Calibrating IR Standard Stars

Calibrating MIR standard stars - VISIR observations

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Emission line free IR telluric standards

Valentin D. Ivanov

Building up a database of spectro-photometric standards from the UV to the NIR

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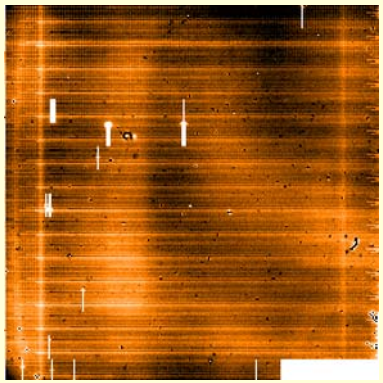
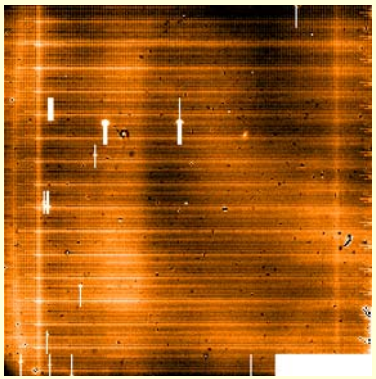
Compilation of the MIR spectro-photometric standard star catalog of the VLT

- **The catalog is based on the radiometric all-sky network of absolutely calibrated stellar spectra (Cohen et al. 1999) and the TIMMI2 standards.**
- **Contains 425 sources *(*http://www.eso.org/instruments/visir*).***
- **MIR ZP fluxes [Jy] were calculated taking into account: filters transmission curves, detector efficiency, atmosphere model.**
- **81 sources further selected for VISIR to test photometric precision of the instrument (est. 3%). Criteria: no variability (Hipparcos), not visual binaries (SIMBAD), absolute flux calibration errors < 20 % (Cohen et al. 1999).**
- **Out of these, 12 stars selected for daily observing: uniformly distributed in RA, similar spectral types (K III), bright in N and Q bands.**

Processing of the VISIR standard stars

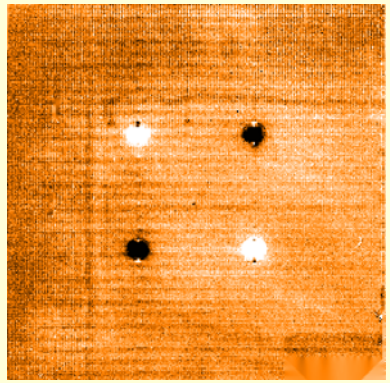


raw1



raw2

pipeline recipe



product

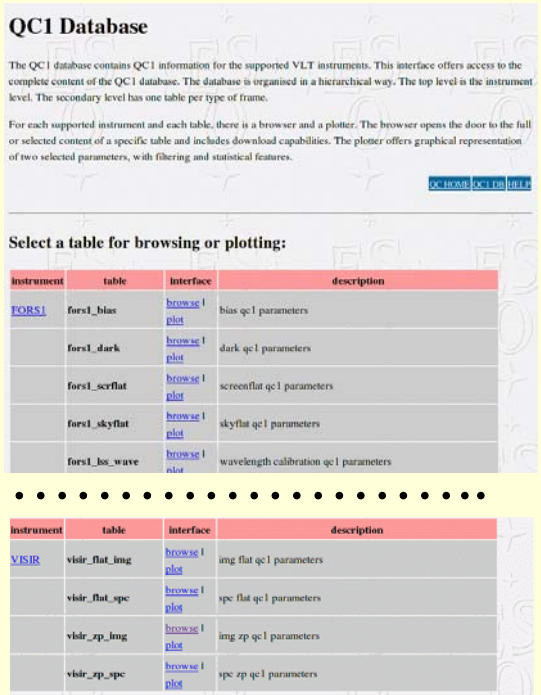
QC1 parameters: sensitivity, conv.factor, background, etc.

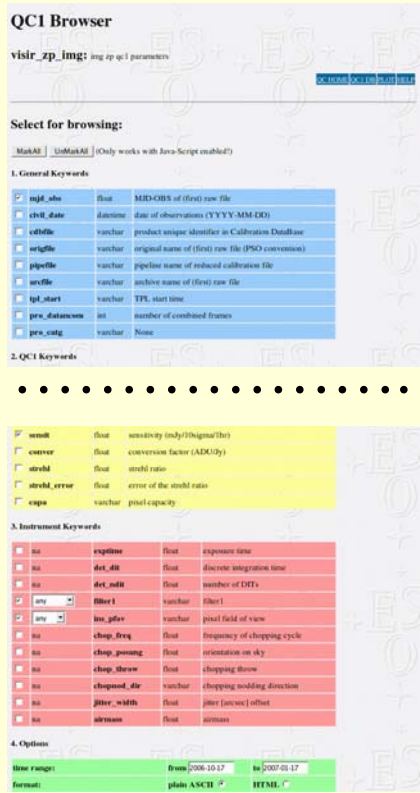
General and instrument keywords

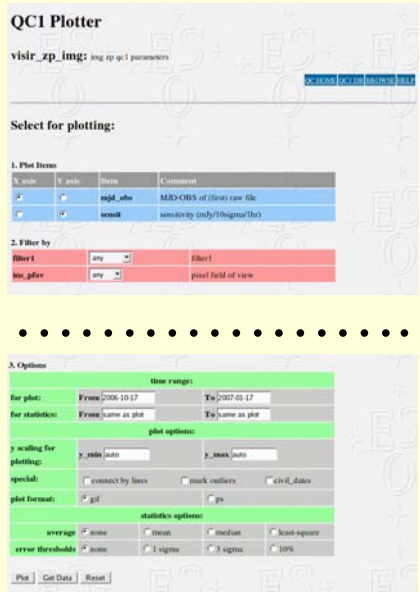
QC1 Database

VISIR QC1 database

QC1 database is publicly available at http://archive.eso.org/bin/qc1_cgi.
Contains QC1 information for all supported VLT instruments.

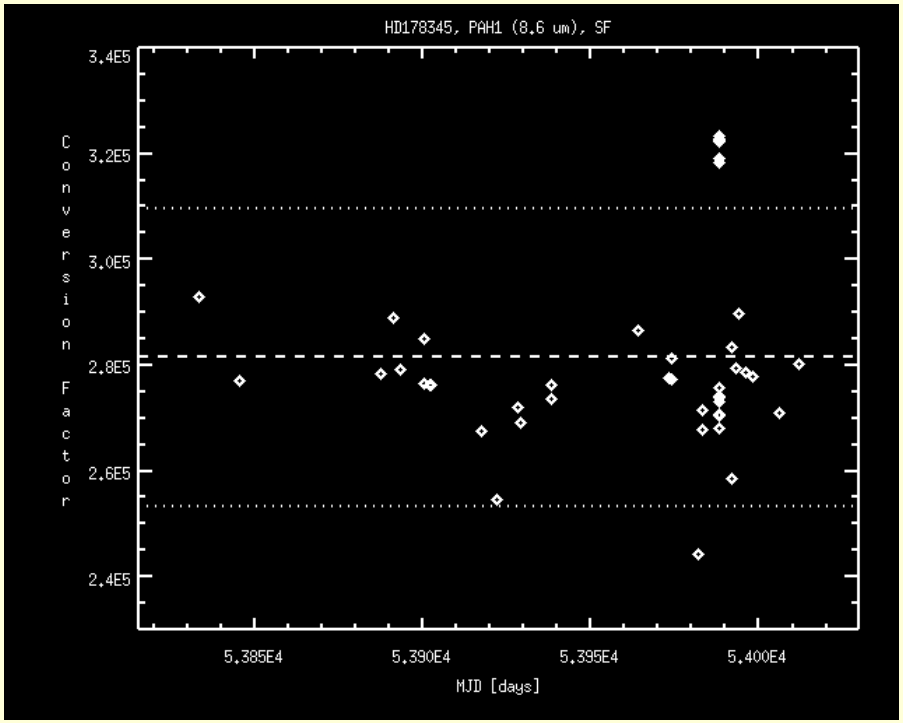




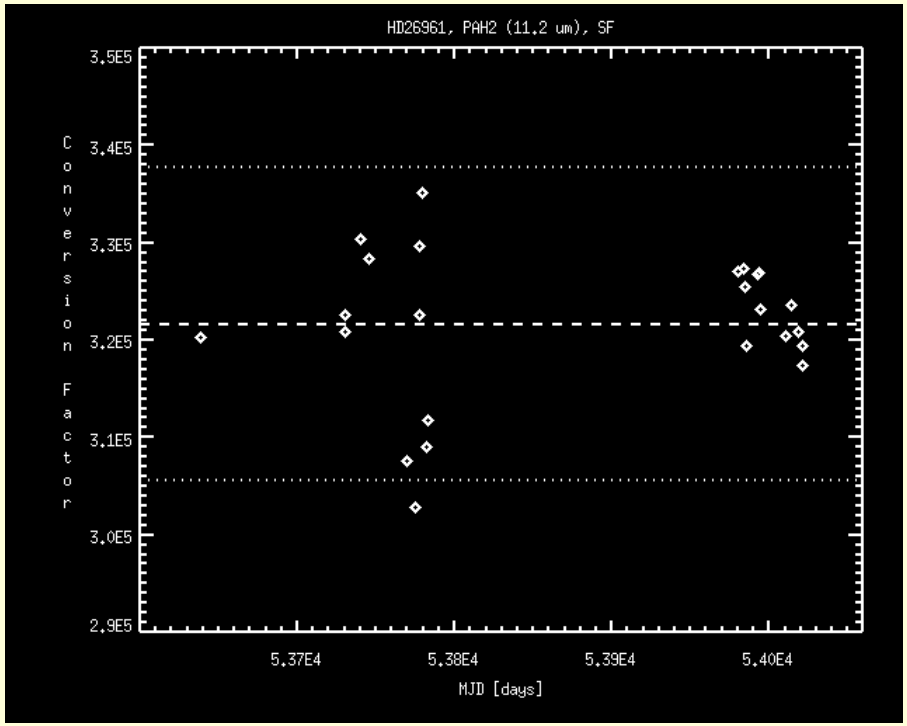


Conversion factor vs. time

Conv.Factor = $F_{tot\_observed}$ / F_{model} [ADU/Jy]



Variations within 10%



Variations within 5%

Results

Variations of the Conversion Factor (Aug.2005 – Dec.2006)

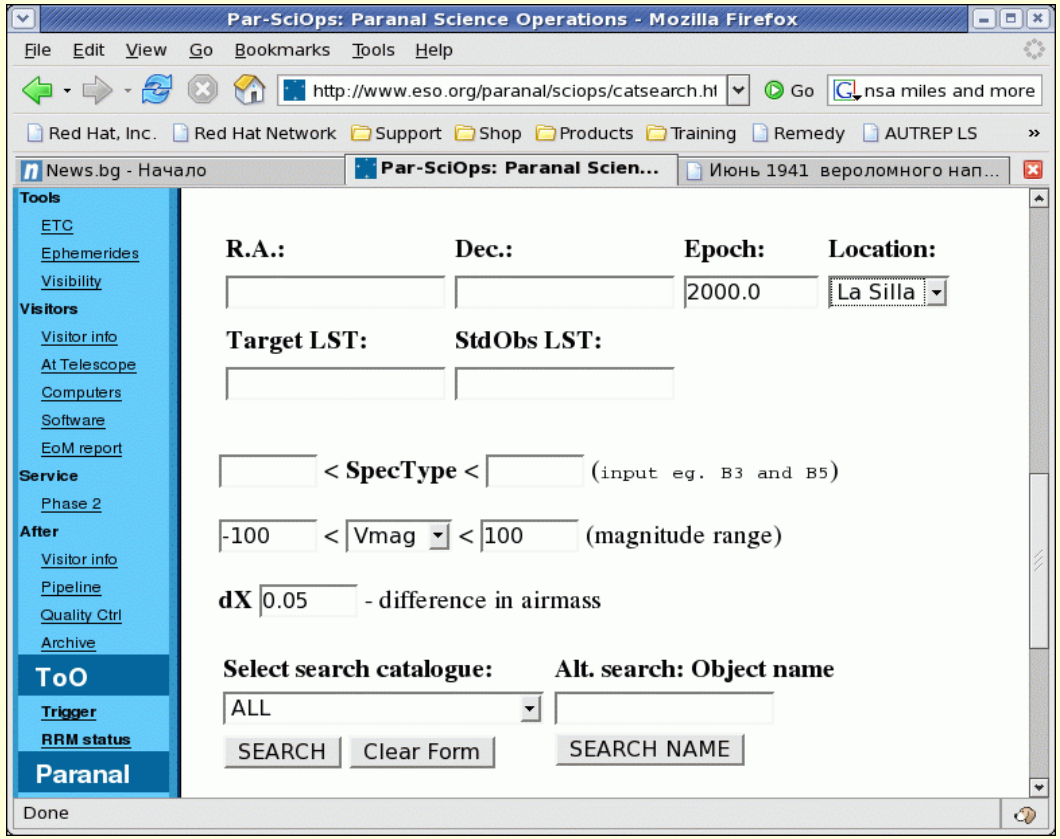
STAR NAME	PAH1 (8.6 um) SF	PAH2 (11.2 um) SF	Q2 (18.7 um) SF
HD12524	10% (17)	8% (15)	6% (2)
HD 26967	8% (25)	6% (24)	11% (7)
HD 41047	9% (15)	11% (15)	10% (3)
HD 75691	8% (19)	7% (16)	<20% (5)
HD 99167	7% (20)	4% (15)	15% (4)
HD 145897	6% (19)	8% (17)	<18% (10)
HD 178345	13% (44)	10% (31)	<20% (11)
HD198048	6% (8)	6% (12)	<20% (8)

The selected MIR standard stars show flux variability <10% in N band and <20% in Q band.

Emission line free infrared telluric standards

Valentin D. Ivanov

(Science Operations)



Background

- **The problem:** the variable atmospheric transition, easily changes by factor of a few over 100-200A; to monitor these variations and to correct for them the observes should obtain spectra (with the same airmass and set up as their science targets) of objects with known intrinsic spectra – of telluric standards.
- Most **commonly used telluric standards** are solar analogs (Maiolino et al. (1996, AJ, 111, 537) or hot stars (i.e. Hanson et al. 1996, ApJS, 107, 281); ideally, the observers select telluric standards with no features in the spectral region of interest, i.e. solar analogs when they study hot stars and vice versa; but this requirement can not be always satisfied.
- A major problem is **the presence of strong emission lines in some hot stars**; over the years, there has been numerous reports of telluric stars with emission lines among the ESO offered list of 129 O-type stars and 6447 B-type stars, with accurate positions from HIPPARCOS; our goal was to exclude from the list all the emission line stars.

Selection and results

- Based on the SIMBAD database info we removed from the lists all stars with classifications that match any of the following:
  - Be, WR, emission line stars, stars with "e" or "n" in the spectral type;
  - Variables, including eclipsing and pulsating stars;
  - Binaries (including spectroscopic ones) and double stars, regardless of their angular separation on the sky;
  - stars with recent updated spectral type different from the original spectral classification, i.e. there were stars of F or even K-type.
- We preferred conservative approach. The final corrected lists with updated spectral types consist of 52 O-type (60% drop rate) stars and 4275 B-type stars (34% drop rate). **Nearly 1/3 from the current telluric lists may be unsuitable!**
- **DISCLAIMER:** No guarantees that this clean up is complete because of the diverse and inhomogeneous data sources used in SIMBAD. However, considering the high apparent brightness of the telluric standards, it is likely that most emission line stars have been removed.

Building up a database of spectro-photometric standards from the UV to the NIR

J. Vernet, F. Kerber, S. D'Odorico, R. Bohlin, V. Ivanov, C. Lidman, E. Mason, T. Rauch, F. Saitta, A. Smette, J. Walsh, R. Fosbury, P. Goldoni, P. Groot, F. Hammer, L. Kaper, M. Horrobin, P. Kjaergaard-Rasmussen, R. Pallavicini, F. Royer

- Situation: current methods for spectro-photometric calibration in the NIR no more precise than 20-30% because a proper set of NIR spectro-photometric standards simply does not exist at the moment.
  - Needed for X-shooter (intermediate resolution spectrograph from 320 to 2500 nm, first 2nd gen. instruments @ VLT)
  - Needed for all NIR spectrographs
  - Stepping stone for calibrating ELT spectroscopic observations

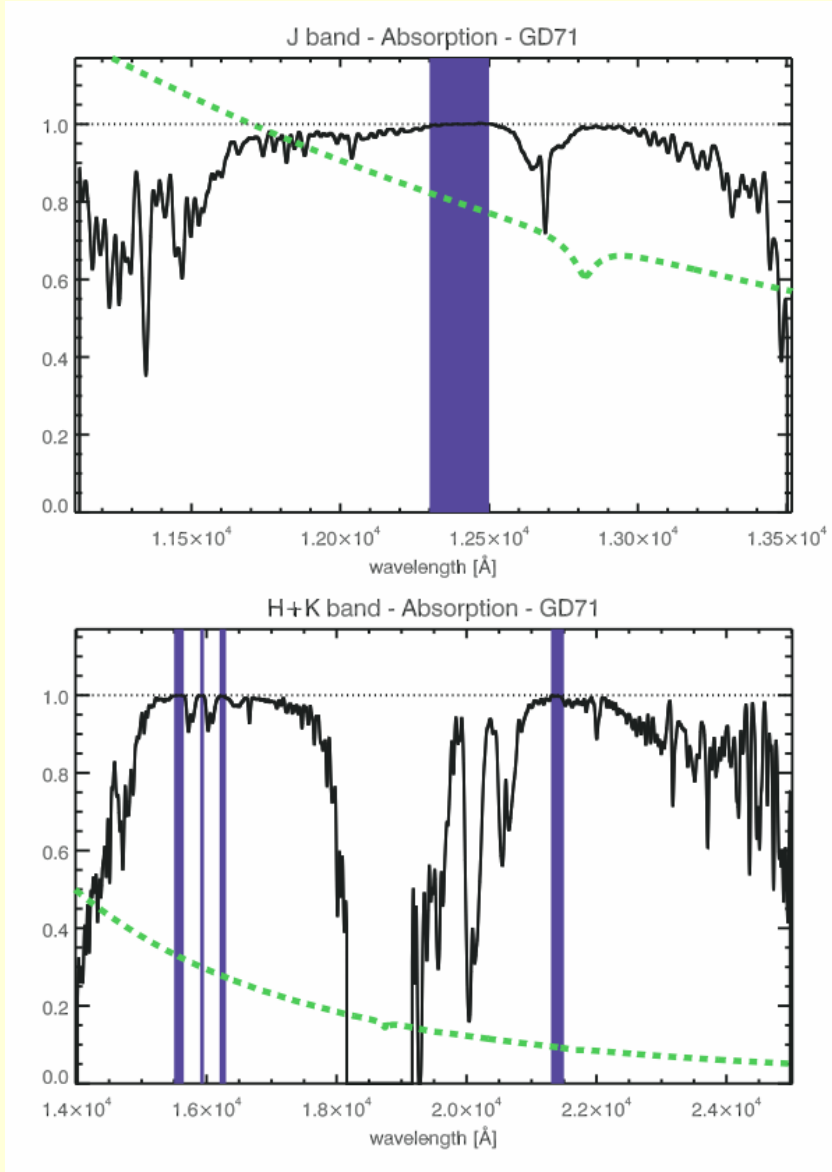
- Problem:
  - Strong variable telluric absorption
  - OH sky lines

⇒ Measure flux in well chosen atmospheric feature free windows

⇒ Appropriate resolution needed (R>1000)

\+ Wide aperture not to loose flux

SINFONI IFU in no-AO mode (8”x8” field) in two settings J (R=2000) and H+K (R=1500)



Strategy

- Extend the wavelength coverage of the well established UV/Optical spectro-photometric standards (Oke 1990, Hamuy et al. 1992,1994) into the near-IR
- Rely on the 2 HST Primary Standards (WD):
  - robust reference: flux measured outside the atmosphere between 115 and 1800 nm (accuracy better than 1%, Bohlin 2007)
  - Interpolate between flux measurement windows using state-of-the-art stellar atmosphere models (TMAP) and derive and absolute flux table for each Secondary Standard across the whole wavelength range
- Will be carried out as an Observatory Programme. First data expected soon.
- Full database should be ready by mid-2008