# GIS SOFTWAR

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added section
`gis_calib` us
described `gis`
added the new

are available for a particular task use the

```
tftd [,'search_string', lines=lin
```

this is similar to the UNIX apropos comm directories for all occurrences of the searc information about individual routines rea

```
xdoc, 'routine_name'
```

## 1.1 Related Documents

The GIS software forms part of the CDS Goddard, MSSL, and other places. The as particularly useful and they come as part distribution. A few of them are listed belo web at *http://orpheus.nascom.nasa.gov/c*

> CDS software note 54 - The GIS the GIS instrument.

> CDS software note 20 - CDS Qui introduction to the general CDS s

> CDS software note 22 - CDS on-l IDL software in the CDS SolarSo

> CDS software note 9 - The CDS information about the 'quick look

be one of:

- off limb: not on the solar disk. The ex
  these areas are below 5 counts/second/
- quiet sun: any quiet area of the sun, in
  maximum count rates are 20 counts/se
- active region: active regions, includin
  count rates are above 20 counts/secon

Once the zone and other observation para
location, etc.) are determined, the CDS pl
can insert the GIS observation into the cu
selected will prompt the CDS planner to

The GSETs themselves are pre-determine
the GIS. A number of raw observations f
various high voltage settings, are examin
selected to produce the current set of GS
GSET are also used to produce the 'ghost
4.2.3.

There has been no change in the set of 11
the end of commissioning , although regu
have been noticed since the loss and reco
yet fully quantified.

```
IDL> show_struct, qlds
```

The pre-defined wavelength calibration (s
Instrument Guide) is performed automati
a qlds.

With xcat it is also possible to read the se
the need for readcdsfits.

```
IDL> xcat, qlds, tstart='28-Feb-1
```

This will display the CDS data catalogue
satellite between two dates in 1998. Selec
e.g. 10716, then the index (or raster) with
file' and 'Read and exit with ql in data str
variable `qlds`.

# 3. Displaying GIS data

To display intensities of spectral lines the
However it is possible to display the origi
or images.

Another useful way of displaying the data
plot_map to overlay maps. For instance t
index and data, with GIS data from dete

```
IDL> index2map, index, data, trac
IDL> plot_map, tracemap, fov=[35,

IDL> map = mk_cds_map(qlds,0)
IDL> plot_map, map, /over
```

See the header documentation for plot_m
more details about mapping and using TR

# 4. Correcting GIS Data for Ins

## *4.1 Fixed Patterning*

Fixed patterning is an effect caused by th
with the analogue detector read-outs; it is
spectra. Figure 1 shows a subset of data fr
will reduce the fixed patterning seen in th
somewhat; the increase depending on the
convolution with a Hanning function is us
function preserves the total counts in the
in the background, or increasing the line

To smooth the data within a qlds use:

```
gis_smooth, qlds [,smoothsize=siz
```

The option `smoothsize` exists to change
(`smoothsize=7`) works under normal circ

To assist with the smoothing operation, a
automatically, the smooth is applied, and
missing again. It is not recommended to r
using any of the GIS processing software
programs.

## *4.2 Ghosts*

An effect in the GIS detectors is the prese
lines, or parts thereof, caused by an ambi
The routine `ghost_buster` is used to rem

When the GIS is in raw data mode, it tran
of co-ordinate pairs from the detectors. W
a spiral (see the GIS Instrument Guide) w
length of the spiral, and the intensity is th
the spiral. To translate these pairs into sp

then plots the data with information to he

Figure 2 was produced using:

```
IDL> qlds = readcdsfits('s10716r0
IDL> gis_smooth, qlds
IDL> ghost_plot_one, qlds, 1, /sa
```

The areas of the resulting plot are describ

- theoretical quiet sun spectrum: This is keyword. There are a number of warn see `xdoc, 'ghost_plot_sample'` fo an aid to ghost restoration, the intensi
- left shifted spectrum and (correlation) observed data, but shifted to the left b only be from an original line one arm scale is not linear, the amount of shift If the `/cross_cor` keyword is used, tl generated likelihood between the orig where the ghosts are by performing a spectra, and if the absolute cross corre a thick bar. This is only a guide to wh located, and is easily confused by line plotted.
- right shifted spectrum, A copy of the optional correlation.

- SPECTRUM: The lower part of the p
the exposures in the observation have
arbitrary units to show most of the lin
logarithmically with `/logscale`.

The grey boxes underlying the plot are in
which show where the ghosts are expecte
where the spectral lines between about 17
between about 154Å and 162Å. Both thes

To summarise the data from all four dete

```
ghost_plot_all, qlds [ /angstroms
```

### 4.2.2 Finding Ghosts

To check whether a line is ghosted, or its

Suppose we have seen a line, and want to
on the plot between 160 and 161Å. This l
grey bars on the plot. The first check is to
it shows that there are no lines at this loca
however further checking shows that the
point. This strongly suggests that the line
pushed to the right to correct the line. The

## 4.3 Ghost Correction

There are currently two modes for ghost c
ghost_buster works in ghost free mode.
of interest does not need correcting then u
have been removed with this mode, then t
problems.

If the region does need correcting, then ru
manually corrected data; it is possible to r
changes, yet the software still allows furth
rates must be used for the count rate depe
below), it is important to replace the ghos
further. Only ghosts of the lines within th
others can remain in place without affecti

If spectral lines need to be fitted, it is reco
calibrate the data, and then fit the lines.

In either mode, it is possible to run ghost
mode, although if it is run on the same de
all spectra to the uncorrected state it is ne

### 4.3.1 Ghost free mode

This mode uses the ghost information file
the GIS spectra that show very little (less

main cursor are printed the correspondinc

To move a ghost that has been identified, and press and drag the left mouse button ghost previously identified at around 160 with the cursor just to the left of 160Å, ke Let go of the mouse and enter `r` in the ter Repeat this procedure until all the lines o

When moving a ghost, remember to inclu either side of the line of interest. It is poss program again, on the same detector or ar keywords to see the final result; alternati finished.

### 4.3.3 Saving and restoring `ghost_bu`

By adding the `save = save_struct` key corrections made in manual mode into an restore these corrections to uncorrected d

```
ghost_buster, qlds, detno, restor
```

For example:

```
IDL> ghost_buster, qlds1, 1, save
IDL> save, save_struct, filename=
```

and then at a later time

```
pixel = wave2pix (spec_id, wavele
```

Where, for the GIS, `spec_id` is a string c
`wavelength` can be a single value or an a
B. Similarly

```
wavelength = pix2wave (spec_id, p
```

Which will return the wavelengths of the
can be a single value or an array.

Variations of about 20% of a line width a
mainly by GIS hardware temperature diff
sun, or very high count-rates (more than a
distortions in the electronic processing.

Note that the wavelength calibration vari
compare two GIS observations that used
wavelength calibration. This is simplified
instance, below is part of an IDL session

```
IDL> qlds_1 = readcdsfits('s8965r
IDL> qlds_2 = readcdsfits('s8966r

IDL> gis_smooth, qlds_1
IDL> gis_smooth, qlds_2

IDL> if (restore_wavecal(qlds_1)
IDL>                               p
IDL> wave_1 = pix2wave('GIS1', fi
```

The region around the HeII 304Å line is s
than 1% of the original efficiency; by def
is possible to override this check with the
line for morphology, where absolute calib

The GIS calibration coefficients used are
tests[1], the coefficients can be viewed usin

### 5.2.1 Calibration details

The corrections and calibrations made by

- FIFO dead time: The dead time is a st First In First Out (FIFO) event queuin simultaneously, and involves a consta counts per second through unhindered
- Simple correction for Quiz-show dead correction is simply an upper limit on microseconds apart then the data are r is then 1.0/(6.0×10$^{-6}$) or approximatel

---

[1] The Laboratory Calibration of the SOHO Corona
Technical Report RAL-TR-1999-036. Submitted t

## *6.1 Extracting the data from the*

To extract the spectral data from a qlds al

```
data = gt_windata (qlds, window [
                              /nopadding ,
```

These routines will work with all storage
data, specify the qlds and the 'window', w
For example, to extract detector 3 data fro

```
IDL> GIS3data = gt_windata(qlds,
```

The returned data are a floating point arra
2048 pixels for the GIS), solar x, solar y,
for data that have multiple exposures at th

To get information about the extracted da

```
gt_windesc (qlds, window [,/noche
```

For example:

```
IDL> GIS3desc = gt_windesc(qlds,
```

---

[2] See Landi, E., Del Zanna, G., Breeveld, E. R., L
Relative Intensity Calibration of CDS-GIS Detect
Astronomy and Astrophysics Supplement, v.135,

```
IDL> wavescale = pix2wave('GIS3',
IDL> data = GIS3data[*, 0, 0, 0]
IDL> waverange = [415, 420]
IDL> ezfit, wavescale, data, wave
```

Another routine, `cds_gauss`, has been de

```
yfit = cds_gauss(x, y, [a, k])
```

where `x` is the independent vector; `y` is de
coefficients and `k` defines the order of the

A more complicated but very comprehen

```
yfit = cfit(x, y, a, fit [,sigmaa
```

where `x, y` are the data to be fitted, `a` is
defined then used as an initial guess to th
each component in the fit; `sigmaa` contai
in `a`. For detailed information about `cfit`
Component Fitting System for IDL.

Because of the complexities of fitting spe
currently no GIS specific line fitting routi
development to make more areas of the G
all of the quiet sun data being available, a

CDS/SUMER

| | |
|---|---|
| ghost_plot_all | Plots all 4 GIS det |
| ghost_plot_sampl e | Plots (or returns) a |
| ghost_plot_one | Plots a GIS detect |
| gis_calib | Applies calibratior |
| gis_plot | Summarise data fr |
| gis_smooth | Smoothes GIS spe |
| gis_write_calib | Prints calibration f volume emission n |
| mk_cds_map | Make an image ma |
| pix2wave | Calculate CDS wa |
| plot_map | Plot an image map |
| readcdsfits | Read and return th |
| show_struct | Display contents a |
| tftd | Search for a string |
| utplot | Plot X vs. Y with U |
| wave2pix | Calculate detector |
| xcat | widget interface to |
| xcds_snapshot | Widget interface to |
| xdoc | Front end to online |

* refers to GIS specific routines.

```
;
    int_spec = gt_bimage(qlds, la
                                ysolar
;
    spec_id = 'GIS' + trim(detno)
    print, 'Pixels chosen:', wave
    print, 'Bottom left position
                                    m.
;
; plot the image
;
    window, 1
    loadct, 0
    tvscl, congrid(int_spec, 512,
;
    return
end
```

| | |
|---|---|
| O VI | 183.94 - 18 |
| Fe X | 184.54 |
| Fe XI | 184.79 |
| Fe VIII/Ni XVI | 185.22 |
| Fe VIII | 186.60 |
| Fe XII | 186.88 |
| Fe VIII | 187.23 |
| Fe XI | 188.22 |
| S XI | 188.67 |
| Fe X | 190.04 |
| Fe XIII/SXI | 191.26 |
| Fe XIII | 200.02 |
| Fe XII/XIII | 201.12 |
| Fe XIII | 202.04 |
| S VIII | 202.61 |
| Fe XIII | 203.79 |
| Fe XIII | 204.26 |
| Fe XIII | 204.94 |
| S X | 208.32 |
| Fe XIII | 208.68 |
| Fe XIII | 209.62 |
| Si VIII / Si XII | 214.76 - 21 |
| Si VIII | 216.90 |
| Fe XII | 217.27 |
| S XII | 218.18 |

| | |
|---|---|
| Si VII | 275.37 - 275.76 |
| Mg VII | 276.15 |
| Si VII / Si VII | 276.77 - 276.85 |
| Mg VII / Si X | 277.04 - 277.27 |
| Mg VII / Si VII | 278.40 |
| S XI | 281.42 |
| S XI | 281.83 |
| S XII | 299.50 |
| Fe XI | 308.54 |
| Fe XIII | 318.14 |
| Si VIII | 319.83 |
| Fe XIII | 320.80 |
| Fe XV | 321.78 |
| Fe XV | 327.02 |
| Fe XII | 338.26 |

| | |
|---|---|
| N III | 685.83 |
| C II | 687.20 |
| Ca IX | 693.80 |
| Al III | 696.00 |
| Mg IX * / Ne I | 735.90 |
| O V | 758.60 |
| O V | 759.44 |
| O V | 760.40 |
| O V | 762.00 |
| N III | 764.00 |
| Ne VIII | 780.30 |
| S XI | 782.00 |
| Mg VIII | 783.00 |

* Second order line blend

| Ion |
| --- |
| Mg VII |
| S XI |
| S XI |
| S XI |
| Fe XII |
| Fe XIII |
| Fe XIII |
| Fe XIII |
| Fe XIII |
| Fe XIII |
| Fe XIII |

| | |
|---|---|
| Fe XIII | 203.79 |
| Fe XIV | 220.08 |
| Fe XVII | 200.80 |

GHOST-FREE GIS LINES SUITABLE

| Ion | Wavelength (Å) |
|---|---|
| Fe XXIII | 154.27 |
| Fe XXIII | 166.74 |
| Fe XXIII | 173.31 |
| Fe XXIII | 263.76 |
| Fe XXII | 217.30 |
| Fe XXIV | 192.02 |