



*Heliophysics
Integrated
Observatory*

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Feature Description
Filaments V2.0

<i>Title:</i>	Feature Description: Filaments
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Revision History

Version	Date	Released by	Detail
1.0	9/5/2010	J. Abouardham, N Fuller	First draft
2.0	1/10/2010	J. Abouardham, N. Fuller, C. Renié, X. Bonnin	Add duplication of information in the filament table in order to be able to plot them directly, without having to read other times... Note that copy of the files must be updated

Note: Any notes here.

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Feature Description

Filaments appear as dark features on observations of the solar chromosphere (see figure 1 for examples of filaments)

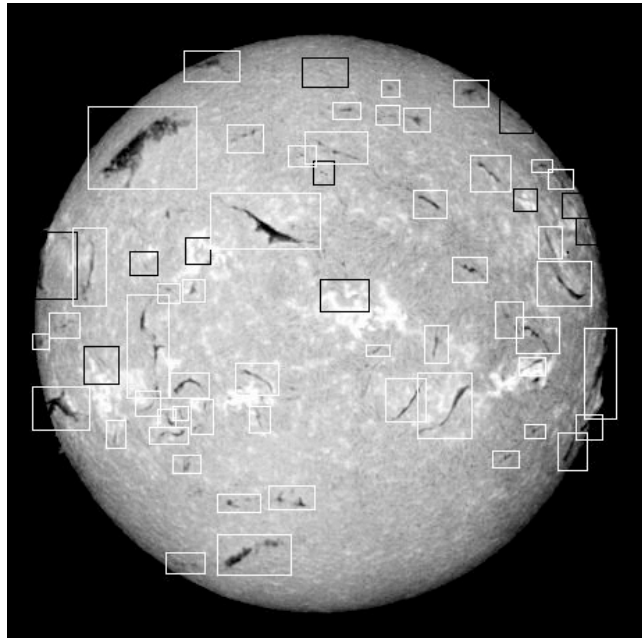


Fig 1: Rectangles surround filaments automatically detected on a solar H α image

They are elongated features with several footpoints. They can bend on or several times. It is to be noticed that filaments may suffer sudden disappearances which may be followed in some cases by re-appearances (in fact, filaments only disappear at some wavelength, probably due to changes in their background characteristics – temperature, pressure...).

Feature Characteristics

Output of the Feature Recognition Code

The filament FR code produces the following three ASCII files for each month:

1. Ha_FIL_Observation_Table_yyyymm.txt (containing information concerning the original image)
2. Ha_FIL_Processed_yyyymm.txt (containing information concerning the processed image)
3. Ha_FIL_yyyymm.txt (containing all the parameters describing the detected filaments)

Ha : Halpha wavelength
mm : the selected month
yyyy : the selected year

Some example of each kind of file follow.

1) Ha_FIL_Observation_Table_200204.txt

```

1      2      3      4      5      6      7      8      9    10 11 12 13      14      15      16      17 18      19
1:2002-04-01T08:45:00.000;2002-04-01T08:45:00.000;2452365;0.86456333;N;1988;1.00000;0.000000;16;914;917;420.67999;452.00000;447.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020401_084500_b.fits;
2:2002-04-02T08:57:00.000;2002-04-02T08:57:00.000;2452366;0.87291667;N;1988;1.00000;0.000000;16;933;965;420.58000;464.00000;480.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020402_085700_b.fits;
3:2002-04-03T08:44:00.000;2002-04-03T08:44:00.000;2452367;0.86388889;N;1988;1.00000;0.000000;16;920;911;420.44000;462.00000;467.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020403_084400_b.fits;
4:2002-04-04T07:23:00.000;2002-04-04T07:23:00.000;2452368;0.80763889;N;1988;1.00000;0.000000;16;920;923;420.32001;463.00000;468.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020404_072300_b.fits;
5:2002-04-05T08:09:00.000;2002-04-05T08:09:00.000;2452369;0.83958333;N;1988;1.00000;0.000000;16;907;936;420.19000;461.50000;478.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020405_080900_b.fits;
6:2002-04-06T07:10:00.000;2002-04-06T07:10:00.000;2452370;0.79861111;N;1988;1.00000;0.000000;16;907;904;420.07001;452.00000;450.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020406_071000_b.fits;
7:2002-04-07T08:20:00.000;2002-04-07T08:20:00.000;2452371;0.84722222;N;1988;1.00000;0.000000;16;897;936;419.95001;444.50000;468.50000;2.2800000;2.2800000;W;meud_halfh_fd_20020407_082000_b.fits;
8:2002-04-08T07:36:00.000;2002-04-08T07:36:00.000;2452372;0.81666667;N;1988;1.00000;0.000000;16;928;942;419.62999;464.50000;470.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020408_073600_b.fits;
9:2002-04-09T07:41:00.000;2002-04-09T07:41:00.000;2452373;0.82013889;N;1988;1.00000;0.000000;16;919;930;419.70999;444.00000;471.00000;2.2800000;2.2800000;W;meud_halfh_fd_20020409_074100_b.fits;

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20      21      22      23
/data2/fuller/FITS/Ha/2002/mh020401.084500.fits.Z;2002-04-01T08:45:00.000;2002-04-01T08:45:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020402.085700.fits.Z;2002-04-02T08:57:00.000;2002-04-02T08:57:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020403.084400.fits.Z;2002-04-03T08:44:00.000;2002-04-03T08:44:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020404.072300.fits.Z;2002-04-04T07:23:00.000;2002-04-04T07:23:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020405.080900.fits.Z;2002-04-05T08:09:00.000;2002-04-05T08:09:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020406.071000.fits.Z;2002-04-06T07:10:00.000;2002-04-06T07:10:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020407.082000.fits.Z;2002-04-07T08:20:00.000;2002-04-07T08:20:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020408.073600.fits.Z;2002-04-08T07:36:00.000;2002-04-08T07:36:00.000;= 'Y axis is the North/South axis of the Sun';
/data2/fuller/FITS/Ha/2002/mh020409.074100.fits.Z;2002-04-09T07:41:00.000;2002-04-09T07:41:00.000;= 'Y axis is the North/South axis of the Sun';

```

No	Name	Format	Description	Notes
1	INDEX	Long	Primary Index	Internal use
2	DATE-OBS	String	Date and time of the start of the observation in UTC	e.g. 2003-10-01T17:15:32.123
3	DATE-END	String	Date and time of the end of the observation in UTC	Same format as above
4	JDINT	Long	Julian day of the observation, integer part	calculated from DATE_OBS
5	JDFRAC	Double	Julian day of the observation, fraction part	calculated from DATE_OBS
6	EXPTIME	Float	Exposure time	As extracted from the header
7	CARROT	Integer	Carrington rotation	As in header or calculated from DATE_OBS
8	BSCALE	Float		As extracted from the header
9	BZERO	Float		As extracted from the header
10	BITPIX	Integer	Coding of the original image	As extracted from the header
11	NAXIS1	Integer	First dimension of the original image (X)	As extracted from the header
12	NAXIS2	Integer	Second dimension of the original image (Y)	As extracted from the header
13	R_SUN	Float	Radius of the Sun, in pixels	As extracted from the header
14	CENTER_X	Float	Coordinate of Sun centre in X, in pixels	As extracted from the header
15	CENTER_Y	Float	Coordinate of Sun centre in Y, in pixels	As extracted from the header
16	CDELTA1	Float	Spatial scale of the original observation (X axis)	As extracted from the header
17	CDELTA2	Float	Spatial scale of the original observation (Y axis)	As extracted from the header
18	QUALITY	TBD	Quality of the original image	Has to be defined (/N)

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			(in terms of processing)	
19	FILENAME	String	Name of the original file	As extracted from the header
20	LOCAL_FILENAME	String	Name and path to the original file	Internal use
21	DATE-OBS-STRING	String	Date and time of the start of the observation in UTC	Internal use
22	DATE-END-STRING	String	Date and time of the end of the observation in UTC	Internal use
23	COMMENT	String		As extracted from the header

2) Ha_FIL_Processed_200204.txt

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1          2          3          4          5          6          7          8
1:2003-02-26 12:50:25;Ha/2002/PROCESSED/mh020401.084500_subtract_processed.fits;2.2836900;2.2836900;1050.00;/data2/fuller/FITS/Ha/2002/mh020401.084500.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020401.084500_subtract_processed.fits;
2:2003-02-26 12:51:02;Ha/2002/PROCESSED/mh020402.085700_subtract_processed.fits;2.2830400;2.2830400;1541.00;/data2/fuller/FITS/Ha/2002/mh020402.085700.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020402.085700_subtract_processed.fits;
3:2003-02-26 12:51:38;Ha/2002/PROCESSED/mh020403.084400_subtract_processed.fits;2.2823900;2.2823900;1879.00;/data2/fuller/FITS/Ha/2002/mh020403.084400.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020403.084400_subtract_processed.fits;
4:2003-02-26 12:52:13;Ha/2002/PROCESSED/mh020404.072300_subtract_processed.fits;2.2817400;2.2817400;2122.00;/data2/fuller/FITS/Ha/2002/mh020404.072300.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020404.072300_subtract_processed.fits;
5:2003-02-26 12:52:50;Ha/2002/PROCESSED/mh020405.080900_subtract_processed.fits;2.2810300;2.2810300;1874.00;/data2/fuller/FITS/Ha/2002/mh020405.080900.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020405.080900_subtract_processed.fits;
6:2003-02-26 12:53:24;Ha/2002/PROCESSED/mh020406.071000_subtract_processed.fits;2.2803800;2.2803800;1223.00;/data2/fuller/FITS/Ha/2002/mh020406.071000.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020406.071000_subtract_processed.fits;
7:2003-02-26 12:53:59;Ha/2002/PROCESSED/mh020407.062000_subtract_processed.fits;2.2797300;2.2797300;1429.00;/data2/fuller/FITS/Ha/2002/mh020407.062000.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020407.062000_subtract_processed.fits;
8:2003-02-26 12:54:34;Ha/2002/PROCESSED/mh020408.073600_subtract_processed.fits;2.2790800;2.2790800;1567.00;/data2/fuller/FITS/Ha/2002/mh020408.073600.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020408.073600_subtract_processed.fits;
9:2003-02-26 12:55:11;Ha/2002/PROCESSED/mh020409.074100_subtract_processed.fits;2.2784300;2.2784300;1721.00;/data2/fuller/FITS/Ha/2002/mh020409.074100.fits.Z;/data2/fuller/FITS/Ha/2002/PROCESSED/mh020409.074100_subtract_processed.fits;

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No	Name	Format	Description	Notes
1	INDEX	Long	Primary Index	Internal use
2	RUN_DATE	String	Date when the PP code was run	
3	LOC_FILE	String	Name of the pre-processed file, including the path from the local organization	
4	NAXIS1	Integer	First dimension of the image used for detection (X)	As extracted from the header
5	NAXIS2	Integer	Second dimension of the image used for detection (Y)	As extracted from the header
6	R_SUN	Float	Radius of the Sun, in pixels, in the image used for detection	As extracted from the header
7	CENTER_X	Float	Coordinate of Sun centre in X, in pixels	As extracted from the header
8	CENTER_Y	Float	Coordinate of Sun centre in Y, in pixels	As extracted from the header
9	CDEL1	Float	Spatial scale of the pre-processed observation (X axis)	Calculated based on standardisation parameters
10	CDEL2	Float	Spatial scale of the pre-processed observation (Y axis)	
11	QSUN_INT	Float	Quiet Sun value estimated after pre-processing	
12	LOCAL_FILENAME	String	Name and path to the original file	Internal use
13	PP_LOCAL_FILENAME	String	Name of the pre-processed file, including the full path	Internal use

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			from the local organization	
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3) Ha_FIL_200204.txt

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1,2004-01-22T17:09:04,-67.368855,-640.42720,-67.540324,318.82624,129,15.758405,0.81109637,-87.922065,-855.24190,-44.531955,-825.55394,473,137,492,150,1122,630,851.651,CHAIN CODE,																				
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37					
485,136,-60.517785,-657.52559,6.9963512,-1,0.895833,-24.7859,491,144,-46.815845,-839.25608,4445545666566700000007700070700122333322333344433,51,111007007077770770,18,																				
38																				
/data2/fuller/FITS/Ha/2002/PROCESSED/mh020401.084500_subtract_processed.fits;																				

No	Name	Format	Description	Notes
1	IND	Long	Observation index	Internal use
2	RUN_DATE	String	Date when the feature recognition code was run	
3	GC_ARC_X	Float	Gravity centre in arcsecs (X)	
4	GC_ARC_Y	Float	Gravity centre in arcsecs (Y)	
5	GC_CAR_LAT	Float	Gravity centre in heliographic (°)	
6	GC_CAR_LON	Float	Gravity centre in heliographic (°)	
7	FEAT_NPIX	Long	Number of pixels included in the feature	
8	FEAT_AREA	Float	Area of the feature, in square degrees	
9	FEAT_MEAN2QSUN	Float	Mean of the feature to QS intensity ratio	
10	BR_ARC_X0	Float	Bounding rectangle coordinates, in arcsec (x, lower left)	
11	BR_ARC_Y0	Float	Bounding rectangle coordinates, in arcsec (y, lower left)	
12	BR_ARC_X1	Float	Bounding rectangle coordinates, in arcsec (x, upper right)	
13	BR_ARC_Y1	Float	Bounding rectangle coordinates, in arcsec (y, upper right)	
14	BR_PIX_X0	Integer	Bounding rectangle coordinates, in pixels (x, lower left)	
15	BR_PIX_Y0	Integer	Bounding rectangle coordinates, in pixels (y, lower left)	
16	BR_PIX_X1	Integer	Bounding rectangle coordinates, in pixels (x, upper right)	
17	BR_PIX_Y1	Integer	Bounding rectangle coordinates, in pixels (y, upper right)	
18	FEAT_MAX_INT	Integer	Feature maximum value, in units of the original obs.	As in UNITS
19	FEAT_MIN_INT	Integer	Feature minimum value, in units of the original obs.	As in UNITS
20	FEAT_MEAN_INT	Float	Feature mean intensity value, in	As in UNITS

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			units of the original obs.	
21	ENC_MET	String	Encoding method	e.g. raster, chain code, None... TBC
22	CC_PIX_X	Integer	Coding 1st position in pixels, X axis	
23	CC_PIX_Y	Integer	Coding 1st position in pixels, Y axis	
24	CC_ARC_X	Float	Coding 1st position in arcsecs, X axis	
25	CC_ARC_Y	Float	Coding 1st position in arcsecs, Y axis	
26	SKE_LNTH_DEG	Float	Skeleton length in degrees	
27	CURVATURE	Float	Curvature index (from 0 to 10)	ratio btw length and distance btw end points
28	ELONG	Float	Elongation factor (-1 if not enough points)	$\text{Area}/(2d)^2$ where $d=\text{thickness}$
29	ORIENTATION	Float	Global orientation of the filament (CCW from Ox axis)	
30	CC_SKE_PIX_X	Integer	Skeleton coding 1st position in pixels, X axis	
31	CC_SKE_PIX_Y	Integer	Skeleton coding 1st position in pixels, Y axis	
32	CC_SKE_ARC_X	Float	Skeleton coding 1st position in arcsecs, X axis	
33	CC_SKE_ARC_Y	Float	Skeleton coding 1st position in arcsecs, Y axis	
34	CHAIN_CODE	String	Chain code of the filament boundary	
35	CC_LNTH	Integer	Number of pixels included in the chain code	
36	CHAIN_CODE_SKE	String	Skeleton chain code	
37	CC_SKE_LNTH	Integer	Number of pixels included in the skeleton chain code	
38	PP_LOCAL_FILENAME	String	Name of the pre-processed file, including the full path from the local organization	Internal use

Description of Fields

The characteristics that are automatically detected concerning filaments as they appear in the HFC are:

Name	Format	Description	Notes
ID	Int(11)	Index to identify file and link files together	Internal use, may be used as an unique ID
FRC_INFO_ID	Int(4)	Ref. to FR code information	

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PROCD_OBS_ID	Int(11)	Ref. to Processed Observ. where detect. Was made	
RUN_DATE	datetime	Date when FR code was run	
SC_ARC_X	Double	X coordinate of skeleton centre in arcsec	
SC_ARC_Y	Double	Y coordinate of skeleton centre in arcsec	Different
SC_CAR_LAT	Double	Carrington latitude of skeleton centre (°)	
SC_CAR_LON	Double	Carrington longitude of skeleton centre (°)	
FEAT_NPIX	Int(11)	Number of pixels included in the feature	
FEAT_AREA	Double	Area of the feature, in degrees ²	
FEAT_MEAN2QSUN	Double	Mean of the feature to QS intensity ratio	
BR_ARC	Double	Bounding rectangle coordinates, in arcsec	From lower left to upper right: X _{ll} , Y _{ll} , X _{ur} , Y _{ur} ; (BR_ARC_X0, BR_ARC_Y0, BR_ARC_X1, BR_ARC_Y1)
BR_PIX	Int(8)	Bounding rectangle coordinates in pixels	Same as BR_ARC; (BR_PIX_X0, BR_PIX_Y0, BR_PIX_X1, BR_PIX_Y1)
FEAT_MAX_INT	Float	Feature max. value, in units of the original obs.	As in UNITS
FEAT_MIN_INT	Float	Feature min. value, in units of the original obs.	As in UNITS
FEAT_MEAN_INT	Float	Feature mean intensity value, in units of the original obs.	As in UNITS
ENC_MET	Varchar(50)	Encoding method	e.g. raster, chain code, None... TBC
CC_PIX_X	Int(8)	X coordinate of chain code start position in pixels	To Be Confirmed
CC_PIX_Y	Int(8)	Y coordinate of chain code start position in pixels	TBC
CC_ARC_X	Float	X coordinate of chain code start position in arcsec	TBC
CC_ARC_Y	Float	Y coordinate of chain code start position in	TBC

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		arcsec	
SKE_LEN_DEG	Float	Length of the filament in degrees	
CURVATURE	Float	Index of curvature of the skeleton	
ELONG	Float	Elongation factor	=area/(2d) ² where d=thickness
ORIENTATION	Float	Orientation of the filament	
COD_SKE_PIX_X	Int(8)	X coordinate of skeleton chain code start in pixels	
COD_SKE_PIX_Y	Int(8)	Y coordinate of skeleton chain code start in pixels	
COD_SKE_ARC_X	Float	X coordinate of skeleton chain code start in arcsec	
COD_SKE_ARC_Y	Float	Y coordinate of skeleton chain code start in arcsec	
CHAIN_CODE	text	Boundary chain code	
CHAIN_CODE_SKE	text	Skeleton chain code	
ID_ASCII	Int(11)		
CCODE_LNTH	Int(11)		
CCODE_SKE_LNTH	Int(11)		
PR_LOCFNAME	Varchar(150)		

- The coordinates of the centre of a filament skeleton (SC_ARC_X, GC_ARC_Y, SC_CAR_LAT, GC_CAR_LON) are coordinates of the middle pixel of the filament's skeleton converted to units of arcsec or to Carrington coordinates.
- The filament parameters associated with its intensity (FEAT_MEAN2QSUN, FEAT_MAX_INT, FEAT_MIN_INT, FEAT_MEAN_INT) are calculated with the cleaned image pixel values.
- The area and length of a filament (FEAT_AREA, SKE_LEN_DEG) are calculated by mapping (back projection) the detected region to the heliographic surface.
- The bounding rectangle associated with a detected filament (BR_PIX, BR_ARC) is the smallest rectangle which encloses the filament skeleton. It is represented as described under sunspots.
- The boundary of a filament is represented using the chain code (CHAIN_CODE) represented as described under active regions.
- The skeleton of a filament (CHAIN_CODE_SKE) is represented using a chain code as defined for CHAIN_CODE which starts from one extremity (COD_SKE_PIX_X, COD_SKE_PIX_Y) of the skeleton and ends at the other extremity.
- The shapes of filaments are represented by two parameters; an elongation factor (ELONG) defined by FEAT_AREA/(2d)² where 'd' is the thickness of the detected region and a curvature index (CURVATURE) defined as 10 * (1 - (distance between end points)/length).
- The orientation of a filament (ORIENTATION) is the main direction of the filament, in degrees counted clockwise from Ox.

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