SPIRE-UCF-MHO-002149

SPIRE Consortium Meeting

RAL

28-30 September 2004

Compilation of Presentations

List of Presentations

Introduction and Project Status	
Introduction and meeting objectives	**Matt Griffin**
Herschel-Planck Project status update	**Carsten Scharmberg**
SPIRE Project status and schedule	**Eric Sawyer**
CQM test update and PFM test plan	**Bruce Swinyard**
Time allocation: rules, proposal guidelines, schedule	**Göran Pilbratt**
SPIRE performance update	**Matt Griffin**
ICC Status and Planning	
ICC overview and outline plan for next 12 months	**Ken King**
AOT definition: HSC plan and schedule	**Sarah Leeks**
AOT definition: SPIRE status and plan	**Dave Clements**
Data products and data proc. pipeline: photometer	**Dave Clements**
Data products and data proc. pipeline: FTS	**David Naylor**
SAG programmes	
SAG 1: High-redshift galaxies	**Jamie Bock**
SAG 2: Local galaxies	**Suzanne Madden**
SAG 3: Star formation	**Philippe André**
SAG 4: The ISM	**Alain Abergel**
SAG 5: Solar System	**Bruce Swinyard**
SAG 6: Stellar and circumsteller	**Mike Barlow/Göran Olofsson**
HIGAL status	**Bruce Swinyard**
Other related programmes	
Open Time extragalactic surveys	**Steve Eales**
PACS and HIFI science programme status	**Matt Griffin**
Planck-related Herschel programmes	**Ken Ganga**
Report on STAC meeting	**Matt Griffin**
AOT Workshop	**Dave Clements and Mattia Vaccari**

Introduction and Objectives of the Meeting

Matt Griffin

Meeting Objectives

Instrument and ICC:

- **Update the full consortium and science team on the instrument and Herschel Project Status**
- **Review ICC development**
  - **Consortium capabilities**
  - **Detailed plans**
- **See the SPIRE CQM**

SPIRE Science Programme

- **Review Stage-2 GT proposals produced by the SAG**
- **Update the plan for preparation of the SPIRE Science Teams proposals for GT and OT**

Meeting Format

Day 1

- Introduction and updates on Herschel and SPIRE projects
- CQM and flight model test programme
- Update on ESA's plans for observing time allocation
- Update on SPIRE performance estimates
- ICC
  - Work-plan for next 12 months
  - AOT definition
  - Data processing pipelines (photometer and FTS)
- Splinter meetings
  - SAGs
  - Technical

Meeting Format

Day 2

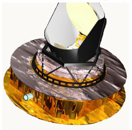
- Presentation of the SAGs' proposed GT programmes
- Current status of
  - HIGAL
  - Extragalactic Open Time plans
  - Planck- related programmes
  - PACS and HIFI plans

- STAC (=Co-Is) Meeting
  - Funding situation
  - Assessment of SAG proposals
  - Revision of SPIRE Science Team plan

Meeting Format

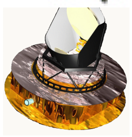
Day 3

- Report on STAC meeting
- ICC Steering Group meeting
- ICC workshop and planning meeting



SPIRE Consortium Meeting
Herschel/Planck Project Status

C. Scharmberg

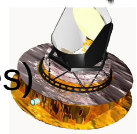


- PLM Status
- Herschel Telescope Status
- Herschel Planck Project Review Status
- Launch Date
- Instrument delivery dates
- Instrument Qualification Review

PLM Status

- **EQM:**
  - Integrating of tubing is ongoing
  - Cryo-harness will be late (i.p. SPIRE CVV external harness)

- **PFM (STM):**
  - HTT delivered. Cryo-components mounted (except LHe valves)
  - Instrumentation is integrated
  - MLI to be mounted this week
  - HOT delivered to ASED, and mounted onto lower SFW
  - CVV cylinder delivered to ASED
  - Thermal straps delivered to ASED



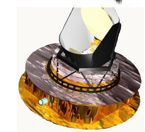
Telescope development status (1/2)

Engineering and AIT activities:

- qualification levels successfully passed on M1 and hexapod structure (supporting M2) during their proof-tests [vibration tests up to 10g (20 g at edges) for M1 and 30-40 g on hexapod]
- mass budget increasing up to 315/320 kg after M1 weighing.
- mechanical / thermal analyses on the hexapod legs for protection against hot spots (coming from sun reflection on M1 during early launch phase).
- Finalisation of M1 thermal design: partial or full VDA Kapton design (trade-off: telescope temperature; life time and thermal H/W qualification temperature)
- specification issue 7 agreed

Planning

- major 2004 steps: M1 and M2 mirror polishing completed in Dec 04
- Start of telescope integration in 2005
- telescope delivery planned end of July 2005



Telescope development status (2/2)

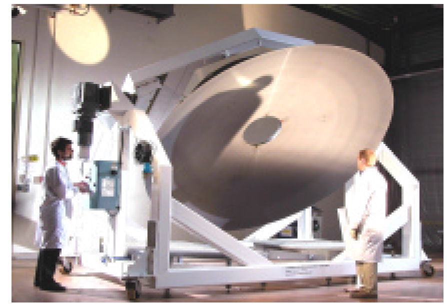
- Flight Primary Reflector:

→ Successfully ground in May 2004

→ Vibrations qualified in June 2004

→ Delivered to Opteon for end of polishing this year

→ Coating planned beginning 2005



Grinding → Vibration proof-test → polishing → coating

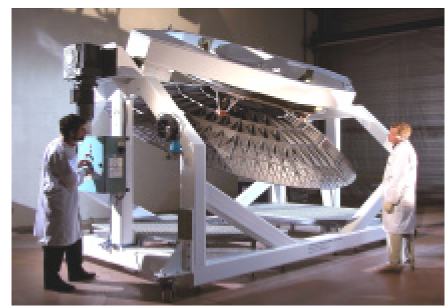
- present status:

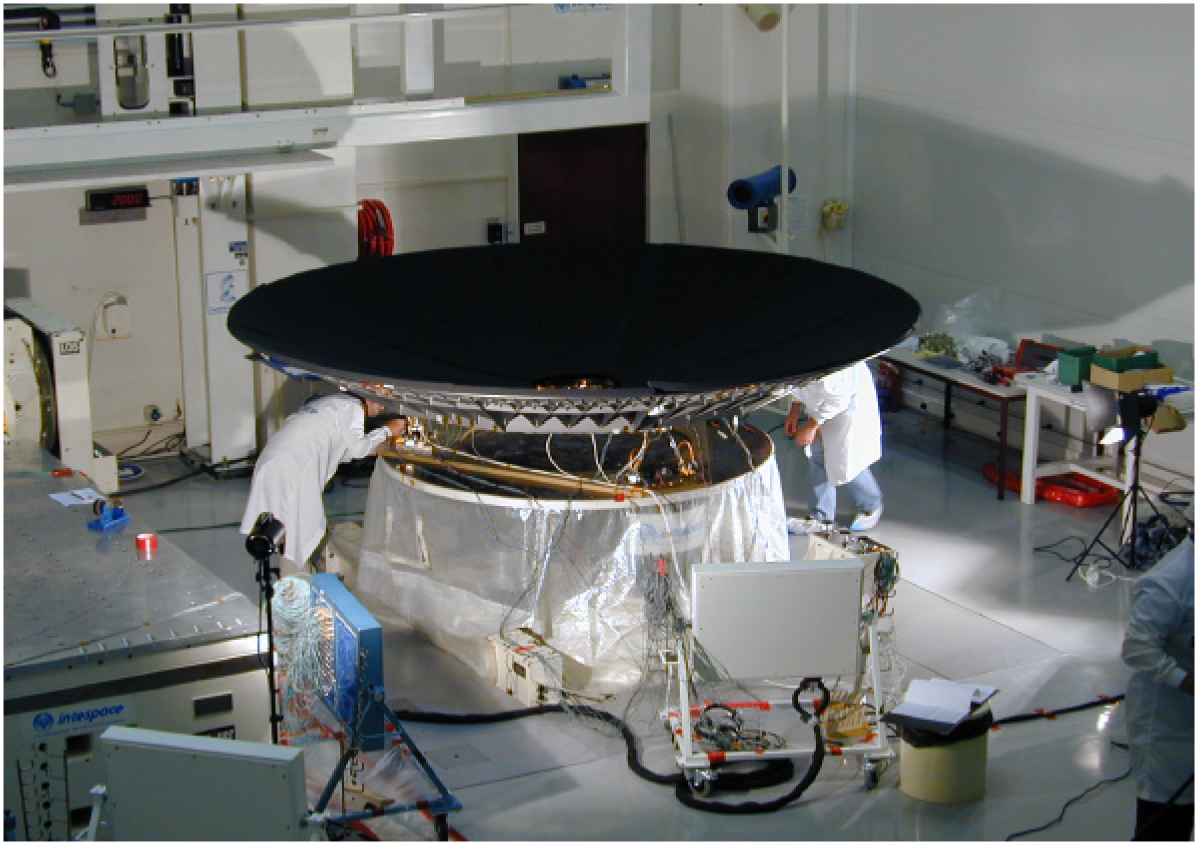
→ M1 and hexapod proof-tests successfully passed

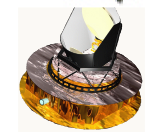
→ M1 coating qualification tests successful

→ M2 under manufacturing

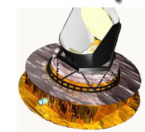
→ Optical GSE's under procurement



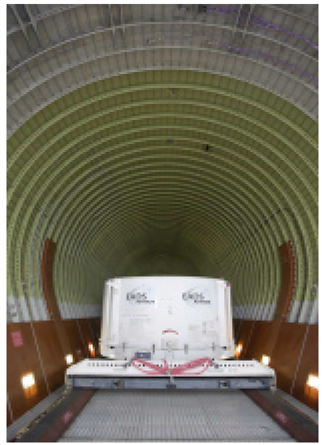


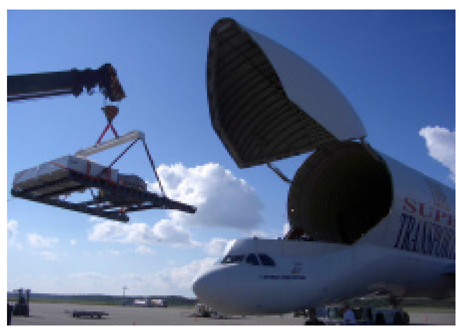


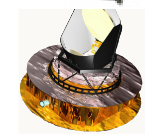
M1 Vibration Test at Intespace



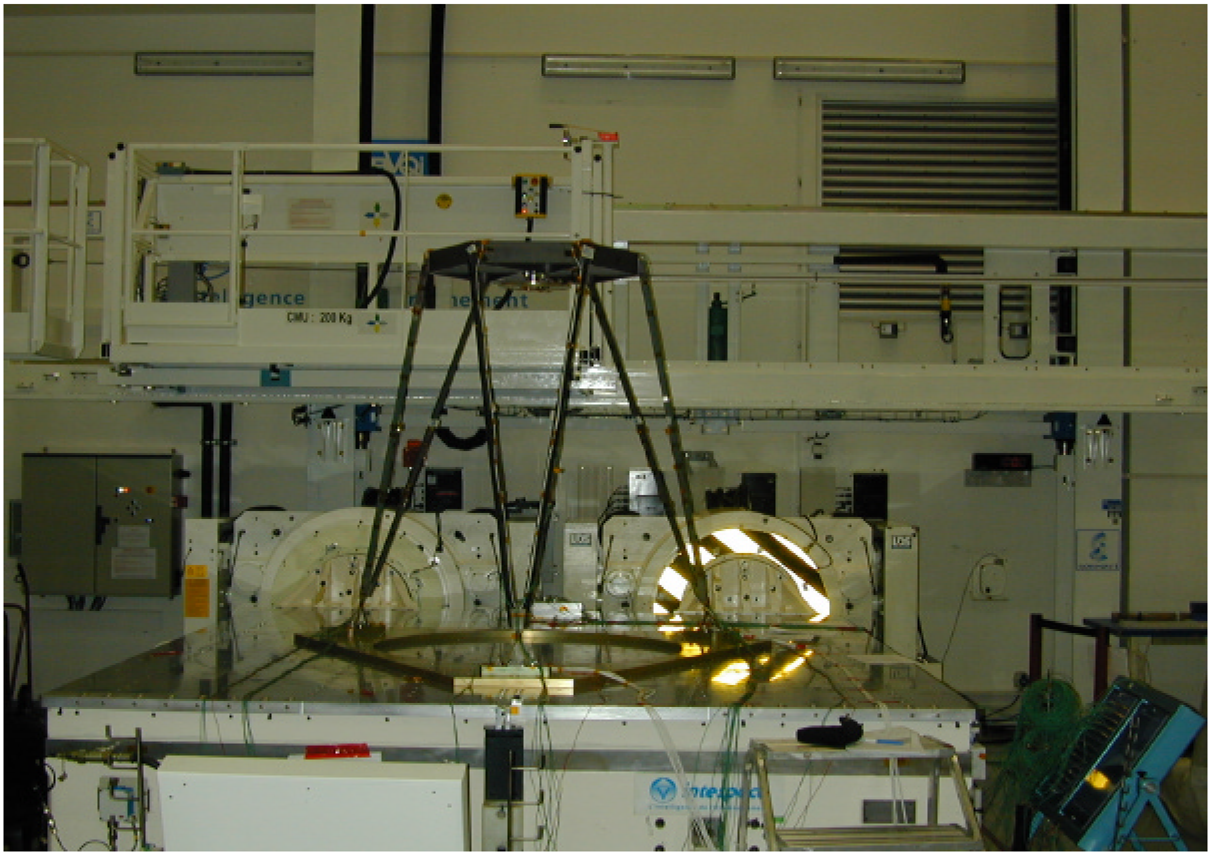
M1 Transport to Opteon (1/2)

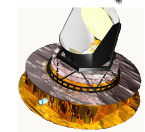




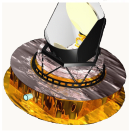


M1 Transport to Opteon (2/2)

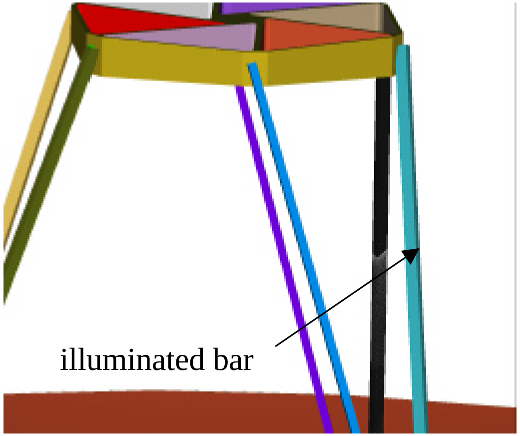




Hexapod Vibration Test at Intespace

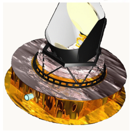


Sun Illumination Problem



Reflection of the Sun on the M1 leads to hot spots (~1000 solar constant for periods of 10-20 sec on some inner part of the hexapod legs

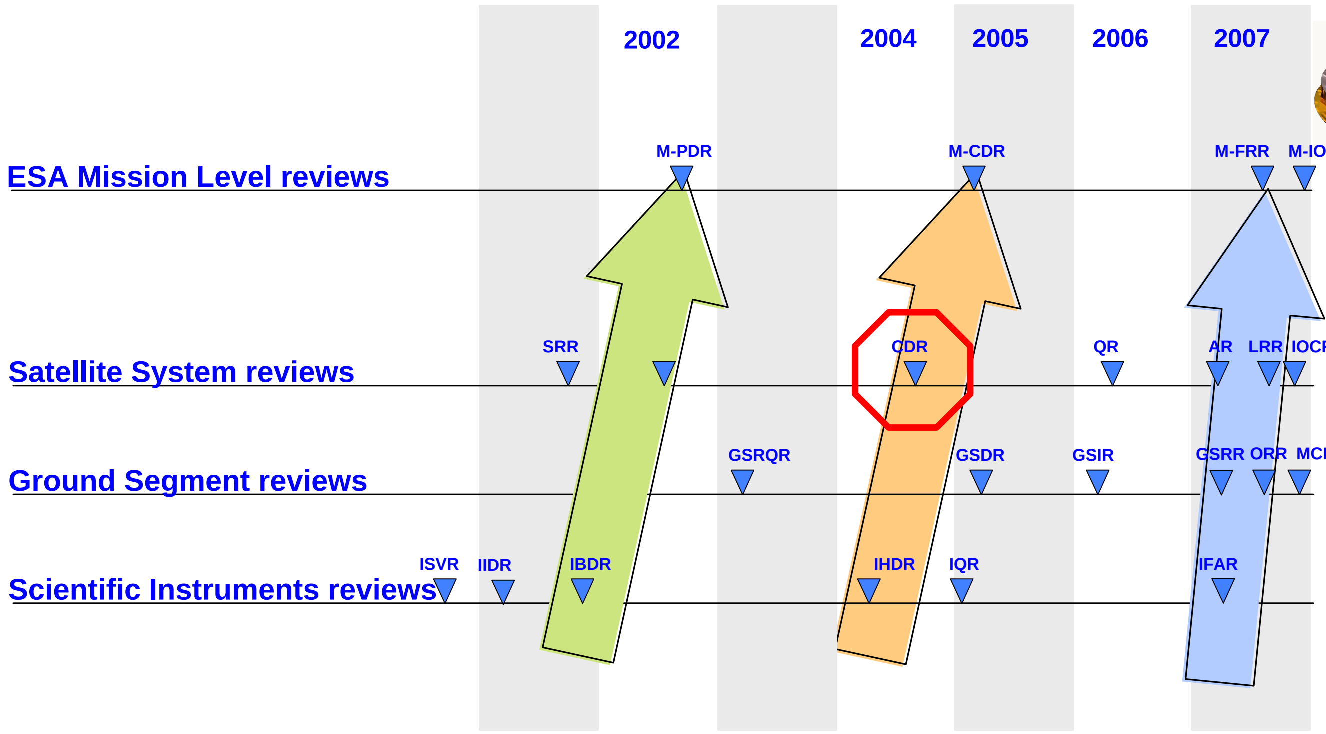
Replacement of VDA kapton foils around the legs by VDA kapton adhesive tapes with some perforations (taking benefit of SiC leg high thermal inertia and high thermal conductivity) → max predicted temperature locally at 180 C (far from any gluing point)

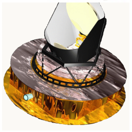


Herschel Telescope Status

- Interfaces to S/C consolidated and under configuration control
- Development going nominally with two technical issue to be tracked:
  - sun illumination problem on hexapod legs
  - Verification of telescope performance after system environmental test (M1-M2 distance verification)
- Program in schedule for a telescope delivery in July 2005

Herschel / Planck Programme Reviews





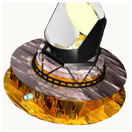
Herschel / Planck CDR

- Critical Design Review in 3 steps:

1. Planck Payload CDR (March / April 2004)
→ 194 RID's raised (81 classified "Major")
→ 71 RID's still open

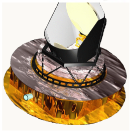
2. Herschel EPLM CDR (May / June 2004)
→ 332 RID's raised (101 classified "Major")
→ 26 RID's still open

3. H/P System CDR (Ongoing)
→ 631 RID's raised (308 classified "Major")
→ Co-location meeting this week at Alcatel



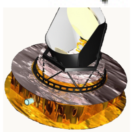
H/P System CDR

- Kick-off held at 17th August 2004 @ESTEC
  - ➢ Instruments have been involved / PI&PM invited to Kick-off
  - ➢ Limitted subset of documents available to HST)
- 631 RID’s raised (308 major)
- Co-Location: 27/09 – 1/10 @ASP
- Board Meeting and closure: 12th October 2004
- Launch delay announced at CDR Kick-off

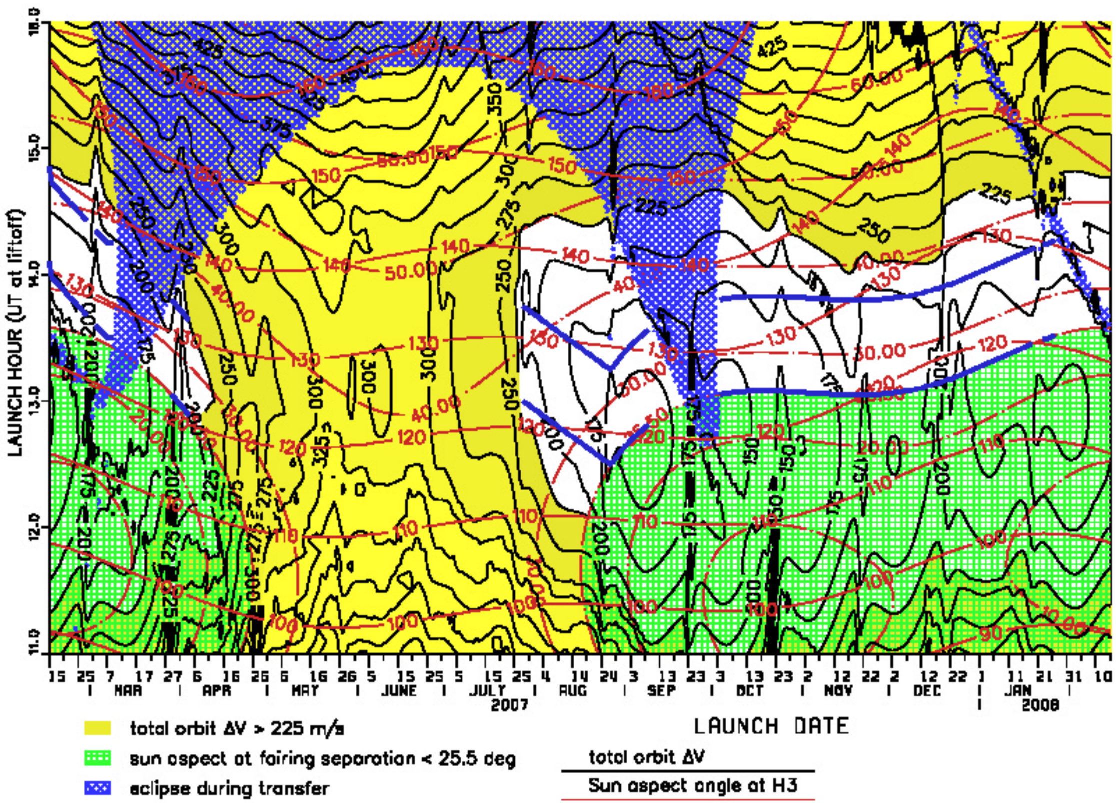


Launch Window Constraints

- Eclipse avoidance during injection and transfer
- Delta-V limitation for Planck orbit injection (<225 m/s)
- Sun impingement on the Herschel telescope:
  > 20 deg (+5.5 deg guidance accuracy)

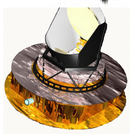


Launch Window



Launch →

3rd August 2007 (TBC)



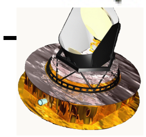
Evolution of Instrument Delivery Dates

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	
August 2004 (CDR)	After EQM tests*	November 2004	November 2005	November 2006**

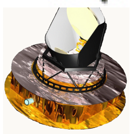
*** Last PI/PM Meeting: Proposal to perform limited AVM test already this year !**

**** To be clarified in detail**

Instrument Interface Management - Status



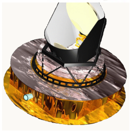
- Management Meetings held between ESA/Industry on a bi-monthly basis.
- Instrument I/F Meetings held every 2 Month between Instruments/ESA/Industry & Monthly Progress Telecons
- H/P IID-A v3.3 issued for CDR
- Update on going v3.4: Aim is to sign in October 2004
- Herschel IID-B's updates are on going
- DRB Procedure will be provided to Instrument teams soon



Instrument Qualification Review (1/2)

Objectives (Ref. IQR Proceedings, SCI-PT-27108):

- Confirmation of instrument hardware and software qualification
- Assessment of scientific performance and compliance with scientific requirements
- Completion of instrument design verification and compliance with requirements
- Identification and confirmation of improvements/modifications for FM
- Completion of OBSW design and demonstration of functionality
- Confirmation of EGSE design and demonstration of functionality
- Confirmation of instrument operability and User Manual



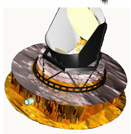
Instrument Qualification Review (2/2)

Steps:

1. **Kick-off Meeting (with Instrument presentations) and data package delivery**
   Location: ESTEC
2. **Document review phase with RID generation**
3. **Co-location meeting/teleconference with instrument to clarify/answer all RIDs**
   Location: Instrument premises
4. **Board Report**

Instrument	K.O. & Data Pack	RIDs to Instrument	Co-Location	Board Report
Herschel				
HIFI	07/12/04	17/12/04	11-12/01/05	01/02/05
PACS	25/11/04	13/12/04	20-21/12/04	19/01/05
SPIRE	16/11/04	26/11/04	09-10/12/04	11/01/05
Planck				
HFI				
LFI	22/02/05	04/03/05	09-10/03/05	18/03/05
SCS	28/10/04	22/11/04	02-03/12/04	17/12/04

Future Events



6.-7. Oct 04:	Quarterly Instrument PA Meeting @MPE
7. Oct 04:	SPIRE I/F Meeting @RAL
27. Oct 04:	SPIRE Progress Telecon #11
15. Nov 04:	Herschel instrument CQM delivery
16. Nov 04:	SPIRE IQR Kick-off Meeting @ESTEC
9.-10. Dec 04:	IQR Co-location @RAL
26. Jan 05:	Quaterly PI/PM Meeting @ESTEC (as part of HST Meeting)

Instrument Status

Eric Sawyer

Topics

- Progress since last consortium
- Present status
- Schedule
- Reviews
- Problem areas and risks
- Overall status

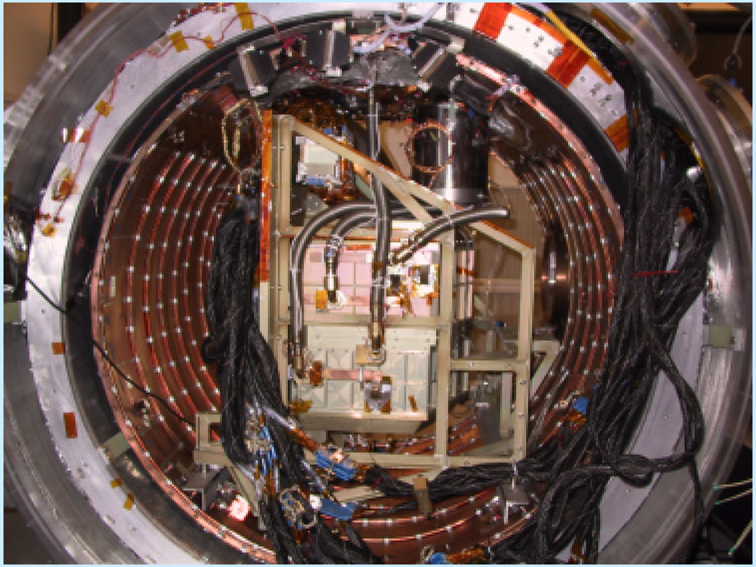
Progress since last consortium meeting

Cold Qualification Model (CQM)

- Following cold alignment
- Reconfigured to CQM
- CQM cooler fitted.
- PLW Detector fitted
- SMEC (STM) fitted
- Improved 300mK supports fitted
- CQM filters fitted.
- Harnesses fitted.

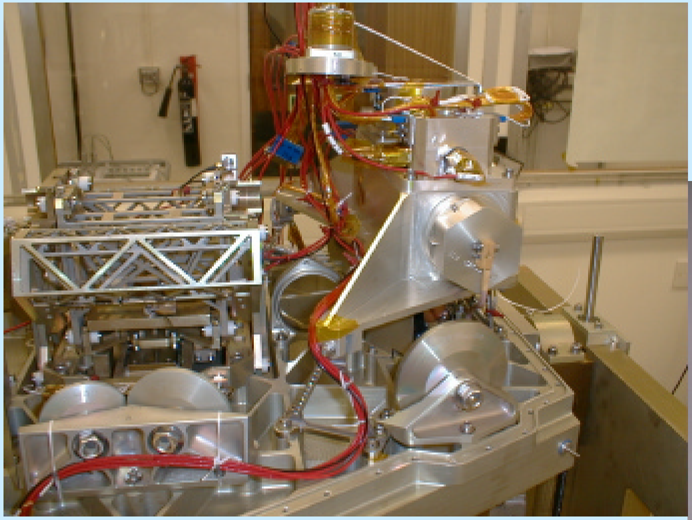
Cold Qualification Model (CQM)

- First cold functional and performance test
- Jan/Feb 04
- Only one detector thermally connected
- Reached 290mK at the detector.
- All worked ok.
- We learned a lot about operating the cryostat



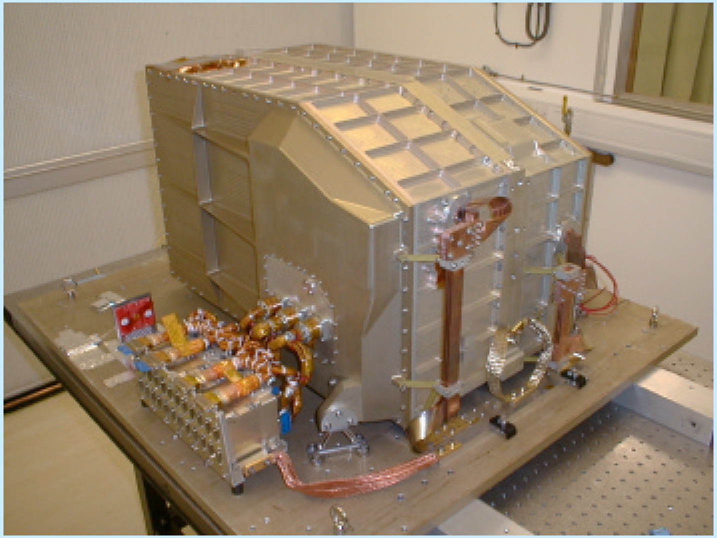
Cold Qualification Model (CQM)

- Cold vibration at CSL, March/April 04



Cold Qualification Model (CQM)

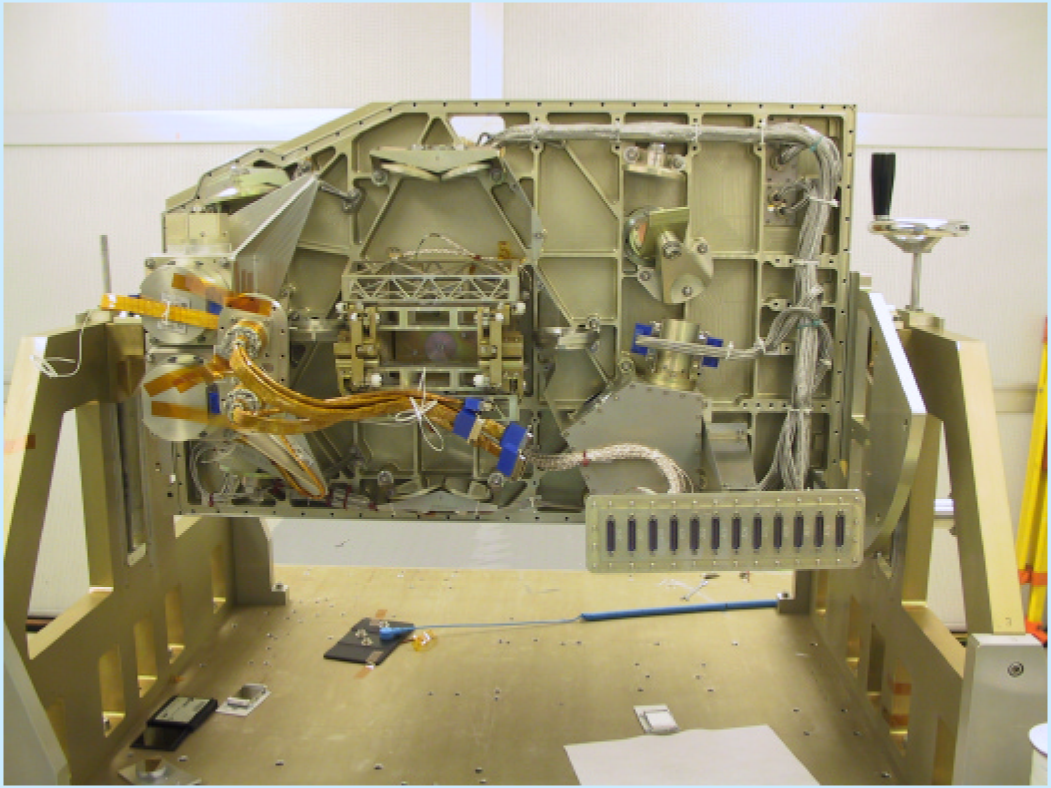
- Full qual levels notched to limit loads on delicate subsystems.
- Three axis
- Two cool downs
- 6 weeks activity split over Easter
- Post vibration inspection revealed no damage
- Post vibration cold functional and performance test now.



Cold Qualification Model (CQM)

- Modifications carried out to improve thermal performance
- 2K strap between the detector boxes improved.
- Material for 300mK system improved.
- Considerable work to improve the L0 straps
- Currently in cold test now.
- Full thermal configuration, all detectors connected, one real, four MTDs.
- Following current test we deliver to Astrium
- 15th November

CQM build



Proto Flight Model (PFM)

- We have been concentrating on the CQM
- But have progressed on the FM as well
- Optics integrated and aligned, well within spec
- Subsystems to be integrated when available
- First build will be spectrometer only, due to BDA availability.
- We are waiting for the SMEC and Cooler.
- First cold test planned for December
- Success depends upon timely subsystem delivery including documentation

AIV

- Test cryostat
  - 5 cool downs
  - One empty
  - four with load (dummy, alignment model, CQMx2)
  - Cool down procedure now well established
  - Minor modifications have been added
  - We can now control the L0 temperature
  - Helium usage much less than early runs
- FTS, telescope simulator, laser
  - Up and running since last September
  - Routinely used as part of the test equipment

Schedule

- CQM/AVM required delivery, 15th November 2004
- On schedule
- PFM required delivery 15 November 2005
- On paper we can do this, but
- Relies heavily on subsystem deliveries including documentation
- Assumes no major problems are encountered
- A long test and calibration period is required, support will be required.

Reviews

- Critical Design Review (CDR) held in July
- Internal review with independent panel members
- Release for FM manufacture
- Series of recommendations from the panel
- Instrument qualification review (IQR)
- November
- Instrument delivery review (DRB)
- November (TBC)
- Support from subsystems required, timely DRBs
- Subsystem EIDPs form part of the instrument EIDP

Major problems and risks

1 Schedule

- Some relaxation in delivery dates was announced
- New model philosophy has enabled us to deliver on time
- But still very tight

2 DRCU development plan

- Now more or less consistent with the rest of the planning.
- Still late delivery to spacecraft (2 months)

Major problems and risks

3 Thermal design.

- Was marginal
- High conductivity material supply was a problem, a lot of effort has been put into sourcing, processing and testing copper samples – good performance now expected.
- Development of electrically isolating joints.
- Improvement of thermal interface with spacecraft
- Change to CFRP feet
- Redesigned L0 straps
- Much modelling.
- Improved cooler performance
- We now have a workable thermal design, but still small margins

Major problems and risks

4 Overshield on cryoharness

- SPIRE grounding scheme requires overshielding on cryoharness inside CVV
- This requirement was not formally accepted by the ESA Project
- Practical discussions with industry and ESA have resulted in a workable solution

Major problems and risks

5 Funding

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

6 FTS Mechanism Vibration Qualification

This unit is still not fully qualified

Major problems and risks

7BDA Performance and Quality

Several problems over the last year, resolved now?

8 JFET Noise and Power Dissipation

Not fully resolved, more power required

9 Microvibrations

Early indications are good, detectors not sensitive.
More work to do, SMEC sensitivity still an issue

10 Spares

As money runs out the flight spare programme comes under threat

Overall status

- Not as far advanced as we would like
- Better position than PACS and HIFI
- We still have technical problems to overcome, probably
- But have made some real progress in recent months
- SM and AM programmes complete
- CQM almost complete
- PFM programme underway
- Several PFM subsystems delivered
- Success assumed programme - Timely Subsystem deliveries, Hardware and Documentation essential to a successful project

CQM Test Programme

Bruce Swinyard

SPIRE CQM Performance Tests

- Overview
- Tests split into three types:
  - Closed cryostat tests on detector performance
    - “Dark” testing with CBB off
    - “Loaded” testing with CBB on
  - Open cryostat “optical tests”
    - HBB with one arm of FTS blocked
    - HBB + FTS
    - Laser
  - Non standard configuration tests using external equipment
    - JFET-BDA harness tests
    - Microphonics tests

General Comments

- We managed to attempt every type of test listed in the performance test plan
- Communication within the team and to the outside world worked well – few if any "handover" problems
- Good support from sub-system teams
  – gold stars to CEA-SAp; CEA-SBT and JPL
- Special mentions also to Sarah Leeks as ESA support person and Bernhard Schulz as IPAC support person
- Basically the instrument works and the test facility does what it should do – some quibbles
  - The in-ability to reliably run command scripts caused problems early on but we got around it
  - The QLA worked well – getting the data out after the fact was a bit tedious but o.k.
  - The CBB did not run cold enough
  - The lack of reliable information on the LHe level caused some problems
  - Fire alarms in the middle of LHe transfers are annoying!

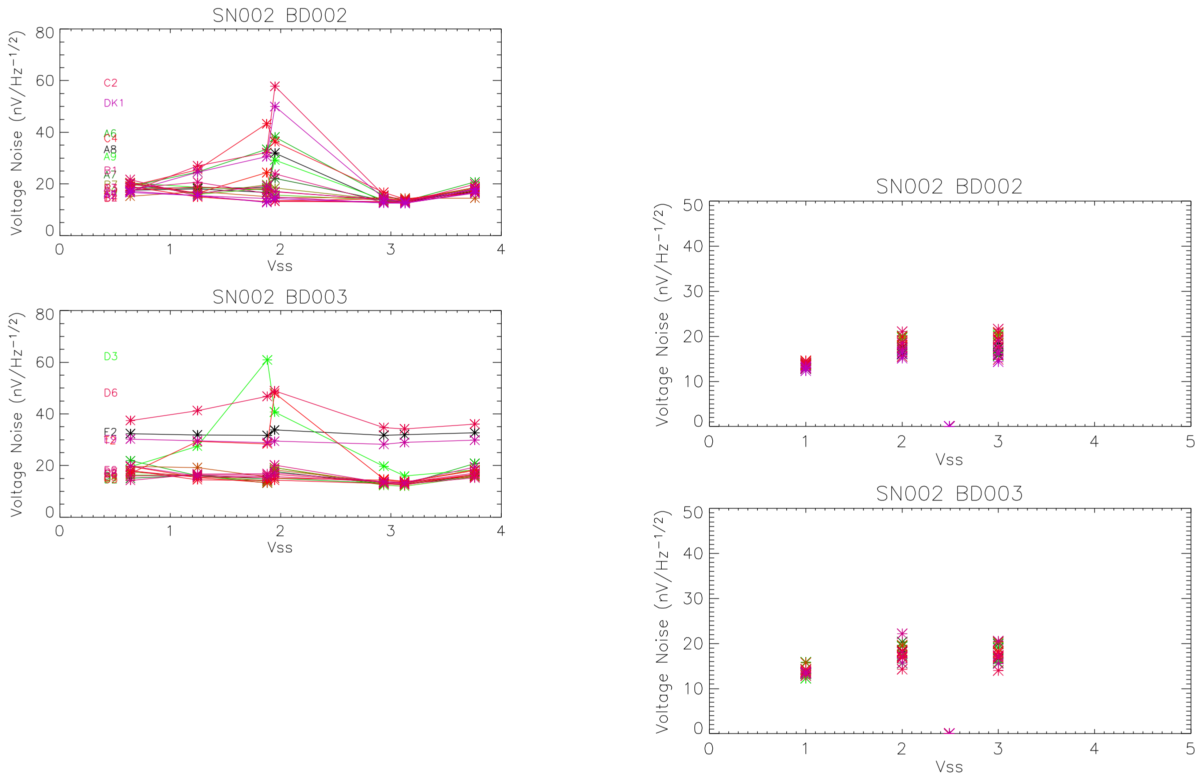
Detector Characterisation

- Photometer JFET shorted input tests
- Biased Detector Noise
- Shorted Noise Tests on Spectrometer STM-JFETs
- Loadcurves
- Optical Efficiency
- Frequency Response Test
- Linearity

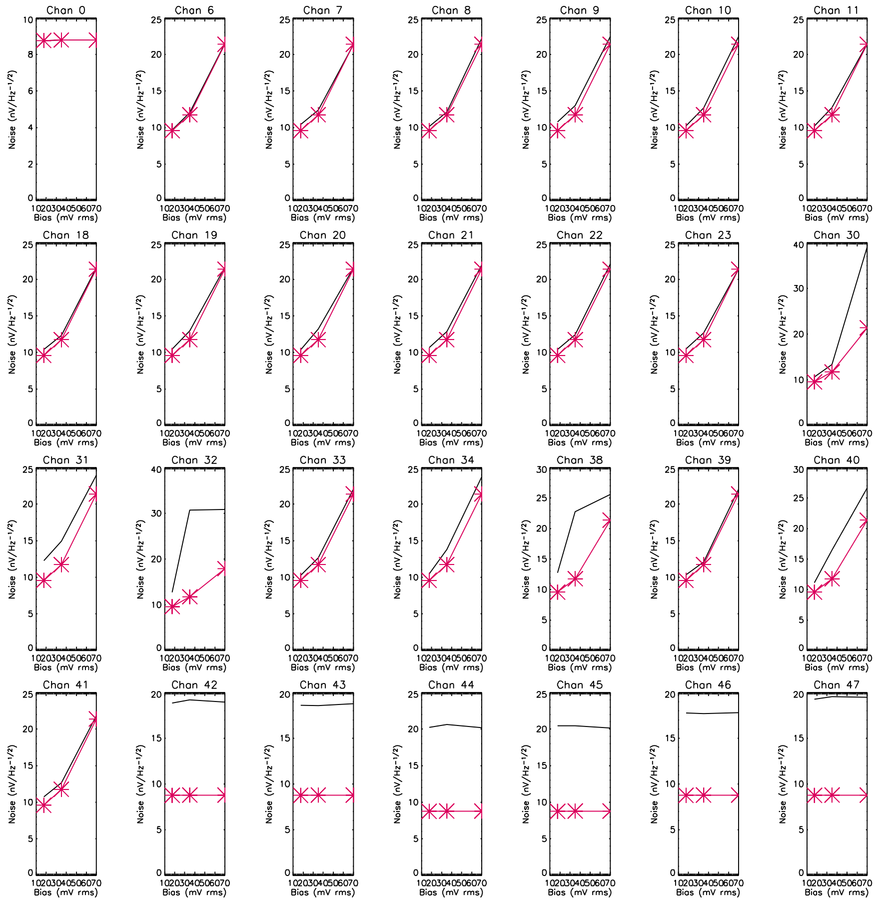
Noise

- Shorted JFETs
  - Detectors warm (~1.7 K) therefore input to JFET shorted
  - Measure noise as a function of JFET bias (V_{ss})
  - Noise dominated by DCU and possibly pick up as harness not in correct configuration
- STM JFETs
  - STMs have representative resistor network allowing noise as a function of applied detector bias to be checked in absence of detector noise
  - Noise increases as a function of bias due to known problem in offset circuitry
- Detectors at operating temperature
  - Ultimate test of system – carried out with and with shorting links in harness
  - Noise is reduced when extra outer shield is in place
  - No new noisy pixels!

Shorted JFETs
With GSE and EM PSU



STM JFETs


Chan 0
Chan 6
Chan 7
Chan 8
Chan 9
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Chan 20
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Chan 30
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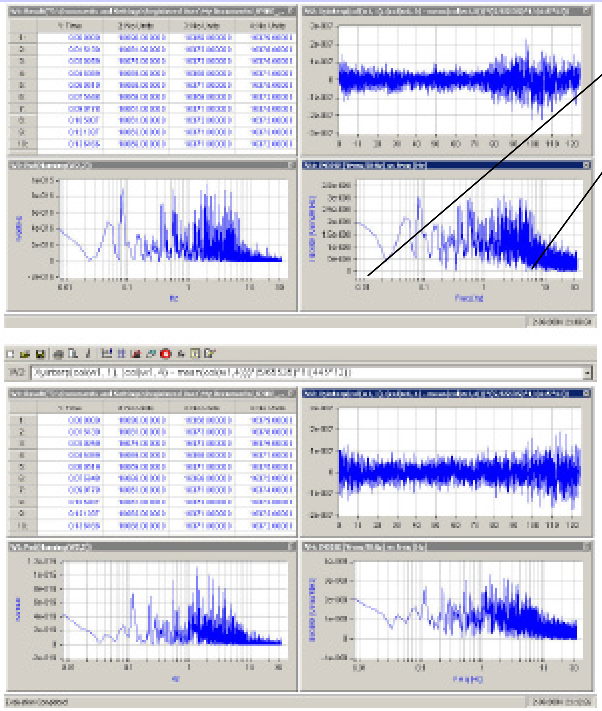
Chan 33
Chan 34
Chan 38
Chan 39
Chan 40
Chan 41
Chan 42
Chan 43
Chan 44
Chan 45
Chan 46
Chan 47
Noise (nV/Hz^-1/2)
Bias (mV rms)

Noise Spectra

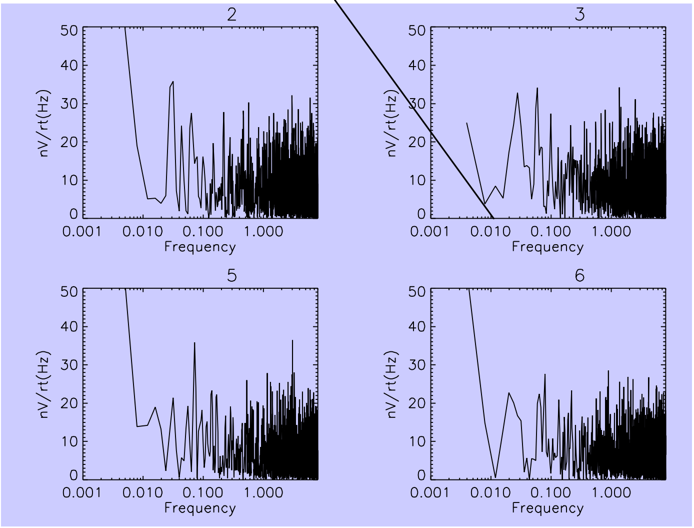
Shorted inputs – Hristov styley



10 mHz

5 Hz

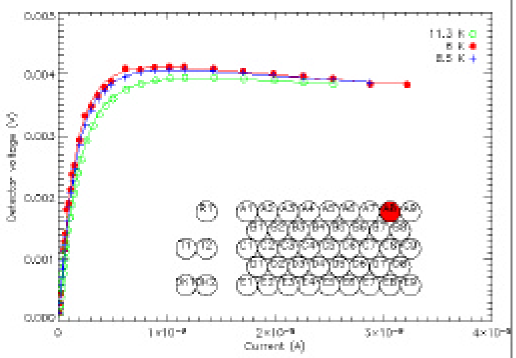
Dark detectors – Swinyard styley



Loadcurves

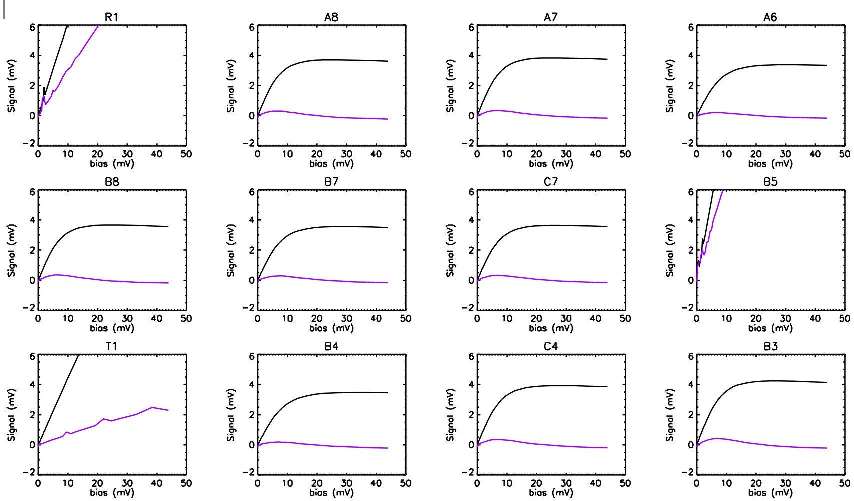
- Loadcurves – power vs temperature measurements were made on the detectors under different bias and optical load conditions
- CQM loadcurves are done with AC bias – comparison with JPL DC loadcurves is - still tricky…
- Difficulty with getting the gounding correct means we have an unwelcome offset that varies with bias – still havent got a decent DC loadcurve

AC vs DC loadcurves

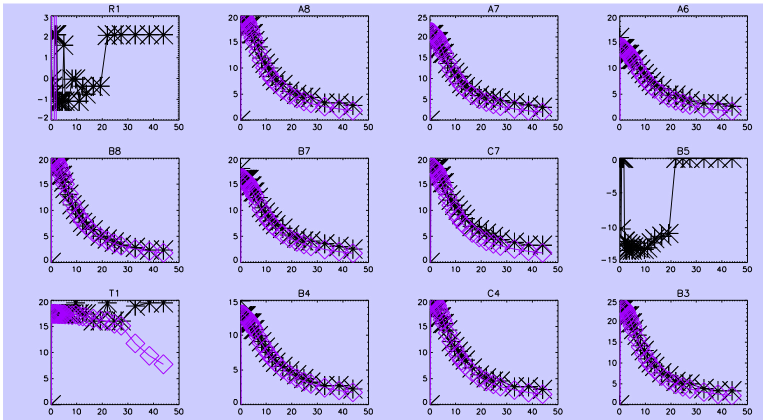


Example of loadcurve taken at RAL with different optical loading

Example of loadcurves taken at RAL with phase set at peak and at 90 degrees wrt to peak



AC vs DC loadcurves

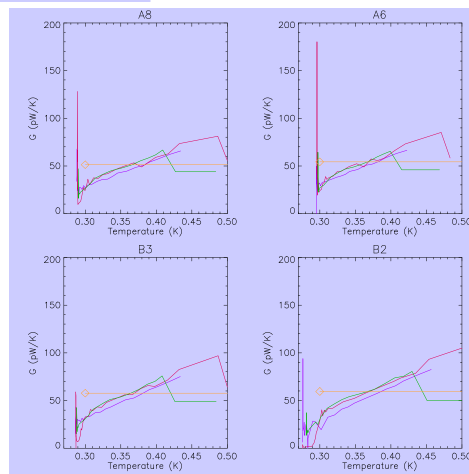


Numerical fudging can convert phase to predicted R and compare to R calculated from JPL unit test calibration

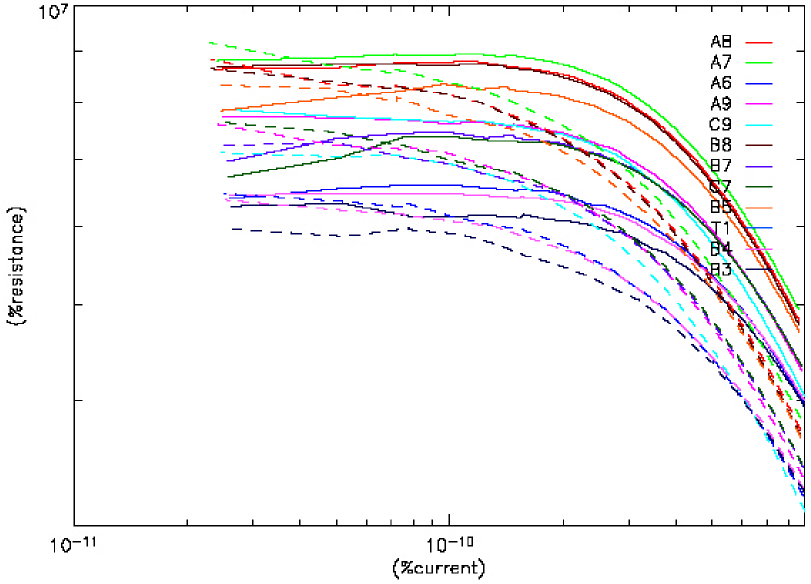
(Using R* and Tg)

But it still doesn’t quite stack up?

Here is predicted G0

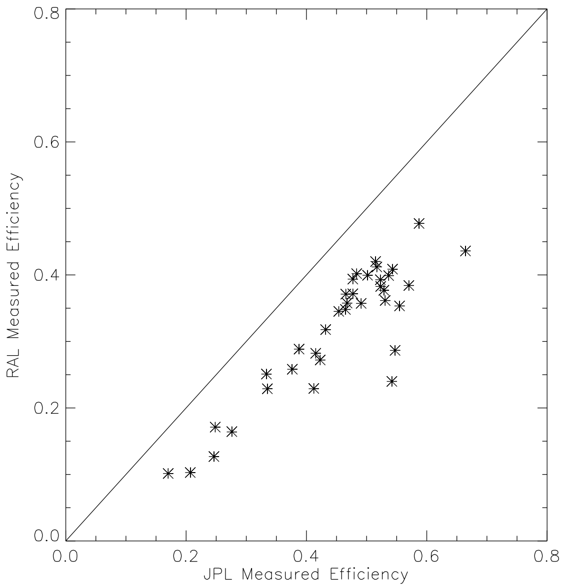


New DC load curve results analysed by Adam

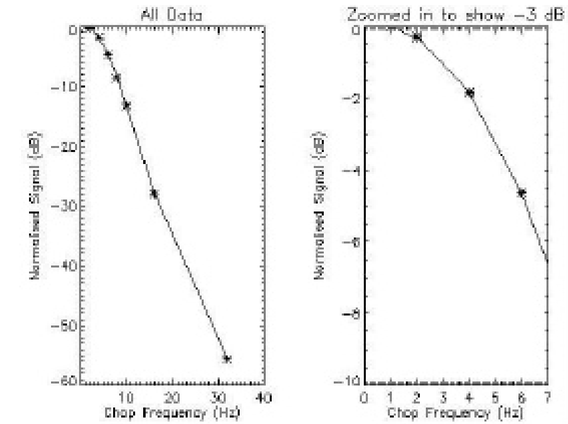


Optical Efficiency

- **Comparing difference between optical load with 11.5 and 8 K CBB we can deduce optical efficiency of BDA**
- **Comparison with JPL shows similar pattern across array but offset amounting to ~20%**



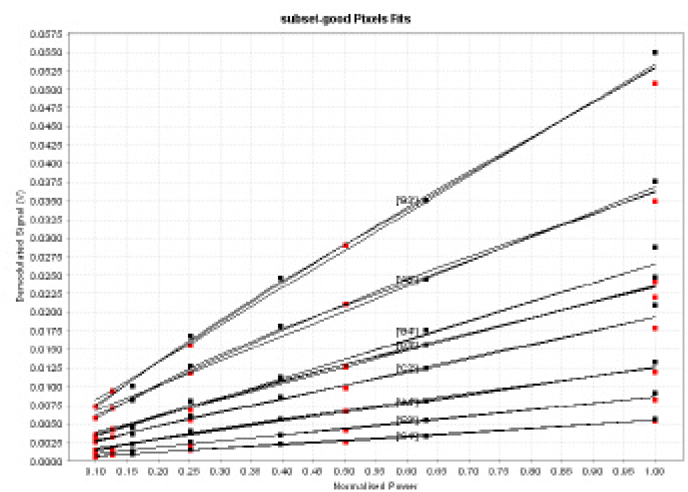
Frequency response and linearity



Optical frequency response checked using external chopper – looks about where expected? Detailed comparison to model now needed

Linearity check carried out with too much power!

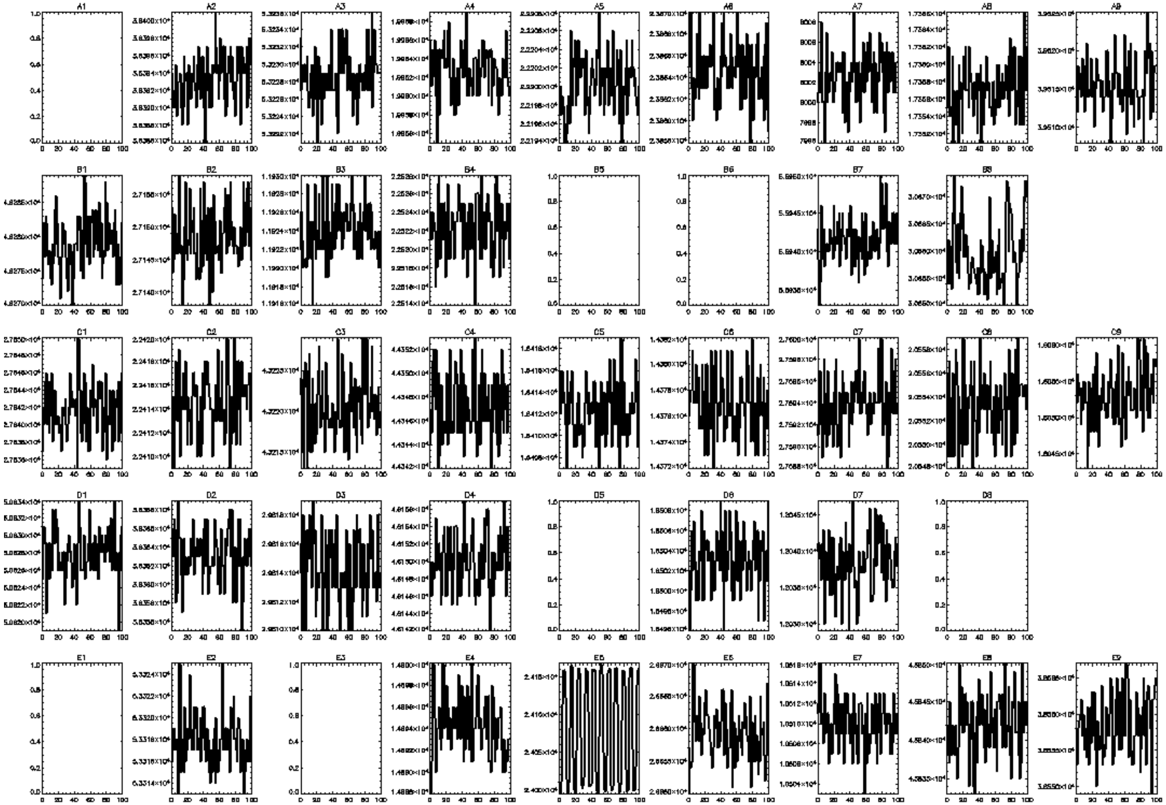
Will repeat during current test – laser much better controlled power now



Optical Tests

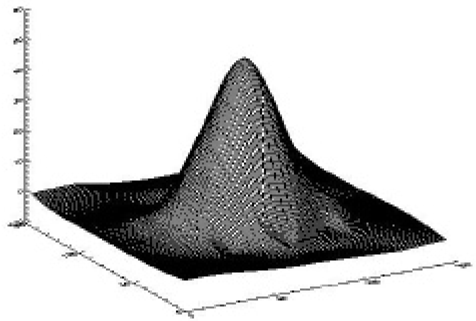
- Optical Cross Talk Test
- Pixel Centre
- PSF Test
- Focus Test
- Pupil Test
- Spectral Response
- Polarisation

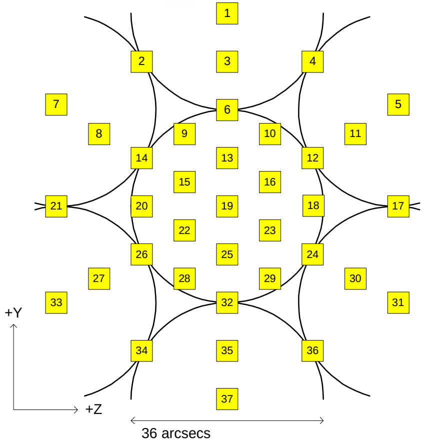
Cross talk check



Centring, focus and PSF

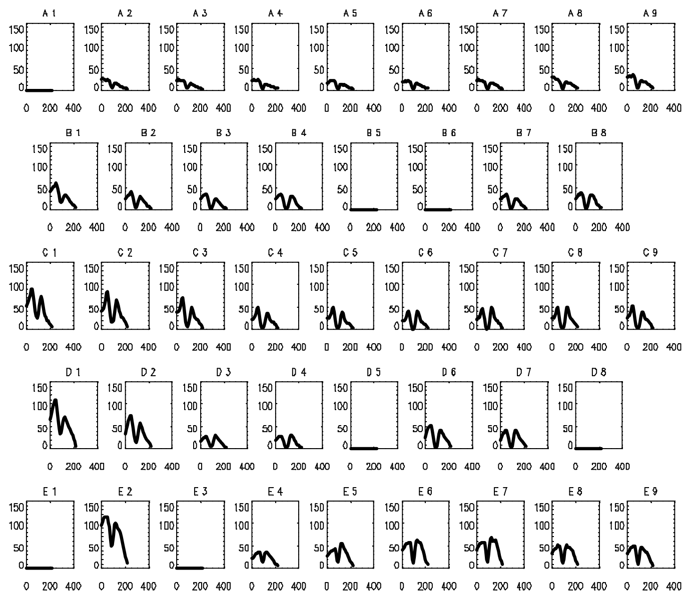
- Centre checking procedure exercised o.k. – relative centres of pixels not fully evaluated as yet
- The depth of focus was very large…as expected
- PSF procedure carried out o.k. using HBB – average FWHM ~37.3+/-1.9 arcsec
- We expected ~33.8 arcsec from measurements of simulator using laser.
- Possible misalignment within the system somewhere?





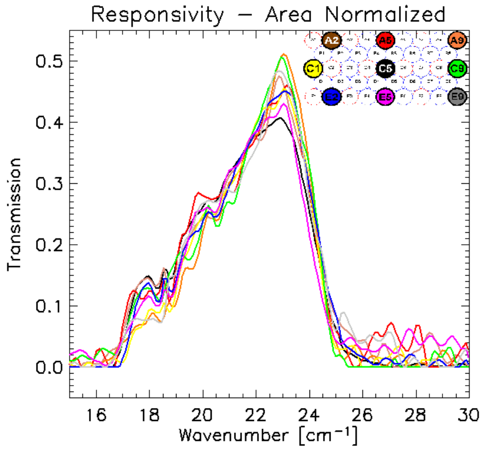
Pupil test

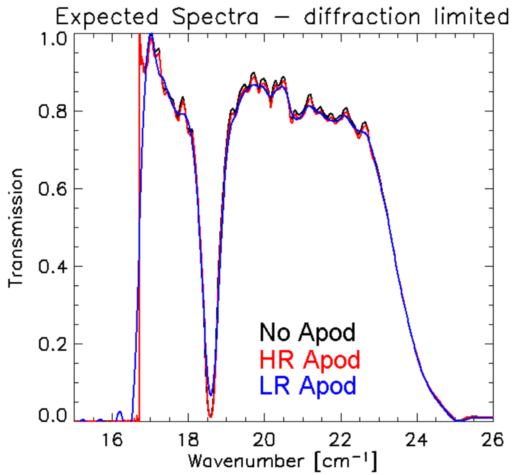
- The one disappointment of the first test campaign
- Combination of not knowing what to expect and not properly aligning telescope simulator for this specific test
- Will repeat using laser this time – we have proven the ethod using a broad band 4-K detector



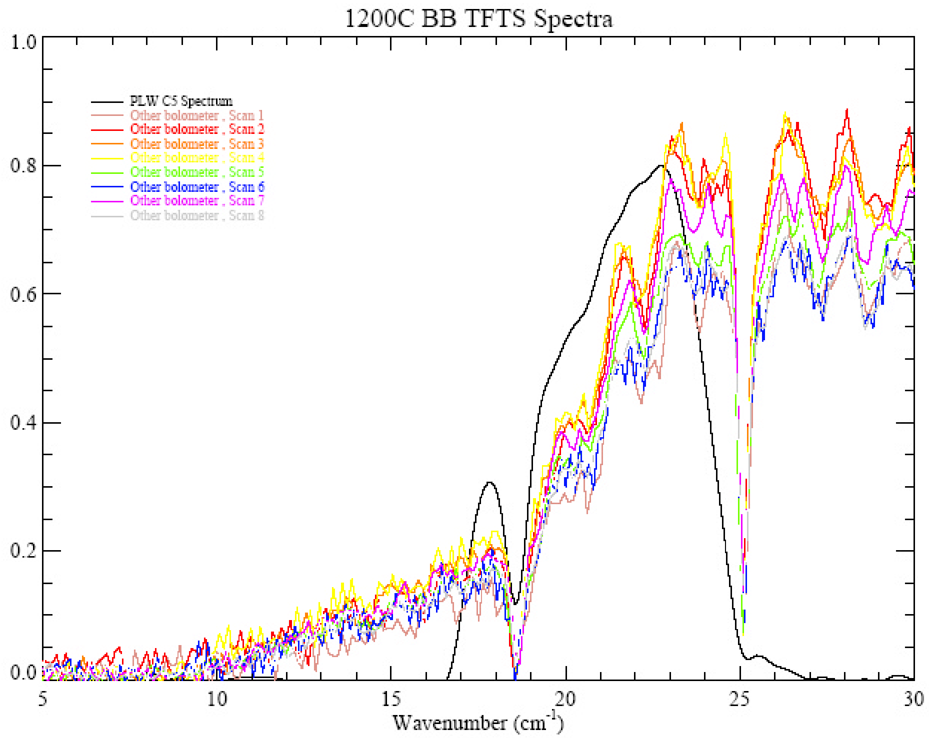
Spectral response

- Test FTS worked very well – air path not dry enough or stable enough
- However we have results with good enough S/N that we know we don't understand something
- Using 4-K bolometer we have shown that the spectral shape at 18-20 cm^{-1} are instrinsic to the TFTS+Hot black body system

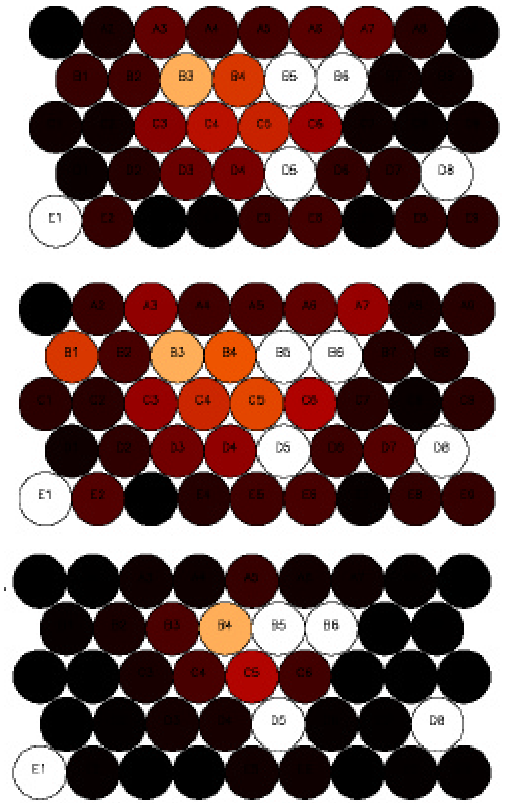




Lab spectra


1200C BB TFTS Spectra
PLW C5 Spectrum
Other bolometer , Scan 1
Other bolometer , Scan 2
Other bolometer , Scan 3
Other bolometer , Scan 4
Other bolometer , Scan 5
Other bolometer , Scan 6
Other bolometer , Scan 7
Other bolometer , Scan 8
1.0
0.8
0.6
0.4
0.2
0.0
5
10
15
20
25
30
Wavenumber (cm-1)

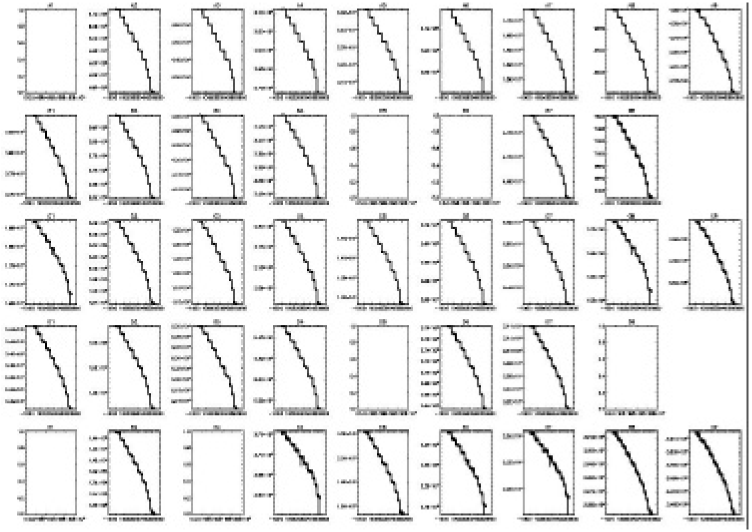
Laser Tests

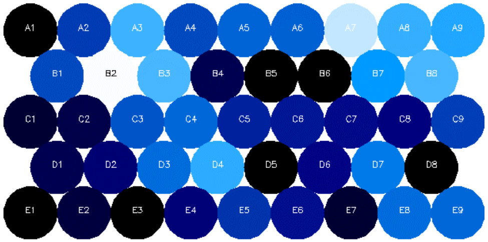


- **Laser intensity was very much too high**
- **Only during polarisation test did the power get turned down sufficiently to see something reasonable**
- **Test shows up straylight glint**
- **Laser power now better controlled using a combination of absorber (everywhere) and polariser to control power**

PCAL Tests

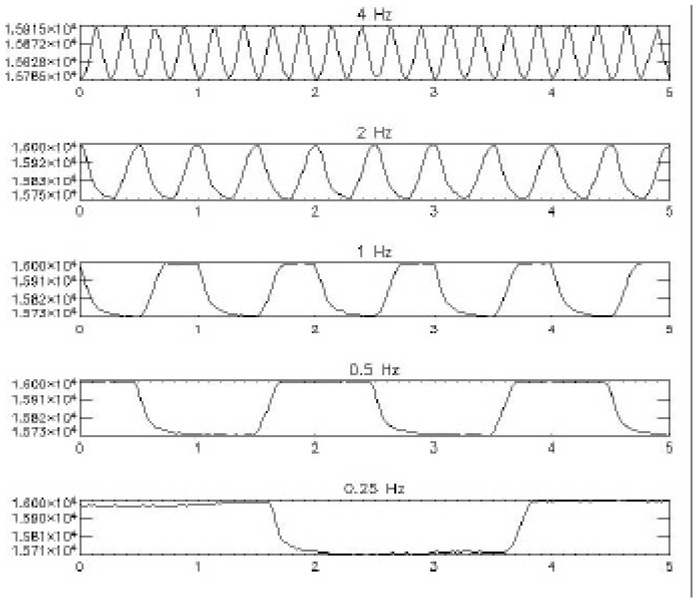
- PCAL Level Response check showed entire array does respond and signal level is good
- Flat field looks slightly different to expectation





PCAL Tests

- PCAL Frequency Response tested ability to command PCAL in “chop” mode
- Thermal response of CQM PCAL was slower than required for flight as expected

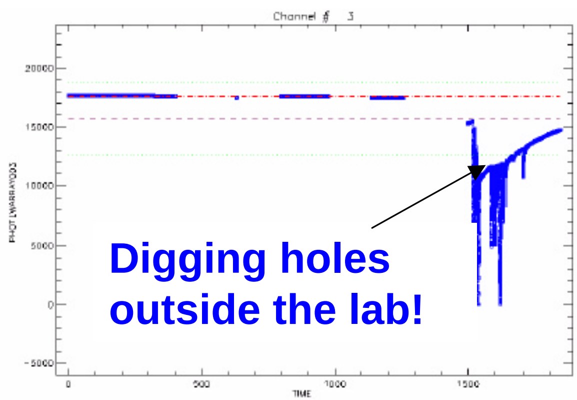


Harness Tests

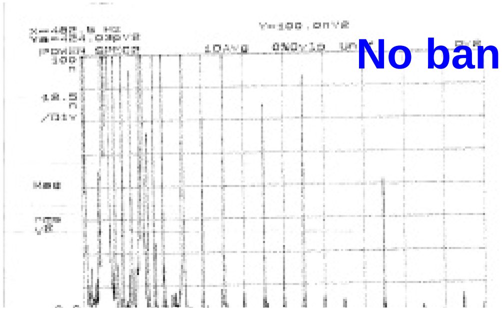
- Tests on the harness and microphonics were carried out by Jamie and Viktor using mixture of GSE and QM1 electronics
- Microphonics test
- Cable RC rolloff test.

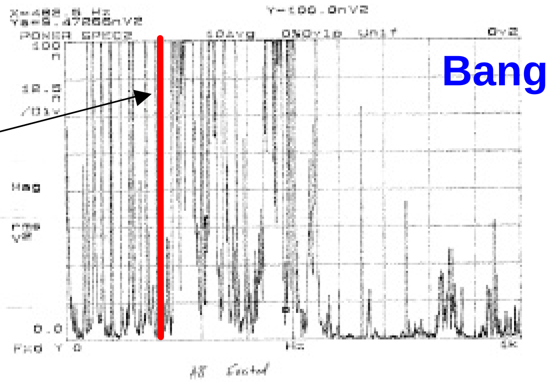
Microphonics Tests

- Microphonics test done with DC biased detectors and H-P spectrum analyser with "calibrated mechanical impulse"
- We now have a proper transducer system and will repeat these measurement quantitatively



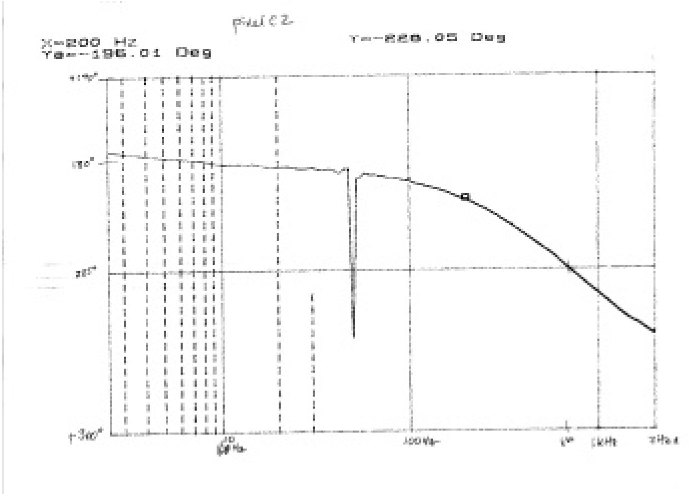
Main microphonic response above ~200 Hz

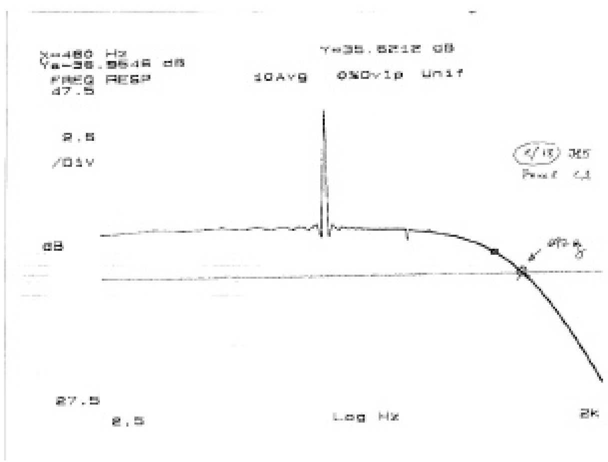




Microphonics Tests

- Rolloff test done with H-P spectrum analyser with chirped bias applied through redundant side harness
- Results show harness C ~ 45 pF





Thermal Balance Tests

- **Done correctly over the last two weeks**
- **Manostat fitted to allow L0 temperature to be controlled to 1.7 K**
- **Much better internal cold straps for L0 stage**
- **All detectors connected to 300 mK system (c.f. one last time)**
- **Cooler held for ~50 hours when L0 held at 1.7 K – held for <24 hours when L0 was at 2 K**
- **DeltaT down strap appears to be ~60 mK – but it's a bad strap**

Tests Not Done (last time)

- Straylight Test
  - Sort of done with laser – now we know how it works we can try again
  - Also we can attempt the scan beyond the edge of the pupil test
- Out of Band Radiation Test
  - Should have been done with laser – again now we know how to do this properly
- EMC Tests
  - Not really attempted – we are now set up for a test during this campaign

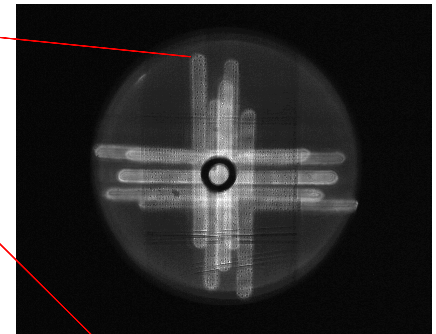
PFM Programme

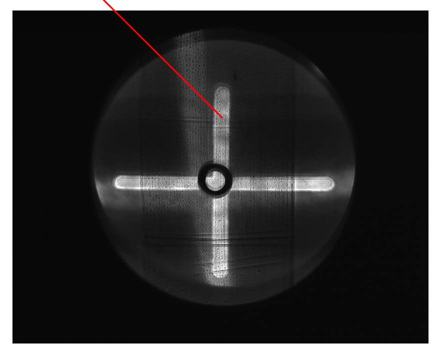
- PFM2 will only be the spectrometer using QM SMEC
- Integration has started and alignment is complete with no problems
- Awaiting delivery of SMEC; Cooler and some CFRP feet.
- Plan to start test before Christmas
- PFM2 is the real flight instrument – assembly starts following PFM1 test in the new year.

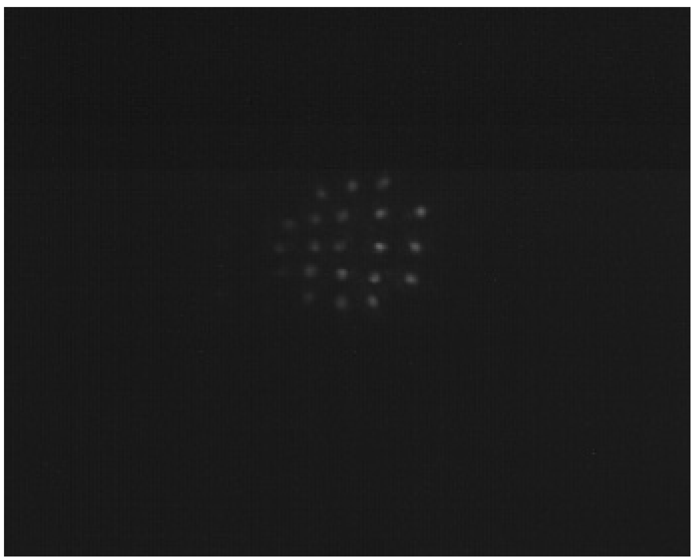
PFM Alignment is very good

All points across photometer well aligned

Spectrometer and photometer co-aligned







Time Allocation:
Rules, Proposal guidelines, Schedule

SPIRE Consortium Meeting
RAL, 28-30 September 2004

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

http://www.rssd.esa.int/herschel

Time allocation

- **Generalities**
- **Rules**
- **Proposal guidelines**
- **Schedule**

http://www.rssd.esa.int/herschel

Herschel mission phases

- **Launch and early operations (LEOP)**
- **Commissioning and performance verification (SC + payload)**
- **Science demonstration phase**
- **Routine science operations phase (36 months)**
  - **Guaranteed time programmes – GT (32%)**
    - open for GT holders only
  - **Open time programmes – OT (68%)**
    - 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 observing - generalities

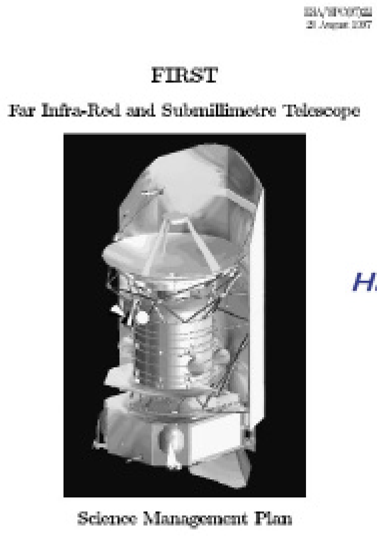
- **Top level considerations**
  - overall goal is to maximise science return and impact
  - Herschel is a strictly consumables limited mission
- **Herschel to a certain degree its own pathfinder**
  - follow-up observations must be feasible (data reduction, scheduling)
  - concept of 'Key Project' programmes upfront
- **Three years of 'routine science operations' available**
  - LEOP, commissioning, PV, science demonstration, initial 6 months
  - followed by 3 years of 'routine science operations'
  - approx 1000 days / 20000 hours schedulable time available
- **Data rights**
  - first year of routine science operations 12 months - then 6 months
  - non-routine phase observations - none (but overlap mechanism)
- **All observing proposals – including for GT programmes – will be assessed by the Herschel Observing Time Allocation Committee for scientific merit**

Herschel ‘Key Projects’

- **Foreseen to be important upfront (SMP/instrument AO)**
  - introduced to ensure that ‘unusually large’ observing programmes can be proposed, selected, and observed
  - need ‘pre-identified’ due to the nature of the foreseen science objectives and the lack of ‘precursor’ (IRAS-type) mission
- **Definition of a ‘Key Project’ programme - it must**
  - exploit unique Herschel capabilities 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 reduction**
  - it is recognised that there is a legitimate science return interest that
    - the data generated by the observations are timely reduced, and
    - the data products and tools are made public
  - therefore ‘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

Rules

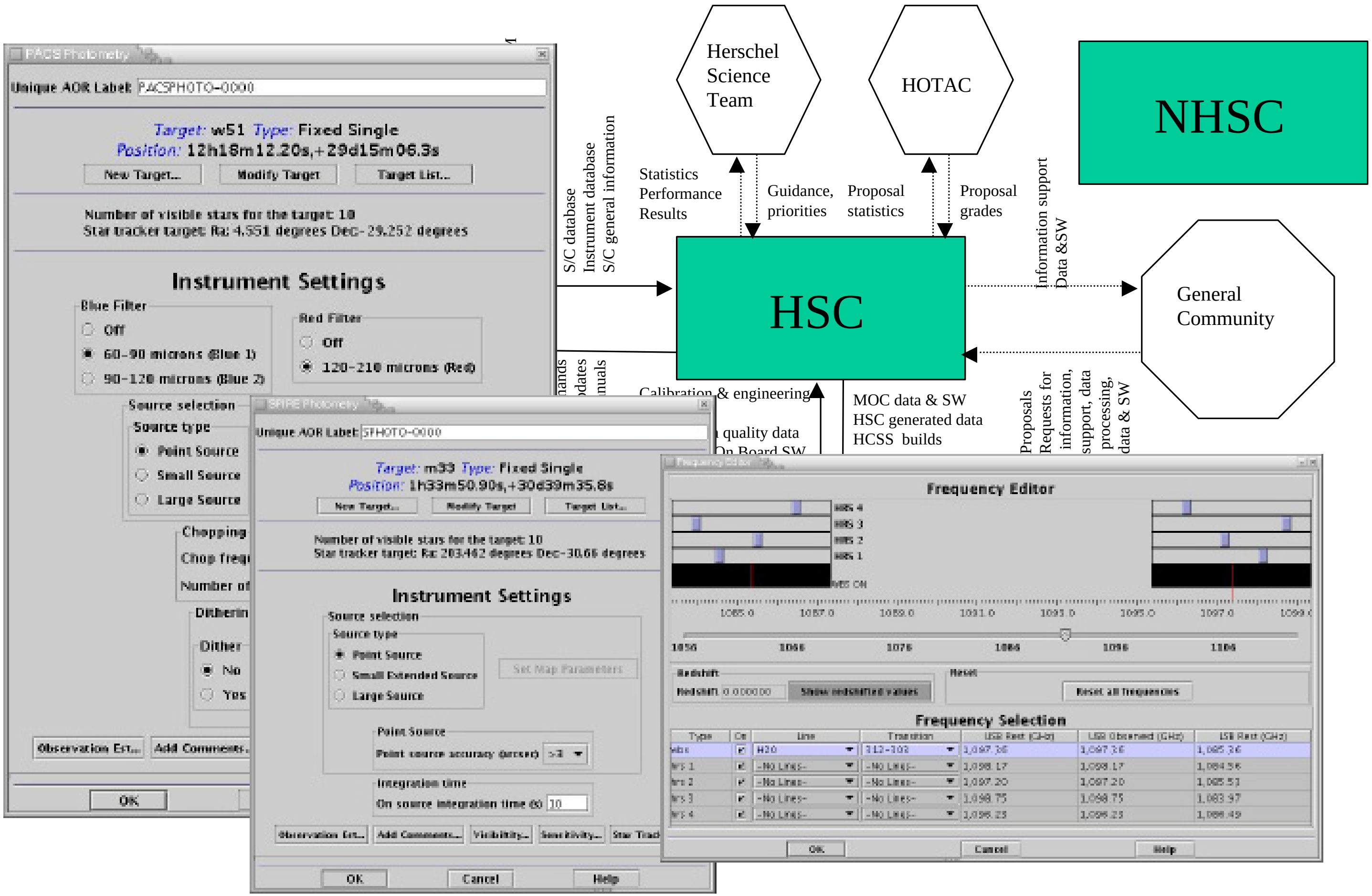
- **SMP**
  - issued 1997
  - SPC approved
  - basis for AO
- **Observation Programmes document**
  - elaborating on SMP
  - AWG approved
  - issued 2004
- **Available on web**
  - ‘community info’
- **Basis for updated SMP**
  - to come



Proposal guidelines

- **Not yet in place**
- **Expect no surprises**
  - do not want/intend to reinvent the wheel
  - but we do want to tailor a good wheel for our needs
  - currently taking inventory of a number of potential 'model' missions (ISO, Spitzer, XMM, Integral, ESO)
- **Data products for KPs**
  - enable follow-up
- **To be discussed in next HerschelST#20**
  - next week

Ground segment



http://www.rssd.esa.int/herschel

Schedule

- Generic schedule timeline in Obs Prog doc

Timeline exercise – (1)

- **Logic: Issue 'Call for Proposals' (AOs) as late as possible**
  - for pure scientific reasons
  - and for performance knowledge reasons
  - but early enough for observers to prepare
  - and 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 in-orbit operations**

Timeline exercise – (2)

- **L: Launch followed by and in-orbit operations**
- **L + 5 mths: Science demonstration workshop & optimisation of observing programmes**
- **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**
- **Subject to optimisation!**

Schedule

- **Generic schedule timeline in Obs Prog doc,**
- **but it needs optimisation based on**
- **overall science return**
  - other results (as late as possible)
  - and readiness (early enough)
  - ‘decouple’ from launch date
- **We did announce initial call ‘summer 2005’**
- **Likely to be ‘winter 2005/2006’**
- **To be discussed in HerschelST#20**


• Herschel is happening now!
• Expect ‘Key Progs’ AO in TBA
• http://www.rssd.esa.int/herschel
• formerly: http://astro.esa.int/herschel
esa
HERSCHEL

Timeline exercise – (3)

- **For illustration purposes:**
  - assume GT holders spend 60% (50-100% allowed) on KPs
  - assume 40% (TBD) of OT allocated to KPs

- **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

SPIRE Instrument Performance Update

Matt Griffin

Sensitivity Models

- **Figures presented at Porquerolles meeting were based on sensitivity estimates detailed in *SPIRE-QMW-NOT-000642* Issue 3.0 (IHDR version) + updated FTS model**

- **New version near completion**
  - **Various revisions and corrections**
  - **More detailed and consistent treatment of**
    - **Thermal system and detector system performance**
    - **Observing overheads (nodding,scanning)**

Nominal Assumptions

• Telescope temperature (K)	80
• Effective telescope emissivity	0.04
• Feedhorn/cavity efficiency	0.7
• Bolometer R_o (W)	100
• Bolometer temperature (mK)	320
• JFET noise (nV $Hz^{-1/2}$)	10
• Bolometer yield	0.8
• Overall inst. transmission	0.4
• Global Observing efficiency	0.85

No degradation from microphionics, EMI, crosstalk, etc.

Revised Sensitivity Estimates

Photometer: New, Porquerolles values

Band		PSW	PMW	PLW
ΔS(5-σ; 1-hr) mJy	Point source (7-point)	2.7 3.3	3.5 3.6	4.2 3.9
	4’ x 4’ jiggle map	10 13	12 15	13 18
	4’ x 8’ scan map	7.6 8.0	9.2 9.7	10.5 11.2
Time (days) to map 1 deg.^{2} to 3 mJy 1-σ	Nominal case	2.1 1.9	3.0 2.8	3.9 3.7

FTS: New, Porquerolles

(Assuming no continuum subtraction)

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 or sparse map	5.9 7.6	5.5 7.1	5.5 - 7.7 7.1 – 9.9
	Fully-sampled map	20 23	18 21	18 – 26 21 - 29

Low-resolution spectrophotometry Ds = 1 cm^{-1}				
l mm		200 - 315	315 - 500	500-670
DS (5-s; 1-hr) (mJy)	Point source	200 250	180 240	180 – 260 240 - 330
	Fully-sampled 2.6' map	530 750	490 700	490 – 690 700 -980

Scan-Map vs. Jiggle-Map

- Basic sensitivity in scan-map mode is better than in jiggle-map mode
  - No nodding overhead
  - No chopping efficiency factor
  - Field of view is bigger by factor of 2
- These advantages offset the disadvantage of slow telescope turn-around
- Based on current assumptions, scan-map could be competitive with jiggle map even for small areas (~ size of SPIRE field)
  - Trade-off depends on detailed performance of the complete system
  - But figure of 40 arcmin as miimum scan map size quoted previously is too high

Sensitivity Model: Plan

- Sensitivity Model (Issue 4) to be released (for November IQR)
  - MathCad worksheets for Photometer, FTS, and appendices
  - Explanatory document
- Document to be reviewed in detail by consortium and experts (instrument) and ESA experts (overheads)
  - Start before IQR
  - Finish by end of year
- Implementation of appropriate corrections, enhancements, updates
  - Jan. 2005
- Production of a simple observing time calculator for use in Stage-3 proposal preparation
  - Feb. 2005
- Figures presented above should be used in the meantime

Uncertainties

- Reflector emissivity
- Stray light
- Instrument sensitivity
  - Assumptions
  - Modelling
  - Actual performance
- Possible unrepaired technical faults
- Etc. . . . .

- Observing programmes should be formulated taking into account at least a factor of 2 uncertainty in sensitivity (factor of at least 4 in speed)

Þ Go for science that is unique to Herschel

SPIRE ICC
Overview and Outline Plan

- Overview of activities
- Current Status
  - **Test support**
  - **AOT definition**
  - **Data Processing**
  - **Software Development**
- Schedule
- Issues

History

- At the last consortium meeting we were concerned at the level of resources available to the ICC and the best way to make effective use of them.
- A set of workpackages was presented which partitioned the ICC work (in particular the data processing) into smaller tasks which could be allocated to individual institutions, in the expectation that they would be able to manage the resources at their sites more efficiently than is possible from a central team
- We identified a set of (so called 'level-1') data products that we thought would be acceptable as meeting the requirements and which could be delivered with the available resources, and proposed that they would be our baseline

Activities over the last year

- The ‘level-1’ data products have been communicated to ESA and established as the planned output of the SPIRE ‘Standard Product Generation’ pipeline – they have accepted this situation, albeit not enthusiastically!
- A provisional allocation of workpackages to institutes was sent out in December. This allocation was made trying to balance the available and required effort in in each institute as well as capability. After some negotiation, all centres confirmed their ability to carry out their assigned workpackages (subject to detailed discussion of the requirements)
- Work started on the most urgent workpackages (AOT Design and Data Processing) in March-April according to the planned schedule
  - Work was already underway on the Test Preparation and Common Software related workpackages
- Some reorganisation of the workpackages has become necessary as the work has been more closely defined.
- This organisation was working well up to the beginning of Summer with groups participating actively in workshops and meetings and telecons. But the loss of Matt Fox in June, in particular, coinciding with the Summer holidays and planned observing trips has led to a slow down in activity.
  - Dave Clements has taken over Matt’s work provisionally and two new staff will be joining the Imperial College team shortly.

Future Activities

- We are looking at possibilities of increasing the resources available:
  - Bid for ‘DAPSAS’ centre in Canada
  - Collaboration with National Astronomical Observatory of China
  - Negotiation with PPARC for additional resources to work on post ’level-1’ processing
  - HSGSSG is putting together a plan for provision of software to allow the generation of ‘level-2’ products.

ICC Status - Test Support

- EGSE
  - Has been available for Instrument-level tests since start of CQM testing
  - IEGSE for use at Astrium has been purchased and integrated ready for delivery and integration at Astrium
    - We are waiting for delivery of database files from the System data base
    - There is a problem with the interface to the CDMS simulator
- EGSE Software
  - EGSE software was installed successfully for CQM pre-vibration testing in February.
  - Updated software was installed for post-vibration CQM testing in September
  - Current system consists of SCOS2000 (v2.3e P5), Test control (v0.5), HCSS (version 0.2.1, build 426) and QLA Version 2.1 (build 32)
- Instrument Databases (MIBs) have been updated to conform to new OBS version
- Test Procedures
  - All functional and performance test scripts have been converted to CUS scripts and corresponding Test Procedures

This system now uses (CUS) scripts held in the HCSS for defining test sequences and allows TM generated to be associated with the commands sent to the instrument. This mirrors the way in which the system will operate in flight giving us increased confidence in the ability of the system to work correctly during the mission.

- On-Board Software
  - Version 1.2j has been installed (pre-release for CGS)
  - Corrects occasional rejection of commands – allows scripting to be used
- Data Processing
  - Still based on export to FITS and passed to consortium for analysis
  - We need to get more data analysis carried out in IA
    - Provides users with expertience in using IA
    - Provides useful feedback to IA developers

Test Results – from an ICC point of view

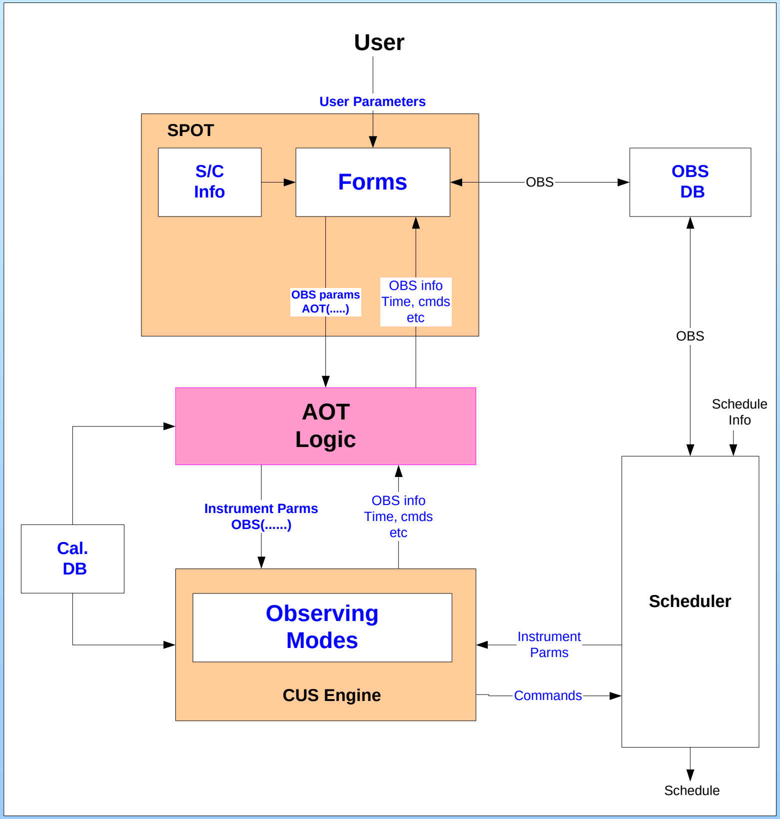
- Long scripts fail because file becomes locked by another process
  - Under investigation
- OBS crash
  - Probably due to request for too many TM packets
  - But in any case the OBS should not crash
- HCSS TM ingestion failed with no error message.
  - Loss of ~ 1 days data
  - We are investigating whether it is possible to regain the lost data
  - Temporary fix in place while problem is investigated
- Minor problem with OBSID allocation by HCSS
  - Means that association of observation (test) with telemetry packets is not possible in real time
  - Will be done off-line later
  - Problem under investigation
- SCOS archive playback sometimes fails (unable to find any data)
  - Only since Patch 5 installed – under investigation

Despite these problems in general the system is working well

Observation Definition

- Proposal Handling
  - Based on SPOT to accept user input and display Observation information such as Time, S/N, Observation Sequence, etc.
  - SPOT calls the AOT Logic to generate the Observing Sequence (defined by Instrument Parameters). This in turn calls the CUS engine to provide the Observation information
  - Once saved the Observing Sequence is fixed (and so is the time)
  - Any changes to Calibration will require the operations team to re-run the AOT logic on each observation and check the affect. The user may then need to be consulted in case of significant changes

This scenario has recently changed and WPs do not yet support it

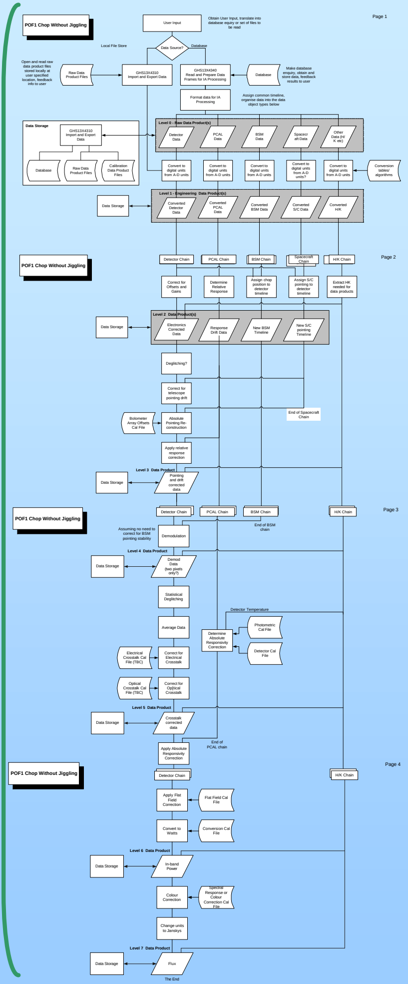


Observation Definition - Status

- **Photometric Observations**
  - Observation types and user inputs have been determined
  - Input to ESA for the definition of the user interface to Proposal Handling (HSPOT) has been defined – agreement with PST due mid October
  - Preliminary logic for Single Point Photometry has been produced (others on the way)
    - based on observing modes document
    - Defines instrument inputs – now needs revising in light of change to proposal handling
  - and is under discussion. Some questions are:
    - What is a building block?
    - How do observing modes relate to ORs
    - How to pass the processing information through to pipeline processing
  - Next step is to define the logic which translates between the User parameters and the Instrument parameters
    - Delivery of a preliminary time-S/N estimate is required by the end of the year.
    - Now it is unclear at what level the estimate is made
- **Spectroscopic Observations**
  - User inputs and decision trees are almost defined for these modes but, questions are still open about possible additional observing modes and some options
    - These need to be decided in order to provide the User inputs to the PST
    - To be discussed later at this meeting

Data Processing

- **Standard Product Generation Pipeline**
  - **Pipeline will initially be implemented as an IA script running a set of Data Processing Steps (not necessarily sequentially)**
  - **Each Data Processing Step is implemented as an IA task with data products passed between them**
- **Provision of each Processing Step**
  - **Carried out in three stages**
    - **Agreement of data product format and contents (interface) between provider and user tasks**
    - **Specification of how to produce the content from input products**
    - **Write/test code to do it**
  - **Followed by pipeline testing**



Data Processing - Status

- Spectroscopic Data Processing Pipeline
  - Plan is to be ready for data from the PFM1 tests (in December) which has the Spectrometer installed
  - Initially based on a simple pipeline of few steps e.g.
    - Extraction of raw data from database and production of the engineering data products
    - Mapping detector data to equally spaced interferogram
    - Addition of interferograms (including deglitching by identifying outliers)
    - Transform to determine Phase
    - Reconvolution to produce phase-shifted interferogram
    - Transform to produce Spectrum
  - Agreement has been made on division of processing stages between Lethbridge and LAM
  - Status
    - SPIRE dataframes have been defined (splits the TM data into convenient blocks of data)
    - Detector Engineering Data Product defined and documented
      - Including specification of processing necessary from raw (dataframe) data
    - Spectrometer Engineering Data Product definition almost complete
      - Specification TBW
    - Prototype code to produce Detector Timeline product is available

Common Development Activities

- **HCSS**
  - **HCSS is now reaching maturity with much of the ICC required functionality already implemented**
  - **It has been used extensively in Instrument-Level Testing (ILT) and is ready for Integrated System Testing (IST)**
  - **Next major steps are:**
    - **Database replication - we are currently having to use the same database for storing current test data at the same time as providing access to data for analysis.**
    - **Browsing of the database to find/access data**

- **Interactive Analysis (IA)**
  - **IA has reached an important milestone with the delivery of 'iteration 5'.**
  - **Provides a framework on top of which the SPG, and other pipelines, can be implemented and tested.**
  - **Provides improved usability and documentation.**

We really need use of IA by the consortium to provide feedback to the developers – see later presentation

Calibration Activities

- **Instrument Ground Calibration**
  - A draft of the instrument Calibration Plan has been issued
  - The set of calibration tables required for up/downlink have been compiled
    - a specification of the tests necessary to provide these has been produced.
    - Some of these have/are being been checked during CQM testing
    - Work is ongoing to define the ground test procedures and processing steps to allow generation of these tables from the ILT.
- **In-flight Calibration**
  - Definition undeway with the ESA Instrument and Calibration Scientist (Sarah Leeks)
- **HCALSG**
  - Preparation of Calibration Database underway
  - Calibration Workshop in December

Schedule Milestones 2004-5

- Observation Definition
  - Agreement with PST for phase 1 user inputs to observations, by Oct 15th
  - Coding of preliminary time estimator (in CUS) by Dec 31st :
    - Delivery, from ESA, of interface definition between AOT Logic and SPOT/CUS by Oct 15th
    - Coding of AOT logic, in java, by Nov 15th
    - TBC Coding of building blocks to provide Time/S/N estimates by Nov 15th
    - Availability of instrument sensitivity information to be included in time estimator by Nov 1st
  - Coding of all building blocks for observations, including time/S/N estimates by June ’05
    - Definition and Implementation of interface to calibration products in HCSS (from AOT logic and CUS) by April 1st 2005, TBC
    - Definition and population of calibration products for phase 2 by May 1st 2005
    - Update of AOT logic by May 1st 2005
    - Testing of Proposal submission May 2005

Schedule Milestones 2004-5

- Data Processing
  - Coding of Spectrometry Building blocks (commands only) in CUS for use in PFM1 testing, by Nov 15th
  - Provision of Spectrometer Test Pipeline by Jan 1st 2005
    - Definition of Spectrometer Test Pipeline by 15th October
    - Definition of Data products for Spectrometry Test Pipeline by Nov 15th
    - Coding of data processing steps and Spectrometry Pipeline by Dec 15th
  - Coding of Photometry Building blocks (commands only) in CUS for use in PFM2 testing, by Apr 15th 2005
  - Provision of Photometer Test Pipeline by July 1st 2005
    - Definition of Photometer Test Pipeline by February 1st 2005
    - Definition of Data products for Photometry Test Pipeline by April 1st 2005
    - Coding of data processing steps and Photometry Test Pipeline by June 1st 2005
  - Provision of Standard Product Generation pipeline by June 2006
    - Definition of Standard Product Generation Pipeline by Dec 2005
    - Definition of Data products for Standard Product Generation by Mar '06
    - Coding of data processing steps for Standard Product Generation by July '06
- Instrument User Manual
  - Delivery with each instrument model delivery
- ICC Preparation
  - ICC Implementation Plan by Jun 2005
  - ICC Implementation, by Jun 2006
  - ICC Operations Plans by Jun 2006

Issues

- **Reduced availability of ICC staff due to instrument testing requirements**
  - **Priority will be given to instrument test and delivery over the next year:**
    - **CQM post-vibration tests will last to mid Oct – delivery mid November**
    - **AVM testing will take place in mid Oct to Mid November**
    - **PFM1 Testing is due to start End of November – until Xmas**
    - **PFM pre-vibration tests March-April**
    - **PFM post-vibration test and calibration June-November '05**
    - **CQM/AVM test campaigns at Astrium in Dec (AVM, TBC?), Spring-Summer '05 (EQM)**
    - **All of these require substantial effort from most of the RAL ICC team for test definition and execution and for others for test data analysis**

    Support from the consortium is necessary if we are to meet our schedule
- **Reduced availability of ICC staff due to other (hardware) priorities**
- **Lack of funds**
  - **In all groups funding levels are defined and limited**
  - **Any change of launch date will incur additional costs, which will require submission of new bids to funding agencies**
  - **It is not clear that these will be forthcoming**

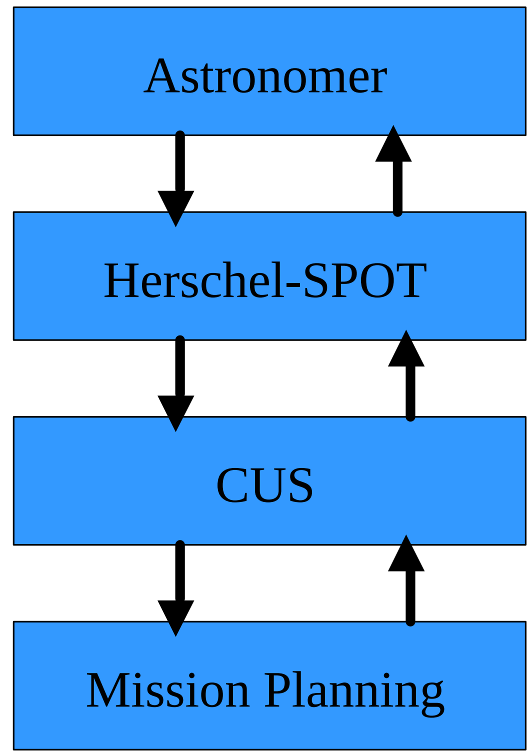
AOT Definition: HSC plan and schedule

SPIRE Consortium Meeting
RAL, 28th September 2004

Sarah Leeks
Herschel Project Science Team
Herschel Science Centre
Astrophysics Missions Division
Research and Scientific Support Department

Overview

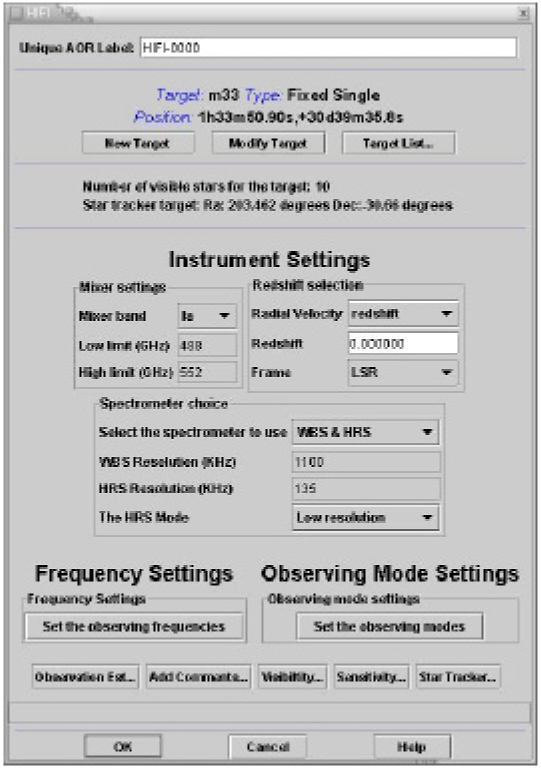
- AOT-> schedule
- Via Herschel Spot, CUS, Time estimation.
- ICC deliverables
- Schedule



Proposal Handling System

Herschel-Spot

- Proposals submitted via Herschel-Spot Tool.
- SPIRE team deliver these AOTs.
- User selects parameters on AOT screen for their observation.
- User can then visualize the AOT on a choice of maps (such as IRAS, 2MASS, MSX…).
- Time estimation, visibility windows.
- Updates and modifications to AOTs.



Common Uplink System (CUS) & Time Estimator

- Observing modes are defined using the CUS scripts written in the CUS language.
- PHS/Herschel-SPOT uses the time capability of CUS to say how long the observation will take using:
  - the user input to AOT
  - instrument parameters
  - CUS scripts
- Time estimator also used to find out needed observing time for user inputted S/N and flux.
- CUS will also use the CUS scripts produce the telecommand sequence associated the observation.
- SPIRE team to deliver CUS scripts and time estimator.

Mission Planning System

- The MPS (mission planning system) uses the time capability of the CUS to schedule observations.
- Having scheduled observations the MPS then generates the schedule which consists of the telecommands from CUS.
- Aim: to be able to produce schedules that use Herschel time (helium) efficiently.

ICC Delivery of AOTs

- The interface between the HCSS (Herschel Common Science System) developers and the SPIRE team has already been established: Me.
- Note circulated on what information is needed.
- I communicate with the PHS developer who then implements the AOTs into Herschel-Spot.
- Chance to update AOTs later.
- The project scientist team are responsible for ensuring a common look and feel for the AOTs across all instruments.

Delivery of Observing Modes/Time Estimator

- The instrument teams deliver their CUS observing modes/Time Estimator to the HCSS development team.
- Indicate with which AOT each is associated.
- The HSC development team will incorporate them into the operational HCSS.

Schedule

- **Mid 2004**: Agree with ESA which CUS-support is needed for observing time calculators
- **Oct 2004**: Agree with PS user input parameters for phase 1 proposals
- **End 2004**: ICCs deliver observing time calculators for all their AOTs
- **Early 2005**: Agree with PS final user input parameters for AOTs in phase 2 proposals
- **Late 2005**: Realistic but still draft CUS scripts to convert AOT user input to telecommands
- **Mid 2006**: Final CUS scripts for all AOTs

AOT Definition: SPIRE Status & Plan

Dave Clements, Mattia Vaccari

Imperial College

Marc Sauvage

CEA Saclay

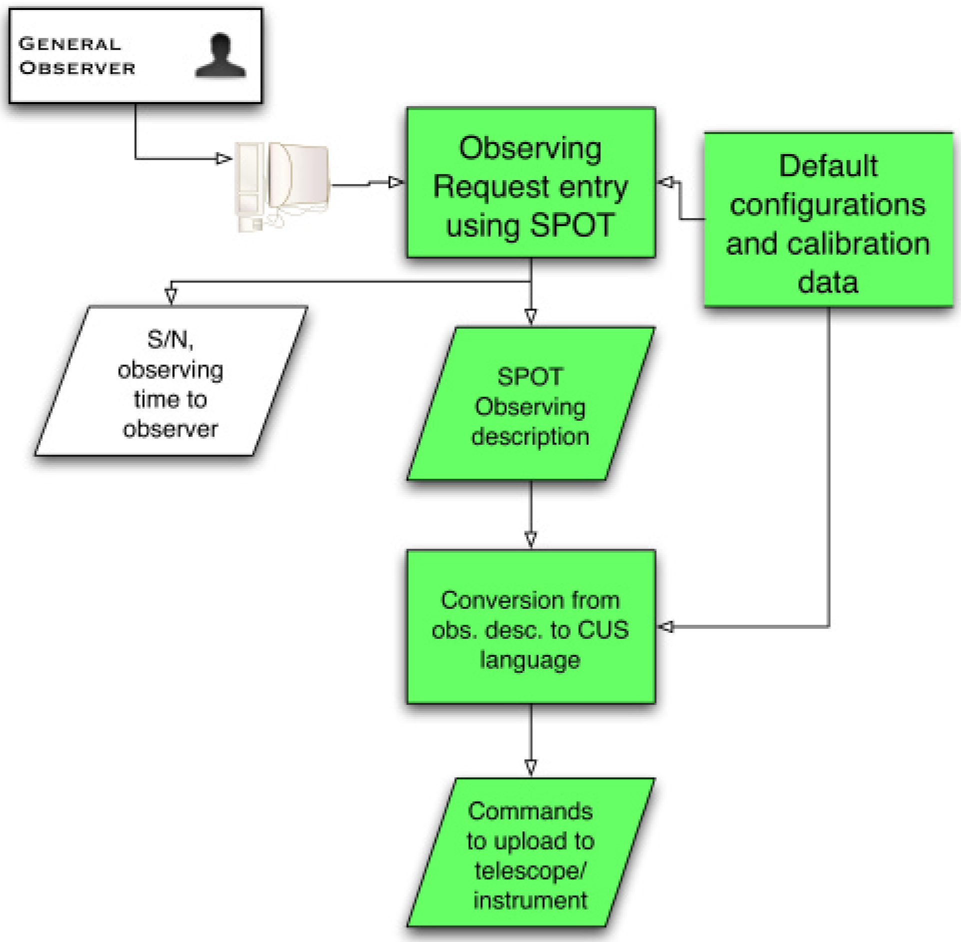
AOTs and Herschel

- AOT, now Observing Requests (OR) are how observers specify their observations
- The definition of AOTs are important for several reasons
  - Its how the observers will interface with the instruments
  - It will be our first main contact point with them
  - The AOT specifications define how SPIRE will be used, what calibrations are needed, and how the data will be reduced

Observing modes and AOTs

- Currently there are many potential ways that SPIRE can be used
- In producing AOTs we go from the infinite range of possibilities to a small number of specific options
  - The fewer options the simpler the calibration and data reduction tasks will be
  - BUT at the same time do not want to limit the observing possibilities

SPIRE AOT operation

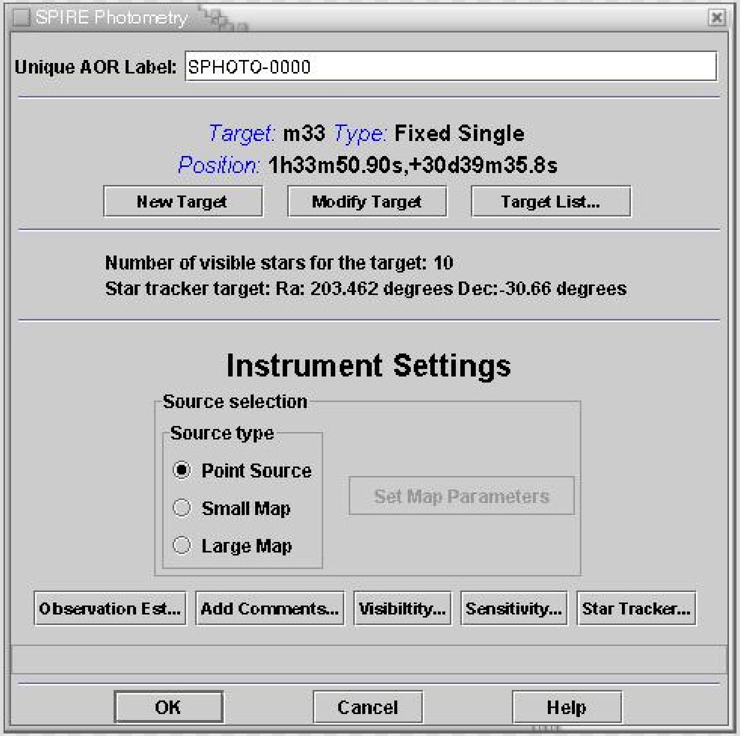


SPOT for SPIRE

- SPOT - Spitzer observation entry tool
- Being modified by HSC for Herschel OR entry
- Inputs required and interfaces for SPIRE observation entry being defined by ICC team
  - Broken into 3 tasks with 3 teams
    - Photometry (DLC), Mapping (MV), Spectrometer (MS)
  - Developments underway
  - Deadline for input interface definition 10 October

Common Interface Tasks

- Target Entry
- Instrument selection
- Observation visualisation
- S/N or time estimation



Photometry Status and Issues

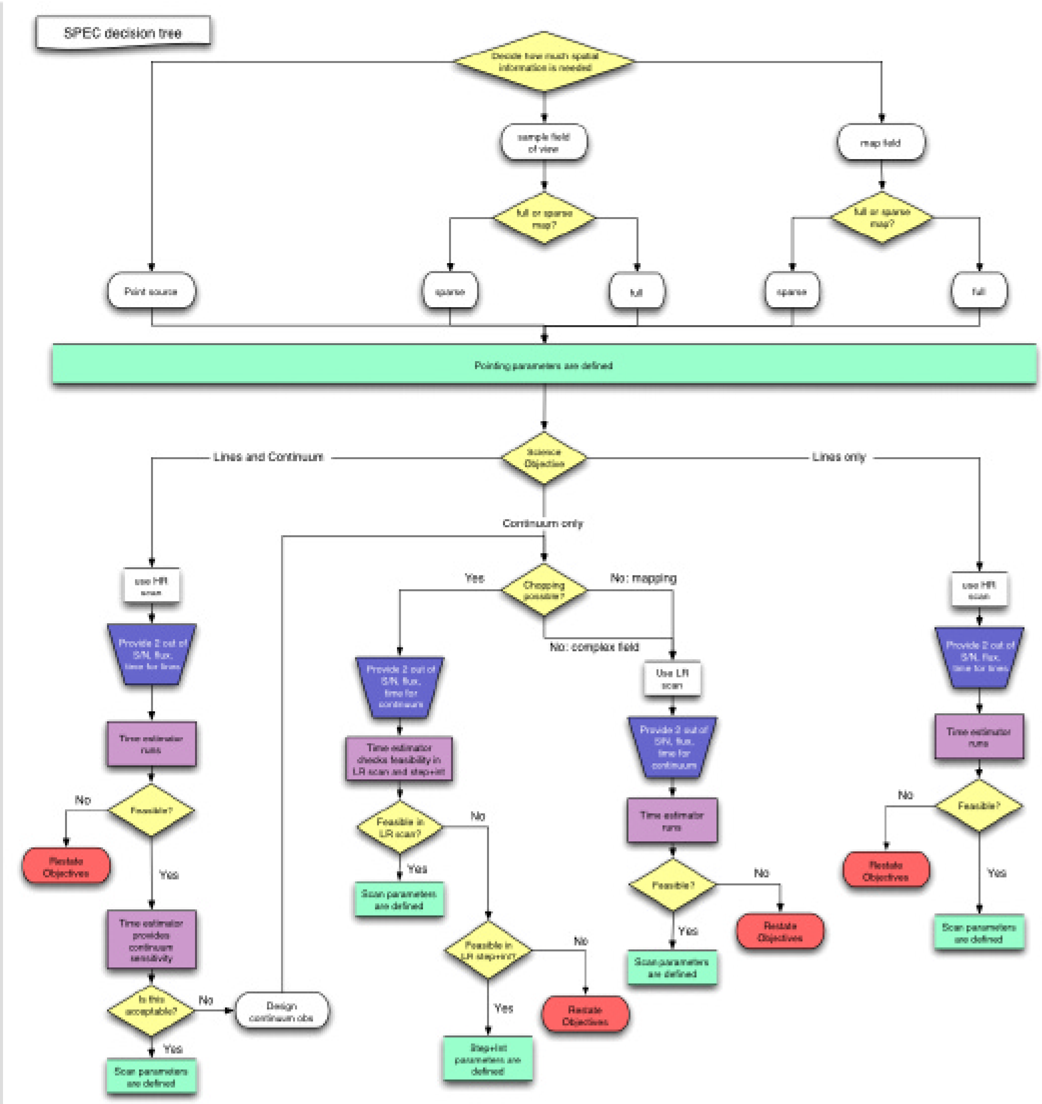
- Will use 7-point jiggle mode for all photometry
  - Staring requires v. good positional accuracy
  - Not certain to be in original data or to be delivered by telescope pointing
- Interface definition largely complete
- What to do about reference position selection?
  - Allowed range of roll angles presents scheduling problems
  - How often will there be sources in reference beam, and when will we know?
  - Are fixed time observations an alternative option?

Mapping status and Issues

- User inputs and CUS conversion being developed
- Amount of user choice between raster-mapping and scan mapping modes?
- Amount of choice for definition of maps
  - Overlap size in rasters
  - Repeat scans for scan maps to allow cross-linking
  - Implications for integration time, but not clear if there is a single optimal solution
- How much control to allow users?

Spectrometer Status and Issues

- User inputs and CUS conversion being developed
- Many modes possible
  - Is there any interest in a moderate 20<R<1000 resolution mode
  - How much interest in R=20 mode?
  - Is there a faster way than 3 mins to get a spectrum?
  - Jiggling or scanning for maps?



3 spectral modes:

High res scanning

Low res scanning

Low res step and int.

3 spatial modes:

Point

Jiggle (7 or 64 point)

Scan

CUS Conversion

- Go from a SPOT observation description to commands in CUS language which tell telescope/instrument how to do observation
- Descriptions of how to convert from SPOT to CUS needed by end of year
- Meeting on this at IC 26th October
- Same division of labour as for AOTs
- Eventual coding into CUS done by RAL team

CUS Conversion Example

- CUS conversion for photometry mode
- Uses a pseudocode that is like CUS, but not identical
- Some elements such as building blocks, data rate, observing time calculations etc. still to be added
- Starting point is a SPOT observation description:

```
Mode=7-point jiggle
RA= value
Dec= value
Int_time= value
```

Code to produce CUS commands

```
; SPOT to CUS conversion pseudocode for long duration 7-point jiggle observation
; Version 0.1 by Dave Clements Sept 3 2004
; assumes integration time needed is greater than the 21 minute period allowed between calibration observations
; calculate the number of full 21 minute observing blocks needed
int Nblock = int_time mod 1260 seconds;
; then calculate the time remaining after that
int Tremain = int_time div  1260 seconds;
; now point the telescope
Point(RA, Dec);
; now do the Nblock sets of 21 minute (ie. 7 nod cycle) integrations
For (int I = 1 .. Nblock) {
Int nod_cycles = 9;
; calibrate
POF8();
; observe for 21 minutes ie. 7 nod cycles
               POF2(chop_freq, chop_direction, chop_throw, jiggle_pattern, chops_per_jiggle, jiggles_per_nod,
                nodding, nod_period, nod_direction, nod_throw, nod_cycles);
; since nodding is being used, we omit the 'total integration time' parameter given in the operating mode document
; calibrate again
POF8();
}
; are there any remaining observations to do?
If (tremain > 0) {
; now do the remaining observations, calculating how many 140 second nod cycles are needed
; always do 1 more full cycle than is needed so as to get the required integration time or slightly more
nod_cycles = (Tremain div 140 seconds) + 1;
; do the observations
               POF2(chop_freq, chop_direction, chop_throw, jiggle_pattern, chops_per_jiggle, jiggles_per_nod, nodding,
                nod_period, nod_direction, nod_throw, nod_cycles);
; since nodding is being used, we omit the 'total integration time' parameter given in the operating mode document
; now do the final calibration
POF8();
}
end;
```

Default Parameters

- CUS conversion will need a set of default observing parameters for each mode as well as the conversion script
- These will define the parameters of the observing mode
- At this stage these are largely the default parameters from the SPIRE observing mode document

CUS Conversion Issues

- How much power to allow observers to change default parameters?
  - Chop/nod throw, direction etc.
  - Implications for calibration and data reduction
- Current thought is to keep the observer's room for maneuver to a minimum

AOT Status: Conclusions

- Observing modes are approaching full definition
- SPOT observation request system on its way
- System to go from SPOT observation descriptions to S/C & SPIRE commands being developed
- Next AOT meeting - 26th October, IC
  - SPOT status
  - CUS conversion

Data Products and Data Processing Pipelines

General Issues & Photometer

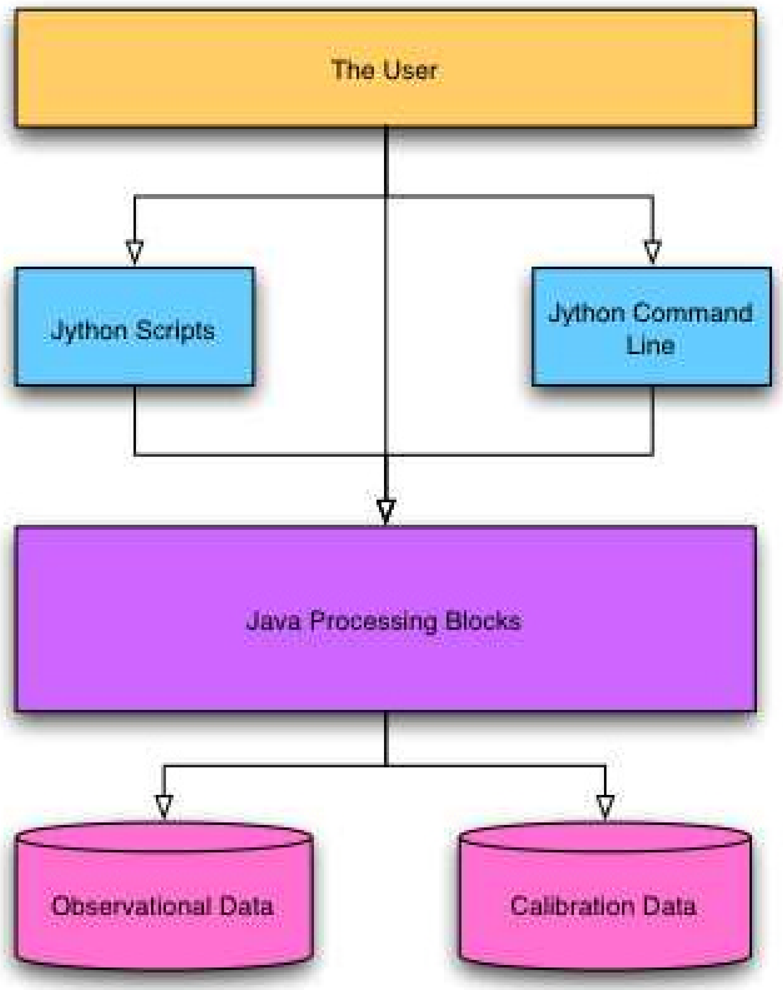
Dave Clements
Imperial
The SPIRE ICC

Data Processing Basics

- Processing modules written in Java
- Data Processing environment uses Java and Jython
- Jython can be used as a command environment
  - like IDL command line
- Jython can be used as a scripting language to tie Java modules together
  - Like IDL procedures and functions

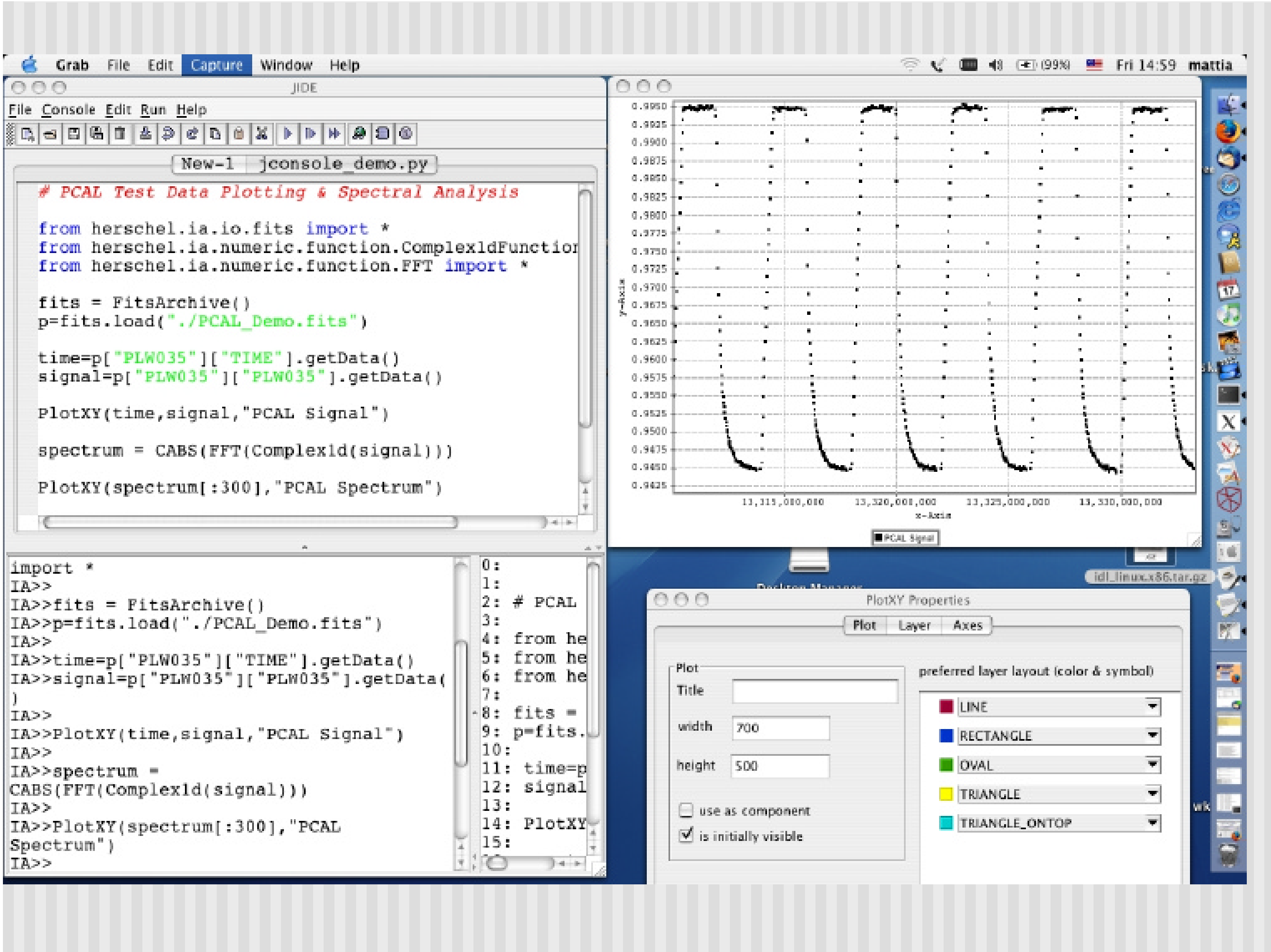
Different Levels of Developer

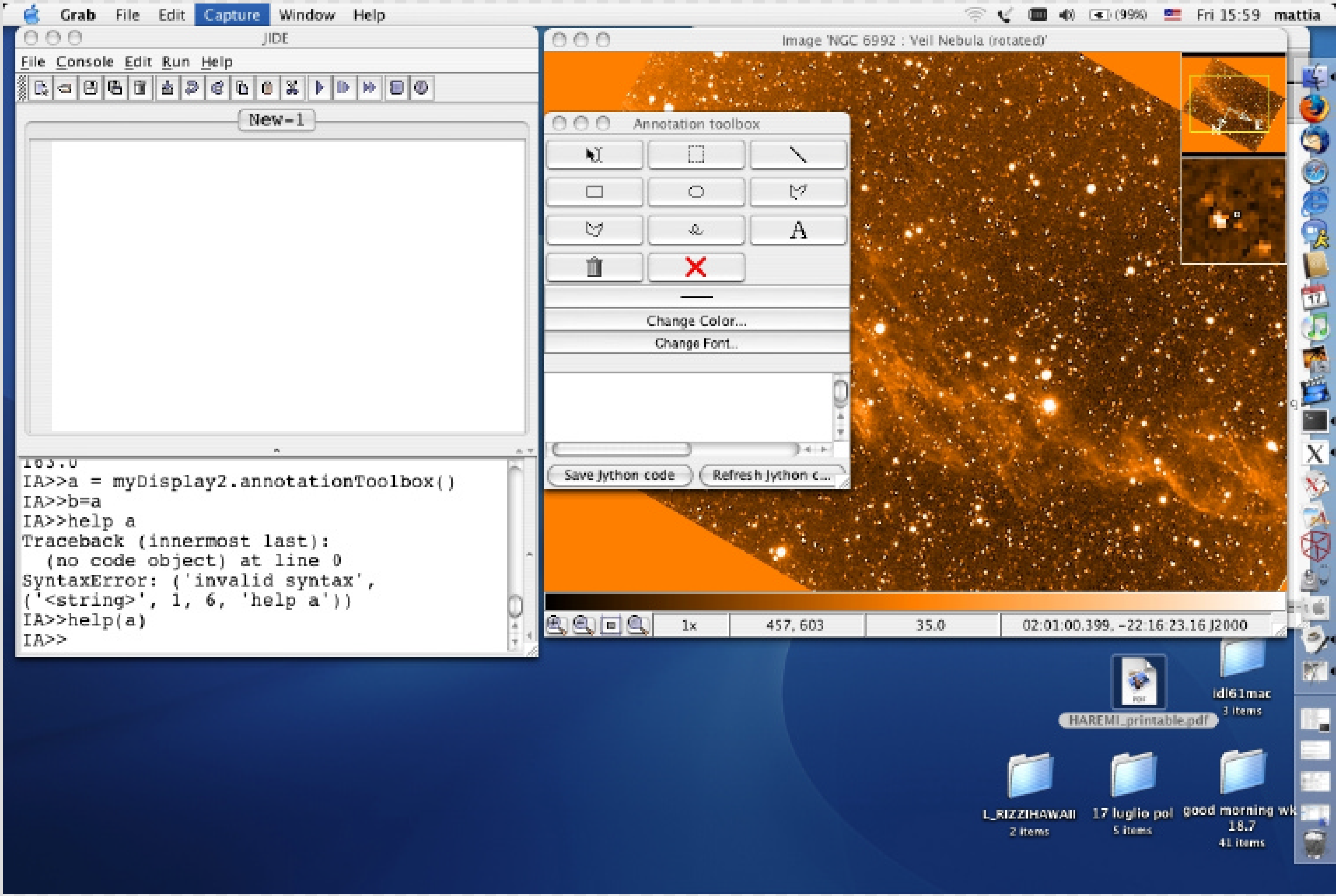
- Software developer
  - Works in Java
  - Writes basic routines for use in IA
- Scientific developer
  - Works in Java and Jython
  - Writes scientific routines in Java
  - Prototypes and scripts tasks in Jython
- Scientific User
  - Uses Jython and Java routines to process and analyse data
  - Can call on developers to code useful Jython tasks into Java


The User
Jython Scripts
Jython Command Line
Java Processing Blocks
Observational Data
Calibration Data

Current Status of HCSS and IA

- Development continuing
- Framework established
- Being used in instrument testing campaigns
- Current release is #5/4
- #6 is on its way


Grab File Edit Capture Window Help
Fri 14:59 mattia
JIDE
File Console Edit Run Help
New-1 jconsole_demo.py
# PCAL Test Data Plotting & Spectral Analysis
from herschel.ia.io.fits import *
from herschel.ia.numeric.function.Complex1dFunctior
from herschel.ia.numeric.function.FFT import *
fits = FitsArchive()
p=fits.load("./PCAL_Demo.fits")
time=p["PLW035"]["TIME"].getData()
signal=p["PLW035"]["PLW035"].getData()
PlotXY(time,signal,"PCAL Signal")
spectrum = CABS(FFT(Complex1d(signal)))
PlotXY(spectrum[:300],"PCAL Spectrum")
import *
IA>>
IA>>fits = FitsArchive()
IA>>p=fits.load("./PCAL_Demo.fits")
IA>>
IA>>time=p["PLW035"]["TIME"].getData()
IA>>signal=p["PLW035"]["PLW035"].getData(
)
IA>>
IA>>PlotXY(time,signal,"PCAL Signal")
IA>>
IA>>spectrum =
CABS(FFT(Complex1d(signal)))
IA>>
IA>>PlotXY(spectrum[:300],"PCAL
Spectrum")
IA>>
0:
1:
2: # PCAL
3:
4: from he
5: from he
6: from he
7:
8: fits =
9: p=fits.
10:
11: time=p
12: signal
13:
14: PlotXY
15:
PlotXY Properties
Plot Layer Axes
Plot
Title
width 700
height 500
use as component
is initially visible
preferred layer layout (color & symbol)
LINE
RECTANGLE
OVAL
TRIANGLE
TRIANGLE_ONTOP


Grab File Edit Capture Window Help
(99%) Fri 15:59 mattia
JIDE
File Console Edit Run Help
New-1
IA>>a = myDisplay2.annotationToolbox()
IA>>b=a
IA>>help a
Traceback (innermost last):
(no code object) at line 0
SyntaxError: ('invalid syntax',
('<string>', 1, 6, 'help a'))
IA>>help(a)
IA>>
Image 'NGC 6992 : Veil Nebula (rotated)'
Annotation toolbox
A
Change Color...
Change Font...
Save Jython code
Refresh Jython c...
1x
457, 603
35.0
02:01:00.399, -22:16:23.16 J2000
HAREMI_printable.pdf
idl61mac
3 items
L_RIZZIHAWAII
2 items
17 luglio pol
5 items
good morning wk
18.7
41 items

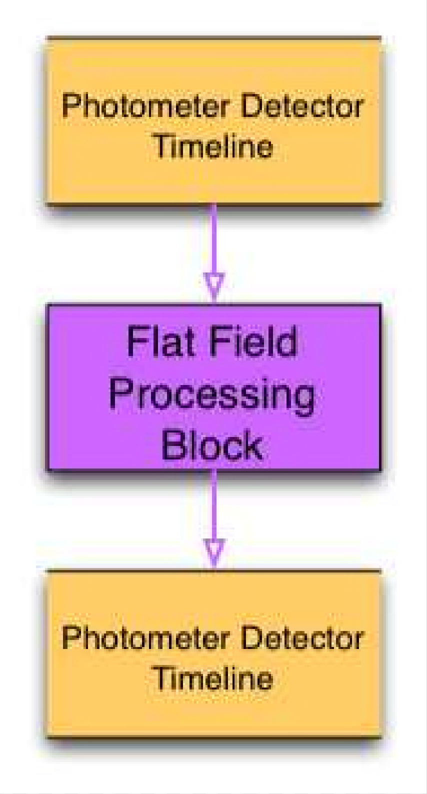
Documentation and Help System

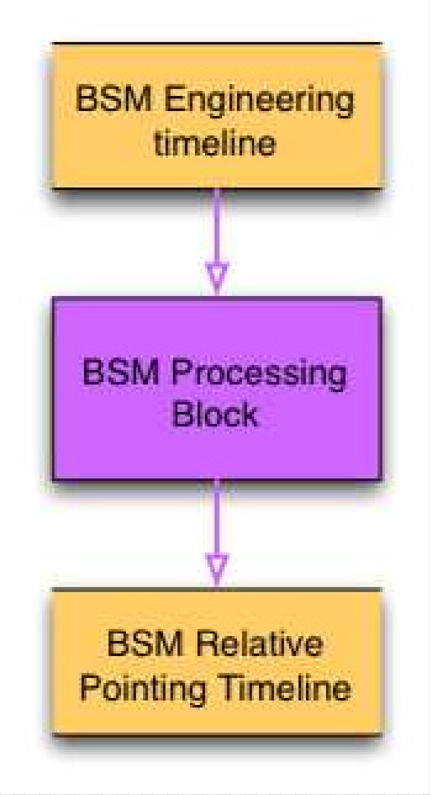
- Expanded help system building on existing javadoc
  - Needs developers to write additional documentation
- Web documentation incorporated into GUI help
- DatasetInspector available
- SessionBrowser coming soon

Pipelining Status

- Link different Java modules that do separate data processing tasks
- Specifying data products to be produced by each module, so the inter-module communication works
- Definition and development of processing modules underway
- For development work pipeline will be a Jython script linking Java modules
- Not clear if eventual full Javaisation needed

Example Processing Blocks and Products





Data Products after Processing

- Still only able to deliver calibrated timelines
  - All instrument signatures removed/dealt with
  - Data then ready for analysis using existing (or slightly modified) packages
  - We are still not able to provide reduced maps from the end of the PHOT pipeline
- The most 'baked' items will be for the simplest modes ie. photometry

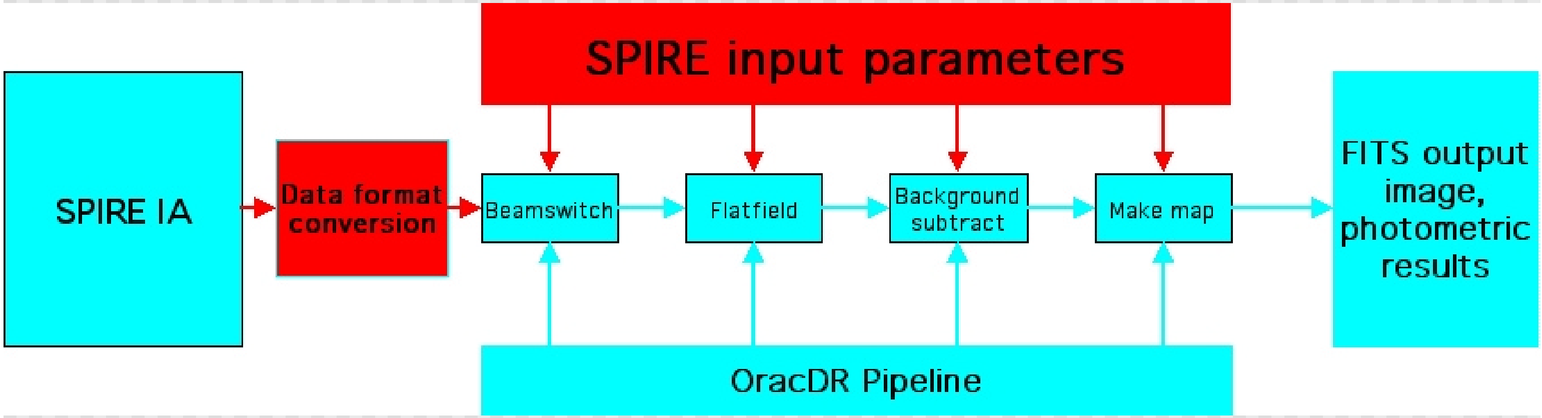
What does ‘calibrated’ mean?

- Just Watts received?
- Correction to Jy?
- Colour corrections on the basis of expected source SEDs?
  - Check questions in data products workpackage

Detector timelines to Maps

- Baseline is still to use a modified SURF to make maps from SPIRE data
  - Users could equally use other mapmaking packages from IRAM, SHARK2, BOLOCAM etc.
- Study to assess the work needed for this are still underway
  - Tim Jenness assures us its not a large job

SPURF


SPIRE input parameters
SPIRE IA
Data format conversion
Beamswitch
Flatfield
Background subtract
Make map
FITS output image, photometric results
OracDR Pipeline

IA Vision and Map Making

- A review of future development routes for the IA system *may* be a route to more resources for us to produce our own map-making routines
  - Mapmaking is a common problem for both PACS and SPIRE in scanning and rastering modes, though with obvious differences
- Unclear what the result from this process will be

Conclusions

- Reduction system basis in place
- IA system being used during testing, so it works!
- Science reduction modules and pipelining under development
  - Includes specialist items such as quality control pipeline for ESA use
- We would like to produce more fully reduced data, but still do not have the resources

SPIRE FTS Data Processing

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University of Lethbridge
Jean-Paul Baluteau,
Laboratoire d'Astrophysique de Marseille

FTS data products & processing

Overview:

- FTS data products
- FTS data processing steps
- Effects of translation stage jitter
- Interpretation of derived FTS spectra

FTS data products

- SPIRESpectrumDataSet is a spectral data-cube in FITS-like format - contains spectra from consecutive FTS scans for pixels from the two arrays.
- For each individual pixel, spectra are identical in terms of scan mode, speed, resolution, integration time etc.
- x-axis: wavenumber, frequency
- y-axis: flux (mJy)
- Plus: evaluation of instrumental error
- Spectral mapping TBD

FTS data processing - general

Raw interferogram to final spectrum

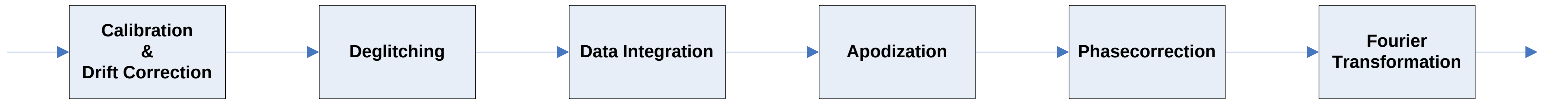
- Calibration
- Drift correction
- Deglitching
- Phase correction
- Apodization
- Fourier transformation (FFT)

FTS data processing – SPIRE

Additional steps for the imaging FTS on SPIRE:

- Cosmic ray hits require reliable detection and removal.
- Merge signals from the detector arrays with metrology data from the translation stage.
- Non-linear phase-correction for beamsplitters.
- Time-sampling leads to irregularly sampled interferograms: FFT doesn’t work!
- Impact of imaging: spectral and intensity flat-fielding.

Data processing steps



Calibration & Drift Correction

Deglitching

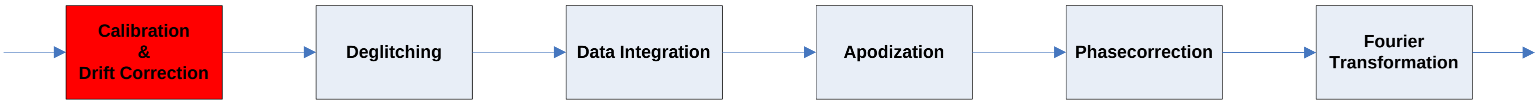
Data Integration

Apodization

Phase correction

Fourier Transformation

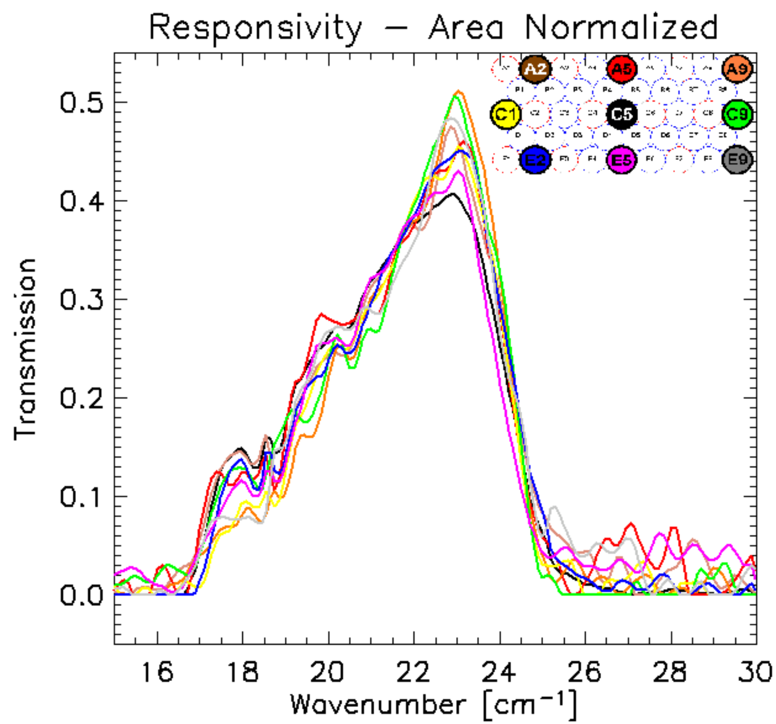
Calibration and Drift Correction



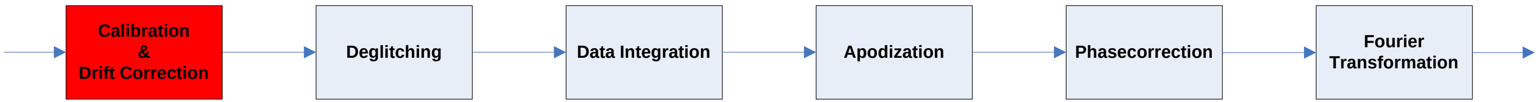
Calibrate:

Wavelength-dependent spectral response of the detectors.

Spectral response from CQM-test data in Feb. still not fully understood.



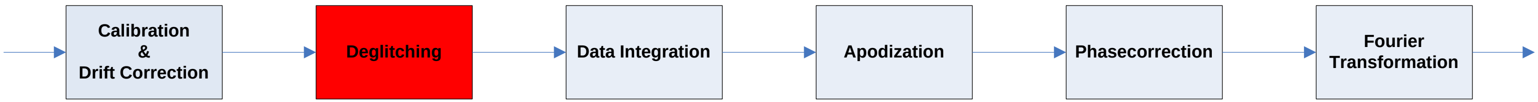
Calibration and Drift Correction



Drift: account for any systematic drifts within

- spacecraft (telescope temperature, emissivity, pointing, etc)
- instrument (SCal, bolometer temperature, read-out electronics, etc).

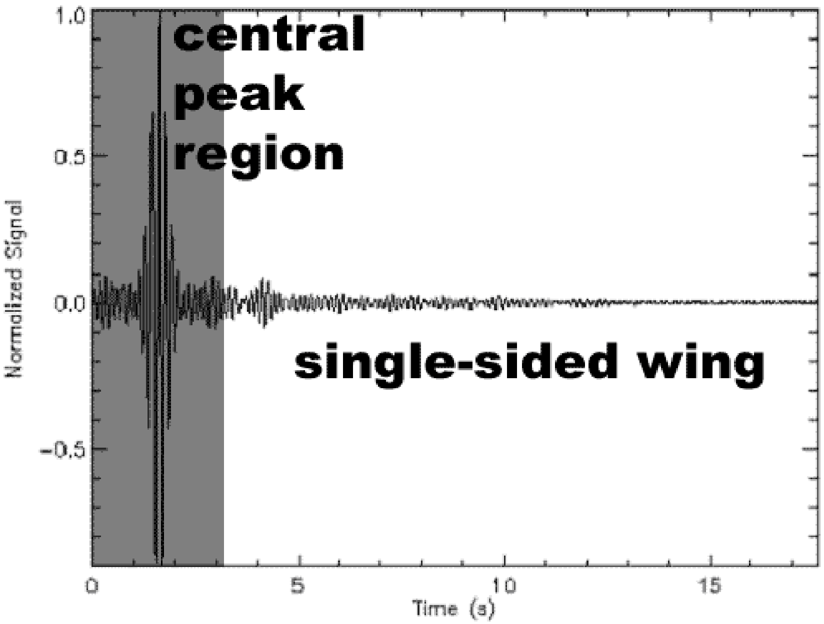
Deglitching



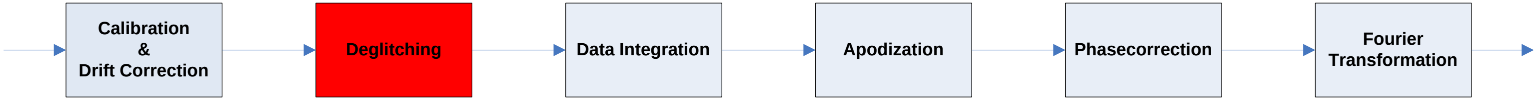
Deglitching: identify and remove glitches due to cosmic ray hits.

Different techniques for the central peak region and the single-sided wing

Possibly with wavelet analysis?



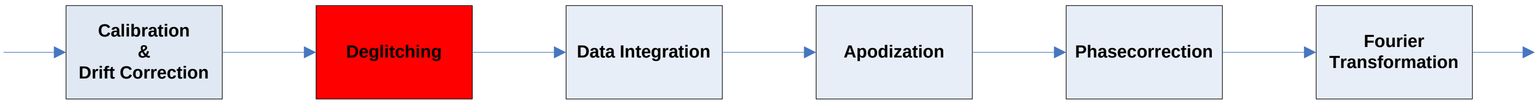
Deglitching



Zero path difference region

1. Re-grid all interferograms from one observation onto a shared position grid
2. Flag low outliers (using skewness) of the interferogram samples
3. Remove outliers by filling in with the average of the remaining interferograms

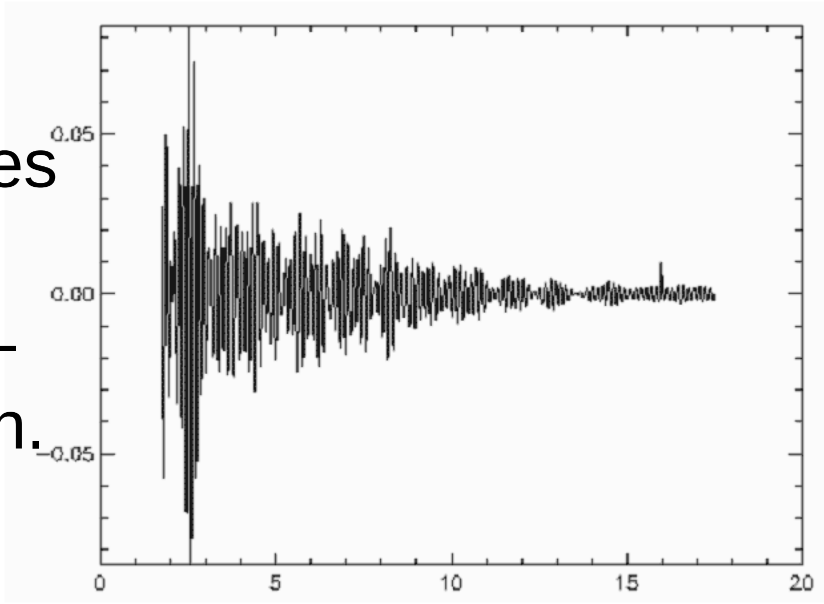
Deglitching



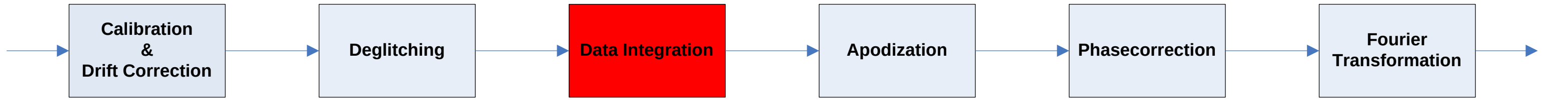
Single-sided wing

Similar to finding glitches in photometer data

- flag outliers in a three-point difference function.

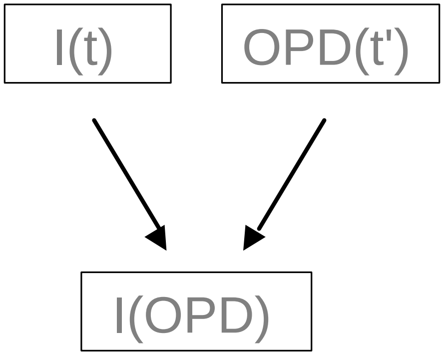


Interpolating the stage position samples onto the detector timeline



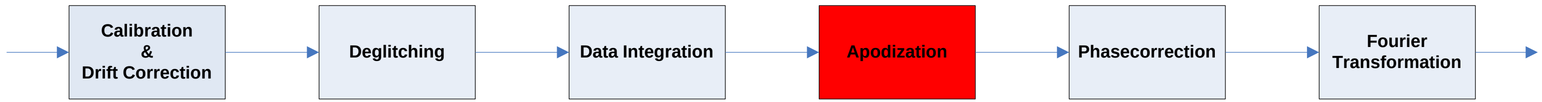
Detector timeline
(80Hz)

Stage timeline
(250Hz)



Interferogram,
signal as a function of
optical path difference

Apodization



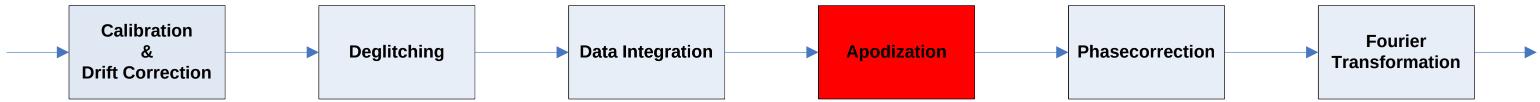
The instrumental line shape of an FTS - sinc function exhibits significant sidelobes

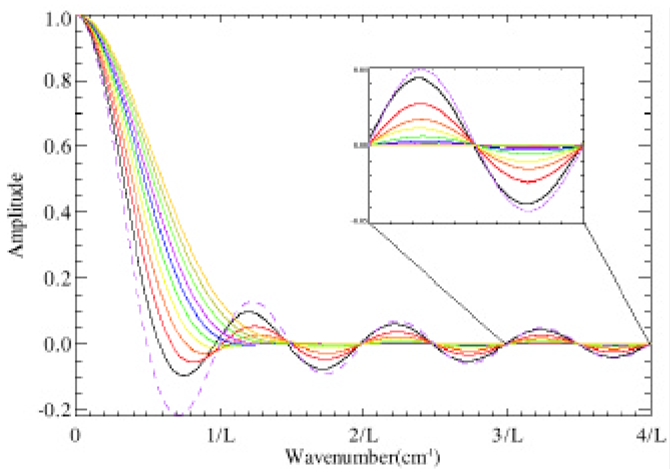
- The user can choose to multiply the interferogram with **apodization** functions to reduce sidelobe amplitides.

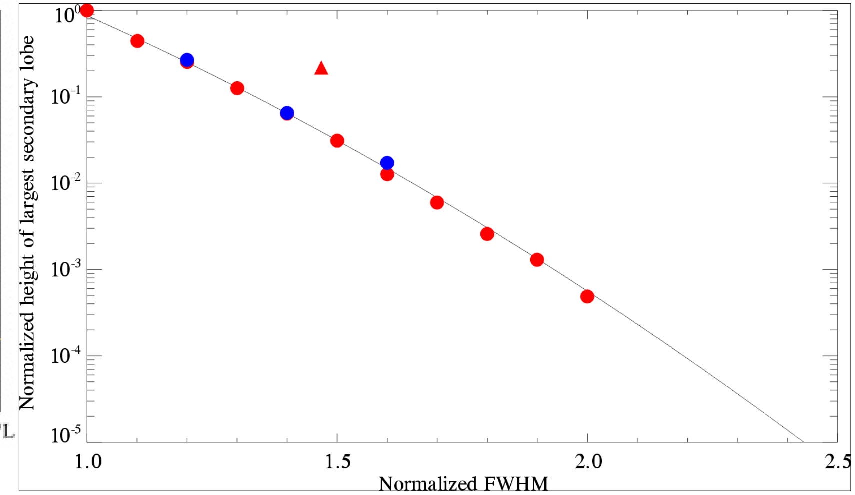
- Trade-off: reduced sidelobes at cost of lower resolution

- Modified Norton-Beer functions with FWHM from 1.0 to 2.0 in steps of 0.1 have been developed – considered optimal.

Apodization

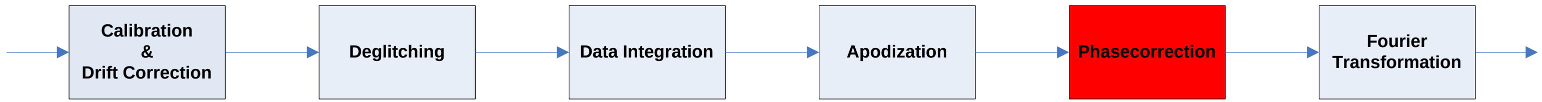






The solid line is the empirically determined optimum boundary.

Phase correction

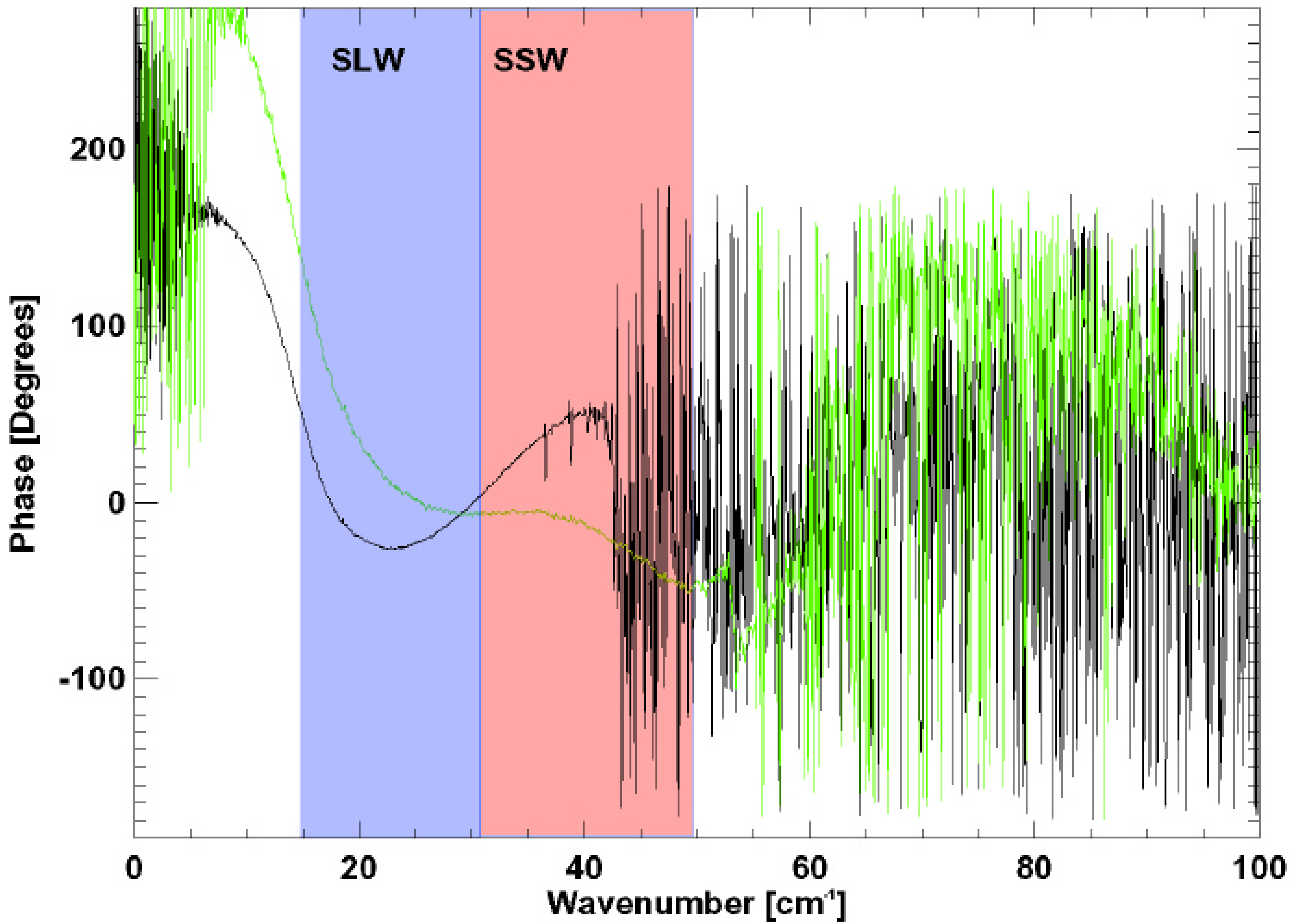


Phase correction: to deal with a variety of instrumental phase errors.

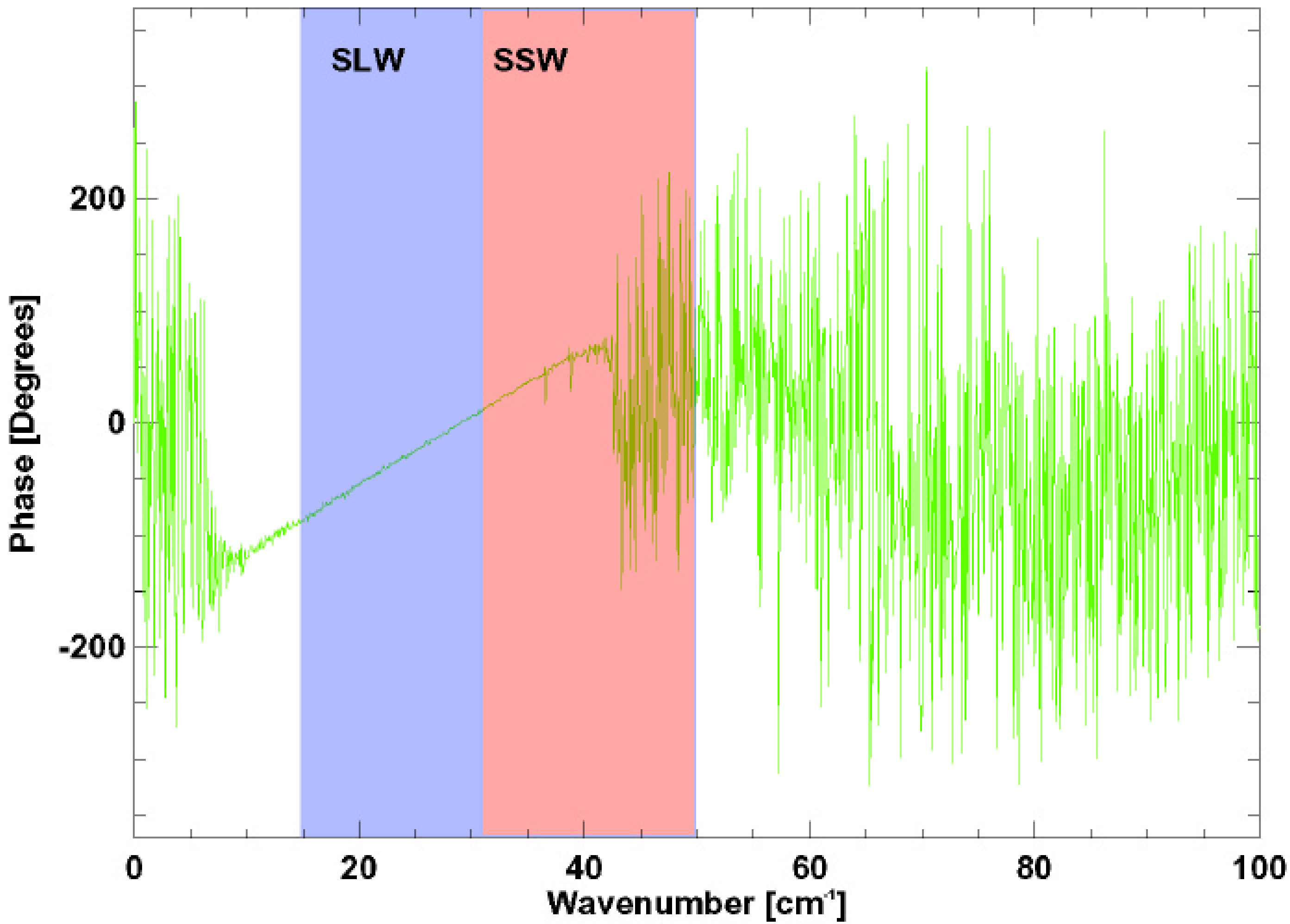
$$I(d) = \int B(\sigma)\cos(2\pi\sigma d)\,d\sigma$$

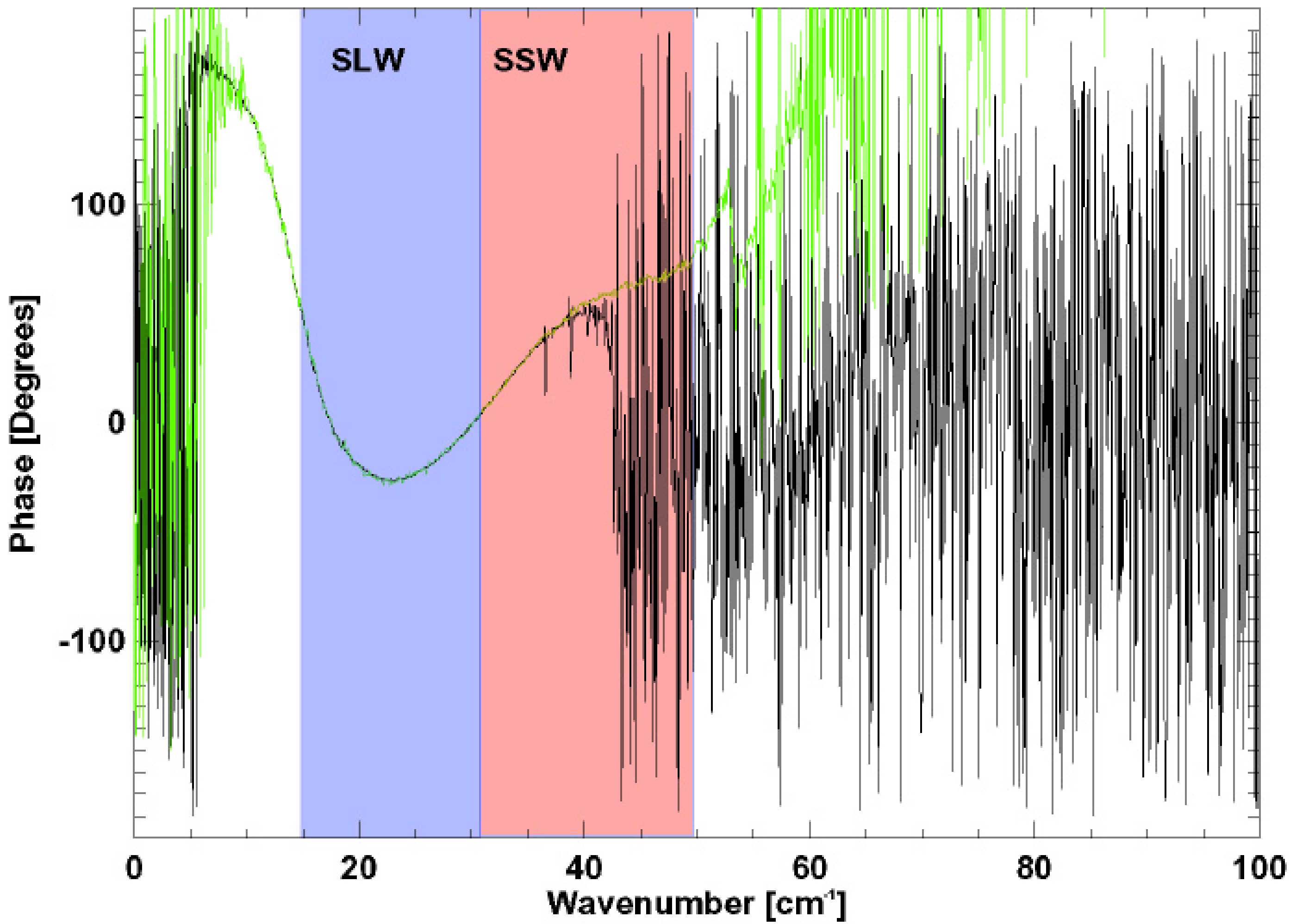
$$I'(d) = \int B(\sigma)\exp(i\varphi(\sigma))\exp(i2\pi\sigma d)\,d\sigma$$

$$\varphi(\sigma) = \varphi(\sigma)_{DC} + \varphi(\sigma)_{linear} + \varphi(\sigma)_{BS} + \varphi(\sigma)_{random}$$

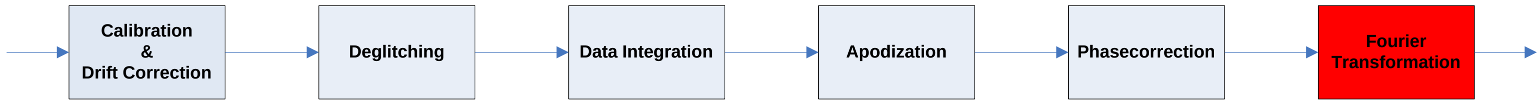


SLW
SSW
200
100
0
-100
Phase [Degrees]
0
20
40
60
80
100
Wavenumber [cm-1]


SLW
SSW
200
0
-200
Phase [Degrees]
0
20
40
60
80
100
Wavenumber [cm-1]


SLW
SSW
Phase [Degrees]
100
0
-100
0
20
40
60
80
100
Wavenumber [cm-1]

Fourier Transformation

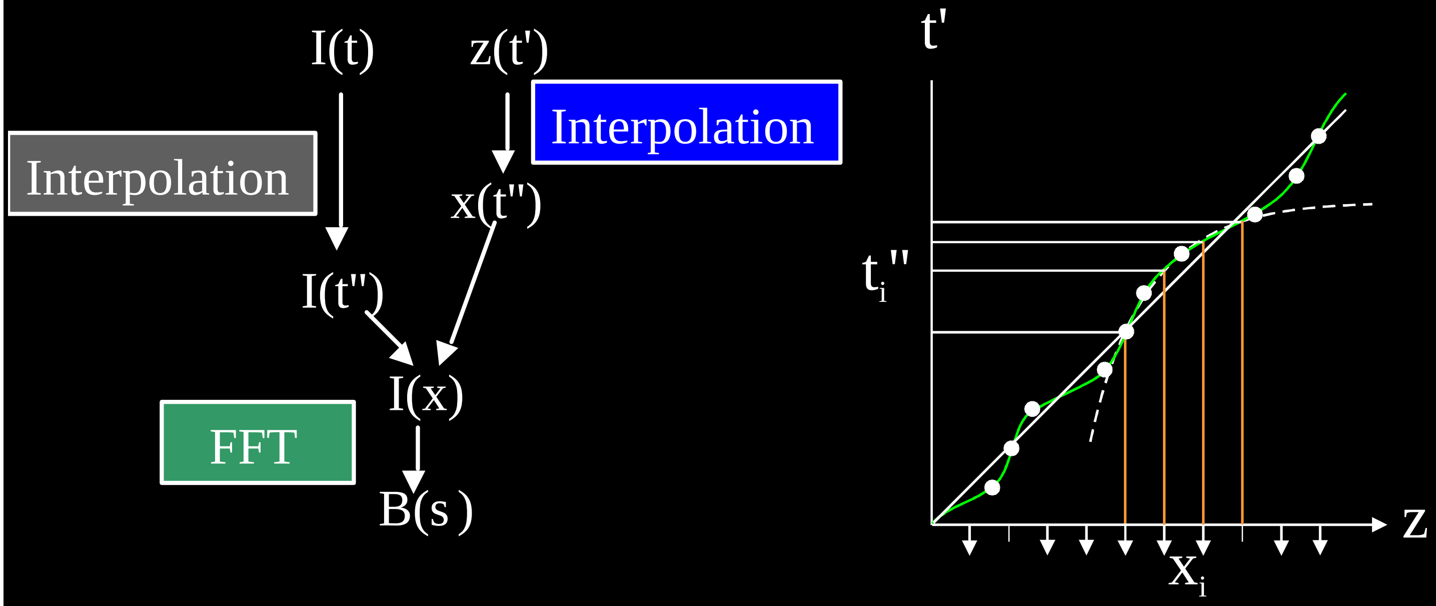


Fourier Transformation: for the irregularly sampled interferograms I(z'):

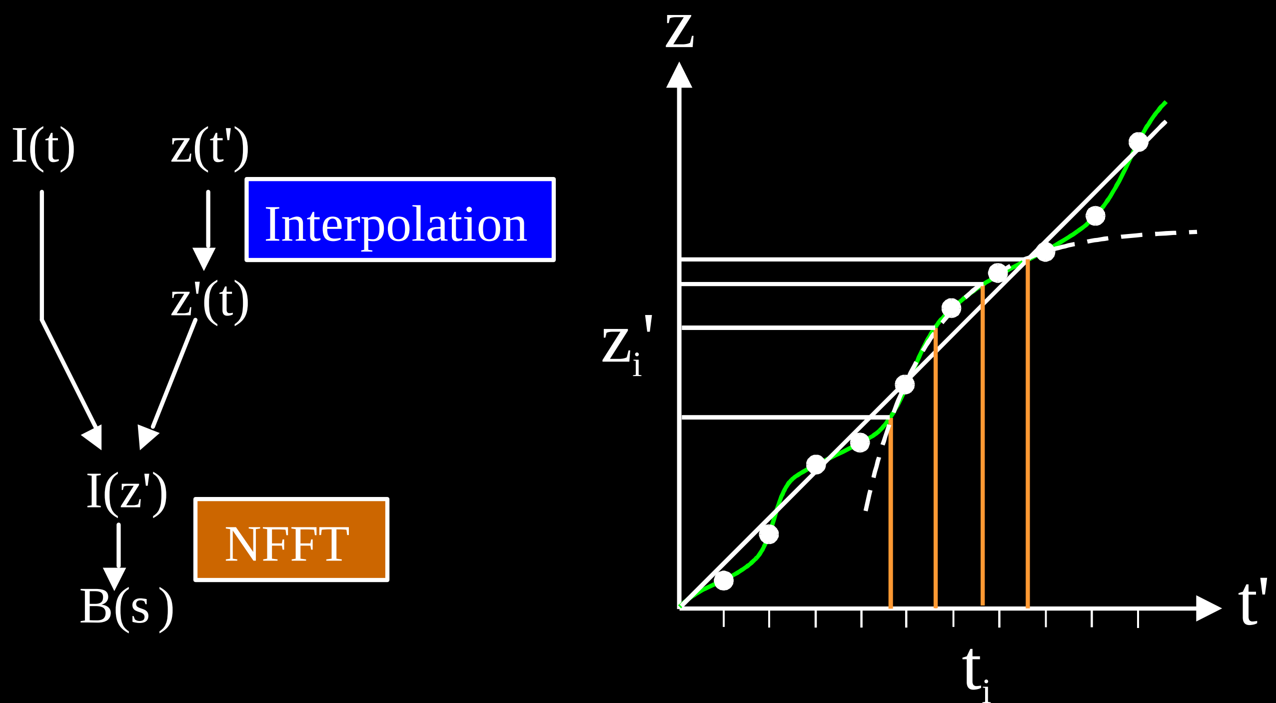
$$B(m\Delta s) = \sum_{n=1}^{N} I(z_n)\exp(-im\Delta s\, z_n)$$

1. NDFT (exact, slow) $O(N^2)$
2. Iterative NFFT (approximate, faster) from Potts et al. at the University of Lübeck, Germany $O(mN\log(N))$
3. Spline or Sinc-Gauss interpolation (Brault) plus FFT (artefacts, fastest) $O(N\log(N))$

Interpolation of interferogram onto regular grid and FFT



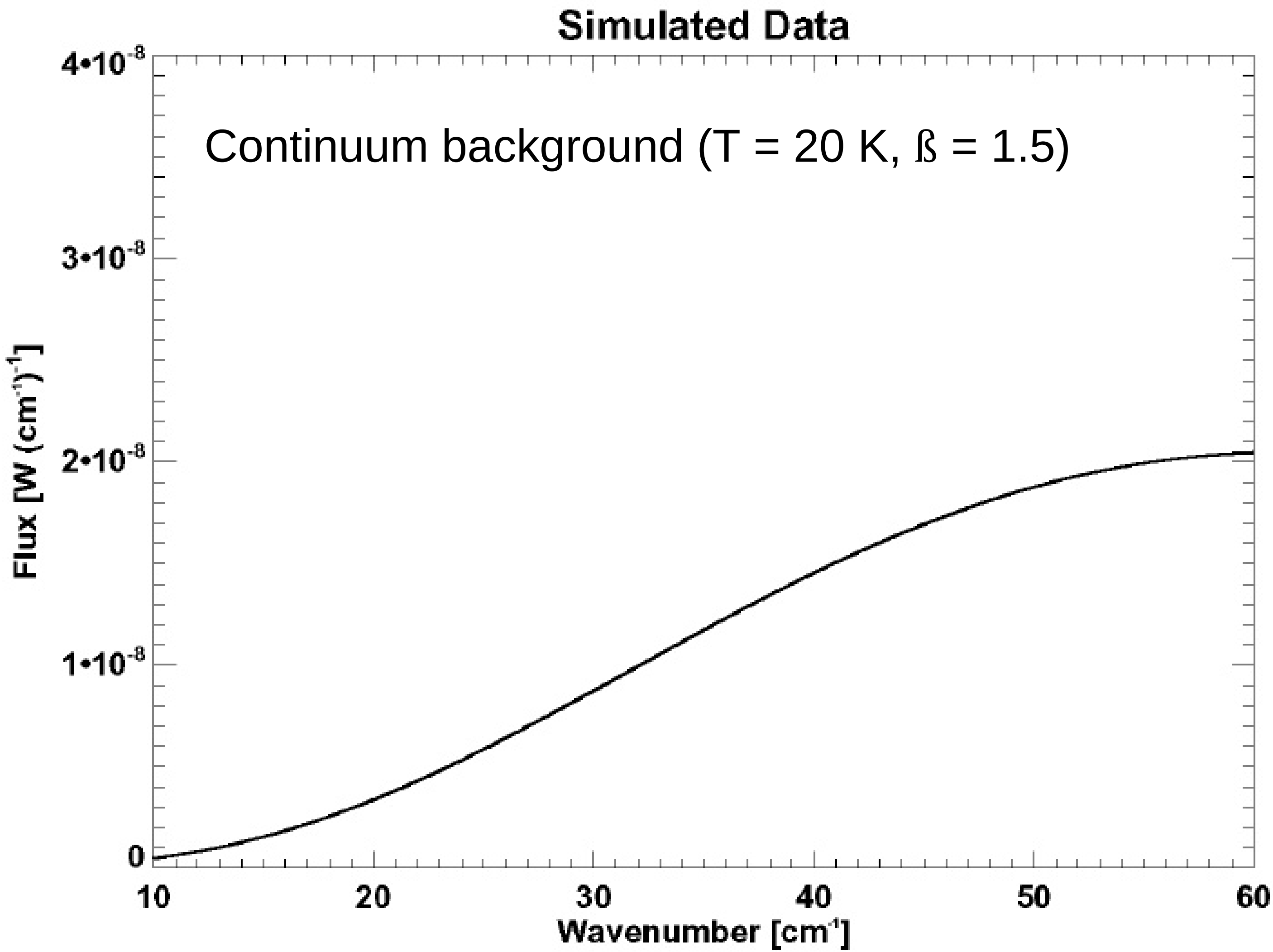
Iterative NFFT



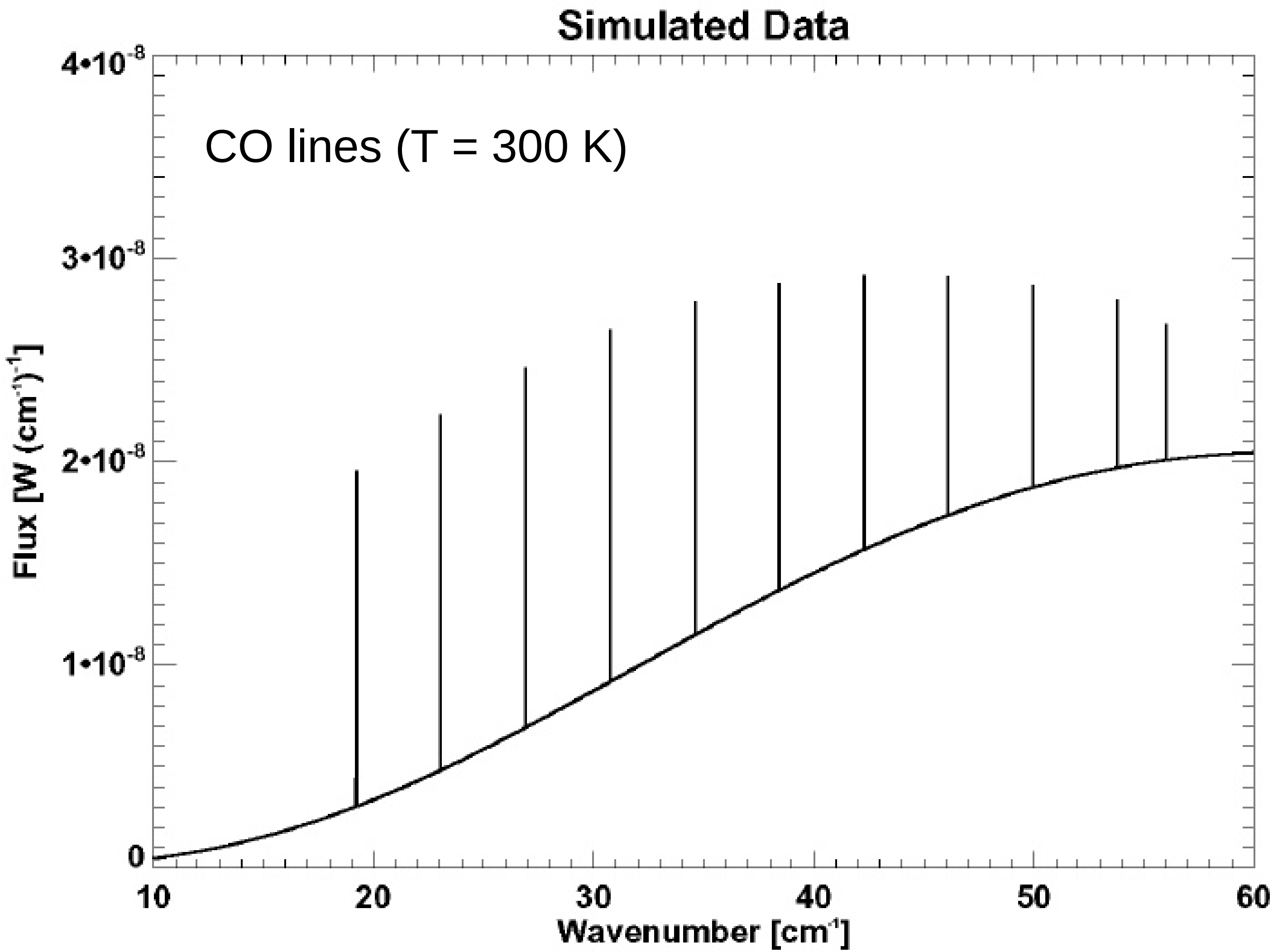
Compare Fourier transformation methods on simulated data

The simulated spectrum is based on:

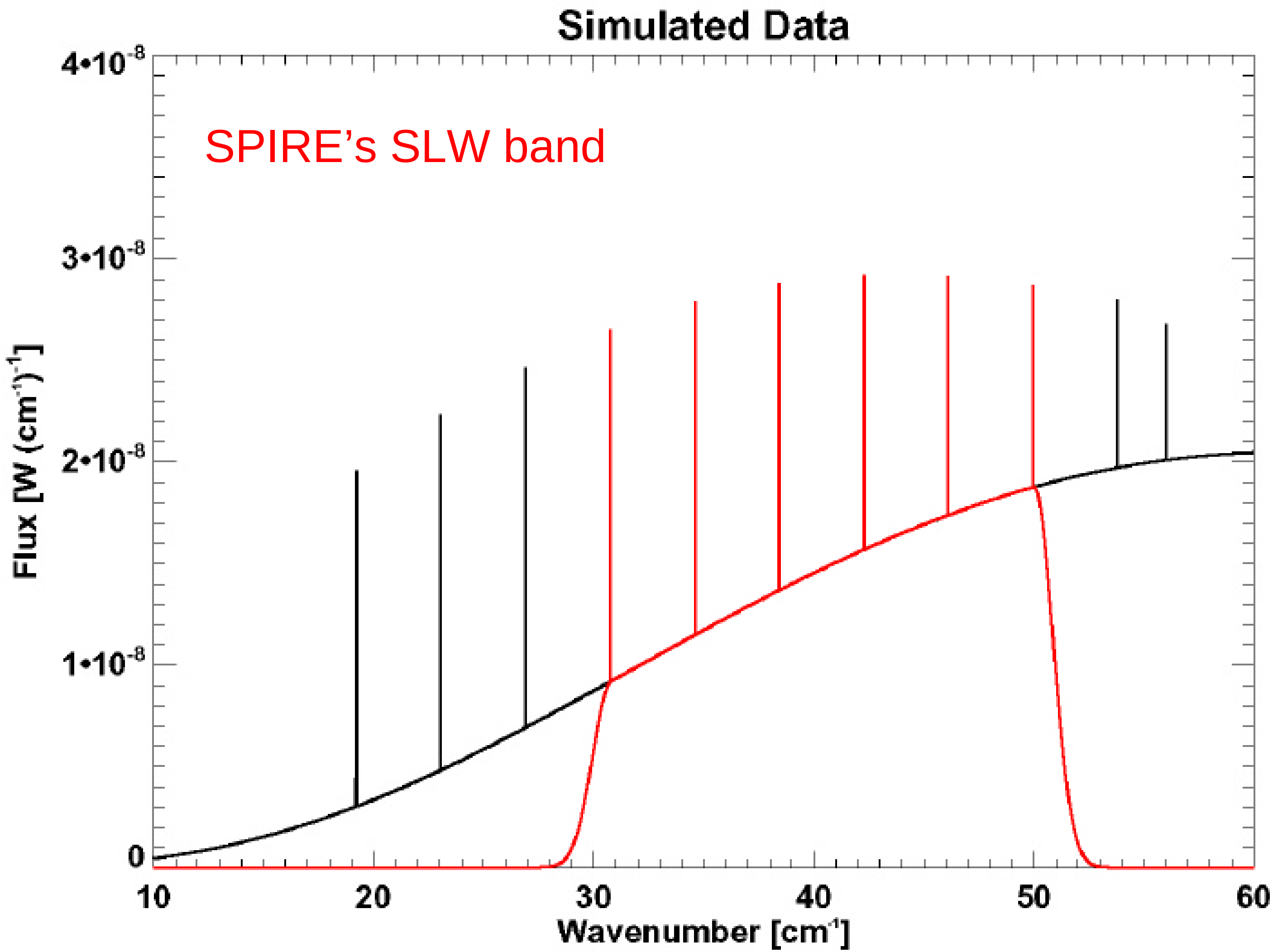
- Continuum from cold dust,T = 20 K, ß = 1.5
- Unresolved lines from hot CO, T = 300 K
- Two SPIRE bands (SSW & SLW)
- Stage jitter: 0.3% and 3%
- Best nominal resolution of $\Delta\sigma = 0.04\ cm^{-1}$



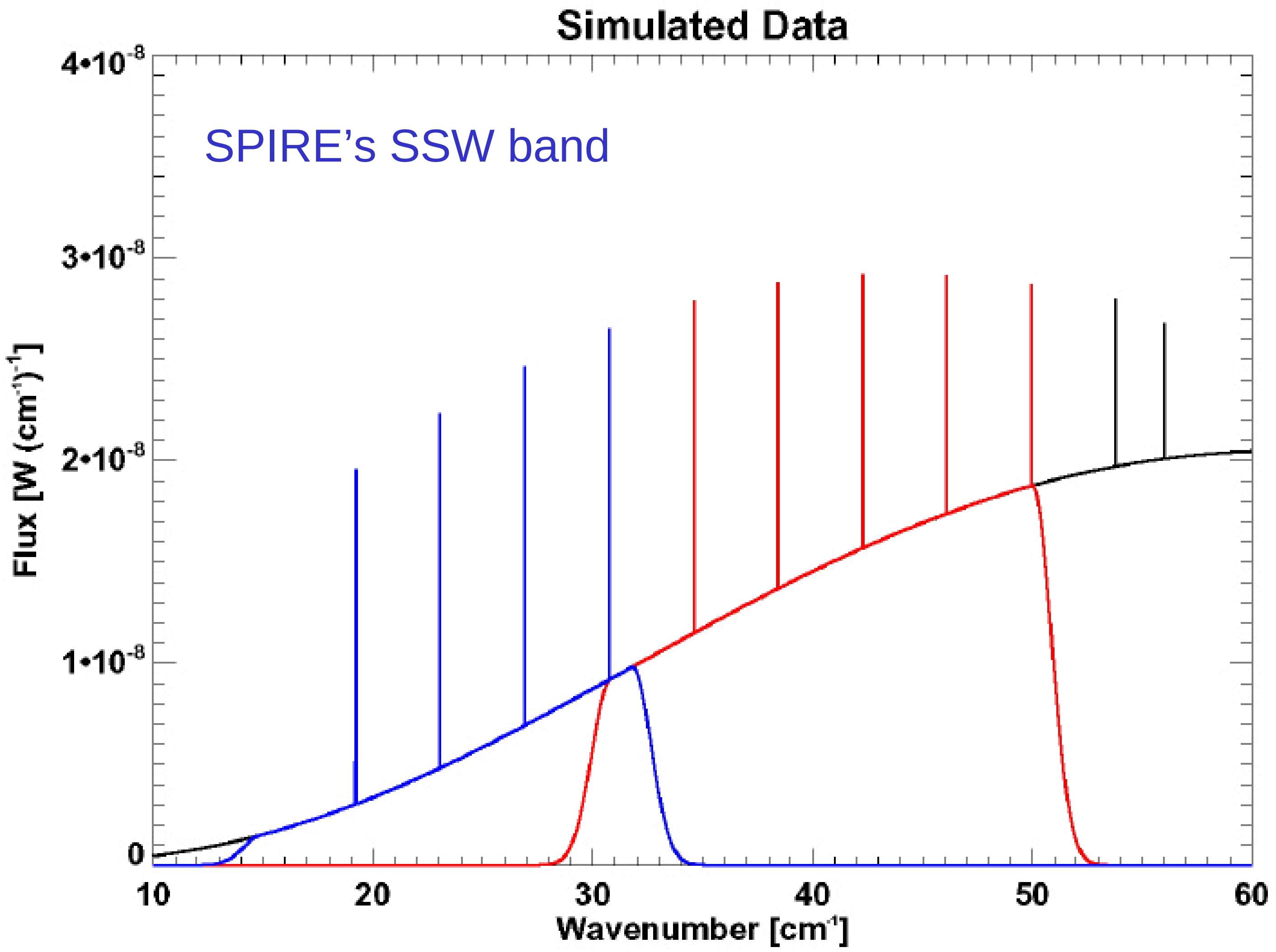
Simulated Data
Continuum background (T = 20 K, ß = 1.5)
4•10-8
3•10-8
2•10-8
1•10-8
0
Flux [W (cm-1)-1]
10
20
30
40
50
60
Wavenumber [cm-1]



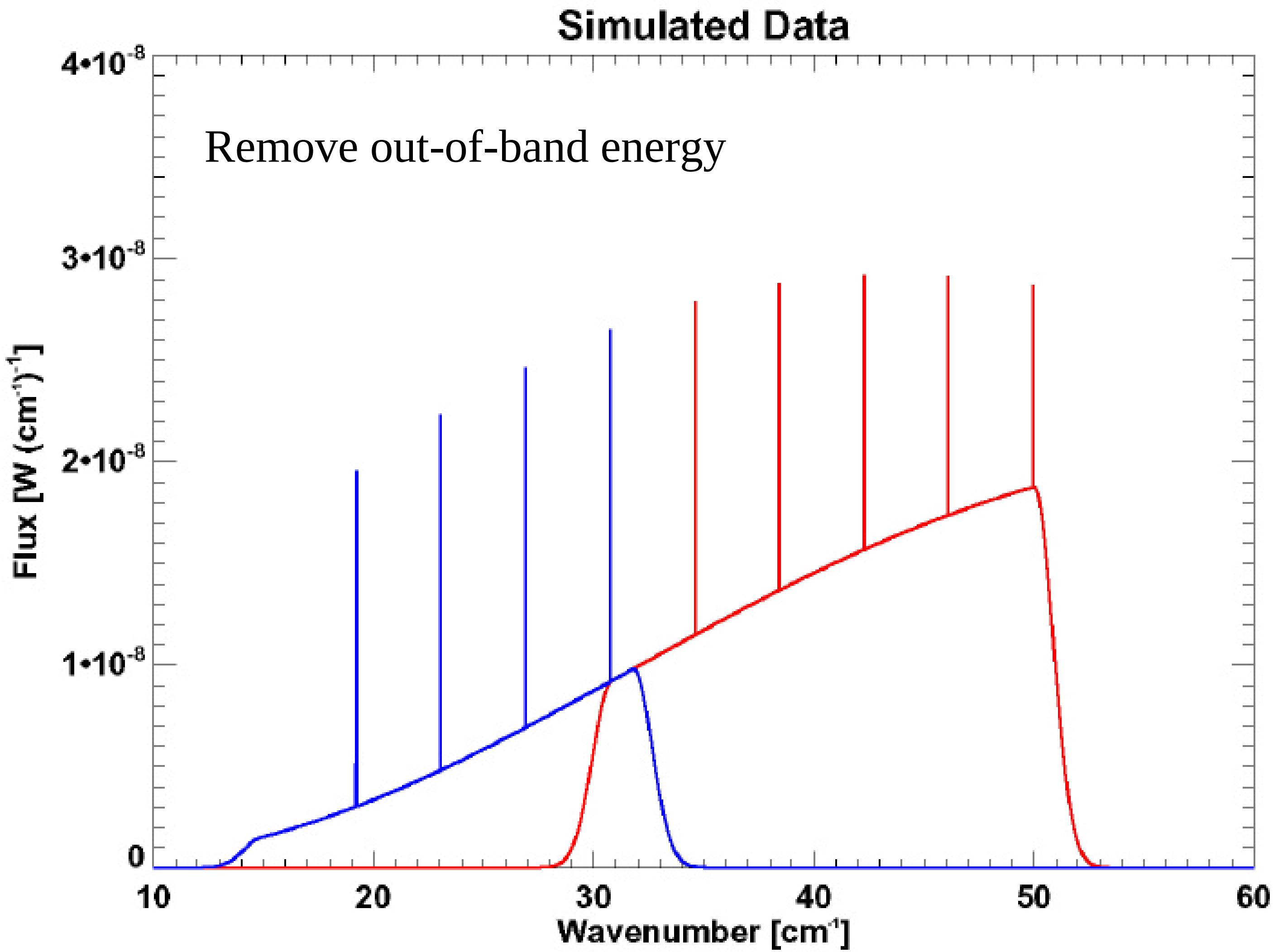
Simulated Data
CO lines (T = 300 K)
4•10-8
3•10-8
2•10-8
1•10-8
0
10
20
30
40
50
60
Wavenumber [cm-1]
Flux [W (cm-1)-1]



Simulated Data
SPIRE's SLW band
Flux [W (cm-1)-1]
Wavenumber [cm-1]
4•10-8
3•10-8
2•10-8
1•10-8
0
10
20
30
40
50
60



Simulated Data
SPIRE's SSW band
Flux [W (cm⁻¹)⁻¹]
4•10⁻⁸
3•10⁻⁸
2•10⁻⁸
1•10⁻⁸
0
10
20
30
40
50
60
Wavenumber [cm⁻¹]



Simulated Data
Remove out-of-band energy
Flux [W (cm⁻¹)⁻¹]
Wavenumber [cm⁻¹]
4•10⁻⁸
3•10⁻⁸
2•10⁻⁸
1•10⁻⁸
0
10
20
30
40
50
60

The effect of stage jitter (0.3%) on the spectrum

Relative uncertainties for continuum and lines for the two SPIRE bands as a function of FT method:

SSW	BB temp diff [mK]	abs beta diff	line centre differences [cm-1]	line amplitudes differences [%]
iNFFT	-1.80	2.76E-04	4.63E-05	0.22%
Sinc-Gaus	-2.48	1.22E-03	4.89E-05	0.68%
Spline	6.68	-1.37E-03	2.95E-05	0.24%
NDFT	54.88	-6.80E-03	4.65E-05	0.24%

SLW	BB temp diff [mK]	abs beta diff	line centre differences [cm-1]	line amplitudes differences [%]
iNFFT	14.37	-3.16E-03	6.55E-05	-0.79%
Sinc-Gaus	-14.88	2.11E-03	2.69E-05	-1.22%
Spline	9.98	-2.49E-03	3.57E-05	-0.56%
NDFT	19.63	-8.09E-04	7.31E-05	0.42%

The effect of stage jitter (3%) on the spectrum

Relative uncertainties for continuum and lines for the two SPIRE bands as a function of FT method:

SSW	BB temp diff [mK]	abs beta diff	line centre differences [cm-1]	line amplitudes differences [%]
iNFFT	-1.96	3.02E-04	4.97E-05	0.23%
Sinc-Gauss	49.75	-3.38E-03	4.20E-05	1.35%
Spline	106.53	-1.80E-02	2.67E-05	0.24%
NDFT	4.93	8.30E-03	4.99E-05	0.75%

SLW	BB temp diff [mK]	abs beta diff	line centre differences [cm-1]	line amplitudes differences [%]
iNFFT	14.65	-3.22E-03	6.67E-05	-0.80%
Sinc-Gauss	-135.00	2.17E-02	2.53E-05	-1.39%
Spline	38.40	-9.71E-03	3.59E-05	-0.57%
NDFT	140.14	-1.09E-02	1.38E-04	0.79%

Processing time (FT)

Processing time to Fourier transform 10000 sample points has been measured on a 333MHz, Pentium2, 512kB cache, 660 bogomip, with 294 MB of memory:

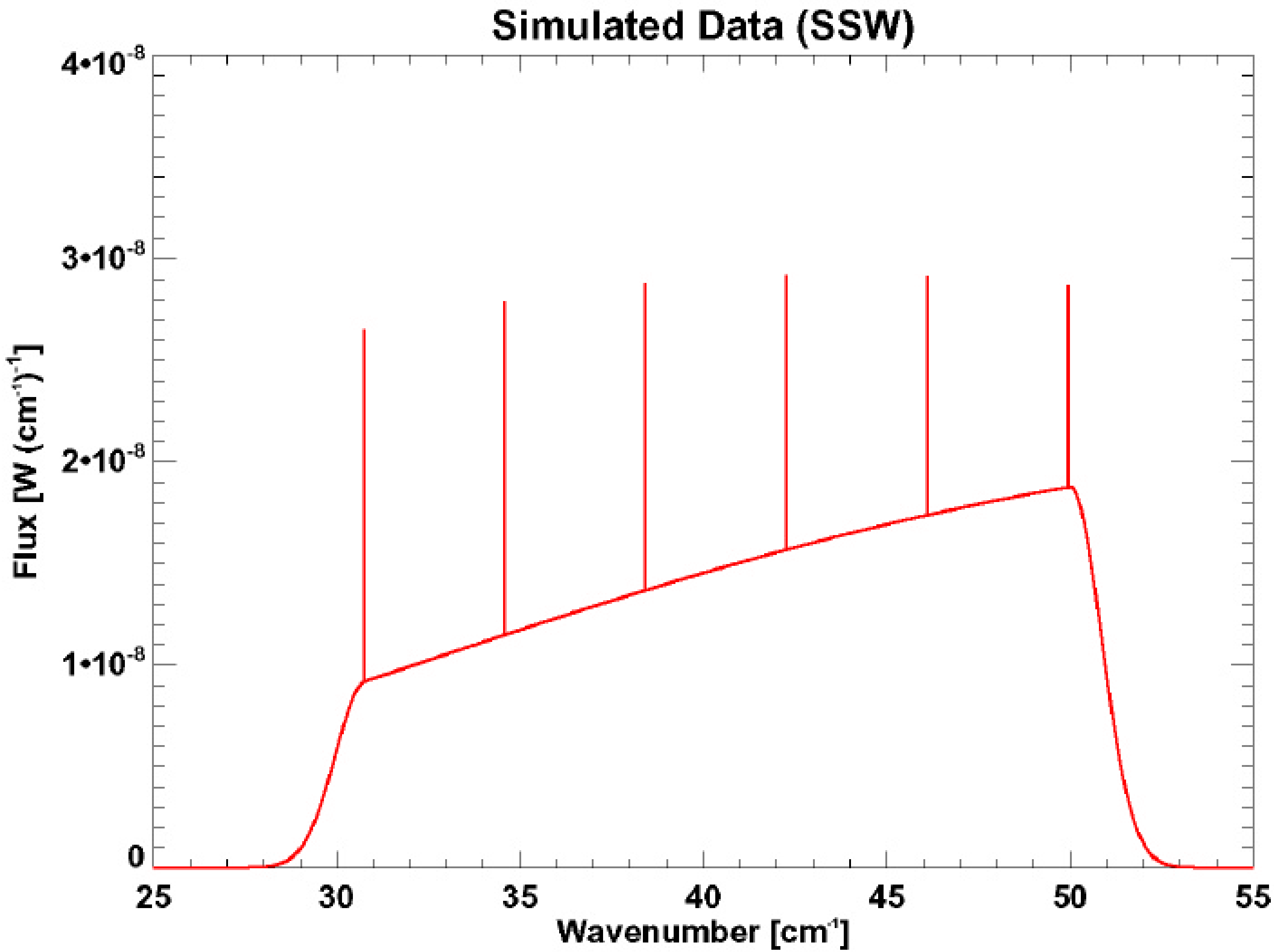
iNFFT	1.24 - 2.48 s
Sinc-Gauss	0.12 s (derived)
Spline	0.12 s (derived)
NDFT	88.12 s

$$for\ N = 10'000 : \frac{N^2}{N \ln(N)} \approx 1000$$

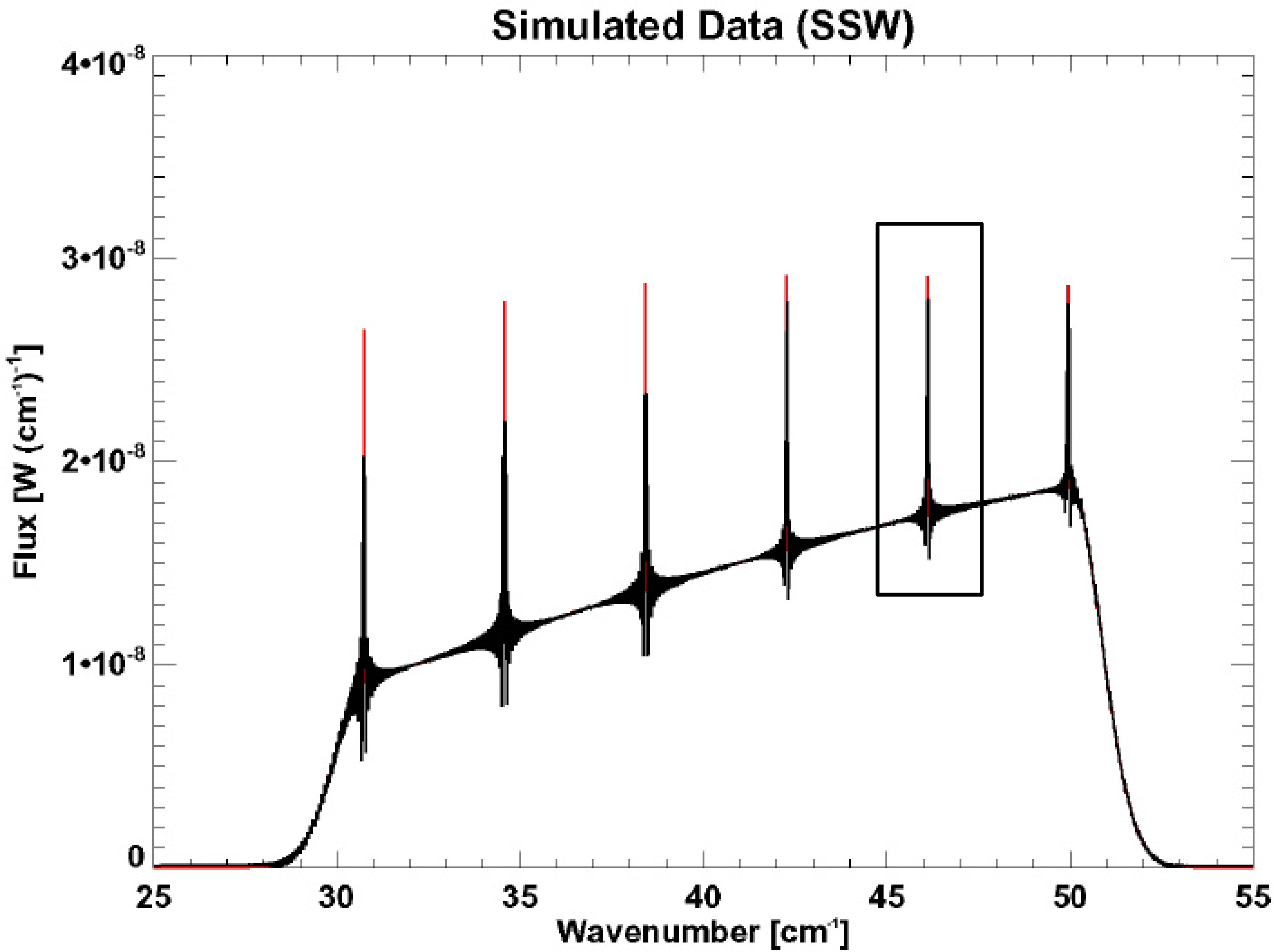
t(NDFT)/ t(FFT) ~ 734

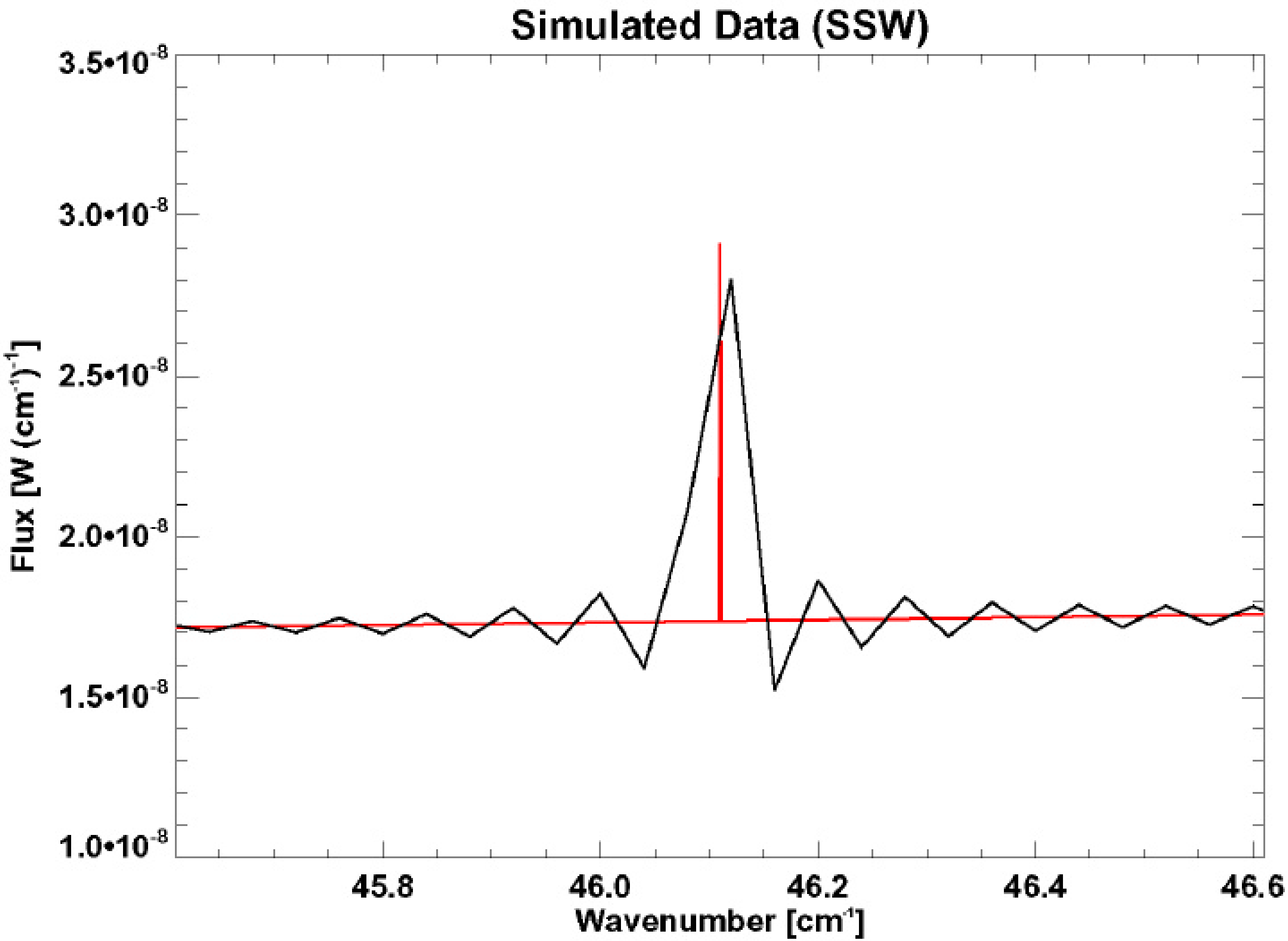
Analysis of FTS spectra requires significant post-processing!

- The FTS has the best Instrumental Line Shape of any spectrometer but it takes some getting used to!
- Can determine line positions to a small factor of the resolution.
- Deconvolution or PCA by fitting of sinc function to data.

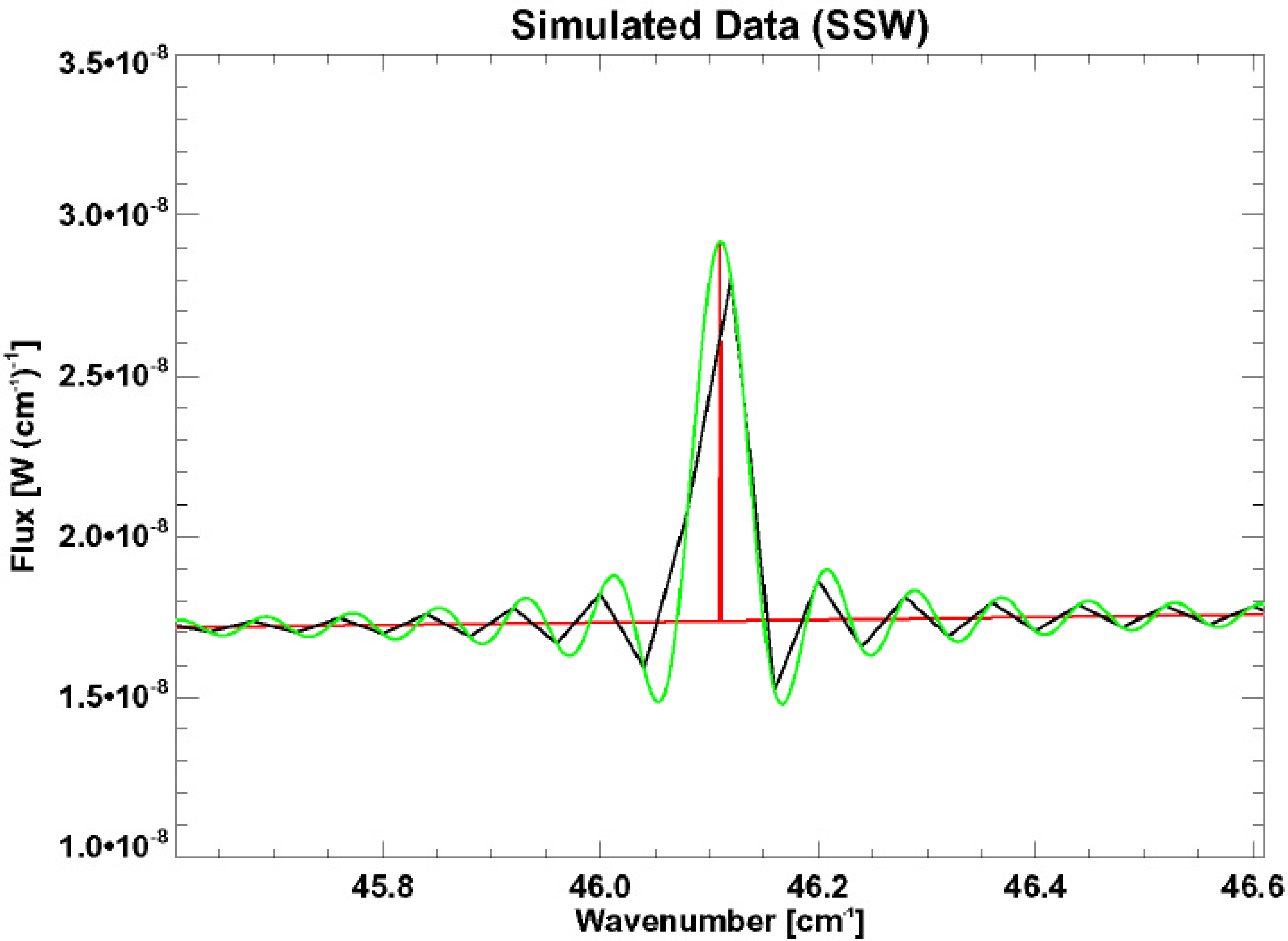


Simulated Data (SSW)
4•10-8
3•10-8
2•10-8
1•10-8
0
Flux [W (cm-1)-1]
25
30
35
40
45
50
55
Wavenumber [cm-1]

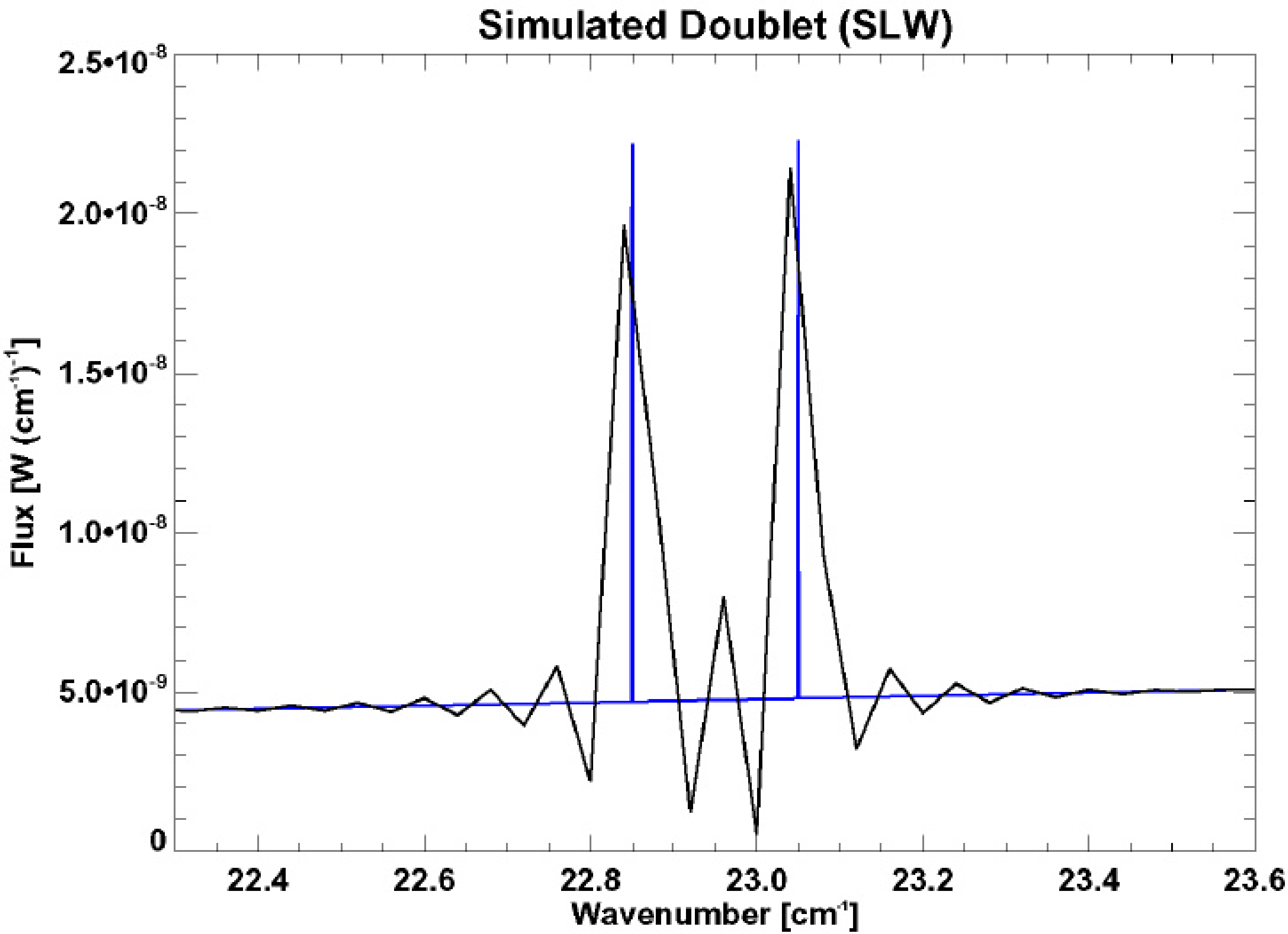

Simulated Data (SSW)
Flux [W (cm⁻¹)⁻¹]
4•10⁻⁸
3•10⁻⁸
2•10⁻⁸
1•10⁻⁸
0
25
30
35
40
45
50
55
Wavenumber [cm⁻¹]



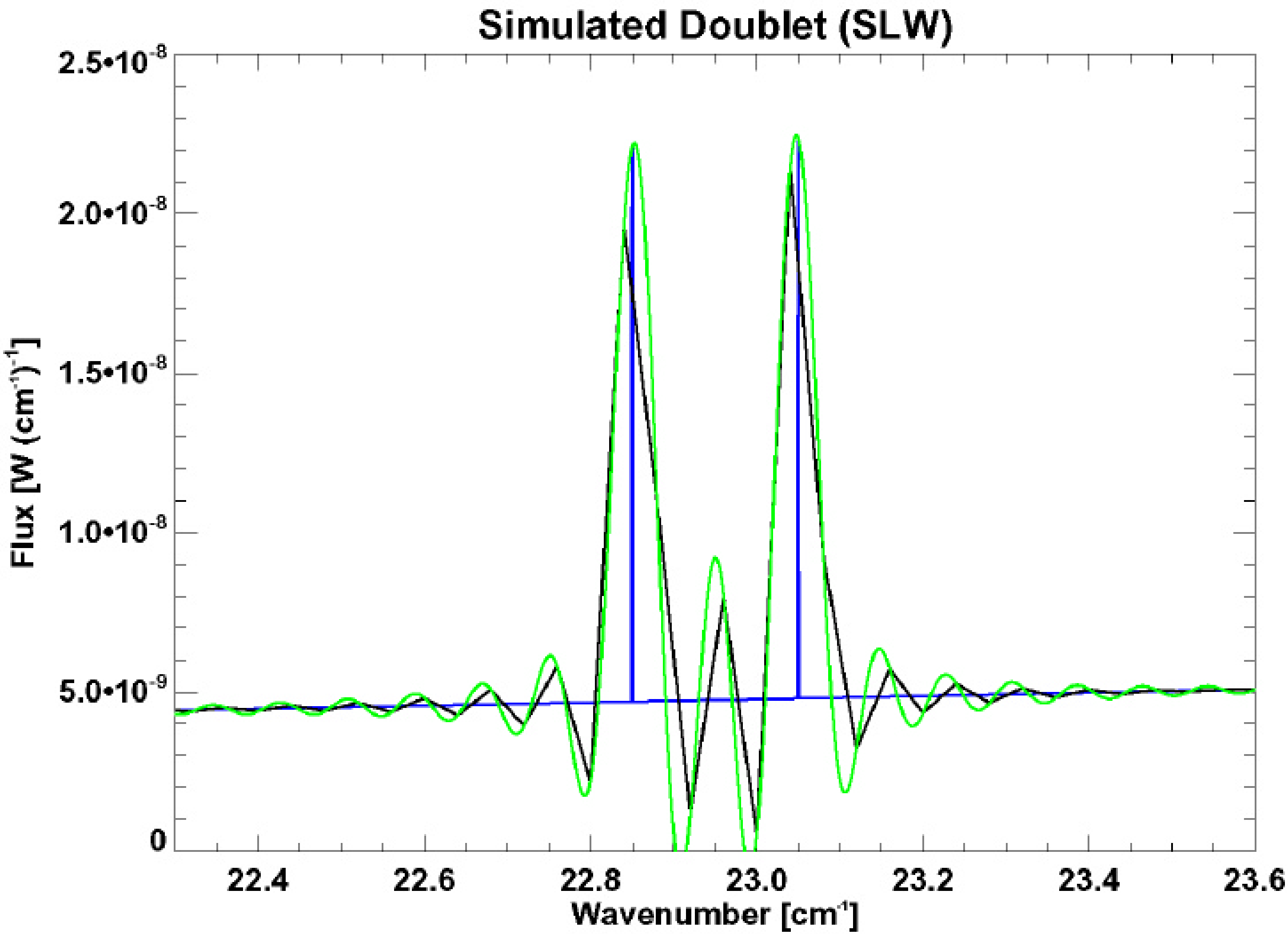
Simulated Data (SSW)
3.5•10-8
3.0•10-8
2.5•10-8
2.0•10-8
1.5•10-8
1.0•10-8
Flux [W (cm-1)-1]
45.8
46.0
46.2
46.4
46.6
Wavenumber [cm-1]



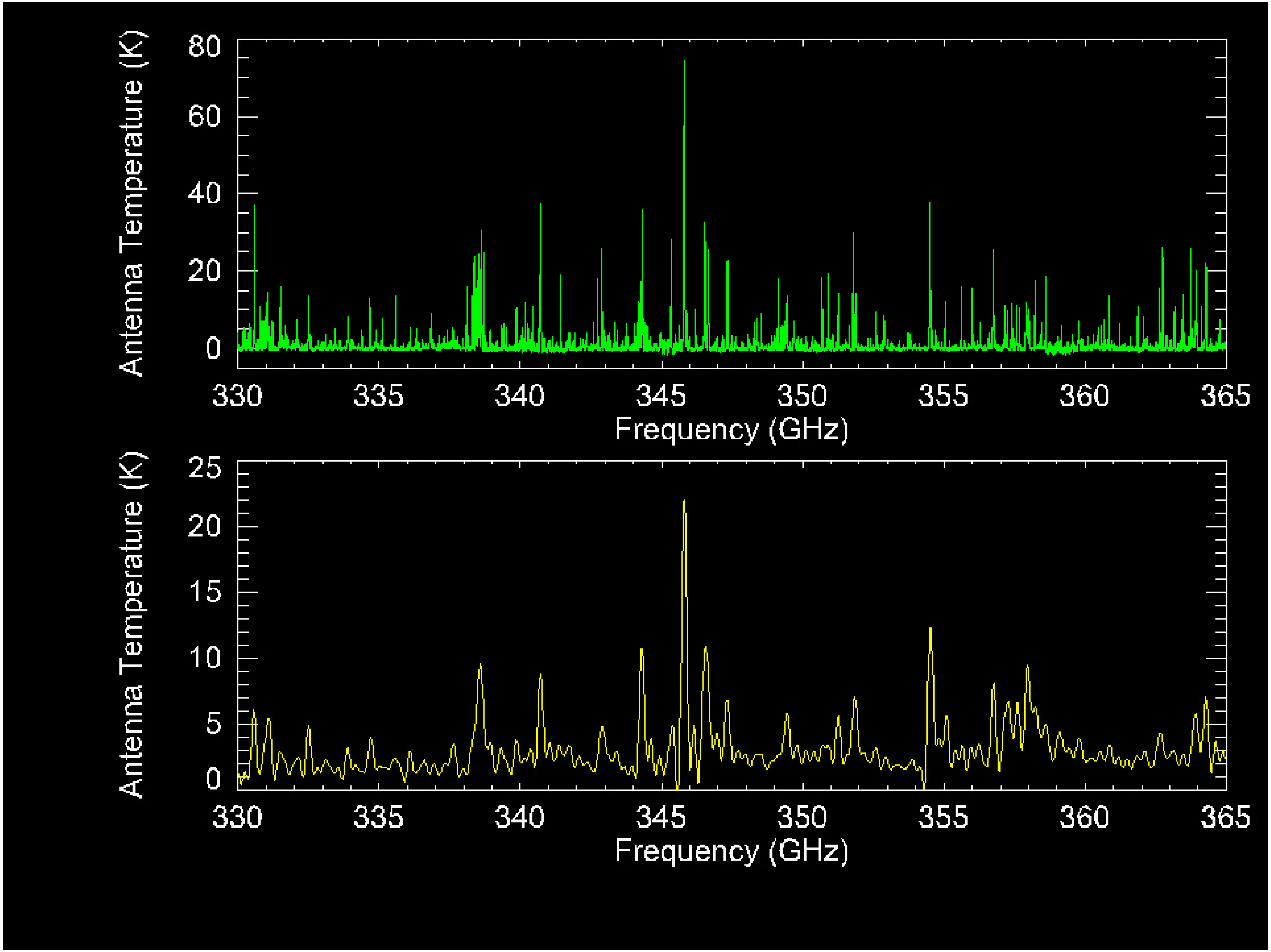
Simulated Data (SSW)
Flux [W (cm⁻¹)⁻¹]
3.5•10⁻⁸
3.0•10⁻⁸
2.5•10⁻⁸
2.0•10⁻⁸
1.5•10⁻⁸
1.0•10⁻⁸
45.8
46.0
46.2
46.4
46.6
Wavenumber [cm⁻¹]



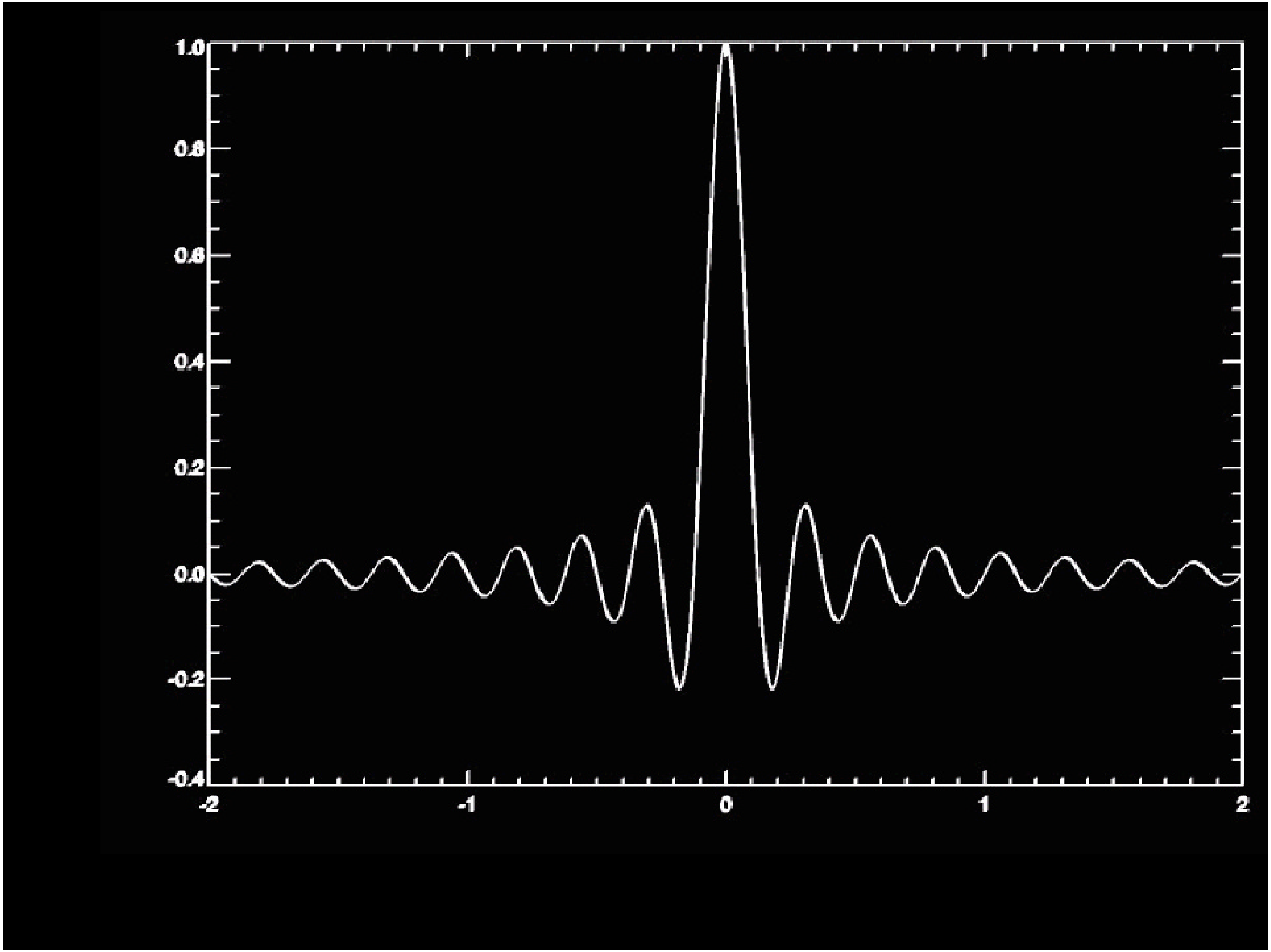
Simulated Doublet (SLW)
2.5•10-8
2.0•10-8
1.5•10-8
1.0•10-8
5.0•10-9
0
Flux [W (cm-1)-1]
22.4
22.6
22.8
23.0
23.2
23.4
23.6
Wavenumber [cm-1]

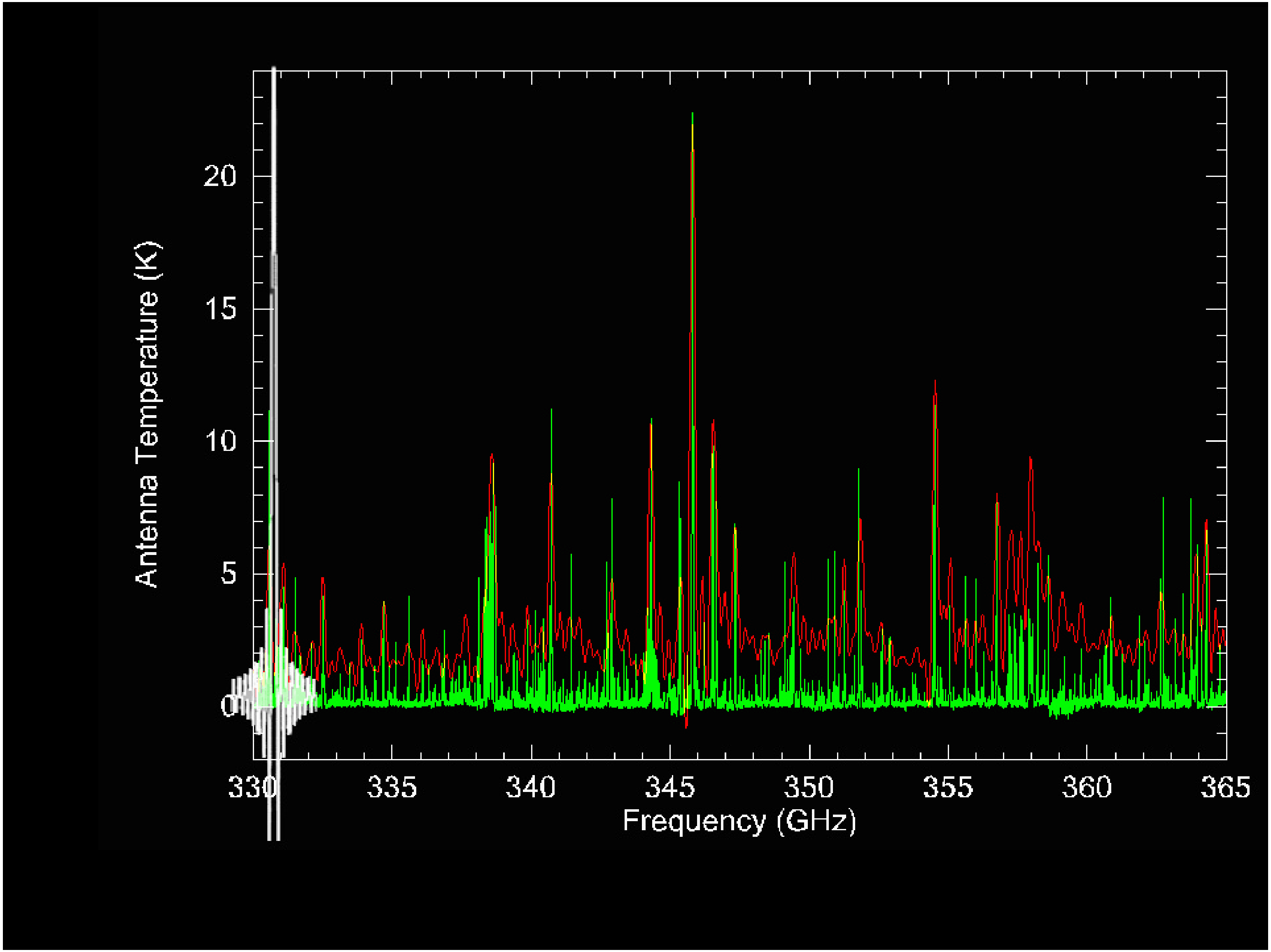


Simulated Doublet (SLW)
2.5•10-8
2.0•10-8
1.5•10-8
1.0•10-8
5.0•10-9
0
Flux [W (cm-1)-1]
22.4
22.6
22.8
23.0
23.2
23.4
23.6
Wavenumber [cm-1]

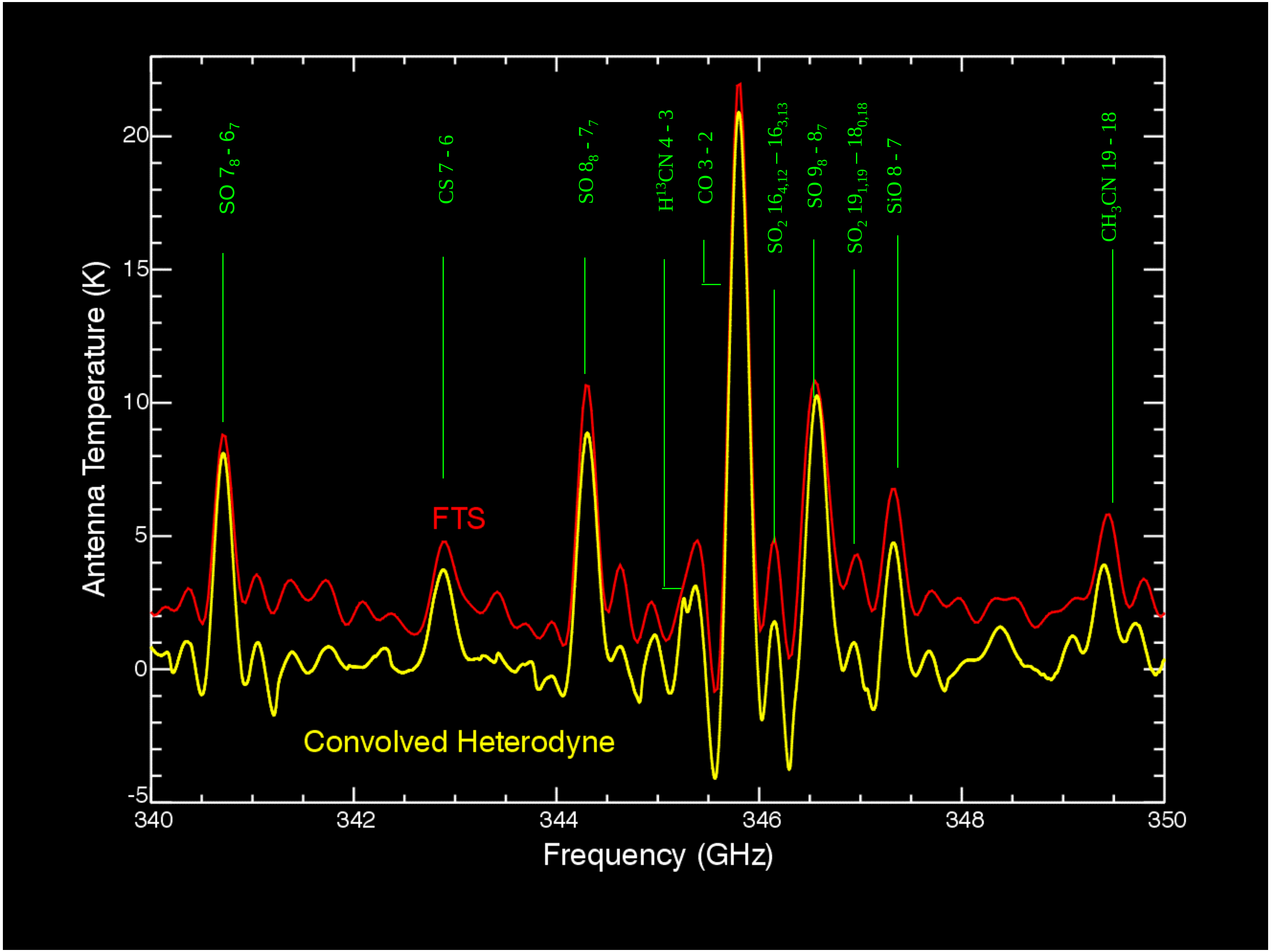


Antenna Temperature (K)
80
60
40
20
0
330
335
340
345
350
355
360
365
Frequency (GHz)
Antenna Temperature (K)
25
20
15
10
5
0
330
335
340
345
350
355
360
365
Frequency (GHz)

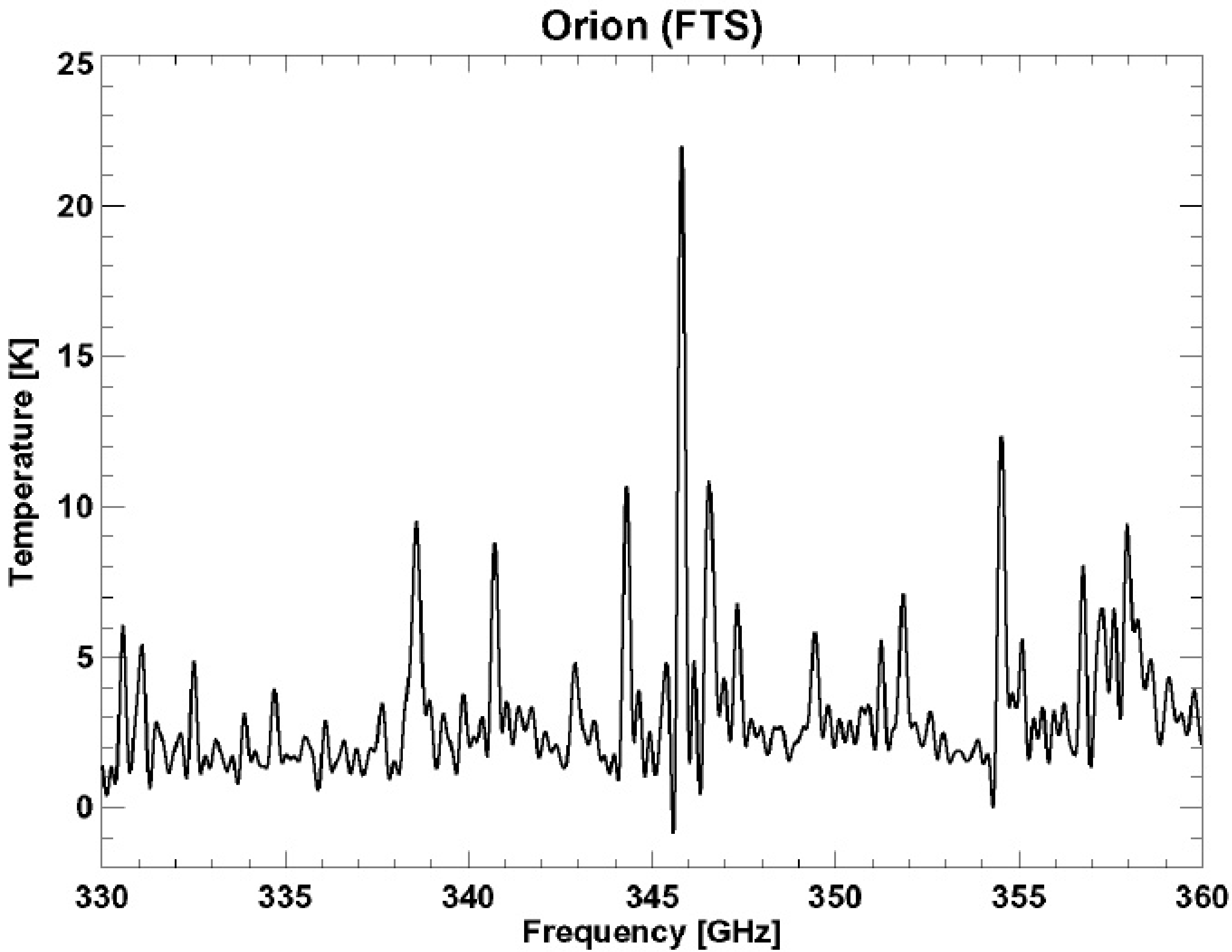

1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-2
-1
0
1
2



Antenna Temperature (K)
0
5
10
15
20
330
335
340
345
350
355
360
365
Frequency (GHz)



SO 7_8 - 6_7
CS 7 - 6
SO 8_8 - 7_7
$H^{13}CN$ 4 - 3
CO 3 - 2
SO_2 $16_{4,12}$ – $16_{3,13}$
SO 9_8 - 8_7
SO_2 $19_{1,19}$ – $18_{0,18}$
SiO 8 - 7
CH_3CN 19 - 18
FTS
Convolved Heterodyne
Antenna Temperature (K)
Frequency (GHz)
-5
0
5
10
15
20
340
342
344
346
348
350



Orion (FTS)
Temperature [K]
Frequency [GHz]
0
5
10
15
20
25
330
335
340
345
350
355
360

Status summary

- No show-stoppers in FTS data processing.
- Effect of stage jitter worse for SSW – but still excellent results from simulations.

Outstanding questions:

- Quantify and correct for cross-talk.
- How to provide the tools required to interpret spectra derived from the SPIRE FTS. (Spectrometer DAPSAS at the U of L.)

Next steps:

- Java code for PFM testing: December 2004
- Delivery of v1.0: September 2005

Report from the High-z SAG

Jamie Bock

Jet Propulsion Laboratory

Fundamental Questions We Will Address

FIR galaxies – produce half the energy density in the EGB…

- What is the luminosity function of FIR galaxies?
- How are FIR galaxies distributed in redshift?
- How are FIR galaxies associated with dark matter?
- What triggers star formation in FIR systems?
- Star formation in rich high-z environments

Formation of clusters & tools for cosmology

- Use clusters to image the high-z universe
- How useful are S-Z clusters as cosmological standard rulers?
- How do clusters form and evolve?

Energetic objects

- Hyper-luminous galaxies and lensed galaxies from Planck?

We realize we are asking for a lot of time. These are compelling questions

Summary of Proposals and Time Request

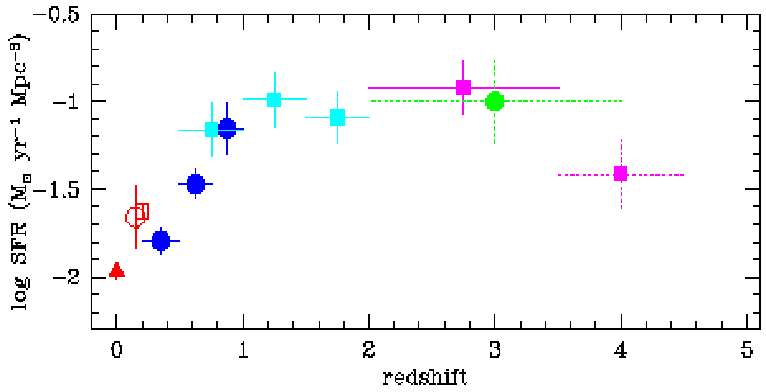
Proposal	Short Title	SAG Priority	Time [h]
The History of Energy Production in the Universe	Star Formation History	2	546 (450)
Mapping Extragalactic Correlations Fluctuations with Herschel	Background Fluctuations	3a	200 (100)
Fluctuation Analysis Below the Confusion Limit of the Far-Infrared Background	P(D)	3b	123 (68)
The Formation of Structure	Large-scale structure	3c	520 (400)
The AGN-Starburst Connection in the Very Distant Universe	AGN/starburst	5	127
Herschel Imaging of Rich Clusters of Galaxies: Ultra-deep Far-Infrared Galaxy Surveys and the Sunyaev–Zel'dovich Effect	Clusters1	1	168
The Evolution of Galaxies in Clusters and Rich Environments from z=0.5 to z=1.5	Clusters2	4	68
Herschel Follow up of Planck Candidate High z Sources	Planck Follow-up	6	50 - 80

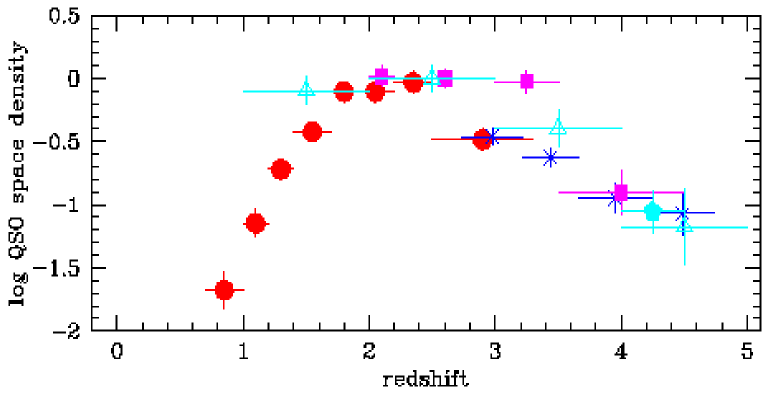
1389 h separate → 1018 h Combined . . . PACS Investment?

Total 1450 h

Detailed time justifications in each proposal – merging has not fully taken place

Star Formation History



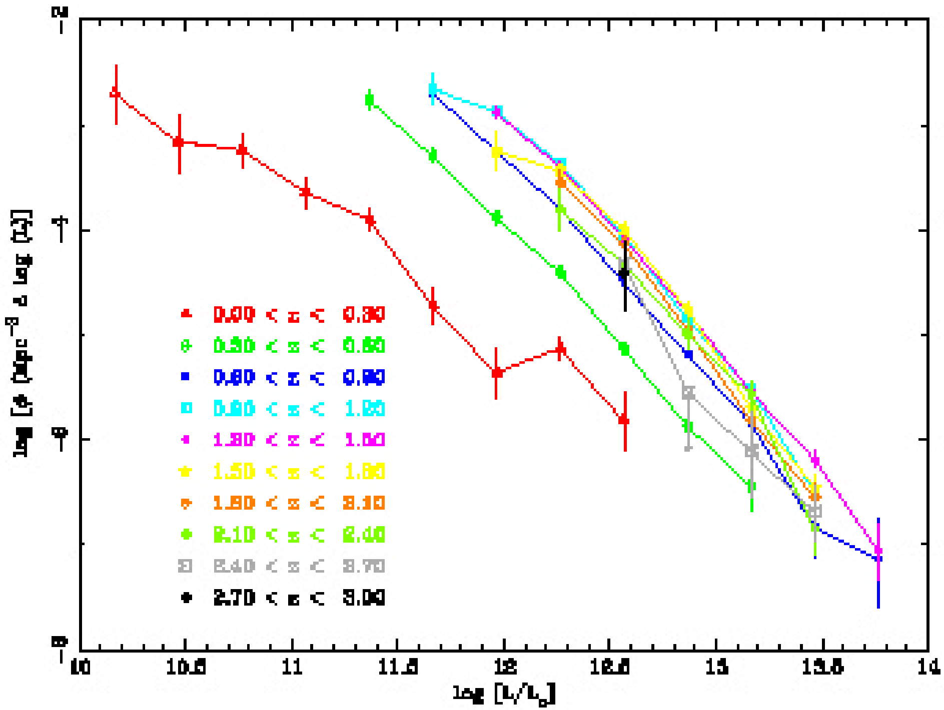


The Upcoming Herschel Epoch
SCUBA ® SPITZER ® HERSCHEL

FIR History of Star Formation
- Multicolor
- Large sample size
- Measures *bolometric* luminosity
- Wide redshift and L(bol) range

The SFR Dataset
- FIR star formation vs. luminosity?
- FIR star formation evolution in time?
- Lasting legacy
- Co-observations with many facilities

Star Formation History – Microsurveys



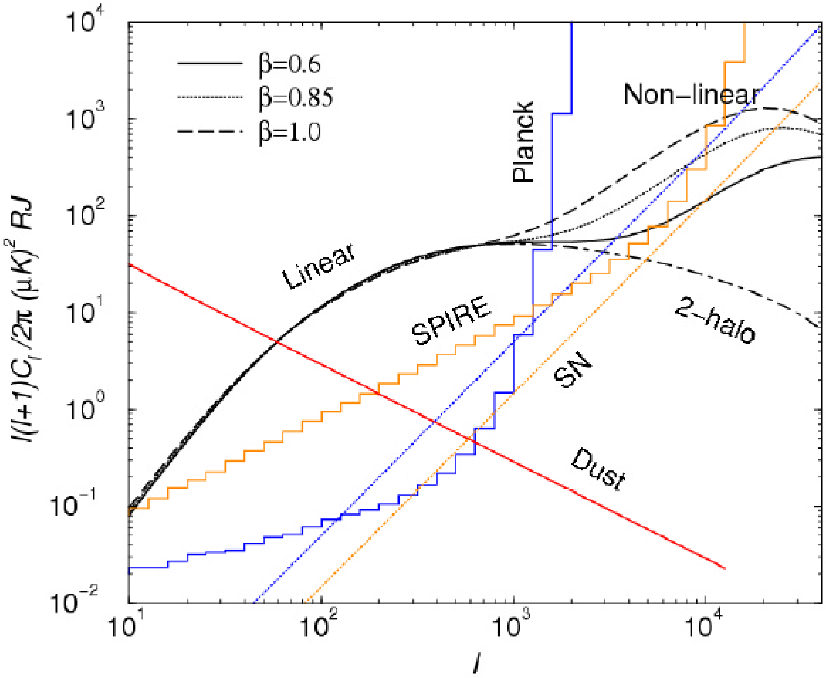
Area /deg^2	Integration Time /hours PACS	SPIRE
0.13	17.8	7.0
0.55	60.6	16.1
2.0	96.1	55.4
8.8	20.4	101.5
38.7	83.0	88.3
50.0	277.9	268.3

Survey is designed to probe L(bol) over wide redshift range

***Field selection is key*: GOODS, UKIDSS, SHADES, SWIRE, XMM etc…**

Survey has high archival value

Extragalactic Background Fluctuations



Background Fluctuations

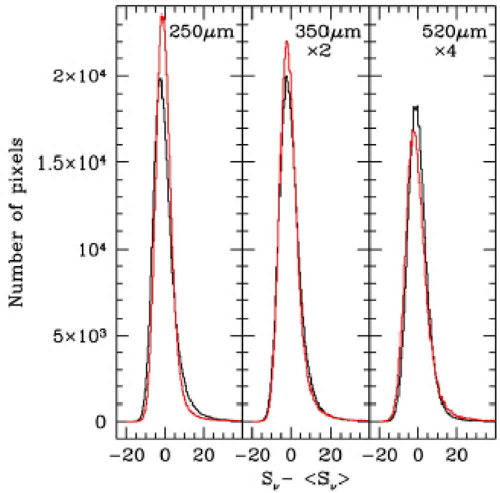
- Traces sources below confusion limit
- Probes clustering of FIR galaxies
- Non-linear clustering at high l
- & weak lensing map
- & high end of source counts

Observations

100 sq. degrees SPIRE 200 h
Optimized for clustering signal

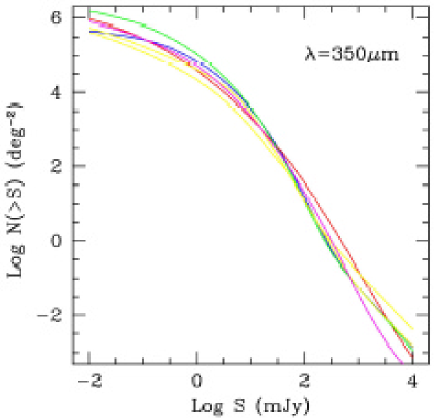
Relies on excellent spatial mapping and understanding instrument noise

P(D) Analysis



P(D) Science

- Probe source counts below confusion limit, at high z, low luminosity
- Much larger statistical power than e.g. SCUBA
- Multicolor information
- & deep source counts
- Essential information for future surveys

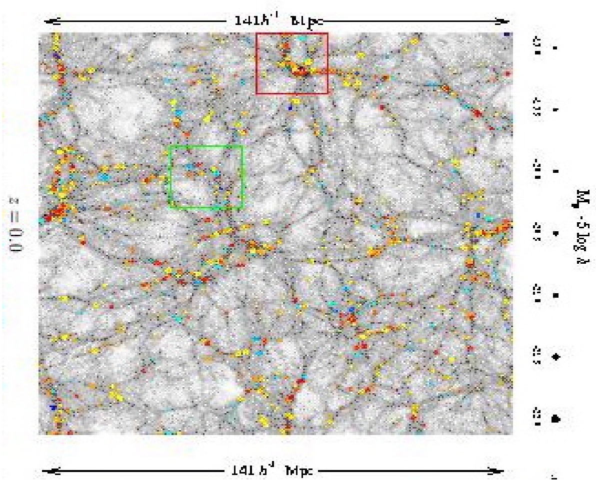


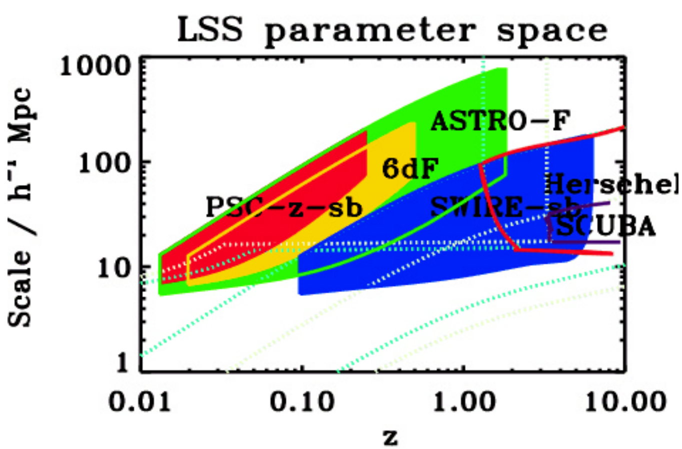
Observations

1 sq. deg. SPIRE	**100 h**
0.1 sq. deg. PACS	**23 h**

σ(inst) ~ σ(sky)/√2 at 250 μm

Large Scale Structure





LSS Science

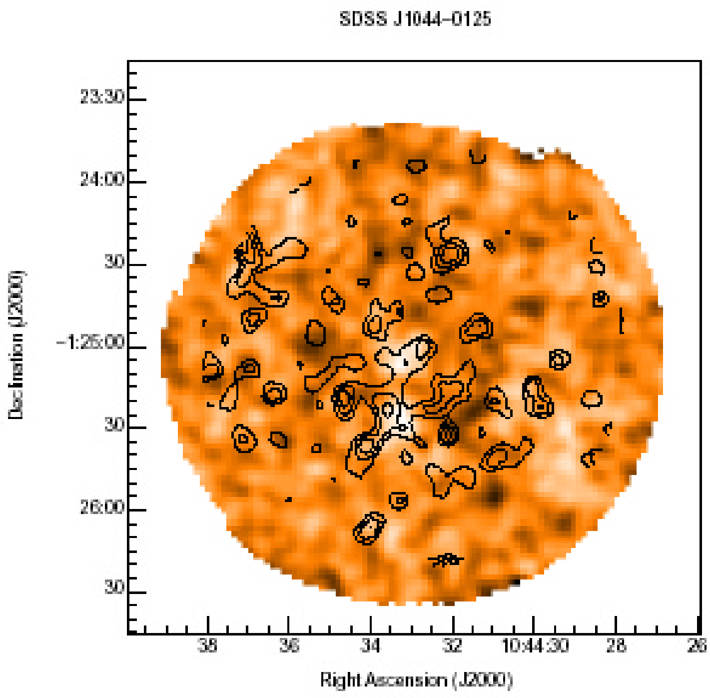
- Galaxies biased wrt dark matter
- What is large-scale structure of FIR galaxies?
- Formation of clusters
- Much larger area than GOODS & SHADES

Observations

3 x (6.25 sq. deg.) SPIRE 520 h

Chosen to measure clustering to 10 % on 5 - 20 h^{-1} Mpc comoving scales

AGN/Starburst



Star Formation in AGN Environments

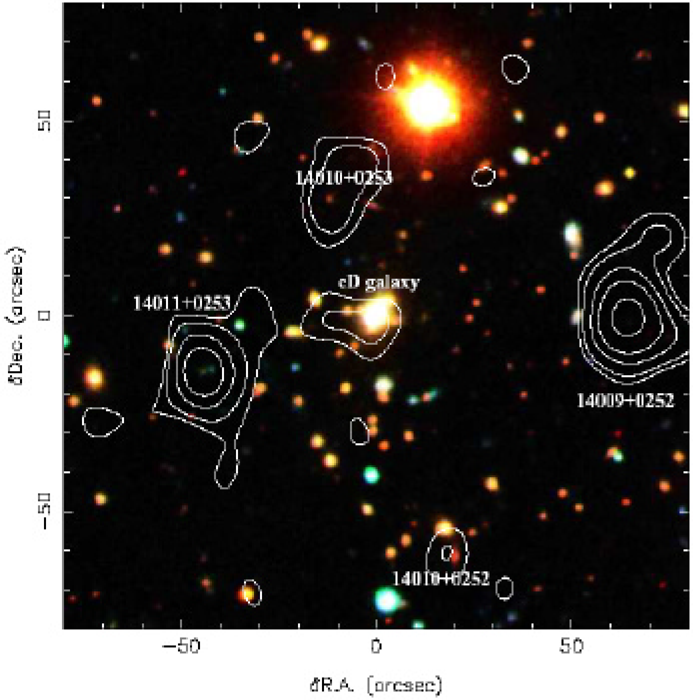
- AGNs tracer for high-z FIR galaxy formation?
- Obtain *rest-frame* SED of source galaxy
- Host galaxy evolution with redshift?
- Galaxies forming near AGN?
- What powers ULIRGs?

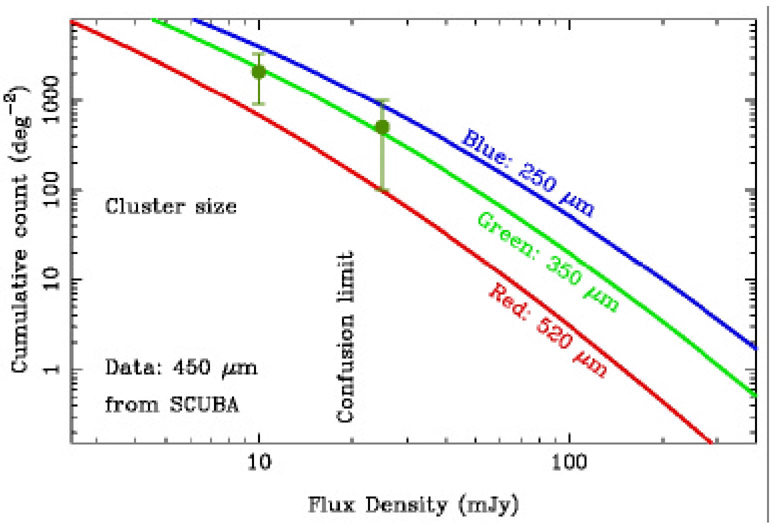
Observations

Photometry of 238 AGNs (2 < z < 6)	
SPIRE	**31 h**
PACS	**31 h**
Images 45 AGNs (2 < z < 6)	
SPIRE	**26 h**
PACS	**26 h**
Slewing	**14 h**
Total	**127 h**

Observations over wide range of AGN types

Clusters1 - Lensing

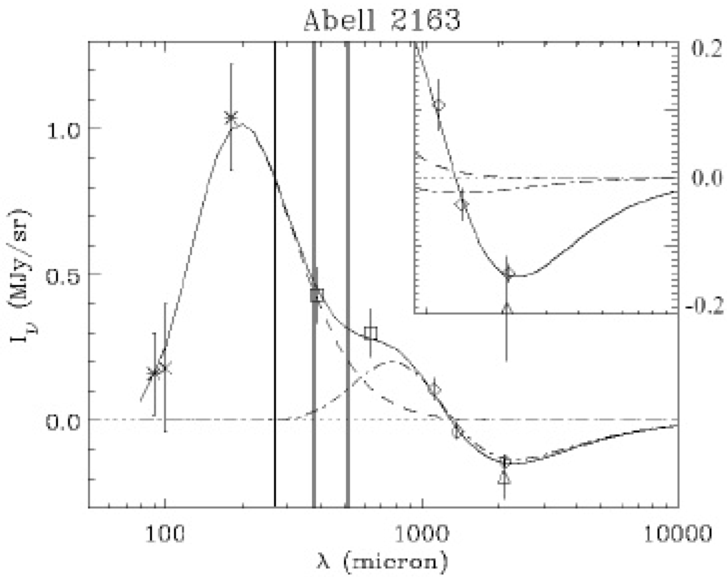




Local Clusters as Gravitational Lenses

- Brightens and separates distant FIR galaxies
- Reduces confusion limit, extends source counts
- Successful first observations with SCUBA

Clusters1 – SZ Effect



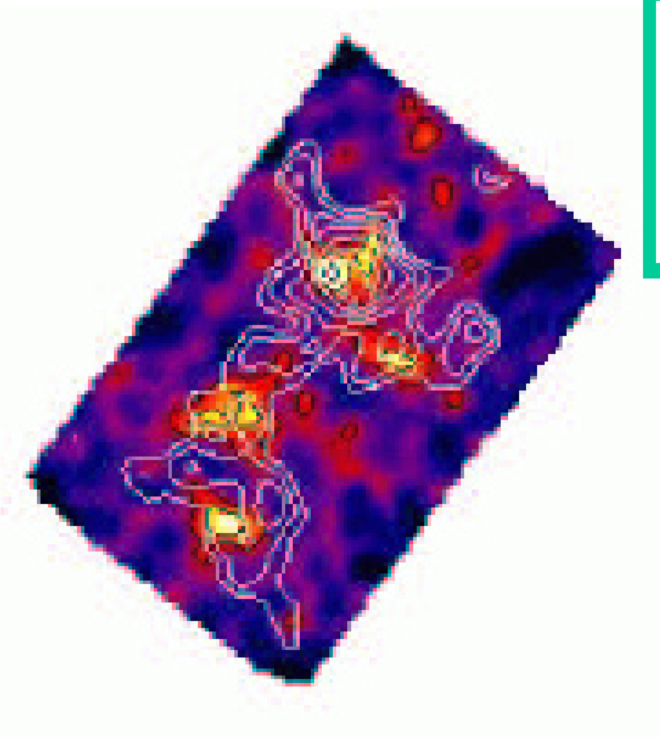
Sunyaev-Zel'Dovich Effect

- Are clusters useful cosmological standards?
- Foreground contamination?
- Intra-cluster dust?
- Galaxy contamination of S-Z effect?
- High-resolution mapping of relativistic S-Z

Observations

Image 15 clusters	
8' x 8' maps with SPIRE (scan map)	
+ 1.75' x 3' maps with PACS	**120 h**
Ultra-deep images of 2 clusters	**48 h**
Total	**168 h**

Clusters2



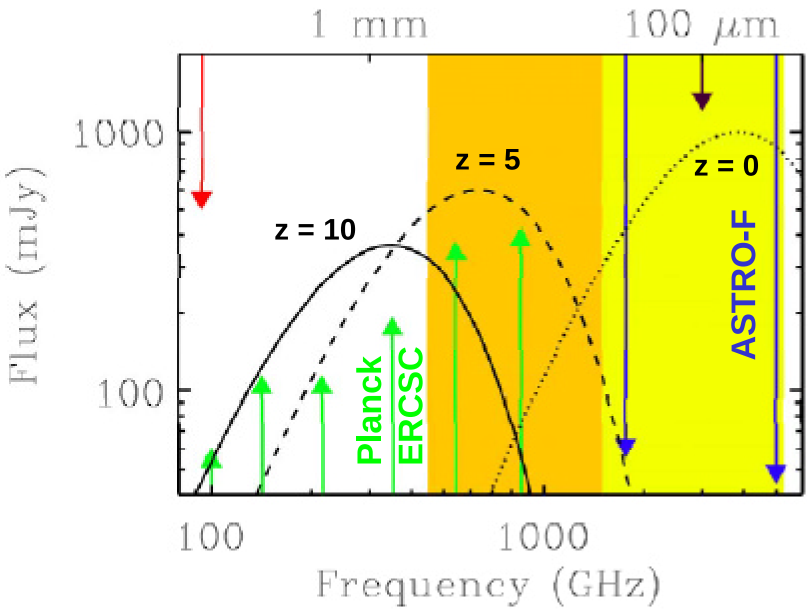
Star Formation and Environment

- Image clusters 0.5 < z < 1 & QSOs 1 < z < 1.5
- Does cluster/QSO SF mirror global SF rate?
- Properties of cluster galaxies?
- Intra-cluster dust?
- A cohesive dataset with clusters1

Observations

Image 5 clusters	
4' x 16' maps with SPIRE	**5 h**
+ 4' x 16' maps with PACS	**50 h**
Image 10 X-ray absorbed QSOs	
SPIRE	**10 h**
PACS	**3 h**
Total	**68 h**

Planck Follow-up



L+21 mos.	Submission deadline for GT2 proposals
	Planck Nominal End of Operations
L+22 mos.	*Planck ERCSC Release*
L+24 mos.	Selection and announcement of GT2 programmes
L+27 mos.	Submission deadline for OT2 proposals
L+30 mos.	Selection and announcement of OT2 programmes
L+42 mos.	End of nominal Herschel mission
L+45 mos.	*Planck Public Data Release*

Extreme Objects in Planck CSCs

- UULIRGs
- Lensed objects
- Source selection key
- ERCSC in time for GT2?
- Final CSC catalog may allow OT/GT2 (with collaboration and delayed source list)

Observations

Spectroscopy of 5 objects	
SPIRE FTS	**50 h**
100x photometry & positions	
SPIRE & PACS	**80 h**

This is not a GT1 proposal

Conclusion – Large Potential Discovery Space

Energy Production	- History of Star Formation: $0 < z < 2.5$ - FIR galaxy Madau plot - Data base with high legacy value - New populations of FIR galaxies?
Background Fluctuations	- How FIR galaxies bias wrt dark matter
Large-scale structure	- FIR galaxy population at high-z?
P(D) Analysis	- Deepest possible number counts
AGN / Starburst	- High-z FIR star formation?
Clusters	- First deep source counts (e.g. SCUBA) - First detection of relativistic SZ effect? - Intra-cluster dust? - Star-formation in cluster environments
Planck Follow-up	- Extreme & exotic objects

Agenda for High-z Splinter

1.	Run through of SAG presentation for next Day	0:15	Jamie
2.	Discussion and optimization of presentation	<0:45	All
3.	Update from OT meeting last week	0:15	Seb
4.	Future work required on proposals.	0:05	Each
	Total	1:55	

SAG 2 Local Galaxies GT Key Programs

Benchmark for understanding fundamental physical processes in the local universe:

– explores the wide variety of physical phenomena in galaxies

– indispensible for understanding galaxy formation & evolution

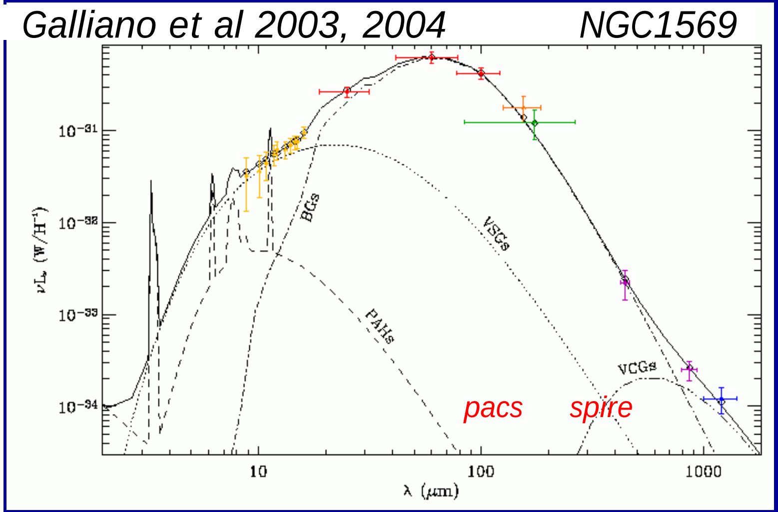
- *Evolution of the gas & dust as a function of Metallicity: Dwarf Galaxies*
- *Physical Processes in Nearby Resolved Galaxies*
- *The Herschel Reference Survey*
- *Complete Sample of Active and Starburst Galaxies*

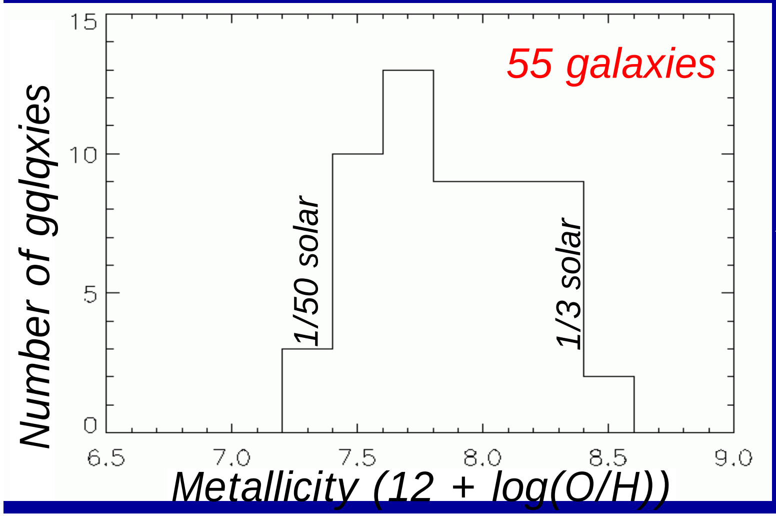
Evolution of the ISM of Galaxies as a function of metallicity: Dwarf Galaxies

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

Requires a cohesive program of SPIRE & PACS FIR/submm photometry and spectroscopy; other complementary data

Dwarf Galaxy Survey – SED Models & Sample





Source selection

- Hamburg/SAO & 1st, 2nd Byurakan Surveys
  - A treasure trove of new low Z galaxies
  - Numerous extremely low metallicity: 1/50 to 1/20
- Fill metallicity bins: at least 9 galaxies in 7 bins (accuracy 30%) where possible
  - Needs at least 55 galaxies to get statistical information in each metallicity bin
- Spitzer Observations
  - All but 10 sources being observed by all 3 Spitzer instruments

Dwarf Galaxy Survey - Observations

- PHOTOMETRY 6 FIR to submm bands
  - PACS (33h) + SPIRE BANDS (33h)
  - 45 single pointings + 10 maps

- Spectroscopy
  - PACS [CII] 2x[OI] [OIII] [NII] 45 gals = 28 h
  - HIFI both [CI] lines 55 gals = 55 h

33 h. SPIRE + 61 h. PACS + 55h HIFI =149hours

Detailed Study of Physical Processes in Nearby Resolved Galaxies

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

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

ISM of Local Galaxies: Strategy

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

  early & late type spirals, low mass spiral,

  edge-on spiral, starburst spiral,

  starburst galaxy, quiescent dwarf,

  starburst dwarf, Seyferts, ellipticals

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

Source Selection

Galaxy	Type	FOV (' x')	spire phot	pacs phot	pacs spec	HIFI / FTS	Total (hr)
M51	Late-type spiral	11'x7'	1.7h	1.7	3.2	3	6.5
M81	Early-type spiral	27'x14'	4.4	4.4	5.9	3	14.7
NGC2403	Low mass spiral	22'x12'	3.4	3.4	5.2	3	12.0
M83	Starburst spiral	13'x12'	2.4	2.4	3.6	9	17.4
NGC891	Edge-on spiral	14'x3'	1.7	1.7	3.6	3	7.0
NGC1068	Sy2	7'x6'	1.2	1.2	1.7	9	13.1
NGC4151	Sy1	6'x5'	1.0	1.0	1.7	3	3.7
NGC6822	Quiescent dwarf	16'x14'	3.0	3.0	3.5	3	9.5
IC10	Starburst dwarf	10'x10'	1.8	1.8	2.5	9	6.1
M82	starburst	11'x4'	1.7	1.7	2.5	9	14.9
Arp220	Late phase merger	2'x1'	0.2	0.2	0.9	9	10.3
Antennae	Early phase merger	4'x4'	0.2	0.2	1.5	9	10.9
CenA	Closest Ellip; AGN	2'x8'	0.5	0.5	1.9	3	11.9
NGC1404	Normal E	<4'	0.2	0.2	1.2	3	1.6
Total (hr)			33h	33h	47h	36 / 27	176h

Herschel Reference Survey of Dust in Galaxies

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

Reference Survey - Sample Selection

- *primary sample*
- 2MASS NIR K-band survey (not optically-biased)
  - Traces stellar mass
  - K< 9 => massive galaxies, descendents of early universe luminous objects
- |b| > 50 deg; unaffected by galactic cirrus
- 15 Mpc < D < 25 Mpc : far enough for single SPIRE pointing & yet close enough for spatial resolution
- K<9 => 195 galaxies (74 Es & S0s) with SPIRE
- *secondary sample*
- 9 < K < 12 & only late type galaxies
  - Stellar mass: vital parameter to predict galaxy properties
- 208 late-type gals => 30 galaxies/Hubble type
- *primary + secondary = 403 gals*

****** 123 HOURS of SPIRE time ******

Complete Survey of AGNs & Starbursts

- Characterisation of emission from starbursts and AGNs – how they interrelate
- understand how these processes influence the far-IR/submm appearance of galaxies in the Local Universe
- Galaxy evolution: provides 0-redshift baseline for high-redshift objects from Herschel exgal surveys

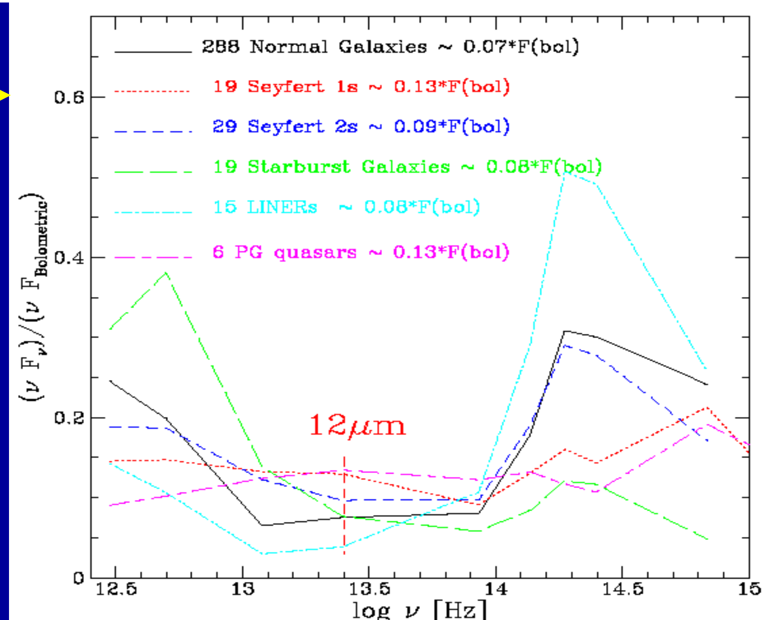
SELECTION CRITERION:

- *12mm (IRAS) Galaxy Survey* (Rush, Malkan & Spinoglio 1993)
  IR-biased sample

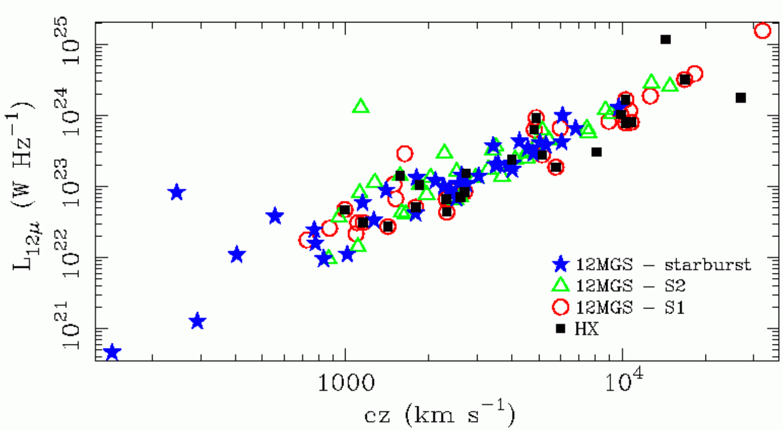
- Piccinotti sample (1982) - HEAO x-ray hard (2-10 keV) X-ray
  - independent of SF, IR radiation and dust properties – the brightest AGNs.

12 MGS: IRAS 12mu contains a constant fraction (1/5) of bolometric flux for active galaxies

Piccinotti sample(2 to 10 keV) selected purely on the basis of accretion radiation – covers the full spectrum of accretion power in the local Universe. - picks out the brightest AGNs



[Spinoglio et al.1995, ApJ 453,616]



12MGS (12 mu flux 0.4 mJY)

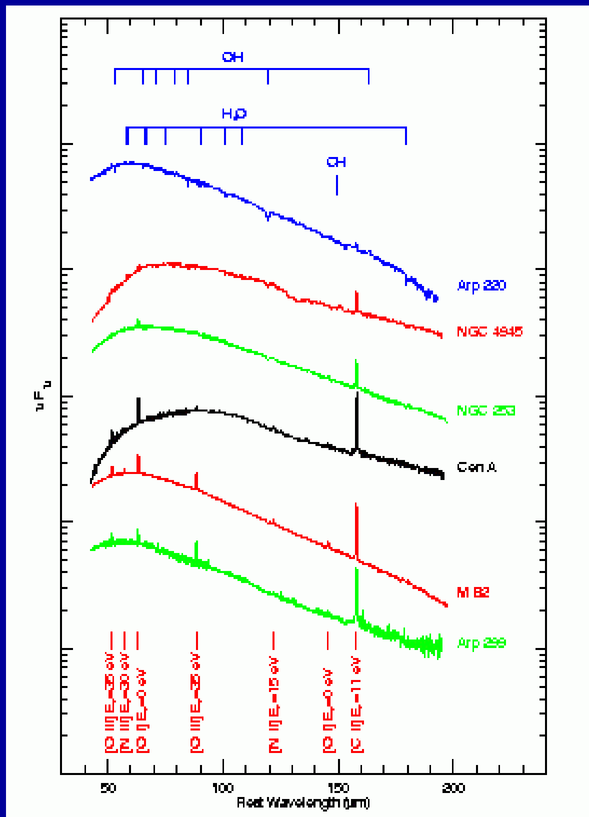
+ Piccinotti (all AGNs)

37 S1s, 34 S2s, 37 SB=108

complete survey of the nearest & brightest objects -

wide range of 12 mu L

Starbursts & AGN survey – Spectro + Photom



ISO LWS: Fischer et al 1999

FIR/submm line diagnostics

PACS 1 pointing (all 108 galaxies)

[CII], 2x[OI], [OIII], [NII] (5 lines)

- 1 to 3 OH rotational doublets
- 1 to 3 H2O lines
- 1 to 3 high J CO lines
- *108 galaxies x 9 lines = 54h*

SPIRE FTS 15 objects (37.5 h)

- high-J lines, H2O, other molecules

Photometry all 108 gals

PACS (70, 110, 170 mu)   (23 h)

- 1 pointing: 75 gals, maps 33 gals

SPIRE (250, 350, 500 mu) (28 h)

•1 pointing: 92 gals, maps16 gals

******   66 h. of SPIRE + 77 h. of PACS = 143 hours ******

SUMMARY of SAG 2 Key Programs

Key program	SPIRE	PACS	PACS* consort	HIFI	HIFI consort	total
Dwarf Galaxies	***33h***	***61h***	~30h	***55h***	?	**149h**
ISM of nearby gal	***60h***	***80h***	~60h	***36h***	?	**176h**
Herschel Reference Survey	***123h***	no		no	-	**123h**
AGNs/ SBs	***65h***	***77h***	~40	no	-	**142h**
Total	*281h*	*218h*		*91h*		*590h*

**Note:* *PACS consortium individuals own their data*

SAG 3 Proposals for SPIRE GT Key Projects

• From clouds to cores to protostars: Probing the origin of the IMF from low-mass to intermediate-mass (**Gould Belt** survey)
Wide-field (~140 deg^2) photometric imaging of nearby clouds

(195 - 9 = 186 hr of SPIRE + 63 hr of PACS follow-ups;
closely coordinated with parallel PACS GT KP: > 170 hr
and with SAG 4 KP: 18 hr of SPIRE + 16 hr of PACS in common)

• Toward a complete evolutionary scenario for **OB star formation** :
Imaging survey of high-mass star-forming complexes at intermediate distances (~ 40 deg^2 = 60 hr of SPIRE + ~ 20 deg^2 = 50 hr of PACS)

Scientific Motivation of the Gould Belt Survey

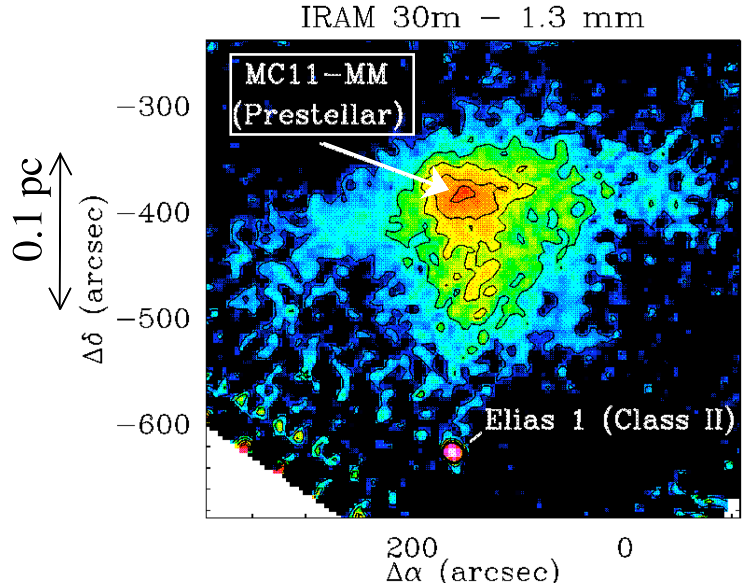
Key questions on the earliest phases of star formation:

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

Prestellar Cores (t < 0)
The progenitors of protostars

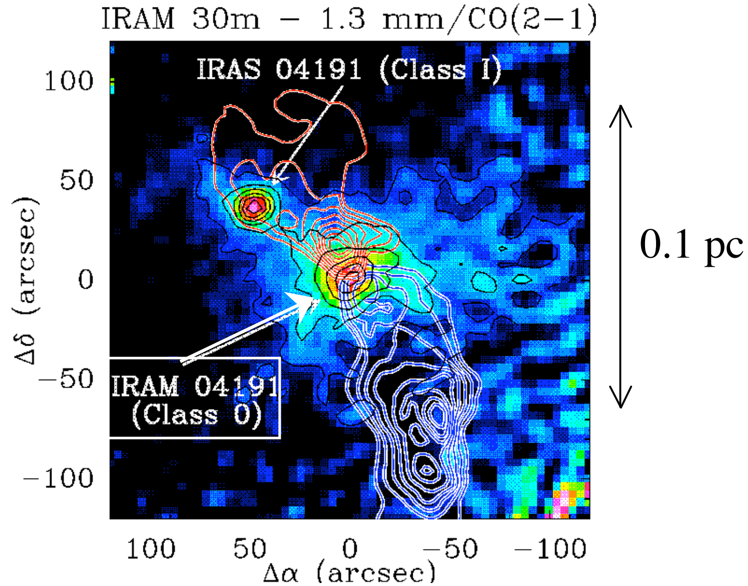
→

Class 0 protostars (t > 0)
Protostars in the build-up phase



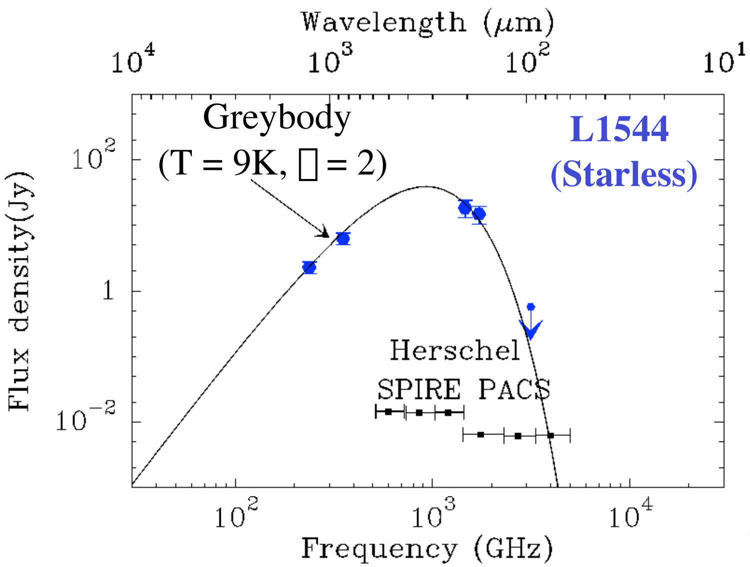
Sizes: ~ 0.01 pc
to ~ 0.1 pc
(**resolved by SPIRE**
up to ~ 0.5 kpc)

No complete census so far



Gravitationally bound ($M \sim M_{VIR}$, $M_* = 0$)

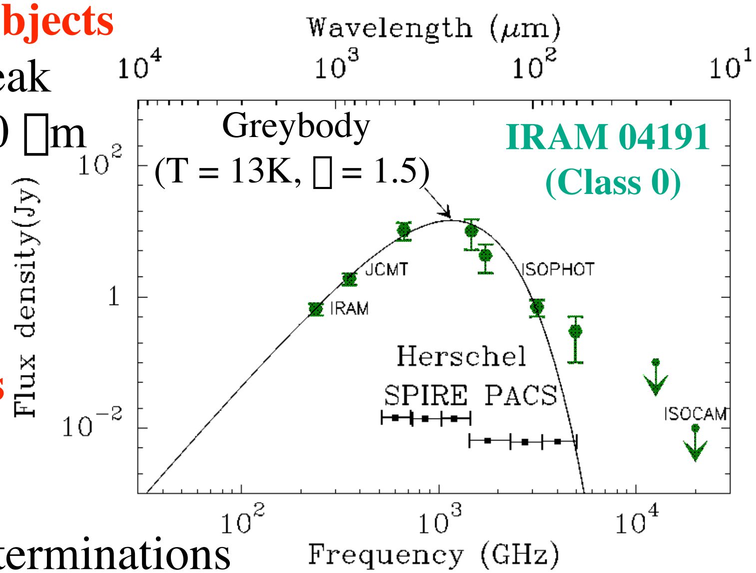
Massive envelopes ($M_{env} > M_*$)



Submm-only objects whose SEDs peak @ λ ~ 100-400 μm

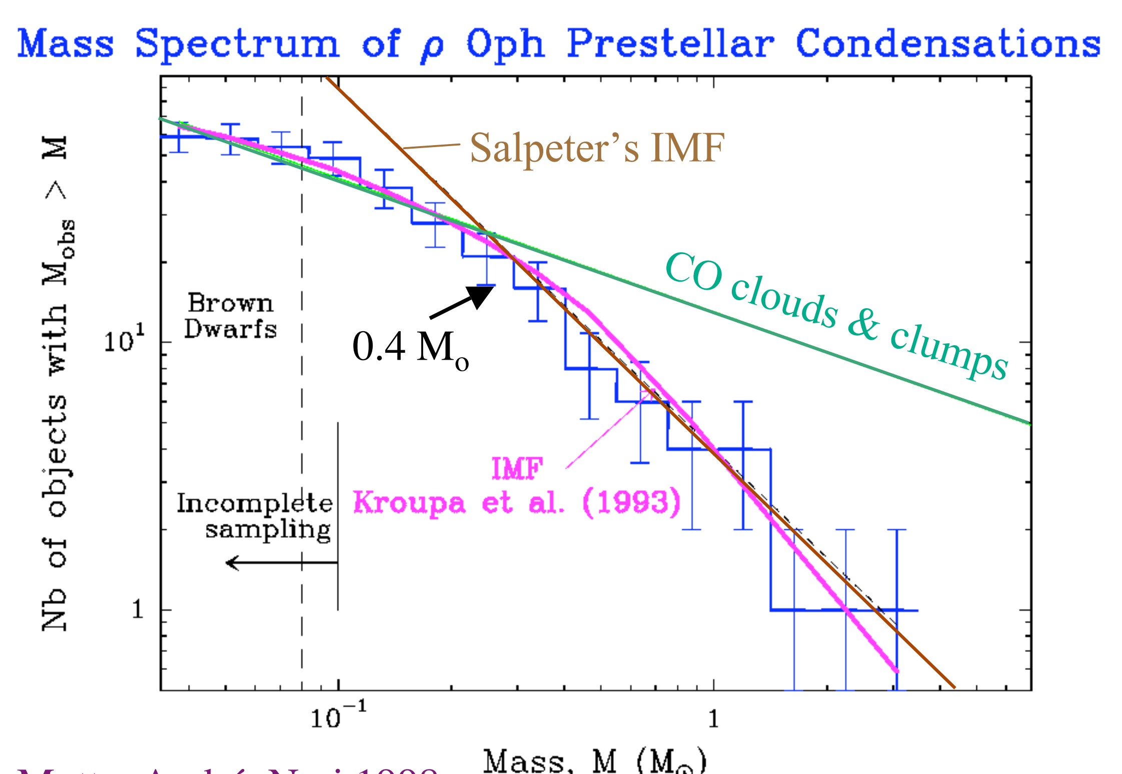
↓

Herschel bands essential for luminosity and temperature determinations



Importance of complete surveys of these early stages

• The mass distribution of prestellar condensations resembles the IMF



Motte, André, Neri 1998

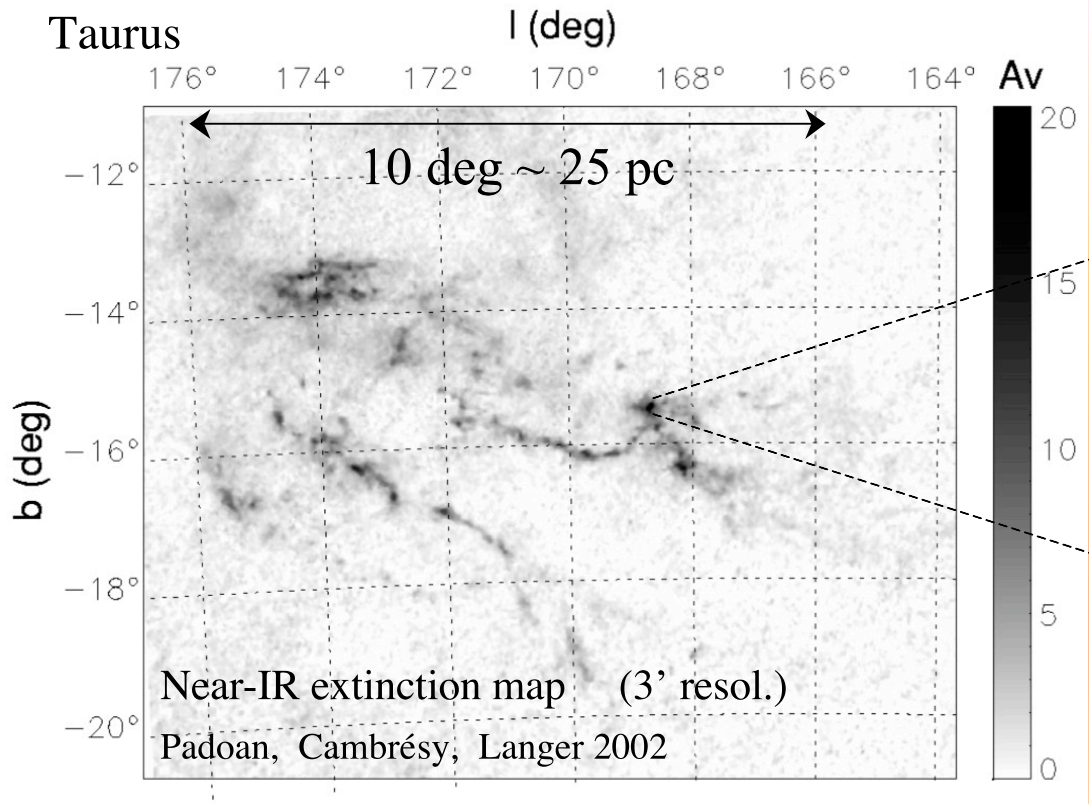
(Motte, André, Neri 1998;
Testi & Sargent 1998;
Johnstone et al. 2000;
Motte et al. 2001;
see also Onishi et al. 2002)

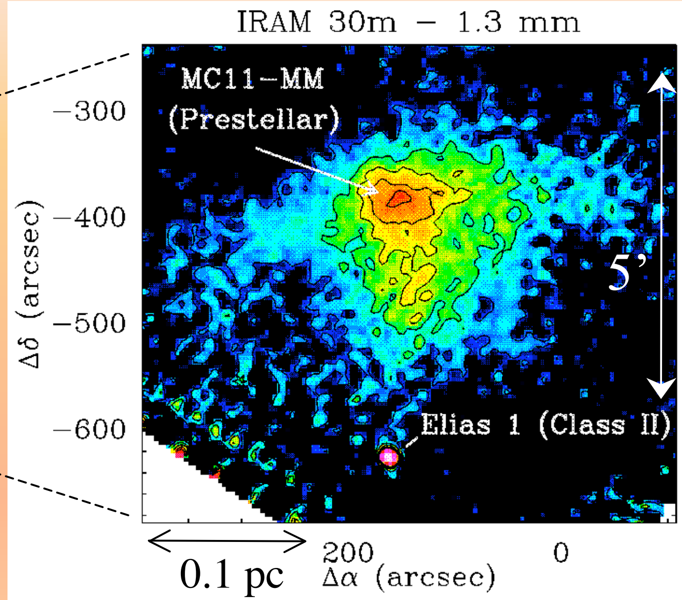
→ IMF at least partly determined by cloud fragmentation at prestellar stage

SPIRE/PACS survey needed to see 1) if this result still holds in the brown dwarf regime and 2) whether the break at ~ 0.5 M_o varies with Jeans mass

Next challenge: What generates prestellar condensations in the ISM ?

Physics of core formation determines the IMF ==> It is crucial to get at a global view of core formation within molecular clouds





➜ Probe a wide range of scales from ~ 0.01 pc (i.e. ~ 17'' @ 140 pc) to ~ 10 pc (several degrees) and a wide range of column densities from the diffuse ISM (A_V < 1) to protostellar condensations (A_V > 10-100).

➜ Calls for wide-field FIR/submm dust imaging with *Herschel* (SPIRE+PACS), followed up by complementary (sub)mm line mapping with, e.g., ALMA …

Cloud sample and justification of the survey area

Owing to their proximity (d < 0.5 kpc), the molecular clouds of the Gould Belt offer the best opportunity to study the formation process of low- to intermediate-mass stars.

→ Complete, homogeneous SPIRE 250-500μm survey of the $A_V > 3$ portions of the Gould Belt, including both active and quiescent clouds (~ 140 deg^2 to rms$_{250\mu m}$ ~ 20 mJy □ 195 hr)

• Sensitivity level ~ cirrus confusion (A_V ~ 1)

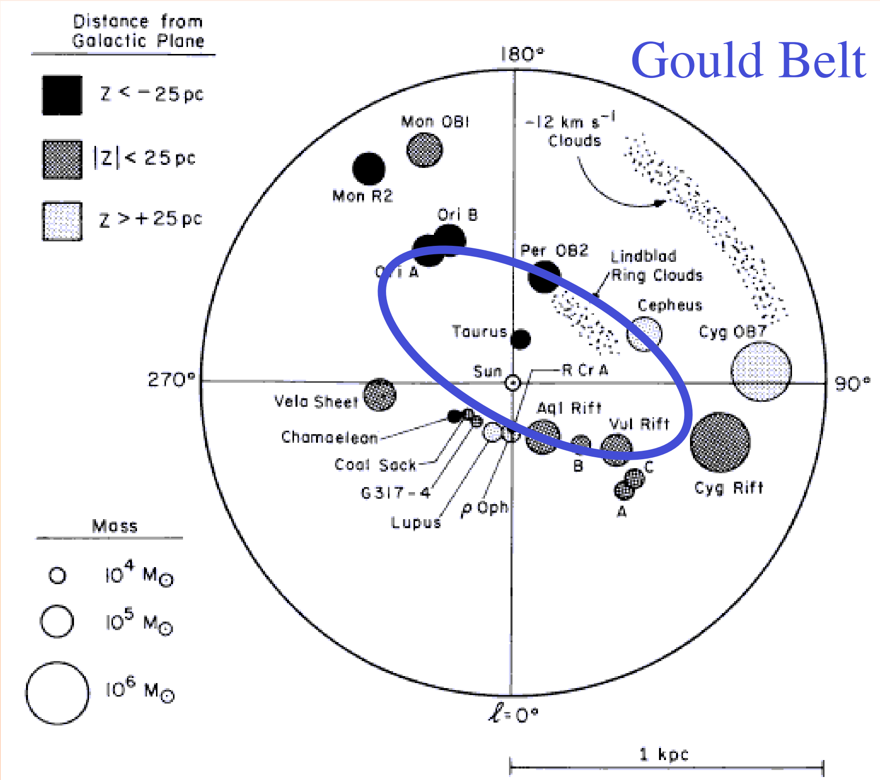
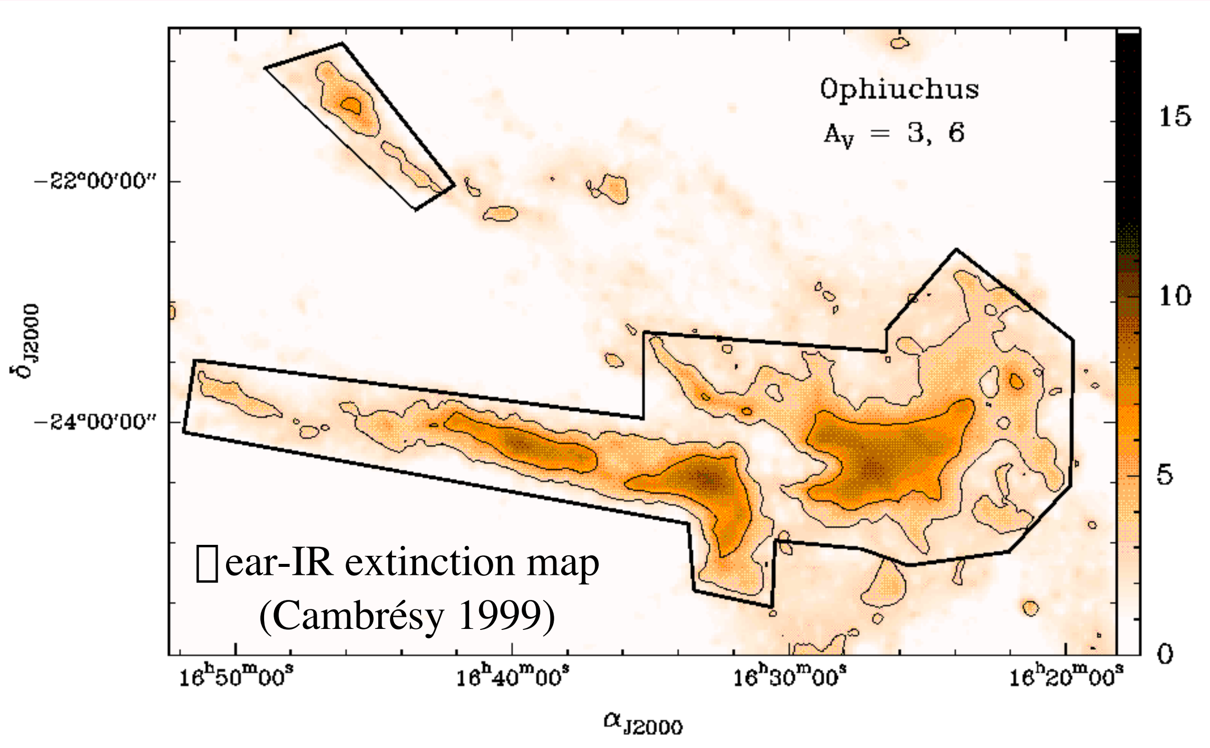


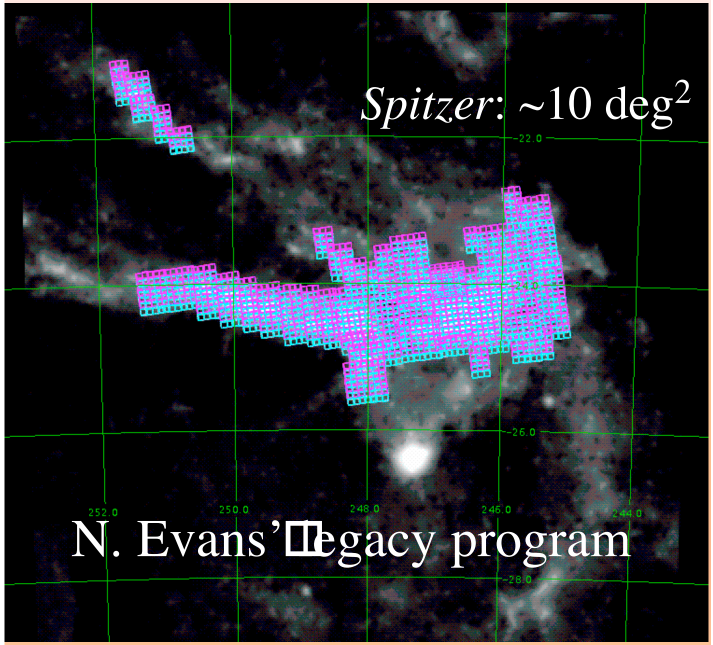
Table 1: **Numbers of protostellar condensations detectable in the 140 deg^2 surveyed area**

Source Type	Substellar[1] 0.01–0.08 $M_\odot$	Low-mass 0.08–0.5 $M_\odot$	Solar-mass 0.5–2 $M_\odot$	Intermediate-mass 2–8 $M_\odot$	High-mass $> 8 M_\odot$
Class 0	30	240	65	10	2
Prestellar	300	2400	650	100	20 ?

~ 20 prestellar condensations expected per 0.15 dex mass bin around 0.01 and 5 M_o

Careful selection of the target fields using extinction maps





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

Sensitivity level ~ cirrus confusion noise:

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

Corresponding column density level: A_V ~ 1 (5σ)

Use of PACS and collaboration with other GT owners

Parallel PACS (110/170 μm) GT KP survey will be carried out by the PACS consortium:

- Same cloud targets, will complete SED coverage
- > 170 hr committed (mainly by CEA/Saclay & IFSI Rome)
- Coordinated by Saraceno & André

Follow-ups: We will also need ~ 6 days for PACS mapping of a representative selection of the prestellar/protostellar sources to be discovered in the wider SPIRE survey.

- We propose to set aside ~ 3 days of SPIRE GT for this
- Informal discussions suggest another ~ 3 days may be contributed by HSC

OB star formation

- Importance of OB stars for evolution and energy budget of galaxies
- Poses a specific theoretical problem (radiation pressure expected to stop the accretion process when $M_* >$ ⊠ M_o)

Key questions

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

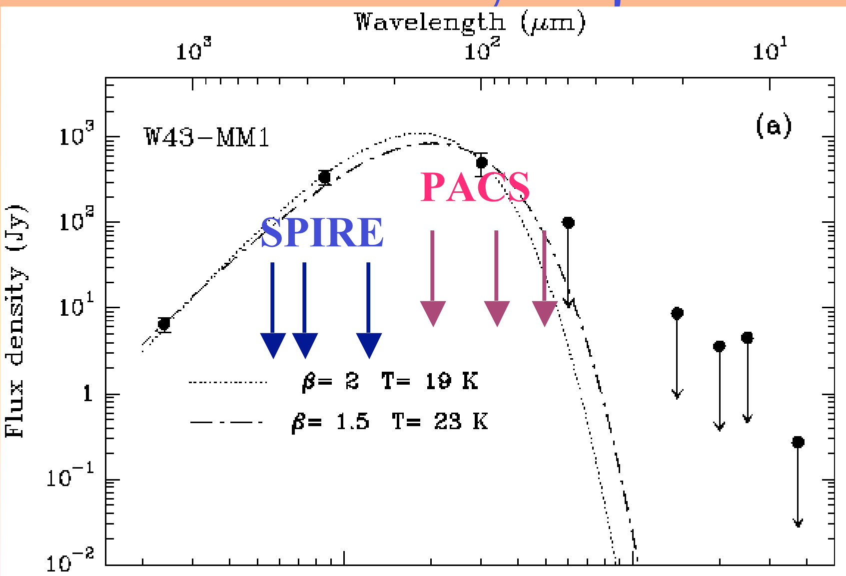
The 3 kpc opportunity for Herschel

To get enough statistics on high-mass protostars, one needs to sample a Galactic volume a few kpc in radius

Table 3: Predicted numbers of OB-like YSOs in the targetted complexes of Table 2.

Source	Spectral type Final mass	B3–B1 $8-20\ M_\odot$	O9–O7 $20-50\ M_\odot$	O6–O3 $50-100\ M_\odot$	O3–O1 $>100\ M_\odot$	Total $>8\ M_\odot$
Pre-stellar core		480	150	40	30	700
Class 0-like protostar		48	15	4	3	70
Infrared protostar		480	150	40	30	700
UCH II region		160	50	15	10	235

Submm only objects



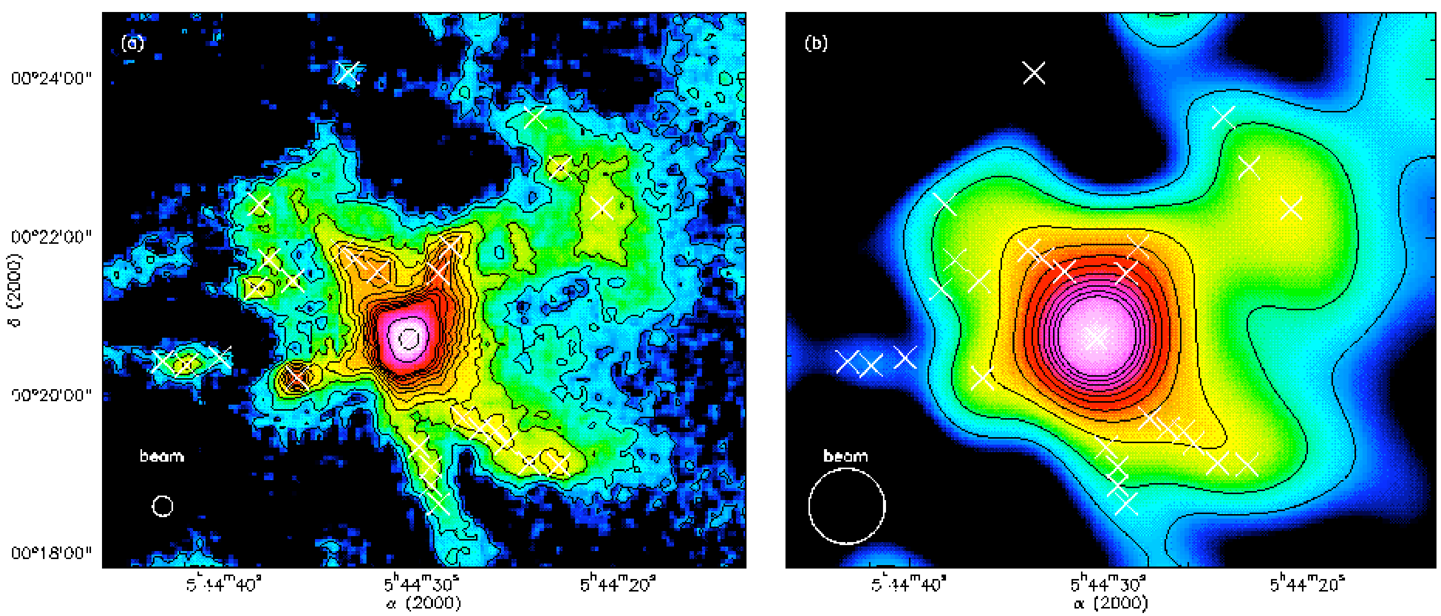
Requirements to derive the basic properties (Mass + Luminosity) of protostars:

- Spectral coverage: PACS and SPIRE
- Sensitivity: not an issue
- Spatial resolution: ~ 0.1 pc

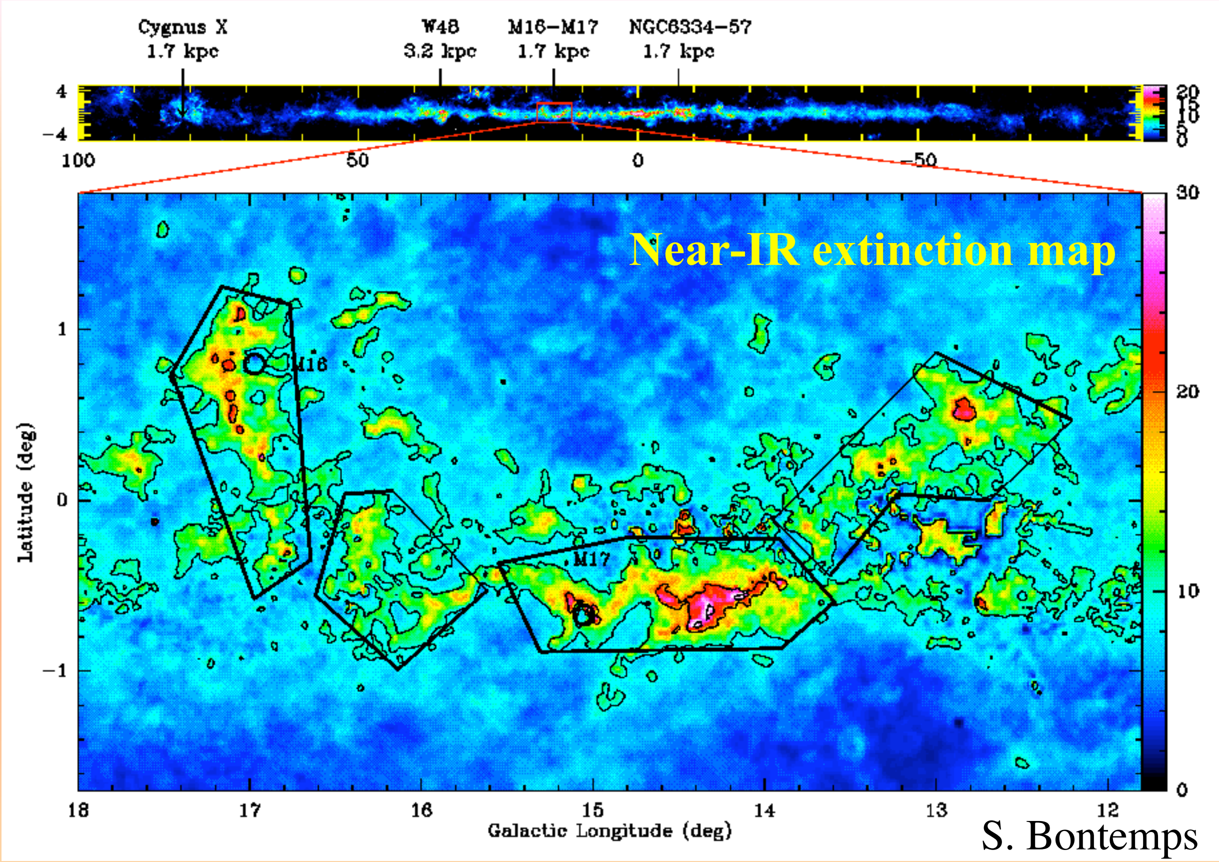
SPIRE has the resolution to reveal high-mass protostars up to ~ 3 kpc

• Much better (~0.1pc) than IRAS and Spitzer (> 0.5 pc)

NGC2071 (OrionB) – SCUBA 850 μm　　NGC2071 with the resolution of SPIRE at 1.7 kpc



40 deg² covering GMCs up to 3 kpc
(represents ~ 40 times the mass of the Orion GMC)



- Unbiased census of all OB star precursors
- Relationship with clusters, OB associations …
- Templates for extragalactic star forming regions

Exploitation Plan

Team focus:

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

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

➜ Luminosity & mass functions

➜ Temperature & density structure of the nearest condensations

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

Legacy value:

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

SAG 3 Proposals for SPIRE GT Key Projects

• From clouds to cores to protostars: Probing the origin of the IMF from low-mass to intermediate-mass (**Gould Belt** survey)
Wide-field (~140 deg^2) photometric imaging of nearby clouds

(195 - 9 = 186 hr of SPIRE + 63 hr of PACS follow-ups;
closely coordinated with parallel PACS GT KP: > 170 hr
and with SAG 4 KP: 18 hr of SPIRE + 16 hr of PACS in common)

• Toward a complete evolutionary scenario for **OB star formation** :
Imaging survey of high-mass star-forming complexes at intermediate distances (~ 40 deg^2 = 60 hr of SPIRE + ~ 20 deg^2 = 50 hr of PACS)

Evolution of interstellar dust

The Guaranteed Time Key Project
prepared by the SAG 4

Interstellar Dust : Key questions

Spitzer, Herschel and Planck (will) observe the emission of dust.

Tracer of the interstellar matter in all Galaxies

Foreground component for extra-galactic observations

But :

Nature of the emission mechanisms, especially in the sub-mm ?

Actor in the life cycle of the matter,

Evolution of the dust properties along this cycle & connection with :

- The chemical, thermodynamical and dynamical evolution of the gas
- The structure
- The illumination (intensity, hardness)
- The past history
- The star formation activity

Dust properties = f (interstellar environment) ?

Evolution of interstellar dust

- **Unbiased surveys with different :**

  Av, Illumination, Density, History, Star forming activity

- **Combination of mapping and Spectroscopy**

  Dust SED : Continuum

  Gas physics : CI, CII, OI, high-level lines of CO.

Relative contribution of all processes acting on the dust particles :

Fragmentation / Coagulation / Condensation / Evaporation / Photo-processing

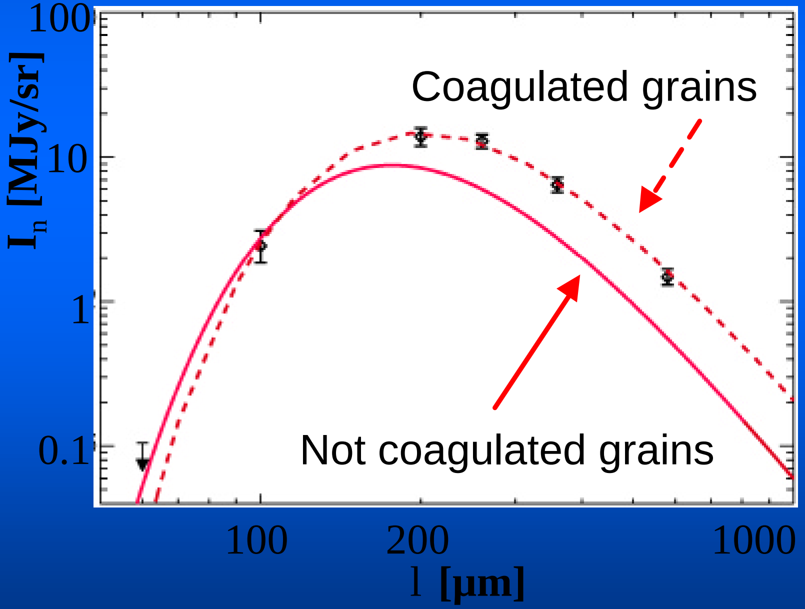
… **in all interstellar environments :**

- Shock processed dust
- Cirrus to Molecular Clouds
- PDRs
- Pre-stellar cores and protostars

Need to define selected targets in nearby regions,
with precise physical conditions and simple geometry

Why Herschel/SPIRE is mandatory ?

- Diffuse regions to Molecular clouds and star forming cores
  - Variations of the size distribution, the abundance and the emitting properties of the dust particles



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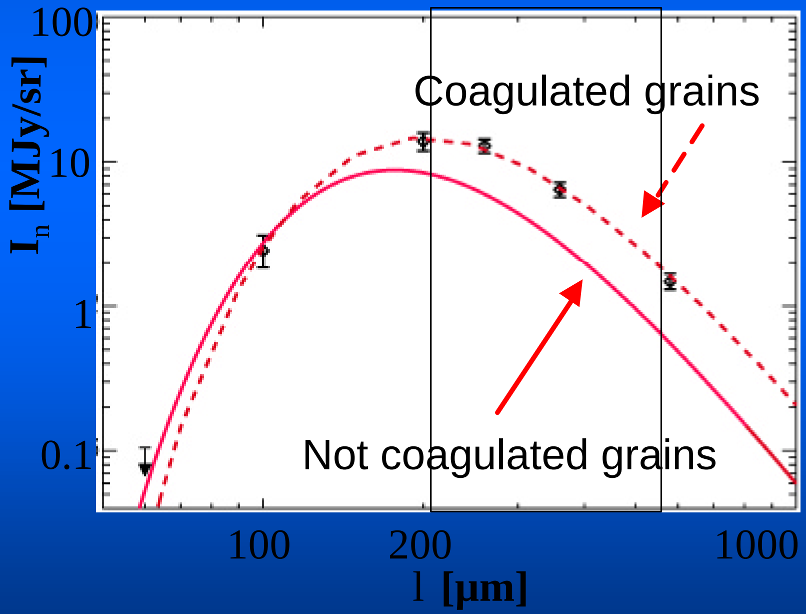

Why Herschel/SPIRE is mandatory ?

- Cirrus to molecular clouds and star forming cores
  - Variations of the size distribution, the abundance and the emitting properties of the dust particles.

    Transition regions (dust/gas) not spatially resolved by IRAS, COBE, ISOPHOT, or SPM/PRONAOS
  - Density structure.
    - Impacts on the penetration of the radiation, the formation of H_2 , the heating of the gas, the condensation processes
  - Dust/gas coupling.

FIR - submm observations at high angular resolution and sensitivity,

➔ Mapping and Spectroscopy (LR and HR)

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

Source	I_{100}[1]	A_V	Physical Properties			Obs[2].
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L1521 E, Taurus		140				0, 3
L1521 F, Taurus		140				0, 3
L1689B, Ophiuchus		140				0, 3
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IRAM04191, Taurus		140	Low			0, 3
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N6334I(N), NGC6334		1700	High			0, 3
Class I protostars		d (pc)	Mass	mm env.		
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EL29, Ophiuchus		140	Intermediate			0, 3
N6334I, NGC6334		1700	High			0, 3

Evolution of interstellar dust

Observing Plan

- **Mapping: 32 (SPIRE) + 32 (PACS) = 64 hours**
  - Large fields in diffuse to molecular regions and PDRs
    - 7 deg^2 with SPIRE, 10 mJy (1 σ) : 30 hours (18 hours common with SAG 3)
    - 1/4 with PACS, 7 mJy (1 σ) : 32 hours (16 hours common with SAG 3)
  - Hot PDRs with HII regions
    - 4000 $arcmin^2$ with SPIRE, 15 mJy (1 σ) : 2 hours
- **LR Spectroscopy with SPIRE/FTS 45 hours**
  - Diffuse regions: 10 hours
  - PDRs: 20 hours
  - Pre-stellar cores, protostars 15 hours
- **HR Spectroscopy : 72 (SPIRE) + 2 + 24 (PACS) + 12 (HIFI) = 86 + 24 = 110 hours**
  - Diffuse regions PACS 2 hours
  - All PDRs SPIRE/FTS 48 hours
    PACS 24 hours
  - Protostars SPIRE/FTS 24 hours
  - Pre-stellar cores HIFI 12 hours (to be coordinated with the HFI team)
- **TOTAL : 149 (SPIRE) + 58 (PACS) + 12 (HIFI) = 219 hours**

  Coordination with the SAG 3
    - 34 hours in common
    - Mapping of Pre-stellar cores and protostars in the survey of nearby star-forming regions

SAG 5

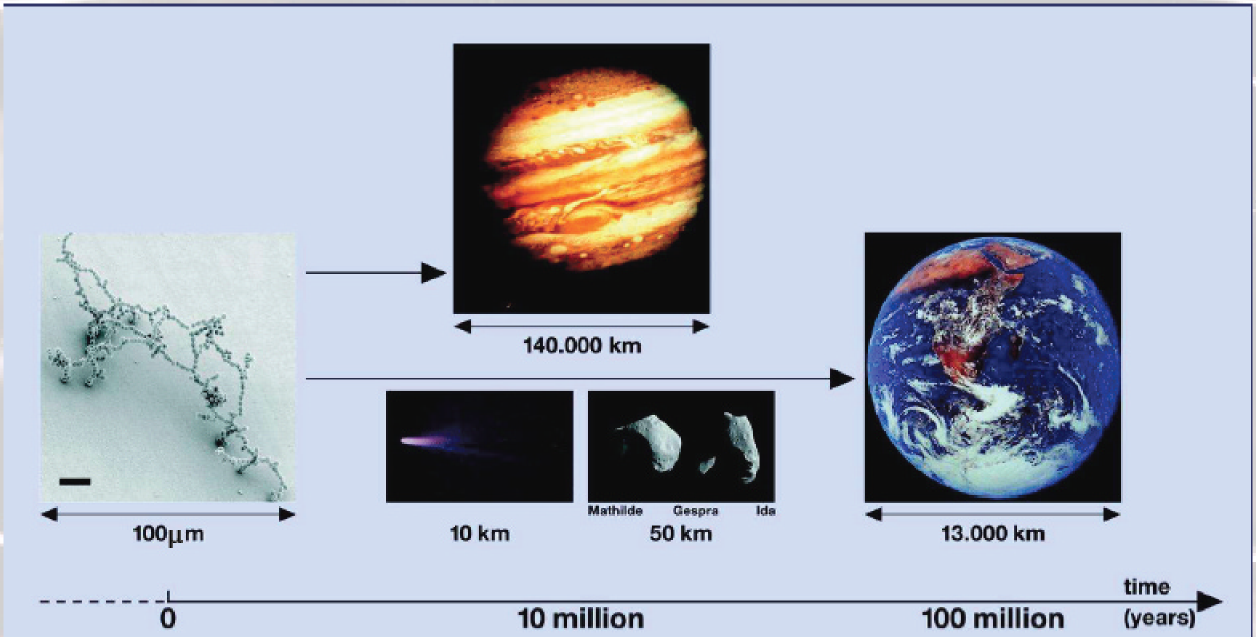
Bruce Swinyard

SPIRE and Planetary Formation

- The formation of planetary systems not yet well understood
- It seems that the primordial disk is lost within a few tens-hundred million years of the onset of nuclear burning (see Goran's talk)
- In this time the dust has to go from lumps of a few microns to planet size things and for some of these to sweep up many Earth masses of gas as well
- The theorists have a problem with doing this… …
- – perhaps SPIRE can help?

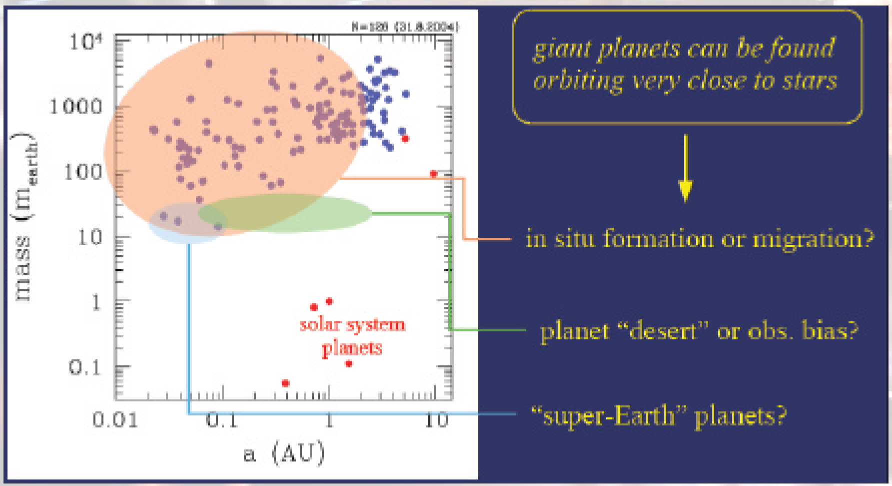
- We propose a coherent programme looking at the outer parts of our Solar system in order to link what we see as the end product of planetary formation with what we see in the disks around other stars to probe the physics of the formation of planetary systems

Cartoon


140.000 km
100μm
10 km
Mathilde
Gespra
Ida
50 km
13.000 km
0
10 million
100 million
time
(years)

Migration?

Other Planetary Systems show gas giants close to the star



Migration?

What part does planetessimal scattering play in the evolution of planetary systems?

Did Neptune and Uranus form closer to the Sun and migrate outwards?

Did Jupiter migrate inwards?

Why did they stop?

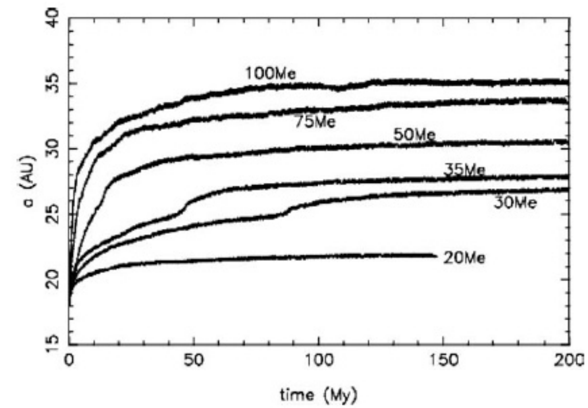


Fig. 10. Examples of Neptune's migration in disks with an outer edge at 30 AU, r^{-1} surface density profiles, and masses equal to 20, 30, 35, 50, 75, and 100 $M_{\oplus}$ from bottom to top. Only in the case of a $20M_{\oplus}$ disk a massive annulus is left between Neptune's position and the original outer edge of the disk. In all other cases, the disk is completely depleted.

Gomes Morbidelli Levison (2004)

How can SPIRE help to answer some of these questions?

1 TNO observations

- Canonical view is that the "scattered" or "hot" TNOs were ejected from further in as part of the migration process and Plutino or "cold" TNOs are from the original disk
- All that is known about most TNOs are there orbits and visible or NIR albedos – SPIRE measurements will give the temperature and therefore the size distribution
- Is there a difference between hot and cold TNOs?
- Is Pluto essentially a big version of the all other TNOs – can we use it as a template for emissivity?
- Proposed target list is a combination of "Hot" and "Cold" TNOs with a wide range of Vis/NIR magnitudes
- Is vis/NIR variation due to size or albedo?

Pinning down the Radius

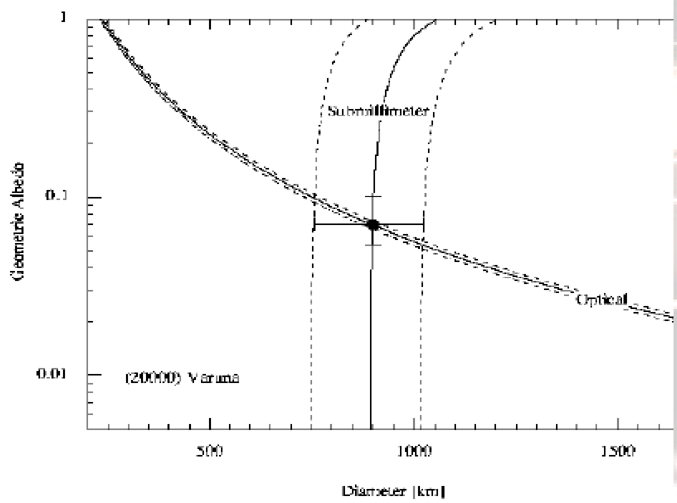


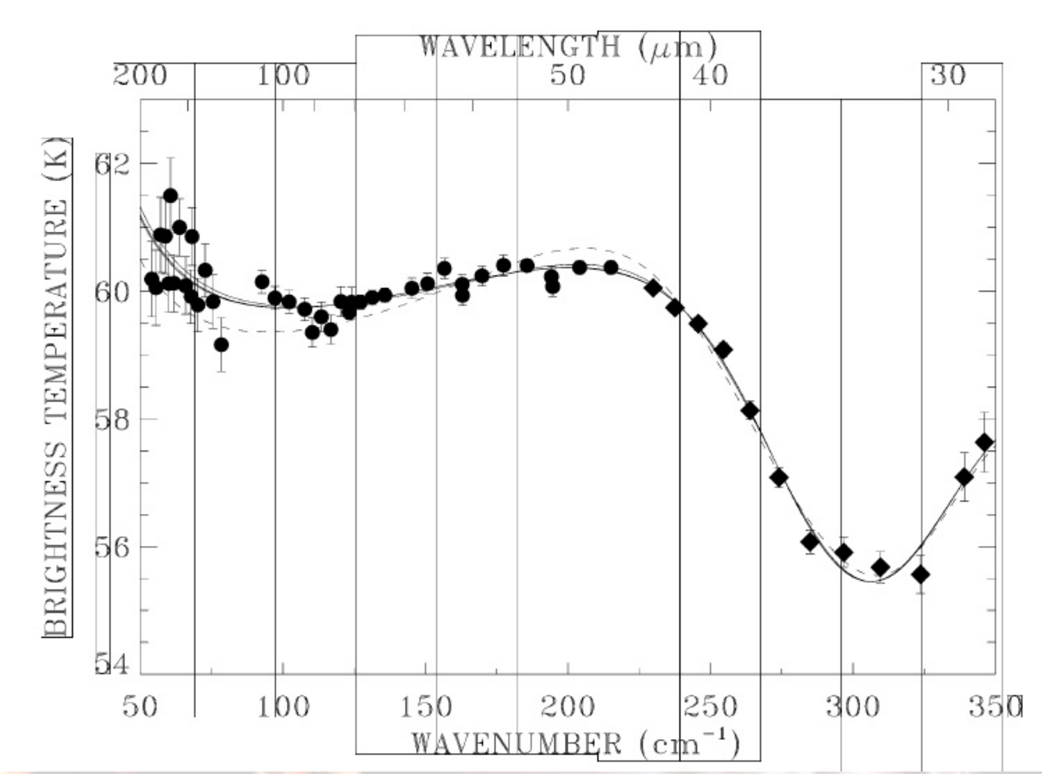
Figure 1: From Jewitt *et al* (2000) showing how observations in the sub-millimetre and NIR can be combined to remove the degeneracy between the object's albedo and diameter.

$$D = ??\left(\frac{2S_?}{p\,k e_?}\right)^{1/2}\left(\frac{s R^2}{F_{sun}}\right)^{1/8}\left(\frac{e_{IR}\,?}{1-A}\right)^{1/8}$$

2 Uranus and Neptune

- **Why are Neptune and Uranus so different – SPIRE can probe for trace gases and complement HIFI observations (e.g. PH_3).**
- **SPIRE can complete measurement of FIR spectrum to establish H/He mixing ratio**
- **Additionally (new since talking to Martin yesterday) we can look for variability in the spectrum to support calibration**
- **This needs more time!**

Neptune H/He mixing



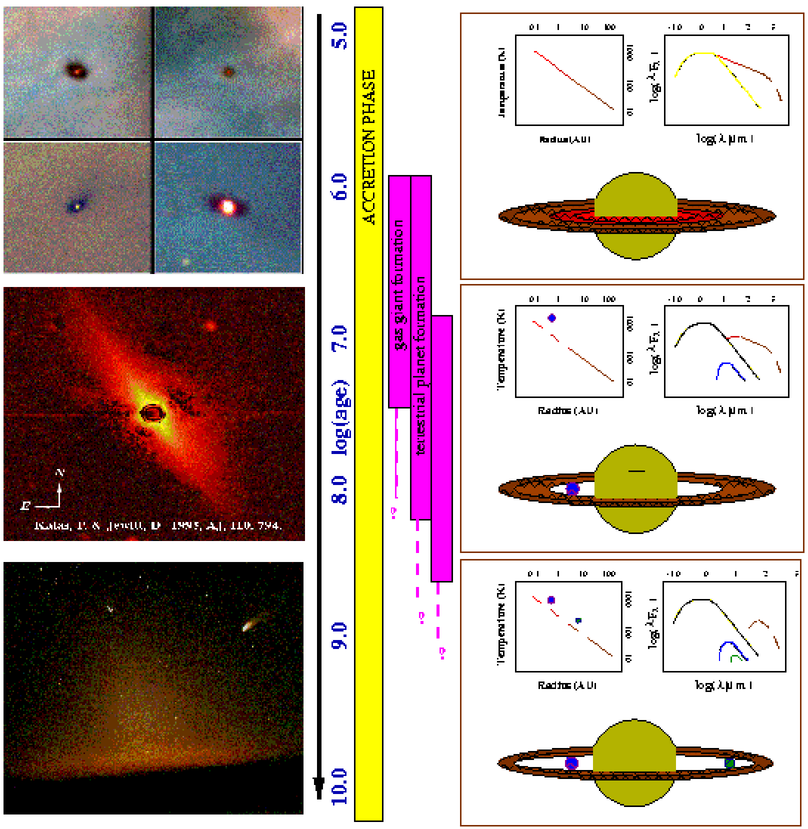
3 Comets

- Short period Comets are supposed to originate from the TNOs – do they?
- Long period (unexpected) Comets are from the Oort cloud - what are the differences?
- SPIRE can look for dust and chemical evolution from Comets as they come close to the Earth
- Water is the most abundant molecule but it has proved difficult to observe because of the low temperature of the gas (10-100 K)
- H_2O 557 GHz (538 micron) line is going to be a prime target for Herschel (HIFI) – SPIRE can cover all the water lines efficiently and make maps to complement HIFI observations
- Also of interest is the HDO 465 GHz (644 micron) line – this is not covered by HIFI but is in the SPIRE band

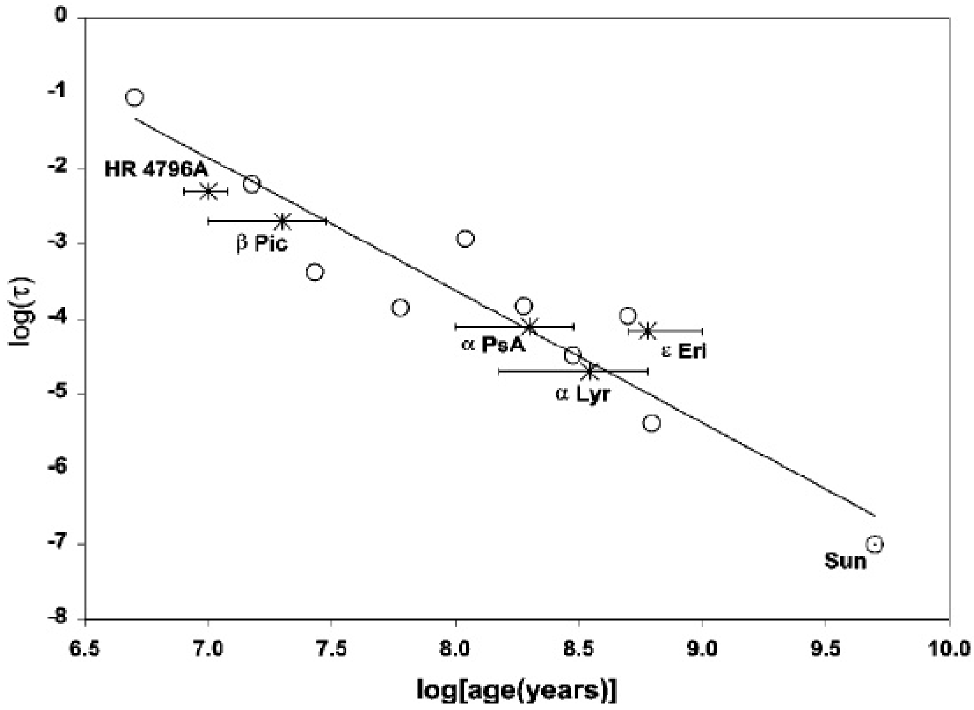
Summary

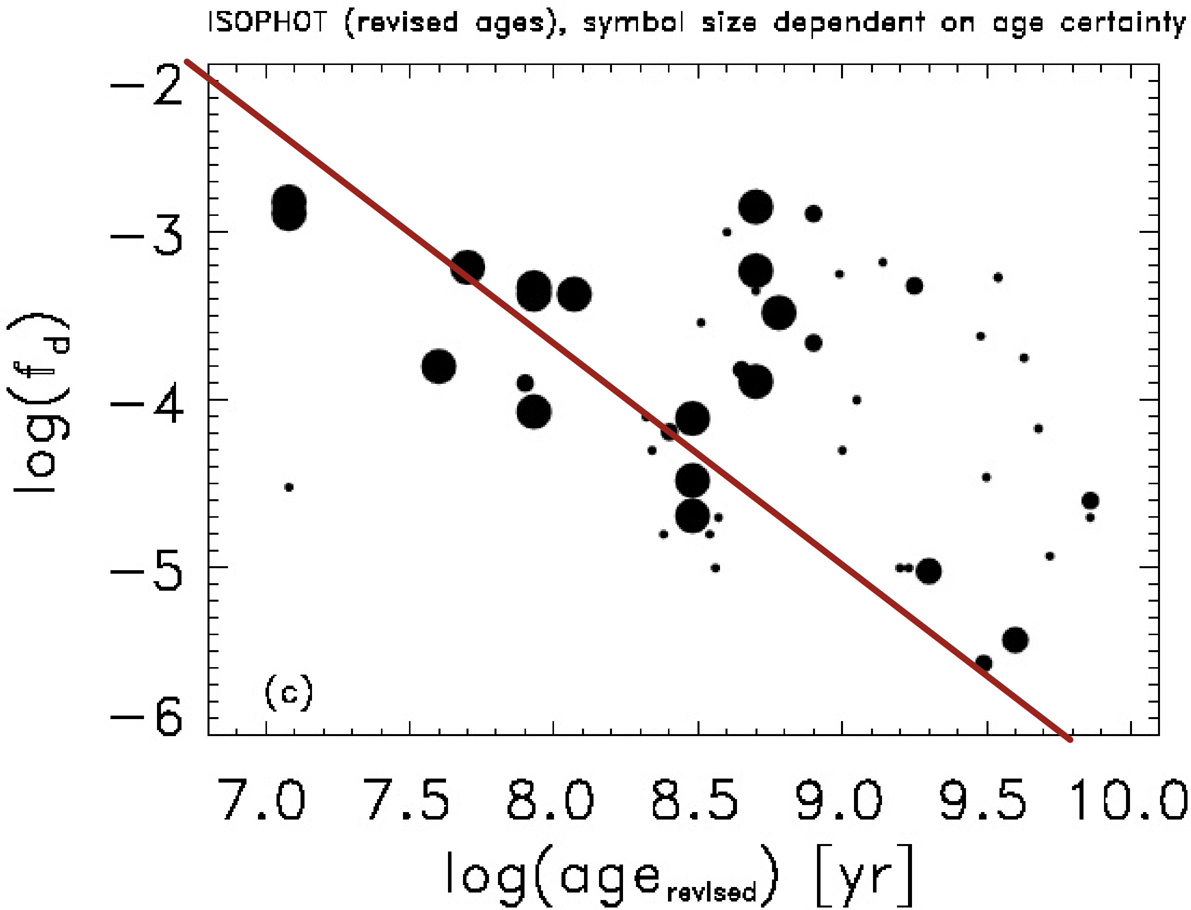
- Three Solar System themes to address the nature of the material from which the Solar system formed and in the co-evolution of the TNOs and outer planets
- We wish to link these observations to the formation and evolution of planetary systems around other stars – see next talk
- We could, therefore, treat the “disks” part of the SAG-6 programme as part of the Solar System SAG programme
- Perhaps rename SAG-5 as “Planetary Systems”?
- Solar System part is complimentary to HIFI and PACS GT programmes
- Requires ~84 hours observing time spread over the mission life.

SAG6: Disk evolution

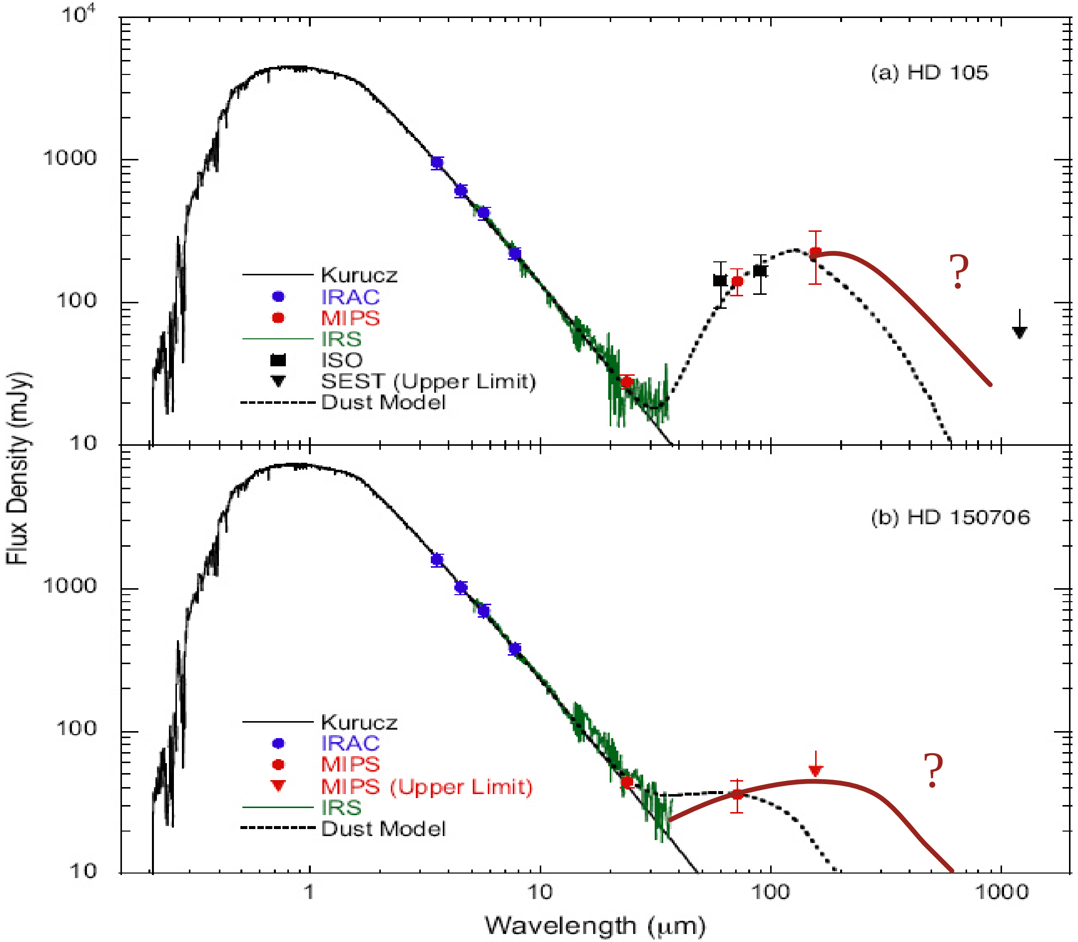


A smooth decline of dust with time?




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

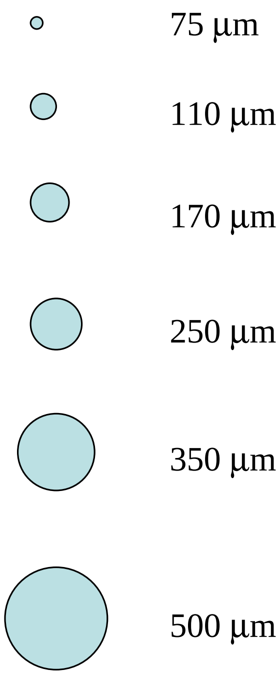
Cold dust - little or plenty?

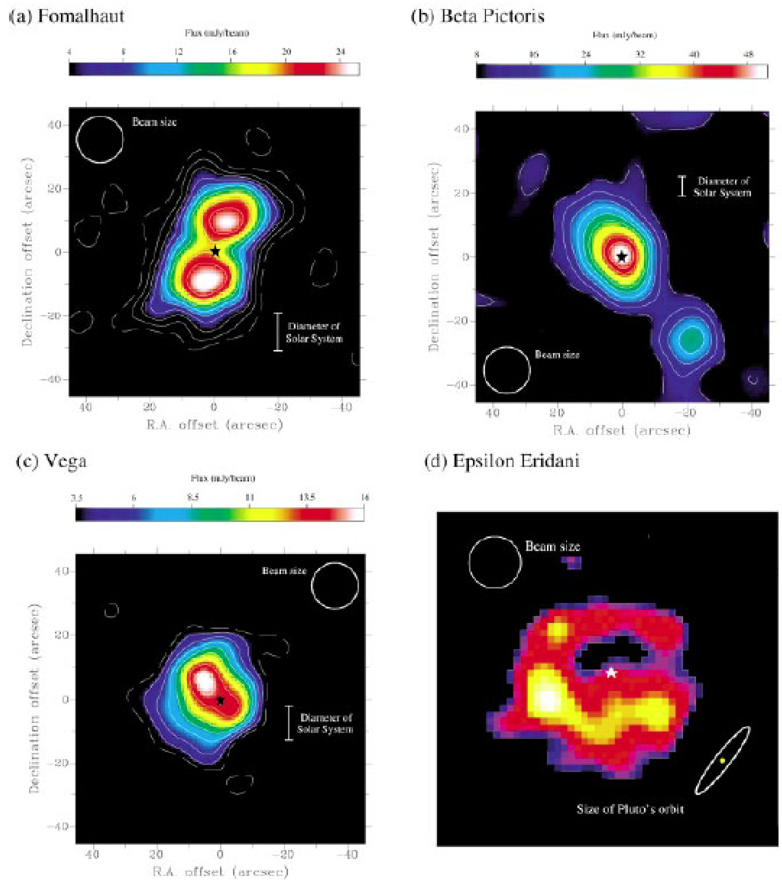


The Spitzer sample

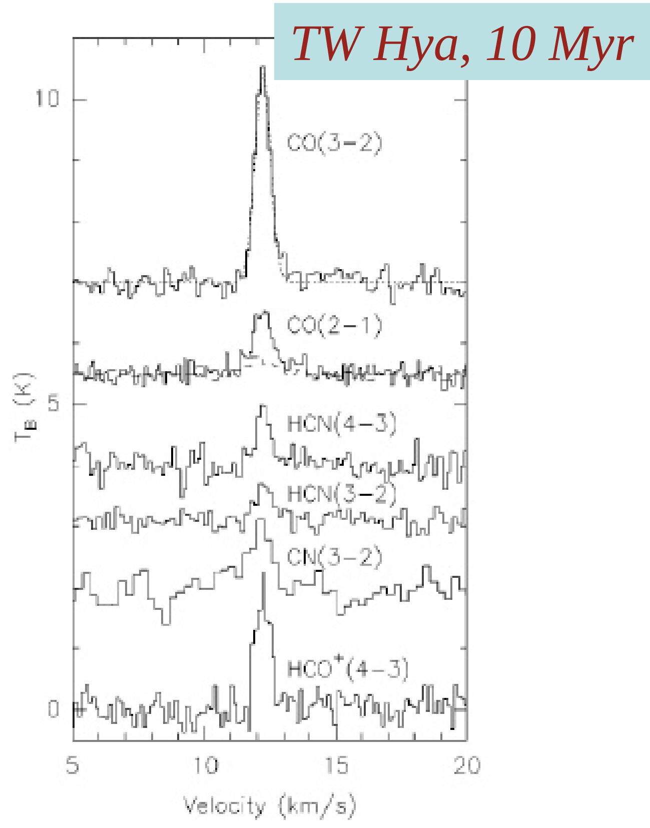
Age	N_* / N_{tot}	Distance (pc)	Target
3-10 Myr	50/ ~140	80-160	Tau, Oph, Cha, Lup, Upper Sco
10-30 Myr	50/ ~110	60-160	Tau, Oph, Cha, Lup, Cen Crux
30-100 Myr	50/ ~130	40-180	IC 2602 & Alpha Per
100-300 Myr	50/ ~100	20-120	Ursa Major, Castor, Pleiades
0.3-1 Gyr	50/ ~1000	20-60	Field stars, Hyades
1-3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

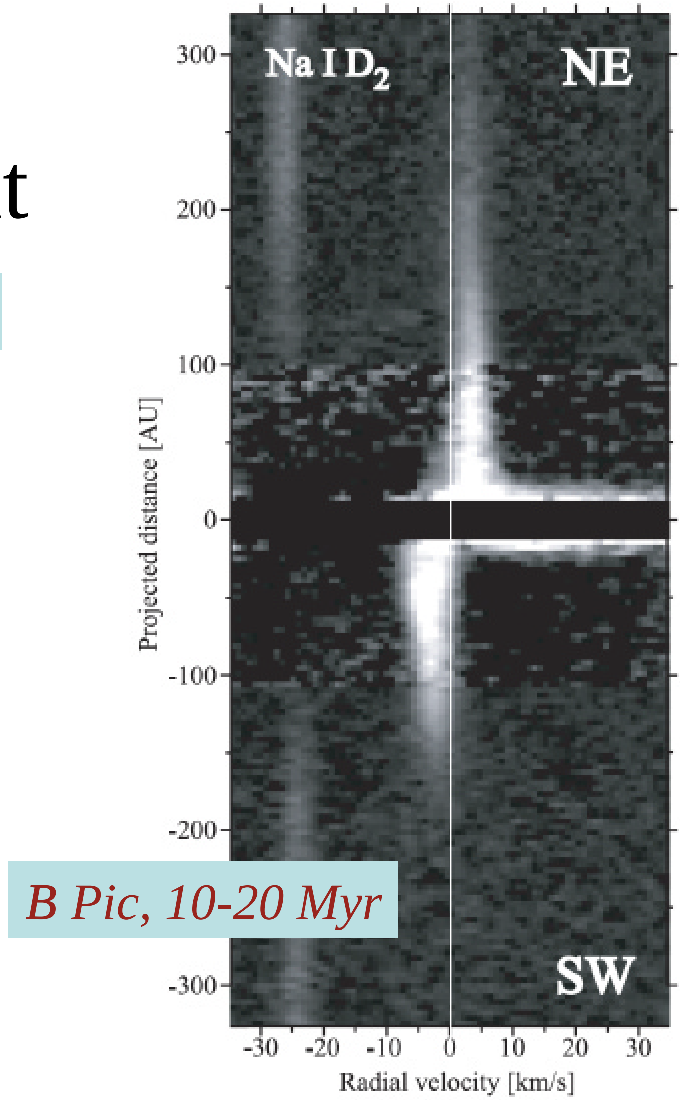
Spatial resolution



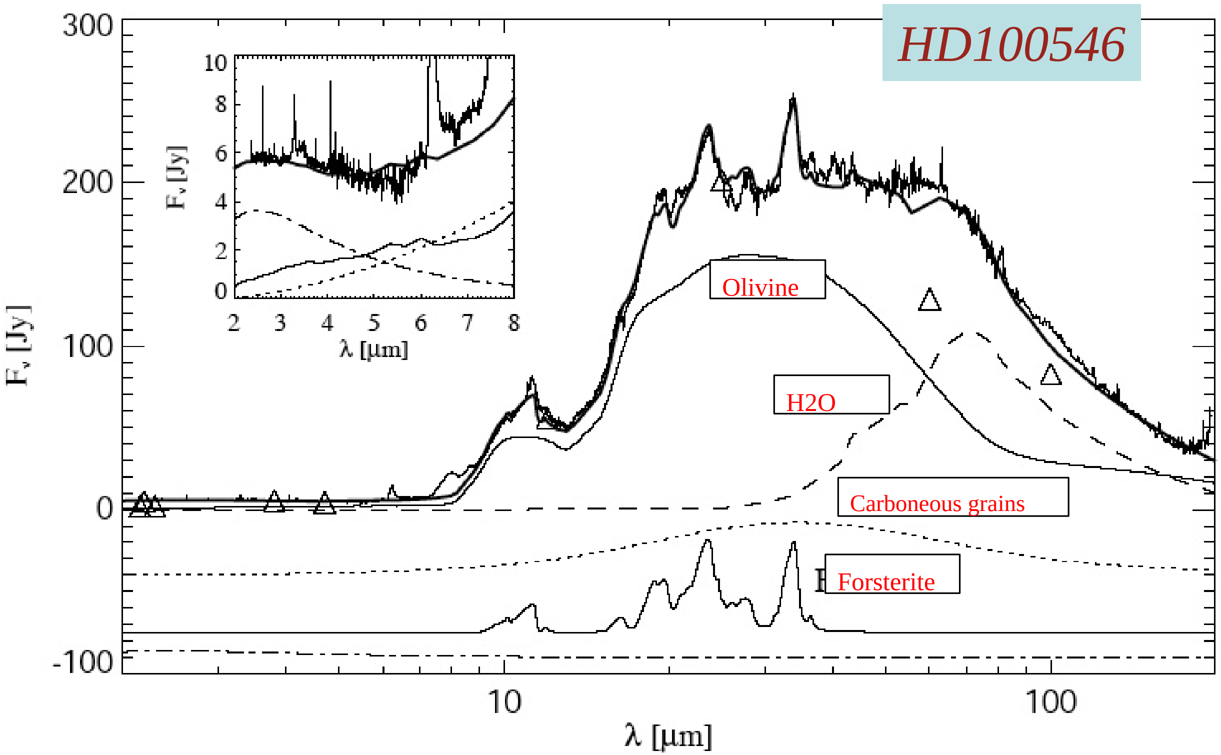


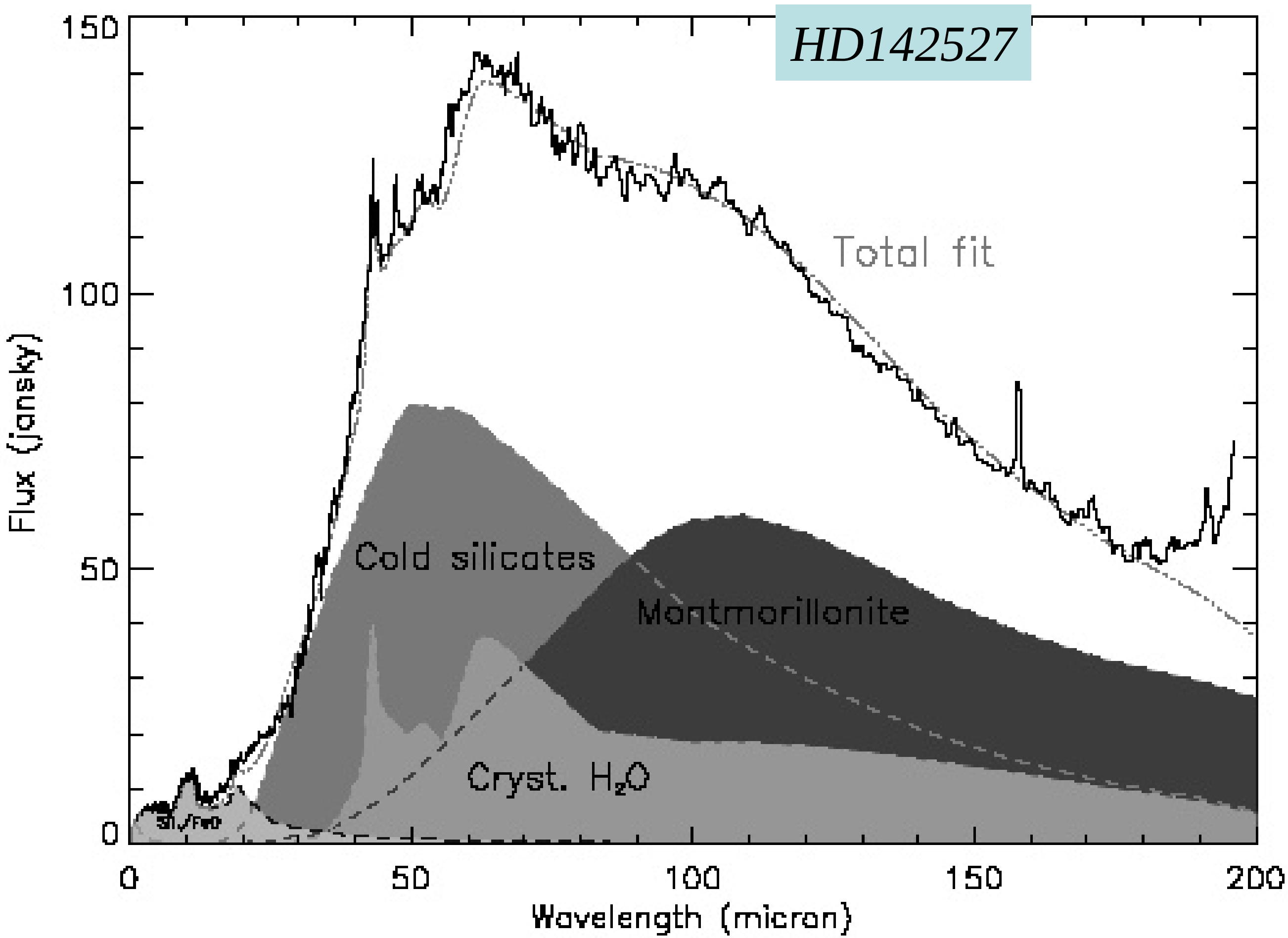
Gas component





Solid state features

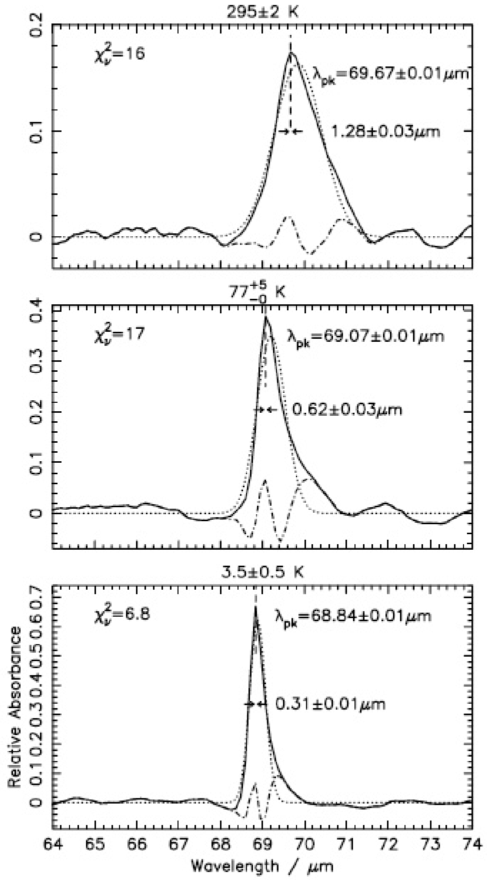


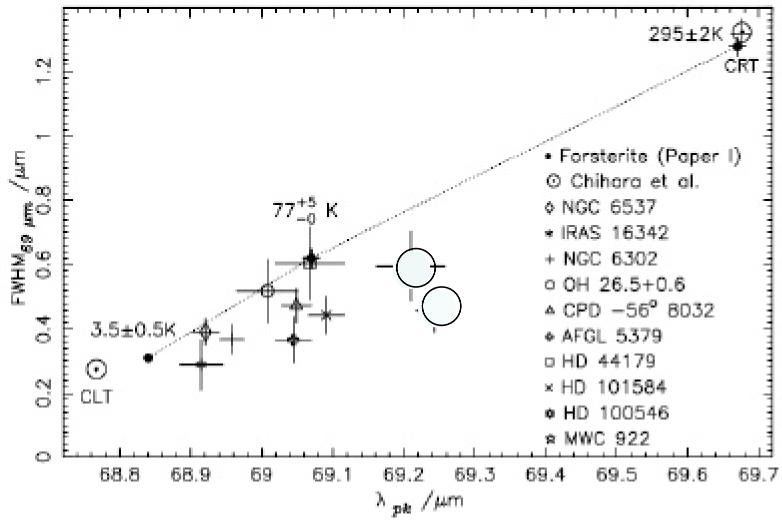


(From Malfait et al., 1999)

Solid state temperature probe:

69 μm forsterite emission





Requested Time

Part	*PACS*	*SPIRE*	*SUM*
Spitzer sample	*33h*	*33h*	*66h*
Spatial resolution	*25h*	*10h*	*35h*
Spectroscopy	*48h*	*26h*	*74h*
TOTAL	*106h*	*69h*	*175h*
SPIRE GTO	*36h*	*69h*	*105h*

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

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

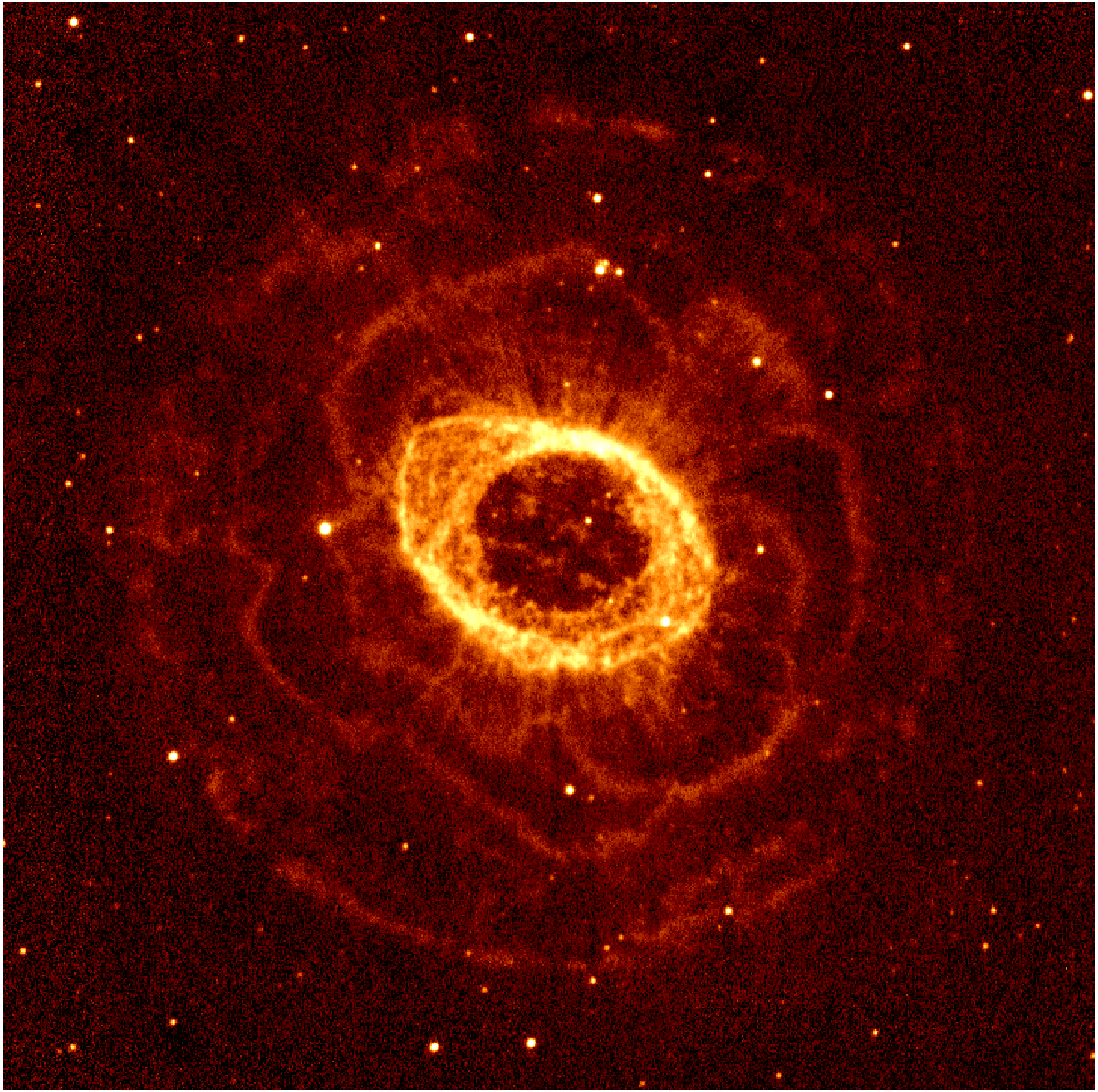
Six 4x4 arcmin jiggled sub-maps with the photometer should provide a fully sampled 8x8 arcmin map centred on each target (for a few of the closest objects, larger maps may be desirable). Time per target: 90 mins + 5 mins settling and slewing time. These maps should provide 5σ per beam for a 2 MJy ster^{-1}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

The 50 targets include AGB stars (O-rich and C-rich), post-AGB objects, PNe and interacting binary systems (symbiotic stars, RV Tauri stars). Enough targets in each class will be observed for the results to be statistically significant. High galactic latitude targets are favoured, to minimise background confusion. The PACS Consortium will obtain complementary imaging photometry in each of the 3 PACS wavelength bands.

Total SPIRE time required: 75 hours

SAG 6

Evolved Stars



NGC 6720 imaged in H_2 2.122μm line.

5x5 arcmin FOV

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

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

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

Targets: 30 point source targets will be observed with the FTS (1 hour per object), encompassing carbon-rich sources, both with and without mid-IR PAHs (post-AGB objects, PNe, carbon stars), as well as oxygen-rich targets (O-rich Miras, post-AGB objects and PNe). These are the phases of 1-8 Msun objects that are believed to be the most important for contributing dust to the Galaxy. Examples of dust-making phases of high-mass objects (M supergiants, LBVs, WC Wolf-Rayet stars) are included. Complete PACS spectra will be obtained of all targets by the PACS Consortium.

Total SPIRE time required: 30 hours

c) Dust in young supernova remnants

Spectra + photometry from 60 to 670μm of the youngest galactic SNRs, e.g. Cas A, Kepler, Tycho, Crab, 3C58, SN1006 and SN1181, G292.0+1.8 (all have ages in the range 320-1600 years).

Angular diameters are typically 5 arcmin → 7 pointings with the FTS's 2.6 arcmin beam for a fully sampled map. Spectroscopy is needed to determine the contributions of lines and any dust bands and to accurately delineate the energy distributions.

For Cas A (~50 Jy) there should be about 500 mJy in a 30 arcsec resolution element → 5σ per 1 cm^{-1} spectral resolution element in a 1-hour 64-point jiggle map. Seven hours to do Cas A with the FTS. For all 8 remnants, SPIRE 3-band 6x6 arcmin photometric maps will be obtained, requiring 1.5 hours per target. Total SPIRE time required = 7 hours (FTS) + 12 hours (photometry) = 19 hours.

PACS imaging photometry will be obtained for all 8 remnants, at 70, 110 and 170 microns, requiring 2 hours per target to reach 12-20 mJy/beam at 5sigma. PACS 88-um line spectroscopy will be obtained for 4 of the targets, requiring 5 hours in total (ISO LWS spectroscopy of CasA showed that this line could dominate 100um fluxes). Total PACS time required = 16 hours (photometry) + 5 hours (spectra) = 21 hours

Total SPIRE Guaranteed Time required = 19 hrs + 21 hrs = 40 hours

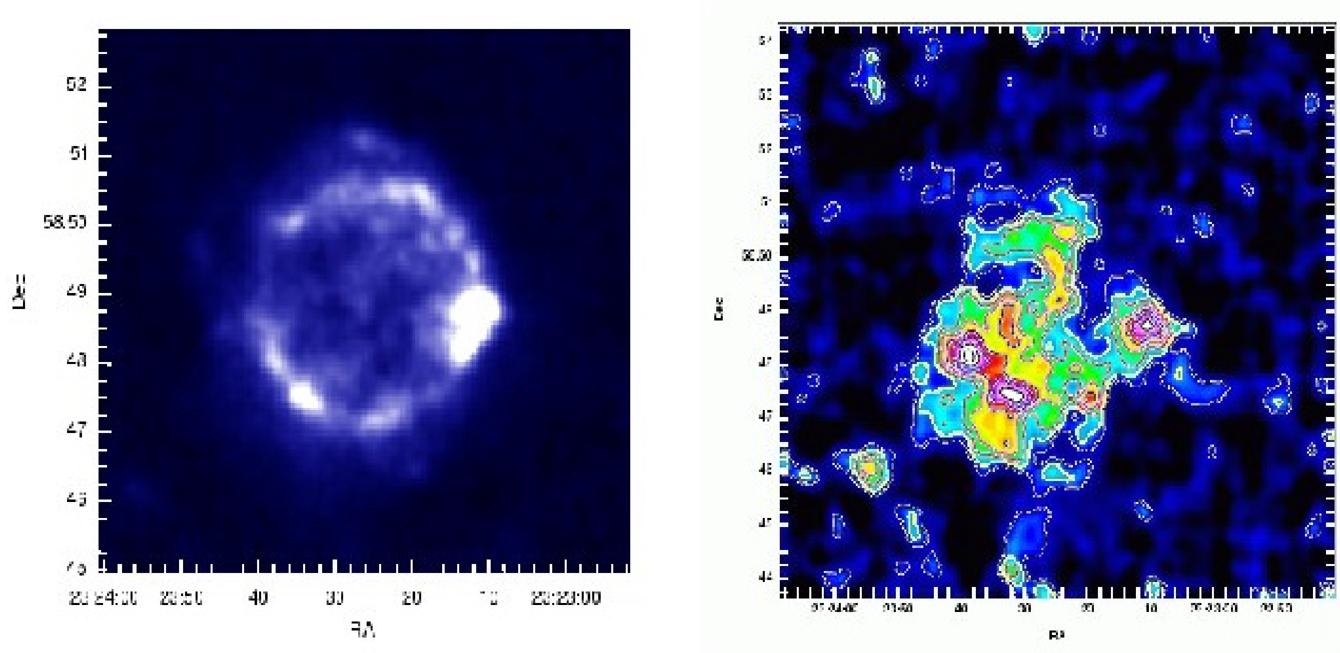


Figure 4: SCUBA images of Cas A, from Dunne et al. (2003). Left: 850-μm image; right: 450-μm image. The morphological difference between the two images was attributed to cold (18 K) dust emission dominating at 450 μm, while two-thirds of the emission at 850 μm is due to synchrotron radiation.

The Herschel infrared Galactic Plane Survey Open Time KP

Sergio Molinari and Bruce Swinyard

Status & Next Milestones

- Team Meeting #3 held in June 17/18 @IAP-Paris
  - About 30 (!) people attended
  - Review of science case
  - Review of ongoing as well as foreseen large Galactic survey projects: presentations from team people involved in IGPS, Planck, ASTRO-F, SCUBA2, APEX
  - First draft of Project architecture and WBS was thoroughly discussed

- Project Structure under definition. A proposal will be circulated
  - Steering group will be created to manage and oversee:
    - Project WBS coming into reality
    - Funding enterprise
  - Science WGs will be simplified
  - Science oversight group will be created (unless it turns out that its functions can be carried out in the steering group)
  - Operations/Observations WG will be created to work in synergy with science WGs

- Check-out all material produced and collected till now (presentations, minutes, WBS etc.) at http://hercules.ifsi.rm.cnr.it/Hi-GAL/index.html
- Next meeting currently scheduled in Rome next 9-10 December

PACS and HIFI Science Programme Preparation Status

Matt Griffin

PACS Science Programme Status

Dieter Lutz and Albrecht Poglitsch

PACS GT definition: constraints

- PACS MOU defines proportionality of contributions to the instrument and the guaranteed observing time
- Scientific interests of consortium partner institutions are an important driver
- Responsibility of PI/CoPI and consortium to come up with a strong and coordinated GT program consistent with SMP constraints

Coordination groups (1):

Stars/Mass Loss O(250h):

SPIRE SAG 6

Leuven, Vienna (Groenewegen)

- **Circumstellar matter in evolved objects**
- **Photometry/Spectroscopy**

Star Formation O(450h):

SPIRE SAG 3

CEA, MPIA, IFSI, Arcetri, Leuven (Andre)

- **Large scale photometric SF survey (cf. also SPIRE)**
- **Detailed investigation of pre-stellar cores and protostars**
- **Mineralogy and Imaging of YSOs and debris disks**
- **Line mapping study of SF regions**

Coordination groups (2):

Extragalactic surveys O(600h):

SPIRE SAG 1

MPE, CEA, Italy, IAC (Lutz)

- Deep blank field and lens assisted surveys
- O(10sq.deg.) 170um confusion limit and smaller/deeper components
- Split over several key multi-wavelength fields
- SPIRE coverage assumed, PACS time or field coordination with SPIRE consortium

Quasars and high-z galaxies O(250h):

SPIRE SAG 1

MPIA, MPE, Liege (Stickel)

- High z Quasar and BAL quasar photometry
- FIR spectroscopy of high-z galaxies

Coordination groups (3):

Local galaxies O(300h):

CEA, MPE, MPIA, Marseille, Gent, Vienna (Madden)

- Luminous IR galaxies – photometry/spectroscopy
- Low metallicity dwarf galaxies
- Nearby normal and elliptical galaxies
- (Nearby) clusters

SPIRE SAG 2

No PACS counterparts for SPIRE SAGs 4 and 5

(ISM and Solar System)

PACS GT definition: process

- Meetings of PACS Science Team in 2000, 2003, 2004 to formulate science programme ideas and interests of partner institutions, and coordinate among institutes – reasonable overview achieved
- GT commitments of partners to observing programmes defined (some revisions possible in finalization of programmes)
- Coordination groups established to achieve detailed coordination of projects, different coordination modes possible: shared, combined, separate

PACS GT definition: process (2)

- A major fraction of PACS GT likely to be in coordinated key programmes
- PACS internal deadline: Nov. 30 2004 for first worked-out proposals
- Then ~ 3 months for further PACS internal coordination
- Coordination 'splinters' with SPIRE and HIFI representatives needed after finalization of PACS input – timeframe first half 2005

HIFI GT Preparation

This is the summary from the April meeting

HIFI GT Preparation

Proposed HIFI-lead key programs :

Science theme	Key program	Coordinator
Solar system	Planets and comets	E. Lellouch/ J. Crovisier
Stellar evolution	Water in stellar outflows Chemical evolution LBV/WR	V. Bujarrabal
Star formation	Water in regions of star formation Physical and chemical evolution Orion and Sgr B2 ISM Dense and warm ISM Molecular carriers	E. van Dishoeck C. Ceccarelli E. Bergin M. Gerin
Extragalactic	ISM of galaxies (inc. Milky Way) ISM of galactic nuclei (inc. Galactic Center)	R. Guesten

HIFI GT Preparation

- Draft proposal for each key program: mid-February, 2004
- Coordinators meeting; end of February, 2004
- Interaction with other Herschel instrument teams: March-Summer 2004
- HIFI science Co-I meeting: end of 2004

OUT OF DATE

Preliminary Planck Plans for Herschel

K. Ganga, B. Guiderdoni,
G. Lagache & L. Valenziano

2004-09-28

Planck Source Sensitivity

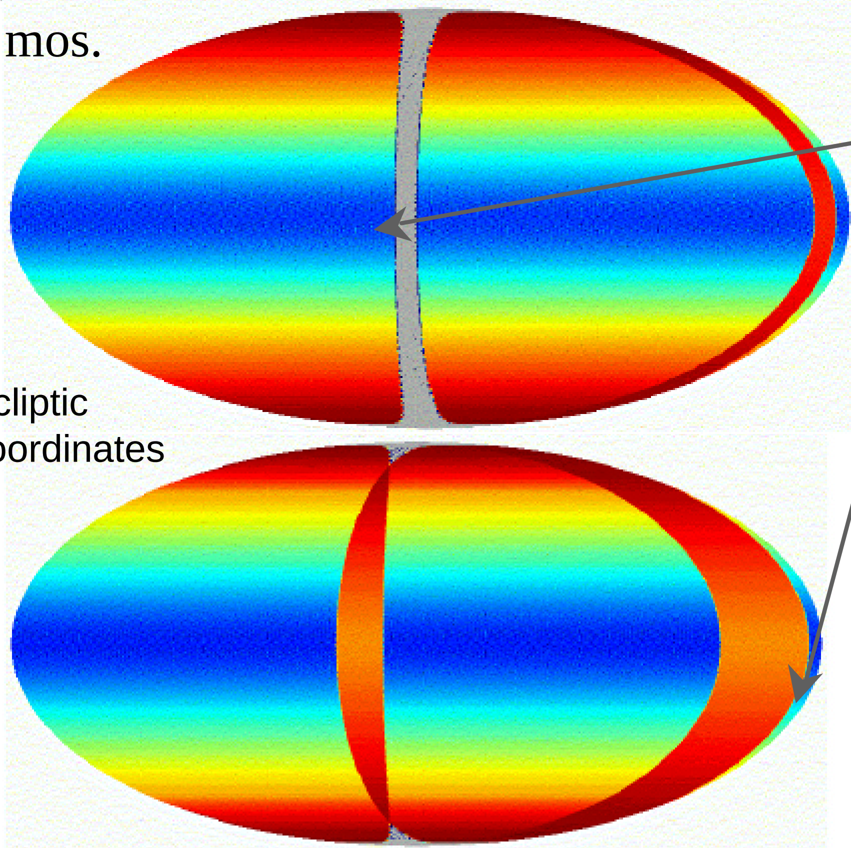
	LFI			HFI					
Frequency (GHz)	**30**	**44**	**70**	**100**	**143**	**217**	**353**	**545**	**857**
Wavelength (mm)	10	6.8	4.3	3.0	2.1	1.4	0.85	0.55	0.35
$N_{detectors}$	4	6	12	8	12	12	6	8	6
$N_{polarized}$	4	6	12	8	8	8	8	0	0
FWHM (arcminutes)	33	24	14	9.2	7.1	5.0	5.0	5.0	5.0
Total Sens. (mJy)	15	23	32	9.8	10	14	27	43	49
ERCSC Sens. (mJy)	150	230	320	98	100	140	270	430	490

These estimates are from the Planck "Blue Book", with some updates by KMG to account for recent instrument changes.

Note that this is "sky-averaged", but that the Planck survey will not be uniform over the sky.

Planck Sky Coverage

6 mos.

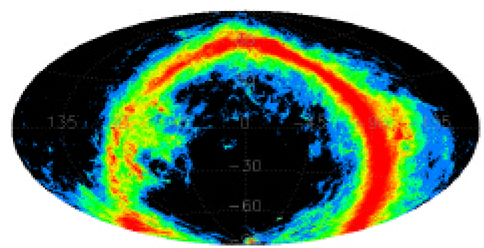


Ecliptic coordinates

7 mos.

Ecliptic longitude of these ‘strips’ depend on launch date.

These are gross features. Details depend on exact scanning strategy.



Post-Launch Proposal Schedule

L+18 mos.	Herschel Cycle 2 AO
L+22 mos.	Planck ERCSC Created
L+21 mos.	Planck Nominal End of Operations
L+21 mos.	Herschel Deadline for GT Targets
L+22 mos.	Planck ERCSC Public Release
L+24 mos.	Herschel GT Targets Announced
L+27 mos.	Herschel Deadline for OT Proposals
L+45 mos.	Planck Public Data Release

Note that this schedule is not definitive; just a construction by KMG.

Planck Groups Related to Herschel

- Extragalactic Sources (Working Group Six)
  - **Follow-up with Herschel (WG 6.4)**
    - *coordinators*: Ken Ganga & Bruno Guiderdoni
- Galactic and Solar System Science (Working Group Seven)
  - **Preparation of and coordination with Herschel key projects (WG 7.5)**
    - *coordinators*: Guilaine Lagache & Luca Valenziano

Possible Example Herschel/Planck Projects

- Herschel/Planck Galactic Plane Survey
- Herschel/Planck Galactic medium-latitude survey (cirrus studies)
- Herschel/Planck Wide Field Survey in high-redundancy zone
- Targeted Herschel observations of Planck pre-launch catalogue sources: SZ clusters, AGNs, radiogalaxies, galaxies
- Others (planets, asteroids ?)

Possible Example: Herschel-Planck Wide Field

- SPIRE Map 400 deg^2 High Redundancy Zone at NEP (b=30°) @ 20 mJy (1σ), in 30 d. Same time on PACS ?
- Expect hundreds of Planck sources and thousands of Herschel sources (but resolve only 1% of CIRB).
- Herschel/Planck cross-calibration of point source fluxes and diffuse component
- Bright galaxy counts at Herschel bands (Euclidean to super-Euclidean). Local LF, Rare objects. Large-scale structures.
- Herschel study of high-latitude cirrus and CIRB fluctuations (component separation, spatial and spectral information, colour- to-redshift inversion) with Planck data.
- A Herschel follow-up of a Planck magnitude limited sample: positions, ID, multiple sources.
- Component separation: test Planck algorithms on Herschel data.

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”.
- A 4x4arcmin^2 map at 100 mJy (5σ) suited to SPIRE follow-up of Planck point sources is obtained in less than 1 mn. Improve fluxes and positions (to ~10 arcsec), study environment.
- Interesting sources in ERCSC and DECSC (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 SZ clusters

Road Map

Date	***Event***
~2004/10/01	Planck Science Team (PST) solicits "abstracts" for "potential proposals" through working group (WG) 6.4 & 7.5 coords.
~2004/10/11-13	Working group 6 & 7 meetings (WG7 meeting will be Oct. 11-13; WG6 may be via telecon). Core teams created for each possible proposal (should contain at least one Herschel team member, if possible).
~2004/10/15	"abstracts" sent to PST through WG 6.4 & 7.5 coordinators.
	i. Teams prepare 2-page description of possible proposal. ii. Teams prepare 1-page slide for presentation to PST.
2004/12/16-17	i. PST reviews proposals from working groups via proposal and presentations. ii. PST issues wider call to ensure nothing is missed.

STAC Meeting Outcome

Matt Griffin

STAC Decision

Nominal SPIRE GT (for 1000 days routine operations): 2000 hrs

Time reserved for non-Key Programme GT: 150 hrs 7.5%

SAG 1	High-z	850 *	42.5% of 2000 hrs
SAG2	Low-z	300	16.2% of 1850 hrs
SAG 3	SF	320	17.3% of 1850 hrs
SAG 4	ISM	180	9.7% of 1850 hrs
SAG5	Solar system	50	2.7% of 1850 hrs
SAG 6	Stellar & circ.	150	8.1% of 1850 hrs

SAG 1 has no access to reserve unless they give up time from the 850

Guidelines to SAGs

- Comments on individual proposals
- Decisions that some programmes should not be done in GT, but suitable for OT)
- But otherwise SAGs can optimise their programmes within the time allocation
- Formal agreements with PACS and HIFI teams may take some time but SAG coordinators can start/continue to work with their counterparts

SPIRE Science Team Plan

1. April meeting:
   - Consideration of Stage-1 proposals from the SAGs ✓
   - Guidelines for Stage-2 proposal format ✓
2. April – Sept.:
   - SAGs produce Stage-2 GT KP proposals ✓
   - Discussions with other GT holders **Continuing**
3. Sept. (at Consortium Meeting):
   - STAC assesses and grades Stage-2 KP proposals ✓
   - Decision on fraction of GT which each SAG will get ✓

Updated SPIRE Science Team Plan

4. **Next steps**
   (to be revised/detailed by Matt. Laurent, Jean-Paul and Walter)

   - **Policy meeting PACS/SPIRE/HIFI early 2005**
   - **SAGs decide on detailed use their GT allocation**
   - **Refinement and detailing of GT KP proposals**
   - **Discuss with other GT holders**
   - **Draft stage 3 proposals (inc. PACS and HIFI collaboration if relevant) by June 05 for STAC review**
   - **Final Stage-3 proposals internal review ~ end Sept. 05**
   - **Ready for submission to ESA winter 2005**

AOT Workshop

Dave Clements

Newsflash!!!

- SPIRE ICC bulletin board has been relaunched
- New topics focused on workpackages and other ICC activities
- URL is: http://astro.ic.ac.uk/Research/Spire/BulletinBoard/index.php
- Previous users will need to re-register
- Previous material has been lost

General Issues

- What is the effect of the changes in proposal handling?
- What is a building block?
- Relationship between observing modes and ORs?
- How is OR information to be communicated to data reduction system?

Open Issues Remaining on SPOT Interfaces

- User interface specification
  - Need to trim the level of flexibility for some observing modes before we can complete this specification
  - Are we happy with all the modes?
  - Suggested medium-res. Mode for spectrometer
- October 10th deadline

Photometry Issues

- Are we happy with 7-point jiggle only?
- How to specify unacceptible chop/nod reference positions?
- How much freedom to give observer in selecting chop/nod freq, chop/nod throw?
  - Impact on calibration if we allow flexibility
  - Impact on science if we don’t?

Mapping Issues

- How to handle uncertainty over jiggle or scan being best mode?
- Do we let observer choose scan/raster, or work out best mode ourselves?
  - If we do it ourselves, how to decide?
- How much control to give observer over details of mapping modes?
  - Raster overlaps, scan rates/directions and no. of repeat scans?
  - Implications for calibration?

More Mapping Issues

- How to define map shape?
  - Problem with roll angle
  - Odd shaped maps from eg. Star formation SAG
  - If roll angle unconstrained, can only guarantee central circle of a given map
  - Is this acceptable?
  - Implications for projects?
  - How to specify a ‘strip’ where angle is unimportant?

Spectrometer Issues

- Up to 9 modes possible
  - 3 spectral - high res scan, low res scan, step and integrate
  - 3 spatial - point, jiggle (7 pt or 64 point) and scan
  - What do we want to offer?
- Is there any point in a medium res. mode?
- Is there any point in low res. mode?

CUS conversion Issues

- Meeting at IC on Oct 26th dedicated to this
- Example of CUS conversion is now available (DLC document circulated)
- References to CUS language etc. in there
- Things not covered in 7-point example
  - Building blocks
  - Telemetry rate, integration time etc. value returns
- AOT testing

More CUS questions

- Default parameters
  - Are we happy with giving user no control of chop throw/rate, nod throw/rate etc?
- Need to define default parameters for all the modes
  - How far should this go - eg. Map geometry, overlaps etc…
  - What values to pick?
  - Any updates expected from observing mode document?

Data Products

Data Products can mean 2 different things

- Could refer to what we give the users
  - Calibrated time lines
  - Meaning of ‘calibrated’?
  - Issue of mapmaking
  - What products for spectrometer?
- Could also refer to the ‘products’ and data reduction blocks
  - Do we have a comprehensive list?
  - How well defined are these?

Internal Product Status

- Where do we stand?
  - Need to have list and definitions documented centrally
  - On IC ICC website
- What needs to be done?
- Timeline for developments

External Data Products

- What is the meaning of a Level 1 data product?
  - What level of calibration to apply?
  - How to supply astrometry?
- What to do with spectra?
  - More complex and less well known than maps or photometry
  - What do do about FTS maps?

Calibration Data Products

- Need to be defined within the pipeline structure
- Need these definitions soon for pipeline development
- What needs to be done?
- Timeline?

SPIRE Interactive Analysis Software Presentation and Demonstration

Mattia Vaccari

Imperial College

(Thanks to Ken, Juliet & Sarah)

HCSS & IA

- HCSS = Herschel Common Science System
- HCSS consists of software for the Herschel Science Ground Segment (Commanding, Proposal Handling, Mission Planning, etc), in addition to Interactive Analysis software
- Herschel Interactive Analysis (IA) system is part of HCSS
- IA is a common system to be used in the processing and analysis of Herschel data from the HIFI, PACS and SPIRE instruments, and is therefore a common development involving collaboration between the three ICCs and ESA

Current IA “Vision”

- IA is expected to provide a set of flexible analysis routines that can be used across the three instruments
- Will allow users to work directly with pipeline products
- Will allow user to build further specialized tasks
- Will indeed be usable as a prototyping tool for pipeline modules producing data products from 3 instruments

IA Functionalities

- The following are provided by the system
  - Scripting and command-line operations
  - Numerical functions (e.g., FFT, interpolation and fitting)
  - Plotting and image display
  - High-level processing algorithms
  - Configurable environment management
  - GUI support
  - Database interactions for obtaining and storing data

- Instrument specific software (e.g. pipeline modules) will be provided by the instrument teams

IA Long-Term Vision

- As part of the agreements with ESA, the Instrument Consortia have committed to provide, in the common IA framework, the pipeline and interactive analysis modules required for the production of Herschel level-1 products, that is "calibrated data in which the instrument effects have been removed".

- Two areas now need to be improved and extended
  - IA common framework, retaining and improving portability to most commonly used platforms, standalone use and avoidance of commercial licenses.
  - Provision of IA modules for the generation of post-level-1 products, including photometric and spectral maps and data of a quality and in a format suitable for the Herschel Legacy Science Archive and the Virtual Observatory.

- Additional resources have therefore been requested from ESA!

Java, Jython and JConsole/JIDE

- HCSS will be completely written in Java
- Jython is a complete Java implementation of the Python language which will be used for IA
- Jython gives direct access to Java objects while retaining most of the interactive scripting power of Python, has a brief syntax and provides for (some) procedural programming
- JIDE/JConsole are synonyms for the same application, which allows you to run Jython commands as an interactive session

Java Benefits

- HCSS will benefit from Java's strengths as a "real-world" programming language:
  - Free Availability - various vendors provide standard-compliant Java user and developer environments free of charge
  - Ease of Install - Java Runtime Environment and Software Development Kit install out-of-the-box, and often come pre-installed
  - Multi Platform Support - follows java support structure, covering Linux, Windows and Solaris (Mac OS X is supported by Apple)
  - Large RAM needs - up to 6 GB of RAM have been tested under HCSS
  - Continuing Support and Development - guarantees HCSS life well into and beyond the Herschel mission
  - Large User Base - Java is extensively and increasingly being used within the scientific community

Joe Astronomer's Issues

- Bridging the "digital divide" between procedural and OO paradigm
- Jython (and certainly Java:-) is NOT "just" like IDL!
- Comprehensive, updated and easy-to-access documentation
- New developments MUST be backward-compatible
- !!! Familiarity with IA will help in Herschel-wide data reduction !!!

Now let's "hit the road" with IA!

Users?

- Right after getting acquainted with a programming environment, developers tend not to be able to tell the wood from the trees
- Developers aren't necessarily representative of typical users
- Finally, developers ideally tend to be busy doing what they should: coding!
- Hence, USER inputs are required to make HCSS & IA successful

THEREFORE

- Get it and use it for your day-to-day work!
- Share your scripts and your users' experience!
- If you don't, it's unlikely all of your needs will be met in due time!

Hot Issues

- A few features are planned to be added or expanded upon
  - Documentation Rearrangement (helping up the learning curve)
  - Universal FITS I/O (allowing you to do your OWN work under HCSS)
  - Text-editor-like Script Editor (for the computer savvy)
  - Background Processes and Keyboard Interrupts
  - User-Friendly Help System and Error Messages
  - Most existing functionalities need “testing” and “polishing”
- Speak “now” or hold your breath “forever”!?
- SPIRE IA Master Testers are available for any feedback/request

< Mattia Vaccari and Marc Sauvage >