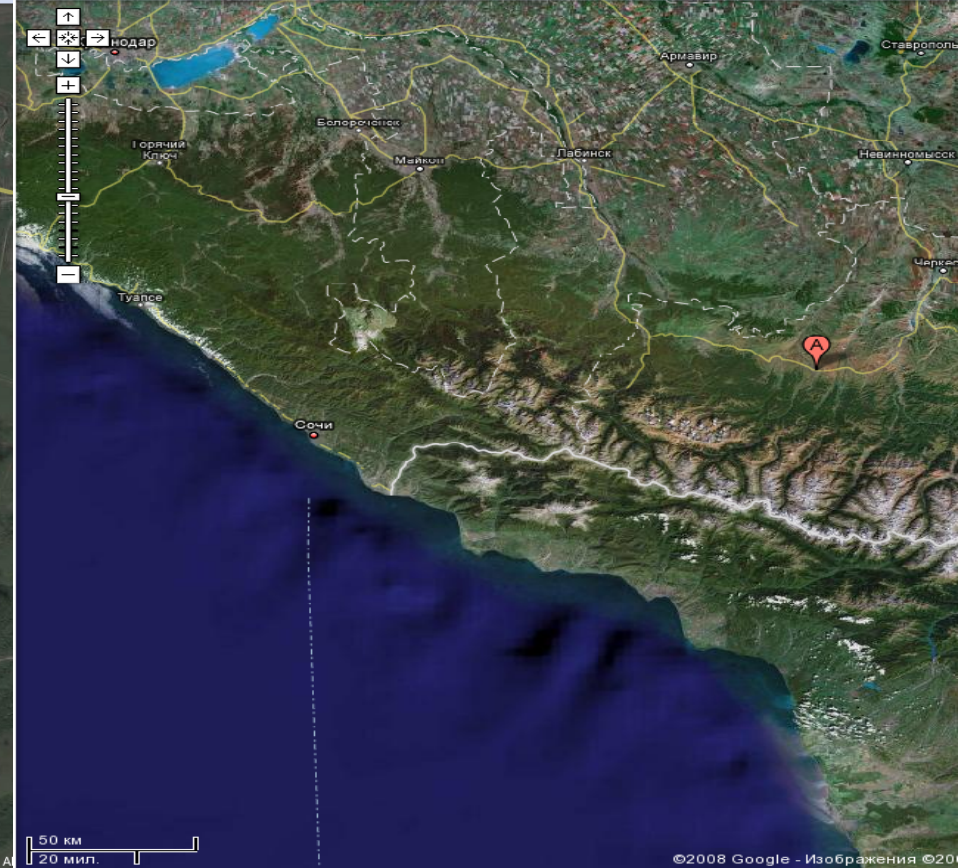
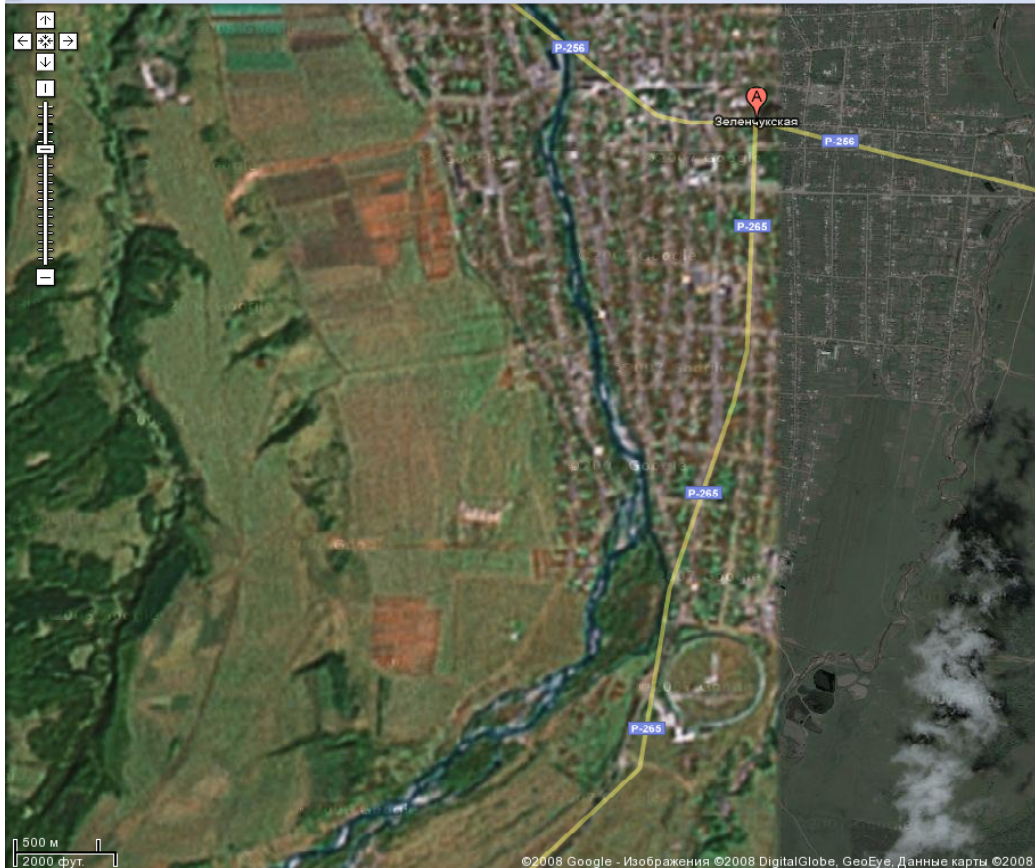


RATAN-600 radio telescope

North Caucas, al: 1000 m
band: 1-30 GHz, s: 5-30 mJy
 $A_{\text{eff}} \sim 1000\text{-}1500\text{m}^2$,
HPBW $\sim 15'' \times 5'$ at 5 GHz

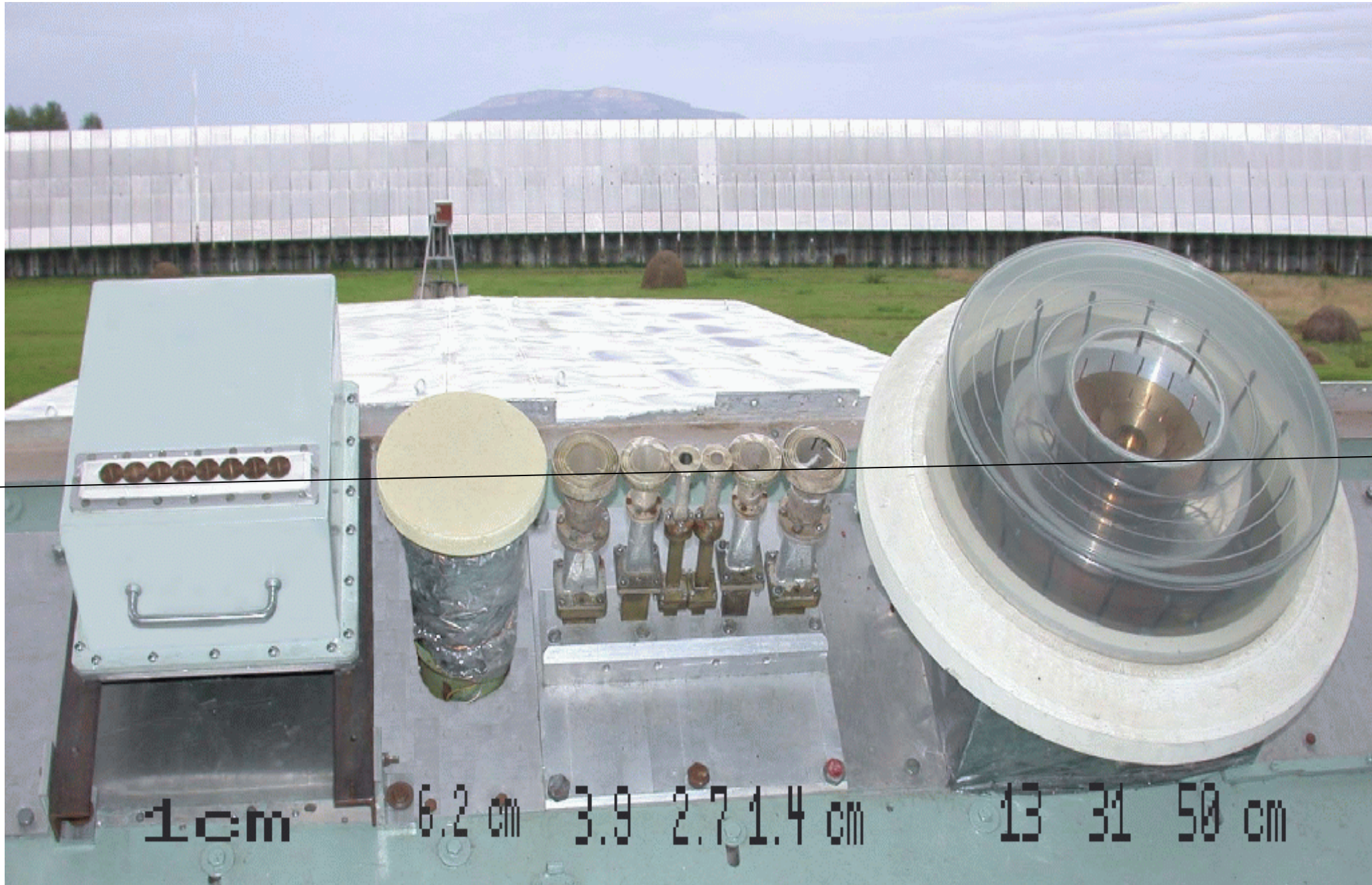


Easy to find with Google maps
lat:43d49'52" long: -02h46m22s



Nearly Sochi -- the site of the next Winter Olympic games in 2014

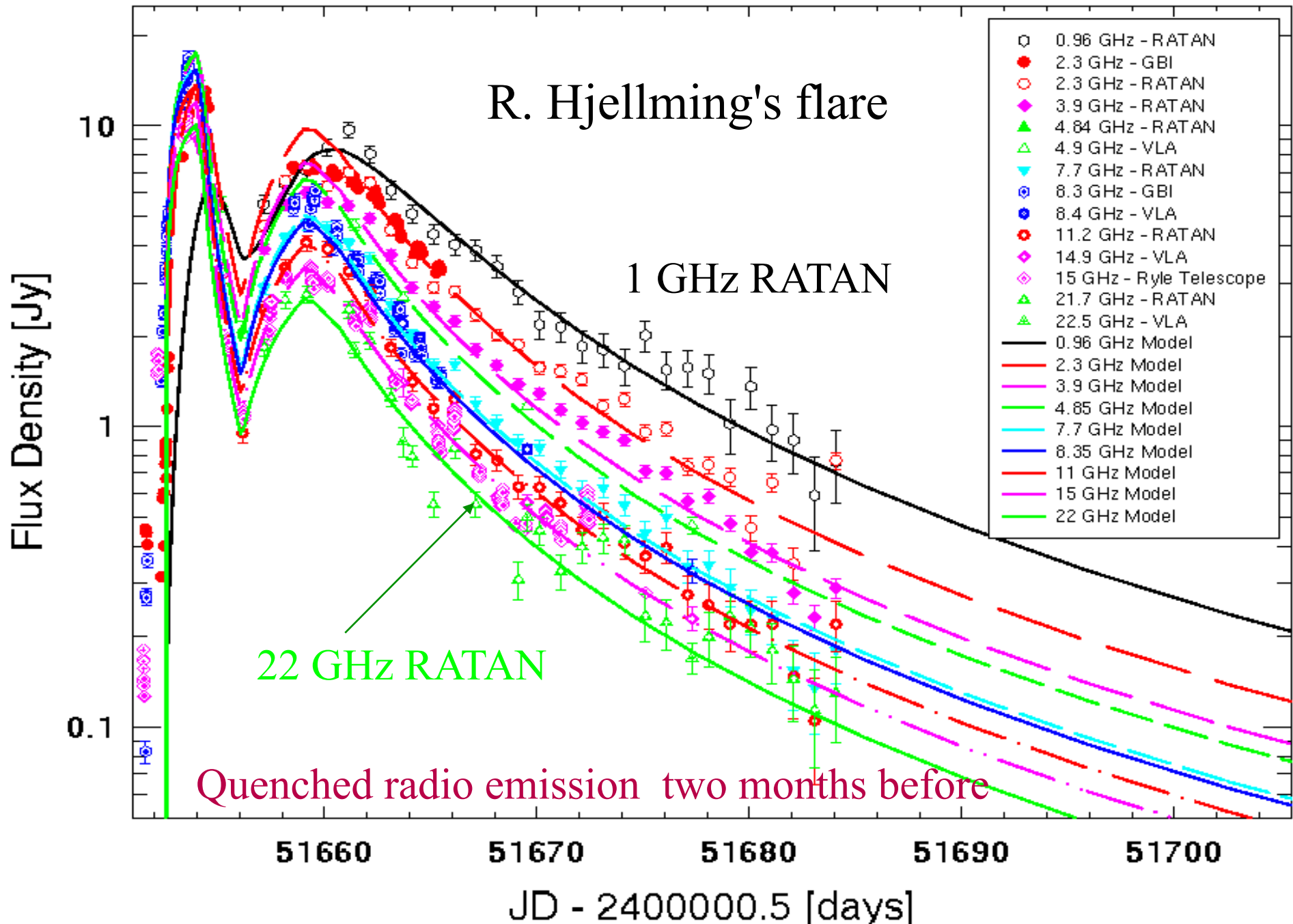
Focal plane of the radiometer horns



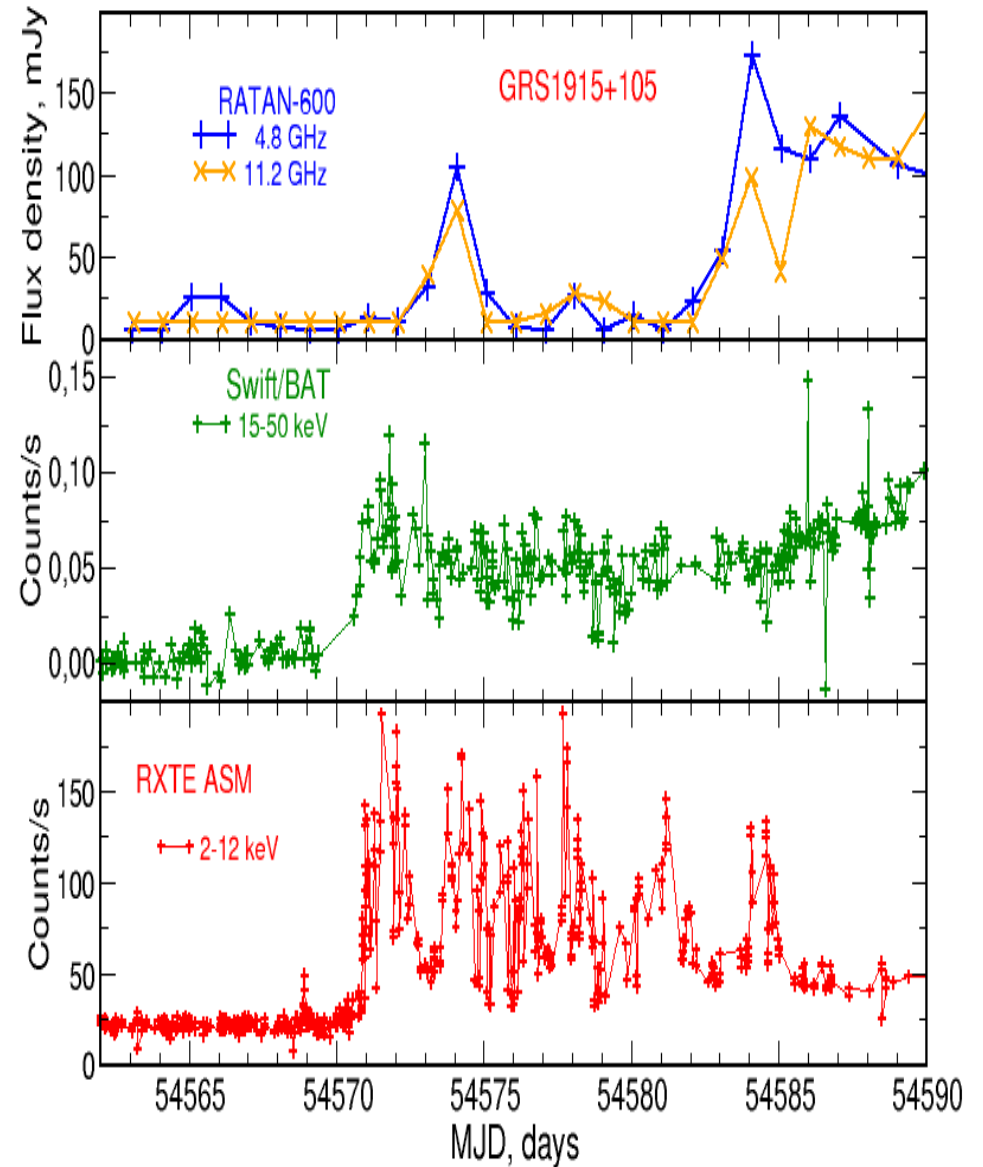
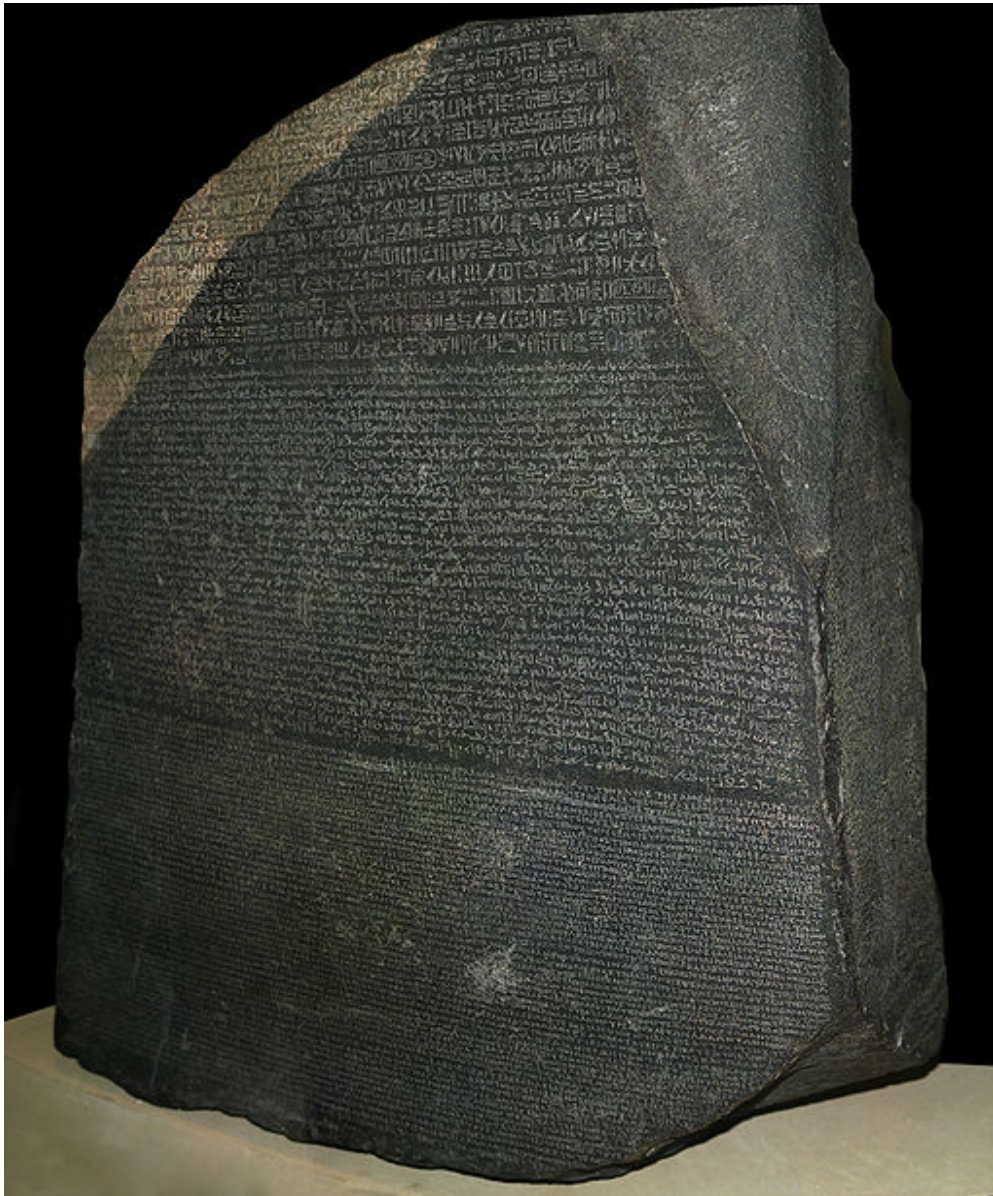
Cyg X-3 (WR-star WN7+BH/NS?)

- **First** flaring Galactic source (Nature sp.issue with 22 papers in 1972. 40 yr \sim 50 flares $>1\text{Jy}$ (in 2006-07: 10!))
- Very close binary: orbital period is only **4.8h**
- Variable velocity of precessing jets: **0.1-0.9c**
- True "classic" synchrotron radio flares.
- Periods of the activity \sim 100 days. (**2006: \sim 200d**)
- **$d = 9\text{ kpc}$** , an inclination jet angle **$< \sim 25\text{deg}$**
- **vHE Γ -source** (AGILE/Fermi, Tavani et al. Nature, 2009)

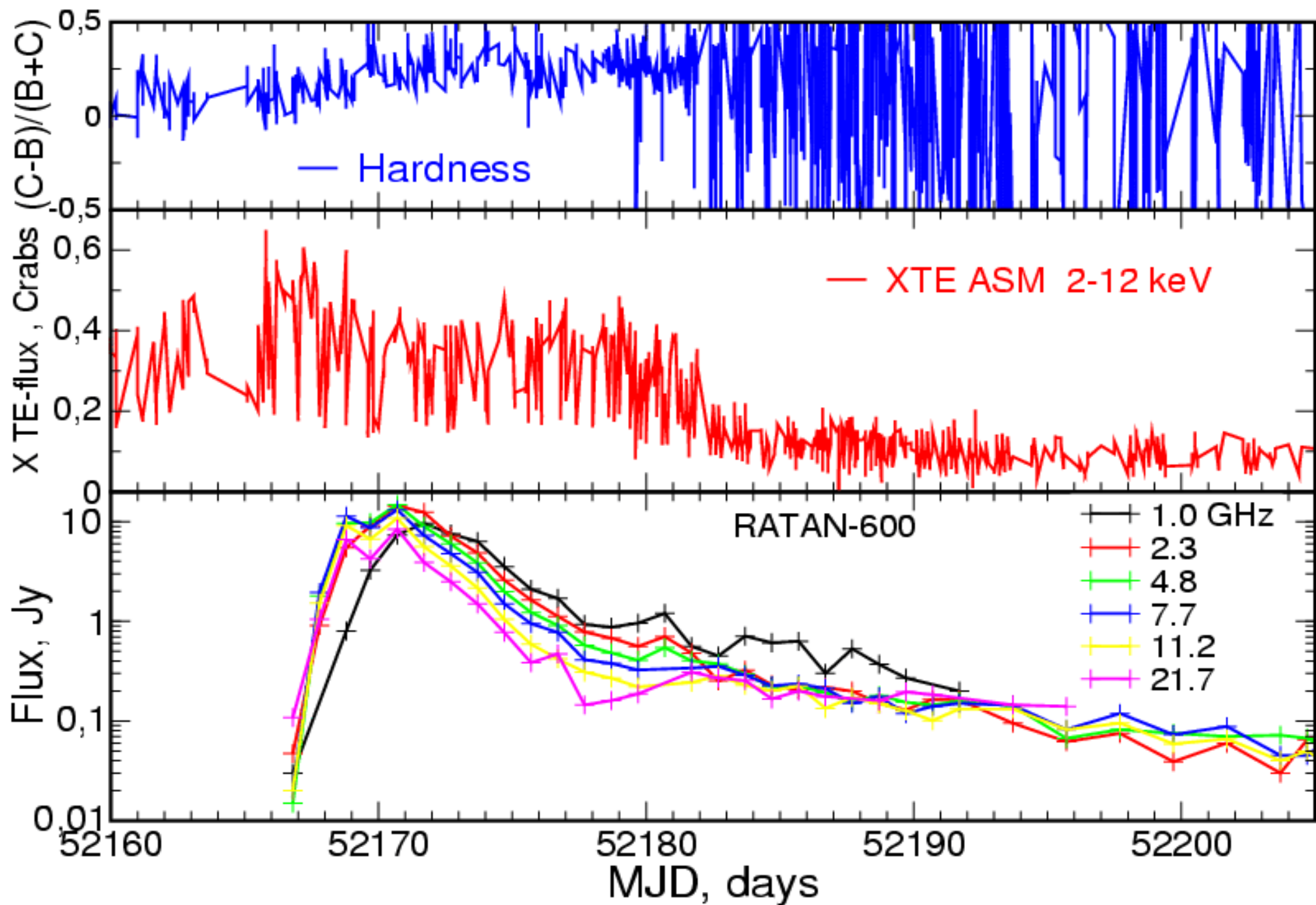
Powerful Cyg X-3 flares in April 2000



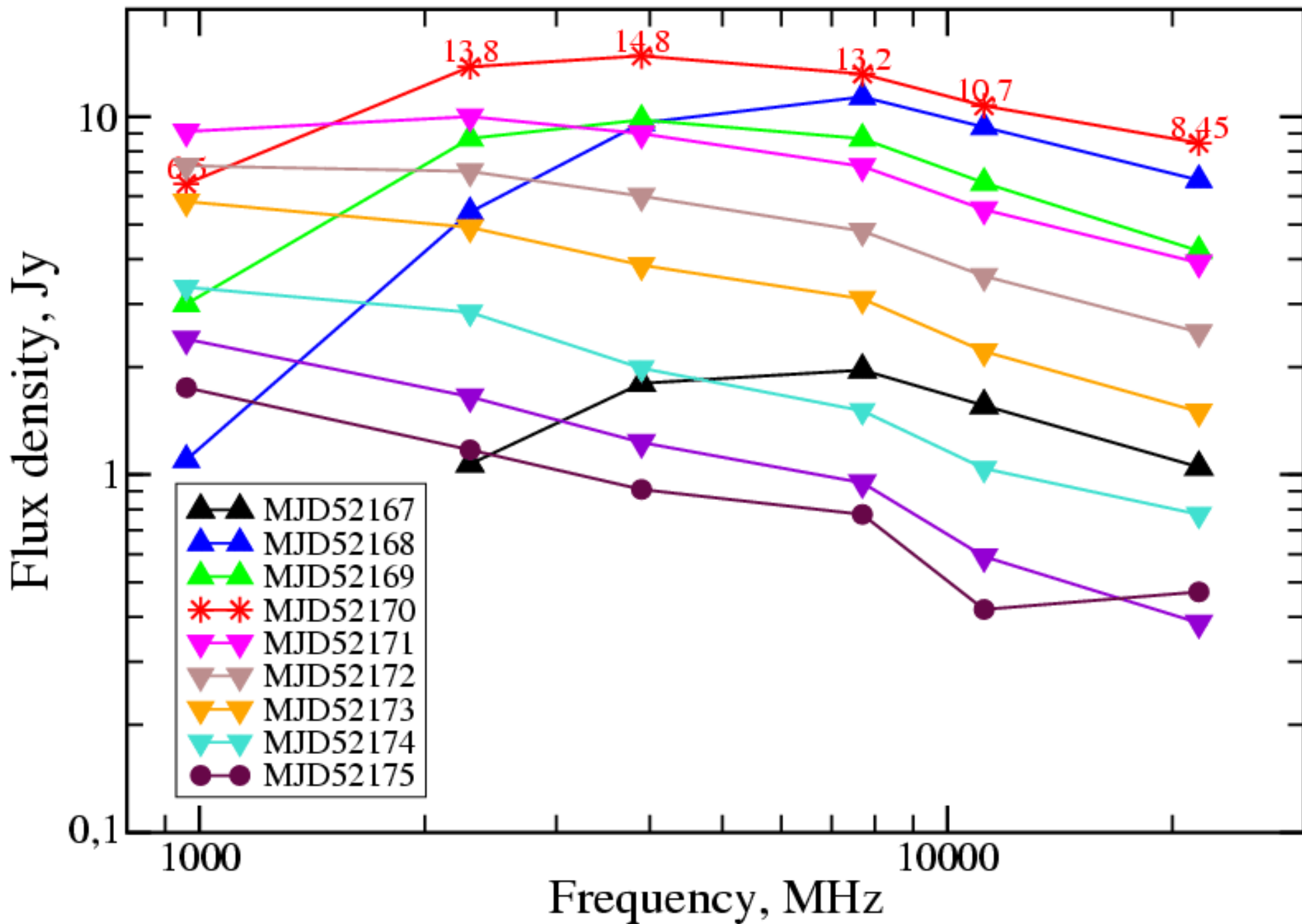
The multi-band light curves = 'texts' of Rosetta stone



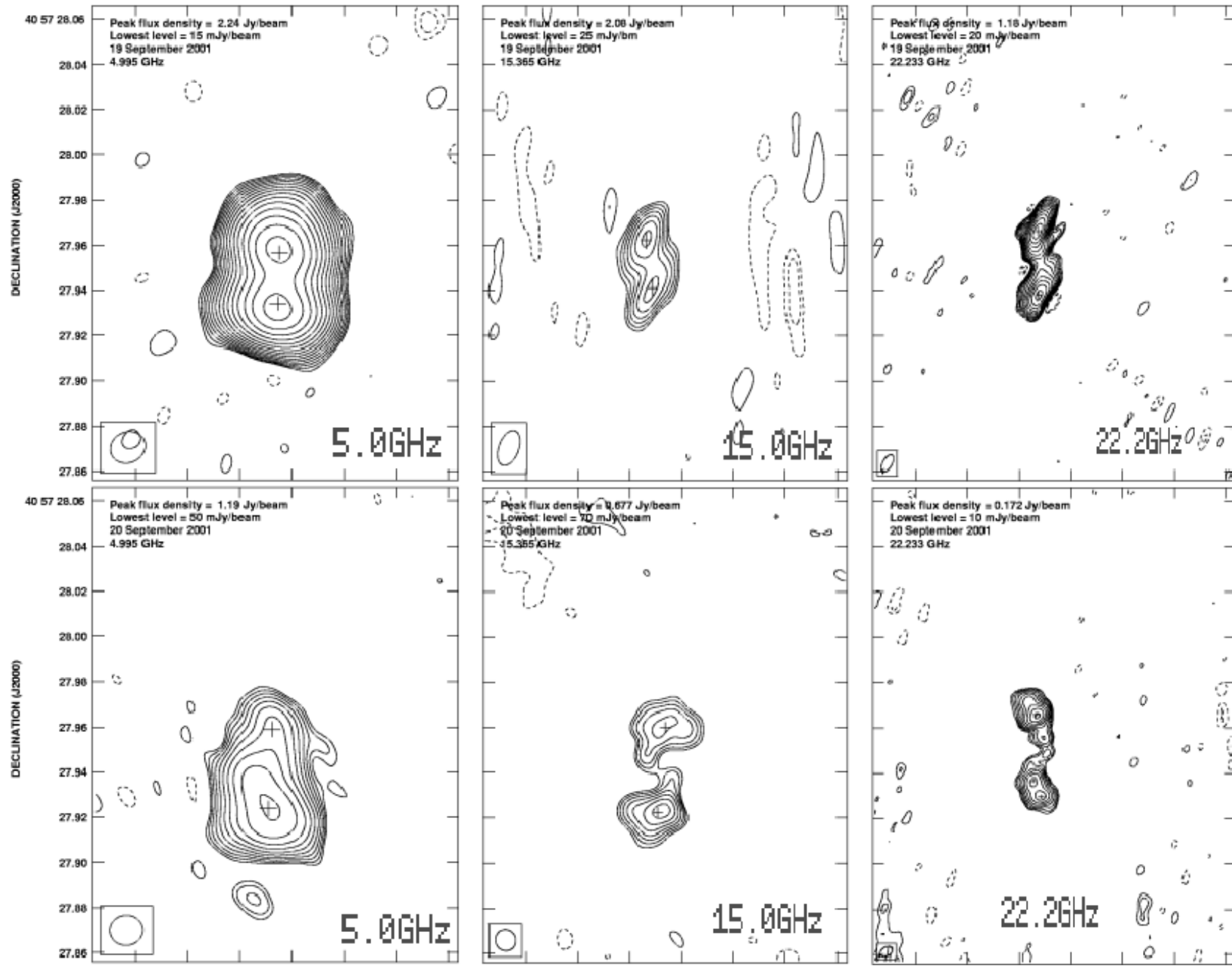
Cyg X-3 flare on 16 September 2001



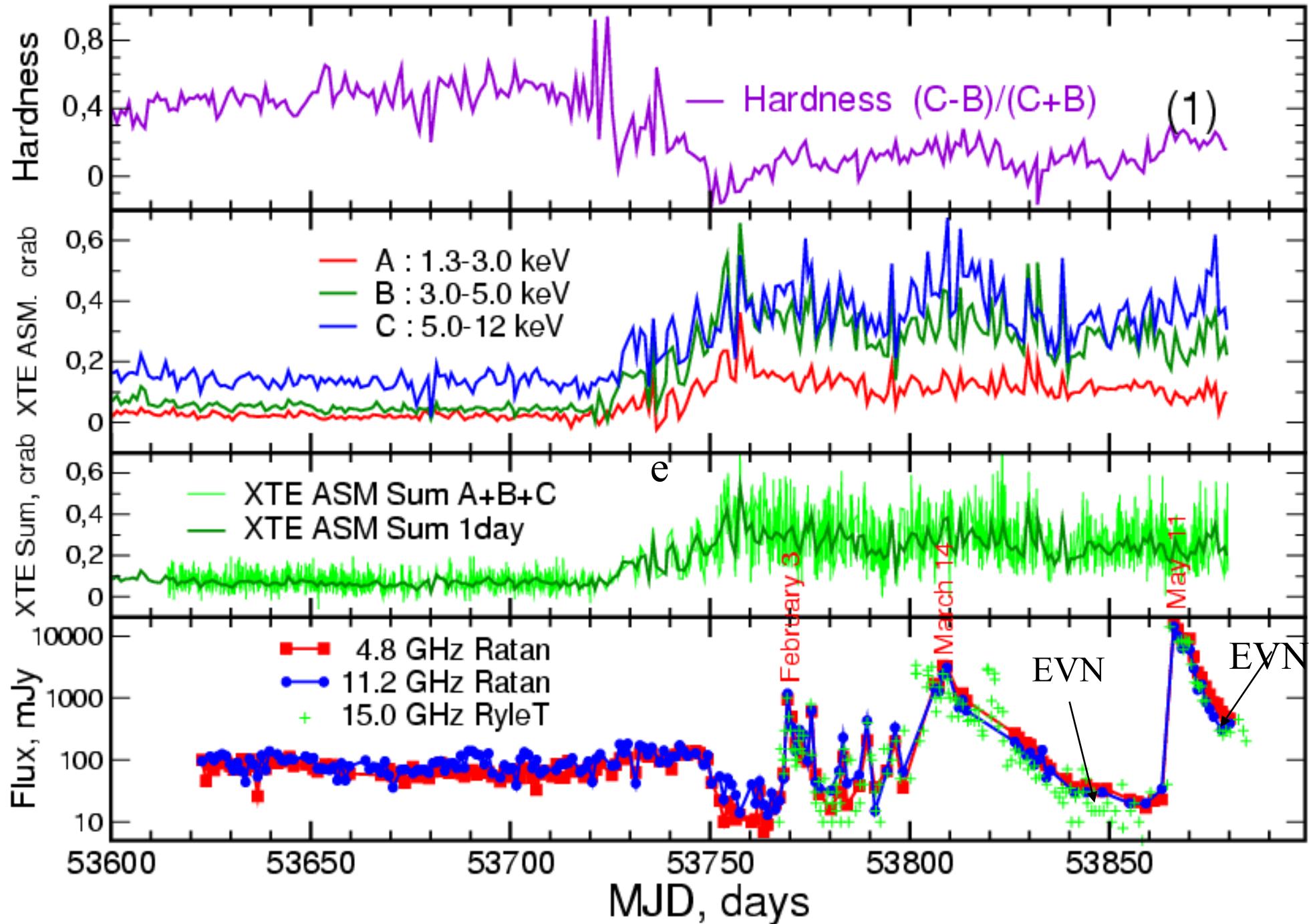
Spectra of the Cyg X-3 flare in Sep.2001



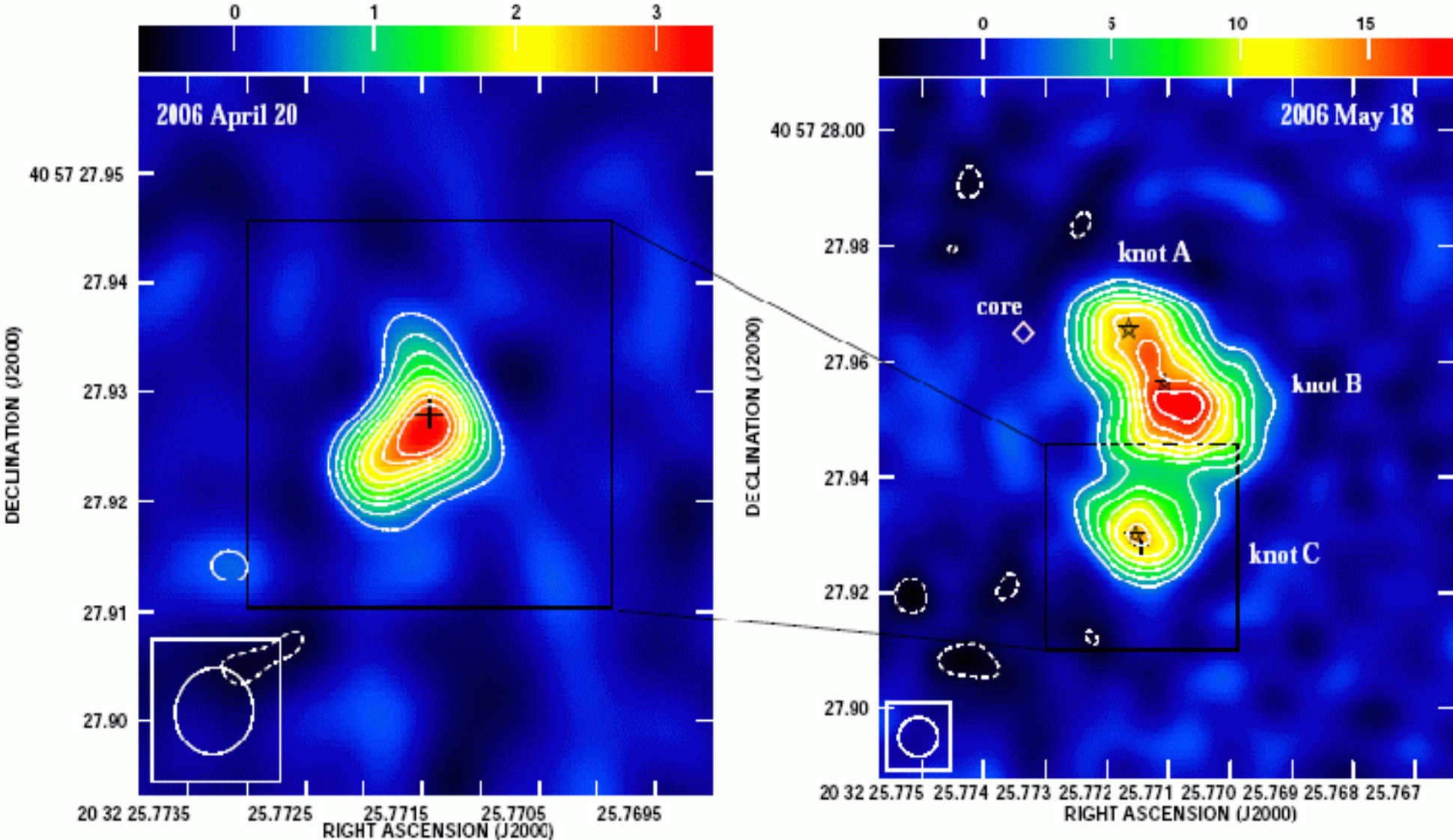
VLBA maps of Cyg X-3 in September 2001 from Miller-Jones et al. (2004)



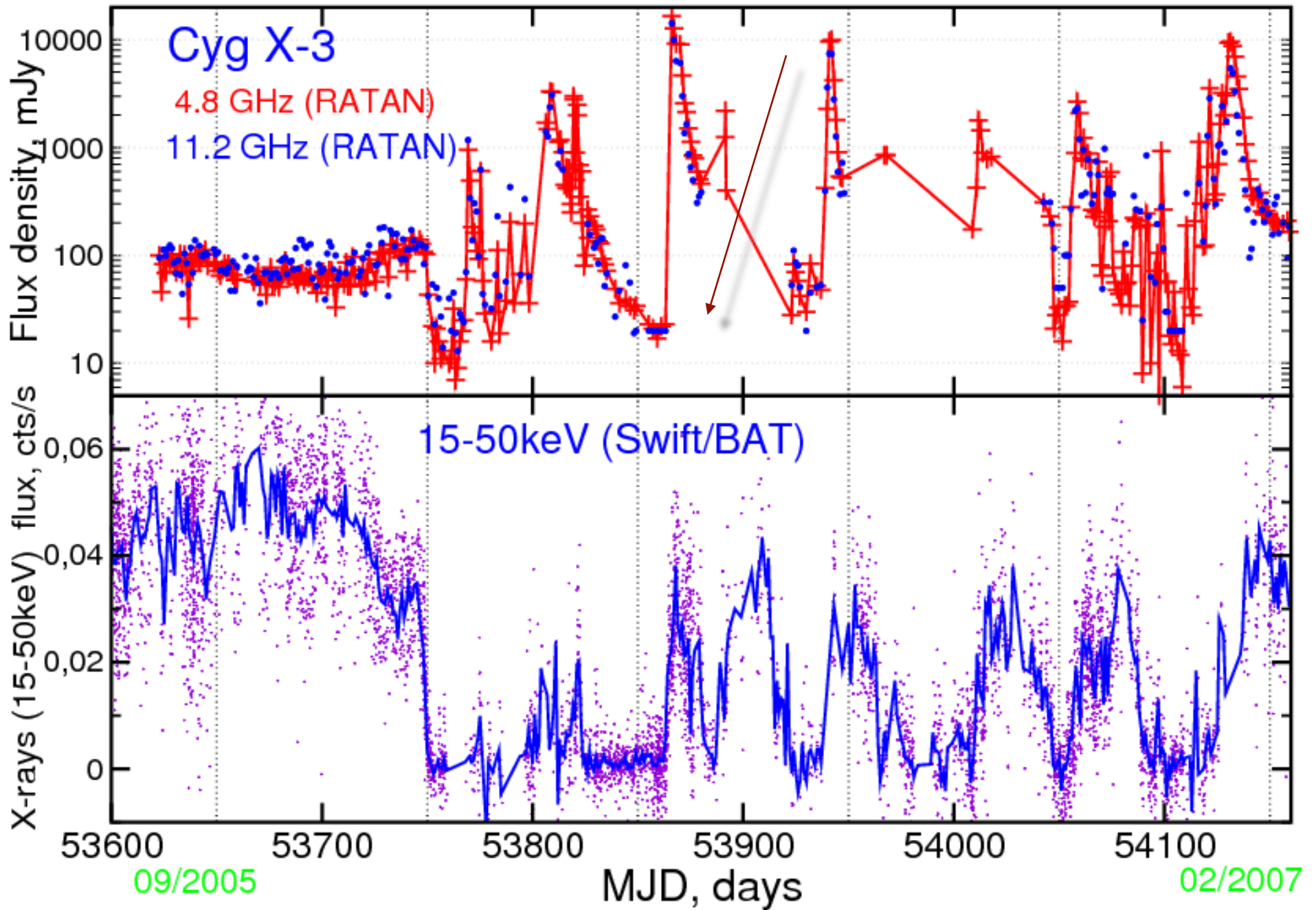
Change of state Cyg X-3 in 2005-2006



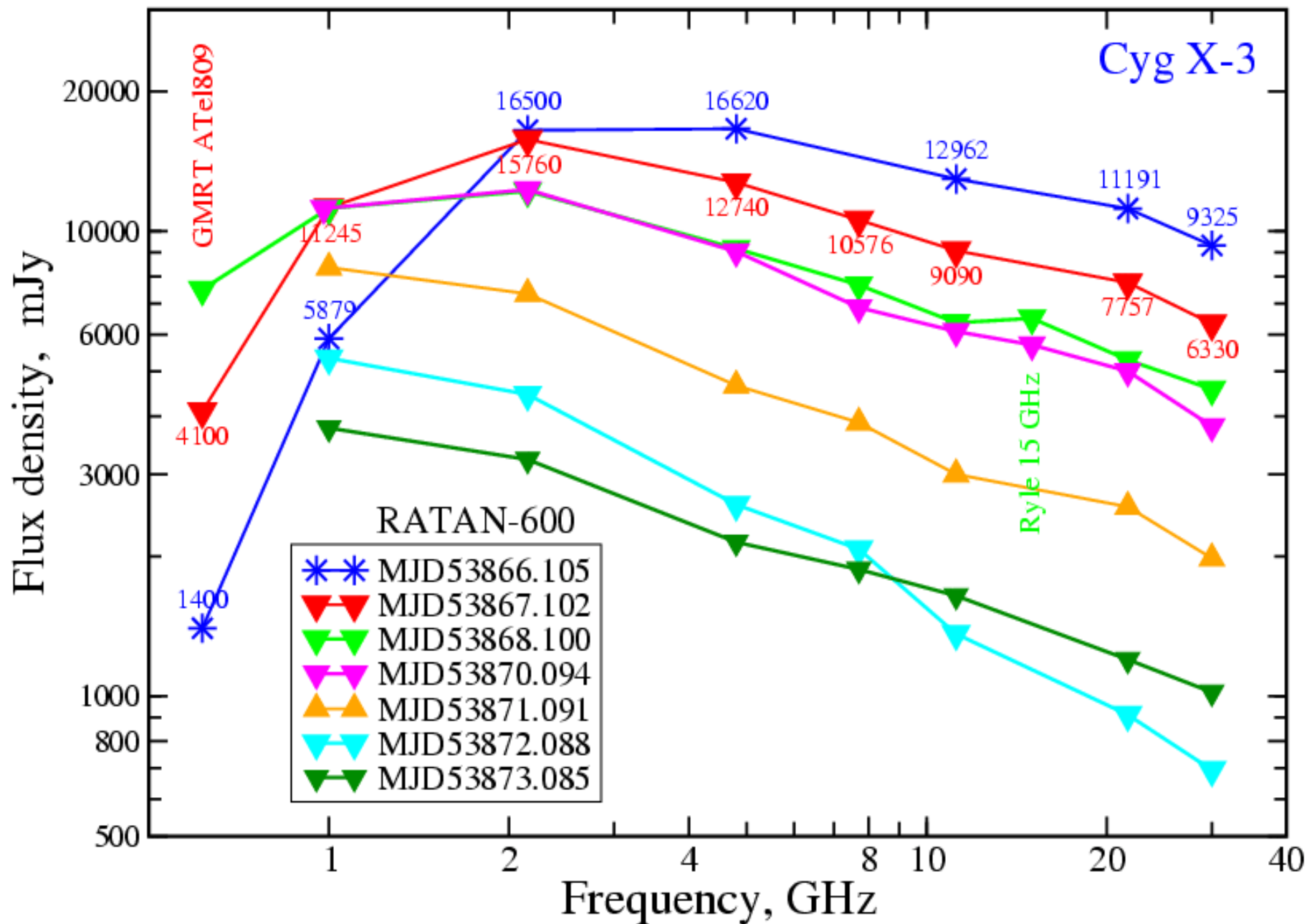
Cyg X-3 in quiet state (left) and in a flare (first maps with the eVN, Miller-Jones et al.)



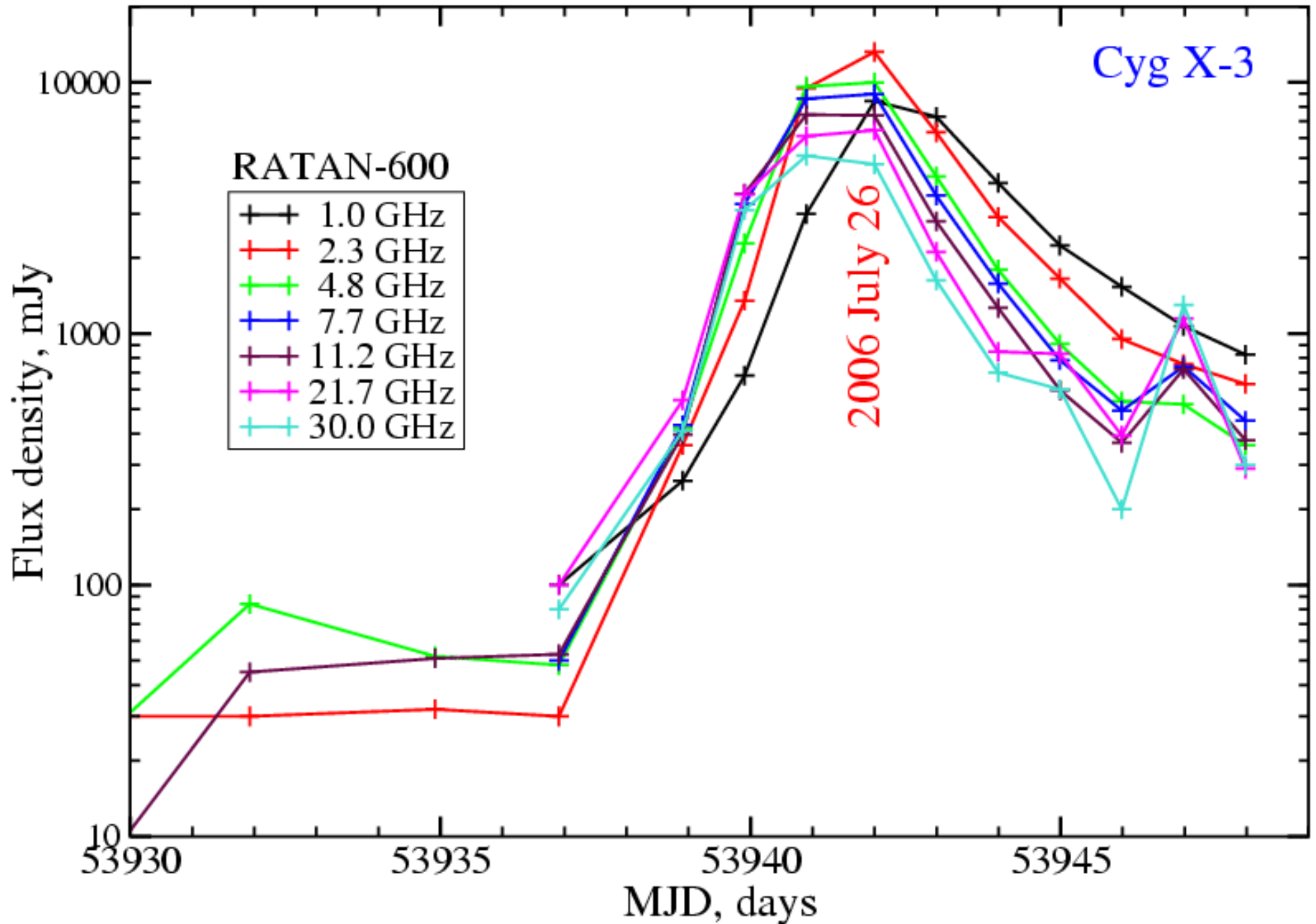
15-50 keV (Swift/BAT) & 5-11 GHz (RATAN)



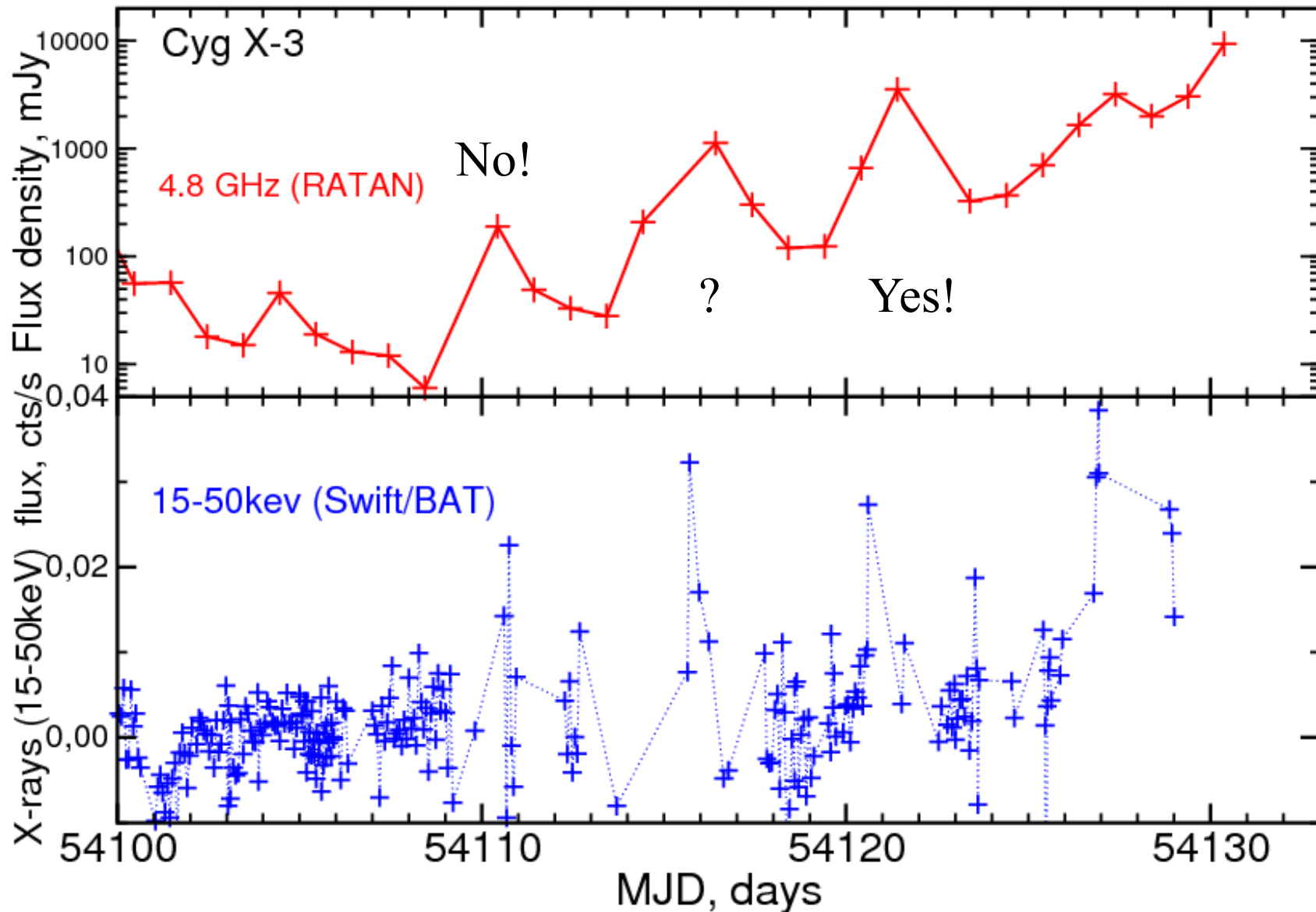
Spectra of the 2006 May flare



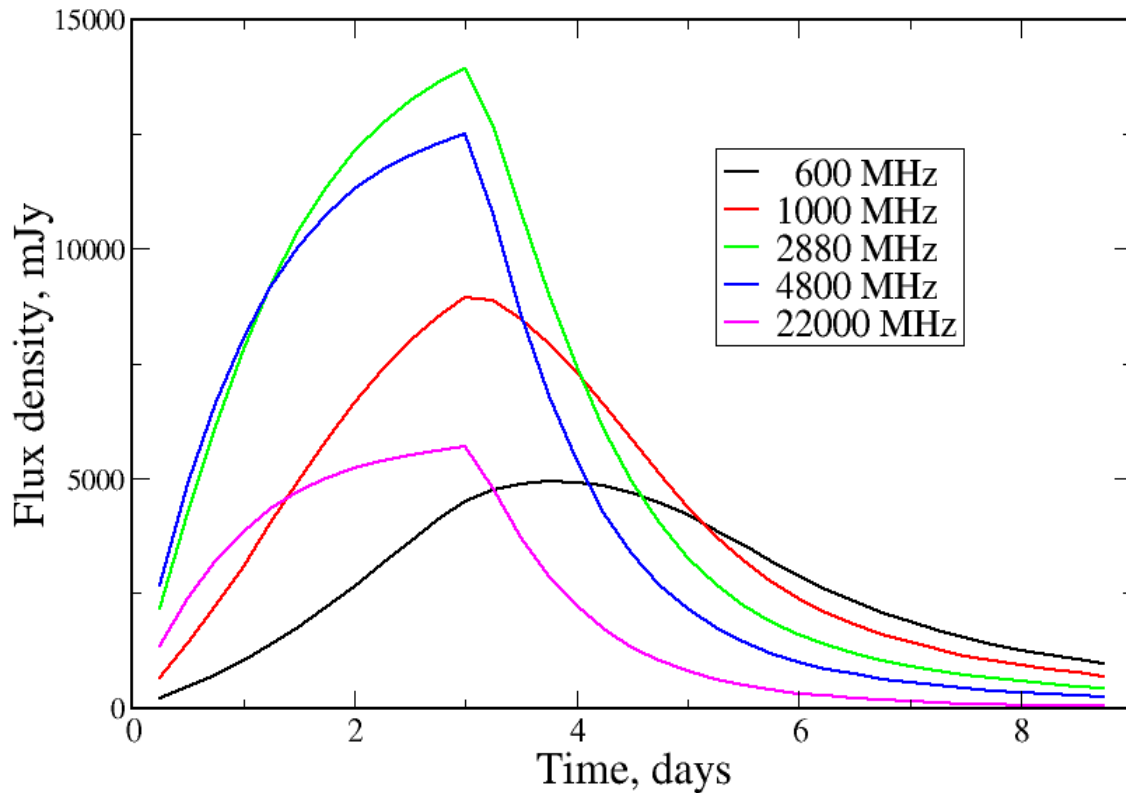
The Cyg X-3 flare in July 2006



Are there the lag of radio from X-rays?

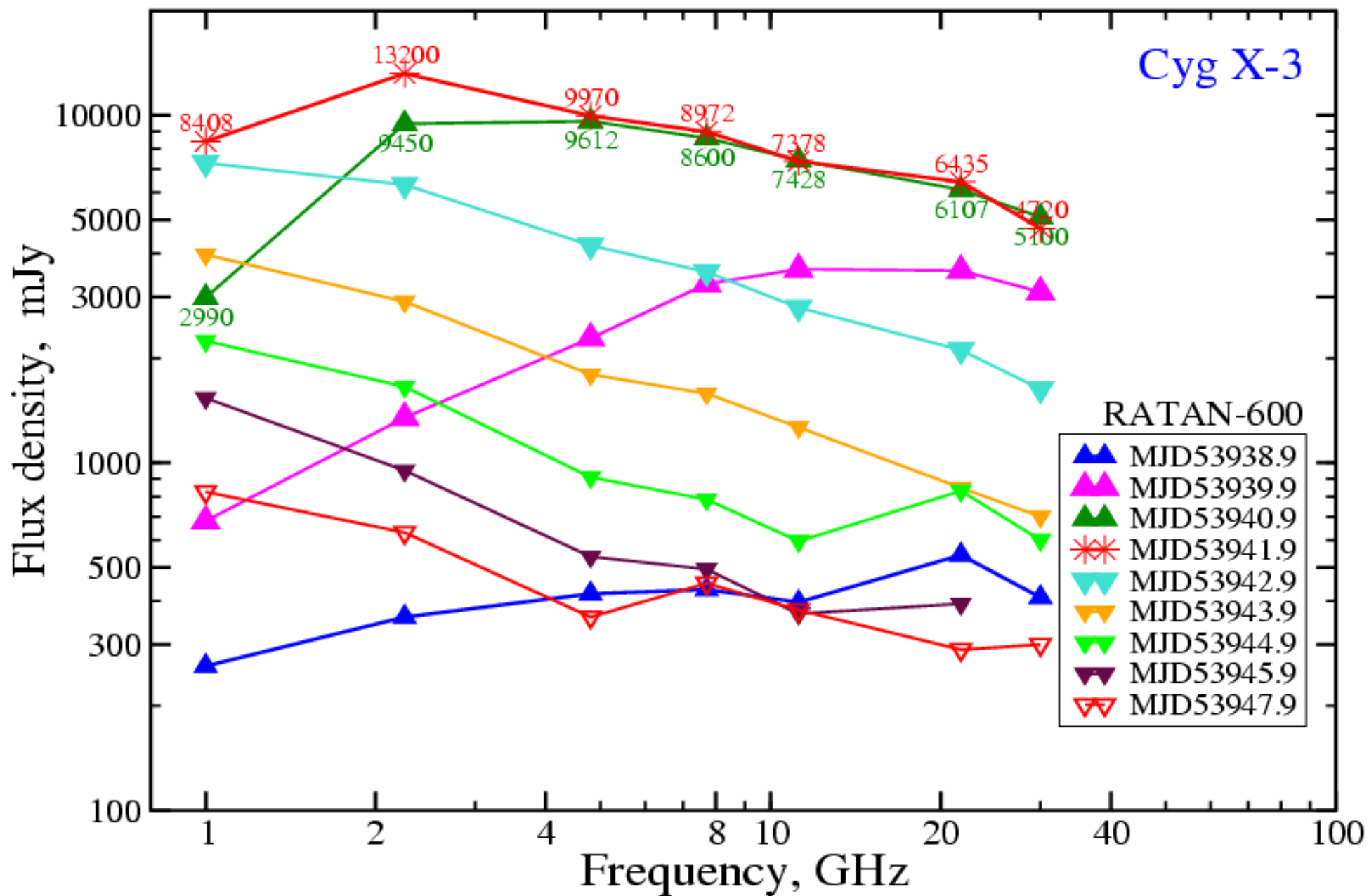


Model light curve of the July flare so-called "of finite jet segments"

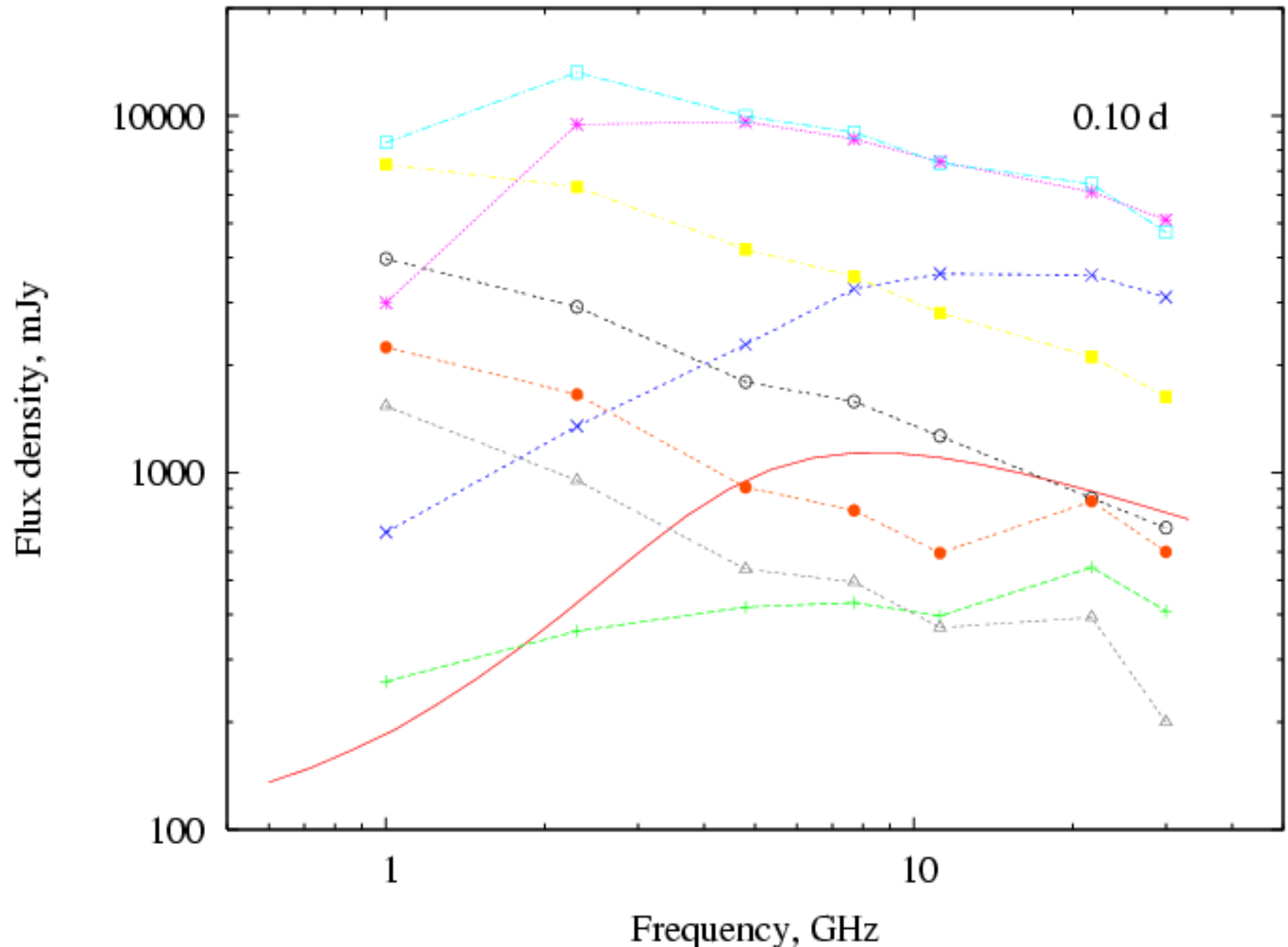


- $t_i \sim 3.1$ d
- $t_{\text{expo_expan}} = \sim 2.4$ d
- $n_{\text{therm}} = 3 \cdot 10^5 \text{ cm}^{-3}$
- $\dot{M}_{\text{rel}} = 6.62 \cdot 10^{18}$
- $v_{\text{jet}} = 0.3-0.6c$
- $B_0 = 0.05$ Gs
- $N(E) \sim N \cdot E^{-1.85}$
- $T_e = 10^4$ K

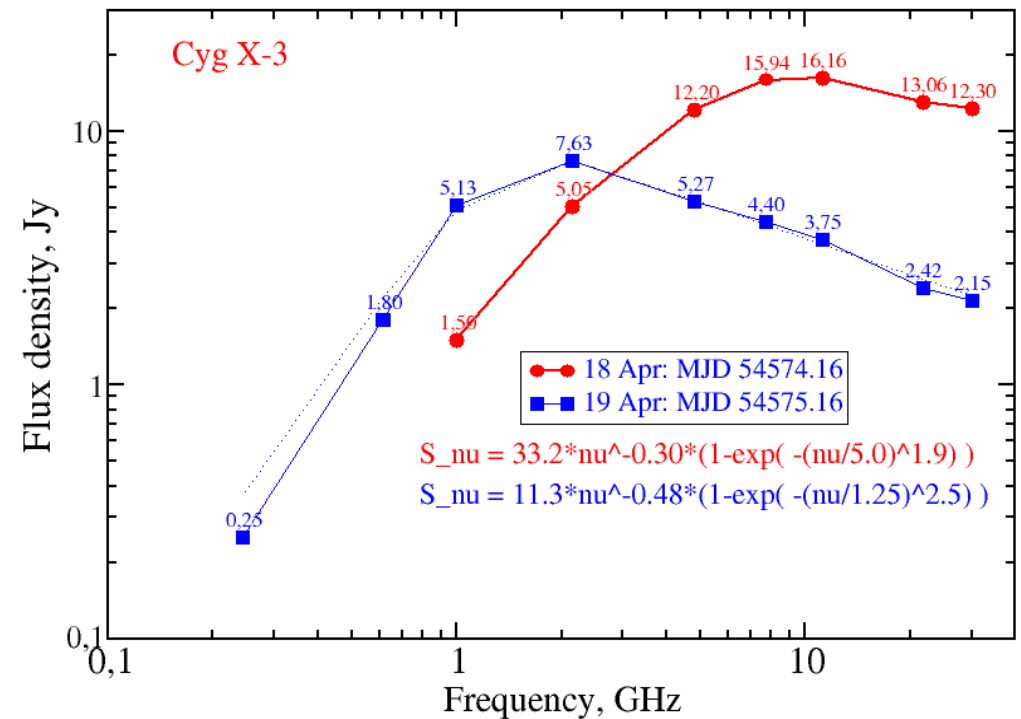
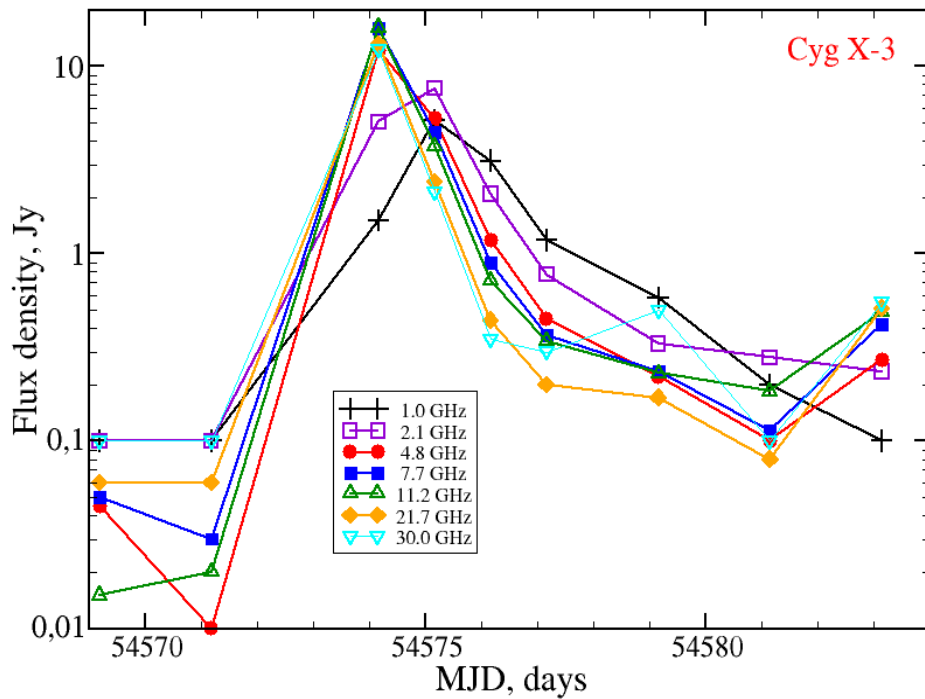
Spectra of Cyg X-3 in July 2006



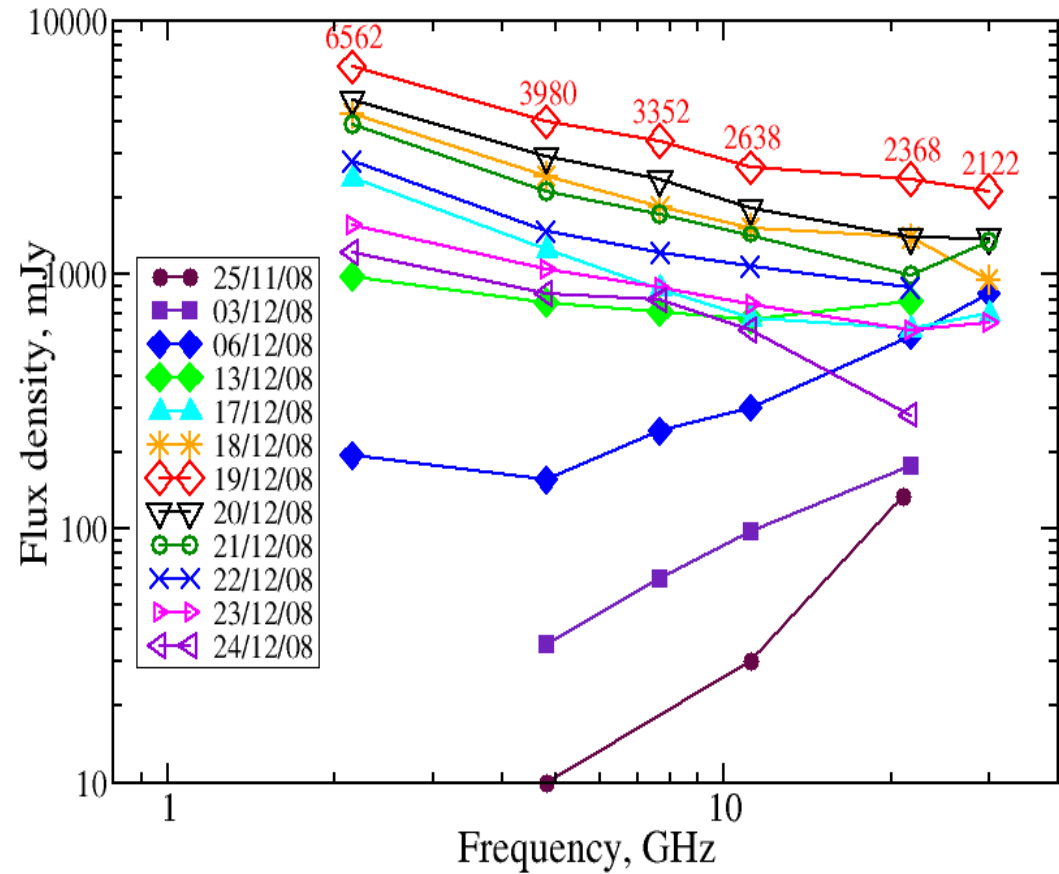
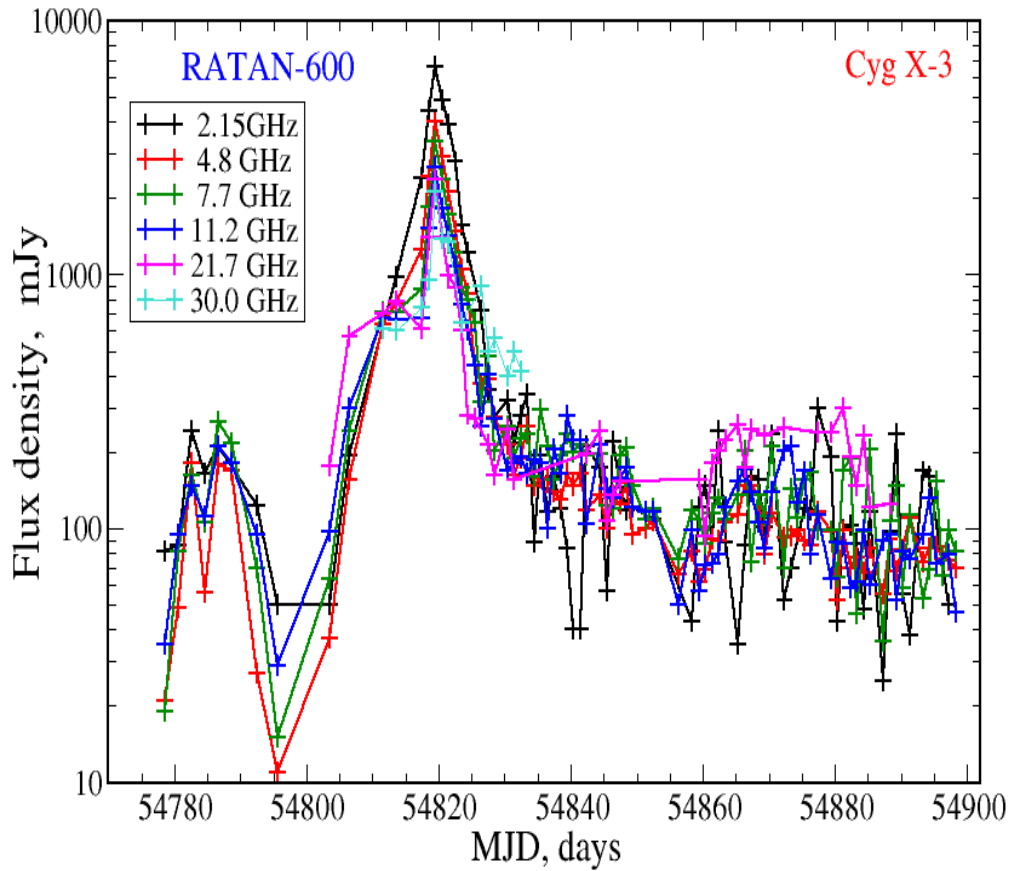
Fitting of the model and real spectra



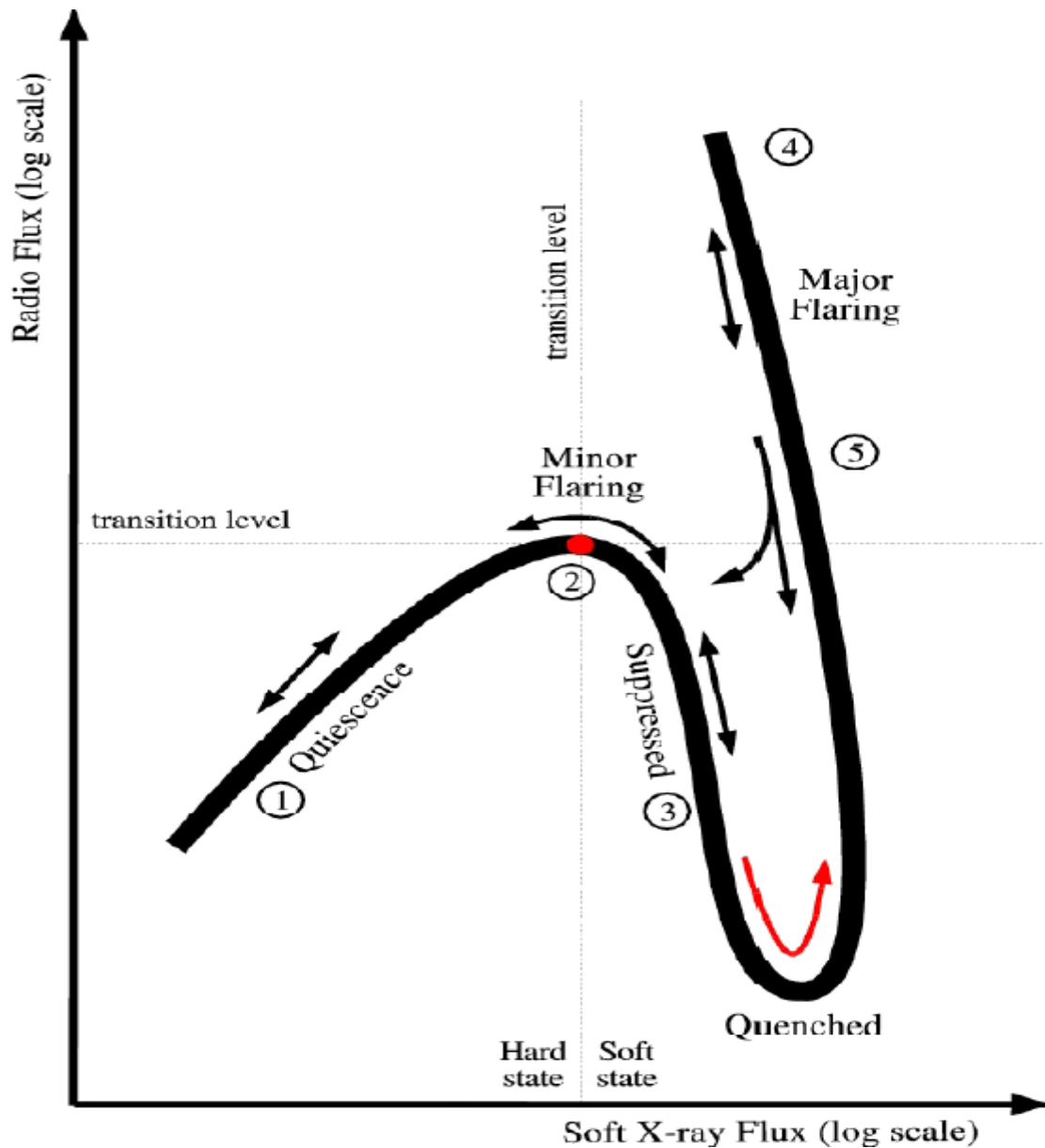
A bright flare in April 2008 with a clear synchrotron self-absorption



Cyg X-3 in Nov 2008 -March 2009

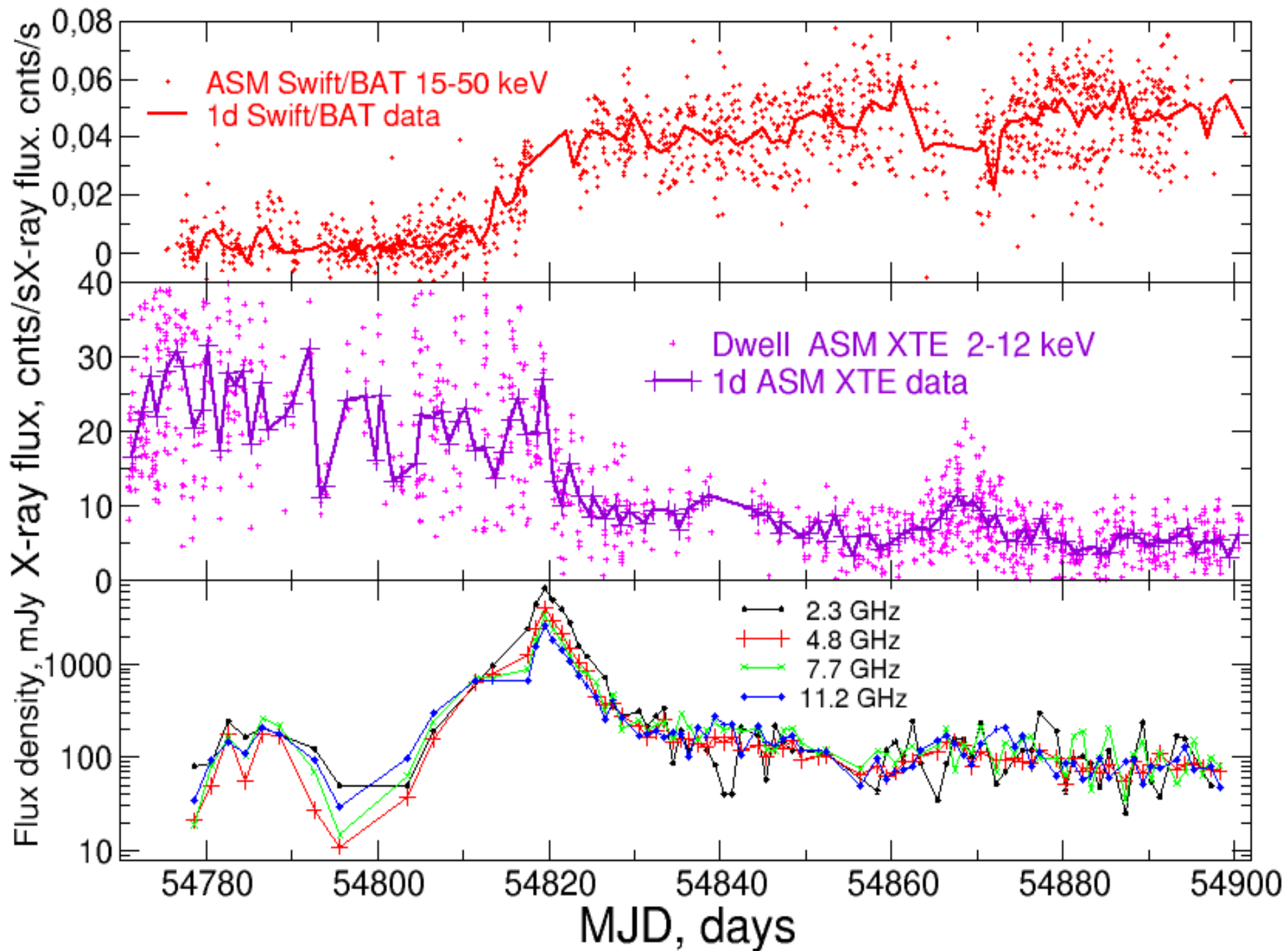


'Formula 1 track' of flaring Cyg X-3

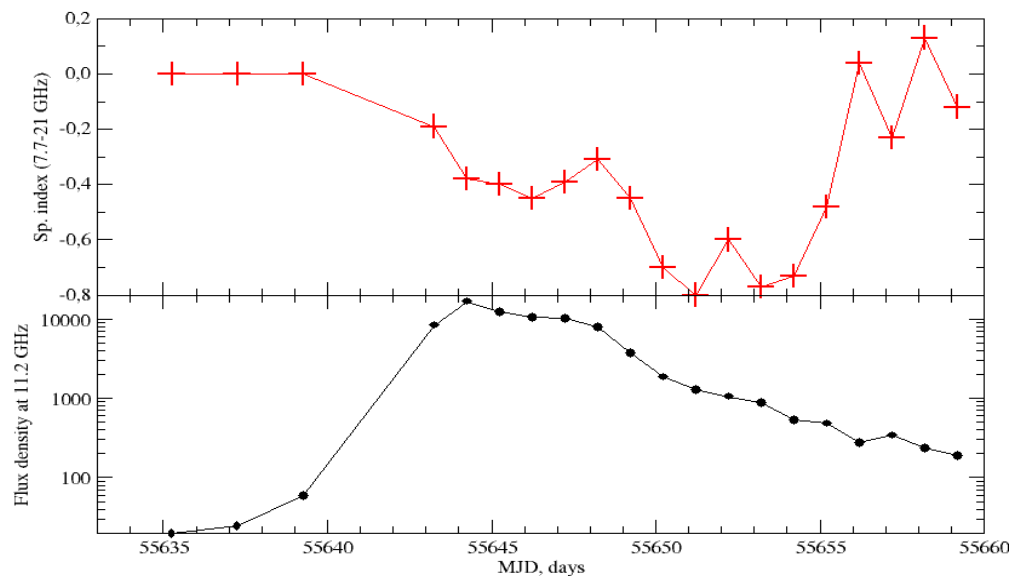
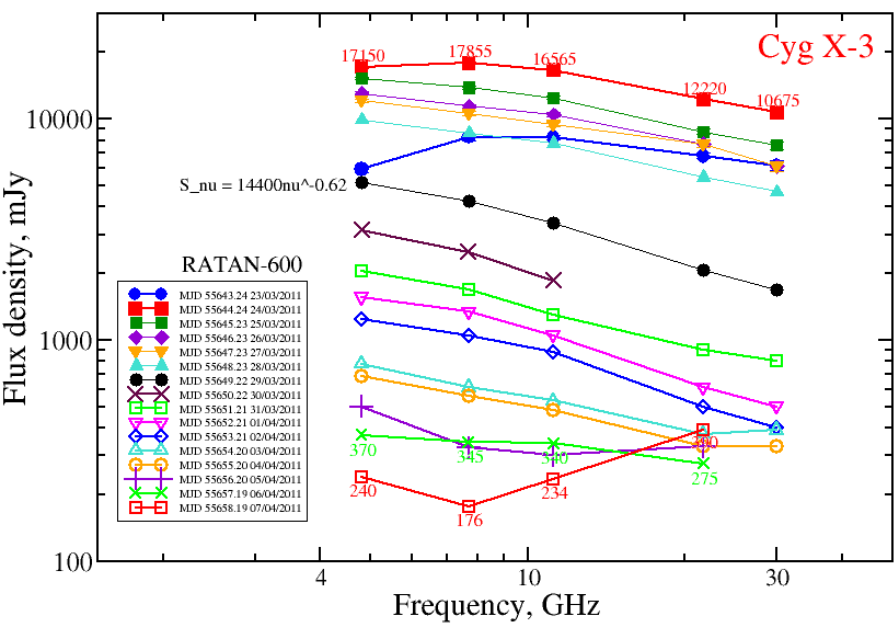
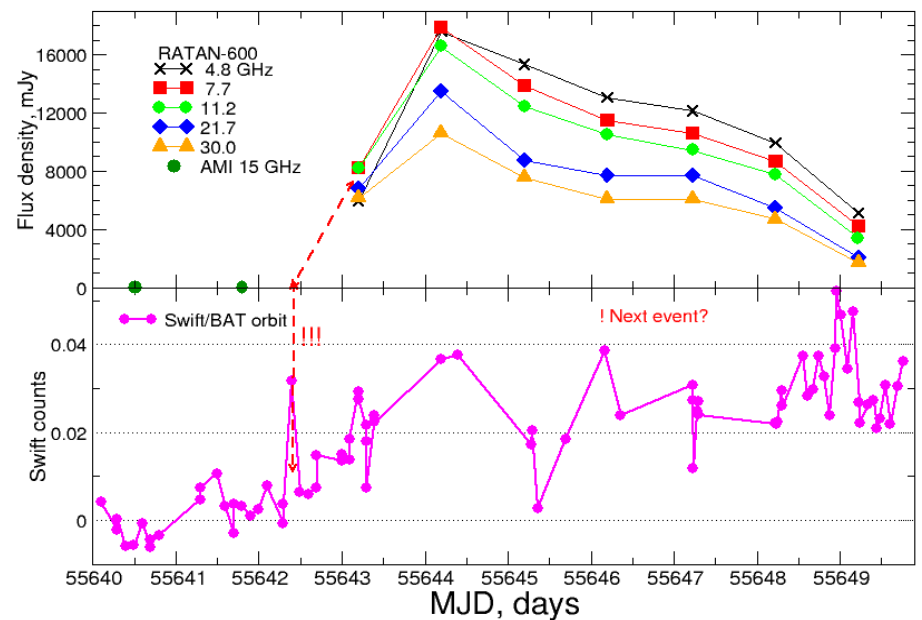
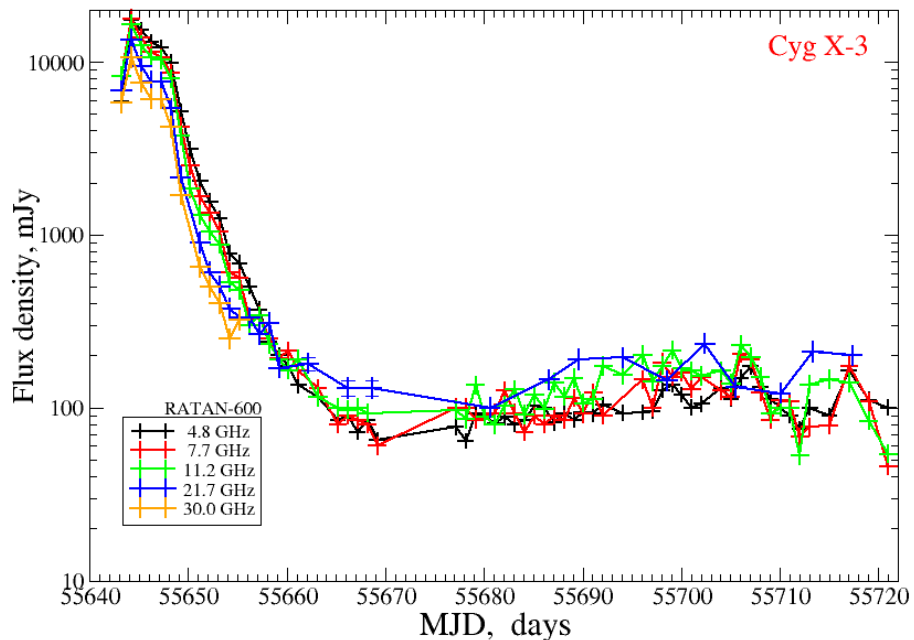


In Silverstone

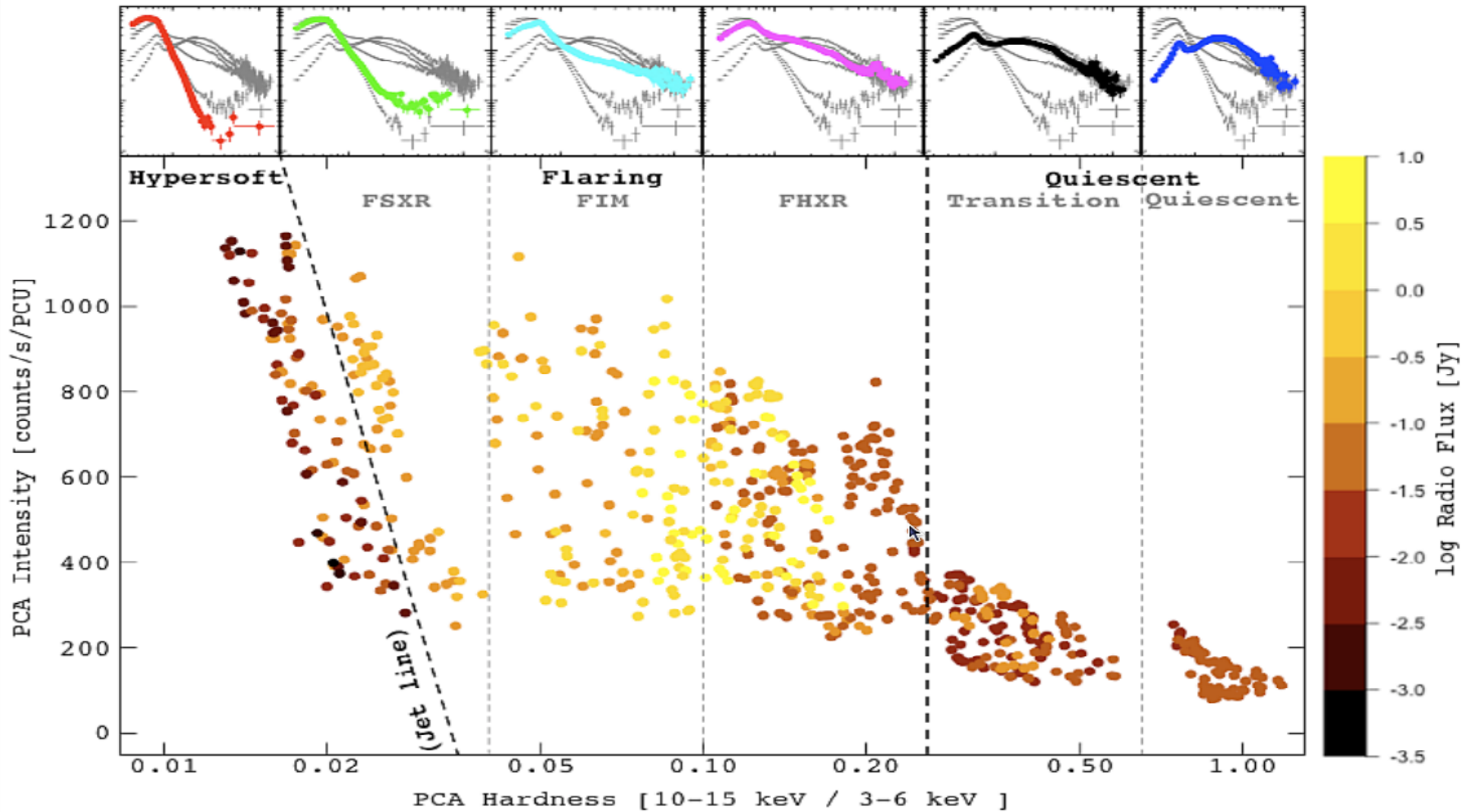
Cyg X-3 at 15-50 keV, 2-12 keV and 2-11 GHz in 2010-11



Giant flare of Cyg X-3 in Mar-Apr 2011



Hardness-Intensity Diagram of Cyg X-3



- Koljonen et al., 2009, see their poster.

Giant radio flares of Cyg X-3:

- Giant radio flares are **tracers** of the the jet activity or massive ejections. We may predict giant flares over hyper-soft states.
- Very clear **correlation** between hard X-ray and radio flaring fluxes (thus X-ray states \Leftrightarrow internal shocks and IC in jets).
- '**Multi-frequency-ness**' means knowledge of optically thick & thin regions of jets – evidence of initial generation of electrons.
- By the way RATAN measures the light curves of most of bright muQSO: SS433, GRS 1915+105, Cyg X-1, LSI+61d303, LS5039 with the similar and other results.
- **Nature (is it really BH?) of Cyg X-3 is unknown yet :(((**

To be continued :)