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# CONFIGURATION AND ENGINEERING INTEGRATION IN THE IFMIF-DONES PROJECT*

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*Abstract*

The IFMIF-DONES facility (International Fusion Materials Irradiation Facility – DEMO Oriented Neutron Source) is currently under design and being prepared for the construction phase within the framework of a EUROfusion Consortium work package. Its location will be in Escúzar, Granada and it will be the largest science and technology infrastructure project developed in Spain. Its objective is the study and certification of irradiated fusion materials by the generation of a neutron flux with a broad energy distribution covering the typical neutron spectrum of a (D-T) fusion reactor. For this purpose, a facility which accommodates a 40 MeV at 125 mA deuteron Linac, a liquid lithium target and test module is being undertaken. Building and conventional plant systems are also designed to house, serve and allow main systems correct operation. Due to the complexity and high number of collaborators involved, properly managing design and configuration integration activities is of utmost importance.

This paper describes current CAD management approaches and methodology followed in the project to coherently arrange Structures, Systems and Components (SSCs) throughout the facility's lifecycle, easing the identification of potential design inconsistencies and interferences as early as possible to actively resolve them and speed-up development of the project towards a ready-to-construct status, minimizing future construction, commissioning and O&M issues and associated cost-overruns.

## INTRODUCTION

Multiple industry third-party collaborators and more than fourteen Research Units (RU) all-around Europe are working on the design and development of IFMIF-DONES facility, each of them involved in different areas of the DONES project. Due to the high number of entities taking part in the installation evolution, it is essential to implement a reliable project integration strategy, together with the proper tools, that allow an efficient workflow of information between parties. To establish project integration interdisciplinary links and processes a systems engineering approach was implemented, whose main aim is to comply with the overall project requirements while dealing with transversal areas such as, Requirements, Interfaces and CAD management [1].

To apply systems engineering approach the IFMIF-DONES facility has been first divided into five group of systems (GoS) [2], each of them comprising different number of individual systems following a Plant Breakdown Structure (PBS). This division is intended to ease the identification of boundaries, interfaces and requirements for each individual system. The main group of systems present set are:

- Site, Building and Plant Systems (SBP): This first group includes site facilities, buildings, remote handling elements, conventional plant systems and maintenance and handling equipment, having a total of fourteen systems.
- Test Systems (TSM): Group of six systems comprising irradiation modules, test cell and complementary experiments.
- Lithium Systems (LSM): This group is composed of four systems, all of them related to the management and operation of the liquid lithium target.
- Accelerator Systems (ACS): All seven systems belonging to this group are in charge of producing the required 5MW beam.
- Central Instrumentation and Control Systems (CIS): Three systems devoted to the control and operation of the whole IFMIF-DONES facility.

## REQUIREMENTS MANAGEMENT

Applying systems engineering approaches for requirements management in IFMIF-DONES project, three levels of requirements have been identified, namely: Top-level plant requirements, plant requirements and system requirements. Top level requirements are defined at the highest level in the hierarchy set and describe DONES technical main objectives, these shall be satisfied by plant requirements which shall be fulfilled by those set at level three where all 34 systems making up the facility are established. To ensure traceability of requirements at different levels

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and maintain them up to date as the design process of the systems evolves Visure Requirements tool is being used.

This platform allows the Requirement & Interfaces (R&I) group to check consistency between correlated systems.

## INTERFACES WORKFLOW

Project-developed tool Interface Management System (IMS) is the platform implemented in which interfaces are identified and listed, describing details of the interfacing elements, mostly their basic functions and characteristics.

All identified and agreed interfaces between systems are then listed in dedicated written document or Interface Control Document (ICD). Each individual interface is described in an Interface Sheet (IS). R&I group keeps track of the quality and level of completeness for all documents created. To store and manage ISs and ICDs a EUROfusion provided platform is used.

## CAD MANAGEMENT

### *Integration and Configuration*

As in the case of requirements and interfaces, digital representations CAD models are created for each system defined containing all components making it up at PBS level 3. These 3D digital mock-ups (3DMUs), depending on the type of system are elaborated by different pieces of software. In IFMIF-DONES project 3DMUs belonging to group of systems SBP are mainly developed with Smartplant 3D, a dedicated tool specialised in the design of buildings and conventional plant systems, such as Heating, Ventilation and Air Conditioning (HVAC), electrical system, piping routing, structural design...etc.

Tests, lithium and accelerator systems CAD models, on the other hand are created with a different piece of sofware, called CATIA, a well-known tool highly used for detailed mechanical and electrical designs.

CAD models conducted within IFMIF-DONES project evolve at different paces, having a wide range of maturity and level of detail, hence a way of representing current layout and configuration of the facility has been implemented. Most updated versions of the 3DMUs are gathered by the CAD Office which put them together by means of Autodesk Navisworks creating a complete virtual representation of the IFMIF-DONES facility. This complete CAD model of DONES plant provides a single-point-of-truth where collaborators have the possibility to visualise and assess the current layout, allowing them to adapt their designs. To facilitate and make integration process more efficient, a Global Reference System (GRS) has been defined, to which all CAD models must be referenced for placement in the master model.

Together with the coordinate system set, as the accelerator needs a robust implementation of the parts in order to fulfil beam dynamics requirements, a baseline skeleton is utilised to accurately position mechanical interfaces and accelerator components throughout the multiple systems of ACS.

DONES master model allows to capture current configuration and to perform clash studies at different points of time in the design. Physical collisions identified are assessed and resolved by designers and collaborators applying required modifications. Figure 1 shows 3D Mock-up of the DONES plant master model.

### *Virtual Reality simulations*

Even though, IFMIF-DONES facility has just started its construction phase, future and complex maintenance activities and operations for such a large scientific installation need to be defined at a sufficient level of detail. To tackle this an efficient workflow for the development of VR simulations of maintenance procedures at DONES is defined [3]. First, all the steps required to complete maintenance procedures are identified and listed for both remote handling and hands-on cases. Second step, CAD models present in the area where the virtualization and simulation of the maintenance process takes place are extracted from DONES master model and imported into Unity3D by

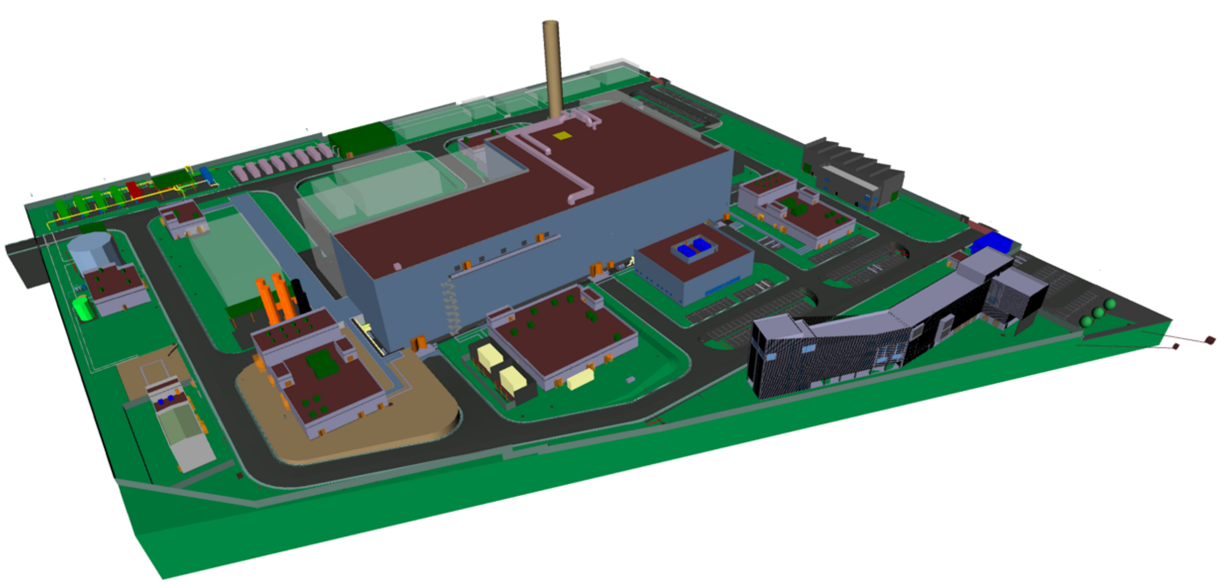

Figure 1: IFMIF-DONES Facility master model.

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means of add-on Pixyz. To achieve high-quality visualization with low computational needs, different optimization techniques had to be performed to the CAD models to reduce their level of detail.

The resulting simulations allow the users to obtain detailed analyses of logistics and maintenance operations in radioactive environments, easing evaluation and validation of their feasibility, safety and duration. A collaborative process involving simulation, maintenance and integration departments is of paramount importance to avoid mismatches between disciplines [4].

### *CAD Collaboration Scheme*

For the IFMIF-DONES design, CATIA V5 has been set as a reference software for both mechanical and plant development, with 3DMUs provided by stakeholders in native format and neutral STEP. A common repository called IDM is currently used to store and exchange versions of CAD models created by project collaborators. Every 3D mock-up uploaded to IDM is reviewed by CAD Office making sure it complies with CAD Guidelines and Quality checks established. New reviewed and approved versions are replaced within the IFMIF-DONES master model, which is released as reference baseline configuration three times per year.

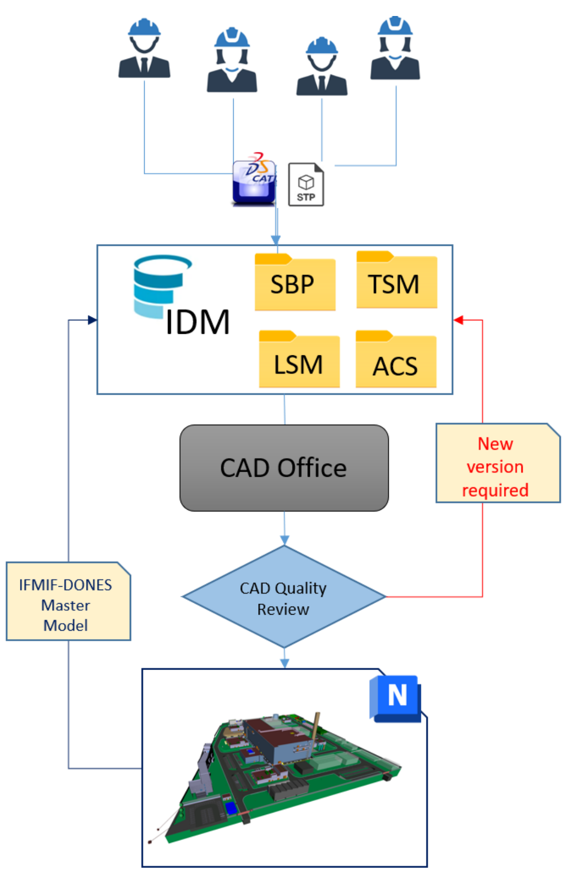


Figure 2: CAD Storage & Exchange Workflow

As it can be seen in Figure 2, the current workflow implemented in the project is based on a file-based exchange scheme, where new versions of 3DMUs are provided once a year. This methodology has been working well up to now. However, as in any big project starting its construction phase, lots of changes in the configuration baseline design are produced, affecting CAD models, their related 2D drawings and the data associated, so the necessity of implementing a collaborative CAD platform has been identified to set a more iterative and synchronous scheme within the different disciplines involved.

## CONCLUSIONS

Configuration and engineering integration management implemented in IFMIF-DONES project has been described in this paper, focusing on the procedures and tools used for project integration activities related to CAD integration management.

It can be stated that the usage of baseline design and integration tools, such as the complete master model of the facility or beam skeleton, are of great help to assess, validate, and track modifications in the design phase. However, as the project evolves and the construction phase begins, engineering change requests and data produced must be properly handled to achieve the configuration control of the "design-construction-operation" management process.

As a conclusion, it has been identified that for the next stages of the project it will be required to keep a consistent exchange and collection of data along the facility lifecycle, avoiding thread disconnections between construction, operation and maintenance phases of the installation.

To achieve this complete asset lifecycle strategy for all structures, systems and components constituting the plant, a building lifecycle management (BLM) concept it is planned to be implemented. This BLM approach consists in the introduction of Building information modelling (BIM) tools together with the integration of PLM capabilities.

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