

Data, Calibration and Analysis with Hinode/SOT

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revise: 2013.08.01

Revised version of http://solar.physics.montana.edu/www/ravindra/sot_talk.ppt

Useful Web pages of SOT

- SOT Analysis Guide (LMSAL)

[http://sot.lmsal.com/doc/rep/sot49/pdf/
SOT00042_SOT_Analysis_Guide_%28SAG
%29.pdf](http://sot.lmsal.com/doc/rep/sot49/pdf/SOT00042_SOT_Analysis_Guide_%28SAG%29.pdf)

- Hinode Quick Look Movies

http://solar-b.nao.ac.jp/QLmovies/index_e.shtml

- SOT planning file

<https://sot.lmsal.com/operations/timeline/>

- Hinode wiki

http://solar-b.nao.ac.jp/hinode_wiki/

- SOT FITS Data Format

[http://solarwww.mtk.nao.ac.jp/katsukaw/sot_fits/
SOT_Keywords_0.94.pdf](http://solarwww.mtk.nao.ac.jp/katsukaw/sot_fits/SOT_Keywords_0.94.pdf)

Filenames of SOT Level-0 fits files

1. **FG**yyyymodd_hhmmss.s.fits

FG → Filtergram. Ex: G-Band, Ca II K, Blue continuum, Na D1 etc.

2. **FGIV**yyyymodd_hhmmss.s.fits

FGIV → Shuttered Stokes I and V images.

3. **FGSIV**yyyymodd_hhmmss.s.fits

FGSIV shutterless Stokes-I and V images.

4. **FGSIQUV**yyyymodd_hhmmss.s.fits

FGSIQUV shutterless Stokes I, Q, U & V images.

5. **SP4D**yyyymodd_hhmmss.s.fits

The Stokes spectrum data (SOT-SP), 4D Stokes I, Q, U & V.

The unit of the file is one slit position, not one raster.

yyyy:Year, mo:Month, dd:Day, hh:Hour, mm:Minutes ss/
ss.s:Second

Examples of SOT/FG filenames

- Each data sets are arranged under the subdirectory **/isas/data/hinode_fits/sot/level0/year/month/date/FG/hour/filenames**

Ex: /isas/data/hinode_fits/sot/level0/2006/12/28/FG/H0000
/isas/data/hinode_fits/sot/level0/2006/12/28/FGIQUV/H1700
/isas/data/hinode_fits/sot/level0/2006/12/28/SP4D/H0000

- Filenames of Level-0 data.

Ex: 1. **FG20061228_00253332.2.fits**
2. **FGIQUV20061228_170032.1.fits**
3. **FGIV20061228_103518.2.fits**
4. **FGSIQUV20061228_170212.5.fits**
5. **SP4D20061228_00645.4.fits**

Routines to calibrate the FG/SOT data

- To check the SOT data catalog.

```
idl>file=sot_filelist(obs,start_time,end_time)
```

Ex.

```
Files=sot_filelist('FG','2007-08-25T00:00:00','2007-08-25T01:00:00')
```

;extract file list from level-0 data tree

```
idl> read_sot,files,index,data
```

To read those files use the routine `read_sot` and the calling sequence is as above.

- To read and calibrate the broad-band image data.

```
idl> ss = where(index.WAVE eq 'Ca II H line')
```

```
idl>fg_prep,file(ss),index_out,image_out
```

Process an SOT BFI or NFI filtergram, magnetogram, dopplergram, or Stokes set

Options: /despike - cosmic ray removal, /no_flat - skip flat fielding (This option is necessary for NFI. **!not needed now!**), /float - return images with floating (default: integer), /quiet - set for fewer messages, /verb - set for lots of messages

Because there is no appropriate flat data prepared, you have to contact with Hinode staff members to do flat fielding of NFI.

Rigid Alignment of the FG images

```
idl> fileb = findfile('FG20070406_*.fits')
idl> mreadfits,fileb,indexb,datab
Idl>fg_rigidalign, indexb, datab, index_outb, data_outb, dx = 512, dy =512, x0
= 10, y0 = 10, nt = 40
```

dx=the x-dimension of the box in which image-to-image correlations are calculated. Default = 256.

dy=the y-dimension of the box in which image-to-image correlations are calculated. ; Default = 256.

X0: the x-coordinate of the lower-left corner of the correlation box. ; Default = image center. ;

Y0: the y-coordinate of the lower-left corner of the correlation box. ; Default = image center. ;

Nt: the number of images correlated at one time, i.e. the number of images ; assembled into a subgroup and aligned with respect to the first image in the group. ; Default = 4. Set this parameter to be less than the number of images over which the ; correlated structures in the images change significantly.

To make a movie

```
Idl>xstepper,data [,info_array , xsize=xsize, ysize=ysize, /interp ,start=start, /
noscale]
```

make Hinode SOT/XRT movies for given time range ;
hinode_make_wwwmovies.pro

Another Alignment (Track sunspot)

```
idl> offset=get_correl_offsets(data)
```

offset is an array of lag pixels compared to the first(data[*,*,0]) image.

offset[0,*] -> lag pixel of x axis direction

offset[1,*] -> lag pixel of y axis direction

```
idl> polyoffx=poly_fit(indgen(n_elements(data[0,0,*])),offset[0,*],2,xfit)
```

```
idl> polyoffy=poly_fit(indgen(n_elements(data[0,0,*])),offset[1,*],2,yfit)
```

smooth offset[0,*] and offset[1,*] by using a quadratic function

```
idl> p_offset=offset
```

prepare an array for smoothed offset pixels

```
idl> p_offset[0,*]=xfit & p_offset[1,*]=yfit
```

```
idl> p_data=shift_img(data,p_offset)
```

Alignment among SOT

Even among BFI, the pixel scales and offsets are different depending on wavelengths.

You have to magnify and shift manually according to the list.

see http://solar-b.nao.ac.jp/hinode_wiki/index.php?FG%20pixel%20offset%20and%20scale

Programs to calibrate the SP/SOT level0 data

- I need to add a line in .cshrc (2013.08.01)

```
setenv IDL_PATH +/nfs/share/soft_develop/sot/sp/sotsp_inv/idl
```

```
idl> sotsp_mkmplis, '2007-05-11', data_top_dir='/isas/data/hinode_fits/  
sot/level0',list_outdir='/nfs/scr01/hiroko',nofits,nodate_dir
```

extract SP4D filename list

```
idl>file=rd_tfile('/nfs/scr01/hiroko/sprsf20070511_204736_006081.txt')
```

```
idl>$mkdir /nfs/scr01/hiroko/scan01/
```

```
idl>sp_prep,'/isas/data/hinode_fits/sot/level0/'+file,outdir='/nfs/scr01/  
hiroko/scan01/'
```

```
idl>files_prof=findfile('/nfs/scr2/hiroko/SP/scan01/SP3D*.fits')
```

```
idl>mreadfits,files_prof,index_prof,data_prof
```

```
idl>stokesi=data_prof[*,*,4*indgen(512)]
```

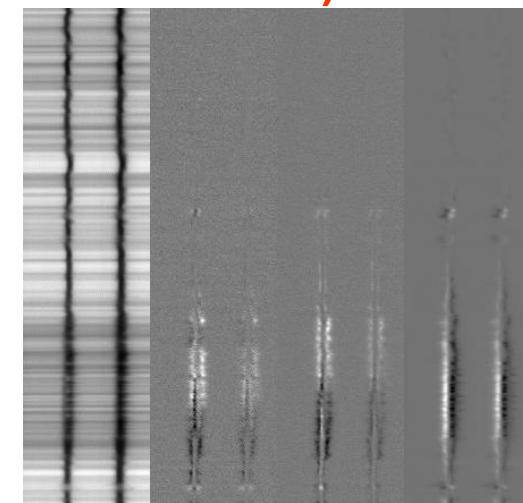
When index.spbshft=1,

the intensity of Stokes I is half scaled.

```
idl>stokesq=data_prof[*,*,4*indgen(512)+1]
```

```
idl>stokesu=data_prof[*,*,4*indgen(512)+2]
```

```
idl>stokesv=data_prof[*,*,4*indgen(512)+3]
```

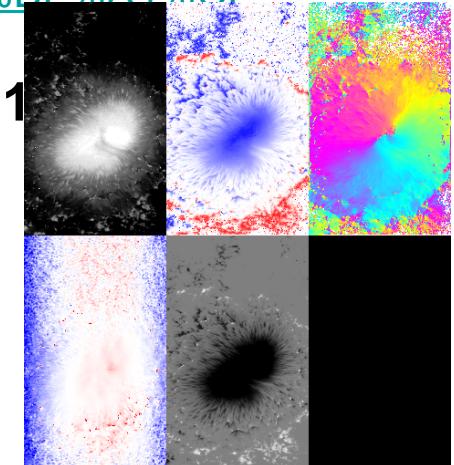


Inversion of the SP/SOT level0 data

see http://hinode.nao.ac.jp/SDAS/manual/meksy_Man_J/node1.html

http://solar-b.nao.ac.jp/hinode_wiki/index.php?SOT%2FSP%20%A5%D5%A5%A3%A5%C3%A5%C6%A5%A3%A5%F3%A5%B0%A5%D7%A5%E%D%A5%B0%A5%E9%A5%E0%A4%C8Level-2%A5%C7%A1%BC%A5%BF%A4%CF%BB%C8%A4%A4%CA%FD

http://hinode.nao.ac.jp/SDAS/manual/meksy_Man_J/node1



Idl>**sotsp_invprep,files_prof,outfile_stray=file_stray**

Idl>**sotsp_fit,files_prof,/gridengine,outfiles_fitparams=**
files_fitparams

Idl>\$ bjobs

After all the jobs were completed, you can proceed next.

Idl>**sotsp_merge_fmd,files_fitparams,outfile=file_level1_5**

Idl>**sotsp_write_rst,file_level1_5,files_prof,file_stray,outfile=file_level2**

Idl>**file='/nfs/scr2/hiroko/SP/20070302H23/sprst.fits'**

This file is the same as file_level2.

Idl>**sotsp_read_rst,file,index,data,idata,coordinates,time,slitpos**

\$,par_type=par_type,par_unit=par_unit

\$,ipar_type=ipar_type,ipar_unit=ipar_unit,straylight=straylight,read_level=1

If you want all the information of SP level2 data, please change **read_level=2**.

Inversion of Stokes signal to vector magnetic field

- Community inversion codes:

<http://www.hao.ucar.edu/public/research/cic/index.html>

(1) LILIA v3.1

(2) MELANIE v2.01

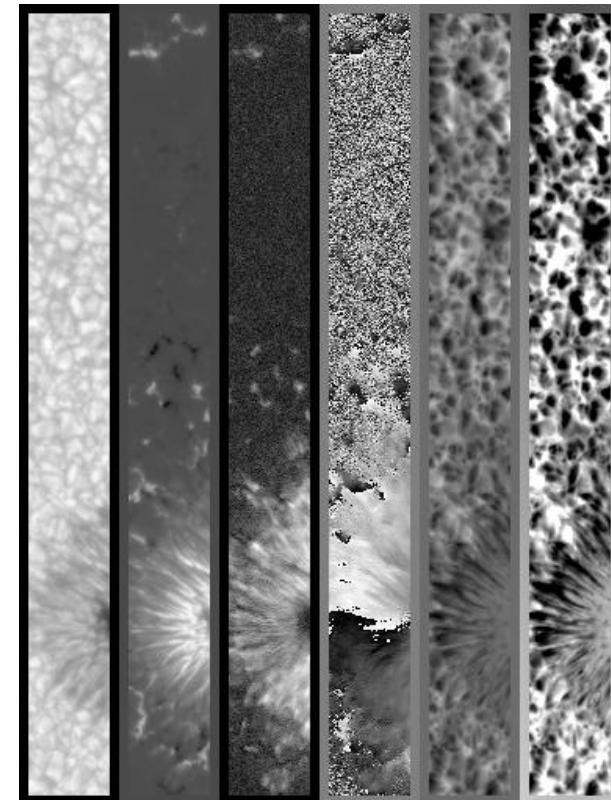
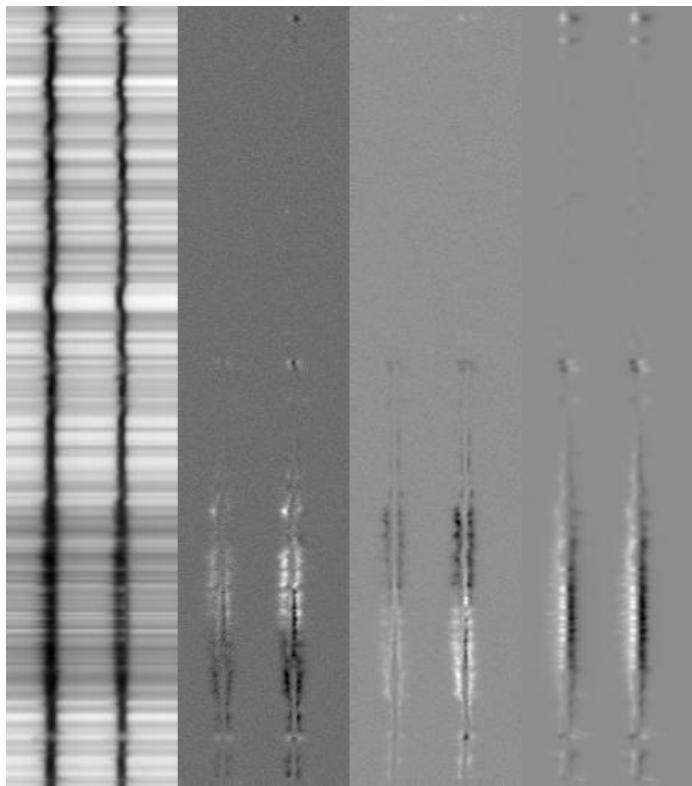
(3) DIANNE v0.9 (BETA!)

Wavelength = ((findgen (112) - index(0).crpix1) * abs (index(0).cdelt1) + index(0).crval1)

Co-ordinate of the
reference pixel

Wavelength of the reference pixel

Spectral res.



THREE DATA ARCHIVES

<http://darts.isas.jaxa.jp/hinode/start.do>

Getting Started Hinode GF-Zing! - this we... Solar Japan Calendars HEAD Home NEWS Harvard University P... Google Hinode data NAOJ Search PageRank ABC Check AutoLink Subscribe Options Hinode data NAOJ

Data Archives and Transmission System DARTS

Astrophysics Solar Physics Solar-Terrestrial Physics Yohkoh Hinode Search

Back Reset Search & Update Get All Data up to 2000M bytes If you have any trouble...

Advanced Search

Data was not found.

Plot No Image Time & Region Time(Large) Region(Large)

Observation Time Target Position

Start: 2007 / 06 / 24 : 00 : 00 (UT)	X(arcsec)	Y(arcsec)
End: 2007 / 06 / 24 : 23 : 55 (UT)	X RANGE	Y RANGE

D : Preliminary data S : Level-0 data

Scientific Properties of Observations

OBS_NUM	JOP_ID	JOIN_SB	---
NOAA No.	TARGET	---	

Scientific Objects (AND / OR)

---	---	---
---	---	---

Satellite Environment / Attitude Control

SAA	Flare
HLZ	Attitude Mode

<http://darts.isas.jaxa.jp/hinode>

<http://sot.lmsal.com/sot-data?cmd=view-recommended-events>

Recommended

Home Planned Recent Popular Recommended Search Help

Recommended Observations

These observations have been found particularly noteworthy by the Hinode science team.

SOT XRT TRACE all
25 matches [1] 2 next

JOP178 prominence study
2007-04-26 13:04:20.0 to 2007-04-26 15:06:00.0
Science Goal: Prominence; PR; West Limb
Program: H1c, CaH 2Kx2K 2x2 for limb 20sec
Target: West Limb
Pointing: xcen=+821.0 ycen=-542.0, Instrument: SOT

Eclipse #2
2007-03-19 02:47:06.0 to 2007-03-19 03:04:08.0
Science Goal: Eclipse; QR
Program: Eclipse2
Target: QR
Pointing: xcen=0.0 ycen=0.0, Instrument: XRT

<http://sot.lmsal.com/sot-data>

<http://kurasuta.cfa.harvard.edu/cgi-bin/VSO/prod/vsoul.pl>

VSO Time / Instrument / Observable / Spectrum / Nickname Search Form

Version 1.4

Start Date/Time: 2007 May 02 / 17 : 00 End Date/Time: 2007 May 02 / 20 : 59
 All Month All Day

Search Clear

All from Provider	All from Source	Instrument	Date Range
<input type="checkbox"/> HANET ^①	<input type="checkbox"/> BBSO ^① <input type="checkbox"/> KANZ ^① <input type="checkbox"/> OACT ^① <input type="checkbox"/> OBSPM ^① <input type="checkbox"/> YNAO ^① <input type="checkbox"/> MLSO ^①	<input type="checkbox"/> BBSO ^① <input type="checkbox"/> KANZ ^① <input type="checkbox"/> OACT ^① <input type="checkbox"/> OBSPM ^① <input type="checkbox"/> YNAO ^① <input type="checkbox"/> chp ^① <input type="checkbox"/> dpm ^① <input type="checkbox"/> mk4 ^① <input type="checkbox"/> RHESSI ^① <input type="checkbox"/> YOHKOH ^① <input type="checkbox"/> BCS ^① <input type="checkbox"/> HXT ^① <input type="checkbox"/> SXT ^① <input type="checkbox"/> WBS ^① <input type="checkbox"/> MtWilson ^① <input type="checkbox"/> GOES-12 ^① <input type="checkbox"/> Evans ^① <input type="checkbox"/> GONG ^①	2000.07.05 → 2001.02.07 → 2002.02.26 → 2004.10.22 → 2000.11.27 → 1996.04.20 → 1994.02.20 → 1998.10.01 → 2002.02.12 → 1991.09.01 – 2001.12.14 1991.09.03 – 2001.12.14 1991.09.03 – 2001.12.14 1991.09.01 – 2001.12.14 1915.08.10 – 1985.12.31 2001.09.10 → 1996.02.05 – 1999.05.28 2005.04.11 → 2005.02.24 → 2005.02.25 →
<input type="checkbox"/> HAO ^①			
<input type="checkbox"/> LSSP ^① <input type="checkbox"/> MSU ^①			
<input type="checkbox"/> MWSPADP ^① <input type="checkbox"/> NGDC ^① <input type="checkbox"/> NSO ^①			

<http://kurasuta.cfa.harvard.edu/VSO>

Thank You