AGILE	IASF CNR Bologna

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TABLE OF CONTENTS

1 INTRODUCTION 8
1.1 Scope And Purpose of the Document 8
1.2 Acronyms 8
2 APPLICABLE AND REFERENCE DOCUMENTS 10
2.1 Applicable Documents 10
2.2 Reference Documents 10
2.3 Document Priority 11
3 INTEGRATED PAYLOAD (IPL) DEFINITION 12
3.1 Configuration 12
4 AIV REQUIREMENTS 13
4.1 General Description 13
4.2 Relation to Laben's AIV Room 13
4.3 Functional Analysis 14
4.4 Functional Requirements 17
4.4.1 IPL Shell Interface Flange 17
4.4.2 IPL Crate 17
4.4.3 IPL Rotating Device 18
4.4.4 IPL Lifting Spider 19
4.5 Performance Requirements 19
4.5.1 Interface Flange 19
4.5.2 IPL Crate 20
4.5.3 Ry Rotation 20
4.5.4 Rx Rotation 20
4.5.5 Lifting Spider 21
4.5.6 Mounting 21
4.6 Interface Requirements 21
4.6.1 Mechanical Interface 22
4.6.2 Electrical Interface 26
5 CALIBRATION BEAM REQUIREMENTS 27
5.1 General Description 27

5.2 Relation to Beam's Facility 27
5.3 Functional Analysis....28
5.4 Functional Requirements....33
5.4.1 IPL Shell Interface Flange 33
5.4.2 IPL Crate 33
5.4.3 MGSE Positioning System 33
5.4.4 MGSE Controller 35
5.4.5 MGSE Computer 35
5.4.6 MGSE Video Surveillance System 36
5.5 Performance Requirements....36
5.5.1 IPL Crate Calibration Flange 36
5.5.2 Ry Rotation....36
5.5.3 Rz Rotation....36
5.5.4 Tz Translation....37
5.5.5 Tx Translation....37
5.5.6 Mounting....38
5.6 Interface Requirements 38
6 GENERAL REQUIREMENTS....39
6.1 Operational....39
6.2 Resource 39
6.3 Quality 39
6.4 Maintainability....40
6.5 Safety 40
7 VERIFICATION 41
7.1 Verification Levels 41
7.1.1 AIV MGSE....41
7.1.2 Calibration MGSE....41
7.2 Verification Methods....42
7.3 Verification Flow 42
7.4 Verification Matrix....42
7.5 Documentation 42

LIST OF FIGURES

Figure 4-1 AGILE Integrated Payload (IPL) 13
Figure 4-2 Rotation stages to be provided by the AIV MGSE 15
Figure 4-3 IPL AIV MGSE context diagram 16
Figure 4-4 IPL maximum dimensions (by Gavazzi – Collavo 08 oct 2003) 22
Figure 4-5 IPL / MGSE interface concept (by Gavazzi – E. Collavo 10 oct 2003) 23
Figure 4-6 IPL / MGSE interface (by Gavazzi – E. Collavo 10 oct 2003) 23
Figure 4-7 Laben' Travelling Crane overall dimensions. 25
Figure 5-1 IPL configuration for the calibration beam campaign 27
Figure 5-2 Reference Axes 28
Figure 5-3 Translation and rotation stages to be provided by the Calibration MGSE 30
Figure 5-4 IPL Calibration MGSE context diagram 32

1 INTRODUCTION

1.1 Scope And Purpose of the Document

The scope of the present document are the P/L System Level activities which shall carried out in order to assembly, integrate and verify the Agile Integrated Payload (IPL) at Laben premises, and the calibration activities which shall be carried out at Beam Facility premises.

The purpose of the present document is to present the requirements related to the IPL IASF MGSE, i.e. the MGSE items to be procured by IASF Bologna.

They shall consists of two set of components.

1. The **IPL AIV IASF MGSE** to be procured in order to support the AIV at the Payload Integration site (LABEN).
2. The **IPL Calibration IASF MGSE** to be procured in order to support the IPL Calibration at the Calibration Beam site.

The specific requirements of each of the above sets are presented in chapter 4 and chapter 5, respectively. General requirements are presented in chapter 6. The description of the IPL configuration is given in chapter 3.

In this document, the requirements have been coded as follows:

[IPL-MGSE-NNNN]	where:
NNNN	Progressive number, unique for each requirement

1.2 Acronyms

AC	Anti-coincidence auxiliary subsystem
Calibration MGSE	Calibration Mechanical Ground Support Equipment
CCOE	Central Checkout Equipment
EGSE	Electrical Ground Support Equipment
GSE	Ground Support Equipment
ICD	Interface Control Document
Instrument SC	Instrument Science Console
IPL	Integrated Payload
MCAL	Mini-calorimeter detector
PD	Photo Diode

PDHU	Payload Data handling Unit
SA	X-Ray detector named Super-AGILE
ST	Silicon Tracker gamma-ray detector
TBC	To Be Confirmed
TBD	To Be Defined
TC	Telecommand
TE	Test Equipment
TM	Telemetry

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

AD [1] AGILE-ITE-SR-006 “AGILE Integrated Payload IASF MGSE Requirement Specifications”, Issue 1, November 2003

AD [2] AGRTI-BD-CGS-001, "AGILE RTI MASS BUDGET", Issue 1, 09/09/2003

AD [3] AGRTI-IC-CGS-001, "AGILE RTI MECHANICAL, THERMAL & ENVIRONMENTAL INTERFACE CONTROL DOCUMENT” ,Issue 1, 09/09/2003

AD [4] doc IPL AIV LABEN

AD [5] RTI IPL Shell ICD

AD [6] AGILE EMC requirements

AD [7] RTI IPL Transportation container ICD

2.2 Reference Documents

RD [1] M.Trifoglio et al, “Assessment of the AGILE Payload MGSE for level 3 and level 4 AIV and Calibration Activities" AGILE-ITE-SR-004, Te.S.R.E. Report 326/01, Issue 3, January 2003.

RD [2] ACO, "AGILE Mechanical, Thermal & Environmental Interface Control Document", ACO-DC-IC-002, Issue 1, February 2002.

RD [3] AGILE-AST-PL-002, "AGILE Payload High Level AIV Plan", Issue 4, February 2003

RD [4] AGILE P/L Thermal Design Report AGILE-AST-RE-002 Issue 2

RD [5] AGILE-AST-ID-001 Issue 1 "AGILE P/L ICD", Issue 1, 11/07/02

RD [6] “AGILE MGSE/EGSE/TE” meeting at LABEN, MOM LA-A3-PY-MN-009-03, 16.09.03.

RD [7] “AGILE MGSE Payload Integrato” meeting at LABEN, MOM LA-A3-PY-MN-012-03, 30.09.03.

2.3 Document Priority

A priority in the applicability of documents is established as follows:

1. AGILE Scientific Requirements
2. P/L System Requirements
3. Current Document
4. Applicable Documents
5. Minutes of Meeting

In case of conflict among technical material contained in these documents, the highest rank document shall have the precedence.

3 INTEGRATED PAYLOAD (IPL) DEFINITION

3.1 Configuration

As presented in AD[2], the AGILE integrated payload (IPL) is composed of :

1. ***Detector*** subdivided in

   - *Detector Core* (DTC) composed by:

     - Silicon tracker gamma-ray detector **(ST)**
     - Mini-calorimeter detector (**MCAL)**
     - X-ray detector named Super-AGILE (**SA**)
     - High Voltage Distribution Box **(HVDB)**
     - Detector Upper Mainframe (**UMF**)
     - Detector Lower Mainframe (**LMF**)
     - Harness Internal to the Detector (**DHSS**)

   - *Anti-coincidence* auxiliary subsystem (**AC**)

   - P/L Multi-Layer Insulation **(MLI)**

   - Light Tight System **(LTS)** TBC

   - Housekeepings

   - Heaters

2. ***Integrated Payload Shell*** (**IPS**) composed by:

   - Shell Module
   - Payload Data Handling Unit (**PDHU**)
   - Power Supply Unit **(PSU)**
   - GPS Unit
   - Two Star Sensors Units (**SSU**)
   - Harness Internal to the P/L Shell (**SHSS**)
   - P/L Shell MLI

4 AIV REQUIREMENTS

4.1 General Description

As presented in AD [4], upon completion of the unit level and subsystem level AIV activities, the AGILE instrument components listed in section 3 shall undergo the system level AIV activities, at LABEN premises in order:

- to populate the Payload Shell with the harnesses, the internal electronics boxes, and the external avionics items;
- to mount the Detector Core and the Anti-coincidence panels on the Payload Shell;
- to perform the electrical, functional and performance tests on the Integrated Payload.

The outcome of the above activities shall be the Integrated Payload (IPL) sketched in fig. Figure 4-1.

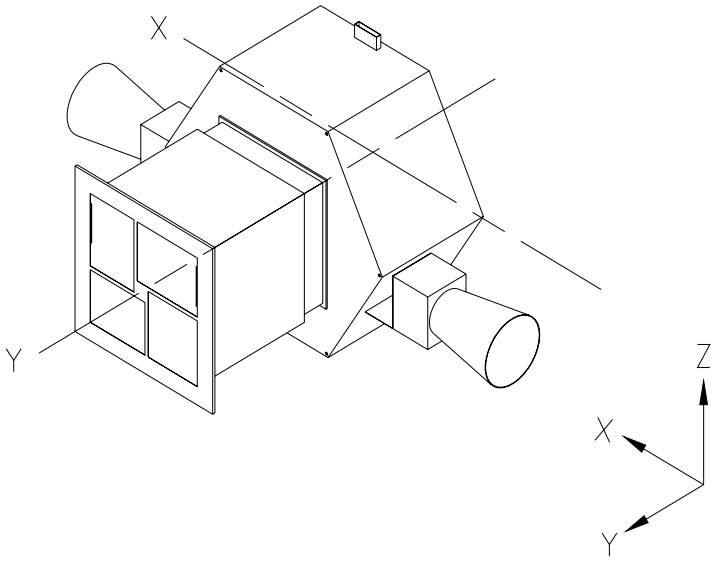


Figure 4-1 AGILE Integrated Payload (IPL)

4.2 Relation to Laben's AIV Room

At the time of writing, it is foreseen that the IPL integration shall be carried out in a clean room (class 100.000) located at LABEN premises.

Any use of cooling by liquid gases (e.g. Nitrogen) must use completely sealed systems in order to avoid any escape of gas into the clean room atmosphere.

The clean room shall be equipped with:

a) a lifting device (LABEN Travelling Crane): this mechanical structure provides a crane hook and is equipped with 4 wheels;

b) main electrical power: 220 V, 50 Hz.

The accessibility to the room is limited by the minimum door width of 1200 mm.

4.3 Functional Analysis

The IASF MGSE shall fulfil the main following tasks:

1. Mechanical Interface:
    a) to provide mechanical I/F between IPL Shell bottom side and AIV MGSE.
2. Mechanical Support:
    a) to provide mechanical support to the IPL during the AIV operations.
3. Ry Rotation:
    a) to provide the rotation stage for the manual rotation of the IPL around the IPL Y axes during all stages of the AIV operations;
    b) to display the current Ry rotation angle.
4. Rx Rotation:
    a) to provide the rotation stage for the manual rotation of the IPL around the IPL X axes during all stages of the AIV operations;
    b) to display locally the current Rx rotation angle.
5. Lifting Interface:
    a) to provide lifting points for the IPL lifting operations;
    b) to provide mechanical Interface to the Laben's Travelling Crane.

A simplified view of the rotations to be provided by the MGSE are sketched in Figure 4-2.

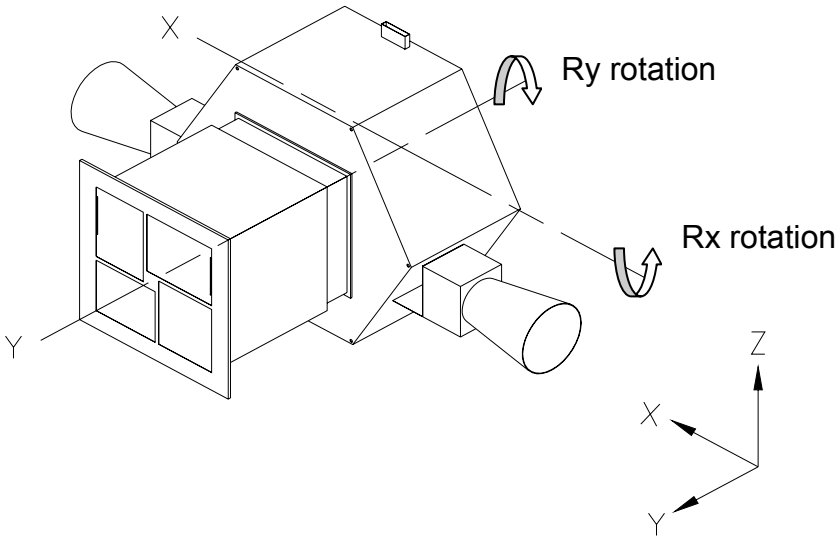


Figure 4-2 Rotation stages to be provided by the AIV MGSE

On the basis of the feasibility assessment (see RD [1]), the above tasks shall be assigned to the following IASF MGSE items:

- **IPL Shell Interface Flange**: task 1a)
- **IPL Crate**: part of task 2a), task 3a), task 3b), task 5a);
- **IPL Rotating Device**: task 4a), task 4b), and task 5a);
- **IPL Lifting Spider**: task 5b).

The corresponding requirements are presented in the remaining sections of this chapter.

The MGSE context diagram for the IPL AIV is shown in Figure 4-3, where the IASF MGSE items are identified by bold boxes.

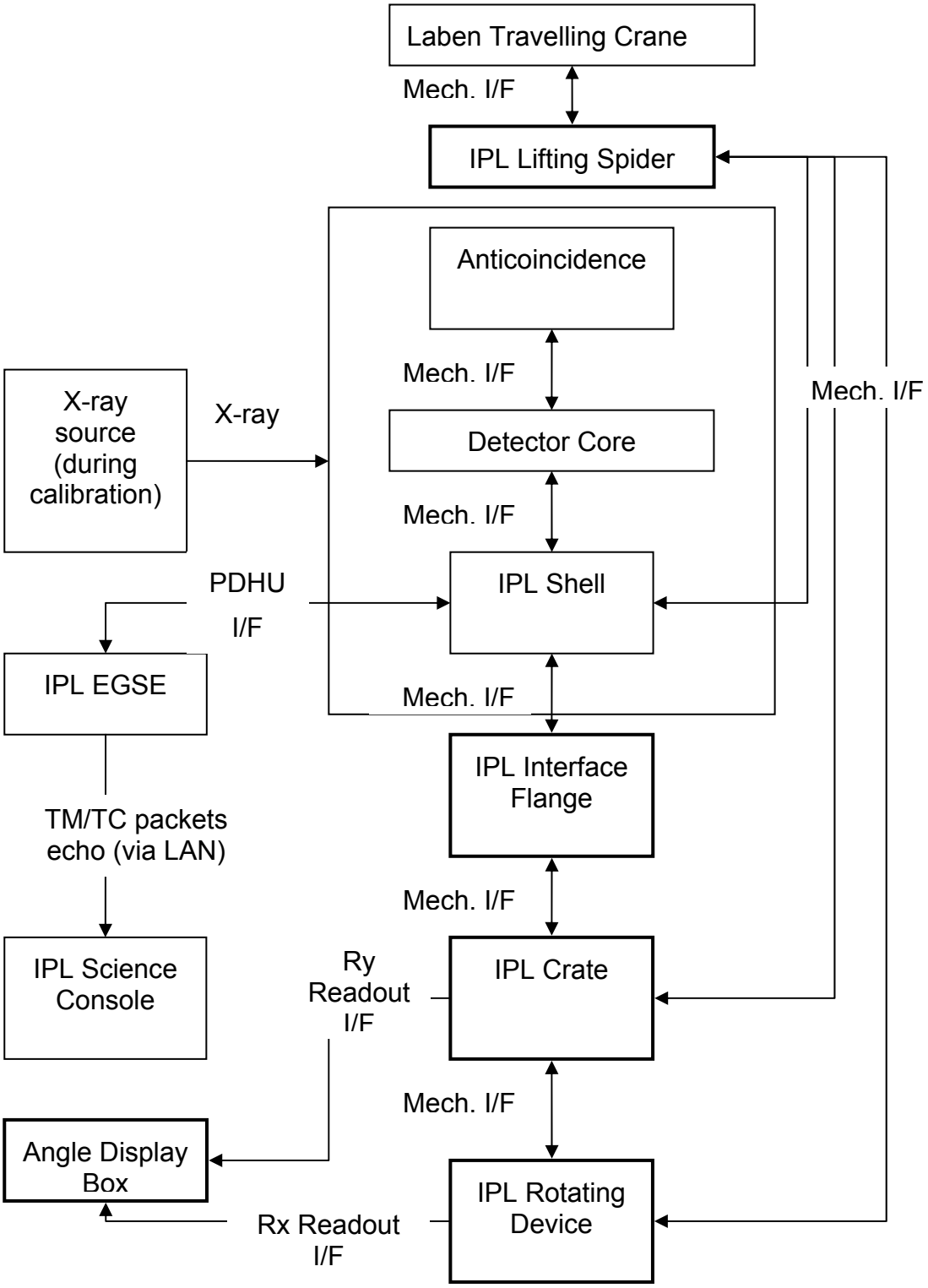


Figure 4-3 IPL AIV MGSE context diagram

4.4 Functional Requirements

4.4.1 IPL Shell Interface Flange

IPL-MGSE-0010	Shell Interface Flange concept

The Shell Interface Flange shall provide the mechanical interface among the Payload Shell and the IPL Crate:

- one side of the Flange shall be fixed on the bottom of the Payload Shell,
- the other side shall be fixed on the Rotation Table of the IPL Crate.

IPL-MGSE-0020	Shell Interface Flange fixing points

On one side, this fixture shall provide:

- the screw fixing points for the P/L Shell;
- the holes corresponding to the plugs placed on the rotating table of the P/L Crate.

On the other side, this fixture shall provide:

- the screw fixing points for the rotating table of the P/L Crate. These fixing points shall be accessible at any stage of the IPL Assembly operations in order to allow the separation of the IPL from the P/L Crate.

4.4.2 IPL Crate

IPL-MGSE-0030	IPL Crate concept

The IPL Crate shall consist of a mechanical structure providing the Ry rotation stage on top of which shall be fixed the IPL Shell bottom side (i.e.: the side towards the Satellite Service Module).

In turn, the IPL Crate shall be fixed to the IPL Rotating Device which shall provide the Rx rotation.

IPL-MGSE-0040	IPL Crate functionality

The IPL Crate shall provide:

- 4 adjustable feet, which shall be used to lean the IPL Crate on the rear side;
- 4 hoist rings in order to safely lift the IPL Crate;
- the Ry Rotation Stage for the manual rotation of the IPL around the Y direction;
- 2 removable lateral flanges for the fixing of the Crate on the Rotating Device.

IPL-MGSE-0050	Ry Rotation Stage functionality

The Ry Rotation Stage shall provide:

- the alignment plugs which shall facilitate the mounting operation of the Shell Interface Flange;
- the fixing points for the Shell Interface Flange;
- the angle transducer device.

IPL-MGSE-0060	Ry rotation angle display

During the Calibration activities to be carried out in the AIV clean room, the MGSE shall be able to display the current Ry ψ angular position.

4.4.3 IPL Rotating Device

IPL-MGSE-0070	IPL Rotating Device concept

The IPL Rotating Device shall consists of:

- the mechanical structure supporting 2 flanges where to fix the IPL Crate;
- the manual Rx Rotation Stage.

IPL-MGSE-0080	IPL Rotating Device functionality

The IPL Rotating Device shall provide:

- 4 removable reels, which shall allow the manual placement of the device;
- 4 adjustable feet, which shall be used to remove the reels and to level and fix the device in the working position;
- 4 hoist rings, to be used in order to safely lift the IPL Rotating Device with the IPL Crate and the IPL mounted on it;
- the mechanical support structure which keeps the IPL Crate at the height of about 1000 mm. from the ground (as imposed by the AIV room ceiling height);
- the Rx rotation stage for the manual rotations of the IPL around the X direction.

IPL-MGSE-0100	Rx Rotation Stage functionality

The Rx Rotation Stage shall provide:

- the rotation table;
- the fixing points for the lateral flanges of the IPL Crate on the rotation table;
- the hand wheel connected to the rotation table through suitable mechanical transmission mechanism.
- the angle transducer device.

IPL-MGSE-0110	Rx rotation angle display

During the Calibration activities to be carried out in the AIV clean room, the MGSE shall be able to display the current Rx Θ angular position.

IPL-MGSE-0120	Rx Rotation brake

The mechanical Rx rotation shall include a manual brake which blocks the rotation.

IPL-MGSE-0130	Rx Reduction Gear

The use of a suitable Reduction Gear applied to the mechanical Rx rotation shall hinder any movement caused by the IPL load weight, also in case the manual brake has not been activated.

4.4.4 IPL Lifting Spider

IPL-MGSE-0140	Lifting Spider Concept

The Lifting Spider shall consist of the mechanical structure and fixtures which shall be used in order to fix the Laben's Travelling Crane to the hoist rings of the IPL Shell and the IPL IASF AIV MGSE during the AIV operations.

IPL-MGSE-0150	Lifting Spider functionality

This provision shall include:

- the cables which shall fix the Spider to the hoist rings of the item to be moved;
- the adapter which shall be required in order to fix the spider to the cable of the LABEN Travelling Crane.

  This adapter shall replace the hook which is currently installed on the LABEN Travelling Crane.

  The adapter shall be designed in order to maximize the space left under the spider.

4.5 Performance Requirements

4.5.1 Interface Flange

IPL-MGSE-0160	Shell Interface Flange sizing

The IPL Shell Interface Flange shall be sized for the weight and dimensions of the Integrated Payload (about 200 Kg).

IPL-MGSE-0170	Shell Interface Flange mating surface

The flange mating surface on Shell side shall have:

- planarity: 0.1/100 mm, 1 mm overall (i.e. the maximum allowed shall not exceed 1 mm, independently by the length of the element);

- roughness: 1.6 μm.

4.5.2 IPL Crate

IPL-MGSE-0180	IPL Crate internal dimensions

The IPL Crate internal dimensions shall allow the Ry rotation for an overall volume of Ø1050mm.

IPL-MGSE-0190	IPL Crate hoist rings performance

The IPL Crate hoist rings shall be sized for the weight of the IPL Crate (about 220 Kg) hosting the IPL (about 200 Kg) and mounted on the IPL Shell Interface Flange (about 15 Kg).

4.5.3 Ry Rotation

IPL-MGSE-0200	Ry Rotation Stage performance

The Ry Rotation Stage shall allow the manual rotation of the IPL around the IPL Y direction with the following performances:

- range $\psi = [-180^{o}, +180^{o}]$
- minimal incremental motion = 0.1^{o}.

IPL-MGSE-0210	Ry rotation angle display performance

The current Ry rotation angle shall be displayed by the MGSE with the following performances:

- display accuracy = 3^{o} over 360^{o} (i.e. the maximum allowed shall not exceed 3^{o}, independently by the angle).
- display format: decimal degrees ±ggg.d (e.g. +160.6).

IPL-MGSE-0220	Ry rotation angle display location

During the AIV operations, the Ry rotation angle display equipment shall be located at the maximum distance of 5 m from the IPL.

4.5.4 Rx Rotation

IPL-MGSE-0230	Rx Stage performance

The Rx Rotation Stage shall allow the manual rotation of the IPL around the IPL X direction with the following performances:

- range $\theta = [0^{o}, \pm 90^{o}]$
- minimal incremental motion = 0.1^{o}.

IPL-MGSE-0240	Rx rotation angle display performance

The current Ry rotation angle shall be displayed by the MGSE with the following performances:

- display accuracy = 0,5° over 180° (i.e. the maximum allowed shall not exceed 0,5°, independently by the angle).
- display format: decimal degrees ±ggg.d (e.g. +160.6).

IPL-MGSE-0250	Rx rotation angle display location

During the AIV operations, the Rx rotation angle display equipment shall be located at the maximum distance of 5 m from the IPL.

4.5.5 Lifting Spider

IPL-MGSE-0260	Lifting Spider performance

The Spider shall be sized for the weight and dimensions of:

- the IPL (about 200 Kg) mounted on the IPL Shell Interface (about 15 Kg), without the IPL Crate, to be lifted from the hoist rings installed on the P/L Shell;
- the IPL (about 200 Kg) mounted on the IPL Shell Interface (about 15 Kg), hosted in the IPL Crate (about 220 Kg), to be lifted from the hoist rings of the IPL Crate itself;
- the empty IPL Crate (about 220 Kg) mounted on the IPL Rotating Device (about 270 Kg), to be lifted from the hoist rings of the IPL of the IPL Rotating Device.

4.5.6 Mounting

IPL-MGSE-0270	Mounting tolerance

The MGSE mounting tolerance for the IPL shall be 100 µm (TBC) for all the axes.

The MGSE angular mounting tolerance shall be 0.1 deg. (TBC) along all the three IPL axes.

4.6 Interface Requirements

This section contains the specific MGSE interface requirements. The requirements cover the following interfaces:

a) IPL / MGSE

b) MGSE / LABEN's AIV Room

c) IPL / EGSE

4.6.1 Mechanical Interface

IPL-MGSE-0280	IPL weight

The IPL shall have a maximum weight of 200 Kg.

IPL-MGSE-0290	IPL dimensions

The IPL shall have the maximum external dimensions given in Figure 4-4.

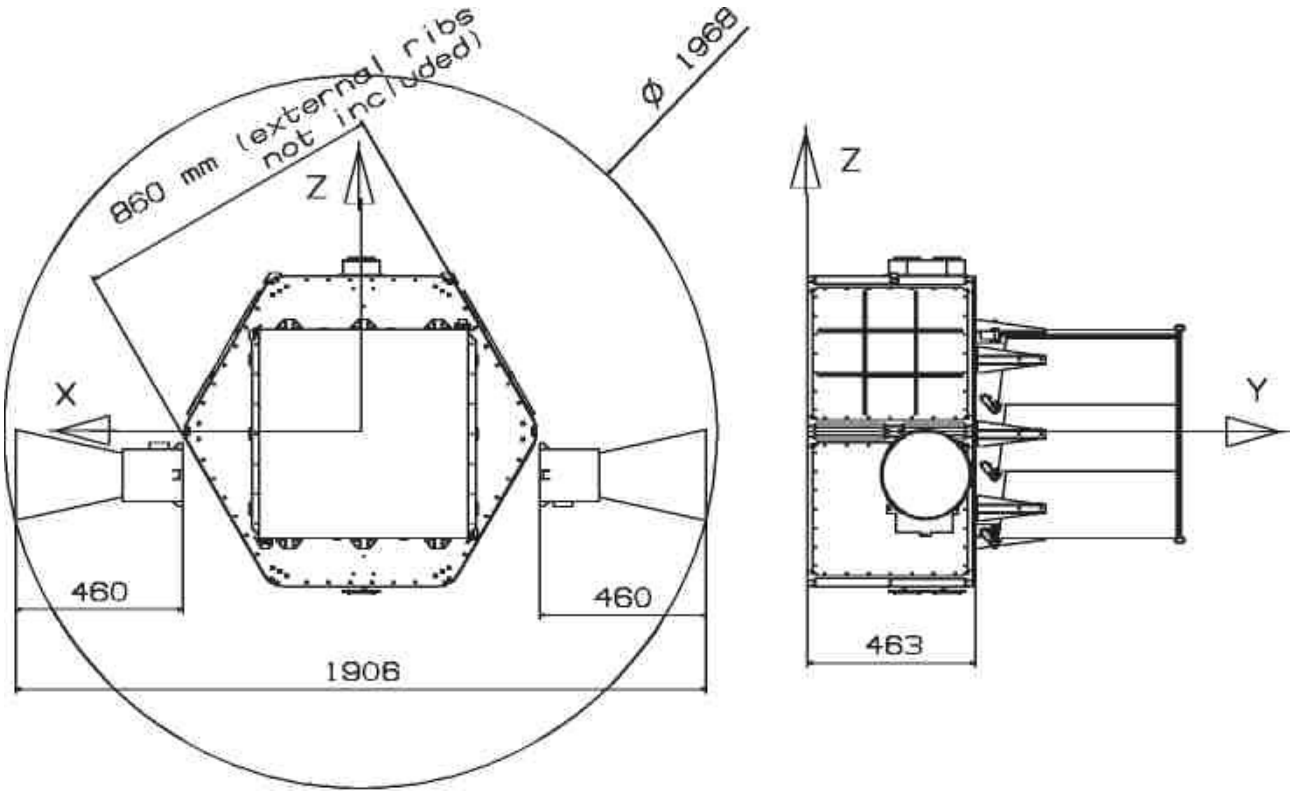


Figure 4-4 IPL maximum dimensions (by Gavazzi – Collavo 08 oct 2003)

IPL-MGSE-0300	IPL / MGSE interface concept

The IPL / MGSE interface concept is sketched in Figure 4-5 and Figure 4-6.

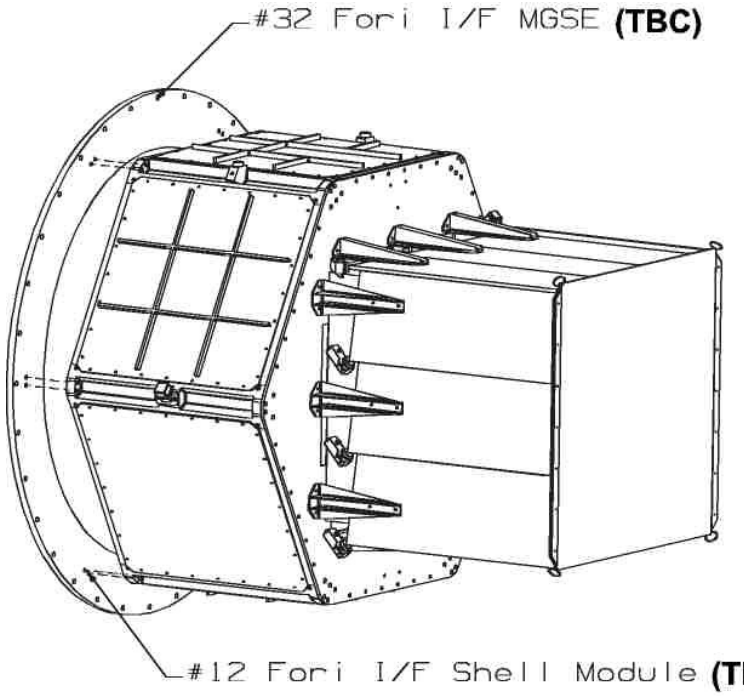


Figure 4-5 IPL / MGSE interface concept (by Gavazzi – E. Collavo 10 oct 2003)

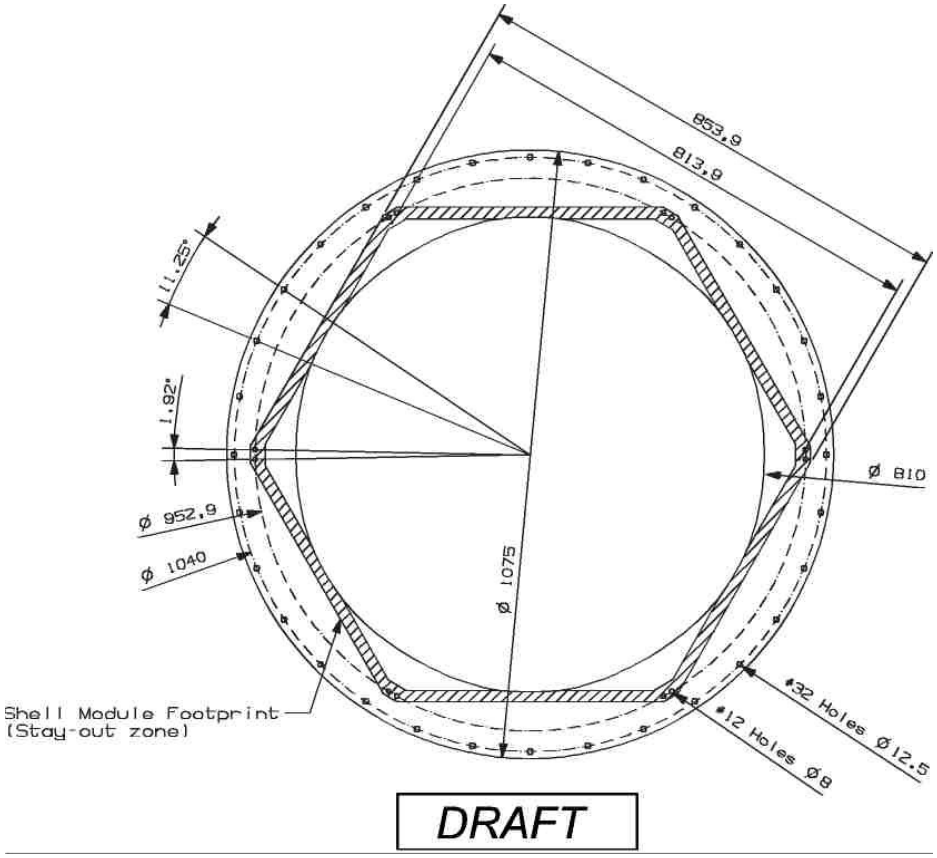


Figure 4-6 IPL / MGSE interface (by Gavazzi – E. Collavo 10 oct 2003)

IPL-MGSE-0310	IPL Shell / Shell Interface Flange

The IPL Shell shall be locked to the Shell Interface Flange by means of the holes available in the IPL Shell bottom side, as defined in AD [5] (TBW).

IPL-MGSE-0320	IPL Shell hoist rings

The IPL Shell shall provide 6 (TBC) hoist rings mounted on the top side of the P/L Shell as defined in AD [5] (TBW).

IPL-MGSE-0330	IPL Shell hoist rings sizing

The IPL Shell hoist rings shall be sized for the total weight of 215 Kg, corresponding to the weight of the IPL (about 200 Kg) plus the weight of the IPL Shell Interface (about 15 Kg).

IPL-MGSE-0340	MGSE / Cooling Device interface

The Cooling Device shall allow the P/L to work switched-on in ground condition (1 ATM, pressure & room temperature of 20°C) maintaining the detectors and the related electronic inside the operative temperature limits (best performance) defined in RD [4] for an undefined period of time.

The Cooling Device shall be procured by LABEN with the adaptation of the IBIS Cooling Device.

In particular, LABEN shall adapt the Cooling Device mechanical interface to the MGSE.

IPL-MGSE-0350	IPL / EGSE interface

During the AIV operations the EGSE shall be interfaced directly to the IPL PDHU connectors. The use of the external connector included in the IPL Shell shall be limited to an unique electrical/functional test which shall be performed during the AIV with the IPL hanging from the LABEN Travelling Crane, without the IPL Crate.

IPL-MGSE-0360	IPL / RTI's IPL Transportation Container I/F

The RTI's IPL Transportation Container shall be able to transport the IPL mounted on the IPL Shell Interface Flange.

The RTI's IPL Transportation Container provision shall include the flange which shall lock the IPL Shell Interface Flange as defined in AD [6] (TBW).

IPL-MGSE-0370	MGSE / Laben's Travelling Crane Interface

The overall dimensions of the Laben's Travelling Crane are summarized in Figure 4-7.

This mechanical structure provides a crane hook at the maximum eight of 2040 mm and is equipped with 4 wheels.

In order to maximize the free height ground-hook, the existing hook shall be replaced with a suitable adapter included in the IPL Lifting Spider provision.

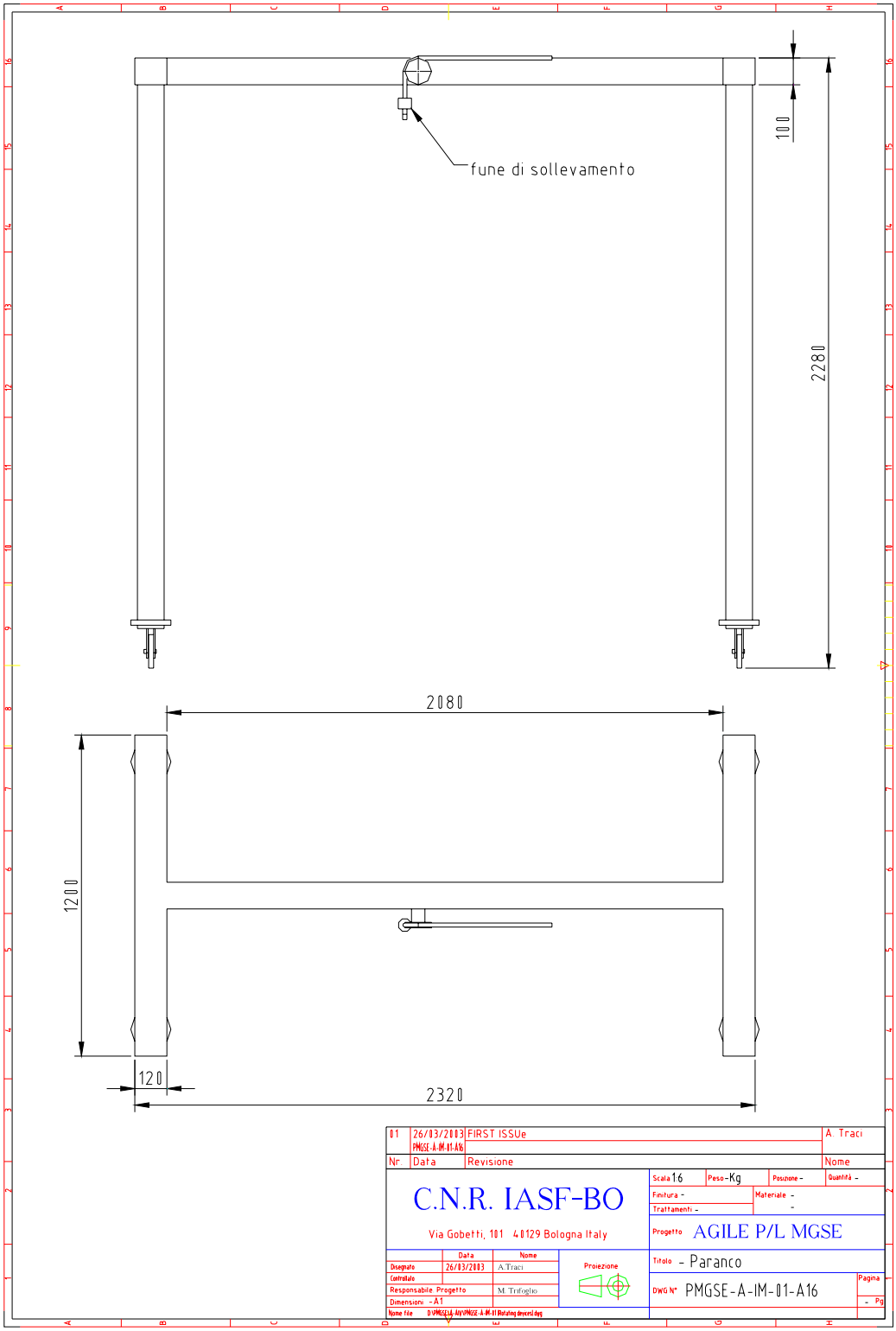


Figure 4-7 Laben' Travelling Crane overall dimensions.

4.6.2 Electrical Interface

IPL-MGSE-0380	Main Power

The MGSE electrical component (if any) shall require 220 V, 50 Hz main electrical power.

5 CALIBRATION BEAM REQUIREMENTS

5.1 General Description

Upon completion of the AIV activities, the Integrated Payload shall be moved to the beam site in order to carry out the IPL calibration beam activities.

At the calibration beam site, it shall be required the accurate mechanical positioning of the IPL in front of the beam in order to illuminate the various parts of the detector volume at different incident beam angle.

The calibration shall be performed on the IPL without the baffle, as sketched in Figure 5-1.

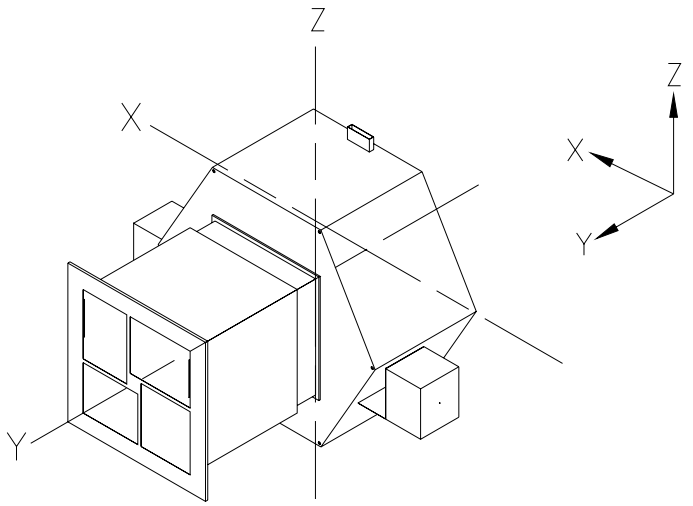


Figure 5-1 IPL configuration for the calibration beam campaign

This chapter contains the requirements related to the IASF MGSE items which shall be provided in order to perform the IPL positioning in front of the calibration beam.

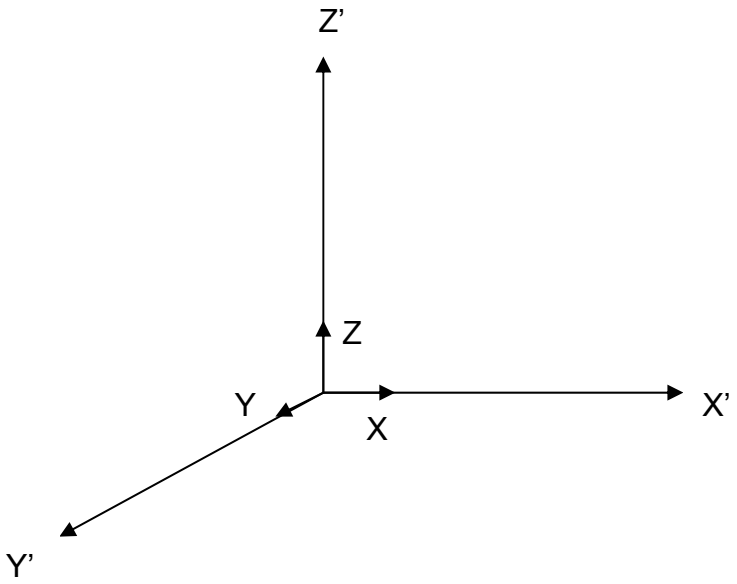
5.2 Relation to Beam's Facility

The Beam facility shall provide:

1. the Beam Area with one Beam Line, where the IPL and the MGSE shall be installed;
2. the User Area, where the MGSE operator shall remotely command and control the IPL positioning;
3. alignment tools in order to allow the alignment of the Local IPL Coordinate System X, Y, Z with the Beam Line Coordinate System X', Y', Z';
4. main power: 3x380V 50Hz, 220 V 50Hz in the Beam Area;

5. main power: 220 V 50Hz in the User Area;
6. Ethernet WAN access in the User Area;
7. the possibility to install cables which connect the Beam Area and the User Area for the MGSE and the EGSE devices.

Reference Axes are shown in Figure 5-2.



X', Y', Z': Beam Facility Coordinate System

X, Y, Z: AGILE IPL Coordinate System

Figure 5-2 Reference Axes

5.3 Functional Analysis

In order to support the IPL calibration beam, the IASF MGSE shall fulfil the main following tasks:

1. Mechanical Interface:
    a) to provide mechanical I/F between IPL Shell bottom side and IASF MGSE.
2. Mechanical Support:
    a) to provide mechanical support to the IPL in front of the beam.

3. Ry Rotation:

    a) to provide the Ry Stage to be activated manually for the IPL rotation around the IPL Y axes;

    b) to display in the Beam Area the current Ry rotation angle and make available the current Ry angle digital value for remote acquisition;

    c) to acquire and display in the User Area the current Ry rotation angle.

4. Rz Rotation:

    a) to provide manual rotation of the IPL around the IPL Z axes parallel to the Z' direction;

    b) to display in the Beam Area the current Rz rotation angle and make available the current Rz angle digital value for remote acquisition;

    c) to acquire and display in the User Area the current Rz rotation angle.

5. Tx positioning:

    a) to provide horizontal positioning of the IPL along the X' direction by controlling the motor that positions the Tx Stage.

6. Tz positioning:

    a) to provide vertical positioning of the IPL along the Z' direction by controlling the motor that positions the Tz Stage.

7. MGSE HK delivery:

    a) to deliver to the Science Console the MGSE position information (MGSE HK);

8. Video Surveillance:

    a. to allow the visual control of the MGSE from the User Area

A simplified view of the rotation movements to be provided by the MGSE are sketched in Figure 5-3.

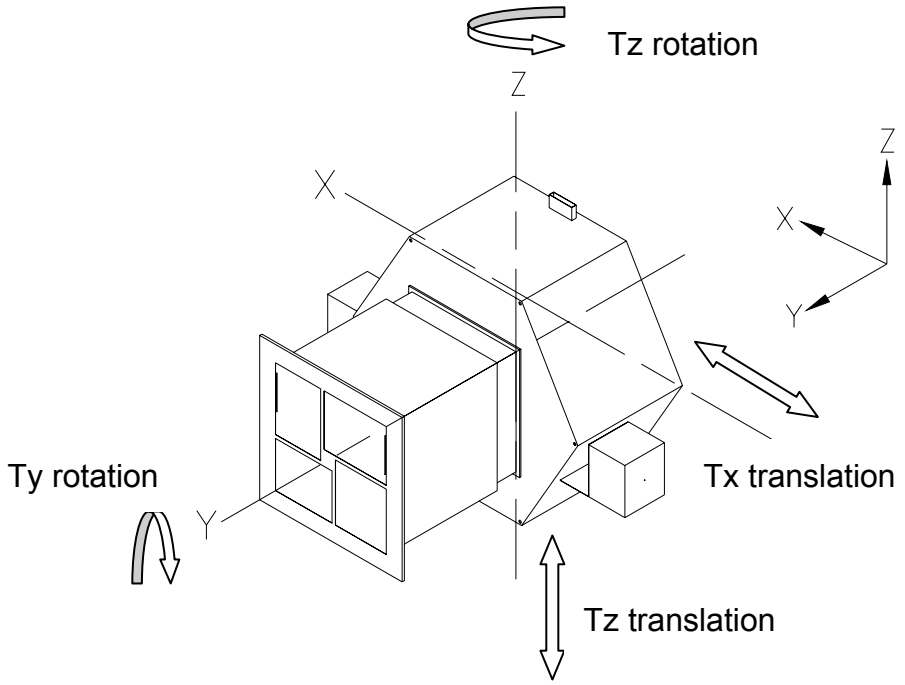


Figure 5-3 Translation and rotation stages to be provided by the Calibration MGSE

On the basis of the feasibility assessment (see RD [1]), the above tasks shall be assigned to the following IASF MGSE items:

- **IPL Shell Interface Flange**: task 1a. This item shall be part also of the AIV MGSE presented in Chapter 4.
- **IPL Crate**: part of task 2a, and task 3a. This item shall be part also of the AIV MGSE presented in Chapter 4.
- **IPL MGSE Positioning System**: it shall be in charge of performing mechanical handling operations related to tasks 4, 5, 6;
- **IPL MGSE Controller**: it shall be the intelligent unit which shall manage and control the MGSE Positioning System for what concern the motorized movements (Tx and Tz);
- **IPL MGSE Computer**: which shall allow the MGSE operator to supervise the MGSE Positioning System and the MGSE Controller System either from the Beam Area or from the User Area. The Computer shall also be connected to the IPL Science Console via LAN in order to deliver the MGSE position information (task 7a).

The corresponding requirements are presented in the remaining sections of this chapter.

The MGSE context diagram for the IPL Calibration at the beam facility is shown in Figure 5-4, where the IASF MGSE items are identified by bold boxes.

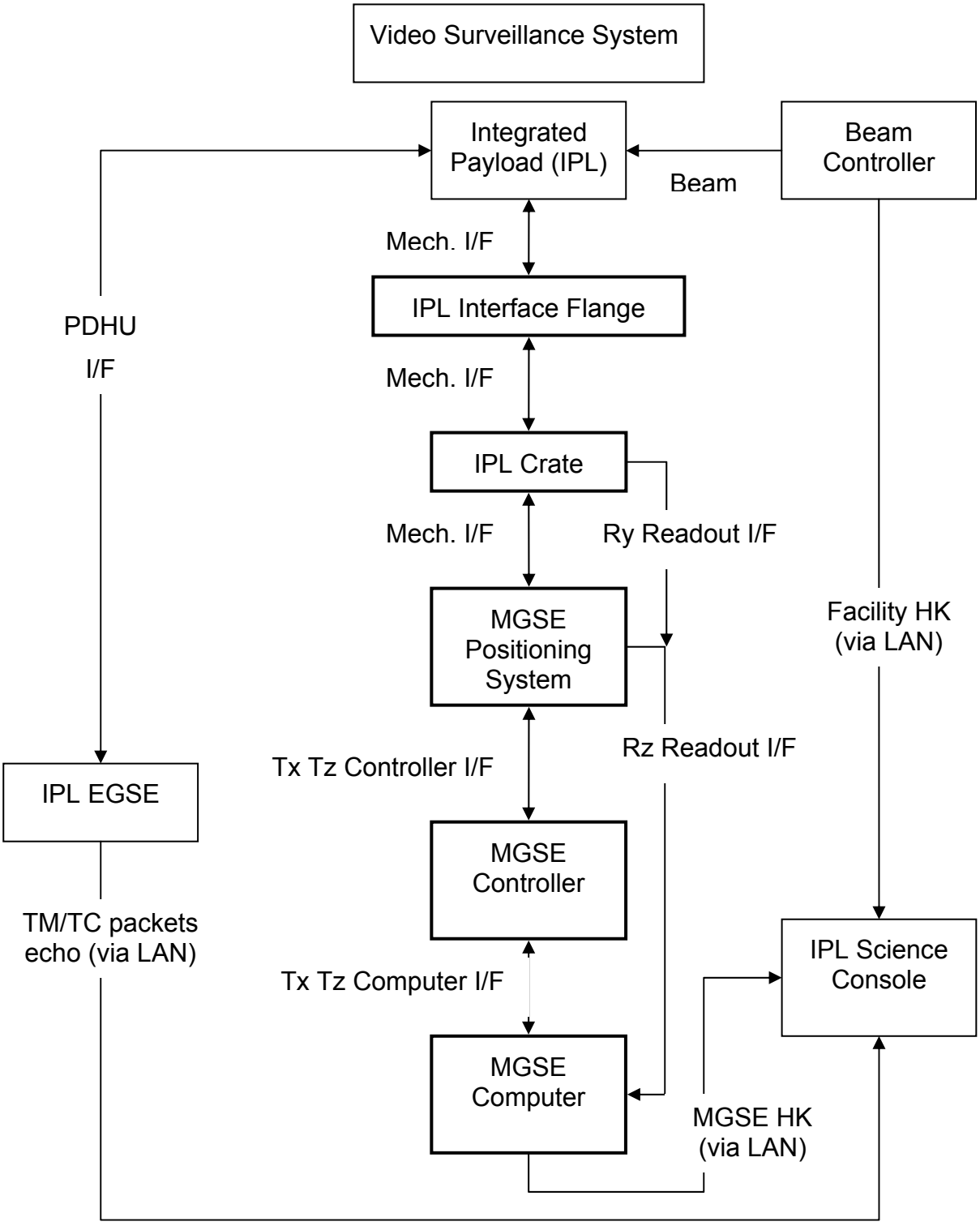


Figure 5-4 IPL Calibration MGSE context diagram

5.4 Functional Requirements

5.4.1 IPL Shell Interface Flange

The requirements presented in the corresponding AIV requirement section for the IPL Shell Interface Flange applies herein.

5.4.2 IPL Crate

IPL-MGSE-1000	IPL Crate concept

The same concept presented in the corresponding AIV requirement section for the IPL Crate applies herein, with the difference that the IPL Crate shall be fixed to the MGSE Positioning System, which shall provide the Rz rotation.

IPL-MGSE-1010	IPL Crate functionality

The same functionality presented in the corresponding AIV requirement section for the IPL Crate applies herein, with the addition that for the calibration the IPL Crate shall provide also the IPL Crate Calibration Flange.

IPL-MGSE-1020	IPL Crate Calibration Flange functionality

The IPL Crate Calibration Flange shall be mounted on the top side of the IPL Crate in order to hung the IPL Crate to the Rz Rotation table of the MGSE Positioning System.

IPL-MGSE-1030	Ry Rotation Stage functionality

The same functionality presented in the corresponding AIV requirement section for the Ry Rotation Stage applies herein.

IPL-MGSE-1040	Ry rotation angle display

In addition to display in the Beam Area the current Rz rotation angle, the MGSE shall make available the current Rz angle digital value for remote acquisition by the MGSE Computer.

5.4.3 MGSE Positioning System

5.4.3.1 Rz Rotation

IPL-MGSE-1050	Rz Rotation Stage concept

The Rz Rotation Stage shall consist of a rotation table which shall be activated manually in order to rotate the IPL around the Z axes parallel to the Z' direction.

IPL-MGSE-1060	Rz Rotation Stage functionality

The Rz Rotation Stage shall provide:

- the rotation table;

- the fixtures to fix the IPL Crate to the rotation table;
- the hand wheel connected to the rotation table through suitable mechanical transmission mechanism.
- the angle transducer device.

IPL-MGSE-1070	Rz rotation angle display

The MGSE shall be able:

- to display in the Beam Area the current Rz rotation angle,
- to make available the current Rz angle digital value for remote acquisition by the MGSE Computer.

5.4.3.2 TX TRANSLATION

IPL-MGSE-1080	Tx Translation Stage concept

The Tx Translation Stage shall consist of a movable carriage which shall provide motor positioning of the IPL along the IPL X axes parallel to the X' direction under the motor control performed by the MGSE Controller.

IPL-MGSE-1090	Tx Translation Stage functionality

The TX Translation Stage shall provide:

- the movable carriage;
- the motor which activates the linear movement of the carriage through a suitable mechanical transmission mechanism;
- the position transducer encoder;
- the limit switches which detect the begin and the end of the linear stroke;
- the home switch which detects absolute reference position;
- the Tx Stage interface to the MGSE Controller for the motion control.

5.4.3.3 TZ TRANSLATION

IPL-MGSE-1100	Tz Translation Stage concept

The Tz Translation Stage shall consist of a movable carriage which shall provide motor positioning of the IPL along the IPL Z axes parallel to the Z' direction under the motor control performed by the MGSE Controller.

IPL-MGSE-1110	Tz Translation Stage functionality

The Tz Translation Stage shall provide:

- the movable carriage;
- the motor which activates the linear movement of the carriage through a suitable mechanical transmission mechanism;
- the position transducer encoder;
- the limit switches which detect the begin and the end of the linear stroke;
- the home switch which detects absolute reference position;
- the Tx Stage interface to the MGSE Controller for the motion control.

5.4.4 MGSE Controller

IPL-MGSE-1120	MGSE Controller concept

The MGSE Controller shall be able to control in real-time the Tx and Tz motors of the Positioning System by means of:

- the motor-driving power stage provided by the MGSE Controller itself;
- the closed-loop feedback provided by the encoder included in the MGSE Positioning System;
- the home and limit switches included in the MGSE Positioning System.

IPL-MGSE-1130	Local / Remote control modes

The MGSE Controller shall allow local and remote control modes.

Local control mode shall allow the operator to command basic Tx and Tz positioning operations without the use of the MGSE Computer.

Remote control mode shall allow the MGSE Computer to take control of the Tx and Tz positioning.

5.4.5 MGSE Computer

IPL-MGSE-1140	MGSE Computer functionality

In remote control mode, the MGSE Computer shall be able to command and control the Tx and Tz positioning by interfacing the Tx and Tz motor drivers, motor encoders, home and limit switches.

5.4.6 MGSE Video Surveillance System

IPL-MGSE-1150	IPL Video Surveillance System functionality

This system shall allow visual control of the MGSE operations from the User Area.

5.5 Performance Requirements

5.5.1 IPL Crate Calibration Flange

IPL-MGSE-1160	IPL Crate Calibration Flange performance

The IPL Crate Calibration Flange shall be sized for the maximum weight of about 435 Kg as required for the IPL (about 200 Kg) mounted on the IPL Shell Interface (about 15 Kg), hosted in the IPL Crate (about 220 Kg).

5.5.2 Ry Rotation

IPL-MGSE-1170	Ry Rotation Stage performance

The corresponding requirement presented for the IPL Crate in the AIV requirements section applies herein.

IPL-MGSE-1180	Ry rotation angle display performance

The corresponding requirement presented for the IPL Crate in the AIV requirements section applies herein.

IPL-MGSE-1190	Ry rotation angle display location

The Ry rotation angle display equipment shall be located at the maximum distance of 10 m from the IPL.

5.5.3 Rz Rotation

IPL-MGSE-1200	Rz Stage performance

The Rz Rotation Stage shall allow the manual rotation around the IPL Z axes parallel to the Z' direction with the following performances:

- range $\theta = [0^o, +180^o]$
- minimal incremental motion = 0.1^o.

IPL-MGSE-1210	Rz rotation angle display performance

The current Rz rotation angle shall be displayed by the MGSE with the following performances:

- display accuracy = $0{,}5^o$ over 180^o (i.e. the maximum allowed shall not exceed $0{,}5^o$, independently by the angle).

- display format: decimal degrees ±ggg.d (e.g. +160.6).

IPL-MGSE-1220	Rz rotation angle display location

The Rx rotation angle display equipment shall be located at the maximum distance of 10 m from the IPL.

5.5.4 Tz Translation

IPL-MGSE-1230	Tz Stage performance

The motorized vertical stage Tz shall provide the linear translation along the Z IPL axes parallel to the Z' direction, with the following performances:

- translation range: 800 mm;
- minimal incremental motion: 1 mm;
- speed: 0 ÷ 600 mm/min
- accel.: 0,15 m/s^2 .

IPL-MGSE-1240	Tz position display performance

The current Tz position shall be displayed by the MGSE with the following performances:

- display accuracy = 2 mm over 800 mm (i.e. the maximum allowed shall not exceed 2 mm, independently by the translation).
- display format: mm ±nnnn (e.g. +0600).

5.5.5 Tx Translation

IPL-MGSE-1250	Tx Stage performance

The motorized horizontal stage Tx shall provide the linear translation along the X IPL axes parallel to the X' direction, with the following performances:

- translation range: 1338 mm;
- minimal incremental motion: 1 mm;
- speed: 0 ÷ 600 mm/min
- accel.: 0,30 m/s2 .

IPL-MGSE-1260	Tx position display performance

The current Tx position shall be displayed by the MGSE with the following performances:

- display accuracy = 2 mm over 1338 mm (i.e. the maximum allowed shall not exceed 2 mm, independently by the translation).
- display format: mm ±nnnn (e.g. +0600).

5.5.6 Mounting

5.6 Interface Requirements

This section contains the specific MGSE interface requirements. The requirements cover the following interfaces:

a) IPL / MGSE

b) MGSE / Beam Facility

c) IPL / EGSE

5.6.1.1 MECHANICAL INTERFACE

IPL-MGSE-1270	IPL Configuration

The IPL shall not include the Star Sensor Baffles.

5.6.1.2 ELECTRICAL INTERFACE

6 GENERAL REQUIREMENTS

This chapter contains the specific MGSE operations, resource, quality, reliability, maintainability and safety requirements.

6.1 Operational

IPL-MGSE-2000	Component sheilding

The MGSE components subjected to performance degradation or wrong behaviour when exposed to X-rays or Gamma-rays, shall be adequately shielded.

IPL-MGSE-2010	Component susceptibility

The MGSE components shall present no performance degradation or wrong behaviour when subjected to the radiated electromagnetic field reported in the AGILE EMC requirements.

IPL-MGSE-2020	Component emissivity

The MGSE components shall not radiate electromagnetic field reported in excess of the level reported in the AGILE EMC requirements.

IPL-MGSE-2030	MGSE transportability

The MGSE shall take into account the transportability of the equipment.

IPL-MGSE-2040	MGSE containers

The MGSE shall include suitable transportation container.

IPL-MGSE-2050	MGSE lifting points

The MGSE shall be provided of lifting points.

6.2 Resource

IPL-MGSE-2060	Recommended use of commercial hardware

The use of commercial available hardware which has world-wide service support is recommended.

6.3 Quality

IPL-MGSE-2070	CAD methodology

During the design phase, CAD tools shall be used to develop MGSE hardware and software.

6.4 Maintainability

IPL-MGSE-2080	Maintenance/Inspection/Replacement

The MGSE shall be designed in such a way to allow maintenance, assembly/disassembly, inspection and replacement/substitution of its components.

6.5 Safety

IPL-MGSE-2090	Limit switches

The MGSE shall include limit switches to detect when linear motorized moving parts reach the begin and the end of the stroke.

IPL-MGSE-2100	Failure propagation

The MGSE shall be designed in such a way that a failure in the MGSE shall not propagate to the item under test.

IPL-MGSE-2110	User safety

The MGSE design shall be such that any failure occurring during any test configuration or maintenance operation shall not result in hazards for the users of the MGSE itself.

IPL-MGSE-2120	Emergency push-button

The MGSE shall include emergency push buttons to activate MGSE emergency procedure. The emergency push buttons shall be of RED clour and shall be installed in places to be easy accessible and identified.

IPL-MGSE-2130	Safety features

The MGSE shall be include safety features to avoid that any lifted parts crash when the motors are turned off during emergency turn-of.

IPL-MGSE-2140	Grounding points

The MGSE shall provide a grounding (star) point for the IPL (TBC). This point should be connected to the Electrical part of the MGSE (TBC). The MGSE shall provide separate grounding point for the MGSE equipments (TBC).

7 VERIFICATION

This chapter is intended to provide a guide-line for the IASF MGSE integration and verification activities.

7.1 Verification Levels

7.1.1 AIV MGSE

Preliminary verification shall be carried out at subsystem level during the assembly and integration activities (level 0 verification) of each of the following subsystems:

- IPL Interface Flange
- IPL Crate
- IPL Rotating Device
- IPL Lifting Device

These assembly and integration activities shall be supported by appropriate handling equipment and fixtures.

AIV MGSE Acceptance tests shall be split in “in-house acceptance” (level 1 verification) and “on-site acceptance” (level 2 verification).

Level 1 verification shall be performed at IASF Bologna premises.

Level 2 verification shall be performed at Laben premises.

Level 1 verification shall require the IPL Mock-up which simulates the IPL mass proprieties and which shall be locked to the IPL Crate rotation table.

Level 1 acceptance tests on the IPL Lifting Device shall be performed using the IPL Interface Flange / IPL Crate / IPL Rotating Device / IPL Mock-up.

Before delivery the IPL Crate to Laben premises, Level 1 verification on the IPL Crate shall be carried out also in the calibration configuration (i.e. using the IPL Crate Calibration Flange).

7.1.2 Calibration MGSE

Preliminary verification shall be carried out at subsystem level during the assembly and integration activities (level 0 verification) of each of the following subsystems:

- MGSE Positioning System
- MGSE Controller
- MGSE Computer

Calibration MGSE Acceptance tests shall be split in “in-house acceptance” (level 1 verification) and “on-site acceptance” (level 2 verification).

Level 1 verification shall be performed at IASF Bologna premises.

Level 2 verification shall be performed at Beam Facility premises.

Level 1 verification shall simulate the IPL Crate and the IPL by reusing the IPL Mock-up locked to the IPL Crate Calibration Flange, with additional dummy weight which simulates the IPL Crate.

7.2 Verification Methods

The requirements contained in this document shall be verified by means of one (or more) of the following methods:

- **Analysis** [A]

This verification method implies use of analytical techniques (such as system engineering analysis, statistics, mathematical modeling, simulations) and shall be used to verify such requirements.

- **Review of Design**

This verification method may be used when approved design reports, technical descriptions, engineering drawings unambiguously show that the requirement is met.

- **Inspection** [I]

Verification by inspection is only done when testing is insufficient or inappropriate. This method of verification is for those requirements that are normally performed by some form of visual inspection. This would include workmanship, labeling, envelope requirements etc.

- **Demonstration** [M]

This verification method may be used when actual conduct can verify achievement of requirements such as service and access, transportability, human engineering features and processes hardware. A requirement which is of an operational or functional nature and is not quantified by a specific measurable parameter may be verified by demonstration.

- **Similarity** [S]

This verification method may be used when there is proof that the item is similar or identical in design and manufacturing processes to another previously qualified to equivalent or more stringent criteria.

- **Test** [T]

A requirement may be verified by test alone if the form of the specification is such that the requirement can be directly measured.

Acceptance tests shall verify the requirements specified in the verification matrix.

7.3 Verification Flow

7.4 Verification Matrix

7.5 Documentation