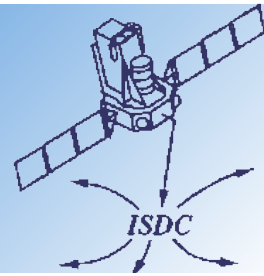
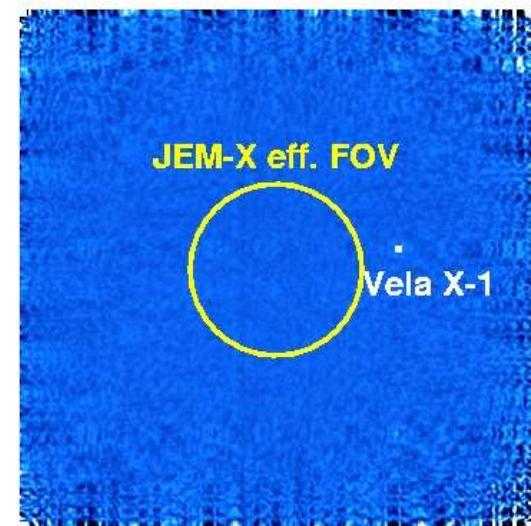
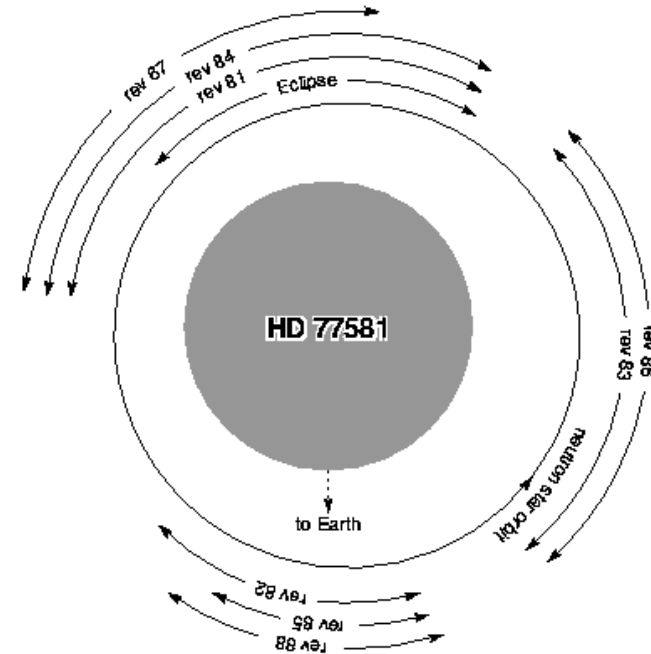


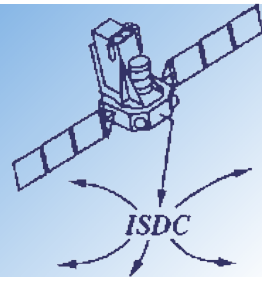
# Vela X-1



- ◆ Classical wind-accreting pulsar.  
 $P_{\text{orb}} = 8.96\text{d}$ ,  $P_{\text{puls}} \sim 283\text{s}$ .
- ◆ Not very luminous ( $\approx 4 \times 10^{36}$  ergs/s) but close ( $\sim 2$  kpc)  
 $\Rightarrow$  bright source in 5–100 keV.
- ◆ Observed as part of Vela region observations in Core Program; not optimized for Vela X-1.
- ◆ Source frequently outside FOV of monitors.

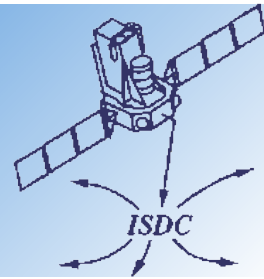


# Selecting data sets



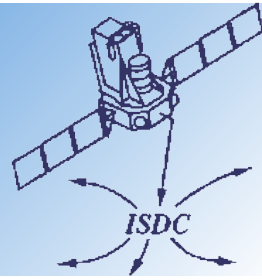
- ◆ Two main obs. periods: June/July and Nov/Dec 2003. Summer observations mostly calm. Very strong flares in winter data but flares missed by monitors! Concentrating on summer data.
- ◆ Selected pointings within 4.2 deg around source position (e.g. with **Browse**), to avoid strong off-axis effects.
- ◆ Built Obs. Groups per revolution, to have manageable size.

# Data reduction



- ◆ Run standard OSA script **jemx\_science\_analysis** `startLevel=COR endLevel=LCR LCR_timeStep=28` or (e.g. on cluster with grid engine) for each ScW **jemx\_scw\_analysis**.
- ◆ **src\_collect** to get overview table of results.
- ◆ **spe\_pick** to obtain averaged spectrum.
- ◆ **lc\_pick** to get merged lightcurve.
- ◆ **txt2idx** can be used to combine data across multiple original observation groups.

# Combining ScW results across OGs



- ◆ Get ASCII list of selected Science Windows in obs branch:

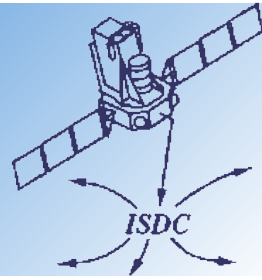
```
> ls -l \  
  $REP_BASE_PROD/obs/Vela*/scw/*/swg_jmx2.fits\  
>! LIST_OF_SWG  
> vi LIST_OF_SWG (add '[1]' to filenames)
```

- ◆ Use txt2idx to create personal ScW-Index:

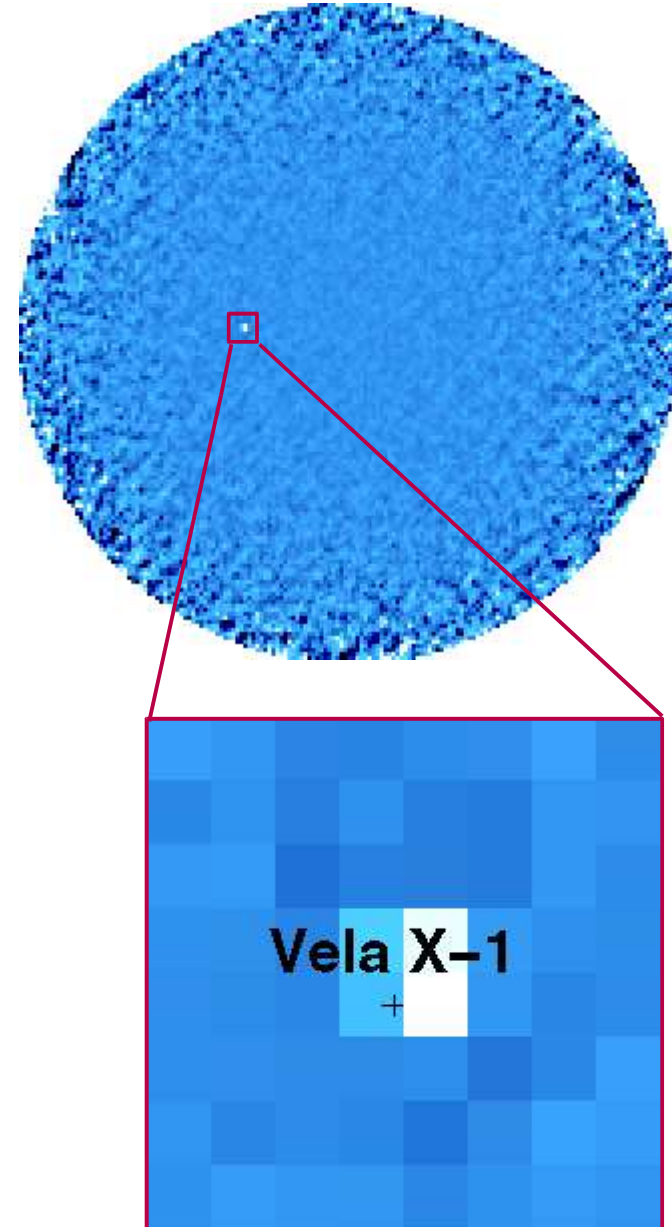
```
> txt2idx index=MultiScws.fits \  
  template=GNRL-SCWG-GRP-IDX.tpl \  
  element=LIST_OF_SWG  
> fparkey JMX2 MultiScws.fits+1 INSTRUME
```

- ◆ Now generic tools (**spe\_pick**, **lc\_pick**) work on all SGWs in input list.

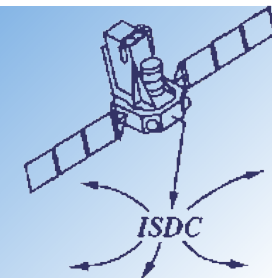
# Imaging results



- ◆ Source easily found in individual pointings. Position well determined, but sky image slightly offset to WCS.
- ◆ Significance of detection strong function of angle as expected.
- ◆ Strong variation of imaging fluxes, some intrinsic to source, some due to known problems in flux reconstruction.



# Imaging results



- ◆ Summary of imaging results with **src\_collect**:  
`src_collect group=MultiScws.fits+1\  
instrument=JMX2 results=summary.fits`
- ◆ Or run analysis to IMA2 level to get mosaics and imaging summary (time consuming!)

fv: Binary Table of summer\_vela.fits[1] in /isdc/scratch3/pkretsch/luxor20/Cons/obs/VelaX

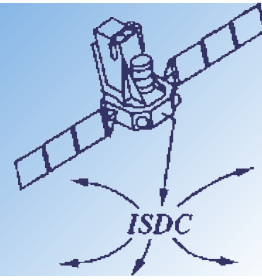
File Edit Tools Help

SWID     SOURCE\_ID     NAME     DETSIG     OFFANGLE  
12A            16A            20A            1E            1E  
deg

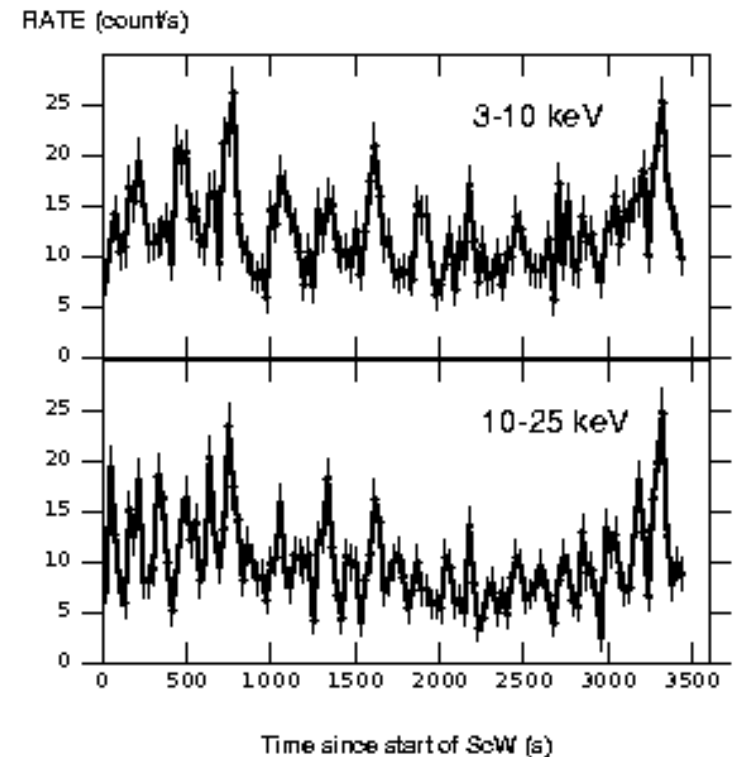
3	008200410010	J090206.9-403317	Vela X-1	3.368861E+01	4.468658E+00
4	008200450010	J090206.9-403317	Vela X-1	2.815907E+01	4.287519E+00
5	008200460010	J090206.9-403317	Vela X-1	3.760082E+01	2.736953E+00
6	008200460020	J090206.9-403317	Vela X-1	4.906850E+01	2.732658E+00
7	008200470010	J090206.9-403317	Vela X-1	3.844623E+01	2.150222E+00
8	008200510010	J090206.9-403317	Vela X-1	5.380784E+01	1.717258E+00

Go to:  Edit cell:

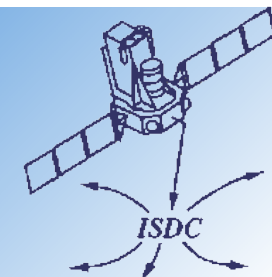
# Timing



- ◆ Lightcurves show individual pulses of source.
- ◆ **But** pulse period determination not trivial:
  - ◆ Gaps between pointings with source in FOV.
  - ◆ Intrinsic, strong pulse to pulse variations.
  - ◆ Pulse shape different and more complex below  $\sim 10$  keV.
- ◆ Pulse period determined from ISGRI data using phase alignment over long time span.



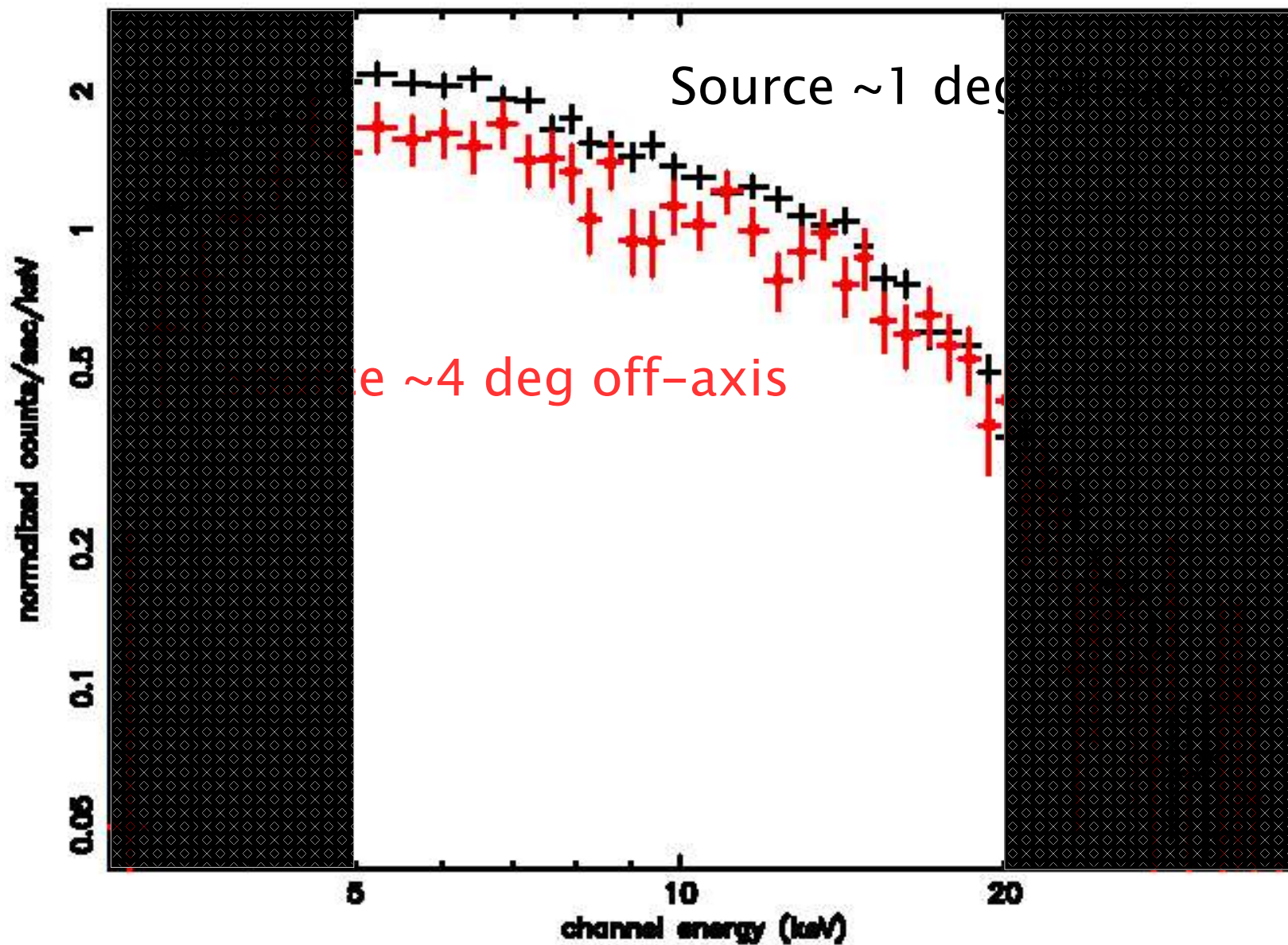
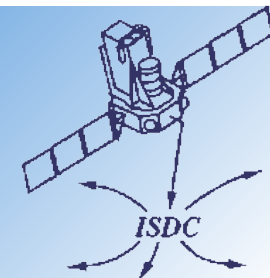
# Spectroscopy per ScW



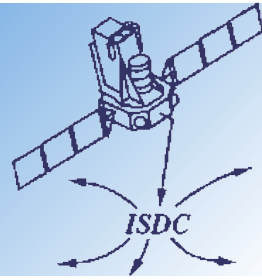
- ◆ Scripts produce tables in each ScW with one spectrum per source in 'FAC II' format (`jmx2_src1_spe.fits`) plus matching ARFs (`jmx2_src1_arf.fits`).
- ◆ These can be directly used in XSPEC, **but**:
  - ◆ Validated range of response is 5–20 keV. Actual valid range still debated.
  - ◆ Spectra by default in 256 channels — should probably be rebinned to  $\sim 1/3$  energy resolution.
  - ◆ 2% systematics on spectral shape.
  - ◆ Current response leads to underestimated fluxes.



# Spectroscopy per ScW



# Spectroscopy of many ScWs



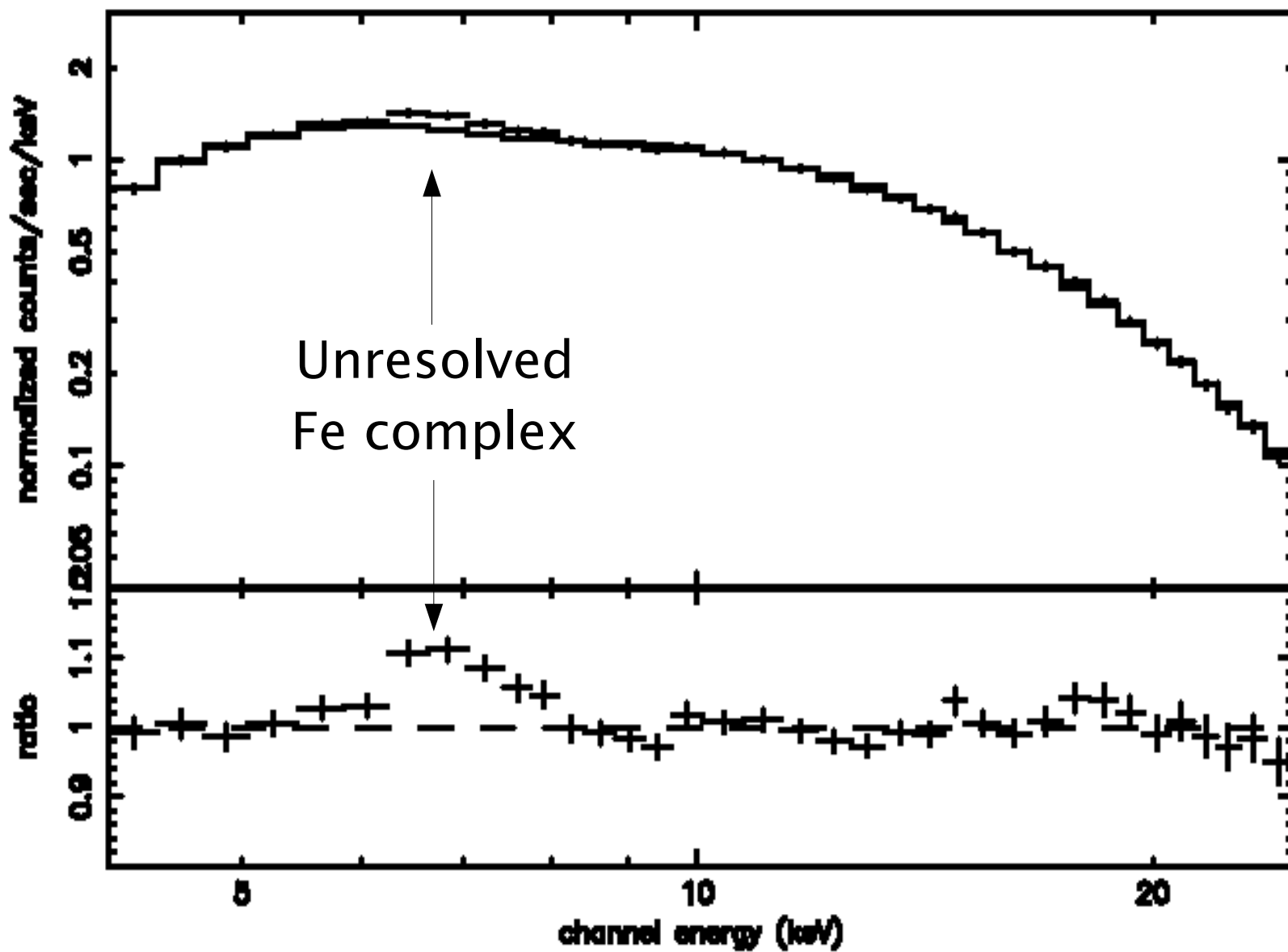
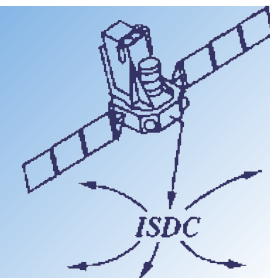
- ◆ **spe\_pick** correctly sums spectra across many ScWs and builds corresponding ARF, e.g.:

```
> spe_pick og_jmx2.fits+1 \  
instrument=JMX2 sum=y  
source='J090206.9-403317'  
rootname=velax1
```

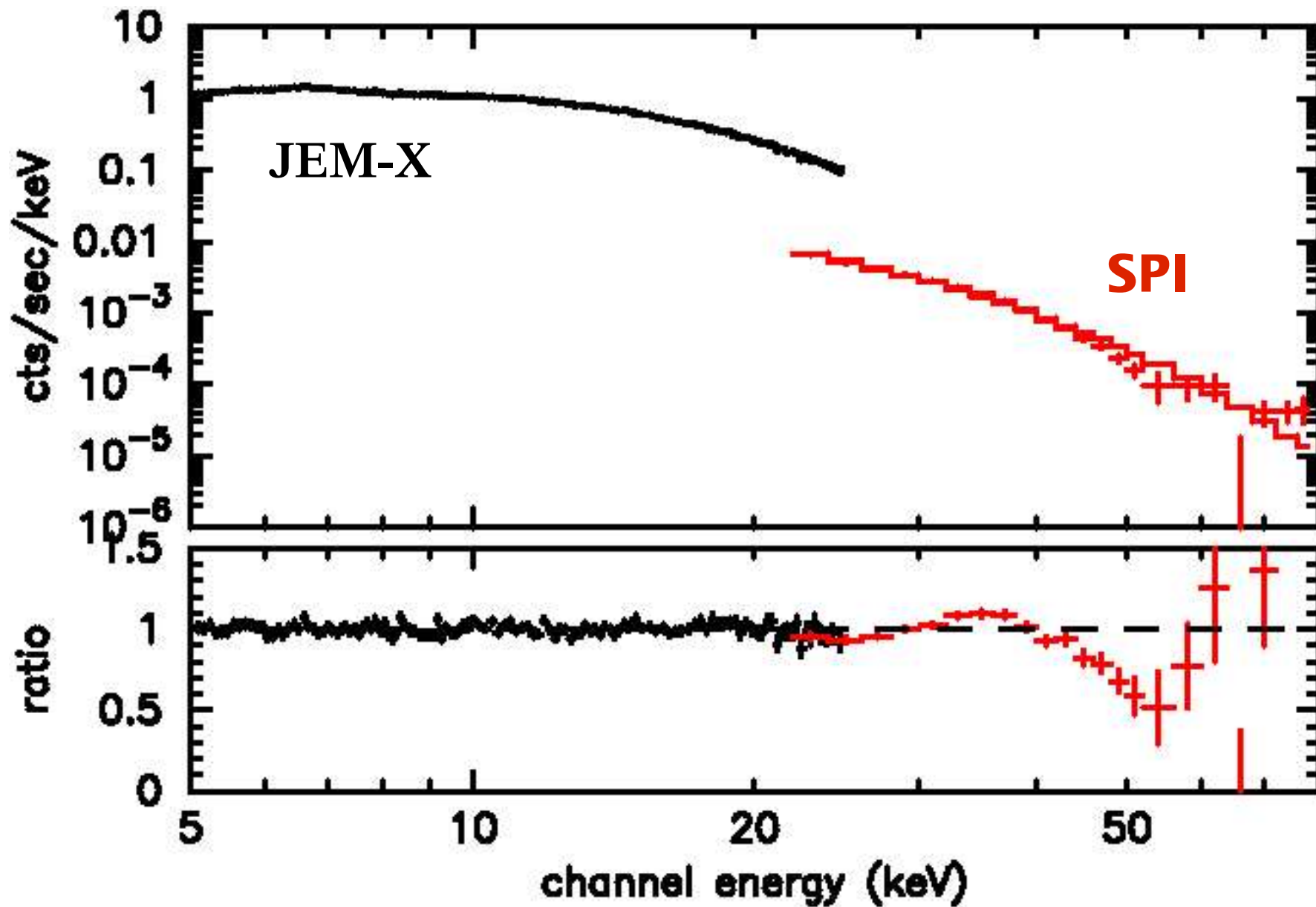
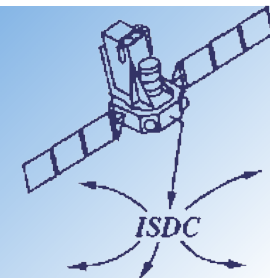
- ◆ Summed spectrum is in PHA1 format:

```
velax1_jmx2_sum_pha1.fits  
velax1_jmx2_sum_arf.fits
```

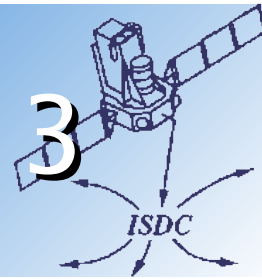
# Spectroscopy of many ScWs



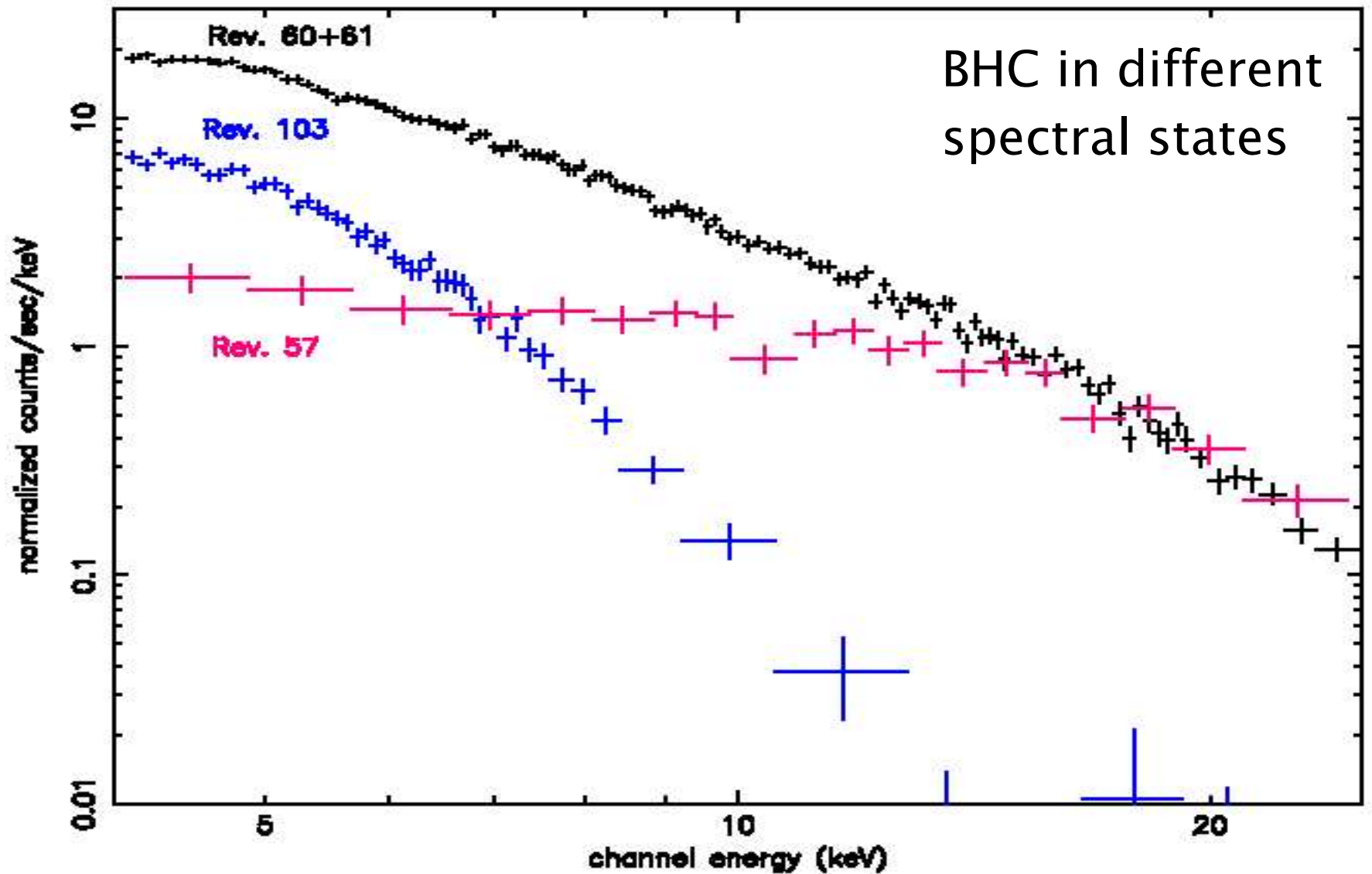
# Combining instruments



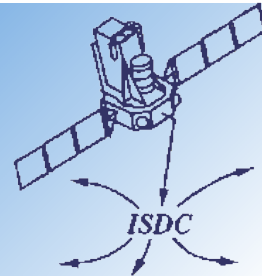
# Other example: IGR J17464-3213



IGR J17464-3213



# Other example: 4U 0115+63



- ◆ Be transient pulsar.
- ◆ TOO observ. of outburst.
- ◆ Preliminary analysis shows lines at  $\sim 13$ ,  $\sim 22$ ,  $\sim 33$  keV.
- ◆ Also seen by RXTE.

