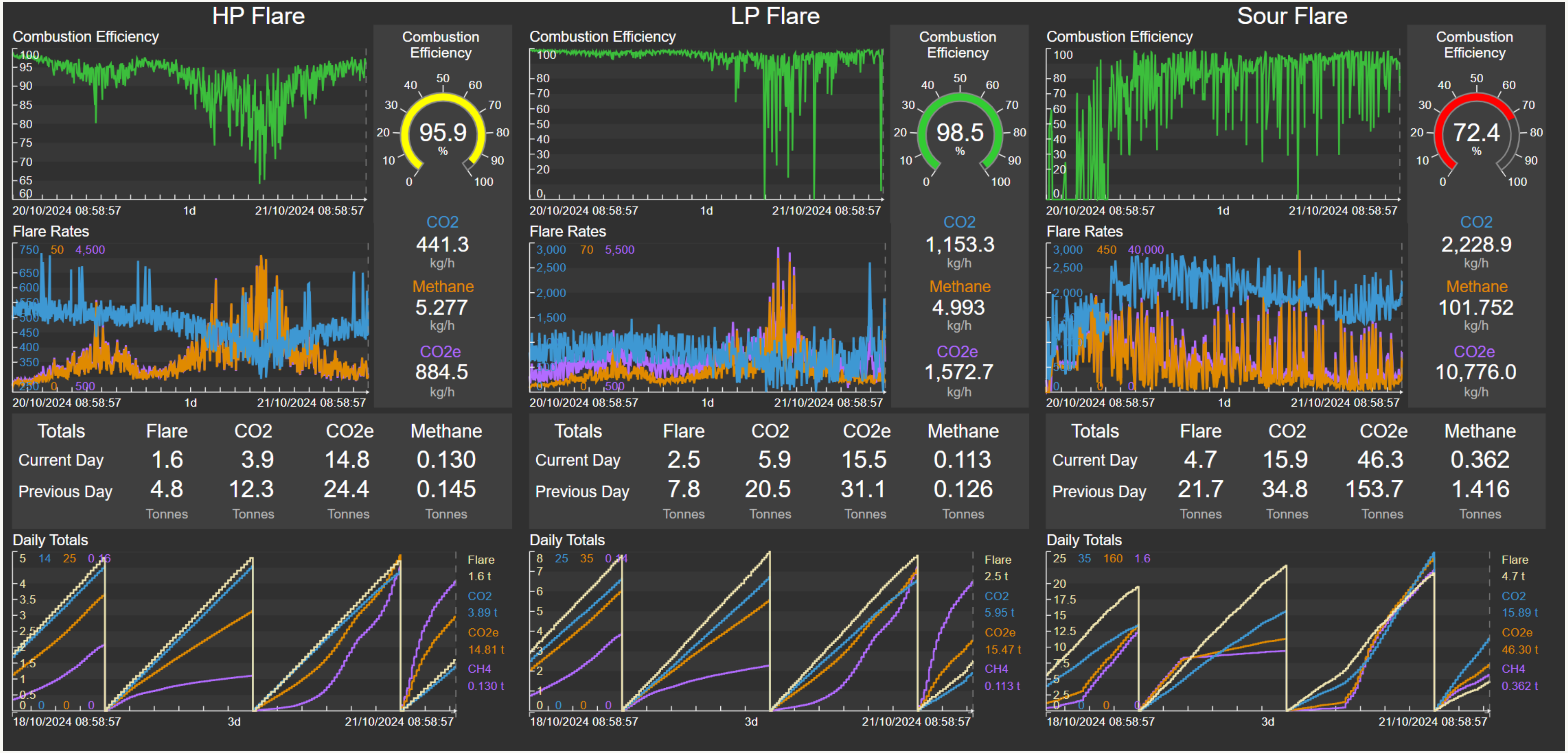
COMBUSTOR

Juan Martin Rodriguez, Bob Peebles

Flare Gas Composition and Destruction Efficiency using Accord's CHARM and Combustor

Combustor Baseline Functionality



Combustor Baseline Functionality

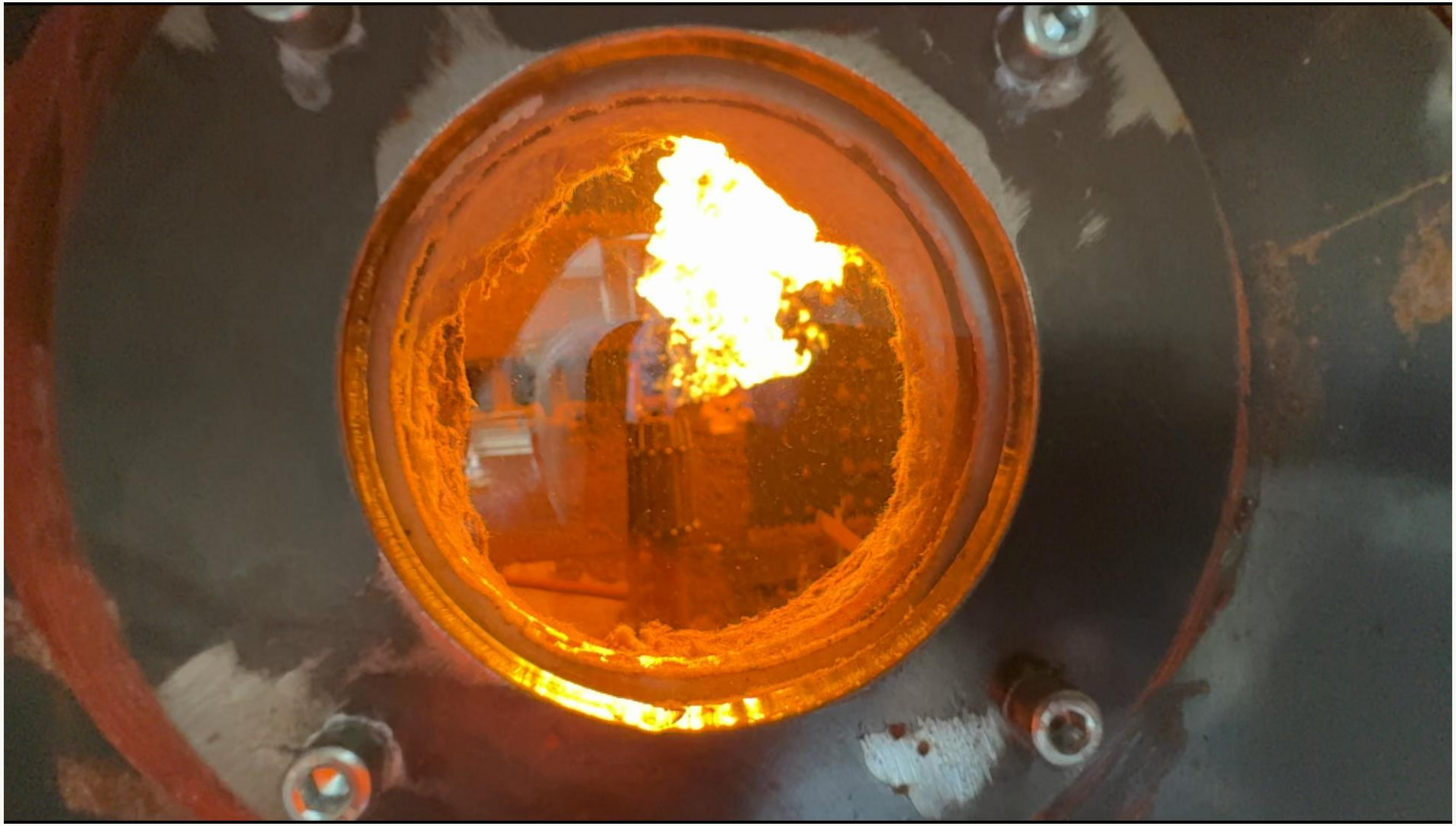
- Minute by minute calculation of CO_2, CH_4, CO_2e flow rates and cumulative totals
- Live uncertainty reporting for Combustion Efficiency
- Identify and optimise CO_2e performance (where plant configuration allows)
- Ability to post process data for mismeasurement events and for verification checks (e.g., fuel gas composition)
- Can be updated to study, inform and incorporate future plant changes
- Pre and post combustion compositional information such as ISO6976 CVs, AGA8 Densities, etc.

Combustor Updates

- Flare Testing with Greens Combustion and TotalEnergies
- Flare test facility uncertainty calculations have been developed
- Destruction Efficiency (DE) calculation developed from results of flare testing
- DE calculation and reporting in CO_2e terms has been implemented in Combustor
- DE uncertainty calculations have been implemented in Combustor
- CO_2e uncertainty calculations for CE have been developed and will be modified to use DE as the baseline
- Speed of Sound Verification Check and Reconciliation (SOS VCR) functionality is being developed

Bari Flare Testing

Bari Flare Testing

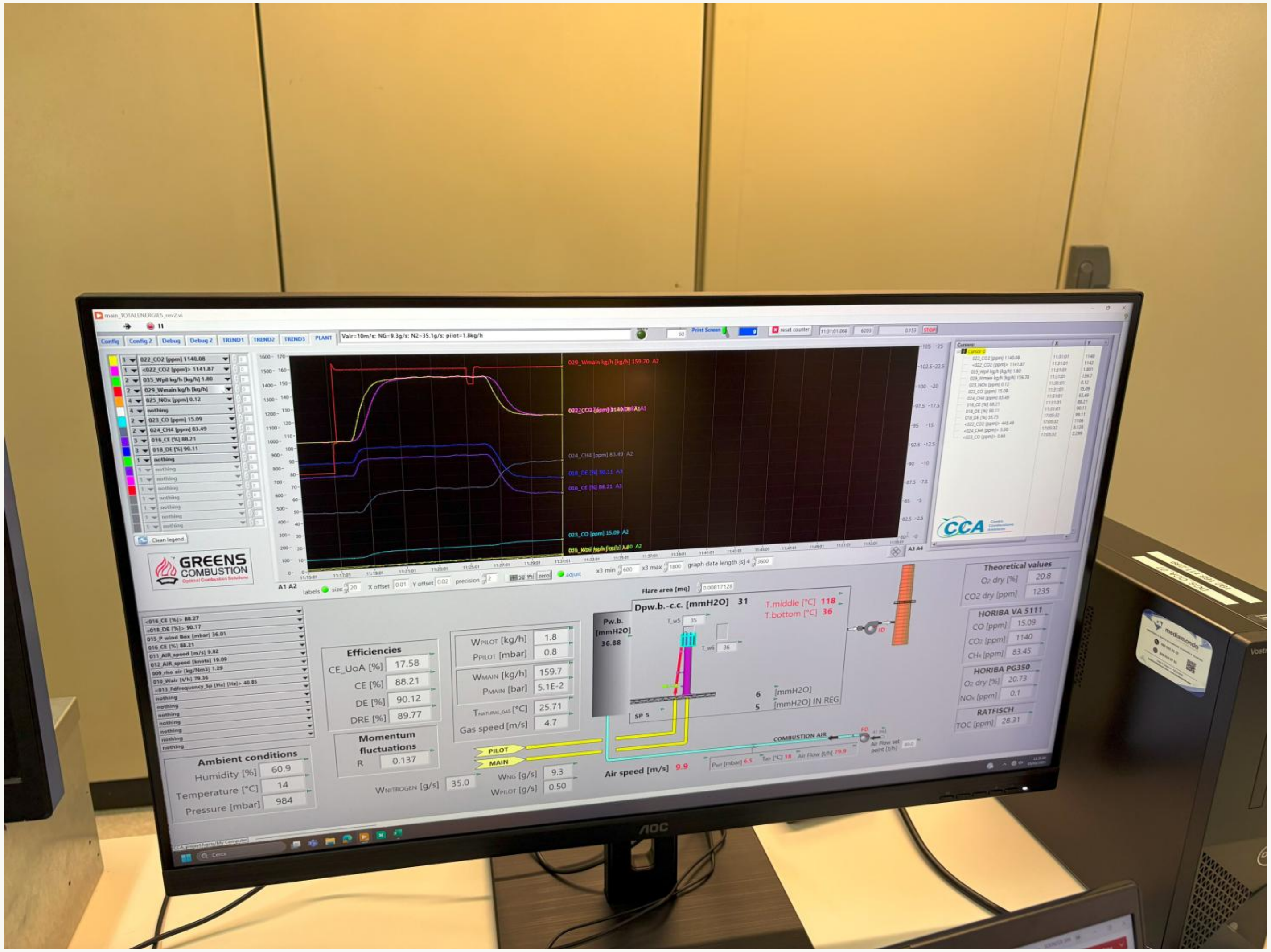


Bari Flare Testing

The Greens Combustion test facility located in Bari, Italy utilises an operator configurable data acquisition and control system which is connected to an array of measurement and analytical instruments.

Pre-designed test matrices are managed by a dedicated control room team, and each test is given a unique identifier and data is date and time stamped.

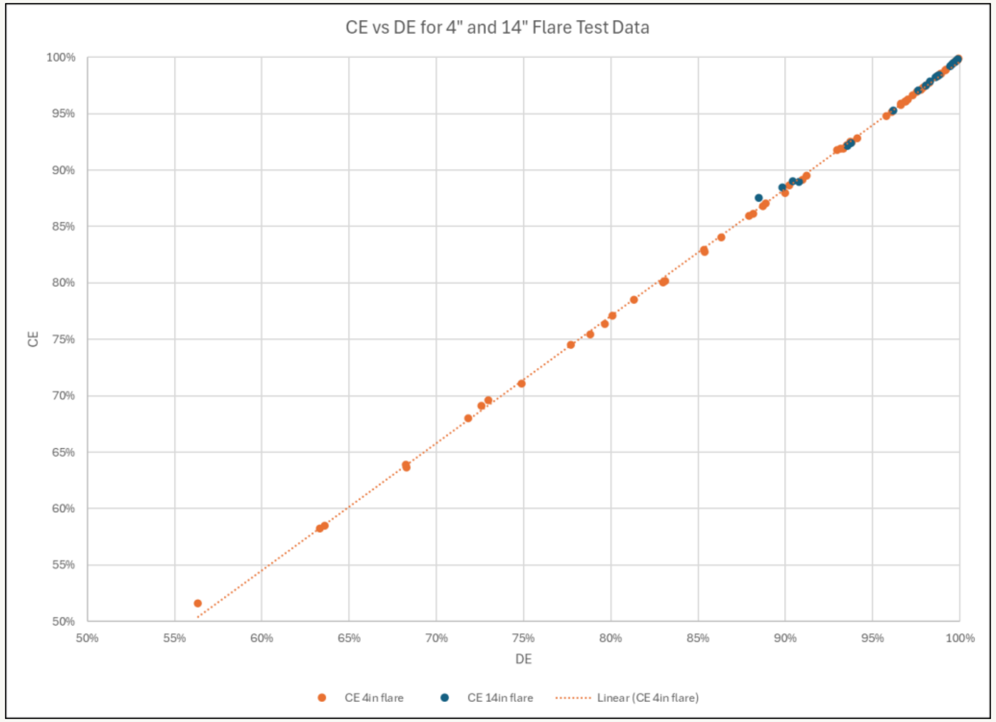
Measurement and analytical equipment is regularly calibrated. Natural gas used for testing is obtained from the local supply grid and regularly analysed.



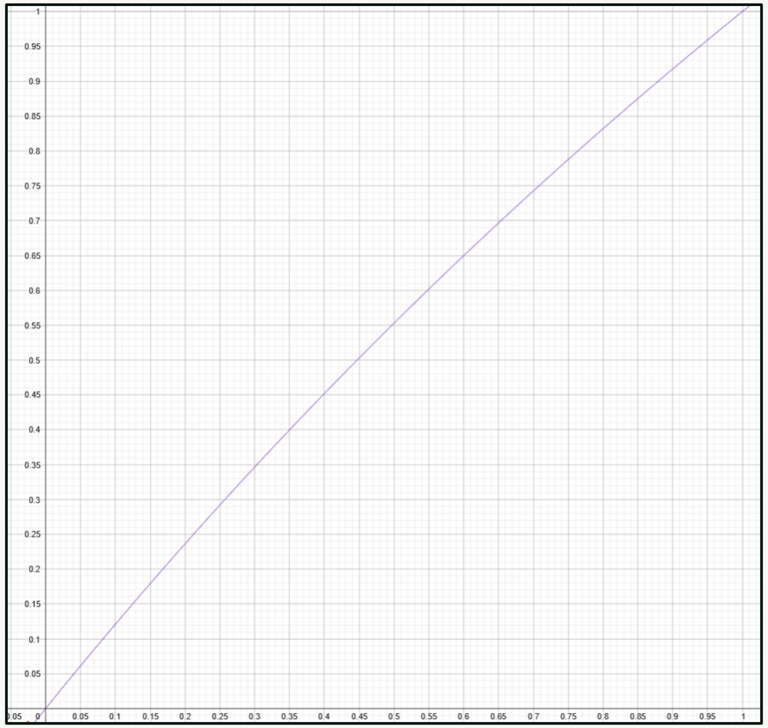
Destruction Efficiency

Based on test results from the Greens Combustion facility we have been able to develop a relationship between Destruction Efficiency (DE) and Combustion Efficiency (CE) – which, in simple terms, means that we can now calculate DE, and the associated uncertainty of DE, within Combustor.

CE versus DE from 4-inch and 14-inch Flare Test Data

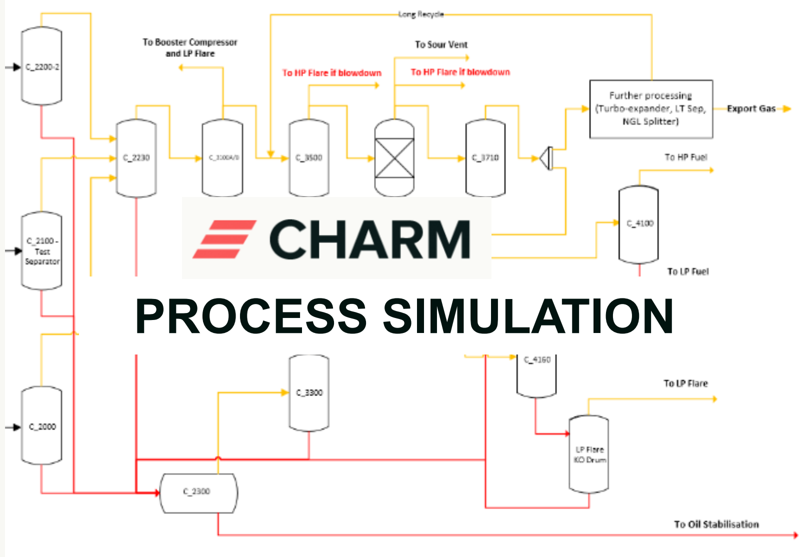


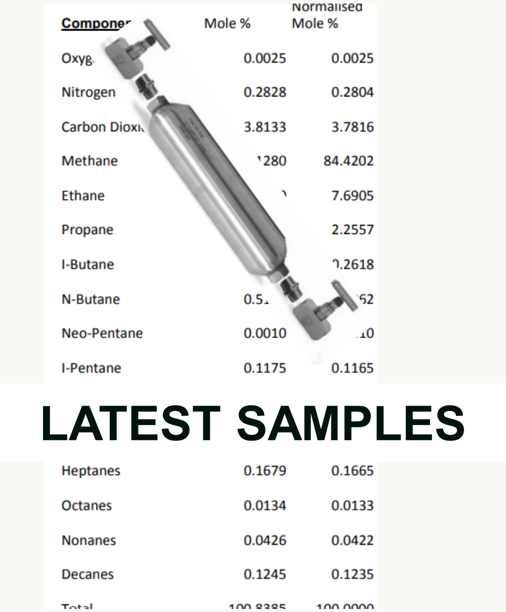
Full Fit of CE and DE data



CHARM VoS VCR

Reconcile the flare gas composition when a significant difference in VoS is observed between the USM, samples and Combustor. CHARM VoS VCR incorporates all relevant information available.



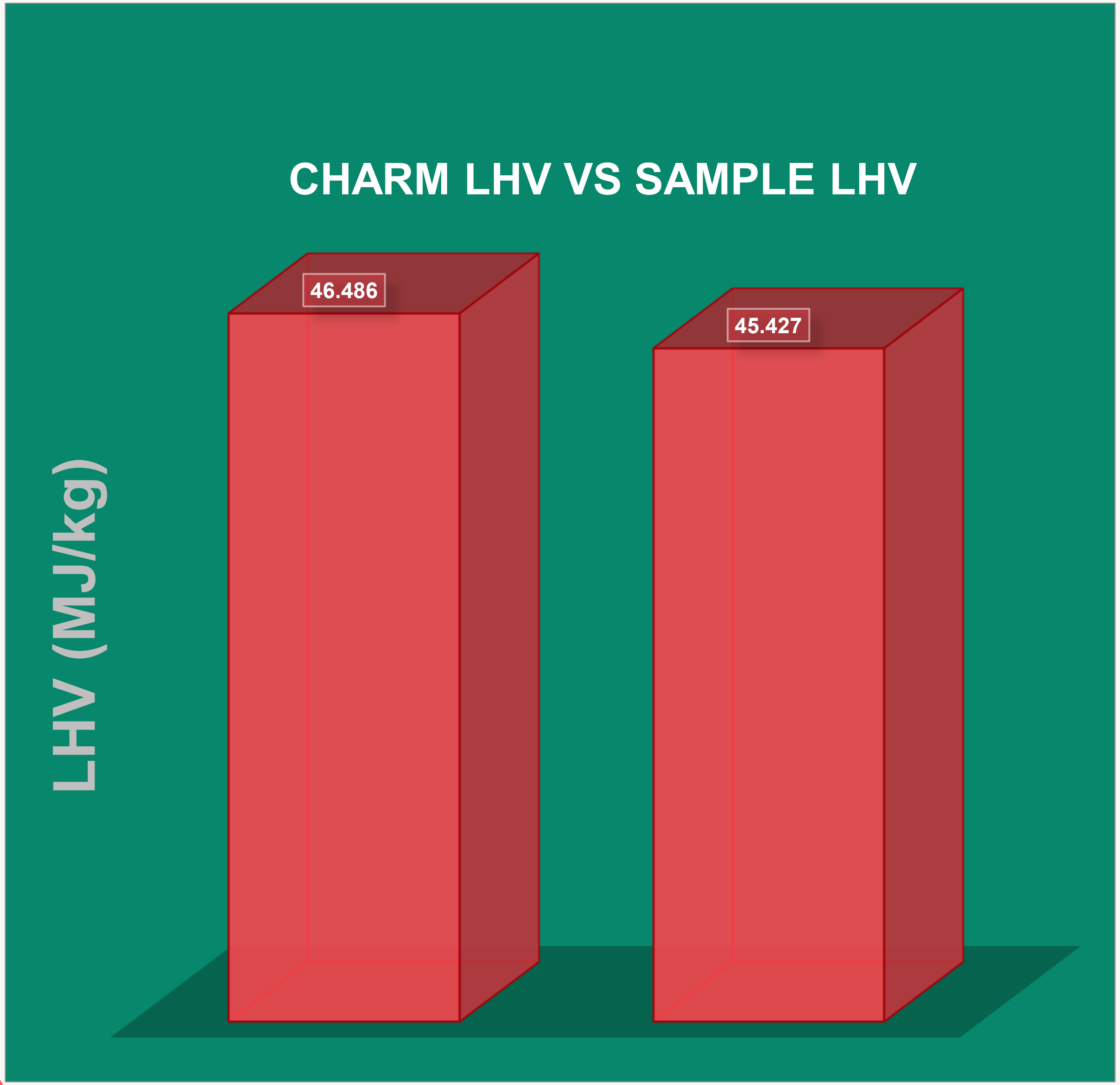


- **Reconciled Flare Gas composition**
- **Reconciled SOS**

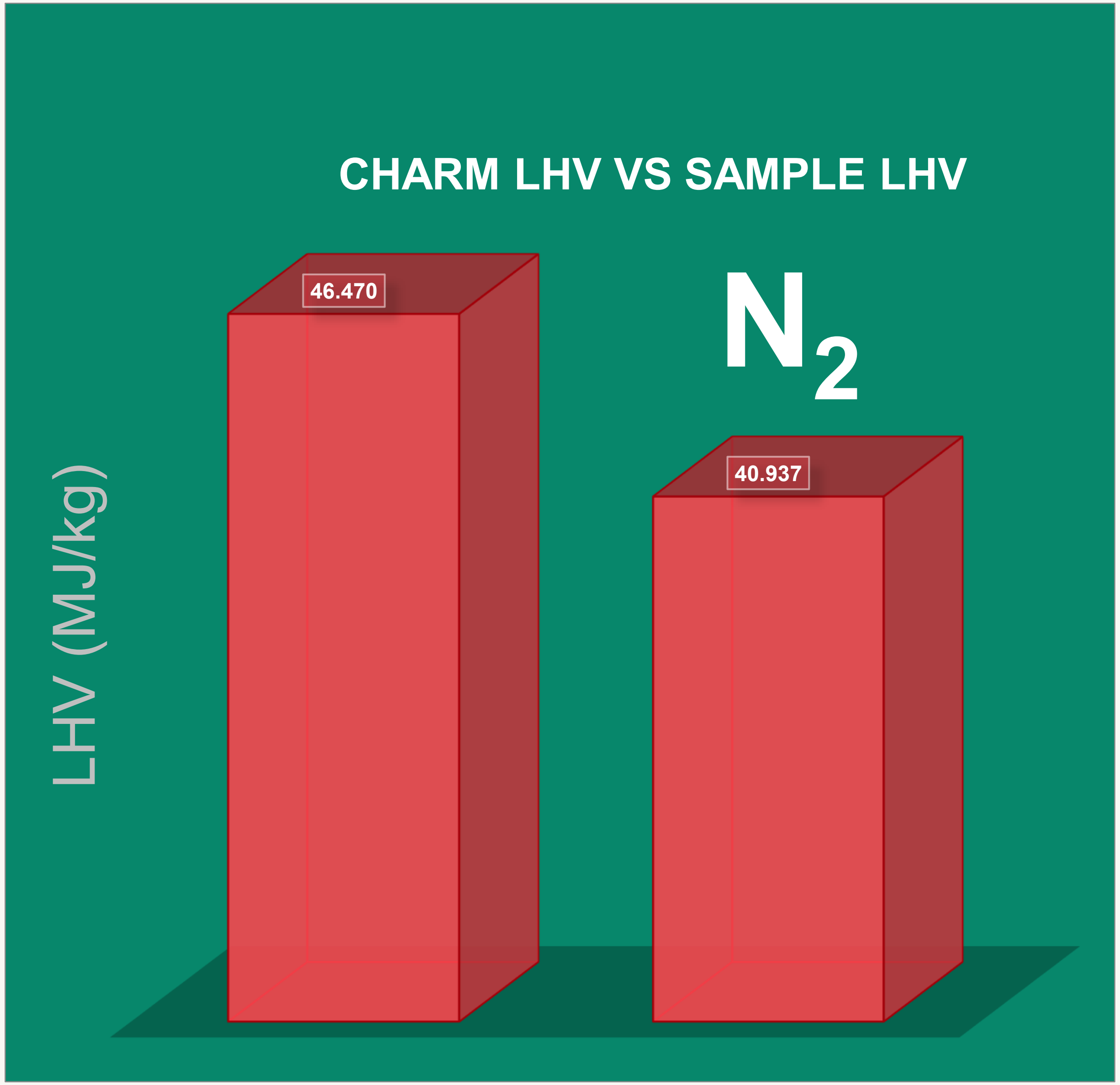
Accord and Data Reconciliation

- Papers
  - PUFMW 2008: Experiences in the Use of Uncertainty Based Allocation in a North Sea Offshore Oil Allocation System
  - NSFMW 2011: Gross Meter Error Detection and Elimination by Data Reconciliation
  - NSFMW 2013: Allocation in an Uncertain World: Maximising the Use of Data with UBA on Global Producer III
  - NSFMW 2019: Data Reconciliation in Microcosm – Reducing DP Meter Uncertainty. Oculus European Patent Awarded 2024
- Projects with successful application
  - UBA in ExxonMobil's Beryl Area offshore oil allocation system
  - MAERSK: Allocation of oil and gas between the Dumbarton and Lochranza fields produced across Maersk's Global Producer III (GPIII) FPSO (Floating Production Storage and Offloading)
  - REPSOL: Introduced UBA to the Flotta pipeline system 2024

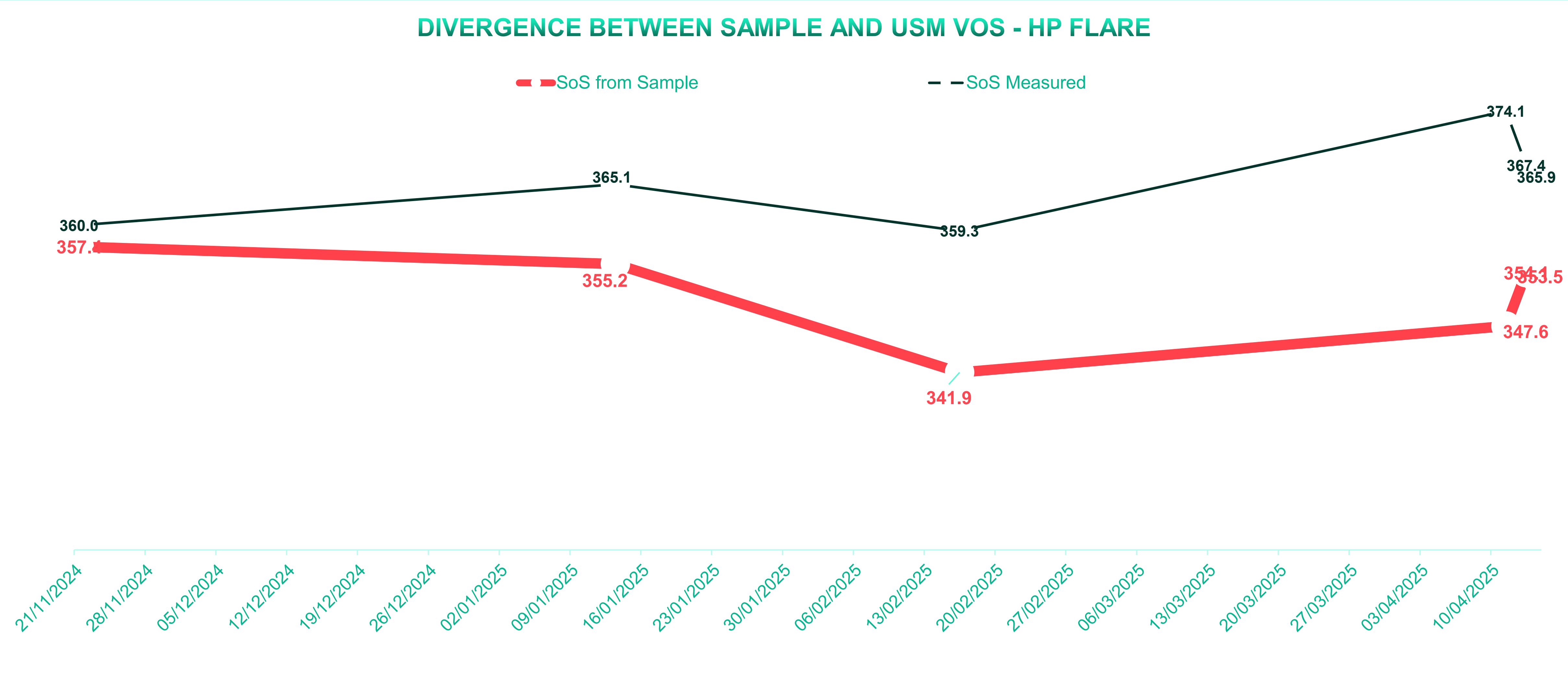
HP Flare - LHV



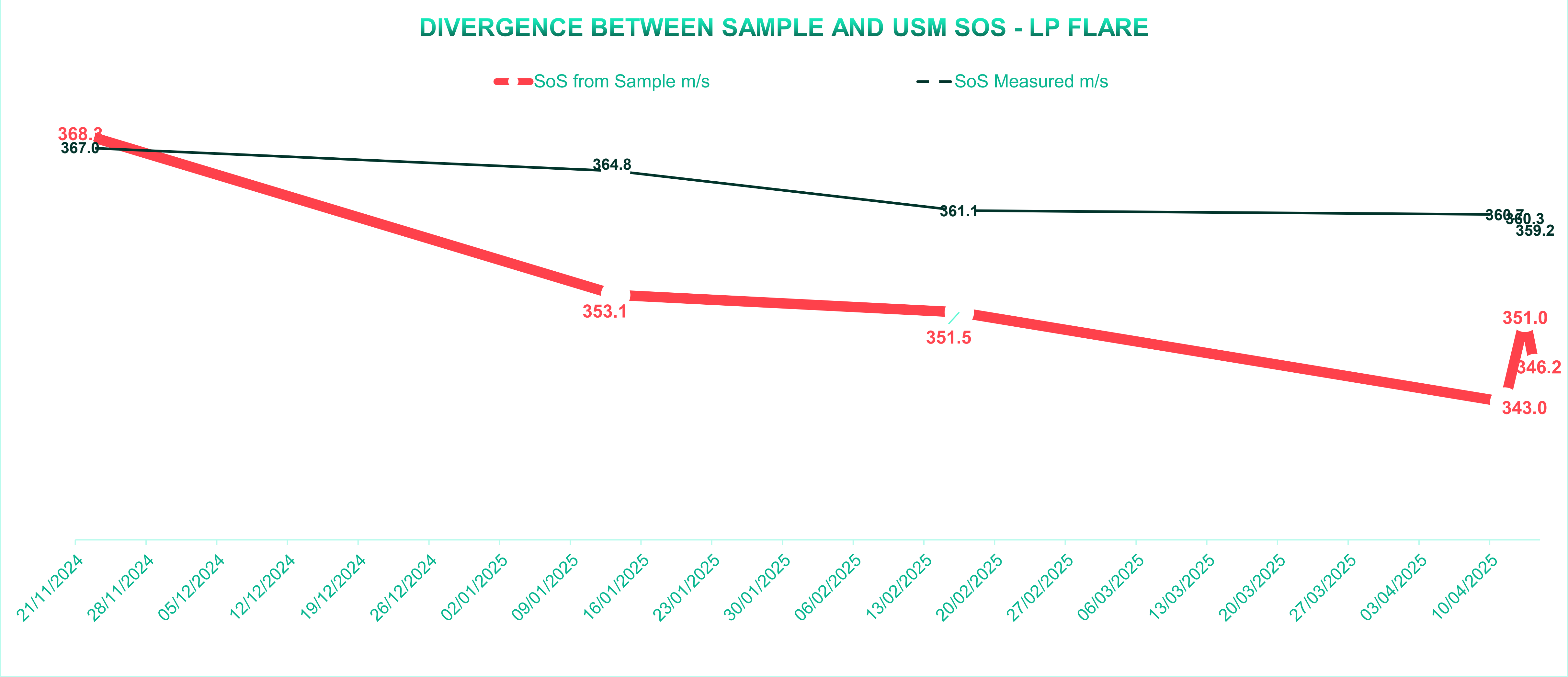
LP Flare - LHV



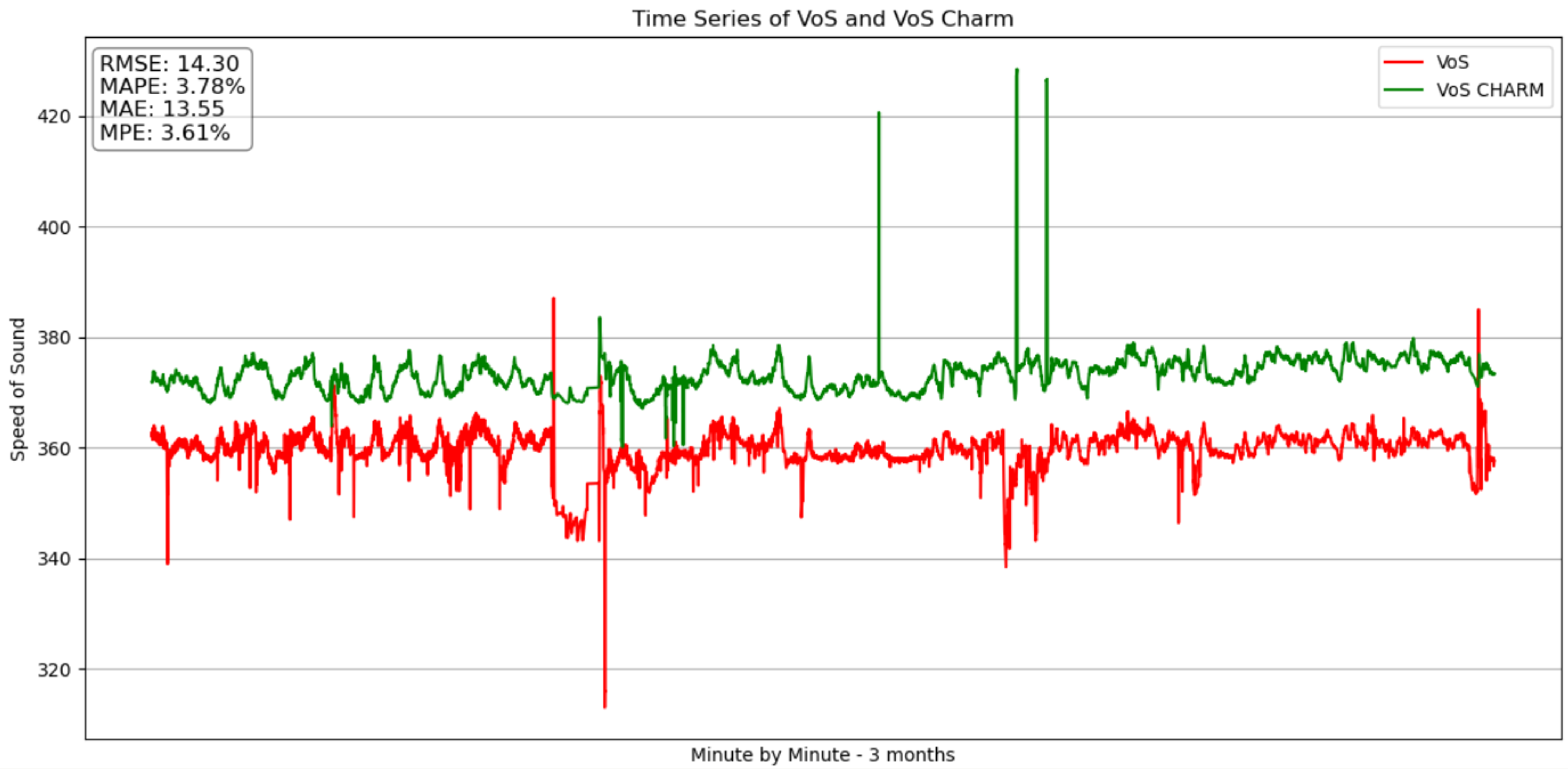
HP Flare – Measured VoS vs Sample VoS



LP Flare – Measured VoS vs Sample VoS



LP Flare - Measured VoS vs CHARM VoS



VoS VCR Example Case

Constrained nonlinear optimization used for data reconciliation
Levenberg–Marquardt algorithm

Other unknown sources

N2	-
CO2	-
CH4	-
C2+	-

CHARM

Unknown Seal Gas Flowrate & Comp

N2	52.4%
CO2	14.7%
CH4	0.0%
C2+	32.8%

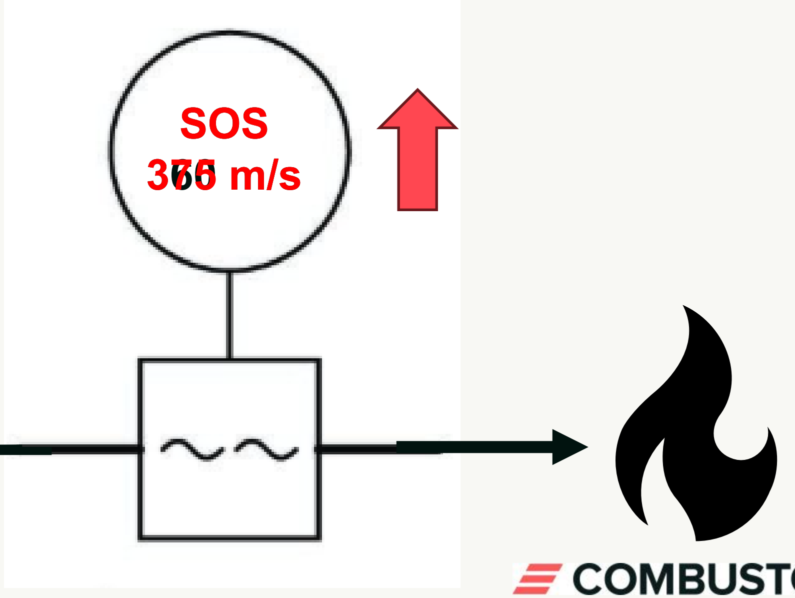
CHARM

CHARM HC Stream Flowrate & Comp

N2	0.4%
CO2	3.0%
CH4	80.5%
C2+	16.1%

VoS VCR

N2	4.8%
CO2	3.4%
CH4	75.7%
C2+	16.0%



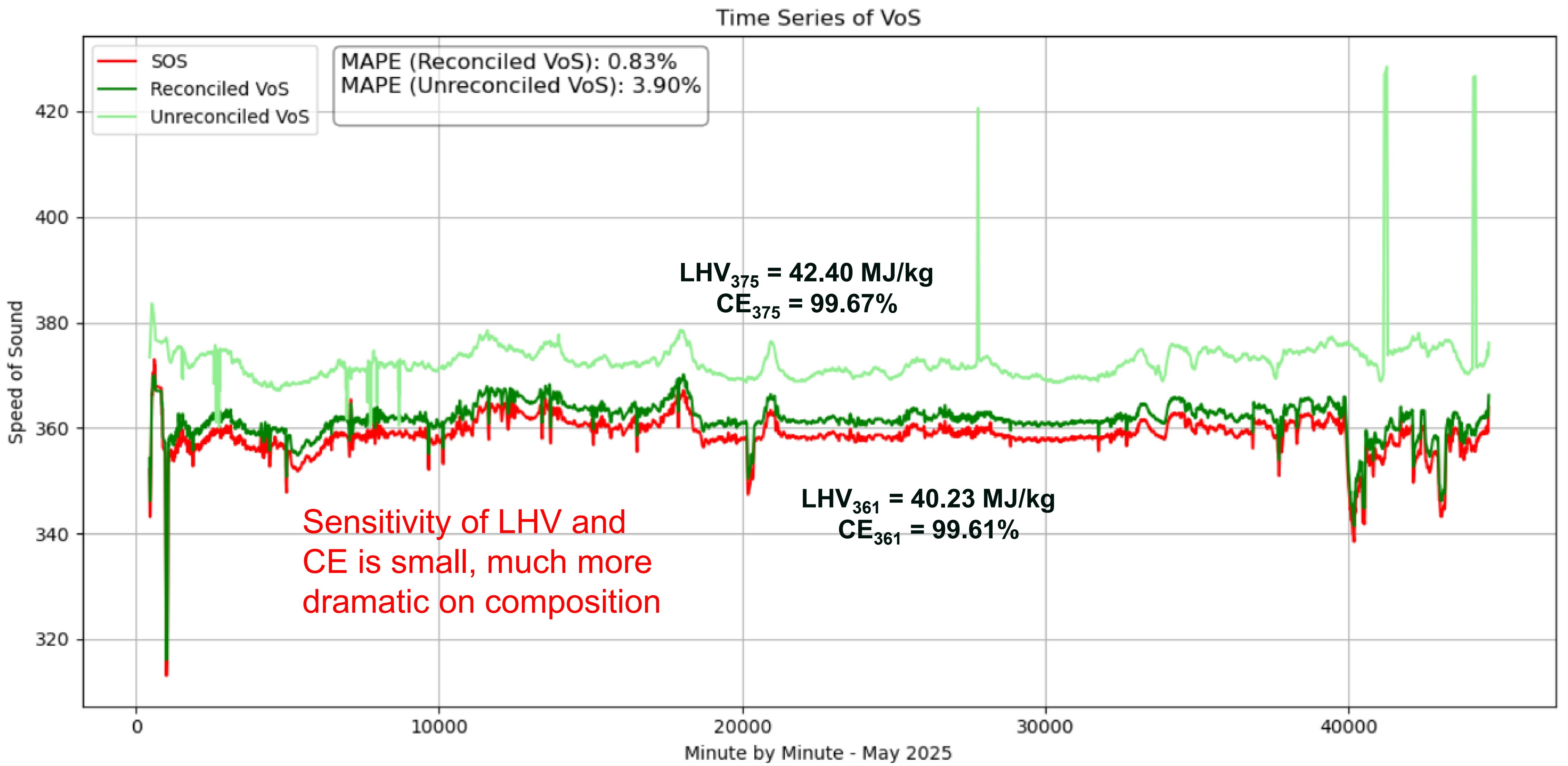
COMBUSTOR

Sensitivity of LHV and CE is small, much more dramatic on composition

LHV_{361} = 40.23 MJ/kg
CE_{361} = 99.61%

LHV_{375} = 42.40 MJ/kg
CE_{375} = 99.67%

VoS VCR – LP Flare



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