Science Team Meeting

IAP

1/2 March 2006

Introduction

Matt Griffin

- **Meeting objectives and format**
- **Herschel-Planck and SPIRE update**
- **ESA plans for KP AO issue**

SPIRE Science Team Plan

- Consortium Meeting in July reviewed status of GT programmes
- SAGs to work on Stage-3 (near-final draft) proposals
  - Written in the approved format
  - Including
    - Details of collaborations
    - Proposed data products
- Stage-3 proposals to be reviewed at this meeting
- Plan to be formulated at this meeting for production of Stage-4 (º final except for minor edits)
- Final review of Stage-4 proposals to be reviewed and approved by STAC prior to submission
- We should aim to have proposals ready to submit when the AO comes out

Today’s Agenda

09:45	Introduction	Matt
	- Meeting objectives and format	
	- Herschel-Planck and SPIRE update	
	- ESA plans for observing time AOs etc.	
10:15	Discussion	
10:45	SAG splinters (to be organised by SAG coordinators)	
12:30	Lunch	
14:00	Presentation of SAG programmes (15 min. + 15 min. discussion)	
	- SAG 1 (High-z)	Jamie/Seb
	- SAG 2 (Low-z)	Sue/Walter
	- SAG 3 (SF)	Philippe/Paolo
	- SAG 4 (ISM)	Alain/Jean-Paul
	- SAG 5 (Sol. Sys.)	Bruce/Regis
	- SAG 6 (Stellar)	Mike/Goeran
17:00	Discussion and formulation of Science Team plan between now and KP proposal submission	
17:30	Summary	

Guidelines for presentation of SAG Proposals Status

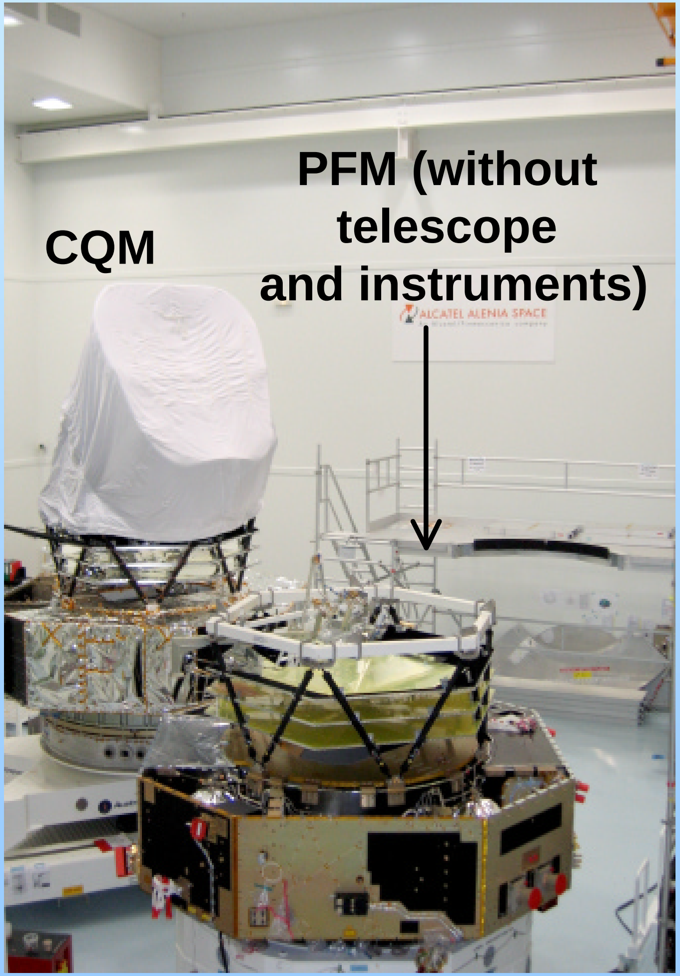
- Condensed summary of the SAGs Stage-3 proposals
  - Science objectives are already well known
- Differences/changes of emphasis since STAC allocations of observing time in Sept. 2004
- Observational programme
- Collaborations and agreements with other teams
- SAG data rights/publication plans
- Data product plans, involvement in any OT programmes
- Open issues, plans for producing final proposals, etc.

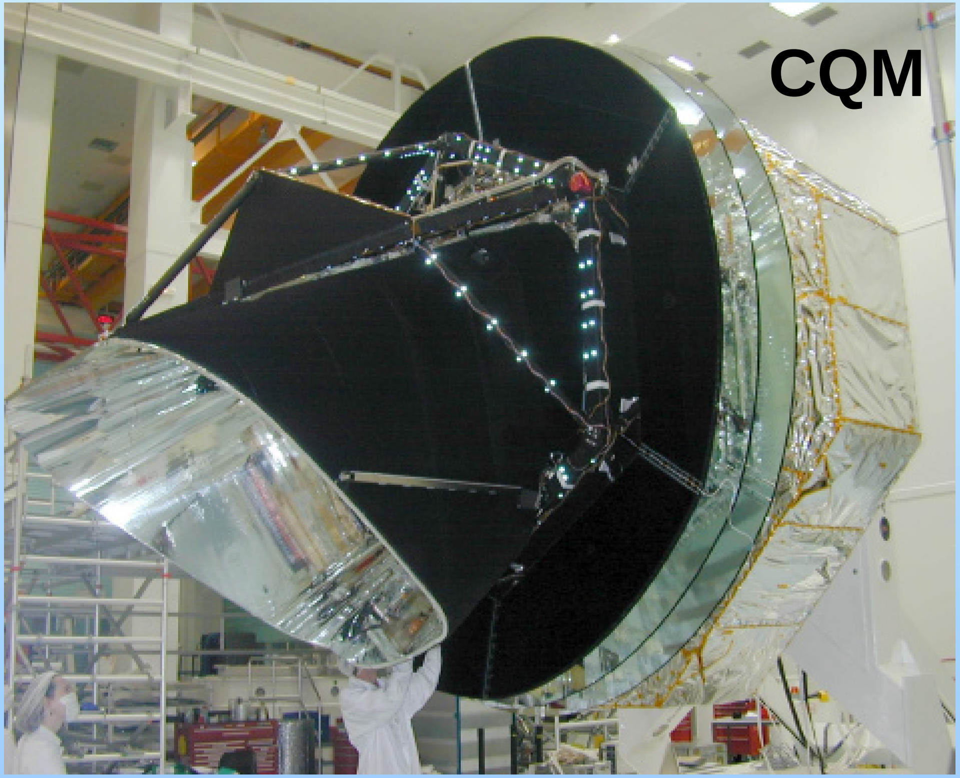
Tomorrow's Agenda

- **STAC meeting (09:00 – 13:00)**
  - **Attended by Co-Is + SAG coordinators**
  - **Parallel SAG meetings can take place (to be organised within the SAGs)**
- **Review of Stage 3 proposals**
  - **Comments on science case**
  - **Assessment of compatibility with the spirit of what was approved in 2004**
- **Common issues**
  - **SAG policies on membership, publication and data rights**
  - **Common elements of proposals (e.g., data products, management plans)**
- **SPIRE Science Team membership update**
  - **Steering Group approval of proposals for WM/AS**
  - **policy on further expansion of the team**
- **Update of the SPIRE Science Team plan**
- **Promotion of SPIRE (talks, conferences etc.)**

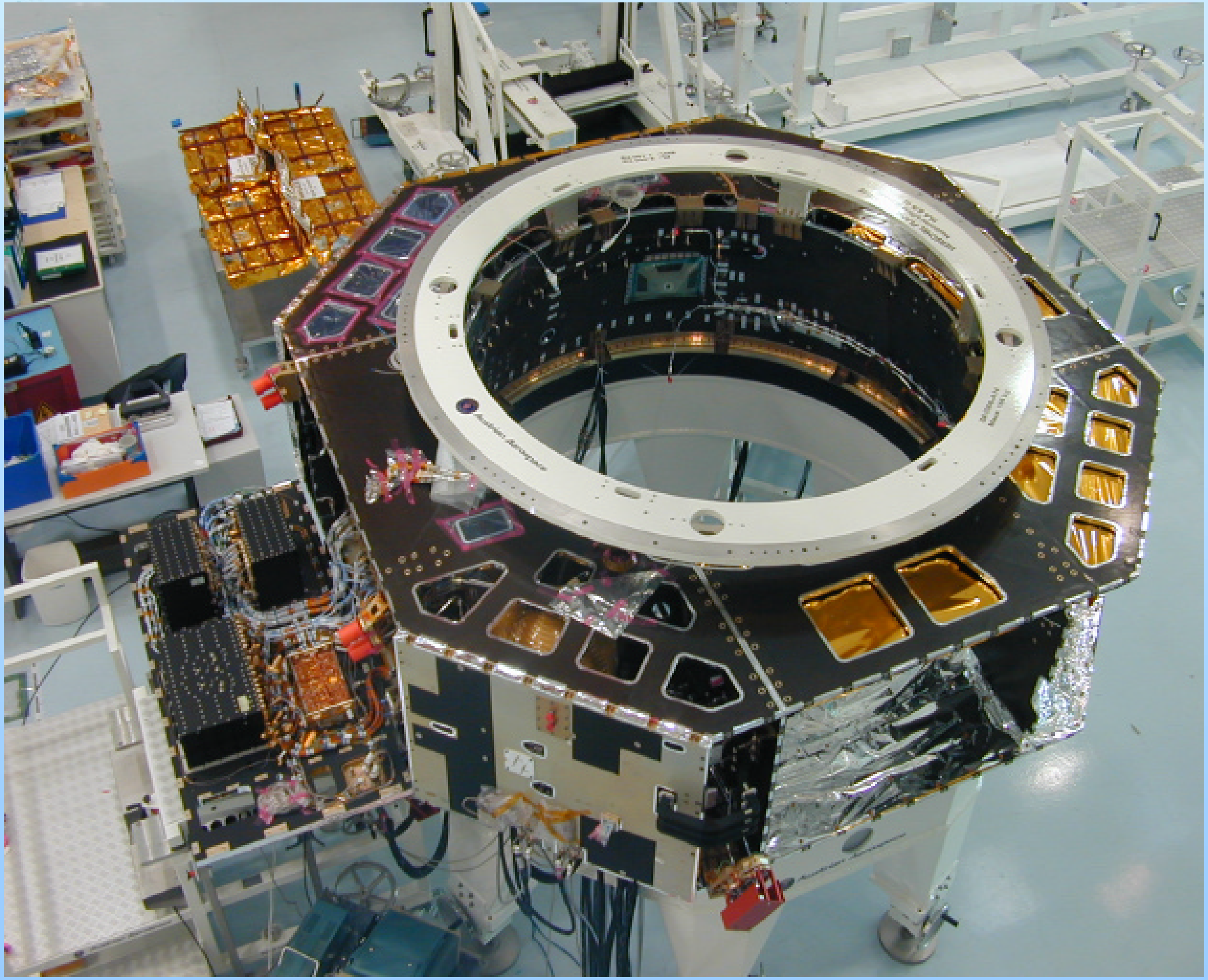
Herschel-Planck Project Update

Planck

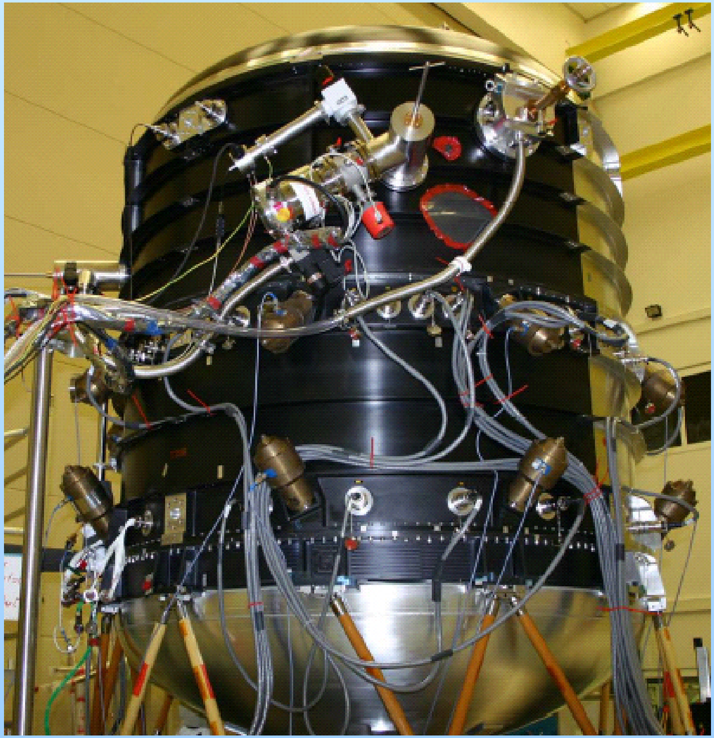

CQM
PFM (without
telescope
and instruments)
ALCATEL ALENIA SPACE


CQM

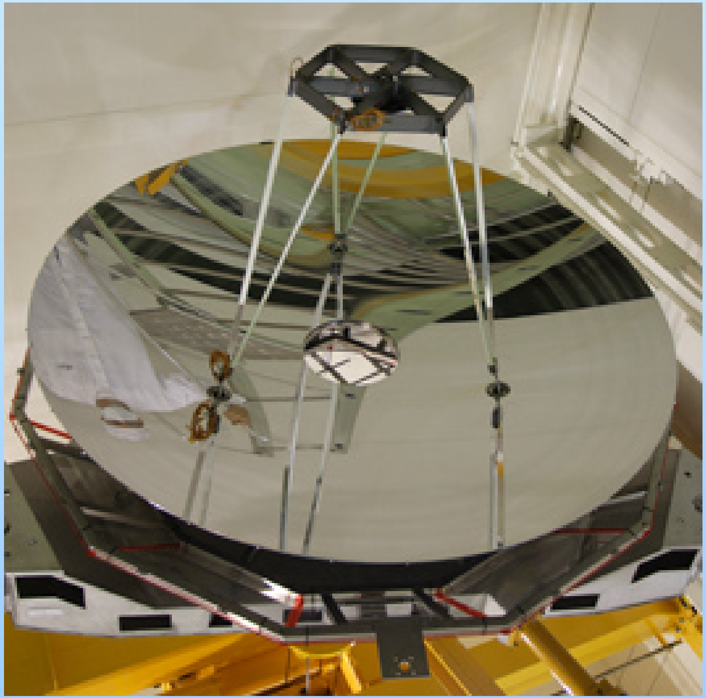
Herschel Service Module



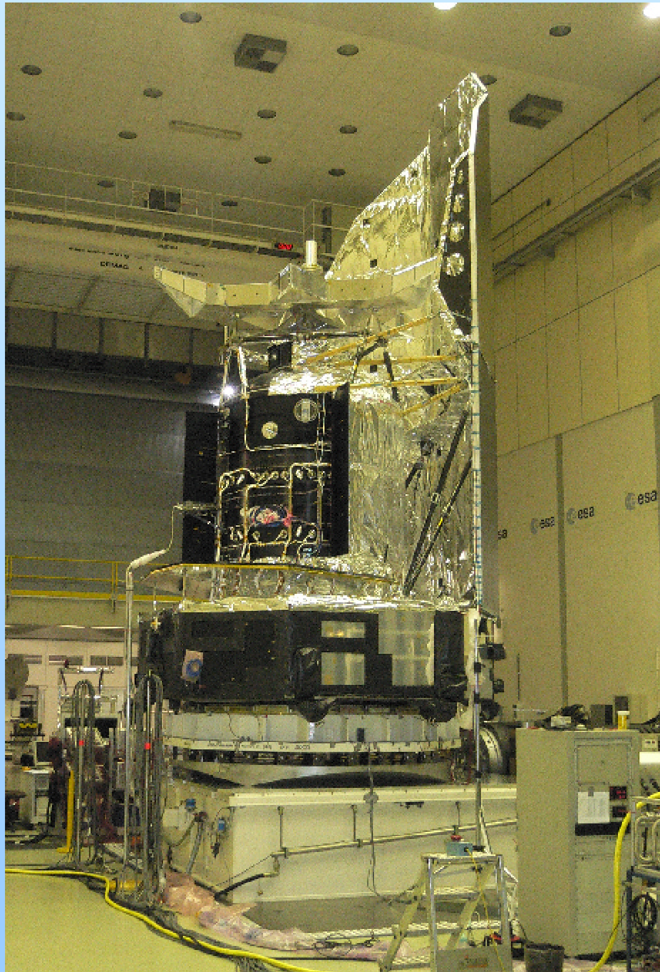
Herschel Cryostat

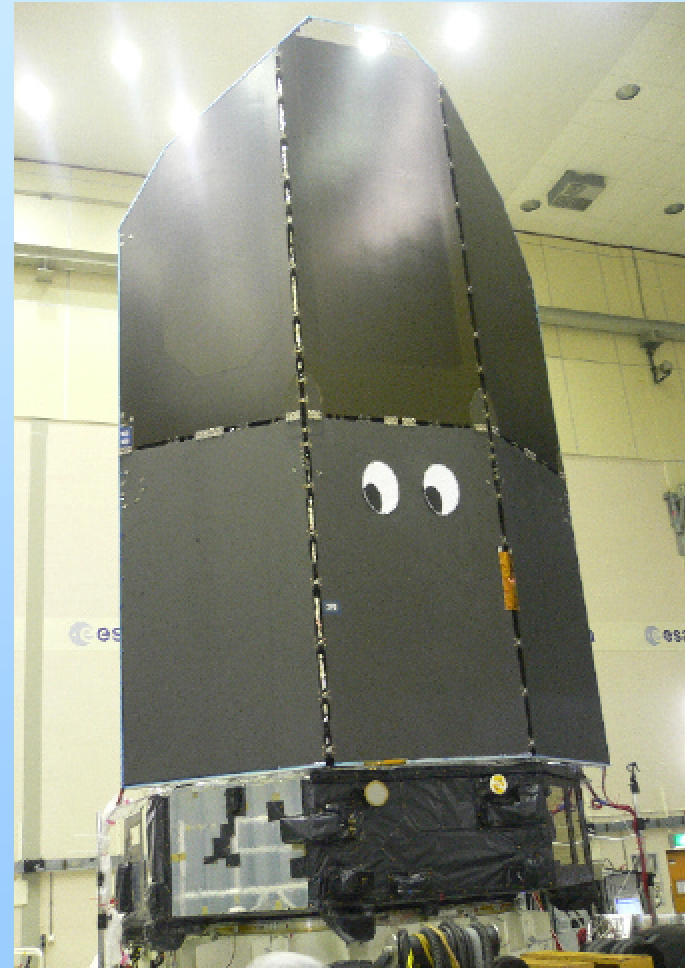


Herschel Telescope



Herschel PLM System Test at ESTEC






esa

Industry Progress

- Industry readiness dates
  - Herschel instruments: March
  - Planck instruments: May
- ESA have instructed Industry to optimise "standby time" by adapting elements of their FM programme
- Little or no further scope for compressing spacecraft-level integration and test
- Planck integration takes ~ 4 months longer
- Quoted instrument delivery dates (at Dec. 16 Agency-level meeting)
  - HIFI: End Sept.
  - PACS: End Aug. (Update: several months later due to recovery from problem with integrity of internal black paint)
  - SPIRE: Sept. ("deliverable" before then)
  - HFI: End June
  - LFI: End July

Inter-Agency Meetings

- **Held routinely following SPC Investigation Group recommendation**
- **Three so far (July, Oct., Dec. 2005); next March 2006**
- **Objectives:**
  - **Stabilise instrument schedules**
  - **Address technical/funding issues that need agency intervention**
- **Conclusions/progress so far:**
  - **Instrument deliveries are not compatible with Aug. 2007 launch**
  - **Some progress made, but ESA still have major concerns About instrument schedules (especially the Planck instruments)**
  - **ESA will not declare a new date until the situation is clear and stable**
- **Next Inter-Agency meeting**
  - **March 6 at ESTEC**
  - **Significant problems/delays expected with Herschel-Planck instrument deliveries**

ESA Perspective (February SPC)

Planck HFI - 4 K cooler electronics:
- Work on 4 alternative possible solutions - no breakthrough yet

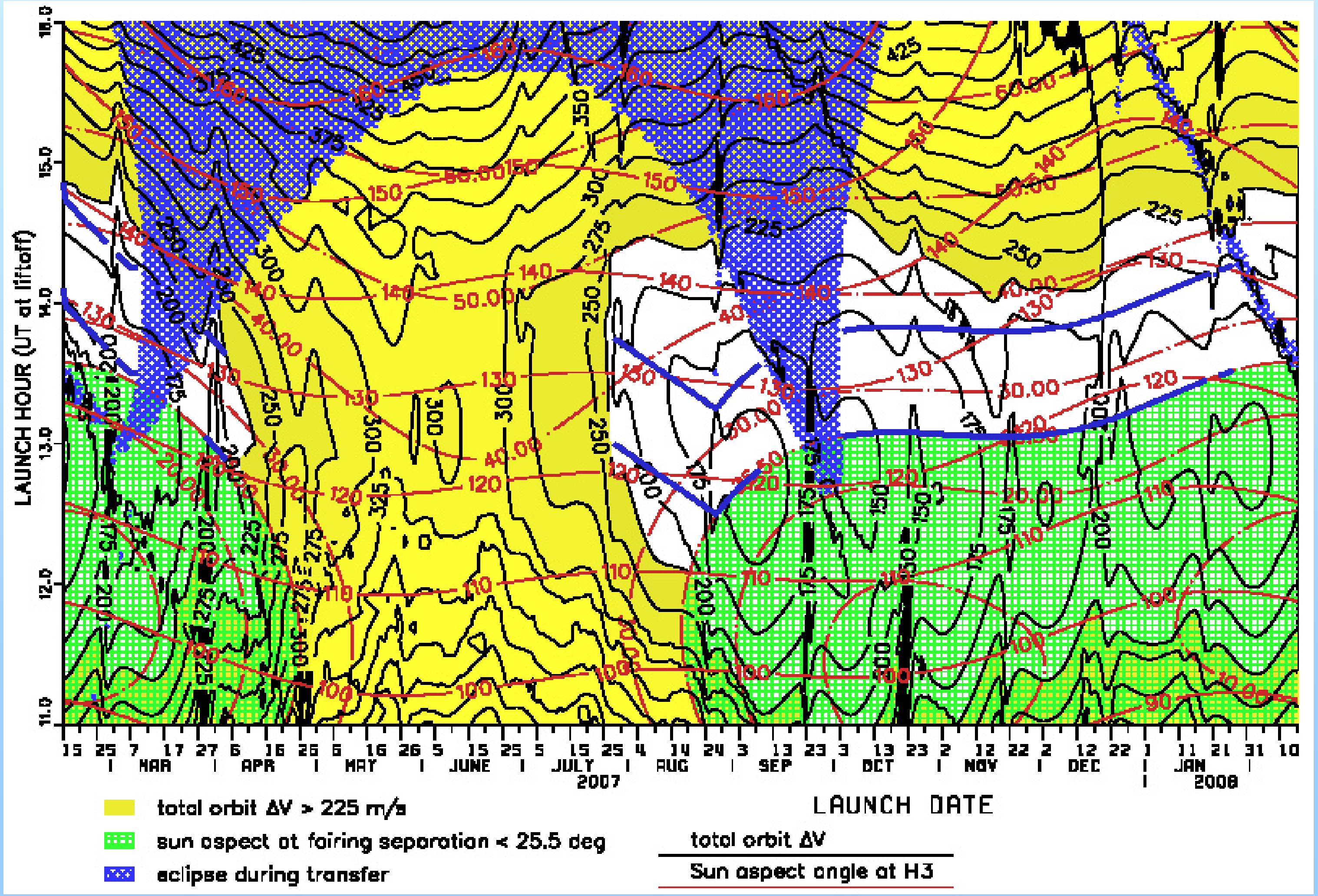
Planck LFI - Radiometer-chain-assemblies:
- Flight hardware RCAs delivered - however late
- Recovery possible at LFI instrument level by dual shift work

Herschel HIFI - Local Oscillator Unit:
- Investigation ongoing - no breakthrough yet
- Need of extended use of development model - to be implemented

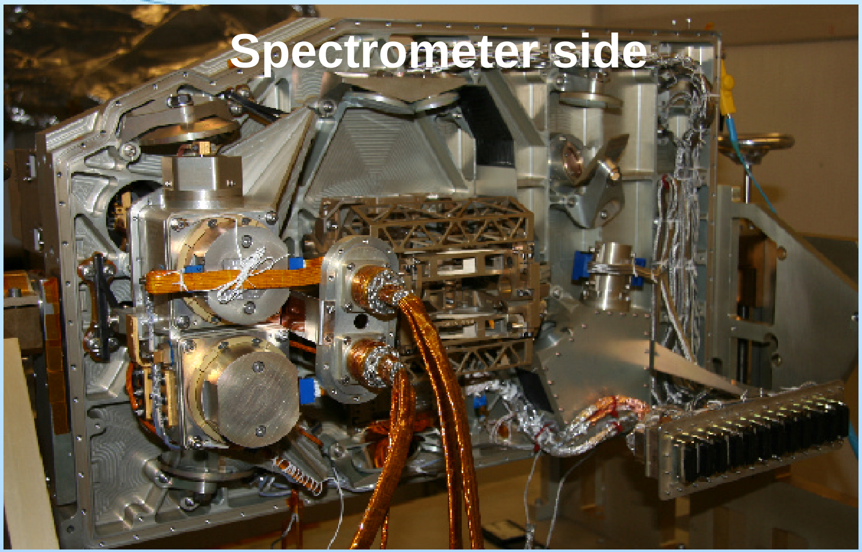
Herschel PACS - Focal Plane unit black paint:
- Flight Model need complete recoating
- Use of qualification model for flight under consideration

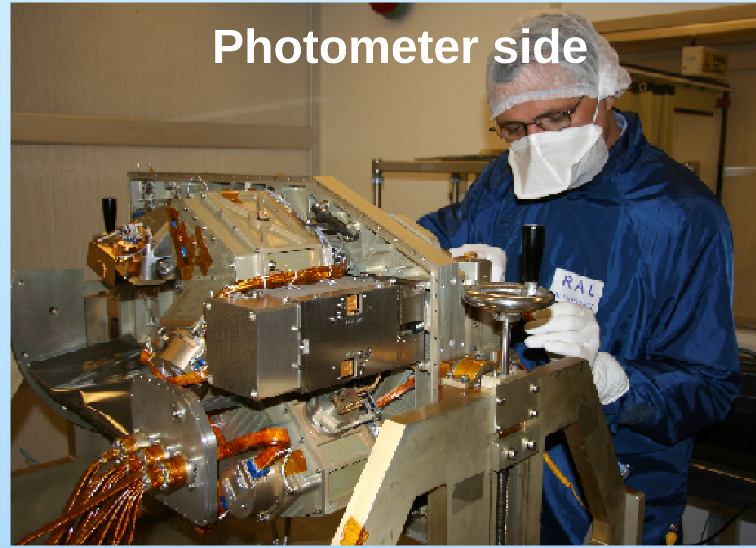
Herschel SPIRE - cryo-vibration
- Hardware repaired - test completed
- Impact on extended calibration time

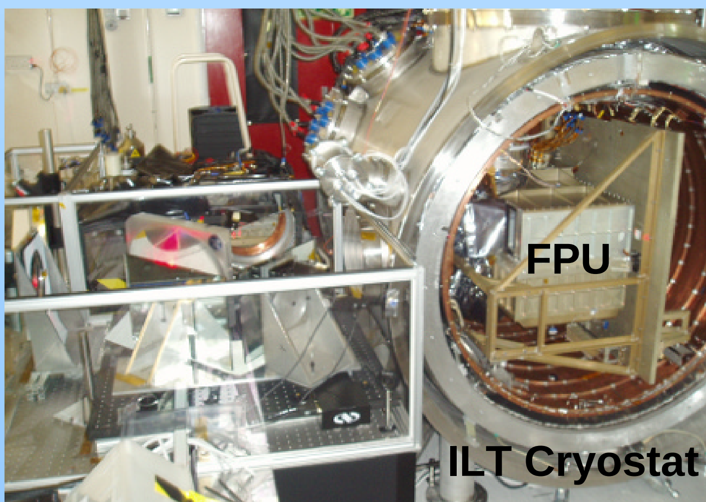
Launch Windows

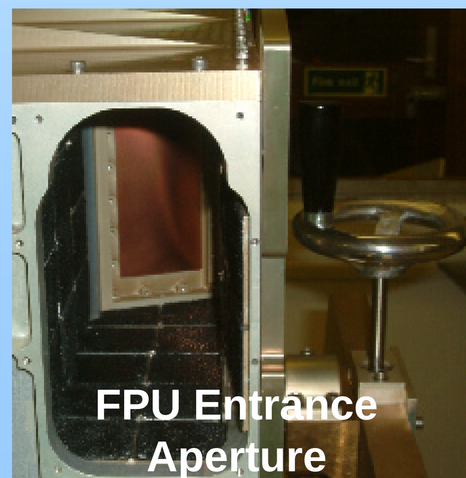


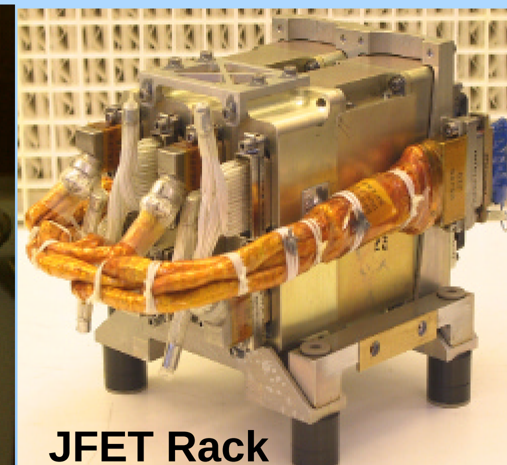
SPIRE Flight Instrument











SPIRE FM Testing

- **Cooldown 1: Feb. 2005**
  - Spectrometer side only
- **Cooldown 2: Sept. 2005**
  - Final flight hardware except for
    - Photometer dichroics (used interim non-flight units)
    - Level-0 thermal straps (not usable in ILT cryostat)
    - Representative non-flight warm electronics units
- **FPU cold vibration at CSL: Nov. 2005 – Jan. 2006**
  - Problem with carbon fibre support during Y-axis vibration
  - Replaced with stainless steel component for Z-axis - OK
  - X-axis vibration in January – OK
  - FPU returned to RAL at end of Jan.
  - No visible anomalies
  - Now being prepared for post-vibration cooldown

Current Flight Model Test Plan

• Preparation of FPU and other hardware	Complete
• PFM3-1 campaign	
- TRR	Complete 24 Feb.
- Pumpdown start	3 March
- Cold tests	14-30 March
• Fit flight SMEC	12 April
• Workmanship cold vibration campaign	
- Transport to CSL	2 May
- Back from CSL	26 May
• PFM3-2 campaign	
- Pumpdown start	9 June
- Cold test campaign (of which 4 weeks actual cold testing)	26 June – 10 Aug.
• Instrument delivery	1 Sept.

SPIRE Science Verification Review

Phase 1

Specific Objectives of SVR Phase 1

- **Held at RAL Jan. 26, 27**
- **Following rationale and procedures defined by ESA PS**
- **Specific objectives**
  - **Assess CQM, FM, and EQM test results that are relevant to in-flight instrument scientific performance**
  - **Review the future FM test and calibration plan (including assessment of what can be done on the ground better than in flight)**
  - **Define our requirements for system-level verification**
  - **Identify any measures needed to ensure delivery of well-tested and calibrated FM**

SPIRE SVR: Some Preliminary Conclusions

- **Instrument performance:**
  - Many issues to be addressed
  - But most performance requirements already met – working on goals
- **EMC test results:**
  - Major concern
    - Possible measurements to diagnose/clarify at ILT level
    - Possibility and impact (cost/schedule/risk) of hardware modifications
- **Need to establish additional test time:**
  - Staffing and working practices for testing and data analysis
  - Consider change to cold workmanship vibration issue
  - Create some margin in the test plan for unforeseen events
- **Prioritisation of tests needed:**
  - P1: Needed to verify requirements that are essential for qualification and pre-flight validation of instrument science requirements
  - P2: Tests relating to instrument optimisation and calibration that must be done and cannot be done after launch.
  - P3: Tests needed to optimise science performance in flight that could be done in orbit but would require significant test time

ESA HSC Plans for AO Issue

ESA HSC Preparation for AO

- AO documentation list has been compiled with ToC for each document
- HSPOT is being prepared as the tool for observation preparation and submission
- A lot of work needs to be done to produce and review the documentation before AO release
- PS is anxious to have AO released this Autumn
- We adopt September as working assumption
- Deadline for our KP proposals would then be December
- Required format and guidelines are unlikely to be very different from the current drafts
- HOTAC chair (yet to be appointed by ESA DSci) will be involved in AO preparation

Calls for Observing Proposals

		Possible Dates
• T:	Issue AO for 'Cycle KP' proposals	Sept. 06 ??
• T + 3 mo:	Submission deadline for GT KP proposals	Dec. 06
• T + 6 mo:	Selection and announcement of GT KPs	Mar. 07
• T + 9 mo:	Submission deadline for OT KP proposals	June 07
• T + 12 mo:	Selection and announcement of OT KPs	
• T + 12 mo:	Issue AO for 'Cycle 1' GT proposals	
• T + 15 mo:	Submission deadline for GT1 proposals	
• T + 18 mo:	Selection and announcement of GT1 progs	
• L:	Launch	Feb. 08 +
• L + 5 mo:	Science demonstration workshop Optimisation of selected observing progs Update of AO information	
• L + 6 mo:	Issue AO for 'Cycle 1' OT proposals	

Summary

- SAG programmes are consistent with the programmes presented in Sept. 2004
- STAC guidance and recommendations have been followed
- The observational programmes and collaborations are mostly clear
- Work is needed in most cases on
  - Addressing explicitly all of the requirements for Key Programmes
  - Management plans (organisation, resources, division of tasks, etc.)
  - Definition of data products
  - Publication/data rights within the SAGs

Summary

- Common tasks and requirements across the SAGS need to be identified and a scheme devised to share the effort over the whole Science Team
- Warning: work on the GT programme 1 work on the ICC
- Tomorrow, STAC will
  - Review Stage-3 programme
  - Devise plan and timetable for Stage 4 and final proposals

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SPIRE SAG-1
Extragalactic Surveys

Jamie Bock
Seb Oliver

Summary of Stage-2 Proposals

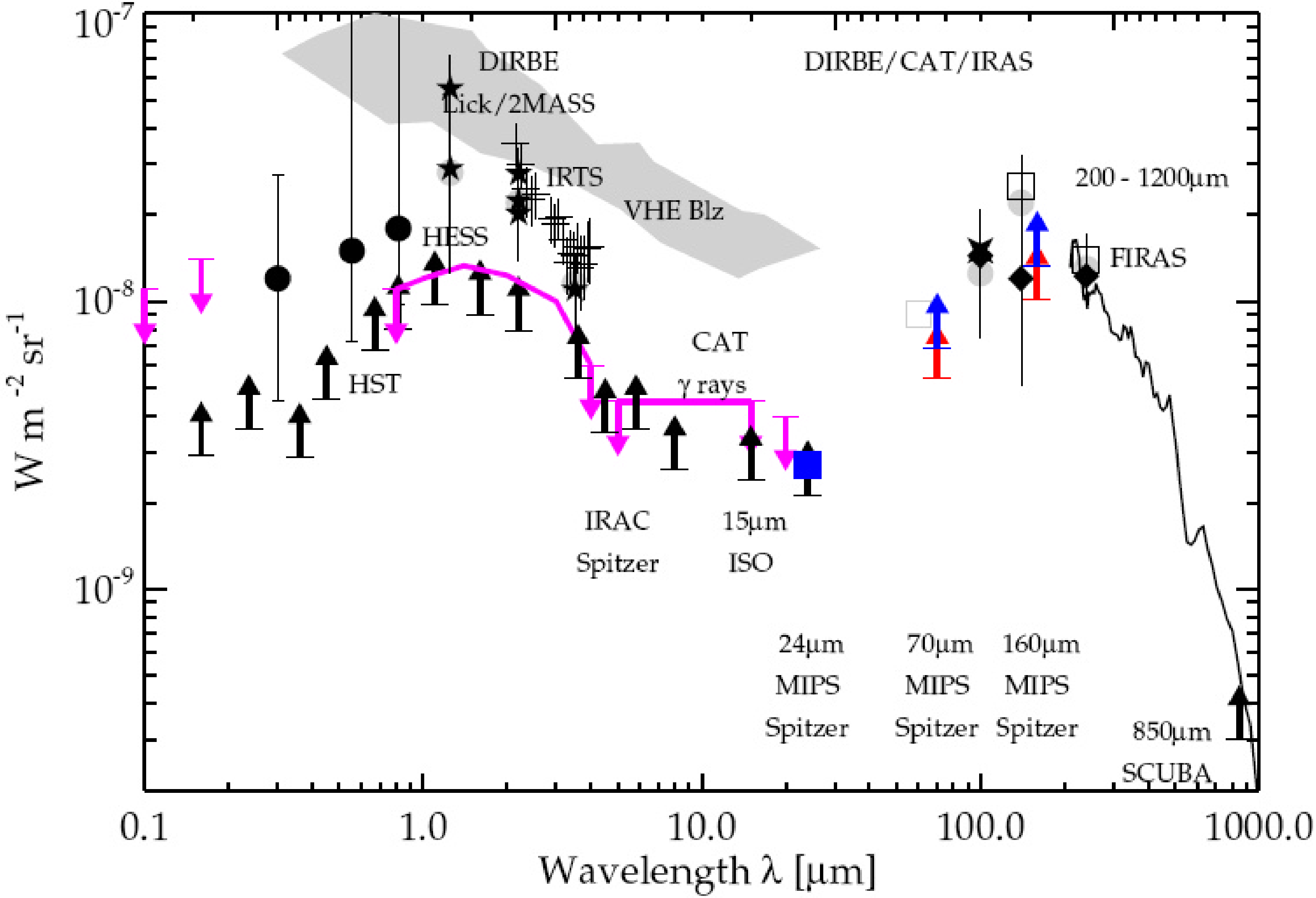
- **History of Star Formation**
  - **Measure luminosity function vs. z**
  - **Wedding cake survey, 5 layers**
  - **Requires PACS, especially for deep layers**
- **Large Scale Structure**
  - **Large scale clustering of detected sources**
  - **20 sq. degree survey, SPIRE only**
  - **near optimal depth for source detection rate**
- **Extragalactic Background Fluctuations**
  - **Clustering of undetected sources**
  - **200 sq. degrees, tie-in with Planck**
- **P(D) survey**
  - **Extract number counts below detection limit**
  - **Deep 1 sq. degree survey**
- **Clusters**
  - **Use lensing to probe faint high-z sources**

Combined time: 1190 h
Allocated time: 850 h

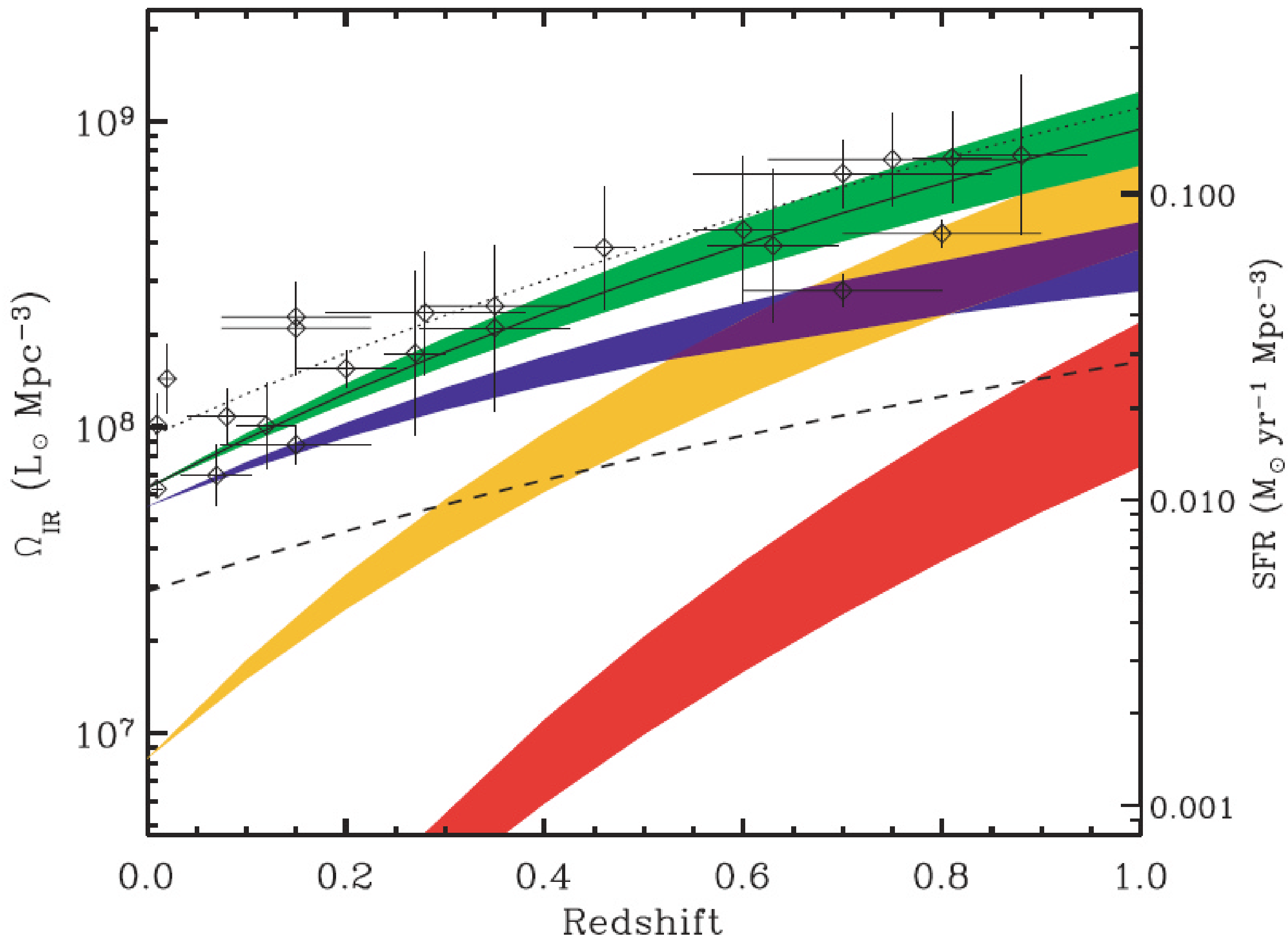
Summary of Stage-3 Proposal

- **A Single Proposal**
  - **A very rich science case**
  - **Accommodates overlap between cataloging sources and statistical approaches to galaxy surveys**
  - **Clusters fit in as deepest layer**
- **Fitting into 850 h allocated**
  - **Requires savings by collaborating with PACS**
  - **Fully exploit internal time savings from overlaps**
  - **Fitting wide-survey with wedding cake**
  - **Martin Harwit donates 10 h toward SPIRE GOODS-S field**
- **Some challenges with this approach**
  - **Negotiating with PACS**
  - **Survey becomes finely balanced – have to plan for changing sensitivities**

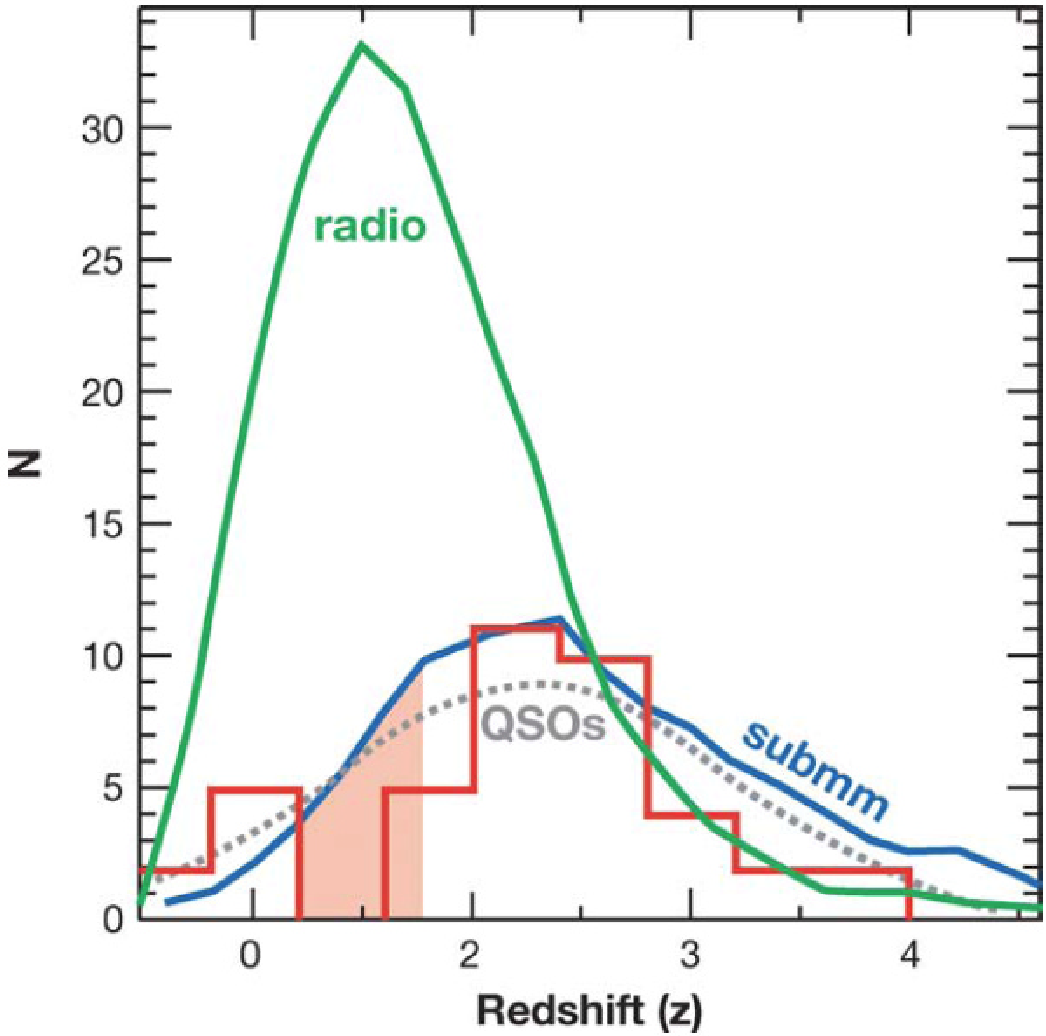
History of Star Formation



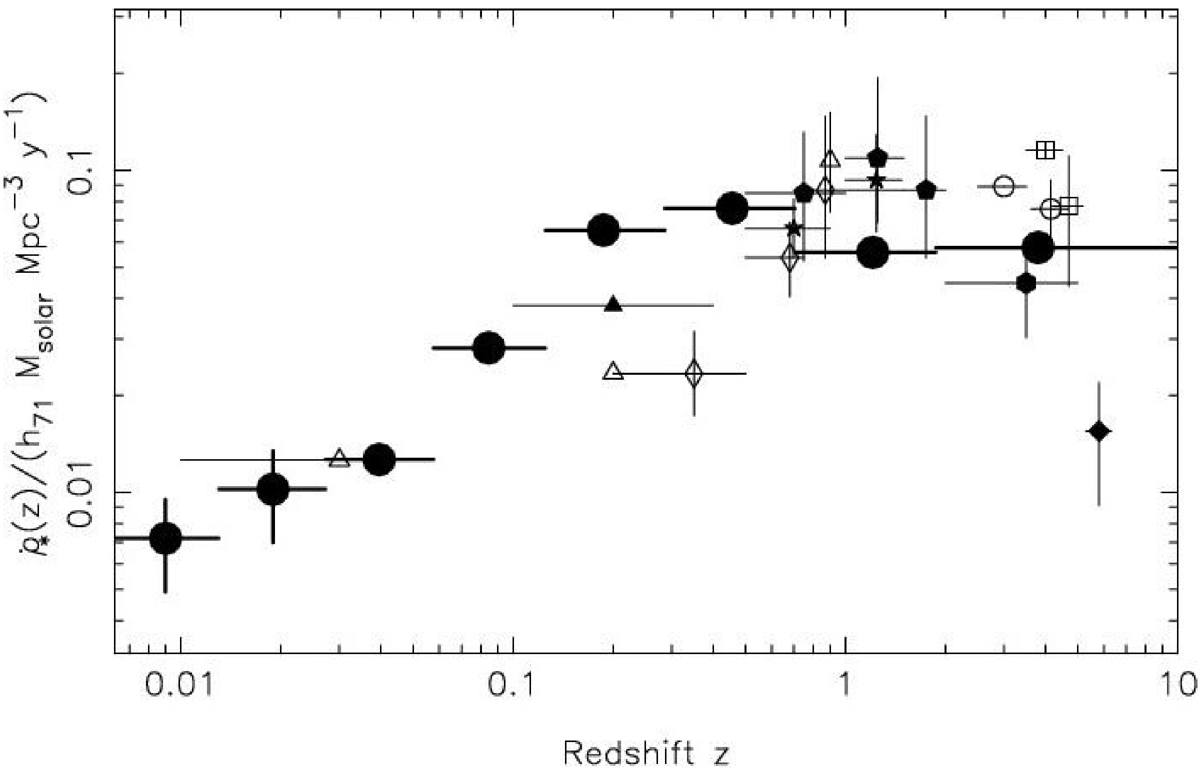
Spitzer 24 μm Galaxies



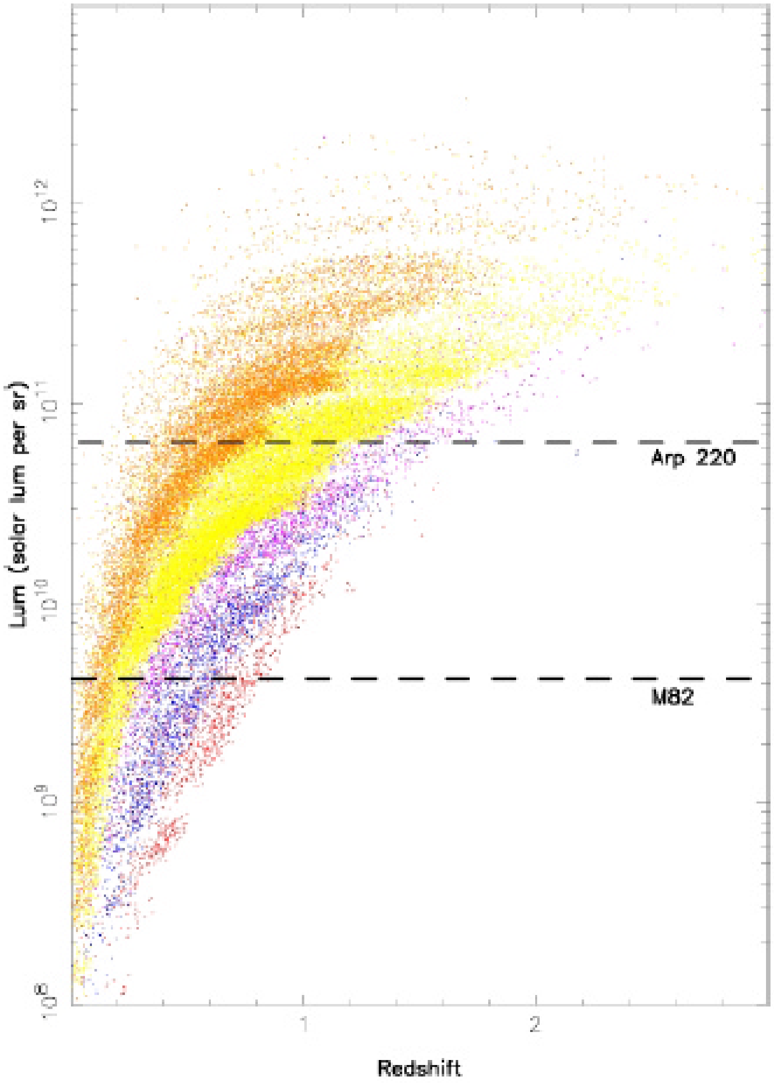
SCUBA Galaxies



Star Formation Rate

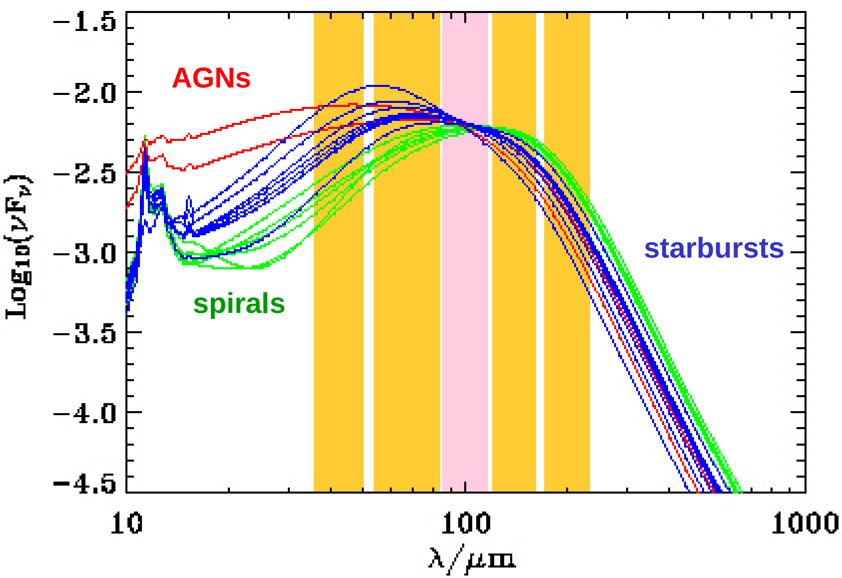


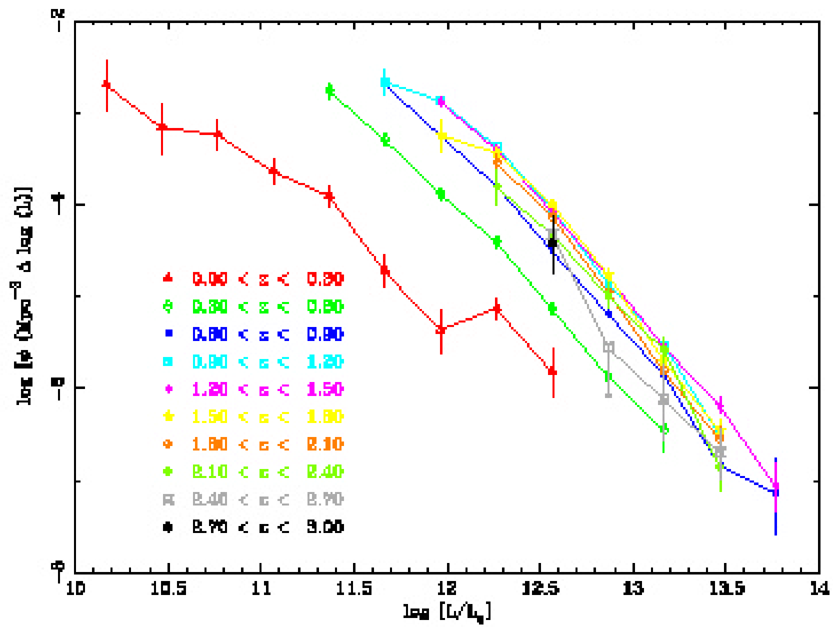
The Wedding Cake Approach



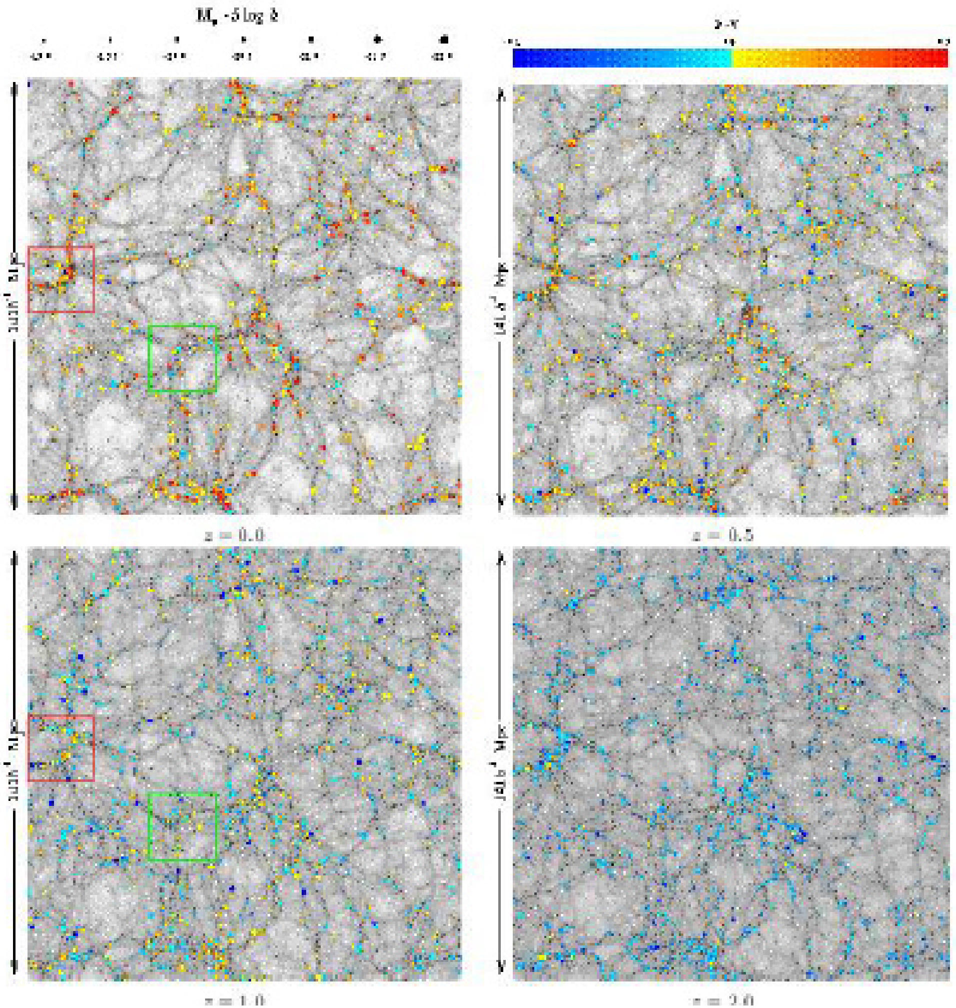
Reconstructing The Luminosity Function

SEDs at z = 1.5



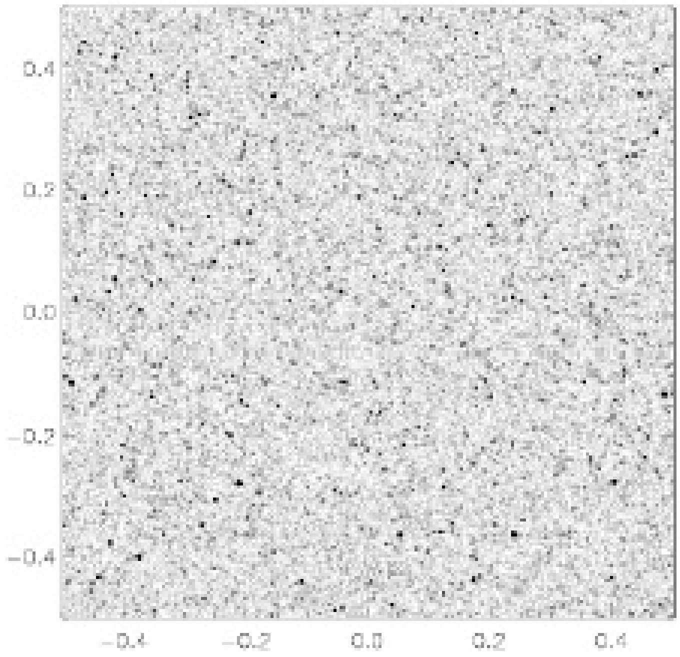


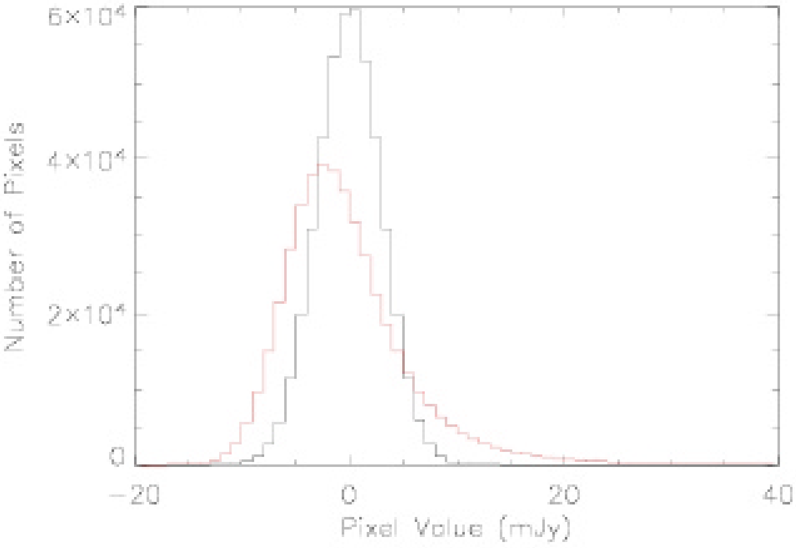
Large Scale Structure



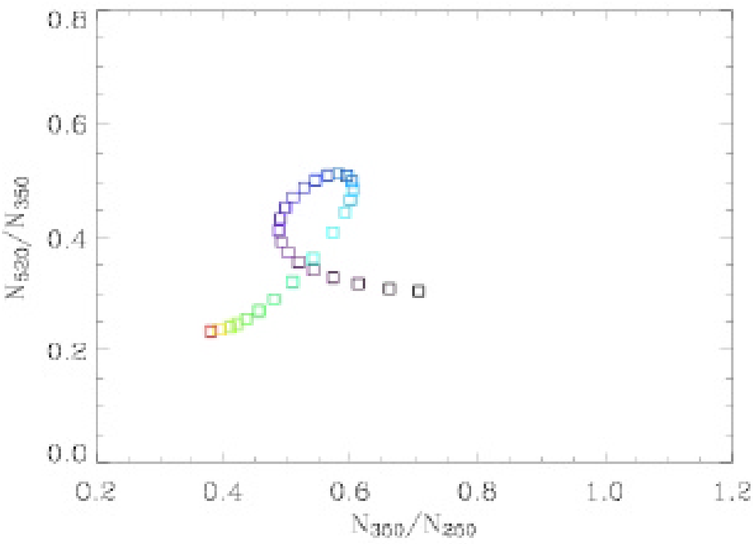
- Angular correlation function of SPIRE sources on $5 < l < 20$ h^{-1} Mpc scales
- Clustering of source cross-detected in MIR, NIR
- Clustering vs. source type
- 3-D clustering (given redshifts)

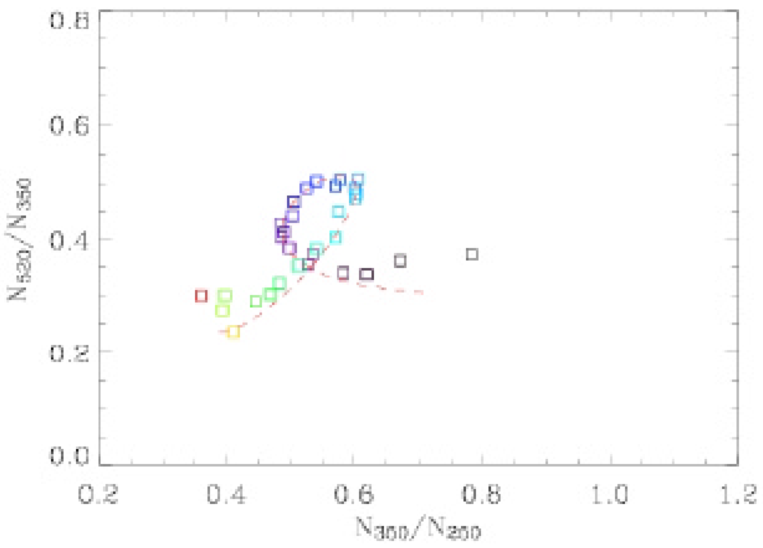
P(D) Analysis


0.4
0.2
0.0
−0.2
−0.4
−0.4
−0.2
0.0
0.2
0.4

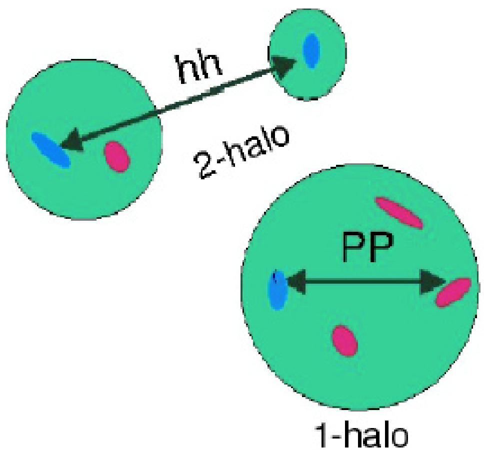

6×10⁴
4×10⁴
2×10⁴
0
Number of Pixels
−20
0
20
40
Pixel Value (mJy)

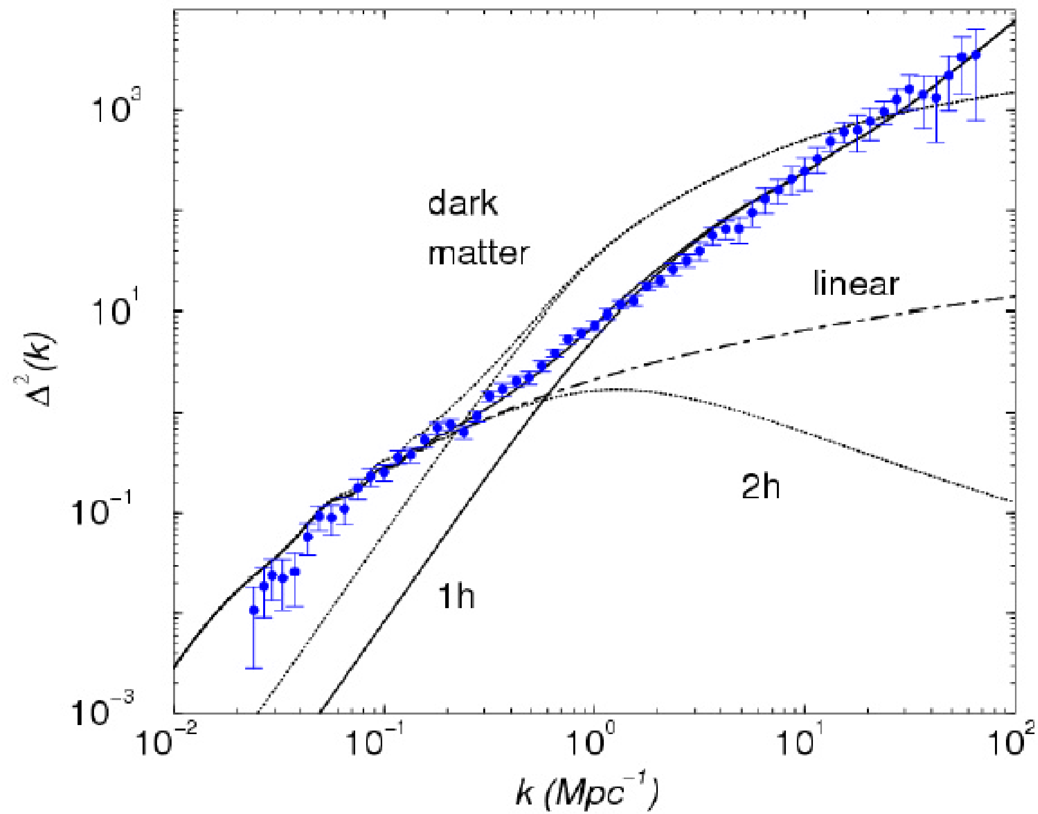
Multicolor Constraints



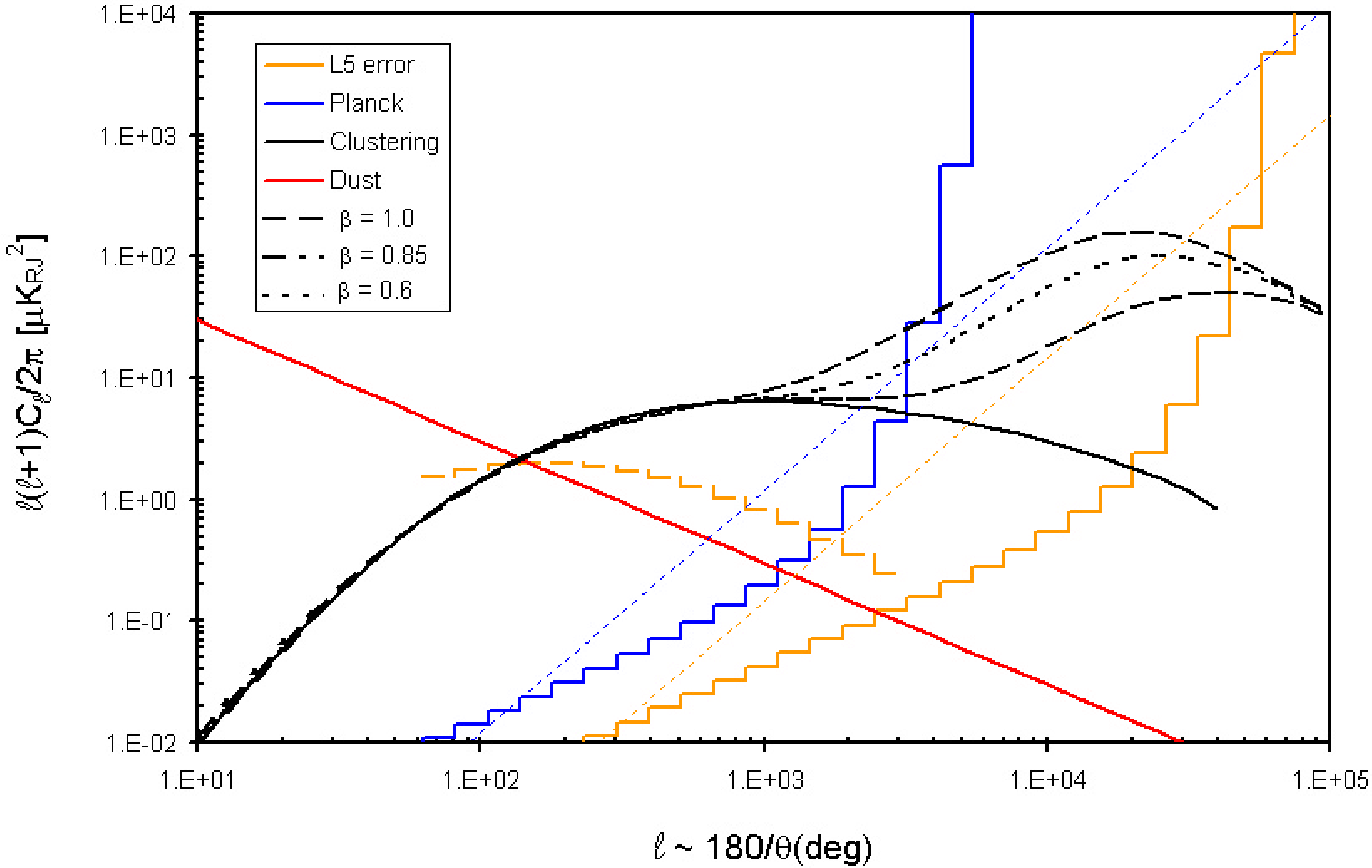


Extragalactic Background Fluctuations





The Clustering Power Spectrum



Revised Fluctuations Strategy

- **Target Non-linear Clustering Signal**
  - **Uses smaller fields**
  - **S/N ~ 100**
  - **1/f noise < sample variance**
  - **Interstellar dust not a major contaminant**
  - **Complementary to Planck**

- **L5 level is highly redundant**
  - **Approximately 50 independent maps**
  - **2-6 independent maps from each single pixel**
  - **Allows for many jack-knifing tests for systematic error assessment**
  - **Maps may be cross-correlated, eliminating non-correlated signals**
    - **Same process used in WMAP data analysis**
    - **Eliminates bias to instrument noise**
    - **Eliminates non-correlated instrument signatures**

Putting It All Together

	PACS Area [sq. deg]	PACS Time [hr]	Depth [hr/sq.deg]	SPIRE Time [hr]
PofD 1	0.11	23	209	
PofD 2	1			100
SFR 1	0.13	18	138	7
SFR 2	0.68	75	110	20
SFR 3	2.68	129	48	74
LSS	19			520
SFR 4	11.5	27	2.3	132
SFR 5	50	108	2.2	115
WIDE	100			200
Clusters 1a		60		60
Clusters 1b				48
Total		440		1276
Grand Total	1716		Allocation	850

<u>Strategies for reducing time</u>

Combine layers of survey

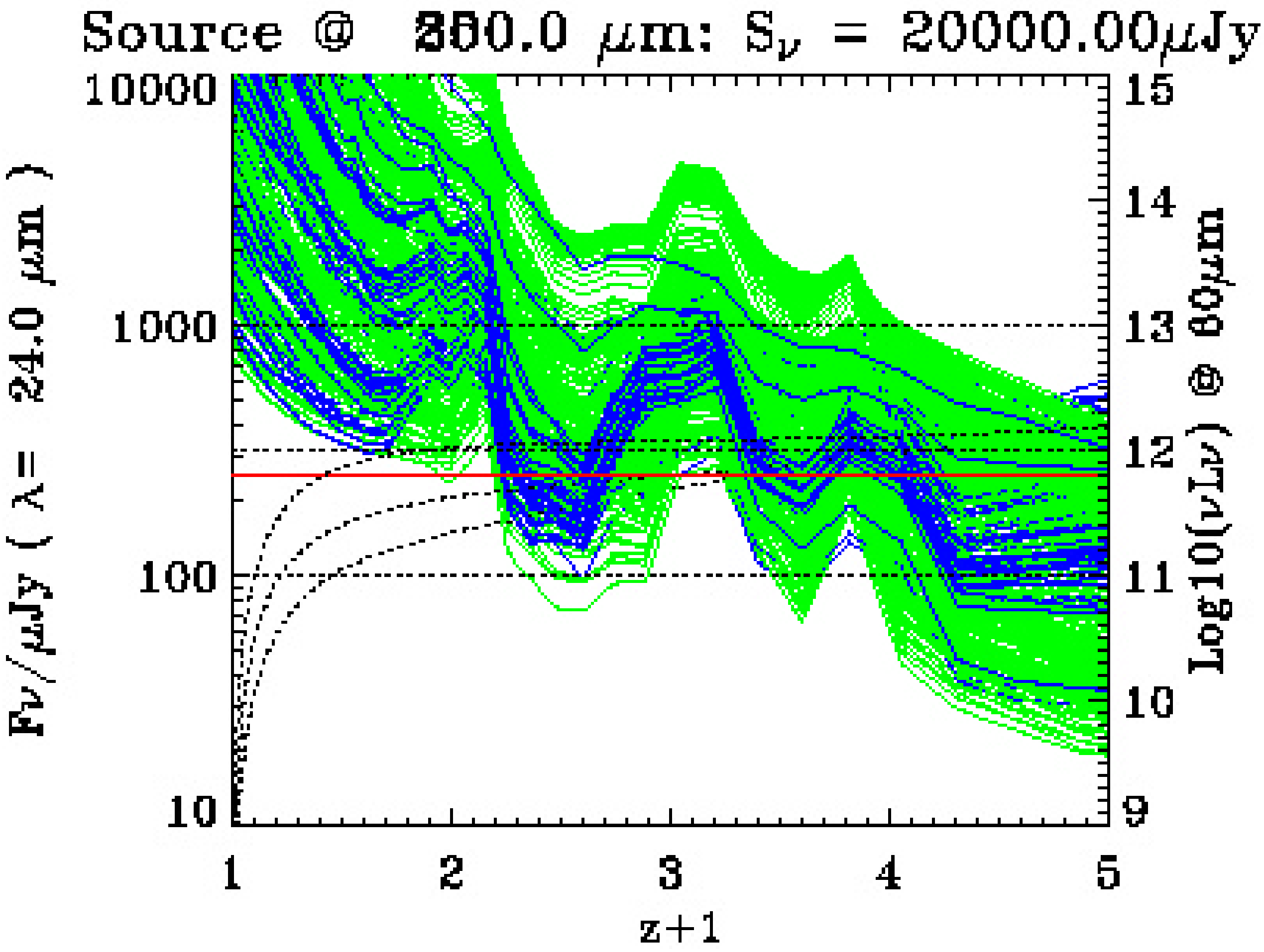
Use PACs GT

WIDE science in SFR 4&5

Revised Wedding Cake

Name	Area /sq.deg.	Fields	Integration Time /hours PACS	SPIRE	Depth in band /mJy 70	110	170	250	350	500
Clusters			60	108						
Level-1	0.07		PGT – 90	(7)	0.6		0.6	(11)	(13)	(15)
	0.07	GOODS-S	PGT – 90	(7)	0.6		0.6	(11)	(13)	(15)
Level-2	0.21[1]		PGT – 120	14		3	3	11	13	15
	0.07	GOODS-N	PGT – 40	7		3	3	11	13	15
	0.07	GOODS-S	PGT – 40	7		3	3	11	13	15
	0.07	QSO[1]	PGT – 40			3	3			
Level-3	0.5[2]		(PGT – 50)	50		11	11	11	13	15
	0.5	TBD[3]	(PGT – 50)	50		11	11	11	13	15
Level-4	5		PGT – 290	125		11	11	21	25	29
	0.7	SXDF	PGT – 290	25		11	11	21	25	29
	2	COSMOS		50		11	11	21	25	29
	0.5	Lockman-XMM		25		11	11	21	25	29
	1	CDFS		25		11	11	21	25	29
	1	Groth		25		11	11	21	25	29
Level-5	10		250	250		16	16	21	25	29
	10[4]	Lockman	250	250		16	16	21	25	29
		/XMM-LSS				16	16	21	25	29
		/CDFS				16	16	21	25	29
Level-6	50			150	18[5]		120[5]	61	74	84
	11[6]	Lockman		33	18		120	61	74	84
	9	ELAIS-N1		27	18		120	61	74	84
	8	CDFS		24	18		120	61	74	84
	7	ELAIS-S1		21	18		120	61	74	84
	4.5	ELAIS-N2		13.5	18		120	61	74	84
	9	XMM-LSS		27	18		120	61	74	84
	9	Bootes		27	18		120	61	74	84

Use Spitzer 24 µm for Source IDs



PACS-SPIRE Collaborative Projects

- **PACS and SPIRE propose for GT time in consultation**
  - **Agree on common fields and clusters in advance**
- **SPIRE and PACS each own their own data**
  - **SPIRE-only and PACS-only projects proceed independently**
  - **Structure of instrument teams is much different!**
- **Propose PACS/SPIRE Coordination Group for collaborative projects using both data sets**
  - **Proposals after GT programs accepted**
  - **Program membership and authorships to represent relative instrument contributions in a given CP**
  - **CG approves proposals and papers - adjustments may be advised.**
  - **Free and open exchange of data and software for approved CPs**
  - **Use of data for any other purpose is not allowed**
  - **Collaboration remains in effect 1-year after the proprietary period expires**
  - **CG: Poglitch, Griffin, Bock, Oliver, Lutz, and Elbaz**

SAG-1 Issues for Discussion

- **PACS/SPIRE MOU**
- **Evaluating time requirements for wedding cake layers**
- **Legacy data products**
- **Science exploitation plan**
- **Overlap with OT KPs**
- **Authorship policy**

SAG-1 Issues for Discussion

- **PACS/SPIRE MOU**
  - **Any final changes?**
  - **When should we have calls for collaborative projects?**
  - **How narrowly or broadly should they be defined?**
- **Evaluating time requirements for wedding cake layers**
  - **P(D) & Fluctuations easier to quantify**
  - **LSS, SFH, clusters?**
  - **We have to face this as a major potential problem when flight sensitivities and confusion limit become available**
- **Legacy data products**
  - **Source catalogs: early release, cross-IDs, redshifts**
  - **Maps?**
  - **Software?**
  - **How are these data products made accessible?**

SAG-1 Issues for Discussion

- **Overlap with OT key programs**
  - **How do we maximize instrument team involvement?**
- **Science exploitation plan**
  - **Who does what**
  - **Should there be more than one pipeline?**
  - **How far does the pipeline go? e.g. scanned maps but not P(D)?**

Open Time Galaxy Surveys

- **Several Efforts in Europe in Formulation Phase**
  - **EXTRAHOT http://astronomy.sussex.ac.uk/~sjo/extrahot/**
    - **Large surveys**
      - **Extend PACS GT fields**
      - **Surveys jointly with SCUBA II and/or LABOCA**
      - **Expanded cluster survey specializing in high-z clusters**
      - **Observations of known AGNs at z ~ 1**
      - **Planck/Herschel shallow survey**
    - **Smaller programs**
      - **Dust in ellipticals**
      - **Dust in clusters**
      - **Follow-up of ASTRO-F sources**
      - **Follow-up of Planck sources**
      - **HIFI observations of local galaxies**
      - **Survey of local AGNs and starbursts**

SAG-1 Issues for Discussion

- **Authorship and data rights policy**
  - **SAG-1 and SPIRE have been ignoring this up until now**
  - **Issue is going to be forced by PACS/SPIRE CPs**
  - **How should be proceed to draft a policy? (some ideas)**
    - **Similar arrangement as SPIRE/PACS could work for papers**
    - **Process must not overlook contributors to instrument & ICC**
      - **Limited or open access to all SAG-1 members on SAG-1 papers?**
      - **Major contributors (~co-Is) on all early papers?**
    - **Timing? First-call somewhat after HOTAC accepts proposal**
      - **Accommodate major themes early on, e.g. series of first pubs**
      - **Subsequent calls for follow-on topics**
    - **Binding beyond last data release**

SAG2: Galaxies in the Local Universe

- Physical Processes in the ISM of Very Nearby Galaxies (100 + 50 [pacs] hr)
- The Herschel Galaxy Reference Survey (100 hr)
- The ISM in Low Metallicity Environments - Bridging the Gap Between the Local Universe and Primordial Galaxies (100 hr)

Physical Processes in the ISM of Very Nearby Galaxies

15 resolved nearby galaxies observed in detail in FIR & submm gas and dust properties

- Reference study for local unresolved galaxies and high-z galaxies
- Physics of different ISM components; heating, cooling
- star formation interplay with ISM with conditions spanning a wide range of SF activity, morphology, luminosity & metallicity
- variations inside a galaxy as well as global properties

- ***SPIRE + PACS + HIFI***

Physical Processes in the ISM of Very Nearby Galaxies - Source Selection

Galaxy	type	FOV	D_{25}	Distance	SCUBA?	Spitzer?
M51	late-type spiral	11' x 17'	11.3'	8.0 Mpc	yes	yes
M81	early-type spiral	27' x 14'	26.9'	3.6	yes	yes
NGC2403	low mass spiral	22' x 12'	21.9'	3.2	yes	yes
NGC891	edge on spiral	13.5' x 6'	13.5'	10.5	yes	yes
M83	starburst spiral	13' x 12'	12.9'	4.5	yes	yes
M82	starburst	15' x 15'	11.2'	3.2	yes	yes
NGC6822	quiescent dwarf	16' x 14'	15.5'	0.50	no	yes
IC10	starburst dwarf	10' x 10'	6.3'	0.66	yes	yes
Arp220	late-phase merger	2' x 1'	1.5'	79	yes	yes
NGC4038/39	early-phase merger	6'x6'	$\sim$ 6'	14	yes	yes
NGC1068	Sy2	7' x 6'	7.1'	14.4	yes	yes
NGC4151	Sy1	6' x 5'	6.3'	14	no	yes
CenA	closest E; agn	26' x 20'	25.7'	3.8	yes	yes
NGC4125	normal E	6' x 3"	5.8'	17.5	yes	yes
NGC205	dwarf E	22' x 11'	21.9'	0.72	no	no

Physical Processes in the ISM of Very Nearby Galaxies - Observations

Galaxy	FOV	PACS fields	SPIREphot	PACSphot	PACSspec	HIFI/FTS*	Total
M51	11'x7'	7	2.1	2.1	2.8	3	10.0 hr
M81	27x14'	18	5.4	5.4	5.2	3	19.0 hr
NGC2403	22x12'	14	4.4	4.4	4.4	3	16.2 hr
NGC891	13.5'x6'	9	2.2	2.2	3.3	3	10.7 hr
M83	13x12'	–	3.0	3.0	–	9*	15.0 hr*
M82	15x15'	–	3.7	3.7	–	9*	16.4 hr*
Arp220	2x1'	–	0.3(J)	0.3(J)	–	–	0.6 hr
NGC4038/39	6'x6'	–	1.5	1.5	–	–	3.0 hr
NGC1068	7x6'	–	1.6	1.6	–	–	3.2 hr*
NGC4151	6x5'	–	1.4	1.4	–	3	5.8 hr
CenA	26'x20'	16	6.9	6.9	4.1**	9*	26.9 hr*
NGC4125	6x3'	4	1.2	1.2	2.2	3	7.6 hr
NGC205	22'x11'	14	4.1	4.1	4.4	3	15.6 hr
Total			37.8 hr	37.8 hr	26.4 hr	21/27* hr	150.0 hr

ISM of Local Galaxies: Strategy

- *Diverse* sample of nearby galaxies
- A sample of 15 galaxies
  - Examples chosen to represent very different types of galaxies

early & late type spirals, low mass spiral,
edge-on spiral, starburst spiral,
starburst galaxy, quiescent dwarf,
starburst dwarf, Seyferts, ellipticals

- Extremely well-studied from x-ray to radio
  - First time imaged at FIR at same high resolution as ISO at MIR and SCUBA
  - interrelationship of the various components of the ISM determining how they influence the observed SED

Physical Processes in the ISM of Very Nearby Galaxies – overlap with other GT proposals

HIFI: CI observations in Arp220, NGC1068, NGC4038/39 will be mapped in the center.

PACS: Arp220, NGC1068, NGC4038/39, M82, M83, NGC4151, the nucleus of Cen A, IC10 and NGC6822 are being observed with the FIR lines

SPIRE: IC10 & NGC6822 are a part of the SPIRE key program of dwarfs

Resulting program: removed spectroscopy for the AGNs/SBs and no dwarfs in this program: 150 hr

Herschel Reference Survey of Dust in Galaxies

- Provides the *statistical* survey of dust in the nearby universe
- How dust mass depends on galaxy type and environment
  - Hubble sequence, luminosity, inc. Virgo & Fornax cluster
  - Relate the global dust properties to other tracers of the ISM (molecular gas, atomic gas, X-ray emitting gas)
- Targets Es & S0s – connection with luminous high-z gals
  - Dust evidence: HST IRAS ISOPHOT ISOCAM Spitzer
  - Merging events, cooling flows, mass loss from late-type ☆
  - SPIRE best instrument for the study of dust in elliptical galaxies (λ & sensitivity)
- Redshift =0 to ~ 0.5 benchmark
- Requires SPIRE photometry

Herschel Reference Survey - Sample Selection

- *primary sample: 155 galaxies*
- 2MASS NIR K-band survey (not optically-biased)
  - Traces stellar mass
  - K< 9 => massive galaxies, descendents of early universe luminous objects
- |b| > 54 deg; unaffected by galactic cirrus
- 15 Mpc < D < 25 Mpc : single SPIRE pointing + spatial res.
- 155 galaxies => 67 Es & S0s
- *secondary sample: 165 galaxies*
- 9 < K < 12 & A_B <0.15 only late type galaxies
  - Stellar mass: vital parameter to predict galaxy properties
- 165 late-type gals => 30 galaxies/Hubble type
- *primary + secondary = 320 gals*
- *(includes 94 Virgo + Fornax cluster galaxies)*

****** 100 HOURS of SPIRE time ******

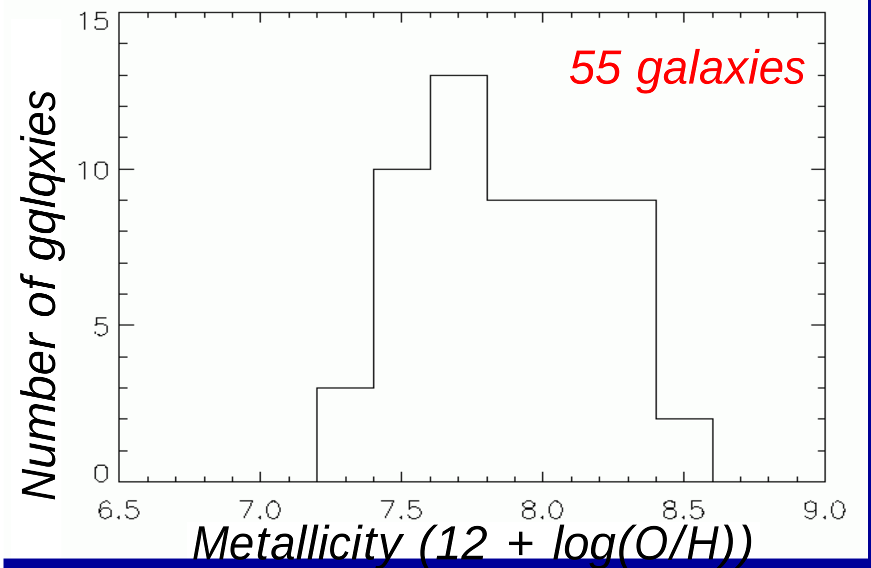
(no overlap with other GT programs)

The ISM in Low Metallicity Environments - Bridging the Gap Between the Local Universe and Primordial Galaxies

- Local universe low metallicity dwarf galaxies - analogs to high-z building blocks
- How do metals evolve in the ISM of galaxies?
- Dust properties appear different from metal-rich counterparts
- How does metallicity influence the ISM structure, radiation field/star formation activity
- Super Star Clusters prevalent in dwarf galaxies - profound impact on the surrounding gas and dust
  - how much SF is completely enshrouded and optically thick in NIR/MIR? (e.g. SBS0335-052, 1/40 solar metallicity)

Requires a cohesive program of SPIRE & PACS FIR/submm photometry and spectroscopy + HIFI (+ other complementary data)

Dwarf Galaxy Survey – Source Selection



Fill metallicity bins: at least 9 galaxies in 7 bins (accuracy 30%) where possible

– Needs at least 55 galaxies to get statistical information in each bin

- Hamburg/SAO & 1st, 2nd Byurakan Surveys
  - A treasure trove of new low Z galaxies
  - Numerous extremely low metallicity: 1/50 to 1/20
- Spitzer Observations
  - All but 10 sources being observed by all 3 Spitzer instruments

Dwarf Galaxy Survey - Observations

- PHOTOMETRY 6 FIR to submm bands
  - 44 single pointings + 11 maps
  - SPIRE BANDS (35h) + PACS (30h)

- Spectroscopy
  - PACS [CII] 2x[OI] [OIII] 2x[NII] 40 gals = 29 h
  - HIFI both [CI] lines: 6 gals (+5 by HIFI) = 6 h

- Overlaps with other GT programs:

PACS observes: spectroscopy of 15 galaxies (omit them here)

HIFI observes: CI in 5 big galaxes. Omit them here.

35 h. SPIRE + 59 h. PACS + 6h HIFI =100 hours

SUMMARY of SAG 2 Key Programs

	SPIRE	PACS	PACS consort	HIFI	HIFI consort	
Nearby galaxies	65h	64h	35h	21h	9h	150h*
Reference survey	100h	-		-		100h
Dwarf galaxies	35h	59h	30h	6h	4h	100h
TOTAL	***200h***	***123h***	***65h***	***27h***	***13h***	***350h***

Directly relevant to project.
Time belongs to PACS or HIFI teams

* Additional 50h 'donated' by PACS

SAG2 (nearby galaxies) Open Issues

- Collaboration: MoU with PACS:
  - Ghent & Vienna (PACS GT) contributing 50h to Nearby Galaxy program
  - Nearby Galaxy program mapping CenA in spectroscopy – PACS GT doing center only
  - Dwarf Galaxies spectral mapping by PACS GT

  - No MoU with HIFI needed

- SAG2 data rights, responsibility policy, authorship?
  - Meeting to be organised before the fall to define responsibilities (first papers? Internal paper proposals ?)

Open Issues (cont’d)

- Data products ?
  - Continuum images of target galaxies
  - Catalogs of compact sources for each galaxy and each continuum level
  - Flux-calibrated data cubes of FTS spectra for central regions
  - Flux-calibrated cubes of FIR spectra of each PACS field (continuum removed)
  - Images of each spectral line observed with PACS or SPIRE FTS; contiguous images obtained with PACS will be stitched together to form a single imageSEDs combinning Spitzer, Astro-F and Herschel data
  - Dedicated web page to compile Herschel results and existing complementary data – *necessary to plan followup observations (now!)*
- Resources ?

Open Issues (cont'd)

- Identify SAG2 or Inter-SAG technical working groups
  - i.e. map making: SAG2 maps: 20' to 30 '
  - Extended emission

SAG 3 Proposals for GT Key Projects

• ***Probing the origin of the stellar IMF*** **(Gould Belt** survey)

Coordinators : Ph. André and P. Saraceno

Wide-field (~140 deg^2) photometric imaging of nearby (d < 0.5 kpc) molecular clouds **Requested : 249 hr** ~ **Allocated : 235 hr**

• ***The birth of high-mass stars*** **(OB star formation** survey)

Coordinators : F. Motte, A. Zavagno, and S. Bontemps

Multi-band imaging survey of high-mass star-forming complexes at intermediate (d < 3 kpc) distances

Requested (Stage 2) : 110 hr > **Allocated : 85 hr**

⟶ OB star formation survey area reduced to ~ 24 deg^2

SAG 3 Total Time Allocation : 320 hr = 235 +85 hr of SPIRE GT

Scientific Motivation

Key questions addressed by the Gould Belt Survey:

- What determines the distribution of stellar masses = the IMF ?
- What generates prestellar cores and what governs their evolution to protostars and proto-brown dwarfs ?
- Timescale of core/star formation ? Slow, quasi-static process or fast, dynamic process ?

Key questions addressed by the OB Star Formation Survey:

- Initial conditions and evolutionary sequence for high-mass star formation ?
- Role of external triggers in massive star formation ?
- Do OB stars form by direct collapse and accretion like low-mass stars or via a different mechanim such as coalescence ?

Two Unified SPIRE/PACS GT Key Projects

Collaborations and Time Contributions

- ***Probing the origin of the stellar IMF*** (**Gould Belt** survey)

Joint SPIRE/PACS GT KP based on a total of 462-482 hr (TBD) of GT :

- 235 hr of SPIRE GT from SAG 3
- 17 hr of SPIRE GT from SAG 4 (18 h of SPIRE + 16 h of PACS common)
- 70 hr of PACS GT from CEA Saclay
- 70 hr of PACS GT from IFSI Rome
- 20 hr of PACS GT from KU Leuven
- 10 hr of PACS GT from MPIA Heidelberg
- 40-60 hr (TBD) of GT from HSC

- ***The birth of high-mass stars*** (**OB star formation** survey)

Joint SPIRE/PACS GT KP based on a total of 125 hr of GT :

- 85 hr of SPIRE GT from SAG 3
- 20 hr of PACS GT from OAMP Marseille
- 20 (15+5) hr of GT from HSC

Plans for data/publication rights

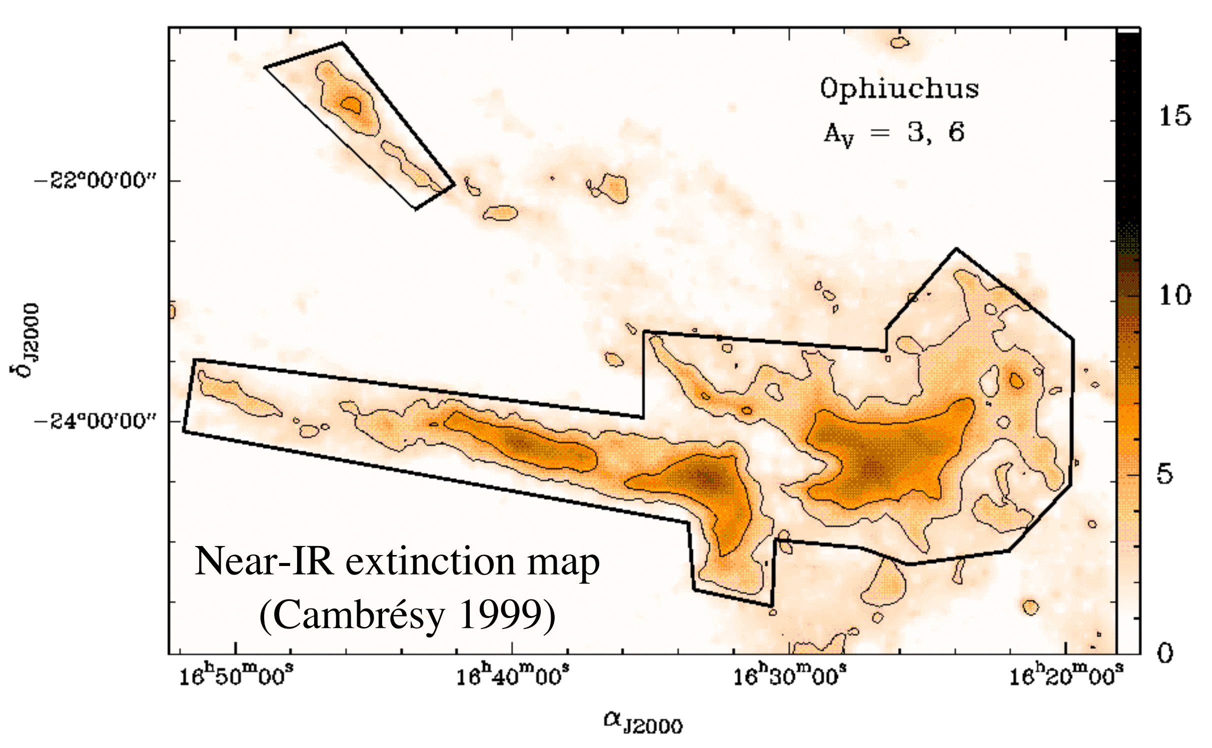
Summary of Proposed Constitution for the Gould Belt KP

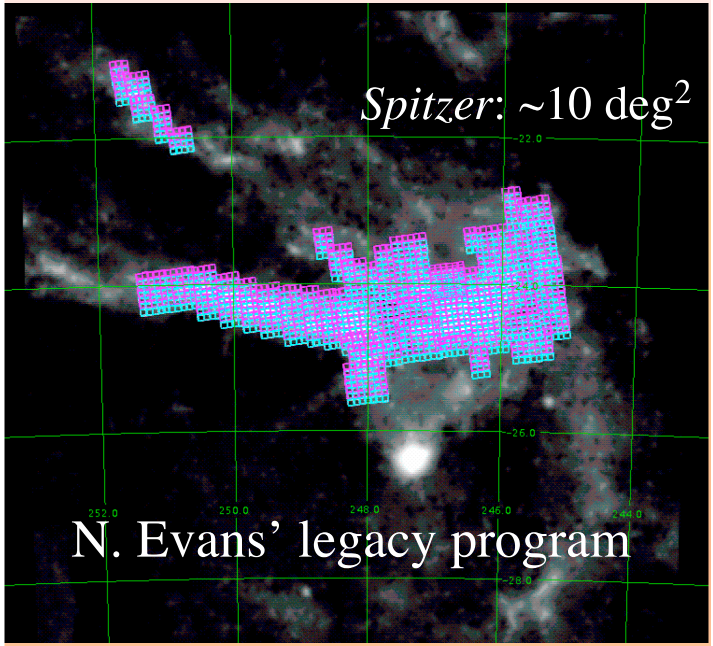
- **Management of the project:** 'Project Science Team' (SAG3 : 9/17 votes)
- Sub-teams responsible for the work on the various regions
- **Data/publication rights** relative to the SPIRE and PACS GT data from the project governed by the rules of the SPIRE and PACS consortia, respectively
- **SPIRE GT data** owned by SAGs 3 & 4 with data/publication rights according to the SPIRE constitution
- **PACS GT data** owned by CEA Saclay, IFSI Rome, INAF Arcetri, KU Leuven, MPIA Heidelberg, HSC according to distribution of fields given in the proposal, with corresponding publication rights
- **Collaborations** between the SPIRE and PACS sub-teams owning/working on the SPIRE and PACS data of a particular region are strongly encouraged
- For each region, such bi-lateral collaborations acquire exclusive publication rights within the GB consortium until 1 year after end of normal proprietary period

Suggested Distribution of Responsible Subteams for the SPIRE Survey of the Gould Belt

Cloud complex	Area (deg^2)	Dist (pc)	Cirrus Noise$_{250\mu}$ (mJy/b)	Required rms$_{250\mu}$ (mJy/beam)	Mass Sensitivity (M_o)	Required Time (hr)	Responsible Subteam(s)
Taurus Taurus	25 5	140	10	20 10	0.02 0.01	24.5 19.5	Cardiff/Saclay ? Saclay/Orsay ?
Ophiuchus	12.5	140	35	20	0.02	12	Saclay/Cardiff ?
Pipe Nebula	3	140	35	20	0.02	2.9	Saclay ?
Polaris Flare	4	150	3	10	0.01	15.6	Orsay/Saclay ?
Lupus	3	100	15	20	0.01	2.9	Rome/RAL ?
Coalsack	1.5	150	90	20	0.02	1.5	Saclay ?
Cham I-III + Musca	5	160	5	10	0.01	19.5	HSC/Orsay
Corona Australis	3	170	10	10	0.01	11.7	RAL/Cardiff ?
Serpens Aquila Rift	12.5 12.5	260	30 90	20	0.07	12 12	Rome /RAL ? Saclay ?
Perseus	4	300	5-15	10	0.04	15.6	Rome/Canada ?
IC 5146	1	400	25	20	0.15	1	Rome ?
Cepheus Flare	9	440	5	20	0.2	9	Canada ?
Orion A Orion B	10 10	450	20	20 20	0.2 0.2	10 10	Saclay/Cardiff ? Rome/Canada ?

Careful selection of the target fields using extinction maps



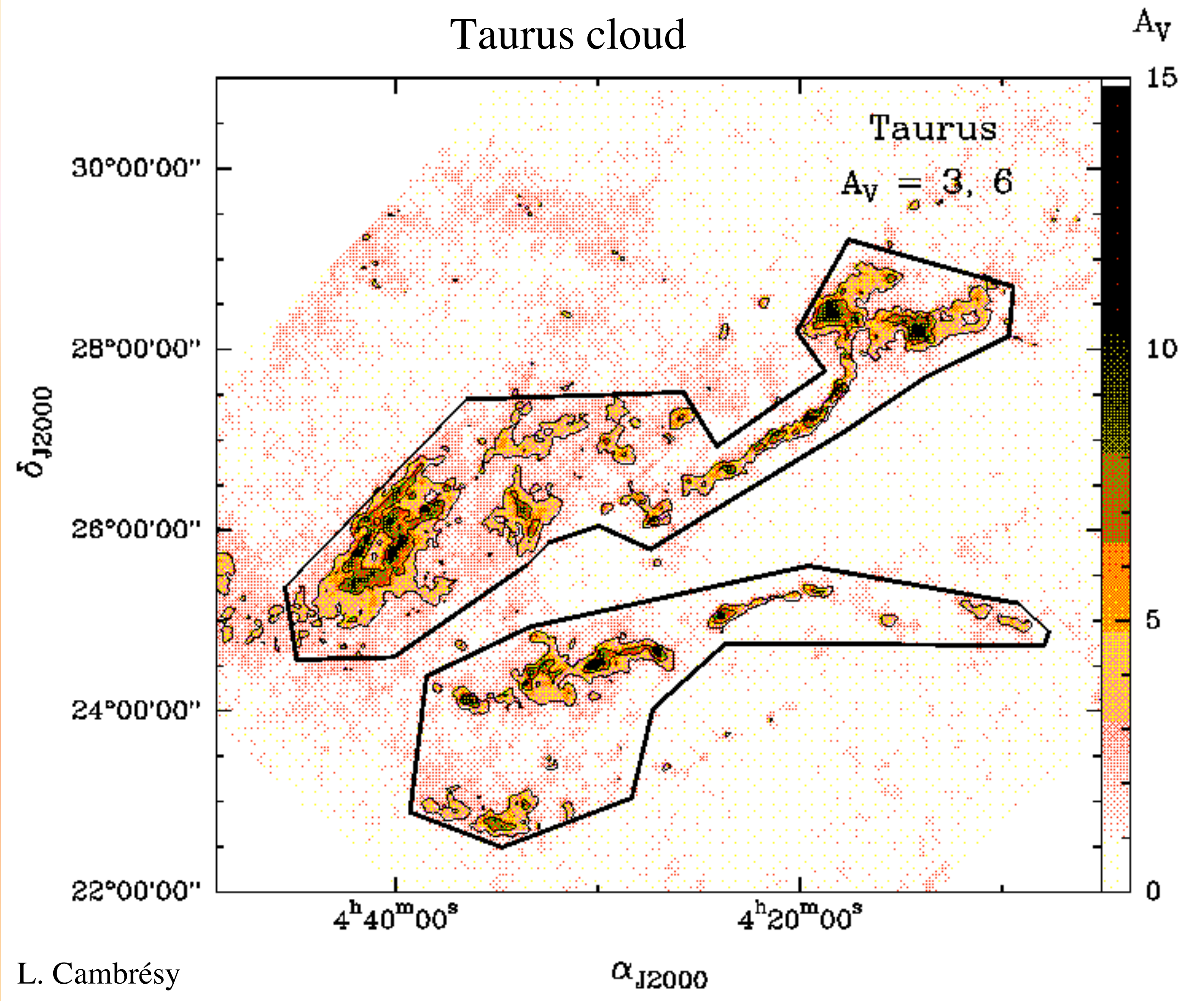


--> ~ 10 deg^2 in scan-map mode with SPIRE

Sensitivity level ~ cirrus confusion noise:

$\sigma_{250} \sim 20$ mJy x $(B_{100}/55\mathrm{MJy/sr})^{1.5}$

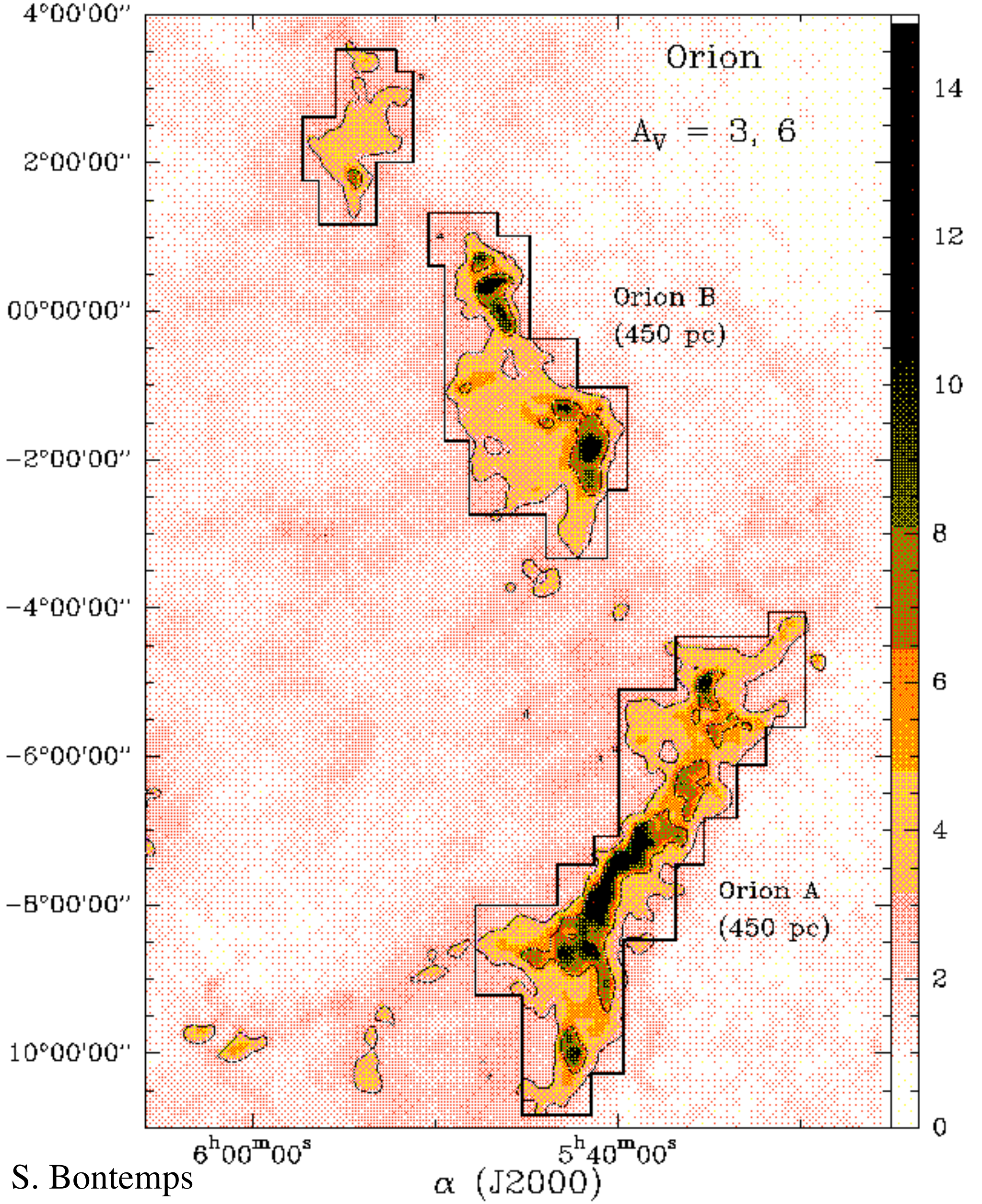
Corresponding column density level: $A_V \sim 1$ (5σ)



→~ 25 deg^2 to rms$_{250}$ ~ 20 mJy/beam in scan-map mode with SPIRE
\+ 5 deg^2 to rms$_{250}$ ~ 10 mJy/beam

Estimated cirrus confusion noise: σ_{250} ~ 10 mJy x (B$_{100}$/35MJy/sr)$^{1.5}$

Orion A/B complex



S. Bontemps

→~ 20 ~ 10+10 deg^2 in scan-map mode with SPIRE

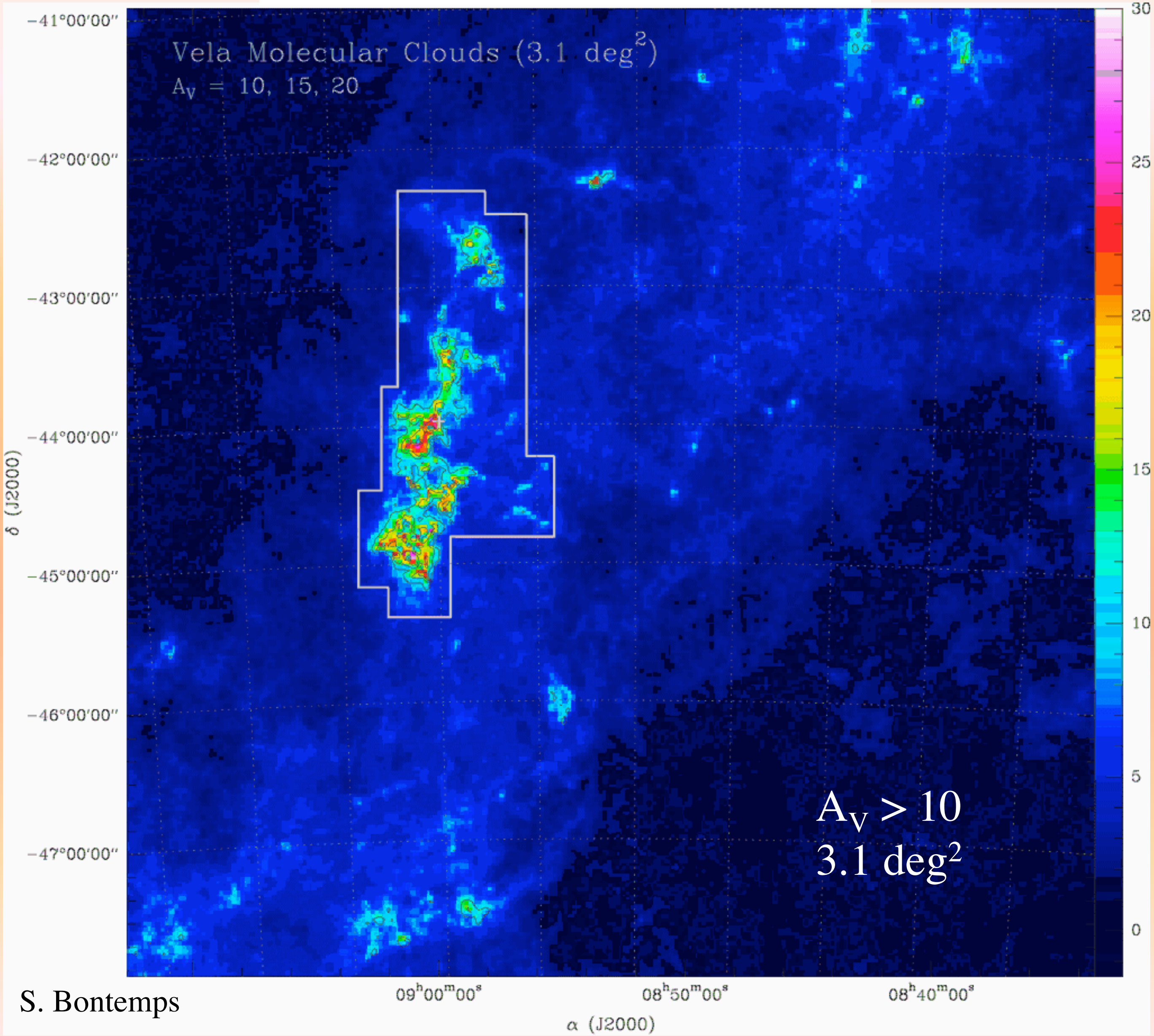
Sensitivity ~ cirrus confusion noise:

$\sigma_{250} \sim 20$ mJy x $(B_{100}/55\text{MJy/sr})^{1.5}$

List of regions to be surveyed with SPIRE/PACS in the 'OB Star Formation' Key Project

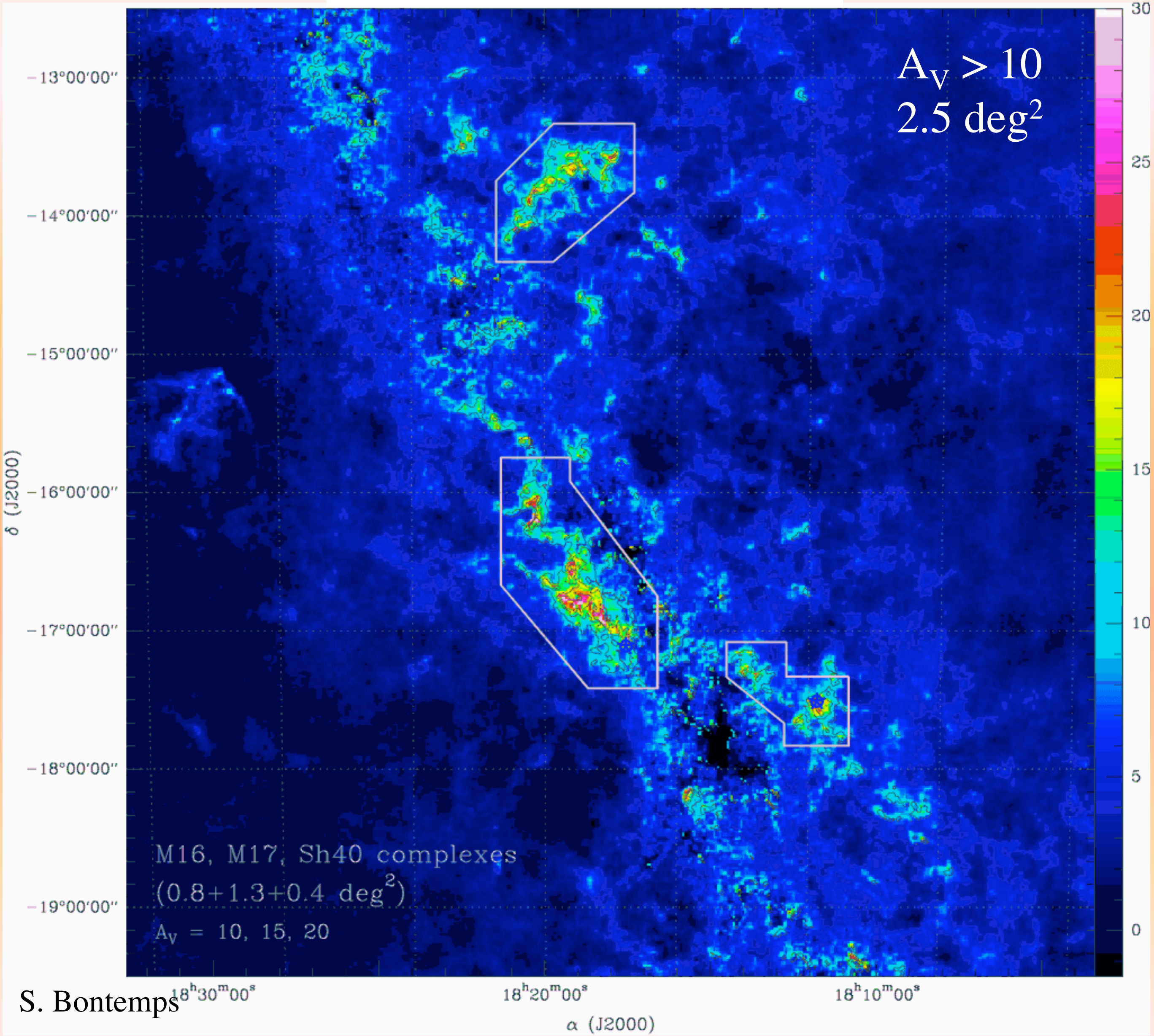
Cloud complex	Area (deg^2)	Dist (kpc)	Cirrus $Noise_{250\mu}$ (mJy/b)	Required $rms_{250\mu}$ (mJy/beam)	Required SPIRE+PACS Time (hr)
Vela	3.1	0.7	40	20	13
Mon R1/R2 + Rosette	3.5	0.8	30	20	14.5
Cygnus X	6	1.7	100	20	25
M16/M17 /Sh40	2.5	1.7	< 1000	20	10.5
NGC 6334 /6357 /6231	3.5	1.7	< 1000	20	14.5
W3/W5 /KR140	1.5	2.2	10	20	6.5
NGC 7538	0.6	2.8	25	20	2.5
W48	3.9	3.0	10	20	16.5

Vela Molecular Cloud Complex



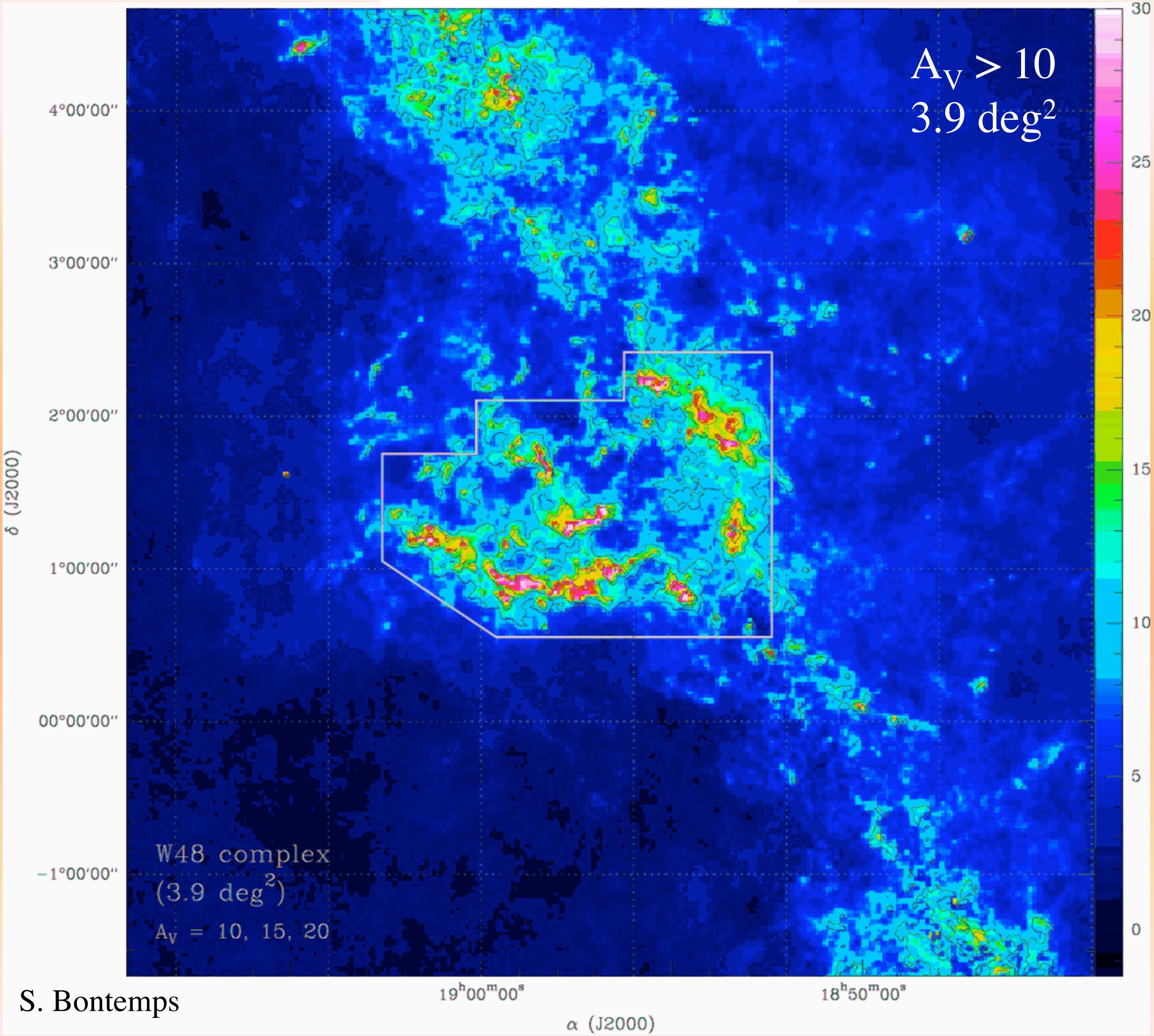
S. Bontemps

M16, M17, Sh40 Complex



S. Bontemps

W48 Cloud Complex



S. Bontemps

Exploitation Plan

Team focus:

- Complete catalog of starless condensations and Class 0 protostars (to be delivered early)

→ Lifetimes of the various stages (as a function of density & mass)

→ Luminosity & mass functions

→ Temperature & density structure of the nearest condensations

- Genetic link between low surface brighteness structures and compact self-gravitating condensations

Legacy value:

- The proposed surveys will provide unique, long-lasting databases, including in the southern hemisphere, for future high-resolution molecular line/dust continuum studies with ground-based instruments (e.g. ALMA)

Data Product Plans

- At the end of the proprietary period:
  - Calibrated multi-band maps of the target regions at 110-500 μm
  - Preliminary catalog of compact sources with estimated sizes, peak/integrated flux densities, background level
- After the end of the proprietary period:
  - Updated release(s) of the compact source catalog
  - Extended source catalog

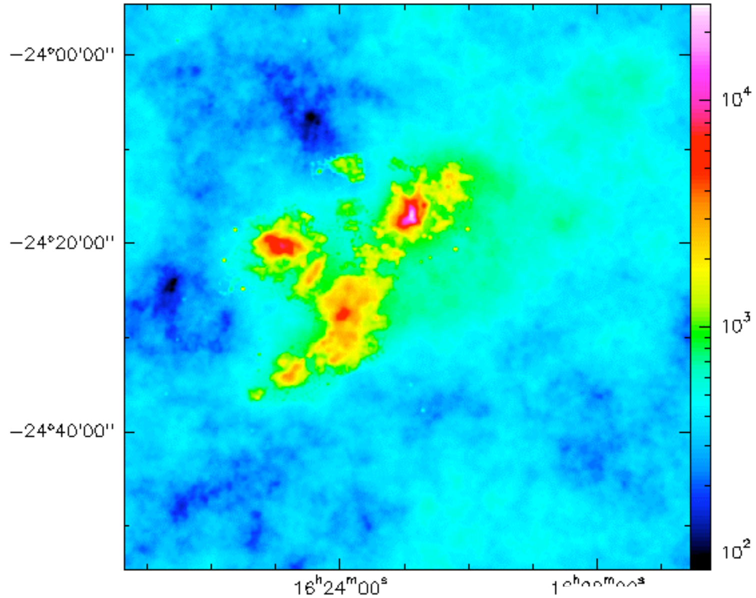
Technical Working Group within SAG 3

- Simulations : B. Sibthorpe, S. Pezzuto, D. Ward-Thompson, Ph.André, N. Schneider
- Pipeline : P. Martin, G. White, S. Molinari, A. Abergel, F. Motte
  - Map making
  - Source extraction
  - Photometric calibration

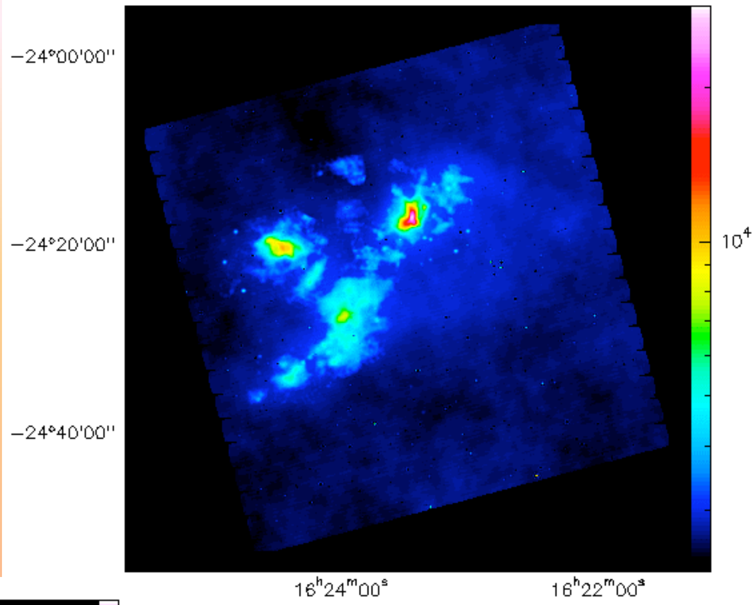
Synergies with HiGal OT KP

Simulations of the SPIRE/PACS mapping

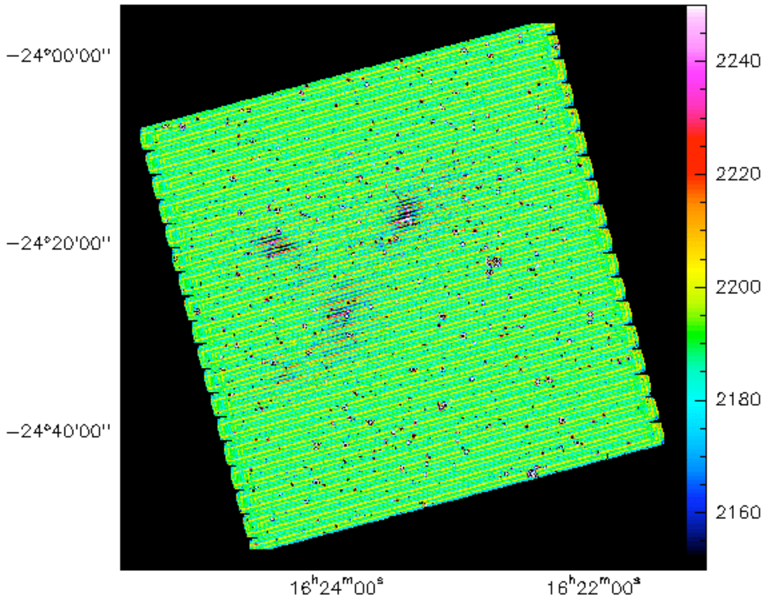
Sky Input



Simulated Output



Difference



SAG 4 : ISM

Alain Abergel, Jean-Paul Baluteau

1 Guaranteed Time Key Project: “Evolution of interstellar dust“

Allocation: 180 hours

Evolution of interstellar dust

- **Unbiased survey with different :**

  Av, Illumination, Density, History, Star forming activity

- **Mapping and Spectroscopy : SPIRE + PACS, coordinated with HIFI**

  Dust SED : Continuum

  Physical conditions : CI, CII, OI, high-level lines of CO.

Relative contribution of all processes acting on the dust particles :

Fragmentation / Coagulation / Condensation / Evaporation / Photo-processing

… **in all interstellar environments :**

- Most diffuse regions (shock processed dust)
- Cirrus, Molecular Clouds
- Low excitation PDRs, Hot PDRs with HII regions
- Pre-stellar cores and protostars

Complement the large scale mapping of star forming regions :

Mapping limited to PDRs and low density regions

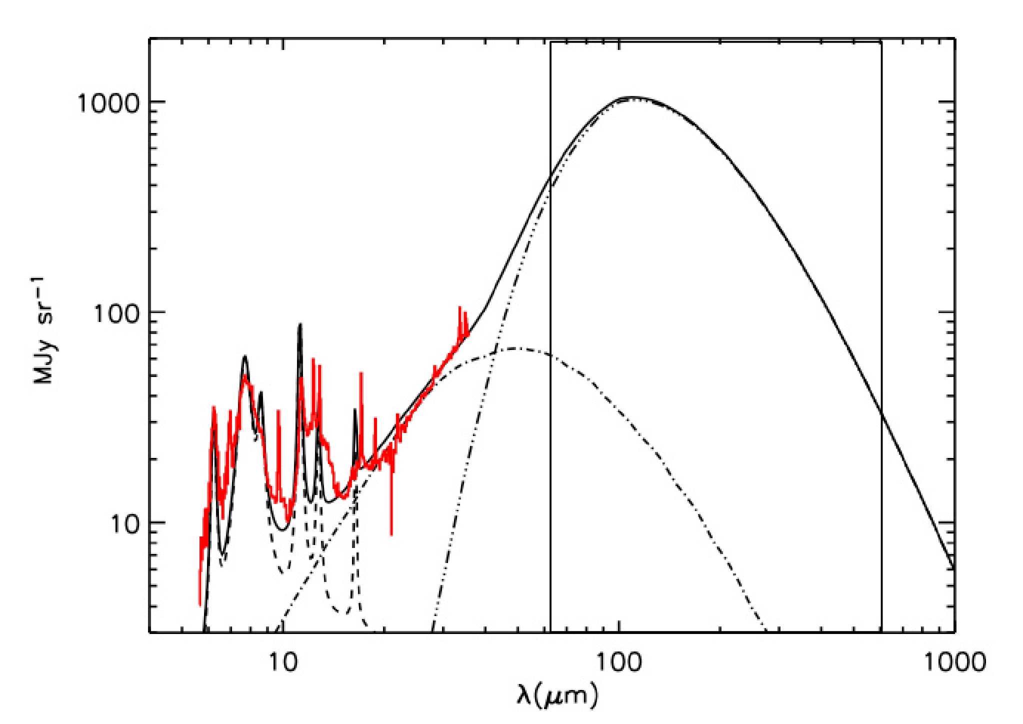
Selected targets in nearby regions : Precise physical conditions, Simple geometry

Spitzer + ASTROF + Herschel + Planck :
Full emission spectrum of interstellar dust.

Horsehead Nebula with IRS

Compiegne et al. (in prep.)

ASTROF observations (rank 1)



- IRS: Evolution of PAHs and Very Small Grains, in relation with the physical Conditions, Compiegne et al. (in prep)

  H_2 lines: excitation conditions, structure, Habart et al. (in prep)

- SPIRE and PACS : Evolution of Large Grains and Very Small Grains + Main cooling lines

Evolution of interstellar dust : From stage-2 to stage-3 proposals

- Update the observing program
- Data exchange with SAG 3
- Discussions with the HIFI teams for coordinated observations
- Impacts of different sensitivities
- Science exploitation
- Data processing
- First definition of the data products

Evolution of interstellar dust : Old Stage 2 Observing Program

Source types	SPIRE Mapping deg^2, 1σ, hours	PACS Mapping deg^2, 1σ, hours	SPIRE LR N, hours	SPIRE HR N, hours	PACS HR N, hours	HIFI HR hours
Shock pr. dust	1.8, 10 mJy, 8 h	0.45, 7 mJy, 8 h				
Cir-Mol. Cl.	5.05, 10 mJy, 21 h	0.7, 7 mJy, 12 h	1, 10 h		1, 2 h	
PDRs	0.12, 10 mJy, 1 h	0.12, 7 mJy, 3 h	12, 20 h	36, 36 h	36, 18 h	
Hot PDRs	1.8, 15 mJy, 2 h			12, 12 h	PACS LAM	
Pre-stellar c.			12, 9 h			12 h
Cl. 0 protost.			12, 3 h	12, 12 h		
Cl. I protost.			12, 3 h	12, 12 h		
Total (hours)	32 h (18 common)	23 h (+16 PACS/CEA)	45 h	72h	20h	12h

Total = 203 h SPIRE time, 180 h allocated

Remove : - one classical PDR
- the HIFI observations of pre-stellar cores (12 h):
(challenging observations done in the spectral survey program of HIFI for L1544)

Only SPIRE and PACS observations

Evolution of interstellar dust : Stage 3 Observing Program

Source types	SPIRE Mapping deg^2, 1σ, hours	PACS Mapping deg^2, 1σ, hours	SPIRE LR N, hours	SPIRE HR N, hours	PACS HR hours
Shock pr. dust	1.8, 10 mJy, 8 h	0.45, 7 mJy, 8 h			
Cir-Mol. Cl.	5.05, 10 mJy, 21 h	0.7, 7 mJy, 12 h	1, 10 h		1, 2 h
PDRs	0.12, 10 mJy, 1 h	0.12, 7 mJy, 3 h	11, 18 h	33, 33 h	33, 16 h
Hot PDRs	1.1, 15 mJy, 2 h			12, 12 h	PACS LAM
Pre-stellar c.			12, 9 h		
Cl. 0 protost.			12, 3 h	12, 12 h	
Cl. I protost.			12, 3 h	12, 12 h	
Total (hours)	32 h	23 h (+ 16 PACS/CEA)	43 h	69h	18h

Total = 201 h = 180 h SPIRE time

+ 16 h from SAG 3 (Polaris, Taurus)

+ 5 h HIFI (common spectroscopic observations of PDRs: in discussion)

Source	I_{100}[1]	A_V	Physical Properties			Obs[2].
Shock processed dust			n_H, H cm^{-3}	v, km s^{-1}	HI/CO[3]	deg^2
Spica H II	1-4	0.1	0.5	0	n/n	0.9, 0
IVC G86.5+59.6	1-2	0.1	10	-40	y/n	0.9, 0
Cirrus to Molecular Clouds			α[4]	f_{CO}[5]		
Ursa Major	4-8	< 1	100	0.	y/y	1.5, 0
Polaris flare	5-10	0.3-2	10	0.3	y/y	1.5, 0
G300-17/Cham III	8-18	1-3	2/5	0.1/1	n/y	1.3, 0
Taurus filament	10-20	1-3	1	1	n/y	0.75, 0
PDRs		d (pc)	T_{eff} (K), star	G_0[6]	Geometry[7]	arcmin^2, N
NGC7023	1000	440	17,000, B3Ve	1500	E-O	16, 3
NGC7023 E	200	440	17,000, B3Ve	200	E-O	16, 3
NGC2023	2000	450	23,000, B1.5V	1000	E-O, C	100, 3
Horsehead	500	450	33,000, O9.5V	100	E-O	64, 3
IC63	100	230	30,000, B0.5IV	650	E-O, CG	16, 3
IC59	100	230	30,000, B0.5IV	480	E-O	16, 3
Ced201	100	420	10,500, B9.5V	200	F-O	16, 3
ρ Oph filament	500	160	22,000, B2V	400	E-O, C	16, 3
ρ Oph SR-3	500	160	13,000, B7	1000	S	16, 3
L1721	100	130	22,000, B2IV	10	E-O	150, 3
California	100	3500	37,000, O7	30	E-O	16, 3
Hot PDRs with H II regions		d (pc)	T_{eff} (K), star	G_0[6]	Geometry[7]	arcmin^2, N
Sh2-104, Cygnus		4000			Shell, F-O	800, 3
RCW 79		4300			Shell, F-O	1280, 3
RCW 82		2900			Shell, F-O	800, 3
RCW120		1200			Shell, F-O	960, 3
Pre-stellar cores		d (pc)	Mass			
L1544, Taurus		140				0, 3
L1521 E, Taurus		140				0, 3
L1521 F, Taurus		140				0, 3
L1689B, Ophiuchus		140				0, 3
Class 0 protostars		d (pc)	Mass			
IRAM04191, Taurus		140	Low			0, 3
IRAS16293, Ophiuchus		140	Intermediate			0, 3
N1333-IRAS4, Perseus		350	Intermediate			0, 3
N6334I(N), NGC6334		1700	High			0, 3
Class I protostars		d (pc)	Mass	mm env.		
IRAS04191, Taurus		140	Low	yes		0, 3
L1489-IRS, Taurus		140	Low	no		0, 3
EL29, Ophiuchus		140	Intermediate			0, 3
N6334I, NGC6334		1700	High			0, 3

, 2006

Source	I_{100}[1]
Shock processed dust	
Spica H II	1-4
IVC G86.5+59.6	1-2
Cirrus to Molecular Clouds	
Ursa Major	4-8
Polaris flare	5-10
G300-17/Cham III	8-18
Taurus filament	10-20
PDRs	
NGC7023	1000
NGC7023 E	200
NGC2023	2000
Horsehead	500
IC63	100
IC59	100
Ced201	100
ρ Oph filament	500
ρ Oph SR-3	500
L1721	100
California	100
Hot PDRs with H II regions	
Sh2-104, Cygnus	
RCW 79	
RCW 82	
RCW120	
Pre-stellar cores	
L1544, Taurus	
L1521 E, Taurus	
L1521 F, Taurus	
L1689B, Ophiuchus	
Class 0 protostars	
IRAM04191, Taurus	
IRAS16293, Ophiuchus	
N1333-IRAS4, Perseus	
N6334I(N), NGC6334	
Class I protostars	
IRAS04191, Taurus	
L1489-IRS, Taurus	
EL29, Ophiuchus	
N6334I, NGC6334	

Evolution of interstellar dust: Discussion with other GT KP teams

Survey of nearby star-forming cloud complexes (SPIRE/PACS GT Key project) :

- Common sources: Polaris flare and Taurus
- We give 17 hours of our SPIRE time.
- We have access to the equivalent time of SAG 3 data

HIFI GT KP teams:

- The dense and warm interstellar medium (12 PDRs):
  - Goal: Chemical and dynamical analysis of PDRs
  - Scientific Connexions: Energy budget, Density structures, dust surface chemistry, …
  - Actually: 5 common sources : Horsehead, NGC7023, IC 63, Ced 201, ρ Oph.
  - Comparable PACS HR observations:
    - Common strategy + agreement in discussion
  - More common sources :
    - Orion Bar in our proposal
    - L1721 in the HIFI proposal: in discussion
- Other common objects
  - Spectral survey: 1 Common object (L1544 : pre-stellar core)
  - Water in star forming regions:
    - 2 pre-stellar cores + 2 class-0 protostar + 2 class-1 protostars
- We suggest to put common objects in top priority in SPIRE and HIFI proposals

Evolution of interstellar dust: Impact on different sensitivities

Main goal: detect the evolution of dust from the outer part regions of all objects, where the emission is near 0

Increase by a factor of 2 : We will not decrease the total exposure times, but :

- increase the sensitivity in the outer regions
- and/or observe more positions for the brightest sources (e.g., four hot PDRs)

Decrease by a factor of 2 : Keep the initial sensitivities : Reduce the number of objects

2-4 classical PDRs, 1-2 hot PDRs, 1-2 pre-stellar cores, 1-2 Cl-0 protostars, 1-2 CL-1 protostars

1 diffuse region to study the effects of shocks

Keep most of common sources (2 fields with SAG 3 and the common sources with HIFI)

SED measurement with SPIRE/FTS in a cirrus: 10 hours → 40 hours (likely dropped out)

Evolution of interstellar dust: Science exploitation

< 1 Year:

In all objects, from SPIRE and PACS data:

- Optical properties and abundance of the dust: dust models + radiative transfer tools
- Physical conditions: PDR models
- Density structures, Energy Budget

\+ for hot PDRs : source extraction of massive young stars

> 1 Year:

Interpretation: impact of physical processes acting on dust

- Shocks, Coagulation, Fragmentation, …
- Laboratory measurements

Value of the archive in the longer term:

Dust models including all dynamical and evolutionary processes acting on dust

Used to derive key physical quantities (mass, dust/gas, abundances,…) in a lot of objects

Component separations

Evolution of interstellar dust: Data processing

Start: level-2 products delivered by the HSC

Goals:

- First version of the data processed in a homogenous way after 1 year
- Broad-band maps photometric valid on all observed angular scales
- Intensity maps for the main lines and calibrated SED maps

Actions during the proprietary period (and after…) :

- Correction of residual artefacts using redundant coverage of the same region
- Correction of the photometric calibration for the extended emission (maps and spectra)
- Extraction of the main lines in HR spectra, and parameters (T,β) from PACS+ LR SPIRE spectra
- Fully sample spectral maps for SPIRE/FTS data.
- Photometric validation

  DIRBE, Planck if available, cross-calibration broad-band maps-spectra, …

Evolution of interstellar dust : Data products

< 1 Year: First release of processed data

- Broad band maps, calibrated for the extended emission
- For diffuse regions, maps of T and β
- Intensities of the detected lines for each pixel of spectroscopic observations
- LR spectra for each pixel of spectroscopic observations
- A first version of fully sample spectral maps

With uncertainties

After 2 years: Second release

After 3 years: Final products

Source	I_{100}[1]
Shock processed dust	
Spica H II	1-4
IVC G86.5+59.6	1-2
Cirrus to Molecular Clouds	
Ursa Major	4-8
Polaris flare	5-10
G300-17/Cham III	8-18
Taurus filament	10-20
PDRs	
NGC7023	1000
NGC7023 E	200
NGC2023	2000
Horsehead	500
IC63	100
IC59	100
Ced201	100
ρ Oph filament	500
ρ Oph SR-3	500
L1721	100
California	100
Hot PDRs with H II regions	
Sh2-104, Cygnus	
RCW 79	
RCW 82	
RCW120	
Pre-stellar cores	
L1544, Taurus	
L1521 E, Taurus	
L1521 F, Taurus	
L1689B, Ophiuchus	
Class 0 protostars	
IRAM04191, Taurus	
IRAS16293, Ophiuchus	
N1333-IRAS4, Perseus	
N6334I(N), NGC6334	
Class I protostars	
IRAS04191, Taurus	
L1489-IRS, Taurus	
EL29, Ophiuchus	
N6334I, NGC6334	

Evolution of interstellar dust: Organisation of our team

Scientific organisation
- Preliminary works:
  - Modelling (dust, radiative transfers tools, PDRs, …)
  - Other observations: Spitzer, ASTROF, ground-based
  - Simulations
  - Laboratory works
  - …
- Proprietary work
- Longer term

Sub-teams for each class of objects

Technical organisation
- Most of the work to be performed in, or in collaboration with, the ICC.
- Preliminary work
  - Preparation of the observations
  - Tools to process the data (map-making, spectral maps, …)
  - Calibration for the extended emission
- Proprietary period
- Longer term

SAG 5 Solar System

Bruce Swinyard

Original Proposal

- Three Solar System themes to address the nature of the material from which the Solar system formed and the co-evolution of the TNOs and outer planets
- 50 hours allocated by STAC in 2004
- However an Open Time key project is now proposed led by Thos Mueller
- As our KBO observations don't fit into the main "Water in the Solar System" KP they would be scooped by the OT-KP
- We have decided therefore to join the OT consortium with our KBO observations and to re-orientate the SPIRE GT and merge with the overall Herschel Solar System proposal

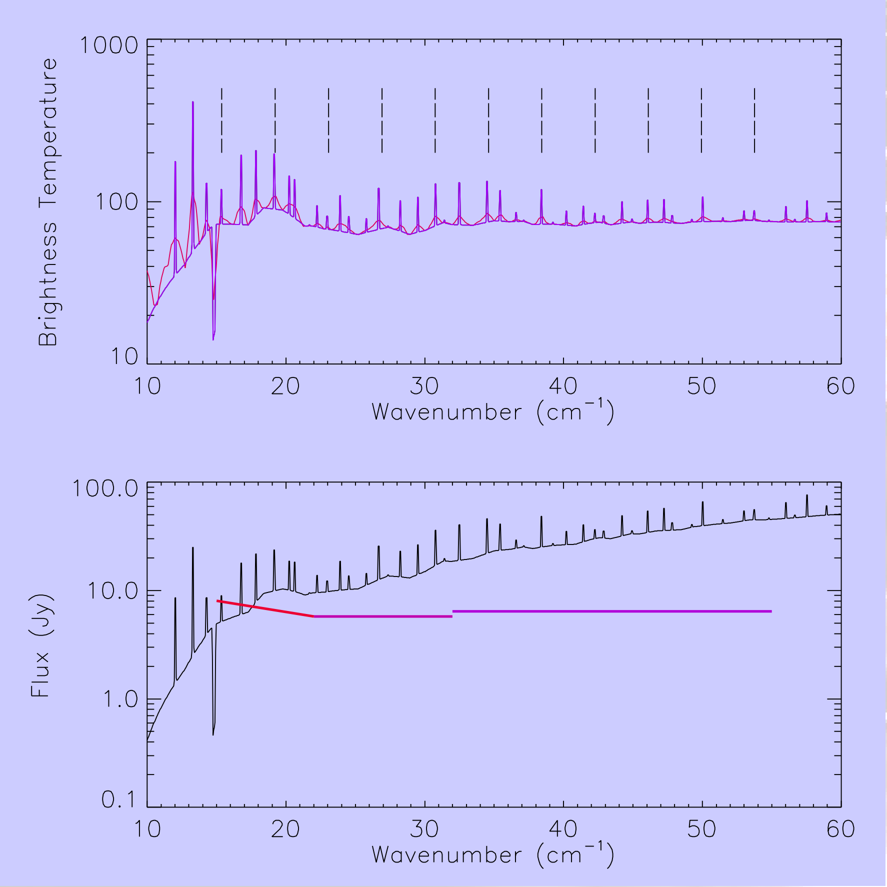
Proposal for redistribution of SPIRE time

- Make long spectroscopic observation of Titan – looking for isotopic lines and water (probably with PACS)
- Observe Neptune and Uranus with SPIRE as before
- Observe Neptune and Uranus HD lines with very high S/N to complement full PACS spectrum (NL time)
- Ensure comets are observed with high signal to noise more integration time and mapping observations

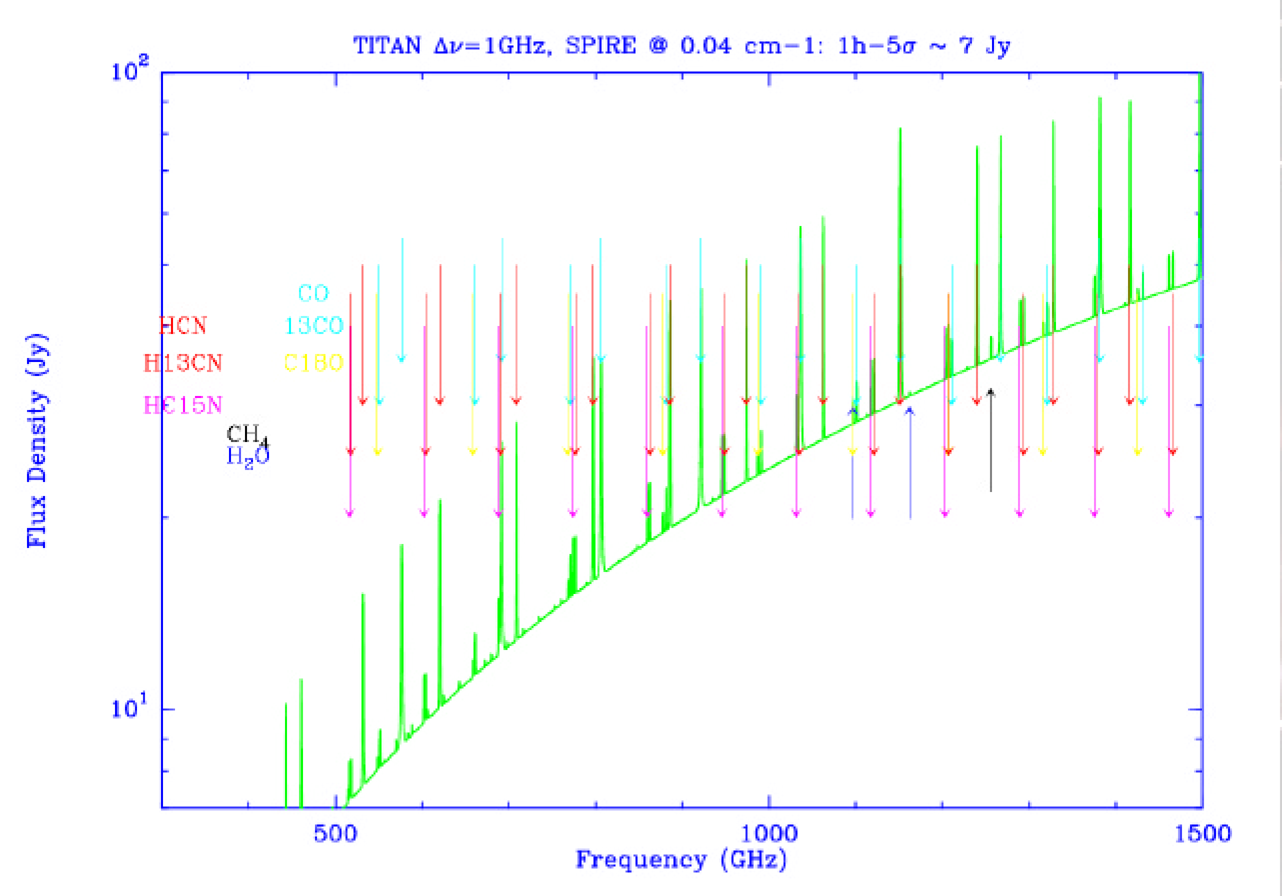
Time contributions to the Herschel Solar System GT-KP

- Total time for the Solar system project will be 282 Hrs made up as follows:
  - HIFI – 192 Hrs
    - 108 Hrs German HIFI time (Paul Hartogh is consortium leader)
    - NL 30 Hrs
    - US 16 Hrs
    - Poland 20 Hrs
    - France 11 Hrs
    - Spain 1.5 Hr
    - Switzerland 6 Hr
  - PACS (Belgian time) 20 Hrs – comets only
  - SPIRE 50 Hours
  - Mission scientists 20 Hrs
    - 10 Hrs Pepe Cernicharo for water in comets
    - 10 Hrs Pierre Encrenaz for TBD
- No formal agreement of division of data rights etc – still to be discussed.

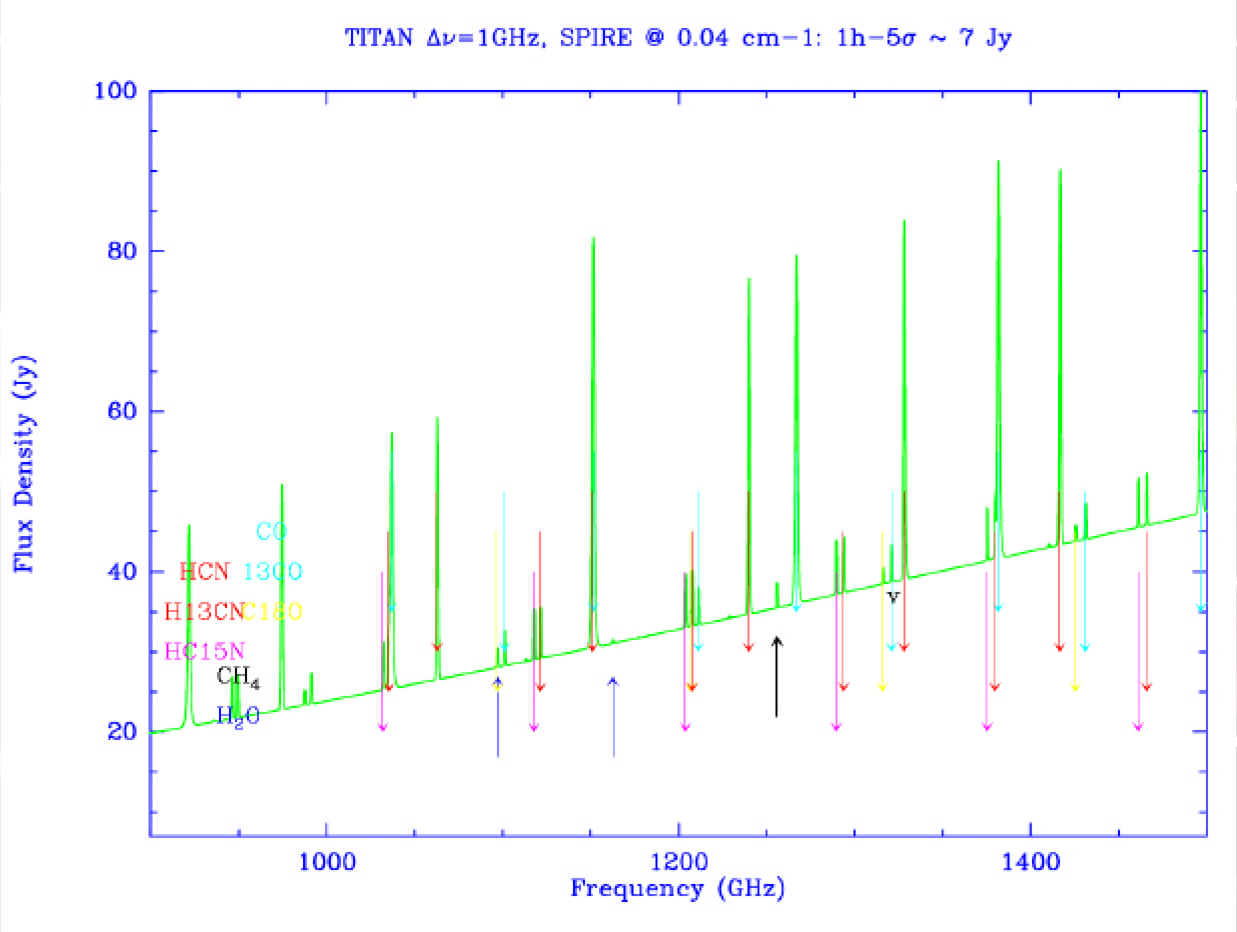
Titan – CIRS and SPIRE compared



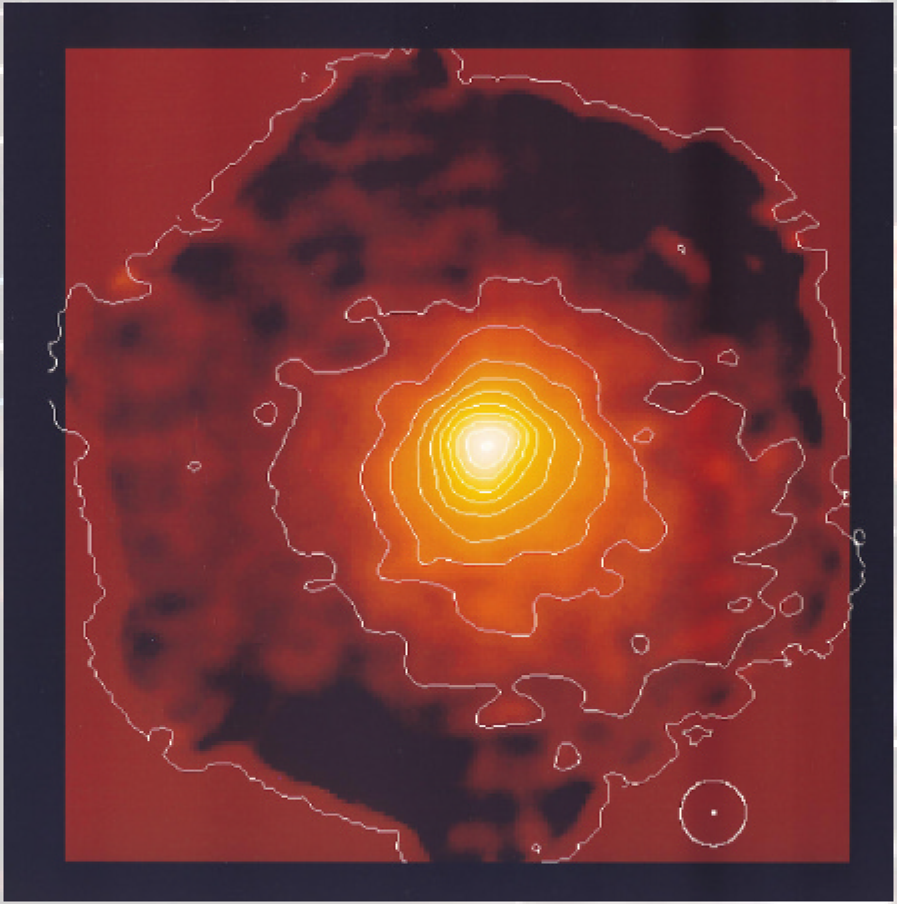
Titan – model spectrum



Titan – model spectrum



Mapping Comets
Hale-Bopp at 1 AU with SCUBA



HD within Uranus and Neptune

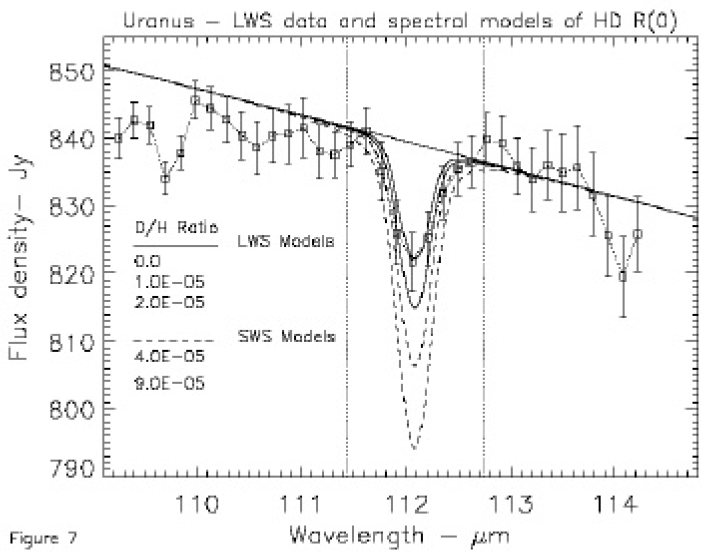


Figure 7

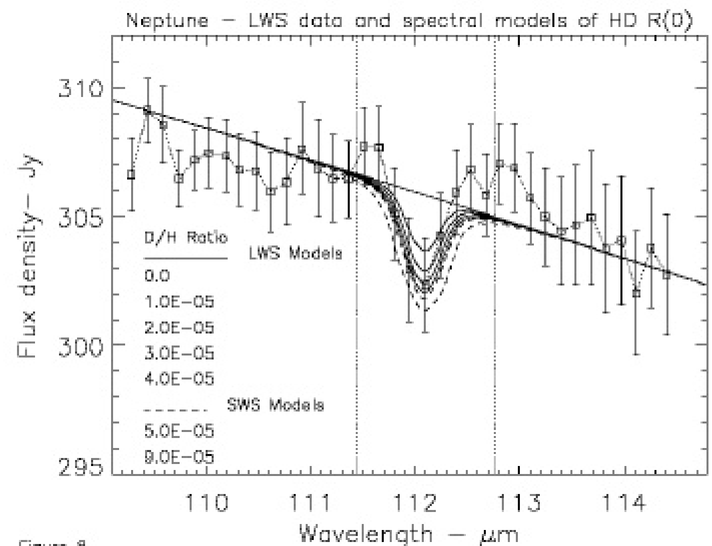


Figure 8

- **Need to cover reasonable chunk of the spectrum in order to properly measure the continuum**

Breakdown of SPIRE observing time

- Comets
  - Full resolution spectroscopy 14 hours
  - Dust mapping 13 hours
  - Total: 27 hours (depends on the number of long period comets)
- Titan
  - Full resolution SPIRE spectroscopy 10 hours
  - PACS spectrometer long integrations on water lines - ~3.5 hours
- Uranus and Neptune
  - Full resolution SPIRE spectroscopy on each planet with 4 repeated observations to look for time variability and remove contamination - 8 hours total
  - PACS spectrometer long integrations on HD lines 1 hour each

Data processing and modelling

- Comets
  - Modelling – Meudon/RAL (+CSIC/Lindau?)
  - Data products
    - Point sources
      - calibrated spectra and 3 band photometry with backgrounds subtracted
    - Extended sources
      - calibrated maps in each photometric band with backgrounds subtracted
      - Calibrated line emission maps for identfied lines in spectrum with background subtracted

Data processing and modelling

- Comets (ctd)
  - Data processing
    - Start from standard products
    - Photometry on point sources
      - close to a standard product?
      - available quickly ~1 month
    - Spectroscopy on point sources
      - close to a standard product?
      - available quickly ~ 1 month
    - Photometric maps
      - diffuse emission is difficult to map
      - generic problem for SPIRE
      - use ICC effort from Cardiff and RAL
    - Line maps
      - even more problematic
      - another generic problem for SPIRE
      - use ICC effort from Lethbridge and RAL

Data processing and modelling

- Titan
  - Modelling – Meudon
  - Data products calibrated spectrum in Jy with background subtracted
  - Data Processing
    - PACS spectra – To be discussed with Helmut Feuchtgruber
    - SPIRE spectrum
      - long integration with possible contamination problems from Saturn
      - standard product may not be suitable
      - may have to start from an earlier point to the processing
    - Use ICC effort from Lethbridge and RAL plus additional effort with dedicated RA

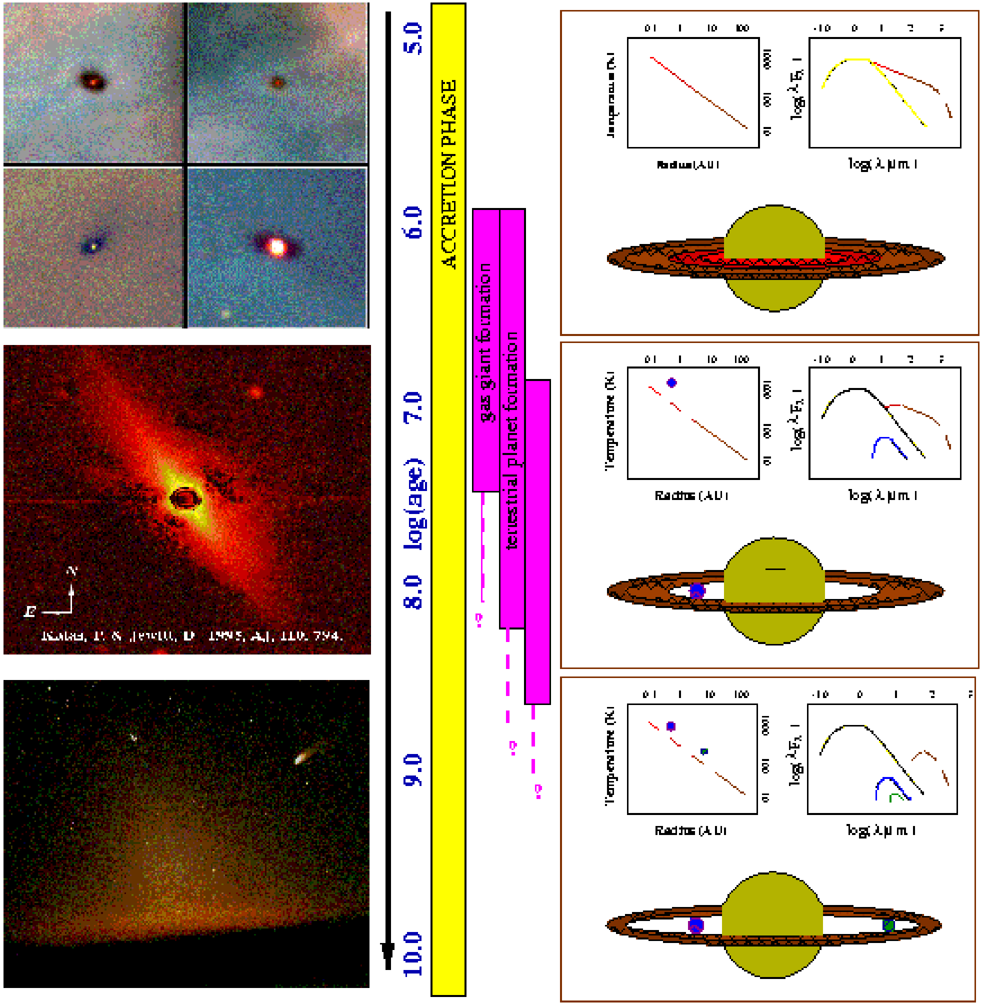
Data processing and modelling

- Uranus and Neptune
  - Modelling – JPL/Meudon/RAL
  - Data products – calibrated spectra in T_b and Jy with background subtracted
  - Data Processing
    - PACS spectra – to be discussed with Helmut
    - SPIRE spectra
      - start from standard product
      - close to a standard product?
      - available quickly ~ 1 month

Consortium and data rights

- Two new “consultants” are proposed
  - Glenn Orton from JPL
  - Helmut Feuchtgruber from MPE
- Data belongs to everybody in SPIRE consortium
- Need to detail who does what on which sources
- Access to/from rest of Herschel Solar System consortium to be negotiated with Paul et al – meeting on April 3rd

SAG6: Disk evolution



Proposers

A. List of proposers and institutes

Project Scientist team: Göran Pilbratt, Malcolm Fridlund and Ana Heras (ESTEC)

Mission Scientist: Paul Harvey (Univ. of Texas, US)

SPIRE team: René Liseau and Göran Olofsson (Stockholm Observatory, Sweden)
Mike Barlow (UCL, UK)
Helen Walker and T.L Lim (RAL, UK)
James di Francesco (HIA, Canada)
Steve Eales (Cardiff, UK)
Rob Ivison (ROE, UK)
Martin Cohen (UC, Berkely, US)

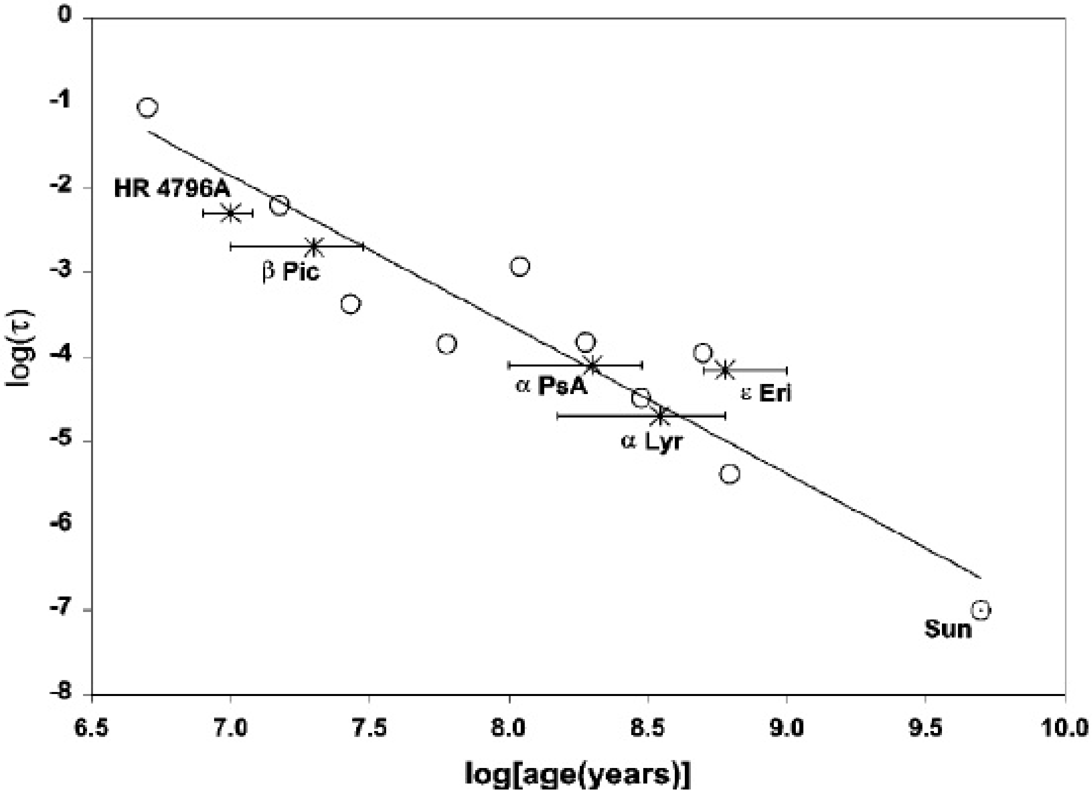
PACS team: Bram Acke, Joris Blommaert, Pierre Royer, Bart Vandenbussche, Christoffel Waelkens (Leuven)
Jeroen Bouwman, Thomas Henning (MPI, Heidelberg)
Eric Pantin (CEA, France)

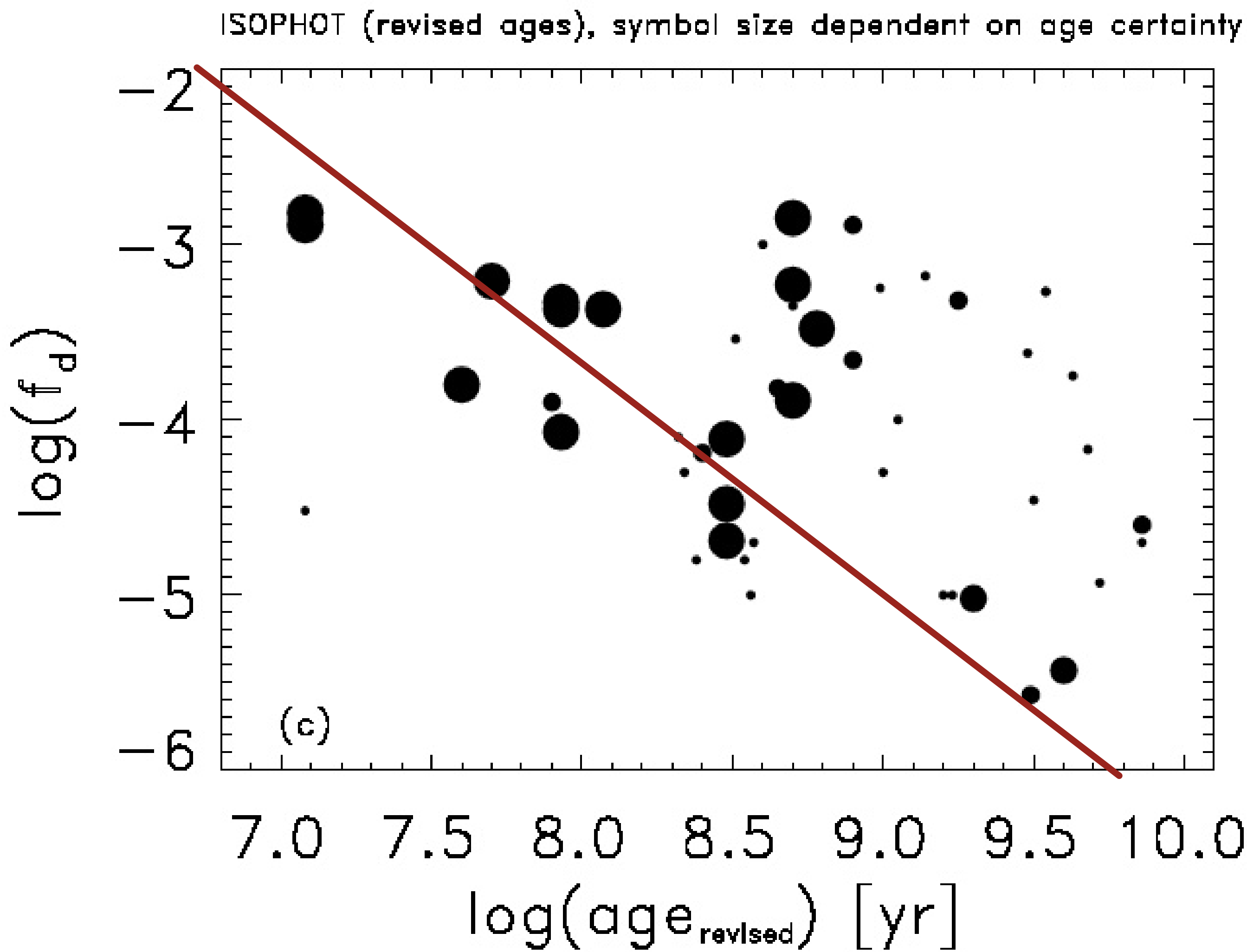
Time contributions

Project Scientist, G. Pilbratt: 70h
Mission Scientist, P. Harvey: 30h
SPIRE GT: 70h
PACS GT, Belgium: 50h
PACS GT, France: 10h

SUM 230h

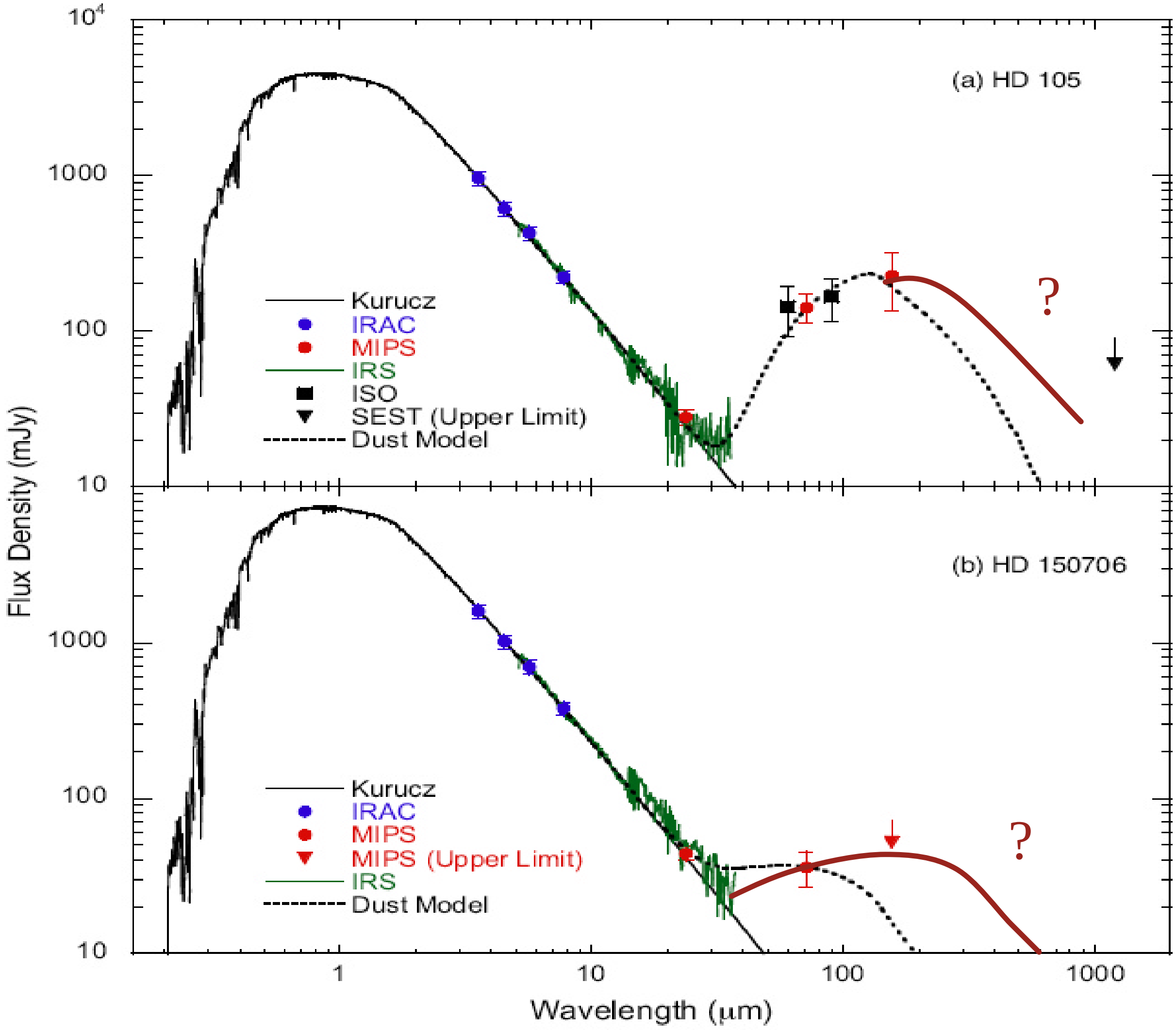
A smooth decline of dust with time?





ISOPHOT (revised ages), symbol size dependent on age certainty
−2
−3
−4
−5
−6
log(f_d)
(c)
7.0
7.5
8.0
8.5
9.0
9.5
10.0
log(age_revised) [yr]

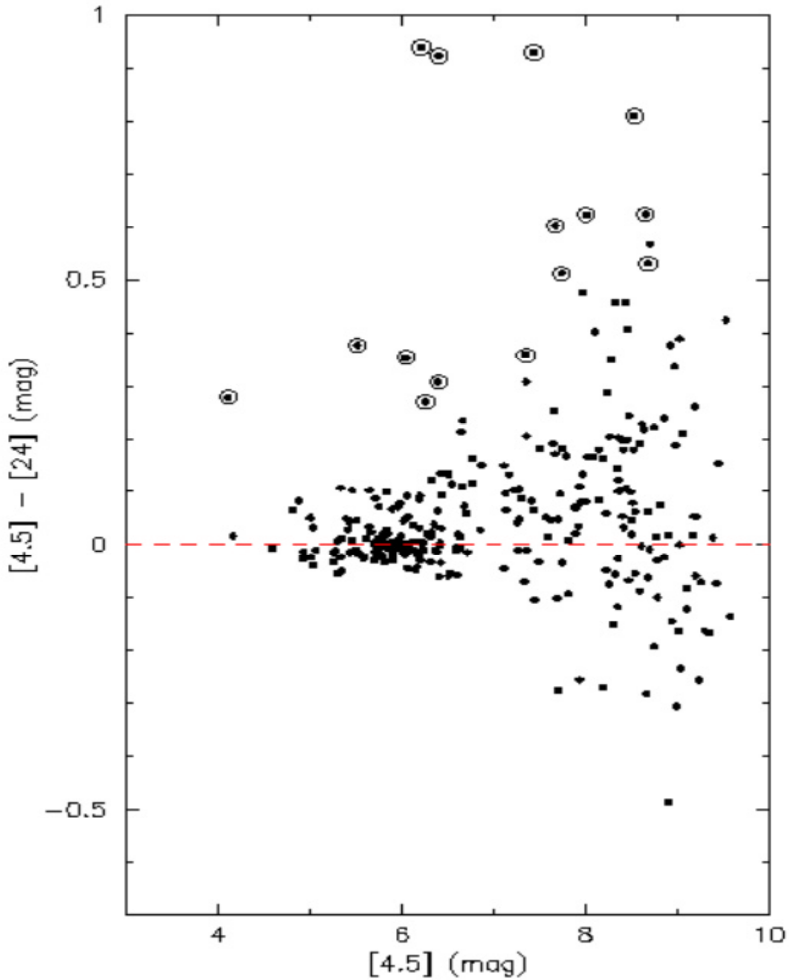
Cold dust - little or plenty?

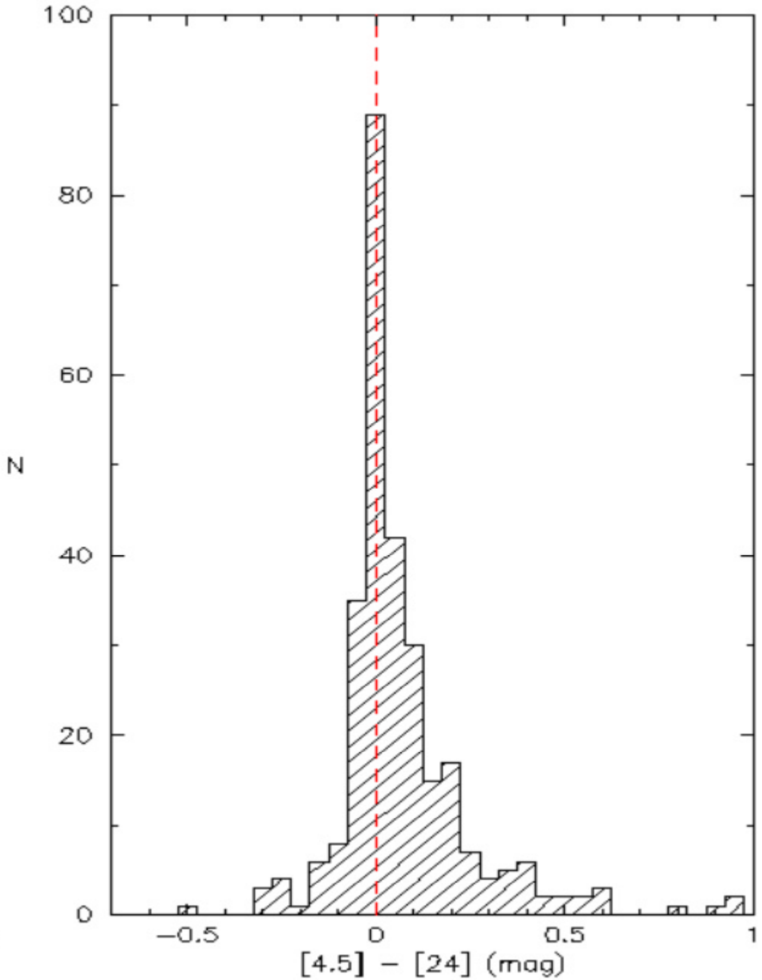


The Spitzer sample

Age	N_* / N_{tot}	Distance (pc)	Target
3-10 Myr	50/ ~140	80-160	Tau, Oph, Cha, Lup, Upper Sco
10-30 Myr	50/ ~110	60-160	Tau, Oph, Cha, Lup, Cen Crux
30-100 Myr	50/ ~130	40-180	IC 2602 & Alpha Per
100-300 Myr	50/ ~100	20-120	Ursa Major, Castor, Pleiades
0.3-1 Gyr	50/ ~1000	20-60	Field stars, Hyades
1-3 Gyr	50/ ~1000	20-60	Field stars

FEPS, only 15 stars with excess at 24 µm





Kuiper belts and zodiacal light around nearby stars

- *Herschel sensitive to very faint, cool excess emission*
- *Potential for spatial resolution*
- *Important information for future Earth-like planet searches*
- *But poor age determination*

Nearby stars, sample

Distances according to spectral type				Z	Z	Z	
distance	F,G,K,M	F,G,K	F	G	K	M
0-5 [pc]	10	1	0	0	1	9
5-10 [pc]	34	7	0	2	5	27
10-15 [pc]	97	42	3	10	29	55
15-20 [pc]	133	86	11	23	52	47
20-25 [pc]	171	126	15	34	77	45
sum	**445**	**262**	**29**	**69**	**164**	**183**

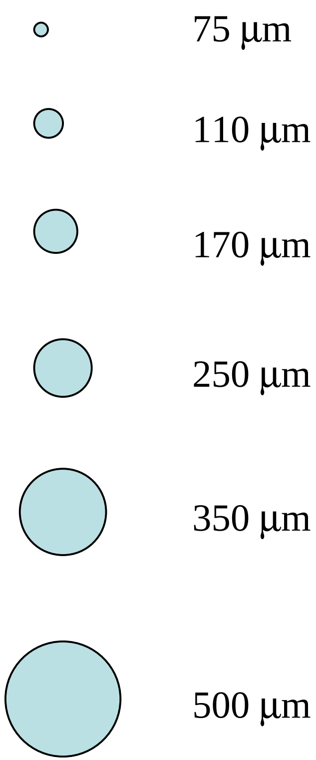
The Sun+Kuiper belt at distance

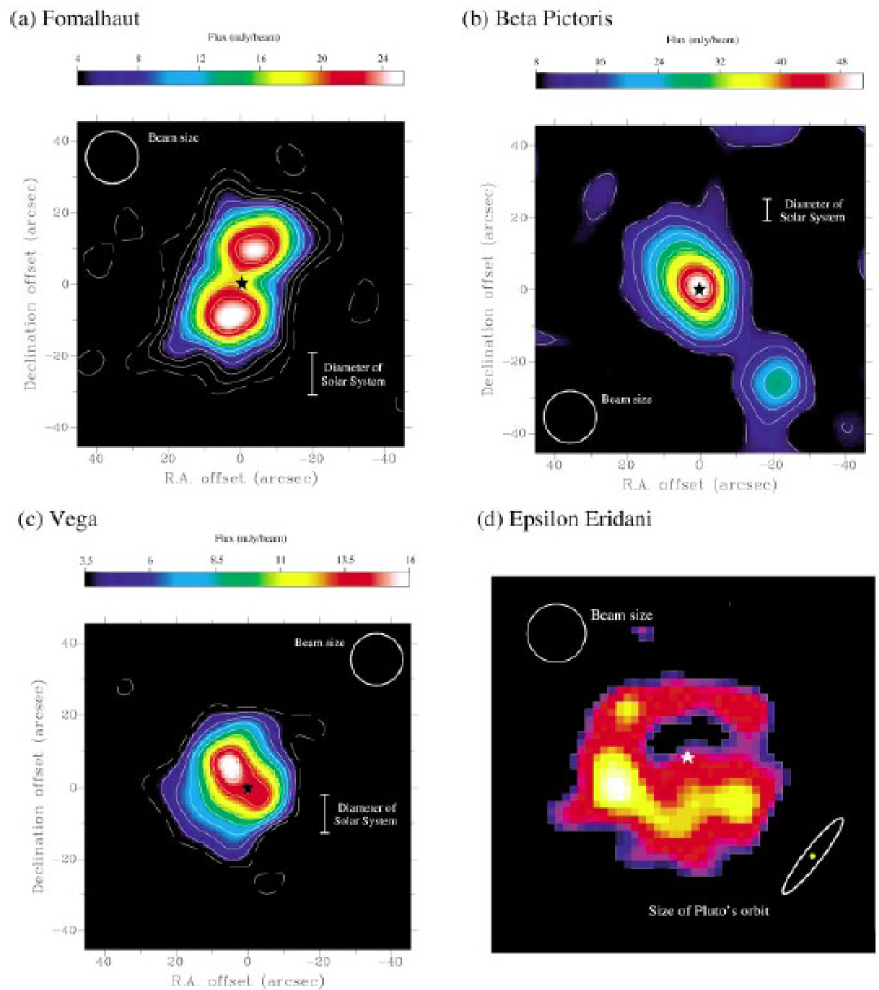
Wavelength μm	Flux (10pc) Jy	Flux (20pc) Jy
70	0.004	0.001
100	0.007	0.002
130	0.008	0.002

Contrast ratio L_{dust}/L_{sun}

Wavelength μm	R (10pc)	R (20pc)
70	0.04	0.04
100	0.14	0.17
130	0.27	0.27

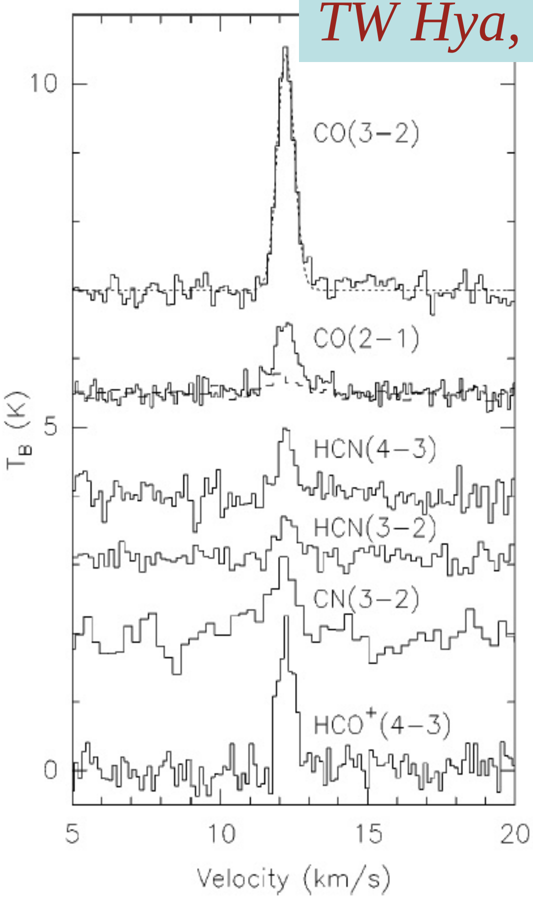
Spatial resolution

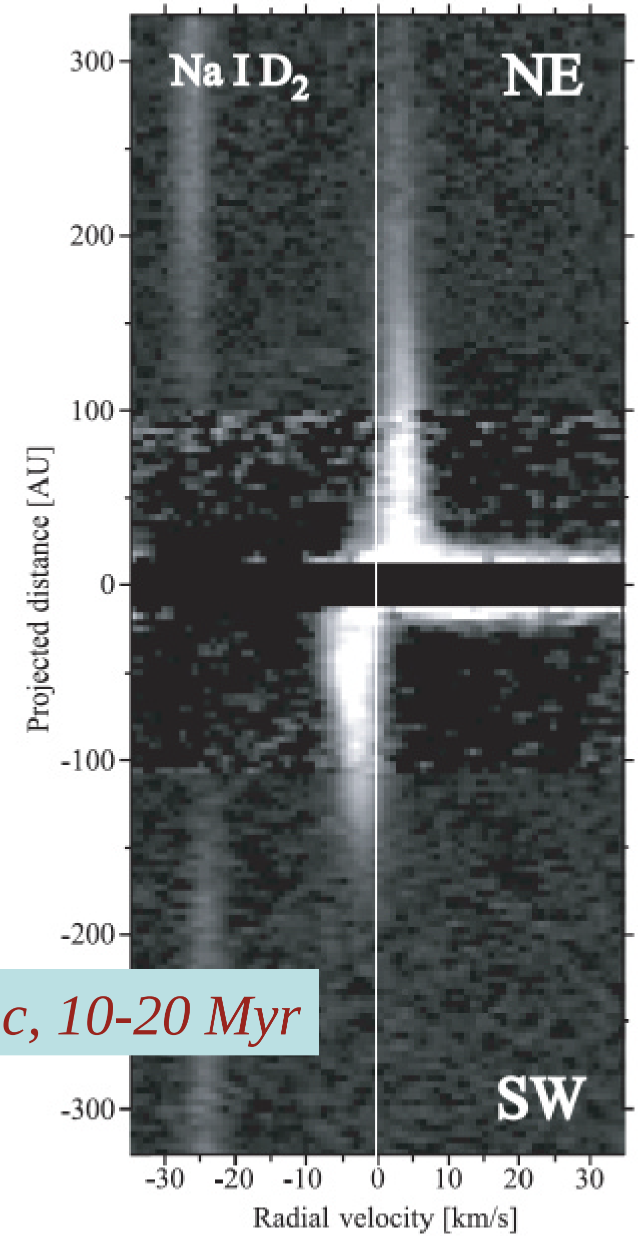




Gas component

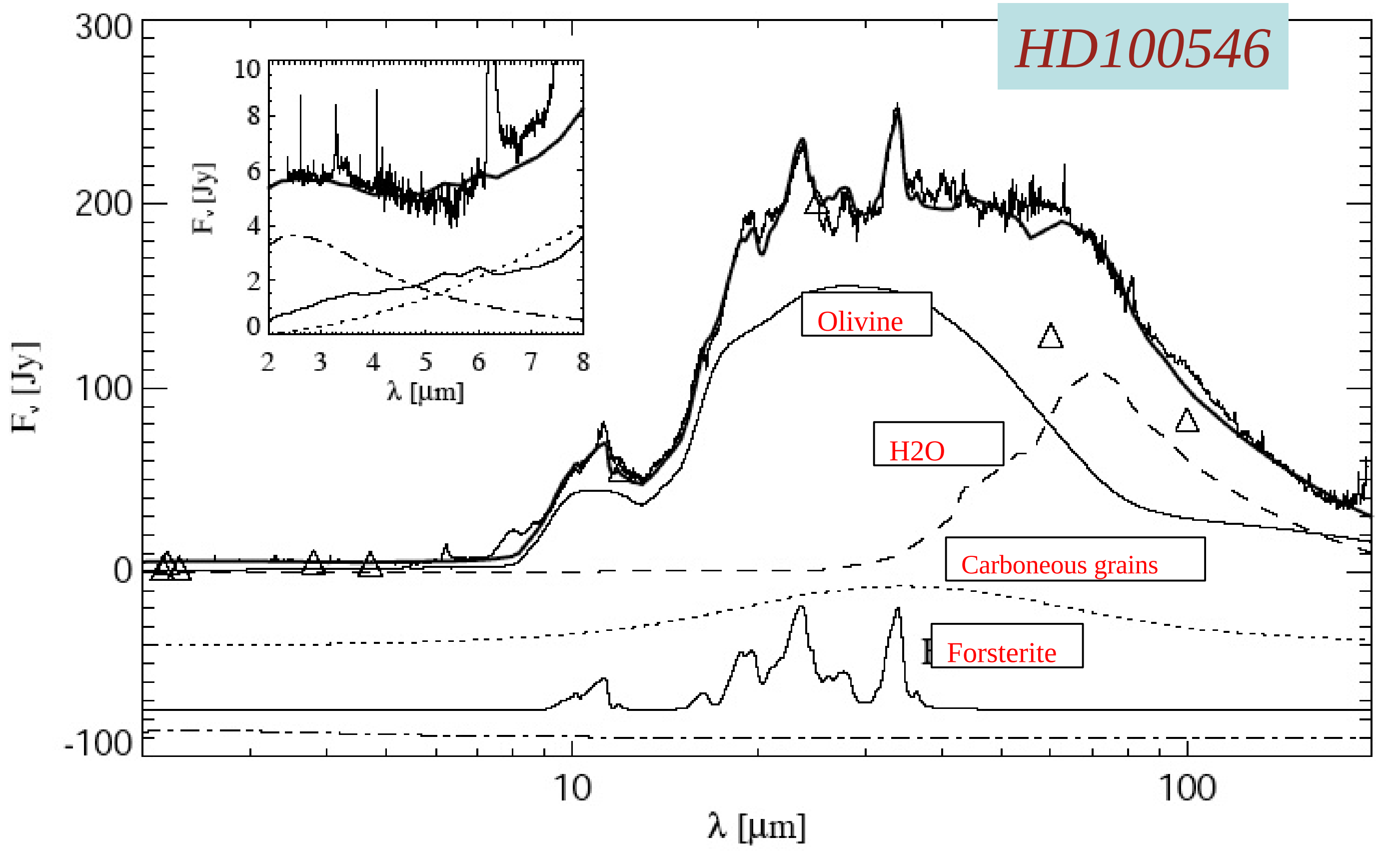
TW Hya, 10 Myr





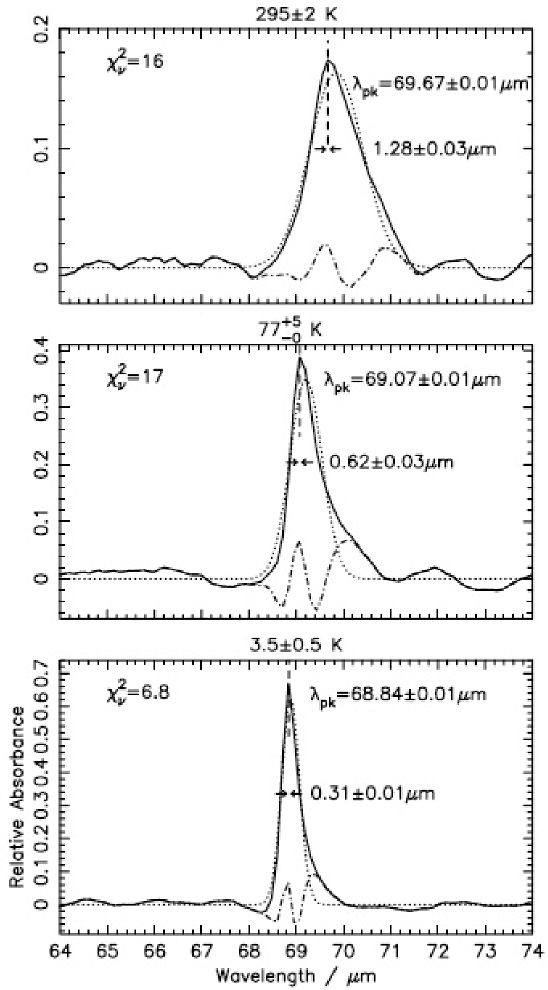
B Pic, 10-20 Myr

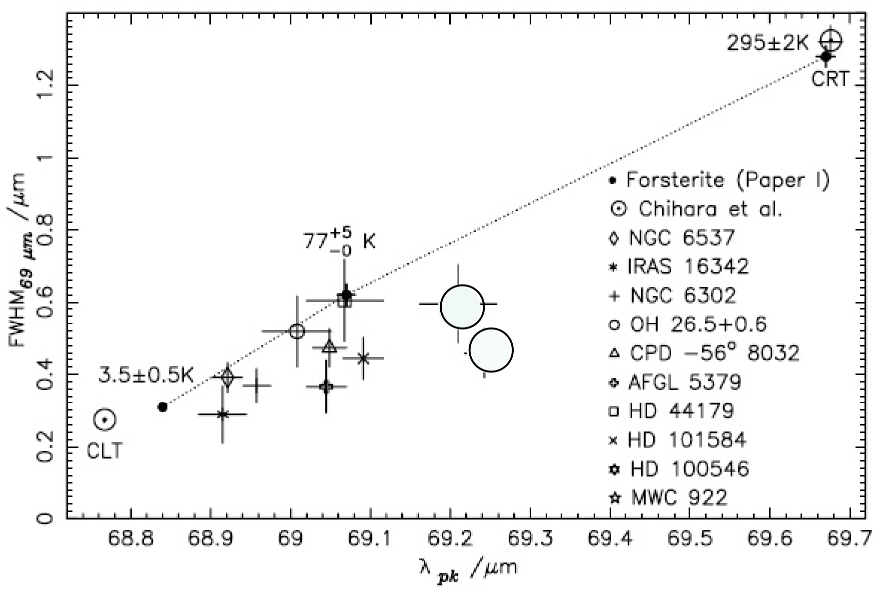
Solid state features



Solid state temperature probe:

69 μm forsterite emission





Sensitivity

Wavel	flux (1h, S/N=5)	confusion limit
75	4(2.2) mJy	0.7 mJy
110	4(2.1)	3.2
170	4(2.3)	11
250	2.7	15
350	3.5	15
500	4.2	15

Time distribution

Theme	PACS	SPIRE	Total
Disk evolution	22	18	40
Nearby stars	60	11	71
Big five	25	10	35
Spectroscopy	59	26	85
SUM	166	65	231h

Management

theme	PACS	SPIRE	PACS	SPIRE
	Institutes*		lead scientists	
disk evol.	MSc,MPIA	RAL, Sto	P.H.	H.W.
Nearby disks	HSc,MSc,CEA HIA	ROE, HSc HIA	G.P.	G.P
'Big five'	KUL,CEA	ROE, UCL	B.V.	R.I.
Spectr	KUL,MPIA	UCL, Sto	C.W.	M.B.

Coordination (PI): G.O.

**) Institutes responsible for data reduction and first analysis*

Herschel-SPIRE SAG 6

Post Main Sequence Science

a) Detecting and determining the masses of extended dust shells via multi-wavelength photometric imaging

Aim: to achieve an understanding of the complete mass loss history of evolved stars. The detection of shells produced by past mass loss events via their extended dust emission is the most sensitive tool available for this goal. Multi-wavelength photometry → fluxes and dust temperatures → dust masses.

Six 4x4 arcmin jiggled sub-maps with the photometer should provide a fully sampled 8x8 arcmin map centred on each target (for a few of the closest objects, larger maps may be desirable). Time per target: 90 mins + 5 mins settling and slewing time. These maps should provide 5σ per beam for a 2 MJy ster^{-1} extended source (corresponding to 23 mJy per 25 arcsec beam) and will provide photometric data at 3 wavelengths (to be supplemented by PACS GT observations at 70, 110 and 170um).

The 24 targets include AGB stars (O-rich and C-rich), post-AGB objects, PNe. High galactic latitude targets are favoured, to minimise background confusion. The PACS Consortium will obtain complementary imaging photometry in each of the 3 PACS wavelength bands (they are allocating 70 hours to observe 80 objects).

Total SPIRE time required: 36 hours

b) Far-infrared – sub-mm spectroscopy of evolved objects with specific dust chemistries.

Main aims – (a) to identify any dust features or bands that are present in their spectra. These features may also occur in the spectra of star forming regions and galaxies, but the best place to isolate and identify them is in the spectra of objects with known chemistries, around which they have formed.

(b) Dust continuum spectral properties, such as emissivity laws, have yet to be fully characterised in the SPIRE spectral region -- the results of this programme will therefore be of benefit to many other SPIRE programmes.

Targets: 20 point targets will be observed with the FTS (1 hour per object), encompassing carbon-rich sources, both with and without mid-IR PAHs (post-AGB objects, PNe, carbon stars), as well as oxygen-rich targets (O-rich Miras, post-AGB objects and PNe). These are the phases of 1-8 Msun objects that are believed to be the most important for contributing dust to the Galaxy. Several examples of the dust-making phases of high-mass objects (M supergiants, LBVs) are included.

PACS consortium have allocated 120 hours for spectroscopy of 42 objects.

Total SPIRE time required: 20 hours

c) Dust in young supernova remnants

Spectra + photometry from 60 to 670μm of selected young galactic SNRs, to be chosen from Cas A, Kepler, Tycho, Crab, SN1006 and SN1181, G292.0+1.8 (all have ages in the range 320-1600 years).

Cas A ~5 arcmin → 7 pointings with the FTS's 2.6 arcmin beam for a fully sampled map. Spectroscopy is needed to determine the contributions of lines and any dust bands and to accurately delineate the energy distributions. For Cas A (~50 Jy) there should be about 500 mJy in a 30 arcsec resolution element → 5σ per 1 cm^{-1} spectral resolution element in a 1-hour 64-point jiggle map. Seven hours to do Cas A with FTS.

For Cas A and 3 other remnants, SPIRE 3-band 6x6 arcmin photometric maps will be obtained, requiring 1.5 hours per target. Total SPIRE time required = 7 hours (FTS) + 6 hours (photometry) = 13 hours.

PACS 7'x7' photometry will be obtained for all 4 remnants, at 70, 110 and 170 microns, requiring 2 hours per target to reach 12-20 mJy/beam at 5sigma. PACS [OIII] 88-um line spectroscopy will be obtained for all the targets, requiring 3 hours in total. Total PACS time required = 8 hrs (photometry) + 3 hrs (spectra) = 11 hours.

Total SPIRE Guaranteed Time required = 13 hrs + 11 hrs = 24 hours

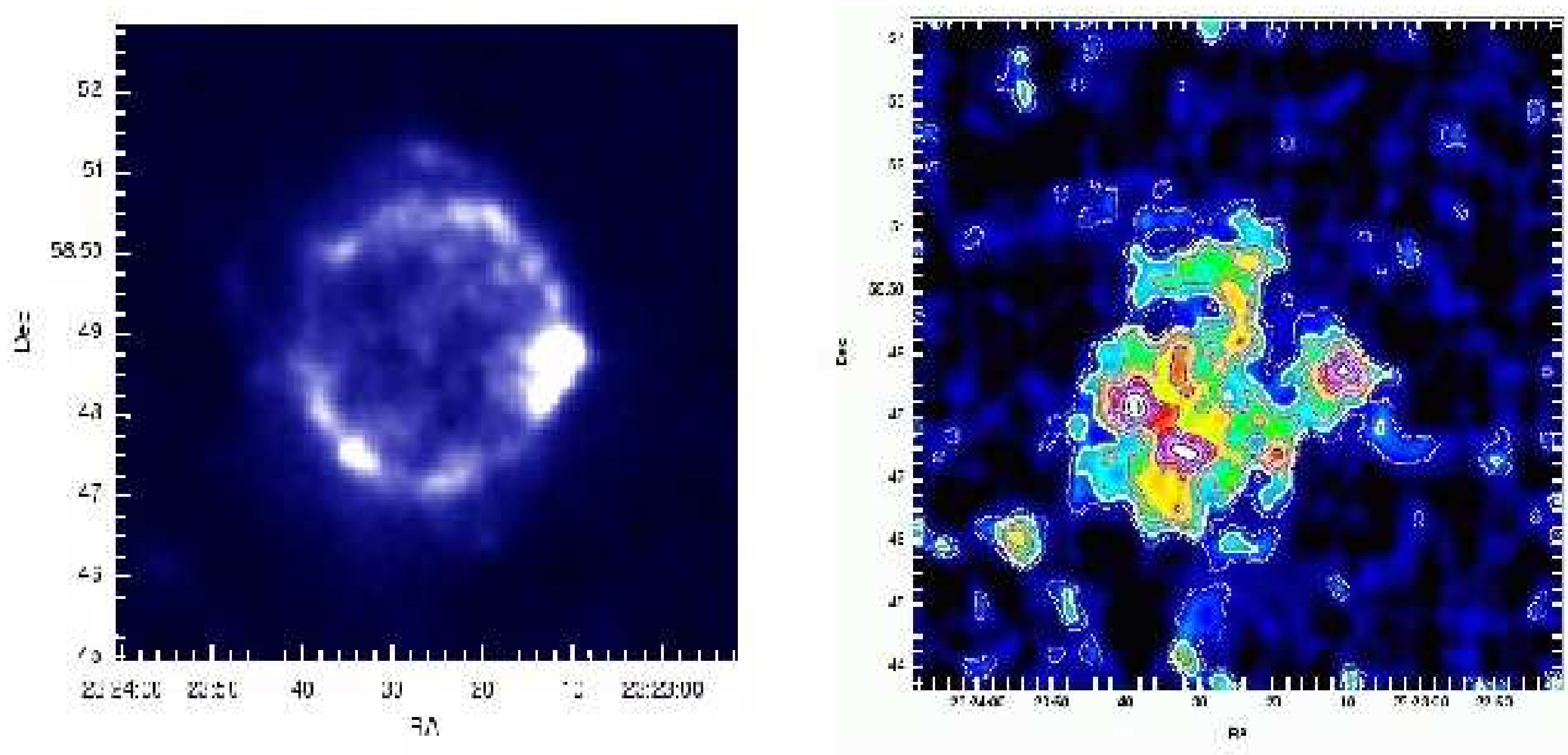
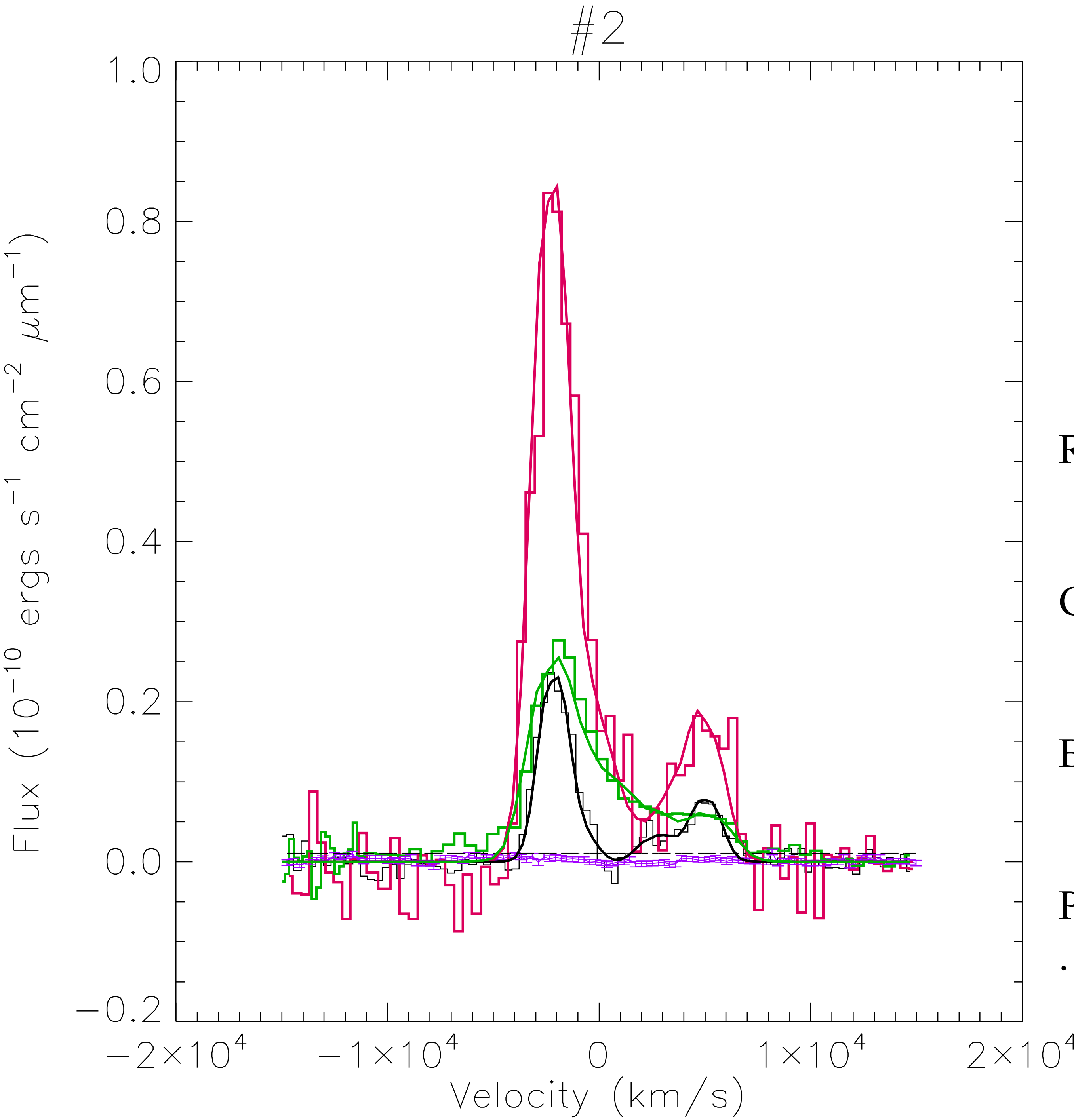


Figure 4: SCUBA images of Cas A, from Dunne et al. (2003). Left: 850-μm image; right: 450-μm image. The morphological difference between the two images was attributed to cold (18 K) dust emission dominating at 450 μm, while two-thirds of the emission at 850 μm is due to synchrotron radiation.



ISO LWS grating spectrum of Cas A (N)

Red = 52um [OIII]

Green = 88um [OIII]

Black = 63um [OI]

Purple = 146um [OI] (absent)