Notes about eis_prep

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http://folk.uio.no/gardini/EIS_PREP.ppt

What is eis_prep?

Eis_prep is the standard tool to convert raw level-0 data of Hinode/EIS into calibrated level-1 data.
It is written in IDL and is part of the Solarsoft package.

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Level-0 data.

Level-0 data consist of EIS CCD intensities arranged in arrays of 3D windows, called datacubes. Datacubes coordinates are the wavelenght (λ), the CCD's spatial Y coordinate, and the time. Intensities are expressed in data numbers (DN).

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Level-1 data.

Level-1 data consist of datacubes containing the calibrated intensities and datacubes containing the corresponding errors.
Both intensities and errors are given (by user's choice) in:
• erg/cm2/s/sr/Å (physical units), or
• DN (data numbers), or
• photon counts.

Bad pixels are marked as "missing" by setting their error value to -100.

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Calling eis_prep on a level-0 file.

IDL> eis_prep, filename,/save

where filename is the name of the file:

• eis_l0_YYYYMMDD_HHMMSS.fits

The /save keyword tells eis_prep to create

• eis_l1_YYYYMMDD_HHMMSS.fits
• eis_er_YYYYMMDD_HHMMSS.fits

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Calling eis_prep on an eis_data object.

IDL> data=obj_new('eis_data', filename)
IDL> eis_prep, data

Calibrated intensities remain stored in the computer memory in the same input object, while errors are stored in an eis_cal object pointed by it.
Level-1 data can be then saved in a file through the eis_data "save" method.

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What does eis_prep do?

1. Flagging saturated data.
2. Subtracting dark current (/retain).
3. Cosmic ray removal (/nocr).
4. Flagging hot and warm pixels (/nohp, /nowp).
5. Flagging pixels affected by dust (/nodp).
6. Radiometric calibration (/noabs,/photons).

This sequence of steps is performed rigidly. To change the steps' order, execute eis_prep with the proper keywords on the same eis_data object twice or more.

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Step 1: Flagging saturated data.

As EIS CCDs have a 14 bit dynamic range, saturation occurs at 16,383 DN.

All these pixels are marked as missing.

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Step 2: Dark current subtraction.

Dark current is usually modeled as a polynomial,
and coefficients are stored in specific calibration files.
A particular file can be selected by the dc_file keyword,
or the default file can be selected by /default.
Otherwise, a window pops up asking to select one.

If no file is available the following procedures apply.

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Step 2: Dark current subtraction (2).

In the raw data, intensities are found to sit on a background of about 500 DN (from bias and DC).

For each 3D data window, 2% of the detector pixels are isolated that have the lowest DN values.
Their median value is assumed as the background level and subtracted from the DN value of each pixel.

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Step 2: Dark current subtraction (3).

Alternatively, for full CCD spectra, regions are identified
where no lines are present.
Their median value is assumed as the background level
and subtracted from the DN value of each pixel.

Some pixels end up with negative values: they are set to 0
and marked as missing, unless the /retain keyword is set.
In this case, they maintain their own negative value,
and the corresponding error is set to the DC error estimate.

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Step 3: Cosmic rays removal.

It is performed by eis_despike which wraps new_spike, originally written for SOHO/CDS.

The nearest-neighbor removal option is switched off.

Removed pixels are marked as missing and their values replaced by the mean value of the valid pixels in the 5x5 square (in λ and Y) surrounding them.

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Step 4: Flagging hot and warm pixels.

Hot and warm pixels have anomalously high DN values: either above and below 25,000 electrons/pixel/s at room temperature.
Separate maps of hot and warm pixel are generated every 2-4 weeks by the EIS team, following inspection of 100s dark exposures.
The maps closest in time to observations are used by eis_prep to mark hot and warm pixels as missing.
Their values are filled recursively by median values of valid neighbors (now, along Y only).

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Step 5: Flagging dusty pixels.

Several small pieces of dust are found to completely block the CCD signal at their location.
They are fixed in position an occupy less than 0.1% of the CCDs, but affect some strong lines.

Dusty pixels are marked as missing but not refilled.

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Step 6: Radiometric calibration.

Finally, DN values are converted to intensities in physical units: erg/cm2/s/sr/Å.
Errors are computed assuming photon statistics together with an error estimate for the DC: 2.24 to 2.37 DN.

The /noabs keyword allows to retain DN data.
The /photon keyword allows to get photon counts.

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Additional keywords.

The /refill keyword allows eis_prep to refill *all* the pixels marked as missing according to the prescriptions recommended in the Warm Pixel Study, to better preserve scientific information.

The /quiet keyword sets eis_prep to run without popping up information widgets.

Additional information.

Additional information can be found in

- the header of the eis_prep routine
- EISWiki
- http://folk.uio.no/gardini/Eis_prep.doc