Vela X-1
New faces of an old friend

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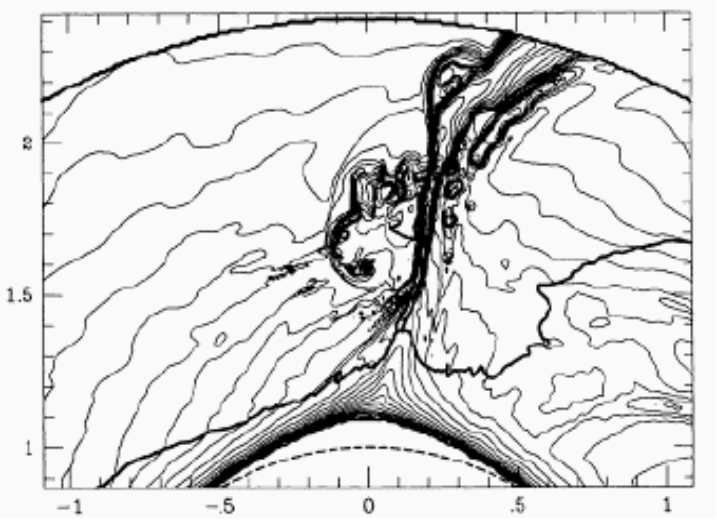
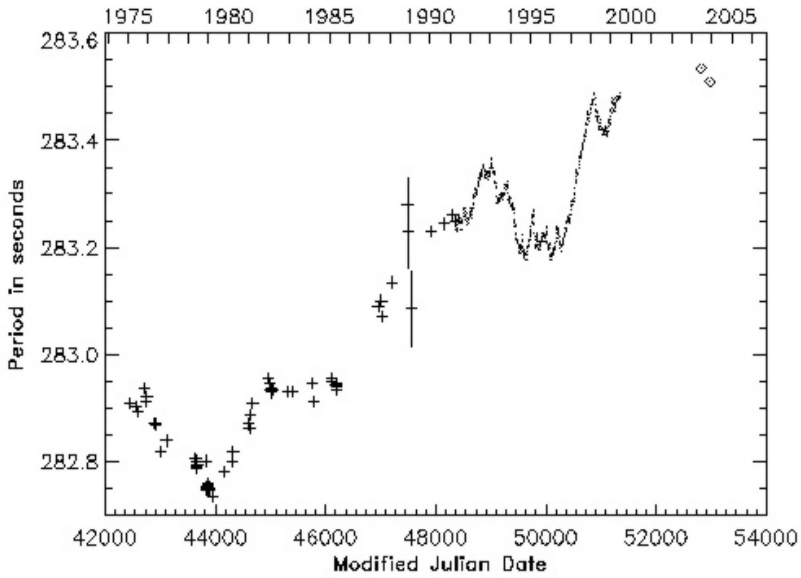
Stephan Schanne (Saclay)

Introducing Vela X-1

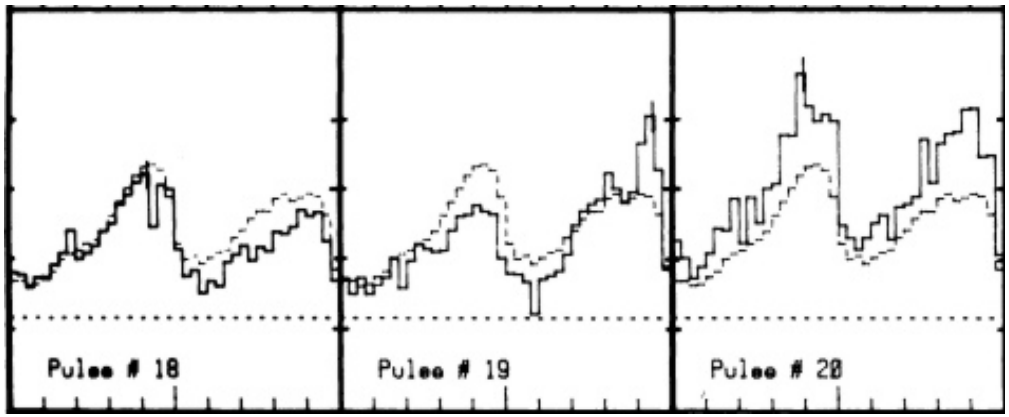
- HMXB with supergiant mass-donor HD 77581 of ~23 $M_{\odot}$, 2.0 kpc from Earth. M_{NS}~1.7 $M_{\odot}$
- Orbital period 8.96d with an eclipse of ~2.2d.
- Embedded in dense, lumpy stellar wind. Most probably with large scale structures, like accretion wake, bow shock ...
- Pulse period ~283s, evolving as random walk over all sorts of timescales from days to years.



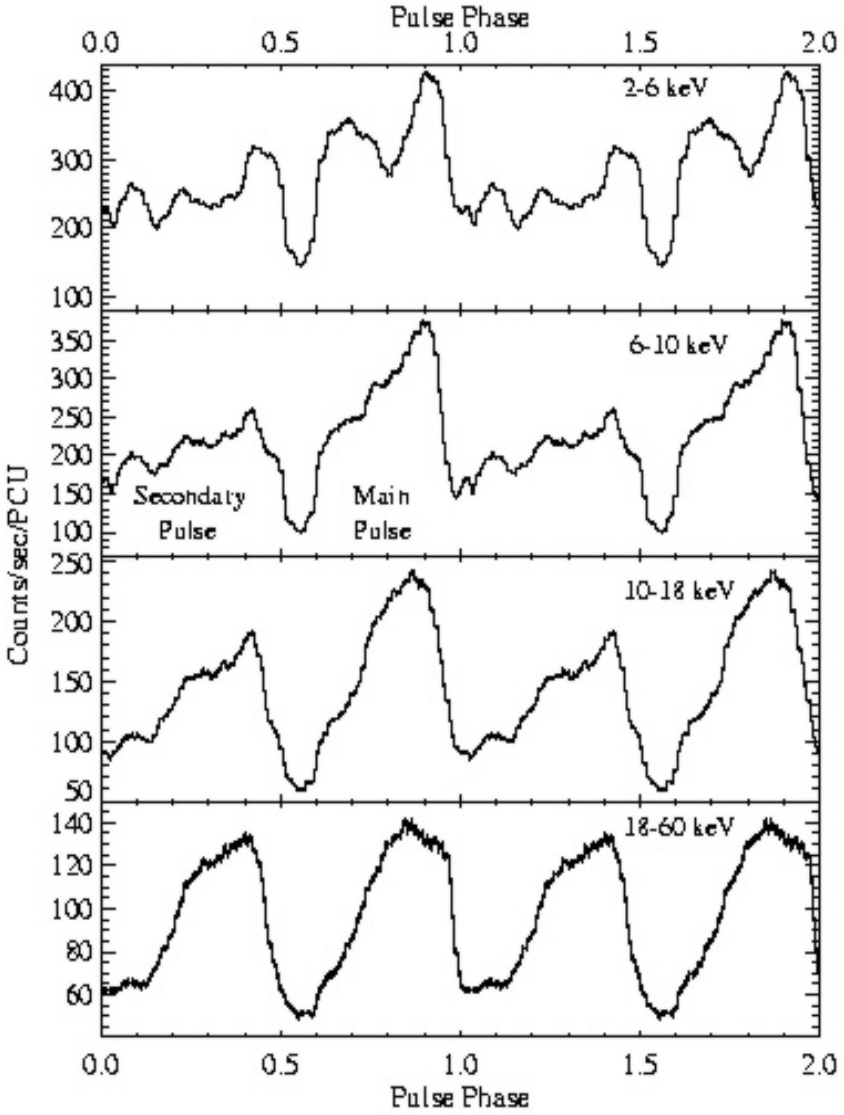


Repetitive, but not boring

- Complex pulse profile at low energies, evolving to double puls above ~10 keV.
- Individual pulses vary strongly (problem for timing analysis) but mean pulse profile stable.

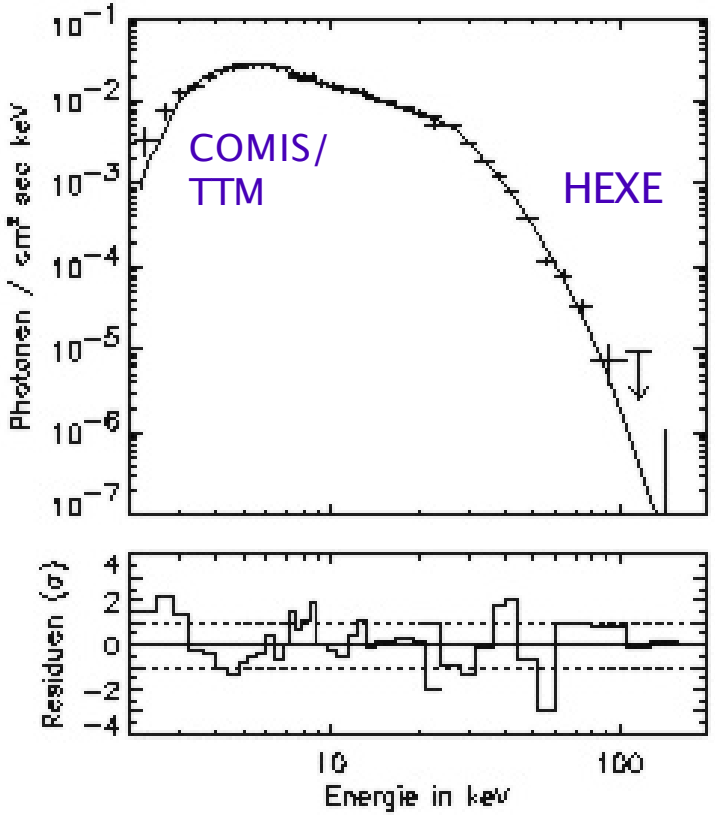


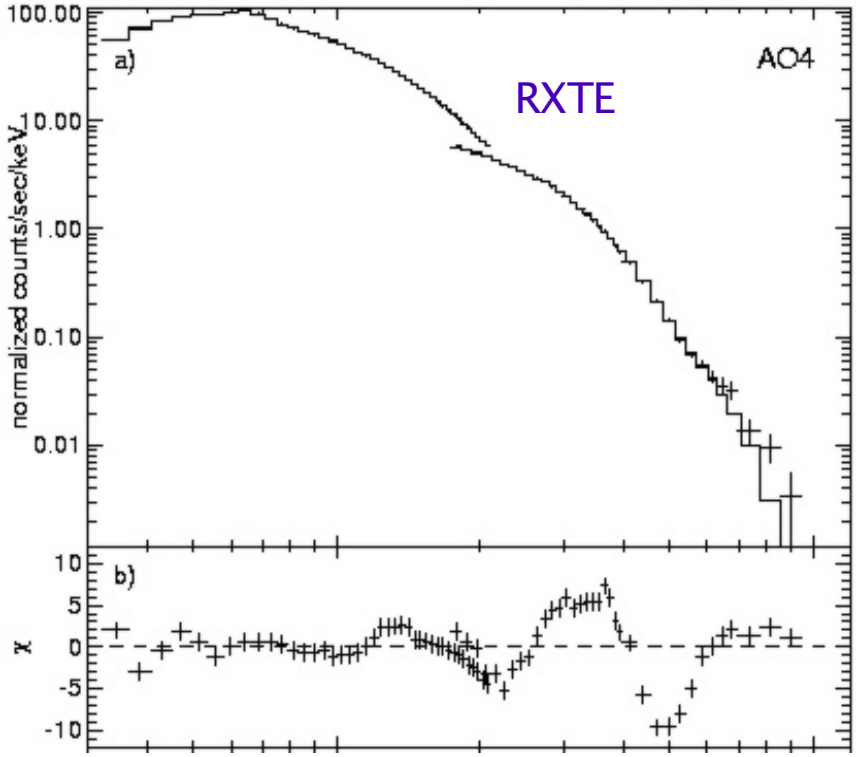
Staubert et al. 1980



A complex character

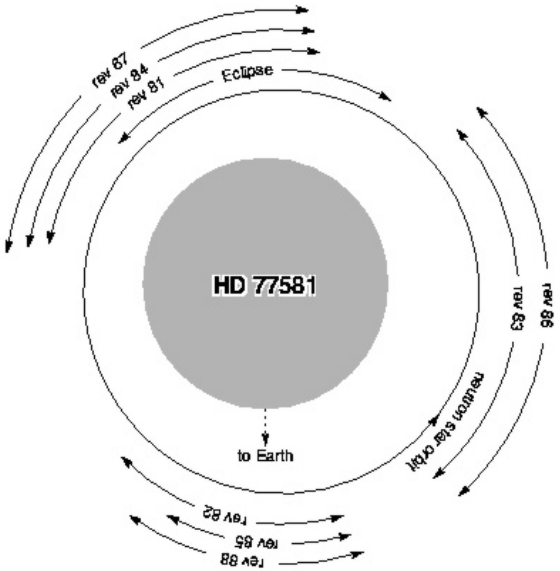
- Normal accreting pulsar spectrum with absorption (very variable), Fe line and cutoff above ~20 keV.
- Phase dependent cyclotron lines at 20–25 and 50–55 keV. First line still somewhat disputed.

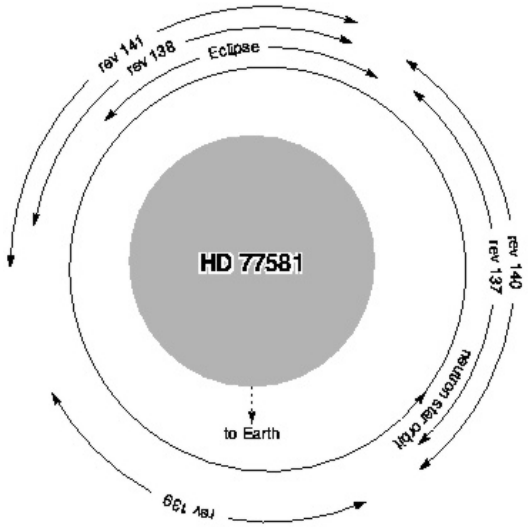


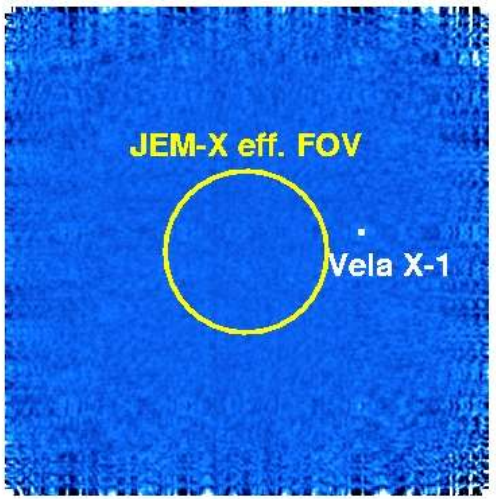


The INTEGRAL viewpoint

- Two major rounds of observations. 8 revolutions in summer, 5 in winter 2003.
- Due to different FOVs exposure times are very different for monitors versus main instruments. Observation strategy defined for whole region and ***not*** optimized for Vela X-1!



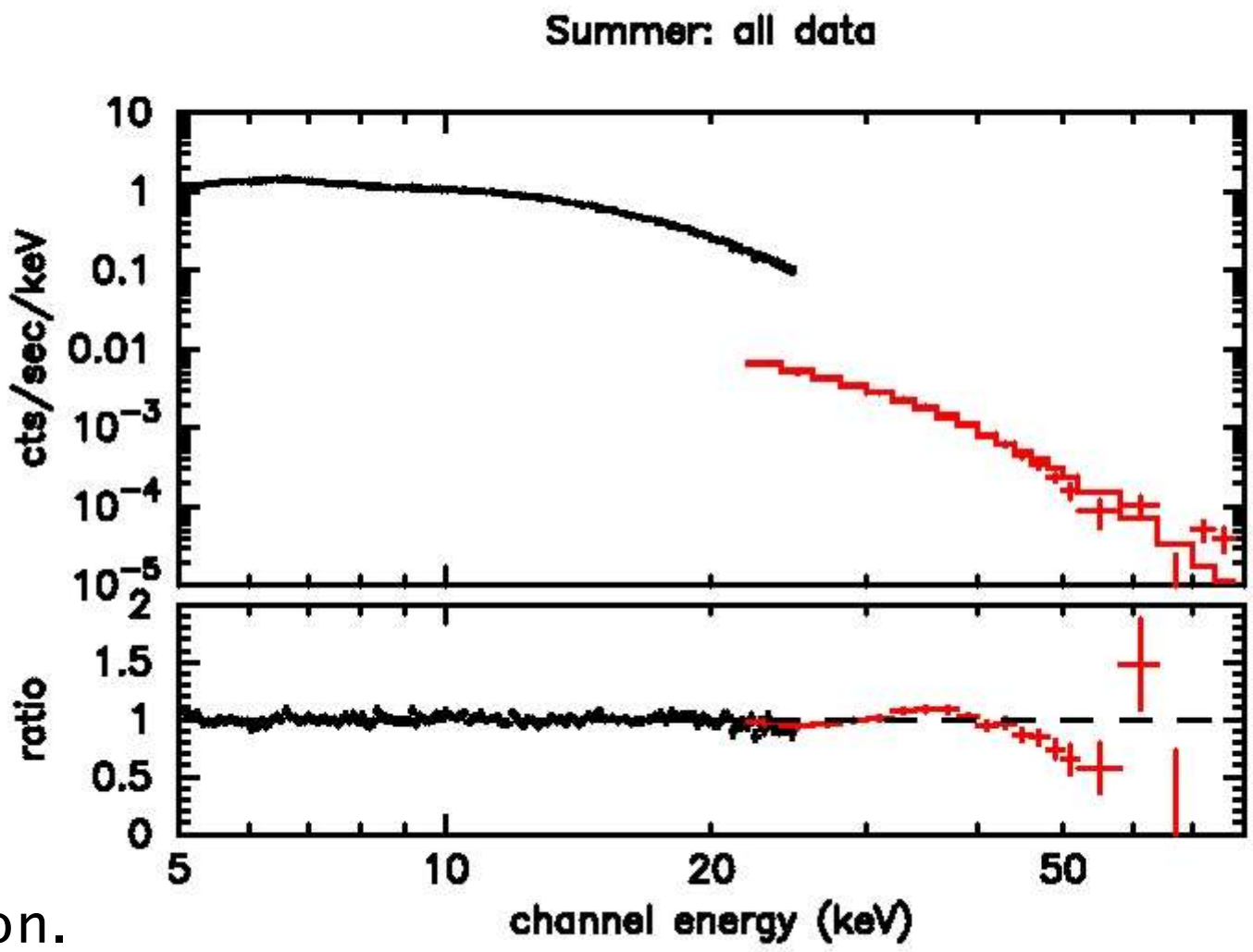




Probing the wrinkles

Combined long-term spectra of ***JEM-X*** & ***SPI*** show missing flux at ~50 keV.

Cross-calibration not mature enough to allow ~25 keV line determination.



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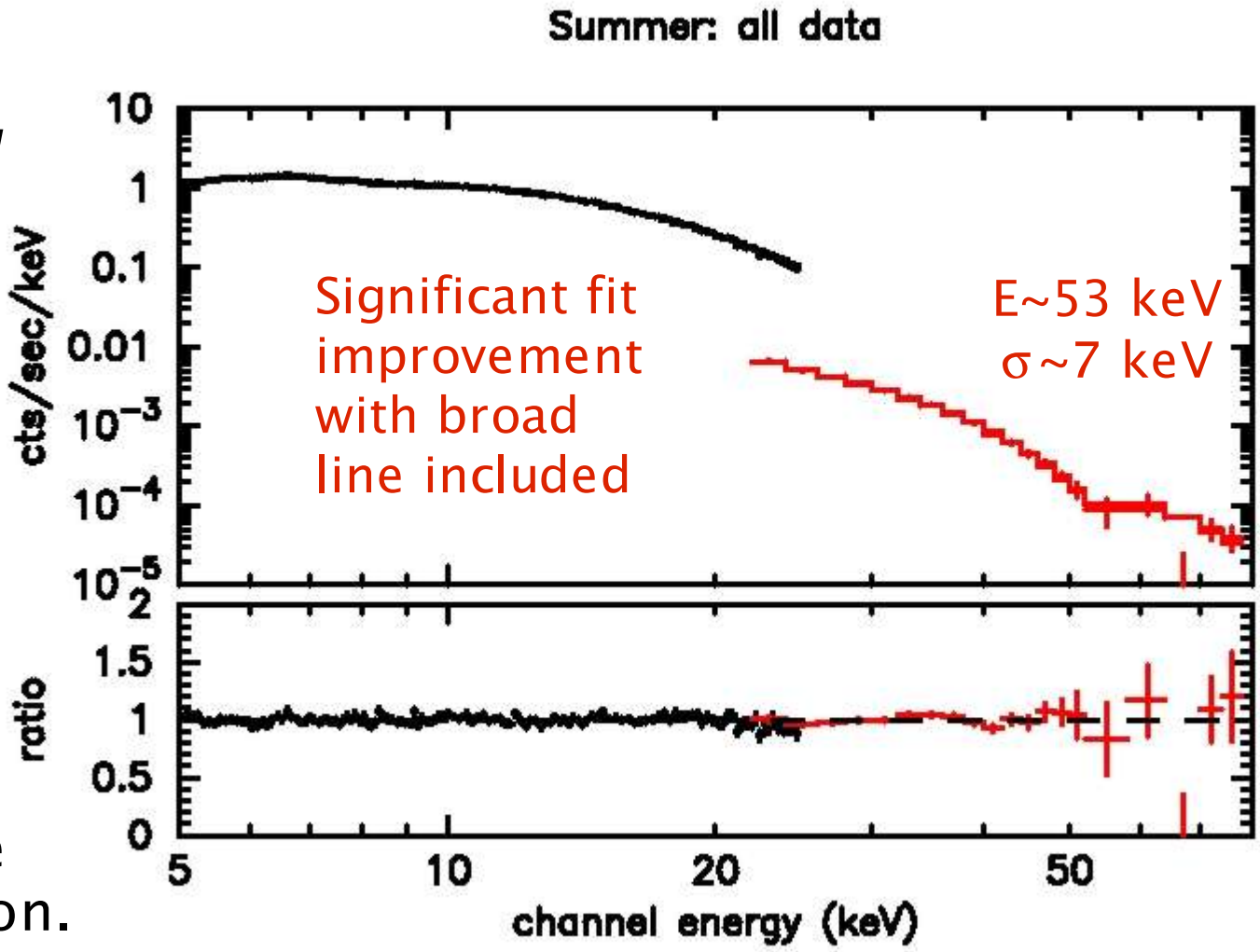
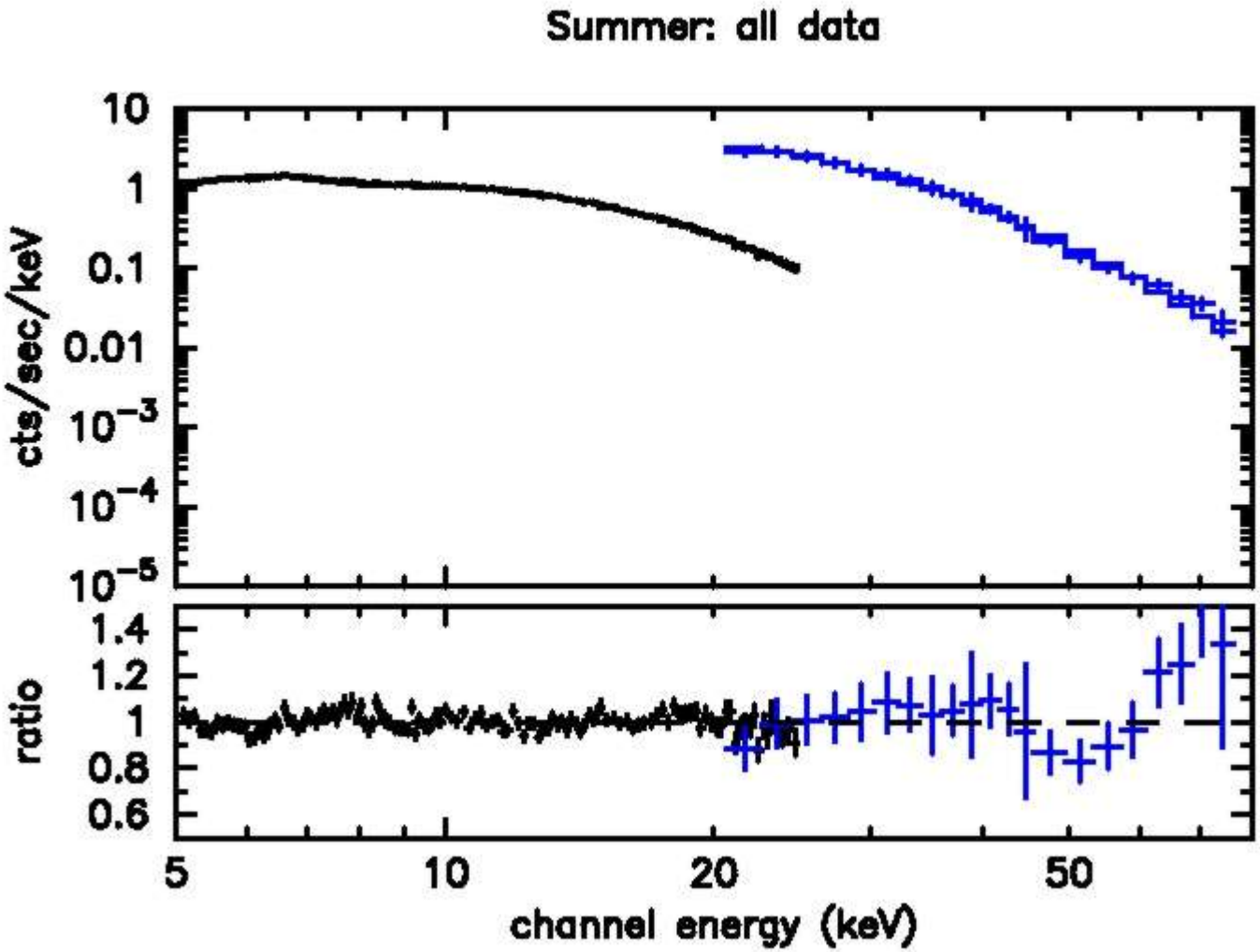


Probing the wrinkles further

Combined long-term average spectra of ***JEM-X*** and ***ISGRI*** ***also*** show missing flux at ~50 keV.



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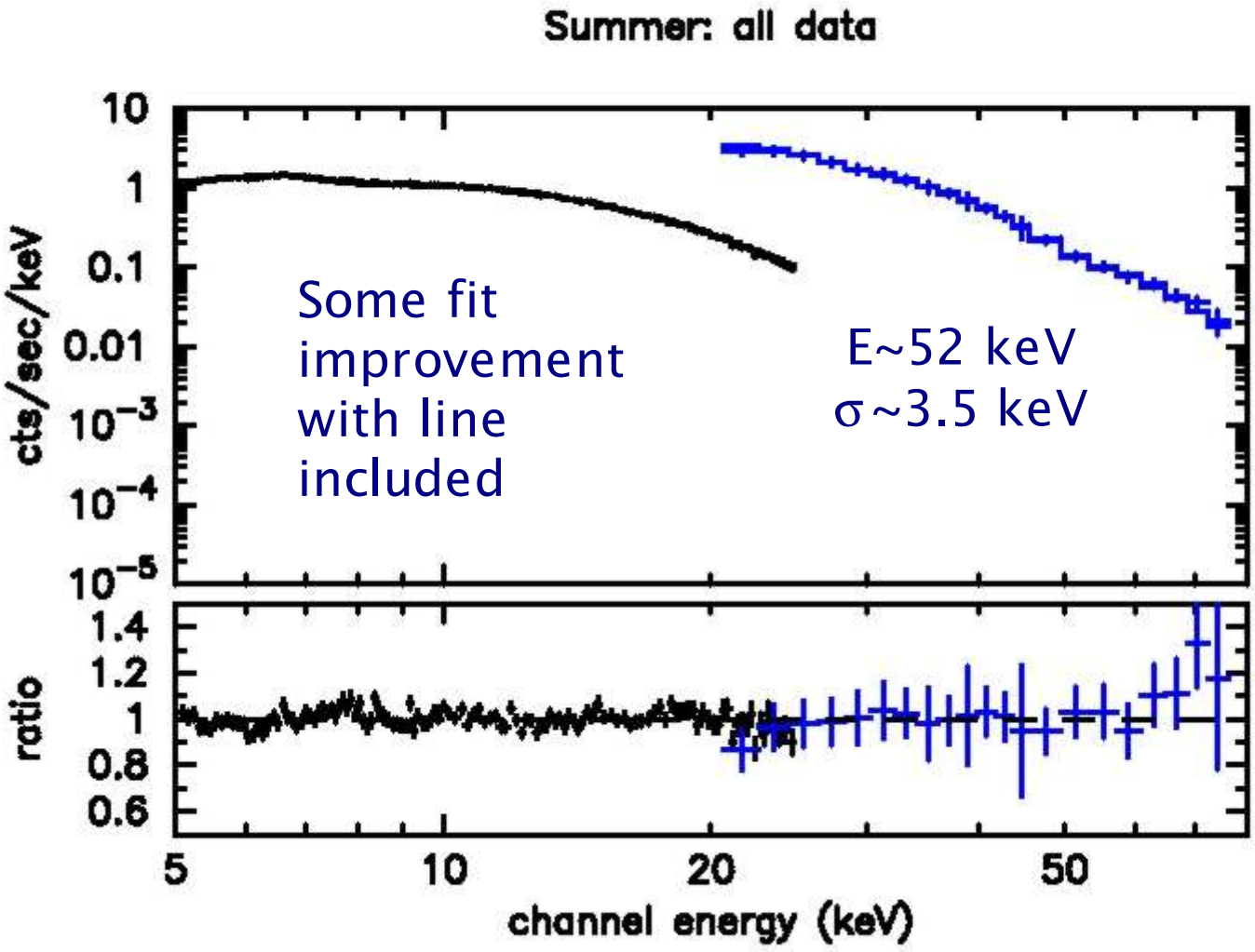
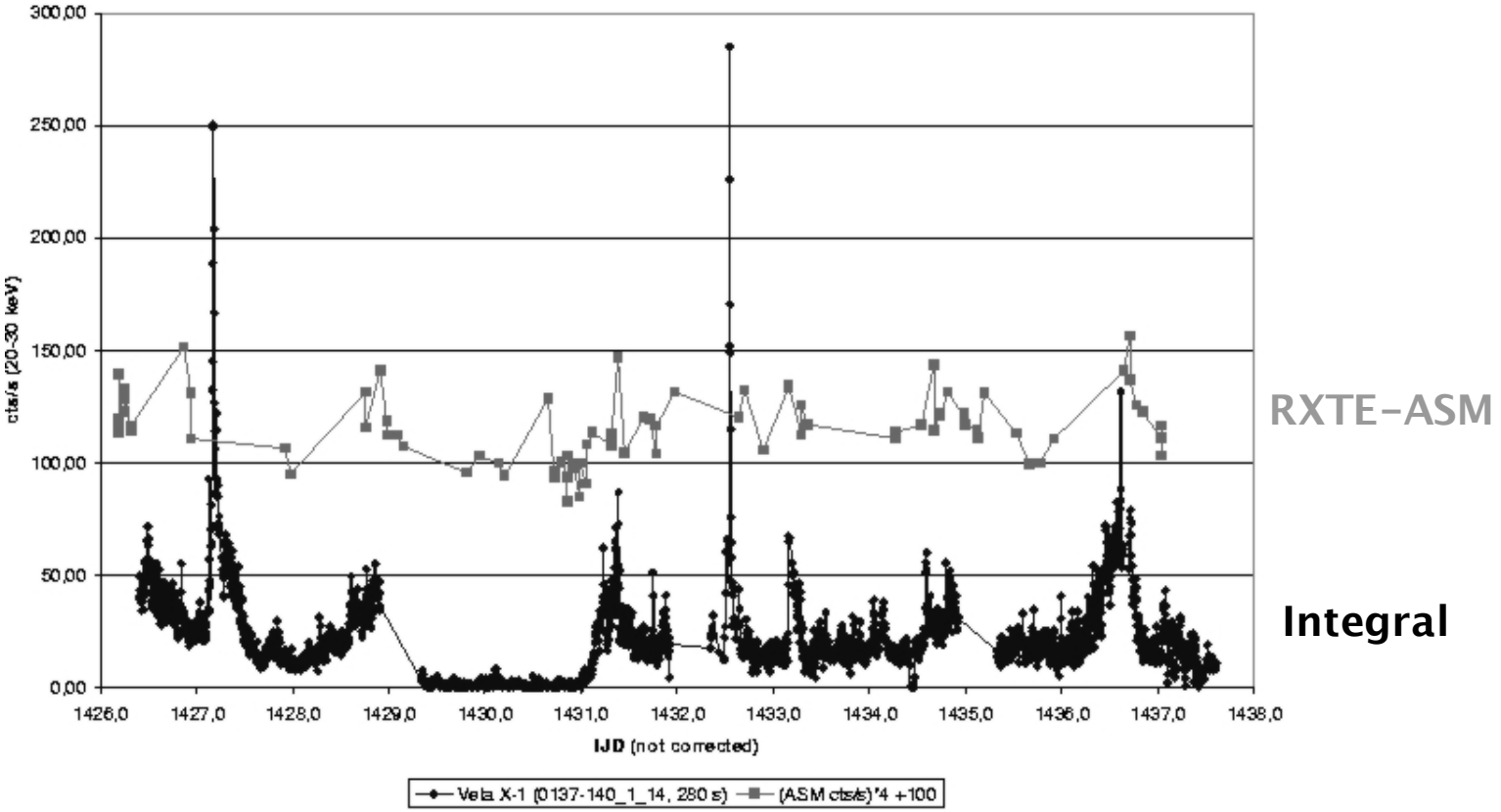


An unexpected temperament

- (Mostly) calm during summer observations.
- Winter different: big flare on Nov 28, followed by at least two more massive flares. Not seen in RXTE/ASM and outside FOV for INTEGRAL monitors!

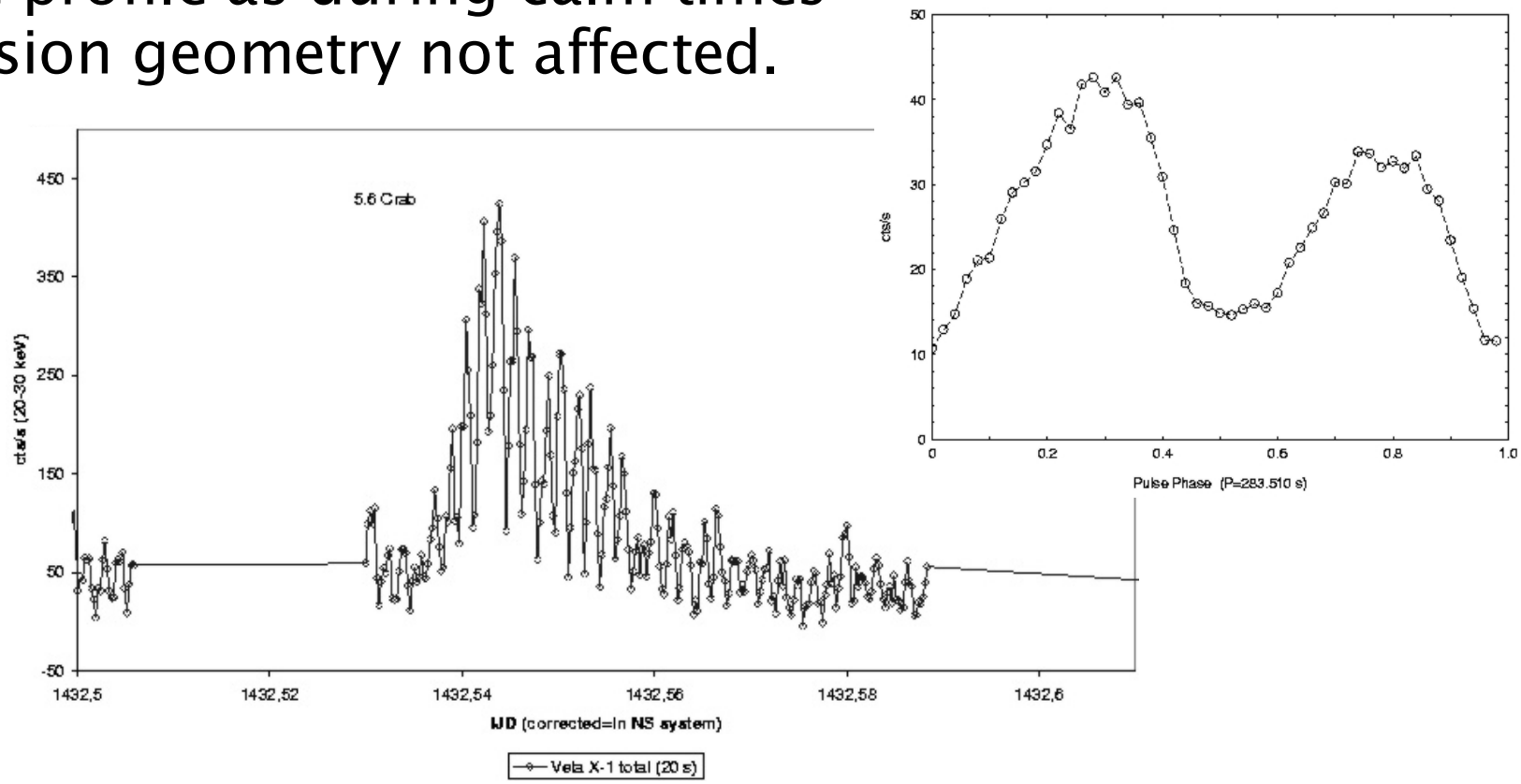


RXTE-ASM

Integral

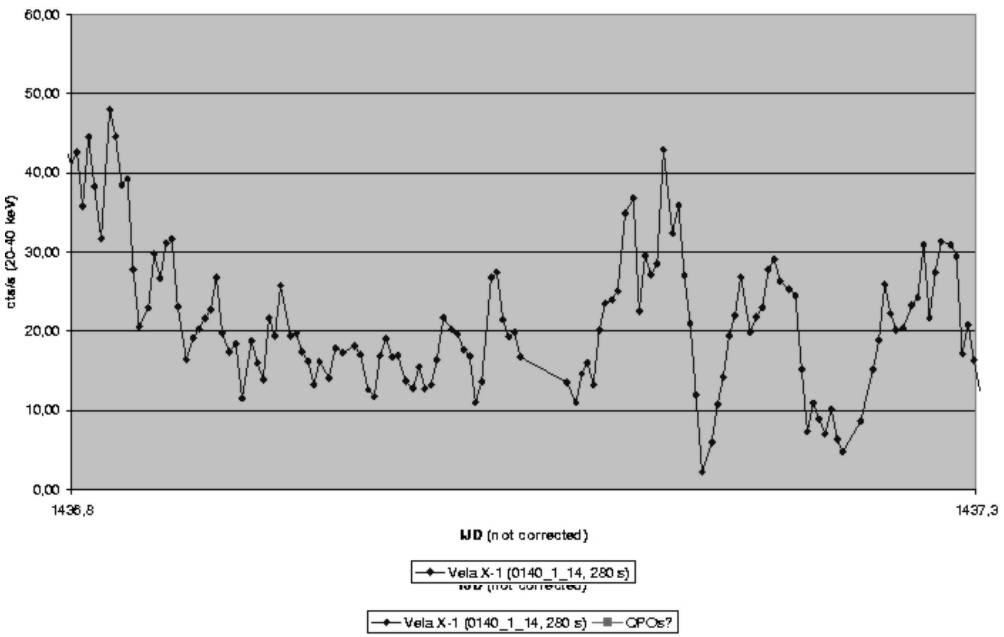
More of the same

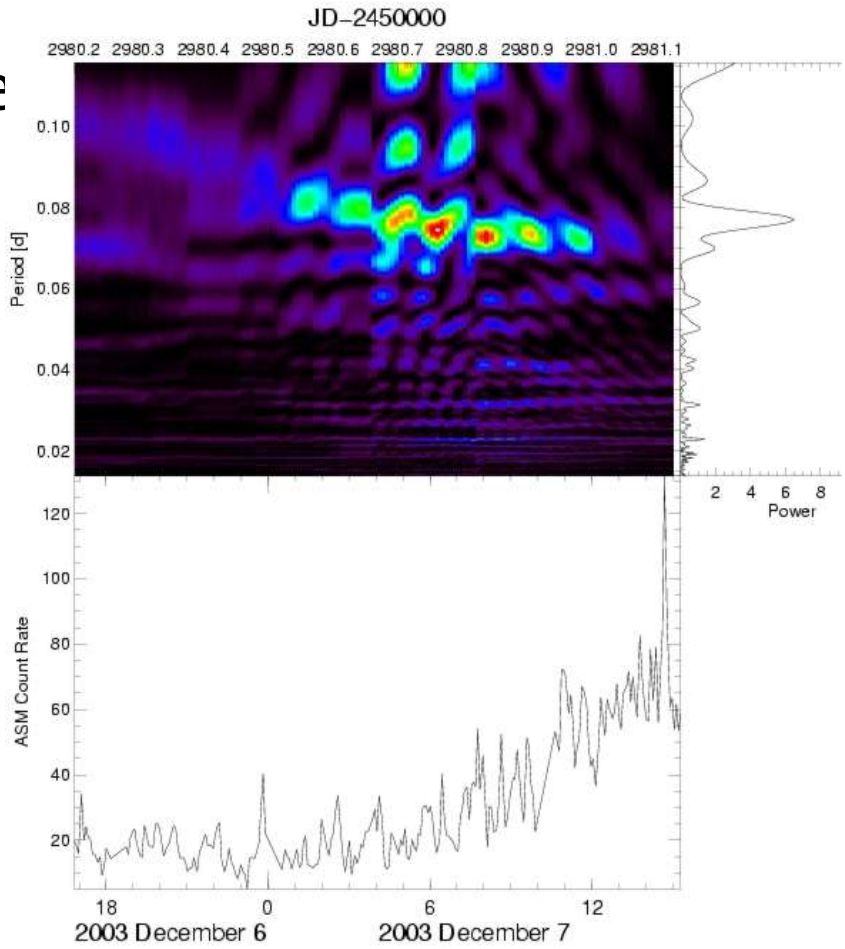
- Flux rises by factor of ~10 in flare
- Maximum flux in pulse peak: ~7 Crab in 20–40 keV band.
- But pulse pattern essentially unchanged
  – same profile as during calm times
  ⇒emission geometry not affected.



Not just pulsating

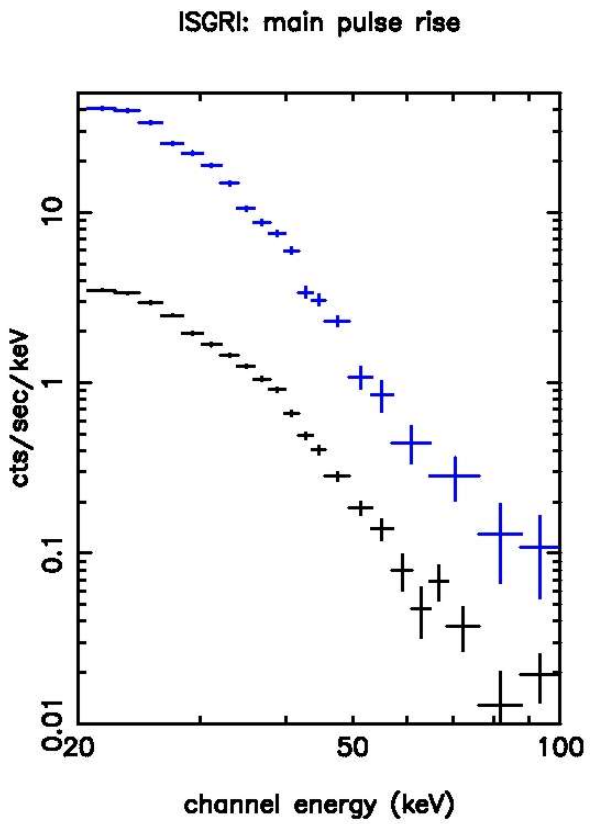
- Visual impression shows stretches of data with (quasi-) periodic behaviour of several 1000 seconds on top of normal pulsations.
- Dynamic PSD plot supports these periodicities – to be studied further.

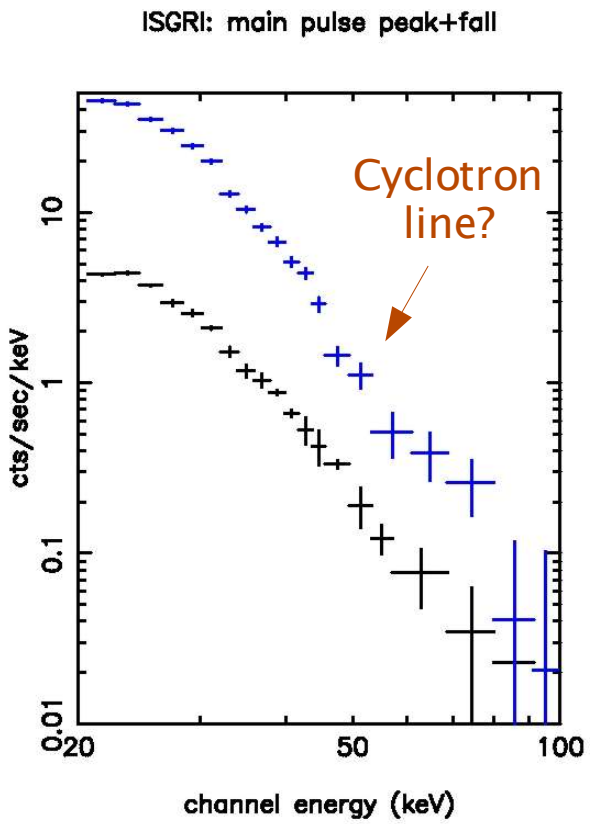


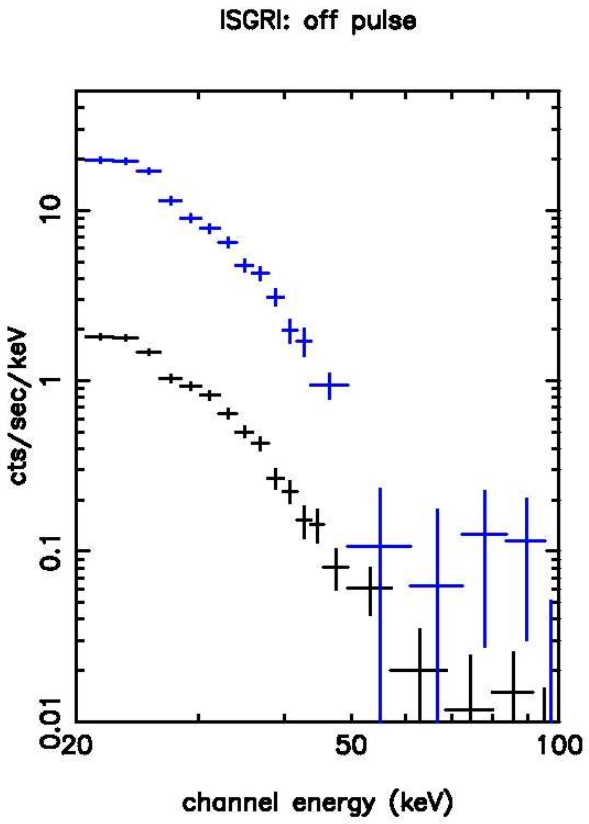


Staying in character

Comparing pre-flare with first flare in revolution 137:
Factor ~10 flux increase & phase dep. spectral softening ~1-1.5 keV in E_{fold} seen in both gamma-ray instruments but no dramatic changes. Line studies ongoing.







Staying in character (2)

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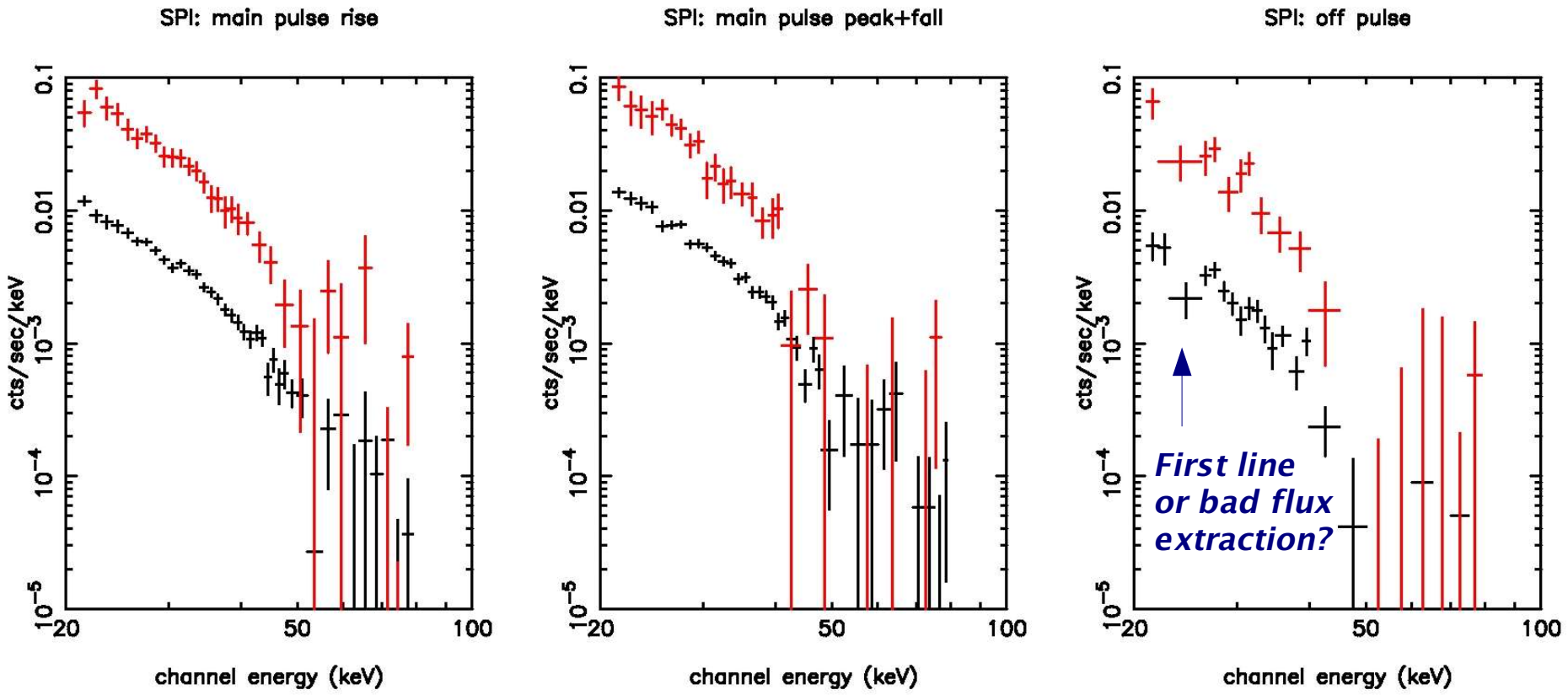

Summary

- Long observations in hard X-ray / soft gamma-ray band reveal new properties of system about which "we knew everything".
- Massive flare, but temporal & spectral properties surprisingly similar to low state – is Vela X-1 normally just on diet?
- Cycloytron line at ~50 keV clearly observed. ***Probably first real measurement of resolved line width thanks to SPI!***
  Line at ~25 keV yet to be disentangled from (cross-)calibration issues.