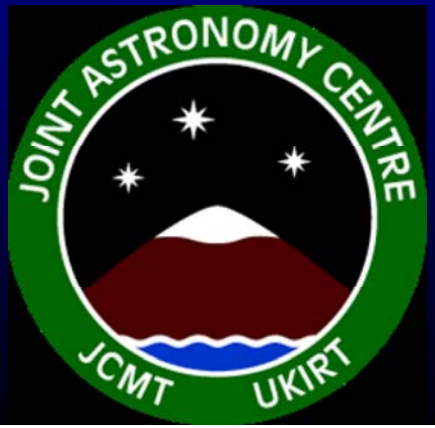
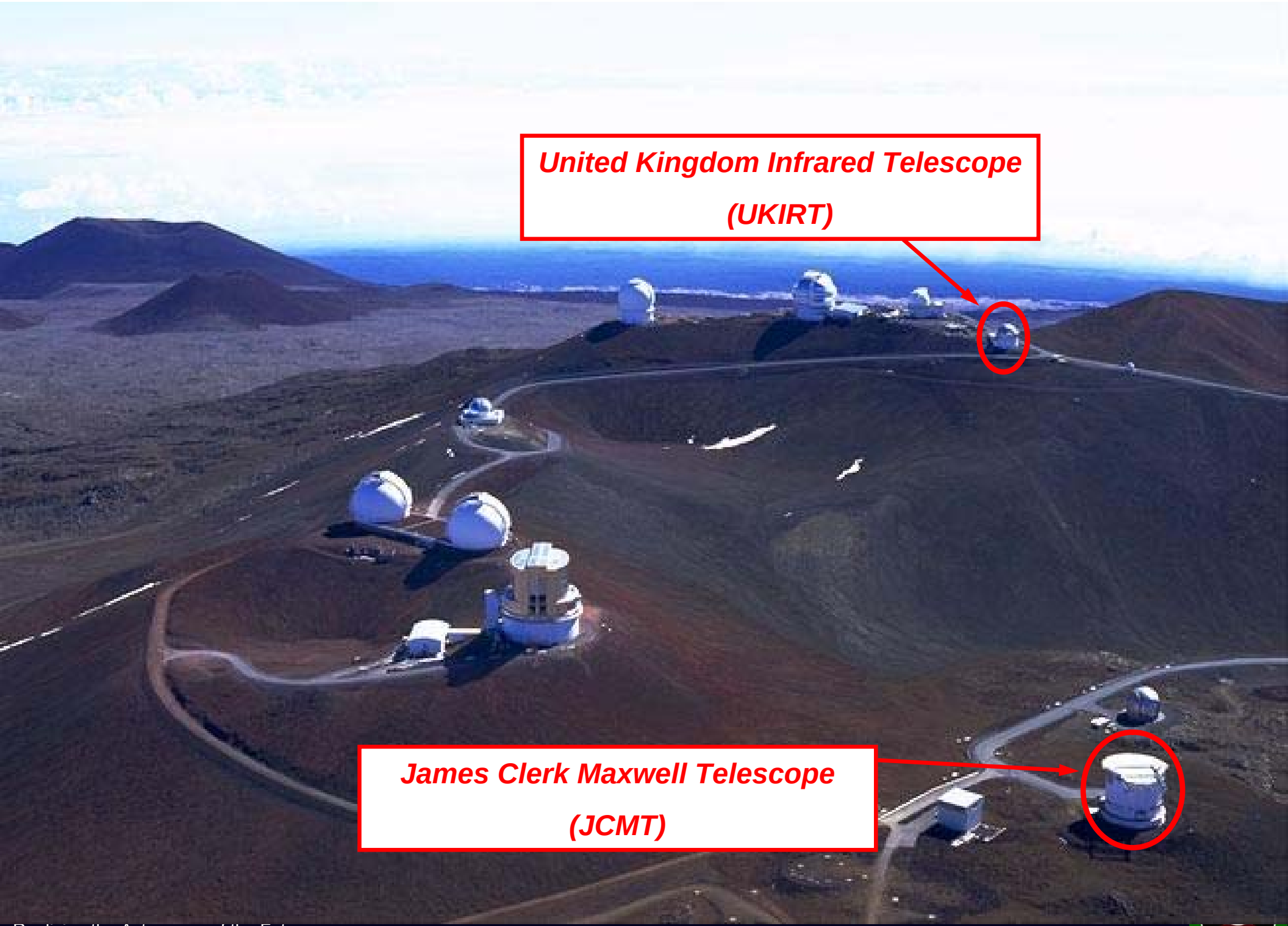
UKIRT and the JCMT: Inspiration and Instrumentation

Professor Gary Davis

Director, Joint Astronomy Centre

6th June 2012




United Kingdom Infrared Telescope
(UKIRT)
James Clerk Maxwell Telescope
(JCMT)

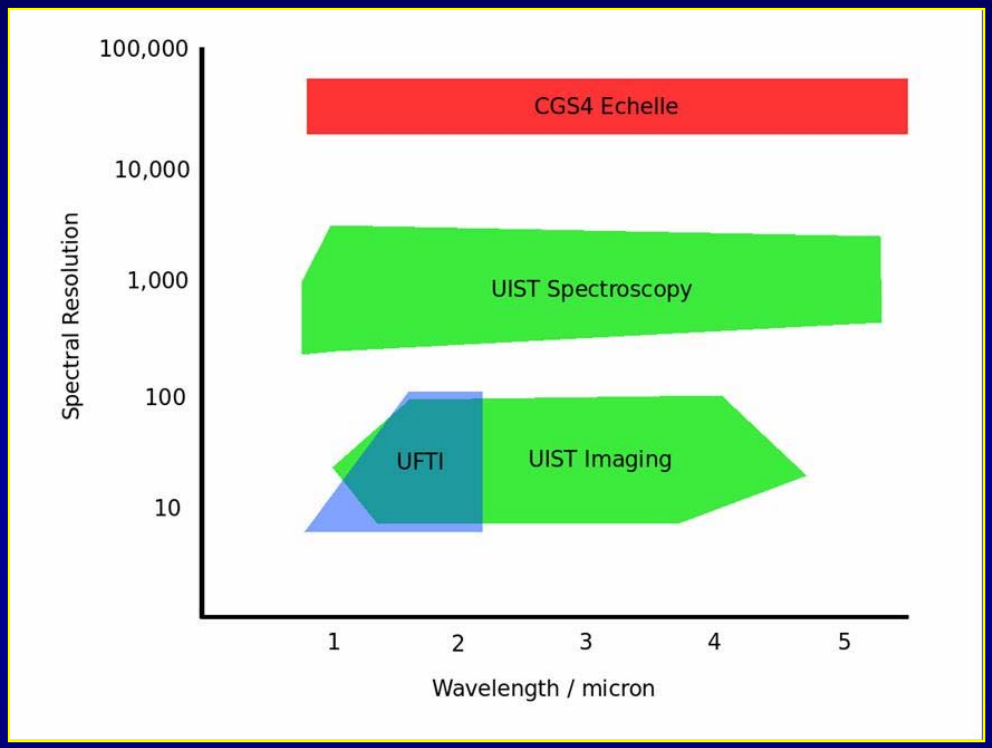
Introduction to UKIRT

Vital Statistics:

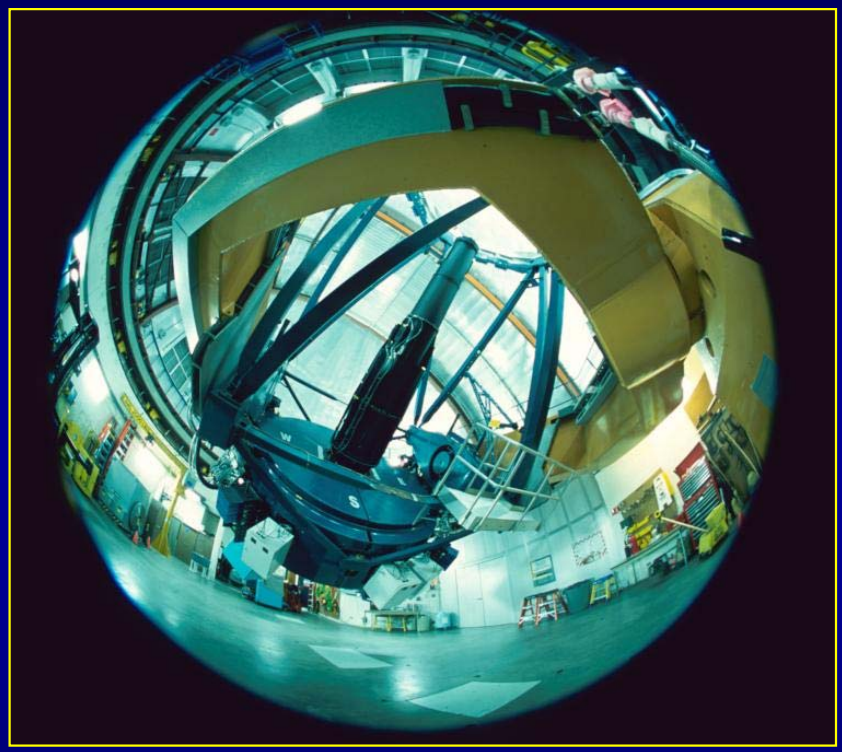
- first light 1979
- primary diameter 3.8m
- operates exclusively in the infrared
- funded 100% by the United Kingdom
- member of OPTICON
- ongoing collaborations with SNU/CEOU and KASI

Instrumentation

Previously on UKIRT:



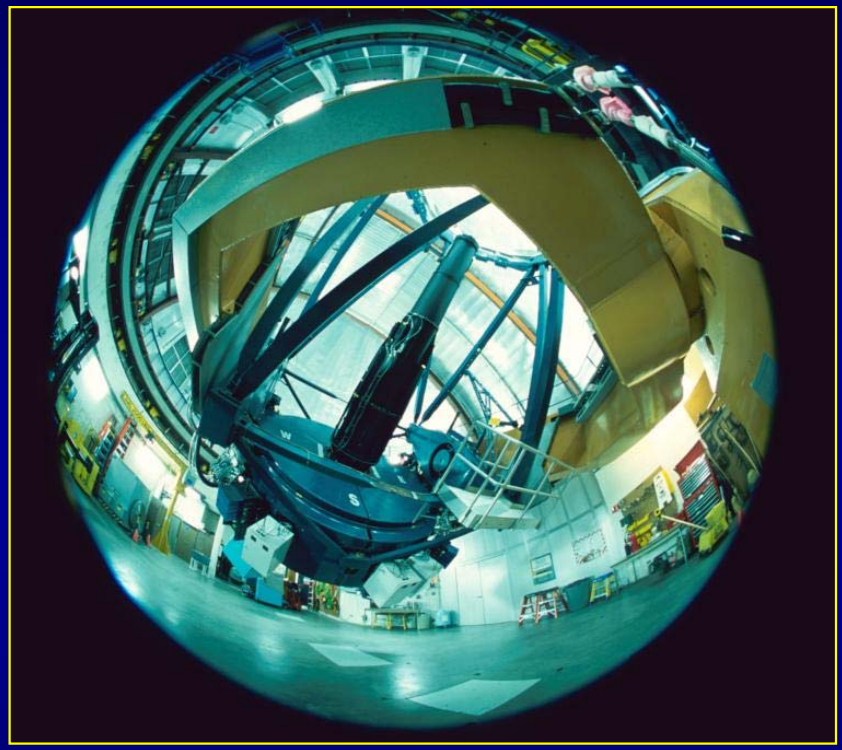
Cassegrain 25%



Wide-Field 75%

Instrumentation

From 1st February 2009:

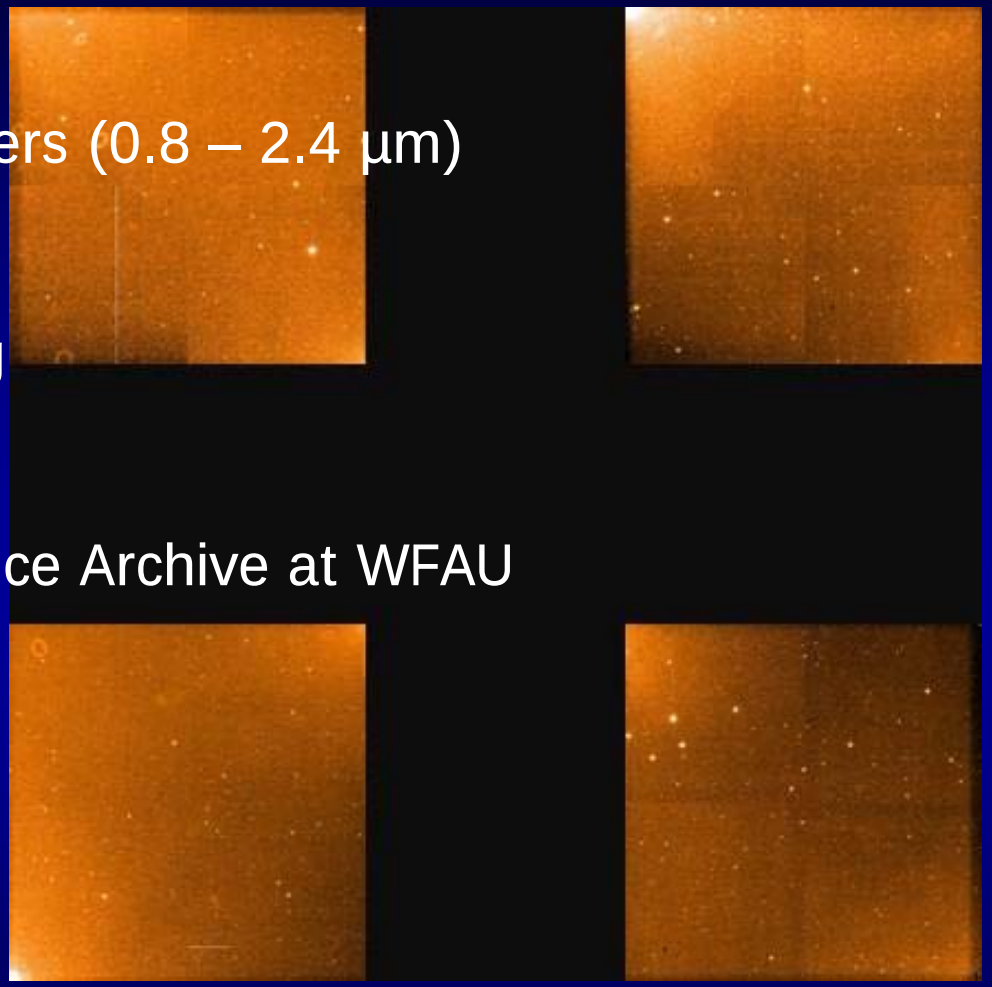


Wide-Field
100%

Instrumentation

Wide Field Camera (WFCAM)

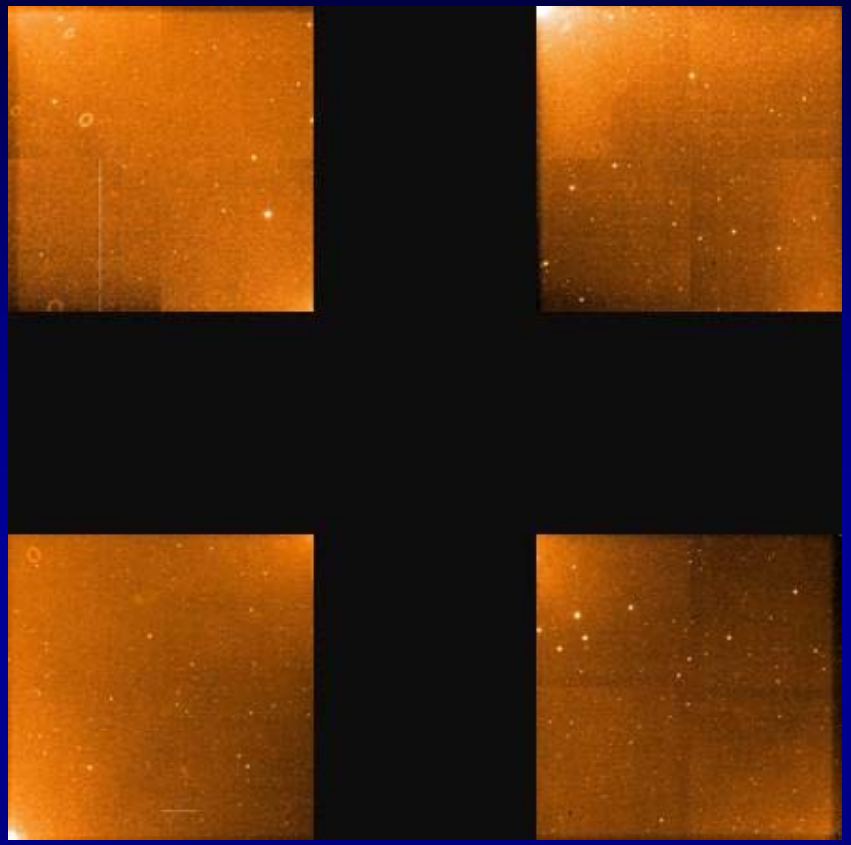
- panoramic camera, ZYJHK filters (0.8 – 2.4 μm)
- four Hawaii-II 2k x 2k arrays
- instantaneous field 0.2 sq deg
- pixel size 0.4”
- data reduction at CASU, Science Archive at WFAU



WFCAM Project

- led by UKATC
- final cost £4.9M

Wide-Field Imaging



UFTI

1k x 1k

2.25 sq arcmin

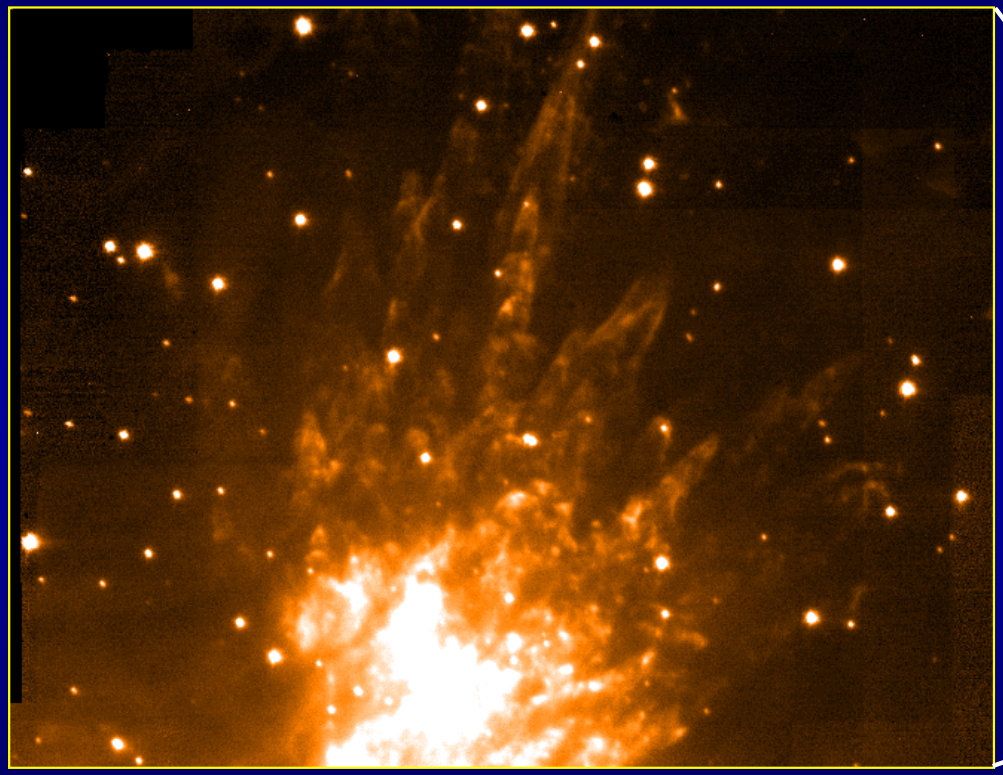
WFCAM

4 x 2k x 2k

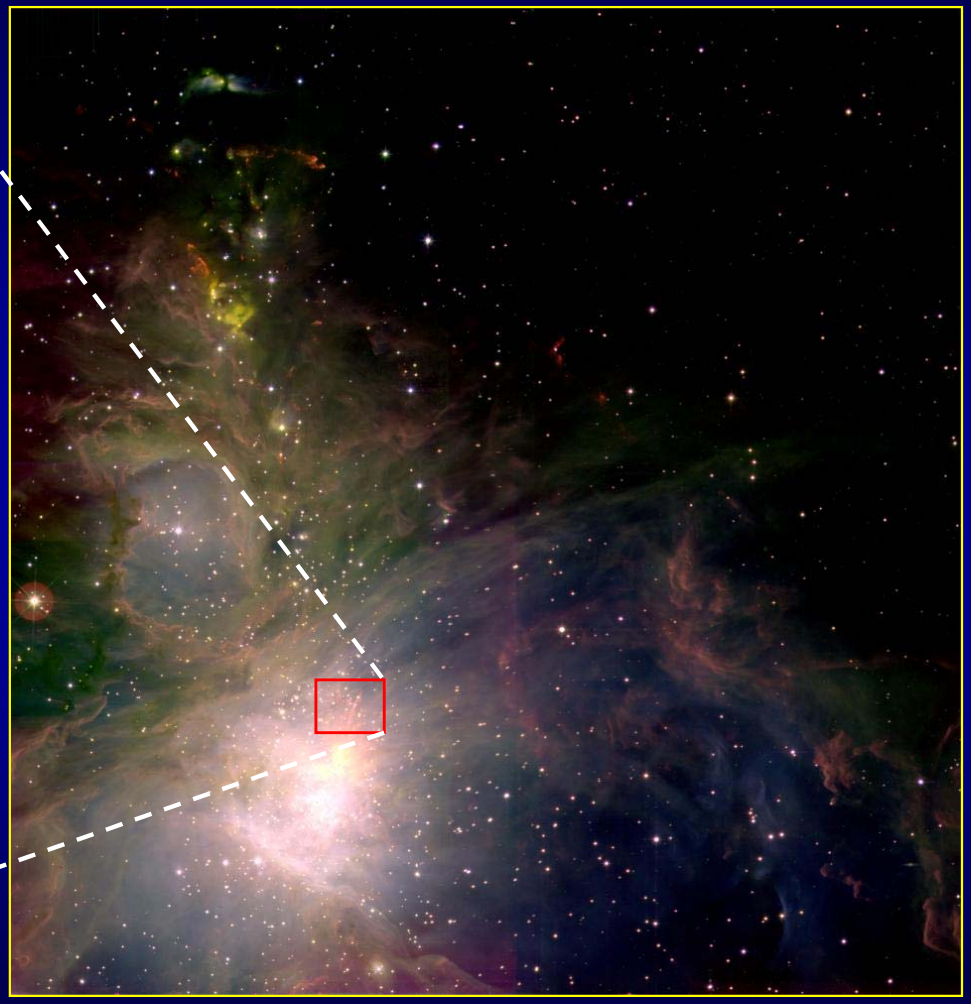
745 sq arcmin

Wide-Field Imaging

Orion:



UFTI H2 S(1)



WFCAM J, H, H2 S(1)
central portion of one tile

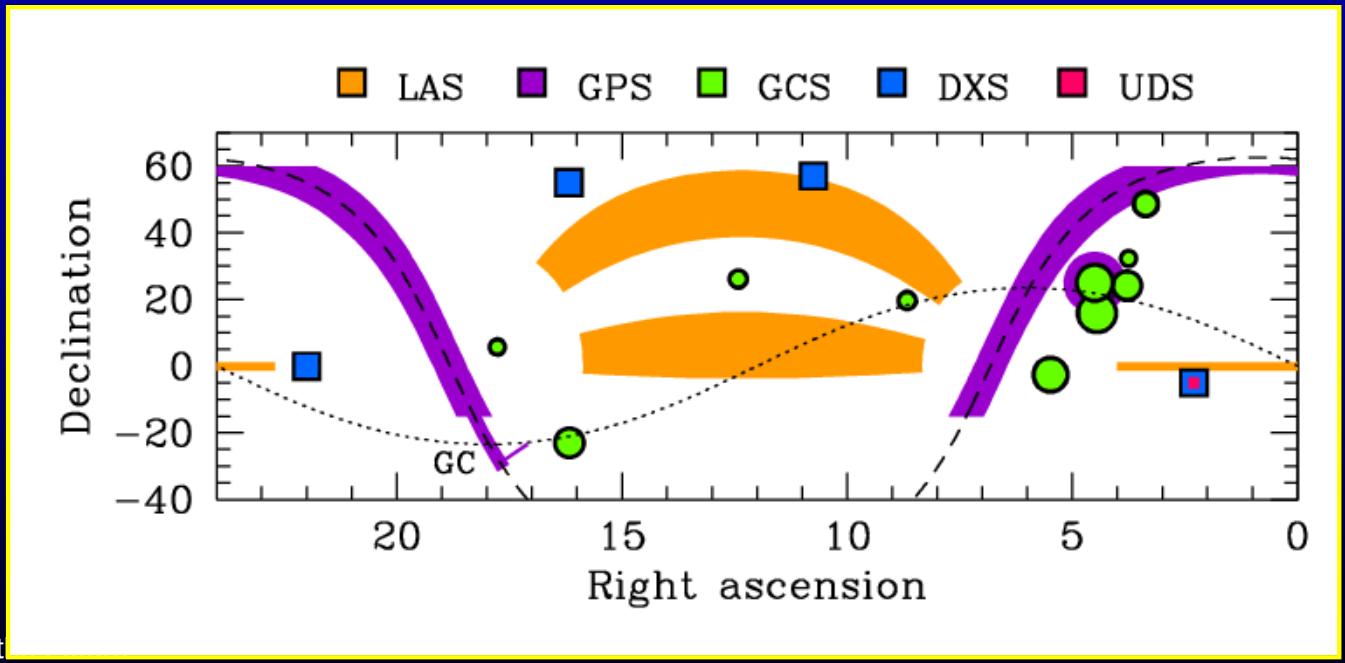
UKIDSS

UKIRT Infrared Deep Sky Survey:

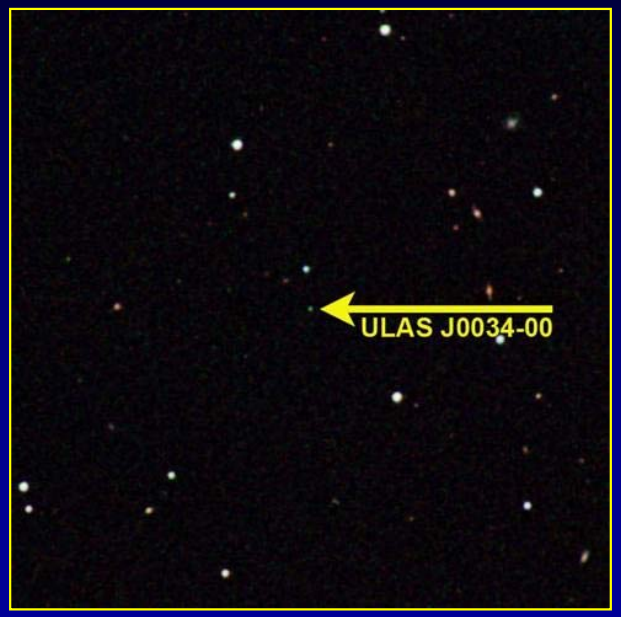
- 7,500 square degrees to minimum depth K=18.3
- >3 magnitudes deeper than 2MASS
- originally planned for 1,000 nights over 7 years
- commenced May 2005
- ESO public survey: data releases every 9mo
- world releases 18mo later

UKIDSS Survey Design

Survey Name	ID	Filters	K limit	Area (sq deg)	Type
Large Area Survey	LAS	YJHK	18.4	4000	both
Galactic Plane Survey	GPS	JHK	19.0	1800	Gal
Galactic Clusters Survey	GCS	ZYJHK	18.7	1600	Gal
Deep Extragalactic Survey	DXS	JK	21.0	35	ExGal
Ultra Deep Survey	UDS	JHK	23.0	0.77	ExGal

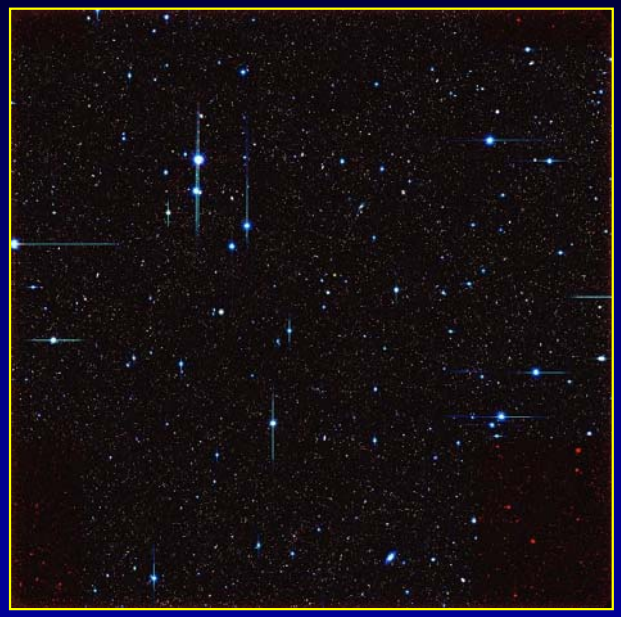


UKIDSS Highlights



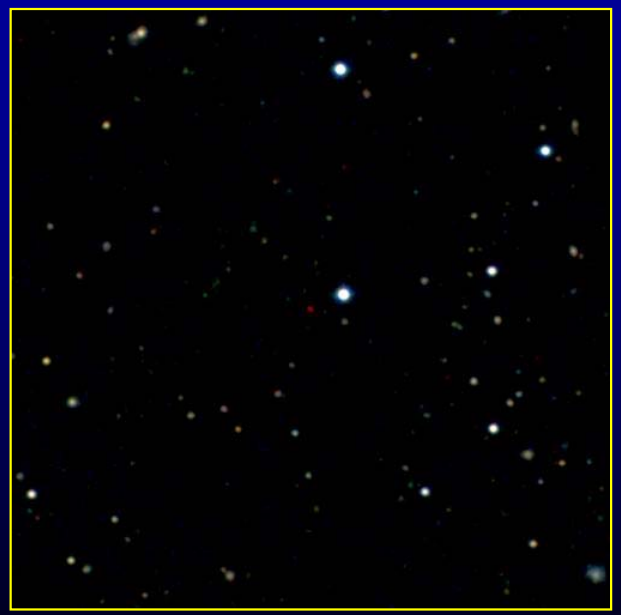
Brown Dwarf at 600 K, 12.6 pc

Warren et al. (2007)



Galaxies at z > 6

PI Almaini



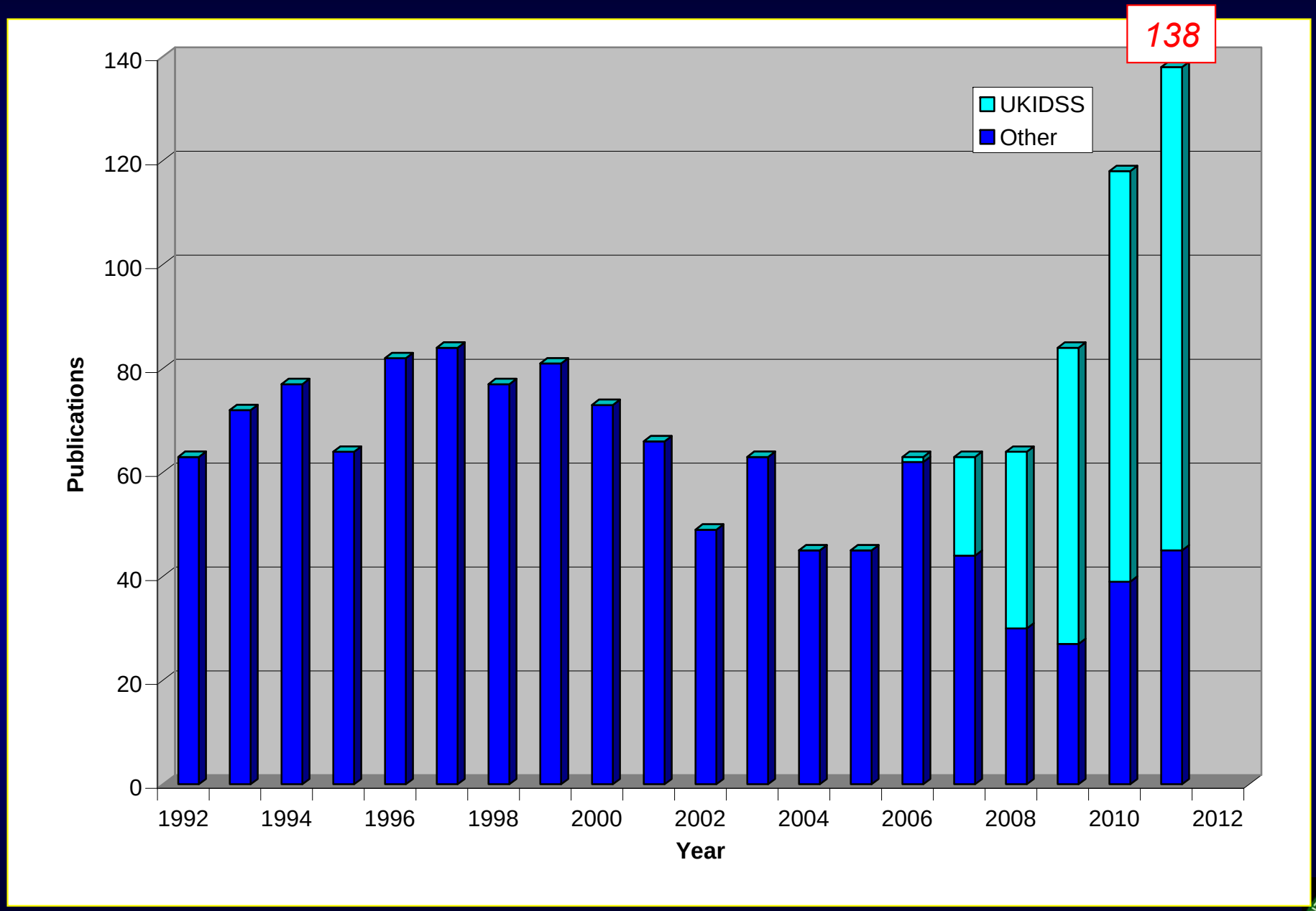
First quasar beyond z = 6.4

Mortlock et al. (2011)

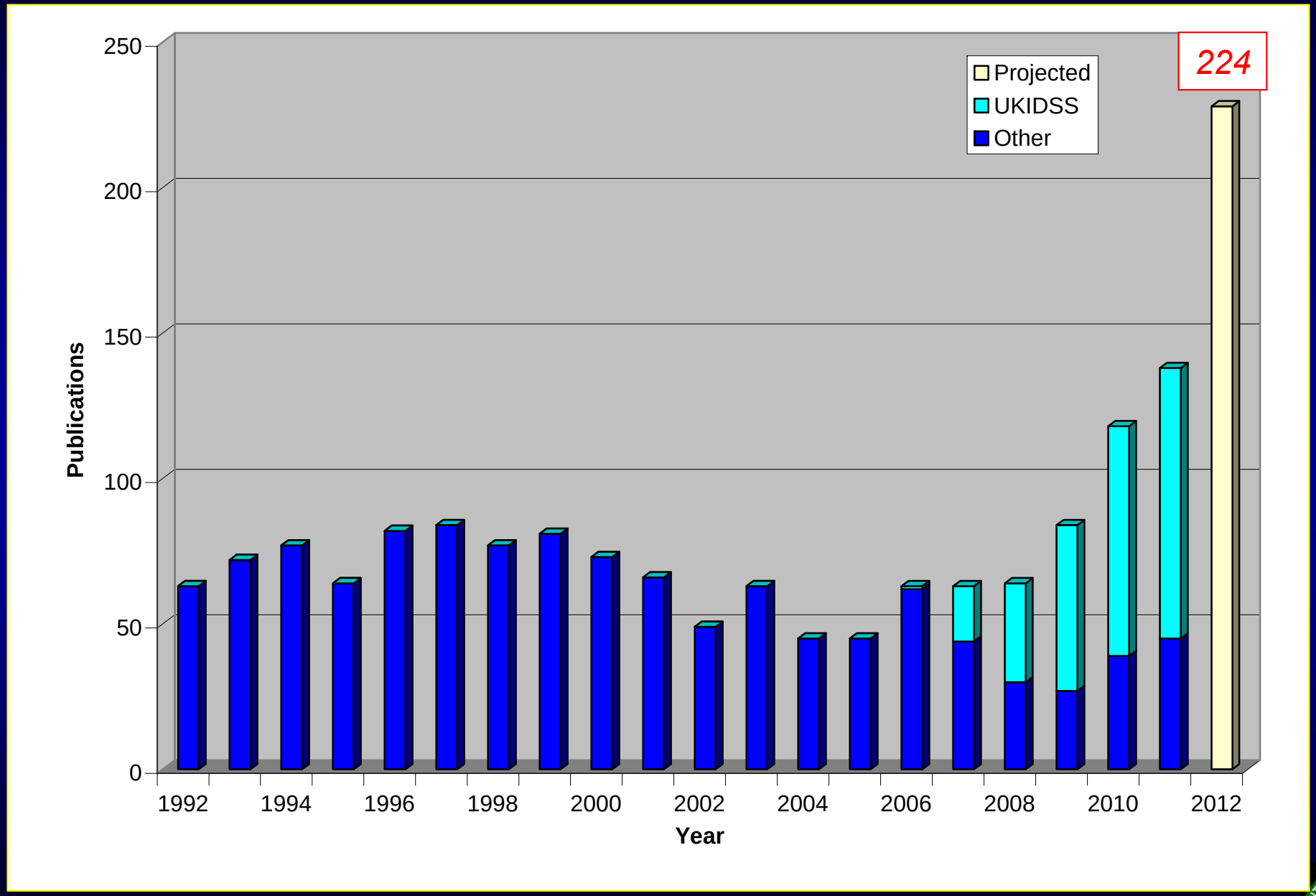
GRB at z = 8.2

Tanvir et al. (2009)

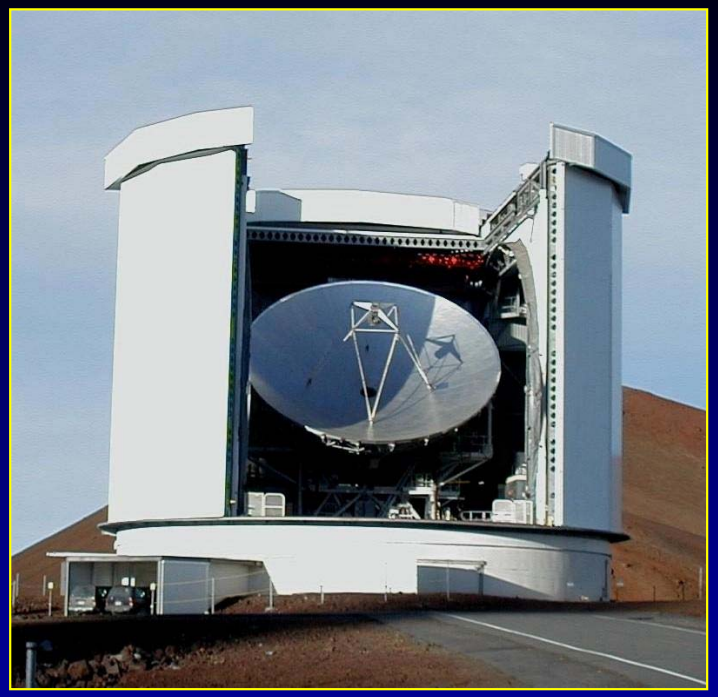
Productivity



Productivity



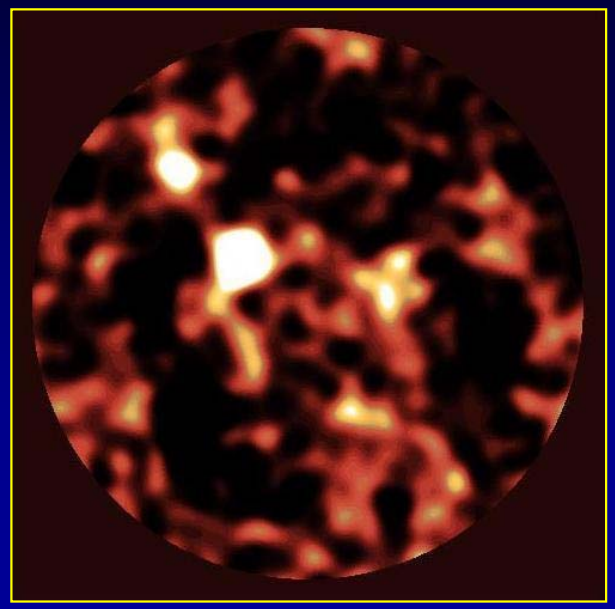
Introduction to the JCMT



Vital Statistics:

- first light 1987
- primary diameter 15m
- surface accuracy 22μm rms
- Gore-Tex membrane
- partnership:
  - *55% UK*
  - *25% Canada*
  - *20% Netherlands*
- member of RadioNet

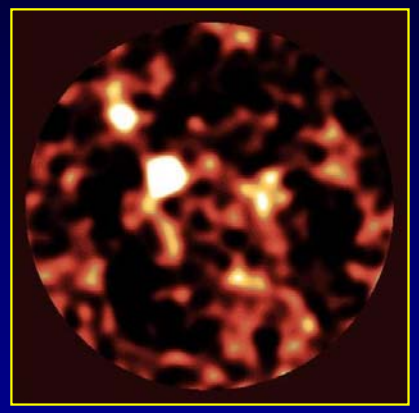
The Legacy of SCUBA

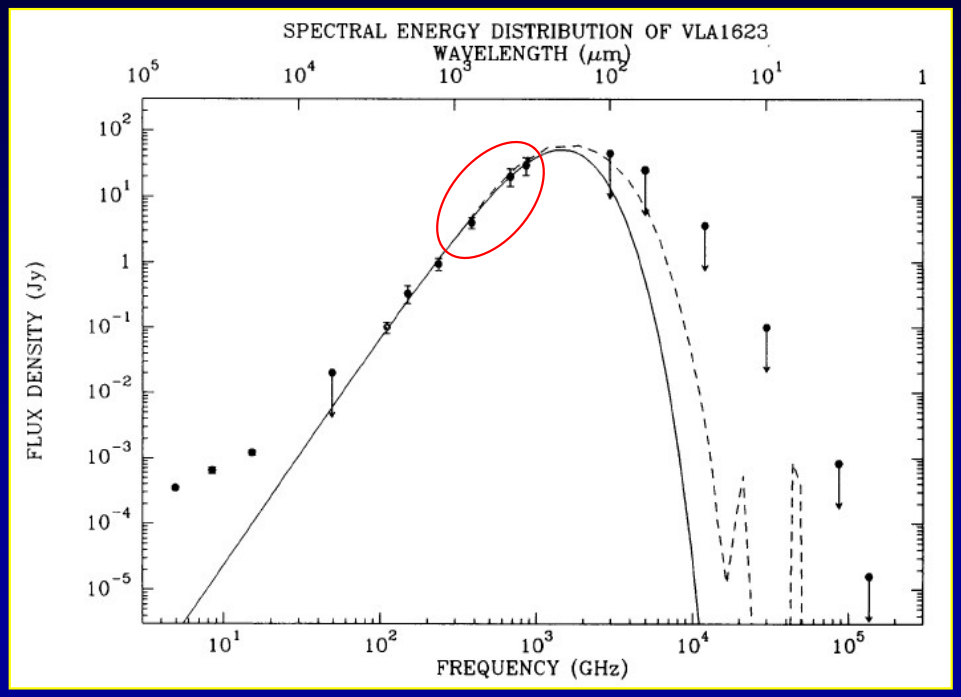


Hubble Deep Field at 850μm

Hughes et al. (1998)

The Legacy of SCUBA

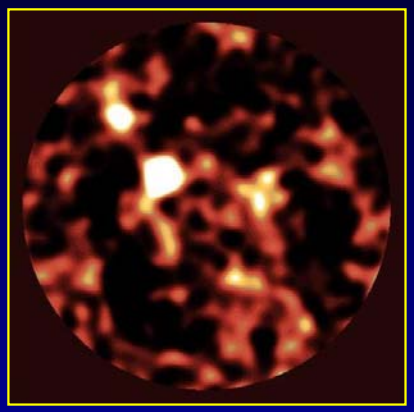


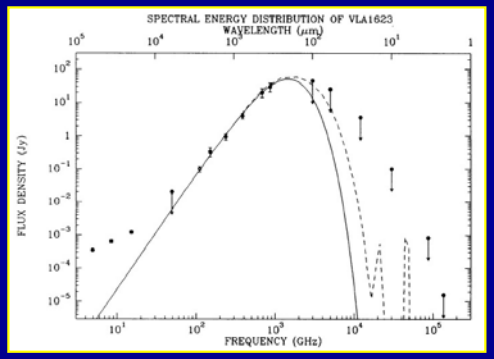


VLA1623 spectrum

André et al. (1993)

The Legacy of SCUBA

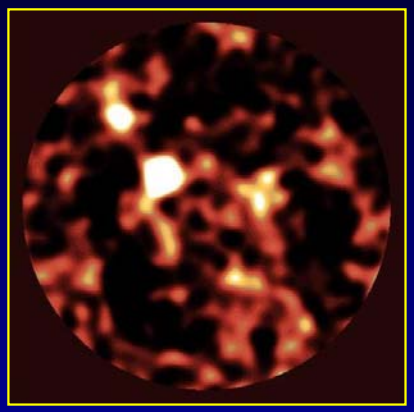


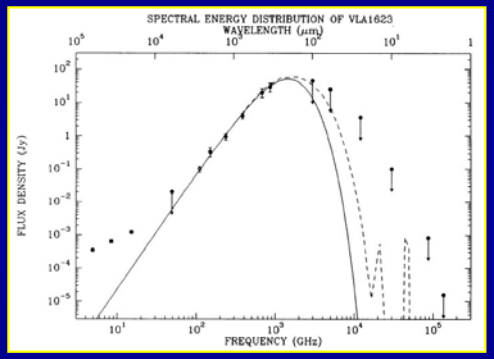


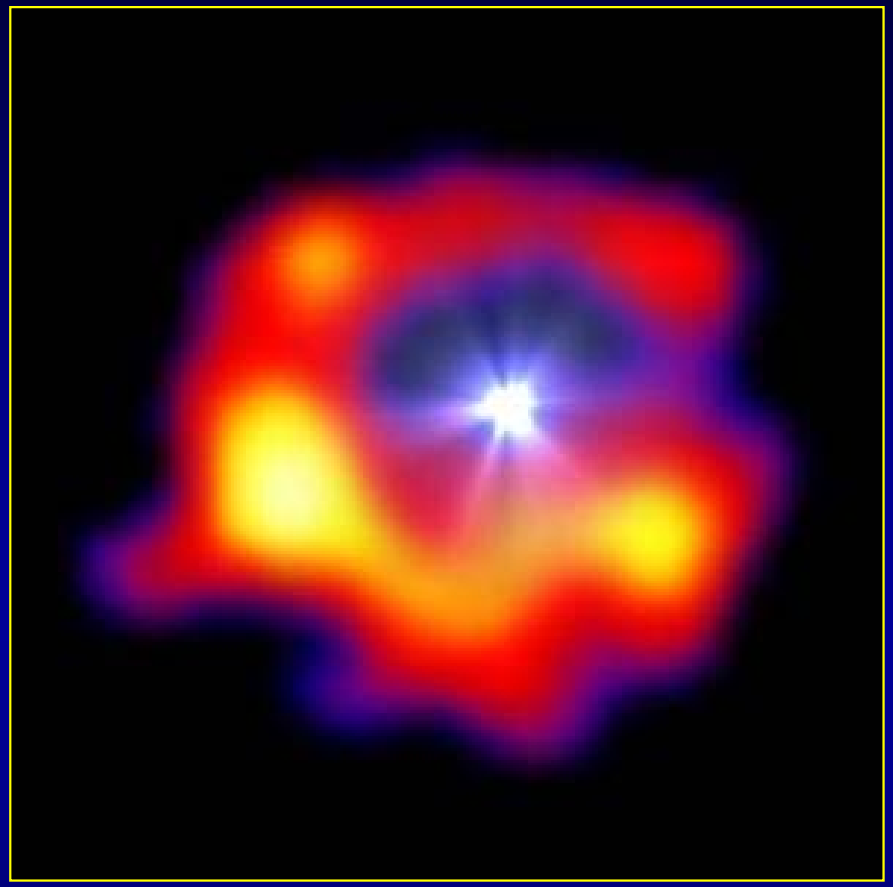
Orion filament

Johnstone & Bally (1999)

The Legacy of SCUBA



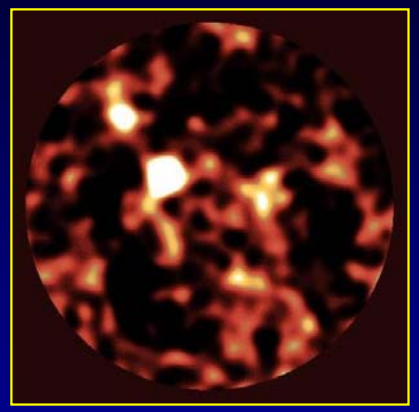


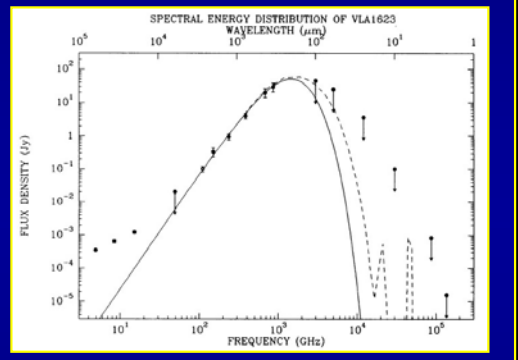


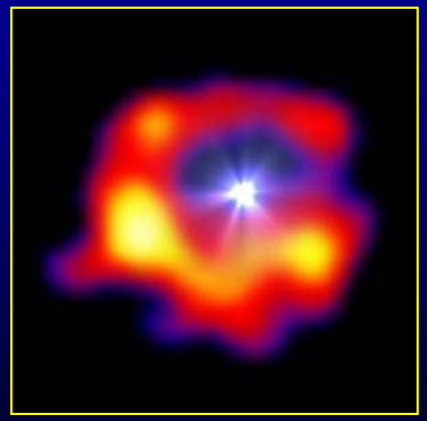
ε Eridani

Greaves et al. (1998)

The Legacy of SCUBA







SCUBA

1997–2005

Transformation of the JCMT

Science Driver:

- limited to date by small sample sizes
- shift to study of statistically-significant samples

Strategy:

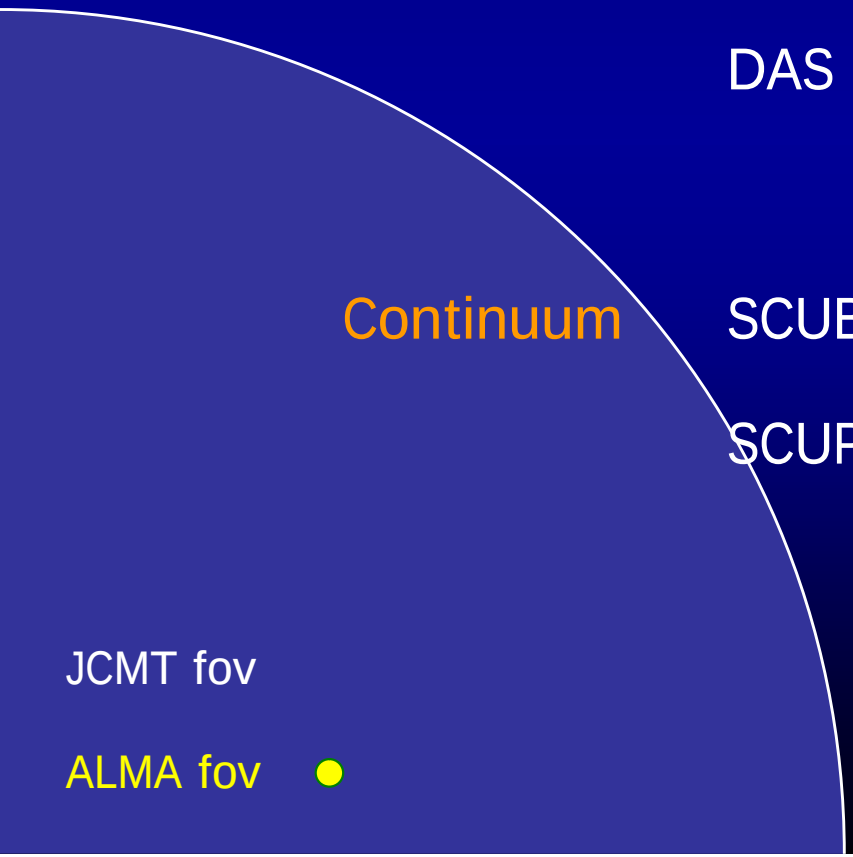
- capitalise on strengths of a large, single dish
- replace the entire instrument suite with new instruments optimised for wide-field astronomy
- total investment ~£25M

JCMT fov

ALMA fov

Transformation of the JCMT

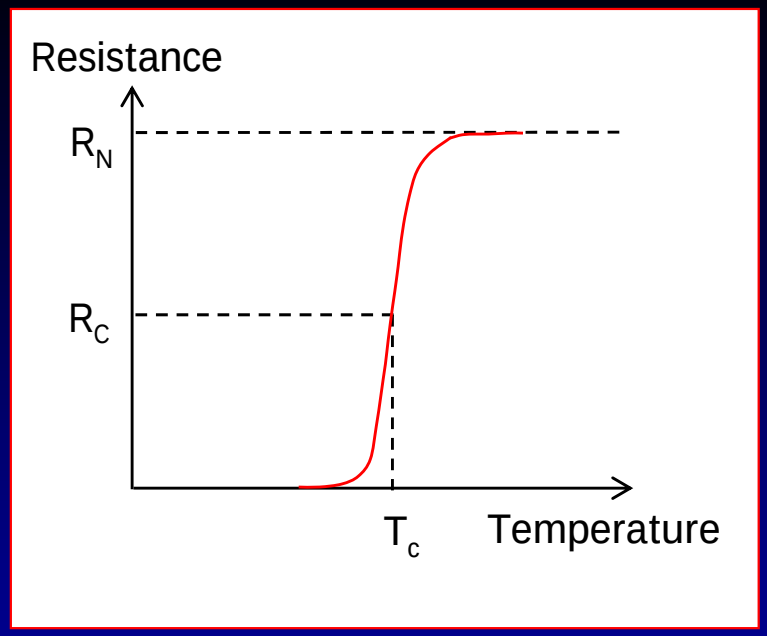
Spectroscopy	RxA	→	RxA	
	RxB	→	HARP	✓
	RxW/C	→	RxW/B	✓
	RxW/D	→	RxW/D	✓
	DAS	→	ACSIS	✓
Continuum	SCUBA	→	SCUBA-2	✓
	SCUPOL	→	POL-2	*2012*
			FTS-2	*2012*



SCUBA-2 Design

Key Features:

- simultaneous imaging at 450 & 850μm
- sensitivity governed by sky background
- large field of view: > 50 sq arcmin
- fully sampled images in < 4 s
- novel scanning strategies



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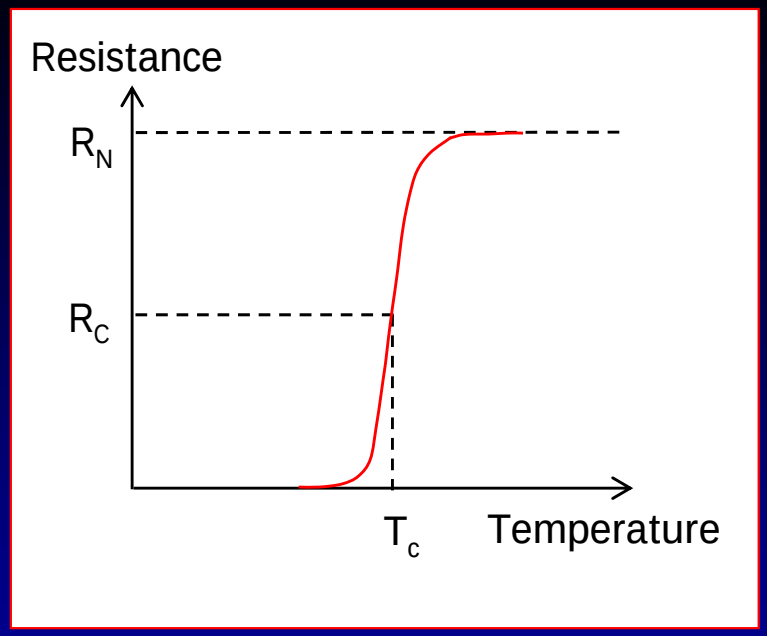

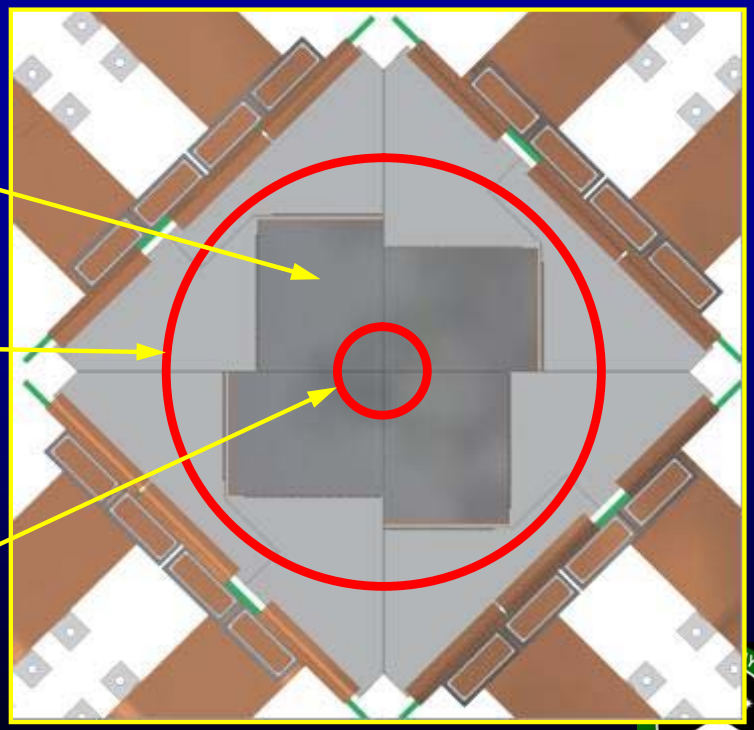

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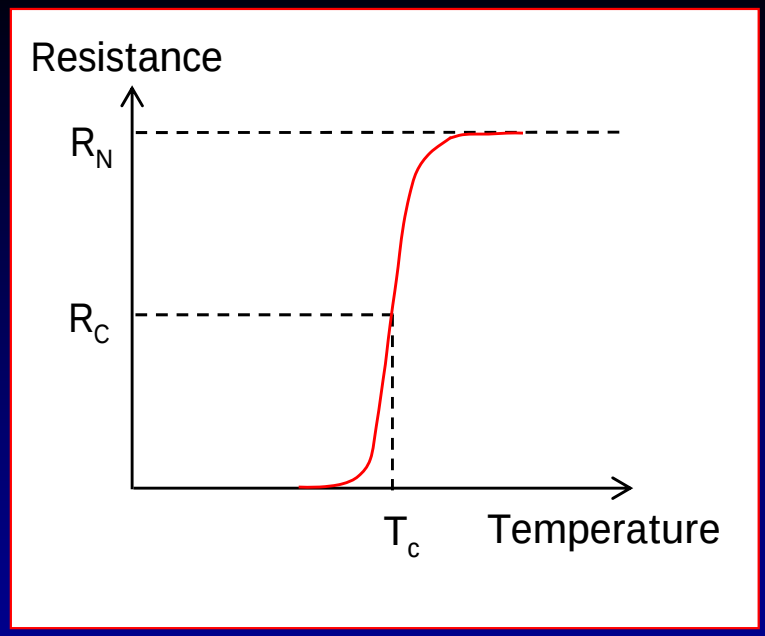
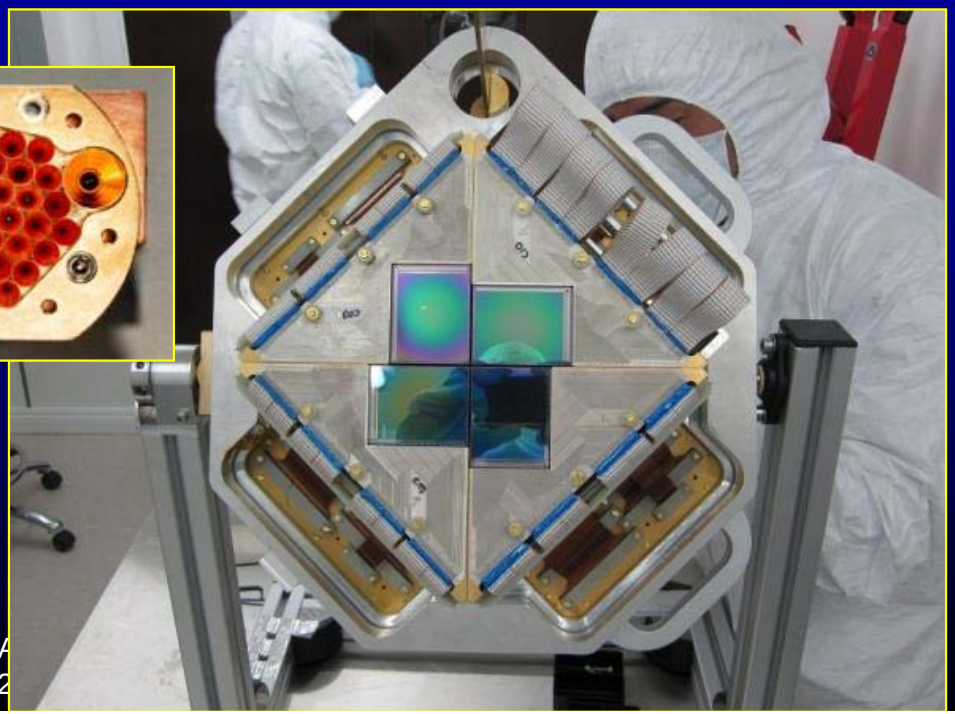
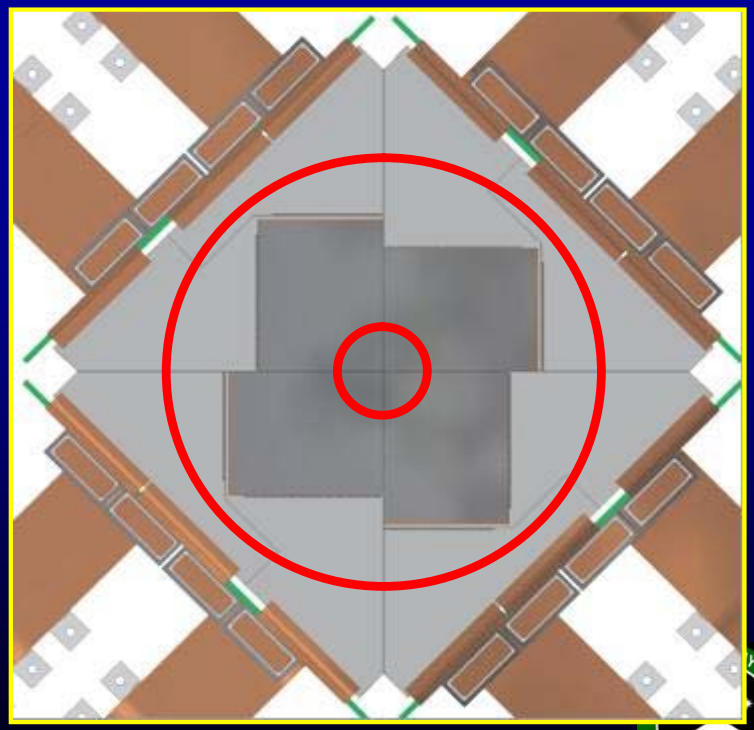






SCUBA-2 Design

Key Features:

- simultaneous imaging at 450 & 850μm
- sensitivity governed by sky background
- large field of view: > 50 sq arcmin
- fully sampled images in < 4 s
- novel scanning strategies

SCUBA-2 can map the submm sky
~200 times faster than SCUBA

JCMT Legacy Survey

Survey	SCUBA-2	HARP
Spectral line survey		38
Debris disk survey	23	
Gould's belt survey	34	21
Galactic plane survey	38	
Nearby galaxy survey	8	21
Cosmology survey	148	
SCUBA-2 all-sky survey	40	

65% of UK/Ca/NL time

Approved to 30th September 2014

PI time subscription > 8

SCUBA-2 Project

1998	First concept of monolithic sub-mm arrays
1999	Endorsed by International Review of the JCMT
2002	Successful proof-of-concept review
2003	Approval to proceed for £10.1M
2004	Delivery of first prototype array
2005	Re-approval to proceed to completion for £14.4M
2005	Demonstration of single-pixel sensitivity
2006	Construction of telescope infrastructure
2007	Delivery of engineering arrays
2008	Delivery of SCUBA-2 to the JCMT
2009	Delivery of first two science arrays
2010	Early science observing
2010	Delivery of remaining arrays
2011	Final acceptance and release to community

SCUBA-2 Project

Key Points & Lessons:

- recognised from beginning as high-risk, high-reward project
- endorsed by community as top priority development
- matching science programme to fully exploit new capability
- built by a consortium of world-leading laboratories
  - *led by UKATC*
  - *detector arrays developed by NIST*
  - *universities of British Columbia, Cardiff, Edinburgh, Waterloo*
- under-resourced from the beginning
- unforeseen technical/programmatic challenges, and a lot of bad luck
- but it meets spec and is delivering community science!

The JCMT2020 Study

Science cases & instrumentation:

- ultra-wide-field imaging: KID camera
- imaging spectroscopy: 100-element heterodyne camera
- multi-object spectrograph: imaging spectrometer-on-a-chip
- all require larger field of view

Resource

- £30M over next decade

The JCMT Partnership

Netherlands (20%)

- will withdraw on 31st March 2013

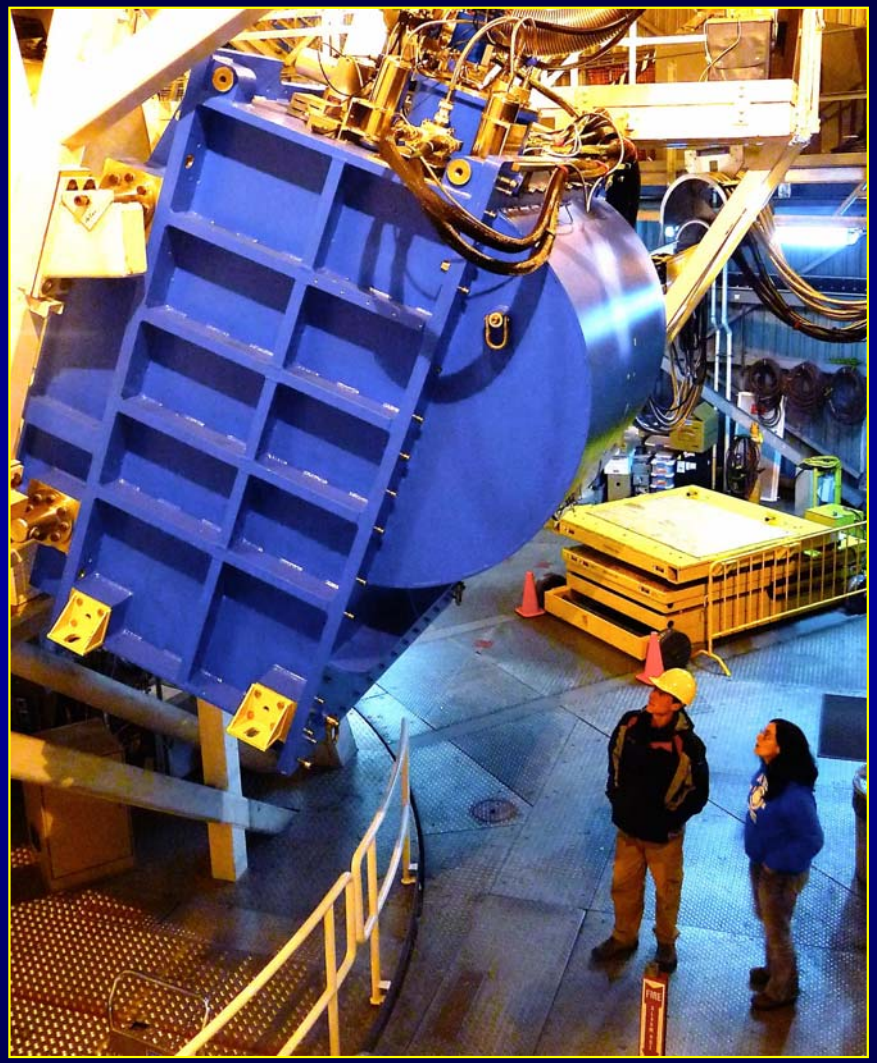
Canada (25%)

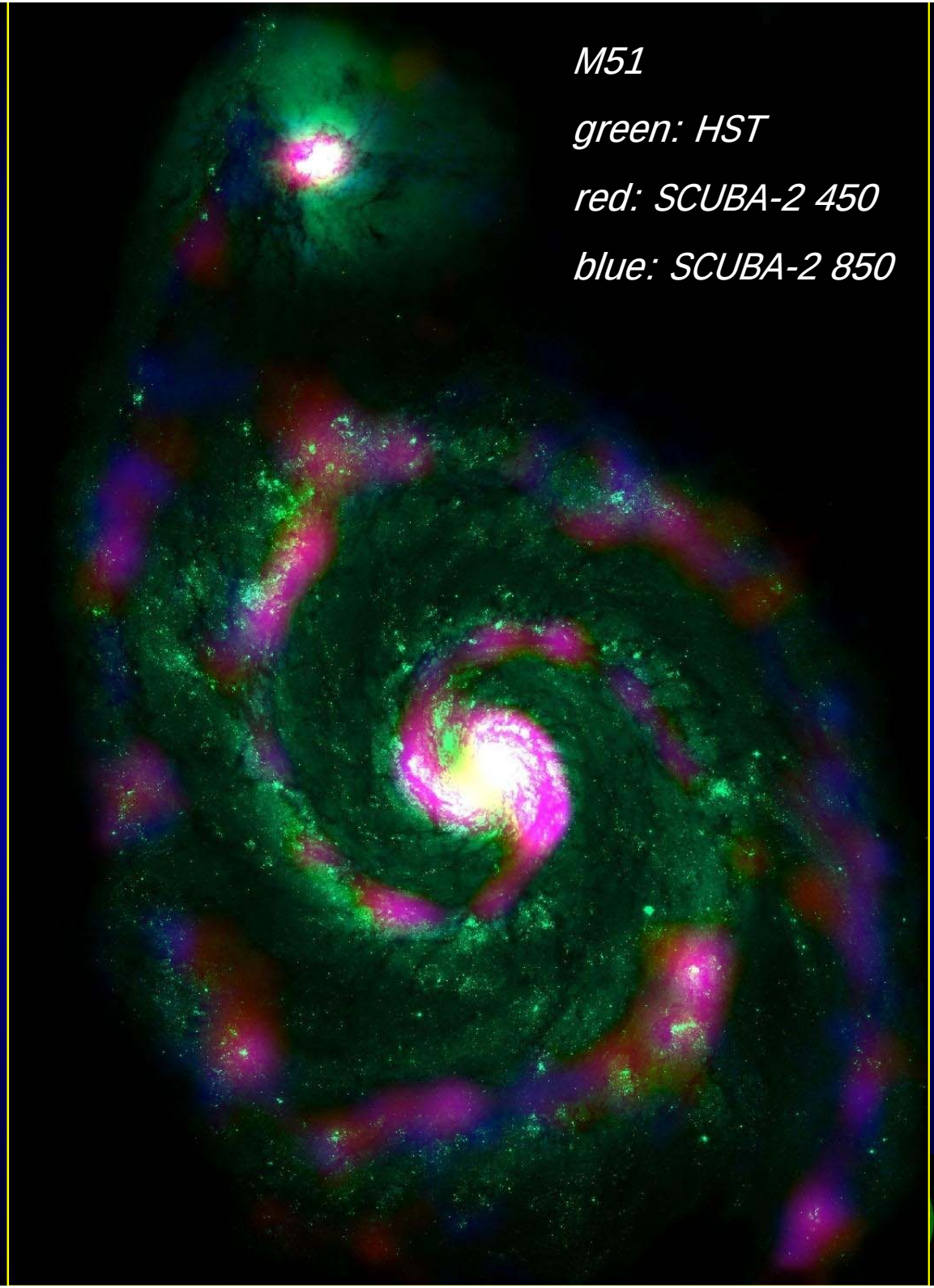
- NRC contributions already reduced
- will withdraw on 30th September 2014

UK (55%)

- operational support will cease on 30th September 2014

Three years to fully exploit SCUBA-2!





M51

green: HST

red: SCUBA-2 450

blue: SCUBA-2 850