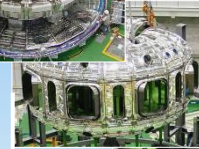
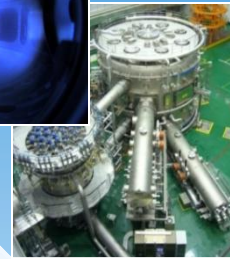
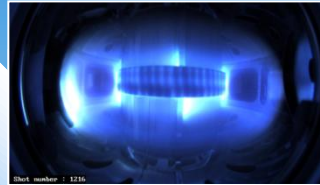


2009

2008



2002

2003

2004

2005

2006

2007

Development of the Operation Tools for the 2009 KSTAR Experiment

Sulhee Baek

KSTAR Research Center

1998

KSTAR

Korea Superconducting Tokamak Advanced Research

Outline



- **Introduction**
- **Operator interface**
- **Data access tools**
- **Misc. tools**
- **Summary**



KSTAR

Introduction

Operator interface

Data access tools

Misc. tools

Summary

KSTAR

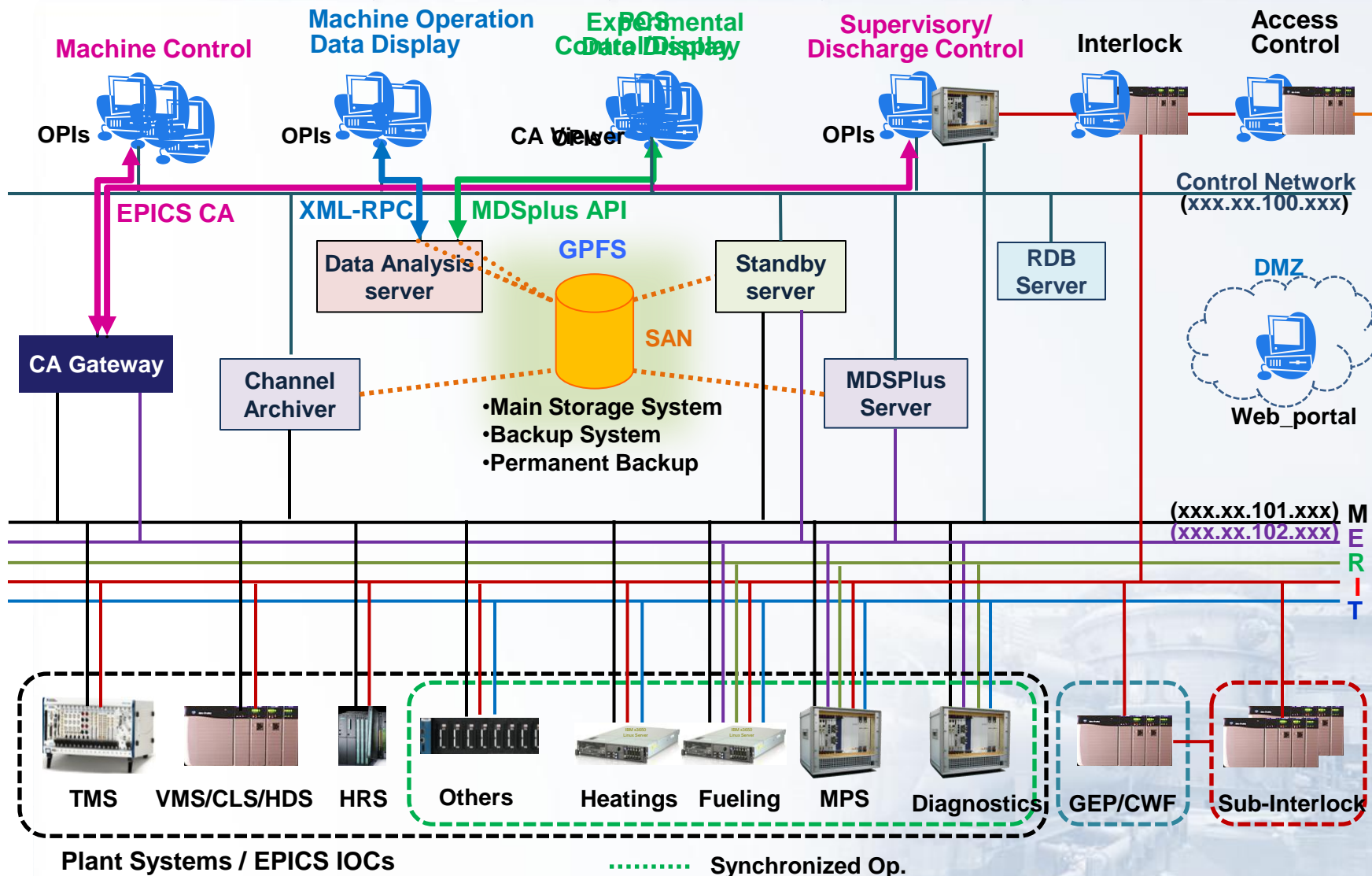
- **KSTAR (Korea Superconducting Tokamak Advanced Research) is not an Accelerator but a Tokamak, Nuclear fusion research device.**
- **Refer to the invited talk, O-25, “Operational Results and Experience of KSTAR Integrated Control System” by Mi-Kyung Park.**



KSTAR control system



Introduction Operator interface Data access tools Misc. tools Summary

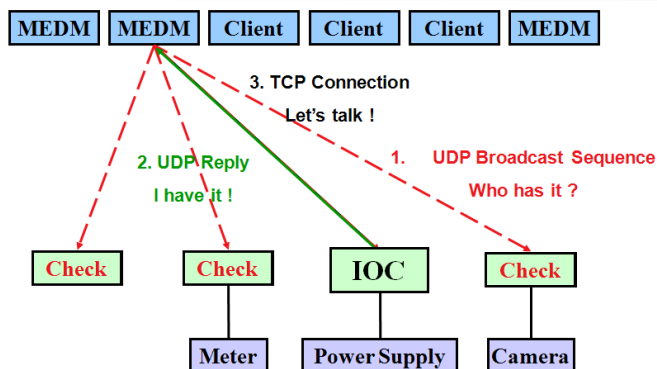


Data access interface



• EPICS Channel Access (CA) API:

- Live data access API
- Search and Connect Procedure



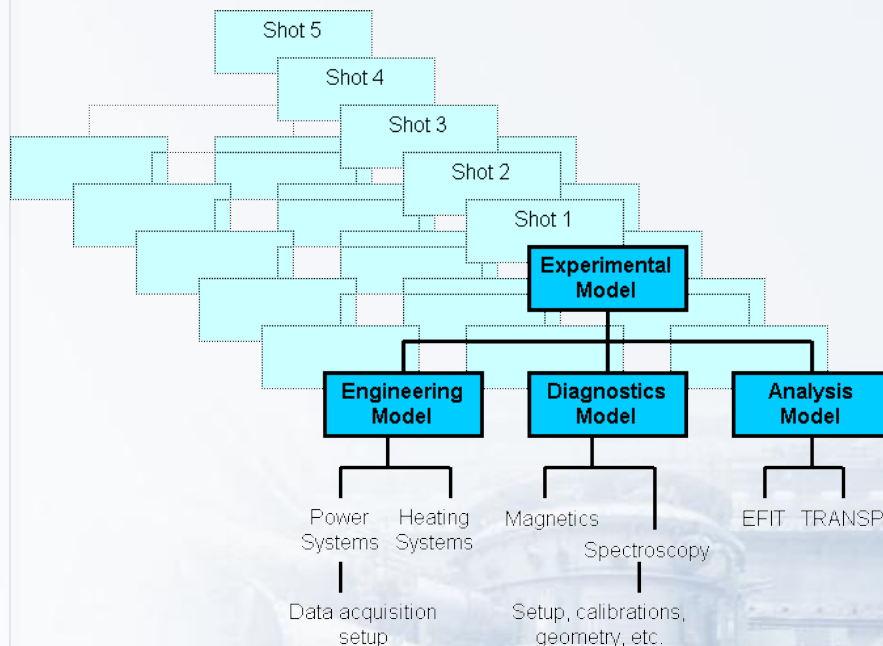
- Basic Procedure for a Channel Access Client
 - Initialize CA → Search → Do get or put → Monitor → Give CA a chance to work → Clear a channel → Close CA

• XML-RPC:

- Archived operation data service protocol
- A remote procedure call protocol which uses XML to encode its calls and HTTP as a transport mechanism
- Archive data server's calls return following information
 - **archiver.info:** version information
 - **archiver.archives:** the archives that this data server can access
 - **archiver.names:** channel names and start/end times
 - **archiver.values:** values from the archive identified by the key for a given list of channel names and a common time range

• MDSPlus API:

- Experimental data access API
- Data Hierarchy – Trees, Nodes, and Models
 - hierarchy of model trees (□)
 - hierarchy of shot trees (□)



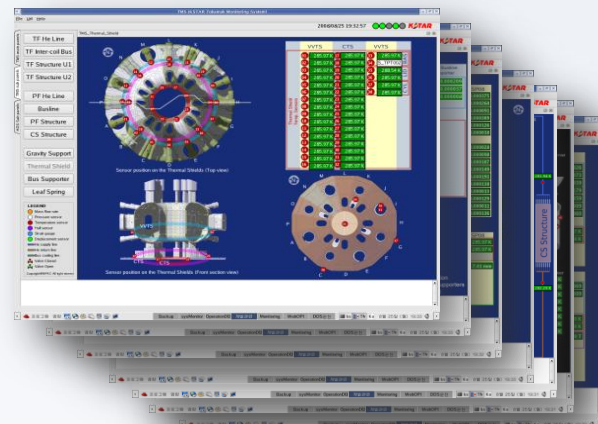
- Basic Procedure for a MDSplus connection
 - mdsconnect → mdsopen → result = mdsvalue → mdsput → mdsconnect → mdsdisconnect

KSTAR OPI Panels



Introduction | **Operator interface** | Data access tools | Misc. tools | Summary

- **Development tools**
 - Qt (KWT, QtCATool), MEDM, EDM
 - ❖ **KSTAR Widget Toolkit (KWT)** is a development toolkit to make Qt-application for the EPICS-based control system.
- **Total number of the panels**
 - about 150 EA including sub-panels



Tokamak Monitoring System OPI

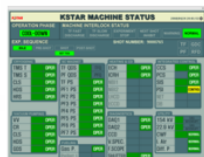
MenuWindow: Collection of icons



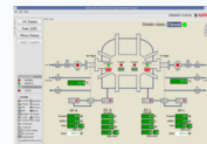
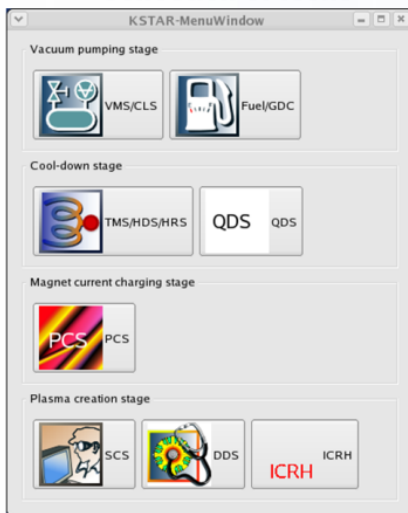
VMS (KWT)



TMS (KWT)



SCS (KWT)



Fuel+GDC (KWT)



QDS (MEDM)



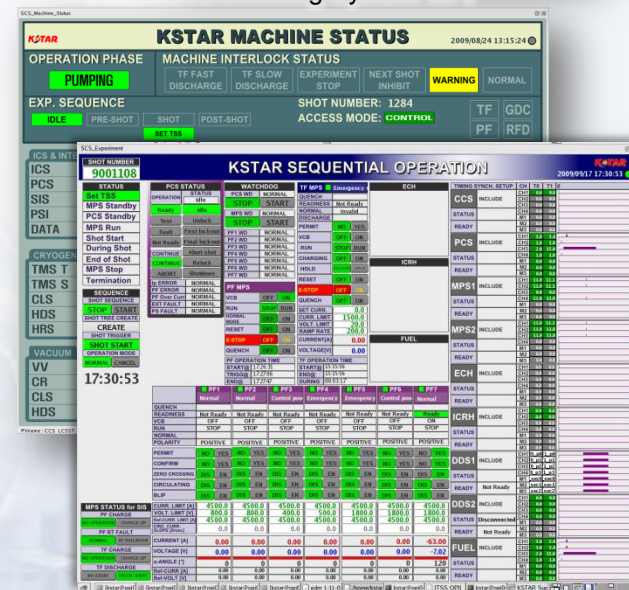
MPS (EDM)



ICRH (KWT)



ECH (KWT)



DDS (QTCATOOL) TSS (QTCATOOL)

MenuWindow and Operator Interfaces for the KSTAR operation

Supervisory Control System OPI

KSTAR Widget Toolkit (KWT)



Introduction | **Operator interface** | Data access tools | Misc. tools | Summary

Requirements of KSTAR OPI

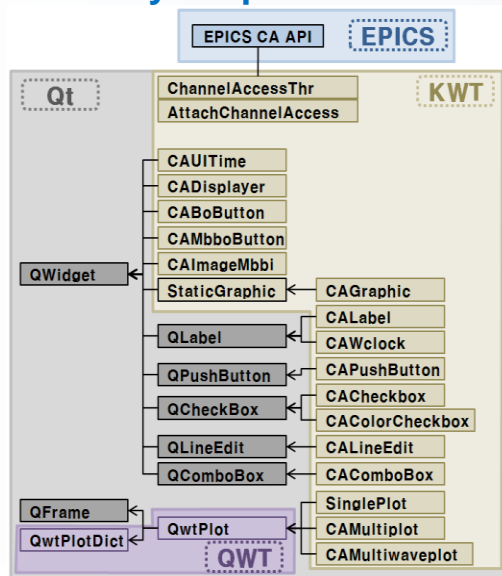
- Performance
- Stable EPICA CA communication
- Easy & fast development
- Usability
- Consistency of appearance

Features of KWT library

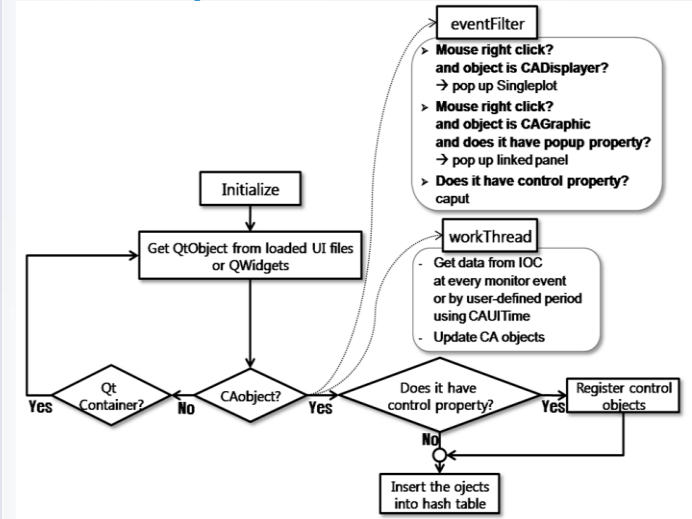
- Intuitive C++ class library
- Portability across desktop and embedded operating systems
- Integrated development tools with cross-platform IDE
- High runtime performance and small footprint on

Inheritance Hierarchy of Library Properties

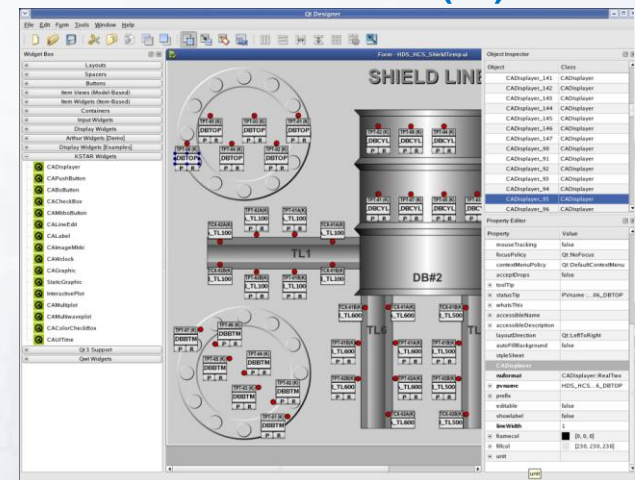
- Qt -4.3.2
- QWT-5.0.0rc1
- EPICS base-3.14.8.2



Principal of the Qt-CA Interface



Screenshot of the KWT(Qt) IDE



Live data tools

Introduction

Operator interface

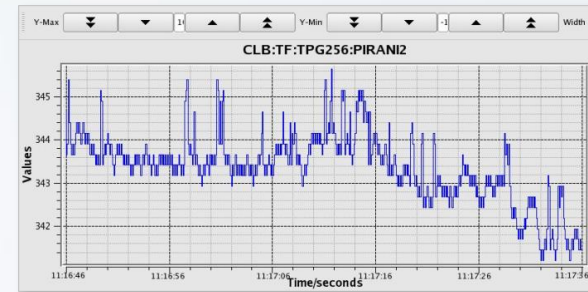
Data access tools

Misc. tools

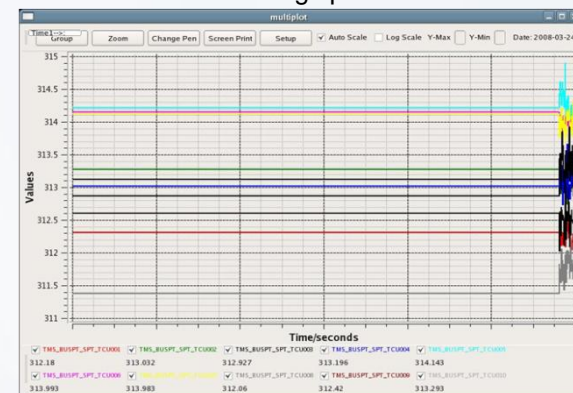
Summary



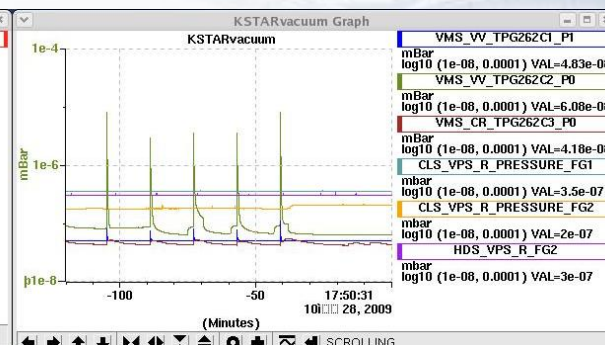
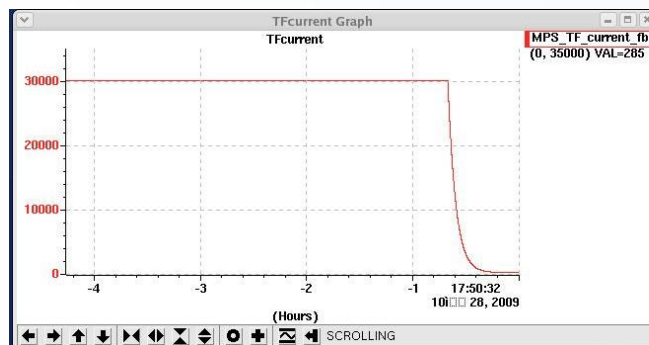
- **Run-time chart**
 - StripTool, StripToolLegend (customized StripTool)
 - Multiplot (Multiwaveplot)
 - Plot 10 ch at a time
 - Application and Plug-in widget
 - Singleplot
 - Popped up at the mouse right-click
- **Debugging utilities**
 - camonitor
 - Probe (Motif Channel Monitoring program)
- **Operator interface utilities**
 - MEDM (Motif Editor and Display Manager)
 - EDM (Extensible Display Manager)
 - DM2K
- **Gateway**
 - Gateway
- **CA Interfaces to other tools and languages**
 - JCA (Java Channel Access)



Singleplot



Multiplot

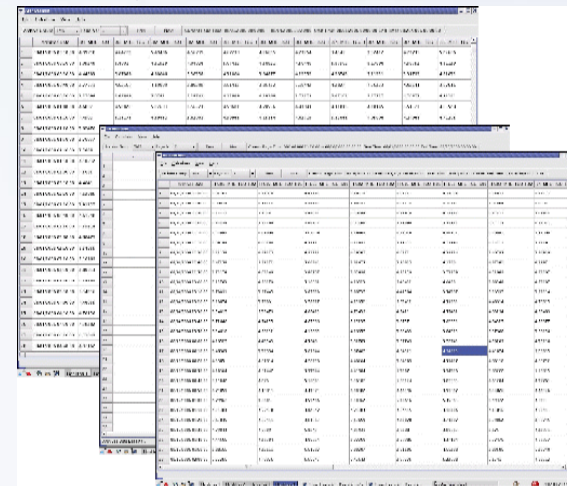
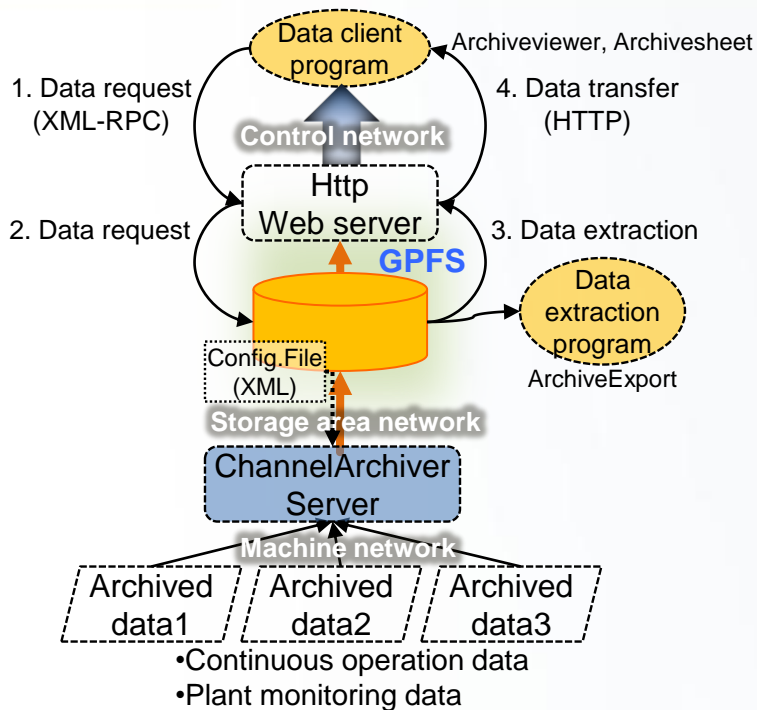


StripTool

Archived operation data tools



Introduction | Operator interface | **Data access tools** | Misc. tools | Summary



Archivesheet



Archiveviewer

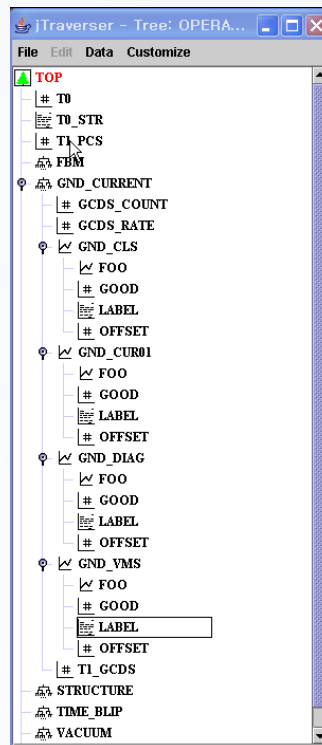
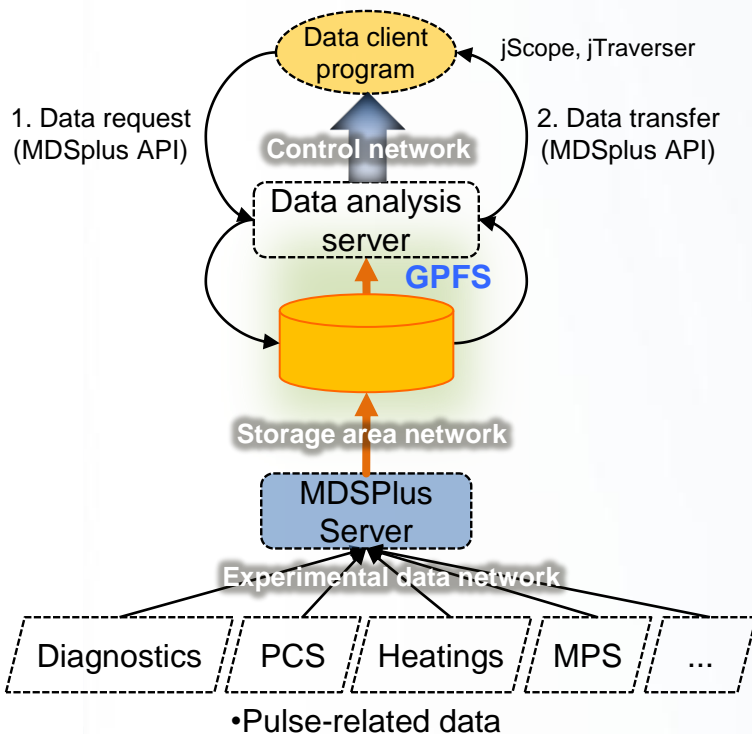
Software	Remark	Library	Language
ArchiveEngine	•Core module for Channel Archiver server •Acquire data via CA and store it	Xml-rpc, Xerces, Channelarchiver	C/C++
ArchiveDataServer	•Retrieve the operational data based on information extracted from index file and requests from OPI	Xml-rpc, Xerces, Channelarchiver	c/cgi
ArchiveExport	•Command-line archive data retrieval tool	Channelarchiver	C/C++
Archiveviewer	•Plot data in 2-D chart	Archiveviewer.jar	Java
Archivesheet	•Display data in a spread sheet	Developed using xml-rpc, Qt	C++/Qt

Software for Operational Data Management System

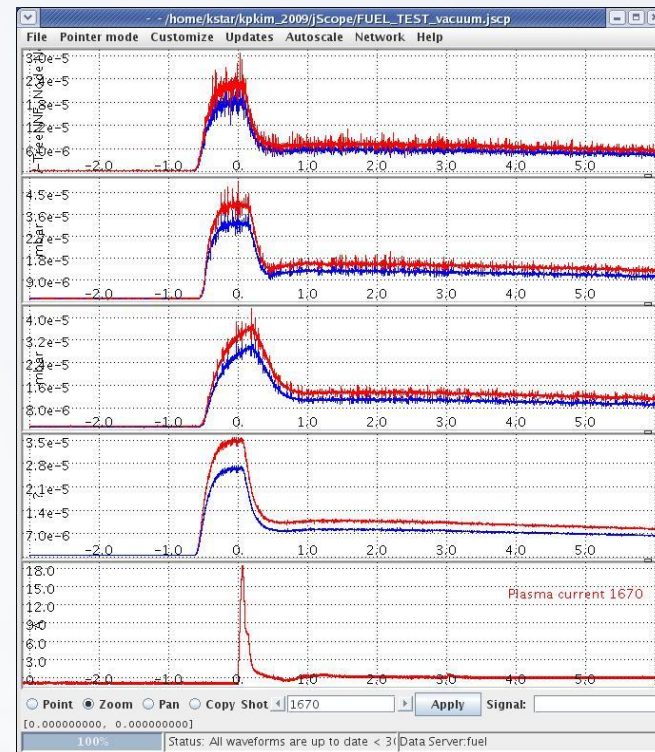
Experimental data tools



Introduction Operator interface **Data access tools** Misc. tools Summary



jTraverser



jScope

Software	Remark	Library	Language
mdsip	Core module for the Mdsplus server to generate the experimental data files	mdsip	C/C++
jScope	Displaying tool for 2-D plot	jScope.jar	Java
jTraverser	Tool to configure MDSplus DB structure	jTraverser.jar	Java

Software for KSTAR Experimental Data Management System

Common interface

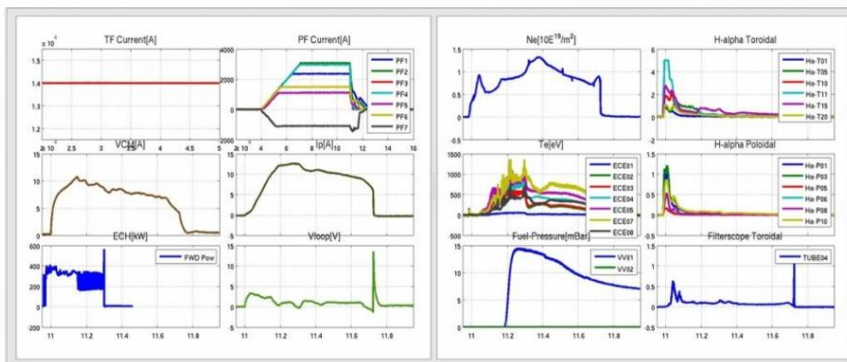


Introduction Operator interface **Data access tools** Misc. tools Summary

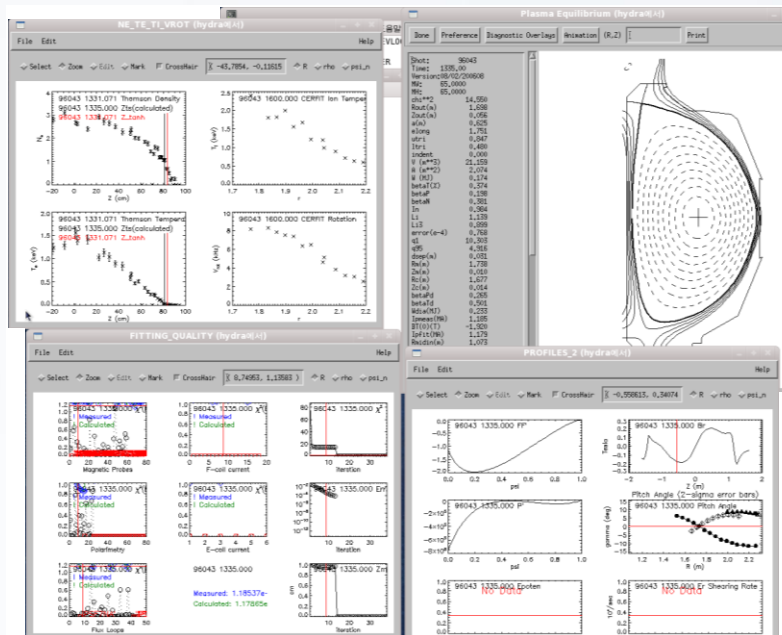
- Interface library for the commercial S/W**

Software	Remark	Data to access	Library	Language
IDL	Commercial program for scientific calculation	Operation data	Ezca	IDL script
		Experimental data	Mdsconnect, Mdsopen...	IDL script
MATLAB	Commercial program for scientific calculation	Operation data	Mca	MATLAB script
		Experimental data	Mdsconnect, Mdsopen...	MATLAB script

Common interface for KSTAR Data Management System



An image generated using MATLAB chart function and MDSplus API



EFIT viewer (one of the IDL applications) using MDSplus API [DIII-D data]

Web-based logbook



Introduction | Operator interface | Data access tools | **Misc. tools** | Summary

- **E-logbook**
 - Introduction of the GA DIII-D E-logbook
 - Functions
 - Making logbook entry
 - Search by selection option or SQL
 - Customized query
 - Total number of the logbook entries was 7323.
- **Shot-summary**
 - Shot-summary generated automatically by the KSTAR shot sequence
 - Functions
 - Search by shot number, date, and values
 - Display searched result as Web page or PDF

KSTAR Electronic Logbook

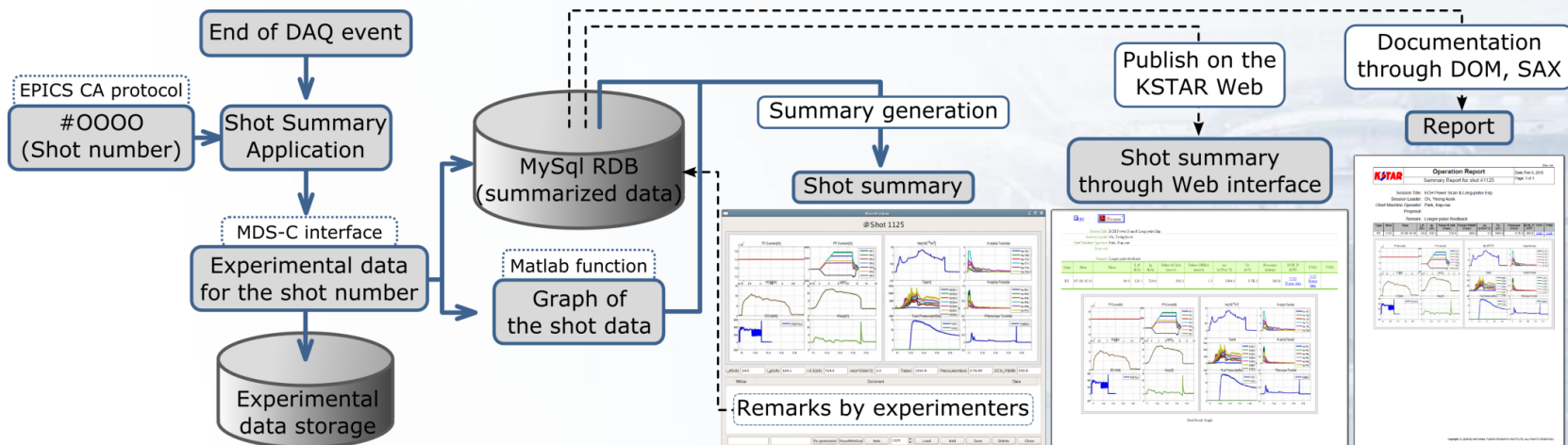
KSTAR DB shbaek [Logout] Selection Options | Display Options | Make Entry | Show Current Row | Do Query | Custom Query | Print Format | Refresh Result

SELECT ISHONERIC (SHOT), AS NE, FROM ENTRIES WHERE (BIN = "20091202") AND (USERNAME='SHBAEK' OR TOPIC IN ('ANALYSIS', 'CCS', 'CHIEF_OPERATOR', 'DIAGNOSTIC', 'ECH', 'GOOD_SHOT', 'ICRF', 'PCS', 'PRYSICS_OPERATOR', 'SESSION_LEADER', 'STATUS', 'TESTING')) ORDER BY NE DESC, BIN DESC, SHOT_DESC, ENTERED_DESC

Results 1 - 80 of 142

Shot No.	Operator	Category	Date	Time
2343	shbaek	Testing	Dec 03 2009	11:29AM
2343	shbaek	Testing	Dec 03 2009	11:29AM
2343	shbaek	Testing	Dec 03 2009	11:28AM
2342	hahnsh	PHYSICS_OPERATOR	Dec 02 2009	04:42PM
2342	hahnsh	PCS	Dec 02 2009	04:42PM
2341	hahnsh	PHYSICS_OPERATOR	Dec 02 2009	04:38PM
2341	hahnsh	PCS	Dec 02 2009	04:38PM
2340	hahnsh	PHYSICS_OPERATOR	Dec 02 2009	04:33PM

KSTAR E-logbook



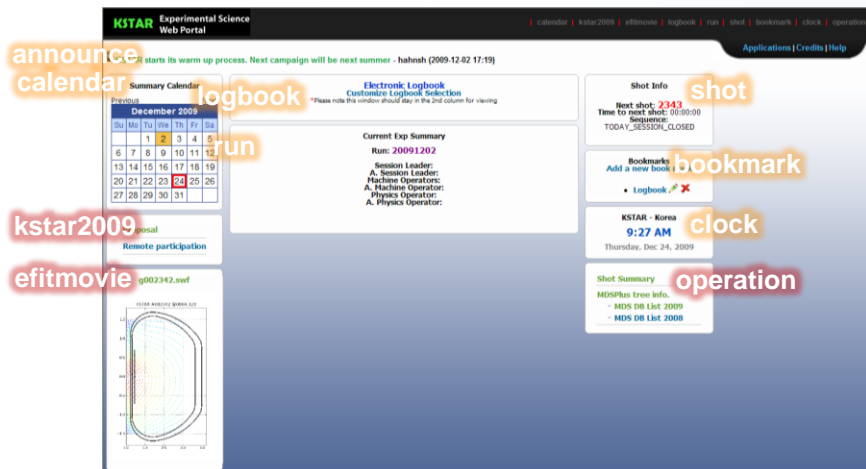
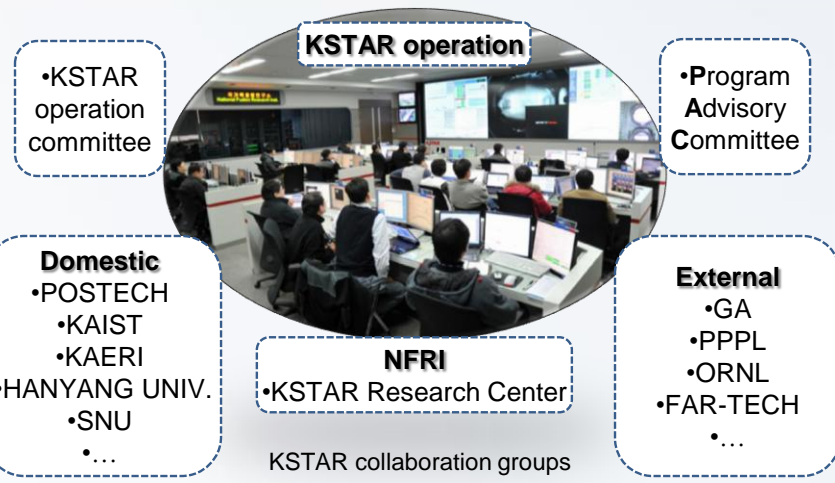
Shot-summary generation procedure

Remote participation service



Introduction | Operator interface | Data access tools | **Misc. tools** | Summary

- **Experimental proposal**
 - 45 experimental proposals were submitted by collaborators.
- **Web-portal**
 - Introduced GA DIII-D web-portal package including various web applications needed for the nuclear fusion experiment.
- **Experimental data access**
 - Remote access control service to the experimental data
- **Machine access**
 - Device access control to the machine in the KSTAR network
- **Video conferencing service**
 - (H.323)



KSTAR Web-portal

	Institute	Webportal users	Exp. data access	Machine access	Video conference
External users	GA	5	35	31	2
	PPPL	6	19	2	1
	FAR-TECH	1	-	-	-
	MIT	1	-	-	-
	ORNL	1	4	-	-
	NIFS	1	1	-	-
Domestic users	JAEA	1	2	-	-
	POSTECH	13	13	-	-
	KAERI	5	5	-	-
	SNU	4	-	-	-
	KAIST	3	3	-	-
etc.	5	-	-	-	
Sum		164	254	162	3

Summation of the 2009 KSTAR remote participation services

Control system monitoring



Introduction Operator interface Data access tools Misc. tools Summary

• sysMon

- Integration of Linux, VxWorks, CA Gateway system monitoring packages

The image shows two monitoring panels. The left panel is 'sysMonitor OPI' displaying various system metrics like rack temperatures, CPU loads, and storage temperatures. The right panel is 'Gateway cagateway' showing active/inactive PVs, connections, and event rates.

Monitoring panels of the IOC servers

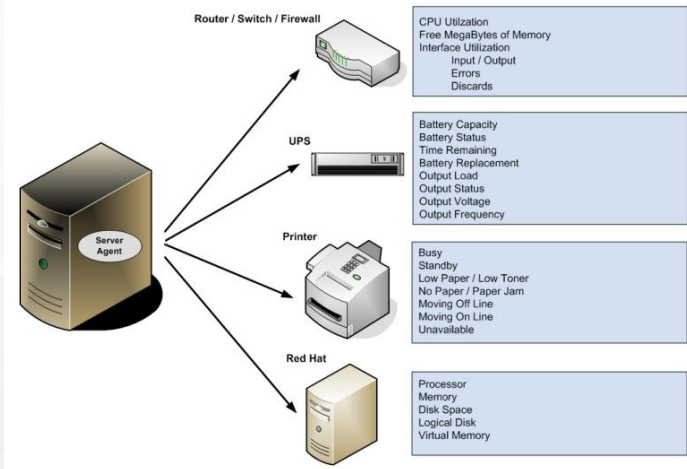
Monitoring panel of Gateway

• Investigation of the control system monitoring tools

- IRMIS
 - It describes relationships between the elements using relational database (RDB) implementation instead of the drawing-based method.
 - PV crawlers for 15 IOCs were automated to crawl process variable information from the IOC and for 4 IOCs were installed to be operated manually.
- SNMP
 - Monitoring resources
 - CPU load, Free memory, service programs (httpd, sshd, ...)
 - User defined programs, disk information

The screenshot shows the KSTAR IRMIS application interface with various search filters, a search results table, and PV info details.

KSTAR IRMIS application



SNMP Monitoring resources

Configuration management

Introduction

Operator interface


Data access tools

Misc. tools

Summary



- **EPICS database configuration**
 - VDCT (Visual Database Configuration Tool)
- **Version Control of source code and configuration files: CVS**
 - CVS Tools: ViewVC (web interface), CVSmonitor (statistics tool)
- **Remote S/W management**
 - How it works?
 - **remoteopicontrol** on the engineering workstation executes a command for **remotesvr** running on a pi server, and remotesvr does actions allowed in the opi server.
 - Communication protocol: XML-RPC
 - Commands: opiupdate, opipluginupdate, opiinstall, shutdown
- **Remote service monitoring**
 - servicechecker: A tool to check registered processes on IOCs and OPI servers

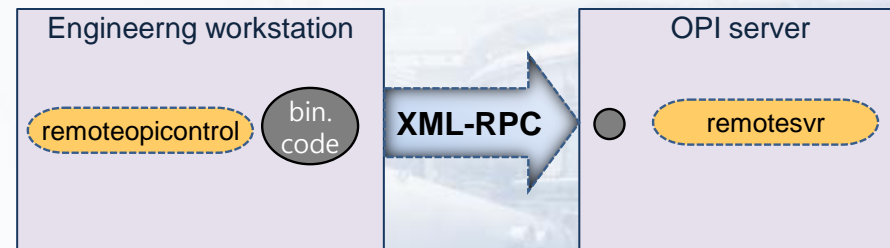
Index of / 

Files shown: 0
Sticky Tag:

File	Rev.	Age	Author	Last log entry
Parent Directory				
DG535Lib/				
ESP300Lib/				
SRSRGALib/				
TPG250Lib/				
agilent6652ALib/				
asynLib/				
configure/				
gdb/				
devSequenceLib/				
ether_piLib/				
gasproolLib/				
heproplib/				
include/				
niPXISCSXLib/				
nicFP20x0Lib/				
pfifferTPG262Lib/				
pumpLib/				
seqLib/				
timestampRecordLib/				
zocGP307Lib/				
zmcUniverseLib/				
zmmme2534Lib/				
zmmme3122Lib/				
zmmme5565RfmLib/				
zrStatsLib/				

[Download GNU tarball](#)

KSTAR CVS (ViewVC web interface)



Remote S/W management tools

Improvement plans

[Introduction](#)[Operator interface](#)[Data access tools](#)[Misc. tools](#)[Summary](#)

• KWT

- Supporting diverse EPICS DB request type
 - KWT widgets request channel response as DBR_DOUBLE type. Changing of DBR_TYPE from DBR_DOUBLE to DBR_STRING is not difficult but we have to modify all OPIs in that case.
- Adding general scalability features
 - Qt has various layout widgets but we need new layout widget and policy to make CAwidgets be scalable with the consistent ratio.
- Enhancing usability for the development of popup panel
 - To make popup panel as template, all pvnames for the panel is come from the CAGraphic widget (symbol). So developer has to match the order of widgets. We need better usability for that.

• Live data tools

- Elaboration of Multiplot (Multiwaveplot) and Singleplot

• Archived operation data tools

- Investigation of alternative retrieval tools for Channel Archiver

• Control system monitoring tools

- Application of IRMIS and SNMP for control system description and monitoring
- MDSPlus crawler development

Summary

[Introduction](#)[Operator interface](#)[Data access tools](#)[Misc. tools](#)[Summary](#)

- About 150 OPI panels were developed using KWT and EPICS OPI tools, and there were no critical problems during a two year operation.
- Some live data tools were developed and used for KSTAR operation.
- We need to find out alternatives of the archiveviewer. Because the original author of the archiveviewer is no longer willing to maintain it.
- ❖ The KWT V1.0 was released. (<http://kwt.sourceforge.net>)



KSTAR Operation tools


[Introduction](#)
[Operator interface](#)
[Data access tools](#)
[Misc. tools](#)
[Summary](#)

Category	Name <i>Description</i>	Package or developer	Category	Name <i>Description</i>	Package or developer
Operator interface	KWT <i>Qt-based OPI development tool-kit with 16 plug-in widgets</i>	NFRI	Web-based applications	E-logbook <i>Web-based electrical logbook</i>	GA
	TMS, VMS, SCS, DDS, TSS, Fuel, QDS, MPS, ... <i>KSTAR OPIs</i>	NFRI		Web-portal <i>Web-based portal application</i>	GA, NFRI (customization)
Live data tools	Multiplot (Multiwaveplot) <i>Multi-channel live data plot application</i>	NFRI	System monitoring tools	Shot summary <i>Summarized shot information</i>	NFRI
	Singleplot <i>Multi-channel live data plot library</i>	NFRI		sysMon <i>Control system monitoring package</i>	NFRI (customization)
	StripToopLegend <i>Customized StripTool to display seperated legend window</i>	NFRI (customization)		IRMIS <i>Control system describing tool</i>	EPICS extensions
Archived operation data tools	StripTool, camonitor, probe, MEDM, ... <i>EPICS extensions</i>	EPICS extensions	Configuration management tools	SNMP <i>Distributed server resource monitoring tool</i>	
	ArchiveEngine, ArchiveDataServer, ArchiveExport <i>Channel Archiver tools</i>	EPICS extensions		VDCT <i>EPICS database configuration tool</i>	EPICS extensions
	Archiveviewer <i>Archived operation data retrieval tool</i>	EPICS extensions		CVS, ViewVC, CVSmonitor <i>Version control tool of source code and configuration files</i>	
Experimental data tools	Archivesheet <i>Archived operation data retrieval and conversion tool</i>	NFRI	❖ KWT, Multiplot (Multiwaveplot), Singleplot, StripToopLegend and Archivesheet can be applied to the EPICS-based control system.	remoteopicontrol, remotesvr, opiupdate, etc. <i>Remote S/W management tools</i>	NFRI
	MDSip <i>Core module for the MDSplus server to generate the experimental data files</i>	MDSplus		Servicechecker <i>Remote service monitoring tool</i>	NFRI
	jScope <i>2-D plotting tool of experimental data (MDSplus)</i>	MDSplus			
	jTraverse <i>Model-tree browsing tool of experimental data (MDSplus)</i>	MDSplus			
	MDSplus API <i>General purpose interface to experimental data (MDSplus)</i>	MDSplus			

Thank you.

