Submm Common-User Bolometer Array - 2

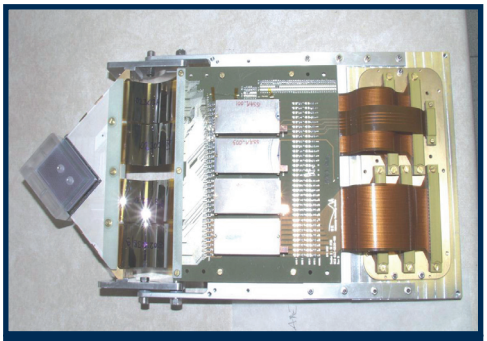
Science & Technology Facilities Council
UK Astronomy Technology Centre

The Submillimetre Common-User Bolometer Array – 2 (SCUBA-2) is a new generation wide-field submillimetre camera for the James Clerk Maxwell Telescope. It is an international project being led by the UK Astronomy Technology Centre in Edinburgh. SCUBA-2 was delivered to the telescope in March 2008.

Over the past decade the UK has established itself as a world leader in submillimetre astronomy with access to the best telescope facilities and the most advanced instrumentation. In particular, the SCUBA camera, in conjunction with the James Clerk Maxwell Telescope (JCMT), has completely revolutionised this previously poorly explored area of astronomy. SCUBA-2 will capitalise on this success by providing the JCMT community with a state-of-the-art, wide-field camera giving unprecedented sensitivity and imaging power over and above that provided by SCUBA.

The SCUBA-2 project is a collaboration between the UK ATC, the National Institute of Standards and Technology, the University of Edinburgh, Cardiff University, the Joint Astronomy Centre, Hawaii and a consortium of Canadian universities.

SCUBA-2 represents a major innovation from current submillimetre instruments. Incorporating state-of-the-art technology will allow the realisation of the first large-format "CCD-like" camera for submillimetre astronomy.



Detector array module for SCUBA-2

Science Goals

SCUBA-2 will provide the JCMT with an unprecedented imaging and survey instrument for studying astronomy in the submillimetre region. With over 10,000 pixels in two arrays, SCUBA-2 will map the submillimetre sky up to a thousand times faster than SCUBA to the same signal-to-noise and will reach the (extragalactic) confusion limit at 850μm in less than an hour.

SCUBA-2 will also act as a 'pathfinder' for the new generation of submillimetre interferometers (e.g. ALMA) by performing large-area surveys to an unprecedented depth. Such an instrument will have an impact on almost all areas of astronomy, from studies of our Solar System and surveys of star formation in the Milky Way, to answering key questions about the formation and evolution of galaxies in the early Universe.

In summary, the scientific case for the instrument is based upon the following:

- A dual-wavelength camera operating at both 450 and 850μm simultaneously
- A field-of-view of 50 square arc-minutes at both wavelengths – some 13 times the area of SCUBA
- A mapping speed at least a factor of 100 greater than SCUBA at both wavelengths
- A point-source sensitivity at least a factor of 2 better than SCUBA

SCUBA-2 being lifted into the JCMT enclosure (3rd April 2008)

Technical Specifications

To achieve the science goals requires the following specification:

- A wide-field optical design encompassing the 50 square arc-minute field-of-view

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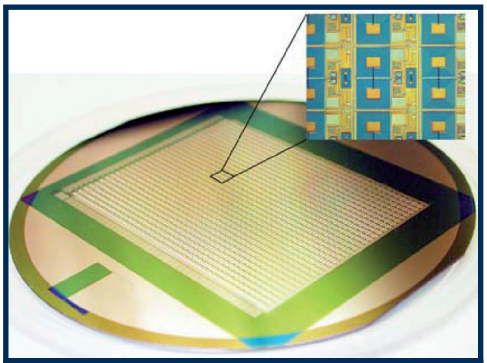
- Detectors with sensitivities governed by the sky background
- A focal plane design with separate arrays optimised for 450 and 850μm
- Fully-sampled images of the sky being achievable in ≤ 4 seconds
- Detectors that are DC-coupled to read-out electronics
- Novel imaging modes to realise large area surveys



Focal plane MUX

Key Features:

Superconducting TES detectors – in focal plane SQUID multiplexers bump-bonded to the detector chip

A liquid-cryogen free dilution refrigerator to cool the arrays to 100mK

Pulse-tube coolers to cool the cryostat optics to 4K to minimise extraneous background on the arrays

A cold shutter for taking "dark" frames

A high efficiency dichroic to split the incoming beam to the two arrays

A rapid data reduction pipeline to process images in real time

Management and Responsibilities

The SCUBA-2 project management and work-packages are currently split as follows:

UK ATC: Prime contractor, management of contracts, costs and schedules, design and production of instrument, systems engineering, array control software, assembly, integration and verification, telescope commissioning.

NIST: Development of detector arrays, SQUID read-out and cold electronics, production of prototype arrays, production of science arrays

UoE: Development of array structures, bump bonding of detector and multiplexer (contract with Raytheon), co-development of prototype arrays, co-production of science arrays.

Cardiff: Focal plane unit design, construction and test, filter production, cryostat window development and production, testing of prototype arrays, support of lab verification and telescope commissioning.

JAC: Prime design of telescope infrastructure systems, installation and commissioning, data reduction and pipeline processing software (with Canada).

Canada: Design, construction and testing of room-temperature multi-channel electronics and data acquisition system, data reduction and pipeline processing software (with JAC), multiplexer testing/screening, polarimeter and Fourier transform spectrometer.

Milestones

In summary, the major project milestones are as follows:

Oct 01 – Optical design preliminary design review

Mar 02 – Focal plane unit preliminary design review

Oct 02 – Array technology "Proof of Concept" review

Mar 03 – Cryostat preliminary design review

Apr 04 – June 04 – Cryostat critical design reviews

Sept 04 – First prototype (32×40) sub-array available (for 850μm)

May 05 – Start of instrument assembly and integration

Jun 05 – Second prototype sub-array available (450μm)

Dec 05 – Instrument verification phase begins

Oct 06 – First commissioning-grade sub-arrays available

Mar 08 – Delivery (with 2 engineering-grade arrays) to the telescope

Aug 09 – Upgrade to 2 science-grade arrays

Nov 09 – First science operations

Jan 10 – Upgrade to full array complement

Apr 10 – Full science operations

SCUBA-2 is jointly funded by the UK Science and Technology Facilities Council, the JCMT Development Fund and the Canadian Foundation for Innovation.

SCUBA-2 was delivered to JCMT in Mar 2008.