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SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Title - Sujet
SPICA FTS Ph.0-RFP

Solicitation No. - N° de l'invitation 9F052-130304/A	**Amendment No. - N° modif.** 001
Client Reference No. - N° de référence du client 9F052-13-0304	**Date** 2014-01-08

GETS Reference No. - N° de référence de SEAG
PW-$MTB-770-12534

File No. - N° de dossier MTB-3-36133 (770)	**CCC No./N° CCC - FMS No./N° VME**

Solicitation Closes - L'invitation prend fin
at - à 02:00 PM
on - le 2014-01-16

Time Zone
Fuseau horaire
Heure Avancée de l'Est HAE

F.O.B. - F.A.B.
Plant-Usine: ☐ **Destination:** ☑ **Other-Autre:** ☐

Address Enquiries to: - Adresser toutes questions à: Champoux, Annick	**Buyer Id - Id de l'acheteur** mtb770
Telephone No. - N° de téléphone (514) 496-3428 ( )	**FAX No. - N° de FAX** (514) 496-3822

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Veuillez modifier la demande de proposition ci-dessus mentionnée:

1. La date de fermeture pour la demande de proposition a été modifiée pour le 16 janvier 2014.

2. La table 2-1 de l'Annexe A mentionnait la présence d'un document intitulé AD-02 SPÉCIFICATIONS SAFARI. Ce document n'était pas inclus dans la demande de soumission. Le document est donc attaché à la présente modification.

Questions et réponses reçues:

1.

La DDP mentionne, à la section 3.1 que la Section I doit contenir un résumé. Toutefois, l'annexe E ''Soumission technique et critères d'évaluation'' ne contient aucune information relative au contenu, à la structure et au nombre de pages demandé du résumé. Il sera donc assumé que 2 pages incluant du contenu similaire aux autres Demande de proposition du l'ASC pour une mission de concept sera acceptable.

Réponse: Aucune indication n'est indiqué concernant ce qui devrait être inclus ou la longueur du résumé.

2.

Question: Concerant la section 3.1 de la demande de proposition, veuillez confirmer qu'il doit y avoir 2 clés USB distinctes concernant la Section 1 en plus d'une troisième clé USB contenant l'information contenu dans la section II.

Réponse: Oui, votre interprétation est correcte.

Tous les autres termes et conditions de la demande de proposition demeurent inchangés.

VERSION FRANÇAISE DISPONIBLE SUR DEMANDE, CONTACTER L'AUTORITÉ CONTRACTANTE DU DOSSIER

SAFARI FTS Specification

Prepared by:	W. Jellema D. van Loon M. Eggens J. Evers	date:
Checked by:		date:
Agreed PA:		date:
Approved PM:		date:

Distribution:

SRON:

DOCUMENT CHANGE LOG

Issue	Date	Sections	Description
Draft 0.2	09-04-2013	All	First draft issue
Draft 0.3	09-08-2013	Various	Comments and additions of DvL included Updated SAFARI block diagram Various additions
Draft 0.31	28-08-2013	Various	Comments from DvL processed (mail 28-08-2013)
Draft 0.32	02- 09-2013	Various	Comments of WJ and DvL processed (mail 02-09-2013) and other additions and changes
Draft 0.33	02-09-2013	4	Figures SAFARI electrical overview and ICU concept added. Text of DvL on FTSCU in ICU environment added.

Table of Contents

1. General

1.1 Introduction

TBI

1.2 Scope

This specification establishes the requirements for the analysis, design, development, manufacturing, validation and preparation for delivery of the SAFARI FTS subsystem.

The specification is fully applicable to the QM and FM. The DM shall comply with the functional and interface requirements, but reduced performance as define herein is allowed.

The documents listed in section 2.1are fully applicable. In case of conflicting requirements the requirements given in this specification have precedence.

2. Documents

2.1 Applicable documents

	Document number	Issue	Document title
AD01	SRON-SAFARI-SP-2009-001		SAFARI Instrument specification
AD02	SRON-SAFARI-PL-2009-013		SAFARI Product Assurance Plan
AD03	SRON-SAFARI-SP-2011-002		Environmental and test specification
AD04	SRON-SAFARI-SP-2011-007		Data Handling Protocol
AD05			

2.2 Reference documents

	Document number	Issue	Document title
RD01	SRON-SAFARI-RP-2012-001	1.0	SAFARI Instrument design description
RD02			

3. Abbreviations

AD	Applicable document
BC	Beam Combiner
BS	Beam Splitter
FPU	Focal Plane Unit
FTSM	Fourier Transform Spectrometer Mechanism
FTSCU	Fourier Transform Spectrometer Control Unit
ODL	Optical Delay Line
OPD	Optical Path length Delay
RD	Reference document
TBC	To Be Confirmed
TBD	To Be Defined
TBI	To Be Inserted
WFE	Wave Front Error

To be
completed

4. SAFARI description

Text tbi

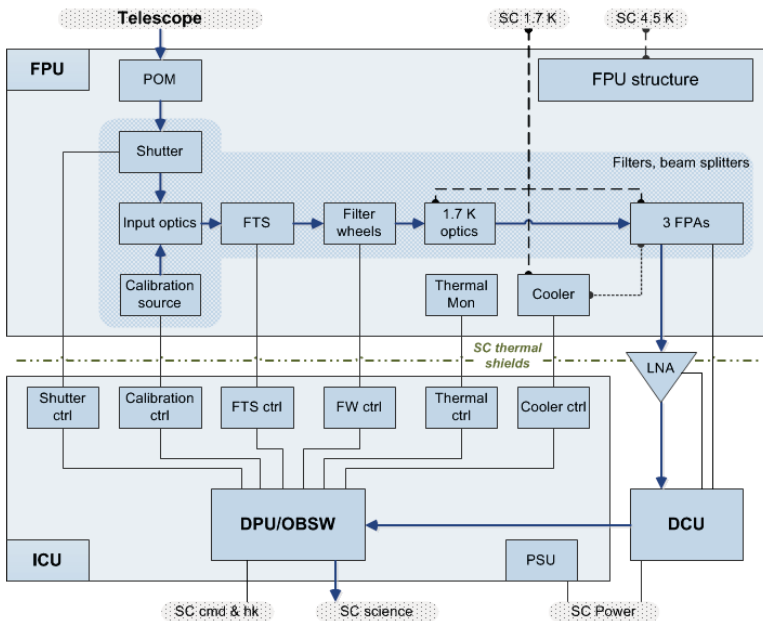


Figure 1 - SPICA-SAFARI block diagram

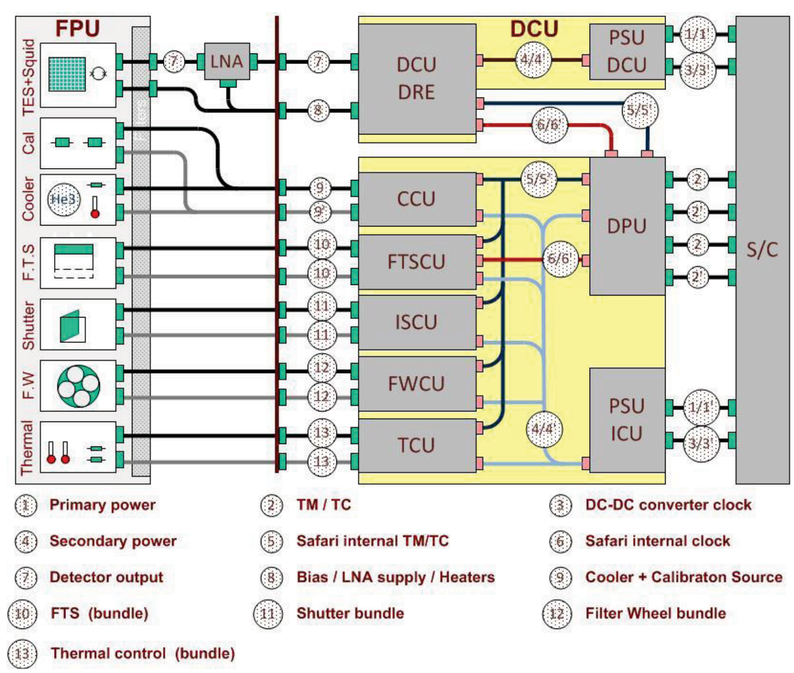


Figure 2 - SAFARI electrical system overview

The FSTCU belongs to the FTS system as well as to the ICU (unit). The power supply of the ICU (PSU-ICU) will supply the necessary secondary voltages to the FTSCU within a range of 3.3V – 15V. Details of this interface should be iterated by both suppliers. The FTSCU interfaces directly to the Data Processing Unit (ICU-DPU) through a TM/TC spacewire interface with the protocol defined in AD04. The ICU units are cold redundant (without cross strapping, TBC) and therefore consists of two identical FTSCU boards. Finally the FTSCU interfaces to the FTSM through the Instrument Cryo Harness.

The current baseline of the ICU is shown in Figure 3. Each functional board is enclosed in a drawer of aluminium and stacked on top of each other. Although the mechanical structure is under discussion due to the increase of the number of boards, this provides a starting point. The drawer will be supplied by the ICU responsible (Italian industry) such that the FTSCU provider can mount the FTSCU board in it.

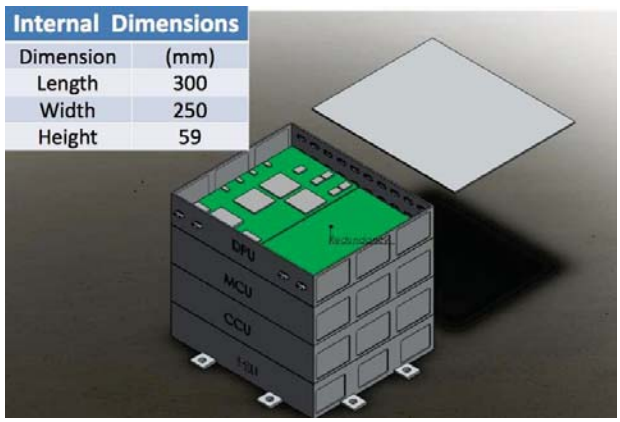


Figure 3 - ICU Mechanical concept

Ideally an ICU drawer consists of two boards next to each other such that prime and redundant boards share the same drawer. However, based on the current best estimate for the FTSCU area, shown in Figure 4, it could be that it is necessary to allocate one full ICU board for prime and one for the redundant FTSCU.

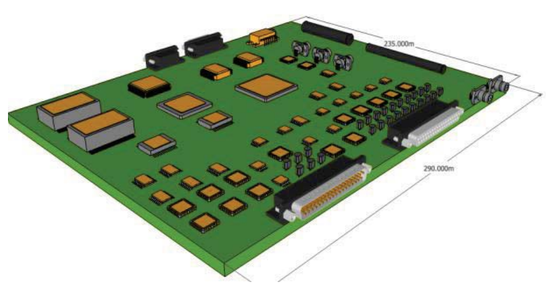


Figure 4 - FTSCU concept PCB

5. FTS sub-system baseline concept description

5.1 Sub-system architecture

The Fourier-Transform Spectrometer (FTS) subsystem separates the incoming radiation into two optical arms, and modulates the Optical Path Difference (OPD) between the two arms in order to produce an interferometric fringe after coherent addition of the optical signals at its output by beam combination. The interferometric fringe measured as function of OPD, also known as the interferogram, is the Fourier Transform of the source spectrum and is measured using the SAFARI detector subsystem. The FTS subsystem therefore provides a mechanism to obtain the astronomical spectrum from the radiation collected at the detectors and provides the spectrometer function of the SAFARI instrument.

The interferometer in the FTS subsystem is a key and central part of the optical layout of the Focal Plane Unit (FPU) as shown in the block diagram in Figure 5. The FTS interferometer combines two inputs, one from the sky, the other from an independent optical path fed by a calibration source, and provides two output ports, one for the Long-Wavelength (LW) channel, the other for a combined Short- and Medium-Wavelength (SW/MW) channel.

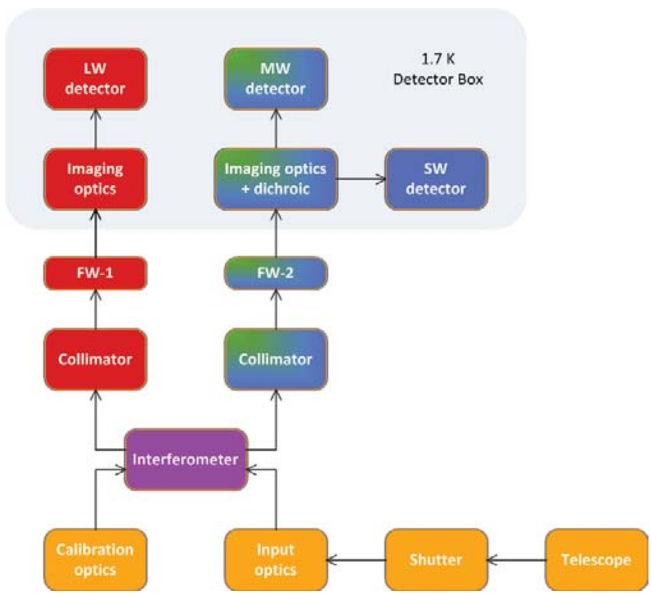


Figure 5 - Optical configuration SAFARI

The FTS subsystem consists of the following elements:

- The FTS interferometer optics defined from the input Beam-Splitter (BS) to the output beam-combiner (BC) including intermediate imaging optics.
- The FTS Mechanism (FTSM), which is the cryogenic mechanism translating a mirror in order to modulate the OPD between the two arms of the FTS interferometer optics. The FTSM is part of the SAFARI FPU which is located on the SPICA OIB.
- The FTS Control Unit (FTSCU), which is part of the Instrument Control Unit (ICU) and contains the drive and readout electronics for motion control and position sensing. The ICU is located on the SPICA warm Service Module.
- The FTSCU and FTSM are interconnected through the cryo harness.

Figure 6 shows the location of the FTS optics in the SAFARI optical design. The block diagram in Figure 7 shows the detailed functions of the FTS subsystem baseline concept and the interconnections between the warm and cold sub-units.

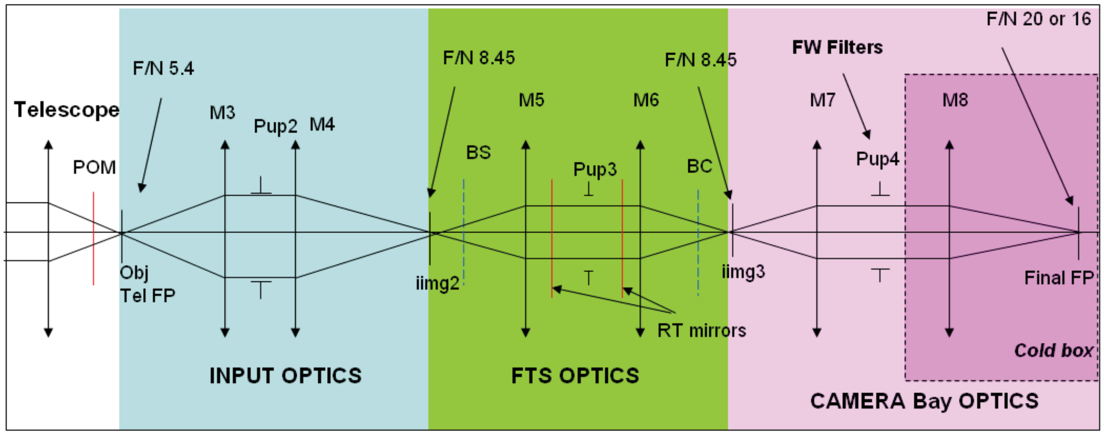


Figure 6 - Block diagram of the SAFARI optical design

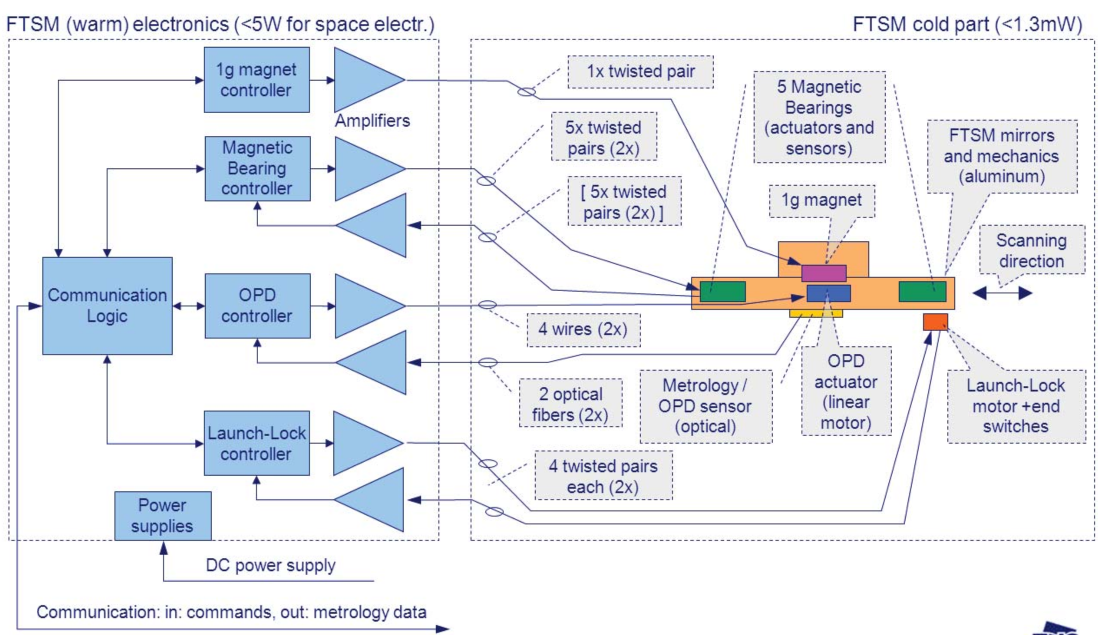


Figure 7 - Block diagram of the warm FTSCU electronics connected to the cryogenic FTSM

Remark:
Update text in Figure 7.

- Make number of wires consistent with 6.4.11
- Thermistors

6. FTS subsystem requirements

6.1 Functional requirements

The FTS shall have the following functionality:

Identifier	Requirement	Upper Link	Verification method
6.1.01	The FTS shall support a nominal fast-scan mode (constant velocity scan) as well as a step-and integrate-mode		
6.1.02	Provide SAFARI in the spectroscopic imaging mode a medium spectral resolution (R = 2000) sub-mode	IS-4.1.2-3	
6.1.03	Provide SAFARI in the spectroscopic imaging mode a modest spectral resolution (200 < R < 500) sub-mode	IS-4.1.2-4	
6.1.04	Provide SAFARI in the spectroscopic imaging mode a spectrophotometric or low spectral resolution (20 < R < 50) sub-mode	IS-4.1.2-5	
6.1.05	Provide SAFARI a mode for Photometric Observations with the FTSM at a fixed OPD at a considerable (TBD) distance of ZOPD In this position the FTSM shall be locked during launch.		
6.1.06	The metrology system shall be capable of supporting a high rate, oversampled, calibration mode for diagnostic purposes		
6.1.07	Split incoming radiation in two equal parts by amplitude		
6.1.08	Introduce an OPD between the two intermediate optical signals by mechanical displacement of a mirror		
6.1.09	Produce an interference fringe at the common output by recombination of the two optical signals		
6.1.10	Operate simultaneously at the input signals from two independent input ports, which are both multiplexed to two independent output ports		
6.1.11	Provide the movable mirrors for the Mach-Zehnder Fourier transform spectrometer of SAFARI		
6.1.12	Provide time-stamped metrology data for the OPD introduced between the two interferometer arms to the DPU		
6.1.13	Have the ability to synchronize to the external clock coming from the DPU		
6.1.14	Have a prime and redundant actuator system		
6.1.15	Have a prime and redundant OPD metrology system		
6.1.16	Have its full functional and performance capabilities at 1 and zero gravity conditions at the operational temperature (is still under discussion within SAFARI how to interpret this and in which test set-ups this is necessary)		
6.1.17	Have a reusable, failsafe, locking system for the scan deck to be used during transport, handling and launch to prevent damage		
6.1.18	Have magnetic shielding, if necessary, to reduce magnetic fields that may interfere with the detector systems		
6.1.19	Have stray light shielding, if necessary, to reduce radiation that may interfere with the detector systems		
6.1.20	Provide facilities for a reproducible mounting in the SAFARI FPU with respect to the optical-mechanical references		
6.1.21	The FTSM shall provide the means to fine tune the alignment with respect to the optical-mechanical interface after the initial mounting in the FPU		
6.1.22	Have the ability to be functionally health checked at room temperature (to be further defined)		
6.1.23	Have the ability to measure the temperature of the main structure of the FTSM		

6.2 FTS subsystem performance requirements

The FTS subsystem shall comply with the following performance requirements:

Identifier	Requirement	Upper Link	Verification method
6.2.01	The scan mechanism shall have a linear stroke (z-direction) relative to zero OPD from -4 to 31.5 mm		
6.2.02	The scan velocity range of the OPD shall be commandable between 25 – 550 µm/s		
6.2.03	In the step-and-integrate mode the minimum step size shall be smaller than 750 nm.		
6.2.04	In the constant-velocity mode the resolution of the commandable scan velocity shall be 1 µm/s		
6.2.05	The settling time for the minimum step size in the step-and-integrating mode is better than 200 ms (TBC).		
6.2.06	The RMS velocity jitter shall be less than 1% across a 3-20 Hz bandwidth		
6.2.07	The scan mechanism shall accelerate from stand-still to maximum speed within 0.5 mm.		
6.2.08	The scan mechanism shall decelerate from maximum speed to stand-still within 0.5 mm.		
6.2.09	The absolute mechanical position error in stand-still is less than 15 nm.		
6.2.10	The FTS shall have a pupil diameter of 33 mm. This is a compromise between spectral resolution, fringe contrast and mechanical compactness of the instrument		
6.2.11	The FTS shall have a field of view of 3.5°		
6.2.12	The angle of incident of the beams at BS and BC shall be less than 22.5°		
6.2.13	The distance between BS and retro-reflector first mirror (at ZPD) shall be less than 375 mm		
6.2.14	The FTSM mirror optical axis rotation at any position shall be less than +/-30’’		
6.2.15	The FTSM mirror lateral displacement at any position shall be less than +/-100 µm		
6.2.16	The total WFE error budget for the optics and BS and BC shall be less than 1µm rms		
6.2.17	The WFE differences between the two branches including variations over the full scan shall be less than λ/20 RMS @ λ=633 nm		
6.2.18	The fringe contrast budget is > 50% across the 34-210 µm wavelength range (goal > 60%) Budgets: Intrument field of view + spectral resolution (stroke): > 80% Interferrometer optical design: > 85% (goal >90%) Interferrometer optical components and alignment > 80% (goal >85%) BS/BC: > 90% (goal >95%)	IS-4.2.3-4	
6.2.19	The differential beam shear at BC shall be less than 16% of beam diameter		
6.2.20	The initial static differential field rotation (between the two arms) at BC shall be less than 100 arcmin, with target value 0		
6.2.21	The differential field rotation (between the two arms) at BC shall be less than 10 arcmin. (variation during scanning)		
6.2.22	The differential wavefront tilt (between the two arms) at BC shall be less		

	than 4.5 arcmin, with target value 3.3 arcmin (sum of initial static and scanning/dynamic)		
6.2.23	The OPD internal sensor accuracy shall be better than 15 nm (rms)		
6.2.24	The OPD internal sensor shall have a sampling frequency of 1 kHz.		
6.2.25	FTSM maximum magnetic field emission at 10 mm (TBC) from the envelope: $<10^{-4}$ T (TBC)		
6.2.26	FTSM magnetic field stability at 10 mm (TBC) from envelope: $<0.510^{-6}$T over 200s (TBC)		
6.2.27	FTSM magnetic field noise at 10 mm (TBC) from envelope: $<0.510^{-6}$T/√Hz (TBC)		
6.2.28	FTSM maximum stray light emission is 1 aW in-band and 1 pW out-of-band TBC		
6.2.29	The FTSM shall have a maximum heat load on the 4.8 K level of 1 mW. This includes: • all electrical power dissipation in the FTSM itself, • ⅔ of the dissipation in the cryo harness between the 4.8K and 20K levels of the SPICA systems • the parasitic heat load in the cryo harness, including the fibers of the metrology system, between the 4.8K and 20K levels • light absorption of the metrology system but excluding the active power dissipation of the 1g off-loading bearing system. The cryo harness resistance is defined in section 6.4.11		
6.2.30	The FTSM 1 g off-loading bearing shall have a maximum heat load on the 4.8 K level of TBD mW (this is including ⅔ of the dissipation in the cryo harness between the 4.8K and 20K levels of the SPICA systems) The cryo harness resistance is defined in section 6.4.11		
6.2.31	The FTSCU shall have a maximum power dissipation, w.r.t. secondary supply voltages, of 10 W (TBC)		
6.2.32			

6.3 Redundancy

Identifier	Requirement	Upper Link	Verification method
6.3.01	The FTSM shall have an independent set of prime and redundant actuators.		
6.3.02	The FTSM shall have an independent set of OPD sensors.		
6.3.03	The FTS shall have an independent set of prime and redundant wire harnesses.		
6.3.04	The FTSCU shall consist of a prime and redundant unit physically independent		
6.3.05	The prime FTSCU shall interface with the prime ICU-PSU, prime ICU-DPU, prime FTSM actuators and prime FTSM ODP sensor.		
6.3.06	The redundant FTSCU shall interface with the redundant ICU-PS, redundant ICU-DPU, redundant FTSM actuators and redundant FTSM ODP sensor.		
6.3.07	The prime and redundant systems will not be cross-strapped (TBC)		

6.4 Interfaces

Identifier	Requirement	Upper Link	Verification method
6.4.01	The optical interfaces of the FTSM are given in drawing 0092-028-1 (Appendix A)		
6.4.02	The FTSM shall fit within the envelope given in drawing 0092-028-0 (Appendix A)		
6.4.03	The FTSCU boards shall fit a mechanical frame as given in drawing TBD (Appendix B) (The FTSCU is part of the ICU. Another party will supply the mechanical frame. However, the FTSCU responsible will need to mount the board in the respective mechanical frame. Details are TBD. For the time being the maximum dimensions are 300 x 250 mm)		
6.4.04	The FTSCU shall have a data interface with the ICU-DPU through a Space Wire link defined in AD04		
6.4.05	The FTSCU shall have a clock interface with ICU-DPU as depicted in Appendix D (TBD)		
6.4.06	The external clock coming from the DPU has a frequency of 10MHz		
6.4.07	The FTSCU shall have a power interface with the ICU-PSU as depicted in Appendix B.		
6.4.08	The ICU-PSU will supply secondary voltages in the range 3.3V – 15V. Lower voltages, when needed, should be implemented on the FTSCU board. Details should be discussed between ICU-PSU supplier and FTSCU supplier		
6.4.09	The connector type and pin lay-out of the FTSCU electrical interface with the ICU-PSU shall be as specified in Appendix ??		
6.4.10	The angle with respect to the 1 g environment during ground operations is maximal 0.5° (TBC)		
6.4.11	The total resistance between the FTSCU and the FTSM is: 1. OPD 3-phase actuator: 2 quad cables, 8 wires, 1000 Ω/wire		

	2. Magnetic bearing Hor/Ver: 4 quad cables, 16 wires, 18 Ω/wire 3. Magnetic bearing Rz: 2 twisted wires, 4 wires, 18 Ω/wire 4. Magnetic bearin 1g: 1 twisted pair, 2 wires, 47 Ω/wire 5. Launch lock actuator: 2 quad cables, 8 wires, 40 Ω/wire 6. Launch lock sensor: 2 twisted pairs, 4 wires, 1000 Ω/wire 7. Thermistors: 2 twisted quad, 8 wires, 1000 Ω/wire This is based on the concept given in Figure 7 and includes prime and redundant systems. For the power dissipation estimate as defined in section **Error! Reference source not found.** one has to use 1/6 of the total resistance given in this section.		
6.4.12	Safari system allocated 4 fiber cables for the metrology system (2 x 2 for redundancy) consisting of a pure silica core with 125um diameter and a coating of ETFE from 125um to 1600 um diameter		
6.4.13	More harness specifications: capacitance		
6.4.14	More harness specifications: induction		
6.4.15	The thermal interface of the FTSM shall be through the mechanical mounting feet.		
6.4.16	The thermal resistance of the thermal interface is TBD		
6.4.17	More thermal specifications: thermal capacitance at interface?		

6.5 Cleanliness requirements

Identifier	Requirement	Upper Link	Verification method
6.5.01	The FTSM shall have, at delivery to SAFARI, a particulate cleanliness level of less than TBD ppm as defined in TBD		
6.5.02	The FTSM shall have, at delivery to SAFARI, a molecular cleanliness of less than TBD g.cm^{-2} as defined in TBD		
6.5.03	The FTSCU outside surfaces shall have, at delivery to SAFARI, a particulate cleanliness level of less than TBD ppm as defined in TBD		
6.5.04	The FTSCU outside surfaces shall have, at delivery, to SAFARI, a molecular cleanliness of less than TBD g.cm-2 as defined in TBD		

6.6 Design and construction requirements

The FTS shall comply with the following design requirements:

Identifier	Requirement	Upper Link	Verification method
6.6.01	Safari uses the principal that the dimensioning (metric) is done for room temperature. The design shall take into account the effects of cooling to the operational temperatures		
6.6.02	In this document the SPICA spacecraft co-ordinate system is used		
6.6.03	On ground gravity acts in the spacecraft –Z direction		
6.6.04	The optical wavelength range of SAFARI is 34-210 µm	IS-4.1.4-1	

6.6.05	The FTS shall be designed for a nominal mission lifetime of 5 (TBC) years beginning at the day of launch	ICS-3-220	
6.6.06	The FTS shall be designed for an additional 5 years for on ground operations		
6.6.07	The design life of the FTS shall include all non-operational and operational phases on ground such as ground testing, integration, handling, transport, storage, and all in-orbit phases		
6.6.08	The FTSM shall be designed for of at least 2000 scans during ground tests and at least 150,000 (TBC) scans in flight without degradation		
6.6.09	The FTS QM, FM and FS models shall be designed and built such that they are fully interchangeable		
6.6.10	The safety factors given in Table 1shall be applied for the dimensioning of the mechanism to cover uncertainties of load factor evaluation, material data and analysis as well as to avoid undesirable influences of manufacturing tolerances. They shall be applied to the design limit loads, yield against permanent deformation, ultimate against rupture and loss of functionality		
6.6.11	The mass of the FTSM shall be less than 3000 grams		
6.6.12	The mass of the FTSCU shall be less than TBD grams		
6.6.13	The structural stiffness of the FTSM shall be designed so that the eigenfrequency is greater than 250 Hz (TBC)		
6.6.14	The structural stiffness of the FTSCU shall be designed so that the eigenfrequency is greater than TBD Hz		
6.6.15	Both units shall be designed against the limit loads given in Table 2		
6.6.16	Small venting holes shall be provided for the confined spaces in the FTS units to accommodate the rate of barometric pressure change during evacuation and pressurisation of the harbouring test cryostats and during launch		
6.6.17	The design of the venting holes shall be such that the venting plume during both depressurization and pressurization is directed away from sensitive parts like mirrors, open electronic die, etc.		
6.6.18	Both FTS units shall have a permanent identification showing the CI and a serial numbers		
6.6.19	The electrical connectors in the FTSM shall be of the rectangular micro-D type (TBC)		
6.6.20	Each connector of both units shall have an identification number that shall be visible after mating of the cable harness.		
6.6.21	Transport/storage containers shall be labelled or marked showing CI and serial number		
6.6.22	The materials used for the FTSM shall have outgassing properties as given in Table 3		
6.6.23	The materials used for the FTSCU shall have outgassing properties as given in Table 4		
6.6.24	The probability of survival of the FTSCU for the operational lifetime shall be at least TBD%		
6.6.25	The FTSM main bonding path is through the mounting interface. The DC resistance shall be less than 10mΩ. This level applies for both directions of polarity across the bonds.		
6.6.26	Parts of the FTSM isolated from the main structure shall be provided with an electrically conducting path to the main structure. The DC resistance of this path shall be less than 10 kΩ.		

6.6.27	Each FTSM and FTSCU unit shall be provided with an identification and serial number		

Item	Yield SF	Ultimate SF	Buckling SF
Conventional metallic materials	1.1	1.5	2.0
Unconventional materials	1.4	2.0	2.0
Inserts and joints	1.5	2.0	N/A

Table 1, Safety and sizing factors

	Levels for FTSM	Levels for FTSCU
Axial load (X-Y plane)	120 g TBC	120 g TBC
Radial load Z axis	120 g TBC	120 g TBC

Table 2, Quasi Static Loads

Mass (g)	TML (%)	CVCM (%)
>100	<0,1	<0.01
10-100	<1	<0.05
<10	<1	<0.1

Table 3, Outgassing properties of materials for use in the SAFARI FPU

Mass (g)	TML (%)	CVCM (%)
>100	< TBD	< TBD
10-100	< TBD	< TBD
<10	< TBD	< TBD

Table 4, Outgassing properties of materials for use in the SAFAR SVM units

6.7 Environmental requirements

The FTS shall comply with the environmental requirements given in AD03 and the additional requirements given in the table below:

Identifier	Requirement	Upper Link	Verification method
6.7.01	The operational temperature of the FTSM is 4.8 K ± TBD K. Within this temperature range the FTSM shall comply with all functional and performance requirements		
6.7.02	The FTSM operational temperature drift is <TBD K/hr		
6.7.03	It shall be possible to test the FTSM at 22º C (±5º C). In this temperature range it shall be possible to test all functions but reduced performance is allowed		

6.7.04	The operational temperature of the FTSCU is 20º C (+TBD, -TBDº C). Within this temperature range the FTSCU shall comply with all functional and performance requirements		
6.7.05	The FTSCU operational temperature drift is <TBD º C /hr		
6.7.06	The FTSCU shall be capable to make a hot start at TBD º C, reduced performance is allowed outside the operational temperature range		
6.7.07	The FTSCU shall be capable to make a cold start at -TBD º C, reduced performance is allowed outside the operational temperature range		
6.7.08	The FTSM shall be able to withstand TBD bake-outs at a temperature of 80°C (TBC), in vacuum, for 72 TBC hours without performance degradation		
6.7.09	The FTSM shall be able to withstand thermal cycling between room temperature and its operational temperature 15 times without performance degradation. The maximum thermal change rate for this cycling is TBD K/min		
6.7.10	The operational pressure on orbit for both FTS units is $<10^{-4}$ hPa		
6.7.11	Both FTS units shall be capable to operate at ambient pressure.		
6.7.12	The maximum depressurization rate during launch is 50 hPa/s (TBC). Depressurization of SAFARI test cryostats or the SPICA cryostat will be less than the above rate (TBC). Pressurization of test cryostats or the SPICA cryostat will be less than the above rate (TBC).		
6.7.13	The scan axis deviation from horizontal during ground testing will be less than 0.5 degrees (TBC)		
6.7.14	The FTS units shall be capable to be handled, assembled, integrated, tested, stored and transported in air with a relative humidity of 40 – 70%. The on orbit operational environment is in vacuum and so with 0% RH		
6.7.15	The FTSM shall be designed to quasi static loads of 120 g (TBC) in any direction.		
6.7.16	The FTSM shall be capable to survive, without any degradation, the sine and random vibration loads given in Table 6 and Table 7		
6.7.17	The FTSM shall be capable to survive, without any degradation, the shock loads given in Table 5 (TBC)		
6.7.18	The FTSCU shall be designed to quasi static loads of TBD g in any direction.		
6.7.19	The FTSCU shall be capable to survive, without any degradation, the sine and random vibration loads given in Table 8 and Table 9		
6.7.20	The FTSCU shall be capable to survive, without any degradation, the shock loads given in Table 5		
6.7.21	The FTSM shall be performing within the requirements with the FTSM exposed to the micro-vibrations as given in Table 10		

All the values given in Table 5 through Table 10 are preliminary estimates of the input levels for the SAFARI FPU and ICU respectively. The levels and spectra for the FTSM and FTSCU will be highly probable different and will change when design and analyses mature.

Frequency (Hz)	Shock level/slope
100 -1500	+8 dB/oct (TBC)
1500 - 4000	500 g (TBC)

Table 5 Shock levels

	Frequency		Acceleration	
	[Hz]	[Hz]	Qualification [g]	Acceptance [g]
All axes	5	100	25 TBC	20 TBC
Sweep rate [oct/min]			2	4

Table 6 FTSM sine vibration levels

	Qualification		Acceptance	
Frequency range	**Slope/level**	**RMS value**	**Slope/level**	**RMS value**
20 - 40	+6 dB/octave	20 g TBC	+6 dB/octave	TBD
40 - 1000	TBD g^2/Hz		TBD g^2/Hz	
1000 – 2000	-12 dB/octave		-12 dB/octave	
Duration	120 s		60 s	

Table 7 FTSM random vibration levels

	Frequency		Acceleration	
	[Hz]	[Hz]	Qualification [g]	Acceptance [g]
All axes	5	100	25 TBC	20 TBC
Sweep rate [oct/min]			2	4

Table 8 FTSCU sine vibration levels

	Qualification		Acceptance	
Frequency range	**Slope/level**	**RMS value**	**Slope/level**	**RMS value**
20 - 40	+6 dB/octave	TBD	+6 dB/octave	TBD
40 - 1000	TBD g^2/Hz		TBD g^2/Hz	
1000 – 2000	-12 dB/octave		-12 dB/octave	
Duration	120 s		60 s	

Table 9 FTSCU random vibration levels

	Frequency		Acceleration	
	[Hz]	[Hz]	Qualification [g]	Acceptance [g]
All axes	TBD	TBD	30 µg TBC	TBD
	TBD	TBD	TBD	TBD
	TBD	TBD	TBD	TBD

Table 10 - FTSM micro-vibration environment

6.8 Test requirements

TBI

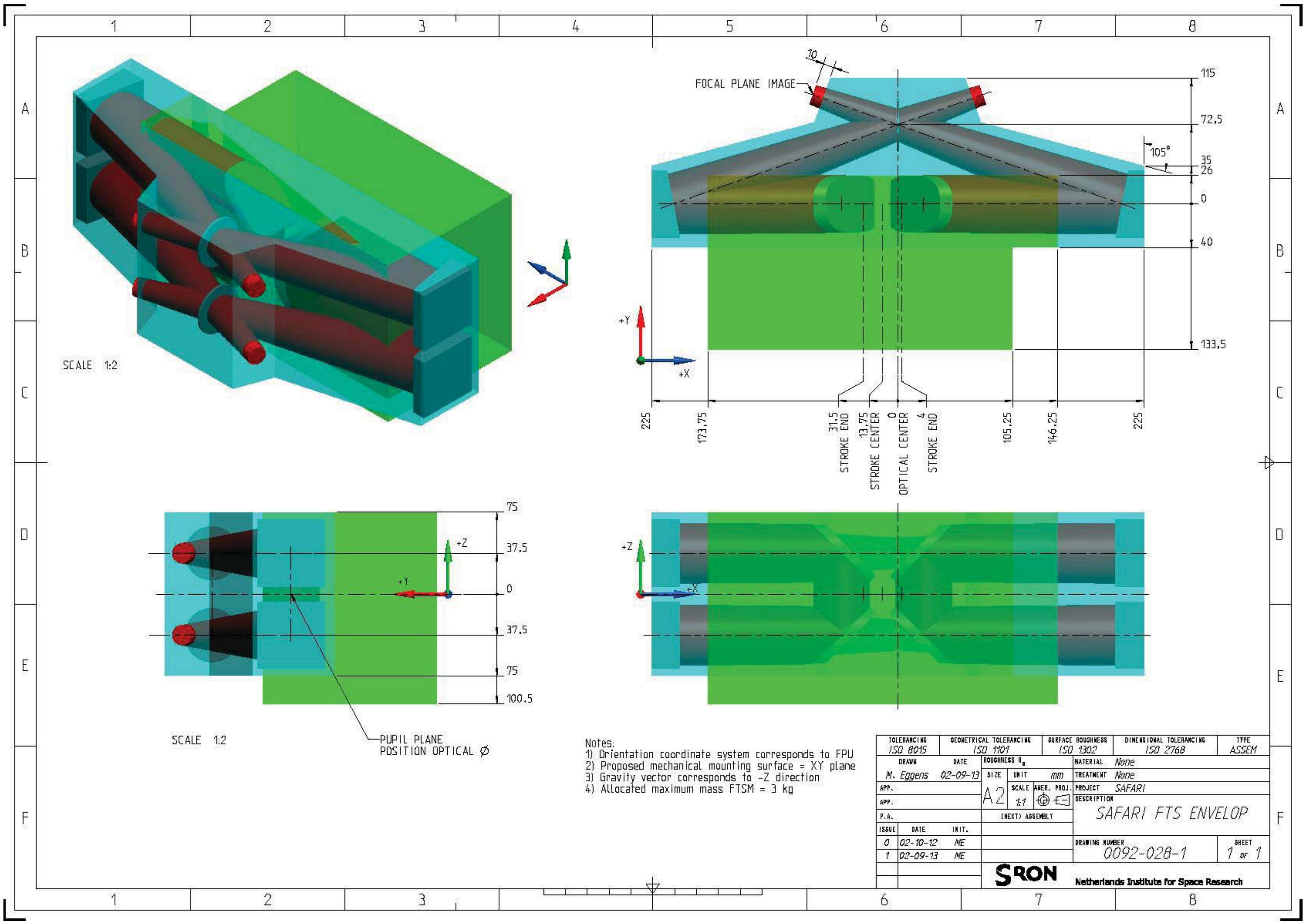
6.9 Alignment concept

TBI

7. List of deliverables

TBI

Appendix A



SCALE 1:2
FOCAL PLANE IMAGE
10
115
72,5
105°
35
26
0
40
133,5
+Y
+X
225
173,75
31,5 STROKE END
13,75 STROKE CENTER
0 OPTICAL CENTER
4 STROKE END
105,25
146,25
225
75
37,5
0
37,5
75
100,5
+Z
+Y
+Z
+X
SCALE 1:2
PUPIL PLANE
POSITION OPTICAL Ø
Notes:
1) Orientation coordinate system corresponds to FPU
2) Proposed mechanical mounting surface = XY plane
3) Gravity vector corresponds to -Z direction
4) Allocated maximum mass FTSM = 3 kg
TOLERANCING ISO 8015
GEOMETRICAL TOLERANCING ISO 1101
SURFACE ROUGHNESS ISO 1302
DIMENSIONAL TOLERANCING ISO 2768
TYPE ASSEM
DRAWN M. Eggens DATE 02-09-13
MATERIAL None
TREATMENT None
PROJECT SAFARI
SIZE A2
UNIT mm
SCALE 1:1
DESCRIPTION SAFARI FTS ENVELOP
ISSUE 0 DATE 02-10-12 INIT. ME
ISSUE 1 DATE 02-09-13 INIT. ME
DRAWING NUMBER 0092-028-1
SHEET 1 of 1
SRON Netherlands Institute for Space Research

Appendix B

To be inserted

Appendix C

To be inserted