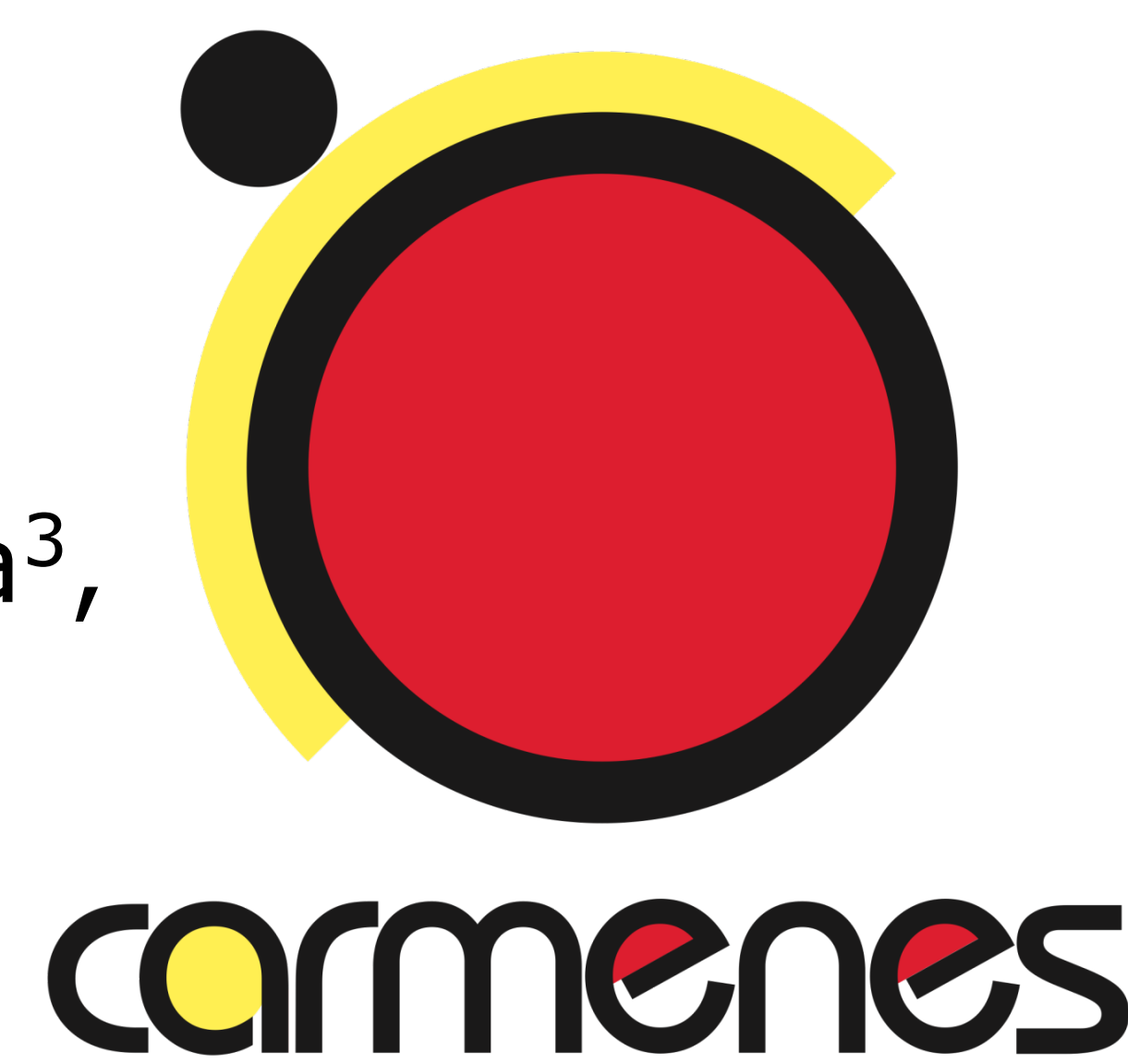


# MARCOT: A new concept of a large aperture telescope to feed CARMENES

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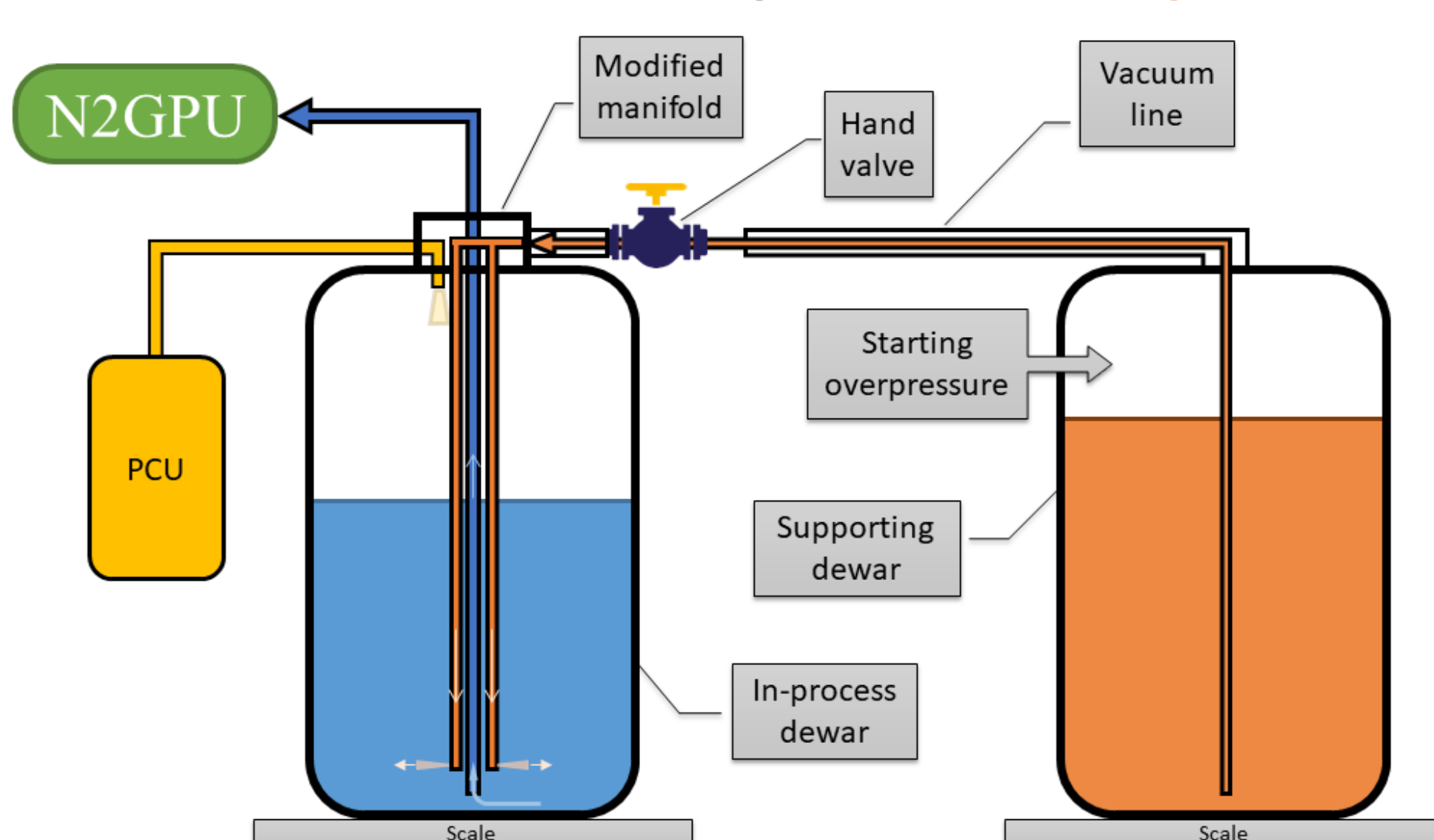
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**Abstract.** CARMENES is a dual optical (VIS) and near-infrared (NIR) high resolution spectrograph installed at the 3.5-m telescope of Calar Alto Observatory (CAHA, Almeria, Spain). It has been in operation since 2016 [1,2] using guaranteed time to detect exoplanets around M dwarfs [4,5]. Since 2021, the survey has been extended for other 3+2 years to execute a Legacy program. During this period, we are carrying out a project to upgrade the instrument, improving its performance and long term stability, in particular for the NIR channel. Though the project is still ongoing, the internal precision of the NIR channel has already been improved to be similar to that of the VIS channel. In the near future, we will develop a new concept of a large aperture telescope, MARCOT (Multi Array of Combined Telescopes [6,7]), to feed CARMENES with a 5-15m light collecting area from a battery of several tens of small telescopes that are incoherently fed into the final joint single fibre feed of the spectrograph.

## CARMENES-PLUS: an upgrade of the NIR CS stability [8,9]

- AVSTL: Automatic vacuum system for transfer lines (Fig. 2)
- Continuous flow mode
- Pressure control unit (PCU)
- Fixed dewar configuration (Fig. 1)



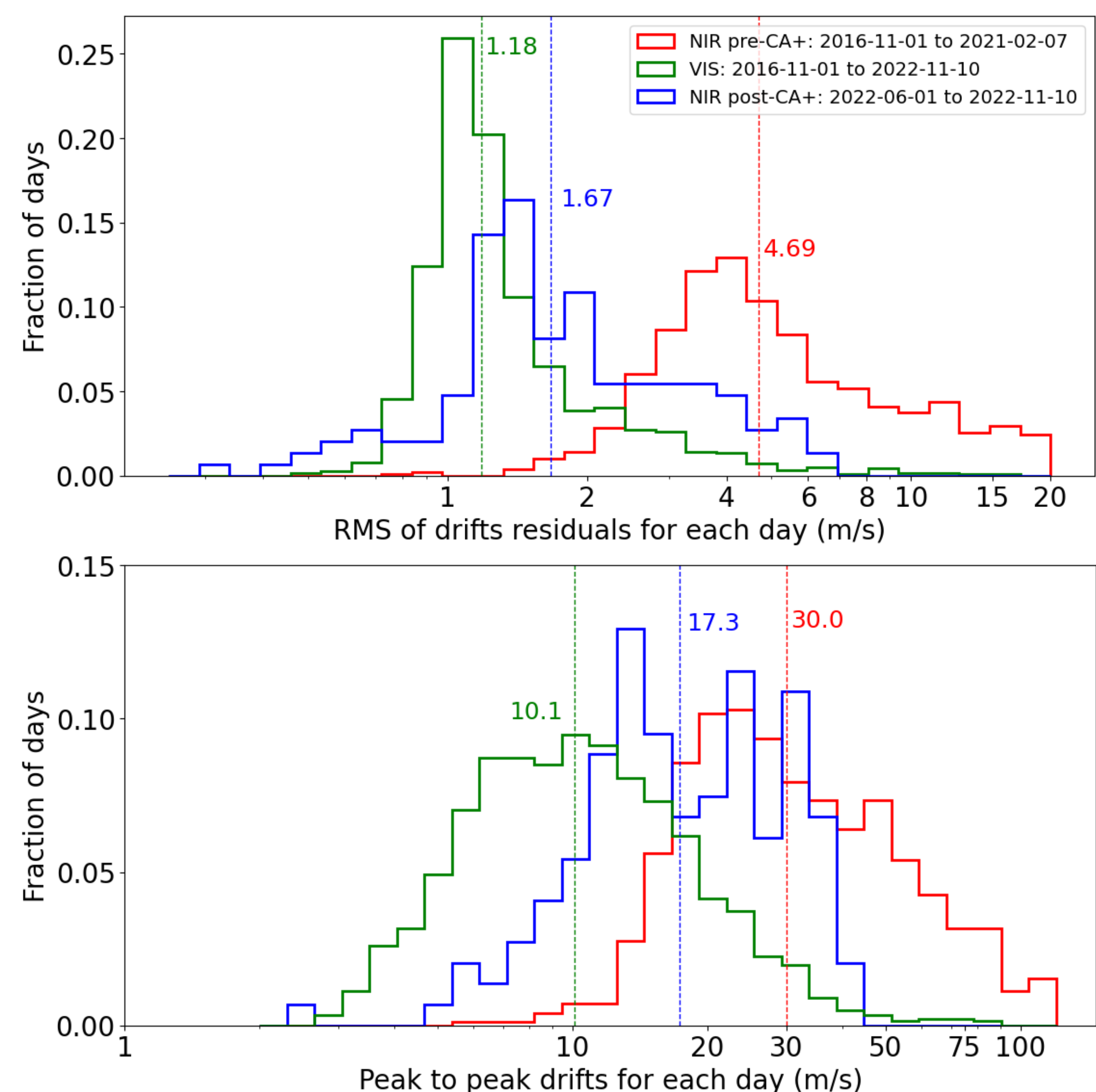
**Fig. 1:** Fixed dewar configuration setup



**Fig. 2:** AVSTL around the N2GPU

## CARMENES-PLUS: results (Fig. 3)

- RMS: from 4.69 to 1.67 m/s (pre vs post-CA+), 1.18 m/s for the VIS
- Peak to peak: from 30 to 17.3 m/s, 10.1 m/s for the VIS
- Smaller (peak to peak) and smoother (RMS) nightly RV drifts, close to the VIS performance



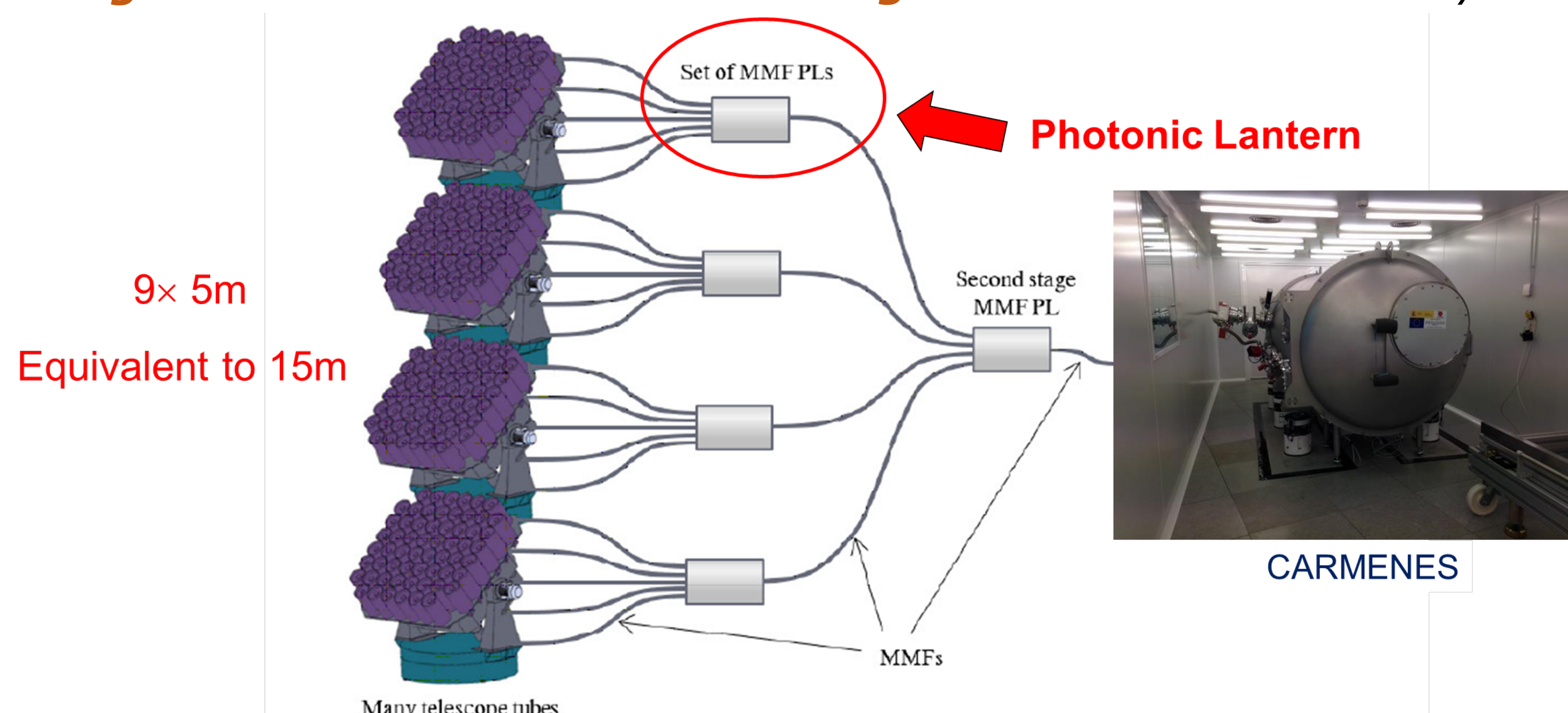
**Fig. 3:** Histograms of the RMS and peak to peak values of the nightly RV drift



**Fig. 4:** MARCOT Pathfinder



**Fig. 5:** Calar Alto Observatory



**Fig. 6:** MARCOT concept for a equivalent structure of 15 m

**MARCOT.** Multi Array of Combined Telescopes [6,7]. The light collected by the modules through the individual optical fiber feed of each OTA is optically injected into a novel multi-mode photonic lantern (MM-PL), which can either directly feed the astronomical instrument attached to the telescope or, feed a second stage MM-PL that can combine the light from a cascade of several MARCOT modules.

- Goals:
  - Modules of about 5 m
  - Infrastructure equivalent to 15 m
- MARCOT Pathfinder Telescope (Fig. 4): placed at Calar Alto Observatory (Fig. 5), consists of 7-unit telescopes in one cell connected to the MRS spectrograph [10]
- MM-PL: 3-year project, to be launched in 01/2023
- CARMENES: the ultimate goal is to inject the light of 15-m MARCOT to CARMENES spectrographs (Fig. 6). This will allow to greatly improve the SNR of the instrument (now on a 3.5-m telescope), making possible an exoplanet survey in ultra-cool dwarfs (UCDs) and brown dwarfs (BDs)

**References.** [1] Quirrenbach et al. 2016, Proc. SPIE 9908, 990812-12 [2] Quirrenbach et al. 2018, Proc. SPIE 10702, 107020W-18 [3] Quirrenbach et al. 2016, Proc. SPIE 11447, 114473C-1 [4] Reiners et al. 2018, A&A, 609, L5 [5] Ribas et al. 2023, A&A, 670, A139 [6] Roth, M. et al. 2022, Proc. SPIE 12182, id.121820M-10 [7] Amado et al. 2023 [8] Mirabet, E. et al. 2014, Proc. of SPIE 9151, 91513Y-1 to 91513Y-16 [9] Becerril, S. et al. 2016, Proc. SPIE 9912, 991262 [10] Moralejo, B. et al. 2016, SPIE 9912, 991222

