

SCUBA-2 system interfaces

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SCUBA-2 Website: http://www.roe.ac.uk/atc/projects/scuba_two



Outline

- Current status of SCUBA-2 detector development
- Key system technologies for focal plane integration

Posters and talks:-

Y11 (Ullom), RO4 (Hilton), Y25,26 (Audley), Y27 (Ullom), E05 (Doriese), E01 (Irwin)

Cover in detail array construction and manufacture, pixel test results and multiplexer design as well as ideas for excess noise reduction.



Arrays

Tested single pixels with Tc's and power handling appropriate for handling the back ground power loading at both 450 and 850 μm 's.

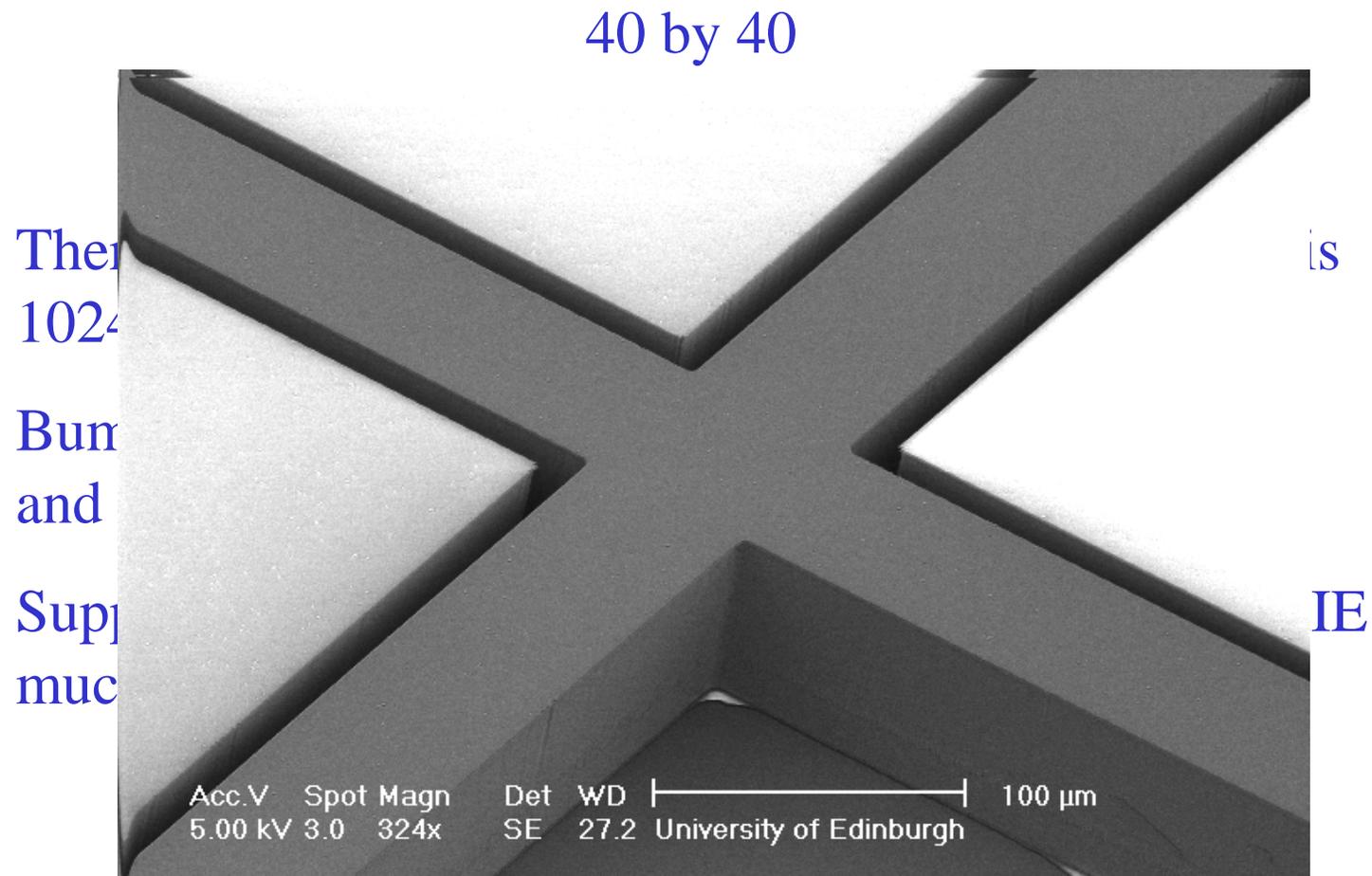
- NEP's meets specification of 10^{-17} W/sqrt Hz. Some excess noise at 450 μm
- Time constants 1 msec or less (to 70 μsec) .
- Tc variation $<7\text{mK}$ in 140mK across a test wafer
- Responsivity measured with both heater and IV power

Multiplexer

1 * 32 test chip measured for speed and 1/f SQUID noise reduction using dark SQUID.

SCUBA-2 unit cell developed and tested

Three major changes to design since last LTD:-





Processes

Bump bonding demonstrated

Thermal conductance of bumps measured and no. of bumps per pixel chosen (60).

Deep RIE etching after bump bonding demonstrated

Doping to achieve 400 ohm per sq for absorber measured for both n and p type wafers

Wafer bonding demonstrated

Final masks now under fabrication

expect in-hand example of prototype by end of this year

detailed tests by end of March 2004.

System interfaces for arrays



- **Optical**

QE; stray light; background; filters; alignment of arrays;

- **Thermal**

focal plane power dissipation; attachment to refrigerator, thermal cross talk, achieving operating temperature

- **Mechanical**

optical alignment, stiffness v's heat leak; hold arrays flat; sub-array buttable solutions; easy installation

- **Electrical**

signal, bias and multiplexer clock connections; heat leak; connection density

- **Cryogenics**

base temperature; cooling power; long cooling path; temperature stability



System interfaces for arrays

As focal planes become larger coping with these system issues becomes much more *difficult* and *expensive*

SCUBA-2 - integration of the focal planes

Astronomical + background photons + bias power

- $1\mu\text{W}$



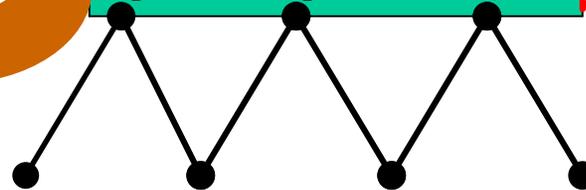
Connection to dilution refrigerator

- 5-6.5 μW heat flow
- 35 mK
- Boundary resistance
- Differential contraction
- Hold arrays flat



Focal plane (4 sub-arrays)

- power dissipation 2-3.5 μW

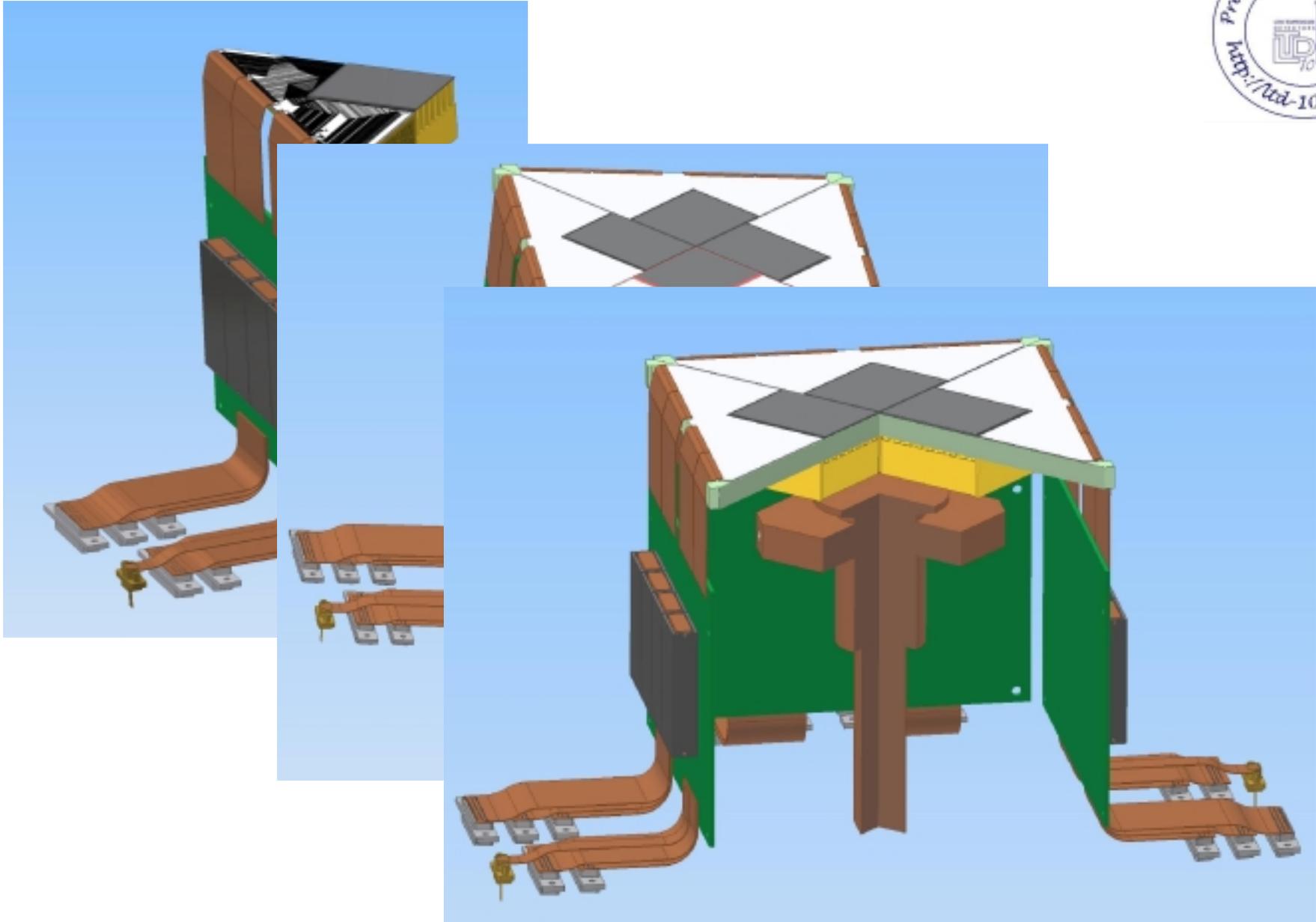


Electrical connections - 1200 per focal plane

- $< 2\mu\text{W}$ heat leak
- very low impedance

Mechanical support

- Resonant frequency $\sim 100\text{ Hz}$
- Accurately locates and supports up to 7 kg
- $< 2\mu\text{W}$ heat leak (to dilution refrigerator only)





Mechanical support

Kevlar/carbon cloth wheels

~ 140 mm dia.

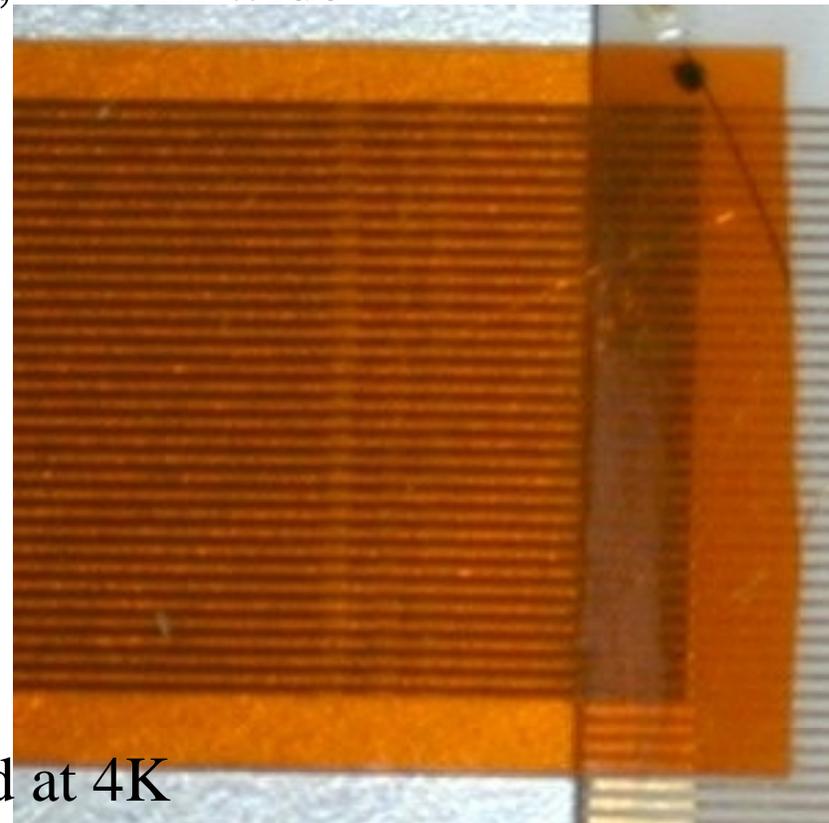
0.1 mm thickness

$< 2 \mu\text{W}$ heat leak from 1K

high stiffness and easy to manufacture

Electrical interface - kapton flex

- Niobium tracks
- 50 micron Kapton, 55 mm length, 44 mm wide
- 12 flex per focal plane
- Heat leak $\sim 1.6 \mu\text{W}$ (1K to 40 mK)
- spare tracks (10%)
- z-axis adhesive
- track pitch of $380 \mu\text{m}$
- thermally cycles
- contact resistance being measured at 4K



Connection to dilution refrigerator



- Be/Cu ‘hair brush’
- Tines ~ 0.5 by 0.5 mm cross section, 21 mm long on 1.135 mm pitch
- Head of pins is ~ 1mm by 1mm
- Arrays epoxied to hair brush
- Good thermal transport (~7 mK drop across interface)
- Thermally cycles
- Low thermal stresses
- Holds arrays flat
- Large dilution refrigerator

400+ μW at 100 mK to give 20 μW @ 25 mK

