The Herschel Multi-tiered Extragalactic Survey

HerMES

http://astronomy.sussex.ac.uk/~sjo/Hermes/

Seb Oliver

UK
ATC
Cardiff
Herts.
Imperial
MSSL
Sussex

SPAIN
IAC

ESA
ESTEC

USA
Caltech
Colorado
Cornell
GSFC
IPAC
JPL
UC Irvine

France
CEA
IAP
IAS
LAM
Lyon

Italy
OAPd
Uni. Padova

Canada
UBC

FMOS Meeting Oxford 22nd June 2009

SWIRE View of Distant Galaxies Spitzer Space Telescope • IRAC
Visible (blue): Isaac Newton Telescope
NASA / JPL-Caltech / C. Lonsdale (Caltech/IPAC) and the SWIRE Team
sig05-019

HerMES & other Herschel Surveys

University of Sussex

Scientific motivation

Unique role for Herschel

Survey design

Status

FMOS synergies

Science Questions

University of Sussex

When did most stars form?

- SFR density distribution c.f. stellar mass density

What are the typical star-formation rates?

- Fractions of LIRGS/ULRGS etc.

What are the feedback processes?

- Relation between SFR and M_*, star-bursts & AGN?

Relation between star-formation and environment?

- Merging and halo occupancy

What are the progenitors of high-z red/dead galaxies?

Cosmic History of Star formation
Down-sizing?

University of Sussex

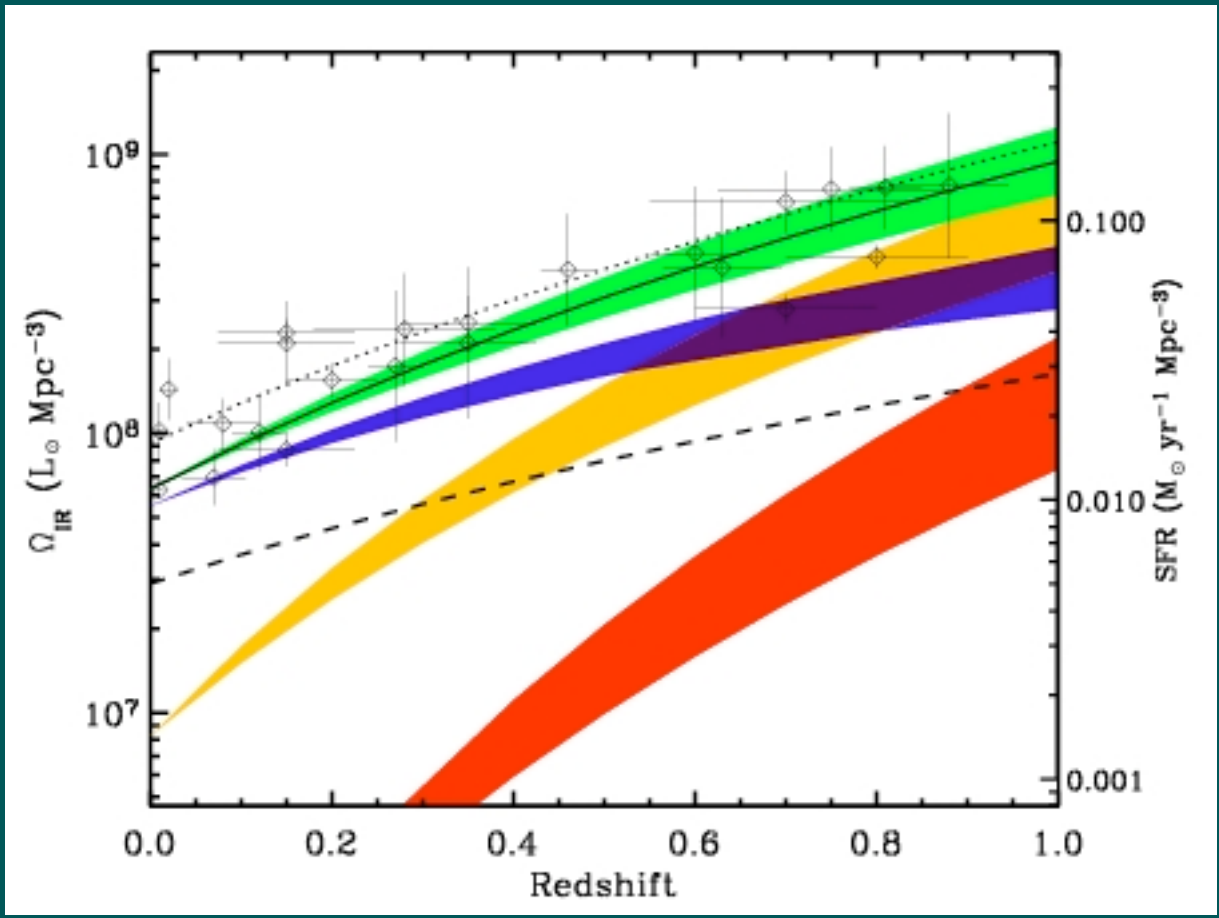
All

Low luminosity

LIRGS

ULIRGS

GTO surveys

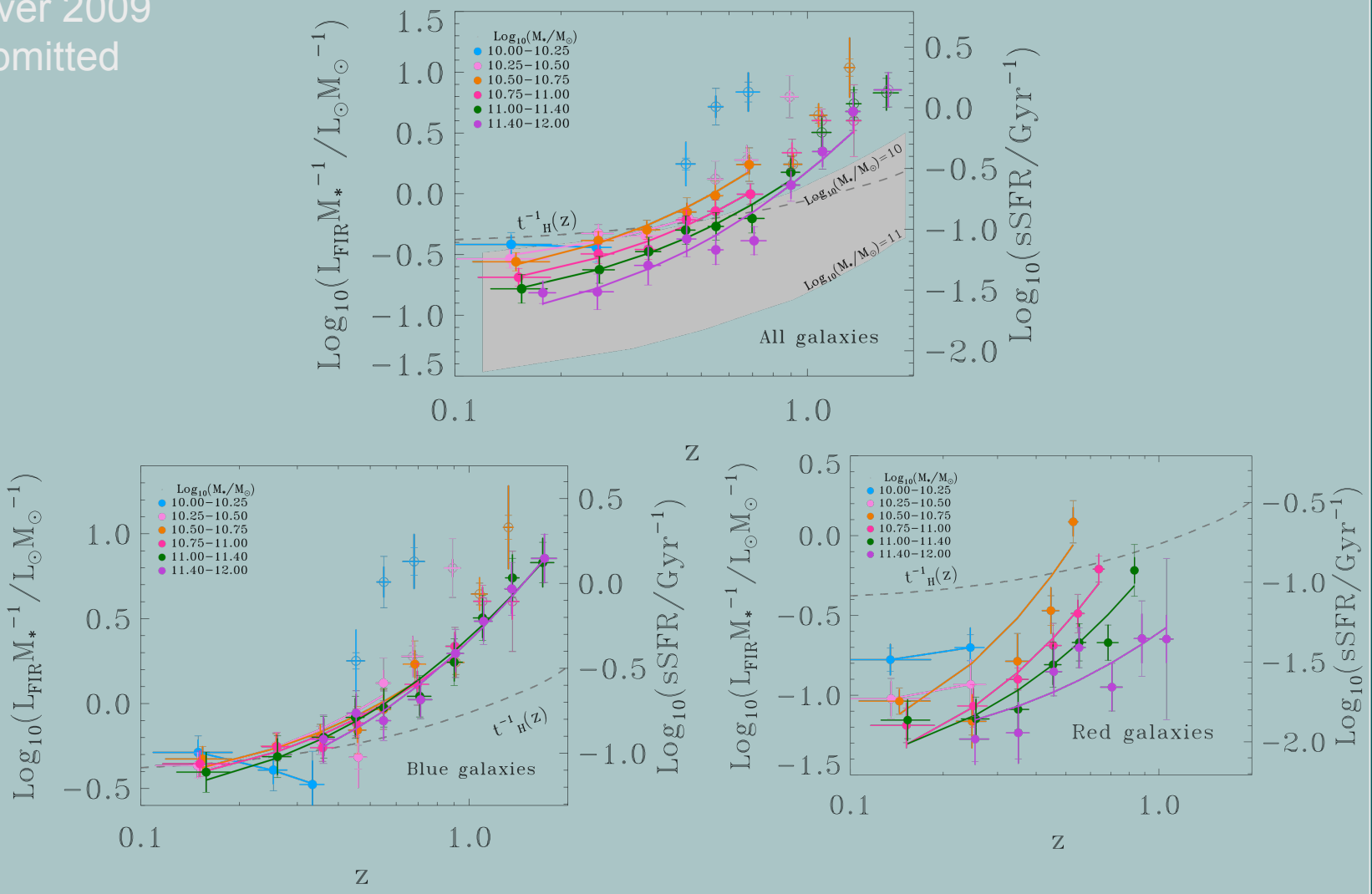


Le Floch et al. 2005

Specific SFRs in FIR

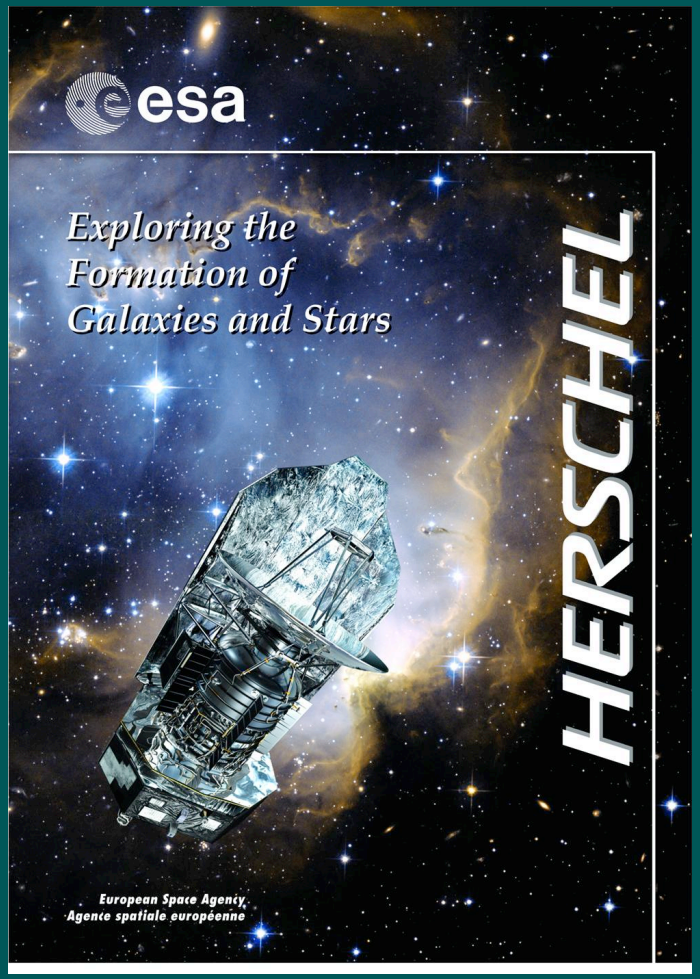
University of Sussex

Oliver 2009
submitted



Unique role of Herschel

University of Sussex

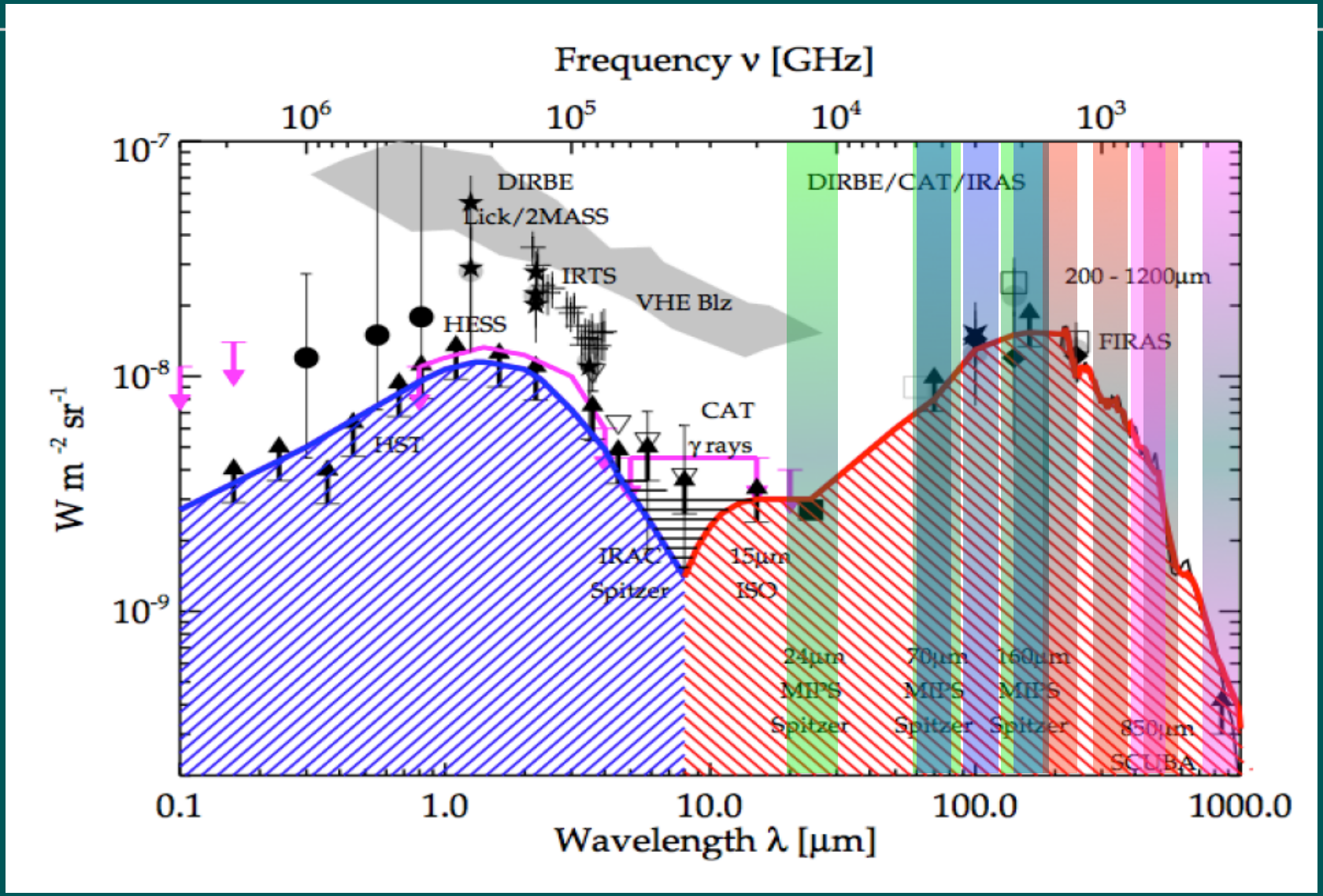


Probes the bolometric power from obscured star-formation
70-500 micron

Fast mapping allows large samples over significant volumes

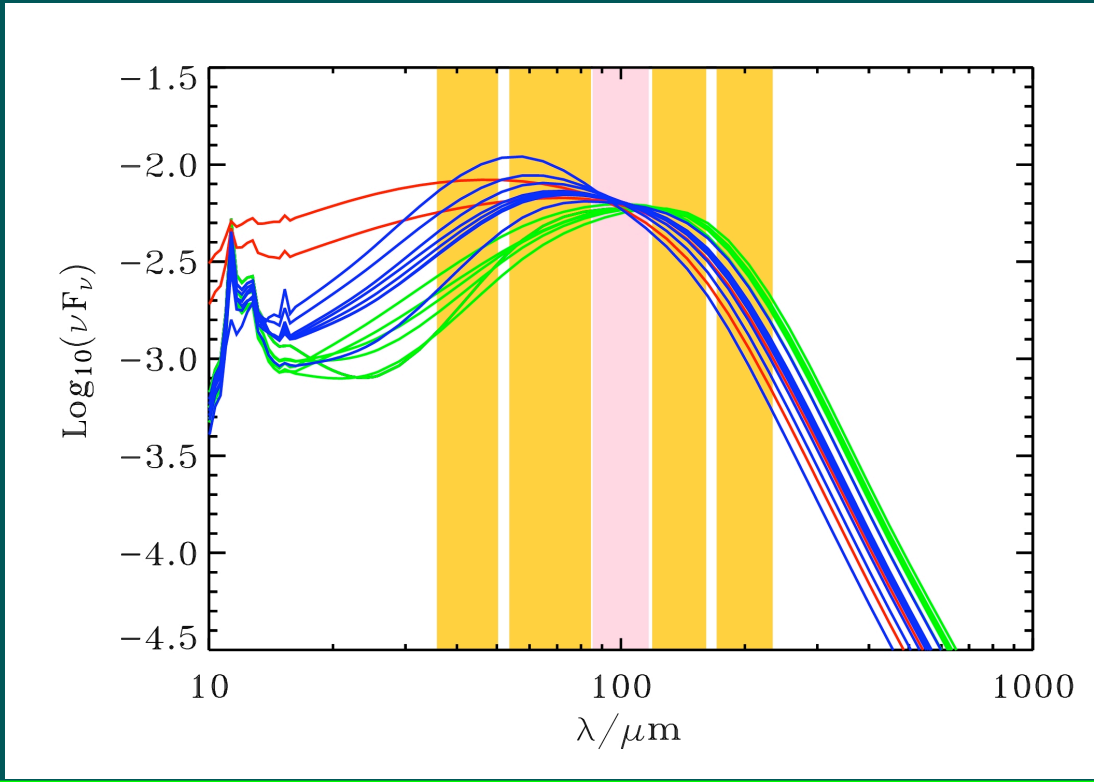
The Cosmic Far-Infrared Background Radiation

University of Sussex



Constraining Bolometric Luminosity

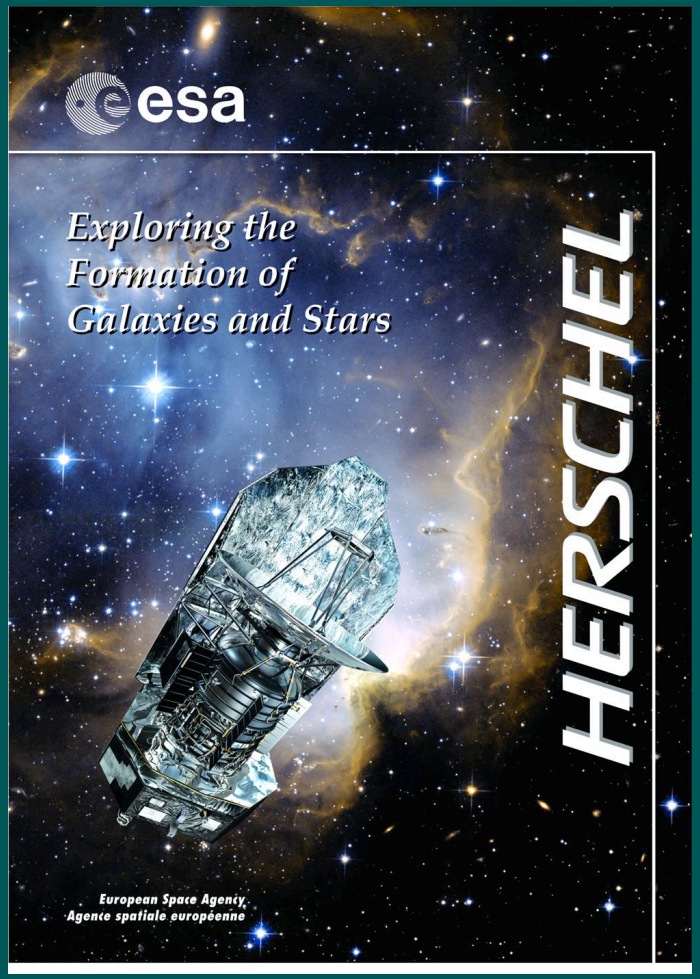
University of Sussex



Herschel bands will be crucial in constraining the bolometric luminosity of galaxies. This will help untangle the contribution of AGN and star-formation cool/ warm dust and thus constrain the star-formation history. Various model spectra shown here are at z=1.5 and normalized to their bolometric luminosity

Herschel Key Programmes

University of Sussex



Herschel Multi-tiered Extragalactic Survey (HerMES, 900hrs)

PACS Evolutionary Probe (PEP, 650hrs)

The Herschel Thousand Degree Survey (600hrs)

The Great Observatories Origins Deep Survey: far-infrared imaging with Herschel (363hrs)

The Herschel Lensing Survey (292h)

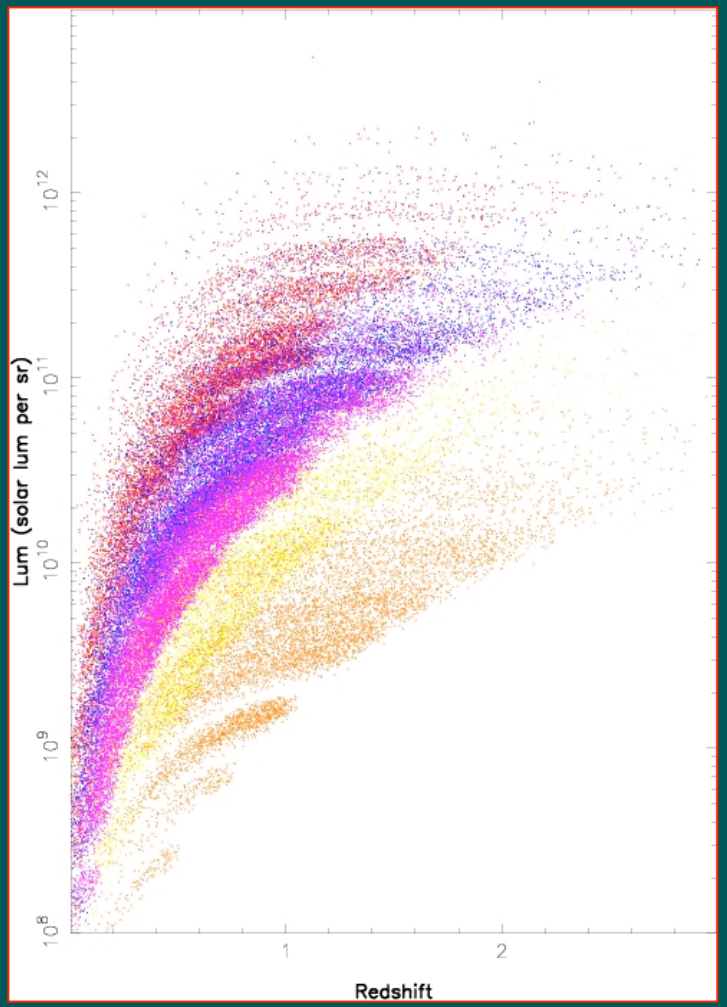
Herschel Survey Fields

Confusion Limits in mJy					
30 beams/src	**2.9**	**11.9**	**20.6**	**23.0**	**19.5**
+/-	*1.0*	*0.9*	*2.2*	*5.3*	*8.4*
4 sigma P(D)	**1.3**	**8.5**	**20.6**	**25.9**	**24.1**
+/-	*0.7*	*2.5*	*5.0*	*5.8*	*6.1*

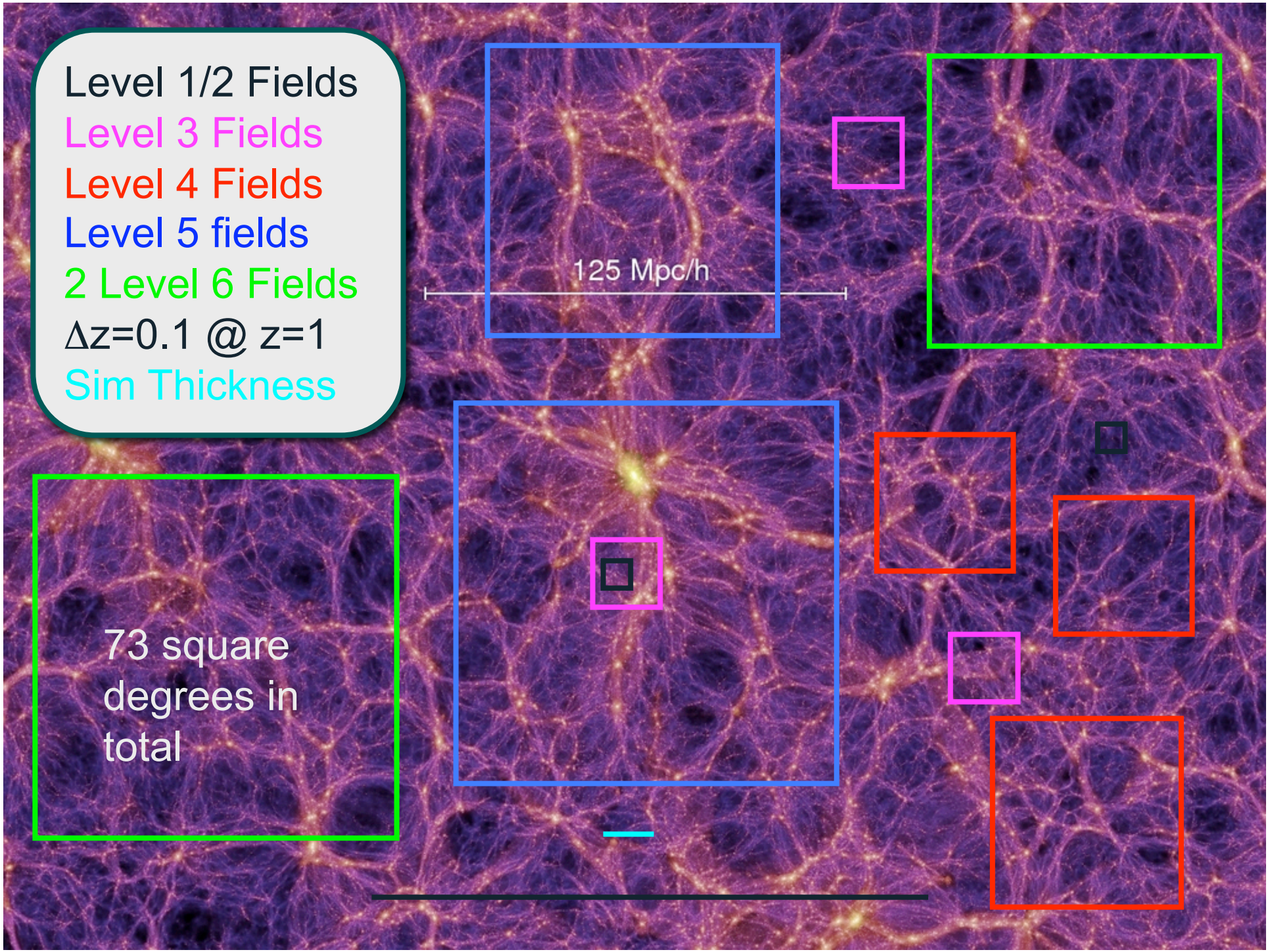
				Area [sq. deg.]			Number of SCANs in each mode								5-sigma sensitivity (ignoring confusion) [mJy]				
Level	**Fields**	**RA**	**Dec**	**Nom.**	**Donut**	**Cum.**	**PACS-MED**	**PACS-SLOW 25"**	**PACS-SLOW 50"**	**PARALLEL**	**SPIRE-FAST**	**SPIRE-NOM**	**Time/hr PACS**	**Time/hr SPIRE**	**70**	**110**	**160**	**250 ⇓**	**350**	**500**
PACS ultra deep	GOODS-S	03h32m30.4s	-27d48m17s	0.012	0.0117	0.012							206.7			0.6	0.9			
	GOODS-S	03h32m30.4s	-27d48m17s	0.0175	0.0058	0.0175							above			0.8	1.2			
	GOODS-S	03h32m30.4s	-27d48m17s	0.0231	0.0056	0.0231							above			1.0	1.5			
Clusters Deep	Various			0.01	0.01	0.01		72				400	75.4	55.0		2.0	3.0	3.4	4.6	4.0
Cluster Shallow	Various			0.04	0.04	0.05		30				200	above	77.2		3.1	4.7	4.8	6.5	5.7
Super Deep	GOODS-N	12h36m54.9s	+62d14m19s	0.0417	0.0417	0.0917							124.7	31.1		1.5	2.3	4.2	5.7	4.9
Level-1	GOODS-S	03h32m30.4s	-27d48m17s	0.11	0.0869	0.18		112		4	20	240	229.2	22.9		1.6	2.4	4.2	5.7	4.9
Clusters Highz	Various			0.03	0.03	0.21		24				120	above	14.7		3.5	5.2	6.2	8.4	7.3
Level-2	GOODS-N	12h36m54.9s	+62d14m19s	0.11	0.0683	0.28		30				60	30.7	3.8		3.1	4.7	8.8	11.9	10.3
	ECDFS	03h32m25s	-27d48m50s	0.25	0.14	0.42			16	4	20	38	34.7	8.5		5.9	8.3	8.7	11.8	10.2
Level 3	Lockman-ROSAT	10h52m43s	+57d28m48s	0.25	0.25	0.67			24	4	20	14	35.1	3.2		4.8	6.8	11.1	15.2	13.0
	UDS	02h17m48s	-05d05m45s	0.25	0.25	0.92			21	7		14	27.0			5.1	7.2	11.1	15.2	12.9
	Groth	14h19m17.4s	+52d49m34s	0.25	0.25	1.17			20	7		14	34.7	3.7		5.2	7.4	11.1	15.2	12.9
	Lockman-North	10h46m00s	+59d01m00s	0.25	0.25	1.42			18	4	20	14	34.6	3.2		5.5	7.8	11.1	15.2	13.0
	HDFN	12h36m49.4s	+62d12m58s	0.25	0.14	1.56						38		6.7				11.0	15.0	13.0
Level-4	COSMOS	10h00m28.6s	+02d12m21s	2	2.0	3.6	52					40	213	44.2		6.2	8.7	10.7	14.6	12.7
	UDS	02h17m48s	-05d05m45s	0.7	0.5	4.0			7	7		14	35.294	8.5		8.3	11.8	11.1	15.2	12.9
	VVDS	02h26m00s	-04d30m00s	0.7	0.7	4.7			7	7		14	49.988	8.5		8.3	11.8	11.1	15.2	12.9
Level-5	XMM	02h21m36s	-04d39m00s	5	3.6	8.3				7				44.2		20.6	29.3	14.0	19.3	16.3
	ELAIS-N1-SCUBA2	16h10m00s	+54d30m00s	2	2.0	10.3				7				26.1		20.6	29.3	14.0	19.3	16.3
	Bootes-SCUBA2	14h32m06s	+34d16m48s	2	2.0	12.3				7				21.4		20.6	29.3	14.0	19.3	16.3
	EGS-SCUBA2	14h19m12s	+52d48m00s	1.3	1.1	13.4				7				24.3		20.6	29.3	14.0	19.3	16.3
	CDFS	03h32m00s	-28d16m00s	8	7.8	21.1				4	20			94.6		27.3	38.8	14.0	19.3	16.3
	Lockman	10h45m00s	+58d00m00s	11	10.5	31.6				4	20			123.0		27.3	38.8	14.0	19.3	16.3
Level-6	XMM	02h21m20s	-04d30m00s	9.3	4.3	35.9				2				14.8		38.5	54.8	26.2	36.1	30.4
	ELAIS S1 SWIRE	00h38m30s	-44d00m00s	7	7.0	42.9				2				23.1		38.5	54.8	26.2	36.1	30.4
	ELAIS N1 SWIRE	16h11m00s	+55d00m00s	9.3	7.3	50.2				2				29.5		38.5	54.8	26.2	36.1	30.4
	ELAIS N2 SWIRE	16h36m48s	+41d01m45s	4.8	4.8	55.0				2				17.0		38.5	54.8	26.2	36.1	30.4
	NDWFS/Bootes	14h32m06s	+34d16m48s	8	6.0	61.0				2				26.0		38.5	54.8	26.2	36.1	30.4
	FLS	17h18m00s	+59d30m00s	4.7	4.7	65.7				2				17.1		38.5	54.8	26.2	36.1	30.4
	0444 Akari	04h41m24s	-53d22m12s	7	7.0	**72.7**				2				23.5		38.5	54.8	26.2	36.1	30.4
H-ATLAS	Various			550.0	550.0	622.7								600		67.0	94.0	45.0	62.0	53.0

Redshift-Luminosity Space Probed by Herschel

University of Sussex

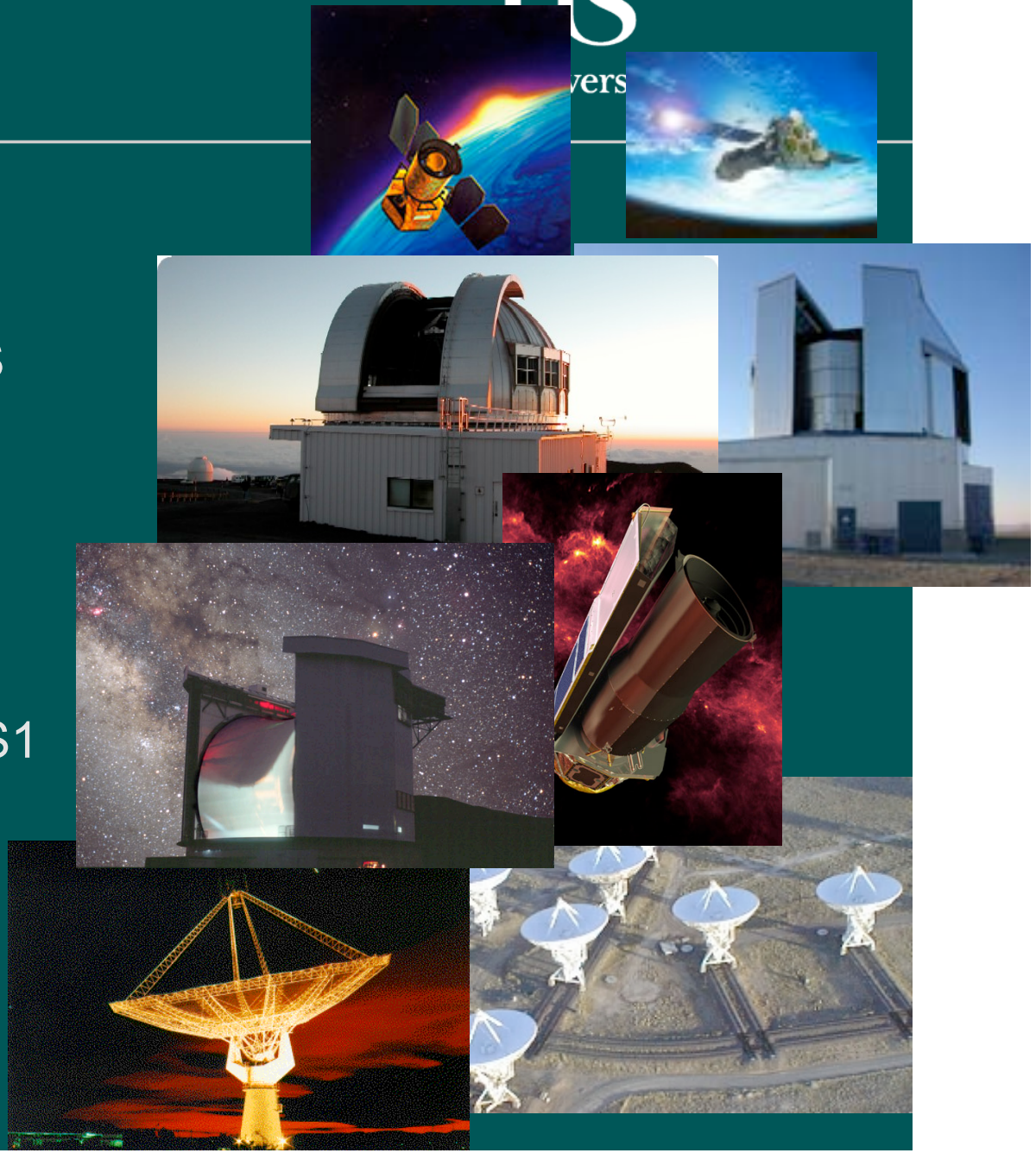


This plot shows the redshift-luminosity space probed in a 4-tier wedding cake survey. Yellow: 0.25 square degrees, 1.7 mJy 5σ threshold at 120 μm (PACS); red, blue, and magenta: 0.9, 9, and 90 square degrees, with 5σ thresholds of 10, 31, and 100 mJy at 250 μm (**SPIRE**). The **PACS** and first **SPIRE** surveys would be confusion-limited. The luminosities of Arp 220 and M82 are indicated.


Level 1/2 Fields
Level 3 Fields
Level 4 Fields
Level 5 fields
2 Level 6 Fields
Δz=0.1 @ z=1
Sim Thickness
125 Mpc/h
73 square degrees in total

Well studied fields

GOODS North / HDFN
GOODS South CDFS ECDFS
Lockman wide & Deep
Extended Groth Strip
Bootes
XMM/VVDS/UDS
SWIRE fields (ELAIS N1/N2/S1
FLS
AKARI SEP



Key Surveys..

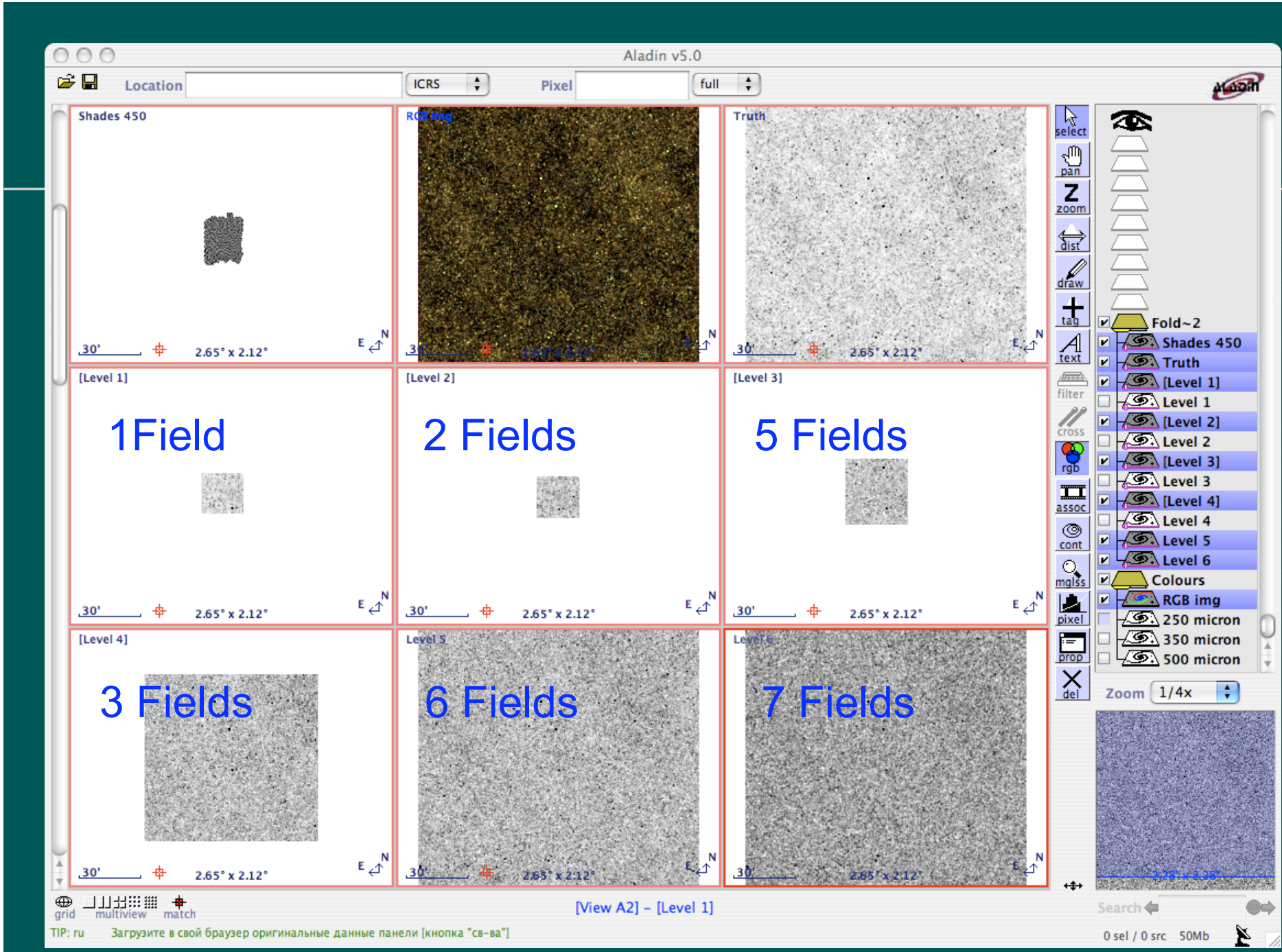
University of Sussex

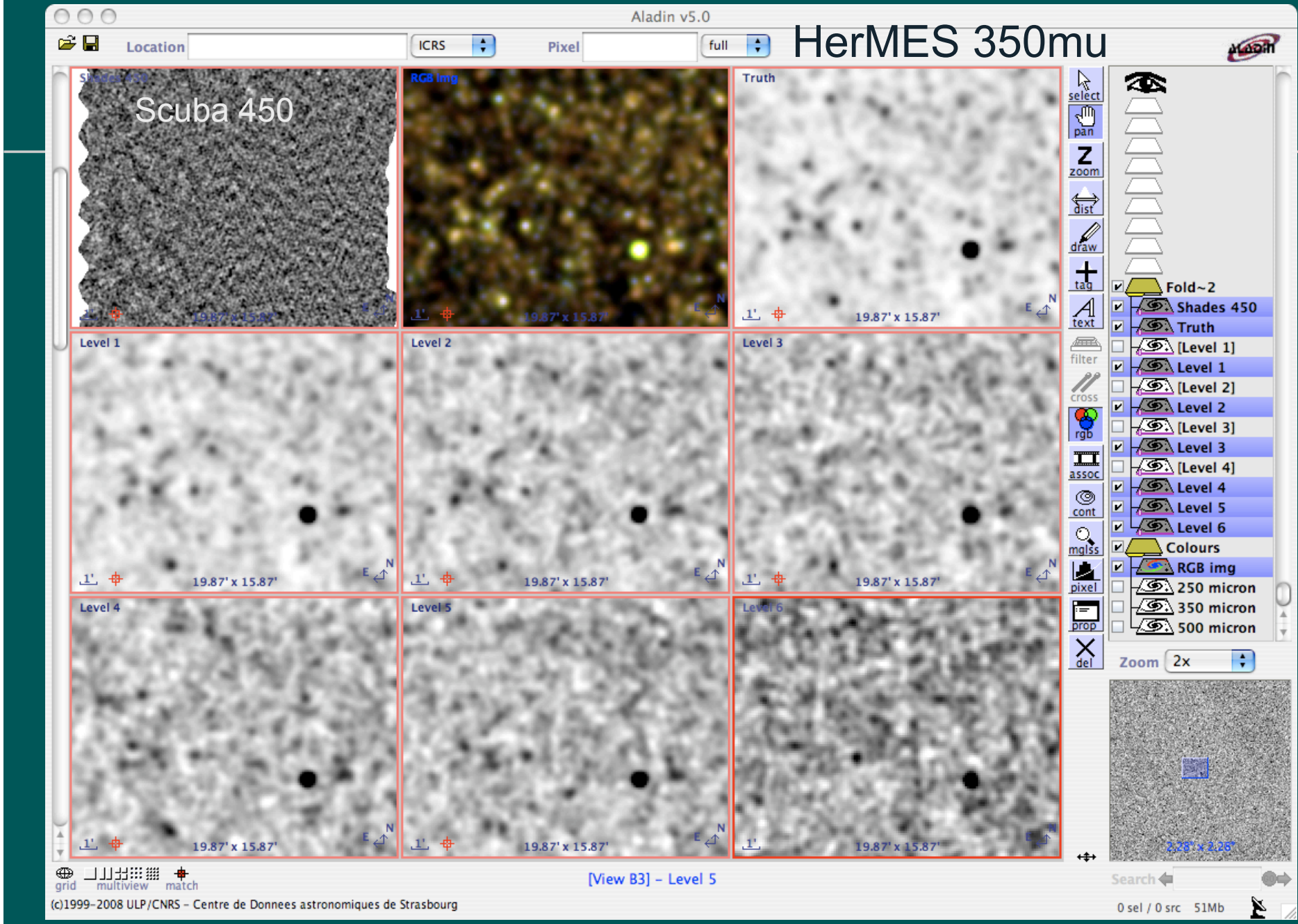
SERVS – 18 sq. deg. 1muJy at 3.6 micron + 4.5 micron

L* at z ~5 and 0.1 L* at z=1,

Hvega=22.5

Name	Area ($deg^{2)}$	Center	Overlapping
ELAIS-S1	3	9.45, -44.0	VIDEO, Hermes L6, ATLAS
XMM-LSS	4.5	35.5, -4.8	VIDEO, Hermes L5
CDFS	4.5	53.08, -28.1	VIDEO, Hermes L2,5, ATLAS
Lockman Hole	4	162.3, +58.11	UDX, Hermes L3,5,S2CLS
ELAIS-N1	2	242.5, +54.5	UDX, Hermes L5, S2CLS

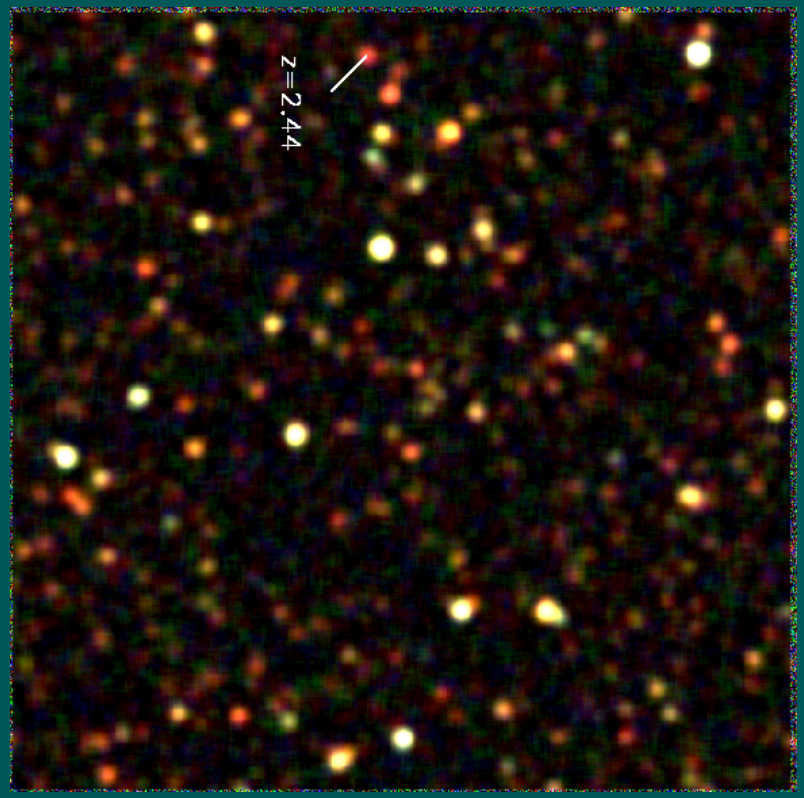

Aladin v5.0
Location
ICRS
Pixel
full
Shades 450
RGB img
Truth
[Level 1]
1Field
[Level 2]
2 Fields
[Level 3]
5 Fields
[Level 4]
3 Fields
Level 5
6 Fields
Level 6
7 Fields
2.65° x 2.12°
30'
select
pan
zoom
dist
draw
tag
text
filter
cross
rgb
assoc
cont
mgiss
pixel
prop
del
Fold~2
Shades 450
Truth
[Level 1]
Level 1
[Level 2]
Level 2
[Level 3]
Level 3
[Level 4]
Level 4
Level 5
Level 6
Colours
RGB img
250 micron
350 micron
500 micron
Zoom
1/4x
grid
multiview
match
[View A2] - [Level 1]
Search
TIP: ru
Загрузите в свой браузер оригинальные данные панели [кнопка "св-ва"]
0 sel / 0 src
50Mb



SHADES Kristin Coppin HerMES sims Fernandez-Conde et al. 2008 & Rupert Ward

PACS

University of Sussex



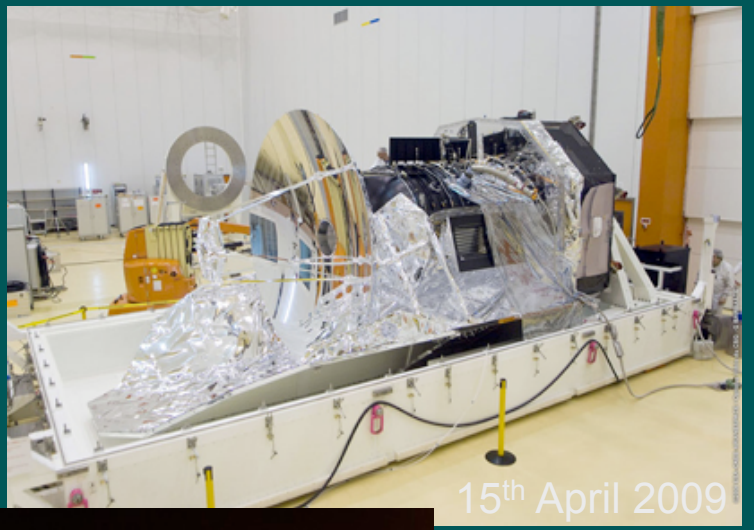
Summary FIR/Mid-IR surveys

University of Sussex

Survey	Wavelength	Area	Number	<z>
SWIRE	24	50	610k	1.0
SHADES	850	0.25	120	2.2
BLAST	250-500	10	250	0.5
HerMES	110-500	73	120k	1.0
S2CLS	850 (450)	20	10k	2.1

Herschel Launched

University of Sussex



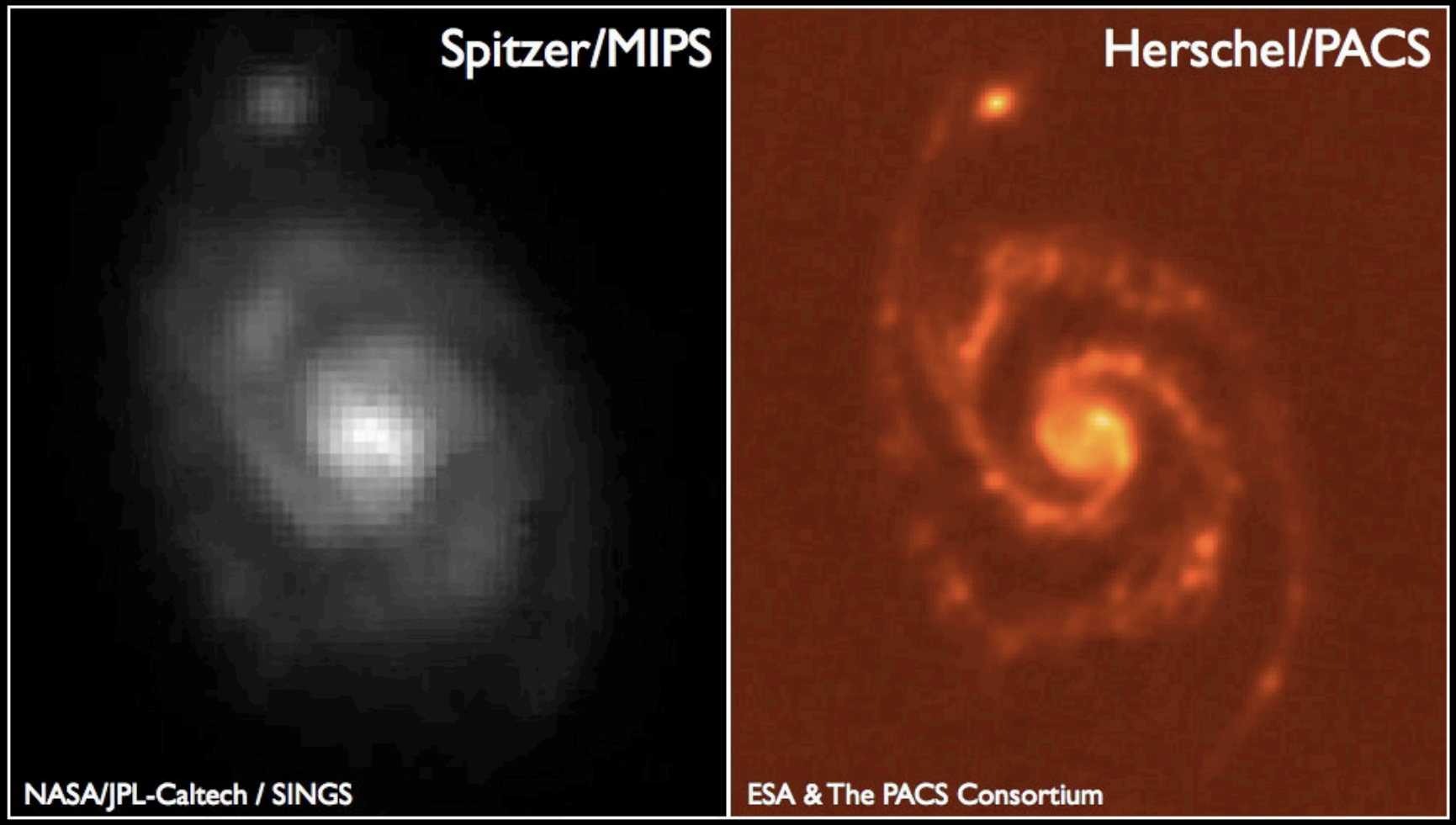
15th April 2009

16 Feb 2009

Herschel arrives in French Guiana

First Light

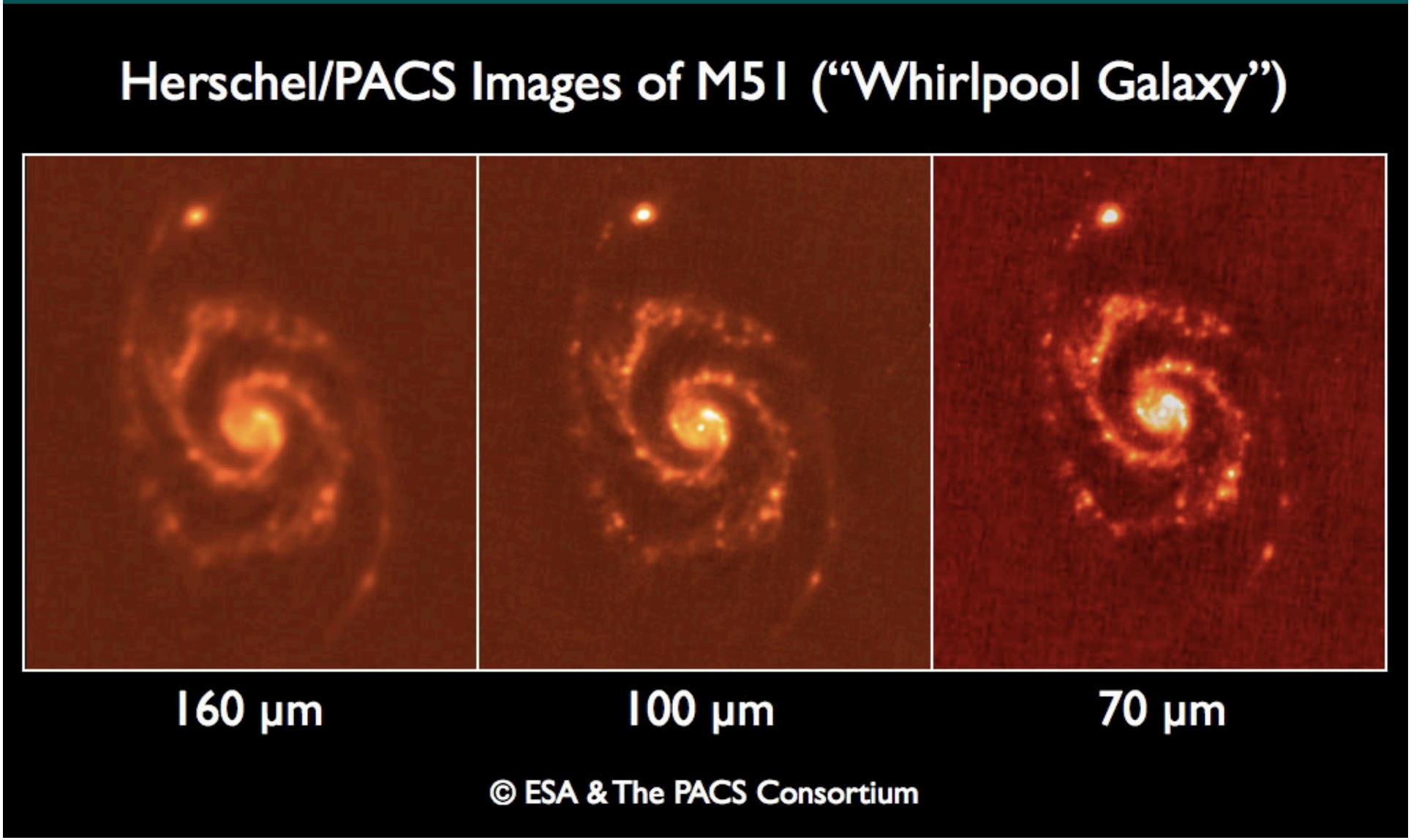
University of Sussex



Spiral Galaxy M51 ("Whirlpool Galaxy") in the Far Infrared (160μm)

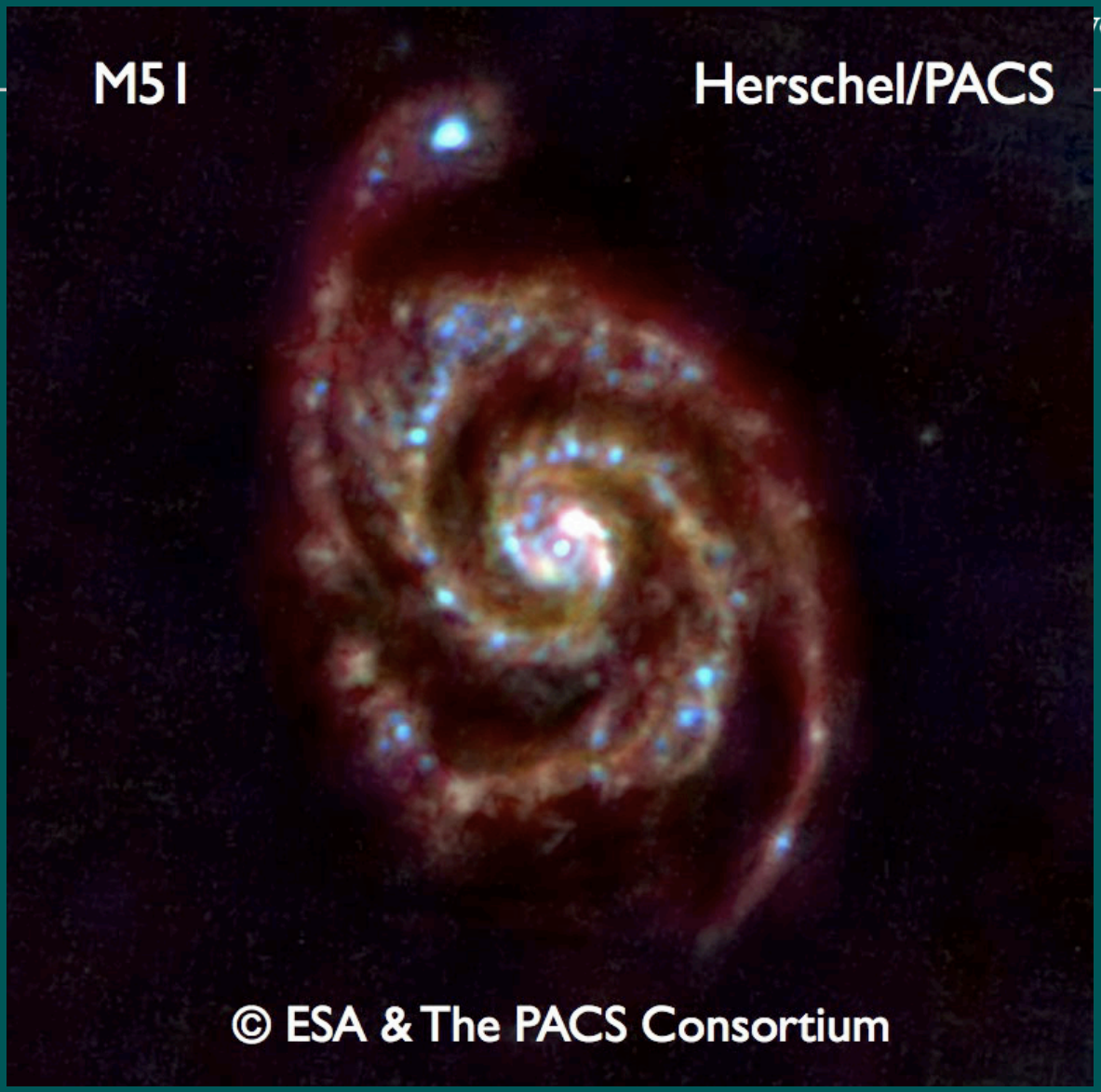
~15 June, released 19 th June

University of Sussex



~15 June, released 19 th June

University of Sussex

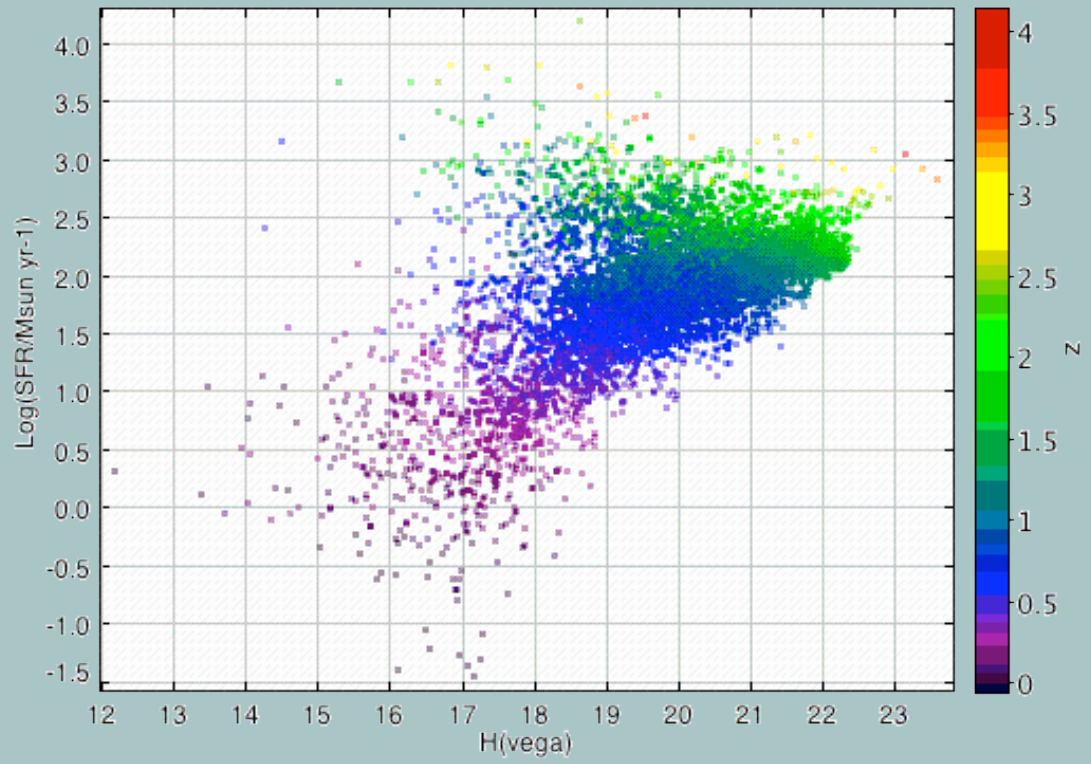


Draft Schedule

University of Sussex

Launch 14th May 2009		
L+5 Oct. '09	Science Demonstration	
L+6 Nov. '09	Routine Obs. Start	
L+7 Dec. '09	ESA SDP Workshop	
L+12 May 2010	ESA SDP Conference	
	(Prior to AO2)	EDR
L+18 Nov. 2010	(ROS+12)	DR1
L+42 Nov. 2012	(End of Mission)	DR2

Herschel / FMOS synergies



Herschel / FMOS synergies

University of Sussex

- Confusion limit of Herschel ~ 2000 sq. deg. = 400 / FOV
- Redshift distribution <z>~1 well matched to FMOS
- FMOS may be able to get redshifts for obscured Herschel galaxies inaccessible at other wavelengths
- Herschel will give a bolometric measurement of obscured star-formation direct comparison (calibration?) of Halpha measures
- FMOS surveys will gain by being done in Herschel fields
- Surveys of Herschel galaxies could provide “easy” first science

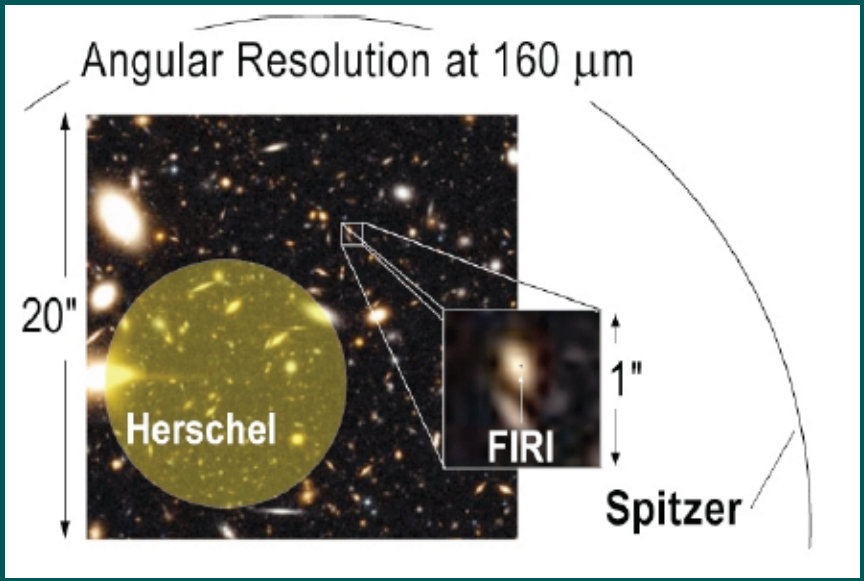
Conclusions

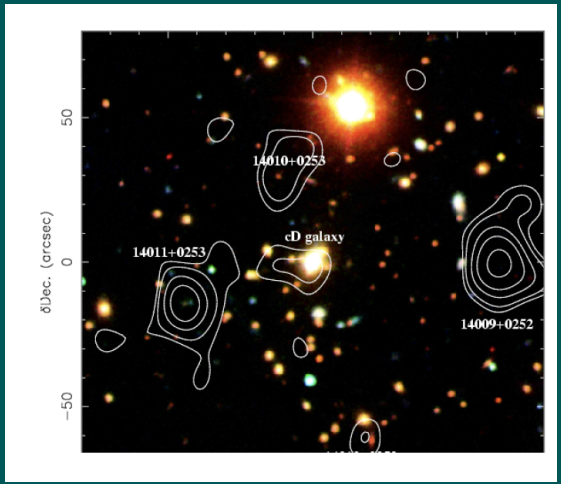
University of Sussex

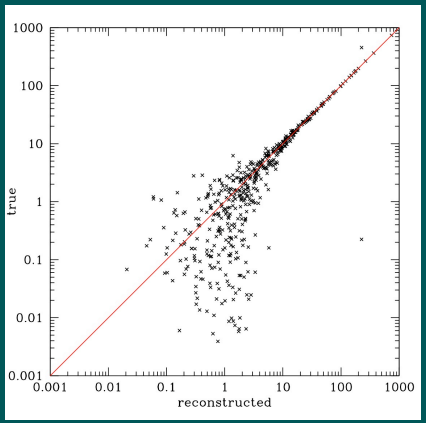
- Herschel is Now!
- Herschel will probe the peak of the bolometric emission of obscured star-forming galaxies
- HerMES surveys will provide the volume and sample sizes to address questions of galaxy formation with statistical precision (73 sq.deg. >100k sources)
- FMOS/Herschel have strong synergies

Probing Below the nominal Confusion Limit

University of Sussex







- Clusters as lenses
- Source position priors
- Fluctuations
- P(D)
- Stacking