MIDI: an overview

2010 VLTI School

Observation and data reduction with the Very Large Telescope Interferometer

Porquerolles, France
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Contents: Olivier Chesneau
Observatoire de la Côte d'Azur, F
Presentation: Tijl Verhoelst
KULeuven, B

MIDI, what is it?

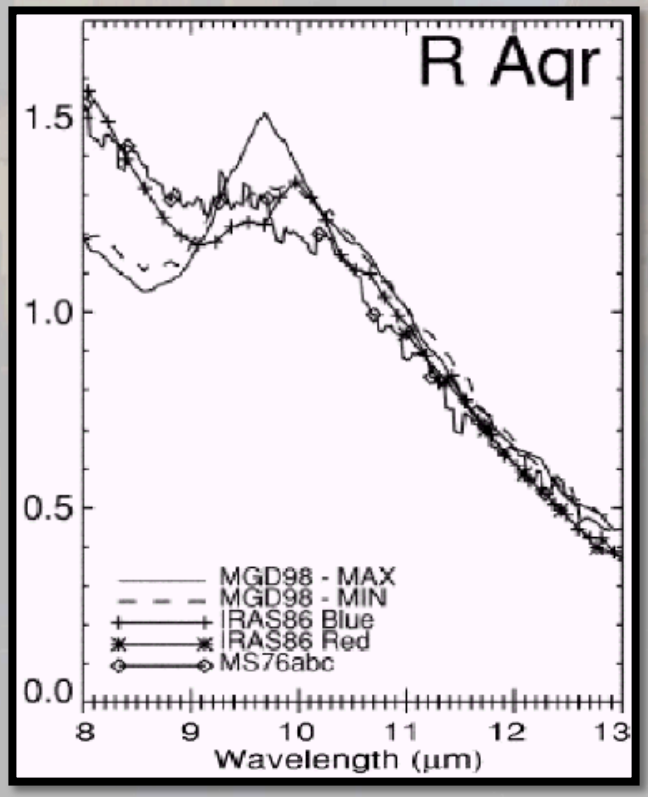
MIDI: MID-infrared Interferometric Instrument
MIDI concept presented in 1997, first fringes in 2003
Offered to the community in 2004

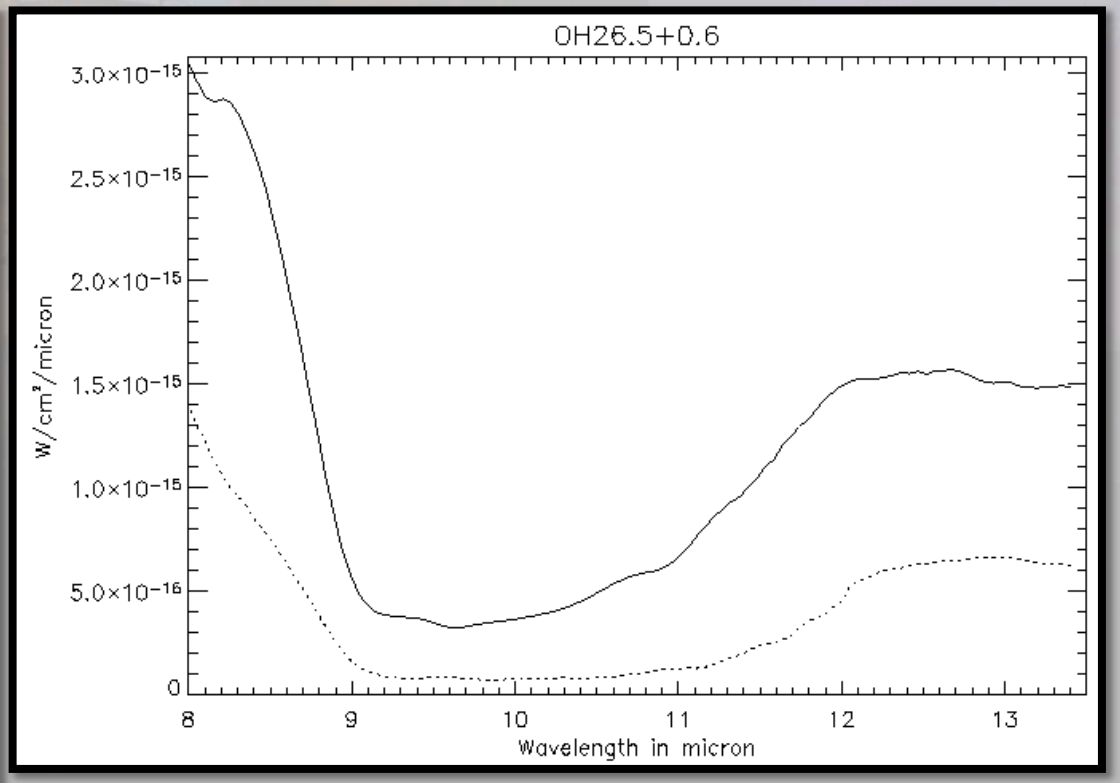
Spectral dispersion, 30 et 230, accuracy 5-15%, 2 telescopes

Consortium:
D: Max-Planck Institut für Astronomie: Heidelberg
PI: Christoph Leiner, PM: Uwe Grase
Nl: Leiden Observatory, ASTRON (Dwingeloo)
D: Kiepenheuer-Institut Friburg,
F: Meudon Observatory and Côte d'Azur Observatory

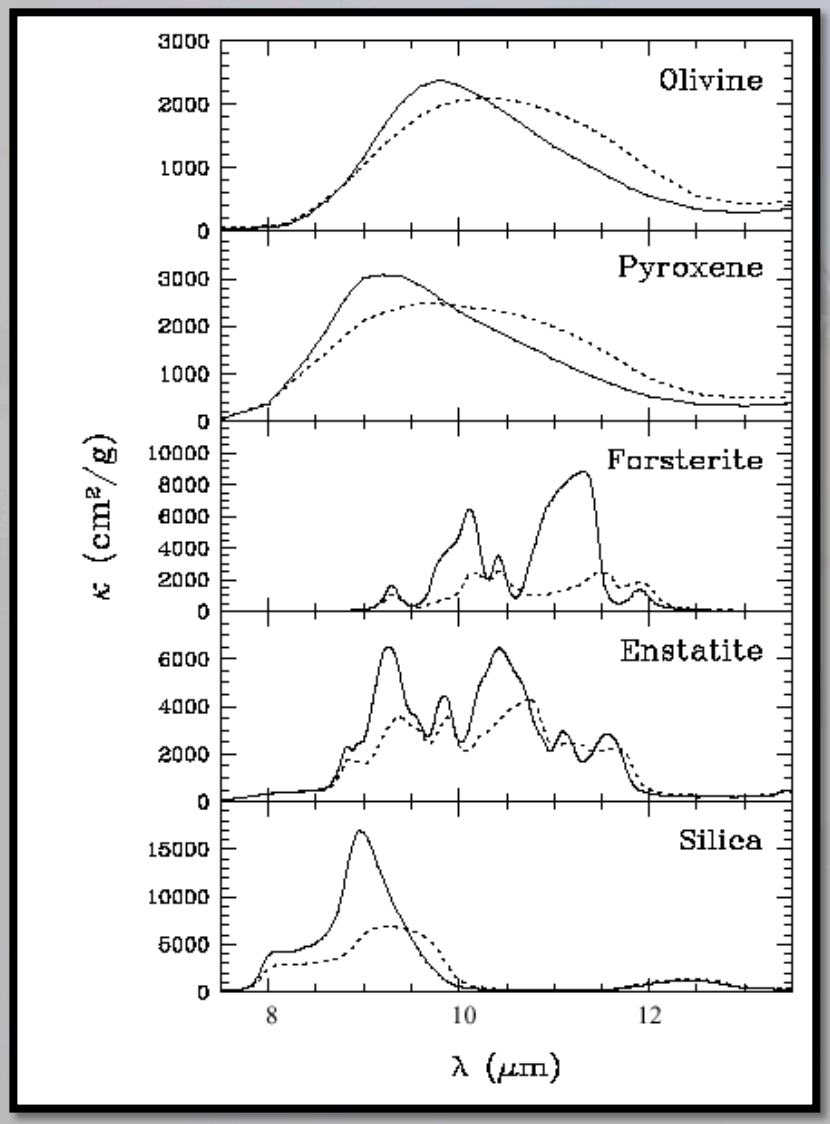
MIDI, why was it built?

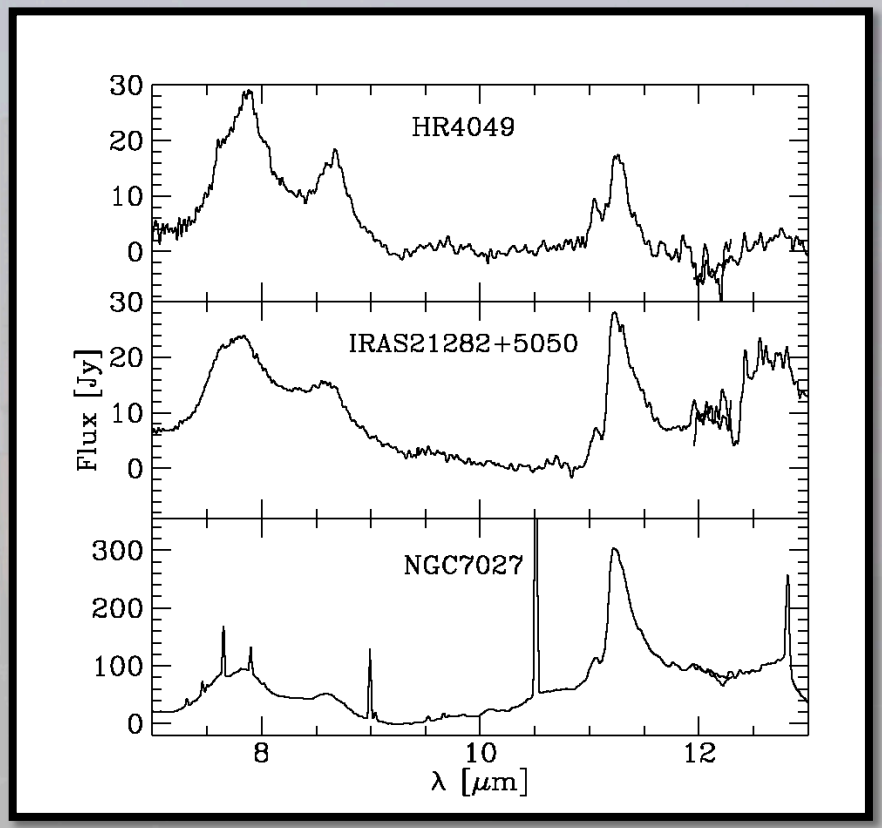
To study compact dusty objects: young stars with protoplanetary disks, old stars with circumstellar matter, extreme stars with mass loss, AGN,…





MIDI, why was it built?





MIDI, why was it built?

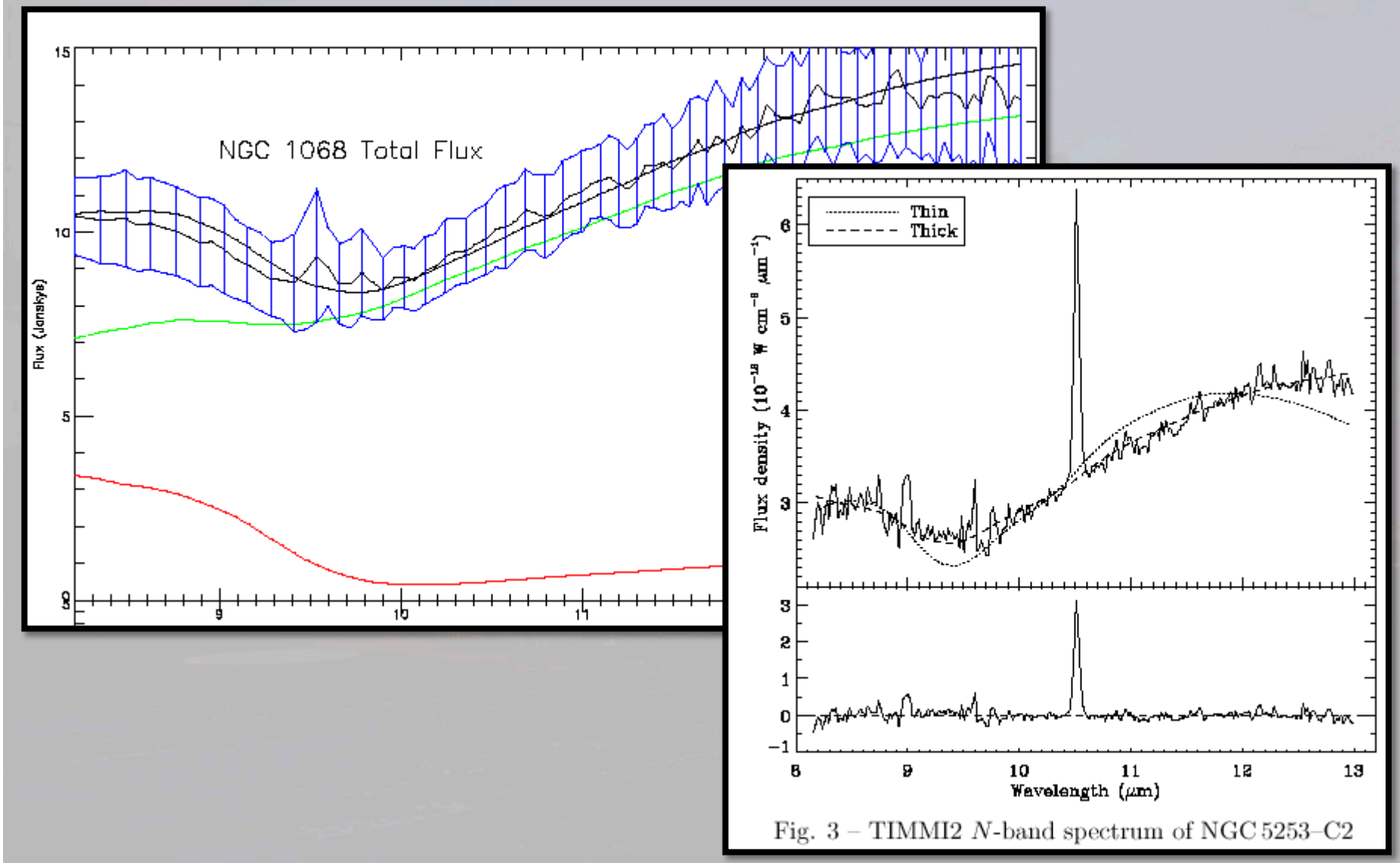


Fig. 3 – TIMMI2 *N*-band spectrum of NGC 5253–C2

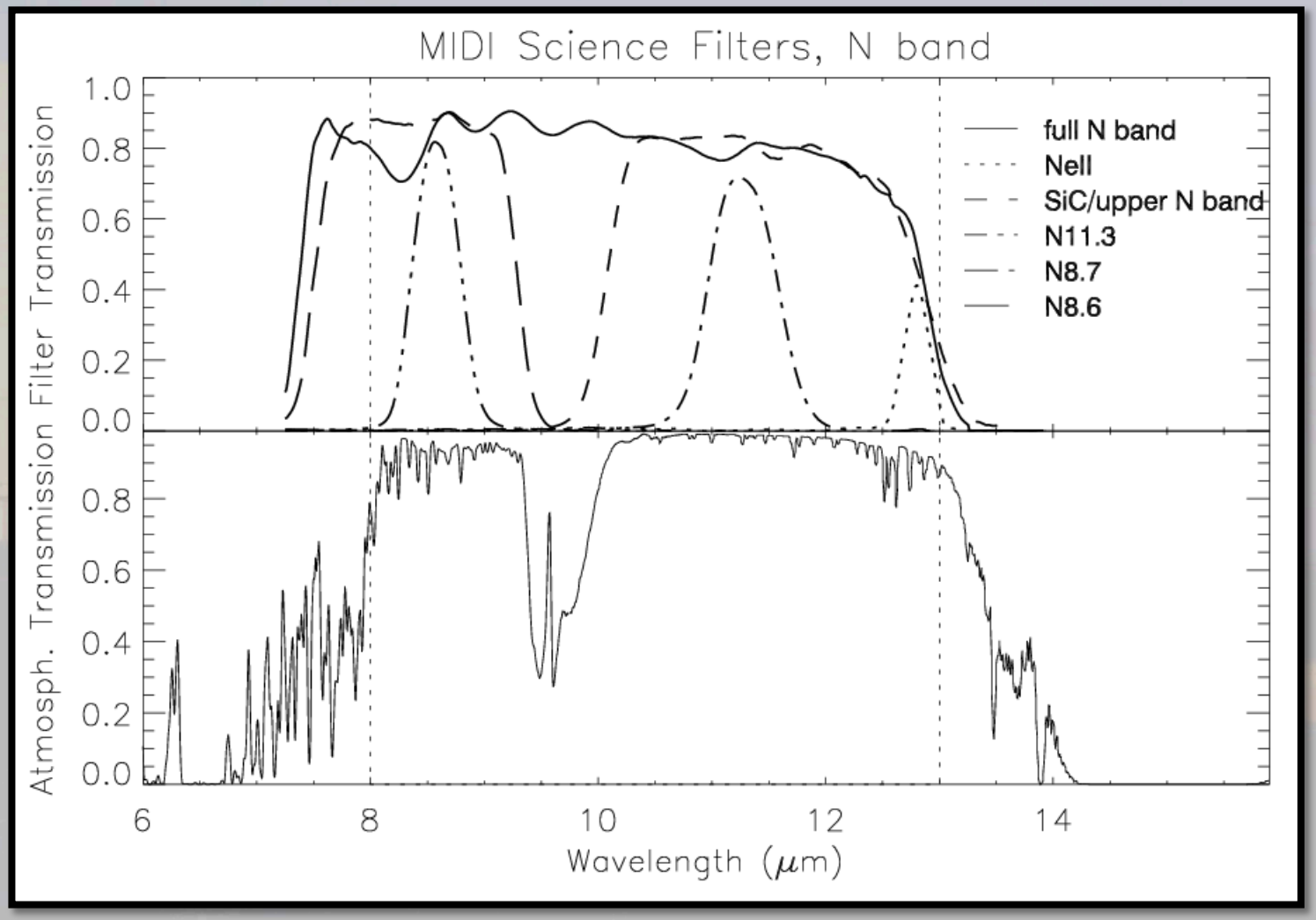
Working in Mid-IR: the Good, the Bad, and the Ugly

Table 4.1: Characteristic parameters for different wavelengths, a zenith distance of $\zeta = 0°$, a wind speed of $v = 10\,\mathrm{ms}^{-1}$, and a telescope diameter of $D = 4\,\mathrm{m}$.

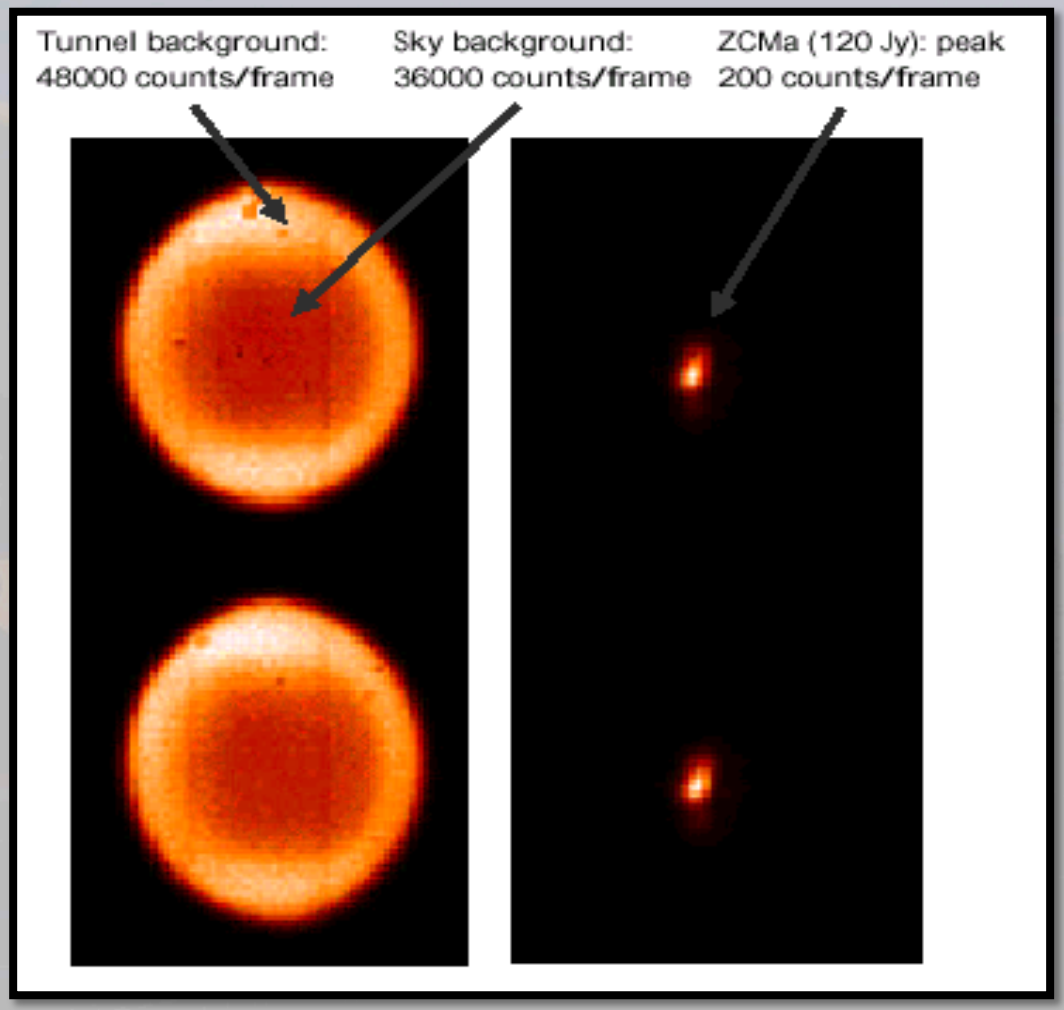
		0.55 μm	2.2 μm	10 μm
Fried paramter	r_0	10 cm	60 cm	≈ 4 m
seeing limit	λr_0^{-1}	$1.1''$	$0.76''$	$0.52''$
coherence time	$r_0 v^{-1}$	10 ms	60 ms	400 ms
diffraction limit	λD^{-1}	$0.028''$	$0.11''$	$0.52''$

The Mid-IR is *easier* for interferometry because the individual images are (close to) diffraction limited, and the coherence time is long

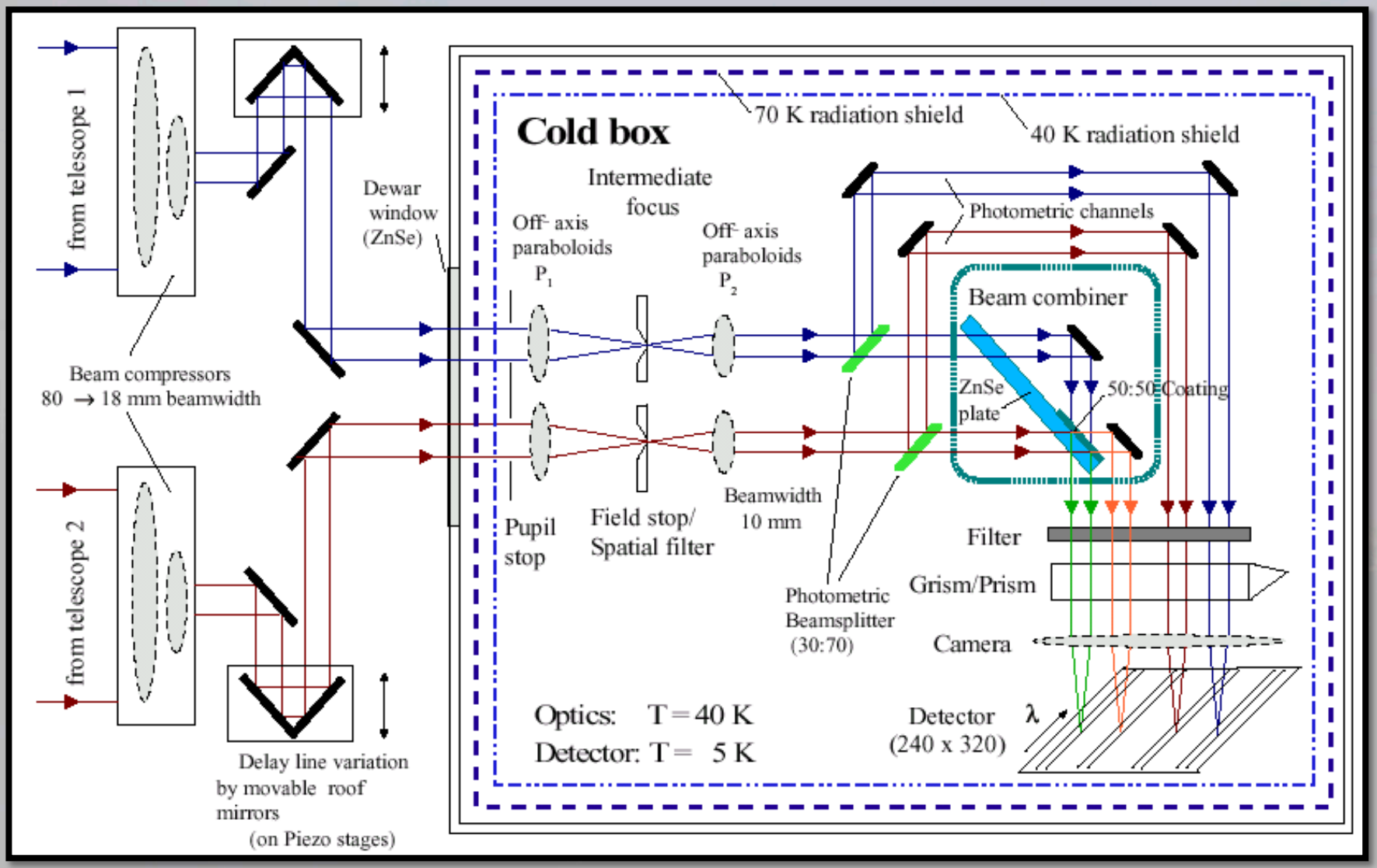
Working in Mid-IR: the Good, the Bad, and the Ugly



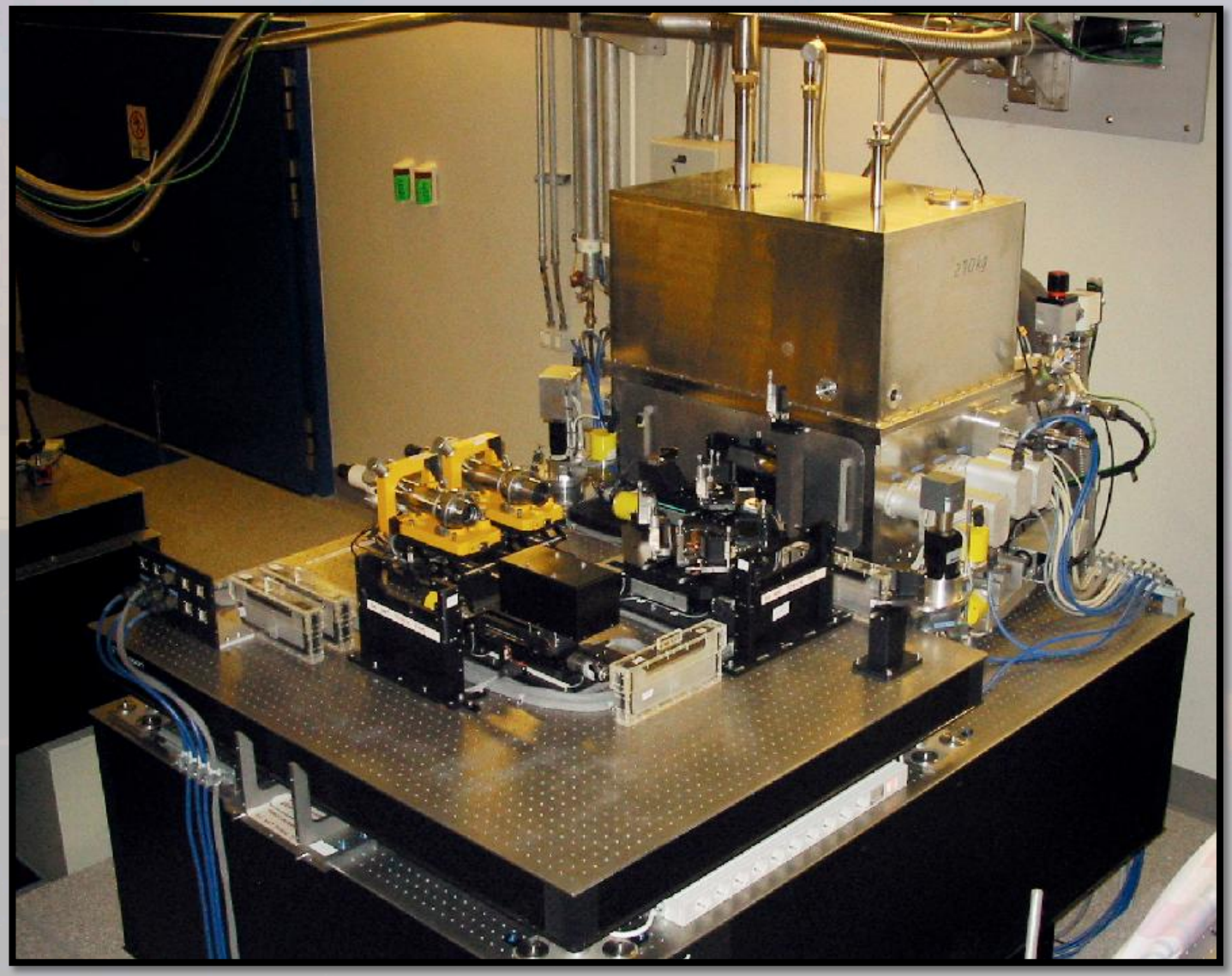
Working in Mid-IR: the Good, the Bad, and the Ugly



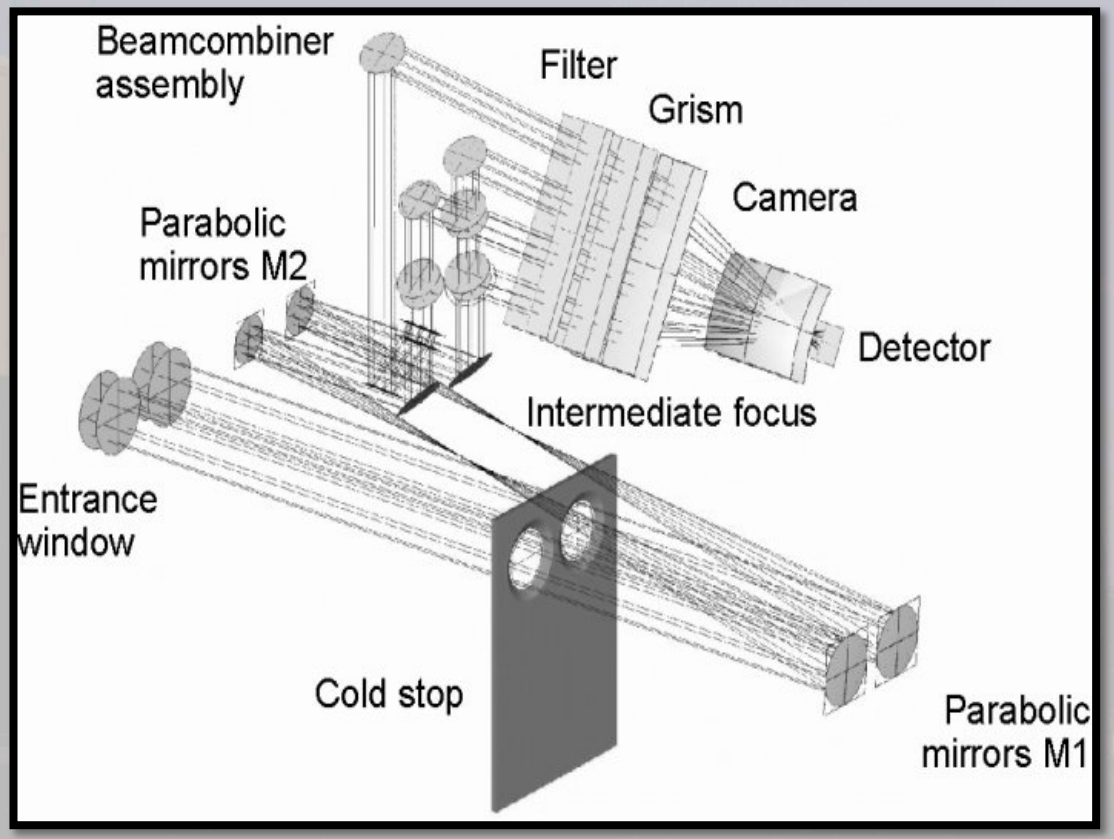
MIDI: the instrument



MIDI: the instrument

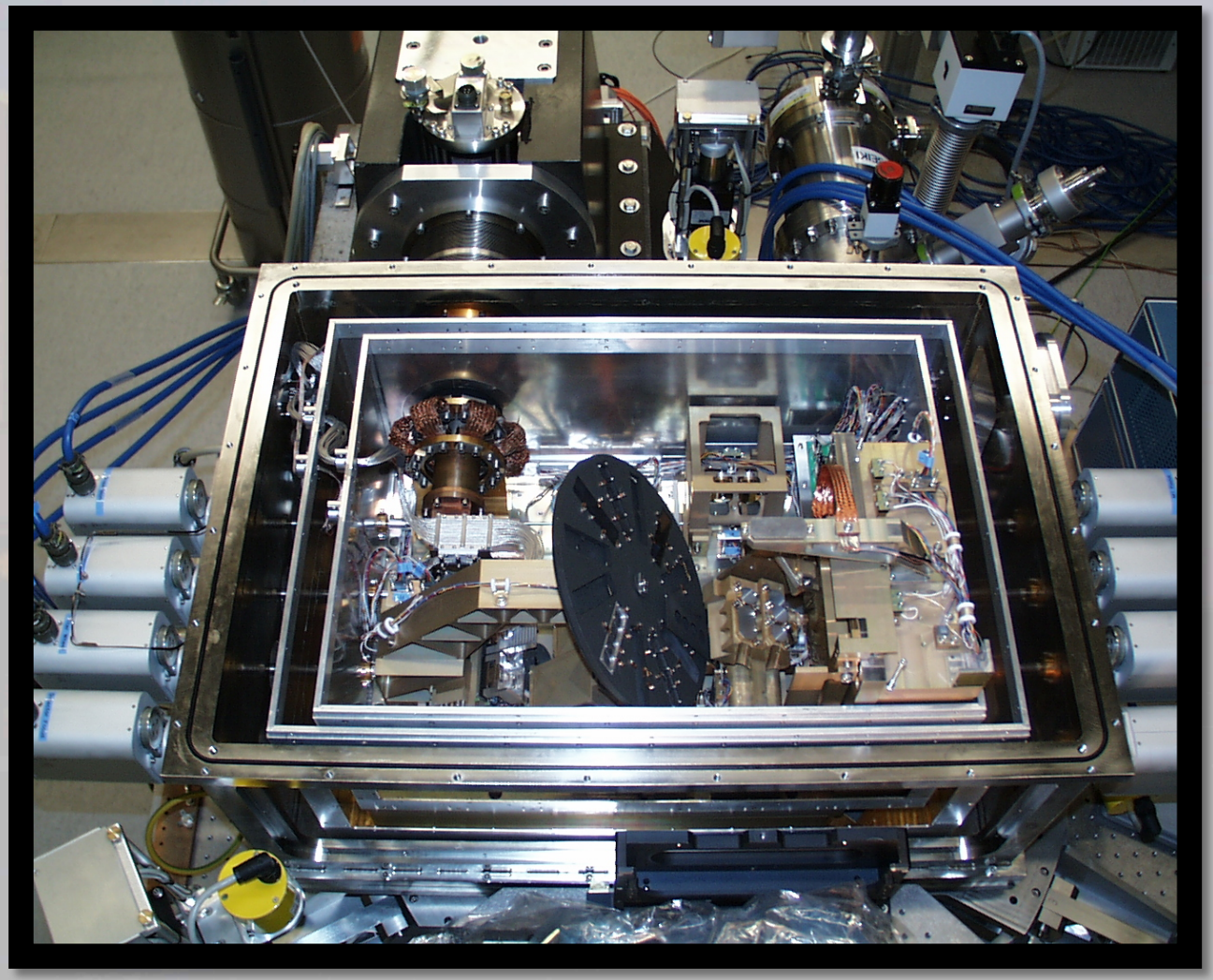


MIDI: the instrument

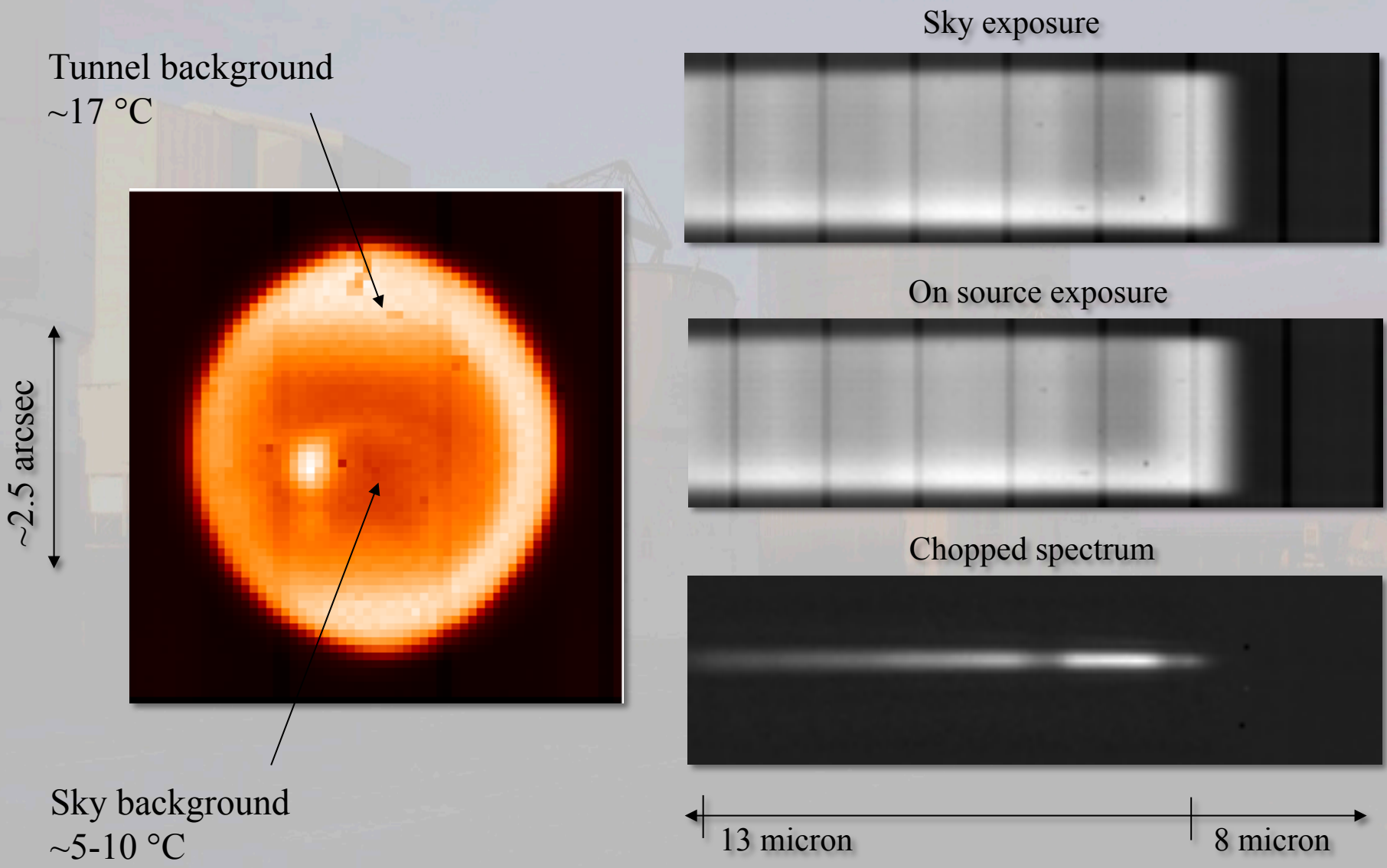


Inside the dewar

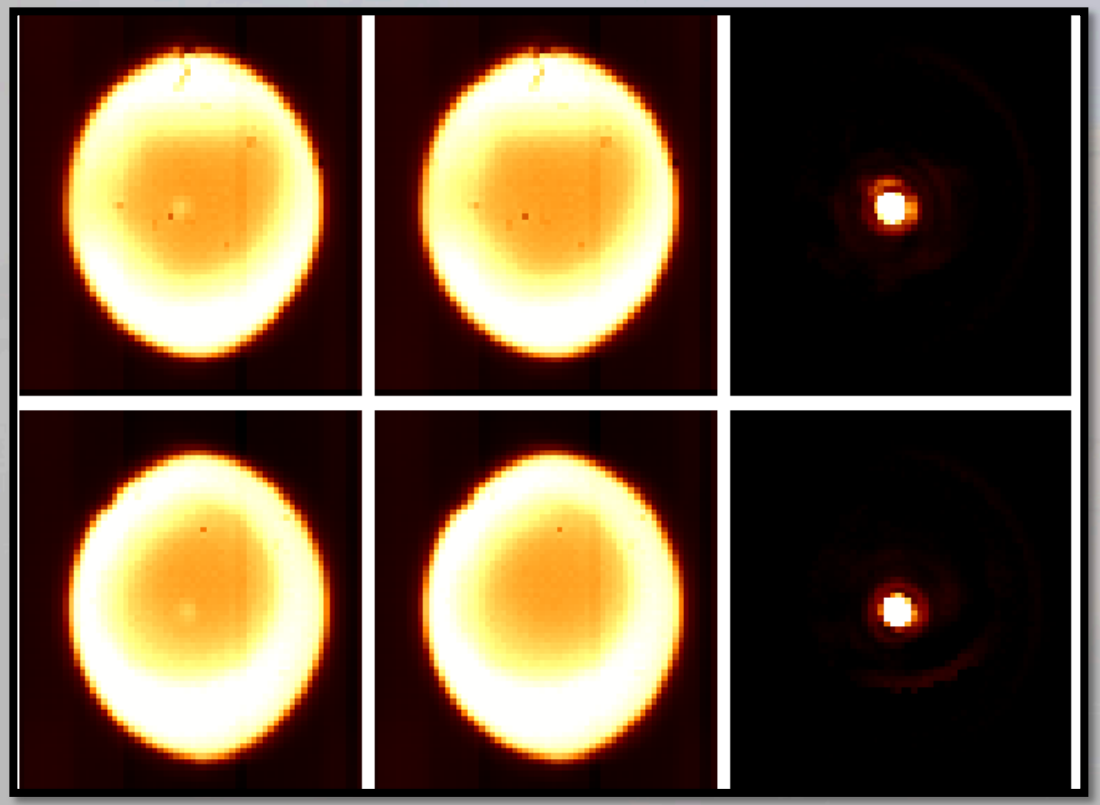
MIDI: the instrument



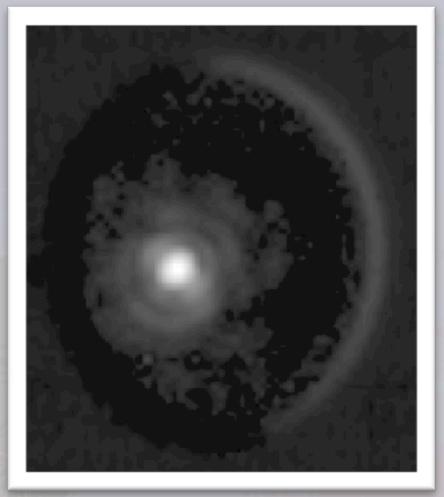
What does MIDI see?



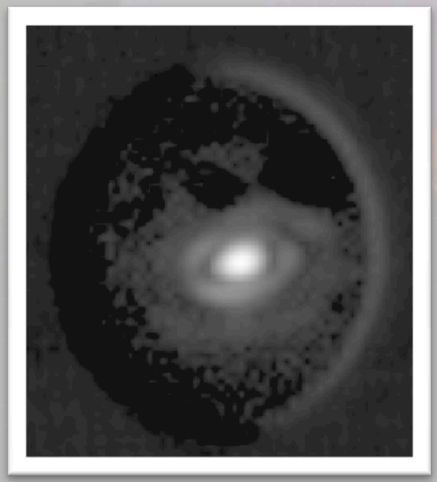
What does MIDI see?



Z CMa

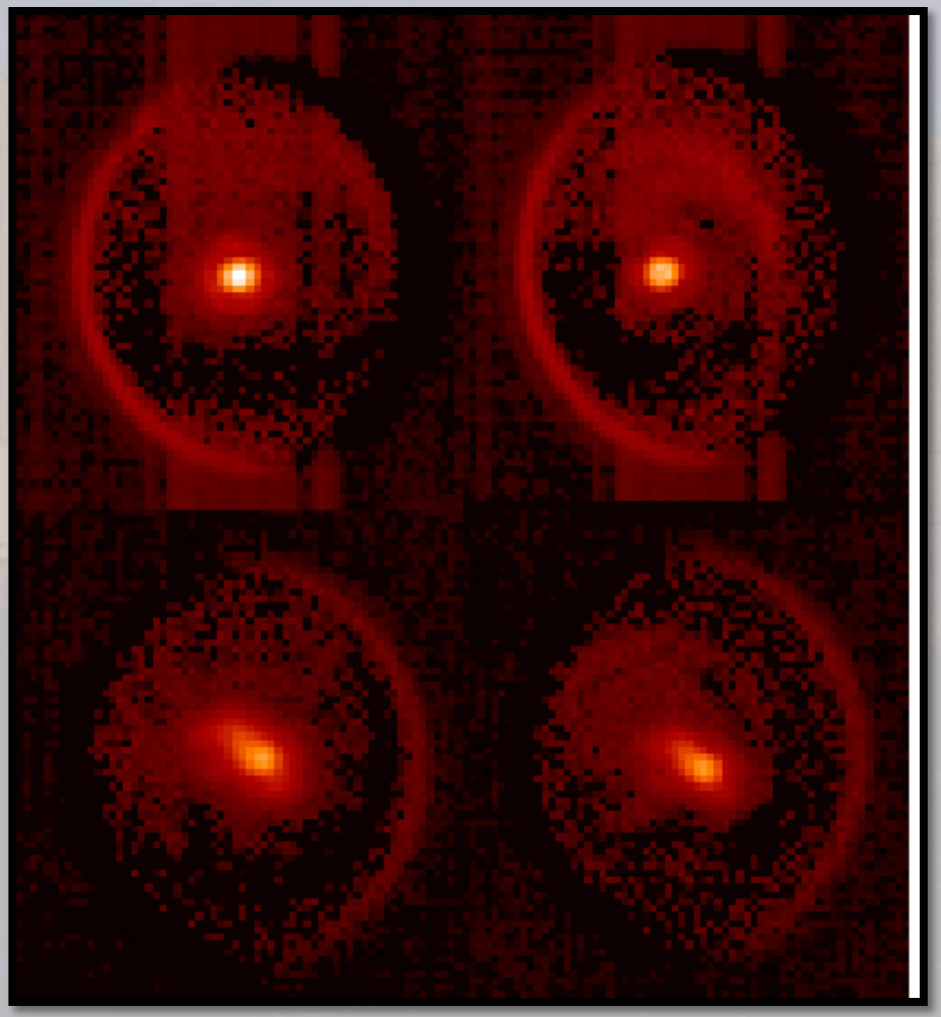


Z Cma: $I^{1/4}$ in Beam B



Z CMa: $I^{1/4}$ in Beam A

What does MIDI see? A caution!



Calibrator

NGC 1068

Two Observing Modes

HIGH-SENS: the High Sensitivity mode:

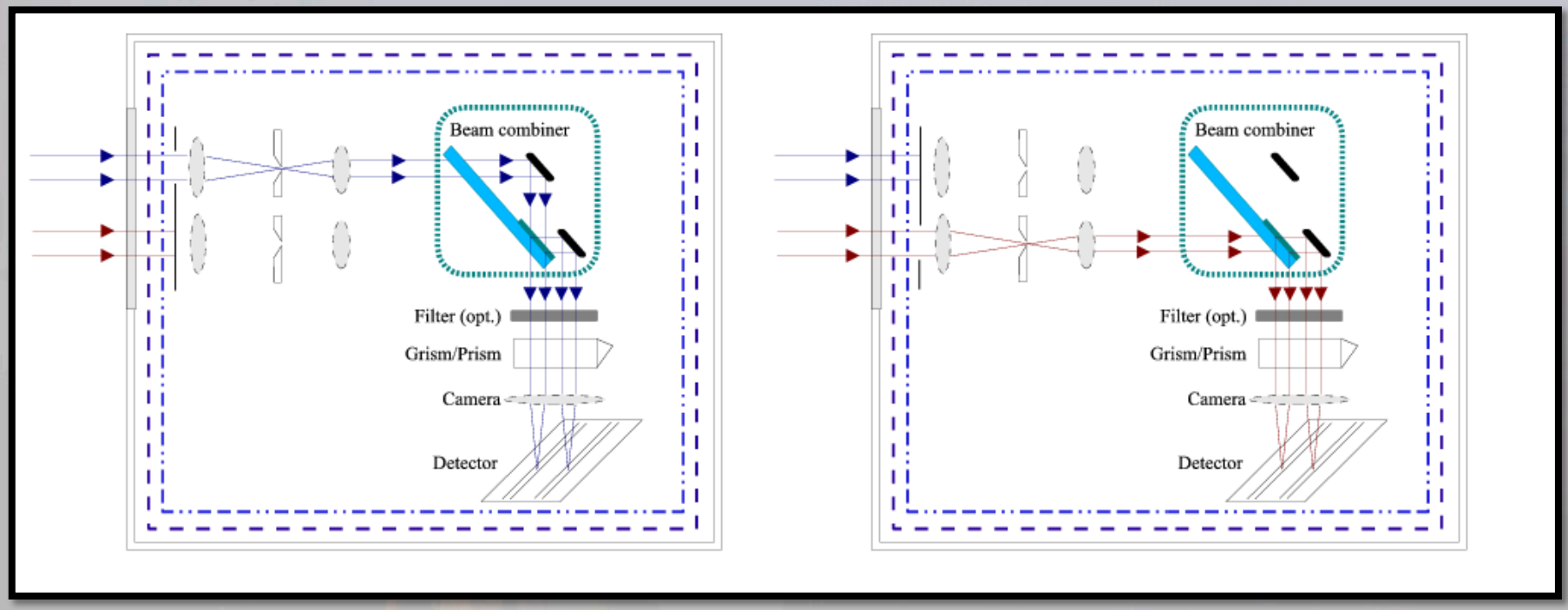
Fringe tracking: exclusively on the source, no chopping
2 windows
Photometry of telescope A: shutter B, beam combiner inserted, chopping
2 windows located at the same place in the detector
Advantage: simple data sets in the same detector position
Drawback: Photometry performed at 2-5 minutes intervals. The accuracy on the visibility is typically 7-15% under good to medium atmospheric conditions,

SCI-PHOT: the high accuracy mode

Fringe tracking: chopping working at a frequency which is an integer multiple of the scanning frequency
4 windows: 2 interferometric, 2 photometric
Advantage: simultaneous photometry
Drawbacks: chopping simultaneously with scanning, heavy real time control
: distorsion of the photometric beams, added detector noise

Unknown: coupling coefficients: is MIDI stable?

HIGH-SENS: delayed photometric calibration



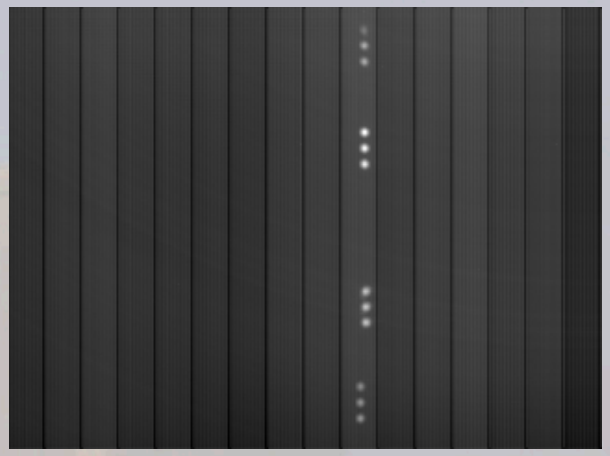
TIP: separate photometry is also useful for SCI-PHOT observations of faint sources

What do we see on the MIDI detector?

Detector: 320 x 240 pixels

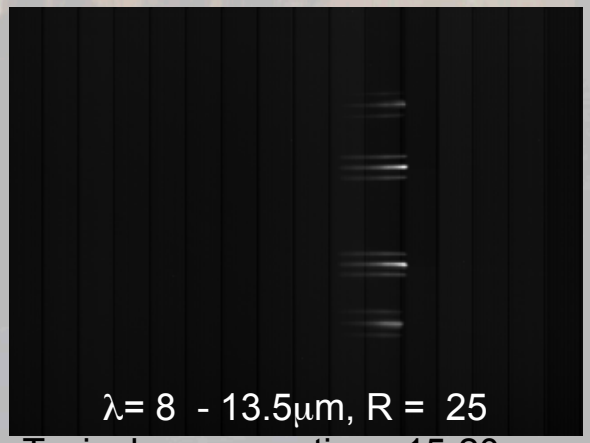
Acquisition (Field Camera) High-Sens Mode

Typical exposure time: 4ms



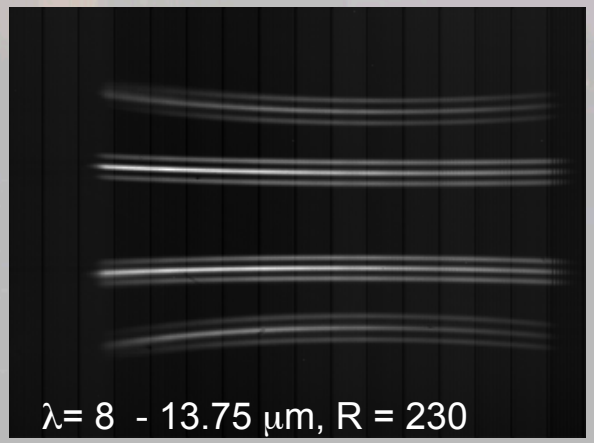
70% Interfero., 30% Phot.

Dispersion with Prism



Typical exposure time: 15-20 ms

Dispersion with Grism



Typical exposure time: 30-40 ms

What do we see on the MIDI detector?

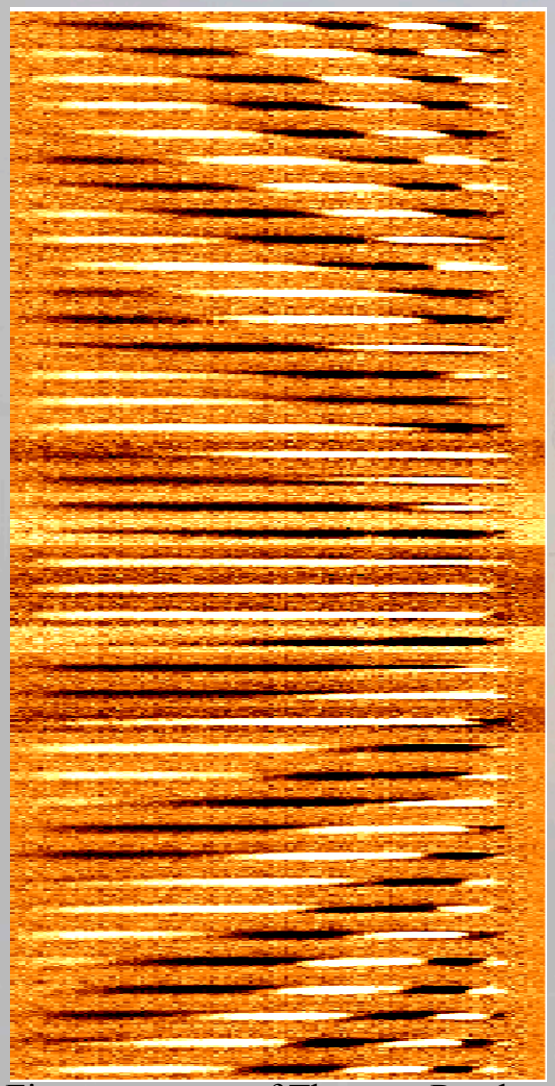
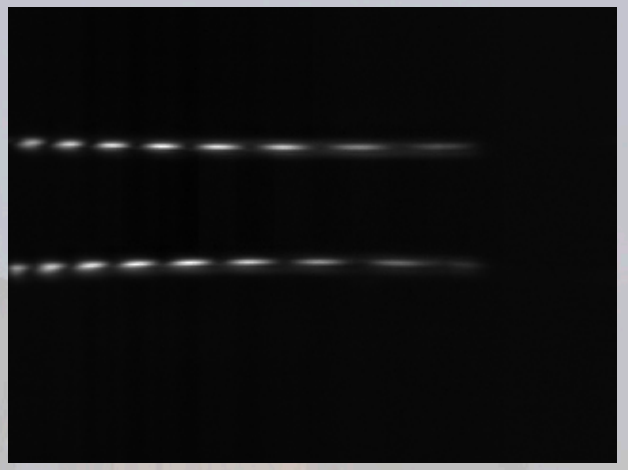


Figure courtesy of Thorsten Ratzka

→ Limit of the scan

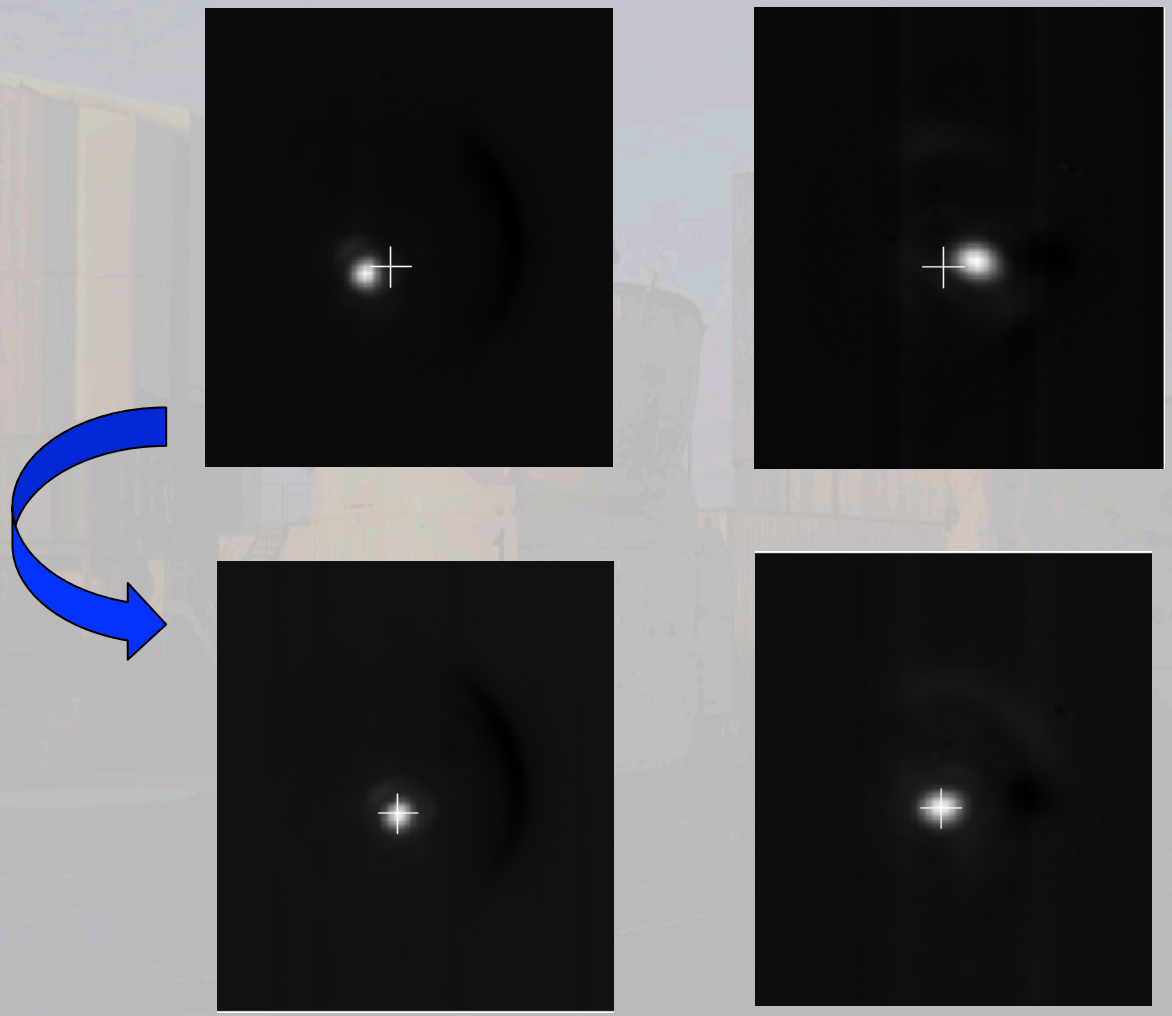


→ Zero OPD: white fringe at all wavelengths

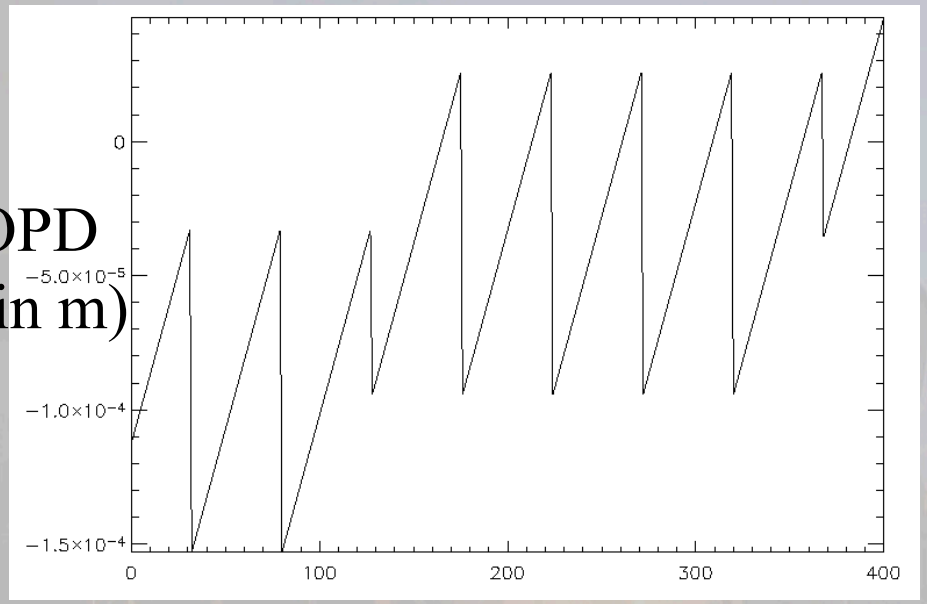
A MIDI observation from A to Z

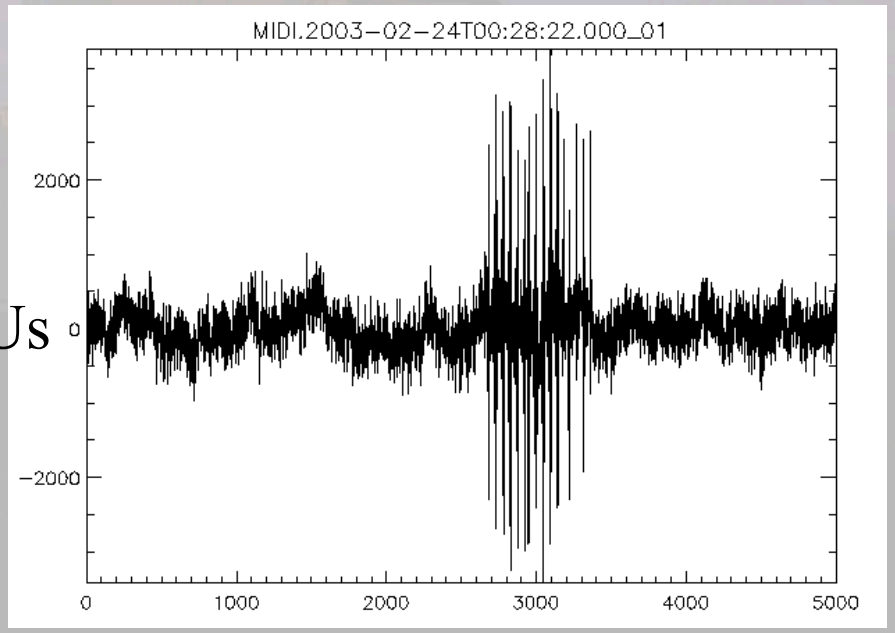
- Acquisition and fine acquisition
- Fringe search
- Fringe track
- (Photometry A and B)
- All of this for the calibrator

1: Source Acquisition

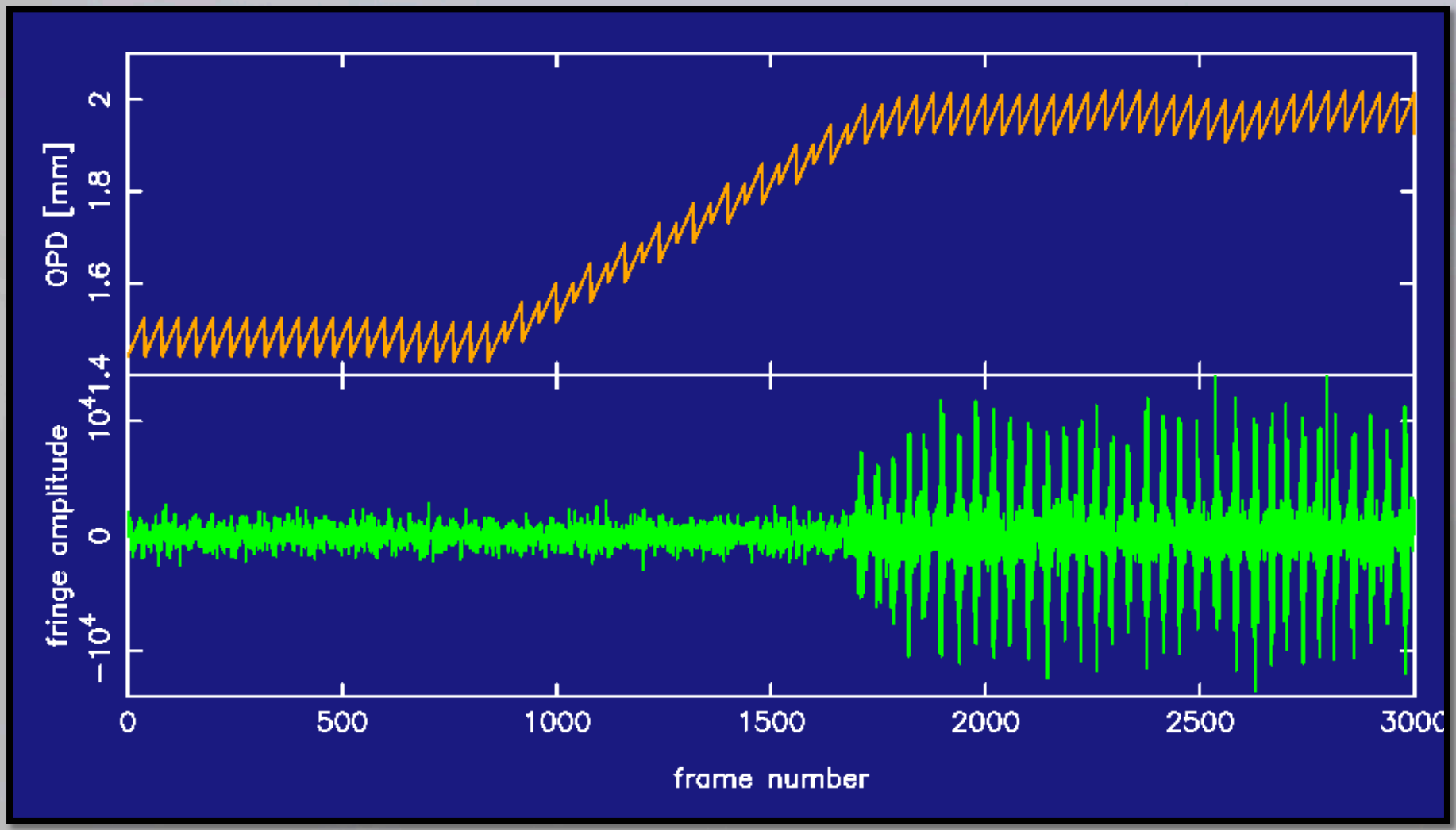


2: Fringe Search

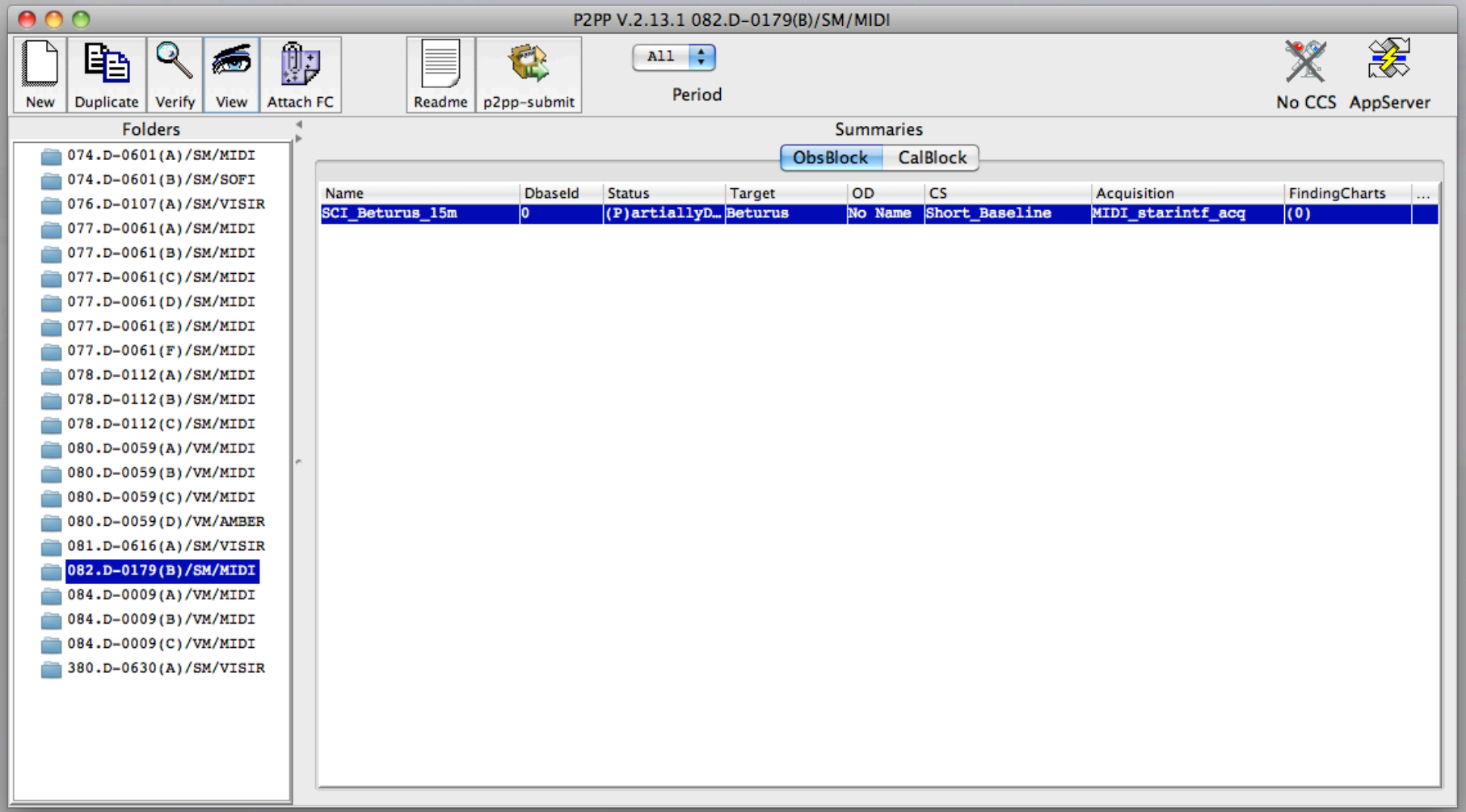




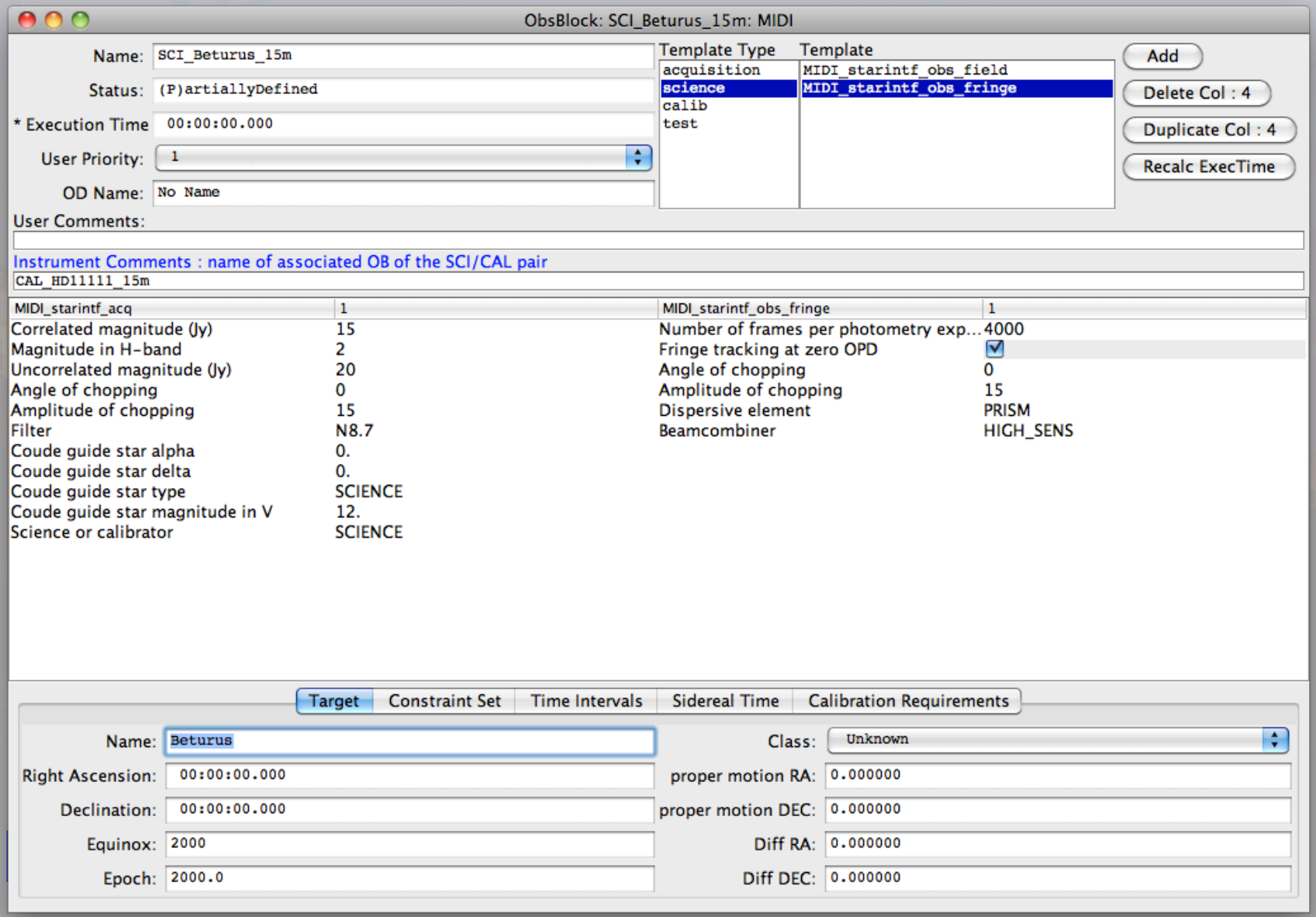
3: Fringe Track



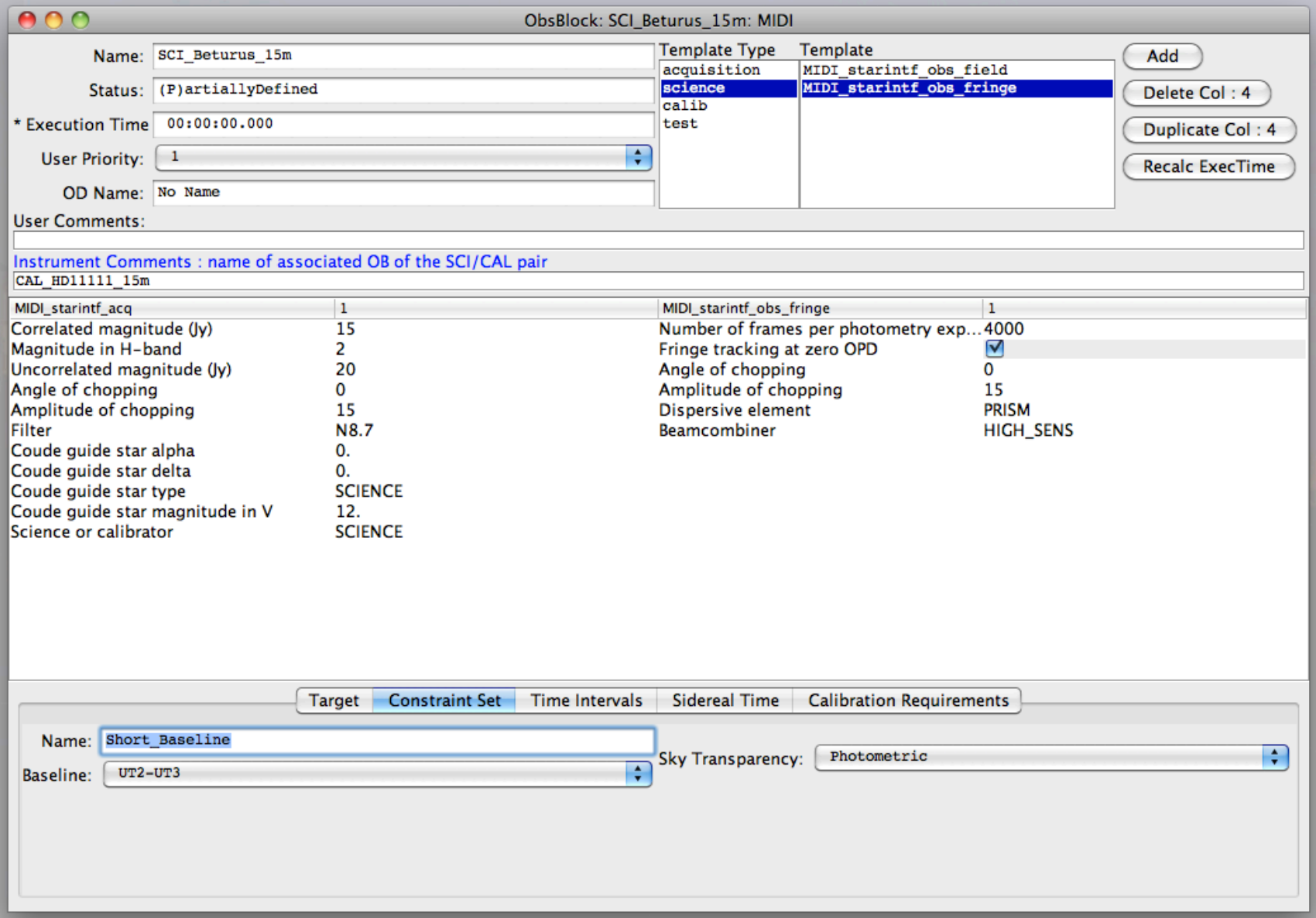
Preparing Observations:
Observing Block creation with p2pp



Preparing Observations:
Observing Block creation with p2pp



Preparing Observations:
Observing Block creation with p2pp



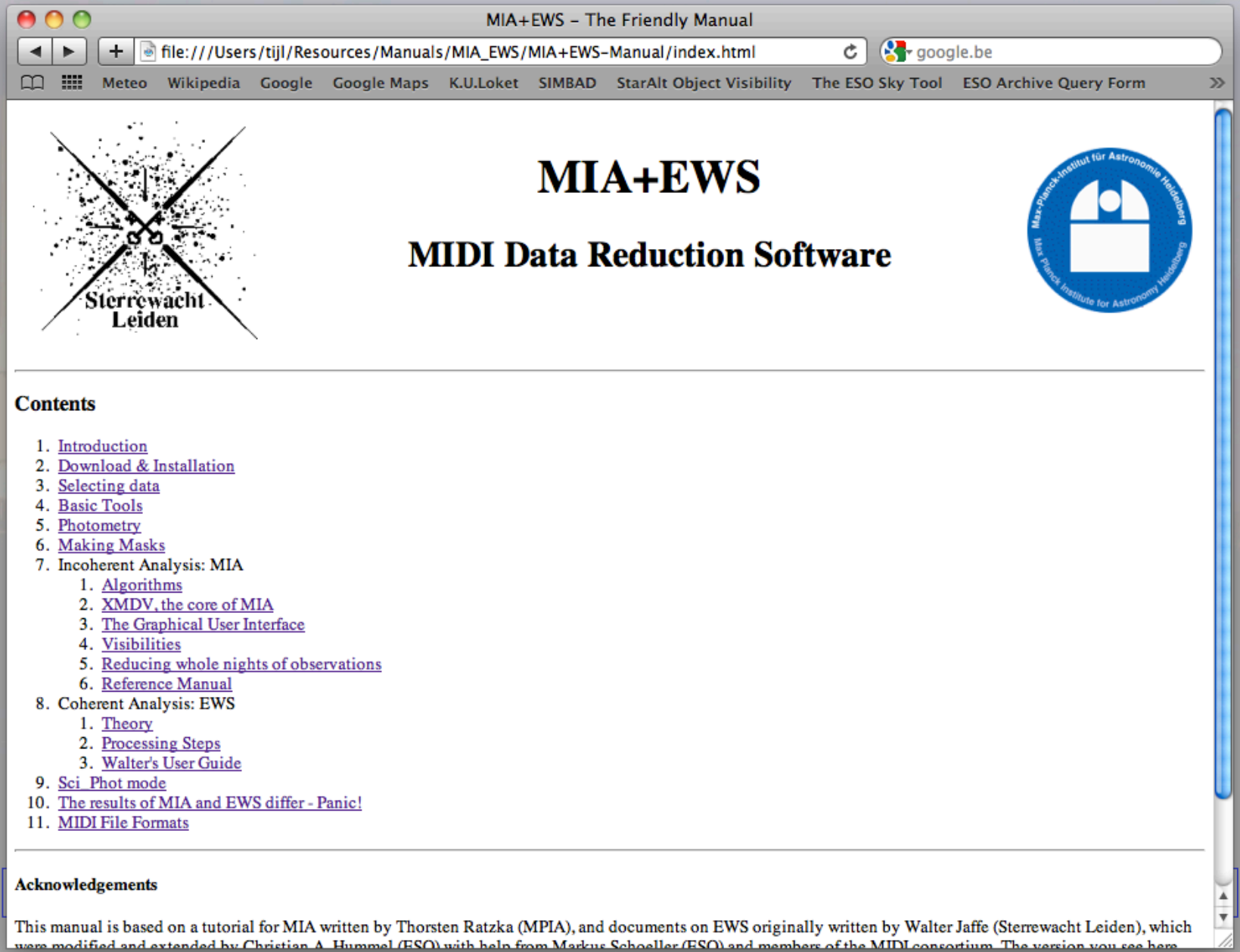
Reducing and calibrating MIDI observations

Walter Jaffe
Rainer Köhler
William Cotton
Olivier Chesneau
Thorsten Ratzka
Quynh Nhu Nguyen
Guy Perrin
Christian Hummel
MIDI/ESO team

Where can one get started?

- http://www.strw.leidenuniv.nl/~koehler/MIA+EWS-Manual (http://mia at the school)
- http://www.ub.uni-heidelberg.de/archiv/5516 : Thorsten Ratzka's PhD thesis
- The ESO webpages: http://www.eso.org/sci/facilities/paranal/instruments/midi/
- Christian Hummel's homepage: http://www.eso.org/~chummel/midi/midi.html

Reducing and calibrating MIDI observations

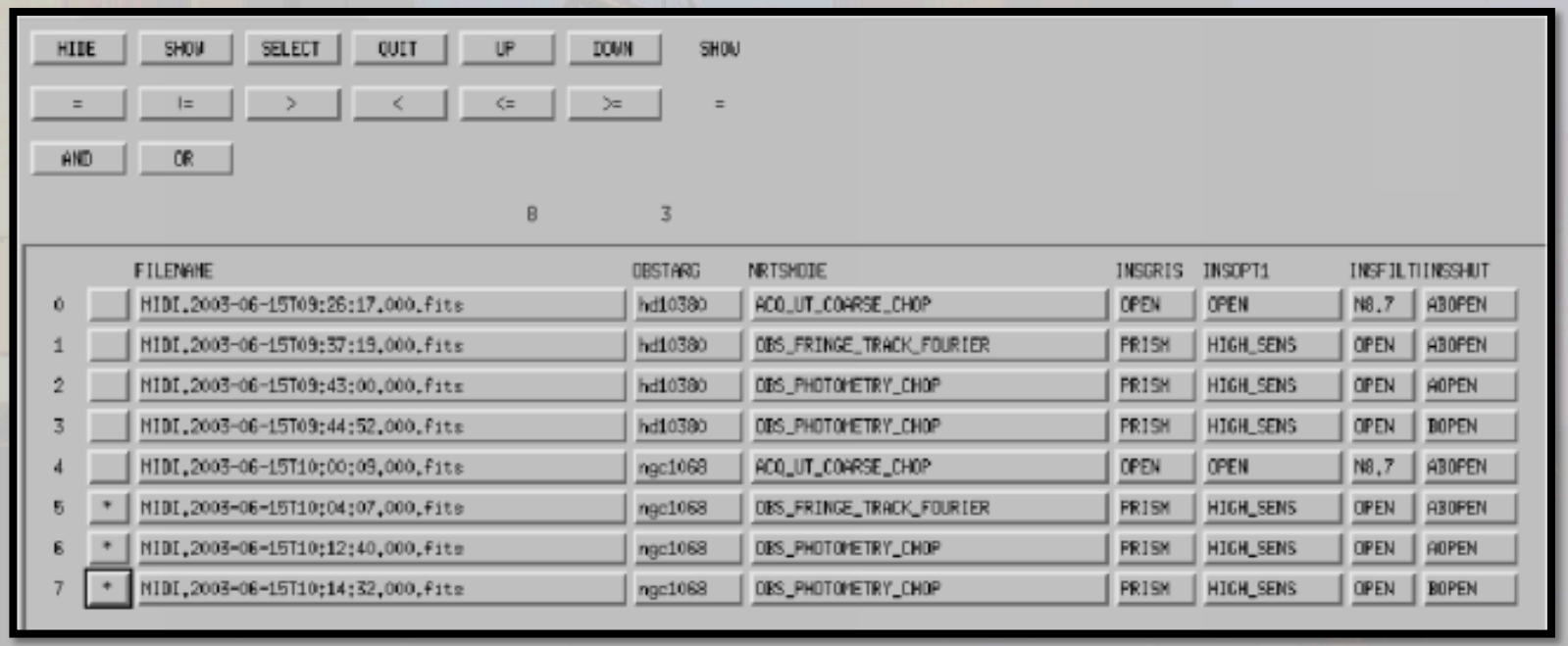


Reducing and calibrating MIDI observations: File sizes

```
MIDI.2003-06-15T09:26:17.000.fits.Z   HD10380 C      Acquisition    20 MB
MIDI.2003-06-15T09:37:19.000.fits.Z   HD10380 C      FringeTrack    110 MB
MIDI.2003-06-15T09:38:35.451.fits.Z   HD10380 C      FringeTrack
(continuation)110 MB MIDI.2003-06-15T09:39:51.901.fits.Z    HD10380 C
      FringeTrack(continuation)106 MB MIDI.2003-06-15T09:43:00.000.fits.Z
      HD10380 C      Photometry (A)         52 MB
MIDI.2003-06-15T09:44:52.000.fits.Z   HD10380 C      Photometry (B)
      52 MB
MIDI.2003-06-15T10:00:09.000.fits.Z   NGC1068 S      Acquisition    30 MB
MIDI.2003-06-15T10:04:07.000.fits.Z   NGC1068 S      FringeTrack    111 MB
MIDI.2003-06-15T10:05:23.451.fits.Z   NGC1068 S      FringeTrack
(continuation)111 MB MIDI.2003-06-15T10:06:39.901.fits.Z    NGC1068
      S      FringeTrack (continuation)107 MB MIDI.
2003-06-15T10:12:40.000.fits.Z        NGC1068 S      Photometry (A)
      52 MB
MIDI.2003-06-15T10:14:32.000.fits.Z   NGC1068 S      Photometry (B)
      52 MB
```

Reducing and calibrating MIDI observations: Selecting data

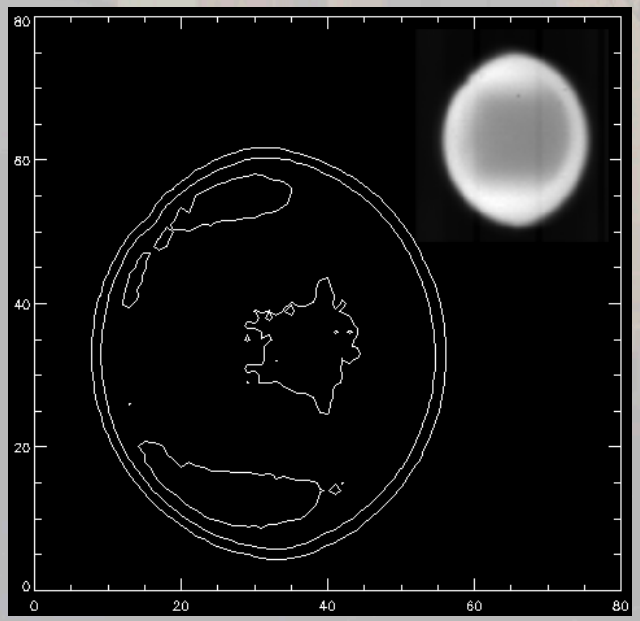
```
Mia:> files=midigui(dir='<path>')
```

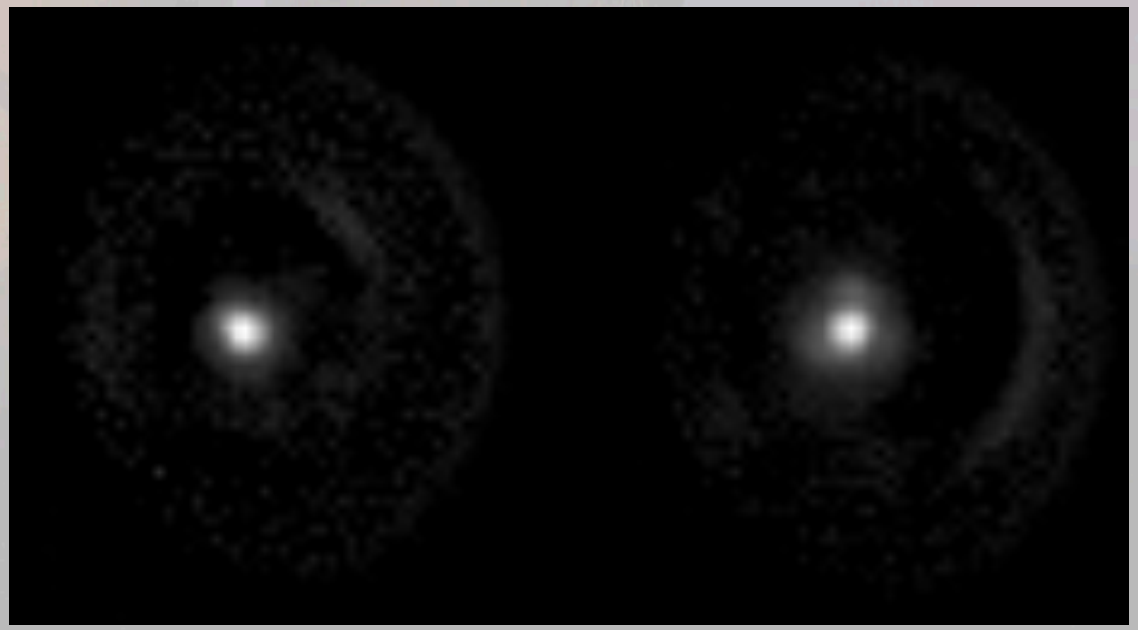



```
Mia:> print, files[i]
```

Reducing and calibrating MIDI observations: Acquisition images

```
Mia:> acq=oirgetdata(files[0])
Mia:> tvsclm,acq[100].data1,5 ; show 101th frame
Mia:> contour,acq[100].data1,nlevels=20
Mia:> chop_nod_phot,files[0]
```





Reducing and calibrating MIDI observations: Acquisition images

---

Aperture Photometry of
MIDI.2003-06-15T09:26:17.000.fits

---

rA= 5 : rB= 5

Flux (photons) - error - Sky - error
MIDI Beam B: 2.8368597e+08 - 747517.64 - 68528.595 - 63923.805

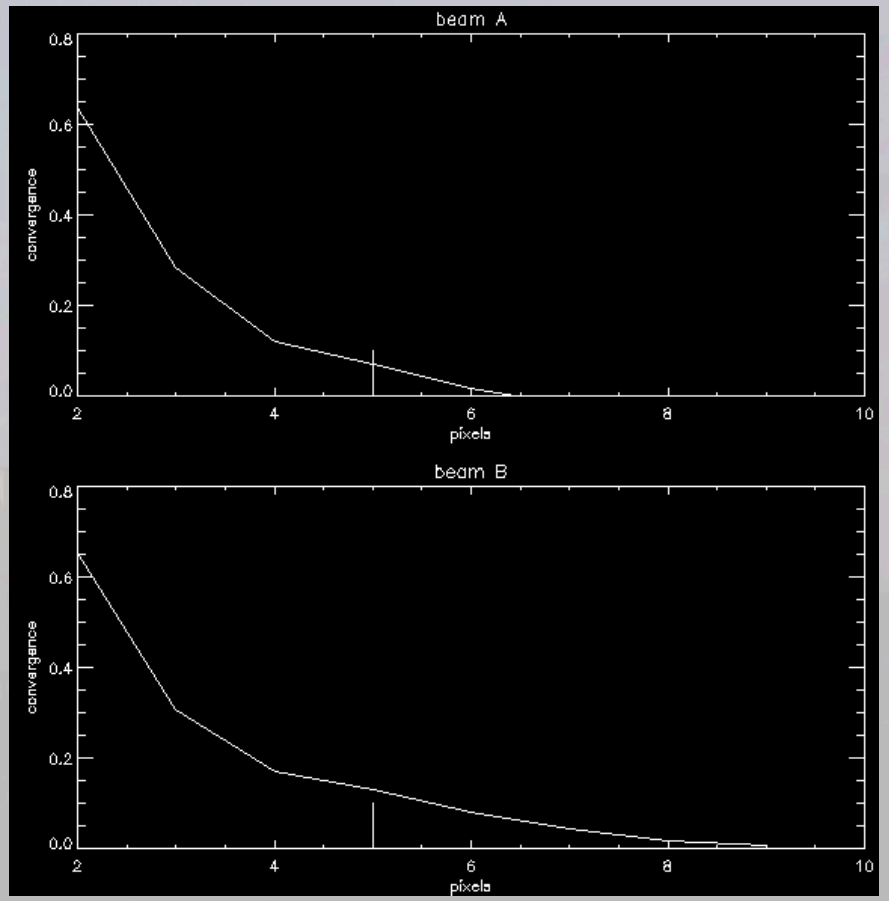
MIDI Beam A: 1.7577727e+08 - 865017.33 - 80041.702 - 76718.819

---

rA= 6 : rB= 6

Flux (photons) - error - Sky - error
MIDI Beam B: 3.0853491e+08 - 940967.04 - 68528.595 - 63923.805

MIDI Beam A: 1.8071686e+08 - 1101247.1 - 80041.702 - 76718.819



All output is written to an ascii file within the newly created subfolder
`'<path>/PHOTOMETRY'`

Reducing and calibrating MIDI observations: Photometry with dispersed data

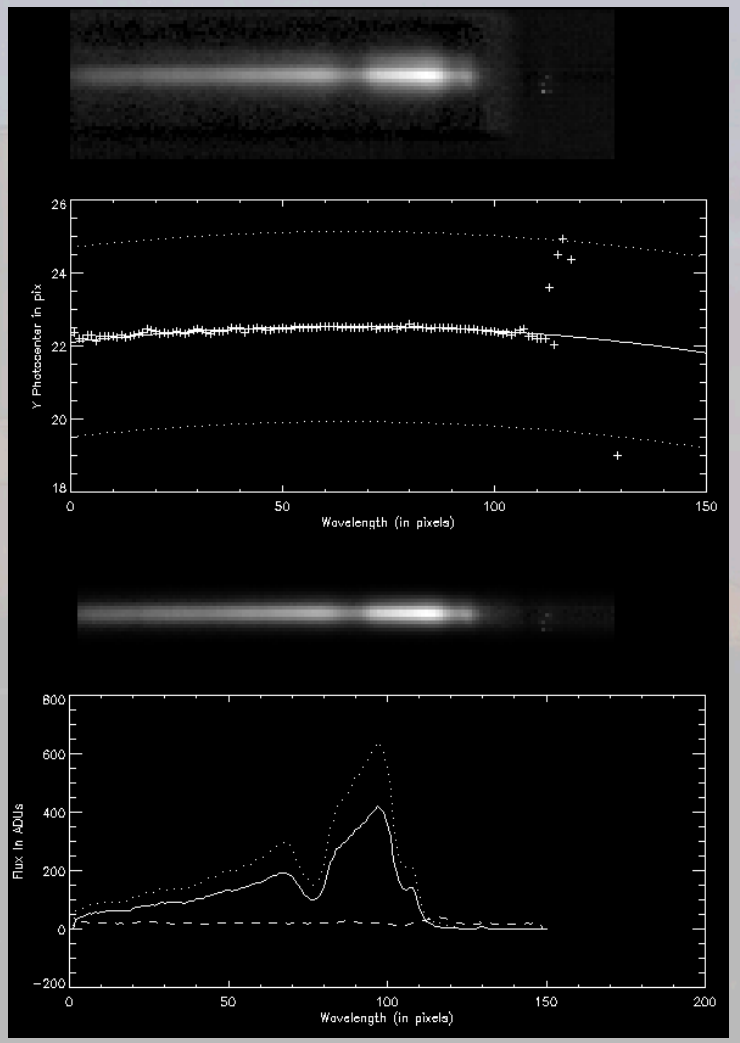
```
Mia:> chop_nod_disp,files[3]
```

Options

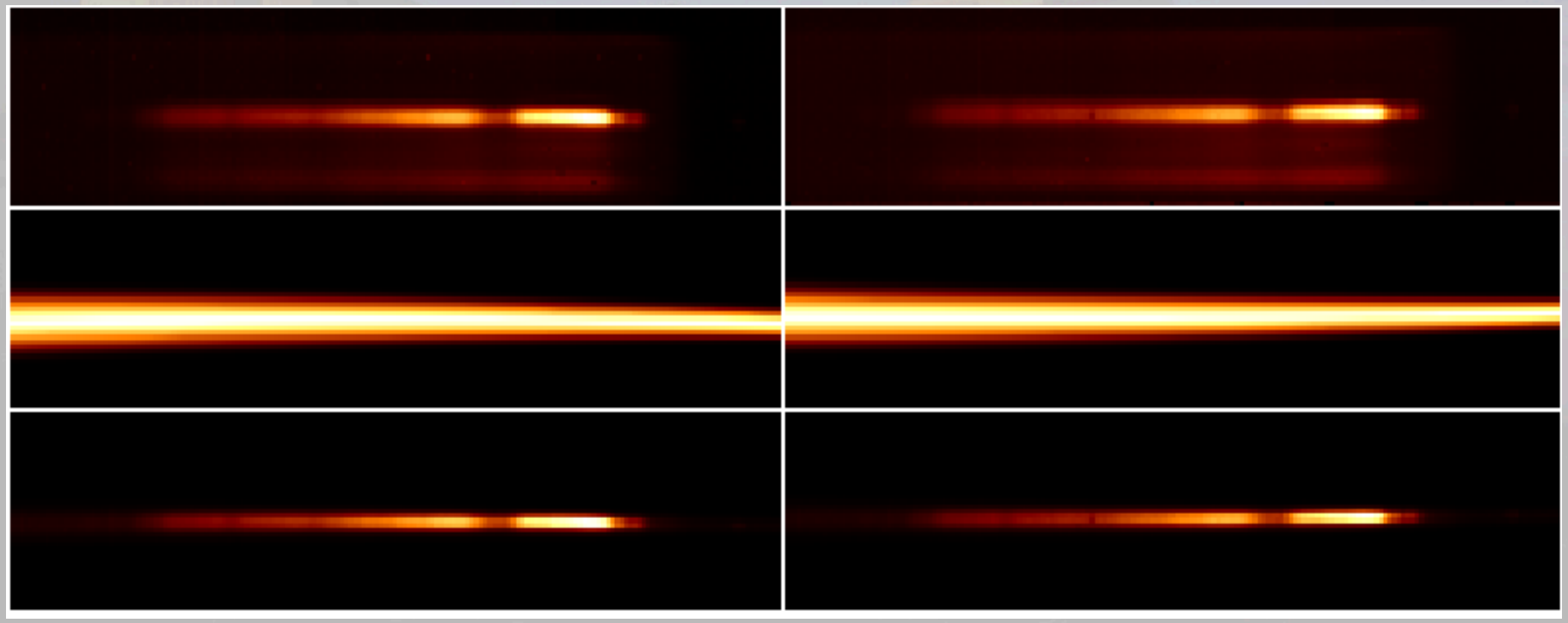
- `WIDTH=w`, width of 1D-gaussian relative to width of fit (by default 1.0)
- `TRACE_ORDER=o`, order of polynopmial used to fit position (by default 2)
- `FWHM_ORDER=o`, order of polynopmial used to fit FWHM (by default 1)
- `BEFORE=b`, number of frames to skip before chop (by default 1)
- `AFTER=a`, number of frames to skip after chop (by default 1)
- `/SILENT` , tells routine to be non interactive

OUTPUT: an ascii file in the directory PHOTOMETRY

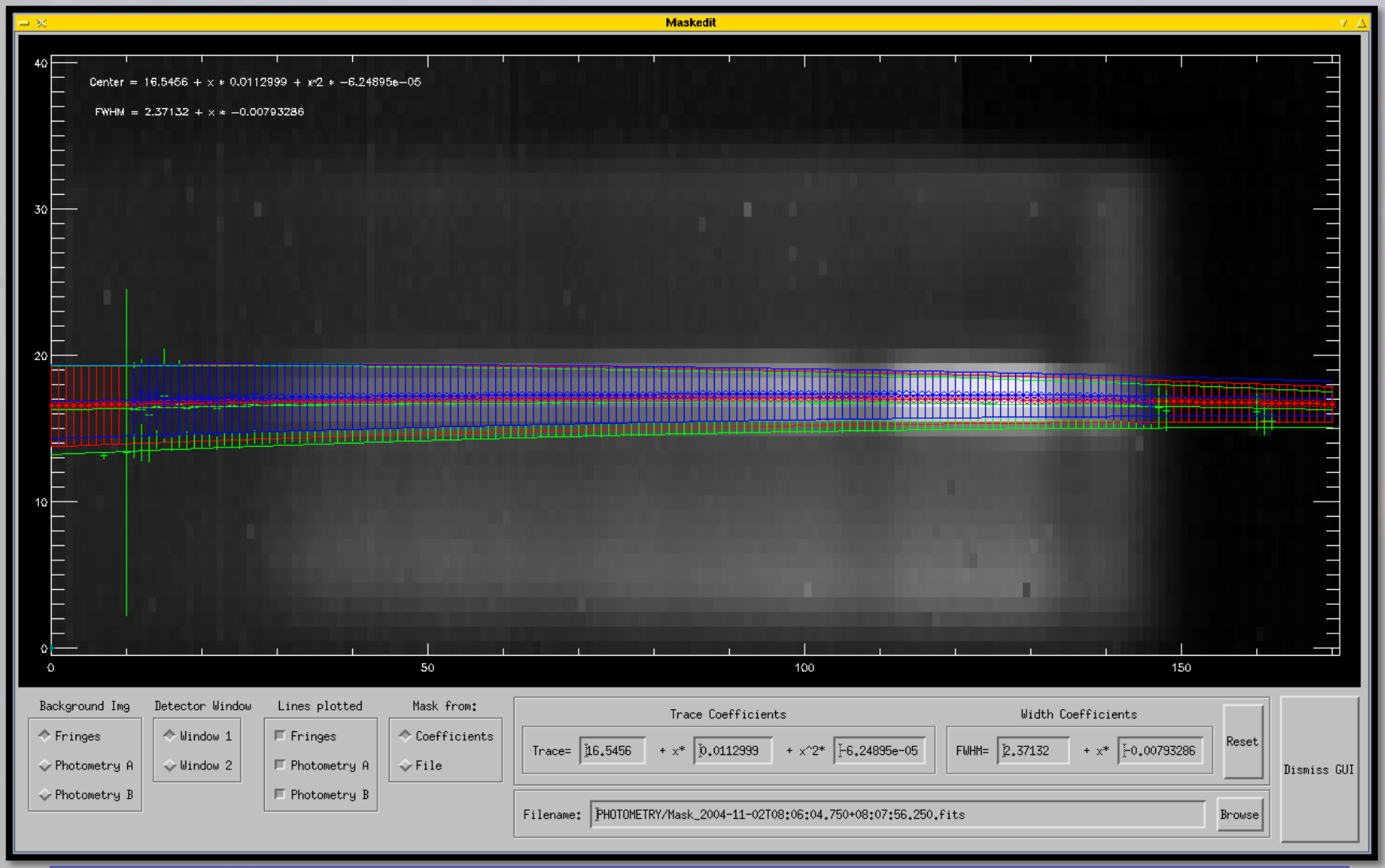
Can be read by the command: readphot, filename



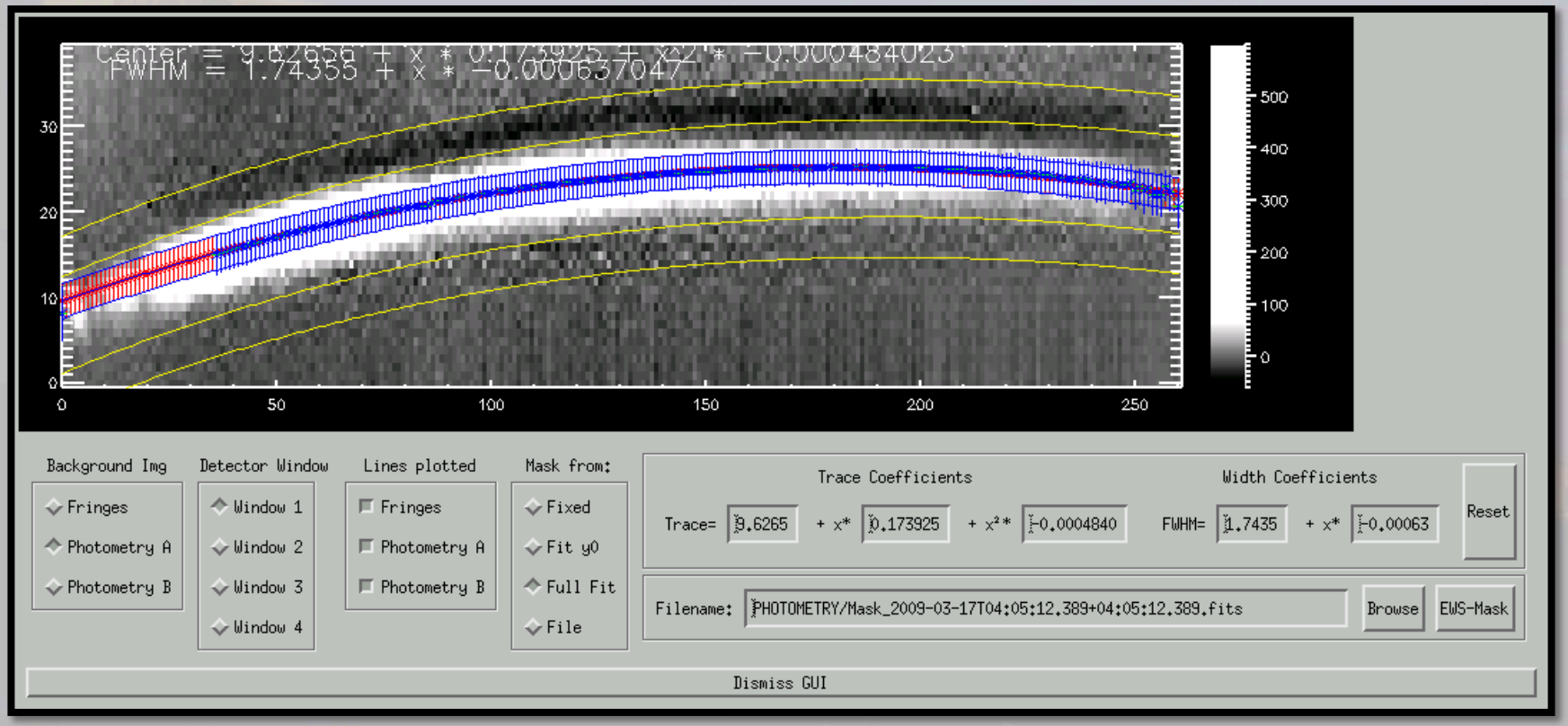
Reducing and calibrating MIDI observations
Intermezzo: the role of the masks



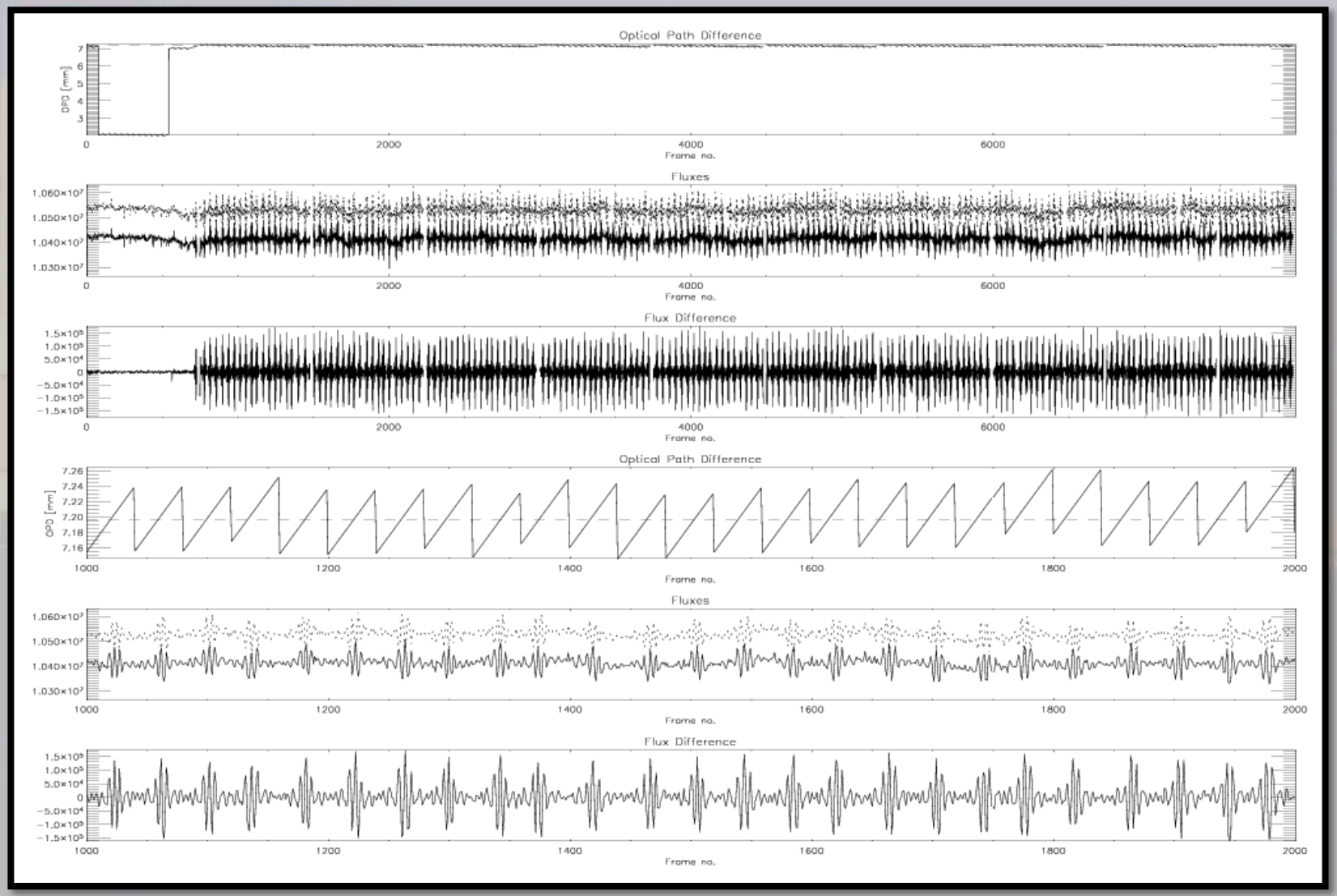
Reducing and calibrating MIDI observations
Intermezzo: the role of the masks



Reducing and calibrating MIDI observations
Intermezzo: the role of the masks

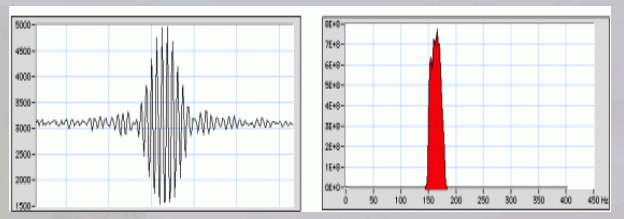


Reducing and calibrating MIDI observations
Measuring the fringes



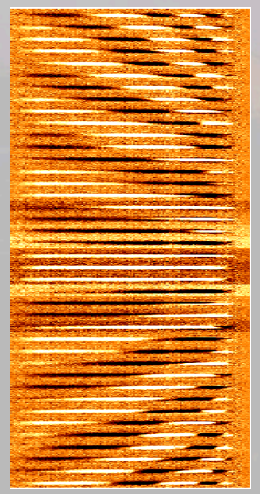
Reducing and calibrating MIDI observations: Measuring the power in the fringes

Incoherent (MIA):



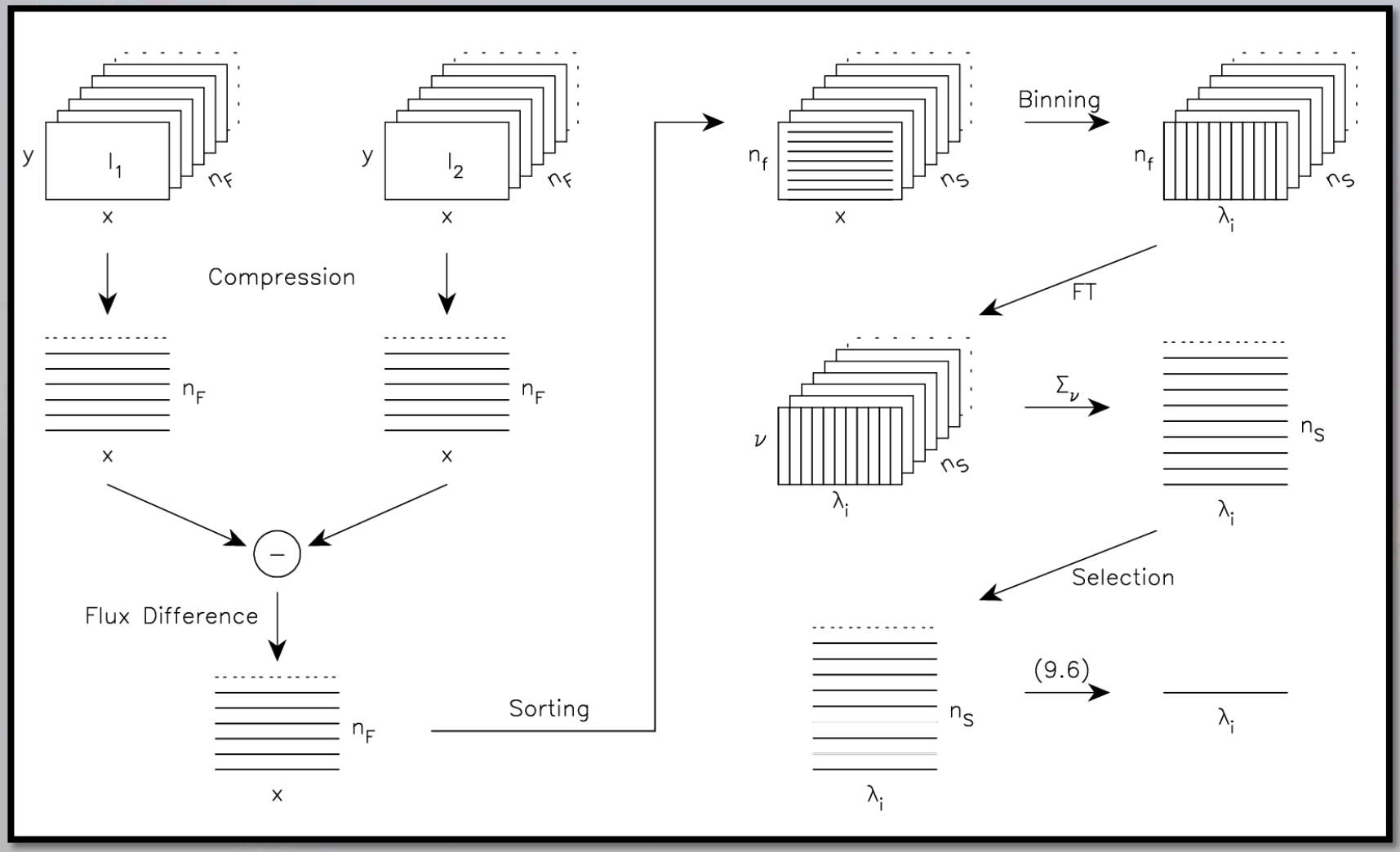
Measure the power in the FT of each fringe scan, and add up these power measurements

Coherent (EWS):



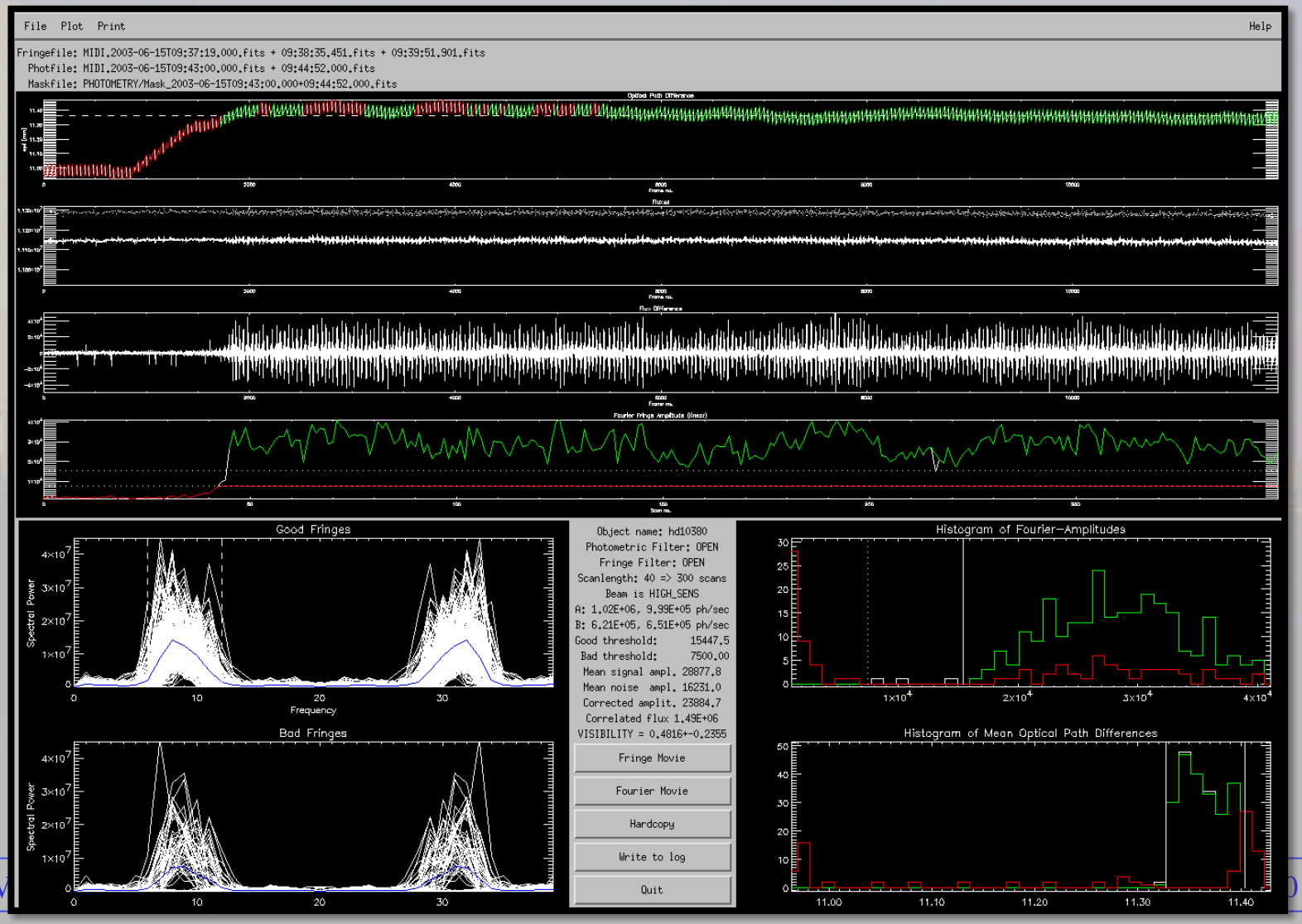
Use the dispersion, and the fact that we don't observe exactly at zero opd, to estimate the zero-opd location for each scan. Co-phase them, add them up, and then FT.

Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis

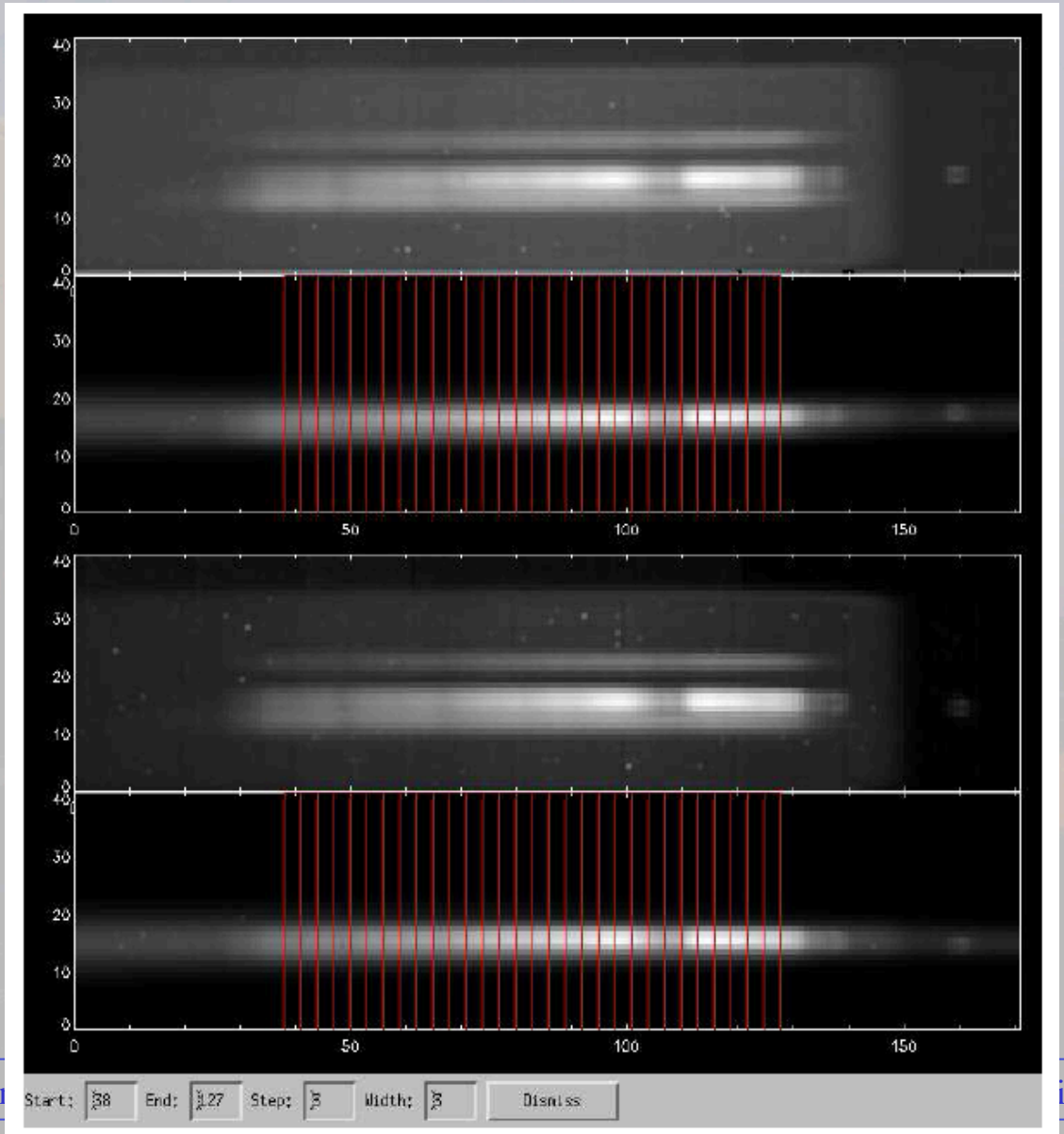


Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis

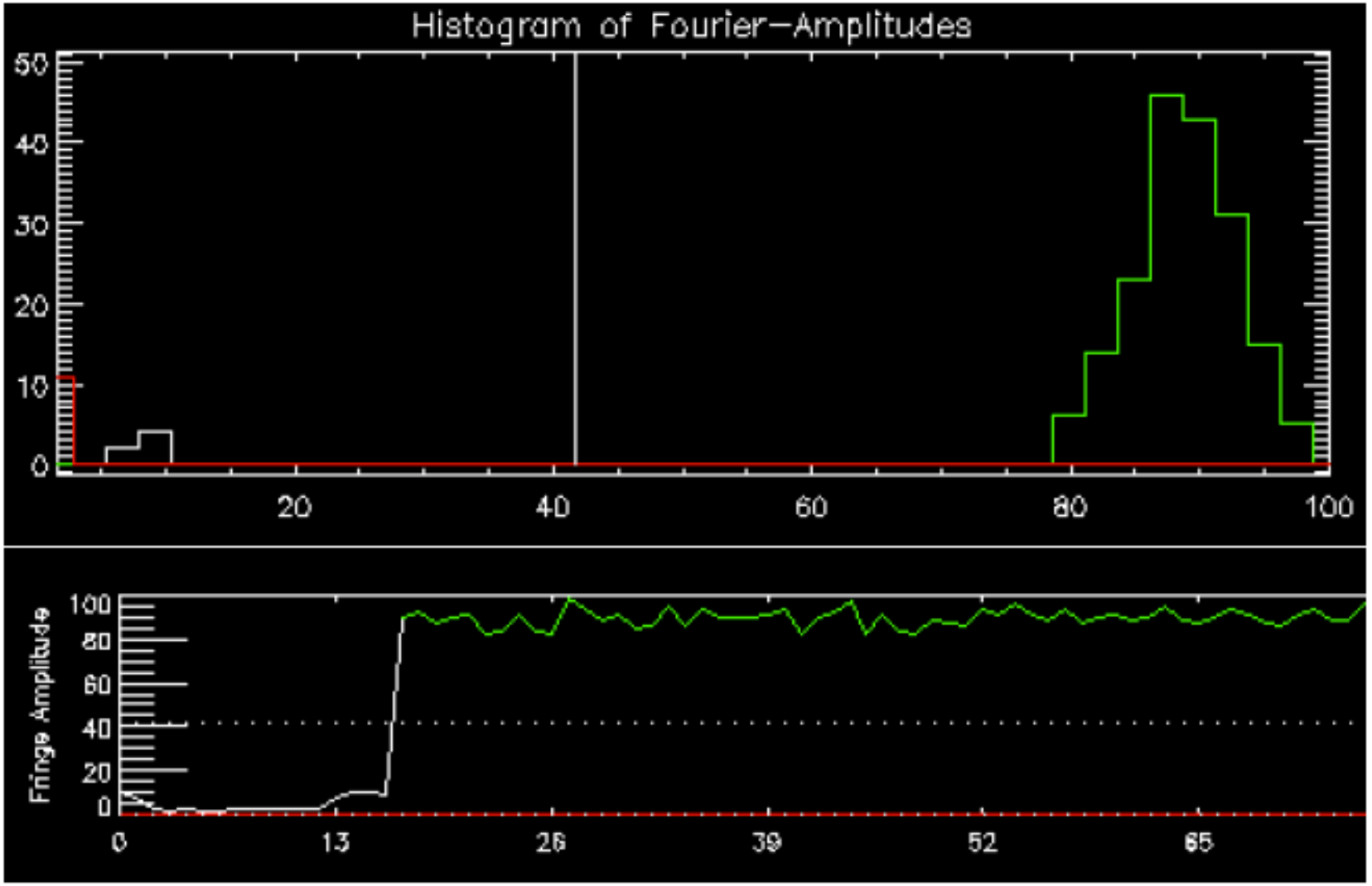
```
Mia:> cal=xmdv(calfiles) & cal->gui,/tru
```



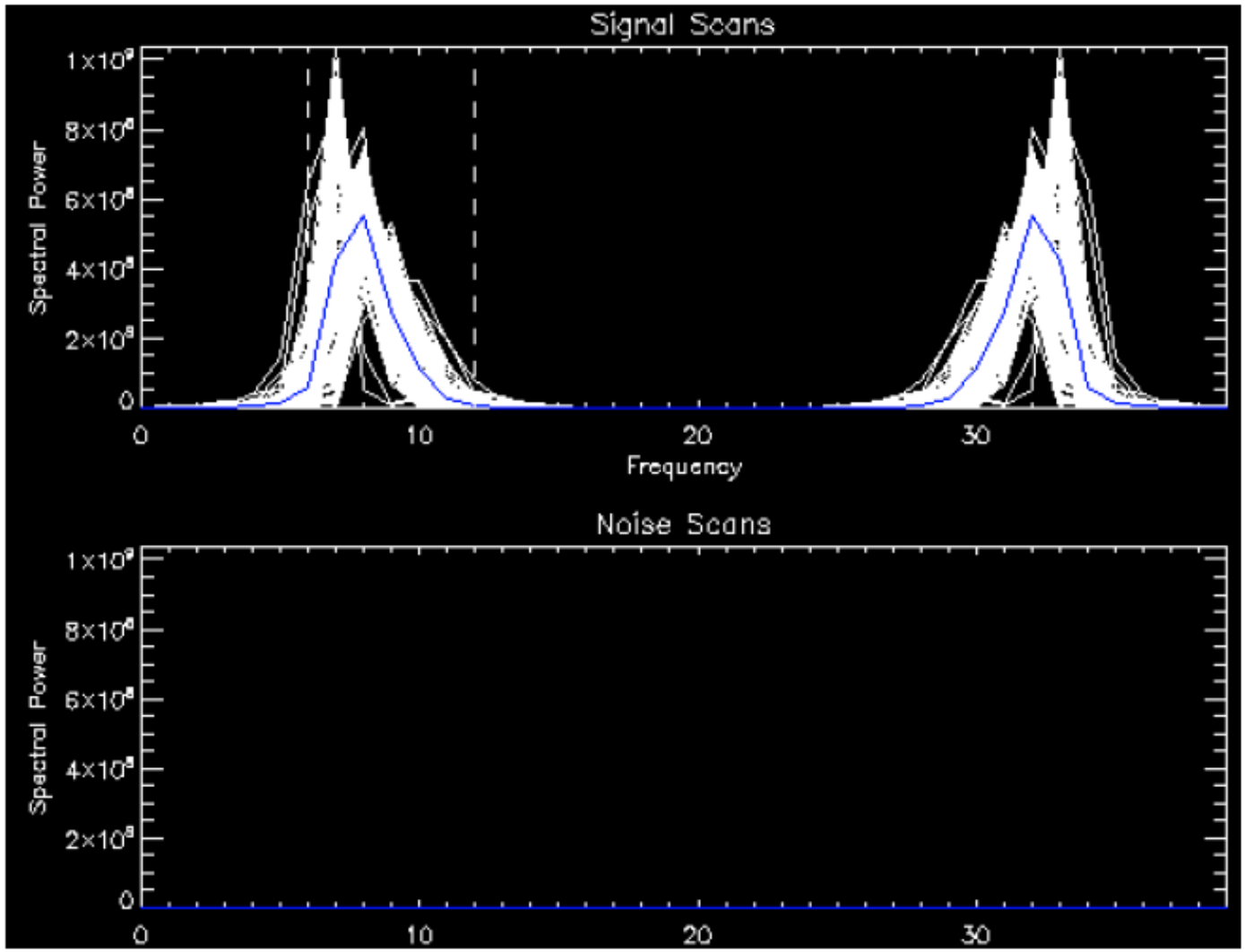
Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis



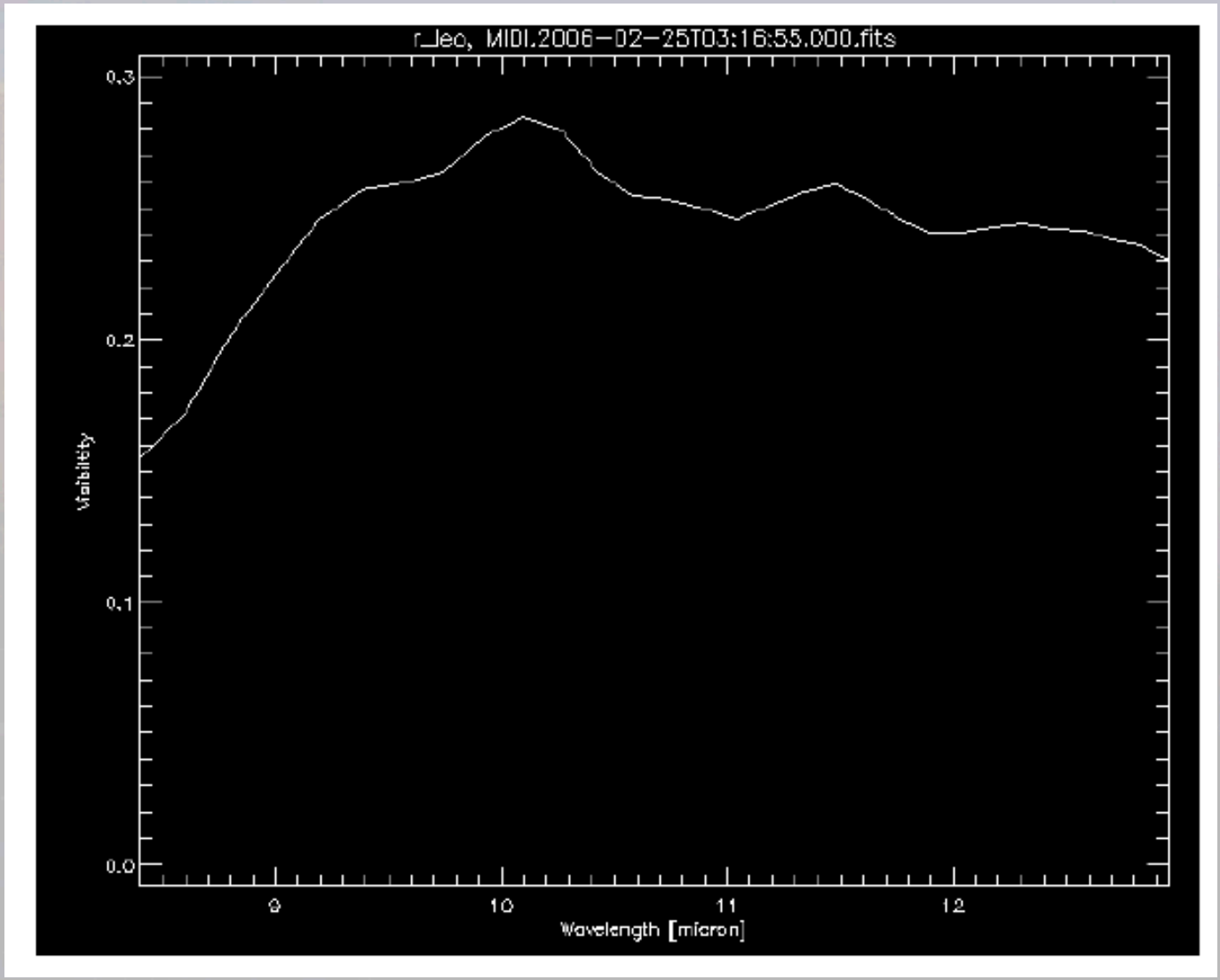
Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis



Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis



Reducing and calibrating MIDI observations
Incoherent HIGH-SENS analysis



Reducing and calibrating MIDI observations
Calibrating

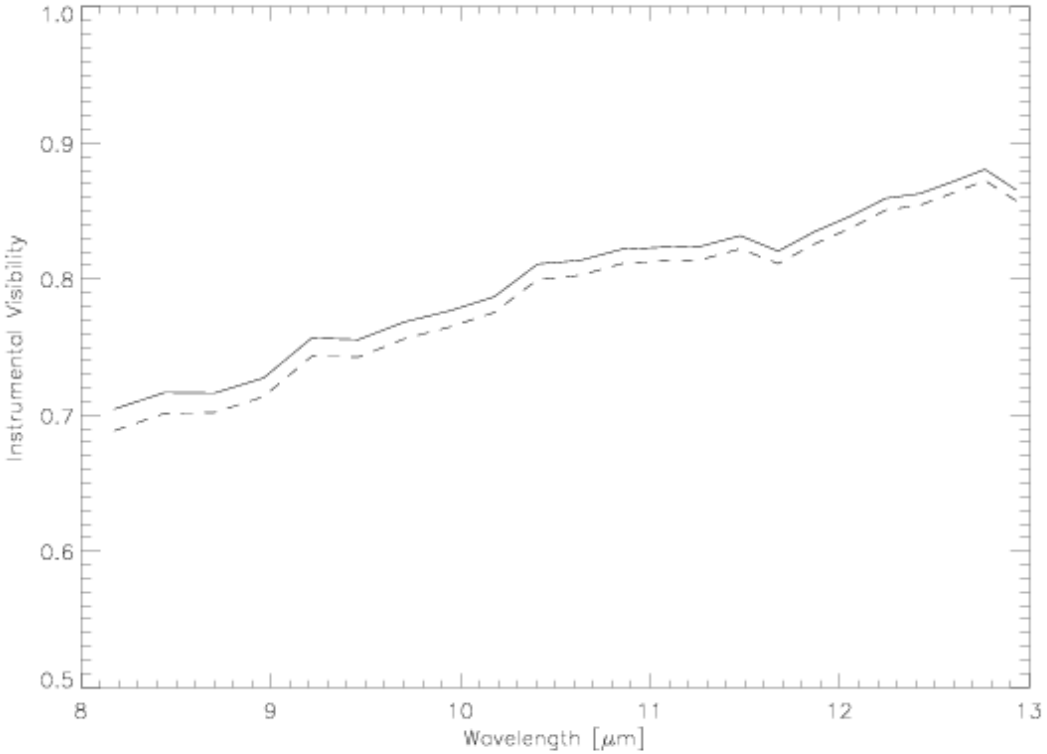
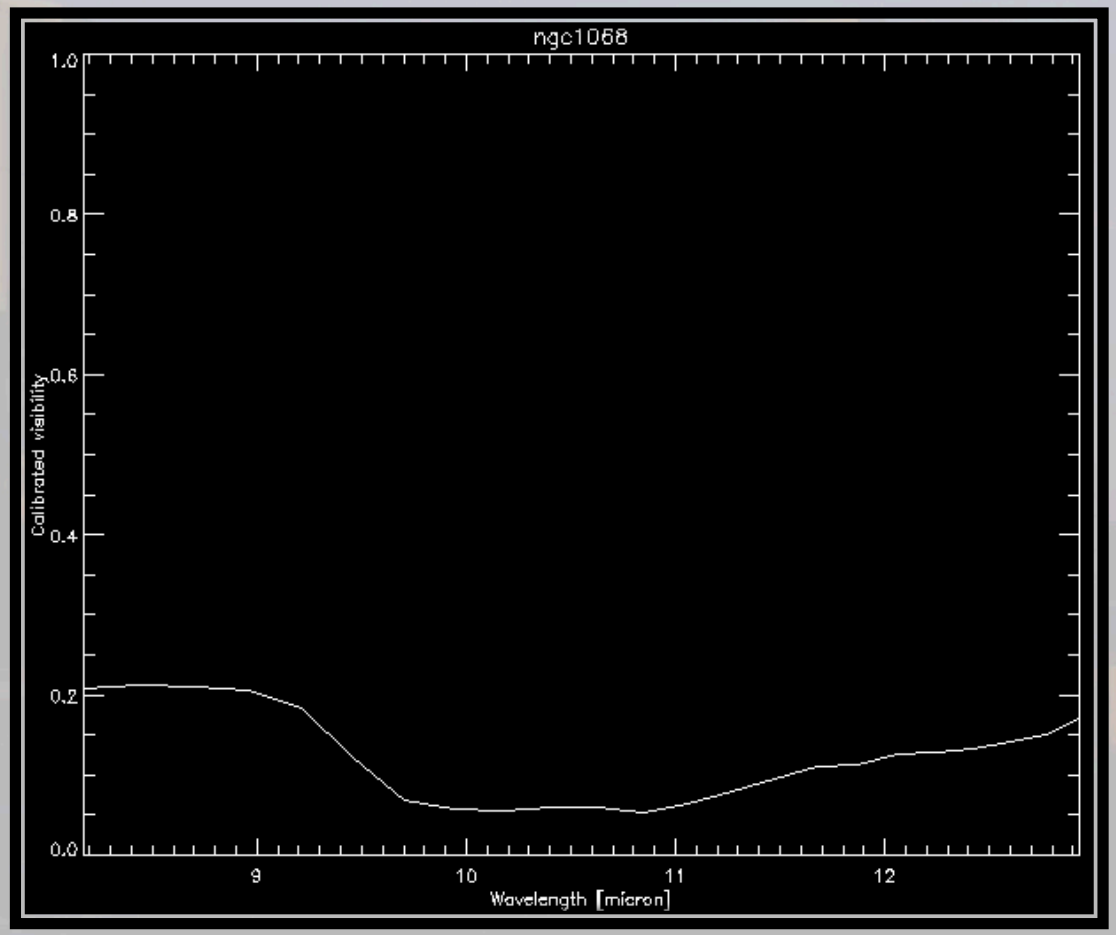


Figure 9.22: The raw visibility (dashed) of HD 50778 and the instrumental visibility (solid) derived from it.

Reducing and calibrating MIDI observations
Calibrating

Mia:> *calvis = sci->calibratedvisi(cal,/VISPLOT)*



Now go out and propose, observe, reduce, analyse, and publish!