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CHANGE RECORD

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1. INTRODUCTION

Scope of this document is to describe the tests to be performed for the characterisation of MCAL detector and their objectives.

1.1 ACRONYMS

BLR	Base Line Restorer
DH	Data Handling
DR	Detector Ratemeters
GRID	Gamma Ray Detector Imager
HK	HouseKeeping
MCAL	Agile Minicalorimeter
PD	PhotoDiode
PG	Pulse Generator
SC	Science Console
SIT	Short Integration Time
SR	Scientific Ratemeters
TBC	To Be Confirmed
TBD	To Be Decided
TC	Telecommand
TE	Test Equipment

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD [1] AGILE-DWG-SS-002 Issue 5
AD [2] AGILE-AST-TN-009 Issue 1

2.2 REFERENCE DOCUMENTS

RD [1] AGILE Phase A Report
RD [2] TL16397 – Issue 2 AGILE Phase C/D Technical Proposal – Executive Summary
RD [3] ECSS-E-70/41 – Draft-04
RD [4] AGILE-AST-TN-005 Test dei preamplificatori per il Minicalorimetro di AGILE
RD [5] AGILE-ITE-PR-001 Test plan per la caratterizzazione delle barre CsI del Minicalorimetro di AGILE
RD [6] AGILE-AST-TN-012 Test performed on the SEM MCAL electronics.

3. MCAL CHARACTERIZATION STRUCTURE

3.1 MCAL CHARACTERISATION PHASES

The bottom-up structure of MCAL characterization flux is described in Figure 3.1.1

Phase 1: Component characterization

- First performance evaluation tests will be done on the single MCAL detectors (bars).
  - The result of these tests (bar parameters) will validate the conformance of the detectors to requirements
  - The result of these tests will be also used to define the population path of the MCAL plane.
- In the mean time the characterization of MCAL electronic will be done.
  - The result of these tests will confirm the conformance of the electronics functionality to requirements

All these activities are LABEN responsibility

Phase 2: MCAL plane characterization

- Then MCAL plane characterisation will be done in two steps
  - Step 1 will include HW optimisation and verification of the performances of MCAL
  - Step 2 will completely characterize MCAL as a stand alone detector and will result on all the response matrixes needed to use the detector

Step 1 activity is LABEN responsibility.
It is proposed that step 2 activity is IASF-BO responsibility. In this case this task should allocate at least 2 month duration.

Phase 3: Payload calibration

- Finally MCAL will be characterized on the payload. All the response matrix will be re-evaluated with on the payload configuration considering the effects of the shadows induced on MCAL by the payload.

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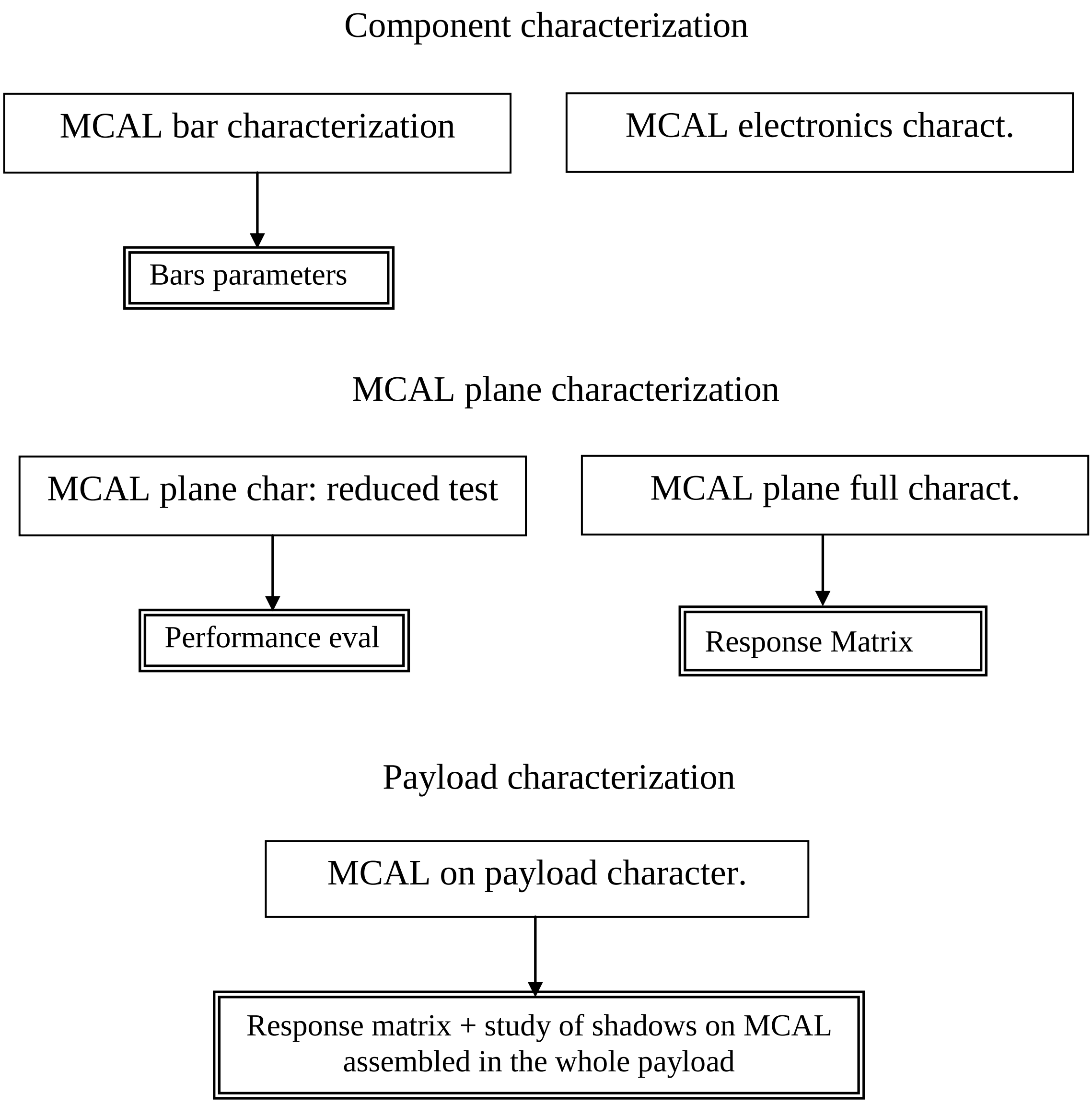


Figure 3.1.1 **Structure of MCAL calibration with indication of main goals of each group of tests. The sequence of test is divided in three phases following MCAL assembly path.**

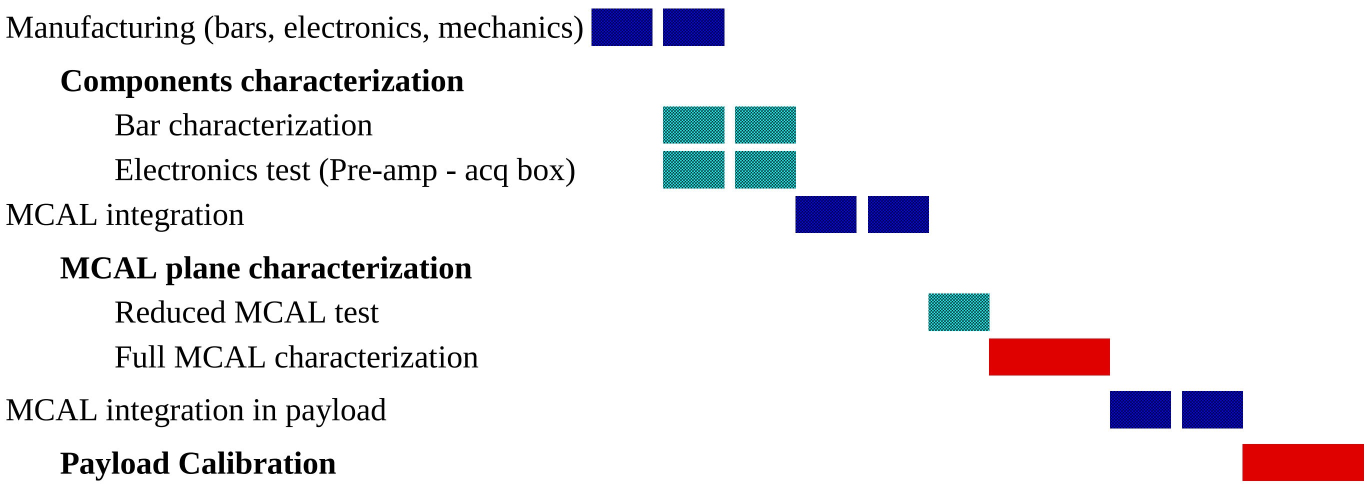


Table 3.1.1 **Timing sequence of test activity .**
Blue contour indicates a LABEN responsibility, red contour a IASF-BO responsibility.
The duration of each block is indicative with the exception of full MCAL characterisation that should be at least 2 month.

4. MCAL BARS CHARACTERIZATION

4.1 BAR CHARACTERIZATION ENVIRONMENT

The MCAL bars characterization will be performed on each single MCAL CsI(Tl) bar once mounted inside its bar housing.
For these measures the Bars Test Equipment, developed by LABEN, will be used, along with the Science Console, the quick look and analysis software developed by IASF-Bologna.
The Bars Test Equipment should include standard and calibrated pre-amplifiers (not necessarily the flight ones, but with the same characteristics).
Bars characterization tests will be performed in Laben during the bars assembly phase.
Figure 4-1-1 depicts the bar characterization scenario.

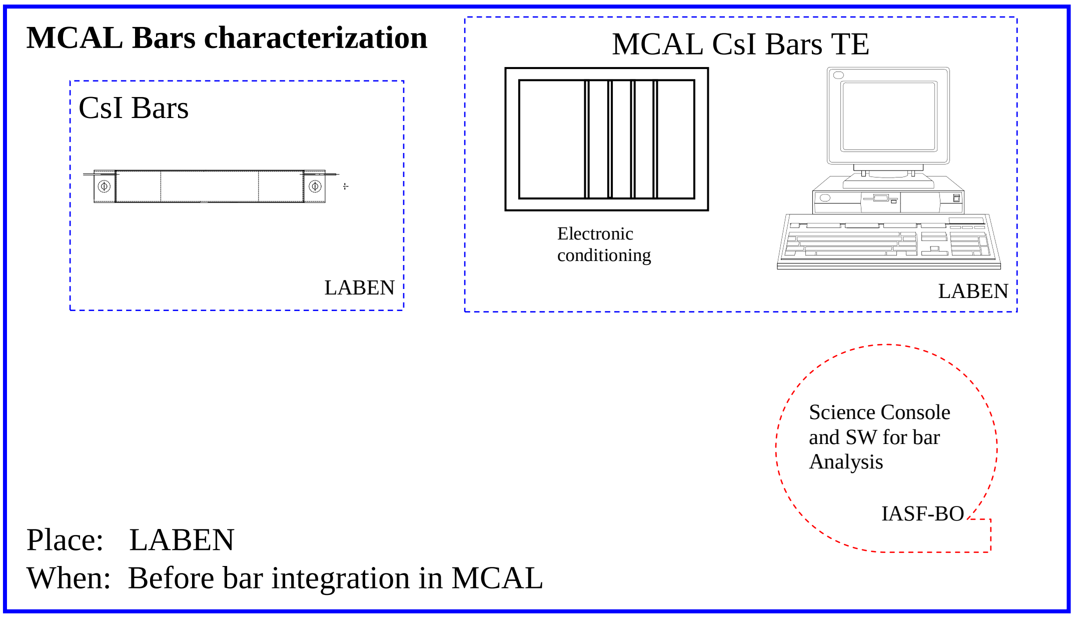


Figure 4-1-1 MCAL bars characterization scenario. Blue contour indicates a LABEN responsability, red countour a IASF-BO responsability.

4.2 GOALS

Objective of the bar characterization procedure is to determine the characteristics of the bars in terms of:

- Light Output: Measure of the light output in e-/keV of each bar at different positions. The measure method is described in RD[5]. For a reference of the sources to use and the positions of the source along the bars, see Table 4.4-1 and Table 4.4-2
- Light Attenuation: The attenuation of the light along the bars in cm^{-1} will be calculated from the light output measures taken at different positions (see point above and RD[5]).
- Threshold: The threshold of the bars in keV will be calculated as a function of the position along the bar, taking as a reference the light output measured at different positions.
- Energy Resolution: The energy resolution ($\Delta E/E$) of each bar will be calculated, for different energies and at different positions (see Table 4.4-1 and Table 4.4-2). For this measure it is necessary to acquire both bar sides simultaneously.
- Spatial Resolution: The spatial resolution ($\Delta x/x$) of each bar will be calculated, for different energies and at different positions (see Table 4.4-1 and Table 4.4-2). For this measure it is necessary to acquire both bar sides simultaneously.
- Temperature Tests: For a sample of TBD bars, all of the above characteristics should to be measured as a function of temperature, with T varying inside the AGILE operative range, with steps as shown in Table 4.4-3.

Source	Energy (keV)	Half life	Activity	Photons Yield, γ_Y [(a)]
Am-241	60	432 yr	10 μCi	35.9 %
Cs-137	662, 32.2	30.1 yr	100 μCi	94.4 %
Na-22	511, 1275	2.6 yr	100 μCi	2 × 90% (511); 100% (1275)
Y-88	1840	107 days	100 μCi	99.2%

Table 4-2-1: List of the sources to use during the bar calibration tests. (a) Photons/line over 4π srad.

Source	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5	Pos. 6	Pos. 7	Pos. 8
Cs-137	1	2	4	5	8	12	16	20
Na-22	1	2	4	5	8	12	16	20
Y-88	1	2	4	5	8	12	16	20

Table 4-2-2: Positions in cm of the sources along the bar during the bar calibration tests, (dist. from each PD).

The measures with Am-241 will be made positioning the source as close as po ssible to the PD.

Temperature list (°C)												
-20	-15	-10	-5	0	5	10	15	20	25	30	35	40

Table 4.2-3: List of temperatures at which test MCAL sample bars.

4.2.1 ACCURACY

The accuracy in the determination of the desired parameters drives the number of counts to be acquired in the count spectrum. Both key scientific parameters (lower energy threshold and energy resolution) must be measured for each bar at 1 % precision.

5. MCAL ELECTRONICS CHARACTERIZATION

5.1 MCAL ELECTRONICS ELEMENTS

The MCAL electronics characterization will be performed on:

- all the preamplifier boards
- MCAL electronics acquisition box
- all the systems (PD, pre-amp boards and electronics boards) powered with MCAL power supply.

5.2 PRE-AMPLIFIER

To test the pre-amp boards the MCAL CsI Bars Test Equipment, developed by LABEN, will be used, along with the Science Console, the quick look and analysis software developed by IASF-Bologna.
Pre-amp boards characterization tests will be performed in Laben during the bars assembly phase.
Figure 5-2-1 depicts the pre-amp characterization scenario.

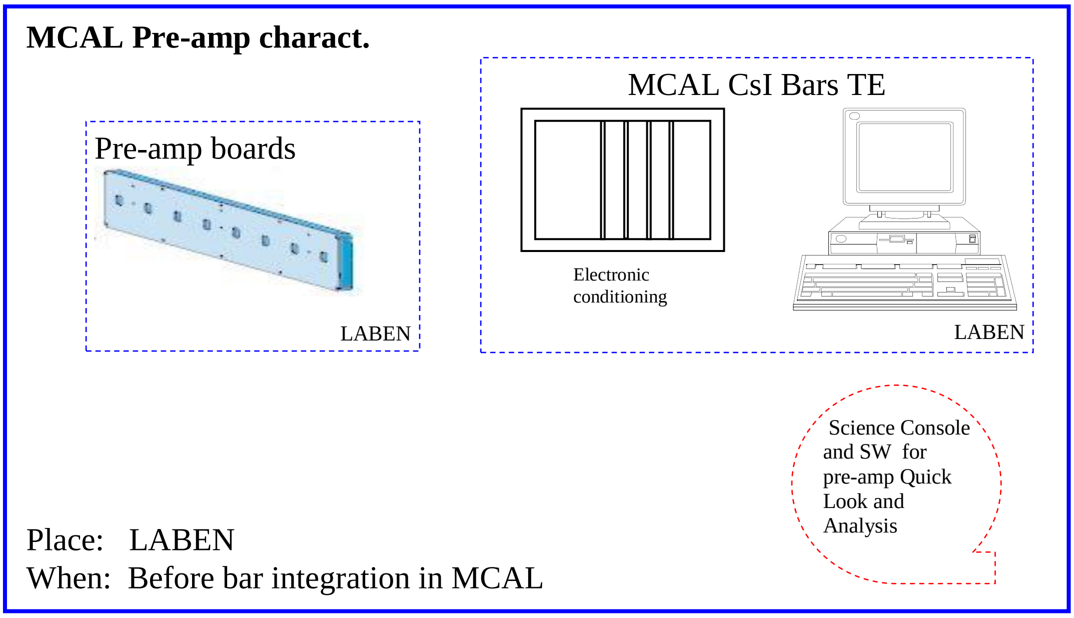


Figure 5-2-1 MCAL pre-amp board characterization scenario. Blue contour indicates a LABEN responsability, red countour a IASF-BO responsability.

5.3 PRE-AMP BOARD TEST GOALS

All the measures will be done with a reference PD connected to the pre-amp.
Both PD and pre-amp will be powered with the MCAL power supply.
Objective of the pre-amp characterization procedure is to determine the characteristics of each pre-amp in terms of:

- Gain and Offset: Measure of gain and offset of the electronic pre-amp chains connected to the bars. The measure method is described in RD[4] and RD[5]. For this measure a first set of pulses from a pulse generator will be used, then, as a reference, an Am-241 source will stimulate the PD. Gain will be calculated in μV/e-.
- Noise: Measure of the noise in e^-_{rms} of the electronic chains connected to the bars via a pulse generator and the Am-241 source with the method described in RD[4] and RD[5].
- Linearity A measure of the non linearity of the electronic chain has to be performed as well

5.4 MCAL ACQUISITION BOX

To test the MCAL electronics acquisition box the MCAL Test Equipment, developed by LABEN, will be used, along with the analysis software developed by IASF-Bologna.
For some kind of test the MCAL TE will be replaced by standard laboratory instruments as oscilloscope etc.
MCAL acquisition box characterization tests will be performed in Laben before MCAL full integration phase.
Figure 5-4-1 depicts the MCAL acquisition box characterization scenario.

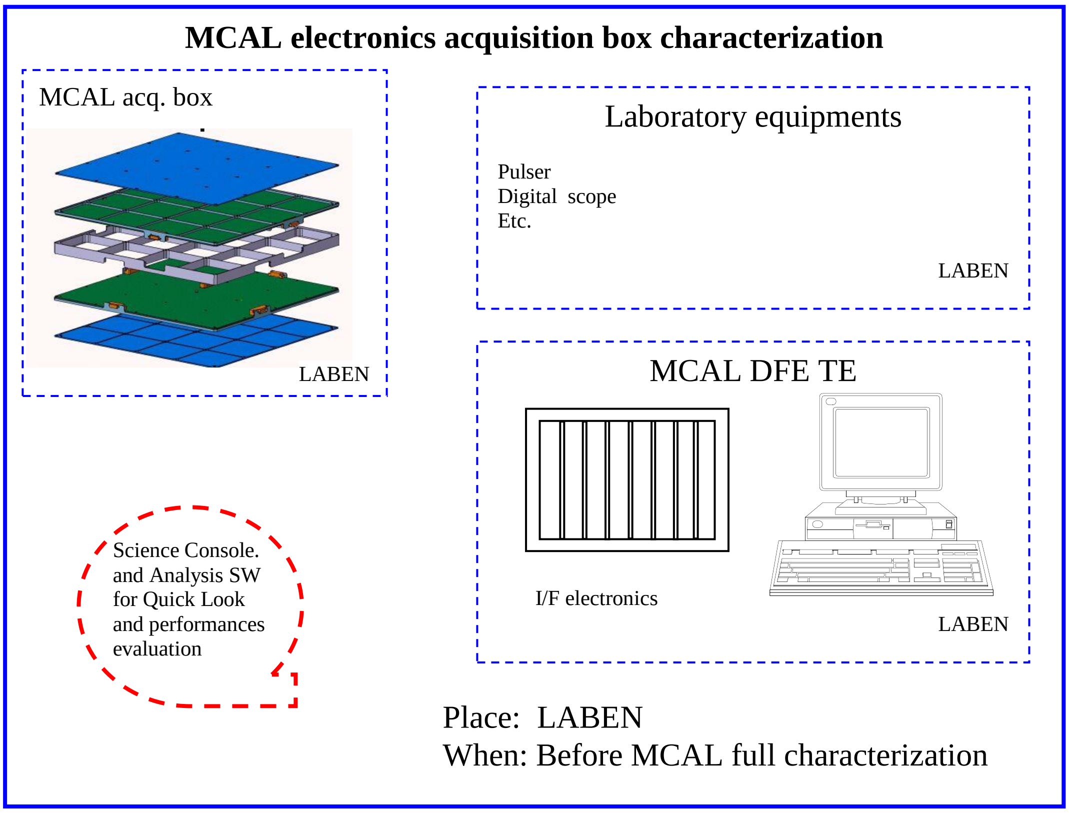


Figure 5-4-1 MCAL acquisition box characterization scenario. Blue contour indicates a LABEN responsability, red countour a IASF-BO responsability.

5.5 MCAL ACQUISITION BOX TEST GOALS

Objective of MCAL acquisition box test is to verify that all the functions required work correctly and allow to reach the performances required.
Functional and performance tests will have the same path and use the same methods described in RD[6].
MCAL acquisition box will be stimulated both with pulser generated signals and with detector generated signals.

5.5.1 MCAL ACQUISITION BOX FUNCTIONAL TEST

- Amp chains: For each bar channel and side it will be verified the correct shaping recording it with a scope as in RD[6]. This test will allow to verify also the uniformity of the various channels in shaping the signals.
- Amp pole-zero: Each bar channel and side will be stimulated via the their pre-amp with and with a pulser simulating a scintillation in the CsI(Tl). The magnified falling edge output of each amplifier will be recorded with a scope and from its shape the correctness of pole-zero setting will be verified. The falling edge of the pulse should not present an undershoot and overshoot greater than TBD
- Burst chain discrimin. The correct functionality of each bar discriminator (3 for each bar) will be verified as described in RD[6].
- Burst signal stretch. For each bar channel and side it will be verified the correct functionality and timing of the burst chain signal stretching recording the relevant signal with a scope as in RD[6].
- Burst data generation The correct sequence of burst data generation will be verified as described in RD[6]. In particular it should be verified that the burst FIFO management does not slow down data generation and transmission.
- GRID signal stretch. For each bar channel and side it will be verified the correct functionality and timing of the GRID chain signal stretching recording the relevant signal with a scope as in RD[6].
- GRID data generation The correct sequence of GRID data generation will be verified as described in RD[6].
- HK The correct generation of each HK should be verified.
- TC The correct implementation of each TC should be verified.

5.5.2 MCAL ACQUISITION BOX PERFORMANCE TEST

Burst chain linearity	For each bar channel and side it will be measured the linearity of the processing chain that includes shaping amp, stretcher, MUX and ADC. The measure method is described in RD[6].
Burst chain noise	For each bar channel and side it will be measured the noise of the processing chain with the PD and pre-amp connected and powered by the MCAL power supply. The measure method is described in RD[4] and RD[6].
Burst chain discr.	For each bar channel it will be characterised the efficiency of the discriminators (3 for each bar). Furthermore the jitter and walking time of each discriminator will be evaluated. The measure methods are described in RD[6].
Burst chain range	For each bar channel the operation range will be evaluated.
Saturated signal effect	It will be evaluated the effect of saturated signal; i.e. inputting with a pulser signals TBD greater than the maximum signal the effects on trigger, dead time etc will be evaluated.
Burst chain continuity of data	On all the bars, it will be verified the continuity of burst data generation for different rate of input signals.
Burst chain dead evaluation	The dead time of the burst chain will be evaluated.
GRID chain linearity	For each bar channel and side it will be measured the linearity of the processing chain that include shaping amp, stretcher, MUX and ADC. The measure method is described in RD[6].
GRID chain noise	For each bar channel and side it will be measured the noise of the processing chain with PD and pre-amp connected and powered by the MCAL power supply. The measure method is described in RD[4] and RD[6].
GRID chain range	For each bar channel the operation range will be evaluated for each of the selectable gains of this chain.

6. MCAL PLANE CHARACTERIZATION

The MCAL plane characterization will be done on the whole MCAL sub-system, i.e.

- the 30 MCAL bars mounted inside their bar housing and assembled in the MCAL frame
- the MCAL pre-amplifier boards
- the MCAL Front End Electronics
- AGILE lower mechanical structure
- MCAL power supply
- MCAL harness to power supply

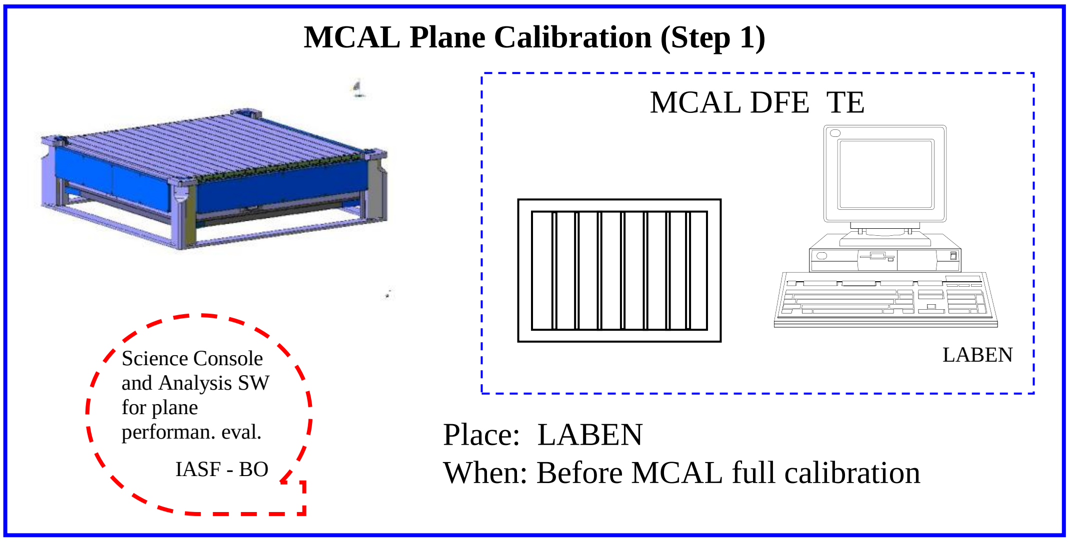
The MCAL plane will be assembled in LABEN.

MCAL characterization will be split in two step:

- **First Step Plane Characterization:** An preliminary calibration phase to be performed in LABEN. It will include a limited sequence of performance test. For these measures the MCAL Test Equipment produced by LABEN will be used, along with Science Console and with analysis software developed by IASF-Bologna.

- **Second Step Plane Calibration:** A complete MCAL calibration sequence will be performed at IASF-Bologna. For these measures the MCAL Test Equipment produced by LABEN will be used, along with Science Console and with analysis software developed by IASF-Bologna.

Fig 6-0-1 depicts the plane calibration scenario



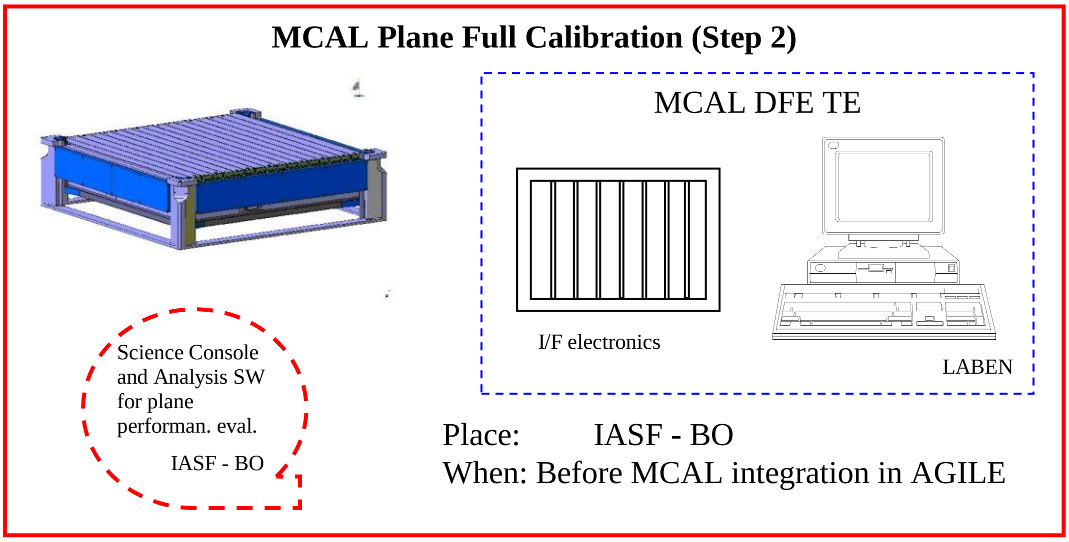


Figure 6-0-1 MCAL Plane calibration scenario.
The operation will be done in two steps: a first characterisation in LABEN
a full calibration at TESRE

6.1 MCAL PLANE CHARACTERIZATION GOALS

6.1.1 FIRST STEP CALIBRATION

Scope of the MCAL plane first step calibration is both to optimise some hardware value and to verify the compliance of MCAL with the requirements measuring the parameters having main influence of the whole MCAL behaviour:

- Hardware optimisation see 6.2.1
- Full functional test see 6.2.2
- Gain and Offset measures see 6.2.3
- Noise measures see 6.2.4
- Sub msec burst trigger

6.1.2 SECOND STEP CALIBRATION

Scope of the MCAL plane second step characterization is to determine the instrumental characteristics of the detector i.e.:

Primary goals:

- Response matrix: see 6.3.1
- Energy Resolution: see 6.3.2
- Position Resolution: see 6.3.3
- Threshold: see 6.3.4
- Dead Time: see 6.3.5
- Flood measures see 6.3.6

Secondary goals (TBC):

- Burst Mode: This test will simulate a burst with the use of radioactive sources combined with a suitable device. The burst search algorithm will be reconstructed via software and tested. The correlation between the position of the source and the counts in the detector ratemeters will be investigated, in order to estimate the source location.

- Muon particles test: This test has to be performed in GRID mode, in conjunction with a proper trigger detector (Si tracker OR TBD), to test the functionality of this operating mode.

- Scientific Ratemeters: Will be reconstructed via software in order to determine their functionality.

6.2 **FIRST STEP CALIBRATION**

6.2.1 HARDWARE OPTIMISATION

Hardware optimisation concern hardware settings that, starting from the measured parameters of each bar, attempt to equalise the whole plane response.
With the whole detector assembled the following these operations includes:

- Pole zero compensation
- Gain equalisation
- Hold GRID signal delay setting

6.2.1.1 POLE ZERO COMPENSATION

The setting will be done for each PD analogue channel.
A scope will be connected on the test point of the channel corresponding tho the BLR output and a collimated Cs-137 source will be placed at 1 cm from the PD.
The tail of the signal on the scope will be monitored.
If necessary the values of the passive components in the shaping net will be modified to achieve the best pole zero compensation

6.2.1.2 GAIN EQUALISATION

The scope of this activity is to have an uniform response on the whole MCAL plane and to compensate from different performances of the bar detectors.
The gain of each PD chain will be evaluated starting from the light output response of each bar that should be already know from bar testing.
If necessary the value of the passive components in the amplifying net will be modified to achieve the desired gain value.

6.2.1.3 HOLD GRID SIGNAL DELAY SETTING

Scope of this activity is to find the optimal delay setting between the T1_YES signal and the HOLD_GRID signal. The optimal value will minimize the noise of the system on the whole range.

6.2.2 FULL FUNCTIONAL TEST

With the whole detector assembled the following test will be done

- Test of TC execution
- Test of HK generation
- Test of the Burst Chain acquisition
- Test of the GRID Chain acquisition
- Burst chains range evaluation
- GRID chain range evaluation
- Discriminators burst chain functionality
- Fast threshold test

6.2.2.1 TEST OF TC EXECUTION

The correct reception and execution of every MCAL TC will be tested

6.2.2.2 TEST OF HK GENERATION

All HK will be tested verifying that:
The Voltages correspond to values already measured with external voltmeters
The Temperatures correspond to values already measured with external thermometers
The correct value of the ratemeters will be evaluated stimulating MCAL using the Calibration function and injecting a well defined number of pulses.

6.2.2.3 TEST OF BURST CHAIN ACQUISITION

First each channel will be tested using the Calibration function of MCAL with at least 7 pulse levels and a well defined number of pulses; the correspondent spectra will be acquired on the TE. The analysis of the peak position and number of events will validate a correct acquisition

Then a flood measures will be done on the following conditions:

Background TBD h
Cs-137 of TBD activity at TBD cm for TBD h
Na-22 of TBD activity at TBD cm for TBD h
Y-88 of TBD activity at TBD cm for TBD h

Activity of the sources, distance of the sources from plane and measure time will be defined in order to obtain a 1% precision in the parameters (position and width) describing the peaks.

6.2.2.4 TEST OF THE GRID CHAIN ACQUISITION

The GRID chain acquisition will be tested by stimulating MCAL with a device as represented in Fig 6.2.1

A Na-22 source will be monitored with a standard detector, for example a scintillator + PM, a discriminator on the PM output will allow to detect the 511 photons from the source and to generate quickly a T1_YES signal.

On MCAL the peaks of 511 and 1275 lines will be detected.
The analysis of the peak position will validate a correct acquisition

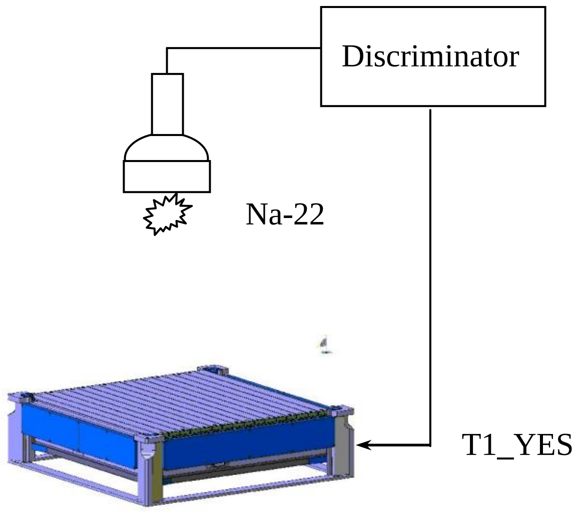


Figure 6-2-1 GRID acquisition scenario. A Na-22 source will be placed above MCAL and will be monitored with a detector that will generate the T1_YES signals needed in the GRID

6.2.2.5 BURST CHAIN RANGE EVALUATION

The burst chain range evaluation will be determined as the difference between the saturation and lower detectable levels.

Lower detectable level
The lower detectable level of a PD chain when a bar is connected is evaluated in Burst mode.
The scintillator is stimulated with

- a Na-22 source collimated at 1 cm from the PD.
- Background with different thr levels

An evaluation of the noise edge is evaluated fitting the bkg spectra with an exponential law.
The thr level showing a deviation from the exponential low should allow to determine the channel with the minimum detectable signal. A comparison with the position of the Na-22 peaks should allow an absolute calibration in energy.

Saturation level
The saturation level of a PD chain when a bar is connected is evaluated in Calibration mode and looking at the Burst spectra.
The input of each analogue channel is stimulated with pulses of different height.
Saturated signal will be considered as that one exceeding the linearity for TBD %
A comparison with the position of the Na-22 peaks should allow an absolute calibration in energy.

6.2.2.6 GRID CHAIN RANGE EVALUATION

The GRID chain range evaluation will be determined as the difference between the saturation and lower detectable levels.
The test will be done using calibration pulses once a coarse calibration in energy of the chain has been done using the data collected with the test described in 6.2.2.4

6.2.2.7 DISCRIMINATORS BURST CHAIN FUNCTIONALITY

Scope of the test is to verify the burst chain discriminators functionality by evaluating the level of discriminated signal vs the thresold value setting for all the discriminators.
A test method could be the following:
In the channel under test the thr value is set.
A fixed number of pulses of various amplitude, whose relation with energy deposit in the bar is know (with a relation extracted from data taken with tests described in 6.2.2.3), are sent to the channel input and the detected events are counted.
The discriminated energy corresponding to the discriminator value is that for which TBD % of input events are counted.
The test will be done with TBD discriminator values.

6.2.2.8 FAST THRESHOLD TEST

Scope of the test is to verify the fast threshold discriminators functionality by evaluating the level of discriminated signal vs the thresold value setting.
A test method could be as that described in 6.2.2.7 but with input stimuli in more than one bar

6.2.3 GAIN AND OFFSET EVALUATION

Scope of the test is to measure the gain and offset of each PD chain with the whole detector assembled and electronics.
A measure of the non linearity of the electronic chain has to be performed as well.

Each channel will be tested using the Calibration function of MCAL with at least TBD pulse levels and a well defined number of pulses; the correspondent spectra will be acquired on the TE. The analysis of the peak position will determine gain and offset.

An absolute calibration will be achieved operating in Burst mode and stimulating each PD with an AM-241 source. From the position of the 60 keV peak (detected by the PD) the gain in e^-/channel and offset in channel will be evaluated

The linearity of each chain will be calculated

6.2.4 NOISE MEASURES

With the whole detector assembled the noise of each chain will be evaluated using the measures already done for gain evaluation and the width of the 60 keV from Am-241 source with the method described in RD[4] and RD[5].

6.2.5 MCAL_SUBMSBTR SUB-MILLISECOND BURST TRIGGER

TBD

6.3 SECOND STEP CALIBRATION

6.3.1 RESPONSE MATRIX

A set of measures will be performed to determine the response of the MCAL plane to single photons. The measures will be done positioning collimated radioactive sources over the MCAL detector in a defined set of positions.

To map the detector plane, two radioactive sources will be used (Na-22 and Y-88).
The MCAL will operate in Burst Mode

Each collimated radioactive source will be placed in different positions along the plane, as shown in figure 6.3.1 for a TBD exposure time that should ensure a sufficient statistic to determine the various parameter with +/- 1% error.
The map is designed to measure 5 points for each bar, each point accounts for both the planes.
The total number of points to measure is 75 for each source. In each point energy and position will be reconstructed and compared with the true value to determine the response matrix of the plane.

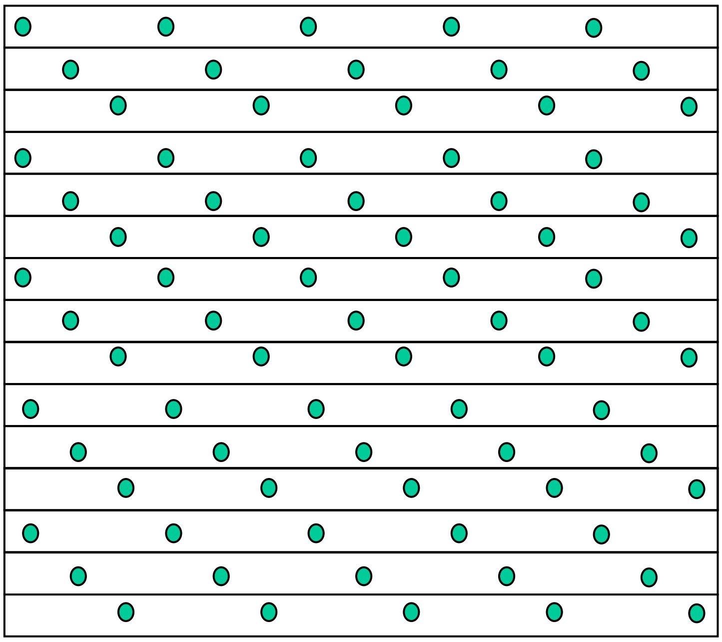


Figure 6.3.1: Map of the points to measure on the MCAL plane, top view of the MCAL plane.

6.3.2 ENERGY RESOLUTION

Using the Burst data, for every measure described in 6.3.1 it will be reconstructed the energy spectra of the bar where the collimated source radiation is impinging.
For every photon, the energy reconstruction will take into account the bar parameter already determined with the test on the bars described in 4.2.
For each position and for each source the mean channel value and channel width of the peaks will be evaluated

A map of energy calibration and energy resolution in the measured points will then be constructed.

An extension of the above map on all the MCAL plane will be determined with a TBD algorithm.

6.3.3 POSITION RESOLUTION

Using the Burst data, for every measure described in 6.3.1 will be reconstructed the position of the point where the collimated source radiation is impinging.
For every photon, the position reconstruction will take into account the bar parameter already determined with the test on the bars described in 4.2.
For each position and for each source the channel value and channel width of the peak will be evaluated

A map of position reconstruction and position resolution in the measured points will then be constructed.

An extension of the above map on all the MCAL plane will be determined with a TBD algorithm.

6.3.4 THRESHOLD EVALUATION

A threshold map of MCAL will be evaluated starting from flood measures taken using the detector in Burst mode and exposing it to Background and with the threshold at different setting.

In each measure for each photon Energy and position will be reconstructed.
The MCAL bars will then be divided in TBD zones.
Spectra of each zone will then be constructed using the bar parameter already determined with the test on the bars described in 4.2.

The threshold will be then evaluated in each zone.

6.3.5 DEAD TIME EVALUATION

The dead time of the electronic chain will be evaluated analytically comparing a MCAL plane simulation response to radioactive sources and the detected events with a dedicate algorithm.

A verification of the value obtained will be carried out with the use of a random pulse generator connected to the charge preamplifiers. Pulses will be generated at different rates and the amount of pulses converted by the electronics versus the amount of pulses discarded will be evaluated.

6.3.6 FLOOD MEASURES ON THE MCAL PLANE

Measures made with uncollimated sources have to be performed. The sources will be positioned at different angles around the detector plane. Sources to be used here are Na-22 and Y-88.
Objective of this measure is to determine the response of the detector to uncollimated sources, and to investigate the presence of eventual shielding effects (shadows) due to MCAL electronics boards. Table 6.3.2 report the angles of measure (TBC)

Source	ϕ	**Time**
Na-22, Y-88	0°	TBD
	30°	TBD
	60°	TBD
	90°	TBD
	120°	TBD
	150°	TBD
	180°	TBD

Table 6.3.2: Type of radioactive source and exposure as a function of the angle with respect to the MCAL vertical axis.

In figure 6.3.1 is shown an example of source positioning pattern to follow during this kind of measure.

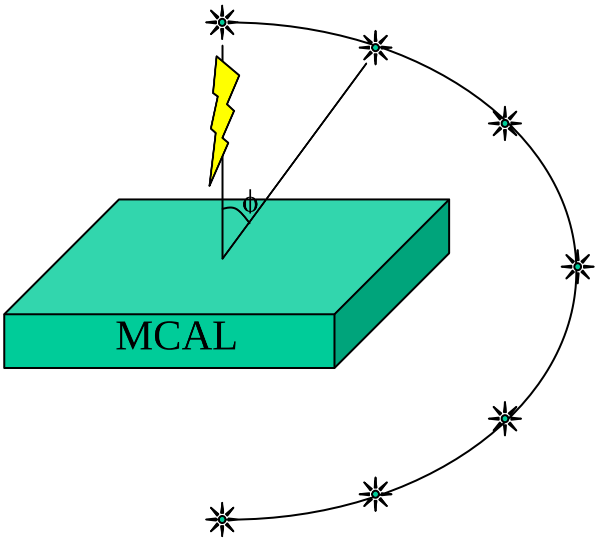


Figure 6.3.1: Source positioning pattern of the flood measures to be performed with uncollimated sources.

6.3.7 TEST WITH BURST SIMULATOR (TBC)

In order to test the different timings of the burst search procedure, an appropriate burst simulator tool has to be developed. This tool could be made up of a rotating device with a window on one side (chopper) and a radioactive source inside (see Figure 6.4.1). The rotation would give rise to short bursts of radiation in coincidence with the window on the chopper.

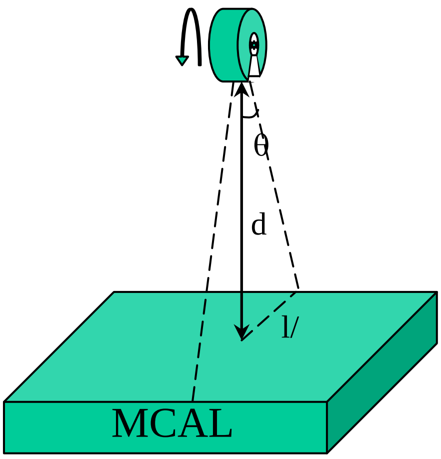


Figure 6.4.1: Possible Burst simulator showing the rotating chopper with the source inside.

The burst search algorithm will be reconstructed via software and tested. Tests will be performed to simulate all the 7 SITs (1ms, 16ms ..., 65536ms) of the burst search procedure and to verify their correct operation. To simulate bursts of different duration the angular velocity of the chopper will be varied.

To evaluate the response of the MCAL plane to a burst coming from a random direction, the burst simulator will be placed at different angles with respect to the MCAL plane. A table of the positions of the source and relative exposures is shown below.

Source	ϕ	**Time**
Burst simul.	0°	TBD
	30°	TBD
	60°	TBD
	90°	TBD
	120°	TBD
	150°	TBD
	180°	TBD

Table 6.3-1: Table of the positions of the source with respect to the MCAL vertical axis and relative exposures.

6.3.8 MUON PARTICLES TEST (TBC)

Using a muon particle detector with trigger output test with this kind of particles from the natural background could be done.
In GRID mode MCAL will be used connecting the trigger of the muon detector to T1_YES.
In burst mode MCAL could be used connecting the inverse of trigger of the muon detector to the AC INPUT.

6.3.9 TEST OF THE SCIENTIFIC RATEMETERS (TBC)

Using the flood measures the algorithms used in AGILE DH to determine the scientific ratemeters will be simulated and compared with MonteCarlo simulations of MCAL

7. MCAL CHARACTERIZATION IN AGILE

7.1 INTRODUCTION

With MCAL will be assembled in the AGILE payload, calibration measures of the whole detector will be carried out during the calibration campaign. The tests will be performed using the telemetry data packets acquired with the AGILE payload TE in a scenario depicted in Figure 7.1.1.
The responsibility of this activity is of AGILE team.
In the following are briefly reported the calibration activity peculiar to MCAL that should be undertaken.

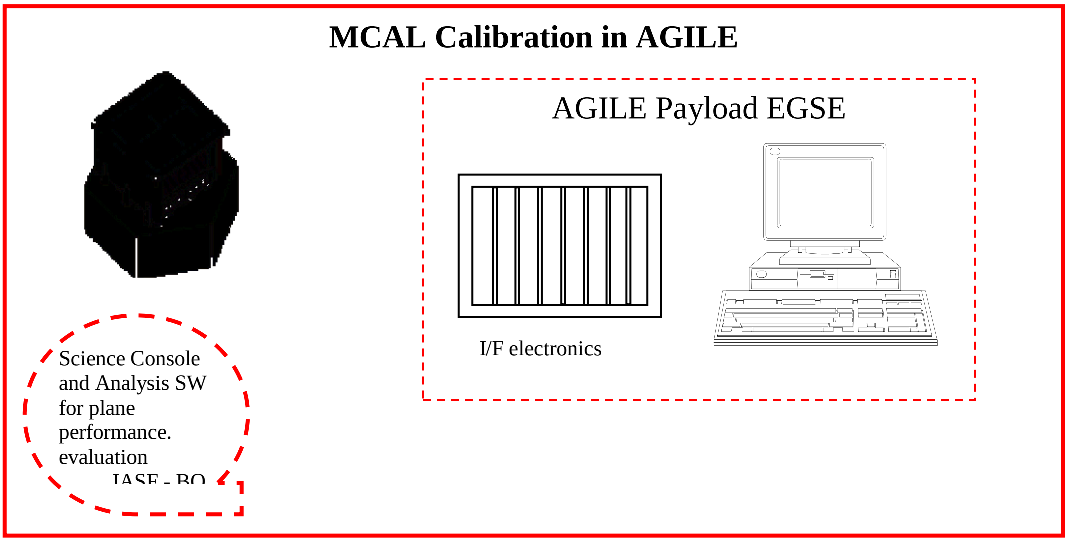


Figure 7.1.1: Scenario of MCAL calibration integrated in AGILE.

7.2 MCAL CALIBRATION IN AGILE: GOALS

Scope of the MCAL characterization on AGILE is to determine the following instrumental characteristics:

- Response matrix: A set of flood measures will be performed positioning uncollimated radioactive sources around the payload at different angles, in order to determine the response of the MCAL detector to photons. An evaluation of the shadows due to the payload structure (and eventually to the satellite structure) will be made.
- Burst Mode (TBC): This test will simulate a burst with the use of radioactive sources combined with a suitable chopper. The burst search algorithm in the DH will be tested. The correlation between the position of the source and the counts in the Detector Ratemeters will be investigated, in order to estimate the source location.
- Calibration mode: The MCAL will be tested in calibration mode together with the Silicon Tracker. The front panel of the AC system will be deactivated and a measure with incoming protons will be carried out, to simulate the in-flight calibration mode procedure.

7.3 FLOOD MEASURES ON THE MCAL

Measures will be made with uncollimated sources to determine what modifications have to be made to the response matrix of MCAL, taking into account the presence of shielding effects (shadows) due to the payload and satellite structure, that weren't present at the plane characterization phase. Sources will be positioned at different angles around the payload as described in table 7.3.1. Sources to be used here are Na-22 and Y-88.

Source	ϕ	**Time**
Na-22, Y-88	0°	TBD
	30°	TBD
	60°	TBD
	90°	TBD
	120°	TBD
	150°	TBD
	180°	TBD

Table 7.3.1: Type of radioactive source and exposure as a function of the angle with respect to the MCAL vertical axis.

In the figure 7.3.1 is shown an example of source positioning pattern to follow during this kind of measure.

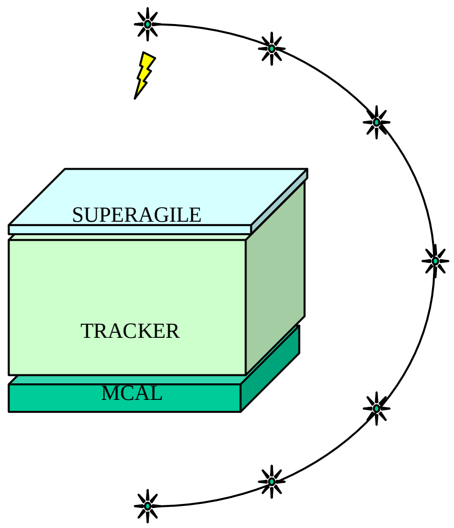


Figure 7.3.1: Source positioning pattern of the flood measures to be performed with uncollimated sources at different angles ϕ. AC is not shown for clarity.

7.4 TEST WITH BURST SIMULATOR (TBC)

In order to test the different timings of the burst search procedure present in the DH, an appropriate burst simulator tool should be developed (see par.6.3.7).
Measures will be performed for different angular velocities of the chopper, in order to simulate different burst durations.

Measures will also be carried out at different angles with respect to the vertical axis of the satellite in order to evaluate the correlation between the position of the source and the counts in the DRs.

7.5 AGILE CALIBRATION MODE TEST

Test of AGILE calibration function with particles should be done
The configuration is TBD.
It will use the top AC as particle trigger and TRACKER to determine the position of interaction of the particles on MCAL plane.