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VLTI Visitor Instrument Requirements

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1. Introduction

1.1 Scope

The purpose of this system requirements document is to provide a template that specifies a minimum set of requirements from the observatory. The document will also establish system architecture, interface and requirements, as well as, system acceptance criteria agreed upon ESO and consortia developing the VLTI visitor instrument. The ownership for this document will be with the consortium responsible for the VLTI visitor instrument.

The main goal of these predefined requirements is to ensure that the visitor instrument is designed in a way so that it:

- Fits into the Paranal infrastructure and can make optimal use of the provided resources
- Is able to obtain its optimal performance under the given conditions
- Complies to ESO Paranal safety regulations
- Minimizes the impact on Paranal operations

1.2 Definitions, Acronyms and Abbreviations

This document employs several abbreviations and acronyms to refer concisely to an item, after it has been introduced. The following list is aimed to help the reader in recalling the extended meaning of each short expression:

AD	Applicable Document
AT	Auxiliary Telescope
AIV	Assembly, Integration, Verification
EMC	ElectroMagnetic Compatibility
ESO	European Southern Observatory
IC	Interferometric Complex
ICD	Interface Control Document
ISS	Interferometer Supervisor Software
IT	Information Technology
LAN	Local Area Network
OPD	Optical Path Difference
MLE	Maximum Likely Earthquake
NA	Not Applicable
PSD	Power Spectral Density
RD	Reference Document
RMN	Reflective Memory Network
SCP	Service Connection Point
TBC	To Be Clarified
TBD	To Be Defined
TIM	Time Interface Module
UPS	Uninterruptible Power Supply
UT	Unit Telescope
VLT	Very Large Telescope
VLTI	Very Large Telescope Interferometer

1.3 Requirement Structure

Throughout this document, the following requirement structure is used:

Requirement number	Requirement name
Requirement	
Reference for requirement	Verification method

The requirement number shall be in the following format: VIR-XXX-YYY-ZZZ where XXX states the requirement area (SY for system, IF for interface, EV for environmental, , and TR for training), YYY the specific subarea (e.g. MEC for mechanical interfaces) and ZZZ the requirement numbering.

1.4 Requirement References

For all technical requirements the corresponding reference document with more information is given. Aside from technical requirements this document contains also programmatic requirements that reflect ESO Paranal policies for VLTI visitor instruments. For these requirements an NA is given as in this document serves as reference for policies on how to accept visitor instruments at the Paranal observatory.

2. Related Documents

2.1 Applicable Documents

The following documents, of the exact version shown, form part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this document, the content of this document shall be considered as superseding.

AD references shall be specific about which part of the target document is the subject of the reference.

AD1 Interface Control Document between VLTI and its Instruments (Part I);
ESO-045686 Version X

AD2 VLT Environmental Specification
VLT-SPE-ESO-10000-0004, Issue 6,

AD3 Electrical and Electronic Design Standard;
ESO-044295 Version 4

AD4 VLTI Laser Interlock System;
ESO-276858 Version 1

AD5 Standard Components and Guidelines for Cooling Circuits;
ESO-254314 Version 4

AD6 VLTI Instrumentation Software Specification;
ESO-043105 Version 6

2.2 Reference Documents

The following documents, of the exact version shown herein, are listed as background references only. They are not to be construed as a binding complement to the present document.

RD1 Functional Description of the VLTI with the 2nd Generation of Instruments;
ESO-286900 Version 1

RD2 VIBMET – Design of the VLTI Vibration Metrology Sensor;
ESO-299931 Version 1.6

RD3 VLT Instrumentation Software Template for Software Management Plan;
ESO-043673 Version 1

3. General System Requirements

3.1 Instrument Configuration

Req-SY-CFG-001	Combability of visitor instrument concept
The visitor instrument concept shall be in such a way that no modifications of the VLTI environment presented in AD1 are necessary.	
AD1	Verification: by design

Req-SY-CFG-002	Compliance to ESO soft- and hardware standards
In terms of compliance to the ESO hard- and software standards, the visitor instrument shall choose one of the two approaches stated below: 1. Full compliance to the standards stated in AD6. In that case the visitor instrument can make use of ESO facilities like control network, RMN, time bus and have full communication with all VLTI systems. Also 2. Follow their own standards and act as standalone systems. In that case the visitor instrument shall have no connection to the Paranal VLTI control systems. The configuration and setup of the VLTI shall be made via the ISS while the control of the visitor instrument itself is done through independent means (e.g. dedicated fiber link). The selected approach shall well in advance be discussed with ESO in order to verify its feasibility in the VLTI environment. A mix of both approaches shall not be possible.	
AD6	Verification: by design

Req-SY-CFG-003	Remote control
There shall be no need for physical proximity or local intervention to the instruments during observations. All status and controls, as well as reset/restart procedures shall be under software control and accessible via the instrument LAN or a dedicated fiber link.	
NA	Verification: by design

Req-SY-CFG-004	Configuration changes
There shall not be any modification on the instrument hardware or configuration once the visitor instrument is installed in Paranal without prior agreement from ESO.	
NA	Verification: by planning

Req-SY-CFG-005	Modifications to the VLTI
The visitor instrument team shall not attach or remove any device to the VLTI system without prior approval from ESO.	

NA	Verification: by planning

Req-SY-CFG-006	Network configuration
The visitor instrument team shall not make changes in the network configuration. Specifically, the instrument team shall not change any IP address within their instrument nor attach/detach any cabling that connects the instrument to the VLT LAN.	
NA	Verification: by planning

3.2 Instrument AIV, Maintenance and Operation

3.2.1 AIV Phase

Req-SY-AIV-001	AIV scheduling
The AIV shall be scheduled in such a way that: • VLTI is not closed for more than 4 days. • No more than 2 persons at the same time required in the VLTI lab	
NA	Verification: by planning

Req-SY-AIV-002	AIV tools
AIV teams shall use their own tools for any integration, tests and installation activities. If special tools are needed from ESO, they shall be requested at latest at PAE to ensure availability.	
NA	Verification: by planning

Req-SY-AIV-003	ESO Handling and transportation devices
If ESO Paranal standard handling or transportation devices (described in AD1 -6.2) are intended to be used at any operation, their availability and suitability shall be agreed with ESO before arriving to Paranal.	
NA	Verification: by planning

Req-SY-AIV-004	Equipment labelling
The following labelling shall be applied for components interfacing with the VLTI: • All connectors and used sockets shall be marked to uniquely identify them. Thy shall be the same as those used in the instrument documentation. • Power cables shall identify whether they are intended for normal mains or UPS power.	
NA	Verification: inspection

3.2.2 Maintenance

Req-SY-MAT-001	Execution of preventive maintenance tasks
All preventive maintenance tasks shall be defined in a way that they do not require: • Intervention from ESO personal • More than two persons a • More than one hour per day between end of calibrations and two hours before regular VLTI start-up	
NA	Verification: by planning

Req-SY-MAT-002	Preventive maintenance activities by Paranal staff
The visitor instrument shall be designed in such a way that no regular maintenance activities, except nitrogen refilling, need to be performed by Paranal staff.	
NA	Verification: by planning

Req-SY-MAT-003	Execution corrective maintenance tasks
Corrective tasks shall not require: • intervention from ESO personal • More than two persons • More than one hour per day between end of calibrations and two hours before VLTI start-up	
NA	Verification: by planning

3.2.3 Operations

Req-SY-OPS-001	Presence of visitor instrument team during observations
A visitor instrument shall be operated in visitor mode only, i.e. the presence on-site of instrument team members is required to supervise the observations.	
NA	Verification: by planning

Req-SY-OPS-002	Instrument state when not in operation
The visitor instrument shall be designed that when not operated it can be switched to the following modes without endangering the instrument health: • Stand-by mode when not in operation during an allocated period at VLTI. In this mode, all parts of the instrument that are not required for maintaining network connection or keeping the temperature of critical components shall be powered off. Switching between power-on and stand-by modes shall be done through remote commands. • Fully powered-off at the end of the allocated observation period.	

NA	Verification: by design

3.3 Safety Requirements

Req-SY-SAF-001	Autonomy
Safety critical electronics shall operate without supervision by humans or software. Safety critical electronics shall autonomously and adequately react to emergency conditions that may occur at any time.	
NA	Verification: by design

Req-SY-SAF-002	Alarm an status signals
The visitor instrument shall implement status and alarm signals: • The alarms shall include all in the hazard analysis identified issues that put either persons, the visitor instrument itself or the VLTI environment in danger. • The status signal shall allow to assess the instrument health status.	
NA	Verification: by design

Req-SY-SAF-003	Safe State
In case of emergency, the instrument shall if necessary place itself automatically in a Safe State that maintains the integrity and safety of the instrument and detector.	
NA	Verification: by design

Req-SY-SAF-004	Failure in coolant flow
If the visitor instrument makes use of the VLTI cooling system, it shall incorporate any protection mechanisms necessary to prevent damage to the instrument or its control electronics in the event of a failure in the flow of coolant.	
NA	Verification: by design

Req-SY-SAF-005	Electrical and Electronics safety
Regarding electrical and electronics safety, the instrument shall comply with the design requirements defined in AD3.	
AD3 – 3.2	Verification: by design

Req-SY-SAF-006	VLTI laser interlock

In case a class 3b or higher laser is used, the VLTI laser interlock system [AD4] shall be used after approval of ESO.	
ADX	Verification: by design

Req-SY-SAF-007	Emergency procedures
The responsibility for the instrument safety shall at all times be with the instrument consortium. The consortium shall deliver emergency procedures (power blackout, earthquake, cooling distribution, cryogenic part) that allow Paranal staff to bring the instrument into a safe state for the case this state is not reached automatically, and no consortium staff can be reached.	
NA	Verification: by design

4. Environmental Requirements

4.1 Temperature Requirements

VIR-EV-TMP-001	Operational temperature
The visitor instrument shall be designed so that it is operational between 10 and 18 °C.	
AD1 - 4.3.1	Verification method: by design

4.2 Humidity Requirements

VIR-EV-RHU-001	Operational relative humidity
The visitor instrument shall be designed so that it is operational for a relative humidity between 5% and 50%.	
AD1 - 4.3.2	Verification method: by design

4.3 Seismic Requirements

VIR-EV-SEI-001	Micro-seismic Environment
The instrument shall be designed to meet its performance under the micro-seismic environment defined in AD1.	
AD1 - 4.1.2	Verification method: by design

VIR-EV-SEI-002	Maximum Likely Earthquake

A Maximum Likely Earthquake as defined in AD1 shall not endanger the visitor instrument integrity and/or safety. (especially rupture of cooling lines).	
AD1 - 4.1.2	Verification method: by design

4.4 Acoustic and vibrational requirements

VIR-EV-VIB-001	Acoustic noise generated by instrument
The visitor instrument shall not generate acoustic noise in excess of 50 dB(A) at 2 m in all the directions.	
AD1 – 8.8.1	Verification method: by test

VIR-EV-VIB-002	Vibrations generated by instrument
The vibrations generated by the VI to other VLTI instruments and systems must be so that the cumulated power in terms of OPD over the 0-100Hz frequency range is lower than 20 nm. The verification will be done by ESO in the VLTI lab using the VIBMET tool (RD2).	
AD1 – 8.8.2	Verification method: by test

4.5 Light condition requirements

VIR-EV-LGT-001	Light pollution by visitor instrument
During standby or observation, the visitor instrument inside the VLTI lab shall not have light-emitting devices switched ON and susceptible to be seen by other instruments in the wavelength range: 0.4-2.5 µm.	
AD1 – 8.8.3	Verification method: by test

Req-EV-LGT-002	Light conditions for calibrations
All necessary instrument calibrations that do not tolerate any light (0.4-2.5 µm) in the VLTI lab, shall not take longer than 2 hours per day.	
AD1 – 8.8.3	Verification: by design

5. Interface Requirements

5.1 Mechanical Interfaces

VIR-IF-MEC-001	Use of optical tables in VLTI lab
For the visitor instrument, the optical table VISITOR1/VISITOR2 shall be used.	
AD1 - 5.1.3	Verification: by design

VIR-IF-MEC-002	Visitor instrument volume in the VLTI lab
The volume of the instrument plane shall not exceed the defined volume: • VISITOR1: 200 x 80 x 55 (U x V x W, cm^3) over the table top surface • VISITOR2: 150 x 420 x 80 (U x V x W, cm^3) over the table top surface The exact location for installation can be found in AD1.	
AD1 - 5.1.2.8/.9	Verification: by design

VIR-IF-MEC-003	Visitor instrument volume in C104
The volume for additional equipment in IC104 shall not exceed the defined volume: • VISITOR1: 150 x 80 x 235 (U x V x W, cm^3) above the floor. • VISITOR2: 30 x 80 x 215 (U x V x W, cm^3) and 245 x 80 x 235 (U x V x W, cm^3) above the floor. The exact location for installation can be found in AD1.	
AD1 - 5.1.2.8/.9	Verification: by design

VIR-IF-MEC-004	Instrument weight on optical table
The weight of the instrument installed on the optical table shall not be larger than: • VISITOR1: 400 kg • VISITOR2: 500 kg	
AD1- 5.1.3	Verification: by design

Req-IF-MEC-005	Coolant supply connection through SCP
The instrument cooling system shall be connected via the assigned SCP (Visitor1/Visitor2) as defined in AD1.	
AD1 - 6.3/6.6/6.7	Verification: by design

Req-IF-MEC-006	Cooling connections
The cooling equipment of the instrument shall: • Use self-sealing connectors on both feed and return lines • The hose clamped positively to the connector • Use hoses that are suitable for a working design pressure of at least 12 bar • Be filled and leak tested at pressure of 10 bar before connection	
AD5 - 5	Verification: by design

Req-IF-MEC-007	Cryogenic connectors
The cryogenic connectors shall be compliant with the ESO design.	
AD1 – 6.1.4	Verification: by design

Req-IF-MEC-008	Dewar vacuum gauge
Each dewar shall be equipped with a vacuum gauge remotely readable.	
ADX	Verification: by design

Req-IF-MEC-009	Nitrogen fill state indicators
For each nitrogen tank, the following logical signals (YES/NO) shall be provided: • indicating if the dewar is full • indicating if the tank has more than 2 hours of autonomy left	
ADX	Verification: by design

Req-IF-MEC-010	Primary vacuum connectors
The connector of the primary vacuum shall be compatible to standard KF DN25.	
ADX	Verification: by design

Req-IF-MEC-011	Portable vacuum pump location
The portable vacuum pump shall stay outside the interferometric lab and in IC104 room for the visitor instrument.	
AD1 – 8.8.2	Verification: by design

VIR-IF-MEC-012	Electrical connection through dedicated breakers
For the electrical connection the assigned breakers shall be used: • VISITOR1: • VISITOR2:	
AD1 – 7.3	Verification: by design

VIR-IF-MEC-013	Fiber network connection
Connection to the VLTI fibre infrastructure shall be done through the SCP ports allocated for VISITOR1/VISITOR2 in AD1.	
AD1 - 8.4	Verification: by design

VIR-IF-MEC-014	Fiber types and connectors
For the network connection, the fibres and connectors stated in AD1 shall be used.	
AD1 - 8.4	Verification: by design

VIR-IF-MEC-015	Feedthroughs between VLTI lab and IC104
For the connection between the instrument in the VLTI lab and support equipment in IC104 only the free spaces in the following existing feedthroughs shall be used: • VISITOR1: #1, #2 • VISITOR2: #2, #3.1, #3.2, #3.5, #3.6, #3.8	
AD1 – 9.2	Verification: by design

VIR-IF-MEC-016	Use of cable trays
The visitor instrument shall make use of the existing cable trays outlined in AD1. No unguided free hanging instrument cables or hoses longer than 1 m shall be allowed. • VISITOR1: 9.1.7 • VISITOR2: 9.1.8	
AD1 – 9.1	Verification: by design

5.2 Thermal Interfaces

Req-IF-THE-002	Convected heat load in VLTI lab

The total convected heat load from all heat-producing systems of the visitor instrument shall not exceed 10 W in the VLTI lab.	
AD1	Verification: by test

Req-IF-THE-003	Convected cooling load in VLTI lab
The total convected cooling load from all cold-producing systems of the vistor instrument shall not exceed -20 W in the VLTI lab.	
AD1	Verification: by test

Req-IF-THE-004	Convected heat load in IC102
The total convected heat load from all heat-producing systems of the visitor instrument shall not exceed 1 kW IC102.	
AD1	Verification: by test

Req-IF-THE-005	Convected heat load in CCL
The total convected heat load from all heat-producing systems of the visitor instrument shall not exceed 3 kW in the Combined Coude Lab.	
AD1	Verification: by test

Req-IF-THE-007	Convected heat load in IC104
The total convected heat load from all heat-producing systems of the visitor instrument shall not exceed 3 kW in room IC 104.	
AD1	Verification: by test

Req-IF-THE-008	Surface temperature difference
All equipment of the visitor instrument located in the VLTI lab, shall not have an outer surface temperature different by more than +0.5 / -1°C from the ambient lab air temperature.	
AD1	Verification: by test

Req-IF-THE-009	Coolant return temperature
The coolant return temperature shall not be higher than 8° C above the supply temperature.	

AD1 6.1.1	Verification: by design

Req-IF-THE-010	Coolant flow speed
The visitor instrument cooling system shall be dimensioned such that the coolant flow speed through any part of the system is not greater than 1.2 m/sec	
AD1 - X	Verification: by design

5.3 Electrical Interfaces

VIR-IF-ELE-001	Normal power consumption
The visitor instrument power consumption shall be compliant with the supplied power available from the assigned breakers.	
ADX	Verification: by test

VIR-IF-ELE-001	Power consumption UPS
The instrument UPS power consumption shall be compliant with the supplied power available from the assigned breakers.	
ADX	Verification: by test

VIR-IF-ELE-003	EMC compatibility
Electrical equipment shall respect the EMC requirements stated in AD4.	
AD3 – 3.3	Verification: by test

5.4 Network Interfaces

The requirement in this section are only applicable if Req-SY-CFG-002 -Option 1 (compliant to ESO hard- and software standards and use of ESO control network) is chosen.

VIR-IF-NET-001	LAN connection
The instrument work stations shall connect to the LAN through its own Network Interface Card.	
AD1 - 8.4	Verification: by design

VIR-IF-NET-002	Network address assignment
The visitor instrument shall comply with the address assignment and type of network interface as defined in ADX.	
AD1 -	Verification: by design

VIR-IF-NET-003	Interface between instrument and Data Flow System
The interface between the visitor instrument and the Data Flow System shall comply to ADX.	
AD1 -	Verification: by design

VIR-IF-NET-004	Continuous transfer rate
The continuous transfer rates shall not exceed 100Mbit/sec per computer. More input from IT needed!	
AD1 -	Verification: by design

VIR-IF-NET-005	RMN connection
If the visitor instrument wants to connect to the Reflective Memory Network, it shall comply to the specifications in ADX.	
ADX	Verification: by design

5.5 Instrument Software Interfaces

The requirement in this section are only applicable if Req-SY-CFG-002 -Option 1 (compliant to ESO hard- and software standards and use of ESO control network) is chosen.

VIR-IF-ISW-001	DICB
The instrument shall propose and request approval from the DICB: • The information to be stored in the headers and columns of the different tables • The keywords for the VLT standard main FITS header in form of a dictionary.	
ADX	Verification: by design

VIR-IF-ISW-002	FITS header data retrieval

In order to retrieve FITS header data from VLTI, the Instruments shall use the specific library provided by VLTICS.	
ADX	Verification: by design

5.6 Optical Interfaces

VIR-IF-OPT-001	Optical alignment
Each Instrument shall provide its own mean to materialize the nominal axis of its entrance beams. The alignment procedure that will be used to bring the VLTI reference axes onto the instrument entrance beam shall be defined and agreed with ESO.	
AD-8.9	Verification: by design

VIR-IF-OPT-002	Visitor instrument feeding optics
The visitor instrument team shall provide the optics (mirror or dichroics) for the instrument feeding optics. The provided optics shall be compliant with the opto-mechanical mounts (see AD1) provided by ESO.	
NA	Verification: by design

VIR-IF-OPT-002	IRIS feeding optics
IF the visitor instrument intents to use IRIS, it shall provide the optics that fits into the existing optomechanical mount (AD1).	
NA	Verification: by design

6. Visitor Instrument Acceptance Criteria

Visitor instruments shall demonstrate their compliance with the basic requirements of the observatory. ESO will follow its standard verification rules for such checks, i.e. all requirements will be verified based on documents submitted by the visitor instrument team.

6.1 Requirement Verification

For each requirement a dedicated verification is required. The result of that verification shall be documented in a verification matrix. The following verification methods are requested:

6.1.1 Verification by design

Requirements that request this verification type shall be subject to design review by ESO using computer modelling where necessary. Commercial components shall be checked against manufacturers data sheets and test reports. The results documented in the verification matrix shall be part of the acceptance process for the visitor instrument.

6.1.2 Verification by inspection

Requirements that request a verification by inspection shall be inspected in the lab and the results shall be documented in the verification matrix shall be part of the acceptance process for the visitor instrument.

6.1.3 Verification by test

Requirements that request this verification type, the following test shall be performed:

- For hardware, a test plan shall be established in which the methods for verification are presented. This test plan shall be discussed with ESO well in advance. The execution of the tests and documentation of the results in the verification matrix shall be part of the acceptance process for the visitor instrument.
- For software the proper implementation of the software interfaces and of the templates that address directly the VLT environment will be tested. For this purpose, a dedicated software commissioning shall be foreseen before the start of observations.

6.1.4 Verification by planning

In order to verify the operational and configuration requirements for the visitor instrument presented in chapter 6, a detailed planning of the AIV phase, necessary maintenance activities and operational concept shall be presented and agreed with ESO. The execution of these activities, especially for AIV and maintenance activities shall be tested in the lab before arrival to Paranal. The results shall be documented in the verification matrix.

6.2 Safety requirements

In order to verify the safety related requirements, a preliminary hazard analysis of the instrument for all phases of its re-integration, installation, operation, un-installation and removal following delivery to Paranal shall be provided at the time of proposal. Potential hazards (e.g. high voltages, liquid helium, etc.) shall be explicitly addressed in this analysis.

6.3 Request for Waiver

In the case a requirement cannot be met, ESO shall be contacted immediately in order to discuss and agree on a way forward:

- Issue a request for waiver (RfW). This RfW has to be submitted in a written form and be accepted by ESO.
- In case a RfW cannot be accepted (e.g. critical safety related requirements), discuss and agree possible design changes so that requirements are met or an RfW can be accepted.

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