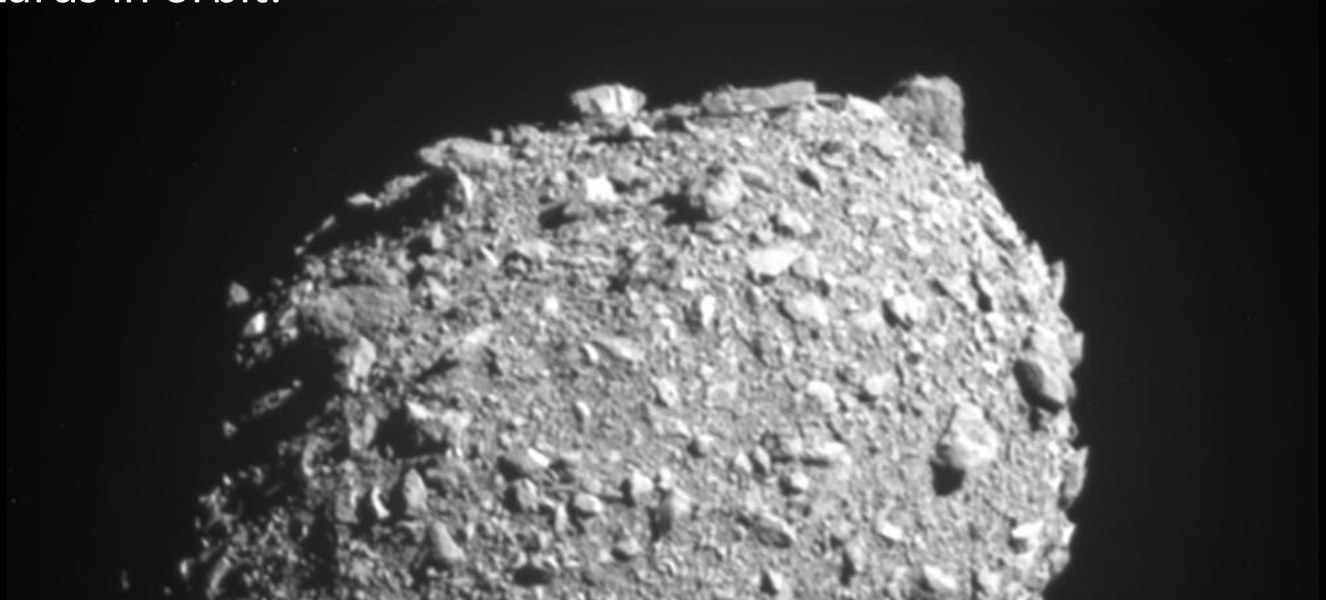
Welcome to the Future: Quantum & Photonic in Space

- Over the next decade, space missions will be faster, smarter, and more secure thanks to **quantum** and **photonic** technologies.

- From ultra-secure communications to centimetre-accurate navigation, these breakthroughs will transform how we explore, operate, and protect our space assets.

The Perfect Match for Space Challenges

- These technologies address key space challenges:
  - **Distance**: Deep-space missions demand high-speed data links.
  - **Precision**: Lunar landings and formation flying require centimetre accuracy.
  - **Security**: Space assets must be protected from cyber threats.
  - **Awareness**: Better tools are needed to monitor Earth and track hazards in orbit.



Low Earth Orbit to Deep Space Communication

- Supports **telecommunications, crewed missions, advanced telemedicine, and complex image delivery**.

- Technologies: **Lasers, quantum entanglement, Quantum Key Distribution, cryptography.**

- **Benefits**
  - Faster data transfer for real-time decision making
  - More robust and secure communication links
  - Reliable connections over interplanetary distances
  - Greater data capacity for high-resolution imagery and science

Positioning, Navigation & Timing (PNT)

- Quantum tech enhances reliability of space-based PNT via **atomic clocks & quantum-enhanced navigation.**

- **Benefits**
  - Centimetre-level positioning accuracy
  - Reliable navigation in GPS-denied environments
  - Critical for autonomous spacecraft and lunar / Mars missions
  - Reduced navigation errors for formation flying

Monitoring the Earth

- Better images aid **agriculture, disaster relief, and climate modelling**.
- **Precise gravity measurements** detect subtle sea-level changes and subsurface water.
- **Benefits**:
  - Faster disaster response with accurate situational awareness
  - Better crop management and resource planning
  - Early detection of climate change indicators
  - More effective environmental protection and planning

Monitoring Space Objects

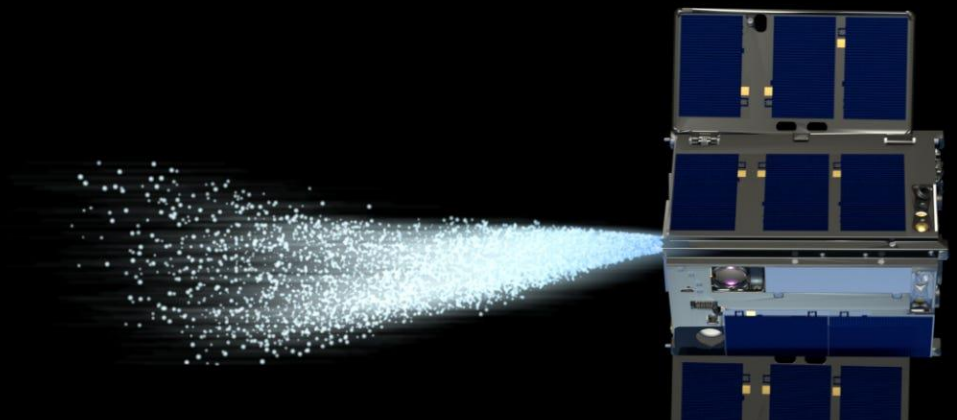
- Quantum tech tracks fast-moving, low-reflectivity objects — critical for debris avoidance and asteroid monitoring.

- **Benefits:**
  - Increased safety for crewed and uncrewed spacecraft
  - Enhanced space situational awareness
  - Reduced collision risks in congested orbits
  - Better planetary defence capabilities

Quantum Computing for Space Mission Support

- Optimises satellite constellation design, orbit planning, and real-time data processing.

- **Benefits**
  - Faster and more efficient mission planning
  - Improved allocation of satellite resources
  - Real-time analysis of incoming space data
  - Lower operational costs through optimised scheduling



By 2035, Expect…

- Global quantum-secure satellite networks
- GPS-independent precision navigation
- Terabit-speed optical satellite communication
- Superior space object tracking
- Smarter planetary and climate monitoring

Preparing for the Quantum Era

- If the 2010s were about cheaper launches, the 2030s will be about intelligent, secure, autonomous space systems — powered by quantum and photonic breakthroughs.

- Now is the time to engage, invest, and prepare.