MIDI

The MIDI-Infrared Instrument for the VLTI

Two beam interferometry at 7-14 µm

The MIDI project - problems and solutions

Uwe Graser, Ringberg, 1.-5. September 2003

The MIDI project

- The MIDI consortium/organization
- MIDI milestones
- MIDI basics

The challenges:

- New field: mid-IR interferometry on very large telescopes
- Interfaces (Paranal/VLTI/ESO/consortium)

MIDI critical points:

- Fluctuating high background
- Alignment
- Vibrations
- .....

The MIDI consortium/Organization:

- **Max-Planck-Institute for Astronomy, Germany**
  PIs: Leinert (P-Scientist), Graser (P-Manager)

- **NOVA, Netherlands: Co-PI: Rens Waters**
  ASTRON/Dwingeloo (Cold optics)
  NEVEC/Leiden (SW: NRTS, EWS, SW-Manager: W.Jaffe)

- **France: Co-PI: Guy Perrin**
  Paris/Meudon, France (Fiber, SW: DRS)
  Observatoire de Nice (Chair of science group: B. Lopez)

- **Kiepenheuer Institut, Freiburg, Germany**
  (Warm optical bench)

- **Landessternwarte Tautenburg, Germany (Calibrators)**

(ESO Instrument-scientist: M. Schöller/Andrea Richichi)

MIDI Milestones

16/17 Jun 1997	*First MIDI-meeting at MPIA*
15-17 Jul 1997	*ISAC-Meeting at ESO*
9 Dec 1997	*Steering committee at ESO*
15-17 Jul 1998	*Internal concept Review at MPIA*
15 Dec 1998	*Concept Design Review at ESO*
29 Jul 1999	**Final Design review Optics**
29 Feb 2000	**Final Design Review MIDI**
10 Sep 2002	**Preliminary Acceptance Europe**
4.11.-15.12.2002	**Assembly, Installation, Verification, Paranal**
15 Dec 2002	**MIDI first fringes with UT's (UT1, UT3)**
20-24 Feb 2003	**First commissioning, Paranal (2 n_{eff})**
16-21 May 2003	Second commissioning, Paranal (3 n_{eff})
7-13 Jun 2003	First GT- and SDT observations, Paranalization
Aug, Sep 2003	Paranalization
6-9 Nov 2003	SDT
11.-15. Dec003	Third Commissioning
27.1-9.2. 2004	Paranalization, GTO, SDT
spring 2004	Open for community (in commissioned modes only)

(SDT = Science demonstration time, GTO = Guaranteed time observation)

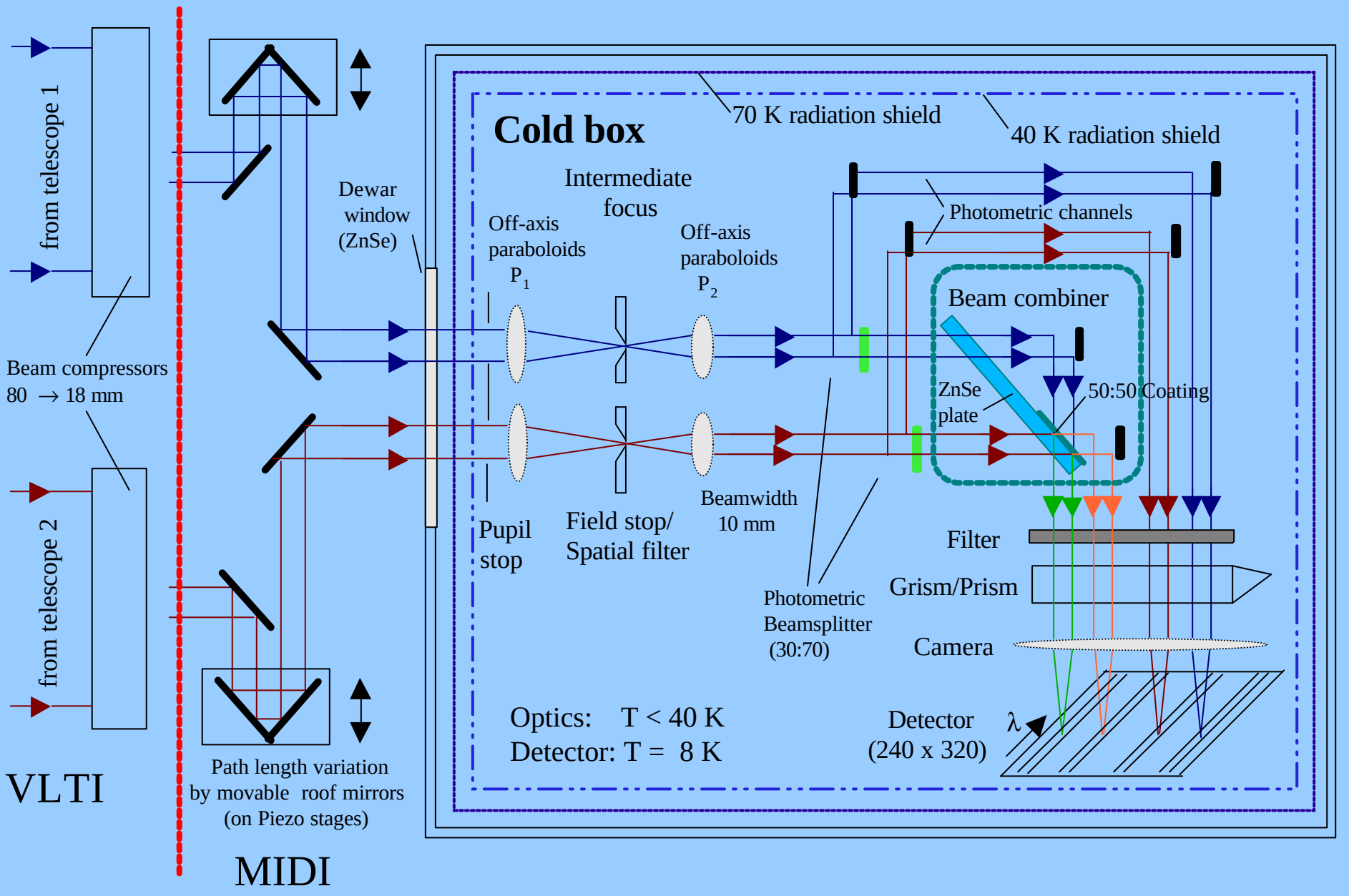
MIDI basic parameter:

MIDI: 2-beam pupil plane interferometer at m-IR wavelengths

Wavelength coverage:	N (8 µm - 13 µm), expandable to Q (17 - 26 µm)
Spectral resolution	up to 300 (prism, grism)
Sampling time for fringe motion	100 ms ... 1 sec
Atmospheric stability for chopping	200 ms (estimated)
Detector pixel size	50 µm
(320 x 240) Full well	$2 \cdot 10^7$ electrons (Raytheon Si:As HiB IBC)
Read noise	~ 800 electrons
scale	430 µm/arcsec (on sky)
Background noise from sky+VLTI	$3.5 \cdot 10^9$ photons/sec
from tunnel (at UT in Airy disk)	$4.6 \cdot 10^9$ photons/sec
FOV on sky, beam-diameter in MIDI	2 " , 18/10 mm

VLTI:	UTs	ATs
VLTI baselines:	47 ...130 m	8 ... 202 m
VLTI spatial resolution at 10 µm	0.044" ... 0.016"	0.26" ... 0.010"
Airy disk (FWHM) at 10 µm	0.26"	1.14"
Limiting N-magnitude (without/with external fringe tracking)	3-4 / 8-9 mag	0-1 / 5-6 mag

Principle of MIDI - the Mid-Infrared Interferometer for the VLTI



Critical points for MIDI: the interfaces

- Interface to ESO: VLTI group in process of formation .... (JMM, AGl)
  (ICD 1.0: Nov 99, SOW: June 2000)

- Interface to Paranal: S. Morel at MPIA for 1 year (knowledge transfer)

- SW-interface to ESO (... in process of ....)
  ⇒ new data fits format (table fits)

- SW-interface in collaboration ([OS, DCS, ICS] - [NRTS, EWS] - [DRS])
  MPIA *NEVEC* *Meudon*
  ⇒ software manager (SW-M)

Critical points for MIDI: the hardware

- **High Background:** $3.5 \cdot 10^9$ e^-/sec from sky+VLTI
  (on UT in Airy disk) (full well: $2 \cdot 10^7$ e^- !)

  ⇨ dispersion of the signal: prism, grism
  ⇨ short integration times: 0.2 - 20 msec
  detector: Read-out-time: 1 .... 6.9 msec
  ⇨ high frame/data rate: 1 - 36 Mbyte/sec (3 Mb/sec to archive)

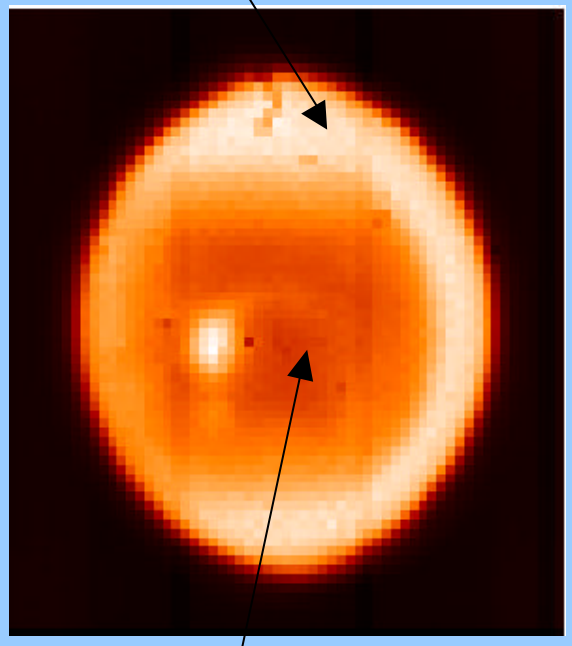
- **Background fluctuations:** ⇨ Chopping (for accurate photometry)
  (Photometric mode, AO, fringe tracker)
- **Coherence time with filter:** ~ 100 msec

- **Cooling:** Closed cycle cooler ⇨ vibrations
- **Alignment of optics:** to keep alignment when cooling to < 40 K

Background in the mid-infrared

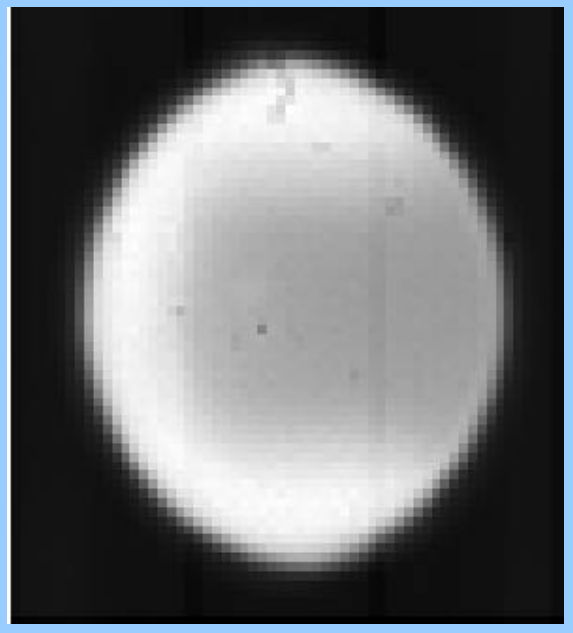
Eta Carina (~ 11000 Jy)

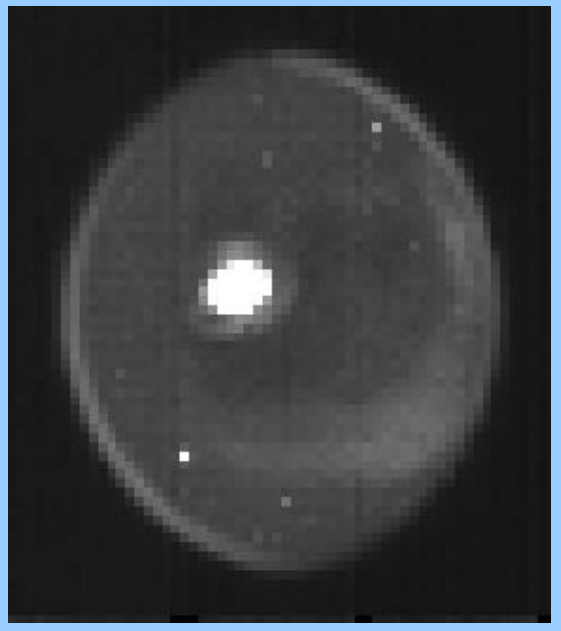
Tunnel background
~17 °C



Sky background
~5-10 °C

Z CaM (~ 100 Jy)





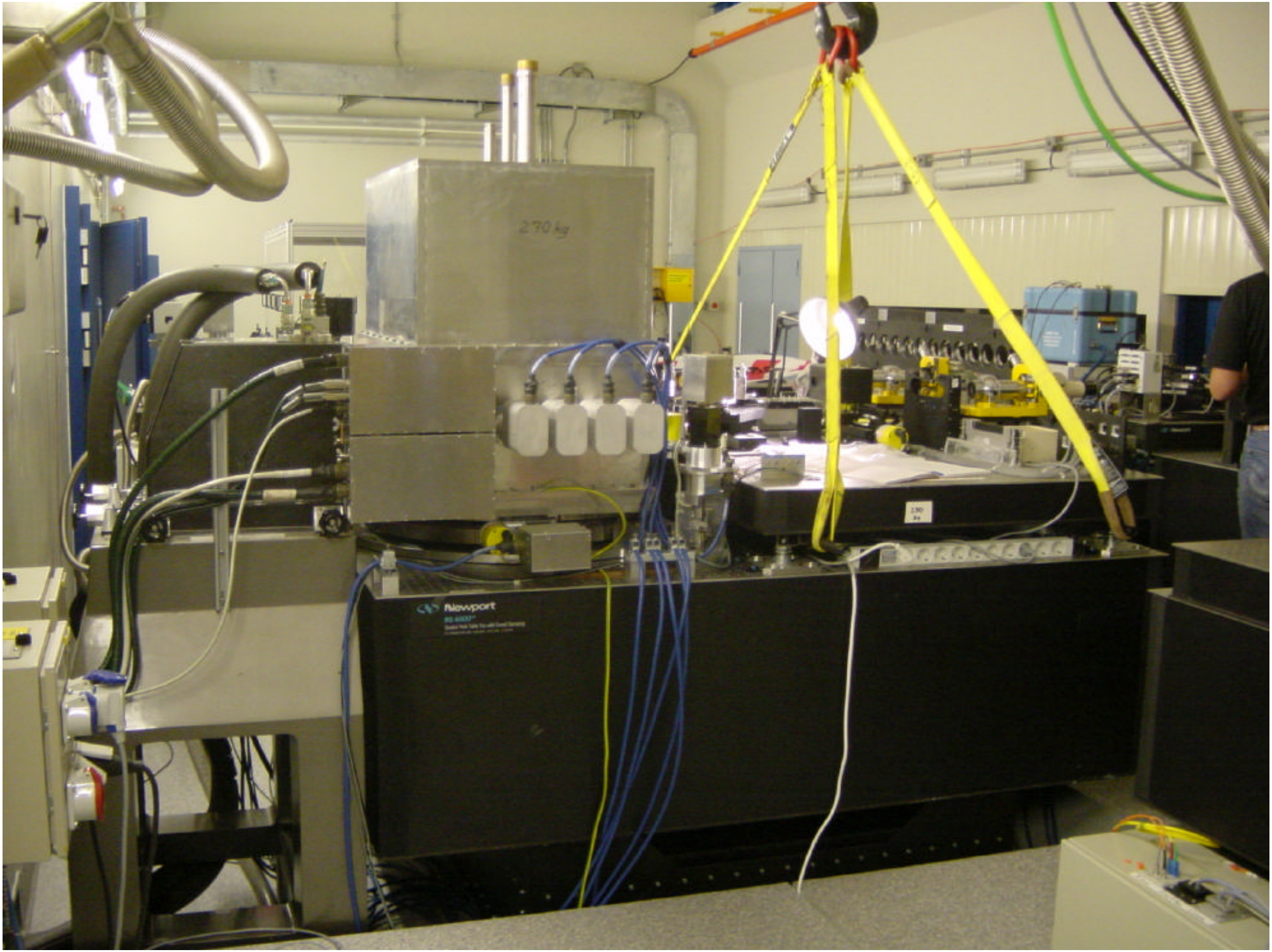
UT1 Beam A

Vibrations:

Paranal: no liquid He $\Rightarrow$ use of a closed cycle cooler
$\rightarrow$ 1 Hz vibrations

$\rightarrow$ Separate mount for CCC (650 kg)
$\rightarrow$ connection via metallic bellow
$\rightarrow$ damping feet, copper braid, ...

$\Rightarrow$ internal jitter on detector: 0.04 pixel

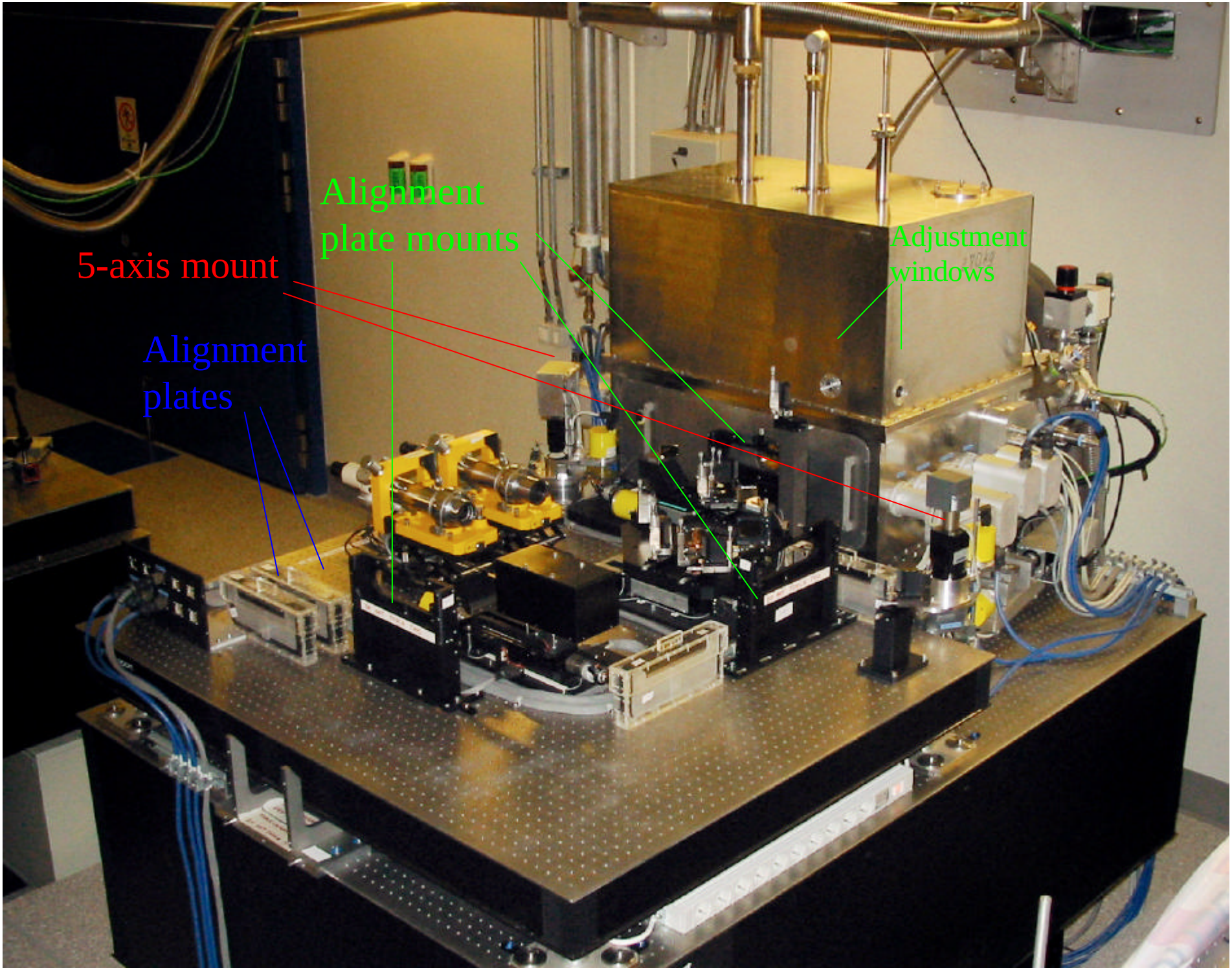

270 kg
Newport

The Alignment of MIDI:

1) Separate alignment/adjustment in the warm with visible light
- **alignment of ''cold optics'' (MIDI open)**
- **alignment of warm optical bench**

2) Cooling down of MIDI
- **shrinking homologous,**
- **position/direction correction by 5-axis mount**

→ Iteration:
- alignment of warm optical bench to cold optics
- **alignment of MIDI to VLTI (5-axis mount)**


Alignment
plate mounts
5-axis mount
Adjustment
windows
Alignment
plates

Conclusion:

MIDI: December 97 ..... December 2002 $\rightarrow$

Installation and first commissionings/measurements
have shown that MIDI works as planned .....

..... yet up to now only in the commissioned mode(s)
(i.e. self-fringe-tracking with prism or filter)

Still to come:

More commissioning .... (up to now only 5 UT-nights !):

- Commissioning of further modes (grism, ...)
- Commissioning with external fringe tracker
  (available by begin of 2004)
- Commissioning with ATs (available by autumn 2004)

MIDI extensions: 20 µm, Apres-MIDI