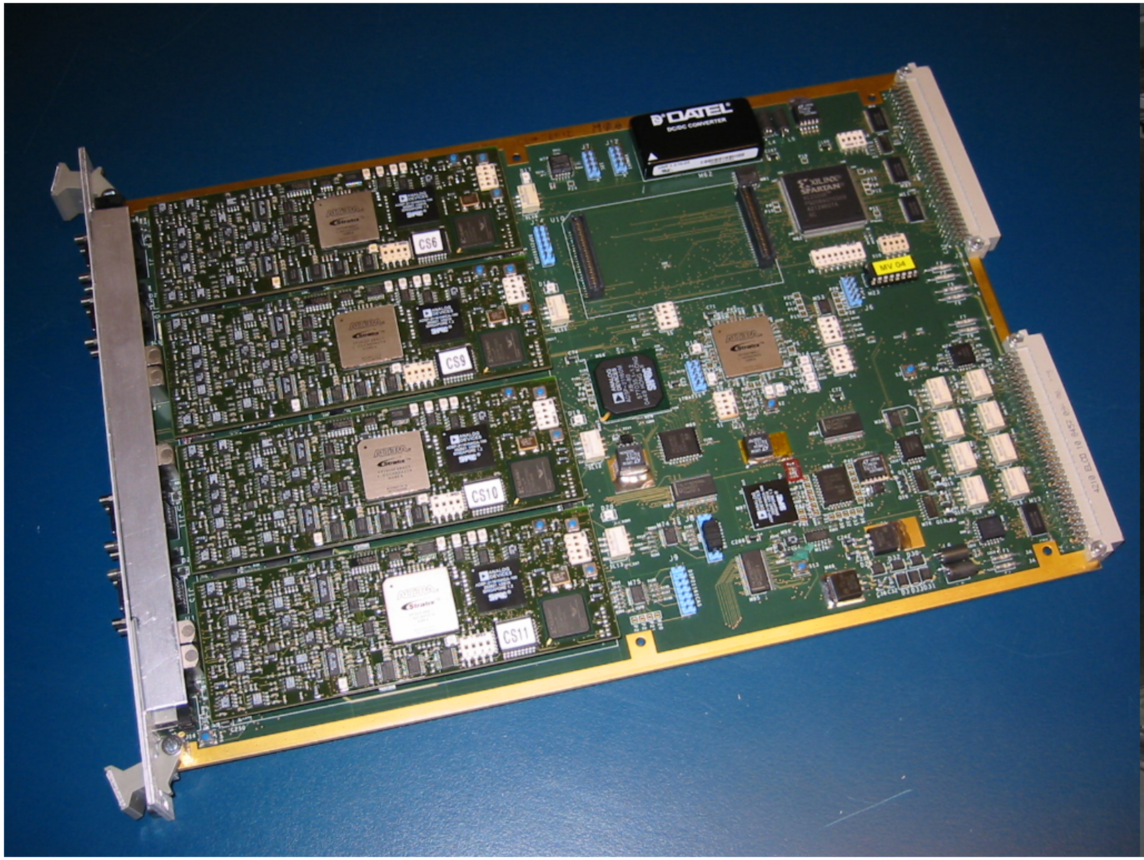
MUST2
MUVI CARD USER MANUAL



optimal reading with the following tools:
KPDF (LINUX)
ACROREAD (WINDOWS)
APERCU (MAC OS X)

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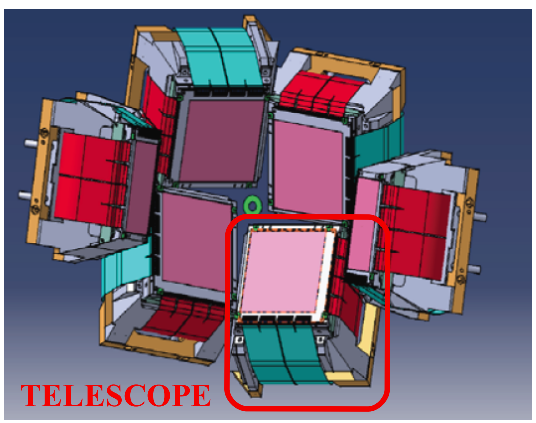
081013

OVERVIEW

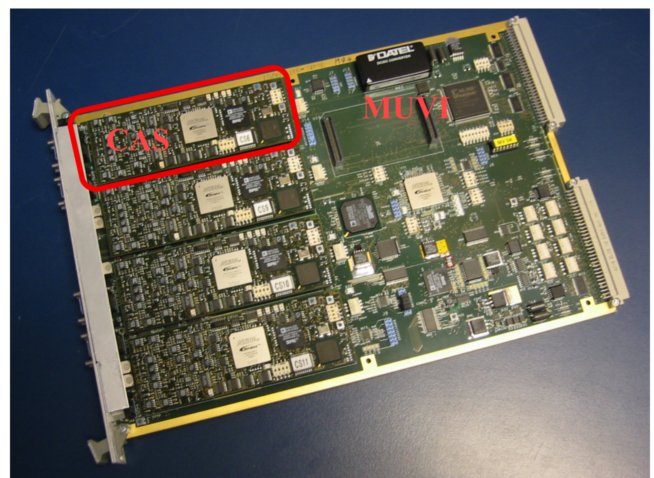
Project **MUST2** (**MU**r à **ST**rips) is a multidetector of 10 telescopes; each telescope is made up with two X and Y plans of 128 Si tracks followed by 16 SiLi and 16 CsI. MUST2 is dedicated to the study of the light products produced from the interaction of radioactive beams with a target.

MUST2 Electronics is based on ASICs (Application Specific Integrated Circuit) so called **MATE**. MATEs are housed on **MUFEE** cards located closed to the detectors. In each MATE 16 detector channels are analog processed in order to get the 16 energy (E) and 16 time (T) analog steps . These steps are serially sent to MUVI.

MUVI is a C sized VXI card in which are implemented the 14 bits analog to digital conversion, the digital processing, the physics parameters readout and the MATEs control. MUVI was specially designed in order to pay attention at the aspects of resolution, density of channel and reduction of the dead time of acquisition. It manages 4 telescopes and delivers more than 2000 E and T parameters processed in 4 **CAS** daughter cards.



LINKs
MUFEE-MUVI



VXI-C STANDARD

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link: direct access to the page

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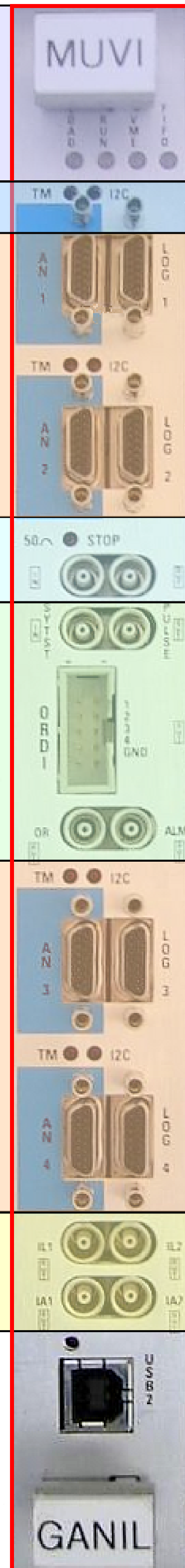
MUVI card FRONT PANEL (VXI-C standard)

LOAD	🟢	**load FPGAs and DSPs : OK**
	🔴	**loading défault**
RUN	🟢	**acquisition RUN**
	🔴	**acquisition STOP**
VME	🟢	**access to backplane**
FIFO	🟢	**access of events read FIFO**
TM	🔴	**dead time of TELESCOPE**
I2C	🔴	**I2C access in progress**



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SLOW CONTROL
\+
ANALOG TRANSFERT

Micro D
ITT Cannon
90° stacked
MDSM-30PE

TEMPi	LVDS
SDAi	LVDS
SCLi	LVDS
MRSTi	LVDS
CHAINi	LVDS
SYNTSTi	LVDS
ORDi	LVDS
STOPi	LVDS
HOLDi	LVDS
Cki	LVDS
AN1i	Analogique
AN2i	Analogique
AN3i	Analogique
AN4i	Analogique
CLRi	LVDS

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STOP
NIM INPUT lemo 00 coax

STOP
NIM OUTPUT lemo 00 coax

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SYTST
NIM INPUT lemo 00 coax

ORDi
DISCRI OUTPUT ECL differentiel
T&B ANSLEY 622-1606 2c*5r mâle

OR
NIM OUTPUT lemo 00 coax

PULSE
ANALOGIC OUTPUT
lemo 00 coax

ALM
NIM OUTPUT lemo 00 coax

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IL1
OUTPUT NIM lemo 00 coax
IA1
ANALOGIC OUTPUT lemo 00 coax

IL2
OUTPUT NIM lemo 00 coax
IA2
ANALOGIC OUTPUT lemo 00 coax

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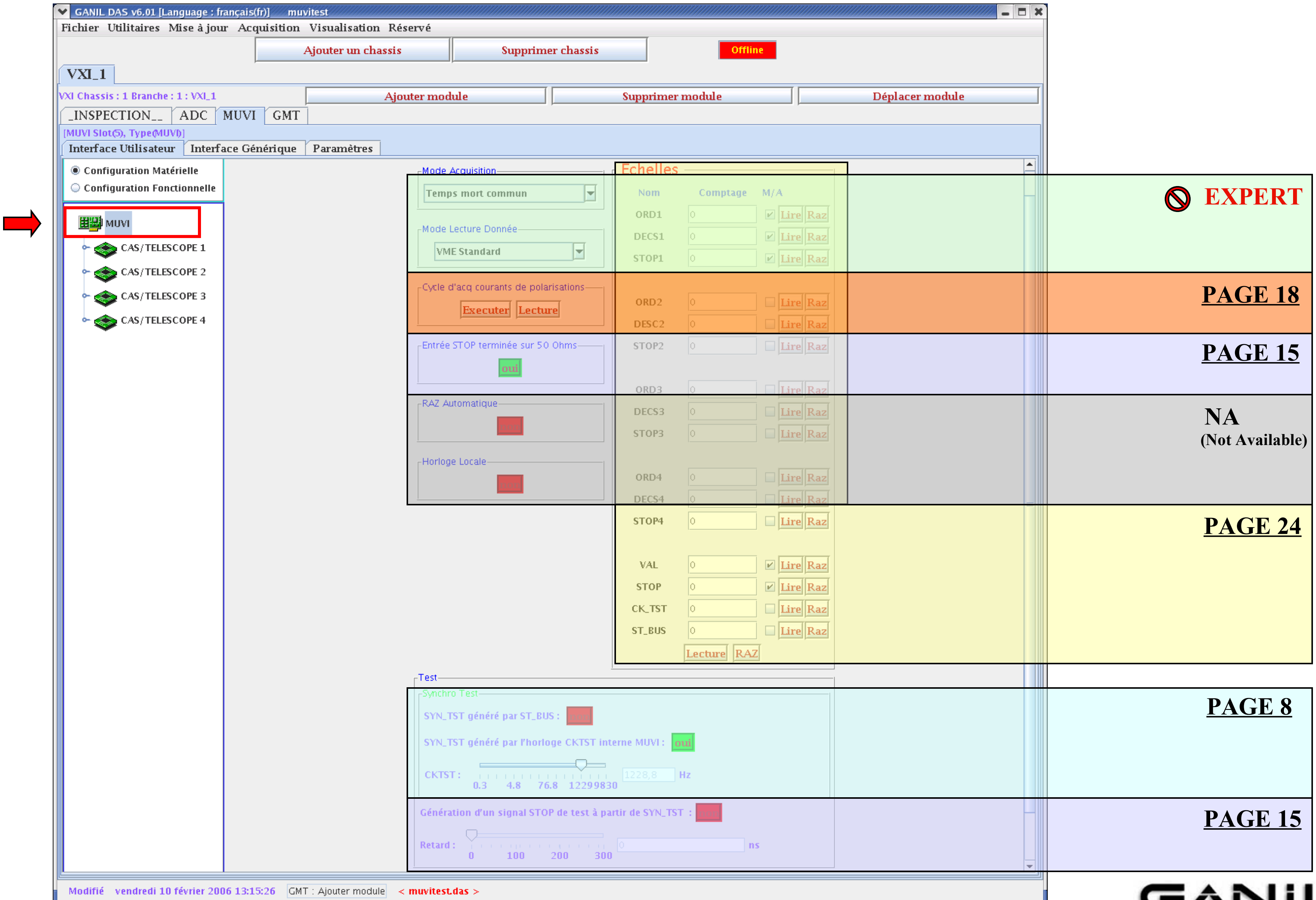
DAS GUI => MUVI card SETUP



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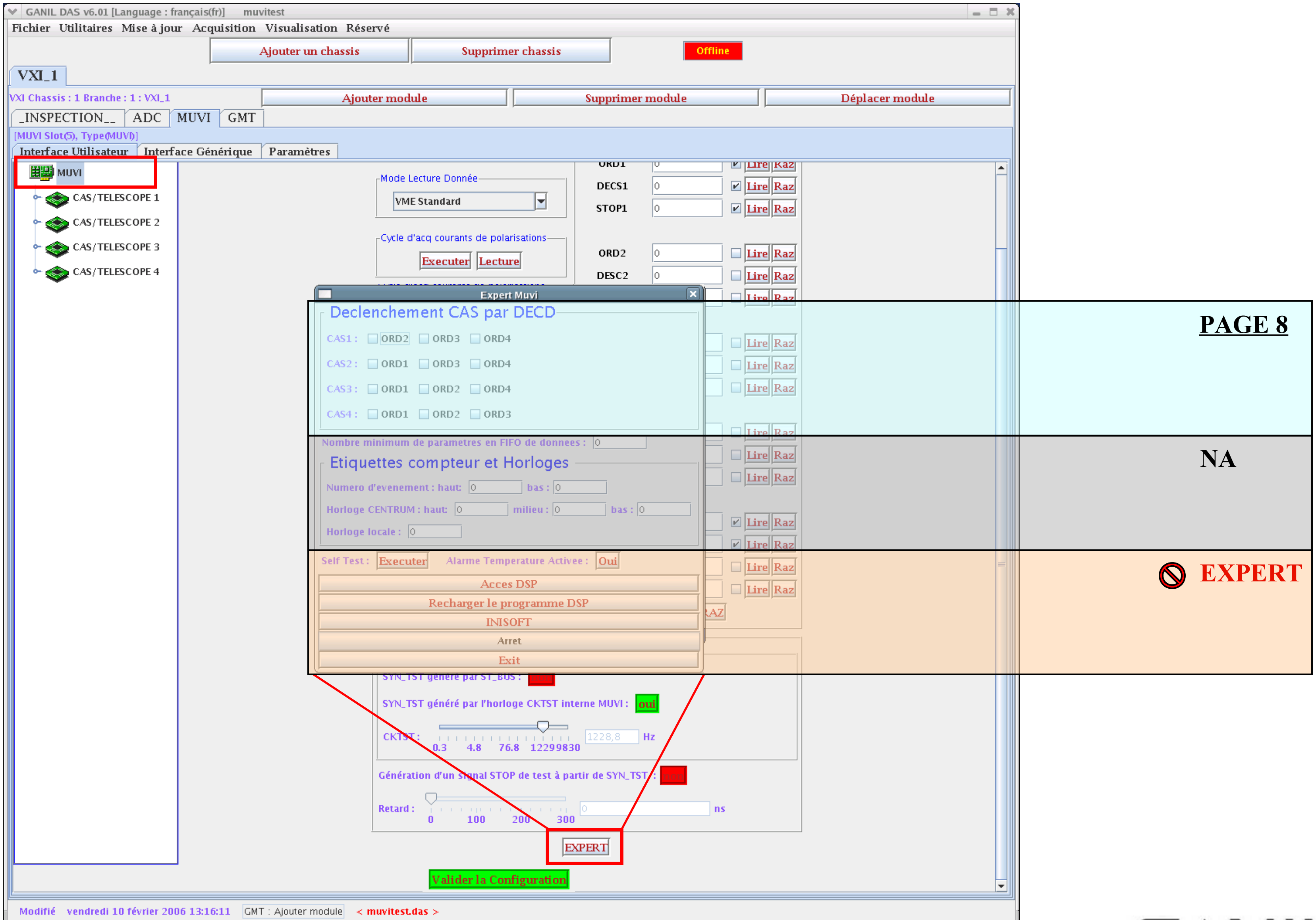
DAS GUI => MUVI card SETUP => EXPERT



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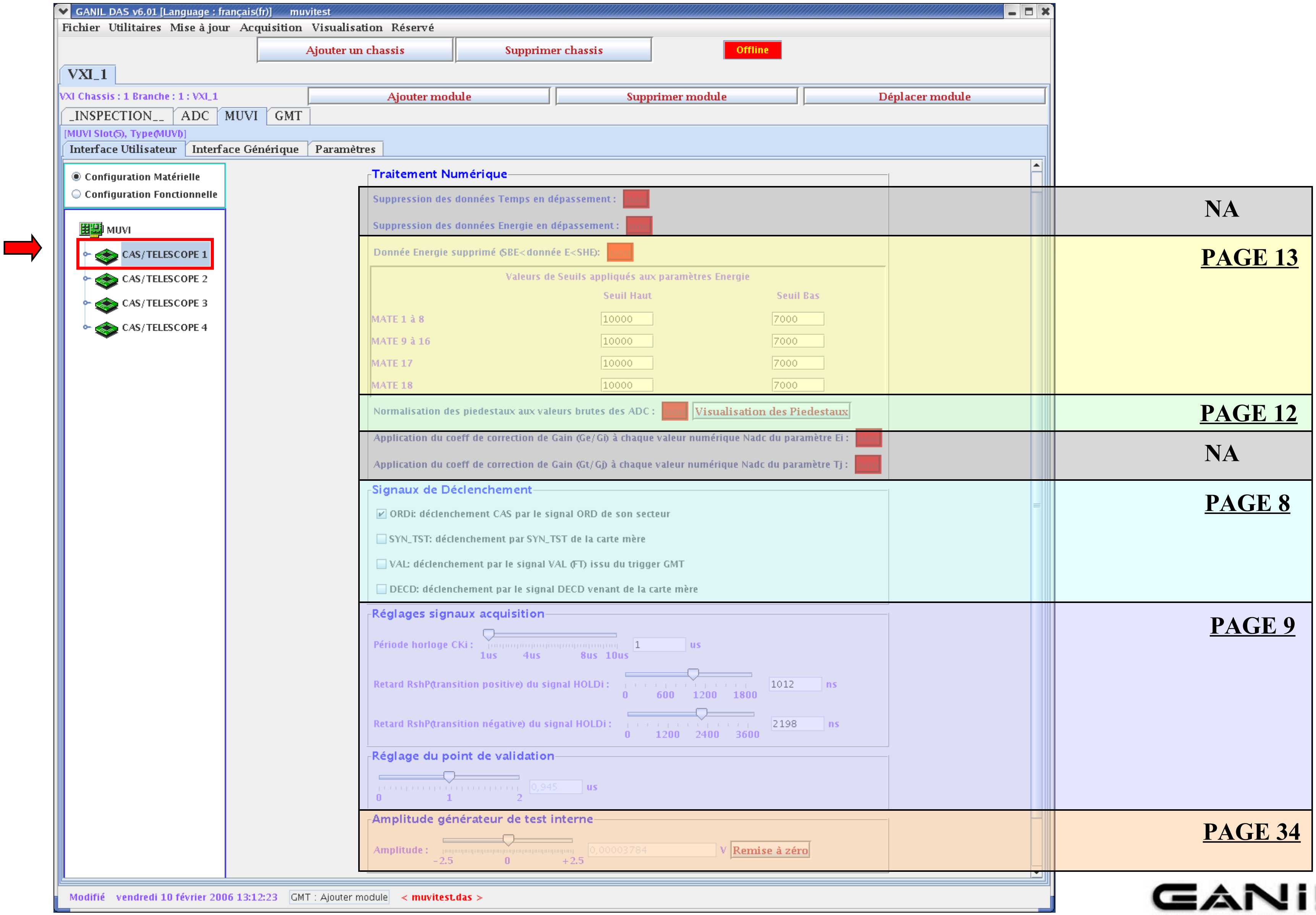
DAS GUI => CAS/TELESCOPE daughter card SETUP



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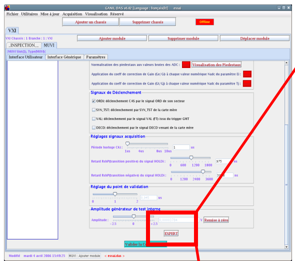
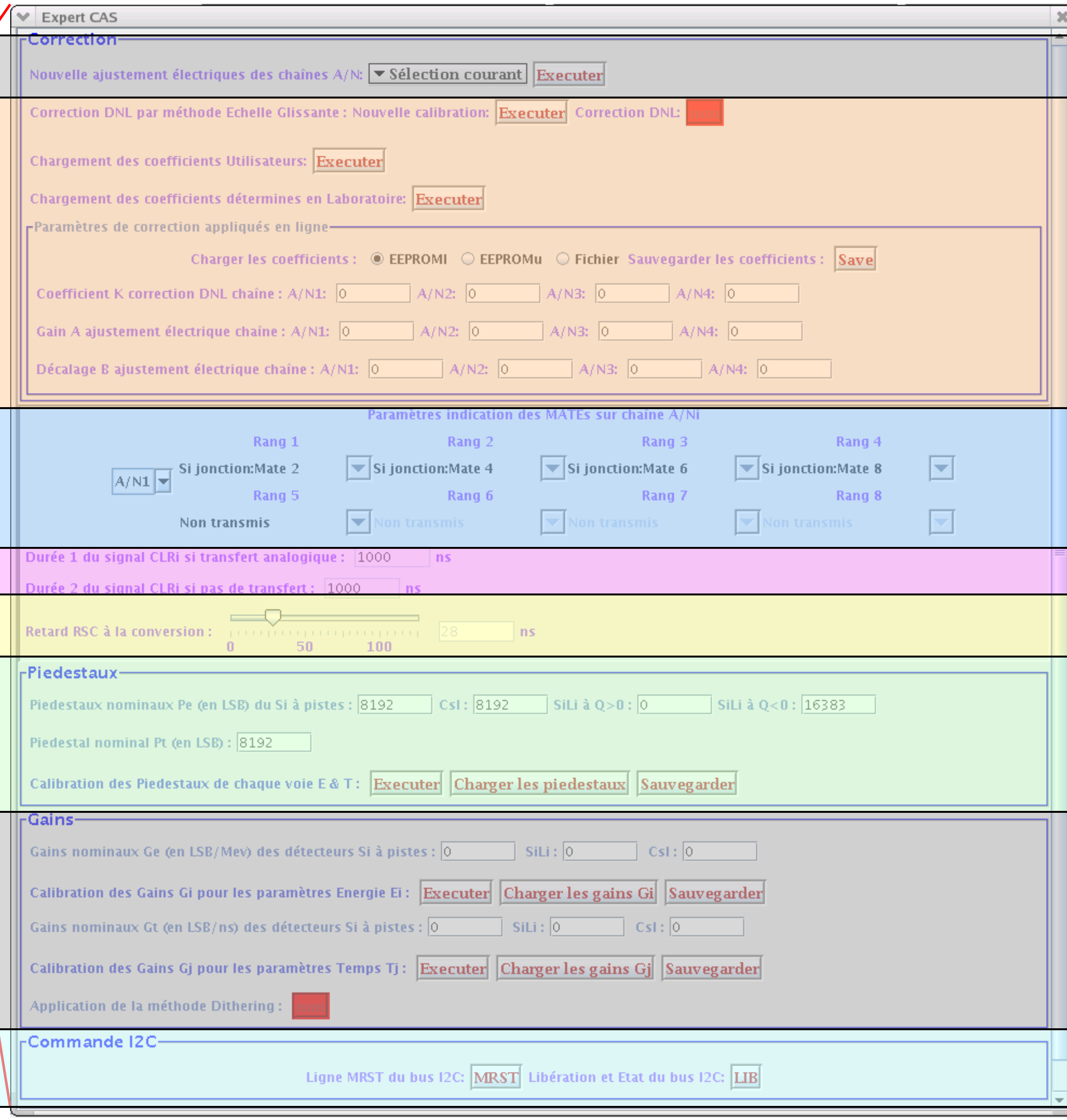
DAS GUI => CAS/TELESCOPE daughter card SETUP => EXPERT





NA

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NA

EXPERT

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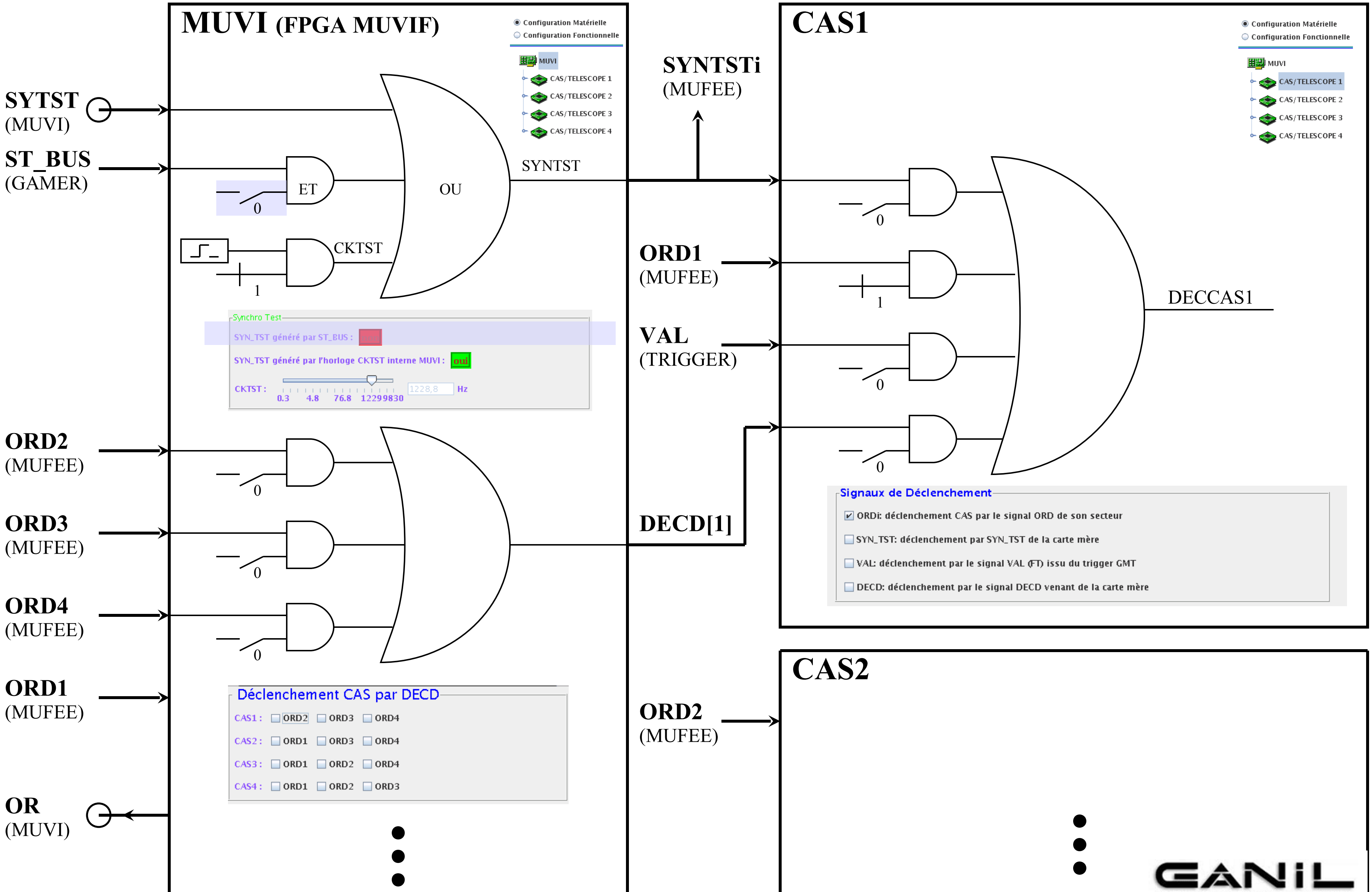
SOURCES of TRIGGER in MUVI and in CAS



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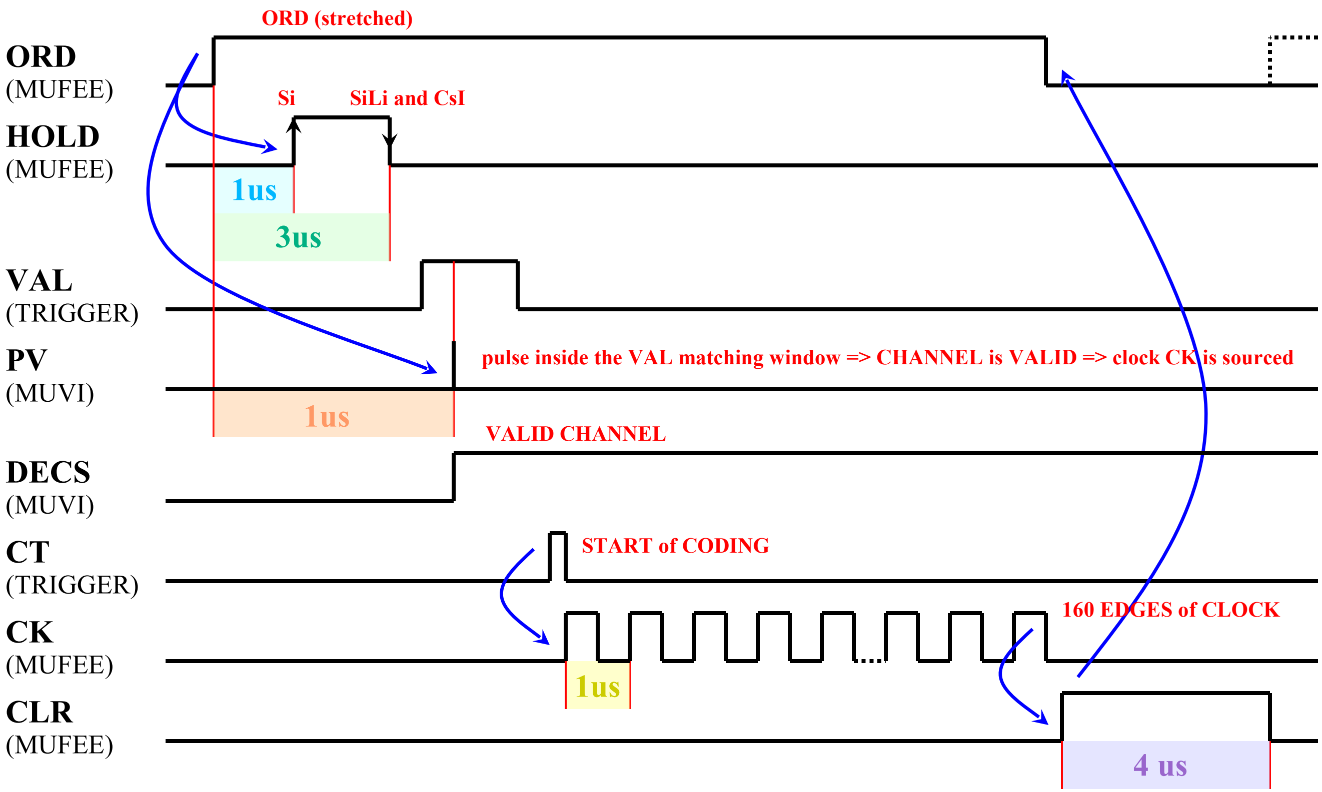
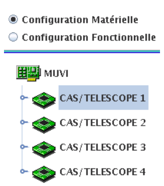
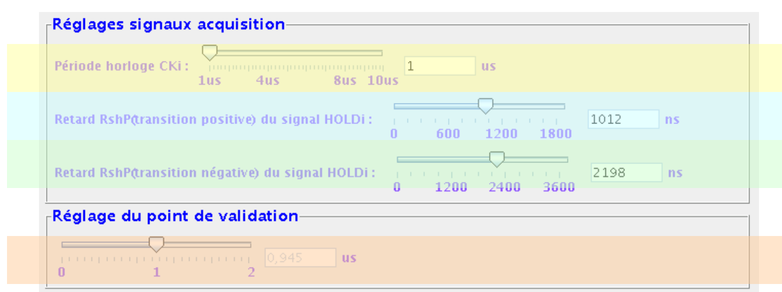
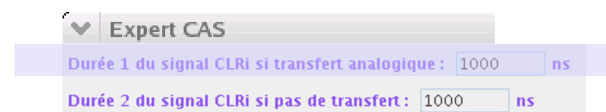
BASIC MUVI-MUFEE SIGNALS
A) VALID CHANNEL in COMMON DEAD TIME (trigger ORD=DECCAS)









steps of parameter are:
CKi, PV et CLRi 100ns
HOLD 7.5ns

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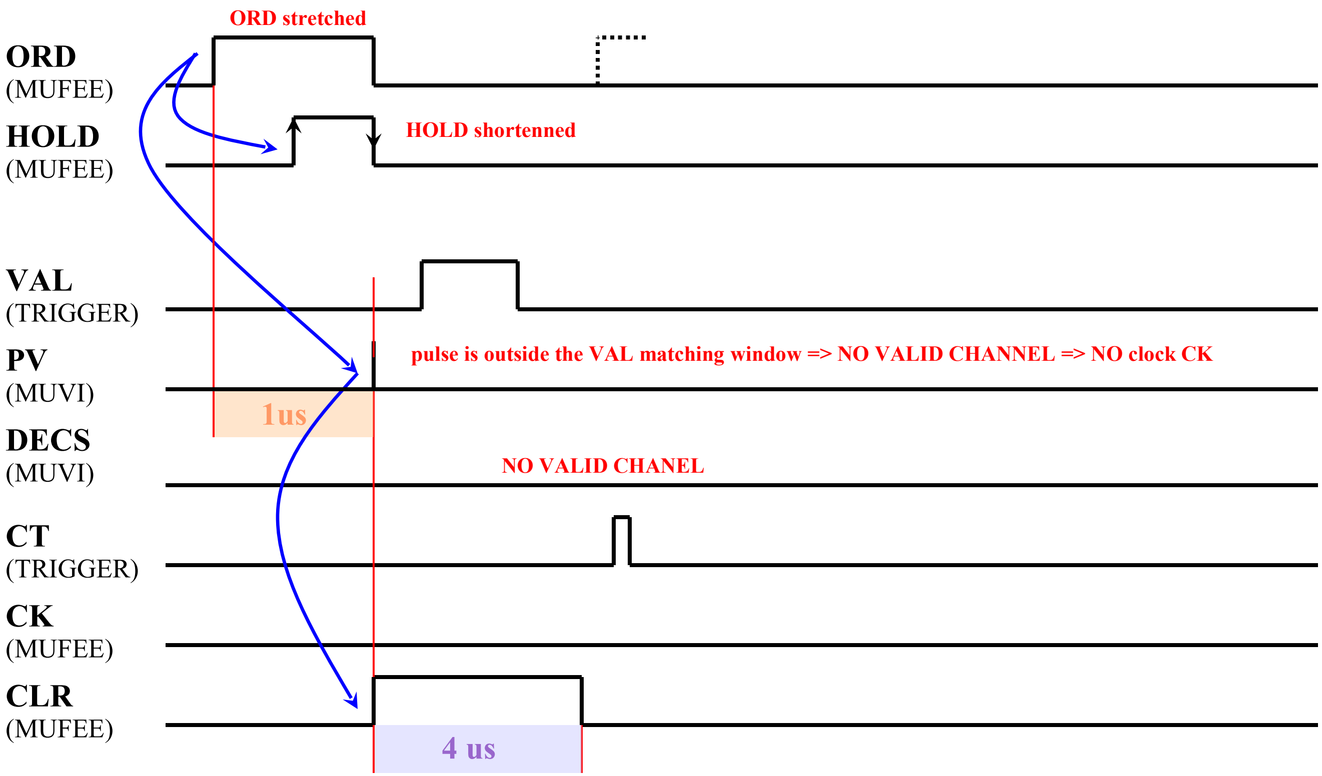
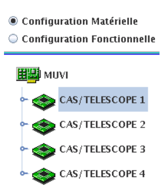
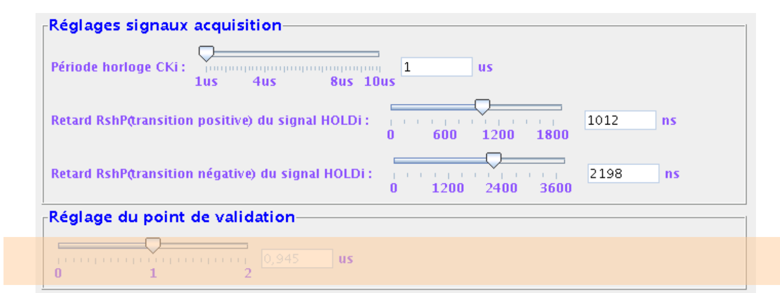
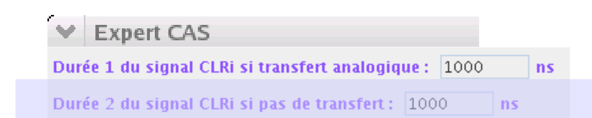
BASIC MUVI-MUFEE SIGNALS

B) NO VALID CHANNEL in COMMON DEAD TIME (trigger ORD=DECCAS)









steps of parameter are:

CKi, PV et CLRi 100ns

HOLD 7.5ns

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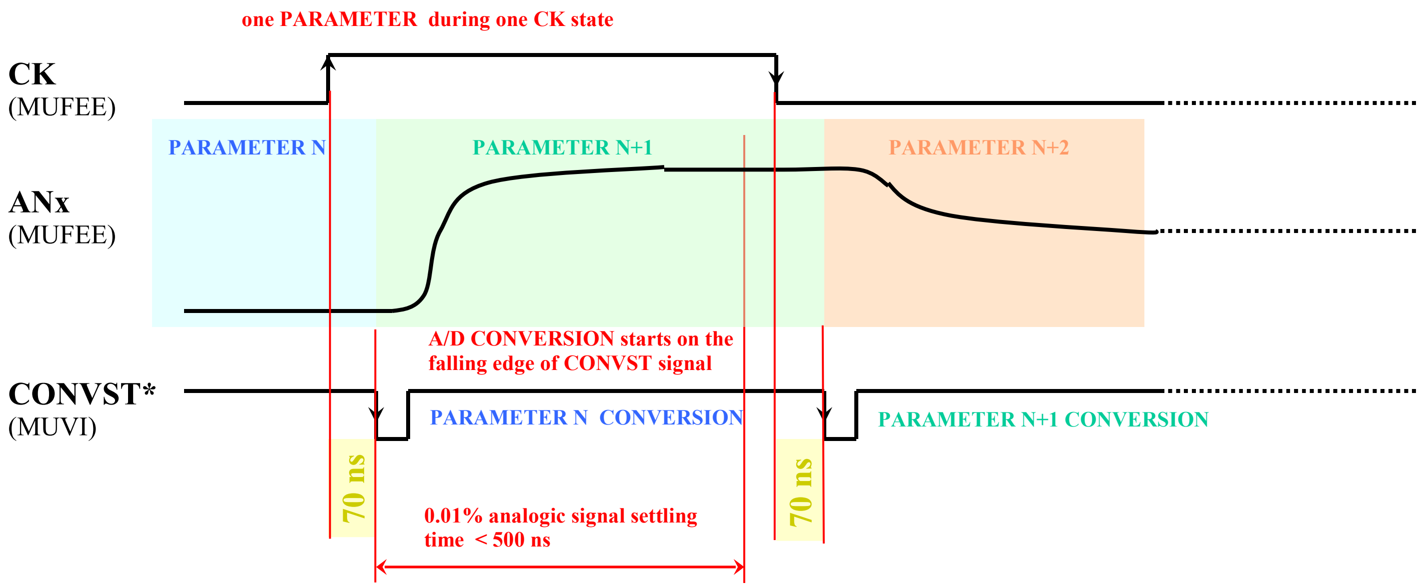
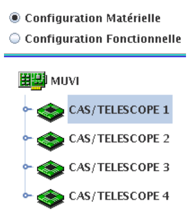
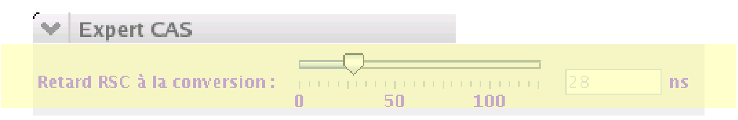
BASIC MUVI-MUFEE SIGNALS

C) ANALOGIC SIGNALS TRANSMISSION on ANx lines



Delaying the start of A/D conversion cancels the delays due to the cables and the buffers (estimated at 70ns), then keeps the CK half period dedicated to the analogic signal settling. This cancellation delay is 500ps steps programmable.





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DIGITAL PROCESSING
A) PIEDESTALS CALIBRATION, PARAMETER NORMALIZATION

=> ACQ in STOP state during the calibration:

➔ the calibration of piedestals is processed on line (during the transmission of the analogic signals, clock CK); for each detector channel, the piedestal average value (from 2304 values) is computed

➔ CK, CLR and HOLD signals are automatically sourced; no external trigger is needed

=> ACQ in RUN mode:

For each detector channel E and T parameter of the 4 A/Ni channels ($1 \le i \le 4$), the normalization relation is :

$$N1i = ADC1i - (P1i - Pnom)$$

$$N2i = ADC2i - (P2i - Pnom)$$

$$N3i = \dots$$

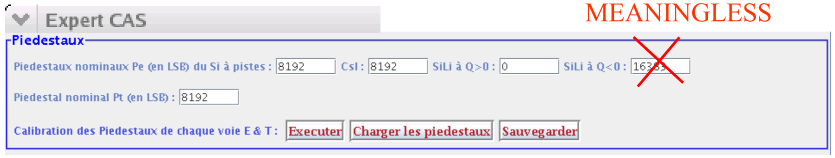
Avec:

N1i	=> value of parameter1 once corrected
ADC1i	=> raw value of parameter1
P1i	=> average piedestal (processed or loaded) of parameter 1, from 2304 piedestals
Pnom	=> nominal piedestal depends on the detector

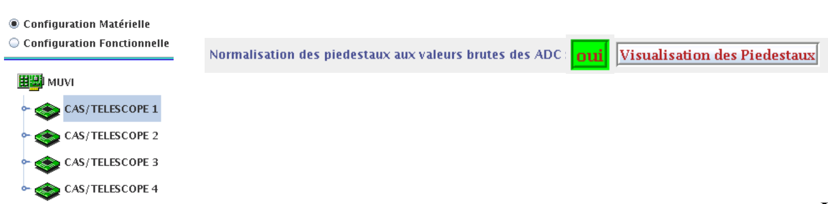
Energy parameter		Time parameter	
Pnom = 8192	=> Si and CsI detectors	Pnom = 8192	=> Si, CsI and SiLi detectors
Pnom = 0	=> SiLi Q < 0 detectors		
Pnom = 16383	=> SiLi Q > 0 detectors		

1) TO RUN the calibration OR TO LOAD the piedestals (starting from a textual file): P1i,P2i…P2304i

MEANINGLESS

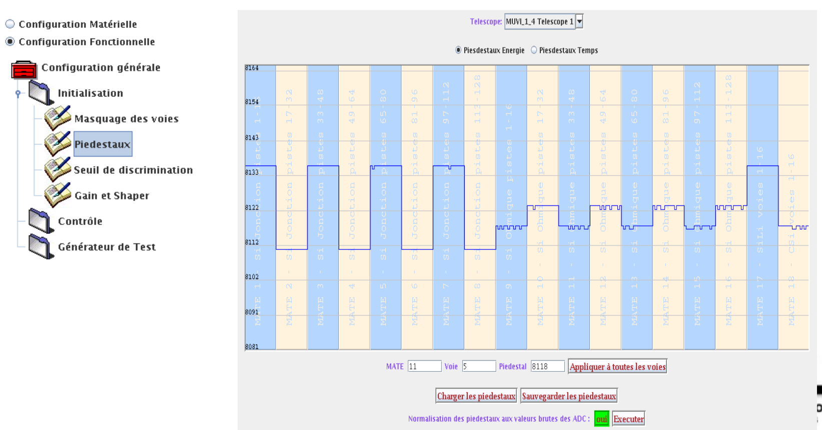


2) On line, CALIBRATION of the piedestals with their Pnom nominal piedestals and DISPLAY



OR

In the FUNCTIONAL VIEW, in a single window, all the following commands EXECUTION, VISUALIZATION, LOADING, SAVE of piedestal by telescope are avalaible

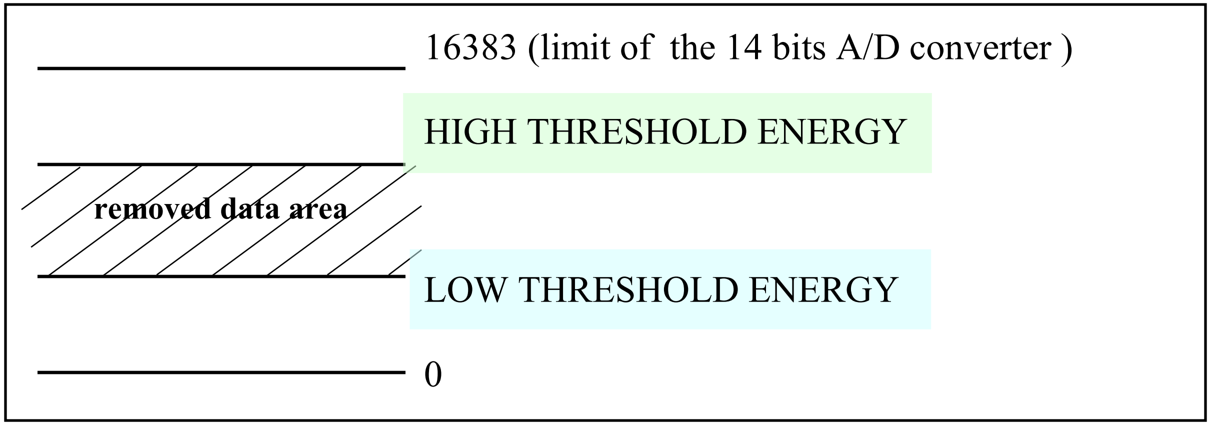


DIGITAL PROCESSING

B) DATA SUPPRESSION (REDUCTION)

=> Because only 8 registers per telescope are dedicated to programmable thresholds, a standardization of piedestal is needed in order to make more efficient the data suppression

=> DATA are REMOVED if they are within the interval (LIMITS NOT INCLUDED)



If the E energy parameter is removed from the vent readout, the associated T time parameter is also removed

oui Compression enable (some E and T parameters are removed)

non Compression disable (All the parameters (576) of the TELESCOPE are kept)

Identical values for the thresholds HIGH and LOW keep the whole data in the event readout

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DIGITAL PROCESSING
C) DNL (Differential No Linearity) CORRECTION by SLIDING SCALE

=> ACQ in STOP state: calibration of the sliding scale (NO reset needed)

=> ACQ in RUN state:

- ➔ the correction of the DNL is made on line (during the reception of the analogic signals synchronized by CK clock)
- ➔ For each E and T parameter of detector channels sent on the 4 A/Ni channels ($1 \leq i \leq 4$), the relation is :

N1i = ADC1i - (ki.DACi)

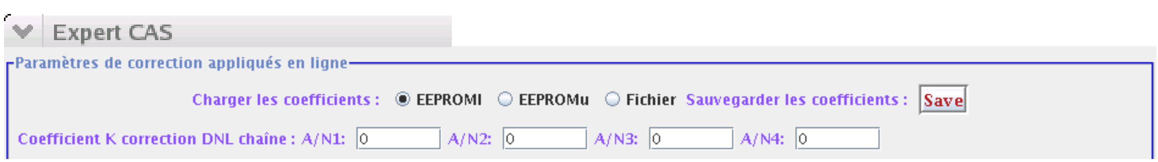
N2i = ADC1i - (ki.DACi)

N3i = …

With:		
	N1i	=> corrected value of the parameter1
	ADC1i	=> raw value of parameter1
	ki	=> corrective coefficient of the A/D channel i associated to the A/Ni analogic channel
	DACi	=> value of DAC (sliding scale on 8 bits)

1) EXECUTE calibration AND ENABLE DNL correction

2) VISUALIZATION of the coefficients (k1 to k4) AND SAVE



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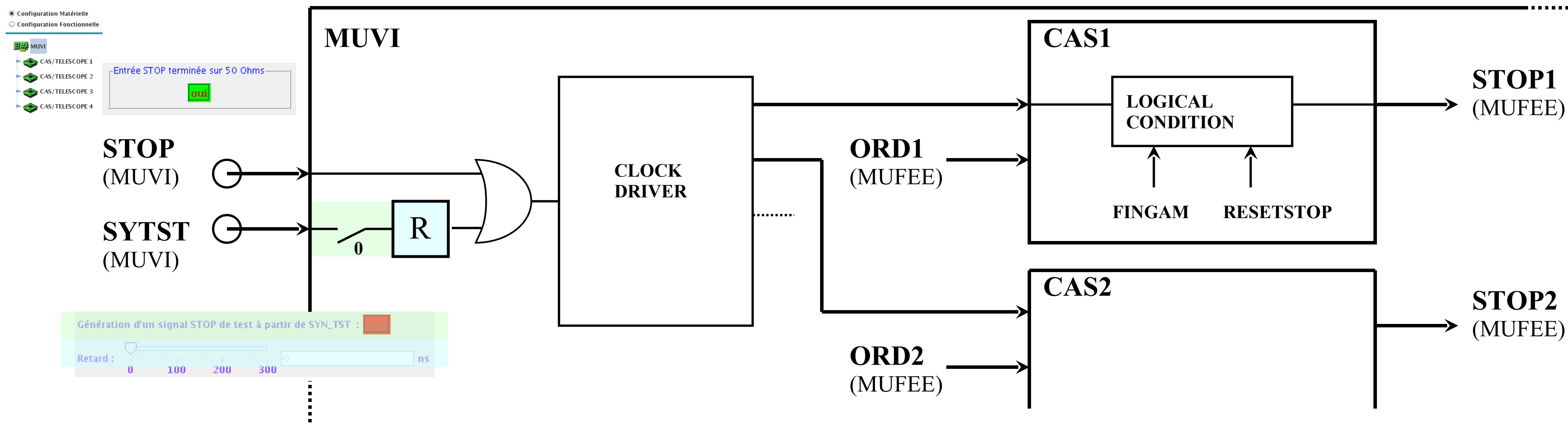
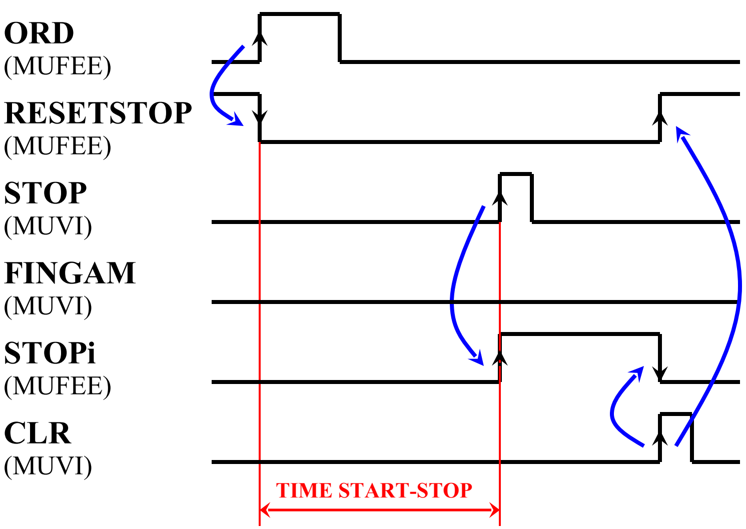
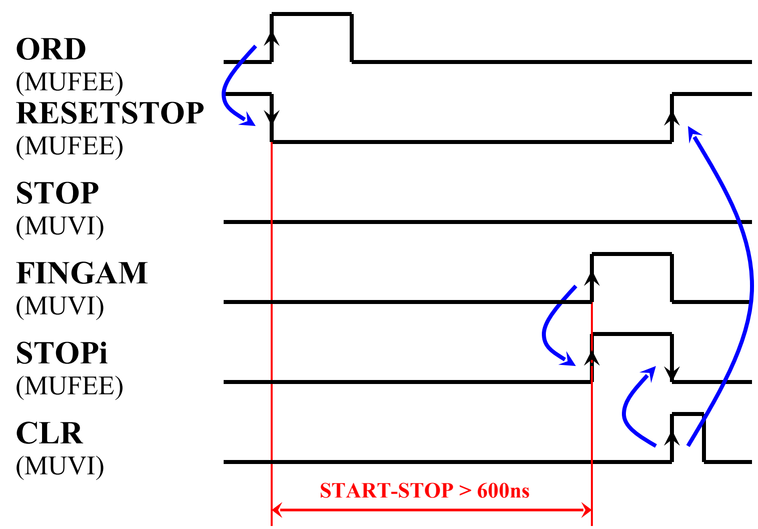
STOP MANAGEMENT



A) START-STOP < range



B) START-STOP > range



There is a 60 ns TAC DEAD ZONE (due to the propagation delay of ORD signal from MUFEE to MUVI (30ns) and the one of STOP from MUVI to MUFEE (30ns))

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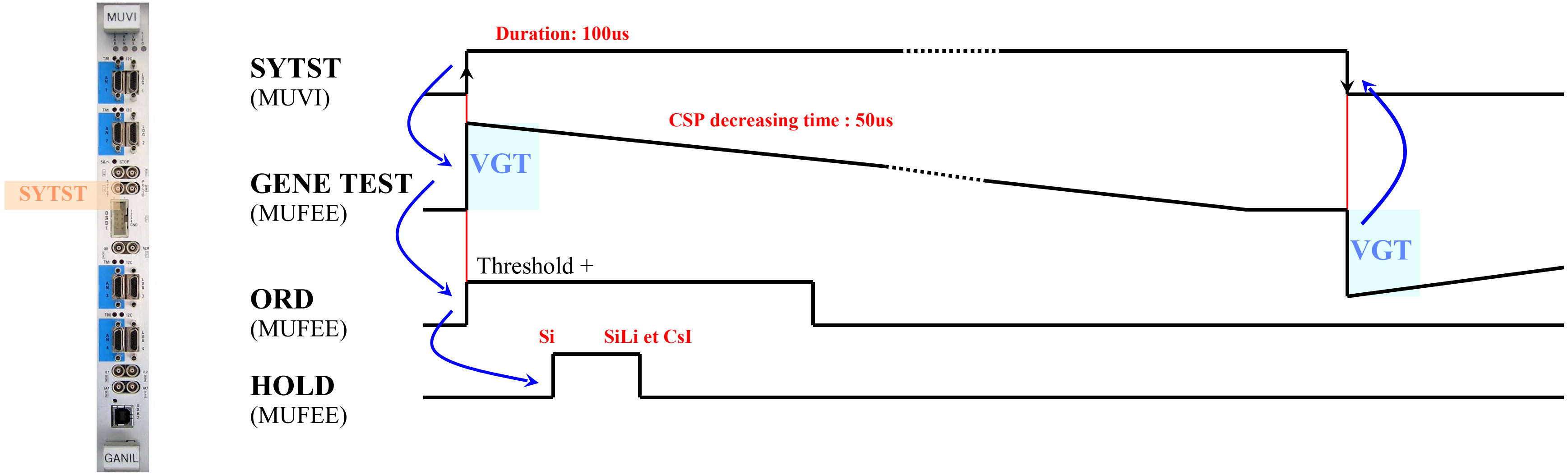
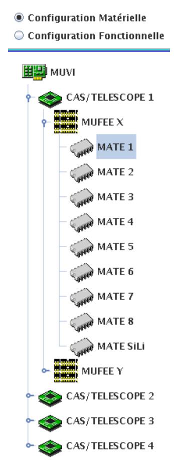
INTERNAL GENERATOR OF TESTS



1) CHOOSE INTERNAL generator of tests started by SYTST signal of VGT amplitude

2) CHOICE of a MATE channel to be in TEST (1 among 16)



VGT amplitude must be > discri threshold of channel in test, and with the same polarity as the discri threshold one .
SYTST signal can be internally generated by CKTST clock of MUVI card

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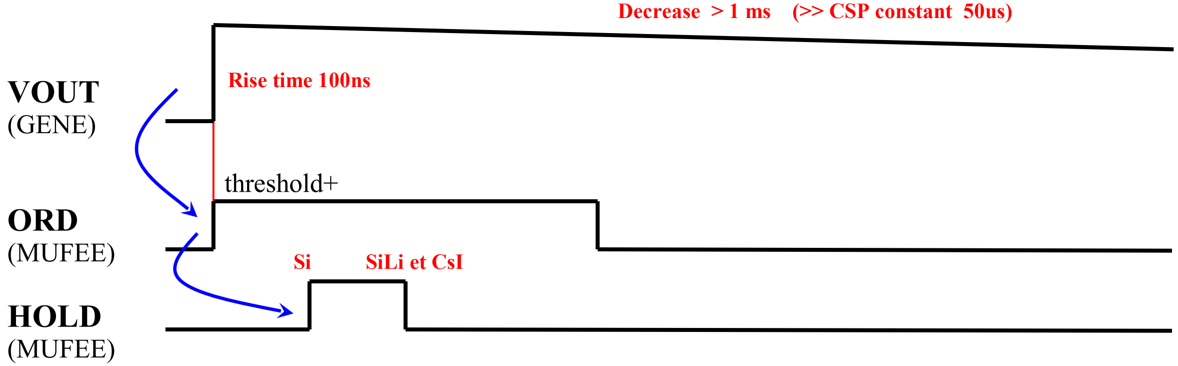
EXTERNAL GENERATOR OF TESTS

Output of the EXTERNAL generator must be connected to the following inputs:
GX for MUFEE X and GY for MUFEE Y (SUPPORT signals MUFEE)

GENERATOR
(BNC PB4)

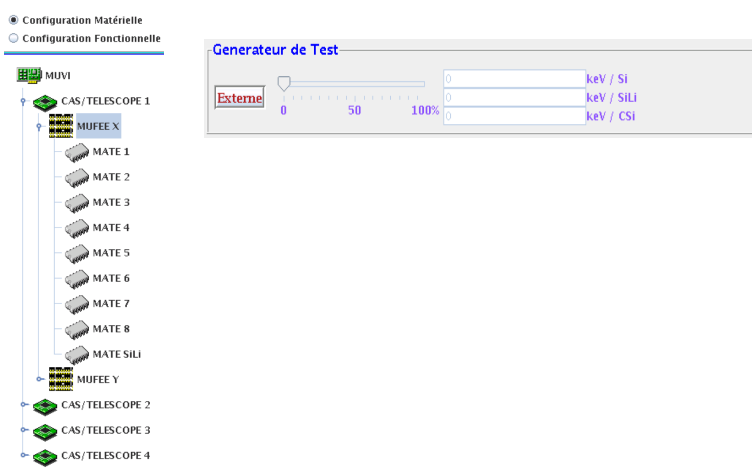
FREQUENCY 250 Hz
RISE TIME 0.1 us
FALL TIME 1ms

VOUT

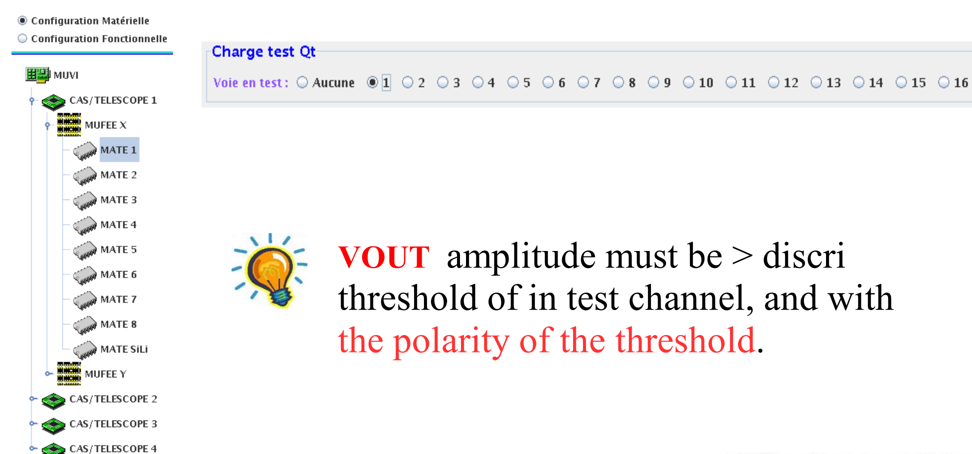


the analog amplitude of gene must be > threshold
BUT < 1V (on 50 ohms load)

1) CHOOSE EXTERNAL generator of test



2) CHOOSE one MATE channel o be TESTED (1 among 16)



VOUT amplitude must be > discri threshold of in test channel, and with the polarity of the threshold.

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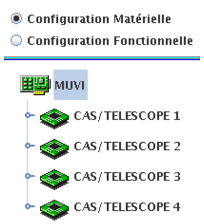
BIAS CURRENT

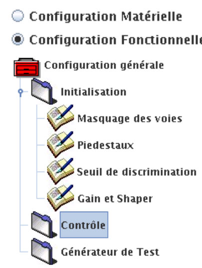
The bias currents of the Si detectors strips are only measured on the ohmic side ie in the MATE 9 to 16 of MUFFEE Y card

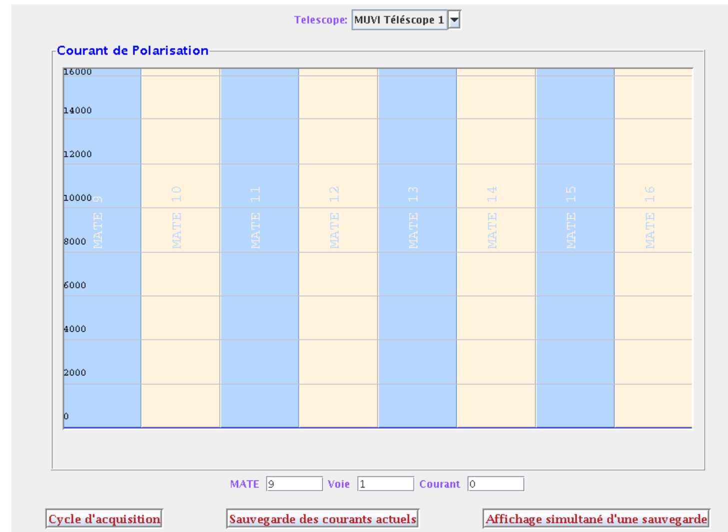
1) ACQ in STOP mode

2) RUN

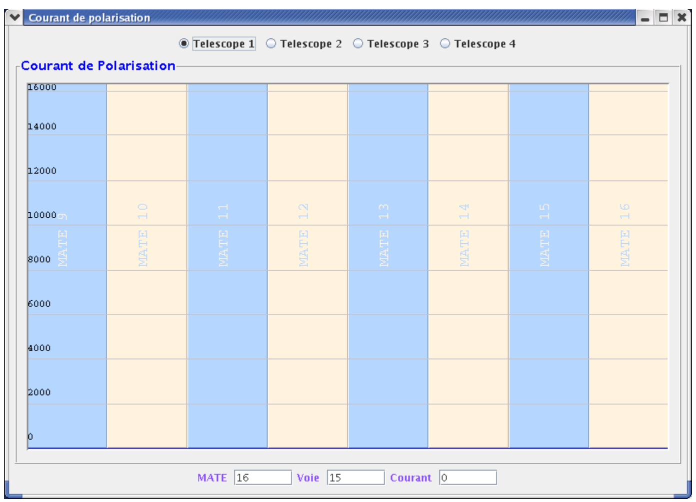


OR





3) READ



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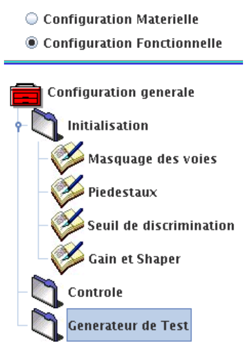
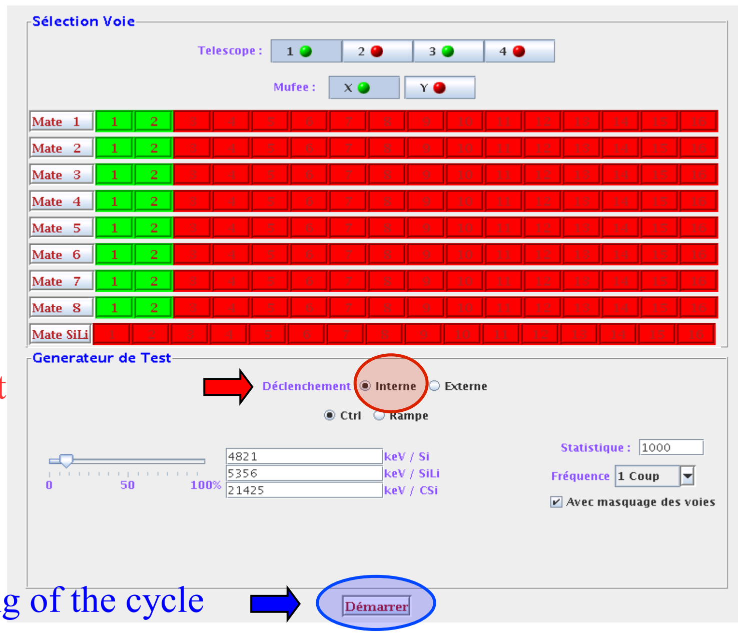
CALIBRATIONs of ENERGY et TIME

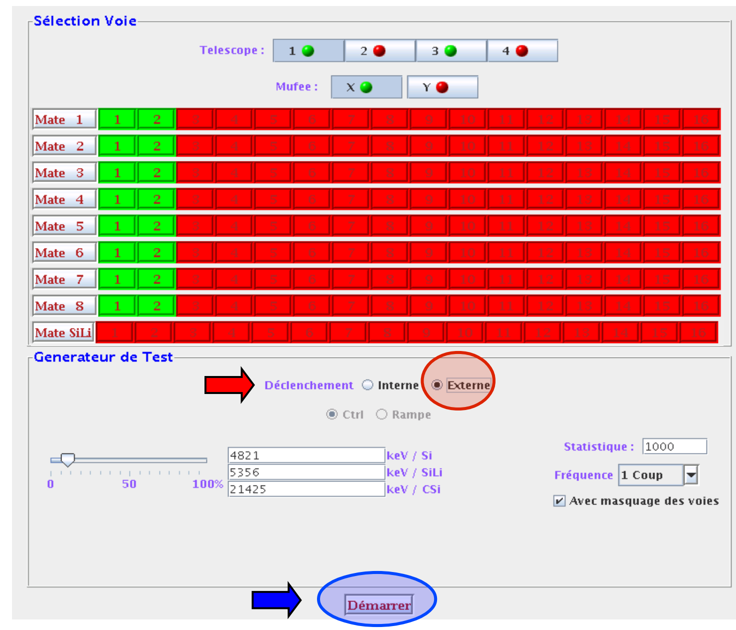
For the calibration of the ENERGY data, the INTERNAL generators on the level of each MUFEE card are requested, it is also possible to use an EXTERNAL generator. The source of trigger being INTERNAL SYTST (ORD for acquisition).
For the calibration of the data TIME, an EXTERNAL generator of type TIME CALIBRATOR is essential.
The source of trigger being EXTERNAL SYTST (SYTST for acquisition)
The choice between the 2 types of calibration is carried out by ITEM the source of trigger.

CALIBRATION of ENERGY
INTERNAL trigger

CALIBRATION of TIME
EXTERNAL trigger







Operat

Starting of the cycle

1 CHANNEL in TEST

NO TEST

before starting a cycle of CALIBRATION
put acquisition in START

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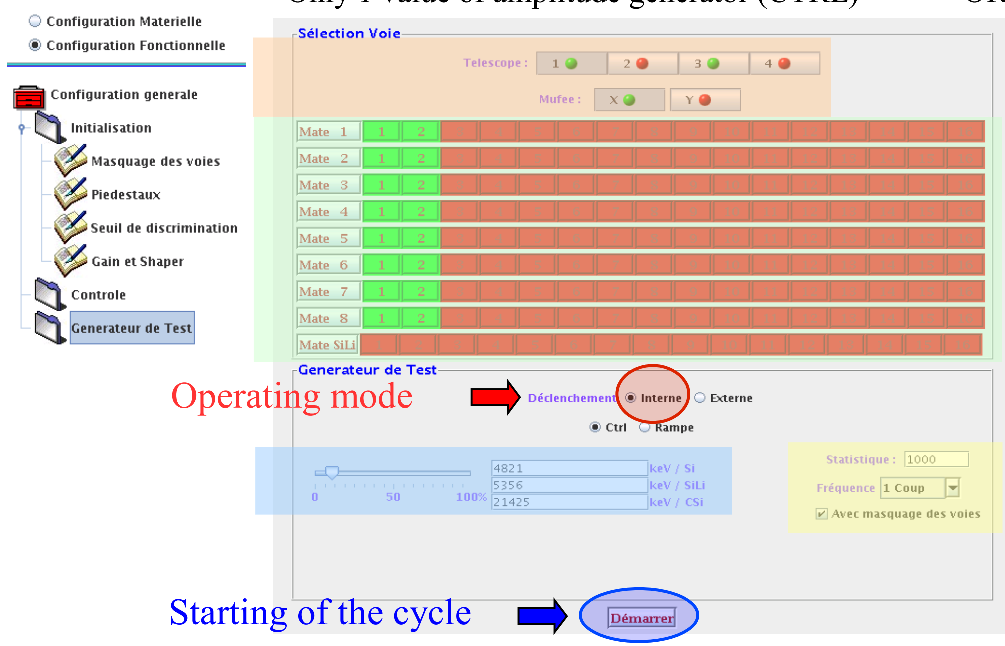
CALIBRATION of ENERGY by internal generator

This function allows the injection of test charges from the internal generator located on each MUFEE card, that only for one amplitude (CTRL) or N equidistant values of amplitude (SLOPE). This procedure can be specific (1 blow) or repetitive (all 3 min, 1H...). Switching of the various channels in test are carried out in an automatic way.

Only 1 value of amplitude generator (CTRL) OR N value of amplitude generator (SLOPE)



CHOICE of TELESCOPES and MUFEE

DO NOT request the MUFEE X and Y at the same time, because of the difference in polarity between Si detectors of MUFEE X and Y, this remark is identical for SiLi

CHOICE of the MATE channel on which a charge is injected (only one CHANNEL per MATE is requested simultaneously)

CHOICE of the MINIMUM amplitude of test for a slope, CONSTANT for CTRL mode, this value must be > discri threshold

CHOICE of the MAXIMUM amplitude of test for a slope, with the choice of N equidistant values (nb val)

CHOICE of the number of blows for each value of generator (Statistic) and the frequency of occurrence of the cycle.
Only the channels selected in the masking box have their disci enable.

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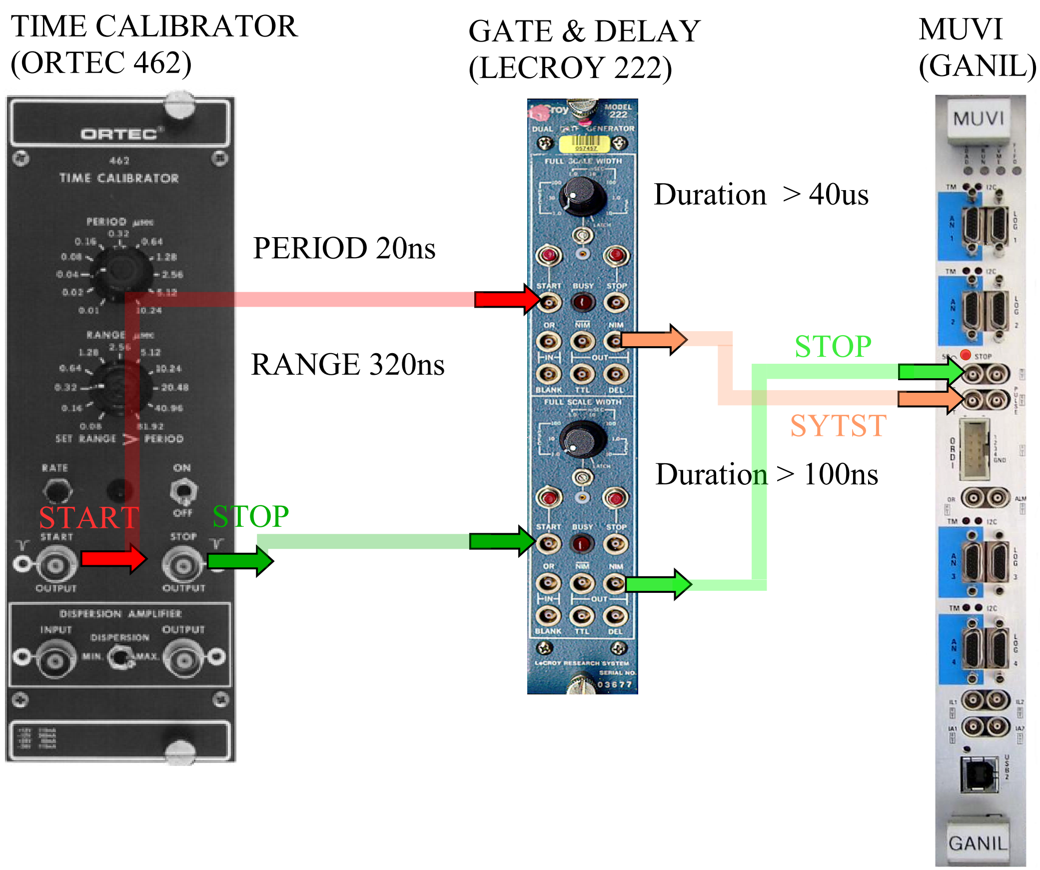
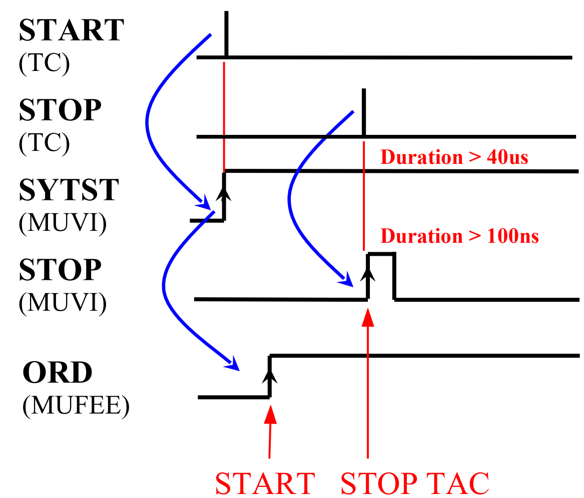
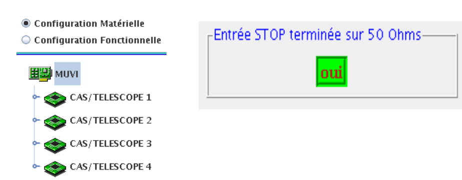
TIME CALIBRATION => PROCEDURE of TIME CALIBRATOR

This functionality uses a TIME CALIBRATOR. A GATE & DELAY module is needed for fitting signals to MUVI inputs



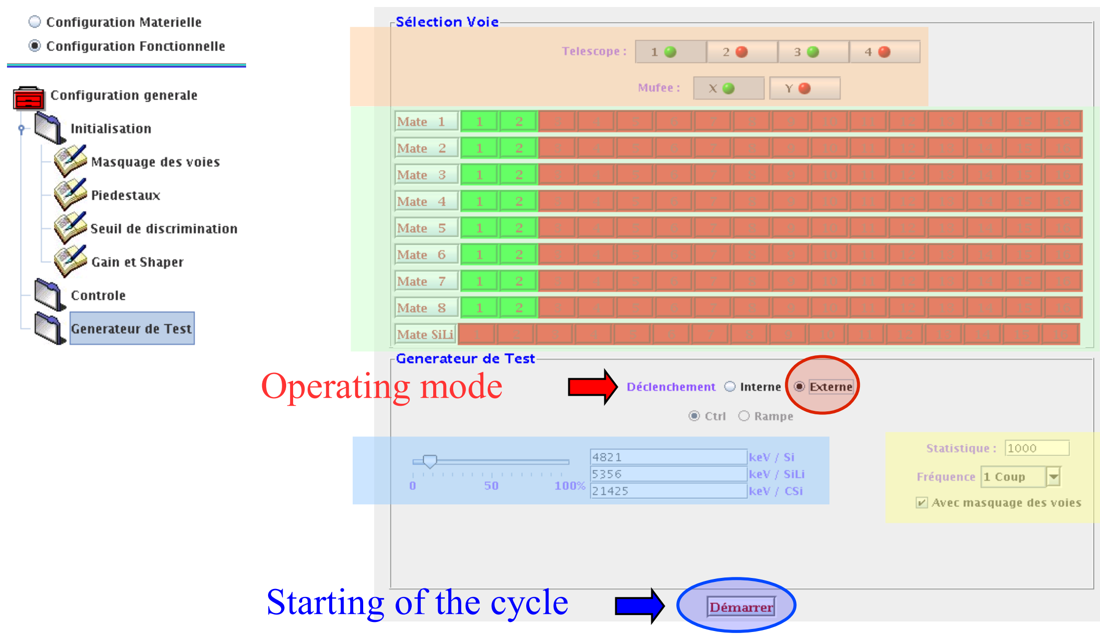


STOP input of MUVI must be loaded on 50 ohms



TIME CALIBRATION by external generator (TIME CALIBRATOR)

This functionality allows the injection of a test charge which starts the TAC of the matching MATE channel.
This procedure can be specific (1 blow) or repetitive (all 3 min, 1H...).
EXTERN means that source of trigger is SYNTST signal from TIME CALIBRATOR



CHECK PV signal.
CAS card is triggered by SYNTST and NOT by ORD

CHOICE of TELESCOPES and MUFEE

DO NOT request the MUFEE X and Y at the same time, because of the difference in polarity between Si detectors of MUFEE X and Y, this remark is identical for SiLi

CHOICE of MATE channels on which a charge is injected (only one CHANNEL per MATE is requested simultaneously)

CHOICE of the test amplitude starting a trigger ORD, therefore a START of TAC this value must be > discri threshold

CHOICE of the number of blows for each value of gene (Statistic) and the frequency of occurrence of the cycle.
Only the channels selected in the masking box have their discri enable.

HT ON for calibration

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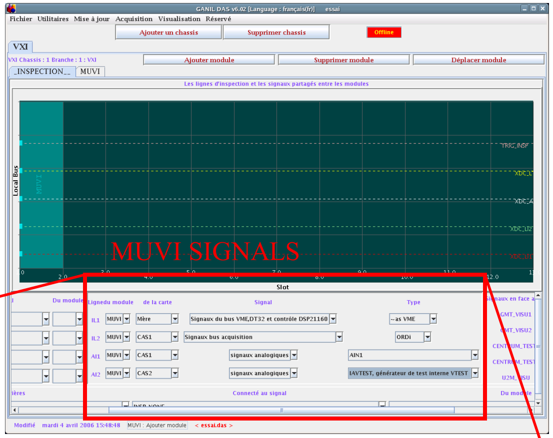
INSPECTIONS LINES

4 lines are implemented for the inspection of MUFEE, MUVI and CAS 1 to 4 signals

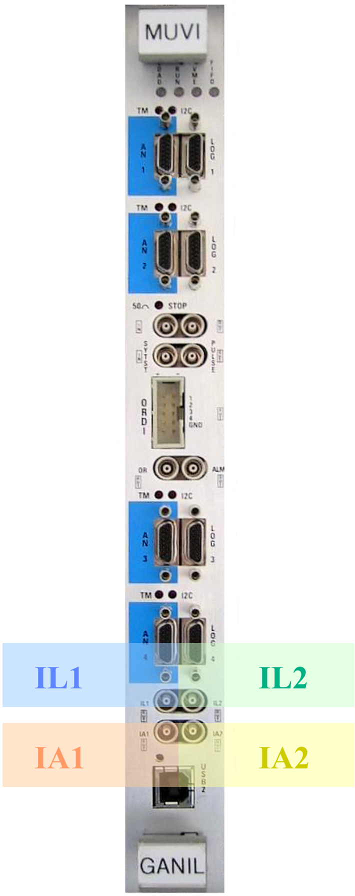
=> IL1 and IL2 numeric signals (ORDi, CK …)

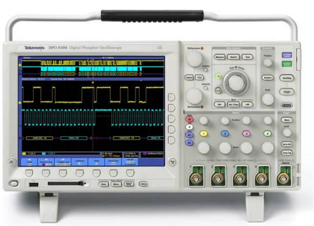
=> IA1 and IA2 analogic signals (ANi …)

INSPECTION PART



Ligne	du module	de la carte	Signal	Type
IL1	MUVI	Mère	Signaux du bus VME,DT32 et contrôle DSP21160	~as VME
IL2	MUVI	CAS1	Signaux bus acquisition	ORDi
AI1	MUVI	CAS1	signaux analogiques	AIN1
AI2	MUVI	CAS2	signaux analogiques	IAVTEST, générateur de test interne VTEST





To display NIM (0, -800mV) signals on the oscilloscope, end line on 50 Ω

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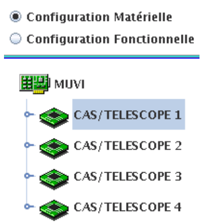
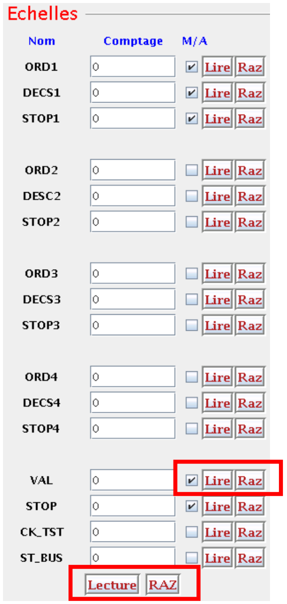
SCALERS





SCALERS

ORDi: TELESCOPE i « physical » trigger
DECSi: validated ORDi
STOPi: conditioned stop of TAC of TELESCOPEi (END of RANGE included)

.

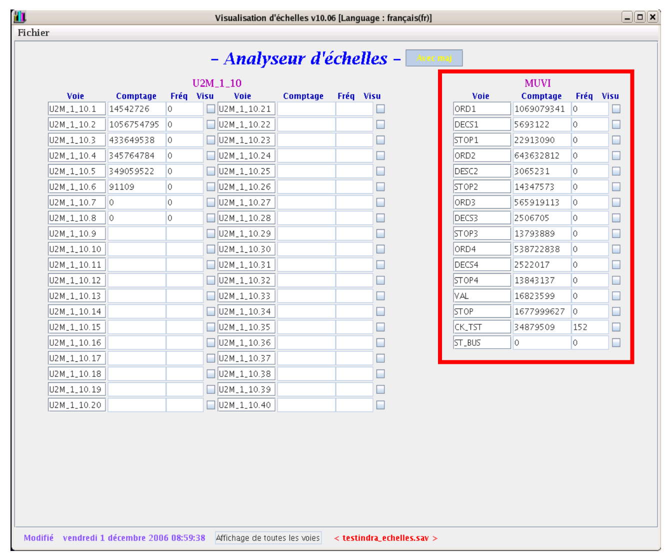
.

VAL: TRIGGER validation
STOP: common STOP of MUVI TAC
CK_TST: internal source of MUVI trigger
ST_BUS: source of trigger coming from GAMER

Individual READOUT of a scaler (notch RUN/STOP of the scaler)

General READOUT of all the scalers

AUTOMATIC READOUT
of all the scalers



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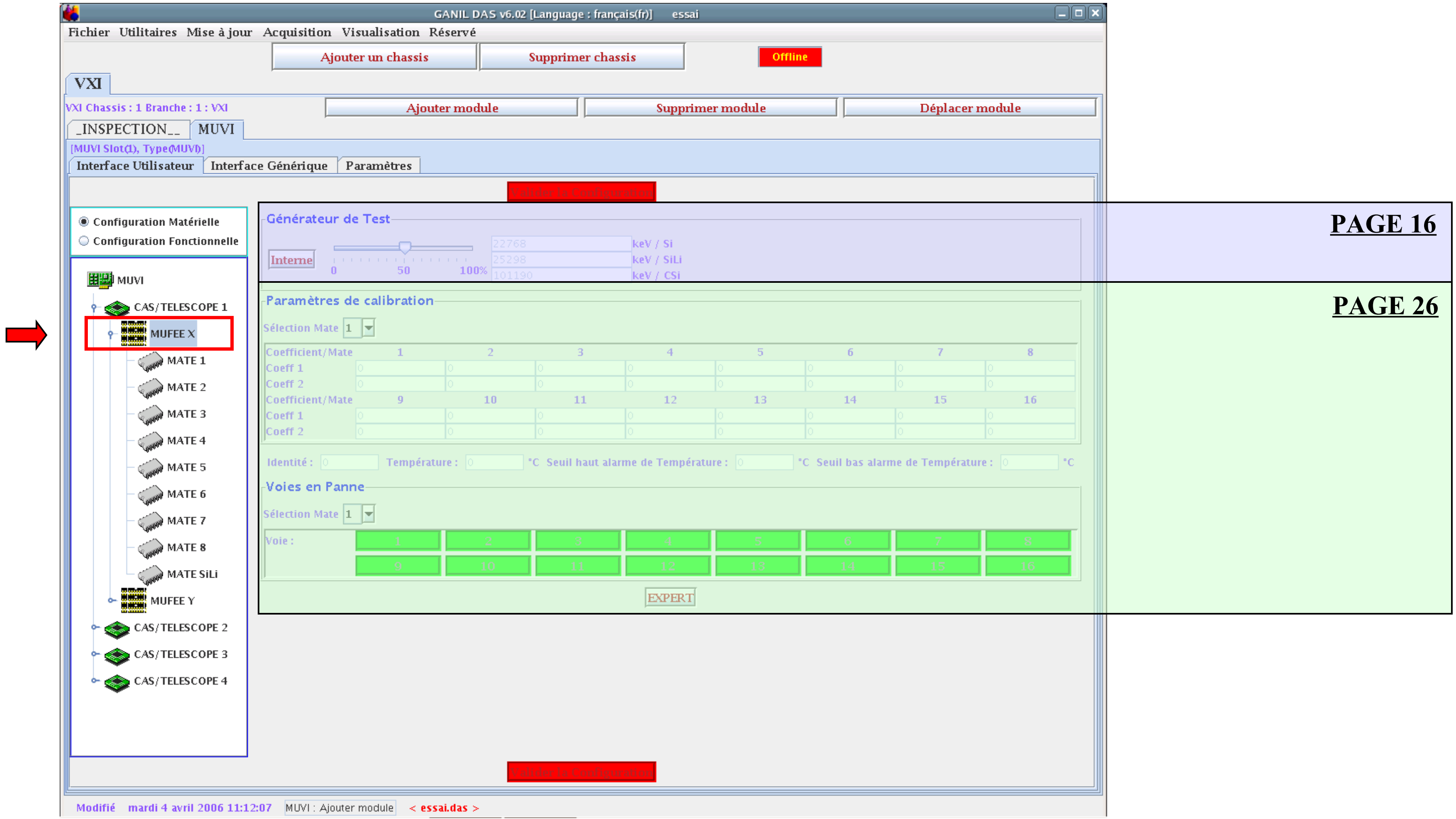
DAS GUI => MUFEEs SETUP



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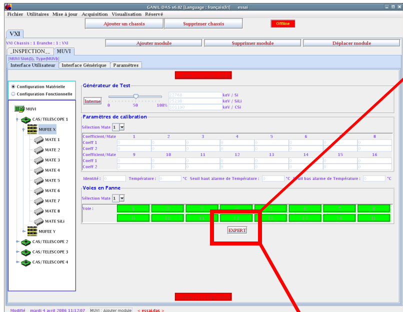
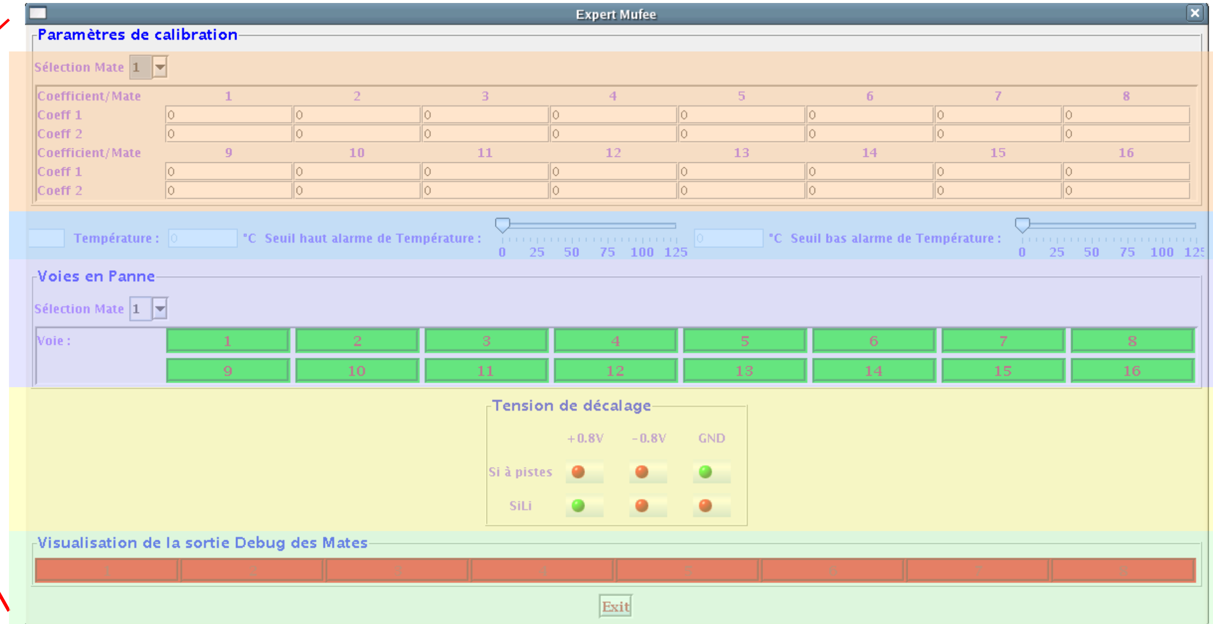
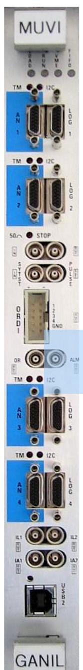
DAS GUI => MUFEEs SETUP => EXPERT







ALM

In a non volatile memory for MUFEE cards storage of a and b calibration coefficients (equation of the non linearity correction : $y=ax+b$)

When the temperature of a MUFEE card exceeds the HIGH threshold, ALM signal is ASSERTED. ALM is DEASSARTED once the temperature goes down below of the LOW threshold (hysteresis)

History of the broken channels, stored in non volatile memory in MUFEE card

Shift of the numerical values => +0.8V (2000) -0.8V (14000) GND (8000)
default values: strips Si GND SiLi (IPN) +0,8V SiLi (JULICH) GND and CsI GND

Choose the MATEs channel (signals CHOICE: SEE page 23), visualization of the signals connected directly to MUFEE, independently of MUVI

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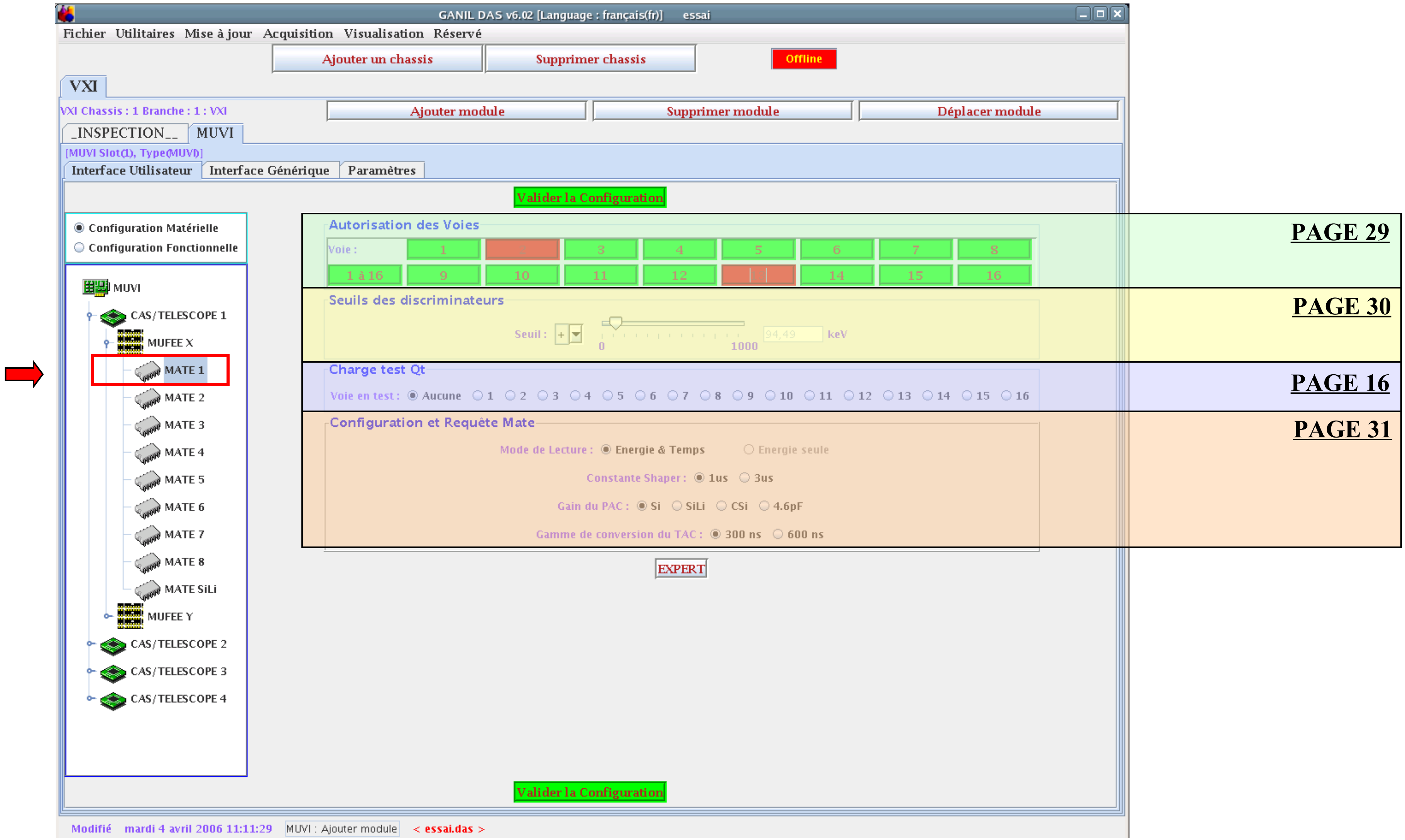
DAS GUI => MATEs SETUP



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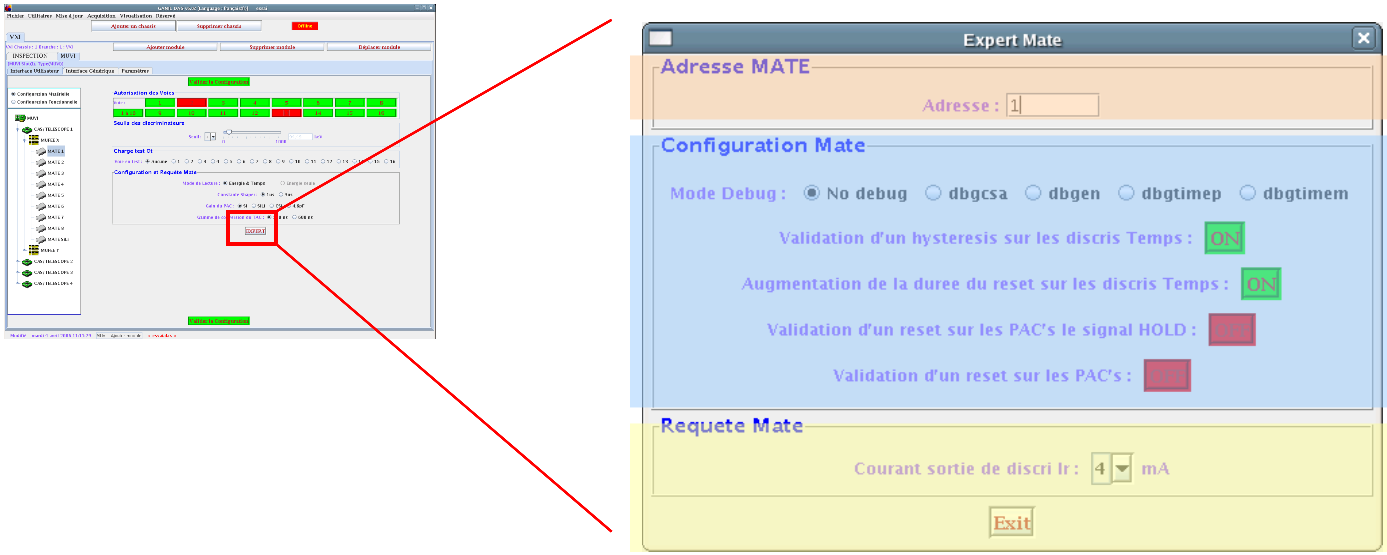
DAS GUI => MATEs SETUP=> EXPERT



single address of MATE DO NOT MODIFY

Choice of the DEBUG signals, only for the channel number 16
<u>example:</u> dbgcsa, signal of the CSP output …
SEE DOC of the MATE ASIC for more details

Must be of 4mA DO NOT MODIFY

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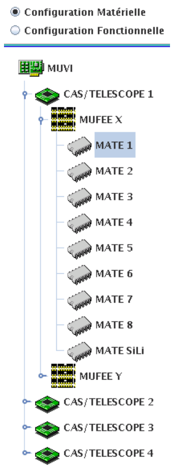
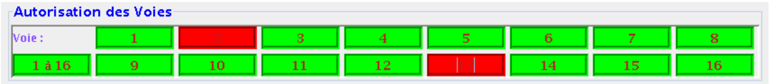
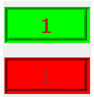
DAS GUI => MATEs SETUP => INITIALIZATION => MASK

=> From the HARDWARE CONFIGURATION view, individual mask of the channels one MATE at a time





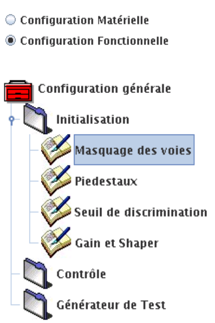


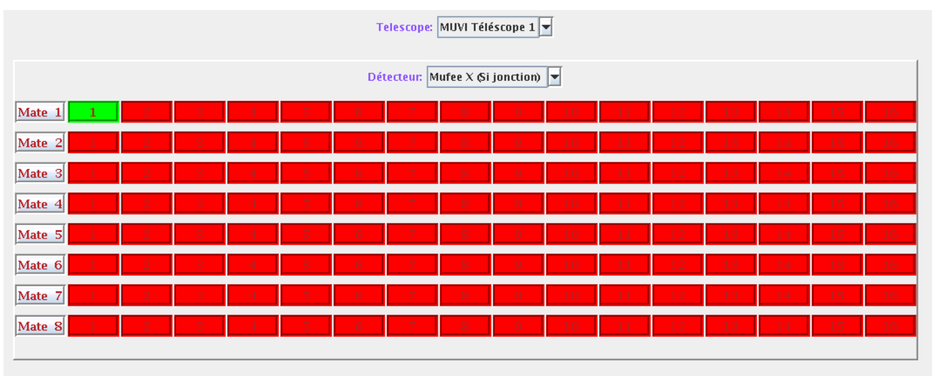
Channel authorized

Channel masked

OR

=> The comprehensive view (FUNCTIONAL CONFIGURATION) give the possibility to mask some channels per MATE, or the whole channels of a MATE or the whole channels of the telescope





Right click options of masking

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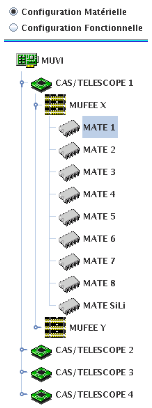
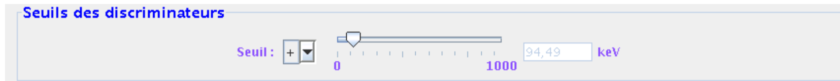
DAS GUI => MATEs SETUP => INITIALIZATION => DISCRI THRESHOLD

=> From the HARDWARE CONFIGURATION view, set of the trigger threshold of the MATE channels One MATE at a time (1 threshold per MATE adjustable in energy and polarity)





OR

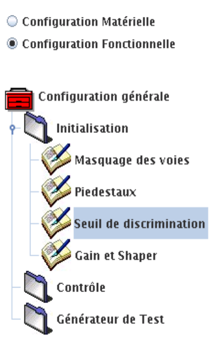
Thresholds polarity with "PHYSICS":

+ Si MUFEE X
- Si MUFEE Y
- SiLi (IPN)
+ SiLi (JULICH)
- CsI

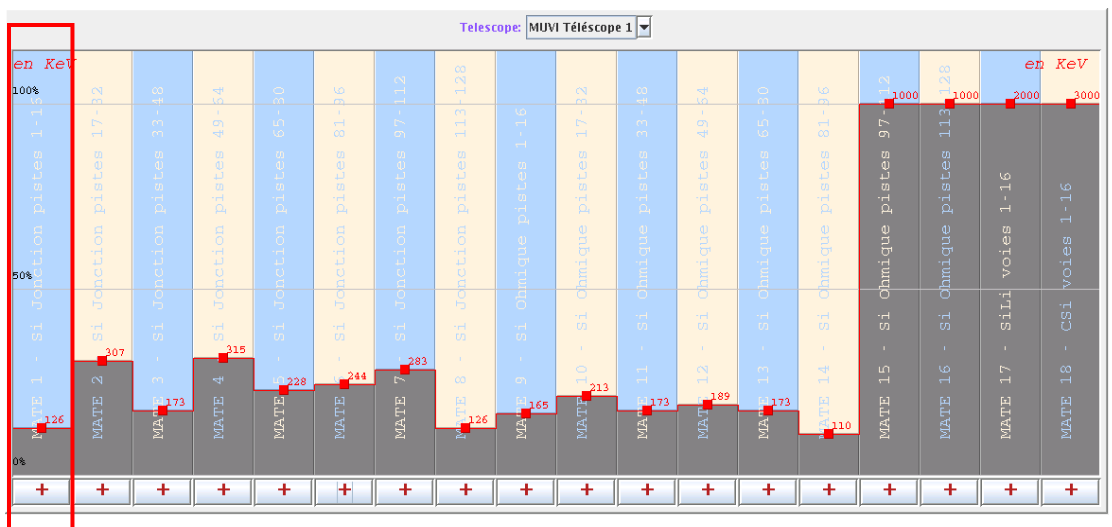
Thresholds polarity with TEST GENERATOR

+ Si MUFEE X
- Si MUFEE Y
- SiLi (IPN)
+ SiLi (JULICH)
- CsI

=> Synthetic vision (FUNCTIONAL CONFIGURATION) of the channels of MATEs in order to set a threshold for one MATE at a time or for the TELESCOPE



MATE1



Threshold

Polarity

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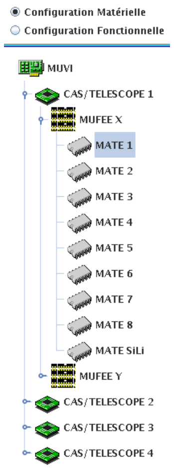
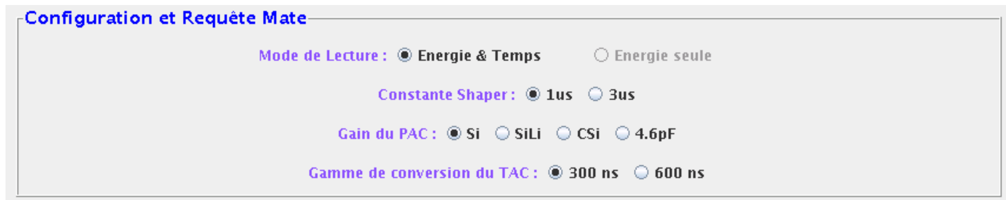
DAS GUI => MATEs SETUP => INITIALISATION => GAIN and SHAPER

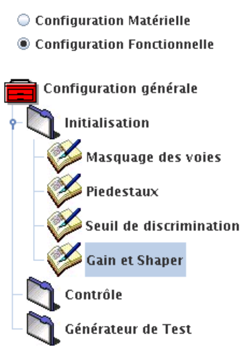
=> From the HARDWARE CONFIGURATION view, set the values of the SHAPING constant and the CSP (one MATE at a time)

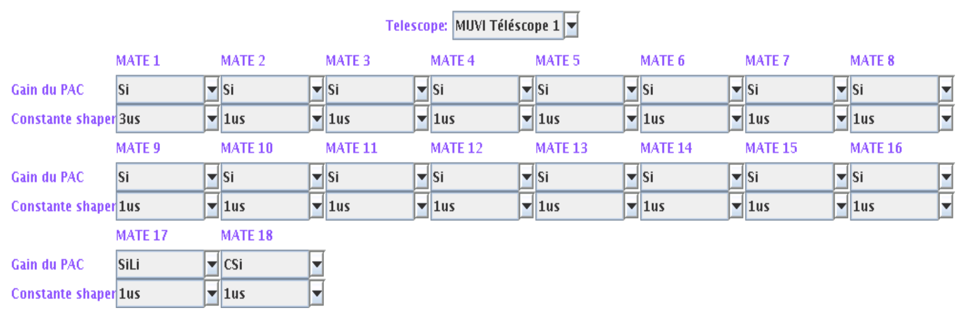




OR

=> The synthetic view (FUNCTIONAL CONFIGURATION) shows both parameters (shaping and gain) of the MATEs in a TELESCOPE





SEE DOCUMENT on the MATE ASIC (CEA/DAPNIA) for more details about these parameters.

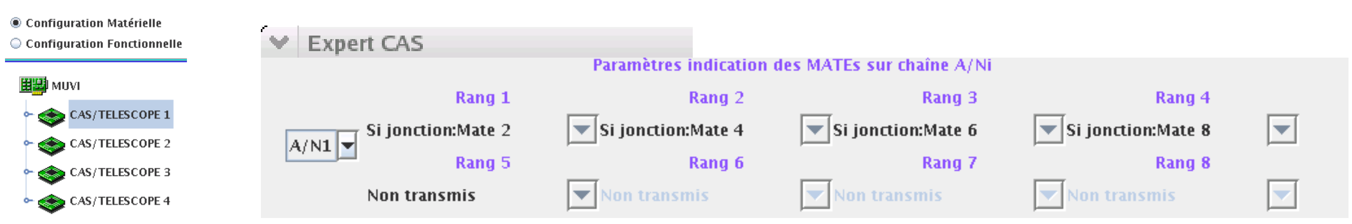
APPENDIX
A) ANALOG CHAINS of MATEs

1 MATE => 16 CHANNELS with 32 parameters (alternatively E and T…)

MATE 1 to MATE 16 => linked to detector Si
MATE 17 => linked to detector SiLi
MATE 18 => linked to detector Csi

AN1	2	4	6	8		=> 32 x 4 = 128 parameters	=> MUFEE X
AN2	1	3	5	7	17	=> 32 x 5 = 160 parameters	=> MUFEE X
AN3	9	11	13	15	18	=> 32 x 5 = 160 parameters	=> MUFEE Y
AN4	10	12	14	16		=> 32 x 4 = 128 parameters	=> MUFEE Y

total 576 (E and T parameters) for 1 telescope
2304 (E and T parameters) for 4 telescopes



DO NOT MODIFY This set of analog chains corresponds to the physical order of MATEs cabled on the MUFEE X and Y cards

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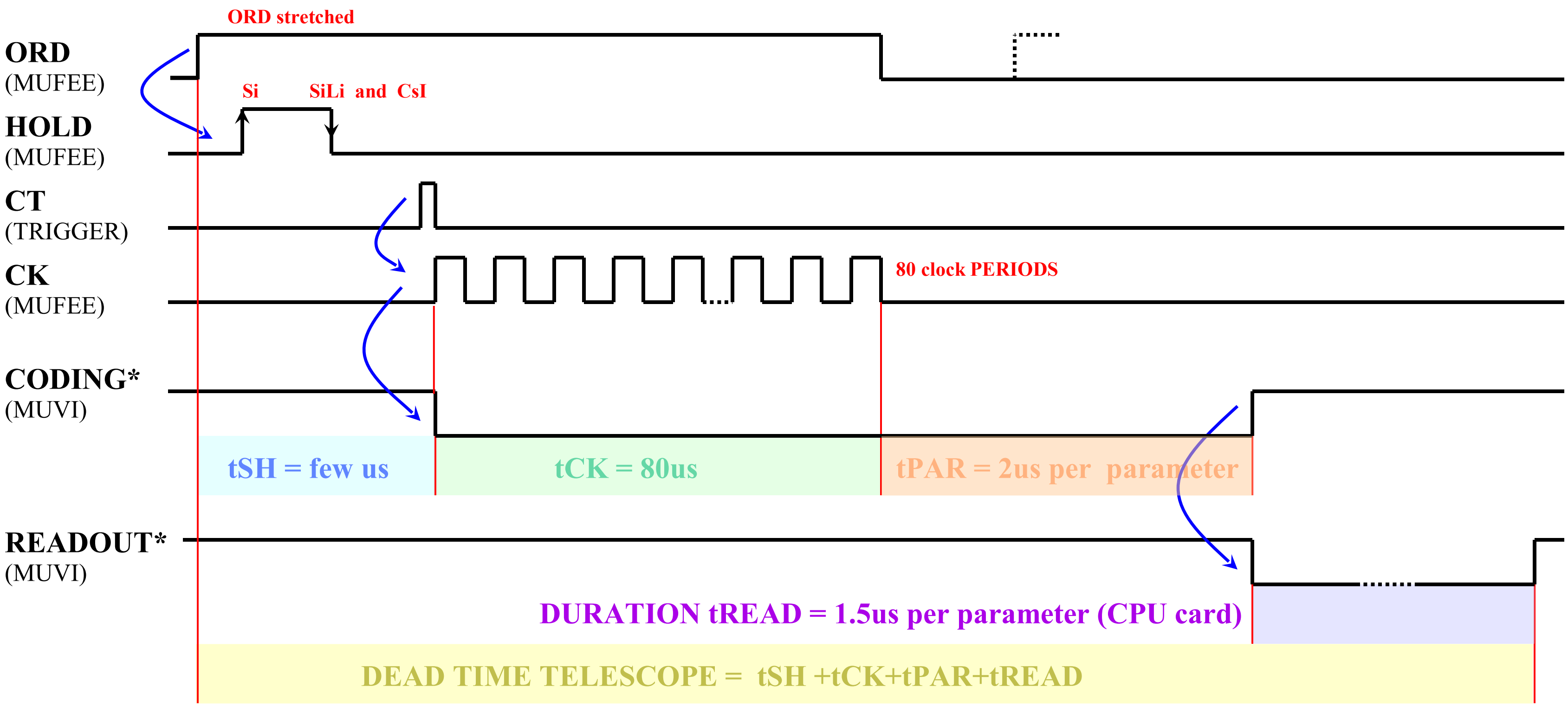
APPENDIX
B) RECKONING of MUVI-MUFEE DEAD TIME



=> <u>EXAMPLE:</u> for one TELESCOPE WITHOUT compression (=> readout of 576 parameters)
tCODING (tCK + tPAR) = 1.2ms and tREADOUT (tREAD) = 860us => TM = 2 ms

WITH compression (=> readout of 10 parameters)
tCODING (tCK + tPAR) = 100us and tREADOUT (tREAD) = 15us => TM = 115 us

The tREAD readout time is drastically reduced with the implementation of the FAST READOUT ENGINE running in the GAMER module: tREAD goes down to 200ns per parameter

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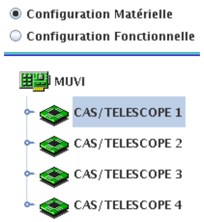
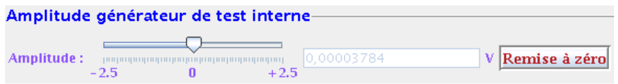
APPENDIX
C) ADDITIONAL FUNCTIONS



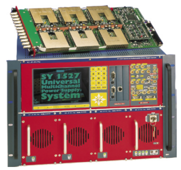


Extra OFFSETs for the 4 ADC chains of a telescope (null value = 0 V)

This generator is implemented in each CAS card and has nothing to do with the inner test generator of MUFEE card

APPENDIX
D) START PROCEDURE (HARDWARE)

1) POWER CAEN (ON for all LOW VOLTAGEs)

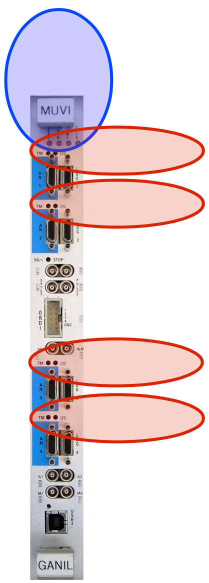


ERROR

<u>CHECK:</u>
LV & HV cables (inner and outer)
LV cards , overload, overvoltage.
Status of the KILL signal (front panel)
connection box

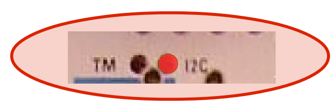
OK

2) BOOT VXI crate with MUVI card (all MUVI-MUFEE cables are connected)



<u>TURN OFF/ON the crate</u>
IF PROBLEM contact technical group GAP/GANIL

BOOT MUVI card
- **programmable components loaded**
- **acquisition in STOP**



<u>CHECK:</u>
LV are ON
LV and HV cables

- **No DEAD TIME (Temps Mort) on this Telescope**
- **i2C not actif**

TO SOFTWARE START PROCEDURE

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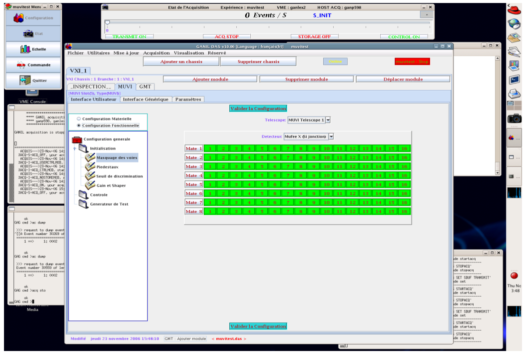
APPENDIX

E) START PROCEDURE (SOFTWARE)

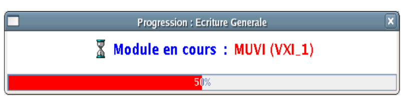
3) SETUP of HARDWARE with DAS

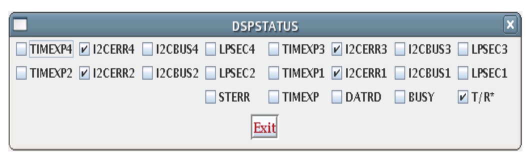


OPEN file your_manip.das

Connect DAS to the hardware (VME)

Write hardware registers





NO error
START acquisition

<u>CHECK:</u>
EXTERNAL and INTERNAL MUVI-MUFEE cables of the telescope having an I2C error
LV power (static values)

IF PROBLEM, contact technical group GAP/GANIL

I2c ERROR: NORMAL when one or more telescopes are not linked to MUVI card
START acquisition

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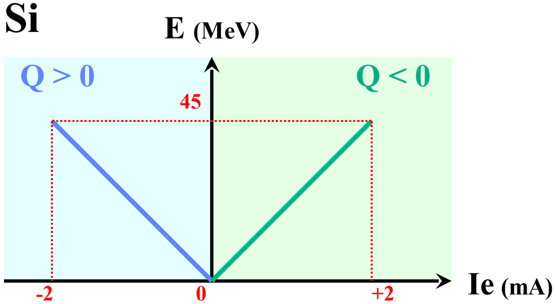
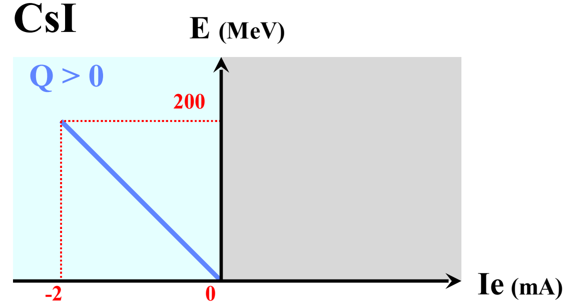
APPENDIX
F) ENERGY TRANSFER FUNCTIONS of Si and CsI detectors

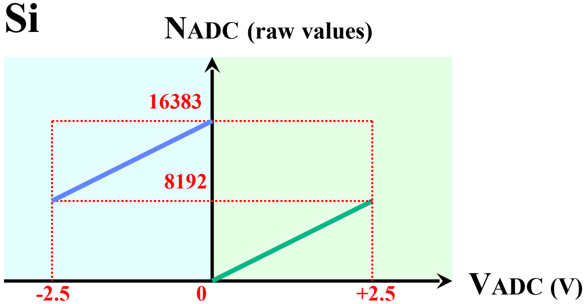
Si



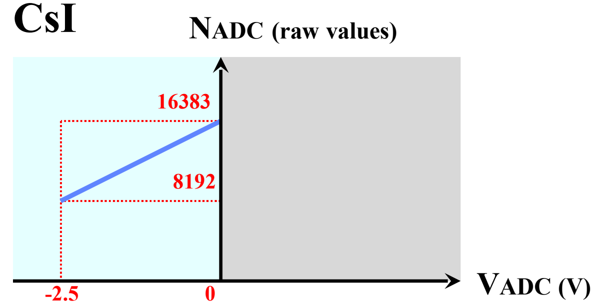
CsI



Si

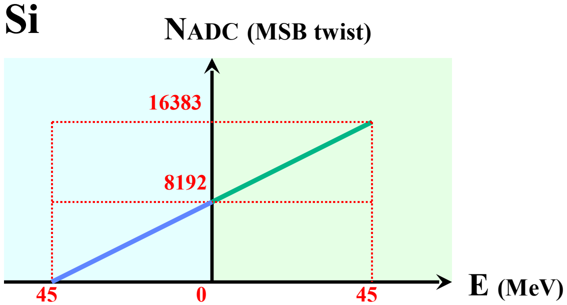


CsI

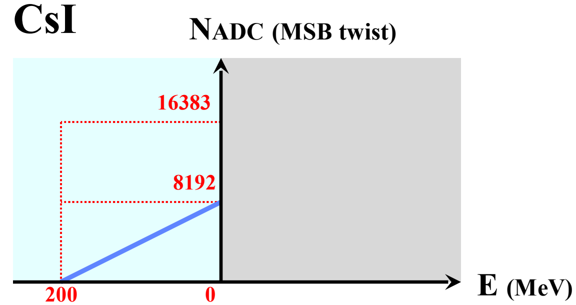


TRANSFER FUNCTIONS implemented in MUVI

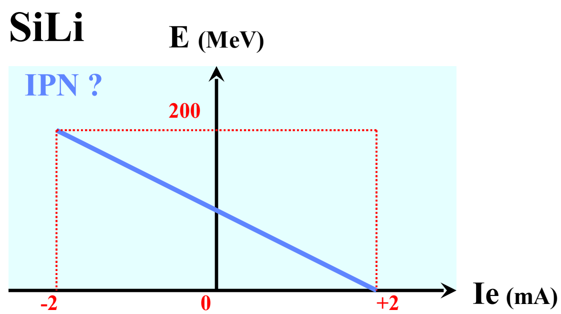
Si

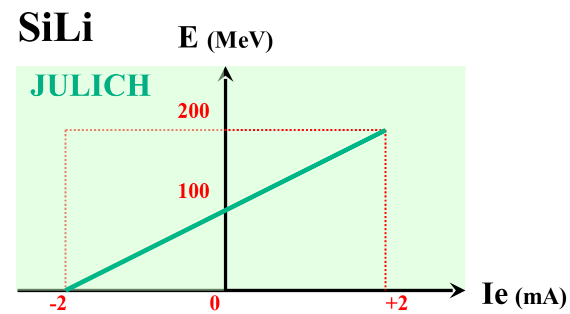


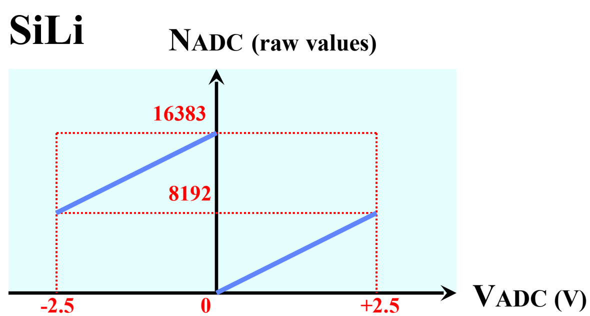
CsI

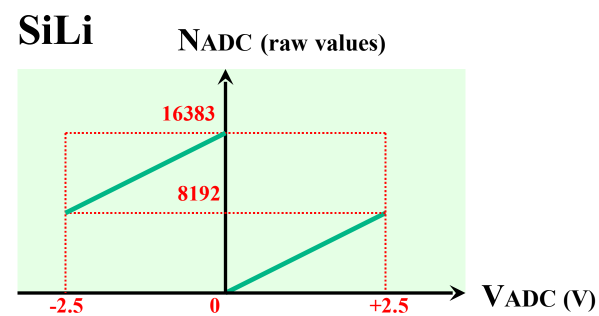


APPENDIX
G) ENERGY TRANSFER FUNCTIONS of SiLi detectors

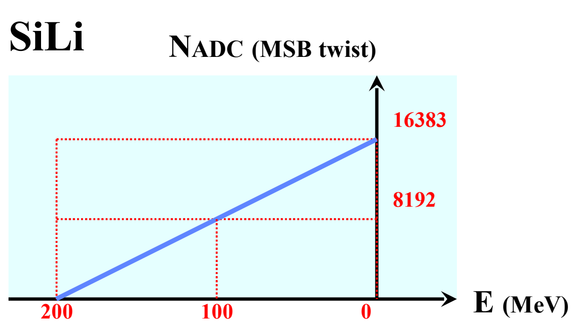


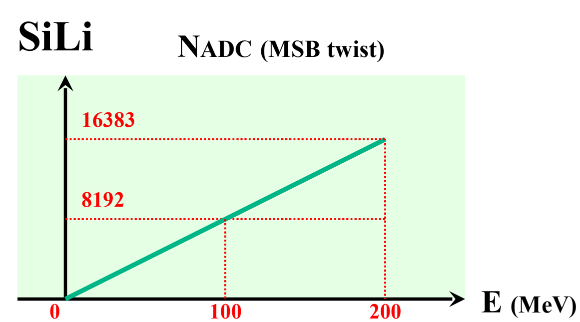






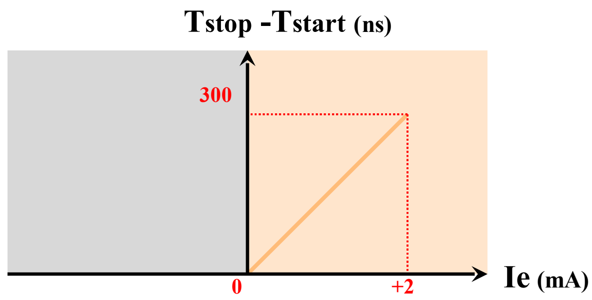
TRANSFER FUNCTIONS implemented in MUVI

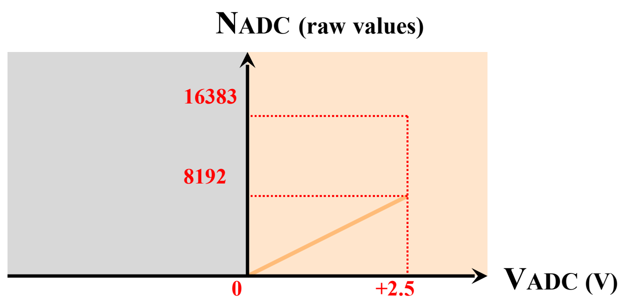




APPENDIX

H) TIME TRANSFER FUNCTIONS of Si, CsI et SiLi detectors





TRANSFER FUNCTIONS implemented in MUVI