

SUMER FITS HEADER DESCRIPTION

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The SUMER data in the archive can be processed by using the software available in the **solarsoft**. A dedicated program has been written (and is maintained) by IAS/SUMER team which makes an automatic correction of distortion, FlatField and optionally of detector non-linearity and of radiometry by calling the appropriate subroutines in the `sumer/contrib`.

This program (`sum_read_corr_fts.pro`) is available in [/solarsoft/soho/sumer/idl/contrib/bocchialini](#) . It calls subroutines:

```
sumFField.pro
deadtme_corr.pro
local_gain_corr.pro
radiometry.pro
destr_bilin_multi.pro
```

the outputs are `.sav` files. A description of the program use is at the beginning of the program.

SUMER Fits headers are compatible with the general description of Fits headers, and take into account the rules adopted for SOHO Fits headers.

All the SUMER files have two headers:

The **PRIMARY HEADER** give the general description of the file with some parameters of the SOHO spacecraft (attitude, solar coordinates,..) useful for the data reduction.

The **BINARY HEADER(S)** give a more detailed description of the binary tables which constitute the data file. If there are several binary tables in the same file there is a **BINARY HEADER** for each table.

Nevertheless some used parameters are specific to SUMER instrument and operation and need to be described in more details.

First the parameter list and the description obtained directly from the primary headers and binary headers are shown. Most of them are self-descriptive. Following, the parameters which require a more detailed explanation (underlined in the list) have a full description.

An example of HEADERS is given to support the description of each parameter.

To fully understand the means of the SUMER parameters it is recommended to read the SUMER spectrometer description before operation (Wilhelm et al., 1995) and at the beginning of operation (Wilhelm et al., 1997; Lemaire et al., 1997).

A brief description of SUMER is following:

SUMER telescope: one off-axis parabola mirror rotating around its focus along two axes (`solar_x` and `solar_y`) by steps of 0.76 arcsec (half-steps possible).

SUMER slits:

n° 1	4" x 300"	(width x height)
2	1" x 300"	
3	1" x 120"	(top or south)
4	1" x 120"	(middle)
5	1" x 120"	(bottom or north)
6	0.3" x 120"	(top or south)
7	0.3" x 120"	(middle)
8	0.3" x 120"	(bottom or north)
9	1" hole	

(5' hole used for special purposes above the solar limb e.g. star calibration. This hole is not referenced by name and is most of the time under slit 9, the signature of this hole is the very low line resolution -about 300 pixels).

Top, middle, bottom refer to the image on the 360 pixel height detectors. North and South refer to the relative position in solar coordinates. The SUMER slits can be adjusted to furnish the best telescope focus. Using the focussing mechanism in the spectrometer, the best focus of the spectrometer can

also be adjusted. This was done time-to-time to check (to control) the aging of the structure and individual optical components.

SUMER spectrometer: an off-axis parabola mirror collimates the beam issued from the slit, which is deflected at a variable angle (scan mechanism) by a plane mirror, then is collected, diffracted and focussed by a concave grating. The focussed beam is collected by the 2-D (360 x 1024 pixels²) detectors A or B.

SUMER detectors: detectors A and B are similar (microchannel plate -MCP- + x and y anodes). Each detector has 2 photocathodes with different sensitivity along the dispersion (1048 pixels): on the edges the bare MCP is used and on the center the deposit of KBr increases the sensitivity in the long wavelength range (800 A to 1600 A). At the extremities of the each detector an attenuator with holes masks about 30-40 pixels.

SUMER wavelengths: the wavelengths are in angstrom either in the first (800-1600 A, detector A; ,detector B), the second (400-800 A, detector A; , detector B) or the third (, detector B) grating order. Each detector (one is in use at a time) receives about 42 A (first order) and the change of wavelength performed by rotation of the scan mirror and translation of the grating permits to cover the full 500-1600 A spectral range simultaneously in two orders. The monochromatic and stigmatic images of the slit gives approximatively one solar arcsecond per pixel. Along the dispersion a pixel corresponds to about 0.043 A (The scalings are given in the **BINARY HEADER**).

PRIMARY HEADER

```
SIMPLE = T /Written by IDL: 16-Nov-1997 03:59:19.00
BITPIX = 8 /
NAXIS = 0 /
EXTEND = T /File contains extensions
DATE = '1999-01-20' /
FILENAME= 'SUM_960703_060112.FTS' /Name of the FITS file
SORIG = 'AXP/OPENVMS' /
DATASRC = 'Final Distribution (CDROM)' /Data source
TELESCOP= 'SOHO ' /
INSTRUME= 'SUMER ' /
OBS_SEQ = ' Raster ' /Name of observing sequence
DATE_MOD= '1997-11-16' /Date of the last modification
ORIGIN = '<1> SOHO-EOF' /Command source
STUDY_ID= 503 /Study number
STUDY_NM= 'LEM JOP22_RUN_JAB02 ' /Study name
CORORB = F /Orbitology corrected
DATE_OBS= '1996-07-03T06:01:12.094' /Beginning of observation date
DATE_END= '1996-07-03T06:30:18.524' /End of observation date
OBT_TIME= 1.2150649e+09 /Starting time of acquisition (in TAI seconds)
OBT_END = 1.2150666e+09 /Ending time of acquisition (in TAI seconds)
DETECTOR= '<1> A ' /Detector used
EXPTIME = 14.7502 /Exposure time (second)
IXWIDTH = 176.320 /Image width (arcsec)
IYWIDTH = 300.000 /Image heigth (arcsec)
SLIT = '<2> 1.0 * 300 centered' /Slit number
OBJECT = 'NET ' /Target
SCI_OBJ = 'JOP 22 Network Dynamcis ' /Science objective
OBS_PROG= 'JOP022_RUN_JULY_AB_02, IN S VI,LY EPS,N III,NE VI ' /Name of scientis
CMP_NAME= '<121> Network Evolution and Dynamics ' /Name of campain observation
CMP_ID = 121 /Campain number
POPUDP = 14 /POP/UDP number
PROG_TYP= 1 /Program type 1 : UDP / 0 : POP or SCL function
SCIENTIS= '<9> Philippe Lemaire ' /Scientist responsible of POP/UDP
TREATMT = F /Treatment applied on data
PHYSCOM = ' ' /Comment concerning physical informations data
PHYSDAT = ' ' /Physical data obtained
```

```

PROC_COM= ' ' /Comments on processing
SC_COM = ' ' /Scientific comments on data
T_QUAL = ' ' /Quality of image /target
I_QUAL = ' ' /Absolute quality
FFONOFF = T /Flat field ON/OFF (True=ON False=OFF)
BINX = 1 /Binning X (1-1024)
BINY = 1 /Binning Y (1-360)
ININM_ID= '<0> none ' /Master ID
ININSE = '<0> No Event ' /Inter instrument solar event
ININVALX= 0.000000 /Inter instrument value X
ININVALY= 0.000000 /Inter instrument value Y
ROTCMP = 0.000000 /Solar rotation compensation
PROCESS = '<0> RAW ' /0 => Creation by SUMER FITS software
COMPRESS= '<5> Quasi Log Min-Max ' /Compression method
COMPAR1 = 33 /Compression parameter 1
COMPAR2 = 70 /Compression parameter 2
COMPAR3 = 0 /Compression parameter 3
ININSMOD= '<0> No interrupts allowed' /Inter instrument mode
WAVEMIN = 933.380 /Minimum wavelength
WAVEMAX = 937.800 /Maximum wavelength
SOLAR_P0= -1.55518 /Solar angle P0 (degrees)
SOLAR_B0= 3.15672 /Solar angle B0 (degrees)
INS_X = -480.125 /Pointing of instrument / instrument X-axis
INS_Y = 217.875 /Pointing of instrument / instrument Y-axis
INS_X0 = 0.000000 /Pointing of instrument origin / spacecraft/sola
INS_Y0 = 0.000000 /Pointing of instrument origin / spacecraft/sola
SC_X0 = -1.83378e-05 /Spacecraft pointing / solar X-axis
SC_Y0 = 0.0142153 /Spacecraft pointing / solar X-axis
SC_ROLL = 0.0739116 /Spacecraft roll angle relative to the solar coo
XCEN = -436.878 /Centre of the instrument FOV / solar X-axis
YCEN = 217.875 /Centre of the instrument FOV / solar Y-axis
ANGLE = 0.000000 /Angle of rotation of the vertical of the instrum
RASTYPE = ' RASTER ' /Sequence type
UDP_ID = 897 /Reference to observing program
PROG_NM = 'UDP LEM J22JA02 ' /Name of observing program
SFDUADID= ' ' /SFDU ADID
COMMENT
HISTORY
END

```

BINARY HEADER

```

XTENSION= 'BINTABLE' /Written by IDL: 16-Nov-1997 03:59:21.00
BITPIX = 8 /
NAXIS = 2 /Binary table
NAXIS1 = 4182960 /Number of bytes per row
NAXIS2 = 1 /Number of rows
PCOUNT = 0 /Random parameter count
GCOUNT = 1 /Group count
TFIELDS = 7 /
CONVENTN= 'TDIM ' /Convention used
EXTNAME = 'BIN_EXT 1/1' /Extension name
DATAMAX = 141.000 /
TFORM1 = '1044000I' /Integer*2 (short integer)
TDIM1 = '(25,360,116)' /Array dimensions for column 1
TUNIT1 = 'Counts ' /Units of column 1
TDMIN1 = 0.000000 /Minimum value in column 1
TDMAX1 = 141.000 /Maximum value in column 1
TDESC1 = '(WAVELNTH,SOLAR_Y,SOLAR_X)' /Axis labels for column 1
TRVAL1 = '( 933.380, 217, -480)' /Reference position for column 1
TDEL1 = '( 0.0444845, 1.01659, 0.752174)' /Axis increments for column 1

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TRPIX1 = '( 13, 181,1)' /Reference pixel
TSPIX1 = '( 426, 179,1)' /Sumer Reference co-pixel plus 1
TCUNIT1 = '(ANGSTROM,ARCSEC,ARCSEC)' /Units
TWAVE1 = 933.380 /Observation wavelength in Angstrom
TDETX1 = 0 /Starting pixel in detector X
TDETY1 = 0 /Starting pixel in detector Y
TTYPE1 = 'W_933.380' /Column name
UCMPIM1 = 0 /Number of uncompleted images
TFORM2 = '1044000I' /Integer*2 (short integer)
TDIM2 = '(25,360,116)' /Array dimensions for column 2
TUNIT2 = 'Counts ' /Units of column 2
TDMIN2 = 0.000000 /Minimum value in column 2
TDMAX2 = 110.000 /Maximum value in column 2
TDESC2 = '(WAVELNTH,SOLAR_Y,SOLAR_X)' /Axis labels for column 2
TRVAL2 = '( 937.800, 217, -480)' /Reference position for column 2
TDELT2 = '( 0.0444715, 1.01629, 0.752174)' /Axis increments for column 2
TRPIX2 = '( 13, 181,1)' /Reference pixel
TSPIX2 = '( 525, 179,1)' /Sumer Reference co-pixel plus 1
TCUNIT2 = '(ANGSTROM,ARCSEC,ARCSEC)' /Units
TWAVE2 = 937.800 /Observation wavelength in Angstrom
TDETX2 = 0 /Starting pixel in detector X
TDETY2 = 0 /Starting pixel in detector Y
TTYPE2 = 'W_937.800' /Column name
UCMPIM2 = 0 /Number of uncompleted images
TFORM3 = '1160I ' /Integer*2 (short integer)
TDIM3 = '(2,116,5)' /Array dimensions for column 3
TUNIT3 = '(None) ' /Units of column 3
TDMIN3 = 1.000000 /Minimum value in column 3
TDMAX3 = 255.000 /Maximum value in column 3
TDESC3 = '(COL_IDX,IMG_IDX,STATUS)' /Axis labels for column 3
TRPIX3 = '( 2, 59,1)' /Reference pixel
TCUNIT3 = '(IDX,IDX,IDX)' /Units
TTYPE3 = 'SUM_STATUS' /Column name
TFORM4 = '232D ' /Real*8 (double precision)
TDIM4 = '(2,116) ' /Array dimensions for column 4
TUNIT4 = '(Seconds)' /Units of column 4
TDMIN4 = 0.000000 /Minimum value in column 4
TDMAX4 = 1716.93 /Maximum value in column 4
DESC4 = '(COL_IDX,IMG_IDX)' /Axis labels for column 4
TRPIX4 = '( 2, 59)' /Reference pixel
TCUNIT4 = '(IDX,IDX)' /Units
TTYPE4 = 'DEL_TIME' /Column name
TFORM5 = '232E ' /Real*4 (floating point)
TDIM5 = '(2,116) ' /Array dimensions for column 5
TUNIT5 = '(Seconds)' /Units of column 5
TDMIN5 = 14.7502 /Minimum value in column 5
TDMAX5 = 14.7503 /Maximum value in column 5
TDESC5 = '(COL_IDX,IMG_IDX)' /Axis labels for column 5
TRPIX5 = '( 2, 59)' /Reference pixel
TCUNIT5 = '(IDX,IDX)' /Units
TTYPE5 = 'EXPTIME ' /Column name
TFORM6 = '232E ' /Real*4 (floating point)
TDIM6 = '(2,116) ' /Array dimensions for column 6
TUNIT6 = '(Arcsecs)' /Units of column 6
TDMIN6 = -480.125 /Minimum value in column 6
TDMAX6 = -393.625 /Maximum value in column 6
TDESC6 = '(COL_IDX,IMG_IDX)' /Axis labels for column 6
TRPIX6 = '( 2, 59)' /Reference pixel
TCUNIT6 = '(IDX,IDX)' /Units
TTYPE6 = 'SOLAR_X ' /Column name
TFORM7 = '232E ' /Real*4 (floating point)

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TDIM7   = '(2,116) '           /Array dimensions for column 7
TUNIT7  = '(Arcsecs)'         /Units of column 7
TDMIN7  =           217.875    /Minimum value in column 7
TDMAX7  =           217.875    /Maximum value in column 7
TDESC7  = '(COL_IDX,IMG_IDX)' /Axis labels for column 7
TRPIX7  = '( 2, 59)'         /Reference pixel
TCUNIT7 = '(IDX,IDX)'        /Units
TTYPER7 = 'SOLAR_Y '         /Column name
COMMENT = 'EXTEND keyword removed by Luis Sanchez on 1999/01/20' /
END

```

More on underlined parameters

FILENAME : SUM, SUMFF, SUMHM, SUMRSC are the identifiers of several types of data obtained by SUMER.

SUM : normal data files collected through A or B detectors

SUMFF : FlatField file generated onboard

SUMHM : History Memory file, binned image of the accumulated counts on the detector A or B (12 x 512 pixels). Along the slit one pixel every 18, in the spectral dispersion one pixel over two are successively selected and added.

SUMSRC : Rear Slit Camera file (1 x 512 or 50 x 512 pixels).

OBS_SEQ : observing sequence.

Raster : telescope scan perpendicular to the slit length (azimuth or solar_x)

STUDY_ID : study number referenced in the planning tool

STUDY_NM : study name defined by the observer (planner)

DETECTOR : detector used (A or B)

IXWIDTH : width of the image in the case of a Raster (telescope step width x number of steps)

IYWIDTH : image height corresponding to the slit

OBJECT : target as defined by the observer (planner)

SCI_OBJ : scientific objective as defined by the observer (planner)

OBS_PROG : name of the observation program as defined by the scientific observer (planner)

CMP_NAME : name of the SOHO campaign, useful to coordinate with data taken by other instruments on SOHO, TRACE, .. and Ground-Based Observatories

CMP_ID : number of the campaign (see SOHO archive and operations)

POPUDP : number of the Predefined Operation Program (POP) or User Defined Program (UDP) which were used to generate the observation **établir un lien avec la base UDP**

ROTCMP : if 0, no solar rotation compensation. If not 0, the value is the number of seconds between increments (but it has to be verified that the UDP was set for this increment with a good choice of loop and spectrohelio, see the Observation guide

http://www.linmpi.mpg.de/english/projekte/sumer/text/sum_opguide.html).

COMPRESS : compression method used on-board. Most data are automatically decompressed (<5> Quasi Log Min-Max,)
Some compression methods are using the COMPARI keywords, the most used are:
<7> gauss_a1, 4 parameters transmitted: background, the maximum (without background), the centroid and the width at half-maximum ;the average width and the average centroid of the whole line are in COMPAR1 and COMPAR2
<8> gauss_a2, 4 parameters transmitted, the averaged width is in COMPAR1
<9> gauss_a4, 4 parameters transmitted in the data table
<10> gauss_b1, 4 parameters from a gaussian fit: background, the maximum (without background, total intensity divide by the width), the centroid and the width; the average width and the average centroid of the whole line are in COMPAR1 and COMPAR2
<11> gauss_b2, 4 parameters transmitted, the averaged width is in COMPAR1
<12> gauss_b4, 4 parameters transmitted in the data table
<13> prim_1, the total intensity divided by the spectral dimension is transmitted
<14> prim_2, 2 parameters transmitted: the total intensity divided by the spectral dimension and the centroid
<15> prim_4, 4 parameters transmitted: background, the maximum (without background, total intensity divide by the width), the centroid and the width
<16> Lemaire's addition scheme, for a 50 pixel width window the sum of the 50 pixels is transmitted
<17> Lemaire's 5 moments of 3 lines scheme, first line:profile maximum, centroid and width, second line: total intensity, third line: total intensity

To obtain more information see The Observation guide
(http://www.linmpi.mpg.de/english/projekte/sumer/text/sum_opguide.html).

WAVEMIN : in the list of the lines provided in the program to set windows on the detector, it is the shortest wavelength line. The 'real' uncalibrated minimum wavelength is the named wavelength minus the window half-width (in Å)

WAVEMAX : similar to WAVEMIN comment applied with the maximum wavelength

SC_ROLL : Roll angle of the spacecraft. Most of the time the value is near 0. Few S/C rotations have been performed. But, since May 2003, a problem with the High gain antenna obliged to roll by 180° about every 3 months. So, the roll angle must be taken into account to determine the angle of the spectrometer slit with the solar axes after this date (This will be implemented in **sum_read_corr_fts.pro**).

XCEN : centre of the field of view along solar_x of the data in the data file, not necessary of the full program

YCEN : centre of the field of view along solar_y of the data in the data file, not necessary of the full program

RASTYPE : raster, Full Sun (special raster to build the Full solar disk image), Temporal (temporal sequence) or nothing.

UDP_ID : UDP number used in the SUMER data base at the program loading

PROG_NM : name of the program, identification in the SUMER UDP base

TFIELDS : number of fields (columns) in the binary table
Minimum is 6: data (2 or 3_D), status, del_time, exp_time, solar_x, solar_y

EXTNAME : number of this binary table in the total number of binary tables

(1 to several hundred). Where binary tables are present, that means one parameter has changed, but the del_time is still referenced to the beginning time in the Primary Header

 i : indice which can take any value between 1 and 19, related to the number of wavelengths in the data

TDIMi : dimension of the data set, if 3_D: along spectral, along spatial, temporal or number of raster steps

 If COMPRESSION = 16, the first parameter is 5 (intensity, position and width of the first line, intensities of the second and third lines)

TRVALi : values as described above in TDESCi

TDELTi : axis increment (spectral pixel in Å, angular pixel in arcsec, angular increment for a raster in arcsec)

TRPIXi : position of the central pixel in the detector window: spectral pixel, angular pixel

TSPIXi : position of the window reference pixel within the full detector frame: spectral pixel (increasing wavelength), angular pixel (increasing along south-north solar axis)

TWAVEi : wavelength specified in the observation program (center of the detector window) may not correspond to the absolute wavelength (in average the scan mechanism accuracy is better than 0.14 Å, 1 step at short wavelength; but other factors may affect the accuracy, such as thermal variation mainly during periods where SUMER is in standby and time between 2 resets of the scan mechanism, error accumulation.

TTYPER3 : SUM_STATUS, value 0 or 1, some evaluation of the data quality
 3 is only because 2 wavelengths (detector windows)are use in this data

TTYPER4 : DEL_TIME, first time of the file since the Primary Header time in second

TTYPER5 : EXP_TIME, exposure time of the data

TTYPER6 : SOLAR_X, slit position along x solar axis in arcsec. This table has to be preferred in building rasters (in excluding few errors, 0 or very high number)

TTYPER7 : SOLAR_Y, central slit position along y solar axis (increasing from south to north)

References

Lemaire, P., Wilhelm, K., Curdt, W., Schühle, U., Marsch, E., Poland, A.I., Jordan, S.J., Thomas, R.J., Hassler, D.M., Vial, J.-C., Kühne, M., Huber, M.C.E., Siegmund, O.H.W., Gabriel, A., Timothy, J.G., Grewing, M., 1997, First Results of the SUMER Telescope and Spectrometer Solar Ultraviolet Measurements of Emitted Radiation on SOHO - (II) Imagery and Data Management, Solar Phys. **170**, 105-122.

Wilhelm, K., Curdt, W., Marsch, E., Schühle, U., Lemaire, P., Gabriel, A.H., Vial, J.C., Grewing, M., Huber, M.C.E., Jordan, S.D., Poland, A.I., Thomas, R.J., Kühne, M., Timothy, J.G., Hassler, D.M., and

Siegmund, O.H.W.,(1995), 'SUMER' - SOLAR ULTRAVIOLET MEASUREMENT OF EMITTED RADIATION, Solar Phys.**162**, 189-231

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