Raster joining (stitching) using Anti Solar Rotation Compensation (ASRC) Side-effect

Scanning rasters in the EIS have a fixed field-of-view (FOV) set by the slit/slot Y-height and in the X-direction by the number of exposures and the FMIR step size. The FOV cannot be changed dynamically (directly) at the timeline (TL) stage. However, it is possible to use the raster repeat function together with a 'side-effect' of EIS Anti-Solar Rotation Compensation (ASRC) to build up a large FOV in the X-direction using studies with a small width (less than or equal 30" X-FOV).

If a raster is repeated N times while Hinode is in tracking mode (Solar rotation compensation), it will repeatedly scan the same area of Sun. Although the Hinode satellite performs Solar Rotation Compensation when required, EIS ASRC was originally intended to compensate against solar rotation so that EIS can maintain the same fixed target pointing.

The parameters used for this operation (ASRC) are part of the EIS sequence structure overview:

http://msslxr.mssl.ucl.ac.uk:8080/SolarB/docs/sciDocs/seq_TN014_06.pdf

In summary, these parameters are as follows:

Raster repeat: No. of times the raster is to be run

Direction: ASRC specific (not needed for raster stitching)

SKIP: ASRC specific (not needed for raster stitching)

Compensation steps: Number of FMIR steps required for compensation. The compensation steps are applied at the start of subsequent rasters by readjusting the FMIR initial position (MIP). The compensation steps required for 'solar rotation compensation' is on the order of a few arcseconds. However, the maximum field available in the raster structure definition is 7 bits (127 steps or just over 30"). Hence the maximum size of rasters that can be joined together (stitched) is 30".

Note that only the **raster repeat** and **compensation steps** are required for raster stitching.

Raster stitching and example raster:

Raster stitching can be achieved by determining the FOV in X of a scanning raster, as follows:

FOVX" = (NPOINT+1)*FMIRR_STEP_SIZE"

Where NPOINT is the number of raster pointing positions (number of exposures-1) and FMIRR_STEP_SIZE is the fine mirror step size in arcseconds. To use ASRC, we need to know FOVX in fine mirror step units. This is calculated by dividing by 0.25 (the fine mirror step size in arcseconds).

Example raster:

The study HPW017AR_30x400_30S2 was designed for the purpose of raster stitching.

For this study, the calculation of compensation steps was made as follows:
NPOINT=29
FMIRR_STEP_SIZE= 1”
COMPENSATION STEPS = [(29+1)*1]/0.25 = 120

Note: For studies that were designed for raster stitching, the **compensation steps** parameter is provided in the **study description**.

Notes to planners:

In order to use ASRC for raster stitching, the following steps should be followed:

1 – Insert the study on the TL, select the raster and set the number of raster repeat (example: to scan 120”, the raster repeat of the example above is set to 4, i.e. 4X30”)

2 – Select the raster and click on the ASRC icon. **Enable** ASRC and set the compensation step size (120 in the example above). The rest of the ASRC parameters (Skip and direction) **must not** be changed (keep default).

Normal raster repeat vs. ASRC:

R1 |----------------------|

R2 |----------------------|

R3 |----------------------|

R4 |----------------------|

30”X400” scan (normal raster repeat)

```
R1 |----------------------|
R2                       |----------------------|
R3                                              |----------------------|
R4                                                                     |----------------------|
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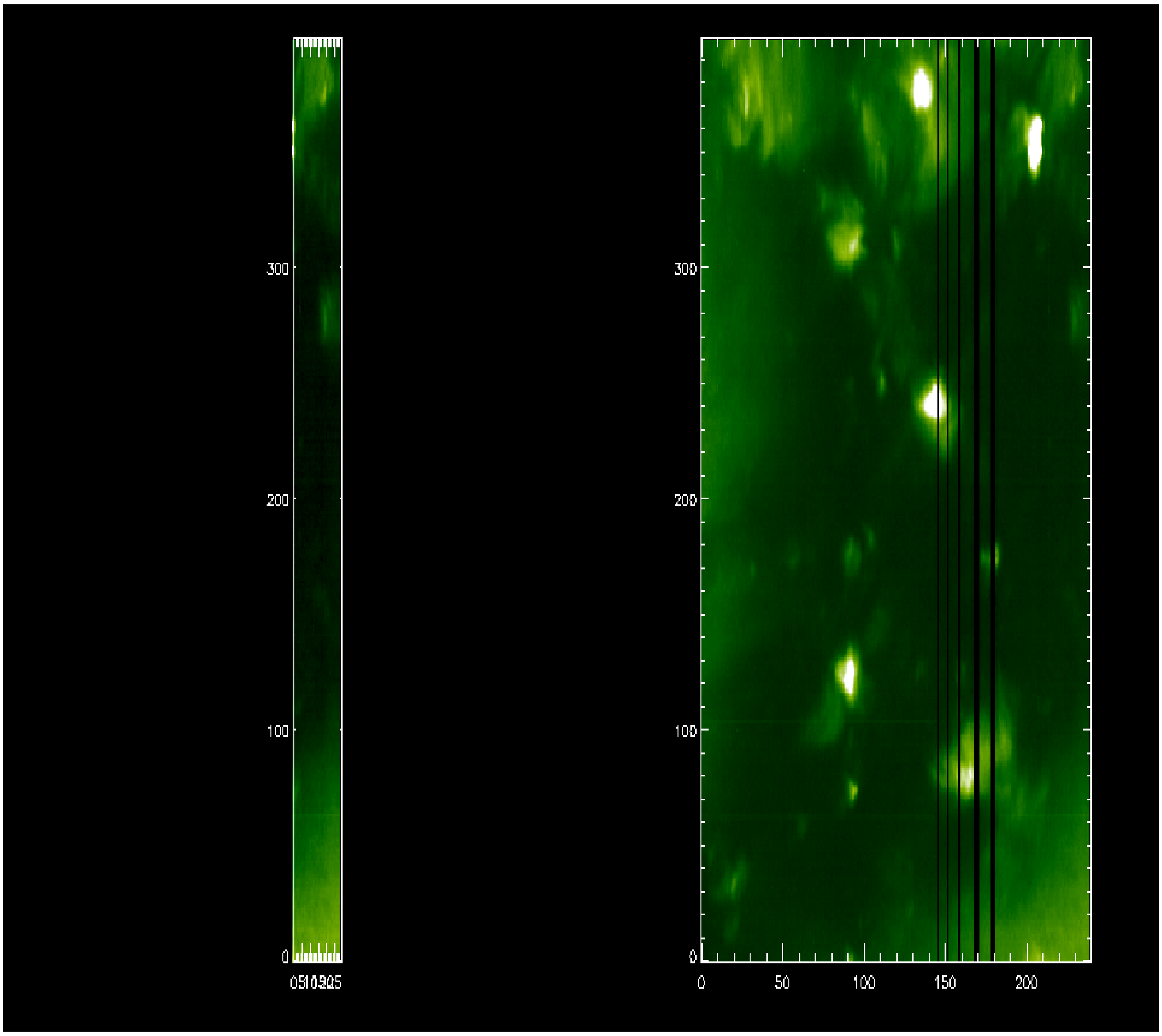
120”X400” scan (30” raster repeat with ASRC enable)

Example run:

The following figure shows an example of a CH observation in Fe XII 195A that was run on October 30th 2008.

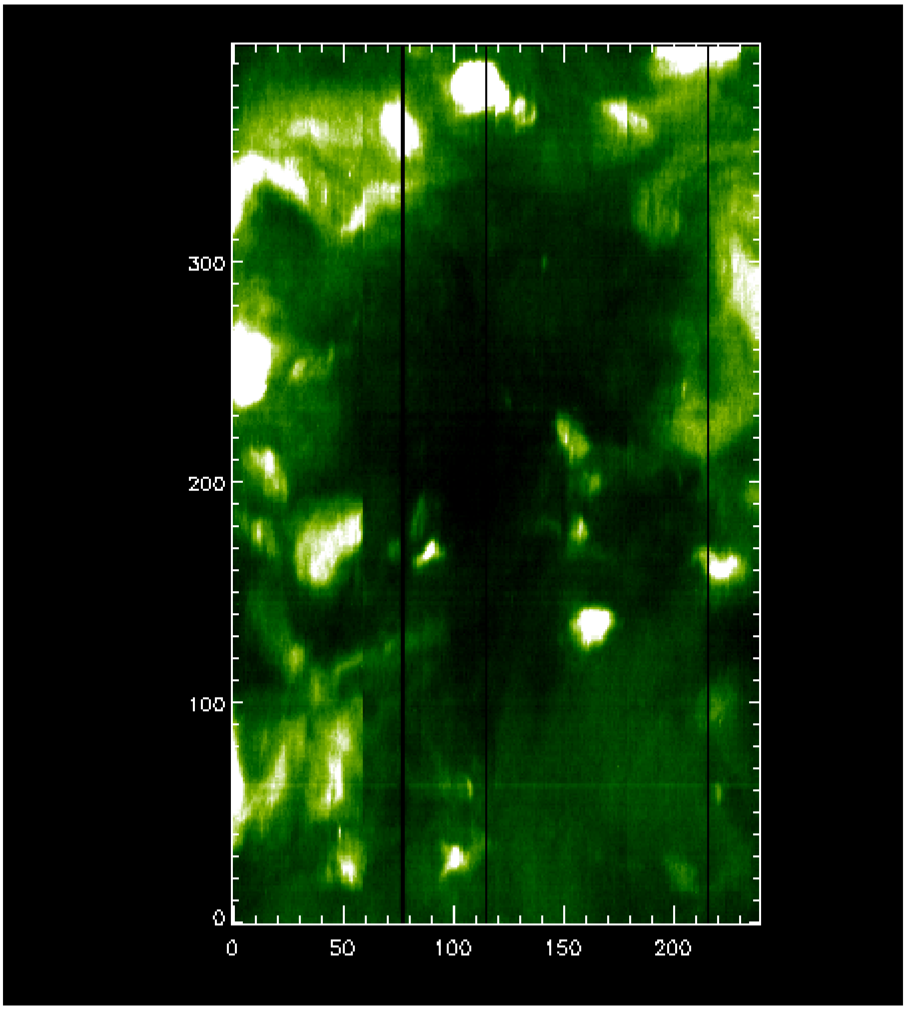


The study used is NRL_QSCH_30x400_60s. The FOV of this study is 30" in X and 400" in Y and an example of an individual raster from one fits file is shown on the left in the Figure. On the right in the Figure is the expanded FOV observation. The raster was repeated 8 times to cover a FOV of 240" by 400".

ASRC Advantages:

Studies designed to take advantage of this functionality can be run on multiple targets of different sizes. There are many occasions when requested active region studies are not run because the region is larger or smaller than the study FOV. This can be an inefficient use of limited S-band resources.

Another advantage of this method is that blocks of repeats can be set on the timeline between SAAs, thus allowing SAA free raster scans to be created even in periods with many SAAs. Here is an example of an Fe XII 195A image created in this way.



This observation was made on the 7th February 2009 between 23UT and 06UT the next day. Three major SAAs occurred during these observations, but they are not seen in the stitched raster.

Limitation:

Raster stitching makes use of a side-effect of ASRC. This limits the stitched raster size to 30”. However, larger rasters can be stitched together “manually”. For example, if a **60”** raster is pointed at X=100”, the second raster can be pointed at X=160”. In this way the X-FOV is extended to 120”, as illustrated below:

R1 (pointing = 100”) |---------------------|

R2 (pointing = 160”) |---------------------|

Example 60” rasters stitching

Of course, raster repeat cannot be used here and the second raster (study) has to be inserted, preferably chained to the first one, on the TL. Subsequent rasters (R2 onward) have to be pointed individually. A block of studies can be copied from one TL position to another (e.g. SAA avoidance).

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