SPIRE Consortium Meeting

Porquerolles

7, 8 October 2003

List of Presentations

Introduction and Project Status	
Introduction and meeting objectives	Matt Griffin
Herschel-Planck Project status	Carsten Scharmberg
SPIRE Project status	Eric Sawyer
Instrument design, performance and test plan	
SPIRE instrument design and performance update	Matt Griffin
Instrument-level and system-level test plan	Bruce Swinyard
SPIRE and Herschel Calibration	
Instrument ground and in-orbit calibration plan	Tanya Lim
The Herschel Calibration Steering Group	Peter Hargrave
ICC Status and Plan	
ICC overall status (structure, scope, priorities, plan)	Ken King
Brief status reports from the ICC teams	
Software	Ken King
Operations	Sunil Sidher
Observations and Science Data Reduction	Dave Clements
Calibration	Tanya Lim
SPIRE data products	Matt Griffin
SPIRE Simulations	
Photometer simulation plans	Matt Griffin
Spectrometer simulation plans	Bruce Swinyard
Sky and data processing simulation status and plans	Seb Oliver
Herschel Observing Time	
The SPIRE Scientific Constitution	Matt Griffin
Arrangements for Herschel observing time allocation	Göran Pilbratt
Implications for the SPIRE Consortium	Matt Griffin
The SPIRE Science Programme	
Organisation and coordination of the SPIRE Science Team	Matt Griffin
Extragalactic science: summary of consortium options	Walter Gear
Galactic science: summary of consortium options	Jean-Paul Baluteau
Solar System Science: summary of consortium options	Bruce Swinyard
Herschel/Planck synergy	Bruno Guiderdoni
Extra-galactic Surveys with Herschel	Seb Oliver
The Herschel Galactic Plane Survey Open Time KP	Sergio Molinari
Conclusions and future plans	Matt Griffin

List of participants

Alain	Abergel
Philippe	André
Jean-Paul	Baluteau
Jamie	Bock
Alessandro	Boselli
Veronique	Buat
Helen	Bright
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Paul	Feldman
Hans-Gustav	Floren
Walter	Gear
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Peter	Hargrave
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Seb	Oliver
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Ismael	Perez-Fournon
Göran	Pilbratt
Paolo	Saraceno
Marc	Sauvage
Eric	Sawyer
Carsten	Scharmberg
Bernhard	Schulz
Douglas	Scott
Sunil	Sidher
Jason	Stevens
Bruce	Swinyard
Laurent	Vigroux
Derek	Ward-Thompson
Christine	Wilson
Glenn	White
Annie	Zavagno

Introduction and Objectives of the Meeting

Matt Griffin

Meeting Objectives

1. Update the full consortium and science team on the instrument and Herschel Project Status

2. Review plans for
   - Instrument AIV and calibration
   - ICC development

3. Review the rules and timeline for Herschel observing time allocation, and their implications for us

4. Set up the Specialist Astronomy Groups (SAGs) that will formulate the consortium's science programme

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Meeting Format

Day 1

- Introduction and project status
- Calibration plans and ICC status
- Plans for sky and instrument simulations
- Rules of the game for Herschel Observing time allocation
- Meeting of SPIRE Steering Group (open to all Co-Is)

Steering Group Meeting Agenda

- Overview of SPIRE programmatic and funding status
- Reports on funding status in SPIRE partner countries
- Appointment of new Associate Scientists
- Arrangements for definition of the consortium's science programme
  - Agreement on SAGs and appointment of SAG coordinators

Objectives of the meeting | Matt Griffin | 3

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Meeting Format

Day 2

- Organisation of the SPIRE Science Team:
  - Report from the Steering Group: SAGs and SAG Coordinators
- Overview of SPIRE Consortium options for its scientific programme (galactic, extragalactic, solar system)
- Large Key Programmes and Herschel-Planck Synergy
- Conclusions and future plans
  - SAG membership and activities
  - Future Science-focussed meetings
  - Consortium support of the instrument and ICC programmes

Objectives of the meeting | Matt Griffin | 4

SPIRE Consortium Meeting
ESA Project Status

C. Scharmberg

System/Spacecraft Development

- **The detail design of the S/C is progressing well.**
- **Nearly all Unit and Sub-System PDR,s have been passed and EM/QM hardware is under production. Many CDR's planned before end of the year. Star Tracker EQM test in November.**
- **Schedule recovery on SVM results in staggered release for manufacture. MRR1(Primary Structure), MRR2 (Secondary and closure panels and MRR3 (Sub platform and instrument panels) Completion of CDR in October.**
- **Freezing of WU interfaces, open points to be closed**
- **High level meeting with Alenia in July→No more short time working from September onwards.**
- **Industry schedule stable and solid – no intention to delay H/P launch. (also confirmed by D/SCI to SPC)**

System Development

- Quarterly Progress Meeting Held in Cannes 15th-19th July, as usual all PI's and PM's invited.
- Plenary Presentations by ESA and Industrial Core Teams, followed by dedicated Splinters.
- Closed meeting held between ESA and both Herschel/Planck Instruments on schedule and problem areas. Instigated initially by Herschel Problems
- Dedicated sessions : on Instrument delivery dates and Industry AIV and need dates, Instrument interface management, instrument open interface issues (e.g. HIFI LSU, shielding and qualification, Mechanical Analysis,)

Instrument Schedule:Closed Meeting

- Herschel Instruments reported significant delays in delivery of FM's with respect to January 2005.FPU's : June to October and November 2005 for PACS and SPIRE detector readout and control electronics.
- Issues of funding discussed. Both Herschel and Planck are effected by ASI funding problems. All Herschel DPU's and software development.
- Incompatibility between instrument and industry AIV and schedule

Herschel/Planck

Evolution of Instrument Delivery Dates

Date	AVM	CQM	PFM	FS
September 2000 (ITT)	April 2003	April 2003	July 2004	July 2005
July 2001 (SRR)	April 2003	April 2003	July 2004	July 2005
June 2002 (PDR)	October 2003	October 2003	January 2005	January 2006
July 2003 (QPM)	April 2004*	April 2004*	April/May 2005*	

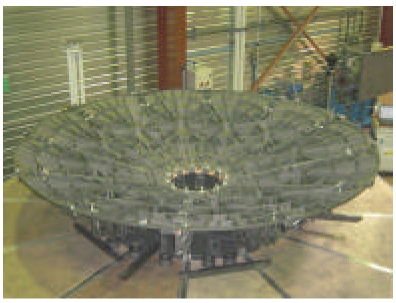
*** Industry Schedule and AIV could be re-arranged to meet late deliveries of instruments**

Herschel/Planck

Herschel Telescope Development

- M1 brazing in July was unsuccessful, due to contamination during cleaning, and a non optimum brazing agent.
- M1 is left on the side and could be reused as spare after some corrective actions.

M1 in assembly for brazing



Petal ready for brazing in July 03

Herschel Telescope Development

Polishing machine at Opteon for M1

- New M1 mirror to be brazed by beginning of November 03.
- No impact on schedule (within margin).
- All other SiC elements are produced.
- Polishing development activities on demo mirrors:
  M1 at Opteon (SF)
  M2 at Zeiss (D).

Herschel Alignment Review

- Concept:
  - ➢Alignment requirements valid for in-orbit operational conditions.
  - ➢Alignment will be performed on ground (1g, 1bar).
  - ➢Different conditions (1g->0g, 1bar->0bar) have to be compensated by analysis.
- Largest contributor/uncertainty of alignment: Shrinkage of the CVV ~ 3 mm. All other contributors are small.
- Most critical alignment requirements: HIFI LOU/FPU.
- The criticality is due to the large shrinkage of the CVV (CVV ~ 3 mm) during TB/TV testing and during In-orbit conditions.

Herschel/Planck

Herschel Alignment Review

- EQM
  - ➢Early verification of the alignment as far as possible.
  - ➢No telescope → Only LOU alignment w.r.t. HIFI FPU.
  - ➢"lessons learned" reduce risk for STM & PFM.
- STM
  - ➢Qualification of the structure.
  - ➢Confirmation of mathematical model.
  - ➢Alignment verification before, between and after environmental tests.
- PFM:
  - ➢Acceptance using approved procedures from STM

7th, 8th October 2003 SPIRE Consortium Meeting 9
ESA Project Status

Herschel/Planck

Instrument Interface Management - Status

- Management Meetings held between ESA/Industry in January, April, June, and at QPM.
- Instrument I/F Meetings held every 2 Month between Instruments/ESA/Industry & Monthly Progress Telecons
- Herschel IID-A update is ongoing.
- Herschel IID-B's updates are almost finished, will be ready for signature in October.
- FTP server set-up to IID-A and IID-B's and CR status list + other items-Visible to all parties:

- ftp.hp-instruments.as-b2b.com -

7th, 8th October 2003 SPIRE Consortium Meeting 10
ESA Project Status

Herschel/Planck

Future Events in 2003

- Herschel Science Team — 13th, 14th October
- H/P PI's & PM's with ESA — 22th October
- Herschel Telescope Working Group — 29th October
- PACS IHDR — 12th to 14th November
- H/P QPM — 8th to 12th December
- HIFI IHDR — 15th, 16th December

Herschel/Planck

And finally: 15th February 2007

Instrument Status

Eric Sawyer

Topics

- Model philosophy
- Present status
- Schedule
- Problem areas and risks
- Overall status

Model Philosophy

Old Baseline Programme

AVM
- Electronics units and simulators only.

STM
- Proof of structural integrity
- Proof of thermal design
- Not deliverable

- CQM
  - Refurbished STM
  - Full working instrument
  - Limited functionality, 3 BDA arrays (some Spec and Phot)
  - Performance measurements in AIV cryostat
- PFM and FS
- This results in late delivery of CQM and PFM

New Programme

- Structural Model (SM)
  - Early vibration test to confirm subsystem input levels + qual
  - No electronics
- Alignment Model (AM)
  - Fit OGSE to STM and do warm and cold alignment check.
  - No electronics except OGSE drive electronics
- Cold Qualification Model (CQM)
  - Refurbish STM/AM by fitting one detector chain, CQM cooler, photometer filters, thermal interfaces
  - This will be representative of the photometer side of SPIRE
  - It will be thermally representative
  - This is the model we deliver to, and we can deliver on time.
  - QM electronics required with this model.

New Programme

- PFM
  - Uses a dedicated FM structure, as before
  - Two stage build, spectrometer first
  - We can start earlier and use CQM (FS) subsystems if necessary.
  - Electronics required, initially QM1 DRCU, TBD
  - As FM subsystems become available they can replace the CQM subsystems during the second integration phase.
  - This allows a longer test period
  - No subsystems are required to deliver earlier than for the old plan with the possible exception of the PFM cooler.
- FS
  - Refurbish CQM to be FS, no change planned

Consequences

- CQM cooler and PLW BDA will be delivered with the CQM
- PFM cooler will be needed earlier, although not earlier than original planning
- QM1 warm electronics will be unavailable after delivery of CQM to ESA/Industry
- This will leave us short of electronics to drive the system
- QM2 not available until November 04
- This was already a problem before the change in model philosophy, the change has not made this worse

Pros and Cons

Old philosophy

- Pro
  - Technical risk to PFM programme is lower
  - CQM delivered for EPLM tests has high fidelity
- Con
  - CQM delivered in Summer 2004
  - PFM starts very late and programme compressed to beyond credibility
  - PFM realistic delivery not before Summer 2005

New philosophy

- Pro
  - PFM programme starts on time
  - A CQM is delivered in early 2004
  - We get much longer to test the PFM albeit in different build phases
- Con
  - Integration is more complex
  - Delivered CQM has reduced fidelity
  - Higher technical risk

Warm electronics

- DRCU model philosophy is not optimised wrt. SPIRE development plan
- Options have been discussed during IHDR and afterwards
- CEA and CNES regard an intermediate stage between QM1 and FM as essential
- New plan is to upgrade QM1 after CQM testing
- This can then be used for the first stage of PFM testing before QM2 is ready
- This means that QM1 will not be available for spacecraft testing
- QM2 will use flight components to minimise risk due to late delivery of FM

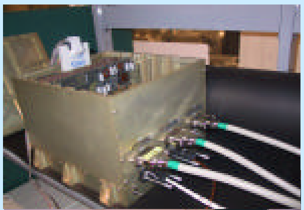
Present status

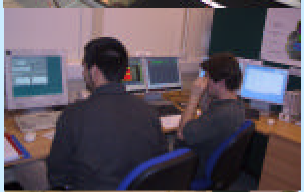
AVM

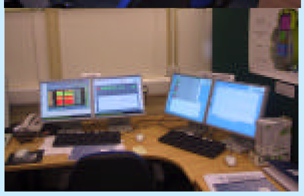
Consists of:

- AVM DPU
- DRCU simulator (simulates DRCU and FPU)

- Delivered April 03
- Preliminary testing complete.
- Simulator software needs updating
- DPU software will be updated
- Formal acceptance planned for October.
- Preliminary testing of OBS and EGSE software continuing

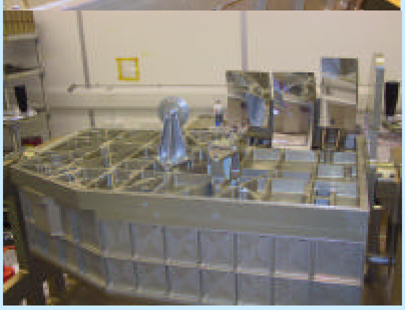




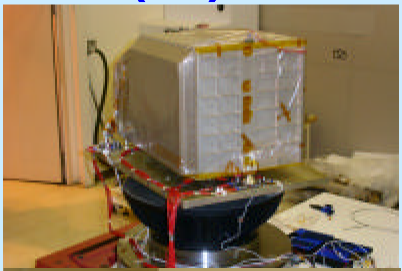


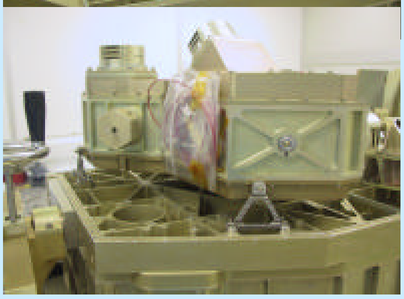
Structural Model (SM)

- Assembled March/April 03
- All mirrors fitted
- STM subsystems, BDAs, Cooler, BSM, SMEC, SCAL, 300-mK bus bar
- Warm vibration test, main objective to quantify subsystem levels, Full qual levels used.
- Issue with movement of 300-mK strap support.
- Sub system levels available



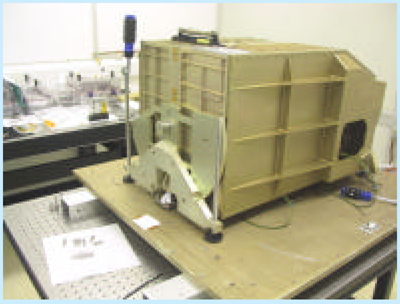
Structural Model (SM)





Alignment Model (AM)

- Fit OGSE in place of SMEC and BDAs – May 03
- Warm alignment check.
- Instrument into cryostat
- Warm alignment recheck.
- Cool down – 6K, heat leak due to window
- Cold alignment check
- Warm alignment check.
- CM3 replaced and alignment re-verified.



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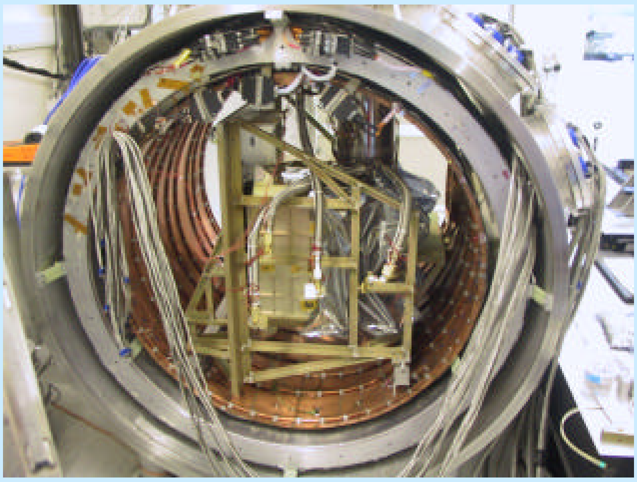
Cold alignment



Instrument status report SPIRE 15

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Cold Qualification Model (CQM)

- Following cold alignment
- Reconfigure to CQM
- CQM cooler fitted.
- PLW Detector fitted
- SMEC (STM) fitted
- Improved 300mK supports fitted
- CQM filters delivery this week.
- Harness is causing some delay
- Support required for testing

Instrument status report SPIRE 16

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CQM continued

- DRCU QM1 delivered 17/9/03
- Acceptance test completed
- Integration with DPU carried out
- No significant problems identified

Instrument status report SPIRE 17

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Proto Flight Model (PFM)

- Structure mostly manufactured
- Cooler – release for parts manufacture.
- DRCU – Some activities, but waiting for CQM feedback before full commitment to FM man.
- SMEC – CQM delivered in December
- Mirrors – in manufacture
- BDA - SSW and SLW in assembly
- DPU funding issues
- Calibrators, filters – in manufacture
- BSM – In manufacture
- PFM FPU integration to start late Oct

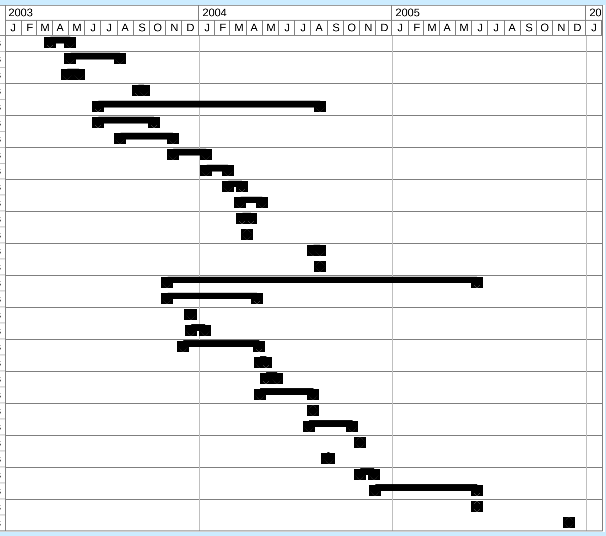
Instrument status report SPIRE 18

AIV

- Test cryostat
  - 3 cool downs
  - One empty
  - Two with load
  - Last cool down with mass dummy – 1.4K on L0 I/F
  - Cool down procedure now well established
- FTS
  - Delivered in September
  - Checked out and integrated into test facility

Schedule

Task Name	Duration
SM AIV programme	25 days
AM programme	64.5 days
AVM programme	15 days
Warm electronics programme	10 days
CQM programme	290 days
STM/CQM FTB Subsystem Deliveries	76 days
Preparation of CQM	72.5 days
CQM Cold Verification 1	34 days
CQM Cold Vibration	30 days
CQM Cold Verification 2	19 days
Update QM1 DRCU	30 days
CQM modifications before delivery	13 days
Possible delivery to ESA FPU only	0 days
CQM Delivery Preparation	9 days
Delivery of full CQM to ESA	0 days
PFM AIV programme	408 days
CQM/PFM FPU Subsystem Deliveries	112 days
PFM FTB Subsystem Deliveries	3 days
PFM FTB Integration	8 days
FPU integration phase 1	93 days
Warm electronics Deliveries	9 days
QM1 Warm Electronics re Integration	15 days
Instrument integration and test phase 1	72 days
QM1 DRCU available for CQM delivery	0 days
FPUintegration phase 2	58 days
Delivery of DRCU QM2	0 days
Delivery of FM DPU	5 days
Instrument integration and test phase 2	20 days
PFM Verification	138 days
Delivery of PFM to ESA	0 days
Delivery of warm electronics to ESA	0 days



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Major problems and risks

1. SPIRE Instrument Schedule

- Original development plan has been adapted so PFM can be delivered on time
- The original CQM programme has been reduced to allow a more or or less on time delivery
- The alternative plan has been accepted by ESA and Industry
- Purpose of this adapted plan: to protect as much as possible the on-time delivery of the PFM
- It is already being implemented (SM/AM programme)
- Revised programme has pros and cons
- **This will only work if subsystems deliver on time**

3. DRCU Development Plan

- Original DRCU development plan involves waiting until QM design verified by instrument CQM tests before starting PFM programme.
- This is now incompatible with the SPIRE Instrument schedule and with on-time PFM delivery
- Discussion and analysis of various scenarios has been taking place since DRCU review in March
- This issue highlights the general issue of risk-cost-schedule tradeoffs in SPIRE (and Herschel-Planck)

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5. Thermal design

- Thermal performance is critical for SPIRE's scientific performance
- Problems with cooler hold time, temperature stability and absolute detector temperature
- Continuing iteration between SPIRE/Industry/ESA on SPIRE requirements and interfaces
- Pragmatic approach being adopted with industry/ESA
- SPIRE is implementing all possible measures to improve thermal performance - see also 7 (FPU support redesign) and 8 (SPIRE Level-0 strap interface)

Instrument status report SPIRE 25

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6. EMC: Harness overshielding

- SPIRE grounding scheme requires overshielding on cryoharness inside CVV
- This requirement was not formally accepted by the ESA Project
- In April SPIRE requested reconsideration of this decision based on high risk to scientific performance
- Practical discussions with industry have resulted in a workable solution

Instrument status report SPIRE 26

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7. Funding

- All groups have some funding problems
- Extra funding has been secured from ESA
- System group have a large amount of mopping up operations.
- Delays are causing cost escalations
- Interface definition
- Subsystem deliveries

Instrument status report SPIRE 27

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Others

8. FPU and Level-0 Detector Box Supports
9. SPIRE Level-0 Strap Interface
10. FTS Mechanism Vibration Qualification
11. BDA Performance and Quality
12. JFET Noise and Power Dissipation
13. 300-mK Thermal Strap Supports
14. FPU Internal Black Coating
15. Filter Availability
16. Microvibrations

Instrument status report SPIRE 28

2. CQM Programme

- First assembly and test of many subsystem and system elements
- Many "small" problems to be sorted out
- Project Team places high priority on addressing these issues sometimes at the expense of other work
- The schedule is vulnerable to any problems with AIV facility

Overall Status

Overall status

- Not as far advanced as we would like
- Similar position to PACS and HIFI
- We still have technical problems to overcome
- But have made some real progress in recent months
- SM and AM programmes complete
- CQM underway
- Many CQM subsystem delivered
- AIV facility qualified
- Success assumed programme - Timely Subsystem deliveries, Hardware and Documentation essential to a successful project

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end

Instrument Design and Performance Update

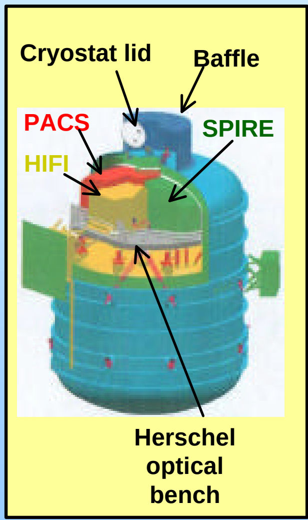
Matt Griffin

Instrument Design Drivers

- **Photometer**
  - Deep mapping with highest efficiency and largest possible field of view
    - Multi-band coverage with simultaneous observation
  - Point and compact source observation with high efficiency
- **Spectrometer**
  - Sensitivity optimised for point/compact source spectroscopy
  - Imaging spectroscopy with maximum available field of view
  - Wide wavelength coverage
  - Variable spectral resolution (few x 10 to few x 100)
- **Both**
  - Thermal background dominated by the Herschel telescope
  - Simplicity, affordability, reliability, ease of operation
  - Complementary to other Herschel instruments and other facilities

Instrument Summary

- **3-band imaging photometer**
  - 250, 360, 520 μm (simultaneous observation)
  - $\lambda/\Delta\lambda \sim 3$
  - 4 x 8 arcminute field of view
  - Diffraction limited beams (17, 24, 35”)
- **Imaging FTS**
  - 200 - 670 μm
  - 2.6 arcminute field of view
  - $\Delta\sigma$ = 0.04 – 2 cm^{-1} ($\lambda/\Delta\lambda \sim$ 20 - 1000 at 250 μm)
- **Design features**
  - Sensitivity limited by thermal emission from the telescope (<u>Assumption</u>: 80 K; ε = 4%)
  - ^3He cooled detector arrays (0.3 K)
  - Feedhorn-coupled spider web NTD bolometers
  - Minimal use of mechanisms
    - Beam steering mirror; FTS mirror drive
  - No on-board data processing or compression
  - Simple commanding scheme



Instrument Design Overview

See

SPIRE Design Description

(SPIRE-RAL-PRJ-000620)

for a comprehensive overview and description of the instrument

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Sensitivity Models

- **Sensitivity estimates detailed in *SPIRE-QMW-NOT-000642* Issue 3.0**
  - **Photometer sensitivity model updated**
  - **FTS model not updated (but new estimates presented at IHDR)**

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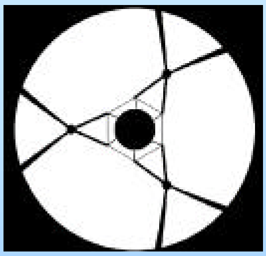
Photometer Model Updates



- **Physical bolometer model incorporated**
- **Telescope obscuration up from 3% to 13%**
- **Lower bolometer R_o (was 180 W, now 100 W)**
- **Additional Ö2 noise contribution due to LIA demodulation included**
- **Nominal bolometer temperature up to 320 mK**
- **Overall transmission increased from 30% to 40%**
- **Nominal feed efficiencies increased slightly**
- **Nominal, best and worst case values studied for all parameters**

Best, Nominal and Worst Case Parameters

	Best	Nominal	Worst
• Telescope temperature	60	80	90
• Telescope emissivity	0.02	0.04	0.06
• Feedhorn/cavity efficiency	0.8	0.7	0.6
• Bolometer R_o (W)	180	100	70
• Bolometer temperature (mK)	300	320	340
• JFET noise (nV $Hz^{-1/2}$)	7	10	15
• Bolometer yield	0.9	0.8	0.75
• Overall inst. transmission	0.48	0.4	0.32
• Observing efficiency	0.95	0.85	0.75

Background Power, NEP and DQE (Nominal Case)

		Photometer band		
		PSW	PMW	PLW
Background power/detector IBDR (March 2002) values	pW	5.7 3.8	4.1 3.0	3.4 2.6
Background-limited NEP IBDR values	W $Hz^{-1/2}$ x 10^{-17}	9.7 7.9	6.9 5.9	5.3 4.6
Overall NEP (inc. detector) IBDR values	W $Hz^{-1/2}$ x 10^{-17}	13.6 9.7	10.7 7.1	9.1 5.9
Detector DQE (at LIA output) IBDR values		0.51 0.73	0.42 0.68	0.34 0.61

Photometer Sensitivity (Nominal Case)

Band		PSW	PMW	PLW
DS(5-s; 1-hr) mJy	Point source (7-point)	2.7	3.5	4.2
	IBDR values	2.4	2.8	3.1
	4' x 4' jiggle map	9.5	11.5	13.2
	IBDR values	8.5	9.3	9.7
	4' x 8' scan map	7.6	9.2	10.5
	IBDR values	6.8	7.4	7.7
Time (days) to map 1 deg.^{2} to 3 mJy 1-s	Nominal case	2.1	3.0	3.9
	IBDR values	1.7	2.0	2.1

AO estimates (point source, 5-s 1-hr) < 4 mJy in all three bands

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Mapping Speed (Best Case)

		PSW	PMW	PLW
Time (days) to map 1 sq. deg. to 3 mJy 1-s	Nominal case	2.06	3.01	3.92
	IBDR values	1.7	2.0	2.1
Factor by which speed improves with best case parameters (other parameters at nominal values)	e_{tel} = best	1.87	1.81	1.83
	T_{tel} = best	1.50	1.42	1.40
	$t_{filters}$ = best	1.19	1.19	1.18
	R_o = best	1.18	1.22	1.26
	en_{FET} = best	1.15	1.18	1.22
	h_{feed} = best	1.14	1.14	1.13
	T_o = best	1.13	1.17	1.19
	Yield = best	1.13	1.13	1.13
	h_{obs} = best	1.12	1.12	1.12
	Nominal telescope; best inst.	2.02	2.18	2.35
	Nominal inst; best telescope	2.58	2.33	2.31

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Mapping Speed (Worst Case)

		PSW	PMW	PLW
Time (days) to map 1 sq. deg. to 3 mJy 1-s	Nominal case IBDR values	2.06 1.7	3.01 2.0	3.92 2.1
Factor by which speed gets worse with worst case parameters (other parameters at nominal values)	e_{tel} = worst	1.56	1.55	1.58
	en_{FET} = worst	1.32	1.38	1.43
	$t_{filters}$ = worst	1.25	1.27	1.26
	T_{tel} = worst	1.19	1.16	1.16
	h_{feed} = worst	1.17	1.17	1.17
	T_o = worst	1.15	1.19	1.21
	R_o = worst	1.15	1.17	1.20
	h_{obs} = worst	1.13	1.13	1.13
	Yield = worst	1.07	1.07	1.07
	Nominal telescope; worst inst.	2.76	3.04	3.24
	Nominal inst.; telescope worst	1.91	1.85	1.89

CQM PLW parameters: factor of 1.56 slower

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Line Spectroscopy (Nominal Case)

Line spectroscopy Ds = 0.04 cm^{-1}				
l mm		200 - 315	315 - 500	500-670
DF (5-s; 1-hr) W m^{-2} x 10^{-17}	Point source IBDR values	5.9 4.7	5.5 4.0	5.5 - 7.7 4.0 - 5.6
	Map IBDR values	20 13	18 11	18 - 26 11 - 15
Factor by which <u>speed improves</u> with best case parameters as indicated (other parameters at nominal values)	e_{tel} = best	1.76	1.74	1.74
	T_{tel} = best	1.46	1.37	1.37
	$t_{filters}$ = best	1.21	1.21	1.21
	R_o = best	1.17	1.22	1.22
	en_{FET} = best	1.15	1.19	1.19
	h_{feed} = best	1.16	1.08	1.08
	T_o = best	1.15	1.18	1.18
	Yield,h_{obs} best	1.12	1.12	1.12

AO estimate: 5-s 1-hr: 4 x 10^{-17} W m^{-2} in 200-400 mm band

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Line Spectroscopy (Best Case)

Line spectroscopy Ds = 0.04 cm^{-1}				
l mm		200 - 315	315 - 500	500-670
Factor by which <u>speed improves</u> with best case parameters as indicated (other parameters at nominal values)	e_{tel} = best	1.76	1.74	1.74
	T_{tel} = best	1.46	1.37	1.37
	$t_{filters}$ = best	1.21	1.21	1.21
	R_o = best	1.17	1.22	1.22
	en_{FET} = best	1.15	1.19	1.19
	h_{feed} = best	1.16	1.08	1.08
	T_o = best	1.15	1.18	1.18
	Yield = best	1.12	1.12	1.12
	h_{obs} = best	1.12	1.12	1.12
Nominal telescope; instrument best		2.17	2.26	2.26
Nominal instrument; telescope best		2.34	2.18	2.18

Instrument Dsesign and Performance Update Matt Griffin 13

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Line Spectroscopy (Worst Case)

Line spectroscopy Ds = 0.04 cm^{-1}				
l mm		200 - 315	315 - 500	500-670
Factor by which <u>speed gets worse</u> with best case parameters as indicated (other parameters at nominal values)	e_{tel} = worst	1.49	1.51	1.51
	T_{tel} = worst	1.17	1.15	1.15
	$t_{filters}$ = worst	1.28	1.28	1.28
	R_o = worst	1.13	1.18	1.18
	en_{FET} = worst	1.30	1.39	1.39
	h_{feed} = worst	1.18	1.13	1.13
	T_o = worst	1.16	1.21	1.21
	Yield = worst	1.07	1.07	1.07
	h_{obs} = worst	1.13	1.13	1.13
Nominal telescope; instrument worst		3.48	3.74	3.74
Nominal instrument; telescope worst		1.78	1.79	1.79

Instrument Dsesign and Performance Update Matt Griffin 14

Low-Resolution Spectrophotometry (Nominal Case)

Low-resolution spectrophotometry $\Delta\sigma$ = 1 cm^{-1}				
λ μm		200 - 315	315 - 500	500-670
ΔS (5-σ; 1-hr) mJy	Point source	200 160	180 140	180 - 260 140 - 190
	2.6' map IBDR	530 430	490 360	490 - 690 360-500

AO proposal estimate: 5-σ; 1-hr: 130 mJy in 200-400 μm band

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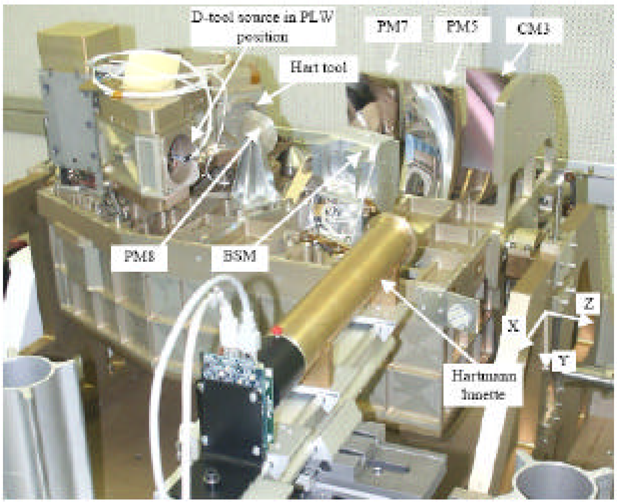
Instrument Level and System-Level Test Plan

Bruce Swinyard

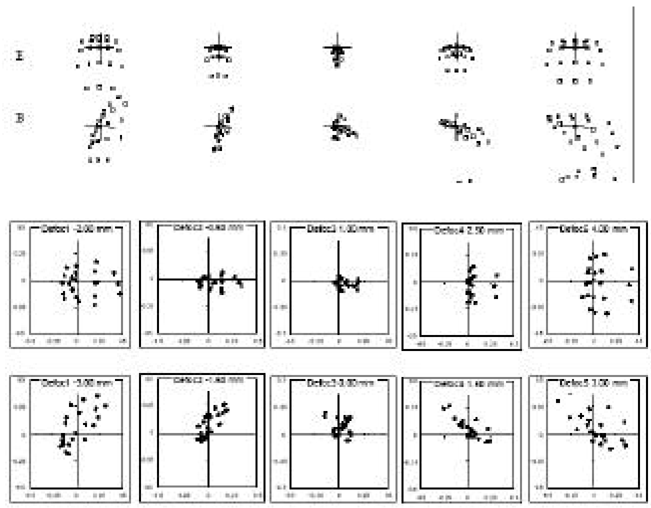
Outline of Instrument Testing

- Structural Model – assembly and testing completed
- Alignment Model – assembly and testing completed
- CQM build has started
  - CQM has photometer PLW only
  - No working mechanisms
  - This goes to EADS$_{Astrium}$ for EQM testing
- We will build the PFM in two phases I and II
  - PFMI spectrometer only – both arrays;CQM SMEC; PFM BSM
  - PFMII adds the photometer channel

Alignment Model



Photometer Hartmann Results



Photometer WFE

Table 5. Comparison of RMS coefficients, total RMS wavefront error, and corresponding Strehl ratio at 250μm for the raytracing model and for the as-built STM.

Aberration	InstrOnly_E	InstrOnly_B	PhtSTM_E	PhtSTM_B
Focus	0.18	0.44	1.45	0.20
Astigmatism	0.72	2.74	1.03	2.35
Coma	0.87	0.63	0.94	0.71
SphAb	0.11	0.11	0.29	0.52
Tri5	0.33	0.21	0.49	0.36
Ast5	0.05	0.04	0.24	0.08
Coma5	0.01	0.01	0.08	0.09
WFE RMS	**1.20**	**2.85**	**2.10**	**2.54**
Strehl 250um	**0.999**	**0.995**	**0.997**	**0.996**

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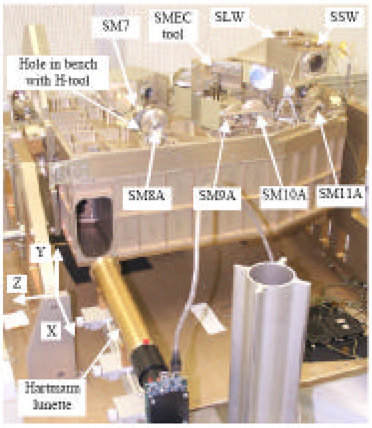
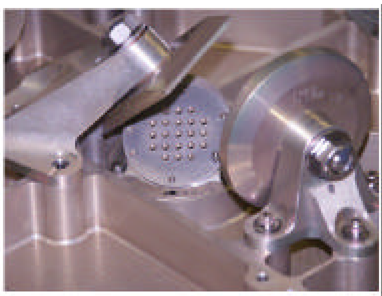
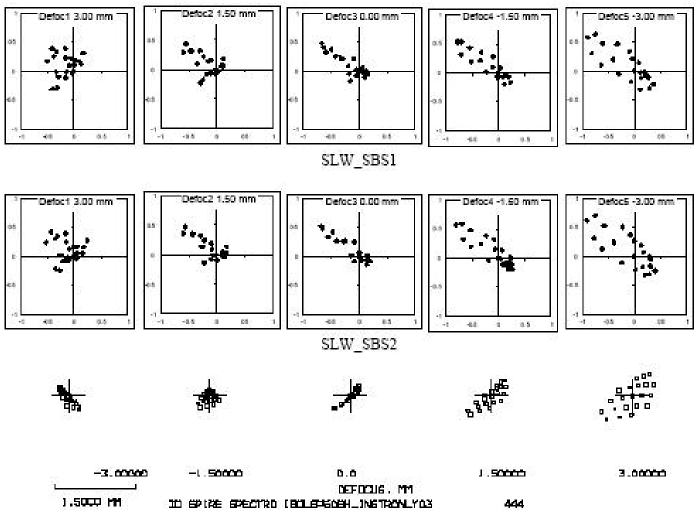
Spectrometer Alignment





Spectrometer Hartmann Results



Spectrometer WFE

Table 3. Comparison of RMS coefficients, total RMS wavefront error, and corresponding Strehl ratio at 250μm for the raytracing models and for the as-built STM.

Aberration	BolSp509h InstrOnly	BolSp509h SM8A = 2.5°	STM SLW_SBS1	STM SLW_SBS2
Focus	2.64	2.61	4.47	5.40
Astigmatism	1.44	5.02	6.42	6.41
Coma	0.35	0.33	1.90	1.79
SphAb	0.02	0.02	0.45	0.59
Tri5	0.63	0.64	0.65	0.90
Ast5	0.09	0.09	0.16	0.06
Coma5	0.00	0.00	0.40	0.28
WFE RMS	**3.09**	**5.70**	**8.10**	**8.64**
Strehl 250um	**0.994**	**0.979**	**0.959**	**0.953**

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CQM Testing

- Integration and Thermal Tests:
  - Integration into cryostat and warm check out (1 week)
  - Test Readiness Review
  - Pump and cool to operating condition (1 week 24/7)
  - Cold functional check out (2 days 14 hr)
  - Thermal Case 1 (Off) (1 day 14 hr)
  - Off > On > Init > Redy > Recycle > Phot Standby
  - Thermal Case 2 (Phot Standby) (continuous 48 hr)

Instrument and System Level Testing Bruce Swinyard 9

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CQM Testing (ctd)

- Performance Tests (2 weeks - 5 day week 14 hour days):
  - Three groups – “dark” without thermal disturbance ; using CBB; Optical
  - Dark – done during Thermal Case 2
    - Noise vs everything
    - Dark load curves
  - With CBB – maybe also possible during Thermal Case 2
    - Optical load curves (also with PCAL)
    - Loaded noise
  - Optical
    - Peaking up and FIR alignment checks
    - Hot BB/laser for beam maps/pixel position/spatial impulse response
    - FTS and laser for spectral response and polarisation checks
    - Hot BB and chopper for frequency response

Instrument and System Level Testing Bruce Swinyard 10

CQM Testing (ctd)

- Final checks and warm up will be a further week
- Testing planned for total 6 elapsed weeks
- Present planned start is "early November"
- Need support from the consortium during the performance test phase particularly the first time we turn it all on
- In particular support from SAp for electronics; SBT for cooler operations and JPL for detector switch on and bias set up is needed in first week
- We expect to be shipping data for detailed analysis to the sub-system groups as soon as possible after each test

EQM Testing

- Old ISO cryostat has been reconfigured to mimic the Herschel flight situation
- A retro reflecting cooled lid will give a background similar the flight conditions
- The outer shields are cooled to give flight thermal conditions
- With the SPIRE CQM we will be able to repeat the thermal test cases with more flight like conditions
- Will be able to check the basic design of the cryoharness
- We may also be able to do some EMC testing – this is limited de to the QM1 electronics build standard

EQM Cryocover

principle:

SPIRE and PACS shall see inner experiment holes only (by specular reflection) when viewing the closed cryocover

realized by
spherical mirror for PACS
toroidal mirror for SPIRE

PFMI

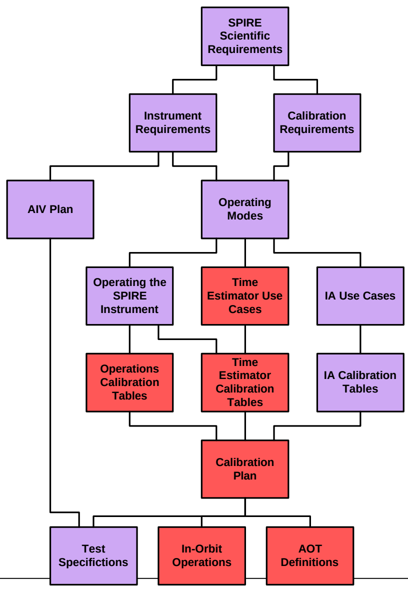
- Build commences November
- Testing will start no earlier than end April 2004
- For these tests we will need spectrometer and mechanism expertise with support expected from LAM and ATC for critical tests

- Finally the AIVCAM is at……
  http://www.ssd.rl.ac.uk/spire/consortium/aivcam.shtm

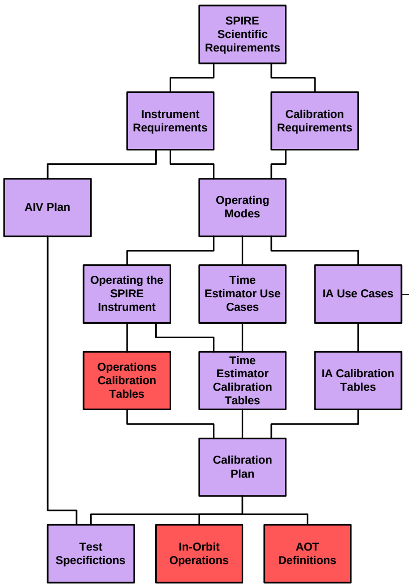
The Calibration Plan

Tanya Lim

RAL

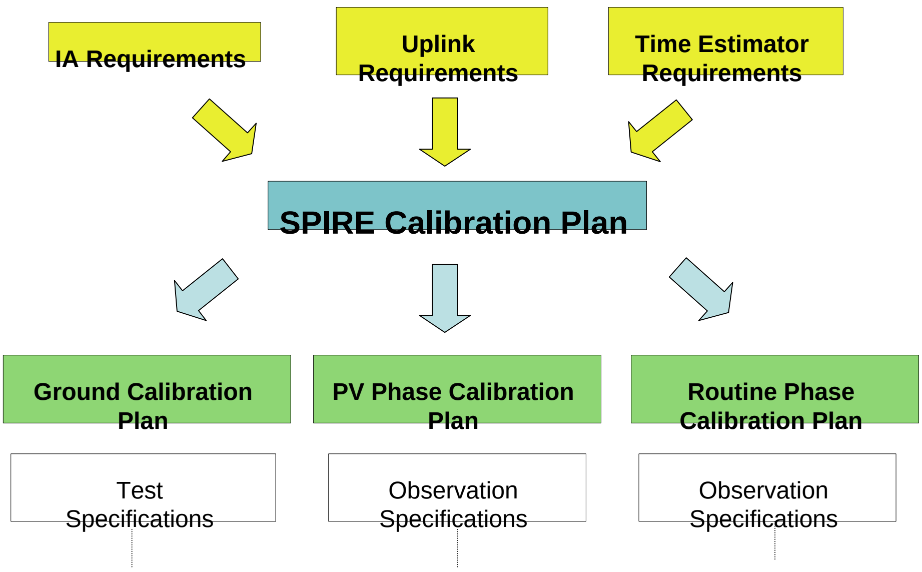


Calibration Plan



SPIRE Calibration Plan Tanya Lim SPIRE Consortium Meeting, Porquerolles, 7/8 Oct 2003

Calibration Plan



SPIRE Calibration Plan Tanya Lim SPIRE Consortium Meeting, Porquerolles, 7/8 Oct 2003

Calibration Plan

The calibration plan…

Combines requirements from the three areas…..

- IA – fairly complete
- Time Estimator – fairly complete
- Uplink – still to do

Combined requirements split into:

- Tables which are needed
- Tables which may be needed, depending on details of data processing

Each table is then described

Calibration Plan

The calibration plan layout

- Table combining the requirements
- Outline of each cal table
  - Table description
  - Upwards Requirement
  - When Needed
  - Relevant Tests
  - Relevant Observations
  - When Generated
  - Analysis
  - Definitely Needed?
- Cross reference cal tables to tests
- Cross reference cal tables to observations
- Cal tables cross referenced to mission phase

Calibration Plan

Dead Pixel Mask
NEP Tables
Pseudo Noise Tables
Detector Response Reference Table
Detector Responsivity Variation with Detector Operation
Signal vs Chop Frequency
Detector Response Temporal Drift Correction
Detector Response to different PCAL Settings
PCAL Temporal Drift Correction
Telescope Temperature Drift
Astronomical Flux Conversion Table
Detector Non-Linearity Correction
Photometer Spectral Response
ZPD For Each Detector
Mirror Position Counter to Mechanical Position
LVDT to Mechanical Position
Mechanical Position to OPD
Apodisation Map
Spectral Resolution vs Scan Range
Spectral Resolution vs Wavelength
SMEC Vignetted Pixel Mask
Spectrometer Spectral Response
Spectral Response vs SMEC Speed
Spectral Response Time Dependance
SCAL Commanded Current vs SCAL Temperature
Detector Response vs SCAL Temperature
SCAL Spectrum Lookup Table
SCAL Temperature Drift
Instrument Spatial Function
Photometer Instrument Throughput
Spectrometer Instrument Throughput
Electrical Crosstalk
Optical Crosstalk
Photometer Flatfield
Spectrometer Flatfield
Temporal Stability of Flatfield
Detector Positions
Instrument Vignetted Pixel Mask
Commanded ADU vs BSM Position Closed Loop
Commanded ADU vs BSM Position Open Loop
Commanded Position vs Readout Position Closed Loop
Commanded Position vs Readout Position Open Loop
Detector Positions in BSM coordinates

Calibration Plan

Detector Responsivity Variation with Detector Operation
ID: CALT-D05

Table Description: Tables will need to be generated of the detector responsivity (A/W) in order to convert to astronomical units. As the detector responsivity is dependent on temperature, chop frequency and may be dependent on bias frequency, like the NEP, the exact format of the tables is still TBD.

Req Source: IA-BTC, IA-RBC, TECR-006

When needed: Test plus flight

Relevant Tests: ILT-PERF-DAL, ILT-PERF-DRB

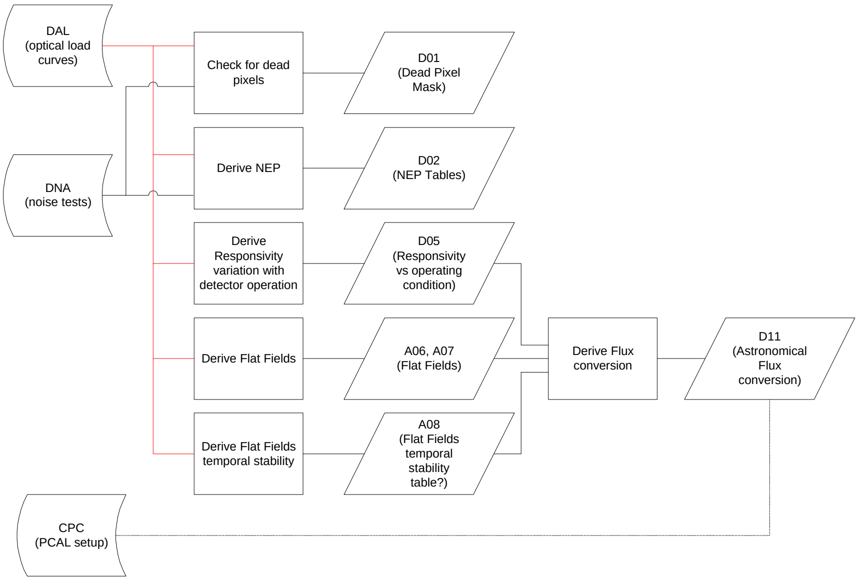
Relevant Observations: Standard astronomical source of known flux (likely to be Neptune for the photometer and possibly Uranus for the spectrometer), scanned across the FOV, spending a short amount of time centred in each of a selection of detectors.

Generated How Often?: Once on the ground, must be generated in flight during PV phase, regular, weekly checks during routine phase.

Analysis: ILT-PERF-DAL will establish the responsivity to a uniform illumination of known flux. In test the point source version of this will be done via ILT-PERF-DRB although it is not yet clear whether it will be possible to obtain a high level of accuracy due to atmospheric conditions in the lab. In flight, the observations of the standard source should be used as the definitive source of this information.

Definitely needed?: Yes

Calibration Plan



Calibration Plan

Summary

- First draft of calibration plan nearly ready
  - ➢ Currently defined ‘performance tests’ will give the right type of information without the need for new tests
    - ⇨ Tests referenced, PV and routine observations outlined
- Next
  - ➢ Ensure plan is complete for uplink
  - ➢ Agree plan with observations and operations teams
    - ⇨ Exact table formats constitute ongoing work
  - ➢ Derive calibration file derivation procedures (CFDP)
  - ➢ Write the ground calibration plan
    - ⇨ For each file show CFDP, detail parameter space explored, detail analysis required where necessary.
  - ➢ Outline PV and routine phase plans
    - ⇨ Use inputs from Sarah on baseline sources

The Herschel Calibration Steering Group

Peter Hargrave
Cardiff

HCalSG Terms of Reference (issue 1.0)

HST decided (mtg#9, 20-22 June 2001): *The objective vis-à-vis data reduction is to be able to reduce data well by the end of the performance verification phase, i.e. about four months into the mission*

To fulfill this objective and cover the SIRD requirements, the Herschel Calibration Steering Group has been set up (HCalSG)

ToR have been approved by HST

The HCalSG reports to the Herschel Science Team, directly or via the Project Scientist

ICC Calibration Responsibilities-1

Following SIRD V1.1, 18 May 2001

- Define (with HSC) Instrument Calibration Plan
- Generate and manage instrument ground-calibration data
- Define, jointly with HSC, the implementation of the ground-based calibration program
- Design, implement, test and validate the S/W required for instrument scientific data processing

ICC Calibration Responsibilities-2

- Provision of instrument calibration requests during operations
- Perform instrument calibration
- Maintain optimal scientific instrument performance during operations
- Support specific instrument modes (e.g. PACS/SPIRE parallel mode)

HSC Calibration Responsibilities-1

Following SIRD V1.1, 18 May 2001

- Define (with ICCs) instrument calibration requirements (ICC responsibility)
- Set and run the Herschel Calibration Steering Group
- Monitor instrument design and characterization activities: Check against performance requirements

HSC Calibration Responsibilities-2

- Coordination (with ICCs) of the ground-based calibration programme
- Monitor instrument calibration activities (on ground)
- Preparation (with ICCs) of the in-orbit instrument calibration programme (ICC responsibility)
- Define (with the ICCs) the instruments in-orbit cross-calibration plan

HSC Calibration Responsibilities-3

- Define (with the ICCs) the instrument in-orbit Performance Verification Plan (ICC responsibility)
- Support the active archive phase, including overall recalibration and cross-calibration

HCalSG Responsibilities

- Define uniform level of calibration objectives
- Review Instrument Calibration Plans
- Monitor pre-launch and post-launch calibration activities
- Identify serious problems or show-stoppers and inform PS and HST
- Identify and coordinate instrument common activities
- Define a clear policy and get support for calibration preparatory proposals submission to ground and space facilities

SPIRE

HCalSG Activities-1

- Review and build-on the calibration experience from other missions (ISO, SIRTF): e.g. *"ISO lessons learned"*
- Discuss and agree concrete calibration objectives
- Discuss and agree primary and secondary calibrators
- Review and compare Instrument Calibration Plans
- Coordinate preparation and review in-orbit instrument calibration requirements documents

SPIRE

HCalSG Activities-2

- Agree policy on submission of calibration proposals to ground and space facilities
- Organize workshops/presentations with theoreticians, modelers, laboratory experts, other missions specialists
- Establish collaborations with external experts
- Discuss and agree the adoption of models for calibration
- Monitor and assess instrument calibration activities

HCalSG Activities-3

• Monitor and discuss impact of satellite subsystems on calibration

• Create/supervise/call dedicated working groups or meetings for:

- Preparation of preparatory calibration proposals
- Distribution of the work for data reduction regarding preparatory calibration data
- Selection of existing observational data for Herschel calibration
- Coordination of calibration during PV and routine phases, including impact on operations and mission planning

HCalSG Composition-1

Chairperson – Ana Heras, ESA

• Calibration Scientists:

– Juergen Stutzki (HIFI)

– Frank Helmich (HIFI, not permanent)

– Ulrich Klaas (PACS)

– Joris Blommaert (PACS)

– Tanya Lim (SPIRE)

– Peter Hargrave (SPIRE)

– Sarah Leeks (HSC/SPIRE)

HCalSG Composition-2

• Mission Scientists:

– José Cernicharo

– Martin Harwit

• ESA representative for Astronomer I/O:

– Timo Prusti

• Relevant experts invited to each meeting:-

– e.g. Therese Encrenaz, Martin Cohen, Leen Decin, Thomas Mueller etc……

HCalSG Meetings

•Every four months (variable depending on mission phase)

•Meetings so far have followed the format:-

- •Calibration progress reports from instrument teams
- •Talks from invited experts
- •Update on spacecraft issues – pointing etc
- •Ground-based calibration work

•Main focus at present is production of the first drafts of calibration plans for each instrument for review

•Several concerns voiced by instrument teams so far:-

- • Instrument level tests de-scoped – schedule pressure.
- •ArianeSpace have large cleanliness (dirtiness!) budget for integration of Herschel – contamination of primary from fairing
- •Herschel & star-tracker alignment depends on PACS alignment – no bore-sighted detector

Herschel Calibration Steering Group meeting #4
Agenda

Date: 18 June 2003
Starting time: 9:00
End time: 16:30
Place: ESTEC, room Ea112

1. Agreement of the agenda
2. Review of actions (all, 30 min.)
3. HIFI calibration progress report (F. Helmich/J. Stutzki, 20 min. + 10 min. discussion)
4. PACS calibration progress report (J. Blommaert, 20 min.+ 10 min. discussion)
5. SPIRE calibration progress report (T. Lim, 20 min. + 10 min. discussion)
6. SIRTF calibration plans (G. Helou, 45 min. + 15 min discussion)
7. CSO observations of planets (J.R. Pardo, 30 min. + 15 min. discussion)
8. Pointing issues (T. Prusti, 20 min. + 10 min. discussion)
9. Miscellaneous (A. Heras, 20 min.+ 10 min. discussion)
10. Date and place of next meeting
11. AOB

Global Herschel Calibration Objectives

- Ensure the most accurate conversion between physical parameter measured by the detector and astronomical units
- Monitor and characterize the instruments and S/C subsystems (e.g. pointing, telescope) in-orbit performance
- Final required absolute and relative calibration accuracy is established by each instrument team
- Minimum required calibration accuracy (uplink and downlink) at the end of PV, for execution of Key Programs and follow-up observations?

Calibration Milestones (TBC)

• Ground Segment Requirements Review	February 2003
• Ground Segment Design Review	February 2004
• Call for Key project observation proposals	February 2004
• Calibration Plans (per instrument, cross-calibration)	December 2004
• In-orbit calibration requirements document, issue 1	December 2004
• Call for Guaranteed Time Proposals	February 2005
• Call-1 for Open Time Proposals	February 2006

Calibration Milestones (TBC)

• Ground Segment Implementation Review	February 2006
• PV observations in database	June 2006
• In-orbit calibration requirements document, issue 2	October 2006
• Ground Segment Readiness Review	October 2006
• Ground Segment Simulations	November 2006
• HCSS Readiness Review	December 2006
• Operations Readiness Review	January 2007
• PV observations timeline	March 2007

Calibration Milestones (TBC)

• Launch	February 2007
• End Commissioning Phase	March 2007
• End PV Phase	May 2007
• End Science Demonstration Phase	June 2007
• Mission level in-orbit commissioning review	June 2007
• Call 2 for Open Time Proposals	February 2008
• Call 3 for Open Time Proposals	February 2009
• End in-orbit phase	October 2010

SPIRE ICC

Ken King
RAL

- SPIRE ICC Status Overview
- ICC and Herschel Ground Segment
- ICC Review
- Schedule

ICC Status - Staff

- ICSTM
  - Dave Clements has taken on the role of ICSTM DAPSAS Manager
  - Helen Bright (Oct 02) and Kenton D'Mellow (recently) joined
  - Matthew Graham and Toshinubo Takagi left this Summer
  - 50% to be appointed
- RAL
  - Asier Aramburu has been appointed by the University of Lethbridge as their ICC representative and has taken up the post, based at RAL. He is working with Sunil on OPST
- Trieste
  - Maohai Huang has moved from Trieste
    - replacement TBD
    - significant impact on the Software Team

Sarah Leeks has been appointed to the Project Scientist Team at ESTEC and has been assigned to work with SPIRE - she will be working, in particular, with Tanya Lim on the Calibration Plan Definition

ICC Status - Test Preparations

- **EGSE**
  - The latest version of SCOS2000 (v2.3e P3) has been installed and tested. This includes the patch required to allow retrieval of TC History and OOL data.
  - Instrument Databases (MIBs) have been produced for the AVM instrument and for test equipment – CDMS Simulator, TFTS & TFCS. These have been successfully used to control/monitor the equipment.
  - HCSS (version 0.1.3) has been accepted and installed
    - a new version (0.1.4) will be available at the end of October
    - Test Scripts are being written and tested
  - QLA Version 1.2 (AVM) has been installed and tested
    - version 2.0 (CQM) with more functionality should be available by end of October
    - Testing of scripting and functionality is ongoing
- **Training**
  - A training week for users of the ILT test systems was held in the week beginning 23rd June.
- **On-Board Software**
  - The AVM (DPU and DRCU Simulator) were delivered in April with a first version
  - A subset of the OBS SVVP was been performed as a preliminary OBS checkout.
  - Testing is now ongoing with the CQM DRCU (and FPU Simulator)
  - SPRs have been raised and are being addressed
    - Main problem: OBS crashes after several minutes of continuous science data
    - Good exercise of the configuration control / maintenance facilities

ICC Status - Observations

- **Observations Definition**
  - The definition of the commands required to perform the transition between basic instrument operating modes have been written into the 'Operating the SPIRE Instrument' document.
  - Data processing diagrams for each of the main SPIRE Observing modes have been produced to identify the data processing steps to be included in IA and, more urgently, the necessary calibration information to be obtained in testing the CQM.
  - This needs to be tied in to the Observation (and Building Block) definitions
- **Calibration:**
  - The set of calibration tables required for up/downlink have been compiled and a specification of the tests necessary to provide these has been produced. Work is now ongoing to define the ground test procedures and processing steps to allow generation of these tables from the ILT.
  - Work has started on the in-flight calibration with the ESA Instrument and Calibration Scientist (Sarah Leeks)
  - Participation in HCALSG

ICC Status – Common Development

- HCSS
  - V 0.1.3 was successfully acceptance tested and could form the base for ILT testing.
  - With delay in delivery of IST version a new ILT version V0.1.4 will be produced (there is some additional functionality - e.g support for Command Lists, which would be useful). This will be installed time permitting
  - V 0.2 (for IST) is now due in March
- IA working group
  - Successfully demonstrated a prototype implementation of an IA framework
  - Is now charged with producing a first version of a common IA framework for use by all the instruments (due Spring 2004).
  - The developing framework is already available in a useable form and the SPIRE QLA is based upon this.
    - This allows us to feedback problems/changes to the WG, while benefiting from the additional resources supplied by other teams.

ICC & Herschel Ground Segment

As part of the Herschel Mission Review cycle, the Science Ground Segment was reviewed in November. This took the form of a review of the Science Implementation Plans of the three instruments and the Herschel Science Centre and a review of the status of software development so far.

- The main conclusions were that the software development was in a good state for this stage of the development, but it became clear that for SPIRE and HIFI the available resources were not likely to be sufficient to provide the ICC described in the SIP. (For SPIRE this was based on the resources identified at the consortium meeting in Rome)
- We have therefore begun an evaluation of the SPIRE ICC with the objective of defining a system that can be provided with the resources available.
- This will avoid the penalties (loss of Guaranteed Time) associated with any possible ESA support. A report will be produced at the end of the process
- We have a one-to-one meeting with ESA in November

ICC Review

- The areas being looked at are:
  - Increasing the resources available
    - Support from IPAC – they are able to provide support (~4sy) to some data processing tasks (still TBS)
    - Better use of small percentage effort resources – reorganisation of Workpackages to be discussed tomorrow
    - Additional resources – any offers?
  - Reviewing the scope of the ICC workpackages defined in the SIP to reduce the effort required
    - Matt has proposed a definition of data products for SPIRE observing modes that would minimise the data processing required, yet still provides a product that can be used to do science – later presentation
    - The level of processing of data to be provided by the ICC and the product to be distributed has been discussed at a meeting at Cardiff on the 12th June. The conclusion was that it looks just possible to keep within the planned resources (total cost was 57sy, c.f 55 available), but
      - requires all effort to be used in full
      - Requires certain caveats on the ICC tasks (reduced scope)

ICC Scope Reduction

- Minimise Data Processing by ICC
  - Redefinition of Data Products
    - Removal of instrument signature leaving data scientfically usable but not fully processed (basically calibrated timelines with pointing information)
    - Requires effort by the observer to get a publishable product (averaging, making maps, finding sources, lines etc)
    - May not provide HSC with a Standard Data product for all modes
    - This may rebound in Operations Phase when observers start processing data and finding 'problems'
  - Drop standard support for some modes
    - Chop-scanning, Spectroscopy of extended sources
    - Map Scanning – how far do we rely on consortium to help here?
    - Require an instrument expert to be part of the proposal?
  - Use of external processing packages possibly adapted to use the SPIRE products
    - to be investigated
      - SURF, the SCUBA data analysis package, Sussextractor
      - Joint development with PACS
      - IPAC support
    - implications for HSC - free provision to observers, maintenance

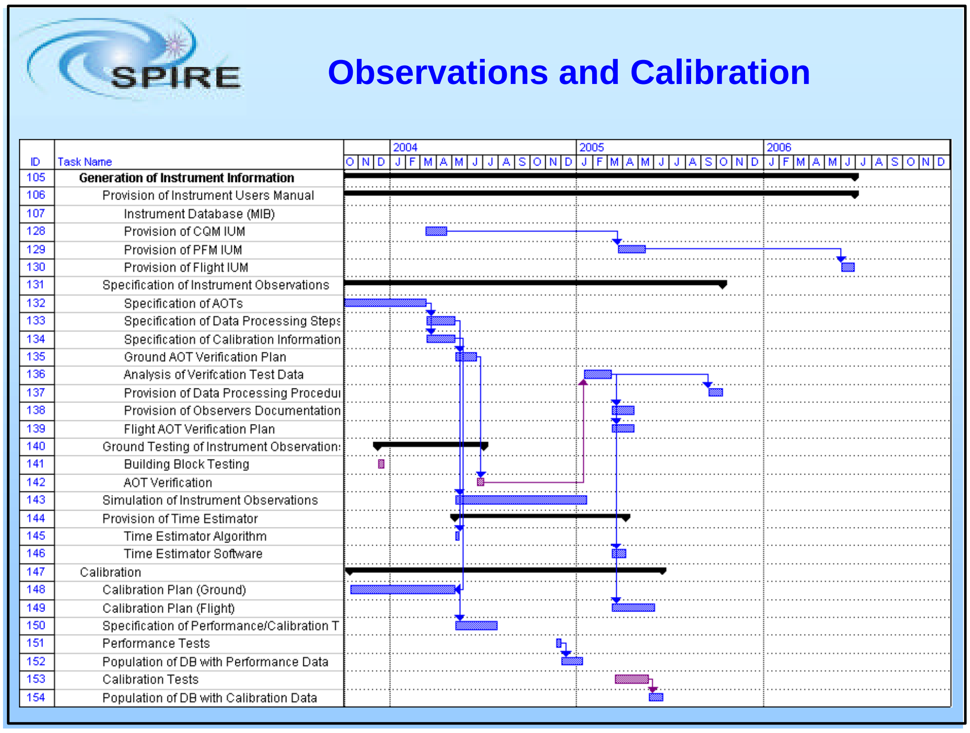
ICC Scope Reduction

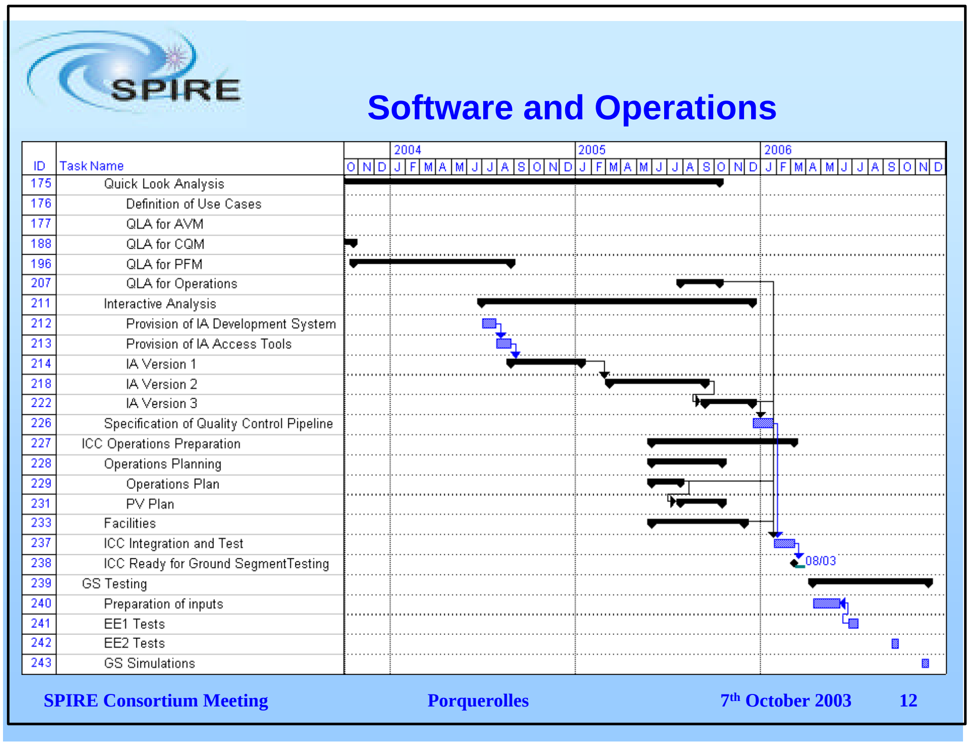
- Re-evaluation of Workpackages
  - Time Estimator – what is really required? Does CUS do the job? Does SPOT provide the GUI?
  - No uplink validation software
  - No support for processing for Key Programmes
  - Reduction in PA support – Developers will handle software configuration control
  - Reduced contribution to HCS/IA activities after this year
- Possible changes to the implementation of the ICC and its facilities
  - for example a reduction in number of DAPSAS Centres?

The result is an ICC that is probably implementable, but comes at a cost of extra effort by others or by SPIRE in the Operations Phase

Schedule

- ICC Definition
  - Workpackage details to be agreed by November meeting with ESA
  - ICS Steering Committee will review approach to workpackage consolidation and Assignment (TBC)
- Short Term Priorities
  - QLA delivery for CQM Tests
  - Definition of Observations and Data processing Steps ready to start implementation of IA
  - Definition of Calibration Tests
  - Support to CQM/PFM testing


SPIRE
Observations and Calibration
2004
2005
2006
ID
Task Name
105 Generation of Instrument Information
106 Provision of Instrument Users Manual
107 Instrument Database (MIB)
128 Provision of CQM IUM
129 Provision of PFM IUM
130 Provision of Flight IUM
131 Specification of Instrument Observations
132 Specification of AOTs
133 Specification of Data Processing Steps
134 Specification of Calibration Information
135 Ground AOT Verification Plan
136 Analysis of Verifcation Test Data
137 Provision of Data Processing Procedu
138 Provision of Observers Documentation
139 Flight AOT Verification Plan
140 Ground Testing of Instrument Observation
141 Building Block Testing
142 AOT Verification
143 Simulation of Instrument Observations
144 Provision of Time Estimator
145 Time Estimator Algorithm
146 Time Estimator Software
147 Calibration
148 Calibration Plan (Ground)
149 Calibration Plan (Flight)
150 Specification of Performance/Calibration T
151 Performance Tests
152 Population of DB with Performance Data
153 Calibration Tests
154 Population of DB with Calibration Data


SPIRE
Software and Operations
2004
2005
2006
ID
Task Name
175 Quick Look Analysis
176 Definition of Use Cases
177 QLA for AVM
188 QLA for CQM
196 QLA for PFM
207 QLA for Operations
211 Interactive Analysis
212 Provision of IA Development System
213 Provision of IA Access Tools
214 IA Version 1
218 IA Version 2
222 IA Version 3
226 Specification of Quality Control Pipeline
227 ICC Operations Preparation
228 Operations Planning
229 Operations Plan
231 PV Plan
233 Facilities
237 ICC Integration and Test
238 ICC Ready for Ground SegmentTesting
239 GS Testing
240 Preparation of inputs
241 EE1 Tests
242 EE2 Tests
243 GS Simulations
08/03
SPIRE Consortium Meeting
Porquerolles
7th October 2003
12

SPIRE ICC Software Development Team Status Report

Steve Guest, ISDT Team Leader

ISDT Team Members

- Current Team Members
  - Helen Bright (IC)
  - Kenton D'Mellow (IC, just started)
  - Matt Fox (IC)
  - Rene Gastaud (CEA, currently not active for personal reasons)
  - Steve Guest (RAL)
- User Contacts
  - Tanya Lim (RAL)
  - Sunil Sidher (RAL)
- Previous team members
  - Matthew Graham (Caltech, was IC)
  - Maohai Huang (Beijing, was Trieste)
  - Toshinobu Takagi (Kent, was IC)

SPIRE

ISDT Status Report

HCSS Contribution

Core HCSS	**Responsible**	**Collaborators**
Data Access	Steve	
Telecommand History	Steve	
Out-of-Limits	Steve	
Logging	Helen	HSC

Common IA	**Responsible**	**Collaborators**
User Interfaces	Helen	Steve
User Preferences	Helen	
Plotting	PACS	Kenton, was Maohai
IO	HSC	Steve

SPIRE

ISDT Status Report

QLA Work Packages

Package	**Responsible**	**Collaborators**
Framework	Steve	Sunil
Pipeline support	Steve	
Parameter Selection	Matt	
Image Displays	Matt	
Fourier & Noise	Matt	
Peak-up tool	Matt	
Data I/O	Kenton	
Plotting	Kenton	
Help	Helen	
Parameter Display	Helen	
Demodulation	Rene	Steve
Product Contents	Tanya	Steve
Test scripts	Tanya	Steve, Matt
Fitting/Filtering/Statistics	*Now Common IA*	
Engineering Simulator	Rene	

Miscellaneous ISDT Activities

- Groups and Teams:
  - Common Software Development Team (Steve, Helen)
  - (Common) Interactive Analysis Working Group (Steve, Helen)
    - The above include inputs, analysis and reviews
  - HCSS Software Coordination Group (Steve)
  - HCSS CCB (Steve)
- Other
  - Data interfaces to other sites e.g. UoL, IPAC (Steve)
  - Data servers for remote data access (Steve)
  - Database administration (Steve).
  - Meetings and telecons function as CCB (ISDT + Tanya, Sunil)
  - Configuration Control and SPR/SCR systems supplied by ESA

SPIRE software status

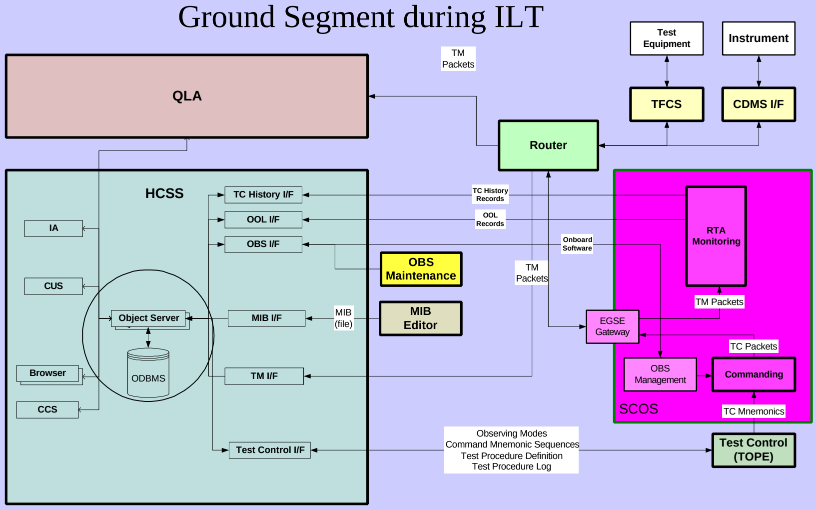
QLA

- The developers version of QLA 2.0 to support the CQM tests is installed on the ICC machines at RAL and is being tested with real instrument data.
- *Most* functionality has now been implemented
  - Some parts fairly mature
  - Other parts still in prototype stage and need attention and/or rewriting
  - Scripts to support specific tests now being produced
- Uses elements of HCSS and common IA
- Demo Available

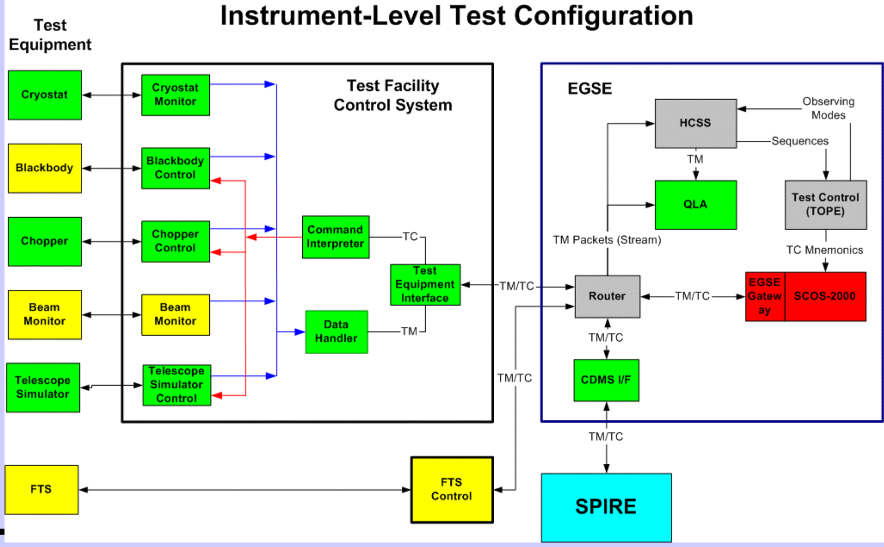
IA

- Not (formally) started yet
- QLA contains some IA-like features (interactivity, scripting etc) which can be reused for IA
- ISDT also involved in common IA infrastructure development

Ground Segment during ILT



Instrument-Level Test Configuration



SPIRE EGSE-ILT Components - I

Key components of the SPIRE EGSE during ILT are:

- EGSE Router – Developed by HIFI. Transfers telecommands and telemetry packets to interested clients
- SCOS 2000 – Generic Space Craft Operations System. Provided by ESOC (via ESTEC) for use by Herschel during all mission phases.
- Test Operations & Procedure Environment (TOPE) – Provided by ESTEC as an extension to SCOS 2000. Allows the preparation and execution of test scripts.
- Test Control – Developed by PACS. An extension to the TOPE system which, in conjunction with the Test Control Interface, allows communication with the HCSS.
- CDMS Simulator – Developed by SPIRE. Simulates operation of the Herschel spacecraft computer.
- Test Facility Control System – Developed by SPIRE. Includes control of the telescope simulator and test cryostat using SCOS 2000 and TOPE.
- Test Fourier Transform Spectrometer – Developed by University of Lethbridge, Canada. To be used for for SPIRE testing in ILT. Controlled via SCOS 2000 and TOPE.

SPIRE EGSE-ILT Components - II

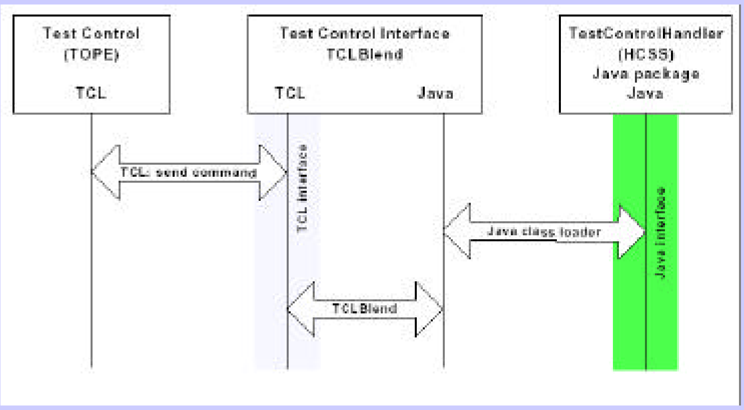
HCSS – The Herschel Common Science System. Includes the Object Oriented Database Management System (ODBMS). This central database server has interfaces to the following HCSS components:

- Test Control
- Common Uplink System (CUS)
- Telemetry ingestion
- Quick Look Analysis (QLA)
- Interactive Analysis (IA)
- Telecommand (TC) History ingestion
- On Board Software (OBS)
- Out of Limits (OOL) data ingestion

SPIRE EGSE Status

- SCOS 2000 – Version 2.3e (Patch Level 3) in use since August. No major problems.
- TOPE – A number of SPRs were reported to ESTEC which have been addressed in the latest version (received a couple of weeks ago)
- Test Control – Version 0.1 in use since January 2003.
- CDMS Simulator – Version 2.4 in use since July 2003
- Test Facility Control System – Version 1.0 operational. Test cryostat functionality present. Currently being upgraded for the telescope simulator and Test FTS weather station.
- Test FTS – Functional since early September. Awaiting further tests using the hot black body source.

TestControl Interfaces



HCSS Status

- Version 0.1.3 (build #168) was system tested in June by the HSC.
- SPIRE acceptance test carried out immediately afterwards. Five Non Conformance Reports were raised but they did not affect the outcome of the test.
- Version 0.1.3 seems capable of supporting some of the CQM testing.

Example Test Procedure

```
# @author   Sunil Sidher
# @date     19th June 2003
# @version 1.0
# @purpose Support for SPIRE-HCSS acceptance test
# @param a integer 2 Value of a
# @param b integer 4 Value of b
# @param c integer 6 Value of c

appendLogMessage " Log file for HCSS 0.1.3 acceptance test procedure"

catch {unset obsParams}
set obsParams(a) $a
set obsParams(b) $b
set obsParams(c) $c

set cmdList [getObservationCommands Mode_POF1_1 obsParams]
sendObservationCommands $cmdList

closeTest 0 "Test closed OK"
```

Default values for parameters a, b and c

Prompts the user for parameters a, b and c

TCs for observation Mode_POF1_1 returned from the HCSS in variable cmdList

TCs sent to the instrument via TOPE

SPIRE On Board Software

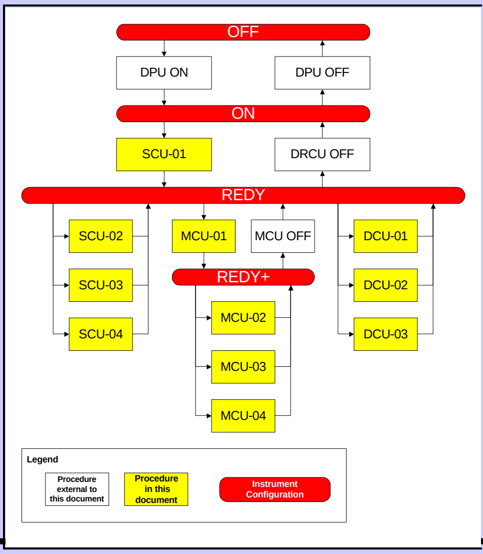
- The AVM DPU with version 1.0 of the OBS was delivered to RAL in April 2003.
- Acceptance tests were carried out using the DRCU simulator and basic functionality verified. A number of SPRs were raised.
- Latest OBS version being tested at RAL is 1.2d. This includes modifications made following the preliminary testing with the CQM DRCU (viz. **QM0 MCU, QM1 DCU and QM1 SCU**).
- The OBS has still to be tested under operational conditions with
  - the OBS being uploaded using telecommands rather than the JTAG probe.
  - the DRCU simulator.
  - the DCU, MCU and SCU all being commanded and generating science telemetry simultaneously.
  - the instrument and subsystems being commanded using the Virtual Machine Language command lists. *Functionality to support Command Lists is not yet available in the HCSS.*
  - the autonomy functions fully implemented.

SPIRE MIBs

- At present there are several versions of the SPIRE telemetry and telecommand database, popularly known as the MIB (Mission Information dataBase).
- MIBs exist for SPIRE AVM, CQM, TFCS, Test FTS and the CDMS simulator.
- These MIBs are subject to the naming convention standards as agreed between the Herschel EGSE working group, CSDT and Alcatel.
- The SPIRE MIB needs to conform strictly to these conventions for successful ingestion into the HCSS – otherwise the CUS cannot be used to define observing modes or building blocks.
- The latest MIB has not been ingested into the HCSS yet because of a few event and function reports not being uniquely defined. This is not a problem for ingestion into SCOS 2000.

SPIRE CQM Test Preparation

- 11 Integration Tests fully specified for each subsystem and mechanism in the DRCU Integration Test Plan (Ken King).
- These tests exercise the interface between the DPU and DRCU and check that data is transferred in both directions according to the interface specification.
- Test scripts written in TCL for execution using the SCOS 2000 and TOPE system .
- QLA scripts also prepared to respond to science and housekeeping data generation from each of these tests and to produce data products for offline analysis (Tanya Lim & Steve Guest).



Functional Tests

- These are tests of different subsystems (SCU, MCU, SMEC, BSM, PCAL, SCAL, DCU) that will be performed on different model of the instrument (AVM, CQM, PFM and FS). They consist of integrity checks and characterisation tests.
- They will initially be performed using the AVM (DPU, DRCU Simulator, CDMS Simulator, SCOS 2000 and TOPE.
- Once these initial tests have been conducted successfully the warm functional tests will be carried out on the CQM.
- During the CQM test campaigns *all* the functional tests will be performed with the cold instrument.
- Test Specification document and many of the test scripts have been prepared by Asier Aramburu (RAL).

SCU Functional Tests

- **FUNC-SCU-01:** SCU Science packet generation check
- **FUNC-SCU-02:** SCU Science data check
- **FUNC-SCU-03:** SCU DC thermometry check
- **FUNC-SCU-04:** SCU PCAL check
- **FUNC-SCU-05:** SCU SCAL check
- **FUNC-SCU-06:** SCU AC thermometry check
- **FUNC-SCU-07:** SCU cooler heater check
- **FUNC-SCU-08:** SCU Test pattern test

MCU, SMEC and BSM Functional Tests

- **FUNC-MCU-01:** MCU power on
- **FUNC-MCU-02:** MCU Science packet generation check
- **FUNC-MCU-03:** MCU Science data check
- **FUNC-MCU-04:** MCU test pattern test
- **FUNC-SMEC-01:** SMEC switch on and initialisation
- **FUNC-SMEC-02:** SMEC launch latch check
- **FUNC-SMEC-03:** SMEC LEDs test
- **FUNC-SMEC-04:** SMEC position test
- **FUNC-SMEC-05:** SMEC multiple position test
- **FUNC-SMEC-06:** SMEC saw tooth scan test
- **FUNC-SMEC-07:** SMEC triangular scan test
- **FUNC-BSM-01:** BSM power on motor and sensor
- **FUNC-BSM-02:** BSM position test
- **FUNC-BSM-03:** BSM scan test
- **FUNC-BSM-04:** BSM operating mode test

DCU, PCAL and SCAL Tests

- **FUNC-DCU-01:** DCU Science Packet generation check
- **FUNC-DCU-02:** DCU Science data check
- **FUNC-DCU-03:** DCU Test pattern test
- **FUNC-DCU-04:** DCU LIAs switch on
- **FUNC-DCU-05:** DCU Offset test
- **FUNC-DCU-06:** DCU JFET heaters
- **FUNC-DCU-07:** DCU JFET test
- **FUNC-DCU-08:** DCU Phase shift test
- **FUNC-DCU-09:** DCU Bias frequency test
- **FUNC-DCU-10:** DCU Bias amplitude test
- **FUNC-DCU-11:** DCU detectors switch on
- **FUNC-PCAL-01:** PCAL characterisation test
- **FUNC-SCAL-01:** SCAL characterisation test
- **FUNC-SCAL-02:** SCAL PID test

Performance Tests

- The Performance Test Specification document exists (Tanya Lim)
- Performance test scripts and QLA scripts are all still to be written.
- They will follow the general structure of the functional tests.
- These tests will fully exercise the HCSS from telecommanding through to TM ingestion.

Observing Mode and Building Block Definitions

- “Operating the SPIRE Instrument” was revised for the IHDR in July.
- Still needs a lot of work to define all the commanding scenarios for the different modes.
- These definitions will be incorporated into the CUS , together with the requisite uplink calibration table definitions.

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London

Observations and Data Processing Team (OBST)

Matt Fox

(Dave Clements)

Responsibilities are detailed in SPIRE-RAL-N-001327

Summarised…

Definition of the observing modes of SPIRE in terms of the available instrument operations and input parameters provided by observers (AOT definition)

Specification of algorithms for IA data processing modules used for reduction of scientific observations data

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London

OBST Update

Main activities:

The detailed definition of work packages for the individual modules of SPIRE data reduction (SPIDR?)

Definition and format of Astronomical Observation Templates

Simulations of extragalactic sky at SPIRE wavelengths and confusion analysis

With ISDT / CSDT

The design and coding of QLA modules for AVM and currently CQM

With CALT

Time Estimator Usecases, flowcharts and decision trees

Definition of data processing steps and dependencies.

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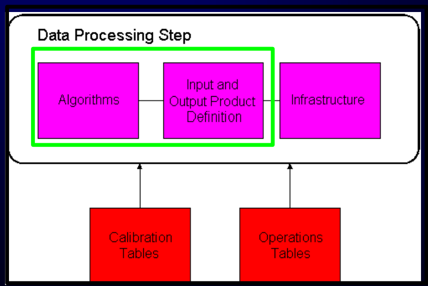
Drivers of data processing development:

- Requirements of test data reduction
- The operating modes of SPIRE



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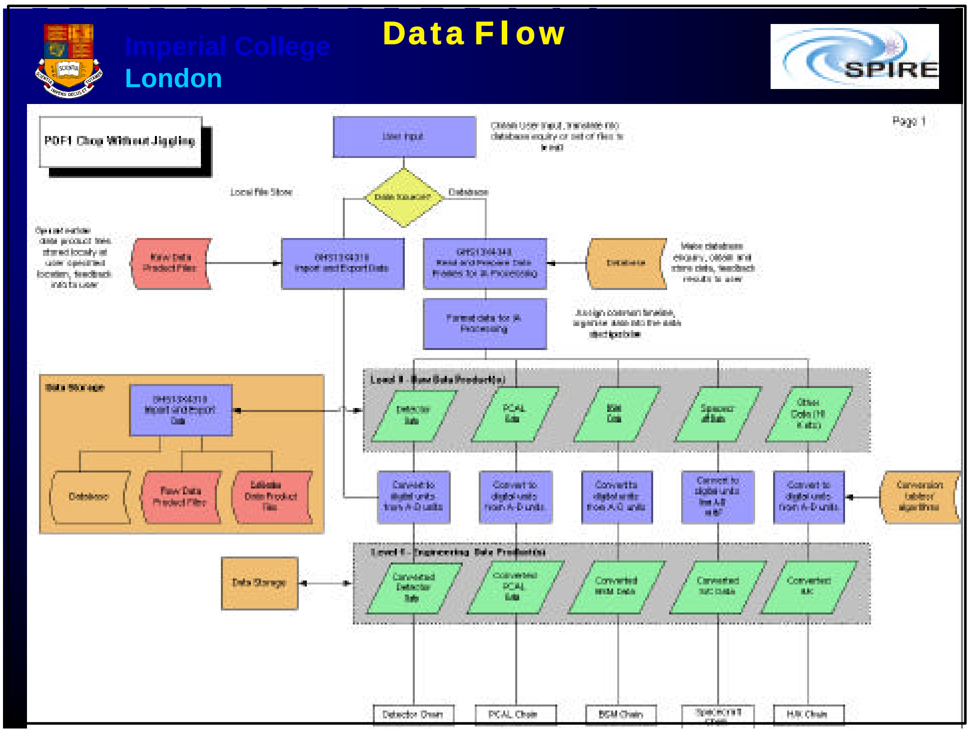
Data Flow

Getting the data

Storing the data

Initial processing of the data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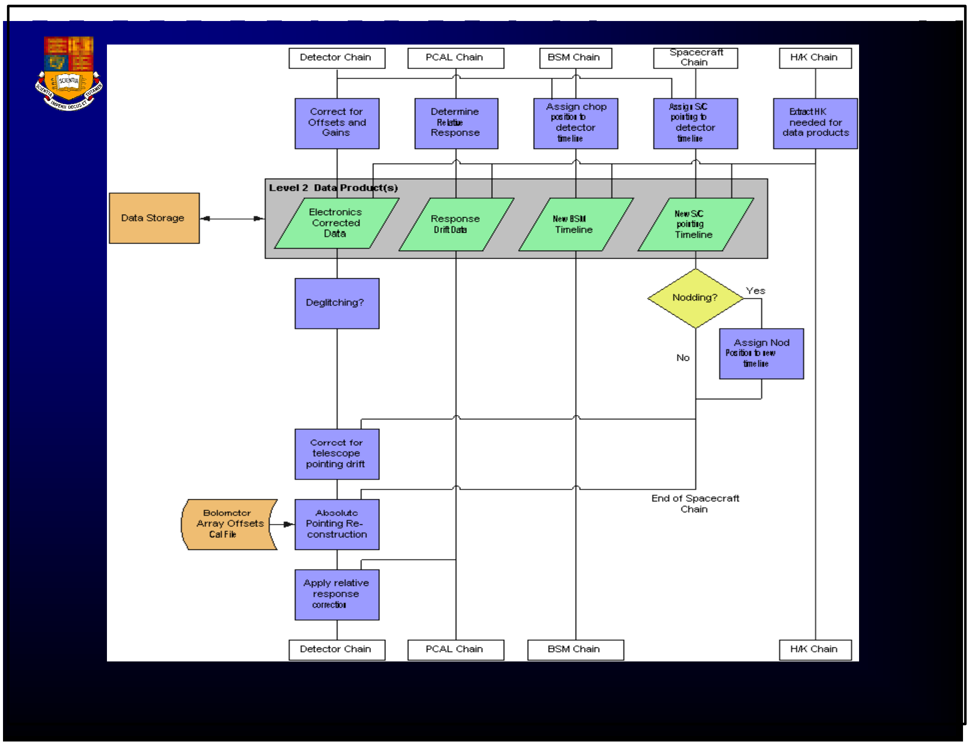
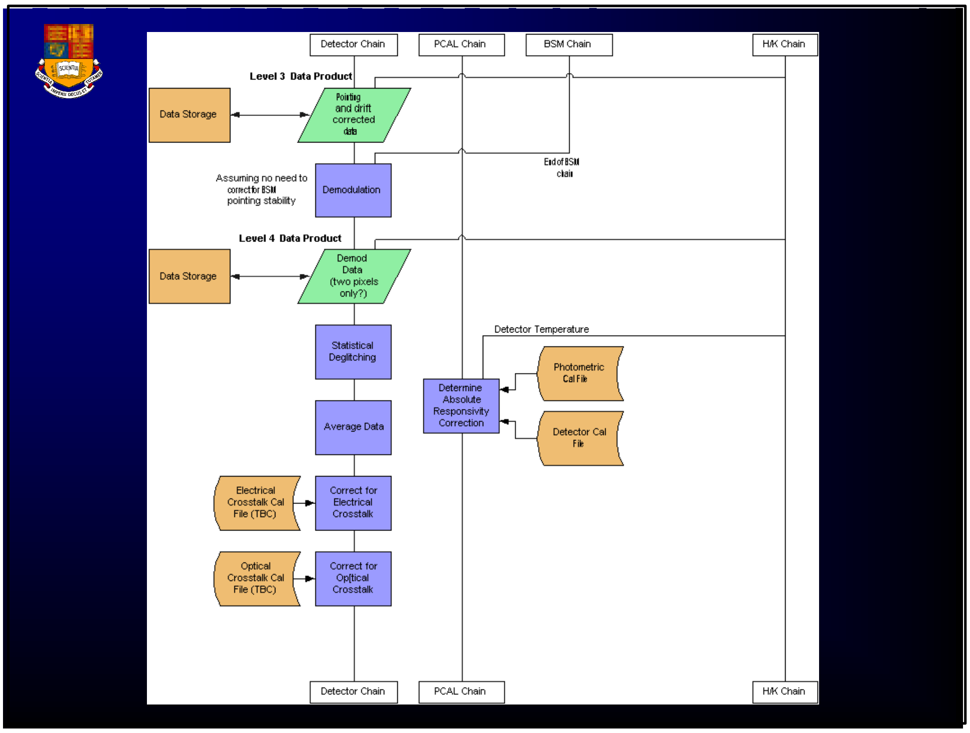
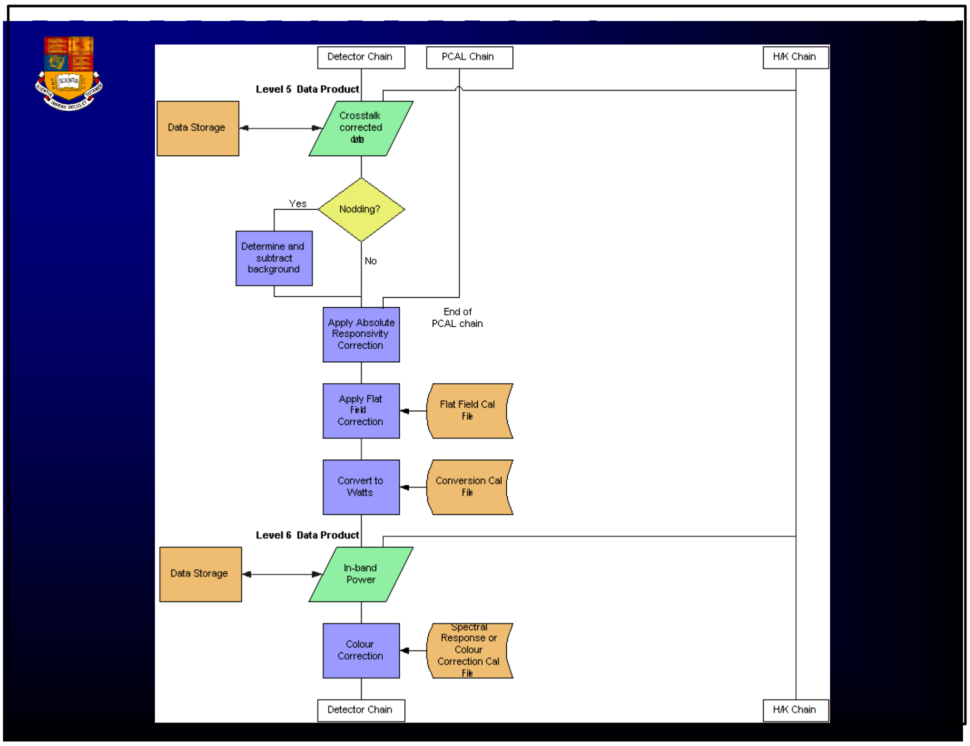
Data Flow
SPIRE
Page 1
PDF1 Chop Without Jiggling
User Input
Local File Store
Database
Raw Data
Product Files
Database
Level 0 - Raw Data Product(s)
Data Storage
Level 1 - Engineering Data Product(s)
Data Storage
Conversion
tables/
algorithms
Detector Chain
PCAL Chain
BSM Chain
H/K Chain


Detector Chain
PCAL Chain
BSM Chain
Spacecraft
Chain
H/K Chain
Correct for
Offsets and
Gains
Determine
Relative
Response
Assign chop
position to
detector
timeline
Assign S/C
pointing to
detector
timeline
Extract HK
needed for
data products
Level 2 Data Product(s)
Data Storage
Electronics
Corrected
Data
Response
Drift Data
New BSM
Timeline
New S/C
pointing
Timeline
Deglitching?
Nodding?
Yes
No
Assign Nod
Position to new
timeline
Correct for
telescope
pointing drift
End of Spacecraft
Chain
Bolometer
Array Offsets
Cal File
Absolute
Pointing Re-
construction
Apply relative
response
correction
Detector Chain
PCAL Chain
BSM Chain
H/K Chain



Detector Chain
PCAL Chain
BSM Chain
H/K Chain
Level 3 Data Product
Data Storage
Pointing and drift corrected data
End of BSM chain
Assuming no need to correct for BSM pointing stability
Demodulation
Level 4 Data Product
Data Storage
Demod Data (two pixels only?)
Detector Temperature
Statistical Deglitching
Photometric Cal File
Determine Absolute Responsivity Correction
Average Data
Detector Cal File
Electrical Crosstalk Cal File (TBC)
Correct for Electrical Crosstalk
Optical Crosstalk Cal File (TBC)
Correct for Op[tical Crosstalk
Detector Chain
PCAL Chain
H/K Chain



Detector Chain
PCAL Chain
H/K Chain
Level 5 Data Product
Data Storage
Crosstalk corrected data
Yes
Nodding?
Determine and subtract background
No
End of PCAL chain
Apply Absolute Responsivity Correction
Apply Flat Field Correction
Flat Field Cal File
Convert to Watts
Conversion Cal File
Level 6 Data Product
Data Storage
In-band Power
Colour Correction
Spectral Response or Colour Correction Cal File
Detector Chain
H/K Chain

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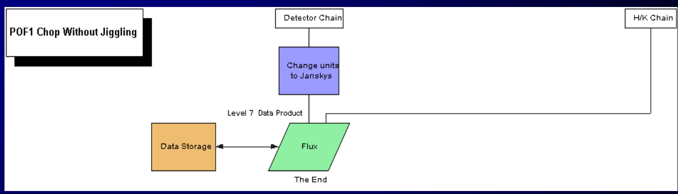

Where do we stop the SPIDR pipeline?

How much work will be developed as part of common IA framework?

What level of data product is the 'Standard Product'?

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SPIRE Data Reduction

SPIDR driven by ® GUIs

® Command line

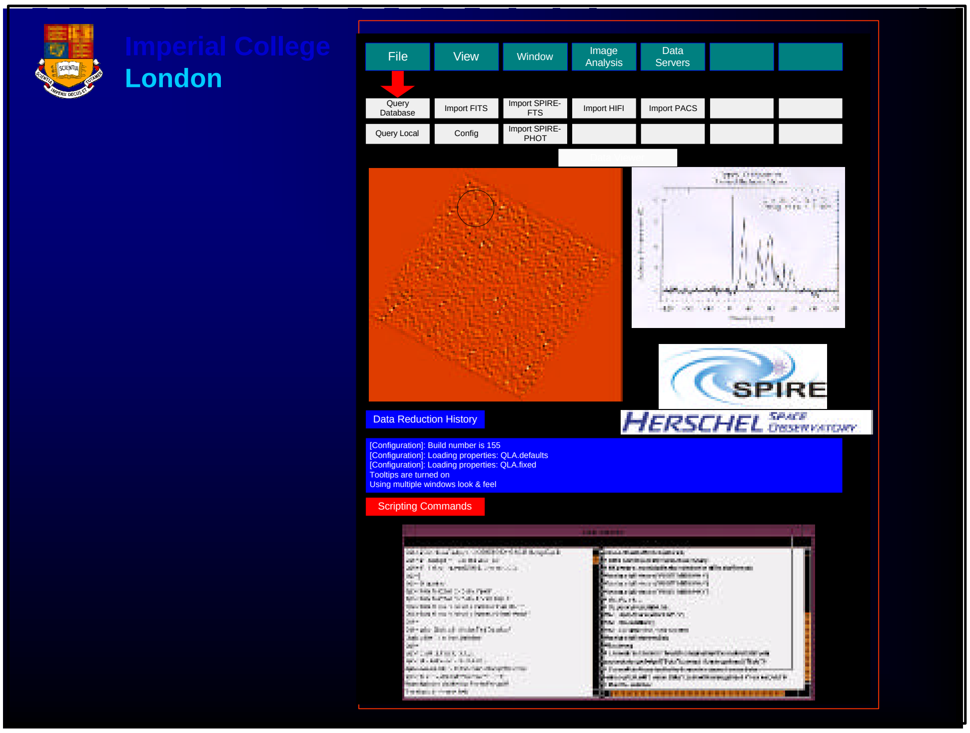
Jython looks and feels like IDL

Pipeline: essentially a recipe using individual reduction steps

Comprehensive error messaging + Help system

Export/import to existing reduction packages via popular data formats

All features now exist in the SPIRE-QLA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File
View
Window
Image Analysis
Data Servers
Query Database
Import FITS
Import SPIRE-FTS
Import HIFI
Import PACS
Query Local
Config
Import SPIRE-PHOT
SPIRE
HERSCHEL SPACE OBSERVATORY
Data Reduction History
[Configuration]: Build number is 155
[Configuration]: Loading properties: QLA.defaults
[Configuration]: Loading properties: QLA.fixed
Tooltips are turned on
Using multiple windows look & feel
Scripting Commands

Calibration Team Status

Tanya Lim

RAL

Current Resources

Tanya (55%, shared with testing)

Cal Team Management, Support to ISDT and OBST, HCalSG representative, Cal Plan, IA Cal, Performance Tests

Marc (30%?)

Cal Team Management, Time Estimator

Sarah (50%)

In-flight preparation

Sunil

Uplink

Bernhard (Unofficial support)

Detector testing

Pete

HCalSG representative

Overall Status

Management Activities

- Work packages produced and costed
- Overall schedule defined
- Support to OBST and ISDT work package definition

Calibration Definition

- First CALT meeting - Documentation tree agreed
- Requirements definition
  - ➢ IA Files defined at top level, IA dataflow definition ongoing
  - ➢ Time Estimator requirements defined, TE dataflow/cal files defined at top level
  - ➢ Ops calibration definition still TBD
- In-flight preparation progressing
- Calibration Plan

Overall Status

Other Activities

- Regular feedback/requirements definition on QLA via formal testing, SPR/SCRs, attendance at meetings etc…
- Definition/writing of QLA scripts
- Co-ordination of data processing effort for the performance tests
  - ➢ UOL
  - ➢ IPAC
- Definition and prioritisation of IA work packages
- HCalSG participation

Future Work

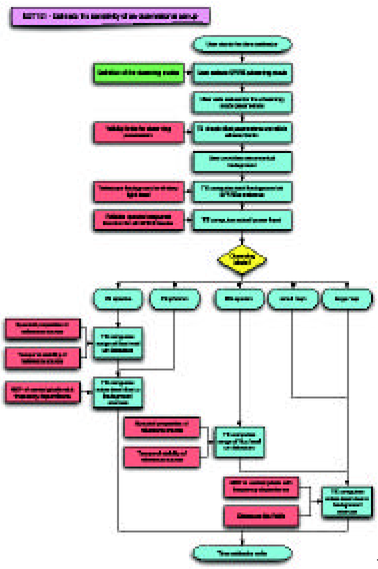
Next Year

- Ensure that uplink is correctly documented in the calibration plan
- Complete the first version of the CFDPs
- Write the ground calibration plan

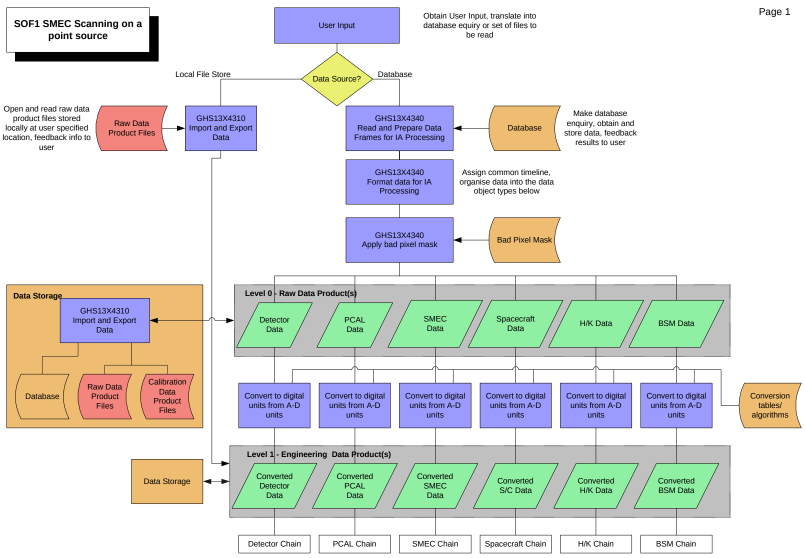
- Agree initial cal table outline with IA WP owners and update calibration plan if necessary
- Define the calibration database
- Write s/w to analyse the test data
- Analyse the test data

- Produce an initial outline of the PV phase plan
- Produce an initial outline of the Routine phase plan

Time Estimator Definition



IA Definition - I



Calibration Approach

Starting point – Calibration Requirements Document (Bruce)

Capture detailed requirements
- IA (Tanya)
- Time Estimator (Marc)
- Ops (Sunil)

Combine three areas into single set of requirements and produce master list of calibration tables to be generated.

Document how each cal table will be produced

Test tables with IA and uplink

Define tests and analysis needed and show how tests will produce calibration files

Run tests and produce tables

SPIRE Data Products

Matt Griffin

SPIRE *Standard Processing*

- Will be Java-based to avoid reliance on commercial or platform-dependent systems
- Will be built up from "IA" routines
- Will run automatically and provide as a usable output:
  - Photometer:
    - Map observations: Time-ordered, flux-calibrated data, positions, statistical uncertainties
    - Points sources: Signal, statistical uncertainty, position
  - Spectrometer: Spectrum in terms of signal vs. wavelength
- Will be updated at appropriate (e.g. six monthly) intervals during mission operations

Standard Processing

- Results will be good, but not necessarily the best quality:
  - out-of-date with respect to the very latest algorithms that instrument experts have devised
  - no implementation of sophisticated interactive routines that can allow astronomers' skill and judgement to enhance data quality
- But *Standard Processing* will provide the general user with a good enough product to do science
- All assumptions made in calibration will be documented and thoroughly explained
- Processing steps that the user will be expected to carry out (using their own software or commonly available packages) are:
  - Baseline subtraction
  - Re-gridding, averaging and coaddition of co-addition of map data
  - Colour correction and other interpretational processing of photometric data

Data reduction functions included in *Standard Processing*

- First level deglitching
  - Removal of spikes greater than a defined threshold
- Flat fielding
  - Multiplication of map arrays by detector relative responsivity matrix
- First order drift compensation
  - Removal of linear drifts
- Flux calibration
  - To a documented calibration scheme with all assumptions stated and explained
  - Signal in terms of power/beam/unit spectral interval at the telescope aperture
- Astrometry
  - RA, Dec for each detector sample
- Fourier transformation of FTS data
  - Spectrum in units of power/beam/unit frequency vs. frequency

Standard Processing outputs

1. Chopped point source photometry
   - Calibrated signal with astrometric positions, statistical and pointing uncertainties
   - Data provided for all bolometers, in addition to the prime set corresponding to the source position
   - Statistical errors based on mean and standard deviation of the set of de-glitched On-Off pairs
2. Seven-point photometry
   - As for point source photometry for the individual map positions
   - Results of a simple fit to signal and position with a quality caveat (? – probably not)
2. N-point Jiggle-map
   - Calibrated signal, statistical uncertainties and astrometric positions for each bolometer for each of its map positions

Standard Processing outputs

3. Scan map
   - Deglitched time-ordered data for each detector (signal vs. position)
   - Telescope turn-around periods flagged as astrometrically uncalibrated data

   This mode is for large spatial survey programmes:

   - Full analysis of scan-map data to produce final maps, noise estimates and source extraction will be complex and specialised.
   - To be carried out by large consortia with relevant expertise, and and additional data-processing capabilities over and above what the ICC will provide.

Standard Processing outputs

4. FTS

- Averaged (TBC) spectrum (signal in beam vs. frequency) for each detector at each relevant spatial position
- All observations reduced and calibrated as point sources
- Standard apodisation, resolution element shape, width and sampling
- Basic deglitching already done at interferogram level
- All pixels frequency calibrated
- Filter transmission and flux calibration derived using standard astronomical source
- All calibration data and steps to be fully explained
- Extended source observations to be encouraged only for expert observers

Standard Processing outputs

Summary:

- Deglitched and calibrated data provided in a form that the astronomer can process further using standard packages (e.g., SURF)
- Limited ICC and HSC resources mean that some of the burden of data reduction be borne by the users
- The SPIRE ICC will not guarantee to provide a high degree of interactive routines for the users - depends on available effort from within the consortium
- SPIRE's core science will most effectively be carried out in the form of large projects in which the observing team can produce specialised software tailored to their own particular scientific programme

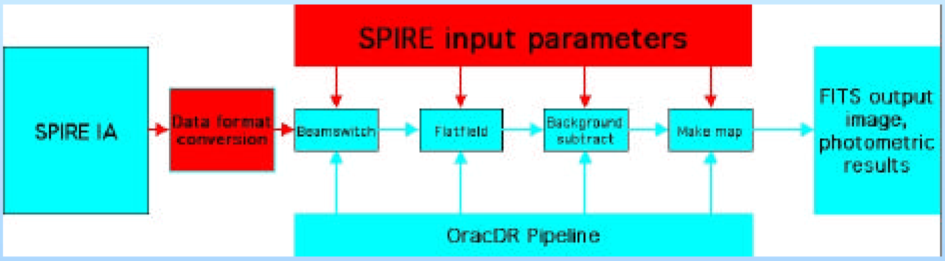
Standard Processing evolution

- The ICC will maintain trial versions of the *Standard Processing* prior to their public release, allowing
  - Scrutiny and parameter choice at all steps of the analysis
  - Replacement of routines with different or updated versions
  - Analysis of data taken in special engineering modes
- The ICC will also develop S/W for trend analysis, calibration analysis, instrument diagnostics, study of systematics, observation optimisation (e.g., more sophisticated time estimator, simulators, etc.)

SPIRE and SURF

- SURF is the user reduction software for the JCMT bolometer camera SCUBA
- To generate bolometer maps and photometry SURF requires:
  - Bolometer signal timelines
  - Pointing timelines
  - Calibration information, focal plane layout
- SURF is designed to cope with bolometer systems other than SCUBA and could be modified to handle SPIRE data

SPIRE + SURF = SPURF



- Data reduced to images and/or photometry
  - Output can be read into standard package (eg. IRAF, IDL)
- Little new effort need (highlighted in red)
  - Estimated effort needed 2 - 3 man months
- The SURF package is free for non-commercial use
  - Currently runs under Solaris and Linux

Photometer Simulation Plans

Matt Griffin

Existing SPIRE Performance Simulations

- Mathcad sensitivity models for Photometer and Spectrometer (Griffin)
- Some IDL code for FTS performance analysis (Swinyard)
- Various photometer deep survey simulations (Oliver *et al.*)
- For ILT, AOT definition and optimisation, problem solving, time estimation, etc., we need a simulator that will accurately mimic the performance of the system and subsystems

SPIRE Time Estimators

- Proposal preparation:
  - "Cookbook" to allow rough estimation of time needed for proposed observations
    - Simple rules for sensitivity vs. observing time and observing overheads
    - Could be simple S/W or just tables and charts
    - Can be based on the Mathcad sensitivity model
- Observation planning
  - Much more detailed representation of the instrument operation and performance, inc. commanding, mechanism operation, detector sensitivity, data sampling, etc.

Purpose of Photometer Simulator

- Simulator will be used for
  - Evaluating photometer scientific performance
  - Testing observing modes and optimisation of POF parameters
  - Modelling and understanding instrument behaviour during ILT and in operation
  - Comparing simulated data analysed using photometer data reduction S/W with the input sky
- The simulator could form the basis of time estimator to be used to plan SPIRE observations
- Results will be compatible with the Mathcad sensitivity model, but much more detailed and realistic

Simulator Architecture

- Physical models of the photometer and its subsystems
- Implementation of standard observing modes
- Separate modules with defined inputs and outputs
  - Internal operation/sophistication of the modules can be modified without affecting other modules
- Timeline outputs:
  - All commanded parameters
  - Temperature fluctuations and drifts
  - Background and signal power levels on detectors
  - Actual positions (mechanisms, telescope pointing)
  - Sampled science and housekeeping data

Module Summary

Module	Abbreviation	Description
Sky Simulator	SKYSIM	Simulation of the area of sky to be observed, with a resolution finer than the SPIRE beam
Input	INPUT	Specifies the observation in "astronomer's terms"
Observatory Function	OBSFUN	· Specifies observing Mode in terms of the appropriate Observatory Function and its parameters. · Defines the commanded telescope and BSM pointing timelines
Optical System	OPTICS	Main optical properties of the telescope and the photometer (including the filters), and the positional mapping of the detectors on the sky
Thermal System	THERMAL	Temperatures of the instrument and the telescope, and their temporal drifts and fluctuations

Module Summary

Module	Abbreviation	Description
Telescope Pointing Timeline Generator	POINTING	Actual telescope boresight pointing timeline (inc. pointing noise)
Beam Steering Mirror	BSM	Actual BSM timeline in the form of an additional pointing timeline to be superimposed on that of the telescope.
Background Power Timeline Generator	BACKGROUND	Timeline for the background power on each detector, due to all contributions (telescope and instrument and thermal drifts and fluctuations)
Astronomical Power Timeline Generator	SIGNAL	Timeline for the power absorbed by each detector from the astronomical sky

Module Summary

Module	Abbreviation	Description
Science Data Timeline Generator	DATA	Digitised timelines for each detector channel
Housekeeping Data Timeline Generator	HK	Digitised timelines for all HK parameters
PCAL	PCAL	· Timeline of the power incident on each detector from PCAL · PCAL power dissipation

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Simulator Development Plan

- Simulator will be developed and implemented in IDL
  - Future conversion to Java TBD
- Define architecture and modules (Oct. 2003)
- Implement simplified trial version (Jan. 2004)
- Revise/enhance based on experience with simulator and CQM ILT (2004)
- Development of first-generation of full system (Jan. 2005)
- Thorough documentation at all stages
- Photometer simulator team:

Cardiff	RAL
Bruce Sibthorpe (PhD student)	Tanya Lim
Adam Woodcraft (PDRA)	Sunil Sidher
Lloyd Watkin (MPhys Project student)	
Matt Griffin	

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Initial Simple Version

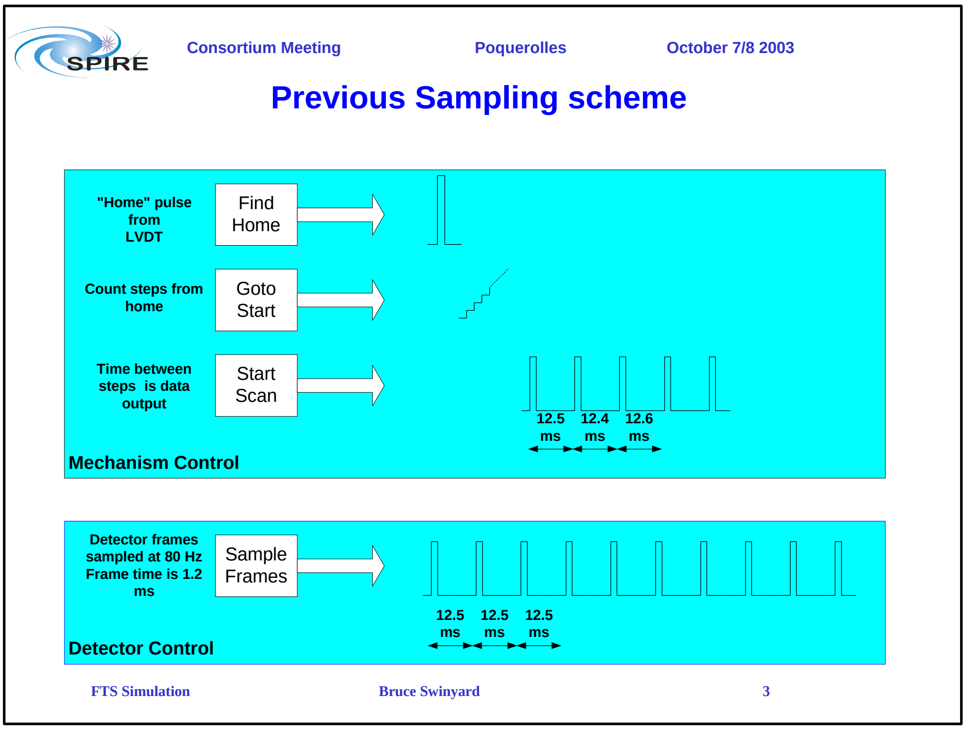
- Test sky
  - E.g., delta-functions for point sources and gradient for background
- One bolometer for each channel (co-aligned)
- Simplified filter profiles
- Simplified bolometer and electronics models
- Stable telescope and instrument temperatures
- No BSM position error
- Modes to be included:
  - Point source photometry (POF 1)
  - Scan-mode (POF 5)
  - 7-point jiggle (POF2) - TBD
- Implementation within the design architecture that will allow extension to full functionality

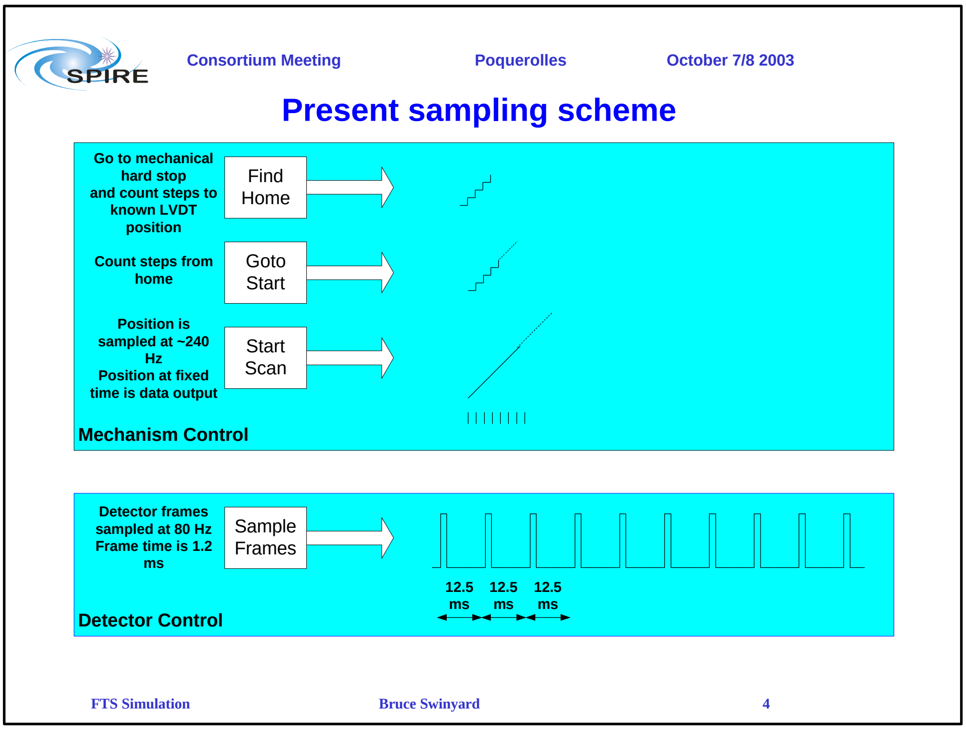
Simulations of FTS Performance

Bruce Swinyard
RAL

Simulations of FTS Performance

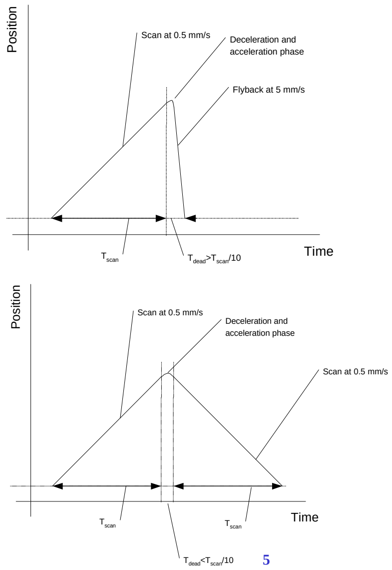
- FTS simulator effort started 99/00 to investigate need for calibrator and velocity control
- Validated against laboratory measurements with laser
- Sampling scheme has changed meantime from time sampling to positions sampling
- Simulator recently updated to incorporate this change


SPIRE
Consortium Meeting
Poquerolles
October 7/8 2003
Previous Sampling scheme
"Home" pulse from LVDT
Find Home
Count steps from home
Goto Start
Time between steps is data output
Start Scan
12.5 ms
12.4 ms
12.6 ms
Mechanism Control
Detector frames sampled at 80 Hz Frame time is 1.2 ms
Sample Frames
12.5 ms
12.5 ms
12.5 ms
Detector Control
FTS Simulation
Bruce Swinyard
3


SPIRE
Consortium Meeting
Poquerolles
October 7/8 2003
Present sampling scheme
Go to mechanical hard stop and count steps to known LVDT position
Find Home
Count steps from home
Goto Start
Position is sampled at ~240 Hz
Position at fixed time is data output
Start Scan
Mechanism Control
Detector frames sampled at 80 Hz Frame time is 1.2 ms
Sample Frames
12.5 ms
12.5 ms
12.5 ms
Detector Control
FTS Simulation
Bruce Swinyard
4

Issues arising…..

- Data rate has to increase (slightly)
- Position is evenly sampled in time
- DSP now has to do more calculations – restricts the speed to <1mm/s
- Fly back mode is no longer an efficient option



Simulator operation

- Generate perfect interferogram with high sampling frequency (1 kHz) for input “sky” and “calibrator” ports – sky port has telescope background as well as object
- Take position noise spectrum and generate velocity with errors during scan – use this to generate “actual” time for each sample
- Send time and signal arrays through model bolometer and electronics filter with additional shot noise
- Resample signal onto fixed time to simulate sampling scheme
- Generate position at fixed time from “errored” velocity
- Can input optical filters/beam splitter performance
- Can generate interferograms for off axis pixels
- Can simulate effects of pointing jitter

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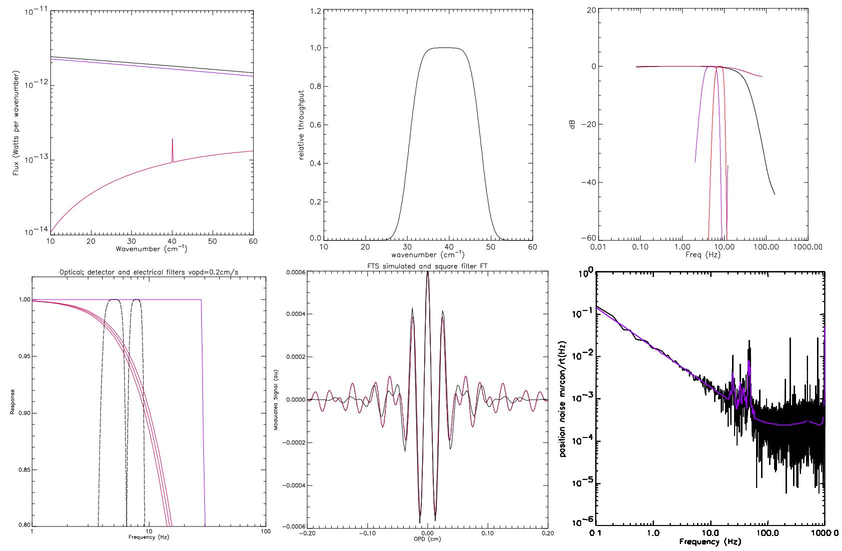
…and in pictures



FTS Simulation Bruce Swinyard 7

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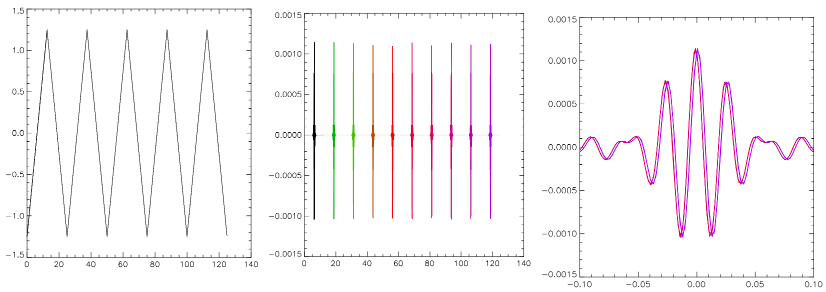
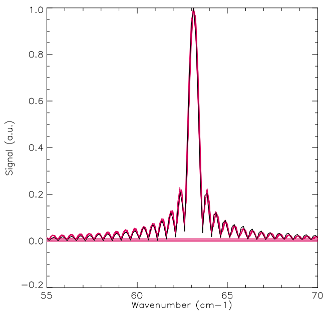
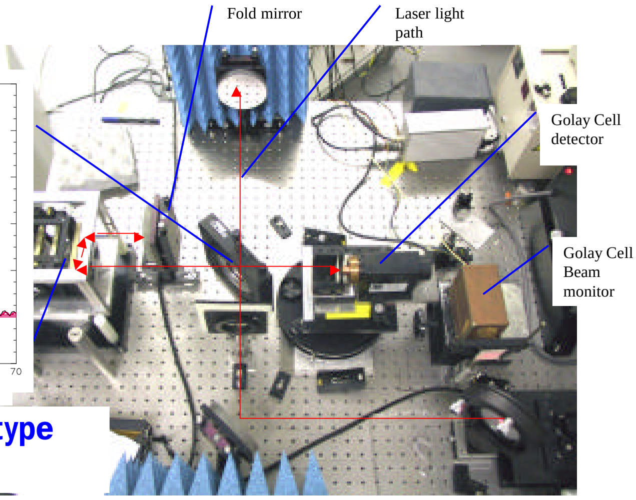
…ctd



FTS Simulation Bruce Swinyard 8

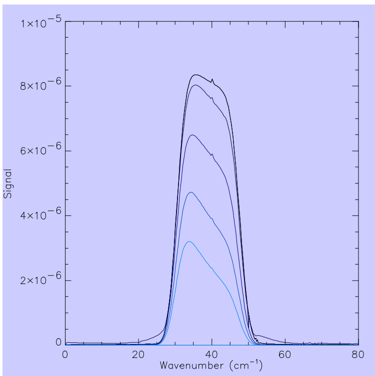
Results and use so far….

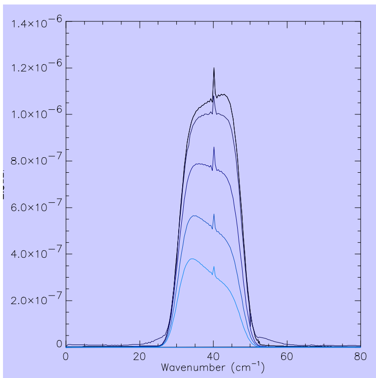




Comparison to prototype test with laser

Results ctd….





Prediction of effects of velocity errors on S/N

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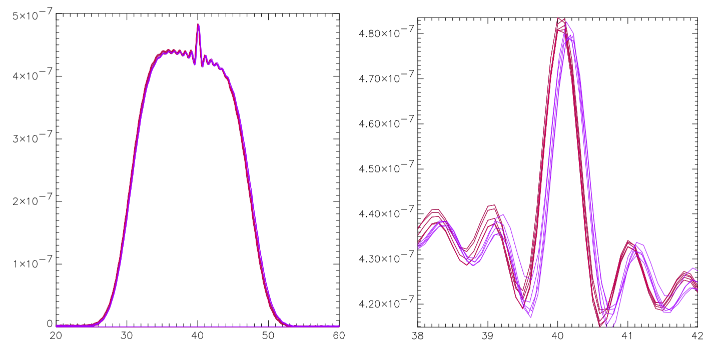
Results ctd….



Prediction of forward and reverse scan effects

FTS Simulation Bruce Swinyard 11

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Next steps….

- Send data to UoL to try more advanced extraction routines
- Add phase shift into beam splitters
- Add other detectors in proper arrangement
- More realistic filter/detector responses
- Take in more realistic sky
- Simulate step and chop mode
- Generic routines for filtering can be applied to photometer simulators

FTS Simulation Bruce Swinyard 12

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Sky Simulations

Seb Oliver

With many contriubutions

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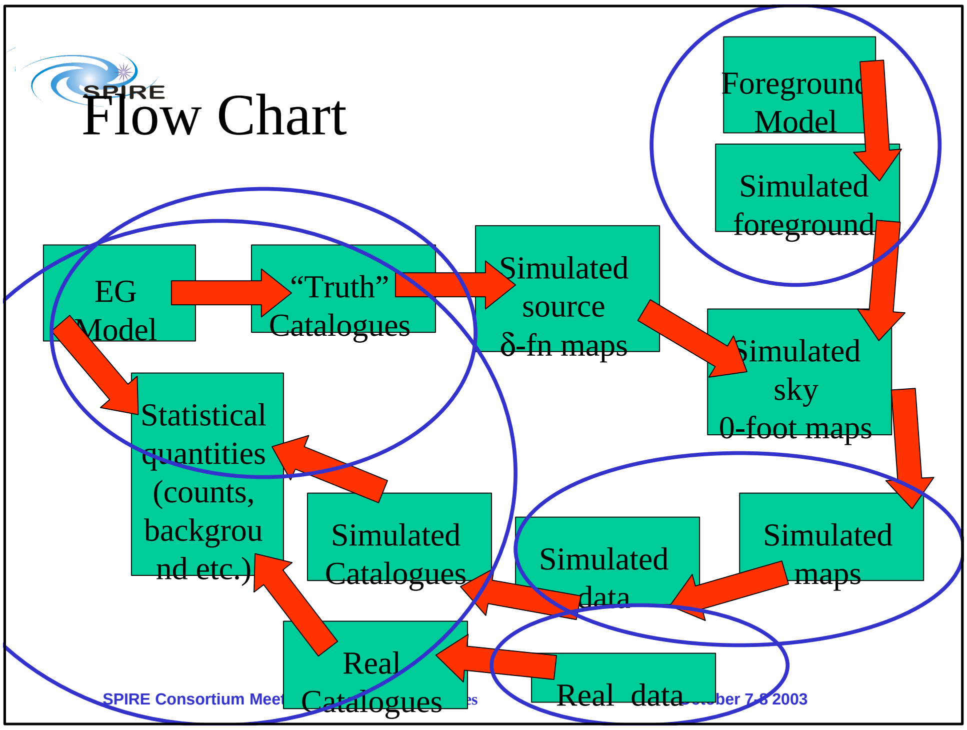
Flow Chart



Requirements

What does SPIRE need Simulations for

- Optimising Instrument Design
- Science Cases
- Optimising Observing Modes
- Design & Optimisation of Observing Programs
- Testing software
  - QLA
  - IA data reduction software
  - FTS software
  - Key Programme software

Optimising Instrument Design

- Too late!
- Simulations were used to help with…
- Choice of filters
  – Required multi-band catalogues (not sky), realistic SEDs & Distributions, but not particularly counts
- Filled array vs feedhorns
  – Realistic counts

Science Case

- Questions
  – How many sources to what depths over what areas,
  – Confusion limits
  – How well can do photo-z
  – How do they cluster …
- Requires:
  – Different models with contrasting predictions
  – Mix of physical and phenomenological models
  – Clustering
  – Truth catalogues
  – Multi-band catalogues
  – Simulated Maps

Observing

- Optimising Observing Modes
  - How to tune parameters pre-launch
  - Realistic sky is required
  - Accurate instrument simulator
- Designing-optimising observing plans
  - Which mode to use
  - Which fields to choose
  - Requirements:
  - Cirrus at various latitudes
  - Realistic source counts
  - Clustering

Testing Software

- QLA:
  - Basic Instrument simulator
  - Toy sky model should suffice
- IA Photometer:
  - Does input relate to output
  - Detailed Instrument simulator
  - Basic sky model
- IA FTS software:
  - High spectral resolution "3D" data
- Key Programme software: Optimisation
  - Models with realistic statistical properties
  - Detailed Instrument simulator with observing modes

Summary of Requirements

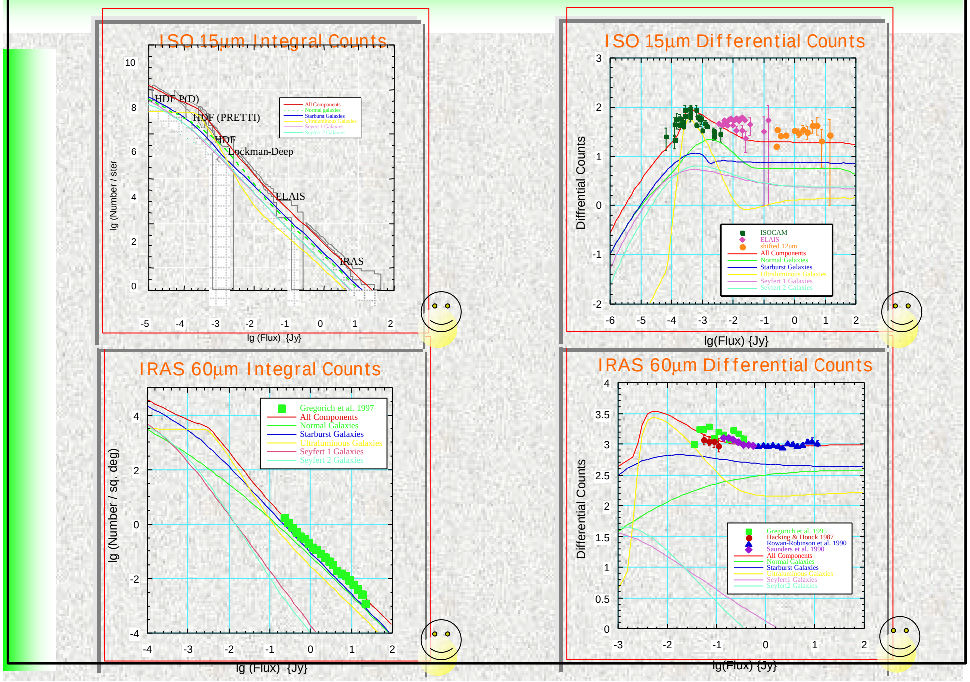
- Multi-wavelength catalogues from variety of models
- Bands extending across all parts of em spectrum
- Realistic counts
- Cirrus maps at variety of latitudes
- Realistic Clustering

Source Models

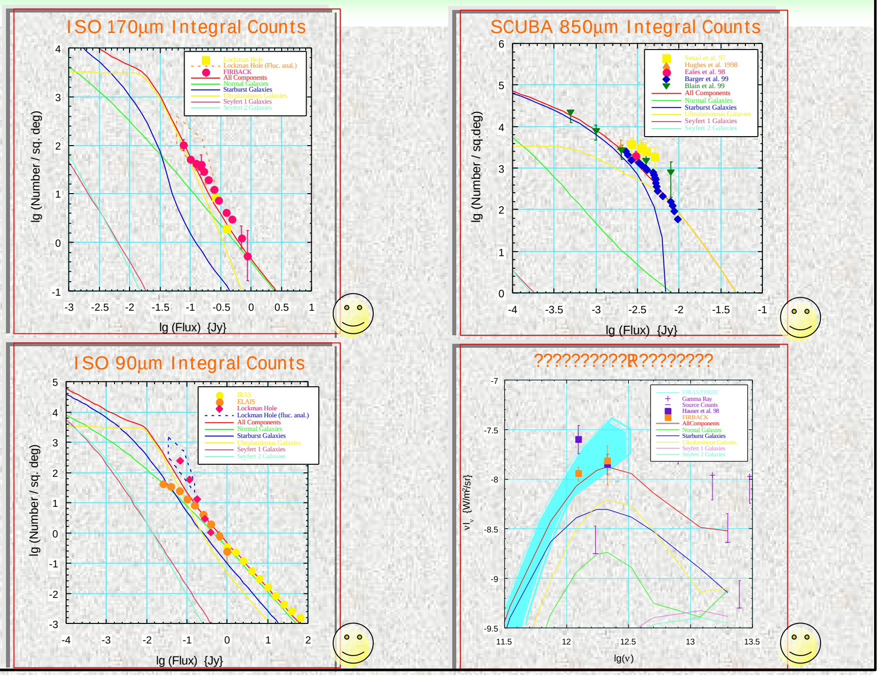
Types of EG Models

- Toy models
  - Simple! Source: not source
- Phenomenological models
  - Consistent with most available data
  - Often don’t include clustering
- Physical models
  - Testable predictions of physical models
  - Less tuneable so sometimes inconsistent with some data
  - Usually include clustering
- Hybrid
  - Physical models tuned to phenomenological models or real data

A NEW GALAXY COUNT MODEL



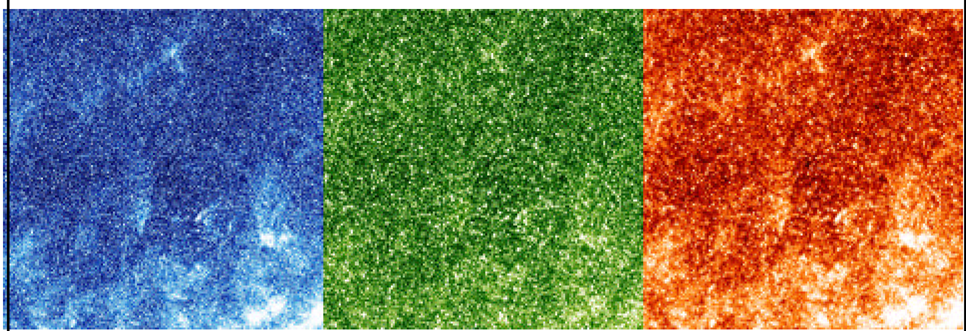
A NEW GALAXY COUNT MODEL



G. Lagache, H. Dole, M.A. Miville-Deschênes, B. Stepnik

Panchromatic IR Sky

Simulated sky: 5 squares degrees



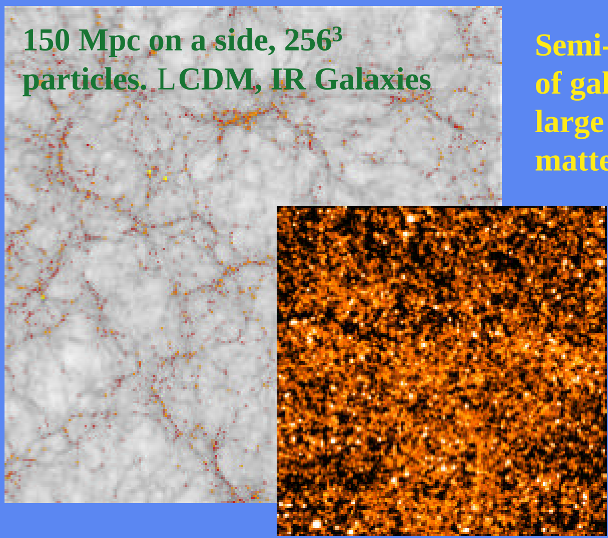
MIPS 24 mm **MIPS 70 mm** **MIPS 160 mm**

Dole, Lagache, Puget, 2003, ApJ

SPIRE Consortium Meeting Porquerolles October 28 2003

Hierarchical Galaxy Formation: The GalICS Project

Galaxies In Cosmological Simulations

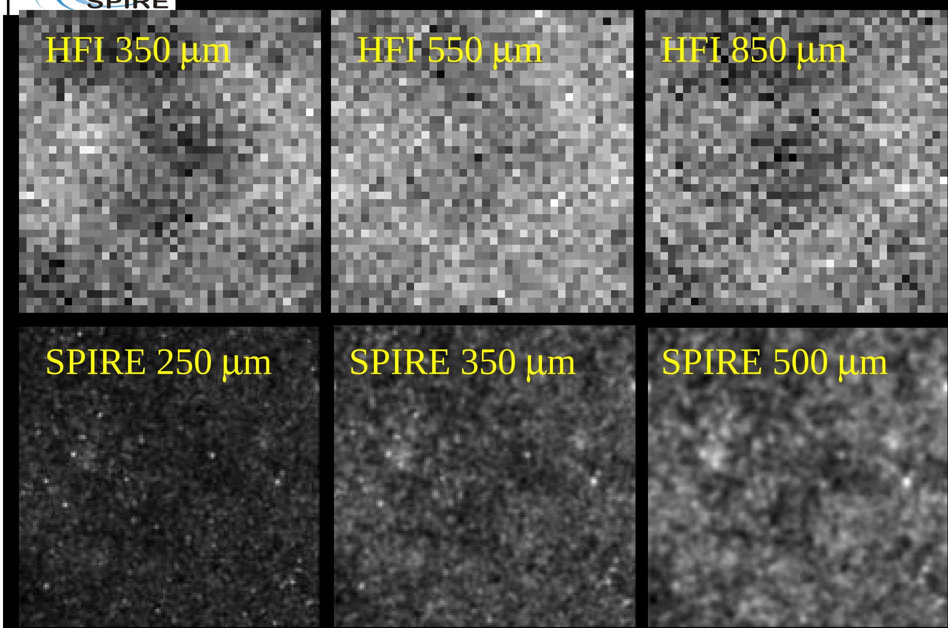


Semi-analytical modelling of galaxy formation in large cosmological dark-matter simulations

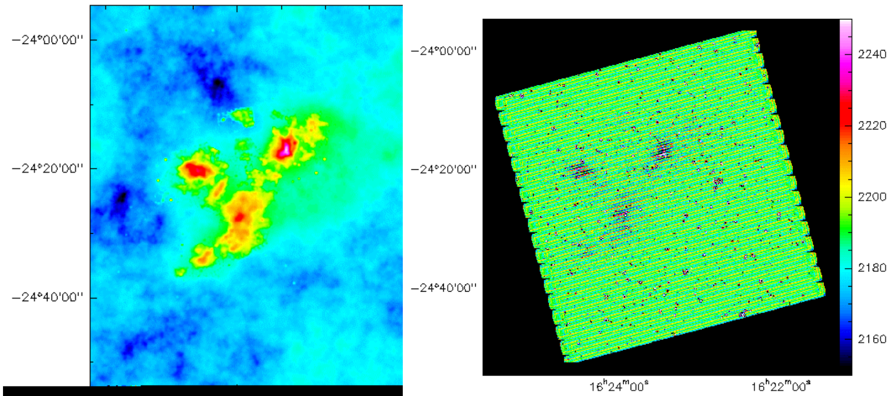
…to mock images and catalogues of extragalactic point sources for HERSCHEL and PLANCK

Herschel/SPIRE 350 μm, 1 deg², t_{exp}=1 h

Dusty sources in a 1 deg² HFI and SPIRE field (+noise)



Galactic Molecular Cloud Simulation



[redacted]

	(1)Phenomenolgical (2) Semi-Anal. (3) Hybrid	Public	WWW	L=0.7, W=0.3	Scenarios	Varied SEDs	Catalogues				Maps				Multi-band	Resolution	Cirrus	Instrument
							1	10	100	All-sky	1	10	100	All-sky				
Imperial MRR, Fox, et al.	1	✓	✓	✓	☹	4	0.2nJy @90mu	2.5 0.1mJy @90mu	Strips	☹	✓	✓	☹	☹	✓	PSF	☹	☹
IAP, Galics BG et al.	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	PSF	☹	☹
Dole, Lagache, et al	1	✓	✓	✓	☹	2	✓	✓	50	☹	✓	✓	50	☹	✓	0.4” 25”	✓	☹
Pearson	1	✓	✓	✓	✓	4	0.01mJy	0.01mJy	☹	☹					✓			
SNO Lee et al.		☹	☹								✓	✓	✓	✓		PSF	✓	✓
IPAC Xu …	1			✓		✓	✓		☹	☹	✓	☹	☹	☹	✓	PSF	✓	✓
Franceschini	1																	
Granato…	2																	
Edinburgh	2&3																	
Durham	2																	
Chary & Elbaz																		
Mexico, Hughes …																		
Sussex	2&3										✓						✓	
Andre, Motte, Okumura																	✓	✓

SPIRE

	X-ray (high)	X-ray (low)	Galex	Optical	NIR	IRAS	ISO	SIRTF		ASTRO F	PACS	SPIRE	Planck	Other FIR	SCUBA	Radio
Imperial MRR, Fox, et al.	☹	☹	☹	✓~	✓~	☹	☹	✓	✓	✓	✓	✓	✓	☹	✓	✓
IAP, Galics BG et al.	☹	☹	☹	✓	✓	✓	✓	✓	✓	☹	✓	✓	✓	☹	✓	☹
Dole, Lagache, et al	☹	☹	☹	~	~	✓	✓	✓	✓	✓	✓	✓	✓	~	✓	~
Pearson	✓~	✓~	☹	☹	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓~
SNO Lee et al.										✓						
IPAC Xu …			✓	✓	✓			✓								
Franceschini																
Granato…															✓	
Edinburgh															✓	
Durham															✓	
Chary & Elbaz																
Mexico, Hughes …												✓			✓	
Sussex															✓	
Andre, Motte, Okumura											✓	✓				

SPIRE

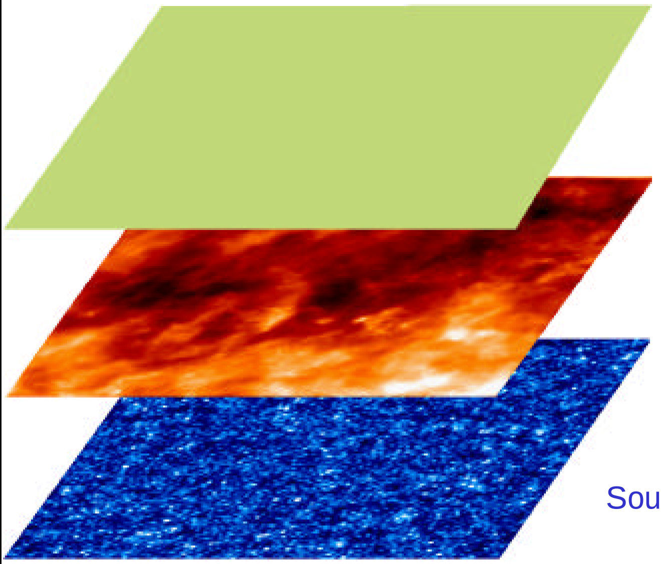
Foreground Models

What Foreground models are there

- COBE-normalised IRAS cirrus (Schlegel et al.)
- Extrapolation of P(K) to smaller scales
  - Gaussian (random phase noise)
  - Self-similar extrapolation
- Extended galaxies
- Crowded galactic fields

G. Lagache, H. Dole, M.A. Miville-Deschênes, B. Stepnik

Cosmic Sandwich

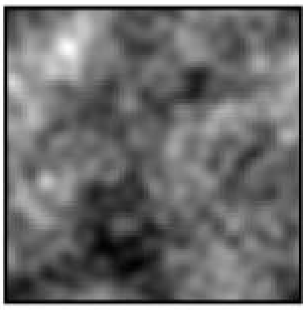


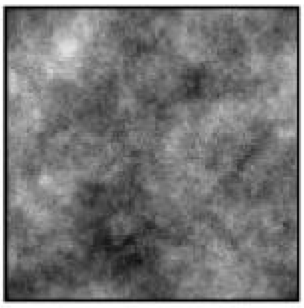
3 components in the simulations:

Solar System Zodiacal Cloud

Galactic Cirrus

Extragalactic Sources & Background

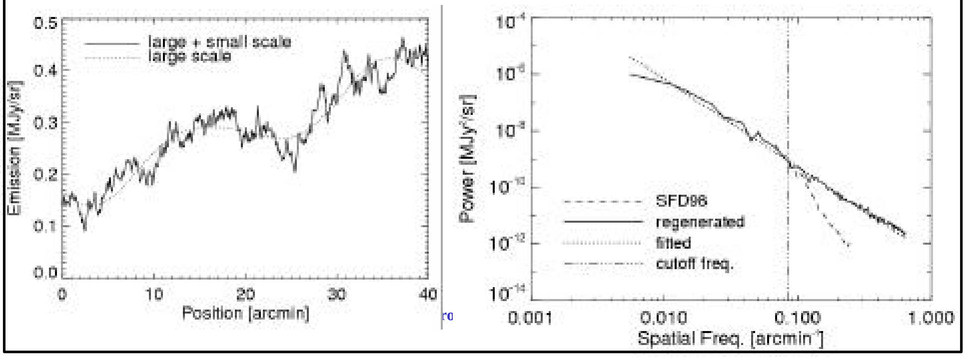




W. Jeong &
H. M. Lee

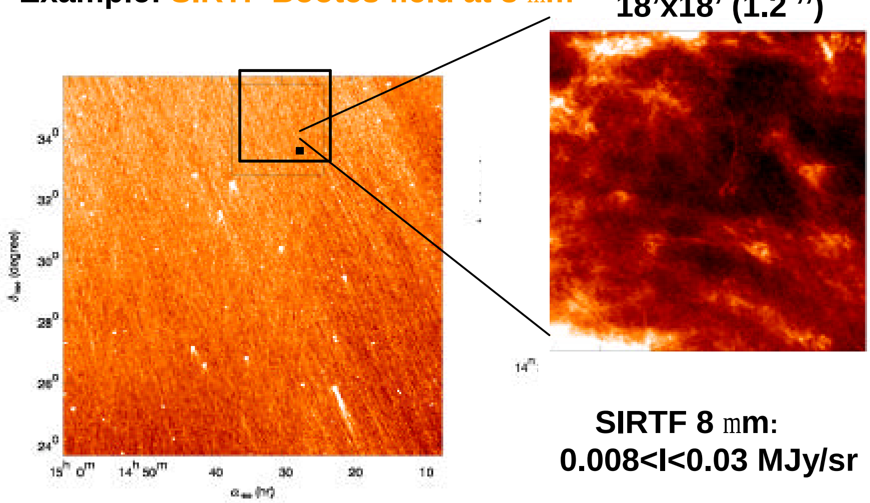
Original data

Small scale power added map



Example: **SIRTF Bootes field at 8 mm**

18'x18' (1.2 '')



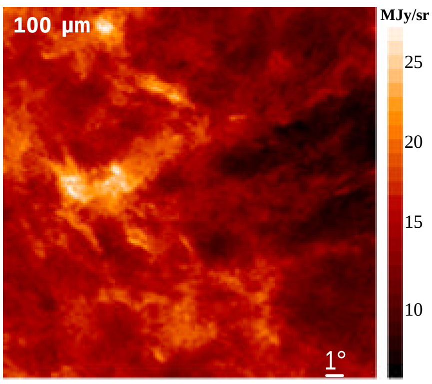
SIRTF 8 mm:
0.008<I<0.03 MJy/sr

IRAS ISSA 12 mm

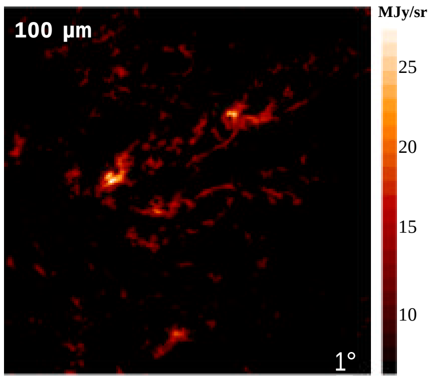
G. Lagache, H. Dole, M.A. Miville-Deschênes, B. Stepnik

2 component - model: separation

IRAS 60 and 100 µm



Diffuse medium Standard dust



Dense medium: Coagulated dust

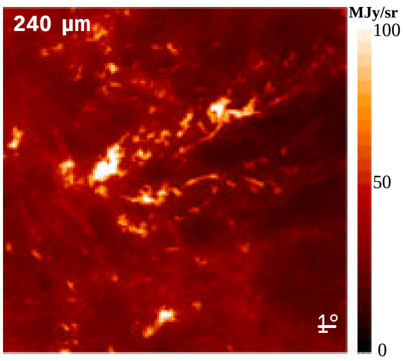
2 component model: simulation

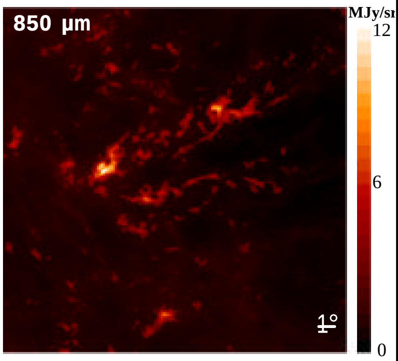
100 µm → 240 µm → 850 µm

16.5 K

+

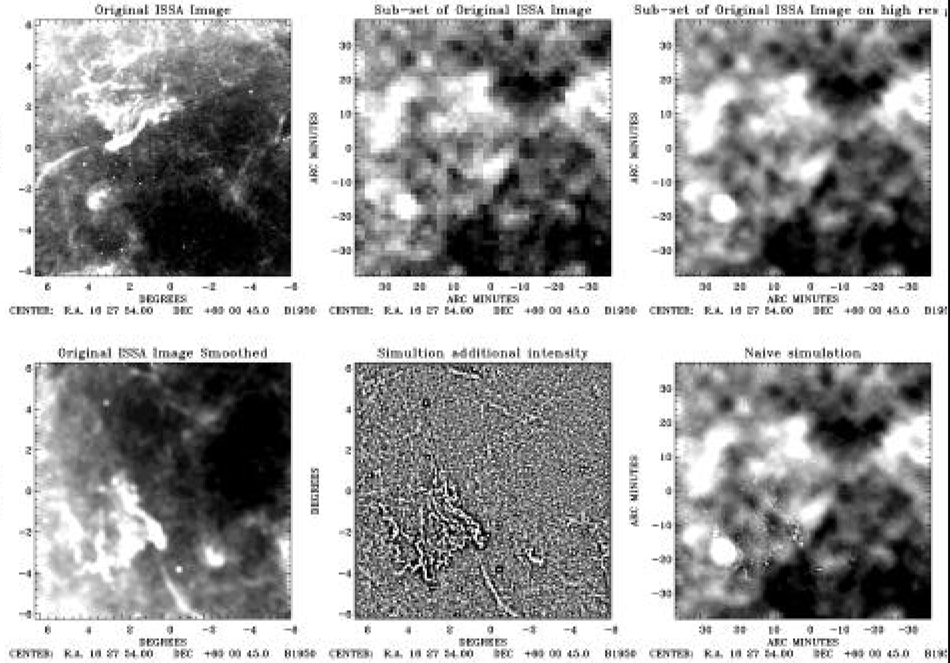
12 K





G. Lagache, H. Dole, M.A. Miville-Deschênes, B. Stepnik

Adding real and simulated cirrus



SPIRE

Where to go

Proposal

- Separate sources and foreground
- Book-keeping
  - Compilation of comparison data sets
  - Compilation of filter profiles (& psfs)
  - Specification of formats
- SPIRE software
  - Single (trivial) tool to turn catalogues into d-fn maps
  - Single (trivial) tool combine d-fn maps & foreground map.
  - Single PSF convolution (part of instrument simulator)

Proposed Catalogue Format

- Flux densities: in Jy, Monochromatic-in band
- Bands: X (high-low energy), Galex, SDSS, UKIDSS, (IRAS ISO), SIRTF, Astro-F, SCUBA, PACS, SPIRE, Planck, 21cm…
- Areas: 1, 10, 100, (1000) sq. deg.
- Depths: to be defined on source density 75k per sq. deg.
- Issue: What about optical galaxies

Proposed Foreground

- Brightness units Mjy sr
- Cirrus & extended EG sources (no zodi.)
- Various mean I100: 0.5, 1., 2. , 5, 10., 100 Mjy sr^{-1}
- Dust model may be significant
- Gaussian or non-Gaussian extrapolation
- Areas: 1, 10, 100, 1000, full-sky sq. deg.

Conclusions

- Sky simulations are in a very advanced state. Most exceed our urgent requirements
- Main requirements to come from SAGs
- Need for a consistent data format
  - Proposed catalogues to fixed depths and areas
- Volunteer to maintain a WWW page to point to models & collate requirements etc.
- Instrument simulator is high priority

SPIRE Scientific Constitution

Matt Griffin

SPIRE Scientific Constitution

- Principles discussed and approved at Co-Is' meeting in Saclay, June 2000.
- Draft *SPIRE Scientific Constitution* based on those principles was presented to Co-Is at Cardiff meeting, July 2001
- Document has been agreed by Co-Is and is now formally issued
- Some minor changes may be made after this meeting

SPIRE Consortium Meeting, Porquerolles, 7, 8 October 2003

Scientific Constitution for the SPIRE Consortium

SPIRE-UCF-PRJ-001615

Issue 1.0

30 September 2003

Prepared by: Matt Griffin
Approved by: SPIRE Co-Investigators

Contents

SPIRE Consortium Meeting, Porquerolles, 7, 8 October 2003

Scientific Constitution

1. **SPIRE Consortium: SPIRE Co-Investigators and those working within Co-Investigators' institutes who contribute substantially to the delivery of the SPIRE instrument and/or the ICC.**

2. **SPIRE Guaranteed Time: observing time with <u>any of the Herschel instruments</u> which is counted against the allocation of GT given to the SPIRE Co-Investigators.**

3. **SPIRE Open Time: observing time with any of the Herschel instruments which is awarded, in response to Open Time proposals, to groups which include SPIRE Co-Investigators.**

Scientific Constitution

4. SPIRE Science Team: scientists, from within or outside the Consortium, who contribute to the work of the Consortium and wish to use SPIRE GT or OT data for scientific research.

   Co-Investigators: The people who proposed the SPIRE instrument to ESA or who have subsequently been appointed as Co-Is by the SPIRE Steering Group.

   Associate Scientists: Others who actively and substantially contribute to the work of the SPIRE Consortium by:

   (i) contributing to hardware, software or other scientific or engineering expertise;
   (ii) assisting the Co-I's in the preparation and execution of the SPIRE GT programme;

   Consultants: Experts who are consulted by Co-Investigators about an individual observation, programme or publication.

SPIRE Consortium Meeting, Porquerolles, 7, 8 October 2003

Scientific Constitution

5. The scientific work shall be organised by a Specialist Astronomy Groups (SAGs), overseen by a Standing Committee for Science.

6. SPIRE Consultants shall be associated with one particular SAG.

7. Each SPIRE Associate Scientist shall be associated with an individual Co-Investigator.

8. The GT and OT programmes shall be devised by the SAGs.

9. Any SPIRE Science Team member may be a member of any Specialist Astronomy Group.
   - But members are expected to confine their activities to a limited number of groups.

Scientific Constitution

10. Standing Committee for Science:
    - Currently: PI, Co-PI, Project Scientists, Coordinators of the SAGs.

11. Standing Committee for Science shall be responsible for:
    - (i) guiding the activities of the SAGs;
    - (ii) coordination of Science Team interactions with other Herschel consortia and teams;
    - (iii) maintaining an up-to-date list of Science Team members;
    - (iv) approving the GT programme to be put to the HOTAC;
    - (v) approving proposals for OT by ST members;
    - (vi) approving the content and authorship of all publications based on SPIRE GT, OT or other SPIRE Consortium data (for instance, calibration data);
    - (vii) arbitrating in cases of any dispute within the Science Team;
    - (viii) revising these terms of reference as appropriate.

SPIRE Consortium Meeting, Porquerolles, 7, 8 October 2003

Scientific Constitution

12. Standing Committee for Science shall make all decisions by consensus.

13. No Co-I shall be dropped from the Science Team without good cause and without the unanimous agreement of all other Co-Investigators.

14. No Associate Scientist or Consultant shall be dropped from the Science Team without good cause and without the unanimous agreement of the SPIRE Steering Group.

15. Prospective Associate Scientists shall be proposed to the SPIRE Steering Group by a Co-Investigator.

16. Consultants may be appointed by SAG leaders with the agreement of all Co-Is who are members of that SAG.

Scientific Constitution

17. Co-Is are responsible for all aspects of the GT Programme, before, during, and after the mission.

18. Science Team members shall be fully committed to the scientific programmes of their SAGs and
    - avoid any conflict of interest in their scientific activities
    - avoid participating in other Herschel GT or OT programmes which compete with, or inappropriately overlap with, the programmes of their own Specialist Astronomy Groups.

19. Science Team members shall consult SAG leaders about collaborations with outsiders.

20. All SPIRE GT data shall be the property of the Co-Investigators until the expiry of the proprietary period.

Scientific Constitution

21. All Co-Is have equal rights of access to any GT data.

22. Associate Scientists shall have data rights in accordance with their contributions to the project as a whole and to the particular areas of science for which the data are to be used. Associate Scientists' contributions shall be monitored and reported to the Standing Committee by the relevant Co-Investigators.

23. Associate Scientists or Consultants shall have rights to data resulting from any SPIRE Science Team observations to which they have contributed.

24. In exceptional circumstances, the Standing Committee for Science may deny the use of SPIRE Guaranteed Time data to a Science Team member.

Scientific Constitution

25. Data from the SPIRE OT programme shall be the property of the proposers.

26. Any Co-I has the right to co-authorship of any paper that is published by the Science Team, based on GT data. Co-Investigators shall not abuse this right.

27. Any Associate Scientist has the right to co-authorship of any paper to which he or she has contributed (either prior to or after the observations).

28. Any Consultant has the right to co-authorship of any paper on which he or she has been consulted (either prior to or after the observations).

Scientific Constitution

29. Co-Is or Associate Scientists, starting analysis of GT data for publication, shall invite other members of the appropriate SAG to participate in the analysis.

30. All papers by the Science Team based on SPIRE GT data must be approved prior to submission by the relevant SAG leaders and endorsed by the Standing Committee. The Standing Committee has the right to refuse authorisation for publication.

31. A copy of every paper or article published by Science Team members, based on Herschel data, shall be deposited with the SPIRE Project Office.

32. All disputes concerning membership, data rights or publication rights, shall be referred to the Standing Committee for Science for arbitration.

SPIRE Associate Scientists

- List of 60 was given in the SPIRE proposal
- Number of Associates is now 83
- Activity levels
  - High: People who have already put in a lot of effort over a number of years
  - Medium: People who have already put in a reasonable amount of effort
  - Low: People who have made some contribution but not major so far
  - Zero: People who have yet to start making a significant contribution to the work of the consortium
  - Former: People who have been involved in the past but have now moved on or no longer seem to be associated with the project (but are not forgotten)

Associate Scientists

Guidelines for further appointments

- The Science Team includes a good balance of skills and is of a reasonable size, so we do not need actively to expand it.
- But there will be good reasons for appointing some new Associates to reflect the efforts of people who have already been making a contribution for some time and are interested in Herschel science.
- Associates can be appointed at any time (normally at Steering Group meetings).
- Associates should be people who have already been fairly active for some time, not just people who may become active in the future.

Steering Group Meeting

Main Agenda Items

- Overview of Herschel/SPIRE programmatic status
- Reports on funding status in SPIRE partner countries
- Appointment of new Associate Scientists
- Arrangements for definition of the consortium's science programme

Herschel observing programmes

SPIRE Consortium mtg

Porquerolles, 7-8 October 2003

Göran L. Pilbratt
Herschel Project Scientist
Astrophysics Missions Division
Research and Scientific Support Department

HERSCHEL SPACE OBSERVATORY

- **Proposed implementation to AWG**
- **A detailed document is under preparation**
- **Disclaimer: Exact wording and fine tuning of minor open points/timing still pending**

Herschel observing - generalities

- **Top level considerations**
  - overall goal is to maximise science return and impact
  - Herschel is a strictly consumables limited mission
  - available observing time must be used in best possible way
- **Herschel needs - to a certain degree - to be its own pathfinder**
  - follow-up observations must be feasible
  - imposes timely availability of data reduction capabilities
  - imposes scheduling constraints
- **Coordination of observing programmes**
  - coordinated (large or 'multiple' small) programmes more productive
    - exceptions proving this are expected and 'allowed'
  - will be reflected in the 'Calls for proposals' (AOs)
- **Only observations using validated AOTs will be scheduled**
  - instruments will offer a limited number of AOTs
  - AOTs will normally be assumed tested and validated in the PV phase

Herschel observing time

- **Three years of 'routine science operations' available**
  - LEOP, commissioning, PV, science demonstration, and 'early failure protection' (TBC) observations during initial 6 months
  - followed by 3 years of 'routine science operations'

- **Available routine observation hours**
  - assume 21 out of 24 hours observing per day
    - the earth contact time can in principle also be used but in a restricted manner
  - assume 1/7 (TBC) to be used for engineering/calibration
    - and potentially for additional AOT testing and validation
  - (6/7) x 365.24 x (21/24) x 24 = 6574 hours/year
  - **~ 20,000 hours** in total (= 19,723 x 1.01)

- **Available routine observation days**
  - (6/7) x 365.24 = 313 days/year
  - **~ 1000 days** in total (= 939 x 1.06)

Guaranteed and open time

- **Note: 1% can be considered ~ equal to 10 days – 200 hours**
  – for illustration purposes only

- **32% guaranteed time (320 days – 6400 hours)**
  – of routine science operations; shared as follows:
  – 30% to each (3) PIs/instrument consortia (96 days – 2048 hours)
  – 7% to Herschel PS/Science Centre (22 days – 448 hours)
  – 0.6% to each (5) Mission Scientist (1.9 days – 38 hours)
  + 0.6% to Optical System Scientist (1.9 days – 38 hours)

- **68% open time (680 days – 13,600 hours)**
  – competitive proposals from community incl. GT holders
  – max 3.75% can be used as discretionary time
    - ~0.25% used for OSS GT

- **All observing proposals – *including for GT programmes* – will be assessed by the Herschel Observing Time Allocation Committee for scientific merit**

HERSCHEL SPACE OBSERVATORY

Herschel observing programmes

- **As required by the SMP there will be three kinds**
  - ‘Key Projects’ programmes – GT and OT
    - GT part open for GT holders only
    - OT part open for all – including GT holders
  - Guaranteed time programmes – GT
    - open for GT holders only
  - Open time programmes – OT
    - including discretionary time and targets of opportunity
    - open for all – including GT holders

- **Three ‘Call for proposals’ (AO) cycles are foreseen**
  - one Call for ‘Key Projects’ programmes only (GT and OT)
  - two Calls for regular programmes (GT and OT)

- **Each AO will be divided in two parts**
  - GT awarded first
  - OT awarded after GT in same cycle

Herschel ‘Key Projects’ – (1)

- **Foreseen to be important upfront (SMP)**
  - introduced to ensure that ‘unusually large’ observing programmes can be proposed, selected, and observed
  - need pre-identified due to the science objectives and lack of ‘precursor’ mission
- **Definition of a ‘Key Project’ programme - it must**
  - exploit unique Herschel capabilities to address (an) important scientific issue(s) in a comprehensive manner
  - require a large amount of observing time to be used in a uniform and coherent fashion
  - produce a resulting well characterised dataset of high archival value
- **Data rights**
  - all ‘Key Project’ programmes data will have a 1 year proprietary time (since the date of observation), applicable to individual sub-observations if not contiguously scheduled

Herschel 'Key Projects' – (2)

- **Additional strings attached**
  - GT owners must spend 50% or more of their GT on 'Key Projects'
    - the SMP makes no difference between the different GT holders
    - now proposed that this applies only to the major owners (PI consortia)
    - open point whether there should be an upper limit

- **Data reduction**
  - it is recognised that there is a legitimate science return interest that
    - the data generated by the observations are reduced, and
    - the data products and tools are made public
  - it is therefore proposed that:
  - 'Key Project' consortia must demonstrate commitment and ability to perform data reduction, and must make data products and tools publicly available at the end of the proprietary time period
  - this should be a key selection criterion when awarding time
  - this is a new (vs. the SMP) requirement

Herschel mission phases

- **Launch and early operations (LEOP)**
- **Commissioning and performance verification (SC + payload)**
- **Science demonstration phase**
- **Early failure protection phase (TBC)**
- **Routine science operations phase (36 months)**

- **Cycle KP (duration ~ 45% or ~ 16 months)**
  - GT 'Key Project' progs: fraction x (*ass.* 60%) of GT = 192 days
  - OT 'Key Project' progs: 40% of OT = 272 days
- **Cycle 1 (duration ~ 27% or ~ 10 months)**
  - GT1 progs: max fraction (1-x)/2 of GT = max 64 days
  - OT1 progs: 30% of OT = 204 days
- **Cycle 2 (duration ~ 27% or ~ 10 months)**
  - GT2 progs: remainder of GT = max 64 days
  - OT2 progs: 30% of OT = 204 days

Proposed timeline – (1)

- **Logic: Issue ‘Call for Proposals’ (AOs) as late as possible**
  - for pure scientific reasons
  - for mission performance knowledge reasons
  - but early enough to have observations available for scheduling
  - and enable community support staff ‘training on the job’

- **L - 24 mths: Issue AO for ‘Cycle KP’ proposals**
- L - 21 mths: Submission deadline for GT KP proposals
- L - 18 mths: Selection & announcement of GT KP programmes
- L - 15 mths: Submission deadline for OT KP proposals
- L - 12 mths: Selection & announcement of OT KP programmes

- **L - 12 mths: Issue AO for ‘Cycle 1 GT’ proposals**
- L - 9 mths: Submission deadline for GT1 proposals
- L - 6 mths: Selection & announcement of GT1 programmes

- **L: Launch followed by and in-orbit operations**

HERSCHEL SPACE OBSERVATORY

Proposed timeline – (2)

- **L: Launch followed by and in-orbit operations**
- **L + 5 mths: Science demonstration workshop**
- **L + 6 mths: Issue AO for 'OT1' proposals**
- L + 9 mths: Submission deadline for OT1 proposals
- L + 12 mths: Selection & announcement of OT1 programmes
- **L + 18 mths: Issue AO for 'Cycle 2' proposals**
- L + 21 mths: Submission deadline for GT2proposals
- L + 24 mths: Selection & announcement of GT2 programmes
- L + 27 mths: Submission deadline for OT2 proposals
- L + 30 mths: Selection & announcement of OT2 programmes
- **L + 42 mths: End of nominal mission**

Herschel Time Allocation Rules: Implications for the SPIRE Consortium

Matt Griffin

Observing Time Categories

Nominal mission: 1000 observing days

- Open Time (OT): 68% = 680 days
- Guaranteed Time (GT): 32% = 320 days
  - Three instrument teams: 30% each = 96 days
  - SPIRE GT will be reduced by 2% as payback for ESA support of the consortium: nominal SPIRE GT = <u>94 days</u>

Key Projects

- Two kinds of Key Projects: GT and OT
- They are required to be separate: each KP is of one kind or the other and must be complete and coherent
- Key Project consortia will be required to produce mature and easily usable data products (details TBD)
- Most Key Projects are envisaged to be done early in the mission
  - To ensure core science done in case of misfortune
  - To allow for follow-up observations
- Unlike regular programmes, KPs will be defined BEFORE the in-operation sensitivities are known

Some Implications for SPIRE

Large surveys will need to be done as OT Key Projects

- Total SPIRE GT ~ 94 days
- SPIRE/PACS large extragalactic survey > 100 days
- SPIRE galactic survey > 100 days

We are required to use > 50% (~ 50 days) for Key Projects

- Collaboration with PACS/HIFI GT holders is allowed
  - But they have different rules about data rights
  - Some SPIRE Co-Is are also PACS Co-Is
- Option: small focussed SPIRE consortium-only GT KPs: E.g.
  - Small area extragalactic survery (below confusion limit)
  - Full survery of a few molecular clouds

Proposal Selection Scheme

- GT Key Programmes are selected first
  - We can reserve and protect our highest priority programmes
- OT Key Programmes are selected next
  - Others can then reserve their programmes, restricting our freedom of choice for regular GT programmes
- Then Regular GT Programmes are selected
- Then Regular OT Programmes are selected
- Should we implement as much as possible of our science programme in the form of GT Key Programmes to protect it from our colleagues in the wider community?

Collaborations

- PACS and HIFI have very different ways of allocating data rights within their consortia – making direct collaboration on joint programmes difficult
  - Should we seek to implement joint programmes with PACS or keep things formally separate?
  - In any scenario, we have to work closely with PACS on the observing plan and data reduction
  - Dedicated PACS-SPIRE meeting is envisaged after SPIRE SAGs have developed first-cut programmes
- OT Key Programmes
  - Will need instrument team expertise for definition, execution, and data analysis
  - Will have to involve the wider community
  - May have to be led by non-Herschel people
  - How should we approach the task of defining these programmes and setting up the consortia?
- Herschel-Planck Synergy
  - Strong interest in this within the SPIRE Consortium

Illustrative Possibilities

- SPIRE GT must include a reasonably wide range of programmes to serve the broad interests of the consortium
- The SPIRE Consortium has particularly strong interests in star and galaxy formation
- SPIRE GT = 94 days
  - Key Projects:
    - ~ 50 days total
    - 2 extragalactic
    - 2 galactic
    - 1 other
    - So typically 10 days per programme
  - Regular GT programmes
    - ~ 44 days
    - Wide range of science
    - Many small programmes or fewer substantial ones?

Some Possible Key Programmes

- Large-area SPIRE + PACS extragalactic survey
  - Unbiased survey of population of high-z dusty star-forming galaxies
  - Far too big for GT
- SPIRE + PACS survey of nearby molecular clouds
  - Complete samples of protostars and pre-collapse condensations down to $M_{proto} \sim 0.03\ M_{\odot}$ and d ~ 1 kpc
  - SED coverage of spectral peak
  - Accurate mass, luminosity, temperature
  - Lifetimes
  - Mass function down to brown dwarf mass regime
  - Temperature and density profiles for nearby sources
  - Can it be done in combined SPIRE and PACS GT?
- Compete multi-band galactic plane survey to ~ 20 mJy rms
  - Census of all observable galactic star forming regions
  - Wide range of masses and evolutionary stages
  - Global properties of the ISM and molecular clouds
  - Far too big for GT

Some Possible Key Programmes

- **SPIRE low-resolution spectrophotometry of known high-z galaxies**
  - Detailed SEDs and dust properties
  - Possible in GT?
- **PACS fine structure line spectroscopy of high-z galaxies**
  - AGN vs. starburst diagnostics; unified schemes
  - Are we interested in this?
- **Imaging photometry and spectroscopy of nearby galaxies**
  - Templates for high-z galaxies
  - Dust and gas physics
  - Environment influence on galaxy evolution
  - Can a useful programme be done in GT?

Some Possible Key Programmes

- **Planck HFI Deep Early Compact Source survey follow-up**
  - Detailed photometry and spectroscopy
  - Accurate positions, higher sensitivity, wider spectral coverage
  - May be too big for GT
- **Shallow (~ 20 mJy rms) Survey of Planck Deep Survey Areas**
  - Detailed photometry and spectroscopy
  - Planck foreground characterisation
  - Accurate positions, higher sensitivity, wider spectral coverage
  - May be too big for GT
- **Spectral surveys with HIFI**
  - High sensitivity, accurate calibration, access to THz region
  - Diffuse gas to circumstallar disks
  - Composition vs. mass, luminosity
  - Circumstellar envelope clearing
  - Gas-phase vs. grain surface molecule formation
  - Role of H_2O and O_2
  - Are we interested in this?

Unknowns

The HOTAC

What will be their views on:

- Scientific priorities?
- Large vs. small programmes?
- Herschel-Planck synergy?
- Instrument team involvement in OT Key Programmes?

Herschel follow-up of Planck data

- Access to Planck data during the Planck proprietary period – needs to be addressed by the Herschel and Planck Science Teams

Instrument sensitivity

- Large unertainties in observing time estimates: how should KP proposals take this into account?

Proposed Timeline

- L - 24 mo : Submission of GT Key Progs.
- L - 18 mo : Approval, announcement of GT KPs
- L - 15 mo : AO for OT KPs
- L - 12 mo : Approval, announcement of OT KPs
- L - 9 mo : Submission of GT Round 1 proposals
- L - 6 mo : Approval, announcement of GT1 proposals
- L : Launch, February 2007
- L + 1.5 mo : PV phase start
- L + 4 mo : Science Demonstration phase start
- L + 5 mo : Workshop; Issue of AO for OT Round 1
- L + 6 mo : Routine operations start
- L + 8 mo : Submission of OT1 proposals
- L + 11 mo : Approval/announcement of OT1 proposals

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Proposed 3-Phase Scheduling Scenario

- Launch followed by PV and Science Demonstration Phase
- Phase 1 (15 months)
  - GT Key Programmes: Fraction x (~ 50%) of 320 days
  - OT Key Programmes: 40% of 680 days
- Phase 2 (9 months)
  - GT – first round: Max. (1-x)/2
  - OT – first round: 30% of 680 days
- Phase 3 (Remainder)
  - GT – second round (remainder)
  - OT – second round (30% of 680 days)

Organisation and Co-ordination of the SPIRE Science Team

Matt Griffin

Specialist Astronomy Groups

1. High-redshift Galaxies
2. Galaxies in the Local Universe
3. Star Formation in the Galaxy
4. The Galactic Interstellar Medium
5. Solar System
6. Stellar and Circumstellar

SAG Co-ordination: Principles

- SAGs are expected to organise the production of proposals for GT for consideration by the Standing Committeee for Science.
- Co-ordinators
  - experienced and high ranking figures in the consortium
  - enthusiastic experts in the relevant fields
  - able to devote the necessary time to the task
- Need for balance with respect to the leading participating countries (but without disorting the optimisation from the point of view of coordinators' capabilities).
- To share the work, SAGs have two co-ordinators who have equal status

SAG Co-ordination: Principles

- SAG coordinators are organisers and generators of activity, not dictators or owners of the programme. They are not necessarily the leaders of proposals emerging from their SAGs.
- SAGs are expected to have many members, with activity levels varying from very high to very low
- SAGs will set up appropriate sub-groups internally (for example to formulate particular proposals).
- SAGs will produce proposals for SPIRE GT for consideration by the Standing Committee for Science.

SAG Coordinators (TBC by themselves)

High-redshift Galaxies	Jamie Bock + Seb Oliver
Galaxies in the Local Universe	Walter Gear + Sue Madden
Star formation in the Galaxy	Philippe André + Paolo Saraceno
The Galactic ISM	Jean-Paul Baluteau + Pierre Cox
Solar system	Regis Courtin + Bruce Swinyard
Stellar and Circumstellar	Mike Barlow + Göran Olofsson

Large Key Programme Working Groups

- SPIRE's plans to be formulated initially under the auspices of the relevant SAGs
- Final proposals will involve, and may even be led by, non-SPIRE people.
- These programmes have to be open to the wider community: Instrument teams must not be seen to lead them too strongly
  - But strong instrument team involvement is needed to do them properly
- Large Extragalactic Survey
  - Formation of working group deferred until GT programme SAG has made some progress
- Large Galactic Plane Survey
  - Working group already active, coordinated by Sergio Molinari and Bruce Swinyard
  - Wider participation will be sought shortly

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Herschel-Planck Synergy

- Liaison with Planck to be organised by the SAG coordinators
- Not clear yet how much Planck follow-up can/should be done in GT

Science Team Organisation Matt Griffin 7

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The Standing Committee for Science

- The SPIRE Steering Group has agreed that the SCS comprise just the SPIRE Co-Investigators
  - international and institute balance is more naturally catered for;
  - the full range of scientific interests and expertise is included;
  - the decision-making power is where it rightly resides, since the Co-Is are officially the owners of all SPIRE GT data
- The SPIRE Scientific Constitution will be updated accordingly

Science Team Organisation Matt Griffin 8

Next Steps

- Science Team members to join the appropriate SAG(s)
  - contact the appropriate SAG organiser(s)
- Matt (in consultation with Laurent, Jean-Paul, Walter) to produce a note providing guidelines for the SAG coordinators
  - Instrument sensitivities to be assumed
  - Recommended standard format for "proposals"
  - Outline of the plan/timeline for programme definition
  - Other relevant guidance
  - Deadline for this: mid. November (but SAGs can get started before then)
- SAGs to work for ~ 6 months (through e-mail, telecons, meetings as appropriate) to
  - formulate first-cut programmes
  - consider collaborations/liaison with other SAGs/groups
- Full Science Team meeting (~ March 2004 timeframe) to review work to date and plan for detailed programme definition and assessment by the Co-Is

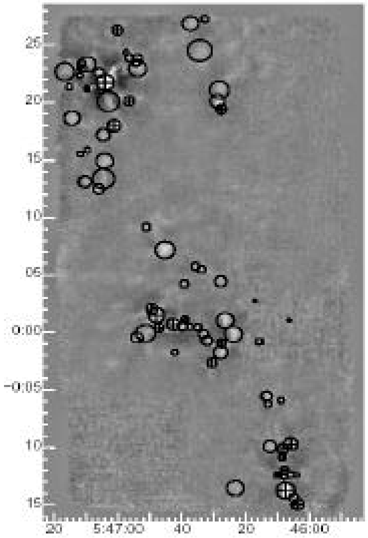
Galactic Science: Summary of Consortium Options

Jean-Paul Baluteau

Galactic Science: SPIRE Photometer

- 3 bands over 200-700 µm
- each band → density structure
- bands combination
  - assume β coefficient
  - derive 'mean' Td → mass distribution

Galactic Science: SPIRE Photometer



Johnstone et al. 2001

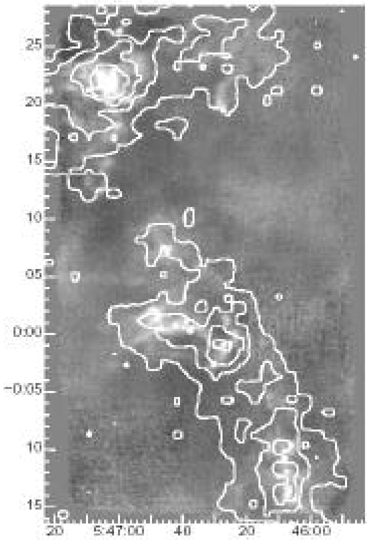
Orion B
450 pc

α , δ
2000

SCUBA
JCMT
850µm

fwhm 15''
(0.03pc)

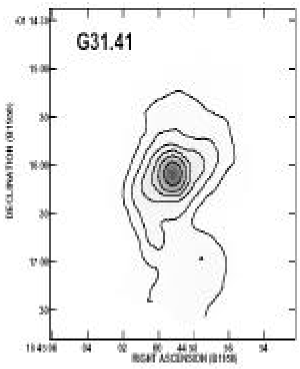
chop throws
20-70''

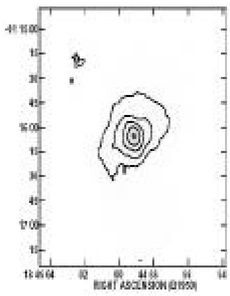


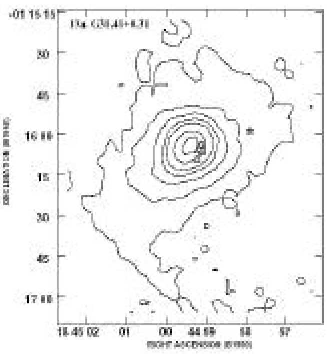
CS contours from Lada et al. 1991

Galactic Science: SPIRE Photometer

G31.41+0.31
core/halo
5 kpc







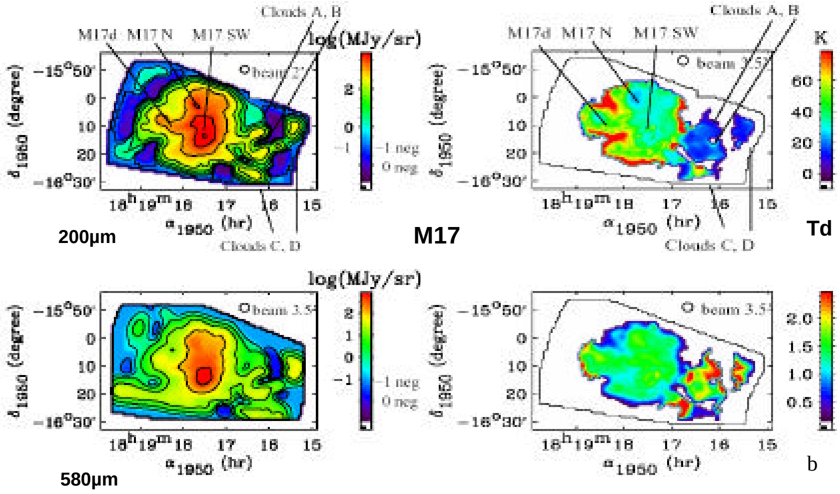
850µm SCUBA/JCMT 450µm
15'' fwhm 9''

Hatchell et al. 2000

SHARC/CSO 350µm
fwhm 11''

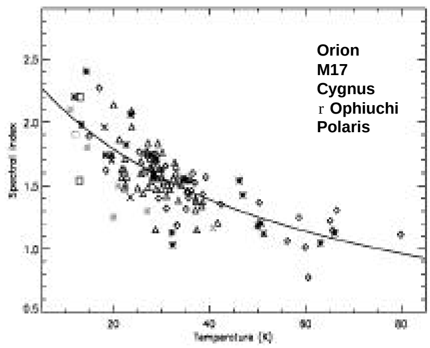
Hunter et al. 2000

Galactic Science: SPIRE Photometer



PRONAOS Dupac et al. 2002

Galactic Science: dust SED



Dupac et al. 2003

PRONAOS 4 bands
over 200 – 800 µm
+ IRAS 100µm

$$I_{fit} = c\,\lambda^{-\beta}\,B_\nu(\lambda,T)$$

assume 1 β and 1 T

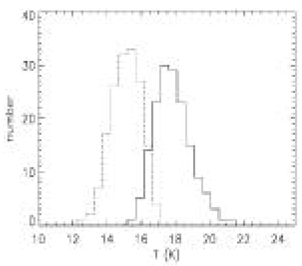
Galactic Science: dust SED

correlation β vs Td

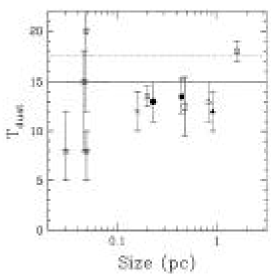
- Tp dependance of grains intrinsic optical properties ?
  - Agladze et al. 96: silicate precursors
    ⇨ resonant tunneling effect between ground states (Phillips 72)
  - Mennela et al. 98: crystalline & amorphous grains analogs
    ⇨ 2-phonon difference processes (Sparks et al. 82)
- variation of chemical composition or physical state ?
  - fluffy silicate grains + ice compounds in cold media ⇨ β ~2 – 3
  - aggregates of silicates + porous graphite + amorph. C in warm media ⇨ β ~1
- grain – grain coagulation into fluffy aggregates ?
  - Stepnik et al. 03: removal of VSGs and enhanced β in densest parts of galactic filaments

Galactic Science: dust SED

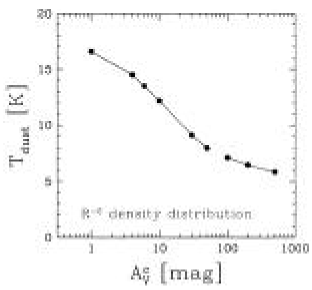
different temperature regimes



Lagache et al. 1998 histogram 'cirrus' & 'cold' components from DIRBE data



Laureijs 1999 compilation temperature of dense cores in clouds vs linear size



Bernard et al. 1992 dust temperature at cloud centre

Galactic Science: dust SED

study of dust spectral properties

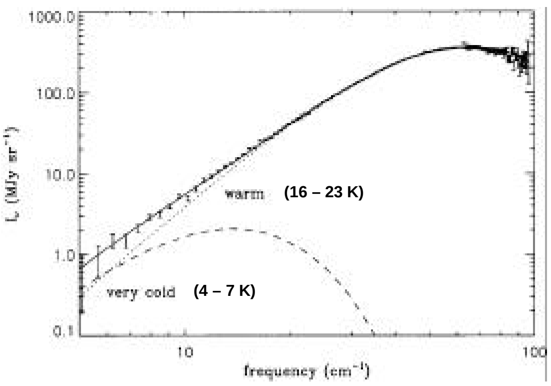
assumption: 2 components (6 parameters)
requires more than 8 spectral measurements

⇩

SPIRE FTS
+
PACS spectrometer (or ISO/LWS)
+ ground 1.3 mm

Galactic Science: SPIRE FTS

I------ SPIRE ------I



FIRAS galactic (l~45°) spectrum
Reach et al. 1995

Study of galactic dust SED

needs to separate effects due to
- # temperatures
- β change vs λ

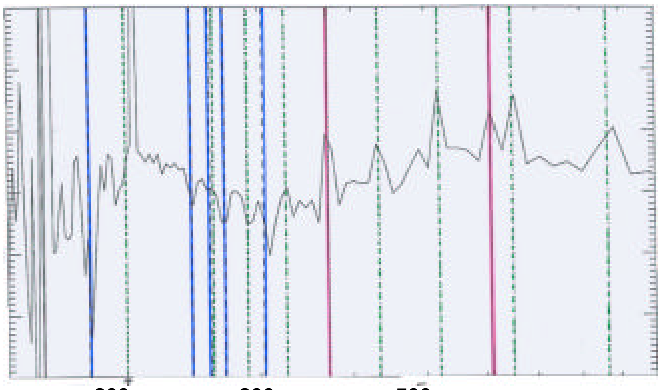
⇩

requires FTS medium R
to remove main lines
to add extra λ measures (~submm)

requires accurate calibration

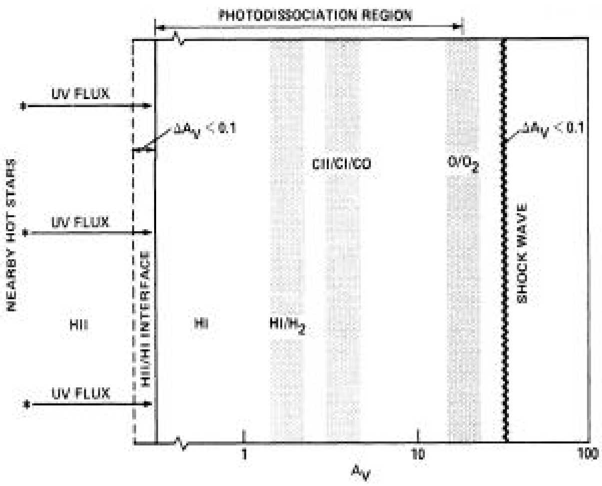
Galactic Science: SPIRE FTS

FIRAS spectrum of the Galaxy



Galactic Science: SPIRE FTS

PDR theory (from Tielens et al. 1985)



to set constraints on PDR models

FTS unique
provides simultaneous & homogeneous line coverage of [CI] & CO (4-3 to 13-12)

need [CII] from PACS

Galactic Science: STAR FORMATION

- low & intermediate mass SF:

  Wide field submm survey of Gould Belt (~20 cloud complexes at <1kpc)

  population (low end) and origin of the IMF
  lifetimes of the various stages
  tp & density structure of pre-stellar cores
  luminosity & mass function, universality of the IMF

- high mass SF:

  selection of nearby massive SF regions

- triggered SF
- ……

Galactic Science: Physics of the ISM

- OT 'large galactic survey' Key Program:

  distribution & mass function of SF regions throughout the galaxy
  structure & physics of the ISM

- physics of the ISM in specific targets:

  cold & dense molecular cloud complexes
  at # SF activities and # metallicities (MCs)
  diffuse galactic plane emission
  high latitude cirrus & translucent clouds
  cold material in SNRs
  ……..

Galactic Science: STELLAR

- YSOs

  molecular line emission in the cold molecular flows
- physics of the CSM of evolved stars

  large fraction of mass lost during evolutionary phases
  properties of envelopes & enrichment rates (heavy elements & dust)
- disk debris

  selection of MS stars with dust debris (coolest & more extended shells)
  study of gas clearing as function of age
- ......

Solar System Science: Summary of Consortium Options

Bruce Swinyard

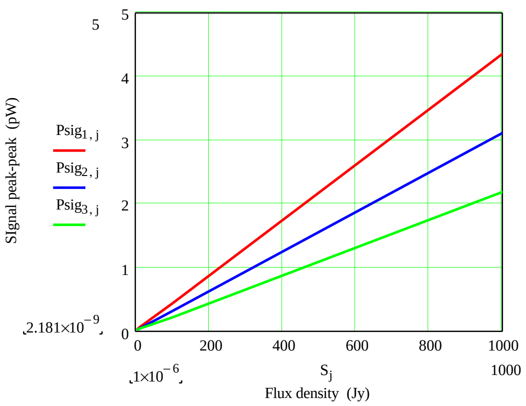
Solar System in the FIR/Sub-mm

- Basic questions about the origins of the planets and distribution of elemental abundances through the Solar system
- FIR/Sub-mm probes the deeper layers of the gas giants
- Jupiter/Saturn need HIFI type resolution to say anything new
- Neptune/Uranus not well done with ISO
- Solid bodies can use thermophysical models of the surfaces to predict the FIR/Sub-mm emissivity
- Can push these to get the rotation light curves for asteroids
- Comets contain “pristine” material and are important probes of the elemental abundance during Solar system formation
- What is beyond Neptune?
- What is the nature of the Zodiacal dust?

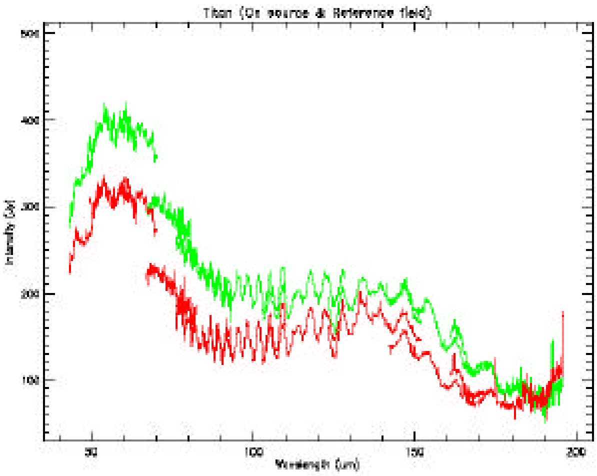
Solar System possibilities

- Jupiter and Saturn way too bright…… HIFI targets
- Neptune (95 Jy@350) and Uranus (250 Jy@350) – possibly with spectrometer
- Galillean satellites – possibly use Callisto in reflection
- Titan (properly this time – see later)
- Comets
  - Hyatuke few Jy at 450 micron –
  - Hale-Bopp continuum and water lines measured with ISOLWS out to 190 micron
- Asteroids (almost anything with a name)
- Outer edge objects:
  - Pluto ~100 mJy at 350 micron
  - Triton ~130 mJy at 350 micron

Signals….



Titan with ISOLWS



How much time….

- Asteroids/Neptune/Uranus (+Callisto?) are calibration targets
- Can we do some of this stuff as “calibration” instead of GT?
- Some science is achieved by complete spectra – H_2O, CO etc span Herschel waveband
- Do we put some of our GT into using HIFI and/or PACS?
- Given this area is not SPIRE’s “bag” it should not take more than a couple of % of GT

Herschel/Planck key projects and follow-up: what strategy ?

Bruno Guiderdoni[1] & Guilaine Lagache[2]

[1] *Institut d'Astrophysique de Paris*

[2] *Institut d'Astrophysique Spatiale, Orsay*

Porquerolles SPIRE Meeting— October 7-8, 2003

Planck Science Case

- **CMB anisotropy maps to an accuracy** DT/T=10^{-6}**, on angular scales < 10 arcmin to 180°.**
- Cosmological parameters H_0, Ω_O, Λ, Ω_{bar} to an accuracy of a few percent.
- Tests of inflationary models of the early universe, non-gaussianity, and topological defects.
- Initial conditions for formation of large-scale structures.
- Detection of Sunyaev-Zeldovich effect in thousands of rich galaxy clusters.
- Detection of thousands of IR/submm dusty galaxies, and constraints on models of galaxy formation.
- IR/submm extragalactic background.
- Maps of the Milky Way (dust, free-free and synchrotron emissions).
- Star formation and the physics of the ISM.

Planck Technical Work Groups

1. prepare data processing and analysis (transfer to DPC), & 2. develop science case (write “proposals”)

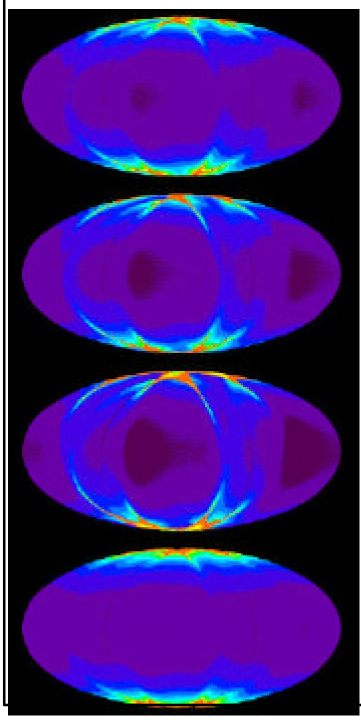
- WG 1: Systematic Effects (9 WsubG)
- WG 2: Components Separation (9 WsubG)
- WG 3: Cosmological Parameters (3 WsubG)
- WG 4: Non-Gaussianity (4 WsubG)
- WG 5: Clusters and Secondary Anisotropies (6 WsubG)
- WG 6: Extragalactic Sources (5 WsubG)
- WG 7: Galactic and Solar System Science (7 WsubG)
- WG 8: Virtual Observatory
- WG 9: Test

Technical Work subGroups related to Herschel

- In WG 6 (Extragalactic Sources), **WG 6.4: Follow-up with Herschel** (*coordinators*: Ken Ganga, Bruno Guiderdoni & Jens Hjorth)
- In WG 7 (Galactic and Solar System Science), **WG 7.5: Preparation of and coordination with Herschel key projects** (*coordinators*: Luca Valenziano & Guilaine Lagache)

List of WG 6.4 Work Packages

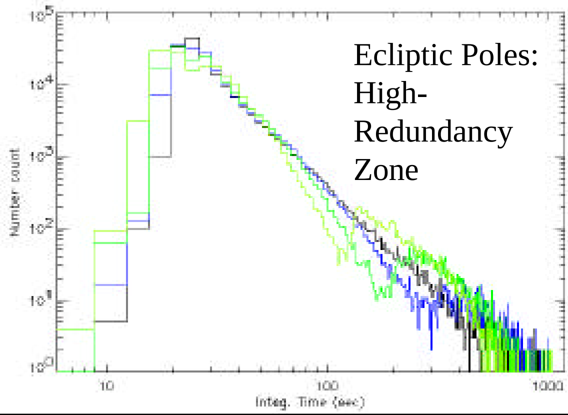
- 6.4.1 Contacts with the SPIRE team, overview on SPIRE GT, and feedback to WG6.4.
- 6.4.2. Contacts with the PACS team, overview on PACS GT, and feedback to WG6.4.
- 6.4.3 Strategy for identification of interesting sources in ERCSC, and Herschel follow-up. Link with Herschel GT.
- 6.4.4 Herschel follow-up of strong variable sources found in ToD (in collaboration with WG6.1).
- 6.4.5 100-400 deg^2 Herschel survey of the Planck deep survey in a «clean» region of the sky (refer to scanning strategy). Link with Herschel GTO and other legacy-type observations.
- 6.4.6 Strategy for Herschel follow-up of a complete sample of Planck bright galaxies.
- 6.4.7 Strategy for extraction of Planck candidates for high-redshift galaxies in the ERCSC, DERCSC and final CSC, and Herschel follow-up.
- 6.4.8 Strategy for using Planck catalogues for complementing Herschel data.
- 6.4.9 Link with WG6.2.



Planck Scanning Strategy

After 6 months : 1 all-sky survey (ECSC and DECSC)

After 14 months : 2 all-sky surveys with different coverage (CSC and DCSC)



Planck sensitivities and confusion limits

Λ µm	FWHM arcmin	σ_{inst} mJy	σ_{cirrus} mJy	σ_{conf} mJy	σ_{CMB} mJy	$5\sigma_{tot}$ mJy
350 HRZ	5	43.3 0.1%: 14	120 Clean: 60	89.4	—	779 543
550	5	43.8	62	40.0	3	429
850	5	19.4	18	15.9	16	174
1380	5	11.5	5	4.5	31	169
2097	7.1	8.3	6	2.2	56	285
		All-sky	Best 10 %	IAS model		

Predicted Planck CSC

Λ In µm	S_{lim}(Mexican Hat Wavelet) In mJy	N(> S_{lim}) 2π sr Vielva et al.	N(> S_{lim}) 2π sr IAP GalICS	N(> S_{lim}) 2π sr IAS model
350	1050	24,221	8,457	2,828
550	630	3,496	7,848	411
850	260	1,497	3,601	167
1380	170	1,130	317	54
2097	180	1,256 (RG)	45	19

Why Planck is interesting for Herschel Science

- Complementary wavelength coverage (esp. 850 µm, 1380 µm) to bright sources found in Herschel Projects.
- Polarization.
- All-sky detection of «new», «rare» sources for Herschel follow-up.
- Cross-calibration of bright point sources, and diffuse background.
- Separation of diffuse components (using Planck machinery + all-sky, multi-wavelength information).
- **Need to define policy for data exchange before Planck data release (Herschel and Planck Science Teams), as well as nature of Planck products that are useful for Herschel.**

Herschel Follow-up of Planck Sources (Mostly Cycle 1 and 2 GT & OT)

- Strong variable sources found in Planck ToD. Target-of-Opportunity observing mode? Would be considered as “expected ToO”.
- Interesting sources in ECSC and DECSC (6 mo) (how many of them will be non-IRAS, non-Astro-F sources?)
- New (ie : non-IRAS, non-Astro-F sources), bright, «cold» sources in CSC and DCSC
- Possible rare, high-redshift monsters (HyLIRG) in CSC and DCSC
- New, bright, medium-redshift clusters

Possible Herschel Key Projects

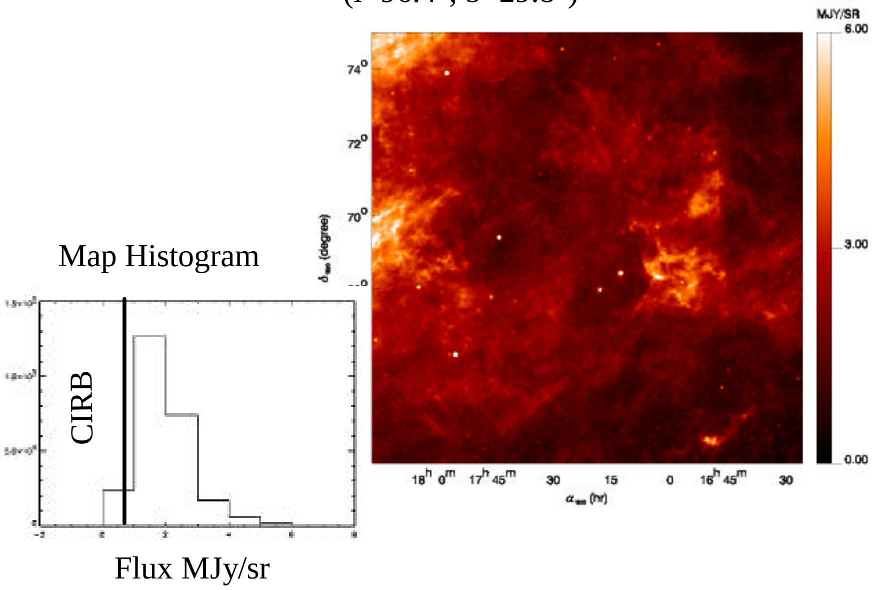
- SPIRE/PACS Molecular Cloud Survey
  - Gal. Conf. Limit 10 mJy (1σ), 100 deg^2, 30 d. OT KP?
- HIFI Spectral Survey
- SPIRE Galactic Plane Survey |b|<2.5°
  - 30 mJy (1σ), 1800 deg^2, 54 d. OT KP?
- SPIRE/PACS Deep Fields and confusion (~6 mJy 1σ)
  - 3 mJy (1σ), 1 deg^2, 3 d. GT KP?
- SPIRE/PACS Medium-Deep Field
  - Extragal. Conf. Limit 6 mJy (1σ), 6 x 1 deg^2, 4.5 d. GT KP?
- SPIRE Herschel/Planck Wide Field (HPWF)
  - 20 mJy (1σ), 100 — 400 deg^2, 7.5 — 30 d. GT vs OT KP?

A Herschel-Planck Wide Field

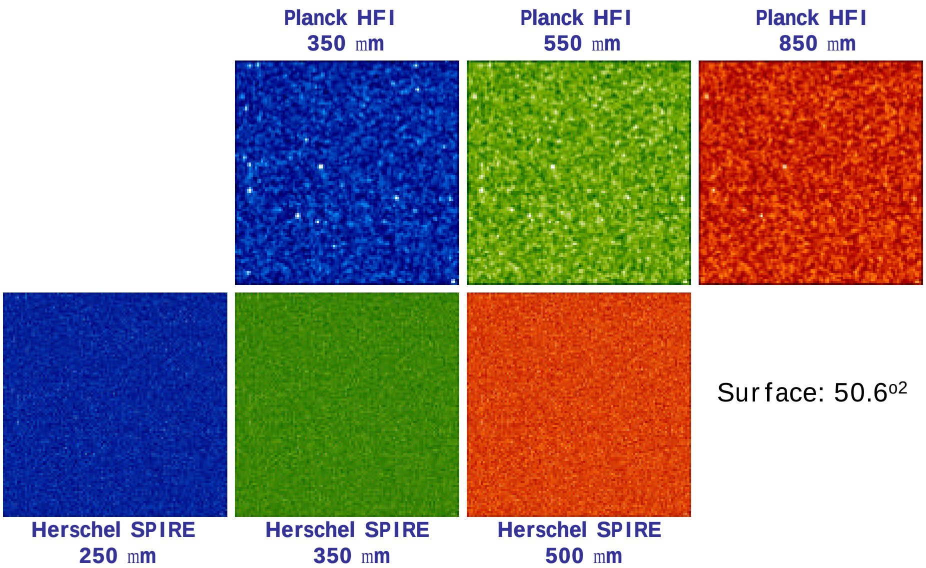
- Map 100 — 400 deg^2 High Redundancy Zone at NEP (b=30°) @ 20 mJy (1σ), in 7.5 — 30 d.
- Expect hundreds of Planck sources and thousands of Herschel sources (but resolve only 1% of CIRB).
- An Herschel follow-up of a Planck magnitude limited sample: positions, ID, multiple sources.
- Large-scale structures.
- H/P cross-calibration of point source fluxes.
- H/P cross-calibration of diffuse component.
- Component separation: test Planck algorithms and export to Herschel.
- Herschel study of high-latitude cirrus and CIRB fluctuations (spatial and spectral information, inversion).

IRAS 100 mm 12 x 12 deg^2 Map of the NEP

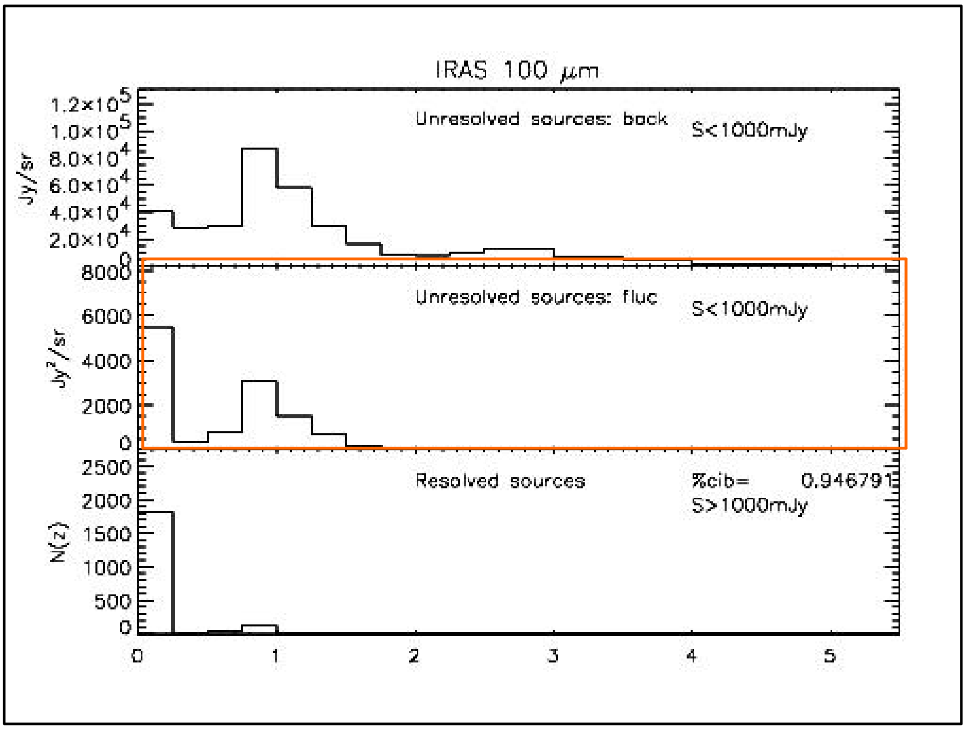
(l=96.4°, b=29.8°)

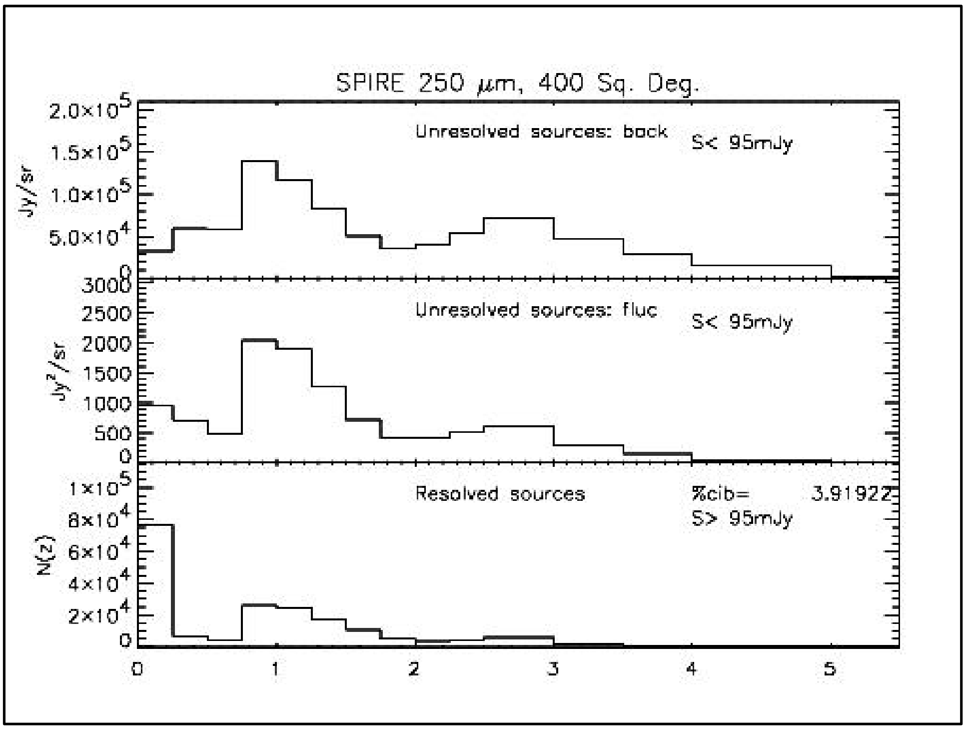


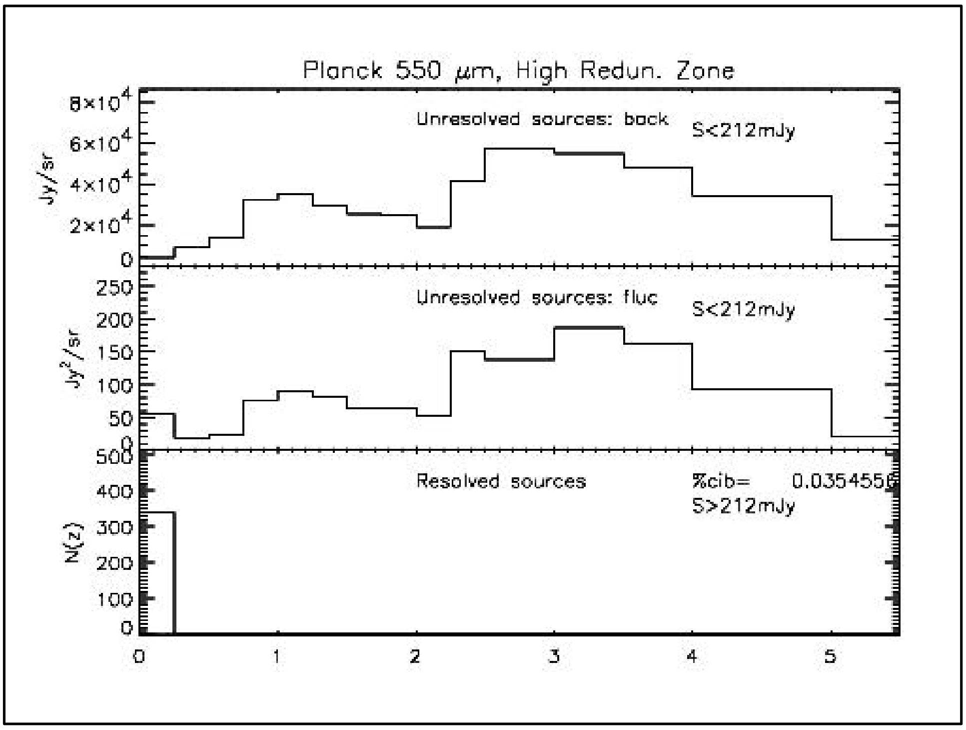
IR & Submm Panchromatic Sky

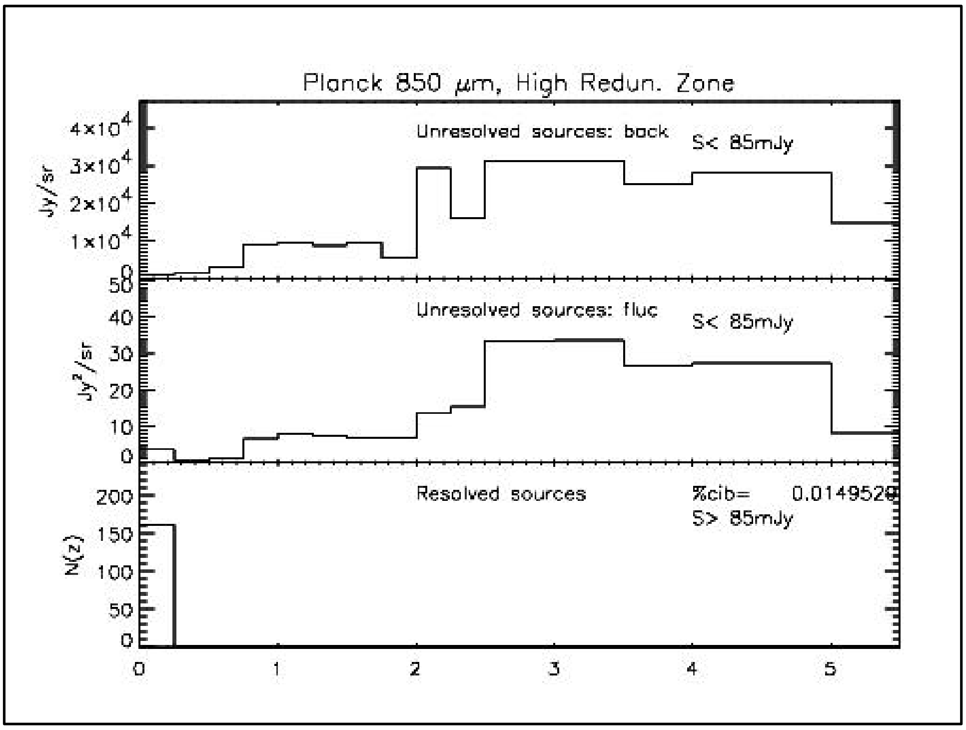


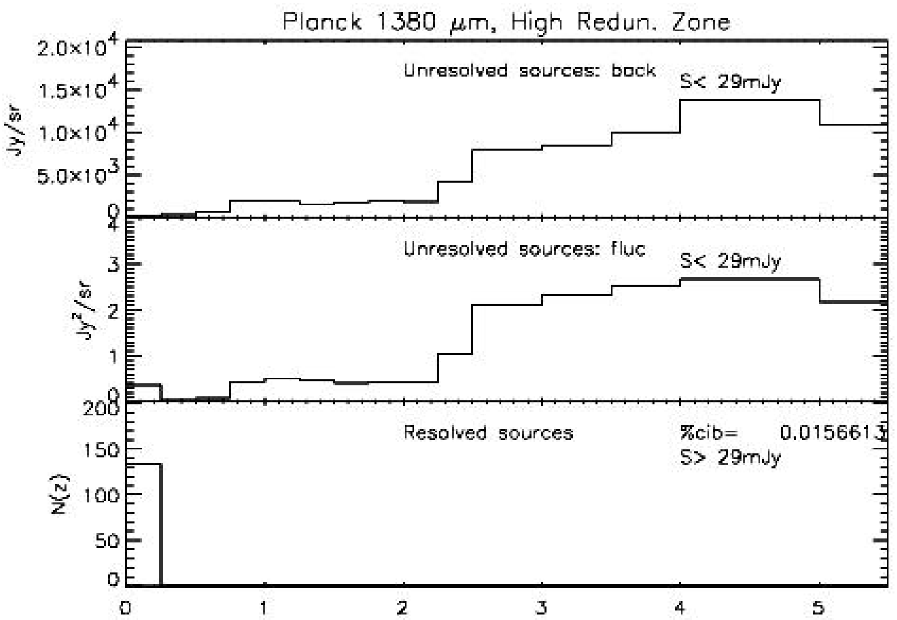
Sims from Dole, Lagache, Puget, 2003, ApJ


IRAS 100 μm
Unresolved sources: back
S<1000mJy
Jy/sr
Unresolved sources: fluc
S<1000mJy
Jy²/sr
Resolved sources
%cib= 0.946791
S>1000mJy
N(z)

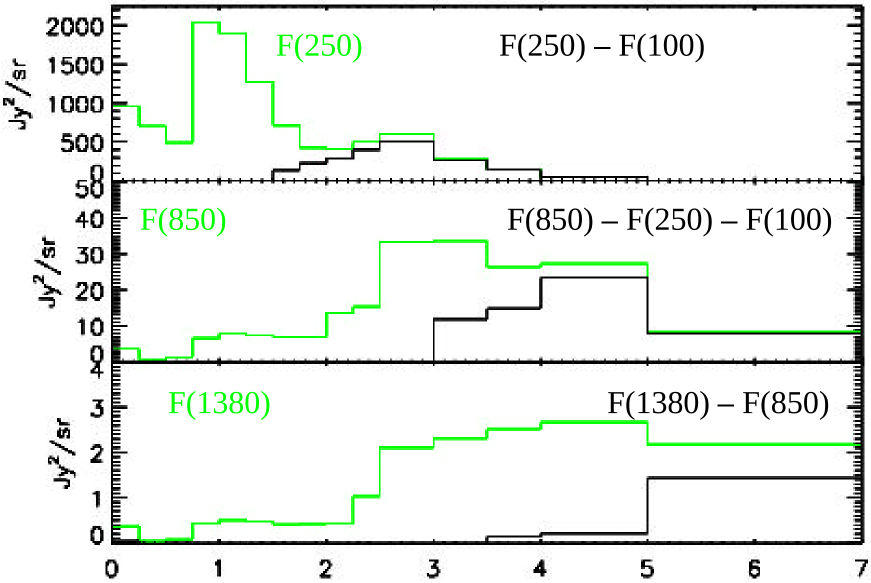

SPIRE 250 μm, 400 Sq. Deg.
Unresolved sources: back
S< 95mJy
Jy/sr
Unresolved sources: fluc
S< 95mJy
Jy²/sr
Resolved sources
%cib= 3.91922
S> 95mJy
N(z)


Planck 550 μm, High Redun. Zone
Unresolved sources: back
S<212mJy
Jy/sr
Unresolved sources: fluc
S<212mJy
Jy²/sr
Resolved sources
%cib= 0.0354556
S>212mJy
N(z)


Planck 850 μm, High Redun. Zone
Unresolved sources: back
S< 85mJy
Jy/sr
Unresolved sources: fluc
S< 85mJy
Jy²/sr
Resolved sources
%cib= 0.0149520
S> 85mJy
N(z)

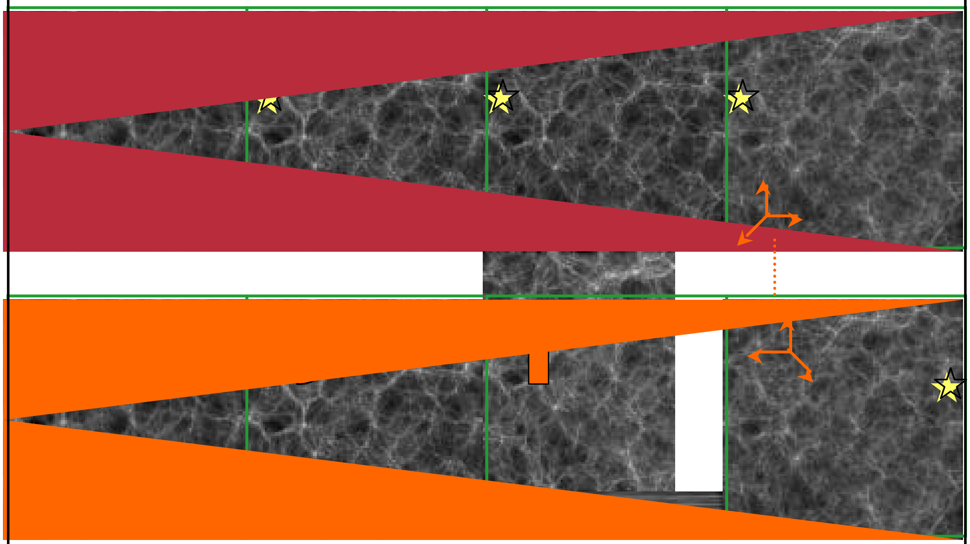


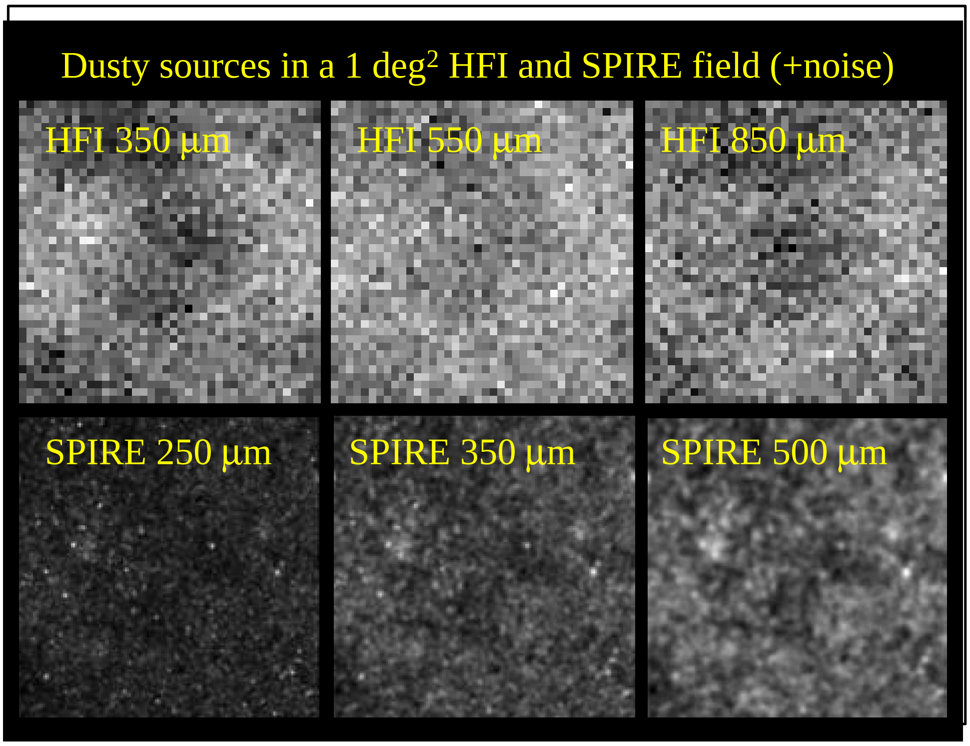
Example of Inversion



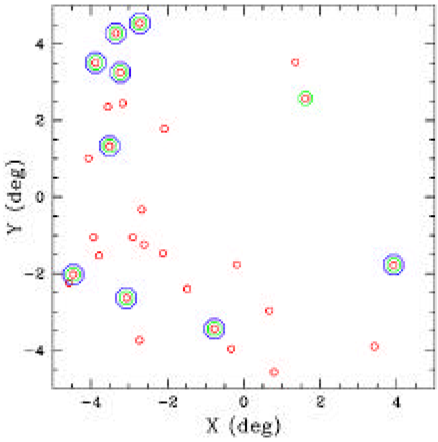
(Sorel, PhD thesis)

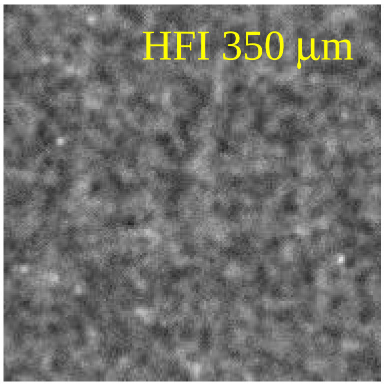
Replication effects





Dusty sources in a 100 deg² field: The effect of large-scale structures





Red dots S_{350} > 1.03 Jy

Green dots S_{550} > 0.53 Jy

Blue dots S_{850} > 0.28 Jy

29 dusty sources @ 350 µm, z < 0.1

Mean sky density: 41 sources / 100 deg²

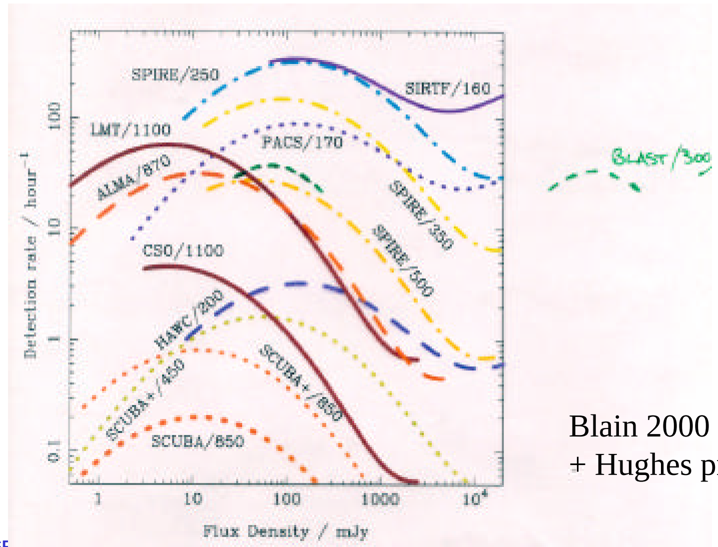
Actions

- Discussion between SAGs 1—2 and WG 6.4, and between SAGs 3—4 and WG 7.5.
- Consider post-launch agenda.
- Use common models/sky simulations.
- Planck Ancillary catalogues. Of any use for Herschel?
- Links/web pages ?
- Next Full Science Team Meeting (March 2004): presentation of a first set of Herschel/Planck proposals.

Extra-galactic Surveys with Herschel

Seb Oliver

SPIRE



Blain 2000
+ Hughes priv. Com.

Reasonable Pie Sharing

Time for Key programs

- SPIRE GT only 50-100 days
- SPIRE+PACS 100-200 days
  - (ignore this option for time being)
- OT: 276 days
- Guesstimate SPIRE GT
  - 50% EG – 50% Galactic
  - Split EG into Survey – non-survey 50% 50%
  - All EG Surveys are Key programmes :- 25d
- With PACS :- 50 days

SIRTF Legacy Programs

• GOODS:	647	64%	75%
• SWIRE:	851		25%
• SINGS:	512		
• GLIMPSE:	400	36%	35%
• Mol. Cores :	350		65%
• Planetary Disks:	400		

Total: 60% on blank field surveys, 40% on target obs.
EG Surveys 47% of total time.

Herschel: 25-50% of Key programme time on EG Surveys I.e. 70-140 days

Science Cases

Survey Options

- Small, very deep, below confusion noise
- Large @ confusion limit
- V. Large above confusion limit
- Small, below confusion limit using lensing

Survey Options: Deep

- Small, very deep, below confusion noise
  - Early determination of faint counts
  - Best possible resolution of background
  - Fluctuation analysis: intra and inter band
  - Early population studies
  - Statistical detections
  - Component separation
- Small, below confusion limit using lensing
  - As above, but aims to go deeper

SPIRE

Survey Options: Large

- Large @ confusion limit
  - Determination of counts across most dynamic range
    - discriminating between competing models
  - FIRSub-mm colour distributions
    - classification of different populations
    - refinement of phenomenological models
  - Luminosities, Luminosity Functions, Luminosity densities using photo-z
    - Full characterisation of phenomenological models
  - Clustering
    - Testing physical models of structure formation (semi analytic & SPH models)
  - LIRGS, ULIRGS, HLIRGS, üLIRGS
  - Samples for follow-up with ALMA, 8-10m class telescopes, JWST, etc.

SPIRE

Survey Options: V. Large

- V. Large above confusion limit
  - Cross-correlation with Planck
  - Determine the brightest source counts
  - Searching for the most luminous objects
  - Large area required to maximise volume
  - Local Galaxies
  - Cross-correlation with ASTRO-F
  - Bright = high luminosity

Detailed Justifications

Need hard numbers and rival theories!

Need to justify

- **Depth** } Numbers of sources
- **Area**
- **Fields**
- **Shape**
- **Scanning patterns**

Models: Rowan-Robinson 2000, Sensitivities Griffin 2003, Poglitsch 2001

Assumptions: (to cover 1 degree)

	90	120	175	250	350	500
N_{conf} [sq.deg.$^{-1}$]	10185	5730	2680	1320	670	330
S_{conf} [mJy]	0.74	3.2	11	19	20	17
T_{conf} [days]	377	22	1.6	1.3	1.7	3.2
S_{1000} [mJy]	3.5	10	21	22	15	7.9
T_{1000} [days]	17.1	2.2	0.4	0.9	(2.9)	(14)

3 days to reach SPIRE confusion limit in all bands

2 days to reach PACS confusion limit at 175μm & 1000 sources at 120μm

22 days to reach PACS confusion limit at 120μm

SPIRE

Deep Survey

- For fluctuation analysis really need some competing models but…
- Depth:
  - P(D) is a Gaussian defined by s (confusion limit is 5 s)
  - Subdivide P(D) into 10 bins across +- 2 s
  - Thus instrumental errors must be 0.4 s
  - Thus integration time is $(0.4)^{-2}$ confusion limited I.e. 6x
- Area:
  - 100 resolution elements per bin gives 10% errors.
  - 3% of resolution elements in lowest bin
  - ➔ 3.5k resolution elements, say 10k for round numbers
  - Area = 0.74 sq. deg.
- No arguments based on Super Resolution!

$$s \propto t^{-1/16(g-1)} \propto t^{-0.04}$$

SPIRE

Deep Survey

- Depth:
  - 6 X Confusion integration time
- Area:
  - ~ 1 Sq degree
- Fields:
  - As many as economical
  - HDF
  - HDFS
  - CDFs
  - Lockman
- Numbers of (unconfused) sources: 1320, 670, 330
- Sufficient for constraint of faint counts and providing reasonable follow-up opportunities (less than 1 z>5)

Of order 20 days

Deep Survey: PACs

- Confusion limited PACS survey @ 120μm over same field would take 22 days
  - well below the confusion limit @ 175μm
    - $T=14xT_{conf}$, $\sigma_{conf} = 3.7\ \sigma$
  - Coordinated but independent PACS GT KP
  - Or combined SPIRE-PACS GT KP
- A ~2 day PACS survey included in SPIRE GT KP would reach a similar source density to SPIRE
- Sub-confusion @ 120μm or confusion at 70μm would have to be over a small field and are not compatible

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Deep Survey: Next steps

- Selection of number count models (consistent with existing data) to show variation in confusion limit estimates
- What can:can't you do with this many sources
- Models that agree on counts above confusion limit to show range of P(D) predictions and requirements to discriminate them

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Large Survey

Large Survey

- Area requirements from LFs
- From Hyper-luminous galaxies
- From LSS

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Large Survey

- Estimate 1. To study evolution of LF
  - Typical L: Luminosity Density ➔ f(L)
    Df: say 20%
  - ➔ DlogL=
    Dz(z): Photo-z slices 0.23(1+z)

  - 10% accuracy ➔ N_{bin}=100
  - N=f DLDzdvdz DW➔ DW = N f DLDz

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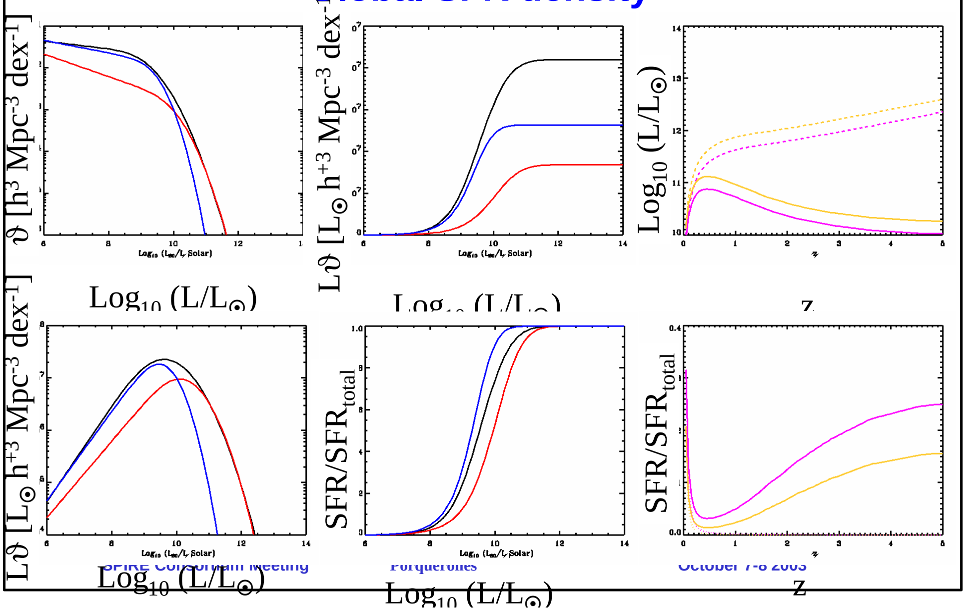
Large Survey: Slicing in photo-z

	Z-Range	0-1	1-2	2-3	3-4	4-5	>5
	N_{bins}	7	4	3	2	2	1
Number of galaxies per bin per sq. deg.	90	1085	590	72	8.2	0.51	
	120	685	221	16	1.2		
	175	316	113	4.6	0.40		
	250	138	86	3.7	0.26		
	350	52	68	9.6	0.70	0.034	
	500	16	40	16	3.7	0.26	0.033

Large Survey: Estimate 1 plots

1. **Cumulative Luminosity density vs. Luminosity ➔ critical luminosity**
2. **Flux of critical luminosity vs z. (evolution no evolution)**
3. DW **vs z**

Global SFR density



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Large Survey Estimate 2

- Choose “reasonable” ultra-luminosity to be interested in 10^{13} Lsun (z=0)

  F gives number density of sources above this
- Want to detect a minimum number ➔
- Volume per sq. degree vs z
- Volume required
- Luminosity vs z for confusion limited flux

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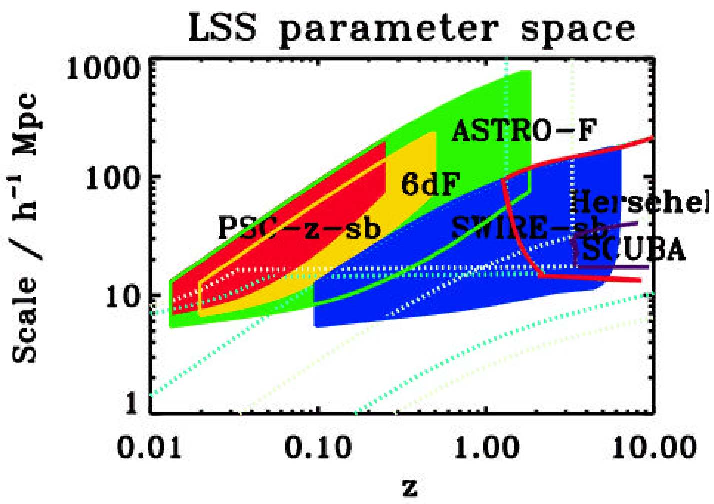
LSS c.f. other IR surveys



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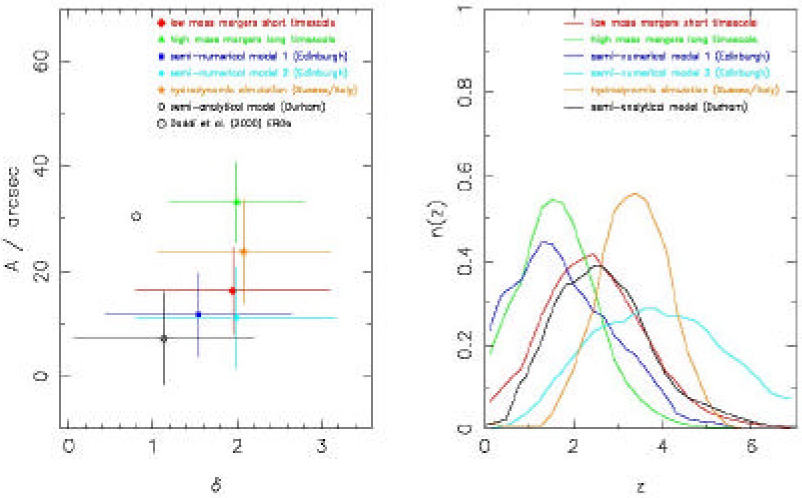
SCUBA & LSS



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Large Survey Field: Complementary data

- **Importance of Multi-lambda coverage**
- **For SEDs & Source Characterisation (photo-z)**
- **For identification**
- **For complementary populations**

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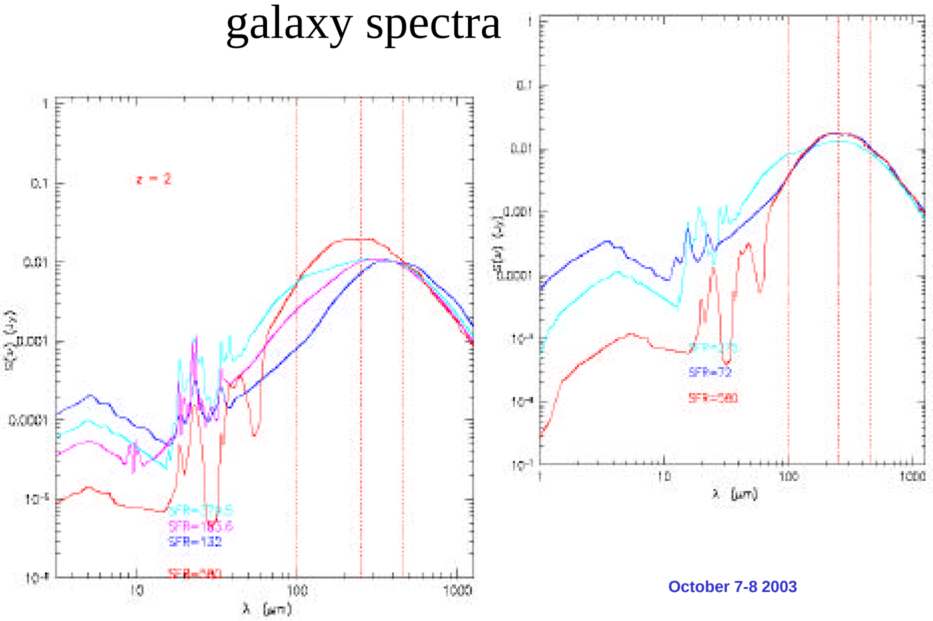
Degeneracies in the long-λ galaxy spectra



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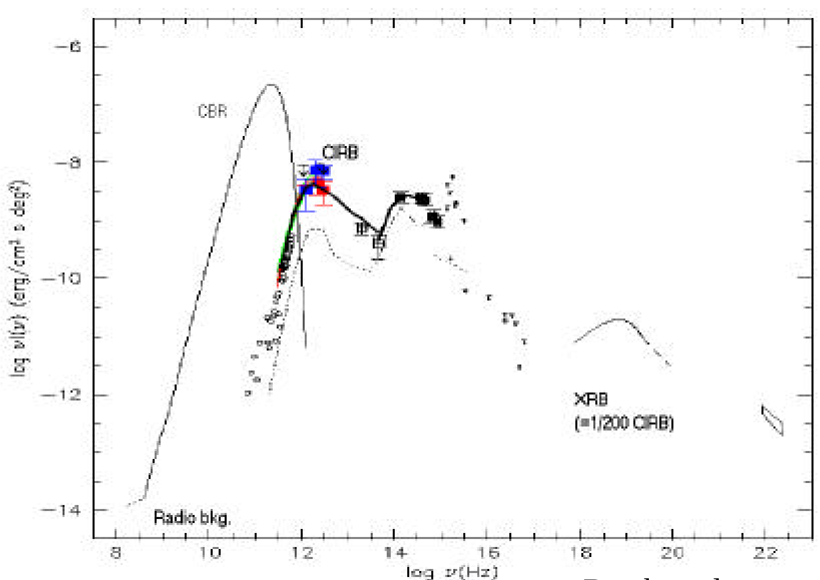
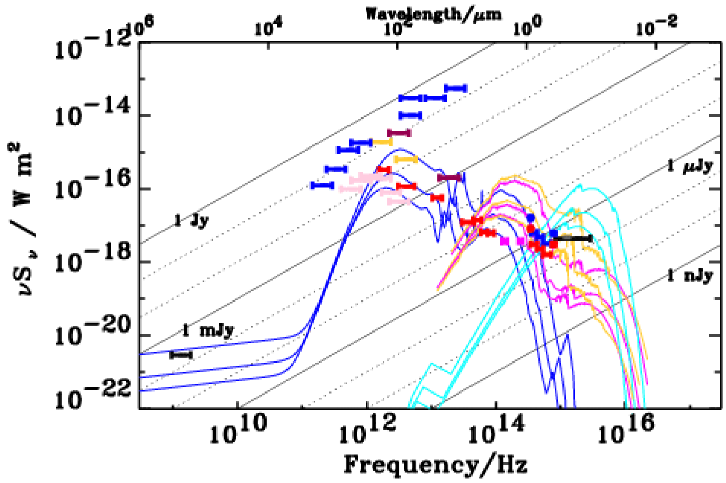
The Global Background Radiation

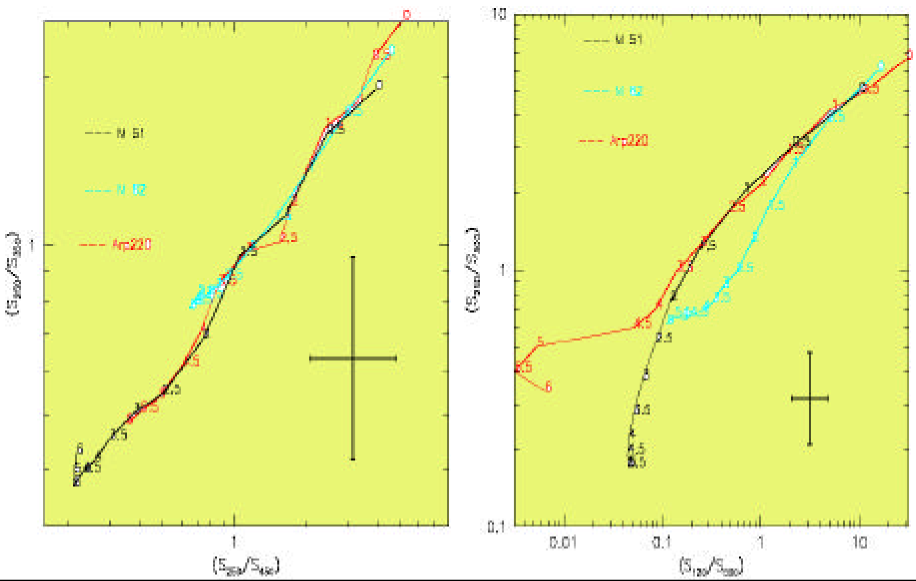


e.g. Dwek et al.

Surveys @ many l



Estimate of the redshift from FIR photometry including or not a channel at short wavelengths



Identifications

Band	z=1	z=2	z=3	z=4
0.3	23.33	25.45	28.25	30.32
0.5	23.63	25.01	26.20	28.28
0.6	22.33	24.18	24.81	25.52
0.8	21.04	23.36	24.07	24.46
0.9	20.27	22.53	23.57	23.97
1.2	19.04	20.75	22.09	22.85
1.6	18.06	19.28	20.27	21.18
2.2	17.12	18.07	18.64	19.23
3.8	1.3e-01	7.3e-02	5.5e-02	4.7e-02
4.5	1.2e-01	8.7e-02	6.7e-02	5.8e-02
5.8	1.1e-01	8.8e-02	8.8e-02	7.8e-02
8.0	1.0e-01	7.7e-02	9.0e-02	1.0e-01
24.0	9.4e-01	4.3e-01	2.3e-01	8.3e-02
60.0	4.4e+00	1.1e+00	6.6e-01	7.7e-01
90.0	1.2e+01	3.1e+00	1.5e+00	1.0e+00
175.0	2.8e+01	1.4e+01	8.4e+00	5.4e+00
250.0	2.8e+01	1.9e+01	1.6e+01	1.3e+01
350.0	2.0e+01	2.0e+01	2.0e+01	2.0e+01
500.0	8.0e+00	1.5e+01	2.0e+01	2.3e+01
850.0	1.5e+00	3.8e+00	9.2e+00	1.7e+01

Large Survey: Fields

- **Fields:**
- **More than one field how many: <10, >=3**
- **Which fields**
  - **multi-wavelength fields (e.g. SWIRE fields)**
  - **Multi-hemisphere N.B. Alma**
- **Shape of fields: Near circular**
- **Scanning strategies: maximise cross-linking**

Very Large Survey

Very Large survey

- Matched to Deep Planck Survey ~ 100mJy at 350mm
- 20mJy RMS: 0.0675 days sq. deg. → 27 days for 400 sq. deg.
- Detection of uber-luminous objects
- Volume to detect rare objects
- Colour cuts for detection (850mm detections that are not detected at shorter wavelengths)
- Better for Planck than SPIRE

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Plan

SPIRE

Timeline

- **L-40 : SPIRE Consortium meeting Poquerolles**
- L-39 : *SPIRE SAG meet form teams to develop GT cases*
- *L-38 : develop SPIRE GT cases*
- *L-37 : SPIRE-PACS KP meeting (form KP teams)*
- *L-36 : develop SPIRE-PACS GT:OT cases*
- *L-35 : Full SPIRE Science Team Meeting*
- *L-34 : Open EG Surveys Key Programs meeting*
- *L-33 :*
- *L-32 : develop GT KP cases in GT:OT context*
- *L-31 :*
- *L-30 : develop GT KP cases in GT:OT context*
- *L-29 :*
- **L-28 : SPIRE Consortium meeting** *finalise GT KP*
- *L-26 : Preparation of cases*
- **L-24 : Submission of GT Key Progs. (Feb. 2005)**
- **L : Launch, February 2007**

The Herschel Galactic Plane Survey Open Time KP

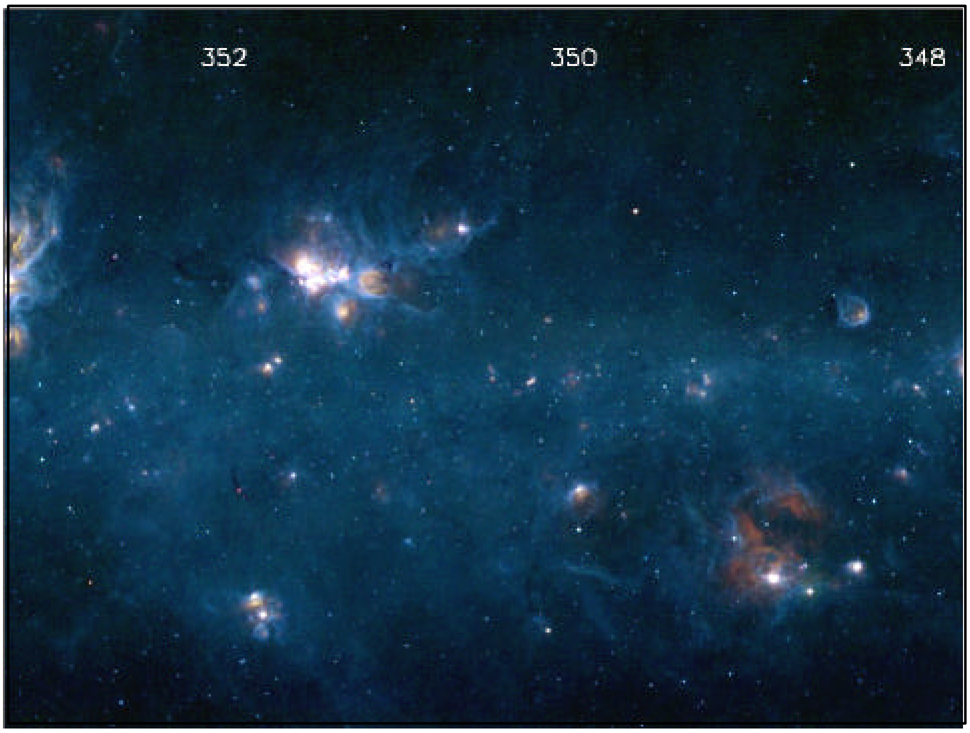
"Dirt constitutes 90% of everything"
(Anonymous Housewife)

"Dust you were and dust you shall return"
(Christian Priest on Ash Wednesday)

Question

Can we address a large number of topics with one, unique, uniform, coherent, "self-calibrated" dataset ?

The total must be greater than the sum of its parts



Past

- First mention of SPIREGAL in "Promise of Herschel" (Dec 2000) proceedings (Molinari & Swinyard)
- SPIREGAL presentation by Bruce at the SPIRE Consortium Meeting in Cardiff (Oct 2001)
- SPIREGAL+PACS presentation by Sergio at the PACS Science Meeting in Munich (Jan 2003)

Present

- Preliminary scheme for Herschel KP implementation circulated by ESA (June 2003)
- Kick-Off meeting for an Herschel Open Time KP for the Galactic Plane Survey @IFSI 21-22 July 2003

The Consortium

- IFSI-CNR
  - S. Molinari
  - P. Saraceno
  - A.M. DiGiorgio
  - S. Pezzuto
  - S. Viti
  - M. Benedettini
  - L. Montinaro
  - L. Spinoglio
- Arcetri Obs.
  - L. Testi
  - R. Cesaroni
  - P. Caselli
  - M. Walmsley
- Univ. Roma 1
  - S. Masi

esa

- HERSCHEL Science Center
  - G. Pilbratt

- Univ. of Cardiff
  - M. Griffin
- RAL
  - B. Swinyard
- Univ. of Kent
  - G. White
- ATC
  - G. Wright

- Stockholm Obs.
  - G. Olofsson

- IPAC/Caltech
  - A. Noriega-Crespo
  - G. Helou
  - B. Ali
  - B. Schulz
  - K. Ganga
- UC Berkeley
  - M. Cohen

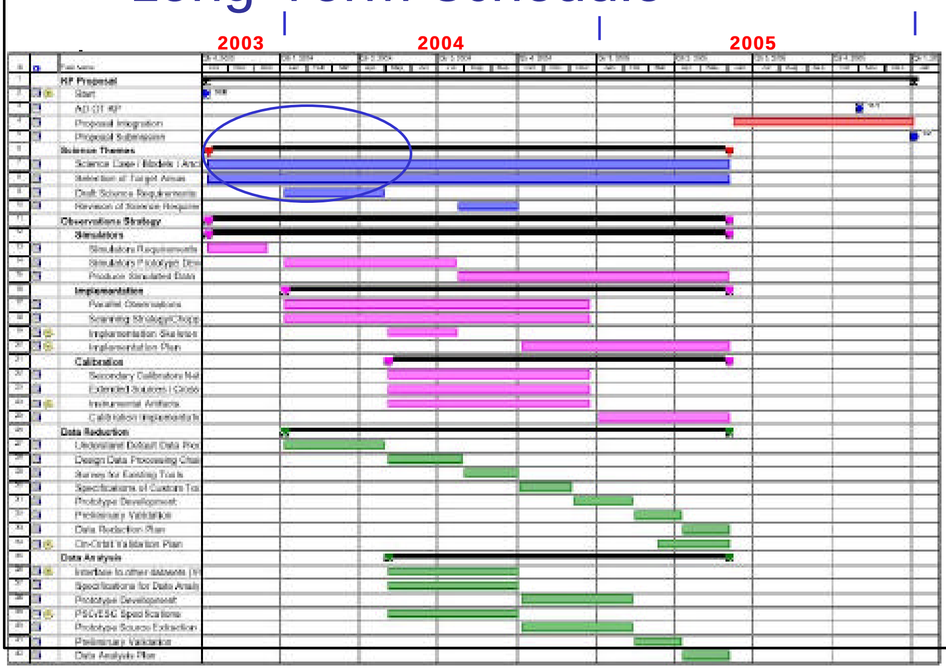
- CESR
  - J.P. Bernard
  - M. Giard
- IAS
  - A. Abergel
  - F. Boulanger
  - P. Cox
- LAM
  - A. Zavagno
  - J.P. Baluteau
- CEA
  - P. Andre`
  - F. Motte

The Current Concept

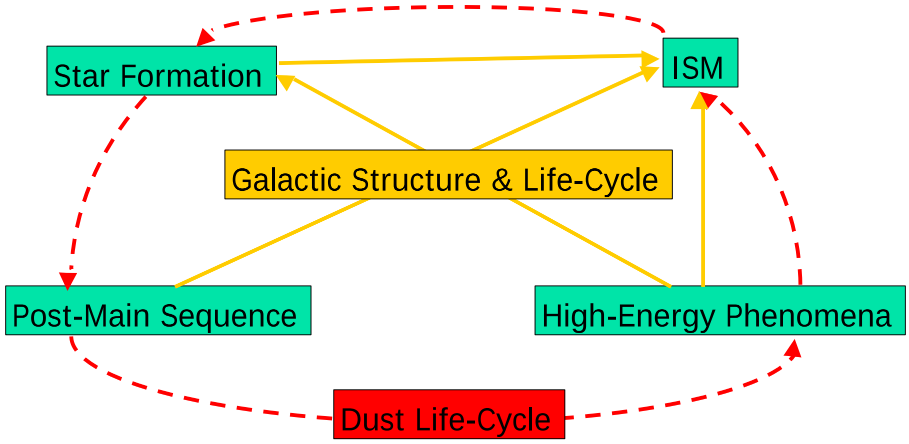
- SPIRE+PACS Multi-band imaging
- Diffraction limited
- 1800^{o2} sky coverage
- Sensitivity of 100mJy @ 5s

~100 days

Long-Term Schedule



Science Themes



Science Working Groups

- Tasks
  - Build the Big Picture bottom-up
  - Issue Science Requirements
- Structure
  - Participation via expression of interest sent to the KP coordinator
  - Coordinated by coordinators (the KP coordinator will bug them quite often)

Short-Term Schedule

- Set up Science Working Groups
- Identify key non-Herschel astronomers and invite them to join in
  - Expertise
  - Manpower
- 1st Progress Meeting: December 15-16 2003, location TBD
- 2nd Progress Meeting: May 3-4 2004, location TBD
  - Issue of Science Requirements

Meeting Conclusions

Matt Griffin

Meeting Objectives – Largely Achieved

1. Update the full consortium and science team on the instrument and Herschel Project Status

2. Review plans for
   - Instrument AIV and calibration
   - ICC development

3. Review the rules and timeline for Herschel observing time allocation, and their implications for us

4. Set up the Specialist Astronomy Groups (SAGs) that will formulate the consortium's science programme

Main actions

- Matt: Confirm with indentified SAG co-ordinators that they are willing to take on the task (and may God have mercy on their souls . . .)
- ST members: sign up to SAGs by contacting co-ordinators
- Matt et al.: Produce guidelines note for SAGs
- SAG coordinators: Commence and organise work on programme definition, liaison with others
- Matt: Revise and distribute Scientific Constitution after approval by Co-Is

Caveats

- Rules of the game are not yet approved
- Instrument teams' Guaranteed Time is at risk if ESA have to provide more financial support of the payload
- Instrument sensitivity is highly uncertain and vulnerable to being sacrificed on the altar of the schedule