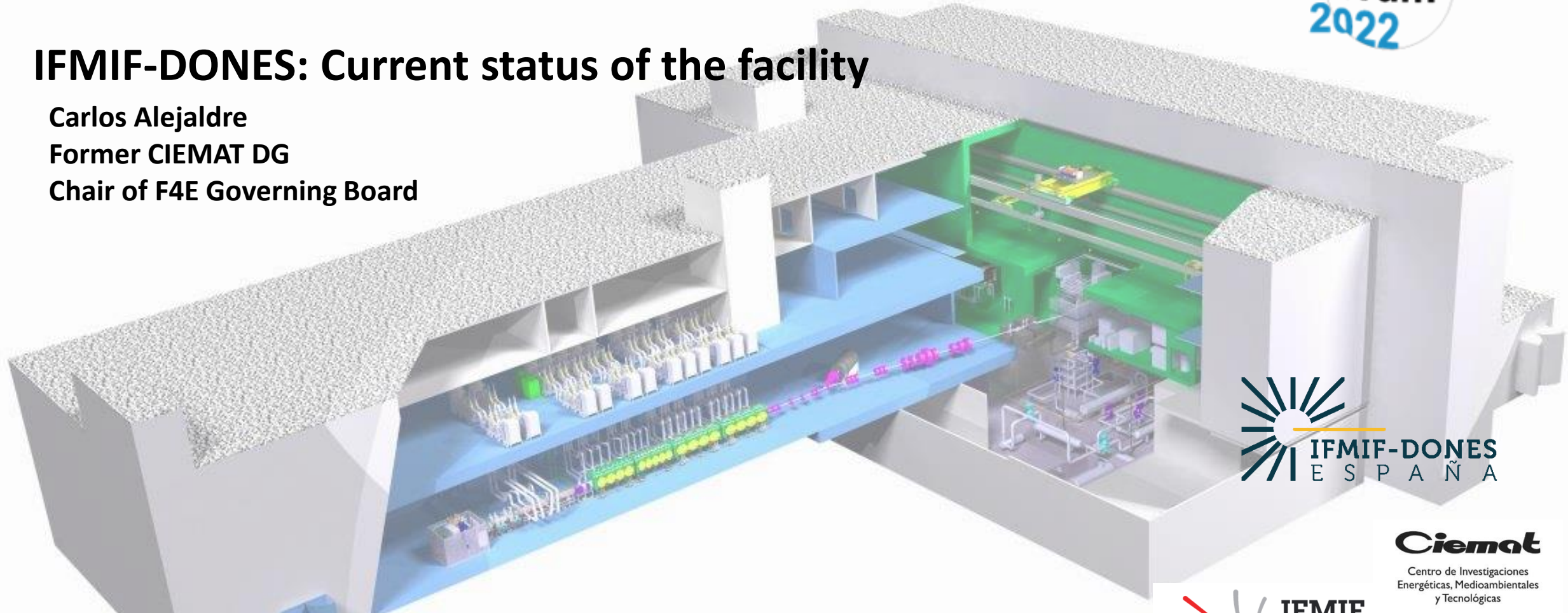


IFMIF-DONES: Current status of the facility

Carlos Alejandre

Former CIEMAT DG

Chair of F4E Governing Board



Ciemat

Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas



UNIVERSIDAD
DE GRANADA



This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

F4E Mission Statements (Effective from 1 January 2022)

F4E_D_26JCNW v4.11

F4E Missions and Responsibilities

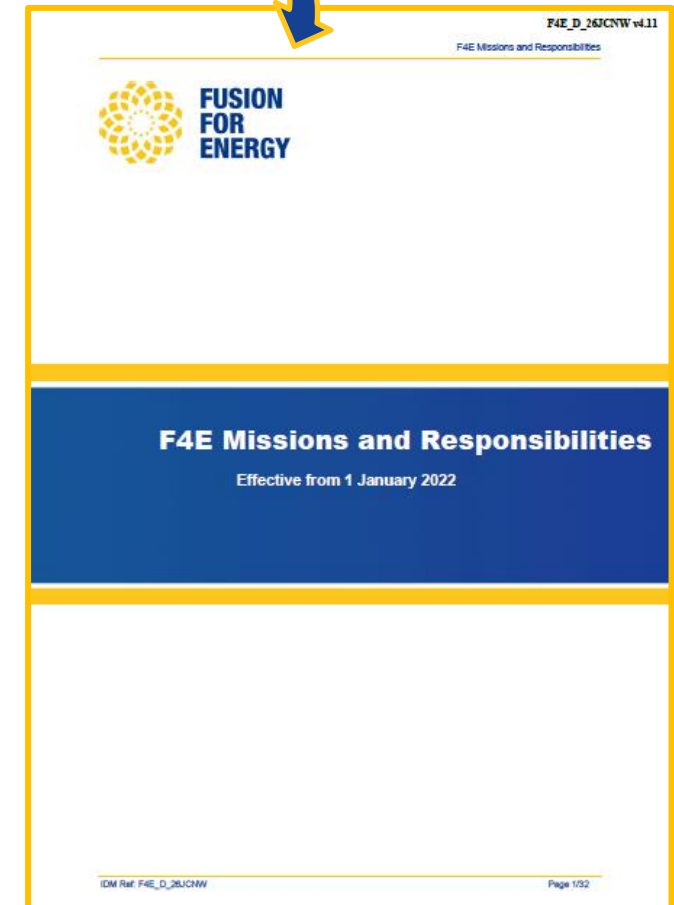
1. VISION AND OVERALL F4E MISSION

"Bringing the power of the sun to earth"

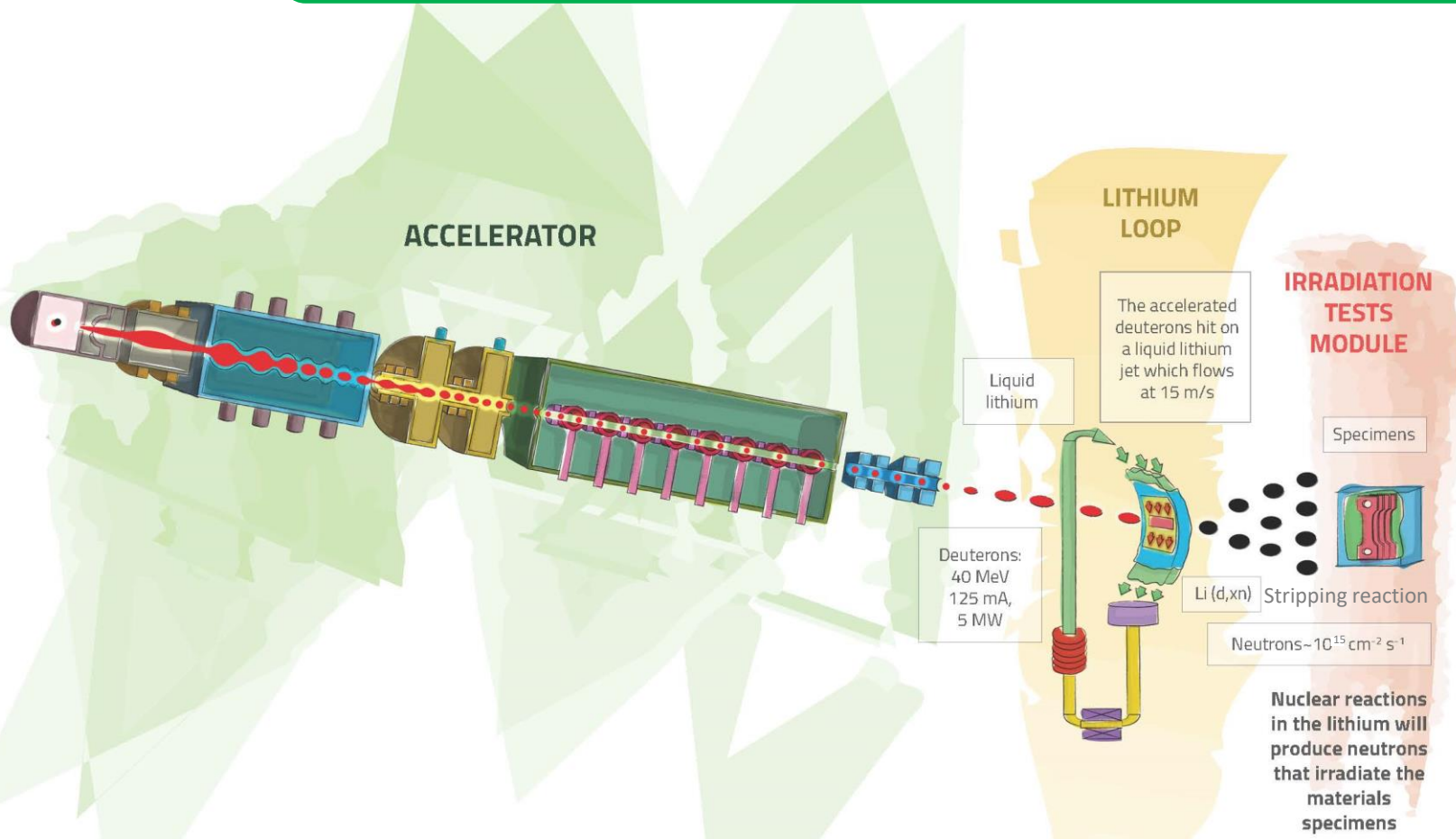
This vision communicates the active role Fusion for Energy (F4E) takes in advancing fusion towards becoming a reliable source of clean abundant base load energy.

F4E is the European centre to develop and build ITER and other facilities to turn fusion into a sustainable source of energy for mankind. F4E bridges the EU research community and the EU industry, to broaden the European industrial base for fusion technology. F4E was set up for 35 years from 19 April 2007 with a threefold mission:

1. To provide the contribution of the European Atomic Energy Community (Euratom) to the **ITER International Fusion Energy Organisation**;
2. To provide the contribution of Euratom to **Broader Approach Activities with Japan** for the rapid realisation of fusion energy;
3. To prepare and coordinate a programme of activities in preparation for the construction of a **demonstration fusion reactor** and related facilities including the **International Fusion Materials Irradiation Facility (IFMIF)**.



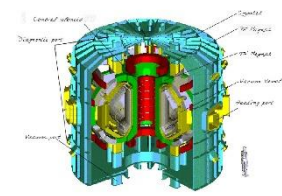
An accelerator based fusion-like neutron source to be used for the qualification of the materials to be used in the DEMO Reactor



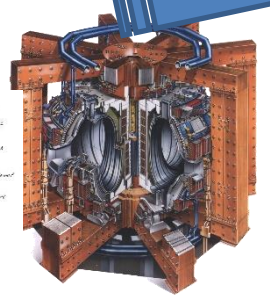
A neutron flux of $\sim 10^{15} \text{ n/cm}^2/\text{s}$ is generated with a neutron spectrum up to 55 MeV energy

High Flux Test Module:
 20 dpa/fpy in 100 cm³ of material
 Controlled Temperature:
 250 < T < 550 °C

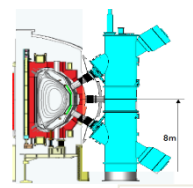
Identified as high priority in the EU Fusion Roadmap
 Included in the ESFRi Roadmap as a EU strategic facility



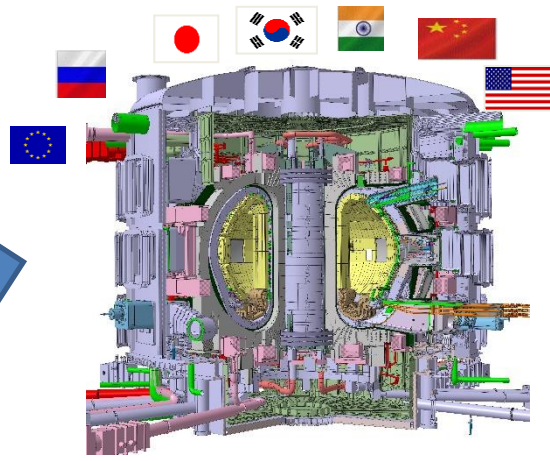
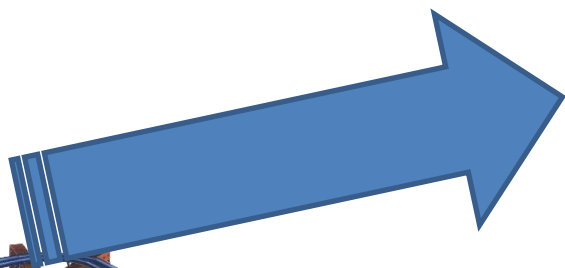
K-STAR



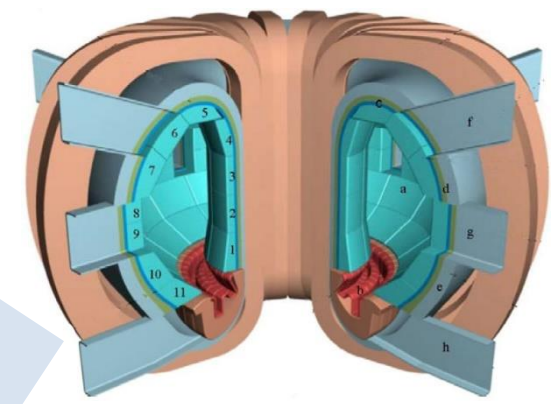
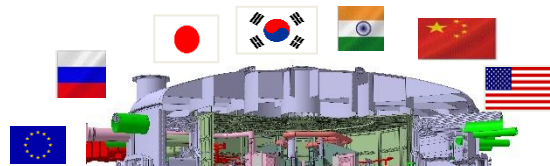
JET



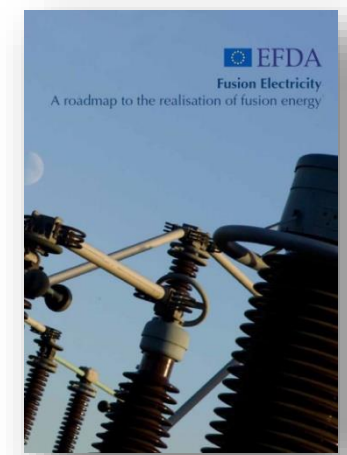
JT-SU



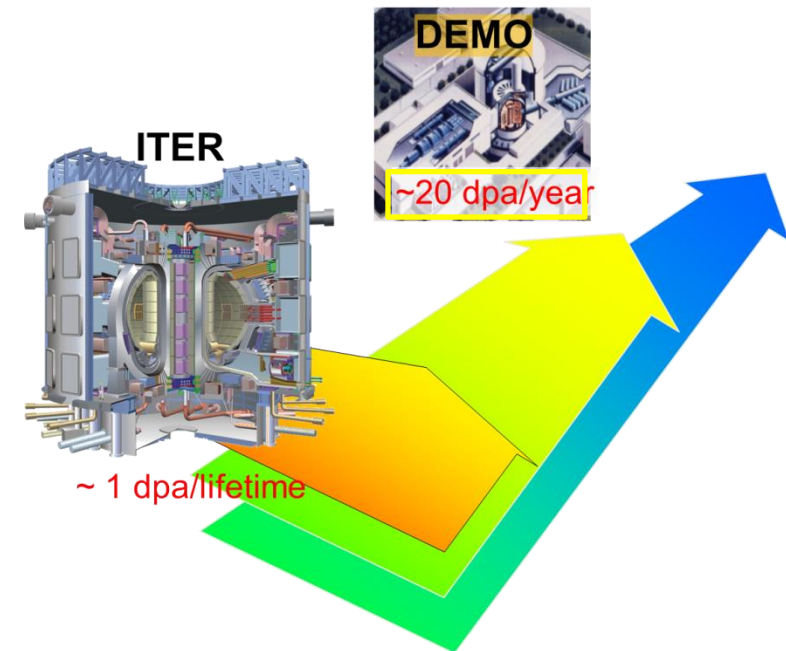
ITER – 500 MW_{th}
300– 500 secs



DEMO ≥ 500 MW_{el}
1 – 2 horas

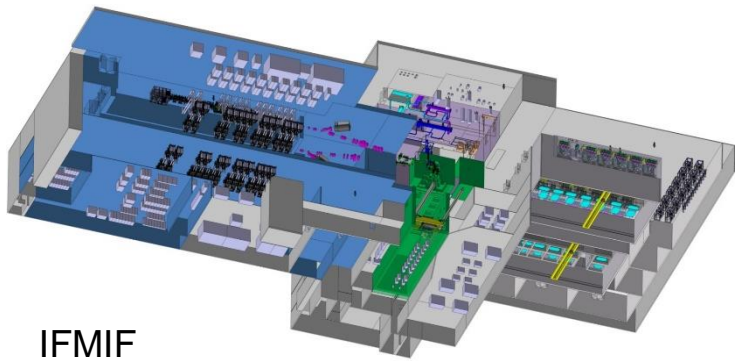


One of the main differences between ITER and DEMO is the radiation dose:
at DEMO more than two orders of magnitude higher

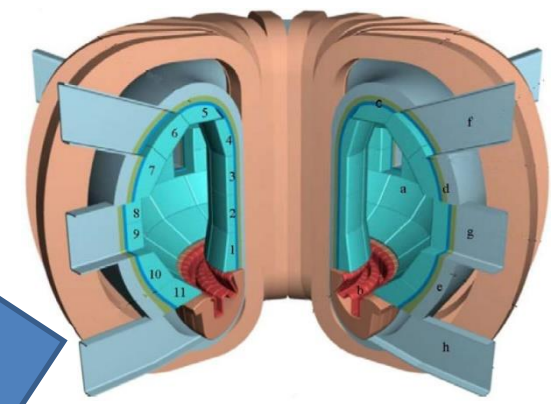
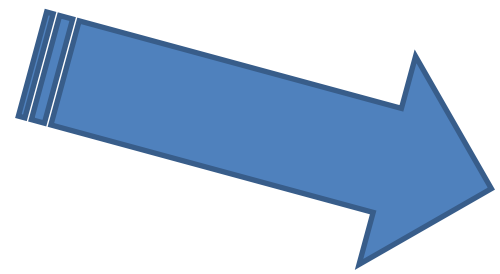


- Selection and qualification of candidate materials for fusion reactors
- Generation of engineering data for design, licensing and safe operation of DEMO up to end-of-life
- Completion, calibration and validation of databases (mainly generated from fission reactors research)
- Material testing and simulation carried out simultaneously to correlated fundamental understanding of radiation response of materials

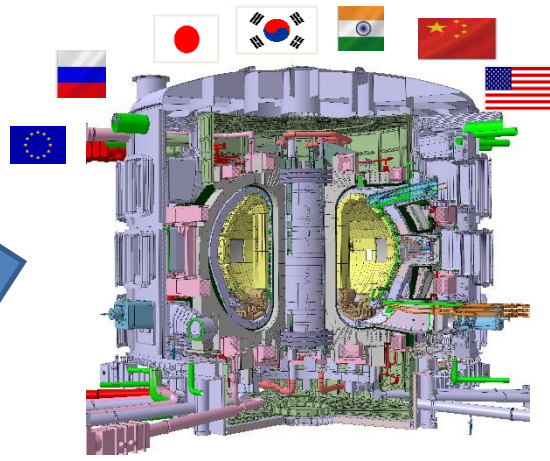
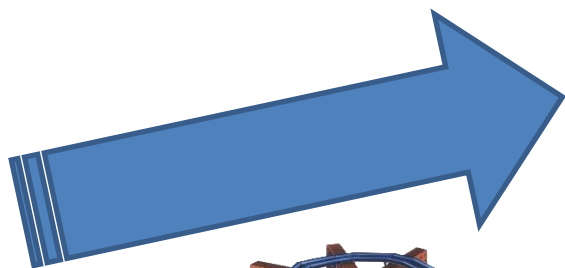
**International Advisory Panels pointed out Fusion Neutron Source as essential need toward Fusion Power Plant
→ best fulfilled with a D-Li stripping source (IFMIF concept)**



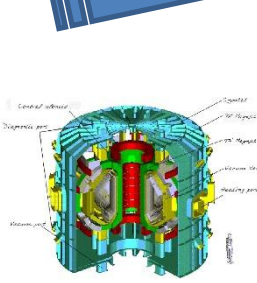
IFMIF
2 D+ beams, 40 MeV, 125 mA on a Li target



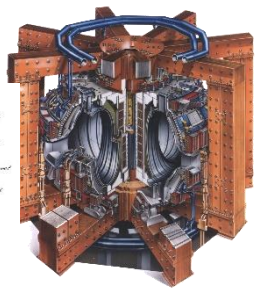
DEMO $\geq 500 \text{ MW}_{el}$
1 – 2 horas



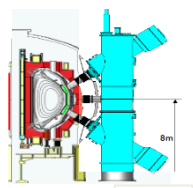
ITER – 500 MW_{th}
300– 500 secs



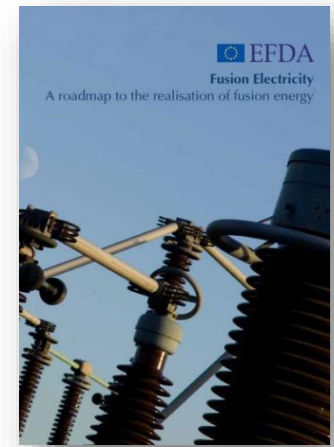
K-STAR



JET



JT-SU



Applications of medical interest

- Radiopharmaceuticals for therapy (e.g. ^{99}Tc)
- Accelerator-based boron-neutron-capture therapy (BNCT)
- ...

Basic physics studies

- Half-life measurements on long-lived isotopes
- Neutron and neutrino oscillations
- Solid state physics studies



Nuclear physics and radioactive ion beam facility

- Nuclear Structure & Astrophysics
- Mechanism of nuclear fission
- Cross-section measurements for applied physics
(n,γ), (n,xn), (n,lcp)
- ...

Industrial application of neutrons

- Mechanical properties of irradiated materials from small samples
- Computed tomography imaging using fast neutrons
- Transmutation doping of silicon and radiation-damage testing of electronics



- ❖ **Deuterons** extracted from the accelerator beam but only a small fraction (a few percent)
- ❖ **Neutrons** available behind the Irradiation Module either inside or outside the Test Cell

Applications of medical interest

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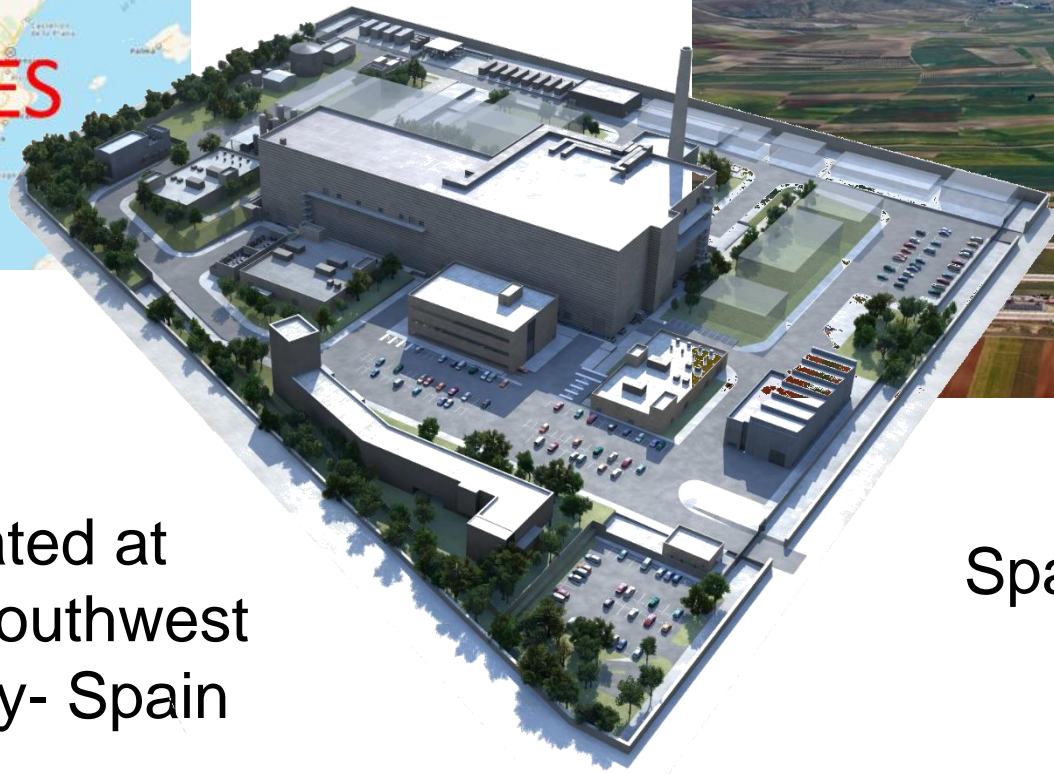
DONES will be a unique facility and new type of experiments will be feasible

Nuclear physics

- Nuclear Structure & Astrophysics
- Mechanism of nuclear fission
- Cross-section measurements for applied physics
(n,γ), (n,xn), (n,lcp)
- ...

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The site is located at Escúzar -18 km southwest from Granada city- Spain

Spanish - Croatian site selected by EU

Pictures of first Building DONES & UGR



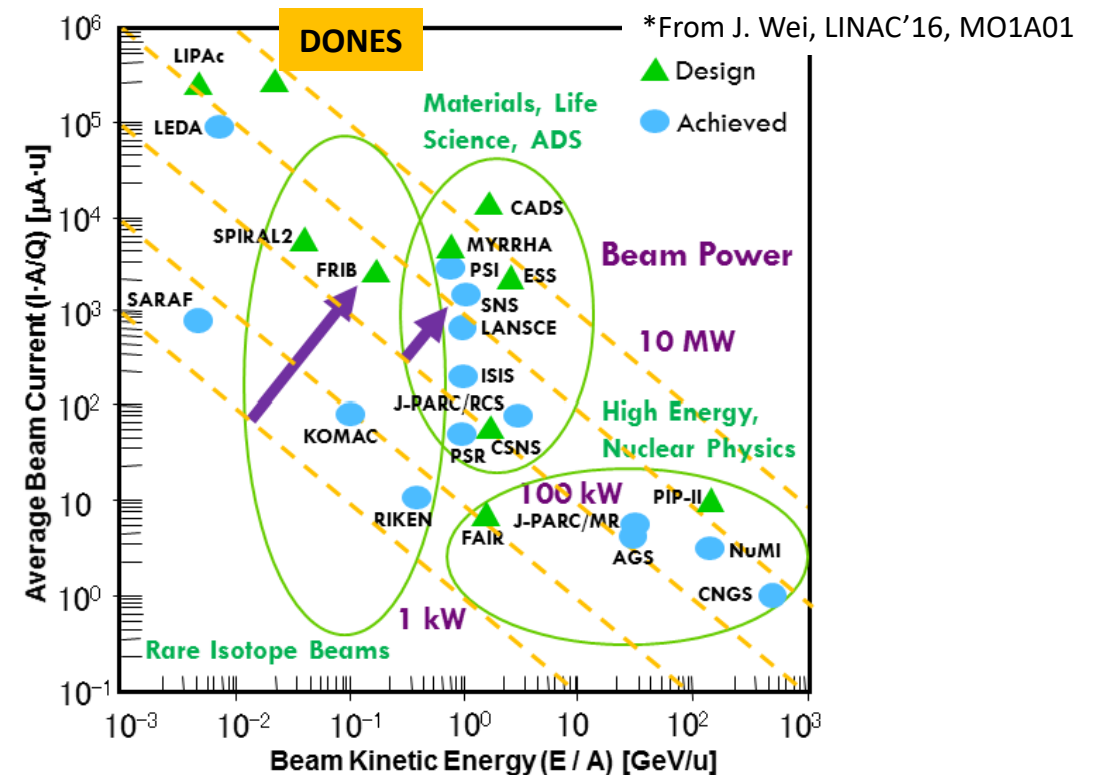
DONES will be take a number of relevant technologies to a new stage of development opening the way to new future developments

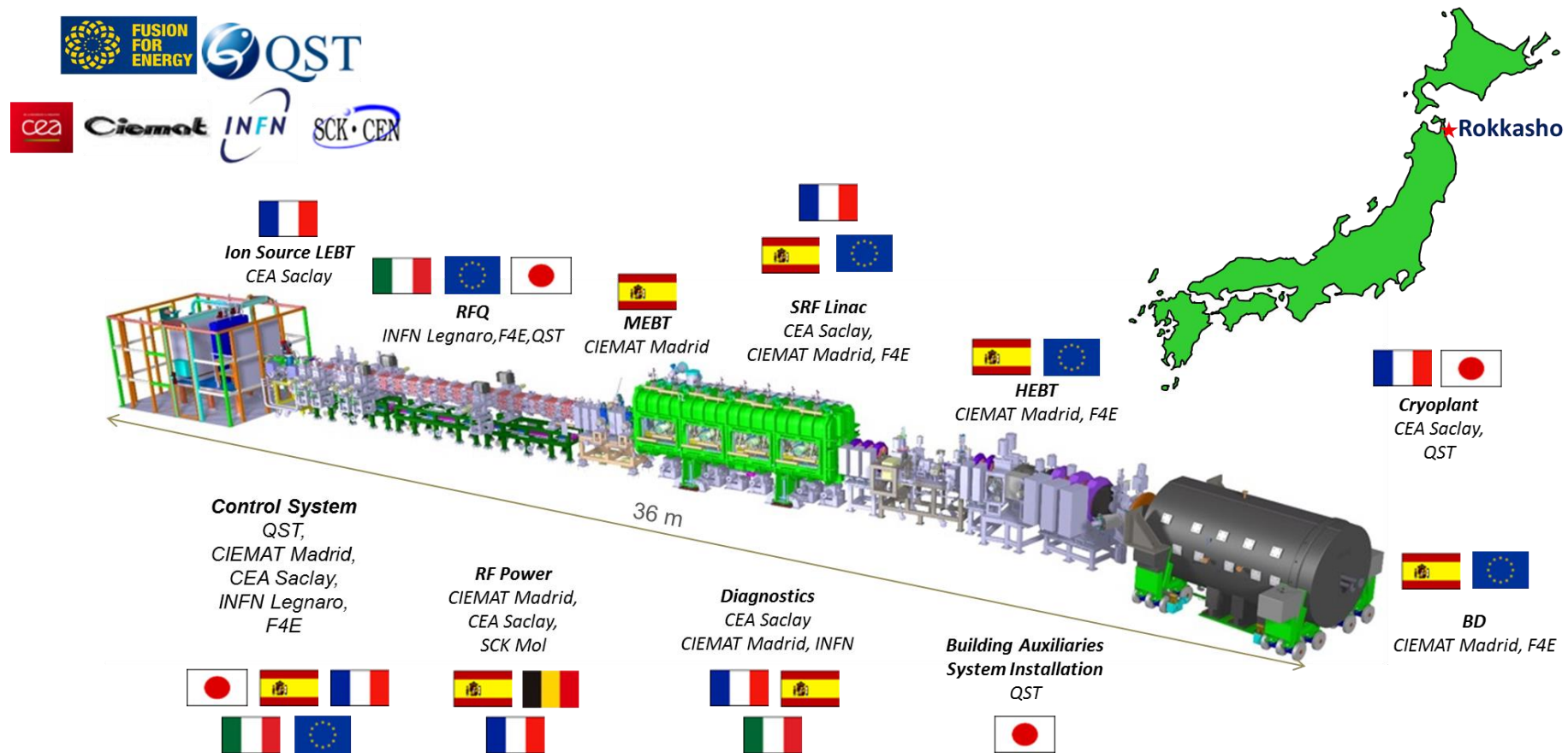
DONES will be a first of a kind facility and will became a reference for the future

Just one example: we are opening a new technology area in the accelerators community

High technology development in many different areas, including:

- Liquid metals management (lithium)
- Robotics and remote handling
- Control systems
- Sensors and diagnostics
- Cryogenics
- Mechatronics
- Materials
- Medical radioisotopes
-



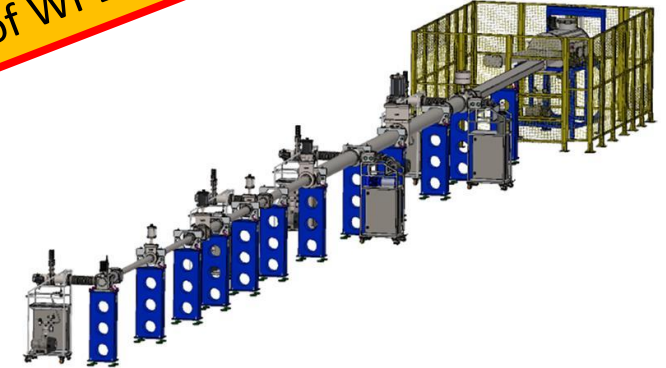
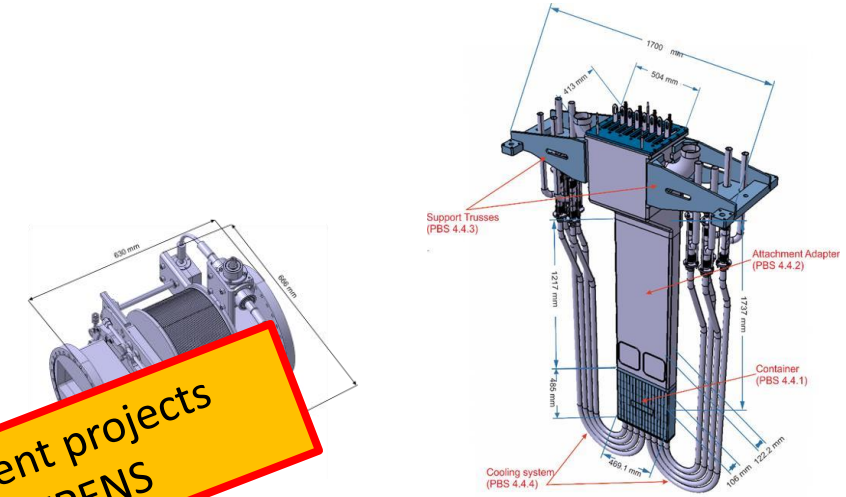


Project IFMIF-EVEDA, Rokkasho, Japan, collaboration EU-Japan

Many of these things already in development:

- ✓ **Start-Up Monitoring Module (STUMM)** prototype to validate the final design and diagnostics,
- ✓ **Quick Disconnecting System (QDS)**. To validate RH connection system
- ✓ Multipurpose VaCuum accidental scenarios (MuVaCas). To analyze different possible accidental scenarios related with Vacuum
- ✓ **SRF LINAC High Beta** cavity prototyping to validate the final design
- ✓ **Electromagnetic Pump** prototype
- ✓ Li purification prototipe loop (**LITEC**) to test impurities control technology
- ✓ **LIFIRE** facility to study Lithium fire risks
- ✓ **ANGEL** facility to evaluate Nitrogen
- ✓ **Valeria lab** for virtual reality maintenance and RH modelling
- ✓ **Be in Lithium loop** for evaluation of the behaviour in Lithium
- ✓

Many of them built in the framework of different projects but later on to be exploit in the framework of WPENS



**DONES-PRIME
DONES-UGR**

Accelerators and related technologies for Big Science Facilities (ACTECA project)

Strategic objective: development of key technologies to push for the Spanish involvement in the construction of a Big Science project, as well as other Big Science projects.

ACTECA

APPROVED in Dic 2021!!!

Foreseen activities

- Development of key technologies including a VMEC and development of amplifiers
- Key components for the accelerator
 - RF Superconducting
 - Advanced diagnostics
 - Liquid metal
 - Diagnostics for the beam
- Safety and environmental handling

2017-2020
7-8 M€

New materials, technologies and advanced processes to contribute to the new era of fusion energy (FUSION FUTURE Project)

Strategic objective: To contribute to the main critical technologies to fusion energy around DONES and DEMO.

FUSION FUTURE

APPROVED in Dic 2021!!!

Foreseen activities

- Development of advanced materials for DONES
- Development of Li and Be for DONES and DEMO
- Development of key exposed components
- Key technologies for the test cell
 - Inspection sensors
 - Tritium transport
 - Liquid metals technology
 - Diagnostics for the beam
- Safety and environmental handling

2020-2023
6 M€

Research on Technologies and Processes for IFMIF-DONES (DONES EVO Project)

Strategic objective: Mitigation of IFMIF-DONES key technological risks

DONES EVO

APPROVED in Dic 2021!!!

Foreseen activities

- Development of advanced processes for optimization
- Development of beam transport
- Development of technical solutions for medical isotopes
- Development of an advanced diagnostic system
- Optimization of the tritium cycle
- Development of impurity control
- Development of a Target Blanket made of representative materials
- Modeling tools for tritium and lithium
- Safety and environmental handling of the Test Cell

2021-2024
6 M€

Neutron Exposed Technologies for the IFMIF-DONES Test Cell (DONES NEXT Project)

Strategic objective: Development of key technologies for the neutron exposed component for the IFMIF-DONES Test Cell

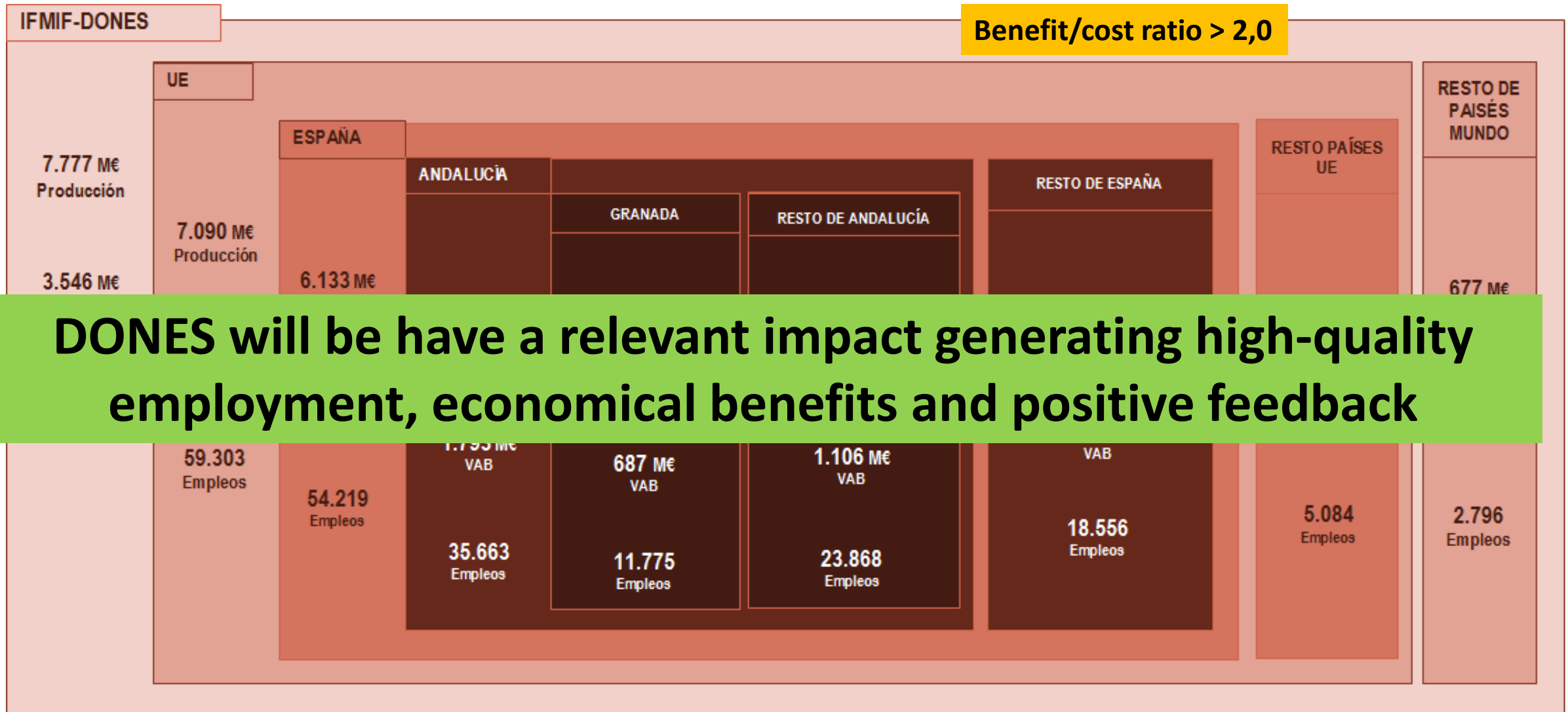
DONES NEXT

APPROVED in Dic 2021!!!

Foreseen activities

- Development and testing of alignment technologies for Test Cell parts
- Development of optimized processes for the Test Cell manufacturing
- Development of an optimized design for the internal wiring, piping and sensors of the test cell, including mechanical and electronic design.

2021-2023
2 M€



DONES will have a relevant impact generating high-quality employment, economical benefits and positive feedback

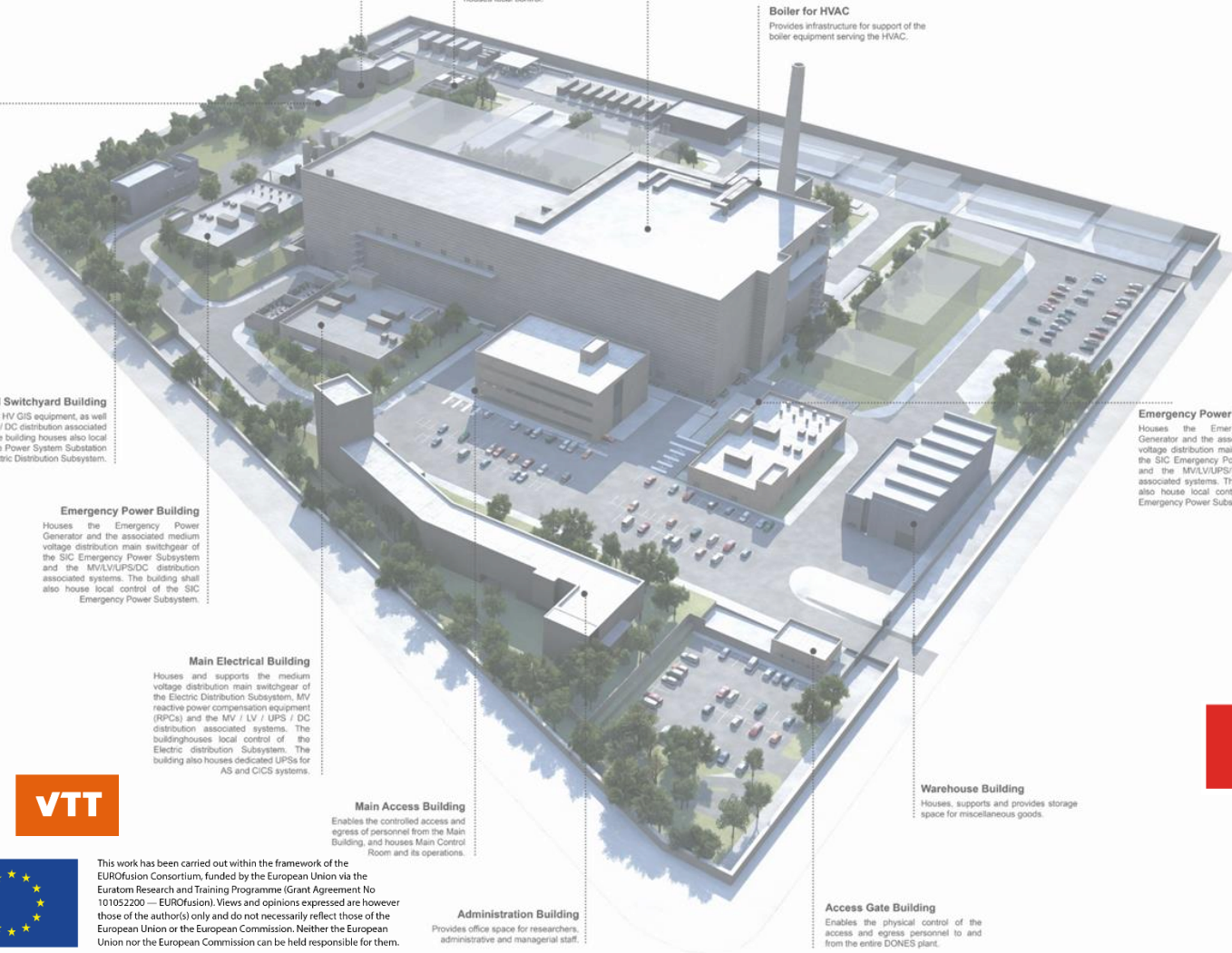
The work carried out during these last years within the framework of the WPENS Project made it possible to consolidate the design of the IFMIF-DONES Plant and its accelerator and establish **a complete Governance proposal,**

Although some validation activities are still expected **no major issues exist** to start construction phase of IFMIF-DONES,

The strategy implemented to **find synergy** with other facilities (e.g. ESS, SPIRAL2, ...) as well as the strengthening of the collaboration with LIPAc is an important asset **to minimize/mitigate the risk** and will be pursued,

Preliminary work at the site, including auxiliary buildings and laboratories, **has already started** and a **Consortium for the implementation** of the Project between Central and Local Government has been formed

The IFMIF-DONES Programme is expected to start formally its Construction Phase very soon....



Fire Water Pumps Building
Houses and supports pumping equipment of fire fighting (FF) system. The building also provides infrastructure for FF industrial water supply tank.

Cooling Towers and Chillers Electrical Building
Houses and supports the MV / LV / UPS / DC distribution boards of the Electric Distribution Subsystem. The building houses local control.

Main Building
The home of the particle accelerator, test and lithium systems.

Boiler for HVAC
Provides infrastructure for support of the boiler equipment serving the HVAC.

Water Plant
Includes Water treatment plant and Potable and Demi water plant. Houses and supports process equipment serving systems of Potable water, Demi water and industrial service water.

Electrical Switchyard Building
Houses EPS HV GIS equipment, as well as LV / UPS / DC distribution associated systems. The building houses also local control of the Power System Substation and Electric Distribution Subsystem.

Emergency Power Building
Houses the Emergency Power Generator and the associated medium voltage distribution main switchgear of the SIC Emergency Power Subsystem and the MV/LV/UPS/DC distribution associated systems. The building shall also house local control of the SIC Emergency Power Subsystem.

Main Electrical Building
Houses and supports the medium voltage distribution main switchgear of the Electric Distribution Subsystem, MV reactive power compensation equipment (RPCs) and the MV / LV / UPS / DC distribution associated systems. The building houses local control of the Electric distribution Subsystem. The building also houses dedicated UPSs for AS and CICS systems.

Main Access Building
Enables the controlled access and egress of personnel from the Main Building, and houses Main Control Room and its operations.

Administration Building
Provides office space for researchers, administrative and managerial staff.

Access Gate Building
Enables the physical control of the access and egress personnel to and from the entire DONES plant.

Emergency Power Building
Houses the Emergency Power Generator and the associated medium voltage distribution main switchgear of the SIC Emergency Power Subsystem and the MV/LV/UPS/DC distribution associated systems. The building shall also house local control of the SIC Emergency Power Subsystem.

Warehouse Building
Houses, supports and provides storage space for miscellaneous goods.

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