



Overall Status of the Herschel Spacecraft: Lessons Learned from Commissioning and Performance Verification

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Outline

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- Telescope status after COP and “sneak preview”
- General scheme during PV
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- Mirror emissivity and temperature
- Pointing performance
 - Accuracy
 - Tracking
 - Scanning
- Observing modes status at the end of PV
 - SPIRE
 - PACS
- HIFI during PV
- Conclusions



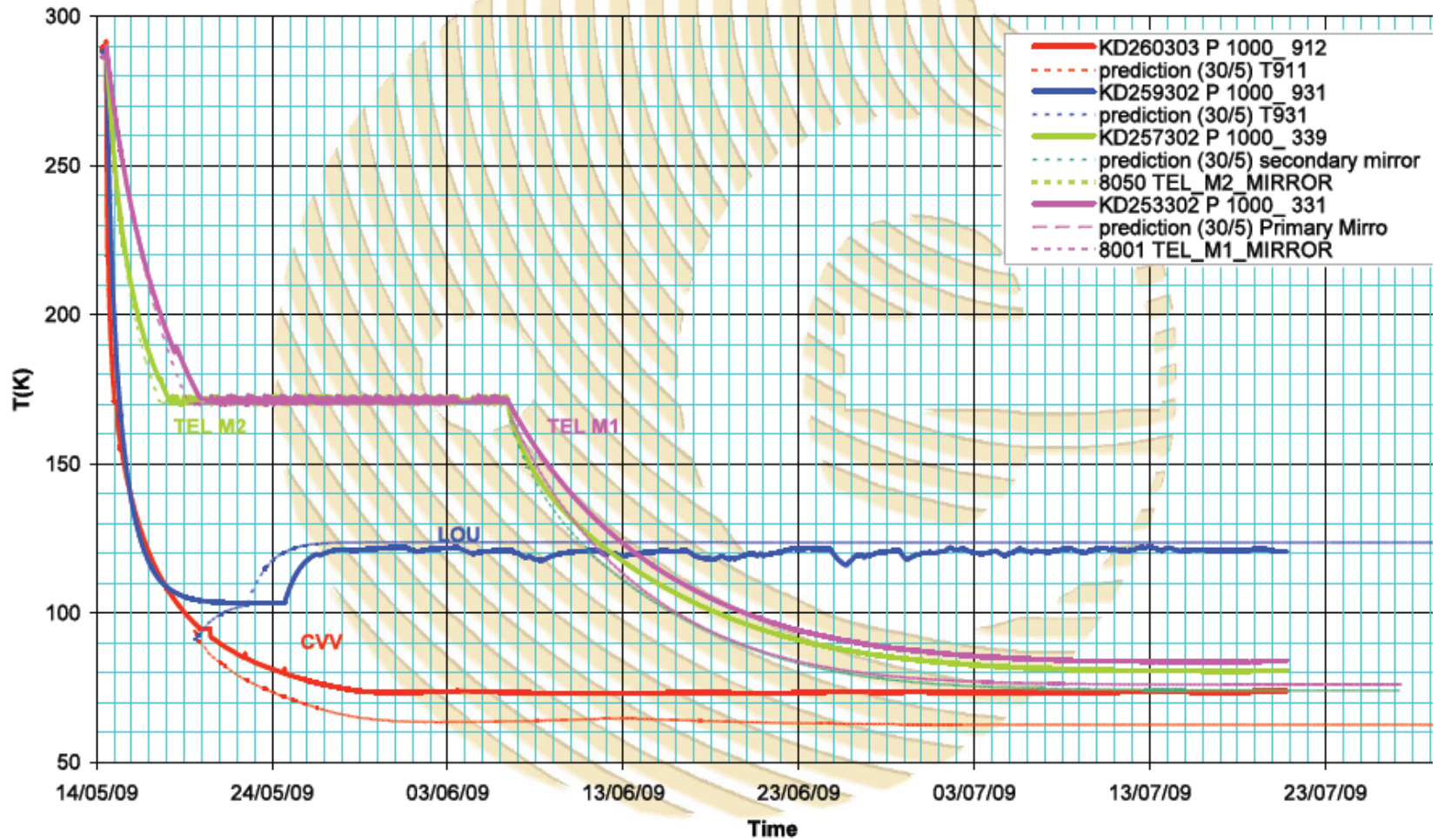
Overall Scheme for COP

- Intention:

- To functionally test all instruments.
- To assess initial calibrations prior to and just after cryo-cover opening (e.g., check against internal calibrators, assess stability, adjust satellite heaters).
- Checkout pointing/ACMS system (STRs point opposite direction to instruments, check misalignment between STRs).
- Heat system to ensure contaminant removal.
- Cryocover opening on OD39.
- Assess straylight and telescope background.



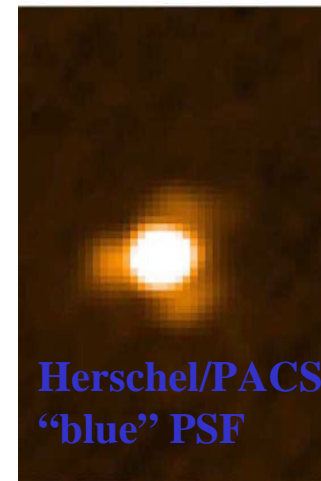
Cooling System During COP



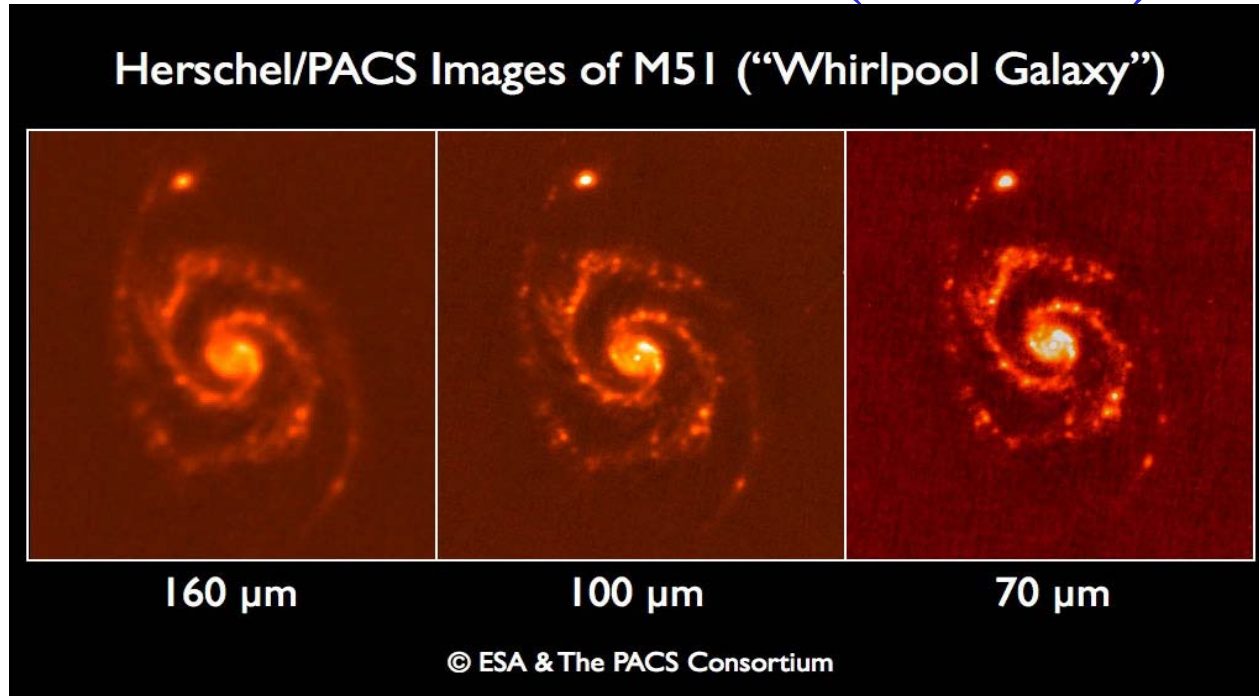


Telescope Status After COP

- Telescope allowed to passively cool down to 170K (M1 and M2 cooled at slightly different rates). Held at 170K for decontamination purposes, then allowed to cool from day 27 so that at 120K around opening on day 32.
 - **No hint of contamination**
 - Local oscillator windows of HIFI show no evidence for contaminants/ice at all.
- **Focus very good** – measurements with PACS indicate diffraction-limited PSFs down to the shortest wavelengths of Herschel.
- PSFs – these show the **diffraction-limited core**, but wings at lower levels giving a triangular shape (diffraction from the hexapod holding the secondary mirror)



“Sneak Preview (OD32)”



But – very inefficient and observatory was far from ready.

Very useful for early understanding of focal plane geometry for all instruments.

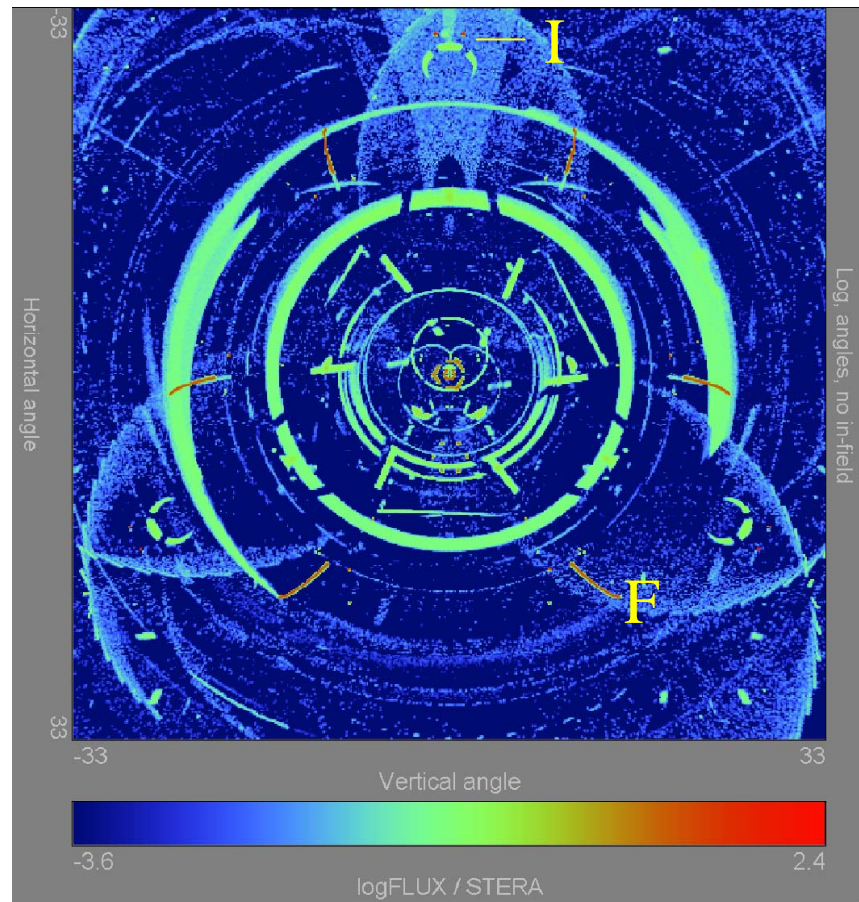


Overall Scheme for PV

- Based on the instrument PV plans that were reviewed well before launch.
- Intention: to verify observing modes and optimize sufficiently that close to / at / above sensitivity expectations.
- Typically worked in 12 day cycles (to start) which allowed time for analysis, commanding updates (CUS), and planning cycles.
- Literally dozens of changes made to instrument commanding. Typically 5000 to 10000 telecommands uplinked daily. Very few commanding problems.
- When ready, each AOT went through a release review, included uplink and downlink (pipeline) concerns and issues to inform users about.
- SDP observations started with release of mode.
- Assessed performance of the observatory.

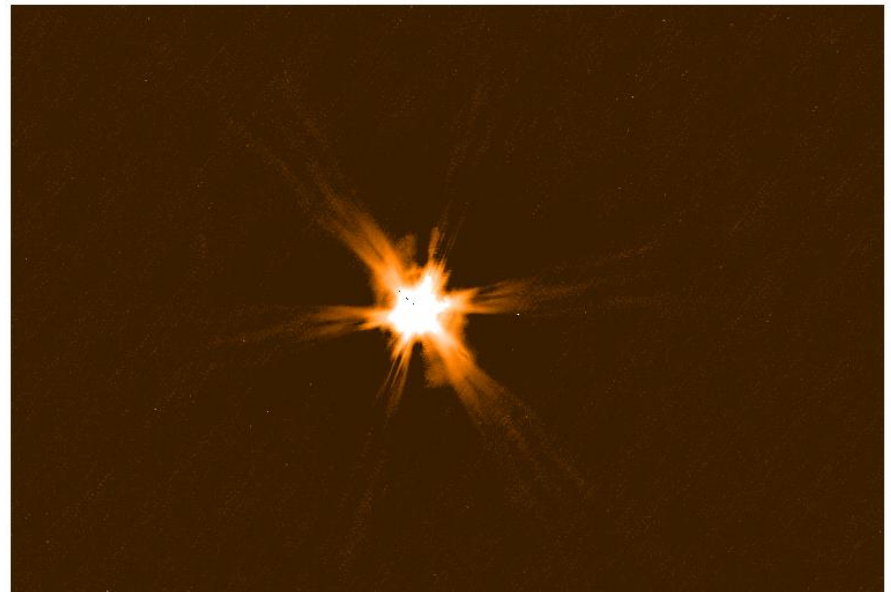
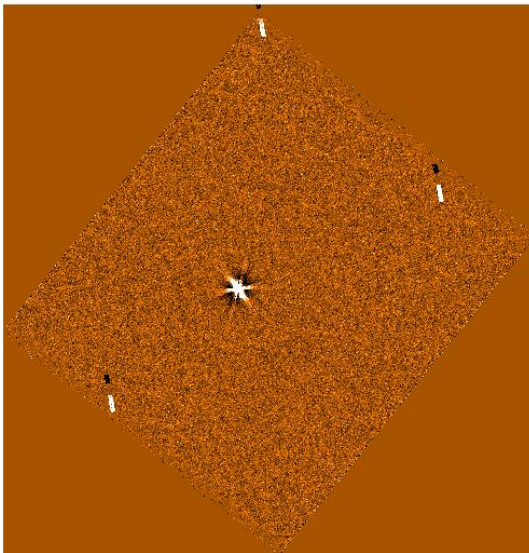
Straylight Model (Marc Ferlet)

- Red spots indicate areas relative to the PACS field of view where strongest straylight reflections can be expected.
- Straylight point “I” first looked at for far-field measurements.

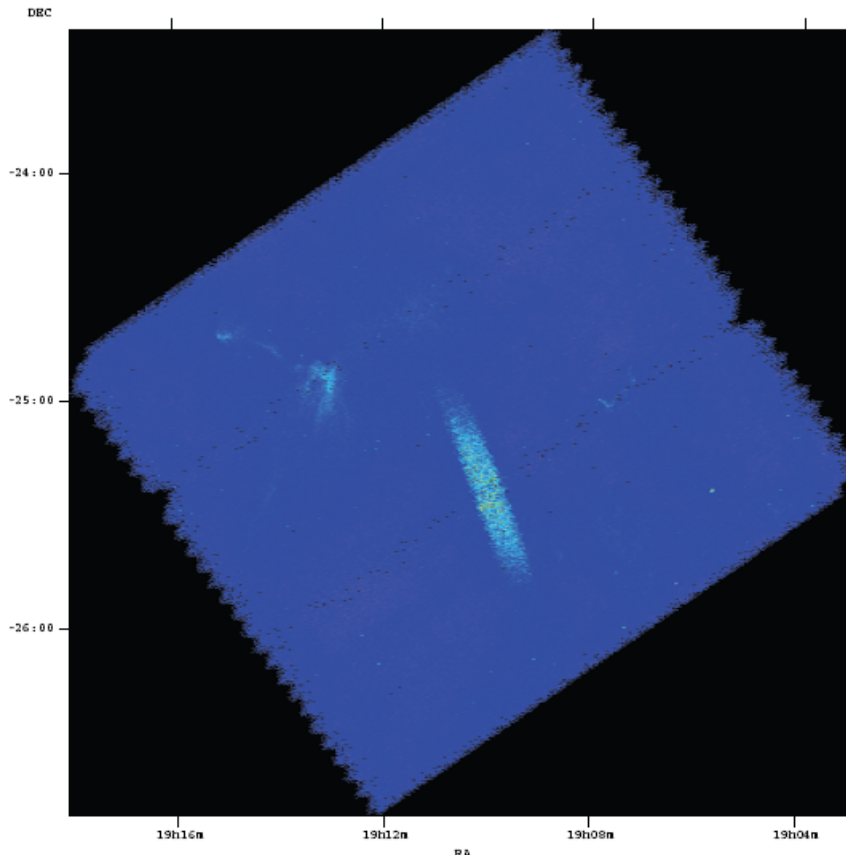


Straylight results (near-field)

- Mars seen with PACS. PSF shows hexapod structure but no near-field straylight.



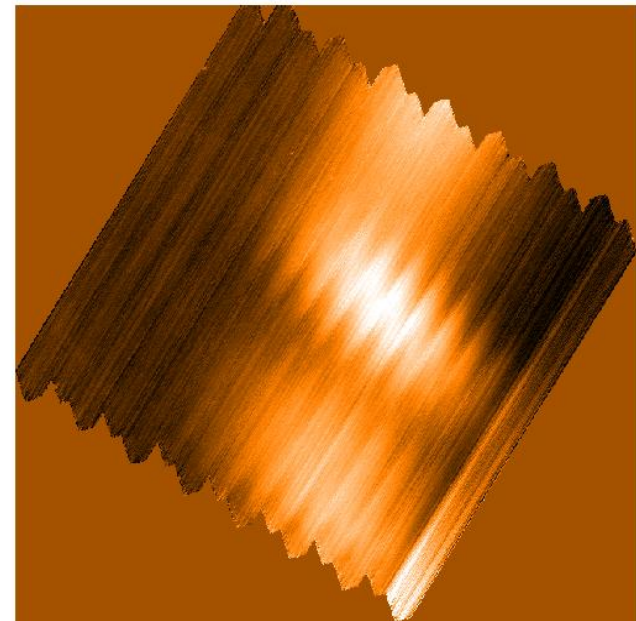
Straylight (far-field)



- Jupiter straylight – shining off of hexapod legs. Jupiter at position “I” (SPIRE/PSW). Also seen by PACS – parallel mode maps used.
- Model of straylight qualitatively verified.

Straylight (Moon at point “F”)

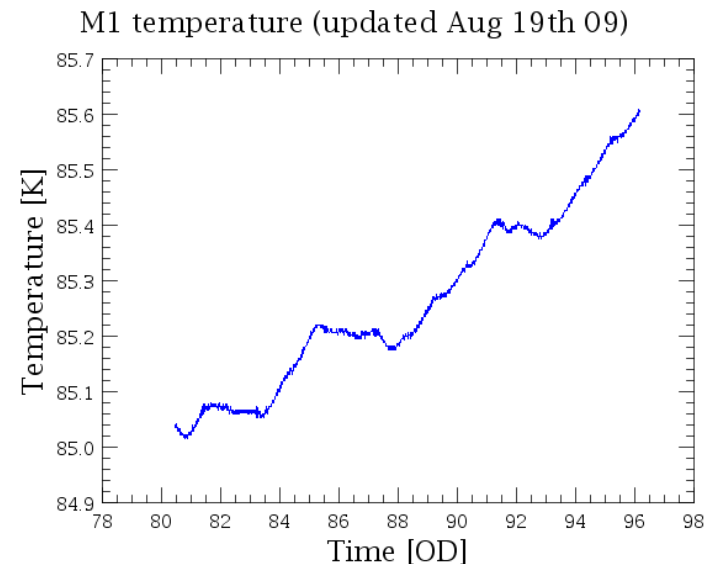
- Also used the Moon – significant extended straylight BUT only possible ~1x per year and have to be at right position!





Mirror Emissivity and Temperature

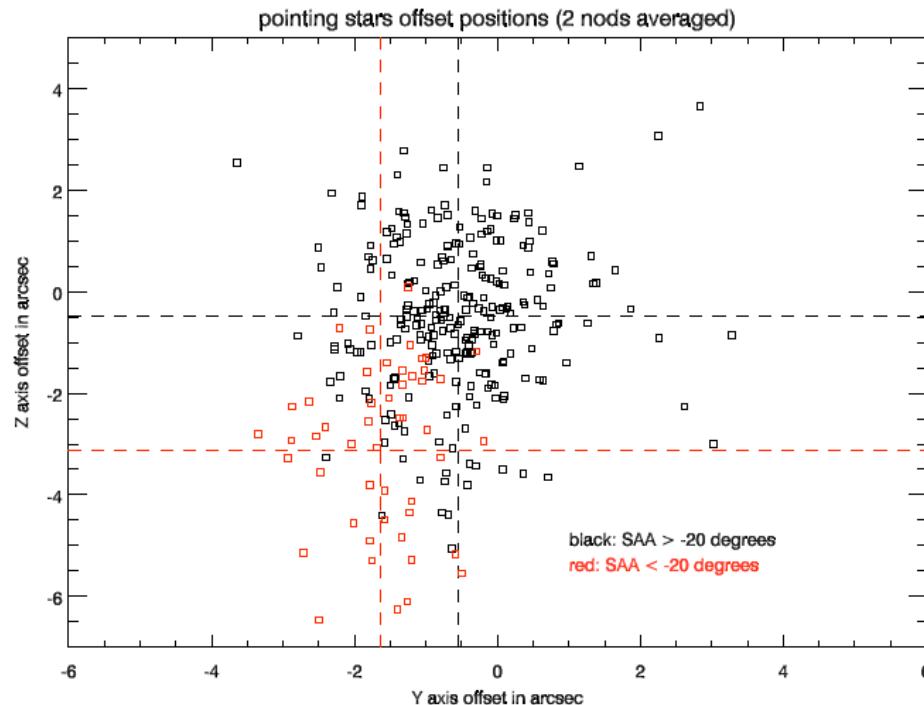
- Basically – low emissivity → higher temperature for mirror. Overall, lower background with lower emissivity. We are towards the low end of expected.
- Temperature of primary/secondary will change over the mission. This is seasonal and has a deviation of as much as 8 degrees (peak in January).





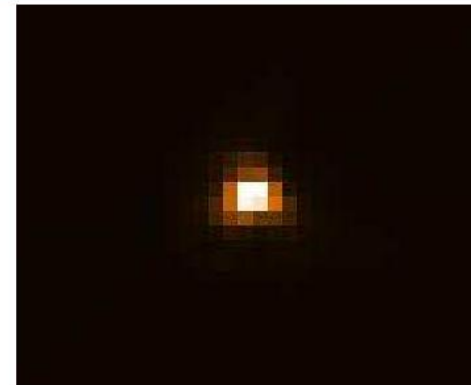
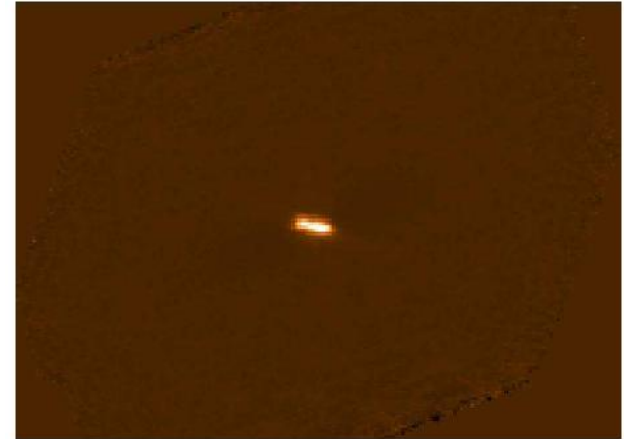
Pointing Performance

- Generally speaking we are where we expected to be, which is better than requirements on direct staring (absolute pointing – 1.8 arcsecs).



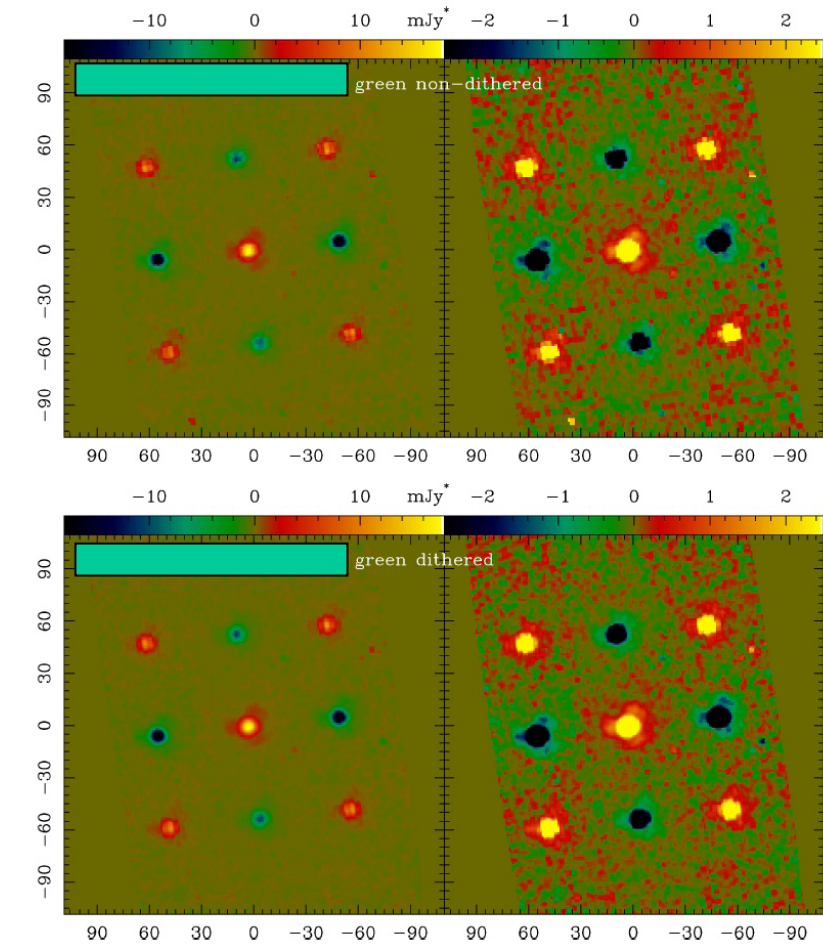
Tracking

- Tracking has been shown to be excellent. Solar system targets have been shown to easily stay within a single PACS blue frame pixel for observations of 1 hour+.
- E.g., 18 Melpomene ($67''/\text{hour}$).





Tracking– Pt.2



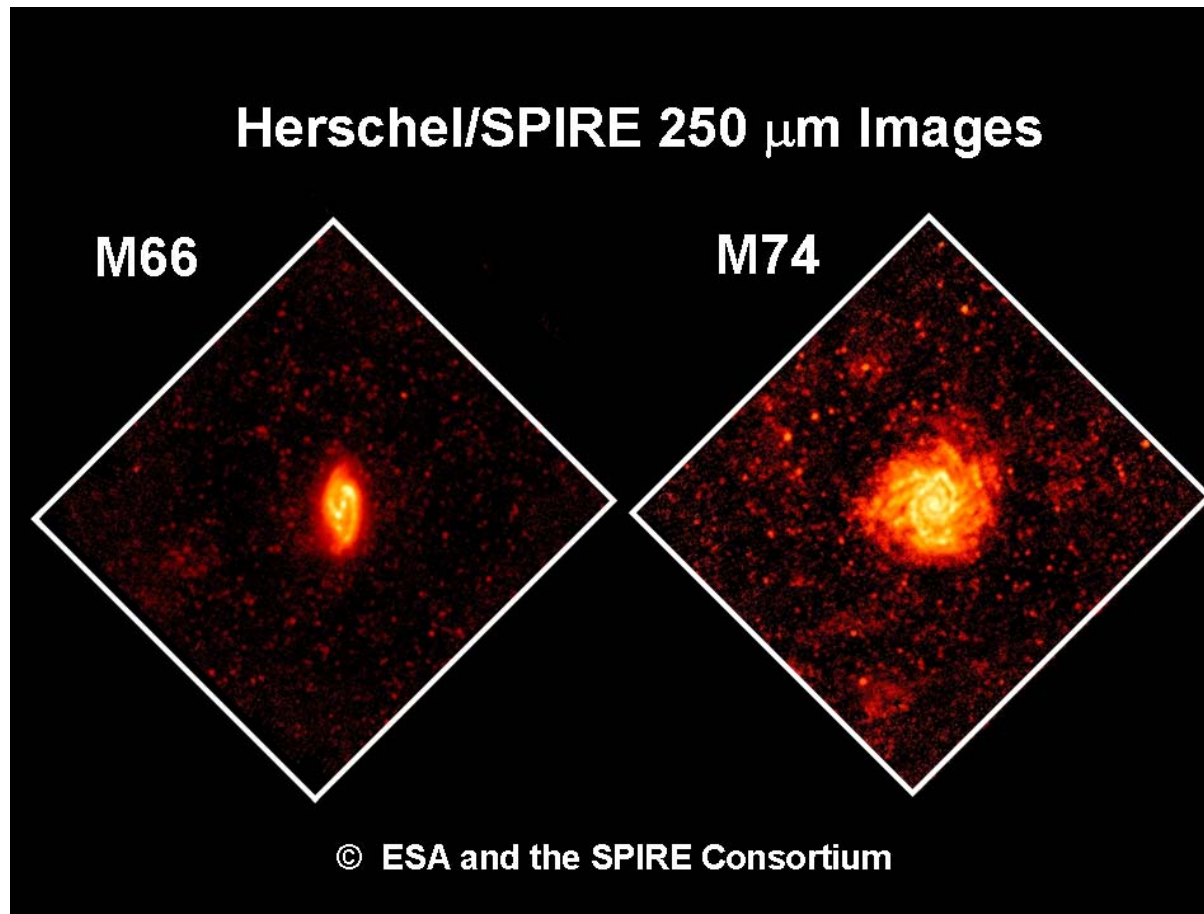


Scanning

- Scan maps work well for both PACS and SPIRE. **But** we do notice some jumps in scanning speed/reported direction for portions of some scans. This is a concern and there are corrections being considered in data processing and updates to ACMS system.
- Delays noted at the beginning of scan legs have been reduced in latest planning software. Provide ~10% (average) saving in observing times in PACS scan maps.
- Improvements in SPIRE scan leg turnaround currently being addressed.



SPIRE Scan Maps





Parallel Mode Scan Maps





Observing Mode Status: SPIRE

SPIRE Modes	Sensitivity	Released	Comments
<i>Phot - point</i>	Yes	No	7-pt jiggle. Expected release soon. Completing flux cal using Neptune.
<i>Phot – small map</i>	No	No	Not 64-pt jiggle. Will use orthogonal scan maps instead.
<i>Phot – scan map</i>	Yes (~same as HSpot, 2 or 3 scans → confusion limit, 20% flux cal accuracy)	Yes	Bright source mode released.
<i>Parallel mode SPIRE/PACS</i>	Yes (as for scan map)	Yes	Bright source mode close to full release. Colour correction/high flux linearities to derive.
<i>Spec - point</i>	Yes (~2x better than HSpot)	Yes	High and low resolutions only.
<i>Spec - mapping</i>	No	No	Intermediate and large map. Available Feb. 2010



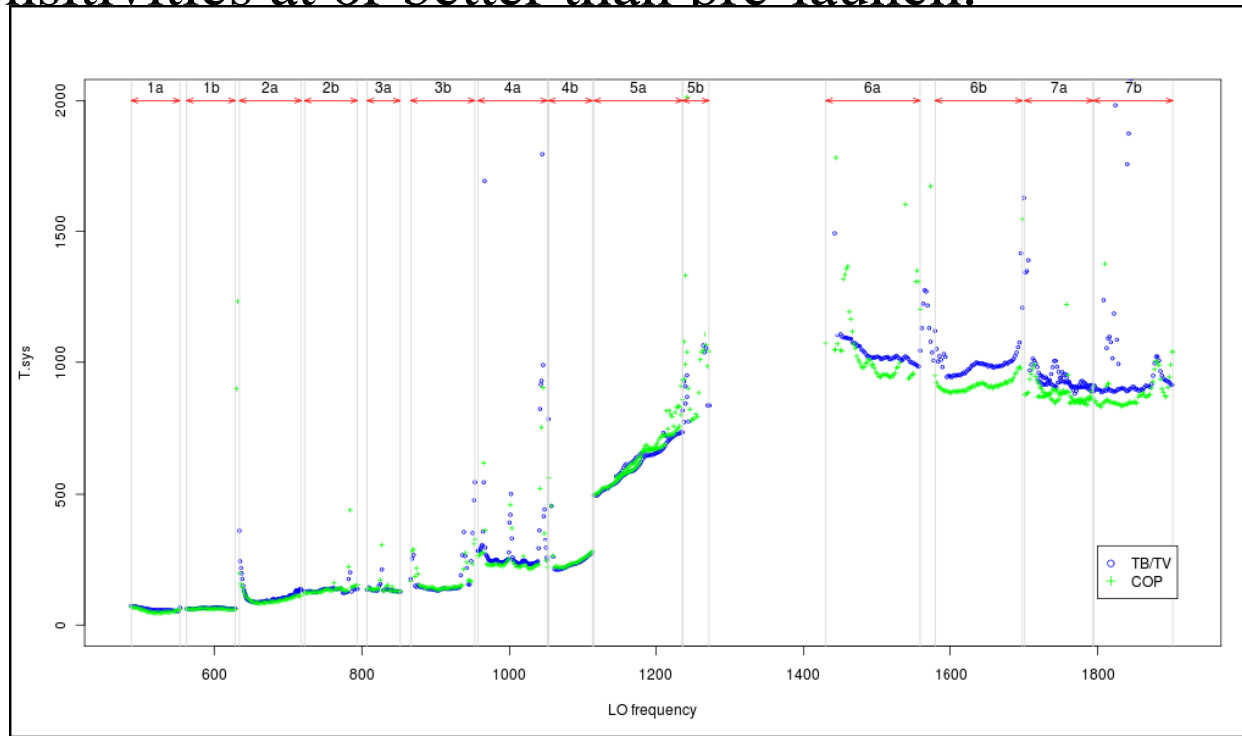
Observing Mode Status: PACS

PACS Modes (all limited to 9.1h)	Sensitivity	Released	Comments
<i>Phot - point</i>	Yes (approx. 2 times worse than HSpot)	Yes	Provides best PSF. Photometer flux cal accuracy ~10% in DP 2.0.0
<i>Phot - small source/raster</i>	No	No	Use scan map mode instead.
<i>Phot - large scan</i>	Yes (slightly worse than HSpot)	Yes	Use 20"/sec scan speed NOT 10"/sec.
<i>Spec - point&raster /range & chop/nod</i>	Yes (at or slightly better than in HSpot)	Yes	Adaptations to repetitions. Each cycle of observing is now longer. Faint and bright line mode + high sampling range spec.
<i>Spec - SED spectroscopy</i>	No	No	SED/full range and mapping not yet released (this week). Other range scans – same comment as for chop/nod.
<i>Spec - Wavelength switching</i>	Yes (at or slightly better than in HSpot)	Yes	Only up to level 0.5 on release. More complete pipeline available very soon.



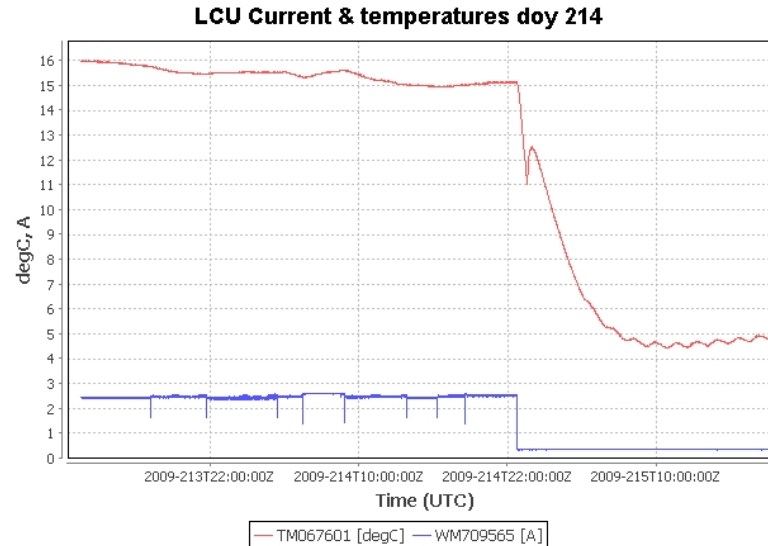
HIFI During PV

- Very successful up to OD 81 (5 days of PV observations).
- DBS mode not far off being made available.
- Sensitivities at or better than pre-launch.

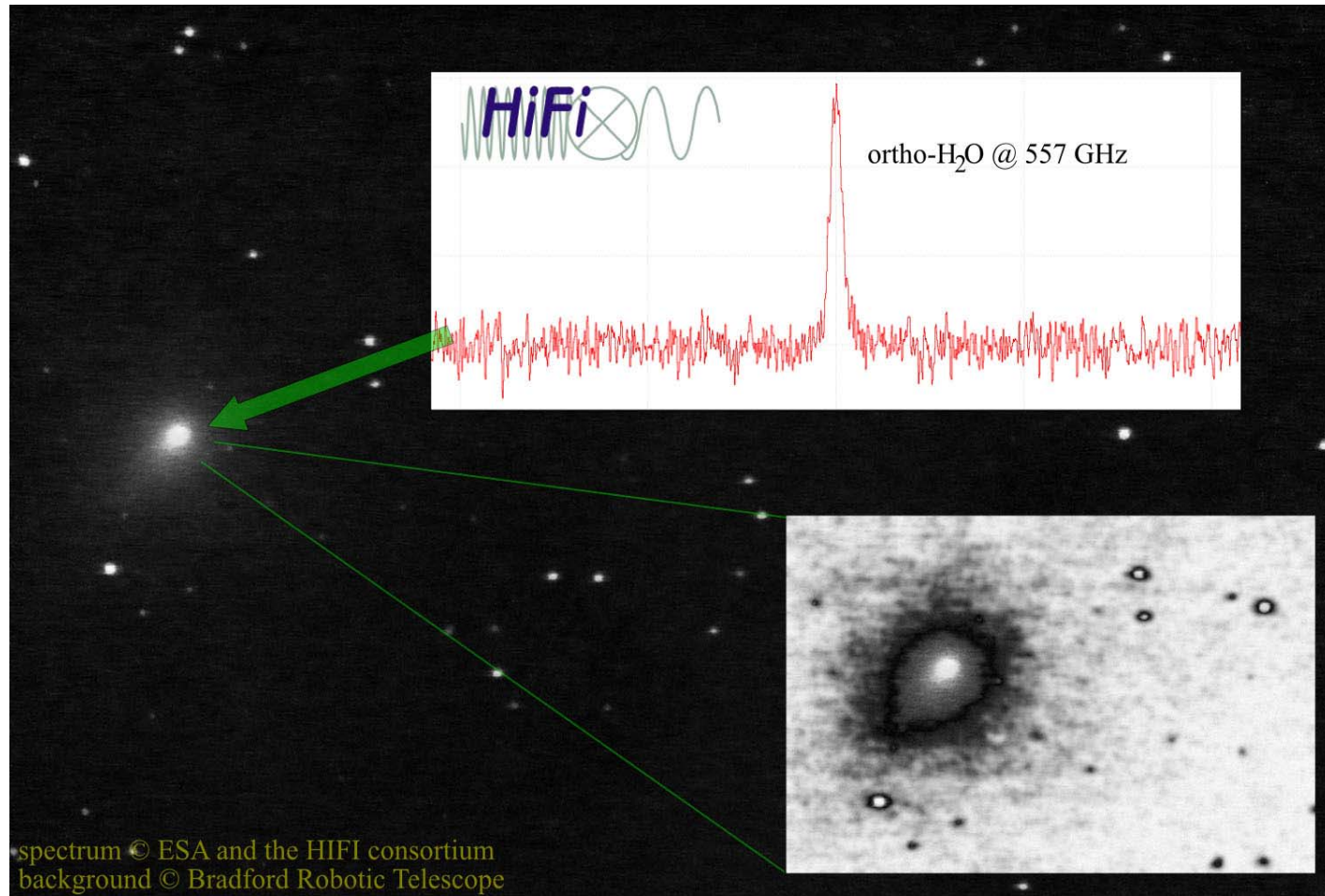


HIFI anomaly...very briefly

- On OD81 – loss of communication and use of LO control unit (LCU).
- Ever since been working to find cause (complex).
- Turned on redundant side electronics and checkout of FPU.
All okay – 6/7 Dec.



Nevertheless – early results promising



spectrum © ESA and the HiFi consortium
background © Bradford Robotic Telescope



Other Issues

- The SPIRE DCU heat dissipation affects HIFI laser leading to instability in the HIFI V polarization measurements. SPIRE needs to be off for at least 10 hours before HIFI comes on.
 - Current schedule has SPIRE separated from HIFI by at least one observing day.
- Almost simultaneous measurements have been made by SPIRE and Planck, covering same wavelength range. Possibilities of later cross-calibration with the CMB?
- Improved pointing via interlacing of STRs and gyro propagation (various types).
- HIFI full switch-on mid-January. Some weight towards “catching up” with HIFI measurements in schedule up to April.



Conclusions

- Approx. 90% of all SPIRE and PACS Key Project AORs can now be scheduled using modes that are released. Most of the rest soon.
- Sensitivities are mostly similar to or better than pre-launch predictions (for HIFI also).
- Some modes changed and recommended updates communicated to KP teams.
- There will be further improvements in the future.
- HIFI will be available shortly after the new year.
- Possible problems areas that are not:
 - Focus: none (also known that LO windows aligned with waveguides)
 - Contamination: none seen
 - Straylight: Modeled. As expected.
- Pipelines are catching up with all the lessons learned but some work will be needed from astronomers...which is why you are here!!



Finally... Thanks

- **Thanks to the ICC teams.** We (ICS team) have been working with them and intimately involved in instrument testing and analysis for quite some time, and the hospitality is much appreciated.
- **Thanks to my team (ICS team).** They have done a tremendous amount of work not just at the HSC but at the ICCs too – and of excellent quality. These are also your Helpdesk mentors.



Additional Slides





Organigram for Operations

Calibration (7.5 fte)

- A. Marston (Group Lead/ HIFI Inst. Cal. Sci.)
- B. Altieri (PACS Inst. Cal. Sci.)
- D. Teyssier (HIFI Inst. Cal. Sci.)
- I. Valtchanov (SPIRE Inst. Cal. Sci.)
- M. Sanchez (Pointing Expert)
- R. Vavrek (PACS Inst. Cal. Sci.)
- L. Conversi (SPIRE Inst. Cal. Sci.)
- B. Merin (DP Astronomer 0.5fte)

