OGRECam

An EM-CCD camera system for the Off-plane Grating Rocket Experiment (OGRE) mission.

Introduction

The Off-Plane Grating Rocket Experiment (OGRE) mission is a NASA-funded sub-orbital sounding rocket mission being led by the Nanofabrication and Astronomical Instrumentation Group at Penn State University in Pennsylvania. XCAM is supplying the camera system for the mission.

OGRE aims to increase the technology readiness levels of three new space technologies; state-of-the-art X-ray optics, co-aligned arrays of off-plane reflection gratings, and an X-ray camera based around four Electron Multiplying CCDs. These technologies will be launched into space on a NASA Black Brant IX sounding rocket in 2025 to capture a high resolution X-ray spectrum of the Capella star system. The data from the mission will be used to assess the performance of the instrument and compare with current state-of-the-art measurements.

OGRE will act as a proving ground for new space technologies which could be adopted in the next generation of space-based X-ray astronomical telescopes, the eventual successors to e.g. NASA's Chandra observatory and ESA's XMM-Newton observatory.

Technology Demonstration

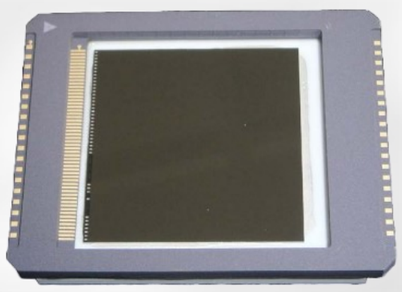
Three new technologies will be demonstrated as part of the OGRE mission which have not flown in space before.

X-ray Optics

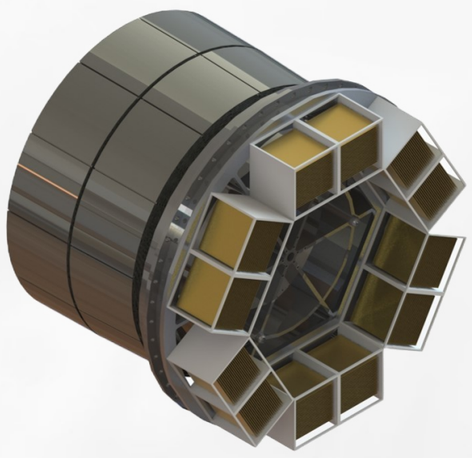
State-of-the-art X-ray optics are being developed at NASA's Goddard Space Flight Centre (GSFC) using thin, light-weight polished silicon shells.

Reflection Gratings

The high precision reflection gratings are being developed at Penn State and manufactured from Invar-36 using electron-beam lithography. OGRE will contain over 220 gratings housed across 12 gratings modules.



Photograph of an EM-CCD.
Credit: Teledyne e2v



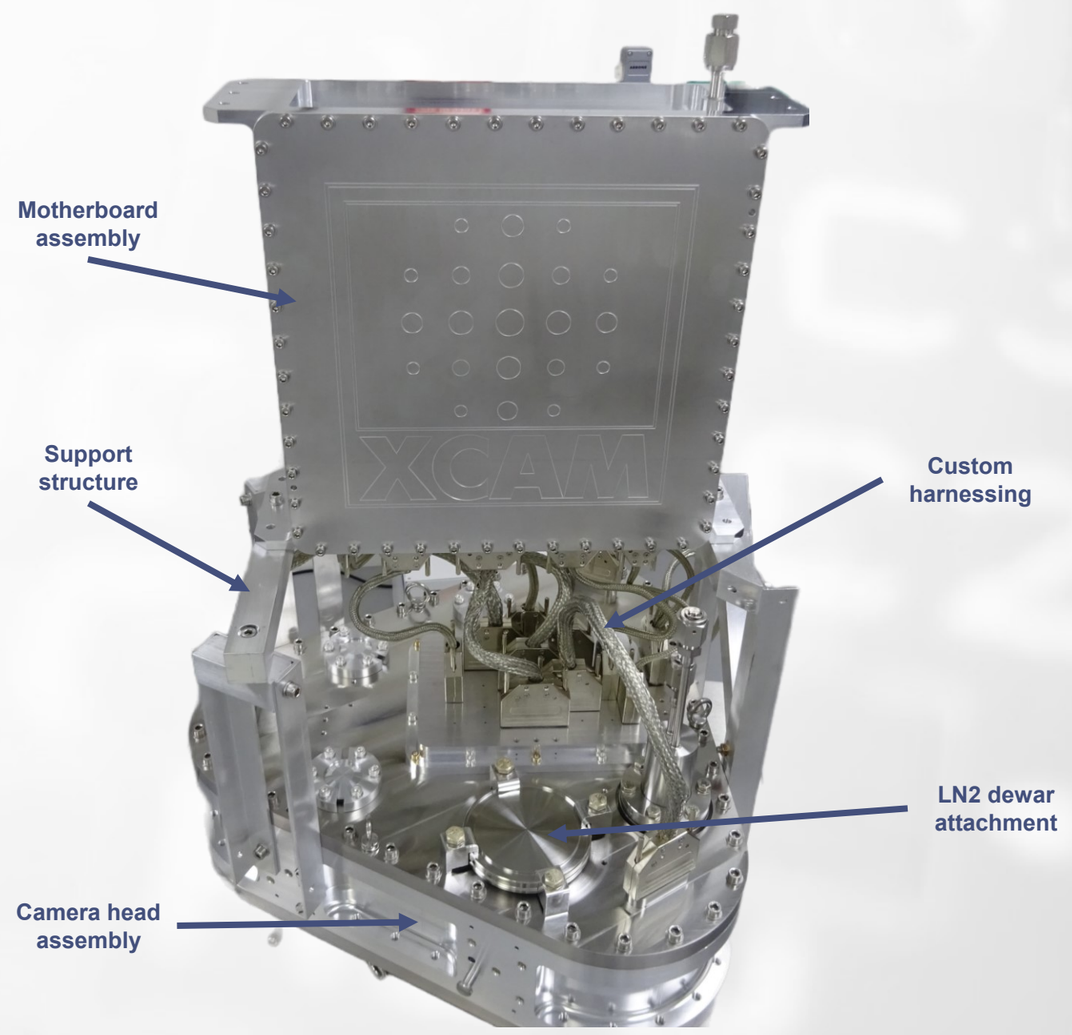
CAD rendering of the OGRE X-ray optics and the 12 module gratings assembly.
Credit: PSU

EM-CCDs

The four Electron-Multiplying CCDs are supplied by Teledyne e2v and offer superior signal-to-noise ratio over other imaging sensor technologies by amplifying the signal detected in each pixel prior to read-out.

EM-CCD Camera

OGRECam is an advanced digital camera system which drives four EM-CCD sensors enabling unparalleled low-noise performance for the OGRE X-ray spectroscopy application. The system incorporates many of the highly specialised technologies XCAM is known for including; complex low-noise detector drive electronics, multi-detector focal planes, in-vacuum operation and cryogenic cooling.

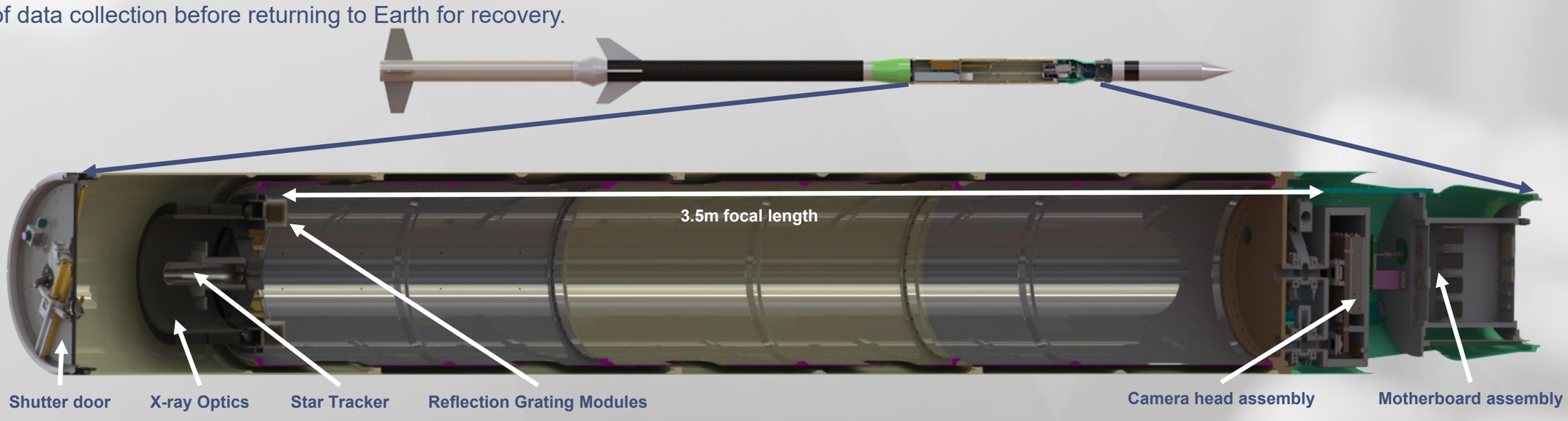


The system is made up of two main parts. The camera head assembly consists of a triangular chamber and houses the four EM-CCDs each of which are capable of being cooled to -100 °C during flight operations using liquid nitrogen (LN2). This is connected via custom harnessing to the motherboard assembly, another chamber housing the detector drive electronics and the instrument on-board computers.

Data processing will occur onboard during flight operations to identify X-ray events captured by the camera and package them for telemetry to the ground – thus minimising the bitrate required for telemetry. The data processing algorithms were developed in collaboration with the Open University in the UK via a co-sponsored PhD programme. The camera is expected to capture ~500 X-ray events over the 300 second data collection period.

Full OGRE Spectrometer Instrument

The full OGRE spectrometer is designed to fit the payload bay of the Black Brant IX sounding rocket and is one of the longest payloads to be launched on a NASA sounding rocket. This 12.2m 2-stage rocket will launch OGRE into space from the Poker Flat Research Range in Alaska, enabling approx. 300 sec of data collection before returning to Earth for recovery.



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