IMPLEMENTATION OF MIPAS POST-LAUNCH CALIBRATION AND VALIDATION TASKS

- ENVISAT -

Michelson Interferometer for Passive Atmospheric Sounding

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	Name	Signature	Date
Prepared by	H. Nett, ESTEC/EOP-PPP		7 March 2002
Checked by	G. Levrini, ESTEC/EOP-PPP		
Checked by MIPAS CalVal Team			

Document Change Record

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Draft 1		26 Nov 2000	first draft of document
1 (draft)		10 April 2001	comments by DLR-DFD (G. Schwarz), e-mail 6 Dec 2000 changes resulting from ORM study progress meetings # 13, #14 details provided in TN 'L2 Algo. Characterisation & Validation Strategies' ([RD8]) note on data acquisition requirements for project AO#652 (IRAC), 30 Feb. 2001 changes agreed during ESA internal coordination meetings
1		30 May 2001	results from discussions during second MCAS subgroup meeting, 19 April 2001, taken into account (po-mn-esa-gs-1188)
1	A	27 Sept. 2001	Table 1: addition of new Task CC_31 Table 12: correction of SODAP activity M_SO_5, according to [AD3] removal of measureemnt IF13 inclusion of background mission definition Appendix 2: Table A.2 modified to include mission planning parameters re-definition of measurement IF10 refinement of some measurement scenarios General: minor corrections Change bars refer to issue 1 of document

... continued			
Issue	**Revision**	**Date**	**Change description**
1	B	6 March 2002	Change bars reset Update of appl. / ref. documents list Correction in Fig. 1 Several modifications in tables 1,3, 7, 8, 9, 10, 11; detailing of team responsibilities, processing sites Deletion of task AX_2_6 (Table 7) Deletion of tasks MV_2_5/6/7/18/20/23/24 (Table 8) Correction in Table 12 Correction in Fig. A.1 Correction in Table A.2 according to updated [RD 13] Additional, minor corrections Change bars refer to issue 1 A of document

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1.0 Purpose of Document

This document shall compile the essential calibration and validation activities to be performed during the early in-flight operation of MIPAS, in preparation of the routine exploitation phase. It shall identify all necessary measurement sequences as well as the corresponding on-ground analysis steps and establish an overall schedule of activities covering the initial 9 months' period after launch.

2.0 Scope

This plan defines an approach for the implementation of MIPAS in-flight calibration and characterisation measurements and outlines the corresponding data processing requirements. It aims at the definition of key input data for the on-ground algorithm chain and at the assessment of performance parameters as needed for a full and correct interpretation of data products. Finally, the plan shall allow to consolidate the overall strategy for instrument and ground processor operation during the routine mission exploitation phase. A summary will be given on dedicated measurements and analysis steps allowing to

- check/optimise critical instrument settings
- (re-)characterise primary instrument performance parameters
- verify critical functions within the Level 0 to Level 2 ground processing chain
- verify/optimise input parameters of the L 1B & 2 processor components
- generate a complete set of optimised ground processor auxiliary data
- validate the full Level 1B and (subsets of) Level 2 data products.

Moreover, a survey of required facilities, tools and interfaces as well as the responsibilities assigned to the individual sub-groups of the MIPAS calibration & validation team will be provided. References to key documents providing detailed information on measurement scenarios, data sets to be acquired and the types of analyses will be given.

Not included in this plan are tests to verify the instrument's commandability, the acquisition of measurement (X, K_a-band) and house keeping data (S-band), as well as tests related to the overall data circulation and handling within ENVISAT Payload Data Segment (PDS), Flight Operation Segment (FOS), ENVISAT Engineering Calibration Facility (IECF) and the MIPAS Calibration Processor (MICAL).

3.0 Definitions

Accuracy

Accuracy is the absolute uncertainty or error of a measurement result, assuming that the ‘true’ value of a measurable parameter is known exactly. In general, the accuracy of a measurement is affected by both, random and systematic error sources. In many cases the assignment of accuracies is difficult or even impossible as independent, accurate measurements taken under identical conditions are not available. Often, the accuracy of a measured parameter is estimated through comparisons with other measurements acquired under variable conditions or indirectly, by means of analyses.

Calibration

Calibration is the process of transforming data represented in arbitrary or instrument specific (‘engineering’) units into physically meaningful units. An example is the ‘total power’ calibration of a passive radiometer by means of a two point blackbody measurement. In this case the detector output (e.g., an ADC reading) is recorded for two well known irradiance levels which allows, given a linear detector response, to assign an absolute spectral irradiance to an unknown source at the instrument’s inupt.

Characterisation

Characterisation represents a set of measurements of a specific quantity under well-defined, variable conditions. The purpose of a characterisation is to allow the assignment of an expected result valid at a later instant, given the exact conditions valid at that instant and the results of the characterisation measurements. An example is the characterisation of MIPAS non-linear detector response curves. Here, a detector output is recorded while the irradiance of a target (blackbody source) is varied in a controlled way over a pre-defined range of values (temperatures). The result is used later to correct a measured radiance level (e.g., an unknown scene) for the effect of the non-linear detector response.

Precision

Precision is the uncertainty within which a specific measurement can be reproduced. Assuming that fluctuations in the result of a repeated measurement are of pure random origin, precision is given as the estimated standard deviation (1 σ) of the difference (relative or absolute) between individual samples and the average over all measurements.

Validation

Validation is the process of assessing the overall confidence in a reported measurement result. The confidence is often expressed as the estimated standard deviation (1 σ) or as the 99.7 % confidence interval (~ 3 σ) assigned to a reported result. These parameters are often derived from intercomparisons between a measurement result, taking into account all its known error components, and the sum of available independent reference measurements.

In the context of this document validation may also refer to an algorithm used for on-ground data processing, or a component thereof. In this case validation is the sum of tests performed on that component under variable conditions, with the purpose of assessing its overall performance with respect to numerical accuracy, impacts of modelling/ approximation errors and sensitivity to measurement or auxiliary input data errors.

Verification

Verification is the process of testing a measurement result, an assumption or a functional component through comparison with an expected result or by testing against the performance of a reference component, respectively, making use of a set of pre-defined error margins. The result of a verification is always binary, i.e., ‘passed’ or ‘failed’.

4.0 Abbreviations List

ACVT	(ENVISAT) Atmospheric Chemistry Validation Team
ADF	Auxiliary Data File
ADS(R)	Annotation Data Set (Record)
(A)ILS	(Apodised) Instrument Line Shape
ANX (time)	(time of) Ascending Node crossing (intersection of Envisat orbit with x-y plane in Earth fixed coordinate system)
ASAT	Azimuth Start Angle Table
ASU	Azimuth anlge Scanning Unit
BB	Blackbody (calibration etc.)
CBB	Calibration Blackbody
CFI	Customer Furnished Items
CT	Commandable (instrument control) Table
CTI	Configuration Table Item
DPM/PDL	Detailed Processing Model/Parameter Data List Document
DS	Deep Space (calibration etc.)
DSD	Data Set Descriptor
DSR	Data Set Record
ESACT	Elevation Start Angle Correction Table
ESU	Elevation anlge Scanning Unit
FCE	interferogram sampling Fringe Count Error
FHPBW	Full Half Power Beam Width
FIR (filter)	Finite Impulse Response (filter)
FOS	Flight Operations Segment
FOV	Instrument Field of View
GADS	Global Annotation Data Set
IECF	Instrument Engineering Calibration Facility
IGM	Interferogram
IODD	Input / Output Data Definition Document
IPF	(MIPAS) Instrument Processing Facility
LOS	Instrument Line-of-Sight
LRAC	Low Rate Archiving Centre
MCMD	Macrocommand
MDS(R)	Measurement Data Set (Record)
MICAL	MIPAS Calibration Processor

MJD	Modified Julian Day
ML2PP	MIPAS Level 2 Processor Prototype
MPD	Maximum (optical) Path Difference
MPS	Mission Planning System
MPH	Main Product Header
(non-)LTE	(non-) Local Thermodynamic Equilibrium
NESR	Noise Equivalent Spectral Radiance
NOM	MIPAS measurement mode Nominal activity
NRT	Near Real Time
OFM	Optimised Forward Model
OM	(microwindow) Occupation Matrix
p	Atmospheric pressure
(D-)PAC	(German) Processing and Archiving Centre
PAW	(detector) Pre-Amplifier / Warm
PCD	Product Confidence Data
PDHS (-K /-E)	Payload Data Handling Station (-Kiruna / - ESRIN)
PDS	ENVISAT Payload Data Segment
PSM	Parameter Setting Macrocommand
RGT	ENVISAT Reference operations plan Generation Tool
ROP	ENVISAT Reference Operations Plan
SAIT	(elevation) Scan Angle Increment Table
SBT	Satellite Binary Time
SE (scan, ..)	Special events (scan, ..)
SEM	MIPAS measurement mode Special Events activity
SNR	Signal-to-Noise Ratio
SODAP	Switch On and Data Acquisition Plan
SPH	Specific Product Header
SPE	Signal Processing Electronics
SVD	Singular Value decomposition
T	Atmospheric kinetic Temperature
TBC	To Be Confirmed
TBD	To Be Defined (/Detailed)
TBC	To Be Confirmed
TEP	Test Entry Point
t_{ZPD}	UTC time of interferogram Zero Path Difference crossing
USF	User Service Facility

UTC	Universal Time Correlated
VMR	Atmospheric volume mixing ratio
MW	Microwindow
z	Line-of-sight tangent altitude
ZPD	Interferogram Zero Path Difference

5.0 Documents

5.1 Applicable Documents

	Document	Issue	Title
[AD 1]	ESA/PB-EO/DOSTAG (97) 14	Rev. 8	ENVISAT High Level Operation Plan
[AD 2]	PO-MA-DAS-MP-0001	4.0	MIPAS Instrument Operations Manual
[AD 3]	PO-PL-DOR-MP-0214	2 C	MIPAS Switch On and Data Acquisition Plan (SODAP)
[AD 4]	PO-TN-BOM-GS-0013	1 B	In-Flight Characterisation and Calibration Definition
[AD 5]	190190-PA-NOT-005/6	1.0	ENVISAT Instrument Calibration DPM (IECF). Vol. 6: MIPAS
[AD 6]	190190-PA-NOT-005/6A	1.2	ENVISAT Instrument Calibration DPM (IECF). Vol. 6 A: MIPAS Mispointing
[AD 7]	PO-ID-DOR-SY-0032	5	ENVISAT PGICD, Vol. 8 (MIPAS) (with update pages, DCR's until/including 7 Nov. 2000)
[AD 8]	PO-RP-DAS-MP-0082	1.0	MIPAS FM Instrument Characterisation Data Base
[AD 9]	PO-IF-DOG-GS-0002	1 D	MIPAS Ascii Input Data Interface Control Document

5.2 Reference Documents

	Document	Issue	Title
[RD 1]	PO-PL-ESA-GS-1092	1.03	ENVISAT Calibration and Validation Plan
[RD 2]	PO-RP-BOM-GS-0003	4 D	DPM / PDL for MIPAS Level 1B Processing
[RD 3]	PO-TN-BOM-GS-0016	1 E	Interface Control Document for the IECF MIPAS GS Calibration Software Library
[RD 4]	PO-TN-ESA-GS-0830	1.2	IECF CTI Tables Specifications
[RD 5]	EN-PL-ESA-GS-0334	1.7	ENVISAT Reference Operation Plan
[RD 6]	... ??? ...	-/-	ENVISAT RGT Operations Manual (in preparation)
[RD 7]	PO-TN-BOM-GS-0010	4 D	MIPAS Level 1 B Input/Output Data Definition
[RD 8]	TN-IROE-GS0002	draft	Level 2 Algorithm Characterisation & Validation Strategies (15 Jan. 2001)
[RD 9]	PO-RS-ESA-GS-0177	3 C	MIPAS Level 2 Input/Output Data Definition
[RD 10]	- / -	1	Project AO IDs # 145, 304, 323, 652; DLR-ESL/L2 TN1: Project Summary
[RD 11]	PO-TN-BOM-GS-0016	1	Definition of MIPAS Calibration Processor (MICAL) Algorithm Chains
[RD 12]	PO-TN-BOM-GS-00167	1	MIPAS Calibration Processor (MICAL) Input/Output Data Definition
[RD 13]	PO-TN-DOR-MP-0464	draft B	MIPAS CalVal Phase Procedure Inputs
[RD 14]	IROE-GS00-01	1	ESA Contract 11717/95/NL/CN. Proposal for CCN5

6.0 Introduction

As one of the atmospheric instruments on board ENVISAT MIPAS will routinely sense the Earth's limb emission in the mid infrared and acquire radiance data in a total of 5 spectral bands. The mission concept foresees the systematic processing of MIPAS scene and calibration measurements up to fully calibrated, geo-located limb radiance data (Level 1B) and vertical profiles of atmospheric pressure, temperarture and volume-mixing-ratios of the primary target species O_3, H_2O, CH_4, N_2O, NO_2 and HNO_3 (Level 2). Prerequisites for a stable data acquisition and ground processing scenario are a number of calibration, characterisation and diagnostics activities that support the operation of both, instrument and ground processor throughout the envisaged mission lifetime of four and a half years. Moreover, the overall accuracies of geophysical parameters and associated information provided in the data products need to be evaluated and reported on, to allow full and correct interpretation by MIPAS users. This includes, in particular, the compilation of total error budgets, taking into account random and systematic contributions due to instrumental effects including characterisation uncertainties, in-flight calibration errors, modelling/approximation errors in the ground processing algorithms and auxiliary data inaccuracies. Whenever appropriate, both the ground processor functionalities and generated output parameters will be validated through intercomparisons with correlative measurements or with data from other, non-ENVISAT information sources.

This document shall establish a full set of instrument performance and ground processor output parameters to be analysed during the initial in-flight operation of MIPAS (and to be periodically checked in the subsequent exploitation phase) and establish the corresponding validation/verification requirements. For each validation task the adopted acquisition and analysis methods, input data requirements, and type of provided outputs will be provided.

The geophysical validation of MIPAS products, that means, the provision and evaluation of correlative data based on non-ENVISAT information sources, as well as the interpretation of intercomparison results will be performed in the frame of the Atmospheric Chemistry Validation Team (ACVT) project. A number of planned ACVT activities are non-instrument specific, and are the result of a coordinated effort involving expert teams of all three atmospheric sensors on board ENVISAT, i.e., MIPAS, GOMOS and SCIAMACHY. These activities are defined in the overall ENVISAT Cal-Val Plan, [RD 1], and will be discussed only in general terms within this document. It is further assumed that the generation of MIPAS data products for use in geophysical validation projects will not require any special operations of the instrument other than a nominal scene acquisition scenario. Whenever possible, this document will identify time segments during which MIPAS will acquire 'nominal' scene data and the ground processor will generate the corresponding preliminary data products for use in the comparison exercise.

7.0 Overview of MIPAS Cal/Val Activities

7.1 Commissioning Phase Related Tasks

We define the MIPAS commissioning phase as the initial in-flight period during which a number of specific checks and calibration measurements are performed in order prepare the instrument for operation during routine exploitation. These activities cover

1. tests to verify the full functionality of the instrument, its commandability in various configurations and modes as well as the communication between instrument, satellite and ground segment facilities (FOS, PDHS)
2. (re-)characterisation and definition of instrument parameters controlling the acquisition of scene and calibration data in terms of observation geometry, spectral resolution and on-board signal processing
3. (re-)characterisation of instrument components and performance parameters as required by the Level 1B processor to validate and process calibration and scene data
4. optimisation of periodic in-flight calibration scenarios and computation of corresponding instrument settings
5. optimisation of primary settings of the Level 1B algorithm, to ensure correct performance of basic ground processor components
6. initialisation of performance monitoring / verification functions, i.e., definition of settings used on ground for routine checks of the overall instrument health and to detect potential degradations with respect to the initial performance.

7.2 Tasks Related to Product Validation

The above listed analyses will serve to verify vital functionalities of the instrument and of algorithm components implemented on ground, such that a stable acquisition scenario according to the ENVISAT High Level Operation Plan (see [AD 1]) can be established. These tests will, however, not suffice to verify the correct computation of the full set of parameters reported in the data products. It is the purpose of the validation project to generate correlative data against which MIPAS geophysical product parameters can be compared, and from which error budgets / confidence intervals can be derived.

Whenever possible correlative data will be produced on the basis of reference measurements which are co-located with MIPAS measurements, such that comparisons can be performed with a minimum of additional assumptions or processing steps. Correlative data may also be produced by means of data assimilation, allowing to compare reference measurements with MIPAS data making use of suitable transformations of geophysical parameters in time and space.

The generation or provision of correlative data (i.e., preparation of a measurement campaign, the measurement itself, data processing etc.) for use in the geophysical validation of MIPAS products as well as the interpretation of results are not subject of this plan. However, because of the timely overlap of algorithm related tasks and the geophysical validation these activities are included in summaries, **Chapters 10** (‘*Data Acquisition Requirements*’), **14** (‘*Schedule*’) and **Appendix 2** (‘*Mission Planning Information*’). The full validation of MIPAS products will be completed only after the transfer of the instrument into the routine operation phase.

8.0 Sequence of Activities

The envisaged MIPAS activities can be grouped according to

- *initial performance verification, update of instrument configuration & calibration scenario*
- *tasks related to Level 1B algorithm characterisation & verification*
- *tasks related to Level 2 related characterisation & verification*
- *geophysical validation of Level 1B and 2 products by comparison with non-ENVISAT correlative data.*

Figure 1 illustrates the essential steps of the initial MIPAS calibration / validation and lists basic tasks according to the above classification.

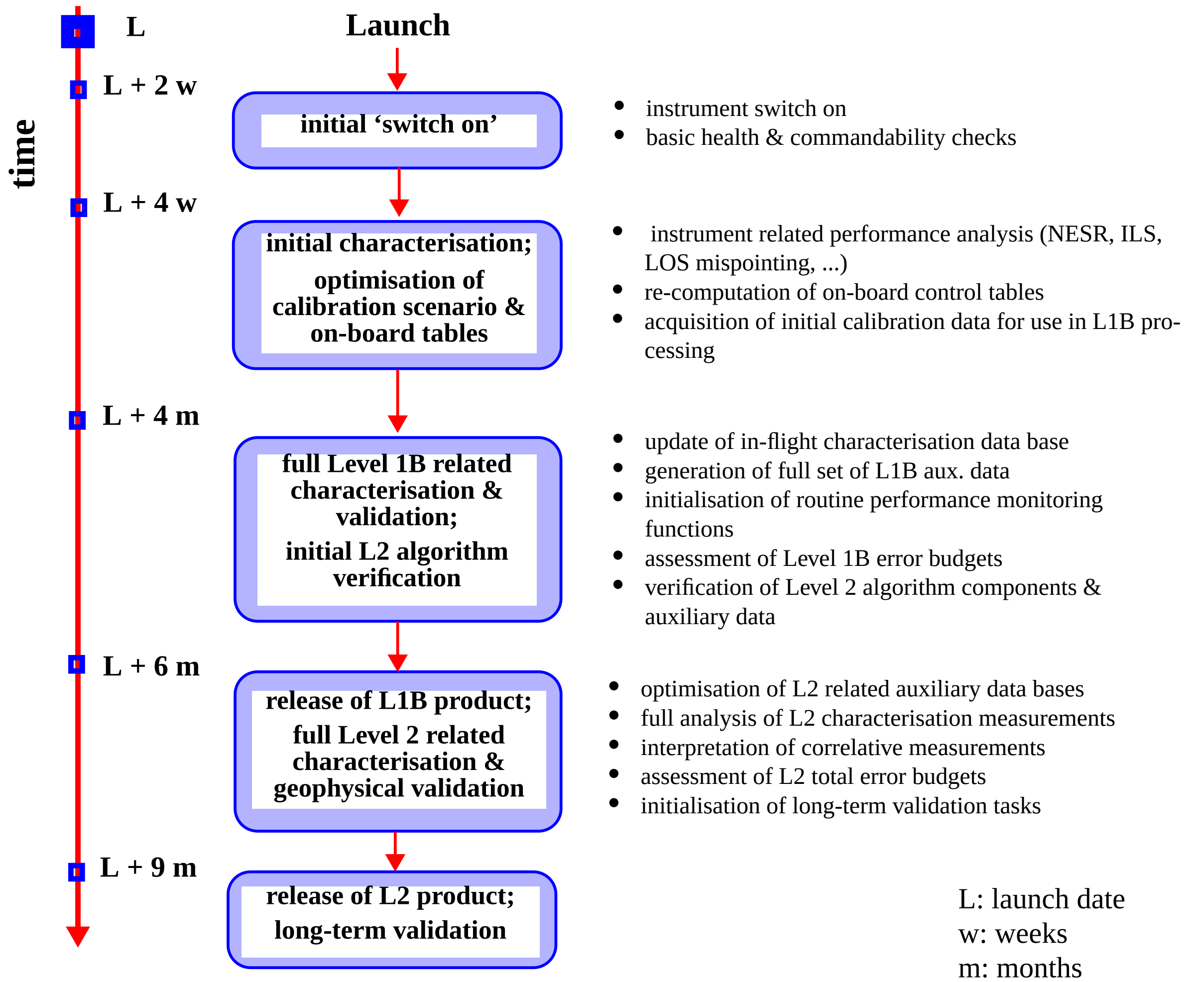

Figure 1. Overview of Early MIPAS Cal / Val Activities

9.0 Summary of MIPAS Commissioning Phase Tasks

9.1 Instrument Related Verification & Characterisation

Table 1 provides an overview of instrument related characterisation tasks. This list includes the initial verification of raw instrument data (source packets) as well as the analysis of essential performance parameters. The results will be used in subsequent tasks that aim both at the updating of on board configuration tables / settings and at the characterisation of on-ground algorithm components (IPF/MICAL) and corresponding input data.

TABLE 1. Summary of instrument related characterisation tasks

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Switch-on activities				
payload data analysis				
SO_1: instrument data verification	verification of instrument source packet data	extract ISP header, source data and aux. parameters and compare to expected values / ranges; check warning / error information	SODAP processing site (supported by MICAL, tbc)	SODAP activity, see [AD 3]
SO_2: ISP auxiliary data verification	verification of ISP auxiliary data	extract aux. data from ISPs for different modes / activities, perform calibration/ conversion and check against expected values / ranges	SODAP processing site (supported by MICAL, tbc)	SODAP activity, see [AD 3]
mission planning related tasks				
SO_3: instrument timeline characterisation	(re-)characterisation of the interferometer's slide turn around time (t_{turn})	extract scan gate time parameters from ISP aux. data; analyse mean and rms deviation of turn around time for sweep sequences (preferably DS&BB measurements)	SODAP processing site (supported by MICAL, tbc)	SODAP activity, see [AD 3] parameter used by mission planning tool, RGT/MIPAS
SO_4: max. angle increments characterisation	characterisation of maximum el./az. angle increments (1) within the turn around time (t_{turn}) and (2) within t_{turn} plus duration of extra compensation sweep	acquire limb sequences with successively increasing az./ el. angle increments and analyse ASU/ESU position data as a function of time (HK monitoring enabled)	SODAP processing site (supported by MICAL, tbc)	SODAP activity, see [AD 3] parameters used by mission planning tool, RGT/MIPAS
others (TBD)				

TABLE 1. Summary of instrument related characterisation tasks

(continued ...)

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Initial in-flight characterisation				
CC_1: LOS characterisation	initial characterisation of systematic instrument line-of-sight mispointing (bias & orbit harmonics)	acquire IR star signals in channel D (total power). Characterise bias and orbit harmonic components	MICAL	[AD 4] / IF0
CC_2: analog gain characterisation	characterise optimum PAW gain settings for nominal scene measurements	compute igm dynamic range in individual detector channels and compute optimised settings	MICAL	[AD 4] / IF1 & [AD 5] / UR-MI-5.4
CC_3: spectral axis characterisation	assessment of residual (linear) spectral correction errors	compute (linear) spectral axis correction factors as a function of time / orbit phase	MICAL	[AD 4] / IF2
CC_4: aliasing verification	characterisation of radiometric errors due to aliasing	assess radiometric errors through analysis of raw (unfiltered, undecimated) igm data	MICAL	[AD 4] / IF3
CC_5: non-linearity characterisation	verification / re-generation of NL correction coefficients	characterise detector responsivity for non-linear detectors A1, A2, B1, B2 as a function of CBB temperature	MICAL	[AD 4] / IF4 AO_652
CC_6: channel combination characterisation	verification / re-generation of channel combination filters	characterise relative response of detectors to be combined on board (C1/C2 & D1/D2) and on ground (A1/A2)	MICAL	raw mode measurements [AD 4] / IF5
CC_7: CBB and DS SNR characterisation	optimisation of coaddition factors for BB and DS igms in gain calibration measurements	characterise noise propagation from BB & DS data in calibrated scene radiances as a function of coaddition factors	MICAL	[AD 4] / IF6
CC_8: phase characterisation	determination of initial relative phase relationship between DS and BB measurements	characterise & correct fringe count errors in gain calibration measurements	MICAL	[AD 4] / IF7
CC_9: radiometric calibration characterisation	characterisation of variabilities in radiometric offset and gain calibration data	characterise orbit variations and long-term drifts in offset and gain calibration data	MICAL	[AD 4] / IF8 AO_652

TABLE 1. Summary of instrument related characterisation tasks

(continued ...)				
ID / Task	**Purpose**	**Approach**	**Processing site / project**	**Remarks / ref-erences**
Initial in-flight characterisation				
CC_10: offset tangent height charac-terisation	determination of minimum tangent height required for radiometric offset calibra-tions	characterise radiometric errors induced by narrow atmospheirc line emissions as a function of tangent height	MICAL	[AD 4] / IF9
CC_11: $NESR_0$ verifi-cation	verification of specified $NESR_0$ levels in all spectral bands	characterise NESR levels in high resolution deep space measurements treated as scenes and compare to pre-stored template	MICAL	[AD 4] / IF10 AO_145, AO_652
CC_12: check absence of high resolu-tion features	verify level of high resolu-tion spectral features in BB and DS calibration measure-ments	characterise level of residual spectral features in DS and BB measurements acquired at high rersolution	MICAL	[AD 4] / IF11 AO_145
CC_13: $NESR_T$ assess-ment	characterise $NESR_T$ levels and spectral dependency across all bands and for all tangent heights	assess NESR levels in atmo-spheric scene spectra through analysis of imagi-nary part.	MICAL	[AD 5] / UR-MI-2.9
CC_14: ILS characteri-sation	initial characterisation of instrument lineshape	fit ILS modelling parame-ters for selected target lines in scene data located in all 5 spectral bands	MICAL	[AD 5] / UR-MI-2.4
CC_15: ILS reproduce-ability	analysis of residuals in fitted ILS data	compare output of a routine (‘coarse’) ILS fit with an enhanced off-line (‘precise’) analysis	MICAL	[AD 5] / UR-MI-2.5
CC_16: Instrument timeline char-acterisation	characterisation of parame-ters controlling the mea-surement timelines for nominal and special events scenarios. Used by MIPAS NOM/SEM mission plan-ning tool	determine time parameters required for the planning of calibration and NOM, SEM measurements: * sweep turn around time t_{ta} * standard deviation of t_{ta} * deviations of compensation times (automatic / commanded) from commanded settings	RGT, MICAL (tbc)	[RD 6]

TABLE 1. Summary of instrument related characterisation tasks

(continued ...)				
ID / Task	**Purpose**	**Approach**	**Processing site / project**	**Remarks / references**
Initial in-flight characterisation				
CC_17: Mission CFI outputs in L0&L1B outputs	verify time/orbit/ geolocation parameters computed using mission CFI modules ppf_time, ppf_orb, ppf_target	compare mission CFI related parameters reported in MIPAS Level 0 and Level 1B products with reference data generated by means of IPF external test tools: **L0:** MPH: fields #10-24 SPH: fields #2-6 **L1B:** MPH: fields #10-24 SPH: fields #5-10 MDSR: fields #1, 4-10 GeolocationADS: fields #3-7 ScaninfoADS: fields #1, 12.01-12.04	MICAL, ESL site (tbc)	method tbd
CC_18: FOV characterisation	verify / re-characterise instrument FOV patterns	analyse instantaneous FOV pattern and characterise variations between different spectral bands. sampled FOV patterns, after averaging over spectral bands, to be included in L2 aux. file PS2 (see PS_2_4)	MICAL / ESL site (tbc)	method tbd
CC_19: ILS parametrisation verification	verify parametrisation used in routine ILS retrieval algortihm	compare ILS model used in IPF/MICAL retrieval algorithm with enhanced models by means of spectral residuals analysis	AO sites	AO_145 & AO_652
CC_20: ILS reproduceability	characterise dependency of ILS on tangent height and on scene inhomogeinities	perform ILS retrievals for different target data sets and analyse results	AO sites	AO_145 & AO_652
CC_21: Spectral calibration analysis	characterise residual spectral calibration & line position errors	provide enhanced spectral axis correction parameters and compare to IPF/MICAL fit results; estimate line position errors	AO site	AO_145 & AO_652

TABLE 1. Summary of instrument related characterisation tasks

(continued ...)

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Initial in-flight characterisation				
CC_22: NESR assessment verification	analyse systematic errors in IPF/MICAL algorithm for $NESR_T$ assessment	verify / re-assess NESR levels in calibrated scene data by means of independent methods: 1) instrument performance models 2.) deduced, through analysis of L1B spectra	AO sites	AO_145 & AO_652
CC_23: Non-linearity correction verification	estimate residual radiometric errors in IPF/MICAL algorithms for non-linearity characterisation and correction	assess validity of operational L1B non-linearity correction scheme; estimate systematic errors in IPF/ MICAL characterisation & correction	AO site	AO_145 & AO_652
CC_24: Total noise budget analysis	identify & characterise primary noise sources and compile total NESR budgets	analyse noise sources and quantify their contribution to the overall NESR levels observed in scene data	AO site	AO_145 & AO_652
CC_25: Radiometric response analysis	analyse time variations in overall instrument radiometric response	analyse long and short term drifts in instrument response, offset and phase; impacts due to low resolution calibration measurements	AO site	AO_145 & AO_652
CC_26: spectral noise correlation analysis	characterise NESR levels and spectral correlations in calibrated scene spectra	deduce noise variance/covariance data of L1B limb radiances using different methods: 1) *spectral domain:* analysis of radiances in gaps between atmospheric emission lines 2) *time domain:* analysis of ensemble of independent limb radiance measurements (‘sweeps’)	AO sites	AO_145

TABLE 1. Summary of instrument related characterisation tasks

(continued ...)				
ID / Task	**Purpose**	**Approach**	**Processing site / project**	**Remarks / references**
Initial in-flight characterisation				
CC_27: systematic errors in radiometric calibration scheme	characterise impact of systematic errors in IPF MICAL radiometric calibration scheme	analyse specific effects (igm sampling instabilities, high altitude line emissions, ...) and their impact on radiometric & spectral axis accuracy; quantify related systematic errors	AO sites	AO_145 & AO_652
CC_28: validation of L1B radiance spectra	validate fully calibrated MIPAS radiance data through comparisons with forward model results	compare MIPAS L1B radiance data in L2 retrieval microwindows with results of a radiative transfer model making use of best guess atmospheric state parameters (method to be detailed)	AO site	AO_357 [low priority task, as only qualitative results expected]
CC_29: radiometric calibration check	check accuracy of radiometric calibration and assess CBB temperature	analyse CBB measurements acquired for different temperatures and calibrate using gain data computed for variable CBB temperatures	AO site	AO_652
CC_30: characterisation of short-term LOS fluctuations	characterise LOS pointing jitter	check for occurence and significance of short-term pointing fluctuations and characterise frequency spectrum (periods < 100 s, tbc) (method to be detailed)	ESL, AO site	AO_652
CC_31: characterisation of dependency of DS calibration signal of elevation & azimuth pointing angles	verify absence of changes in the instrument's radiometric offset signal for variable ASU/ESU pointing angles	check for changes in radiometric deep space signals acquired for a set of different elevation & azimuth pointing angles	MICAL	see also [RD 13], activity IF10
others (TBD)				

9.2 Update of Instrument Control Parameters

As a result of the analyses compiled in the previous section a number of on-board parameter tables / settings need to be updated. The modification of instrument control parameters, that control the acquisition of scene and calibration data, the on-board signal processing and the contents of the downlinked data stream, will allow to operate the instrument according to an initial *nominal measurement scenario*. The term 'nominal scenario' shall mean here that repetitive atmospheric limb measurements, interleaved with periodic radiometric deep space (DS) and gain sequences, will be acquired for specific time intervals (typical duration: ≥ several orbits). Measurement data collected during such periods will be processed by the MIPAS IPF and generated products can be analysed by the CalVal team.

The instrument parameters update will also ensure that the overall performance will be significantly improved with respect to the initial configuration, especially with regard to

- LOS tangent height acquisition inaccuracies
- radiometric errors (e.g., as induced by noise / drifts in DS and gain measurements)
- excessive noise in calibrated scene data (e.g., due to non-optimum analog gain settings, numerical filters).

The successful completion of the parameters update will allow to conduct subsequent calibration/characterisation work on the basis of enhanced instrument data and also, to generate preliminary Level 1B data sets for use during initialisation of routine verification and monitoring functions (see **Section 9.3**) and to carry out specific tasks related to Level 2 algorithm and auxiliary data characterisation. It is assumed that the updated on-board parameters will be valid for all nominal and special events measurements. An exception is the LOS pointing correction table, generated in task IC_4. This table needs to be re-computed for nominal mode activities whenever a specific tangent height correction law (wrt latitude) is selected or the azimuth angle steering law (via ASAT table) is modified.

Table 2 summarises tasks related to the updating of instrument configuration and control parameters.

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TABLE 2. Functions related to instrument control parameter update

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
(Re-)computation of instrument control parameters				
IC_1: **Analog gain settings (PAW) generation**	optimisation of on-board analog gain settings	compute optimum PAW gain settings for individual detector channels and generate corresponding CTI file ([RD 4], [AD 2], CT-ID 51/52)	MICAL	[AD 5] / UR-MI-2.18 (uses results of CC_02)
IC_2: **FIR / equalisation filters generation**	generation of numerical filter and equalisation coefficients	re-compute numerical filter coefficient sets & equalisation vectors and generate corresponding CTI file (PSM-ID 29-31)	MICAL	[RD 3] / M316 & M321 (uses results from CC_04, CC_06)
IC_3: **SPE parameters update**	generation of SPE parameters / settings	re-generate SPE parameters and generate corresponding CTI file (CT-ID 50)	MICAL	[RD 3] / M316 (uses results from IC_02)

TABLE 2. Functions related to instrument control parameter update

(continued ...)

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
(Re-)computation of instrument control parameters				
IC_4: **LOS pointing correction table generation**	generation of updated elevation start angle correction table (ESACT)	re-compute ESACT parameters taking into account results of LOS mispointing characterisation measurements; generate CTI file (CT-ID 46)	RGT	[RD 6] ... (uses results of CC_01)
IC_5: **Radiometric offset calibration parameters**	generation of instrument parameters controlling periodic offset calibration measurements	re-compute parameters in nom. measurement table (CT-ID= 41, 42): * DS repetition counter * DS elev. angle * no. of sweeps * spectral resolution generate corresponding CTI file ([RD 4])	MICAL / RGT	[AD 2], section 7.2 (uses results from CC_09, CC_10, CC_12, PV_02)
IC_6: **Radiometric gain calibration parameters**	generation of instrument parameters controlling commanded gain calibration measurements	re-compute parameters 1. in DS table (CT-ID= 43): * DS elev. angle * no. of sweeps * spectral resolution 2. in BB table (CT-ID= 44): * no. of sweeps * spectral resolution	MICAL / RGT	[AD 2], section 7.2 (uses results from CC_02, CC_07, CC_09, CC_12, PV_01)
IC_7: **Calibration control parameters: SE / gain measurements**	compute optimum update periods for radiometric offset & gain measurements, for use by RGT in planning of nominal and special events measurement (SEM) timelines: * trigger offset calibrations in SE measurements * commanded gains in NOM and SEM sequences		MICAL	[RD 6] (uses results from CC_09)
others (TBD)				

9.3 Initialisation of Periodic Monitoring Functions

An important commissioning phase task is the initialisation of periodic instrument monitoring functions and the optimisation of the corresponding control parameters. It is assumed that these functions will be fully operational at the end of the commissioning phase, i.e., they will be executed automatically and regular reports will be generated in pre-defined time intervals throughout the entire instrument's lifetime.[1]

Table 3 summarises MIPAS monitoring functions to be analysed during the commissioning phase.

TABLE 3. Periodic Instrument Monitoring Functions

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Periodic instrument related verification / monitoring functions				
PV_1: Radiometric gain analysis	trend analysis of radiometric gain calibration data	analyse variations in radiometric gain data and periodically verify absence of high-resolution features	MICAL	[AD 5] / UR-MI-2.1&2.2
PV_2: Radiometric offset analysis	trend analysis of radiometric offset calibration data	analyse long-term variations in radiometric offset data and periodically verify absence of high-resolution features	MICAL	[AD 5] / UR-MI-2.1 / 2.2
PV_3: Radiometric accuracy assessment	estimate radiometric accuracy across full spectral range	estimate radiometric accuracy budgets using BB and DS measurements acquired in gain calibration sequences	MICAL	see also PA_1_1 [systematic, with each gain calibration]
PV_4: FCE trend analysis	trend analysis of igm sampling fringe count errors in scene and calibration data	extract detected FCE data from L1B products and check for cumulative effects	MICAL	[AD 5] / UR-MI-2.11
PV_5: Monitoring of igm sweeps	monitoring of total number of high / low resolution sweeps and comparison to reference scenario	cumulate total number of interferometer strokes for high and low resolution separately and compare to nominal values vs. mission lifetime	MICAL	[AD 5] / UR-MI-2.14 (wear-out control)
PV_6: Monitoring of ESU leadscrew rotations	monitoring of total number of ESU leadscrew rotations and comparison to reference scenario	cumulate total number of leadscrew rotations and compare to nominal values vs. mission lifetime	MICAL	[AD 5] / UR-MI-2.15 (wear-out control)
others (TBD)				

1. The acquisition of measurement data and allocated data processing / analysis periods for these tasks are defined in **Table 12** and **Figure 2**, respectively.

9.4 Manually Triggered (Re-)Characterisation Tasks

In addition to the monitoring functions listed in **Table 3** that will be executed automatically after initialisation during the commissioning phase a number of characterisation tasks will be repeatedly executed throughout the entire mission lifetime. The purpose of these tasks is to detect potential performance degradations of critical instrument components and, if necessary, to re-characterise essential parameters required for instrument operation and on-ground data processing.

Such tasks are expected to be triggered 'manually' in regular time intervals, according to previously defined update periods, both during commissioning and during the subsequent exploitation phase. In addition, they may be triggered on requests, e.g., upon detection of anomalies in the performance reports generated by the MICAL or in key results reported in the routine data products.

T**able 4** provides a summary of manually triggered re-characterisation tasks.

TABLE 4. Manually Triggered Re-Characterisation Tasks

ID / Task	Approach / processing site	Update cycle	Remarks / references
RV_1: **analog gain re-characterisation**	same as CC_2	2 months	[AD 4] / IF1 & [AD 5] / UR-MI-5.4
RV_2: **aliasing re-characterisation/verification**	same as CC_4	6 months	[AD 4] / IF3
RV_3: **detector non-linearity re-characterisation**	same as CC_5	6 months	[AD 4] / IF4
RV_4: **channel combination re-characterisation**	same as CC_6	6 months	raw mode measaurements ([AD 4] / IF5)
RV_5: **CBB and DS SNR re-characterisation**	same as CC_7	6 months	[AD 4] / IF6
RV_6: **radiometric calibration re-characterisation**	same as CC_9	6 months	[AD 4] / IF8
RV_7: **offset tangent height re-characterisation**	same as CC_10	6 months	[AD 4] / IF9
RV_8: **$NESR_0$ re-characterisation/verification**	same as CC_11	2 months	[AD 4] / IF10
RV_9: **check absence of high resolution features**	same as CC_12	2 months	[AD 4] / IF11
RV_10: **ILS reproduceability**	same as CC_15	6 months	[AD 5] / UR-MI-2.5
others (TBD)			

9.5 Early In-Flight Algorithm Characterisation

In addition to the instrument related tasks a number of analyses are planned to characterise critical on-ground algorithm components and the tuning of key control and configuration parameters. Although a stable instrument performance, in conjunction with an optimised periodic calibration scenario, is essential for a full algorithm validation a number of specific checks can be carried out already at a very early stage.[1]

Table 5 summarises specific checks and characterisation activities related to Level 1B and MICAL algorithm components (note that here and in following sections the short notations ‘PS1’, ‘CO1’, ... are used when referring to products MIP_PS1_AX, MIP_CO1_AX, ...).

TABLE 5. Summary of Level 1B / MICAL related tasks

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Switch-on activities				
SO_A_1: ‘Load data’ verification	verify correct decoding of instrument data (IGM and LOS signals)	extract measurement and auxiliary data from ISP’s and perform L1A processing for various instrument modes / activities (LOS, raw, nominal)	MICAL, IPF	check will be performed in parallel with DAS instrument analysis s/w
SO_A_2: LOS signal acquisition	verify processing of individual reconstructed LOS signals	generate & evaluate cross-correlation data from LOS signals for rearward and sideways viewing geometries	MICAL	check will be performed in parallel with DAS instrument analysis s/w
SO_A_3: initial gain and offset generation	verify correct extraction and processing of radiometric calibration data	extract DS, BB and offset igm data, perform coaddition and generate initial calibration data sets	MICAL	
others (TBD)				
Initial characterisation				
Generation of processing setup parameters				
PS_1_1: offset validation parameters	generation of threshold parameters for offset check template generation	tuning of NESR assessment threshold parameters (PS1, MDS/fields # 16 - 18)	MICAL	[AD 5] -> AX_1_01

1. The acquisition of measurement data and allocated data processing / analysis periods for these tasks are defined in **Table 12** and **Figure 2**, respectively.

TABLE 5. Summary of Level 1B / MICAL related tasks

(continued ...)

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Generation of processing setup parameters				
PS_1_2: radiometric validation parameters	generation of threshold parameters for radiometric accuracy checks (gain)	tuning of radiometric validation threshold parameters (PS1, MDS/fields # 21 - 23)	MICAL	[AD 5] -> AX_1_02
PS_1_3: scene quality check parameters	generation of threshold parameters for scene check template generation	tuning of radiometric validation threshold parameters (PS1, MDS/fields # 26 - 28)	MICAL	[AD 5]
PS_1_4: spike detection threshold parameters	generation of threshold parameters for spike detection	tuning of standard deviation threshold for igm spike detection (PS1, MDS/fields # 31 - 32)	MICAL	[AD 5]
PS_1_5: S/C & ILS retrieval parameters	generation of spectral calibration & ILS fit parameters	tuning of parameters controlling scene data extraction and fitting routine for spectral calibration and ILS retrieval (PS1, MDS/fields # 39.2 - 43 and # 45.2 - 73.2)	MICAL	[AD 5]
others (TBD)				
Generation of other auxiliary data				
AX_1_1: offset validation templates (CO1/MDS#2)	generation of initial NESR assessment template (offset)	compute initial NESR vector for use in offset data validation	MICAL	[AD 5]
AX_1_2: radiometric validation templates (CG1/ MDS#2)	generation of initial radiometric accuracy template (gain)	compute initial radiometric accuracy vector for use in gain data validation	MICAL	[AD 5]
AX_1_3: MW dictionary / L1B (MW1)	generation of input parameters for use in ILS retrievals & spectral calibration	generate / tune input parameters (frequency / height limits, line parameters, accuracy thresholds, MW1, MDS/ fields # 7 - 15)	MICAL / AO sites (tbd)	[AD 5] TBC: AO_145, AO_652, AO_357

TABLE 5. Summary of Level 1B / MICAL related tasks

(continued ...)				
ID / Task	**Purpose**	**Approach**	**Processing site / project**	**Remarks / references**
Generation of other auxiliary data				
AX_1_4: LOS processing parameters (LP1 / MICAL)	generation of input parameters for use in LOS calibration processing	check / update LOS processing parameters (acquisition error & characterisation data, NLS fit parameters, accuracy thresholds, MDS#1/all fields(tbc))	MICAL	[AD 5]
others (TBD)				
Periodic characterisation / verification tasks				
PA_1_1: Radiometric gain calibration	re-generation of radiometric gain calibration data for use by IPF/L1B	process of BB and DS data and generate aux. product MIP_CG1_AX	MICAL	[AD 5] / UR-MI-7.1
PA_1_2: radiometric offset validation	re-generation of offset validation data for use by IPF/ L1B	perform validation and statistical analysis of offset calibration data and generate aux. product MIP_CO1_AX	MICAL	[AD 5] / UR-MI-7.5
PA_1_3: periodic ILS retrieval	retrieval of ILS parameters and off-line generation of linear spectral correction factor	fit ILS modelling parameters from routine L1B scene data and generate aux. product MIP_CS1_AX	MICAL / IPF	[AD 5] / UR-MI-7.4
PA_1_4: non-linear spectral correction characterisation	determination of non-linear residual errors in spectral axis assignment	determine precise spectral shifts for different frequencies and computation of 2nd order polynom correction. Polynom coefficients to be included in L2 aux. file PS2 (GADS#1 / fields # 74-76)	MICAL	[AD 5] / UR-MI-1.2 & 7.3
PA_1_5: LOS mispointing characterisation	(re-)characterisation of systematic instrument's LOS mispointing	determine bias and orbit harmonic components of roll and pitch mispointing; generate LOS related aux. products CL1, LP1, IN1, CTI file (ESACT)	MICAL (/ RGT)	[AD 6] / (LOS characterisation will result in update of CTI and L1B aux. input files)
others (TBD)				

9.6 Update of IPF / L1B and MICAL algorithm components

It is expected that the analyses listed in **Tables 1 - 5** will not only result in adjustments to the instrument control parameters and auxiliary input data but also may necessitate modifications to the on-ground algorithm. Such corrections may, e.g., be due to unexpected outputs of specific software modules when applied to ‘real’ instrument data, that means, in the presence of systematic errors sources not correctly accounted for in previous analyses. Also, the on-ground processors may exhibit malfunctions that were not encountered during earlier simulations.

It is envisaged to identify urgent corrections to the on-ground algorithms as soon as the results of individual test have been evaluated and interpreted. This will ensure that the corresponding software modifications can be implemented at an early stage and subsequent analyses can optimally benefit from these enhancements.

Two updates of IPF/L1B and MICAL s/w components are foreseen, one after completion of the algorithm related characterisation tasks (as listed in **Table 5**) [tbc] and a second update at the end of the commissioning phase.

9.7 Level 2 algorithm related tasks

The routine MIPAS Level 2 processing will be controlled by a number of settings, threshold parameters or other auxiliary data that need to be optimised during the initial MIPAS in-flight operation. Such parameters include, for instance, settings related to input data health check, the pre-processing of initial guess data and quantities controlling the overall convergence behaviour of the algorithm. Other auxiliary data define the selection of observational input data (by means of the so-called microwindows (MW's) and occupation matrices (OM's) or the construction of the retrieval internal model atmosphere.

In principle, all settings or auxiliary data sets have been optimised - or at least set to best guess values - prior to launch through accurate simulations of instrument / signal processing, target atmosphere and measurement geometry, taking into account all known error sources. However, the final performance of the system instrument - on-ground processing chain can be predicted with limited accuracy only. Also, essential atmospheric state parameters and assumed variabilities as well the validity of critical assumptions or approximations as reflected in the retrieval algorithm can only be verified once MIPAS is acquiring 'real' data. Consequently, a number of post-launch analyses have been defined allowing to systematically validate auxiliary data bases and algorithm settings. Whenever possible, the analyses shall provide quantitative results on systematic errors as induced by instrument, on-ground algorithm components or by inaccurate assumptions on the observed target atmosphere.

The Level 2 related tasks can be grouped according to

- verification, optimisation of algorithm setup and configuration parameters
- verification, re-generation/maintenance of auxiliary data bases
- verification of critical algorithm sub-models and underlying assumptions.

9.7.1 Optimisation of processing setup parameters

Table 6 summarises tests aiming at verification and optimisation of Level 2 algorithm setup parameters and of quantities related to instrument modelling. The checks focus on

- framework setting and instrument modelling parameters
- settings for p, T and VMR retrieval modules (forward model and inversion algorithm)
- general settings, common to p, T and VMR retrieval modules.

The updated parameters need to be included in Level 2 auxiliary product MIP_PS2_AX. The optimisation work is performed either within the MICAL or by external expert teams, and may require use of specific supporting tools. Implementation of the PS2 file is subject of the auxiliary data base verification / maintenance work (see **Section 9.7.2**).

TABLE 6. Summary of Level 2 related tasks

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
Generation of processing setup parameters				
1. Framework settings				
PS_2_1: **L1B health check characterisation**	generation of health check threshold parameters	tune L1B input health check threshold parameters in aux. file PS2 (GADS#1): * spike statistics (#6, 7) * max. no. of corrupted sweeps, bands (#10, 11) * NESR threshold vector (#12 - 15)	MICAL	method tbd
PS_2_2: **L2 pre-processing parameters: ILS modelling**	generation of parameters for (A)ILS modelling	tune/update parameters in aux. file PS2 (GADS#1): * NB apodisation function (#36, 37) * frequency dependent ILS parameters (#38-41) * frequency independent ILS parameters (#42-41)	MICAL	modification of ILS parameters upon modification of L1B aux. files CS1, PS1 (uses results from CC_14, PA_1_03, MV_2_12)
PS_2_3: **L2 pre-processing parameters: spectral correction**	generation of parameters for MW specific spectral correction	update coefficients for second order polynomial frequency correction, aux. file PS2/GADS#1 (#74-76)	MICAL	(uses results from PA_1_04, MV_2_15)
2. pT & VMR retrieval settings				
PS_2_4: **FOV modelling parameters in pT and VMR retrievals**	update FOV patterns for forward modelling in pT and VMR retrievals	generate FOV patterns averaged over spectral bands for use in pT and VMR forward modelling. Include parameters in aux. file PS2, GADS#2 and GADS#3, fields #103-105, respectively	MICAL	(uses results from CC_17)
PS_2_5: **definition of pT retrieval parameters**	re-generation / optimisation of pT retrieval parameters in aux. file PS2 / GADS#2: 1. convergence check parameters (#11, 12, 12.5, 13, 14) 2. iteration feedback & profile update control parameters (#34, 35, 69-72, 95-100) 3. initial guess pre-processing parameters (82-90) 4. parameters controlling choice of unknowns (#26-27.5) 5. pT specific forward model parameters (#36-41, 46-67, 76-81, 93, 94, 101-105) (the final convergence thresholds (item 1) shall reflect an acceptable compromise between computing time, accuracy and reproduceability of the χ^2 minimum)		ESLs: U. Bologna, ISM, IROE MICAL	[RD 8]

TABLE 6. Summary of Level 2 related tasks

(continued ...)				
ID / Task	**Purpose**	**Approach**	**Processing site / project**	**Remarks / references**
Generation of processing setup parameters				
2. pT & VMR retrieval settings				
PS_2_6: definition of VMR retrieval parameters	re-generation / optimisation of VMR retrieval parameters in aux. file PS2 / GADS#3: 1. convergence check parameters (#11, 12, 13, 14) 2. iteration feedback & profile update control parameters (#30, 31, 69, 71, 72, 95-99) 3. initial guess pre-processing parameters (82-90) 4. parameters controlling choice of unknowns (#23, 24, 26-27.5) 5. VMR target gas specific forward model parameters (#32-37, 42--66, 78-81, 93, 94, 101-104) (the final convergence thresholds (item 1) shall reflect an acceptable compromise between computing time, accuracy and reproduceability of the χ^2 minimum)		ESLs: U. Bologna, ISM, IROE MICAL	[RD 8]
3. general settings				
PS_2_7: general parameters tuning	re-generation / optimisation of general processing setup parameters (PS2): 1. GADS#1 (Framework settings): 1.1 lower eigenvalue threshold in SVD matrix inversions (#87) 1.2 genereal forward model parameters (#92-94) 2. GADS#2 (pT): 2.1 general thresholds related to iteration (#15-20, 38-45, 73, 74) 3. GADS#3 (VMR): 3.1 general thresholds related to iteration (#15-20, 38-45, 73, 74)		ESLs: U. Bologna, ISM MICAL	method tbd
PS_2_8: ascii format input file for PS2 building	generation of ascii format input file for generation of PDS compatible aux. product MIP_PS2_AX		ESL: IROE MICAL	[AD 9] format
PS_2_9: ascii format input file for PS2 building	alternative generation of of ascii format input file for generation of PDS compatible aux. product MIP_PS2_AX through use of editing function provided by L2 prototype code (ML2PP)		MICAL (tbc)	[AD 9] format
others (TBD)				

9.7.2 Auxiliary data base generation, maintenance and verification

The Level 2 processing component requires, in addition to the setup and control parameters discussed in the previous section, a number of auxiliary data bases. The updating and maintenance of these data bases is typically performed by expert teams external to the MICAL, and requires the use of dedicated processing and analysis tools. A specific file interface has been implemented allowing to import such externally produced data sets into the MICAL that will perform final verification checks and conversion to the PDS compatible product format. The formats for delivered auxiliary input data are defined in [AD 9]. All MIPAS Level 2 auxiliary files, with the exception of the forward model file, MIP_FM2_AX, are generated through conversion from ascii to PDS product format.

The tasks related to L2 auxiliary data generation and maintenance are summarised in **Table 7**.

TABLE 7. Level 2 auxiliary data generation and maintenance tasks

ID / Task	Subject	Processing site / project	Remarks / references
Generation of Level 2 auxiliary data			
AX_2_1: A priori pointing information VCM data (PI2)	re-generation / optimisation of a priori LOS pointing VCM data, using best guess information on the instrument's LOS pointing errors (stability wrt periods in between sweeps within a scan and bias / orbit harmonic errors)	ESL: U. Bologna	(uses results from PA_1_5, CC_30)
AX_2_2: atmospheric modelling / initial guess profile data (IG2)	re-generation of climatology profile data base, including p, T profiles and VMR data for all significant absorbers (target and non-target species). Use best guess information on geophysical parameters and variabilities. Tabulation wrt latitude and season	ESL: U. Leicester	[AD 9] format
AX_2_3: broadband spectroscopic line data base (HITRAN)	re-generation of MIPAS specific spectroscopic line data base ("HITRAN_MIPAS"). Use best guess information on spectroscopic line parameters.	ESLs: LPM, IROE	HITRAN96 compatible format
AX_2_4: Microwindow data (MW2)	re-generation of microwindow data base using • optimised settings for MW/OM processing tool • updated instrument parameters (NESR levels, (A)ILS data) • updated climatology data base • information on latitudinal / seasonal variabilities • updated assumptions on measurement scenarios Tabulation wrt latitude and season	ESL: U. Oxford MICAL	[AD 9] format uses results of AX_2_2
AX_2_5: Occupation matrix data (OM2)	re-generation of MW occupation data base using inputs as for AX_2_4 Tabulation wrt latitude and season	ESL: U. Oxford	[AD 9] format uses results of AX_2_2, AX_2_4

TABLE 7. Level 2 auxiliary data generation and maintenance tasks

(continued ...)

ID / Task	Subject	Processing site / project	Remarks / references
Generation of Level 2 auxiliary data			
AX_2_6: ~~spectral correlation of fitted continuum data (MW2)~~	~~re-generation of MW specific 'umbrella radii' for inclusion in MW data base. Use best guess information geophysical parameters and enhanced models.~~	~~ESL~~	- task deleted -
AX_2_7: **p, T error propagation matrix data (OM2)**	re-generation of OM specific pT error propagation matrix data	ESL: ISM	[AD 9] format uses results of AX_2_2, AX_2_4, AX_2_5
AX_2_8: **cross section LUT (CS2), irregular spectral grids (GRD) and absorber lists**	(1) re-generation of MW specific cross section look-up tables using • inputs as for AX_2_4 • updated spectroscopic line catalogue (new version of data base HITRAN_MIPAS) • optimised settings of LUT processing tool (2) re-generation of irregular grids (for inclusion in MW data base) (3) re-generation of MW specific absorber lists (for inclusion in MW data base)	ESL: U. Oxford	[AD 9] format uses results of AX_2_2 - AX_2_4
AX_2_9: **spectroscopic line data (SP2)**	re-generation of MW specific spectroscopic line data files using • inputs as for AX_2_4 • updated spectroscopic line catalogue (new version of data base HITRAN_MIPAS) • optimised settings of line selection tool • MW specific absorber lists generated in task AX_2_8	ESL: FZ-IMK	[AD 9] format uses results of AX_2_2 - AX_2_4, AX_2_8
AX_2_10: **ascii to PDS format conversion (PS2, PI2, IG2, MW2, OM2, CS2, SP2)**	generation of Level 2 auxiliary input products MIP_ {PI2/IG2/MW2/OM2/CS2/SP2/PS2}_AX using ascii input data conversion tool (part of MICAL / ADF builder function). Input: ascii input data produced in tasks PS_2_8 and AX_2_1, _2, _4 ... _7, _9	MICAL	uses results of PS_2_8, AX_2_1, _2, _4 ... _7, _9
AX_2_11: **pre-tabulated forward model results file (FM2)**	generation of forward model results file, MIP_FM2_AX using Level 2 prototype code (ML2PP), updated set of L2 auxiliary input data and work order parameters	MICAL	uses results of AX_2_10

TABLE 7. Level 2 auxiliary data generation and maintenance tasks

(continued ...)			
ID / Task	**Subject**	**Processing site / project**	**Remarks / ref-erences**
Overall performance re-verification			
AX_2_12: aux data con-sistency and L2 performance verification	perform L1B to L2 processing ‘dry runs’ with L2 protptype code (ML2PP) using selected simulated or ‘real’ Level 1B data and aux. input data produced under AX_2_10, _11. Verify correct processing performance for variable settings in PS2 & work order parameter files, through inspection of TEP output data and log information. Generate report on detected anomalies and overall process-ing performance Details to be worked out	MICAL ESL: IROE (tbc)	
AX_2_13: aux data con-sistency and IPF perfor-mance verifica-tion	verify performance of MIPAS IPF code / L2 component using selected simulated or ‘real’ Level 1B data and aux. input data produced under AX_2_10, _11. Generate report on detected anomalies and overall process-ing performance Details to be worked out	TBD	
others (TBD)			

9.7.3 Verification of critical Level 2 sub-models and assumptions

In addition to the verification and optimisation of auxiliary L2 input data a number of checks on specific algo-rithm components neded to be performed. These tests shall allow to identify malfunctions or inconsistencies in the L1B to L2 processing chain and to assess systematic errors induced by inaccurate sub-models.

In general, these tasks require specific processing strategies and dedicated analysis tools. Both, the analysis methods and required tools are defined in document [RD 8].

Table 8 summarises tasks on the verification of critical Level 2 sub-models and assumptions.

TABLE 8. Verification of critical L2 sub-models and assumptions

ID / Task	Subject	Processing site / project	Remarks / references
Atmospheric modelling assumptions			
MV_2_1: analysis of non-LTE effects	quantification of non-LTE effects in operational retrieval MWs through analysis of residual spectra for • variable target atmospheres (e.g., day / night scenes) • different meaasurement geometries, incl. the upper atmospheric observation mode (UAOM) • others (tbd)	ESLs: IROE	[RD 8], [RD 10], AO_304, AO_323, AO_145 pre-requisites: completion of tasks IC_1 - IC_7
MV_2_2: impact of horizontal inhomogeneities	assessment of systematic retrieval errors induced by horizontal inhomogeneities along the instrument's line of sight through analysis of • retrieval results from adjacent scans • fit results for target atmospheres with known gradients (from external information sources) • retrieval results obtained with enhanced algorithms • correlation between occurence of excessive χ^2 values and presence of gradients.	AO site ESLs: U. Bologna, IROE, U. Oxford, DLR-IMF	[RD 8], AO_323
MV_2_3: hydrostatic equilibrium assumption	*specific p, T retrievals:* check results obtained without use of hydrostatic equilibrium constraint *nominal p, T retrievals:* check consistency between retrieved height correction data and engineering pointing information	ESLs: U. Bologna, DLR-IMF	[RD 8] (approach to be revised)
MV_2_4: modelling of interfering species	perform profile retrievals with varying abundancy profiles for interfering gases; use best knowledge of mean profiles and variabilities. In case of 'retrievable' interfering gases repeat propcessing using 'enhanced', retrieved VMR profiles	AO site ESLs: ISM, Oxford, DLR-IMF	[RD 8], AO_357
MV_2_5: ~~Earth model gravity~~	~~analysis method tbd~~	~~ESL site (tbc)~~	- tasks deleted - (theoretical analysis only, not subject of Cal-Val activities)
MV_2_6: ~~refractive index model~~	~~analysis method tbd~~		
MV_2_7: ~~spherical symmetry assumption~~	~~perform retrievals assuming different local radii of curvature, corresponding to maximum expected curvature variations along the line of sight~~ ~~approach to be checked / detailed~~		

TABLE 8. Verification of critical L2 sub-models and assumptions

(continued ...)			
ID / Task	**Subject**	**Processing site / project**	**Remarks / references**
Spectroscopic modelling assumptions			
MV_2_8: spectroscopic line parameter errors	check for the presence of line parameter errors through • inspection of retrieval residuals (nominal MW selections) • comparisons of retrieval results otained for different MW selections • others (tbd)	AO sites ESLs: IROE, Oxford	[RD 8], AO_145, AO_323
MV_2_9: lineshape modelling errors	check for lineshape modelling errors through • inspection of retrieval residuals (height dependency of linewidth errors) • others (tbd)	AO site ESLs: tbd	[RD 8], AO_145
MV_2_10: line mixing errors	check for systematic errors due to neglection / erroneous modelling of line-mixing effects through • inspection of retrieval residuals in MWs differently affected by line-mixing effects • others (tbd)	AO site ESLs: IROE, Oxford	AO_323
instrument related modelling errors			
MV_2_11: erroneous FOV modelling	check for systematic errors due to inappropriate modelling of the instrument's FOV through • comparison of retrieval results using different vertical layerings for the FOV convolution in height ranges of strong vertical gradients • others (tbd)	ESL: IROE, DLR-IMF	[RD 8]
MV_2_12: (A)ILS errors	check lineshape modelling errors through inspection of retrieval residuals and repeated retrievals using modified ILS parameters	AO site ESLs: IROE, Oxford	[RD 8], AO_145
MV_2_13: AILS perturbation errors	check worst case perturbations of AILS due to scene inhomogeneities [and other effects (tbd)] through • inspection of retrieval residuals in areas of strong vertical / horizontal inhomogeneities • ILS retrievals using target scenes affetced by scene inhomogeneities (tbd)	AO site	AO_145
MV_2_14: finite AILS width	- removed -		
MV_2_15: residual spectral calibration errors	analyse systematic retrieval errors due to inaccurate spectral axis calibration through • inspection of retrieval residuals • repeated retrievals using modified/enhanced spectral correction parameters • others (tbd)	AO sites ESLs: IROE, Oxford	[RD 8], AO_145, AO_323

TABLE 8. Verification of critical L2 sub-models and assumptions

(continued ...)			
ID / Task	**Subject**	**Processing site / project**	**Remarks / references**
instrument related modelling errors			
MV_2_16: erronous radiometric gain calibration	analyse systematic retrieval errors due to inaccurate radiometric gain calibration through comparison of retrieval results obtained with different MW selections, to cover target lines • located in different spectral bands (differently affected by gain calibration errors) • with variable optical thicknesses • others (tbd)	AO site ESLs: IROE, Oxford	[RD 8], AO_145 (only qualitative results expected as isolation of rad. gain errors difficult)
MV_2_17: erroneous radiometric offset calibration	check systematic retrieval errors due to residual radiometric offset errors [due to straylight effects, others (tbc)] by analysing • systematic height dependency of residual offsets (height dependent offset fit and/or residual inspection) • potential dependency of residual offsets on solar aspect angle • others (tbd)	AO site ESL: U. Bologna	[RD 8], AO_145
L2 algorithm induced errors			
MV_2_18: ~~pT error propagation in VMR retrievals~~	~~check for impact of excessive retrieval p, T retrieval errors on VMR retrieval results through~~ • ~~analysis of χ^2 values in VMR retrievals~~ • ~~others (tbd)~~	~~ESL site~~	- task deleted -
MV_2_19: inappropriate convergence criteria & thresholds	- removed -		
MV_2_20: ~~neglection of spectral noise correlation~~	~~verify absence of retrieval errors due to neglection of spectral correlation of noise in measurements through~~ • ~~analysis of minimum achievable χ^2 values in absence of other systematic error sources (tbc)~~ • ~~compare retrievals with results obtained with enhanced obs. data VCMs (use results of L1B noise correlation analysis, task CC_25)~~ • ~~others (tbd)~~	~~ESL site~~	- task deleted -
MV_2_21: inappropriate profile regularisation	assess retrieval errors due to inappropriate choice of regularisation parameters through • comparisons of retrieval results obtained without regularisation and for different settings of regularisation parameters • others (tbd)	ESL: DLR-IMF	

TABLE 8. Verification of critical L2 sub-models and assumptions

ID / Task	Subject	Processing site / project	Remarks / references
(continued ...)			
auxiliary data induced errors			
MV_2_22: inappropriate atmospheric layering	assess retrieval errors due to finite thickness of atmospheric layers used in the internal radiative transfer integration through • comparisons of retrieval results obtained with different layering parameters • analysis of partial χ^2 values in MWs affected by strong gradients (tbc) • others (tbd)	ESL: DLR-IMF	
MV_2_23: ~~approximations related to Curtis-Godson integration~~	~~assess retrieval errors due to approximation errors related to computation of Curtis Godson integrals ('secant law' approximation & 'linear in tau' method) through~~ • ~~comparisons of retrieval results obtained with different layering parameters~~ • ~~analysis of partial χ^2 values in MWs with nearly saturated target lines~~ • ~~others (tbd)~~	~~ESL site~~	- task deleted -
MV_2_24: ~~approximations related to irregular fine grids and cross section LUTs~~	~~assess retrieval errors resulting from inaccurate computation of radiances and Jacobians due to use of irregular fine grids and pre-tabulated, compressed cross section LUTs through~~ • ~~comparisons of retrieval results obtained with nominal grid/ LUT data and with line-by-line computations using full, regular fine grids~~ • ~~analysis of spectral residuals in MWs processed with/without approximation errors due to irreg. grids and LUTs~~ • ~~others (tbd)~~	~~ESL site~~	- task deleted -
others (TBD)			

9.7.4 Algorithm verification by means of correlative data analysis

In addition to analyses that base on the use of dedicated models and on consistency checks of MIPAS data alone, it is envisaged to perform specific tests making use of non-ENVISAT, co-located measurements. Such data will be acquired during the early in-flight operation MIPAS, i.e., in a period of 5 - 9 months after launch (tbc).

These tests focus on comparisons of MIPAS data with independent measurements acquired with temporal, spatial and spectral overlap with the ENVISAT sensor. The results shall help to identify systematic error sources in the Level 2 processing stage such as

- incorrect assumptions on radiometric calibration errors
- incorrect assumptions of short term LOS pointing errors
- wrong modelling of contaminants in retrieval microwindows.

The following experiments will be employed in this exercise:

- MIPAS-B2 (balloon-borne sensor, operated by FZ-IMK)

- others (tbd).

Table 9 summarises tasks related to correlative data analyses.

TABLE 9. Tasks based on correlative data analyses

ID / Task	Subject	Processing site / project	Remarks / references
CA_1: generation of processing input data	delivery of (1) fully calibrated, geo-located radiance data from the co-located measurements (2) L2 relevant instrument characterisation parameters and of other input data required for the Level 2 analysis of the co-located measurements	AO sites (tbd) ESL: FZ-IMK	[RD 14] Task 8 WP description
CA_2: Level 2 analysis of correlated measurements	perform p, T and VMR profile retrievals for the L1B type correlative data for all MIPAS target species using an algorithm compatible to the Level 2 baseline algorithm and using auxiliary input data consistent with those of MIPAS	AO sites (tbd) ESL: ISM	[RD 14] Task 8 WP description
CA_3: interpretation of L2 analysis results	intercompare L2 results fitted obtained from MIPAS and the correlative measurements and identify systematic discrepancies between both results. In ranges of spectral overlap between the two sensors, analyse also spectral residuals, fitted continuum parameters, others (tbc)	AO sites (tbd) ESLs: IMK, IROE	[RD 14] Task 8 WP description
others (TBD)			

9.7.5 Characterisation of overall Level 2 processing performance and total error budgets

Purpose of this task is to compile total error budgets for Level 1B and Level 2 processing outputs taking into account the results of activities

- **CC_1 - CC_31** instrument characterisation tasks
- **PV_1 - PV_3** periodic monitoring functions
- **RV_1 - RV_10** manually triggered re-characterisation tasks
- **AX_2_1 - AX_2_9** L2 aux. data update (re-assessment of error budgets)
- **AX_2_12 - AX_2_13** performance re-verification
- **MV_2_1 - MV_2_24** verification / validation of critical L2 algorithm sub-models
- **CA_1 - CA_3** correlative data analyses
- others (tbd).

For each reported error budget, also the conditions / ranges of validity (e.g., wrt calibration, measurement scenarios, atmospheirc conditions) shall be reported. The tasks shall cover all primary results reported in the MIPAS Level 1B and Level 2 data products, as well as auxiliary input data as contained in L1B/2 aux. products. A complete list of affected parameters is provided in **Table 10**.

TABLE 10. Total error budget assessment (L1B/2 and aux. data)

ID / Task	Subject	Processing site / project	Remarks / references
TE_1: error budgets in L1B auxiliary data	assess total budgets of processed parameters as reported in MIPAS L1B auxiliary products *Gain Cal. file (MIP_CG1_AX)* • MDS#1: fields #13-18, 23-66 • MDS#2: fields#9-10 (repeat for all bands, A - D) *LOS Cal. file (MIP_CL1_AX)* • MDS: fields #15-17 *ILS/Spectral Cal. file (MIP_CS1_AX)* • MDS: fields #3.9-3.10, 4.3, 4.4 (repeat for all ILS&s/c peaks) *Offset Val. file (MIP_CO1_AX)* • MDS#1: field #8 (repeat for all bands, A - D) • MDS#2: fields #9, 10 (repeat for all bands, A - D) *Instrument Char. file (MIP_CA1_AX)* • MDS: fields #13, 13.1, 13.2 • MDS: other fields (tbd) *Processing Parameters file (MIP_PS1_AX)* • MDS: fields #51-73.2 • MDS: other fields (tbd)	MICAL, AO sites ESLs: tbd	validity range of reported total error budgets (e.g., wrt calibration scenario, instrument performance) to be defined AO_145, AO_652, others (tbd)
TE_2: Level 1B total error budgets	assess total budgets of processed parameters as reported in routine MIPAS Level 1B data products, including *Level 1B* • MPH / SPH: fields tbd • SQADS: fields tbd • geoADS: fields #3-7 • ScaninfoADS: fields tbd • MDS: fields #6, 7, 16, 17-21, 26-30 • OffsetCalADS: fields#8, 10, 11-13, 16-55 • other L1B DS fields (tbd)	MICAL, AO sites ESLs: tbd	validity range of reported total error budgets (e.g., wrt atmospheric conditions, measurement scenario, instrument performance) to be defined AO_145, AO_652, AO_357, others (tbd)

TABLE 10. Total error budget assessment (L1B/2 and aux. data)

(continued ...)

ID / Task	Subject	Processing site / project	Remarks / references
TE_3: **error budgets in L2 auxiliary data**	assess total budgets of processed parameters as reported in MIPAS L2 auxiliary products *Microwindow Data file (MIP_MW2_AX)* • no fields (tbc) *Occupation Matrix file (MIP_OM2_AX)* • MDS#2: fields #10, 11, 13-15 (repeat for all species, #2-6) • other fields (tbd) *Cross Section LUT file (MIP_CS2_AX)* • MDS#1--7: fields #10, 11 (in each MDS, repeat for all absorbers & MWs) • other fields (tbd) *Spectroscopic Line Data file (MIP_SP2_AX)* • MDS#1: fields #1-5 (for all included DSR, covering all absorbers & MWs) • other fields (tbd) *Initial Guess Profile Data file (MIP_IG2_AX)* • MDS#3: field #2 (repeat for all target&non-target species modelled as contaminants) • other fields (tbd) *Forward Model Results file (MIP_FM2_AX)* • no fields (tbc) *A Priori Pointing Data file (MIP_PI2_AX)* • MDS#1: field #5 (for all included DSR, covering all MPD ranges) • other fields (tbd) *Processing Parameters file (MIP_PS2_AX)* • GADS#1: fields #40, 42, 49-68 (tbc), 71-76, • GADS#2 (pT): fields #66,67, 102-105 • GADS#3-8 (6*VMR): fields #65, 66, 101-104 • all GADS: other fields (tbd)	MICAL, AO sites ESLs: tbd	validity range of reported total error budgets (e.g., wrt measurement scenario, atmospheric conditions, instrument performance) to be defined AO_145, AO_652, AO_323, others (tbd)

TABLE 10. Total error budget assessment (L1B/2 and aux. data)

(continued ...)

ID / Task	Subject	Processing site / project	Remarks / references
TE_4: **Level 2 total error budgets assessment**	assess total budgets of processed parameters as reported in routine MIPAS Level 2 data products, including *Level 2* • MPH / SPH: fields tbd • geoADS: fields #3-7 (same as in TE_2 results) • ScanInfoADS: fields #4-6, others (tbd) • MDS#1 (pT): fields #5, 10-13, 15-17 • MDS#2-7 (6*VMR) : fields #5, 7-12, 14 • MDS#8 (offsets/continua): fields # 14-19, 24-26 (repeat for all target species & all MWs per species) • ADS#5 (PCDs): fields #14-17, 19-22 (repeat for all target species) • ADS#7 (residuals): fields #10, 11, 14, 15 (repeat for all target species) • ADS#8 (proc. parameters): fields #13, 14, 16, 18 (repeat for all records included in L2 file) • other fields (tbd)	MICAL, AO sites ESLs: tbd	validity range of reported total error budgets (e.g., wrt measurement scenario, atmospheric conditions, instrument performance) to be defined AO_323, AO_304, AO_145, others (tbd)
others (TBD)			

9.7.6 Long-term Level 2 verification / validation tasks

The analyses discussed in the previous sections focus at the early in-flight verification of critical Level 2 algorithm components and corresponding auxiliary data, and will be carried out during the initial 9 months of the instrument's in-flight operation.

That work has to be complemented by long-term verification and validation activities in order to

- account for long term drifts in the instrument's overall performance (e.g., radiometric accuracy/noise budget, residual errors in line-of-sight mispointing characterisation)
- characterise seasonal and latidudinal variations in geophysical target parameters (to improve choice of initial guess data or to enhance modelling of primary contaminants)
- characterise impacts due to variations in specifc non- or poorly modelled effects (e.g., non-LTE emissions, minor contaminants' abundancies and variabilities)

A summary of envisaged long-term verification / validation tasks is given in **Table 11**.

TABLE 11. MIPAS long-term verification / validation tasks

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
LV_2_1: characterisation of variabilities in retrieved profiles	generate mean profiles and variability data for optimisation of L2 auxiliary data (initial guess data base, and for optimisation of generation and and of seasonal / latitudinal sampling intervals	cumulate statistics of retrieved atmospheric profiles (p, T, VMR, continuum data) and compute latitudinal and seasonal means and variabilities for use in aux. file IG2, and Optimise sampling intervals for tabulation of IG2 data	AO sites (tbd) ESLs: DLR-IMF, others (tbd)	details to be worked out affected aux. files: IG2, MW2, OM2, CS2, SP2
LV_2_2: statistical analysis of short term LOS mispointing	assessment of LOS mispointing VCM data through statistical analysis of pT retrieval results	characterise systematic (relative) LOS mispointing and rms fluctuations through statistical analysis of retrieved L2/pT height correction profiles (pT retrieval to be done without use of a priori pointing information, tbc)	MICAL (tbd) ESLs: DLR-IMF, others (tbd)	details to be worked out affected aux. file: PI2
LV_2_3: consolidation of spectroscopic data base	(re-)assessment of spectroscopic data base parameters from cumulated L2 residual analyses	cumulate statistics of L2 spectral residuals in order to identify erronous / incomplete spectroscopic line data	ESL site, AO sites (tbd)	details to be worked out affected aux. file: CS2, SP2 (IG2)

TABLE 11. MIPAS long-term verification / validation tasks

(continued ...)

ID / Task	Purpose	Approach	Processing site / project	Remarks / references
LV_2_4: seasonal / latitudinal variations in non-LTE emissions	characterisation of seasonal and latitudinal dependencies in non-LTE effects	cumulate statistics of L2 spectral residuals in order to identify erronous / incomplete spectroscopic line data	ESL site, AO sites, MICAL (tbd)	details to be worked out affected aux. file: CS2, SP2 (, IG2)
LV_2_5: L2 total error budget analysis	compilation of total error budgets in routine MIPAS L2 products, taking into account all known error sources, e.g. • instrument NESR • inaccuracies in spectroscopic line data • mean profiles and variabilities of contaminants • instrument related inaccuracies (e.g., radiometric & spectral calibration errors, mispointing) • algorithm induced errors • others (tbd)	re-assess systematic and random error components in retrieved geophysical MIPAS Level 2 , making best possible use of long term statistics of processed MIPAS products and of correlative data analyses (using non-Envisat information sources)	ESL site, AO sites, MICAL (tbd)	details to be worked out affected aux. file: MW2, OM2, CS2, SP2 (, IG2)
others (TBD)				

10.0 Data Acquisition Requirements

Purpose of this section is to identify requirements with respect to mission planning, preparation of specific instrument control parameters/tables and on data acquisition, covering the tasks defined in the previous chapter. Because in general, acquired measurement data are used in different tasks, the requirements are reported in terms of measurement sequences. The results are compiled in **Table 12**.

For each of the envisaged measurements mission planning related information is summarised in **Appendix 2**.

TABLE 12. Summary of CalVal related measurements

Measurement ID	Scenario	Total duration	Input data set / product type	estimated size [bytes]	Task [projects]	Remarks / references
SODAP measurements ([AD 3])						
M_SO_1	several elev. scan sequences (initial default scenario)	~ 110 min	NL__0P	30 M	SO_1, SO_2, SO_A_1	SODAP phase 7.1, 7.2
M_SO_2	several elev. scan sequences (nominal&non-nominal scenarios)	< 20 min	NL__0P	60 M	SO_2, SO_4, SO_A_1	SODAP phase 7.3, 7.4, 8.3
M_SO_3	BB, DS sequences	~ 30 min	NL__0P	150 M	SO_2, SO_3, SO_A_1, SO_A_3	SODAP phase 8.1
M_SO_4	initial DS + BB measurements, followed by several NOM and SEM sequences	~ 1 orbit	NL__0P	300 M	CC_16	SODAP phase 10.1, 10.2
M_SO_5	short NOM sequences in raw data mode	~ 1 min	RW__0P	50 M	SO_A_1	SODAP phase 10.3
M_SO_6	LOS: star acquisitions (including MPS)	~ 1 orbit	LS__0P LOS aux. files: CL1, LP1, IN1, CA1, PS1	200 k	SO_2, SO_A_1, SO_A_2	SODAP phase 10.4
total estimated volume: 600 Mbytes						
CalVal Phase background mission						
M_BG_0	global measurement scenario; standard limb sequences; periodic DS and gain calibrations	variable	NL__1P, NL__2P L1B, L2 aux. data	throughput: ~ 320 M / orbit	routine processing & archiving in ENVISAT - PDS	return to background mission after completion of individual calibration measurements

TABLE 12. Summary of CalVal related measurements

(continued ...)

Measurement ID	Scenario	Total duration	Input data set / product type	estimated size [bytes]	Task / project	Remarks / references
Instrument & L1B/L2 algorithm related measurements						
M_IF_0 ... M_IF_11	calibration / characterisation measurements	total duration ~ 2400 min	NL__0P L1B aux. data	~ 10 G (see [AD 4], annex A)	CC_1, ..., CC_12, CC_23 - CC_28, CC_29, CC_31	different scenarios & measurement modes. See table A.3 / Appendix 3 and [AD 4] Note: Modified scenario for IF#10
M_IF_12	standard limb scanning geometry, initial and final gain cal. sequence	~ 14 orbits (gain: 2*20 min)	NL__0P, NL__1P L1B aux. data	8.4 G	CC_13 - CC_15, CC_19 - CC_22	'quasi-routine' scenario with gain sequences
M_IF_13	- deleted -					
M_IF_14	specific scanning sequence (tbc)	~ 2 orbits	NL__0C L1B aux. data	tbd (< 100 M)	CC_18	approach & scenario to be worked out
M_IF_15	specific limb scanning sequences with high and low spectral resolution scene measurements, include initial gain and periodic DS calibration measurements	~ 2 orbits (gain: 20 min)	NL__0P, NL__1P L1B aux. data	1.2 G	CC_22, CC_24, CC_26, CC_30	contiguous scan sequences with constant LOS tangent altitudes (10, 20, 30 km, tbc) for fractions of an orbit
M_IF_16	standard limb sequences in raw data mode, include initial, short gain and DS sequences	~ 10 min	RW_0P	530 M	CC_23, CC_24	high spectral resolution for scene and DS measurements
M_MV_1 - M_MV_17	manually triggered re-characterisation/verification measurements (as M_IF_0 - M_IF_16)	tbd	NL__0P L1B aux. data	tbd	RV_1 - RV_10	detailed scenarios, duration parameters may deviate from initial measurements M_IF_0 - M_IF_16

TABLE 12. Summary of CalVal related measurements

(continued ...)

Measurement ID	Scenario	Total duration	Input data set / product type	estimated size [bytes]	Task / project	Remarks / references
Instrument & L1B/L2 algorithm related measurements						
M_PV_1	periodic radiometric gain calibration, followed by several orbits with nominal scene and DS calibration measurements	~ 3 orbits	NL__0P L1B aux. data	1 G	PA_1_1 - PA_1_4 PV_1 - PV_4	update cycle: ca. 7 days (tbc)
M_PV_2	periodic LOS mispointing characterisation, with star acquisitions in rearward and sideways geometries	~ 3 orbits	LS__0P, LOS aux. data	20 M	PA_1_5	update cycle: ca. 7 days (tbc)
M_RP_1	routine scenario with standard limb scans and periodic DS and initial gain calibration measurements	~ 43 orbits (~3 days)	NL__0P, NL__1P NL__2P L1B aux. data L2 aux. data	26.5 G	PA_1_1 - PA_1_4 PV_4 - PV_6 PS_2_1 - PS_2_7 MV_2_1 - MV_2_4; MV_2_8 - MV_2_17; MV_2_21 - MV_2_22 AX_2_12, AX_2_13	
total estimated volume (instrument & L1B/L2 related measurements): ~ 80 Gbytes						
Geophysical validation measurements						
M_RP_2	routine scenario with extended tangent height range (‘upper atmospheric scan’), and periodic DS and initial gain calibration measurements	~ 43 orbits (~3 days)	NL__1P, NL__2P L1B aux. data L2 aux. data	26.5 G	MV_2_1 MV_2_3 - MV_2_4 AX_2_12, AX_2_13	Upper Atmospheric Observation Mode (UAOM), [RD 10]

TABLE 12. Summary of CalVal related measurements

Measurement ID	Scenario	Total duration	Input data set / product type	estimated size [bytes]	Task / project	Remarks / references
(continued ...)						
Geophysical validation measurements						
M_RP_3	routine scenario with standard limb scans and periodic DS and initial gain calibration measurements	~ 14 orbits (~1 day)	NL__1C, NL__2C L1B aux. data L2 aux. data	25 G	CA_1, CA_2, CA_3 PA_1_1 - PA_1_5	selected scans, co-located measurements with MIPAS-B2 balloon sensor.
M_GEO_1	routine scenario with standard limb scans and periodic DS and initial gain calibration measurements	several campaigns, each ~ 43 orbits (~3 days)	NL__1P, NL__2P L1B aux. data L2 aux. data	26.5 G (per campaign)	ACVT Geophysical Validation Project [RD 1] PA_1_1 - PA_1_5	selected scans, co-located measurements with non-ENVISAT experiments (groundbased, balloon-/airborne sensors, ...)
M_GEO_2	routine scenario with standard limb scans and periodic DS and gain calibration measurements	full repeat cycle, 501 orbits (35 days)	NL__1P, NL__2P L1B aux. data L2 aux. data	160 G	ACVT Geophysical Validation Project [RD 1] PA_1_1 - PA_1_5	global data set, co-located measurements with non-ENVISAT experiments (groundbased, balloon-/airborne sensors, ...)
others (TBD)						
total estimated volume (geophysical validation meaasurements): ~ 290 Gbytes [three campaigns assumed for M_GEO_1]						

11.0 ACVT: Geophysical Validation

11.1 Correlative Measurement Campaigns

An essential contribution to the MIPAS validation project will be provided through intercomparison of retrieved geophysical parameters with correlative data provided by non-ENVISAT instruments. In general, correlative measurements will be carried out such that the validation of all three atmospheric sensors on-board ENVISAT (MIPAS, GOMOS and SCIAMACHY) is supported. This is ensured through the organisation of dedicated campaigns during which sufficient spatial and temporal overlap of measurements acquired by the sensors on-board ENVISAT and the non-ENVISAT measurements is established.

Such co-ordinated measurement campaigns will involve

- large stratospheric balloon experiments (MIPAS-B2, TRIPLE, LPMA, ...)
- aircraft sensors (MIPAS-STR, SAFIRE-A on board M-55/Geofysika, ASUR on FALCON, ...)
- small balloon sondes (O_3, ..)
- ground-based measaurements (LIDAR (O_3, H_2O, ...), MWR, FTS, ...)
- others (tbd).

The organisation of correlative measurement campaigns as well as the analysis of acquired data will be carried out in a co-ordinated effort, involving experts of all participating ENVISAT and non-ENVISAT instruments. An overview of the involved experiments and of the overall organisation of measurement campaigns is provided in [RD 1].

11.2 Data Assimilation and Satellite Intercomparison

An additional source of correlative information for use in the geophysical validation will be supplied through data assimilation projects. These projects make use of specific models on atmospheric transport (and partly also on atmospheric chemistry) that allow to transform a reference result (from non-ENVISAT measurements) in space and time to the location and instant of a MIPAS measurement, such that direct comparisons between MIPAS data and the reference results become possible. Data assimilation in principle allows to relax the constraints imposed by co-located measurements.

A group of validation projects focuses on the analysis of satellite data, in order to perform intercomparisons of atmospheric parameters (trace gas abundancy profiles, column densities) supplied by such missions with MIPAS results on both localised and global scales. Among the candidate missions for satellite intercomparison projects are GOME / ERS2, SMR(&OSIRIS) / ODIN, MOPITT / EOS, ILAS-2 / ADEOS-II and SABER / TIMED.

See [RD 1] for further details on data assimilation and satellite intercomparison projects.

12.0 Data Availability and Circulation Requirements

During commissioning early ground processing results will be available by means of the User Service Facility (USF). Such data will, however, be provided on a non-continous basis. Interruptions of the data flow will be mainly due to

- non-nominal calibration and characterisation measurements
- orbit manoevers
- functional checks of payload instruments and platform components
- unavailability of data link (X and K_a band).

The circulation of MIPAS data will therefore be restricted to pre-defined time / orbit segments and to measurement modes/activities as specified in this document (see **Chapter 10** / **Table 12**). Moreover, the data access to MIPAS data will be restricted to the members of the MIPAS Cal/Val team and the ACVT, respectively.

In the case of ‘non-product’ data (e.g., uncalibrated, ‘L1A’ type data, raw mode output data, MICAL analysis reports, etc.) the circulation will be restricted to project teams relying on such data sets and with whom a corresponding data exchange agreement has been achieved.

Table 13 provides an overview of data requirements to support both ESL and AO projects.

TABLE 13. Data circulation requirements / ENVISAT-MIPAS. Summary for AO and ESL projects

Project	Measurement ID	products / data sets	data volume [bytes]	Remarks / specific needs
SODAP processing site	M_SO_1 ... 5	NL__0P, LS__0P, RW___0P LOS aux. data	0.6 G	
MICAL L1B-ESL (tbc)	all M_SO, all M_IF, M_MV, M_RP M_GEO (tbc)	all (tbc)	400 G	
L2-ESL	M_IF_12, all M_RP, M_GEO	NL__1P, NL__2P, L1B&L2 aux. data	400 G	
AO #145	M_IF_11, _12, _15, M_RP_1	NL__1P, L1B aux. data	33 G	
AO #652	M_IF_4, M_IF_11, _12, _15, _16	RW___0P, NL__0P, NL__1P, L1B aux. data	12 G	alternatively to RW/NL___0P L1A type data could be provided, in agreement with ESA
AO #357	M_IF_12, _15, all M_RP, M_PV_1, M_GEO_1	NL__1P, NL__2P, L1B&L2 aux. data	90 G	M_IF_12, _15 data used for initial algorithm checks only
AO #304	all M_RP, M_GEO	NL__1P, NL__2P, L1B&L2 aux. data	320 G	
AO #323	all M_RP, M_GEO	NL__1P, NL__2P, L1B&L2 aux. data	320 G	
ESABC, other ACVT subgroups	M_RP_2, _3, all M_GEO	NL__2P or NL__2C, L2 aux. data	250 G (tbd)	details on data needs may vary significantly for different projects

13.0 ESA Provided Tools

To support the preparation of the CalVal tasks discussed in **Chapter 9**, and the corresponding evaluation of measurement data and analysis results a number of software tools and will be provided by ESA. The list of items to be delivered by ESA shall comprise:

1. Enviview (version 2 or 3) Envisat Products Analysis and Visualisation Tool

2. Set of simulated MIPAS L1B, L2 products and auxiliary data

3. ILS tool, stand alone tool, allowing to generate instrument lineshape data from parameters contained in L1B aux. files MIP_PS1_AX, MIP_CS1_AX, and in L2 aux. file MIP_PS2_AX

to be confirmed:

4. Suit of tools allowing to export MIPAS L2 products and aux. data to ascii format

5. Suit of tools allowing to export MIPAS L1B products and (selected) aux. data to ascii format

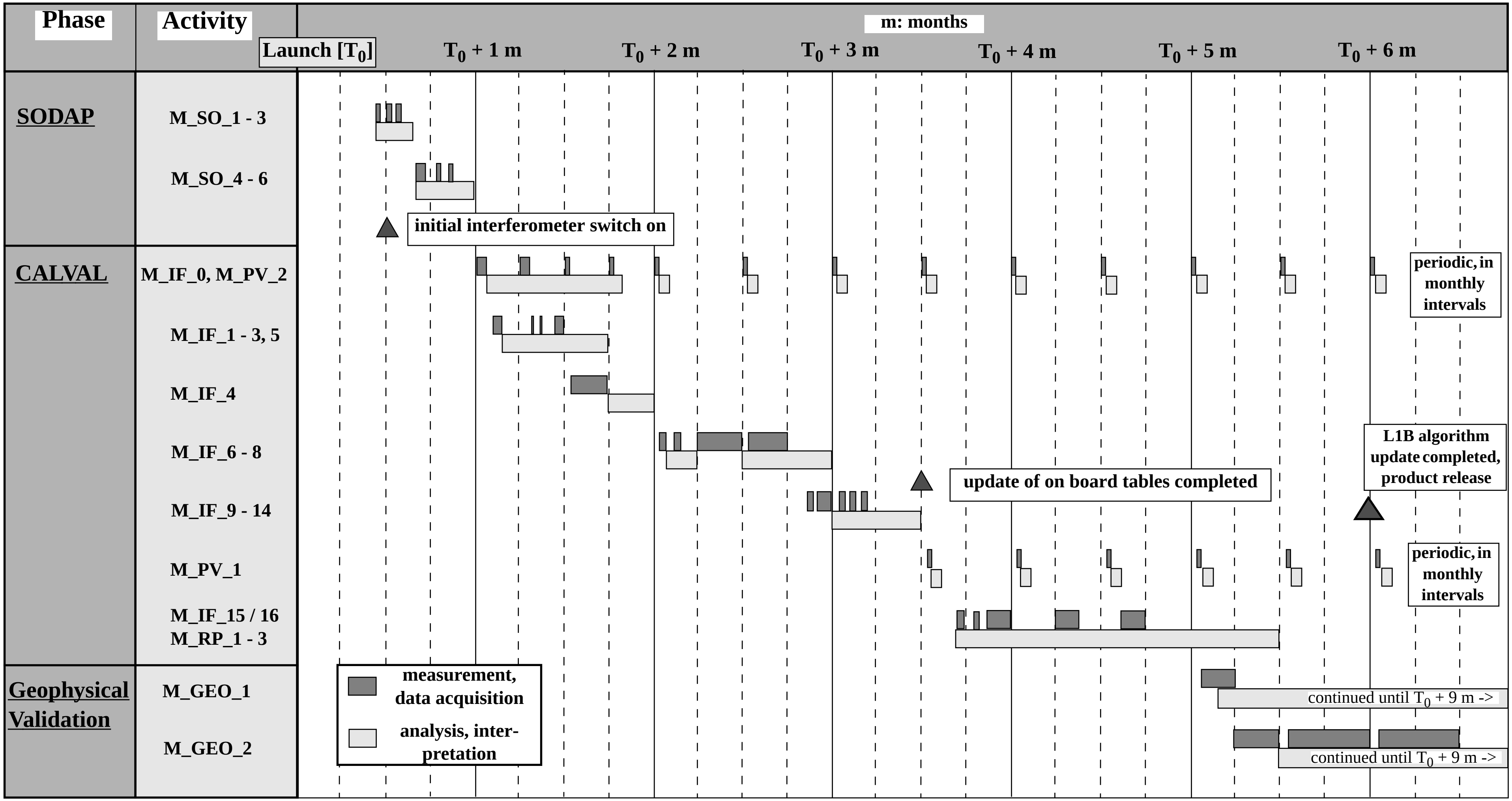
All tools will be provided as executables, for installation/operation on a SUN workstation running a SOLARIS 2.5.1 (or higher version) operating system. A read_me file supporting installation / operation will be provided with each tool.

14.0 Schedule

The overall schedule of planned initial MIPAS CalVal measurements is given in **Fig. 2**. Also shown are the approximate periods allocated to the various data processing and analysis activities (see **Table 12**, column ‘Task/ project’).

Measurement and data analysis intervals are indicated by dark and light shaded horizontal bars, respectively.

Figure 2. Schedule of initial MIPAS measurement and analysis activities



Appendix 1. Organisation of the MIPAS CalVal Algorithm Subgroup

The MIPAS CalVal algorithm subgroup is composed of expert teams each of which will carry out a number specific tasks within the CalVal project. These tasks, in turn, have been initiated within the ENVISAT AO or form part of an ESL (Expert Support Laboratory) activity, by means of a long term, ESA initiated study contract. In the former case projects details on envisaged work packages are outlined in a so-called ‘Project Description’ document ([RD 10] / AO#145, AO#304, AO#323, AO#357, AO#652). In the case of ESL activities tasks are defined in documents [AD 4] and [RD 8], respectively. The CalVal algorithm subgroup will be supported by industry experts in the areas of instrument operations (commanding, preparation of calibration/characterisation activities) and software engineering (coding/verification).

Fig. A.1 illustrates the composition of the MIPAS CalVal Algorithm subgroup.

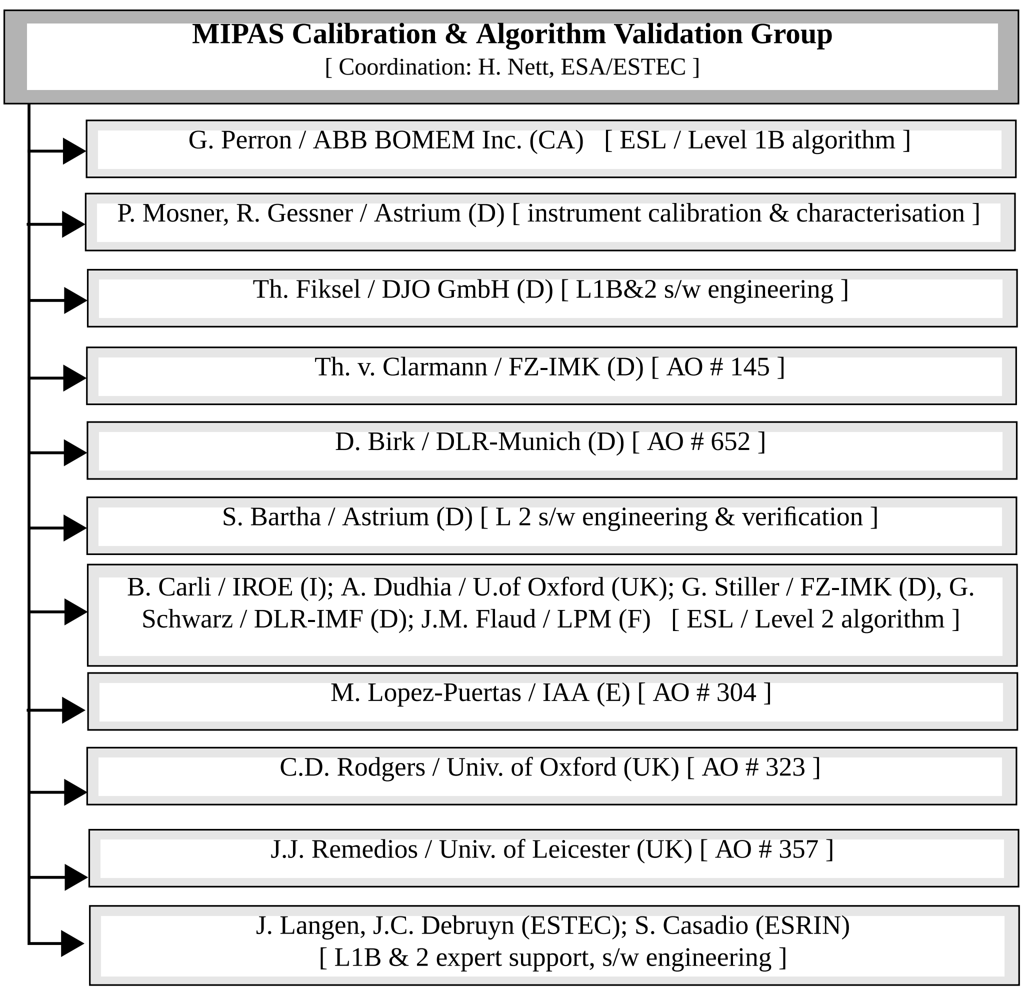


Fig. A.1 MIPAS Calibration & Algorithm Validation subgroup: Team composition

Appendix 2. Definition of Measurement Scenarios and Mission Planning Related Parameters

Table A.2 shall define the measurement scenarios referred to in **Table 12**, as well as primary input parameters of the MIPAS mission planning tools (MIPAS_NOM, MIPAS_SEM, MIPAS_LOS) used during generation of CTI data sets.

The detailed procedures to be followed for each measurement activity are defined in [RD 13].

Remarks:

1. The relative orbit numbers provided in **Table A.2** for each activity shall be assumed relative to a reference orbit, N_{orb0}. The absolute orbit number corresponding to N_{orb0}, UTC start time (ANX) and state parameters of that orbit still need to be defined.
2. Relative orbit numbers are counted with respect to the first orbit of Kiruna station visibility following the start of the CalVal phase. The UTC start time of the MIPAS CalVal phase is tbd.
3. The start orbit numbers for all activities have been selected such that the corresponding payload data are acquired via X-band by the Kiruna ground station (PDHS-K), during overpasses following immediately after each measurement interval.

TABLE A.2. Definition of measurement scenarios and primary planning parameters

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_NOM_01	**Scene measurements:** standard limb sequence in nom activity, full spectral resolution. 17 geometries, tangent altitudes: 68, 60, 52, 47 km; 42 ... 6 km in 3 km steps **DS / offset calibration ('standard DS' scenario):** repetition cycle: 5 scans no. of DS sweeps: 6 resolution: 1/10 tangent height: 210 km (min, along full orbit) **Gain calibration ('standard gain' scenario):** 6 groups of BB & DS sequences each 100 DS sweeps + 100 BB sweeps resolution: 1/10 repetition cycle: 100 orbits ANX start time: 2500 s Initial gain sequence upon each (re-) activation of background scenario	M_BG_0, M_IF_12, M_IF_13, M_IF_16, M_PV_1, M_RP_1, M_RP_3	6	- / -	CTI_NOC_MP, CTI_Nxx_MP, CTI_AST_MP, CTI_Sxx_MP, CTI_Exx_MP, MPL_CAL_MP, CTI_DSN_MP, CTI_BBN_MP, CTI_TCP_MP, CTI_SEW_MP, MPL_ORS_MP	background scenario; upload of settings / tables at end of SODAP phase **RGT:** nominal azimuth correction (sine law, correct for orbit inclination & yaw steering), pointing tables optimised globally, systematic limb height error minimised for 21 km
S_IF0_01	acquisition of LOS target star signals in rearward and sideways geometries repetition cycle: 100 orbits	M_IF0, M_PV_2	20	3 ... 5 per sequence	MPL_LOS_MP [SAIT's generated by FOS]	**RGT:** absolute start / stop orbit # for primary and secondary sequence, total duration, multiple crossing parameters, others

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_IF1_01	**BB sequences:** 64 sweeps, low resolution (1/10) activity: raw, sequence repeated in nom data mode **Scene measurements:** low resolution (1/10) measurements at constant tangent height (5 km) along full orbit, 63 increments (all zero). **DS (offset) calibration:** 'standard DS scenario' (repeat cycle: 5 scans)	M_IF1	37	63	all S_NOM_01 except MPL_CAL_MP, CTI_SEW_MP, MPL_ORS_MP	**RGT:** nominal azimuth correction, pointing tables optimised globally, systematic limb height error minimised for 5 km definition of time segment of overpass for raw mode measurement
S_IF2_01	**Scene measurements:** limb sequence in nom activity, full spectral resolution. 10 sweeps per scan, 42 - 30 km, alternating steps: 0 km + 3 km **DS (offset) calibration:** 'standard DS scenario' (repeat cycle: 5 scans) **Gain calibration:** initial calibration, 'standard gain scenario'	M_IF2	122	9	all S_NOM_01 except MPL_CAL_MP, CTI_SEW_MP, MPL_ORS_MP	two sweeps ('F' and 'R') performed at each fixed altitude, 42 km, 39 km ... Scenario modified wrt description in [AD 4] **RGT:** nominal azimuth correction, pointing tables optimised globally, systematic limb height error minimised for 36 km
S_IF3_01	**BB sequence:** 200 sweeps, low resolution (1/10) activity: raw data mode	M_IF3	149	1	CTI_BBN_MP, MPL_ORS_MP	**RGT:** definition of time segment of overpass

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_IF4_01	periodic BB & DS measurements at low resolution, for variable CBB temperatures; both, heat-up and cooling sequence are used. Two sequences shall be acquired per orbit over the entire 30 orbit duration. ANX start time: 2500 s & 5500 s **Gain calibration:** initial calibration, 'standard gain scenario', at nominal CBB temperature (220 K)	M_IF4	178	30 (tbc)	all S_NOM_01, except CTI_SEW_MP	scenario modified wrt description in [AD 4] **RGT:** definition of time segments for BB measurements (typ. 2 segments per orbit, tbc) Remark: after completion of this measurement a 'stabilisation' period of at least 14 orbits shall be allowed for before acquiring subsequent BB data (e.g., for gain calibration). This shall allow the CBB to reach again a stable operating temperature
S_IF5_01	**BB sequence:** 120 sweeps, full resolution; measurement repeated for 3 consecutive orbits activity: raw data mode	M_IF5	250	3	CTI_BBN_MP, MPL_ORS_MP	**RGT:** definition of time segments of over-passes, 2 consecutive orbits
S_IF6_01	**DS + BB sequence:** 400 sweeps at low resolution for DS and BB target, respectively, nom activity	M_IF6	264	1	CTI_DSN_MP, CTI_BBN_MP, MPL_ORS_MP	
S_IF7_01	**DS + BB sequence:** periodic DS + BB sequences, each 2 sweeps at low (1/10) resolution, nom activity	M_IF7	335	1	CTI_DSN_MP, CTI_BBN_MP, MPL_ORS_MP	
S_IF8_01	**Periodic gain calibration:** periodic calibrations, 'standard gain scenario' repetition cycle: 14 orbits ANX start time: 2500 s	M_IF8	350	4 per sequence	CTI_DSN_MP, CTI_BBN_MP, MPL_ORS_MP, MPL_CAL_MP	15 sequences in total

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_IF9_01	**Scene measurements:** limb sequence in nom activity, full spectral resolution. 22 geometries, 210 - 150 km, alternating steps: 0 km + 6 km steps **DS (offset) calibration:** repetition cycle: 2 scans no. of DS sweeps: 6 resolution: 1/10 tangent height: min 240 km (tbc) **Gain calibration:** initial calibration, ‘standard gain scenario’	M_IF9	407	3	all S_NOM_01 tables	two sweeps (‘F’ and ‘R’) performed at each altitude, 210 km, 204 km ... **RGT:** nominal azimuth correction, pointing tables optimised globally, systematic limb height error minimised for 210 km
S_IF10_01	**Sequence of deep space measurements for variable azimuth and elevation pointing angles** individually commanded DS sequences, each 20 sweeps, medium (1/2 of full) resolution 3 azimuth and elevation positions, respectively (total = 9 DS measurements), values tbd ANX start time: 2500 s	M_IF10 (modified)	278	1	CTI_DSN_MP, MPL_ORS_MP	full azimuth range for rearward scene measurements (75^0 ... 110^0, wrt x-axis) to be covered
S_IF11_01	**Periodic DS and BB sequences:** per sequence: 200 DS + 200 BB sweeps, full spectral resolution tangent height (for DS sweeps):min 210 km (tbc) ANX start time: 2500 s	M_IF11	292 + n * 501, n = 0, 1, 2, ...	1	CTI_DSN_MP, CTI_BBN_MP, MPL_ORS_MP	scenario to be repeated in periodic time intervals, to account for spatial and temporal variations of the upper atmospheric scene

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_IF12_01	**Scene & DS (offset) calibration measurements:** same as in M_NOM_01 **Gain calibration:** one calibration at start and stop of measurement interval, 'standard gain scenario'	M_IF12	507	21	all S_NOM_01	
S_IF13_01	- deleted -					
S_IF14_01	specific scan sequences in nom / raw mode	M_IF14	tbd	1 (per campaign)	tbd	scenario & mission planning requirements to be detailed; see also [RD 13], section 4.16
S_IF15_01	**Scene measurements:** limb sequences in SEM activity, full spectral resolution. Each scan 25 geometries with constant height, repeated 4 times. Limb height: 30 km. 4-scan Scenario repeated for height = 25, 20, 15, 10 km, respectively. Total = 4 * 5 scans same sequence repeated for medium resolution (1/4) **DS (offset) calibration:** settings as for 'standard DS scenario', repeated every second SEM scan. **Gain calibration:** initial calibration, 'standard gain scenario'	M_IF15	564	1	all S_NOM_01 tables	**RGT:** nominal azimuth correction, pointing tables optimised globally, systematic limb height error minimised for 210 km

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
S_IF16_01	**Scene measurements:** same as in M_NOM_01, raw data mode **DS (offset) calibration:** 'standard DS scenario' **Gain calibration:** DS sweeps: 60 BB sweeps: 60 resolution: 1/10	M_IF16	593	2	all S_NOM_01 except MPL_CAL_MP, CTI_SEW_MP, MPL_ORS_MP	total duration: 10 min / orbit orbit 1: short gain (120 s) + 5 scans orbit 2: 6 scans **RGT:** definition of time segments of over-passes
M_UAOM_01	**Scene measurements:** limb sequence in nom activity, full spectral resolution. 21 geometries, tangent altitudes: 102 - 42 km in 5 km steps 42 - 18 km in 3 km steps **DS (offset) calibration:** 'standard DS scenario' (repeat cycle: 3 scans) **Gain calibration:** 'standard gain scenario'	M_RP_2	865	43	all S_NOM_01 tables	**RGT:** nominal azimuth correction, pointing tables optimised globally, systematic limb height error minimised for 30 km

TABLE A.2. Definition of measurement scenarios and primary planning parameters

(continued ...)

Scenario ID	Description	Used with measurement ID	start orbit [rel #]	duration [orbits]	CTI files to be generated	Remarks / specific planning tool settings
M_GEO_01	**Scene measurements:** same as in M_NOM_01 **DS (offset) calibration:** 'standard DS scenario' **Gain calibration:** 'standard gain scenario'	M_GEO_1, M_GEO_2	1294	43 per campaign	CTI_NOC_MP, CTI_Nxx_MP, CTI_AST_MP, CTI_Sxx_MP, CTI_Exx_MP, MPL_CAL_MP, CTI_DSN_MP, CTI_BBN_MP, CTI_TCP_MP, CTI_SEW_MP, MPL_ORS_MP	several campaigns re-initialisation of nom activity for each orbit, in order to maximise spatial overlap of MIPAS scan with Earth fixed reference measurement **RGT:** same as M_NOM_01; MCMD execution time to be computed for individual Earth fixed targets

- end of document -