# Status Report of RAON Control System

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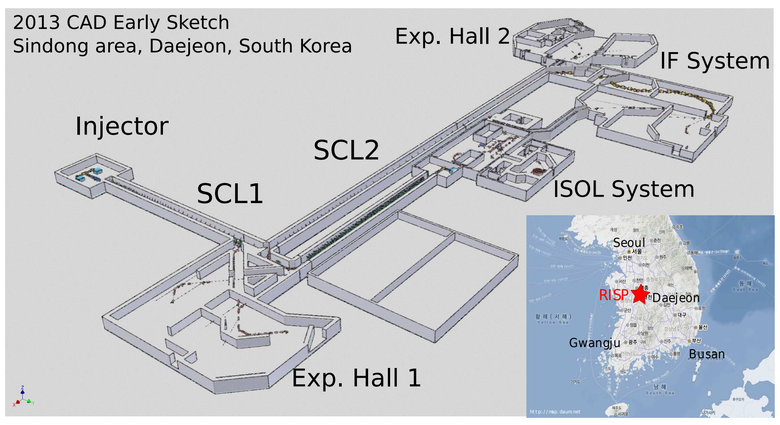
## Abstract

The RAON [1] is a new heavy ion accelerator under construction in South Korea, which is to produce a variety of stable ion and rare isotope beams to support various researches for the basic science and applied research applications. To produce the isotopes to fulfill the requirements we have planed the several modes of operation scheme which require fine-tuned synchronous controls, asynchronous controls, or both among the accelerator complexes. The basic idea and development progress of the control system as well as the future plan are presented.

## The RAON

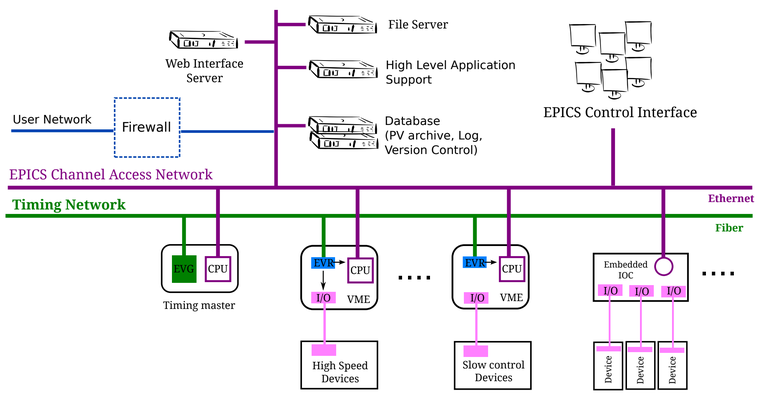



The RAON consists of both the 400 kW In-flight Fragmentation (IF) facility and the 70 kW Isotope Separator On-Line (ISOL) facility. The IF accelerator system is designed to produce stable ion beams with maximum energy up to 200 MeV/u for uranium (600 MeV for proton). The ISOL accelerator system delivers rare isotope beams with maximum energy of 18.5 MeV/u. The two different systems should be operated both independently and concurrently with respect to the user requirements, which is the unique feature of RAON accelerator system.

## Requirements

- Integration of many different subsystems :
  RF system, beam diagnostics, power supply, vacuum control, beam line control, and machine protection
- An exclusive operation two and more accelerator systems for two facilities :
  In-flight Fragmentations (IF) and Isotope On-Line (ISOL)
- C.W. and pulsed beam operation
- Beam off latency $< 50$ $\mu$secs
- Automation of most of subsystems and manual control of beam line elements
- EPICS integration

## Architecture

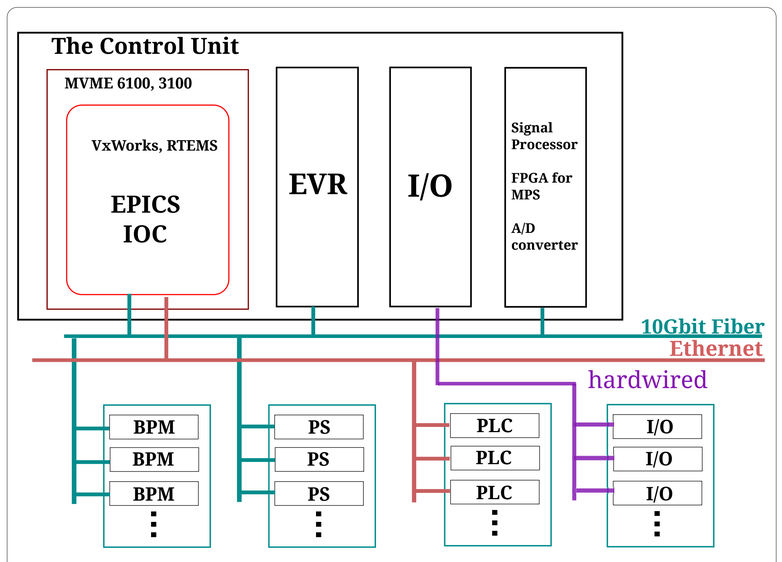



- Tightly integrated with the EPICS
- Using two network grid : Timing event network and EPICS channel access (CA) network
- The main building block is the control unit $\rightarrow$ for simplified and fast integration
- CA network is linked to the database, HLA and EPICS control interface for users

### System Standards

- **EPICS**, All and Sundry systems ;-)
- Debian Linux for OS, VxWorks for RTOS
- PostgreSQL for accelerator configuration
- SVN or git for sources & documents version control
- International / market standard hardwares
- 10 GB Ethernet backbone (1 GB for Usernet)

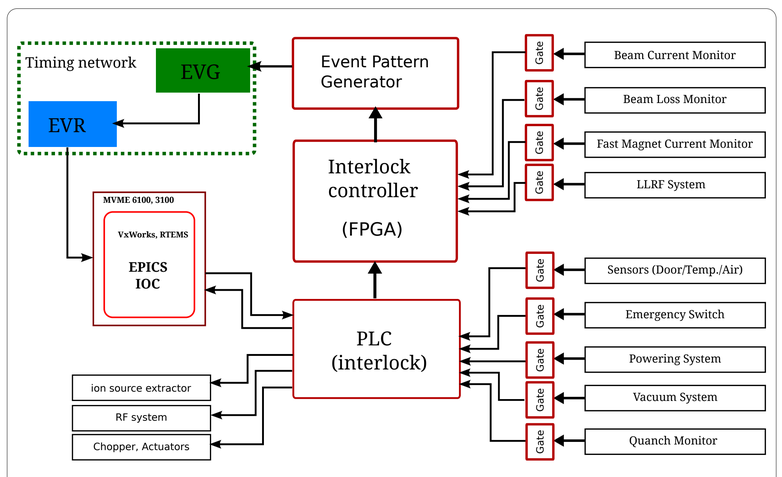
## The Control Unit




- VME platform.
- Consists of a SBC running with RTOS, EVR and I/O board.
- EPICS I/O Controller controls the PLC and subsystem.
- Ethernet connection with time stamps given by EVR.
- PLC is the front-end interface to the subsystems.

## Timing system & Machine protection

- Timing system requires :
  - low latency, jitter in fs level.
  - deterministic operation.
  - high speed signal processing.
  - identifying a bunch.
- We will use :
  - MRF EVG/EVR hardwares [3]
  - Libera BPM products [4]
- We are considering to :
  - use White Rabit for timing system [5].
  - develope homemade BPM with domestic company.




- Interlock controller : use PLC (S7, AB, LSIS [2])
- Integrated with timing system using FPGA based controller.
- Still need idea for more complicated system.

## Database

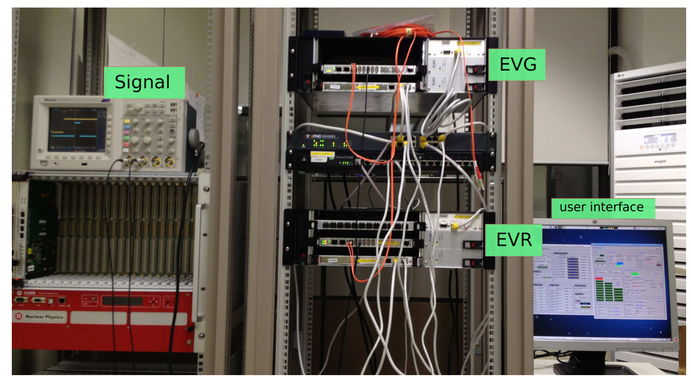
- Data Archieving : PV, HW/SW configuration, A/D signals, Logging.
- Documentaion and version control.
- DAQ and pre-processing : BPM and RF related data.
- Use open-source based programs : Channel Archiever with PostgreSQL.
- Develope an archiving framework dedicated to RAON.

## User Interface / High Level Application

- Intuitive, Comprehensive.
- Applying existing EPICS CA Clients : EDM, MEDM, StripTool, CSS.
- Developing an UI envrionment dedicated to RAON using existing tools :
  - C/C++ : EPICS Qt
  - JAVA : JCA
  - Python : Cothread
  - LabView : CaLab
- SNS, CSNS, ESS, GANIL, TRIUMF, and FRIB use/plan to use the XAL [6].
- Consider to use XAL and join OpenXAL [7] project.

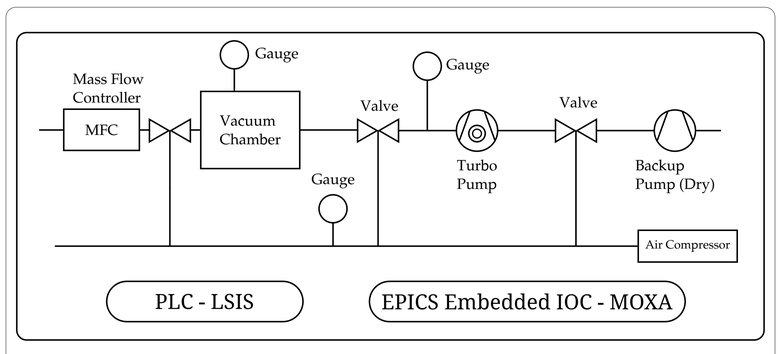
## Status

### The control unit for timing system




- Two test VME crates consisting of EVG, EVR, and MVME6100 with VxWorks 6.9.
- Connected via EPICS channel access using fiber cables for event network.
- Test : jitter, delay time, latency.
- It will be used to test injector and superconducting LINAC system.
- The international bidding for prototyping is under way in parallel.

### The vacuum control system




- A testbed for the vacuum control system is being developed with a domestic company.
- The vacuum system controlled by PLC will be integrated with EPICS and be used for the test facilities.

### Naming convention

- Important for the system integration
- Should be comprehensive to user and maintainer.

A primitive naming convention study is done and shown as following:

DDDDIII-SSSS:TTTT.XXXX,

where DDDDIII is a device identifier, SSSS is a system name, TTTT is the signal name followed by the EPICS DB convention, and XXXX is the signal suffix. This naming convention is not fixed but being improved upon the user's request.

## Summary & Outlook

The goal of RAON control system is to provide good environment to operate the IF and ISOL accelerator systems. The notion of system architecture and the control unit are being developed. The development of a testbed for vacuum control system and a prototype of timing system together with MPS are also proceeding. Since a test facility for injector and linear accelerator is planned to be finished in next year, the two prototyping of control and timing system will be tested and evaluated. In addition the engineering design of central control system will start soon.

## Acknowledgement

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## References

[1] Y. K. Kwon, *et. al*,"Status of Rare Isotope Science Project in Korea", Few-Body Syst 54, 961-966, (2013).

[2] LSIS PLC solutions, http://www.lsis.co.kr/ls/product/product_cate02.asp?cate01=A03&cate02=001

[3] Event system by Micro-Research Finland Oy, http://www.mrf.fi

[4] BPM phase & position processor, http://www.i-tech.si

[5] M. Lipinski, J. Serrano, T. Wlostowski, and C. Prados, "Reliability in a White Rabbit Network", ICALEPCS'11, WEMMU007 (2011).

[6] J. Galambos, *et. al*., "SNS Application Programming Environment", EPAC 2002, Paris, France (2002).

[7] Open XAL project, http://xaldev.sourceforge.net