

# Calibrating IR Standard Stars

---

## Calibrating MIR standard stars - VISIR observations

Danuta Dobrzycka, L.Vanzi, A.Smette, E.Pantin, R.Siebenmorgen, M.Sterzik, M.Van Den Ancker, H.U.Kaeufl, Y.Jung, L.Lundin, N.Huelamo, and VISIR IOT

## Emission line free IR telluric standards

Valentin D. Ivanov

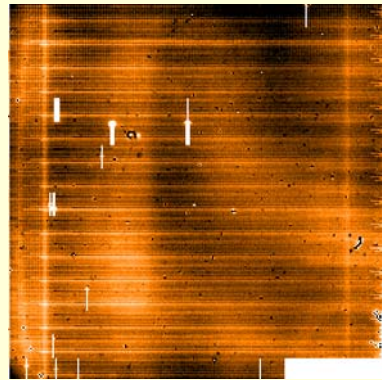
## Building up a database of spectro-photometric standards from the UV to the NIR

Joel 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.Kjaedrgaard-Rasmussen, R.Pallavicini, F.Royer

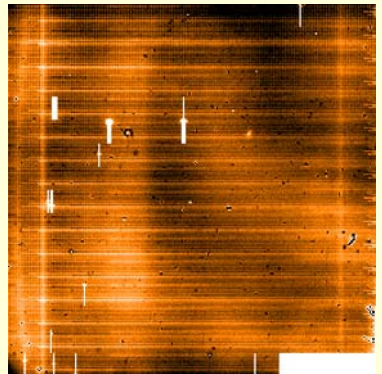
# Compilation of the MIR spectro-photometric standard star catalog of the VLT

- 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.

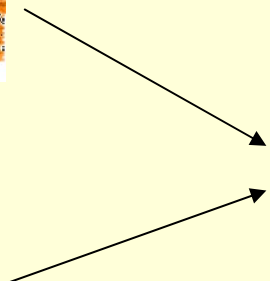
# Processing of the VISIR standard stars



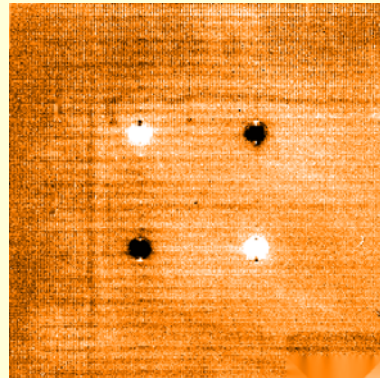
raw1



raw2



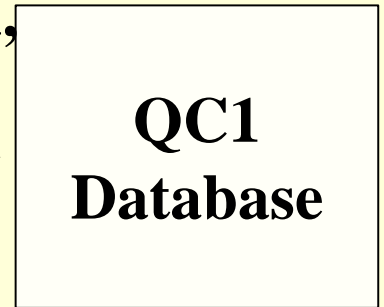
pipeline  
recipe



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.

**QC1 Database**

The QC1 database contains QC1 information for the supported VLT instruments. This interface offers access to the complete content of the QC1 database. The database is organised in a hierarchical way. The top level is the instrument level. The secondary level has one table per type of frame.

For each supported instrument and each table, there is a browser and a plotter. The browser opens the door to the full or selected content of a specific table and includes download capabilities. The plotter offers graphical representation of two selected parameters, with filtering and statistical features.

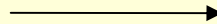
[QC1 Home](#) [QC1 DB](#) [Help](#)

**Select a table for browsing or plotting:**

Instrument	table	interface	description
<a href="#">FORSL</a>	fors1_bias	<a href="#">browse</a>   <a href="#">plot</a>	bias qc1 parameters
	fors1_dark	<a href="#">browse</a>   <a href="#">plot</a>	dark qc1 parameters
	fors1_scrflat	<a href="#">browse</a>   <a href="#">plot</a>	screenflat qc1 parameters
	fors1_skyflat	<a href="#">browse</a>   <a href="#">plot</a>	skyflat qc1 parameters
	fors1_bs_wave	<a href="#">browse</a>   <a href="#">plot</a>	wavelength calibration qc1 parameters

---

Instrument	table	interface	description
<a href="#">VISIR</a>	visir_flat_img	<a href="#">browse</a>   <a href="#">plot</a>	img flat qc1 parameters
	visir_flat_spc	<a href="#">browse</a>   <a href="#">plot</a>	spc flat qc1 parameters
	visir_zp_img	<a href="#">browse</a>   <a href="#">plot</a>	img zp qc1 parameters
	visir_zp_spc	<a href="#">browse</a>   <a href="#">plot</a>	spc zp qc1 parameters



**QC1 Browser**

visir\_zp\_img: img zp qc1 parameters

[QC1 Home](#) [QC1 DB](#) [Help](#)

**Select for browsing:**

[Mark All](#) [UnMark All](#) (Only works with Java-Script enabled!)

**1. General Keywords**

<input type="checkbox"/>	mid_obs	float	MID-OBS of (first) raw file
<input type="checkbox"/>	conv_date	datetime	date of observations (YYYY-MM-DD)
<input type="checkbox"/>	calfile	varchar	product unique identifier in Calibration Database
<input type="checkbox"/>	origfile	varchar	original name of (first) raw file (PSO convention)
<input type="checkbox"/>	pipefile	varchar	pipeline name of reduced calibration file
<input type="checkbox"/>	arcfile	varchar	archive name of (first) raw file
<input type="checkbox"/>	tpl_start	varchar	TPS, start time
<input type="checkbox"/>	pre_datacount	int	number of combined frames
<input type="checkbox"/>	pre_savg	varchar	None

**2. QC1 Keywords**

<input checked="" type="checkbox"/>	snr	float	sensitivity (only 10sigma/1hr)
<input type="checkbox"/>	convfact	float	conversion factor (ADU/h)
<input type="checkbox"/>	snrhd	float	snr/h ratio
<input type="checkbox"/>	snrhd_error	float	error of the snr/h ratio
<input type="checkbox"/>	capex	varchar	pixel capacity

**3. Instrument Keywords**

<input type="checkbox"/>	iso	exposure	float	exposure time
<input type="checkbox"/>	iso	det_dti	float	discrete integration time
<input type="checkbox"/>	iso	det_ndti	float	number of DTIs
<input checked="" type="checkbox"/>	any	filter1	varchar	filter1
<input checked="" type="checkbox"/>	any	iso_pfov	varchar	pixel field of view
<input type="checkbox"/>	iso	chop_freq	float	frequency of chopping cycle
<input type="checkbox"/>	iso	chop_posang	float	orientation on sky
<input type="checkbox"/>	iso	chop_throw	float	chopping throw
<input type="checkbox"/>	iso	chopmod_dir	varchar	chopping nodding direction
<input type="checkbox"/>	iso	filter_width	float	filter (arcsec) offset
<input type="checkbox"/>	iso	airmass	float	airmass

**4. Options**

time range: From 2006-10-17 to 2007-01-17

formats: plain ASCII HTML

**QC1 Plotter**

visir\_zp\_img: img zp qc1 parameters

[QC1 Home](#) [QC1 DB](#) [Help](#)

**Select for plotting:**

**1. Plot Items**

X axis	Y axis	Item	Comment
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	mid_obs	MID-OBS of (first) raw file
<input type="checkbox"/>	<input checked="" type="checkbox"/>	snr	sensitivity (only 10sigma/1hr)

**2. Filter by**

filter1: any filter1

iso\_pfov: any pixel field of view

**3. Options**

time range: From 2006-10-17 to 2007-01-17

For plot: From same as plot To same as plot

For statistics: From same as plot To same as plot

plot options:

Y scaling for plotting: y\_min: auto y\_max: auto

special:  connect by lines  mark outliers  circ\_dates

plot format:  gif  ps

statistics options:

average:  none  mean  median  scan-square

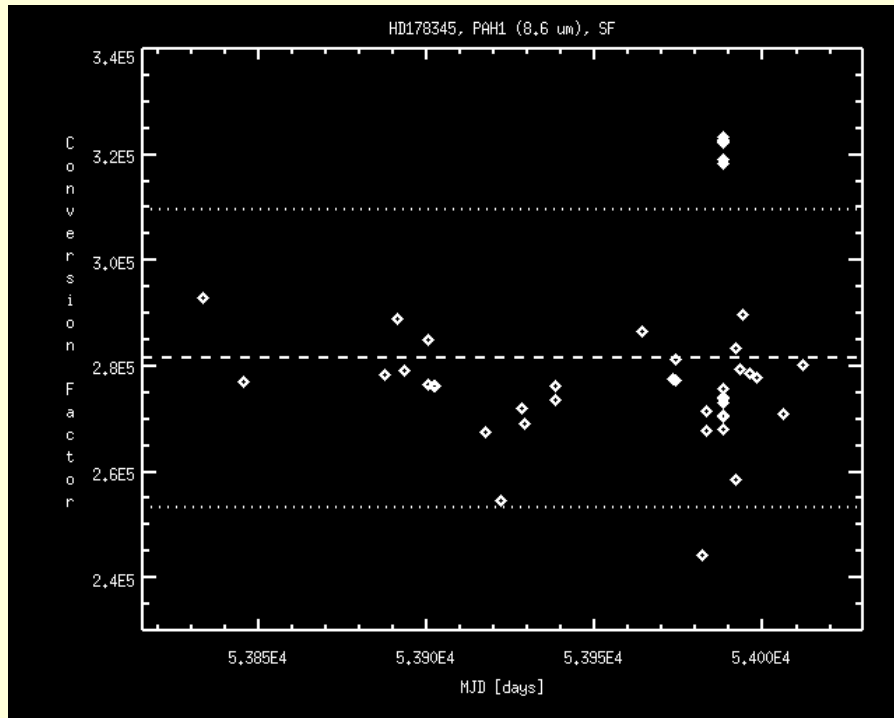
error thresholds:  none  1 sigma  3 sigma  10%

[Plot](#) [Get Data](#) [Reset](#)

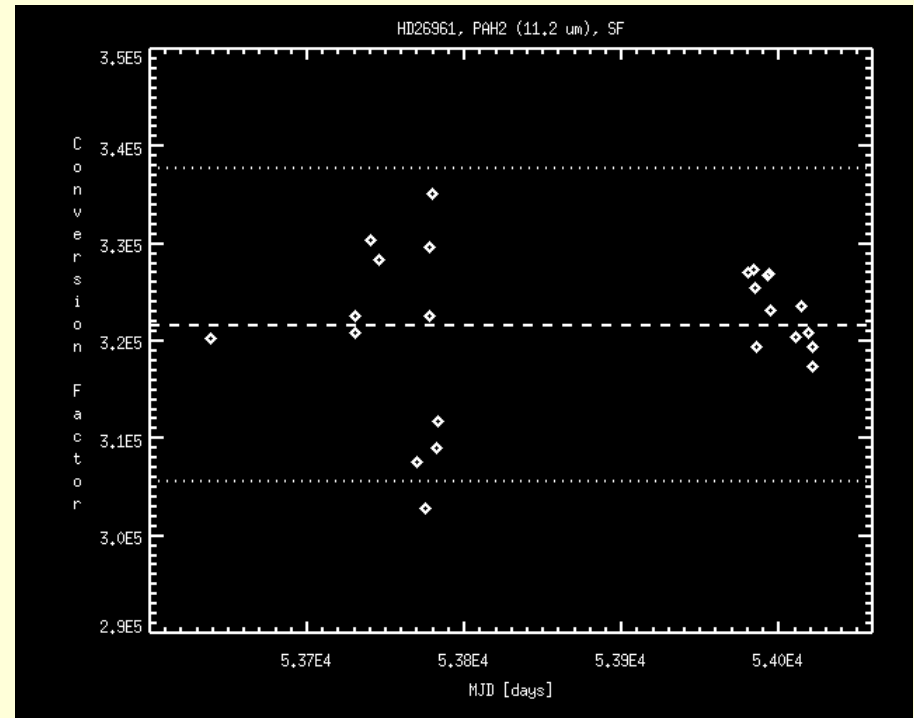


# Conversion factor vs. time

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



Variations within 10%



Variations within 5%

# Results

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

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

**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)**

The screenshot shows a Mozilla Firefox browser window titled "Par-SciOps: Paranal Science Operations - Mozilla Firefox". The address bar shows the URL "http://www.eso.org/paranal/sciops/catsearch.ht". The page content includes a search form with the following fields and options:

- R.A.:**
- Dec.:**
- Epoch:**
- Location:**
- Target LST:**
- StdObs LST:**
- SpecType:**  < SpecType <  (input eg. B3 and B5)
- Vmag:**  < Vmag <  (magnitude range)
- dX:**  - difference in airmass
- Select search catalogue:**
- Alt. search: Object name:**
- Buttons:** SEARCH, Clear Form, SEARCH NAME

The left sidebar contains a navigation menu with categories: Tools (ETC, Ephemerides, Visibility), Visitors (Visitor info, At Telescope, Computers, Software, EoM report), Service (Phase 2), After (Visitor info, Pipeline, Quality Ctr, Archive), ToO (Trigger, RRM status), and Paranal.

# Background

- **The problem:** the variable atmospheric transmission, easily changes by factor of a few over 100-200Å; to monitor these variations and to correct for them the observers 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

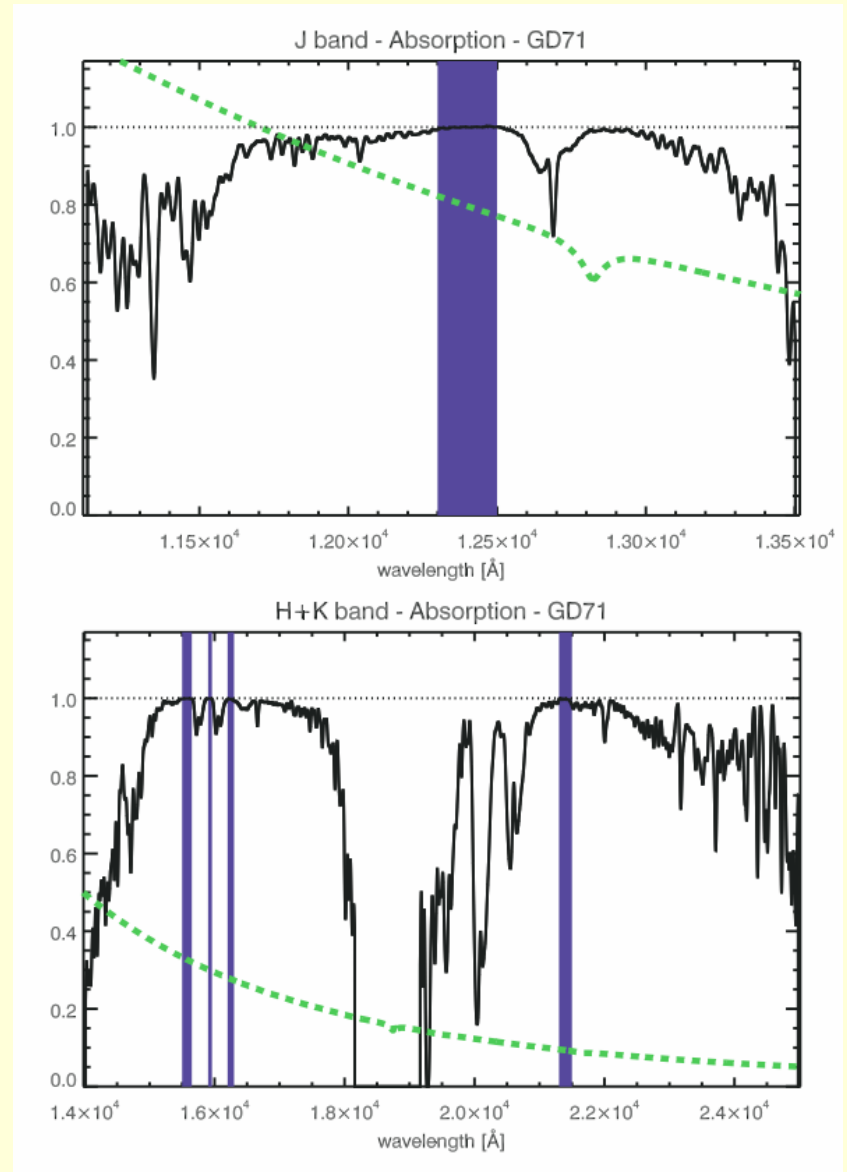
J. Vernet, F. Kerber, S. D'Odorico, R. Bohlin, V. Ivanov, C. Lidman, E. Mason, T. Rauch, F. Saitta, A. Smette, J. Walsh, R. Fosbury, P. Goldoni, P. Groot, F. Hammer, L. Kaper, M. Horrobin, P. Kjaergaard-Rasmussen, R. Pallavicini, F. Royer

- 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 lose 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 an 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