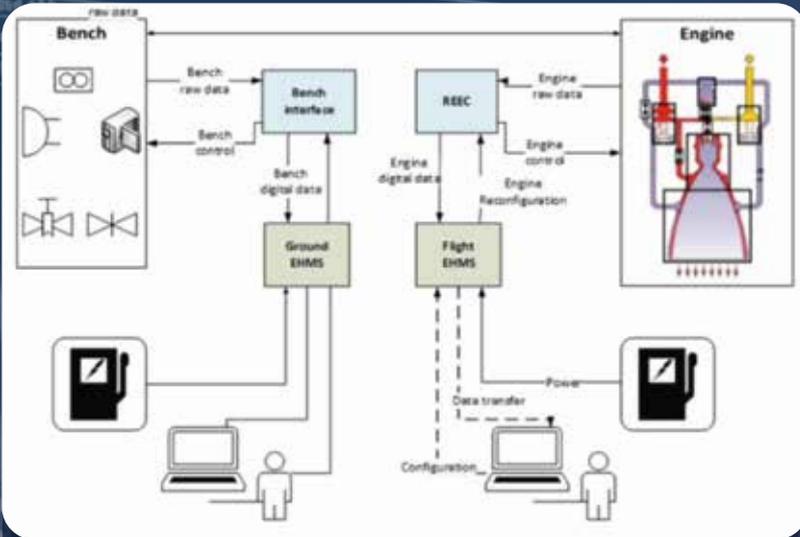**ENLIGHTEN**

A more efficient and competitive way to space, leading to new possibilities in the sky and on earth

Factsheet #6
Engine Health Monitoring System

An AI-powered Engine Health Monitoring System (EHMS) is being developed to improve the reliability and safety of Europe's next-generation rocket engines. Building on the current Health Monitoring System (HMS) within the Rocket Engine Electronic Controller (REEC), the ENLIGHTEN project integrates artificial intelligence (AI) and machine learning (ML) for more advanced diagnostics.

The EHMS runs on dedicated hardware, the Engine Health Monitoring Card (EHMC), which offloads computationally heavy ML tasks from the REEC. It processes real-time sensor and actuator data to detect anomalies, diagnose failures, and potentially reconfigure the engine in flight.

Using AI/ML models such as temporal convolutional autoencoders, histogram-based boosting trees, and conformal anomaly detection, the system analyses critical phases like start-up transients and steady flight. This enables early fault detection and continuous monitoring beyond traditional methods. Post-launch, it delivers detailed diagnostics to support faster maintenance and accurate assessments for reusable engines.

Companies involved

EDGX 🇧🇪 BE	arianeGROUP 🇫🇷 FR	ONERA THE FRENCH AEROSPACE LAB 🇫🇷 FR
DLR 🇩🇪 DE	PROEKSPERT 🇪🇪 EST	AIKO 🇮🇹 IT

Key parameters

Built around an NVIDIA Jetson Orin NX 16 GB module that combines an 8-core Arm Cortex-A78AE CPU, a 1024-core Ampere GPU and two NVDLA 2.0 accelerators, delivering roughly 100 TOPS of compute for the different AI pipelines:

⏻ **Ignition & start-up**   by AIKO
🚀 **Steady-state flight**   by Proekspert
🎛 **Electrical valve actuators**   by ONERA

from	to
TRL 2 ⟫⟫⟫	⟫⟫⟫ **TRL 5**
literature gathered on the subject	integration on a bench and dedicated hardware

Expectations for testing phase

The AI-powered Health Monitoring System (HMS) will undergo an on-ground hot-fire test campaign to validate its performance. A key goal is to prove the generalisation of the AI models, initially trained on simulations and later retrained with real data from the modified Vulcain 2.1 engine. This will show the system's adaptability to future European engines, accelerating development and cutting costs.

An off-board module analyzing data such as sound and video will also be integrated to enhance safety and fault analysis in real-time. A dedicated fault injection system will systematically challenge the algorithms during Hardware-in-the-Loop (HIL) tests. A successful campaign will deliver a validated AI-based HMS, ready for future low-cost, reusable European launchers.

Pros and Cons

⊕ **Enables Cost-Effective Reusability**
⊕ **Increases Launch Availability and Safety**
⊕ **Accelerates Post-Flight Analysis**

⊖ **Data Scarcity and Quality for training AI models**
⊖ **Model Reliability and Explainability**
⊖ **Simulation vs. Real-World Gap**