Specification of WCS module for external FITS writer.

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Purpose

The module shall write WCS FITS header information into the temporary database table used for holding the external FITS information.

The WCS information shall be based on the geometry information of the ongoing exposure and the telescope pointing (RA, DEC, position angle) for the ongoing exposure.

The WCS FITS header information shall be written into the image extensions of the FITS file.

Constraints / Usage

This module will produce valid data based on the content of the temporary database table. This means that the Ivy message to trigger this module must be preceded by an Ivy message to collect information for the FITS header. In any other case the data produced by this module will produce WCS data based on old or outdated data.

This module shall be called/initiated once per. amplifier used in the readout of the image for which the FITS header is destined.

After reception of the output control Ivy message the WCS headers for the particular image extension (that contains image data for a particular amplifier) can be read from the temporary database table.

To resume: 1) Send Ivy message to collect FITS information. 2) Send Ivy message to trigger the creation of the WCS header data. 3) Retrieve the WCS header data from the temporary database table. 4) Store the result. 5) Repeat 2, 3, 4 for each amplifier used in the readout, indicating which image extension it is destined for (will be reflected in the dest. Database 'DESTEXT' field). 6) Read the rest of the FITS header information from the temporary database table. 7) Write the FITS header information into the image file in the correct image extensions.

Input (Control)

- An Ivy message bus message of the format:

  ```
  ccd3.fits.extinfo.wcs.xbin=1.ybin=1.xstart=1.ystart=1.ampl=AB.destext=1
  ```

  The essential is that the message is sent by the CCD3 program and that it contains information about X/Y binning, X/Y start (X/Y size is not relevant), amplifier(s) used for readout and the MEF image extension that the WCS information is destined for (this last information the ccd3 program has).

Input (Data)

From already collected TCS information

- RA
- DEC
- FIELD

From detector characteristics information (source unknown)

- ROTOFFSET (difference from FIELD to get position_angle)
- REFPIXEL (in X and Y, unbinned image)
- SCALE (in degrees per. pixel with wcs specific sign)

- AMPLOFFSET (offset (image+overscan pix) to other amplifier image. Only user for dual amplifier readout)

From the CCD3 program
- XBIN
- YBIN
- XSTART
- YSTART

Processing
- REFPIXEL = REFPIXEL - AMPLOFFSET
- REFPIXEL = REFPIXEL/BINNING (in X and Y)
- SCALE = SCALE * BINNING
- POSITION_ANGLE = ROTOFFSET – FIELD

- OBSMODE = (if a grism is in ”1” else ”0”)

- CD[0] = SCALE[0]*COS(POSITION_ANGLE*DEG_RAD)
- CD[1] = -SCALE[1]*SIN(POSITION_ANGLE*DEG_RAD)
- CD[2] = SCALE[0]*SIN(POSITION_ANGLE*DEG_RAD)
- CD[3] = SCALE[1]*COS(POSITION_ANGLE*DEG_RAD)

Output (Control)
- An Ivy message indicating the successful completion of the output. Format:

```
extinfo.wcs.done
```

  This will indicate to the caller/initiator that the header information can be written into the image file.

Output (Data)
FITS headers in temporary table

If OBSMODE=0 (IMAGING):

- Name: CTYPE1, value: ”RA---TAN”, comment: ”Gnomonic projection”
- Name: CTYPE2, value: ”DEC—TAN”, comment: "Gnomonic projection”
- Name: CRVAL1, value: RA, comment: ”RA at reference point”
- Name: CRVAL2, value: DEC, comment: ”DEC at reference point”
- Name: CUNIT1, value: ”deg”, comment: ”Unit of 1st axis”
- Name: CUNIT2, value: ”deg”, comment: ”Unit of 2nd axis”
- Name: CRPIX1, value: REFPIXEL[0], comment: ”Reference pixel on 1st axis”
- Name: CRPIX2, value: REFPIXEL[1], comment: ”Reference pixel on 2nd axis”
- Name: CD1_1, value: CD[0], comment: ”Transformation matrix for primary WCS”
- Name: CD1_2, value: CD[1], comment: ”Transformation matrix for primary WCS”
- Name: CD2_1, value: CD[2], comment: ”Transformation matrix for primary WCS”
- Name: CD2_2, value: CD[3], comment: ”Transformation matrix for primary WCS”

If OBSMODE=1 (SPECTROSCOPY)

- Name: CTYPE1, value: ”X”, comment: ”Coordinate type of 1st axis”

- Name: CTYPE2, value: ”Y”, comment: ”Coordinate type of 2nd axis”
- Name: CRVAL1, value: XSTART, comment: ”X at reference point”
- Name: CRVAL2, value: YSTART, comment: ”Y at reference point”
- Name: CUNIT1, value: ”pixel”, comment: ”Unit of 1st axis”
- Name: CUNIT2, value: ”pixel”, comment: ”Unit of 2nd axis”
- Name: CRPIX1, value: XSTART, comment: ”Reference pixel on 1st axis”
- Name: CRPIX2, value: YSTART, comment: ”Reference pixel on 2nd axis”
- Name: CDELT1, value: XBIN, comment: ”Increment on 1st axis”
- Name: CDELT2, value: YBIN, comment: ”Increment on 2nd axis”

Test

The module shall produce the same WCS headers as currently produces at the NOT. This shall be verified by setting the input data to the same as in actual NOT images (for all instruments) and send the input control Ivy message to generate the WCS headers.

The input control Ivy message shall be set up so that the following situations are tested:

- Full frame, single amplifier (A).
- Full frame, single amplifier (B).
- Full frame, dual pmplifier.
- Same as preceeding 3, but with 2x, 3x, 4x binning.
- Window on amplifier A.
- Window on amplifier B.
- Same as preceeding 3, but with 2x, 3x, 4x binning.

Special attention should be given to the number of pixels to offset (the AMPLOFFSET) the pixel coordinate of amplifier B over to the REFPIXEL on amplifier A.