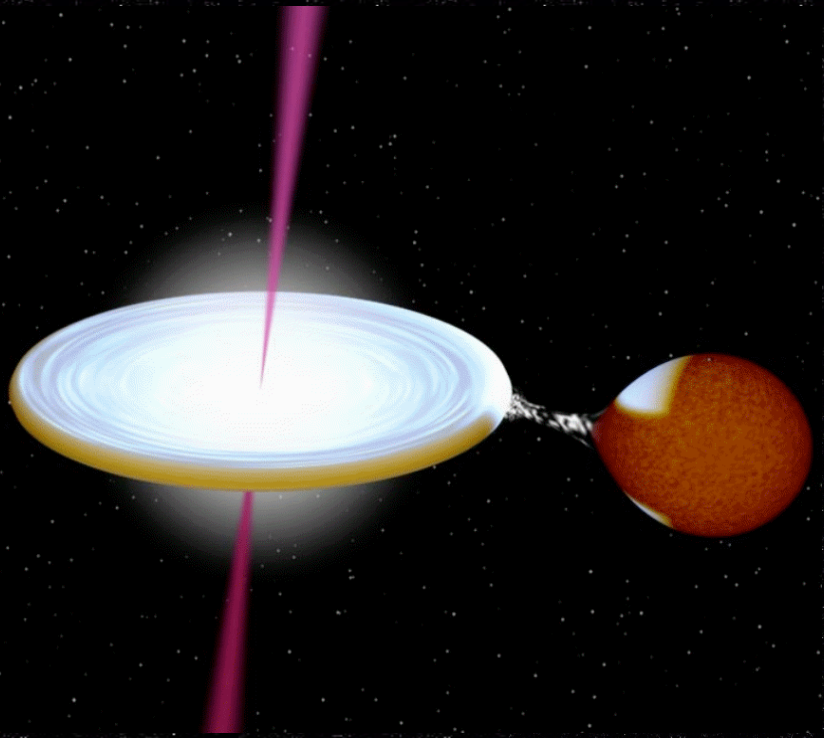
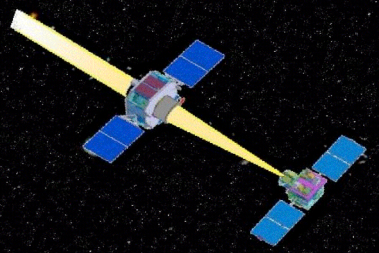
Quasi-Periodic Oscillations and SIMBOL-X:

A Case Study



GRS 1915+105



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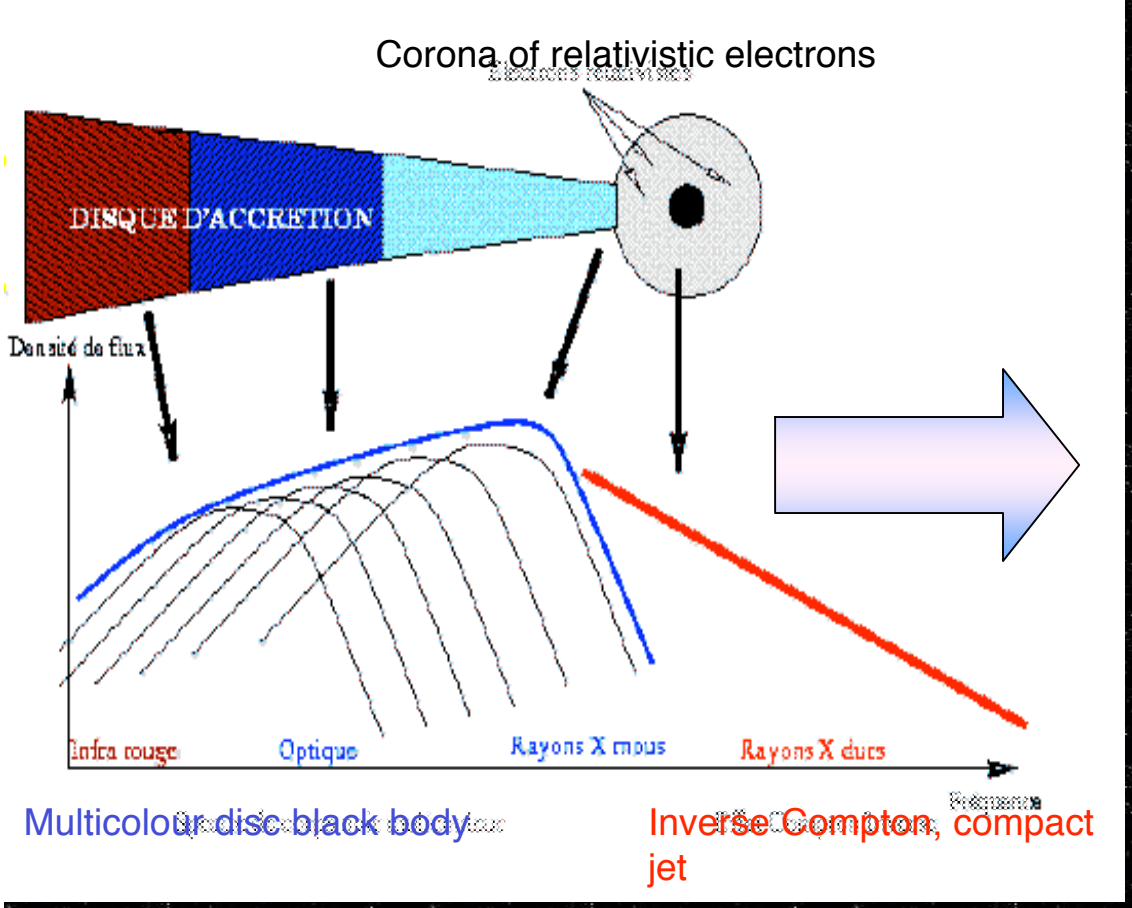
Summary

- Microquasar/XRB
- GRS 1915+105
- RXTE : recent observations/results
- Spectral simulations
- QPO studies with SIMBOL-X
  - LFQPOs
  - HFQPOs
  - Other sources
- Conclusions

Microquasar/X-ray Binary

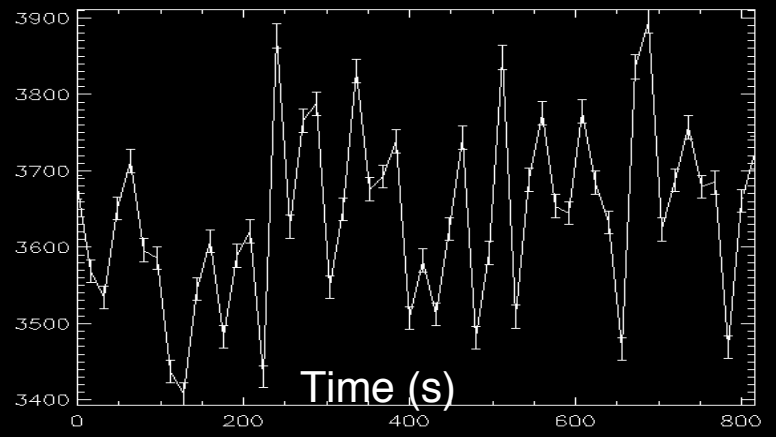
Spectral analysis

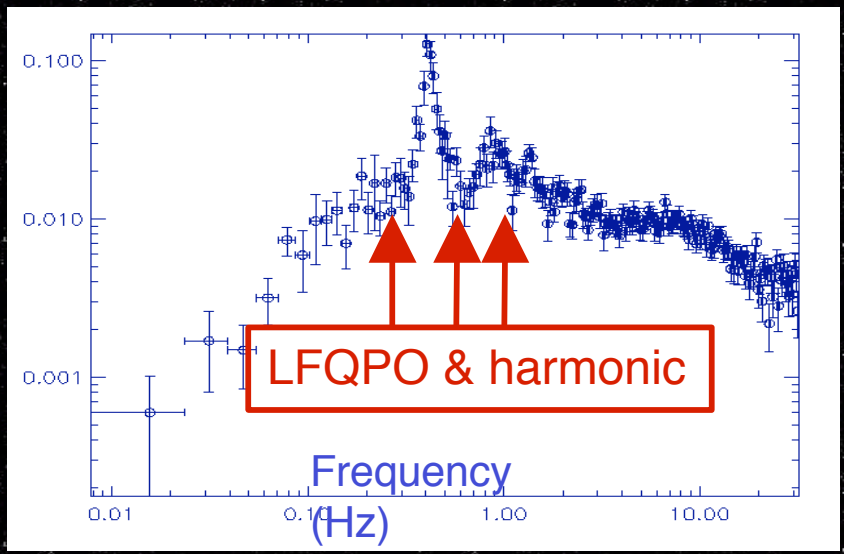


Multicolour disc black body

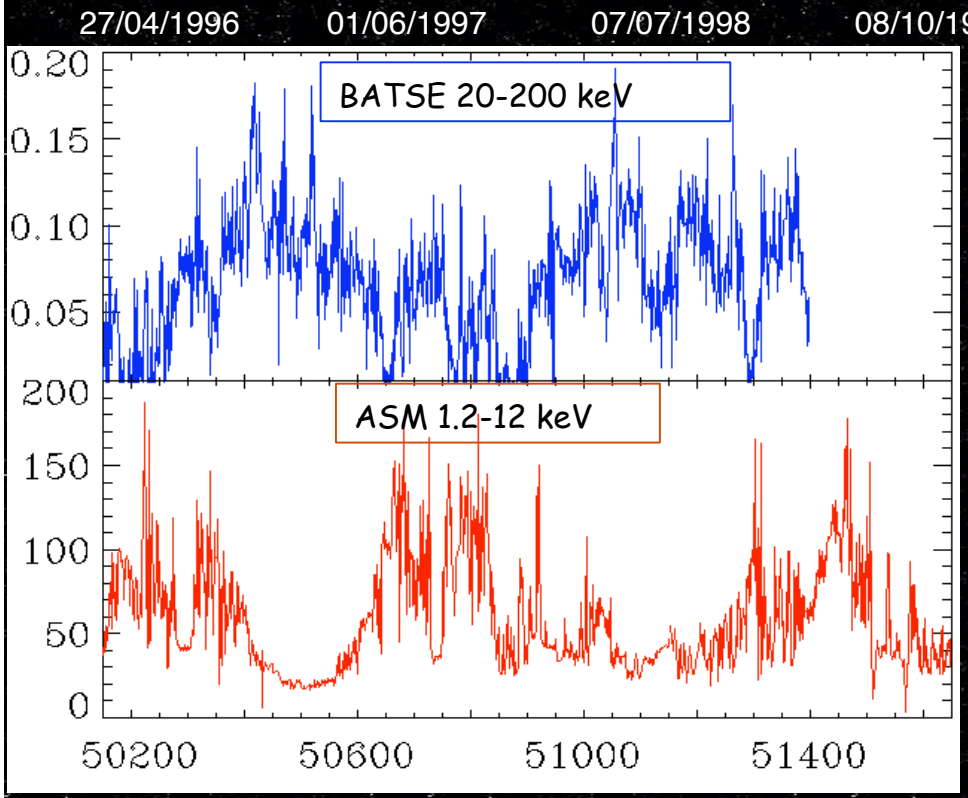
Inverse Compton, compact jet

Temporal analysis





GRS 1915+105: a brief history

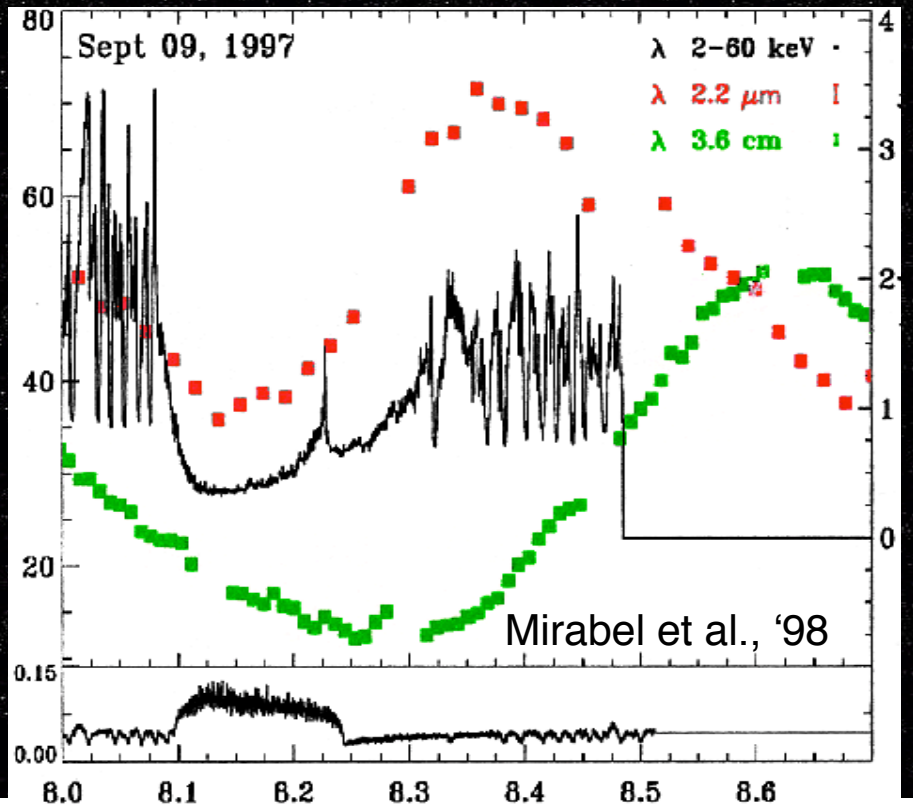


Discovered in 1992 (Castro-Tirado et al, '92)

Black Hole M=14 ± 4 Msol (Harlaftis & Greiner '03)

Superluminal Ejections (Mirabel & Rodriguez, '94)

12 classes 3 spectral states (Belloni et al., '00)



Compact jet in 'hard state' (Dhawan et al., '00, Fuchs et al. '03)

Plasmoid ejection 30 minute cycle (Mirabel et al., '98 ; Chaty, '98)

LF & HFQPO (e.g. Markwardt et al.'99; Muno et al. '99, Morgan, Remillard, Greiner '97)

Magnetic Flood & AEI (Tagger, Varnière, R., Pellat, '04)

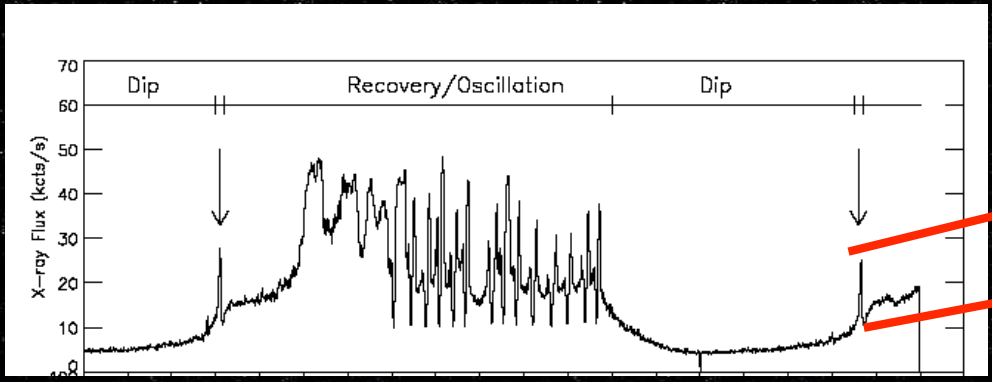
Other phenomena ?

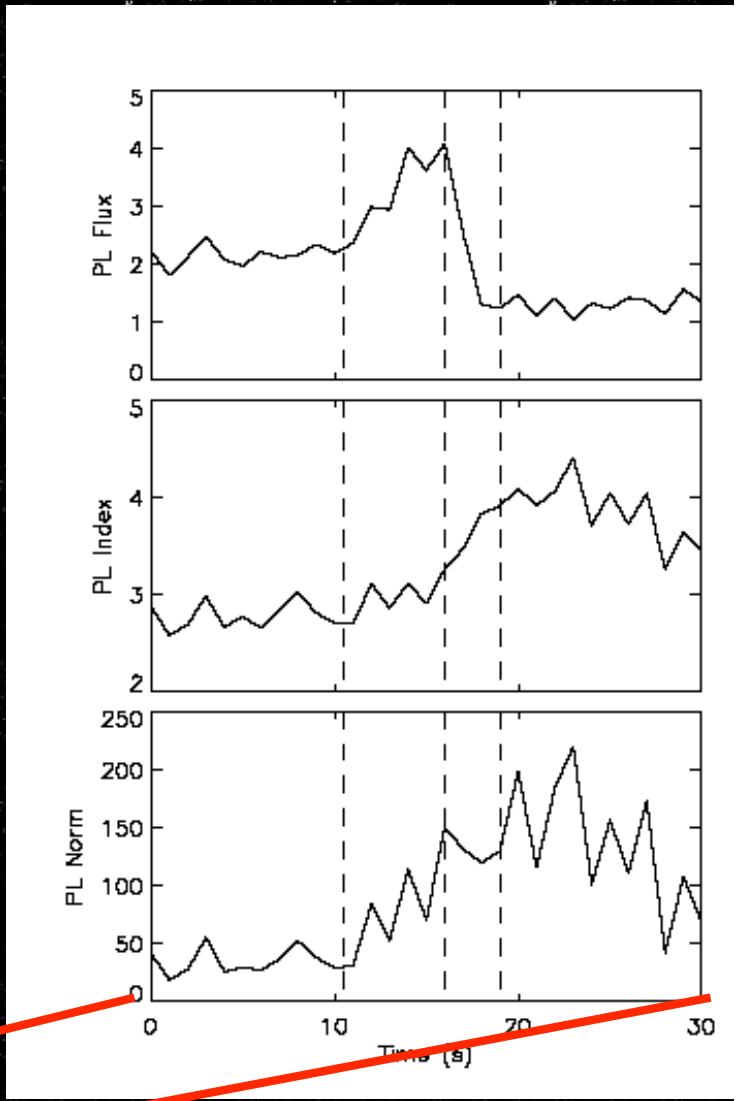
In the context of "Magnetic Flood" scenario

e.g. Eikenberry&Van Putten, detailed analysis of the spike in GRS 1915+105

<=> relativistic ejection
<=> magnetic reconnection ?

detailed spectral diagnosis needed for modelling of reconnection !!



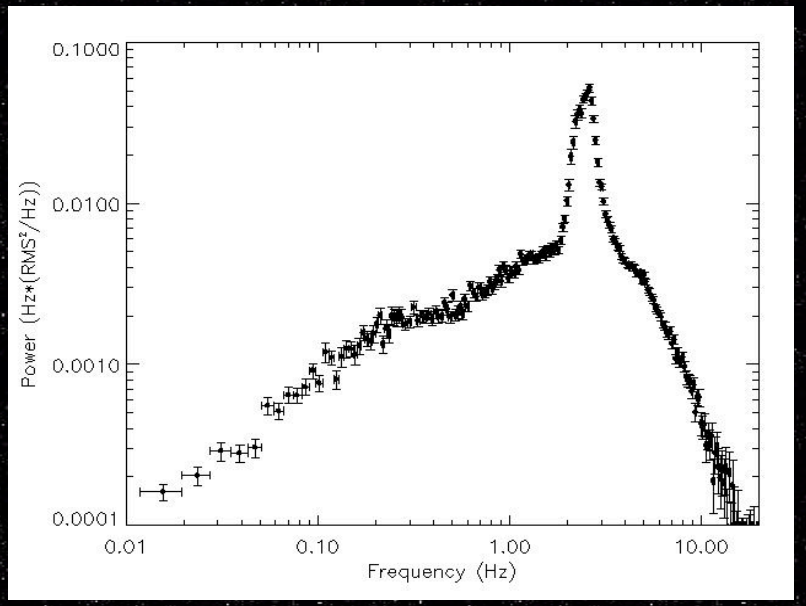


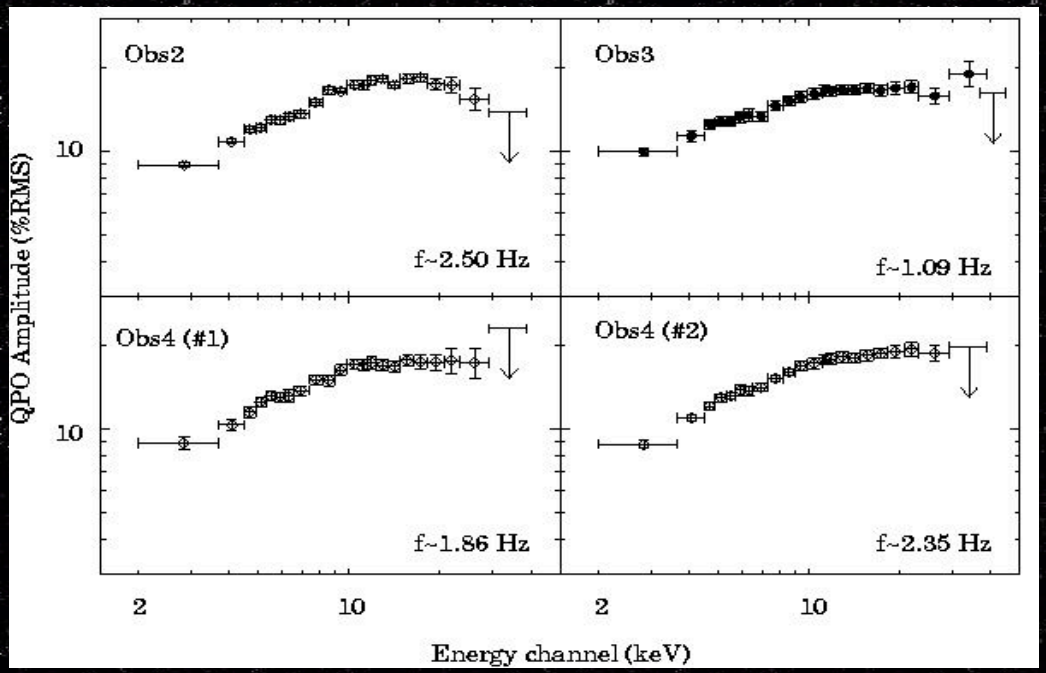
RXTE, power-law with 1 s resolution

RXTE Observations

- ~10 ks Observations with RXTE
- 3 obs. -> source in steady (“hard”) state with strong QPO (~13-15% RMS)
- QPO frequency constant

->Energy dependence of QPO amplitude (R. et al '04 for more details)





Origin of the turn over ?

- Turn over expected at some point
- Already seen in previous obs. (e.g. Tomsick & Kaaret '01; R. et al. '02)
- Evolution between similar states <-> NEW
- Cut-off energy not related to QPO freq.
- What is its origin??

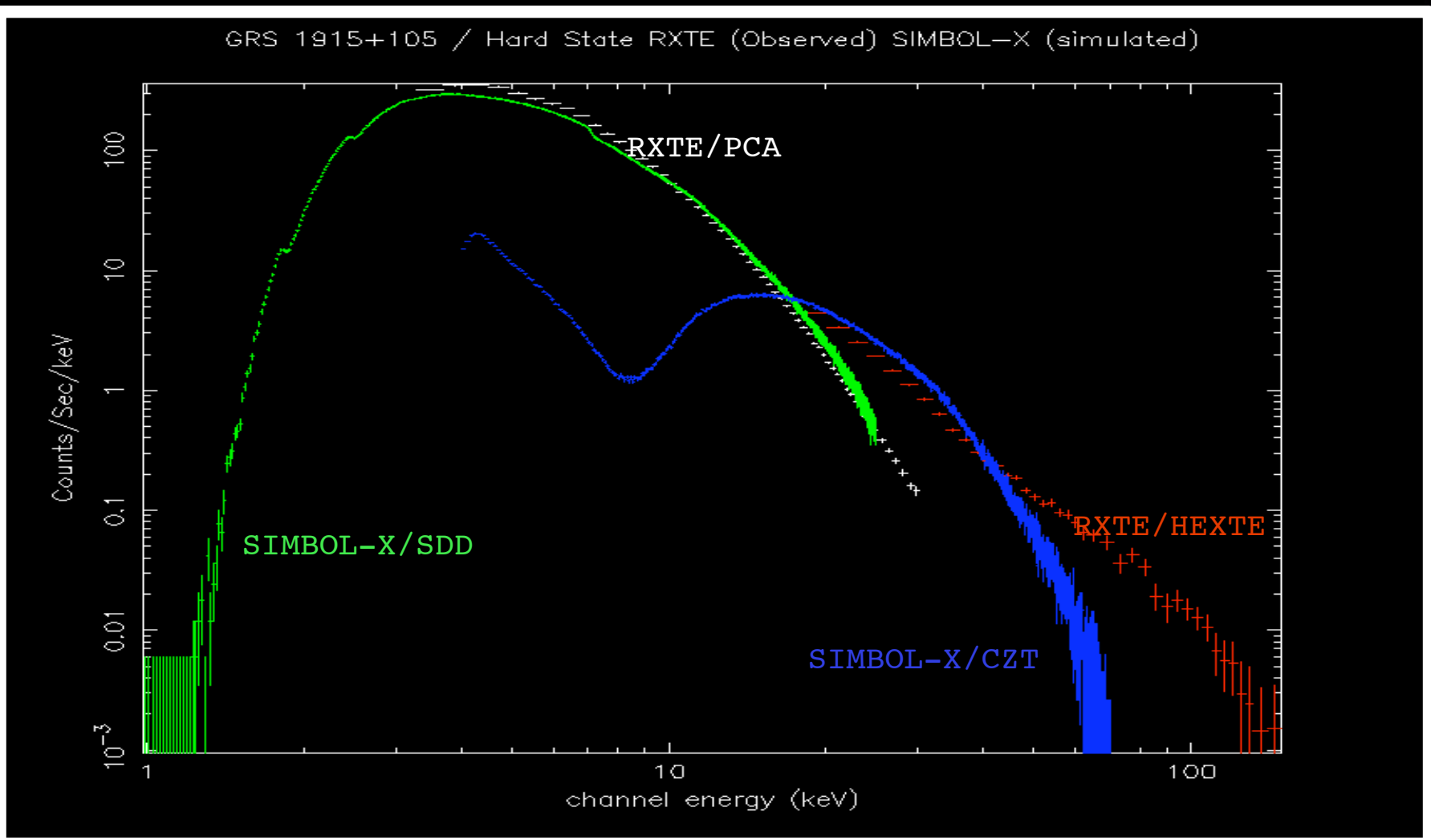
The compact jet ? (detected during each obs. in radio & IR, Fuchs et al. '03 and Hannikainen et al '04)

Double interest for SIMBOL-X :

- Spectral Analysis of the Hard Tail
- Spectral analysis of the QPO amplitude

Feasibility: Spectral approach

- Spectral fit of PCA+HEXTE spectrum Simulation of SIMBOL-X spectra (10 ks)
- Spectra of high quality (due to high sensitivity & low bgd)
- Lower energy+ up to 70 keV, better simult. coverage of thermal+non thermal comp.

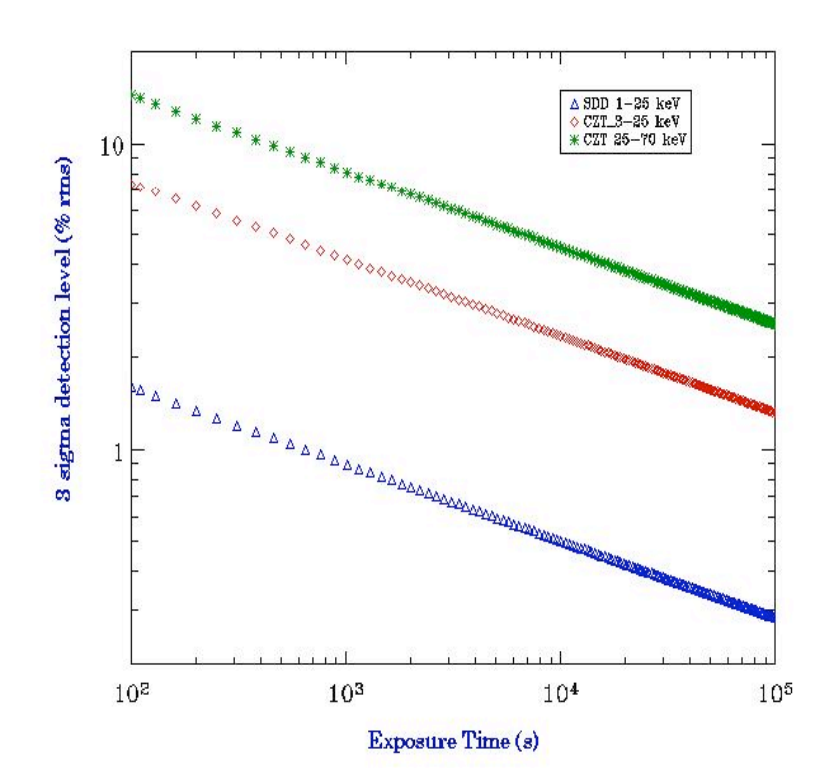


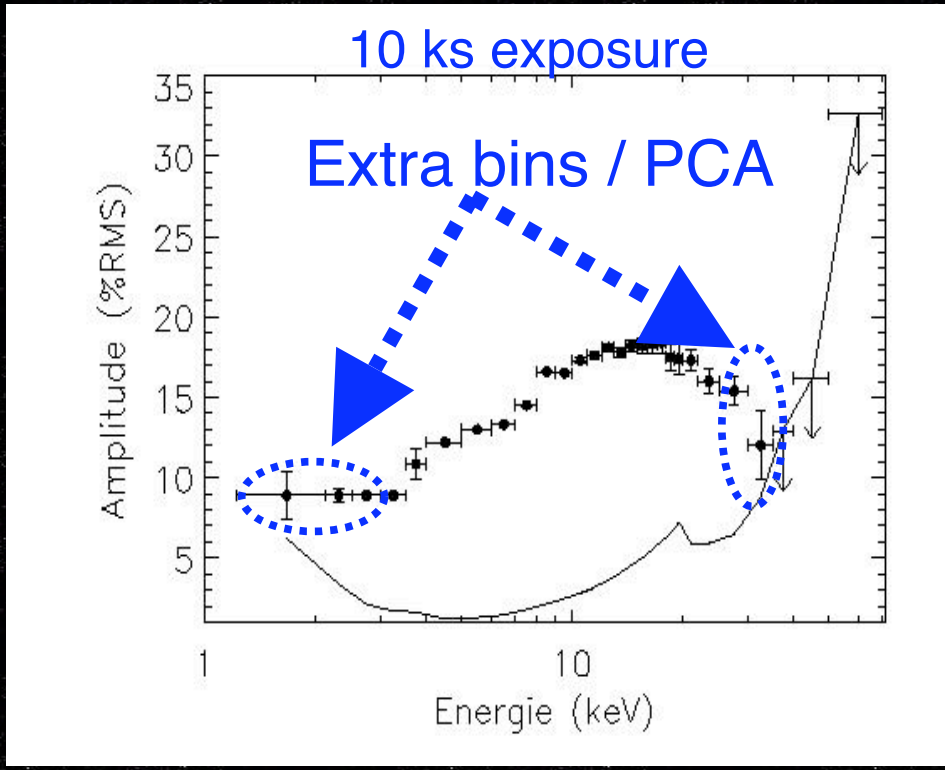
Feasibility: QPO Analysis

$$n_\sigma = \frac{1}{2}\frac{S^2}{(S+B)}A^2\sqrt{\frac{T}{\Delta\nu}}$$

-> Rate+bgd rate (simul.)

-> QPO amplitude (PCA obs.)





LFQPO detected with short exposures

Feasibility: HFQPOs

- HFQPO small amplitude (<0.3% -~2% rms, Morgan, Remillard, Greiner '97)
- Spectral sim. of state with 67 Hz QPO (MRG'97)

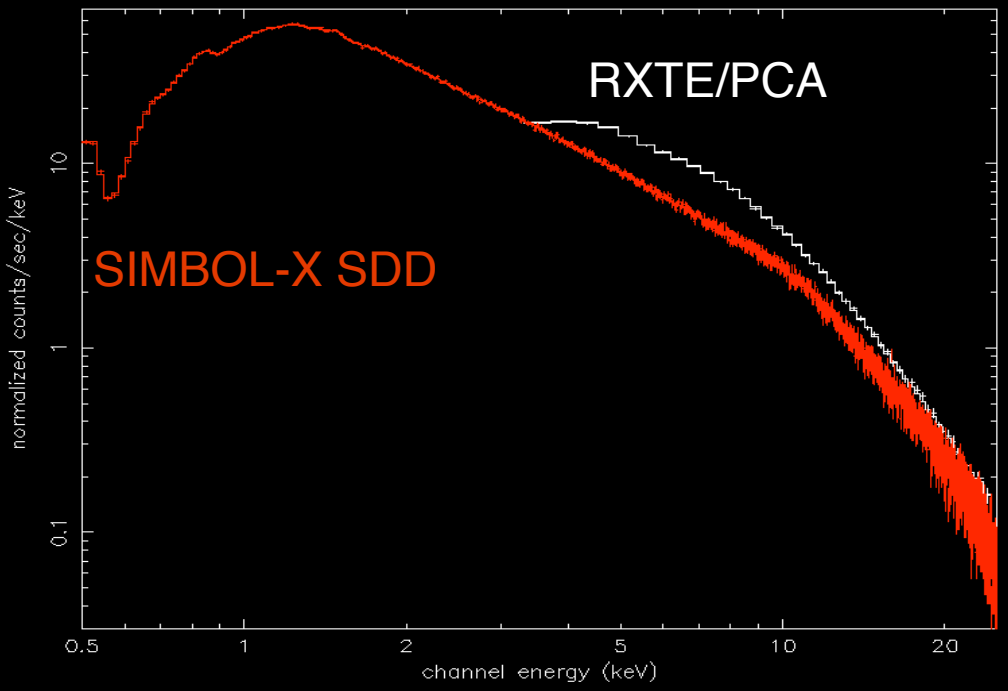
→ Estimate of the expected count rate in SIMBOL-X

→ A=1.6% (observed), T_{exp}=10 ks → QPO @~ 13 →

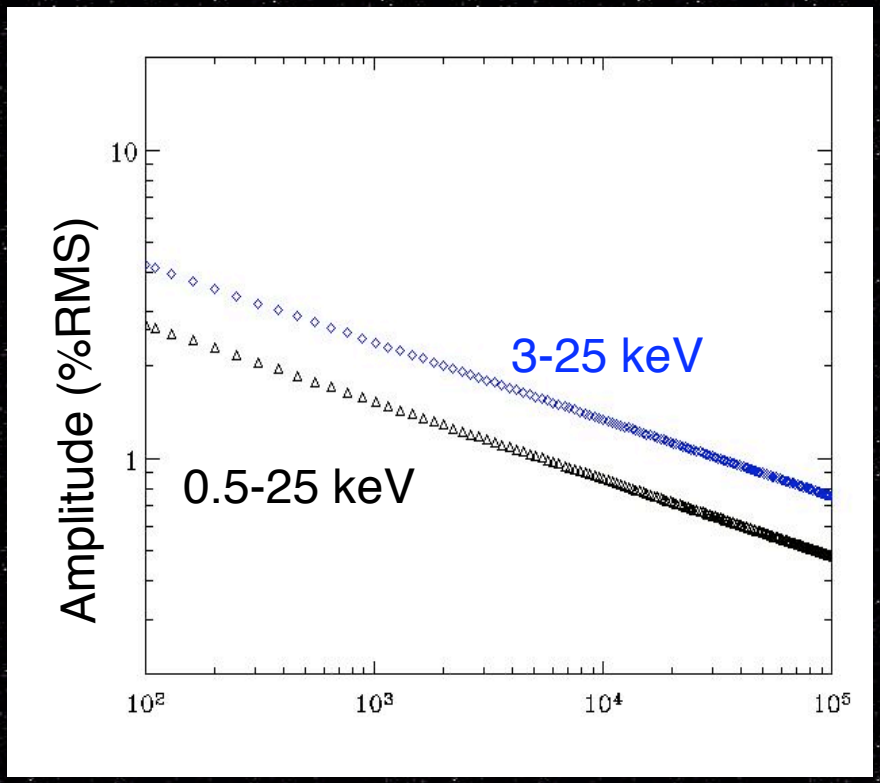
→ 3 → limit during 10 ks is 0.6 % (PCA=0.3%)

Other sources ?

-> XTE J1118+480, weak hard state outburst in 2000
-> LFQPO with small FWHM



Simul. ->150 cts/s between 0.5 and 25 keV
62 cts/s between 3 and 25 keV



Conclusions

- Simultaneous wide band spectral and temporal coverage
- Detection of QPOs (HF and LF) possible down to a low amplitude even for faint sources.
- LFQPOs: energetic dependences of the QPO parameters possible.
- LFQPOs: additional energy bins (below 3 keV and above 25 keV) compared to PCA
- High spectral resolution can be achieved for bright sources, in short (~10ks) exposure.

SIMBOL-X will bring very important diagnostics on QPOs and thus accretion-ejection flows in X-ray Binaries