WP4: PM Measurement

CU, ZHAW, UoM, ONERA

RAPTOR

Clean Sky 2

Aim & Objectives of WP4

Quantification of uncertainty associated with current and future ICAO standards using historic, contemporary and new PM data acquired from representative gas turbine sources.

- Quantification of uncertainty associated with CAEP/10 nvPM standard (WP4.1)
- Improvement in nvPM regulatory uncertainty during CAEP/11 (WP4.2)
- Potential reduction of impact of aviation nvPM post CAEP/11 (WP4.3)

Literature Review & 3 distinct test campaigns will be used

This project has received funding from the Clean Sky 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 863969.

WP4.1- Quantification of uncertainty associated with Current nvPM standard

CAEP/10 (February 2016) agreed to the inaugural engine nvPM Certification Requirement:

Compliance by 1st Jan 2020 (in production & new engines)

Certification Requirement: Chapter 4 and Appendix 7 to Annex 16

- Standardised nvPM Measurement System
- Mandatory Reporting of LTO EIs and max. EIs (nvPM Mass & Number)
- Engine nvPM Emission Limit: SN correlated to Mass
- System Losses – (Appendix 8)

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WP4.1- Quantification of uncertainty associated with current nvPM standard

E31 → Particulate Matter Task Group (PMTG), uncertainties in reported EI nvPM,

- System variability & drift
- Limits of detection and quantification (LOD/LOQ)
- Calibration

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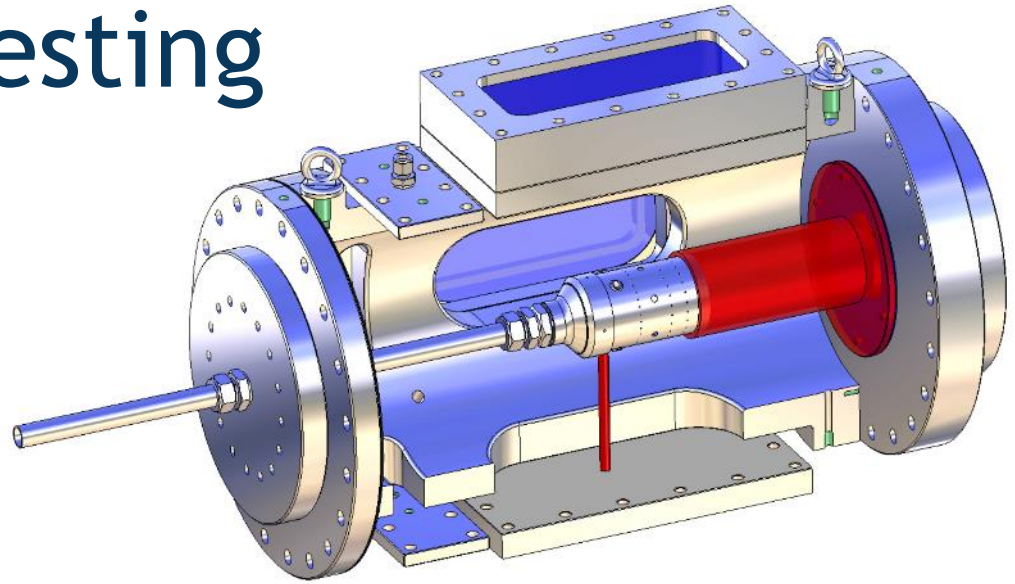
WP4.1- GTRC Combustor Testing



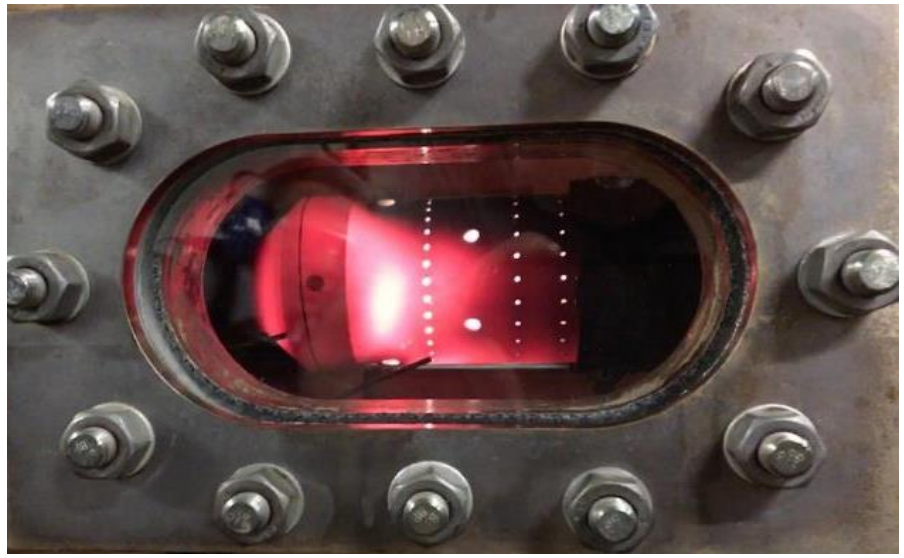
2 Week Long Tests - (60hrs)

Small Scale: Low fuel / access

JETSCREEN: range of EIs & Size

MkII burner being developed

- Longer run times
- Humidity
- Wider Temperature / Pressure range



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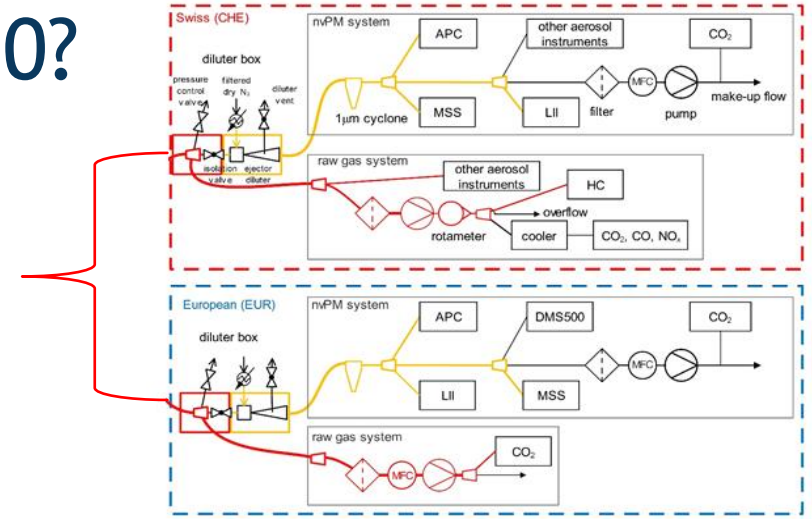
WP4.1: Sampling & measurement system variability, calibration & drift (CU, ZHAW)

Other Data: SAMPLE/APRIDE – AVIATOR??

Combustor Test 1: Jun 2020?

- Parallel nvPM measurements
- Mass
  - LII & MSS
  - Filters NIOSH 5040
  - Raw line measurement (LOD)
- VPR penetration?
- Size measurement DMS, SMPS, Pegasor??, EEPS??



Joint Calibration AVL Gratz May 2020??

Retest Test 2: June 2021 no recalibration

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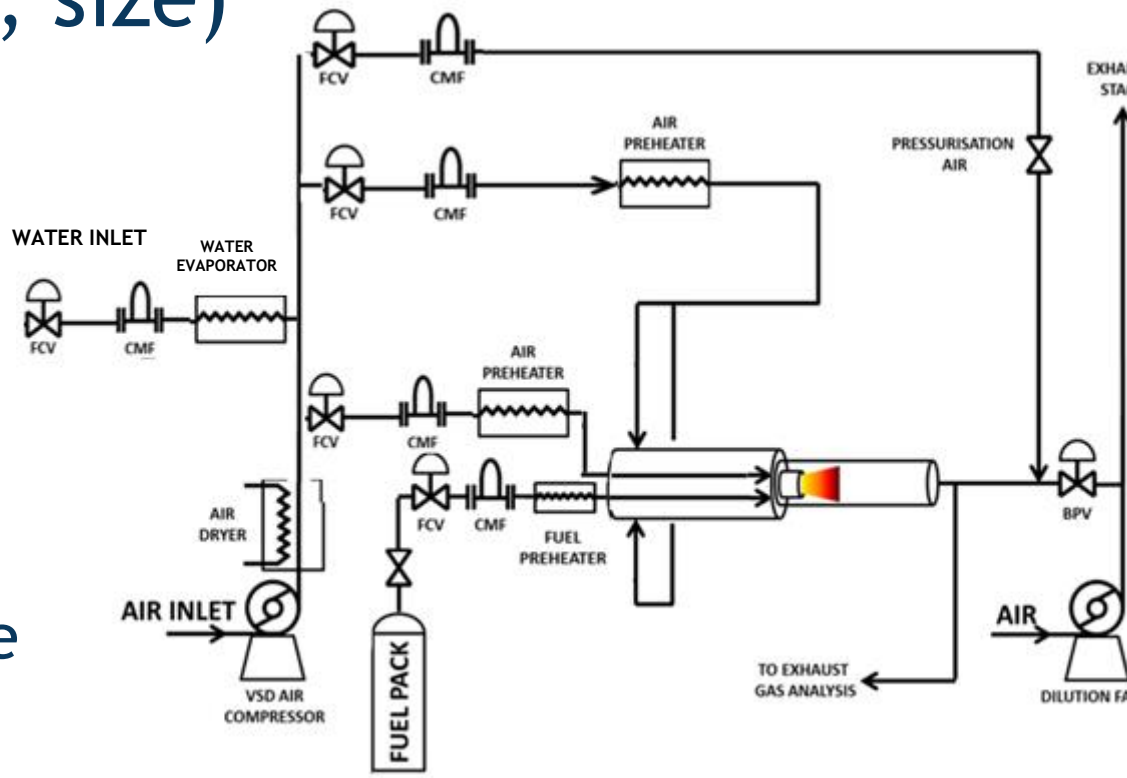
WP4.2: Ambient condition & loss correction (CU, UoM, ZHAW)

Past Data- loss methodology (n/m, size)

Combustor Test 2: Spring 2021?

- 12 month Drift
- Humidity, Pressure & Temperature
  - SAMPLE/ FLITES - trends
- Size measurement
  - Size measurements probe, dilutor, sample line, cyclone
  - Catalytic Stripper??
- Thermophoresis – Fractal correlation??



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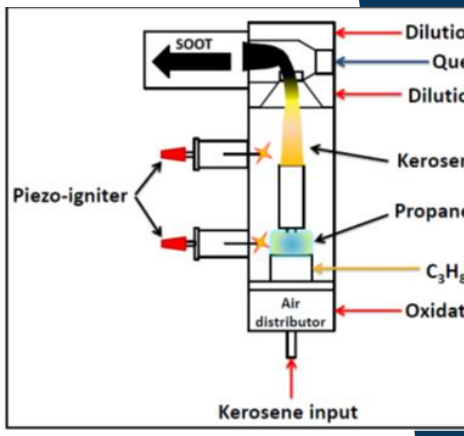
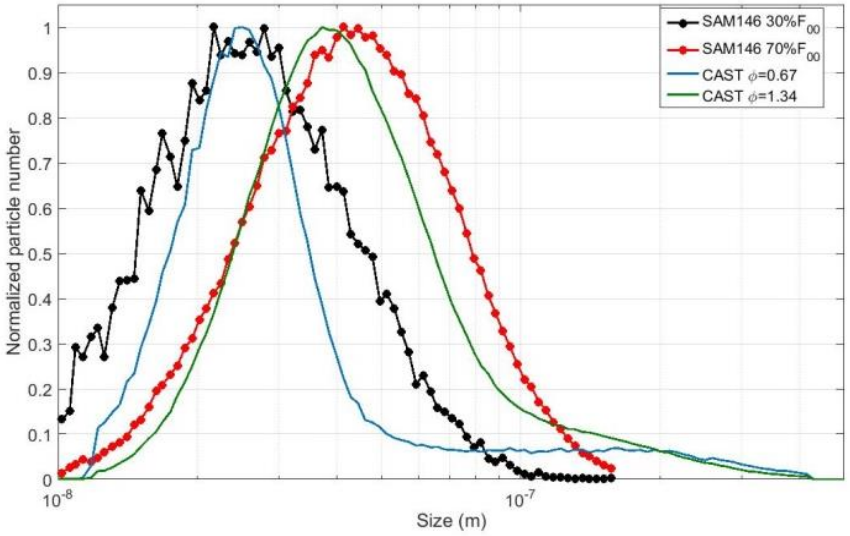
WP4.2- Alternative Fuels (ONERA)

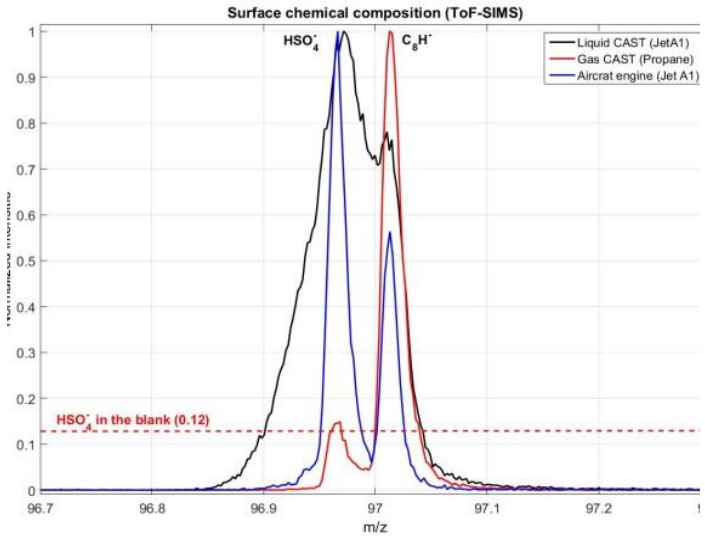


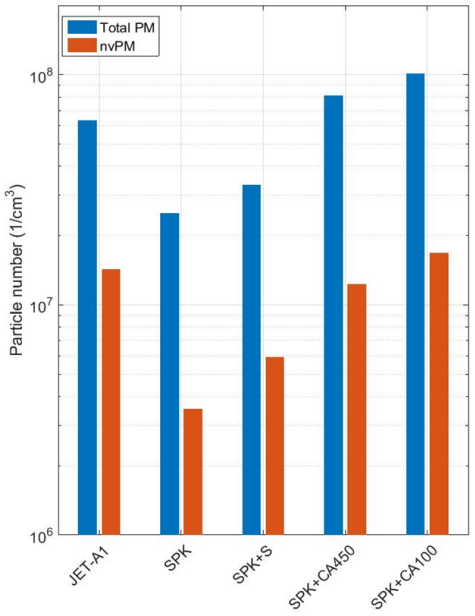
Liquid Fuel Diffusion Burner (CAST)

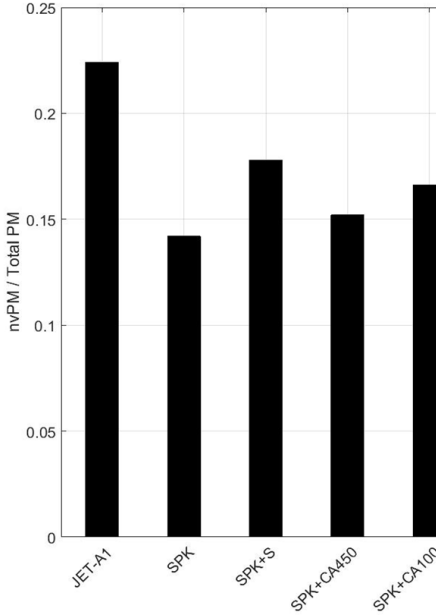
ASTM Fuel variation – Sulphur & aromatics

Testing Feb 2020?? (UNREAL)









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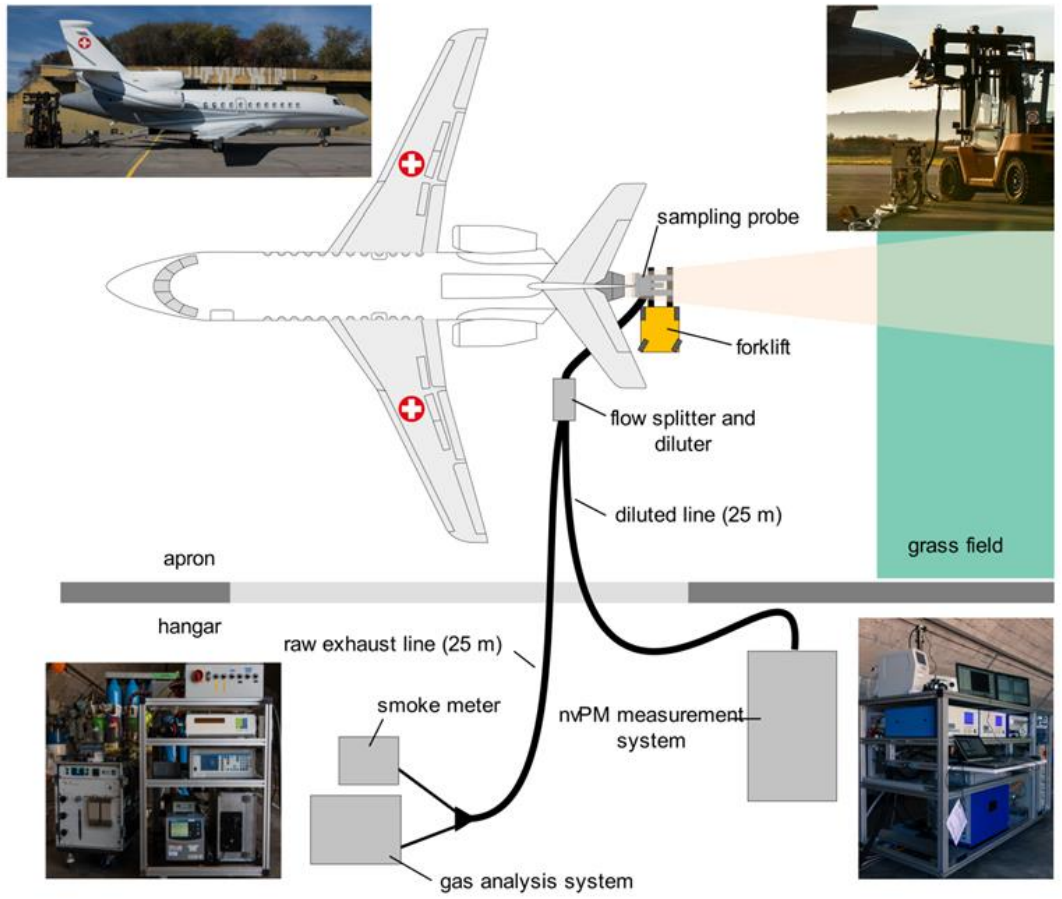
WP4.3- Non-regulated Engines (ZHAW & CU)

Contemporary Data-

- HW TFE731-6027 (22.4kN)
- Williams FJ44-4-QPM (19.9kN),
- P&W PT6 & HW TPE331??

Previous Data-

- Honeywell APU
- GNOME
- AVIATOR APU's ???



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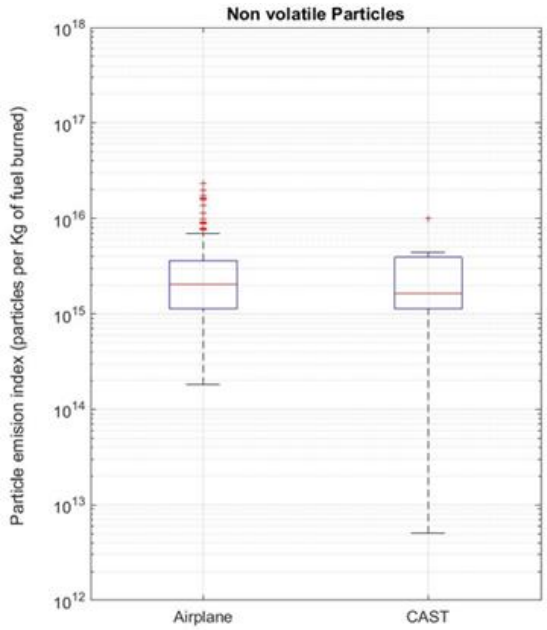
WP4.3- Future Technologies & Volatile Regulation
(ONERA, UoM, ZAHW & CU)

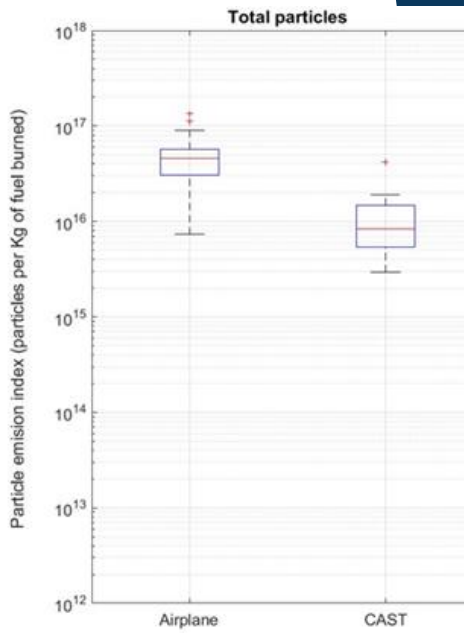
Literature Based Assessment

Future Technologies: Lean Burn?

Future Fuels:

Roadmap – Health (WP6)/ Total PM?





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WP4: Deliverables, Milestones & Schedule

AVIATOR Tests– Madrid Sept 2020 & Jan 2021

M4.1 & D4.1 – Rig Test 1 & Current uncertainty Data Report

- Assessment of previous data – Montecarlo uncertainty - ongoing
- Joint calibration of EU & Swiss systems – TBC Spring 2020
- Rig Test 1 GTRC – Jun 2020 (M8)?
- Data Report “Uncertainties” (M10 – Sept 2020)

M4.2, 4.3 & D4.2 – ONERA Test, Rig Test 2 & Corrections Data Report

- ONERA Test: Feb 2020?
- Rig Test 2 GTRC – Spring 2021??
- Data report “Correction Requirements” (M21 – July 2021)

D4.3 – Report with recommendations for future regulation and technology adoption

- Analysis of unregulated engine data - ongoing
- Analysis of future technologies/ Fuels - ongoing
- Analysis of total PM regulation
- Report “recommendations” (M22 – Aug 2021)

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