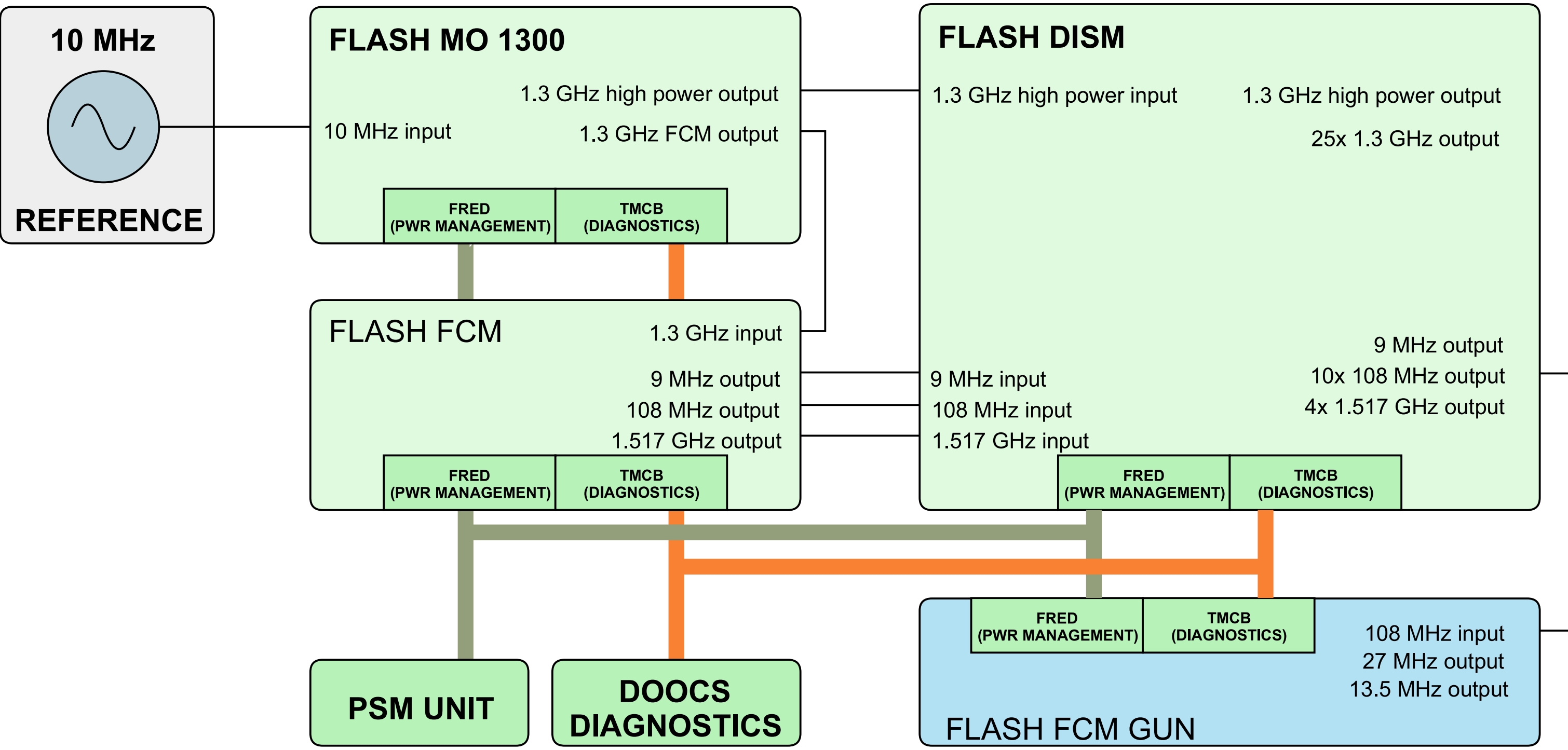




# Recent Experience in the Operation of FLASH2020+ RF Reference Generation System

The redesigned RF reference generation and distribution system at FLASH was installed in 2022. The upgrade is based on a European-XFEL-based Main Oscillator (FL-MO1300), Frequency Conversion (FL-FCM), and RF Distribution (FL-DISM) modules. The main 1.3 GHz RF reference signal is synthesized in FL-MO1300, and the remaining signal frequencies are synthesized in FL-FCM and synchronized to the main 1.3 GHz reference. All reference signals are distributed via the FL-DISM. All the modules provide live monitoring of most RF signals and diagnostic information via the DESY DOOCS system. The contribution presents the recent operation experience of the upgraded RF reference system at FLASH, including long-term logged parameters, like main oscillator stability, distribution output power level, and the system modules' temperature stability.

## System overview



A completely redesigned generation and distribution system for FLASH, based on E-XFEL solution [1,2,4].

System provides 26 1.3 GHz outputs, 2 outputs for 9 MHz, 10 for 108 MHz, and 4 for 1517 MHz signals. The amplitude stability is better than 0.1 %.

0.8 fs  
10.7 fs

Phase stability in terms of 1.3 GHz signal integrated jitter, in ranges from 1 kHz to 1 MHz, and 10 Hz to 1 MHz [4]



A new design of FLASH Main Oscillator [2, 4].

The FL-MO 1300 is commercially available from KVG: <https://kvg-gmbh.de/>

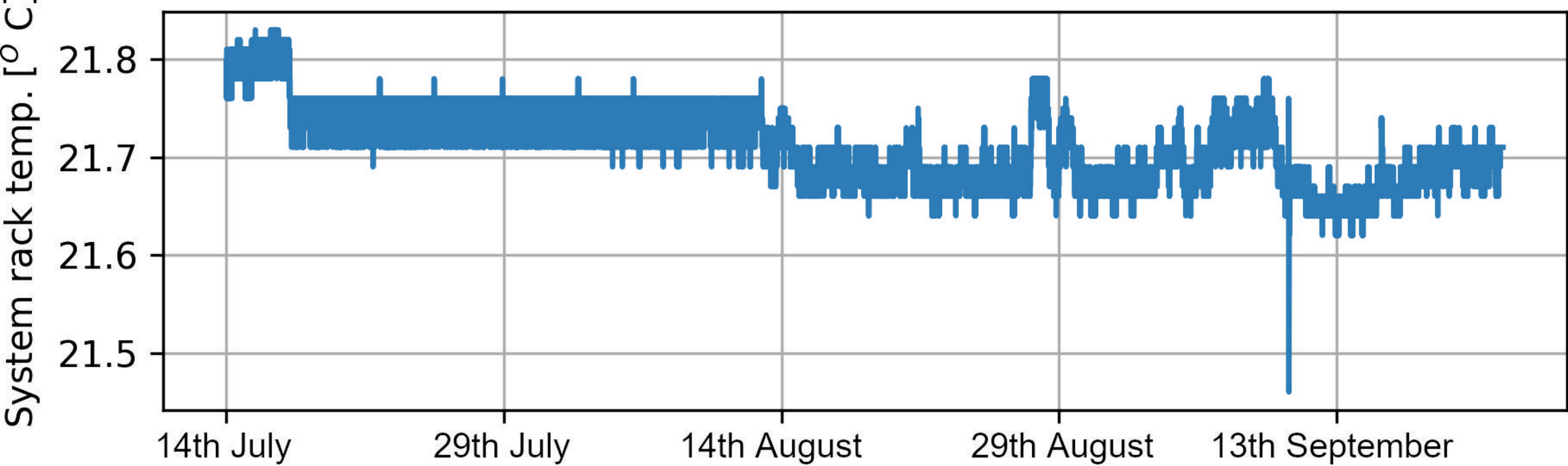


New boxes of Frequency Conversion Module (FL-FCM, upper), and Distribution Module (FL-DISM, lower) [2,3,4].

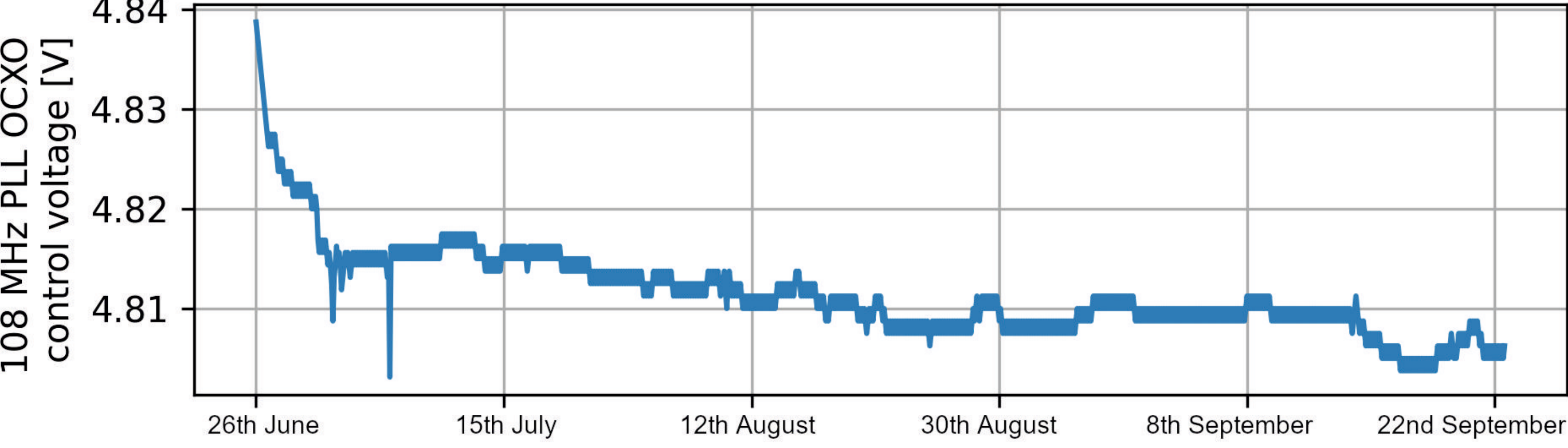
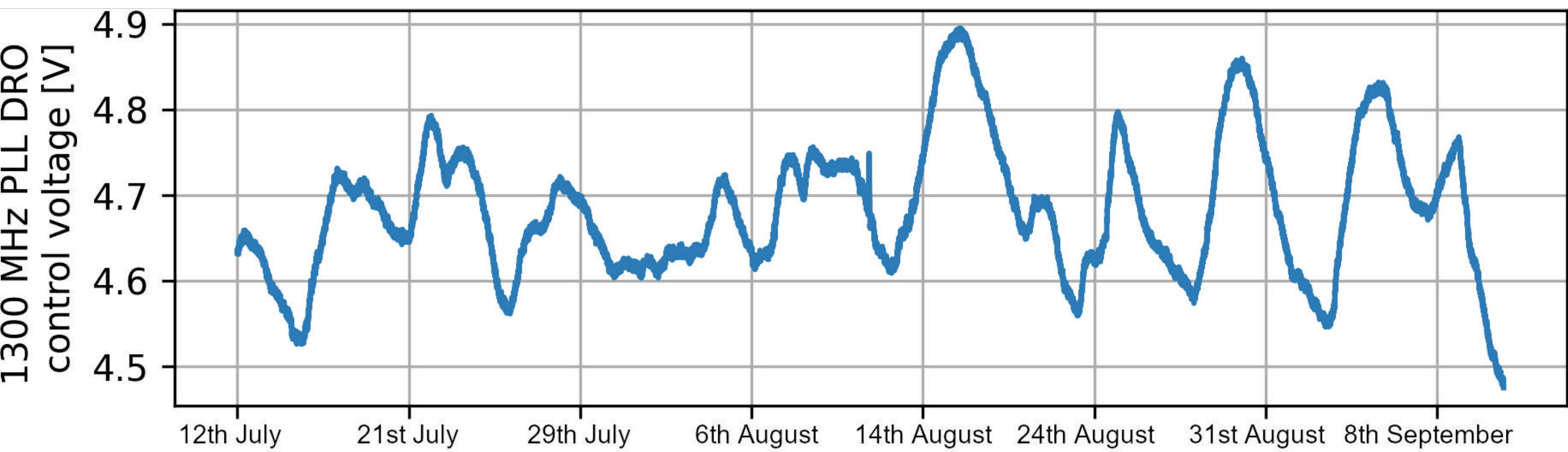
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## Long-term diagnostic data plots of the system Collected in 2024.

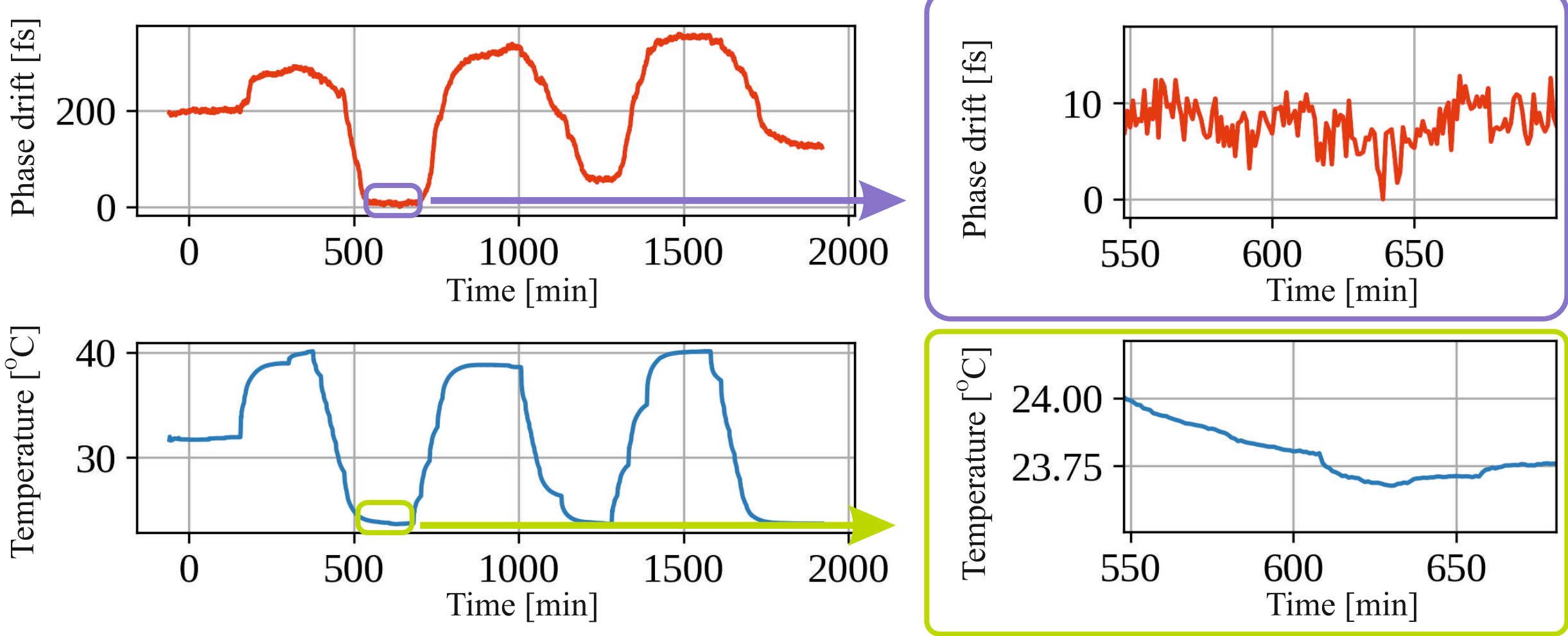


## Long-term temperature data collected in the modules' sensors. Diagnostic data - courtesy of C. Schmidt<sup>2</sup>.



FL-MO1300 DRO tuning voltage and FCM 108 MHz OCOs tuning voltages vs. time. Courtesy of C. Schmidt<sup>2</sup>.

## Distribution module phase drifts



FL-DISM power splitter module tested phase drift (between outputs, total and stabilized).

## References

1. B. Gąsowski, et. al., *Concept of Master Oscillator Upgrade for FLASH*, 23rd International Microwave and Radar Conference MIKON, 2020
2. M. Urbanski, et.al., FLASH2020+ RF Reference Generation System Upgrade Status, Low Level RF Workshop 2022 (LLRF22), 2022
3. M. Urbanski, et.al., An upgraded universal frequency divider module for the new FLASH2020+ RF reference generation system, IPAC'23
4. M. Urbanski, Development of Phase Reference Distribution Systems of Linear Particle Accelerators with Femtosecond Stability, Ph.D. Thesis, October 2023, Warsaw University of Technology, Warsaw, Poland

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