

Mini Workshop Interferometry

ESO Vitacura, 28 January 2004

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MIDI

(MID-infrared Interferometric instrument)

- 1st generation VLTI instrument
- 2-beam recombination
- Unit Telescopes or Auxiliary Telescopes (1.8 m)
- Covered wavelengths = 8 to 13 μm (N-band)

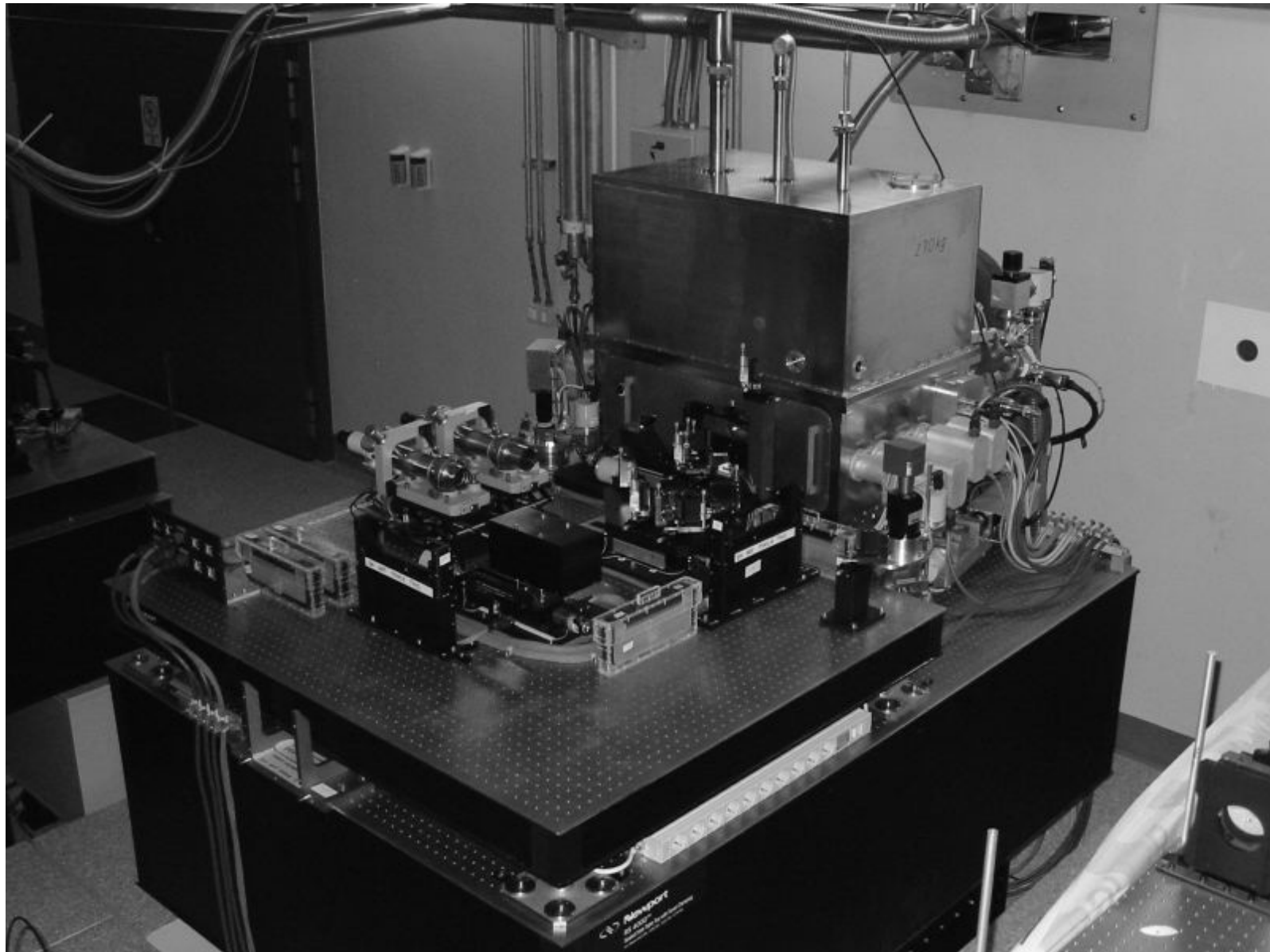
The MIDI Consortium:

Major contributions

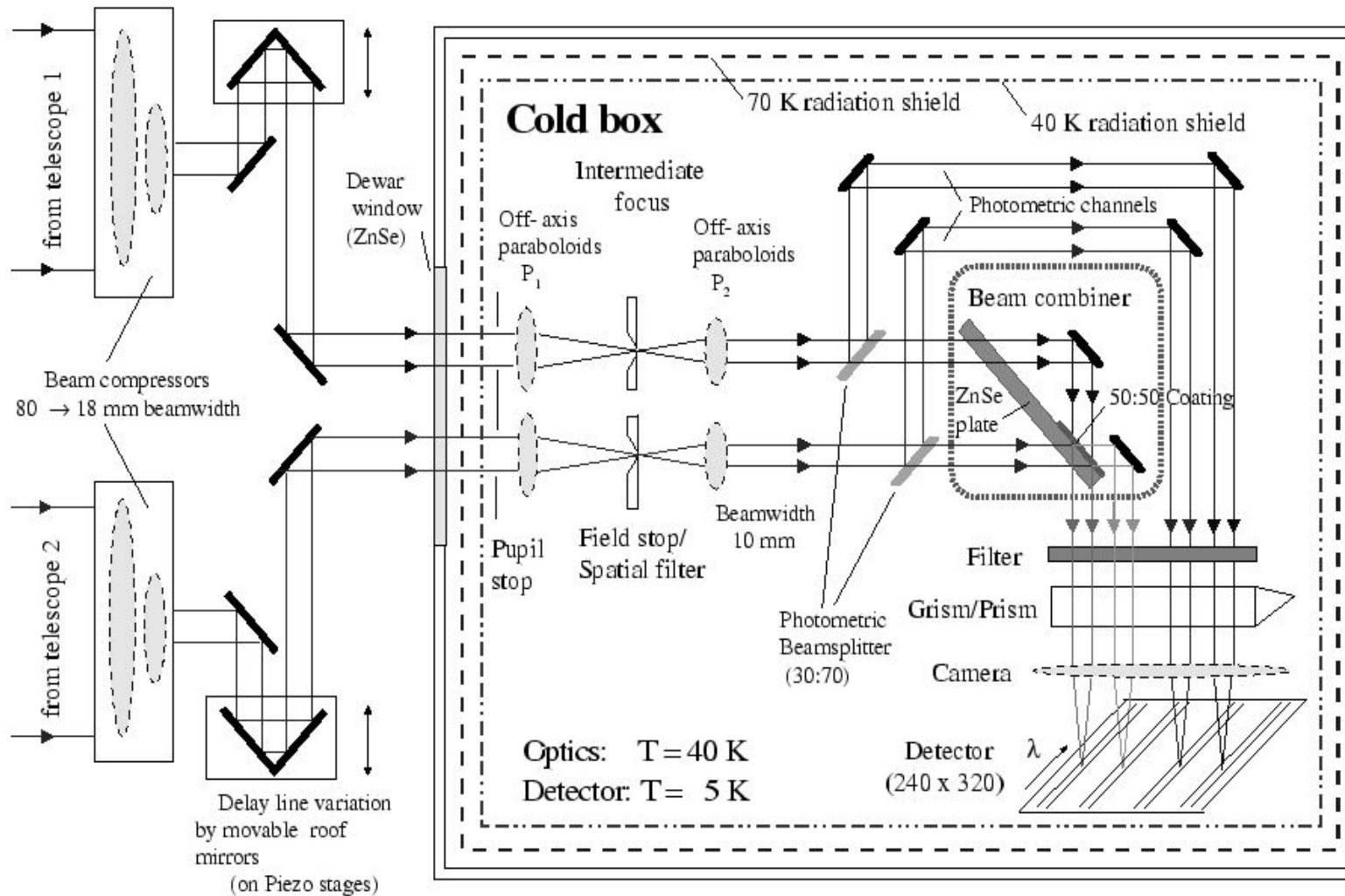
- Max-Planck Institut für Astronomie (Heidelberg, D): cryostat, control electronics, detector, OS, ICS, “GEIRS” (low level DCS).
- ASTRON, (Dwingeloo, NL): cold optics (bench inside cryostat).
- NEVEC, (Leiden, NL): NRTS (high level DCS), first templates.
- Kiepenhauser Institut für Sonnenphysik (Freiburg/Bresgau, D): warm optics (bench outside cryostat).
- DESPA (Meudon, F): single mode fibers (not implemented yet).

MIDI Milestones

- February 2000: Final Design Review (hardware)
 - April 2001: Final Design Review (software)
 - September 2002: Preliminary Acceptance Europe
 - November 2002: Integration at Paranal
 - December 2002: First fringes
 - March 2003: Commissioning #1
 - May 2003: Commissioning #2
 - June 2003: Paranalization #1, Science Demonstration #1, GTO #1
 - August 2003: Paranalization #2
 - September 2003: Paranalization #3
 - November 2003: Science Demonstration #2
 - December 2003: Commissioning #3
- + Technical time on UT3 only (useful for acquisition tests).

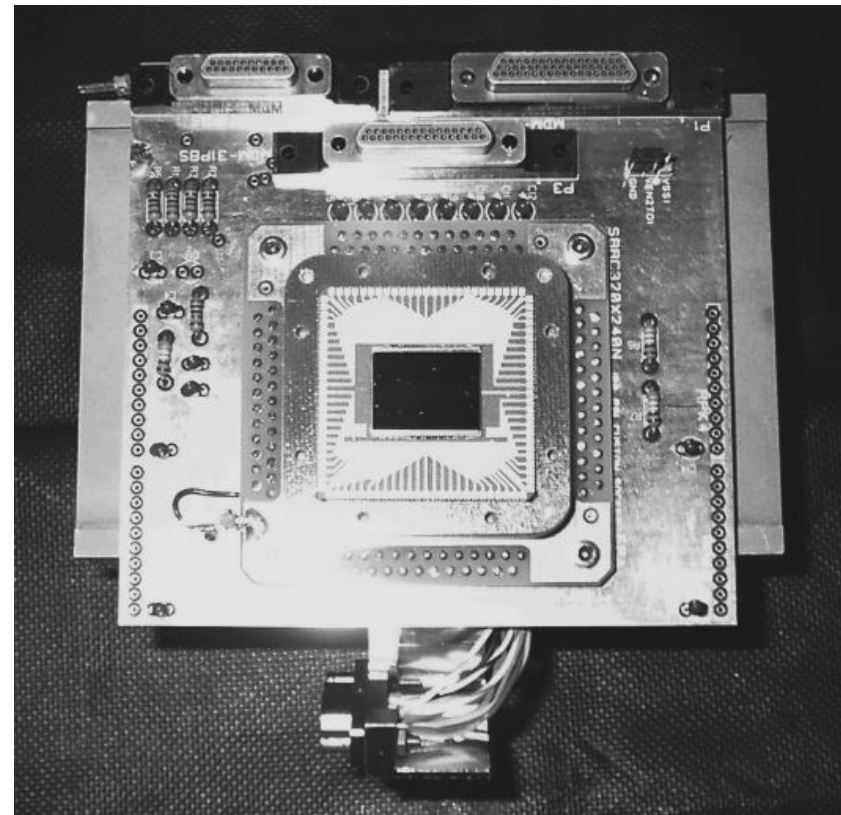


Principle of MIDI - the MID- infrared Interferometer for the VLTI



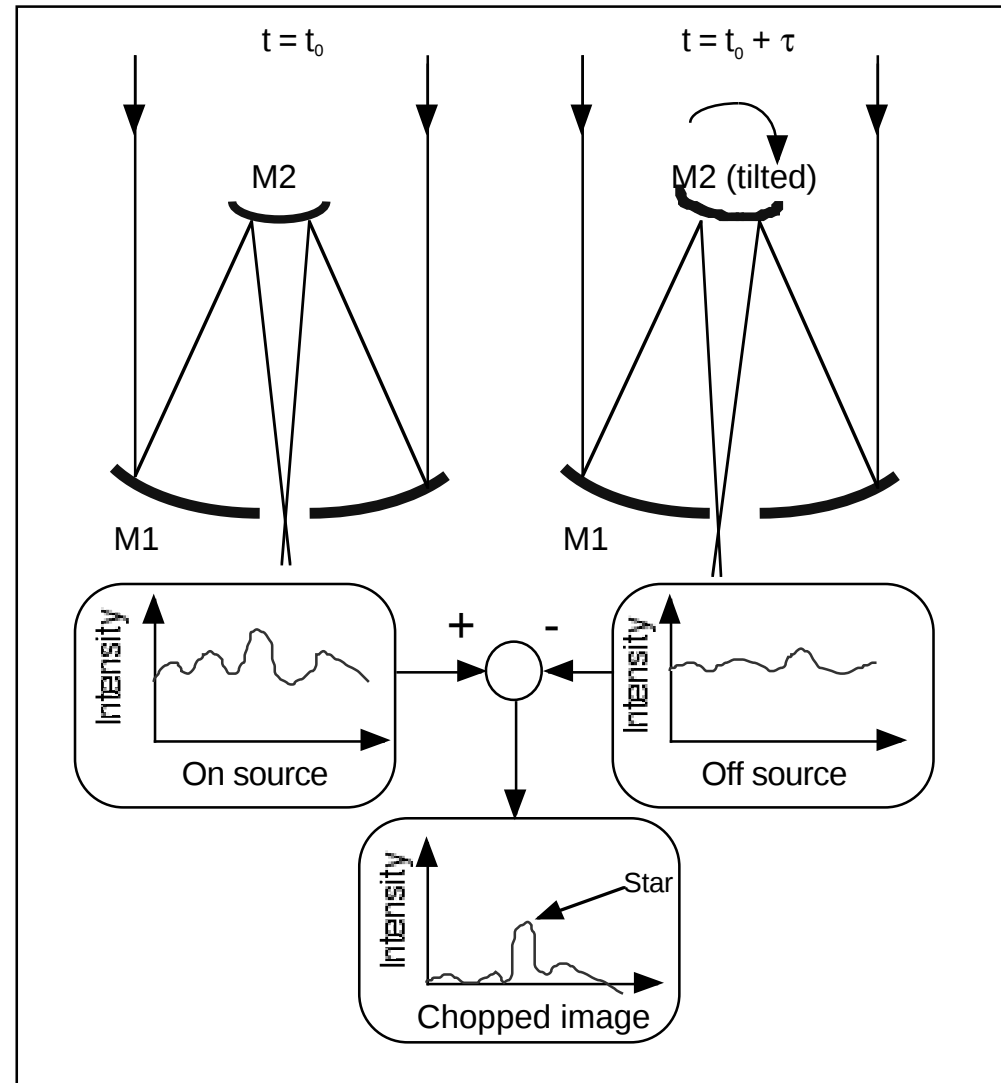
The MIDI Detector

- Raytheon Si:As (IBC)
- 320 x 240 pixels
- Full frame readout time= 6 to 7 ms
- Windowing (row selection)
- 2000 e- (!) readout noise



Problems of mid-IR observations

- Sky glows with spatial and temporal fluctuations of intensity (H_2O vapor).
- Thermal emission of optics proportional to ϵT^4
- Mirrors: $\epsilon \approx 0.05$
- $\Rightarrow$ Requirement for chopping



Other peculiarities of mid-IR observations

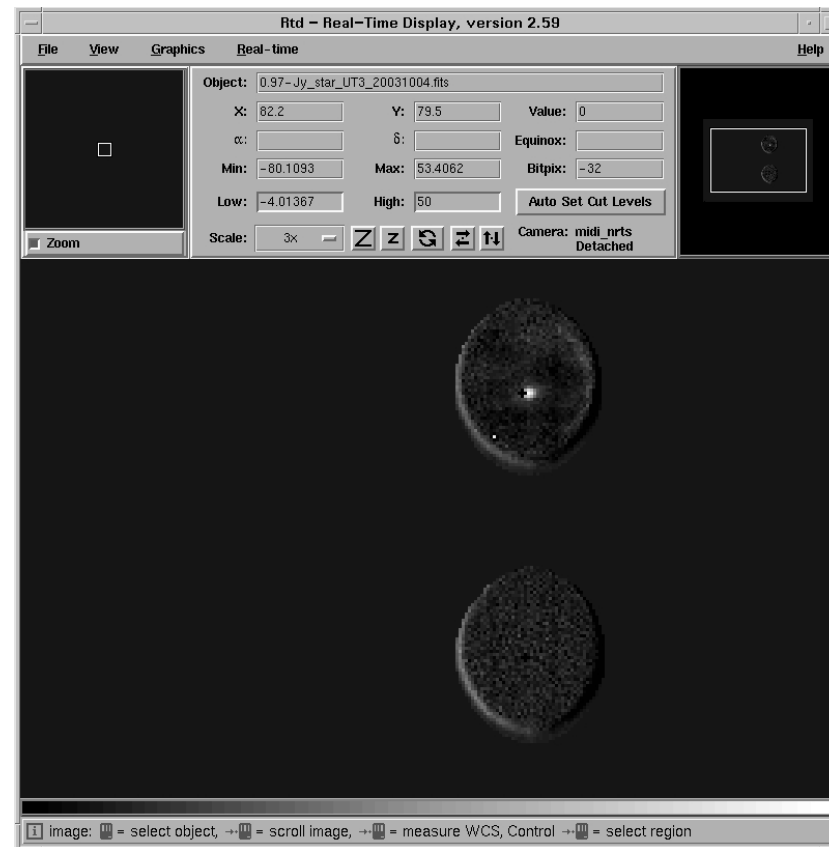
- Atmospheric Seeing !
 - r_0 and τ_0 are proportional to $\lambda^{6/5}$
 - ➔ Diffraction-limited images on MIDI if tip-tilt corrected (if DIMM seeing better than ≈ 0.8 arcsec).
 - Tip-tilt corrected by STRAP (APD quadrant sensor acting on M2).
 - ➔ $\tau_0 \approx 100$ ms. “Slow” scan possible (better SNR)
- However, DIT is limited by saturation from sky background.
 - To increase DIT: spread photons over pixels by spectral dispersion
 - ➔ DIT= 16 ms instead of 0.6 ms in non-dispersed (N-band filter).
 - Be careful of non-linearity of detector (starting at 45000 ADUs).

MIDI data archiving

- Classic VLT instrument $\approx$ digital still camera.
- MIDI $\approx$ fast (160 frames/s) video camera.
- ➔ Data production rate $\approx$ 40 Gbytes/night after optimization !
- Optimization:
 - Hardware windowing: row selection by detector clocking patterns.
 - Software windowing: column selection by real-time post-processing.
- Difficulties to store data on off-line workstation. Old data has to be gotten from Paranal DHA as DVD copies.

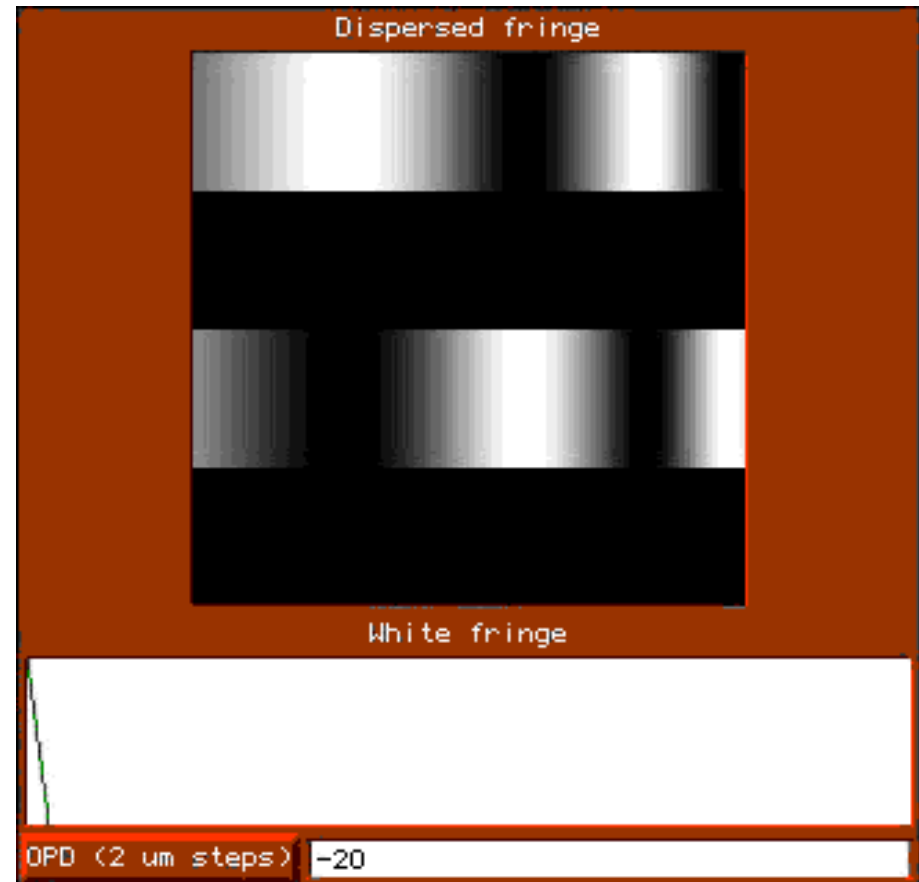
MIDI Imaging Mode

- Used for acquisition. Can be used for fringes (not very interesting).
- Removal of background: M2 chopping at 2 Hz typically.
- Filtering around $8.7 \mu\text{m}$ to help to reduce background.
- Acquisition: offset M2 (STRAP guiding) to overlap beams and get fringes.



MIDI Dispersed Fringe Mode

- Prism (R=30) used.
- Background removal: subtraction of interferometric signals (phase opposition)
- “Fourier mode”:
 - 8 to 12 fringes ($\langle \lambda \rangle$) / scan
 - 5 frames (OPD samples) / fringe
- If no photometric channels, “photometry exposures” (one beam only with beam combiner inserted) required for data reduction.



MIDI in open time P73 (April-September 2004)

- One mode offered only: prism, high sensitivity (no photometric channel), no filter.
- Allocation as slots (1 hour/calibrated visibility).
- Observation blocks very simple to build (OB description: 2 templates, 6 user keywords to set in templates for the whole OB !)

The screenshot displays the MIDI software interface for configuring an observation block. The main window has a menu bar with 'File', 'Edit', 'Synchronise', and 'FindingCharts'. Below the menu bar, there are several input fields for block metadata: 'Name' (UT2UT3_SCI_H076294), 'Status' (Defined), 'Execution Time' (00:30:00.000), 'User Priority' (1), and 'OD Name' (No Name). To the right of these fields is a table for 'Template Type' and 'Template'. The 'Template Type' column has entries for 'acquisition', 'science', 'calib', and 'test'. The 'Template' column has a single entry 'MIDI_starintf_acq'. To the right of this table are buttons for 'Add', 'Delete', 'Duplicate', and 'Recalc ExecTime'. Below these fields is a 'User Comments' text area. The main part of the interface is a table with two columns: 'MIDI_starintf_acq' and 'MIDI_starintf_obs_fringe_sci'. The table has several rows for parameters: 'Amplitude of chop in arcseconds on sk...' (15), 'Angle on chop (0-399 degrees)' (0), 'Coude guide star alpha' (0), 'Coude guide star delta' (0), 'Coude guiding mode' (SCIENCE), and 'Coude guide star magnitude in V' (12). At the bottom of the interface, there are tabs for 'Target', 'Constraint Set', 'Time Intervals', and 'Calibration Requirements'. The 'Target' tab is selected, showing fields for 'Name' (No Name), 'Sky Transparency' (Variable, thin cirrus), 'Seeing' (2.0), 'Strehl R. % (NACO only)' (0.0), 'Airmass' (5.0), 'Lunar Illumination' (1.0), and 'Moon Angular Distance' (30).

MIDI_starintf_acq	1	MIDI_starintf_obs_fringe_sci	1
Amplitude of chop in arcseconds on sk...	15		
Angle on chop (0-399 degrees)	0		
Coude guide star alpha	0		
Coude guide star delta	0		
Coude guiding mode	SCIENCE		
Coude guide star magnitude in V	12		

Target	Constraint Set	Time Intervals	Calibration Requirements
Name:	No Name	Airmass:	5.0
Sky Transparency:	Variable, thin cirrus	Lunar Illumination:	1.0
Seeing:	2.0	Moon Angular Distance:	30
Strehl R. % (NACO only):	0.0		

MIDI Perspective

- Photometric channels

- 2% - 4% visibility accuracy.
- Commissioned in December 2003.
- Perhaps offered for P74.

- Grism

- $R > 200$
- Commissioned in December 2003
- Certainly offered for P74.

- MIDI + FINITO (fringe-tracker at $\lambda = 1.6 \mu\text{m}$)

- Limiting magnitude $N = 10 \text{ mJy}$ (with UTs).
- Commissioning end 2004 ?

- MIDI + Auxiliary Telescopes

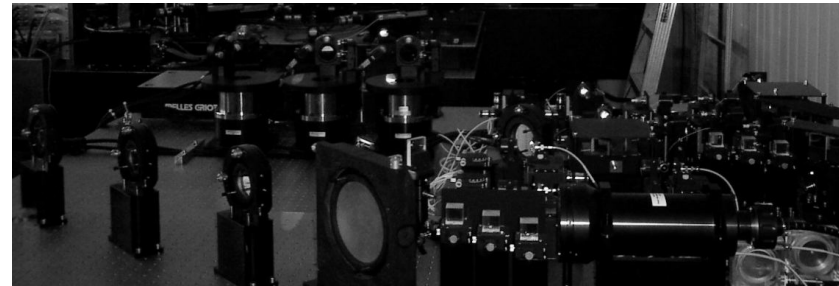
- Limiting magnitude $N = 0.2 \text{ Jy}$ (with FINITO).
- Commissioning ?

- Q-band ($\lambda \approx 20 \mu\text{m}$) mode

- TiC, SiO₂, FeS, FeO, [FeI] ,...
- Study of YSO environment .
- Installation end 2005 ?

- Single mode fibers (spatial filtering)

- 1% visibility accuracy.
- Installation ?



More information on MIDI

- <http://www.eso.org/instruments/midi>