Searching for VLTI calibrators with the JMMC's Search Calibrator tool

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Abstract

In stellar interferometry, the raw fringe visibilities must be calibrated to obtain the true object visibility which will give the object parameters that can be interpreted in term of astrophysical parameters.

With the installation of AMBER and MIDI instruments and PRIMA facility at the VLTI, the selection of suitable calibration stars is crucial to reach the ultimate precision of the interferometric observations.

A new version of ASPRO's "Virtual observatory" companion tool looking for possible calibrators in the vicinity of a science object has been released.

This user dedicated software creates an evolutive catalog of stars giving the useful information for the selection of calibrators with respect to the requirements of the astrophysical program and of the instrumental configuration. A list of possible calibrators is obtained from a set of catalogs available at the Centre de Données astronomiques de Strasbourg (CDS). The CDS request is based on some criteria like the maximum angular distance and the range of magnitude around the scientific target. This new version includes an K-Band (for AMBER) and an N-Band (for MIDI) calibrator search. It can be found on the JMMC Web site:

http://mariotti.ujf-grenoble.fr/aspro_page.html

Problematic and method

For numerous programs the calibrators must have properties close to those of the scientific target :
- close sky location and close apparent magnitude to observe with same instrument configuration,
- similar color (spectral type) in case of interferometric observation in large spectral band to limit the chromatic effect.

Ideally, a calibrator must be a point source giving a fringe visibility equal to 1.0. Strictly, no object with a measured angular diameter will respect it, but in practice, the smaller the calibrators the lesser the sensibility of the angular diameter determination to their intrinsic visibility or sources of instabilities. This is particularly true in the case of search for faint calibrators.

Method :

To create a dynamical catalog of calibrators surrounding the science object, using a method of the ''virtual observatory'' type.

Definition of calibrator field
- Rectangular box centered on the scientific object which size is defined by the maximum distance in right ascension and declination.

In the case of faint calibrators search ($K > 5$), to limit the number of returns from CDS request, the size of the searching calibrator field will be automatically adapted on the base of stellar count computed using a predictive model of the stellar population in the Milky Way, ("A synthetic view on structure and evolution of the Milky Way", Robin et al., 2003).

Selection of possible calibrators from CDS inquiry
- Requests to the VisieR data base at CDS using the calibrator field parameters in a given photometric band (V, J, H or K). Gives a list of stars with known parameters (astrometry, spectral type, photometry, indication of variability and multiplicity, measured angular diameter).

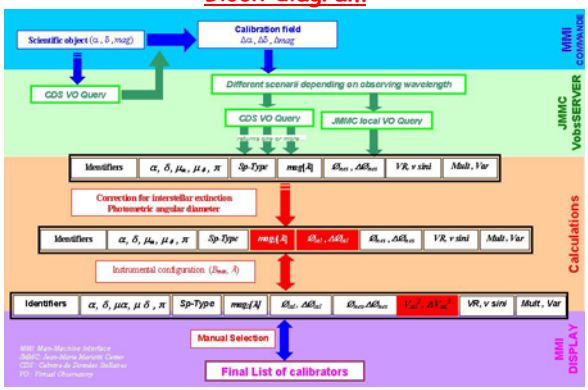
Calculation (for each star)
- The angular diameter is computed using a surface brightness method and color index calibration (for V,J,H,K bands)(Delfosse and Bonneau, 2004).

For the N band, the angular diameter is taken from van Boekel et al., 2005, ''Photometric observations and angular size estimates of mid infrared interferometric calibration sources''.
- The squared visibility and associated error are computed using an uniform disc model.

Final selection

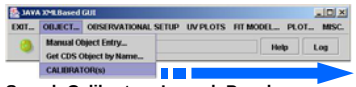
To refine the choice of the calibrators by changing, *a posteriori*, the selection criteria: field around the science object, object – calibrator magnitude difference, spectral type and luminosity class, accuracy on the calibrator visibility, indications of variability and multiplicity.

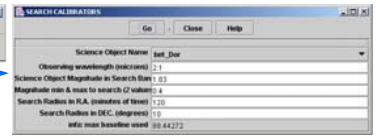
Block diagram



MMI Command

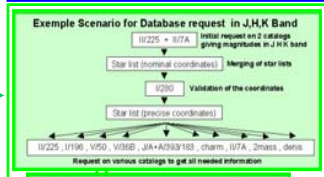
The software tool **ASPRO** allows to prepare interferometric observations (Duvert et al., 2002).
The **Search Calibrators** tool allows to select the reference stars required to convert properly observed visibilities into calibrated visibilities.

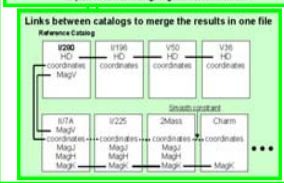




Search Calibrators Launch Panel

- to define the calibrator field
- to constraint the request to CDS
- to apply the automatic selection of the calibrators





Virtual Observatory Server

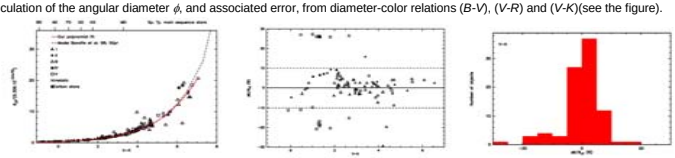
The useful information for stars found in the calibrators box are compiled from different catalogs in the data base VisieR at CDS (Ochsenbein et al., 2000). The links between the catalogs, to sort the result, are done from coordinates and m_v (for V band), or from coordinates and m_K (for IR bands).

Requested catalogs for bright calibrators search ($K \leq 5$)
- I/280 : All-sky Compiled Catalog of 2.5 million stars (Kharchenko, 2001)
- II/7A : UBVRIJKLMNH Photoelectric Catalog (Morel et al., 1978)
- II/225 : Catalog of Infrared Observations, Edition 5 (Gezari et al., 1999)
- J/A+A/386/492/charm : Catalog of High Angular Resolution Measurements (Richichi, 2002)
- J/A+A/393/183 : Catalog of calibrator stars for LBSI (Bordé et al., 2002)
- I/196: Hipparcos Input Catalogue, Version 2 (Turon et al., 1993)
- V/50 : Bright Star Catalog, 5th Revised Ed. (Hoffleit et al., 1991)
- V/36B : Supplement to the Bright Star Catalog (Hoffleit et al., 1983)
- II/246: The 2MASS all-sky survey Catalog of Point Sources (Cutri et al., 2003)
- B/denis: DENIS data base (DENIS consortium, 2003)

For faint calibrator ($K > 5$), the IR photometric catalogues **2MASS** and **DENIS** will be used as primary catalogs.

Calculations

- Interstellar absorption is calculated from trigonometric parallax using the Chen et al (1998) law and the observed magnitudes are corrected with the Fitzpatrick (1999) coefficients. Only stars with $\pi_{HIP} > 1$ mas can be selected as bright calibrators ($K \leq 5$).
- Missing photometry is calculated from various published *color-luminosity class-spectral type* relations.
- Calculation of the angular diameter ϕ, and associated error, from diameter-color relations (B-V), (V-R) and (V-K)(see the figure).

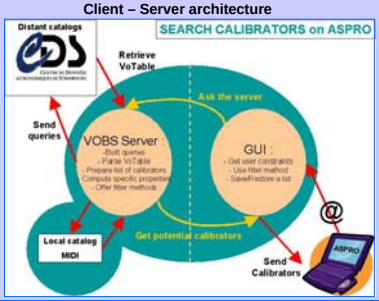


Left: newly determined angular diameter (θ_{LD}) – (V-K) relation. Middle: relative residual in angular diameter. Right:distribution of the relative residuals (Delfosse & Bonneau, 2004). With –1.1 ≤ (V-K) ≤ 7.0, it is possible to determine the angular diameter with typical precision of ~7 % .

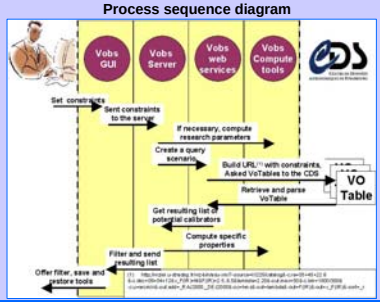
For faint calibrators ($K > 5$), the angular diameters will be computed using a (θ_{LD}) – (I-K) relation with a precision $\Delta\phi / \phi \sim 9\%$.
- Rejection of the stars if one value of ϕ differs from more than 2σ from the mean.
- Calculation of the calibrator visibility and its error as function of the angular diameter (measured or computed) and its error for the maximal angular resolution λ/B_{max}

Technical aspects

Client – Server architecture

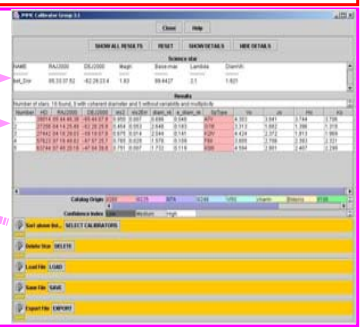


Process sequence diagram



Results display

- Information on the science object
- **List of selected calibrators**



Operation on display

•Manual selection of calibrators