Status of RAON (with delight) Control Systems

RAON is the name of the RISP accelerator

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Rare Isotope Science Project (RISP) - Location

Here we are

Facility for Rare Isotope Beams

http://www.google.com/maps
2014 RISP Conceptual Bird's Eye View
Sindong, Daejeon, S.Korea

Early Morning

Supply/Utility Bldg
Exp. Halls
Preserved Forest Area
Main Bldg
Main Gate
RISP accelerator - RAON - Operation Modes

RAON Major Operation Modes

- **M1**: ECR-IS > SCL1 > ExHalls
- **M2**: CYC > ISOL > ExHalls
- **M3**: ECR-IS > SCL1/2 > ExHalls
- **M4**: CYC > ISOL > SCL3 > ExHalls
- **M5**: ECR-IS > SCL1/2 > IF > ExHalls
- **M6**: ECR-IS > SCL3 > ExHalls

*Mx*: Low Energy Facility  
*Mx*: High Energy Facility

Driver Linac

- SCL2 (~200 m)
  - 200 MeV/u, 8.3 μA for U⁷⁸
  - 600 MeV, 0.66 mA for P

Post Accelerator

- **M1**: Recoil Spectrometer (KOBRA)
- **M4**: Large Acceptance Spectrometer
- **M6**: Nuclear Science Facility
- **M2**: High-Precision Mass Measurement
- **M3**: Collinear Laser Spectroscopy
- **M5**: β-NMR

ISOL System

- **M1**: Large Acceptance Spectrometer
- **M2**: High Resolution & Zero Degree Spectrometer
- **M3**: Bio-medical Research (II)
RISP accelerator - RAON - Operation Modes

Driver Linac
- SCL2 (~200 m)
  - 200 MeV/u, 8.3 μA for U^{78+}
  - 600 MeV, 0.66 mA for P

Post Accelerator
- SCL3 (~100 m): 18.5 MeV/u

IF System
- M7
  - Large Acceptance Spectrometer
  - High Resolution & Zero Degree Spectrometer

ISOL System
- ECR-IS-3 (10 keV/u, 12 μA)
- RFQ1 (500 keV/u, 9.5 μA)
- ECR-IS-1 (10 keV/u, 12 μA)
- MEBT1
- LEBT1
- LEBT2
- RFQ2
- LEBT2.2
- A/q Separation
- CB
- HRMS
- ISOL
- Targets
- Cyclotron
- IF Target
- Gas Catcher
- Fragment Separator

RAON Major Operation Modes
- M4 : CYC > ISOL > SCL3 > ExHalls
- M5 : ECR-IS > SCL1/2 > IF > ExHalls
- M7 : CYC > ISOL > SCL3/2 > IF > ExHalls

Most Interesting OP Mode
2015.05
RAON Control System Mission, Goals, & Members

**Mission**
- Build reliable, usable, scalable, and efficient accelerator control systems for the RAON accelerator facility and its user community

**Goals**
- An efficient and conservative system in terms of budget, schedule, construction phase, and human resources
- EPICS integration of all possible signals from overall accelerator sub-systems
- Versatility in order to meet design requirements, which are operation modes, beam species, and beam energies, from user community and various science goals

**Members**

Control Members have

- Work Experiences at JLab (U.S.A.), MAMI, GSI (Germany), PAL, & KSTAR (S.Korea)
- Various Major Backgrounds
  - Experimental Nuclear/Hadron Physics
  - Electrical Engineering
  - Bio-medical Engineering
  - Control Engineering
  - Computer Science and Engineering
RAON Control System Fact

until 2015.05

- EPICS, All and sundry systems ;-) (R3.14.12.5)
- Debian Linux 64bit for OS (Wheezy)
- PostgreSQL, MySQL/MariaDB for SW and configuration
- git for sources & documents version control
- MRF EVG/EVR boards, MVME6100, MVME3100, VxWorks, and RTEMS for timing system
- Broadcade ICX 6430 and 6910 for Layer 2 Network Switch
- AB, Siemens, LSIS (S.Korea Domestic vendor) for PLC
- RTP3000
- CSS and KSTAR Widget Toolkit (QT based) for OPI
- Simple Network Management Protocol (SNMP) V2c (Read) and V3 (Write) for overall Ethernet-based devices
- Raspberry Pi (low cost) for monitoring low priority PVs
ONE Development Environment for control members

RAON EPICS Development Environment

can be ready for use by 'shell scripts' semi- automatically (x86, x64, arm)

Lv0. download
Lv0. epics version

Lv1. base : EPICS base
Lv1. epicsLibs : synApps, and others EPICS Libs
Lv1. extensions : EPICS extensions
Lv1. siteApps : RAON specific EPICS apps
Lv1. siteLibs : RAON EPICS Libs
Lv1. setEpicsEnv.sh : Dynamic Env Setup Script

This is the quick-and-dirty approach, but the cost-effective way for us.
Note that we want to move the 100% Debian packaging SoOoOoOoON~~~
ONE Development Environment for control members

RAON EPICS Development Environment

can be ready for use by 'shell scripts' semi-automatically (x86, x64, arm)

RAON_SITELIBS : epics/versions/siteLibs

Lv0. db, dbd, lib, include

use only RAON_SITELIBS to make any EPICS Apps

Lv0. Various Developing RAON Specific EPICS Libs

Lv0. One Makefile

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maintained through github.com

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Note that we want to move the 100% Debian packaging SoOoOoOoON~~~
RAON EPICS Development Environment

can be ready for use by 'shell scripts' semi-automatically (x86, x64, arm)

RAON_SITEAPPS : epics/versions/siteApps

Lv0. bin : raon_ioc_bash
> start the selected IOC within the SCREEN session,
  - if the IOC is already running, attach to it
  - if no IOC is running, create and attach to it

Lv0. EPICS Apps Examples

Lv0. Developing EPICS Applications

Lv0. Internal Traning EPICS IOCs

maintained through github.com

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Scene - where we burn ourselves out

Control Test Room

Test Racks for Ctrl & Timing
Development on RAON control system

Timing System

- Event Generator
- Event Receiver
- RTOS-VxWorks
- GPS / NTP / Clock
- Oscilloscope
- Signal Generator
- 1Hz Pulse Mode
- TS Demo System
- User Interface

Programmable Time Delay
Programmable Time Width
Development on RAON control system

Stepper Motor Testbeds
- can test 3 types of Stepper Motor (encoder, spindle, motor)
- based on LSIS PLC + touch pad
- EPICS integration in progress

A Stepper Motor Control Box
for leak valve control

- Raspberry PI B+ (R.Pi) as EPICS IOC (Ethernet to R.Pi): Rev 0
- So far, no issue yet, except Ethernet connection loss
- R.Pi2 as EPICS IOC
  > Ethernet to R.Pi
  > Direct Serial2Optical to R.Pi in progress
    : can control "a motor" when we lose the Ethernet connection

CSS UI
Development on RAON control system

EPICS monitoring system for Office Environment

CS Studio User Interface

Printer Monitoring System
- XEROX
  - Ready
  - Notification: Cyan Cartridge needs to be replaced soon.
  - Tray5 needs to be filled.

KYOCERA
- Ready
  - Notification: Job Activity: 0
  - MP Tray needs to be filled.

Paper Tray
- Tray 1: A4 OK 75%
- Tray 2: A4 OK 75%
- Tray 3: A4 OK 100%
- Tray 4: A3 OK 75%
- Tray 5: Empty

PAPER

Toner Cartridge
- Cartridge: OK
- Cyan: Change
- Magenta: OK
- Yellow: OK
- Waste Toner
  - Cartridge: State
  - Waste: OK
  - R1 (Cyan): OK
  - R2 (Magenta): OK
  
Office Environment
- Room: 25 °C
- Humidity: 34%
- CO2: 0.0 ppm

Server Room
- Room: 21.0 °C
- Humidity: 39.0%
- CO2: 1.1 ppm

Control Room
- Room: 24.0 °C
- Humidity: 34.0%
- CO2: 186.7 ppm

modified NSCL/FRIX devSNMP RC8
SNMPv1/v2c

Raspberry Pi
(Temp, Humidity, Air Quality)
Development on RAON control system

RAON EPICS integration of SNMPv3 - independent upon devSNMP

CS-Studio UI for SNMPv3 Reference (APC 7910 PDU)

- work well with APC PDU
- asked the Wiener-d to support SNMPv3 a year ago
- delivered the prototype fantray
- testing it under EPICS+SNMPv3
- issue: no response from Fanspeed (R/W). Still unknown where it comes from
Development on RAON control system

ECR-IS Control System Works in progress

EPICS IOCs for Others

AB PLC for Vacuum

50kV HV Platform (currently grounded)

connection test
Development on RAON control system

Environment Monitoring System at SRF test facility

Raspberry Pi, EPICS, Archiver Appliance, jQuery, web monitoring site
RTP3000 Testbed - Dual Redundant

Components
- Node & Chassis Processors
- Power Supplies
- AI, DI, DO, AO cards
- AI convertor (backplane)
- Thermo couple sensor (backplane)
- DI LED Lamps
- DO switch & LED lamps
- AI voltage meter

EPICS Integration in progress
Warm-up studies on RAON control system

ZynQ: Processing System (PS) with Programmable Logic (Xilinx FPGA)

- attend ZynQ trainings
- run EPICS soft IOC on PS (Dual core ARM)
- plan to connect with Stepper motor testbed and the timing system (ZC706 Evaluation kit has SFP/SFP+ module connector)
- plan to extend this study to BPM electronics Digital Frontend and FPGA communication logic development

Camonitor, an EPICS Process Variable under Ubuntu in VMware

EPICS soft IOC under peta-Linux on PS
Warm-up studies on RAON control system

Temperature Control Rack: CnCR

- Temperature control within ±0.1°C can be archived by the vendor. However, we want to test it.
- Planning for Temp. control test
- The main controller is a Linux PC (CentOS 6 with JAVA)
- EPICS integration within a Debian Linux PC in progress
- Proposed the vendor CnCR to an Ethernet Port with SNMP support instead of a Linux PC
- 42 U rack estimated cost ~ 12,000 k KRW
Main Control Center : MCC

Main Control Center Floor Plan 2015.4.

SCALE : 1/300
Summary and Outlook

- We are laying the slow and steady groundwork for EPICS integrated RAON control system.
- Still, we know, it is the big challenge to build the system so as to fulfill various operation modes.
- And definitely, there are many subjects that we can collaborate together within any forms.
- We would welcome your advice, critic, comment, suggestion, possible collaborated work with open arms.
- My email is jhlee@ibs.re.kr and jeonghan.lee@gmail.com
감사합니다!

Thank you!

Dankeschön!

謝謝！

¡Gracias!

Merci!

ありがとうございます！

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