Ifmif Cryoplant : installation and commissioning

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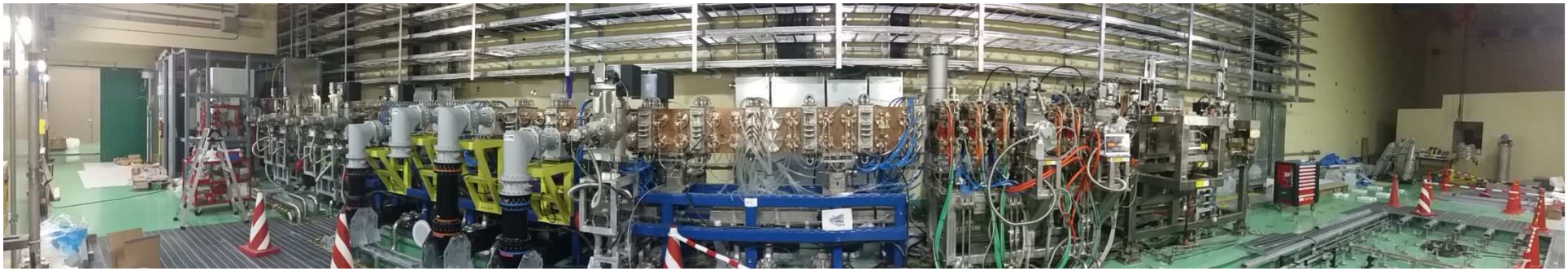
Ifmif-eveda

The International Fusion Materials Irradiation Facility (Engineering Validation and Engineering Design Activities phase), is an accelerator-based neutron source that will use Li(d,xn) reactions to generate a flux of neutrons with a broad peak at 14 MeV equivalent to the conditions of the Deuterium-Tritium reactions in a fusion power plant.

Under a procurement agreement between F4E (EU) and QST (JA), the cryoplant is meant to cool one SRF Linac with 8 Half-wave resonators and 8 solenoids packages.



The Ifmif cryoplant is medium-size standard and was delivered by Air Liquide Advanced Technologies

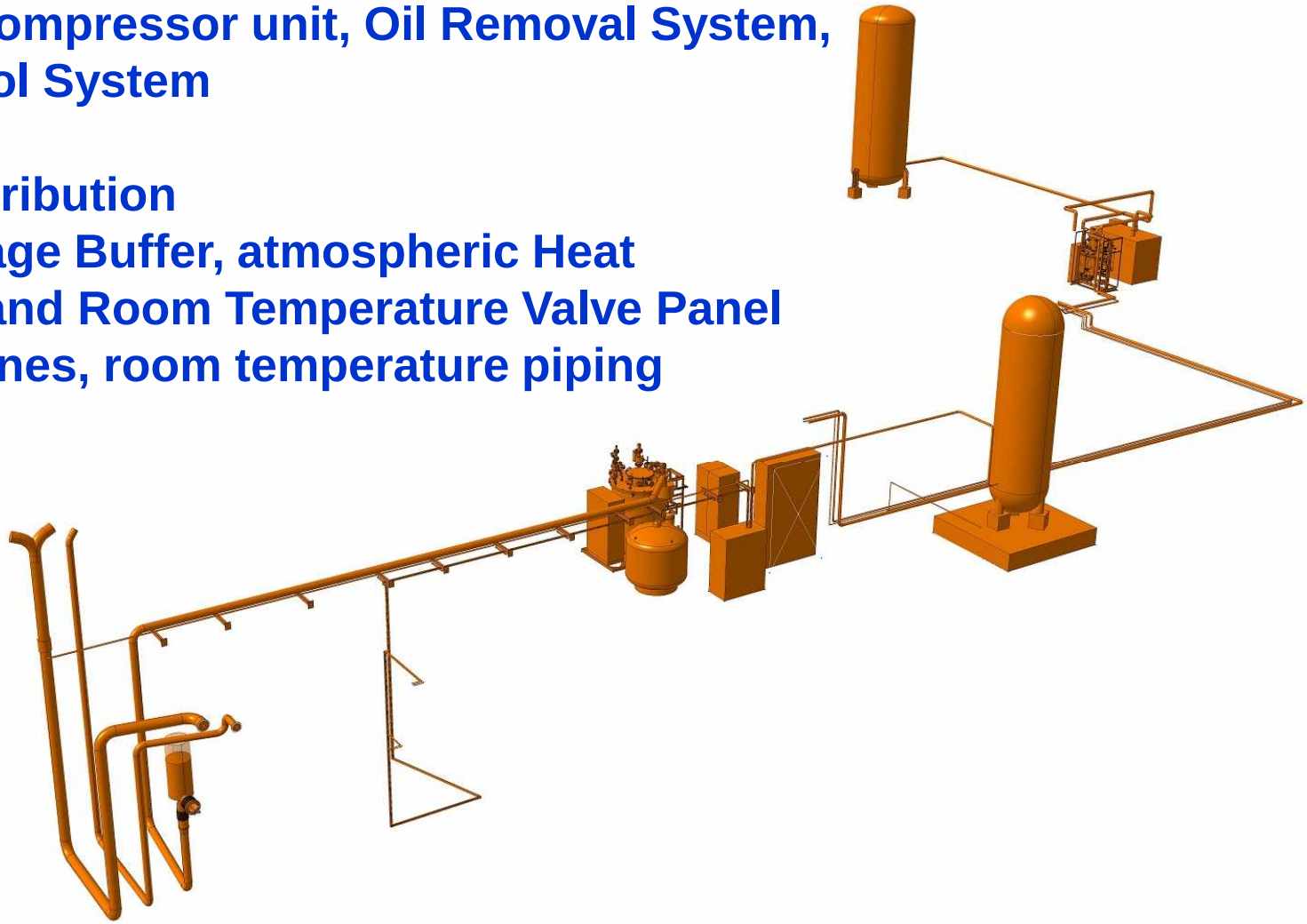
Ifmif Cryoplant description

Cryogenic production

- **Cold Box, Compressor unit, Oil Removal System,**
- **Local Control System**

Cryogenic distribution

- **Dewar, storage Buffer, atmospheric Heat Exchanger and Room Temperature Valve Panel**
- **Cryogenic lines, room temperature piping**
- **cabling**



Ifmif Cryoplant preparation

Cryoplant and cryomodule interfaces installation in advance
All connections with +/-10 mm flexibility in 3D

- **cryogenic connection (with additional cooling flexibility for internal lines)**
- **Current Leads outlets**
- **Power Couplers outlets**
- **Safety relief chimneys**

Cryogenic power margin

- **50% margin for static loads**
- **20% margin for dynamic loads**

Licensing preparation
(ASME + additional requirements)

- **Equipment and tests**
- **Certificates**

Ifmif Cryoplant: installation

Installation risk analysis

Utilities unavailable (Power, cooling water, instrument air, LN2, GN2, GHe, vacuum pumps, He leak detector, nitrogen trace detector)

- **Risk: limited commissioning and testing**
- **Mitigation: anticipation**

Major GHe leaks or pollution of the buffer

- **Risk: large helium loss**
- **Mitigation: separate circuits with separate safety valves, systematic testing with precise protocols**

Installation work and adjustments

WORK CONTENT

ADJUSTMENTS

Deliveries

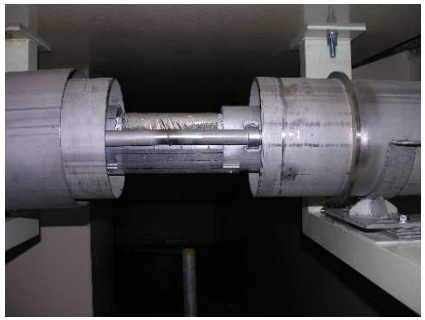
- **EU equipment**
- **Local piping and cabling material**

Heavy paperwork

Positioning and anchoring

Creation of a matrix of responsibilities to precise ownership, work sharing, toolings, anchor calculation responsibility, supervision…

Cryogenic lines installation



X-ray replaced by Dye-penetration tests

Interface connections

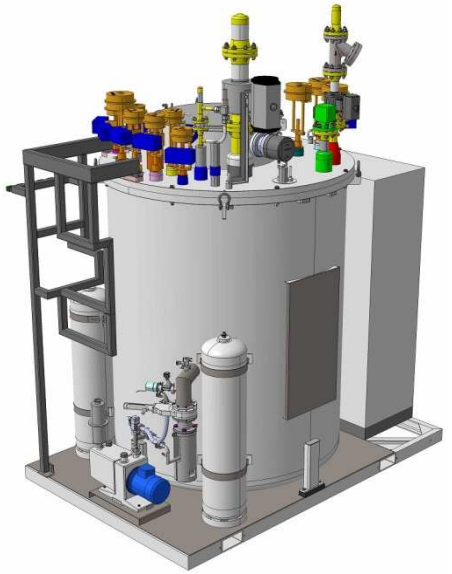
Room temperature piping work

Modifications reporting on 3DMU

Cabling work

Power safety rules and documentation

Installation adjustments



3D Mock-up

Expectations had to be clarified:

- **Precise tool for accelerator and interfaces, but rough volume reservation for some piping and cabling**

Corrections:

- **Inevitable mistakes and surprises (wall position, lamp, missing cable tray…) that required fast decisions**

Schedule and on-site rules

- **Work steps conducted in parallel, so only the duration of operations were useful**
- **Weather constraints and work priorities**

Safety and coactivity

- **Weekly meetings, daily meetings to follow operations**
- **Schedule for each work area**
- **Safety rules of each activity (welding, confined work…)**

Ifmif Cryoplant: commissioning and tests

Commissioning and tests risk analysis

Startup helium contamination

- **Risk: damage the Cold Box turbines**
- **Mitigation: careful monitoring of pollution during conditioning and cooling**

Cryogenic power needed is heavily increased (beyond margin)

- **Risk: duration of dynamic tests heavily reduced**
- **Mitigation: increase storage Dewar size**
- **Correction: optimization of cryogenic power use, and eventually increase storage buffer size**

Commissioning problem solving

COMMISSIONING CONTENT

Utilities checks
Electrical checks
Connection checks

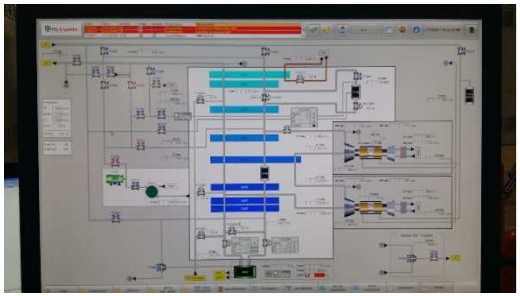
Conditioning
(compressor oil, ORS charcoal drying,
CB adsorbers drying, GHe conditioning)

Programs checks
Safety checks

Compressor commissioning
Turbines installation

PROBLEM SOLVING

Incorrect connections…
Missing parts, leaks,
labelling, protections…



By compressor
Manufacturer
24h operation needed

Cryoplant tests

CRYOPLANT TESTS	ADJUSTMENTS
	Work overtime necessary
Cooling	Parameter settings time constant ~6h
Performance tests	
• Cryogenic elements tightness	Leak sensitivity x1000
• Dewar losses	Performances confirmed after
• Refrigeration 101 W and liquefaction 52 l/h @5K	post-processing
Acceptance tests	Passed in terms of cryogenic power!
Complete documentation:	Meetings and exchanges to clarify
• Manufacturer book	content and additions
• Operation manual	
• Maintenance manual	
Operators training	Postponed
Storage of material	

Conclusions

Special Ifmif challenges:

- **Cultural/communication challenges in Japan (paperwork, safety rules, working hours…)**
- **Licensing regulation challenges in Japan**
- **Limited local support: best if maintenance and operation teams are already operational**

General lessons

- **As much tests as possible in factory**
- **Commissioning consists mainly in problem solving!**
- **Industry is highly experienced**
- **Although deeply modified, the schedule proves to be efficient**
- **Commissioning engineers have the support of industry experts**

The Ifmif cryoplant is waiting for parameters adjustments (cooling parameters fine tuning, cryogenic line phase separator setting…) and for the SRF Linac cryomodule connection.