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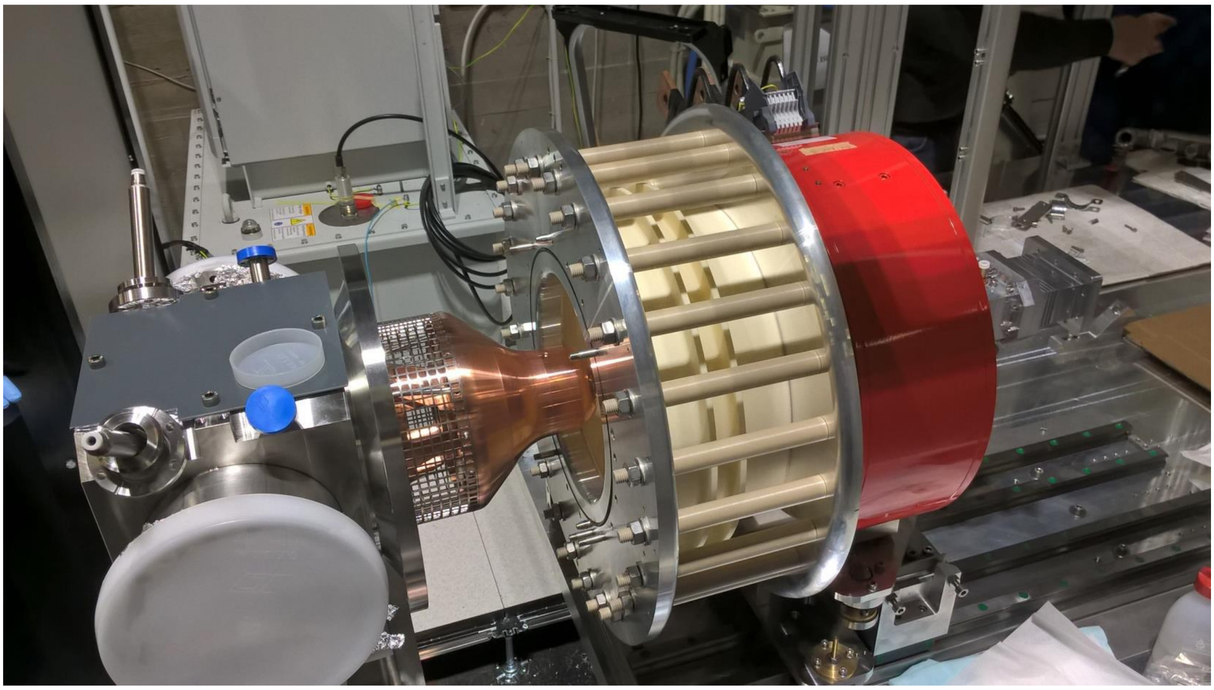
User manual of the ESS ISRC and LEBT



	Audience	Affiliation
Owner	Jean-François DENIS	CEA
Authors	Jean-François DENIS	CEA
Reviewers	Françoise Gougnaud	CEA
Approvers	Florence Ardelier	CEA

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1. INTRODUCTION

The European Spallation Source (ESS) ion source is based on ECR technology and it's 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 Low Energy Beam Transmission (LEBT). It's based on Experimental Physics and Industrial Control System (EPICS).

This document will present the control command of the ESS Source and the LEBT. If more information are needed on a control of a device, please refer to the documentation dedicated.

2. PRESENTATION

2.1 Source (Isrc)

The devices to be controlled are located on the HV platform and at ground potential. In order to prevent damages for instrumentations due to HV discharges all the devices interacting with the beam line and platform shall be adequately grounded. The link between the HV plateform and the ground is done by an optical fiber.

Devices to be controlled on the HV platform are:

- Magnetron
- Automatic tuning Unit (ATU)
- MFC, vacuum gauge & valve
- COILS Power supply
- PLC (remote I/O)
- Ethercat remote I/O (sensors, temperatures)

Devices to be controlled at the ground are:

- High Voltage power supply
- Repeller electrode
- PLC
- Ethercat Remote I/O (Sensors, temperatures)

2.2 LEBT

The LEBT is composed of:

- Faraday Cup
- Power supplies dedicated to steerers, solenoids.
- The chopper
- The IRIS
- Two EMUs vertical and horizontal
- Doppler
- And other devices, but not on the charge of CEA.

3. SYSTEM CONFIGURATION

3.1 Hardware: ESS Control Box

The control command uses the Control Box provided by ICS. It's based on a VME-64x architecture and Industrial PC (NEXCOM NISE 6500).

3.1.1 Isrc

The ISRC VME crate is composed of:

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	VME format
Timing Receiver	MRF-EVR-230	VME Format

Table 2: ISRC VME Control Box composition

3.1.2 LEBT

Excepted for both EMU, the devices installed on the LEBT are controlled by the IPC of the source (IPC_ISRC-LEBT).

The EMUs VME crate is composed of:

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

Table 3: EMU VME Control Box composition

3.2 Network architecture

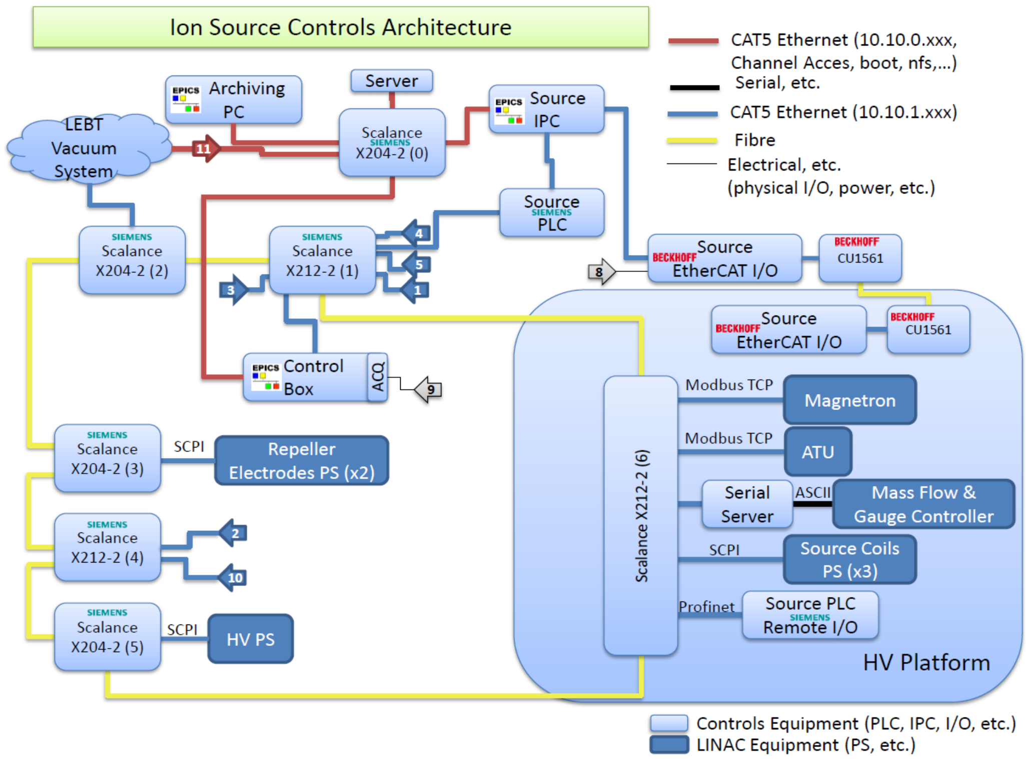


Figure 1: Isrc Network architecture

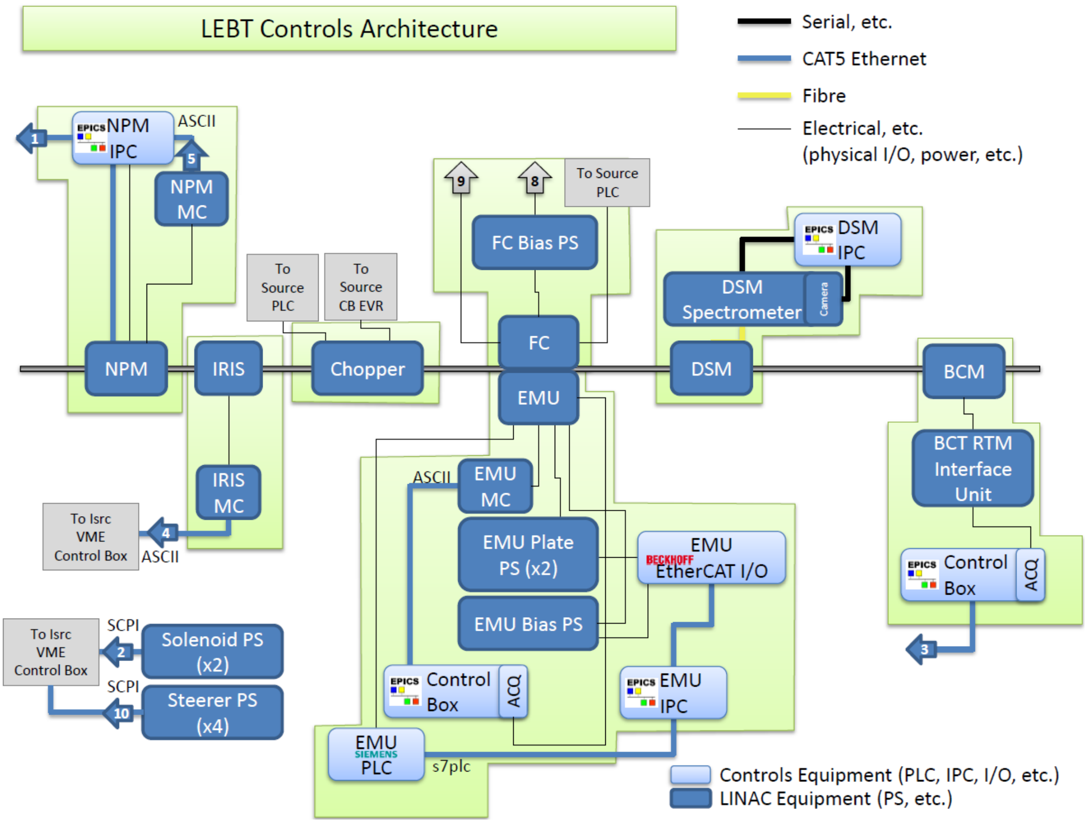


Figure 2: LEBT network architecture

3.3 IP address of devices

Description	Name	IP ADDRESS NETWORK	IP ADDRESS SUBNETWORK (CA)
MAIN DEVICES			
Main server	Server	172.16.30.135	10.10.0.1
User or Devell PC	Devenv	172.16.30.136	10.10.0.10
Archivage	Sispck16	---	10.10.0.11
VME Source	VME_SOURCE	---	10.10.0.15
IPC Source	IPC_ISRC-LEBT	---	10.10.0.16
VME EMU	VME_EMU	---	10.10.0.19
IPC_EMU	IPC_EMU	---	10.10.0.18
Doppler PC	Doppler	---	10.10.0.20
SOURCE DEVICES			
ATU	SAIREM AI4S	---	10.10.1.36:502
Magnetron	SAIREM GMP20KED	---	10.10.1.38:502
HV PS	FUG HCH15K100K	---	10.10.1.37:2101
Reppeler PS	FUG HCP353500	---	10.10.1.34:2101
Coils PS	TDK GEN10500	---	10.10.1.31/32/33/:8003
MFC & Gauge	MOXA GATE-WAY	---	10.10.1.20
PLC	PLC-Source	---	• Interface IPC : 10.10.2.2 • Interface VME : 10.10.1.30 (I/O on HV) • Remote IO : 10.10.1.29
LEBT DEVICES			
Steerer PS 1	SORENZEN SGA30x501d	---	10.10.1.53 :5025
Steerer PS 2	SORENZEN SGA30x501d	---	10.10.1.54:5025
Steerer PS 3	SORENZEN SGA30x501d	---	10.10.1.55 :5025
Motor Controller IRIS	GEOBRICK	---	10.10.1.40
Motor Controller EMU Ver. and Hor.	GEOBRICK	---	10.10.3.42 (Subnet on IPC_EMU)
PLC EMU	PLC-EMU	---	10.10.2.3 (Subnet on IPC_EMU)
Solenoid PS	SOL1-PS	---	10.10.1.35
Solenoid PS	SOL2-PS	---	10.10.1.36

*CA: Channel Access

Table 1: IP addresses of devices of ISRC and LEBT

3.4 Software: Linux

3.4.1 Server

The installation of the main server is full compliant with the INKIND EEE Server:

https://confluence.esss.lu.se/display/DE/In-kind+EEE+server+setup

3.4.2 Client

The installation of the client is full compliant with the IN-KIND EEE Devenv:

https://confluence.esss.lu.se/display/DE/In-kind+physical+DM+setup

4. EPICS CONTROL SOFTWARE

4.1 Overview

A module is developed for each device. In the following tables is presented all modules used to control and test the Source (Isrc) and LEBT:

4.1.1 Isrc modules

Device	Module
Magnetron	m-epics-sairemgmp20ked
ATU	m-epics-sairemai4s
MFC	m-epics-vac_ctrl_mks946
	m-epics-vac_mfc_mks_gv50a
	m-epics-vac_gauge_mks_vgd
COILS Power supply	m-epics-tdkgen10500
PLC	m-epics-plc-source
HV Power supply	m-epics-fug
Faraday Cup	m-epics-faradaycup
FastAcquisistion	m-epics-fastacquisition
DataAcquisition	m-epics-dataacquisition

Table 2: List of modules used for Isrc

The module **m-epics-source** is used essentially to load all devices modules with their EPICS database. It contains main screens and only one database for sensors and ISEG power supply (Faraday Cup).It has the following structure.

Folder	File	Description
	Makefile	makefile of the module
db	source-sensors.substitutions	Substitution file to create Database
doc	ISrcEPICSmanual.pdf	this document
opi	source.opi	Main opi
opi	Source-second.opi	Diags OPI

Folder	File	Description
opi/scripts	DiagOpiSwitch.js	javascript used by Source-second.opi to switch views
opi/scripts	PlcOpiSwitch.js	javascript used by Source-second.opi to switch views for the PLC part
Startup	Source-vme.cmd	IOC startup script on the VME
Startup	Source-ipc.cmd	IOC startup script on the IPC

Table 3: m-epics-source module structure

The last version tagged on bitbucket of ESS is: **v1.2.0-catania**

4.1.2 LEBT modules

Device	Module
Steerers PS	m-epics-sorensenXG125120
Solenoids PS	m-epics-sorensenSGA30x501d
Iris	m-epics-iris
EMU	m-epics-emu
EMU (PLC)	m-epics-emu-plc
EMU (PMAC)	m-epics-emu-pmac
Doppler	m-epics-doppler
Chopper	m-epics-chopper

Table 4: List of modules used for LEBT

The module **m-epics-lebt** is used essentially to load all devices modules with their EPICS database. It has the following structure.

Folder	File	Description
	Makefile	makefile of the module
db	Lebt.substitution	Substitution file
doc	ISrc-LEBT_usermanual.pdf	this document
Startup	lebt-ipc.cmd	IOC startup script on the IPC

Table 5: m-epics-lebt module structure

The last version tagged on bitbucket of ESS is: **v0.2.0**

4.2 Database

4.2.1 Isrc

This database is used essentially to control sensors and ISEG power supply (Faraday cup). These measures are done by Ethercat remote I/O. To reduce the cost of Ethercat controller, the I/O of the chopper located on the LEBT were added to this list (Red).

EQPT	DEVICE NAME	AREA	SIGNALS	DEVICE	CHANNEL
Temperature1 - coil1 exit temperature (copper) (PT100)	**LNS-ISRC-10:ISS-Coil-01**	HV	TempR	ES3208 (1)	Chan 1
Temperature2 - coil2 exit temperature (copper) (PT100)	**LNS-ISRC-10:ISS-Coil-02**	HV	TempR	ES3208 (1)	Chan 2
Temperature3 - coil3 exit temperature (copper) (PT100)	**LNS-ISRC-10:ISS-Coil-03**	HV	TempR	ES3208 (1)	Chan 3
Temperature4 - plasma chamber (PT100)	**LNS-ISRC-10:PBI**	HV	tempPlasmR	ES3208 (1)	Chan 4
Temperature5 - matching transformer (PT100)	**LNS-ISRC-10:PBI**	HV	TempMatch-TransR	ES3208 (1)	Chan 5
Temperature6 - collimator (PT100)	**NC - TBD**	Ground	TempR	ES3208 (2)	Chan 1
Temperature7 - chopper (PT100)	**LNS-ISRC-10:PBI-PrChop**	Ground	TempR	ES3208 (2)	Chan 2
Temperature8 – temperature ambiant (PT100)	**LNS-ISRC-10:PBI**	Ground	TempAmbR	ES3208 (2)	Chan 3
Temperature9 - humidity (PT100)	**LNS-ISRC-10:PBI**	Ground	TempHumR	ES3208 (2)	Chan 4
BIAS Power supply FC1 – Set current	**LNS-ISRC-10:PBI-PSFC-01**	Ground	RepCurS	ES4104	Chan1
BIAS Power supply FC1 – Set Voltage	**LNS-ISRC-10:PBI-FC1**	Ground	RepVolS	ES4104	Chan2
LEBT Chopper Setpoint	**LNS-LEBT-010:BMD-Chop**	Groud	VolS	ES4104	Chan3
BIAS Power supply FC1 – Get Current	**LNS-ISRC-10:PBI-FC1**	Ground	RepCurR	ES3164	Chan1
BIAS Power supply FC1 – Get Voltage	**LNS-ISRC-10:PBI-FC1**	Ground	RepVolR	ES3164	Chan2
BIAS Power supply FC1 – Set ON	**LNS-ISRC-10:PBI-FC1**	Ground	RepOnS	ES2124	Chan1
LEBT Chopper voltage	**LNS-LEBT-010:BMD-Chop**	Ground	VolR	ES3164	Chan3
LEBT Chopper current	**LNS-LEBT-010:BMD-Chop**	Ground	CurR	ES3164	Chan4

Table 6: Ethercat remote I/O

The substitution file is:

```
######################### INPUT ANA 0-10V ########################################
file ecat2el316x.template
{
pattern {PREFIX,CH_ID, SLAVE_IDX, PDO_IDX,EGU,ESLO,EOFF}
        {"LNS-ISRC-010:PBI","TempAmbR",2 ,0, "mA", 0.003051850947599719,"-30"}
        {"LNS-ISRC-010:PBI","TempHumR",2 ,1, "V", 0.002136296,"0"}
        {"LNS-ISRC-010:PBI-FC-BPS","CurR",3 ,0, "mA", 0.000244148,"0"}
        {"LNS-ISRC-010:PBI-FC-BPS","VolR",3 ,1, "V", 0.09155553,"0"}
}
######################### OUTPUT ANA 0-10V ########################################
file ecat2el41xx.template
{
pattern  {PREFIX,CH_ID, SLAVE_IDX,PDO_IDX, EOFF, ESLO, DRVL, DRVH, PREC,EGU}
         {"LNS-ISRC-010:PBI-FC-BPS","CurS", 4 ,0, 0,0.000244148, 0, 8,1,"mA"}
         {"LNS-ISRC-010:PBI-FC-BPS","VolS", 4 ,1, 0 , 0.09155553, 0, 1500,1,"V"}
         {"LNS-LEBT-010:BMD-Chop","VolS", 4 ,2, 0,0.0003051850947599719, 0, 10,2,"kV"}
}
############################ PT100 ################################################
file "ecat2el3208.template"
{
pattern {PREFIX,CH_ID, SLAVE_IDX, PDO_IDX,EGU,ESLO}
        {"LNS-ISRC-010:ISS-Coil-01","TempR",8 , 0, C, 0.1}
        {"LNS-ISRC-010:ISS-Coil-02","TempR",8 , 1, C, 0.1}
        {"LNS-ISRC-010:ISS-Coil-03","TempR",8 , 2, C, 0.1}
        {"LNS-ISRC-010:PBI","TempPlasmR",8,3 , C, 0.1}
        {"LNS-ISRC-010:PBI","TempMatchTransR",8,4 , C, 0.1}
}
```

4.2.2 LEBT

This database is used to control power supplies of Steerers, Solenoids, Chopper, Iris.

The substitution file is:

```
############### STEERERS POWER SUPPLIES ###############
file sorensenXG125120.template
{
pattern
{ proto_file, secsub, disdevidx, connection_name,VOLT_HOPR,VOLT_LOPR,CURR_HOPR,CURR_LOPR,VOLT_PROT_HOPR, VOLT_PROT_LOPR"}
{"../misc/sorensenXG125120.proto"," PWRC-SteerPS-H1", "LNS-LEBT-010","SteerPS-H1","12.5","0","120","0","15","1"}
{"../misc/sorensenXG125120.proto"," PWRC-SteerPS-V1", "LNS-LEBT-010","SteerPS-V1","12.5","0","120","0","15","1"}
{"../misc/sorensenXG125120.proto"," PWRC-SteerPS-H2", "LNS-LEBT-010","SteerPS-H2","12.5","0","120","0","15","1"}
{"../misc/sorensenXG125120.proto"," PWRC-SteerPS-V2", "LNS-LEBT-010","SteerPS-V2","12.5","0","120","0","15","1"}
}

############### SOLENOID POWER SUPPLIES ###############

file sorensen30x501d.template
{
pattern  { proto_file, secsub, disdevidx, connection_name}
      {"../misc/sorensen30x501d.proto"," PWRC-SolPS-01", "LNS-LEBT-010","SolPS-01}
      {"../misc/sorensen30x501d.proto"," PWRC-SolPS-02", "LNS-LEBT-010","SolPS-02}
}
```

```
############### MOTOR IRIS ############################
file motor_iris.template
{
pattern  {P       M        MOTOR    EGU      SCAN               PREC     SPORT}
         {LEBT    IRIS     1        mm       ".1 second"        3        GEOBRICK_ASYN}
         {LEBT    IRIS     2        mm       ".1 second"        3        GEOBRICK_ASYN}
         {LEBT    IRIS     3        mm       ".1 second"        3        GEOBRICK_ASYN}
         {LEBT    IRIS     4        mm       ".1 second"        3        GEOBRICK_ASYN}
         {LEBT    IRIS     5        mm       ".1 second"        3        GEOBRICK_ASYN}
         {LEBT    IRIS     6        mm       ".1 second"        3        GEOBRICK_ASYN}
}

file get_value_pmac.template
{
pattern  {P, M ,NAME, DESC, EGU, P-VARIABLE, PREC, SCAN , SPORT}
         {LEBT, IRIS, INIT_PROCESSING, "inidcates if a init procedure is running", Boolean, P4800, 0
         ".1 second",GEOBRICK_ASYN}
         {LEBT, IRIS, LAST_COMMAND, "LAST_COMMAND of iris's position send", mm, P4805, 0, ".1 second"
         GEOBRICK_ASYN}
         {LEBT, IRIS, APERTURE_MIN, "get the aperture min", mm, P4829, 0, ".1 second", GEOBRICK_ASYN}
         {LEBT, IRIS, INIT_PROCEDURE_DONE, "if this PC=0 => init procedure not done", boolean
         P4837, 0, ".1 second", GEOBRICK_ASYN}
         {LEBT, IRIS, CABLING_ISSUE, "bit cacling issue (limit or power motor",Boolean, P4889, 0
         ".1 second", GEOBRICK_ASYN}
         {LEBT, IRIS, IRIS_MOVING, "iris is running a program?", Boolean, M5280, 0, ".1 second"
         GEOBRICK_ASYN}
}

file set_value_pmac.template
{
pattern  {P       M        NAME              DESC
         EGU      DRVL     DRVH     CALC     VAL      ADEL     MDEL     PREC     P-VARIABLE
         SPORT}
         {LEBT    IRIS     INIT              "launch an init procedure"                  boolean
         0        1        A        0        -1       -1       0        P4800             GEO-
BRICK_ASYN}
         {LEBT    IRIS     APERTURE "set an aperture"                           mm       1
         76       A        0        0        0        0        P4801             GEOBRICK_ASYN}
         {LEBT    IRIS     VELOCITY "velocity between 1 (slow) and 5 (fast)"    mm/s     1
         5        10*A     5        0        0        0        P4803             GEOBRICK_ASYN}
         {LEBT    IRIS     OFFSET_X "move the center of the iris"                        mm
         -20      20       A        0        0        0        3        P4807             GEO-
BRICK_ASYN}
         {LEBT    IRIS     OFFSET_Y "move the center of the iris"                        mm
         -20      20       A        0        0        0        3        P4808             GEO-
BRICK_ASYN}
         {LEBT    IRIS     BLADES_KIND       "set iris blades kind"
         boolean  0        1        A        0        0        0        0        P4838
         GEOBRICK_ASYN}
}

file console.template
{
pattern  {P       M        SPORT}
         {LEBT    IRIS     GEOBRICK_ASYN}
}
```

The Ethercat remote IO of the chopper used the same Ethercat controller than the source.

Substitution file of the chopper looks like:

```
######################### SETTING Volt: OUTPUT ANA 0-10V ########################################
file ecat2el41xx.template
{
         pattern {PREFIX,CH_ID, SLAVE_IDX,PDO_IDX, EOFF, ESLO, DRVL, DRVH, PREC,EGU}
                  {"LNS-LEBT-010:BMD-Chop","VolS", 4 ,2, 0,0.0003051850947599719, 0, 10,2,"kV"}
}

######################### MEASURE Volt and Curent: INPUT ANA 0-10V
########################################
file ecat2el316x.template
{
pattern {PREFIX,CH_ID, SLAVE_IDX, PDO_IDX,EGU,ESLO,EOFF}
        {"LNS-LEBT-010:BMD-Chop","VolR",3 ,2, "kV", 0.0003051850947599719,"0"}
        {"LNS-LEBT-010:BMD-Chop","CurR",3 ,3, "mA", 0.0003051850947599719,"0"}
}
```

4.3 IOC

4.3.1 Startup scripts

4.3.1.1 source-vme.cmd

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

Module	Version	Description
Modbus	2.9.0-ESS0	modbus driver
Streamdevice	2.7.7	Streamdevice driver
Ps-fug	1.0.2	HV Power supply application
sairemgmp20ked	1.0.1	Magnetron application
Sairemai4s	1.0.1	ATU application
tdkgen10500	1.0.1	COILS Power supply application
vac_ctrl_mks946	1.0.1	MFC - MKS946 application
vac_gauge_mks_vgd	2.0.2	
vac_mfc_mks_gv50a	2.0.5	
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-ESS0	Timing driver
Pev	0.1.2	
Faradaycup	1.1.1	Faraday cup application
PVArchiving	1.0.2	Archiving application driver

Table 7: List of modules+version used on the VME-SOURCE

The startup script begins with the require statements.

```
require modbus, 2.9.0-ESS0
require streamdevice, 2.7.7
require ps-fug, 1.0.2
require sairemgmp20ked, 1.0.1
require sairemai4s, 1.0.1
require tdkgen10500, 1.0.1
require vac_ctrl_mks946, 1.0.1
require vac_gauge_mks_vgd, 2.0.2
require vac_mfc_mks_gv50a, 2.0.5
require ifcdaq,0.2.1+build0
require FastAcquisition,1.0.4
require DataAcquisition,1.1.1
require mrfioc2,2.7.13-ESS0
require pev,0.1.2
require faradaycup,1.1.+
require acct,0.0.+
require autosave,5.0.0
require PVArchiving,1.0.2
```

The following environment variables are created.

```
# ARCHIVE macros #
epicsEnvSet("ARCHIVE-MACRO","LNS-ISRC-010:ISS")
# 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")
```

Configuration of devices on the HV platform

```
# FUG HCH 15k-100k [High Voltage Power Supply]
drvAsynIPPortConfigure("HVPS", "10.10.1.37:2101")
dbLoadRecords("fughch15k100k.db")

# FUG HCP 35-3500 [Repeller Power Supply]
drvAsynIPPortConfigure("RepPS-01", "10.10.1.34:2101")
dbLoadRecords("fughcp353500.db")
```

Configuration of devices at ground

```
# Sairem GMP20KED [Magnetron]
drvAsynIPPortConfigure("conn-LNS-ISRC-ISS-Magtr", "10.10.1.38:502", 0, 0, 1)
modbusInterposeConfig("conn-LNS-ISRC-ISS-Magtr", 0, 1000, 0)
drvModbusAsynConfigure("sgmp20ked-modbus-write-word", "conn-LNS-ISRC-ISS-Magtr", 1, 6, 0,
9, 0, 1000, "Function6")
drvModbusAsynConfigure("sgmp20ked-modbus-read-word", "conn-LNS-ISRC-ISS-Magtr", 1, 3,
100, 109, 0, 1000, "Function3")
dbLoadRecords("sairemgmp20ked.db")

# Sairem AI4S [ATU]
drvAsynIPPortConfigure("conn-LNS-ISRC-ISS-ATU", "10.10.1.36:502", 0, 0, 1)
modbusInterposeConfig("conn-LNS-ISRC-ISS-ATU", 0, 1000, 0)
drvModbusAsynConfigure("sai4s-modbus-write-word", "conn-LNS-ISRC-ISS-ATU", 0, 6, 0, 10,
0, 1000, "Function6")
drvModbusAsynConfigure("sai4s-modbus-read-word", "conn-LNS-ISRC-ISS-ATU", 0, 3, 100, 5,
0, 1000, "Function3")
dbLoadRecords("sairemai4s.db")

# TDK Lambda Genesys 10-500 [Coils]
drvAsynIPPortConfigure("CoilsPS-01", "10.10.1.31:8003")
drvAsynIPPortConfigure("CoilsPS-02", "10.10.1.32:8003")
drvAsynIPPortConfigure("CoilsPS-03", "10.10.1.33:8003")
dbLoadRecords("tdkGen10500.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
```

4.3.1.2 ipc-source.cmd

This startup IOC runs on the IPC_ISRC-LEBT. It controls the PLC, different sensors and the ISEG power supply used for the Faraday cup. The control software of the source requires the following ICS EPICS modules (only explicit IOC dependencies are listed).

Module	Version	Description
Ecat2db	0.4.3	ethercat driver
S7plc	1.0.0	S7PLC driver
Plc-source	1.0.3	PLC

Table 8: List of modules used on the IPC

The startup script begins with the require statements.

```
require ecat2db,0.4+
require source,1.1+
require s7plc, 1.1.0
require plc-source, 1.0+
require autosave,5.0+
```

Configuration of devices

```
# PLC configuration
s7plcConfigure("plc", "10.10.2.2", 2000, 138, 24, 1, 1000, 500)
dbLoadRecords("output.db")
dbLoadRecords("input.db")

# Beckhoff module (Iseg PS and PT100)
ecat2configure(0,500,1,1)
dbLoadTemplate(source-sensors.substitutions)
```

4.3.1.3 ipc-lebt.cmd

This startup IOC runs on the IPC_ISRC-LEBT. It controls the chopper, power supplies (Steerers, Solenoids), Iris. For the chopper, the Ethercat part uses the same controller than used for sensors.

For both EMU it's a dedicated VME and IPC. The control software of the LEBT requires the following ICS EPICS modules (only explicit IOC dependencies are listed).

Module	Version	Description
m-epics-sorenzenxg	0.4.3	Steerer Power supplies
m-epics-sorensenSG	1.0.0	Solenoid Power supplies
m-epics-iris	1.1.0	IRIS
Ecat2db	0.4.3	ethercat driver

Table 9: List of modules used on the IPC

The startup script begins with the require statements.

```
require asyn,4.31+
require streamdevice, 2.7.7
require sorensenxg125120, 0.2+
require sorensensga30x501d,0.3+
require lebt,0.2+

require iris, 1.1+
require tpmac,3.11.2-ESS0

## SOLENOIDS
drvAsynIPPortConfigure("SolPS-01", "10.10.1.50:5025")
drvAsynIPPortConfigure("SolPS-02", "10.10.1.51:5025")

## STEERERS
drvAsynIPPortConfigure("SteerPS-H1", "10.10.1.52:5025")
drvAsynIPPortConfigure("SteerPS-H2", "10.10.1.53:5025")
drvAsynIPPortConfigure("SteerPS-V1", "10.10.1.54:5025")
drvAsynIPPortConfigure("SteerPS-V2", "10.10.1.55:5025")

## GEOBRICK (IRIS)
pmacAsynIPConfigure("GEOBRICK_ASYN", "10.10.1.40:1025")

dbLoadRecords("lebt.db")
```

Configuration of devices

4.3.2 Booting configuration

At each boot of VME or IPC, scripts will executed in order for instance to configure IP or to load kernel module. A script a dedicated for each machine inside the directory: /opt/startup/bot/{VME_NAME or IPC_NAME}

For the VME, inside the directory */opt/startup/boot/VME_SOURCE/*

```
#FMCModules.sh => load kernel module for timing(mrf)and acquisition(pev)
#! /bin/bash
modprobe mrf
ioxos_load pev-linux-ppc
#ip.sh => configure IP address
#! /bin/bash
ifconfig eth0 10.10.1.1 netmask 255.255.255.0
ip route add 192.84.151.3 via 10.10.0.1 dev eth1
#pev_irq.sh => IRQ priority
```

For the IPC, inside the directory */opt/startup/boot/IPC_ISRC-LEBT/*

```
#ethercat.sh => load kernel module for ethercat
#! /bin/bash
modprobe ec_master main_devices="a0:36:9f:78:0c:4d"
modprobe ec_generic
#ip.sh => configure IP address
#! /bin/bash
ifconfig enp5s0 10.10.2.1 netmask 255.255.255.0
nmcli con mod enp5s0 connection.autoconnect yes

ifconfig enp1s0f0 10.10.1.2 netmask 255.255.255.0
```

4.3.3 Services starting

At each boot of VME or IPC, IOCs will start automatically. A script a dedicated for each IOC inside the directory: /opt/startup/ioc/{VME_NAME or IPC_NAME}/{name of the service}

For the VME, inside the directory: ***/opt/startup/ioc/VME_SOURCE/source/***

```
Require source, 1.1.0-catania
< /opt/epics/modules/source/1.1.0-catania/startup/source-vme.cmd
```

For the IPC_ISRC-LEBT, inside the directory: ***/opt/startup/ioc/IPC_ISRC-LEBT/source/***

```
Require source, 1.1.0-catania
< /opt/epics/modules/source/1.1.0-catania/startup/source-ipc.cmd
```

For the IPC_ISRC-LEBT, inside the directory: ***/opt/startup/ioc/IPC_ISRC-LEBT/lebt/***

```
Require source, 1.1.0-catania
< /opt/epics/modules/lebt/1.1.0-catania/startup/source-ipc.cmd
```

5. OPERATOR INTERFACE

The control of the source is designed to use two screens. One screen is dedicated to control the source, and another one to control all diagnostics.

5.1 Main User interface: source.opi

This main User Interface is used to control the source and the LEBT. It's composed of tabs.

The first tab which is the main tab gives a global status of the Source.

There is also a tab for:

- Interlock PLC which gives a status of the interlock on all the injector (Isrc + LEBT)
- Vaccum PLC which gives a status of the vaccum on all the injector (Isrc + LEBT)
- LEBT which allows to control all devices installed on the LEBT.

For all other tabs, it's a view more detailed dedicated to a device.

5.1.1 Main tab: source control

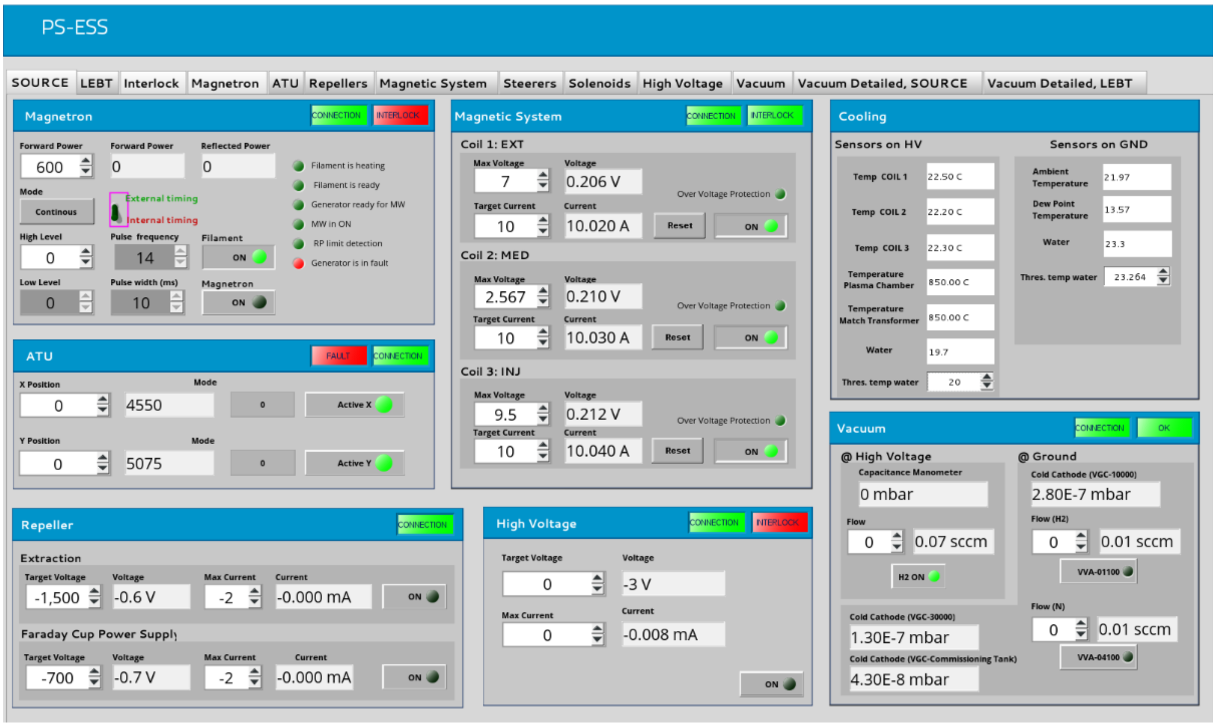


Figure 3: Main User Interface

The main tab is composed of subsection as descripted in following lines.

5.1.1.1 Magnetron

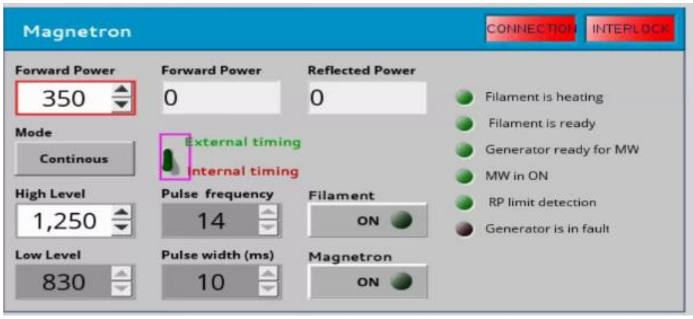


Figure 4: Magnetron User Interface

This subsection allows to control the magnetron and the shape of the beam. The type of pulse could be selected: **Pulse** or **continuous**. According to this option, some parameters like Pulse Frequency or Pulse width are enable or disable.

Leds located on the right gives the status of the magnetron: Filament is heating, MW is ON, etc…

On the top of this subsection, two square Leds represent the status of:

- The connection between the device and the VME

- The interlock status given by the PLC interlock.

For more information please refer to: **sairemgmp20ked.pdf**

5.1.1.2 Automatic Tuning Unit (ATU)

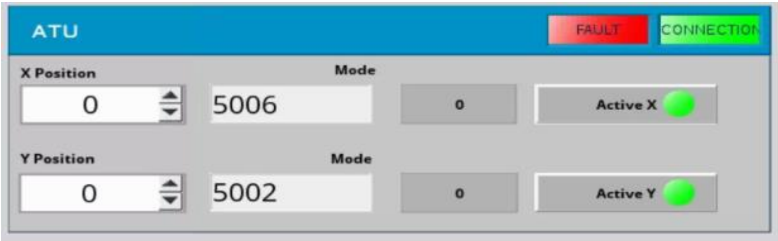


Figure 5: ATU User Interface

This subsection allows to control the ATU. For each axe (X or Y) there is a button to activate the "automatic mode". By default, the mode is configured in "manual mode".

On the top of this subsection, two square Leds represent the status of:

- The device (Fault mode or OK)
- The connection between the device and the VME

For more information please refer to: **sairemai4s.pdf**

5.1.1.3 Magnetic System

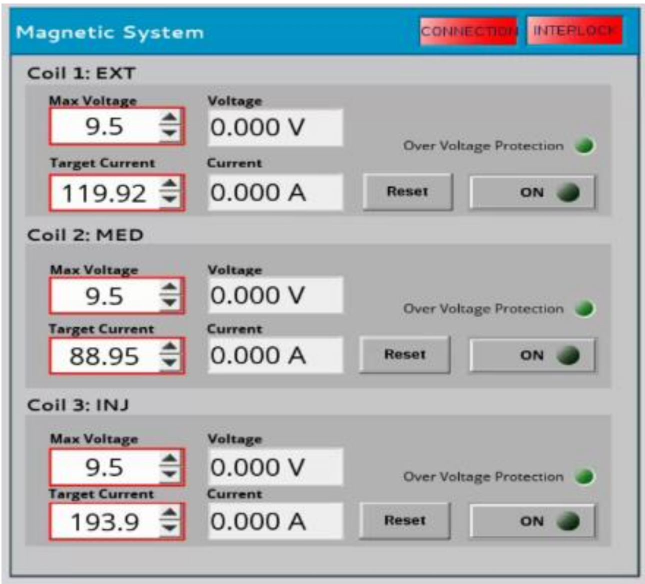


Figure 6: Magnetic system User Interface

This subsection allows to control COILS Power supplies. For each power supply, the Max voltage and the Target current can be adjusted. A status of the Over Voltage Protection is also displayed.

On the top of this subsection, two square Leds represent the status of:

- The connection between devices and the VME
- The interlock status given by the PLC interlock.

5.1.1.4 High Voltage Power supply

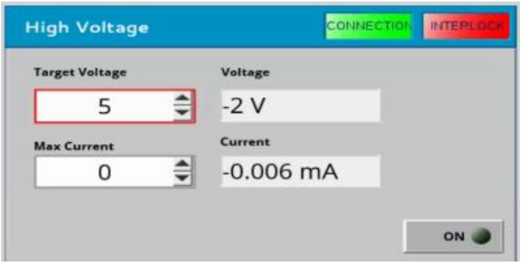


Figure 7: HV User interface

This subsection allows to control the High Voltage Power supply. The Max current and the Target voltage can be adjusted.

On the top of this subsection, two square Leds represent the status of:

- The connection between the device and the VME
- The interlock status given by the PLC interlock.

For more information please refer to: **ps-fug.pdf**

5.1.1.5 Repeller Power supply

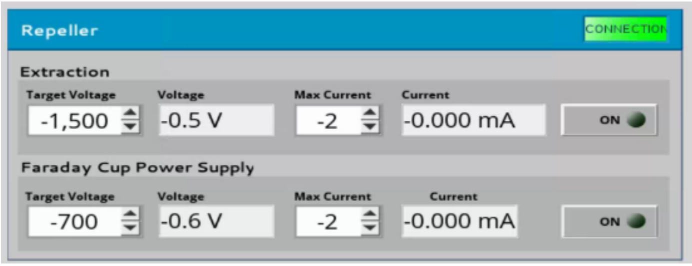


Figure 8: Reppeler User Interface

This subsection allows to control the Repeller Power supply. The Max current and the Target voltage can be adjusted.

On the top of this subsection, on square Led indicates the status of the connection between the device and the VME.

For more information please refer to: **ps-fug.pdf**

5.1.1.6 Sensors

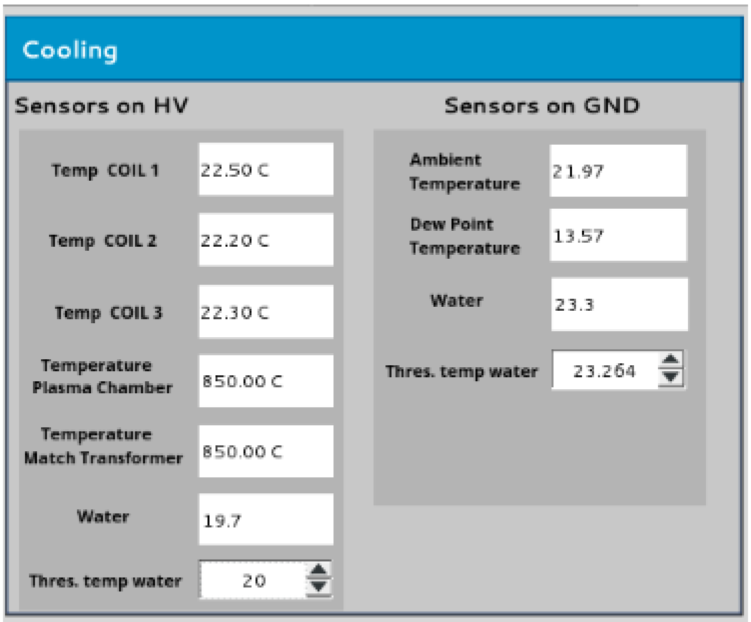


Figure 9: Cooling User Interface

This subsection allows to display all sensors around the source located at the ground and on the High Voltage platform.

5.1.1.7 Vacuum status

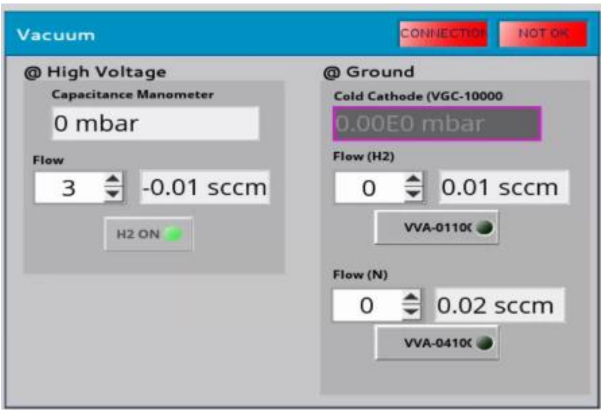


Figure 10: Vacuum User Interface

This subsection allows to control hydrogen injection and the open/close valve on the High Voltage platform.

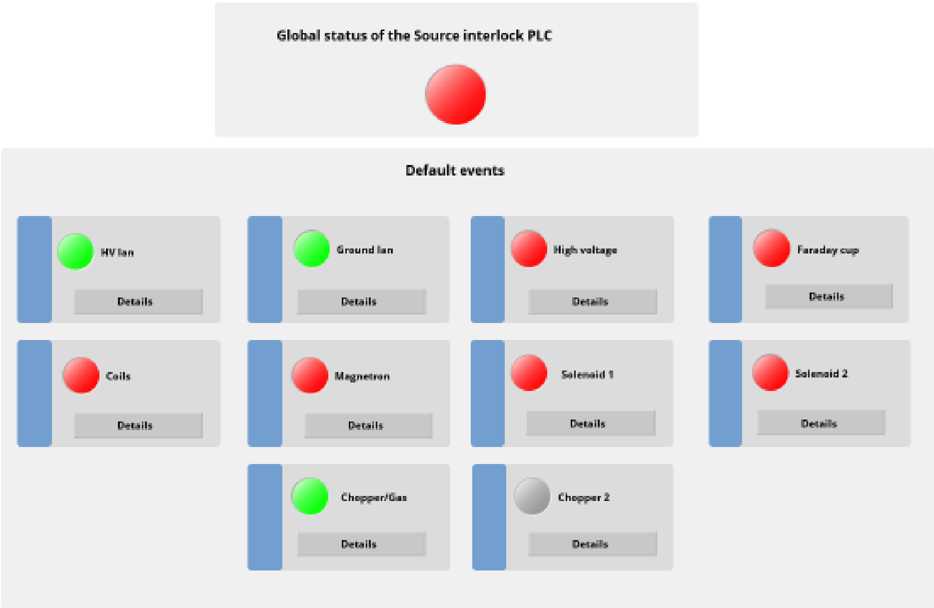
On the top of this subsection, two squares Leds indicates the status of:

- The connection between the device and the VME.
- The status of the device (Fault mode or OK)

For more information please refer to: **mks946.pdf**

5.1.2 Interlock tab

This tab is dedicated to have an overview of all Interlocks on the Source and LEBT.



For more information about the EPICS part please refer to: **ESS_Source_PLC_usermanual.pdf**

5.1.3 Vaccum tab

This tab is dedicated to have an overview of the Vaccum on the Source and LEBT.

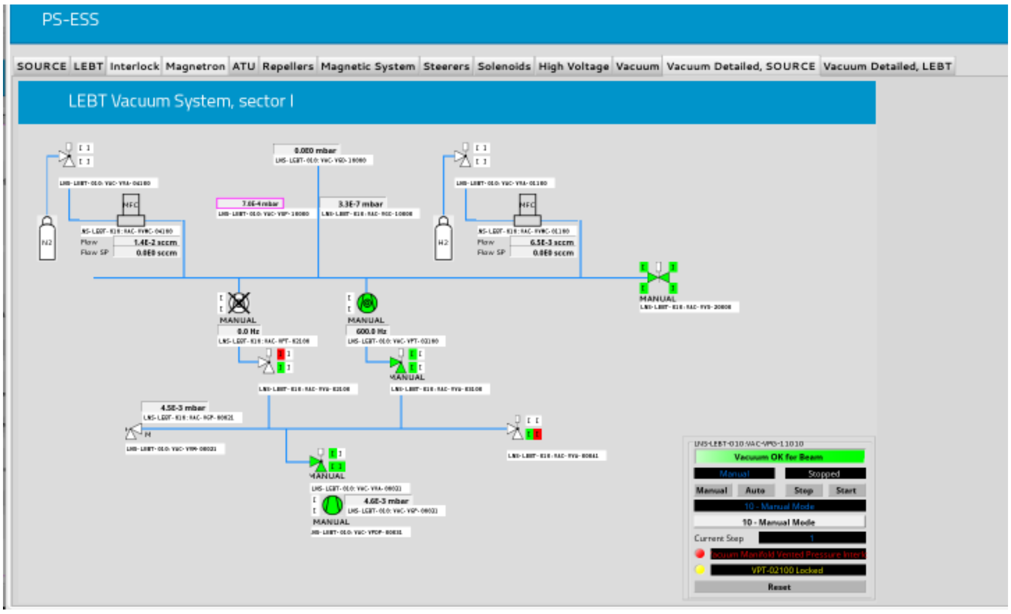


Figure 11: LEBT Vacuum system (Source)

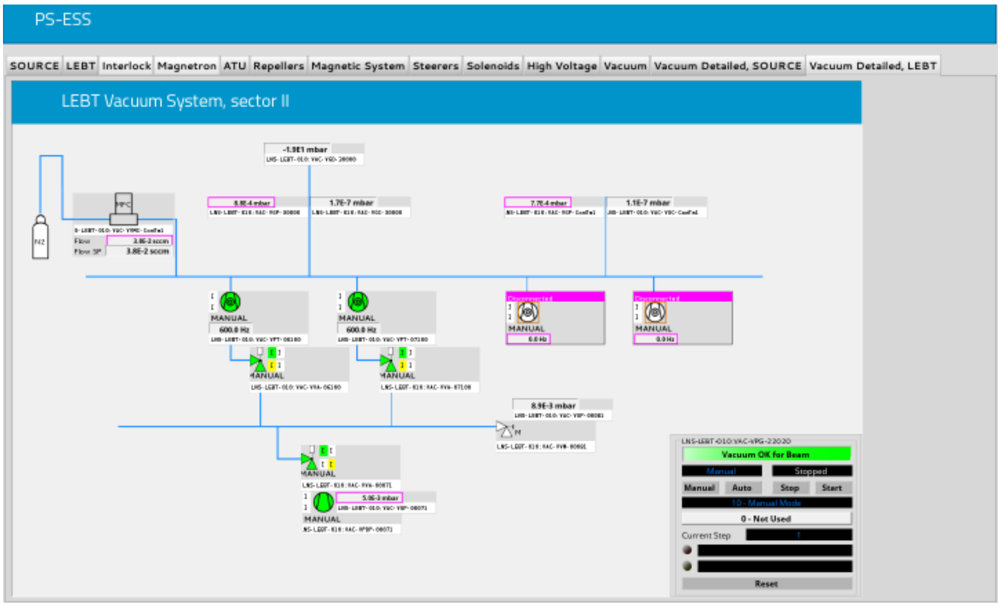


Figure 12: LEBT vacuum system

5.2 Diagnostic User interface: second-source.opi

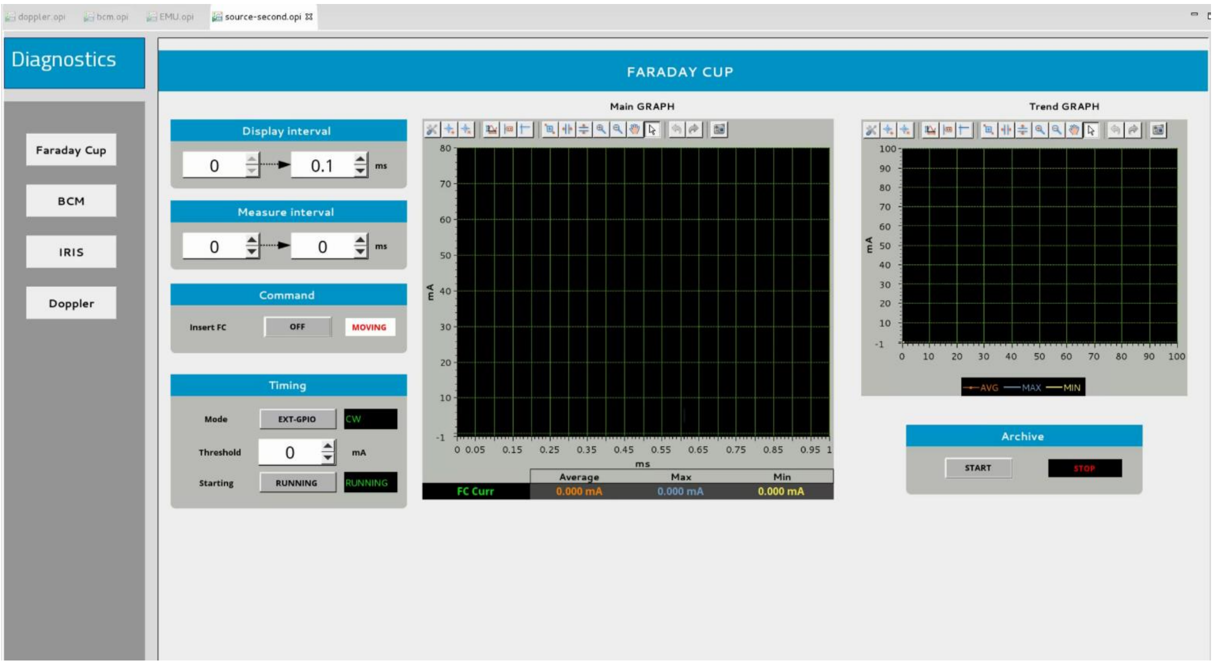


Figure 13: second-source.opi => Diagnostics User Interface

This screen is composed on two parts:

- On the left, a menu to select the diagnostic
- On the right, an embedded display to display the User Interface dedicated to the diagnostic selected

On this document will be treated only the User interface of diagnostics. For more details of a diagnostic, please refers to the dedicated documentation.

5.2.1 Faraday Cup

When the button **Faraday Cup** is selected, this OPI appears:

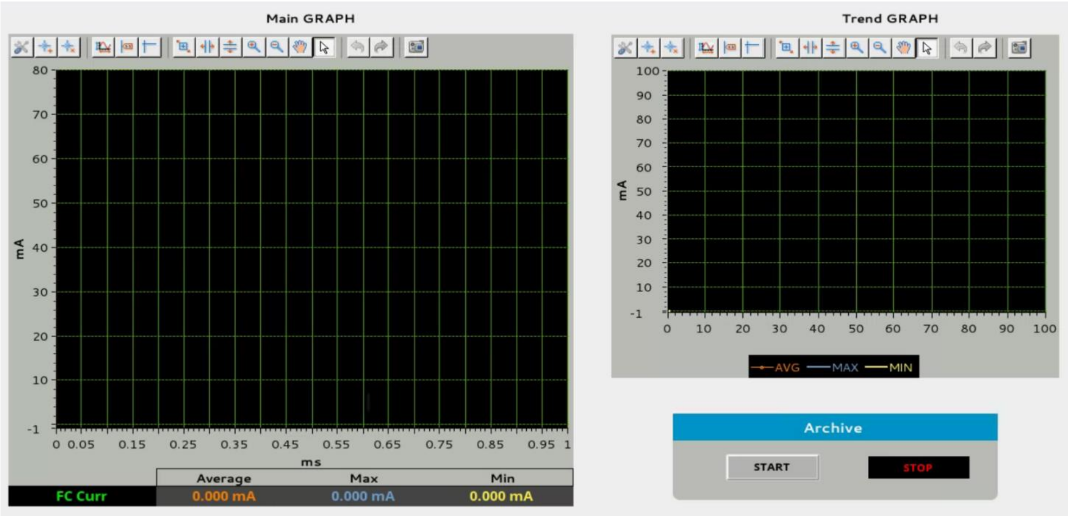
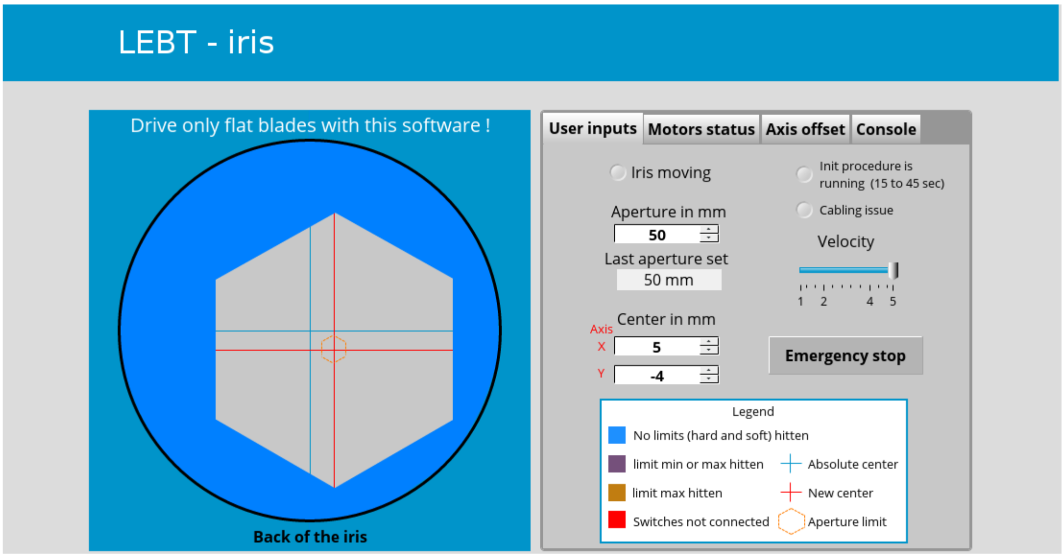


Figure 14: Display the beam on the Faraday Cup

For more information please refer to: **FaradayCup_usermanual.pdf**

5.2.2 IRIS

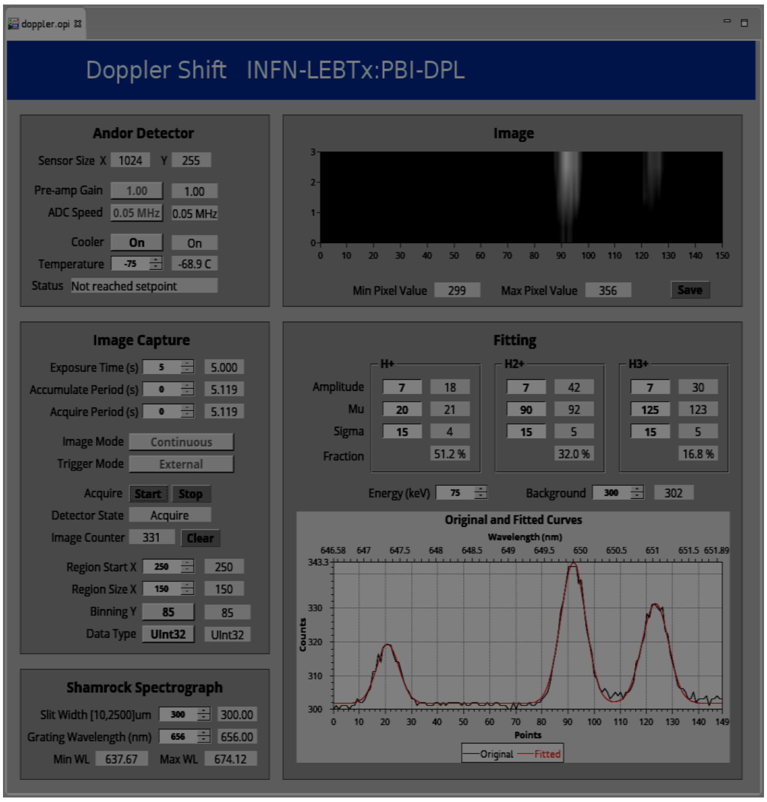
When the button **IRIS** is selected, this OPI appears:



For more information please refer to: **Iris_control_systeme_documentation_v1.pdf**

5.2.3 Doppler

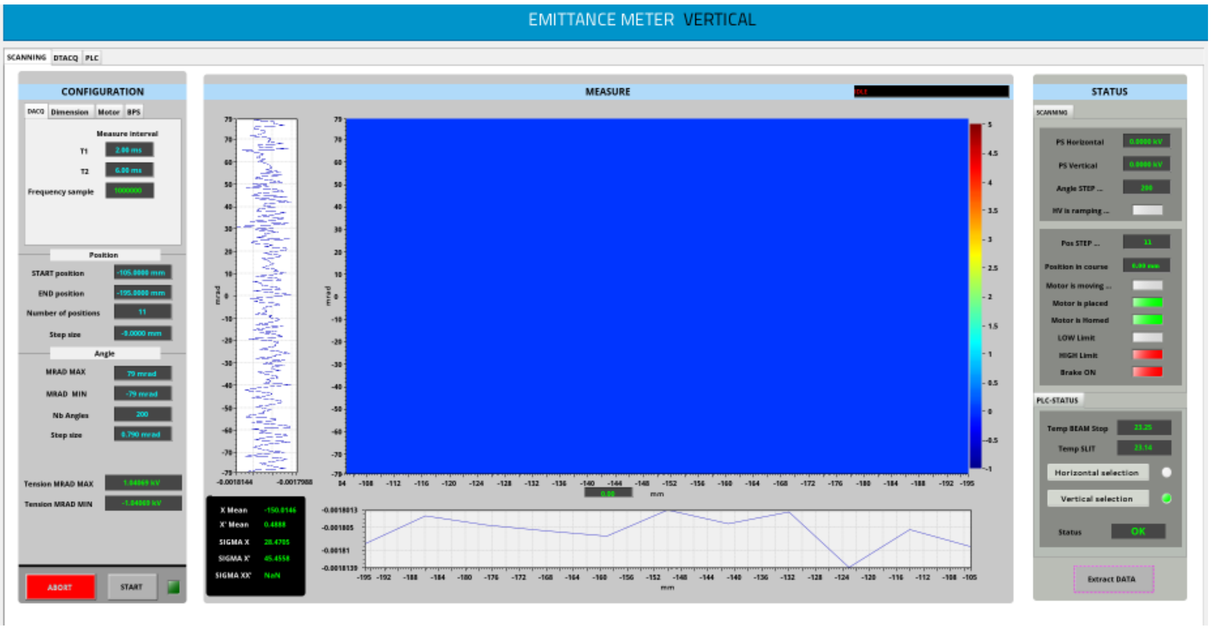
When the button **DOPPLER** is selected, this OPI appears:



For more information please refer to: **Doppler_Shift_Software.pdf**

5.2.4 EMU

When the button **EMU** is selected, this OPI appears:



For more information please refer to: documentation in progress…

6. LIST OF ABBREVIATIONS

Abbreviation	Definition
GUI	Graphical User Interface
IOC	Input Output Controller
ISRC	Source
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
IPC	Industrial Personal Computer