| ITESRE | AGILE |
|---|---|

**DOCUMENT TYPE:** REQUIREMENTS DOCUMENT

**TITLE:** USER REQUIREMENTS AND DESIGN GUIDELINES FOR THE TEST EQUIPMENTS OF THE AGILE-MINICALORIMETER *CsI* BARS


**DOCUMENT No.** AGILE-ITE-SS-004 **PAGE:** I of ii,11

**PROJECT Ref.:** AGILE EGSE

**ISSUE No.:** Rev. 1.0/Draft 2.0 **DATE:** September 2000
Te.S.R.E. Report 295/00



**PREPARED BY:** MASSIMO TRIFOGLIO
FULVIO GIANOTTI
JOHN B. STEPHEN
ENRICO CELESTI
CLAUDIO LABANTI
ELIO ROSSI

# TABLE OF CONTENTS

# 1 Introduction

## 1.1 Purpose and Scope

The purpose of this note is to present the users requirements and to outline the design guidelines for the Test Equipments (CAL-CsI TE) required in order to support the test activities to be carried out during the development, acceptance, validation and calibration of the CsI bars of the AGILE Minicalorimeter subsystem.

The present document reflects the evolution of the CAL-CsI TE design concept defined in [1] as discussed in [2].

The scope of the CAL-CsI TE is limited to the test activities to be carried out on the CsI bars before integration with the Minicalorimeter front end and read-out electronics.

Within this scope, two different test scenarios are foreseen:

- CERN beam tests: a first prototype made of 8 (TBC) bars will be tested in November 2000 at CERN.
- Characterisation tests: these are the tests which evaluate the bars characteristics; these tests will be carried out at the bar manufacturer premises and at Laben premises on at least 4 bars (max 8) at a time.

In both cases, the CAL-CsI TE shall include a prototype of the Minicalorimeter Front End and Readout Electronics.

In addition, for the characterisation tests the CAL-CsI TE shall provide the additional mechanical and electrical tools required to host and position the gamma ray sources along the bars.

The CAL-CsI TE will be designed in order to maximise the commonality with the other TEs to be developed and procured for further test activities to be carried out at Minicalorimeter subsystem level (CAL DFE TE), and at AGILE payload level (AGILE EGSE).

## 1.2 Reference Documents

[1] LABEN, AGILE Payload TE and EGSE Design Concept, TL16369, Issue 1, February 2000.

[2] LABEN, MOM Agile meeting 07/06/00, LA-A3-DT-MN-0006/00.

[3] LABEN, AGILE Minicalorimeter Architectural Design, TL16067.

## 1.3 Document History

| | |
|---|---|
| Issue 1.0/Draft 1.0 | First Issue with document name AGILE-ITE-SS-002 |
| Issue 1.0/Draft 2.0 | Document renamed to AGILE-ITE-SS-004. Circulated within ITESRE on 11 September 2000. |

Note: Text modification with respect to the previous version are identified by a vertical bar on the right side

# 2 Test Set up

## 2.1 Instrument Front-End and Read-Out Electronics

The CAL-CsI Test Equipment will include a prototype of the Minicalorimeter Read Out and Front End Electronics (CsI ROFE) which will be used for both the characterisation tests and the CERN beam tests of the CsI bars.

As sketched in fig. 2.1-1, the CsI ROFE will include:

- Preamplifier, one for each PDs;
- Shaper Amplifier, one for each PDs;
- Threshold discriminators;
- Multiplexer;
- ADC.

A trigger imposes the ADC conversion of the signals from all the PDs. It is noted that two different modalities are foreseen for the read-out trigger:

- internal trigger, to be used during the characterisation tests and for other stand alone tests;
- external trigger, to be used during CERN beam tests.

Upon receiving a trigger:

- a buffer containing in a fixed positions all the PDs converted values will be made available on a FIFO;
- a suitable interface/s will be provided in order to be able to read the FIFO data in two different modalities depending on the trigger selection:
  - in the internal trigger case: the data will be read by the PC included in the CsI TE;
  - in the external trigger case: the data will be read in parallel from two PCs, i.e. the PC included in the CsI TE and the PC which generated the trigger.

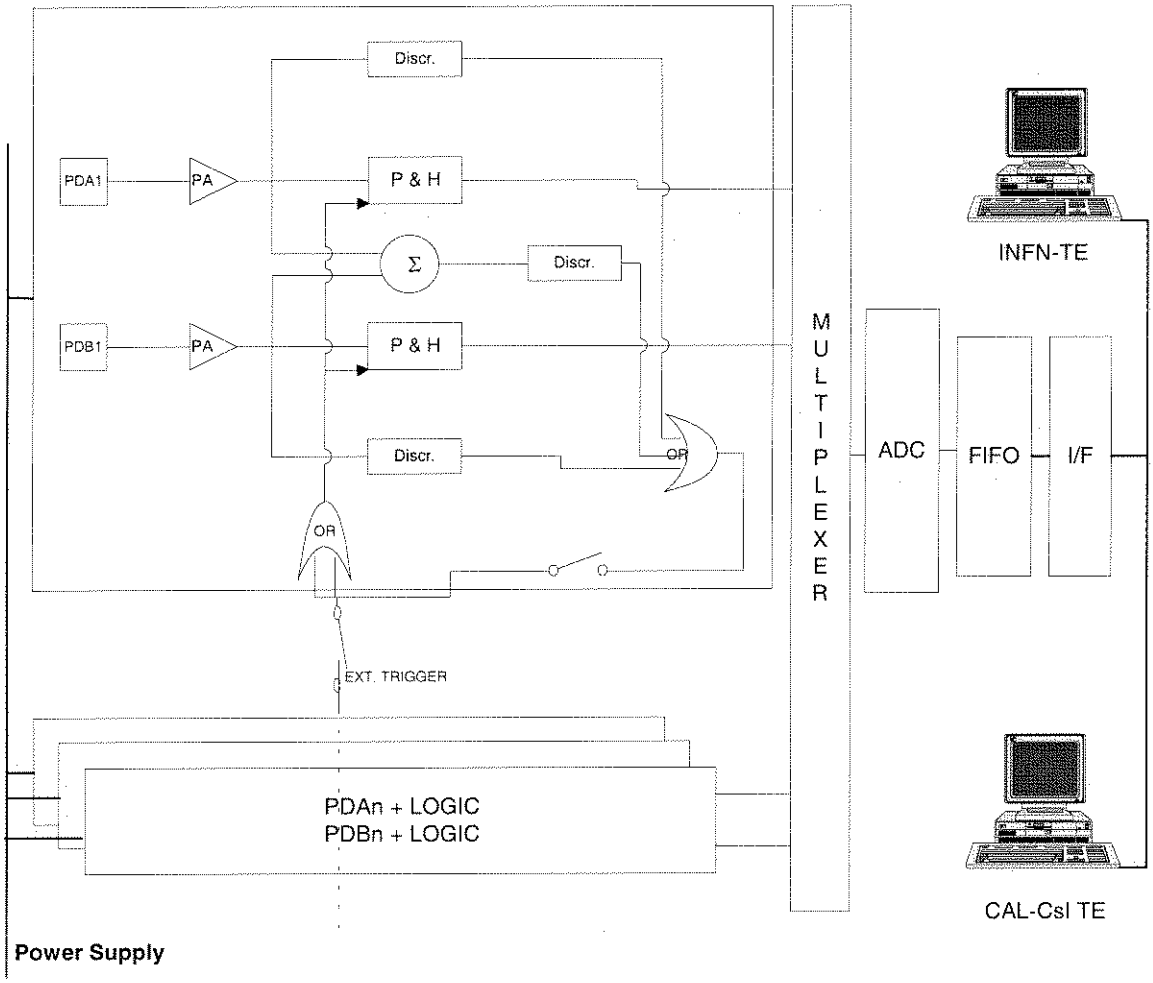


Fig. 2.1-1: Instrument Configuration

## 2.2 CERN beam tests

Once positioned, the bars will be illuminated with a beam of particles (e.g. e, π, μ) and the measured Photo Diodes (PD) signals will be acquired by the CAL-CsI TE in order to derive PD signal distribution, the energy spectrum and the position of the incident particles.

As sketched in figure 2.2-1, at CERN the test set up includes:

- 8 (TBC) CsI bars, with two PDs for each bar;
- the front-end and read-out electronics described in the previous section;

- the CAL-CsI Computer, included in the CAL-CsI TE provision;
- The CAL-CsI Science Console (SC), provided by ITeSRE and devoted to Quick Look and archiving purposes;
- The INFN-TE, provided by INFN-Trieste for the Silicon Tracker and the beam reference detectors;

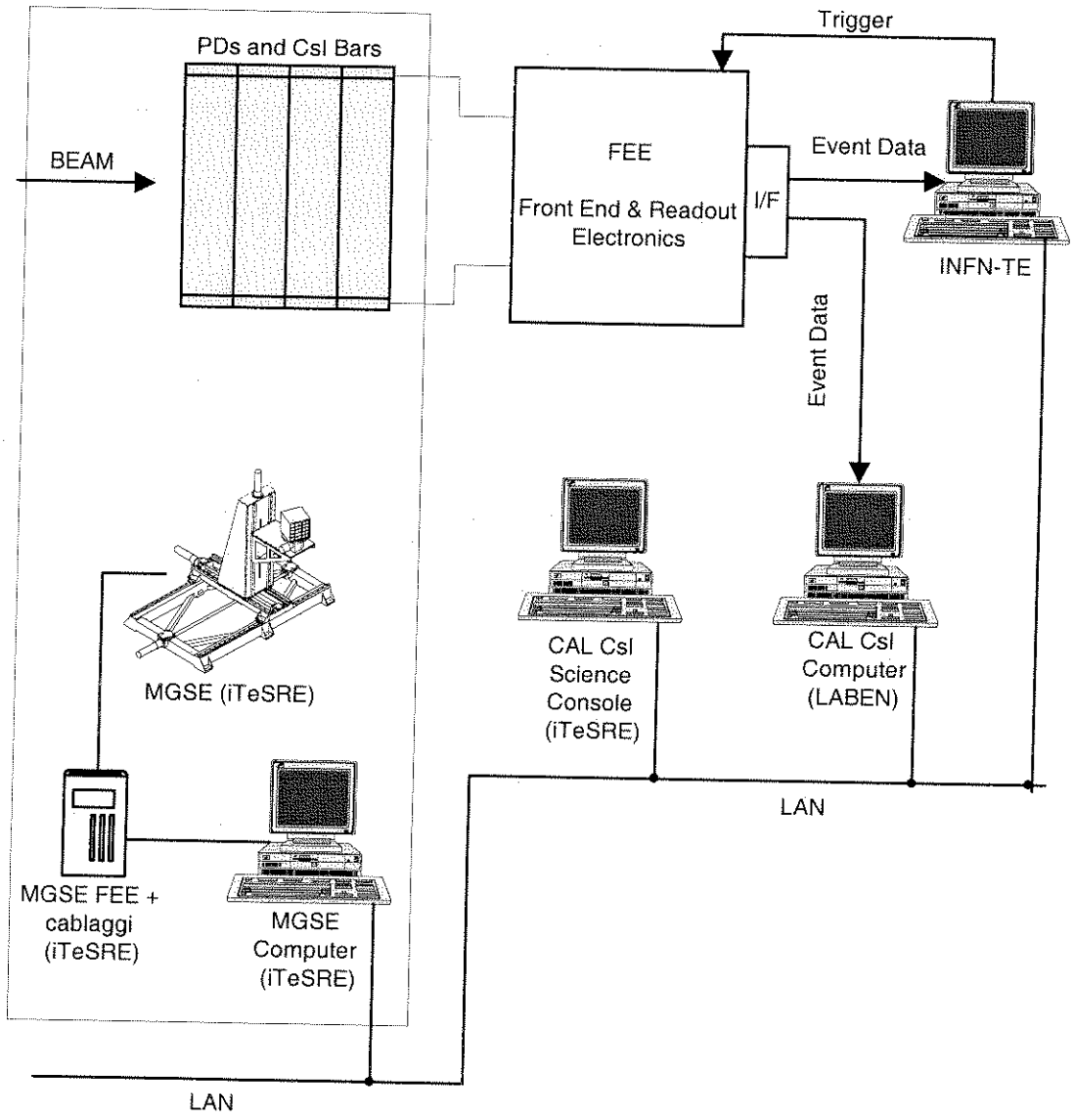


Fig: 2.2-1: CERN Beam Tests Set up

At CERN, the external read-out will be selected in order to allow the synchronisation with the Tracker detector, by using the trigger generated by the INFN-TE.

Through a FIFO, the instrument will make available the data, in output from the ADC, on a TBD Interface where they will be read in parallel by the CAL CsI Computer and by the INFN-TE.

In near real time, and through two different TCP/IP sockets, the CsI-TE SC will:

- receive, from the CAL-CsI Computer, the CsI Bars data;
- receive, from the INFN-TE, the CsI-Bars data together with the corresponding data produced by the Silicon Tracker and by the relevant reference detectors

The positioning of the instrument in front of the beam will be in charge of the Mechanical GSE provided by ITeSRE. This will provide two translating mechanical stages of max 1100 x 650 mmm (horizontal x vertical) of displacement, and one rotational stage of max 360° degree angle rotation.

Additional EGSE items are included in order to operate the MGSE from the user area, located at least 20 meters from the beam area.

They consists of the Front End Equipment (MGSE-FEE) cabinet containing the control electronics, and the MGSE Computer, which provides to the operator the set of commands required in order to perform the various operations e.g.: system configuration, system initialisation, relative and absolute translation and rotation of the available stages.

In near-real time, the MGSE computer presents to the operator a graphical view of the current MGSE status and/or value of the different parameters (e.g. current absolute position of each movement) and the related commanded value.

In order to allow their inclusion in the archive of the scientific data, the MGSE Computer generates and sends periodically (every *n* configurable seconds) on the Ethernet LAN an UDP broadcast message including the current position value of all the available.

## 2.3 Characterisation tests

These tests will be carried out at the bar manufacturer and at Laben in order to characterise the CsI bars in terms of:

- light output;
- light attenuation along the bar;
- position resolution;

- energy resolution.

As shown in figure 2.3-1, the following differences are envisaged in the instrument set up with respect to the CERN case:

- the instrument is kept in a fixed position, while the sources are moved by using the Gamma Ray Positioning System (GSPS) to be provided by LABEN;
- the number of bars under test will be at least 4, and possibly 8 (TBC);
- the auto trigger read-out shall be selected.

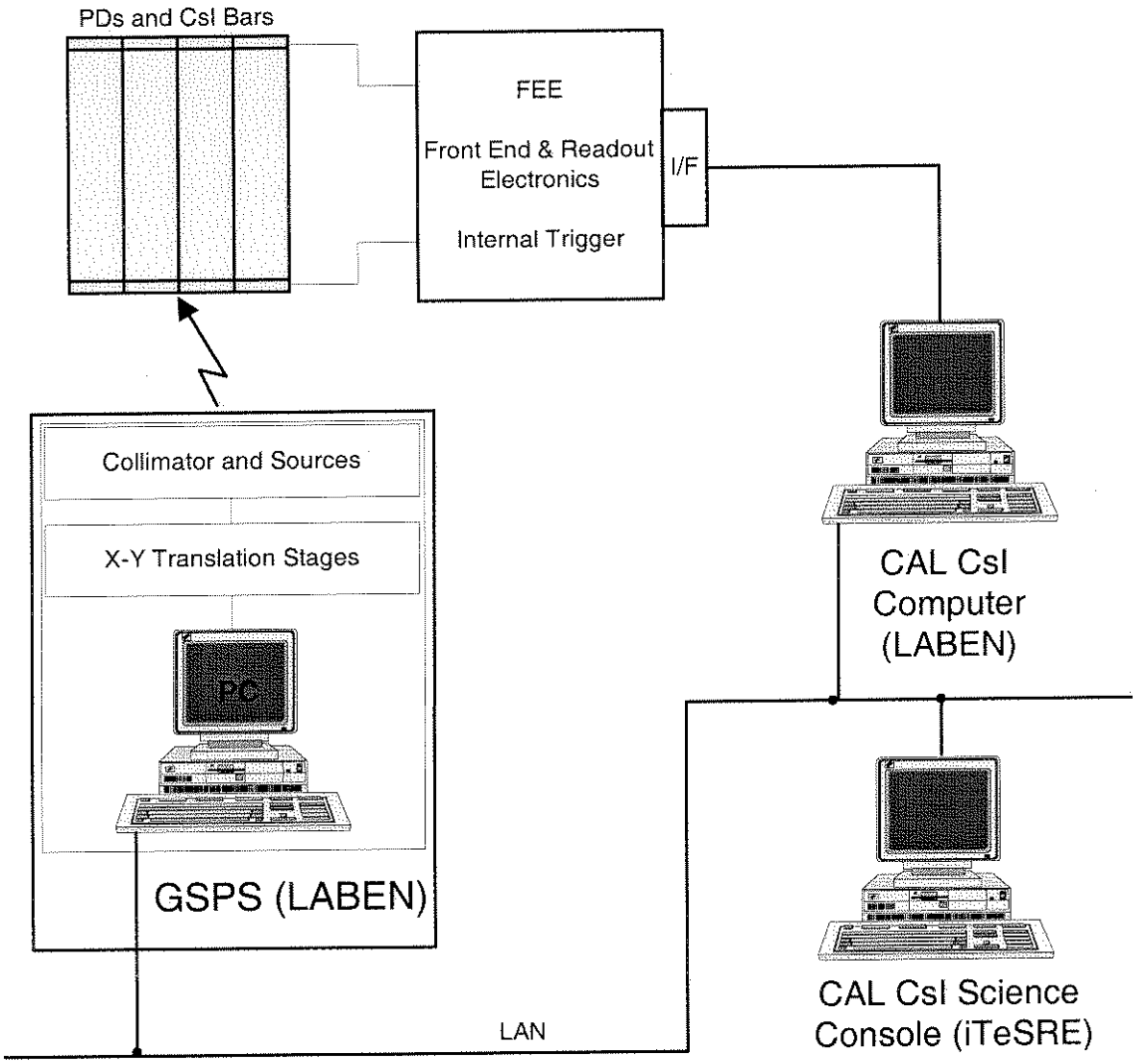


Fig: 2.3-1: Chacterisation Tests Set up

In addition to the capabilities required for the CERN beam tests, the CAL-CsI TE will be provide the mechanical and electrical tools required to host and position the gamma ray sources along the bars before starting the measurement. The tools, to be developed and procured by LABEN, will include two translating mechanical stages of max TBD xTBD mmm of displacement.

Concerning the remaining TEs items, as shown in fig. 2.3-1, it is noted that:

- only the CAL CsI Computer will interface to the instrument to acquire the data;
- the INFN-TE is not included.

# 3 Data acquisition and processing requirements

## 3.1 CERN beam tests

Upon receiving an external trigger signal, the CAL CsI TE will execute the following operation:

a) Conversion of all the signals coming from all the PDs of the bars under test;

b) Acquisition of all the signals converted by the ADC, which are stored into a FIFO and made available on a TBD I/F;

c) The above I/F will allow the CAL CsI Computer and the INFN TE to acquire the data in parallel;

d) The CAL CsI Computer will:

   I. acquire from the above I/F all the data related to the current trigger having a value over the threshold;

   II. acquire the CPU system time;

   III. create with the CPU system time and the PDs acquired data a data block (*trigger data block*) where fixed location are assigned to each bar;

   IV. in the data block, assigns predefined values (e.g. 0) to the bar which are missing or which were below the threshold;

   V. store the trigger data block in the Data Field of a ESA Packet Telemetry (TM) buffer capable of containing up to 30 (TBC) of them;

VI. when the TM Data Field is full or the time-out (user defined) is expired, send the Packet TM, with its Packet Header, to the Science Console, through a TCP/IP Stream socket.

In turn, after having provided the external trigger to the CAL CsI TE, the INFN TE will:

1. acquire, in parallel, the same data acquired by the CAL CsI TE at step d.I above;
2. acquire the CPU system time;
3. create a data block (*trigger data block*) consisting of the CPU system time, the PDs acquired data and the data derived from the corresponding data acquired from the Silicons and the other reference detector;
4. store the trigger data block in the Data Field of a ESA Packet Telemetry (TM) buffer capable of containing up to TBD of them;
5. When the TM Data Field is full or the time-out (user defined) is expired, send the Packet TM, with its Packet Header, to the Science Console, through a TCP/IP Stream socket.

### 3.2 Characterisation tests

It is intended to acquire data using 4 (or more) radioactive sources of the same kind, in order to illuminate uniformly all the bars under test at the same time, as a result the following differences in the CAL CsI TE design are to be considered:

a) A custom collimator hosts the n (TBD) sources in order to move them along the CsI bars.

b) An appropriate GSPS (controlled by PC) shifts the collimator along the bars in order to reach the target position. The bars are kept in a fixed position during the characterisation set of measures.

c) During the characterisation tests the trigger is internal and is given by the combination of:

- For each bar the OR of the following three signals is taken:
  1. PDA Discriminator.
  2. PDB Discriminator.
  3. Discriminator on the sum of both PDA and PDB signals.
- Subsequently the OR of all the bars is taken.

d) Data acquisition is performed only by the CAL-CsI Computer, which processes and sends the data to the CAL-CsI SC exactly as described in the previous section for the CERN beam tests case.

# 4 LAN Protocol definitions.

## 4.1 CERN beam tests

During this phase, communication between three pairs of systems must be established through a LAN connection (see fig. 2.2-1), namely:

- INFN TE – SC
- CAL CsI Computer – SC
- MGSE Computer – SC

Below are described the communication protocols used between each pair of systems.

a) INFN TE to SC

The two computers will exchange telemetry packets in "ESA standard" format, with a two byte prefix that contains packet length information (in Big Endian format); the connection used is a STREAM SOCKET TCP/IP.

To establish the connection, the SC opens a TCP/IP socket as server and then waits for a connection request from INFN TE on a fixed port (e.g. 9003).

The connection is established at the beginning of a set of measures and must be restored automatically in case of interruption.

On the sending of appropriate telecommand packets the SC will organise his archive in measure RUNs, where each RUN is identified by a suitable RUN-ID.

b) CAL CsI Computer to SC

The same protocol seen for "INFN TE to SC" is used here, except that SC waits for a connection on a different port (e.g. 9002), this enables SC to acquire data simultaneously from both the connections.

c) MGSE Computer to SC

The two computers will exchange packets in a TBD format (maybe ESA standard similar to HK type). No connection is established in this case, the MGSE computer opens a UDP socket

in broadcast mode and sends data on the LAN that are made available to all the servers listening on a certain port (e.g. 10000).

These packets, that contain information on the MCAL position, are continuously sent on the LAN every TBD seconds.

The SC reads data at the beginning of (or even during, TBC) every RUN of measure, in order to combine them with the ones acquired from the MCAL himself.

### 4.2 Characterisation tests

During this phase of tests, communication must be established between two pairs of systems through a LAN connection (refer to fig. 2.3-1), namely:

- CAL CsI Computer – SC
- GSPS – SC

Below are described the protocols used between each pair of systems.

a) CAL CsI Computer to SC

The same protocol seen for CERN beam tests will be used here.

b) GSPS to SC (TBC)

The same protocol seen for the communication between MGSE and SC should be used here.