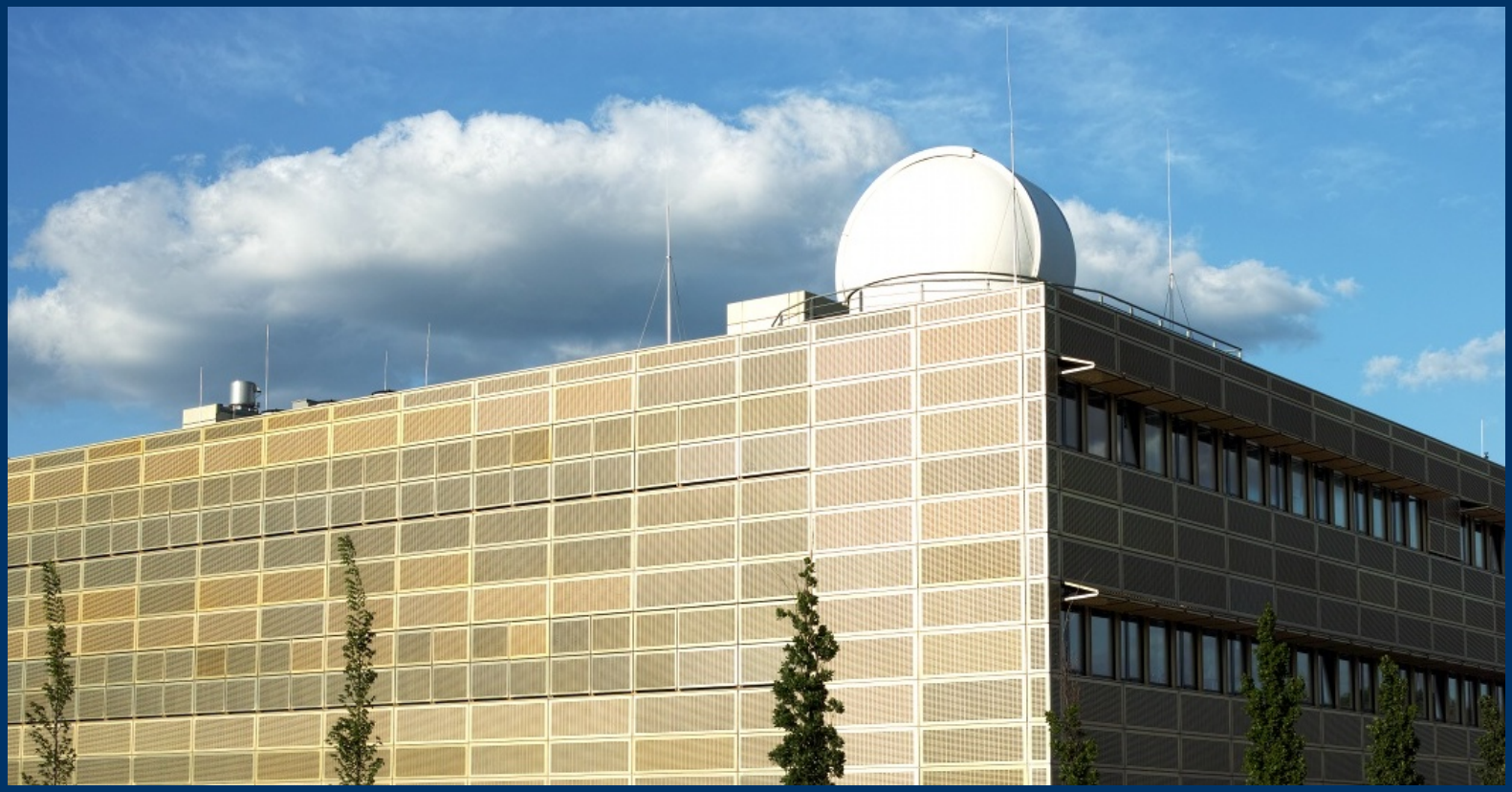
Quasar absorption spectroscopy



Summer 2021 – 23.04.2018

Messages

Wendt,M.: Absorption Spectroscopy

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> SoSe 2017 > Physik > abs_spec > General > Collection of small Wiki articles per student > Science articles > View

Collection of small Wiki articles per student

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Science articles

These link to individual Wiki pages per topic/person.

- Data reduction (Kirill)
- Quasars (David)
- Line profiles (Purnima)
- Curve of growth (Kawa)
- QSO absorption systems (Patricia)
- Quasars2 (Adnan)
- Quasars3 (Marzieh)
- *Physics with ALS* (?)
- *others...*
-

LaTeX formula example:

$$\frac{I_{7664}}{I_{7699}} = \frac{(1-e^{-\tau})}{(1-e^{-\tau/2})}$$

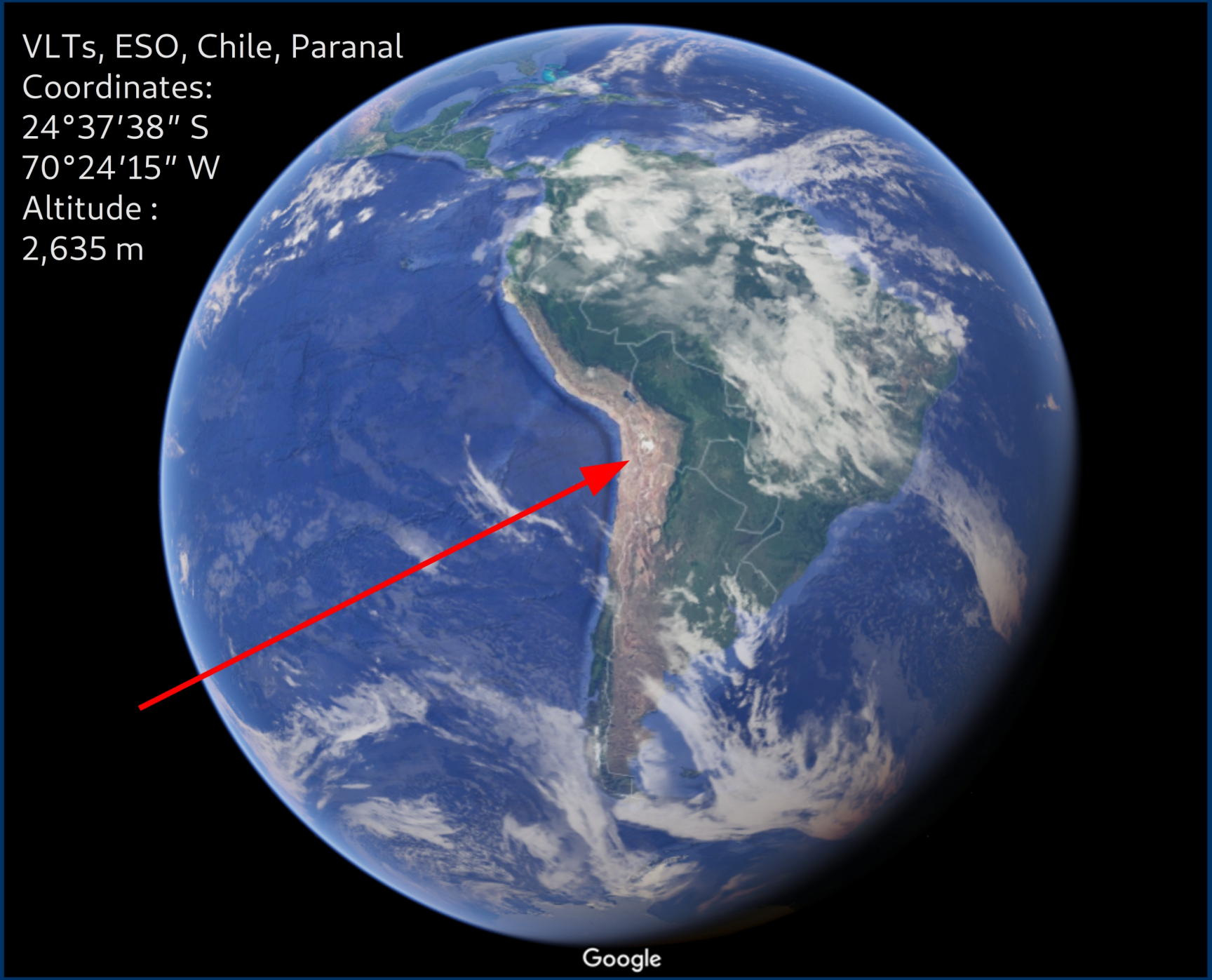
VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

VLTs, ESO, Chile, Paranal

VLT / UVES

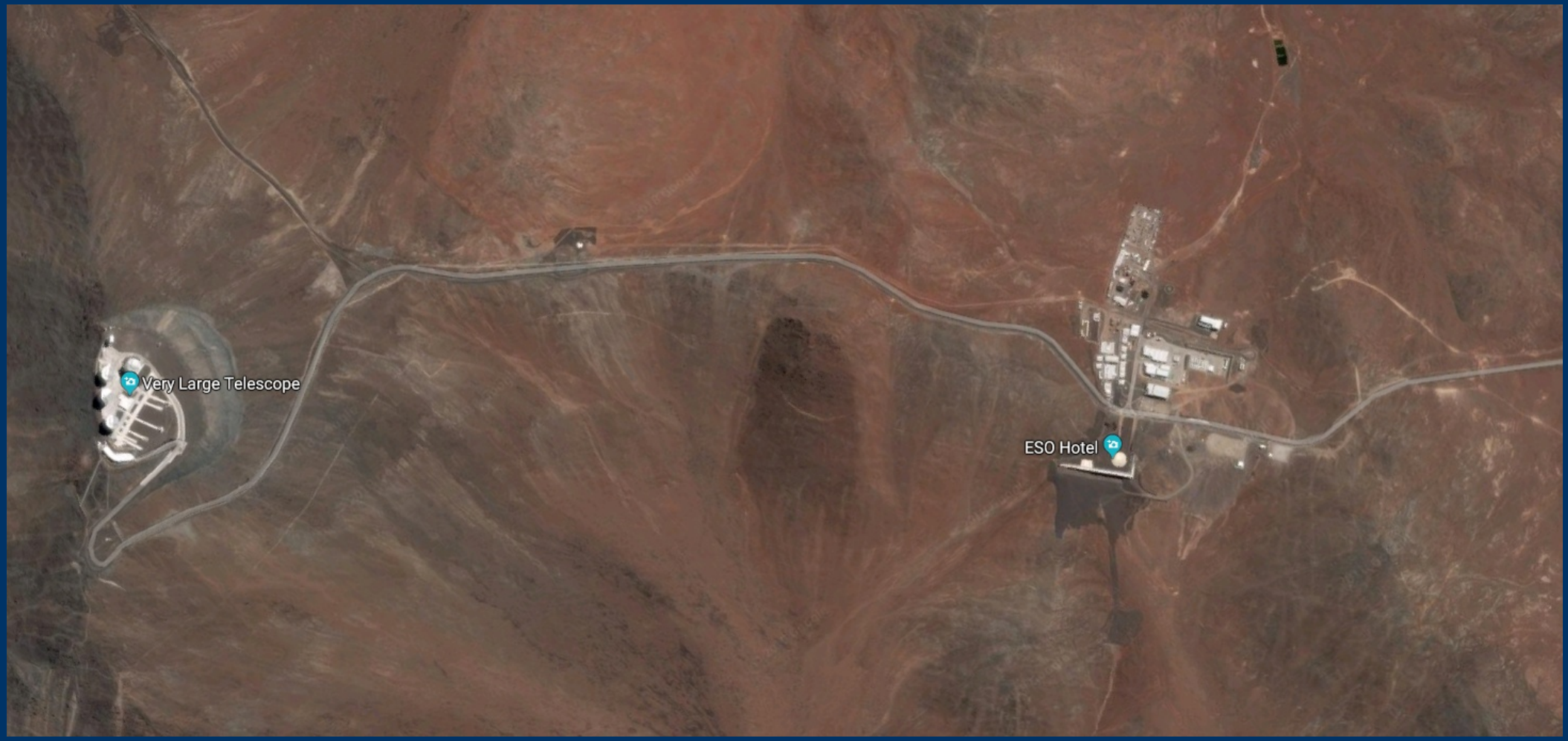
Ultraviolet and Visual Echelle Spectrograph



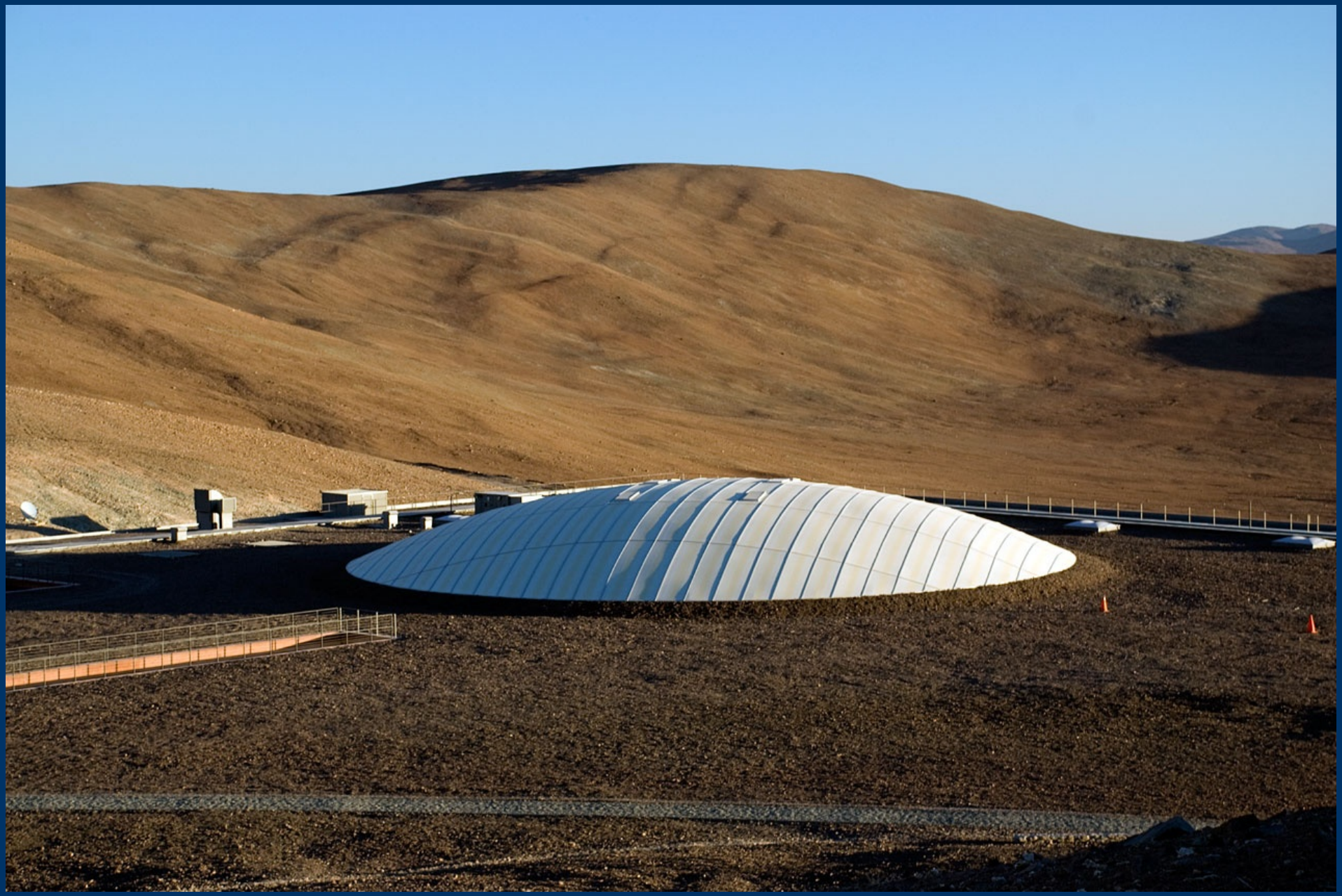
VLTs, ESO, Chile, Paranal

VLT / UVES

Ultraviolet and Visual Echelle Spectrograph



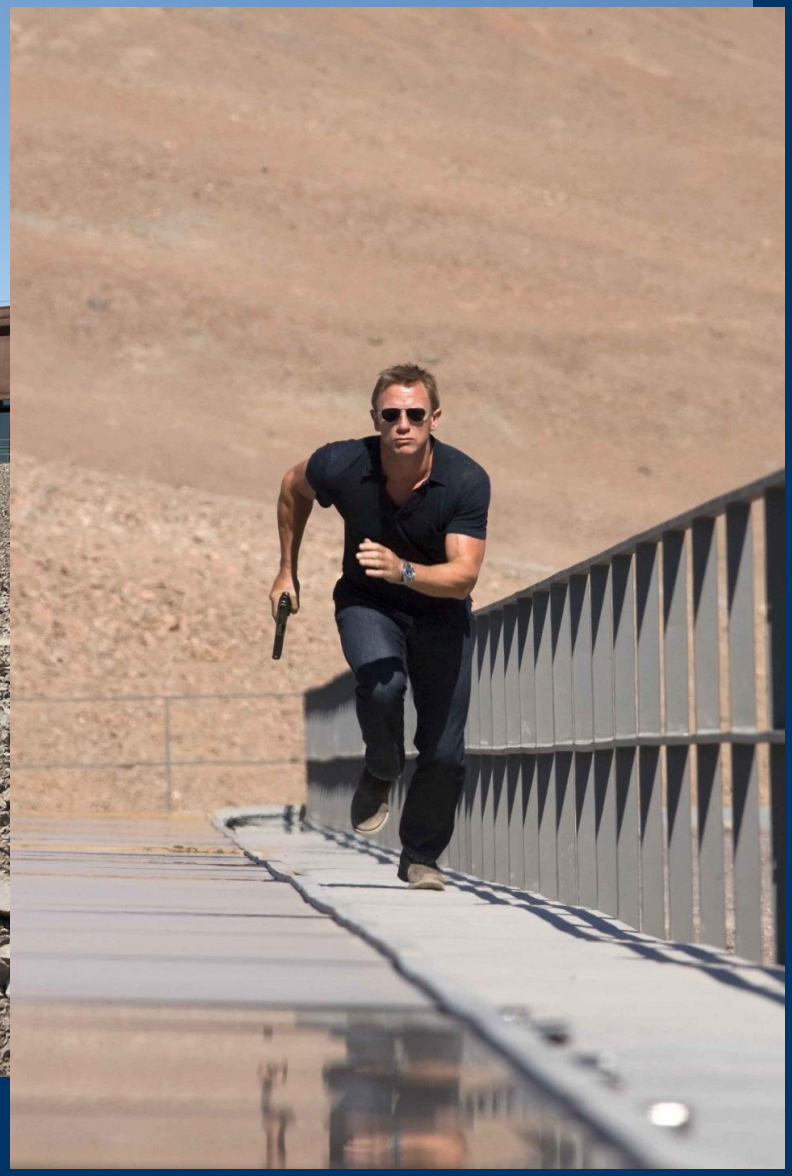
VLTs, ESO, Chile, Paranal



VLT / UVES

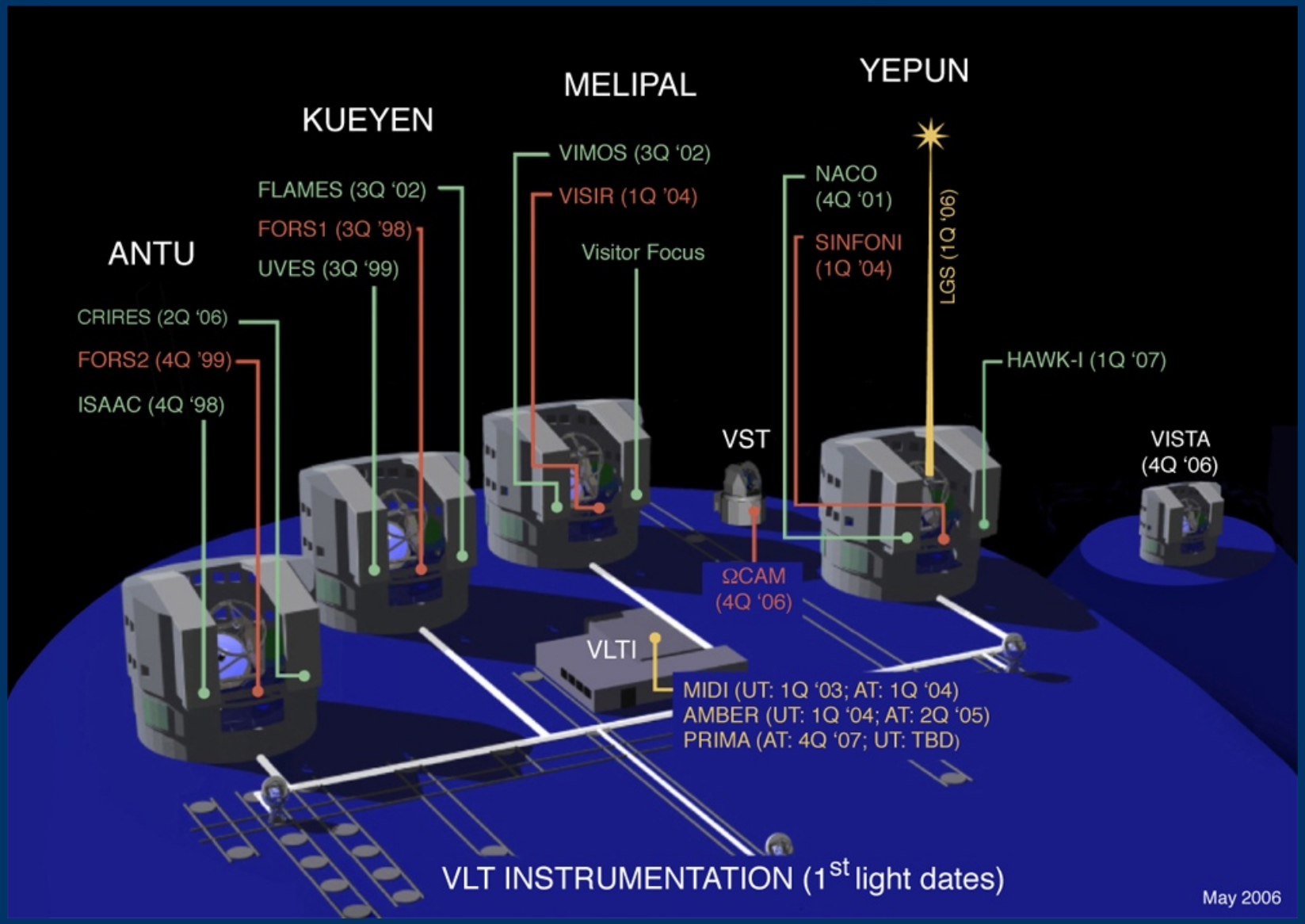
Ultraviolet and Visual Echelle Spectrograph

Star Track



VLT / UVES

Ultraviolet and Visual Echelle Spectrograph



Kueyen

VLT / UVES

xu23 134.171.226.93
DimmPlotTau0 – ASM Dimm Tau0
DimmPlotSeeing – ASM Dimm Seeing & Lossam
Seeing @ WL500nm/zenith [arcsec] with Quality
Seeing @ WL500nm/zenith [arcsec]
Rel flux var (loassam) [ratio]
asmDimm – @wasm
Seeing: 0.72 (arcsec)
from: 2011-10-31T09:21:09
RA: 91312 (hms)
Dec: -694302 (dms)
Airm: 1.50
MeteoPlotRH – ASM Meteo Rel Humidity
RH1 [%]: Relative Humidity at 30 m height
RH2 [%]: Relative Humidity at 2 m height
RH3 [%]: Relative Humidity below summit
RI1 [%]: Rain Intensity (%)
MeteoPlotTH – ASM Meteo Temperatures
TH1 [Celsius]: Temperature at 30 m height
TH2 [Celsius]: Temperature at 2 m height
MeteoPlotWS – ASM Meteo Wind Speed
WS1 [m/s]: Wind-speed at 30 m height
WS2 [m/s]: Wind-speed at 10 m height
MeteoPlotWD180 – ASM Meteo Wind Direction
Three
Four
Five
LogMonitor
DELL

VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

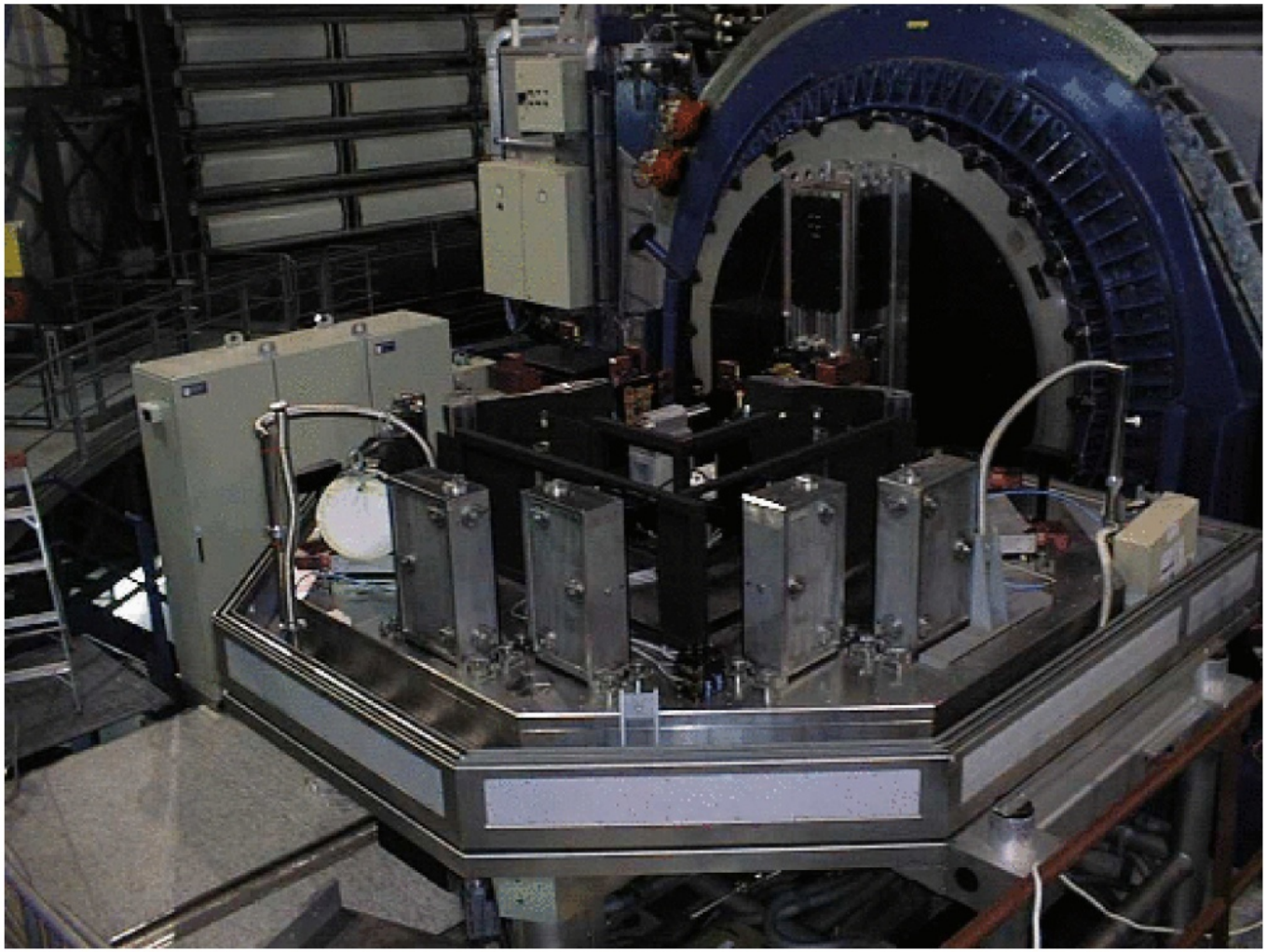
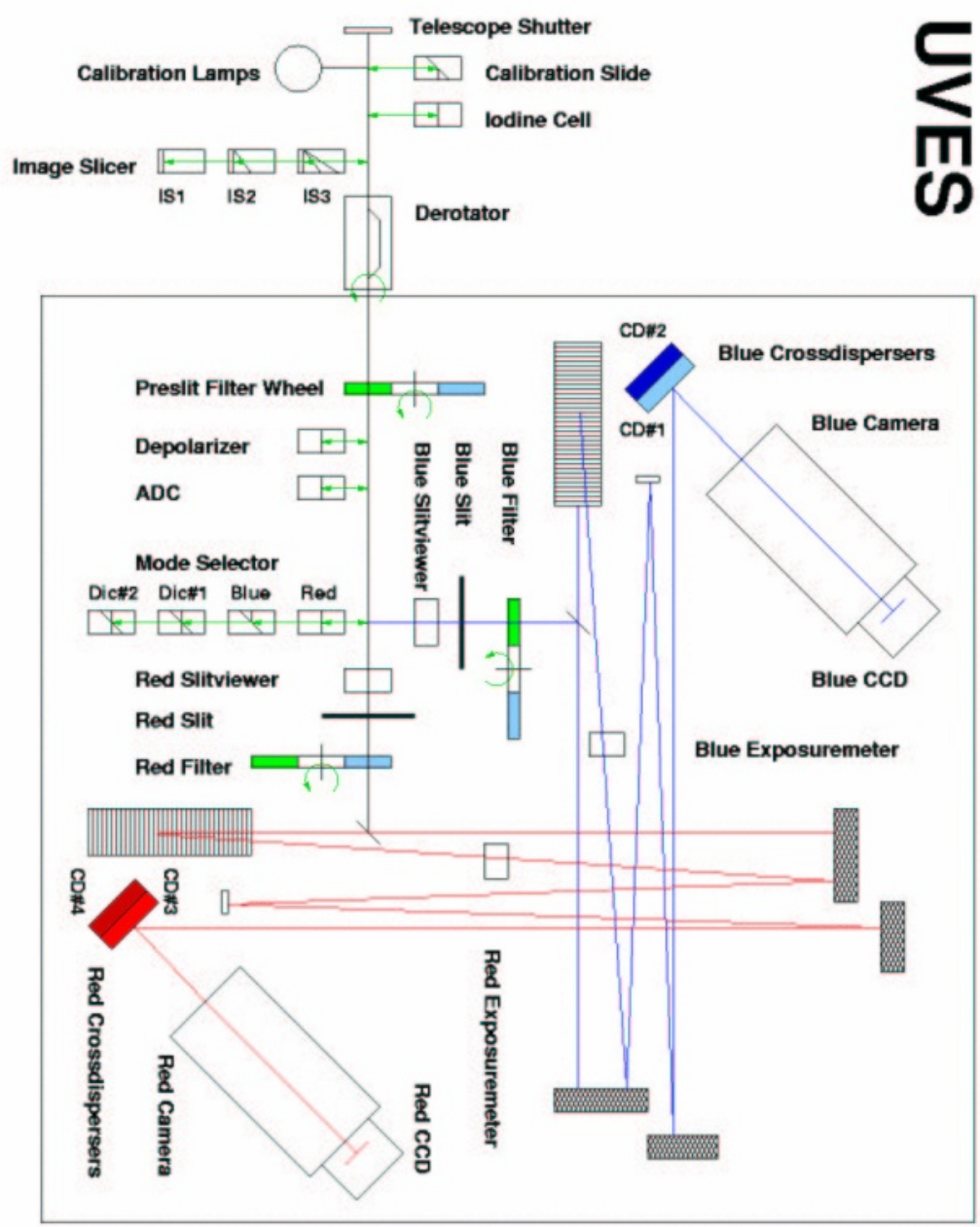


Figure 4.1.1: A photo of UVES mounted at the Nasmyth B focus of Kuyen (VLT-UT2).


UVES
Telescope Shutter
Calibration Lamps
Calibration Slide
Iodine Cell
Image Slicer
IS1
IS2
IS3
Derotator
Preslit Filter Wheel
Depolarizer
ADC
Mode Selector
Dic#2
Dic#1
Blue
Red
Red Slitviewer
Red Slit
Red Filter
Blue Slitviewer
Blue Slit
Blue Filter
CD#2
CD#1
Blue Crossdispersers
Blue Camera
Blue CCD
Blue Exposuremeter
CD#4
CD#3
Red Crossdispersers
Red Camera
Red CCD
Red Exposuremeter

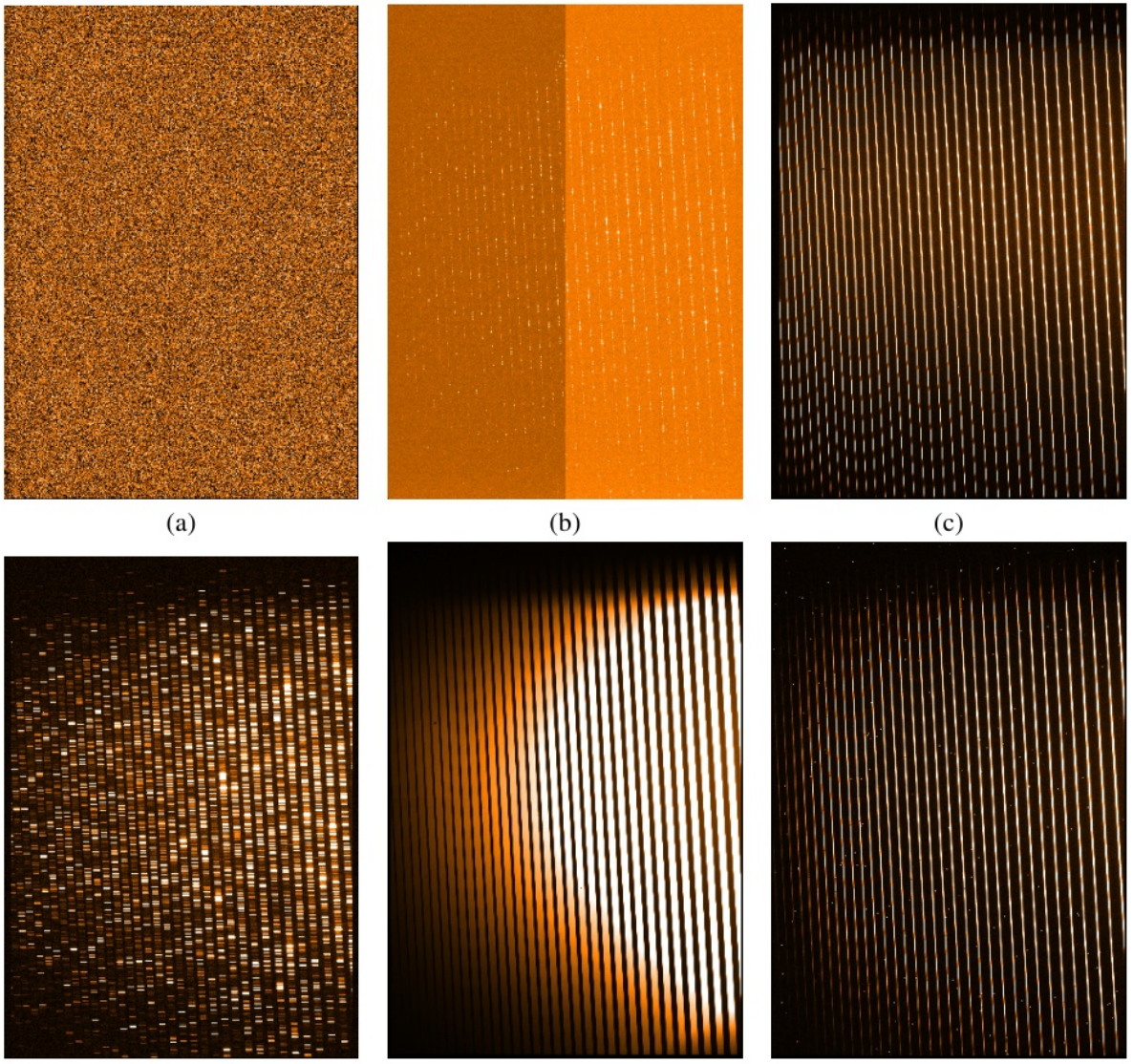
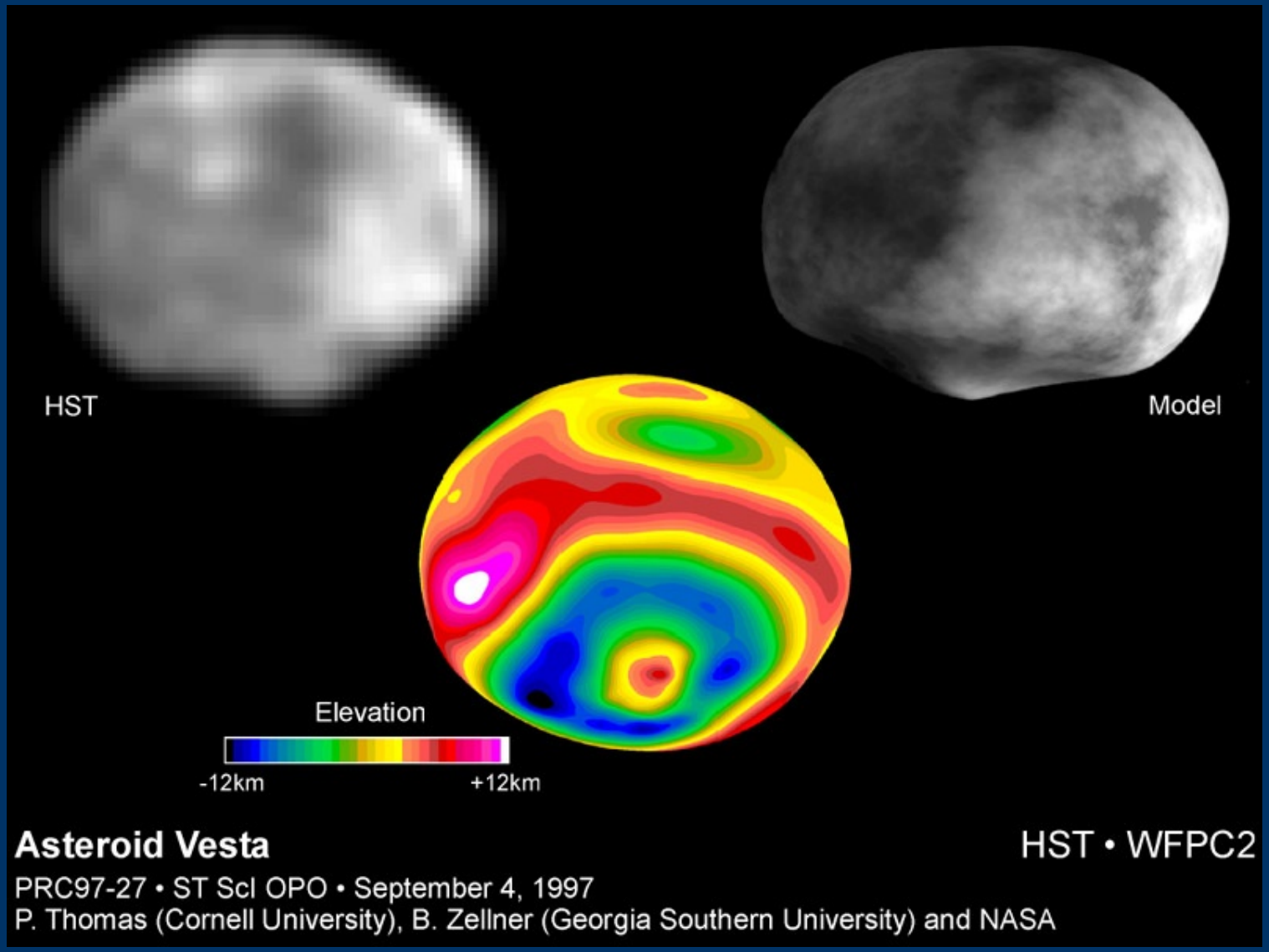


Figure 7.9.0: (a) a raw bias frame; (b) a raw format check frame; (c) a raw order frame; (d) a raw arc lamp frame; (e) a raw flatfield frame; (f) a raw std star frame.

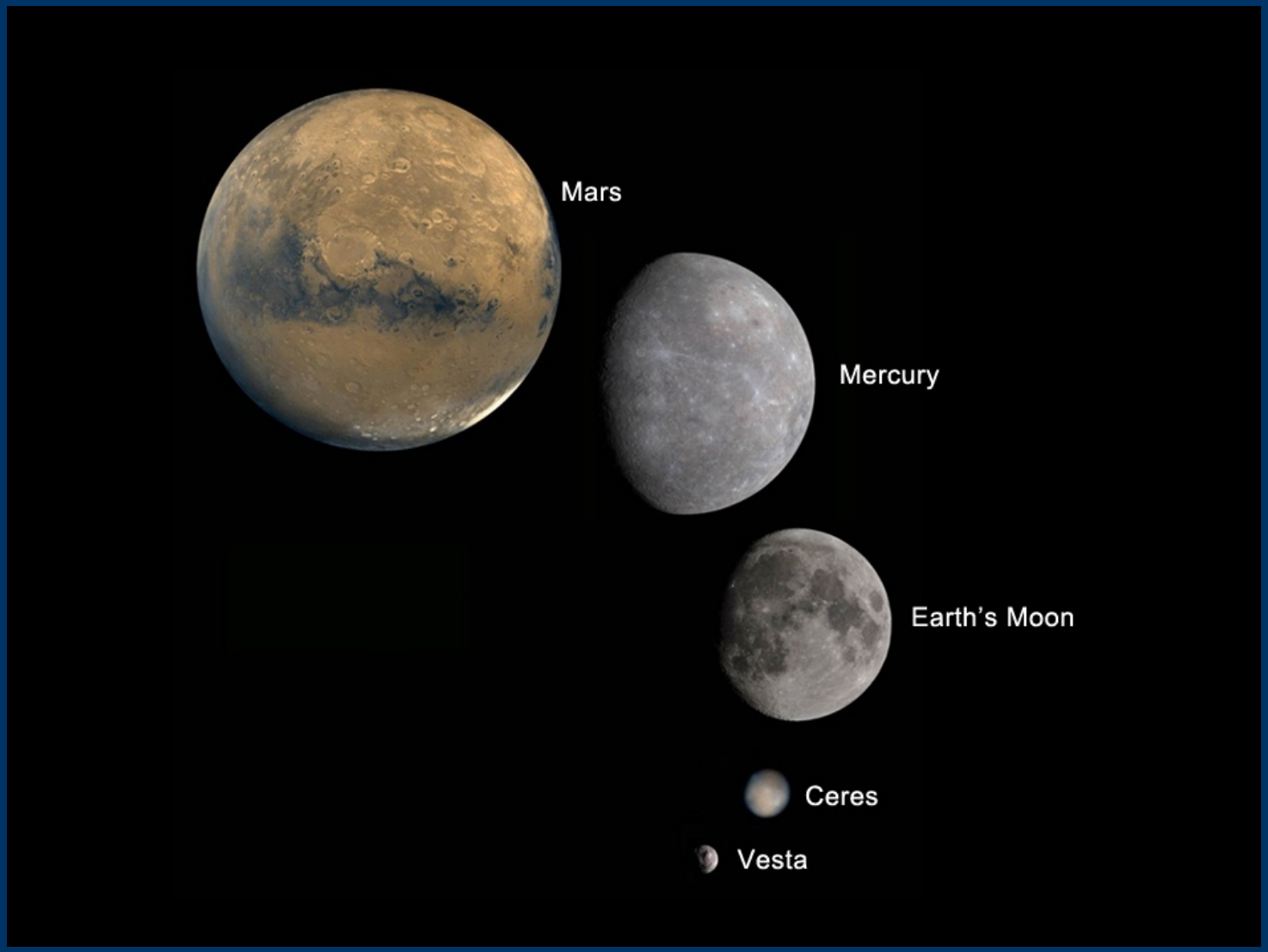
VLT / UVES

Ultraviolet and Visual Echelle Spectrograph



VLT / UVES

Ultraviolet and Visual Echelle Spectrograph



VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

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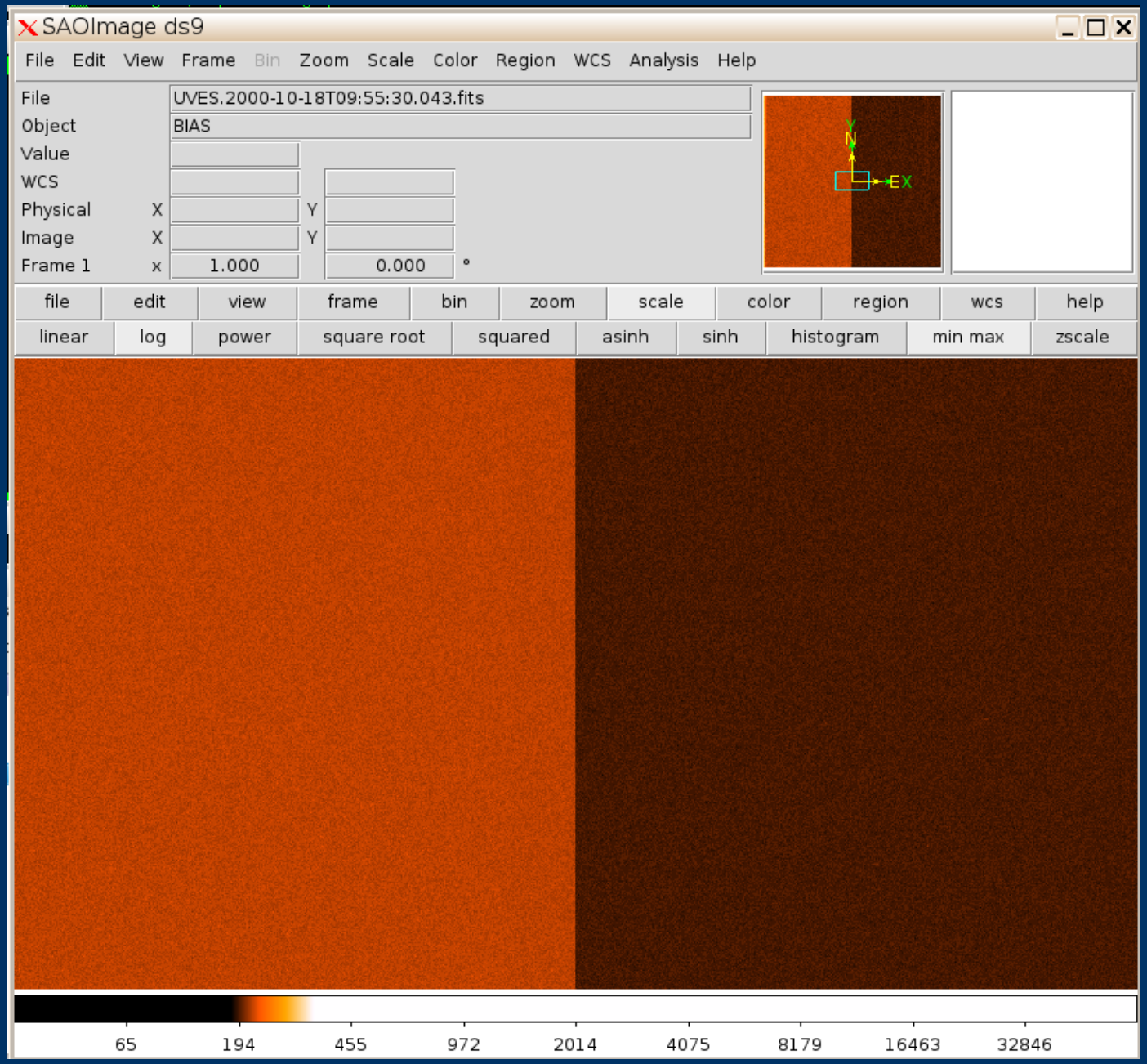
UVES.2000-10-17T13:39:29.724.fits
UVES.2000-10-17T13:40:41.000.fits
UVES.2000-10-17T13:41:52.587.fits
UVES.2000-10-17T13:43:03.754.fits
UVES.2000-10-17T13:44:15.218.fits
UVES.2000-10-18T00:00:49.456.fits
UVES.2000-10-18T09:55:30.043.fits
UVES.2000-10-18T09:56:19.900.fits
UVES.2000-10-18T09:57:09.751.fits
UVES.2000-10-18T09:57:59.604.fits
UVES.2000-10-18T09:58:49.448.fits
UVES.2000-10-18T11:26:13.456.fits
```

UVES data for Vesta observations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File UVES.2000-10-18T09:55:30.043.fits
Object BIAS
Value
WCS
Physical X Y
Image X Y
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E
file edit view frame bin zoom scale color region wcs help
linear log power square root squared asinh sinh histogram min max zscale
65 194 455 972 2014 4075 8179 16463 32846

BIAS frame

VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

```
UVES.2000-10-17T13:39:29.724.fits
UVES.2000-10-17T13:40:41.000.fits
UVES.2000-10-17T13:41:52.587.fits
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UVES.2000-10-18T00:00:49.456.fits
UVES.2000-10-18T09:55:30.043.fits BIAS
UVES.2000-10-18T09:56:19.900.fits BIAS
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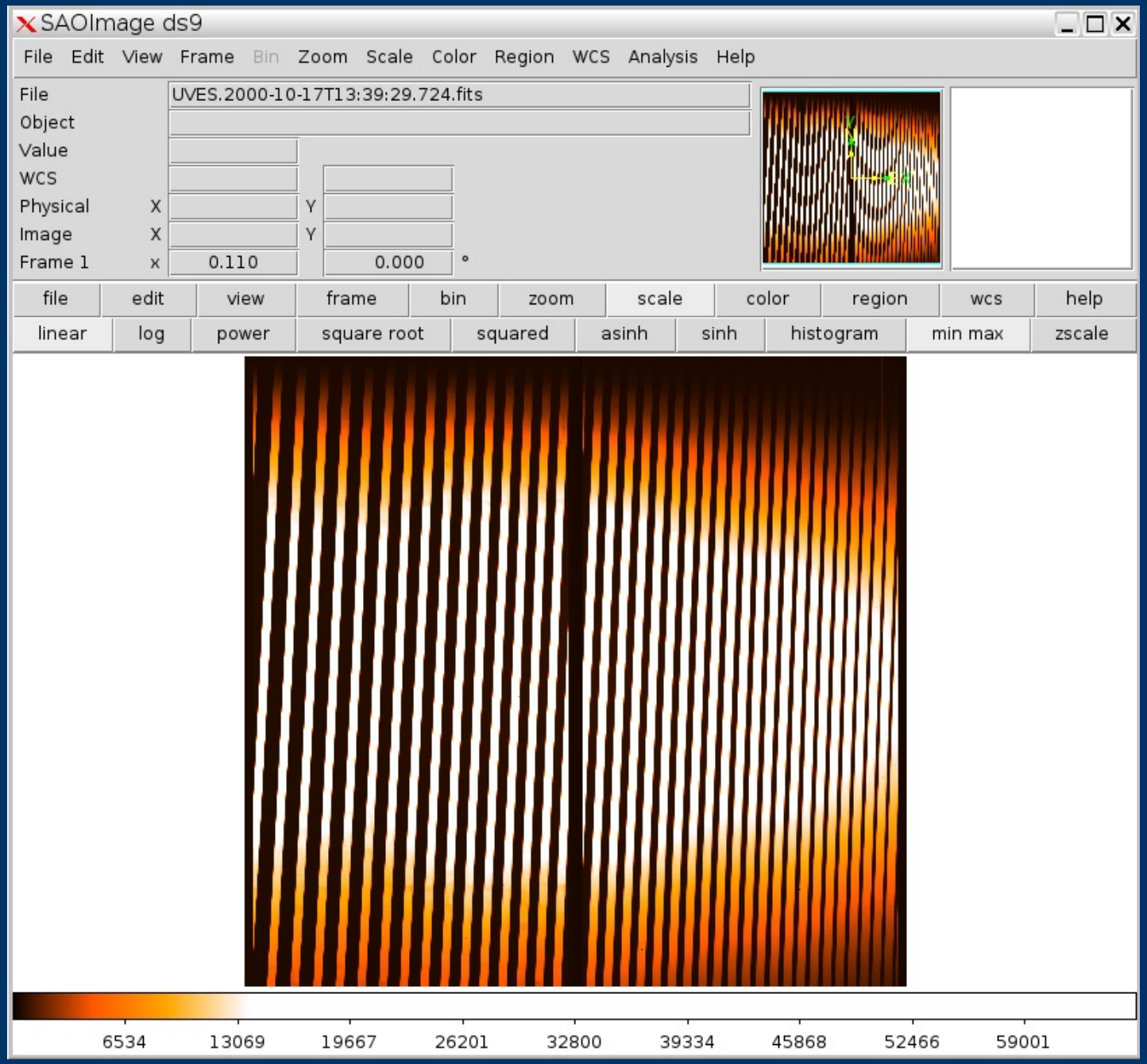
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linear log power square root squared asinh sinh histogram min max zscale
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VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

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UVES.2000-10-18T00:00:49.456.fits
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UVES.2000-10-18T09:56:19.900.fits BIAS
UVES.2000-10-18T09:57:09.751.fits BIAS
UVES.2000-10-18T09:57:59.604.fits BIAS
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Several FLAT fields

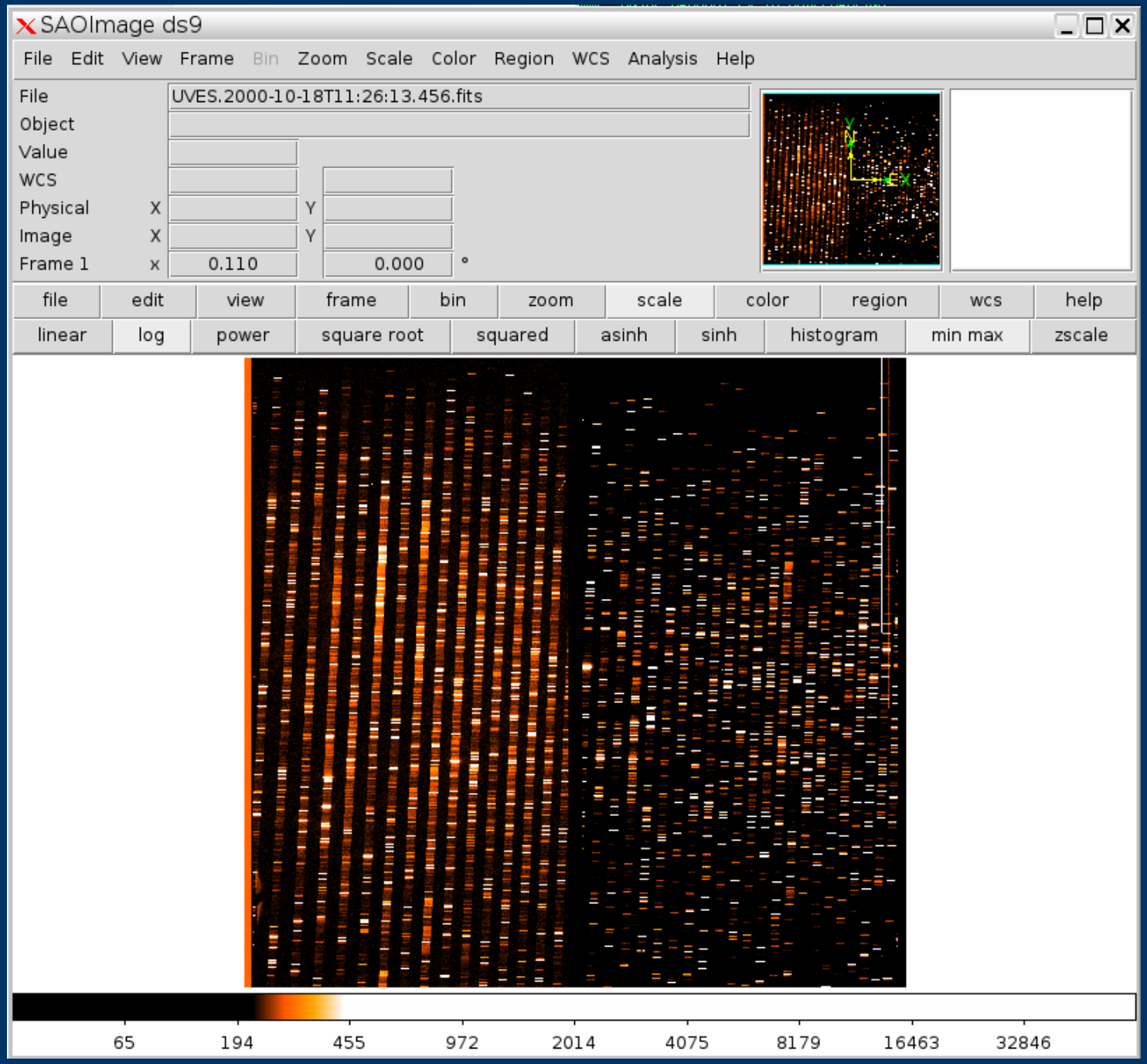
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Image X Y
Frame 1 x 0.110 0.000 °
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linear log power square root squared asinh sinh histogram min max zscale
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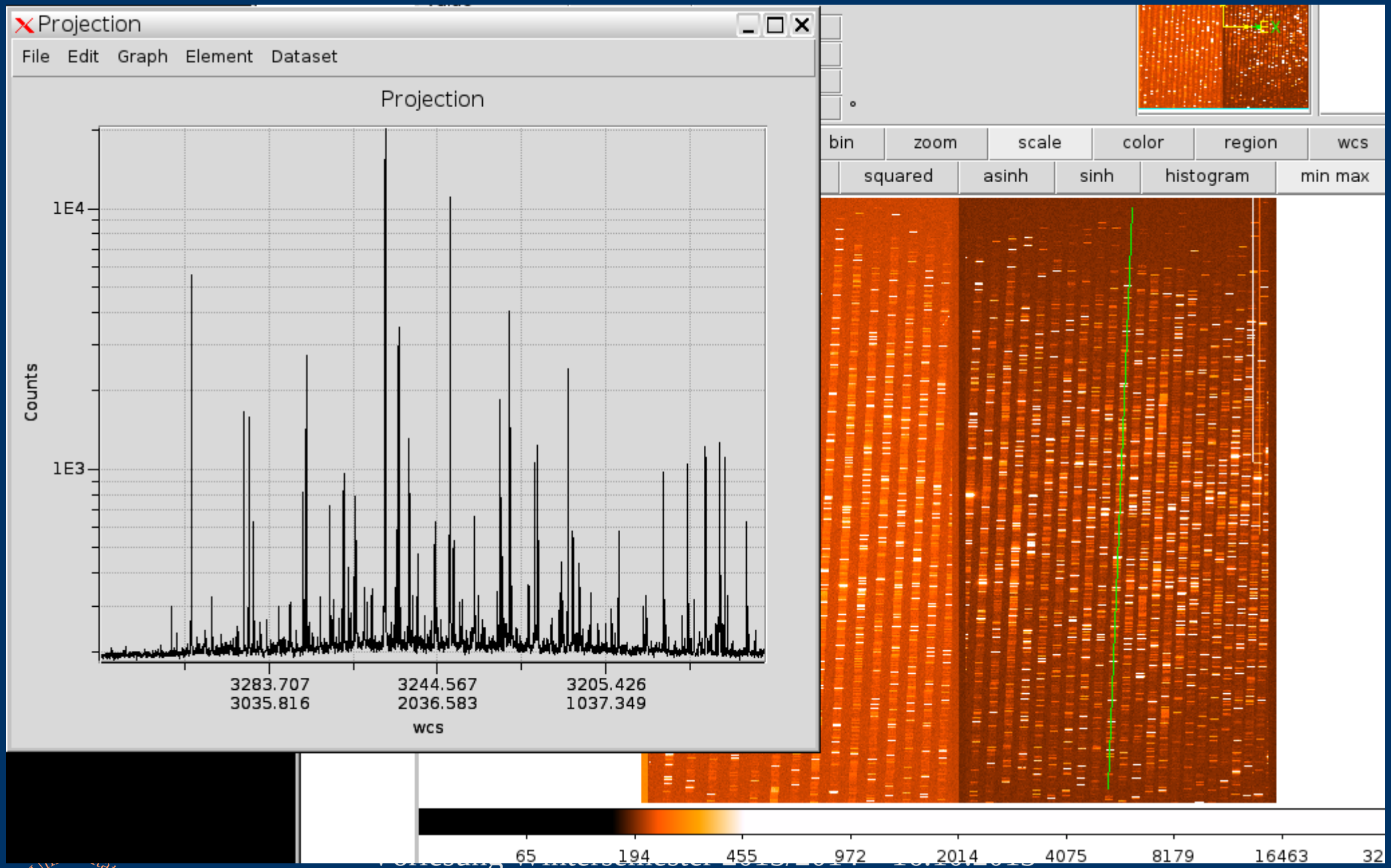
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bin zoom scale color region wcs
squared asinh sinh histogram min max
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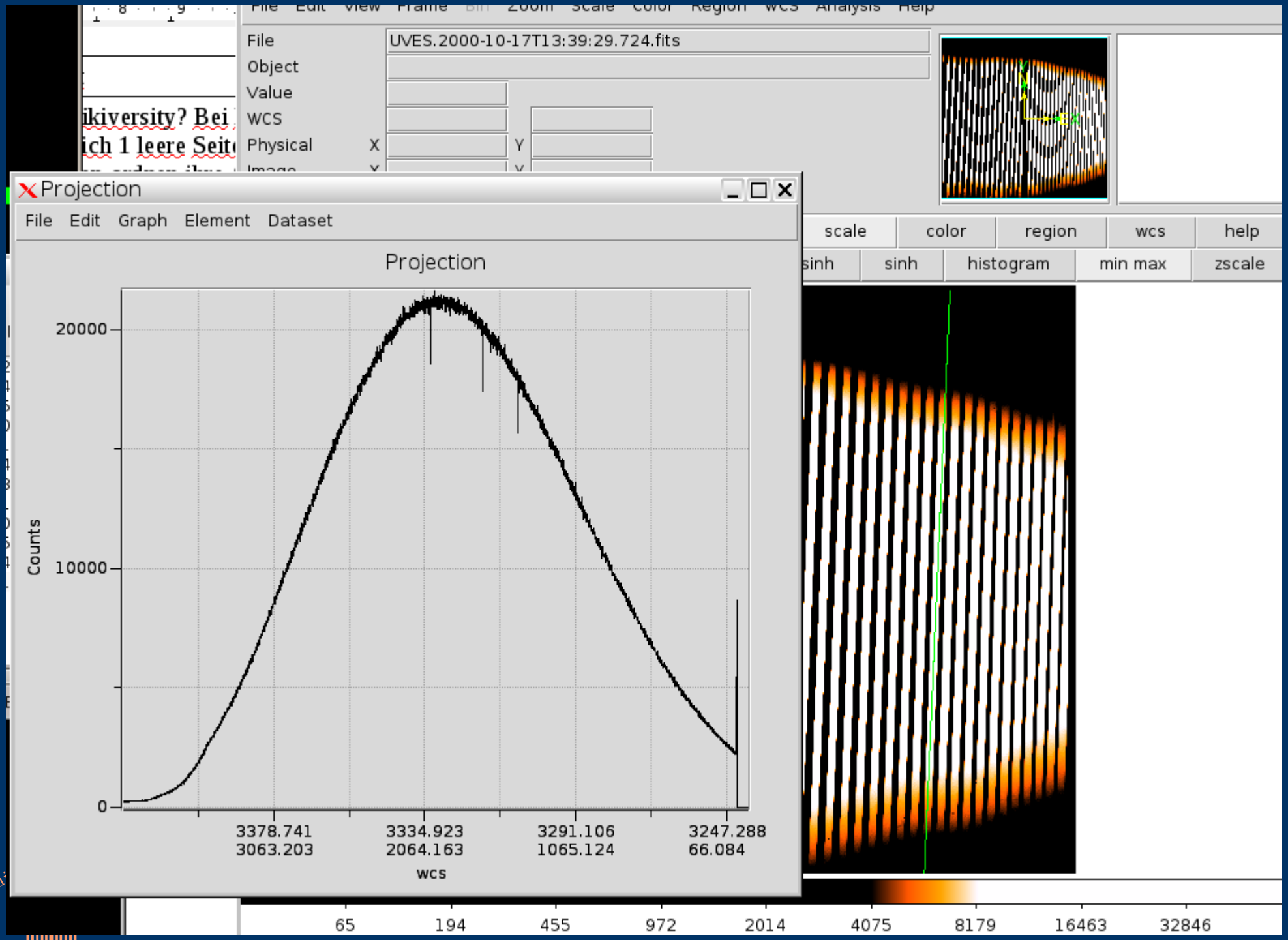
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Y
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color
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wcs
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histogram
min max
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Projection
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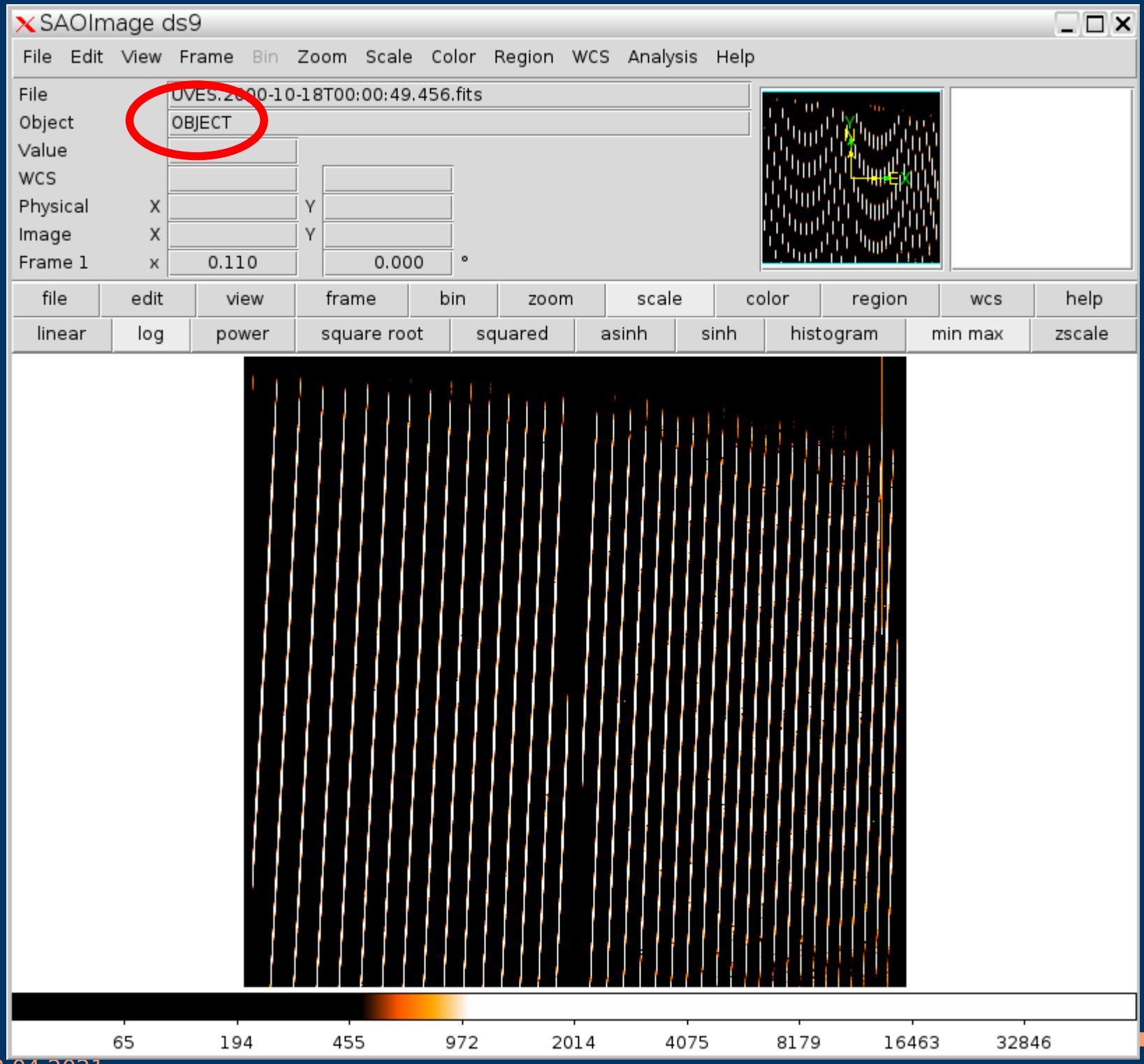
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Image X Y
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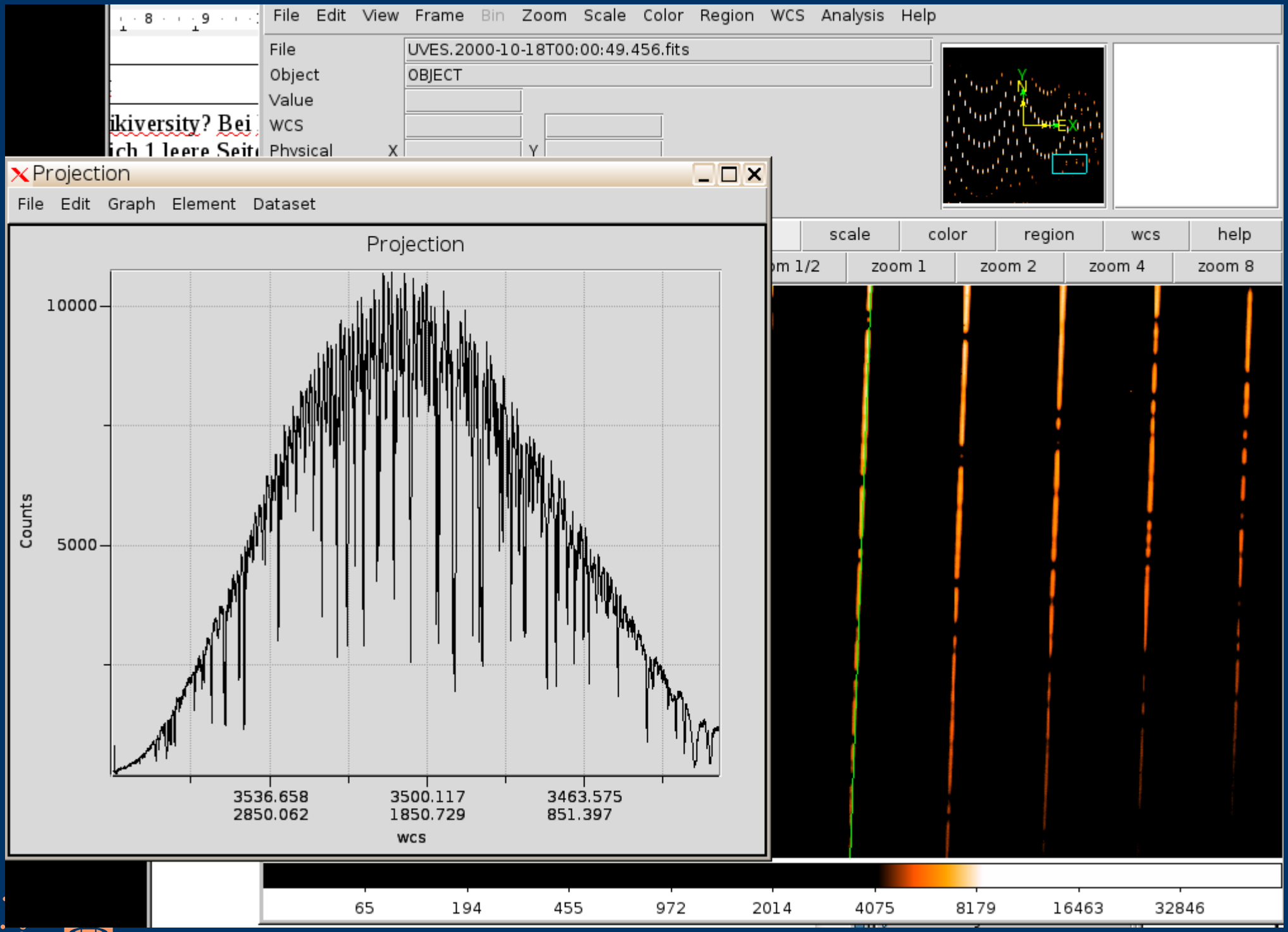
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VLT / UVES

Ultraviolet and Visual Echelle Spectrograph

```
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UVES.2000-10-17T13:40:41.000.fits FLAT
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UVES.2000-10-17T13:43:03.754.fits FLAT
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UVES.2000-10-18T09:55:30.043.fits BIAS
UVES.2000-10-18T09:56:19.900.fits BIAS
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UVES.2000-10-18T09:57:59.604.fits BIAS
UVES.2000-10-18T09:58:49.448.fits BIAS
UVES.2000-10-18T11:26:13.456.fits CALIB
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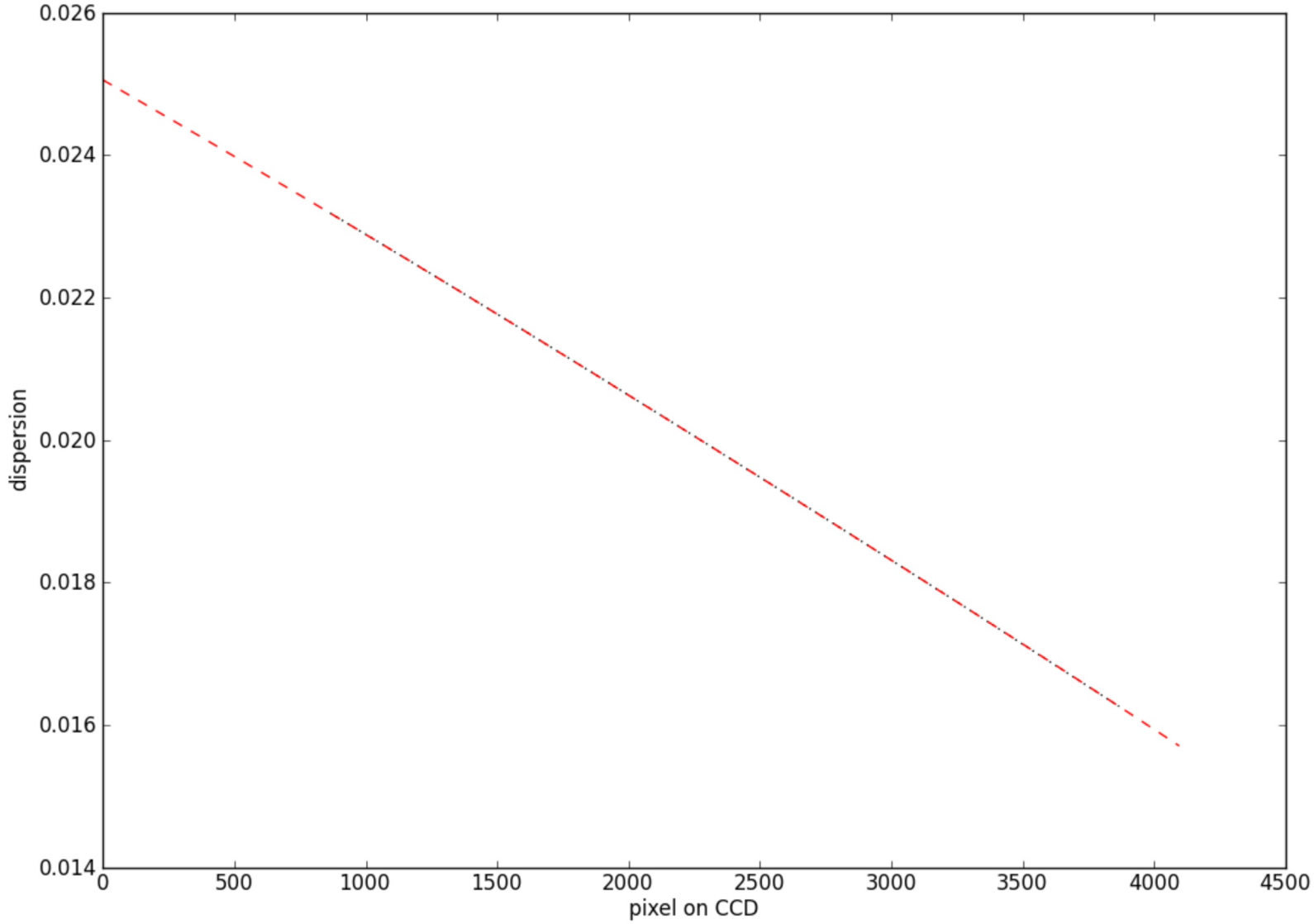
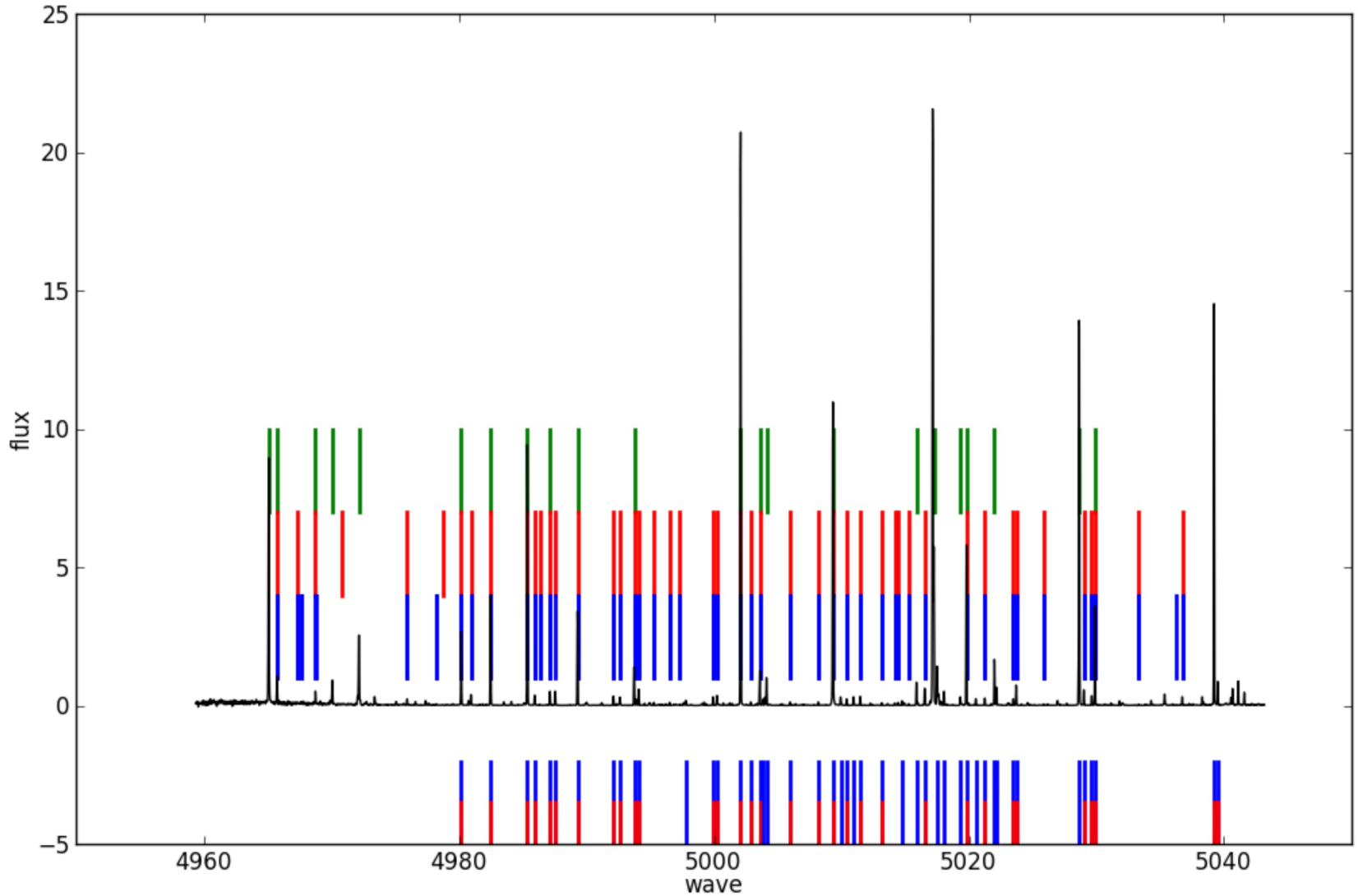
Required files for a single science exposure.



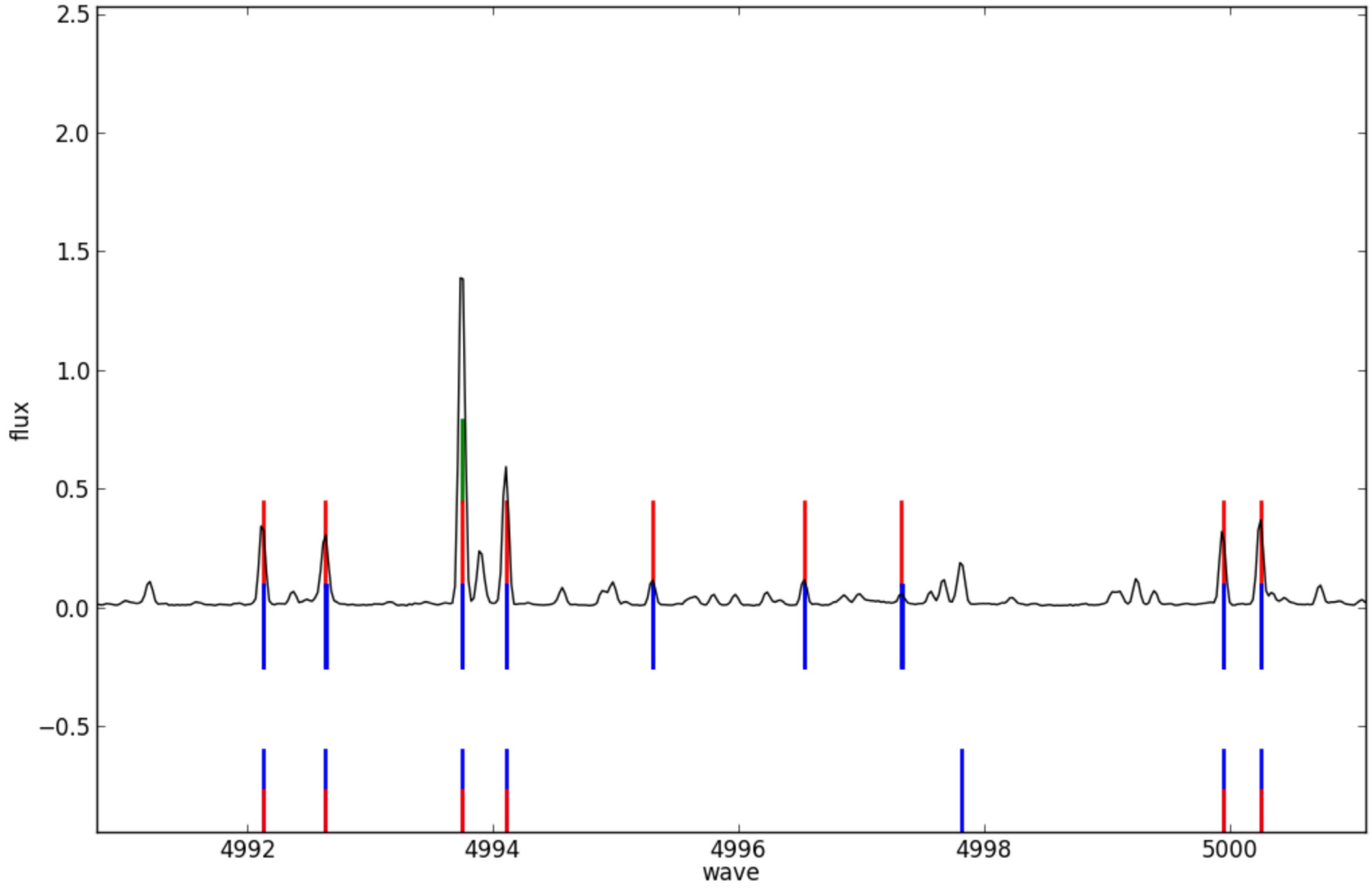
Dispersions Relation (projezierte Groesse)



calibration spectrum, ThAr lines from database, ONE Echelle order

best guess

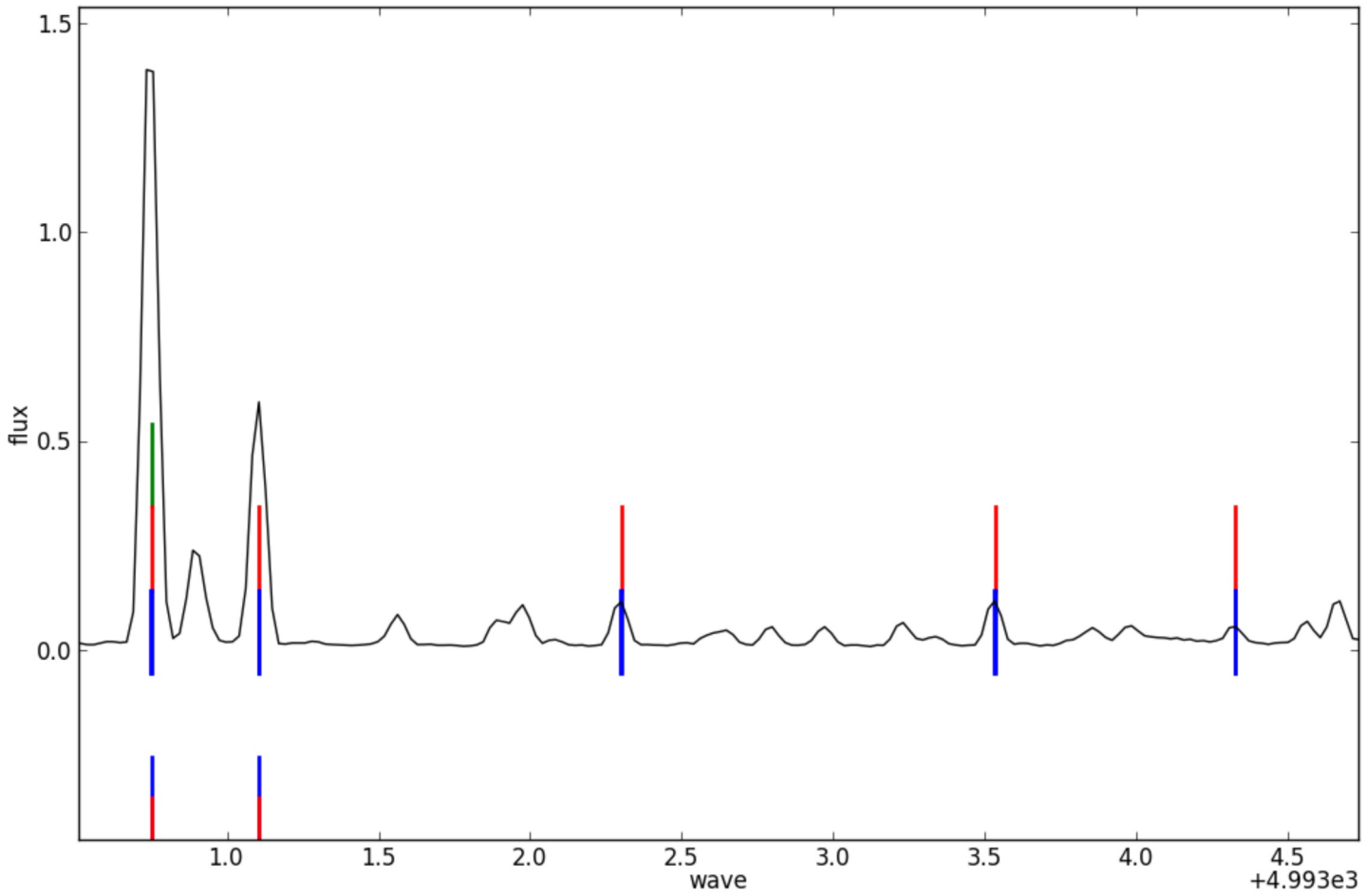
calibration spectrum, ThAr lines from database, ONE Echelle order

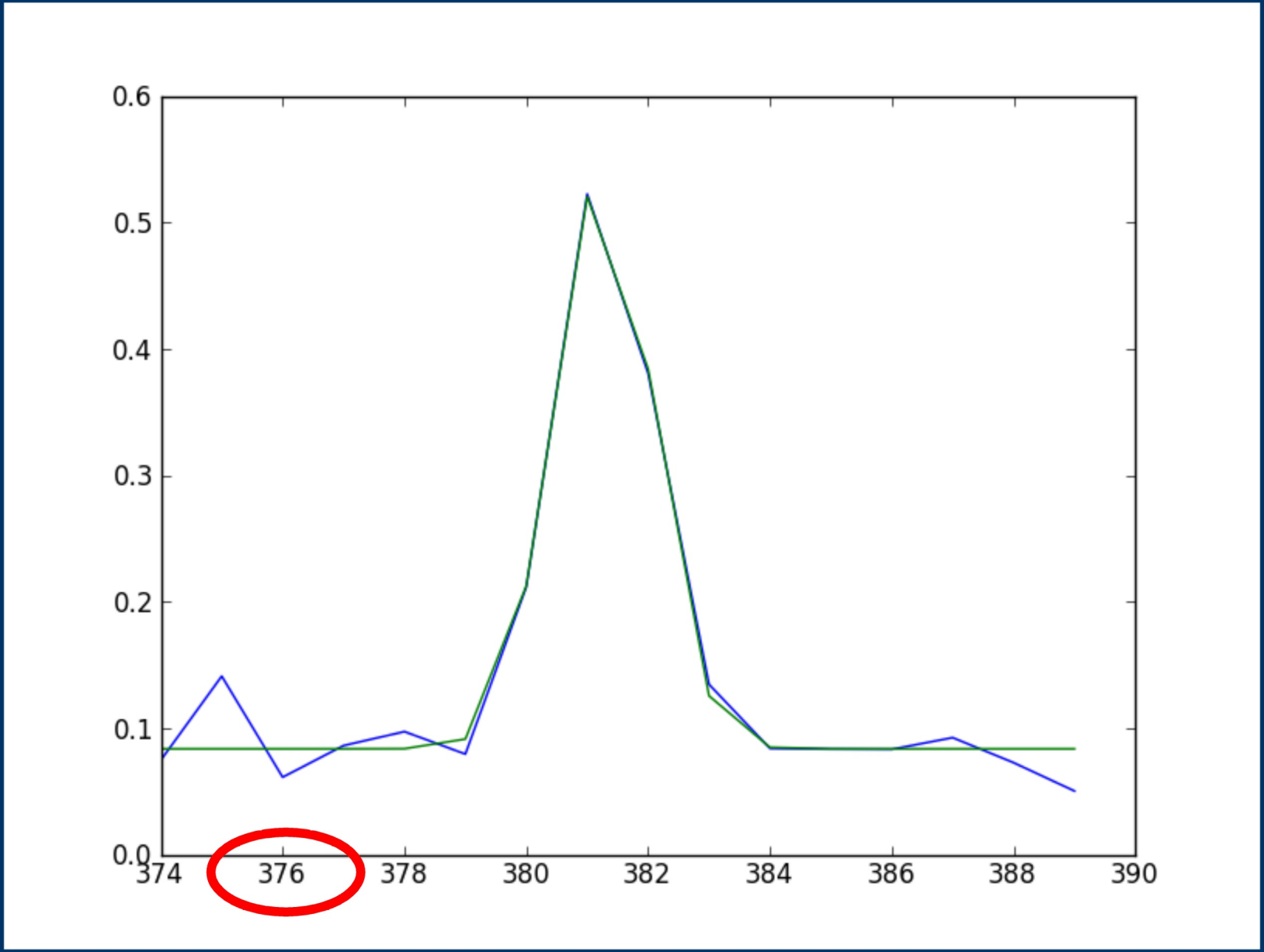


identified ThAr lines

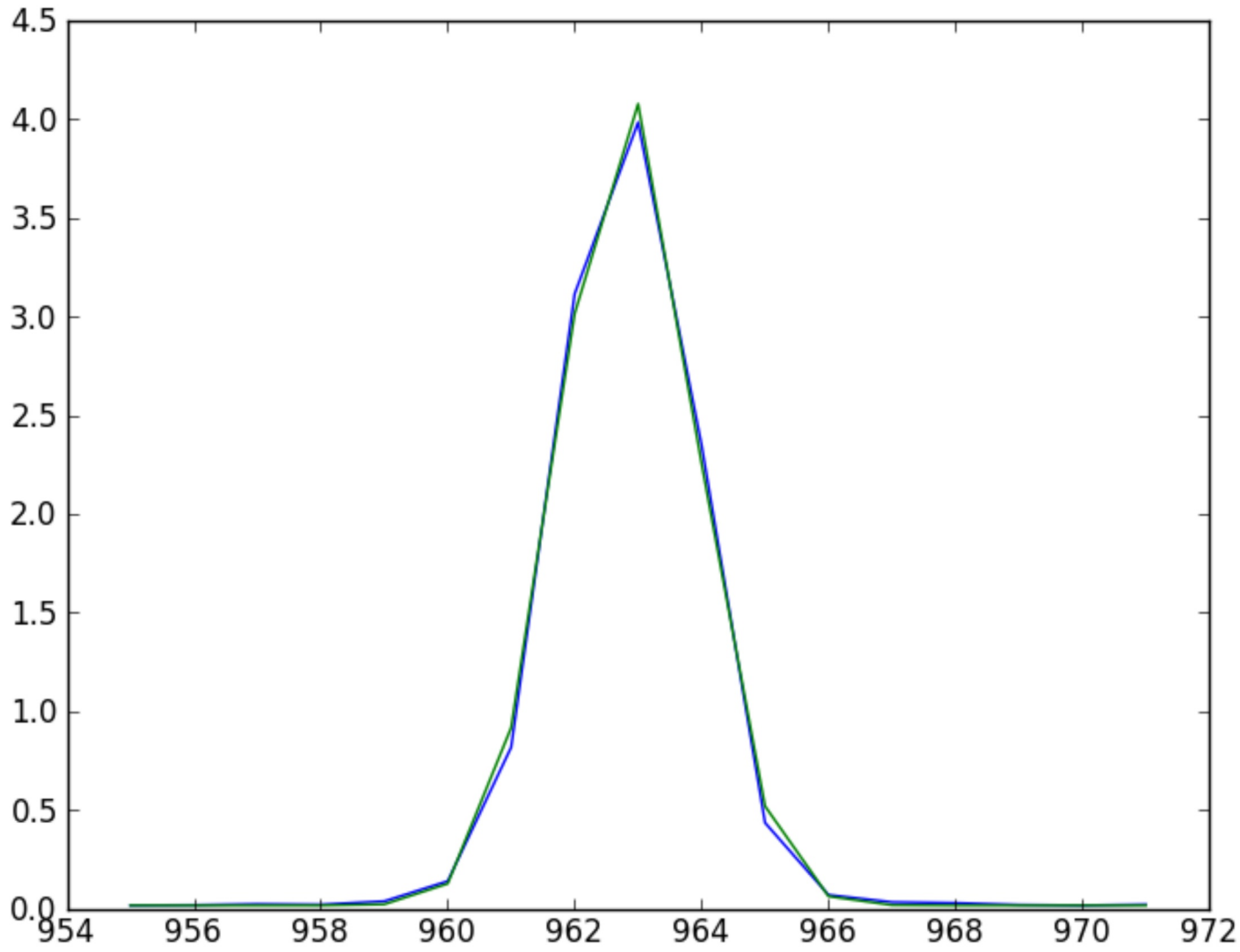
VLT / UVES

Ultraviolet and Visual Echelle Spectrograph





Gaussian fit in PIXEL space!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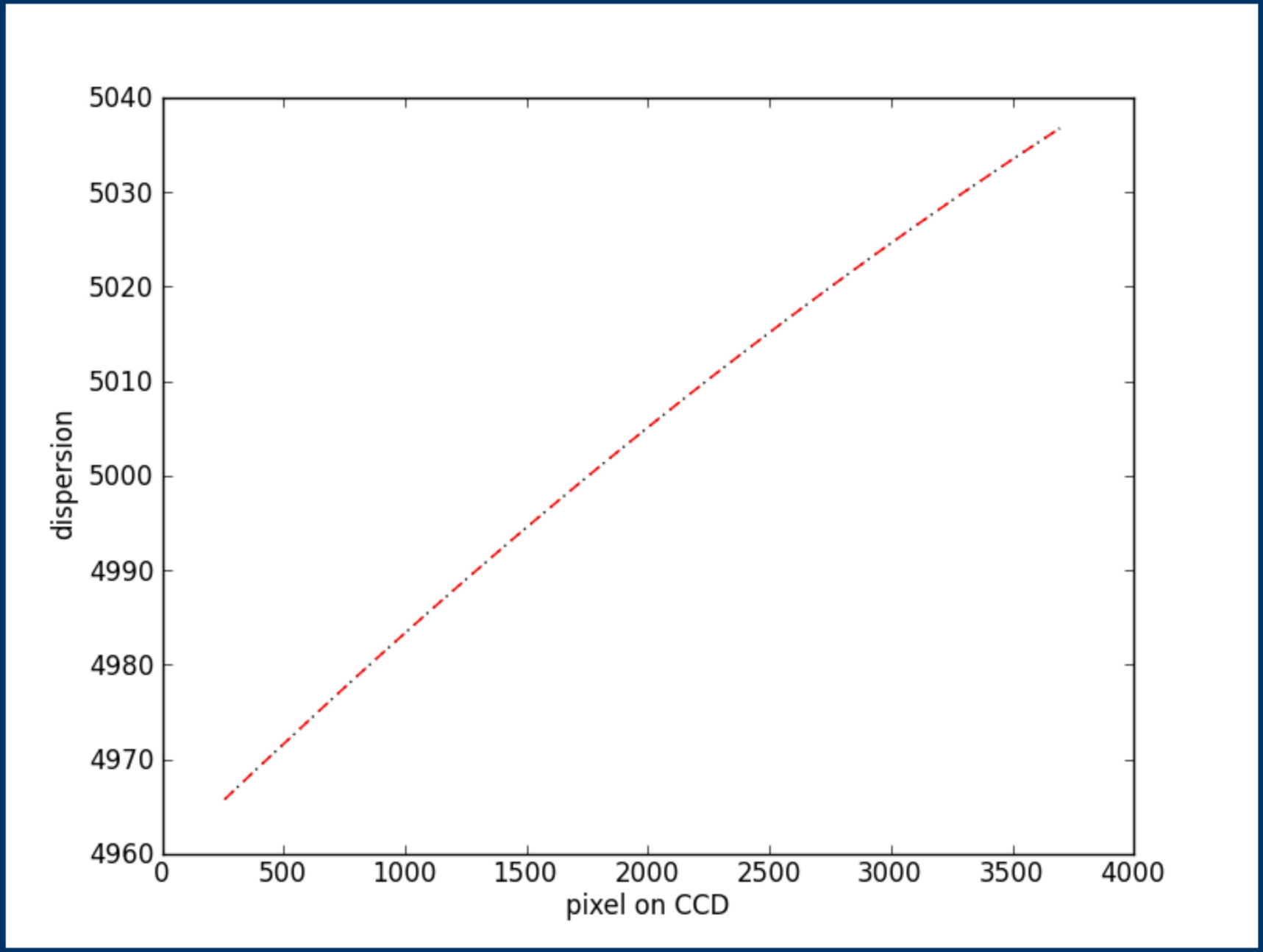
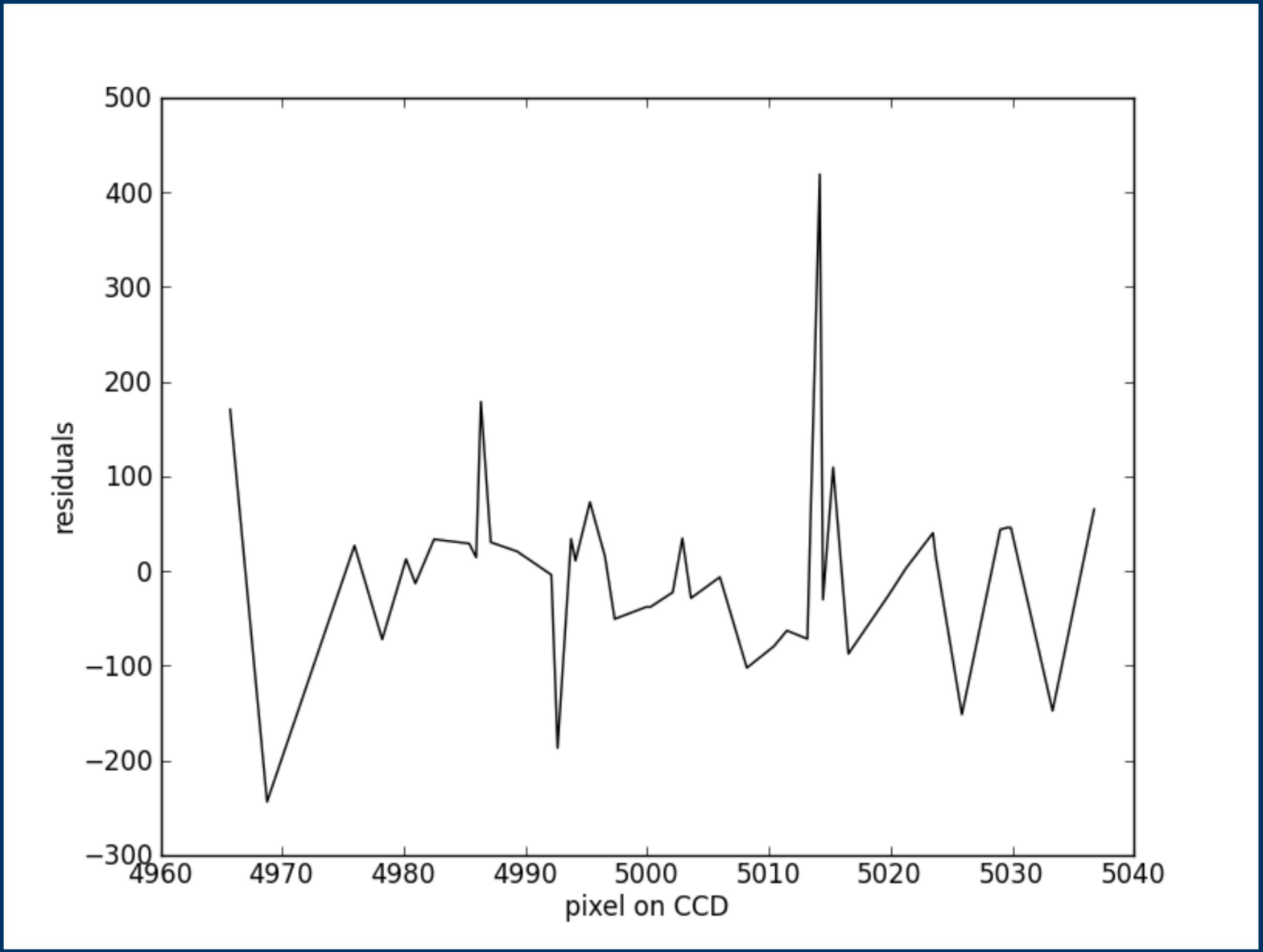
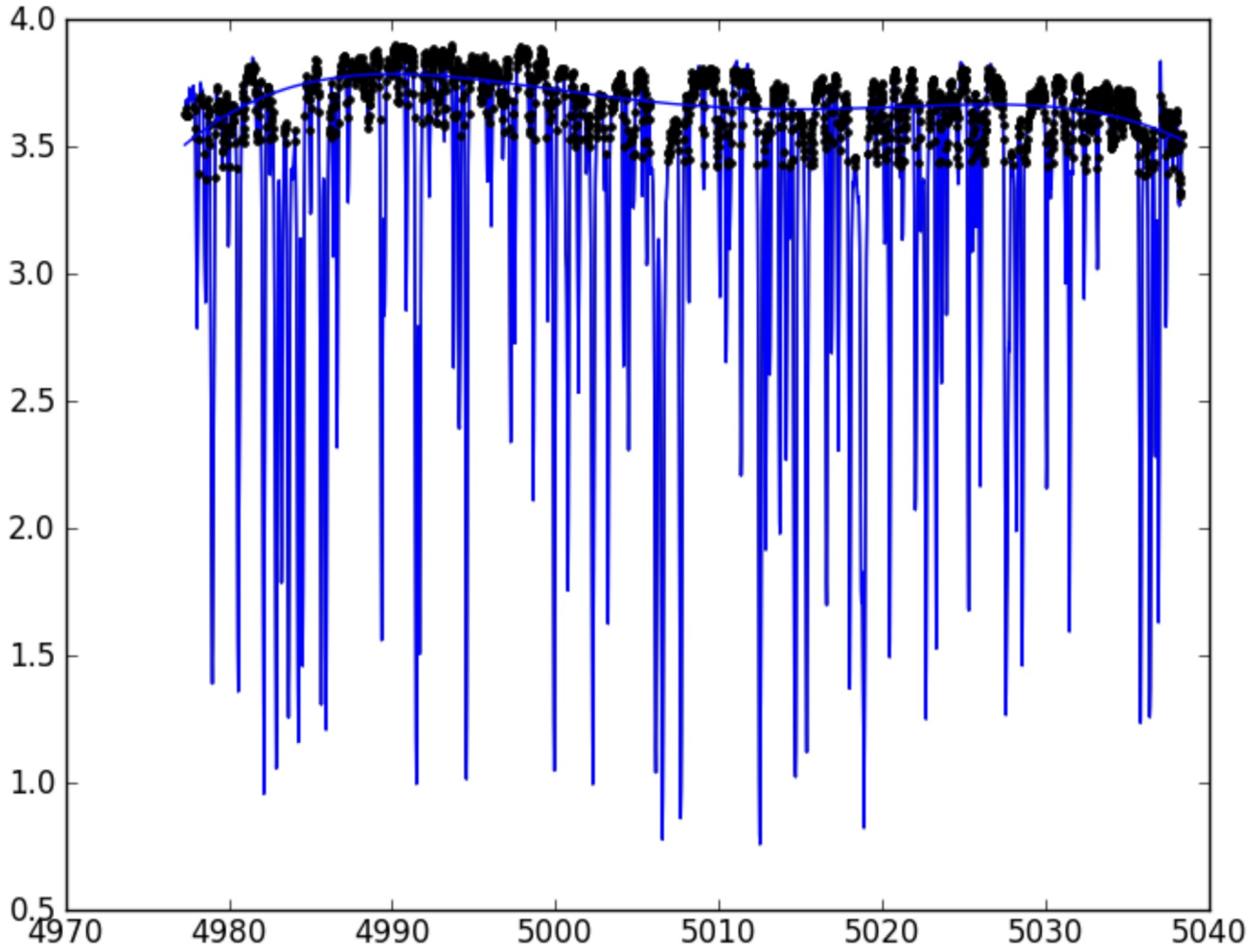


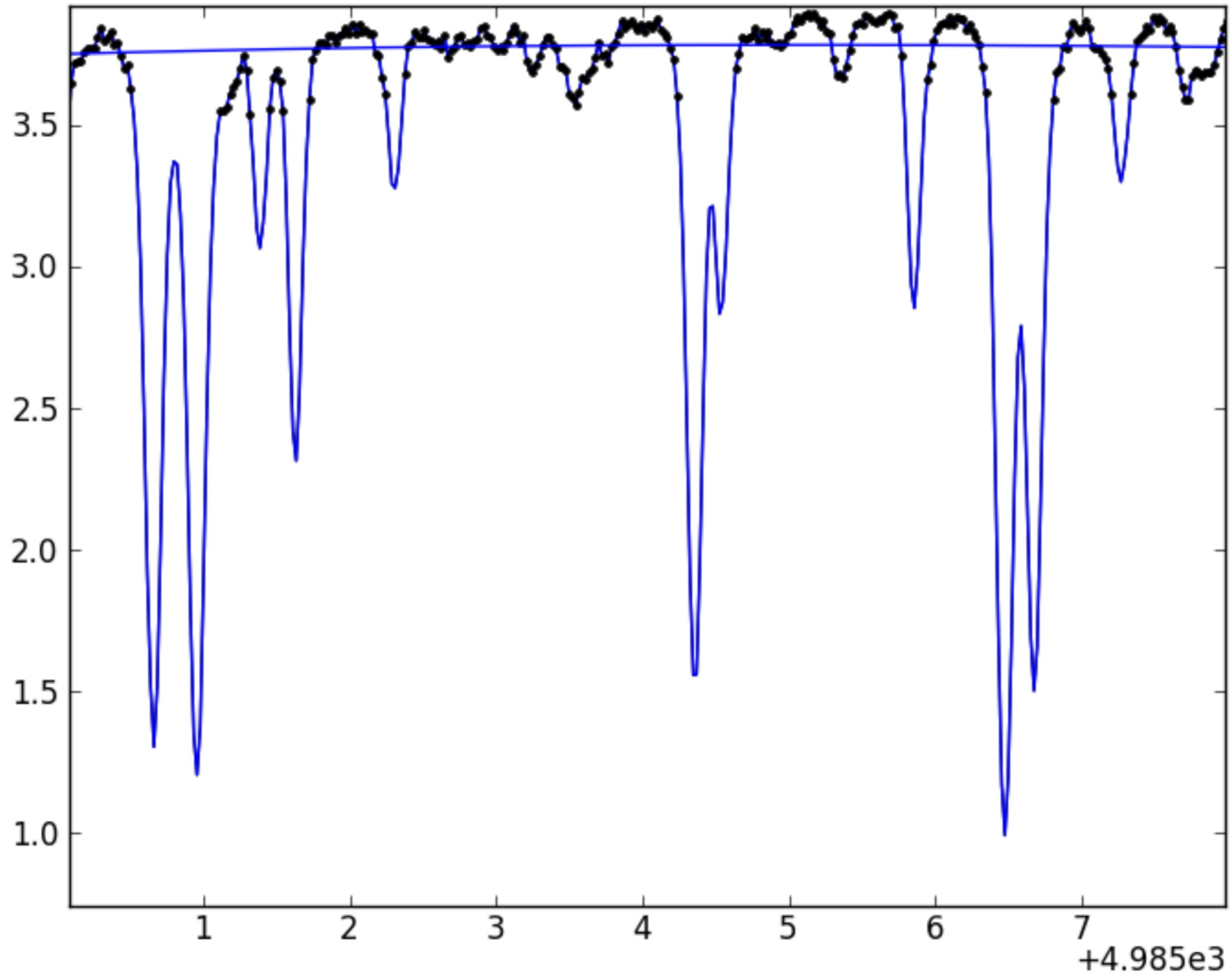
Wavelength – pixel relation



Residuals for measured ThAr lines from Polynomial fit in m/s.



Extracted, corrected order with continuum fit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7
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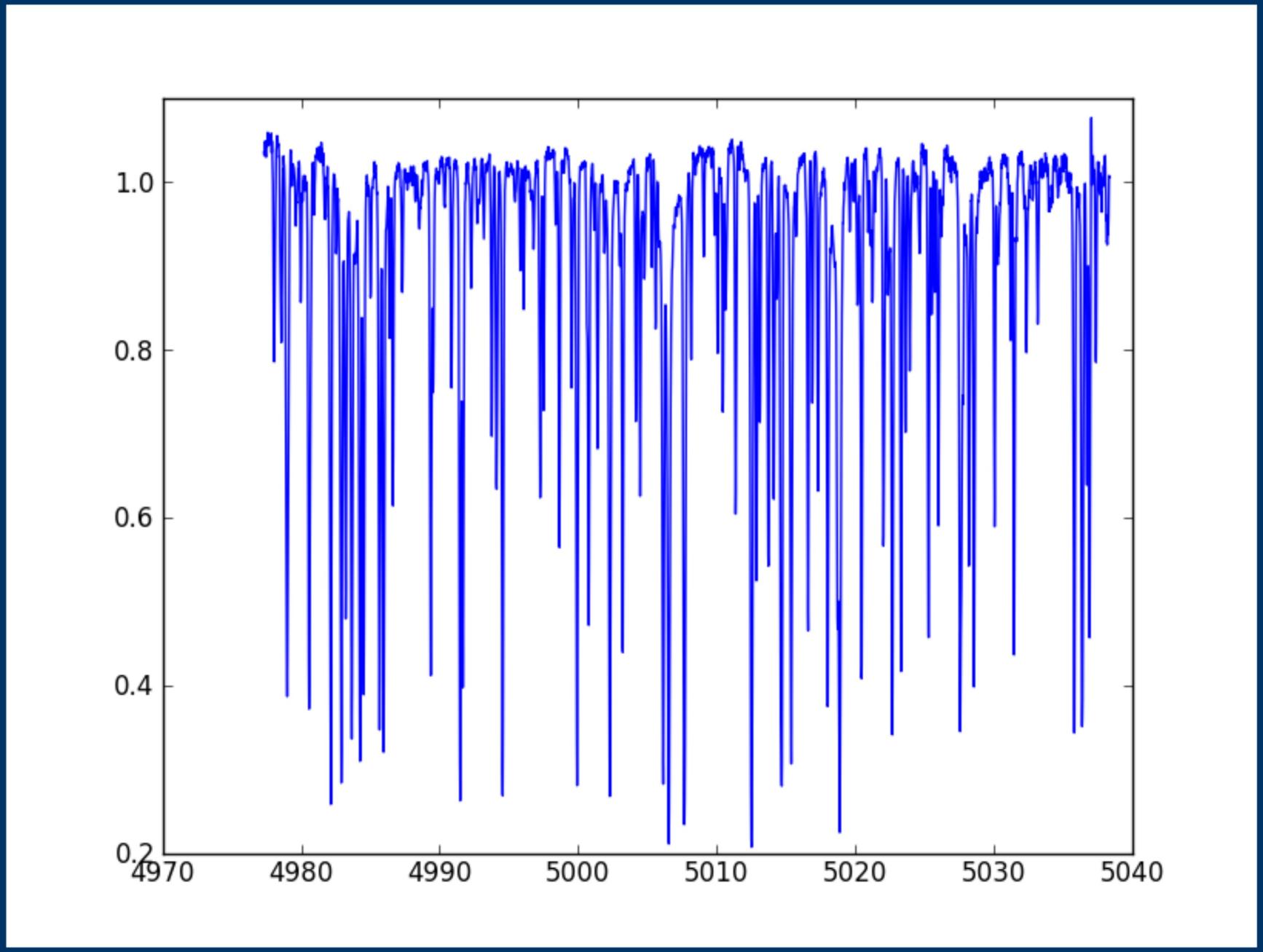
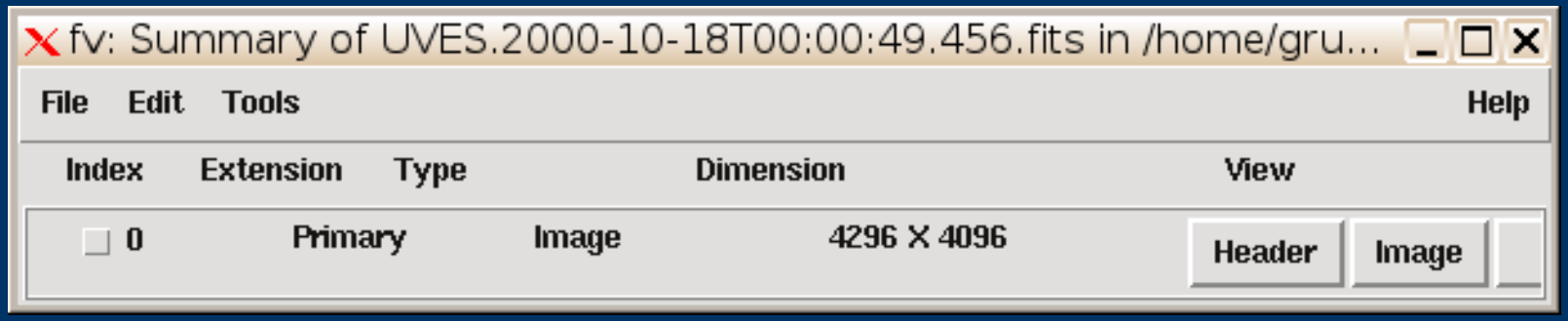


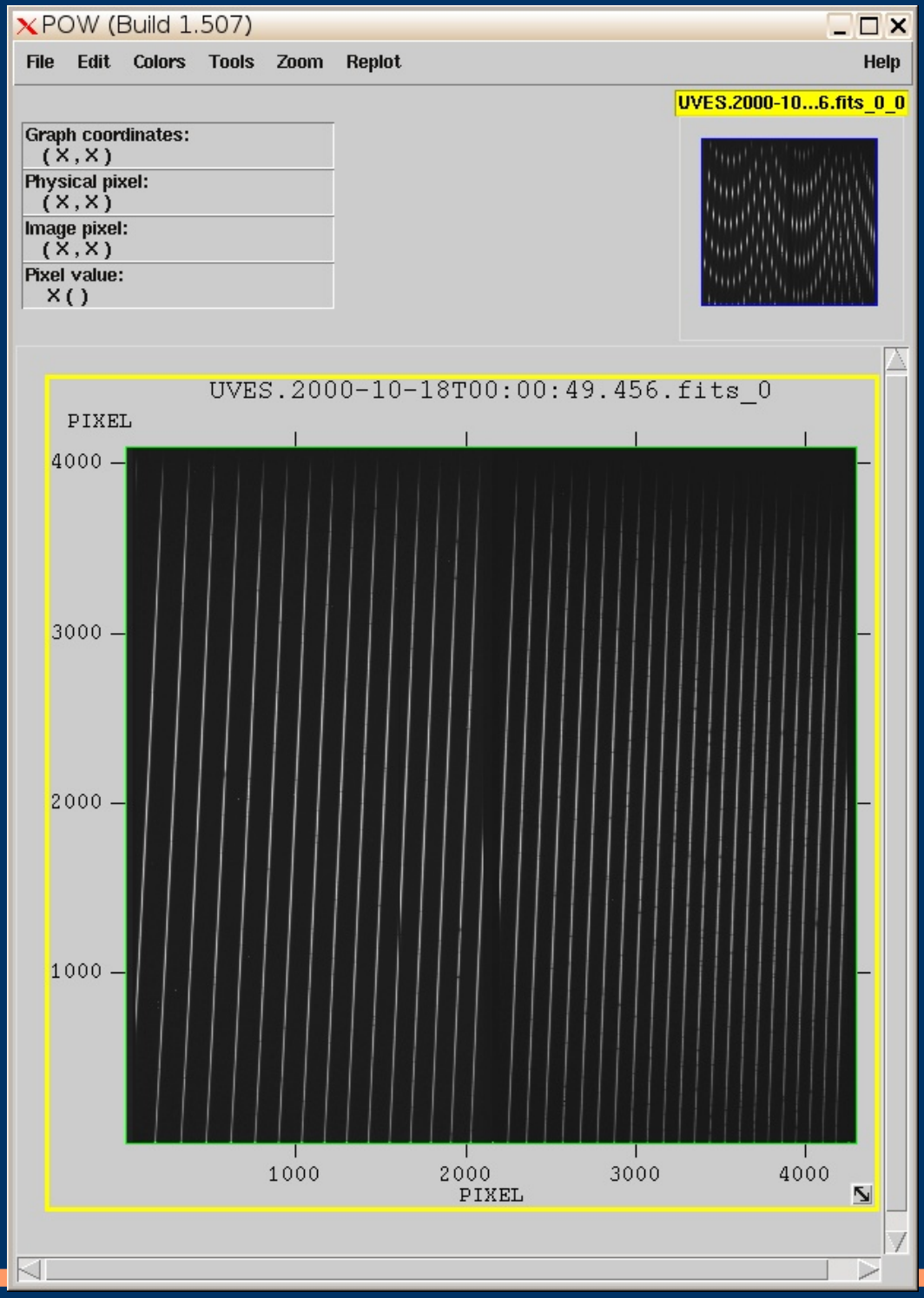
final normalized spectrum

VLT / UVES

Ultraviolet and Visual Echelle Spectrograph



FITS file format


POW (Build 1.507)
File
Edit
Colors
Tools
Zoom
Replot
Help
UVES.2000-10...6.fits_0_0
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Physical pixel:
(X , X)
Image pixel:
(X , X)
Pixel value:
X ( )
UVES.2000-10-18T00:00:49.456.fits_0
PIXEL
4000
3000
2000
1000
1000
2000
3000
4000
PIXEL

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

File Edit Tools Help

Search for: Find Case sensitive? No

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SIMPLE  =                    T / Standard FITS format (NOST-100.0)
BITPIX  =                   16 / # of bits storing pix values
NAXIS   =                    2 / # of axes in frame
NAXIS1  =                 4296 / # pixels/axis
NAXIS2  =                 4096 / # pixels/axis
ORIGIN  = 'ESO     '           / European Southern Observatory
DATE    = '2000-10-18T00:04:51.104' / UT date when this file was written
CRVAL1  =                  1.0 / value of ref pixel
CRPIX1  =                  1.0 / Ref. pixel of center of rotation
CDELT1  =                  1.0 / Binning factor
CTYPE1  = 'PIXEL   '           / Pixel coordinate system
CRVAL2  =                  1.0 / value of ref pixel
CRPIX2  =                  1.0 / Ref. pixel of center of rotation
CDELT2  =                  1.0 / Binning factor
CTYPE2  = 'PIXEL   '           / Pixel coordinate system
BSCALE  =                  1.0 / pixel=FITS*BSCALE+BZERO
BZERO   =              32768.0 / pixel=FITS*BSCALE+BZERO
MJD-OBS =       51835.00057241 / MJD start (2000-10-18T00:00:49.456)
DATE-OBS= '2000-10-18T00:00:49.456' / Date of observation
EXPTIME =             240.0014 / Total integration time
EXTEND  =                    F / Extension may be present
INSTRUME= 'UVES    '           / Instrument used
OBJECT  = 'OBJECT  '           / Original target
OBSERVER= 'UNKNOWN '           / Name of observer
OSEXPOID=                19267 / OS expoId
PI-COI  = 'UNKNOWN '           / Name of PI-COI
TELESCOP= 'ESO-VLT-U2'         / ESO Telescope Name
RA      =           299.630387 / 19:58:31.2 RA (J2000) pointing (deg)
DEC     =            -25.80077 / -25:48:02.7 DEC (J2000) pointing (deg)
EQUINOX =                2000. / Standard FK5 (years)
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

File Edit Tools Help

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```
RADECSYS= 'FK5     '            / Coordinate reference frame
LST     =            75972.935 / 21:06:12.935 LST at start (sec)
UTC     =               41.000 / 00:00:41.000 UTC at start (sec)
HIERARCH ESO OBS TPLNO =     2 / Template number within OB
HIERARCH ESO OBS DID = 'ESO-VLT-DIC.OBS-1.4' / OBS Dictionary
HIERARCH ESO OBS OBSERVER = 'UNKNOWN ' / Observer Name
HIERARCH ESO OBS PI-COI NAME = 'UNKNOWN ' / PI-COI name
HIERARCH ESO OBS PI-COI ID = 719 / ESO internal PI-COI ID
HIERARCH ESO OBS TARG NAME = 'Vesta    ' / OB target name
HIERARCH ESO OBS GRP = '0       ' / linked blocks
HIERARCH ESO OBS NAME = 'Vesta-f ' / OB name
HIERARCH ESO OBS ID = 200101870 / Observation block ID
HIERARCH ESO OBS START = '2000-10-17T23:59:44' / OB start time
HIERARCH ESO OBS PROG ID = '165.N-0276(A)' / ESO program identification
HIERARCH ESO TPL DID = 'ESO-VLT-DIC.TPL-1.1' / Data dictionary for TPL
HIERARCH ESO TPL ID = 'UVES_dic1_obs_expfree' / Template signature ID
HIERARCH ESO TPL NAME = 'Dic1 Free Observation' / Template name
HIERARCH ESO TPL PRESEQ = 'UVES_dic_obs.seq' / Sequencer script
HIERARCH ESO TPL START = '2000-10-17T23:59:44' / TPL start time
HIERARCH ESO TPL VERSION = '@(#) {Revision: 1.1$}' / Version of the template
HIERARCH ESO TPL NEXP =      1 / Number of exposures within templat
HIERARCH ESO TPL EXPNO =     1 / Exposure number within template
HIERARCH ESO DPR TECH = 'ECHELLE ' / Observation technique
HIERARCH ESO DPR TYPE = 'OBJECT  ' / Observation type
HIERARCH ESO DPR CATG = 'SCIENCE ' / Observation category
HIERARCH ESO TEL DID = 'ESO-VLT-DIC.TCS' / Data dictionary for TEL
HIERARCH ESO TEL ID = 'v 1.290.1.2' / TCS version number
HIERARCH ESO TEL DATE = 'not set ' / TCS installation date
HIERARCH ESO TEL ALT = 74.668 / Alt angle at start (deg)
HIERARCH ESO TEL AZ = 82.038 / Az angle at start (deg) S=0,W=90
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

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```
HIERARCH ESO TEL GEOELEV = 2681. / Elevation above sea level (m)
HIERARCH ESO TEL GEOLAT = -24.6279 / Tel geo latitute (+=North) (deg)
HIERARCH ESO TEL GEOLON = -70.4048 / Tel geo longitute (+=East) (deg)
HIERARCH ESO TEL OPER = 'I, Condor' / Telescope Operator
HIERARCH ESO TEL FOCU ID = 'NB      ' / Telescope focus station ID
HIERARCH ESO TEL FOCU LEN = 120.000 / Focal length (m)
HIERARCH ESO TEL FOCU SCALE = 1.718 / Focal scale (arcsec/mm)
HIERARCH ESO TEL FOCU VALUE = -30.154 / M2 setting (mm)
HIERARCH ESO TEL PARANG START = 89.283 / Parallactic angle at start (deg)
HIERARCH ESO TEL AIRM START = 1.037 / Airmass at start
HIERARCH ESO TEL AMBI FWHM START = 0.75 / Observatory Seeing queried from AS
HIERARCH ESO TEL AMBI PRES START = 745.10 / Observatory ambient air pressure q
HIERARCH ESO TEL TRAK STATUS = 'NORMAL  ' / Tracking status
HIERARCH ESO TEL DOME STATUS = 'FULLY-OPEN' / Dome status
HIERARCH ESO TEL CHOP ST =   F / True when chopping is active
HIERARCH ESO TEL PARANG END = 89.766 / Parallactic angle at end (deg)
HIERARCH ESO TEL AIRM END = 1.042 / Airmass at end
HIERARCH ESO TEL AMBI FWHM END = 0.88 / Observatory Seeing queried from AS
HIERARCH ESO TEL AMBI PRES END = 745.15 / Observatory ambient air pressure q
HIERARCH ESO ADA ABSROT START = 16.04805 / Abs rot angle at exp start (deg)
HIERARCH ESO ADA POSANG = 0.00000 / Position angle at start
HIERARCH ESO ADA GUID STATUS = 'ON      ' / Status of autoguider
HIERARCH ESO ADA GUID RA = 299.724520 / 19:58:53.8 Guide star RA J2000
HIERARCH ESO ADA GUID DEC = -25.87096 / -25:52:15.4 Guide star DEC J2000
HIERARCH ESO ADA ABSROT END = 16.50427 / Abs rot angle at exp end (deg)
HIERARCH ESO INS ID = 'UVES    ' / Instrument ID
HIERARCH ESO INS DID = 'UVES_ICS' / Data dictionary for INS
HIERARCH ESO INS SOFW ID = '$Revision: 1.85 $' / Instrument SW
HIERARCH ESO INS SOFW MODE = 'NORMAL  ' / Simulation mode
HIERARCH ESO INS PATH = 'RED     ' / Optical path used
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

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```
HIERARCH ESO INS MODE = 'DICHR#1 ' / Instrument mode used
HIERARCH ESO INS MIRR1 ID = 'FREE     ' / Mirror unique ID
HIERARCH ESO INS MIRR1 NAME = 'FREE     ' / Mirror common name
HIERARCH ESO INS MIRR1 NO =  1 / Mirror slide position
HIERARCH ESO INS OPTI1 ID = '1        ' / General Optical device unique ID
HIERARCH ESO INS OPTI1 NAME = 'OUT      ' / General Optical device common name
HIERARCH ESO INS OPTI1 NO =  1 / Slot number
HIERARCH ESO INS SLIT1 NAME = 'FREE     ' / Slit common name
HIERARCH ESO INS SLIT1 NO =  1 / Slide position
HIERARCH ESO INS DROT MODE = 'ELEV     ' / Instrument derotator mode
HIERARCH ESO INS DROT RA = 195831.292820 / %HOURANG RA (J2000) pointing (deg
HIERARCH ESO INS DROT DEC = -254802.761130 / %DEGREE DEC (J2000) pointing (de
HIERARCH ESO INS DROT POSANG = 0.0000 / Position angle (deg)
HIERARCH ESO INS DROT BEGIN = 142.6580 / Physical position at start (deg)
HIERARCH ESO INS DPOL MODE = 'OFF      ' / Instrument depolarizer mode
HIERARCH ESO INS DPOS NAME = 'OUT      ' / Instrument depolarizer slide posit
HIERARCH ESO INS DPOS NO =   1 / Depolarizer slide position
HIERARCH ESO INS ADC MODE = 'OFF      ' / ADC mode
HIERARCH ESO INS ADCS NAME = 'OUT      ' / ADC slide position
HIERARCH ESO INS ADCS NO =   1 / ADC slide position
HIERARCH ESO INS ADC1 MODE = 'OFF      ' / ADC mode
HIERARCH ESO INS ADC1 RA = 195831.292820 / %HOURANG RA (J2000) pointing (deg
HIERARCH ESO INS ADC1 DEC = -254802.761130 / %DEGREE DEC (J2000) pointing (de
HIERARCH ESO INS ADC2 MODE = 'OFF      ' / ADC mode
HIERARCH ESO INS ADC2 RA = 195831.292820 / %HOURANG RA (J2000) pointing (deg
HIERARCH ESO INS ADC2 DEC = -254802.761130 / %DEGREE DEC (J2000) pointing (de
HIERARCH ESO INS FILT1 ID = 'FREE     ' / Filter unique id
HIERARCH ESO INS FILT1 NAME = 'FREE     ' / Filter common name
HIERARCH ESO INS FILT1 NO = 13 / Filter wheel position index
HIERARCH ESO INS OPTI2 ID = 'DIAPHR.27MM' / General Optical device unique ID
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

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```
HIERARCH ESO INS OPTI2 NAME = 'OVRSIZ  ' / General Optical device common name
HIERARCH ESO INS OPTI2 NO =  3 / Slot number
HIERARCH ESO INS MIRR2 ID = 'DICHR#1 ' / Mirror unique ID
HIERARCH ESO INS MIRR2 NAME = 'DICHR#1 ' / Mirror common name
HIERARCH ESO INS MIRR2 NO =  3 / Mirror slide position
HIERARCH ESO INS SLIT3 WID = 0.45 / Slit width (arcsec)
HIERARCH ESO INS SLIT3 Y1FRML = 'ENC=OFFST+RESOL*acos(WID-(MAX+MIN)/(MAX-MIN))'
HIERARCH ESO INS SLIT3 Y1OFFST = 4750.0 / Offset in Formula
HIERARCH ESO INS SLIT3 Y1RESOL = 40.0 / Resolution in encoder steps
HIERARCH ESO INS SLIT3 Y1MIN = 0.062 / Minimum slit width (arcsec)
HIERARCH ESO INS SLIT3 Y1MAX = 5.572 / Maximum slit width (arcsec)
HIERARCH ESO INS SLIT3 Y2FRML = 'ENC=OFFST+RESOL*acos(WID-(MAX+MIN)/(MAX-MIN))'
HIERARCH ESO INS SLIT3 Y2OFFST = 4560.0 / Offset in Formula
HIERARCH ESO INS SLIT3 Y2RESOL = 40.0 / Resolution in encoder steps
HIERARCH ESO INS SLIT3 Y2MIN = 0.050 / Minimum slit width (arcsec)
HIERARCH ESO INS SLIT3 Y2MAX = 5.513 / Maximum slit width (arcsec)
HIERARCH ESO INS SLIT3 Y1ENC = 11158 / Slit Vertical top motor absolute e
HIERARCH ESO INS SLIT3 Y2ENC = 10935 / Slit Vertical bottom motor absolut
HIERARCH ESO INS SLIT3 LEN = 10.00 / Slit length (arcsec)
HIERARCH ESO INS SLIT3 X1FRML = 'ENC=OFFST+RESOL*acos(LEN-(MAX+MIN)/(MAX-MIN))'
HIERARCH ESO INS SLIT3 X1OFFST = 2381.0 / Offset in Formula
HIERARCH ESO INS SLIT3 X1RESOL = 40.0 / Resolution in encoder steps
HIERARCH ESO INS SLIT3 X1MIN = 0.087 / Minimum slit length (arcsec)
HIERARCH ESO INS SLIT3 X1MAX = 15.752 / Maximum slit length (arcsec)
HIERARCH ESO INS SLIT3 X2FRML = 'ENC=OFFST+RESOL*acos(LEN-(MAX+MIN)/(MAX-MIN))'
HIERARCH ESO INS SLIT3 X2OFFST = 2307.0 / Offset in Formula
HIERARCH ESO INS SLIT3 X2RESOL = 40.0 / Resolution in encoder steps
HIERARCH ESO INS SLIT3 X2MIN = 0.064 / Minimum slit length (arcsec)
HIERARCH ESO INS SLIT3 X2MAX = 15.833 / Maximum slit length (arcsec)
HIERARCH ESO INS SLIT3 X1ENC = 6856 / Slit Horizontal left motor absolut
```

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```
HIERARCH ESO INS SLIT3 X2ENC = 6785 / Slit Horizontal right motor absolu
HIERARCH ESO INS FILT3 ID = 'BS4      ' / Filter unique id
HIERARCH ESO INS FILT3 NAME = 'SHP700  ' / Filter common name
HIERARCH ESO INS FILT3 NO =  4 / Filter wheel position index
HIERARCH ESO INS DET6 NAME = 'Red exp. meter PMT' / detector name
HIERARCH ESO INS DET6 CTMIN = 134128. / Minimum count during exposure
HIERARCH ESO INS DET6 CTMAX = 235803. / Maximum count during exposure
HIERARCH ESO INS DET6 CTMEAN = 190469.5 / Average counts during exposure
HIERARCH ESO INS DET6 CTRMS = 19249.49 / RMS of counts during exposure
HIERARCH ESO INS DET6 TMMEAN = 0.50 / Normalised mean exposure time
HIERARCH ESO INS DET6 CTTOT = 45419308. / Total counts during exposure
HIERARCH ESO INS DET6 UIT = 1.000 / User defined Integration time
HIERARCH ESO INS DET6 OFFDRK = 0. / Average dark background counts
HIERARCH ESO INS DET6 OFFSKY = 6. / Average sky background counts
HIERARCH ESO INS SHUT6 NAME = 'Red exp. meter sh.' / Shutter name
HIERARCH ESO INS SHUT6 ST =  T / Shutter open
HIERARCH ESO INS GRAT2 ID = 'CD#3     ' / Grating unique ID
HIERARCH ESO INS GRAT2 NAME = 'CD#3     ' / Grating common name
HIERARCH ESO INS PIXSCALE = 0.182 / Pixel scale
HIERARCH ESO INS GRAT2 X = 2048.0 / X pixel for central wavelength
HIERARCH ESO INS GRAT2 Y = 2048.0 / Y pixel for central wavelength
HIERARCH ESO INS GRAT2 FRML = 'ENC=OFFST+RESOL*asin(WLEN*GRV/(2*cos(ROT)))' / C
HIERARCH ESO INS GRAT2 OFFST = 1216484.0 / Offset in Formula
HIERARCH ESO INS GRAT2 RESOL = 15000.0 / Resolution in encoder steps
HIERARCH ESO INS GRAT2 GRV = 0.0006000 / Grating grooves/nm
HIERARCH ESO INS GRAT2 ROT = 22.668 / Grating rot angle
HIERARCH ESO INS GRAT2 NO =  1 / Grating wheel position index
HIERARCH ESO INS GRAT2 WLEN = 580.0 / Grating central wavelength
HIERARCH ESO INS GRAT2 ENC = 1379521 / Grating absolute encoder position
HIERARCH ESO INS TILT2 POS = 0.0 / Science camera tilt (pixels)
```

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```
HIERARCH ESO INS TILT2 FRML = 'ENC=OFFST+RESOL*asin(2*POS-(MAX+MIN)/(MAX-MIN))'
HIERARCH ESO INS TILT2 OFFST = 15927.0 / Offset in Formula
HIERARCH ESO INS TILT2 RESOL = -100.0 / Resolution in encoder steps
HIERARCH ESO INS TILT2 POSMIN = -222.0 / Minimum camera tilt (pixels)
HIERARCH ESO INS TILT2 POSMAX = 222.0 / Maximum camera tilt (pixels)
HIERARCH ESO INS TILT2 ENC = 15927 / Camera tilt absolute encoder posit
HIERARCH ESO INS DROT END = 143.1340 / Physical position at end (deg)
HIERARCH ESO INS TEMP31 NAME = 'Iodine cell temp.' / Temperature sensor name
HIERARCH ESO INS TEMP31 START = 11.5 / Temperature at start
HIERARCH ESO INS TEMP31 STOP = 11.4 / Temperature at end
HIERARCH ESO INS TEMP31 MIN = 11.4 / Minimum temperature
HIERARCH ESO INS TEMP31 MAX = 11.5 / Maximum temperature
HIERARCH ESO INS TEMP31 MEAN = 11.5 / Average temperature
HIERARCH ESO INS TEMP1 NAME = 'Temp. blue camera' / Temperature sensor name
HIERARCH ESO INS TEMP1 START = 10.5 / Temperature at start
HIERARCH ESO INS TEMP1 STOP = 10.5 / Temperature at end
HIERARCH ESO INS TEMP1 MIN = 10.5 / Minimum temperature
HIERARCH ESO INS TEMP1 MAX = 10.5 / Maximum temperature
HIERARCH ESO INS TEMP1 MEAN = 10.5 / Average temperature
HIERARCH ESO INS TEMP2 NAME = 'Temp. red camera' / Temperature sensor name
HIERARCH ESO INS TEMP2 START = 10.7 / Temperature at start
HIERARCH ESO INS TEMP2 STOP = 10.7 / Temperature at end
HIERARCH ESO INS TEMP2 MIN = 10.7 / Minimum temperature
HIERARCH ESO INS TEMP2 MAX = 10.7 / Maximum temperature
HIERARCH ESO INS TEMP2 MEAN = 10.7 / Average temperature
HIERARCH ESO INS TEMP3 NAME = 'Temp. table' / Temperature sensor name
HIERARCH ESO INS TEMP3 START = 11.1 / Temperature at start
HIERARCH ESO INS TEMP3 STOP = 11.1 / Temperature at end
HIERARCH ESO INS TEMP3 MIN = 11.1 / Minimum temperature
HIERARCH ESO INS TEMP3 MAX = 11.1 / Maximum temperature
```

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```
HIERARCH ESO INS TEMP3 MEAN = 11.1 / Average temperature
HIERARCH ESO INS TEMP4 NAME = 'Temp. inside air' / Temperature sensor name
HIERARCH ESO INS TEMP4 START = 11.7 / Temperature at start
HIERARCH ESO INS TEMP4 STOP = 11.7 / Temperature at end
HIERARCH ESO INS TEMP4 MIN = 11.7 / Minimum temperature
HIERARCH ESO INS TEMP4 MAX = 11.7 / Maximum temperature
HIERARCH ESO INS TEMP4 MEAN = 11.7 / Average temperature
HIERARCH ESO INS SENS26 NAME = 'Barometer pressure' / sensor common name
HIERARCH ESO INS SENS26 START = 744.3 / sensor value at start
HIERARCH ESO INS SENS26 STOP = 744.4 / sensor value at end
HIERARCH ESO INS SENS26 MIN = 744.3 / Minimum sensor value
HIERARCH ESO INS SENS26 MAX = 744.4 / Maximum sensor value
HIERARCH ESO INS SENS26 MEAN = 744.4 / Average sensor vlaue
HIERARCH ESO INS SHUT1 NAME = 'Telescope shutter' / Shutter name
HIERARCH ESO INS SHUT1 ST =  T / Shutter open
HIERARCH ESO DET ID = 'CCD FIERA - Rev 2.60' / Detector system Id
HIERARCH ESO DET NAME = 'ccdUvR - ccdUvr' / Name of detector system
HIERARCH ESO DET DATE = '09-07-1998' / Installation date
HIERARCH ESO DET DID = 'ESO-VLT-DIC.CCDDCS,ESO-VLT-DIC.FCDDCS' / Diction
HIERARCH ESO DET BITS =     16 / Bits per pixel readout
HIERARCH ESO DET RA = 299.63038673 / Apparent 19:58:31.2 RA at start
HIERARCH ESO DET DEC = -25.80076698 / Apparent -25:48:02.7 DEC at start
HIERARCH ESO DET SOFW MODE = 'Normal  ' / CCD sw operational mode
HIERARCH ESO DET CHIPS =     2 / # of chips in detector array
HIERARCH ESO DET CHIP1 ID = 'CCID-20 ' / Detector chip identification
HIERARCH ESO DET CHIP1 NAME = 'MIT/LL, EEV' / Detector chip name
HIERARCH ESO DET CHIP1 DATE = '09-07-1998' / Date of installation [YYYY-MM-DD]
HIERARCH ESO DET CHIP1 X =   1 / X location in array
HIERARCH ESO DET CHIP1 Y =   1 / Y location in array
HIERARCH ESO DET CHIP1 NX = 2048 / # of pixels along X
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

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```
HIERARCH ESO DET CHIP1 NY = 4096 / # of pixels along Y
HIERARCH ESO DET CHIP1 PSZX = 15.0 / Size of pixel in X
HIERARCH ESO DET CHIP1 PSZY = 15.0 / Size of pixel in Y
HIERARCH ESO DET CHIP2 ID = 'CCD-44  ' / Detector chip identification
HIERARCH ESO DET CHIP2 NAME = 'MIT/LL, EEV' / Detector chip name
HIERARCH ESO DET CHIP2 DATE = '09-07-1998' / Date of installation [YYYY-MM-DD]
HIERARCH ESO DET CHIP2 X =   2 / X location in array
HIERARCH ESO DET CHIP2 Y =   1 / Y location in array
HIERARCH ESO DET CHIP2 NX = 2048 / # of pixels along X
HIERARCH ESO DET CHIP2 NY = 4096 / # of pixels along Y
HIERARCH ESO DET CHIP2 PSZX = 15.0 / Size of pixel in X
HIERARCH ESO DET CHIP2 PSZY = 15.0 / Size of pixel in Y
HIERARCH ESO DET EXP NO = 7381 / Unique exposure ID number
HIERARCH ESO DET EXP TYPE = 'Normal  ' / Exposure type
HIERARCH ESO DET EXP DUMDIT = 0 / # of dummy readouts
HIERARCH ESO DET EXP RDTTIME = 39.597 / image readout time
HIERARCH ESO DET EXP XFERTIM = 39.589 / image transfer time
HIERARCH ESO DET READ MODE = 'normal  ' / Readout method
HIERARCH ESO DET READ SPEED = '2pts/225kHz/lg' / Readout speed
HIERARCH ESO DET READ CLOCK = '225kHz/2ports/l' / Readout clock pattern used
HIERARCH ESO DET OUTPUTS =   2 / # of outputs
HIERARCH ESO DET OUTREF =    0 / reference output
HIERARCH ESO DET OUT1 ID = 'L       ' / Output ID as from manufacturer
HIERARCH ESO DET OUT1 NAME = 'L       ' / Description of output
HIERARCH ESO DET OUT1 CHIP = 1 / Chip to which the output belongs
HIERARCH ESO DET OUT1 X =    1 / X location of output
HIERARCH ESO DET OUT1 Y =    1 / Y location of output
HIERARCH ESO DET OUT1 NX = 2048 / valid pixels along X
HIERARCH ESO DET OUT1 NY = 4096 / valid pixels along Y
HIERARCH ESO DET OUT1 PRSCX = 50 / Prescan region in X
```

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```
HIERARCH ESO DET OUT1 OVSCX = 50 / Overscan region in X
HIERARCH ESO DET OUT1 CONAD = 1.46 / Conversion from ADUs to electrons
HIERARCH ESO DET OUT1 RON = 3.69 / Readout noise per output (e-)
HIERARCH ESO DET OUT1 GAIN = 0.68 / Conversion from electrons to ADU
HIERARCH ESO DET OUT4 ID = 'R       ' / Output ID as from manufacturer
HIERARCH ESO DET OUT4 NAME = 'R       ' / Description of output
HIERARCH ESO DET OUT4 CHIP = 2 / Chip to which the output belongs
HIERARCH ESO DET OUT4 X = 4096 / X location of output
HIERARCH ESO DET OUT4 Y =    1 / Y location of output
HIERARCH ESO DET OUT4 NX = 2048 / valid pixels along X
HIERARCH ESO DET OUT4 NY = 4096 / valid pixels along Y
HIERARCH ESO DET OUT4 PRSCX = 50 / Prescan region in X
HIERARCH ESO DET OUT4 OVSCX = 50 / Overscan region in X
HIERARCH ESO DET OUT4 CONAD = 1.59 / Conversion from ADUs to electrons
HIERARCH ESO DET OUT4 RON = 3.42 / Readout noise per output (e-)
HIERARCH ESO DET OUT4 GAIN = 0.63 / Conversion from electrons to ADU
HIERARCH ESO DET FRAM ID =   1 / Image sequencial number
HIERARCH ESO DET FRAM TYPE = 'Normal  ' / Type of frame
HIERARCH ESO DET WINDOWS =   1 / # of windows readout
HIERARCH ESO DET WIN1 STRX = 1 / Lower left pixel in X
HIERARCH ESO DET WIN1 STRY = 1 / Lower left pixel in Y
HIERARCH ESO DET WIN1 NX = 4296 / # of pixels along X
HIERARCH ESO DET WIN1 NY = 4096 / # of pixels along Y
HIERARCH ESO DET WIN1 BINX = 1 / Binning factor along X
HIERARCH ESO DET WIN1 BINY = 1 / Binning factor along Y
HIERARCH ESO DET WIN1 NDIT = 1 / # of subintegrations
HIERARCH ESO DET WIN1 UIT1 = 240.000000 / user defined subintegration time
HIERARCH ESO DET WIN1 DIT1 = 240.001412 / actual subintegration time
HIERARCH ESO DET WIN1 DKTM = 241.9109 / Dark current time
HIERARCH ESO DET SHUT TYPE = 'Slit    ' / type of shutter
```

fv: Header of UVES.2000-10-18T00:00:49.456.fits[0] in /home/grus/mw...

File Edit Tools Help

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```
HIERARCH ESO DET WIN1 BINY = 1 / Binning factor along Y
HIERARCH ESO DET WIN1 NDIT = 1 / # of subintegrations
HIERARCH ESO DET WIN1 UIT1 = 240.000000 / user defined subintegration time
HIERARCH ESO DET WIN1 DIT1 = 240.001412 / actual subintegration time
HIERARCH ESO DET WIN1 DKTM = 241.9109 / Dark current time
HIERARCH ESO DET SHUT TYPE = 'Slit     ' / type of shutter
HIERARCH ESO DET SHUT ID = 'ccdUvr shutter' / Shutter unique identifier
HIERARCH ESO DET SHUT TMOPEN = 0.036 / Time taken to open shutter
HIERARCH ESO DET SHUT TMCLOS = 0.039 / Time taken to close shutter
HIERARCH ESO DET TELE INT = 60.0 / Interval between two successive te
HIERARCH ESO DET TELE NO =   3 / # of sources active
HIERARCH ESO DET TLM1 NAME = 'CCD T1   ' / Description of telemetry param.
HIERARCH ESO DET TLM1 ID = 'CCD Sensor1' / ID of telemetry sensor
HIERARCH ESO DET TLM1 START = 135.00 / Telemetry value at read start
HIERARCH ESO DET TLM1 END = 135.00 / Telemetry value at read completion
HIERARCH ESO DET TLM2 NAME = 'CCD T2   ' / Description of telemetry param.
HIERARCH ESO DET TLM2 ID = 'CCD Sensor2' / ID of telemetry sensor
HIERARCH ESO DET TLM2 START = 137.10 / Telemetry value at read start
HIERARCH ESO DET TLM2 END = 137.10 / Telemetry value at read completion
HIERARCH ESO DET TLM3 NAME = 'EBOX T   ' / Description of telemetry param.
HIERARCH ESO DET TLM3 ID = 'Box Temp' / ID of telemetry sensor
HIERARCH ESO DET TLM3 START = 285.30 / Telemetry value at read start
HIERARCH ESO DET TLM3 END = 285.40 / Telemetry value at read completion
ORIGFILE= 'UVES_DIC1R_OBS291.5.fits' / Original File Name
ARCFILE = 'UVES.2000-10-18T00:00:49.456.fits' / Archive File Name
CHECKSUM= 'G9WBJ6UBG6UBG6UB'    / HDU checksum updated 2013-07-23T09:00:25
HDRVER  = '2010-06-23T16:30:03.976' / Header timetag
COMMENT processed by HOTF_version : 1.1 on 2013-07-23T09:00:25
DATASUM = '3127886529'          / data unit checksum updated 2013-07-23T09:00:25
END
```