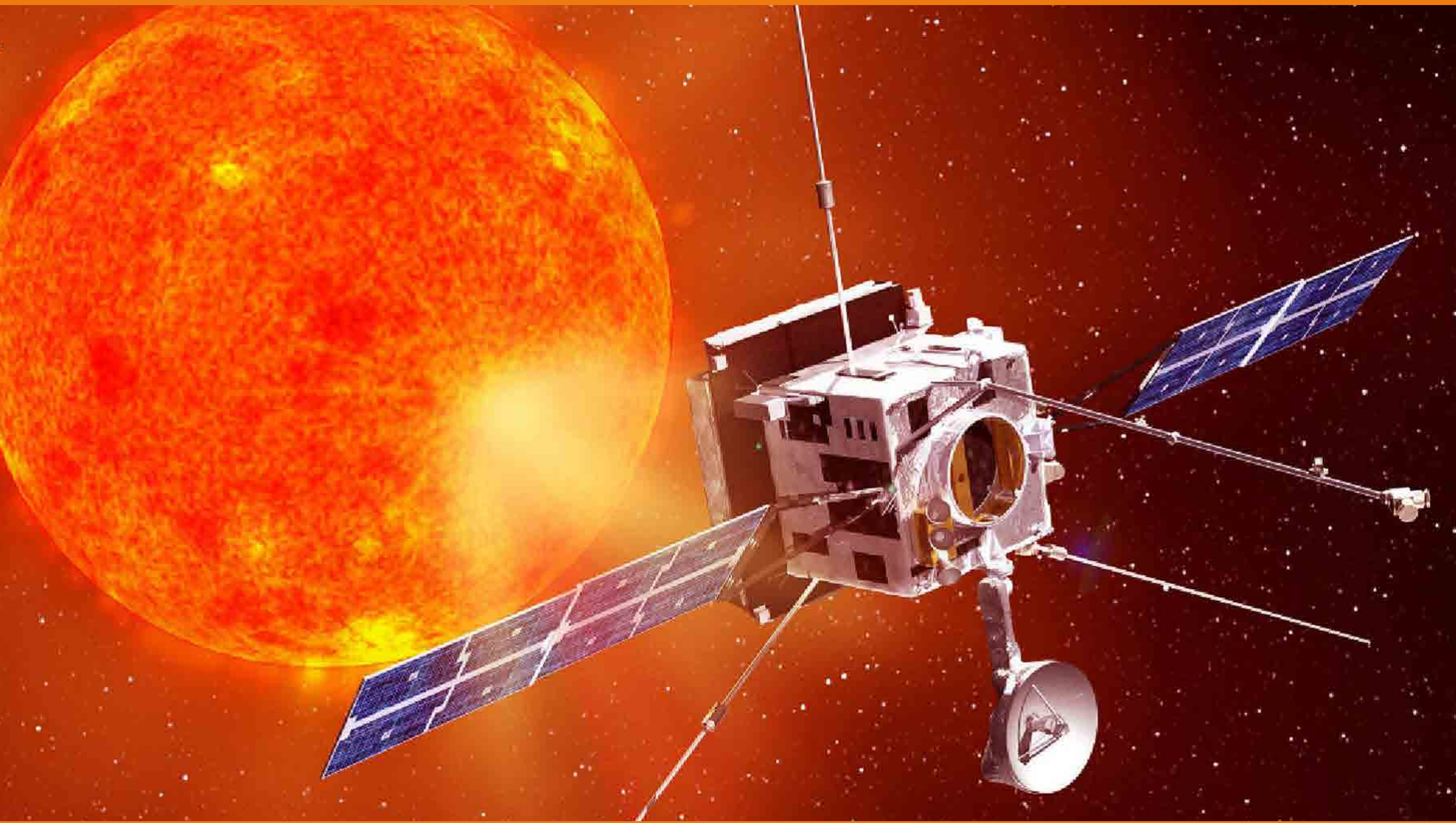
European Metrology Research Programme
Delivering Impact



Advanced magnetic sensing

Magnetic sensors are used in a range of applications that require high-resolution data on an object's direction and position, for example, orbiting satellites and safety systems in the automotive industry. Rapid developments in these fields require advanced sensors with significantly improved specifications, including resolution, reliability, and signal-to-noise ratio. To verify sensor specifications, users need to be able to accurately test, characterise and calibrate them.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Magnetic sensors can be found in a broad range of applications in the communications, oil and gas exploration and aerospace industries. A major challenge in these sectors is the determination of exact position, for example, of engine components during the ignition cycle or satellites during space flights. Magnetic sensors detecting small changes in magnetic fields offer a potential measurement method. This relies on the precise calibration of sensors. However, the magnetic properties of sensor materials exhibit strong variation with temperature, and, until recently, data extrapolation was the only way to relate material properties to temperatures other than that at which the calibration was performed.

This poses a problem, as magnetic sensor applications such as space navigation commonly experience significant temperature variations. Spacecraft use fluxgate sensors (a type of magnetic sensor which senses the direction of the Earth's magnetic field) to carry out manoeuvres such as orientation correction. By measuring the Earth's magnetic field, a spacecraft can determine its position in space and, if necessary, correct it. However, temperatures in space change drastically, dependent on whether the spacecraft is shielded from or exposed to the sun, meaning that sensors often operate under conditions far different from those in which they were calibrated.

Improved procedures and facilities are needed which enable sensor calibration to be performed under conditions closer to those experienced in real-life use, to ensure reliable data is produced over a sensor's working temperature range.

Solution

The EMRP project *Metrology for advanced industrial magnetics* developed an improved calibration facility for advanced magnetic sensors. This facility enables a sensor's response to specific magnetic fields to be determined over an extended temperature range, from -80 °C to 200 °C. This enables sensor performance to be characterised over a temperature range closer to that experienced in the harsh conditions of space and other extreme environments, giving a more accurate indication of in-service performance. Crucially for devices designed for use in space the low magnetic fields at this facility enables compensation for the Earth's own magnetic field.

Impact

Bartington Instruments, a UK-based manufacturer of high-performance fluxgate sensors, was one of the first users of this new calibration facility. Bartington tested four fluxgate sensors in the new calibration facility, validating their sensor's response across an extended temperature range. Using these results, Bartington have upgraded their own measurement procedures and validated the performance of in-house test equipment. They are now also able to offer customers a UKAS accredited calibration service for magnetic sensors as a result of project interaction.

RAL Space, at the Rutherford Appleton Laboratory (RAL) in the UK, is using Bartington's validated sensors as part of navigational instrument preparations for future gravitational astronomy missions like LISA. These missions require spacecraft to be 'magnetically clean' ensuring it is possible to correct these sensors for the effects of small magnetic fields induced by spacecraft components.

This is just one early example of the impact created by the new magnetic field calibration facility, which will benefit not only the space industry, but all industries that require magnetic sensor calibration with improved accuracy over a more extended temperature range.

Metrology for magnetic sensors

The EMRP project *Metrology for advanced industrial magnetics* delivered measurement tools and methods to enable the development, testing and calibration of advanced magnetic sensors, and accelerate their application in present and emerging technologies. The new capabilities allow users to carry out traceable characterisation of advanced materials and traceable measurements of the magnetic properties of devices, to support the development of advanced sensors with improved specifications, such as reliability, operation temperature, device size, field range and calibration uncertainty.

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