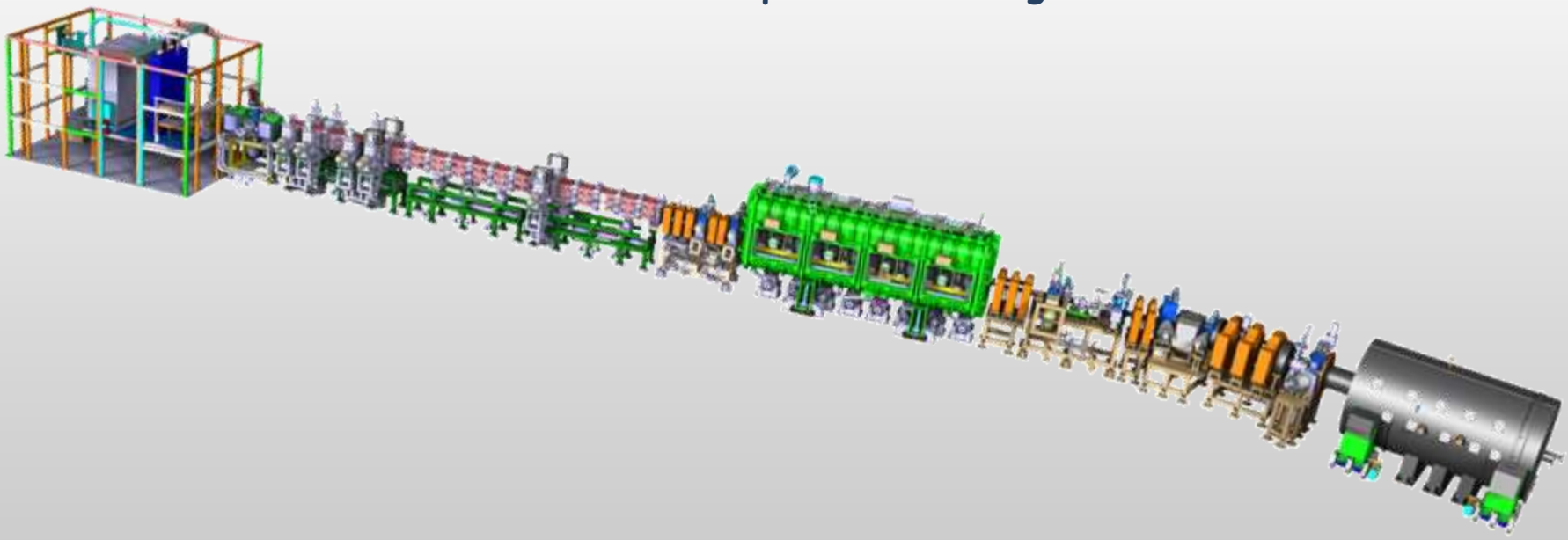
LIPAc Control System

Reliability improvements

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



LIPAc = Linear IFMIF Prototype Accelerator

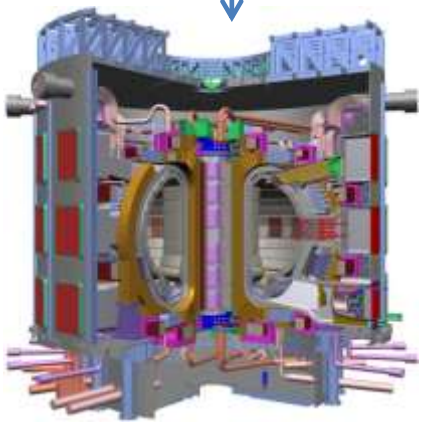
A bit of history…

21 November 2006

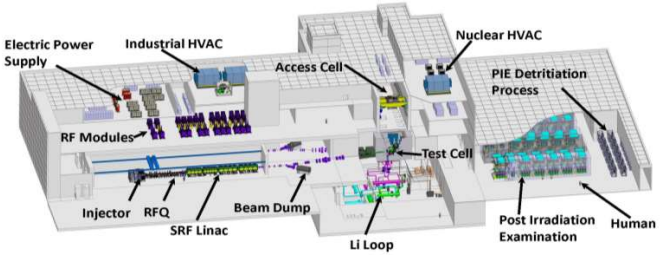
ITER Agreement

1 June 2007

Broader Approach Agreement

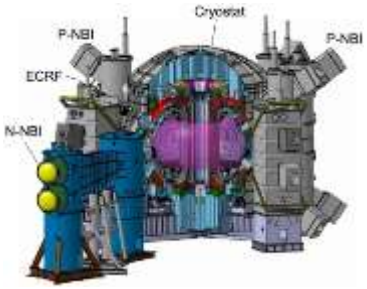


ITER



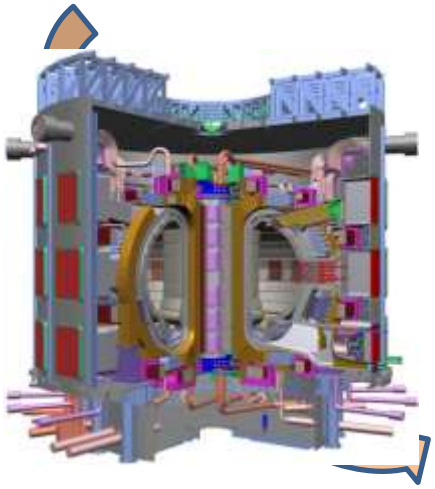
IFMIF/EVEDA

JT60-SA



IFERC

Main contributors to DEMO design

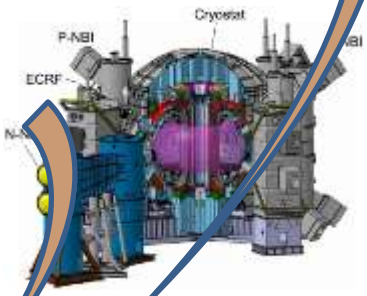


ITER

DEMO

IFMIF/EVEDA

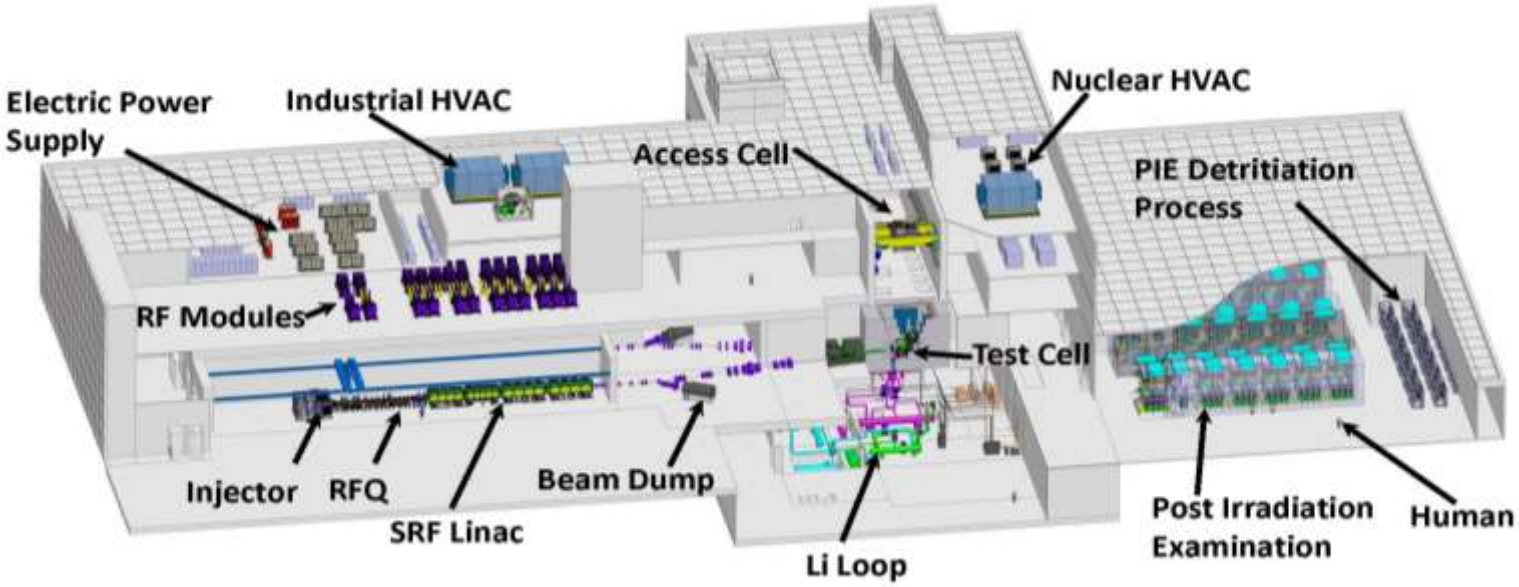
JT60-SA



IFERC

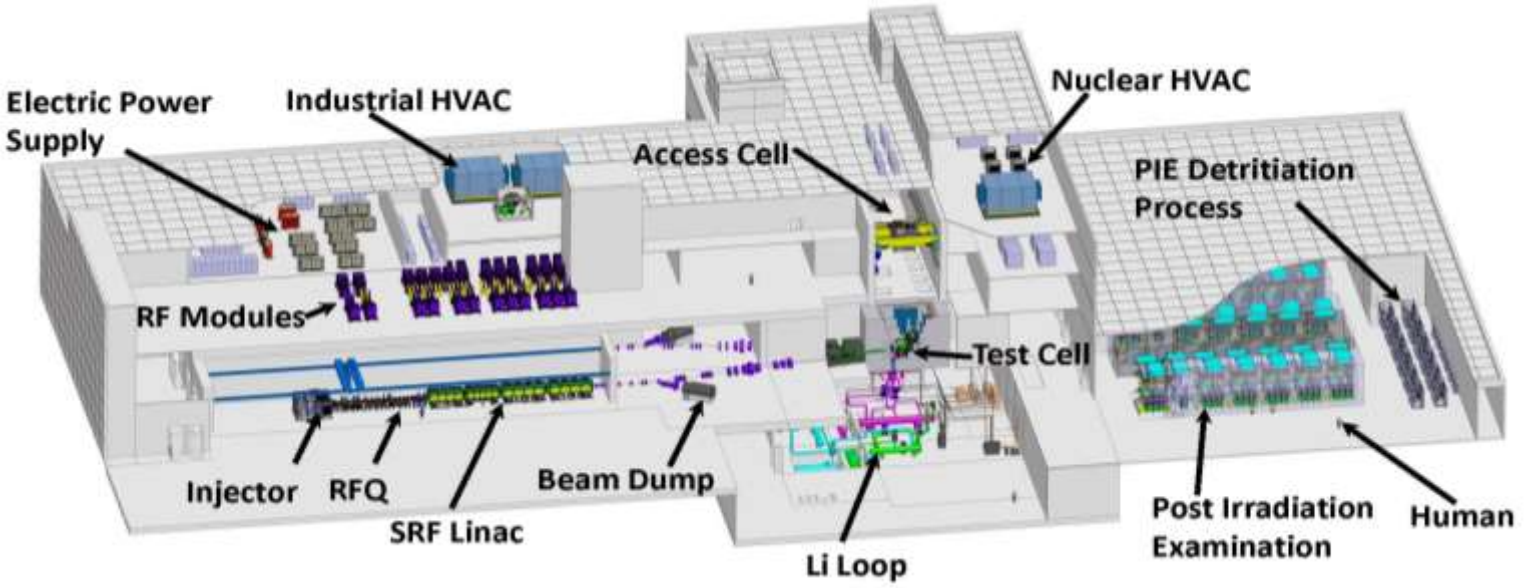
IFMIF -> International Fusion Materials Irradiation Facility

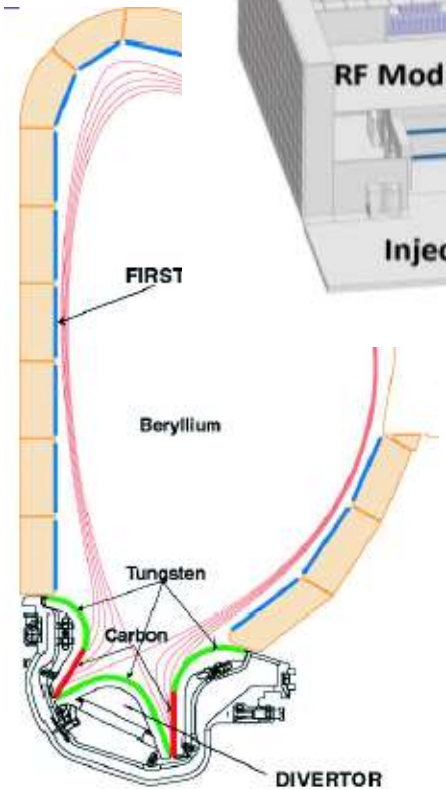
(the fusion relevant neutron source)



IFMIF -> International Fusion Materials Irradiation Facility

(the fusion relevant neutron source)





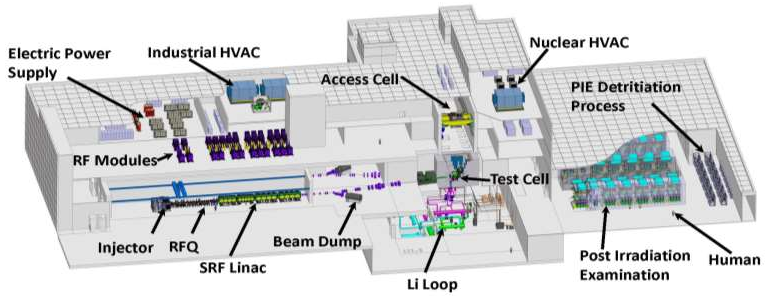
ITER first wall will present
<2 dpa at the end of its operational life

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

Existing neutron sources do not provide the needed answers

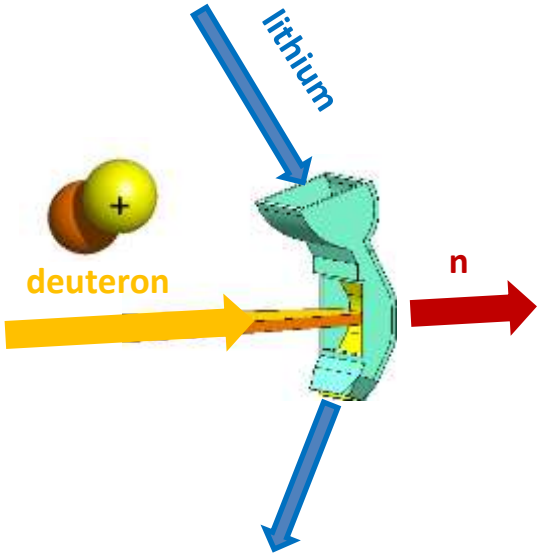
IFMIF -> International Fusion Materials Irradiation Facility

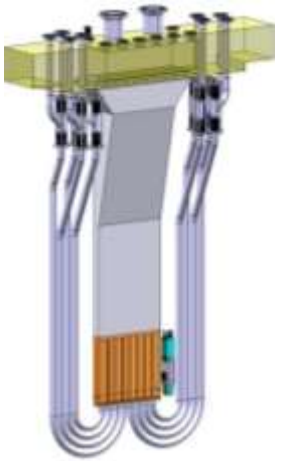
(the fusion relevant neutron source)



Li loop:

250ºC, 15m/s, ±1mm amplitude stability





D^+ Accelerator:

40 MeV, 125 mA CW

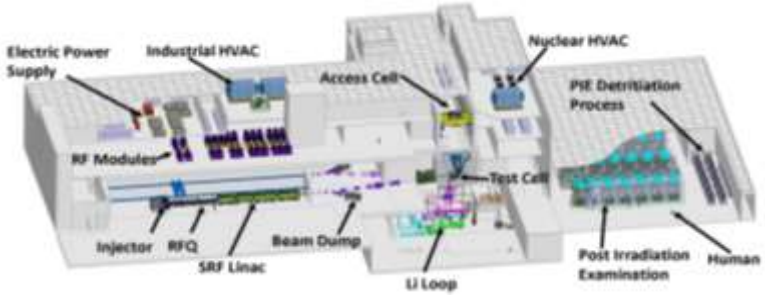
5 MW

Test facility:

Withstand dpa levels

IFMIF -> International Fusion Materials Irradiation Facility

(the fusion relevant neutron source)

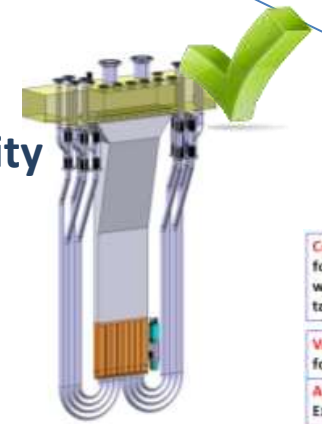


EVEDA -> Engineering Validation and Engineering Design Activities

EDA phase:

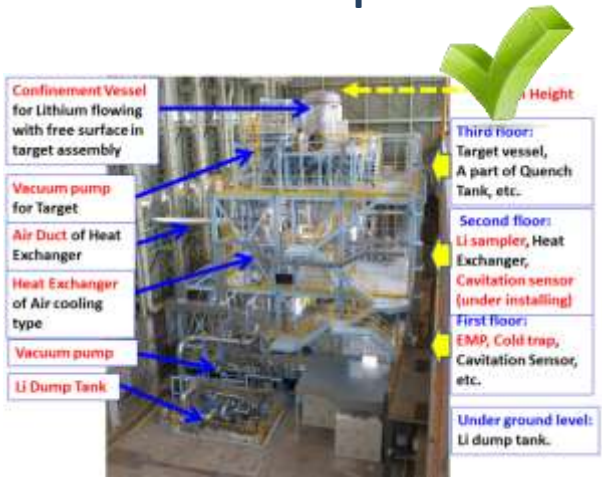
IFMIF II-EDR

Test Facility



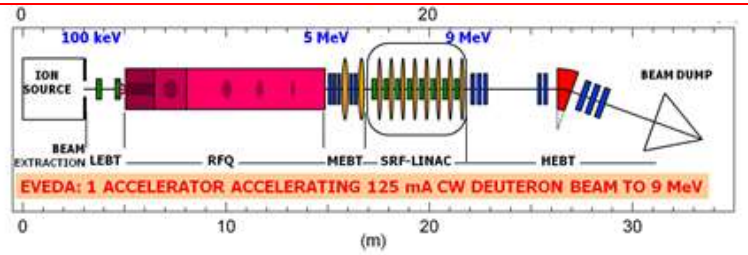
LIPAc (Accelerator Facility)
9MeV, 125mA CW, 1.25 MW

EVA phase:



Target Facility

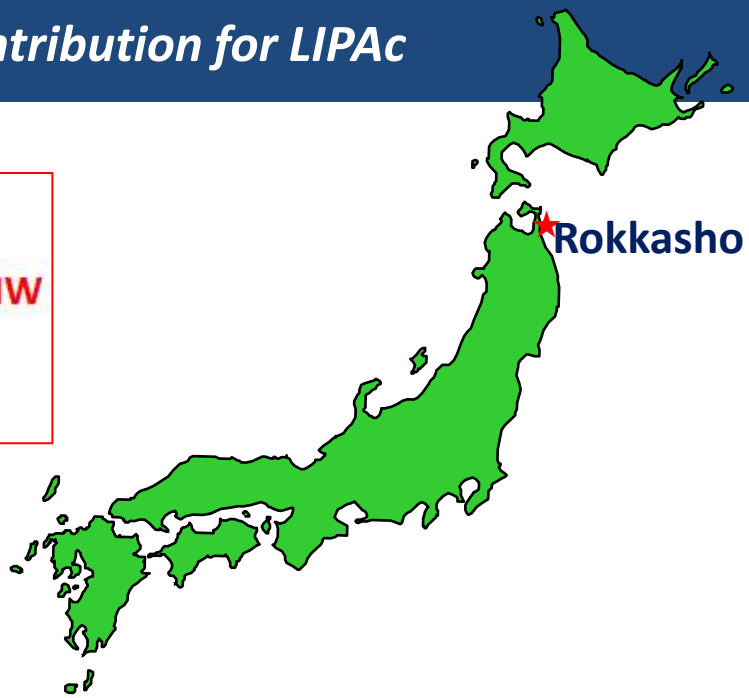
Breakdown of contribution for LIPAc



9 MeV

125 mA

1.125 MW



Injector + LEBT
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

36 m

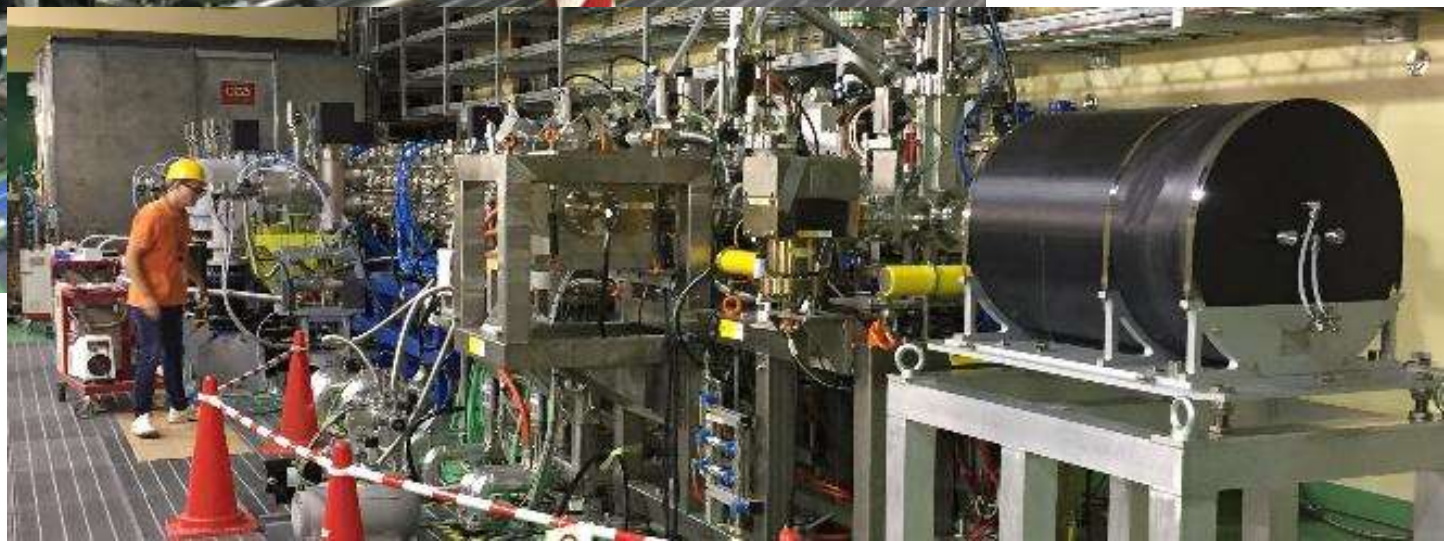
RF Power
CIEMAT Madrid
CEA Saclay
SCK Mol

Building
Auxiliary System
Control system
Installation
QST

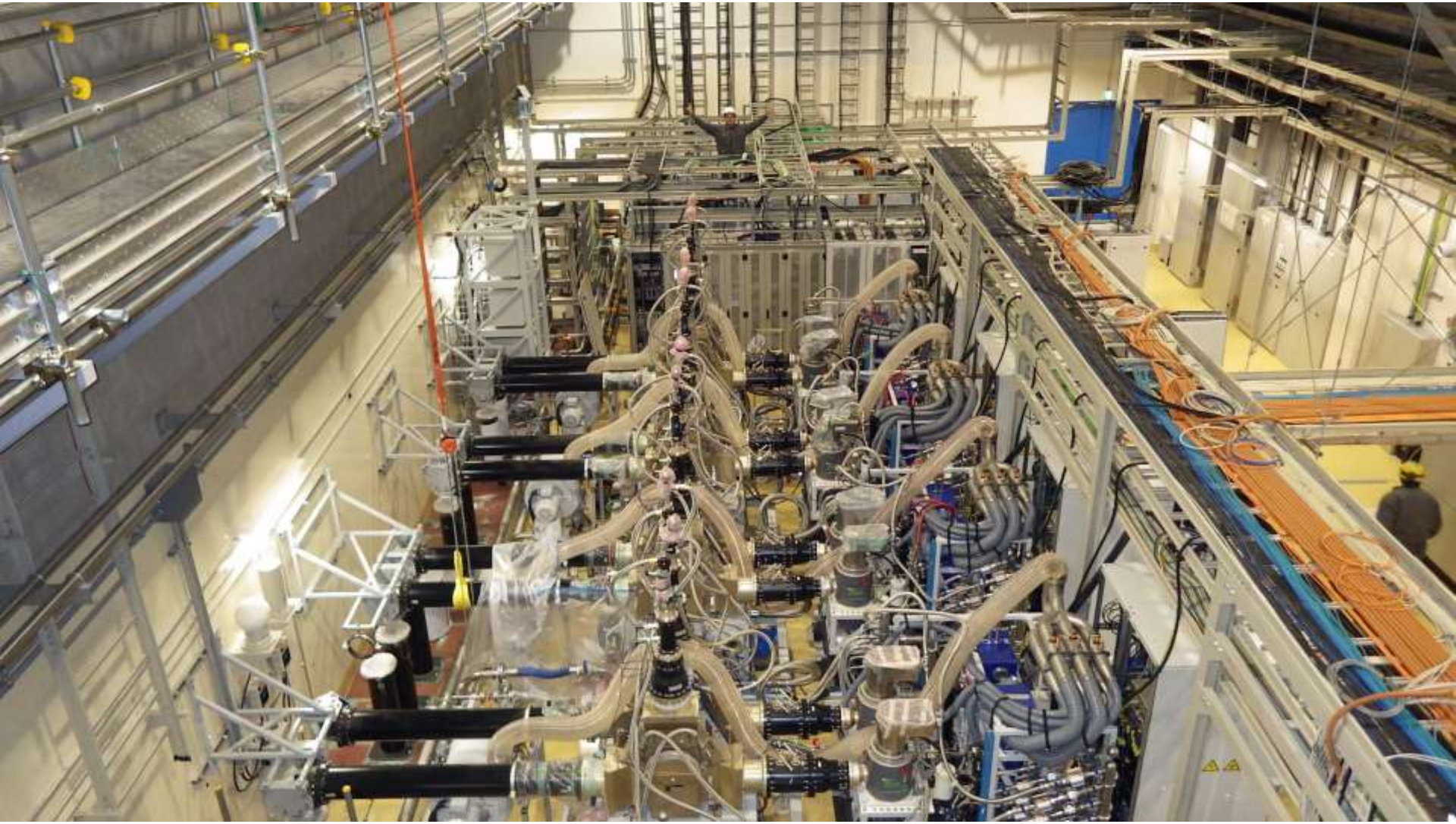
FUSION FOR ENERGY
QST
cea
Ciemat
INFN
SCK·CEN

Conventional facilities

RFQ/MEBT/D-Plate in line



RF system installation



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

Cryogenic system

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**

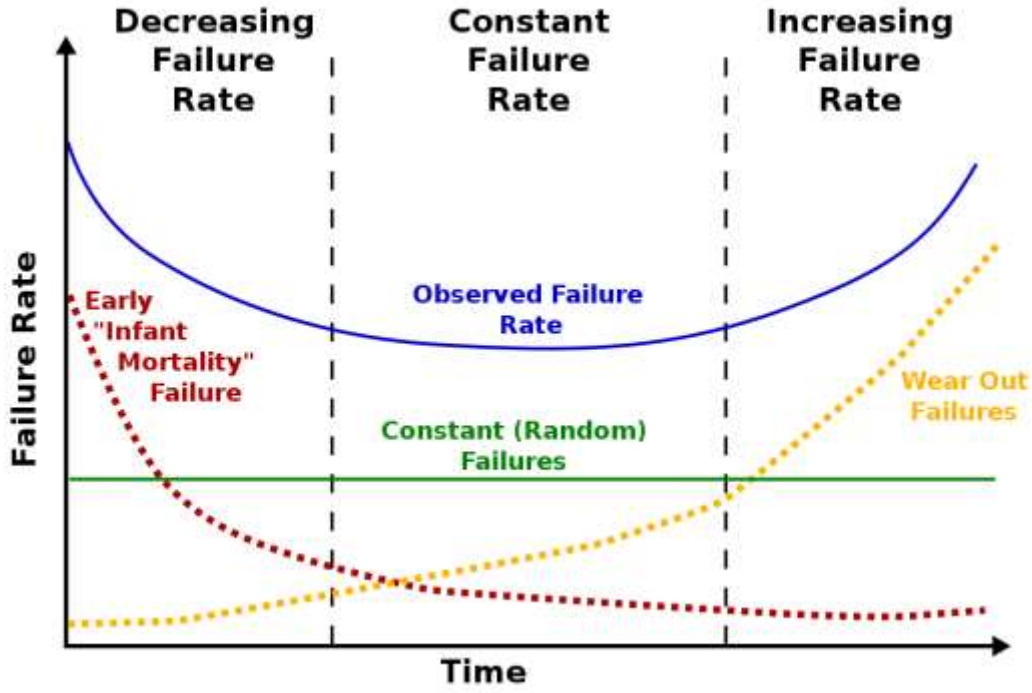
Prototype

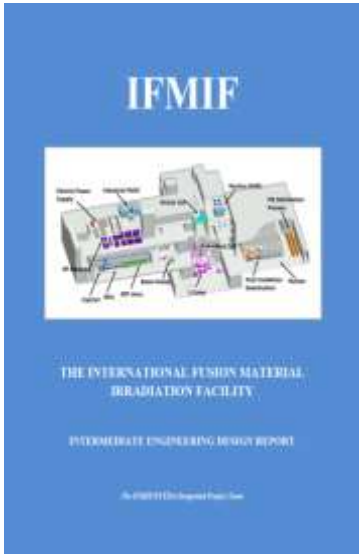
↓

Voluntary contribution

↓

Requirements…





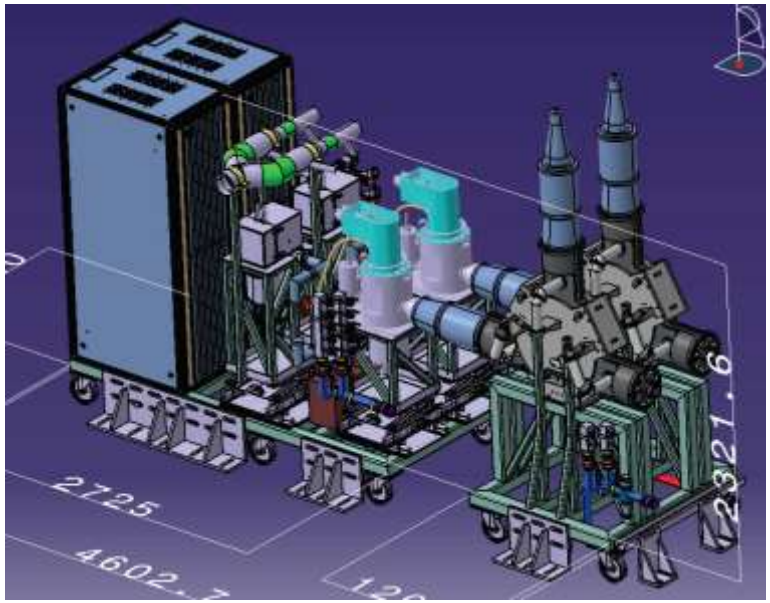
→

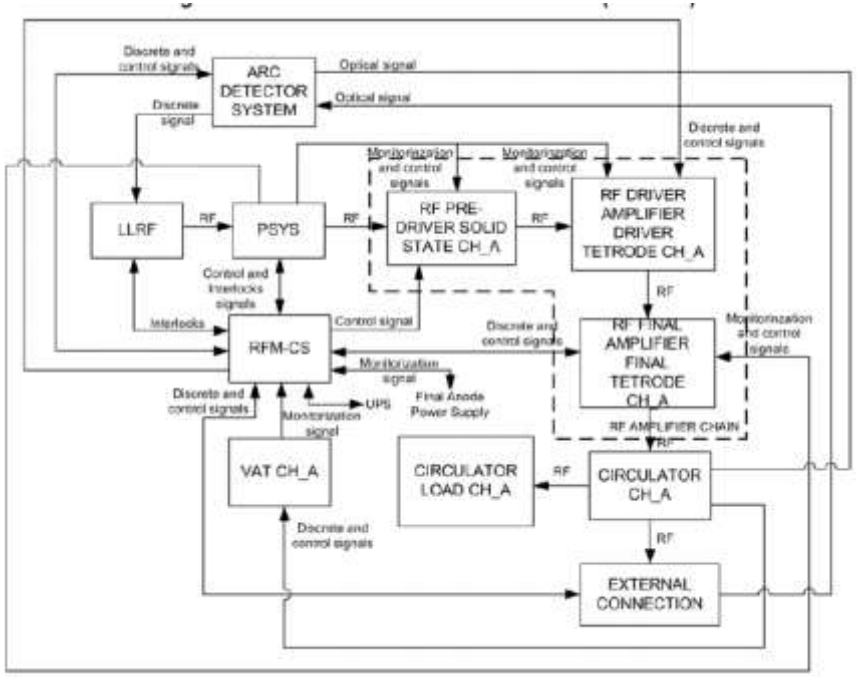
IFMIF Facilities	Availability requirements
Test Facility	96%
Target Facility	94%
Accelerator Facility	87%
Conventional Facilities	98%
Central Control System & Common Instr.	98%
TOTAL (product)	75%

RF modules modular design

↓

Enhancing maintenance by reducing MTTR



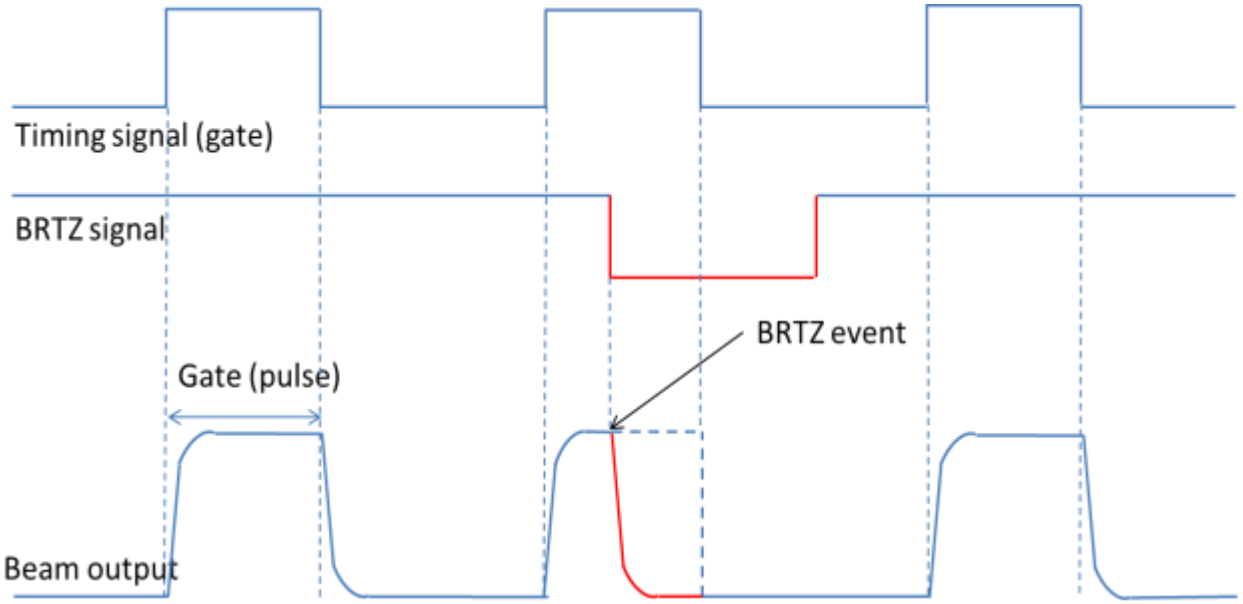


RF protection system

↓

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)

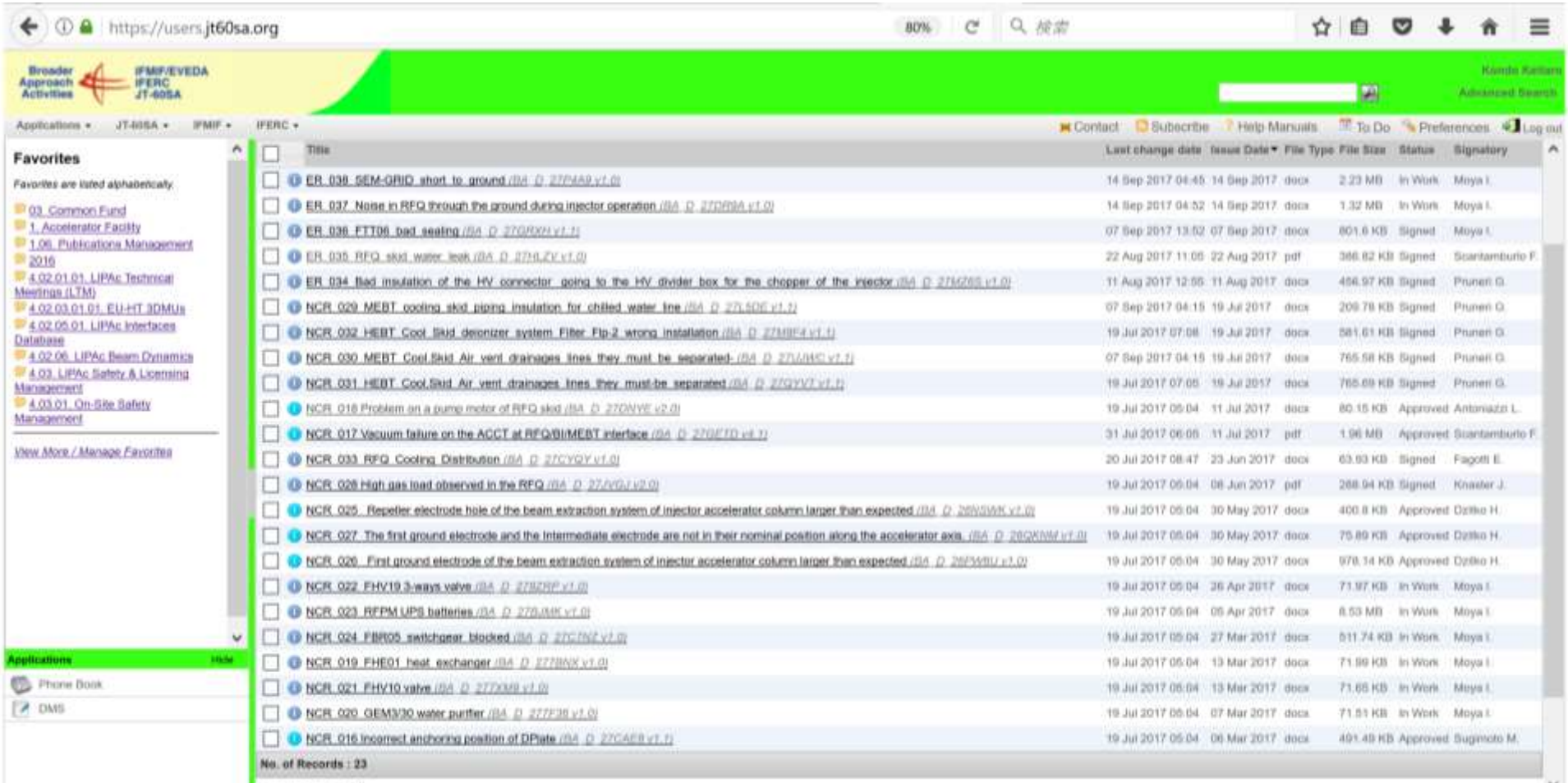
cPCI & Intel i7 + ADC-DAC for LLRF, BPMs

+ a number of other specific devices

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

Event report system,

As part of **quality system**



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 ☐ A ☒
☐ Injector ☐ RFQ ☐ MEBT ☒ RF-Power ☐ SRF LINAC	☐ HEBT & BD ☐ Auxiliaries ☐ Instrum & DP ☐ Control system ☐ PPS/MPS		Surge Protection damage *Component(s) description*		☐ Install ☒ Comm ☐ Checkout ☐ Maintenance ☐ 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 8 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

So we found that Phase 2 of the electri

3	Analysis	*Further description*

5	Authorisation for actions	QST	F4E	PT
	Required? ☐ YES ☐ NO	-	-	-

IMPACT(s)

☒ Cost (ex.: new procurement of components…) to be determined
☐ Schedule (☐ <1 day, ☒ <1 week, ☐ <1 month, ☐ >1 month)
☐ Duration of the corrective action (in cumulated working hours): 24 h
☐ Update documentation (precise the type):
- ☐ procedures;
- ☐ drawings;
- ☐ others:

☐ Technical (precise the type):
- ☐ Manufacturing Process;
- ☐ Assembly process;
- ☐ Product Interface;
- ☐ Check-out;
- ☐ Other:

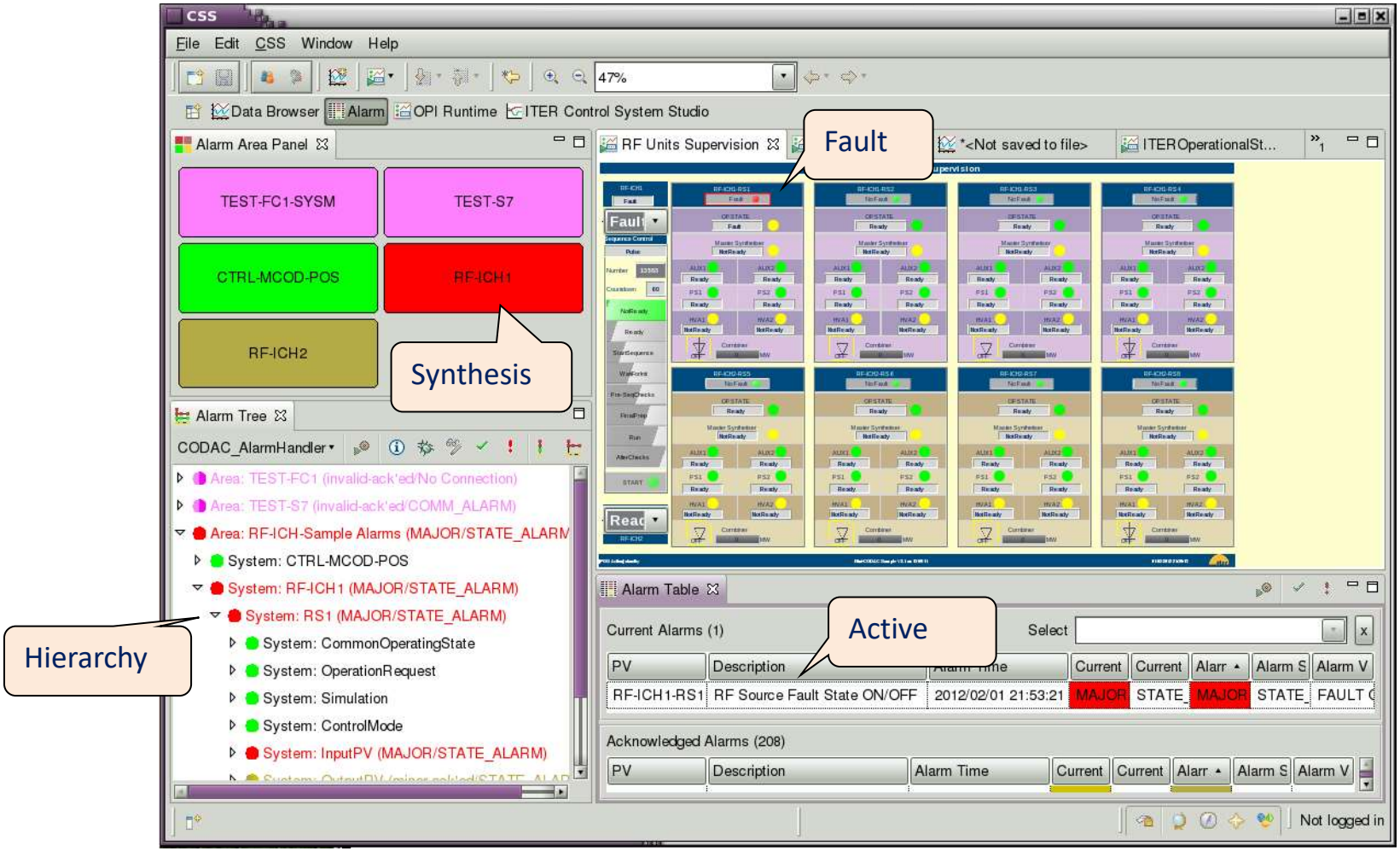
- ☐ Maintenance;
- ☐ Integration process;
- ☐ Operations;

6	Maintenance request date	Maintenance completion date – Expected	Maintenance completion date – Executed	Machine down time (h)	Elapsed time to complete the operation (h)
	10/10/17	12/10/17	--/--/17	- h	- h

7	Event closed on:	--/--/17	VISA:	(DMS approval)

Facing reality:

Importance of early identifying the failure

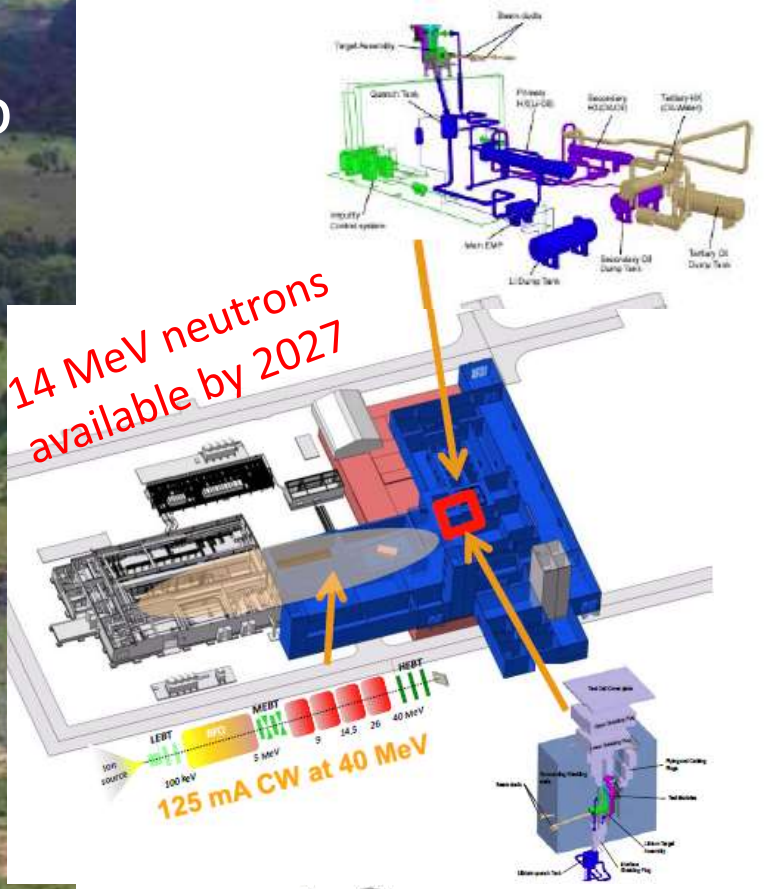


For fast maintenance, it does not help…

- 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

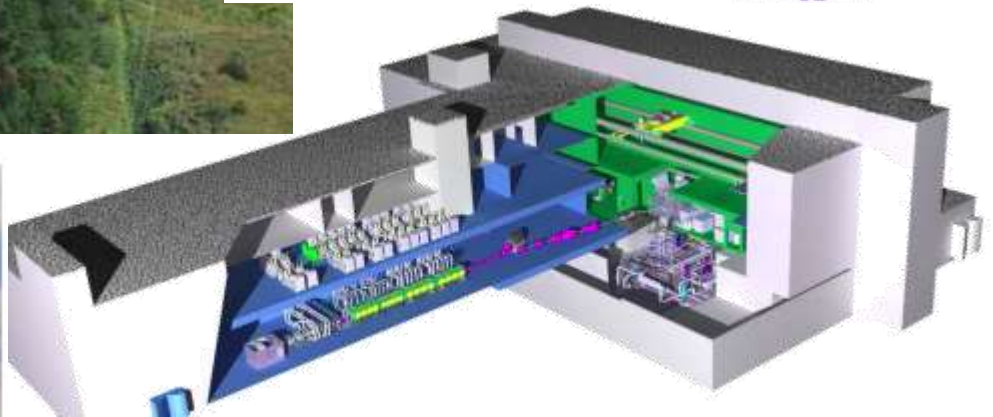
A-FNS

Plans are to construct it in Rokkasho



DONES

125 mA at 40 MeV



THANK YOU!