

# **PACS Calibration Documentation Overview**

**PACS ICC Calibration Working Group**

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## Change Record

Version	Date	Changes	Remarks
Draft 1 (Issue 0.1)	May 13, 2014	–	New document
Draft 2 (Issue 0.15)	May 14, 2014	2	Incomplete but exemplary lay-out
		3	Extension flight report overview
Draft 3 (Issue 0.20)	May 23, 2014	1.1	Extension flight report overview
		2	Rephrasing
		3	Extension & corrections flight report overview
Issue 0.50	July 01, 2014	2	Extension & corrections flight report overview
Issue 1.00	August 22, 2014	2	Include FM-ILT & FM-IST reports IDs
		3	Include FM-ILT & FM-IST reports
Issue 1.10	November 27, 2014	1.1	Extension
		2	Update Experimental Astronomy references
		3	Include further IDs from FM-IST & FM-ILT
			Include requirements not contained in PCD issue 1.0 and related references
2 & 3	Update Experimental Astronomy references		
Issue 1.10	November 27, 2014	2 & 3	Include further FM-IST & FM-ILT reports
			Include requirements not contained in PCD issue 1.0 and related reports
			Update req. 3.2.2
			Update req. 4.1.1
			Update reqs. 7.3.3 & 7.3.4
			Include req. 7.4.4
			Include req. 9.1.1

## Acronyms

ACMS	Attitude Control and Measurement Subsystem
AOT	Astronomical Observation Template
CCD	Charge Coupled Device
CoP	Commissioning Phase
CRE	Cold Read-out Electronics
FIR	Far-Infrared
FM	Flight Model
FM-ILT	Flight Model Instrument Level Test
FM-IST	Flight Model Integrated System Test
FOV	Field-of-View Distortion
Ge:Ga	Galium doped Germanium photoconductor
ICC	Instrument Control Centre
IRAS	InfraRed Astronomy Satellite
MIPS	Multi-band Imaging Photometer for Spitzer
NEP	Noise Equivalent Power
OD	Operational Day
OGSE	Optical Ground Support Equipment
PACS	Photometric Array Camera and Spectrometer
PCD	PACS Calibration Document (Requirements plus high level implementation and analysis procedures)
PSF	Point Spread Function
PV	Performance Verification
QSO	Quasi Stellar Object
RG	Radio Galaxy
RPE	Relative Pointing Error
S/C	SpaceCraft
SED	Spectral Energy Distribution
SPT	Short Performance Test
SRPE	Spatial Relative Pointing Error
STR	Star Tracker
ULIRG	Ultra-Luminous InfraRed Galaxy

## Contents

<b>1</b>	<b>Introduction</b>	<b>13</b>
1.1	Scope	13
1.2	Documents	13
1.2.1	Applicable Documents	13
<b>2</b>	<b>PCD - Documentation Trace Matrix</b>	<b>14</b>
<b>3</b>	<b>Detailed Document Reference</b>	<b>21</b>
3.1	Req. 1.1.0: VRL and VH_BLIND calibration	21
3.1.1	in-flight	21
3.1.2	FM-IST	21
3.1.3	FM-ILT	21
3.2	Req. 1.1.1: Control optimum pixel bias settings: Determination of basic bias settings to get signal within dynamic range	21
3.2.1	FM-ILT	21
3.3	Req. 1.1.1bis: Control optimum pixel bias settings: Determination of the optimum bias settings for responsivity/NEP	21
3.3.1	in-flight	21
3.3.2	FM-ILT	21
3.4	Req. 1.1.4: Monitor nominal responsivity variations with time	22
3.4.1	in-flight	22
3.5	Req. 1.1.5: Monitor detector temperature variations with time	22
3.5.1	in-flight	22
3.6	Req. 1.1.7: Monitor cooler recycling frequency	22
3.6.1	in-flight	22
3.6.2	FM-ILT	22
3.6.3	FM-ILT	22
3.7	Req. 1.1.8: Measure bolometer time constants after switch-on	22
3.7.1	FM-ILT	22
3.8	Req. 1.1.9: Measure time constants after cosmic ray impact	23
3.8.1	in-flight	23
3.9	Req. 1.1.10: Measure the time constants after a flux change	23
3.9.1	in-flight	23
3.9.2	FM-IST	23
3.9.3	FM-ILT	23
3.10	Req. 1.1.11: Measure the low frequency noise	23
3.10.1	in-flight	23
3.10.2	FM-IST	24

3.10.3 FM-ILT . . . . .	24
3.11 Req. 1.1.12: Measure the bolometers noise equivalent power . . . . .	24
3.11.1 in-flight . . . . .	24
3.11.2 FM-ILT . . . . .	24
3.12 Req. 1.1.13: Calibrate the detector non-linearity . . . . .	24
3.12.1 in-flight . . . . .	24
3.12.2 FM-ILT . . . . .	24
3.13 Req. 1.1.14: Establish the detector linearity . . . . .	24
3.13.1 in-flight . . . . .	24
3.13.2 FM-ILT . . . . .	24
3.14 Req. 1.1.15: Establish the relative positions of the individual matrices . . . . .	25
3.14.1 in-flight . . . . .	25
3.14.2 cal file design . . . . .	25
3.15 Req. 1.1.16: Measure the signal dependence on chopping frequency . . . . .	25
3.15.1 in-flight . . . . .	25
3.15.2 FM-ILT . . . . .	25
3.16 Req. 1.1.18: Measure the level of electrical cross-talk . . . . .	25
3.16.1 in-flight . . . . .	25
3.16.2 FM-ILT . . . . .	25
3.17 Req. 1.1.20: Measure the level of correlated noise on the detector . . . . .	26
3.17.1 in-flight . . . . .	26
3.17.2 FM-ILT . . . . .	26
3.18 Req. 1.1.22: Measure the relative system response of the detectors . . . . .	26
3.18.1 PACS pass-bands measured on-ground . . . . .	26
3.19 Req. 1.1.23: Optimize switching between $V_{\text{bolo}}$ and VRL in DDCS mode . . . . .	26
3.19.1 FM-ILT . . . . .	26
3.20 Req. 1.1.24: Find optimum detector read-out frequency . . . . .	26
3.20.1 FM-ILT . . . . .	26
3.21 Req. 1.1.25: Assess performance of detector read-out modes . . . . .	26
3.21.1 FM-ILT . . . . .	26
3.22 Req. 1.1.26 On-board signal processing, photometer . . . . .	26
3.22.1 in-flight . . . . .	26
3.23 Req. 1.2.1: Optimum detector bias settings . . . . .	27
3.23.1 in-flight . . . . .	27
3.23.2 FM-ILT . . . . .	27
3.24 Req. 1.2.2: Optimum detector temperature settings . . . . .	27
3.24.1 FM-ILT . . . . .	27
3.25 Req. 1.2.3: Dynamic range per selected integration capacitor . . . . .	27

3.25.1 FM-ILT	27
3.26 Req. 1.2.4: CRE check-out voltage	27
3.26.1 FM-ILT	27
3.27 Req. 1.2.6: Detector dark current	27
3.27.1 FM-IST	27
3.27.2 FM-ILT	28
3.28 Req. 1.2.10: Noise Equivalent Power	28
3.28.1 in-flight	28
3.28.2 FM-ILT	28
3.29 Req. 1.2.11: Linearity of CRE readout	28
3.29.1 FM-ILT	28
3.30 Req. 1.2.13: Ionizing radiation: Responsivity, spectrometer	28
3.30.1 in-flight	28
3.31 Req. 1.2.14: Ionizing radiation: Noise, spectrometer	28
3.31.1 in-flight	28
3.32 Req. 1.2.17: Time constant: bias change, spectrometer	29
3.32.1 FM-IST	29
3.32.2 FM-ILT	29
3.33 Req. 1.2.18: Time constant: flux changes, spectrometer	29
3.33.1 in-flight	29
3.33.2 FM-IST	29
3.33.3 FM-ILT	29
3.34 Req. 1.2.20: Time variation responsivity spectrometer	29
3.34.1 in-flight	29
3.35 Req. 1.2.22: Cross-talk, electrical, spectrometer	29
3.35.1 FM-ILT	29
3.36 Req. 1.2.23: Curing spectrometer	30
3.36.1 in-flight	30
3.37 Req. 2.1.1: Filter transmission nominal	30
3.37.1 PACS pass-bands measured on-ground	30
3.38 Req. 2.2.2: Grating: Stability of positions during a spectral scan	30
3.38.1 FM-ILT	30
3.39 Req. 2.3.1: Angular calibration of the focal plane chopper	30
3.39.1 in-flight	30
3.39.2 FM-IST	31
3.39.3 FM-ILT	31
3.40 Req. 2.3.2: Chopper duty cycle of waveforms	31
3.40.1 in-flight	31

3.40.2	FM-IST	32
3.40.3	FM-ILT	32
3.41	Req. 2.5.1: Temporal stability of PACS calibration sources	32
3.41.1	FM-ILT	32
3.42	Req. 2.5.3: Time constants: heat-up and cool down times of PACS calibration sources	32
3.42.1	in-flight	32
3.42.2	FM-IST	32
3.42.3	FM-ILT	33
3.43	Req. 2.5.4: Emissivity of PACS calibration sources	33
3.43.1	FM-IST	33
3.43.2	FM-ILT	33
3.44	Req. 2.6.1: Absolute pointing error	33
3.44.1	in-flight	33
3.44.2	STR & ACMS system related	33
3.44.3	source lists	33
3.45	Req. 2.6.2: Relative pointing error (RPE/SRPE)	34
3.45.1	in-flight	34
3.45.2	CP raster tests	34
3.46	Req. 2.6.4: Relative pointing error scan mode	34
3.46.1	in-flight	34
3.46.2	source lists	34
3.47	Req. 2.6.5: Check time synchronisation of PACS detector data with Herschel pointing product data	34
3.47.1	in-flight	34
3.48	Req. 3.1.1: Photometer central pointing position	34
3.48.1	FM-ILT	34
3.48.2	cal file design	35
3.48.3	source lists	35
3.49	Req. 3.1.2: Relation between chopper position and angular displacement on sky	35
3.49.1	FM-ILT	35
3.49.2	cal file design	35
3.49.3	source lists	35
3.50	Req. 3.1.3: Photometer field-of-view distortion	35
3.50.1	in-flight	35
3.50.2	FM-ILT	35
3.50.3	cal file design	35
3.50.4	source lists	35
3.51	Req. 3.1.4: Photometer point-spread function	36



3.51.1	in-flight	36
3.51.2	FM-ILT	36
3.51.3	model input	36
3.51.4	source lists	36
3.52	Req. 3.1.5: Photometer ghosts	36
3.52.1	in-flight	36
3.52.2	FM-ILT	36
3.53	Req. 3.1.6: Photometer stray-light	36
3.53.1	in-flight	36
3.54	Req. 3.1.7: Background Structure in the Photometer Field-of-View over the Full Chopper Angle Range	36
3.54.1	in-flight	36
3.54.2	FM-IST	37
3.54.3	FM-ILT	37
3.55	Req. 3.2.1: Derive photometer nominal responsivity	37
3.55.1	in-flight	37
3.55.2	FM-ILT	37
3.55.3	model input zero point	37
3.55.4	source lists	38
3.56	Req. 3.2.2: Monitor nominal responsivity variations with time	38
3.56.1	in-flight	38
3.56.2	FM-ILT	38
3.57	Req. 3.2.3: Calibrate the photometer's non-linearity	38
3.57.1	in-flight	38
3.57.2	on-ground	38
3.57.3	FM-ILT	38
3.57.4	cal file design	38
3.58	Req. 3.2.4: Calibrate the photometer's non-linearity	39
3.58.1	FM-ILT	39
3.59	Req. 3.2.5: Relative system response and colour corrections photometer	39
3.59.1	PACS pass-bands measured on-ground	39
3.60	Req. 3.2.8: Measure the photometer full system flat-field	39
3.60.1	in-flight	39
3.61	Req. 3.2.9: Telescope background and its stability	39
3.61.1	in-flight	39
3.62	Req. 3.2.10: Determine the amount of straylight to the internal calibration source flux	39
3.62.1	FM-ILT	39
3.63	Req. 3.4.1: Electromagnetic interference of photometer operations	40

3.63.1	in-flight	40
3.63.2	FM-ILT	40
3.64	Req. 4.1.1: Spectrometer central pointing position and grating alignment	40
3.64.1	in-flight	40
3.64.2	FM-ILT	40
3.64.3	cal file design	40
3.65	Req. 4.1.2: Spectrometer field-of-view distortion	40
3.65.1	FM-ILT	40
3.65.2	cal file design	40
3.66	Req. 4.1.3: Spectrometer Point Spread Function	41
3.66.1	in-flight	41
3.66.2	FM-ILT	41
3.67	Req. 4.1.4: Spectrometer ghosts	41
3.67.1	FM-ILT	41
3.68	Req. 4.1.6: Spectrometer full field-of-view characterization	41
3.68.1	in-flight	41
3.68.2	FM-IST	41
3.68.3	FM-ILT	41
3.69	Req. 4.2.1: Grating wavelength calibration	41
3.69.1	in-flight	41
3.69.2	FM-ILT	42
3.69.3	source lists	42
3.70	Req. 4.2.3: Spectral Purity	42
3.70.1	in-flight	42
3.71	Req. 4.2.4: Spectral Ghosts	42
3.71.1	in-flight	42
3.72	Req. 4.2.5: Grating wavelength calibration, dependence on source position in slit	42
3.72.1	in-flight	42
3.73	Req. 4.3.1: Absolute flux calibration internal sources, spectrometer	42
3.73.1	in-flight	42
3.74	Req. 4.3.2: Reproducibility internal sources, spectrometer	42
3.74.1	FM-ILT	42
3.75	Req. 4.3.3: Absolute flux calibration external sources, spectrometer	43
3.75.1	in-flight	43
3.75.2	FM-ILT	43
3.76	Req. 4.3.8: Absolute flux calibration external sources, spectrometer	43
3.76.1	FM-ILT	43
3.77	Req. 4.3.10: Flat-field spectrometer external sources	43

3.77.1 in-flight	43
3.78 Req. 5.1.1: Optimized observing strategy for Point Source Photometry AOT	43
3.78.1 in-flight	43
3.78.2 data reduction	44
3.79 Req. 5.1.4: Optimized observing strategy for scan map photometry	44
3.79.1 in-flight	44
3.79.2 data reduction	44
3.80 Req. 5.2.1: Optimized observing strategy for chopping/nodding line spectroscopy	44
3.80.1 in-flight	44
3.81 Req. 5.2.2: Optimized observing strategy for line spectroscopy in wavelength switching mode	45
3.81.1 in-flight	45
3.82 Req. 5.2.3: Optimized observing strategy for range spectroscopy	45
3.82.1 in-flight	45
3.83 Req. 5.2.4: Optimized observing strategy for SED modes	45
3.83.1 in-flight	45
3.84 Req. 5.2.5: Optimized observing strategy for unchopped line spectroscopy	45
3.84.1 in-flight	45
3.85 Req. 5.2.6: Optimized observing strategy for unchopped range spectroscopy	45
3.85.1 in-flight	45
3.86 Req. 7.1.1: Herschel telescope focus verification	46
3.87 Req. 7.3.3: Verification of Moon stray-light occurrence in stray-light spot F	46
3.87.1 in-flight	46
3.88 Req. 7.3.4: Sensitivity to bright out-of-field sources inside or outside the Herschel focal plane	46
3.88.1 in-flight	46
3.89 Req. 7.4.1: Relative location of PACS photometer and spectrometer field-of-views in the Herschel focal plane	46
3.89.1 in-flight	46
3.89.2 FM-ILT	46
3.90 Req. 9.1.1: Influence (Interference) SPIRE on bolometers	46
3.90.1 EQM-IMT	46
3.91 Req. 10.1.1: OGSE chopper positioning	46
3.91.1 FM-ILT	46
3.92 Req. 10.1.2: OGSE chopper frequency	47
3.92.1 FM-ILT	47
3.93 Req. 10.1.3: OGSE chopper duty cycle	47
3.93.1 FM-ILT	47
3.94 Req. 10.2.1: Stability of OGSE internal black-body radiation	47
3.94.1 FM-ILT	47

3.95	Req. 10.2.2: OGSE internal black-body flux calibration	47
3.95.1	FM-ILT	47
3.96	Req. 10.3.1: Characterize OGSE point source simulator (external BB with pin hole mask in front)	47
3.96.1	FM-ILT	47
3.97	Req. 10.3.2: Characterize OGSE raster simulator (X-Y-stage)	47
3.97.1	FM-ILT	47
3.98	Req. 10.3.3: Characterize OGSE wavelength reference (H <sub>2</sub> O cell)	48
3.98.1	FM-ILT	48

## 1 Introduction

### 1.1 Scope

This document aims to provide a complete systematic and categorized link between the different PACS and Herschel telescope calibration aspects, as outlined in the form of calibration requirements in the PACS Calibration Document PCD [AD1], and calibration reports and publications generated along the Herschel/PACS project from the development phase on-ground over the mission time to the post-operations phase. In that respect the document is an inventory of available calibration information related to the PACS instrument which can be of help for the compilation of the PACS Explanatory Supplement documentation.

Note, that a specific report can cover several (usually related) requirements and is hence listed under each of them. Also for some requirements cross-references to other requirements covering this specific calibration aspect is given (e.g. the verification Herschel telescope focus quality, req. 7.1.1 was covered by the assessment of the PACS 70  $\mu\text{m}$  PSF, req. 3.1.4).

The calibration reports and technical notes are mostly stored in the PACS Central File (<http://pacs.ster.kuleuven.ac.be/>, with password access only). Links to calibration publications in journals are included, too.

### 1.2 Documents

#### 1.2.1 Applicable Documents

AD1 PACS Calibration Document (PACS-MA-GS-001),  
Issue 1.05, 09-May-2014

## 2 PCD - Documentation Trace Matrix

The following tables constitute the trace matrix between the PACS Calibration Document PCD [AD1] requirements and the document numbers of the calibration reports or the journal references of calibration publications. There are some reports, which lack a document number. They are referenced by a representative version of the file name, however the correct file name must be checked in Sect. 3, because some of them are too long to fit into the column.

The column “auxiliary” covers items which belong to model input, source lists or calibration file design.

PCD requirement	short title	in-flight	documentation on-ground	auxiliary
1.1.0	VRL& VHBLIND calibration	SAP-PACS-MS-0705-09	SAP-PACS-KO-0698-09 FM_ILT_draft.pdf	
1.1.1	Basic bias settings for signal dynamic range		FM_ILT_draft.pdf	
1.1.1bis	Bolometer bias settings for responsivity/NEP	SAP-PACS-KO-0731-12 SAP-PACS-KO-0726-11 SAP-PACS-KO-0722-11	FM_ILT_draft.pdf	
1.1.4	Bolometer responsivity variation with time	ExA 37, 129, 2014 ExA 37, 225, 2014 PICC-CR-TN-041		
1.1.5	Bolometer temperature variation with time	ExA 37, 129, 2014 ExA 37, 225, 2014		
1.1.7	Cooler recycling frequency	ExA 37, 397, 2014	SAP-PACS-MS-0693-08 SAP-PACS-MS-0669-07	
1.1.8	Bolometer time constants after switch-on	SAP-PACS-MS-0704-09	FM_ILT_draft.pdf PICC-NHSC-TR-006	
1.1.9	Time constants after cosmic ray impact	SAP-PACS-KO-0719-11 SPIE774102, 2010		
1.1.10	Bolometer time constants after flux change	SAP-PACS-KO-0731-12 SAP-PACS-KO-0723-11 SAP-PACS-MS-0710-09 reportSPTcop.pdf	SAP-PACS-KO-0698-09 FM_ILT_draft.pdf	
1.1.11	Bolometer low frequency noise	SPIE774102, 2010 reportSPTcop.pdf	SAP-PACS-KO-0698-09 FM_ILT_draft.pdf	
1.1.12	Bolometer noise equivalent power	SPIE774102, 2010 SAP-PACS-MS-0711-019 ⇒ Req. 3.2.3	FM_ILT_draft.pdf	
1.1.13	Bolometer non-linearity	⇒ Req. 3.2.3	FM_ILT_draft.pdf	
1.1.14	Bolometer linear range	⇒ Req. 3.2.3	FM_ILT_draft.pdf	
1.1.15	Positions of individual bolometer matrices	PICC-ME-TN-044		PICC-ME-TN-019
1.1.16	Signal dependence on chopping frequency	SAP-PACS-MS-0710-09	⇒ Req. 1.1.10	
1.1.18	Bolometer electric cross-talk	SAP-PACS-KO-0720-11 SAP-PACS-KO-0716-10 PICC-ME-TN034 PICC-NHSC-TR-023 SPIE774102, 2010	FM_ILT_draft.pdf	
1.1.20	Photometer correlated noise	hpf.psf.tn_final	FM_ILT_draft.pdf	
1.1.22	Bolometer absorption (spectral response)		PICC-ME-TN-038	
1.1.23	Switching between $V_{\text{bolo}}$ and VRL in DDCS		FM_ILT_draft.pdf	

PCD requirement	short title	in-flight	documentation on-ground	auxiliary
1.1.24	Optimum detector read-out frequency		FM_ILT_draft.pdf	
1.1.25	Performance of detector read-out modes		SAP-PACS-MS-0662-07	
1.1.26	On-board signal processing, photometer	A&A 527, A102, 2011		
1.2.1	Optimum Ge:Ga bias settings	PICC-KL-TR-023	PICC-MA-TR-030 PICC-MA-TR-027	
1.2.2	Optimum Ge:Ga detector temperature settings		PICC-MA-TR-030	
1.2.3	Dynamic range of integration capacitors		PICC-MA-TR-045 PICC-MA-TR-043	
1.2.4	CRE check-out voltage		PICC-MA-TR-025	
1.2.6	Dark current of Ge:Ga detectors		PICC-KL-TR-022 PICC-MA-TR-064 PICC-MA-TR-051 PICC-MA-TR-029 PICC-MA-TR-026	
1.2.10	Noise Equivalent Power (NEP) Ge:Ga detectors	PICC-KL-TR-023		
1.2.11	Linearity of CRE readout		PICC-MA-TR-045	
1.2.13	Ionizing radiation impact on Ge:Ga responsivity	PICC-KL-TR-023		
1.2.14	Ionizing radiation impact on Ge:Ga noise	PICC-KL-TR-023		
1.2.17	Time constants bias change Ge:Ga detectors		PICC-MA-TR-063 PICC-MA-TR-052 PICC-MA-TR-030 PICC-MA-TR-027	
1.2.18	Time constants flux change spectrometer	PICC-KL-TR-024	PICC-KL-TR-017 PICC-KL-TR-010	
1.2.20	Time variation of Ge:Ga responsivity	PICC-KL-TR-023	PICC-NHSC-TR-008	
1.2.22	Electrical cross-talk spectrometer		FMILT3_Spec_Spatial_cal	
1.2.23	Curing spectrometer detectors	PICC-KL-TR-023		
2.1.1	Filter transmission		PICC-ME-TN-038	
2.2.2	Grating: Stability of positions		PICC-ME-TR-006/I	
2.3.1	Angular calibration focal plane chopper	PICC-MA-TR-095 PICC-MA-TR-090 PICC-MA-TR-088 PICC-MA-TR-079	PICC-MA-TR-066 PICC-MA-TR-067 PICC-MA-TR-049 PICC-MA-TR-021 PICC-MA-TR-020 PICC-MA-TR-023 PICC-MA-TR-034 PICC-MA-TR-075 PICC-MA-TR-042	



PCD requirement	short title	documentation		auxiliary
		in-flight	on-ground	
2.3.2	Chopper duty cycle of waveforms	PICC-MA-TR-083 PICC-MA-TR-082	fin_tbtv_chopper_performance PICC-MA-TR-057 PICC-MA-TR-040 PICC-MA-TR-039 PICC-MA-TR-031	
2.5.1	Temporal stability of PACS calibration sources		PICC-MA-TR-033 PICC-MA-TR-032	
2.5.3	Internal CS heat-up & cool-down times	PICC-MA-TR-084	PICC-MA-TR-060 PICC-MA-TR-054 PICC-MA-TR-033 PICC-MA-TR-032	
2.5.4	Emissivity of internal calibration sources		PICC-KL-TR-020 PICC-NHSC-TR-003	
2.6.1	Absolute pointing error	ExA 37, 453, 2014 HERSCHEL-HSC-DOC-1515		PICC-MA-TN-003 PICC-MA-TN-004
	STR & ACMS related	PICC-ME-TN-041 PICC-ME-TN-040		
2.6.2	Relative pointing error (RPE/SRPE)	PICC-ME-TN-031 PICC-MA-TR-096 PICC-MA-TR-094 PICC-MA-TR-093 PICC-MA-TR-091		
2.6.4	Relative pointing error scan mode	SAP-PACS-HA-0729-11		PACS-ME-TN-035
2.6.5(new)	Time synchronisation detector-ACMS data	PICC-ME-TN-043		
3.1.1	Photometer central pointing position		PICC-ME-TR-006/III	PICC-ME-TN-019 PICC-ME-TN-023
3.1.2	Chopper angular position on sky		PICC-ME-TR-006/III	PICC-ME-TN-019 PACS-ME-TN-035
3.1.3	Photometer field-of-view distortion	PICC-ME-TN-044	PICC-ME-TR-006/III	PICC-ME-TN-019 PACS-ME-TN-035
3.1.4	Photometer PSF	PICC-ME-TN-033	PICC-ME-TR-006/III	PICC-ME-TN-029 PICC-ME-TN-024
3.1.5	Photometer ghosts	PICC-ME-TN-033		
3.1.6	Photometer stray-light	SAP-HERSCHEL-KO-0723-10	PICC-ME-TR-006/III	

PCD requirement	short title	in-flight	documentation on-ground	auxiliary
3.1.7	Photometer full field-of-view scan	SAP-PACS-MS-0707-09 PICC-NHSC-TR-021 PICC-NHSC-TR-019	PICC-NHSC-TR-016 PICC-NHSC-TR-014 PICC-NHSC-TR-002 PICC-NHSC-TR-010	
3.2.1	Photometer nominal responsivity	SAP-PACS-HA-0713-09 ExA 37, 129, 2014 ExA 36, 631, 2013 PICC-ME-TN-037	FM_ILT_draft.pdf	PICC-MA-TN-011 ExA 37, 253, 2014
3.2.2	Photometer responsivity variations with time	ExA 37, 225, 2014 ExA 37, 129, 2014 ExA 36, 631, 2013 SPIE774102, 2010	FM_ILT_draft.pdf	
3.2.3	Photometer non-linearity	SPIE774102, 2010	PICC-NHSC-TR-031 FM_ILT_draft.pdf	PICC-NHSC-TR-031
3.2.4	Photometer linearity		FM_ILT_draft.pdf	
3.2.5	Relative system response color correction		PICC-ME-TN-038 PICC-CR-TN-044	
3.2.8	Photometer flat-field	SAP-PACS-KO-0734-14		
3.2.9	Photometer telescope background stability	ExA 37, 129, 2014 ExA 36, 631, 2013 SAP-PACS-MS-0709-09 SAP-PACS-MS-0707-09		
3.2.10(new)	Straylight to internal CS flux		FM_ILT_draft.pdf	
3.4.1(new)	Electromagnetic interference of photometer	SPIE774102, 2010	SAP-PACS-KO-0688-08 FM_ILT_draft.pdf	
4.1.1	Spectrometer central pointing position	PICC-KL-TN-043	FMILT3_Spec_Spatial_cal	PICC-ME-TN-019
4.1.2	Spectrometer field-of-view distortion		FMILT3_Spec_Spatial_cal	PICC-ME-TN-019
4.1.3	Spectrometer PSF	PICC-KL-TN-041	FMILT3_Spec_Spatial_cal	FMILT3_Spec_Spatial_cal
4.1.4	Spectrometer ghosts		FMILT3_Spec_Spatial_cal	
4.1.6	Spectrometer full FoV characterization	PICC-KL-TR-028	PICC-MA-TR-062 PICC-MA-TR-050 PICC-MA-TR-028	PICC-ME-TN-013
4.2.1	Spectrometer wavelength calibration	PICC-KL-TN-041	PACS_Wavecal_FM.1.pdf	
4.2.3	Spectrometer spectral purity	PICC-KL-TN-041		
4.2.4	Spectrometer spectral ghosts	PICC-KL-TN-041		
4.2.5	Wavelength shifts with source position	PICC-KL-TN-041		
4.3.1	Spectrometer absolute flux cal internal	PICC-KL-TN-047		

PCD requirement	short title	documentation		
		in-flight	on-ground	auxiliary
4.3.2	Reproducibility of spectrometer int. sources		PICC-ME-TR-006/II	
4.3.3	Spectrometer absolute flux cal external	PICC-KL-TN-041	PICC-ME-TR-006/II	
4.3.10	Flat-field spectrometer external sources	PICC-KL-TN-045	PICC-ME-TR-006/II	
5.1.1	Chop/nod point source observing mode	PICC-ME-TN-036 PICC-MA-TN-010 PICC-MA-TN-006 SAP-PACS-MS-0711-019 PICC-NHSC-TR-027		
	Chop/nod point source data reduction	ExA 36, 631, 2013 ExA 37, 347, 2014 PICC-ME-TN-037		
5.1.4	Scan map photometry observing mode	PICC-ME-TN-035 PICC-ME-TN-036 PICC-ME-TN-032		
	Scan map photometry data reduction	ExA 37, 129, 2014 PICC-ME-TN-037 PICC-NHSC-TN-029		
5.2.1	Line scan spectroscopy observing mode	PICC-KL-TN-038		
5.2.2	Wave switching line spectroscopy mode	PACS.WaveSwitching_ReleaseNote		
5.2.3	Range scan spectroscopy observing mode	PICC-KL-TN-038 PICC-KL-TN-039		
5.2.4	SED spectroscopy observing mode	PICC-KL-TN-039 PICC-KL-TN-040		
5.2.5new	Unchopped line scan spectroscopy "bright" line mode	PACS_Unchopped_ReleaseNote PACS_UnchopRelNote_BrightLines		
5.2.6new	Unchopped range scan spectroscopy	PACS_Unchopped_ReleaseNote		
7.1.1	Herschel telescope focus	⇒ Req. 3.1.4	⇒ Req. 3.1.4	
7.3.3	Moon stray-light occurrence in spot F	ExA 37, 331, 2014		
7.3.4	Out-of-field sources stray-light model	SAP-HERSCHEL-KO-0723-10 ExA 37, 331, 2014		
7.4.4	Rel. focal plane location PACS-S to PACS-P (SIAM)	SAP-HERSCHEL-KO-0723-10 ⇒ Req. 2.6.1 ⇒ Req. 4.1.1	⇒ Req. 3.1.1	
9.1.1	Influence SPIRE on PACS-P		PICC-KO-TR-001	
10.1.1	OGSE chopper positioning		PICC-ME-TR-005	

PCD requirement	short title	documentation		
		in-flight	on-ground	auxiliary
10.1.2	OGSE chopper frequency		PICC-ME-TR-005	
10.1.3	OGSE chopper duty cycle		PICC-ME-TR-005	
10.2.1	Stability of OGSE internal black-body radiation		PICC-ME-TR-005	
10.2.2	OGSE internal black-body flux calibration		PICC-KL-TN-004	
10.3.1	OGSE point source simulator (BB & pin hole)		PICC-ME-TN-012	
			PICC-ME-TN-011	
10.3.2	OGSE raster simulator (X-Y-stage)		PICC-ME-TR-005	
10.3.3	OGSE wavelength reference (H <sub>2</sub> O cell)		PICC-ME-TR-005	

### 3 Detailed Document Reference

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##### 3.1.1 in-flight

- 1) [SAp-PACS-MS-0705-09](#): Vrl-Vhblind calibration - readout circuit transfer function calibration, M. Sauvage et al., 22-Jun-2009, issue 1.2

##### 3.1.2 FM-IST

- 1) [SAp-PACS-KO-0698-09](#): TV/TB test analysis report: Vrl and Vhblind calibration, K. Okumura, 06-Feb-2009, issue 1.0

##### 3.1.3 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf**: PACS photometer ILT analysis report update, section Vrl and VHBlind calibration, K. Okumura & N. Billot, 31-Oct-2007, issue 1.1

#### 3.2 Req. 1.1.1: Control optimum pixel bias settings: Determination of basic bias settings to get signal within dynamic range

##### 3.2.1 FM-ILT

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#### 3.3 Req. 1.1.1bis: Control optimum pixel bias settings: Determination of the optimum bias settings for responsivity/NEP

##### 3.3.1 in-flight

- 1) [SAp-PACS-KO-0731-12](#): PACS photometer optimum bias monitoring, K. Okumura, 31-Aug-2012, issue 1.0
- 2) [SAp-PACS-KO-0726-11](#): PACS photometer NEP measurements on OD 0806, K. Okumura, 28-Sep-2011, issue 1.1
- 3) [SAp-PACS-KO-0722-11](#): PACS photometer NEP measurements on OD 0453, K. Okumura, 16-Jun-2011, issue 1.0

##### 3.3.2 FM-ILT

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### 3.4.1 in-flight

- 1) **ExA 37, 129, 2014:** The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps,  
Z. Balog et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 129-160, 2014
- 2) **ExA 37, 225, 2014:** PACS photometer calibration block analysis,  
A. Moór et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 225-238, 2014
- 3) **PICC-CR-TN-041:** The drift of the bolometers gain,  
S. Pezzuto, 30-Oct-2009, issue 3.0

## 3.5 Req. 1.1.5: Monitor detector temperature variations with time

### 3.5.1 in-flight

- 1) **ExA 37, 129, 2014:** The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps,  
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- 2) **ExA 37, 225, 2014:** PACS photometer calibration block analysis,  
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## 3.6 Req. 1.1.7: Monitor cooler recycling frequency

### 3.6.1 in-flight

- 1) **ExA 37, 397, 2014:** Operations and performance of the PACS instrument 3He sorption cooler on board of the Herschel space observatory,  
M. Sauvage et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 397-431, 2014
- 2) **SAP-PACS-MS-0704-09:** Full Functional Test (FFT) and Short Performance Test (SPT) cooler report,  
M. Sauvage, 14-Jun-2009, issue 1.1

### 3.6.2 FM-ILT

- 1) **SAP-PACS-MS-0693-08:** Cooler behavior and performances during FM IST,  
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### 3.6.3 FM-ILT

- 1) **SAP-PACS-MS-0669-07:** Cooler behavior during FM ILT,  
M. Sauvage, 30-Nov-2007, issue 2.0

## 3.7 Req. 1.1.8: Measure bolometer time constants after switch-on

### 3.7.1 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section measure bolometer time constants after switch-on,  
K. Okumura, 03-Dec-2007, issue 1.0

- 2) **PICC-NHSC-TR-006**: Switch-On Bolometer Current Stability, D. Frayer et al., 04-Sep-2007, issue 1.0

### 3.8 Req. 1.1.9: Measure time constants after cosmic ray impact

#### 3.8.1 in-flight

- 1) **SAP-PACS-KO-0719-11**: PACS photometer glitch analysis on the electronics, K. Okumura, 07-Feb-2011, issue 1.0
- 2) **SPIE774102, 2010**: CEA bolometer arrays: the first year in space, N. Billot et al., Proc. of SPIE, Vol. 7741, 774102-1, 2010, DOI: 10.1117/12.856449

### 3.9 Req. 1.1.10: Measure the time constants after a flux change

#### 3.9.1 in-flight

- 1) **SAP-PACS-KO-0731-12**: PACS photometer optimum bias monitoring, K. Okumura, 31-Aug-2012, issue 1.0
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- 4) **No doc ID, file name: reportSPTcop.pdf**: Photometer SPT during commissioning phase, section time constant for flux change in photometry, K. Okumura, 05-Jul-2009, Issue 1.0

#### 3.9.2 FM-IST

- 1) **SAP-PACS-KO-0698-09**: TV/TB test analysis report: Time constant for flux change in photometry, K. Okumura & Th. Müller, 06-Feb-2009, issue 1.0

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### 3.10 Req. 1.1.11: Measure the low frequency noise

#### 3.10.1 in-flight

- 1) **SPIE774102, 2010**: CEA bolometer arrays: the first year in space, N. Billot et al., Proc. of SPIE, Vol. 7741, 774102-1, 2010, DOI: 10.1117/12.856449
- 2) **No doc ID, file name: reportSPTcop.pdf**: Photometer SPT during commissioning phase, section staring measurement on calibration source for low frequency noise, K. Okumura, 05-Jul-2009, Issue 1.0

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- 1) **SAP-PACS-KO-0698-09**: TV/TB test analysis report: Staring measurement on calibration source for low frequency noise,  
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### 3.10.3 FM-ILT

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## 3.11 Req. 1.1.12: Measure the bolometers noise equivalent power

### 3.11.1 in-flight

- 1) **SPIE774102, 2010**: CEA bolometer arrays: the first year in space,  
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- 2) **SAP-PACS-MS-0711-019**: Simulations of the point source AOT sensitivity,  
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### 3.11.2 FM-ILT

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## 3.12 Req. 1.1.13: Calibrate the detector non-linearity

### 3.12.1 in-flight

- 1) cf. Req. 3.2.3

### 3.12.2 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf**: PACS photometer ILT analysis report update, section calibrate the detector non-linearity,  
N. Billot & K. Okumura, 25-Jan-2007, issue 1.0

## 3.13 Req. 1.1.14: Establish the detector linearity

### 3.13.1 in-flight

- 1) cf. Req. 3.2.3

### 3.13.2 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf**: PACS photometer ILT analysis report update, section establish the detector linearity,  
K. Okumura, 19-Oct-2007, issue 1.0



## 3.14 Req. 1.1.15: Establish the relative positions of the individual matrices

### 3.14.1 in-flight

- 1) **PICC-ME-TN-044**: In-orbit rederivation of PACS photometer FOV distortion, D.Lutz & H. Feuchtgruber, 02-Jun-2013, issue 1.0

### 3.14.2 cal file design

- 1) **PICC-ME-TN-019**: PACS spatial calibration files, D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0

## 3.15 Req. 1.1.16: Measure the signal dependence on chopping frequency

### 3.15.1 in-flight

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### 3.15.2 FM-ILT

- 1) cf. **Req. 1.1.10**

## 3.16 Req. 1.1.18: Measure the level of electrical cross-talk

### 3.16.1 in-flight

- 1) **SAP-PACS-KO-0720-11**: PACS photometer electric cross-talk analysis, K. Okumura, 07-Jul-2011, issue 1.0
- 2) **SAP-PACS-KO-0716-10**: Faint linear artefact in PACS photometer, K. Okumura, 10-Dec-2010, issue 1.0
- 3) **PICC-ME-TN034**: In-orbit cross-talk in the PACS photometer, D. Lutz, 25-Sep-2009, issue 1.1
- 4) **PICC-NHSC-TR-023**: Photometer red channel cross-talk (from FoV scans), B. Ali, 15-Sep-2009, issue 1.0
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### 3.17 Req. 1.1.20: Measure the level of correlated noise on the detector

#### 3.17.1 in-flight

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#### 3.17.2 FM-ILT

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### 3.18 Req. 1.1.22: Measure the relative system response of the detectors

#### 3.18.1 PACS pass-bands measured on-ground

- 1) **PICC-ME-TN-038:** PACS photometer passbands and colour correction factors for various source SEDs, T. Müller et al., 12-Apr-2011, issue 1.0

### 3.19 Req. 1.1.23: Optimize switching between $V_{\text{bolo}}$ and VRL in DDCS mode

#### 3.19.1 FM-ILT

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### 3.20 Req. 1.1.24: Find optimum detector read-out frequency

#### 3.20.1 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section possible improvement: change the readout frequency, K. Okumura, 31-Oct-2007, issue 1.1

### 3.21 Req. 1.1.25: Assess performance of detector read-out modes

#### 3.21.1 FM-ILT

- 1) **SAP-PACS-MS-0662-07:** Performance of the DDCS mode with an alternate sequencer (also contained in PACS photometer ILT analysis report, FM\_ILT\_draft.pdf) M. Sauvage, 26-Jul-2007, issue 1.0

### 3.22 Req. 1.1.26 On-board signal processing, photometer

#### 3.22.1 in-flight

- 1) [A&A 527, A102, 2011](#): Feasibility and performances of compressed sensing and sparse map-making with Herschel/PACS data, Barbey et al., Mar-2011

### 3.23 Req. 1.2.1: Optimum detector bias settings

#### 3.23.1 in-flight

- 1) [PICC-KL-TR-023](#): Herschel-PACS Commissioning Phase GeGa Optimisation, P. Royer et al., 17-Jul-2009, issue 1.0

#### 3.23.2 FM-ILT

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### 3.24 Req. 1.2.2: Optimum detector temperature settings

#### 3.24.1 FM-ILT

- 1) [PICC-MA-TR-30](#): Optimum detector bias and temperature settings for Ge:Ga detectors, time constant: bias change spectrometer, J. Schreiber et al., 26-Sep-2007, issue 1.0

### 3.25 Req. 1.2.3: Dynamic range per selected integration capacitor

#### 3.25.1 FM-ILT

- 1) [PICC-MA-TR-045](#): Linearity of detector ramps during ILT, J. Bouwman et al., 11-May-2009, issue 1.0
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### 3.26 Req. 1.2.4: CRE check-out voltage

#### 3.26.1 FM-ILT

- 1) [PICC-MA-TR-025](#): CRE check-out voltage test during ILT, J. Bouwman et al., 06-May-2008, issue 1.3

### 3.27 Req. 1.2.6: Detector dark current

#### 3.27.1 FM-IST

- 1) [PICC-KL-TR-022](#): SOVT-2 test report: Dark current measurements in spectroscopy  
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### 3.27.2 FM-ILT

- 1) [PICC-MA-TR-29](#): Dark current of Ge:Ga detectors from FM-ILT,  
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### 3.28.1 in-flight

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### 3.29.1 FM-ILT

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## 3.30 Req. 1.2.13: Ionizing radiation: Responsivity, spectrometer

### 3.30.1 in-flight

- 1) [PICC-KL-TR-023](#): Herschel-PACS Commissioning Phase GeGa Optimisation,  
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## 3.31 Req. 1.2.14: Ionizing radiation: Noise, spectrometer

### 3.31.1 in-flight

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### 3.32 Req. 1.2.17: Time constant: bias change, spectrometer

#### 3.32.1 FM-IST

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### 3.33 Req. 1.2.18: Time constant: flux changes, spectrometer

#### 3.33.1 in-flight

- 1) **PICC-KL-TR-024**: SPT 510: Time constants for flux changes in spectroscopy, C. Jean et al., 26-Jun-2009, issue 1.0

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#### 3.33.3 FM-ILT

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#### 3.34.1 in-flight

- 1) **PICC-KL-TR-023**: Herschel-PACS Commissioning Phase GeGa Optimisation, P. Royer et al., 17-Jul-2009, issue 1.0

### 3.35 Req. 1.2.22: Cross-talk, electrical, spectrometer

#### 3.35.1 FM-ILT

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#### 3.36.1 in-flight

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### 3.37 Req. 2.1.1: Filter transmission nominal

#### 3.37.1 PACS pass-bands measured on-ground

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### 3.38 Req. 2.2.2: Grating: Stability of positions during a spectral scan

#### 3.38.1 FM-ILT

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#### 3.39.1 in-flight

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M. Nielbock, 14-Jul-2011, issue 1.0
- 2) **PICC-MA-TR-090:** Analysis of nominal He-II open loop aging check of the PACS FM1 Chopper during the Routine Science Phase,  
M. Nielbock & U. Klaas, 28-Jun-2010, issue 1.0
- 3) **PICC-MA-TR-088:** Analysis of nominal He-II open loop functional tests of the PACS FM1 chopper during the Commissioning Phase,  
M. Nielbock et al., 24-Jun-2009, issue 1.1
- 4) **PICC-MA-TR-079:** Analysis of nominal He-II Cold Short Functional Test (CSFT) of the PACS FM1 chopper during the commissioning phase,  
M. Nielbock et al., 26-May-2009, issue 1.0

### 3.39.2 FM-IST

- 1) **PICC-MA-TR-075:** Analysis of He-I Cold Short Functional Test (CSFT) of the PACS FM1 chopper at CSG Kourou M. Nielbock et al., 12-Mar-2009, Issue 1.0
- 2) **PICC-MA-TR-066:** Analysis of PACS chopper characteristics by closed loop full range FOV Scan at He-II stage during FM-IST TV/TB, M. Nielbock et al., 14-Jan-2009, issue 1.0
- 3) **PICC-MA-TR-067:** Analysis of He-II Cold Short Functional Test (CSFT) of the PACS FM1 chopper during TV/TB, M. Nielbock et al., 28-Jan-2009, issue 1.0
- 4) **PICC-MA-TR-049:** Analysis of He-II Cold Short Functional Test (CSFT) of the PACS chopper on Integrated System Level, M. Nielbock et al., 03-Dec-2008, Issue 1.1
- 5) **PICC-MA-TR-042:** Analysis of Warm Short Functional Tests (WSFT) of the PACS chopper on Integrated System Level, M. Nielbock et al., 20-Feb-2008, issue 1.2

### 3.39.3 FM-ILT

- 1) **PICC-MA-TR-021:** Angular Calibration and Zero Point Offset Determination of PACS FM1 Chopper for cold He II ( $T = 4.2$  K) conditions, M. Nielbock et al., 16-Jul-2007, issue 2.4
- 2) **PICC-MA-TR-020:** Angular Calibration and Zero Point Offset Determination of PACS FM1 Chopper for room temperature ( $T = 295$  K) conditions, M. Nielbock et al., 03-Jul-2007, issue 1.2
- 3) **PICC-MA-TR-023:** Basic Drive Parameters of PACS FM1 Chopper - Specific Torque, Open Loop Oscillation Frequency and Damping - from FM ILT measurements at liquid helium ( $T = 4.2$  K) conditions, M. Nielbock et al., 30-Jul-2007, issue 1.2
- 4) **PICC-MA-TR-034:** Basic Drive Parameters of PACS FM1 Chopper - Specific Torque, Open Loop Oscillation Frequency and Damping - from FM ILT measurements at Room Temperature ( $T = 295$  K), M. Nielbock et al., 19-Sep-2007, issue 2.0

## 3.40 Req. 2.3.2: Chopper duty cycle of waveforms

### 3.40.1 in-flight

- 1) **PICC-MA-TR-083:** PACS Chopper Dynamic Behaviour Verification (H\_COP\_PAC\_CHP2\_01) during CoP on June 1, 2009, J. Bouwman et al., 03-Jul-2009, issue 2.0
- 2) **PICC-MA-TR-082:** PACS Chopper Stability Verification (H\_COP\_PAC\_CHP1\_01) during Commissioning Phase on May 30, 2009, J. Bouwman et al., 15-Jun-2009, issue 1.0

### 3.40.2 FM-IST

- 1) **No doc ID, file name: fm\_tbtv\_chopper\_performance\_report.pdf:** IMT 504: Chopper Performance Test during TB/TV, J.Bouwman et al., 02-Feb-2009, issue 1.1
- 2) **PICC-MA-TR-057:** IMT 504: Chopper Performance Test during cold FM-IST, J.Bouwman et al., 03-Nov-2008, issue 1.2
- 3) **PICC-MA-TR-040:** Summary of PACS chopper verification and tuning during FM-IST on the 11th July 2008, J. Bouwman et al., 27-Jul-2008, issue 1.0
- 4) **PICC-MA-TR-039:** Summary of PACS chopper verification and tuning during FM-IST on the 14th May 2008, M. Nielbock et al., 28-May-2008, issue 1.0

### 3.40.3 FM-ILT

- 1) **PICC-MA-TR-031:** IMT 504: Chopper Performance Test during cold FM-ILT/IST, J.Bouwman et al., 25-Sep-2007, issue 1.1

## 3.41 Req. 2.5.1: Temporal stability of PACS calibration sources

### 3.41.1 FM-ILT

- 1) **PICC-MA-TR-033:** Functional and Performance Test of PACS Internal Calibration Sources during cold FM ILT, H. Dannerbauer et al., 05-Nov-2007, issue 1.1
- 2) **PICC-MA-TR-032:** IMT 511 - Internal calibration sources performances, H. Dannerbauer et al., 26-Oct-2007, issue 1.1

## 3.42 Req. 2.5.3: Time constants: heat-up and cool down times of PACS calibration sources

### 3.42.1 in-flight

- 1) **PICC-MA-TR-084:** SPT 511 - Internal calibration sources Short Performance Test during Herschel Commissioning Phase, H. Dannerbauer et al., 25-Jun-2009, issue 1.0

### 3.42.2 FM-IST

- 1) **PICC-MA-TR-060:** SPT 511 - Internal calibration sources performances during TV/TB, H. Dannerbauer et al., 16-Jan-2009, issue 1.0
- 2) **PICC-MA-TR-054:** SPT 511 - Internal calibration sources performances during cold IST, H. Dannerbauer et al., 16-Sep-2008, issue 1.0



### 3.42.3 FM-ILT

- 1) **PICC-MA-TR-033**: Functional and Performance Test of PACS Internal Calibration Sources during cold FM ILT,  
H. Dannerbauer et al., 05-Nov-2007, issue 1.1
- 2) **PICC-MA-TR-032**: IMT 511 - Internal calibration sources performances,  
H. Dannerbauer et al., 26-Oct-2007, issue 1.1

## 3.43 Req. 2.5.4: Emissivity of PACS calibration sources

### 3.43.1 FM-IST

- 1) **PICC-KL-TR-020**: PACS TV/TB test analysis: Calibration sources emissivity,  
B. Vandenbussche, 01-Feb-2009, issue 1.0

### 3.43.2 FM-ILT

- 1) **PICC-NHSC-TR-003**: Emissivity of PACS calibration sources, FM data,  
D. Fadda, 28-Jan-2007, issue 1.0

## 3.44 Req. 2.6.1: Absolute pointing error

### 3.44.1 in-flight

- 1) **ExA 37, 453, 2014**: The Pointing System of the Herschel Space Observatory. Description, Calibration, Performance and Improvements,  
M. Sanchez-Portal et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 453-479, 2014
- 2) **HERSCHEL-HSC-DOC-1515**: Herschel pointing calibration report,  
M. Sanchez-Portal et al., 25-Nov-2009, issue 1.0

### 3.44.2 STR & ACMS system related

- 1) **PICC-ME-TN-041**: Herschel STR-A CCD sub-pixel structure,  
H. Feuchtgruber, 23-Jul-2013, issue 3.0
- 2) **PICC-ME-TN-040**: Herschel guide stars: Assessment of quality,  
H. Feuchtgruber, 08-Dec-2011, issue 1.0

### 3.44.3 source lists

- 1) **PICC-MA-TN-003**: PACS pointing calibration sources,  
M. Nielbock et al., 26-Feb-2010, issue 1.5
- 2) **PICC-MA-TN-004**: QSOs, RGs and ULIRGs for PACS pointing calibration,  
H. Dannerbauer et al., 26-May-2008, issue 1.0

### 3.45 Req. 2.6.2: Relative pointing error (RPE/SRPE)

#### 3.45.1 in-flight

- 1) **PICC-ME-TN-031**: PACS PV report: RPE in staring mode (PCD/PV Plan 2.6.2B), D. Lutz, 02-Oct-2009, issue 1.1
- 2) **PICC-MA-TR-096**: Determination of the telescope nodding reproducibility of the OD 858 pointing programme after the ACMS/STR two-dimensional parameter update, M. Nielbock & U. Klaas, 07-Oct-2011, Issue 1.0
- 3) **PICC-MA-TR-094**: Investigation of nodding behaviour with S/C fine pointing mode: Performance tests with PACS photometer on OD 200, U. Klaas et al., 30-Mar-2011, issue 1.0

#### 3.45.2 CP raster tests

- 1) **PICC-MA-TR-093**: Gyro nodding pointing mode (aka CP raster): Performance test 2 with PACS photometer on OD 649, M. Nielbock et al., 25-Mar-2011, issue 2.0
- 2) **PICC-MA-TR-091**: Gyro nodding pointing mode (aka CP raster): Performance test 1 with PACS photometer: Performance comparison with fine pointing mode on OD 516, H. Linz et al., 25-Mar-2011, issue 2.0

### 3.46 Req. 2.6.4: Relative pointing error scan mode

#### 3.46.1 in-flight

- 1) **SAP-PACS-HA-0729-11**: Towards and accurate reconstruction of Herschel pointing, H. Aussel, 25.Nov-2011, issue 1.0

#### 3.46.2 source lists

- 1) **PACS-ME-TN-035**: PACS sky fields and double sources for photometer spatial calibration, M. Nielbock et al., 27-Jul-2009, issue 2.7

### 3.47 Req. 2.6.5: Check time synchronisation of PACS detector data with Herschel pointing product data

#### 3.47.1 in-flight

- 1) **PICC-ME-TN-043**: A check for timing shifts of PACS photometer data vs. pointing product, D. Lutz, 16-Nov-2012, issue 1.0

### 3.48 Req. 3.1.1: Photometer central pointing position

#### 3.48.1 FM-ILT

- 1) **PICC-ME-TR-006/III**: PACS Test Analysis Report FM-ILT, partIII, section photometer central pointing position, D. Lutz, 17-Oct-2007, issue 1.0

### 3.48.2 cal file design

- 1) **PICC-ME-TN-019**: PACS spatial calibration files,  
D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0

### 3.48.3 source lists

- 1) **PICC-ME-TN-023**: Bright isolated FIR sources for locating the PACS bolometers,  
D. Lutz, 25-Nov-2007, issue 1.0

## 3.49 Req. 3.1.2: Relation between chopper position and angular displacement on sky

### 3.49.1 FM-ILT

- 1) **PICC-ME-TR-006/III**: PACS Test Analysis Report FM-ILT, partIII, section relation between chopper position and angular displacement on sky,  
D. Lutz, 17-Oct-2007, issue 1.0

### 3.49.2 cal file design

- 1) **PICC-ME-TN-019**: PACS spatial calibration files,  
D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0

### 3.49.3 source lists

- 1) **PACS-ME-TN-035**: PACS sky fields and double sources for photometer spatial calibration,  
M. Nielbock et al., 27-Jul-2009, issue 2.7

## 3.50 Req. 3.1.3: Photometer field-of-view distortion

### 3.50.1 in-flight

- 1) **PICC-ME-TN-044**: In-orbit rederivation of PACS photometer FOV distortion,  
D.Lutz & H. Feuchtgruber, 02-Jun-2013, issue 1.0

### 3.50.2 FM-ILT

- 1) **PICC-ME-TR-006/III**: PACS Test Analysis Report FM-ILT, partIII, section photometer field of view distortion,  
D. Lutz, 17-Oct-2007, issue 1.0

### 3.50.3 cal file design

- 1) **PICC-ME-TN-019**: PACS spatial calibration files,  
D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0

### 3.50.4 source lists

- 1) **PACS-ME-TN-035**: PACS sky fields and double sources for photometer spatial calibration,  
M. Nielbock et al., 27-Jul-2009, issue 2.7

### 3.51 Req. 3.1.4: Photometer point-spread function

#### 3.51.1 in-flight

- 1) [PICC-ME-TN-033](#): PACS photometer point spread function, D.Lutz, 04-Apr-2012, issue 2.0

#### 3.51.2 FM-ILT

- 1) [PICC-ME-TR-006/III](#): PACS Test Analysis Report FM-ILT, partIII, section photometer point spread function, D. Lutz, 17-Oct-2007, issue 1.0

#### 3.51.3 model input

- 1) [PICC-ME-TN-029](#): Herschel/PACS modeled point-spread functions, N. Geis & D. Lutz, 03-Aug-2010, issue 2.0

#### 3.51.4 source lists

- 1) [PICC-ME-TN-024](#): Use of blazars for PACS spatial calibration, D. Lutz, 03-Mar-2008, issue 1.1

### 3.52 Req. 3.1.5: Photometer ghosts

#### 3.52.1 in-flight

- 1) [PICC-ME-TN-033](#): PACS photometer point spread function, D.Lutz, 04-Apr-2012, issue 2.0

#### 3.52.2 FM-ILT

- 1) [PICC-ME-TR-006/III](#): PACS Test Analysis Report FM-ILT, partIII, section photometer ghosts, D. Lutz & P. Popesso, 17-Oct-2007, issue 1.0

### 3.53 Req. 3.1.6: Photometer stray-light

#### 3.53.1 in-flight

- 1) [SAp-HERSCHEL-KO-0723-10](#): Herschel stray-light report, Herschel Stray Light Working Group (K. Okumura), 07-Feb-2011, issue 1.0

### 3.54 Req. 3.1.7: Background Structure in the Photometer Field-of-View over the Full Chopper Angle Range

#### 3.54.1 in-flight

- 1) [SAp-PACS-MS-0707-09](#): Instrument background determination and red-side signal level investigation, M. Sauvage et al., 27-Jul-2009, issue 1.0

- 2) **PICC-NHSC-TR-021**: Photometer field-of-view (FoV) analysis report: PV OD64 data, B. Ali, 06-Aug-2009, issue 1.01
- 3) **PICC-NHSC-TR-019**: Photometer field-of-view (FoV) analysis report: CoP data, B. Ali, 04-Aug-2009, issue 1.1

### 3.54.2 FM-IST

- 1) **PICC-NHSC-TR-016**: PACS test analysis report TV/TB: Photometer FoV scans, D. Frayer, 22-Jan-2009, issue 1.0
- 2) **PICC-NHSC-TR-014**: FOV Scan FIST-SPT Phot519, D. Frayer, 16-Sep-2008, issue 2.0

### 3.54.3 FM-ILT

- 1) **PICC-NHSC-TR-002**: Bolometer FOV Chopper Scans, D. Frayer et al., 04-Sep-2007, issue 1.0
- 2) **PICC-NHSC-TR-010**: OGSE Spots Observed from FOV Chopper Scans, D. Frayer et al., 12-Dec-2007, issue 1.0

## 3.55 Req. 3.2.1: Derive photometer nominal responsivity

### 3.55.1 in-flight

- 1) **SAP-PACS-HA-0713-09**: PACS responsivity from standard stars observations, H. Aussel, 29-Oct-2009, Issue 0.1
- 2) **ExA 37, 129, 2014**: The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps, Z. Balog et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 129-160, 2014
- 3) **ExA 36, 631, 2013**: The Herschel PACS photometer calibration. A time dependent flux calibration for the PACS chopped point-source photometry AOT mode, M. Nielbock et al., refereed publication in Experimental Astronomy, Volume 36, Issue 3, pp. 631-660, 2013
- 4) **PICC-ME-TN-037**: PACS photometer - point source flux calibration, T. Müller et al., 12-Apr-2011, issue 1.0

### 3.55.2 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf**: PACS photometer ILT analysis report update, section derive photometer nominal responsivity, K. Okumura, 19-Oct-2007, issue 1.0

### 3.55.3 model input zero point

- 1) **PICC-MA-TN-011**: Zero magnitude conversion for the PACS photometer, M. Nielbock & U. Klaas, 01-Oct-2013, issue 1.0

### 3.55.4 source lists

- 1) **ExA, 253, 2014:** Herschel celestial calibration sources - Four large main-belt asteroids as prime flux calibrators for the far-IR/sub-mm range,  
T. Müller et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 253-330, 2014

## 3.56 Req. 3.2.2: Monitor nominal responsivity variations with time

### 3.56.1 in-flight

- 1) **ExA 37, 225, 2014:** PACS photometer calibration block analysis,  
A. Moór et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 225-238, 2014
- 2) **ExA 37, 129, 2014:** The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps,  
Z. Balog et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 129-160, 2014
- 3) **ExA 36, 631, 2013:** The Herschel PACS photometer calibration. A time dependent flux calibration for the PACS chopped point-source photometry AOT mode,  
M. Nielbock et al., refereed publication in Experimental Astronomy, Volume 36, Issue 3, pp. 631-660, 2013
- 4) **SPIE774102, 2010:** CEA bolometer arrays: the first year in space,  
N. Billot et al., Proc. of SPIE, Vol. 7741, 774102-1, 2010, DOI: 10.1117/12.856449

### 3.56.2 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section monitor nominal responsivity variations with time,  
K. Okumura, 16-Oct-2007, issue 1.0

## 3.57 Req. 3.2.3: Calibrate the photometer's non-linearity

### 3.57.1 in-flight

- 1) **SPIE774102, 2010:** CEA bolometer arrays: the first year in space,  
N. Billot et al., Proc. of SPIE, Vol. 7741, 774102-1, 2010, DOI: 10.1117/12.856449

### 3.57.2 on-ground

- 1) **PICC-NHSC-TR-031:** Non-linearity correction module for the PACS photometer,  
N. Billot, Feb-2011, issue 0.2

### 3.57.3 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section calibrate the photometer's non-linearity,  
N. Billot & K. Okumura, 25-Jan-2007, issue 1.0

### 3.57.4 cal file design

- 1) **PICC-NHSC-TR-031:** Non-linearity correction module for the PACS photometer,  
N. Billot, Feb-2011, issue 0.2

## 3.58 Req. 3.2.4: Calibrate the photometer's non-linearity

### 3.58.1 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section establish the linearity of the full system, K. Okumura, 19-Oct-2007, issue 1.0

## 3.59 Req. 3.2.5: Relative system response and colour corrections photometer

### 3.59.1 PACS pass-bands measured on-ground

- 1) **PICC-ME-TN-038:** PACS photometer passbands and colour correction factors for various source SEDs, T. Müller et al., 12-Apr-2011, issue 1.0
- 2) **PICC-CR-TN-044:** The bandwidth of the PACS photometric system, S. Pezzuto, 07-May-2013, issue 1.1

## 3.60 Req. 3.2.8: Measure the photometer full system flat-field

### 3.60.1 in-flight

- 1) **SAP-PACS-KO-0734-14:** PACS photometer flat field measurement, K. Okumura, 17-Jan-2014, issue 1.1

## 3.61 Req. 3.2.9: Telescope background and its stability

### 3.61.1 in-flight

- 1) **ExA 37, 129, 2014:** The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps, Z. Balog et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 129-160, 2014
- 2) **ExA 36, 631, 2013:** The Herschel PACS photometer calibration. A time dependent flux calibration for the PACS chopped point-source photometry AOT mode, M. Nielbock et al., refereed publication in Experimental Astronomy, Volume 36, Issue 3, pp.631-660, 2013
- 3) **SAP-PACS-MS-0709-09:** Investigation of the impact of seasonal changes of the telescope temperature on the PACS photometer, M. Sauvage, 04-Sep.2009, issue 1.0
- 4) **SAP-PACS-MS-0707-09:** Instrument background determination and red-side signal level investigation, M. Sauvage et al., 27-Jul-2009, issue 1.0

## 3.62 Req. 3.2.10: Determine the amount of straylight to the internal calibration source flux

### 3.62.1 FM-ILT

- 1) **No doc ID, file name: FM\_ILT\_draft.pdf:** PACS photometer ILT analysis report update, section straylight on the internal calibration sources, K. Okumura, 19-Oct-2007, issue 1.0

### 3.63 Req. 3.4.1: Electromagnetic interference of photometer operations

#### 3.63.1 in-flight

- 1) [SPIE774102, 2010](#): CEA bolometer arrays: the first year in space, N. Billot et al., Proc. of SPIE, Vol. 7741, 774102-1, 2010, DOI: 10.1117/12.856449

#### 3.63.2 FM-ILT

- 1) [SAp-PACS-KO-0688-08](#): Report on the PACS susceptibility to solar array EM perturbation, K. Okumura & M. Sauvage, 12-Sep-2008, issue 1.2
- 2) [No doc ID, file name: FM\\_ILT\\_draft.pdf](#): PACS photometer ILT analysis report update, section electromagnetic perturbation tests, K. Okumura, 18-Jul-2008, issue 1.0

### 3.64 Req. 4.1.1: Spectrometer central pointing position and grating alignment

#### 3.64.1 in-flight

- 1) [PICC-KL-TN-043](#) PACS spectroscopy chop/nod FPG verification from line scan maps OD 370 – 373, B. Vandenbussche, 31-May-2010, issue 1.0

#### 3.64.2 FM-ILT

- 1) [No doc ID, file name: FMILT3\\_Spec\\_Spatial\\_cal\\_21Dec07.pdf](#): FM-ILT3 Spectrometer spatial calibration, A. Contursi, 21-Dec-2007

#### 3.64.3 cal file design

- 1) [PICC-ME-TN-019](#): PACS spatial calibration files, D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0

### 3.65 Req. 4.1.2: Spectrometer field-of-view distortion

#### 3.65.1 FM-ILT

- 1) [No doc ID, file name: FMILT3\\_Spec\\_Spatial\\_cal\\_21Dec07.pdf](#): FM-ILT3 Spectrometer spatial calibration, A. Contursi, 21-Dec-2007

#### 3.65.2 cal file design

- 1) [PICC-ME-TN-019](#): PACS spatial calibration files, D. Lutz & A. Contursi, 02-Jun-2013, issue 1.0



### 3.66 Req. 4.1.3: Spectrometer Point Spread Function

#### 3.66.1 in-flight

- 1) **PICC-KL-TN-041**: PACS spectroscopy performance and calibration, B. Vandenbussche et al., 16-Jun-2011, issue 2.4

#### 3.66.2 FM-ILT

- 1) **No doc ID, file name: FMILT3\_Spec\_Spatial\_cal\_21Dec07.pdf**: FM-ILT3 Spectrometer spatial calibration, A. Contursi, 21-Dec-2007

### 3.67 Req. 4.1.4: Spectrometer ghosts

#### 3.67.1 FM-ILT

- 1) **No doc ID, file name: FMILT3\_Spec\_Spatial\_cal\_21Dec07.pdf**: FM-ILT3 Spectrometer spatial calibration, A. Contursi, 21-Dec-2007

### 3.68 Req. 4.1.6: Spectrometer full field-of-view characterization

#### 3.68.1 in-flight

- 1) **PICC-KL-TR-028**: PV analysis report: Calibration source emissivity and stray-light, K. Exter & P. Royer, 13-Jan-2010, issue 2.0

#### 3.68.2 FM-IST

- 1) **PICC-MA-TR-062**: IMT 409: Spectrometer field-of-view scan during TV/TB FM-IST at HeII, J. Schreiber et al., 16-Jan-2009, issue 1.0
- 2) **PICC-MA-TR-050**: IMT 409: Spectrometer field-of-view scan during FM-IST, J. Schreiber et al., 23-Sep-2008, issue 1.1

#### 3.68.3 FM-ILT

- 1) **PICC-MA-TR-028**: IMT 409: Spectrometer field-of-view scan during FM-ILT/IST, J. Schreiber et al., 04-Oct-2007, issue 1.1

### 3.69 Req. 4.2.1: Grating wavelength calibration

#### 3.69.1 in-flight

- 1) **PICC-KL-TN-041**: PACS spectroscopy performance and calibration, B. Vandenbussche et al., 16-Jun-2011, issue 2.4

### 3.69.2 FM-ILT

- 1) **No doc ID, file name: PACS\_Wavecal\_Report\_FM\_1.pdf:** Wavelength calibration of the PACS spectrometer during FM-ILT1,  
H. Feuchtgruber, 12-Feb-2007, issue 1.0

### 3.69.3 source lists

- 1) **PICC-ME-TN-013:** Use of late type stars for PACS wavelength calibration,  
D. Lutz, 13-Oct-2004, issue 1.0

## 3.70 Req. 4.2.3: Spectral Purity

### 3.70.1 in-flight

- 1) **PICC-KL-TN-041:** PACS spectroscopy performance and calibration,  
B. Vandenbussche et al., 16-Jun-2011, issue 2.4

## 3.71 Req. 4.2.4: Spectral Ghosts

### 3.71.1 in-flight

- 1) **PICC-KL-TN-041:** PACS spectroscopy performance and calibration,  
B. Vandenbussche et al., 16-Jun-2011, issue 2.4

## 3.72 Req. 4.2.5: Grating wavelength calibration, dependence on source position in slit

### 3.72.1 in-flight

- 1) **PICC-KL-TN-041:** PACS spectroscopy performance and calibration,  
B. Vandenbussche et al., 16-Jun-2011, issue 2.4

## 3.73 Req. 4.3.1: Absolute flux calibration internal sources, spectrometer

### 3.73.1 in-flight

- 1) **PICC-KL-TN-047:** PACS spectrometer flux calibration with the calibration blocks,  
C. Jean et al., 25-Aug-2011, issue 1.0

## 3.74 Req. 4.3.2: Reproducibility internal sources, spectrometer

### 3.74.1 FM-ILT

- 1) **PICC-ME-TR-006/II:** PACS Test Analysis Report FM-ILT, partII, section reproducibility internal sources, spectrometer,  
J. Blommaert, 12-Nov-2007, issue 1.0,

**3.75 Req. 4.3.3: Absolute flux calibration external sources, spectrometer****3.75.1 in-flight**

- 1) **PICC-KL-TN-041**: PACS spectroscopy performance and calibration, B. Vandenbussche et al., 16-Jun-2011, issue 2.4

**3.75.2 FM-ILT**

- 1) **PICC-ME-TR-006/II**: PACS Test Analysis Report FM-ILT, partII, section absolute flux calibration of the spectrometer, J. Blommaert, 10-Oct-2007, issue 1.0

**3.76 Req. 4.3.8: Absolute flux calibration external sources, spectrometer****3.76.1 FM-ILT**

- 1) **PICC-ME-TR-006/II**: PACS Test Analysis Report FM-ILT, partII, section relative spectral response function, B. Vandenbussche, 02-Nov-2007, issue 1.0

**3.77 Req. 4.3.10: Flat-field spectrometer external sources****3.77.1 in-flight**

- 1) **PICC-KL-TN-045**: PACS spectroscopy flat-field correction, B. Vandenbussche, 28-Jun-2010, issue 1.0

**3.78 Req. 5.1.1: Optimized observing strategy for Point Source Photometry AOT****3.78.1 in-flight**

- 1) **PICC-ME-TN-036**: PACS photometer - point/compact source observations: mini scan maps & chop-nod (release note), PACS ICC (T. Müller), 12-Nov-2010, issue 2.0
- 2) **PICC-MA-TN-010**: PACS Performance Verification Phase photometer point source AOT validation: test case: HD 139669, M. Nielbock, 09-Nov-2009, issue 1.0
- 3) **PICC-MA-TN-006**: PACS Performance Verification Phase photometer point source AOT validation: dithered vs. non-dithered, test case: asteroid 360 Carlova, M. Nielbock & U. Klaas, 02-Nov-2009, issue 2.3
- 4) **SAP-PACS-MS-0711-019**: Simulations of the point source AOT sensitivity, M. Sauvage, 05-Oct-2009, Issue 1.0
- 5) **PICC-NHSC-TR-027**: PACS Performance Verification Phase chopper frequency optimization in point source AOT, N. Billot, 20-Nov-2009, issue 0.2

### 3.78.2 data reduction

- 1) **ExA 36, 631, 2013:** The Herschel PACS photometer calibration. A time dependent flux calibration for the PACS chopped point-source photometry AOT mode, M. Nielbock et al., refereed publication in Experimental Astronomy, Volume 36, Issue 3, pp. 631-660, 2013
- 2) **ExA 37, 347, 2014:** First results with the boloSource() algorithm: photometry of faint standard stars observed by Herschel/PACS, G. Marton et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 347-356, 2014
- 3) **PICC-ME-TN-037:** PACS photometer - point source flux calibration, T. Müller et al., 12-Apr-2011, issue 1.0

## 3.79 Req. 5.1.4: Optimized observing strategy for scan map photometry

### 3.79.1 in-flight

- 1) **PICC-ME-TN-035:** PACS photometer - prime and parallel scan mode release note, PACS ICC, 23-Feb-2011, issue 1.2
- 2) **PICC-ME-TN-036:** PACS photometer - point/compact source observations: mini scan maps & chop-nod (release note), PACS ICC (T. Müller), 12-Nov-2010, issue 2.0
- 3) **PICC-ME-TN-032:** A quick comparison of photometer point source sensitivity at scanspeeds 10/20/60 arcsec/sec, D. Lutz, 25-Sep-2009, issue 1.1

### 3.79.2 data reduction

- 1) **ExA 37, 129, 2014:** The Herschel-PACS photometer calibration - Point-source flux calibration for scan maps, Z. Balog et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 129-160, 2014
- 2) **PICC-ME-TN-037:** PACS photometer - point source flux calibration, T. Müller et al., 12-Apr-2011, issue 1.0
- 3) **No doc ID, file name: hpf\_psf\_tn\_final.pdf:** The effect of the high-pass filter data reduction technique on the Herschel PACS photometer PSF and noise, P. Popesso et al., 14-Nov-2012, final version; see also 2012arXiv1211.4257P
- 4) **PICC-NHSC-TN-029:** Surface brightness comparison of PACS blue array with IRAS and Spitzer/MIPS images, B- Ali, 12-Apr-2011, issue 1.01

## 3.80 Req. 5.2.1: Optimized observing strategy for chopping/nodding line spectroscopy

### 3.80.1 in-flight

- 1) **PICC-KL-TN-038:** PACS chopped line scan and high sampling range scan AOT release note, B. Vandenbussche et al., 19-Jan-2010, issue 2.3

### 3.81 Req. 5.2.2: Optimized observing strategy for line spectroscopy in wavelength switching mode

#### 3.81.1 in-flight

- 1) **No doc ID, file name: PACS\_WaveSwitching\_ReleaseNote\_20Jan2010.pdf:** PACS Wavelength Switching AOT release note, PACS ICC, 20-Jan-2010, issue 1.0

### 3.82 Req. 5.2.3: Optimized observing strategy for range spectroscopy

#### 3.82.1 in-flight

- 1) **PICC-KL-TN-038:** PACS chopped line scan and high sampling range scan AOT release note, B. Vandenbussche et al., 19-Jan-2010, issue 2.3
- 2) **PICC-KL-TN-039:** PACS SED and large range scan AOT release note, B. Vandenbussche et al., 10-Mar-2010, issue 1.3

### 3.83 Req. 5.2.4: Optimized observing strategy for SED modes

#### 3.83.1 in-flight

- 1) **PICC-KL-TN-039:** PACS SED and large range scan AOT release note, B. Vandenbussche et al., 10-Mar-2010, issue 1.3
- 2) **PICC-KL-TN-040:** PACS homogeneous SED and Nyquist spectral sampling, B. Vandenbussche & P. Royer, 25-Feb-2010, issue 1.0

### 3.84 Req. 5.2.5: Optimized observing strategy for unchopped line spectroscopy

#### 3.84.1 in-flight

- 1) **No doc ID, file name: PACS\_Unchopped\_ReleaseNote\_20Sep2010.pdf:** PACS Release Note: Unchopped line scan and Unchopped Range Scan/SED Mode (Referred to generically as Unchopped Mode), PACS ICC, 20-Sep-2010, issue 1.0
- 2) **No doc ID, file name: PACS\_UnchoppedReleaseNote\_BrightLines\_15Apr2011.pdf:** PACS Release Note: Unchopped Bright Line-Scan Mode, PACS ICC, 15-Apr-2011, issue 1.0

### 3.85 Req. 5.2.6: Optimized observing strategy for unchopped range spectroscopy

#### 3.85.1 in-flight

- 1) **No doc ID, file name: PACS\_Unchopped\_ReleaseNote\_20Sep2010.pdf:** PACS Release Note: Unchopped line scan and Unchopped Range Scan/SED Mode (Referred to generically as Unchopped Mode), PACS ICC, 20-Sep-2010, issue 1.0

**3.86 Req. 7.1.1: Herschel telescope focus verification**

cf. Req. 3.1.4, Sect. **3.51**

**3.87 Req. 7.3.3: Verification of Moon stray-light occurrence in stray-light spot F****3.87.1 in-flight**

- 1) **ExA 37, 331, 2014:** Herschel out-of-field stray-light characterization, U. Klaas et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 331-345, 2014
- 2) **SAP-HERSCHEL-KO-0723-10:** Herschel stray-light report, Herschel Stray Light Working Group (K. Okumura), 07-Feb-2011, issue 1.0

**3.88 Req. 7.3.4: Sensitivity to bright out-of-field sources inside or outside the Herschel focal plane****3.88.1 in-flight**

- 1) **ExA 37, 331, 2014:** Herschel out-of-field stray-light characterization, U. Klaas et al., refereed publication in Experimental Astronomy, Volume 37, Issue 2, pp. 331-345, 2014
- 2) **SAP-HERSCHEL-KO-0723-10:** Herschel stray-light report, Herschel Stray Light Working Group (K. Okumura), 07-Feb-2011, issue 1.0

**3.89 Req. 7.4.1: Relative location of PACS photometer and spectrometer field-of-views in the Herschel focal plane****3.89.1 in-flight**

cf. Req. 2.6.1, Sect. **3.44** and Req. 4.1.1, Sect. **3.64**

**3.89.2 FM-ILT**

cf. Req. 3.1.1, Sect. **3.48**

**3.90 Req. 9.1.1: Influence (Interference) SPIRE on bolometers****3.90.1 EQM-IMT**

- 1) **PICC-KO-TR-001:** Comparison of the nominal and the PACS/SPIRE parallel mode cooler recycling procedures, Cs. Kiss et al., 30-Nov-2005, issue 1.0

**3.91 Req. 10.1.1: OGSE chopper positioning****3.91.1 FM-ILT**

- 1) **PICC-ME-TR-005:** OGSE characterization during CQM/FM-ILT, Th. Müller et al., 06-Nov-2006

**3.92 Req. 10.1.2: OGSE chopper frequency****3.92.1 FM-ILT**

- 1) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006

**3.93 Req. 10.1.3: OGSE chopper duty cycle****3.93.1 FM-ILT**

- 1) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006

**3.94 Req. 10.2.1: Stability of OGSE internal black-body radiation****3.94.1 FM-ILT**

- 1) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006

**3.95 Req. 10.2.2: OGSE internal black-body flux calibration****3.95.1 FM-ILT**

- 1) **PICC-KL-TN-004**: Flux estimates (in-orbit and OGSE),  
M. Groenewegen, 10-Nov-2003, Draft 1

**3.96 Req. 10.3.1: Characterize OGSE point source simulator (external BB with pin hole mask in front)****3.96.1 FM-ILT**

- 1) **PICC-ME-TN-012**: OGSE hole masks for ILT testing,  
D. Lutz & K. Okumura, 17-Oct-2003
- 2) **PICC-ME-TN-011**: Contrast of observations with punched masks in PACS ILT,  
D. Lutz, 26-Nov-2002
- 3) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006

**3.97 Req. 10.3.2: Characterize OGSE raster simulator (X-Y-stage)****3.97.1 FM-ILT**

- 1) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006

### 3.98 Req. 10.3.3: Characterize OGSE wavelength reference (H<sub>2</sub>O cell)

#### 3.98.1 FM-ILT

- 1) **PICC-ME-TR-005**: OGSE characterization during CQM/FM-ILT,  
Th. Müller et al., 06-Nov-2006