AGILE	IASF CNR Bologna

DOCUMENT TYPE:	**SUBSYSTEM SPECIFICATION**
TITLE:	**INTERFACE CONTROL DOCUMENT FOR THE AGILE IPL CALIBRATION AT INFN-BTF**
DOCUMENT Ref. No.:	AGILE-ITE-ID-006 **N° OF PAGES:** i-iii, 26 IASF Bologna Report 417/05
ISSUE No.:	Issue 1 **DATE:** October 2005
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CHANGE RECORD

ISSUE	DATE	PAGE	DESCRIPTION OF CHANGES	RELEASE
Draft a-b	June 2005		First draft circulated within AGILE team.	
Draft c	June 2005		Delivered to Laben as closure of A.I.#3 Mom AGILE-AST-C 386.	
Draft d	July 2005		Presented at the AGILE Team Calibration meeting hold in Laben on 14/07/2005	
01	October 2005			

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1 INTRODUCTION

1.1 SCOPE AND PURPOSE OF THE DOCUMENT

The scope of the present document are the Calibration of the Agile Integrated Payload (IPL) at the INFN Beam Test Facility (BTF) at Frascati.

The purpose of the document is to identify the information relevant for the interfacing, installation and verification of the test setup.

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 02/A, July 2004

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] AGILE-LAB-PL-007, “AGILE PFM Integrated Payload AIV Plan” Issue 2, 06/05/2004

AD [5] AGILE-IFC-PL-001, “AGILE Payload Calibration Plan”, Issue 1, 14/04/2005

AD [6] AGILE-SIM-022, “Simulazione di un fascio di fotoni taggati presso i Laboratori Nazionali di Frascati”, Issue 3, 09/05/2005

AD [7] AGILE-IFC-TN-011, “GRID Calibration Scientific Requirements”, Issue 6, 27/04/2005

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.

RD [8] Studio A.Zocca - Castel Maggiore - Bologna, IASF Bologna, “AGILE Integrated Payload IASF AIV Design, Analysis and Test Report”, AGILE-ITE-RE-007, IASF Report 409/04, Issue 01, 21 December 2004.

RD [9] ITE Industrialtecnoelettronica S.r.l, Bologna, “Encoder Box – Istruzioni d’uso”, Rev.2, 15/10/04.

RD [10] M.Trifoglio et al, “AGILE Integrated Payload IASF AIV MGSE User Manual" AGILE-ITE-UM-003, IASF Bologna Report 408/04, Issue 01/A, January 2005.

RD [11] M.Trifoglio et al, “AGILE Payload IASF Calibration MGSE Design Report”, AGILE-ITE-RE-006, IASF Bologna Report 376/03, Issue 01, November 2003.

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 CALIBRATION SET UP

The layout of the INFN-BTF premises is given in Figure 3-1, Figure 3-2 and Figure 3-3, where the two beam lines are shown:

- The Photons pipe, which is the straight line to be directed on the IPL.
- The Electrons pipe, which is the line placed at 45°.

Further details on the INFN-BTF can be found at the following URL http://www.lnf.infn.it/acceleratori/btf/docs/BTFCS20041117.pdf.

The various main items to be located into the Beam Area and the User Area are sketched in Figure 3-4. Their functionalities are summarized in the following subsections.

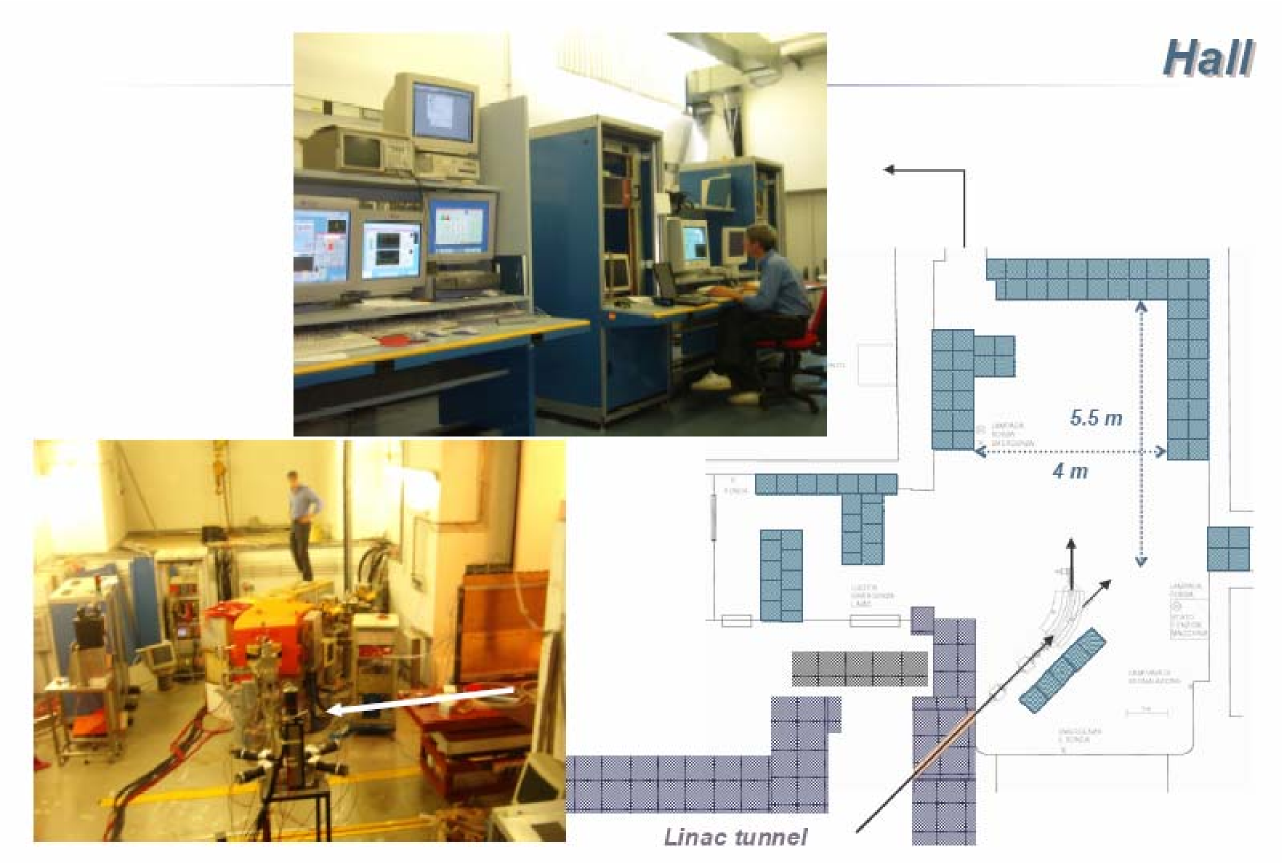

Figure 3-1 Overview of the INFN DAFNE BTF

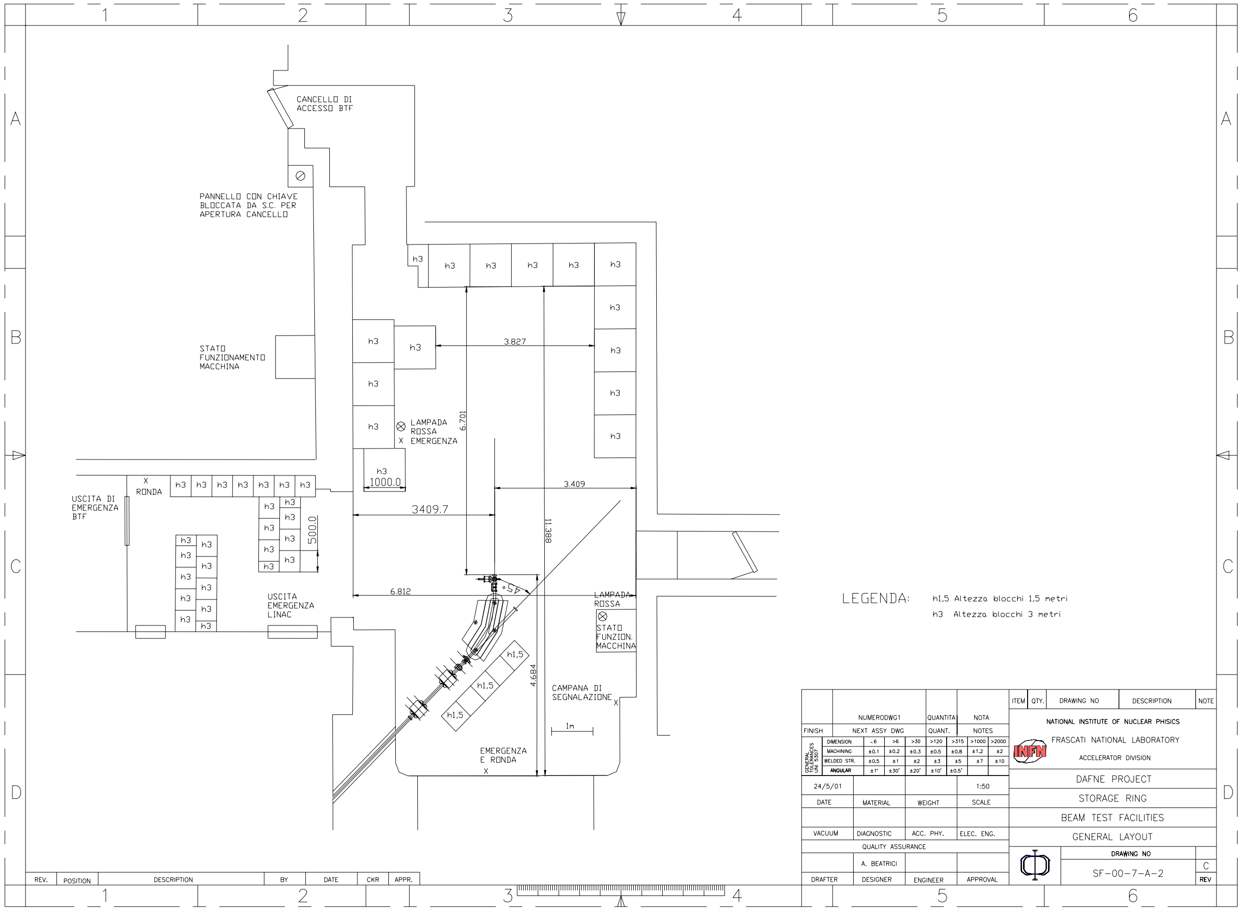

Figure 3-2 Layout of the INFN DAFNE BTF facility

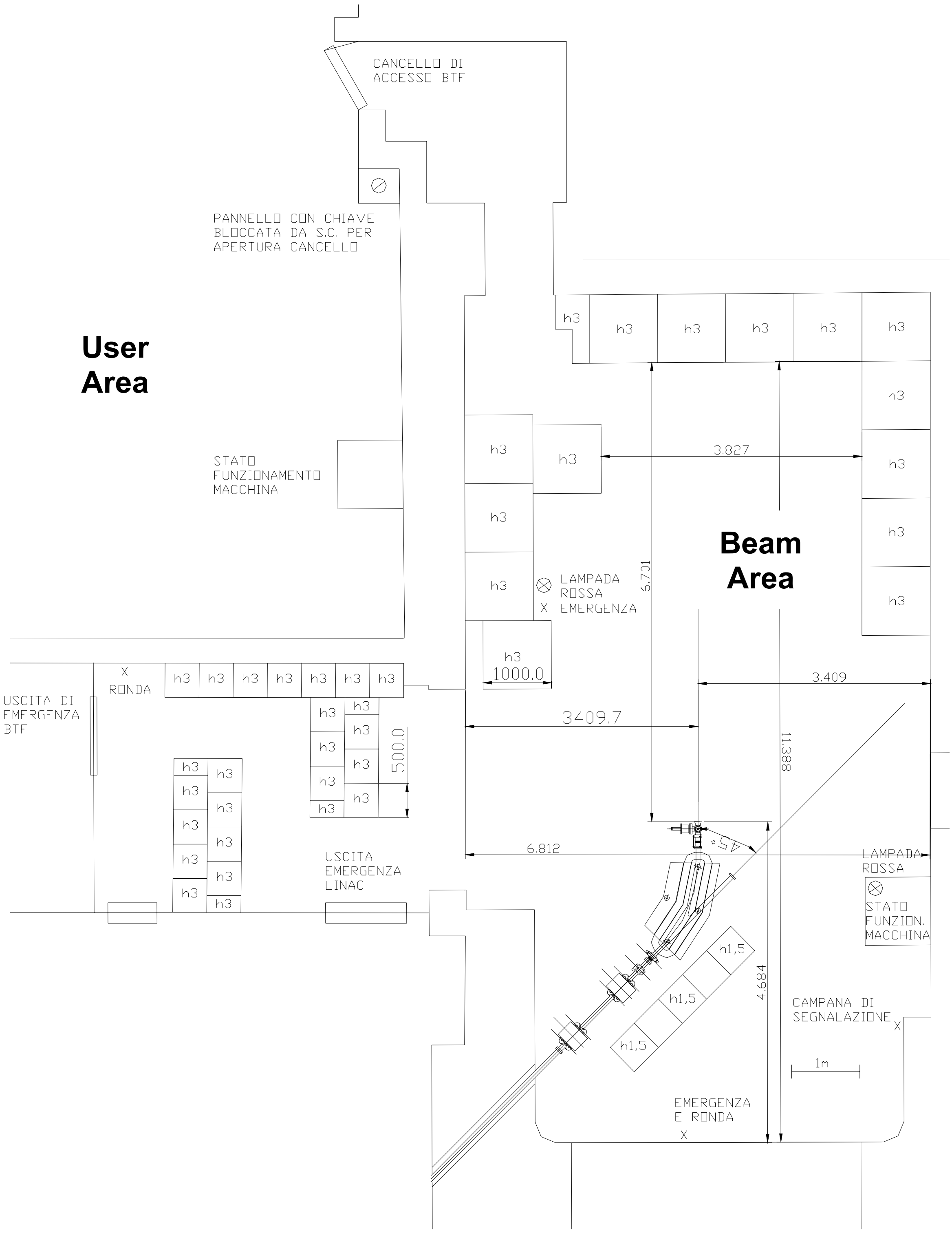

Figure 3-3 Zoomed view of the INFN DAFNE BTF.

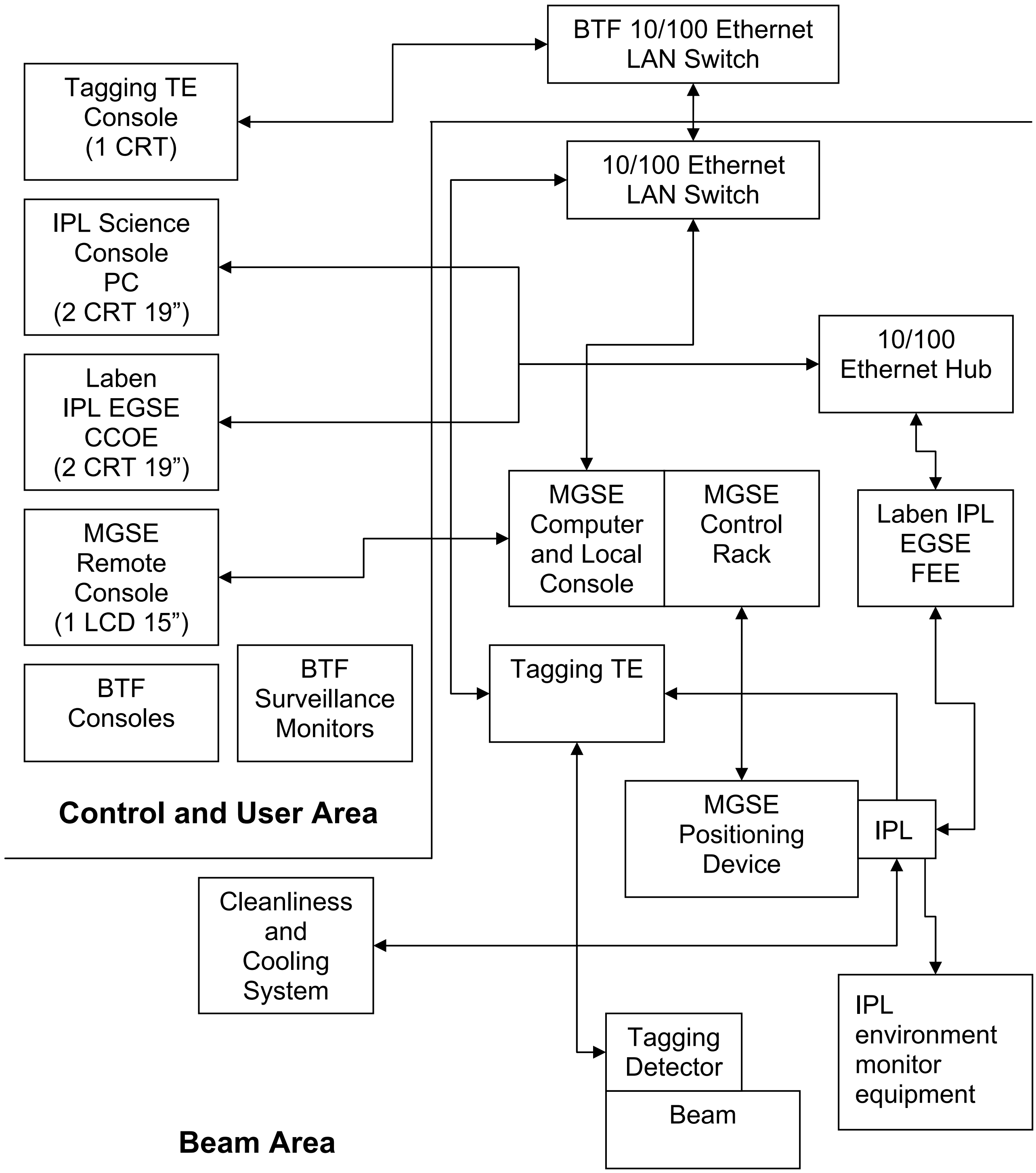

Figure 3-4 Main items and interfaces of the Calibration setup

3.1 Photon Tagging System (PTS)

This system is aimed at:

- Monitoring the beam line setup data (energy, current,...);
- Evaluating the total number of photons generated by the beam towards the IPL;
- Evaluating the energy of those photons;

It consists of:

- the tagging silicon detectors that are placed inside the last dipole magnet of the Electrons pipe
- the Tagging TE, which:
    - interfaces the BTF computer to acquire and monitor the beam line setup data;
    - interfaces the detectors to acquire the silicon strip data;
    - interfaces the IPL test connector to generate the time tag correlated to the IPL On Board Time tag (OBT);

In near real time the TE:

- notifies any major modification in the Beam Line setup;
- displays the tagged photons counter in order to allow the operator to evaluate the incident beam statistics;

  both this counter and the counter of detected photons provided by the Science Console shall allow the operator to evaluate whether the measurement statistics and detector efficiency values are as expected and the running measurement can be terminated.
- stores the beam setup data, the detector data and the time tag data.

At completion of the measurement, the TE:

- processes the above data in order to evaluate the energy of the corresponding photons.
- makes available the photon tagging data set to the Science Console (SC) where shall be archived in FITS format into the IPL data archive.

3.2 IPL Calibration MGSE

The Calibration MGSE is able to position the IPL in front of the beam by means of two motorized translations (Tx, and Tz) and two manual rotations (Ry and Rz).

Its major components are:

- The MGSE Positioning Device, which provides the mechanical structure, motors, encoders and switches required to perform the movements;

- The MGSE Control Rack, which contains the motor drivers and the electromechanical components required to command and control locally the Tx and Ty translations;
- The MGSE Computer which allows to command and control remotely the Tx and Ty translations by means of either a the console located in the Beam Area or the console located in User Area.

The MGSE Computer interfaces also the Ry and Rz absolute encoders in order to acquire their positions. In near real time, the positional information are made available to the Science Console for inclusion with the IPL data.

3.3 Cleanliness and Cooling Device

The IPL Detector Core (AC included) shall be covered with a Lexan (Polycarbonate) cover having a thickness of 3 mm for the bottom and lateral sides and a thickness of 0,75 mm for the top side (Figure 3-5).

The cover shall be fixed to the top side of the Payload Shell using the hoist rings holes.

In order to avoid ESD problems, the cover shall be shielded by aluminum film connected to ground trough kapton + treccia di rame. In turn, the aluminum shall be surrounded by pellicola trasparente.

A Plexiglas flange shall be used in order to close the rear side of the IPL Crate.

Through two suitable flanges installed on the IPL Shell, the internal environment shall be flushed by using:

- the air filtering unit provided by IASF-Bo
- the same air conditioner provided by Laben for the AIV.

The former feeds the air conditioner with ambient air filtered to 100,000 cleanliness class.

The air conditioner shall provide a continuous flush having:

- temperature 15°
- speed 1-7 l/s.

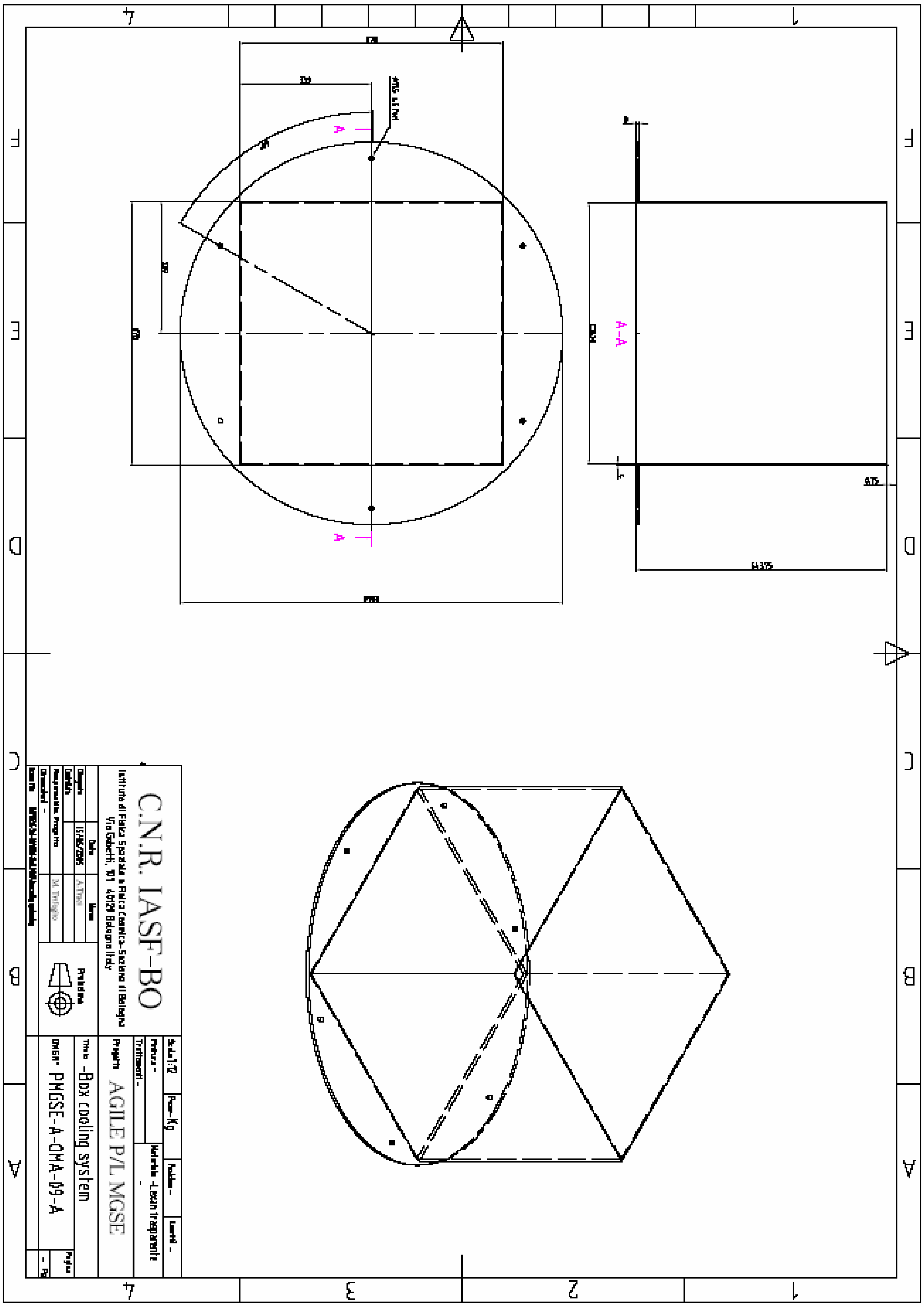

Figure 3-5 IPL Cleanliness cover (To be updated)

3.4 IPL environment monitor equipment

This equipment shall provide the monitoring of temperature (and humidity TBC) inside the Payload. It shall be used mainly when the IPL is switched off and the temperature is not monitored by the IPL EGSE.

3.5 IPL EGSE

The Laben IPL EGSE consists of:

- The EGSE CCOE, which allows the operator to configure, command and control the IPL by generating and sending TC packets and by verifying the relevant TM packets (TM Reports, TM HK).
- The EGSE FEE, which provides to the IPL the missing Spacecraft Interfaces (e.g. electrical power, OBDH Bus). For what concerns the TC and TM packets, the FEE:
    - Forwards the TC to the IPL and forwards the echo of the TC to the Science Console
    - Forwards the TM generated by the IPL to both the EGSE PC and the Science Console.

3.6 IPL Science Console

In near real time, the Science Console provides:

- The acquisition and archiving into the L0 Archive of the IPL TM packets made available by the Laben IPL EGSE;
- The determination (from the incoming TM) of the IPL Configuration ID for inclusion in the L1 data;
- The acquisition and archiving of the IPL positional data made available by the MGSE Computer;
- The processing of the previous data in order to generate and archive the corresponding L1 data files;
- The Quick Look on the L1 data.

The TC packets, together with TM packets, made available in near real time by the EGSE FEE allow the SC to identify the boundaries of each configuration and measurement period and to archive the data in separated files identified by the specific number (RUN ID).

The Science Console shall be allowed to access the Wide Area Network in order:

- To transfer, time to time, the L0/L1 data archive to the Agile Archive Data Server located at IASF-Bologna.
- To connect with the Agile CVS Server located at IASF-Bologna for software maintenance.
- To access the WEB site www.bo.iasf.cnr.it/gtb located at Bologna for data retrieval and software bug reporting.

The Science Console shall be accessible from the WAN in order:

- To allow system and software maintenance from IASF Bologna.

4 PLACEMENT OF THE AGILE ITEMS

The overview of the main MGSE and EGSE items placed in the Beam area is given in Figure 3-1.

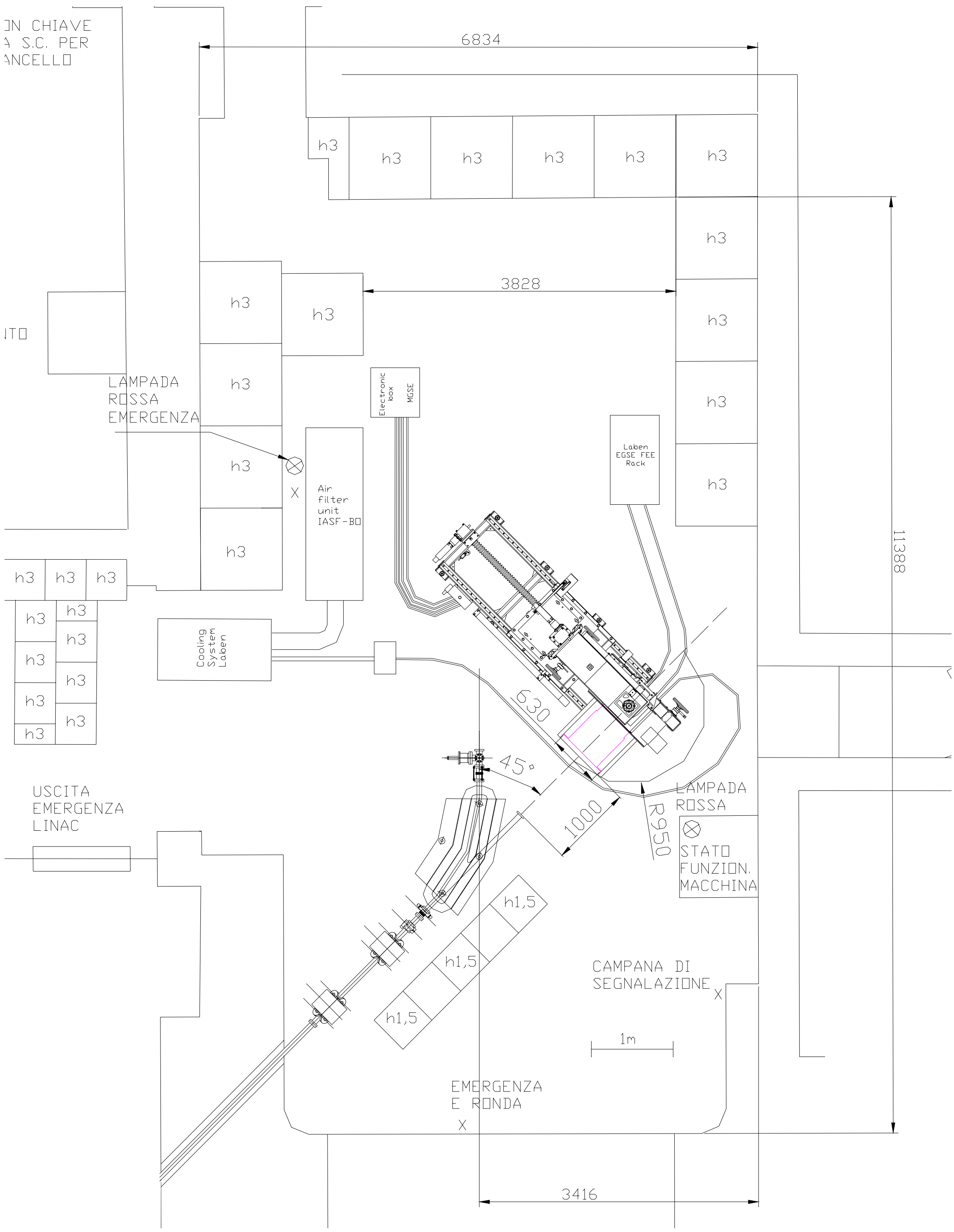

Figure 4-1 Placement of the AGILE IPL and GSE items in the BTF Beam Area

4.1 CALIBRATION MGSE

The procedure for the precise placement of the Calibration MGSE has been defined with reference to the configuration shown in Figure 4-2, where the following elements are identified:

- The IPL Reference Detector Hole, which identifies the origin of the IPL Reference System located in the top side of the Payload Shell as specified in AD[8] and AD[9].
- The Detector Reference Feature, which *(x, y ,z)* coordinates respect to the IPL Reference Detector Hole are given by AD[9]. This reference is provide a reference origin coordinates are given in the IPL Reference System by the IPL ICD.
- The Beam line axis, which is identified by specific reference features located on top of the beam line pipe.
- The MGSE G point, identified by intersection of the MGSE vertical rotation axes (Rz) and the MGSE horizontal rotation axes (Ry), laying in the XZ plane of the MGSE Reference System.

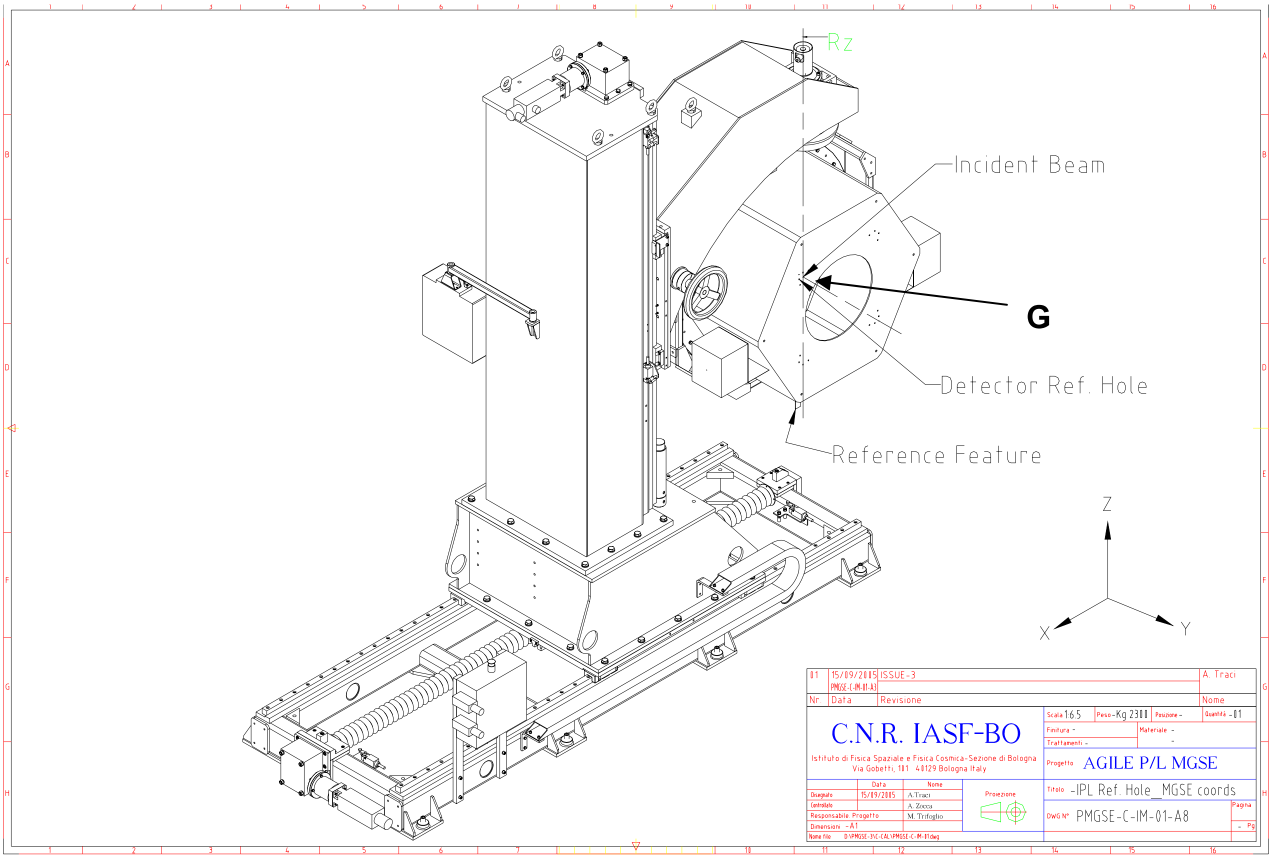

Figure 4-2 Placement of the Calibration MGSE

The placement of the Calibration MGSE in front of the beam has been carried out trough the following steps:

- The MGSE structure has been roughly placed in the position shown in Figure 4-2.

- The Beam Line axes has been identified by means of theodolite devices.
- The external right side surface of the MGSE horizontal X-Y basement has been aligned with the Beam Line axes identified by the theodolite devices. Measured misalignment: 0.2 mm/1000.
- The MGSE horizontal X-Y basement has been leveled, by manually adjusting the leveling screws. Measured leveling: 0.05mm/1000.
- The orthogonal misalignment between the guides of the Z axes and the X axes was 0.1mm/1000.
- The MGSE X, Z translation stages have been moved, using the MGSE PC, until the G point (as identified by the CAD drawings) laid on the Beam Line axes identified by the theodolite.

The resulting setup is summarized in Figure 4-3:

- the MGSE absolute movement X_m=362.8, Z_m=-554.7 commanded by the MGSE Computer moves the G point in the point where the Beam Line axes intersects the X_m, Z_m MGSE translation plane;
- the Reference Hole and the Reference Feature Origin have the following coordinates respect to the (X'_m, Y'_m, Z'_m) Reference System centred in the G point and parallel to the (X_m, Y_m, Z_m) MGSE Reference System:
  - Reference Hole: (238.5, 215.0, 215.0)
  - Reference Feature Origin: (254.27, 189.0, -451.94))

It is noted that with respect the beam line axes:

- the difference between the TX homing procedure commanded by the Controller Rack and that commanded by the MGSE Computer positions is +0.3 mm (i.e. closer to the beam line axis).
- the difference between the TZ homing procedure commanded by the Controller Rack and that commanded by the MGSE Computer positions is -0.3 mm.

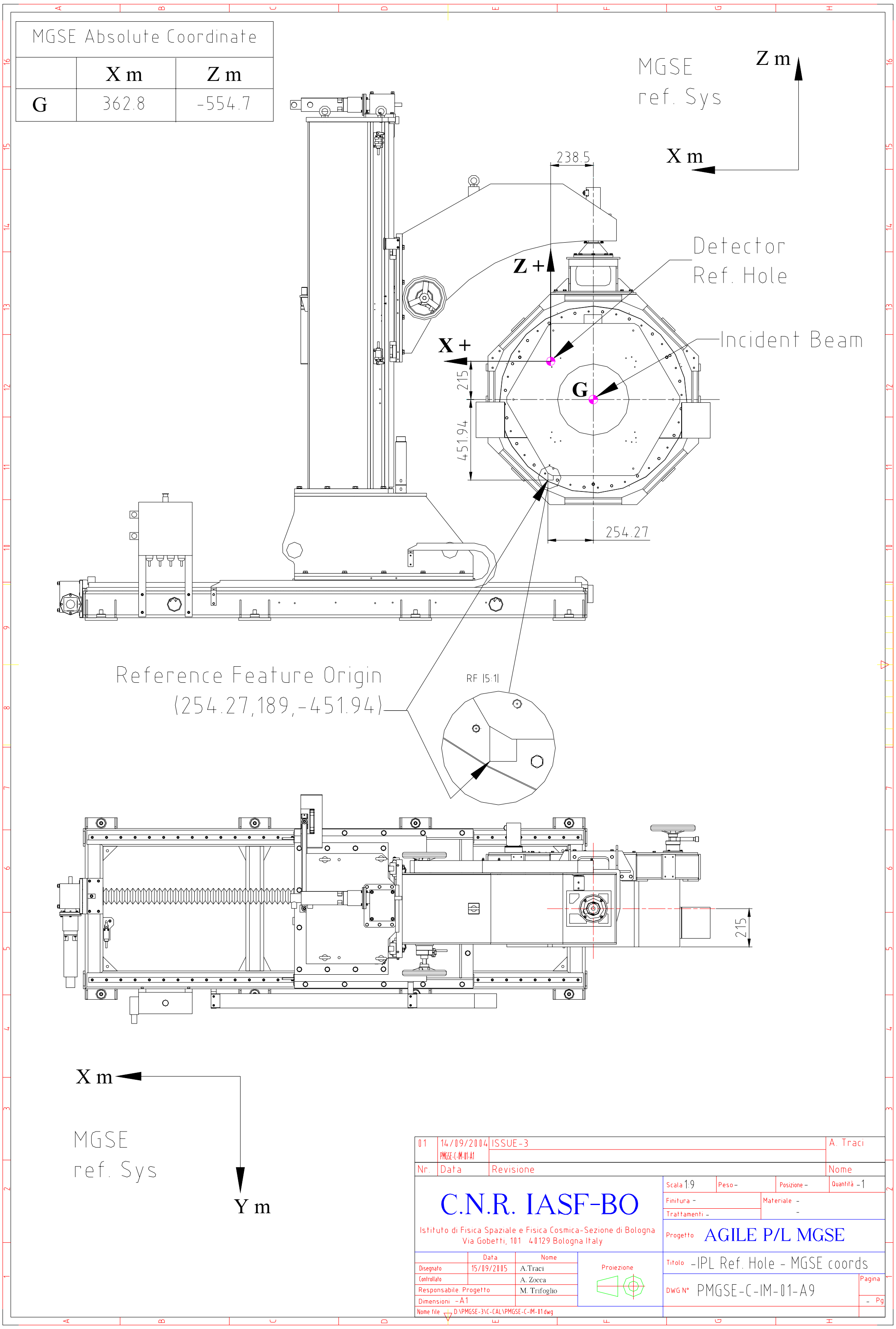

Figure 4-3 Reference Hole and Reference Feature coordinates respect to the MGSE reference system

5 PROVISIONS REQUIRED TO INFN-BTF

The calibration set-up assumes the following INFN-BTF provisions:

- 220 AC Electrical Power sockets located in the User Area;
- 220 AC and 380 AC Electrical Power sockets located in the Beam Area;
- LAN connection among the User Area and the Beam Area equipped with 10/100 Mbps Ethernet LAN sockets, with the possibility of WAN access for a limited number of PC identified by their MAC Address;
- Video Surveillance Monitors located in the User Area connected to 1-2 video cameras which show the MGSE and IPL setup;
- Lifting device to be used for the installation of the MGSE in front of the Beam;
- Support for the alignment of the MGSE with the Beam;
- TBD

Detailed requirements are given in the following subsection.

5.1 INTERFACE REQUIREMENTS

5.1.1 ELECTRICAL INTERFACE

The 380 V AC socket shall be interbloccata trifase da 16 A a 4 poli (3 fasi + PE) a valle di un interruttore con differenziale da 0.3 A Tipo A.

5.1.2 LAN INTERFACE

All the EGSE and TE computer shall be equipped with a 10/100 Ethernet LAN Interface.

They will access to the LAN through a cable connection with the LAN equipment provided by INFN-BTF.

5.1.3 LAN CONFIGURATION

The Laben EGSE and the Science Console shall keep the same network configuration used at Laben for the AIV activities (network 192.168.1.x).

The Science Console shall be allowed to access the WAN with the following network services:

- http, ftp, ssh, cvs

The Science Console shall be accessible from IASF Bologna with the following network services:

- ssh

6 LABEN PROVISIONS

Laben shall take care of:

- Transportation of the IPL and the Laben EGSE items to the INFN-BTF
- Support to the installation of the IPL and Laben EGSE items in the Beam Area

Detailed requirements are given in the following subsection.

6.1 ELECTRICAL INTERFACES

6.1.1 IPL – PHOTON TAGGING TE

The Photon Tagging TE shall interface the IPL Test Connector in order to duplicate the OBT for the time tagging of the photon tagging data.

6.2 MECHANICAL INTERFACES

6.2.1 IPL – FEE CABLES

The IPL–FEE cables for the electrical power and for the TM/TC data shall have 10 m length.

6.2.2 IPL - COOLING SYSTEM

The IPL shall interface to the Cooling System through two thermal insulated pipes having 1”1/4 section 10 m length (provided by Laben).

6.3 SOFTWARE INTERFACES

6.3.1 EGSE FEE – SCIENCE CONSOLE

6.3.1.1 TM/TC

The calibration activities shall require the same TM/TC interface used for the AIV, namely:

- Each TCP/IP message shall contain one Source Packet preceded by the EDEN header.
- At startup and any time the connection is broken, automatically the SC starts waiting for the connection request.
- The connection request is initiated by a specific MMI provided to the operator on the FEE Console.

6.3.2 SCIENCE CONSOLE / PHOTON TAGGING SYSTEM

As shown in Figure 6-1, the SC and the PTS interfacing is based on the use of the NFS protocol.

Through NFS, the PTS DAQ exports to both the Science Console and the PTS Analysis computers the file system containing the data acquired from the tagging silicon detectors in the directory:

/data/agile/datadir_calib

As the Analysis task reads the input data from the directory "./*datadir*", on the SC:

- the PTS DAQ /data file system has been NFS mounted on /dischi/agilebtf/data
- the symbolic link datadir -> /dischi/agilebtf/data/agile/datadir_calib has been defined in the Analysis task working directory.

The PTS DAQ task is started and terminated by the operator manually from the PTS DAQ Console.

Once it is started, the task increments automatically the PTS DAQ Run ID, reset the File ID to "001" and opens a new file having the name:

run*xxxxxx_yyy*.hbook

where: *xxxxxx* = PTS DAQ Run ID; *yyy* = File ID

e.g.: run000009_001.hbook.

The acquired data are written in the ".hbook" file using the CERN/HBOOK binary format. Each file contains a maximum of 5000 events. Every 5000 events:

- the current file is closed
- an empty file is created having the same file name with the additional extension "*.done*". This indicates that the corresponding ".hbook" file is completed and ready for the analysis.
- a new file having the next File ID is created for the forthcoming data.

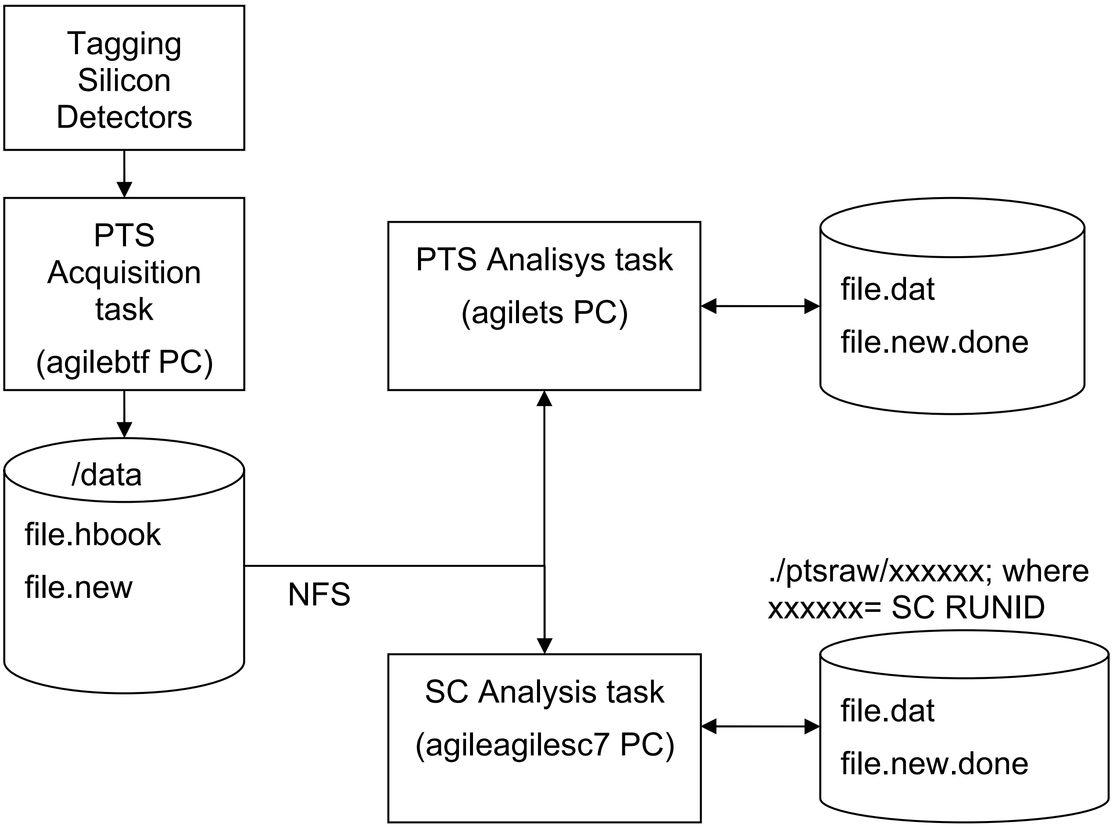

Figure 6-1 PTS/SC Interfacing and data flow

The Analysis task is available on both the PTS and SC computers.

On the SC, as soon as the Enter Observation TC is received from the EGSE FEE, the task is run in batch mode using the script "./batch.tcl" with the following run string parameters:

- PTS DAQ Run ID to be processed
- First PTS DAQ File ID to be processed
- SC destination directory for the output data;
- SC Run ID

The task is terminated by the SC as soon as an Enter IDLE TC is received from the EGSE FEE.

For each input file related to the specified PTS DAQ Run ID and File IDs, the Analysis task generates:

- the ".dat" file, in the specified destination directory;
- the ".new.done" in the current directory; this file indicates that the corresponding ".new" file has already been analysed.

To this purpose, upon it is started, the script:

- removes any ".new.done" file related to the specified PTS DAQ Run ID.

and as long as it is running, for each file pertaining to that Run ID and having File ID ≥ First PTS DAQ File ID, the script:

- looks in the input data directory for the ".new" file related to the specified PTS DAQ Run ID and File ID and
- in case the corresponding ".new.done" file does not exist already, the script:
    - creates the configuration file with the parameters required by the analysis program
    - runs the analysis program which:
        - processes the input file
        - generates the output file ".dat" file
        - generates the ".new.done" files.

In the output file, for each tagged event, the Analysis task writes one ASCII line containing the following blank separated fields:

- Event # (event number, starting from 0)
- PPS
- Micro sec
- (X1,Y1) incident point in the first Silicon detector
- (X2,Y2) incident point in the second Silicon detector
- FLAG (single/multiple event),
- ENERGY (reconstructed energy).

The ".dat" files has the following naming:

ipl_zzzzzzz_run*xxxxxx*_*yyy*.dat

where:

zzzzzz = SC Run ID; *xxxxxx* = PTS DAQ Run ID; *yyy* = File ID

e.g.: ipl_001234_run000009_001.hbook.

Eventually, at completion of the run, on the SC the Fits Archiver task is executed automatically in order to process all the ASCII files generated by the Analysis task for the run and produce the corresponding FITS file.

The script "asciitofits_on.bat" is run with the following run string parameters:

- PTS DAQ Run ID to be processed
- First PTS DAQ File ID to be processed
- SC destination directory for the output data;
- SC Run ID

6.3.3 MGSE COMPUTER – SCIENCE CONSOLE

The MGSE Computer shall interface the Science Console trough the ASCII file:

- MGSE.conf

This file shall be located on the Science Console disk, which shall be mounted by the MGSE Computer using SAMBA FS.

On this file, every 2 seconds, the MGSE Computer shall log the current setup by writing the following lines:

- Measure ID (integer)
- X (mm, floating)
- Z (mm, floating)
- Ry (degree, floating)
- Rz (degree,floating)
- Time (YYY-MM-DD**T**hh:mm:ss)

The previous values shall be overwritten.

7 CALIBRATION DATA PRODUCTS

7.1 L1 FILES FORMAT

7.2 PHOTON TAGGING FILES FORMAT

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions

COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
DATE    = '2005-10-21T09:02:14' / file creation date (YYYY-MM-DDThh:mm:ss UT)
HISTORY  Agile Tag Energy information
HISTORY  October 2005
HISTORY  by AGILE INFN team
END



XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   36 / width of table in bytes
NAXIS2  =                 5000 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    9 / number of fields in each row
TTYPE1  = 'Event   '           / label for field   1
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TTYPE2  = 'Xpos1   '           / label for field   2
TFORM2  = '1E      '           / data format of field: 4-byte REAL
TTYPE3  = 'Xpos2   '           / label for field   3
TFORM3  = '1E      '           / data format of field: 4-byte REAL
TTYPE4  = 'Ypos1   '           / label for field   4
TFORM4  = '1E      '           / data format of field: 4-byte REAL
```

```
TTYPE5  = 'Ypos2   '          / label for field   5
TFORM5  = '1E      '          / data format of field: 4-byte REAL
TTYPE6  = 'Time1   '          / label for field   6
TFORM6  = '1E      '          / data format of field: 4-byte REAL
TUNIT6  = 'mus     '          / physical unit of field
TTYPE7  = 'Time2   '          / label for field   7
TFORM7  = '1E      '          / data format of field: 4-byte REAL
TUNIT7  = 'mus     '          / physical unit of field
TTYPE8  = 'Flag    '          / label for field   8
TFORM8  = '1J      '          / data format of field: 4-byte INTEGER
TTYPE9  = 'Energy  '          / label for field   9
TFORM9  = '1E      '          / data format of field: 4-byte REAL
TUNIT9  = 'MeV     '          / physical unit of field
EXTNAME = 'Tag Energy infor'   / name of this binary table extension
END
```