SMOS L1 Product Performance Evaluation Plan

Code	:	SO-TN-DME-L1PP-0245
Issue	:	1.0
Date	:	05/11/10

	Name	Function	Signature
Prepared by	A. Gutiérrez	Project Engineer	
Checked by	J. Barbosa	Quality A. Manager	
Approved by	J. Barbosa	Project Manager	

DEIMOS Engenharia
Av. D. João II, Lote 1.17, Torre Zen, 10º,
1998-023 Lisboa, PORTUGAL
Tel: +351 21 893 3013
Fax: +351 21 896 9099
E-mail: mailto:deimos@deimos.com.pt

© DEIMOS Engenharia 2010

All Rights Reserved. No part of this document may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of DEIMOS Engenharia

This page intentionally left blank

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

Document Information

Contract Data	Classification	
Contract Number: 4000101241/10/I-AM	**Internal**	☐
	Public	☐
Contract Issuer: ESA	**Industry**	☐
	Confidential	☑

Internal Distribution		
Name	Unit	Copies

External Distribution		
Name	Organisation	Copies
Jean-Claude Debruyn	ESA	1
Steven Delwart	ESA	1

Archiving	
Word Processor:	MS Word 2000
File Name:	SO-TN-DME-L1PP-0245-Product-Performance-Evaluation-Plan-E1-R0
Archive Code:	SO-TN-DME-L1PP-0245

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

Document Status Log

Issue	Change description	Date	Approved
1.0	First Delivery to ESA for L1PP v3.5	2010-11-05	

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

Table of Contents

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

List of Figures

List of Tables

1. INTRODUCTION

1.1. Purpose and Scope

This document describes the SMOS L1 Product Performance Evaluation Plan, containing the expected improvements in the data quality for each of the changes introduced in the L1PP baseline from the beginning of the SMOS Operations Phase.

1.2. Acronyms and Abbreviations

BT	Brightness Temperature
FFT	Fast Fourier Transform
FOV	Field of View
FWF	Fringe Washing Function
MIRAS	Microwave Imaging Radiometer by Aperture Synthesis
NIR	Noise Injection Radiometer
PMS	Power Measurement System
TBH	Temperature Brightness at Horizontal polarisation
TBV	Temperature Brightness at Vertical polarisation
TEC	Total Electron Content
LO	Local Oscillator
ADF	Auxiliary Data File

1.3. Applicable and Reference Documents

1.3.1. Applicable Documents

Ref.	Code	Title	Issue
AD.1	SO-SOW-ESA-GS-6647	SMOS Expert Support Laboratories for the period 2010-2014-ESL Level 1 Calibration and Reconstruction Statement of Work	*1.2*
AD.2	SO-RS-ESA-PLM-0003	SMOS System Requirements Document	*3.0*
AD.3	SO-TN-UPC-PLM-0019	SMOS In Orbit Calibration Plan Phase C-D	*1.5*
AD.4	ECSS-E-40B	ECSS E-40 Software Engineering Standards	

Table 1: Applicable Documents

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

1.3.2. Reference Documents

Ref.	Code/Author	Title	Issue
RD.1	EE-MA-DMS-GS-0001-1-5_090313	Earth Explorer Mission CFI Software MISSION CONVENTIONS DOCUMENT	*1.5*
RD.2	PE-TN-ESA-GS-0001	Earth Explorer Ground Segment File Format Standard	*1.3*
RD.3	EE-MA-DMS-GS-0002-3-7-2_080731	Earth Explorer Mission CFI Software GENERAL SOFTWARE USER MANUAL	*2.0*
RD.4	TN from Juha Kainulainen 11-10-2010	On the NIR Drift	*4.2*
RD.5	SO-TN-DME-L1PP-0240	LO Unlock Algorithms in L1PP	*1.0*
RD.6	SO-TN-DME-L1PP-0240	RFI Algorithms in L1PP	*1.1*

Table 2: Reference Documents

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

2. L1PP V3.5.0 BASELINE

This chapter shows all the algorithm improvements incorporated into L1PP v3.5.0 and explains the expected theoretical improvement that should be achieved in L1 products after the required modifications are performed.

2.1. NIR Averaging Consolidation

2.1.1. Description

This change comprises purely a format change in the ANIR1A product files, in order to consolidate the averaged value of a configurable number of NIR calibration sequences into a separate Dataset. L1PP v3.4. was already computing the average, but it was consolidated as an extra dataset into the NIR calibration sequences Dataset.

2.1.2. Expected Impact

None, as L1PP v3.4 already incorporated the averaging process, and the change is purely a format container update to comply with DPGS requirements.

2.2. NIR Antenna Model

2.2.1. Description

In the NIR model available for L1PP v3.4, the antenna patch losses are taken into account through the L1 attenuation. This is a fixed value characterized on-ground before the launch and introduced in the NIR Auxiliary file.

The updated antenna model takes into account a variation of these antenna patch losses with temperature in the following way:

$$L_1 = L_{1,0} + dL_1 + \alpha \cdot \left(\overline{T}_{p7} - T_{p7,0}\right) + \beta \cdot \left(T_{p7} - T_{p7,0}\right) \qquad \textbf{Eq. 1}$$

Where L_{10} is the original value characterized on ground, $dL1$ an correction term of the on-ground characterized attenuation, $\overline{T}_{p7}$ is the average temperature of the antenna patch during the 6 NIR calibration sequences executed in the last external manoeuvre, T_{p7} is the instantaneous antenna patch temperature and T_{p70} is a reference temperature set to the average temperature of the calibration acquired on the 2nd February for which the rest of coefficients have been obtained.

2.2.2. Expected Impact

The effect that this change will have on L1 products is a flattening of the NIR instrument response with respect to seasonal Tp7 variations.

As described in [RD.4], the observed NIR internal calibration temperature presents the following trend from the beginning of 2010:

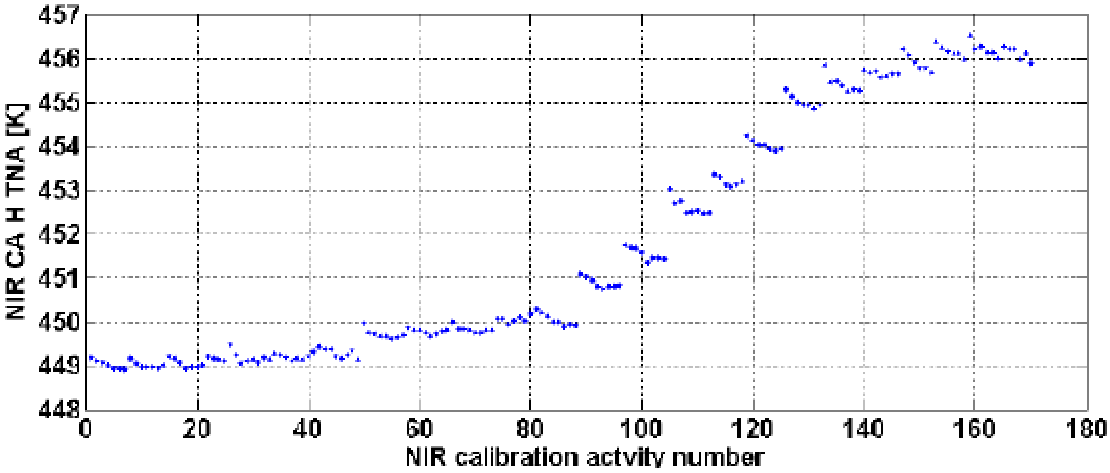

Figure 1: Observed NIR CA drift during 2010

The expected response should have been flatter, with a maximum dispersion of [+2, -2] Kelvin, so this indicates that there is either a severe degradation of the NIR units, or an incorrect characterisation with respect to an orbital varying parameter.

In [RD.4] the drift is tracked to the seasonal variation of *Tp7*, and its compensation is part of the description in section 2.2.1.

A numerical characterisation is not possible, although [RD.4] shows that after the implementation of the new NIR antenna model, the TNA for NIR CA H is flatter than the one presented above (please note that the chart is now a histogram, but the representation scales are the same)

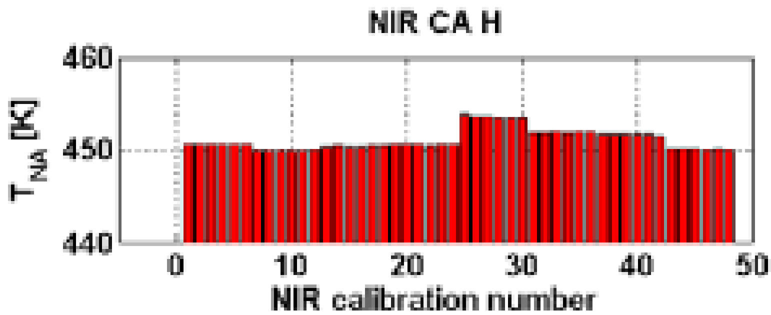

Figure 2: Corrected NIR CA drift during 2010

2.3. LO Unlock Mitigation

2.3.1. Description

This algorithm aims to mitigate the errors introduced in the L0 to L1a processing whenever a CMN Local Oscillator loses lock for a short period and then relocks back to the correct frequency.

As explained in [RD.5], this unlock event causes the FWF phase on certain baselines to jump randomly to a new level (before and after the unlock event). As the FWF phase is tracked by using the LO

Calibration Sequences and then interpolated cubically to each individual science epoch, a phase jump in between two LO Calibration Sequences affects not only the epochs in between, but also the epochs before the next two LO Calibration Sequences, as can be seen in the following figure:

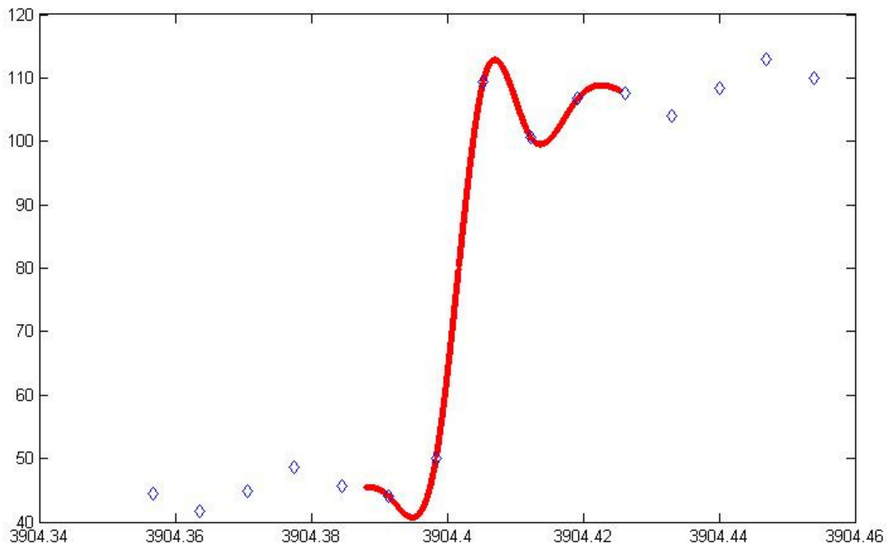

Figure 3: FWF Phase interpolation spline affected by an unlock in L1PP v3.4

The algorithm aims to split the spline interpolation curves whenever an unlock event is detected, such that the FWF phase is not affected by the phase jump. In addition, only interpolation curves from affected baselines shall be cut, whereas the remaining curves shall remain untouched.

Baselines affected by a LO unlock event are formed by correlations between LICEF elements in the unlocked CMN and the remaining LICEF elements in all other CMN.

2.3.2. Expected Impact

In this case, it is not possible to establish a priori quantitative criteria for the impact of this correction, as there is no instrument truth to which the correction can be compared.

Thus, the verification method has to be indirect, by analysing the spline interpolation curves for all baselines surrounding a LO unlock event, and checking that the curves are split on the affected baselines and left untouched on the other ones.

2.4. RFI Mitigation Algorithm

2.4.1. Description

The RFI Mitigation implemented in L1PP v3.5.0 is based on the same algorithm defined by UPC to perform the Sun removal. For this release, the algorithm is only implemented in the dual-polarisation part of the full polarisation data acquired by SMOS.

The algorithm can be summarized in three steps:

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

- Using the geographic coordinates of the RFI, its coordinates in the *(ξ, η)* plane are computed;
  - The coordinates of the RFI are retrieved from the new AUX_RFILST ADF file
- Then, the BT of the RFI is self estimated from the calibrated visibilities as

$$T_{RFI} = \frac{T_{Raw}^{pq}\left(\xi_{RFI},\eta_{RFI}\right) - T_{SceneAverage}}{T_{V_{1K}}\left(\xi_{RFI},\eta_{RFI}\right)} \qquad \textbf{Eq. 2}$$

where $T_{Raw}^{pq}(\xi,\eta)$ is the raw BT from the snapshot, computed as $F^{-1}\left(V^{pq}(u,v) - V_{\mathrm{Rec}}^{pq}(u,v)\right)$, $T_{SceneAverage}$ is the median computed on $T_{Raw}^{pq}(\xi,\eta)$ in a square of [11x11] centred on (ξ_{RFI},η_{RFI}) $T_{V_{1K}}(\xi_{RFI},\eta_{RFI})$ is temperature computed for the instrument response for a point-source with 1K located in the direction of (ξ_{RFI},η_{RFI}) as $T_{V_{1K}}(\xi_{RFI},\eta_{RFI}) = F^{-1}\left(V_{1K}(\xi_{RFI},\eta_{RFI})\right)$;

- Finally, the delta visibilities corresponding to the RFI correction are computed and subtracted from the L1a Calibrated visibilities inside the Foreign Sources loop.

For more details on the mitigation algorithm, please refer to [RD.6].

2.4.2. Expected Impact

This new algorithm will act according to the options specified in the AUX_RFILST ADF, applying the mitigation algorithm previously described. Quantitatively, there is no way to assess on the performance of this algorithm, only a qualitative analysis can be done.

The products generated by L1PP do not suffer any change in format, for only the meaning of the L1b flags is affected – the FTT flag and RFI flag. The two bits that previously reported on the usage of the Flat Target Transformation and the alerted for the presence of RFIs (detected with the max(*Mkj*) algorithm) are now used to tag if mitigation algorithms have been performed in L1b and to report if the snapshot has been marked as corrupt by L1b (sum of RFI BT exceeding a given limit).

2.5. RFI Flagging Algorithms

2.5.1. Description

The flagging of RFI is performed based on the AUX_RFILST ADF and there are four possible flagging methods

- flag the pixels contained in a circle whose radius depends on the BT of the RFI, as presented in Eq. 3;

$$r = 0.39 \log T_{B_{RFI}} + 0.29 \qquad \textbf{Eq. 3}$$

- flag the pixels that form the tails of the RFI, with the tails' width defined as *2r*;
- finally, flag all the pixels from the snapshot as corrupt by RFI.

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.

These three levels of flagging are computed in the L1c module. If the mitigation algorithms are applied, there are however two flags that are inherited from L1b – the RFI Mitigated Snapshot and the RFI Corrupt Snapshot.

2.5.2. Expected Impact

These algorithms have no impact related to the structure of the products. All flags described in the section above have been implemented using already existing bits in the flags field, as described in [RD.6].

The flags changed in L1b are inherited to L1c, and therefore, the bits that correspond to the FTT Flag and RFI Corrupt flag will indicate if any mitigation algorithms have been performed and if the snapshot has been corrupt in L1b due to the presence of too much RFI in the snapshot. In addition, the flag that indicated if pixel was flagged in the AUX_RFI DGG file will be used to flag the pixels contained in the circle computed from Eq. 3, and the flag that classified a pixel as being part of the Extended Alias Free Field of View has reused to mark the RFI tails.

This document is property of DEIMOS Engenharia and cannot be distributed or duplicated without its written permission.