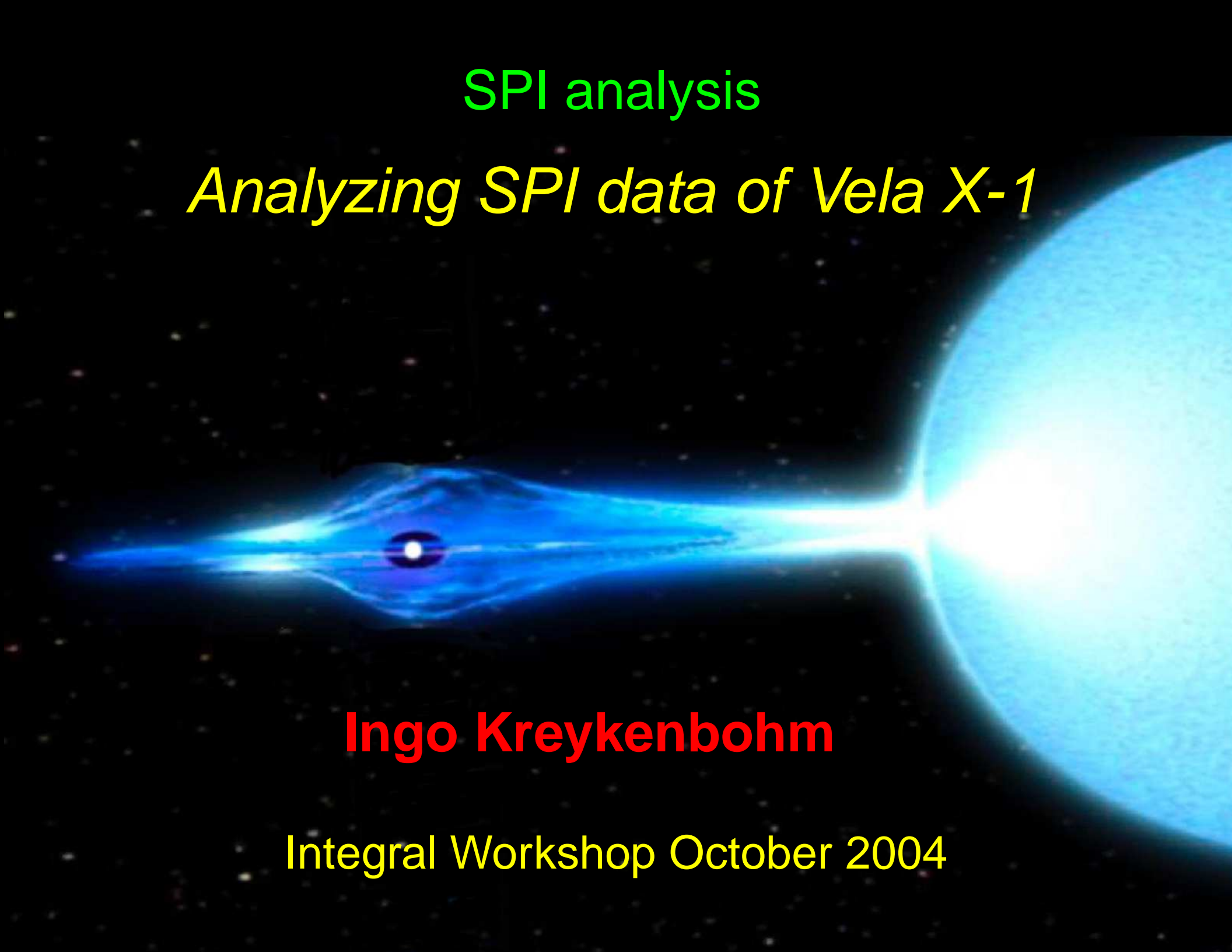


SPI analysis

Analyzing SPI data of Vela X-1

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Integral Workshop October 2004



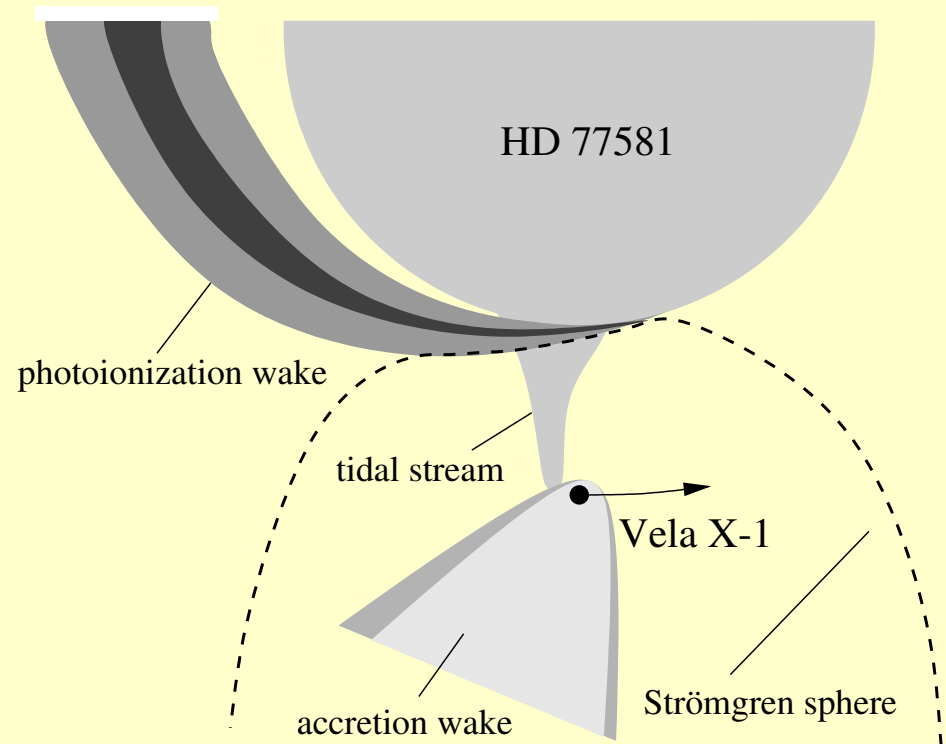
Overview

- The object: Vela X-1
- setting up the data
- pipeline run #1: catalog extraction only
- check & modify catalog
- pipeline run #2: Imaging
- pipeline run #3: spectrum
- pipeline run #4: lightcurve

Vela X-1

Vela X-1: neutron star plus massive optical companion

P_{spin}	283 sec
P_{orb}	8.9 d
L_X	~ 0.1 Crab
Type	B0.5Ib
M_*	$23 M_{\odot}$
R_*	$30 R_{\odot}$
T_{eff}	25.000 K
L_*	$\approx 3 \times 10^5 L_{\odot}$
\dot{M}	$4 \times 10^{-6} M_{\odot}$



⇒ NS is deeply embedded in the dense wind of the optical companion.

⇒ Typical **wind accreting** system.

Data, I

When selecting science windows for SPI analysis, remember:

- SPI has a very large FOV
- SPI has small effective area and a small number of detectors \implies many scws required:
start with 10 even for simple analysis, for complex analyses: several hundred
- observations in staring mode are difficult

Data, II

When selecting science windows for SPI analysis, remember:

- SPI has a very large FOV
- SPI has small effective area and a small number of detectors \implies many scws required:
start with 10 even for simple analysis, for complex analyses: several hundred
- observations in staring mode are **difficult**

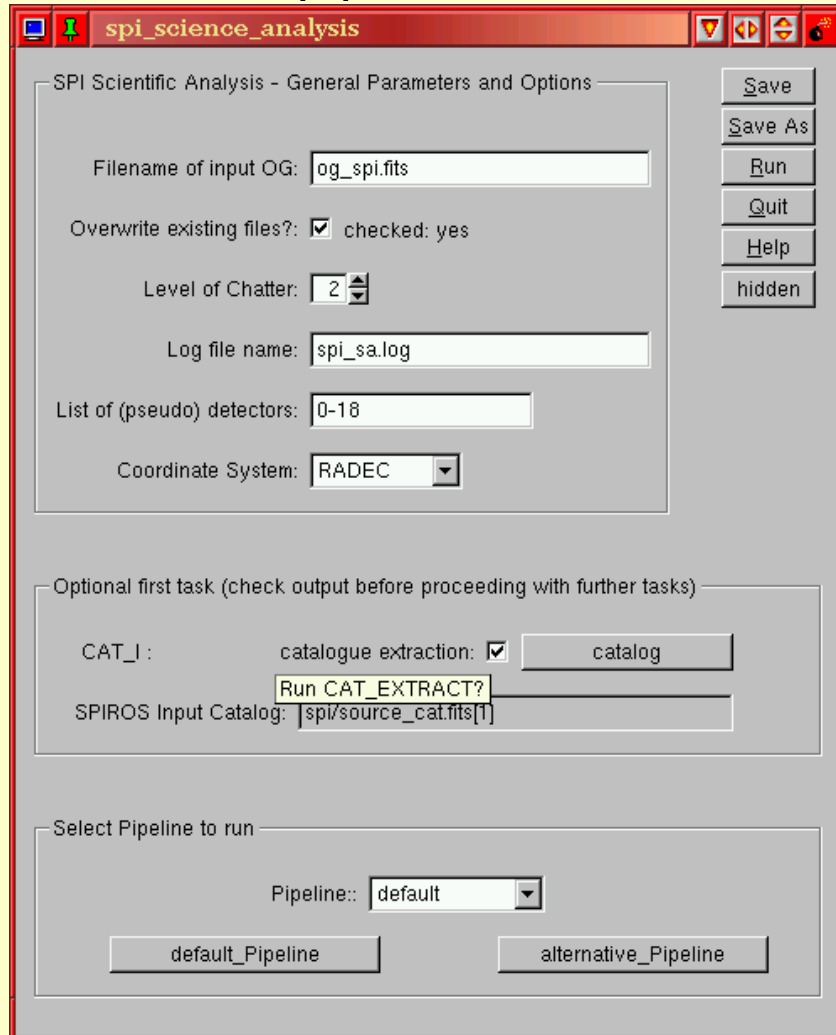
Practical:

- create a list of scws (DOLs), e.g., using W3Browse
- setup your environment (set links, paths, ...)
- create the OG:

```
og_create idxSwg=Vela.lst ogid=vela instrument=SPI baseDir=.
```

Catalog, I

Launch the pipeline GUI:



Catalog, II

Launch the pipeline GUI:

The screenshot shows the 'spi_science_analysis' GUI window. The title bar reads 'spi_science_analysis'. The main content area is titled 'SPI Scientific Analysis - General Parameters and Options'. It contains several input fields and controls:

- Filename of input OG:
- Overwrite existing files?: checked: yes
- Level of Chatter:
- Log file name:
- List of (pseudo) detectors:
- Coordinate System:

On the right side of the window, there are buttons for 'Save', 'Save As', 'Run', 'Quit', 'Help', and 'hidden'. Below the main parameters, there is a section titled 'Optional first task (check output before proceeding with further tasks)'. It contains:

- CAT_I : catalogue extraction:
- Run CAT_EXTRACT?
- SPIROS Input Catalog:

At the bottom, there is a section titled 'Select Pipeline to run'. It contains a dropdown menu for 'Pipeline:' with 'default' selected, and two buttons: 'default_Pipeline' and 'alternative_Pipeline'.

We always use the **default** pipeline:

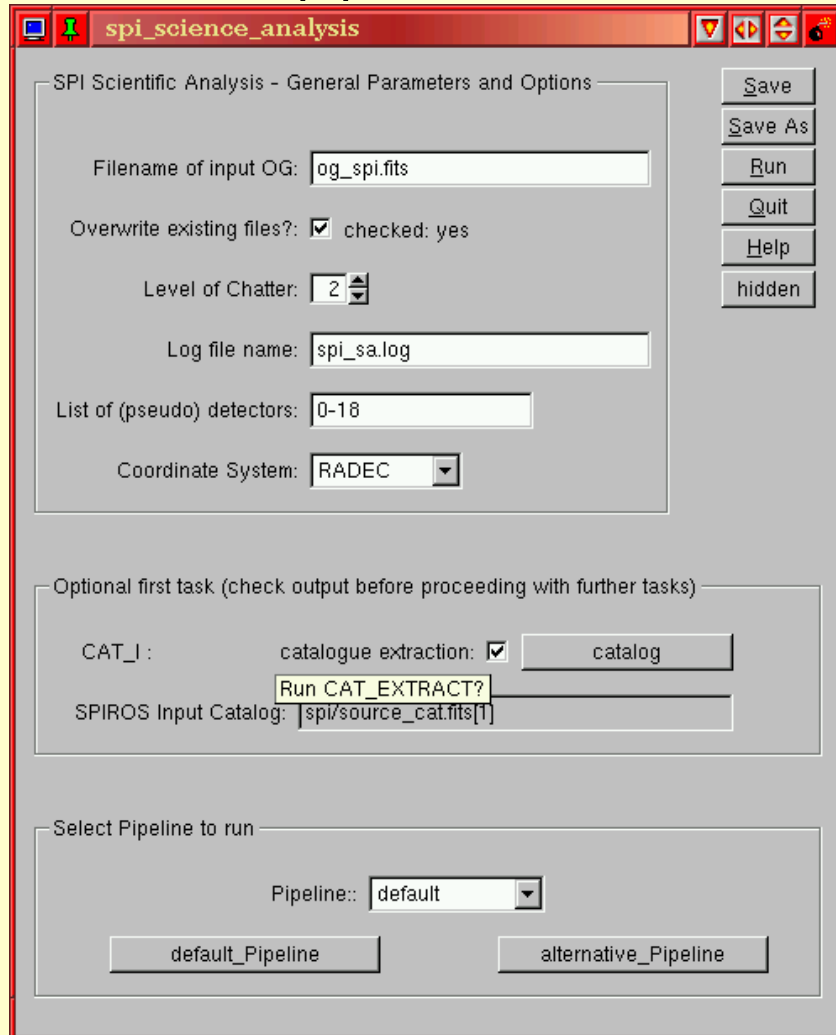
The screenshot shows the 'default_Pipeline' GUI window. The title bar reads 'default_Pipeline'. The main content area is titled 'mark Tasks to run & Options for default Pipeline'. It contains several task selection options:

- COR : save corrected data (optional):
- POIN+GTI : pointing definition:
- BIN_I : event binning:
-
- add simulated source (optional):
- BKG_I : background modeling:
- IMA : image analysis:

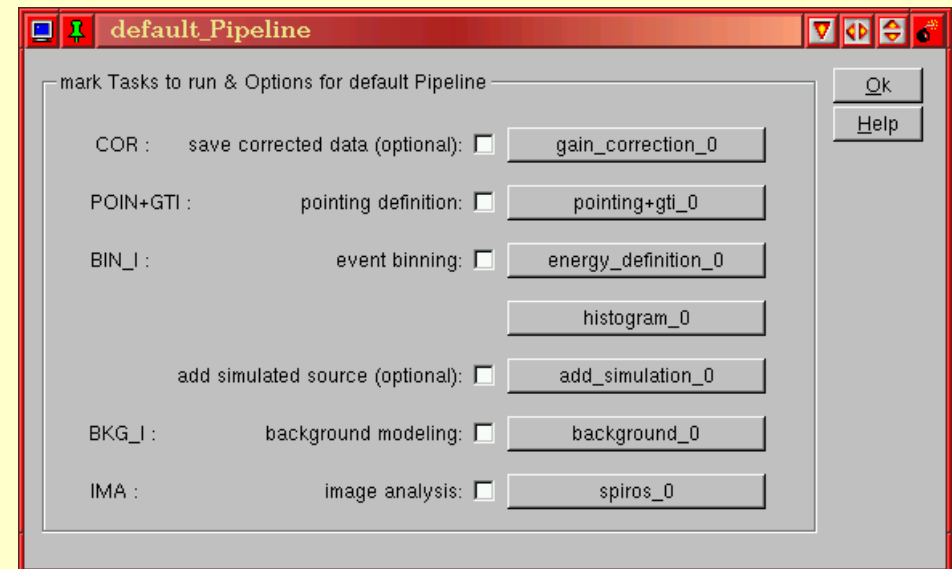
On the right side of the window, there are buttons for 'Ok' and 'Help'.

Catalog, III

Launch the pipeline GUI:

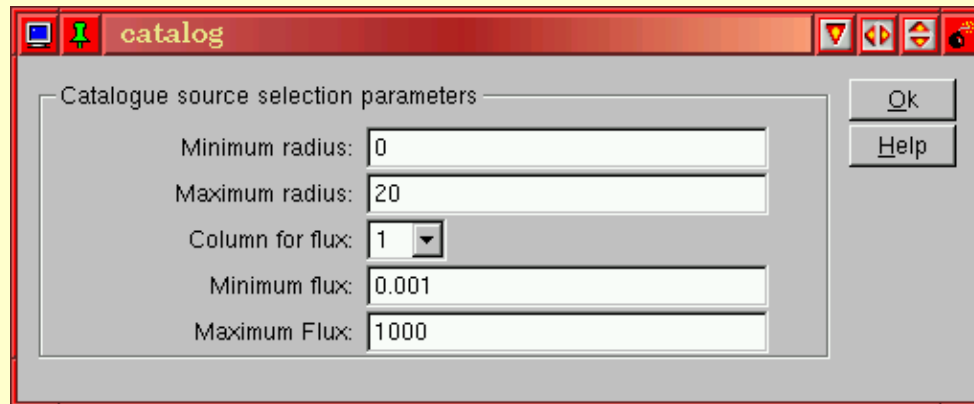


We always use the **default** pipeline:



Catalog, IV

Check the values for the catalog extraction:



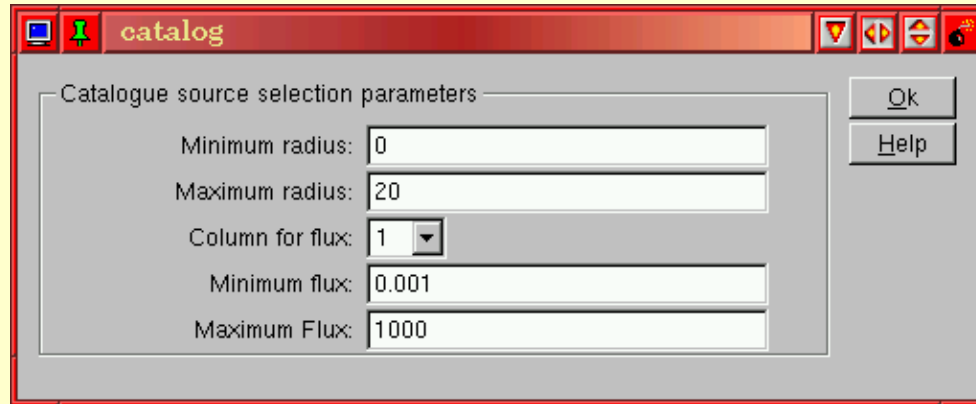
The image shows a software dialog box titled 'catalog'. It contains a section for 'Catalogue source selection parameters' with the following fields and values:

Parameter	Value
Minimum radius:	0
Maximum radius:	20
Column for flux:	1
Minimum flux:	0.001
Maximum Flux:	1000

Buttons for 'Ok' and 'Help' are located on the right side of the dialog box.

Catalog, V

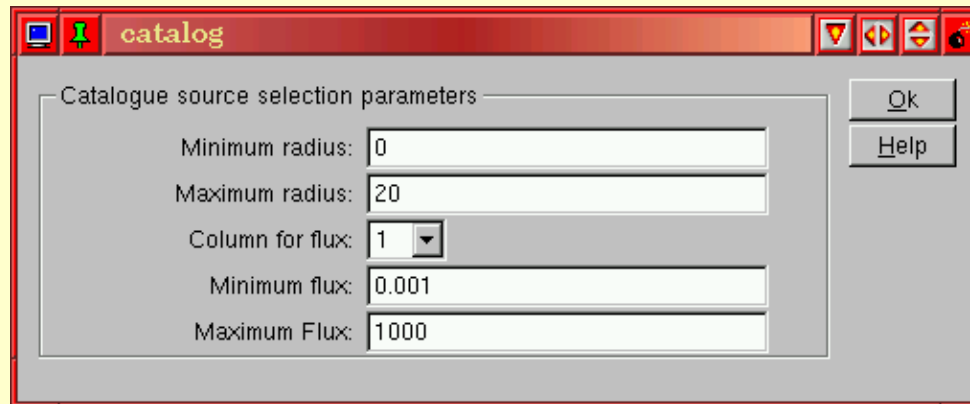
Check the values for the catalog extraction:



⇒ For the time being the default values seem to be ok

Catalog, VI

Check the values for the catalog extraction:



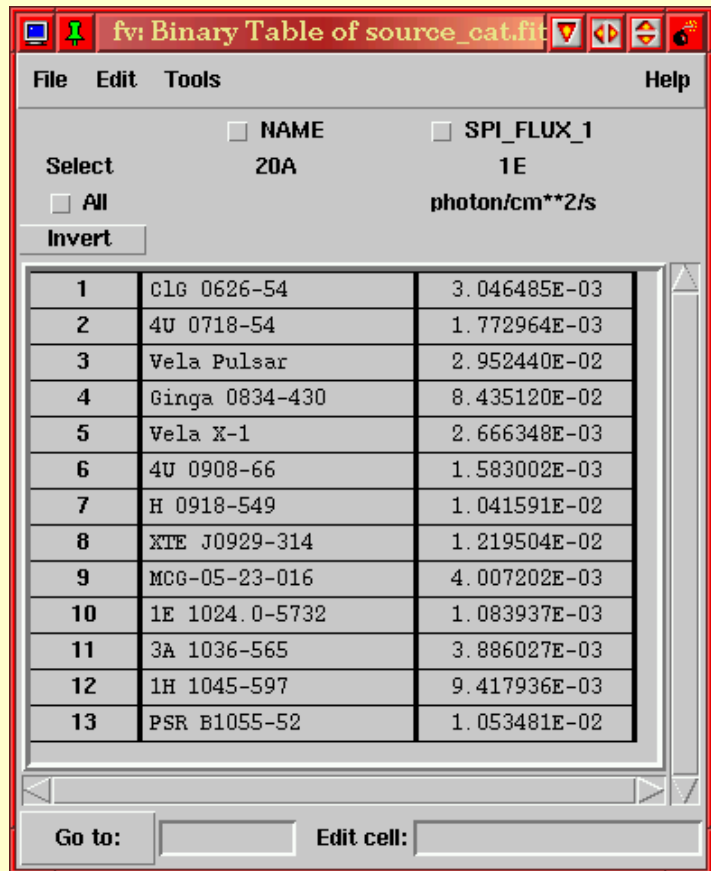
⇒ For the time being the default values seem to be ok

Launch pipeline!

Catalog, VII

Pipeline runs only the catalog extraction step.

Check the resulting catalog: `fv spi/source_cat.fits`:



	NAME	SPI_FLUX_1
1	ClG 0626-54	3.046485E-03
2	4U 0718-54	1.772964E-03
3	Vela Pulsar	2.952440E-02
4	Ginga 0834-430	8.435120E-02
5	Vela X-1	2.666348E-03
6	4U 0908-66	1.583002E-03
7	H 0918-549	1.041591E-02
8	XTE J0929-314	1.219504E-02
9	MCG-05-23-016	4.007202E-03
10	1E 1024.0-5732	1.083937E-03
11	3A 1036-565	3.886027E-03
12	1H 1045-597	9.417936E-03
13	PSR B1055-52	1.053481E-02

Catalog, VIII

Pipeline runs only the catalog extraction step.

Check the resulting catalog: `fv spi/source_cat.fits`:

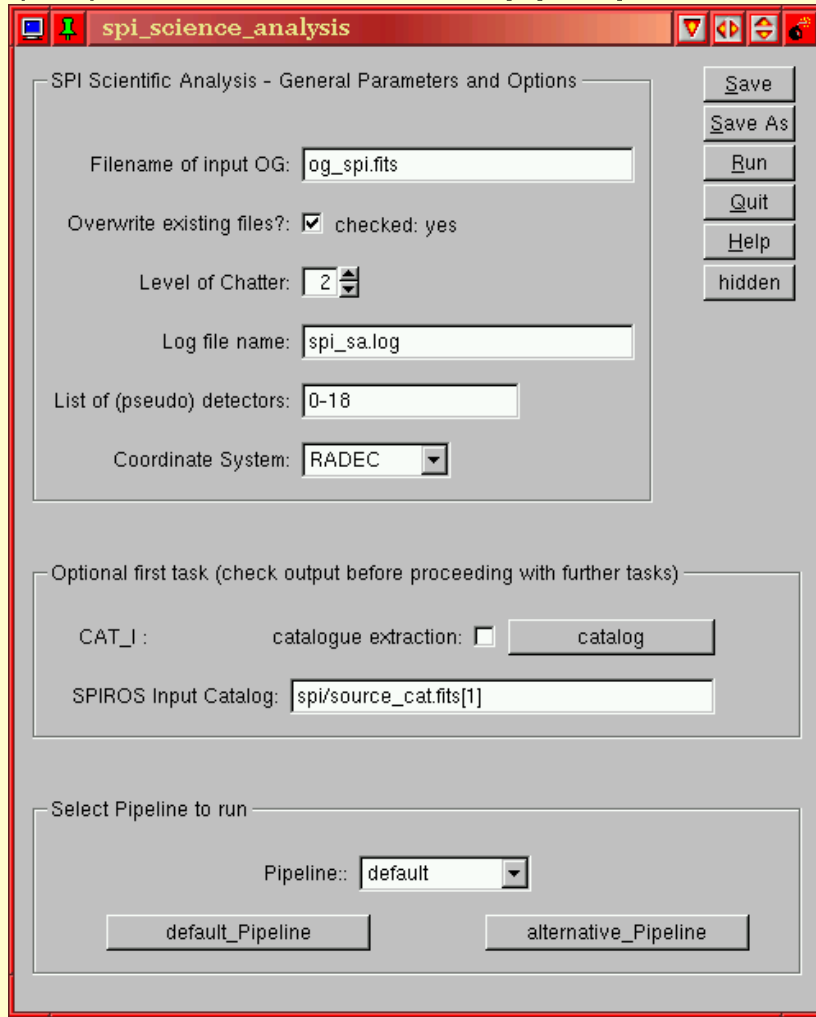
	NAME	SPI_FLUX_1
1	ClG 0626-54	3.046485E-03
2	4U 0718-54	1.772964E-03
3	Vela Pulsar	2.952440E-02
4	Ginga 0834-430	8.435120E-02
5	Vela X-1	2.666348E-03
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8	XTE J0929-314	1.219504E-02
9	MCG-05-23-016	4.007202E-03
10	1E 1024.0-5732	1.083937E-03
11	3A 1036-565	3.886027E-03
12	1H 1045-597	9.417936E-03
13	PSR B1055-52	1.053481E-02

- Depending on the FOV covered by the OG, **many** sources might be in the FOV
- even a bright source like Vela X-1 is not necessarily a bright source in the catalog
⇒ beware of **transients**, bursters, etc
- for many sources the SPI flux is just an **estimate**. It may be wrong!
- make sure that your source is listed
- **adapt** the catalogue settings and **rerun pipeline** if necessary!

Image, I

Launch pipeline GUI

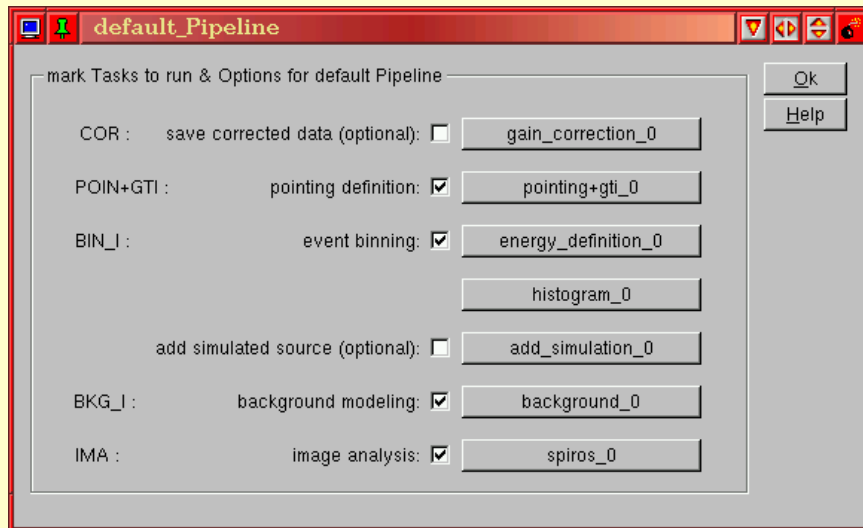
(un)check the appropriate tasks:



Image, II

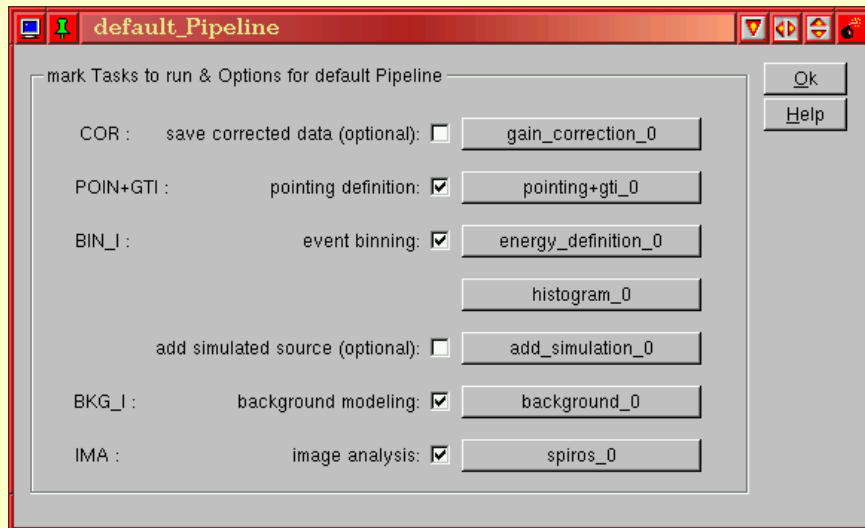
Launch pipeline GUI

(un)check the appropriate tasks:

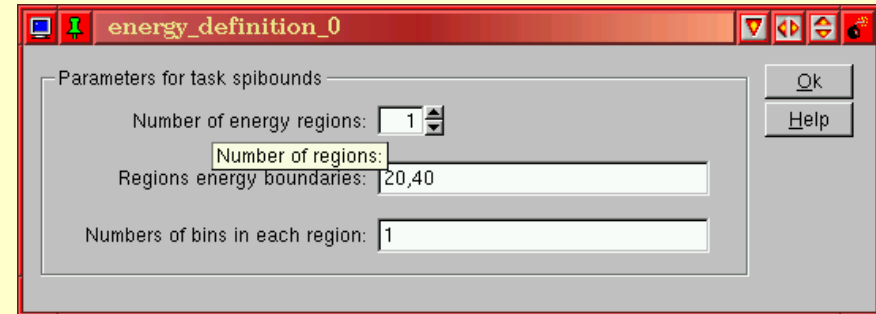


Image, III

Launch pipeline GUI
(un)check the appropriate tasks:



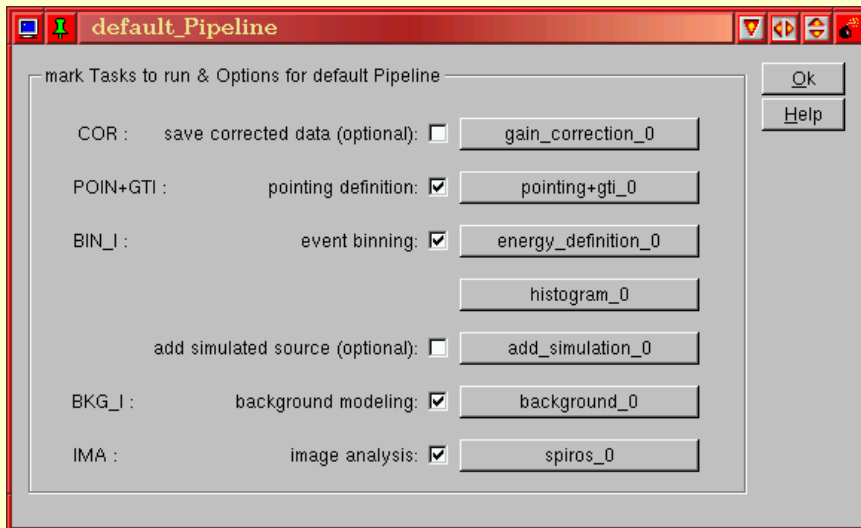
Select a wide energy binning:



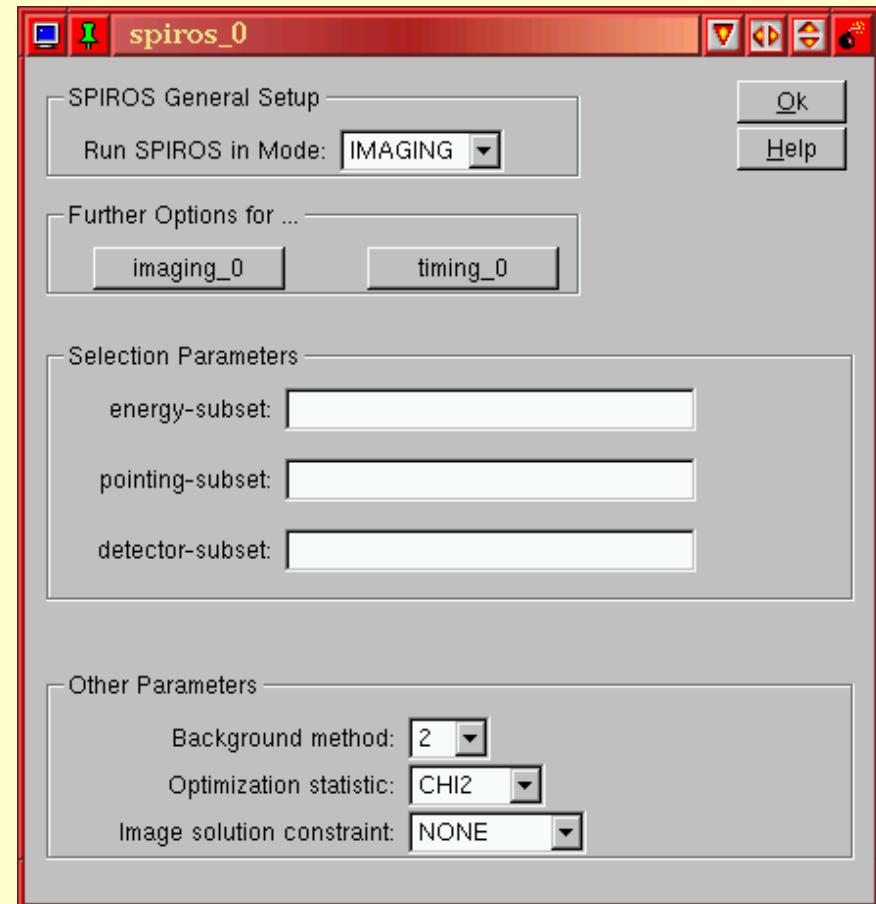
Image, IV

Launch pipeline GUI

(un)check the appropriate tasks:



Setup Spiros Imaging mode:



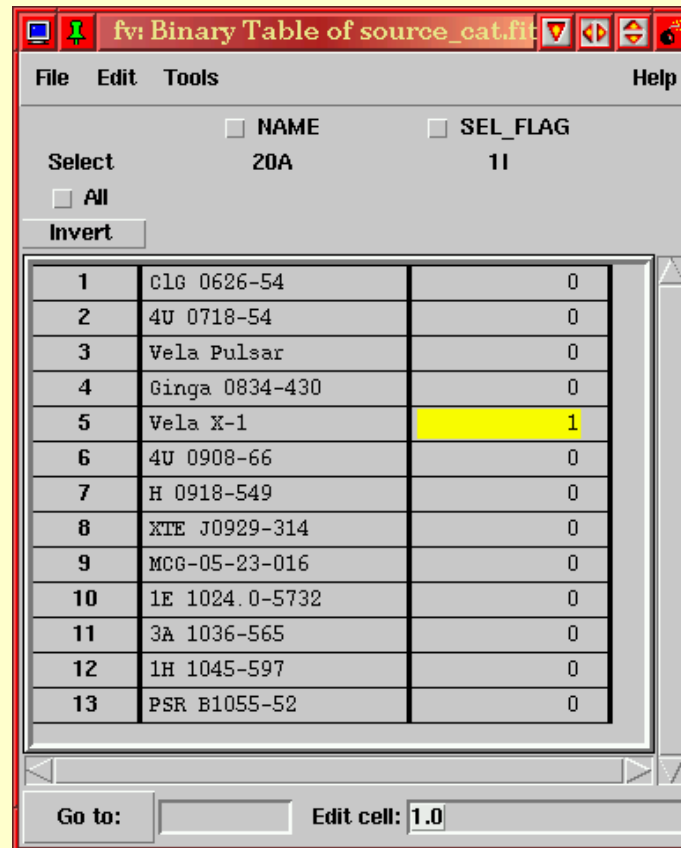
Image, V



ISDC

Spectrum, I

You need to select the sources for which spectra should be extracted:
set the `sel_flag` in the catalog to 1, for all other sources to 0:



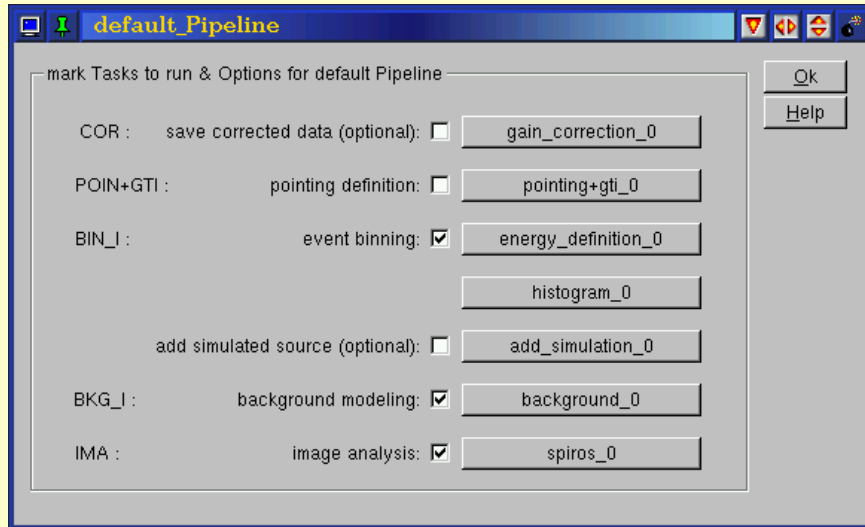
The screenshot shows a software window titled "fv: Binary Table of source_cat.fits". The window has a menu bar with "File", "Edit", "Tools", and "Help". Below the menu bar, there are checkboxes for "NAME" and "SEL_FLAG". The "Select" field is set to "20A" and "11". There are also checkboxes for "All" and "Invert". The main area of the window is a table with 13 rows and 3 columns. The columns are "ID", "NAME", and "SEL_FLAG". The row for "Vela X-1" (ID 5) has a yellow background and a "SEL_FLAG" of 1. The other rows have "SEL_FLAG" values of 0.

ID	NAME	SEL_FLAG
1	CG 0626-54	0
2	4U 0718-54	0
3	Vela Pulsar	0
4	Ginga 0834-430	0
5	Vela X-1	1
6	4U 0908-66	0
7	H 0918-549	0
8	XTE J0929-314	0
9	MCG-05-23-016	0
10	1E 1024.0-5732	0
11	3A 1036-565	0
12	1H 1045-597	0
13	PSR B1055-52	0

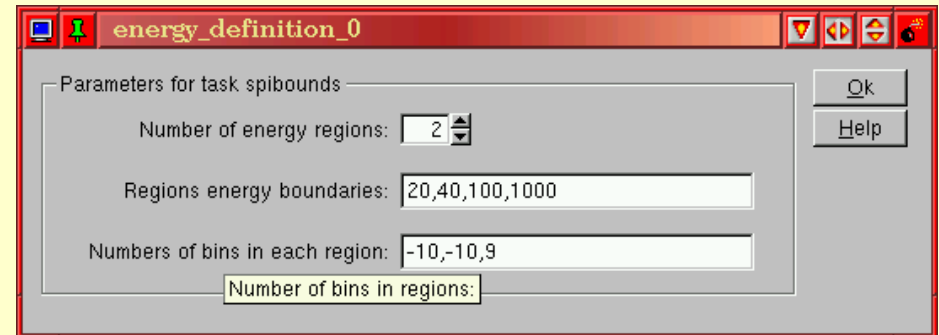
At the bottom of the window, there is a "Go to:" field and an "Edit cell:" field with the value "1.0".

Spectrum, III

Launch GUI, uncheck pointing task:

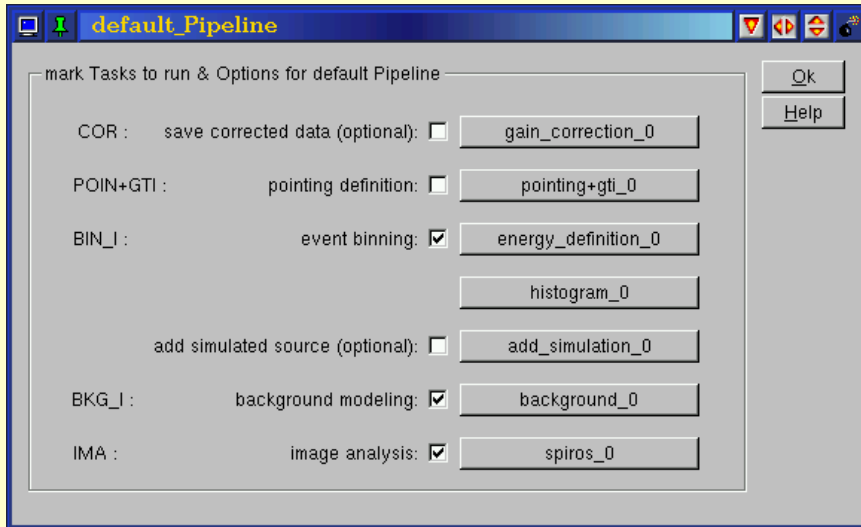


Select an appropriate energy binning:

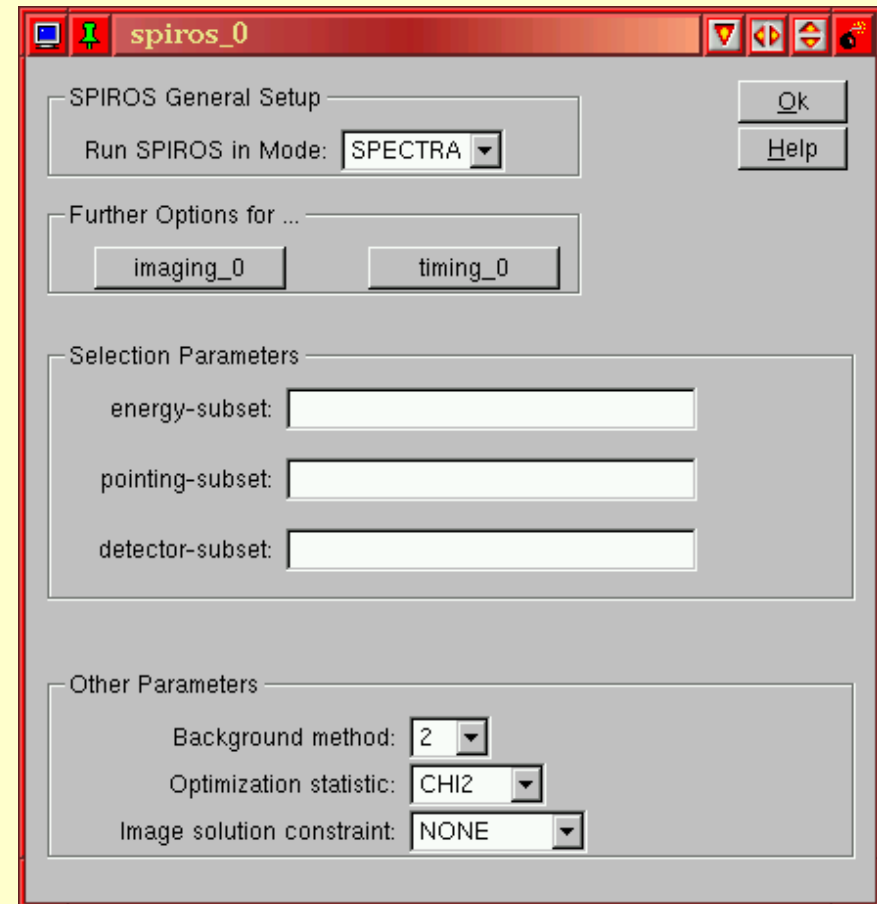


Spectrum, V

Launch GUI, uncheck pointing task:



Set spiros to Spectra mode:



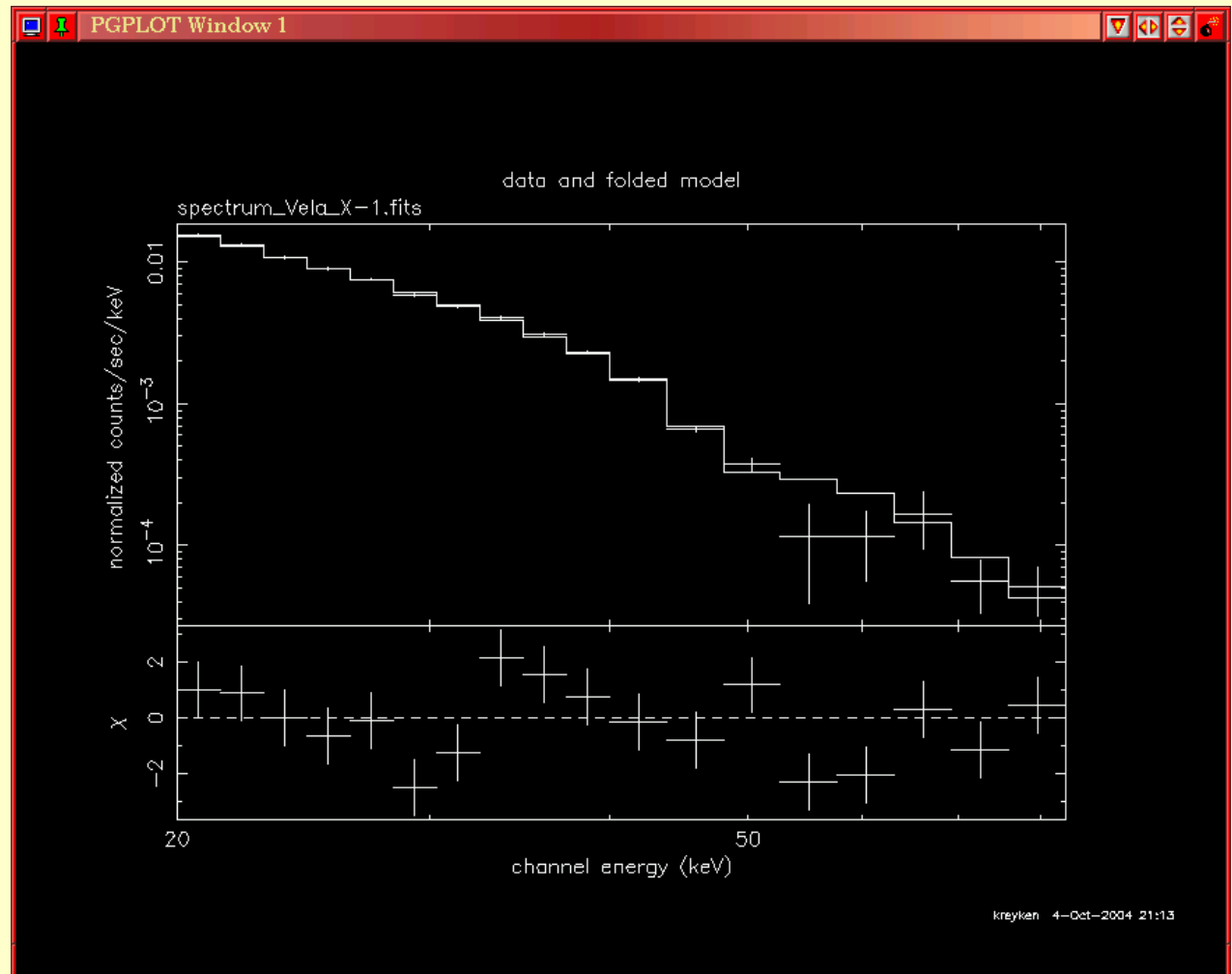
⇒ All image results will be removed - copy your OG!

⇒ Launch pipeline

Spectrum, VI

the SPI pipeline will produce

- ready-to-use PHA files which can be loaded directly into xspec
- an appropriately rebinned response matrix



Lightcurves, I

Smallest possible time resolution: **1 science window!**

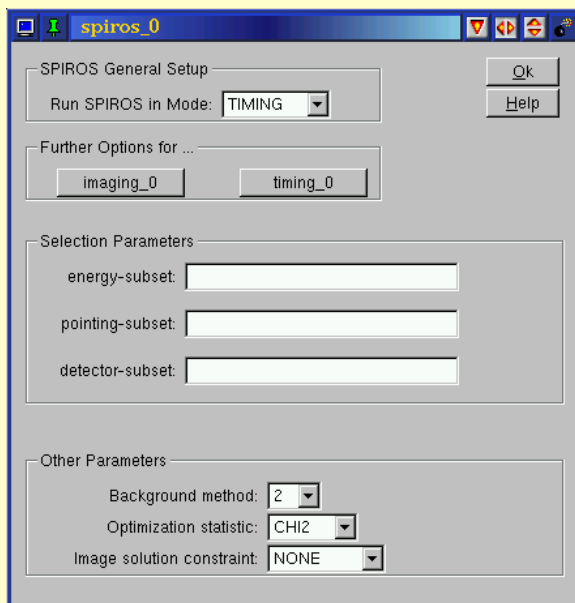
⇒ only suitable for long-term lightcurves.

Lightcurves, II

Smallest possible time resolution: **1 science window!**

⇒ only suitable for long-term lightcurves.

1. select the source in the catalog
2. select an appropriate energy binning
3. set spiros in **timing** mode:

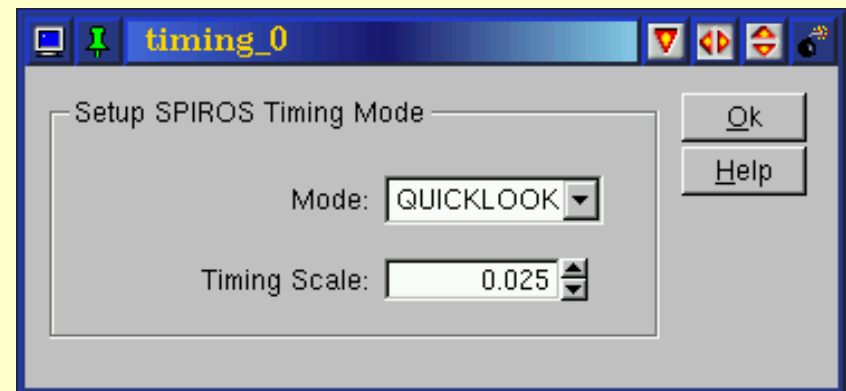
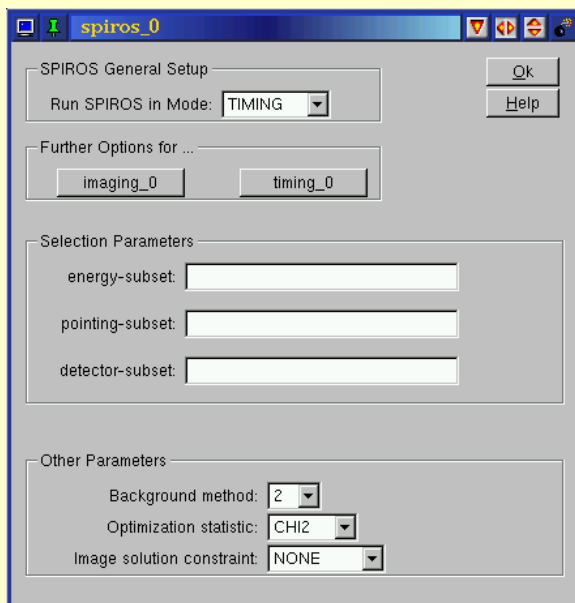


Lightcurves, III

Smallest possible time resolution: **1 science window!**

⇒ only suitable for long-term lightcurves.

1. select the source in the catalog
2. select an appropriate energy binning
3. set spiros in **timing** mode:



Timescale is in **days**

Lightcurves, IV

Lightcurve of a short (20 scw) Observation of Vela X-1:

