

SFMR Calibration: A Collaborative Look at Current Progress and Findings

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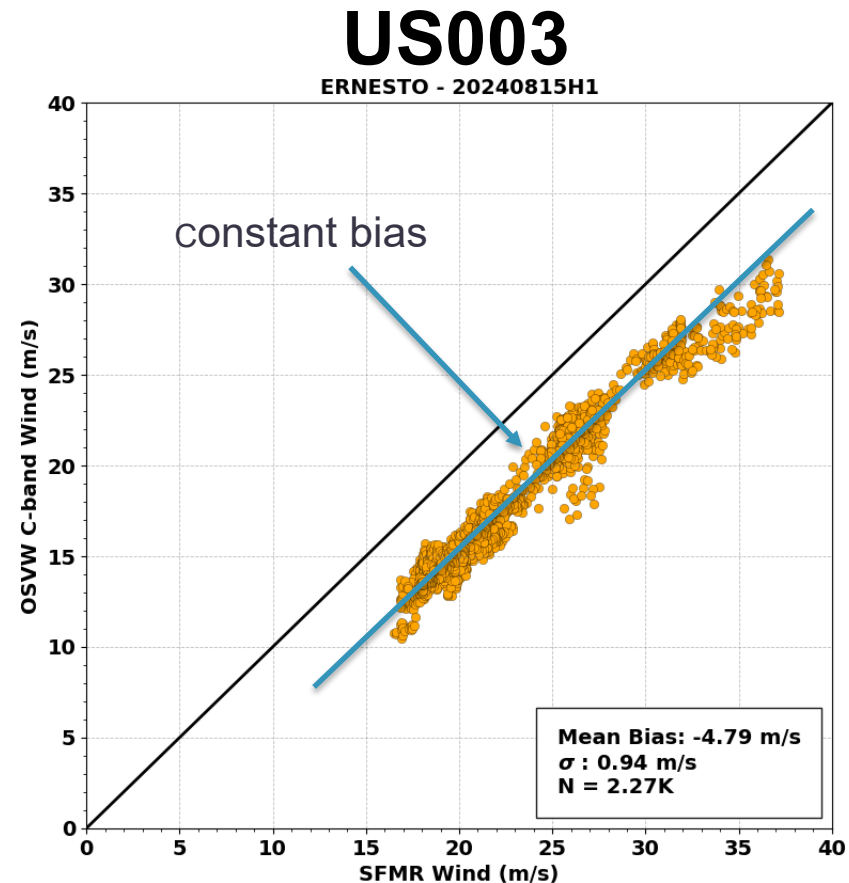
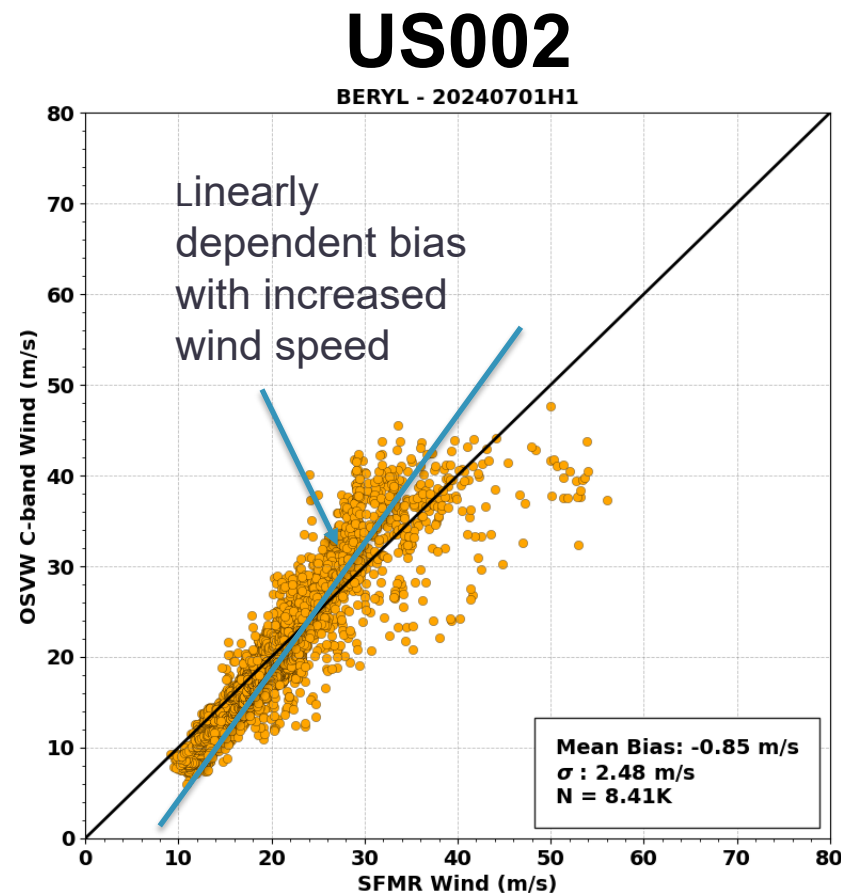
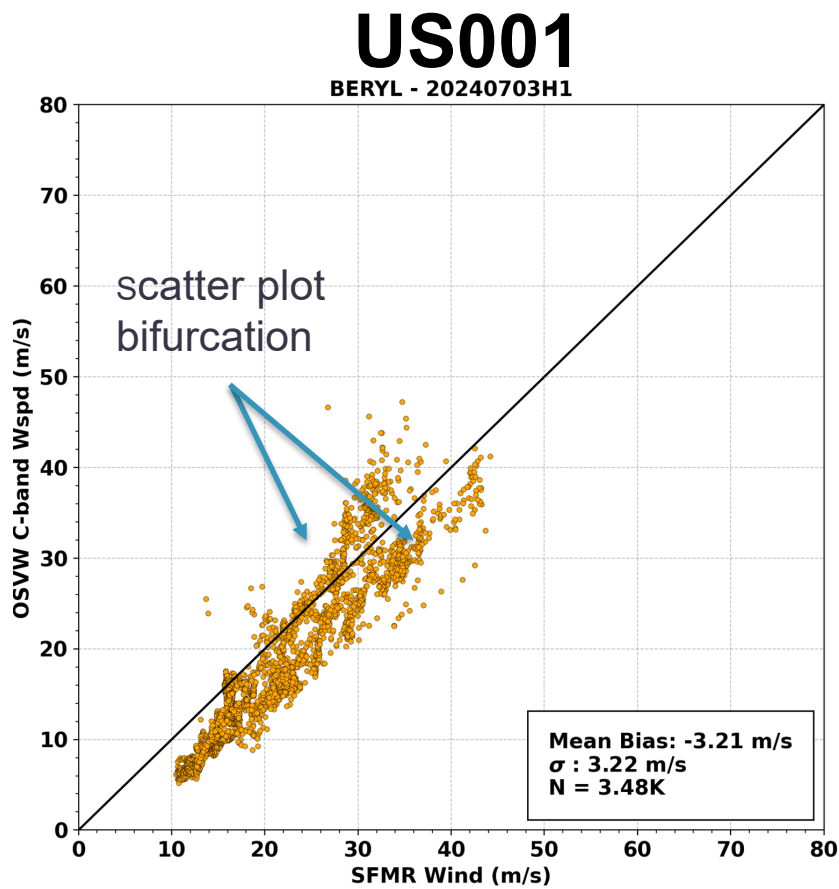


Ivan Popstefanija

Sach Jankharia

NA23OAR4590412 “Real-time Visualization and Interpretation of the Hurricane Wind Structure and Intensity: From Flight Level to the Surface”
NA25OARX459C0258-T1-01 “Stepped Frequency Microwave Radiometer Calibration and Re-calibration Tool”

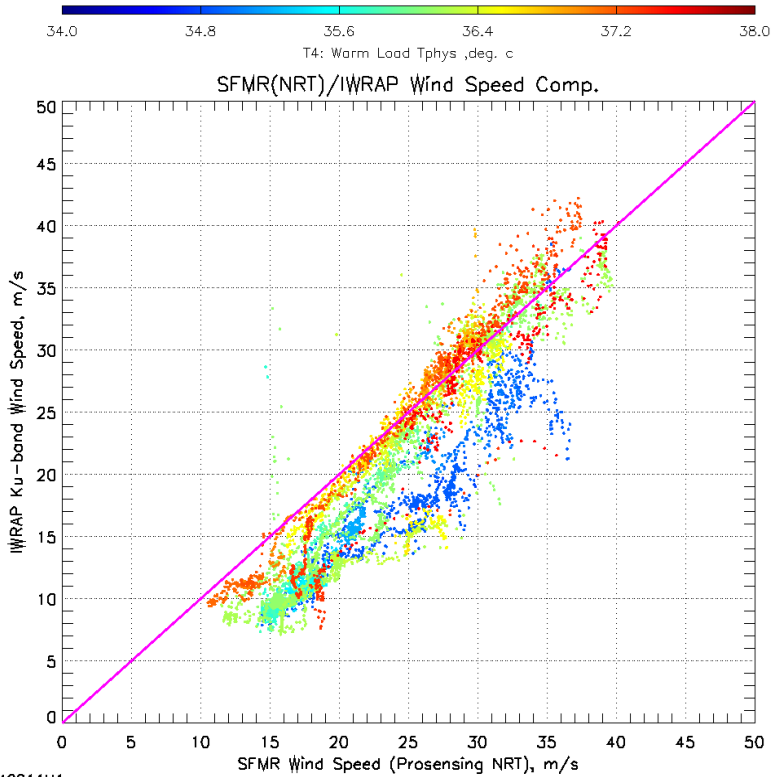




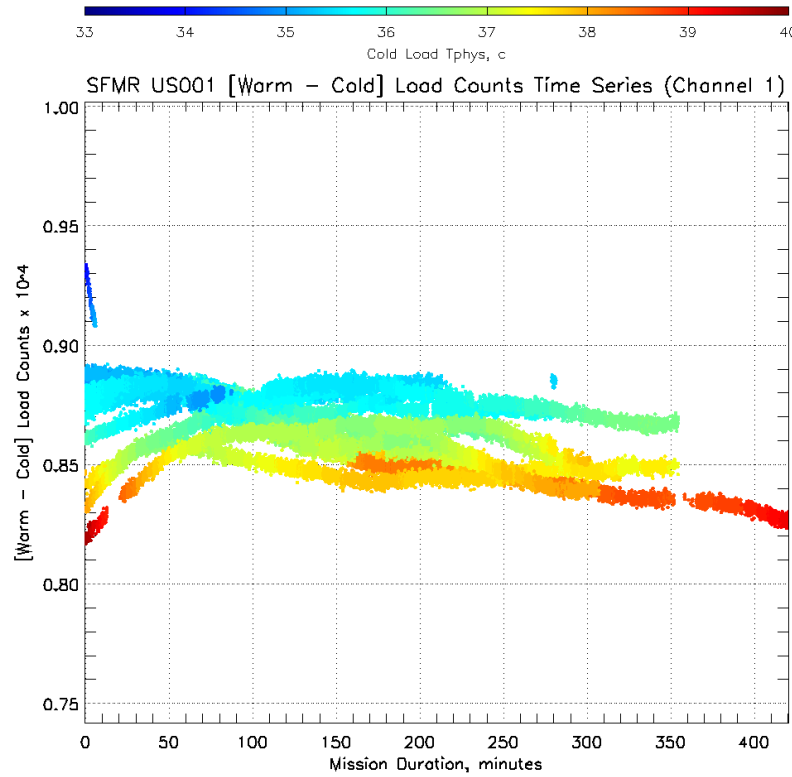
2024 SFMR vs IWRAP comparisons revealed different biases from different NOAA SFMR units

System Temperature Dependence – US001

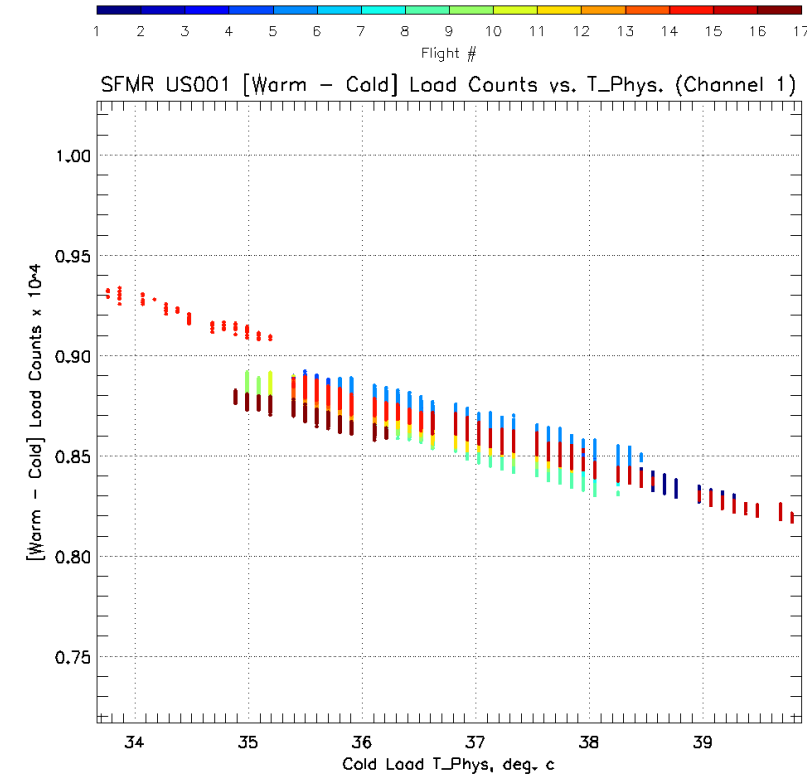
20240730H1
SFMR vs IWRAP



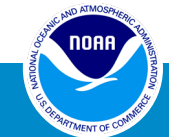
$C_W - C_C$ vs Time per Flight
2024 Season



$C_W - C_C$ vs Temp per Flight
2024 Season



20240911H1



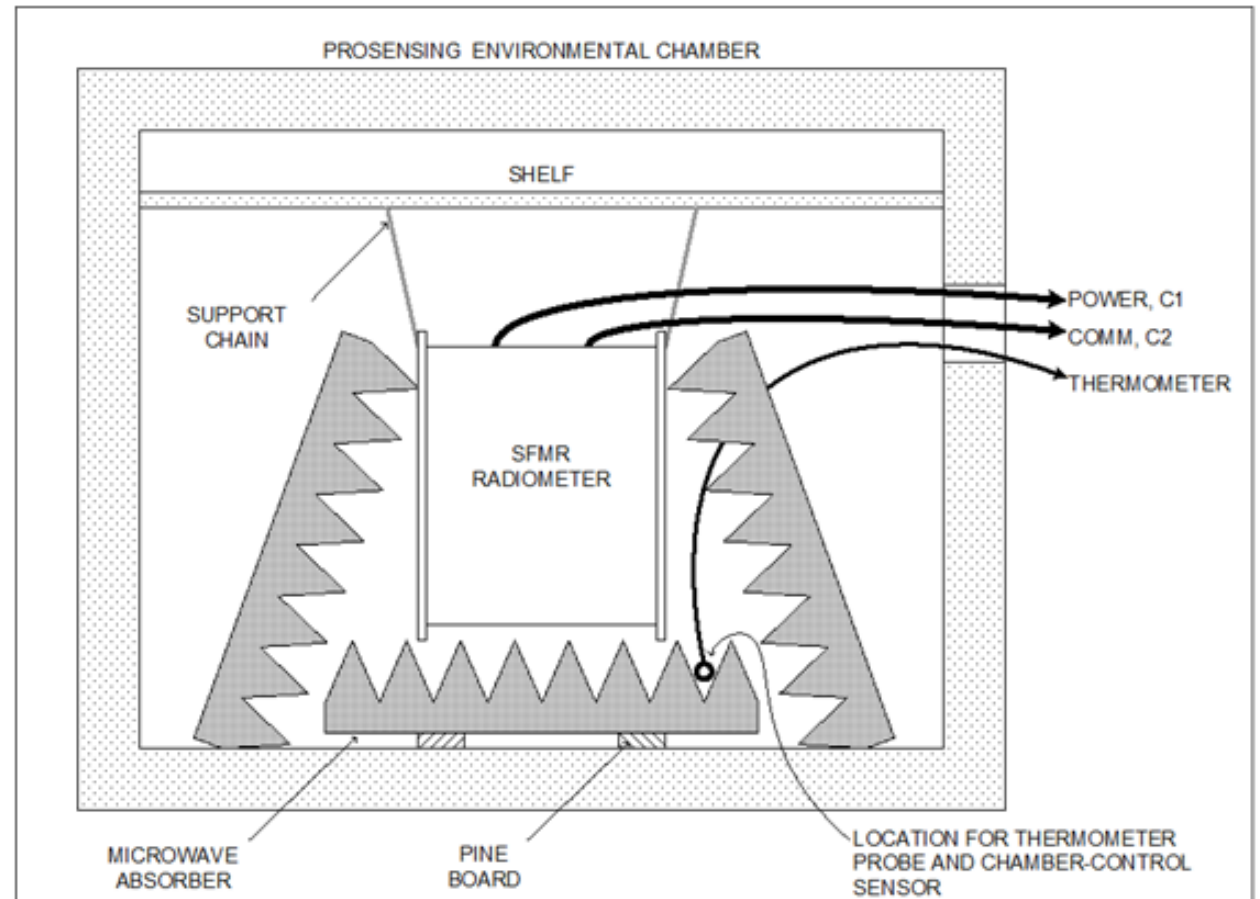
ProSensing Testing of NOAA Units

- **Comprehensive Laboratory Testing:** All three NOAA units were submitted to ProSensing for standardized evaluation and characterization.
 - **Standardized Calibration:** Performed traditional laboratory calibrations across all units to establish baseline performance metrics.
 - **VCO Stability Analysis:** Evaluated all three SFMR units to characterize Voltage Controlled Oscillator (VCO) frequency drift relative to temperature; implemented precision corrections based on performance data.
- **Unit 002 Component Refresh:** Conducted a full restoration of the thermal sensing subsystem, including replacement of thermistors, internal wiring, and signal-to-count conversion electronics.
- **Iterative System Characterization:** Based on initial performance results, **additional lab tests are being jointly designed with ProSensing** to achieve full system characterization.



ProSensing Lab Test Setup

- SFMR is installed in the environmental chamber as it is in the P-3 wing pod (the entire white “box” including antenna and radome).
- Microwave absorber is installed on all 6 sides (not fully shown in diagram to the right).
- The ambient temperature is measured on the absorber near the antenna.
- The standard lab calibration procedure takes SFMR measurements at 5 C and 20 C in the environmental chamber. An outdoor upward looking sky calibration measurement is also performed.





Lab Results

Checking for Frequency Drift in Voltage Controlled Oscillator Controlled Thermal Chamber 5C and 20C Results



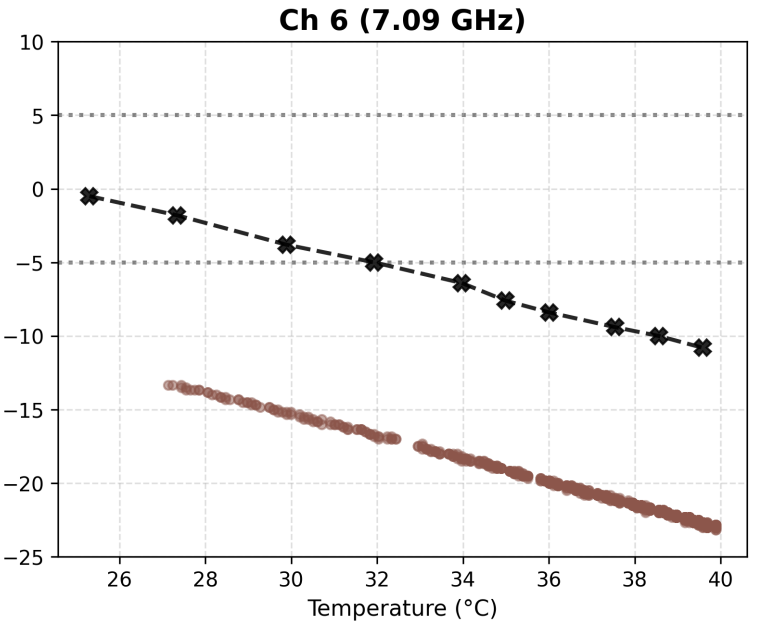
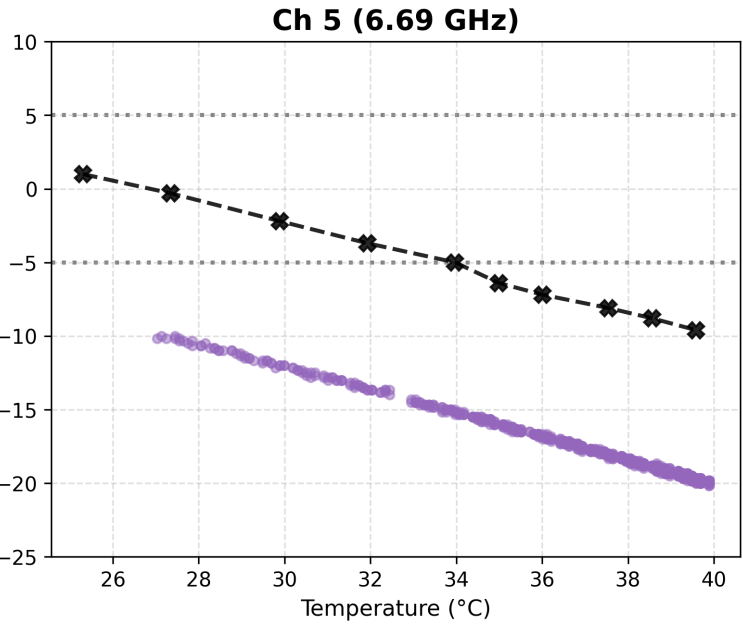
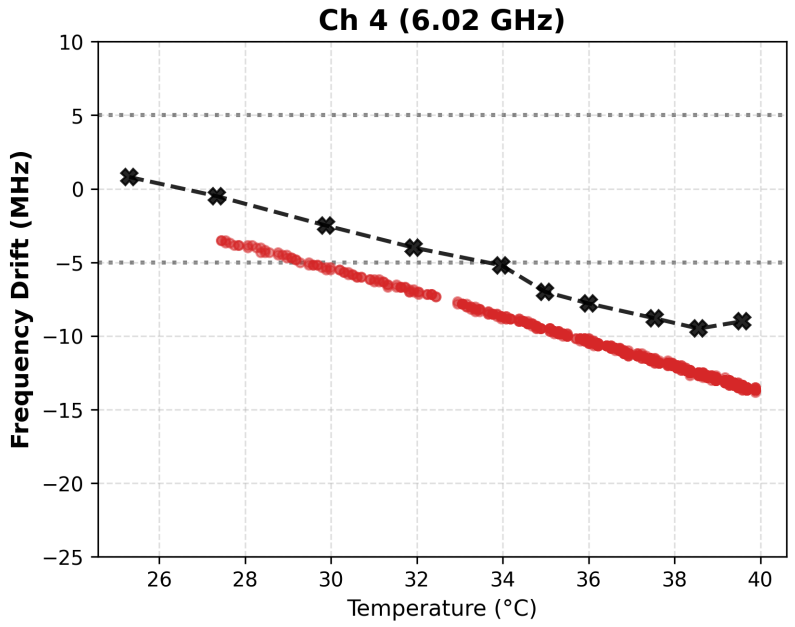
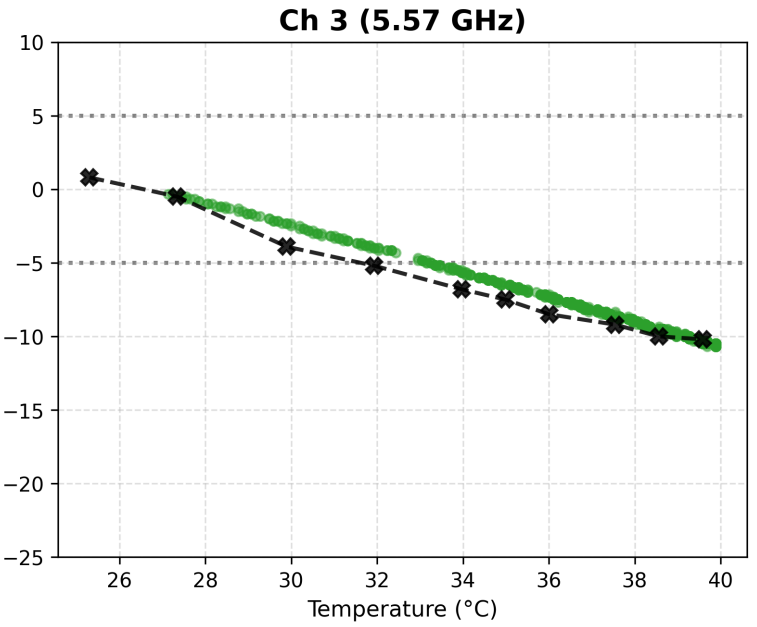
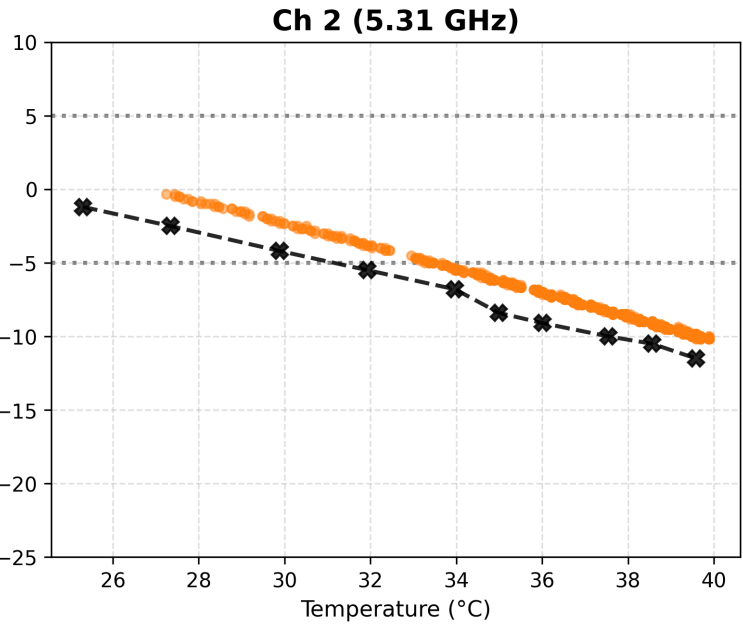
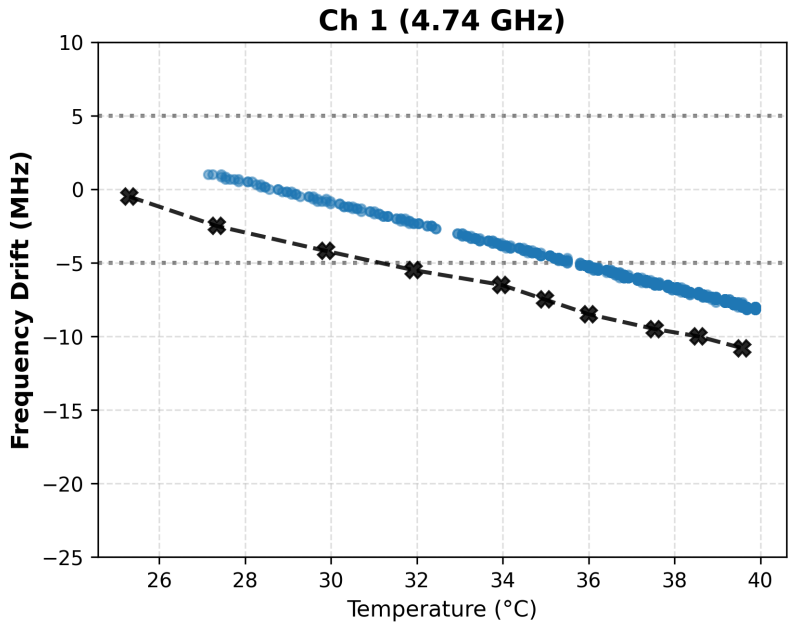
Lab Measured VCO Frequency Drift 2008 vs 2025 Unit 3

● New Calibration * Original (Correction OFF) ···· +/- 5 MHz Limit

Original: 9 Apr 2010

UNIT3 Frequency Drift: Original vs. New

New: 02 Sep 2025



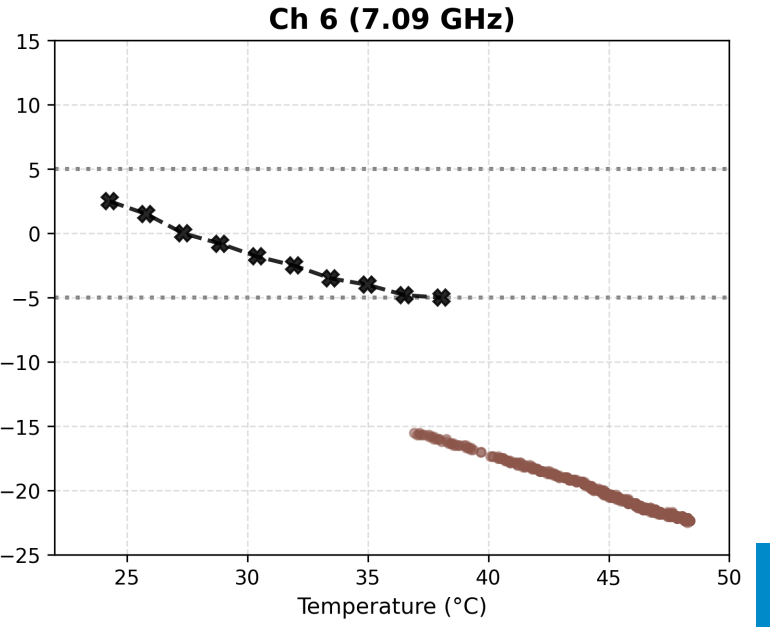
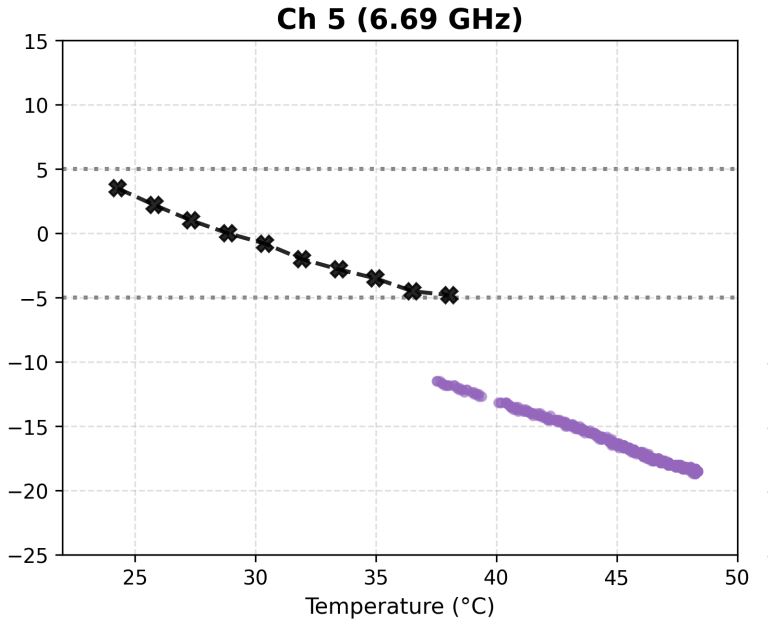
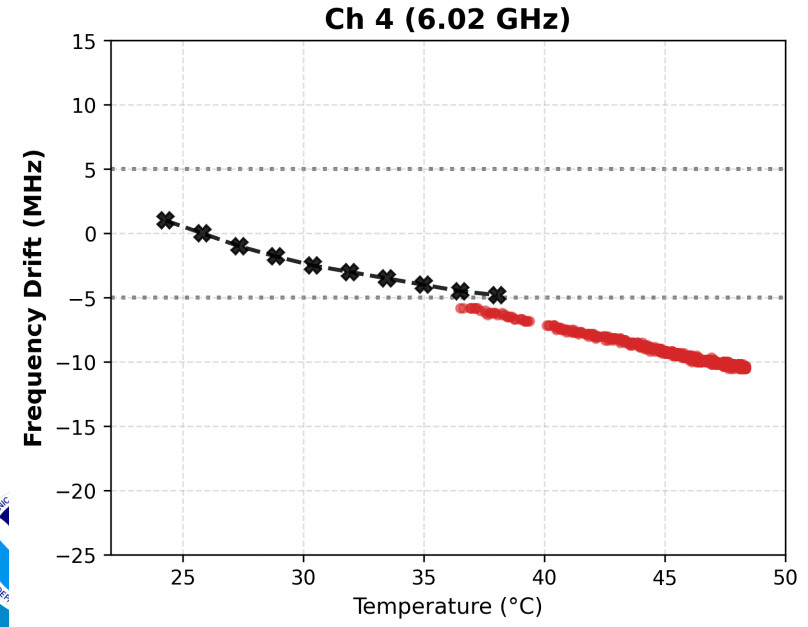
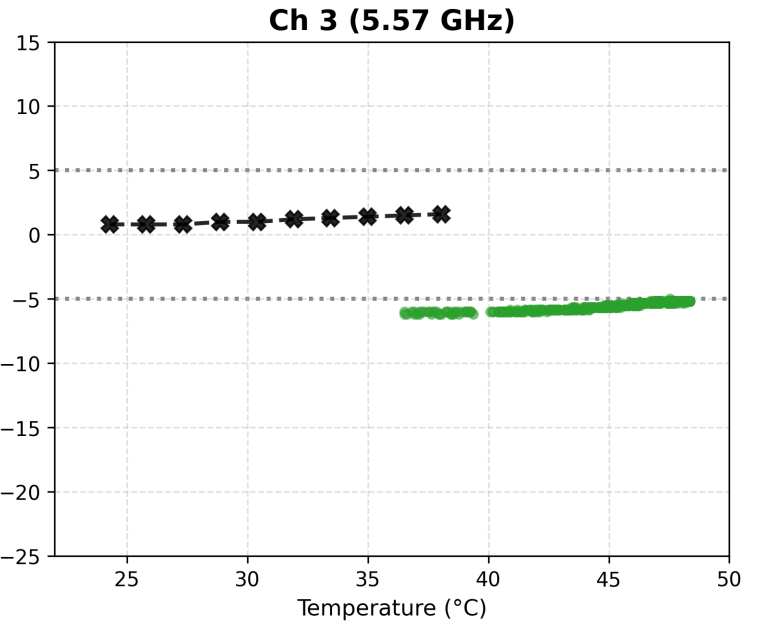
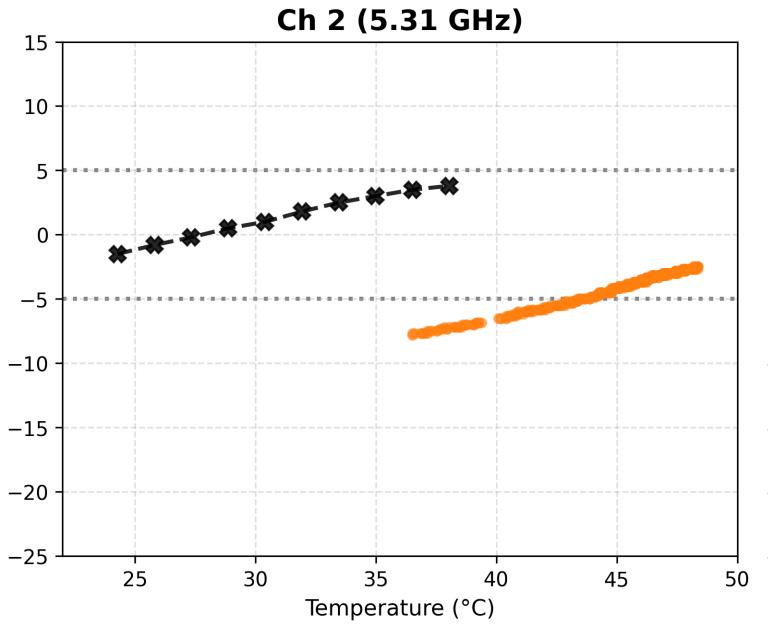
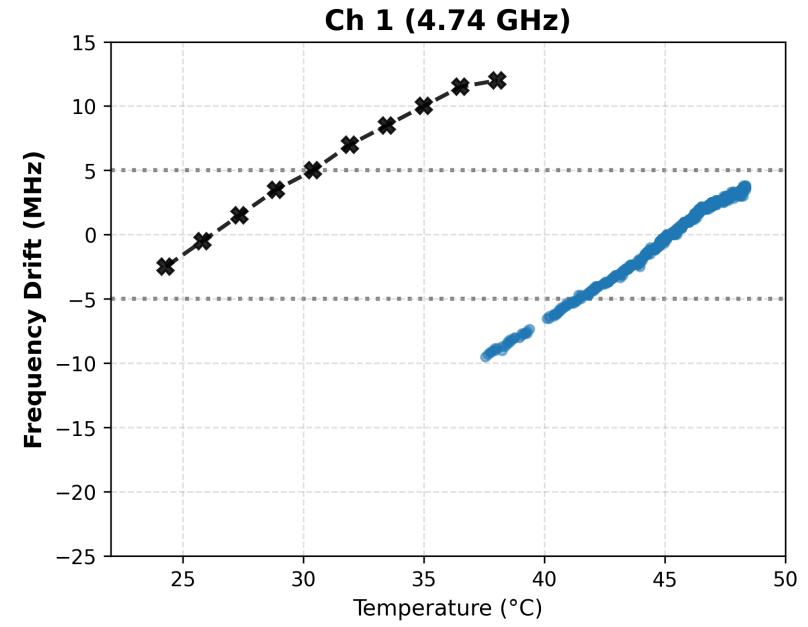
Lab Measured VCO Frequency Drift 2008 vs 2025 Unit 1

● New Calibration * Original (Correction OFF) ···· +/- 5 MHz Limit

Original: 19 May 2008

UNIT1 Frequency Drift: Original vs. New

New: 30 Sep 2025



Lab Measured VCO Frequency Drift 2008 vs 2025 Unit 2

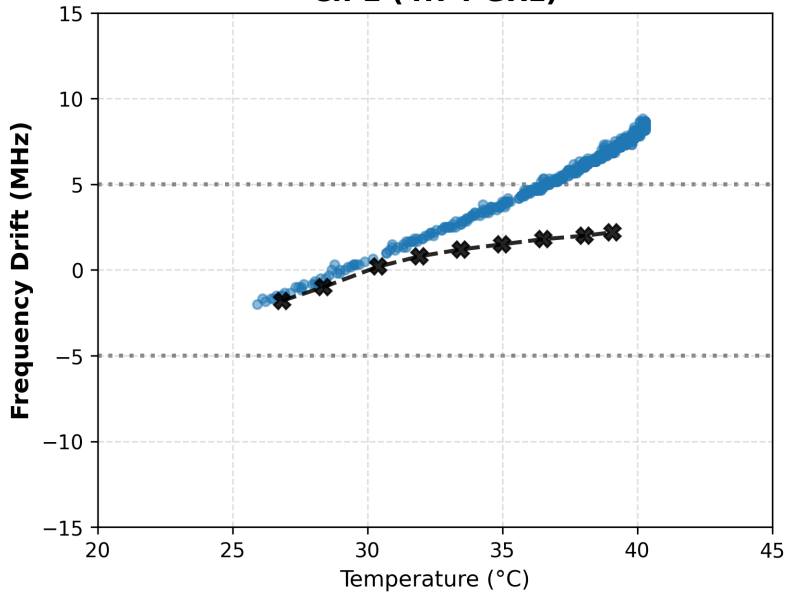
● New Calibration -*- Original (Correction OFF) +/- 5 MHz Limit

Original: 23 Jul 2008

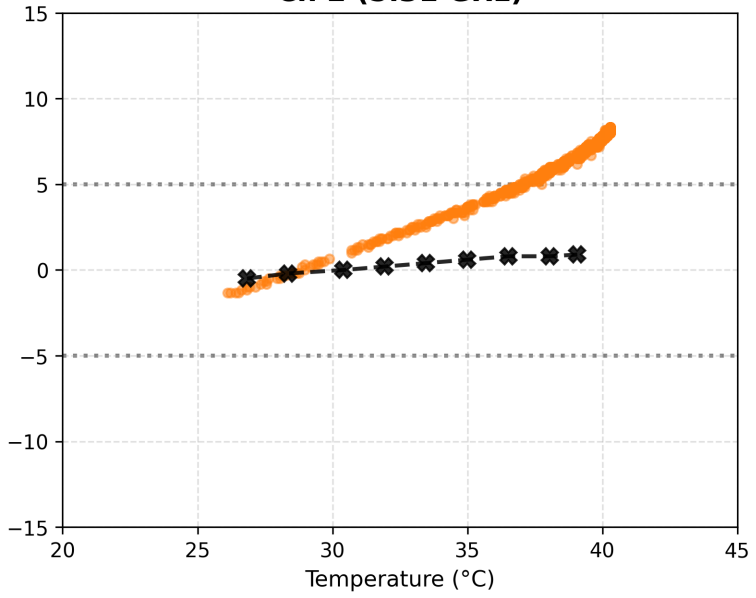
UNIT2 Frequency Drift: Original vs. New

New: 06 Nov 2025

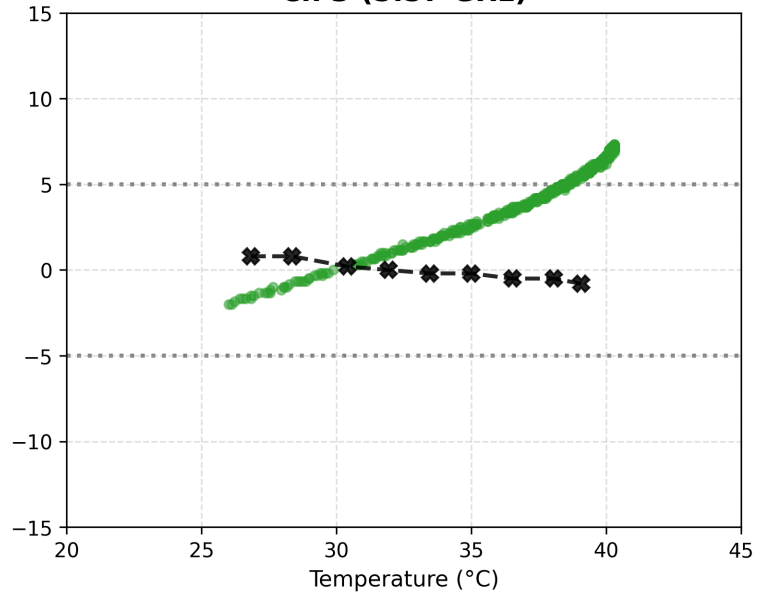
Ch 1 (4.74 GHz)



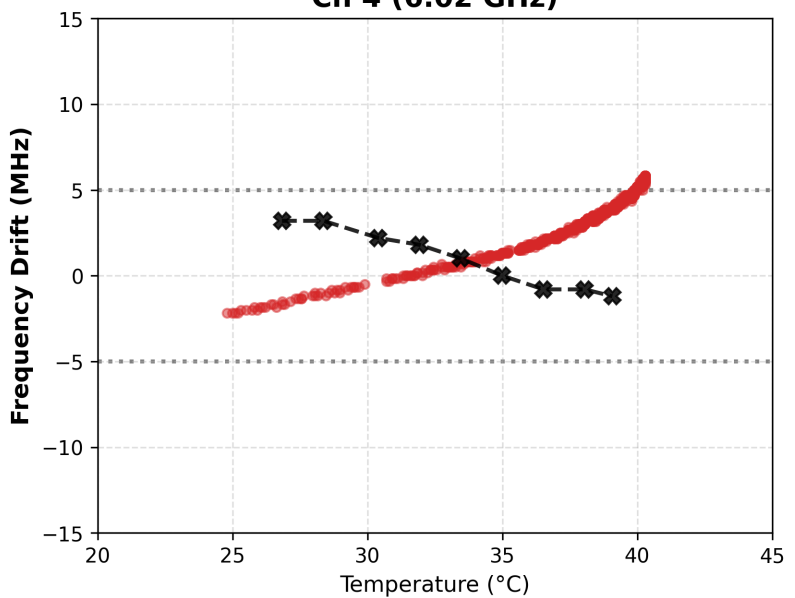
Ch 2 (5.31 GHz)



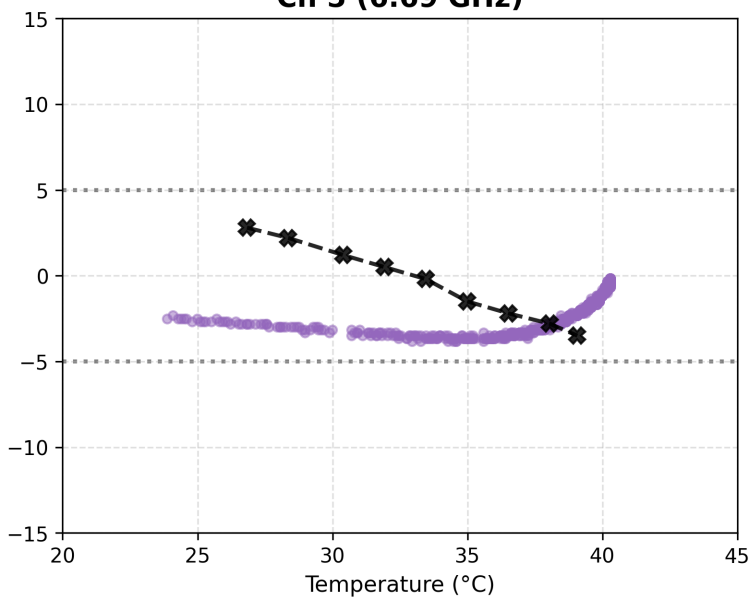
Ch 3 (5.57 GHz)



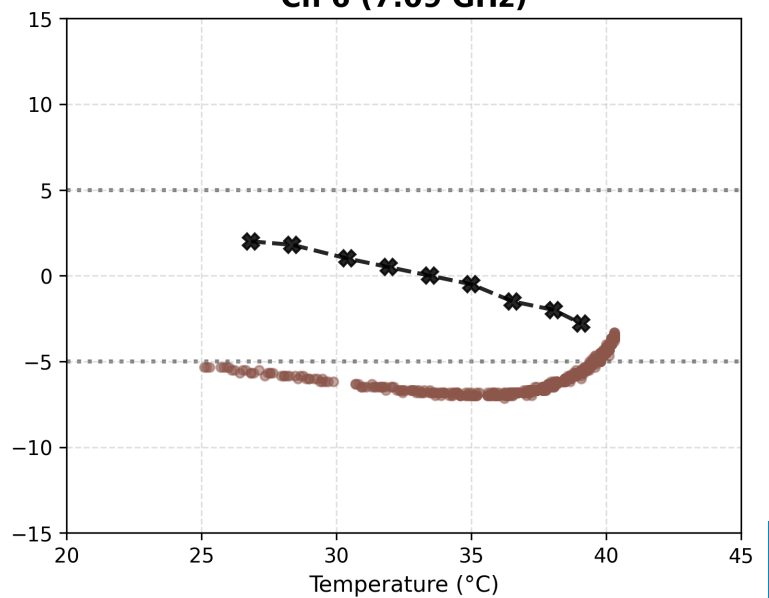
Ch 4 (6.02 GHz)



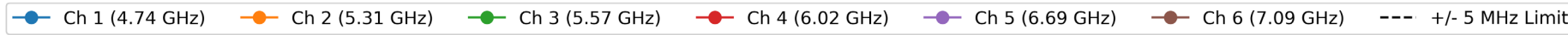
Ch 5 (6.69 GHz)



Ch 6 (7.09 GHz)

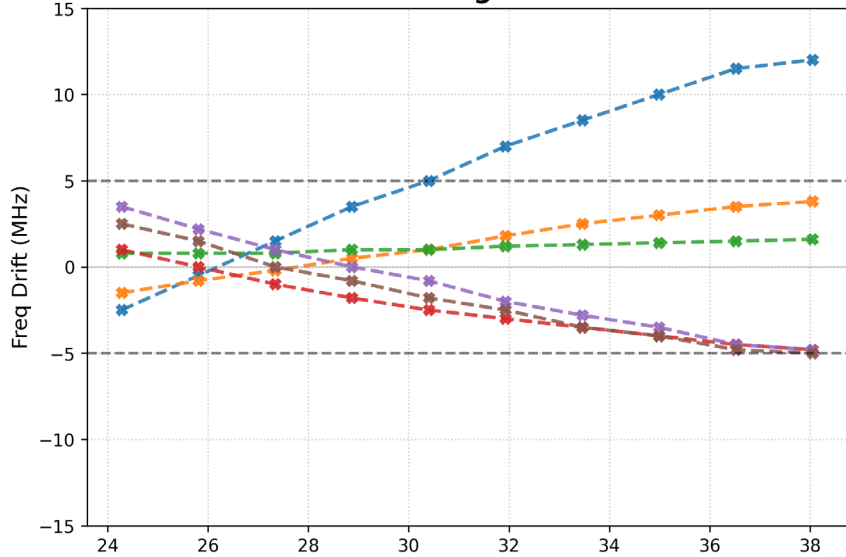


Combined VCO Frequency Drifts 2008 vs 2025

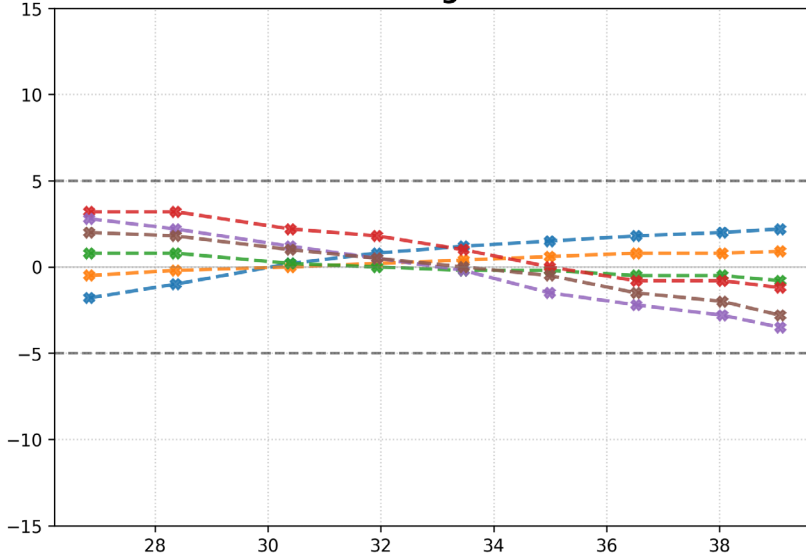


VCO Frequency Drift Summary: Original Calibration vs. New Tests

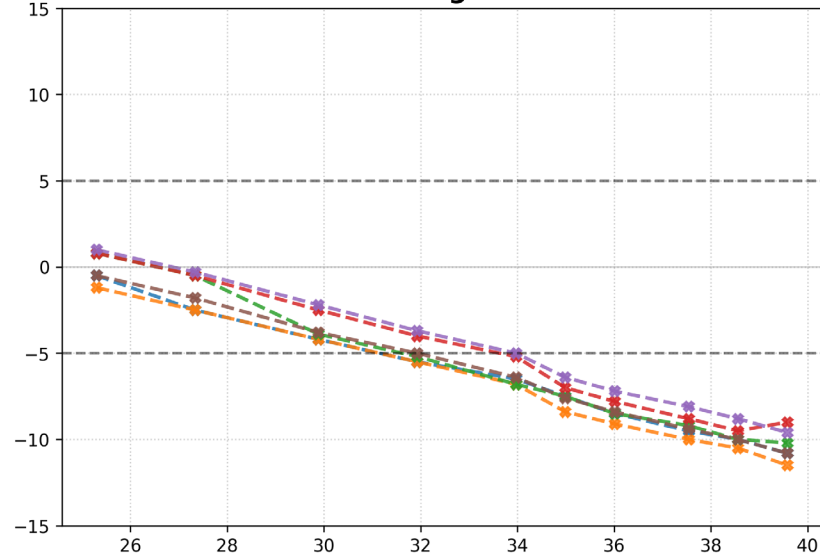
UNIT1 - Original Drift



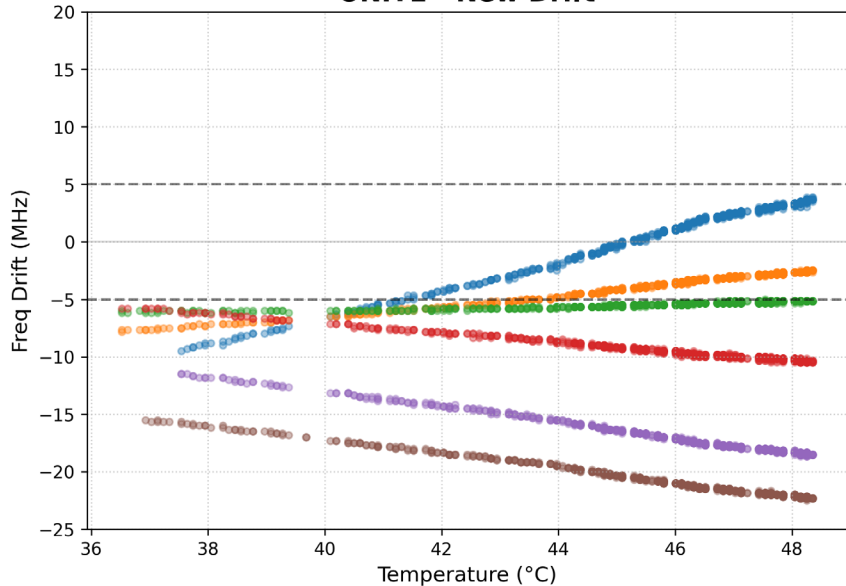
UNIT2 - Original Drift



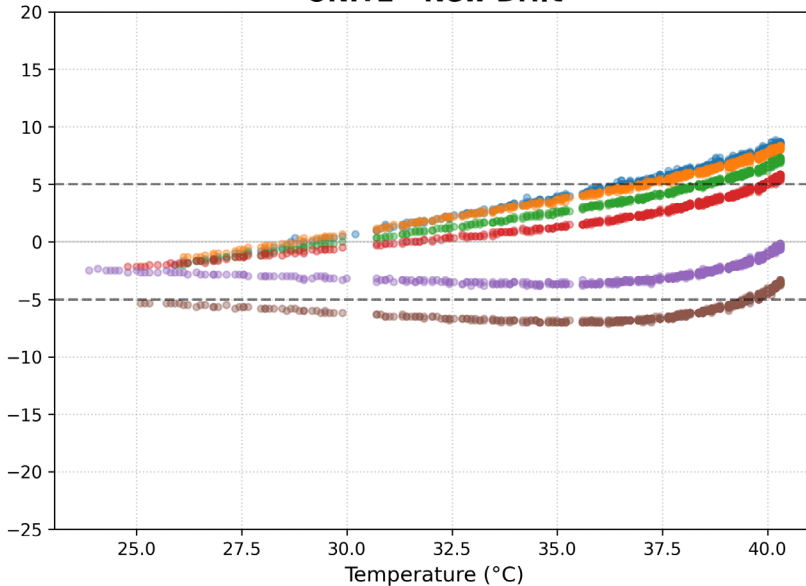
UNIT3 - Original Drift



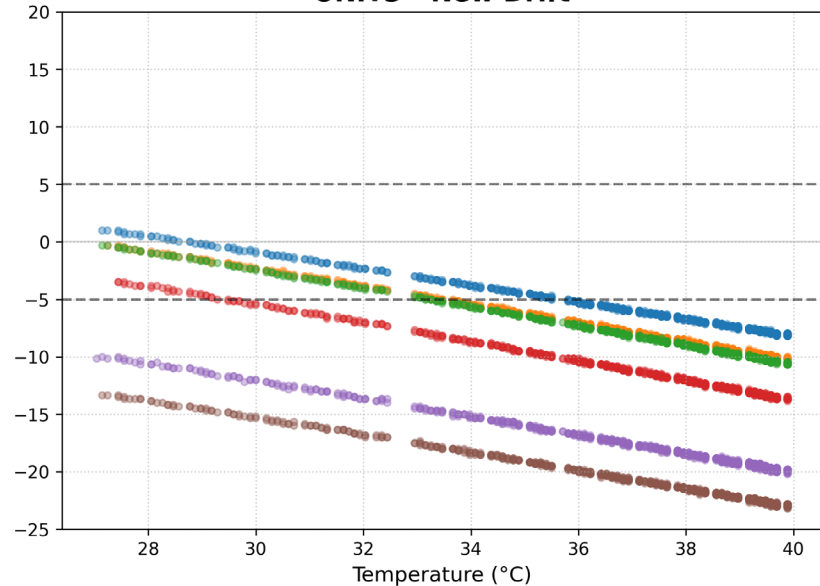
UNIT1 - New Drift



UNIT2 - New Drift



UNIT3 - New Drift

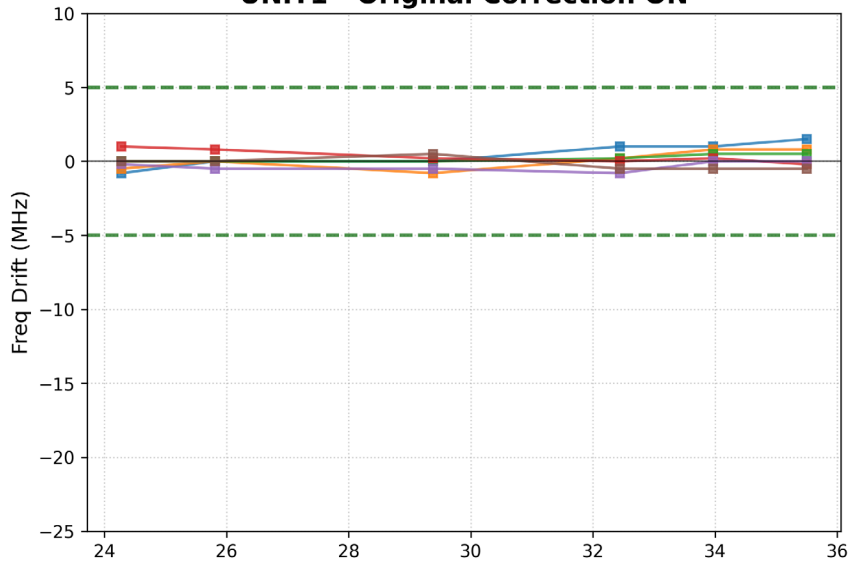


2008 vs 2024 Frequency Adjustment

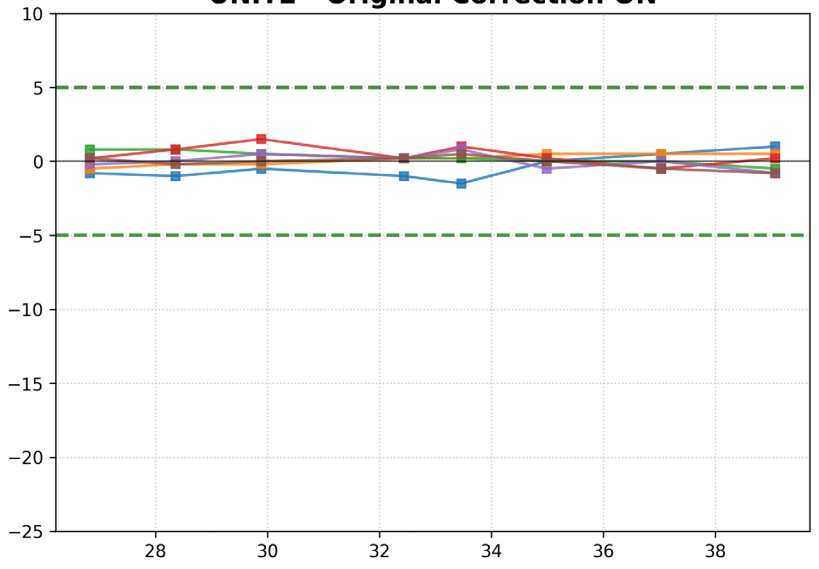


VCO Corrected Frequency Drift Summary: Original Calibration vs. 2024 Season Adjustments

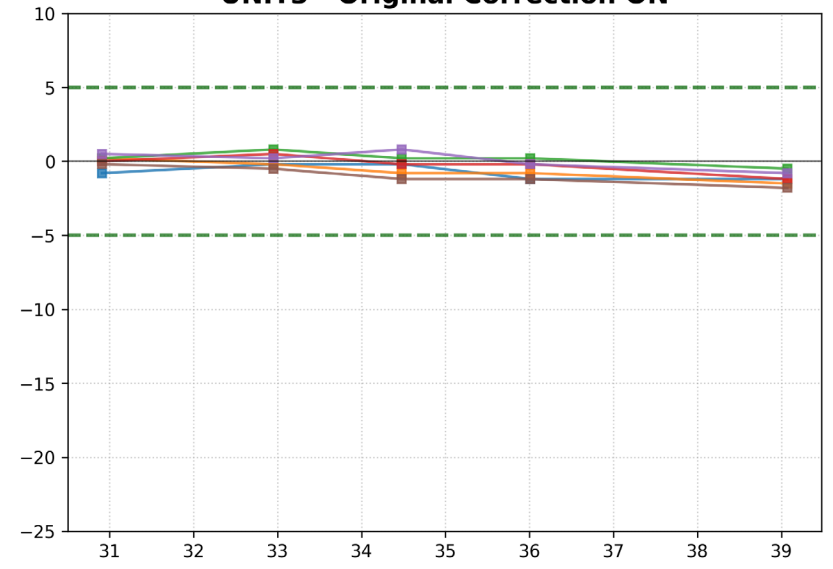
UNIT1 - Original Correction ON



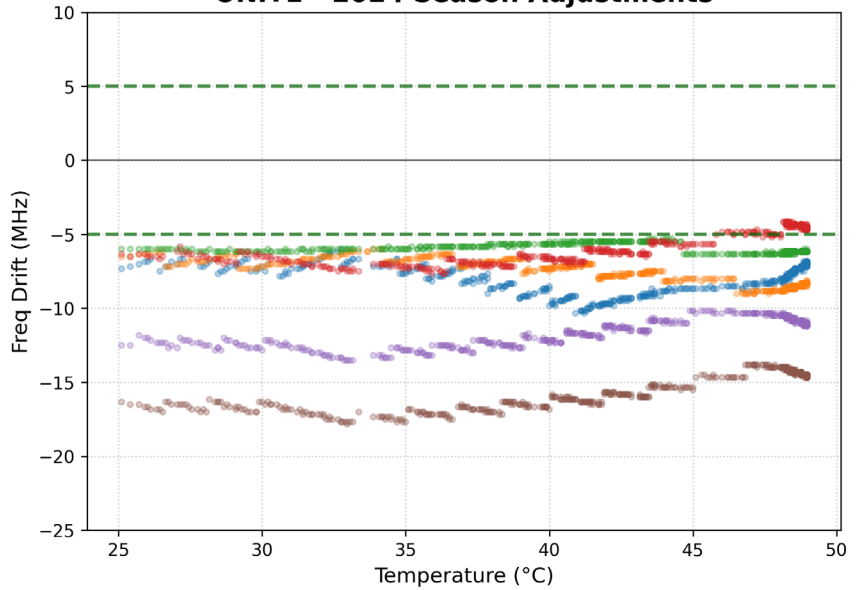
UNIT2 - Original Correction ON



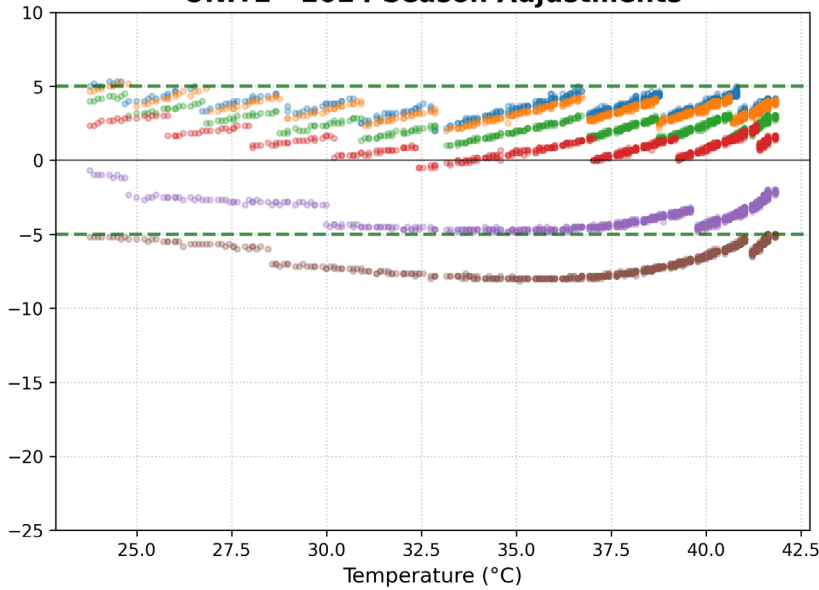
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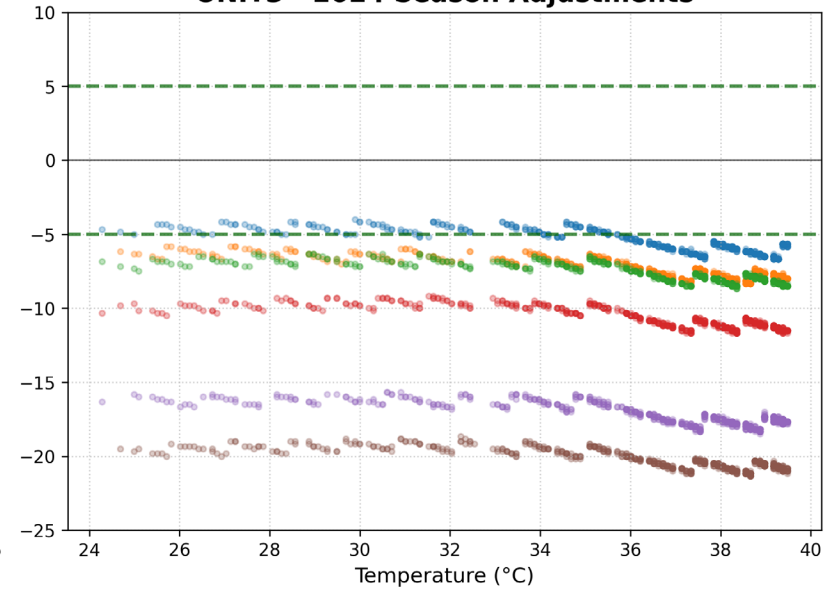
UNIT1 - 2024 Season Adjustments



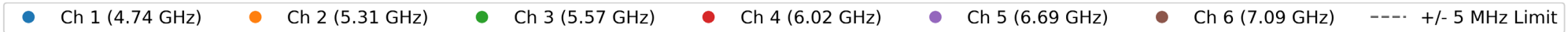
UNIT2 - 2024 Season Adjustments



UNIT3 - 2024 Season Adjustments

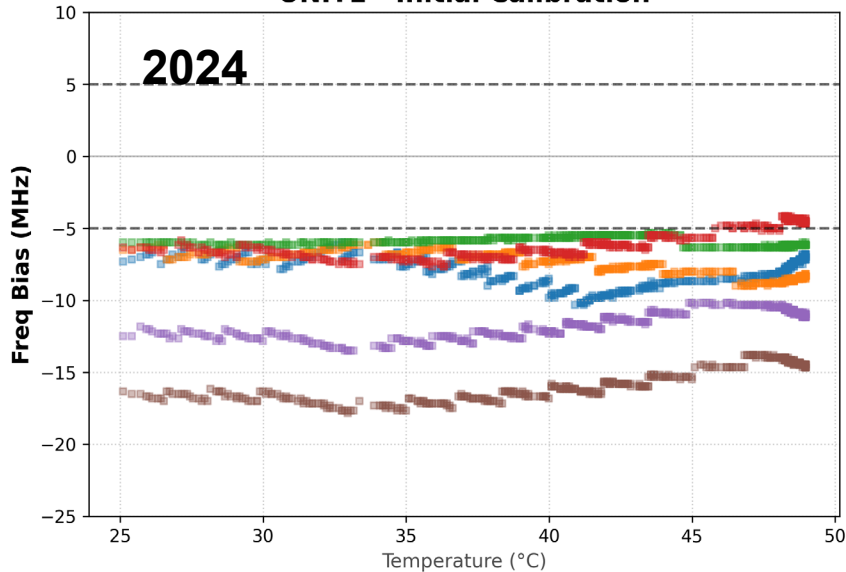


2024 vs 2025 Frequency Adjustment

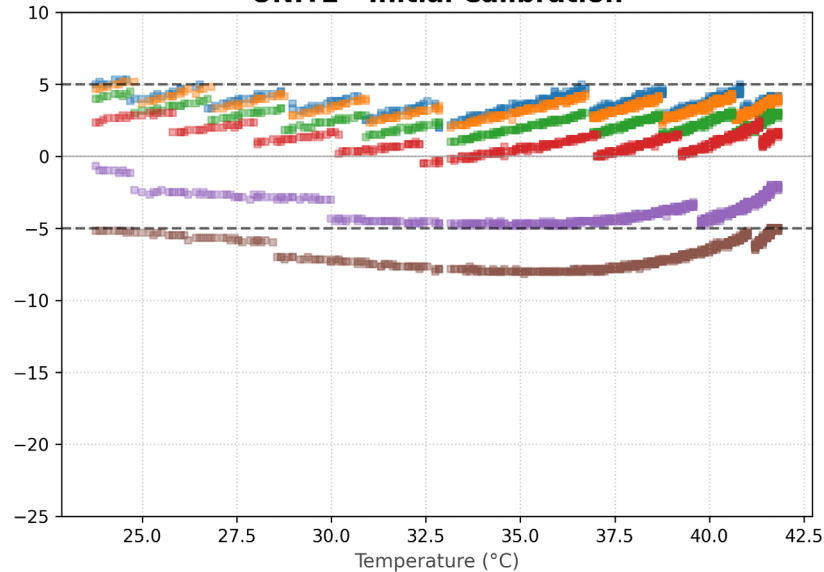


VCO Corrected Frequency Drift Summary: 2024 vs. 2025 Adjustment

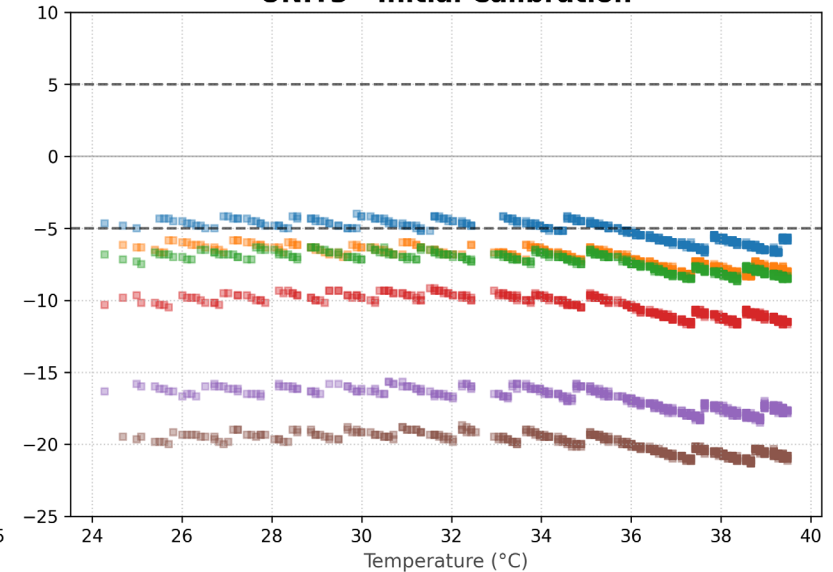
UNIT1 - Initial Calibration



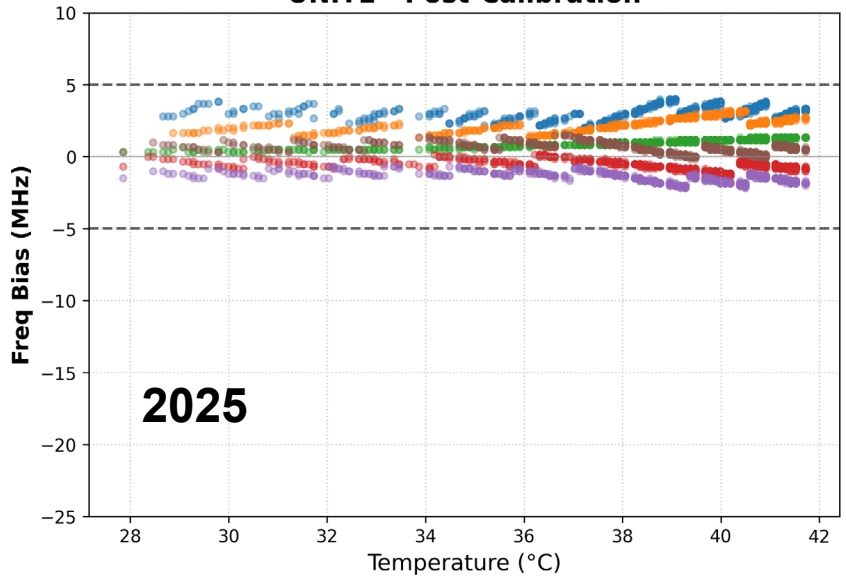
UNIT2 - Initial Calibration



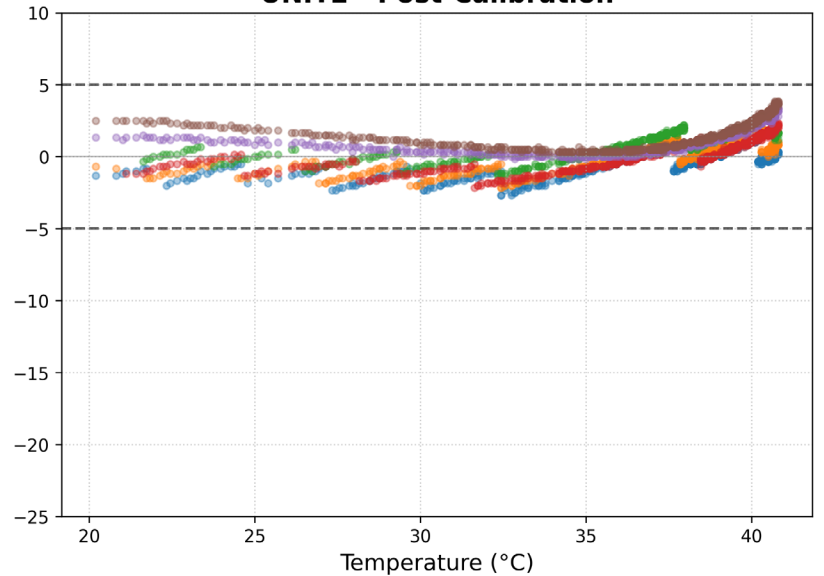
UNIT3 - Initial Calibration



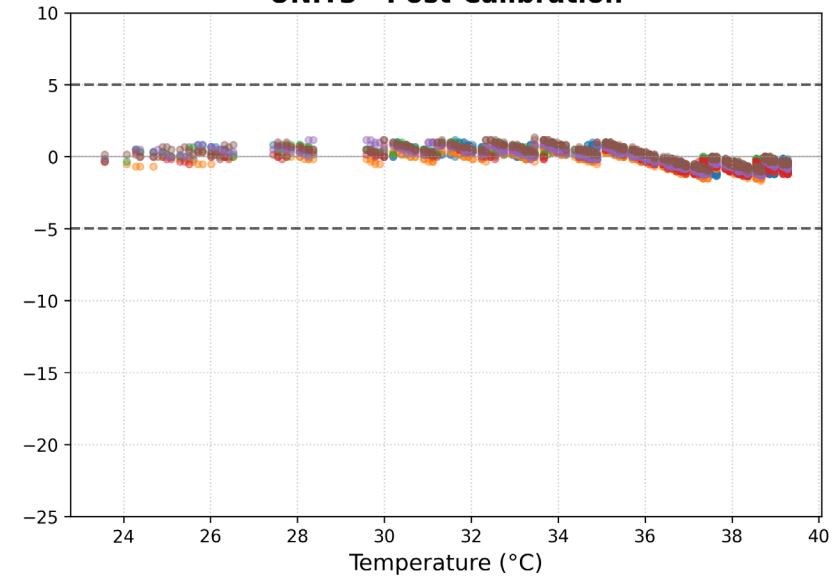
UNIT1 - Post-Calibration



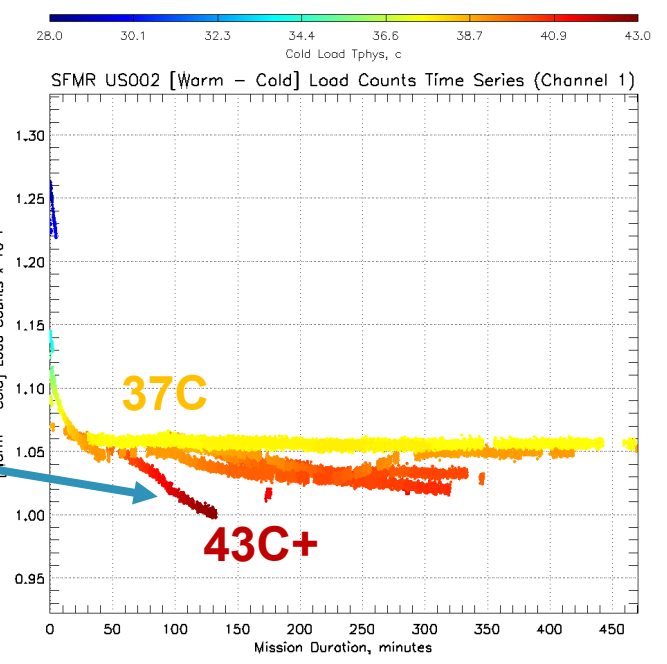
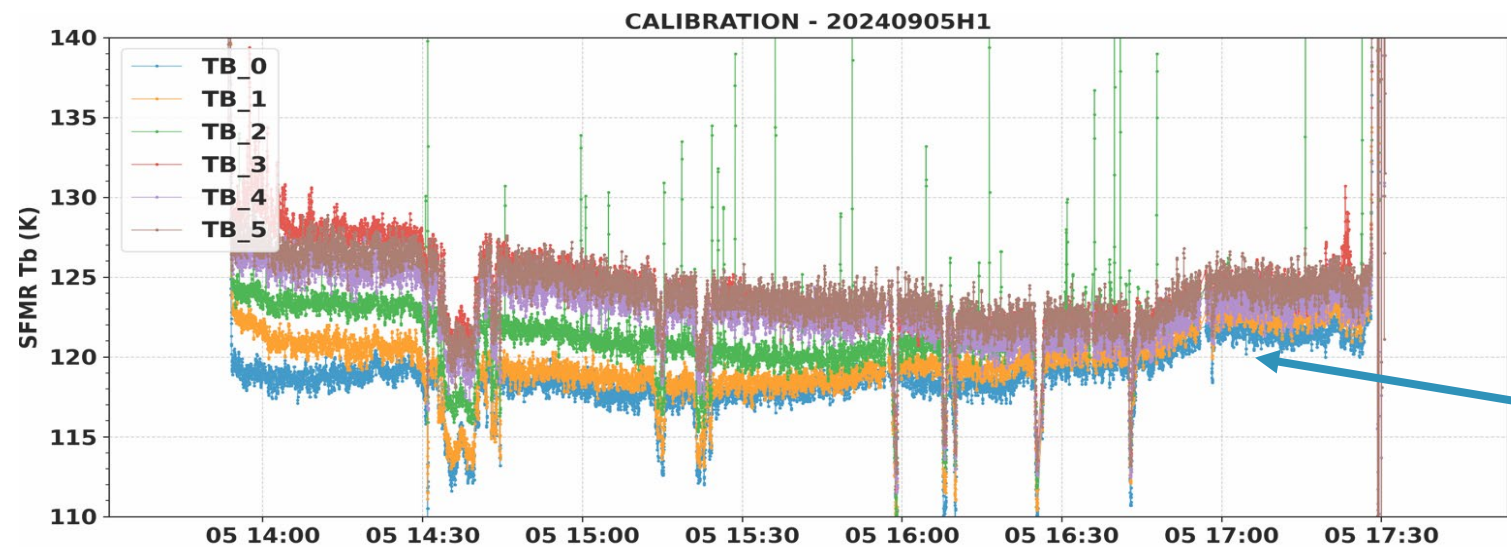
UNIT2 - Post-Calibration



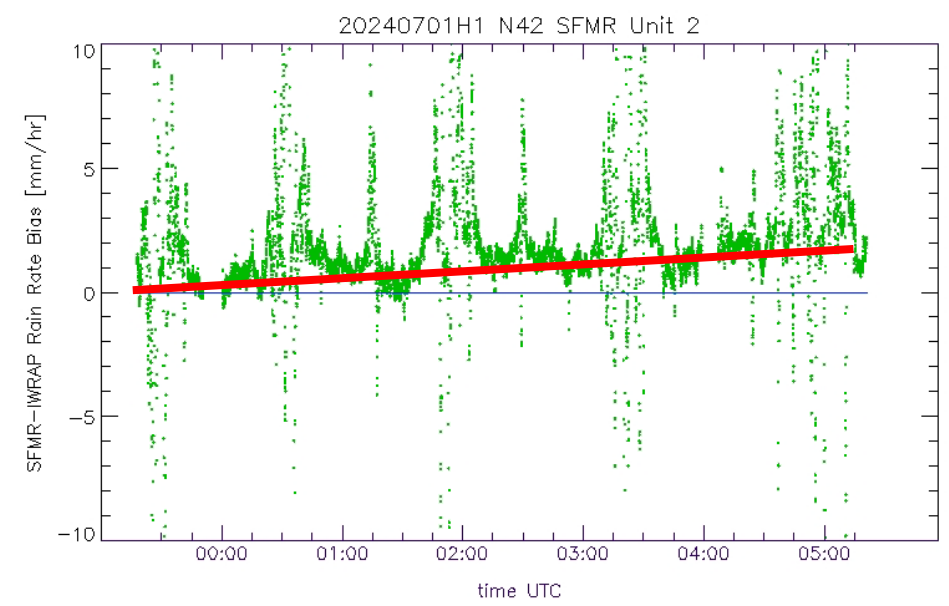
UNIT3 - Post-Calibration



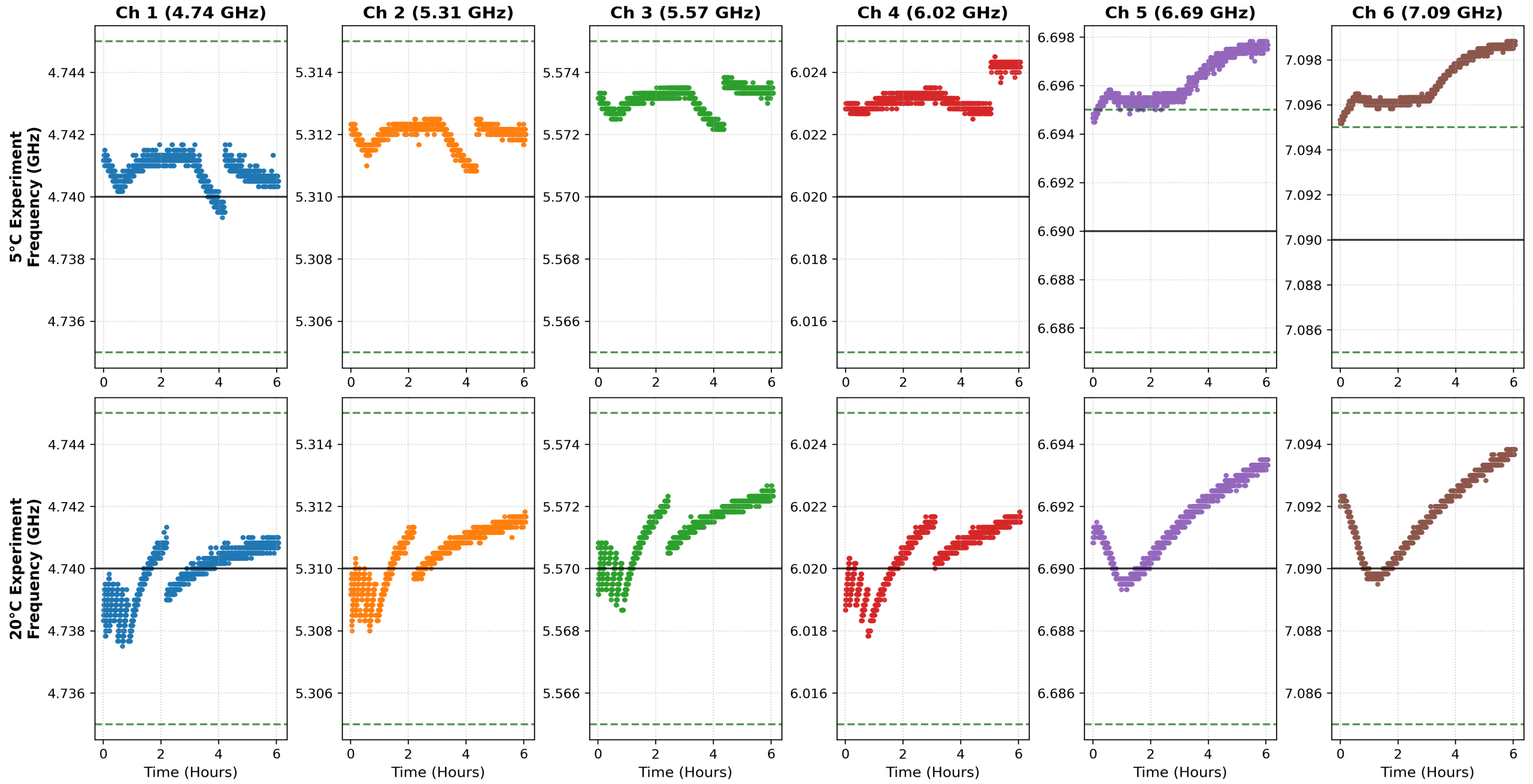
UNIT2 2024 Observations



Clear frequency drift with system temperature was observed from UNIT2 on Sep, 5th, 2024 flight



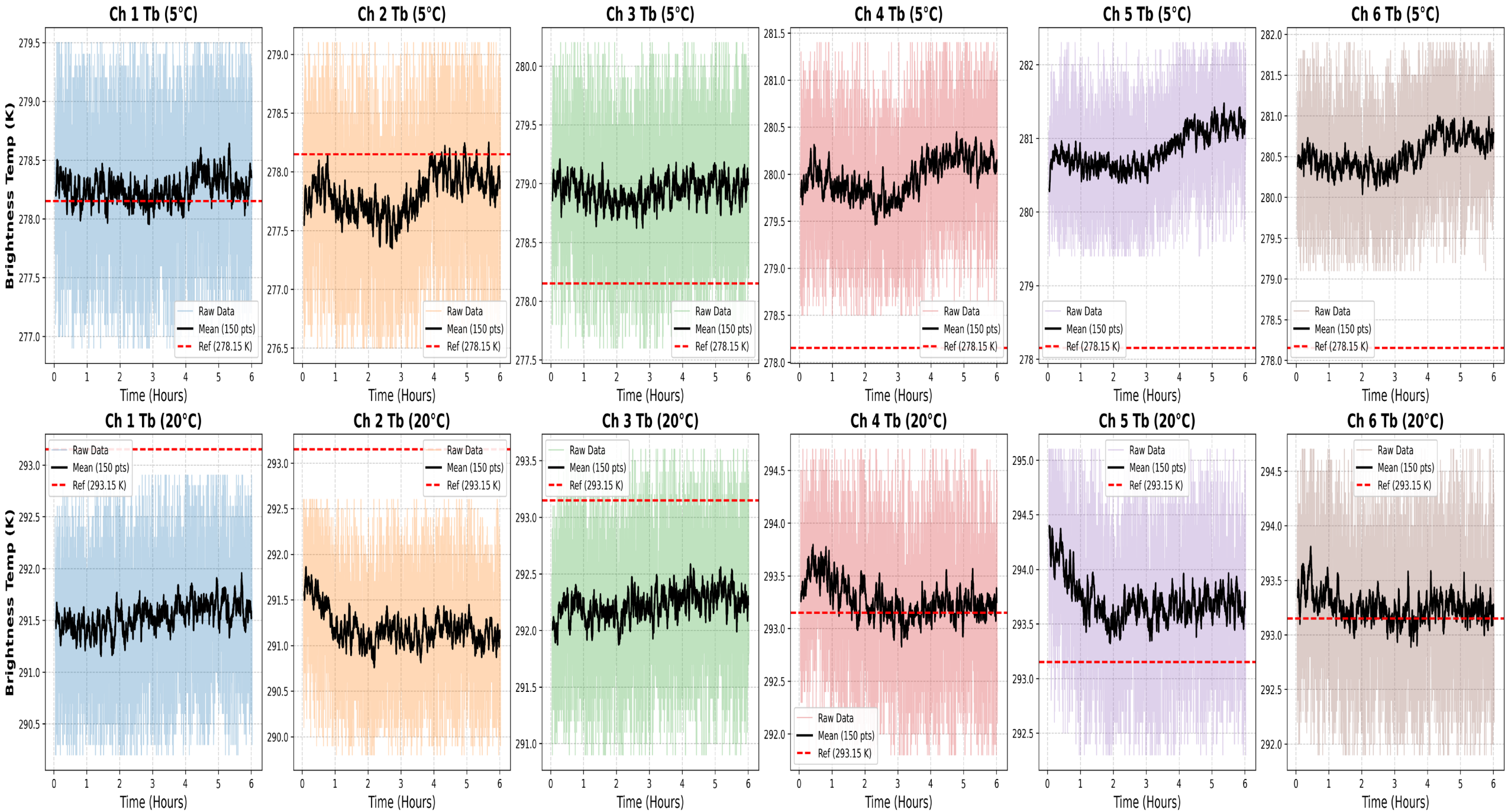
Absolute VCO Frequency vs Time



UNIT2

SFMR Brightness Temperatures: 5°C (Top) vs 20°C (Bottom)

Calibration Coefficients from 2024

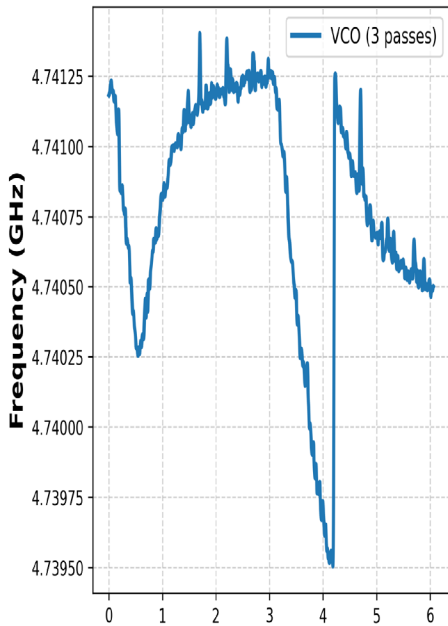


UNIT2

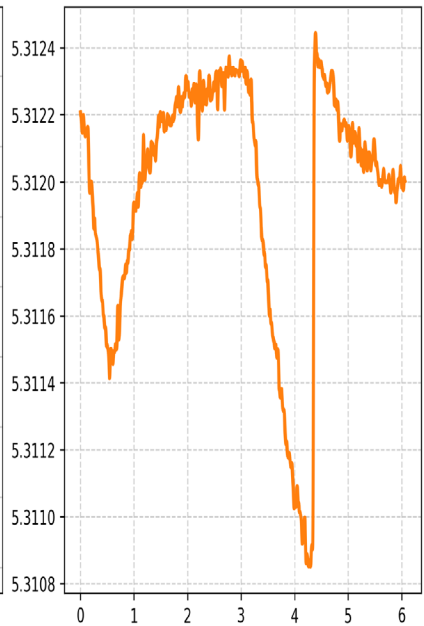
SFMR 5C Cal Experiment (VCO Freq Top, Tb Bottom)

Calibration Coefficients from 2024

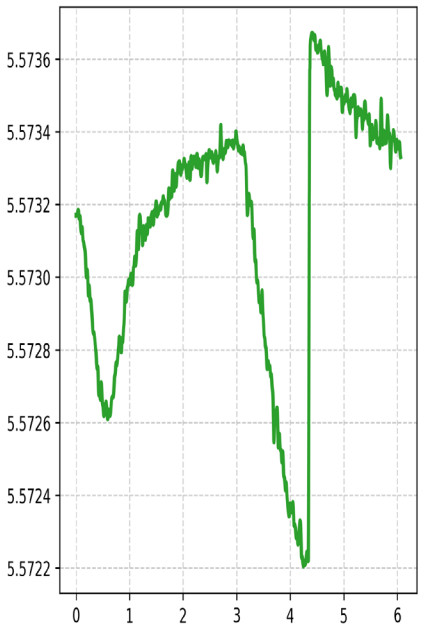
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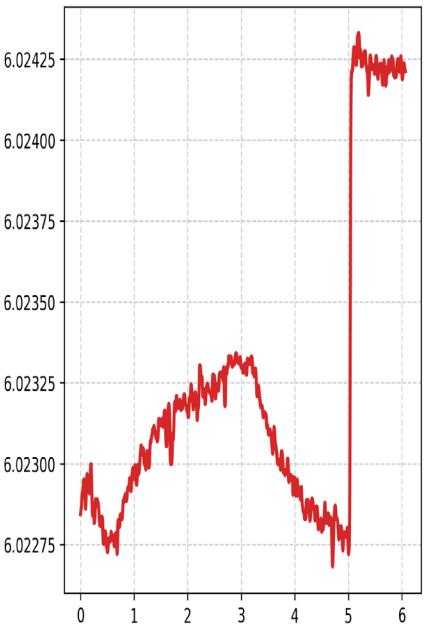
Ch 2 VCO



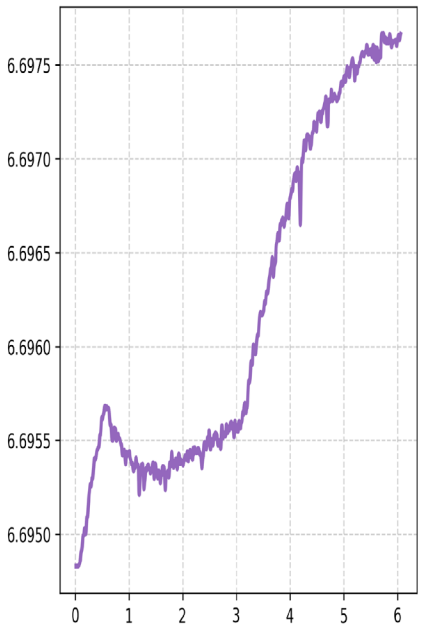
Ch 3 VCO



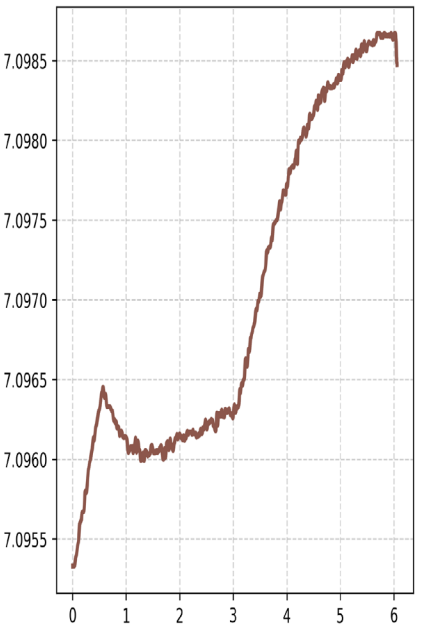
Ch 4 VCO



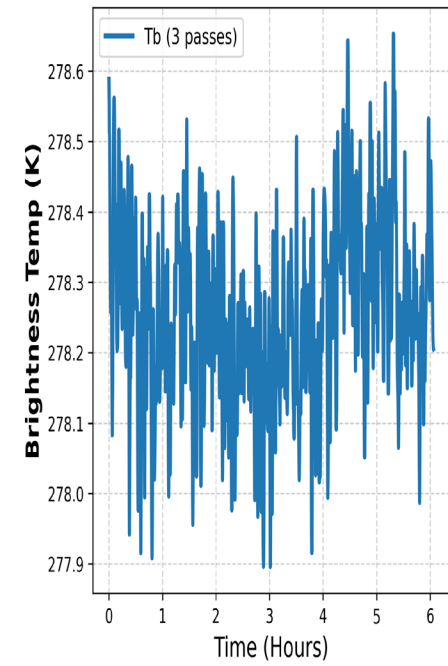
Ch 5 VCO



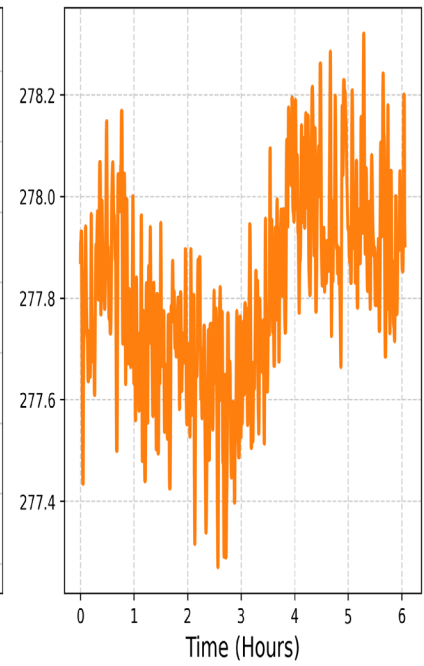
Ch 6 VCO



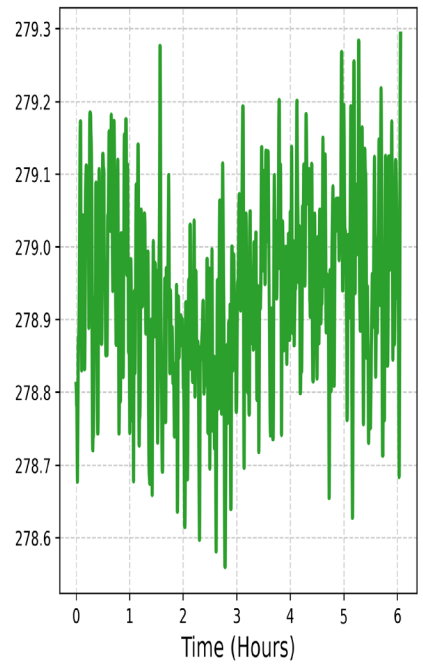
Ch 1 Tb



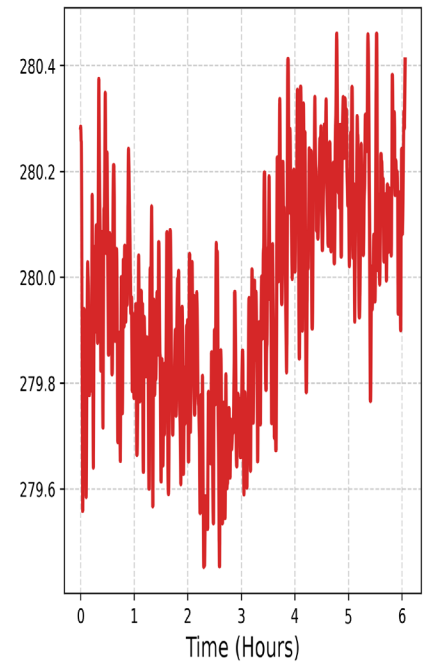
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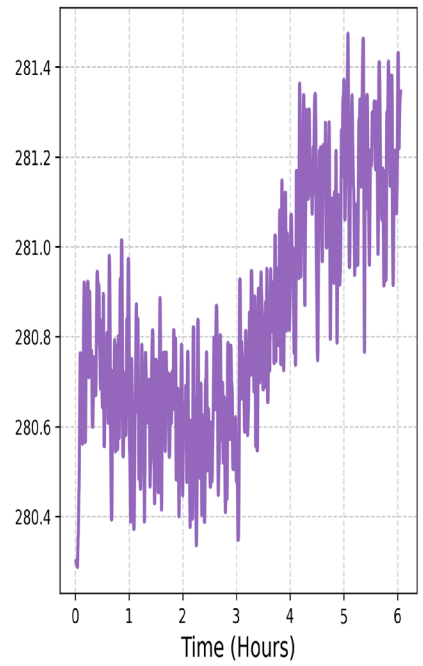
Ch 3 Tb



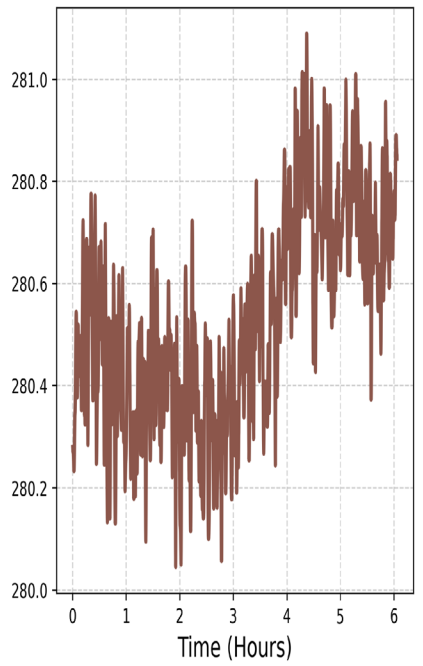
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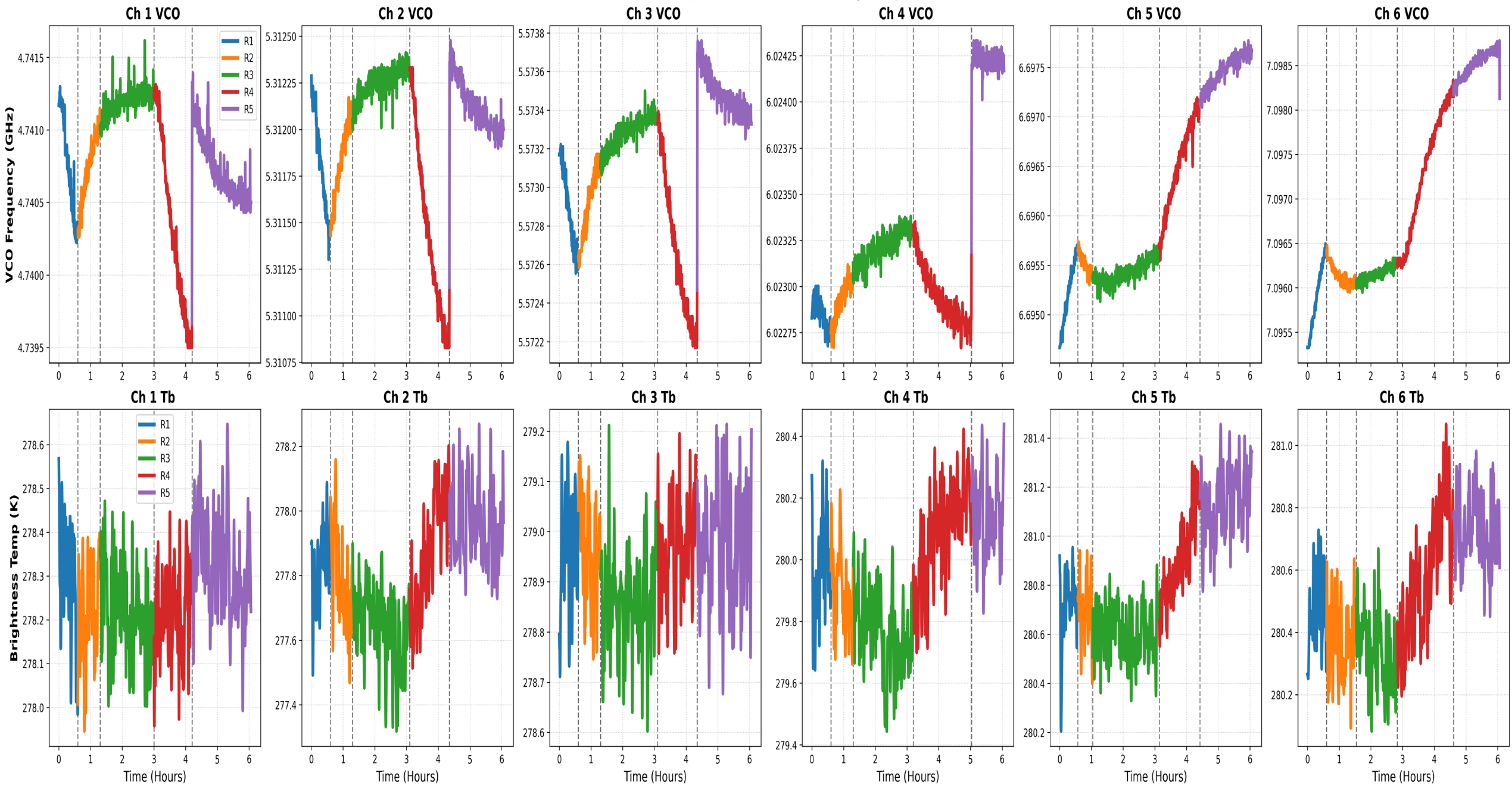
Ch 5 Tb



Ch 6 Tb



SFMR Decoupled Clean Means by Region

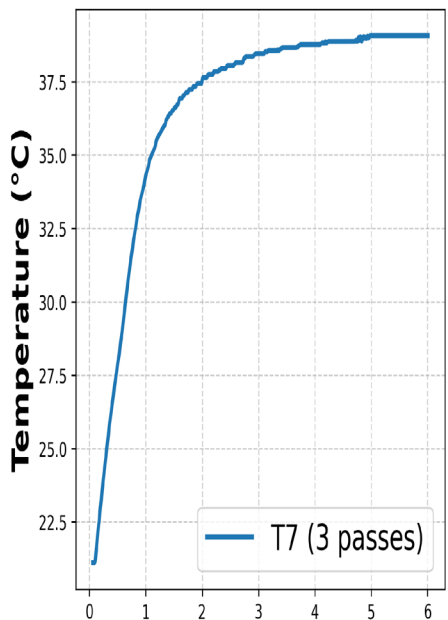


UNIT2

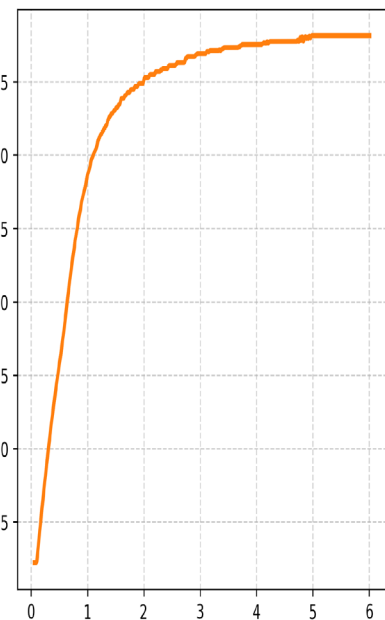
SFMR 20C Cal Experiment (Thermistor 7 Top, Tb Bottom)

Calibration Coefficients from 2024

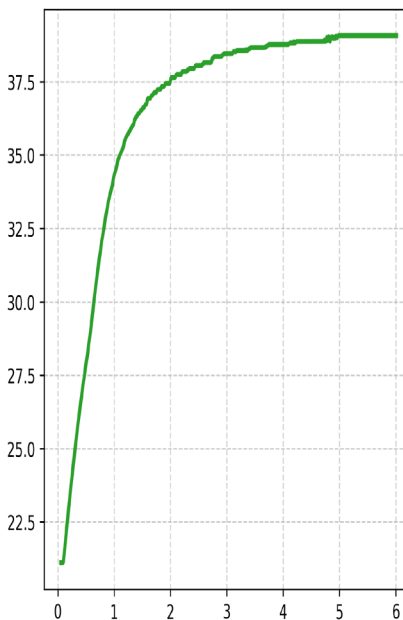
Thermistor 7



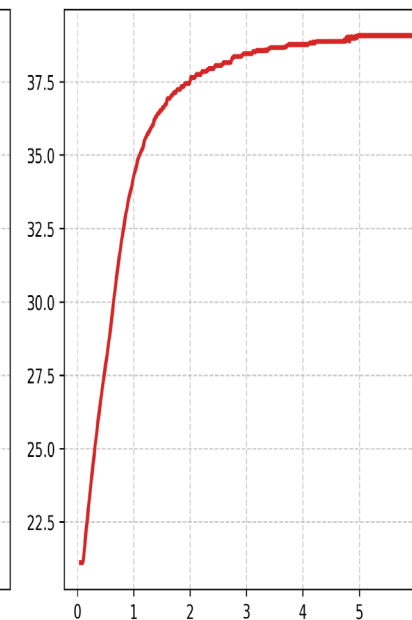
Thermistor 7



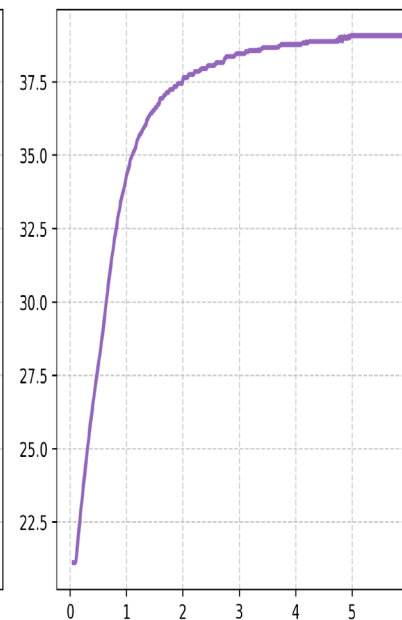
Thermistor 7



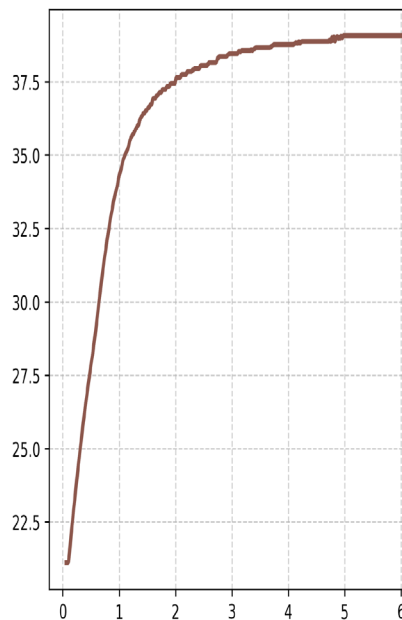
Thermistor 7



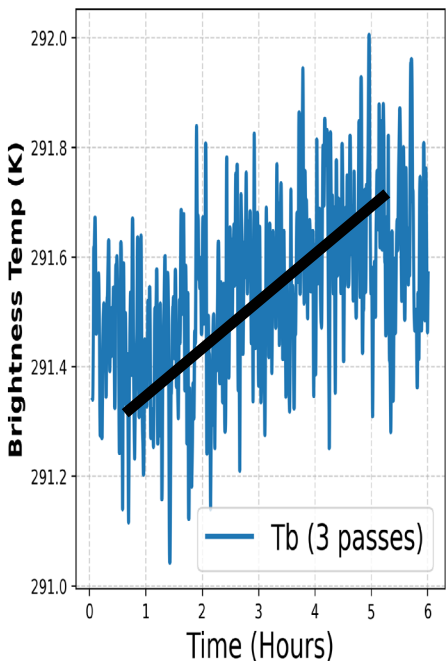
Thermistor 7



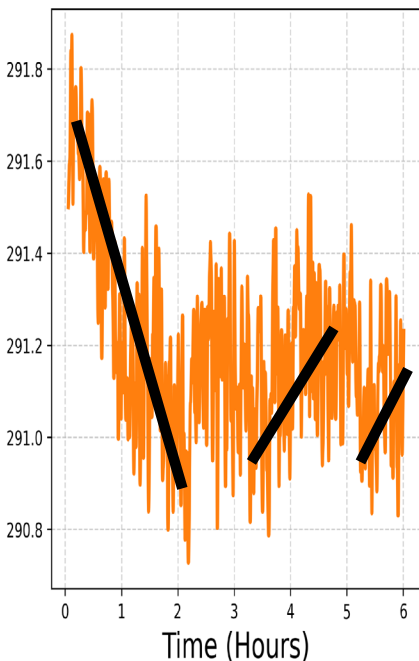
Thermistor 7



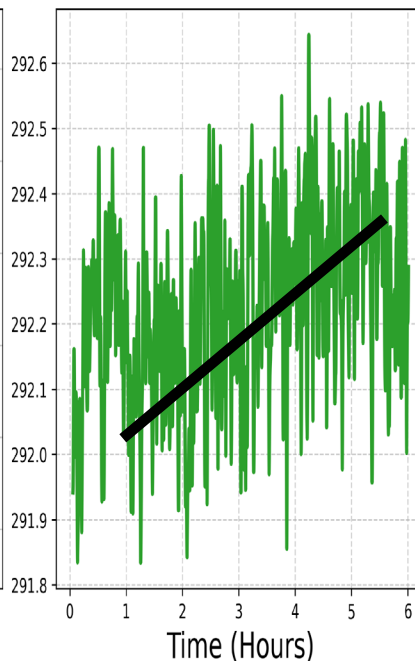
Ch 1 Tb



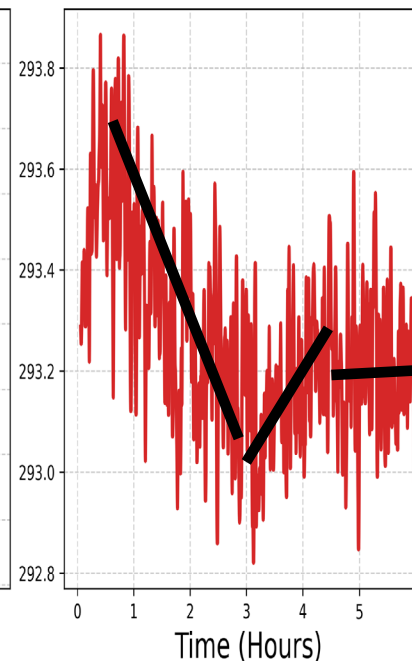
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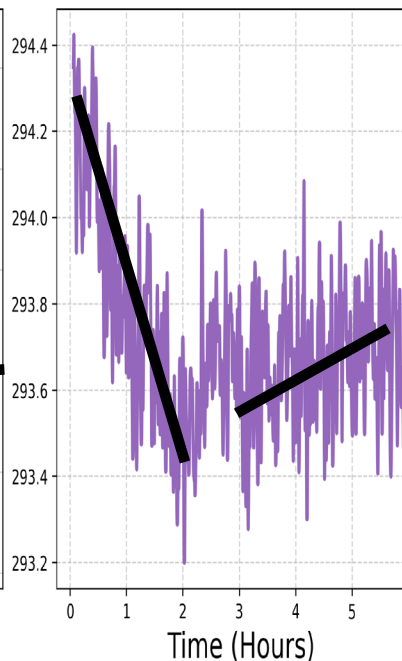
Ch 3 Tb



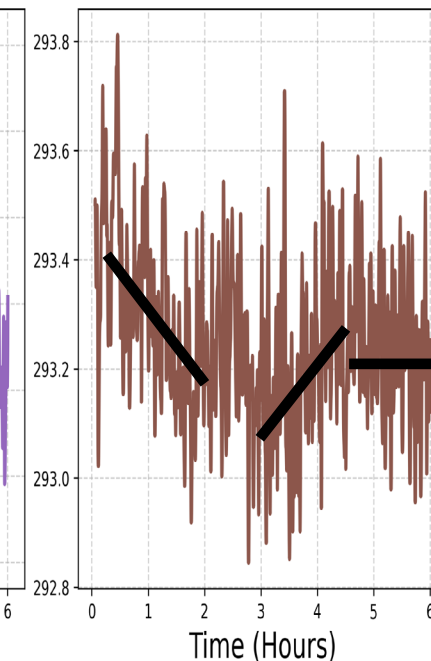
Ch 4 Tb



Ch 5 Tb



Ch 6 Tb



Summary

The objective is to re-establish trust in SFMR with its capabilities and limitations clearly documented

- Re-enable operational utilization
- Reprocess historical data set

Main steps are (1) identify correctable hardware issues, (2) characterize the behavior of a nominally performing SFMR, (3) revisit the geophysical model function

Full characterization in the laboratory environment

- Identify hardware aging issues and correct them as necessary
- Fully characterize the behavior of a properly functioning SFMR
- Use this data to construct performance monitoring criteria and steps to reprocess the historical dataset

Reinstall the SFMR units on the P-3s for testing and validation during the 2026 season