Department of Physics
Atmospheric, Oceanic & Planetary Physics

The Compact Imaging Infrared Radiometer (CIIR) Programme

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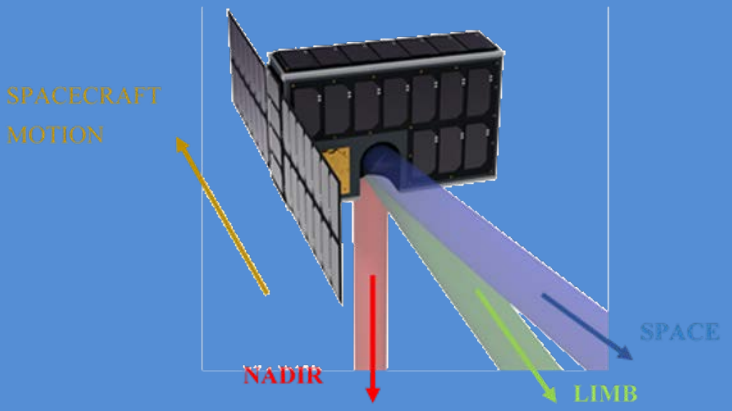
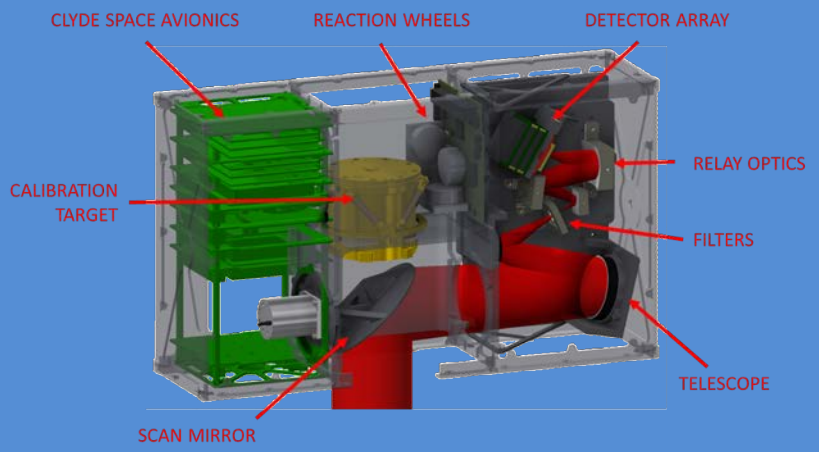
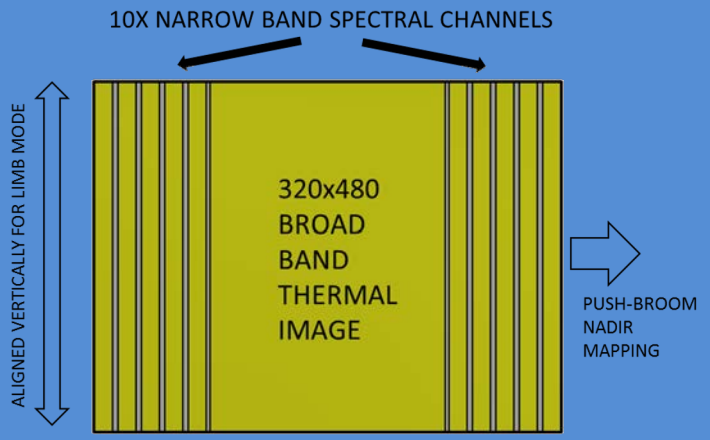


CIIR Concept

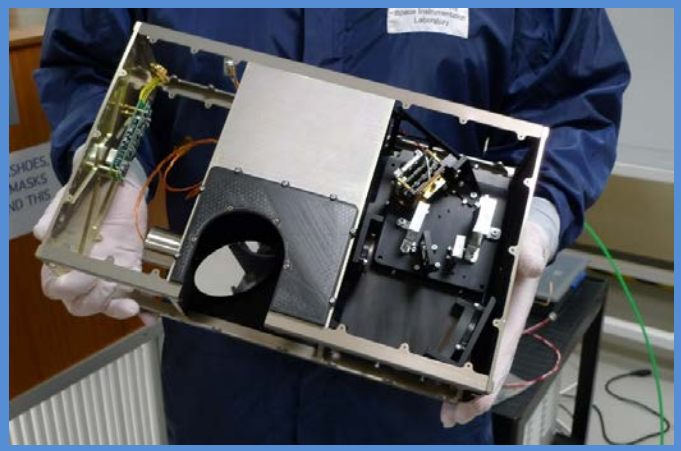
- Broad band thermal imaging + Narrow band mapping in 10 channels
- Integral black body calibration target (goal ±0.25K, requirement ± 0.5K)
- Reflective diamond machined optics allow measurements from visible to far-IR
- Technology demonstrator narrow bands:
  - Limb: aerosol (straightforward) and Ozone (challenging)
  - Nadir: pollution and surface thermal emission
- Aim is to reproduce capability of existing operational satellites from a small platform constellation
- Optical design derived from TechDemoSat-1 CMS instrument
  - 2x3U implementation
  - Uncooled microbolometer array
  - Intermediate focus minimises errors from optical interactions between filters and detectors

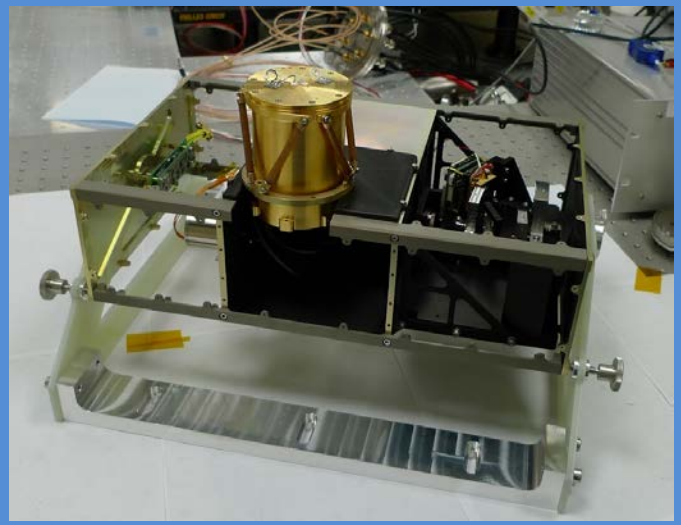




CIIR Development to date

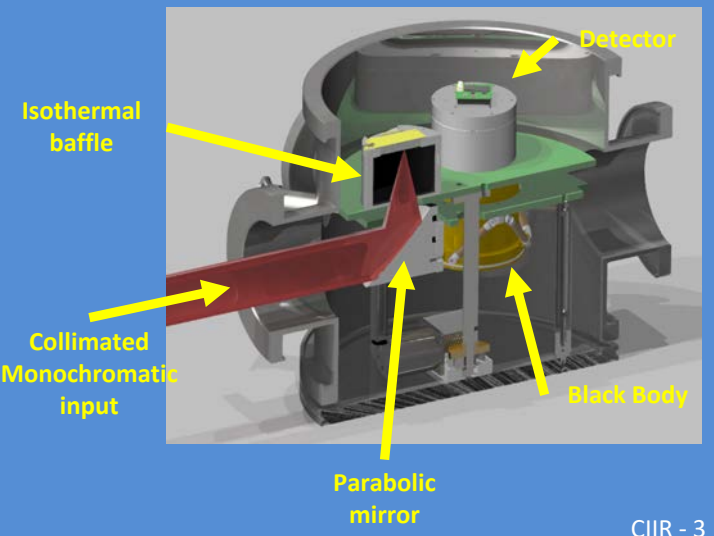
- Phase A study funded by CEOI in 2015
- Follow on Study of Calibration and Pointing 2018
- Manufactured near complete version of instrument
  - Demonstrated detector stability
  - Demonstrated calibration to 0.25K
    - Limited by lab equipment – probably ADCs
    - Optics limited fraction of array calibrated
- Updated instrument design





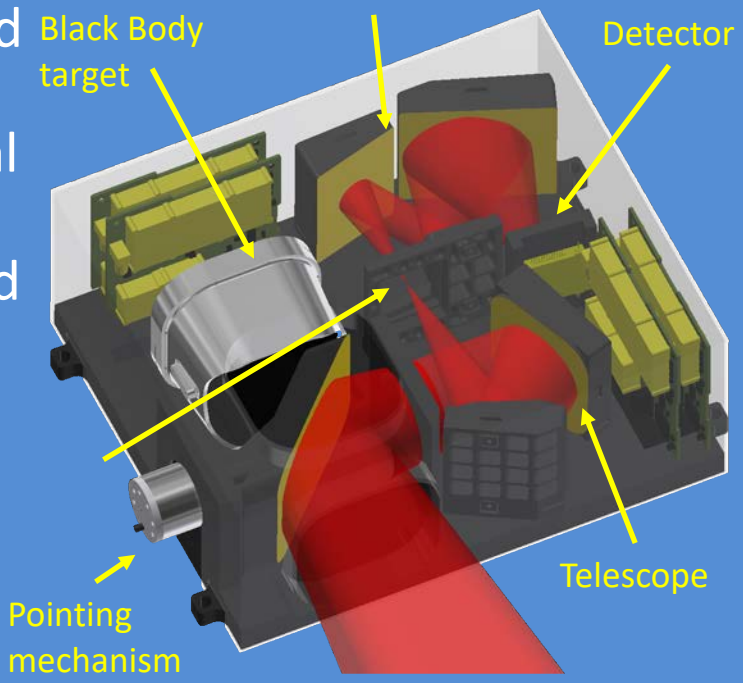
Current developments

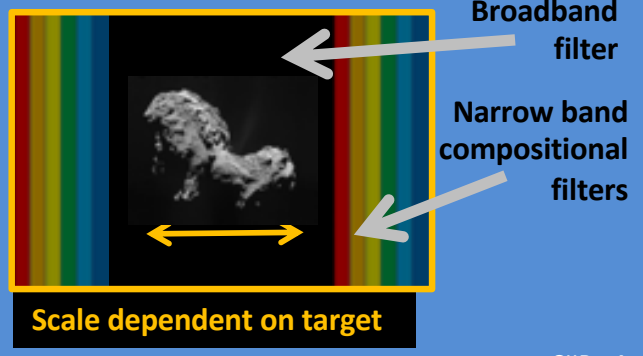
- New large area optical design
  - Designed to support large area arrays
  - Funded by Oxford (Fell Fund)
  - Manufactured by Durham Advanced Manufacturing Facility
  - Delivered March 2020
- Larger area detector arrays
  - Delivered
  - Funded by STFC IAA
- Detector trade off study
  - New detector characterisation rig
  - FPGA code development (RAL Space)
  - Funded by UKSA/NSTP/ESA
- Improved PRT measurement ADCs
  - Circuit built as part of seismometer development
  - Will use same circuits on ground and in-flight
- Ready to go, just waiting CV19 restart



CIIR Path to Orbit and Beyond

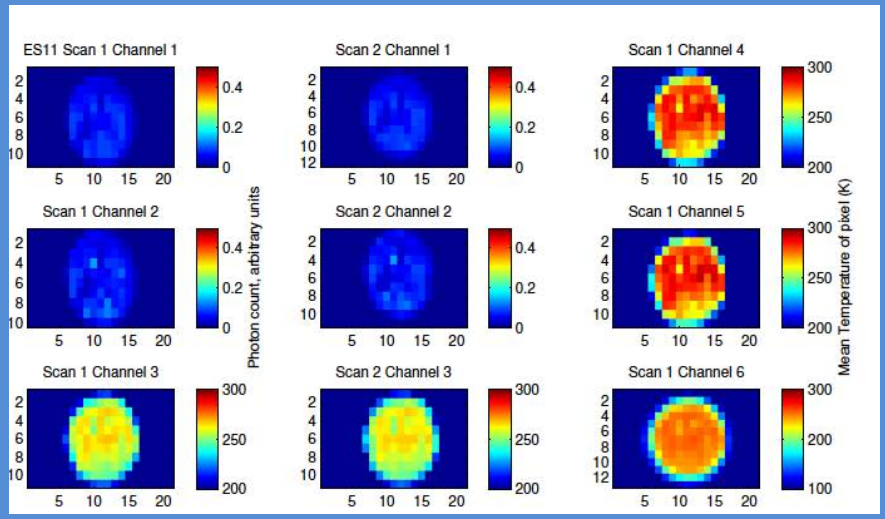
- We have had multiple meetings with the Satellite Applications Catapult and Oxford Innovation
- Next stage is development of commercial data service product.
- Funding has just been awarded by Oxford University Challenge Seed Fund to produce example product
- Commercial funding seems practical mainly for a service provided by the CubeSats and small sats
- Flexible design means we can fly on platforms from 6U to SmallSats
- **We have had success proposing the concept to planetary missions.**
- **Selected for flight on NASA's Lunar Trailblazer and ESA's Comet Interceptor**

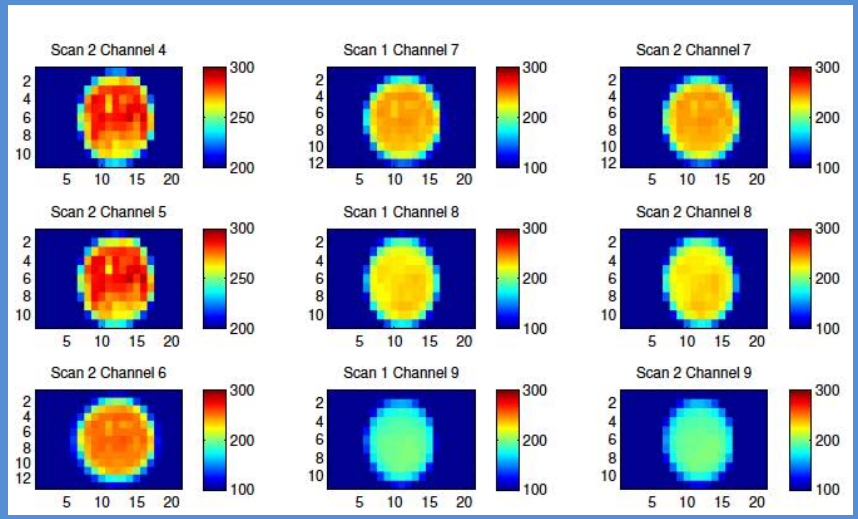




Next Steps for EO version

- Currently in discussion with potential partners to fly an EO version.
- The active development of lunar and comet versions should reduce costs and risks associated with building the EO version.
- Breadboard development programme is now well advanced.
- Next steps are proof-of-concept algorithm development for potential EO science applications and commercial partners.
  - Uses breadboard instrument performance data to produce an example data product.
  - Commercial data products will be based on our discussions with the Catapult and market survey.
  - **Funded by Oxford UCSF June 2020**
- **Awaiting CV19 restart**





Earth from Moon – LRO Diviner

Backup

Two selected instruments: Lunar Thermal Mapper and Comet Interceptor

- Near identical instrument selected NASA Lunar Trailblazer mission
  - PDR Sep 2020
  - Instrument Delivery early 2022, launch 2024
- Targeting lunar volatiles in shadowed regions and water cycle.
- FPGA firmware improved to support time delay integration
- SmallSat ride share launch with NASA's IMAP mission.
- Thermal module for MIRMIS instrument on ESA's Comet Interceptor
  - Collaboration with VTT Finland
  - Covers 0.9 to > 20 µm in three modules
- **ESA contract to study new microbolometer arrays**