HStrayWG mtg#2 - MOM

Herschel/HSC/MOM/1313

Göran Pilbratt, 20 January 2009

The second meeting of the Herschel Straylight Characterisation Working Group (HStrayWG#2) took place as a telecon on 18 Dec 2008, starting at 14:00 hours and finishing at 17:30 hours. The draft minutes were circulated on 30 Dec 2008, comments incorporated in the final minutes issued on 20 Jan 2009.

Attendance

Bruno Altieri (BA)
Dominic Doyle (DD)
Marc Ferlet (MF)
Jackie Fischer (JF)
Ulrich Klaas (UK)
Koryo Okumura (KO)
Göran Pilbratt (GLP)

1. Welcome and Agenda

- GLP acting as meeting chair welcomed everyone to this telecon. He offered his excuses for the oversight of not initially inviting JF to the HStrayWG, and suggested that we add her to the WG which was gladly accepted. GLP to update and circulate the TOR. *(Action_2-1 on GLP)*
- GLP asked for additional comments on the circulated draft agenda *(attached as Appendix 1)*. No further comments, the agenda was adopted for the meeting.

2. Review of actions

HStrayWG1-Action#

1. Add relevant EQM straylight documents into Livelink. Actionee: GLP. Deadline: 8 Dec 2008.

CLOSED. Done on 10 Dec 2008.

2. Add the ISOPHOT straylight document provided by UK into Livelink. Actionee: GLP. Deadline: 8 Dec 2008.

CLOSED. Done on 10 Dec 2008.

3. Issue and circulate the HStrayWG ToR. Actionee: GLP. Deadline: 8 Dec 2008.

CLOSED. Done on 4 Dec 2008.

4. Provide explanation for how N.Geis has computed the ‘attenuations’ presented in App.5. Actionee: UK. Deadline: 15 Dec 2008.

CLOSED. Done by UK on 11 Dec 2008, update by email by N. Geis on 18 Dec 2008.

5. Provide information whether the in-flight model of PM can be used to calculated ‘attenuations’. Actionee: DD. Deadline: 15 Dec 2008.

CLOSED. Done by DD on 16 Dec 2008, by email.

6. Deliver the in-flight ASAP straylight model and the (as-built) Code-V of PM to MF/SPIRE and N.Geis /PACS. Actionee: DD. Deadline: 15 Dec 2008.

CLOSED. Done by DD on 11 Dec 2008.

7. Add PM's SPIE straylight paper into Livelink. Actionee: GLP. Deadline: 8 Dec 2008.

CLOSED. Done on 10 Dec 2008.

8. Provide the Al thickness of the kapton used to cover the hexapod legs. Actionee: DD. Deadline: 15 Dec 2008.

CLOSED. Done on 10 Dec 2008, by email, thickness 100 nm. To put this in perspective, the skin depth δ for a 1 THz / 300 μm signal at a ~80 K Al surface is ~25 nm, it scales with $\lambda^{1/2}$. Thus even at 500 μm the 100 nm coating represents ~3δ, thus basically 'bulk' matter; it is not (semi-)transparent for any Herschel observing wavelength.

9. Check whether locations of 'sore spots' can be predicted and whether Fig.6 in PM's SPIE paper has been produced by using the in-flight Code-V model. Actionee: DD. Deadline: 15 Dec 2008.

CLOSED. Done on 16 Dec 2008. The spots as shown in the SPIE paper have been produced by the ASAP code as of 2004.

10. Identify what practical constraints are important for the operation of SPIRE early in the mission. Actionee: MF. Deadline: 15 Dec 2008.

CLOSED. Done by MF on 15 Dec 2008, email.

11. Can the MPS system handle desired source (in particular Sun, Earth, Moon) relative positional arrangements for the scheduling of straylight characterisation observations. Actionee: GLP. Deadline: 15 Dec 2008.

CLOSED. Done by GLP on 16 Dec 2008, email response circulated.

12. Check and confirm that PM can attend the meeting TBC on 18 Dec 2008. Actionee: DD. Deadline: 8 Dec 2008.

CLOSED. Done on 16 Dec 2008.

13. Review the list of actions in the draft MOM. Actionee: all. Deadline: 2 Dec 2008.

CLOSED. Final minutes issued on 4 Dec 2008.

3. Inside FOV of the telescope

- PACS. The basic information is contained in the MOM of our last meeting. Near-field photometer and spectrometer straylight characterisation will be performed by using a bright source - a planet - and executing scanmaps around the source. The map extent - current plan a few arcmin - will be reviewed in the light of an assessment of the provided straylight documentation.
- SPIRE. A distinction must be made between inside FOV for the instrument and for the telescope. For inside the FOV of the instrument (ghosts etc) characterisation is already included in the current PV plans, for both the photometer and spectrometer. These measurements are similar to what was done during the ILT campaign, although it must be remembered that the ILT campaign was not fully representative.
- Outside SPIRE FOV but inside telescope FOV. Nothing is implemented in the current plans. It was suggested that in particular a source between the PACS and SPIRE FOVs is the most interesting. Proposing scans around bright source which could be Neptune - observed a calibrator - but could also be a brighter source e.g. Uranus, Saturn, Jupiter etc depending on what is available in terms of source visibility.
- The possibility to perform this type of observation in parallel mode, getting data for both PACS and SPIRE simultaneously was raised and discussed. How large a map do we want to make? To what level do we want to map? If we put the source on the telescope boresight it will be approx 9 arcmin away from both PACS and SPIRE.

- Using parallel mode 1x1 deg at low scanspeed takes ~2 hr, this observation provides a map which can be seen as a map with a stationary telescope boresight moving the source around to every pixel in the entire map.
- GLP raised the question as to whether and to what extent separate spectrometer observations would be necessary, or could whatever paths characterised by the photometer observations suffice? Since we are talking about straylight outside of the instrument FOVs could this be regarded strictly a telescope/observatory property?
- MF argued that you could learn about the spectrometer performance from the photometer map. UK argued that he would still would want to confirm the straylight using the spectrometer. MF does not feel that there is a lot more to learn. *(Action_2-2 on UK/MF)*

4. Outside the telescope FOV

- GLP reported that he has been in direct contact with Philippe Martin, TAS-F (PM) regarding the 'in-flight' straylight calculations reported on in the SPIE, Marseille 2008 paper. They are based on the ASED 'in-flight' predictions provided in 2004, they are neither 'new' nor based on a 'correlated' 'as built' straylight model. This fact was not clear to us in our last meeting and was noted.
- DD talked through the presentation provided by PM *(attached as Appendix 2)*. Optical performance provided 'as-built' and 'as-aligned' in the Code-V model. Straylight performance 'as-designed', not updated 'as-built', which was stated considered normal procedure in straylight engineering as the straylight predictions are inherently not exact. PM has provided 'error' estimates (last slide) of directions for possible straylight paths of order 'a few arcmin' and in terms of attenuation levels.
- MF pointed out there is another source of data concerning the telescope: the telescope OICD in HER.NT.0167.T.ASTR issue 6 (06/12/2006). DD confirmed that the flight configuration in this doc is based on the measured as-built item. But this configuration indicates a lateral decentering of M2 of ~0.5±0.5 mm along each axis. This appears to be present neither in the CodeV optical model nor in the ASAP straylight model although from PM's presentation a shift of 0.1 mm for hexapod induces a 1 arcmin shift of stray path on sky; here this would mean between ~0 and ~10 arcmin on each axis potentially.
  - M2 being a telescope optical element with a high magnification factor in Herschel there is potentially for modification of the instruments FOV location on-sky (pointing).
  - A pupil mismatch is also induced between instruments and telescope but this is not a lot more than nominal, nominal predicted seems to indicate margin wrt requirement larger than this for all instruments (see HP-2-ASED-TR-0260, issue 2, 10/10/2008).
  - A secondary effect of a 0.5 mm decentering of M2 is the reduction of imaging quality which makes the predicted performances from the CodeV model less relevant and as consequence in straylight terms, the in-field straylight requirement could be met with lower margin than predicted (as reduced image quality = lower peak irradiance and rise of the sidelobes level in the PSF).
- GLP asked that having clarified that the presented data originate from the 'old' analysis, do we have enough information to actually start designing straylight characterisation observations? UK requested the ASAP results in electronic form, he also questioned the fact the results applied to the telescope boresight rather than to the instrument focal positions. UK argued that what we need are ASAP calculations based on the actual positions of the instruments in the focal plane, and the results in electronic form.
- Is is possible to rerun the existing ASAP model? It was concluded that even for an experienced ASAP user it is difficult to use the existing code because of the way it has been written. MF is prepared to run the existing ASAP model provided he can be supplied with the necessary instruction (procedures) on how to use this particular model. DD will interact with PM and try to get these procedures. *(Action_2-3 on DD)*
- It was suggested that it could be looked into whether we could use another source replacing the Moon in order to be less constrained for when the actual tests on the 'brightest' identified 'points/spots' could be executed.
  - However, a large extended source like the Moon has the advantage that it covers a region on the sky so the accuracy of the prediction as to where the sensitive path is becomes less important, the Moon basically covers the uncertainty.

- JF suggested that a serendipitous database be collected from PV and SD phase observations to monitor straylight from outside the telescope FOV for observations with nearby strong sources outside the telescope FOV (to be followed up with a more detailed note to the WG). *(Action_2-5 on JF)*

5. Self-emission

- It has been established that - due to the measured very low emissivity of representative samples - the telescope optical surfaces are not necessarily the dominating sources of self-emission, in particular not at SPIRE wavelengths.
- In the analysis performed (HP-2-ASED-TN-0023 v4 = Doc#20) the outcome was that the self-emission is dominated - in order of importance - by hexapod, M1, M1 baffle, M2, scatter cone, sunshields. For 'covered' surfaces, e.g. hexapod legs, it will be important to understand the effective emissivity.
  - Do we see the SiC through the kapton?
  - JF volunteered to carry out transmission, and possibly reflection measurements of a kapton sample at the operating temperature for input to model.
  - Cf. discussion of Action_1-8 in Section 2.
- Does it make sense (if possible) to observe the telescope during cooldown?
  - For SPIRE it would only be of interest to perform measurements with a small (<10 K) difference wrt to the final 'stationary' temperature.
  - For PACS we will not be in a position to perform reliable observations until the detectors have been properly characterised and by then the telescope is already cold.
- The instruments are designed to perform differential measurements, you cannot measure the total optical background directly. A set of measurements including - as was the very first suggestion - a coarse spectrum of the background at different temperatures (using the SPIRE FTS without a source in the field), background with closed cryo-cover (which we know is very low), and measurements with sources adding to the background, will all have to be analysed and interpreted with a view to disentangle the background contribution to the observed signals.

7. Next meeting

- Next meeting will take place on 23 Jan 2009 in MPE, taking advantage of the fact that several HStrayWG members will already be in MPE on the previous two days. JF will be offered to hook up by telephone.

8. Action review

- To be performed by commenting on the draft MOM. *(Action_2-4 on all)*

9. AOB

- None.

GLP thanked everyone and closed the telecon.

List of Actions - HStrayWG#2-Action#

1. Update and reissue the HStrayWG TOR. Actionee: GLP. Deadline: 22 Dec 2008.
2. Clarify to what extent separate photometer and spectrometer observations for the characterisation of straylight paths outside instrument FOVs but inside the telescope FOV would be necessary/provide important added value. Actionees: UK/MF. Deadline: 16 Jan 2009.
3. Interact with PM and try to extract and provide procedures for running the existing ASAP model. Actionee: DD. Deadline: 16 Jan 2009.
4. Review the list of actions in the draft MOM. Actionee: all. Deadline: 7 Jan 2008.
5. Clarify usefulness and procedure of using serendipitous observations for characterization of straylight from outside telescope FOV. Actionee: JF. Deadline: 16 Jan 2009.

List of Appendices - HStrayWG#2-Appendix#

1. Draft agenda
2. PM's presentation
3. Input to HStrayWG#2 by MF

Appendix 1

DRAFT agenda for HStrayWG#2

Telecon, 18 Dec 2008, 14:00-17:00

1. Welcome and agenda - GLP

2. Actions review - GLP
- HStrayWG#1 actions closure

3. Inside/near (instrument) FOV straylight - all
- confirm covered by instrument tests
- what tests?
- what is covered?
- complete?
- do we need to come back to this one?
- document for the HStrayWG final report

4. Outside (instrument) FOV straylight - all
- predictions of relevant “areas on the sky”
- software tools - available to us?
- fidelity of predictions discussion
- what else needed to design observations?
- dependency with mission planning
- conclusions?
- open issues?

5. Self-emission - all
- what exactly do we want to characterise, cont’d from HStrayWG#1
- how could this be done? (“in theory”)
- how can it be done? (“in practice”)
- dependency with telescope cooldown and sky availability
- conclusions?
- open issues?

7. Next meetings
- prel output from group “end Jan 2009”
- need to discuss how to proceed
- GLP only available for full day on 23 Jan (in period 12-31 Jan!!)

8. Action review
- open old ones (should be none!)
- new actions

9. AOB

ThalesAlenia Space
A Thales / Finmeccanica Company

Herschel Telescope optical performance flight predictions (WFE & Straylight)

P. Martin

THALES

Outline

- **Documents**
- **Optical performance**
- **Straylight specular path for out-of field of view sources**
  - Modeling status
  - Modeling limitations and estimated accuracy

Documentation

- **Herschel optical performance – flight predictions**
  - H-P-2-ASP-AN-1694 (Iss.1, 2/10/2008)
- **Herschel PLM straylight performance**
  - HP-2-ASED-TN-0023 (Iss.4, 27/9/2004)

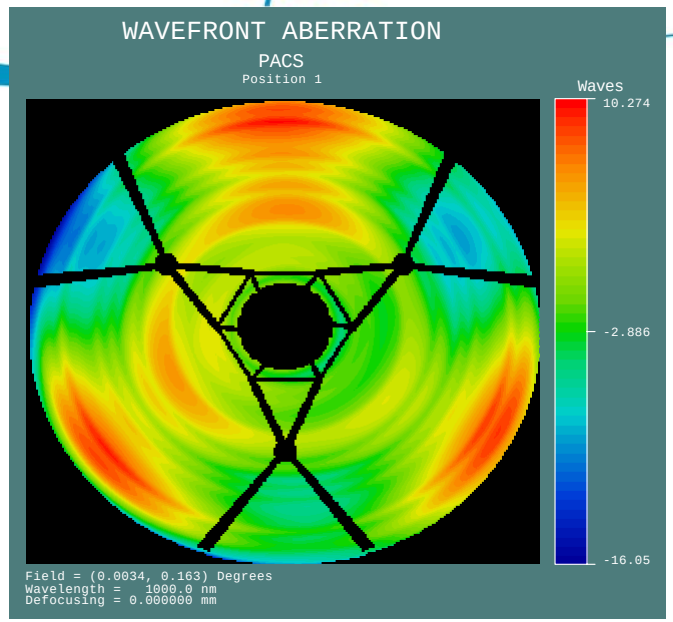
Optical performance

CodeV Model ref = PM-HTP-002

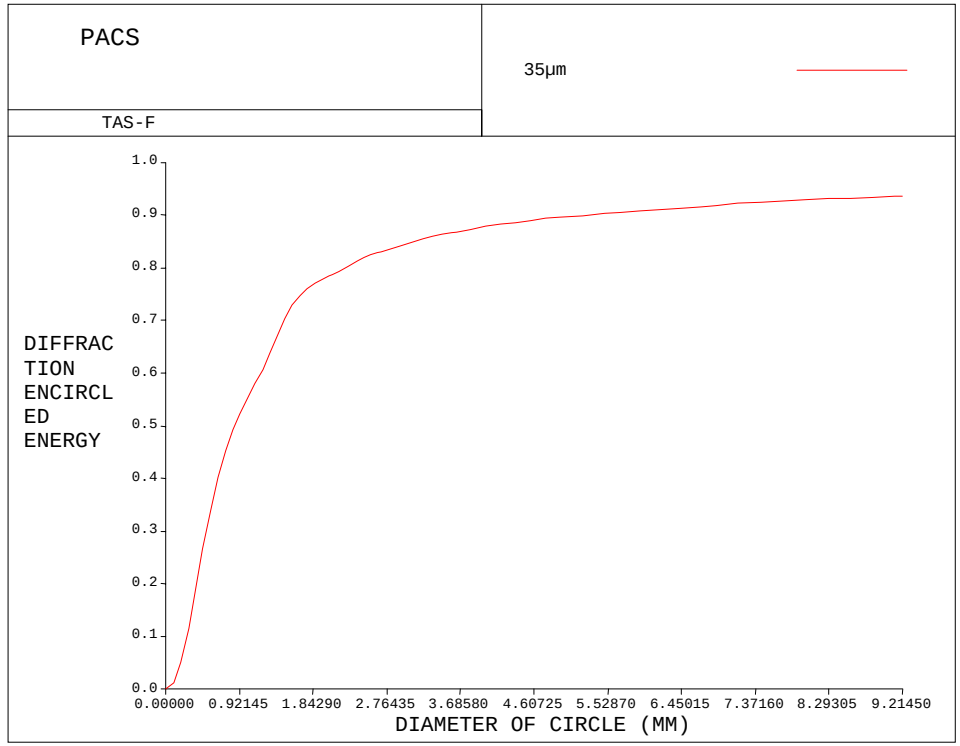
Based on

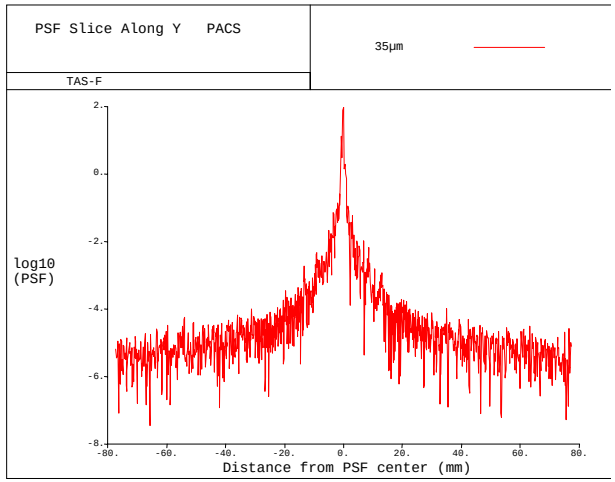
- **As-built telescope model**
- **As measured PLM alignment**
- **At instrument entrance pupils**
- **Provides WFE, Enc. Energy & PSF performance at instrument field bore-sites on best focal surface**

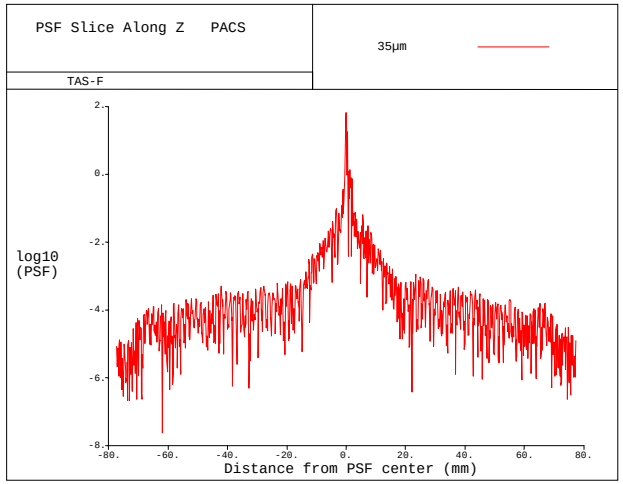
PACS performance



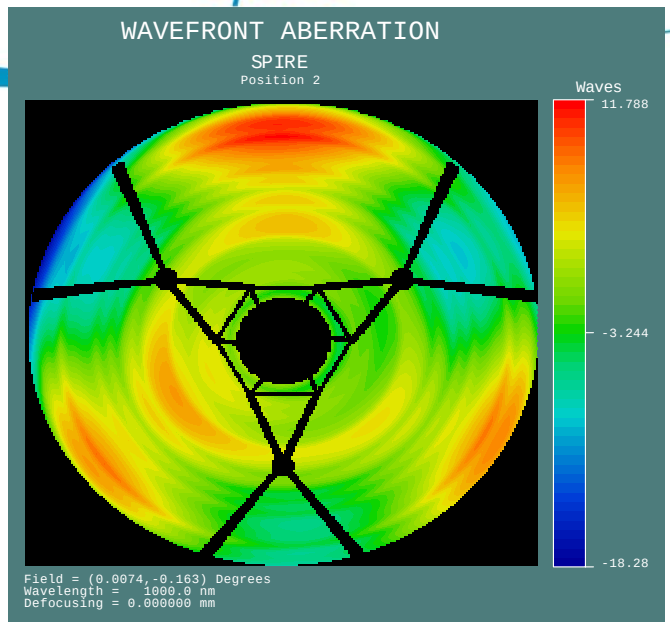
WFE = 4.3µm RMS



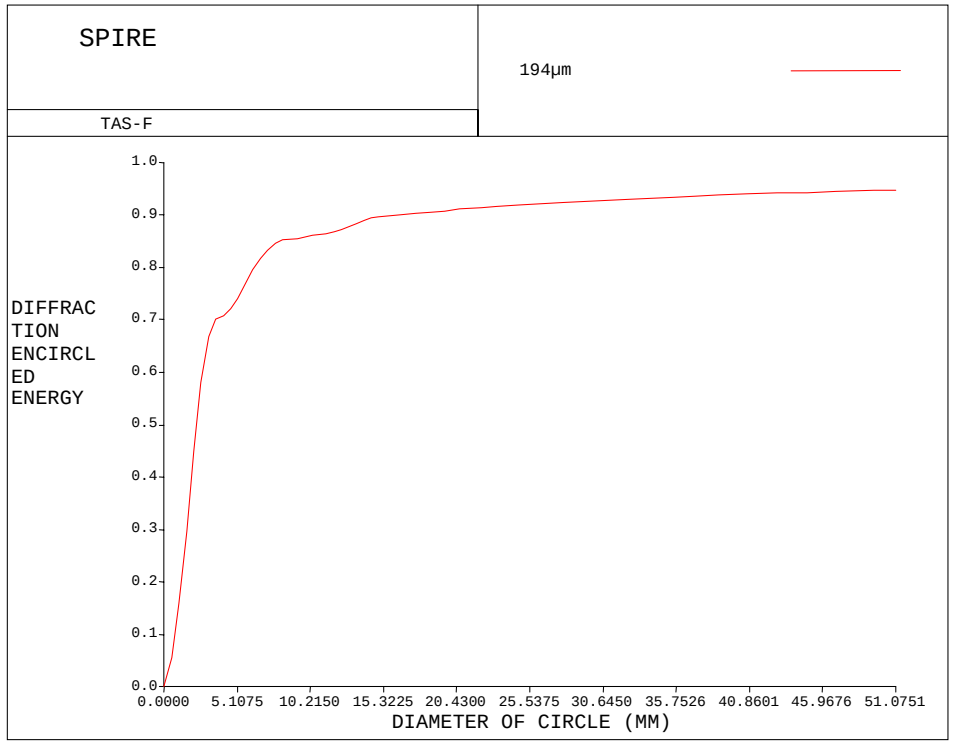


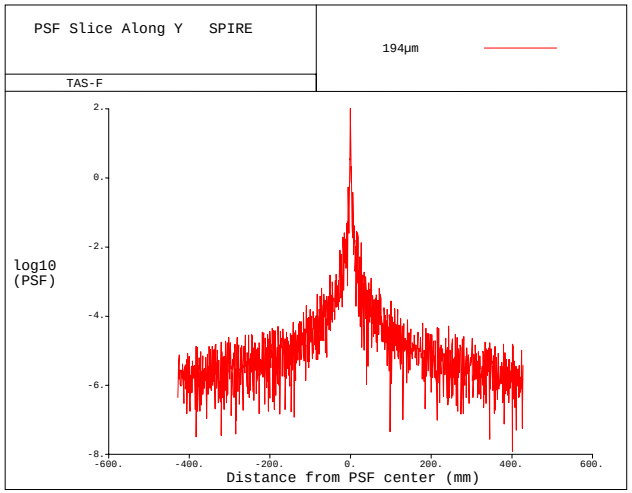


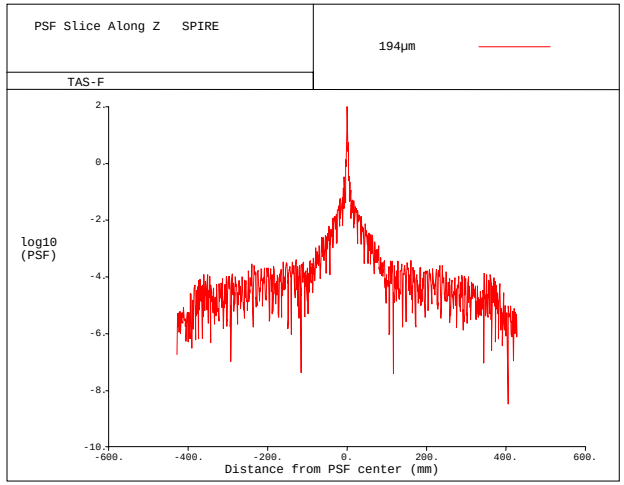
SPIRE performance



WFE=4,4µm RMS







Straylight model

ASAP model = H_issue4_2006_06

Based on a telescope model from 2002 (CDR Design)

Not correlated to the as-built, except for BRDF measurements

Note: one usually does not correlate straylight models, because it would not significantly reduce the inherent inaccuracy of the models

Straylight model limits

The straylight model can be used to predict the specular straylight paths. But it has some limitations which can be quantified as uncertainties:

- **In terms of directions:**
  - As-built/as modelled can shift the straylight paths by a few arcmin

    e.g. a misalignment of 0.1mm of 1 hexapod leg shifts the straylight path by 1 arcmin on the sky => uncertainty at the few arcmin level

- **In terms of attenuation level**
  - Straylight calculations provide orders of magnitude only: with inherent accuracy of about +/- 50%
  - SLI on hexapod legs and M2 barrel are modelled as flat specular surfaces

    Actual shape will scatter the light and reduce the irradiance
  - Diffraction on the legs and M2 barrel is not modelled, it will spread the stray beam paths, and reduce the irradiance reaching the focal surface

Science & Technology Facilities Council

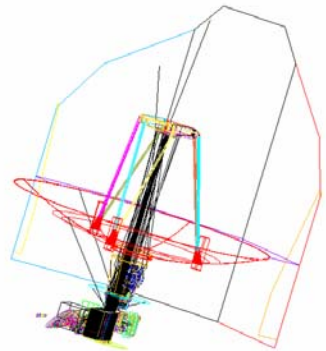
Inputs for HStrayWG #2

Marc Ferlet (STFC-RAL/SSTD, 18/12/08)

SPIRE

SPIRE PCAL illumination

- SPIRE PCAL has been shown to be able to exit SPIRE FPU: see HStrayWG#1 MoM for simulations (matched by ground testing results with closed cryo-cover)
- Most recent ASAP model "H_iss4_2006.inr" (assumed associated with Ph. Martin et al.'s SPIE 2008 paper) delivered by Dominic Doyle (ESA)
- Model modified to include PCAL emitter in BSM/CM4 mirror back and several runs with N>1E6-1E7 rays from PCAL
- M2 anti-narcissus cone sending back some PCAL light towards SPIRE but no real change from nominal (i.e. w/o cryocover) Phot array illumination by PCAL



- PACS relative illumination found at 1E-5 level max four outer structure and much lower for entrance aperture zone (NB: simul excl scattering + cryostat structure not present in model)
- So likelyhood of cross-contamination in parallel mode low; anyway PCAL signal is highly artificial (short low frequency modulated low T source)

Is there something equivalent from PACS to SPIRE ?

Inside FoV straylight

- In-field in-band stray from external source = ghost
- Analysis indicated low level/highly defocused ghost in SPIRE Phot
- More found during ILT but due to GSE (high number of blocking filter not all tilted), still no special expectations
- On Spectro side: spectral signature of ghost (=fringing) found/expected
- Flight characterisation => nothing special

⇒ use basic local maps at different field positions inside respective FoV

⇒ source: preferred continuum point sources (extent <10-20" typically) with in-band flux >~1Jy (up to several 100s Jy); from the standard test source for calib ?

Outside Instruments FoV but inside Telescope FoV

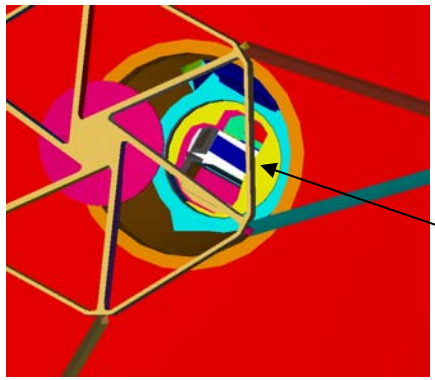
- Shielding/attenuation expected from baffle just above instrument ?
- Idea: drift scans map along Y axis and possible detection of orthogonal "wing" leakage into SPIRE (and/or PACS) FoV:

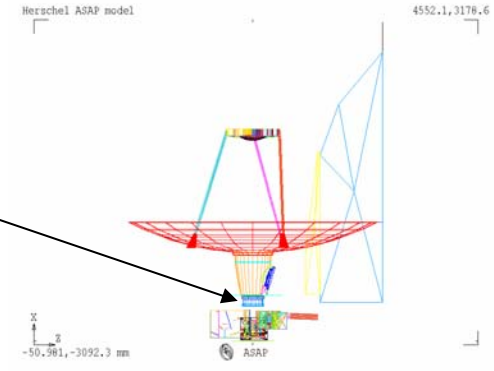
  -Not for imaging so don't need to be too slow

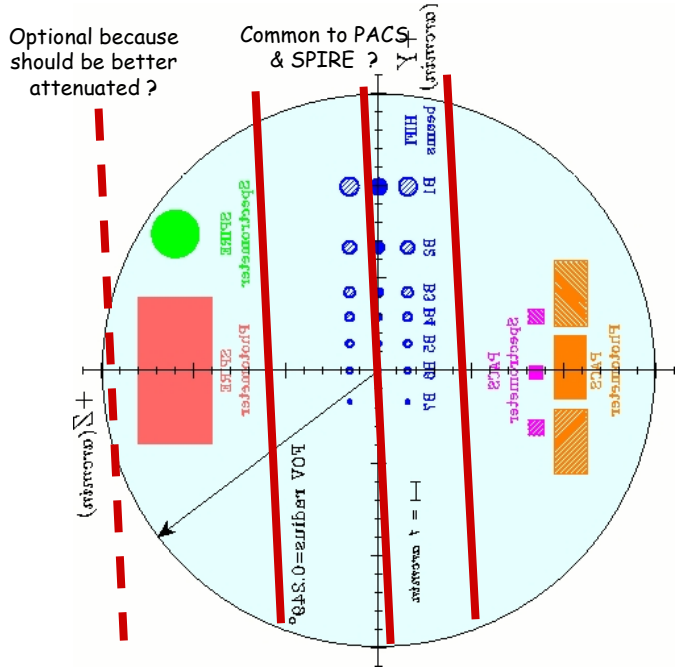
  - A few (see red lines) of ~0.5deg max extent separated by 3-5'

  - With preferred continuum point source (extent <~0.5-1' typically) with in-band flux >~100Jy (e.g. Neptune or Uranus if in HSO visibility)

Maybe some restriction, if in parallel mode, wrt the angle of scan line wrt Y axis ?



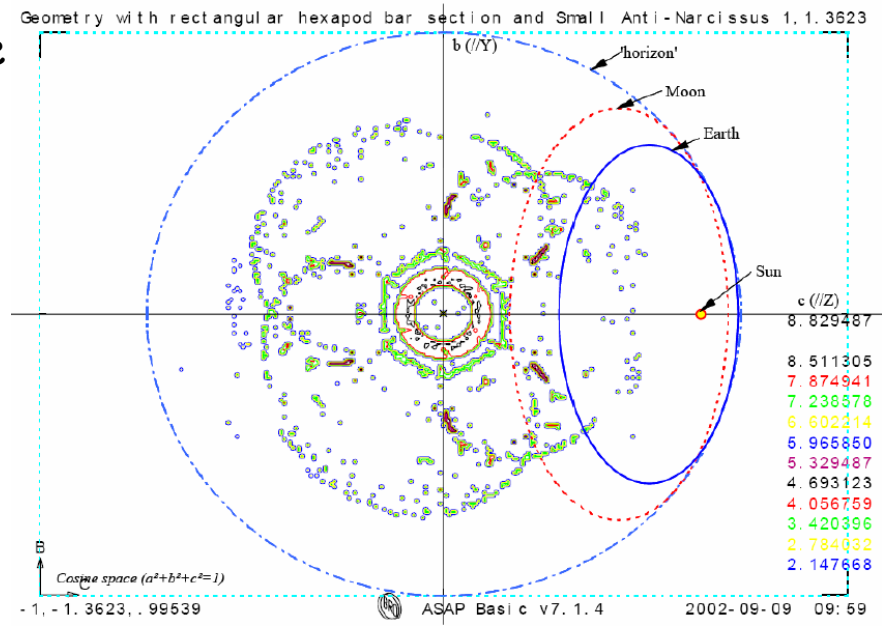




Outside Telescope FoV (i)

- "hot spots" zone from previous analysis is geometric => broaden by diffraction
- "hot spots" zone reliable ? what if not there / elsewhere on sky and/or other features ?
- in theory, out-of-field stray is entire sky "deconvolved" by full wide angle tel + instrument response but to find such response measure of response with sky brightness "deconvolved" first….
- in practice: forget it !

=> instrument FoV too small for wide angle mapping (not a sky survey observatory) + limited knowledge of entire sky in-band (i.e. complex scene) + effect of scanning/pointing (correction depending on where you look) + …



Outside Telescope FoV (ii)

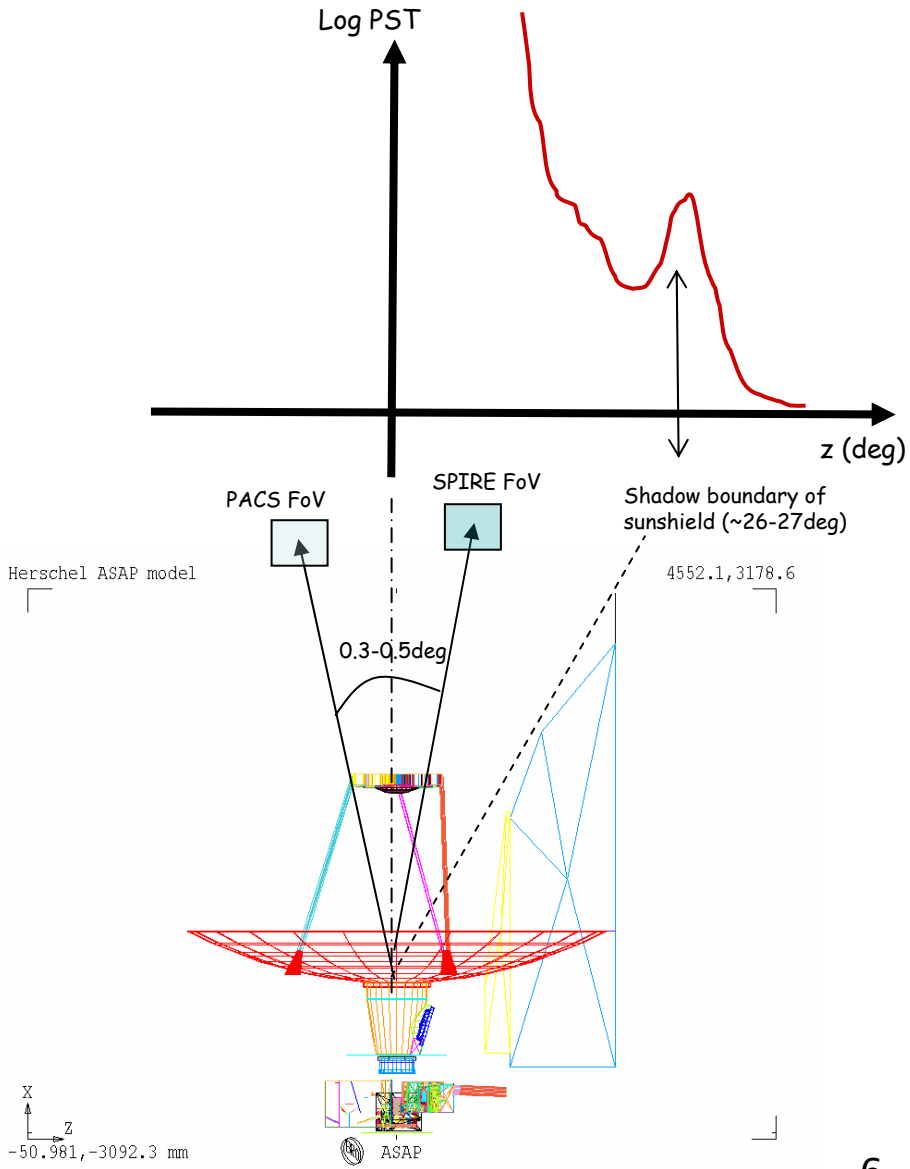
- Alternative:

Sparse sampling/retrieval of PST in the key region (positive Z angles)

=> Large angle step by rotation about y up to max allowed (+30deg ?) + fast telescope drift scan by either rotation about X and/or Z

+ relatively dark sky zone within a few arcmin around instrument boresight better

+ instrument internal chopping (TBC), not for quantitative but "local substraction" ?



Herschel Self-emission

- Accepted fact that telescope emission no longer dominant in-field background
- Still interested to know what is the strongest/dominant ? So what is the "official" worst sources expected from analysis ?
- **To complete….**