Calibration of MIDI data

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MIDI schematic drawing

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

Cold box

Optics: $T = 40 \text{ K}$
Detector: $T = 5 \text{ K}$

Camera

Detector $(240 \times 320)$
MIDI acquisition

- Acquisition uses chopping at 1-2 Hz
- Integration time 4 ms
MIDI chopping beam A (UT3)

- Movie shows all ON and OFF frames with mean sky subtracted
MIDI detector windows

PA
I1
I2
PB
Channeled spectrum
Observing modes

• **Outputs:**
  – Correlated flux
  – Visibility = Correlated Flux/Total Flux

• **Modes:**
  – High sensitivity (= HIGH_SENS)
  – High accuracy (= SCI_PHOT)

• **Difficult Target types:**
  – Weak but high visibility (=> photometry poor)
  – Strong but low visibility (or high accuracy)
MIDI calibrations

- Few lab or daytime calibrations (talk by S. Morel)
- Instrument is physically very stable but external optical train (incl. atmosphere) quite unstable at up to 100 Hz

- Main effects:
  - Beam overlap from 2 telescopes varies
  - Seeing/Strehl ratio varies
  - Atmospheric/Telescope transmission and backgrounds vary

- Detector electronics not so stable: e.g. no point in flat fields (?)
Current practice

- Mostly High-Sens mode; nonsimultaneous interferometry and photometry; nonsimultaneous target and calibrator
- Typical accuracies of visibilities ~5-10%, for limiting weak sources 10-20%

Techniques:
- Photometry: Standard midIR spectroscopy with chopping. Backgrounds quite high limiting accuracy to ~400 mJy. No flat, no bias
- Interferometry: No chopping necessary. Same pixels as Photometry. Limit ~100 mJy. No flat fields no bias
Calibration of correlated flux

- \( F_c(\text{Tar}) = F_c(\text{Cal}) \times \frac{F_i(\text{Tar})}{F_i(\text{Cal})} \)

- Very simple calibration
- \( F_c(\text{Cal}) \) from Cohen models or black bodies

Limitations:
- Knowledge of \( F_c(\text{Cal}) \) for nearby calibrators
- Changes of seeing Tar/Cal
- Difference in overlap Tar/Cal
Calibration of visibility

- \( V(Tar) = V(Cal) \times \frac{(Fi(Tar)/Pi(Tar))}{(Fi(Cal)/Pi(Tar))} \)

- Need more good observations for good answer
- Less sensitive to changes in seeing between Tar and Cal, but just as sensitive to changes between Interf and Phot.
- A single measurement of V can be interpreted physically.

- Limitations:
  - Sensitive to changes in Phot/Interf
  - Poor Phot for weak sources
SCI_PHOT mode

- With beam splitter measure Interf & Photom simultaneously
- Solves problem of seeing changes and overlap between Interf and Photom
- **But:** Requires transfer of calibration between different parts of detector -> Needs both “cross-coupling coefficient” (flat field) + curvature corrections
- Optical quality of photometric channels inferior
- Systematic effects ~5%, not understood
- Under good conditions accuracy ~< 1%
Wavelength calibration

• No arc lamps. There are 3 narrow band filters but these are inadequate for PRISM
• Interferometric channels can be calibrated relatively by fringes. Absolute scale is then determined by sky lines (O3)
• Transfer to photometric channels can be difficult