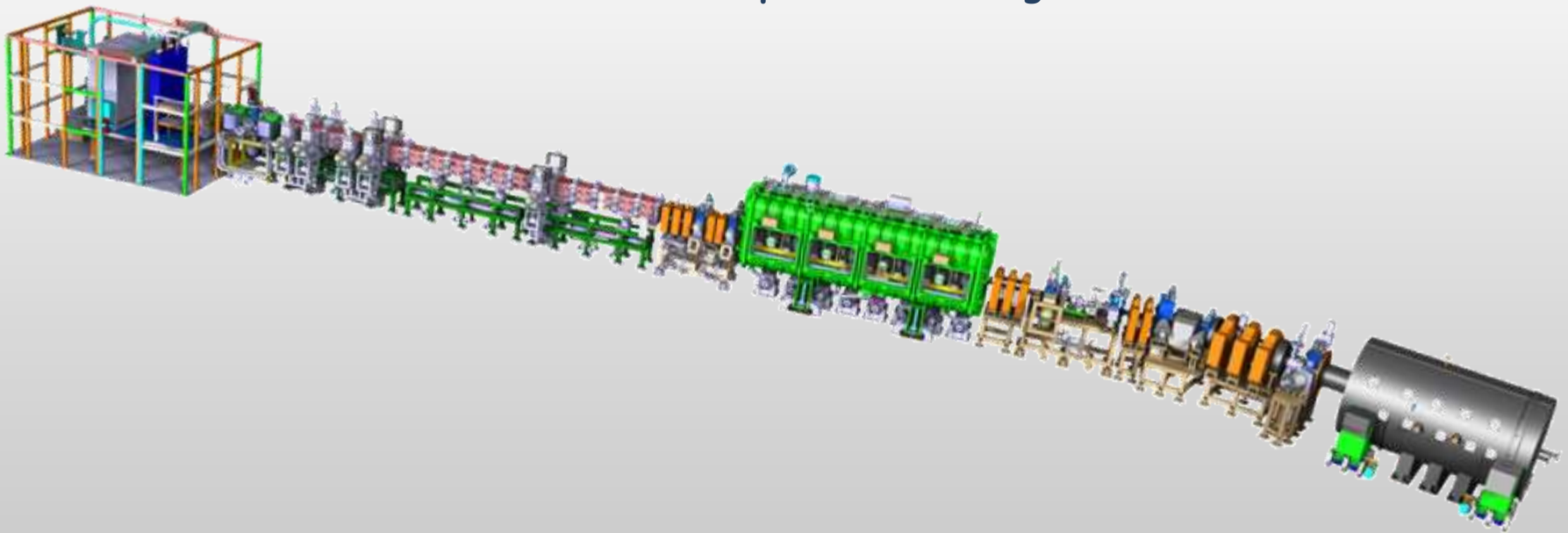


LIPAc Control System

Reliability improvements

Alvaro Marqueta (Fusion For Energy)
alvaro.marqueta@ifmif.org



LIPAc = Linear IFMIF Prototype
Accelerator

A bit of history...



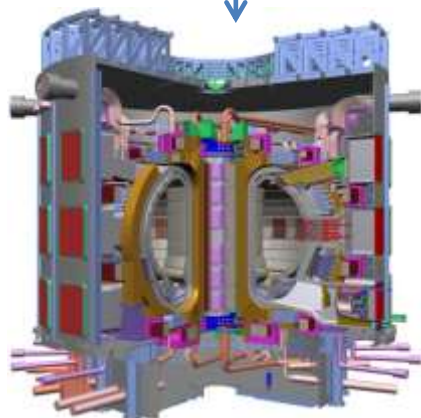
ITER Agreement

21 November 2006

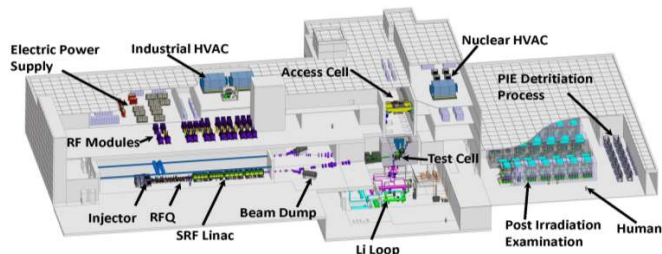


Broader Approach Agreement

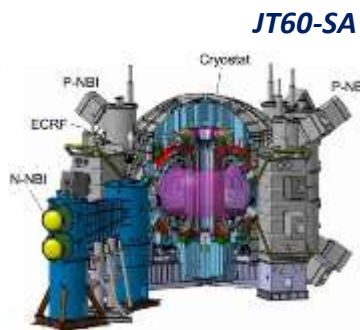
1 June 2007



ITER



IFMIF/EVEDA

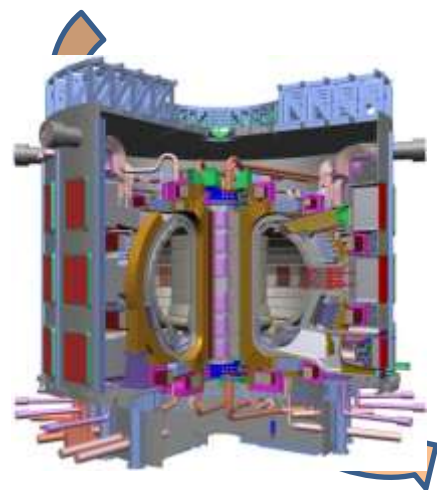


JT60-SA



IFERC

Main contributors to DEMO design

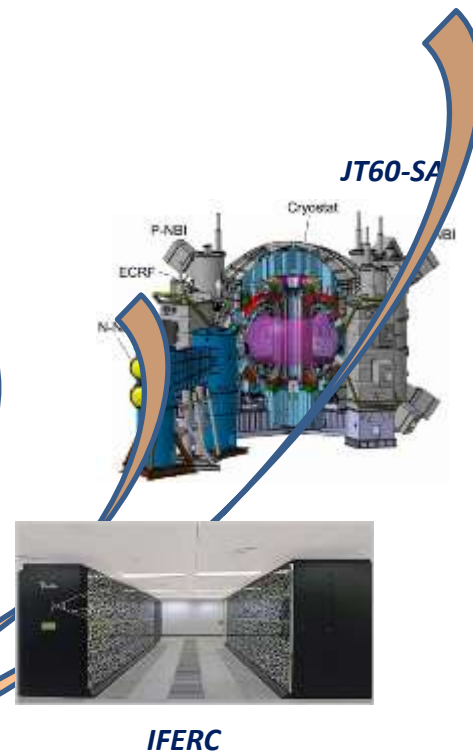


ITER



DEMO

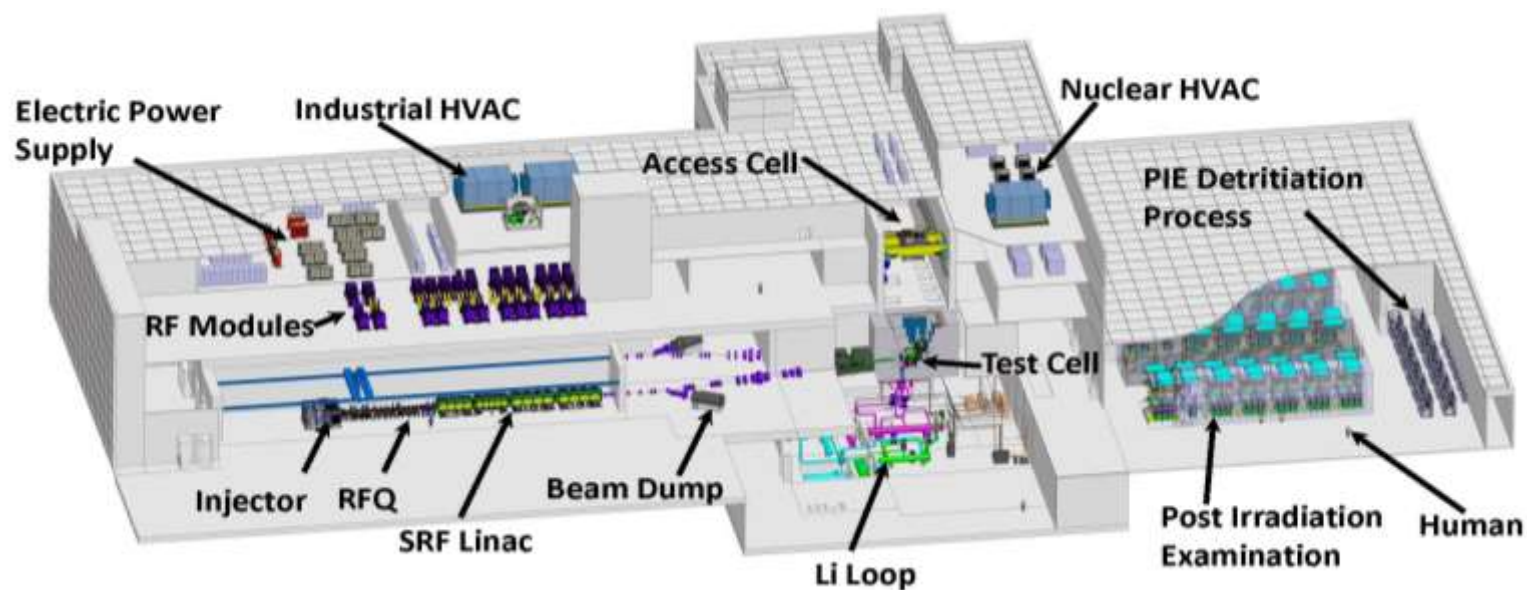
IFMIF/EVEDA



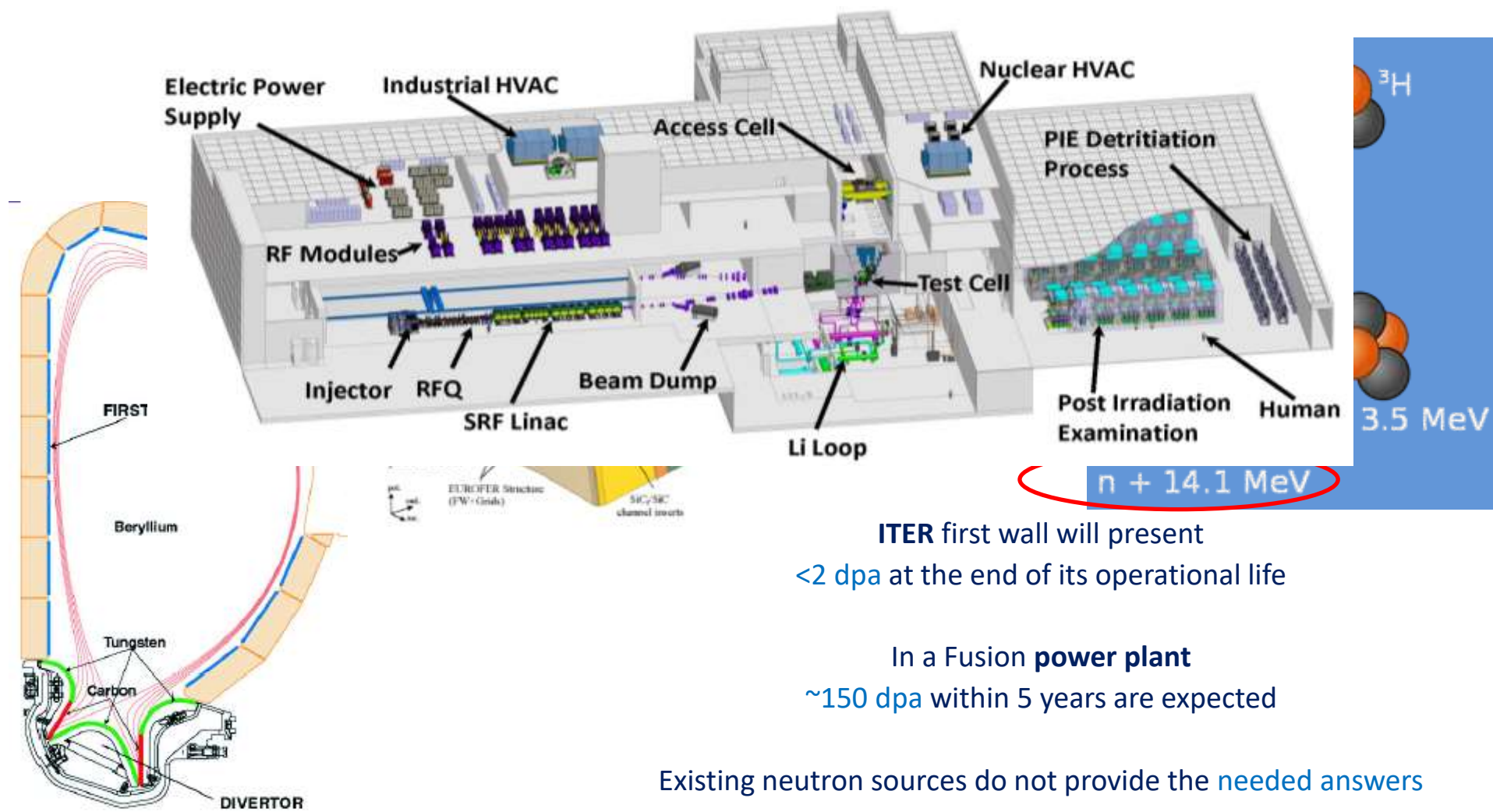
IFERC

JT60-SA

IFMIF -> International Fusion Materials Irradiation Facility (the fusion relevant neutron source)



IFMIF -> International Fusion Materials Irradiation Facility (the fusion relevant neutron source)

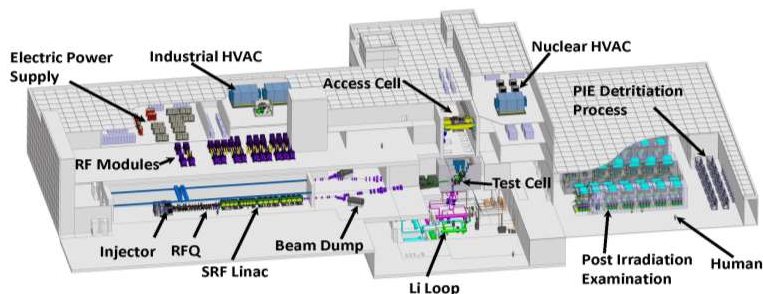


ITER first wall will present
<2 dpa at the end of its operational life

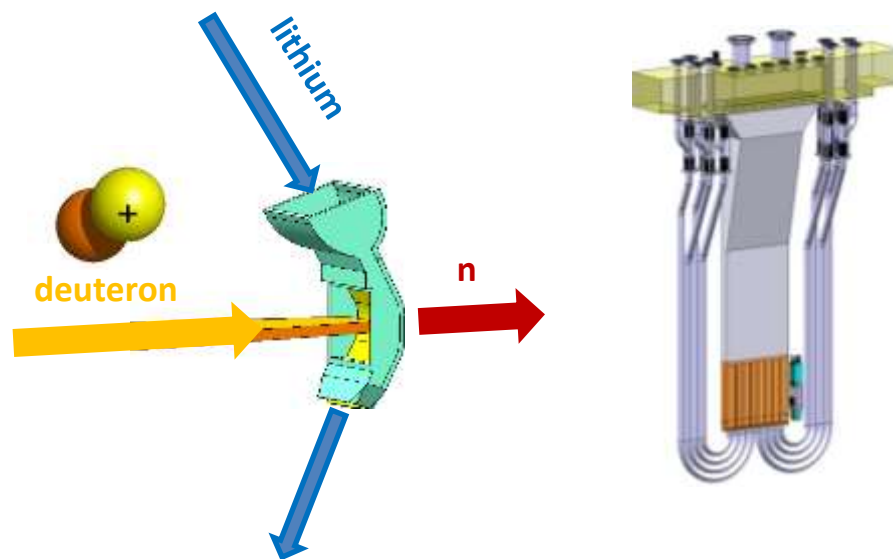
In a Fusion **power plant**
~150 dpa within 5 years are expected

Existing neutron sources do not provide the needed answers

IFMIF -> International **Fusion** Materials Irradiation Facility (the fusion relevant neutron source)



Li loop:
250°C, 15m/s, ±1mm
amplitude stability

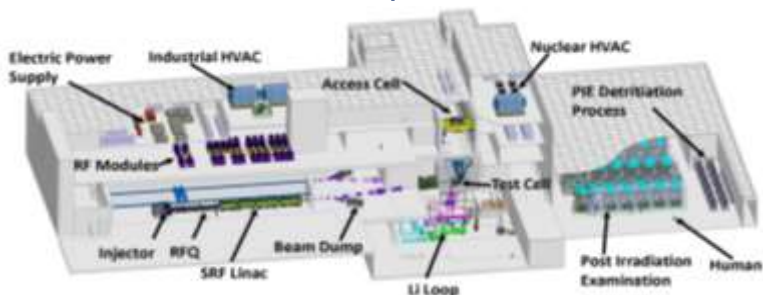


D⁺ Accelerator:

40 MeV, 125 mA CW
5 MW

Test facility:
Withstand dpa levels

IFMIF -> International Fusion Materials Irradiation Facility (the fusion relevant neutron source)



EVEDA -> Engineering Validation and Engineering Design Activities

EDA phase:



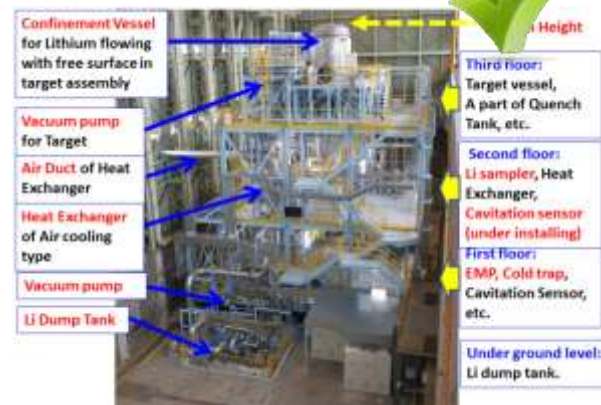
IFMIF II-EDR

Test Facility

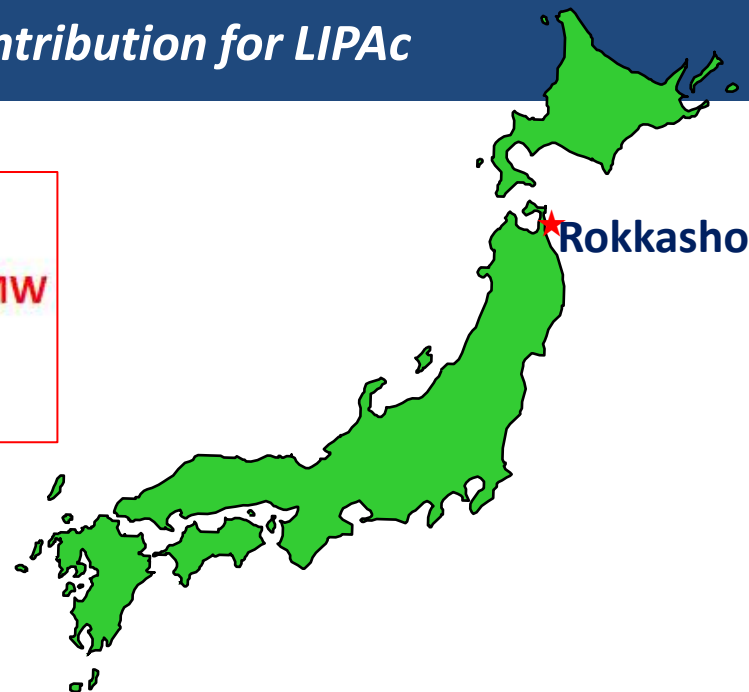


LIPAc (Accelerator Facility)
9MeV, 125mA CW, 1.25 MW

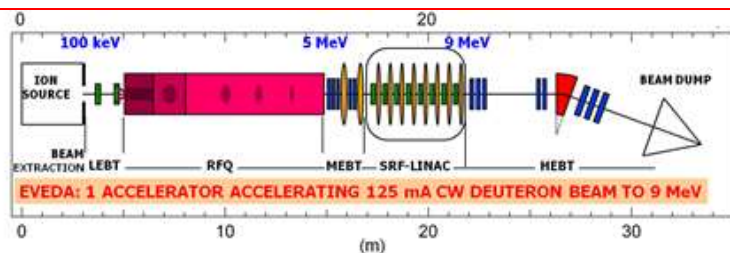
EVA phase:



Target Facility



Rokkasho



9 MeV

125 mA

1.125 MW

Injector + LEPT
CEA Saclay

RFQ
INFN Legnaro
QST

MEBT
CIEMAT Madrid

SRF Linac
CEA Saclay
CIEMAT Madrid

HEBT
CIEMAT Madrid

BD
CIEMAT Madrid

Diagnostics
CEA Saclay
 CIEMAT Madrid

Cryoplant
CEA Saclay

RF Power
CIEMAT Madrid
CEA Saclay
SCK Mol

Building
Auxiliary System
Control system
Installation
QST



Ciemat



SCK • CEN

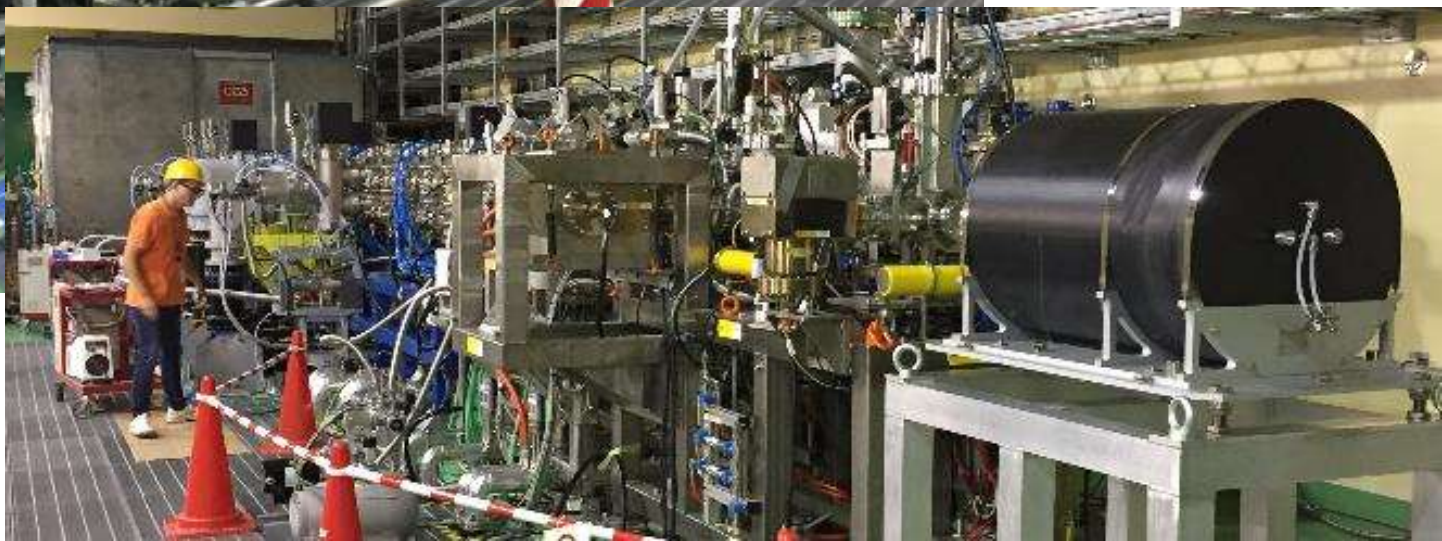


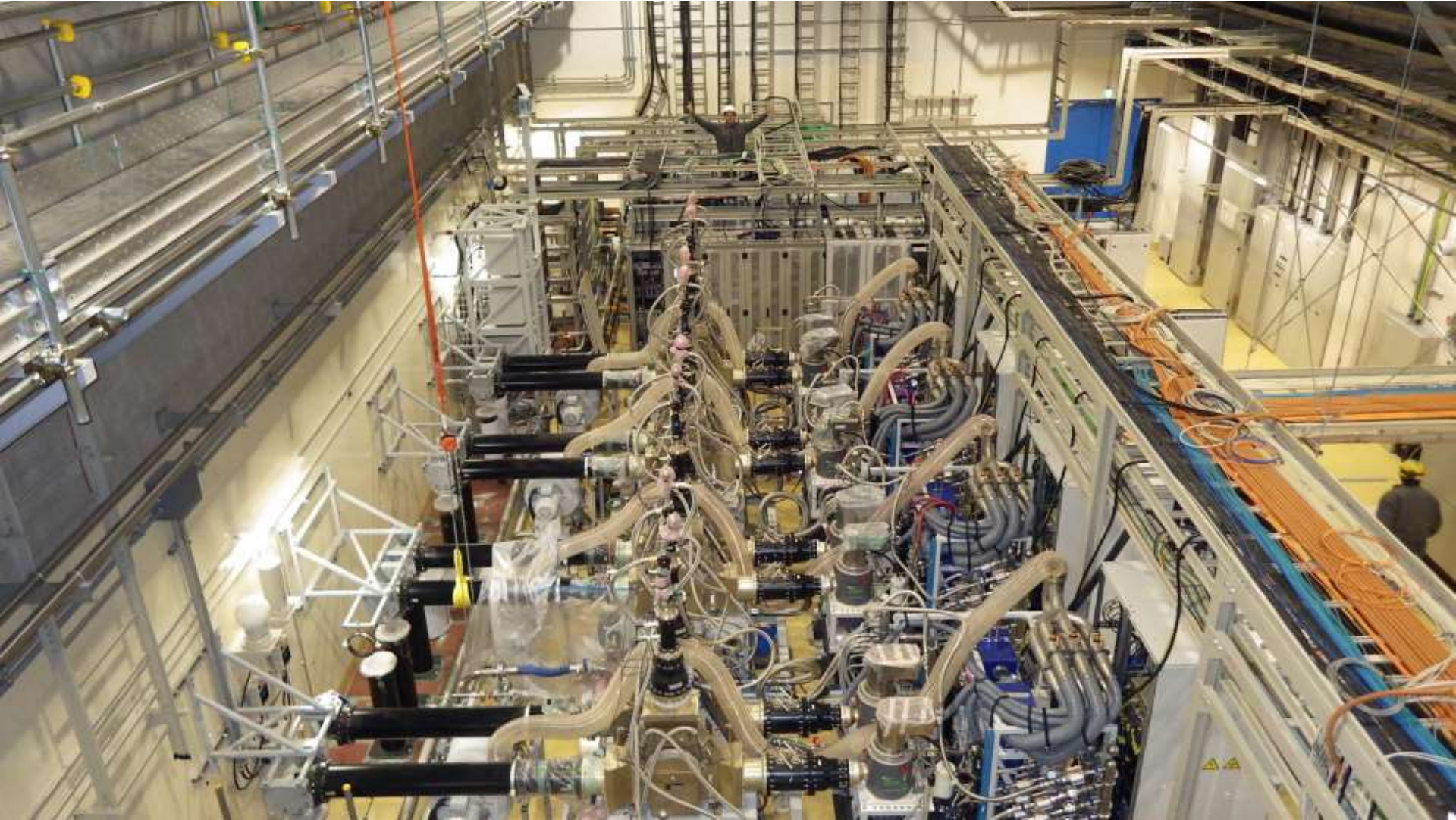
Administration &
Research Building

Computer Simulation &
Remote Experimentation Building

DEMO R&D Building

IFMIF/EVEDA
Accelerator Building





8 RF chains (8 x 200kW) for RFQ + 2 (2 x 105kW) for bunchers



RFQ RF conditioning started!

- 1st RF injection to RFQ cavity: 13 Jul 2017
- Injection to RFQ cavity with 8 RF chains synchronized: 31 Jul 2017



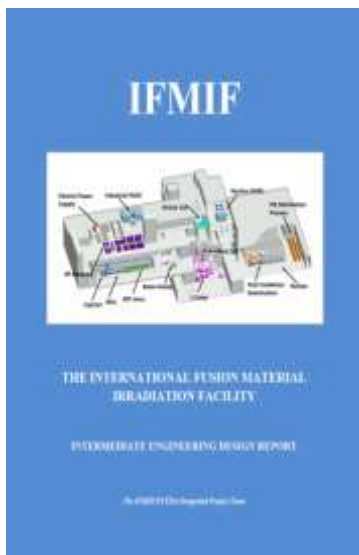
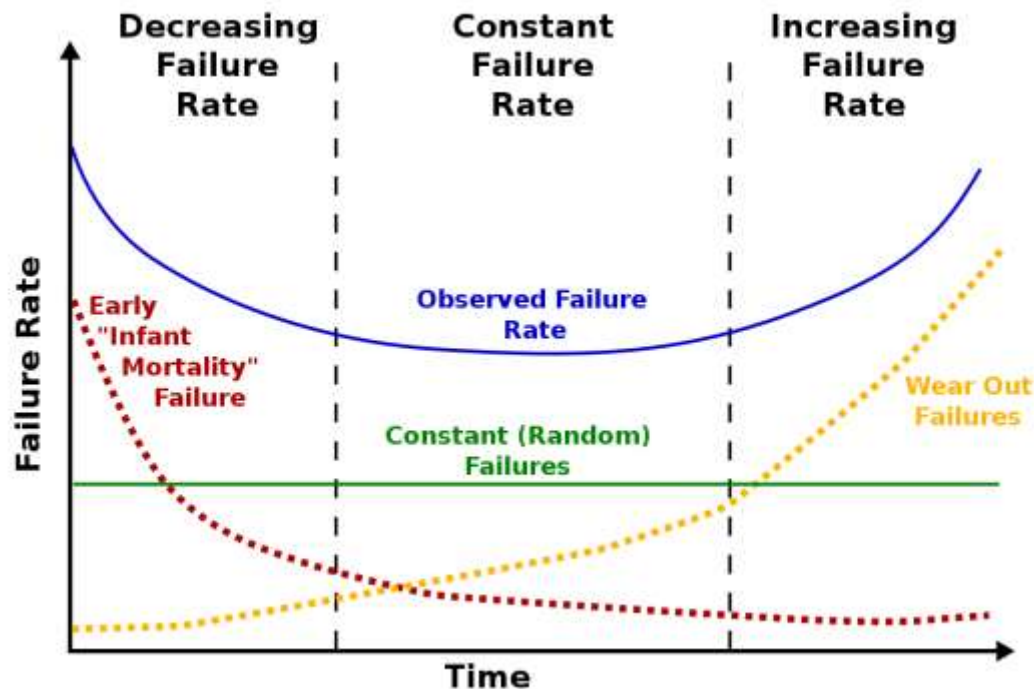
Our activities have entered into a new stage.

- RFQ conditioning till the end of this year
- Beam expected early 2018

Prototype

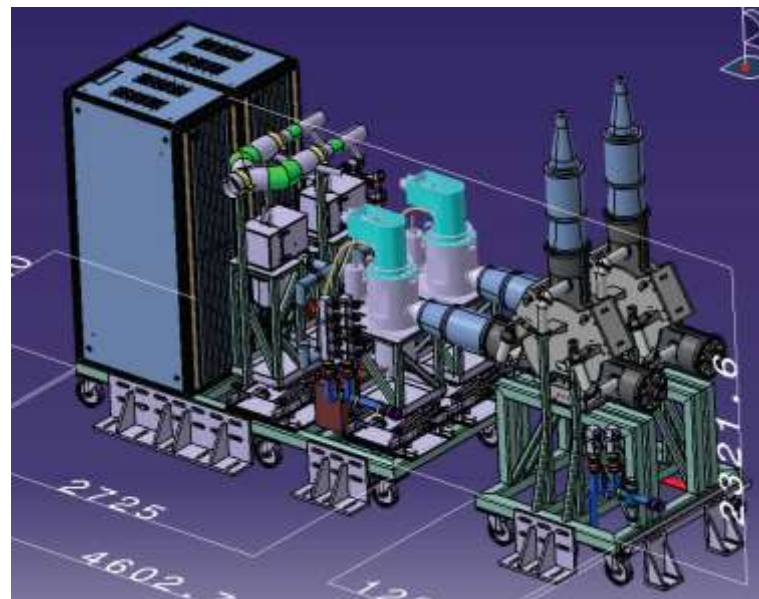
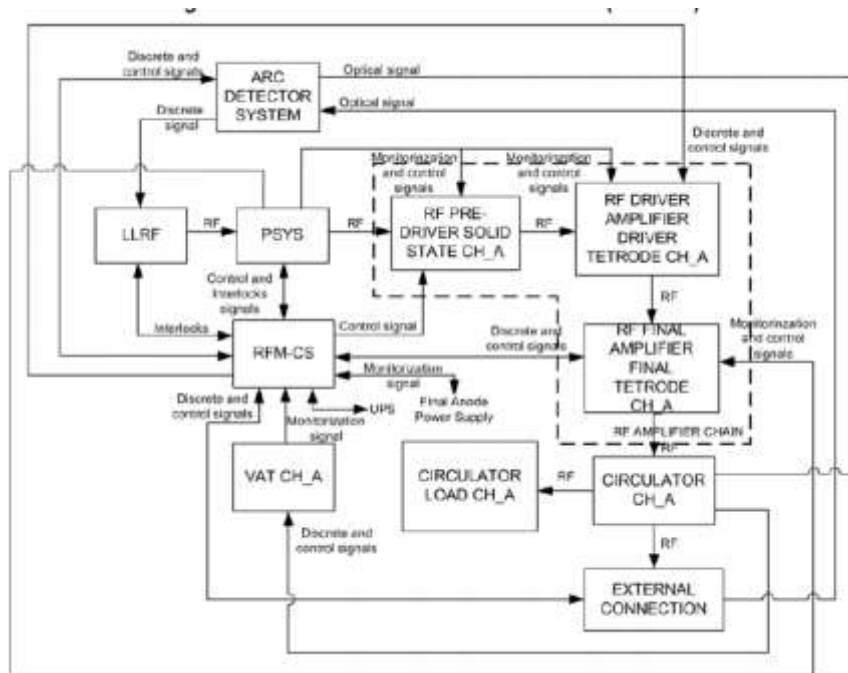
Voluntary contribution

Requirements...



IFMIF Facilities	Availability requirements
Test Facility	96%
Target Facility	94%
Accelerator Facility	87%
Conventional Facilities	98%
Central Control System & Common Instr.	98%
TOTAL (product)	75%

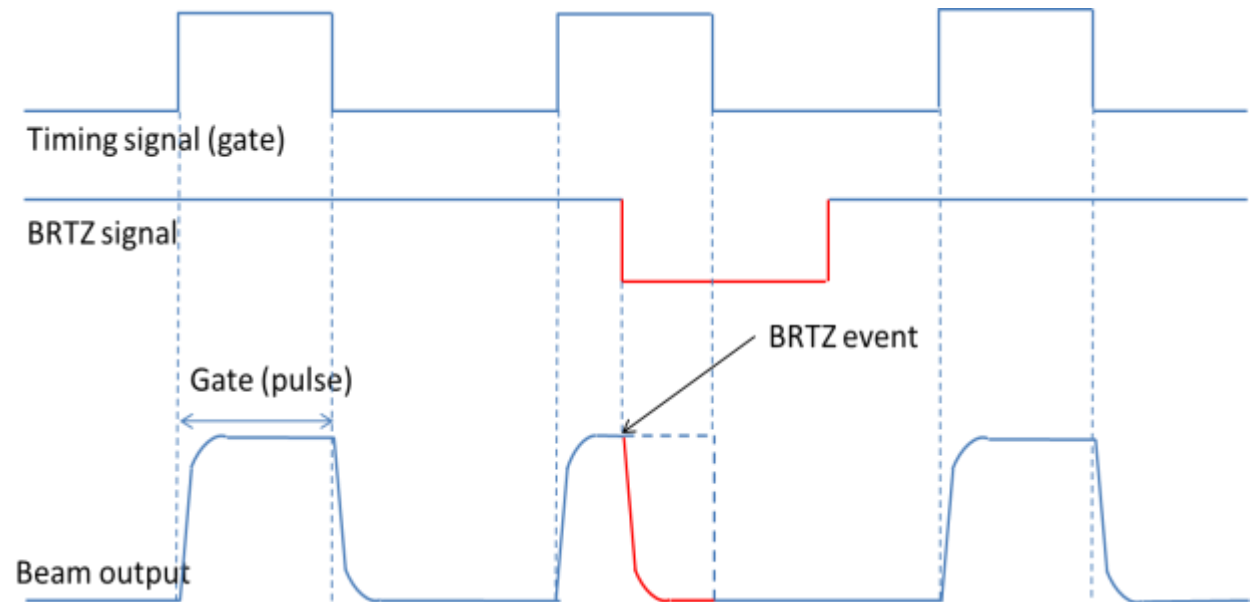
Enhancing maintenance by reducing MTTR



RF protection system

In excess: reducing availability

Beam stop:



Automatic beam rearm for
certain events
(arcs, BLoM)



Experience will tell...

Control system **standardization**:

- Around **50 IOCs** -> Distributed among **8** main subsystems
- More than 40,000 PVs



**VME+ADAS
& MODBUS**



SIEMENS PLC
-> IOC on s7PLC drv
(formerly, OPC)



cPCI & Intel i7 + ADC-DAC
for LLRF, BPMs



+ a number of other
specific devices

- **Obsolescence management**
- **Collaborative tools**
- **Proper transfer of knowledge
& documentation**

Event report system, As part of quality system

Browser: <https://users.jt60sa.org> 80% 検索

Broader Approach Activities IFMIF/EVEDA IERC JT-60SA

Applications JT-60SA IFMIF IERC

Contact Subscribe Help Manuals To Do Preferences Log out

Favorites

Favorites are listed alphabetically.

- 03 Common Fund
- 1 Accelerator Facility
- 1.06 Publications Management 2016
- 4.02.01.01 LIPAc Technical Meetings (LTM)
- 4.02.03.01.01 EU-HT 3DMUs
- 4.02.05.01 LIPAc Interfaces Database
- 4.02.06 LIPAc Beam Dynamics
- 4.03 LIPAc Safety & Licensing Management
- 4.03.01 On-Site Safety Management

[View More / Manage Favorites](#)

Title	Last change date	Issue Date	File Type	File Size	Status	Signatory
ER_036 GEM-GRID short to ground (BA D 27P4A3 v1.0)	14 Sep 2017 04:45	14 Sep 2017	docx	2.23 MB	In Work	Moya I.
ER_037 Noise in RFQ through the ground during injector operation (BA D 27D9A4 v1.0)	14 Sep 2017 04:52	14 Sep 2017	docx	1.32 MB	In Work	Moya I.
ER_038 FTT06 bad seating (BA D 27D9X1 v1.1)	07 Sep 2017 13:52	07 Sep 2017	docx	801.6 KB	Signed	Moya I.
ER_039 RFQ skid water leak (BA D 27J0ZY v1.0)	22 Aug 2017 11:05	22 Aug 2017	pdf	386.82 KB	Signed	Scantamburlo F.
ER_034 Bad insulation of the HV connector going to the HV divider box for the chopper of the injector (BA D 27H2B5 v1.0)	11 Aug 2017 12:55	11 Aug 2017	docx	456.97 KB	Signed	Pruneri G.
NCR_029 MEBT cooling skid piping insulation for chilled water line (BA D 27J5D6 v1.1)	07 Sep 2017 04:15	19 Jul 2017	docx	205.78 KB	Signed	Pruneri G.
NCR_032 HEBT Cool Skid deionizer system Filter Flp-2 wrong installation (BA D 27H8F4 v1.1)	19 Jul 2017 07:08	19 Jul 2017	docx	581.61 KB	Signed	Pruneri G.
NCR_030 MEBT Cool Skid Air vent drainages lines they must be separated (BA D 27J0H5 v1.1)	07 Sep 2017 04:15	19 Jul 2017	docx	765.58 KB	Signed	Pruneri G.
NCR_031 HEBT Cool Skid Air vent drainages lines they must be separated (BA D 27J0V1 v1.1)	19 Jul 2017 07:05	19 Jul 2017	docx	765.69 KB	Signed	Pruneri G.
NCR_018 Problem on a pump motor of RFQ skid (BA D 27D9YE v2.0)	19 Jul 2017 05:04	11 Jul 2017	docx	80.15 KB	Approved	Antonazzo L.
NCR_017 Vacuum failure on the AGCT at RFQ/IMBT interface (BA D 27D9TD v4.1)	31 Jul 2017 06:05	11 Jul 2017	pdf	1.96 MB	Approved	Scantamburlo F.
NCR_033 RFQ Cooling Distribution (BA D 27CYQY v1.0)	20 Jul 2017 08:47	23 Jun 2017	docx	63.93 KB	Signed	Fagotti E.
NCR_028 High gas load observed in the RFQ (BA D 27J0G1 v2.0)	19 Jul 2017 05:04	08 Jun 2017	pdf	288.94 KB	Signed	Knaeber J.
NCR_025 Repeller electrode hole of the beam extraction system of injector accelerator column larger than expected (BA D 26N5V6 v1.0)	19 Jul 2017 05:04	30 May 2017	docx	400.8 KB	Approved	Ozko H.
NCR_027 The first ground electrode and the intermediate electrode are not in their nominal position along the accelerator axis (BA D 26QKNW v1.0)	19 Jul 2017 05:04	30 May 2017	docx	75.89 KB	Approved	Ozko H.
NCR_026 First ground electrode of the beam extraction system of injector accelerator column larger than expected (BA D 26P5WU v1.0)	19 Jul 2017 05:04	30 May 2017	docx	978.14 KB	Approved	Ozko H.
NCR_022 FHV19 3-ways valve (BA D 27H2SP v1.0)	19 Jul 2017 05:04	26 Apr 2017	docx	71.97 KB	In Work	Moya I.
NCR_023 RFPM UPS batteries (BA D 27D9MK v1.0)	19 Jul 2017 05:04	05 Apr 2017	docx	8.53 MB	In Work	Moya I.
NCR_024 FIBR05 switchgear blocked (BA D 27C1N2 v1.0)	19 Jul 2017 05:04	27 Mar 2017	docx	511.74 KB	In Work	Moya I.
NCR_019 FHE01 heat exchanger (BA D 27D9N3 v1.0)	19 Jul 2017 05:04	13 Mar 2017	docx	71.89 KB	In Work	Moya I.
NCR_021 FHV10 valve (BA D 27D9M9 v1.0)	19 Jul 2017 05:04	13 Mar 2017	docx	71.65 KB	In Work	Moya I.
NCR_020 GEM3/30 water purifier (BA D 27D938 v1.0)	19 Jul 2017 05:04	07 Mar 2017	docx	71.51 KB	In Work	Moya I.
NCR_016 Incorrect anchoring position of DPlate (BA D 27D9A8 v1.1)	19 Jul 2017 05:04	06 Mar 2017	docx	491.49 KB	Approved	Sugimoto M.

No. of Records : 23

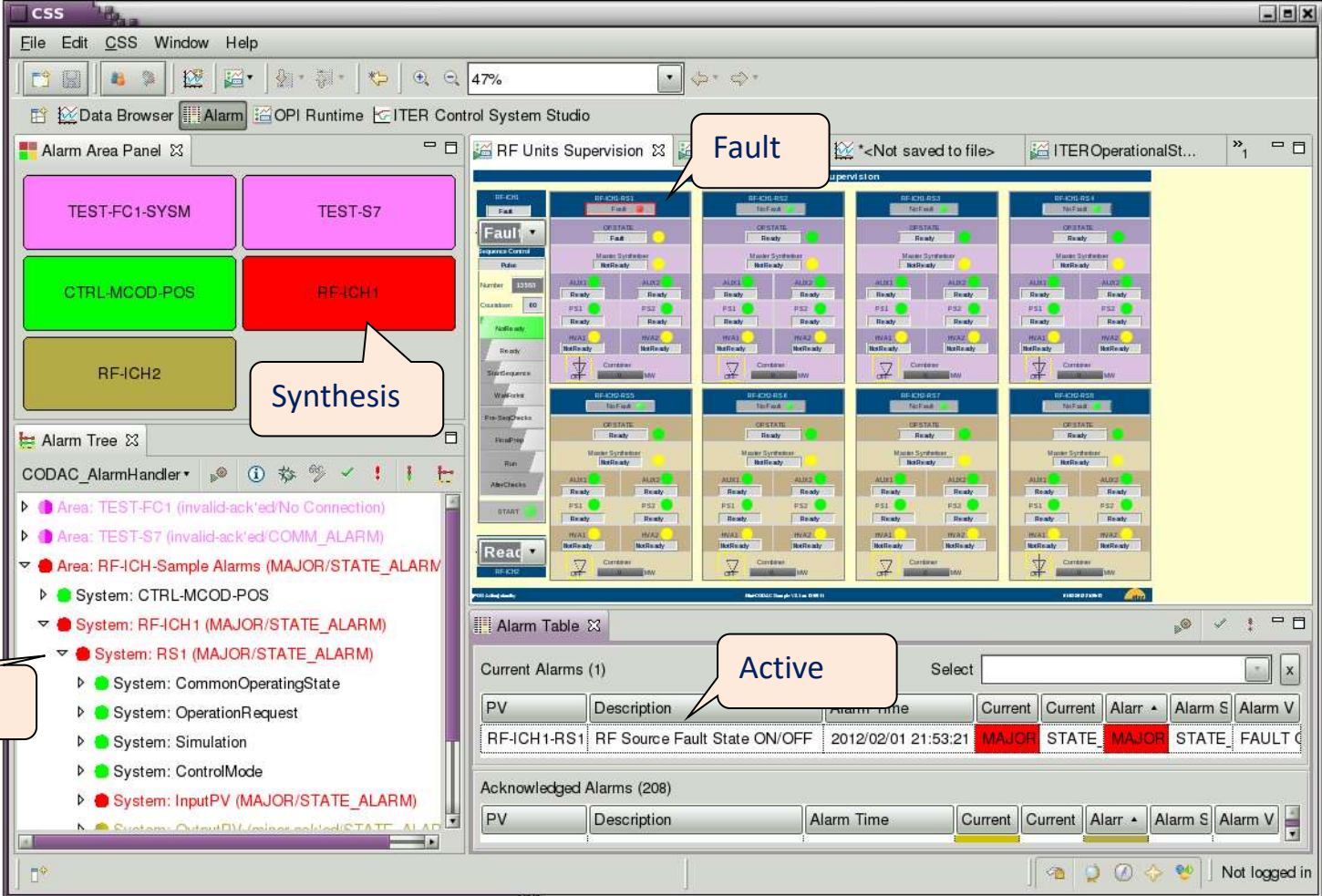
Applications: Phone Book, DMS

Event report system, As part of **quality system**

- identification, after analysis, of the problem
- Corrective actions
- Proposal for design improvements
- Impact in “operation” time (downtime)

1		Event report: ER040 – Surge Protection damaged in RF module													
Discoverer:		M. Weber		Date:	06/10/17										
2	Sub assembly		Component(s): RF Pw. Module #3	PBS Number (DMS_228RFM): 04 10 02 01 05	Phase <input type="checkbox"/> A <input checked="" type="checkbox"/> B										
<input type="checkbox"/> Injector <input type="checkbox"/> RFQ <input type="checkbox"/> MEBT <input checked="" type="checkbox"/> RF-Power <input type="checkbox"/> SRF LINAC		<input type="checkbox"/> HEBT & BD <input type="checkbox"/> Auxiliaries <input type="checkbox"/> Instrum & DP <input type="checkbox"/> Control system <input type="checkbox"/> PPS/MPS		<input type="checkbox"/> Install <input checked="" type="checkbox"/> Comn <input type="checkbox"/> Checkout <input type="checkbox"/> Maintenance <input type="checkbox"/> Beam operation											
Description		Describe as precisely as possible the event (include pictures, schematic views) (Quote the reference of the associated documents, if applicable)													
During integration tasks between RFQ and RF System, when injecting RF in the RFQ (5 kW, 50 μs, 1S period) with 9 RF Chains, an interlock turned off the c															
1. Screen Grid (3) power supply v 2. Driver Amplifier anode power s 3. Other components (those conn		<table border="1"> <tr> <th>5</th> <th>Authorisation for actions</th> <th>OST</th> <th>F4E</th> <th>PT</th> </tr> <tr> <td colspan="2">Required? <input type="checkbox"/> YES <input type="checkbox"/> NO</td> <td>-</td> <td>-</td> <td>-</td> </tr> </table>				5	Authorisation for actions	OST	F4E	PT	Required? <input type="checkbox"/> YES <input type="checkbox"/> NO		-	-	-
5	Authorisation for actions	OST	F4E	PT											
Required? <input type="checkbox"/> YES <input type="checkbox"/> NO		-	-	-											
So we found that Phase 2 of the electric		IMPACT(s) <input checked="" type="checkbox"/> Cost (ex.: new procurement of components...) to be determined <input type="checkbox"/> Schedule (<input type="checkbox"/> <1 day, <input checked="" type="checkbox"/> <1 week, <input type="checkbox"/> <1 month, <input type="checkbox"/> >1 month) <input type="checkbox"/> Duration of the corrective action (in cumulated working hours): 24 h <input type="checkbox"/> Update documentation (precise the type): <input type="checkbox"/> procedures; <input type="checkbox"/> drawings; <input type="checkbox"/> others:													
3 Analysis		Further description													
		<input type="checkbox"/> Technical (precise the type): <input type="checkbox"/> Manufacturing Process; <input type="checkbox"/> Assembly process; <input type="checkbox"/> Product Interface; <input type="checkbox"/> Check-out; <input type="checkbox"/> Other:													
6		Maintenance request date	Maintenance completion date – Expected	Maintenance completion date – Executed	Machine down time (h)										
		10/10/17	12/10/17	--/--/17	- h										
7		Event closed on:		VISA:	(DMS approval)										
		--/--/17													

Facing reality: Importance of early identifying the failure



The screenshot displays the ITER Control System Studio (CSS) interface, which is used for monitoring and controlling the ITER tokamak. The interface is divided into several panels:

- Alarm Area Panel:** Contains buttons for TEST-FC1-SYSM, TEST-S7, CTRL-MCOD-POS, RF-ICH1, and RF-ICH2. A callout labeled "Synthesis" points to the RF-ICH1 button.
- Alarm Tree:** A hierarchical tree structure showing the status of various systems. A callout labeled "Hierarchy" points to this panel. The tree includes:
 - Area: TEST-FC1 (invalid-ack'ed/No Connection)
 - Area: TEST-S7 (invalid-ack'ed/COMM_ALARM)
 - Area: RF-ICH-Sample Alarms (MAJOR/STATE_ALARM)
 - System: CTRL-MCOD-POS
 - System: RF-ICH1 (MAJOR/STATE_ALARM)
 - System: RS1 (MAJOR/STATE_ALARM)
 - System: CommonOperatingState
 - System: OperationRequest
 - System: Simulation
 - System: ControlMode
 - System: InputPV (MAJOR/STATE_ALARM)
 - System: OutputPV (invalid-ack'ed/STATE_ALARM)

- RF Units Supervision:** A grid of 16 panels showing the status of RF units. A callout labeled "Fault" points to the RF-ICH-RS1 panel, which shows a "Fault" status.
- Alarm Table:** A table showing current and acknowledged alarms. A callout labeled "Active" points to the "Current" column. The table includes columns for PV, Description, Alarm Time, Current, Alarm S, and Alarm V.

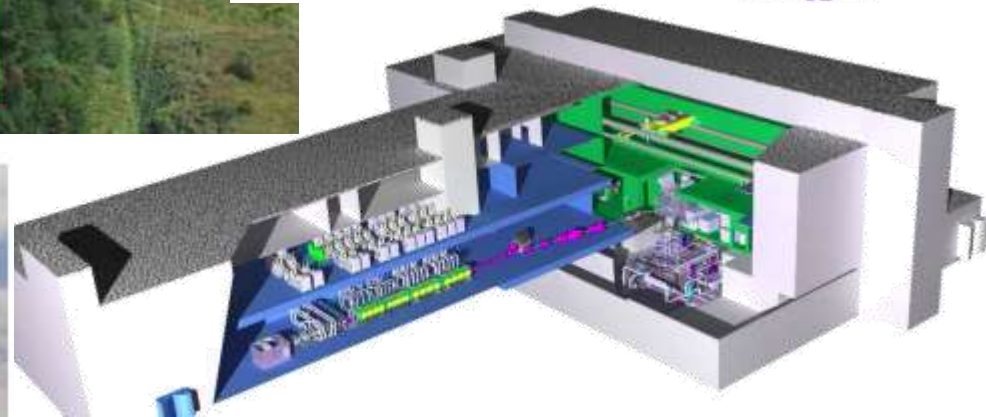
PV	Description	Alarm Time	Current	Alarm S	Alarm V
RF-ICH1-RS1	RF Source Fault State ON/OFF	2012/02/01 21:53:21	MAJOR	STATE	MAJOR STATE FAULT

For fast maintenance, it does not help...

- To have the replacements shipped from Europe
- To have the replacements purchased from Japan
- To have (incomplete) documentation in a language unknown to most operators
- + 7/8 hours time difference from technical support
- Not to have a clear preventive maintenance policy and schedule
- Not to automate most hardware testing

A-FNS

Plans are to construct it in Rokkasho



DONES

125 mA at 40 MeV



THANK YOU!