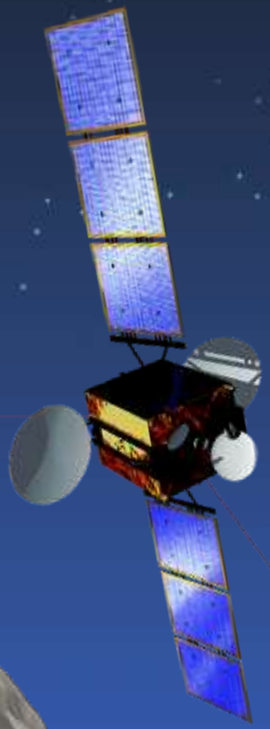
SURREY SATELLITE TECHNOLOGY LTD

Changing the economics of space

CEOI 5th and 6th Open Calls
Final Review

Application of a New Detector Processing Technique for Space-borne Fire Measurement and Monitoring

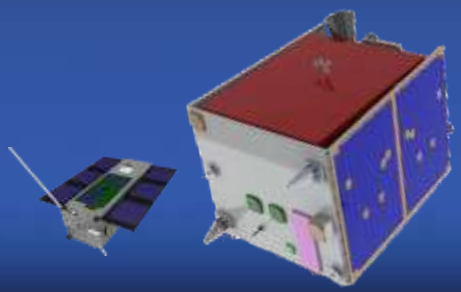


UK SPACE AGENCY

Centre for eo Instrumentation

Mark Chang (SSTL)
Martin Wooster
(King's College, London University)

20th March 2013
London



Project Introduction

- Project rationale
  - Fires have a major impact on ecological and environmental systems.
  - Project key objective
    - Address the need for cost effective measurement & monitoring of fires from space, through
      - Specification of top level science requirements
      - Specification of mission functional requirements
      - Investigation of a-Si microbolometer detectors
      - Definition of instrument system concept

- Commercial & science case
  - Fires are large contributor to annual carbon emissions to atmosphere
  - Due to global appearance, satellite observations are the only method for wide scale quantification

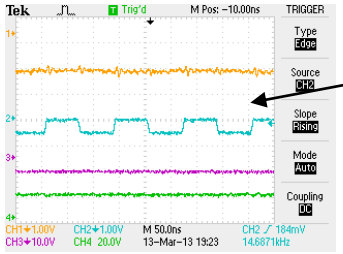
- Project partners
  - SSTL
    - Project lead / Mark Chang
    - Detector testing / Luis Gomez Rojas, Enrico Sain, William Avison, Matthew Price
  - KCL
    - Science and mission requirements / Martin Wooster

Mission & Systems Requirements Specification

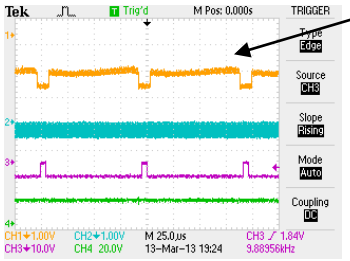
- **Activities undertaken**
  - End User requirements capture by KCL
  - Mission & Instrument requirements proposal by SSTL
  - Requirements iteration (2 instances) to generate requirements baseline
  - Key results
    - Reduction of 29 proposed requirement objects to 22 baseline requirements
    - 3 driving requirements identified
  - **Absolute Radiometric Accuracy per channel**
    - 0.5 K is defined
  - **Saturation Temperatures**
    - MIR (3 to 5 µm) 800 K
    - LWIR (8 to 12 µm) 600 K
  - **Stray Light**
    - Percentage of fire scene pixels leaking into neighbour <1.25% of fire scene pixels' level.
  - Report generated in draft. Release pending final update.

Detector Test Bench Preparation

- **Activities undertaken**
  - Production & testing of interface board for Ulis PICO640E detector
  - Writing and release of timing control files for detector readout via SSTL Universal Camera



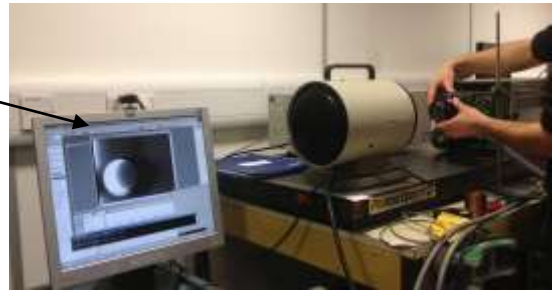
Master clock



Video

  - Test Equipment Readiness Review held 23/11/2013
  - Key results
    - Functional test of detector readout through SSTL Universal Camera electronics completed
    - Performance test of detector readout completed

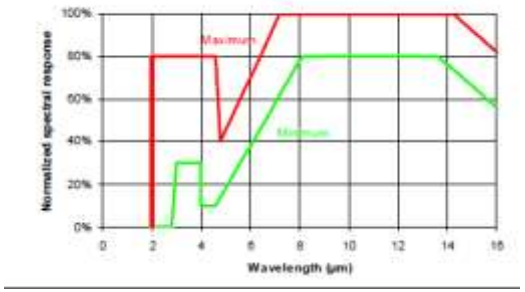
Extended Area Blackbody imaged through wideband IR lens

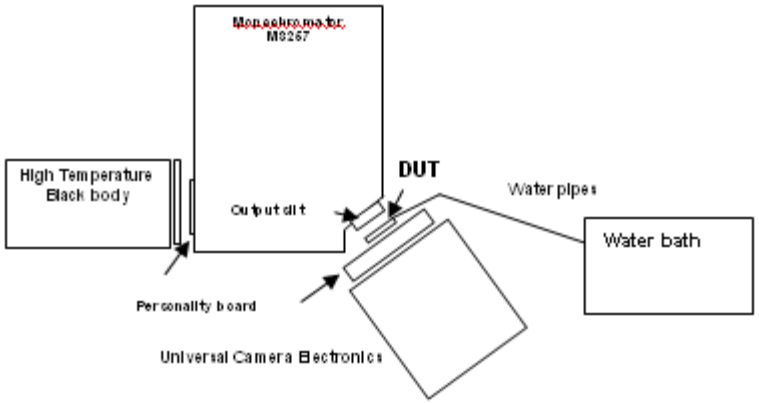


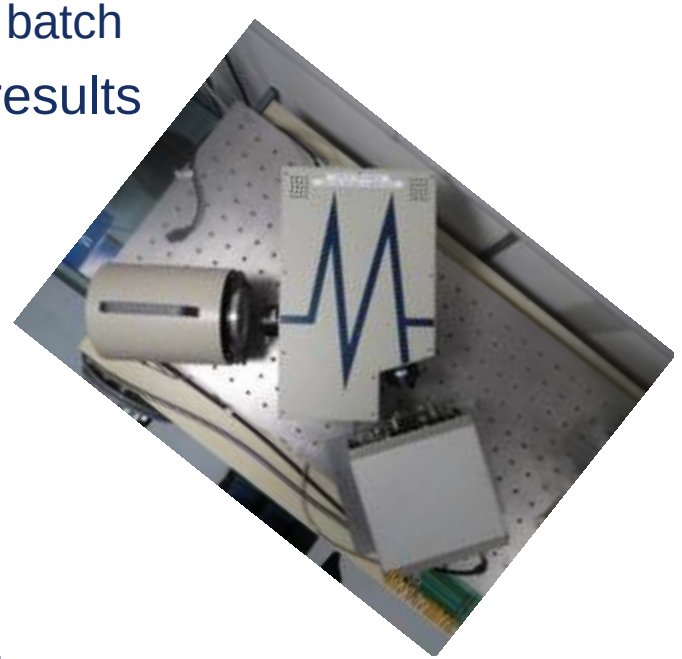
  - Reporting:
    - SSTL Test Report SmarTeam #0202380

Detector Test Programme

- Activities undertaken
  - Tests underway:
    - Detector Spectral Response
    - Detector NEDT (incomplete)
  - Key results
    - Spectral response confirmation from 3 – 16 µm.
    - Assessment of normalised spectral response on 2 detectors selected from same production batch
  - Report in draft, pending NEDT results

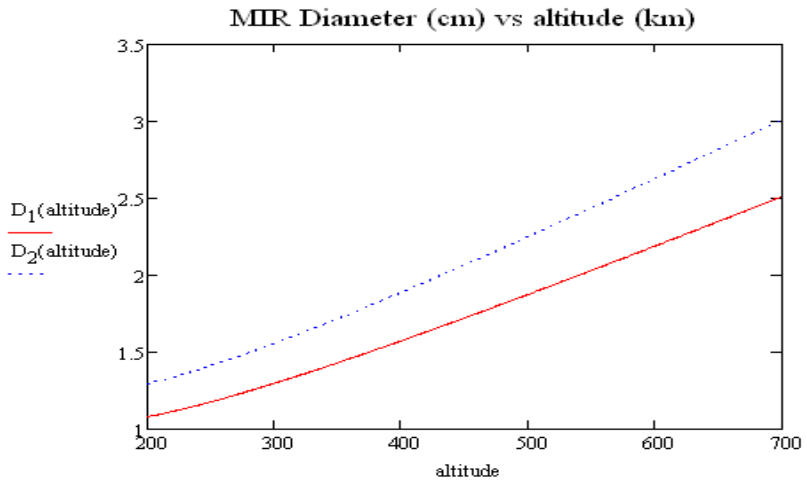


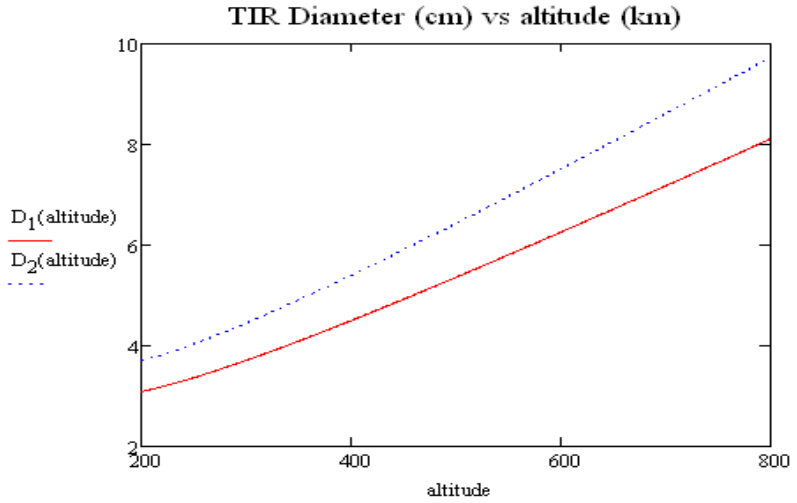




Radiometric Analysis

- Definition of Instrument System Concept
  - Aspects investigated
    - Instrument Geometry
    - Instrument Dynamics
    - Instrument Sensitivity
  - Key results
    - Pushbroom vs Whiskbroom studied
      - Step starer ruled out due to detector limitations
    - Aperture sizes possible are plotted on right
      - F/6 system considered
    - Required NEDT for LWIR (TIR) is easily achievable
    - Required NEDT for MIR to be demonstrated by test
  - Report generated; full release pending Systems requirements report release.





Achievements against goals

- Successfully completed
  - Review of end user requirements
  - Definition of mission and system requirements with justification
  - Test Equipment procurement and manufacture
  - Test Equipment Readiness Review completed
  - Test Programme 50% complete
  - Radiometric analysis produced
    - Altitude range delimited
    - Scanning/Viewing mechanism trade-off produced
    - Aperture sizing completed
    - NEDT and MRDT calculated based on theoretical parameters for MIR, measured parameters for LWIR (TIR)
    - Design trade-offs analysed
      - Saturation
      - Spectral vs spatial imaging paths for MIR/TIR
      - Active thermal control vs thermally stable structural design

Issues and problems encountered

- Test Equipment preparation took longer than anticipated by ~30% calendar time.
  - Detector procurement completed but loan of check-out equipment by detector supplier was never fulfilled (by supplier)
- Test Programme consequently impacted
  - Recently, expert test engineer not available due to illness
  - Junior engineers put in place to complete programme

Positioning achieved

- Presentations & Publications
  - “Fire detection and fire growth monitoring from satellite monitors”, M. Cutter et al, proc. 63rd IAC, 2012.
- Leverage achieved
  - Utilisation of SSTL expertise in use of thermal infrared microbolometer arrays
  - Realisation of a realistic systems specification for a cost-effective satellite monitor
  - Step forward in defining a commercial product
- Collaborations forged/furthered
  - Partnership between KCL & SSTL
  - Partnership between SSTL & detector supplier (Ulis)

Other Achievements

- Training and knowledge exchange
  - KCL/SSTL and end user community knowledge exchange during specifications capture and baseline activity
  - SSTL training of junior engineers on test equipment
- UK Capability enhancement
  - Benefits to UK Space:
    - SSTL & KCL in position to undertake detailed characterisation of new detector product
    - SSTL has made step towards a product design
      - Product design framework in place
      - Iterations required to refine design options

Roadmap

- Missions/exploitation route
  - MIR+TIR (filter based, tbc) imager to be designed
  - Fire monitoring mission on microsatellite platform can take advantage of this
  - Opportunity with e.g. North American Forestry
- Future steps
  - Technology development required
    - Modification of SSTL readout electronics to implement TDI in detector processing chain
      - Can leverage off ongoing ESA programme work at SSTL
  - Issues to be resolved
    - Space qualification of detector