Quantum sensors for space – a case study

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For fundamental physics experiments, space missions offer a number of advantages compared to ground-based laboratory settings, to name a few: the zero-g environment; large variations of the gravitational potential and large velocity variations; a well-controlled micro vibration environment.

Designing an instrument to fly on a satellite requires specific attention to a number of aspects, which are inherent to space missions: radiation environment, accommodation on the spacecraft, instrument autonomy and operability, reliability and redundancy, model philosophy, qualification and validation.

Based on a model mission - probing different aspects of the Einstein Equivalence Principle with dual species cold atom interferometry and atomic clock comparisons – the flow-down starting from the science requirements and instrument needs to the mission definition will be presented, including details of spacecraft design and instrument accommodation, in-orbit operations and instrument calibration aspects.
Examples of trade-offs during the iterative process of maximizing the science return while optimizing the instrument as well as the spacecraft and mission design will be highlighted.