Organisation for Astronomical Research in the Southern Hemisphere

VERY LARGE TELESCOPE

VLT Observatory requirements for visitor instruments at the VLTI

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CHANGE RECORD

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1	19.08.09	All	Creation. New document, merged from VLTI ICD and UT VI documents.

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LIST OF ABBREVIATIONS & ACRONYMS

AD	Applicable Document
AIV	Assembly, Integration, Verification
AMBER	Astronomical Multi-BEam Recombiner
ARAL	ARtificial sources and ALignment toolkit
AT	Auxiliary Telescope
CAS	Central Alarm System
CCL	Combined Coudé Laboratory
CPU	Central Processing Unit
DFS	Data Flow System
DWG	Applicable Drawing
EMC	Electro-Magnetic Compatibility
ESO	European Southern Observatory
FINITO	Fringe tracking Instrument of NIce and TOrino
GPS	Global Positioning System
ICD	Interface Control Document
IRIS	Infrared Image Sensor
ISS	Interferometer Supervisor Software
IWS	Instrument Workstation
LAN	Local Area Network
LCC	LCU Common Software
LCU	Local Control Unit
MARCEL	Multi-beam Alignment, Reference and Calibration (IR) Emitter for the (VLTI) Laboratory
MIDI	Mid-Infrared Interferometric Instrument
P2PP	Phase 2 Proposal Preparation
PRIMA	Phase Referenced Imaging and Micro-Arcsecond facility
RD	Reference Document
RMN	Reflective Memory Network
SCP	Service Connection Point
SWL	Safe Working Load
TCP/IP	Transmission Control Protocol / Internet Protocol
TCS	Telescope Control System
TIM	Time Interface Module
TRS	Time Reference System
UPS	Uninterruptible Power Supply
UT	Unit Telescope (VLT)
UTC	Universal Time Coordinated
VI	Visitor Instrument
VLT	Very Large Telescope
VLTI	VLT Interferometer
VLTICS	VLTI Control Software
VME	Versa Module Eurocard

LIST OF APPLICABLE AND REFERENCED DOCUMENTS

Applicable documents

AD1	VLT Environmental Specifications VLT-SPE-ESO-10000-0004, Issue 6, 12/11/1997
AD2	Interface Control Document between VLTI Supervisor Software and VLTI Instrumentation

Software,
VLT-ICD-ESO-15410-2117, Issue 4, 24/10/2008

AD3 Paranal Network / Computers / Consoles Specification
VLT-SPE-ESO-17100-3439, Issue 6, 15/03/2009

AD4 Interface Control Document between VLTI Fast Link and Delay Line, OPD Controller, FSU, Instruments,
VLT-ICD-ESO-15400-1954 (updated issue to be delivered)

AD5 Liquid Nitrogen Connection Interface,
VLT-TRE-ESO-15800-2316, Issue 1, 12/09/2000

AD6 Nitrogen Gas Exhaust Connection Interface,
VLT-TRE-ESO-15800-2344, Issue 1, 16/10/2000

AD7 Vacuum and cryogenics standard components,
VLT-TRE-ESO-15800-2315, Issue 1, 18/09/2000

AD8 *Service Connection Point Technical Specification,*
VLT-SPE-ESO-10000-0013, Issue 4, 16/02/1997

AD9 *Electromagnetic compatibility and power quality specification Part 1: electromagnetic environment of the VLT observatory and EMC levels of the power system,*
VLT-SPE-ESO-10000-0002, Issue 2, 11/03/1992

AD10 *Electromagnetic compatibility and power quality specification Part 2: electromagnetic disturbance emission and immunity limits of electric and electronic equipment,*
VLT-SPE-ESO-10000-0003, Issue 1, 05/02/1992

AD11 *VLT electronic design specification,*
VLT-SPE-ESO-10000-0015, Issue 5, 06/03/2001

AD12 *ESO Safety Program*
SAF-POL-ESO-00000-0001, Issue 2.0, 01.09.97

AD13 *Safety Conformity Assessments Procedure*
SAF-INS-ESO-00000-3444, Release pending

AD14 *Requirements for Scientific Instruments on the VLT Unit Telescopes*
VLT-SPE-ESO-1000-2723, Issue 1.0, 18.03.05

AD15 *VLTI infrastructure configuration control,*
VLT-aaa-ESO-15000-xxxx

Reference documents

RD1 Interface Control Document between VLTI and its Instruments
VLT-ICD-ESO-15000-1826, Issue 5.0, 12/08/2006

RD2 Interface Control Document between VLTI and its Instruments (Part I)
VLT-ICD-ESO-15000-1826, Issue 6.0, 22/09/2009

RD3 The VLT white book, available from the ESO website at
http://www.eso.org/public/outreach/products/publ/reports/whitebook/wb-contents.html

RD4 VLTI Instrumentation Software Specification
VLT-SPE-ESO-17212-0001, Issue 5, 30/09/2005

RD5 VLTI Instrumentation Software, Template for Software Management Plan
VLT-PLA-ESO-17240-3786, Issue 1, 30/09/2005

RD6 Final Lay-out of VLT Control LANs
VLT-SPE-ESO-17120-1355, Issue 2, 21/07/2003

RD7 Final Lay-out of VLTI Control LANs
VLT-SPE-ESO-15410-1957, Issue 4, 02/07/2004

RD8 VLTI Time Reference System Specification
VLT-SPE-ESO-17300-0376, Issue 1, 04/05/93

RD9 VLT Observatory Requirements for Combined Coudé Instruments
VLT-TRE-ESO-11500-4518, Issue 1, 10/10/2008

RD10 Liquid Nitrogen Distribution for LISA,
VLT-TRE-ESO-15810-2418, Issue 1.0, 13/12/2000

RD11 AMBER Cryostats Filling and Warming up Procedures,
VLT-PRO-AMB-15830-0003, Issue 2.0, 13/01/2004

RD12 Liquid Nitrogen Distribution for MIDI,
VLT-TRE-ESO-15820-2394, Issue 1.0, 17/10/2000

RD13 VLT Paranal Network/Computers/Consoles - Design Description,
VLT-SPE-ESO-17100-3439, Issue 1.0, TBD

RD14 Guideline for the ESO Safety Conformity Assessment Procedure
SAF-INS-ESO-00000-3445, Release pending

RD15 Lockout/Tagout Procedure for Telescope
VLT-PRO-ESO-11000-3396, Issue 1.0, 16/08/2004

RD16 Safety and Emergency Procedure
VLT-PRO-ESO-00000-3399, Issue 1.0, 16/08/2004

RD17 Reflective Memory Access – Simple and Secure Software Design and User Manual
VLT-MAN-ESO-17210-4690, Issue 1.0, 13/02/2009

RD18 Implementation of an Alarm System for the Paranal Observatory
VLT-SPE-ESO-12115-2795, Issue 2.0, 24/09/2004

RD19 Paranal Instrument Interface Document
VLT-SPE-ESO-17100-4838

Applicable drawings

DWG1 Interferometric laboratory Optical Layout,
VLT-DWG-ESO-15000-1738, Issue D, 12/05/2006

DWG2 Interferometric complex Section A-B, feed-through as built,
VLT-ESO-12216-0102012, Issue 02, 16/06/2000

1 Introduction

This document describes the minimum requirements for a visitor instrument to be successfully installed in the VLTI laboratory at Paranal. The document is a subset of the Interface Control Document between VLTI and its instruments (RD1 and RD2) with some additional explanations with respect to visitor instrumentation.

- Items in **bold font are mandatory requirements**,
- Items in *italic font are of major significance*.

Issues regarding the safety at the VLT, mechanical and electrical interfaces, network interfaces and environmental impact (e.g. electromagnetic interference, mechanical/vibrational interference with VLTI) are of paramount importance to the operation of the VLT/VLTI facility and the security of the personnel, and cannot be violated irrespective of the status of the instrument. ESO reserves the right to request an acceptance test in Europe where the instrument shall be demonstrated to be safe.

This document also contains general information on the design of the VLTI, the infrastructure at the Paranal Observatory, and on the various interfaces between the Observatory and Visitor Instruments (VI) installed at the VLTI. Prospective instrument builders should use such general information to optimize their designs and interactions with the facility.

Although this document has been created with great care it is strongly advised to double-check with the ESO contact person all necessary details before designing critical items.

2 A visitor instrument

2.1 General description

A visitor instrument is defined as an instrument that shall be installed in the VLTI laboratory but not operated by ESO. Such an instrument may avoid some of the requirements placed on normal ESO instrumentation. It is the aim of this document to specify the interfaces and requirements that such an instrument will have to meet in order to successfully operate at the VLTI, either with the Auxiliary Telescopes or the Unit Telescopes.

The fact that the VLTI instruments are installed in the interferometric laboratory and thus share environment with other VLTI instruments and systems is the reason for various requirements towards visitor instruments.

Technical support for visitor instruments shall be, a priori, limited to supervision and assistance with installing and removing of the general infrastructure of the instrument in the VLTI laboratory, and connecting the instrumentation computer facilities to the VLT LAN.

A VI instrument is operated in visitor mode only, i.e. the presence on-site of the PI or the co-PI of the program is required to supervise the observations. *ESO reserves the right to limit the number of persons from the VI team present on site during integration and operation phases of the VI instrument, in order to ensure a limited impact on the regular VLT operations*. Support from telescope operator and astronomer will be provided by ESO.

It is explicitly not permitted that the instrument team attaches any device to the VLTI system without prior approval. The visitor instrument team cannot make changes in the network configuration.

Specifically the instrument team must not change any IP address within their instrument nor attach/detach any cabling that connects the instrument to the VLT LAN. Such modifications can only be made by authorized ESO staff or persons authorized by ESO.

It is explicitly not permitted to do any modification on the instrument hardware or configuration once the instrument has been installed without prior agreement with ESO.

2.2 Visitor instrument guidelines for design and operation

The points below present the general guideline and give an overview for the design of a visitor instrument for the VLTI. They are further elaborated upon within the document. However, they are explicitly mentioned here to emphasize the importance that ESO places upon these issues.

The compliance to the following points is considered mandatory for the design and operation of a VI, and shall be used as general guidelines in the earliest stage of the VI design and proposal. The list below is not exhaustive but represents aspects considered to be of high importance. Some of the points are described in more detailed in the document.

GENERAL RULES

1 Paranal is located in a seismically active area. Provisions have to be made such that the instrument is secured in case of earthquake at all times including the times of mounting and dismounting. The safety of the personnel and equipment has to be assured.

2 During all the periods when a VI is operated at the VLTI, a member of the VI team shall be present on the mountain. Exceptions shall be authorized beforehand in writing by ESO.

3 The VI must be complaint with the existing and validated infrastructure and systems of the VLTI at the time of the proposal. If the VI requires an operation mode different from the ones offered in regular operation, it shall be discussed in advance with ESO and the possibility checked in term of schedule and cost. *ESO does not commit on delivering operation modes outside of the ones offered for regular operations.*

DESIGN RULES

4 The VLTI ICDs (RD1 and RD2) shall be extensively used for the design of VI. Except if stated otherwise in this document, the requirements for VLTI instruments described in the ICDs are also applicable to VIs.

5 VI shall be designed in order to allow performing the daily calibrations of the other VLTI instruments.

6 VI must allow at all time access and movement of persons inside the interferometric laboratory and tunnels to allow maintenance and servicing of other systems.

7 The interferometric laboratory shall be restored in its original state at the end of the time granted to VI to allow an immediate return to regular VLTI operation.

8 The space allocated for the VI in the interferometric complex (see section 8.2) shall be discussed with ESO at early stage. Available space is subject to VLTI instruments and systems developments.

9 VI teams shall discuss and agree with ESO the details of the integration activities well before the planned start of instrument integration on Paranal (see section 6.1).

10 The level of support provided by Paranal to VI integration and operation will depend on the level of compliance to the VLTI standards (hardware, software). Non ESO compliant VI shall not rely on any support from Paranal for operation. Request of ESO support to VI shall be discussed well in advance and agreed with ESO.

11 VI shall be designed in order to limit to the minimum possible the access to and presence of

persons in the interferometric laboratory.

12 There must be no needs for physical proximity or local intervention to the VI during observations.

13 The VI shall be strictly compliant with thermal and environmental requirements for the interferometric laboratory (see section 8.6.1, 8.7 and 8.8). ESO reserves the right to conduct its own tests and verification to ensure compliance. Special care must be taken of analyzing the thermal emission and vibration generation.

14 All instrument parts that dissipate power shall be cooled by water (see section 8.7.1.1).

15 No system attached to the VLT may interfere with the Local Area Network configuration or permissions. Visitor instruments must comply with the observatory rules for connectivity.

16 No system attached to the VLT may produce electromagnetic interference incompatible with the ESO specifications.

17 The level of compliance of VI to ESO software shall be clearly stated and discussed in details with ESO (see section 7).

18 The VI shall be designed and delivered to Paranal as a self-contained system.

19 A VI might be allowed to remain installed inside the interferometric laboratory outside the allocated VI time slot. The instrument must then not interfere with regular operation. This option shall be authorized in writing by ESO. The VI must therefore allow the possibility for a complete shutdown, to ensure that no acoustic noise, vibrations, light pollution or thermal load is introduced while not in use.

20 Storage of the VI after periods of use shall be agreed with ESO before installation (see section 6.3).

2.3 VI interface with VLTI

The interfaces of instruments with the VLTI are described in RD1 and RD2. The information contained in those documents also applies to visitor instruments. The performances of the VLTI systems, the characteristics and quality of the beams delivered to instruments are also presented in those documents and shall be used for the design of the VI.

Requirements specifics to VIs are described in this document.

The software and hardware compatibility of VI with VLTI are described respectively in sections 7.1 and 8.6.2. *It is strongly recommended that the VI teams discuss with ESO the level of compatibility before submitting their proposal.*

A complete compliance of the VI would involve a significantly higher support from Paranal staff during the integration (RMN, BOB, UT/AT TCS and ISS) as well as during operation. *This shall be discussed well in advance with ESO and shall be considered in the proposal*. In order to be fully compliant, the involvement of instrumentation and software staff should be ensured at all projects stages.

2.4 Change procedures and document hierarchy

All VLT VIs shall conform to the mandatory requirements contained in this document and in the Applicable Documents (AD). *Deviations from the applicable documents and requirements contained herein have to be approved in writing by ESO, following the VLT Change Request or Request For Waiver procedures.*

3 The Very Large Telescope Interferometer Project.

In this section we describe the overall VLT system, including operational parameters and descriptions.

3.1 VLT concept

The general concept of the Very Large Telescope and its principal performance goals are given in RD3. The observatory has the following main elements:

- Four 8-metre diameter telescopes with their enclosures, each with two Nasmyth foci, a Cassegrain focus and a Coudé focus,
- An interferometer and its supporting auxiliary telescopes,
- Optical and infrared instrumentation,
- Control and communication systems to support both service mode and visitor mode observing,
- A 2.6m VLT Survey Telescope (VST),
- A 4m Visible and Infrared Survey Telescope for Astronomy (VISTA),
- Observatory infrastructure for technical support and for the accommodation of personnel.

3.2 VLT location

The VLTI is located on Cerro Paranal in northern Chile, at a distance of 130 km from the city of Antofagasta, at an altitude of 2635 m above sea level. Access to the observatory is from the Panamericana via 70 km of paved road. Width of the road is 6 m, load width ≤12 m and gradient ≤12%.

3.3 VLT site

The Paranal Observatory comprises three main locations: the Telescope Area at the summit, the “NTT Peak” with VISTA, and the Base Camp with the Residencia and Maintenance Areas. A distance of 3.4 km separates base Camp and Telescope Area. The Telescope Area contains mainly the telescopes, the combined focus and interferometric laboratories, service laboratories and the Control Building.

The plan view of the Telescope Area of the observatory is shown in Figure 1.

3.4 Site infrastructure

The main facilities that are available at the Paranal Observatory are as follows:

1. Telescope Area:
    (a) The four Unit Telescopes and their enclosures,
    (b) VLT Interferometer (VLTI) with four auxiliary telescopes (ATs) which feed the interferometric laboratory,
    (c) The VLT Survey Telescope (VST),
    (d) The Control Building, separated from the telescope enclosures, with
        - Optical and electronics laboratories,
        - Laboratory for instrument integration and tests,
    (e) Time Reference System and Astronomical Site Monitors,
    (f) Facilities for the supply of electrical power, compressed air and cooling liquid, telecommunications facilities.
2. Maintenance Area:

 (a) Mirror maintenance facility,
 (b) Auxiliary Telescope Hall,
 (c) Warehouse and storage facilities,
 (d) Facilities for the storage of liquid nitrogen. No provisions are made for the supply of liquid Helium, and its use is considered incompatible with operations of VLT science instruments.
3. Residencia:
 (a) Accommodation for site personnel and visitors (visiting astronomers, instrument teams); in case the Residencia's capacity is exhausted visitors will have to be transferred to containers,
 (b) Restaurant and recreational facilities.
4. General services:
 (a) On-site technical personnel. The use of ESO technical staff to service a visitor instrument (e.g. LN2 refill) requires prior agreement between the visitor instrument team and ESO.
 (b) Standard vehicles for the handling of equipment and transportation of personnel. No automatic allocation of vehicles to a visitor instrument team should be assumed. Car-pooling is the norm on Paranal.

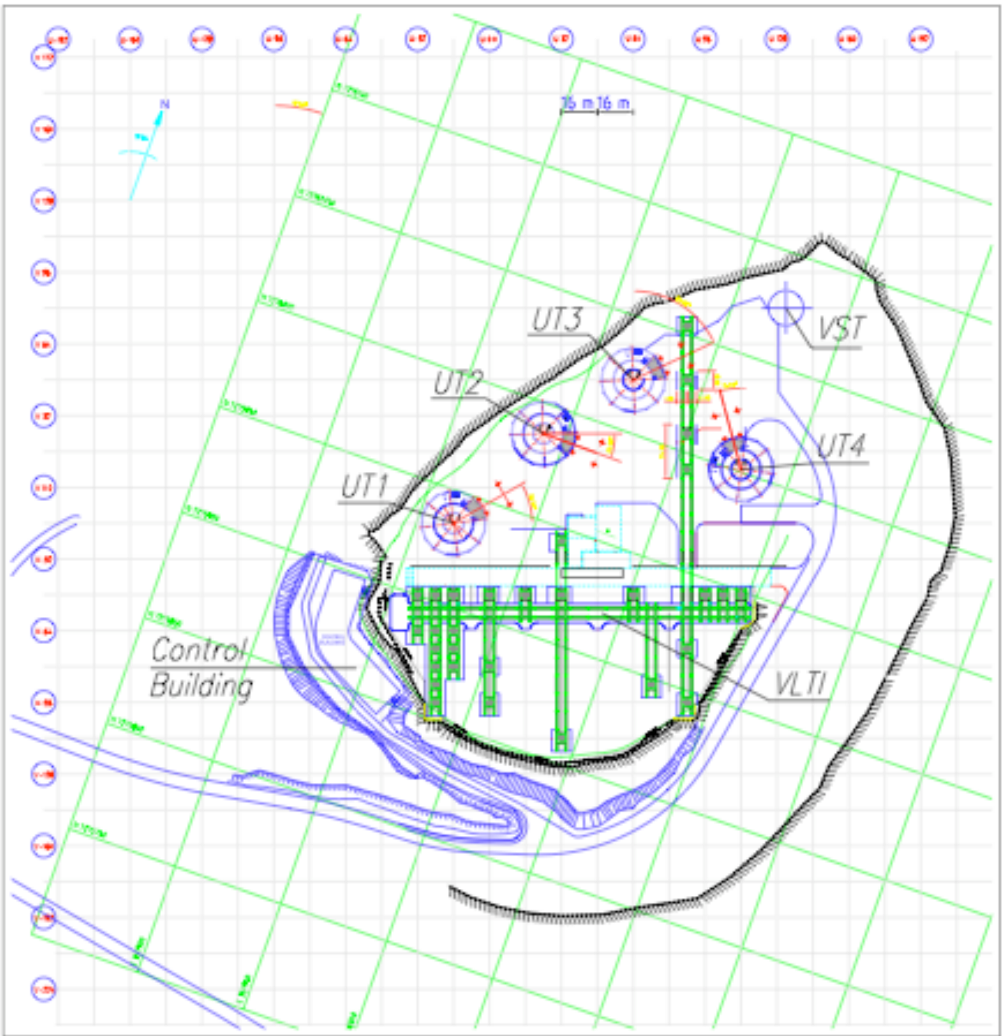

Figure 1 – Plan of the telescope area of the Paranal observatory.

3.5 Astronomical Site Monitors

Information on the environmental conditions at Paranal is given in AD1.

The observatory operates a central Astronomical Site Monitor (ASM) to provide continuous monitoring of the prevailing astronomical conditions at Paranal as well as meteorological data. This information is available to instrument control software via the Online Database System. The facility also provides an archiving system to allow the accumulation of statistics for modelling and prediction.

In addition to the prevailing conditions, ESO calculates and distributes off-line prediction of the meteorological conditions at its observatories: http://www.eso.org/gen-fac/pubs/astclim/forecast/meteo/.

The statistical distribution of the FWHM image diameter at Paranal, from data collected between 1999 and 2004, is shown in Figure 2. The median seeing at the site is 0.8 arcsecond (@λ=0.5μm). Figure 3 presents the statistics of coherence time at Paranal for the year 2005. The median Tau0 was 2.8 ms.

The latest statistical information on coherence time and isoplanatic angle at Paranal can be found at: http://www.eso.org/gen-fac/pubs/astclim/paranal/seeing/adaptive-optics/.

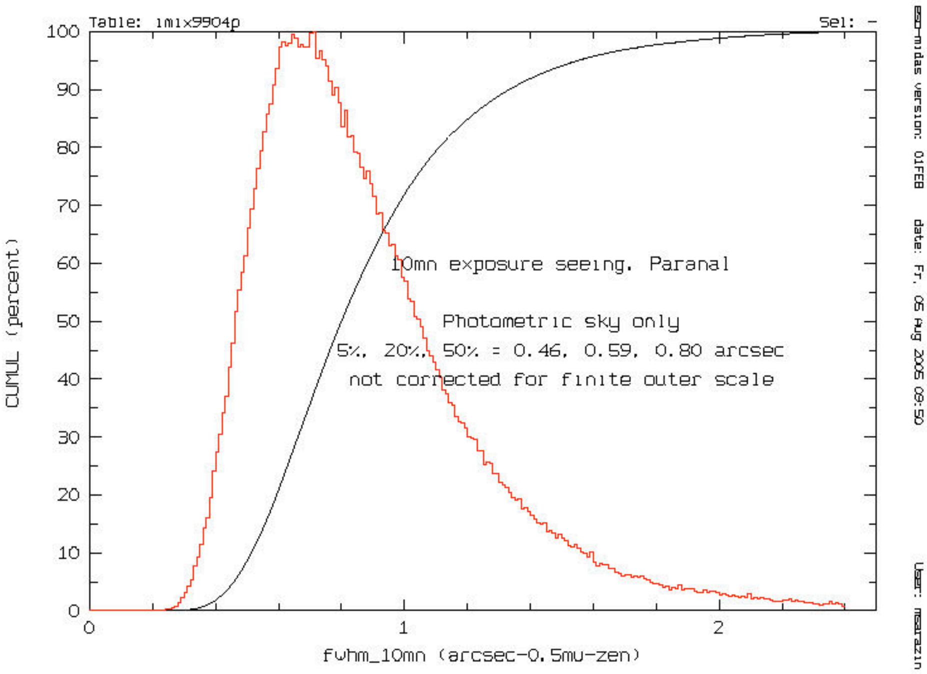

Figure 2 - Statistical distribution of FWHM image diameters at Paranal (10 minutes average, 500 nm at zenith) for the years 1999-2004.

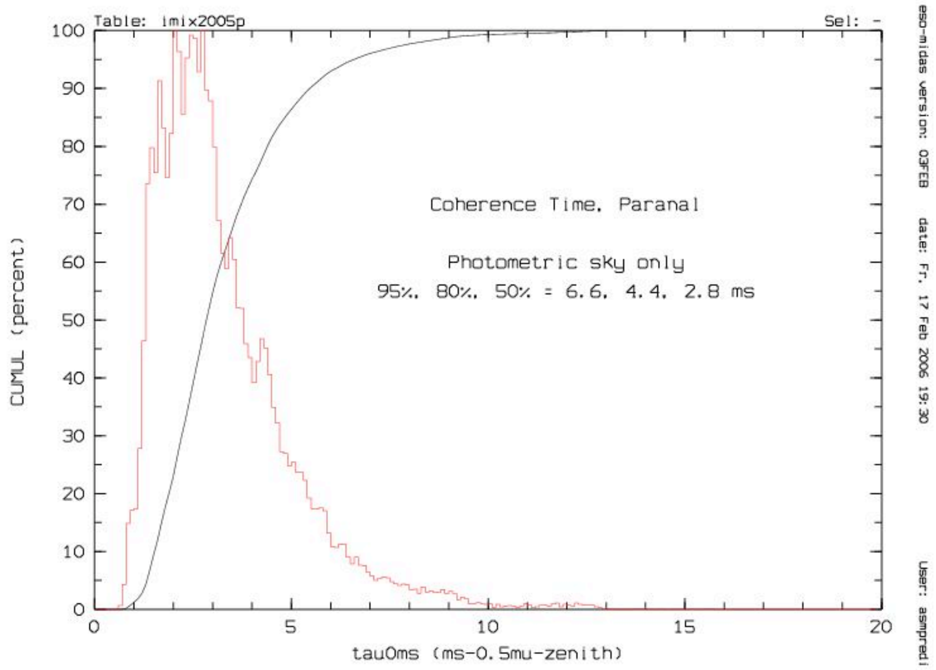

Figure 3 - Statistical distribution of coherence time at Paranal (10 minutes average, 500 nm at zenith) for the year 2005.

4 Visitor instrument operation

This section gives a short overview of the standard way of operating the VLTI, with particular considerations of VIs.

All VI operations are executed from the console that is located in the interferometric complex in the telescope area near the top of Cerro Paranal.

The VLTI console consist of:

- Telescopes control,
- Environmental information (temperature, humidity, wind, seeing, coherence time, etc…),
- Delay Line (DL) control,
- Interferometer Supervisor control,
- Instrument control.

Calibrations are done during daytime. Nighttime calibrations are not permitted. Access to the Telescope Area of Paranal is unrestricted during daytime. Access to the VLTI laboratory needs authorization by the VLTI manager who coordinates the various activities at the VLTI (science activities like calibrations, maintenance, commissioning etc.). It is allowed by default only during daytime. Any regular or planned maintenance or intervention shall be done during daytime.

Access to the DL tunnel area is not allowed during daytime and nighttime.

Nighttime access to the VLTI laboratory is restricted to urgent cases (crucial malfunction, emergencies). It normally also needs VLTI manager authorization. Nighttime car traffic at the observatory should be kept at a minimum and is subject to special restrictions.

The way a VI is being operated strongly depends on the chosen level of compliance with the VLT software and hardware:

1. In the case of a fully compliant instrument (option 1, see section 7.1) operations of a VI are essentially identical to operations of a facility instrument (see Figure 4): Observation Blocks (OB) can be prepared using P2PP, are handed over to the Broker of Observation Blocks (BOB) inside the VLTI DFS and are executed in the standard way. BOB sends setup commands to the instrument and to the ISS via LAN and, upon receiving the relevant feedback from the ISS, executes the observations. Observation data can be processed by the DFS.
2. In the case of a standalone system (option 2, see section 7.1) all VLTI operations (entry of coordinates for target acquisition, etc.) are done independent from the instrument on the ISS console. A Visitor Instrument template is available which controls the pointing of the VLTI; the VI team is informed when the VLTI is guiding and tracking so that the exposure can be started. All operations of the VI are controlled from a computer that is located at the console via an optical fiber linking it directly to the instrument control unit on the VI. The VI computer is not connected to the VLTI LAN but can receive an ntp time signal through an Internet connection; this enables time synchronization with the VLTI computers. VI instruments shall have to use their own data acquisition.

In all cases (option 1 or option2), the VI team is responsible for the data storage. ESO will not provide disk space for storage of the VI technical and scientific data. The data reduction is under entire responsibility of the VI team. No pipeline for data reduction will be installed and maintained by ESO.

Independent of the chosen option the following rules applies:

1. **During all the periods when a VI is operated at the VLTI, a member of the VI team shall be present on the mountain. Exceptions shall be authorized beforehand in writing by ESO**. *For the case that no VI team member is present on the mountain, ESO reserves the right to intervene on the VI if this is required to ensure the safety or integrity of the VLTI, its installations or of the VI.* Possible interventions may include the removal of the VI from the interferometric laboratory.
2. Spare parts are the sole responsibility of the VI team.
3. The supply of consumables (except LN2) is the sole responsibility of the VI team.
4. ESO will provide the VI team with LN2 in 120 liters tanks as much as needed.

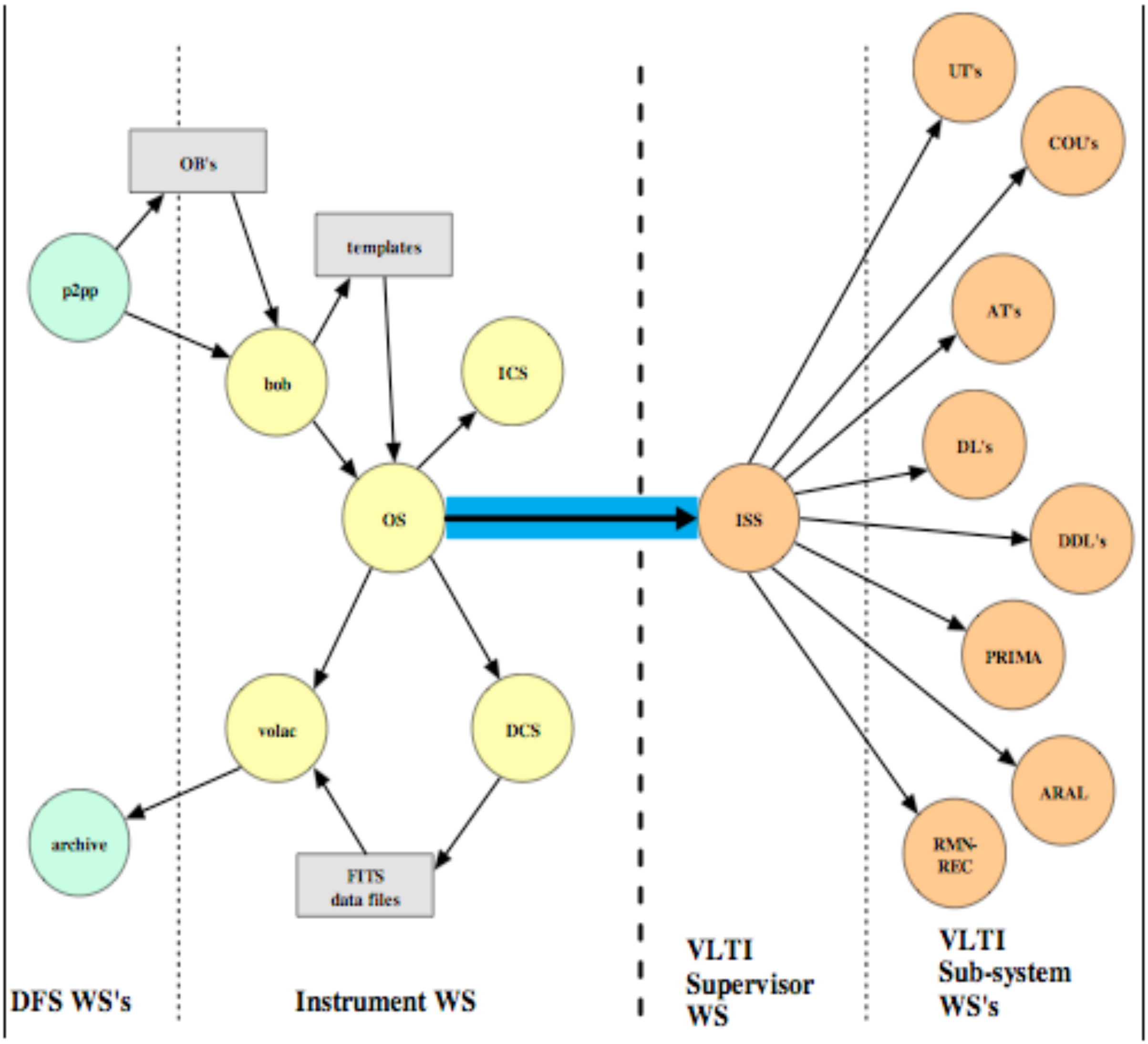

Figure 4 - Principles of software architecture for VLTI Instruments and location of interface to VLTI.

5 Requirements on Instrument Implementation

In addition to the requirements mentioned elsewhere in this document, there are several other considerations that must be respected for all VLT instruments. These are necessary because of the need for multiple-telescope use as well as for maintenance purposes. A number of these implementation requirements are explicitly referring to issues related to the interfacing of an instrument on the VLTI. As such some applicability for VIs exists as marked below.

1. **There must 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 the dedicated fiber link**. This is applicable to all VIs irrespective of the software solution proposed (see section 7.1).

2. **There shall be no special hardware links between the instrument LCU and the IWS or the user**, such as command switches or potentiometers, lamp displays, oscilloscope displays, etc. This is also applicable to VIs.

3. **VIs shall be conceived so that they can be switched to stand-by mode when they are not in operation during an allocated period at VLTI. In this mode, all parts of the instrument and its associated ancillary equipment that are not required for reasons of maintaining LAN contact, or for maintaining the temperature of critical components (for example detectors) should, where possible, be powered off. Switching between power-on and stand-by modes shall be done through remote commands.**

4. **Vis shall be conceived so that they can be safely fully powered off at the end of the allocated period.**

5. Cryostats for instrument and/or detector cooling should not require re-filling more frequently than once every 24-hours after the normal operating temperature has been attained. A filled LN2 tank (manufacturer: Cryodiffusion; type: XRP 120; capacity 127 liters, flange diameter NW50) will be provided by ESO upon request. A manometer shall be fitted on the transfer head to enable a reading of the pressure in the tank. The refilling of the instrument or detector cryostat shall be done under supervision by the VI team. **The possibilities of connections between the LN2 tank and cryostats are described in section 8.4.1.** *The chosen solution for LN2 connection, as described in section 8.4.1, shall be discussed well in advance with ESO.*

6. **The VI shall be designed in order to always allow performing the daily calibrations of the other VLTI instruments.**

7. **It is not required from VI design to allow return to non-VI VLTI operation during a night of the VI allocated period.**

8. **The VI design shall allow immediate return of the VLTI in regular operation at the end of the period allocated to the VI.** This can be achieved through two options:

    - The VI is designed to allow an easy removal and is thus moved out of the interferometric laboratory.

    - The VI remains installed in the interferometric laboratory and must thus show to have no impact on the regular operation. **Authorization to leave the VI installed shall be discussed with ESO and agreed in writing.**

6 Visitor Instrument integration, handling and storage

The detailed planning of all installation activities, including schedule and required resources (manpower, equipment) shall be closely coordinated with ESO.

6.1 Instrument integration

Different options can be envisioned for instrument integration: in the instrument integration facility, in the VLTI complex outside the interferometric laboratory with then a transport of the fully integrated instrument to the laboratory, or in the VLTI complex inside the laboratory. The option for integration will be based on the integration scenario and schedule, and will be discussed on a case-by-case basis.

In all cases, the VI design and integration scenario shall be made to comply with the access possibilities to the interferometric laboratory, as described in section 8.3. The dimensions of the main accesses are summarized in section 8.3.7.

VI teams shall discuss and agree with ESO the details of the integration activities well before the planned start of instrument integration on Paranal. **This is to ensure that there are no conflicts between different teams in the use of the space inside the laboratory and handling equipments.**

VI teams shall use their own tools for any integration, tests and installation activities. Needs for specific tools must be asked well in advance to ESO to ensure availability. VI teams shall bring their own pumps for cryostats. **Pumping systems are available at Paranal but their availability and types is not guaranteed by ESO. If needed, the use of Paranal pumping systems shall be discussed and agreed with ESO.**

6.1.1 Instrument integration facility

This facility is currently inside the control building and comprises:

1. Space: a floor area of up to 6.7 x 13.5 m ^{2}.
2. Access to a small (ca 10 m^2) lower class (100.000 with one person inside) clean room.
3. Standard Service Connection Point (SCP) with electric mains, LAN connection and cooling water.
4. Filtered compressed air.
5. Terminals.
6. Size of access door: 3.1 m x 3.0 m (width x height).
7. Overhead crane serving part of the area: SWL = 5 t, maximum hook height = 3350 m above the floor, positioning accuracy suitable for handling of delicate equipments.

As the Control Building is located in the Telescope Area integration work should preferably be done during the day; nighttime access is strictly controlled and needs prior authorization.

6.1.2 Integration outside the interferometric laboratory

For the integration phase, an optical table might be installed in the Combined Coudé Laboratory (see section 8.3.1.2) in order to avoid interference with the instruments already in use in the interferometric laboratory. **The availability of an optical table for integration is not granted and shall be discussed with ESO.**

Once the instrument has been integrated and tests that do not require the use of telescopes, VLTI systems, or VLTI calibration light have been performed, the instrument can be moved to the interferometric lab. To facilitate this last step, it is desirable to have the instrument made out of modules easily transportable. Once in the interferometric lab, access should be restricted to a minimum in order to maintain the proper conditions of cleanliness and thermal equilibrium.

6.1.3 Integration inside interferometric laboratory

Integration inside the interferometric laboratory is not compatible with normal operation of the other VLTI instruments. This option can be permitted only for integration work that is not very time consuming. **For this option, the planning of integration shall be discussed with ESO and specific technical time shall be requested to ESO to be included in the Paranal schedule**. The period of integration in the laboratory shall be counted as VLTI time awarded to the VI team, as nights will not be available for regular VLTI observations. Access to the VLTI laboratory might not be granted full time, as mandatory daily calibrations and maintenance of instruments and systems in operation might exclude presence of persons in the laboratory. Their duration depends on the amount and kind of the calibrations and maintenance to be executed. In any case the calibrations have priority over VI integration activities.

6.2 Instrument transport

If integrated in the instrument integration facility, the instrument will be carried to the VLTI after assembly and tests (distance of about 0.5 km on asphalted road). Normally the instrument trailer is used to carry the instrument on its carriage. The instrument carriage shall be provided with the instrument by the VI team. The carriage shall be designed so that the full instrument can be moved at once after integration. The carriage shall ensure the stability of the instrument during transport and handling.

The following standard handling and transport devices are available at the Paranal Observatory:

1. Medium forklift, motorized.
   Safe Working Load (SWL) = 3.5 t at 0.5 m and 1.5 t at 1.0 m from the fork base.
2. Small fork lift, hand operated.
   SWL = 2.5 t at 0.5 m, normally located at Mirror Maintenance Building (MMB).
3. Control building integration facility crane serving part of the area.
   SWL = 5 t, maximum hook height 3350 mm above the floor, positioning accuracy suitable for the handling of delicate equipment.
4. Truck including crane:
   Crane: mounted at the rear end of the platform. Its SWL is 3 t at 3 m.
   Platform: height ~ 1.2 m, length = 5 m, width: standard truck size, load capacity 7 t.
5. Instrument trailer:
   SWL = 5 t, platform size 5.0 m x 2.5 m (l x w); height 0.5 m which can be reduced to ~ 0.4 m.
6. Interferometric laboratory bridge crane:
   SWL = 5t, maximum hook height 4250 mm above the floor, positioning accuracy suitable for the handling of delicate equipment.
   Used to move the instrument from a trailer or carriage onto its final location.

Availability and suitability of these devices for the intended use shall be clarified with and confirmed in writing by ESO before incorporating them into the individual instrument operations, handling or maintenance plans.

In addition all basic devices (ropes, chains, shackles, etc) necessary to move or secure loads up to 10 t are available. It is however recommended that instrument teams check with ESO which devices are needed and possibly bring their own set.

6.3 Instrument storage

No provisions are made by default for protected storage of the VI other than when it is installed in the interferometric laboratory. At the request of the VI team ESO may however make storage space available for a VI packed in its transport container, but space inside a Paranal building cannot be guaranteed. Outside storage must be considered. Environmental conditions of such storage may be harsh, including rain, snow, strong wind and solar irradiation. As an indication the measured temperature inside a white painted sea container exceeded +30°C at times. *ESO will not accept any responsibility for a VI stored at Paranal*. **The exact terms of storage at Paranal shall therefore be negotiated beforehand with ESO.**

7 The VLTI and instrument control systems

7.1 Software interface

The interface requirements between the VLTI Control Software and the VLTI Instrument Control Software are defined in the specific document: AD2.

The VLTI is controlled at high level by:

VLTI Control Software (VLTICS) – The complete control software required to operate the interferometer including all its subsystems. It does not include the VLTI Instrumentation control software, or the Data Flow systems, although it defines the infrastructure and interfaces applicable to those systems.

VLTI Supervisor Software (ISS) – The VLTICS subsystem on the highest hierarchical level. It is responsible for coordinating the whole VLTI, configuration of the array and to provide the external interface.

The instruments see the VLTI as one entity and not as a set of individual telescopes and delay lines. One set of setup requests, i.e. right ascension, declination etc., is being broadcast to all individual telescopes and delay lines by ISS. In the same way ISS provides one set of data to the instrument describing, for example, the actual coordinates for VLTI and not coordinates for individual telescopes.

It is the responsibility of ISS to guarantee that all telescopes look at the same source and to determine the VLTI coordinates based on the coordinates from the individual telescopes.

VLTI can use two different types of telescopes: Unit Telescopes (UT) or Auxiliary Telescopes (AT). The differences between these telescopes are hidden by ISS, e.g. the instrumentation software shall not require any knowledge of which type of telescope is currently used. This allows writing acquisition templates independent of which type of telescopes will be used. Nevertheless it is important to understand some of these differences, particularly related to guide stars, in order to write efficient instrumentation software to interface to VLTI.

The standalone operation of an instrument is possible, the setup of the VLTI system being done by the ISS.

Two options are presented below. They offer different levels of functionality. The specific proposal for compliance in the area of software should be assessed on a case-by-case basis. The level of compliance described below will define the permission to be installed on the VLT LAN and communicate with the ISS.

1. Complete compliance: All software and electronics hardware systems comply with the VLT standards. This will allow the use of P2PP and the DFS to execute observations as well as full communication with all subsystems of the VLTI. ESO does provide standard software packages for the instrument control both at the Local Control Unit (LCU) and workstation level and for the Observation Software at the workstation level (Baseline Observation and Instrument Control Software). Assuming the hardware (LCU) is VLT compliant then only configuration files need to be specified for the instrument control software. This is the standard for facility instruments.
2. The standalone system: There is no software connection between the VLTI control system and the VI. The VI can therefore not communicate with any other VLTI system. Target coordinates, etc., are entered on the ISS console. Commands to the instrument (start/stop exposure etc.) are transmitted by optical fibers. This option has been successfully applied to VIs on UTs.

The requirements on software supplied with fully VLT compliant instruments are contained in the following documents and the references contained therein. These documents also define the software standards to be adopted for VLT instrumentation:

- 'VLT Instrumentation Software Specification' (RD4).
- 'Template for Software Management Plan' (RD5).

A non-compliant VI may deviate from these requirements. In the case of a fully VLT compliant VI more VLT software documents are applicable.

VI consortia shall discuss these issues with ESO well in advance and at early stage of the project.

Any visitor instrument proposal shall include a section on software which elaborates which level of compatibility (option 1 or 2) the instrument team proposes to implement and how in the case of option 1 they plan to achieve this. *It is reminded that - except in the case of a standalone VI - the VLTI and instrument form an integrated environment and therefore the software issue is not only one of interfaces but also one of safety for the telescope and personnel.*

Fully VLT compliant VIs shall undergo the mandatory software code and interface checks before shipment to Paranal. Software commissioning in the VLTI environment will be required before observations can start. The details shall be agreed upon with ESO in writing.

7.2 Simulation

The VLTICS simulation package consists of the VLTICS, customised for simulation purposes by means of a special database configuration and the VLTI Simulation software module "vltisim". In the case of complete compliance of the VI, the package is provided to test the VI software, which interacts with the VLTICS. The "vltisim" module will consist of a set of scripts to control the simulation, dummy and a database branch, which is a sub-set of the real VLTICS database branch.

The simulation focuses on the communication between user processes and the VLTICS and not on the internal functionality of the VLTICS. The simulation allows to send commands to the VLTICS via the VLTICS Interface and get replies from there, as well as using the VLTICS data query library, but no actual command execution is performed, except that some database items are updated with simulated values.

The VLTICS Simulation Package will be made available by ESO.

7.3 Control system overview

The control system for the VLT and its instrumentation is based on a system of distributed micro-controllers supplemented by intelligent workstations. These processors act as nodes on Local Area Networks (LANs) which permit information and commands to be transmitted between them. The logical layout of the system is shown in Figure 5. More information on the configuration of the system is given in (AD3).

ESO reserves the right to refuse to install instrument computers on the Paranal LAN if it has reason to suspect that prior to transportation to ESO the system may have been infected by a virus or that security at the home institute of the VI could have been compromised. Fully VLT compliant systems automatically qualify: it is mandatory that all computers to be connected to the VLT LAN have their software re-built prior to installation at the Paranal site. Systems may be shipped to Paranal and integrated or tested outside of the VLTI LAN, however a complete reinstall is required prior to connection to the VLTI LAN. The VI team must agree with ESO when this should happen and permit sufficient time for it to be performed in conjunction with Paranal IT and software staff.

The VI team shall demonstrate that it owns all software in use on their computers and that licenses for the use exist where appropriate.

ESO may require that the instrument consortium remove software from its systems that is deemed to potentially interfere with the VLT system. In particular Internet browsers are not restricted within the control LANs. Outbound network connections are permitted however the /etc/hosts file is strictly controlled with only a limited set of host accessible by name from within the VLTI LAN. All inbound connections to the control network are by default denied. More details on the connections permitted/denied can be found in RD19.

No windows based systems are permitted.

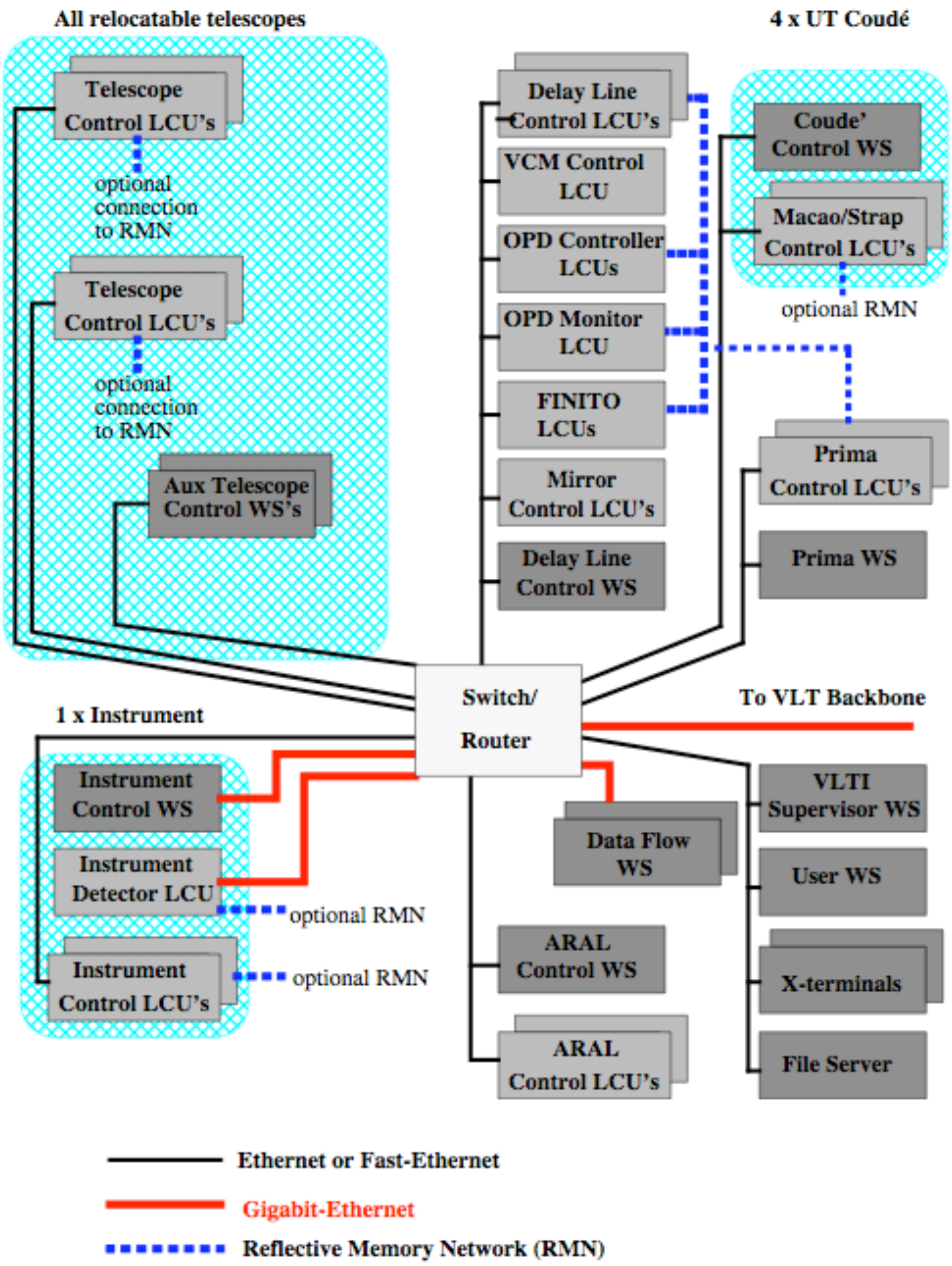

Figure 5 - VLTI Logical Network Topology.

7.4 Local Control Units

Visitor instruments may deviate from the VxWorks LCU standard that ESO has selected for its own subsystems. The VI team itself shall then ensure its own SW support. This cannot be the case for ESO compliant instruments. Communication between the control room and the instrument usually takes place over the VLT LAN. An alternative for non-compliant systems is the fibre connection described in section 7.1. Below the ESO scheme is briefly described.

Each VLTI facility instrument is controlled by one or more dedicated LCU(s), which are linked to the overall system via a LAN. The LCU(s) form an integral part of the instrument, normally physically located on the instrument itself. The LCU contains the electronic hardware necessary for the set-up, control and functioning of the instrument, data readout, self-tests, etc. Control of the instrument is done from workstations located on the network. The system architecture is intentionally very open and permits, in principle, any instrument to be controlled from any workstation on the network. This implies that no dedicated instrument control hardware can be located in the workstation itself. This arrangement offers a number of advantages, including the minimization of the number of cables inter-connections, the solution of most real-time control problems in dedicated microprocessors and straightforward testing of the instrument when not working with the VLTI.

Instruments detector systems normally have their own separate LCU.

7.5 Data Communication

The VLTI Control System provides three data communication channels to VLTI:

- Local Area Network (LAN)
- Time Bus
- Fast Link

The LAN is used to convey commands from the Instrument Control Software to the VLTICS and to transfer back replies and status reports. It is also used to bear the data traffic due to the access to the on-line database.

The Time Bus will distribute the UTC to all the computing nodes within the VLTI Control System and will be used to synchronise real-time tasks.

The VLTI Fast Link is a dedicated high-speed data communication channel connecting some of the VLTI LCUs. This fast link allows rapid exchange of data between different LCUs, and is used in most of the real-time loops involved in the control of the VLTI (fringe sensing, IRIS fast guiding, vibrations corrections).

In general, each (compliant) VLT instrument is operated from one workstation called Instrument Workstation (IWS), and connected to the instrument LCUs through one LAN subnet.

Access to LAN and fast link is only granted to fully VLT-compliant VIs.

7.5.1 Local Area Network

This section only applies to VIs that are VLT compliant; only those can be connected to the VLT LAN.

Visitor instruments connected to the VLT LAN shall comply with the network specifications of the VLT LAN (RD6, RD7). All communications of the instrument with units that do not form part of the mechanical assembly of the instrument (e.g. workstations) must go via the VLT LAN system. Absolutely no communications are permitted to the VLT control LANs from the outside world (i.e. outside the mountain top). The base camp and offices of the Paranal observatory form part of the outside world in this context. Specifically this implies that the control software for the instrument should not rely on data that are to be delivered to it from facilities outside the control LANs of the VLT. Typically the reverse process (i.e. communication from the inside to the outside) is unrestricted. **For one instrument specific IP addresses shall be allocated by Paranal, typically on a single subnet.**

The connectivity options within the control network are described in RD19.

The logical network layout of VLTI follows the same principle as VLT and is shown in Figure 5. The system has been designed to allow the maximum flexibility in configuration, but also to ensure that different sub-systems of the VLTI can operate without being affected by data congestion and priority conflicts from other sub-systems. The networks are divided in subnets connected together via a switch/router. This device also provides the connection to the VLT backbone and the rest of the world. Below is a brief description of the subnets and their purposes:

- 1 subnet for all relocatable telescopes (auxiliary telescopes and siderostats).
- 1subnet for the delay line control system including all LCUs involved in the positioning of all delay lines, the transfer optics, the fringe sensor unit and one supervising workstation.
- 1subnet for auxiliary optics control including LCUs in the UT Coudés, as well as four workstations.
- 1 subnet for calibration sources and feeding optics (ARAL).
- 1 subnet per instrument
- 1subnet for general services and coordination, in particular VLTI Supervisor Workstation and User Workstation.
- 1 subnet for PRIMA.
- Interface speed and location availability as some SCPs are already in use.

7.5.2 Time bus

The time bus is distributed to any LCU requiring high accuracy absolute time information.

The VLTI Control System CPUs rely on the Time Reference System (TRS) to be synchronised to each other and to receive the UTC. The TRS gets the UTC from the GPS satellites and distributes it to all the LCUs using a dedicated Time Bus. The TRS is also available to the VLTI Instrument Control System through the SCPs. All the GW routers are also synchronized via NTP to the timeserver.

Each LCU requiring time synchronisation better than 1 second shall be equipped with a Time Interface Module (RD8), a VME board developed by ESO, which is linked to the Time Bus and decodes the time signal to make it available to the other electronics within the LCU. LCUs requiring less accuracy will synchronise their internal timers with the UTC via the LAN. The LCC software provides the software interface to the TRS.

Access to the distributed time is only available on systems that comply with VLT standards. Such access is necessary for any system that requires synchronization with other VLTI systems.

7.5.3 Fast link

A high performance (low latency) dedicated network based on reflective memory technology connects some of the VLTI LCUs. This fast link allows rapid exchange of data between different LCUs, and is used in most of the real-time loops involved in the control of the VLTI (fringe sensing, IRIS fast guiding, vibrations corrections).

The access to this fast link is done by installing inside the control LCU of each of the involved sub-systems a reflective memory (RMN) board (type VMIVME-5576).

VI might also desire to access real time data from other VLTI systems. This can only be done by sending the data through the fast link. VI access to the fast link shall only be authorized for data existing on the RMN. VI cannot request additional data to be written by ESO subsystems on the RMN. The list of data available on the RMN can be found in RD17. To this end, a slot should be reserved in the LCU crate to install the RMN board. **Non-WME-VxWorks systems are not allowed to access the RMN.**

The detailed interface requirements related to connection to the VLTI fast link, as well as the data definition and specification are defined in AD4.

The inclusion of VLTI VI in the fast link shall be discussed and agreed with ESO on a case-by-case basis. This is particularly true in the case of standalone VI (see section 7.1).

7.6 User interface

In the case of a VLT compliant VI, *an IWS is used among other things to communicate with the VLTI*. The interface between instruments and VLTI is located between the VLTI Control Software (running on the VLTI Supervisor WS) and the Instrumentation Control Software (running on the Instrument WS). The VLTI networks provide the transport media. Figure 4 illustrates the principles of the architecture and the location of the interface. The VLTI Instruments interface towards the VLTI essentially in the same way as VLT instruments interface to VLT. VLTI control software consists of a large amount of software modules and processes. To unify and simplify the access from VLTI instruments to the VLTI functions the ISS exposes a public interface, represented by the *issif* module. The *issif* module is responsible for providing the “single point of contact” for instruments towards VLTICS.

In the case of a standalone VI, the computer used by the observer in the VLTI control room (located in the control building) may be connected to the instrument using optical fibres that connect the VI and the control room. *The availability of this fibre connection shall be checked with ESO.* **Their use has to be agreed by ESO.**

The telescopes are operated from separate workstations, called Telescope Workstations. The on-site user, instrument and telescope workstations for the VLTI are located in the Control Building.

7.7 Detailed software specifications

7.7.1 Workstation operating system

For fully VLT software compliant systems UNIX System V shall be used as the standard operating system for the Workstation system software, and X-Windows Version 11 shall be the standard presentation software for the User Interface.

Standard configurations for Paranal (e.g. workstation hardware platforms and operating systems) can be obtained contacting ESO. The use of non-standard hardware may complicate the installation procedure.

7.7.2 Communications software

The TCP/IP protocol shall be used for LAN communications.

7.7.3 System and common software to be made available by ESO

Standard software packages are made available on request to VI teams for use by the instrument software. They are listed in RD4 and the documents referenced therein.

7.7.4 Maintenance Software

Maintenance software is required for a visitor instrument if it has safety implications (e.g. checking the cool down of a cryogenic instrument).

8 VLTI/Instruments Physical Interface Requirements

The design requirements and interface specifications for VLTI Visitor Instruments are given in this section

8.1 General requirements

All VLTI VI shall be designed to conform to the mandatory requirements (in bold) contained in this document and in the referenced applicable documents.

8.2 VLTI VI space allocation

The VI for the VLTI is installed in the interferometric laboratory (see section 8.3). The electronics and control computers can be located in one of the rooms of the VLTI complex dedicated to this elements (Combined Coude Laboratory, computer rooms, storage rooms). Space is also available for VLTI WS in the VLT computer room inside the control building.

The available space in the whole interferometric complex is dependent on the VLTI instruments and systems installed and/or planned. Priority on space inside the VLTI complex shall be given to instruments (non-visitors). The complete VLTI infrastructure is kept under configuration control and an up-to-date version of the VLTI infrastructure can be found in AD15.

The available space for a VI will be defined by ESO at the time of the proposal. The space allocated for the VI defines the instrument location, the electronic and computers emplacements, the cable routing, the connection to SCPs. **The VI shall be designed to be strictly compliant with the space allocated by ESO.** *Any required modification shall be approved in writing by ESO, following the request for waiver procedure.*

Figure 6 presents the layout of the interferometric laboratory and centre of the tunnel (see DWG1), at the time of the redaction of this document. The positions of the optical tables for the instruments and some systems have been highlighted for clarity. The characteristics of these tables are given in section 8.3.4. The zone called “free space area” is kept free of permanent installation of systems to allow access to the interferometric laboratory and handling of systems.

The table called VINCI is currently considered as a possible location for a VLTI visitor instrument. Its availability shall be checked with ESO at the time of the proposal.

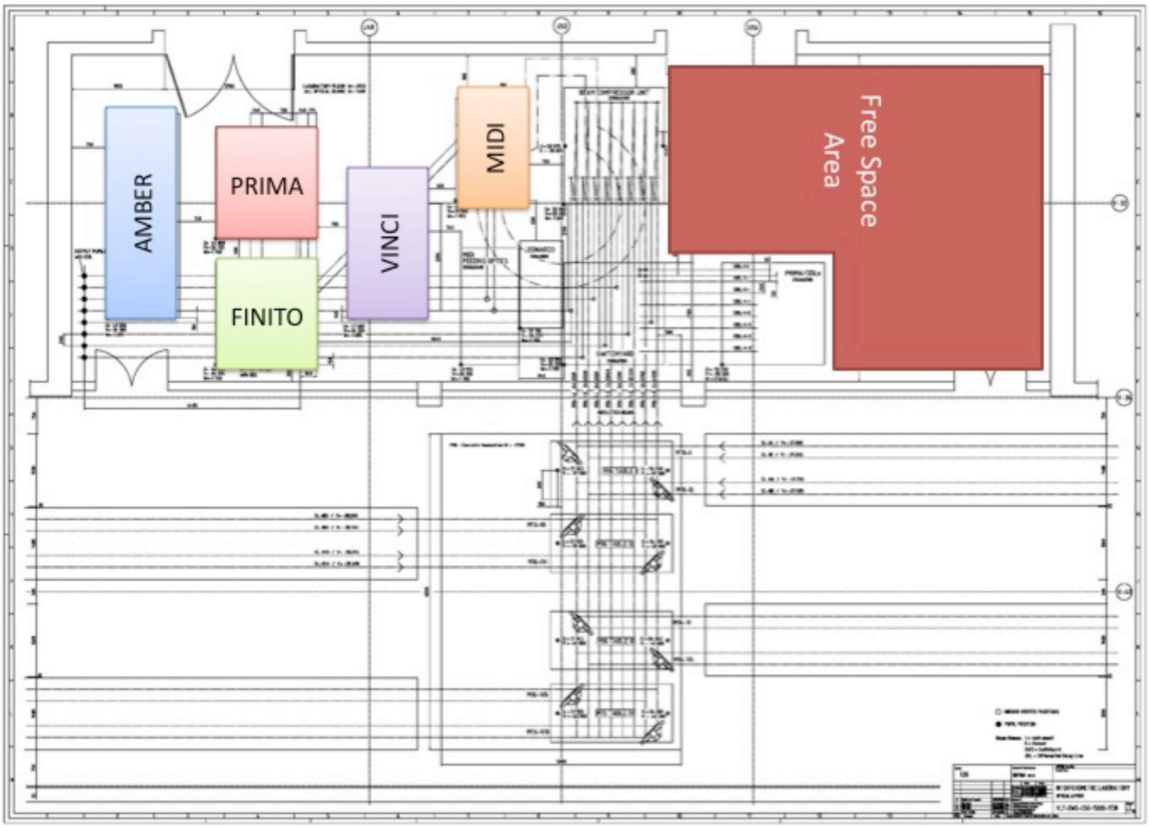

Figure 6 - Layout of the interferometric laboratory (DWG1).

8.3 Mechanical interface

8.3.1 VLTI complex

The so-called "VLTI Complex" houses the Interferometric Lab with its associated rooms as well as the Combined Coudé Lab with its computer room.

8.3.1.1 General description

The VLTI complex is composed of two levels, the entrance level and the laboratory level. It houses the interferometric laboratory, the Combined Coudé Laboratory and all associated rooms. The layout of the different rooms can be found in Figure 7 to Figure 11.

In these figures the following I/F relevant aspects are schematically shown:

1. Door sizes (for access).
2. Lift platform size.
3. Location of Service Connection Points (SCPs).
4. Location of UPS and non-UPS power supplies (additional to SCPs).
5. Location of LAN and Telephone connections (additional to SCPs).
6. Crane access area and available hook height.
7. Locations of feed-throughs for instrument line connections from the Interferometric Lab to the storage room and the computer room.

8. Special removable access hatch (6mx3m) on the roof of the Coudé Lab for exceptional cases.
9. Location of the opening for the Light Beams from the Interferometric Tunnel.

The following chapters refer in more detail to these topics.

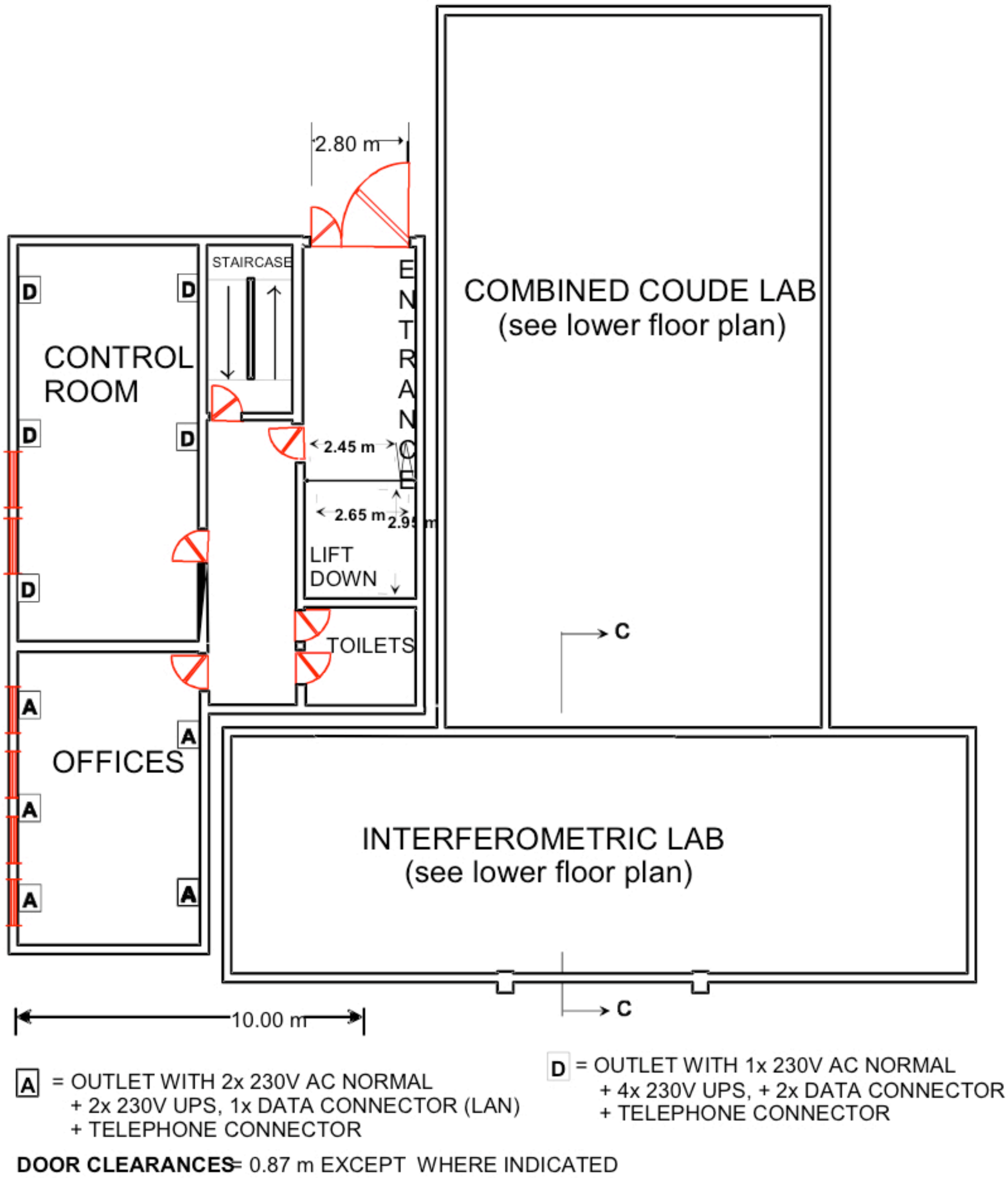

Figure 7 – Entrance level of the VLTI complex (telescopes platform level).

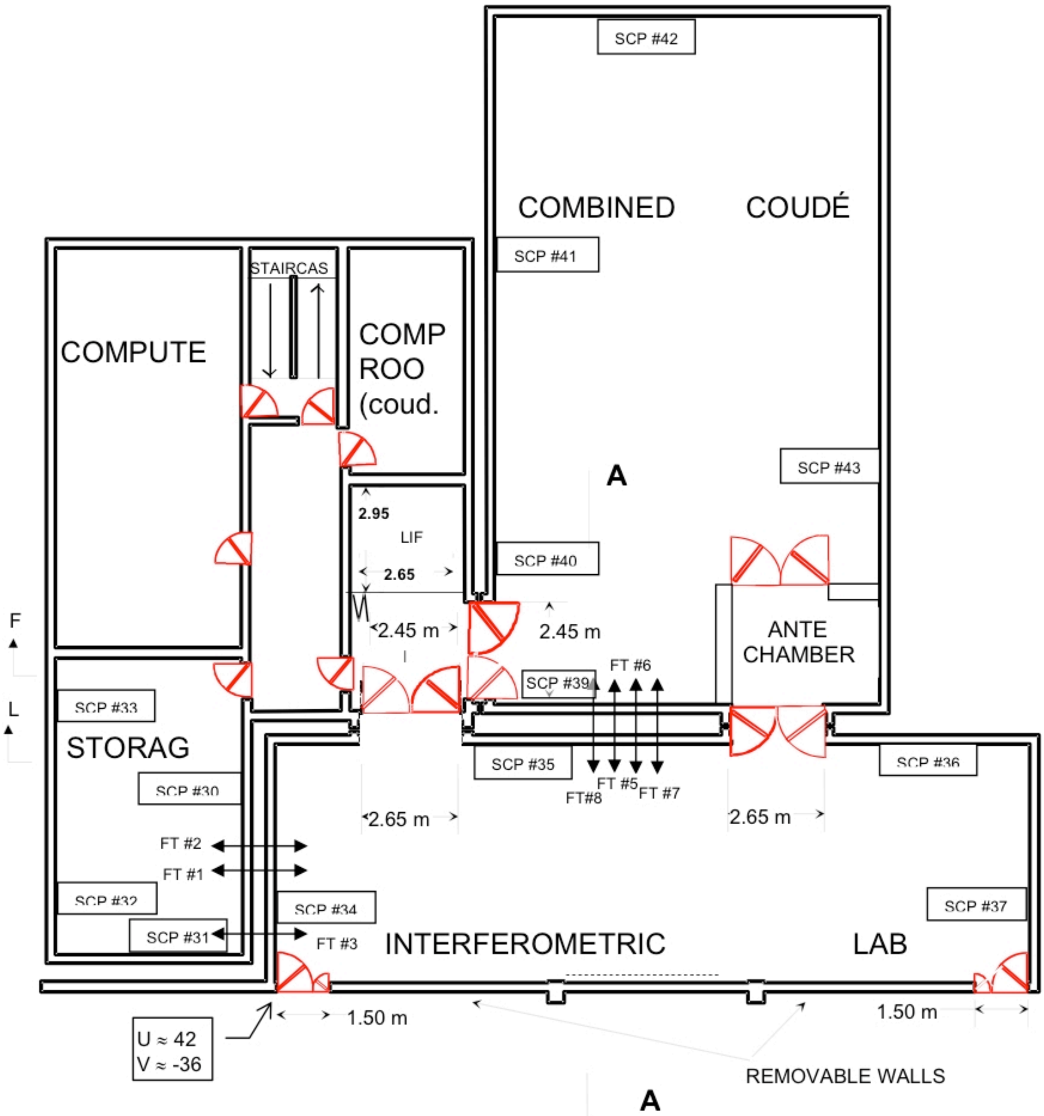

Figure 8 – Laboratory level of the VLTI complex (underground level).

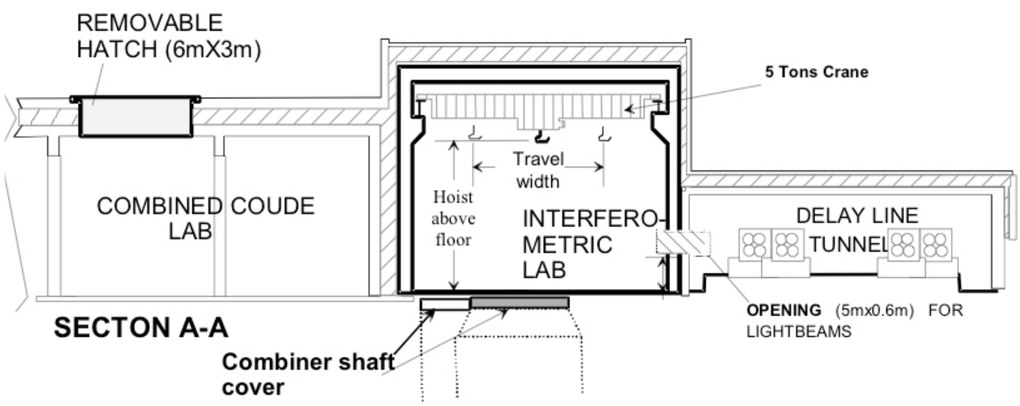

Figure 9 – Section AA (see Figure 8) of the interferometry complex.

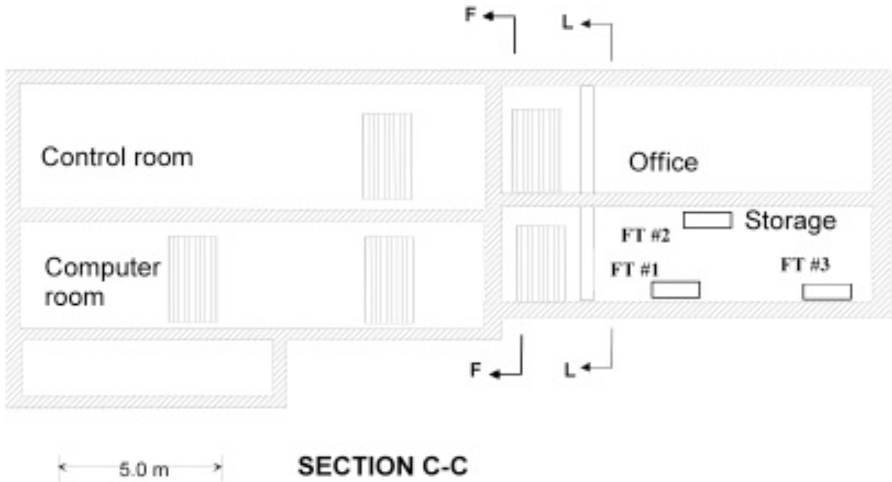

Figure 10 - Feed-throughs from the interferometric Lab to Storage. Section AA (see Figure 7) of the interferometry complex.

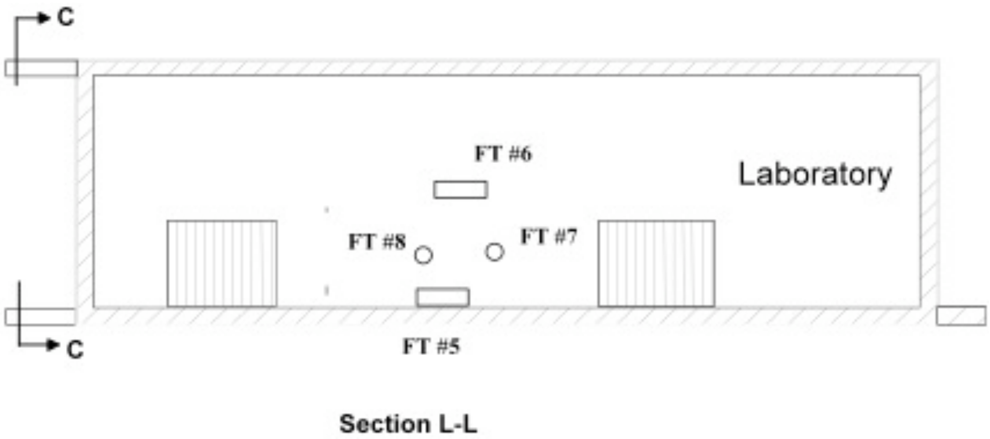

Figure 11 - Feed-throughs from the interferometric lab to Combined Coudé Lab. Section LL (see Figure 10) of the interferometry complex.

8.3.1.2 The Combined Coudé Laboratory (CCL)

The layout of the Combined Coudé Laboratory is presented on Figure 12.

The main dimensions and features of the CCL are listed in Table 1.

Part of the CCL is reserved for future implementation of an instrument at the incoherent focus of the combined UTs (RD9). This area is defined as “Coudé instrument operational area” on Figure 12. The available area for VI integration is called “VLTI area”. *Please note that part of the VLTI area is used for instruments electronics, pumps, and cryogenics connections. The exact available area for integration might vary with arrival of new instruments.* A Free Space Area has been assigned for operations like integration, commissioning, maintenance, etc., of instruments of either the VLTI or the Coudé Instrument Operational Area. During these operations the Safety Zone must be absolutely respected to allow easy access to the emergency exit door. Out of these exceptional operations this Free Space Area must be kept free.

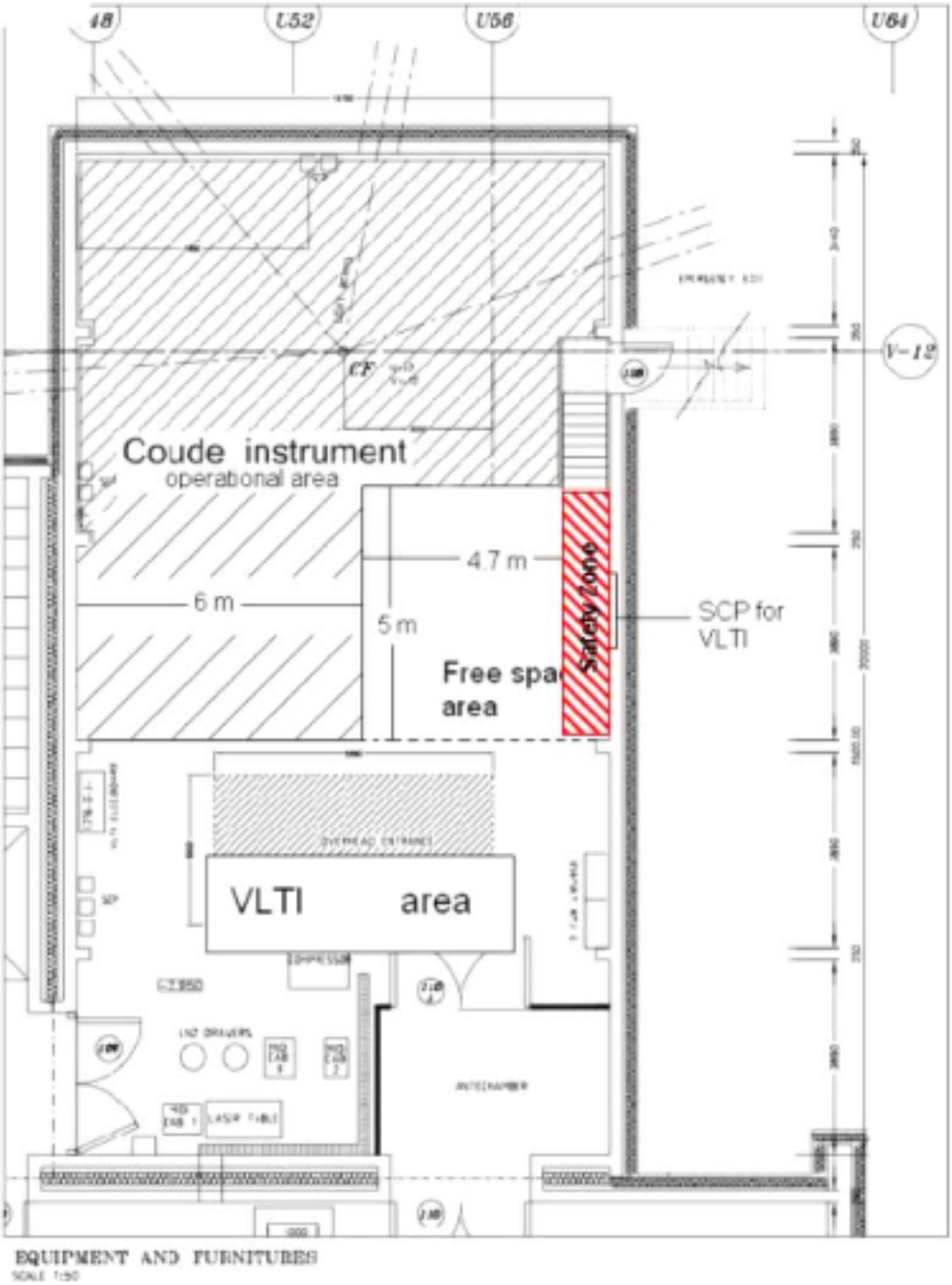

Figure 12 - Operational area in the CCL.

Height	4175 (roof) and 3575 mm (support beams, see pictures and drawings below)
Total surface	10 700 x 20 000 mm
Clear surface (reduced by the columns on the side)	10 000 x 20 000 mm
Expected clear surface for a VI integration	3000 x 6000 mm
Floor material	Linoleum

Walls	Concrete and painted (cream colour)
Access door (width × height)	2585 × 1995 mm
Air conditioning	Not available
Crane	Not available
Emergency exit	Stairs and door.

Table 1 – Main dimensions and features of the CCL.

8.3.1.3 Storage Room

The storage room can be used for electronics cabinets that need to be close to the instrument. Its current layout is presented on Figure 13. The up-to-date information on available space and connections are given in AD15. VI electronics to be installed in this room can be in:

- One electronic rack (maximum size: 80 cm x 60 cm x 230 cm) to be placed on the side of the PRIMET #2 cabinet.
- The (VINCI, ARAL) cabinet at the places of the unused VINCI electronic elements. Two sections are available in the rack, of respective heights of 45 cm and 50 cm.

The connection of the electronics elements (power, network, cooling) can be done to the SCPs (see section 8.5) available in the room. Connection of the electronics to the VI in the interferometric laboratory is done through feed through (FT) available on the separation wall.

The location, connection and cabling with instrument of the electronics parts must be discussed and agreed with ESO.

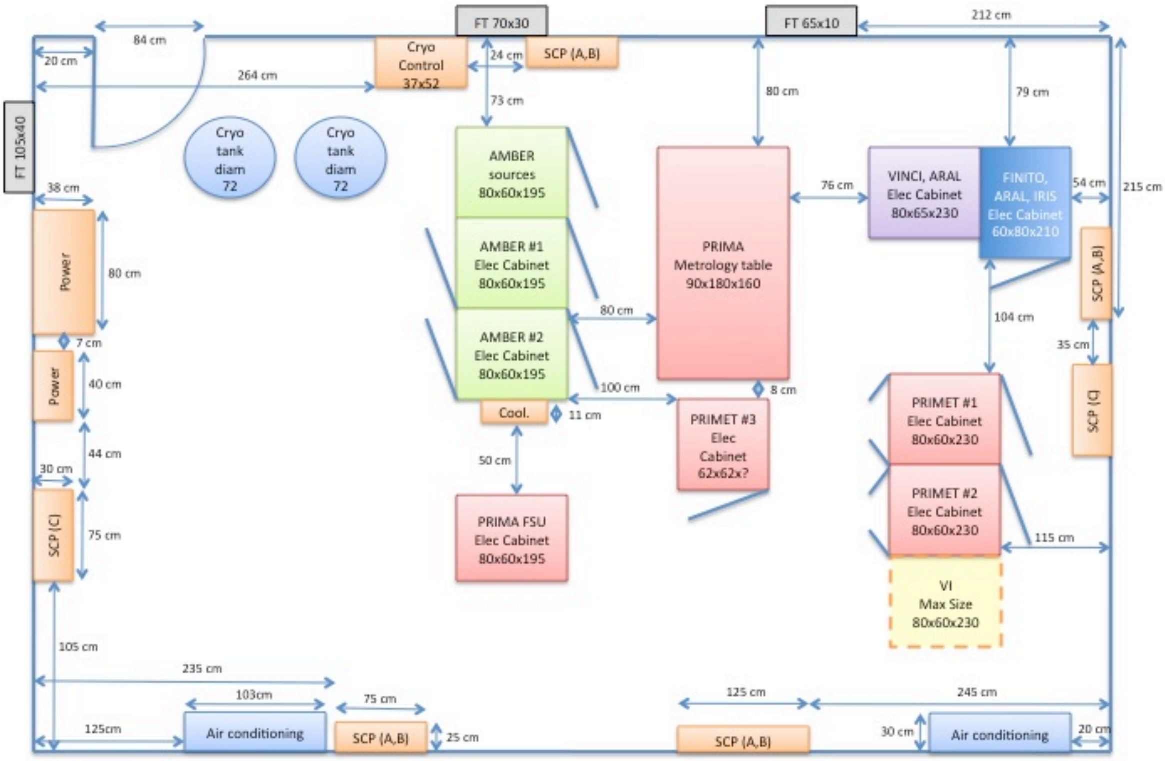

Figure 13 – Layout of the storage room.

8.3.1.4 Hatch

In the VLTI Area of the CCL, an opening on the roof is present (see Figure 9 and Figure 14), the Hatch, of 3 by 6 m allowing the passage of items impossible to pass by the standard accesses. **Only on exceptional circumstances this hatch can be used. It must be carefully planned and submitted to Paranal Observatory at least 6 months in advance**. *Note that the crane is not a Paranal facility and that it is not allowed to load anything on the roof of the CCL.*

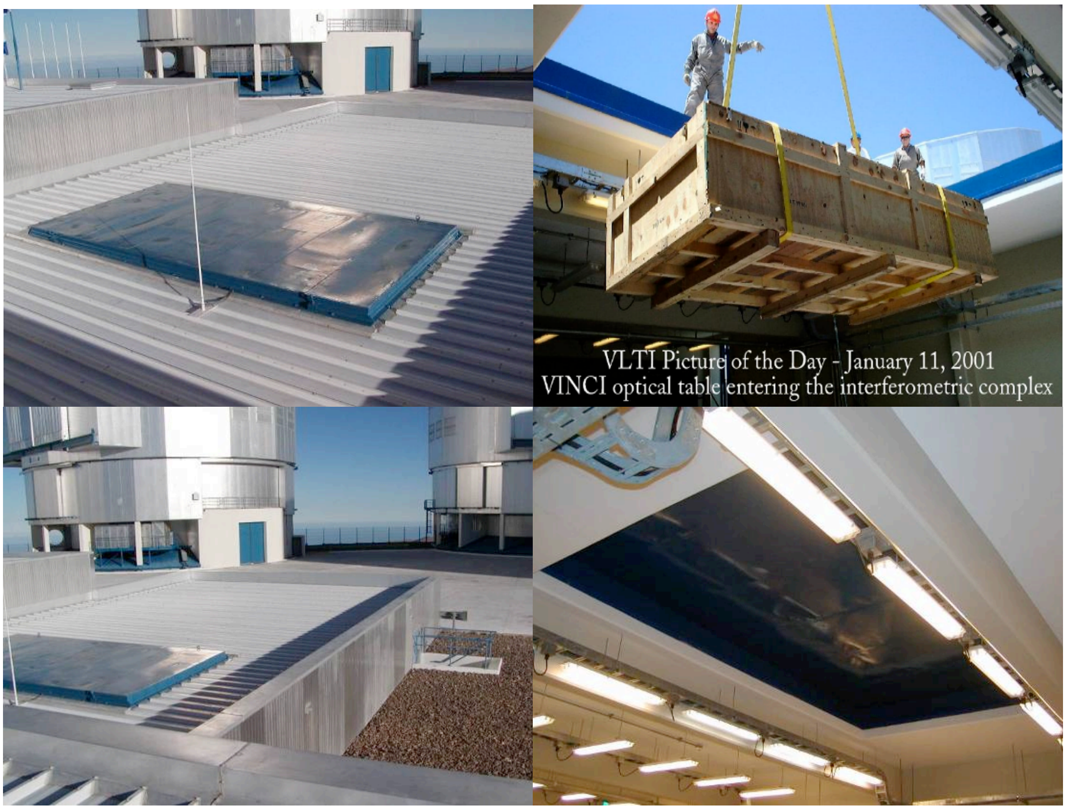

Figure 14 – Pictures of the hatch in the CCL. The crane is not a Paranal facility.

8.3.2 Rooms, access sizes and supplies

The Interferometric Lab with its associated rooms comprise:

1. The interferometric laboratory housing the VLTI instruments. Its current layout is defined in (DWG1).
2. The storage room for electronics cabinets that needs to be close to the instruments.
3. Computer room for the instruments electronic cabinets, computers, pumps and compressors.
4. Combined Coudé laboratory where the antechamber for access the interferometric lab is located. In this room, an area will be reserved for pre-integration of instruments. A reserved space has also been specifically allocated to the MIDI instrument.
5. Control Room for both, the VLTI and the Instrument Control.

The following table shows the main characteristics of these areas, such as access sizes, connections, available power and air conditioning.

Available Characteristic	Concerned Room					
	Combined Coudé Lab	Interferometric Lab	Storage Room	Computer Room I	Computer Room II	Control Room
Size [mxm]	10.7x20.0	20.4x6.7	8.675x5.25	11.55x5.25	6.72x3.05	11.55x5.25
Access widthxheight [mxm]	2.4 x 1.97	2.4 x 2.06	0.80x1.975	0.80x1.98	0.81x1.98	0.80x1.98
Maximum height usable [m]	2.78	3.5	2.40	2.36	2.44	2.44
SCPs Type (A,B,C)	4 +1C	4	4+1C	-	-	-
LAN (additional to SCP's)	-	-	-	6x	-	10x
Non-UPS 230 V (additional to SCP's)	-	-	-	3x	-	30x
UPS 230 V (additional to SCP's)	-	-	-	12x	-	25x
Air Conditioning Unit	-	-	2	1	1	1

Table 2 - Rooms characteristics.

8.3.3 Line Routing from Lab to Computer Room and Storage Room

In order to allow the routing of signal and cooling lines between the Lab and the storage and computer rooms, special feed-throughs are foreseen. Their location is shown in Figure 8 to Figure 11. The sizes available for the instruments are summarised in Table 3.

Ref. #	From:	To:	Number and Shape	Approx. height wrt floor	Size (mm^2)	Detailed drawing	Remark	Wall thickness (mm)
1	Interferometric laboratory	Storage room	1 rectangular	115 mm	110*680	DWG2	FINITO, IRIS, FSU PRIMA, VINCI, AMBER cables	1240
2	Interferometric laboratory	Storage room	1 rectangular	2355 mm	110*670	DWG2	Not usable By instrument (FINITO, IRIS, FSU PRIMA cryostats)	1240
3	Interferometric laboratory	Storage room	1 rectangular	115 mm (TBC)	110*680 (TBC)	TBD	TBD	1240
5	Interferometric laboratory	Comb. Coudé lab	1 rectangular	100 mm	135 * 490	DWG2	MIDI cables	985
6	Interferometric laboratory	Comb. Coudé lab	1 rectangular	2300 mm	640 * 130	DWG2	Not usable By instrument (MIDI, VINCI cryostats)	985

7	Interferometric laboratory	Comb. Coudé lab	1 circular	1460 mm	65 diam	DWG2	MIDI laser	985
8	Interferometric laboratory	Comb. Coudé lab	1 circular	1175 mm	80 diam	-	MIDI cables	985

Table 3 - Feed-through sizes available for the instruments.

8.3.4 Instrument Optical Tables

The optical tables for VI are not provided by ESO. VI shall be delivered with their own optical table. The possibility to use free space (if available) on the existing optical tables shall be discussed with and approved by ESO.

Table 4 lists the optical tables currently installed in the interferometric laboratory and defines their following characteristics:

- Dimensions of the table (width (U direction), length (V direction), thickness),
- Height of the table top surface above the floor: H = 1460 – h, where h is the optical beam height above the table top surface (also given in the Table),
- Table mass,
- First resonance Eigen frequency.

Table Name	Width (m)	Length (m)	Thick-ness (mm)	Table Height[5] (mm)	Beam Height[6] (mm)	Table Mass (kg)	Load mass assumed for frequency (kg)	First resonance frequency[4] (Hz)
Beam Compressor (GENIE FO)	2.10	2.40	457	1348	112	950	400	> 130 Hz
Marcel	0.90	1.80	457	1168	292 [1]	350	150	185
VINCI	1.50	3.00	457	1145	315 [1]	1070	400	140
MIDI	1.50	2.10	610	1075	385	740	500	160
MIDI Feeding Optics	1.20	2.40	457	1168	292 [2]	570	250	160
AMBER	1.50	4.20	610	1260	200 [3]	1360	500	130
PRIMA-1 (FINITO)	2.10	2.10	457	1190	270	< 1200	400	> 130
PRIMA-2 (FSU A&B, IRIS)	2.10	2.30	457	1190	270	< 1315	400	> 130

Table 4 - Actual dimensions and masses of instrument optical tables.

[1] Ref.: Ldv Mechanical Design – VLT-SPE-MEU-15810-2000 – Issue 1.0 – 13/7/99.
[2] Same height as Marcel.
[3] Ref.: AMBER Hardware Interface Control Document– VLT-ICD-AMB-15830-0001– Issue 1.0 – 15/11/00.
[4] From Newport specification.
[5] The upper surface of the table to the nominal height will be +/-0.2 mm.
[6] The actual beam height will be +/-0.2 mm.

For all the tables, the hole pattern is a square grid with 25mm pitch, M6 threaded holes through the 5 mm top plate (in stainless steel). The outer rows of holes are located 37.5 mm from the table edges.

For all tables, the flatness is specified to be less than ±0.2 mm per m^2 on the whole table area.

The footprint of the instrument in the (U, V) plane shall not protrude from the area defined by the tabletop.

8.3.5 Crane, Lifting Platform and Handling Equipment

8.3.5.1 Crane Characteristics

1. Single girder overhead travelling crane for 5 tons.
2. Hoist above floor: 4.25 m
3. Span: 6.4 m
4. Travel width: 4.56 m (from V = -30.05 m to V = -34.61 m).
5. Travel length: 16.64 m (from U = 43.64 m to U = 60.28 m).
6. Speed: Continuously variable or set of selectable values between 0.2mm/s and 50 mm/s inclusive.
7. Position resolution: < 0.1 mm (minimum step).
8. Acceleration: < 0.3 m/s^2
9. Floor operated.

8.3.5.2 Lifting Platform (Elevator) Characteristics

1. Capacity: 5000 kg
2. Travel: 3.20 m
3. Travelling speed: 29 mm per second.
4. Speed control: Start. Speed and levelling through valve Control.
5. Starts per hour: 10 maximum.
6. Logic: Relay based. Automatic Push Button "call" and send control with manual doors.
7. Re-levelling: Constant re-levelling at upper landing to +/- 6mm (with power-on).
8. Door system: Manually operated, collapsible shutter gates at both landings, electrically and mechanically interlocked to the platform travel. No car door.
9. Clear opening: 2.40 m Wide x 2.3 m High x 2.95 Deep.
10. Signals: "In Use" Light in car stations, Buzzer will sound while travelling.

8.3.5.3 Other Handling Equipment

For lifting and moving equipment in the Combined Coudé laboratory and in the Interferometric laboratory (outside the crane area), a number of forklifts and small mobile cranes (typ. 500kg capacity) are available at Paranal. Instruments planning to use such equipment for integration or maintenance shall check details with ESO and obtain approval.

The equipment to be lifted/moved shall have an interface for attachment to a crane hook or a hand pallet truck.

8.3.6 Mass and Volume Requirements

The mass and volume requirements are derived from the access sizes, the crane and lifting platform characteristics, and from the space arrangements in the lab, as described in the preceding sections.

The latter refers to the accessibility and handling requirements with the crane, e.g. the required free overhead space to allow the crane to handle equipment. Taking into account the available information and constraints of the foregoing chapters, only a general, initial rule can be established: it shall always be possible to handle another subsequent equipment of the same size and weight as the equipment in question.

Further dimension constraints are given by the size of the optical tables (see 8.3.4) and instruments. *The total mass of the VI and his table shall be less than 2.5 tons.*

8.3.7 VLTI complex accesses

Entry in the VLTI complex, either for fully integrated instrument or boxes and equipments, shall be through the access of the entrance level whenever possible. Access to the CCL and interferometric laboratory is there done from the elevator (see section 8.3.1). All elements shall thus be designed to fit in the elevator and to allow transport from there to the CCL and interferometric laboratory (see access dimensions in section 8.3.2). Additional constraint might be imposed by the elements installed in the VLTI complex at the time the VI is installed. All elements shall follow the rules defined in section 8.3.6.

The elevator characteristics are listed in section 8.3.5.2. Specific care has to be taken on the elements dimension to be able to manage the necessary turn at the exit of the elevator on the laboratory level (see Figure 8), for access to both the CCL and interferometric laboratory. *Entrance to the VLTI laboratory through the door in front of the elevator is not allowed.*

The dimensions of the main accesses are summarized in the following table.

	Width x Height (x Depth) [mxm(xm)]
Elevator	2.4 x 2.3 x 2.95
Door access from elevator area to CCL	2.4 x 1.97
Interferometric laboratory antechamber access	2.4 x 2.06
Door access from antechamber to laboratory	2.6 x 2.06

Table 5 – Dimensions of the main accesses to VLTI complex.

8.4 Cryogenics and vacuum supplies

8.4.1 Liquid Nitrogen

A nitrogen distribution system is available for instruments in the interferometric laboratory. The purpose of the system is to ease the operations and avoid any human presence in the interferometric laboratory. The system includes the following elements:

- Liquid nitrogen storage tanks. These tanks have a capacity of 120 litres and have a level measuring system. This one gives an alarm one day before the tank is empty. The tanks can be located in the CCL and in the storage room.
- Insulated pipes are used to connect the tanks to the instruments.

This system can be used for cryostats working either in bath or in continuous flow. In order to avoid as much as possible human presence in the interferometric lab, the pipes are constantly connected to the instrument and necessary valves remotely controlled. Nitrogen outgased by the instrument is collected through pipes and redirected outside the interferometric laboratory by ESO for safety reasons.

The LN2 supply of a VI can be done in one of the way described below:

- An unused nitrogen (supply and return) connection exists, and can then be used by the VI. **The cryogenic connectors (one for nitrogen input + one for vapour output for each nitrogen tank) must then be compliant with the ESO design (AD5 and AD6).**
- A manual refilling is foreseen by entering a tank in the interferometric laboratory. The VI must then be delivered with an adequate line connecting the cryostat to the nitrogen tank, taking into account that nitrogen tanks cannot be moved to any location in the lab. This solution shall be checked according to (AD15). *The exhaust line for nitrogen outgasing must also be delivered and ensure safety for persons and other equipments*. The needed length for the lines will be defined according to the VI position and the interferometric configuration at the time of the installation.

To ensure a proper interface between the nitrogen distribution system and the instruments, the following requirements shall be fulfilled:

- Each dewar shall be equipped with a vacuum gauge. Remote reading of the gauge shall be envisioned as much as possible, for ease of operation.
- A logical signal (YES/NO) shall be provided indicating if the dewar is full. Ideally this sensor shall be a PT100 (AD7).
- Each VI team shall provide the position in the (U, V, W) reference frame of the cryogenic connectors (to define the routing of ESO nitrogen distribution pipes).

The specific concept for the liquid nitrogen distribution for VINCI, AMBER and MIDI is described in RD10, RD11, and RD12 respectively, and can be used as reference for the design of the VI

8.4.2 Vacuum

VI teams are requested to bring their own pumping systems with all necessary connections and pipes. ESO is not committing on providing pumps for systems requiring vacuum.

Primary vacuum pumps exist at Paranal, together with connection pipes, but their availability and compatibility is not granted. Use of these equipments for integration or maintenance shall be checked in details with ESO and obtain approval.

8.5 Electrical and Fluid Connections

8.5.1 What is available at SCPs

Most VLTI sub-systems and equipments are connected to the telescope electrical and fluid supplies, and to the communication networks at centralised distribution points called Service Connection Points (SCP).

The location of the SCPs in the VLTI complex is shown on Figure 8.

The SCPs are composed into three parts, which provide electrical, communications and fluid connections respectively. A full description of the SCP is given in AD8. The following sections provide an overview of the SCP connections and lists the principal interface requirements.

Four SCPs are provided in the interferometric laboratory, five in the Combined Coudé Lab, and four in the Storage Room (see section 8.5.2 for their characteristics and use). All cables and hoses connecting instruments to the telescope service supplies shall be connected via these SCPs.

The connection of the VI to SCP (power, network, cooling) must be made in a way ensuring the possibility of independent shutdown in case of problem on the VI, i.e. without interrupting the connection of other VLTI systems.

8.5.1.1 SCP Part A: Electrical Connections

The following electrical connections are provided in SCP Part A. The power quality is specified in AD9, section 4.

8.5.1.1.1 Power Connections

- 400 VAC, 50 Hz (one connector: red-colour coded panel socket outlet; three-phases, neutral and earthing contact at the 6h position; rated current 16A, as per CENELEC document HD 196 S1 (1978)/IEC 309/CEE-el 17.
- 230 VAC, 50 Hz, (two connectors: white or light grey coloured panel socket outlet; phase, neutral and earthing contact; rated current 10/16A, as per CEE-el 7/VII (Schuko).
- 230 VAC Uninterruptible Power Supply (UPS), 50 Hz, (two connectors: blue-colour coded panel socket outlet, single-phase, neutral and earthing contact at the 6h position, rated current 16A, as per CENELEC document HD 196 S1 (1978)/IEC 309/CEE-el 17.

In addition to the socket outlets, power connection to normal or UPS power may also be via direct connection to terminal blocks inside the SCP. Details of the internal electrical connections are given in AD8.

Equipment connected to the SCP electrical socket-outlets shall conform to the following requirements:

- The peak electrical current drawn from one SCP must not exceed 16A per phase for the normal electrical supply, and 16A total for the UPS supply.
- The total average electrical power taken from the UPS outlets by instruments shall not exceed 2 kW per SCP. The total average non-UPS electrical power shall not exceed 6 kW per SCP without the written agreement of ESO.
- Electrical equipment connected to the SCP must respect the EMC requirements for susceptibility and emissions given in AD10.
- The requirements for the design and implementation of electronic equipment contained in AD11 shall be applicable to all equipment connected to the SCP.
- All fuses, circuit breakers and residual current detectors required for the protection of the instrument, supply cables or operator should be incorporated in the instrument concerned.

8.5.1.1.2 Motion Stop Facility

Each instrument SCP is equipped with a motion stop facility, consisting of a red mushroom-type button on top of the SCP and a key switch.

The motion stop shall be used to prevent unforeseen events causing equipment or personal damage.

A connector on the lower surface of all instrument SCPs allow the attachment of an extension cable for a remotely located motion stop button.

A bridging connector is provided on each SCP, which must be plugged in when no extension cable is in use. **ESO prior to use shall approve all such extensions.**

8.5.1.2 SCP Part B: LAN Connections

SCP Part B provides connections to the LAN systems and to the Time Reference System (TRS).

For more details of its functionality, see chapter 7.5.

8.5.1.2.1 Local Area Networks

The SCP Part B allows the physical possibility of connection to the VLT LAN system. The allocation of the LAN connections for VI will be specified by ESO for each individual VI. The SCP fibre optic cables are supplied from Network Access Points where the function of each SCP LAN connection is determined. All SCP LAN connectors are of the following type:

- SCP output connector: ST type.
- Fibre type: Multi-mode, graded index (62.5 μm core, 125 μm cladding), OM1/OM2.
- 12 pairs (24 fibres) per SCP, port 24 is always assigned to TIM bus.

The detailed VLTI LAN layout is defined in RD13.

8.5.1.2.2 Time Reference System

The VLT Observatory has a central Time Reference System (TRS) which distributes Universal Time information to the telescope and instrument control systems, as well as any other systems that may require this information.

For general time setting requirements, Coordinated Universal Time UTC is available to instrument control software via the Instrument-LAN. For applications requiring a high accuracy time reference, the UTC signal is distributed directly to the individual instrument LCUs by means of a dedicated fiber-optic Time-Bus. In this case a standard electronic module (Time Interface Module TIM) within the LCU decodes the full UTC signal and provides a high accuracy local time reference for instruments. The absolute time accuracy of this reference, measured from the moment at which a processor interrupt is generated, is 10μs or better.

While UTC is available at the LCU level with high accuracy and via ntp to all systems at a lower accuracy, other timing values are also computed by the system (e.g. sidereal time) but not distributed as such.

Access to the distributed time is only available on systems that comply with VLT standards. Such access is necessary for any system that requires chopping as the synchronization with M2 is based on absolute time.

The TRS connectors and optical fibres are identical to those for the LAN given in the previous section.

8.5.1.3 SCP Part C: Fluid Connections

SCP Part C provides access to the VLT Observatory service supplies.

8.5.1.3.1 Compressed Air Supply

Compressed air is provided at the SCPs with the following characteristics:

• Supply pressure:	7-8 bar
• Filtering:	5 microns
• Oil content:	< 0.01 ppm
• Relative humidity:	10% RH at 20°C at local atmospheric pressure
• SCP Outlet connector:	Self-sealing female connector according to ISO 97241-1 series B, nominal diameter 12.5

8.5.1.3.2 Coolant Supply

The central observatory chillers system provides a supply to coolant at the SCPs that may be used for instrument cooling. The coolant has the following characteristics:

- Coolant: 33% (vol.) ethylene glycol
- Nominal supply pressure: 6 bar
- Supply differential pressure: min 0.8 bar, max 2 bar
- Supply temperature: 8° C below laboratory ambient
- Maximum flow rate (per SCP): 15 l/min
- Equipment connectors: self-sealing connectors according to ISO 7241-1 series B, size 12.5 (output male, return female)

Equipment connected to the SCP coolant supply shall conform to the following requirements:

- Connected equipment shall use self-sealing connectors on both feed and return lines.
- All connecting cooling hoses shall be insulated to ensure that the thermal requirements specified in section 8.7 are met.
- Hoses shall be positively clamped to the connector.
- All hoses shall be of a type suitable for a working design pressure of at least 12 bars.
- Equipment shall be filled and leak tested at a pressure of 10 bars before connection.
- Equipment having a total coolant capacity greater than 3 litres, as well as all equipment which is not self-purging, must be pre-filled with the appropriate cooling liquid before connection to the SCP coolant supply. Other equipment may be filled by direct connection to the cooling system.
- The coolant return temperature shall not be higher than 8°C above the supply temperature.
- The maximum thermal load for each SCP in the Lab shall not be more than 5 kW (30 min average). For details see AD12. The 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.
- All equipment attached to the coolant supply shall provide monitoring of the coolant return temperature.
- All instruments that make use of the telescope cooling system shall incorporate any protection mechanisms necessary to prevent damage to the instrument or to its control electronics in the event of a failure in the flow of coolant.

8.5.2 Existing SCPs in the Interferometric Complex

SCPs have been installed in the interferometric complex as detailed in the following table:

Ref. #	Room	SCP A	SCP B	SCP C	Approx. U coord.	Approx. V coord.	Remark
30	Storage Room	X	X		40.5 m	-30.0 m	Reserved AMBER
31	Storage Room	X	X	X	39.5 m	-35.0 m	Shared VINCI/TBD
32	Storage Room	X	X		35.5 m	-32.5 m	Reserved PRIMA metrology
33	Storage Room	X	X	X	35.5 m	-29.5 m	Reserved VLTI
34	Interferometric Laboratory	X	X	X	42.0 m	-32.5 m	Shared FINITO/IRIS/DL3-4

35	Interferometric Laboratory	X	X	X	48.5 m	-29.0 m	Shared VINCI/ARAL/FSU
36	Interferometric Laboratory	X	X	X	59.5 m	-29.0 m	Reserved VLTI (partially used DDL)
37	Interferometric Laboratory	X	X	X	62.5 m	-32.5 m	Reserved VLTI DL1-2-5-6
39	Combined Coudé room			X	49.5 m	-27.8	Reserved MIDI cooling Special cooling capacity: 12kW Special connector: ¾"
40	Combined Coudé room	X	X		47.5 m	-23.5 m	Reserved MIDI
41	Combined Coudé room	X	X	X	47.5 m	-15.0 m	Reserved CCL instrument
42	Combined Coudé room	X	X		52.5 m	-8.0 m	Reserved CCL instrument
43	Combined Coudé room	X	X	X	58.5 m	-17.0 m	Reserved VLTI (partially used DDL)

Table 6 - List of SCP existing in the interferometric building

The typical implementation of SCP's in the Interferometric Laboratory is shown on Figure 15. Note that differences exist in the implementation of the SCPs depending on their location.

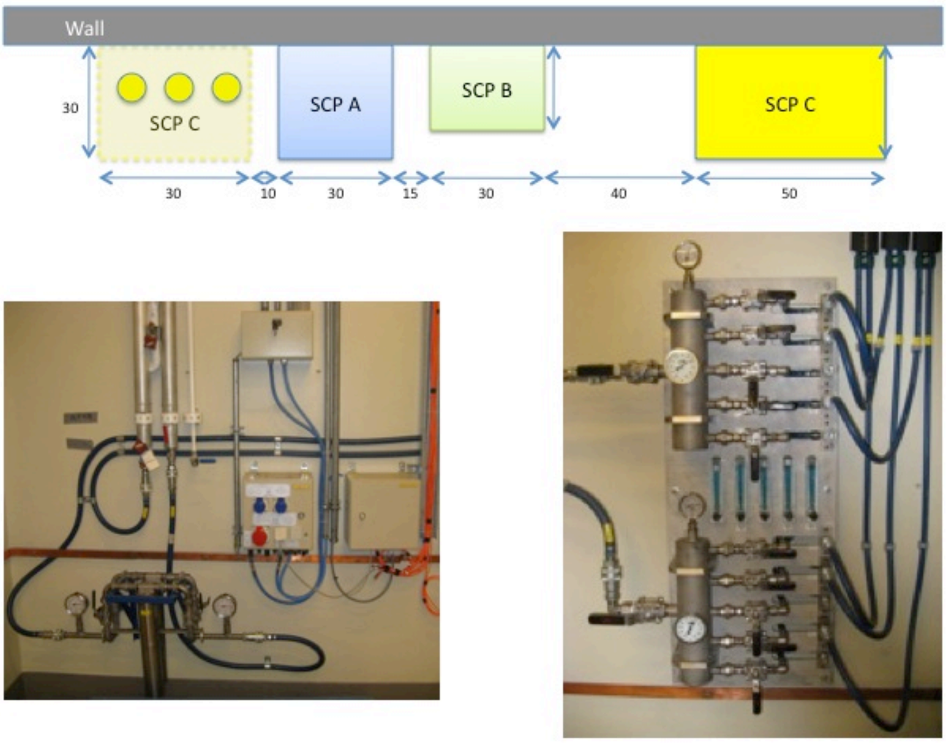

Figure 15 - Typical implementation of SCP's.

8.6 Electronic interface

8.6.1 EMC

All VLT Instruments, as well as any associated auxiliary equipments and components are required to meet the electro-magnetic compatibility requirements that are specified in AD9. This document specifies limits for electro-magnetic emission and immunity applicable to instrument electrical and electronic systems.

8.6.2 Instrument Control Electronics

8.6.2.1 Standardisation of Components

Many Electro-mechanical hardware assemblies and software are developed by ESO for the telescope control and data acquisition systems. In addition, many other commercially available components and standards are adopted for the various VLT systems and sub-systems. *Even if not mandatory, it is advisable that as far as possible these standardised items shall also be used for VI control* in order to:

- Improve the maintainability of the instruments (hardware and software),
- Increase the reliability of the complete system.

The used of standard components might be required in the case of full compliance to ESO SW is chosen for the design of the VI (see section 7). This shall be discussed with ESO early in the design phase. Standalone instruments are not required to use standardised items. In the case of use of non-standard elements, those shall still be compatible with the specifications given in chapters 8.4 to 8.6.1.

VIs may deviate from the ESO standards with respect to the selection of components to be used. Clearly the level of support that can be provided to such a system by the engineers of the observatory is significantly less than in a compliant system. In any cases ESO cannot provide spare parts; the VI team shall supply them.

Note that for a system using VLT standard hardware components the software to operate the instrument is available from ESO and requires only configuration rather than significant coding.

Commercially available standard components and software are specified. They are to be used preferentially for all VI.

Full details on standard electro-mechanical components are listed in AD11. The following types of components are currently listed as standard components.

1. Electronic racks and cabinets
2. Power and signal connectors
3. LAN-controller
4. Electronic bus standard
5. LCU CPU-module
6. Digital-to-Analogue module
7. Analogue-to-Digital module
8. Digital I/O module
9. RS-232 and RS-422 modules
10. Universal time decoder module
11. Intelligent motion controller module
12. DC Motor drive amplifier * 24 VDC, * 3 Amp
13. Computer power supplies
14. Encoder interfaces
15. Programmable Logic Controller

The following items are also considered to be standard items, but will be specified individually:

16. Instrument Workstation (IWS): The choice of IWS will be made at the time the units are required for instrument development. Due to the rapid evolution of the commercial market in this area, the IWS finally installed at the VLT site may differ from that used initially for instrument development, but will be software compatible with that selected initially.

8.6.2.2 Non-Listed Components

The following electro-mechanical components are currently not specified by ESO.

1. Power drive amplifiers > 24 VDC and/or > 3 Ampere.
2. Encoder interpolation electronics
3. Motors
4. Tachometers
5. Encoders
6. Limit switches

8.6.2.3 Recommendations on the Selection of Non-Listed Components

The following recommendations refer to selection of non-listed electro-mechanical components:

1. Drive Systems: For all drive systems it is recommended that DC-motors be used. Experience at ESO in the past has shown that their small volume, low heat dissipation, high speed and wide torque range improve the overall reliability of the electro-mechanical system especially when used in prototypes. The motors shall, however, be of industrial quality. If it is desired to improve the gain in a position loop, the measurement of the actual speed of the velocity loop should be done with a DC-tachometer. ESO recommends the use of DC-motors with drive voltages of between 24 - 30 Volts available from the firms Portescap, Harmonic Drive, Maxon, and Inland. Critical mechanical systems that must not move at all after the positioning shall be locked with a spring-loaded brake (released only with supply voltage 'ON').
2. Position Encoders: In general, position encoding should be done using opto-electronic encoders. In order to avoid additional initialisation procedures, absolute encoders should preferentially be used. Incremental encoders may be used only where the resolution or the count range is too high for an absolute encoder, or where the volume of an absolute encoder is too large. In applications where very high-resolution incremental encoders are needed ESO would prefer the use of encoders with interpolation electronics (EXE's) from the firm Heidenhain.
3. Limit Switches: In order to limit the mechanical movements, or for initialisation purposes, inductive or opto-electronic limit switches are preferred. Electro-mechanical switches may only be used when the motor current is directly switched off locally. Throughout its own instrumentation, ESO has used inductive limit switches from the firm Baumer Electric AG, Hummelstr. 17, CH-8500 Frauenfeld, and these are recommended for VLT instruments. Preferred would be 'NPN types' (normally open contacts) with 5 - 24 Volts operating voltage.

8.6.3 Cables and Hoses

8.6.3.1 General Requirements

No unguided free hanging instrument cables or hoses longer than 1 m are allowed. Wherever possible, all interconnecting cables and hoses longer than 1 m should be laid in fixed cable ducts with removable covers.

There shall be no loose cables crossing areas of the interferometric laboratory floor that will be frequented by observatory maintenance staff (except cables of a temporary nature required for commissioning only).

8.6.3.2 Cable and Connector Markings

All interconnecting signal cables and non-standard power cables that are not permanently attached to equipment shall be marked to identify the VI or equipment to which they belong.

In addition, all connectors (or cable ends) shall be marked to uniquely identify them. All mating sockets shall also be correspondingly marked. Cable connector and socket identifications shall be the same as those used in the VI documentation.

All standard power cables that are not attached to equipment need not be marked. However, **power cables that are permanently attached to equipment as well as panel mounted power inlet sockets shall identify whether the cable is intended for normal mains or UPS power**. Additional requirements on cables and connectors are given in AD11.

8.6.4 Alarm handling

A central alarm system (CAS) is available on Paranal and VIs may be connected to it. The definition of alarms and their handling is described in RD18. The purpose of an alarm is first to warn of any event which could endanger people, damage the telescope and its installations or jeopardize its functioning. **VIs shall implement the alarms for these types of risks.**

In addition, VIs may generate alarms in cases where a fast intervention is needed, e.g. in case of risk for expensive equipment or critical parts of the VI. As described in RD18, these instrument alarms are received on the beeper pager of the Paranal instrumentation group responsible person. VI staff will then be informed so that they can react accordingly. ESO recommends using the alarm annunciator described in RD18. The VI may define up to 8 different alarms and connect them to the alarm annunciator input although by default, any instrument should connect only one alarm to the CAS.

Connection to CAS does not guarantee a response time nor should it be regarded as a safety measure. It is only intended as an additional means of alert. CAS does not replace safety devices. The safety plan for the instrument shall not take into account CAS as means to mitigate problems.

8.7 Thermal interface

8.7.1 Power Dissipated into the interferometric complex

8.7.1.1 Equipment dissipation

The heat dissipated inside the interferometric complex by all subsystems of the instrument (drives, electronics, etc…) shall be carefully minimised by a proper design of the subsystems/equipment and, when necessary, make use of the liquid cooling, which is available at the SCP's.

8.7.1.1.1 Power dissipated in the interferometric laboratory

The total convected heat load from all heat-producing equipments of the VI shall not exceed **10 W**. The total convected cooling load from all cold-producing equipments of each instrument shall not exceed **– 20 W**.

8.7.1.1.2 Power dissipated in the other rooms

The total convected heat load from all heat-producing equipments of each instrument shall meet the following requirements:

	Computer room	Storage room	Control room
Maximum total convected heat load allowed per instrument	**3 kW**	**1 kW**	**2 kW**

Table 7 – Maximum convected heat allowed in the other rooms of the VLTI complex.

8.7.1.2 Operator access to the interferometric laboratory

Before observations the access to the lab has to be avoided **2 hours before an observation** to maintain adequate environmental conditions. This period of time can be reduced to 1 hour if the human presence in the lab was for a short duration (typically less than 15 minutes). Therefore, the VI shall include sufficient remotely controlled devices, or have sufficient autonomy for the instrument (e.g. capacity of the liquid nitrogen/ if applicable).

A list shall be provided of all tasks that can be performed manually, several hours before observation (e.g. coarse alignment, coarse calibration), and of tasks that must be performed shortly before or during an observation run (e.g. fine adjustment, tests with star simulator). These last tasks shall be performed remotely.

Nighttime access of the VI team to the interferometric laboratory might be granted for some specific tasks. **This shall be discussed and agreed by ESO in advance.**

8.7.1.3 Operator access to the delay line tunnel

The access to the delay line tunnel is not permitted for instrument team members, only VLTI staff is allowed in this area.

8.7.2 Surface temperature

In addition to the above power dissipation requirement, all equipment located in the interferometric laboratory shall not have an outer surface temperature different by more than **+0.5 / -1°C from the ambient air temperature**.

8.7.3 Cooling power consumption

The VI equipment shall make use of the coolant supplied at one of the Service Connection Points (SCPs). The cooling power needed by the VI shall be limited to **5 kW**. For details about the constraints regarding the liquid temperatures refer to chapter 8.5.1.3.2.

8.8 Environmental interface

8.8.1 Acoustic noise

The level of acoustic noise inside the interferometric laboratory is expected to be **< 50 dB(A)**.

The VI shall not generate acoustic noise in excess of 40 dB(A) at 2 m in all the directions.

8.8.2 Vibrations

To avoid disturbing other VLTI equipments, the VI shall be designed such that the vibrations generated by them are reduced to a minimum. *It is recommended to discuss with ESO this matter.*

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.

8.8.3 Light pollution

During standby or observation, the VI inside the interferometric laboratory 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.

8.9 Optical interface

This section defines the interfaces between VLTI and the VI applicable to the initial alignment.

The VLTI reference axes are defined by the VLTI optical alignment targets (see section 8.9.1) and are materialised by MARCEL (see section 8.9.2).

The VI shall provide a mean to materialise the nominal axis of its entrance beams (position and tilt). The alignment procedure that will be used to bring the VLTI reference axes onto the instrument entrance beam (adjusting the feeding optics) shall be defined and agreed with ESO.

8.9.1 Optical Alignment Reference

A system of alignment targets has been installed to align the complete VLTI. The VI, for the installation at Paranal, can use some of these targets located in the interferometric laboratory.

These alignment references are described in AD1.

In case the VI wishes to use these references during installation at Paranal, the ESO's approval shall be obtained.

8.9.2 MARCEL

8.9.2.1 Overview

The VLTI provides a reference source, referred as MARCEL, for the VLTI instruments. The MARCEL beams are aligned on the VLTI optical references. MARCEL can be used by VI during AIV phases for alignment purpose. Its use for calibration (day or night) shall not be considered.

MARCEL is the artificial source of the VLTI. It has been integrated and commissioned at Paranal in July and August 2008. MARCEL replaces the two-beam artificial source LEONARDO that was used since 2001. The name "LEONARDO table" has been kept, to designate the 1.8 x 0.9m optical table which previously hosted LEONARDO and is now hosting MARCEL, as LEONARDO is widely used in other VLTI documents written before MARCEL was integrated.

MARCEL sub-system breakdown is shown in Figure 16, which indicates also where each sub-system is located.

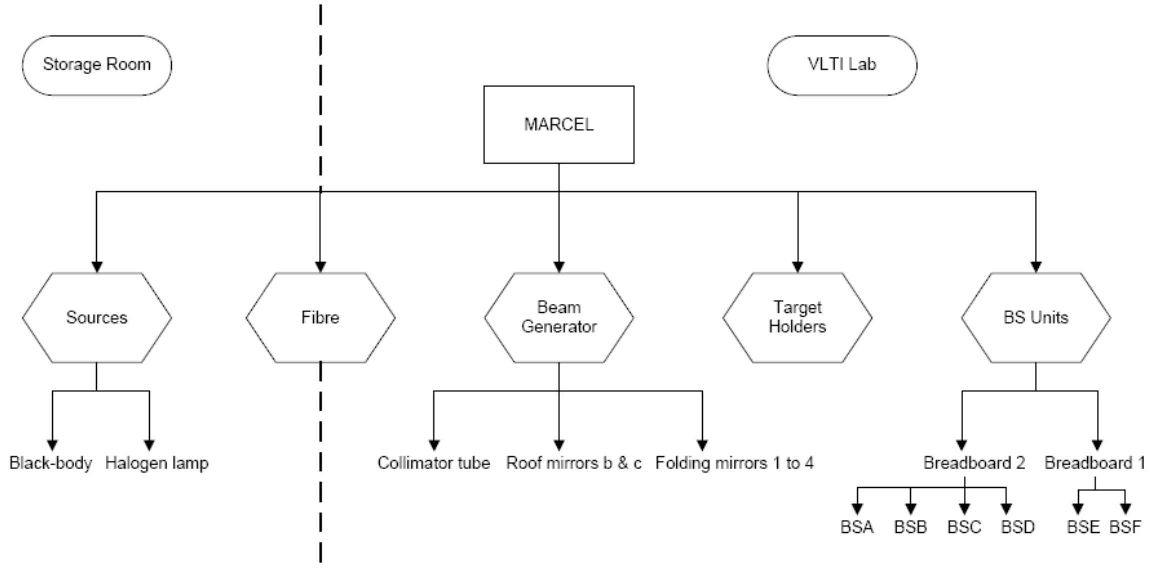

Figure 16 - MARCEL sub-system breakdown.

The opto-mechanical hardware of MARCEL comprises the following elements:

1. Light sources

    - A black-body source (CI Systems Microprocessor Controlled Cavity Blackbody, type SR-20-32) set by default at a temperature of 700°C, and
    - A halogen source (Oriel Universal Lamp Housing Ref. LSH101).

    Both light sources are installed in the storage room of the interferometric complex, on the top part of the PRIMA FSU back-end electronic cabinet. The active source is selected by manually connecting the MARCEL fibre patch cord to the light source FC fibre adaptor. The halogen source is used only during maintenance or alignment. During normal operation only the blackbody is used. The blackbody temperature setting can be changed remotely via the ARAL control software.

2. Fibre patch cord

    The infrared light coming out of the source is transmitted to the MARCEL beam generator located on the LEONARDO table in the Interferometric laboratory, by an infrared fibre patch cord. This patch cord consists of three successive single-mode (in K-band) fluoride glass fibres, respectively 3m, 33m and 1m long, interconnected through Diamond E-2000 connectors. The end of the last fibre section (named “B”) is fitted with an FC connector, which is plugged into the “collimator tube” of MARCEL.

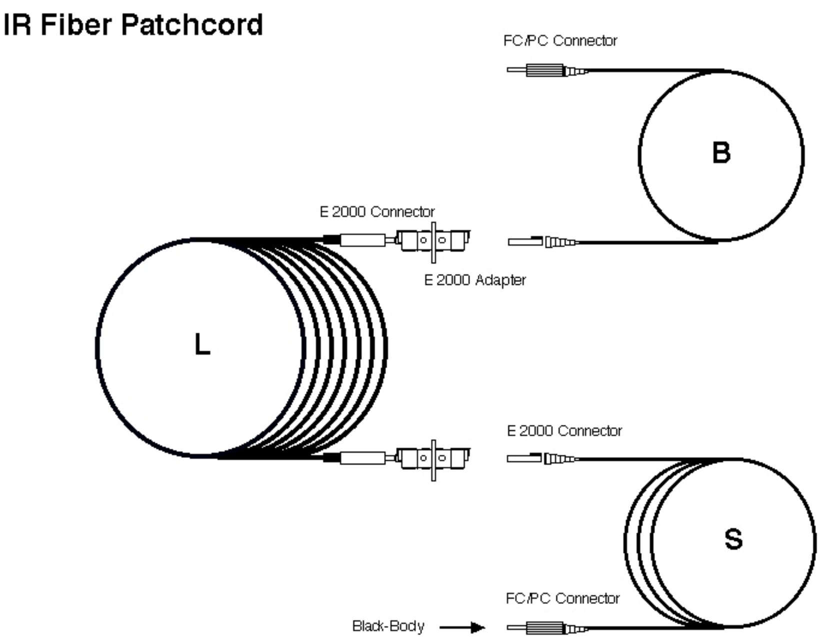

Figure 17 - IR fibre patch cord.

3. Beam generator (BG)
   MARCEL beam generator is mounted on the LEONARDO optical table in the interferometric laboratory. Four beams with optical characteristics identical to the one coming from the telescopes are made available with Marcel.
4. Six beam selection (BS-A through BS-E) units mounted on two breadboards. Each BS unit consists of one Schneeberger TMF3 motorized translation stage whose moving carriage holds:
   - A plane mirror mounted in a Newport SL-38 mirror mount, which fold the beams towards the VLTI instruments (“AUTOTEST” mode), and
   - A reflective prism (reflective coating on the hypotenuse of the prism) mounted on a Newport PO-46 prism mount, which is used to fold the BG beams towards the telescopes (“AUTOCOLL” mode). Only the lower half of the beam pupil is reflected. This semi-circular beam is retro-reflected and flipped at the level of the telescope. The returned beam can therefore propagate above the reflective prism towards the instruments.

8.9.2.2 Accuracy and Stability Performance

Table 8 summarizes the main performance of MARCEL in terms of accuracy and stability of the various beam characteristics (not valid for the N band).

Beam characteristic	**Absolute accuracy (in absolute site coordinate UVW)**	**Stability over a night**	**Stability over a month**	**Remarks**
Lateral position	< ±1 mm	< 40 μm per °C	< 40 μm per °C	
OPD	< ±1 mm	< 40 μm per °C	< 40 μm per °C	

Tip-Tilt	±5 arcsec (/alignment reference of the VLTI)	10 arcsec per °C	10 arcsec per °C	Angle expressed at instrument input (divide by 444 or by 100 for equiv. angle on sky for UT or AT
High Order WFE	< 150 nm RMS			Including focus (collimation) errors

Table 8 - MARCEL accuracy and stability performance.

9 Safety Requirements

ESO's Safety Policy is defined in AD13. The designs of VI and associated equipment (e.g. for handling, test, maintenance and alignment) as well as operating and maintenance procedures shall comply with this policy. *The ESO Safety Conformity Assessment Procedure as described in AD13 shall be followed.* **The general safety requirements defined in the document are applicable to VIs as well as to all their associated handling, test maintenance and alignment devices. A safety analysis shall be carried out for each VI according to that document. The VI team shall be able to demonstrate its compliance with the requirements described in this document and any additional requirements placed at the time the contract is agreed upon prior to shipment of the instrument to Paranal (see section 11). Specifically, a full hazard analysis shall be presented and accepted by ESO prior to shipment to Paranal. In particular an earthquake analysis shall be prepared according to AD[6] which demonstrates that the planned VI will not present a risk to staff or installations of the VLT under the specified conditions.**

Guidelines for executing the ESO Safety Conformity Assessment are given in RD14. Standard safety procedures of Paranal Observatory are described in RD15 and RD16.

The control electronics of the VI is also responsible for its safety aspects. Safety critical electronics shall operate without supervision by humans or software. Status and alarm signals shall however be made available. These electronics shall autonomously and adequately react to emergency conditions that may occur at any time like:

- Electrical power failure (UPS and/or non-UPS),
- Failure of VLT cooling fluid supply,
- Failure of cryogenic cooling system, lack of coolant,
- Vacuum leak (sudden rise of pressure),
- Failure of critical sensors (e.g. pressure or temperature) or their cables/connectors,
- Overheating of electrical cabinet.

When such an event occurs, the VI shall if necessary place itself automatically in a safe state that maintains the integrity and safety of the instrument and detectors. In addition, alarms shall be sent as defined in section 4.20 "Alarm handling" of AD14. The safe state shall be compatible with the findings and requirements of the hazard analysis of the individual instrument (see AD13)

10 Documentation Requirements

The list of documents to be delivered by VI teams shall be discussed with ESO. It shall include all information considered relevant by ESO to ensure proper installation of the VI in the Paranal environment and operation. **The documentation shall include instructions for powering the system down and VI removing if required to restore the VLTI operation configuration in the absence of the VI team**. The procedures to be followed during the powering up of the instrument should also be provided. **Documentation on emergency shutdown procedures shall be included.**

The following numbering scheme has been established by ESO for all VLT-related projects.

Although the VI team can use other numbering scheme internally, it is recommended to use this numbering scheme throughout the project.

As a minimum, all documentation delivered to ESO concerning the VI shall follow this scheme.

10.1 Documents

Documents should use the following numbering scheme:

VLT-BBB-CCC-DDDDD-*GGGG*

Where:

BBB	Identifies the type of document (see list below)
CCC	Is the code for the Firm or Organisation issuing the document (given by ESO)
DDDDD	Is the product code number (see list below for VLTI instruments)
GGGG	Is a sequential identification number (including preceding zeros)

The document type codes (BBB) are defined as follows:

AMD	Contract amendment	PRO	Procedure
CRE	Change Request	RFW	Request for Waiver
LIS	List	SOW	Statement of Work
MAN	Manual	SPE	Specification
MIN	Minutes of Meeting	TRE	Technical Report
PLA	Plan		

A product code numbers (DDDDD) for the VI will be defined by ESO.

10.2 Drawings

Drawings should use the following numbering scheme:

VLT-BBB-CCC-DDDDD-E-FFFFFF-*GGGG*

Where BBB is defined as follows:

DWG	Drawings	DRL	Drawing List
IDW	Interface drawings	PAL	Parts list

CCC, DDDDD, GGGG are defined as for documents (see above).

FFFFFF is the number code of a module, a sub-module or an element defined by the technical product tree.

11 Verification

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 and specifications (as given in this document and the Applicable Documents) will be verified based on documents submitted by the VI team.

Additional verification procedures for VIs may be specified in the agreement for the VI in question. Verification of the requirements and specifications contained in this document are detailed in the following sections.

11.1 Verification by design

Except where otherwise mentioned below in sections 11.2 and 11.3, **all requirements defined in this document shall be subject to design review by ESO using computer modeling where necessary**. Commercial components shall be checked against manufacturers data sheets and test reports.

11.2 Verification by inspection

The requirements listed in sections 8.6.3.1 and 8.6.3.2 on cable installations and marking shall be verified by inspection after installation.

11.3 Verification by test

In the case of VLT software compliant VI 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. Details (schedule, duration) shall be discussed with ESO well in advance.

12 Visitor instrument proposal template

12.1 Scientific justification

The Visitor Instrument proposal shall describe the science case for the instrument on the VLT. It shall describe the current status of the instrument, e.g. if it is a project or an already existing instrument. In the latter case a short history of operation should be included.

12.2 Safety

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 the proposal.

12.3 Operational scenario

A visitor instrument proposal shall describe the operational scenario envisaged by the instrument builders.

In particular the number of nights requested shall be stated. The request should be split into the amount of time expected to be used to make the instrument operational at the telescope (commissioning) and the number of nights to be used for scientific programs. How the later would be distributed over the ESO observing periods should also be addressed. The type of telescopes, ATs or UTs, shall also be specified with the number of nights requested on each type. Observations with mixed type of telescopes, i.e. ATs with UTs, are not possible.

The proposal shall state the number of personnel required to operate the instrument as well as the use of consumables at Paranal (e.g. LN2, storage media, etc.).

The kind of observations envisaged should be discussed (e.g. frequency of presetting, offsetting, chopping etc.).

The operational scenario shall include the amount of daytime access to the instrument required for calibrations, maintenance, etc.

12.4 VLT compliance choices

A VI proposal shall explain the planned software and hardware compliance and/or deviations from the VLT standards.

12.5 Integration requirements

The specific support required re-integrating the instrument on site as well as the duration of the re-integration period should be addressed in the proposal.

12.6 Installation requirements

The specific support and time required to install the instrument on the telescope should be addressed. Specifically the compliance with the cooling and connectivity requirements should be addressed.

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