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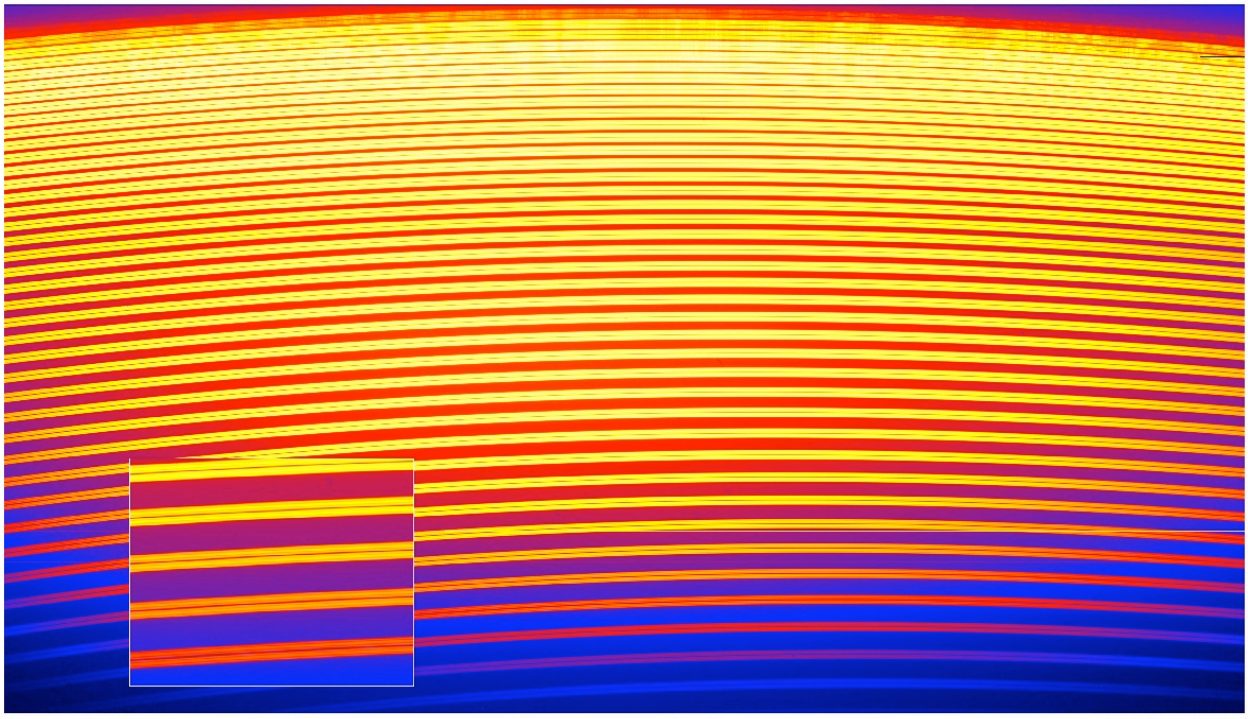
OPERA PIPELINE PROJECT

OPERA Archive Products



DOUG TEEPLE
Canada France Hawaii Telescope
Waimea, HI October 2012

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1. Introduction

The products of a calibration and reduction are stored in FITS format for archival storage. It is important that enough information be stored in the FITS file that many years later, the reduction and calibration can be reproduced. The OPERA pipeline produces much more information about the calibrations and reduction than did Libre-Esprit. It was thought better to take advantage of the switch to OPERA to add a new Product to store the additional information, provided that we also include a tool in OPERA that can extract the original Libre-Esprit format text files (.s) for compatibility.

This is a good opportunity to better serve the community by providing richer more meaningful products from the pipeline.

2. What upena Saves

The spectral and polarimetric data is stored in <odometer>i.fits (intensity) and <odometer>p.fits (polarimetry) simple FITS files. Both the spectra and signal to noise information and errors are saved. Signal to noise is stored as comments in the FITS header.The calibration masters are not archived.

The information stored depends on the instrument mode:

```
(1) Spectroscopy Star only mode
    First column = wavelength in nanometres
    Second column = intensity
    Third column = error bar

(2) Polarimetry
    1st col = wavelength in nanometres
    2d  col = intensity
    3rd col = polarisation (Q or U or V or W)
    4th col = Check Spectra #1
    5th col = Check Spectra #2
    6th col = error bar

(3) Spectroscopy Star + Sky
    1st col = wavelength
    2d  col = star spectra (sky subtracted)
    3rd col = star + sky spectra
    4th col = sky spectra
    5, 6, 7 = error bars for each column 2, 3, 4
```

The data is stored in 4 sets:

- normalized/autowave corrected,
- non-normalized/autowave corrected,
- normalized/non-autowave corrected,
- non-normalized/non-autowave corrected.

2.1 Intensity

An i.fits Intensity FITS file looks like this:

In addition the columns are labelled as new keywords in the header:

COMMENT Fully reduced by Upena at CFHT

COMMENT ---------- Upena Reduction ----------

COMMENT Upena version 1.0

COMMENT Upena processing date: Sun Mar 13 21:07:07 HST 2011

COMMENT Upena website: http://www.cfht.hawaii.edu/Instruments/Upena/

COMMENT Upena email: upena@cfht.hawaii.edu

COMMENT Upena uses J-F. Donati's software Libre-ESpRIT

COMMENT Version 2.12 (2006 Apr. 20)

COMMENT Libre-ESpRIT reference: Donati et al., 1997, MNRAS, 291, 658

REDUCTIO= 'Intensity' / Type of reduction

NORMAL = 2 / Normalized and Un-normalized Data

COMMENT File contains automatic wavelength correction and uncorrected data.

COL1 = 'Wavelength' / Normalized

COL2 = 'Intensity' / Normalized

COL3 = 'ErrorBar' / Normalized

COL4 = 'Wavelength' / UnNormalized

COL5 = 'Intensity' / UnNormalized

COL6 = 'ErrorBar' / UnNormalized

COL7 = 'Wavelength' / Normalized, no autowave correction

COL8 = 'Intensity' / Normalized, no autowave correction

COL9 = 'ErrorBar' / Normalized, no autowave correction

COL10 = 'Wavelength' / UnNormalized, no autowave correction

COL11 = 'Intensity' / UnNormalized, no autowave correction

COL12 = 'ErrorBar' / UnNormalized, no autowave correction

Intermediate Libre-Esprit byproducts (including SNR) are stored as comments:

COMMENT ---- This section contains data from 1287849in.out ----
COMMENT Bias file: 1288010b.fits
COMMENT Detector gain (e/ADU) and read-out noise (e) : 1.510 4.160
COMMENT Rejection threshold [default = 10.0] : 20.0
COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU
COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU
COMMENT Order # 22 : columns -14.4 to 14.4
COMMENT Order # 23 : columns -14.0 to 14.0
COMMENT Order # 24 : columns -14.0 to 13.6
COMMENT Order # 25 : columns -14.0 to 13.6
COMMENT Order # 26 : columns -14.0 to 13.6
COMMENT Order # 27 : columns -14.0 to 13.6
COMMENT Order # 28 : columns -13.6 to 13.6
COMMENT Order # 29 : columns -13.6 to 13.6
COMMENT Order # 30 : columns -13.6 to 13.6
COMMENT Order # 31 : columns -13.6 to 13.6
COMMENT Order # 32 : columns -14.0 to 13.6
COMMENT Order # 33 : columns -14.0 to 13.6
COMMENT Order # 34 : columns -14.0 to 13.6
COMMENT Order # 35 : columns -14.0 to 13.6
COMMENT Order # 36 : columns -14.0 to 13.6
COMMENT Order # 37 : columns -14.0 to 13.6
COMMENT Order # 38 : columns -14.0 to 13.6
COMMENT Order # 39 : columns -14.0 to 14.0
COMMENT Order # 40 : columns -14.0 to 14.0
COMMENT Order # 41 : columns -14.0 to 14.0
COMMENT Order # 42 : columns -14.0 to 14.0
COMMENT Order # 43 : columns -14.0 to 14.0
COMMENT Order # 44 : columns -14.0 to 14.0

COMMENT Order # 45 : columns -14.0 to 14.0

COMMENT Order # 46 : columns -14.0 to 14.0

COMMENT Order # 47 : columns -14.0 to 14.0

COMMENT Order # 48 : columns -14.0 to 14.0

COMMENT Order # 49 : columns -14.0 to 14.0

COMMENT Order # 50 : columns -14.0 to 14.0

COMMENT Order # 51 : columns -14.0 to 14.0

COMMENT Order # 52 : columns -14.0 to 14.0

COMMENT Order # 53 : columns -14.4 to 14.0

COMMENT Order # 54 : columns -14.4 to 14.4

COMMENT Order # 55 : columns -14.4 to 14.4

COMMENT Order # 56 : columns -14.8 to 14.4

COMMENT Order # 57 : columns -14.8 to 14.8

COMMENT Order # 58 : columns -15.6 to 15.6

COMMENT Order # 59 : columns -16.0 to 14.8

COMMENT Order # 60 : columns -13.6 to 13.6

COMMENT Order # 61 : columns -12.4 to 12.8

COMMENT Correcting wavelength scale from Earth motion...

COMMENT Coordinates of object : 11:30: 3.99 & 29:57:53.0

COMMENT Time of observations : 2011 3 13 @ UT 12: 5:33

COMMENT (hour angle = 1.603 hr, airmass = 1.093)

COMMENT Total exposure time : 90.0 s

COMMENT Cosine latitude of observatory : 0.941

COMMENT Heliocentric velocity of observer towards star : -5.395 km/s

COMMENT Geocentric Julian date (UTC) : 2455634.00386

COMMENT Heliocentric Julian date (UTC) : 2455634.00769

COMMENT Heliocentric Julian date (TT) : 2455634.00845

COMMENT SNR per spec/ccd pxl in order # 61 (372 nm): I> 10 / 11

COMMENT SNR per spec/ccd pxl in order # 60 (377 nm): I> 18 / 20

COMMENT SNR per spec/ccd pxl in order # 59 (384 nm): I> 31 / 36

COMMENT SNR per spec/ccd pxl in order # 58 (390 nm): I> 46 / 54

COMMENT SNR per spec/ccd pxl in order # 57 (397 nm): I> 60 / 72

COMMENT SNR per spec/ccd pxl in order # 56 (404 nm): I> 75 / 89

COMMENT SNR per spec/ccd pxl in order # 55 (412 nm): I> 85 / 101
COMMENT SNR per spec/ccd pxl in order # 54 (419 nm): I> 95 / 113
COMMENT SNR per spec/ccd pxl in order # 53 (427 nm): I> 103 / 123
COMMENT SNR per spec/ccd pxl in order # 52 (435 nm): I> 111 / 133
COMMENT SNR per spec/ccd pxl in order # 51 (444 nm): I> 120 / 143
COMMENT SNR per spec/ccd pxl in order # 50 (453 nm): I> 129 / 154
COMMENT SNR per spec/ccd pxl in order # 49 (462 nm): I> 137 / 164
COMMENT SNR per spec/ccd pxl in order # 48 (472 nm): I> 143 / 171
COMMENT SNR per spec/ccd pxl in order # 47 (482 nm): I> 151 / 180
COMMENT SNR per spec/ccd pxl in order # 46 (492 nm): I> 159 / 190
COMMENT SNR per spec/ccd pxl in order # 45 (503 nm): I> 162 / 194
COMMENT SNR per spec/ccd pxl in order # 44 (515 nm): I> 167 / 200
COMMENT SNR per spec/ccd pxl in order # 43 (527 nm): I> 170 / 203
COMMENT SNR per spec/ccd pxl in order # 42 (539 nm): I> 172 / 206
COMMENT SNR per spec/ccd pxl in order # 41 (552 nm): I> 175 / 209
COMMENT SNR per spec/ccd pxl in order # 40 (566 nm): I> 175 / 210
COMMENT SNR per spec/ccd pxl in order # 39 (581 nm): I> 175 / 209
COMMENT SNR per spec/ccd pxl in order # 38 (596 nm): I> 177 / 211
COMMENT SNR per spec/ccd pxl in order # 37 (612 nm): I> 179 / 214
COMMENT SNR per spec/ccd pxl in order # 36 (629 nm): I> 180 / 215
COMMENT SNR per spec/ccd pxl in order # 35 (647 nm): I> 182 / 218
COMMENT SNR per spec/ccd pxl in order # 34 (666 nm): I> 186 / 222
COMMENT SNR per spec/ccd pxl in order # 33 (686 nm): I> 186 / 223
COMMENT SNR per spec/ccd pxl in order # 32 (708 nm): I> 188 / 225
COMMENT SNR per spec/ccd pxl in order # 31 (730 nm): I> 189 / 226
COMMENT SNR per spec/ccd pxl in order # 30 (755 nm): I> 187 / 223
COMMENT SNR per spec/ccd pxl in order # 29 (781 nm): I> 187 / 224
COMMENT SNR per spec/ccd pxl in order # 28 (809 nm): I> 184 / 220
COMMENT SNR per spec/ccd pxl in order # 27 (839 nm): I> 180 / 215
COMMENT SNR per spec/ccd pxl in order # 26 (871 nm): I> 176 / 210
COMMENT SNR per spec/ccd pxl in order # 25 (906 nm): I> 161 / 192
COMMENT SNR per spec/ccd pxl in order # 24 (943 nm): I> 124 / 148
COMMENT SNR per spec/ccd pxl in order # 23 (984 nm): I> 84 / 100

COMMENT SNR per spec/ccd pxl in order # 22 (1029 nm): I> 30 / 35

COMMENT >>> radial velocity correction from telluric lines (km/s): -0.040

COMMENT >>> vmag/teff estimate from sn curve (mag/K): 6.64 7676

COMMENT ---- End of data from 1287849in.out ----

COMMENT ---- This section contains data from 1287849iu.out ----

COMMENT Bias file: 1288010b.fits

COMMENT Detector gain (e/ADU) and read-out noise (e) : 1.510 4.160

COMMENT Rejection threshold [default = 10.0] : 20.0

COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU

COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU

COMMENT Order # 22 : columns -14.4 to 14.4

COMMENT Order # 23 : columns -14.0 to 14.0

COMMENT Order # 24 : columns -14.0 to 13.6

COMMENT Order # 25 : columns -14.0 to 13.6

COMMENT Order # 26 : columns -14.0 to 13.6

COMMENT Order # 27 : columns -14.0 to 13.6

COMMENT Order # 28 : columns -13.6 to 13.6

COMMENT Order # 29 : columns -13.6 to 13.6

COMMENT Order # 30 : columns -13.6 to 13.6

COMMENT Order # 31 : columns -13.6 to 13.6

COMMENT Order # 32 : columns -14.0 to 13.6

COMMENT Order # 33 : columns -14.0 to 13.6

COMMENT Order # 34 : columns -14.0 to 13.6

COMMENT Order # 35 : columns -14.0 to 13.6

COMMENT Order # 36 : columns -14.0 to 13.6

COMMENT Order # 37 : columns -14.0 to 13.6

COMMENT Order # 38 : columns -14.0 to 13.6

COMMENT Order # 39 : columns -14.0 to 14.0

COMMENT Order # 40 : columns -14.0 to 14.0

COMMENT Order # 41 : columns -14.0 to 14.0

COMMENT Order # 42 : columns -14.0 to 14.0

COMMENT Order # 43 : columns -14.0 to 14.0

COMMENT Order # 44 : columns -14.0 to 14.0

COMMENT Order # 45 : columns -14.0 to 14.0

COMMENT Order # 46 : columns -14.0 to 14.0

COMMENT Order # 47 : columns -14.0 to 14.0

COMMENT Order # 48 : columns -14.0 to 14.0

COMMENT Order # 49 : columns -14.0 to 14.0

COMMENT Order # 50 : columns -14.0 to 14.0

COMMENT Order # 51 : columns -14.0 to 14.0

COMMENT Order # 52 : columns -14.0 to 14.0

COMMENT Order # 53 : columns -14.4 to 14.0

COMMENT Order # 54 : columns -14.4 to 14.4

COMMENT Order # 55 : columns -14.4 to 14.4

COMMENT Order # 56 : columns -14.8 to 14.4

COMMENT Order # 57 : columns -14.8 to 14.8

COMMENT Order # 58 : columns -15.6 to 15.6

COMMENT Order # 59 : columns -16.0 to 14.8

COMMENT Order # 60 : columns -13.6 to 13.6

COMMENT Order # 61 : columns -12.4 to 12.8

COMMENT Correcting wavelength scale from Earth motion...

COMMENT Coordinates of object : 11:30: 3.99 & 29:57:53.0

COMMENT Time of observations : 2011 3 13 @ UT 12: 5:33

COMMENT (hour angle = 1.603 hr, airmass = 1.093)

COMMENT Total exposure time : 90.0 s

COMMENT Cosine latitude of observatory : 0.941

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COMMENT Geocentric Julian date (UTC) : 2455634.00386

COMMENT Heliocentric Julian date (UTC) : 2455634.00769

COMMENT Heliocentric Julian date (TT) : 2455634.00845

COMMENT SNR per spec/ccd pxl in order # 61 (372 nm): I> 9 / 9

COMMENT SNR per spec/ccd pxl in order # 60 (377 nm): I> 15 / 17

COMMENT SNR per spec/ccd pxl in order # 59 (384 nm): I> 28 / 32

COMMENT SNR per spec/ccd pxl in order # 58 (390 nm): I> 42 / 50

COMMENT SNR per spec/ccd pxl in order # 57 (397 nm): I> 54 / 64

COMMENT SNR per spec/ccd pxl in order # 56 (404 nm): I> 75 / 89

COMMENT SNR per spec/ccd pxl in order # 55 (412 nm): I> 80 / 95
COMMENT SNR per spec/ccd pxl in order # 54 (419 nm): I> 94 / 112
COMMENT SNR per spec/ccd pxl in order # 53 (427 nm): I> 102 / 121
COMMENT SNR per spec/ccd pxl in order # 52 (435 nm): I> 103 / 123
COMMENT SNR per spec/ccd pxl in order # 51 (444 nm): I> 118 / 140
COMMENT SNR per spec/ccd pxl in order # 50 (453 nm): I> 127 / 151
COMMENT SNR per spec/ccd pxl in order # 49 (462 nm): I> 136 / 162
COMMENT SNR per spec/ccd pxl in order # 48 (472 nm): I> 144 / 172
COMMENT SNR per spec/ccd pxl in order # 47 (482 nm): I> 148 / 177
COMMENT SNR per spec/ccd pxl in order # 46 (492 nm): I> 155 / 185
COMMENT SNR per spec/ccd pxl in order # 45 (503 nm): I> 161 / 193
COMMENT SNR per spec/ccd pxl in order # 44 (515 nm): I> 165 / 197
COMMENT SNR per spec/ccd pxl in order # 43 (527 nm): I> 168 / 201
COMMENT SNR per spec/ccd pxl in order # 42 (539 nm): I> 171 / 205
COMMENT SNR per spec/ccd pxl in order # 41 (552 nm): I> 174 / 208
COMMENT SNR per spec/ccd pxl in order # 40 (566 nm): I> 174 / 208
COMMENT SNR per spec/ccd pxl in order # 39 (581 nm): I> 176 / 210
COMMENT SNR per spec/ccd pxl in order # 38 (596 nm): I> 176 / 211
COMMENT SNR per spec/ccd pxl in order # 37 (612 nm): I> 177 / 212
COMMENT SNR per spec/ccd pxl in order # 36 (629 nm): I> 179 / 214
COMMENT SNR per spec/ccd pxl in order # 35 (647 nm): I> 181 / 216
COMMENT SNR per spec/ccd pxl in order # 34 (666 nm): I> 184 / 220
COMMENT SNR per spec/ccd pxl in order # 33 (686 nm): I> 184 / 220
COMMENT SNR per spec/ccd pxl in order # 32 (708 nm): I> 189 / 226
COMMENT SNR per spec/ccd pxl in order # 31 (730 nm): I> 187 / 224
COMMENT SNR per spec/ccd pxl in order # 30 (755 nm): I> 177 / 212
COMMENT SNR per spec/ccd pxl in order # 29 (781 nm): I> 186 / 223
COMMENT SNR per spec/ccd pxl in order # 28 (809 nm): I> 181 / 217
COMMENT SNR per spec/ccd pxl in order # 27 (839 nm): I> 177 / 212
COMMENT SNR per spec/ccd pxl in order # 26 (871 nm): I> 173 / 207
COMMENT SNR per spec/ccd pxl in order # 25 (906 nm): I> 154 / 184
COMMENT SNR per spec/ccd pxl in order # 24 (943 nm): I> 108 / 129
COMMENT SNR per spec/ccd pxl in order # 23 (984 nm): I> 82 / 98

COMMENT SNR per spec/ccd pxl in order # 22 (1029 nm): I> 30 / 35

COMMENT >>> radial velocity correction from telluric lines (km/s): 0.184

COMMENT ---- End of data from 1287849iu.out ----

COMMENT ---- This section contains data from wcal_OLAPA-a_pol_Fast.out ----

COMMENT Mean spectral resolution in order #22 : 67956 (acc : 4019, #lines : 28)

COMMENT Mean spectral resolution in order #23 : 69213 (acc : 1424, #lines : 57)

COMMENT Mean spectral resolution in order #24 : 65718 (acc : 1054, #lines : 51)

COMMENT Mean spectral resolution in order #25 : 70309 (acc : 965, #lines : 63)

COMMENT Mean spectral resolution in order #26 : 69598 (acc : 1204, #lines : 49)

COMMENT Mean spectral resolution in order #27 : 69708 (acc : 1025, #lines : 51)

COMMENT Mean spectral resolution in order #28 : 70268 (acc : 971, #lines : 63)

COMMENT Mean spectral resolution in order #29 : 70270 (acc : 916, #lines : 39)

COMMENT Mean spectral resolution in order #30 : 70038 (acc : 808, #lines : 41)

COMMENT Mean spectral resolution in order #31 : 72384 (acc : 1778, #lines : 35)

COMMENT Mean spectral resolution in order #32 : 69554 (acc : 1388, #lines : 30)

COMMENT Mean spectral resolution in order #33 : 72196 (acc : 1766, #lines : 35)

COMMENT Mean spectral resolution in order #34 : 69187 (acc : 1510, #lines : 36)

COMMENT Mean spectral resolution in order #35 : 69216 (acc : 2699, #lines : 24)

COMMENT Mean spectral resolution in order #36 : 68801 (acc : 1204, #lines : 57)

COMMENT Mean spectral resolution in order #37 : 68081 (acc : 651, #lines : 94)

COMMENT Mean spectral resolution in order #38 : 68026 (acc : 598, #lines : 87)

COMMENT Mean spectral resolution in order #39 : 68468 (acc : 598, #lines : 64)

COMMENT Mean spectral resolution in order #40 : 68516 (acc : 1980, #lines : 64)

COMMENT Mean spectral resolution in order #41 : 67391 (acc : 532, #lines : 74)

COMMENT Mean spectral resolution in order #42 : 67246 (acc : 732, #lines : 82)

COMMENT Mean spectral resolution in order #43 : 66871 (acc : 570, #lines : 73)

COMMENT Mean spectral resolution in order #44 : 67813 (acc : 577, #lines : 72)

COMMENT Mean spectral resolution in order #45 : 68914 (acc : 744, #lines : 61)

COMMENT Mean spectral resolution in order #46 : 66046 (acc : 865, #lines : 66)

COMMENT Mean spectral resolution in order #47 : 66017 (acc : 830, #lines : 69)

COMMENT Mean spectral resolution in order #48 : 65860 (acc : 759, #lines : 68)

COMMENT Mean spectral resolution in order #49 : 65738 (acc : 998, #lines : 59)

COMMENT Mean spectral resolution in order #50 : 65172 (acc : 794, #lines : 56)

COMMENT Mean spectral resolution in order #51 : 64933 (acc : 569, #lines : 69)
COMMENT Mean spectral resolution in order #52 : 65377 (acc : 697, #lines : 71)
COMMENT Mean spectral resolution in order #53 : 66368 (acc : 686, #lines : 71)
COMMENT Mean spectral resolution in order #54 : 66399 (acc : 647, #lines : 61)
COMMENT Mean spectral resolution in order #55 : 65576 (acc : 618, #lines : 63)
COMMENT Mean spectral resolution in order #56 : 65807 (acc : 594, #lines : 82)
COMMENT Mean spectral resolution in order #57 : 65740 (acc : 771, #lines : 61)
COMMENT Mean spectral resolution in order #58 : 65474 (acc : 1114, #lines : 56)
COMMENT Mean spectral resolution in order #59 : 65310 (acc : 874, #lines : 58)
COMMENT Mean spectral resolution in order #60 : 63214 (acc : 1449, #lines : 39)
COMMENT Mean spectral resolution in order #61 : 71966 (acc : 3354, #lines : 18)
COMMENT ---- End of data from wcal_OLAPA-a_pol_Fast.out ----

2.2 Polarimetry

A polarimetry p.fits FITS file looks like this:

COMMENT Fully reduced by Upena at CFHT
COMMENT ---------- Upena Reduction ----------
COMMENT Upena version 1.0
COMMENT Upena processing date: Sun Mar 13 21:07:07 HST 2011
COMMENT Upena website: http://www.cfht.hawaii.edu/Instruments/Upena/
COMMENT Upena email: upena@cfht.hawaii.edu
COMMENT Upena uses J-F. Donati's software Libre-ESpRIT
COMMENT Version 2.12 (2006 Apr. 20)
COMMENT Libre-ESpRIT reference: Donati et al., 1997, MNRAS, 291, 658
REDUCTIO= 'Polar ' / Type of reduction
NORMAL = 2 / Normalized and Un-normalized Data
COMMENT File contains automatic wavelength correction and uncorrected data.
COL1 = 'Wavelength' / Normalized
COL2 = 'Intensity' / Normalized
COL3 = 'Stokes ' / Normalized
COL4 = 'CheckN1 ' / Normalized
COL5 = 'CheckN2 ' / Normalized
COL6 = 'ErrorBar' / Normalized
COL7 = 'Wavelength' / UnNormalized
COL8 = 'Intensity' / UnNormalized
COL9 = 'Stokes ' / UnNormalized
COL10 = 'CheckN1 ' / UnNormalized
COL11 = 'CheckN2 ' / UnNormalized
COL12 = 'ErrorBar' / UnNormalized
COL13 = 'Wavelength' / Normalized, no autowave correction
COL14 = 'Intensity' / Normalized, no autowave correction
COL15 = 'Stokes ' / Normalized, no autowave correction

COL16 = 'CheckN1 ' / Normalized, no autowave correction

COL17 = 'CheckN2 ' / Normalized, no autowave correction

COL18 = 'ErrorBar' / Normalized, no autowave correction

COL19 = 'Wavelength' / UnNormalized, no autowave correction

COL20 = 'Intensity' / UnNormalized, no autowave correction

COL21 = 'Stokes ' / UnNormalized, no autowave correction

COL22 = 'CheckN1 ' / UnNormalized, no autowave correction

COL23 = 'CheckN2 ' / UnNormalized, no autowave correction

COL24 = 'ErrorBar' / UnNormalized, no autowave correction

COMMENT For Stokes Q, V, and W, keep the Stokes parameter sign as is

COMMENT For Stokes U, invert the sign of the Stokes parameter

COMMENT ---- This section contains data from 1287849pn.out ----

COMMENT Bias file: 1288010b.fits

COMMENT Detector gain (e/ADU) and read-out noise (e) : 1.510 4.160

COMMENT Rejection threshold for unpolarised spectra [default = 10.0] : 20.0

COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU

COMMENT Order # 22 : columns -14.4 to 14.4 (sep. @ col 0.0)

COMMENT Order # 23 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 24 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 25 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 26 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 27 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 28 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 29 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 30 : columns -13.6 to 13.6 (sep. @ col 0.0)

COMMENT Order # 31 : columns -13.6 to 13.6 (sep. @ col 0.0)

COMMENT Order # 32 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 33 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 34 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 35 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 36 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 37 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 38 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 39 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 40 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 41 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 42 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 43 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 44 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 45 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 46 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 47 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 48 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 49 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 50 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 51 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 52 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 53 : columns -14.4 to 14.0 (sep. @ col -0.0)

COMMENT Order # 54 : columns -14.4 to 14.4 (sep. @ col -0.0)

COMMENT Order # 55 : columns -14.4 to 14.4 (sep. @ col -0.0)

COMMENT Order # 56 : columns -14.8 to 14.4 (sep. @ col -0.0)

COMMENT Order # 57 : columns -14.8 to 14.8 (sep. @ col -0.0)

COMMENT Order # 58 : columns -15.6 to 15.6 (sep. @ col -0.0)

COMMENT Order # 59 : columns -16.0 to 14.8 (sep. @ col -0.0)

COMMENT Order # 60 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 61 : columns -12.4 to 12.8 (sep. @ col -0.0)

COMMENT Correcting wavelength scale from Earth motion...

COMMENT Coordinates of object : 11:30: 4.00 & 29:57:53.0

COMMENT Time of observations : 2011 3 13 @ UT 12: 8:45

COMMENT (hour angle = 1.657 hr, airmass = 1.098)

COMMENT Total exposure time : 360.0 s (90.0+90.0+90.0+90.0 s)

COMMENT Cosine latitude of observatory : 0.941

COMMENT Heliocentric velocity of observer towards star : -5.401 km/s

COMMENT Geocentric Julian date (UTC) : 2455634.00608

COMMENT Heliocentric Julian date (UTC) : 2455634.00991

COMMENT Heliocentric Julian date (TT) : 2455634.01067

COMMENT SNR per spec/ccd pxl in order # 61 (372 nm)

COMMENT I> 15 / 17 V> 13 / 14 N> 13 / 14

COMMENT SNR per spec/ccd pxl in order # 60 (377 nm)

COMMENT I> 30 / 35 V> 26 / 30 N> 27 / 31

COMMENT SNR per spec/ccd pxl in order # 59 (384 nm)

COMMENT I> 56 / 66 V> 52 / 62 N> 51 / 61

COMMENT SNR per spec/ccd pxl in order # 58 (390 nm)

COMMENT I> 85 / 102 V> 78 / 93 N> 79 / 94

COMMENT SNR per spec/ccd pxl in order # 57 (397 nm)

COMMENT I> 114 / 136 V> 109 / 130 N> 105 / 125

COMMENT SNR per spec/ccd pxl in order # 56 (404 nm)

COMMENT I> 143 / 171 V> 134 / 160 N> 133 / 159

COMMENT SNR per spec/ccd pxl in order # 55 (412 nm)

COMMENT I> 163 / 194 V> 154 / 184 N> 156 / 186

COMMENT SNR per spec/ccd pxl in order # 54 (419 nm)

COMMENT I> 181 / 217 V> 177 / 212 N> 169 / 202

COMMENT SNR per spec/ccd pxl in order # 53 (427 nm)

COMMENT I> 199 / 238 V> 189 / 226 N> 192 / 230

COMMENT SNR per spec/ccd pxl in order # 52 (435 nm)

COMMENT I> 215 / 257 V> 204 / 244 N> 210 / 252

COMMENT SNR per spec/ccd pxl in order # 51 (444 nm)

COMMENT I> 232 / 278 V> 221 / 265 N> 221 / 264

COMMENT SNR per spec/ccd pxl in order # 50 (453 nm)

COMMENT I> 250 / 300 V> 234 / 280 N> 244 / 292

COMMENT SNR per spec/ccd pxl in order # 49 (462 nm)

COMMENT I> 267 / 320 V> 254 / 304 N> 254 / 304

COMMENT SNR per spec/ccd pxl in order # 48 (472 nm)

COMMENT I> 278 / 333 V> 268 / 322 N> 260 / 312

COMMENT SNR per spec/ccd pxl in order # 47 (482 nm)

COMMENT I> 294 / 352 V> 281 / 337 N> 274 / 328

COMMENT SNR per spec/ccd pxl in order # 46 (492 nm)

COMMENT I> 309 / 371 V> 286 / 343 N> 299 / 359

COMMENT SNR per spec/ccd pxl in order # 45 (503 nm)

COMMENT I> 317 / 380 V> 297 / 356 N> 304 / 365

COMMENT SNR per spec/ccd pxl in order # 44 (515 nm)

COMMENT I> 326 / 391 V> 306 / 367 N> 314 / 377

COMMENT SNR per spec/ccd pxl in order # 43 (527 nm)

COMMENT I> 332 / 398 V> 315 / 378 N> 311 / 372

COMMENT SNR per spec/ccd pxl in order # 42 (539 nm)

COMMENT I> 336 / 403 V> 317 / 380 N> 316 / 379

COMMENT SNR per spec/ccd pxl in order # 41 (552 nm)

COMMENT I> 341 / 409 V> 317 / 380 N> 319 / 383

COMMENT SNR per spec/ccd pxl in order # 40 (566 nm)

COMMENT I> 343 / 411 V> 323 / 387 N> 321 / 384

COMMENT SNR per spec/ccd pxl in order # 39 (581 nm)

COMMENT I> 341 / 409 V> 319 / 383 N> 317 / 380

COMMENT SNR per spec/ccd pxl in order # 38 (596 nm)

COMMENT I> 345 / 414 V> 324 / 388 N> 329 / 394

COMMENT SNR per spec/ccd pxl in order # 37 (612 nm)

COMMENT I> 349 / 418 V> 323 / 387 N> 327 / 392

COMMENT SNR per spec/ccd pxl in order # 36 (629 nm)

COMMENT I> 352 / 422 V> 327 / 392 N> 328 / 393

COMMENT SNR per spec/ccd pxl in order # 35 (647 nm)

COMMENT I> 357 / 428 V> 327 / 392 N> 333 / 400

COMMENT SNR per spec/ccd pxl in order # 34 (666 nm)

COMMENT I> 363 / 435 V> 339 / 407 N> 334 / 401

COMMENT SNR per spec/ccd pxl in order # 33 (686 nm)

COMMENT I> 365 / 437 V> 341 / 409 N> 337 / 404

COMMENT SNR per spec/ccd pxl in order # 32 (708 nm)

COMMENT I> 369 / 442 V> 345 / 414 N> 337 / 404

COMMENT SNR per spec/ccd pxl in order # 31 (730 nm)

COMMENT I> 370 / 443 V> 338 / 406 N> 346 / 415

COMMENT SNR per spec/ccd pxl in order # 30 (755 nm)

COMMENT I> 365 / 438 V> 327 / 392 N> 328 / 393

COMMENT SNR per spec/ccd pxl in order # 29 (781 nm)

COMMENT I> 366 / 439 V> 329 / 395 N> 337 / 404

COMMENT SNR per spec/ccd pxl in order # 28 (809 nm)

COMMENT I> 359 / 430 V> 329 / 394 N> 326 / 391

COMMENT SNR per spec/ccd pxl in order # 27 (839 nm)

COMMENT I> 352 / 422 V> 328 / 393 N> 319 / 382

COMMENT SNR per spec/ccd pxl in order # 26 (871 nm)

COMMENT I> 343 / 411 V> 324 / 389 N> 318 / 381

COMMENT SNR per spec/ccd pxl in order # 25 (906 nm)

COMMENT I> 313 / 376 V> 289 / 346 N> 288 / 345

COMMENT SNR per spec/ccd pxl in order # 24 (943 nm)

COMMENT I> 240 / 288 V> 209 / 250 N> 214 / 256

COMMENT SNR per spec/ccd pxl in order # 23 (984 nm)

COMMENT I> 161 / 193 V> 140 / 167 N> 142 / 170

COMMENT SNR per spec/ccd pxl in order # 22 (1029 nm)

COMMENT I> 53 / 63 V> 43 / 50 N> 42 / 50

COMMENT >>> radial velocity correction from telluric lines (km/s): -0.049

COMMENT >>> vmag/teff estimate from sn curve (mag/K): 6.68 7614

COMMENT ---- End of data from 1287849pn.out ----

COMMENT ---- This section contains data from 1287849pu.out ----

COMMENT Bias file: 1288010b.fits

COMMENT Detector gain (e/ADU) and read-out noise (e) : 1.510 4.160

COMMENT Rejection threshold for unpolarised spectra [default = 10.0] : 20.0

COMMENT Accuracy of 2d bias fit : 0.39 ADU; Readout noise : 3.14 ADU

COMMENT Order # 22 : columns -14.4 to 14.4 (sep. @ col 0.0)

COMMENT Order # 23 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 24 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 25 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 26 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 27 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 28 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 29 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 30 : columns -13.6 to 13.6 (sep. @ col 0.0)

COMMENT Order # 31 : columns -13.6 to 13.6 (sep. @ col 0.0)

COMMENT Order # 32 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 33 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 34 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 35 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 36 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 37 : columns -14.0 to 13.6 (sep. @ col -0.0)

COMMENT Order # 38 : columns -14.0 to 13.6 (sep. @ col 0.0)

COMMENT Order # 39 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 40 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 41 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 42 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 43 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 44 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 45 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 46 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 47 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 48 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 49 : columns -14.0 to 14.0 (sep. @ col 0.0)

COMMENT Order # 50 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 51 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 52 : columns -14.0 to 14.0 (sep. @ col -0.0)

COMMENT Order # 53 : columns -14.4 to 14.0 (sep. @ col -0.0)

COMMENT Order # 54 : columns -14.4 to 14.4 (sep. @ col -0.0)

COMMENT Order # 55 : columns -14.4 to 14.4 (sep. @ col -0.0)

COMMENT Order # 56 : columns -14.8 to 14.4 (sep. @ col -0.0)

COMMENT Order # 57 : columns -14.8 to 14.8 (sep. @ col -0.0)

COMMENT Order # 58 : columns -15.6 to 15.6 (sep. @ col -0.0)

COMMENT Order # 59 : columns -16.0 to 14.8 (sep. @ col -0.0)

COMMENT Order # 60 : columns -13.6 to 13.6 (sep. @ col -0.0)

COMMENT Order # 61 : columns -12.4 to 12.8 (sep. @ col -0.0)

COMMENT Correcting wavelength scale from Earth motion...

COMMENT Coordinates of object : 11:30: 4.00 & 29:57:53.0

COMMENT Time of observations : 2011 3 13 @ UT 12: 8:45 (hour angle = 1.657 hr,

COMMENT Total exposure time : 360.0 s (90.0+90.0+90.0+90.0 s)

COMMENT Cosine latitude of observatory : 0.941

COMMENT Heliocentric velocity of observer towards star : -5.401 km/s

COMMENT Geocentric Julian date (UTC) : 2455634.00608

COMMENT Heliocentric Julian date (UTC) : 2455634.00991

COMMENT Heliocentric Julian date (TT) : 2455634.01067

COMMENT SNR per spec/ccd pxl in order # 61 (372 nm)

COMMENT I> 13 / 14 V> 11 / 12 N> 11 / 12

COMMENT SNR per spec/ccd pxl in order # 60 (377 nm)

COMMENT I> 26 / 30 V> 21 / 24 N> 21 / 25

COMMENT SNR per spec/ccd pxl in order # 59 (384 nm)

COMMENT I> 50 / 59 V> 46 / 54 N> 45 / 53

COMMENT SNR per spec/ccd pxl in order # 58 (390 nm)

COMMENT I> 79 / 94 V> 70 / 83 N> 71 / 84

COMMENT SNR per spec/ccd pxl in order # 57 (397 nm)

COMMENT I> 103 / 122 V> 96 / 114 N> 92 / 110

COMMENT SNR per spec/ccd pxl in order # 56 (404 nm)

COMMENT I> 143 / 171 V> 134 / 160 N> 133 / 159

COMMENT SNR per spec/ccd pxl in order # 55 (412 nm)

COMMENT I> 153 / 183 V> 143 / 171 N> 145 / 173

COMMENT SNR per spec/ccd pxl in order # 54 (419 nm)

COMMENT I> 181 / 217 V> 177 / 212 N> 170 / 203

COMMENT SNR per spec/ccd pxl in order # 53 (427 nm)

COMMENT I> 196 / 235 V> 186 / 222 N> 189 / 226

COMMENT SNR per spec/ccd pxl in order # 52 (435 nm)

COMMENT I> 199 / 238 V> 187 / 224 N> 194 / 232

COMMENT SNR per spec/ccd pxl in order # 51 (444 nm)

COMMENT I> 228 / 273 V> 217 / 260 N> 216 / 259

COMMENT SNR per spec/ccd pxl in order # 50 (453 nm)

COMMENT I> 246 / 294 V> 230 / 275 N> 239 / 287

COMMENT SNR per spec/ccd pxl in order # 49 (462 nm)

COMMENT I> 263 / 316 V> 250 / 300 N> 250 / 300

COMMENT SNR per spec/ccd pxl in order # 48 (472 nm)

COMMENT I> 280 / 335 V> 270 / 323 N> 262 / 313

COMMENT SNR per spec/ccd pxl in order # 47 (482 nm)

COMMENT I> 289 / 347 V> 274 / 328 N> 267 / 320

COMMENT SNR per spec/ccd pxl in order # 46 (492 nm)

COMMENT I> 302 / 363 V> 280 / 335 N> 293 / 351

COMMENT SNR per spec/ccd pxl in order # 45 (503 nm)

COMMENT I> 315 / 377 V> 295 / 354 N> 302 / 362

COMMENT SNR per spec/ccd pxl in order # 44 (515 nm)

COMMENT I> 322 / 386 V> 302 / 362 N> 310 / 372

COMMENT SNR per spec/ccd pxl in order # 43 (527 nm)

COMMENT I> 329 / 394 V> 312 / 374 N> 308 / 369

COMMENT SNR per spec/ccd pxl in order # 42 (539 nm)

COMMENT I> 334 / 401 V> 315 / 378 N> 314 / 377

COMMENT SNR per spec/ccd pxl in order # 41 (552 nm)

COMMENT I> 340 / 407 V> 316 / 379 N> 318 / 381

COMMENT SNR per spec/ccd pxl in order # 40 (566 nm)

COMMENT I> 340 / 408 V> 321 / 385 N> 319 / 382

COMMENT SNR per spec/ccd pxl in order # 39 (581 nm)

COMMENT I> 343 / 411 V> 321 / 385 N> 319 / 382

COMMENT SNR per spec/ccd pxl in order # 38 (596 nm)

COMMENT I> 345 / 413 V> 323 / 387 N> 328 / 393

COMMENT SNR per spec/ccd pxl in order # 37 (612 nm)

COMMENT I> 346 / 415 V> 321 / 384 N> 325 / 389

COMMENT SNR per spec/ccd pxl in order # 36 (629 nm)

COMMENT I> 349 / 419 V> 325 / 389 N> 326 / 391

COMMENT SNR per spec/ccd pxl in order # 35 (647 nm)

COMMENT I> 354 / 424 V> 324 / 388 N> 330 / 396

COMMENT SNR per spec/ccd pxl in order # 34 (666 nm)

COMMENT I> 360 / 432 V> 337 / 404 N> 332 / 398

COMMENT SNR per spec/ccd pxl in order # 33 (686 nm)

COMMENT I> 359 / 431 V> 332 / 398 N> 329 / 394

COMMENT SNR per spec/ccd pxl in order # 32 (708 nm)

COMMENT I> 369 / 443 V> 346 / 415 N> 338 / 405

COMMENT SNR per spec/ccd pxl in order # 31 (730 nm)

COMMENT I> 367 / 440 V> 335 / 402 N> 343 / 411

COMMENT SNR per spec/ccd pxl in order # 30 (755 nm)

COMMENT I> 346 / 415 V> 285 / 342 N> 292 / 350

COMMENT SNR per spec/ccd pxl in order # 29 (781 nm)

COMMENT I> 364 / 437 V> 328 / 393 N> 335 / 402

COMMENT SNR per spec/ccd pxl in order # 28 (809 nm)

COMMENT I> 355 / 425 V> 323 / 388 N> 321 / 384

COMMENT SNR per spec/ccd pxl in order # 27 (839 nm)

COMMENT I> 347 / 416 V> 323 / 387 N> 314 / 376

COMMENT SNR per spec/ccd pxl in order # 26 (871 nm)

COMMENT I> 338 / 406 V> 320 / 383 N> 313 / 375

COMMENT SNR per spec/ccd pxl in order # 25 (906 nm)

COMMENT I> 300 / 360 V> 271 / 324 N> 272 / 326

COMMENT SNR per spec/ccd pxl in order # 24 (943 nm)

COMMENT I> 209 / 250 V> 160 / 192 N> 168 / 201

COMMENT SNR per spec/ccd pxl in order # 23 (984 nm)

COMMENT I> 158 / 189 V> 137 / 164 N> 140 / 167

COMMENT SNR per spec/ccd pxl in order # 22 (1029 nm)

COMMENT I> 54 / 63 V> 43 / 51 N> 43 / 51

COMMENT >>> radial velocity correction from telluric lines (km/s): 0.199

COMMENT ---- End of from 1287849pu.out ----

COMMENT ---- This section contains data from wcal_OLAPA-a_pol_Fast.out ----

COMMENT Mean spectral resolution in order #22 : 67956 (acc : 4019, #lines : 28)

COMMENT Mean spectral resolution in order #23 : 69213 (acc : 1424, #lines : 57)

COMMENT Mean spectral resolution in order #24 : 65718 (acc : 1054, #lines : 51)

COMMENT Mean spectral resolution in order #25 : 70309 (acc : 965, #lines : 63)

COMMENT Mean spectral resolution in order #26 : 69598 (acc : 1204, #lines : 49)

COMMENT Mean spectral resolution in order #27 : 69708 (acc : 1025, #lines : 51)

COMMENT Mean spectral resolution in order #28 : 70268 (acc : 971, #lines : 63)

COMMENT Mean spectral resolution in order #29 : 70270 (acc : 916, #lines : 39)

COMMENT Mean spectral resolution in order #30 : 70038 (acc : 808, #lines : 41)

COMMENT Mean spectral resolution in order #31 : 72384 (acc : 1778, #lines : 35)

COMMENT Mean spectral resolution in order #32 : 69554 (acc : 1388, #lines : 30)

COMMENT Mean spectral resolution in order #33 : 72196 (acc : 1766, #lines : 35)

COMMENT Mean spectral resolution in order #34 : 69187 (acc : 1510, #lines : 36)

COMMENT Mean spectral resolution in order #35 : 69216 (acc : 2699, #lines : 24)

COMMENT Mean spectral resolution in order #36 : 68801 (acc : 1204, #lines : 57)

COMMENT Mean spectral resolution in order #37 : 68081 (acc : 651, #lines : 94)

COMMENT Mean spectral resolution in order #38 : 68026 (acc : 598, #lines : 87)

COMMENT Mean spectral resolution in order #39 : 68468 (acc : 598, #lines : 64)

COMMENT Mean spectral resolution in order #40 : 68516 (acc : 1980, #lines : 64)

COMMENT Mean spectral resolution in order #41 : 67391 (acc : 532, #lines : 74)

COMMENT Mean spectral resolution in order #42 : 67246 (acc : 732, #lines : 82)

COMMENT Mean spectral resolution in order #43 : 66871 (acc : 570, #lines : 73)

COMMENT Mean spectral resolution in order #44 : 67813 (acc : 577, #lines : 72)

COMMENT Mean spectral resolution in order #45 : 68914 (acc : 744, #lines : 61)

COMMENT Mean spectral resolution in order #46 : 66046 (acc : 865, #lines : 66)

COMMENT Mean spectral resolution in order #47 : 66017 (acc : 830, #lines : 69)

COMMENT Mean spectral resolution in order #48 : 65860 (acc : 759, #lines : 68)

COMMENT Mean spectral resolution in order #49 : 65738 (acc : 998, #lines : 59)

COMMENT Mean spectral resolution in order #50 : 65172 (acc : 794, #lines : 56)

COMMENT Mean spectral resolution in order #51 : 64933 (acc : 569, #lines : 69)

COMMENT Mean spectral resolution in order #52 : 65377 (acc : 697, #lines : 71)

COMMENT Mean spectral resolution in order #53 : 66368 (acc : 686, #lines : 71)

COMMENT Mean spectral resolution in order #54 : 66399 (acc : 647, #lines : 61)

COMMENT Mean spectral resolution in order #55 : 65576 (acc : 618, #lines : 63)

COMMENT Mean spectral resolution in order #56 : 65807 (acc : 594, #lines : 82)

COMMENT Mean spectral resolution in order #57 : 65740 (acc : 771, #lines : 61)

COMMENT Mean spectral resolution in order #58 : 65474 (acc : 1114, #lines : 56)

COMMENT Mean spectral resolution in order #59 : 65310 (acc : 874, #lines : 58)

COMMENT Mean spectral resolution in order #60 : 63214 (acc : 1449, #lines : 39)

COMMENT Mean spectral resolution in order #61 : 71966 (acc : 3354, #lines : 18)

COMMENT ---- End of data from wcal_OLAPA-a_pol_Fast.out ----

3. What OPERA Saves

3.1 The Calibration and Beam Data -- m.fits

Much more information is available from OPERA for each exposure. Additional outputs include:

- beam flux, variance, photo center and backgrounds
- Signal to Noise for each spectral Element for each order
- wavelength calibration polynomials
- instrument profile
- aperture profile
- order spacing polynomials
- geometry polynomials
- calculated gain/bias
- reduction and calibration parameters
- flux calibration.

Additionally, the spectra and polarimetry data also contain more information. Most fundamentally, the order number is saved with the spectra. upena does not save the order number, so it is difficult to see where one order ends and the next starts. The .e beam spectrum stores flux, distance, photo center information and variance for each beam and for the background level near each beam.

The tables are most easily stored as float image data. But, how to handle the varying widths and depths of the data?

The most natural solution is to use multi-extension FITS format. Each table is stored as an extension, that is clearly names as to contents. Here is a sample as shown as a MEF FITS image in ds9:

The primary header contains all the keywords associated with the exposure at the time of observation. A sample header dump shows the self-describing format:

```
[1] SIMPLE = T / file does conform to FITS standard
[1] BITPIX = -32 / number of bits per data pixel
[1] NAXIS =  0 / number of data axes
[1] EXTEND=  T / FITS dataset may contain extensions
[1] NEXTEND = 9 / Number of Extensions
[1] BZERO = 32768.0 / Zero factor
[1] BSCALE = 1.0 / Scale factor
[1] COMMENT
[1] COMMENT Observation Summary
[1] COMMENT -------------------
[1] COMMENT
[1] CMMTOBS = 'N/A     '
[1] CMMTSEQ = 'I exposure 1, sequence 1 of 1'
[1] OBSERVER= 'QSO Team'
[1] COMMENT
[1] COMMENT General
[1] COMMENT -------
[1] COMMENT
[1] DATE    = '2011-07-09T15:18:26' / UTC Date of file creation
[1] HSTTIME = 'Sat Jul 09 05:18:26 HST 2011' / Local time in Hawaii
[1] IMAGESWV= 'CFHT DetCom v3.60.8 (Nov 05 2010)' / Image creation software version
[1] OBSTYPE = 'OBJECT  '           / Observation / Exposure type
[1] EXPTYPE = 'OBJECT  '           / See OBSTYPE
[1] EXPTIME =               2163.0 / Integration time (seconds)
[1] DARKTIME=               2163.0 / Dark current time (seconds)
[1] SHUTOPEN=                  0.0 / Shutter blade opening time (seconds)
[1] SHUTCLOS=                  0.0 / Shutter blade closing time (seconds)
[1] COMMENT
[1] COMMENT Detector
[1] COMMENT --------
[1] COMMENT
[1] COMMENT file 1315230o00, raster FULL, etype OBJECT, etime 2163
[1] COMMENT Image data for chip 00
```

```
[1] DETECTOR= 'OLAPA   '           / Science Detector
[1] CCD     = 'Unknown '           / Science Detector (use DETECTOR)
[1] IMAGEID =                    0 / CCD chip number
[1] CHIPID  =                    0 / Use IMAGEID instead
[1] DETSIZE = '[1:2048,1:4608]'    / Total data pixels in full mosaic
[1] RASTER  = 'FULL    '           / Active raster description
[1] CCDSUM  = '1 1     '           / Binning factors
[1] CCDBIN1 =                    1 / Binning factor along first axis
[1] CCDBIN2 =                    1 / Binning factor along second axis
[1] PIXSIZE =                 13.5 / Pixel size for both axes (microns)
[1] AMPLIST = 'a       '           / List of amplifiers for this image
[1] CCDSIZE = '[1:2048,1:4608]'    / Detector imaging area size
[1] CCDSEC  = '[1:2048,1:4608]'    / Read out area of the detector (unbinned)
[1] DATASEC = '[1:2048,1:4608]'    / Imaging area of the detector
[1] BIASSEC = '[2049:2080,1:4608]' / Overscan (bias) area of the detector
[1] MAXLIN  =                65535 / Maximum linearity value (ADU)
[1] SATURATE=                65535 / Saturation value (ADU)
[1] GAINA   =                 1.30 / Amp A gain (electrons/ADU)
[1] RDNOISEA=                 4.20 / Amp A read noise (electrons)
[1] DARKCUR =                    0 / Dark current (e-/pixel/hour)
[1] RDTIME  =                38.00 / Read out time (sec)
[1] MDCOORDS=                    1 / Sequence number within the exposure sequence
[1] MDREPEAT=                    1 / Total number of sequences
[1] CMPLTEXP=                    1 / Exposure number within the exposure sequence
[1] NEXP    =                    1 / Total number of exposures within the sequence
[1] CONSWV  = 'olA=137,DCU=49'     / Controller software DSPID and SERNO versions
[1] DETSTAT = 'ok      '           / Detector temp range (-135..-120)
[1] DETTEM  =               -131.3 / Detector temp deg C = 745.502 + -0.278 * 3154
[1] INHERIT =                    F / No need to inherit global keywords
[1] COMMENT
[1] COMMENT Telescope
[1] COMMENT ---------
[1] COMMENT
[1] TELESCOP= 'CFHT 3.6m'          / Hawaii Big Island, Mauna Kea
[1] ORIGIN  = 'CFHT    '           / Canada-France-Hawaii Telescope
[1] LATITUDE=            19.825252 / Latitude (degrees N)
[1] LONGITUD=          -155.468876 / Longitude (degrees E)
[1] TELSTAT = 'auto_guide'         / Telescope Control System status
[1] TIMESYS = 'UTC     '           / Time System for DATExxxx and TIMExxxx
[1] DATE-OBS= '2011-07-09'         / Date at start of observation (UTC)
[1] UTIME   = '14:42:18.98'        / Time at start of observation (UTC)
[1] UTC-OBS = '14:42:18.98'        / Time at start of observation (UTC)
[1] TIME-OBS= '14:42:23.925'       / Time at start of observation (UTC)
[1] MJDATE  =        55751.6127197 / Modified Julian Date at start of observation
```

```
[1] MJD-OBS =        55751.6127197 / Modified Julian Date at start of observation
[1] SIDTIME = '23:29:12.10'        / Sidereal time at start of observation
[1] LST-OBS = '23:29:12.10'        / Sidereal time at start of exposure
[1] DATEEND = '2011-07-09'         / Date at end of observation (UTC)
[1] UTCEND  = '15:19:03.51'        / Time at end of observation (UTC)
[1] TIMEEND = '15:18:26.950'       / Time at end of observation (UTC)
[1] MJDEND  =        55751.6382351 / Modified Julian Date at end of observation
[1] LSTEND  = '0:06:02.66'         / Sidereal time at end of exposure
[1] EQUINOX =               2000.0 / Equinox of coordinates
[1] RADECSYS= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
[1] COMMENT RA/DEC are current actual telescope position
[1] COMMENT including handset corrections
[1] RA      = '2:55:17.00'         / Telescope right ascension
[1] DEC     = '16:18:33.0'         / Telescope declination
[1] HA      = '-3:26:04.90'        / Telescope hour angle at start of exposure
[1] HAEND   = '-2:49:14.34'        / Telescope hour angle at end of exposure
[1] INSTZRA =                 0.00 / Instrument zero for RA in arc seconds
[1] INSTZDEC=                 0.00 / Instrument zero for Dec in arc seconds
[1] RA_DEG  =           43.820833 / Telescope right ascension in degrees
[1] DEC_DEG =           16.309167 / Telescope declination in degrees
[1] COMMENT OBJxxx are original target position
[1] COMMENT plus proper motion and precession
[1] OBJNAME = 'HD 18144'           / Target name
[1] OBJMAG  =                  0.0 / Target magnitude
[1] OBJEQUIN=               2000.0 / Target equinox
[1] OBJRADEC= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
[1] OBJRA   = '2:55:17.00'         / Target right ascension
[1] OBJDEC  = '16:18:33.0'         / Target declination
[1] OBJRAPM =                 0.00 / Target right ascension proper motion in as/yr
[1] OBJDECPM=                 0.00 / Target declination proper motion in as/yr
[1] NGUIDER =                    1 / TCS Number of guiders
[1] NGUISTAR=                    1 / TCS number of guide stars/probes in use
[1] GUINAME = 'Cass    '           / TCS guider name
[1] GUIEQUIN=               2000.0 / TCS guider equinox
[1] GUIRADEC= 'FK5     '           / TCS guider system for equinox
[1] GUIRA   = '2:56:44.61'         / TCS guider right ascension
[1] GUIDEC  = '16:26:37.3'         / TCS guider declination
[1] GUIRAPM =                 0.00 / TCS guider right ascension proper motion arcsec
[1] GUIDECPM=                 0.00 / TCS guider declination proper motion arcsec
[1] GUIOBJN = 'auto GSC: 0'        / TCS guider object name
[1] GUIMAGN =              -9999.9 / TCS guider object magnitude
[1] XPROBE  =            -174.000 / Telescope bonnette guide probe X position
[1] YPROBE  =             -68.000 / Telescope bonnette guide probe Y position
[1] ZPROBE  =             412.000 / Telescope bonnette guide probe Z position
```

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[1] GUIFLUX =                -9999 / TCS guider flux
[1] GUIFWHX =             -9999.90 / TCS guider average x FWHM in pixels
[1] GUIFWHY =             -9999.90 / TCS guider average y FWHM in pixels
[1] SKYFLUX =                -9999 / TCS total sky flux
[1] AIRMASS =               1.526 / Airmass at start of observation
[1] TELALT  =             41.0389 / Telescope altitude at start of observation, deg
[1] TELAZ   =             85.2383 / Telescope azimuth at start, deg, 0=N 90=E 270=W
[1] DOMEAZ  =                85.0 / Dome azimuth at start, deg, 0=N 90=E 270=W
[1] MOONANGL=              167.00 / Angle from object to moon at start in degrees
[1] MOONPHAS=                0.73 / Moon phase @ 0 HST, 0..1 new>full, -1..0 >new
[1] MOONUP  = 'False   '          / Moon up? True or False
[1] MOONALT =              -53.50 / Moon altitude at start in degrees
[1] MOONAZ  =              268.10 / Moon azimuth at start in deg, 0=N 90=E 270=W
[1] FOCUSID = 'Cass    '          / Telescope focus in use
[1] TELCONF = 'Cass    '          / Telescope focus in use
[1] CALFOCUS=              12.074 / Telescope focus calculated from model in mm
[1] DEFOCUS =               0.000 / Telescope defocus from calculated in mm
[1] FOCUSPOS=               12078 / Telescope focus encoder readout
[1] TELFOCUS=               12078 / Telescope focus encoder readout
[1] BONANGLE=                0.00 / Telescope bonnette rotation angle in degrees
[1] ROTANGLE=                0.00 / Telescope bonnette rotation angle in degrees
[1] TCSGPSBC= '0190 14:42:10.765158' / TCS GPS read out in BCD
[1] TCSGPSTM=             14.70299 / TCS GPS clock time in decimal hours
[1] TCSRBUSS= '14:42:15.873'       / TCS RBUSS clock time
[1] TCSEPICS= '20110709 14:42:08.772' / TCS EPICS clock time
[1] TCSAMODE= 'O       '          / TCS acquire mode - T/O/G/g/P for t/o/g coords
[1] TCSMJD  =        55751.6126242 / TCS MJD
[1] TCSLST  =             23.48440 / TCS LST in decimal hours
[1] TCSAPHA =            308.28232 / TCS apparent hour angle in degrees
[1] TCSAPDEC=             16.35571 / TCS apparent declination in degrees
[1] TCSOBHA =            -51.70585 / TCS observed hour angle in degrees
[1] TCSOBDEC=             16.35819 / TCS observed declination in degrees
[1] TCSENHA =              -188085 / TCS hour angle absolute encoder in bits
[1] TCSENDEC=                44202 / TCS declination absolute encoder in bits
[1] TCSEDHA =            -51.59639 / TCS hour angle absolute encoder in degrees
[1] TCSEDDEC=             16.35079 / TCS declination absolute encoder in degrees
[1] TCSINHA =                    0 / TCS hour angle incremental encoder in bits
[1] TCSINDEC=                    0 / TCS declination incremental encoder in bits
[1] TCSSEHA =               -0.03 / TCS hour angle servo error in arcsec
[1] TCSSEDEC=                0.01 / TCS declination servo error in arcsec
[1] TCSGEHA =                0.00 / TCS hour angle guider error in arcsec
[1] TCSGEDEC=                0.00 / TCS declination guider error in arcsec
[1] TCSMVRA =              0.0000 / TCS right ascension acquisition move in arcsec
[1] TCSMVDEC=              0.0000 / TCS declination acquisition move in arcsec
```

```
[1] TCSMVX  =            -9999.900 / TCS secondary guider acquisition x move in mm
[1] TCSMVY  =            -9999.900 / TCS secondary guider acquisition y move in mm
[1] FFLAMPON= 'OFF     '           / flatfield lamp status ON/OFF
[1] FFLAMP1 =                    5 / flatfield lamp 1 intensity
[1] FFLAMP2 =                   12 / flatfield lamp 2 intensity
[1] CLAMPON = 'OFF     '           / comparison lamp status ON/OFF
[1] COMMENT
[1] COMMENT Instrument Description
[1] COMMENT ----------------------
[1] COMMENT
[1] INSTRUME= 'ESPaDOnS'           / Instrument Name
[1] INSTMODE= 'Spectroscopy, star only, R=80,000' / Instrument Mode
[1] FILTERID=                   -1 / wheel position
[1] FILTER  = 'Unknown '           / description of filter
[1] COMMENT
[1] COMMENT ESPaDOnS Cassegrain Unit
[1] COMMENT ------------------------
[1] COMMENT
[1] EADCPOS = 'IN      '           / ESPaDOnS ADC position IN/OUT of beam
[1] EADC1BEG= '-14.7227348537931'  / ADC prism 1 position at start of exposure
[1] EADC2BEG= '140.108078063241'   / ADC prism 2 position at start of exposure
[1] EADC1END= '-8.01330320046581'  / ADC prism 1 position at end of exposure
[1] EADC2END= '148.192625988142'   / ADC prism 2 position at end of exposure
[1] ECALIBWH= 'P1      '           / ESPaDOnS calibration wheel position (# and deg)
[1] ERHOMB1 = 'P1      '           / ESPaDOnS rhomb 1 position (# and deg)
[1] ERHOMB2 = 'P1      '           / ESPaDOnS rhomb 2 position (# and deg)
[1] EFABPERO= 'P1      '           / ESPaDOnS Fabry Perot position (# and deg)
[1] EWEDWOL = 'WED     '           / ESPaDOnS Wedge/Wollaston slide position WED/WOL
[1] ETEMPPOL=                -8.55 / ESPaDOnS polarimeter temperature deg C
[1] ETEMPCB =                -0.32 / ESPaDOnS calibration box temperature deg C
[1] COMMENT
[1] COMMENT ESPaDOnS Guider
[1] COMMENT ---------------
[1] COMMENT
[1] EGUIDING= 'GO      '           / ESPaDOnS guiding state ON/OFF
[1] EGUISEE =             -9999.90 / ESPaDOnS guider seeing estimate
[1] COMMENT
[1] COMMENT ESPaDOnS Spectrograph
[1] COMMENT ----------------------
[1] COMMENT
[1] ECAMFOC =                -3.45 / ESPaDOnS camera focus position (mm)
[1] EHARTPOS= 'OUT     '           / ESPaDOnS hartmann position FULL/DOWN/UP/OUT
[1] ESLIPOS = 'P4      '           / ESPaDOnS slicer bench position (# and mm)
[1] EHALOPOS= 'OUT     '           / ESPaDOnS halogen lamp position IN/OUT
```

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[1] EHALOGEN= 'OFF     '           / ESPaDOnS halogen lamp state ON/OFF
[1] ESLICER = 'P4      '           / ESPaDOnS slicer position (# and deg)
[1] EDEKKER = 'P7      '           / ESPaDOnS dekker position (# and mm)
[1] EEMSHUT = 'OPEN    '           / ESPaDOnS exposure meter shutter OPEN/CLOSED
[1] EEMSTATE= 'ON      '           / ESPaDOnS exposure meter state ON/OFF
[1] EEMCNTS =                32167 / ESPaDOnS exposure meter counts at end
[1] ETSP1BEG=                13.12 / ESPaDOnS down mirror temp at start (deg C)
[1] ETSP2BEG=                13.31 / ESPaDOnS camera temp at start (deg C)
[1] ETSP3BEG=                13.24 / ESPaDOnS up mirror temp at start (deg C)
[1] ETSP4BEG=                12.65 / ESPaDOnS hygrometer temp at start (deg C)
[1] EPRSPBEG=                -4.05 / ESPaDOnS relative pressure at start (mb)
[1] ERHSPBEG=                26.67 / ESPaDOnS relative humidity at start (%)
[1] ETSP1END=                13.11 / ESPaDOnS down mirror temp at end (deg C)
[1] ETSP2END=                13.32 / ESPaDOnS camera temp at end (deg C)
[1] ETSP3END=                13.25 / ESPaDOnS up mirror temp at end (deg C)
[1] ETSP4END=                12.77 / ESPaDOnS hygrometer temp at end (deg C)
[1] EPRSPEND=                -3.98 / ESPaDOnS relative pressure at end (mb)
[1] ERHSPEND=                26.59 / ESPaDOnS relative humidity at end (%)
[1] EREADSPD= 'Normal: 4.20e noise, 1.30e/ADU, 38s' / ESPaDOnS det read out xslow/sl
[1] TESPMIRE=                 0.38 / 03 temp, surface, primary mirror east deg C
[1] TESPMIRW=                 0.66 / 02 temp, surface, primary mirror west deg C
[1] TESPMIRS=                 0.73 / 01 temp, surface, primary mirror west side degC
[1] TEAPMCLW=                -0.02 / 54 temp, air, primary mirror cell west deg C
[1] TEAMIRCI=                 0.04 / 58 temp, air, mirror cooling in at unit deg C
[1] TEAMIRCO=                -0.04 / 27 temp, air, mirror cooling out at cell deg C
[1] TEAPMSPN=                 0.51 / 65 temp, air, mirror spigot north cass deg C
[1] TEAPMSPS=                 0.54 / 64 temp, air, mirror spigot nouth M3 deg C
[1] TEATRNGE=                -2.19 / 23 temp, air, top ring east deg C
[1] TEATRNGW=                -0.16 / 06 temp, air, top ring west deg C
[1] TEANRLSB=                10.77 / 19 temp, air, north rail support beam deg C
[1] TESHRSET=                -0.36 / 08 temp, surface, horseshoe east top deg C
[1] TESTTRSH=                -0.97 / 97 temp, surface, telescope truss S high deg C
[1] TESTTRNM=                -0.98 / 94 temp, surface, telescope truss N mid deg C
[1] TESTTREM=                -0.72 / 95 temp, surface, telescope truss E mid deg C
[1] TESTTRWM=                -0.93 / 96 temp, surface, telescope truss W mid deg C
[1] TESTTRSL=                -0.95 / 98 temp, surface, telescope truss S low deg C
[1] TESTTRSE=                -0.25 / 69 temp, surface, telescope truss SE lower degC
[1] TEALOWWS=                 0.00 / 38 temp, air, dome lower weather stat side degC
[1] TEATOPWS=                 0.00 / 36 temp, air, dome top weather stat side deg C
[1] TEATOPOP=                 0.00 / 37 temp, air, dome top opposite weath side degC
[1] TEA2INCH=                 0.26 / 45 temp, air, two inches above fifth floor degC
[1] TEA2INEB=                 0.45 / 53 temp, air, two inches up by electronics degC
[1] TEA6FOOT=                 0.53 / 43 temp, air, six feet above fifth floor deg C
[1] TESCONRM=                 2.62 / 61 temp, surface, floor above control room degC
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[1] TESPIERN=                1.61 / 59 temp, surface, floor by north pier deg C
[1] TESPIERS=                1.51 / 60 temp, surface, floor by south pier deg C
[1] TEAWTHRT=                0.80 / 35 temp, air, weathertron deg C
[1] TEMPERAT=               -0.30 / 86 temp, air, weather tower deg C
[1] WINDSPED=               14.04 / 84 wind speed, weather tower knots
[1] WINDDIR =               97.61 / 85 wind direction, weather tower deg (N=0 E=90)
[1] RELHUMID=               10.05 / 87 relative humidity, weather tower %
[1] PRESSURE=              614.85 / 31 barometric pressure, control room mb
[1] DDSEEMEN=                0.58 / Dome DIMM mean seeing, arc seconds
[1] DDSEEMED=                0.54 / Dome DIMM median seeing, arc seconds
[1] DDSEEMOD=                0.47 / Dome DIMM mode seeing, arc seconds
[1] DDSEESTD=                0.18 / Dome DIMM seeing deviation, arc seconds
[1] WMSEEMEN=            -9999.90 / Weather tower MASS mean seeing, arc seconds
[1] WMSEEMED=            -9999.90 / Weather tower MASS median seeing, arc seconds
[1] WMSEEMOD=            -9999.90 / Weather tower MASS mode seeing, arc seconds
[1] WMSEESTD=            -9999.90 / Weather tower MASS seeing deviation, arc second
[1] WDSEEMEN=                1.08 / Weather tower DIMM mean seeing, arc seconds
[1] WDSEEMED=                1.10 / Weather tower DIMM median seeing, arc seconds
[1] WDSEEMOD=                0.90 / Weather tower DIMM mode seeing, arc seconds
[1] WDSEESTD=                0.18 / Weather tower DIMM seeing deviation, arc second
[1] SPOZPMEN=                0.84 / SkyProbe (orig) mean absorption, magnitude
[1] SPOZPMED=                0.26 / SkyProbe (orig) median absorption, magnitude
[1] SPOZPMOD=                0.26 / SkyProbe (orig) mode absorption, magnitude
[1] SPOZPSTD=                2.33 / SkyProbe (orig) absorption deviation, magnitude
[1] SPBZPMEN=            -9999.90 / SkyProbe (B) mean absorption, magnitude
[1] SPBZPMED=            -9999.90 / SkyProbe (B) median absorption, magnitude
[1] SPBZPMOD=            -9999.90 / SkyProbe (B) mode absorption, magnitude
[1] SPBZPSTD=            -9999.90 / SkyProbe (B) absorption deviation, magnitude
[1] SPVZPMEN=            -9999.90 / SkyProbe (V) mean absorption, magnitude
[1] SPVZPMED=            -9999.90 / SkyProbe (V) median absorption, magnitude
[1] SPVZPMOD=            -9999.90 / SkyProbe (V) mode absorption, magnitude
[1] SPVZPSTD=            -9999.90 / SkyProbe (V) absorption deviation, magnitude
[1] ASCLDMEN=                 0.8 / ASIVA mean global (all sky) cloud cover, %
[1] ASCLDMED=                 0.9 / ASIVA median global (all sky) cloud cover, %
[1] ASCLDMOD=                 0.8 / ASIVA mode global (all sky) cloud cover, %
[1] ASCLDSTD=                 0.5 / ASIVA global (all sky) cloud cover deviation, %
[1] ASNERMEN=          -9999.900 / ASIVA mean radiance, NE quadrant, w/m2/u/sr
[1] ASNERMED=          -9999.900 / ASIVA median radiance, NE quadrant, w/m2/u/sr
[1] ASNERMOD=          -9999.900 / ASIVA mode radiance, NE quadrant, w/m2/u/sr
[1] ASNERSTD=          -9999.900 / ASIVA radiance deviation, NE quadrant, w/m2/u/s
[1] ASNESMEN=          -9999.900 / ASIVA mean standard deviation, NE quadrant
[1] ASNESMED=          -9999.900 / ASIVA median standard deviation, NE quadrant
[1] ASNESMOD=          -9999.900 / ASIVA mode standard deviation, NE quadrant
[1] ASNESSTD=          -9999.900 / ASIVA standard deviation deviation, NE quadrant
```

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[1] ASSERMEN=            -9999.900 / ASIVA mean radiance, SE quadrant, w/m2/u/sr
[1] ASSERMED=            -9999.900 / ASIVA median radiance, SE quadrant, w/m2/u/sr
[1] ASSERMOD=            -9999.900 / ASIVA mode radiance, SE quadrant, w/m2/u/sr
[1] ASSERSTD=            -9999.900 / ASIVA radiance deviation, SE quadrant, w/m2/u/s
[1] ASSESMEN=            -9999.900 / ASIVA mean standard deviation, SE quadrant
[1] ASSESMED=            -9999.900 / ASIVA median standard deviation, SE quadrant
[1] ASSESMOD=            -9999.900 / ASIVA mode standard deviation, SE quadrant
[1] ASSESSTD=            -9999.900 / ASIVA standard deviation deviation, SE quadrant
[1] ASSWRMEN=            -9999.900 / ASIVA mean radiance, SW quadrant, w/m2/u/sr
[1] ASSWRMED=            -9999.900 / ASIVA median radiance, SW quadrant, w/m2/u/sr
[1] ASSWRMOD=            -9999.900 / ASIVA mode radiance, SW quadrant, w/m2/u/sr
[1] ASSWRSTD=            -9999.900 / ASIVA radiance deviation, SW quadrant, w/m2/u/s
[1] ASSWSMEN=            -9999.900 / ASIVA mean standard deviation, SW quadrant
[1] ASSWSMED=            -9999.900 / ASIVA median standard deviation, SW quadrant
[1] ASSWSMOD=            -9999.900 / ASIVA mode standard deviation, SW quadrant
[1] ASSWSSTD=            -9999.900 / ASIVA standard deviation deviation, SW quadrant
[1] ASNWRMEN=            -9999.900 / ASIVA mean radiance, NW quadrant, w/m2/u/sr
[1] ASNWRMED=            -9999.900 / ASIVA median radiance, NW quadrant, w/m2/u/sr
[1] ASNWRMOD=            -9999.900 / ASIVA mode radiance, NW quadrant, w/m2/u/sr
[1] ASNWRSTD=            -9999.900 / ASIVA radiance deviation, NW quadrant, w/m2/u/s
[1] ASNWSMEN=            -9999.900 / ASIVA mean standard deviation, NW quadrant
[1] ASNWSMED=            -9999.900 / ASIVA median standard deviation, NW quadrant
[1] ASNWSMOD=            -9999.900 / ASIVA mode standard deviation, NW quadrant
[1] ASNWSSTD=            -9999.900 / ASIVA standard deviation deviation, NW quadrant
[1] ASSPRMEN=                0.047 / ASIVA mean radiance, SkyProbe, w/m2/u/sr
[1] ASSPRMED=                0.050 / ASIVA median radiance, SkyProbe, w/m2/u/sr
[1] ASSPRMOD=                0.055 / ASIVA mode radiance, SkyProbe, w/m2/u/sr
[1] ASSPRSTD=                0.012 / ASIVA radiance deviation, SkyProbe, w/m2/u/sr
[1] ASSPSMEN=               61.394 / ASIVA mean standard deviation, SkyProbe
[1] ASSPSMED=               62.000 / ASIVA median standard deviation, SkyProbe
[1] ASSPSMOD=               56.990 / ASIVA mode standard deviation, SkyProbe
[1] ASSPSSTD=                5.550 / ASIVA standard deviation deviation, SkyProbe
[1] QID     = 55100500000000023812
[1] QOBSEQID= 55001400000000059822
[1] QICSEQID= 55051200000000085770
[1] QOBITER =                    1
[1] REL_DATE= '2012-08-31T00:00:00' / UTC Release Date
END

[2] XTENSION= 'IMAGE   '           / IMAGE extension
[2] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[2] NAXIS   =                    2 / number of data axes
[2] NAXIS1  =                   40 / length of data axis 1
[2] NAXIS2  =               298350 / length of data axis 2
```

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[2] PCOUNT  =                    0 / required keyword; must = 0
[2] GCOUNT  =                    1 / required keyword; must = 1
[2] BZERO   =                   0.
[2] BSCALE  =                   1.
[2] COMMENT ----------------------------------------------------
[2] COMMENT | Processed by the CFHT OPERA Open Source Pipeline |
[2] COMMENT ----------------------------------------------------
[2] COMMENT OPERA version 1.0 - opera-1.0 build date Thu Oct 18 09:55:53 HST 2012
[2] COMMENT Processing Date
[2] COMMENT ---------------
[2] COMMENT Thu Oct 18 09:58:15 HST 2012
[2] COMMENT OPERA Processing Parameters
[2] COMMENT ---------------------------
[2] COMMENT OPERA_PARAM EEV1_namps := 1
[2] COMMENT OPERA_PARAM OLAPAa_namps := 1
[2] COMMENT OPERA_PARAM OLAPAab_namps := 2
[2] COMMENT OPERA_PARAM minimumflatsforgain := 2
[2] COMMENT OPERA_PARAM gainsubwindow := 100 800 500 3000
[2] COMMENT OPERA_PARAM gainMinPixPerBin := 1000
[2] COMMENT OPERA_PARAM gainMaxNBins := 100
[2] COMMENT OPERA_PARAM gainLowestCount := 1000
[2] COMMENT OPERA_PARAM gainHighestCount := 30000
[2] COMMENT OPERA_PARAM geom_limit := 0.2
[2] COMMENT OPERA_PARAM geomsubformat := 8 2040 3 4600
[2] COMMENT OPERA_PARAM maxorders := 44
[2] COMMENT OPERA_PARAM firstorder := 17
[2] COMMENT OPERA_PARAM lastorder := 61
[2] COMMENT OPERA_PARAM spectralsampling := 0.6923
[2] COMMENT OPERA_PARAM colDispersion := 1
[2] COMMENT OPERA_PARAM invertOrders := 1
[2] COMMENT OPERA_PARAM aperture := 26
[2] COMMENT OPERA_PARAM detectionMethod := 2
[2] COMMENT OPERA_PARAM FFTfilter := 0
[2] COMMENT OPERA_PARAM geomnpar_Fast := 3
[2] COMMENT OPERA_PARAM geomnpar_Slow := 4
[2] COMMENT OPERA_PARAM geomnpar_Normal := 4
[2] COMMENT OPERA_PARAM geombinsize := 20
[2] COMMENT OPERA_PARAM nsamples := 3
[2] COMMENT OPERA_PARAM minordertouse := 17
[2] COMMENT OPERA_PARAM thorium_argon_atlas_lines := thar_MM201006.dat.gz
[2] COMMENT OPERA_PARAM thorium_argon_atlas_spectrum := LovisPepe_ThArAtlas.dat.gz
[2] COMMENT OPERA_PARAM wcal_uncalibrated_linewidth := 1.5
[2] COMMENT OPERA_PARAM wcal_use_spectral_lines := 1
[2] COMMENT OPERA_PARAM sp1_IPDimensions := 30 5 6 5
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[2] COMMENT OPERA_PARAM sp2_IPDimensions := 28 5 6 5
[2] COMMENT OPERA_PARAM pol_IPDimensions := 30 5 6 5
[2] COMMENT OPERA_PARAM IPDimensions := 28 5 6 5
[2] COMMENT OPERA_PARAM spectralElementHeight := 1.0
[2] COMMENT OPERA_PARAM DetectionThreshold := 0.5
[2] COMMENT OPERA_PARAM referenceLineWidth := 2.5
[2] COMMENT OPERA_PARAM tilt := -3.0
[2] COMMENT OPERA_PARAM ipBinsize := 90
[2] COMMENT OPERA_PARAM CREATE_NORMALIZED_FLAT := 0
[2] COMMENT OPERA_PARAM normalizedflataperture := 28
[2] COMMENT OPERA_PARAM normalizedflatbinsiz :=
[2] COMMENT OPERA_PARAM FourierFilterWidthNormal := 0.1
[2] COMMENT OPERA_PARAM sp1_numberOfBeams := 2
[2] COMMENT OPERA_PARAM sp2_numberOfBeams := 1
[2] COMMENT OPERA_PARAM pol_numberOfBeams := 2
[2] COMMENT OPERA_PARAM sp1_apertureWidth := 26
[2] COMMENT OPERA_PARAM sp2_apertureWidth := 24
[2] COMMENT OPERA_PARAM pol_apertureWidth := 26
[2] COMMENT OPERA_PARAM sp1_apertureHeight := 0.6
[2] COMMENT OPERA_PARAM sp2_apertureHeight := 0.6
[2] COMMENT OPERA_PARAM pol_apertureHeight := 0.6
[2] COMMENT OPERA_PARAM sp1_backgroundAperture := 2.0
[2] COMMENT OPERA_PARAM sp2_backgroundAperture := 2.0
[2] COMMENT OPERA_PARAM pol_backgroundAperture := 2.0
[2] COMMENT OPERA_PARAM sp1_gapBetweenBeams := 0
[2] COMMENT OPERA_PARAM sp2_gapBetweenBeams := 0
[2] COMMENT OPERA_PARAM pol_gapBetweenBeams := 0
[2] COMMENT OPERA_PARAM apernumberOfBeams := 1
[2] COMMENT OPERA_PARAM apernapertureWidth := 24
[2] COMMENT OPERA_PARAM aperapertureHeight := 0.6
[2] COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
[2] COMMENT OPERA_PARAM apergapBetweenBeams := 0
[2] COMMENT OPERA_PARAM aperpickImageRow := 0
[2] COMMENT OPERA_PARAM spectrumordercol := 1
[2] COMMENT OPERA_PARAM spectrumdistcol := 2
[2] COMMENT OPERA_PARAM spectrumfluxcol := 3
[2] COMMENT OPERA_PARAM spectrumvariancecol := 4
[2] COMMENT OPERA_PARAM spectrumintegratedcol := 5
[2] COMMENT OPERA_PARAM snrordercol := 1
[2] COMMENT OPERA_PARAM snrdistcol := 2
[2] COMMENT OPERA_PARAM snrcol := 3
[2] COMMENT OPERA_PARAM snrintegratedcol := 4
[2] COMMENT OPERA_PARAM wcalordercol := 1
[2] COMMENT OPERA_PARAM wcalwavelengthcol := 2
```

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[2] COMMENT OPERA_PARAM wcalintensitycol := 3
[2] COMMENT OPERA_PARAM wcaltitlecol := 4
[2] COMMENT OPERA_PARAM normalize_usePolynomial := 0
[2] COMMENT OPERA_PARAM normalize_binsize := 120
[2] COMMENT OPERA_PARAM extraction_backgroundBinsize := 400
[2] COMMENT OPERA_PARAM extraction_sigmaclip := 25
[2] COMMENT OPERA_PARAM extraction_usePolynomialFit := 1
[2] COMMENT OPERA_PARAM RawSpectrum := 1
[2] COMMENT OPERA_PARAM StandardSpectrum := 2
[2] COMMENT OPERA_PARAM OptimalSpectrum := 3
[2] COMMENT OPERA_PARAM OperaOptimalSpectrum := 4
[2] COMMENT OPERA_PARAM RawBeamSpectrum := 5
[2] COMMENT OPERA_PARAM StandardBeamSpectrum := 6
[2] COMMENT OPERA_PARAM OptimalBeamSpectrum := 7
[2] COMMENT OPERA_PARAM OperaOptimalBeamSpectrum := 8
[2] COMMENT OPERA_PARAM CalibratedRawSpectrum := 9
[2] COMMENT OPERA_PARAM CalibratedStandardSpectrum := 10
[2] COMMENT OPERA_PARAM CalibratedOptimalSpectrum := 11
[2] COMMENT OPERA_PARAM CalibratedOperaOptimalSpectrum := 12
[2] COMMENT OPERA_PARAM CalibratedRawBeamSpectrum := 13
[2] COMMENT OPERA_PARAM CalibratedStandardBeamSpectrum := 14
[2] COMMENT OPERA_PARAM CalibratedOptimalBeamSpectrum := 15
[2] COMMENT OPERA_PARAM CalibratedOperaOptimalBeamSpectrum := 16
[2] COMMENT OPERA_PARAM DefaultSpectrumTypeName := StandardBeamSpectrum
[2] COMMENT OPERA_PARAM DefaultSpectrumType := 6
[2] COMMENT OPERA_PARAM DefaultCalibratedSpectrumType := 14
[2] COMMENT OPERA_PARAM StokesI := 0
[2] COMMENT OPERA_PARAM StokesQ := 1
[2] COMMENT OPERA_PARAM StokesU := 2
[2] COMMENT OPERA_PARAM StokesV := 3
[2] COMMENT OPERA_PARAM stokesparameter := 1
[2] COMMENT OPERA_PARAM difference := 1
[2] COMMENT OPERA_PARAM ratio := 2
[2] COMMENT OPERA_PARAM polarmethod := 2
[2] COMMENT OPERA_PARAM polarnormalize := 0
[2] COMMENT OPERA_PARAM cNone := 0
[2] COMMENT OPERA_PARAM cRICE := 11
[2] COMMENT OPERA_PARAM cGZIP := 21
[2] COMMENT OPERA_PARAM cHCOMPRESS := 41
[2] COMMENT OPERA_PARAM cPLIO := 31
[2] COMMENT OPERA_PARAM compressiontype := 11
[2] COMMENT OPERA_PARAM extension := .fz
[2] COMMENT OPERA_PARAM gzip := .gz
[2] COMMENT OPERA_PARAM DETECTOR := OLAPA
```

```
[2] COMMENT OPERA_PARAM AMPLIFIER := a
[2] COMMENT OPERA_PARAM MODE := sp2
[2] COMMENT OPERA_PARAM SPEED := Normal
[2] COMMENT OPERA_PARAM OSET :=
[2] COMMENT OPERA_PARAM apernumberOfBeams := 1
[2] COMMENT OPERA_PARAM apernapertureWidth := 24
[2] COMMENT OPERA_PARAM aperapertureHeight := 0.6
[2] COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
[2] COMMENT OPERA_PARAM apergapBetweenBeams := 0
[2] COMMENT OPERA_PARAM apernRowSamples := 10
[2] COMMENT OPERA_PARAM aperMinTiltAngle := -5
[2] COMMENT OPERA_PARAM aperMaxTiltAngle := 0
[2] COMMENT OPERA_PARAM apertiltAnglePrecision := 0.1
[2] COMMENT OPERA_PARAM extraction_minorder := 22
[2] COMMENT OPERA_PARAM extraction_maxorder := 60
[2] COMMENT OPERA_PARAM extractor_sp2 := operaStarOnly
[2] COMMENT OPERA_PARAM extractor_sp1 := operaStarPlusSky
[2] COMMENT OPERA_PARAM extractor_pol := operaPolarIntensity
[2] COMMENT OPERA_PARAM extractor := operaStarOnly
[2] EXTNAME = 'BEAMFLUX'           / Extension name
[2] DETSEC  = '[1:41,1:298351]'    / Mosaic area of the detector
[2] DETSIZE = '[1:41,1:298351]'    / Total data pixels in full mosaic
[2] COMMENT ------------------------------------------------------------------------
[2] COMMENT OPERA Calibration Data
[2] COMMENT ----------------------
[2] COMMENT Beam Flux / Variance
[2] COMMENT --------------------
[2] COMMENT StandardBeamSpectrum
[2] COMMENT Columns:
[2] COMMENT <order number><nElements><nBeams><elementindex><SpectralElements photoCe
[2] COMMENT nterX><SpectralElements photoCenterY><SpectralElements dist><SpectralEle
[2] COMMENT ments flux><SpectralElements flux variance><XCorrelation><nBeams><beam><
[2] COMMENT BeamElements[beam] photoCenterX><BeamElements[beam] photoCenterY><BeamEl
[2] COMMENT ements[beam] flux><BeamElements[beam] flux variance>
[2] COMMENT ------------------------------------------------------------------------
[2] END

[3] XTENSION= 'IMAGE   '           / IMAGE extension
[3] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[3] NAXIS   =                    2 / number of data axes
[3] NAXIS1  =                   40 / length of data axis 1
[3] NAXIS2  =               298350 / length of data axis 2
[3] PCOUNT  =                    0 / required keyword; must = 0
[3] GCOUNT  =                    1 / required keyword; must = 1
```

```
[3] BZERO   =                   0.
[3] BSCALE  =                   1.
[3] EXTNAME = 'SNR     '           / Extension name
[3] DETSEC  = '[42:82,1:298351]'   / Mosaic area of the detector
[3] DETSIZE = '[1:41,1:298351]'    / Total data pixels in full mosaic
[3] COMMENT --------------------------------------------------------------------
[3] COMMENT Signal to Noise Ratio
[3] COMMENT ---------------------
[3] COMMENT Columns:
[3] COMMENT <order number><nElements><Center SNR><wavelength><SNR>
[3] COMMENT --------------------------------------------------------------------
[3] END

[4] XTENSION= 'IMAGE   '           / IMAGE extension
[4] BITPIX  =                 -32 / Real*4 (complex, stored as float)
[4] NAXIS   =                   2 / number of data axes
[4] NAXIS1  =                  40 / length of data axis 1
[4] NAXIS2  =                  44 / length of data axis 2
[4] PCOUNT  =                   0 / required keyword; must = 0
[4] GCOUNT  =                   1 / required keyword; must = 1
[4] BZERO   =                   0.
[4] BSCALE  =                   1.
[4] EXTNAME = 'GEOMETRY'           / Extension name
[4] DETSEC  = '[83:123,1:45]'      / Mosaic area of the detector
[4] DETSIZE = '[1:41,1:45]'        / Total data pixels in full mosaic
[4] COMMENT --------------------------------------------------------------------
[4] COMMENT Geometry Polynomial
[4] COMMENT -------------------
[4] COMMENT Columns:
[4] COMMENT <order number><number of coefficients><ndatapoints>[<polynomial coeffici
[4] COMMENT ent><polynomial coefficienterror>]*MAXPOLYNOMIAL <chisqr><YBinning><miny
[4] COMMENT ><maxy>
[4] COMMENT --------------------------------------------------------------------
[4] END

[5] XTENSION= 'IMAGE   '           / IMAGE extension
[5] BITPIX  =                 -32 / Real*4 (complex, stored as float)
[5] NAXIS   =                   2 / number of data axes
[5] NAXIS1  =                  40 / length of data axis 1
[5] NAXIS2  =                  44 / length of data axis 2
[5] PCOUNT  =                   0 / required keyword; must = 0
[5] GCOUNT  =                   1 / required keyword; must = 1
[5] BZERO   =                   0.
[5] BSCALE  =                   1.
```

```
[5] EXTNAME = 'ORDERPOLY'          / Extension name
[5] DETSEC  = '[124:164,1:45]'     / Mosaic area of the detector
[5] DETSIZE = '[1:41,1:45]'        / Total data pixels in full mosaic
[5] COMMENT ------------------------------------------------------------------------
[5] COMMENT Order Polynomial in Dispersion Direction
[5] COMMENT ----------------------------------------
[5] COMMENT Columns:
[5] COMMENT <number of orders><minorder><maxorder><chisqr><number of coefficients> [
[5] COMMENT <polynomial coefficient><polynomial coefficienterror>]*MAXPOLYNOMIAL
[5] COMMENT ------------------------------------------------------------------------
[5] END

[6] XTENSION= 'IMAGE   '           / IMAGE extension
[6] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[6] NAXIS   =                    2 / number of data axes
[6] NAXIS1  =                   40 / length of data axis 1
[6] NAXIS2  =                   39 / length of data axis 2
[6] PCOUNT  =                    0 / required keyword; must = 0
[6] GCOUNT  =                    1 / required keyword; must = 1
[6] BZERO   =                   0.
[6] BSCALE  =                   1.
[6] EXTNAME = 'WAVELENGTH'         / Extension name
[6] DETSEC  = '[165:205,1:40]'     / Mosaic area of the detector
[6] DETSIZE = '[1:41,1:40]'        / Total data pixels in full mosaic
[6] COMMENT ------------------------------------------------------------------------
[6] COMMENT Wavelength Polynomial
[6] COMMENT ---------------------
[6] COMMENT Columns:
[6] COMMENT <order number><number of coefficients><polynomial coefficients>
[6] COMMENT ------------------------------------------------------------------------
[6] END

[7] XTENSION= 'IMAGE   '           / IMAGE extension
[7] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[7] NAXIS   =                    2 / number of data axes
[7] NAXIS1  =                   40 / length of data axis 1
[7] NAXIS2  =                   40 / length of data axis 2
[7] PCOUNT  =                    0 / required keyword; must = 0
[7] GCOUNT  =                    1 / required keyword; must = 1
[7] BZERO   =                   0.
[7] BSCALE  =                   1.
[7] EXTNAME = 'APERTURE'           / Extension name
[7] DETSEC  = '[206:246,1:41]'     / Mosaic area of the detector
[7] DETSIZE = '[1:41,1:41]'        / Total data pixels in full mosaic
```

```
[7] COMMENT ------------------------------------------------------------------------
[7] COMMENT Extraction Aperture
[7] COMMENT -------------------
[7] COMMENT Columns:
[7] COMMENT <order number><number of beams><measured tilt><tilt error><leftBackgroun
[7] COMMENT dIndex><xsampling><ysampling><lb height><lb width><lb slope><lb xcenter>
[7] COMMENT <lb ycenter><lb fluxFraction><rightBackgroundIndex><xsampling><ysampling
[7] COMMENT ><rb height><rb width><rb slope><rb xcenter><rb ycenter><rb fluxFraction
[7] COMMENT ><beam><xsampling><ysampling><beam height><beam width><beam slope><beam
[7] COMMENT xcenter><beam ycenter><beam fluxFraction>
[7] COMMENT ------------------------------------------------------------------------
[7] END

[8] XTENSION= 'IMAGE   '           / IMAGE extension
[8] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[8] NAXIS   =                    2 / number of data axes
[8] NAXIS1  =                   40 / length of data axis 1
[8] NAXIS2  =               168040 / length of data axis 2
[8] PCOUNT  =                    0 / required keyword; must = 0
[8] GCOUNT  =                    1 / required keyword; must = 1
[8] BZERO   =                   0.
[8] BSCALE  =                   1.
[8] EXTNAME = 'PROFILE '           / Extension name
[8] DETSEC  = '[247:287,1:168041]' / Mosaic area of the detector
[8] DETSIZE = '[1:41,1:168041]'    / Total data pixels in full mosaic
[8] COMMENT ------------------------------------------------------------------------
[8] COMMENT Instrument Profile
[8] COMMENT ------------------
[8] COMMENT Columns:
[8] COMMENT ------------------------------------------------------------------------
[8] COMMENT <number of columns i><number of rows j><xsize><xsampling><ysize><ysampli
[8] COMMENT ng><i><j><number of coefficients><ndatapoints><polynomial coefficients><
[8] COMMENT chisqr>
[8] END

[9] XTENSION= 'IMAGE   '           / IMAGE extension
[9] BITPIX  =                  -32 / Real*4 (complex, stored as float)
[9] NAXIS   =                    2 / number of data axes
[9] NAXIS1  =                   40 / length of data axis 1
[9] NAXIS2  =                    1 / length of data axis 2
[9] PCOUNT  =                    0 / required keyword; must = 0
[9] GCOUNT  =                    1 / required keyword; must = 1
[9] BZERO   =                   0.
[9] BSCALE  =                   1.
```

```
[9] EXTNAME = 'GAIN    '           / Extension name
[9] DETSEC  = '[288:328,1:2]'      / Mosaic area of the detector
[9] DETSIZE = '[1:41,1:2]'         / Total data pixels in full mosaic
[9] COMMENT ------------------------------------------------------------------------
[9] COMMENT --------
[9] COMMENT Gain
[9] COMMENT ----
[9] COMMENT Columns:
[9] COMMENT <amps><amp><gain><noise><gainerror><bias><amp><gain><noise><gainerror><b
[9] COMMENT ias>
[9] COMMENT ------------------------------------------------------------------------
[9] END

[10] XTENSION= 'IMAGE   '           / IMAGE extension
[10] BITPIX  =                   -32 / Real*4 (complex, stored as float)
[10] NAXIS   =                     2 / number of data axes
[10] NAXIS1  =                    40 / length of data axis 1
[10] NAXIS2  =                     1 / length of data axis 2
[10] PCOUNT  =                     0 / required keyword; must = 0
[10] GCOUNT  =                     1 / required keyword; must = 1
[10] BZERO   =                    0.
[10] BSCALE  =                    1.
[10] EXTNAME = 'BIAS    '          / Extension name
[10] DETSEC  = '[329:369,1:2]'     / Mosaic area of the detector
[10] DETSIZE = '[1:41,1:2]'        / Total data pixels in full mosaic
[10] COMMENT ------------------------------------------------------------------------
[10] COMMENT Bias
[10] COMMENT ----
[10] COMMENT Columns:
[10] COMMENT <amps><amp><gain><noise><gainerror><bias><amp><gain><noise><gainerror><b
[10] COMMENT ias>
[10] COMMENT ------------------------------------------------------------------------
[10] END
```

All of the data is stored as float IMAGE data for easy access. Note that the number of columns is constant for every extension, though the number of rows differs. The DETSEC and DETSIZE are used to display the data side-by-side in ds9.

3.1 Intensity - i.fits.fz

For each odometer, the Libre-Esprit-compatible i.fits.fz file are:

1. Contents of the iu.s file (wavelength, un-normalized)
2. Contents of the in.s file (wavelength, normalized)
3. Contents of the iuw.s file (wavelength, autowave, un-normalized)
4. Contents of the inw.s file (wavelength, autowave , normalized)
5. SNR Table (for each mode/speed) as comments

Note that this IMAGE is not MEF format. A representative header looks like this:

```
SIMPLE  =                    T / Standard FITS
BITPIX  =                  -32 / Real*4 (complex, stored as float)
NAXIS   =                    2 / Number of axes
NAXIS1  =                   12 / Number of pixel columns
NAXIS2  =               298350 / Number of pixel rows
BZERO   =                   0. / Zero factor
BSCALE  =                   1. / Scale factor
COMMENT
COMMENT Observation Summary
COMMENT -------------------
COMMENT
CMMTOBS = 'N/A     '
CMMTSEQ = 'I exposure 1, sequence 1 of 2'
OBSERVER= 'QSO Team'
COMMENT
COMMENT General
COMMENT -------
COMMENT
PATHNAME= '/data/niele/espadons/11AQ14-Jul08' / Original directory name at acqui
DATE    = '2011-07-09T10:12:20' / UTC Date of file creation
HSTTIME = 'Sat Jul 09 00:12:20 HST 2011' / Local time in Hawaii
IMAGESWV= 'CFHT DetCom v3.60.8 (Nov 05 2010)' / Image creation software version
OBSTYPE = 'OBJECT  '           / Observation / Exposure type
EXPTYPE = 'OBJECT  '           / See OBSTYPE
EXPTIME =               1880.0 / Integration time (seconds)
```

```
DARKTIME=               1880.0 / Dark current time (seconds)
SHUTOPEN=                  0.0 / Shutter blade opening time (seconds)
SHUTCLOS=                  0.0 / Shutter blade closing time (seconds)
COMMENT
COMMENT Detector
COMMENT --------
COMMENT
COMMENT file 1315217o00, raster FULL, etype OBJECT, etime 1880
COMMENT Image data for chip 00
DETECTOR= 'OLAPA   '           / Science Detector
CCD     = 'Unknown '           / Science Detector (use DETECTOR)
IMAGEID =                    0 / CCD chip number
CHIPID  =                    0 / Use IMAGEID instead
DETSIZE = '[1:2048,1:4608]'    / Total data pixels in full mosaic
RASTER  = 'FULL    '           / Active raster description
CCDSUM  = '1 1     '           / Binning factors
CCDBIN1 =                    1 / Binning factor along first axis
CCDBIN2 =                    1 / Binning factor along second axis
PIXSIZE =                 13.5 / Pixel size for both axes (microns)
AMPLIST = 'a       '           / List of amplifiers for this image
CCDSIZE = '[1:2048,1:4608]'    / Detector imaging area size
CCDSEC  = '[1:2048,1:4608]'    / Read out area of the detector (unbinned)
BIASSEC = '[2049:2080,1:4608]' / Overscan (bias) area of the detector
MAXLIN  =                65535 / Maximum linearity value (ADU)
SATURATE=                65535 / Saturation value (ADU)
GAINA   =                 1.30 / Amp A gain (electrons/ADU)
RDNOISEA=                 4.20 / Amp A read noise (electrons)
DARKCUR =                    0 / Dark current (e-/pixel/hour)
RDTIME  =                38.00 / Read out time (sec)
MDCOORDS=                    1 / Sequence number within the exposure sequence
MDREPEAT=                    2 / Total number of sequences
CMPLTEXP=                    1 / Exposure number within the exposure sequence
NEXP    =                    1 / Total number of exposures within the sequence
CONSWV  = 'olA=137,DCU=49'     / Controller software DSPID and SERNO versions
DETSTAT = 'ok      '           / Detector temp range (-135..-120)
DETTEM  =              -131.3 / Detector temp deg C = 745.502 + -0.278 * 3154
INHERIT =                    F / No need to inherit global keywords
COMMENT
COMMENT Telescope
COMMENT ---------
COMMENT
TELESCOP= 'CFHT 3.6m'          / Hawaii Big Island, Mauna Kea
ORIGIN  = 'CFHT    '           / Canada-France-Hawaii Telescope
LATITUDE=           19.825252 / Latitude (degrees N)
```

```
LONGITUD=          -155.468876 / Longitude (degrees E)
TELSTAT = 'auto_guide'         / Telescope Control System status
TIMESYS = 'UTC     '           / Time System for DATExxxx and TIMExxxx
DATE-OBS= '2011-07-09'         / Date at start of observation (UTC)
UTIME   = '9:40:55.20'         / Time at start of observation (UTC)
UTC-OBS = '9:40:55.20'         / Time at start of observation (UTC)
TIME-OBS= '9:41:00.172'        / Time at start of observation (UTC)
MJDATE  =        55751.4034167 / Modified Julian Date at start of observation
MJD-OBS =        55751.4034167 / Modified Julian Date at start of observation
SIDTIME = '18:26:58.81'        / Sidereal time at start of observation
LST-OBS = '18:26:58.81'        / Sidereal time at start of exposure
DATEEND = '2011-07-09'         / Date at end of observation (UTC)
UTCEND  = '10:12:56.73'        / Time at end of observation (UTC)
TIMEEND = '10:12:20.165'       / Time at end of observation (UTC)
MJDEND  =        55751.4256566 / Modified Julian Date at end of observation
LSTEND  = '18:59:05.59'        / Sidereal time at end of exposure
EQUINOX =               2000.0 / Equinox of coordinates
RADECSYS= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
COMMENT RA/DEC are current actual telescope position
COMMENT including handset corrections
RA      = '21:07:57.00'        / Telescope right ascension
DEC     = '7:25:59.0'          / Telescope declination
HA      = '-2:40:58.19'        / Telescope hour angle at start of exposure
HAEND   = '-2:08:51.41'        / Telescope hour angle at end of exposure
INSTZRA =                 0.00 / Instrument zero for RA in arc seconds
INSTZDEC=                 0.00 / Instrument zero for Dec in arc seconds
RA_DEG  =           316.987500 / Telescope right ascension in degrees
DEC_DEG =             7.433056 / Telescope declination in degrees
COMMENT OBJxxx are original target position
COMMENT plus proper motion and precession
OBJNAME = 'HD 201219'          / Target name
OBJMAG  =                  0.0 / Target magnitude
OBJEQUIN=               2000.0 / Target equinox
OBJRADEC= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
OBJRA   = '21:07:57.00'        / Target right ascension
OBJDEC  = '7:25:59.0'          / Target declination
OBJRAPM =                 0.00 / Target right ascension proper motion in as/yr
OBJDECPM=                 0.00 / Target declination proper motion in as/yr
NGUIDER =                    1 / TCS Number of guiders
NGUISTAR=                    1 / TCS number of guide stars/probes in use
GUINAME = 'Cass    '           / TCS guider name
GUIEQUIN=               2000.0 / TCS guider equinox
GUIRADEC= 'FK5     '           / TCS guider system for equinox
GUIRA   = '21:09:26.05'        / TCS guider right ascension
```

```
GUIDEC  = '7:22:15.9'          / TCS guider declination
GUIRAPM =                 0.00 / TCS guider right ascension proper motion arcsec
GUIDECPM=                 0.00 / TCS guider declination proper motion arcsec
GUIOBJN = 'auto GSC: 0'        / TCS guider object name
GUIMAGN =              -9999.9 / TCS guider object magnitude
XPROBE  =             -183.000 / Telescope bonnette guide probe X position
YPROBE  =               30.000 / Telescope bonnette guide probe Y position
ZPROBE  =              412.000 / Telescope bonnette guide probe Z position
GUIFLUX =                -9999 / TCS guider flux
GUIFWHX =             -9999.90 / TCS guider average x FWHM in pixels
GUIFWHY =             -9999.90 / TCS guider average y FWHM in pixels
SKYFLUX =                -9999 / TCS total sky flux
AIRMASS =                1.325 / Airmass at start of observation
TELALT  =              49.0862 / Telescope altitude at start of observation, deg
TELAZ   =             101.8358 / Telescope azimuth at start, deg, 0=N 90=E 270=W
DOMEAZ  =                100.4 / Dome azimuth at start, deg, 0=N 90=E 270=W
MOONANGL=               111.00 / Angle from object to moon at start in degrees
MOONPHAS=                 0.62 / Moon phase @ 0 HST, 0..1 new>full, -1..0 >new
MOONUP  = 'True    '           / Moon up? True or False
MOONALT =                12.90 / Moon altitude at start in degrees
MOONAZ  =               247.10 / Moon azimuth at start in deg, 0=N 90=E 270=W
FOCUSID = 'Cass    '           / Telescope focus in use
TELCONF = 'Cass    '           / Telescope focus in use
CALFOCUS=               12.131 / Telescope focus calculated from model in mm
DEFOCUS =                0.000 / Telescope defocus from calculated in mm
FOCUSPOS=                12141 / Telescope focus encoder readout
TELFOCUS=                12141 / Telescope focus encoder readout
BONANGLE=                 0.00 / Telescope bonnette rotation angle in degrees
ROTANGLE=                 0.00 / Telescope bonnette rotation angle in degrees
TCSGPSBC= '0190 09:40:36.898925' / TCS GPS read out in BCD
TCSGPSTM=              9.67692 / TCS GPS clock time in decimal hours
TCSRBUSS= '09:40:41.945'       / TCS RBUSS clock time
TCSEPICS= '20110709 09:40:35.892' / TCS EPICS clock time
TCSAMODE= 'O       '           / TCS acquire mode - T/O/G/g/P for t/o/g coords
TCSMJD  =        55751.4032045 / TCS MJD
TCSLST  =             18.44456 / TCS LST in decimal hours
TCSAPHA =            -40.47009 / TCS apparent hour angle in degrees
TCSAPDEC=              7.48199 / TCS apparent declination in degrees
TCSOBHA =            -40.46179 / TCS observed hour angle in degrees
TCSOBDEC=              7.48527 / TCS observed declination in degrees
TCSENHA =              -147133 / TCS hour angle absolute encoder in bits
TCSENDEC=                19929 / TCS declination absolute encoder in bits
TCSEDHA =            -40.35165 / TCS hour angle absolute encoder in degrees
TCSEDDEC=              7.47110 / TCS declination absolute encoder in degrees
```

```
TCSINHA =                    0 / TCS hour angle incremental encoder in bits
TCSINDEC=                    0 / TCS declination incremental encoder in bits
TCSSEHA =                -0.03 / TCS hour angle servo error in arcsec
TCSSEDEC=                -0.01 / TCS declination servo error in arcsec
TCSGEHA =                 0.00 / TCS hour angle guider error in arcsec
TCSGEDEC=                 0.00 / TCS declination guider error in arcsec
TCSMVRA =               0.0000 / TCS right ascension acquisition move in arcsec
TCSMVDEC=               0.0000 / TCS declination acquisition move in arcsec
TCSMVX  =            -9999.900 / TCS secondary guider acquisition x move in mm
TCSMVY  =            -9999.900 / TCS secondary guider acquisition y move in mm
FFLAMPON= 'OFF     '           / flatfield lamp status ON/OFF
FFLAMP1 =                    5 / flatfield lamp 1 intensity
FFLAMP2 =                   12 / flatfield lamp 2 intensity
CLAMPON = 'OFF     '           / comparison lamp status ON/OFF
COMMENT
COMMENT Instrument Description
COMMENT ----------------------
COMMENT
INSTRUME= 'ESPaDOnS'           / Instrument Name
INSTMODE= 'Spectroscopy, star only, R=80,000' / Instrument Mode
FILTERID=                   -1 / wheel position
FILTER  = 'Unknown '           / description of filter
COMMENT
COMMENT ESPaDOnS Cassegrain Unit
COMMENT ------------------------
COMMENT
EADCPOS = 'IN      '           / ESPaDOnS ADC position IN/OUT of beam
EADC1BEG= '1.79948484639146'   / ADC prism 1 position at start of exposure
EADC2BEG= '137.667984189723'   / ADC prism 2 position at start of exposure
EADC1END= '9.67245309832328'   / ADC prism 1 position at end of exposure
EADC2END= '139.366044960474'   / ADC prism 2 position at end of exposure
ECALIBWH= 'P1      '           / ESPaDOnS calibration wheel position (# and deg)
ERHOMB1 = 'P1      '           / ESPaDOnS rhomb 1 position (# and deg)
ERHOMB2 = 'P1      '           / ESPaDOnS rhomb 2 position (# and deg)
EFABPERO= 'P1      '           / ESPaDOnS Fabry Perot position (# and deg)
EWEDWOL = 'WED     '           / ESPaDOnS Wedge/Wollaston slide position WED/WOL
ETEMPPOL=                -8.82 / ESPaDOnS polarimeter temperature deg C
ETEMPCB =                -0.13 / ESPaDOnS calibration box temperature deg C
COMMENT
COMMENT ESPaDOnS Guider
COMMENT ---------------
COMMENT
EGUIDING= 'GO      '           / ESPaDOnS guiding state ON/OFF
EGUISEE =                 0.65 / ESPaDOnS guider seeing estimate
```

```
COMMENT
COMMENT ESPaDOnS Spectrograph
COMMENT ---------------------
COMMENT
ECAMFOC =                -3.45 / ESPaDOnS camera focus position (mm)
EHARTPOS= 'OUT     '           / ESPaDOnS hartmann position FULL/DOWN/UP/OUT
ESLIPOS = 'P4      '           / ESPaDOnS slicer bench position (# and mm)
EHALOPOS= 'OUT     '           / ESPaDOnS halogen lamp position IN/OUT
EHALOGEN= 'OFF     '           / ESPaDOnS halogen lamp state ON/OFF
ESLICER = 'P4      '           / ESPaDOnS slicer position (# and deg)
EDEKKER = 'P7      '           / ESPaDOnS dekker position (# and mm)
EEMSHUT = 'OPEN    '           / ESPaDOnS exposure meter shutter OPEN/CLOSED
EEMSTATE= 'ON      '           / ESPaDOnS exposure meter state ON/OFF
EEMCNTS =                13170 / ESPaDOnS exposure meter counts at end
ETSP1BEG=                13.18 / ESPaDOnS down mirror temp at start (deg C)
ETSP2BEG=                13.35 / ESPaDOnS camera temp at start (deg C)
ETSP3BEG=                13.33 / ESPaDOnS up mirror temp at start (deg C)
ETSP4BEG=                12.92 / ESPaDOnS hygrometer temp at start (deg C)
EPRSPBEG=                -3.68 / ESPaDOnS relative pressure at start (mb)
ERHSPBEG=                27.07 / ESPaDOnS relative humidity at start (%)
ETSP1END=                13.19 / ESPaDOnS down mirror temp at end (deg C)
ETSP2END=                13.35 / ESPaDOnS camera temp at end (deg C)
ETSP3END=                13.33 / ESPaDOnS up mirror temp at end (deg C)
ETSP4END=                12.84 / ESPaDOnS hygrometer temp at end (deg C)
EPRSPEND=                -3.80 / ESPaDOnS relative pressure at end (mb)
ERHSPEND=                26.87 / ESPaDOnS relative humidity at end (%)
EREADSPD= 'Normal: 4.20e noise, 1.30e/ADU, 38s' / ESPaDOnS det read out xslow/sl
TESPMIRE=                 0.57 / 03 temp, surface, primary mirror east deg C
TESPMIRW=                 0.94 / 02 temp, surface, primary mirror west deg C
TESPMIRS=                 1.00 / 01 temp, surface, primary mirror west side degC
TEAPMCLW=                -0.23 / 54 temp, air, primary mirror cell west deg C
TEAMIRCI=                -0.50 / 58 temp, air, mirror cooling in at unit deg C
TEAMIRCO=                -0.40 / 27 temp, air, mirror cooling out at cell deg C
TEAPMSPN=                 0.90 / 65 temp, air, mirror spigot north cass deg C
TEAPMSPS=                 0.98 / 64 temp, air, mirror spigot nouth M3 deg C
TEATRNGE=                -2.54 / 23 temp, air, top ring east deg C
TEATRNGW=                -0.68 / 06 temp, air, top ring west deg C
TEANRLSB=                10.99 / 19 temp, air, north rail support beam deg C
TESHRSET=                -0.06 / 08 temp, surface, horseshoe east top deg C
TESTTRSH=                -1.60 / 97 temp, surface, telescope truss S high deg C
TESTTRNM=                -1.55 / 94 temp, surface, telescope truss N mid deg C
TESTTREM=                -1.74 / 95 temp, surface, telescope truss E mid deg C
TESTTRWM=                -1.54 / 96 temp, surface, telescope truss W mid deg C
TESTTRSL=                -1.25 / 98 temp, surface, telescope truss S low deg C
```

```
TESTTRSE=               -0.91 / 69 temp, surface, telescope truss SE lower degC
TEALOWWS=                0.00 / 38 temp, air, dome lower weather stat side degC
TEATOPWS=                0.00 / 36 temp, air, dome top weather stat side deg C
TEATOPOP=                0.00 / 37 temp, air, dome top opposite weath side degC
TEA2INCH=                0.08 / 45 temp, air, two inches above fifth floor degC
TEA2INEB=               -0.25 / 53 temp, air, two inches up by electronics degC
TEA6FOOT=                0.18 / 43 temp, air, six feet above fifth floor deg C
TESCONRM=                3.22 / 61 temp, surface, floor above control room degC
TESPIERN=                2.58 / 59 temp, surface, floor by north pier deg C
TESPIERS=                1.92 / 60 temp, surface, floor by south pier deg C
TEAWTHRT=                0.20 / 35 temp, air, weathertron deg C
TEMPERAT=               -0.88 / 86 temp, air, weather tower deg C
WINDSPED=               19.98 / 84 wind speed, weather tower knots
WINDDIR =               90.40 / 85 wind direction, weather tower deg (N=0 E=90)
RELHUMID=               13.41 / 87 relative humidity, weather tower %
PRESSURE=              615.65 / 31 barometric pressure, control room mb
DDSEEMEN=                0.62 / Dome DIMM mean seeing, arc seconds
DDSEEMED=                0.59 / Dome DIMM median seeing, arc seconds
DDSEEMOD=                0.57 / Dome DIMM mode seeing, arc seconds
DDSEESTD=                0.12 / Dome DIMM seeing deviation, arc seconds
WMSEEMEN=                0.53 / Weather tower MASS mean seeing, arc seconds
WMSEEMED=                0.52 / Weather tower MASS median seeing, arc seconds
WMSEEMOD=                0.44 / Weather tower MASS mode seeing, arc seconds
WMSEESTD=                0.11 / Weather tower MASS seeing deviation, arc second
WDSEEMEN=                0.90 / Weather tower DIMM mean seeing, arc seconds
WDSEEMED=                0.91 / Weather tower DIMM median seeing, arc seconds
WDSEEMOD=                0.90 / Weather tower DIMM mode seeing, arc seconds
WDSEESTD=                0.19 / Weather tower DIMM seeing deviation, arc second
SPOZPMEN=                0.29 / SkyProbe (orig) mean absorption, magnitude
SPOZPMED=                0.27 / SkyProbe (orig) median absorption, magnitude
SPOZPMOD=                0.26 / SkyProbe (orig) mode absorption, magnitude
SPOZPSTD=                0.05 / SkyProbe (orig) absorption deviation, magnitude
SPBZPMEN=           -9999.90 / SkyProbe (B) mean absorption, magnitude
SPBZPMED=           -9999.90 / SkyProbe (B) median absorption, magnitude
SPBZPMOD=           -9999.90 / SkyProbe (B) mode absorption, magnitude
SPBZPSTD=           -9999.90 / SkyProbe (B) absorption deviation, magnitude
SPVZPMEN=           -9999.90 / SkyProbe (V) mean absorption, magnitude
SPVZPMED=           -9999.90 / SkyProbe (V) median absorption, magnitude
SPVZPMOD=           -9999.90 / SkyProbe (V) mode absorption, magnitude
SPVZPSTD=           -9999.90 / SkyProbe (V) absorption deviation, magnitude
ASCLDMEN=                3.0 / ASIVA mean global (all sky) cloud cover, %
ASCLDMED=                2.9 / ASIVA median global (all sky) cloud cover, %
ASCLDMOD=                3.0 / ASIVA mode global (all sky) cloud cover, %
ASCLDSTD=                0.6 / ASIVA global (all sky) cloud cover deviation, %
```

```
ASNERMEN=            -9999.900 / ASIVA mean radiance, NE quadrant, w/m2/u/sr
ASNERMED=            -9999.900 / ASIVA median radiance, NE quadrant, w/m2/u/sr
ASNERMOD=            -9999.900 / ASIVA mode radiance, NE quadrant, w/m2/u/sr
ASNERSTD=            -9999.900 / ASIVA radiance deviation, NE quadrant, w/m2/u/s
ASNESMEN=            -9999.900 / ASIVA mean standard deviation, NE quadrant
ASNESMED=            -9999.900 / ASIVA median standard deviation, NE quadrant
ASNESMOD=            -9999.900 / ASIVA mode standard deviation, NE quadrant
ASNESSTD=            -9999.900 / ASIVA standard deviation deviation, NE quadrant
ASSERMEN=            -9999.900 / ASIVA mean radiance, SE quadrant, w/m2/u/sr
ASSERMED=            -9999.900 / ASIVA median radiance, SE quadrant, w/m2/u/sr
ASSERMOD=            -9999.900 / ASIVA mode radiance, SE quadrant, w/m2/u/sr
ASSERSTD=            -9999.900 / ASIVA radiance deviation, SE quadrant, w/m2/u/s
ASSESMEN=            -9999.900 / ASIVA mean standard deviation, SE quadrant
ASSESMED=            -9999.900 / ASIVA median standard deviation, SE quadrant
ASSESMOD=            -9999.900 / ASIVA mode standard deviation, SE quadrant
ASSESSTD=            -9999.900 / ASIVA standard deviation deviation, SE quadrant
ASSWRMEN=            -9999.900 / ASIVA mean radiance, SW quadrant, w/m2/u/sr
ASSWRMED=            -9999.900 / ASIVA median radiance, SW quadrant, w/m2/u/sr
ASSWRMOD=            -9999.900 / ASIVA mode radiance, SW quadrant, w/m2/u/sr
ASSWRSTD=            -9999.900 / ASIVA radiance deviation, SW quadrant, w/m2/u/s
ASSWSMEN=            -9999.900 / ASIVA mean standard deviation, SW quadrant
ASSWSMED=            -9999.900 / ASIVA median standard deviation, SW quadrant
ASSWSMOD=            -9999.900 / ASIVA mode standard deviation, SW quadrant
ASSWSSTD=            -9999.900 / ASIVA standard deviation deviation, SW quadrant
ASNWRMEN=            -9999.900 / ASIVA mean radiance, NW quadrant, w/m2/u/sr
ASNWRMED=            -9999.900 / ASIVA median radiance, NW quadrant, w/m2/u/sr
ASNWRMOD=            -9999.900 / ASIVA mode radiance, NW quadrant, w/m2/u/sr
ASNWRSTD=            -9999.900 / ASIVA radiance deviation, NW quadrant, w/m2/u/s
ASNWSMEN=            -9999.900 / ASIVA mean standard deviation, NW quadrant
ASNWSMED=            -9999.900 / ASIVA median standard deviation, NW quadrant
ASNWSMOD=            -9999.900 / ASIVA mode standard deviation, NW quadrant
ASNWSSTD=            -9999.900 / ASIVA standard deviation deviation, NW quadrant
ASSPRMEN=                0.035 / ASIVA mean radiance, SkyProbe, w/m2/u/sr
ASSPRMED=                0.035 / ASIVA median radiance, SkyProbe, w/m2/u/sr
ASSPRMOD=                0.035 / ASIVA mode radiance, SkyProbe, w/m2/u/sr
ASSPRSTD=                0.005 / ASIVA radiance deviation, SkyProbe, w/m2/u/sr
ASSPSMEN=              257.889 / ASIVA mean standard deviation, SkyProbe
ASSPSMED=              261.290 / ASIVA median standard deviation, SkyProbe
ASSPSMOD=              220.280 / ASIVA mode standard deviation, SkyProbe
ASSPSSTD=               26.209 / ASIVA standard deviation deviation, SkyProbe
QID     = 55100500000000023812
QOBSEQID= 55001400000000059819
QICSEQID= 55051200000000085767
QOBITER =                    1
```

```
REL_DATE= '2012-08-31T00:00:00' / UTC Release Date
REDUCTIO= 'Intensity'           / Type of reduction
NORMAL  = '2       '            / Normalized and Un-normalized Data
COMMENT File contains automatic wavelength correction and uncorrected data.
COL1    = 'Wavelength'          / Normalized
COL2    = 'Intensity'           / Normalized
COL3    = 'ErrorBar'            / Normalized
COL4    = 'Wavelength'          / UnNormalized
COL5    = 'Intensity'           / UnNormalized
COL6    = 'ErrorBar'            / UnNormalized
COL7    = 'Wavelength'          / Normalized, no autowave correction
COL8    = 'Intensity'           / Normalized, no autowave correction
COL9    = 'ErrorBar'            / Normalized, no autowave correction
COL10   = 'Wavelength'          / UnNormalized, no autowave correction
COL11   = 'Intensity'           / UnNormalized, no autowave correction
COL12   = 'ErrorBar'            / UnNormalized, no autowave correction
COMMENT -------------------------------------------------
COMMENT | Processed by the CFHT OPERA Open Source Pipeline |
COMMENT -------------------------------------------------
COMMENT OPERA version 1.0 - opera-1.0 build date Thu Oct 18 13:28:56 HST 2012
COMMENT Processing Date
COMMENT ---------------
COMMENT Thu Oct 18 13:34:36 HST 2012
COMMENT ------------------------------------------------------------------------
COMMENT upena-compatible headers for column names in primary extension:
COMMENT (1) Spectroscopy Star only mode
COMMENT     First column = wavelength in nanometres
COMMENT     Second column = intensity
COMMENT     Third column = error bar
COMMENT (2) Polarimetry
COMMENT     1st col = wavelength in nanometres
COMMENT     2d  col = intensity
COMMENT     3rd col = polarisation (Q or U or V or W)
COMMENT     4th col = Check Spectra #1
COMMENT     5th col = Check Spectra #2
COMMENT      6th col = error bar
COMMENT (3) Spectroscopy Star + Sky
COMMENT     1st col = wavelength
COMMENT     2d  col = star spectra (sky subtracted)
COMMENT     3rd col = star + sky spectra
COMMENT     4th col = sky spectra
COMMENT     5, 6, 7 = error bars for each column 2, 3, 4
COMMENT ------------------------------------------------------------------------
COMMENT StandardBeamSpectrum
```

```
COMMENT OPERA Processing Parameters
COMMENT --------------------------
COMMENT OPERA_PARAM EEV1_namps := 1
COMMENT OPERA_PARAM OLAPAa_namps := 1
COMMENT OPERA_PARAM OLAPAab_namps := 2
COMMENT OPERA_PARAM minimumflatsforgain := 2
COMMENT OPERA_PARAM gainsubwindow := 100 800 500 3000
COMMENT OPERA_PARAM gainMinPixPerBin := 1000
COMMENT OPERA_PARAM gainMaxNBins := 100
COMMENT OPERA_PARAM gainLowestCount := 1000
COMMENT OPERA_PARAM gainHighestCount := 30000
COMMENT OPERA_PARAM geom_limit := 0.2
COMMENT OPERA_PARAM geomsubformat := 8 2040 3 4600
COMMENT OPERA_PARAM maxorders := 44
COMMENT OPERA_PARAM firstorder := 17
COMMENT OPERA_PARAM lastorder := 61
COMMENT OPERA_PARAM spectralsampling := 0.6923
COMMENT OPERA_PARAM colDispersion := 1
COMMENT OPERA_PARAM invertOrders := 1
COMMENT OPERA_PARAM aperture := 26
COMMENT OPERA_PARAM detectionMethod := 2
COMMENT OPERA_PARAM FFTfilter := 0
COMMENT OPERA_PARAM geomnpar_Fast := 3
COMMENT OPERA_PARAM geomnpar_Slow := 4
COMMENT OPERA_PARAM geomnpar_Normal := 4
COMMENT OPERA_PARAM geombinsize := 20
COMMENT OPERA_PARAM nsamples := 3
COMMENT OPERA_PARAM minordertouse := 17
COMMENT OPERA_PARAM thorium_argon_atlas_lines := thar_MM201006.dat.gz
COMMENT OPERA_PARAM thorium_argon_atlas_spectrum := LovisPepe_ThArAtlas.dat.gz
COMMENT OPERA_PARAM wcal_uncalibrated_linewidth := 1.5
COMMENT OPERA_PARAM wcal_use_spectral_lines := 1
COMMENT OPERA_PARAM sp1_IPDimensions := 30 5 6 5
COMMENT OPERA_PARAM sp2_IPDimensions := 28 5 6 5
COMMENT OPERA_PARAM pol_IPDimensions := 30 5 6 5
COMMENT OPERA_PARAM IPDimensions := 28 5 6 5
COMMENT OPERA_PARAM spectralElementHeight := 1.0
COMMENT OPERA_PARAM DetectionThreshold := 0.5
COMMENT OPERA_PARAM referenceLineWidth := 2.5
COMMENT OPERA_PARAM tilt := -3.0
COMMENT OPERA_PARAM ipBinsize := 90
COMMENT OPERA_PARAM CREATE_NORMALIZED_FLAT := 0
COMMENT OPERA_PARAM normalizedflataperture := 28
COMMENT OPERA_PARAM normalizedflatbinsiz :=
```

```
COMMENT OPERA_PARAM FourierFilterWidthNormal := 0.1
COMMENT OPERA_PARAM sp1_numberOfBeams := 2
COMMENT OPERA_PARAM sp2_numberOfBeams := 1
COMMENT OPERA_PARAM pol_numberOfBeams := 2
COMMENT OPERA_PARAM sp1_apertureWidth := 26
COMMENT OPERA_PARAM sp2_apertureWidth := 24
COMMENT OPERA_PARAM pol_apertureWidth := 26
COMMENT OPERA_PARAM sp1_apertureHeight := 0.6
COMMENT OPERA_PARAM sp2_apertureHeight := 0.6
COMMENT OPERA_PARAM pol_apertureHeight := 0.6
COMMENT OPERA_PARAM sp1_backgroundAperture := 2.0
COMMENT OPERA_PARAM sp2_backgroundAperture := 2.0
COMMENT OPERA_PARAM pol_backgroundAperture := 2.0
COMMENT OPERA_PARAM sp1_gapBetweenBeams := 0
COMMENT OPERA_PARAM sp2_gapBetweenBeams := 0
COMMENT OPERA_PARAM pol_gapBetweenBeams := 0
COMMENT OPERA_PARAM apernumberOfBeams := 1
COMMENT OPERA_PARAM apernapertureWidth := 24
COMMENT OPERA_PARAM aperapertureHeight := 0.6
COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
COMMENT OPERA_PARAM apergapBetweenBeams := 0
COMMENT OPERA_PARAM aperpickImageRow := 0
COMMENT OPERA_PARAM spectrumordercol := 1
COMMENT OPERA_PARAM spectrumdistcol := 2
COMMENT OPERA_PARAM spectrumfluxcol := 3
COMMENT OPERA_PARAM spectrumvariancecol := 4
COMMENT OPERA_PARAM spectrumintegratedcol := 5
COMMENT OPERA_PARAM snrordercol := 1
COMMENT OPERA_PARAM snrdistcol := 2
COMMENT OPERA_PARAM snrcol := 3
COMMENT OPERA_PARAM snrintegratedcol := 4
COMMENT OPERA_PARAM wcalordercol := 1
COMMENT OPERA_PARAM wcalwavelengthcol := 2
COMMENT OPERA_PARAM wcalintensitycol := 3
COMMENT OPERA_PARAM wcaltitlecol := 4
COMMENT OPERA_PARAM normalize_usePolynomial := 0
COMMENT OPERA_PARAM normalize_binsize := 120
COMMENT OPERA_PARAM extraction_backgroundBinsize := 400
COMMENT OPERA_PARAM extraction_sigmaclip := 25
COMMENT OPERA_PARAM extraction_usePolynomialFit := 1
COMMENT OPERA_PARAM RawSpectrum := 1
COMMENT OPERA_PARAM StandardSpectrum := 2
COMMENT OPERA_PARAM OptimalSpectrum := 3
COMMENT OPERA_PARAM OperaOptimalSpectrum := 4
```

```
COMMENT OPERA_PARAM RawBeamSpectrum := 5
COMMENT OPERA_PARAM StandardBeamSpectrum := 6
COMMENT OPERA_PARAM OptimalBeamSpectrum := 7
COMMENT OPERA_PARAM OperaOptimalBeamSpectrum := 8
COMMENT OPERA_PARAM CalibratedRawSpectrum := 9
COMMENT OPERA_PARAM CalibratedStandardSpectrum := 10
COMMENT OPERA_PARAM CalibratedOptimalSpectrum := 11
COMMENT OPERA_PARAM CalibratedOperaOptimalSpectrum := 12
COMMENT OPERA_PARAM CalibratedRawBeamSpectrum := 13
COMMENT OPERA_PARAM CalibratedStandardBeamSpectrum := 14
COMMENT OPERA_PARAM CalibratedOptimalBeamSpectrum := 15
COMMENT OPERA_PARAM CalibratedOperaOptimalBeamSpectrum := 16
COMMENT OPERA_PARAM DefaultSpectrumTypeName := StandardBeamSpectrum
COMMENT OPERA_PARAM DefaultSpectrumType := 6
COMMENT OPERA_PARAM DefaultCalibratedSpectrumType := 14
COMMENT OPERA_PARAM StokesI := 0
COMMENT OPERA_PARAM StokesQ := 1
COMMENT OPERA_PARAM StokesU := 2
COMMENT OPERA_PARAM StokesV := 3
COMMENT OPERA_PARAM stokesparameter := 1
COMMENT OPERA_PARAM difference := 1
COMMENT OPERA_PARAM ratio := 2
COMMENT OPERA_PARAM polarmethod := 2
COMMENT OPERA_PARAM polarnormalize := 0
COMMENT OPERA_PARAM cNone := 0
COMMENT OPERA_PARAM cRICE := 11
COMMENT OPERA_PARAM cGZIP := 21
COMMENT OPERA_PARAM cHCOMPRESS := 41
COMMENT OPERA_PARAM cPLIO := 31
COMMENT OPERA_PARAM compressiontype := 11
COMMENT OPERA_PARAM extension := .fz
COMMENT OPERA_PARAM gzip := .gz
COMMENT OPERA_PARAM DETECTOR := OLAPA
COMMENT OPERA_PARAM AMPLIFIER := a
COMMENT OPERA_PARAM MODE := sp2
COMMENT OPERA_PARAM SPEED := Normal
COMMENT OPERA_PARAM OSET :=
COMMENT OPERA_PARAM apernumberOfBeams := 1
COMMENT OPERA_PARAM apernapertureWidth := 24
COMMENT OPERA_PARAM aperapertureHeight := 0.6
COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
COMMENT OPERA_PARAM apergapBetweenBeams := 0
COMMENT OPERA_PARAM apernRowSamples := 10
COMMENT OPERA_PARAM aperMinTiltAngle := -5
```

```
COMMENT OPERA_PARAM aperMaxTiltAngle := 0
COMMENT OPERA_PARAM apertiltAnglePrecision := 0.1
COMMENT OPERA_PARAM extraction_minorder := 22
COMMENT OPERA_PARAM extraction_maxorder := 60
COMMENT OPERA_PARAM extractor_sp2 := operaStarOnly
COMMENT OPERA_PARAM extractor_sp1 := operaStarPlusSky
COMMENT OPERA_PARAM extractor_pol := operaPolarIntensity
COMMENT OPERA_PARAM extractor := operaStarOnly
COMMENT SNR Table
COMMENT ---------
COMMENT Format: <order number><Center SNR><center wavelength><SNR>
COMMENT 22 4.1131 0 0.3269
COMMENT 23 2.9515 0 -0.6637
COMMENT 24 8.0527 0 6.3075
COMMENT 25 2.8804 0 0.6435
COMMENT 26 2.7936 0 2.7248
COMMENT 27 1.3457 0 -1.5871
COMMENT 28 0.2911 0 -5.4545
COMMENT 29 2.8727 0 -5.5018
COMMENT 30 3.8747 0 -8.9681
COMMENT 31 5.5693 0 0.4518
COMMENT 32 7.1522 0 5.5946
COMMENT 33 9.8467 0 8.1609
COMMENT 34 11.2245 0 8.8345
COMMENT 35 14.0867 0 10.5535
COMMENT 36 26.2236 0 22.5836
COMMENT 37 125.426 0 105.585
COMMENT 38 458.078 0 420.146
COMMENT 39 471.811 0 459.872
COMMENT 40 466.968 0 425.394
COMMENT 41 458.001 0 426.652
COMMENT 42 453.944 0 408.22
COMMENT 43 443.85 0 438.003
COMMENT 44 434.641 0 265.884
COMMENT 45 421.266 0 415.636
COMMENT 46 403.691 0 398.657
COMMENT 47 383.066 0 290.239
COMMENT 48 363.767 0 354.477
COMMENT 49 337.785 0 329.852
COMMENT 50 320.947 0 317.776
COMMENT 51 296.242 0 261.005
COMMENT 52 272.776 0 268.346
COMMENT 53 245.958 0 236.204
COMMENT 54 229.997 0 108.78
```

```
COMMENT 55 273.836 0 200.977
COMMENT 56 181.768 0 146.283
COMMENT 57 152.319 0 147.137
COMMENT 58 114.482 0 60.4214
COMMENT 59 88.4246 0 70.2363
COMMENT 60 95.2449 0 24.6698
END
```

3.2 Polarimetry - p.fits.fz

For each Polar sequence, with the first odometer in the sequences, the the Libre-Esprit-compatible p.fits.fz contents are:

6. Contents of the pu.s file
7. Contents of the puw,s file
8. Contents of the pn.s file
9. Contents of the pnw.s file

Additionally the calculated gain and bias is added as keywords to the primary header. The output of the Libre-Esprit .out and .dat files which are currently stored as comments, are not be available.

Note that this IMAGE is not MEF format. A representative header looks like this:

```
SIMPLE  =                    T / Standard FITS
BITPIX  =                  -32 / Real*4 (complex, stored as float)
NAXIS   =                    2 / Number of axes
NAXIS1  =                   24 / Number of pixel columns
NAXIS2  =                    0 / Number of pixel rows
BZERO   =                   0. / Zero factor
BSCALE  =                   1. / Scale factor
COMMENT
COMMENT Observation Summary
COMMENT -------------------
COMMENT
CMMTOBS = 'N/A     '
CMMTSEQ = 'U exposure 1, sequence 3 of 3'
OBSERVER= 'QSO Team'
COMMENT
```

```
COMMENT General
COMMENT -------
COMMENT
PATHNAME= '/data/niele/espadons/11AQ14-Jul02' / Original directory name at acqui
DATE    = '2011-07-03T05:52:26' / UTC Date of file creation
HSTTIME = 'Sat Jul 02 19:52:26 HST 2011' / Local time in Hawaii
IMAGESWV= 'CFHT DetCom v3.60.8 (Nov 05 2010)' / Image creation software version
OBSTYPE = 'OBJECT  '           / Observation / Exposure type
EXPTYPE = 'OBJECT  '           / See OBSTYPE
EXPTIME =                  2.0 / Integration time (seconds)
DARKTIME=                  2.0 / Dark current time (seconds)
SHUTOPEN=                  0.0 / Shutter blade opening time (seconds)
SHUTCLOS=                  0.0 / Shutter blade closing time (seconds)
COMMENT
COMMENT Detector
COMMENT --------
COMMENT
COMMENT file 1313250o00, raster FULL, etype OBJECT, etime 02
COMMENT Image data for chip 00
DETECTOR= 'OLAPA   '           / Science Detector
CCD     = 'Unknown '           / Science Detector (use DETECTOR)
IMAGEID =                    0 / CCD chip number
CHIPID  =                    0 / Use IMAGEID instead
DETSIZE = '[1:2048,1:4608]'    / Total data pixels in full mosaic
RASTER  = 'FULL    '           / Active raster description
CCDSUM  = '1 1     '           / Binning factors
CCDBIN1 =                    1 / Binning factor along first axis
CCDBIN2 =                    1 / Binning factor along second axis
PIXSIZE =                 13.5 / Pixel size for both axes (microns)
AMPLIST = 'a       '           / List of amplifiers for this image
CCDSIZE = '[1:2048,1:4608]'    / Detector imaging area size
CCDSEC  = '[1:2048,1:4608]'    / Read out area of the detector (unbinned)
BIASSEC = '[2049:2080,1:4608]' / Overscan (bias) area of the detector
MAXLIN  =                65535 / Maximum linearity value (ADU)
SATURATE=                65535 / Saturation value (ADU)
GAINA   =                 1.60 / Amp A gain (electrons/ADU)
```

```
RDNOISEA=                 4.70 / Amp A read noise (electrons)
DARKCUR =                    0 / Dark current (e-/pixel/hour)
RDTIME  =                32.00 / Read out time (sec)
MDCOORDS=                    3 / Sequence number within the exposure sequence
MDREPEAT=                    3 / Total number of sequences
CMPLTEXP=                    1 / Exposure number within the exposure sequence
NEXP    =                    4 / Total number of exposures within the sequence
CONSWV  = 'olA=137,DCU=49'     / Controller software DSPID and SERNO versions
DETSTAT = 'ok      '           / Detector temp range (-135..-120)
DETTEM  =               -131.3 / Detector temp deg C = 745.502 + -0.278 * 3154
INHERIT =                    F / No need to inherit global keywords
COMMENT
COMMENT Telescope
COMMENT ---------
COMMENT
TELESCOP= 'CFHT 3.6m'          / Hawaii Big Island, Mauna Kea
ORIGIN  = 'CFHT    '           / Canada-France-Hawaii Telescope
LATITUDE=            19.825252 / Latitude (degrees N)
LONGITUD=          -155.468876 / Longitude (degrees E)
TELSTAT = 'auto_guide'         / Telescope Control System status
TIMESYS = 'UTC     '           / Time System for DATExxxx and TIMExxxx
DATE-OBS= '2011-07-03'         / Date at start of observation (UTC)
UTIME   = '5:52:19.87'         / Time at start of observation (UTC)
UTC-OBS = '5:52:19.87'         / Time at start of observation (UTC)
TIME-OBS= '5:52:24.827'        / Time at start of observation (UTC)
MJDATE  =        55745.2446745 / Modified Julian Date at start of observation
MJD-OBS =        55745.2446745 / Modified Julian Date at start of observation
SIDTIME = '14:14:06.60'        / Sidereal time at start of observation
LST-OBS = '14:14:06.60'        / Sidereal time at start of exposure
DATEEND = '2011-07-03'         / Date at end of observation (UTC)
UTCEND  = '5:52:59.37'         / Time at end of observation (UTC)
TIMEEND = '5:52:26.859'        / Time at end of observation (UTC)
MJDEND  =        55745.2451316 / Modified Julian Date at end of observation
LSTEND  = '14:14:46.20'        / Sidereal time at end of exposure
EQUINOX =               2000.0 / Equinox of coordinates
RADECSYS= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
```

```
COMMENT RA/DEC are current actual telescope position
COMMENT including handset corrections
RA      = '16:00:20.00'        / Telescope right ascension
DEC     = '-22:37:18.1'        / Telescope declination
HA      = '-1:46:13.40'        / Telescope hour angle at start of exposure
HAEND   = '-1:45:33.80'        / Telescope hour angle at end of exposure
INSTZRA =                 0.00 / Instrument zero for RA in arc seconds
INSTZDEC=                 0.00 / Instrument zero for Dec in arc seconds
RA_DEG  =           240.083333 / Telescope right ascension in degrees
DEC_DEG =           -22.621694 / Telescope declination in degrees
COMMENT OBJxxx are original target position
COMMENT plus proper motion and precession
OBJNAME = 'delta sco'          / Target name
OBJMAG  =                  0.0 / Target magnitude
OBJEQUIN=               2000.0 / Target equinox
OBJRADEC= 'FK5     '           / Coordinate system for equinox (FK4/FK5/GAPPT)
OBJRA   = '16:00:20.00'        / Target right ascension
OBJDEC  = '-22:37:18.0'        / Target declination
OBJRAPM =                 0.00 / Target right ascension proper motion in as/yr
OBJDECPM=                 0.00 / Target declination proper motion in as/yr
NGUIDER =                    1 / TCS Number of guiders
NGUISTAR=                    1 / TCS number of guide stars/probes in use
GUINAME = 'Cass    '           / TCS guider name
GUIEQUIN=               2000.0 / TCS guider equinox
GUIRADEC= 'FK5     '           / TCS guider system for equinox
GUIRA   = '16:01:50.41'        / TCS guider right ascension
GUIDEC  = '-22:48:25.1'        / TCS guider declination
GUIRAPM =                 0.00 / TCS guider right ascension proper motion arcsec
GUIDECPM=                 0.00 / TCS guider declination proper motion arcsec
GUIOBJN = 'auto GSC: 0'        / TCS guider object name
GUIMAGN =              -9999.9 / TCS guider object magnitude
XPROBE  =             -173.000 / Telescope bonnette guide probe X position
YPROBE  =               91.000 / Telescope bonnette guide probe Y position
ZPROBE  =              412.000 / Telescope bonnette guide probe Z position
GUIFLUX =                -9999 / TCS guider flux
GUIFWHX =             -9999.90 / TCS guider average x FWHM in pixels
```

```
GUIFWHY =             -9999.90 / TCS guider average y FWHM in pixels
SKYFLUX =                -9999 / TCS total sky flux
AIRMASS =                1.551 / Airmass at start of observation
TELALT  =              40.1958 / Telescope altitude at start of observation, deg
TELAZ   =             147.2174 / Telescope azimuth at start, deg, 0=N 90=E 270=W
DOMEAZ  =                143.8 / Dome azimuth at start, deg, 0=N 90=E 270=W
MOONANGL=               118.60 / Angle from object to moon at start in degrees
MOONPHAS=                 0.05 / Moon phase @ 0 HST, 0..1 new>full, -1..0 >new
MOONUP  = 'True    '           / Moon up? True or False
MOONALT =                 6.80 / Moon altitude at start in degrees
MOONAZ  =               284.00 / Moon azimuth at start in deg, 0=N 90=E 270=W
FOCUSID = 'Cass    '           / Telescope focus in use
TELCONF = 'Cass    '           / Telescope focus in use
CALFOCUS=               11.329 / Telescope focus calculated from model in mm
DEFOCUS =                0.000 / Telescope defocus from calculated in mm
FOCUSPOS=                11324 / Telescope focus encoder readout
TELFOCUS=                11324 / Telescope focus encoder readout
BONANGLE=                 0.00 / Telescope bonnette rotation angle in degrees
ROTANGLE=                 0.00 / Telescope bonnette rotation angle in degrees
TCSGPSBC= '0184 05:38:57.960470' / TCS GPS read out in BCD
TCSGPSTM=              5.64943 / TCS GPS clock time in decimal hours
TCSRBUSS= '05:39:01.077'       / TCS RBUSS clock time
TCSEPICS= '20110703 05:38:53.960' / TCS EPICS clock time
TCSAMODE= 'O       '           / TCS acquire mode - T/O/G/g/P for t/o/g coords
TCSMJD  =        55745.2353926 / TCS MJD
TCSLST  =             14.01179 / TCS LST in decimal hours
TCSAPHA =            -30.08699 / TCS apparent hour angle in degrees
TCSAPDEC=            -22.65508 / TCS apparent declination in degrees
TCSOBHA =            -30.07877 / TCS observed hour angle in degrees
TCSOBDEC=            -22.64492 / TCS observed declination in degrees
TCSENHA =              -109347 / TCS hour angle absolute encoder in bits
TCSENDEC=               -62324 / TCS declination absolute encoder in bits
TCSEDHA =            -29.97341 / TCS hour angle absolute encoder in degrees
TCSEDDEC=            -22.65455 / TCS declination absolute encoder in degrees
TCSINHA =                    0 / TCS hour angle incremental encoder in bits
TCSINDEC=                    0 / TCS declination incremental encoder in bits
```

```
TCSSEHA =                -0.14 / TCS hour angle servo error in arcsec
TCSSEDEC=                 0.00 / TCS declination servo error in arcsec
TCSGEHA =                 0.00 / TCS hour angle guider error in arcsec
TCSGEDEC=                 0.00 / TCS declination guider error in arcsec
TCSMVRA =               0.0000 / TCS right ascension acquisition move in arcsec
TCSMVDEC=               0.0000 / TCS declination acquisition move in arcsec
TCSMVX  =            -9999.900 / TCS secondary guider acquisition x move in mm
TCSMVY  =            -9999.900 / TCS secondary guider acquisition y move in mm
FFLAMPON= 'OFF     '           / flatfield lamp status ON/OFF
FFLAMP1 =                   5 / flatfield lamp 1 intensity
FFLAMP2 =                  12 / flatfield lamp 2 intensity
CLAMPON = 'OFF     '           / comparison lamp status ON/OFF
COMMENT
COMMENT Instrument Description
COMMENT ----------------------
COMMENT
INSTRUME= 'ESPaDOnS'           / Instrument Name
INSTMODE= 'Polarimetry, R=65,000' / Instrument Mode
FILTERID=                  -1 / wheel position
FILTER  = 'Unknown '           / description of filter
COMMENT
COMMENT ESPaDOnS Cassegrain Unit
COMMENT ------------------------
COMMENT
EADCPOS = 'IN      '           / ESPaDOnS ADC position IN/OUT of beam
EADC1BEG= '28.4169388822548'   / ADC prism 1 position at start of exposure
EADC2BEG= '95.1025197628458'   / ADC prism 2 position at start of exposure
EADC1END= '28.4169388822548'   / ADC prism 1 position at end of exposure
EADC2END= '95.1025197628458'   / ADC prism 2 position at end of exposure
ECALIBWH= 'P1      '           / ESPaDOnS calibration wheel position (# and deg)
ERHOMB1 = 'P2      '           / ESPaDOnS rhomb 1 position (# and deg)
ERHOMB2 = 'P1      '           / ESPaDOnS rhomb 2 position (# and deg)
EFABPERO= 'P1      '           / ESPaDOnS Fabry Perot position (# and deg)
EWEDWOL = 'WOL     '           / ESPaDOnS Wedge/Wollaston slide position WED/WOL
ETEMPPOL=                -1.46 / ESPaDOnS polarimeter temperature deg C
ETEMPCB =                 8.42 / ESPaDOnS calibration box temperature deg C
```

```
COMMENT
COMMENT ESPaDOnS Guider
COMMENT ---------------
COMMENT
EGUIDING= 'GO      '           / ESPaDOnS guiding state ON/OFF
EGUISEE =             -9999.90 / ESPaDOnS guider seeing estimate
COMMENT
COMMENT ESPaDOnS Spectrograph
COMMENT ---------------------
COMMENT
ECAMFOC =                -3.48 / ESPaDOnS camera focus position (mm)
EHARTPOS= 'OUT     '           / ESPaDOnS hartmann position FULL/DOWN/UP/OUT
ESLIPOS = 'P2      '           / ESPaDOnS slicer bench position (# and mm)
EHALOPOS= 'OUT     '           / ESPaDOnS halogen lamp position IN/OUT
EHALOGEN= 'OFF     '           / ESPaDOnS halogen lamp state ON/OFF
ESLICER = 'P2      '           / ESPaDOnS slicer position (# and deg)
EDEKKER = 'P4      '           / ESPaDOnS dekker position (# and mm)
EEMSHUT = 'OPEN    '           / ESPaDOnS exposure meter shutter OPEN/CLOSED
EEMSTATE= 'ON      '           / ESPaDOnS exposure meter state ON/OFF
EEMCNTS =                   16 / ESPaDOnS exposure meter counts at end
ETSP1BEG=                12.84 / ESPaDOnS down mirror temp at start (deg C)
ETSP2BEG=                12.98 / ESPaDOnS camera temp at start (deg C)
ETSP3BEG=                12.96 / ESPaDOnS up mirror temp at start (deg C)
ETSP4BEG=                12.62 / ESPaDOnS hygrometer temp at start (deg C)
EPRSPBEG=                -1.56 / ESPaDOnS relative pressure at start (mb)
ERHSPBEG=                28.34 / ESPaDOnS relative humidity at start (%)
ETSP1END=                12.85 / ESPaDOnS down mirror temp at end (deg C)
ETSP2END=                13.01 / ESPaDOnS camera temp at end (deg C)
ETSP3END=                12.98 / ESPaDOnS up mirror temp at end (deg C)
ETSP4END=                12.35 / ESPaDOnS hygrometer temp at end (deg C)
EPRSPEND=                -1.57 / ESPaDOnS relative pressure at end (mb)
ERHSPEND=                28.26 / ESPaDOnS relative humidity at end (%)
EREADSPD= 'Fast: 4.70e noise, 1.60e/ADU, 32s' / ESPaDOnS det read out xslow/slow
TESPMIRE=                 6.14 / 03 temp, surface, primary mirror east deg C
TESPMIRW=                 6.16 / 02 temp, surface, primary mirror west deg C
TESPMIRS=                 6.10 / 01 temp, surface, primary mirror west side degC
```

```
TEAPMCLW=                6.37 / 54 temp, air, primary mirror cell west deg C
TEAMIRCI=                5.05 / 58 temp, air, mirror cooling in at unit deg C
TEAMIRCO=                5.93 / 27 temp, air, mirror cooling out at cell deg C
TEAPMSPN=                6.68 / 65 temp, air, mirror spigot north cass deg C
TEAPMSPS=                6.21 / 64 temp, air, mirror spigot nouth M3 deg C
TEATRNGE=                3.89 / 23 temp, air, top ring east deg C
TEATRNGW=                4.62 / 06 temp, air, top ring west deg C
TEANRLSB=               12.26 / 19 temp, air, north rail support beam deg C
TESHRSET=             9999.00 / 08 temp, surface, horseshoe east top deg C
TESTTRSH=                5.53 / 97 temp, surface, telescope truss S high deg C
TESTTRNM=                5.39 / 94 temp, surface, telescope truss N mid deg C
TESTTREM=                5.48 / 95 temp, surface, telescope truss E mid deg C
TESTTRWM=                5.62 / 96 temp, surface, telescope truss W mid deg C
TESTTRSL=                5.72 / 98 temp, surface, telescope truss S low deg C
TESTTRSE=                5.79 / 69 temp, surface, telescope truss SE lower degC
TEALOWWS=            -9999.90 / 38 temp, air, dome lower weather stat side degC
TEATOPWS=            -9999.90 / 36 temp, air, dome top weather stat side deg C
TEATOPOP=            -9999.90 / 37 temp, air, dome top opposite weath side degC
TEA2INCH=                5.53 / 45 temp, air, two inches above fifth floor degC
TEA2INEB=                7.34 / 53 temp, air, two inches up by electronics degC
TEA6FOOT=                5.68 / 43 temp, air, six feet above fifth floor deg C
TESCONRM=                8.32 / 61 temp, surface, floor above control room degC
TESPIERN=                7.53 / 59 temp, surface, floor by north pier deg C
TESPIERS=                7.29 / 60 temp, surface, floor by south pier deg C
TEAWTHRT=                5.10 / 35 temp, air, weathertron deg C
TEMPERAT=                4.25 / 86 temp, air, weather tower deg C
WINDSPED=               28.03 / 84 wind speed, weather tower knots
WINDDIR =               53.35 / 85 wind direction, weather tower deg (N=0 E=90)
RELHUMID=               14.35 / 87 relative humidity, weather tower %
PRESSURE=              618.66 / 31 barometric pressure, control room mb
DDSEEMEN=                0.57 / Dome DIMM mean seeing, arc seconds
DDSEEMED=                0.57 / Dome DIMM median seeing, arc seconds
DDSEEMOD=                0.57 / Dome DIMM mode seeing, arc seconds
DDSEESTD=                0.00 / Dome DIMM seeing deviation, arc seconds
WMSEEMEN=            -9999.90 / Weather tower MASS mean seeing, arc seconds
WMSEEMED=            -9999.90 / Weather tower MASS median seeing, arc seconds
```

```
WMSEEMOD=            -9999.90 / Weather tower MASS mode seeing, arc seconds
WMSEESTD=            -9999.90 / Weather tower MASS seeing deviation, arc second
WDSEEMEN=            -9999.90 / Weather tower DIMM mean seeing, arc seconds
WDSEEMED=            -9999.90 / Weather tower DIMM median seeing, arc seconds
WDSEEMOD=            -9999.90 / Weather tower DIMM mode seeing, arc seconds
WDSEESTD=            -9999.90 / Weather tower DIMM seeing deviation, arc second
SPOZPMEN=                0.21 / SkyProbe (orig) mean absorption, magnitude
SPOZPMED=                0.21 / SkyProbe (orig) median absorption, magnitude
SPOZPMOD=                0.21 / SkyProbe (orig) mode absorption, magnitude
SPOZPSTD=                0.00 / SkyProbe (orig) absorption deviation, magnitude
SPBZPMEN=            -9999.90 / SkyProbe (B) mean absorption, magnitude
SPBZPMED=            -9999.90 / SkyProbe (B) median absorption, magnitude
SPBZPMOD=            -9999.90 / SkyProbe (B) mode absorption, magnitude
SPBZPSTD=            -9999.90 / SkyProbe (B) absorption deviation, magnitude
SPVZPMEN=            -9999.90 / SkyProbe (V) mean absorption, magnitude
SPVZPMED=            -9999.90 / SkyProbe (V) median absorption, magnitude
SPVZPMOD=            -9999.90 / SkyProbe (V) mode absorption, magnitude
SPVZPSTD=            -9999.90 / SkyProbe (V) absorption deviation, magnitude
ASCLDMEN=             -9999.9 / ASIVA mean global (all sky) cloud cover, %
ASCLDMED=             -9999.9 / ASIVA median global (all sky) cloud cover, %
ASCLDMOD=             -9999.9 / ASIVA mode global (all sky) cloud cover, %
ASCLDSTD=             -9999.9 / ASIVA global (all sky) cloud cover deviation, %
ASNERMEN=           -9999.900 / ASIVA mean radiance, NE quadrant, w/m2/u/sr
ASNERMED=           -9999.900 / ASIVA median radiance, NE quadrant, w/m2/u/sr
ASNERMOD=           -9999.900 / ASIVA mode radiance, NE quadrant, w/m2/u/sr
ASNERSTD=           -9999.900 / ASIVA radiance deviation, NE quadrant, w/m2/u/s
ASNESMEN=           -9999.900 / ASIVA mean standard deviation, NE quadrant
ASNESMED=           -9999.900 / ASIVA median standard deviation, NE quadrant
ASNESMOD=           -9999.900 / ASIVA mode standard deviation, NE quadrant
ASNESSTD=           -9999.900 / ASIVA standard deviation deviation, NE quadrant
ASSERMEN=           -9999.900 / ASIVA mean radiance, SE quadrant, w/m2/u/sr
ASSERMED=           -9999.900 / ASIVA median radiance, SE quadrant, w/m2/u/sr
ASSERMOD=           -9999.900 / ASIVA mode radiance, SE quadrant, w/m2/u/sr
ASSERSTD=           -9999.900 / ASIVA radiance deviation, SE quadrant, w/m2/u/s
ASSESMEN=           -9999.900 / ASIVA mean standard deviation, SE quadrant
ASSESMED=           -9999.900 / ASIVA median standard deviation, SE quadrant
```

```
ASSESMOD=            -9999.900 / ASIVA mode standard deviation, SE quadrant
ASSESSTD=            -9999.900 / ASIVA standard deviation deviation, SE quadrant
ASSWRMEN=            -9999.900 / ASIVA mean radiance, SW quadrant, w/m2/u/sr
ASSWRMED=            -9999.900 / ASIVA median radiance, SW quadrant, w/m2/u/sr
ASSWRMOD=            -9999.900 / ASIVA mode radiance, SW quadrant, w/m2/u/sr
ASSWRSTD=            -9999.900 / ASIVA radiance deviation, SW quadrant, w/m2/u/s
ASSWSMEN=            -9999.900 / ASIVA mean standard deviation, SW quadrant
ASSWSMED=            -9999.900 / ASIVA median standard deviation, SW quadrant
ASSWSMOD=            -9999.900 / ASIVA mode standard deviation, SW quadrant
ASSWSSTD=            -9999.900 / ASIVA standard deviation deviation, SW quadrant
ASNWRMEN=            -9999.900 / ASIVA mean radiance, NW quadrant, w/m2/u/sr
ASNWRMED=            -9999.900 / ASIVA median radiance, NW quadrant, w/m2/u/sr
ASNWRMOD=            -9999.900 / ASIVA mode radiance, NW quadrant, w/m2/u/sr
ASNWRSTD=            -9999.900 / ASIVA radiance deviation, NW quadrant, w/m2/u/s
ASNWSMEN=            -9999.900 / ASIVA mean standard deviation, NW quadrant
ASNWSMED=            -9999.900 / ASIVA median standard deviation, NW quadrant
ASNWSMOD=            -9999.900 / ASIVA mode standard deviation, NW quadrant
ASNWSSTD=            -9999.900 / ASIVA standard deviation deviation, NW quadrant
ASSPRMEN=            -9999.900 / ASIVA mean radiance, SkyProbe, w/m2/u/sr
ASSPRMED=            -9999.900 / ASIVA median radiance, SkyProbe, w/m2/u/sr
ASSPRMOD=            -9999.900 / ASIVA mode radiance, SkyProbe, w/m2/u/sr
ASSPRSTD=            -9999.900 / ASIVA radiance deviation, SkyProbe, w/m2/u/sr
ASSPSMEN=            -9999.900 / ASIVA mean standard deviation, SkyProbe
ASSPSMED=            -9999.900 / ASIVA median standard deviation, SkyProbe
ASSPSMOD=            -9999.900 / ASIVA mode standard deviation, SkyProbe
ASSPSSTD=            -9999.900 / ASIVA standard deviation deviation, SkyProbe
QRUNID  = '11AQ14  '           / Q RunID
QOBSERVE= 'Adam Draginda'      / Name of Q Observer
QCOORD  = 'Nadine Manset'      / Name of Q Coordinator
QID     = 55100500000000023669
QOBSEQID= 55001400000000060676
QICSEQID= 55051200000000087042
QOBITER =                    1
REL_DATE= '2012-08-31T00:00:00' / UTC Release Date
REDUCTIO= 'Polar   '           / Type of reduction
NORMAL  = '2       '           / Normalized and Un-normalized Data
```

```
COMMENT File contains automatic wavelength correction and uncorrected data.
COMMENT For Stokes Q, V, and W, keep the Stokes parameter sign as is
COMMENT For Stokes U, invert the sign of the Stokes parameter
COL1    = 'Wavelength'         / Normalized
COL2    = 'Intensity'          / Normalized
COL3    = 'Stokes  '           / Normalized
COL4    = 'CheckN1 '           / UnNormalized
COL5    = 'CheckN2 '           / UnNormalized
COL6    = 'ErrorBar'           / UnNormalized
COL7    = 'Wavelength'         / UnNormalized
COL8    = 'Intensity'          / UnNormalized
COL9    = 'Stokes  '           / UnNormalized
COL10   = 'CheckN1 '           / UnNormalized
COL11   = 'CheckN2 '           / UnNormalized
COL12   = 'ErrorBar'           / UnNormalized
COL13   = 'Wavelength'         / Normalized, no autowave correction
COL14   = 'Intensity'          / Normalized, no autowave correction
COL15   = 'Stokes  '           / Normalized, no autowave correction
COL16   = 'CheckN1 '           / Normalized, no autowave correction
COL17   = 'CheckN2 '           / Normalized, no autowave correction
COL18   = 'ErrorBar'           / Normalized, no autowave correction
COL19   = 'Wavelength'         / UnNormalized, no autowave correction
COL20   = 'Intensity'          / UnNormalized, no autowave correction
COL21   = 'Stokes  '           / UnNormalized, no autowave correction
COL22   = 'CheckN1 '           / UnNormalized, no autowave correction
COL23   = 'CheckN2 '           / UnNormalized, no autowave correction
COL24   = 'ErrorBar'           / UnNormalized, no autowave correction
COMMENT -----------------------------------------------------
COMMENT | Processed by the CFHT OPERA Open Source Pipeline |
COMMENT -----------------------------------------------------
COMMENT OPERA version 1.0 - opera-1.0 build date Thu Oct 18 13:28:56 HST 2012
COMMENT Processing Date
COMMENT ---------------
COMMENT Thu Oct 18 13:50:03 HST 2012
COMMENT ------------------------------------------------------------------------
COMMENT upena-compatible headers for column names in primary extension:
```

```
COMMENT (1) Spectroscopy Star only mode
COMMENT     First column = wavelength in nanometres
COMMENT     Second column = intensity
COMMENT     Third column = error bar
COMMENT (2) Polarimetry
COMMENT     1st col = wavelength in nanometres
COMMENT     2d  col = intensity
COMMENT     3rd col = polarisation (Q or U or V or W)
COMMENT     4th col = Check Spectra #1
COMMENT     5th col = Check Spectra #2
COMMENT      6th col = error bar
COMMENT (3) Spectroscopy Star + Sky
COMMENT     1st col = wavelength
COMMENT     2d  col = star spectra (sky subtracted)
COMMENT     3rd col = star + sky spectra
COMMENT     4th col = sky spectra
COMMENT     5, 6, 7 = error bars for each column 2, 3, 4
COMMENT ------------------------------------------------------------------------
COMMENT StandardBeamSpectrum
COMMENT OPERA Processing Parameters
COMMENT --------------------------
COMMENT OPERA_PARAM EEV1_namps := 1
COMMENT OPERA_PARAM OLAPAa_namps := 1
COMMENT OPERA_PARAM OLAPAab_namps := 2
COMMENT OPERA_PARAM minimumflatsforgain := 2
COMMENT OPERA_PARAM gainsubwindow := 100 800 500 3000
COMMENT OPERA_PARAM gainMinPixPerBin := 1000
COMMENT OPERA_PARAM gainMaxNBins := 100
COMMENT OPERA_PARAM gainLowestCount := 1000
COMMENT OPERA_PARAM gainHighestCount := 30000
COMMENT OPERA_PARAM geom_limit := 0.2
COMMENT OPERA_PARAM geomsubformat := 8 2040 3 4600
COMMENT OPERA_PARAM maxorders := 44
COMMENT OPERA_PARAM firstorder := 17
COMMENT OPERA_PARAM lastorder := 61
COMMENT OPERA_PARAM spectralsampling := 0.6923
```

```
COMMENT OPERA_PARAM colDispersion := 1
COMMENT OPERA_PARAM invertOrders := 1
COMMENT OPERA_PARAM aperture := 26
COMMENT OPERA_PARAM detectionMethod := 2
COMMENT OPERA_PARAM FFTfilter := 0
COMMENT OPERA_PARAM geomnpar_Fast := 3
COMMENT OPERA_PARAM geomnpar_Slow := 4
COMMENT OPERA_PARAM geomnpar_Normal := 4
COMMENT OPERA_PARAM geombinsize := 20
COMMENT OPERA_PARAM nsamples := 3
COMMENT OPERA_PARAM minordertouse := 17
COMMENT OPERA_PARAM thorium_argon_atlas_lines := thar_MM201006.dat.gz
COMMENT OPERA_PARAM thorium_argon_atlas_spectrum := LovisPepe_ThArAtlas.dat.gz
COMMENT OPERA_PARAM wcal_uncalibrated_linewidth := 1.5
COMMENT OPERA_PARAM wcal_use_spectral_lines := 1
COMMENT OPERA_PARAM sp1_IPDimensions := 30 5 6 5
COMMENT OPERA_PARAM sp2_IPDimensions := 28 5 6 5
COMMENT OPERA_PARAM pol_IPDimensions := 30 5 6 5
COMMENT OPERA_PARAM IPDimensions := 30 5 6 5
COMMENT OPERA_PARAM spectralElementHeight := 1.0
COMMENT OPERA_PARAM DetectionThreshold := 0.5
COMMENT OPERA_PARAM referenceLineWidth := 2.5
COMMENT OPERA_PARAM tilt := -3.0
COMMENT OPERA_PARAM ipBinsize := 90
COMMENT OPERA_PARAM CREATE_NORMALIZED_FLAT := 0
COMMENT OPERA_PARAM normalizedflataperture := 28
COMMENT OPERA_PARAM normalizedflatbinsiz :=
COMMENT OPERA_PARAM FourierFilterWidthNormal := 0.1
COMMENT OPERA_PARAM sp1_numberOfBeams := 2
COMMENT OPERA_PARAM sp2_numberOfBeams := 1
COMMENT OPERA_PARAM pol_numberOfBeams := 2
COMMENT OPERA_PARAM sp1_apertureWidth := 26
COMMENT OPERA_PARAM sp2_apertureWidth := 24
COMMENT OPERA_PARAM pol_apertureWidth := 26
COMMENT OPERA_PARAM sp1_apertureHeight := 0.6
COMMENT OPERA_PARAM sp2_apertureHeight := 0.6
```

```
COMMENT OPERA_PARAM pol_apertureHeight := 0.6
COMMENT OPERA_PARAM sp1_backgroundAperture := 2.0
COMMENT OPERA_PARAM sp2_backgroundAperture := 2.0
COMMENT OPERA_PARAM pol_backgroundAperture := 2.0
COMMENT OPERA_PARAM sp1_gapBetweenBeams := 0
COMMENT OPERA_PARAM sp2_gapBetweenBeams := 0
COMMENT OPERA_PARAM pol_gapBetweenBeams := 0
COMMENT OPERA_PARAM apernumberOfBeams := 2
COMMENT OPERA_PARAM apernapertureWidth := 26
COMMENT OPERA_PARAM aperapertureHeight := 0.6
COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
COMMENT OPERA_PARAM apergapBetweenBeams := 0
COMMENT OPERA_PARAM aperpickImageRow := 0
COMMENT OPERA_PARAM spectrumordercol := 1
COMMENT OPERA_PARAM spectrumdistcol := 2
COMMENT OPERA_PARAM spectrumfluxcol := 3
COMMENT OPERA_PARAM spectrumvariancecol := 4
COMMENT OPERA_PARAM spectrumintegratedcol := 5
COMMENT OPERA_PARAM snrordercol := 1
COMMENT OPERA_PARAM snrdistcol := 2
COMMENT OPERA_PARAM snrcol := 3
COMMENT OPERA_PARAM snrintegratedcol := 4
COMMENT OPERA_PARAM wcalordercol := 1
COMMENT OPERA_PARAM wcalwavelengthcol := 2
COMMENT OPERA_PARAM wcalintensitycol := 3
COMMENT OPERA_PARAM wcaltitlecol := 4
COMMENT OPERA_PARAM normalize_usePolynomial := 0
COMMENT OPERA_PARAM normalize_binsize := 120
COMMENT OPERA_PARAM extraction_backgroundBinsize := 400
COMMENT OPERA_PARAM extraction_sigmaclip := 25
COMMENT OPERA_PARAM extraction_usePolynomialFit := 1
COMMENT OPERA_PARAM RawSpectrum := 1
COMMENT OPERA_PARAM StandardSpectrum := 2
COMMENT OPERA_PARAM OptimalSpectrum := 3
COMMENT OPERA_PARAM OperaOptimalSpectrum := 4
COMMENT OPERA_PARAM RawBeamSpectrum := 5
```

```
COMMENT OPERA_PARAM StandardBeamSpectrum := 6
COMMENT OPERA_PARAM OptimalBeamSpectrum := 7
COMMENT OPERA_PARAM OperaOptimalBeamSpectrum := 8
COMMENT OPERA_PARAM CalibratedRawSpectrum := 9
COMMENT OPERA_PARAM CalibratedStandardSpectrum := 10
COMMENT OPERA_PARAM CalibratedOptimalSpectrum := 11
COMMENT OPERA_PARAM CalibratedOperaOptimalSpectrum := 12
COMMENT OPERA_PARAM CalibratedRawBeamSpectrum := 13
COMMENT OPERA_PARAM CalibratedStandardBeamSpectrum := 14
COMMENT OPERA_PARAM CalibratedOptimalBeamSpectrum := 15
COMMENT OPERA_PARAM CalibratedOperaOptimalBeamSpectrum := 16
COMMENT OPERA_PARAM DefaultSpectrumTypeName := StandardBeamSpectrum
COMMENT OPERA_PARAM DefaultSpectrumType := 6
COMMENT OPERA_PARAM DefaultCalibratedSpectrumType := 14
COMMENT OPERA_PARAM StokesI := 0
COMMENT OPERA_PARAM StokesQ := 1
COMMENT OPERA_PARAM StokesU := 2
COMMENT OPERA_PARAM StokesV := 3
COMMENT OPERA_PARAM stokesparameter := 1
COMMENT OPERA_PARAM difference := 1
COMMENT OPERA_PARAM ratio := 2
COMMENT OPERA_PARAM polarmethod := 2
COMMENT OPERA_PARAM polarnormalize := 0
COMMENT OPERA_PARAM cNone := 0
COMMENT OPERA_PARAM cRICE := 11
COMMENT OPERA_PARAM cGZIP := 21
COMMENT OPERA_PARAM cHCOMPRESS := 41
COMMENT OPERA_PARAM cPLIO := 31
COMMENT OPERA_PARAM compressiontype := 11
COMMENT OPERA_PARAM extension := .fz
COMMENT OPERA_PARAM gzip := .gz
COMMENT OPERA_PARAM DETECTOR := OLAPA
COMMENT OPERA_PARAM AMPLIFIER := a
COMMENT OPERA_PARAM MODE := pol
COMMENT OPERA_PARAM SPEED := Fast
COMMENT OPERA_PARAM OSET :=
```

```
COMMENT OPERA_PARAM apernumberOfBeams := 2
COMMENT OPERA_PARAM apernapertureWidth := 26
COMMENT OPERA_PARAM aperapertureHeight := 0.6
COMMENT OPERA_PARAM aperbackgroundAperture := 2.0
COMMENT OPERA_PARAM apergapBetweenBeams := 0
COMMENT OPERA_PARAM apernRowSamples := 10
COMMENT OPERA_PARAM aperMinTiltAngle := -5
COMMENT OPERA_PARAM aperMaxTiltAngle := 0
COMMENT OPERA_PARAM apertiltAnglePrecision := 0.1
COMMENT OPERA_PARAM extraction_minorder := 22
COMMENT OPERA_PARAM extraction_maxorder := 60
COMMENT OPERA_PARAM extractor_sp2 := operaStarOnly
COMMENT OPERA_PARAM extractor_sp1 := operaStarPlusSky
COMMENT OPERA_PARAM extractor_pol := operaPolarIntensity
COMMENT OPERA_PARAM extractor := operaPolarIntensity
COMMENT SNR Table
COMMENT ---------
COMMENT Format: <order number><Center SNR><wavelength><SNR>
END
```

4. Conclusion

OPERA's transparency affords a richness of data not before available. This document describes structures that retain valuable calibration data for posterity in archival format .

5. Appendix - Data Formats

5.1 Beam Distance Spectra (.e)

<order number> <nElements> <nBeams> <elementindex> <SpectralElements photoCenterX> <SpectralElements photoCenterY> <SpectralElements dist> <SpectralElements flux> <SpectralElements flux variance> <XCorrelation> <beam> <BeamElements[beam] photoCenterX> <BeamElements[beam] photoCenterY> <BeamElements[beam] flux> <BeamElements[beam] <flux variance>

5.2 Beam Wavelength Spectra (.s)

<order number> <nElements> <nBeams> <elementindex> <wavelength> <SpectralElements flux> <SpectralElements flux variance> <nElements> <nBeams> <beam> <BeamElements[beam] flux> <BeamElements[beam] flux variance> <beam> <BeamElements[beam] flux> <BeamElements[beam] flux variance>

5.3 Instrument Profile (.prof)

<number of orders> <number of columns i> <number of rows j> <xsize> <xsampling> <ysize> <ysampling> <order number> <i> <j> <number of coefficients> <ndatapoints> <polynomial coefficients> <chisqr>

5.4 Aperture Profile (.aper)

<order number> <number of beams> <measured tilt> <tilt error>\<leftBackgroundIndex> <xsampling> <ysampling> <lb height> <lb width> <lb slope> <lb xcenter> <lb ycenter> <lb fluxFraction><rightBackgroundIndex> <xsampling> <ysampling> <rb height> <rb width> <rb slope> <rb xcenter> <rb ycenter> <rb fluxFraction> <beam> <xsampling> <ysampling> <beam height> <beam width> <beam slope> <beam xcenter> <beam ycenter> <beam fluxFraction> <beam> <xsampling> <ysampling> <beam height> <beam width> <beam slope> <beam xcenter> <beam ycenter> <beam fluxFraction>

5.5 Geometry (.geom)

<order number> <number of coefficients> <ndatapoints> <polynomial coefficient> <polynomial coefficienterror>... <chisqr> <YBinning> <miny><maxy>

5.6 Wavelength (.wave)

<order number> <number of coefficients> <polynomial coefficients>

5.7 SNR (.sn)

<order number> <Center SNR> <wavelength> <SNR>

5.8 Order Spacing Polynomial (.ordp)

<number of orders> <minorder> <maxorder> <chisqr> <number of coefficients> <polynomial coefficient> <polynomial coefficienterror>...

5.9 Polarimetry (.pu.s)

<order number> <StokesParameter_t> <length> <index> <Stokes(Q,U,V) flux> <Stokes(Q,U,V) variance> <StokesI flux> <StokesI variance> <degree of polarization flux> <degree of polarization variance> <first null polarization> <first null polarization variance> <second null polarization> <second null polarization variance>

5.10 Gain (.gain)

<amp> <gain> <noise> <gainerror> <bias>

5.11 Bias (.bias)

<amp> <gain> <noise> <gainerror> <bias>