



26-31 October 2014 **WORKSHOP ON
ACCELERATOR OPERATIONS**
Mainz, Germany

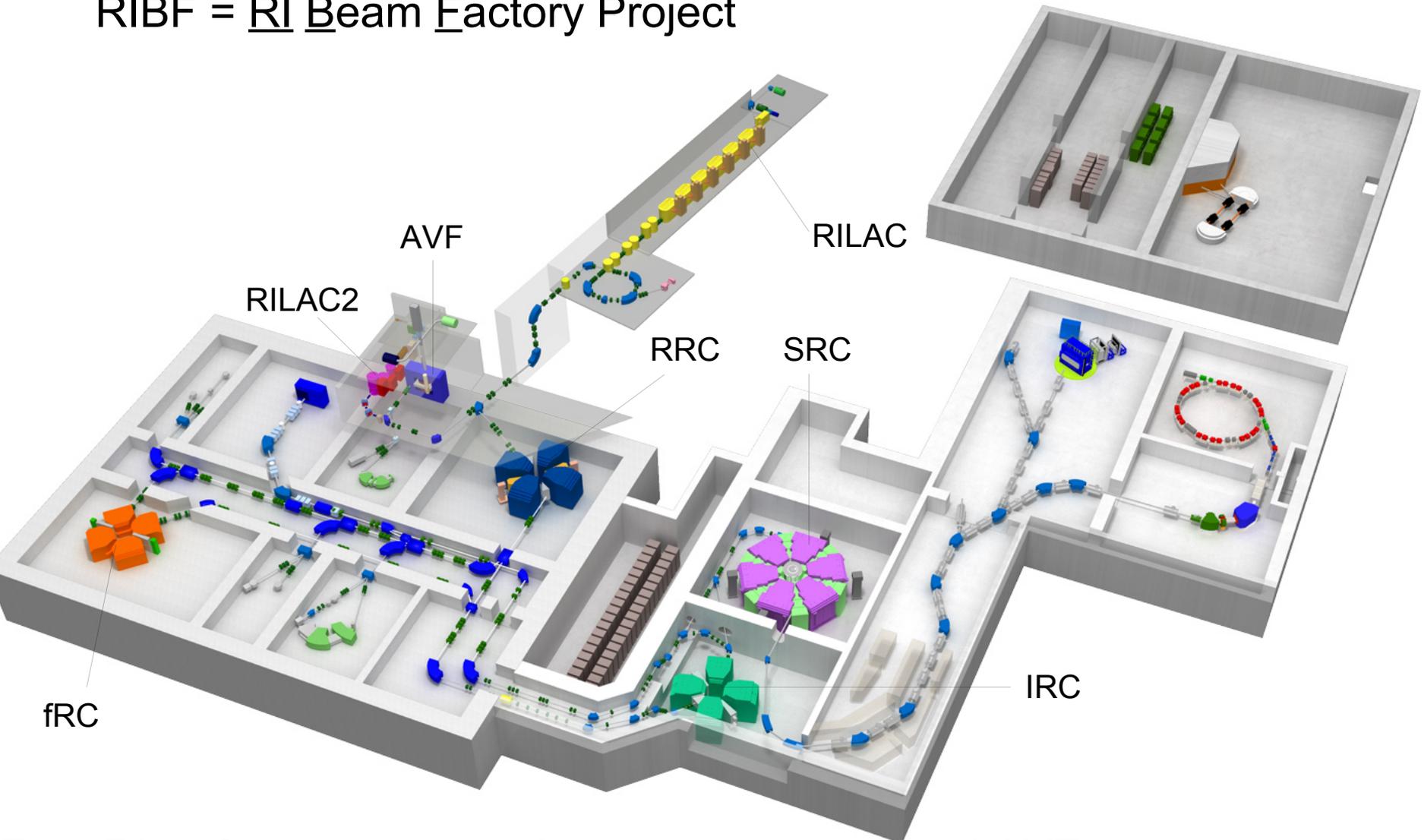
Current Status of Web Application for RIBF Accelerator

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Overview of RIBF(1/2)

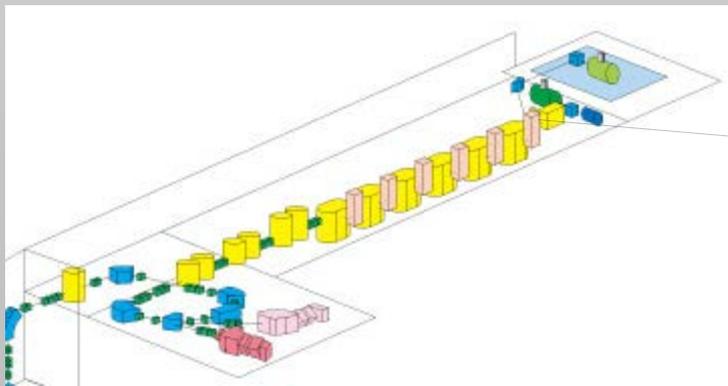
RIBF = RI Beam Factory Project



Four Ring Cyclotrons, two linear accelerators and AVF cyclotron.

Overview of RIBF(2/2)

- Variable heavy ion beams have been provided for experiments.
 - From helium (4He) to uranium (238U)
- Past results are
 - 238U , 148Xe beam $< 345\text{MeV/u}$.
 - 40Ar , 48Ca , 70Zn , 86Kr beam $< 400\text{MeV/u}$.
 - 4He , 14N , 16O beam $< 400\text{MeV/u}$.
- RILAC stand-alone mode have been provided
 - 48Ca , 27Al , 70Zn , 58Fe beam $< 6.0\text{ MeV/u}$.



RIKEN Linear Accelerator (RILAC)

Control System for RIBF

Distributed Control System using EPICS

RIBF control system covers

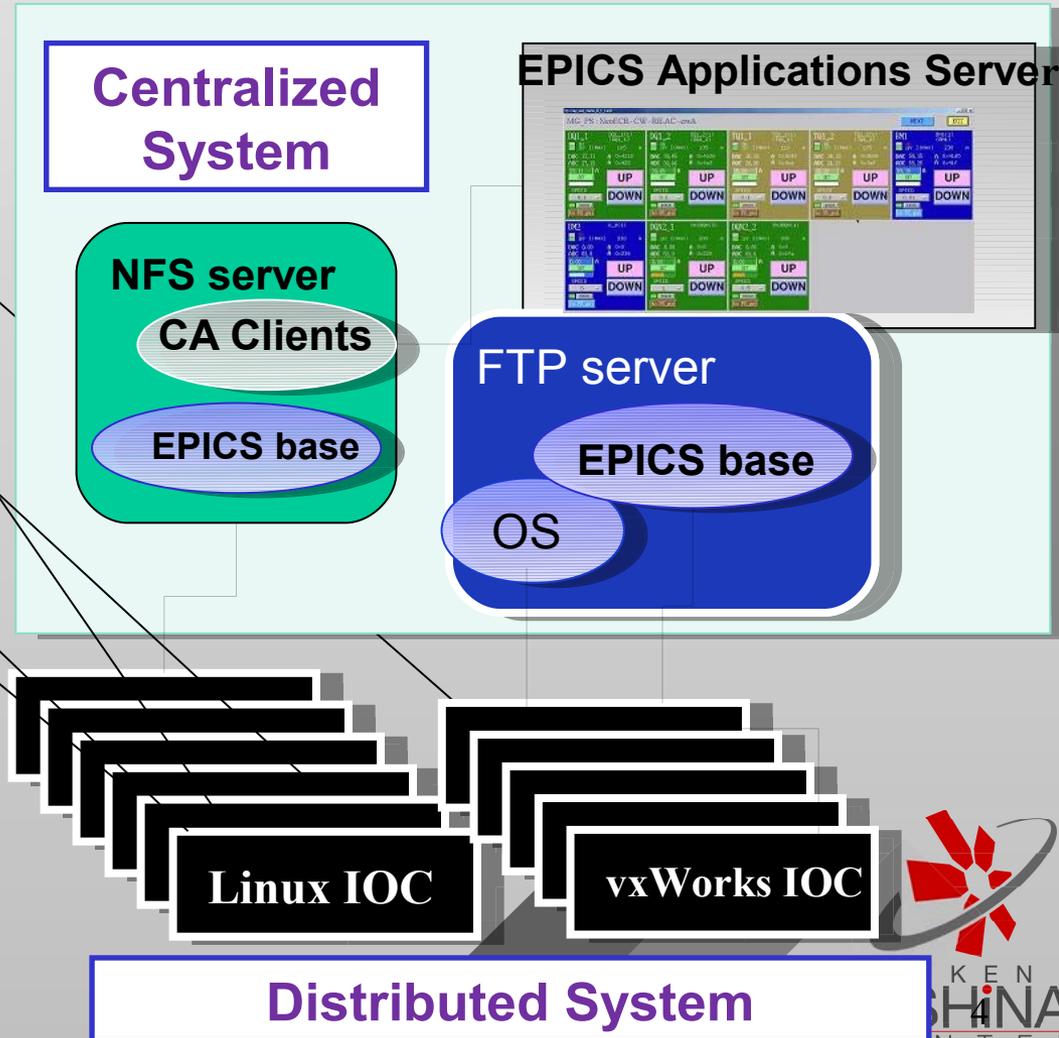
- Magnet Control (~1000)
- Beam Diagnostics (~400)
- **ECR Ion Source Control**
- Vacuum Control
- Beam Interlock System
- **Monitoring System**

Other Services

- **Operational Log System**
- **Data Logging System**
- **System management**
- Alarm System

Stand Alone Control System

- RF Control
- Radiation Management System



Advantage of Web Application

- Web Application has many advantages.

- **Software Usability**

- Web Browser is Only necessary (Win, Linux, Mac)
- For example IE, Firefox, Chrome, Safari, Opera
- Available over the firewalls
 - Because Web is a standard protocol for Internet.



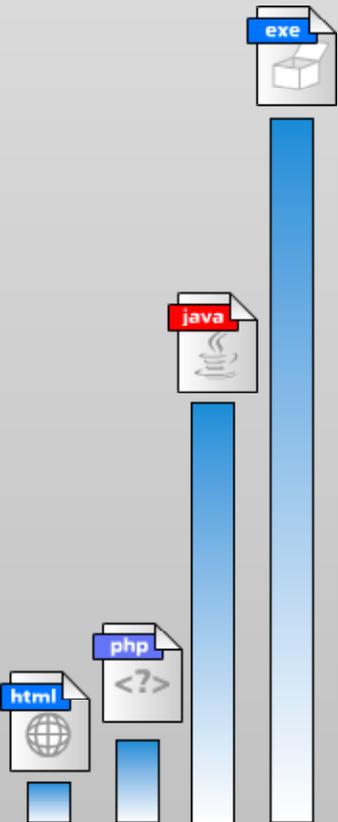
- **Software Portability**

- Not only PC, but also Mobile, etc



- **Low development cost**

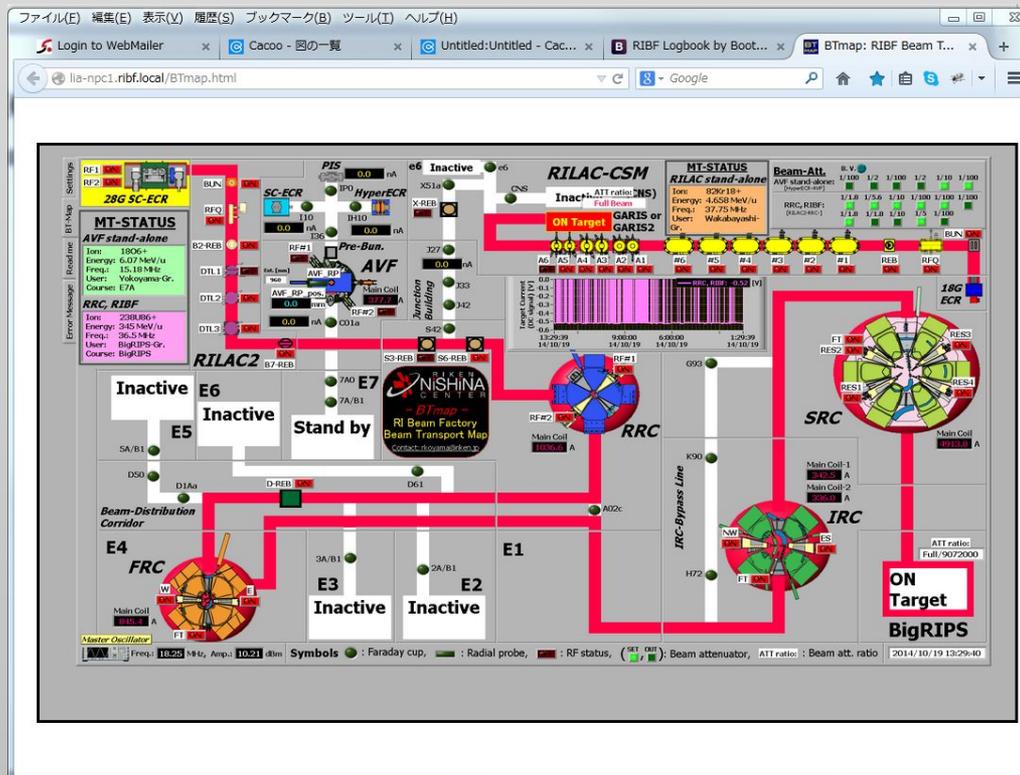
- Java, C GUI application are costly work.
- Web development is easy compared with Java, C.



Monitoring System(1/2)

Realtime beam transport monitoring system

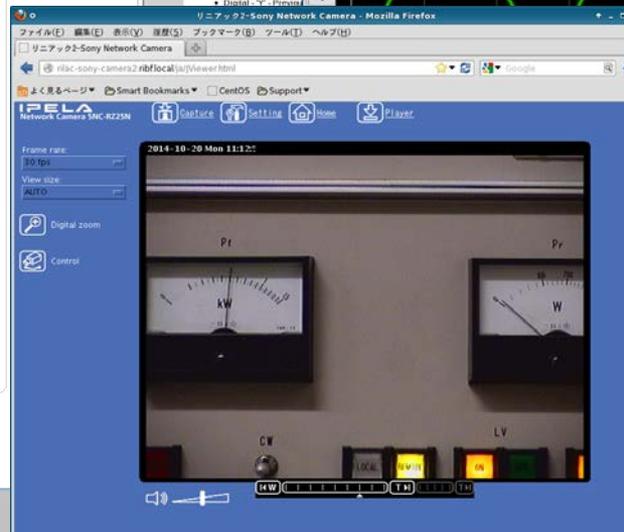
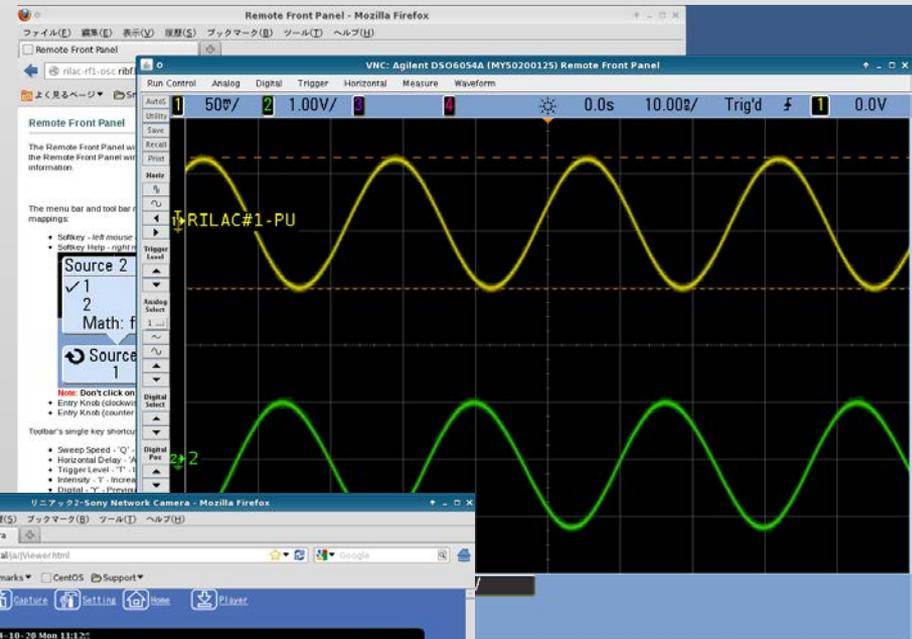
- Beam Transport Map
- LabVIEW-based application
 - NI LabVIEW has Web publishing feature.
 - Shared with Operators, Experiment users, and Accelerator Scientists.



Monitoring System(2/2)

Commercially systems are used via Web in operation.

- Network Camera (Sony)
- Video Server (AXIS)
- Network Oscilloscope (Agilent)

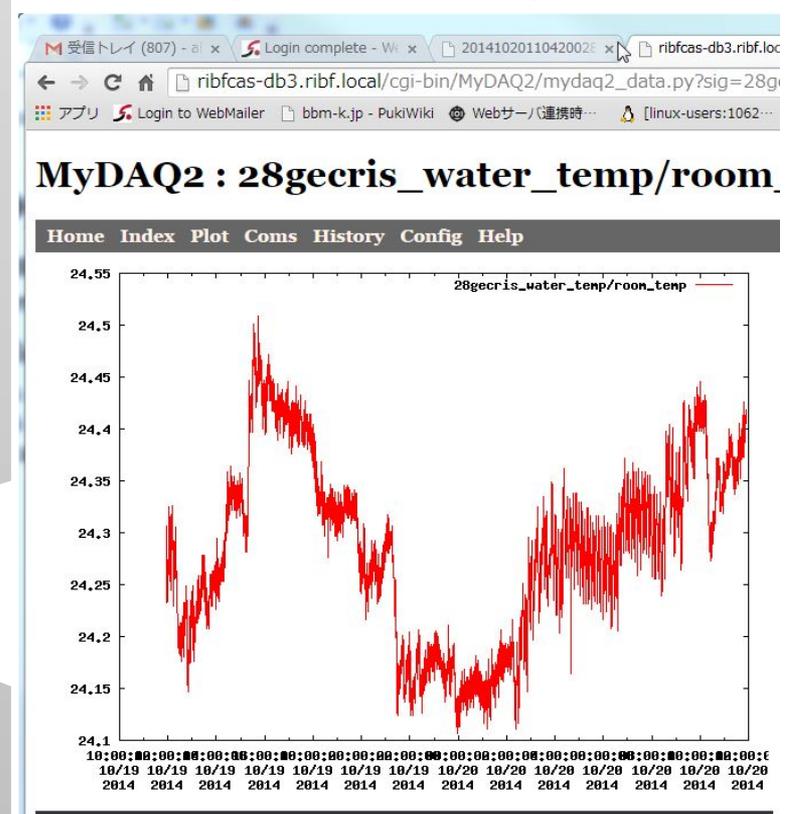
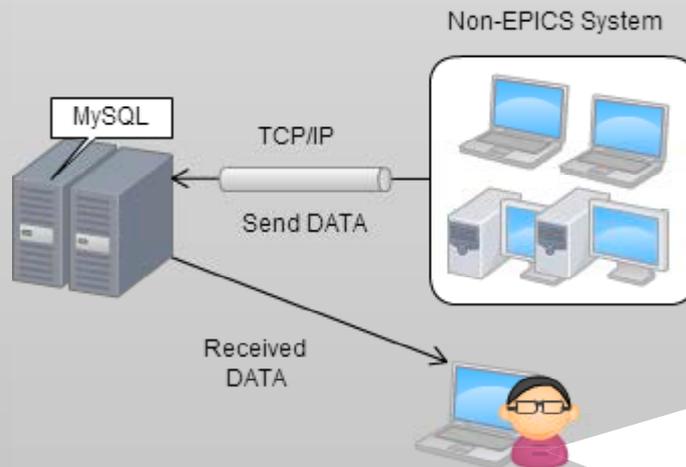


Data Logging System (1/4)

Data Logging System \rightleftharpoons Data Archiver

In RIBF operation, MyDAQ2 is used for Non-EPICS-based system.

- MyDAQ2 is a simple data logging and display system.
- Initial development at Spring-8
- The Data is stored in MySQL-based database by sending simple message via TCP/IP.
- Web Application is used to display the data.
- Data logging cycle is about 1 sec ~ 10 sec.

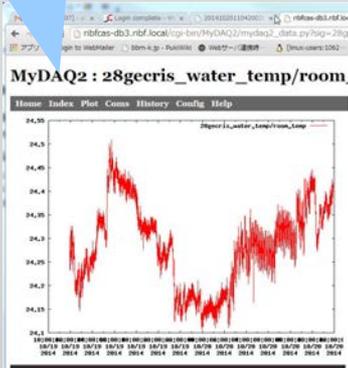


Data Logging System (2/4)

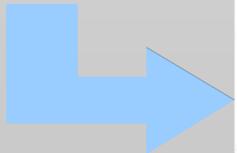
Customized MyDAQ2 is also used in RIBF(1)

- JavaScript chart has advantage of multiaxis data.

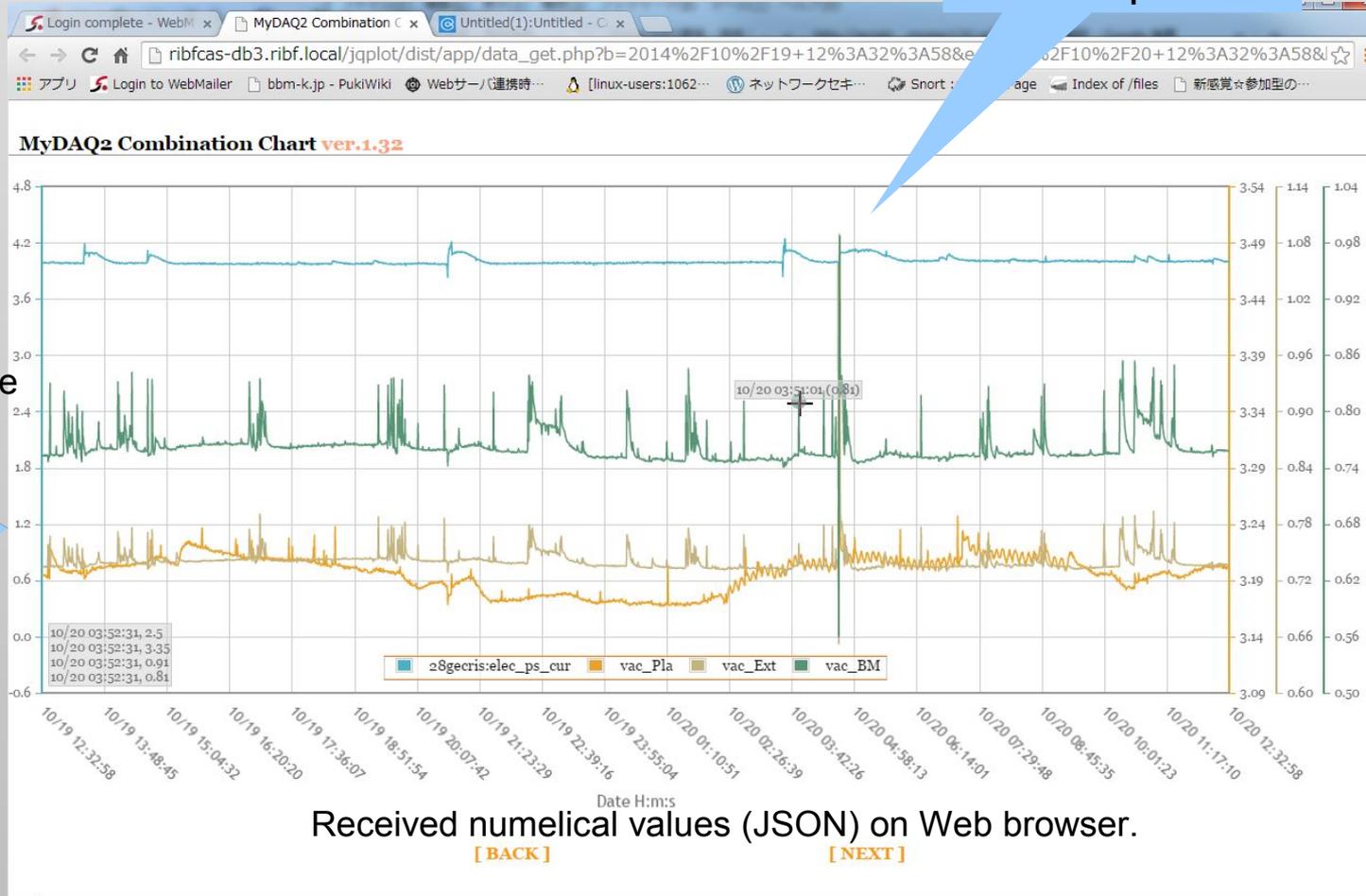
Gnuplot Chart



Received chart image file



JavaScript Chart



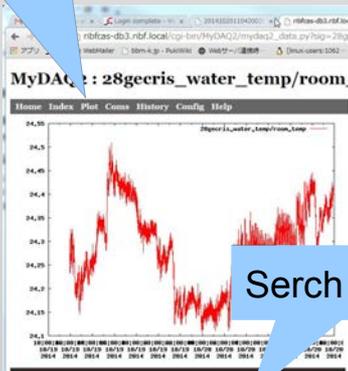
Received numerical values (JSON) on Web browser.

Data Logging System (3/4)

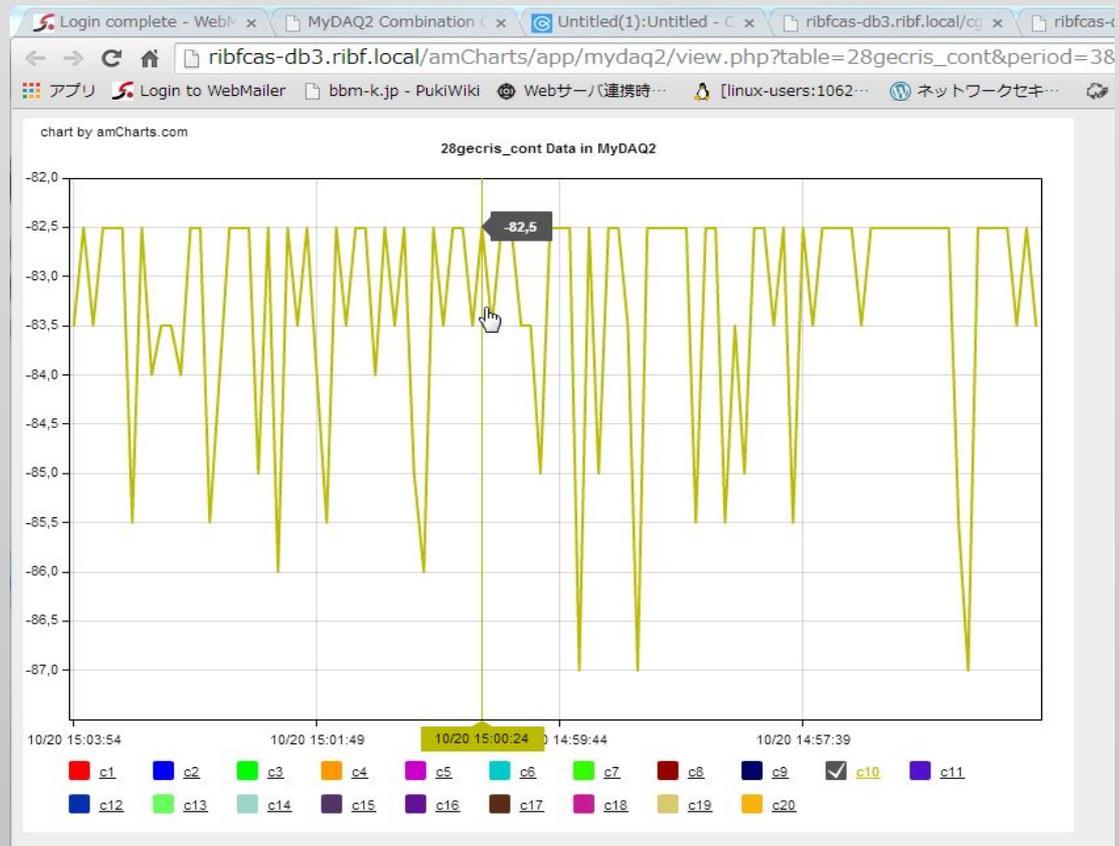
Custmized MyDAQ2 is also used in RIBF(2).

- Visualization of realtime update is shown by Adobe Flash-based chart

Gnuplot Chart



Static Access

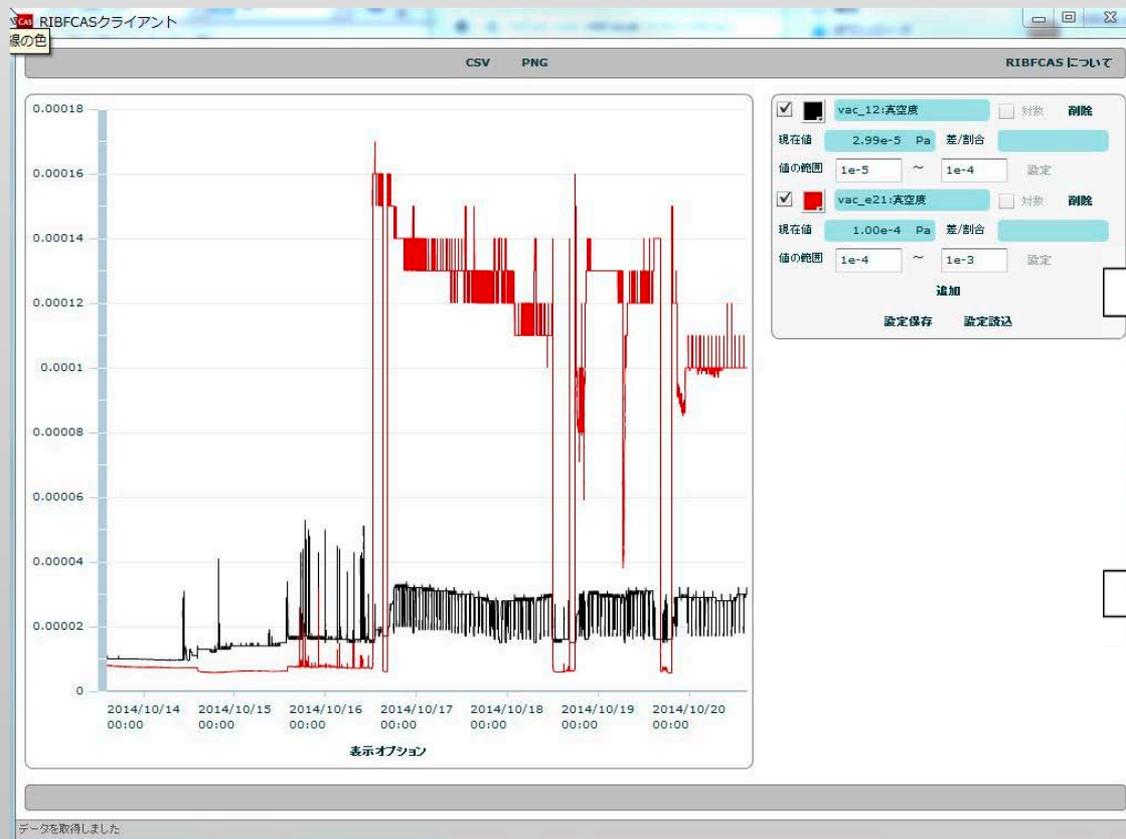


Realtime update like Strip Chart

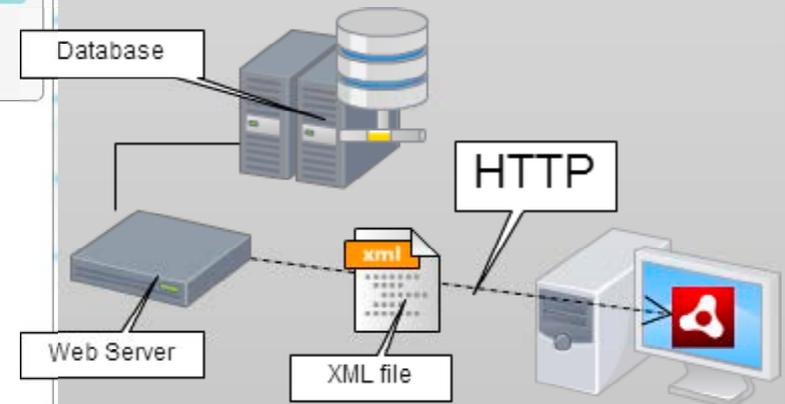
Data Logging System (4/4)

Data Logging System for EPICS (Channel Archiver)

- This Viewer application is developed with Adobe AIR.



© Adobe AIR is used for desktop application, but the data transfer uses HTTP method.



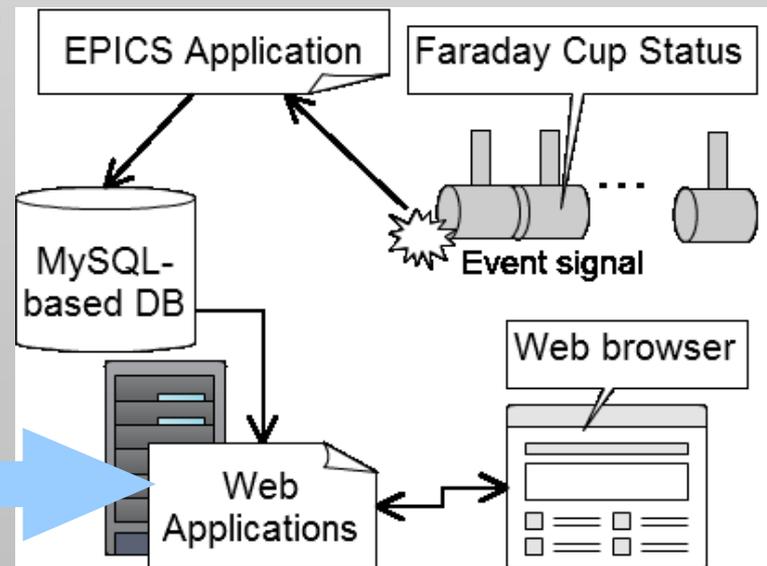
Management (1/4)

Beam Status History

- Visualization system for beam service time.
- Beam Availability is an essential factor for performance of facility.
- Beam service time is measured automatically by Beam Status History.
 - Previously, handwritten log note book was used.

System Design of Beam Status History

- As event signal, faraday cup statuses (set or out) are used.
- The events are stored into MySQL-based database.
- Web application is used for the interface.
- The Web applications are developed with JavaScript chart library and JQuery.



Management (2/4)

Web application for Beam Status History(1)

Mail 1直 Mail 2直 Mail Clear 履歴表示(非表示)

20141019 $^{238}\text{U}^{86+}$ 345 MeV/u 36.5 MHz BigRIPS Gr

ID	ユーザ	停止時間 (Beam OFF)	再開時間 (Beam ON)	中断時間 (OFF~ON 間)	Trigger	コメント欄
	BigRIPS		09:35:04			
1	<input checked="" type="checkbox"/>	09:37:43	09:38:03	00:00:20	FC_K51	
2	<input checked="" type="checkbox"/>	09:42:03	09:44:19	00:02:16	FC_BRPSF0	
3	<input checked="" type="checkbox"/>	09:47:46	09:53:03	00:05:17	FC_G01b	
4	<input checked="" type="checkbox"/>	10:03:36	10:25:46	00:22:10	FC_BRPSF0	
5	<input checked="" type="checkbox"/>	10:34:09	10:45:16	00:11:07	FC_G01b	User
6	<input checked="" type="checkbox"/>	10:58:41	10:58:46	00:00:05	FC_U10	10:57にBIS: BRPS_PRIMが立ち、BISをリセットしても解除されない。FC_U10を入れてビームが居ることを確認。
7	<input checked="" type="checkbox"/>	11:12:54	11:13:17	00:00:23	FC_K51	IRC/RFDWN
8	<input checked="" type="checkbox"/>	12:05:21	12:15:10	00:09:49	FC_G01b	User
9	<input checked="" type="checkbox"/>	13:00:13	13:25:09	00:24:56	FC_U10	SRC RES#2 DOWN。IRC、SRCインクロ確認。トランスミッション確認。
10	<input checked="" type="checkbox"/>	13:25:10	13:29:42	00:04:32	FC_G01b	SRC-RF DOWN
11	<input checked="" type="checkbox"/>	13:36:23	13:39:16	00:02:53	FC_G01b	User
12	<input checked="" type="checkbox"/>	13:42:20	13:47:30	00:05:10	FC_G01b	User
13	<input checked="" type="checkbox"/>	14:05:04	14:25:54	00:20:50	FC_U10	User
14	<input checked="" type="checkbox"/>	14:46:29	14:54:23	00:07:54	FC_U10	User

2014年 10月

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

Management (2/4)

Input Comment
(Not Automatic)

Web application for Beam Status History(1)

Beam ON or OFF

Beam Service Time
&
Beam On/Off Time

User	10:57にBIS: BRPS_PRIMが立ち、BISをリセットしても解除されない。FC_U10を入れてビームが居ることを確認。
IRC/RFDWN	
User	SRC RES#2 DOWN。IRC, SRCインク口確認。トランスミッション確認。
SRC-RF DOWN	

ID	ユーザ	停止時間 (Beam OFF)	再開時間 (Beam ON)	中断時間 (OFF~ON間)	Trigger
	BigRIPS		09:35:04		
1	☑	09:37:43	09:38:03	00:00:20	FC_K51
2	☑	09:42:03	09:44:19	00:02:16	FC_BRPSF0
3	☑	09:47:46	09:53:03	00:05:17	FC_G01b
4	☑	10:03:36	10:25:46	00:22:10	FC_BRPSF0
5	☑	10:34:09	10:45:16	00:11:07	FC_G01b
6	☑	10:58:41	10:58:46	00:00:05	FC_U10
7	☑	11:12:54	11:13:17	00:00:23	FC_K51
8	☑	12:05:21	12:15:10	00:09:49	FC_G01b
9	☑	13:00:13	13:25:09	00:24:56	FC_U10
10	☑	13:25:10	13:29:42	00:04:32	FC_G01b
		13:36:23	13:39:16	00:02:53	FC_G01b
		13:42:20	13:47:30	00:05:10	FC_G01b
		14:05:04	14:25:54	00:20:50	FC_U10
		14:46:29	14:54:23	00:07:54	FC_U10

Trrigered Faraday
Cup Name

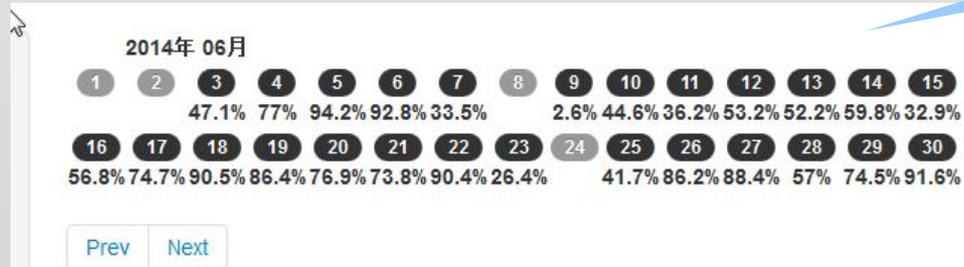
- FC_G01b
- FC_F01b
- FC_F51

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22

Management (3/4)

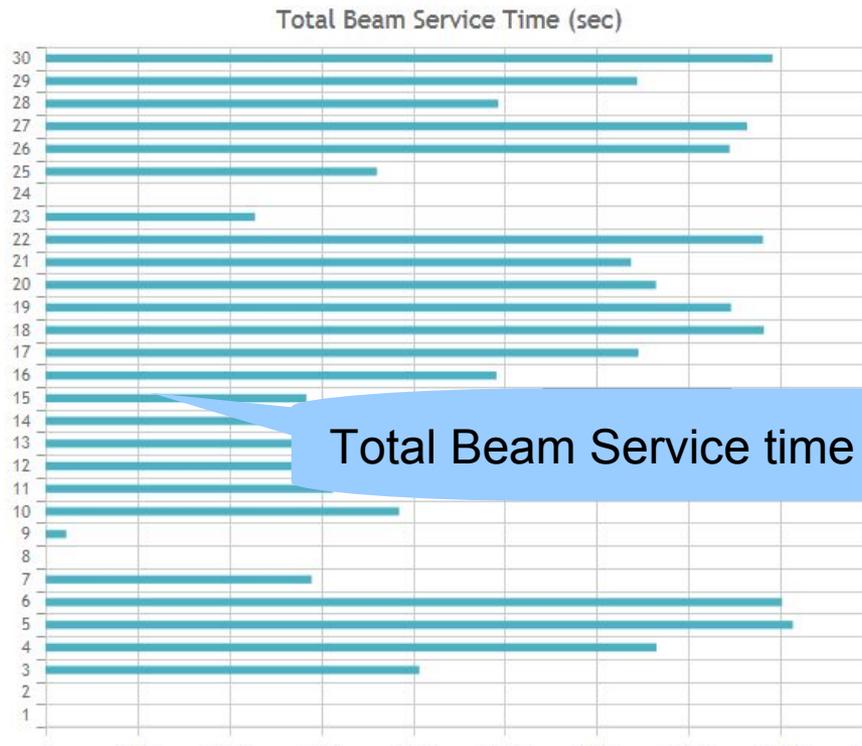
Web application for Beam Status History(2)

Beam-On-Time Ratio



We can check the Beam Availability more easily than before.

$$\text{Beam Availability} = \frac{\text{Beam Service Time}}{\text{Beam Request Time}}$$



Total Beam Service time (second) in 1 day are shown by bar chart.

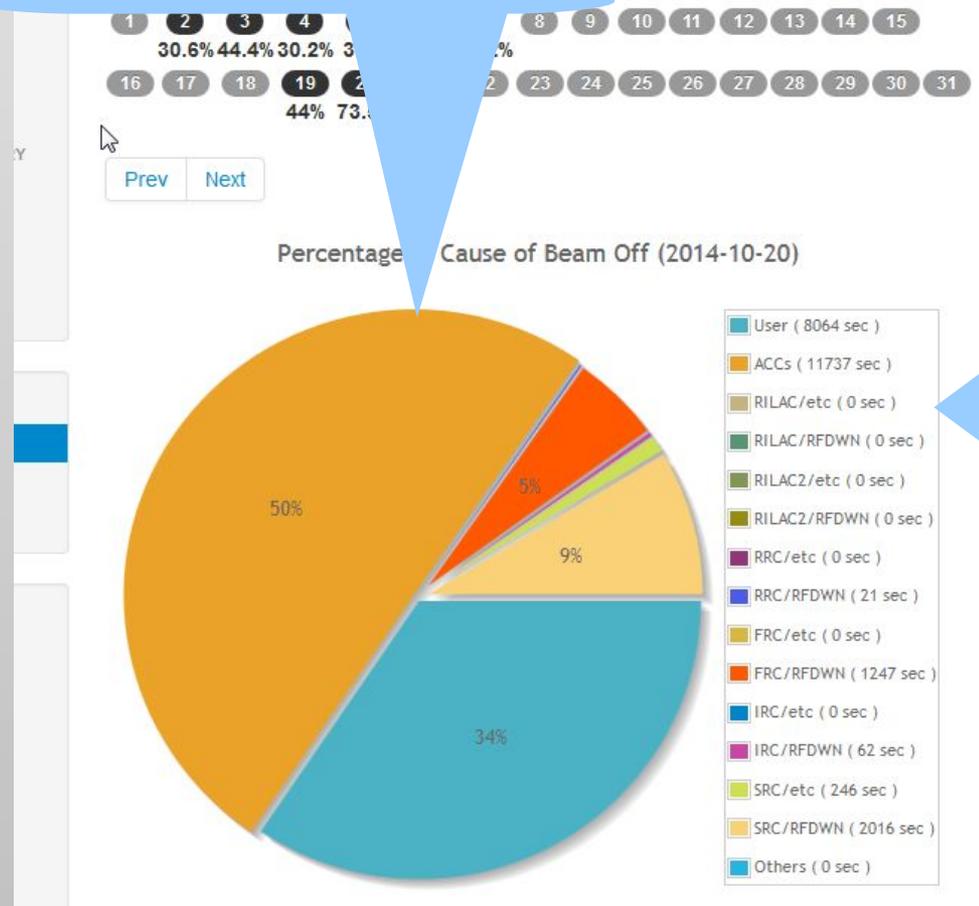
Management (4/4)

Web application for Beam Status History(3)

We can check the accelerator's conditions more easily than before.

Beam-off time are calculated by input comments.

Ratio in cause of beam-off



時間 (ON間)	Trigger	コメント欄
		Auto generated: Keep beam-on-target.
		ACCs
0:05	FC_F01b	ACCs
0:28	FC_F51	FRC/RFDWN
0:23	FC_G50	SRC/etc
1:45	FC_G01b	ACCs
5:34	FC_G01b	SRC/RFDWN
0:15	FC_F51	FRC/RFDWN
0:20	FC_S71	RRC/RFDWN
8:27	FC_G01b	ACCs
0:11	FC_G01b	User
	FC_G01b	User

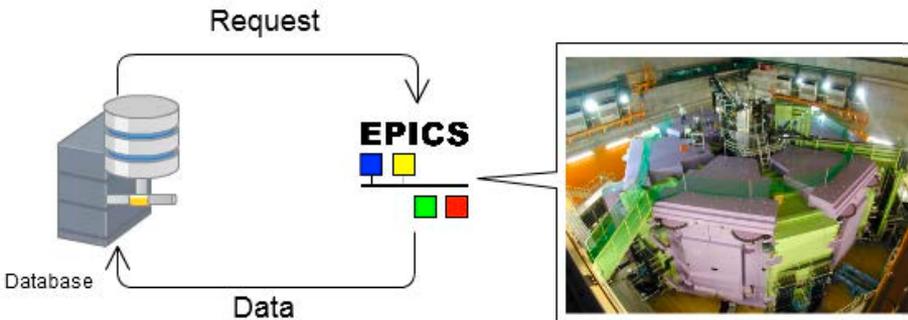
Operational Log System (1/2)

In case of RIBF operation, “**Operational Log**” logs when operators changed device's status.

- Magnet PS DAC operation
- Vacuum operation
- RF operation
- etc

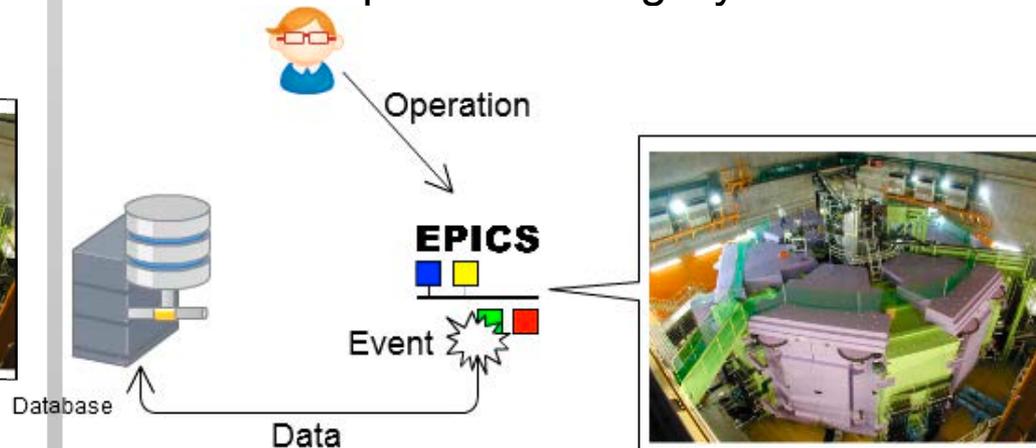
Difference of the Systems

Data Archive System



Polling Access

Operational Log System



Event Driven Access

Operational Log System (2/2)

Web application for Operational Log

The screenshot displays the RIBF Lognote web application interface. The browser address bar shows the URL: `ope_log.ribf.local/operationlog_v1.1/php/magnet_ps.php?key=ribf_operationlog&start_time=2014-10-21_13:00&end_time=2014-10-21_13:00`. The page title is "RIBF Lognote" and the user is logged in as "Guest".

The main content area shows the "Magnet PS OPERATION 2014-10-21 13:00" section. It includes a navigation bar with tabs for CAMAC, NDIM, NIO (selected), F3RP61, and GPIB. Below this, there are time range controls (12, 13, 14) and a "Control Device" dropdown set to NIO. The date range is "2014-10-21 13:00 ~ 2014-10-21 14:00". There are buttons for "Show Chart" and "Clear Chart".

The central table displays operational data for various DACs:

DAC	13:00~	13:10~	13:20~	13:30~	13:40~	13:50~
F_M0F	⇒	1.4~1.4	⇒	⇒	⇒	⇒
R_M0F	⇒	1.6~1.65	⇒	⇒	⇒	⇒
S_P05	⇒	⇒	4.7~5.02	⇒	⇒	⇒

On the right side, there are search filters for "Search by EPICS PVs (ALL list)" and "Search by date (Course list)". The "Search by date" filter shows a selected date of "2014-10-21_13:00" and a "VIEW" button. Below this, the "S_P05 HISTORY" section lists a series of DAC values with timestamps:

- 13:21:39 DAC 5.0200 [A]
- 13:21:40 DAC 5.0100 [A]
- 13:21:40 DAC 5.0000 [A]
- 13:21:56 DAC 4.9900 [A]
- 13:21:56 DAC 4.9800 [A]
- 13:21:57 DAC 4.9700 [A]
- 13:22:07 DAC 4.9600 [A]
- 13:22:07 DAC 4.9500 [A]
- 13:22:07 DAC 4.9400 [A]
- 13:22:08 DAC 4.9300 [A]
- 13:22:17 DAC 4.9200 [A]
- 13:22:18 DAC 4.9100 [A]
- 13:22:18 DAC 4.9000 [A]
- 13:22:18 DAC 4.8900 [A]

The left sidebar contains a navigation menu with categories like RIBF, MAGNET PS, BT, VACUUM, RF, ECRIS, INTERLOCK, STRIPPER CONTROL, ALL (Raw), RIBF, RRC, AVF, RILAC, DB, PostgreSQL, and NIO PS OPE. The NIO PS OPE section shows a calendar for October 2014, with the 21st highlighted.

Operational Log System (2/2)

Web application for Operational Log

The screenshot shows the RIBF Lognote web application. The main content area displays the following information:

- RIBF Magnet PS OPERATION 2014-10-21 13:00**
- Control Device: **NIO** (checked)
- DATE: 2014-10-21 13:00 ~ 2014-10-21 14:00
- Buttons: Show Chart, Clear Chart

DAC	13:00~	13:10~	13:20~	13:30~	13:40~	13:50~
F_M0F	⇒	1.4~1.4	⇒	⇒	⇒	⇒
R_M0F	⇒	1.6~1.65	⇒	⇒	⇒	⇒
S_P05	⇒	⇒	4.7~5.02	⇒	⇒	⇒

S_P05 HISTORY

- 13:21:39 DAC 5.0200 [A]
- 13:21:40 DAC 5.0100 [A]
- 13:21:40 DAC 5.0000 [A]
- 13:21:56 DAC 4.9900 [A]
- 13:21:56 DAC 4.9800 [A]
- 13:21:57 DAC 4.9700 [A]
- 13:22:07 DAC 4.9600 [A]
- 13:22:07 DAC 4.9500 [A]
- 13:22:07 DAC 4.9400 [A]
- 13:22:08 DAC 4.9300 [A]
- 13:22:17 DAC 4.9200 [A]
- 13:22:18 DAC 4.9100 [A]
- 13:22:18 DAC 4.9000 [A]

Search by EPICS PVs (ALL list)

Search

Search by date (Course list)

- 45 HYPER-AVF-E7B
- 50 28G-RILAC2-RRC-FRC-RIBF

0 ALL

2014-10-21_13:00

VIEW

S_P05 HISTORY

- 13:21:39 DAC 5.0200 [A]
- 13:21:40 DAC 5.0100 [A]
- 13:21:40 DAC 5.0000 [A]
- 13:21:56 DAC 4.9900 [A]
- 13:21:56 DAC 4.9800 [A]
- 13:21:57 DAC 4.9700 [A]
- 13:22:07 DAC 4.9600 [A]
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- 13:22:07 DAC 4.9400 [A]
- 13:22:08 DAC 4.9300 [A]
- 13:22:17 DAC 4.9200 [A]
- 13:22:18 DAC 4.9100 [A]
- 13:22:18 DAC 4.9000 [A]
- 13:22:18 DAC 4.8900 [A]

When, What, and How is the operation?
Almost operations are logged and displayed.

Operational Log System (2/2)

Web application for Operational Log

The screenshot shows a web browser displaying the RIBF Operational Log System. The page title is "RIBF Lognote" and the user is logged in as "Guest". The main content area displays the "MAGNET PS OPERATION" for "2014-10-21 13:00". The control device is "NIO". A line graph shows the "S_P05" parameter value over time, starting at approximately 5.02 and decreasing to 4.72. A table below the graph shows the DAC values for F_M0F, R_M0F, and S_P05. A search panel on the right allows filtering by date and course. A calendar on the bottom left shows the current date as October 21, 2014.

RIBF Lognote BEAM STATUS HISTORY **OPERATION LOG** COURSE INFO CONTROL SYSTEM INFO CONTACT Logged in as Guest

RIBF Magnet PS OPERATION 2014-10-21 13:00 CAMAC NDM **NIO** F3RP61 GPIB

« - 12 hours 12 13 14 + 12 hours »

S_P05

Control Device **NIO** ✓ DATE: 2014-10-21 13:00 ~ 2014-10-21 14:00

Show Chart Clear Chart

DAC	13:00~	13:10~	13:20~	13:30~	13:40~	13:50~
F_M0F	⇒	1.4~1.4	⇒	⇒	⇒	⇒
R_M0F	⇒	1.6~1.65	⇒	⇒	⇒	⇒
S_P05	⇒	⇒	4.7~5.02	⇒	⇒	⇒

Search by EPICS PVs (ALL list)

Search

Search by date (Course list)

45 HYPER-AVF-E7B
50 28G-RILAC2-RRC-FRC-RIBF
0 ALL
2014-10-21_13:00
VIEW

S_P05 HISTORY

- 13:21:39 DAC 5.0200 [A]
- 13:21:40 DAC 5.0100 [A]
- 13:21:40 DAC 5.0000 [A]
- 13:21:56 DAC 4.9900 [A]
- 13:21:56 DAC 4.9800 [A]
- 13:21:57 DAC 4.9700 [A]
- 13:22:07 DAC 4.9600 [A]
- 13:22:07 DAC 4.9500 [A]
- 13:22:07 DAC 4.9400 [A]
- 13:22:08 DAC 4.9300 [A]
- 13:22:17 DAC 4.9200 [A]
- 13:22:18 DAC 4.9100 [A]
- 13:22:18 DAC 4.9000 [A]
- 13:22:18 DAC 4.8900 [A]

DB PostgreSQL

NIO PS OPE
← 2014年10月 →
日月火水木金土
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

ope_log.ribf.local/operationlog_v1.1/php/magnet_ps.php?key=ribf_op...

Operational Log System (2/2)

Web application for Operational Log



How many the operations?

Interval of operation is known by the chart.

Notice, Operational Log System is not completed to develop in all features now (90%).



Operator Interface (1/2)

We plan to implement WebSocket-based system as OPI.

- Operator Interface \doteq OPI

Web application was used for static access applications.

- Data logging system
- Operational log system
- System management
- Monitoring system (Periodic time > 5 sec)

WebSocket is available for bi-directional communication.

- Sending operation command and fast monitoring (> 0.1 sec) are available.
- By test system (ion source control in RIBF), the efficient function is confirmed.



If you'd like to know detail, please check ICALEPCS conference papers*.

* Y. Furukawa, et al. Proc. ICALEPCS2011, A. UCHIYAMA, et al. Proc. ICALEPCS2013.

Operator Interface (2/2)

System DEMO

Summary

Web application is useful for Accelerator Operation.

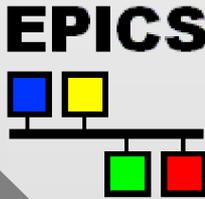
- In case of RIBF operation,
 - Monitoring system (Periodic time > 5 sec)
 - Viewer of data logging system
 - Operational log system
 - Visualization of Beam Service Time
- We should implement leading-edge IT technology for accelerator operation as possible.
- We plan to implement WebSocket-based OPI with real-time Web.

Thank you

BACKUP SLIDE



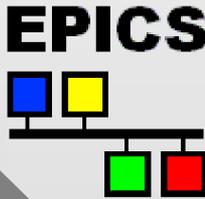
What is EPICS 1 (Overview)



- **Experimental Physics and Industrial Control System**
 - Open Source Software
 - First developed by LANL and ANL
- **Many Facility Construct the System using EPICS**
 - The number of facilities is more than 35.
 - Major Collaborators
 - KEK, SNS, LANL, BESSY, DESY, PSI, ANL, ORNL and SLAC
 - Development with collaboration for the risk of technical and cost problems.



What is EPICS 2 (Architecture)



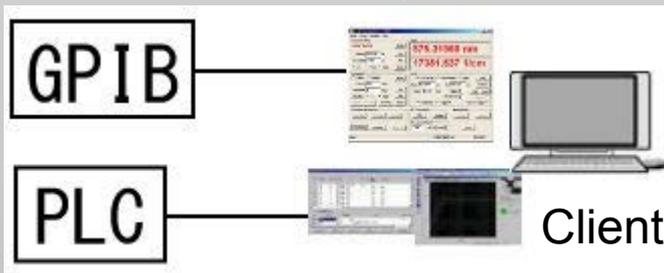
- **A Software Toolkit**

- A collection of software tools collaboratively developed which can be integrated to provide a comprehensive and scalable control system

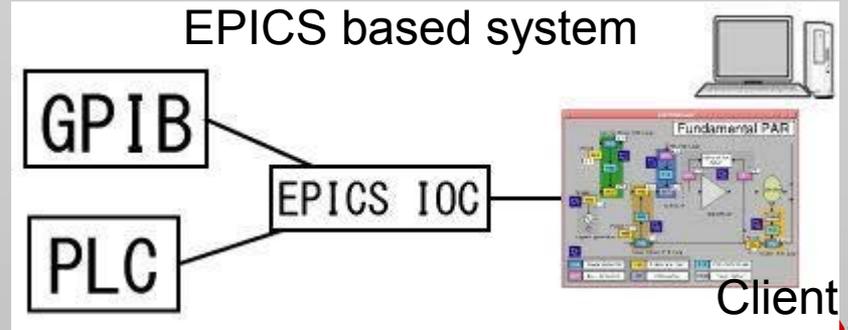
- **A Control System Architecture**

- A client/server model (EPICS Input/Output Controller = IOC)
- Hardware-dependent protocol \longrightarrow Channel Access Protocol (CA)

Non EPICS system

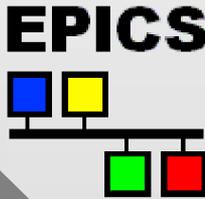


EPICS based system



Protocols are converted to CA by EPICS IOC

What is EPICS 3 (Collaboration)



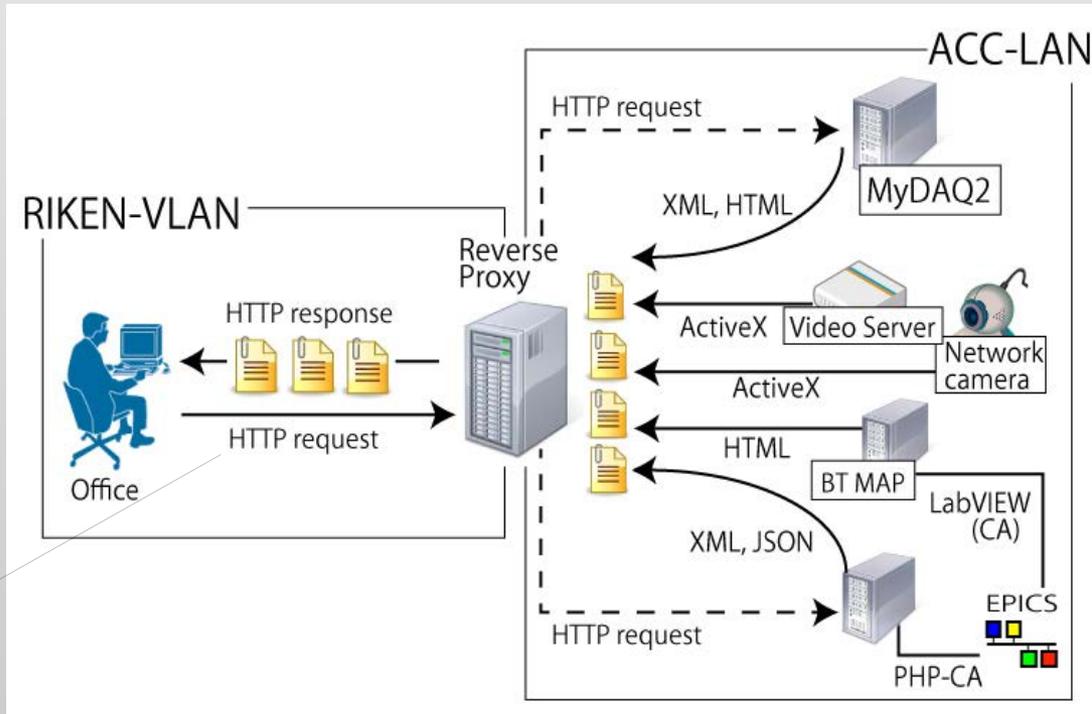
- World-Wide Collaboration
 - Supported by Mailing list, WWW and Meeting
 - Reusability of software
 - It is available to use software developed by other laboratories.
 - Many tools and software are available.
 - Information of Device Support are shared with each other.
 - EPICS developer is not Alone
 - » The users and collaborators help each other.



Author of EPICS
Martin R Kraimer (ANL)



Security for Web Service



Web services are published via Reverse Proxy System.

- Office network(RIKEN-VLAN) can connect to Internet.
- Control system network(ACC-LAN) is independent from RIKEN-VLAN, because of **security**.
- But, independent network is inconvenience to work in office, etc.
 - ex) Data analysis, System management, and Maintenance
- Office users can always connect to ACC-LAN from RIKEN-VLAN via reverse proxy.

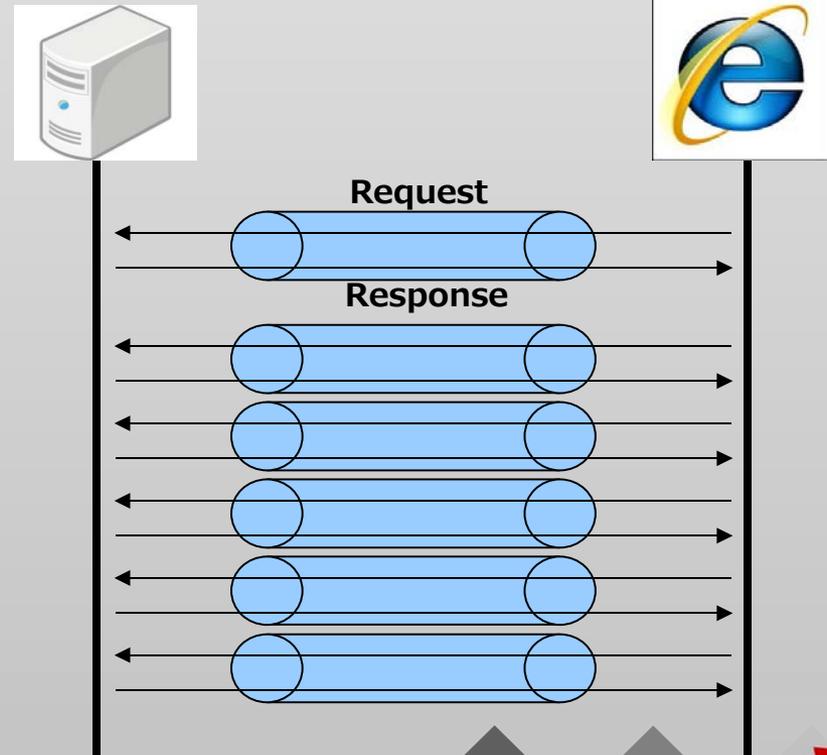
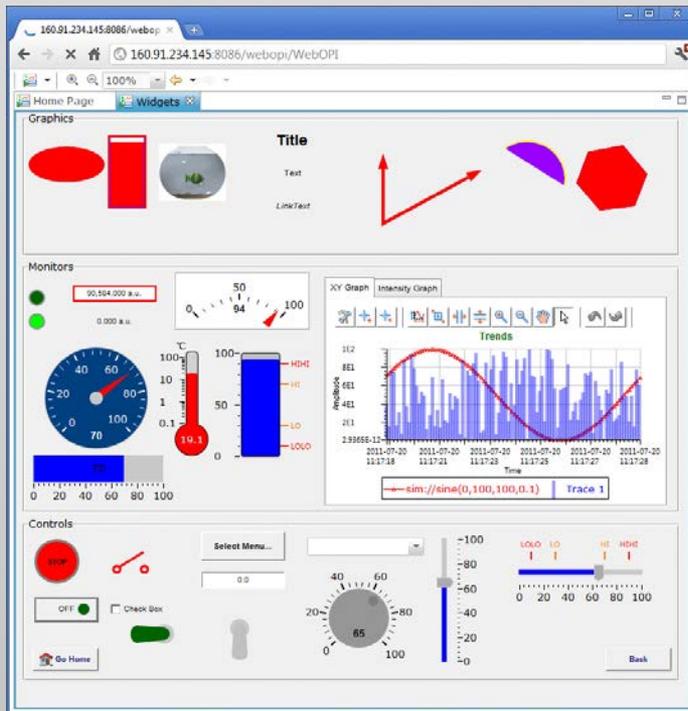
Web-based System Using EPICS (2)

WebOPI
by SNS

• WebOPI can be used to access the GUIs developed by CSS/BOY from a Web browser.

WebOPI is a useful !

Ajax (Asynchronous JavaScript and XML)



• **Ajax** is used for interactive action on the Web.

• Firefox Web browser could access the Web server with a cycle of ~ 100 ms for data transfer on our Intranet environment.

WebSocket

New protocol for bi-directional communication

Disadvantage of Ajax

- Must make the socket connection many time.
 - Response speed is very important for OPI.
- There is no callback function.
- We CanNot know the server status from browsers.



Put



Put ... fail ? success ?



Put



OK

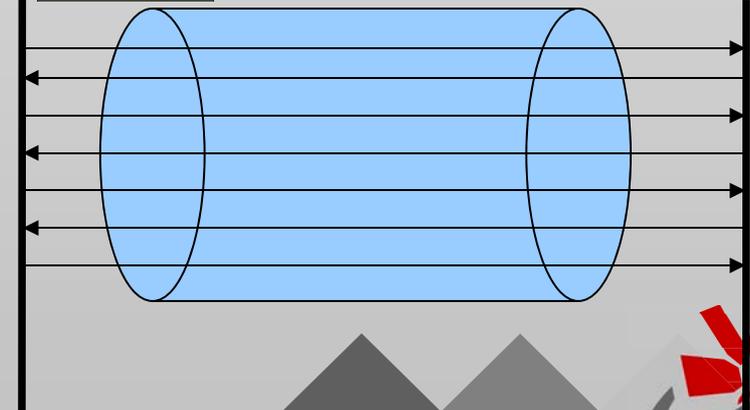
Success because of OK callback



WebSocket Server



connection

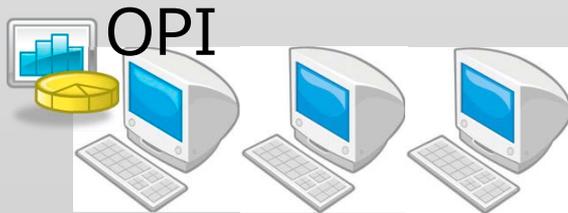


Keep bi-directional communication

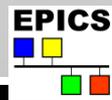
Overview of the System

Example of EPICS-based System

- That's typical system.



CA
Protocol



EPICS IOC

Devices



Overview of the System

WebSocket server and OPI are same layer.

