The calibration sources project

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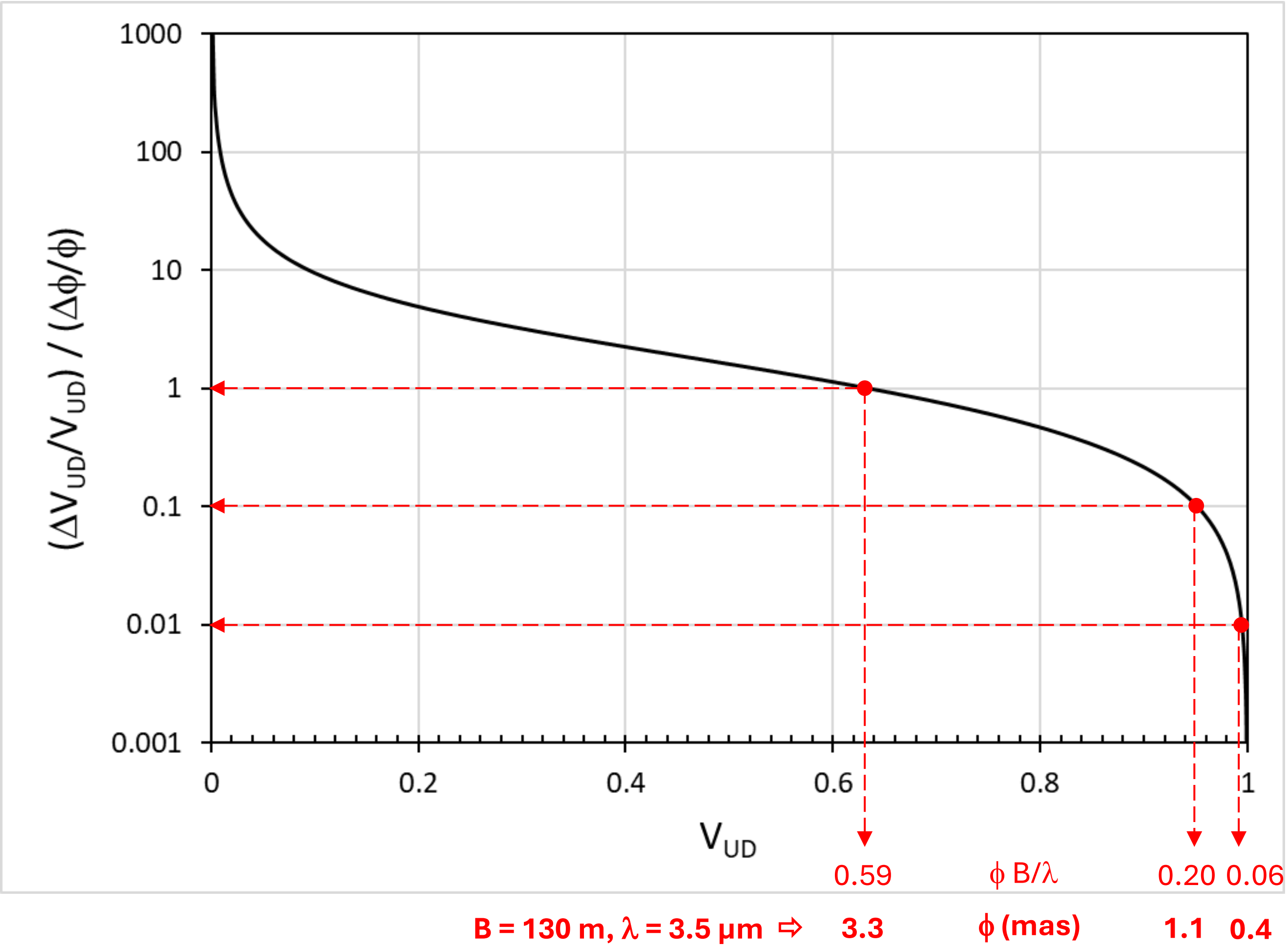
1. Introduction

Calibrating the interferometric observables needs reference targets with well-known angular diameter and accurate absolute visibilities (Mérand et al. 2005)



1. Introduction (contd.)

The JMMC Stellar Diameters Catalog (JSDC, Bourgès et al. 2017) reports angular diameters of ~500 000 stars derived from an improvement of the surface brightness method (Wesselink 1969; Barnes & Evans 1976) thanks to the polynomial fit of the differential surface brightness versus the spectral type number (Chelli et al. 2016) independent of the distance and reddening-free, applied to a set of ~600 reference stars (with known diameters and photometries)

The angular diameters of the IR-excess-free calibrators suitable for MATISSE (mainly K-giants, Cruzalèbes et al. 2019) are reported in the JSDC with 8-10% precision only

The goal of our project is to measure accurate angular diameters of calibrators reaching 1% precision with MATISSE

2. Methodology

Derive the angular diameter from the spectral distribution of the squared visibility in the L band (3.25-3.75 µm) at low spectral resolution (R~30)

Assuming that :

- the calibrator intensity distribution is well-represented by the uniform disk distribution
- the spectral distribution of the instrument+atmosphere transfer function is well-described by a polynomial model

Processing each BCD configuration independently (IN/IN, OUT/IN, IN/OUT, OUT/OUT)

Using the 'customized'-V^2 observable :

$$\tilde{V}^2(B,\lambda) = \frac{V^2(B,\lambda)/V^2(B,\lambda_{\text{ref}})}{V^2(B_{\text{short}},\lambda)/V^2(B_{\text{short}},\lambda_{\text{ref}})}$$

where λ_{ref} is the reference wavelength (taken at the middle of the L band in the flux continuum) and B_{short} is the shortest baseline

2. Methodology (contd.)

The angular diameter ϕ is estimated by minimizing the difference between $\tilde{V}^2_{\mathrm{meas}}$ and $\tilde{V}^2_{\mathrm{model}}$ where $\tilde{V}^2_{\mathrm{model}}$ is given by :

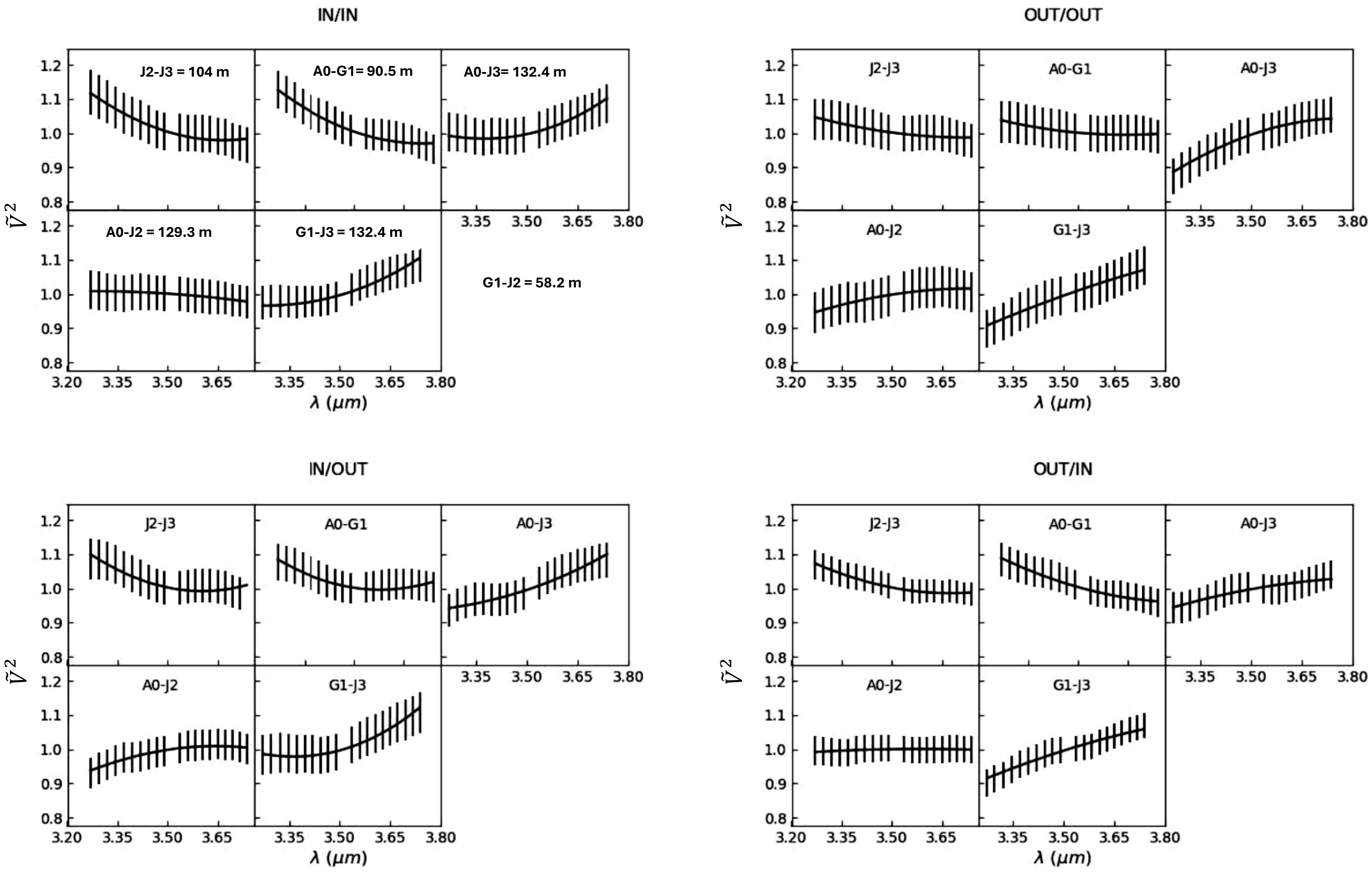
$$\tilde{V}^2_{\mathrm{model}}(B,\lambda) = \underbrace{\{\, 1 + \alpha(B)[\lambda - \lambda_{\mathrm{ref}}] + \beta(B)[\lambda - \lambda_{\mathrm{ref}}]^2 \,\}}_{TF_{\tilde{V}^2}(B,\lambda)} \times \underbrace{\left[\frac{J_1(\pi\phi B/\lambda)\, J_1(\pi\phi B_{\mathrm{short}}/\lambda_{\mathrm{ref}})}{J_1(\pi\phi B/\lambda_{\mathrm{ref}})\, J_1(\pi\phi B_{\mathrm{short}}/\lambda\ \ )} \right]^2}_{\tilde{V}^2_{\mathrm{UD}}(B,\lambda)}$$

The precision on the angular diameter is given by the residual-bootstrap method (Cruzalèbes et al. 2010)

3. Example of 35 Vir

Spectral Type = M0/1III

$\phi_{JSDC} = 2.54 \pm 0.22$ mas



$\phi = 2.51 \pm 0.05$ mas

4. Preliminary results

MATISSE L-band observations of 35 calibration stars (1 to 3 mas) were performed in P103 (from 2019 May to 2020 Feb.) in low spectral resolution using the large AT array (A0-G1-J2-J3) and its variation (A0-G1-J2-K0). One observation used the hybrid config (A0-B2-D0-J3), and one observation was extracted from the ESO archive with the UT array

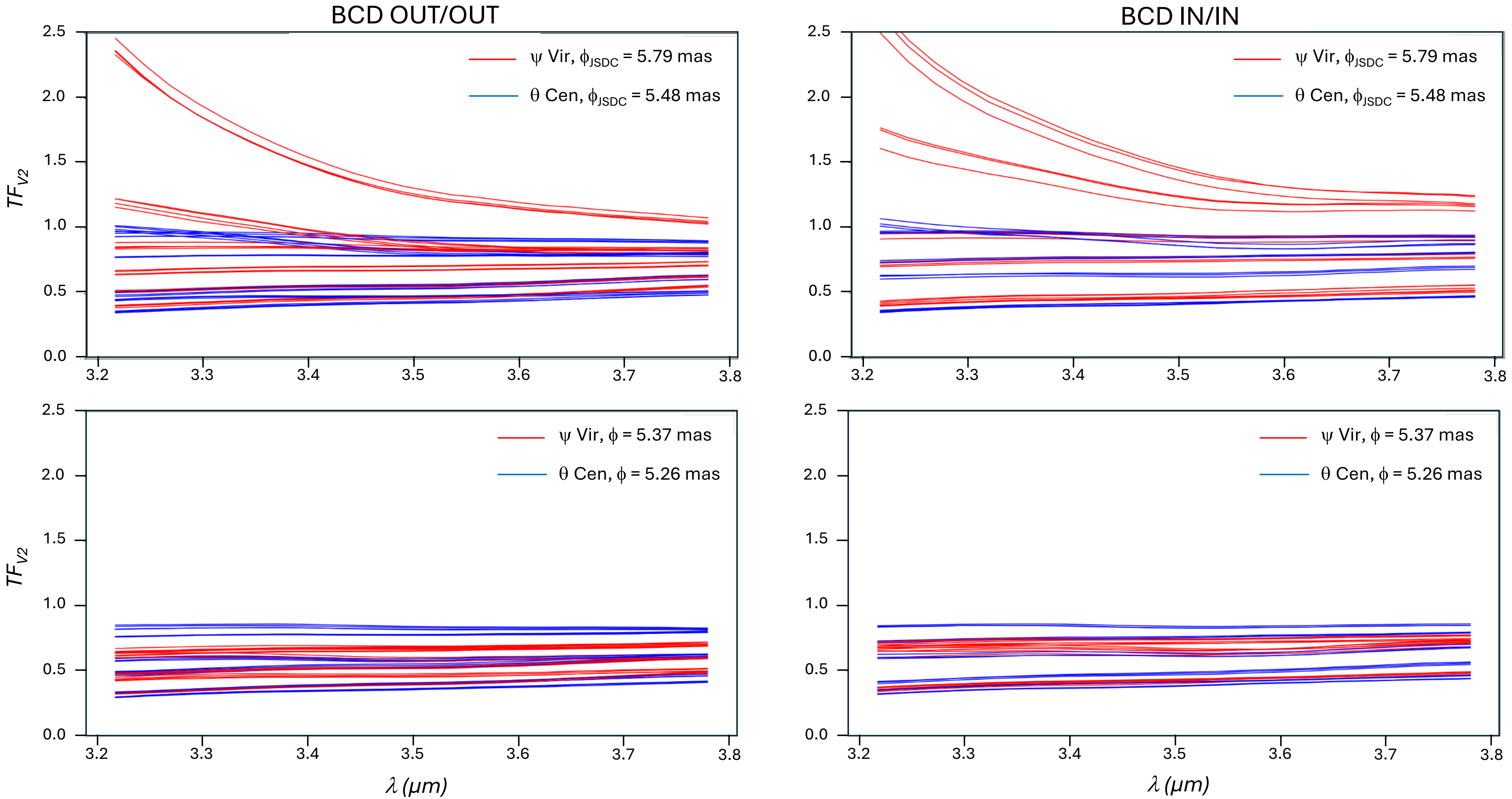
The new estimations of the angular diameter deviate from the JSDC values within 1% on average, while the relative uncertainties range from 0.6% to 4.1% (1.6% on average)

Consecutive observations (in the same night or in 2 successive nights) show reproductible results (within 1%)

The deviations of the angular diameter considering the uniform disk and the limb-darkened disk models stay within the precision of our method

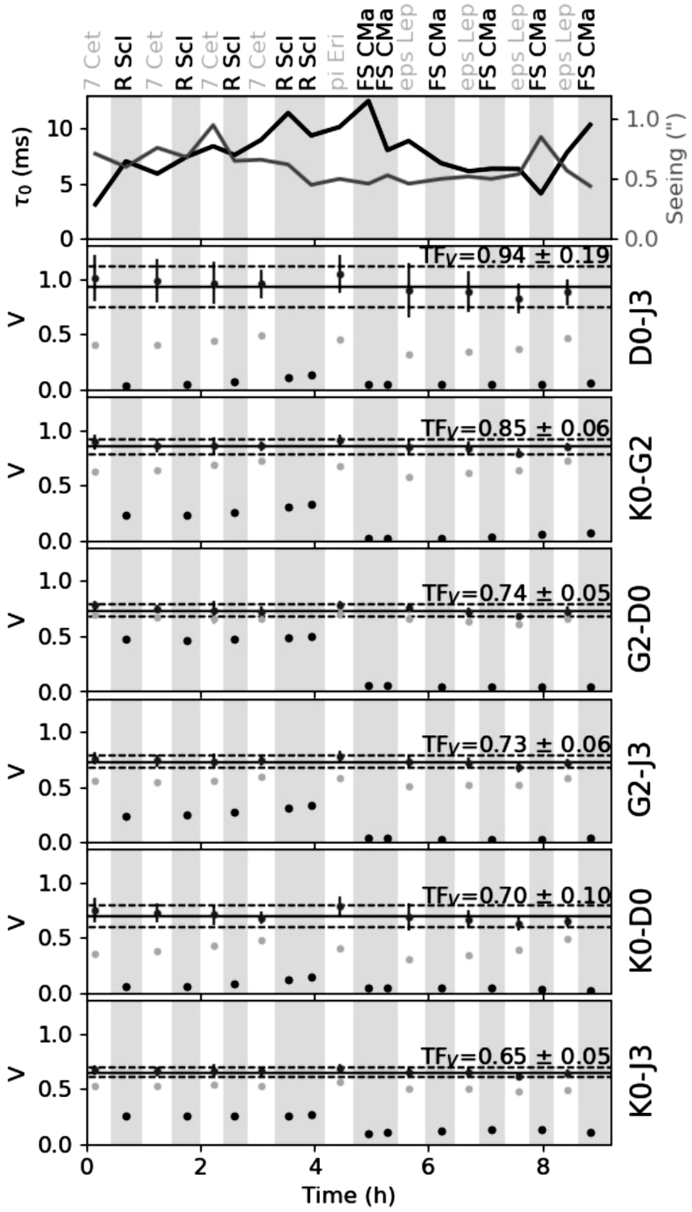
Those results are presented in Robbe-Dubois et al., MNRAS 510, 82 (2022)

4. Preliminary results (contd.)

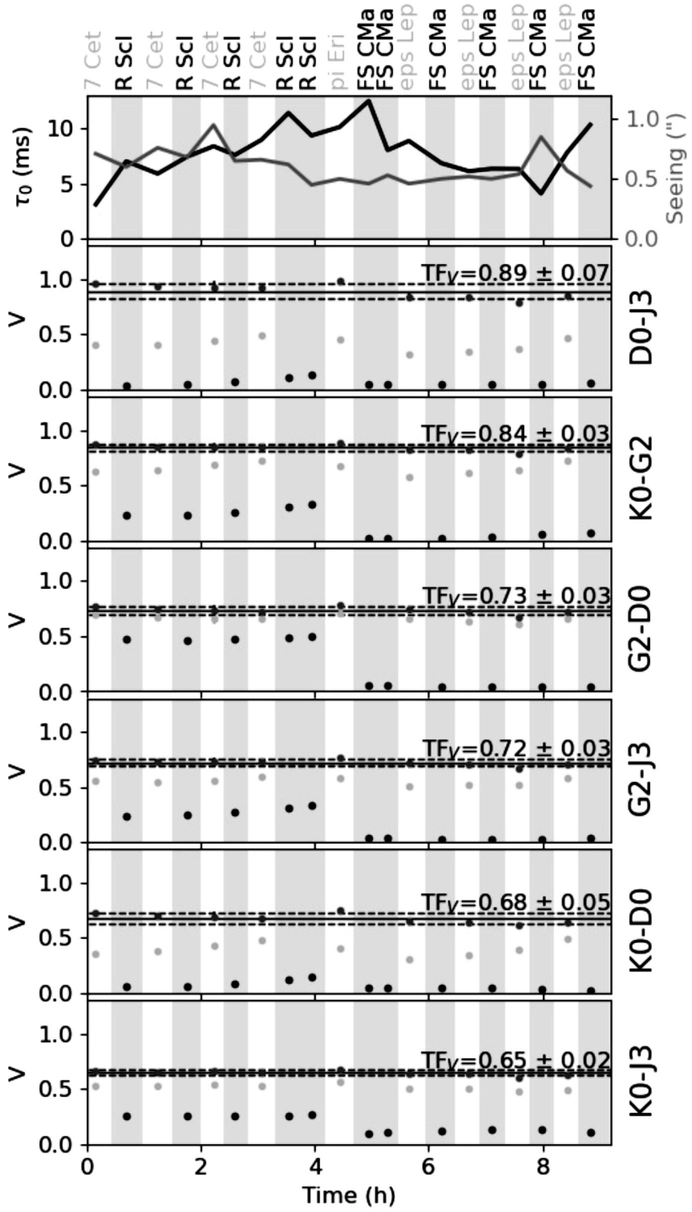


2018 Dec. 09 (3.1-3.8 μm, OUT/OUT)

With the JSDC diameters



With our diameters



5. The calibration sources project

Create a new catalog of measured angular diameters of calibrators

Using MATISSE in L band and the large VLTI array configuration A0-G1-J2-J3

Selection criteria using the Matisse Stellar Diameter and Flux Compilation Catalog (MDFC, Cruzalèbes et al. 2019) :

- DEC > -80° and < 30°
- JSDC-CALFLAG=0 (reliable diam estimate, 'favorable' object type, no close binary)
- MDFC-IRFLAG=0 (no mid-IR feature : excess, extent, variability)
- Angular diam between 1 and 4 mas (not resolved with the longest baseline of the VLTI)
- Correlated flux > 10 Jy in L

239 targets

7% G - 68% K - 25% M, 78% cool giants, 5% MIDI calibrators, 6.5% Cohen standards

Observations taken from the ESO-Archive or to be carried out from P115 to P118

Thanks for your attention !