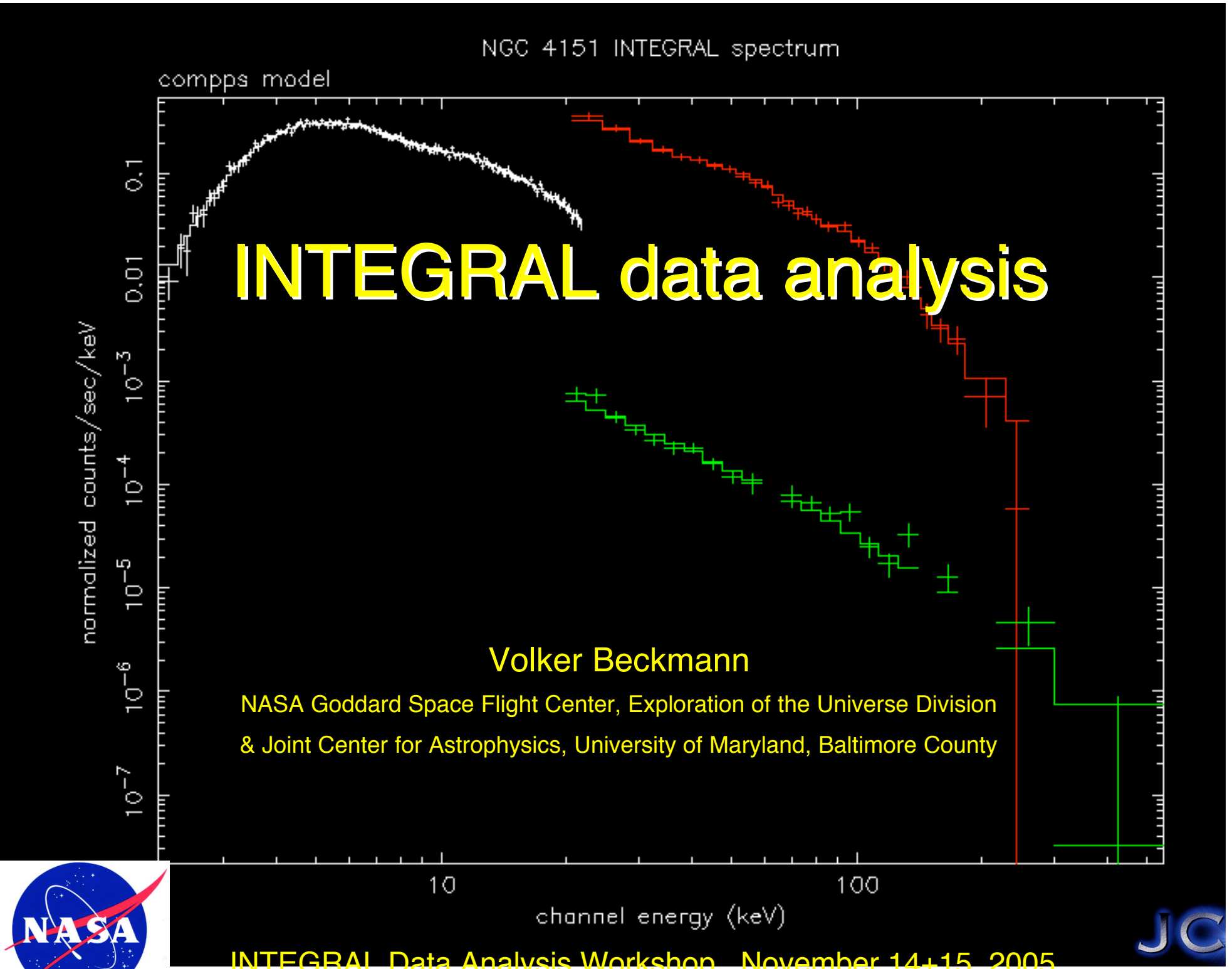

INTEGRAL data analysis

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INTEGRAL data analysis

_ 4 instruments - 1 analysis philosophy

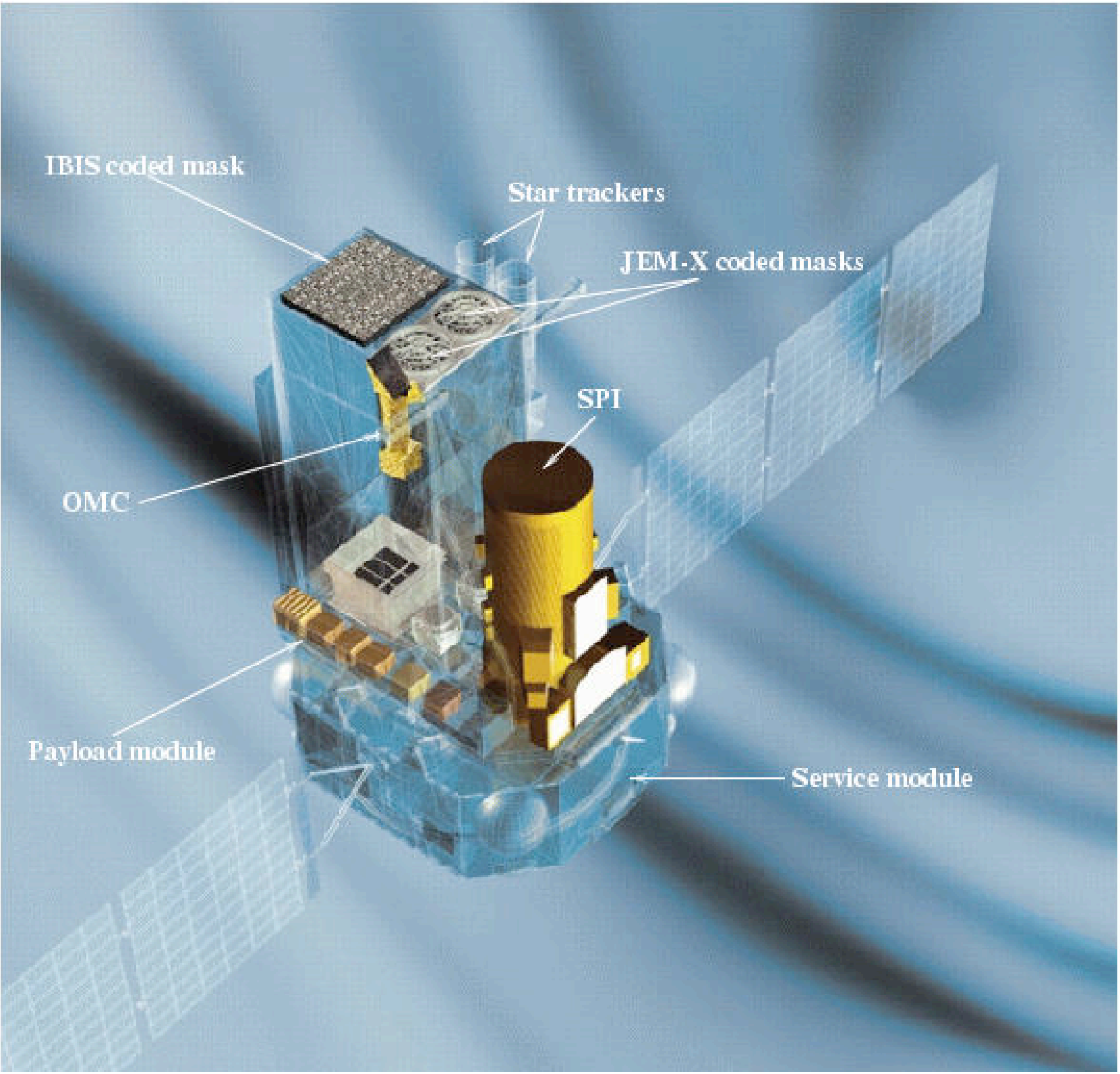
_ What's the input ?

_ What software to run ?

_ Data products

_ additional tools needed: ftools and XSPEC

_ Summary



ISGRI:
20-400 keV
fov: 9º x 9º
12 arcmin

JEM-X:
2-30 keV
fov: 5º, 3 arcmin
FWHM ~0.3 keV

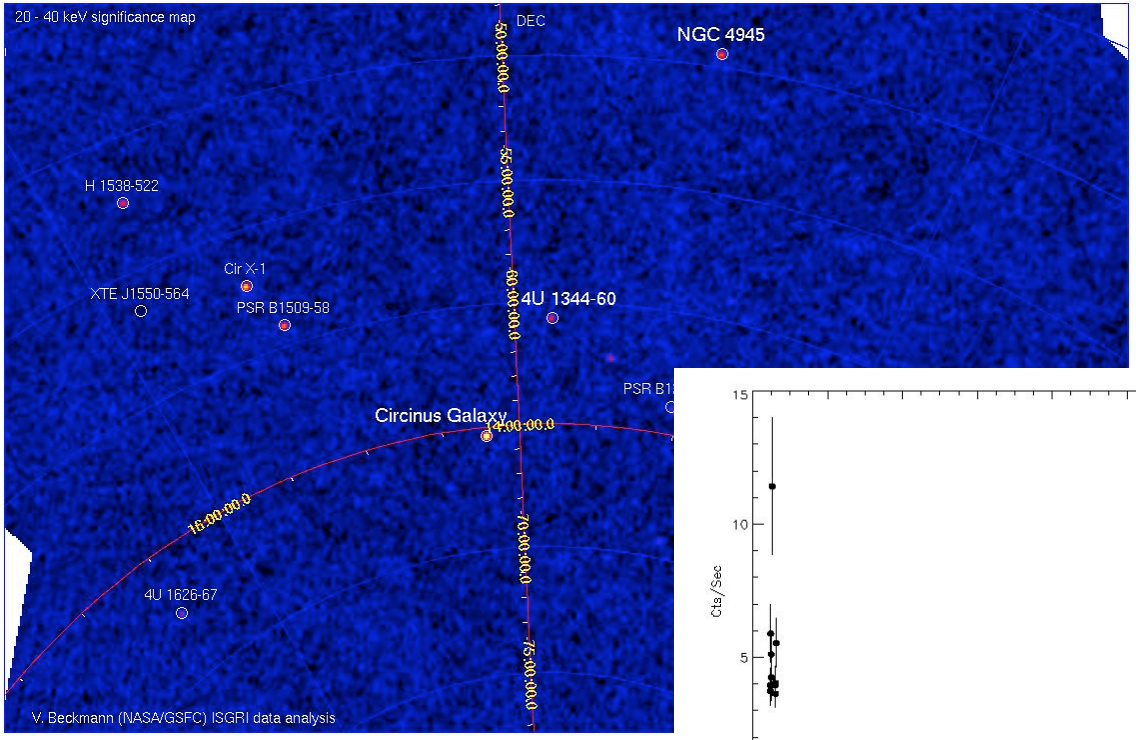
SPI:
20-8000 keV
fov: 16º
2º resolution
1.3 keV @ 1MeV

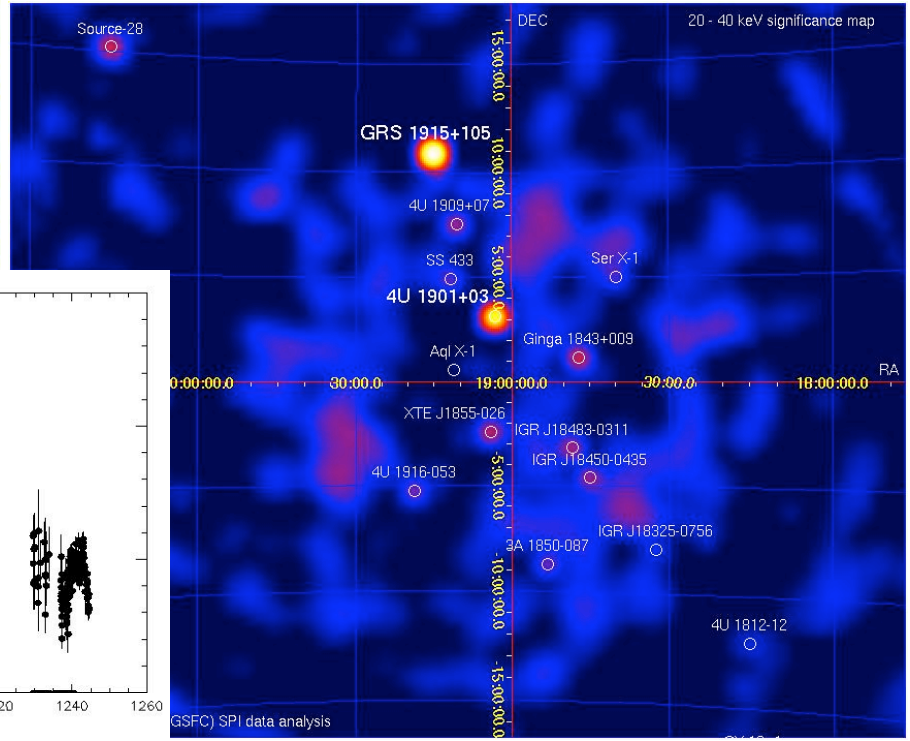
OMC:
V-band imaging

Graphic: ESA

INTEGRAL data analysis

- before you get started, check if there is already some analysis available:
http://heasarc.gsfc.nasa.gov/docs/integral/obslist.html
or check through the Browse system





INTEGRAL data analysis

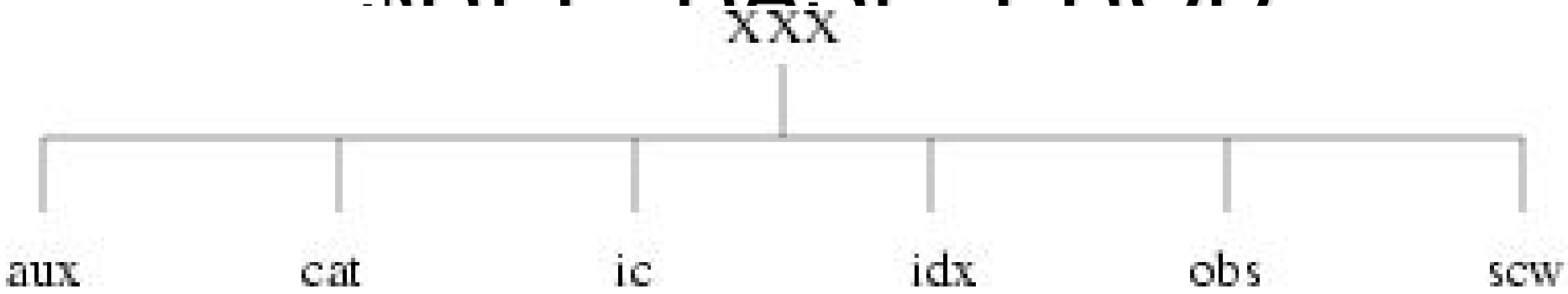
- 3 main instruments have coded masks

- all the data of the detector plane has to be considered simultaneously

- high background level : careful background subtraction is crucial

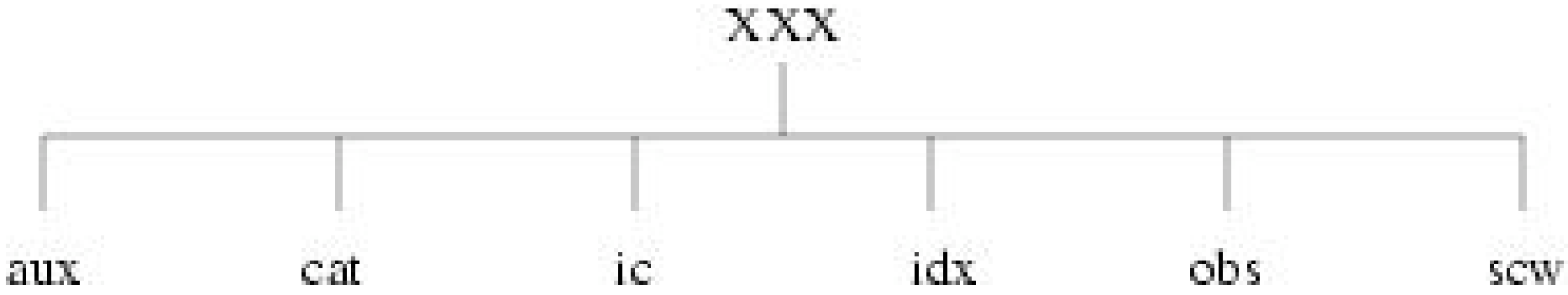
- high energies: long exposure times needed to get some signal-to-noise

INTEGRAL data in $REP_BASE_PROD



- scw/ : the actual data sorted by science windows
- obs/ : here you'll do the data analysis
- idx/ : indices point to the different data
- ic/ : instrument calibration files
- cat/ : input catalogs
- aux/ : auxilliary data

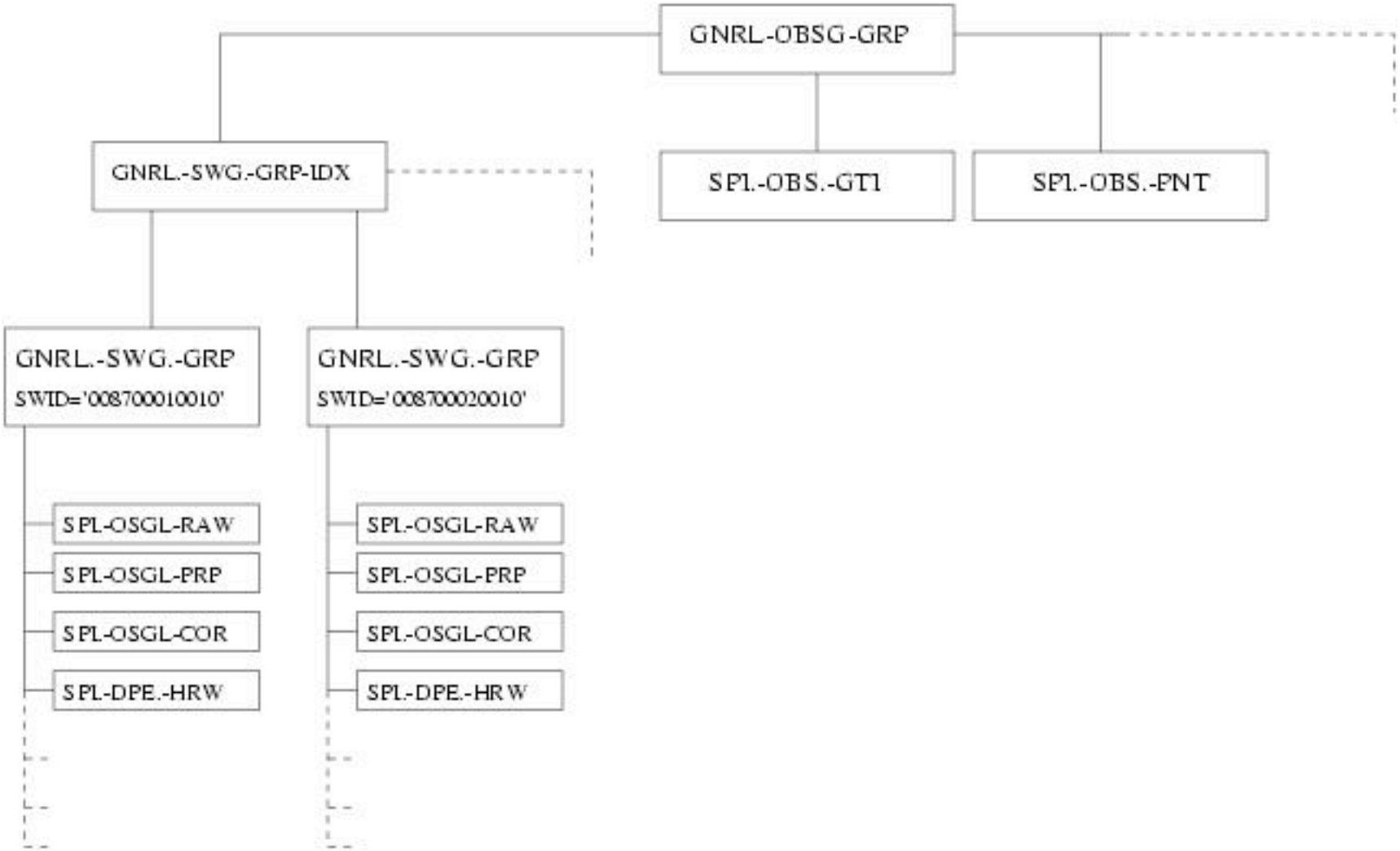
Data in the scw/ directory



- scw/XXXX/XXXXppppssst.rrr/
- XXXX = revolution
- pppp = pointing number
- sss = science window number
- t = type (use ‘0’=pointing only)
- rrr = reprocessing number
- scw/0175/0175000020010.001/swg.fits

INTEGRAL observation groups

- the group concept: have one file which points to all the necessary data



Get started

_ first: build an observation group, including the data you want to analyse

_ what list of science windows? Use only pointed observations (i.e. ***0.001)

_ make an ASCII list of those science windows relative from your base directory:

```
scw/0175/017500020010.001/swg.fits[1]
scw/0175/017500030010.001/swg.fits[1]
scw/0175/017500040010.001/swg.fits[1]
scw/0175/017500050010.001/swg.fits[1]
scw/0175/017500060010.001/swg.fits[1]
scw/0175/017500070010.001/swg.fits[1]
scw/0175/017500080010.001/swg.fits[1]
```

Start a program

- programs use parameter files
- stored in ${PFILES} (try “echo $PFILES”)
- xxxx.par
- example for the parameter file of the first program:

```
#
#       Component : og_create
#
idxSwg,s,ql,"dolsrev175_GCDE_cons.txt",,,"SWG index DOL, 1 SWG DOL or ASCII list of SWG DOL."
instrument,s,ql,"IBIS",,,"Instruments (comma separated list of ALL or any of SPI,IBIS,JMX1,JMX2,OMC)"
ogid,s,ql,"rev175_GCDE_IBIS",,,"Observation group id (used for the path)"
baseDir,s,ql,".",,,"Base directory from where the obs branch will be build. (If null take REP_BASE_PROD)"
obs_id,s,h,"",,,"ISOC Observation id"
purpose,s,h,"",,,"Scientific purpose of the group"
versioning,i,h,0,0|1,,"Put the Version number on the OGID directory (0 = NO; 1 = YES)"
obsDir,s,h,"obs",,,"Directory name under REP_BASE_PROD for the obs directory"
scwVer,s,h,"001",,,"Scw Version to be used if idxSwg is ASCII list of just scwids (default is 001)"
swgName,s,h,"swg",    , , "FITS file to be used in the indices if idxSwg is ASCII list of just scwids (defa
verbosity,i,h,3,,,"Verbosity level (0-10)"
```

Create your observation group

_ og_create idxSwg="dolslist.txt" instrument="IBIS" ogid="rev175_GCDE_IBIS" baseDir="."

_ creates an observation group, containing all science windows listed in dolslist.txt, using the IBIS data, in obs/rev175_GCDE_IBIS

_ now you do the analysis in obs/rev175_GCDE_IBIS

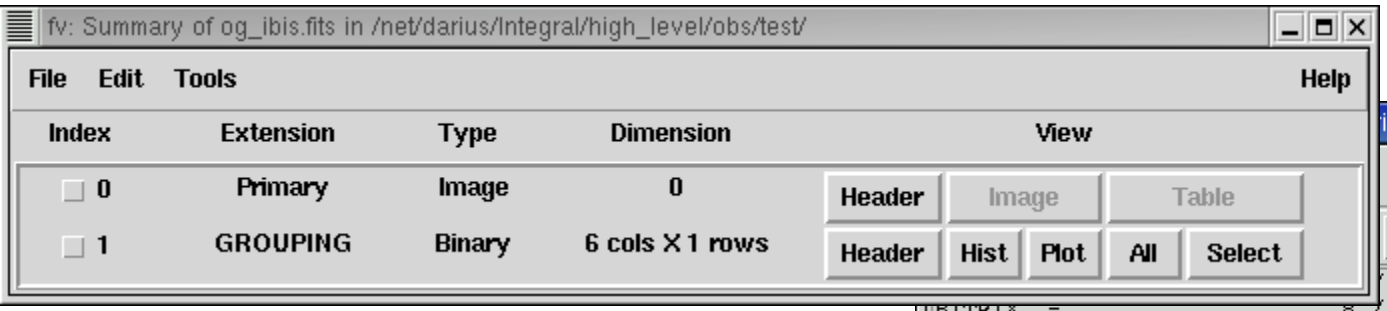
The analysis directory

```
my_computer[Volker]: cd obs/rev175_GCDE_IBIS
/data/obs/rev175_GCDE_IBIS
my_computer[Volker]: ls
og_ibis.fits  scw  swg_idx_ibis.fits
my_computer[Volker]: ls scw/
017500020010.001  017500100010.001  017500180010.001  017500260010.001  017500340010.001
017500030010.001  017500110010.001  017500190010.001  017500270010.001  017500350010.001
017500040010.001  017500120010.001  017500200010.001  017500280010.001  017500360010.001
017500050010.001  017500130010.001  017500210010.001  017500290010.001  017500660010.001
017500060010.001  017500140010.001  017500220010.001  017500300010.001  017500670010.001
017500070010.001  017500150010.001  017500230010.001  017500310010.001  017500680010.001
017500080010.001  017500160010.001  017500240010.001  017500320010.001
017500090010.001  017500170010.001  017500250010.001  017500330010.001
```

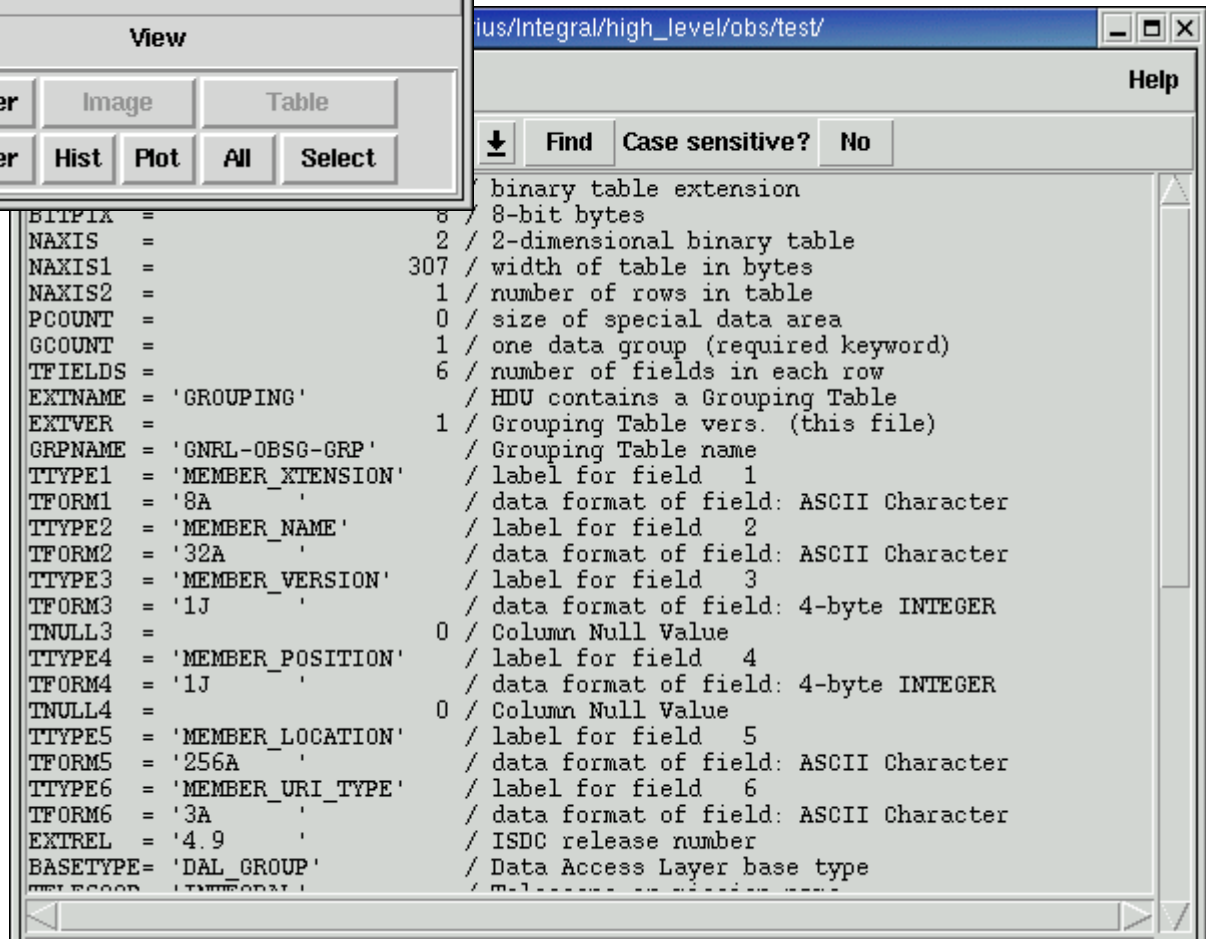
- the observation group (og_ibis.fits) points to the science window group index (swg_idx_ibis.fits), which points to the science windows, which points….

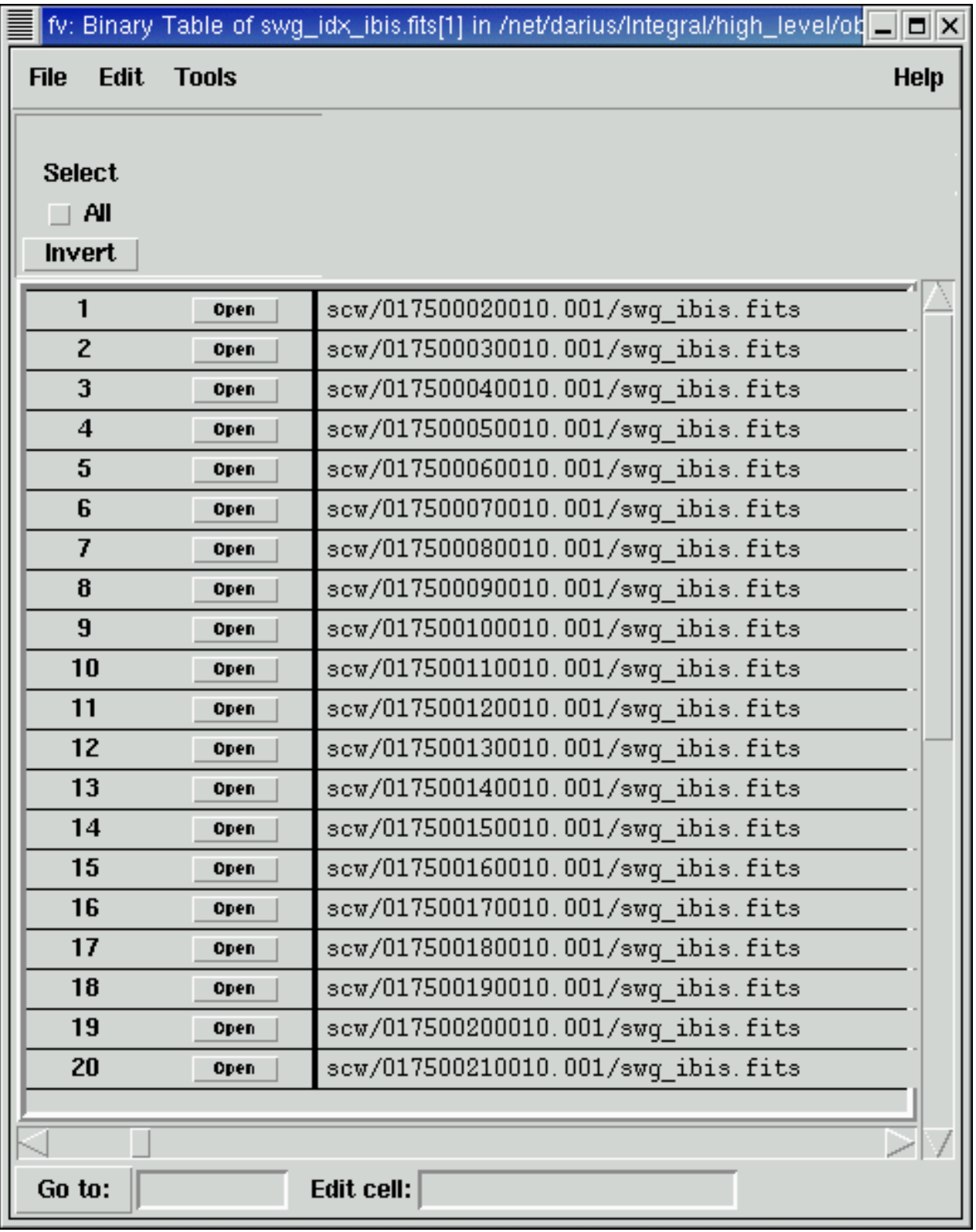
FITS files

- Flexible Imaging Transport System (FITS) file consists of header and table and/or image
- fv to look at fitsfiles



og_ibis.fits[1]





FITS files

table in
swg_idx_ibis.fits

Why analysis scripts

_ Analysis of data has many steps:
_ channel/energy conversion (COR)
_ add information of pointing direction (POIN)
_ which times are usable (GTI, DEAD)
_ data binning (which energy bands?) (BIN)
_ known sources in the field of view (CAT)
_ background determination (BKG)
_ different paths for imaging (IMA), spectral (SPE), lightcurves (LCR)
_ each step = one program, looping over science windows
_ combine all programs and loops in scripts

Analysis scripts

- ibis_science_analysis
- spi_science_analysis
- jemx_science_analysis
- omc_science_analysis

- except for SPI: processing is done science window per scw. Then images are combined in mosaics, lightcurves, spectra extracted from scw results.

Additional tools

- ftools for handling files, e.g. fv

- XSPEC for model fit of data. XSPEC 11 works better with output files.
- XSPEC 12: new approach to fit the SPI data
- alternative: export events files to use e.g. in XCRONOS for timing analysis

Summary

_ INTEGRAL data analysis is complex
_ observation groups help to have all data
_ problem: intelligent system knows which files should be there
_ processing: make list of SCWs, og_create (Instrument), analysis script, XSPEC