Strong interaction studies in antiproton annihilation (SISTINA)

- 2021 Annual Summary Document for the ISAB FAIR-RO-

1.1 Group list (physicists, staff, postdocs, students):

Name	Position
Petre-Constantin BOBOC	Physicist (Research Assistant) – IFIN-HH, PhD *Student*
Alexandru-Mario BRAGADIREANU	Physicist (CS III) – IFIN-HH
Stefan-Alexandru GHINESCU	Physicist (Research Assistant) – IFIN-HH, PhD *Student*
Ovidiu-Emanuel HUTANU	Engineer - IFIN-HH*, Master Student*
Alina MOTORGA	Project accountant - IFIN-HH

1.2 Specific scientific focus of group (state physics of subfield of focus and group's role);

Physics subfields: QCD bound states, Hypernuclear Physics.

Taking into account the expertise of our group (ATLAS, EXCHARM, FOCUS, DEAR and SIDDHARTA experiments) we expressed our interest in the measurements dedicated to charmonium and exotic states and in the Hypernuclear Physics with emphasis on Ξ^- atoms were our experience in detecting X-rays coming from transitions in Kaonic exotic atoms would be beneficial for PANDA Collaboration.

1.3 Summary of accomplishments during the reporting period

Since PANDA experiment is now in Construction phase our short-term objectives, for 2020, were focused on research and development activities for PANDA STT sub-detector and its integration in the PANDA control system.

Accomplishments:

- design and assembly of an enhanced Multifunction Rack Control Unit (MRCU v4)
- development of Epics device support software (IOC) for the MRCU v4;
- development of the operator interface development (OPI) for MRCU v4;
- installation, configuration operation and performance testing of PV archiver system.

2. Scientific accomplishments (max. 3 pages) – Results obtained during the reporting period.

The Multifunction Rack Control Unit (MRCU) is a system based on the Atmega1284P microcontroller produced by Microchip/Atmel. The main role of this system is to monitor and control a set of parameters and a wide range electronic devices and equipment. It was designed in order to be used in the HASC sub-detector electronics racks of the NA62 experiment from CERN, Switzerland but it can also be used in other detectors or experiments. The main functions of MRCU are listed below:

- Seven 230V AC and 16A AC controlled outputs. Each of these seven outputs are connected to a NC relay which are controlled by the microcontroller through a current driver meaning that in normal conditions all the outputs are supplied with 230V AC. If one of the outputs must be disconnected, a 5V DC must be applied to the relay;

- Four low voltage inputs or outputs (5V DC) which can be used for input alarms or to trigger some output alarms. This input/outputs can be used also to control a peripheral system which accept 5V level control signals;

- Four control outputs in NO state which can be used to do a hard reset on the monitored devices or equipment. An example of a device which can be hard reset by the MRCU system is the Raspberry Pi single-board computers which are used in the NA62 experiment;

- A fully integrated Hall Effect linear current sensor is used to monitor the current consumed by the all of the seven outputs and by the power supply of the MRCU system. The output signal from all the eight sensors is read by the analog to digital converter (ADC) inputs of the microcontroller;

- Three NTC type thermistors are used to monitor the inside temperature of the MRCU system. One is placed on the Motherboard and another two will monitor the heat dissipated by the power supply and the ambient temperature;

- Four temperature and humidity sensors (SHT21) are used to monitor the temperature and humidity in different points of interest in the electronics racks or nearby;

- The MRCU system contains also an integrated circuit which can read the temperature from up to 8 PT100 RTD type sensors. The sensors can be connected to the MRCU system by a custom cable with DB25 male connector or by using a custom PCB in different configuration of one to eight sensors;

- All the low voltages used to supply the MRCU system are monitored and can be displayed on a computer display using dedicated software. The analog input of the ESP8266 SoC (System on Chip) is used to monitor these voltages and the thermistors;

- A back-up battery together with a charging circuit it’s used to supply the system in case of a main supply failure. The failure is sensed by a detection circuit which connect the battery voltage to the MRCU supply;

The communication and the control of the MRCU system can be done remotely using an Ethernet connection for very large distances or by a Wi-Fi connection for short distances. For short distances can be also used the RS-232 communication which are also implemented. An USB connection is used in order to upload a firmware on the microcontroller but this can be used just in the maintenance and/or debugging mode. That means that its need to have physical access to the system in order to use this communication and that is because the communication between USB and the microcontroller its hardware removed after the firmware was uploaded.

The main difference between MRCU v3 and MRCU v4 (see fig. 1) is that the circuit used to read the temperature of the PT100 RTD sensor, which was a mezzanine board, it was replaced by a dedicated circuit placed on the same board. By replacing this circuit, the boost converter used to generate 12 V DC used to supply the mezzanine board was also removed. The advantage is that the final price of the system was considerable reduced. Another difference is that the circuit which was used to interface the MRCU motherboard with a Raspberry Pi single-board computer was removed because the motherboard has now a dedicated ethernet connection.

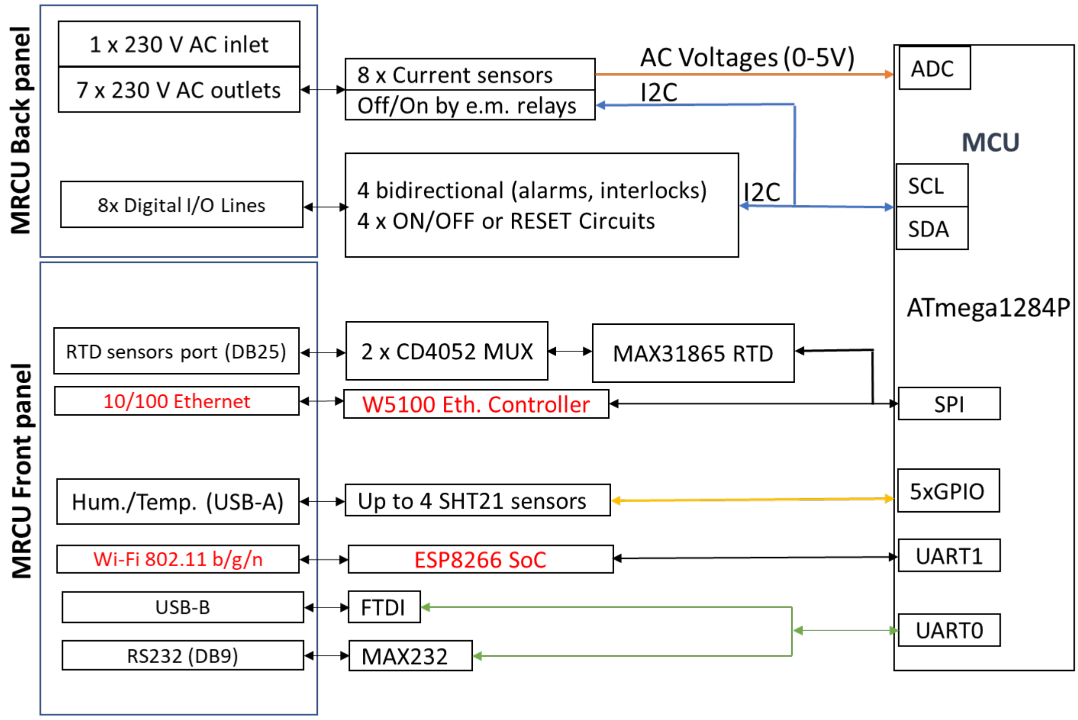

Fig. 1 MRCU v.4 general view

The software controller and the graphical user interface (OPI) were developed using EPICS and Python Display Manager framework (PyDM). The OPI consists on various widgets which can be used to monitor and control the MRCU. As an example the widget developed to control the AC and the current consumption is shown in fig.2.

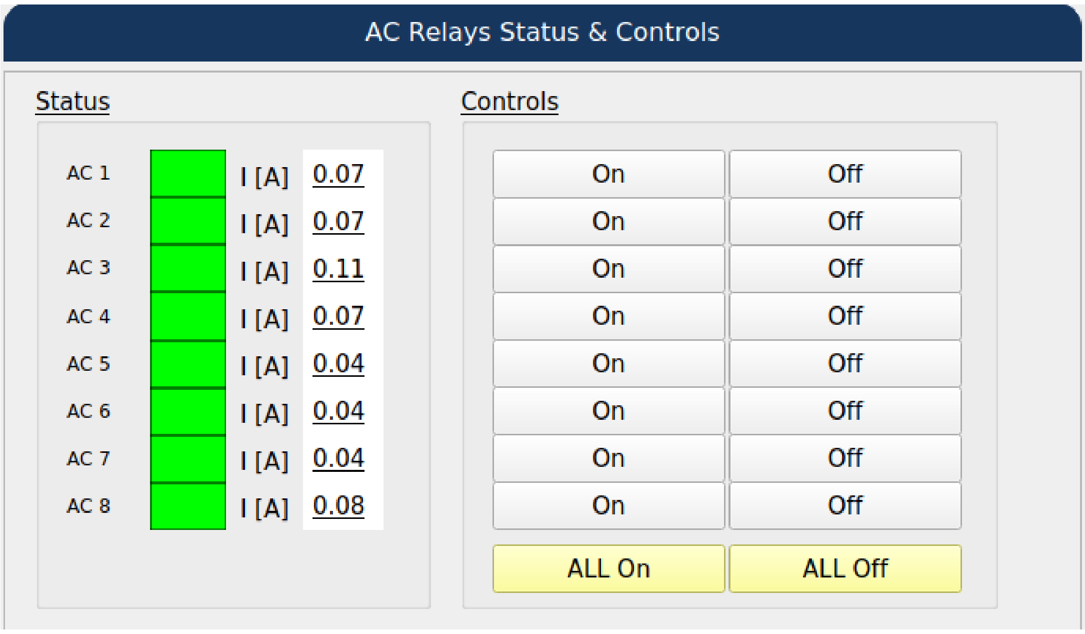

Fig. 2 MRCU v.4 operator interface component

The test bed for database storage and retrieval developed at the begging of 2018 in IFIN-HH, with reused IFIN-HH PANDA grid compute nodes, has been updated in 2021 consisting of 10 reused computers and 1 new computer serving as a database server (fig. 3).

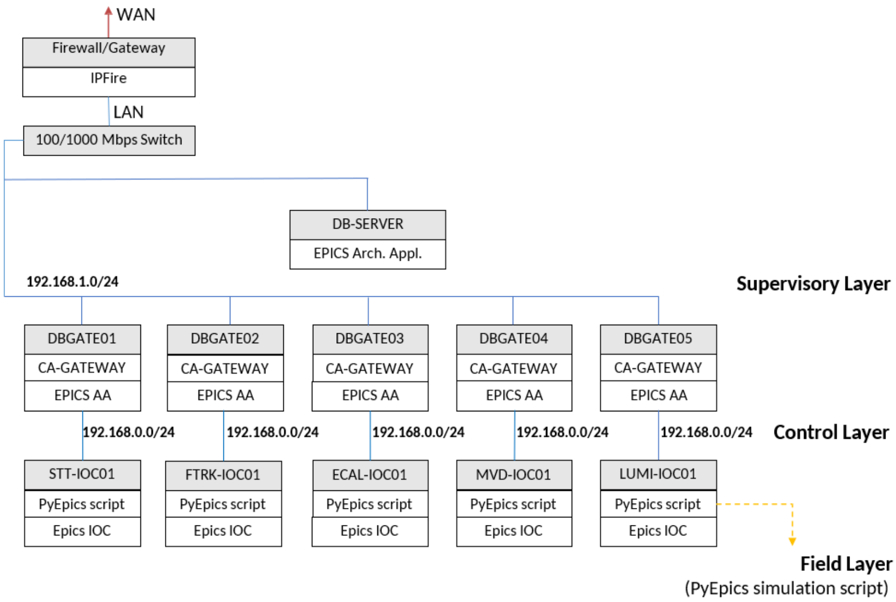

Fig. 3 Process Variable archiving test-bed

We developed a solution to deploy EPICS Archiver Appliance using Docker, the configuration files and the data generated by the Archiver Appliance being able to be stored both locally and on a network file system. The database storage test bed consists of:

- 5 computers in the field layer: each computer runs an EPICS IOC with 12002 Process Variables (PVs) and a Python script used to generate random values for the PVs
- 5 computers in the control layer: each computer runs an instance of EPICS CA-Gateway which serves as a channel access client and server and an instance of EPICS Archiver Appliance archiving 12002 PVs, used as a backup solution for each computer
- 1 computer in the supervisory layer running an instance of EPICS Archiver Appliance which archives all 60010 Process Variables. This computer can also be used as a data retrieval solution using the built-in web data retrieval tool.

Using EPICS' built-in performance monitor, the system load for the machines in the control layer does not exceed 5% and the supervisory layer's computer system load does not exceed 25% (Fig. 2).

Fig. 4 System load and Java Virtual Machine parameters graph

3. Group members (table):

- List each member, his/her role in project and the Full Time Equivalent (FTE) % time in project.

Name	Role	FTE
Petre-Constantin BOBOC	Software development	0.33
Alexandru-Mario BRAGADIREANU	Controls Software development, Hardware integration	0.37
Stefan-Alexandru GHINESCU	Software development	0.33
Ovidiu-Emanuel HUTANU	Electronics hardware design, assembly and testing	0.33
Alina-Petronela MOTORGA	Accounting	0.17
	TOTAL	**1.54**

- List PhD/Master students and current position/job in the institution.

  Petre-Constantin BOBOC– PhD student / research assistant;

  Stefan-Alexandru GHINESCU – PhD student/ research assistant;

  Ovidiu-Emanuel HUTANU – Master student/ engineer.

4. Deliverables in the last year related to the project:

- PANDA Phase One, Eur.Phys.J.A 57 (2021) 6, 184
- Study of excited Ξ baryons with the PANDA detector, Eur.Phys.J.A 57 (2021) 4, 149
- The potential of Λ and Ξ^- studies with PANDA at FAI, Eur.Phys.J.A 57 (2021) 4, 154
- Feasibility studies for the measurement of time-like proton electromagnetic form factors from pp-> μ+μ- at PANDA at FAIR, Eur.Phys.J.A 57 (2021) 1, 30

5. Further group activities (max. 1 page):

In 2020 the Multipurpose Rack Control Unit v.3 was upgraded- with embedded ethernet and Wi-Fi controllers. The unit was built in the framework of NUCLEU project, a new firmware being developed and tested successfully at the end of 2020.

6. Financial Report (budget usage) for the reporting period (see the Annex).

7. Research plan and goals for the next year (max. 1 page).

The research plan is shown in the table below.

Year	2020				2021				2022				2023			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Requirements for the STT read-out electronics																
Integration of STT readout in the control system																
Gas system																

The main goals are to define the requirements for the STT read-out electronics and to implement them in a control system.

Financial Report 2021

according to the regulations from H.G. 134/2011

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Type of expenditures		2021
1	**PERSONNEL EXPENDITURES**, from which:	**192,892.00**
	1.1. wages and similar income, according to the law	188,647.00
	1.2. contributions related to wages and assimilated incomes	4,245.00
2	**LOGISTICS EXPENDITURES**, from which:	**76,493.82**
	2.1. capital expenditures	69,824.35
	2.2. stocks expenditures	6,669.47
	2.3. expenditures on services performed by third parties, including:	0.00
3	**TRAVEL EXPENDITURES**	**0.00**
4	**INDIRECT EXPENDITURES – (OVERHEADS) ***	**99,845.18**
TOTAL EXPENDITURES *(1+2+3+4)*		**369,231.00**

* Specify the rate (%) and key of distribution (excluding capital expenditures).
Indirect Expenditures = General IFIN-HH Overheads (35% from 1+ 2.2 +2.3 +3) + Particle Physics Department Overheads (15 032291%% from 1 +2.2+2.3+3)

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