

COMMISSIONING OF THE IFMIF/EVEDA ACCELERATOR PROTOTYPE – OBJECTIVES & PLANS

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Abstract

In the frame of the IFMIF/EVEDA project, a high-intensity (125 mA) Continuous Wave (CW) deuteron accelerator will be installed and commissioned at the Rokkasho's Broader Approach (BA) site. The main objective of this 9 MeV prototype is to provide information on the feasibility of the design, the manufacturing and the operation of the two linacs (up to 40 MeV) foreseen for IFMIF [1]. Based on the requirements for each System (Accelerators, Lithium target and Tests Facility) which are deduced from the IFMIF fusion material irradiation requirements, given by the users, the objectives of this accelerator prototype are defined and presented here. Also, because of the distributed nature of the design work and the procurement of the accelerator, organization of the installation and commissioning phase is essential. The installation and commissioning schemes, the organization proposed and the overall plans are presented.

INTRODUCTION

In the frame of the BA agreement signed between Euratom and the Japanese government, the development, the construction and the commissioning of a 9 MeV, D^+ , 125 mA, CW accelerator has been decided. The design and construction efforts required are supported by the European (accelerator system) and Japanese (accelerator building) Home Teams. The installation and operation activities are shared between contributors with constant focus on efficiency.

In this paper, the objectives of this Accelerator Prototype Facility (APF) are described and the present plan for the installation and operation activities implementation is presented.

The APF is presented and detailed in [3].

OBJECTIVES

The BA Frame

As described by the BA agreement, the mission of the APF is to validate the design of the accelerator proposed for IFMIF, which shall include:

- the Engineering Design of the whole IFMIF plant,

- the site requirements for IFMIF, and performance of the necessary safety and environmental analyses and,
- a proposal of the program and corresponding estimates of the cost, human resources and schedule for the operation, exploitation and decommissioning of IFMIF.

To transpose these validation objectives into facility specifications, it is important to define, first, the R&D activities required to prepare the IFMIF Engineering Design Report. Obviously, these activities must include the experimental demonstration of an accelerator able to run full D^+ current in CW mode with the required availability. The low beta section of the IFMIF accelerators was considered to be the most critical part by experts [1] and is, thus, the main validation activity of the whole IFMIF/EVEDA project.

Validations Activities Required

As reminder, the key requirements on the IFMIF accelerators are:

- Deuteron energy of 40 MeV for efficient production of the optimum neutron spectrum.
- High availability (88%) of the CW beam within a given beam parameters range.
- Stable beam footprint for uniform irradiation of the material samples.
- High beam current to minimize irradiation duration.

For the accelerator prototype, these requirements are partially translated into the following set of general objectives to be experimentally investigated:

- Produce a CW 125 mA D^+ beam with energy of 9 MeV (after the first SRF cryomodule).
- Exhaustive characterization of the beam parameters along the accelerator.
- Low beam losses enabling “hands-on” maintenance schemes.
- Study of the dependence of the previous points with respect to beam current.

Because of the limited duration of the experiments in the frame of the IFMIF/EVEDA project, an exhaustive Reliability, Availability and Maintainability (RAM) characterization is not foreseen. However, a RAM model

is under development and the experimental results obtained along the operation will enrich this model.

Since the D^+ beam will be stopped into a Cu based beam dump, the interaction between the beam and a liquid Li target will not be experimentally studied.

The main features of the APF are as follows,

- APF is full scale demonstrator of the low energy part of the accelerators required for IFMIF.
- APF allows experimental confirmation of the technologies proposed and detailed in the IFMIF CDR[1] or their evolutions.
- APF permits to obtain a scientific knowledge on “state-of-the-art” accelerator technologies related to high current, low beta, hadrons machines.

The preparation and the utilization of the APF permit also:

- Validation of the manufacturing processes and generation of precise estimations of the construction cost on the IFMIF accelerators.
- Detailed proposals of organization choices, installation plans, commissioning scenarios, operation procedures and maintenance activities useful for IFMIF operation.

Design and Construction Objectives

The design and the construction of the APF are performed with the following objectives. First, three main goals corresponding to transversal activities and then four objectives linked to the design and construction phases.

Objectives of the transversal activities

- Analyze and survey the overall functioning of the accelerator system. This includes exhaustive analysis and comparisons with beam dynamics models.
- Define the safety scope for the facility and survey its fulfillment along the design phases.
- Identify and manage the interfaces between and inside the systems (accelerator and building).

Objectives of the design and construction activities

- Confirm of the technical reference solution for each sub-system.
- Prepare and validate a Preliminary Design for each sub-system.
- Prepare and validate the Engineering Design,
- Manufacture, assemble and deliver to the BA's site, the sub-systems following the specifications detailed in the Engineering Design report.

The validation of the design phases is performed by means of internal and external expertise.

All these activities shall be conducted following relevant Q/A processes.

Operational Objectives

The checkout and commissioning objectives are:

- Validation of the start-up and tuning procedures.
- Characterize the (9 MeV, 125 mA) D^+ beam along the accelerator stages. This objective can

be fulfilled in pulsed mode (with relevant pulse length) in order to permit the use of interceptive diagnostics.

- Operate the APF (D^+ beam in continuous mode) for 500 h with a target availability of 88 %.
- Recording and statistic analysis of the accelerator functioning. This information will be used as input to RAM analysis models.
- Evaluation of the life time of specific components.
- Validation of the most critical maintenance procedures.

INSTALLATION AND COMMISSIONING PLANS

In this section, the overall plans, including the organization, the content of the different installation and operation phases and a preliminary schedule are described.

In September 2009, in Tokyo, a workshop dedicated to the installation, checkout and commissioning of similar international accelerator facilities has been organized. The outcomes of this workshop are summarized below.

Organization

In terms of organization, the principles are the followings:

- Safety and Environmental protection have been considered as top priority. All the “Safety & Environmental” related responsibilities will be taken by the Aomori R&D Center (JAEA). A specific operational group will be established in order to define and apply the relevant regulations.
- Scientific and technical choices shall be made by accelerator experts and specialists involved in the design of the accelerator components and following the validation knowledge required to propose the construction of the IFMIF accelerators.
- The operational coordination shall be globally managed, from the installation to the end of operation by one single permanent team and using the same tools. All specific activities required by sub-systems specialists must be integrated into the global plan of the facility.

The structure proposed to conduct and perform the operational activities of the APF is presented in the **Figure 1**.

Main Phases

There will be four main installation periods and three main beam operation phases: Injector, RFQ and full accelerator including the SRF Linac.

The beam conditions for each phase are indicated in the following tables.

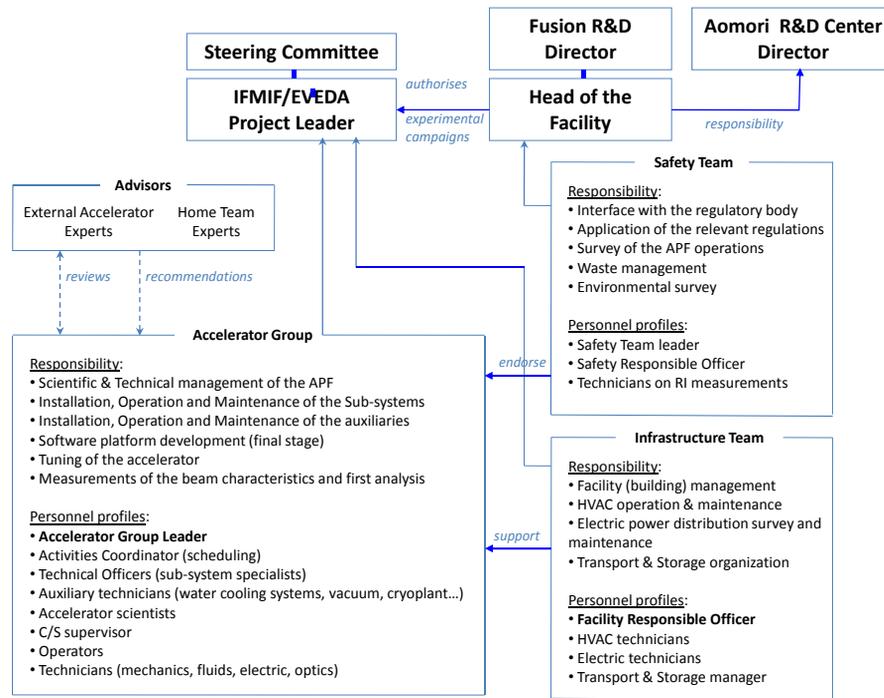


Figure 1: Organization scheme foreseen for the APF

Table 1: Injector Commissioning: Operational Beam Parameters

Beam Type	Particle	Peak Current (mA)	Rep Rate (Hz)	Pulse Length (ms)	Duty cycle (%)
Calibration	H ⁺	10	1	1	0.1
H ⁺ test	H ⁺	125	10	1	1
Tune-up	D ⁺	125	10	1	1
IFMIF	D ⁺	125	CW	CW	100

Table 2: RFQ Commissioning: Operational Beam Parameters

Beam Type	Particle	Peak Current (mA)	Rep Rate (Hz)	Pulse Length (ms)	Duty cycle (%)
Calibration	H ⁺	10	1	1	0.1
H ⁺ test	H ⁺	125	10	1	1
Tune-up	D ⁺	125	10	1	1
IFMIF	D ⁺	125	CW	CW	100

Table 3: SRF Linac Commissioning and Full Machine Operation: Operational Beam Parameters

Beam Type	Particle	Peak Current (mA)	Rep Rate (Hz)	Pulse Length (ms)	Duty cycle (%)
Calibration	H ⁺	10	1	1	0.1
H ⁺ test	H ⁺	125	10	1	1
Tune-up	D ⁺	125	10	1	1
IFMIF	D ⁺	125	CW	CW	100

Preliminary Schedule

The construction of the APF building is completed and the installation of the accelerator component will start end 2011. The overall installation and commissioning operations should last three years.

REFERENCES

- [1] IFMIF International Team, IFMIF Comprehensive Design Report (CDR) 2003.
- [2] M. Sugimoto et al., "Issues to be verified by IFMIF prototype accelerator for Engineering validation", Jour. Nuc. Mat. 307-311 (2002), p1691-1695.
- [3] A. Mosnier et al., MOPEC056, these proceeding.