GIS Data Processing

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- Introduction and status of the GIS system
- Planning GIS Observations
- Displaying GIS Data
- Correcting Instument Effects
  - Fixed Patterning
  - Ghosts
  - Intensity Calibration

Background

The GIS covers the wavelength ranges:150-220Å, 255-340Å, 395-495Å and 655-785Å, with slits ranging from 2×2” to 8×50” and 4×240”.

The GIS has been working successfully for many years, the instrumental effects are now well understood. The detectors use MCPs and a novel, low power, position encoding system using ‘spiral anodes’ (SPAN).

Selected events from the MCPs are quantised using three 8-bit A-D converters, and a look up table to produce a 12-bit spectrum.

Initial intensity and wavelength calibration come from the ground calibration performed at RAL before launch. The relative intensity calibration has been confirmed in-flight.

Current Status

- GIS Software User Manual and GIS Instrument Guide are published as CDS software notes. *(http://orpheus.nascom.nasa.gov/cds/software_notes.html)*
- Most areas of the GIS detectors are available for analysis.
- More than 2300 GIS rasters run,
  - in over 1400 GIS observations,
  - with 315 different GIS studies.
- Currently detector 2 is switched off because of a possible outgassing of insulating material since the recovery of SOHO.

Planning GIS Observations

- GIS is astigmatic - no spatial information from the spectrum: the slit and mirror can be moved to cover larger areas.
- GIS on-board data encoding is sensitive to count rates: the observer must specify a solar ‘zone’ beforehand. These zones are:
  - off limb, below 5 counts/second/pixel
  - quiet sun, up to about 20 counts/second/pixel
  - active region, over 20 counts/secound/pixel
- Combination of zone and slit defines which GIS setup (GSET) to use.

Displaying GIS data

- Access to GIS data is very similar to the NIS, i.e., using *xcat*, *readcdsfits*, etc. to read data into a ‘quick look data structure’ (qlds).
- *gis_plot* can be used to display simple (average) plot of the data in a ‘qlds’.
- Images of two-dimensional data can be extracted from a ‘qlds’ with *gt_bimage*, using the keywords *lambda1* and *lambda2* to select lines.
- *mk_cds_map* works as with NIS data, using the *wrange* keyword to select lines.

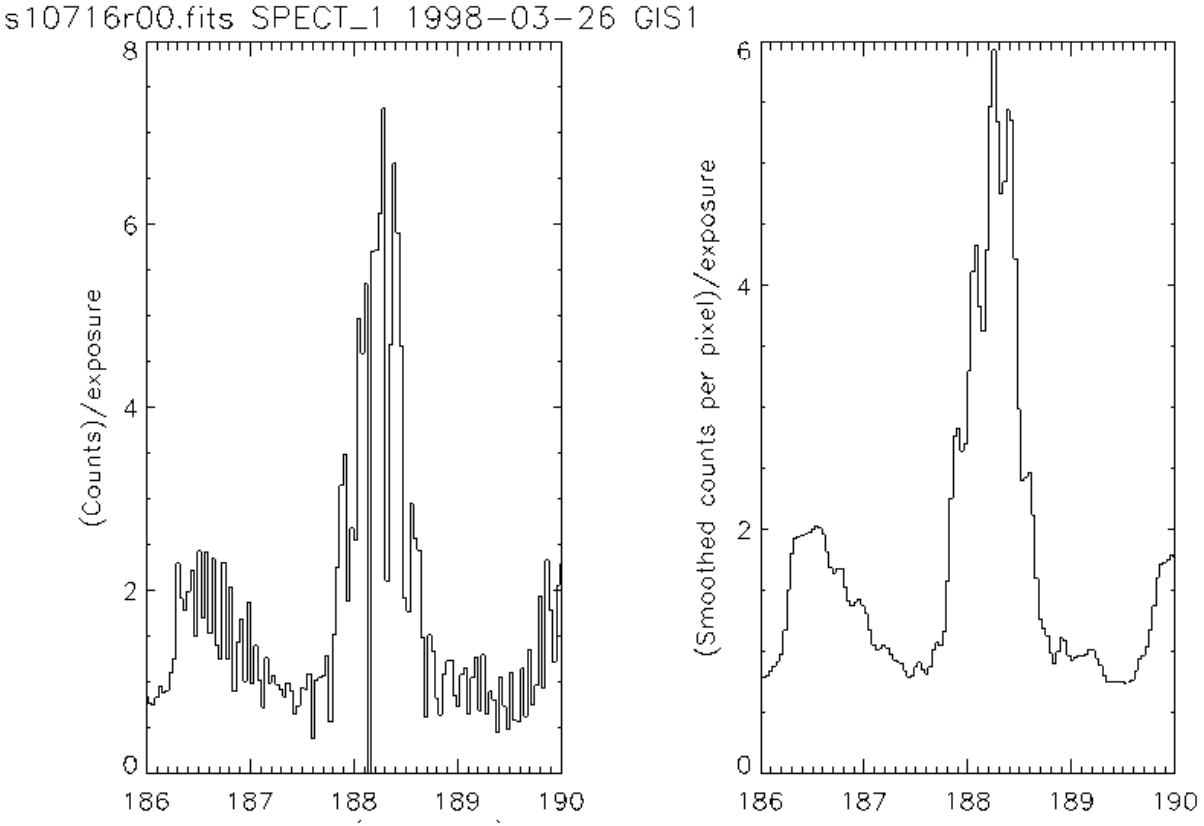
Correcting Instrument Effects

The GIS has a number of instrument effects that need to be corrected for proper processing of the data.

- The use of a LUT introduces fixed patterning, not unusual with digital electronics.
- The SPAN encoders have an ambiguity in the spectral position of some of the incoming events.
- Intensity calibration and effective areas must be applied.

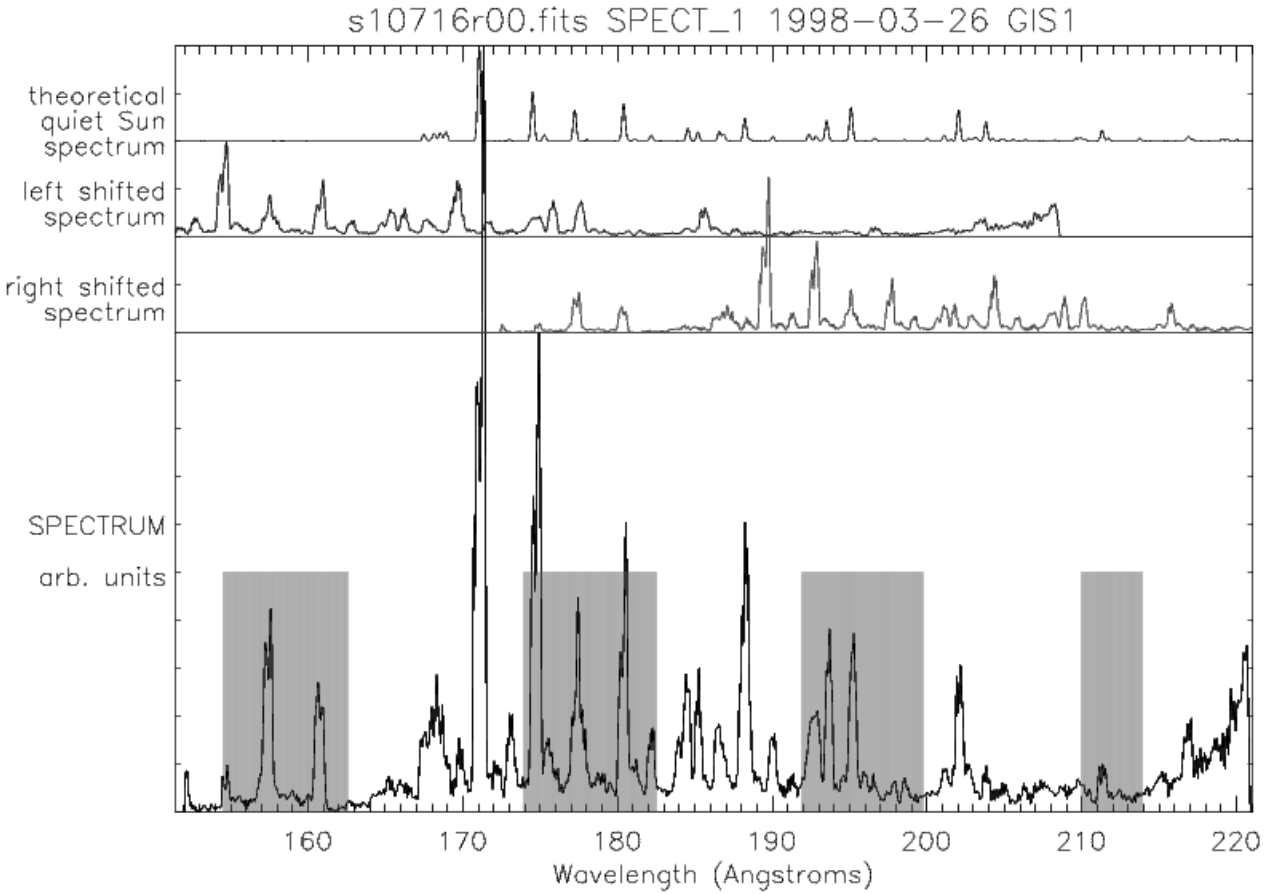
Fixed Patterning

- Seen in some parts of the detectors.
- Corrected with *gis_smooth*, which takes a ‘qlds’ as input.



Ghosting

‘Ghosts’ are displaced parts of spectral lines caused by an ambiguity of the encoding system.



Finding Ghosts - I

First example, using the spectral line seen between 160 and 161Å. This line is in the ghosting regions defined by the bars on the plot.

- The ‘theoretical quiet sun spectrum’ shows that there are no lines at this location.
- Further checking shows that the ‘left shifted spectrum’ also has a line at this point. This strongly suggests that the line at about 160Å is a ghost.

Finding Ghosts - II

Alternatively, if we are familiar with this area on the solar spectrum we know there is an FeXIII line at 202Å.

- To see whether this line needs correcting, first notice that it is a clear area of the plot, i.e., not in a ghosting area.
- Neither the left nor right shifted spectra show lines at this point, and thus this line is free from ghosts.
- The manual ghost correction software explains the process of moving the line in more detail, as well as overlaying a ‘ghost cursor’ on the plot.

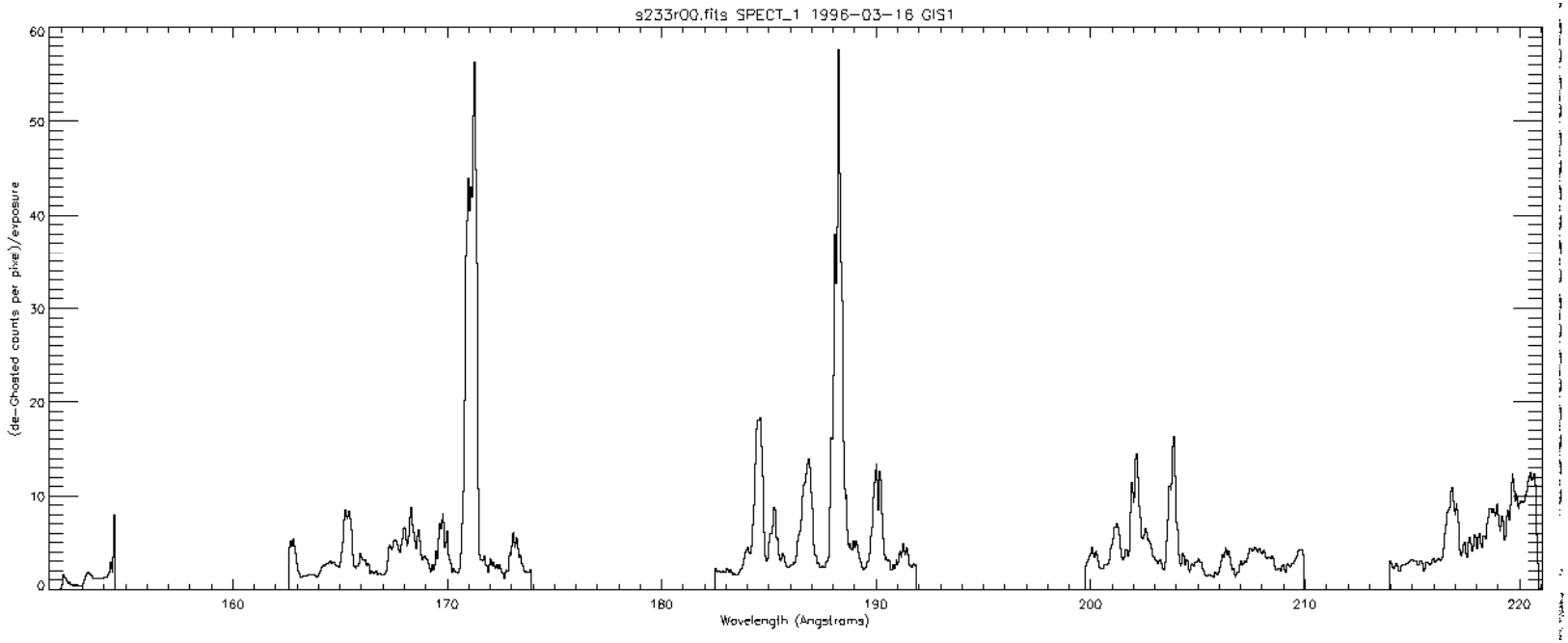
Ghost information files

- Used automatically by both the ghost plotting software and the ghost reduction software.
- Contain pixel location vs. expected ghosting for each GSET, and are included in the CDS SolarSoft directories.
- The information in these files comes from inspecting the raw files associated with each GSET.
- To read the contents of the ghost information file associated with a ‘qlds’ and detector, use *ghost_info.*

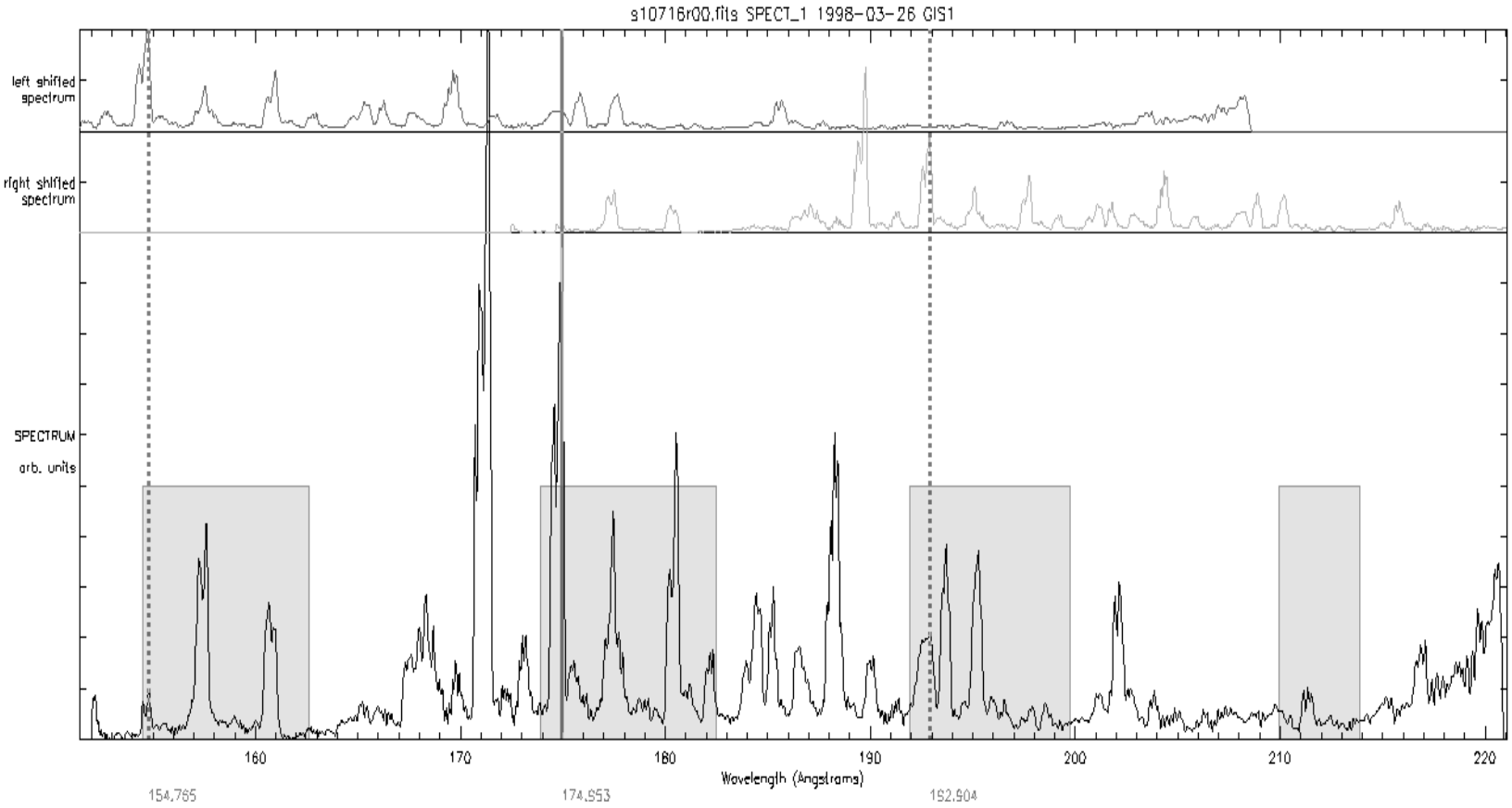
Ghost Correction

- *ghost_buster* operates in two modes:
- Ghost Free: Removes all areas of the detectors that may contain ghosts.
- Manual: Allows the user the move ghosts back to the original locations
- See also *http://www.mssl.ucl.ac.uk/www_solar/soho/gis_analysis.html*

Ghost Free


s233r00.fits SPECT_1 1996-03-16 GIS1
(de-Ghosted counts per pixel)/exposure
Wavelength (Angstroms)
0
10
20
30
40
50
60
160
170
180
190
200
210
220

Manual Ghost correction



Saving and Restoring Ghost Sessions

- By adding the *save* keyword to *ghost_buster*, it is possible to save the ghost corrections made in manual mode into an IDL structure variable.
- It is then possible to restore these corrections to uncorrected data with the *restore* keyword.

Wavelength Calibration

- Wavelength calibrations are automatic when the fits file is read in.
- The wavelength calibration can be accessed by the routines *wave2pix* and *pix2wave*, which translate the GIS pixel co-ordinates as necessary.
- Variations of about 20% of a line width are expected between observations, caused mainly by GIS hardware temperature differences when observing different parts of the sun, or very high count-rates causing distortions in the electronic processing.

Intensity Calibration

- Detectors and their electronics have non-linearities that need to be corrected. On the whole these corrections are less than 10%.
- *gis_calib* performs these corrections, with options to calibrate for the detector sensitivity and telescope effective area .
- The *setmissing* keyword can be used to mark parts of the data as missing if they cannot be calibrated.
- The region around the HeII 304Å line is so bright that the detector efficiency is less than 1% of the original efficiency; by default this region is also marked as missing.

Calibration details

- FIFO dead time: The dead time is a straightforward correction for an on-board First In First Out (FIFO) event queuing chip.
- Simple correction for Quiz-show dead time.
- Analogue dead time: This involves an extending dead time of approximately 2½ microseconds.
- Count rate dependant gain depression.
- Long term gain depression and flat field: Data files can be used to compensate for such gain depression.
- Detector / grating / telescope effective area. The calculations are based on the RAL pre-launch calibration exercise for the whole of CDS.

Using Calibrated Data - I

- Various CDS and other SolarSoft routines exist to use the data once calibrated; most of these can be used with both NIS and GIS data.
- The other utilities mentioned previously will also work with calibrated data.
- To extract the spectral data from a ‘qlds’ always use utilities such as *gt_windata* or *gt_spectrum;* these routines will work with all storage schemes used for CDS data.

Using Calibrated Data - II

- Data returned from *gt_windata* are a floating point array of up to 4 dimensions: spectrum (always 2048 pixels for the GIS), solar x, solar y, and time.
- To get information about the extracted data use *gt_windesc:* The returned structure tells us which units the data use, the wavelength range, etc.
- Alternatively, *xshow_struct* can show all the information in the data structure.
- use *gt_spectrum* to get individual spectra from a raster.

Summary

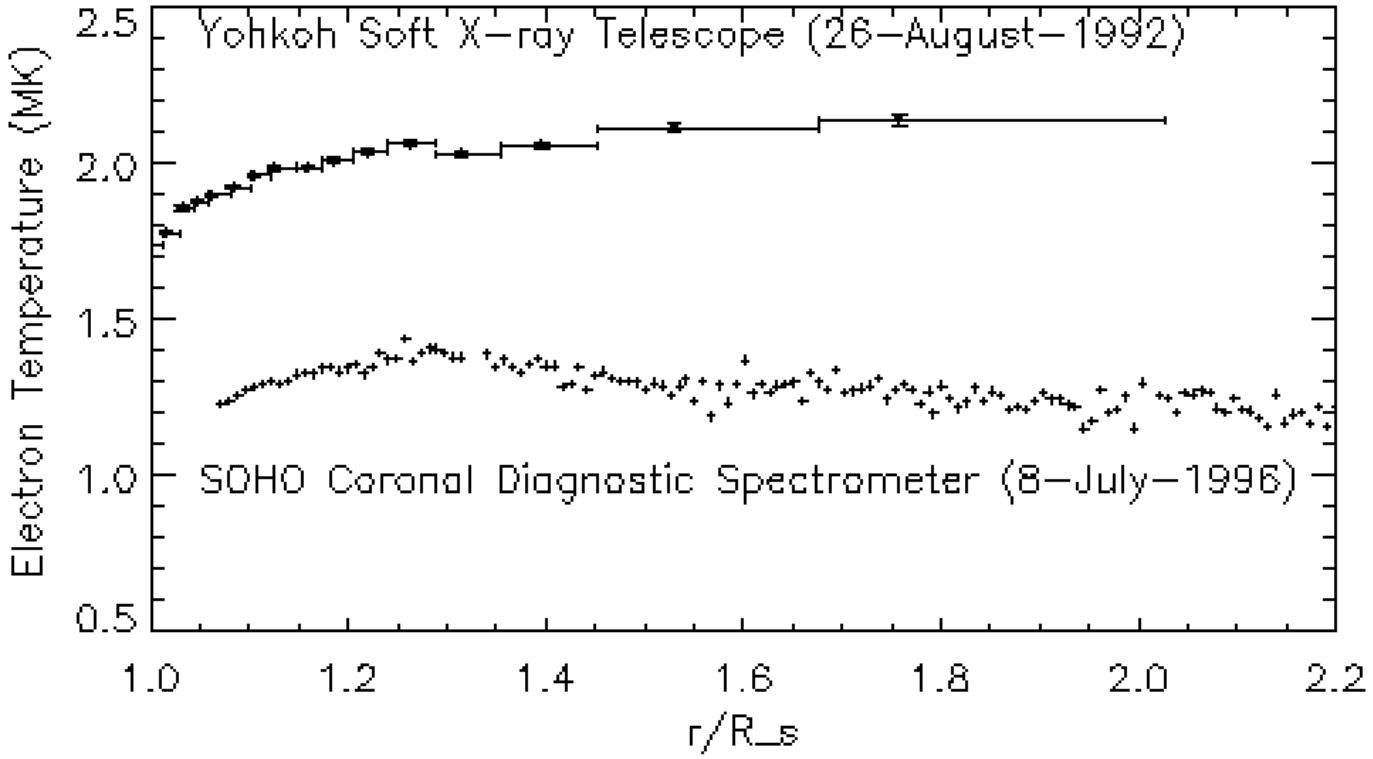
- Can correct GIS data for detector effects.
- Ground calibration is used for sensitivity and effective area.
- GIS well used, but not as much as other SOHO instruments.

Further Work - I

- Confirm the in-flight absolute calibration.
- Quantify other detector effects (edge effects etc.)
- Implement automatic ghost correction where possible.
- Automate line profile fitting.

Further Work - II

- Read the GIS Instrument Guide and Software User Manual.
- Liaise with us with any GIS specific problems.
- Ask for more GIS observations.
- We would like feedback on any GIS related issue!

Some GIS results

See http://www.mssl.ucl.ac.uk/~caf/Firenze/Firenze.html