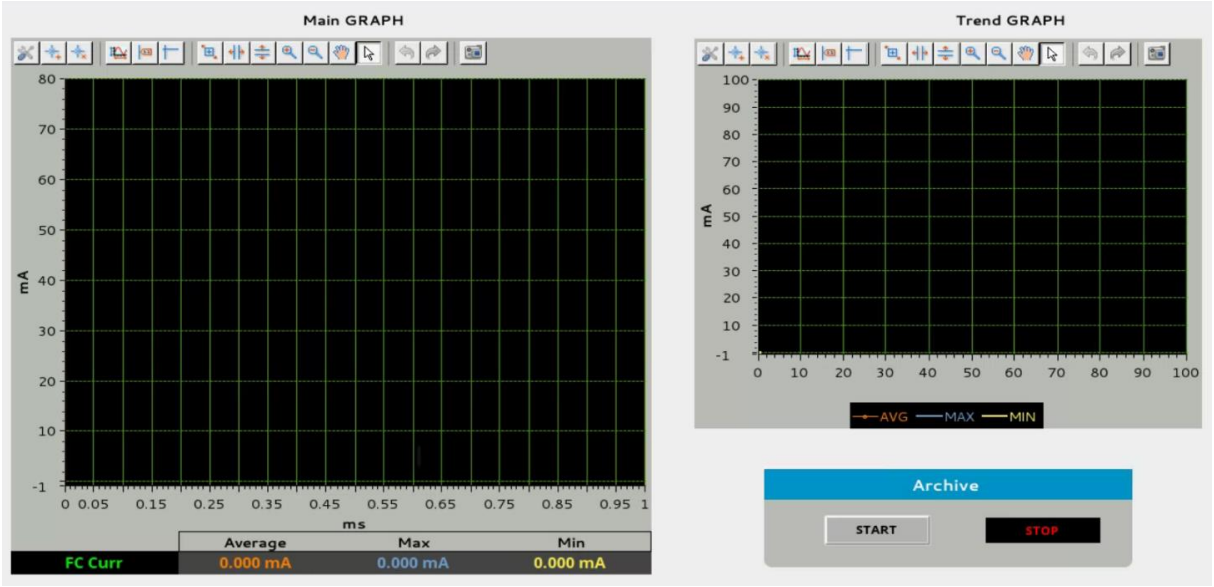
Faraday Cup EPICS module documentation



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1. INTRODUCTION

The European Spallation Source (ESS) ion source is based on ECR technology and its currently develop at INFN-LNS in Catania. The beam will be extracted with an energy of 75 keV. The ion source will be followed by a magnetic Low Energy Beam Transport line, which consists of 2 solenoids, a pre chopper system, and an iris in order to modulate the beam intensity from 6.3 to 62.5 mA at the target window.

CEA is in charge of the control command for the source and LEBT. It's based on Experimental Physics and Industrial Control System (EPICS).

This document will present only the control command of the Faraday Cup. It's installed directly at his output in order to test the beam extracted.

2. PRESENTATION

The Faraday Cup allows to measure the beam current. To acquire signals, a fast acquisition board was chosen.

3. SYSTEM CONFIGURATION

3.1 Hardware: ESS Control Box

The control command uses the Control Box provided by ICS. It's the same VME crate used to control the source with the following main specifications:

Description	Name	Observations
Mother board	IFC1210 (IOXOS)	VME-64X
DACQ Board	ACQ420FMC	4 channels, 16 bits, +/- 10V, 2 MSample, FMC format
Timing Generator	MRF-EVG-230	FMC format
Timing Receiver	MRF-EVR-230	Format FMC

Table 1: Control Box composition

4. EPICS CONTROL SOFTWARE

4.1 Overview

In the following table is presented all modules used to control the faraday cup:

Device	Module
Faraday Cup	m-epics-faradaycup
FastAcquisistion	m-epics-fastacquisition
DataAcquisition	m-epics-dataacquisition

Table 2: List of modules used

The module **m-epics-faradaycup** contains the EPICS software developed for the Faraday Cup. It has the following structure.

Folder	File	Description
	Makefile	makefile of the module
doc	FaradayCup_Software.pdf	this document
opi	FaradayCup.opi	Main opi
db	FaradayCup.substitutions	Substitution file
db	FaradayCup.template	Database file
startup	FaradayCup.cmd	IOC startup script on the VME

Table 3: m-epics-faradaycup module structure

The last version tagged is: **v1.1.1**

4.2 Databases

This module is based on the ***m-epics-fastacquisition*** and ***m-epics-dataacquisition***. For more information, please refer to the documentation: documention in progress….

4.2.1 FaradayCup.template

This template overrides the template "DataAcquisitionChannel.template" provided by the module ***m-epics-dataacquisition***. This overriding allows to add compress record in order to have a trend on the time of the maximum, minimum and the average.

Adding a trend of the maximum:

```
include "DataAcquisitionChannel.template"

# measure maximum custom
record(ai, "$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MAX") {
    field(DESC, "$(DESCRIPTION) : max")
    field(EGU,  "$(UNIT=kW)")
    field(PREC, 2)
    field(FLNK,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MAXwf")
}

record(compress,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MAXwf") {
    field(DESC, "$(DESCRIPTION) : max compress")
    field(ALG, "Circular Buffer")
    field(NSAM, "$(NB_SAMPL_BUFF)")
    field(INP,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MAX")
}
```

Adding a trend of the minimum

```
# measure minimum custom
record(ai, "$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MIN") {
    field(DESC, "$(DESCRIPTION) : min")
    field(EGU,  "$(UNIT=kW)")
    field(PREC, 2)
    field(FLNK,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MINwf")
}

record(compress,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MINwf") {
    field(DESC, "$(DESCRIPTION) : min compress")
    field(ALG, "Circular Buffer")
    field(NSAM, "$(NB_SAMPL_BUFF)")
    field(INP,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):MIN")
}
```

Adding a trend of the average

```
# measure average custom
record(ai, "$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):AVG") {
    field(DESC, "$(DESCRIPTION) : average")
    field(EGU,  "$(UNIT=kW)")
    field(PREC, 2)
    field(FLNK,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):AVGwf")
}

record(compress,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):AVGwf") {
    field(DESC, "$(DESCRIPTION) : average compress")
    field(ALG, "Circular Buffer")
    field(NSAM, "$(NB_SAMPL_BUFF)")
    field(INP,"$(SECTION)-$(SUBSECTION):$(DISC)-$(DEVICE):$(SIGNAL):AVG")
}
```

4.2.2 Database macros

Macro	description
SECTION, SUBSECTION, DISC, DEVICE, SIGNAL	See ESS naming convention
NB_SAMPLE_BUFF	Size of the compress buffer

4.3 IOC Startup Script

4.3.1 FaradayCup.cmd

This startup IOC runs on the VME. Its controls all Acquisition for the Faraday Cup and the timing system. The control software of the source requires the following ICS EPICS modules and versions (only explicit IOC dependencies are listed).

Module	Version	Description
Ifcdaq	0.2.1+build0	Acquisition driver
FastAcquisition	1.0.4	Fast Acquisition application
DataAcquisition	1.1.2	Acquisition treatment application

mrfioc2	2.7.13	Timing driver
Faradaycup	1.1.1	Faraday cup application

Table 4: List of modules with version used on the VME

The startup script begins with the require statements.

```
require ifcdaq,0.2.1+build0
require FastAcquisition,1.0.4
require DataAcquisition,1.1.2
require mrfioc2,2.7.13-ESS0
require pev,0.1.2
require faradaycup,1.1.2
```

The following environment variables are created.

```
# ARCHIVE macros #
# Configuration Timing #
epicsEnvSet("SYS","LNS-ISRC-010")
epicsEnvSet("EVENT_14HZ","14")
# Configuration EVG #
epicsEnvSet("EVG","EVG")
epicsEnvSet("EVG_VMESLOT","2")
# Configuration EVR #
epicsEnvSet("EVR","EVR0")
epicsEnvSet("EVR_VMESLOT","5")
# Channel access maximum size since large waveforms will be transferred.
epicsEnvSet EPICS_CA_MAX_ARRAY_BYTES 40000000
```

Configuration of the timing system (EVG & EVR).

```
# Configuration EVG
mrmEvgSetupVME($(EVG), $(EVG_VMESLOT), 0x100000, 1, 0x01)

dbLoadRecords("evg-vme-230.db", "DEVICE=$(EVG), SYS=$(SYS), EvtClk-FracSynFreq-
SP=88.0525, TrigEvt0-EvtCode-SP=$(EVENT_14HZ), Mxc1-Frequency-SP=14, Mxc1-TrigSrc0-SP=1")

mrmEvgSoftTime("$(EVG)")

# Configuration EVR
mrmEvrSetupVME($(EVR), $(EVR_VMESLOT), 0x3000000, 5, 0x026)

dbLoadRecords("evr-vme-230.db", "DEVICE=$(EVR), SYS=$(SYS), Link-Clk-SP=88.0525, Fron-
tOut0-Src-SP=0, FrontOut0-Ena-SP=1, FrontUnivOut0-Src-SP=0, FrontUnivOut0-Ena-SP=1, Pul0-
Prescaler-SP=77, Pul0-Width-SP=20000, Pul0-Delay-SP=0")

dbLoadRecords("evr-pulserMap.template", "DEVICE=$(EVR), SYS=$(SYS), EVT=$(EVENT_14HZ),
PID=0, F=Trig, ID=0")
```

Loading of the faradaycup datatbase

```
# FaradayCup database
dbLoadRecords("FaradayCup.db")
```

IOC initialization followed by process variables initialization.

```
################### Configuration acquisition ###############
dbpf $(SYS):CARD0:NSAMPLES 100
dbpf LNS-ISRC-010:PBI-FC1:CurR:LinearConversion 0.000000062
dbpf LNS-ISRC-010:PBI-BCM:CurR:LinearConversion 0.000000093132
dbpf $(SYS):CARD0:SAMPLINGRATE 1000000
dbpf $(SYS):CARD0:SAMPLINGRATE 250000
dbpf $(SYS):CARD0:TRIGGERSOURCE "EXT-GPIO"
sleep(1)
dbpf $(SYS):CARD0-STAT ON
sleep(3)
dbpf $(SYS):CARD0-STAT RUNNING
sleep(1)
dbpf $(SYS):CARD0-STAT RUNNING

# Auto switch on and off cold cathod
seq switch_cc_state

# TIMING GENERATOR: timestamp synchronisation
dbpf $(SYS)-$(EVG):SyncTimestamp-Cmd 1

# Archiving configuration
dbpf $(ARCHIVE-MACRO):PVS "LNS-ISRC-010:PBI-FC1:CurR,LNS-ISRC-010:PBI-BCM:CurR")
dbpf $(ARCHIVE-MACRO):Archive 0
```

4.4 Operator Interface

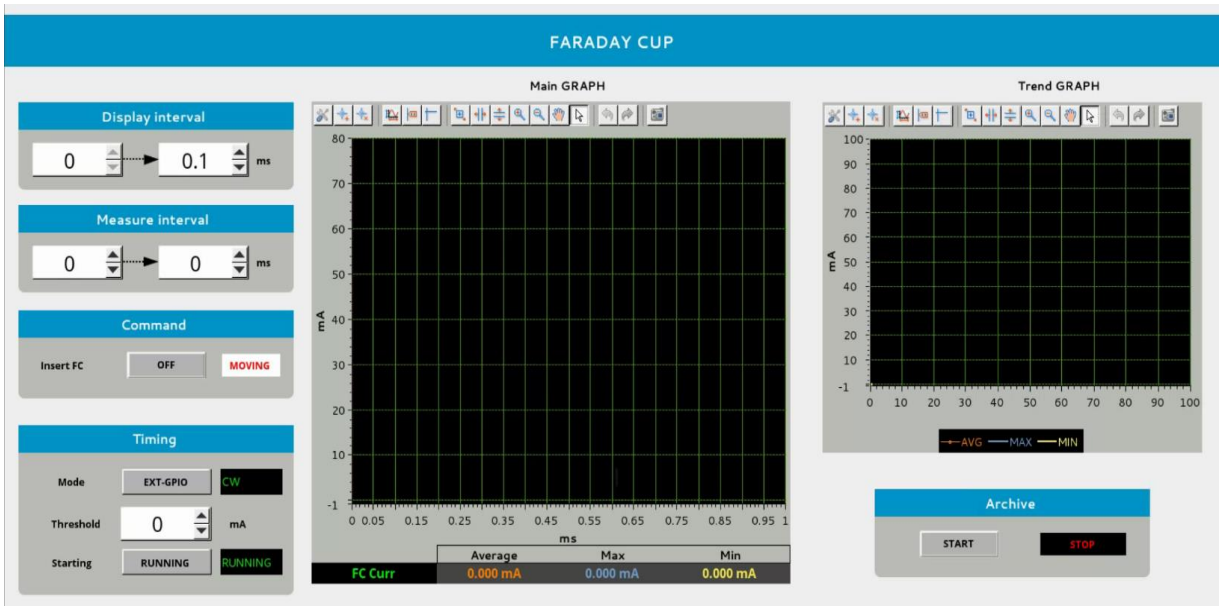

Figure 1: Diagnostic User Interface

4.4.1.1 Faraday Cup: configuration of the acquisition

"Display interval" means the time in ***ms*** to be displayed.

"Measure interval" means the time in ***ms*** to be averaged.

The command "Insert FC ON/OFF" allows to insert or eject the Faraday Cup in the beam.

4.4.1.2 Faraday Cup: display the beam current

On the main graph, an instantaneous value of the current is displayed. The maximum, minimum and an average is also calculated. These calculations are also displayed on a trend graph in order to have an evolution on the time.
A button "Start Archive" allows to start archiving some PVs. For each pulse the waveform, and all measures like Max, Min and Average are archived.

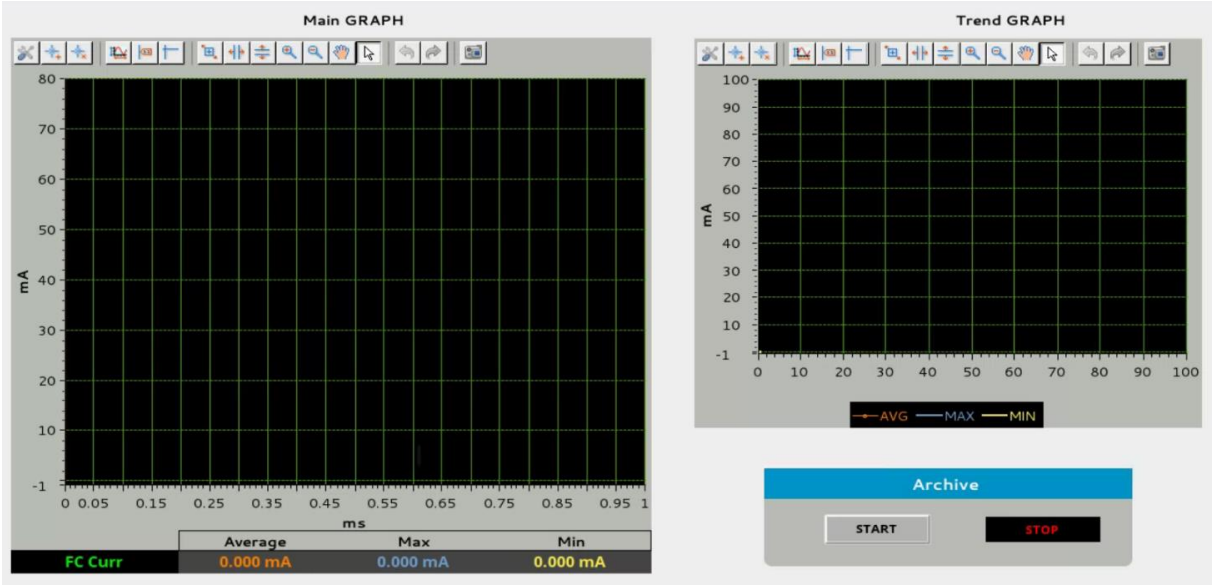

Figure 2: Display the beam on the Faraday Cup

5. LIST OF ABBREVIATIONS

Abbreviation	Definition
GUI	Graphical User Interface
IOC	Input Output Controller
LEBT	Low Energy Beam Transport
EPICS	Experimental Physics and Industrial Control System
MFC	Mass Flow Controller
ATU	Automatic Tuning Unit
HV	High Voltage
I/O	Input/Ouput
EEE	ESS Epics Environment
EVG	Event Generator
EVR	Event Receiver