



ASO-S/LST data analysis

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Download SDI data from:

<http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

The screenshot shows the ASO-S Science Operation and Data Center website. The main navigation bar includes: Quick Look, Data Access, Analysis Software, Guide, Operation, and Back Home. The page title is "Data Archive".

step1 Data Archive

The ASO-S data policy can be found [here](#).

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time: 04/03/2023 03:28 End Time: 04/03/2023 03:30

step2

step3 **step4**

Step 1: Selecting the "Data Archive" link in the navigation bar.

Step 2: Selecting the "SDI Level" checkbox under the "LST" section.

Step 3: Selecting the "SDI Mode" checkbox (Routine) under the "LST" section.

Step 4: Clicking the "Search" button.

Form Fields:

- Level Q1: Hourly Fits, Hourly Png, Data-production status Png
- Level 1: Data
- FMG Level: User-defined Cadence [] s
- LST SDI Level: 1
- LST SDI Mode: Routine, User-defined Cadence [] s
- WST Level: 1
- WST Mode: Routine, Burst-1024, Burst-608, User-defined Cadence [] s

Footer:

Email: Search Tar and Download Data Reset

Result File Count : 2 Probable Size(MB) : 43 Request ID :

Download SDI bkg data from: <http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

The screenshot shows the ASO-S Science Operation and Data Center website. The page title is "Data Archive". The interface includes a navigation bar with "Quick Look", "Data Access", "Analysis Software", "Guide", "Operation", and "Back Home". The main content area contains the following sections:

- step1** (yellow callout): "Data Archive" section. Text: "The ASO-S data policy can be found [here](#)." "The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023." Form fields: "Start Time" (04/02/2023 00:00) and "End Time" (04/02/2023 12:00).
- step2** (yellow callout): "FMG" section. "Level" (2-AR), "Mode" (Routine, User-defined Cadence).
- step3** (yellow callout): "LST" section. "SDI Level" (1, Background), "SDI Mode" (Routine, Burst, User-defined Cadence).
- step4** (yellow callout): "WST" section. "WST Level" (1), "WST Mode" (Routine, Burst-16, Burst-4608, User-defined Cadence).

Below the form fields, there is an "Email" field (zhangqm@pmo.ac.cn), a "Search" button, a "Tar and Download Data" button, and a "Reset" button. The "Result" section shows "File Count : 1", "Probable Size(MB) : 5", and "Request ID :".

The "Data Export Status and Retrieval" section includes a "Request ID" field, a "Check Status" button, and a "Status" field. Below this is a "Link" field and a "Download Link" button.

	File Name	Download
1	sdi_lev10_20230402_bkg_biweekly.fits.gz	download

Download both data from: <http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

The screenshot shows the ASO-S data archive website interface. The browser window title is "Not Secure - aso-s.pmo.ac.cn". The page has a blue header with navigation links: "Quick Look", "Data Archive", "Back Home", and a notification: "A participant has enabled Closed Captioning. Who can see this transcript? Recording On".

step1 Data Archive

The ASO-S data policy can be found [here](#).

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time: 04/03/2023 00:00 End Time: 04/03/2023 00:05

step2

HXI ?

Level Q1 Hourly Fits Hourly Png Data-production status Png

Level 1 Detector Data

Mode Routine User-defined Cadence s

LST ?

SDI Level 1 Background

SDI Mode Routine Burst-460° User-defined Cadence s

WST ?

WST Level 1 User-defined Cadence s

WST Mode Routine Burst-460° User-defined Cadence s

Email:

Result File Count : 3 Probable Size(MB) : 50 Request ID : 20230412102734228218

Data Export Status and Retrieval

Request ID : Status : Ready

Link : <http://aso-s.pmo.ac.cn:80/downloadPackFits/20230412/20230412102734228218.zip>

File Name	Download
-----------	----------

Download SDI cut-out data from:

<http://aso-s.pmo.ac.cn/sodc/cutout.jsp>

The screenshot shows the ASO-S Science Operation and Data Center website. The main heading is "Advanced Space-based Solar Observatory Science Operation and Data Center". The navigation bar includes "Quick Look", "Data", "Analysis Software", "Guide", "Operation", and "Back Home".

The "Cutout Service" section is highlighted. It contains the following fields and options:

- Start Time:** 04/03/2023 07:49
- End Time:** 04/03/2023 07:51
- LST ?** (Link)
- SDI Level:** 1
- Cadence(optional):** User-defined Cadence [] s
- WST Level:** 1
- Cadence(optional):** User-defined Cadence [] s
- Cutout:**
 - Xcenter (arcsec):** 700
 - Ycenter (arcsec):** 700
 - Xrange (arcsec):** 800
 - Yrange (arcsec):** 800
 - Tracking (optional) Reference Time: []

Below the form, there are instructions: "The arcsec range for x-axis is between [-1150,1150]. Xrange $Xcenter+(Xrange/2)$ ≤ 1150." and "The arcsec range for y-axis is between [-1150,1150]. Yrange $Ycenter+(Yrange/2)$ ≤ 1150."

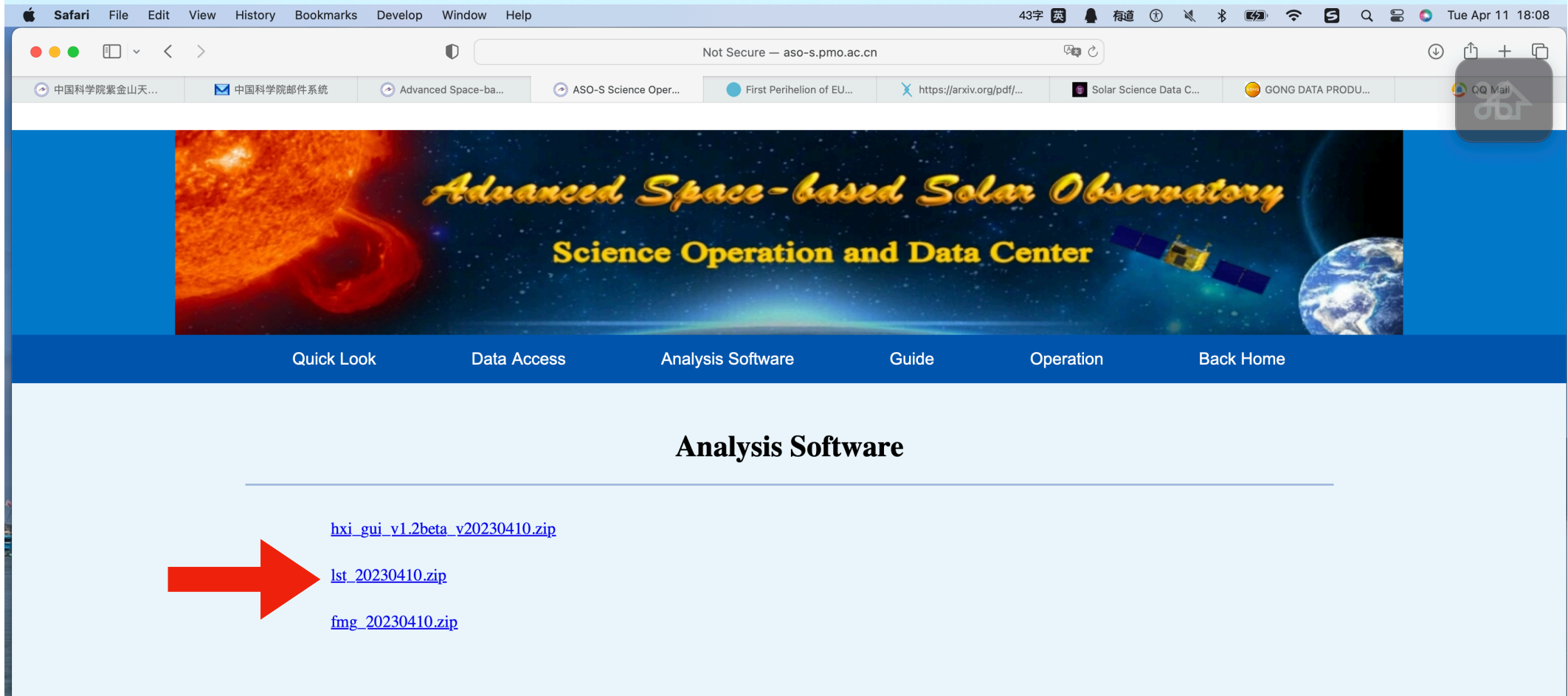
At the bottom, there is an "Email:" field with "zhangqm@pmo.ac.cn", a "Search" button, a "Submit" button, and a "Reset" button. Below this, the "Result" section shows "File Count : 2", "Probable Size(MB) : 45", and "Request ID :".

The "Data Export Status and Retrieval" section includes a "Request ID : []" field, a "Check Status" button, and a "Status : []" field.

Five yellow callout boxes are overlaid on the page, labeled "step1" through "step5", pointing to various elements: "step1" points to the "Cutout Service" title; "step2" points to the "SDI Level" radio button; "step3" points to the "Cadence(optional)" field; "step4" points to the "Tracking (optional)" checkbox; and "step5" points to the "Submit" button.

Download LST programs from:

<http://aso-s.pmo.ac.cn/sodc/analysisSoftware.jsp>



The screenshot shows a Safari browser window displaying the website for the Advanced Space-based Solar Observatory Science Operation and Data Center. The page features a header with the organization's name and a navigation menu. The main content area is titled "Analysis Software" and lists three downloadable files: [hxi_gui_v1.2beta_v20230410.zip](#), [lst_20230410.zip](#), and [fmg_20230410.zip](#). A red arrow points to the [lst_20230410.zip](#) link.

Note: Install **SSW/gen/** package on your computer before running LST programs!

read_lst.pro

```
; PROJECT:
;   ASO-S/LST
; NAME:
;   READ_LST
; PURPOSE:
;   Read LST FITS file(s) into 2D or 3D array
; INPUTS:
;   LSTFILES - LST FITS file(s) name to read
; KEYWORDS:
;   /NODATA - Read in header(s) only, not data.
;   /FITSHEAD - If set, output string index
; OUTPUTS:
;   INDEX - Output the data header(s)
;   DATA - 2D or 3D array of LST image(s)
; EXAMPLES:
;   IDL> read_lst, lstfiles, index, data [,/nodata] [,/fitshead]
```

```
IDL> lstfiles=findfile('0403/sdi/sdi*v01.fits.gz',count=n) full-disk images
IDL> help,lstfiles
```

```
IDL> read_lst,lstfiles,index,data index is a structure
IDL> help,index,data
```

```
IDL> read_lst,lstfiles,index,data, /nodata index is a structure
IDL> help,index
```

```
IDL> read_lst,lstfiles,index,data, /fitshead index is a string array
IDL> help,index,data
```

```
IDL> read_lst,lstfiles,index,data, /nodata, /fitshead index is a string array
IDL> help,index
```

lst_prep.pro

```
; NAME: LST_PREP
;
; PROJECT: ASO-S/LST
;
; PURPOSE: optional preprocessing steps of LST level 1 data including:
;           background subtraction (usually for full-disk images),
;           radiometric calibration,
;           fixing missing/bad pixels,
;           fixing cosmic-ray/spike pixels,
;           image registration (rotation, translation, scaling)
;
;           By default, 'lst_prep' fixes missing/bad pixels and does image registration.
;           If we want to do more, e.g., background subtraction, radiometric calibration, despiking,
;           we need to set /bkgimg_on, /radcalib_on, /despik_on, respectively.
;
; CALL: wst_prep.pro, sdi_prep.pro
;
; INPUTS:
; ihdr, iimg - header and image of level 1 data
; OUTPUTS:
; ohdr, oimg - header and image of output data
; KEYWORDS:
; /bkgimg_on - perform background subtraction,
;             please use the keyword together with bkg_hdr & bkg_dat
; bkg_hdr & bkg_dat - if set /bkgimg_on, then please provide
;                   the header and data array for background (for full-disk observations)
; /radcalib_on - perform radiometric calibration
; /fix_missing_off - no fixing of the missing and bad pixels
; /reg_off - no image registration
; /despik_on - if set, then despik image (remove the cosmic ray hits)
; /la_cosmic - if set, then use la_cosmic method to despik image,
;             please use together with /despik_on
;             note it takes about 30s to process an image of the size 4608*4608
;             approximately, the processing time is linearly proportional to the size of an image array
; outsize - size of output data (only for full-disk images). If not set, it is the default size 4608
; /do_write_fits - write a fits file
; /compress - write a fits.gz file
; outdir - a folder for saving the fits file
; status - 0 for undone, 1 for successful, -1 for failed
; /quiet - suppress output information
```



```
IDL> read_lst,lstfiles,index,data
```

```
IDL> help,index,data
```

```
IDL> ihdr=index
```

```
IDL> iimg=data
```

```
IDL> help,ihdr,iimg
```

```
;;case 1: fixing missing/bad pixels,  
image registration
```

```
IDL> lst_prep, ihdr, iimg, ohdr, oimg
```

```
IDL> index2map,ohdr,oimg,omaps
```

```
IDL> window,/free,xs=600,ys=600
```

```
IDL> lst_lct, wavelnth = 1216, instr = 'sdi'
```

```
IDL> plot_map,omaps[0],/log,dmin=10,dmax=5000
```

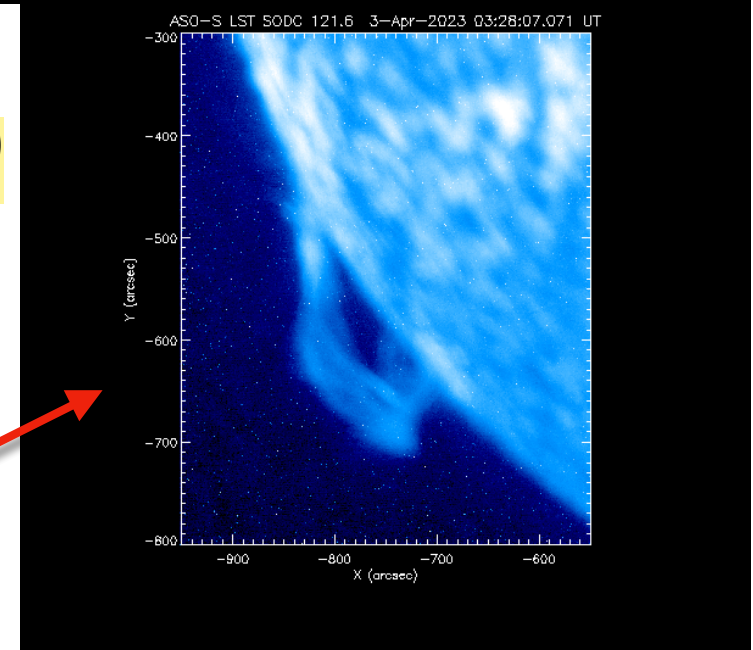
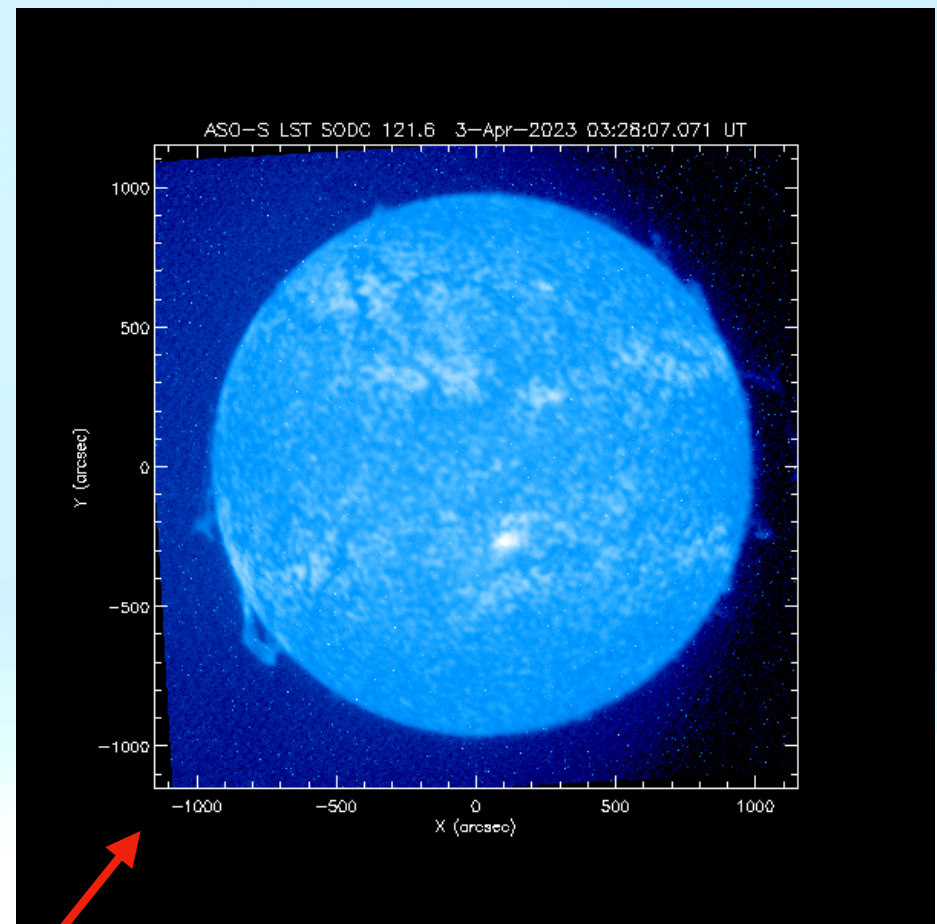
```
IDL> write_png,'omaps0.png',tvrdr(true=1)
```

```
IDL> sub_map,omaps[0],wmap,$
```

```
xrange=[-900,-500],yrange=[-800,-300]
```

```
IDL> plot_map,wmap,/log,dmin=40,dmax=2000
```

```
IDL> write_png,'wmap0.png',tvrdr(true=1)
```



; case 2: fixing missing/bad pixels, despiking, image registration

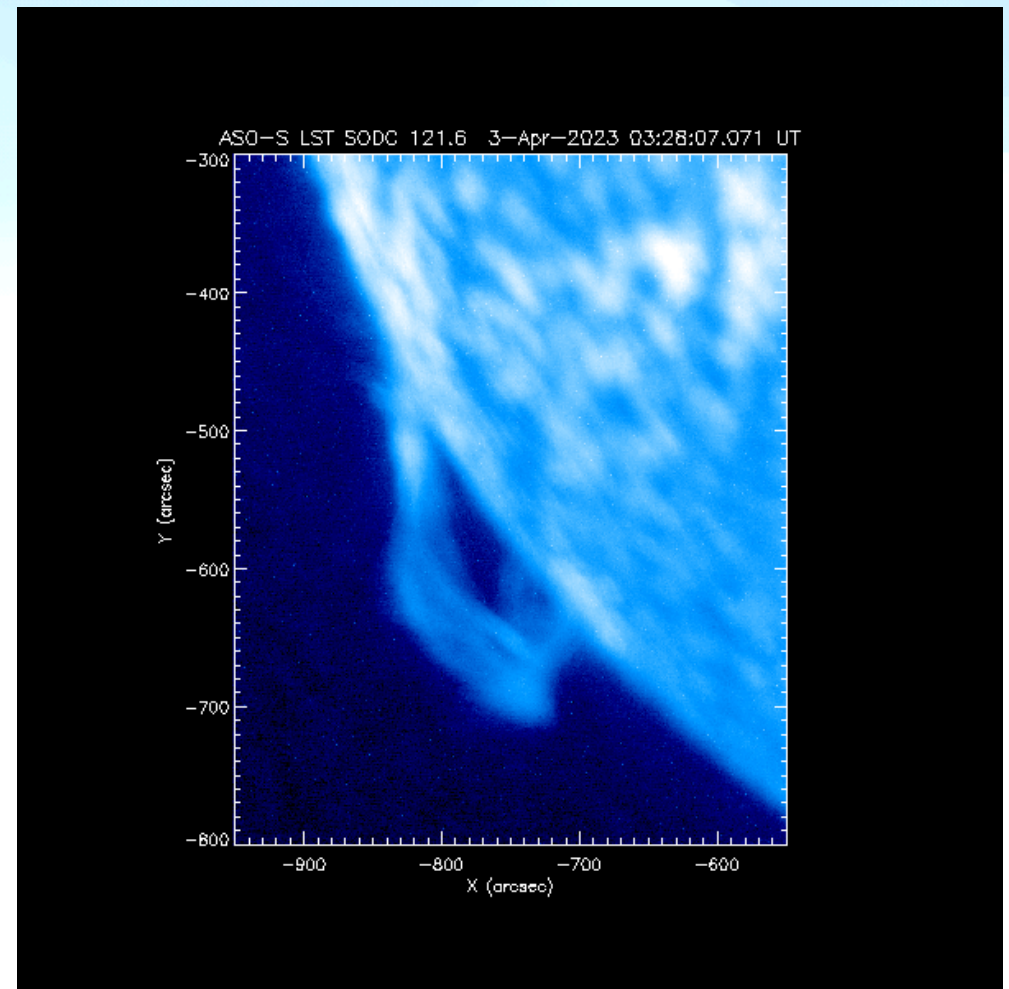
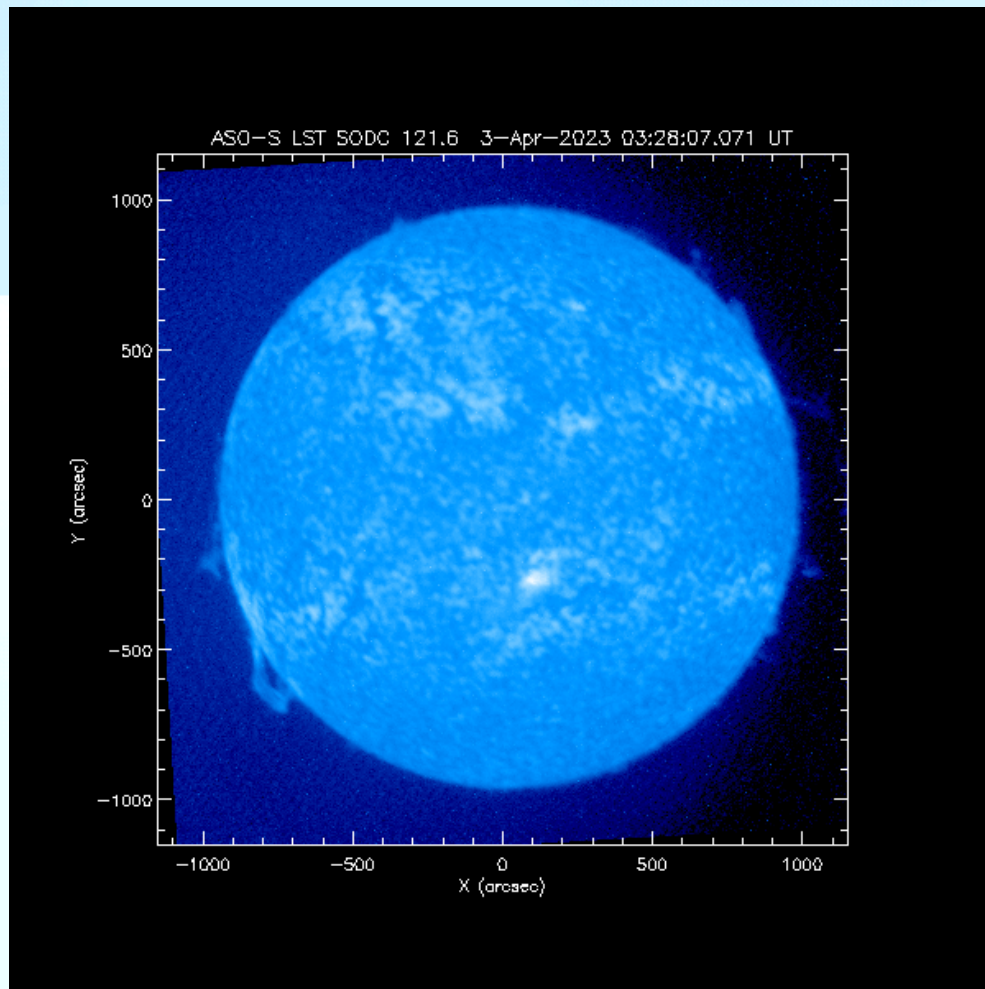
```
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /despike_on
```

```
IDL> index2map, ohdr, oimg, omaps
```

```
IDL> plot_map, omaps[0], /log, dmin=10
```

```
IDL> sub_map, omaps[0], wmap, xrange=[-950, -550], yrange=[-800, -300]
```

```
IDL> plot_map, wmap, /log, dmin=40, dmax=2000
```



; case 3: fixing missing/bad pixels, despiking, no image registration

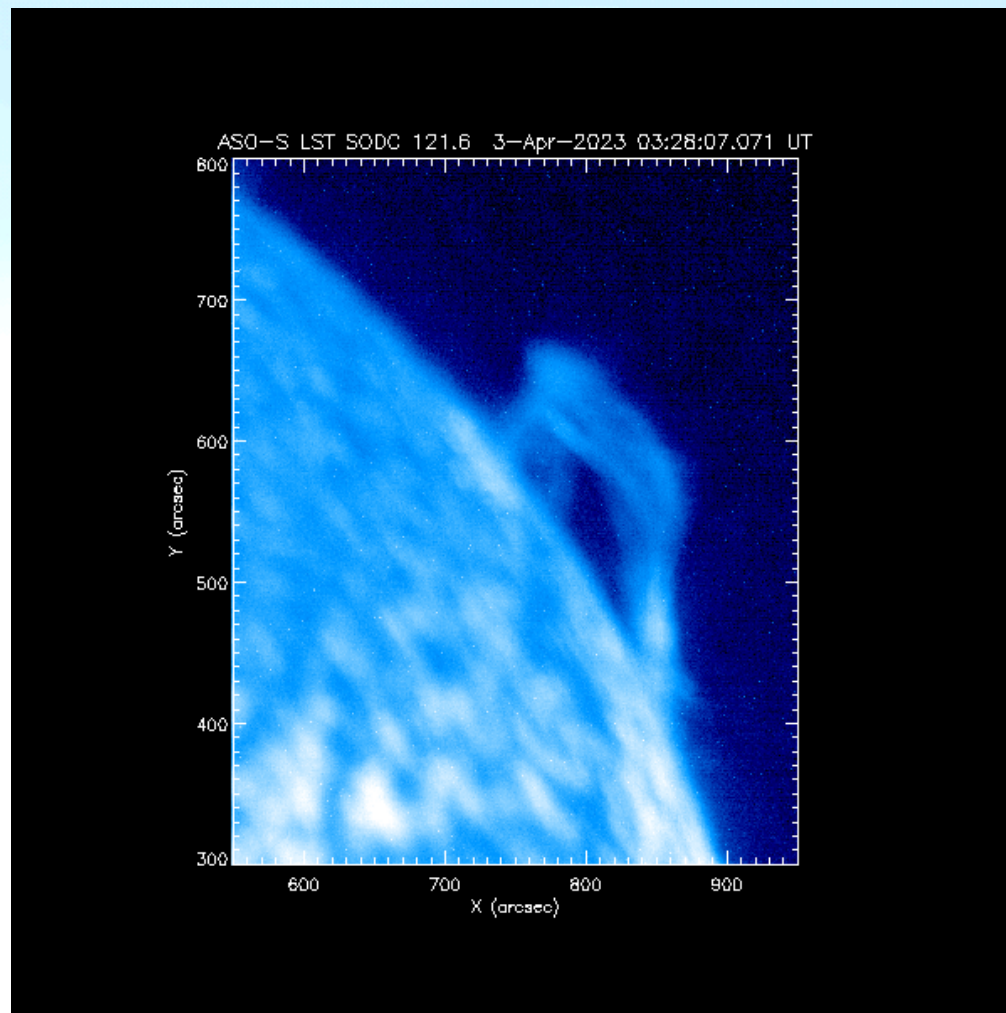
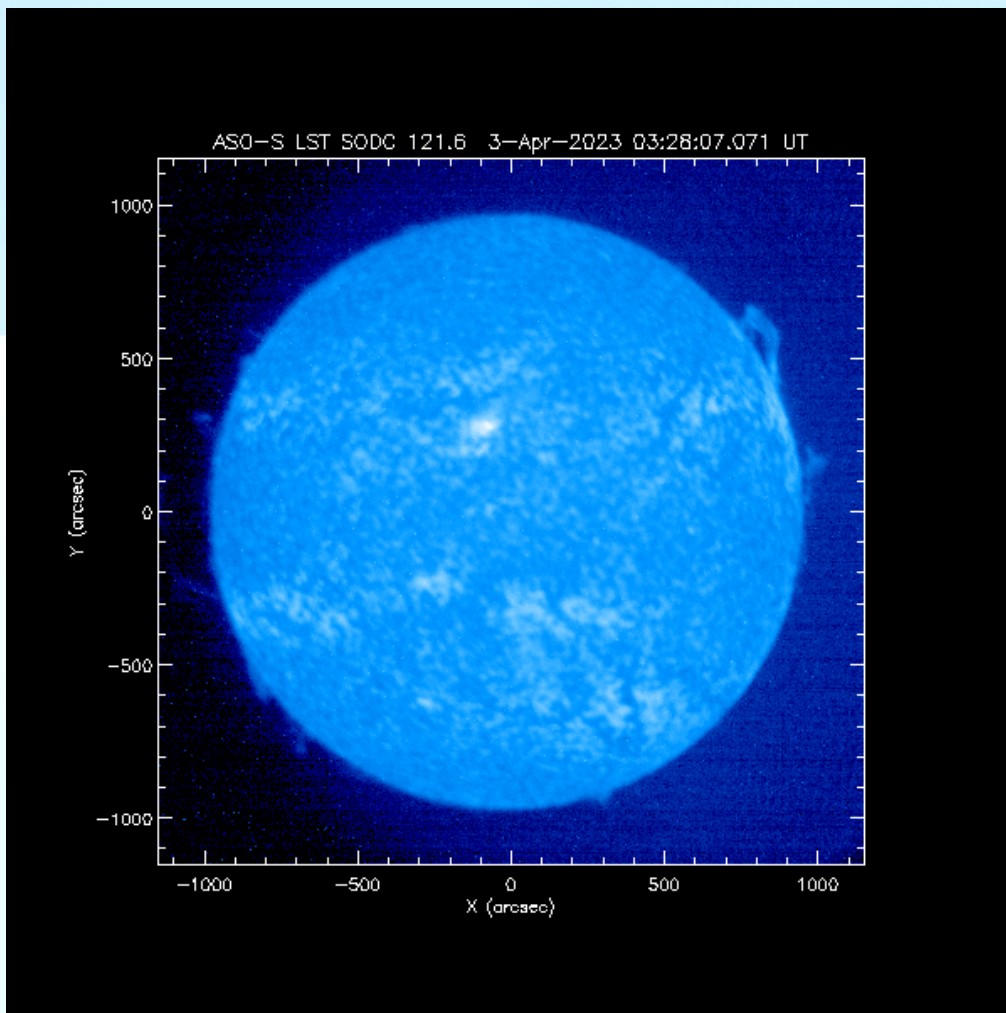
```
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /despike_on, /reg_off
```

```
IDL> index2map, ohdr, oimg, omaps
```

```
IDL> plot_map, omaps[0], /log, dmin=10
```

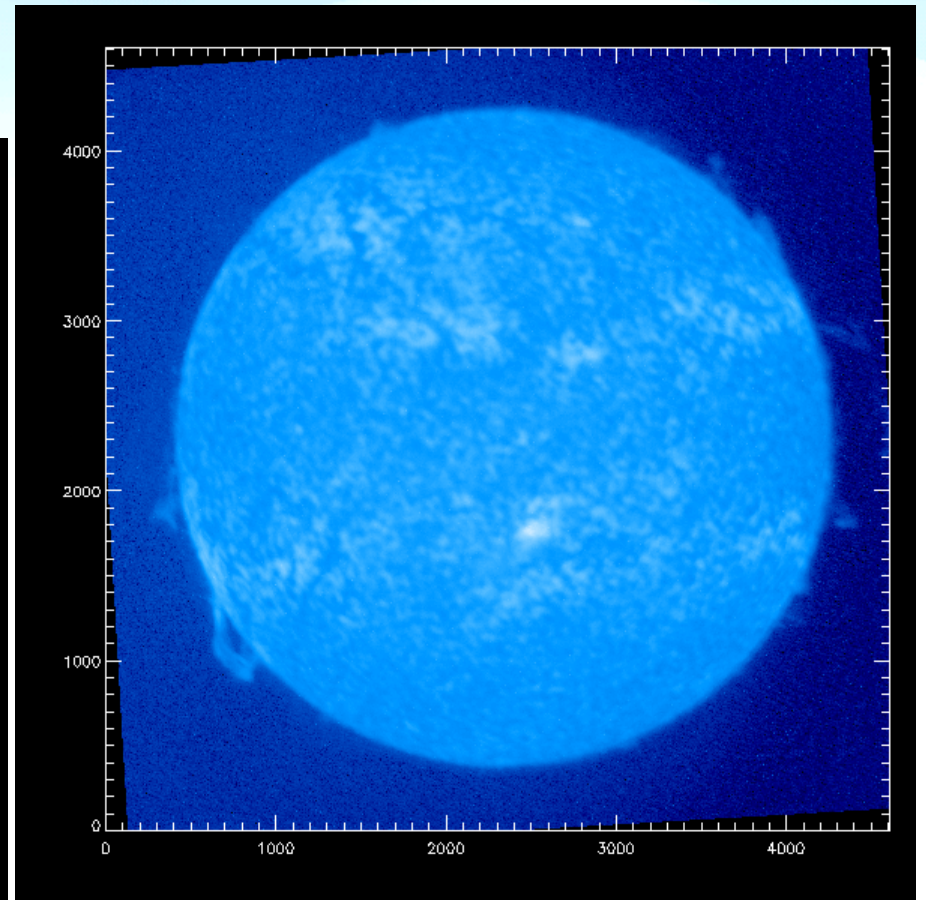
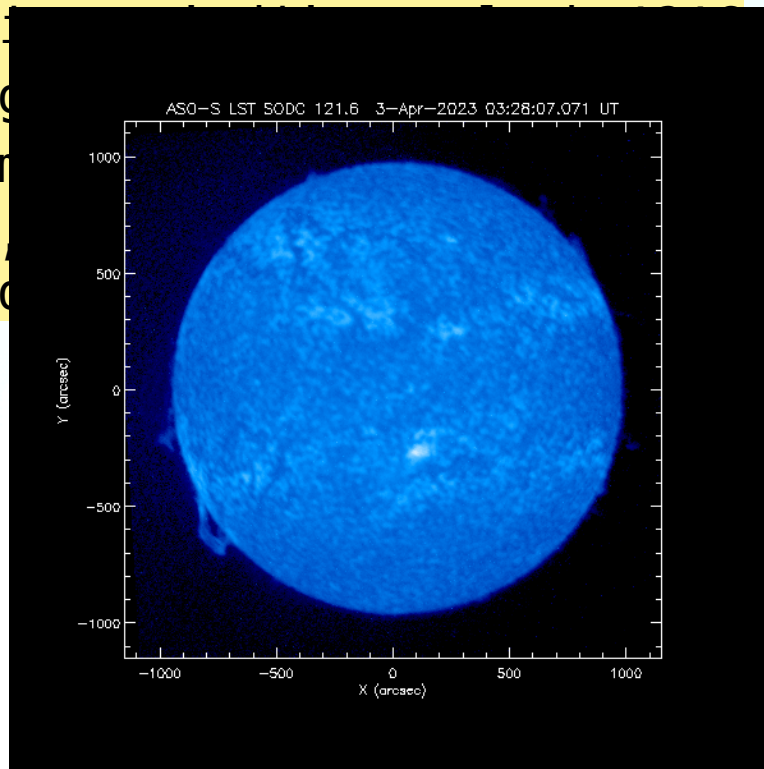
```
IDL> sub_map, omaps[0], wmap, xrange=[550,950], yrange=[300,800]
```

```
IDL> plot_map, wmap, /log, dmin=40, dmax=2000
```



```
; case 4: background subtraction, fixing missing/bad pixels,  
despike, image registration
```

```
IDL> bkgfile='0403/sdi/sdi_lev10_20230403_bkg_biweekly.fits.gz'  
IDL> read_lst,bkgfile,bkg_hdr,bkg_dat  
IDL> help,bkg_hdr,bkg_dat  
IDL> lstfiles=findfile('0403/sdi/sdi*v01.fits.gz')  
IDL> read_lst,lstfiles,ihdr,iimg  
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /bkgimg_on, bkg_hdr=bkg_hdr, $  
bkg_dat=bkg_dat, /despike_on  
IDL> index2map,ohdr,oimg,omaps  
IDL> window,/free,xs=600,ys=600  
IDL> lst_lct,  
IDL> plot_image,  
min=0.5,  
IDL> plot_map,  
dmin=40,0
```




```
; case 5: fixing missing/bad pixels, despik,  
writing compressed fits to outdir, outsize=2304 (/usr/local/...
```

```
IDL> outdir='outdir/'
```

```
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /despike  
outsize=2304, /do_write_fits, /compress,
```

```
IDL> index2map, ohdr, oimg, omaps
```

```
IDL> help, omaps[0].data
```

```
<Expression>      DOUBLE      = Array[2304, 2304]
```

```
IDL> plot_map, omaps[0], /log, dmin=10
```

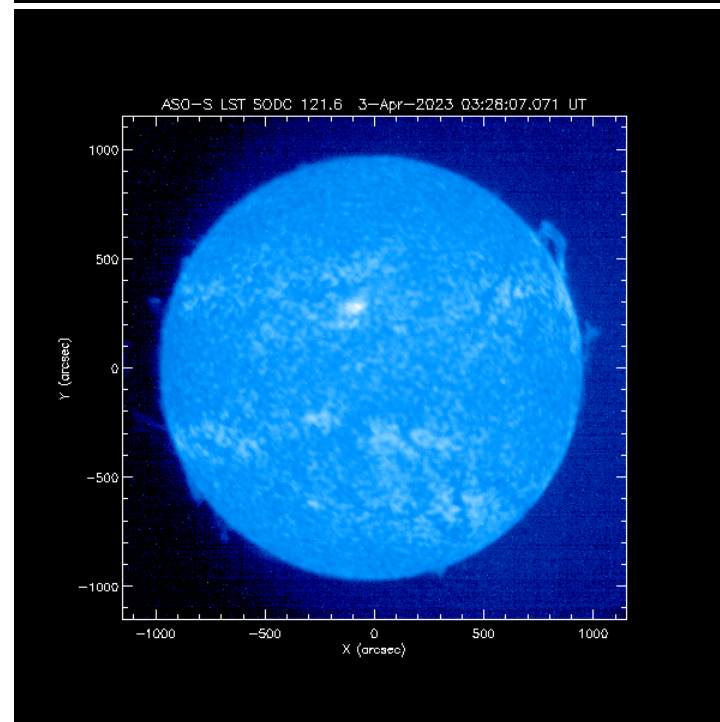
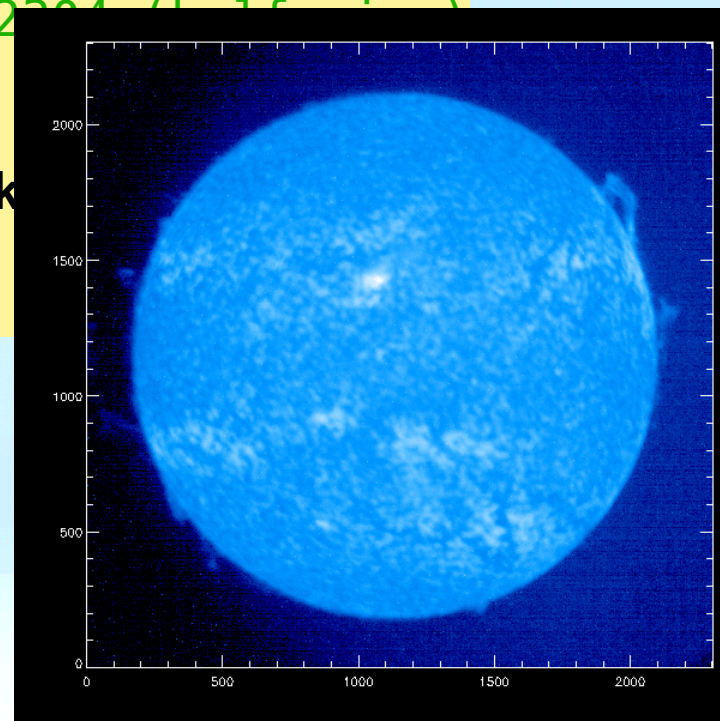
```
IDL> lstfiles=findfile('outdir/sdi*.fits.gz')
```

```
IDL> help, lstfiles
```

```
IDL> read_lst, lstfiles, index, data
```

```
IDL> help, index, data
```

```
IDL> plot_image, alog10(data[*,*], 0) > 10)
```



; case 6: for cutout images: fixing missing/bad pixels,
despike with the slower but maybe better la_cosmic method

```
IDL> lstfiles=findfile('0403/sdi/*v01_cut.fits.gz')
```

cut-out images

```
IDL> help,lstfiles
```

```
IDL> read_lst,lstfiles,ihdr,iimg
```

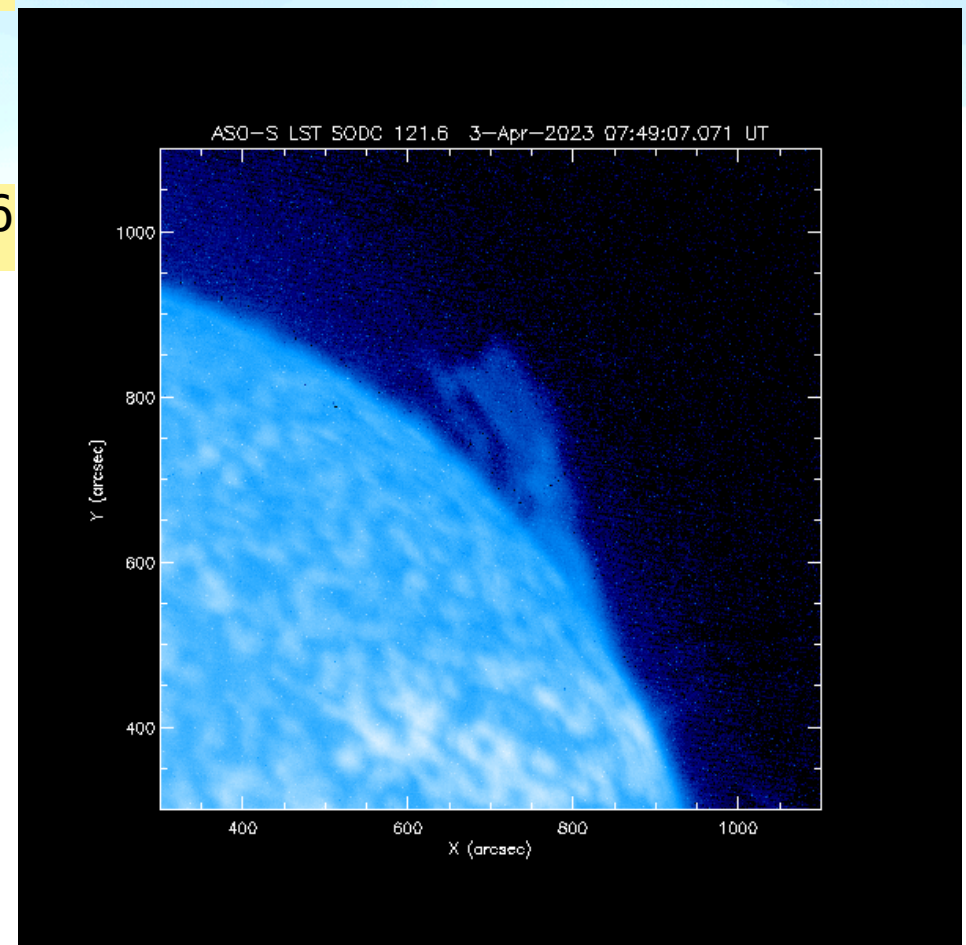
```
IDL> lst_prep, ihdr, iimg, ohdr, oimg,$  
/despike_on, /la_cosmic, /reg_off
```

```
IDL> index2map,ohdr,oimg,omaps
```

```
IDL> window,/free,xs=600,ys=600
```

```
IDL> lst_lct,instr='sdi',wavelnth=1216
```

```
IDL> plot_map,omaps[0],/log,dmin=10
```



Download WST data from:

<http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

The screenshot shows the ASO-S Data Archive web interface. The browser is Safari, and the URL is <http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>. The page has a blue navigation bar with links: Quick Look, Data Access, Analysis Software, Guide, Operation, and Back Home. The main content area is titled "Data Archive" and contains the following information:

step1 Data Archive

The ASO-S data policy can be found [here](#).

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time: 04/03/2023 03:28 End Time: 04/03/2023 03:32

step2 HXI ?

Level Q1 Hourly Fits Hourly Png Data-production status Png

Level 1 Detector Data

step3 FMG ?

Level 2-AR User-defined Cadence s

step4 SDI Mode Routine User-defined Cadence s

WST Level 1 User-defined Cadence s

WST Mode Routine Burst-1024 Burst-4096 User-defined Cadence s

Email: Search Tar and Download Data Reset

Result File Count : 2 Probable Size(MB) : 51 Request ID : 20230411185312467061

Data Export Status and Retrieval

Request ID : Check Status Status : Ready

Link : <http://aso-s.pmo.ac.cn:80/downloadPackFits/20230411/20230411185312467061.zip>

File Name	Download
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Download WST cut-out data from:

<http://aso-s.pmo.ac.cn/sodc/cutout.jsp>

The screenshot shows the 'Cutout Service' page on the ASO-S Science Operation and Data Center website. The page includes a navigation bar with links like 'Quick Look', 'Data', 'Analysis Software', 'Guide', 'Operation', and 'Back Home'. The main content area is titled 'Cutout Service' and contains a form for requesting data cutouts. Five yellow callout boxes are overlaid on the form, labeled 'step1' through 'step5', pointing to specific fields: 'step1' points to the 'Start Time' and 'End Time' fields; 'step2' points to the 'WST Level' dropdown menu; 'step3' points to the 'User-defined Cadence' checkbox; 'step4' points to the 'Xcenter (arcsec)' field; and 'step5' points to the 'Xrange (arcsec)' field. Below the form, there is a 'Result' section showing 'File Count : 2', 'Probable Size(MB) : 51', and 'Request ID : 20230411190858546069'. At the bottom, there is a 'Data Export Status and Retrieval' section with a 'Request ID' field, a 'Check Status' button, and a 'Download Link' button.

step1

step2

step3

step4

step5

Cutout Service

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time 04/03/2023 10:00 **End Time** 04/03/2023 10:03

LST

SDI Level

Cadence(optional) User-defined Cadence

WST Level 1

Cadence(optional) User-defined Cadence s

Xcenter (arcsec) 50 **Ycenter (arcsec)** -250 **Xrange (arcsec)** 600 **Yrange (arcsec)** 600

Tracking (optional) Reference Time

Requirements

The arcsec range for x-axis is between $[-1150, Xcenter - (Xrange/2)]$ and $[Xcenter + (Xrange/2), 1150]$.
The arcsec range for y-axis is between $[-1150, Ycenter - (Yrange/2)]$ and $[Ycenter + (Yrange/2), 1150]$.

Email: zhangqm@pmo.ac.cn **Search** **Submit** **Reset**

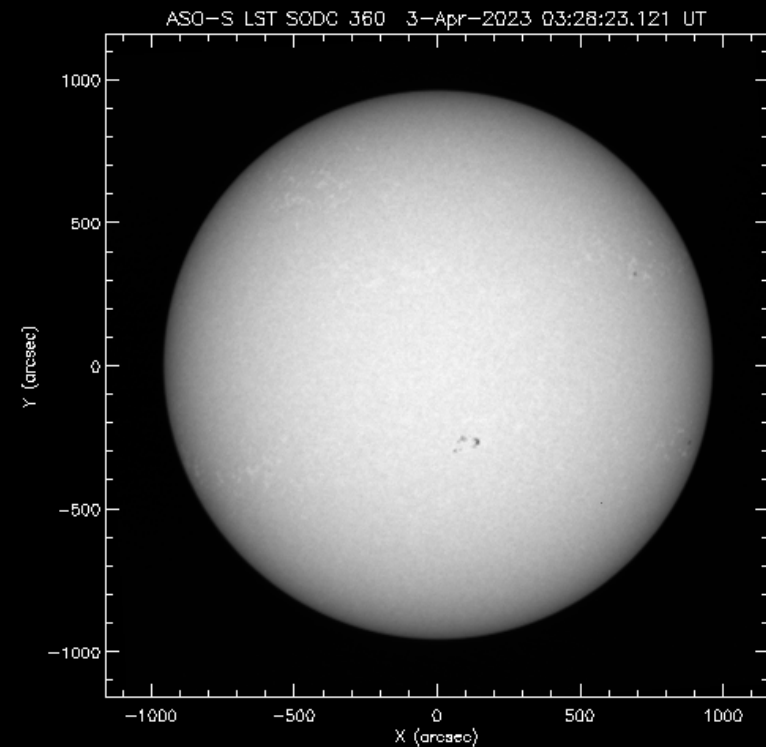
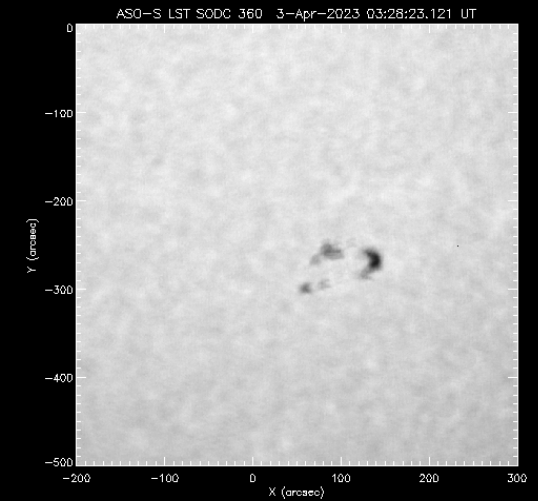
Result File Count : 2 Probable Size(MB) : 51 Request ID : 20230411190858546069

Data Export Status and Retrieval

Request ID : 20230411190858546069 **Check Status** Status : Ready

Link : <http://aso-s.pmo.ac.cn:80/downloadCutout/20230411/20230411190858546069.tgz> **Download Link**


```
IDL> lstfiles=findfile('0403/wst/*v01.fits.gz')
IDL> help,lstfiles
IDL> read_lst,lstfiles,ihdr,iimg
; case 1: fixing missing/bad pixels,
image registration
IDL> lst_prep, ihdr, iimg, ohdr, oimg
IDL> index2map,ohdr,oimg,omaps
IDL> window,/free,xs=600,ys=600
IDL> lst_lct,wavelnth=3600,instr='wst'
IDL> plot_map,omaps[0]
IDL> write_png,'wst0.png',tvrdr()
IDL> sub_map,omaps[0],qmap,$
xrange=[-200,300],yrange=[-500,0]
IDL> plot_map,qmap,dmin=3000
IDL> write_png,'qmap0.png',tvrdr()
```

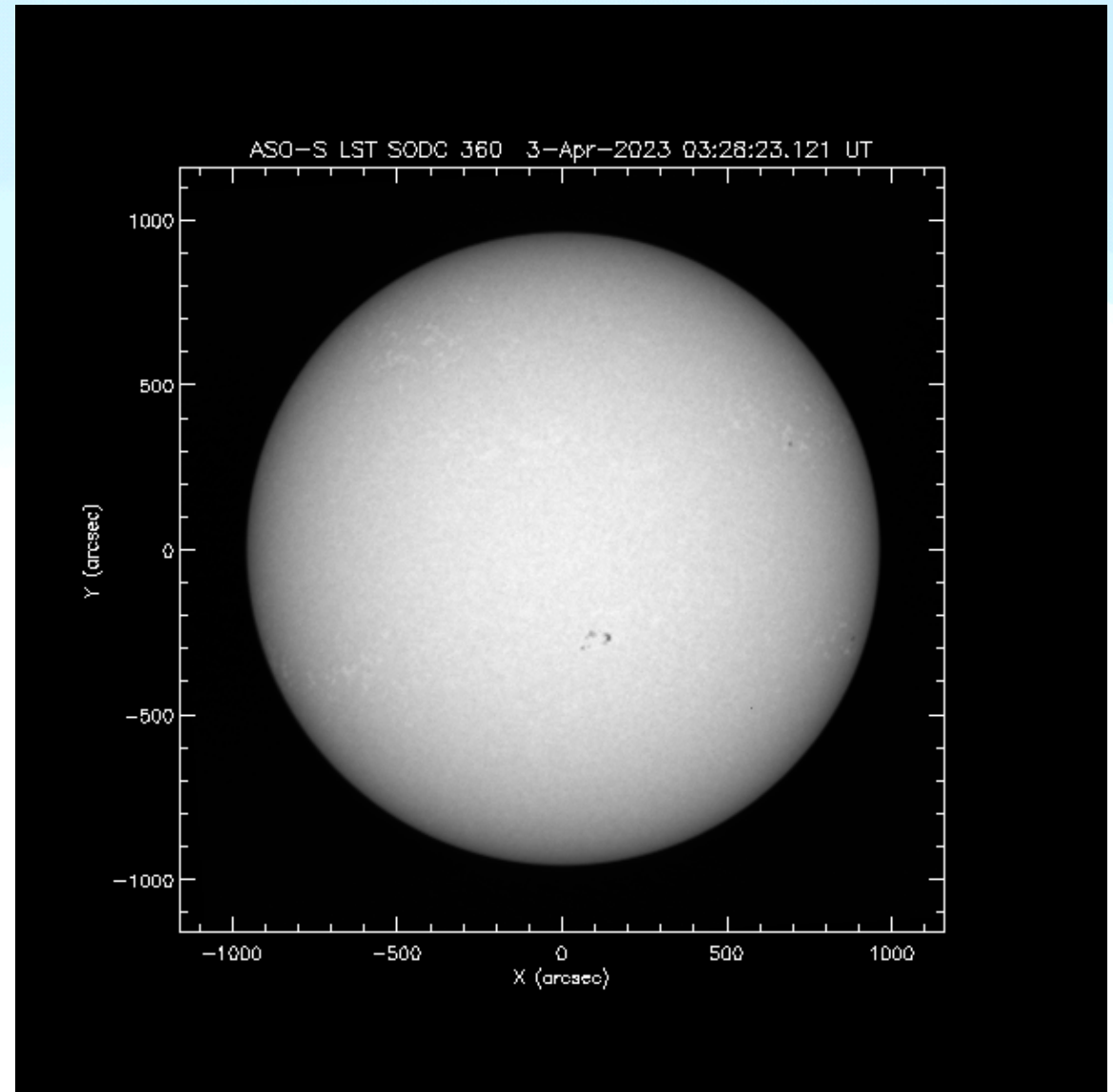


```
; case 2: radiometric calibration, fixing missing/bad pixels,  
image registration
```

```
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /radcalib_on
```

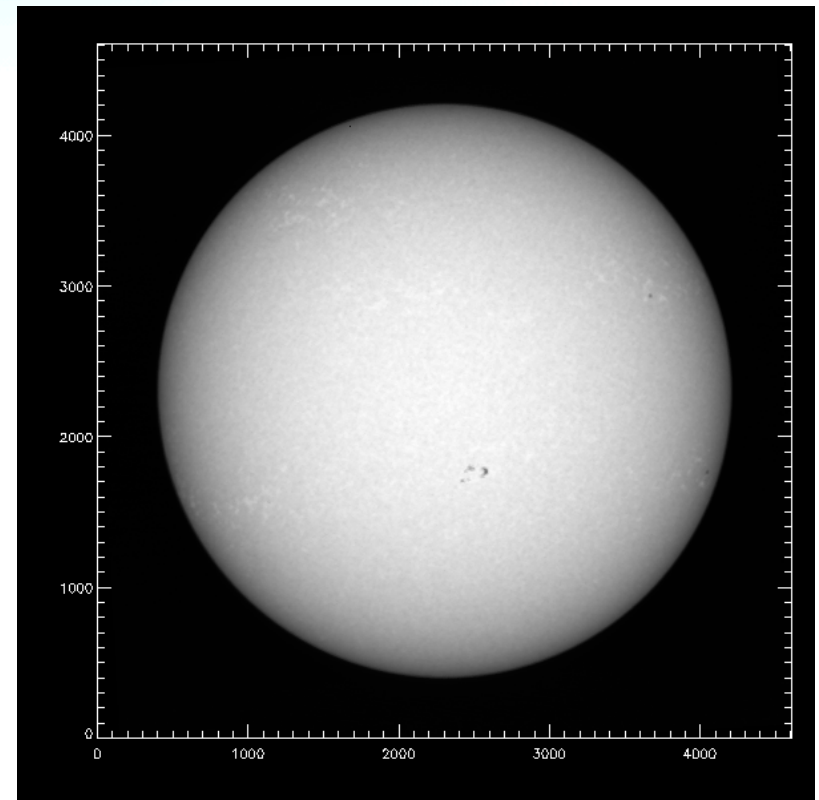
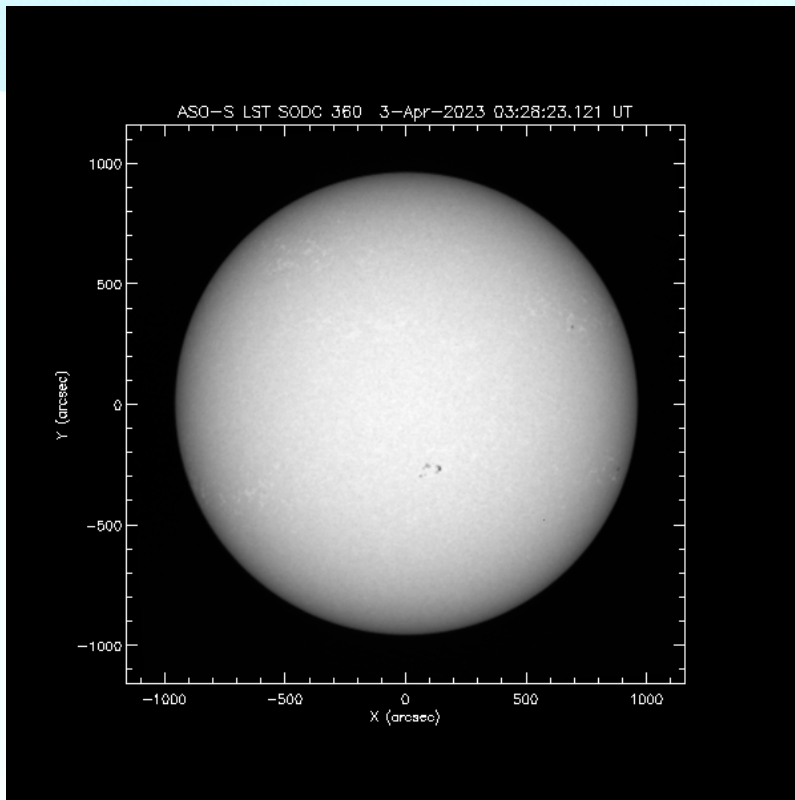
```
IDL> index2map, ohdr, oimg, omaps
```

```
IDL> plot_map, omaps[0]
```



```
; case 3: radiometric calibration, fixing missing/bad pixels,  
despike, image registration, writing compressed fits.gz to outdir
```

```
IDL> outdir='outdir/'  
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /radcalib_on, $  
    /despike_on, /do_write_fits, /compress, outdir=outdir  
IDL> index2map, ohdr, oimg, omaps  
IDL> plot_map, omaps[0]  
IDL> files=findfile('outdir/wst*v01.fits.gz', count=n)  
IDL> help, files  
IDL> read_lst, files, index, data  
IDL> plot_image, data[*,* ,0]
```



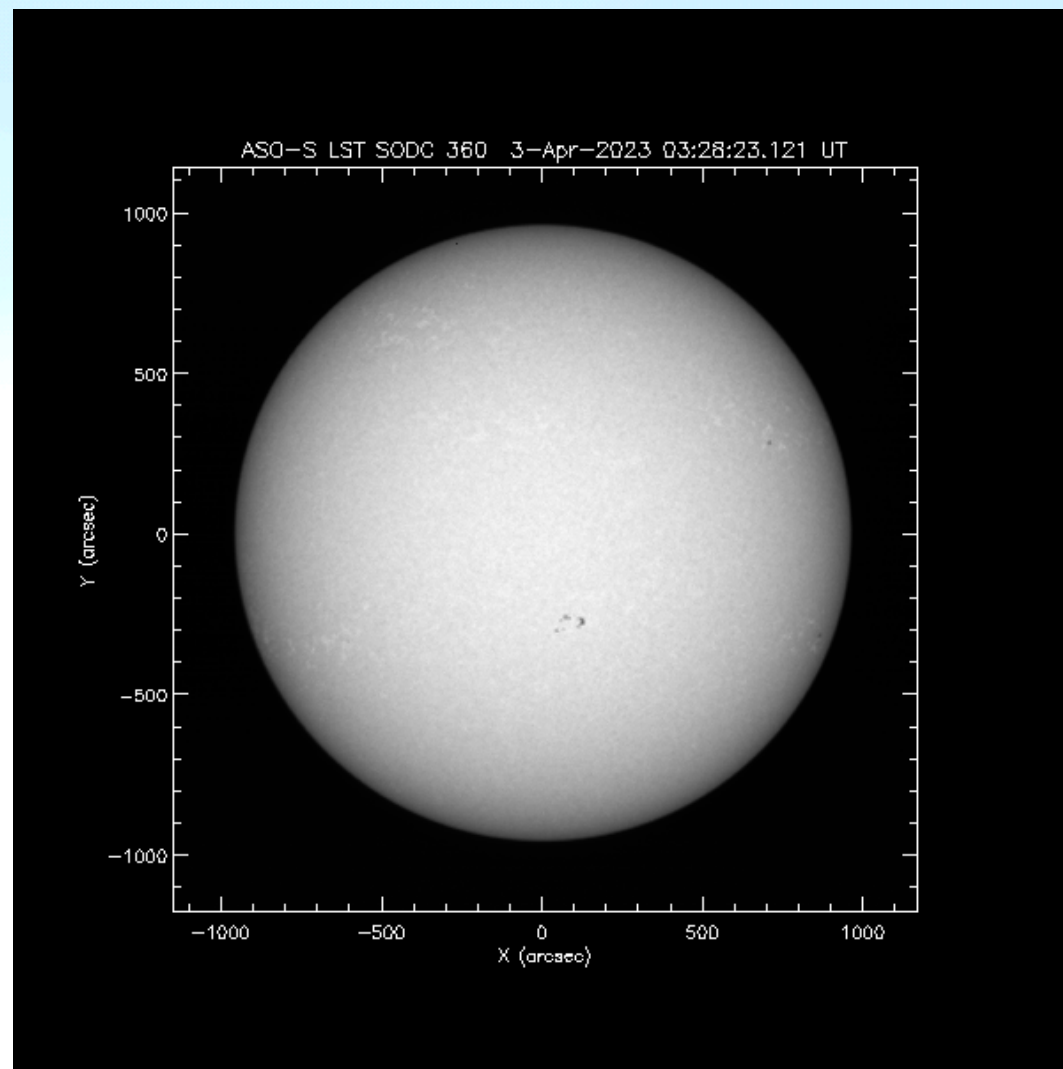
```
; case 4: fixing missing/bad pixels, despiking,  
no image registration, outsize=4096 (same as HMI)
```

```
IDL> lst_prep, ihdr, iimg, ohdr, oimg, $  
/despike_on, /reg_off, outsize=4096
```

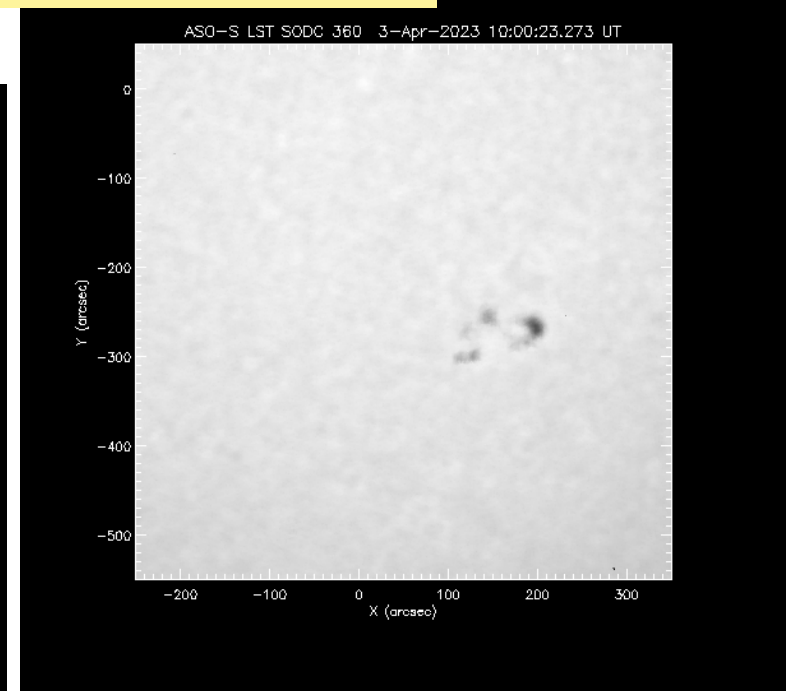
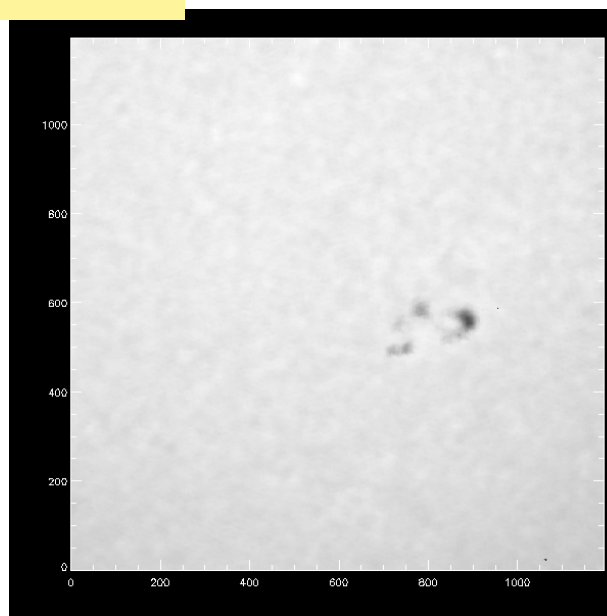
```
IDL> help,ohdr,oimg
```

```
IDL> index2map, ohdr, oimg, omaps
```

```
IDL> plot_map,omaps[0]
```




```
IDL> lstfile='0403/wst/wst_lev10_20230403_100023.273_v01_cut.fits'  
IDL> read_lst,lstfile,ihdr,iimg  
IDL> outdir='outdir/'  
IDL> lst_prep, ihdr, iimg, ohdr, oimg, /radcalib_on, $  
    /despike_on, /do_write_fits, /compress, outdir=outdir  
IDL> index2map,ohdr,oimg,omap  
IDL> window,/free,xs=600,ys=600  
IDL> lst_lct,wavelnth=3600,instr='wst'  
IDL> plot_map,omap  
IDL> file='outdir/wst_20230403_100023.273_v01_cut.fits.gz'  
IDL> read_lst,file,index,data  
IDL> help,data  
IDL> plot_image,data
```



Thank you for your attention!

Contact me (zhangqm@pmo.ac.cn) to get this presentation.