

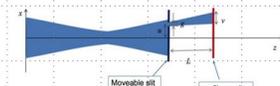
EPICS BASED HIGH-LEVEL CONTROL SYSTEM FOR ESS-ERIC EMITTANCE MEASUREMENT UNIT DEVICE

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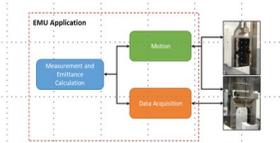
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Scheme showing the Emittance measurement using Slit-Grid EMU. Source: (Oheyama, R. Miyamoto, "Preliminary Design of the ESS Slit and Grid System")



EMU Application



EMU hardware scheme. [Source: I. Maskharan, "EMU Development Document"]

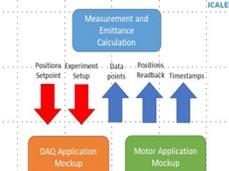
EMU software schema adopted during the application development: it is possible to observe the low-level applications (Data Acquisition and Motion) and the high-level orchestration.

The European Spallation Source (ESS) will be a neutron source using proton beam Linac of expected 5MW beam power. The beam commissioning of low energy beam transport (LEBT) started on 2018 and currently expected to reach to the end of Medium Energy Beam Transport (MEBT). Several diagnostics are installed to characterize the proton beam and optimize the beam matching in radio frequency quadrupole (RFQ) section and rest of accelerator. Among all diagnostics, Allison scanner and Slit-Grid type emittance measurement units (EMUs) will aid by characterizing the beam in transverse plane (both horizontal x and vertical y) in LEBT and MEBT, respectively. Here in this paper the Slit-Grid EMU is explained and the software layer developed in EPICS and realized to orchestrate the entire apparatus and control the different sub-systems will be described.

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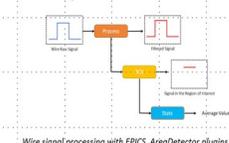


Measurement and Emittance Calculation

Positions Experiment Setup → data points → Positions Readback Timestamps

DAG Application Mockup → Motor Application Mockup

EMU low-level mock-ups used to simulate data acquisition and motion hardware.



Wire signal processing with EPICS AreaDetector plugins.

The low-level software layer

- data acquisition software
 - based in areaDetector drivers (NDArrayPortDriver class);
 - provides the raw analog data as NDArrays that are further processed by a series of areaDetector plugins;
 - the result of the process chain is the average of the current in each wire of the grid, calculated over a region of interest.
- motion control
 - implemented using ECMC framework

The high-level orchestration layer is a pure software application and it defines the core part of the emittance measurement.

- In particular it is in charge of:
 - Provide the interface between the system and the user;
 - Coordinate data acquisition and motion systems;
 - Calculate the beam emittance and all the relative parameters required by the user;
 - Collect all the experimental data and store it via NeXus service.

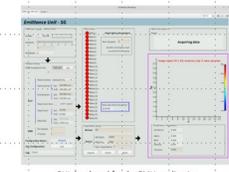
been composed by the following parts:

- A set of state machine programs used to coordinate the low-level functional sub-systems;
- A set of EPICS Databases devoted to map the information exchanged between high-level and low-level and between application and final user;
- Additional custom C libraries used to implement particular functions required by the application and not available in the standard one

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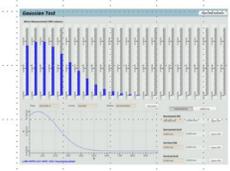


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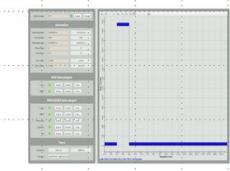


GUI developed for the EMU application.

The Emittance Meter Unit is an important equipment for calculating the transverse emittance related to the beam in the MEBT section of the linac. Due to the requirement and indications coming from ESS-ERIC. Guidelines in terms of hardware and software standards, the application developed has been a great challenge in the matter of technical solutions adopted: during the software upgrade: time optimization had a key role in the entire work.



GUI developed for motion system

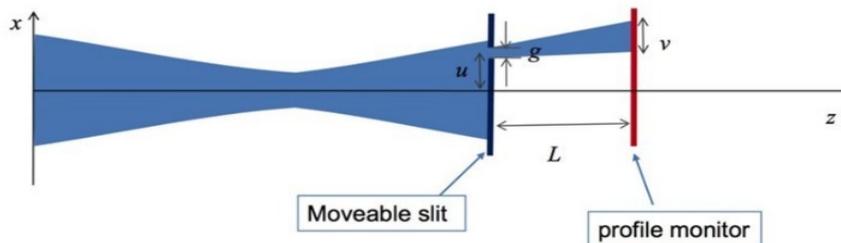


GUI developed for data acquisition system

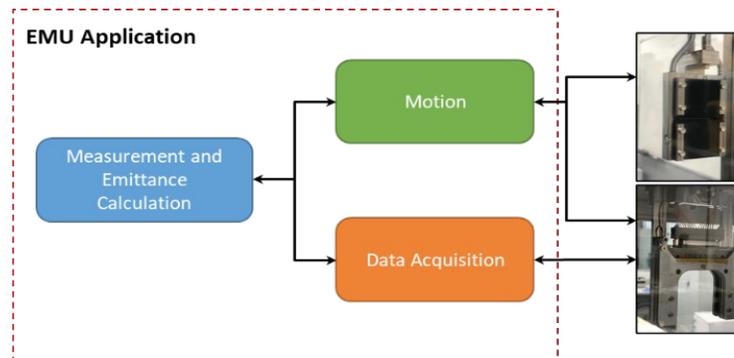
The application has been tested with the simulated environment and the preliminary results are promising. Further tests with the real hardware are scheduled in the next period. In the meanwhile, code optimization in terms of memory usage will be done.

In addition, the long-term goal the team would achieve is using the results of this work to establish a scanning instruments EPICS framework for the entire project, reusing it on the EMU systems in the LEBT and on the Wire Scanners instrumentation.

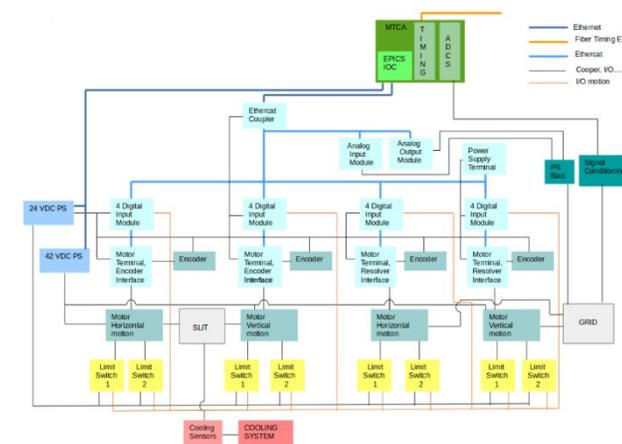
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Scheme showing the Emittance measurement using Slit-Grid EMU. Source: Cheymol, R. Miyamoto, "Preliminary Design of the ESS Slit and Grid System"



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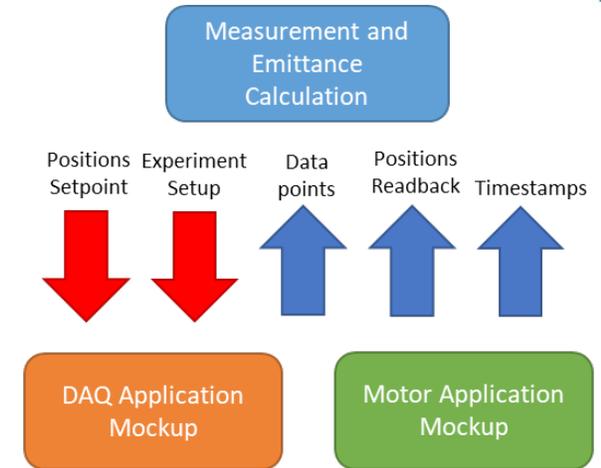
EMU hardware scheme. (Source: I. Mazkarian, "EMU Development Document")

The low-level software layer

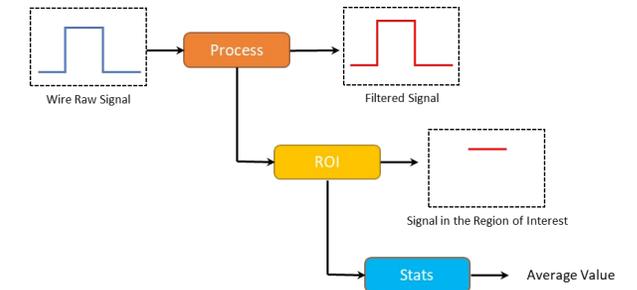
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(EMU low-level mock-ups used to simulate data acquisition and motion hardware.)

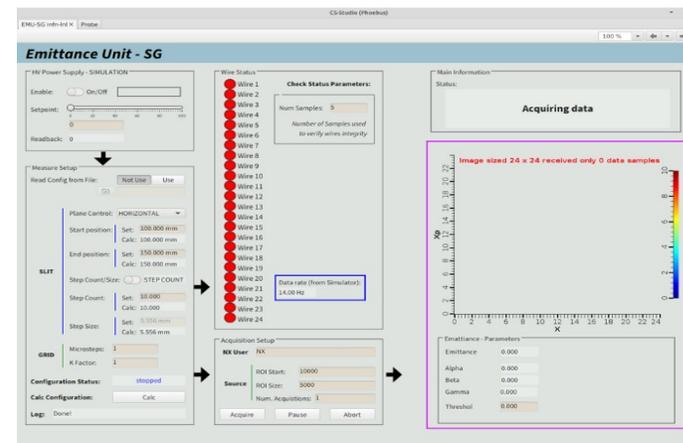


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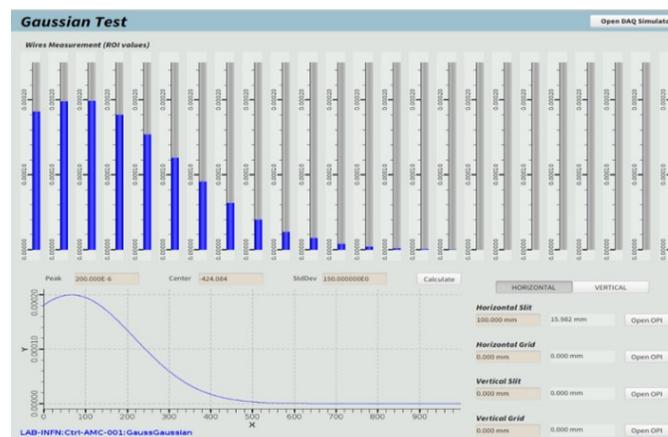
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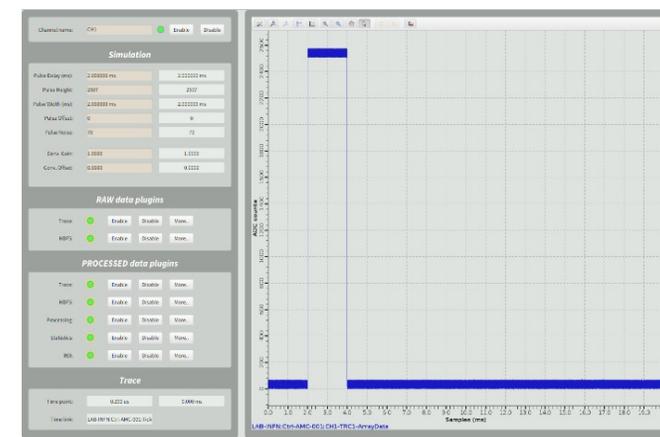
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