ACTIVITIES REPORT

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Introduction

The activities development during my stay at CERN was in the ACORDE (A Cosmic Ray Detector) detector and the installation of the system for the calibration of the TPC (time projection chamber) using cosmic rays in the surface.

The first task was the preparation of the programs for the ACORDE electronics system used for the TPC calibration. This includes the design, construction and installation of the electronics and also the development of the programs for the generation of the trigger signals.

The next step was the development of some programs for the ACORDE detector in the cavern and after this, the generation of the final version of the electronics system for ACORDE. Some tests were done for the communication with the TTC (time, trigger and control), the DAQ (data acquisition system), the trigger generation and the development of the programs to control the states and modes of the ACORDE detector.

The last task was the installation of the ACORDE structure on top of the magnet at point 2. This includes also some test to the modules after the installation in the structure.

ACORDE (TPC calibration in the clean room)

Before the installation inside of the magnet, the TPC will be tested with cosmic rays using 20 ACORDE modules. One ACORDE module consists of 2 plastics and 2 photomultiplier (PMT).

In the figure 1 is showed the array installed for send a trigger signal in the clean room at point 2.

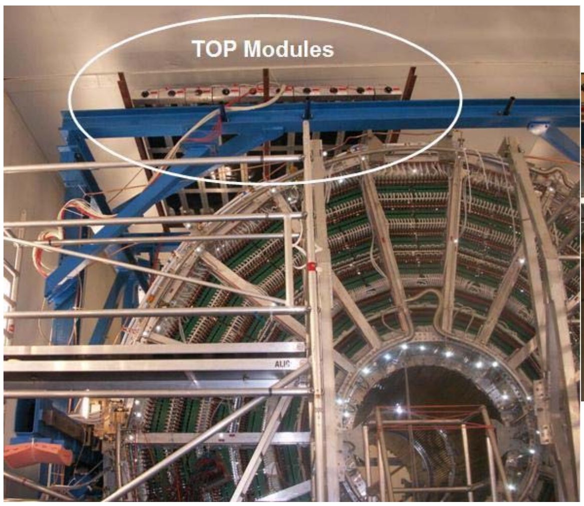

Figure 1: ACORDE modules for the calibration test.

The system consists in 10 ACORDE modules on the top of the DELPHI frame and other 10 modules under the TPC. This is because when a cosmic ray crosses the TPC with a special direction, the ACORDE electronics will generate a trigger signal if this coincide whit the selected modules. These modules will be selected by a special program in Labview called user interface (Figure 2).

The purposes of this user interface consist in activated specifics ACORDE modules with just selecting in the screen. If we wish select the first top module we just have to click in the TM1 bottom, this bottom will select the modules and will make a coincidence with the bottom module selected. If we just select some top modules without any bottom module, the trigger signal will be unavailable because is necessary give the specific trajectory to generate the signals and in the same way for bottom modules selected without any top module selected.

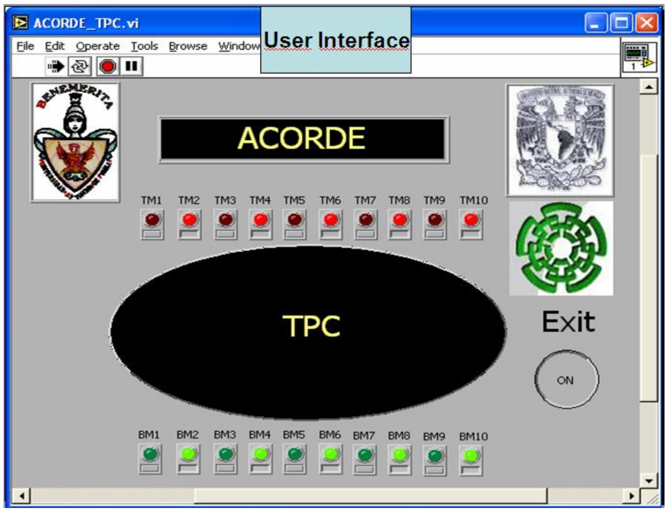

Figure 2: ACORDE Labview program (user interface).

The block diagram for the electronic system is showed in the Figure 3.

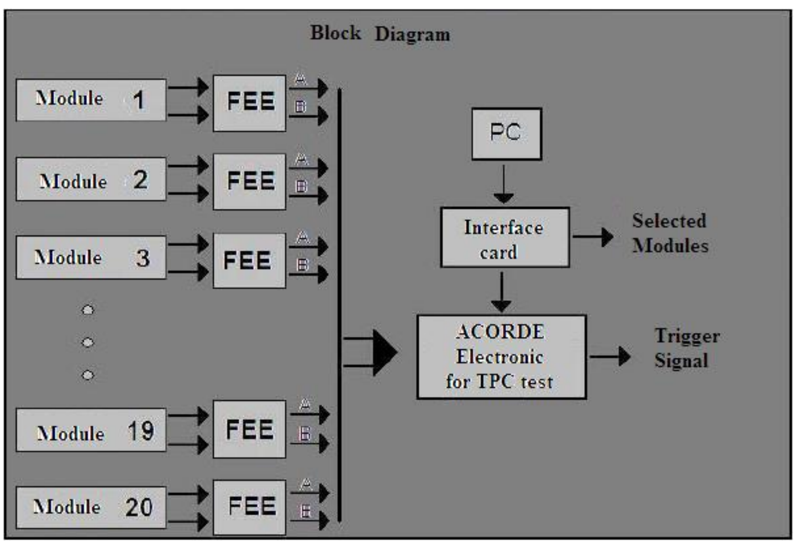

Figure 3: Electronic block diagram.

Each ACORDE module has a front end electronic (FEE) this FEE has 2 discriminators, one for each PMT and send one signal when a cosmic ray pass through the module and is detected for the PMT. The ACORDE electronic compare the information of every plastic of the top and bottom modules and if some have the characteristics selected in the user interface then a signal trigger is send. This signal is also send in LVDS and has a width of 120 ns.

The figure 4 shows the electronic system used for this task.

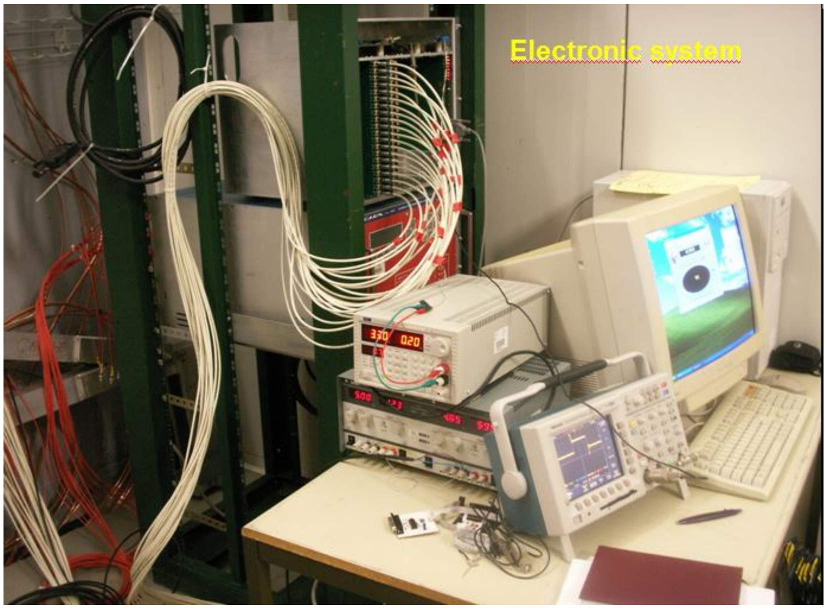

Figure 4: Electronics system for the calibration.

The system consists in one computer for the user interface to select the modules. 2 low voltage power supply for the FEE and the ACORDE electronics and 1 hight voltage power supply for the PMT. This system has been working since may 1st.

ACORDE Electronics

The electronic system of ACORDE was made in México and the test of the DAQ and TTC systems were done at CERN. The mainly task was connect the ACORDE electronic with the TTC and DAQ to check the programs and make the necessaries changes.

The work consists in ensemble the complete system for the trigger. This system is formed by 4 different cards: The LTU (local trigger unit), the TTCex, the TTCvi and finally the VME processor. The system in showed in the figure 5.

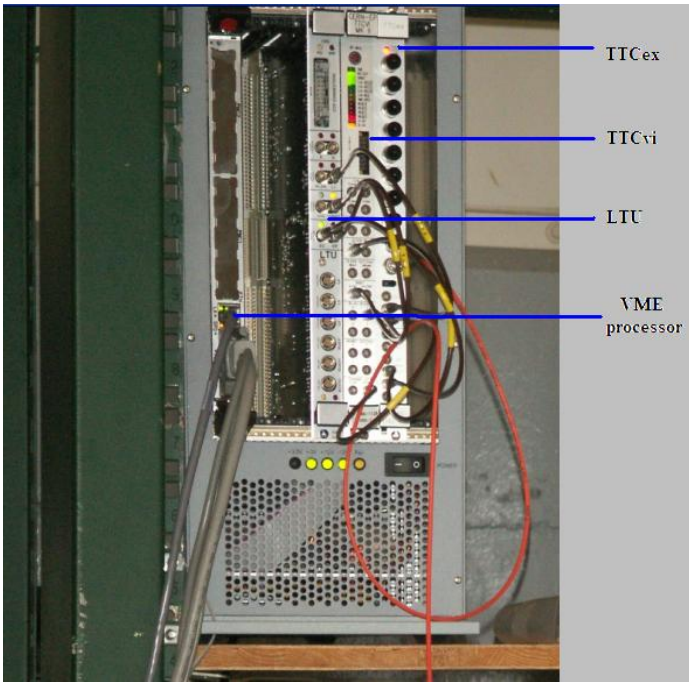

Figure 5: Trigger system

Also this work involved the installation of some programs to control and send the message, the most important was the CTP emulator. This program was installed with the help of Orlando Villalobos and Anton Jusko from the trigger group.

The other system installed for the ACORDE test was the DAQ. This is the way in witch the detector will send to save the information. In figure 6 we show the DAQ computer for ACORDE.

This computer contains the RORC and DIU cards. These cards are the responsible for the communication between the ACORDE detector and the DAQ system. For the other side, we need a SIU car to send the information trough the DDL (data detector link).

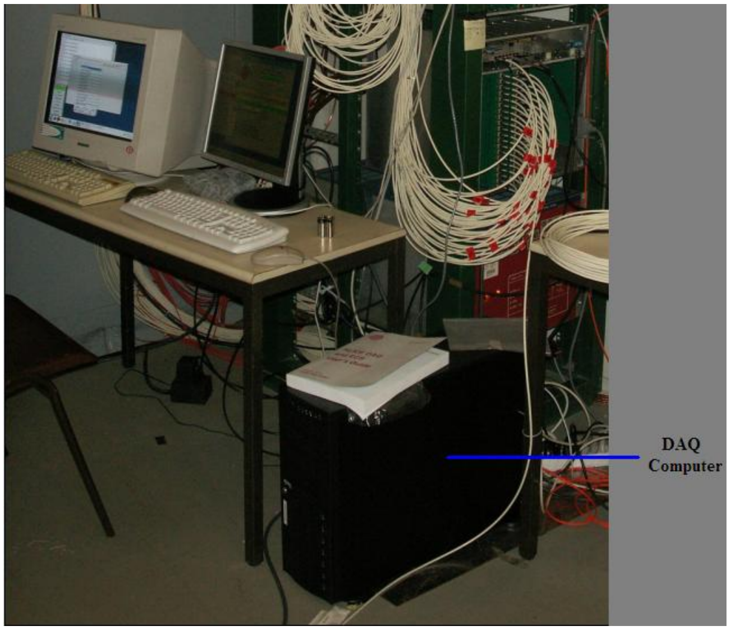

Figure 6: DAQ computer for ACORDE.

The SIU card is installed in the main board of ACORDE electronics. This card sends the information to the DIU card and also we can send commands from the DAQ computer to the ACORDE electronics (figure 7).

If we transfer data from ACORDE to the SIU then it is a status word, otherwise it is a command.

There are two standards front-end commands (FECMDs): Ready to Receive (RDYRX) and End of block Transfer (EOBTR).

And event data transmission transaction can be opened by using a RDYRX command. The RORC may only send this command to ACORDE through the DDL, when it is ready to receive event data. When ACORDE receives this command, it shall transfer an event data block to the SIU after the reception of a L2-acceted signal from the trigger signal.

The figure 8 show the screen when the computer receive data from the ACORDE electronics after the receiving a L2-accepted signal.

ACORDE send 10 words to the DAQ through the DDL. The first 8 words are the data header and the last 2 words are the information of the 60 modules, this information is the number of modules crossed for muons.

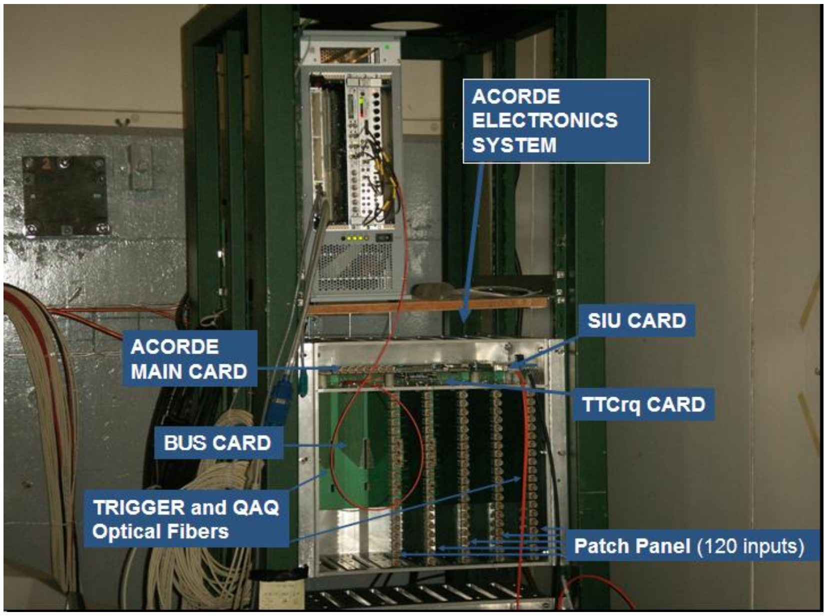

Figure 7: Array for the ACORDE electronics test.

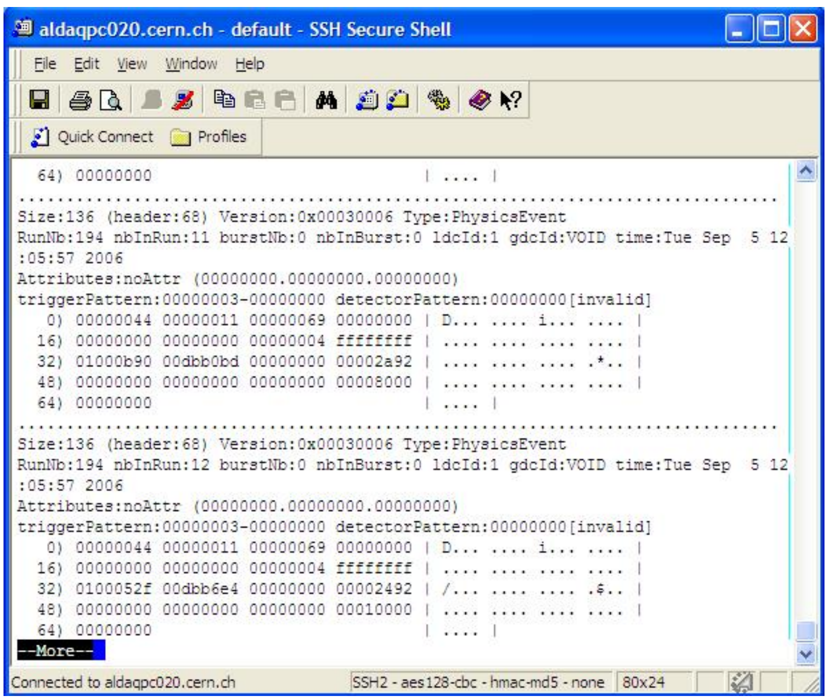

Figure 7: Data from ACORDE

ACORDE can be controlled by using FECTRL commands. Each address represents an independent control function. Also we used a FESTRD command to read-out status words from ACORDE. In figure 8 we can see the front end commands.

D31	D30 D12	D11 D8	D7	D6	D5	D4	D3	D2	D1	D0	data bits
	PARAMETER FIELD	IDENTIFIER FIELD	CODE FIELD				DESTINATION FIELD				command fields
X	FEE address	transaction ID	WRITE	UD	CLOSE	BTR	reserved	FEE	SIU	DIU	FECMD
X	is not used	transaction ID	0	0	0	1	0	1	0	0	RDYRX
X	is not used	transaction ID	1	0	1	1	0	1	0	0	EOBTR
X	address in FEE	transaction ID	1	1	0	1	0	1	0	0	STBWR#address
X	address in FEE	transaction ID	0	1	0	1	0	1	0	0	STBRD#address
X	address in FEE	transaction ID	1	1	0	0	0	1	0	0	FECTRL#address
X	address in FEE	transaction ID	0	1	0	0	0	1	0	0	FESTRD#address

D4: block transfer
D5: close block transfer
D6: user defined command
D7: write/read operation

Figure 8: Front end commands.

ACORDE is controlled and configured by using some Front-end Control and Configuration (FeC2) programs via the DDL. It download commands and data blocks to ACORDE and it also reads status and data blocks.

ACORDE needs 3 states: FREE, READY and DATA TAKING and also 2 modes: synchrony and normal.

FREE: State where ACORDE will change the number of multi-coincidence, also start the calibration test.

READY: State where ACORDE will be ready to enable to read some parameters like the multi-coincidence number.

DATA TAKING: State where ACORDE will send data to the DAQ after the L2-accepted signal and will send the L0 trigger signals in the normal mode.

MODE SYNCHRONY: ACORDE will send the LHC clock divided by 2 to the trigger system to synchronize the reception of the trigger signals.

MODE NORMAL: ACORDE will send a 25ns L0 trigger and a 50ns multi-coincidence trigger signal.

Some scripts files following the FeC2 syntax are necessary to control the states and modes of ACORDE: *ACORDE-setcncd.scr*, *ACORDE-ReadCNCD.scr*, *ACORDE-dat-tkng.scr*, *ACORDE-write-time.scr*, *ACORDE-read-calibration.scr* and *ACORDE-Synchro.scr*.

The script *ACORDE-setcncd.scr* sends a command to write the multi coincidence number. This number will be used to generate the multi-coincidence trigger signal when several modules will be crossed at the same time. The figure 9 shows the write command format.

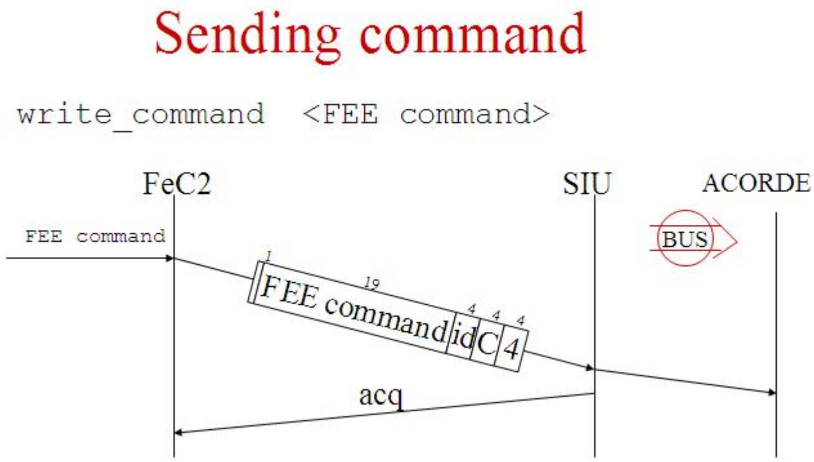

Figure 9: Send a DDL command to ACORDE

To read the multi-coincidence number we have to read this value from ACORDE. To do this we use the script *ACORDE-ReadCNCD.scr*, The picture 10 shows the format to read some values from ACORDE.

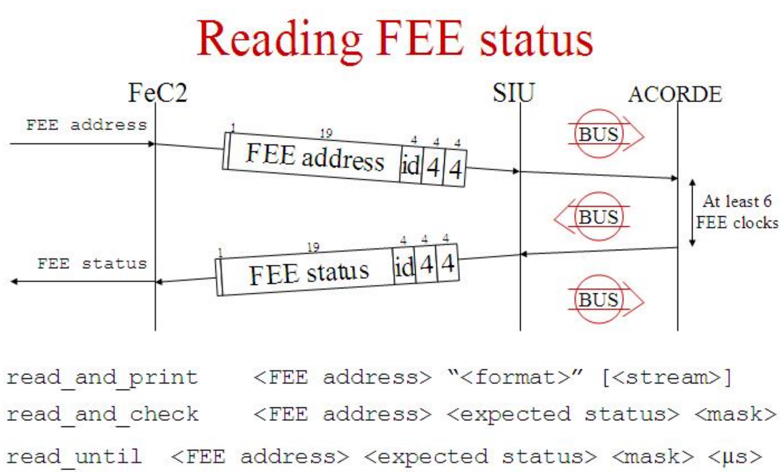

Figure 10: Send a command to ACORDE and print the received value.

The script *ACORDE-dat-tkng.scr* send a command to activate the DATA TAKING states. The picture 11 show the trigger signals L0 (single muon) and ML0 (multi-coincidence muon).

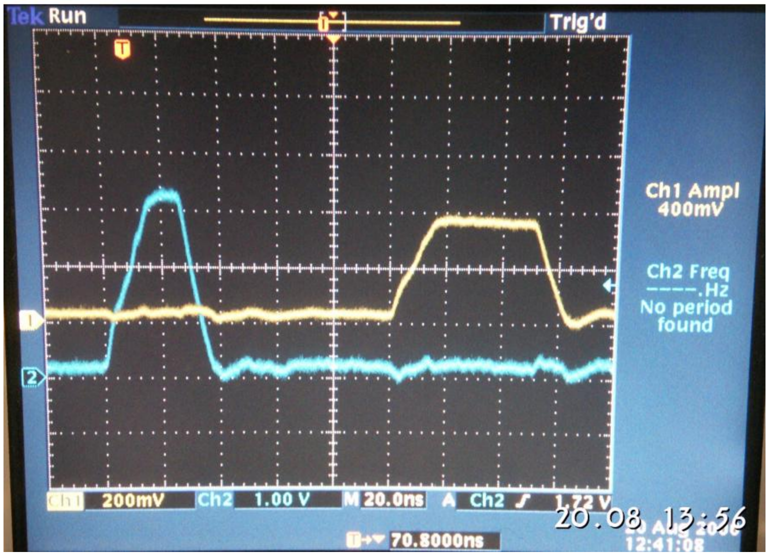

Figure 11: Positive side of L0 and ML0 LVDS trigger signals

The blue channel show the L0 trigger signal and the yellow channel show the ML0 trigger signal. The L0 and ML0 are send in low voltage differential signals (LVDS). The L0 trigger signal is 25ns and the ML0 signal is 50ns.

The ACORDE calibration consist in start a time counter, this time counter will enable 60 counter, one for each module, and we will count all the events in each module during the time calibration. To set the time calibration we use the *ACORDE-Cncdtime.scr* this script sends the time of duration for the calibration.

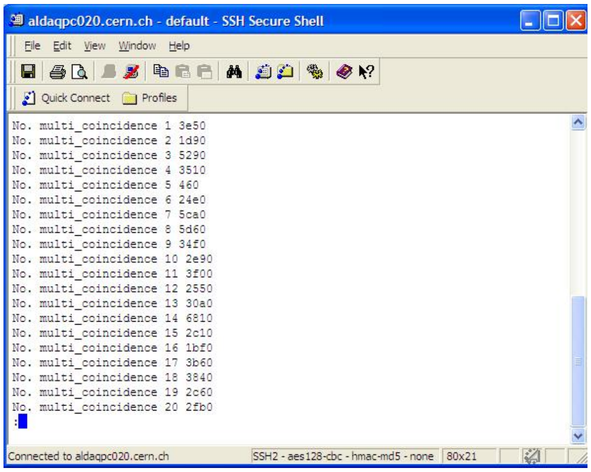

Figure 12: window to display the 60 counter after the ACORDE calibration.

When the calibration finish, all the counter of each module will stop and will keep the value until we send a script to send ACORDE in another state, the time duration is between 1 to 8 minutes and we can select intervals of 30 seconds.

To read the 60 counters we send the *ACORDE-read-calibration.scr* after the time of calibration. This data are saved in the file *cal_cT0X*.

Figure 12 shows the window where we can read the value of the counter after the calibration test.

The final script is *ACORDE-synchro.scr*. This script is used to send a synchronization signal to the trigger system (Figure 13).

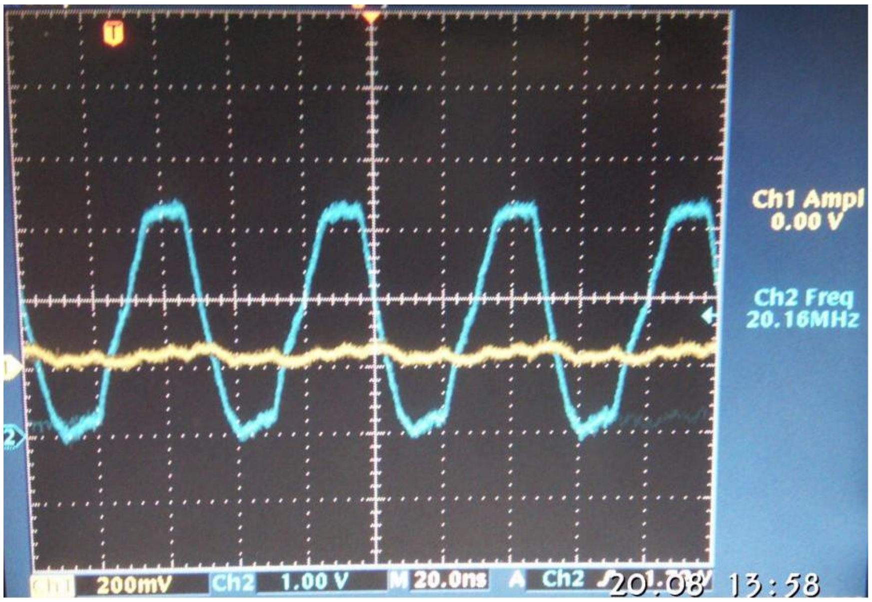

Figure 13: Synchronization signal.

We can see the 20MHz frequency of the signal, also this signal is send in LVDS and here we are seeing in this format.

This shows us, the correct communication between the DAQ, Trigger and ACORDE electronics.

Figure 14 show the final program for ACORDE with the entire configuration described before and also with the results according with the specification.

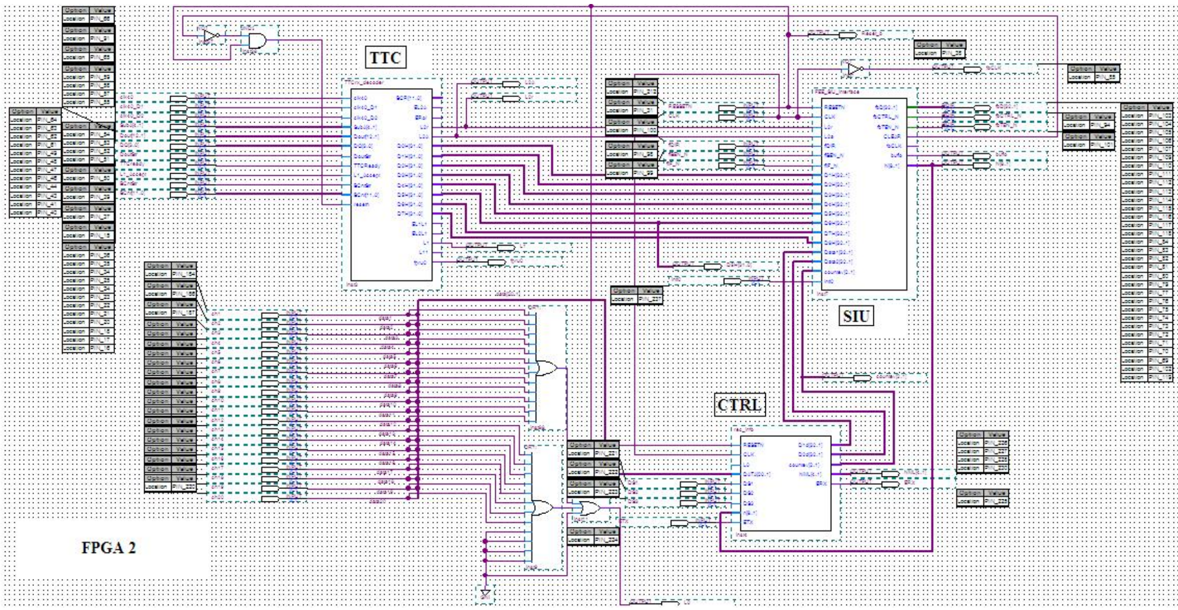

Figure 14: Final version ACORDE firmware.

ACORDE installation

The last task during this stay was the installation of 20 ACORDE modules on top of the magnet at point 2. This consisted in place the structure where the modules will be fixed and after, place the 20 modules and put the cables and connectors.

The figure 15 shows the structure installed with the 20 modules.

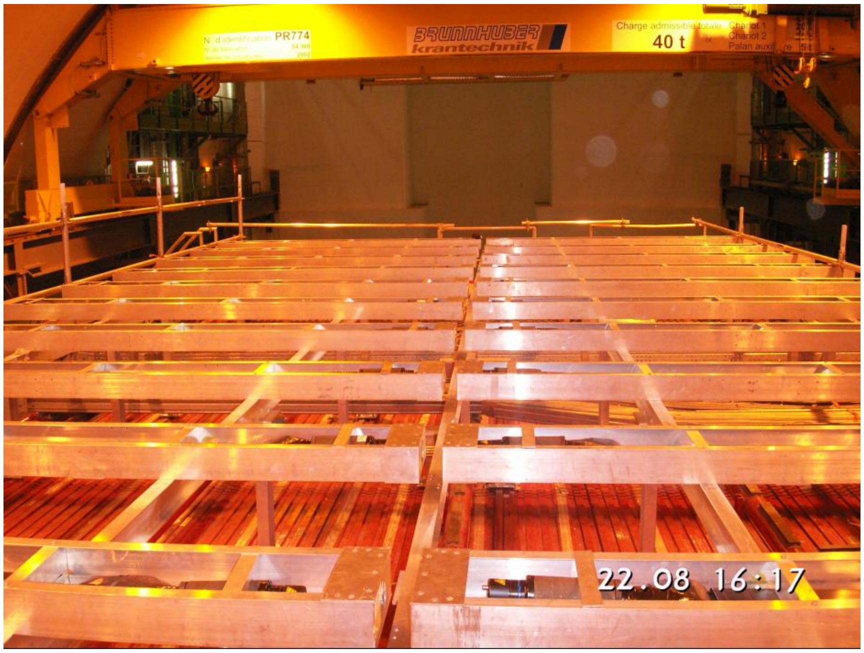

Figure 15: ACORDE structure and modules.

To put the structure was necessary solder several screws to fix the beams. This work required some precision and the surface of the magnet made difficult this work because is not a smooth surface.

The figure 16 shows the high voltage cables with the connectors installed, this was also part of the work for the ACORDE modules installation. There are 60 long high voltage cables from the counting room to the magnet.

The distance for the counting room to the ACORDE rack is 65 meters and from the rack to the more far face of the magnet is 31 meters. It means that we need 20 cables of 96 meters, 20 cables of 90 meters and 20 cables of 84 meters.

Figure 16: High voltage cables in counting room CR4.

For the 20 upper modules were necessary install 40 LVDS cables from the rack to the top of the magnet. Figure 17 show the LVDS cables and the low voltage cables in the rack.

Figure 17: LVDS and low voltage cables.

Figure 18: HV and LVDS cables on top of the magnet.

Figure 18 show the bundle of 60 high voltage and 40 LVDS cables on the magnet. All the cables have the respective connectors and were labeled for the final installation.

CONCLUSIONS

The array placed inside of clean room is still working. Some modifications have been programmed for special trigger condition. After the calibration of the TPC, the modules, structures and electronics will be removed.

The electronic system started to operate the 1st may. Since this date ACORDE has been sending trigger signals for the TPC calibration with any interruption.

The communication with the DAQ system has been tested and all the necessaries modifications have been implemented. This communications are working according to the specification and supervised for some person of the DAQ group.

The trigger system was also tested, the installation of the CTP emulator together with the electronic system that include the VME processor, the TTCvi, TTCex and LTU, was installed for a complete test with ACORDE electronics and DAQ system.

The modes and states of ACORDE to control his operations are ready. Trough the DAQ system we can configure and control the ACORDE detector according with the specification.

The installation of the ACORDE structure and 20 modules in the upper face is done, also the cables and connectors, for all the cables, was installed.

Bibliography

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