EPICS at FREIA Laboratory

K. Gajewski, K. Fransson, Uppsala University, Uppsala, Sweden

FREIA Laboratory in Uppsala, Sweden, is a leading laboratory in accelerator R&D. It has its own helium liquefaction plant, two test cryostats (horizontal and vertical), RF power sources to feed the RF superconducting cavities as well as power converters and energy extraction system for testing the superconducting magnets. All these systems and related instrumentation are controlled from EPICS with Control System Studio (CSS/Phoebus) as the main user interface.

Equipment

Subsystem	Interface	Device Support	Epics records	Archived PVs
Helium liquefier plant	Ethernet Siemens PLC	S7plc, s7nodave, modbus	~1000	750+
Horizontal Cryostat HNOSS	Ethernet Siemens PLC	S7plc, s7nodave	~5500	800+
Vertical Cryostat Gersemi	Ethernet Siemens PLC	S7plc, s7nodave	~10000	~3000
Cryomodule + Valve box	Ethernet Siemens PLC	S7plc	~1500	~300
RF Power Amplifier DB Eletronica	Ethernet Siemens PLC	S7plc	~500	~250
RF Power Amplifier Electrosys	Ethernet Proprietary µcontroller	snmp	~500	~220
Magnet power supply*)	Ethernet Software gateway	stream, fgcepics	~2100	~100
Energy extraction system	Ethernet	modbus	~180	0
Fast interlock	Ethernet cRIO	NI Epics IO server	~200	~25
Slow interlocks	Ethernet Siemens PLC	S7plc	~1100	0
Radiation monitoring	Ethernet	stream,	~500	~25
Timing generator**)	cPCI	MRF hardware support	~550	~50
LLRF**)	µTCA	sis8300llrf	~5000	~850
RF cavity tuning system**)	EtherCAT Beckhoff	ecmc, ecmccfg, ethercatmc	~450	~50
Other instrumentation	Ethernet	stream, pydev, modbus, S7plc	13000+	~700

Table 1: Main subsystems and instrumentation controlled via EPICS.
*) Developed at CERN, including EPICS support
**) On loan from ESS for the tests of double-spoke cavity cryomodules

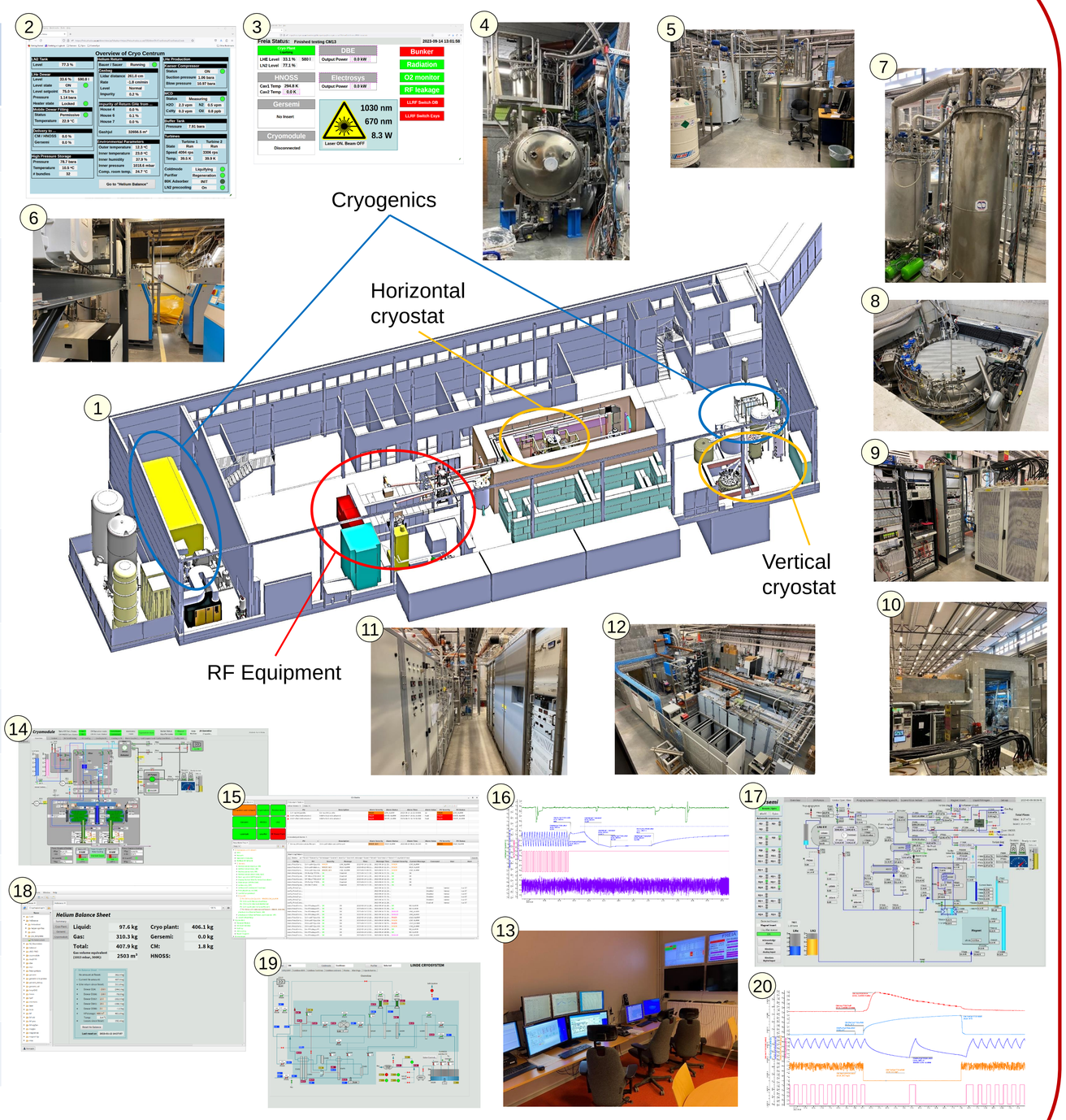

Figure 1: FREIA Laboratory: 1 – general layout; 2,3 – status displayed in the web browser; 4 – HNOSS, 5 – Linde cold box and the dewar, 6 – compressor room; 7,8 – Gersemi; 9 – magnet power supplies and energy extraction system; 10 – the bunkers; 11,12 – high power RF amplifiers and RF distribution; 13 – the control room; 14-20 – CSS/Phoebus screen dumps.

EPICS in numbers

Epics records	43000+
Main device support types	S7plc, s7nodave,stream
IOCs	30+
IOC's hosts	~10
Operator consoles (CSS/Phoebus)	6
Devices in the control network	150+
Archived Process Variables	Short term: 5000+ Long term: 7000+

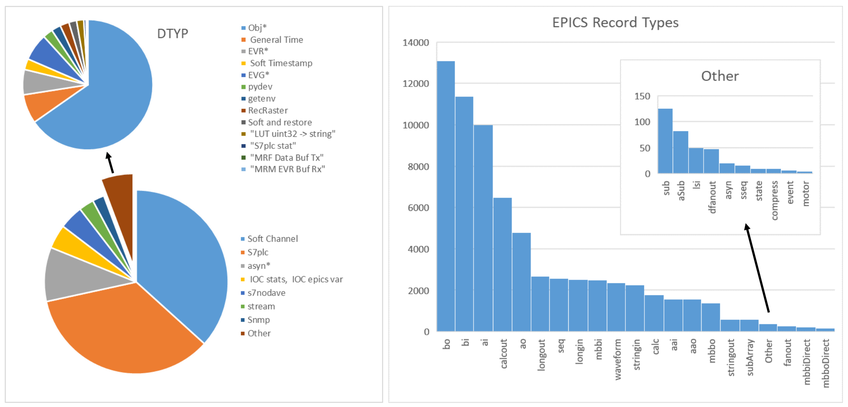

Figure 2: Total distribution of EPICS records according to DTYP field and record type.

PV Count	Connected	Event Rate	Data Rate (GB/day)	Engine write thread(s)
5403	5137	519.95	0.83	0.03
7374	7207	45.96	0.08	0.05

Figure 3: Excerpt from the EPICS Archiver Appliance metrics.

Services

- Archiver (Archiver Appliance)
- Alarm server (CSS/Phoebus)
- Channel Finder + RecSync
- Save/Restore
- Scan Server
- CA gateway between the control and the office network
- Display Builder Web Runtime
- Electronic logbook (Olog) – under tests

The Main Goals – Why EPICS

- Uniform access to all subsystems in the lab
- Common services for archiving, alarms, remote access
- Possibility to add new equipment with minimum effort
- Use the same control system as our main partner (ESS)
- Use a well established, widely used, open source control system

Experience

- Quite a steep learning curve
- Received significant help from the EPICS community and our partners (ESS, CERN)
- Managed to integrate with EPICS nearly all systems with very limited manpower
- The use of the ESS EPICS Environment Build System (E3) made building and maintenance of EPICS modules relatively simple
- We found the IOC programs that we have built and deployed to be very reliable
- The sequencer program running inside the IOC turned out to be very useful, especially when the automation task involved process variables distributed across a number of subsystems
- We appreciate the recent improvements in EPICS documentation

Future plans

- Migration to Olog log-book
- Migration from Centos 7 to Rocky alternative Alma Linux distribution
- Start to use PV Access
- OPC UA for PLC integration
- GitHub Actions for CI/CD
- Integration of new equipment for the upcoming projects