AQUILA

Air-breathing, **QU**antum-secured, **I**ndependently-operated **L**ow-**A**ltitude satellite

Team Blue · Satellite Design Workshop 2026

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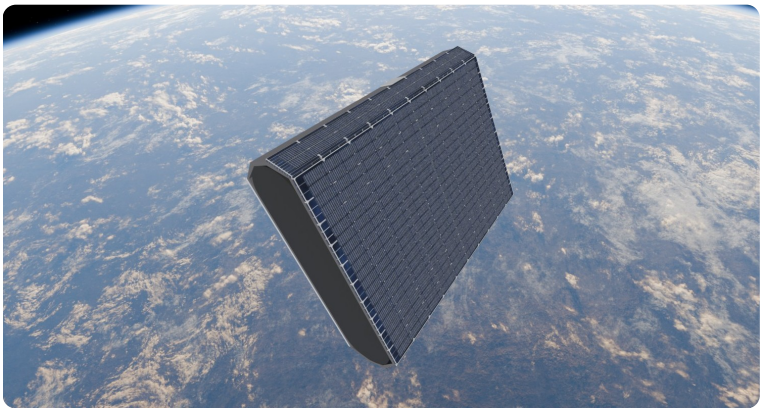


The concept visualized. The narrow side facing down is nadir with instruments, the solar array faces the sun, and the backside radiates IR to deep space.

AT A GLANCE

Launch **Late 2030**	Payload **QKD**
Orbit **180 × 400 km**	Mass **65.67 kg**
Duration **≥ 12 months**	Avg. power **229 W**
Propulsion **ABEP + EP**	Size **130 × 103 × 29 cm**

The Mission

AQUILA is a technology demonstrator operating for at least 12 months in a 180 × 400 km VLEO orbit using novel specular air-breathing electric propulsion (ABEP). It shall show that long-term VLEO operation is feasible and open VLEO as an alternative to Low Earth Orbit (LEO) for intelligence and defense applications. A quantum key distribution (QKD) payload showcases one possible application within VLEO.

New Paths

The space market has recently started to grow exponentially and is of increasing interest to defense departments. VLEO offers multiple advantages over LEO, especially for intelligence and defense. Examples include increased resilience against anti-satellite (ASAT) activities and operational interruptions. Others include better stealth, a self-cleaning debris environment, and improved optical resolution.

Design Philosophy

A minimalistic, complexity-reducing design decreases cost and adds reliability in order to serve the complex ABEP and QKD systems. All subsystems besides propulsion and QKD use TRL 9 COTS parts.

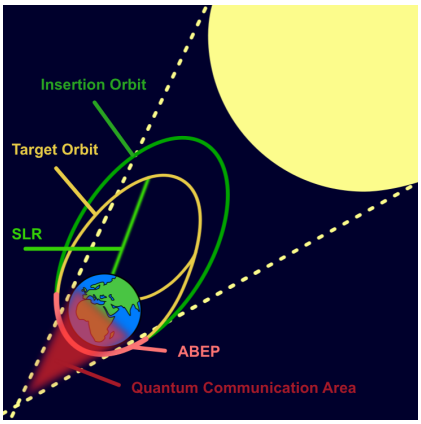
System Design

The primary objective, the demonstration of a novel ABEP, was the main driver of both orbit selection and system design. In VLEO, drag must be counteracted. The drag of the satellite is mainly determined by its frontal area. As the intake is the largest part defining the minimum frontal area, the whole system shall not be much wider or higher than the intake. The high power demand of ABEP led to a sun-synchronous orbit (SSO), easing the load on the power system. A secondary driver was the quantum payload, which requires eclipse times to function.

Mission Analysis

The launch is planned for late 2030.

1. **Launch & insertion.** Launch from Andøya with Isar Aerospace and insertion into a 180 × 700 km orbit, which drag reduces to 180 × 400 km within 6 weeks.
2. **VLEO & ABEP.** VLEO operation and ABEP demonstration for 4 months (primary demonstration).
3. **Apogee raise.** The apogee is raised to 600 km to allow RAAN drift, increasing the eclipse time required for QKD. After 4 months, the apogee has decayed back to 400 km.
4. **QKD demo.** QKD is demonstrated for 4 months while ABEP maintains the 180 × 400 km orbit.
5. **Re-entry.** ABEP is switched off to let the orbit decay; re-entry follows within 6 months. A mission extension is optional.

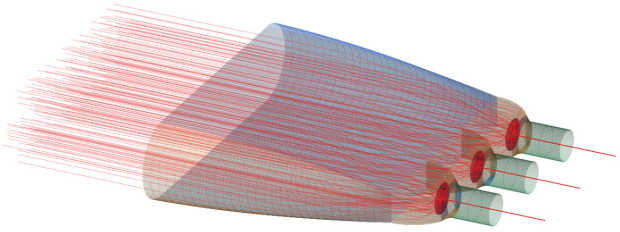


Qualitative orbit overview.

Inside the spacecraft

PS Propulsion System

ABEP with a specular intake is the propulsion system demonstrated by AQUILA. ABEP is particularly suited to VLEO, as it uses the residual atmosphere as propellant and eliminates fuel storage. The novel EPSILON intake increases atmospheric collection, achieving a **20.5 % increase in area ratio** for our design compared to paraboloidal specular intakes. This offers increased mass flow and flexibility in intake width and thruster configuration.
However, the particle flow varies along the orbit and may not always provide the required mass flow. A hybrid (ABEP + EP) architecture was therefore selected for flexibility and as fallback propulsion, with conventional EP supplied by an independent xenon source.



EPSILON – Elongated Parabolic Specular Intake for Low Orbit high Number density.

PL Payload

QKD is used to transmit keys for unhackable data transfer; the actual data is transferred via S-band links. VLEO altitudes and short fly-over times make interception virtually impossible. An optical system with varying attenuation allows usage over the entire eccentric orbit. Retroreflectors are used on the demonstrator for spatial awareness and as a backup option; they are optional for later constellations to increase stealth. Payloads are exchangeable, so the AQUILA platform fits many intelligence and defense missions.

COM Communications

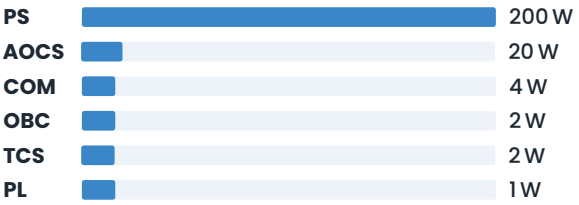
AQUILA hosts two patch antennas, facing nadir and zenith. The nadir antenna is the primary antenna for telemetry and payload data; the zenith antenna is used during detumbling. The demonstrator generates about 2.8 Gbit/day and offers an average downlink of 4–10 Mbit/s, depending on attenuation conditions. A secondary COTS system adds data relay via common relay providers.

AOCS Attitude & Orbit Control

The AOCS uses reaction wheels with 0.12 Nms per axis for three-axis control and magnetorquers to desaturate them without fuel. Attitude and position determination use a star tracker, gyroscopes, sun sensors, magnetometers and GNSS, depending on the operational mode.

EPS Electrical Power System

Total average power budget

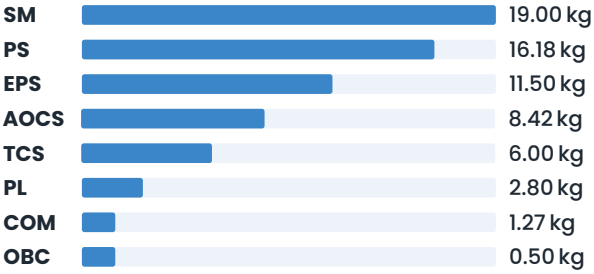


Total: 229 W

The GaAs solar cells cover 1.79 m² with a peak power of 380 W. The Li-ion batteries store 445 Wh. The system peak power during ABEP firing is **1175 W**.

SM Structure & Mechanisms

Total mass budget



Total: 65.67 kg

No external mechanisms are used, which increases reliability and decreases costs. The satellite measures **130 × 103 × 29 cm**.

TCS Thermal Control System

Variable conductance heat pipes (VCHP) are used for thermal management.

250 W	40 W	0.3 m²
Hot-case load	Cold-case load	Req. radiator area

Financials & Scalability

A single AQUILA demonstrator is built to decrease cost risk. Future missions scale to coverage needs.

> 230 M$	38 M$	27 M$
One-time development	Single unit	Per unit, 100-unit constellation

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