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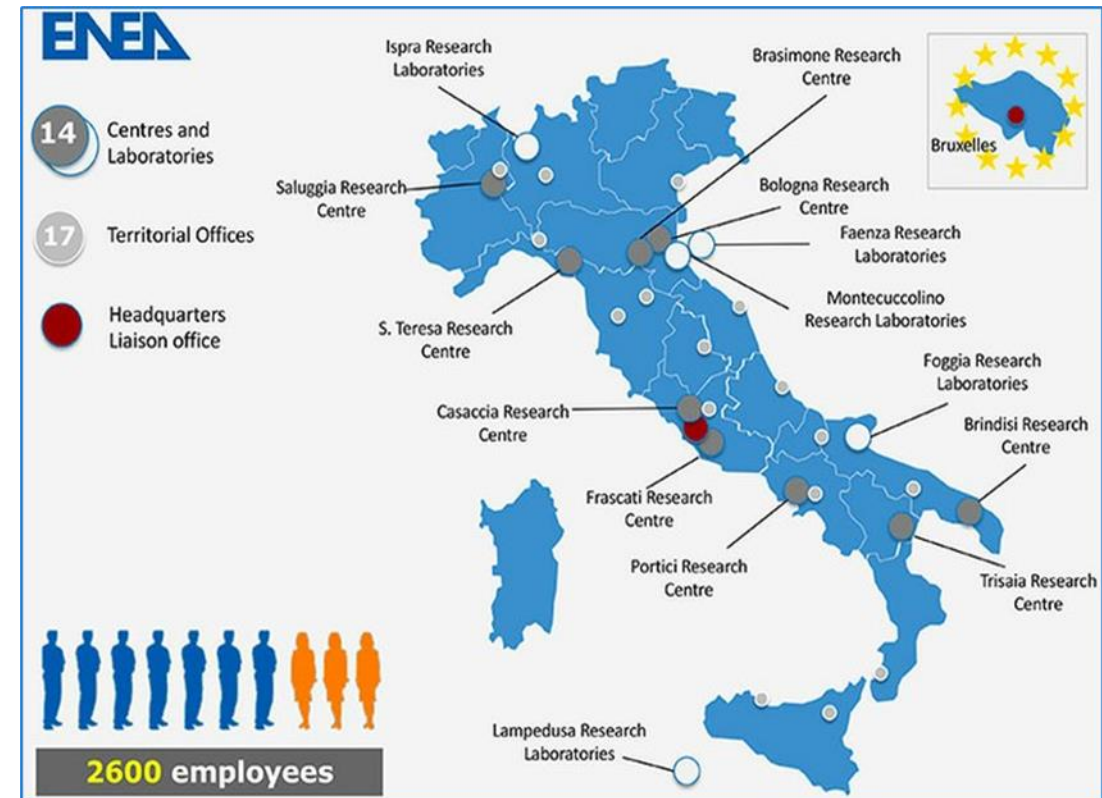
ENEA and its Laboratories

Rome, 25th January 2023

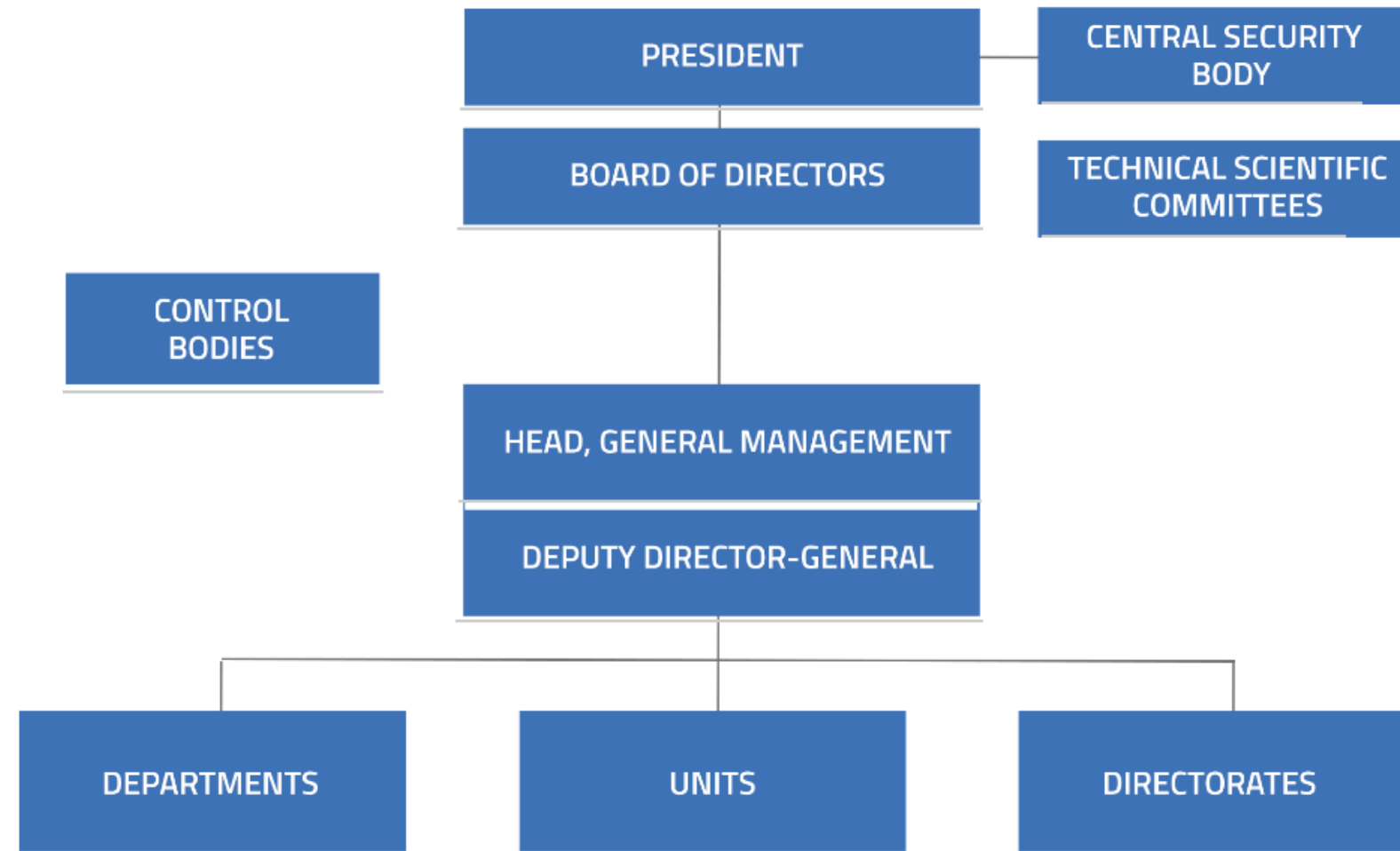
Alessandro Dodaro

ENEA - Organization Profile

- **ENEA** is the National Agency for New Technologies, Energy and Sustainable Economic Development
- is a **public body** aimed at research, technological innovation and the provision of advanced services to enterprises, public administration and citizens in the sectors of energy, the environment and sustainable economic development
- has **9** research centers and **5** Laboratories all around Italy
- operates Radiochemical and Radiometric Labs, Metrology Institute, Research reactors, state-of-art facilities in the fields of energy technologies, nuclear fusion and nuclear safety, energy efficiency, technologies for cultural heritage, seismic protection, food safety, pollution, life sciences, strategic raw materials, climate change



ENEA - Organization Structure



ENEA - Departments

Energy Technologies and Renewable Sources

Develop technologies, processes, components and systems for the safe and efficient exploitation of renewable sources, for the rational use and optimal conversion of energy, decarbonisation of the energy system, sustainable use of fossil fuels, electric, thermal and chemical storage systems, sustainable mobility, smart cities, critical infrastructure resilience, ICT development for cultural heritage and high performance computing.

Fusion and Technology for Nuclear Safety and Security

Activities in the field of nuclear fusion and fission, participation in major research programs in physics and technology at national level, as well as international initiatives like ITER and Broader Approach. Other key activities include the development of IV generation reactors, advanced technologies and systems for security (protection against Chemical, Biological, Radiological, Nuclear agents, and Explosives CBRNe), for the protection of the environment and cultural heritage, the exploration of the territory, optoelectronic and photonic processes and products.

Sustainability

Competitiveness of production systems, innovation and job opportunities, Valorisation, management and protection of the environment, Quality of life, nutrition and public health.

Energy Efficiency Unit

National point of reference in terms of energy efficiency for the public administration, citizens, businesses and the territory, making available innovative methodologies and solutions and providing technical and scientific support for efficient use of energy, reduction of energy consumption and optimisation of processes, with a strong focus on quality and social responsibility.

Fusion and Technology for Nuclear Safety and Security micado

Department - FSN

The ENEA **Fusion and Technology for Nuclear Safety and Security Department** is organized into 18 Research Laboratories and 1 Institute, 3 Sections distributed into 6 Divisions:

- *Plasma Studies and DTT*
- *Fusion Energy Development*
- *Experimental Engineering*
- *Technologies, Equipment and Materials for Nuclear Fission*
- *Nuclear Safety and Sustainability*
- *Physical Technologies for Safety and Health*

FSN Core Subjects

FUSION (Frascati, Brasimone)

- Physics
- Technology
- Engineering
- Safety

FISSION (Bologna, Brasimone, Casaccia)

- Generation IV
- Safety
- Research Reactors
- Radioactive Waste Management

Security, Health, Safety, Environment (Frascati, Casaccia)

- Laser & Neutron based Systems for:
 - Security
 - CBRN-E Risks
 - Environment and Medical applications

Italian National Institute for Ionizing Radiation Metrology (Casaccia)

STAKEHOLDERS

- EURATOM
- FUSION for ENERGY
- ITER
- INTERNATIONAL PRIVATE AND PUBLIC INSTITUTION
- IAEA
- OECD-NEA
- NATO
- MINISTRIES
- INDUSTRIES

FSN Fusion Activities



Fusion
Theory



Experimental
Physics



High Heat
Flux



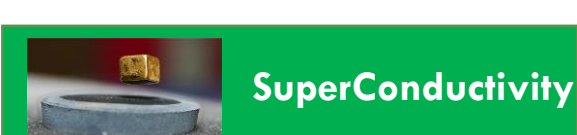
Technology
Remote



Fusion Fuel
Cycle



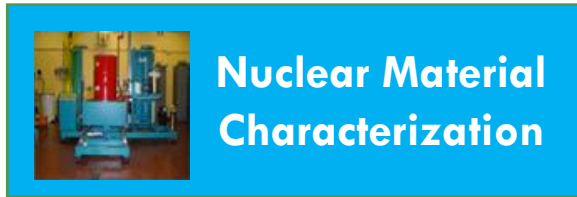
Neutronics



SuperConductivity

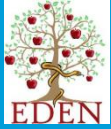
- **Among first to formalize a predictive plasma model** (“first principle code”, excellence recognized by US SciDAC)
- **World Record of plasma density** with Frascati Torus and Frascati Torus Upgrade (two high magnetic field tokamaks)
- **World record of Critical heat flux** (35 MW/m^2 , twice as much as rocket engine power at take off)
- New unique technology to perform **optical measurements in extreme environments** (i.e. high radiation, low accessibility)
- **Breakthrough in fuel cycle technology** allowing reduction in inventory of factor 3x-4x through improved tritium recovery and separation
- **Worldwide reference Lab** on neutron database for: neutron shielding, tritium breeder and diagnostic design
- **World record: 80 kA in a 43 mm dia cable** (sufficient for 8000 houses)

FSN Fission Activities



- **Radiation effects damage**
- Innovative detectors calibration
- Minor Actinides capture cross sections measurements
- **Radioisotopes production**
- **Non-destructive techniques**
- **Destructive techniques**
- **Conditioning matrices qualification**
- Scientific, technical and operational support to Public Administration for nuclear or suspect materials
- **Management of the Integrated for the management of non-electro-nuclear radioactive waste**
- **Gen IV Design – LFR**
- Technology development
- Protected and Unprotected Loss of Flow
- Multi-physics activity based on experimental data

FSN Security, Health, Heritage



Security CBRN-E

- **Detection of ‘dirty bomb’ and explosive** by Integrated Laser system and Imaging Topological Radar demonstrated



Food and Health

- **Non-Destructive analysis** of fruit and vegetable by time-of – flight and Raman spectroscopy



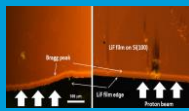
Environment monitoring

- **Air pollution monitoring** by Differential Optical Absorption Spectroscopy



Cultural Heritage

- **Non-Destructive analyses and surface treatment**



Nano Technology & Photonics

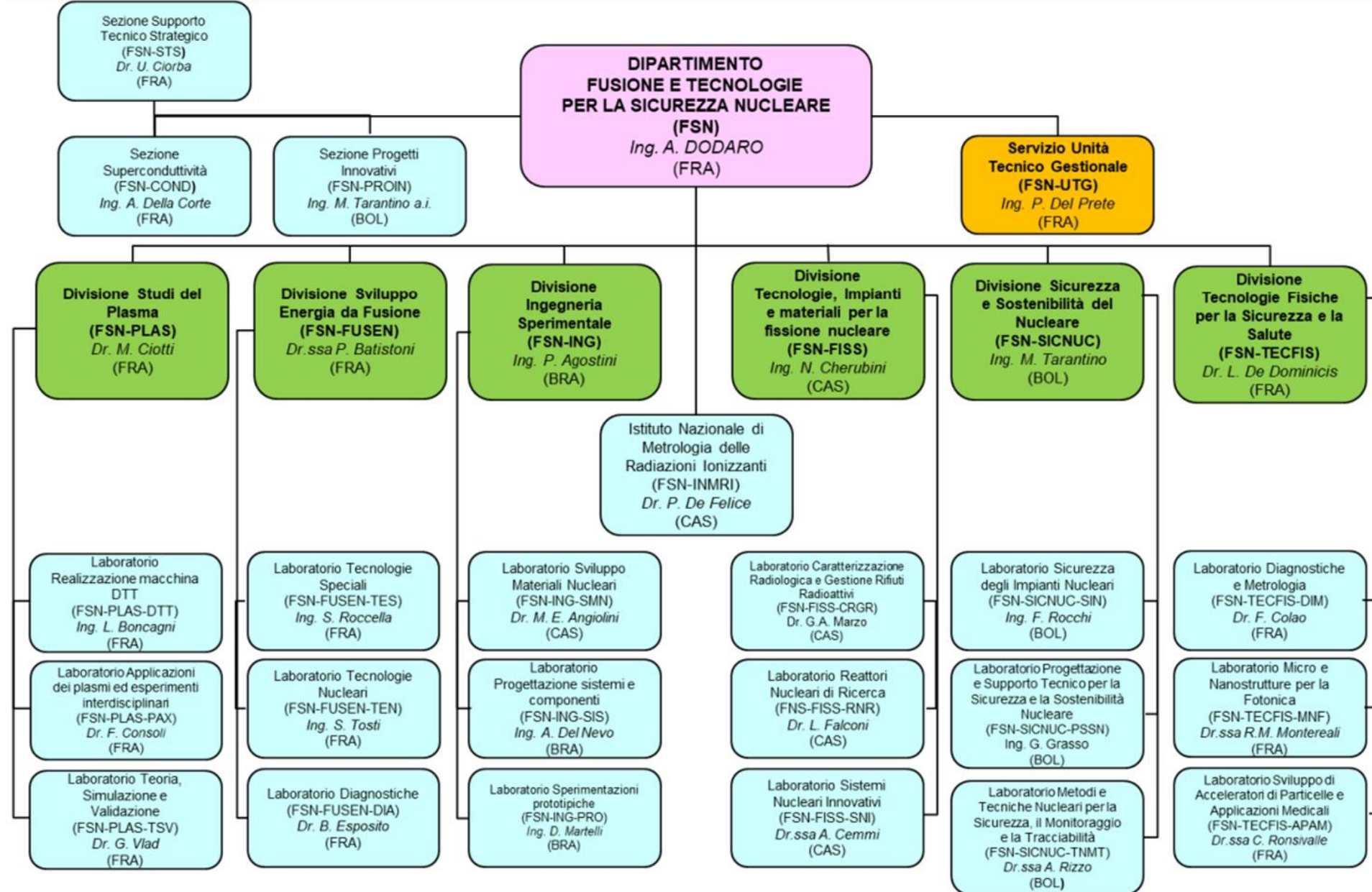
- **Development of Solid State and thin LiF Detectors** for radiation imaging



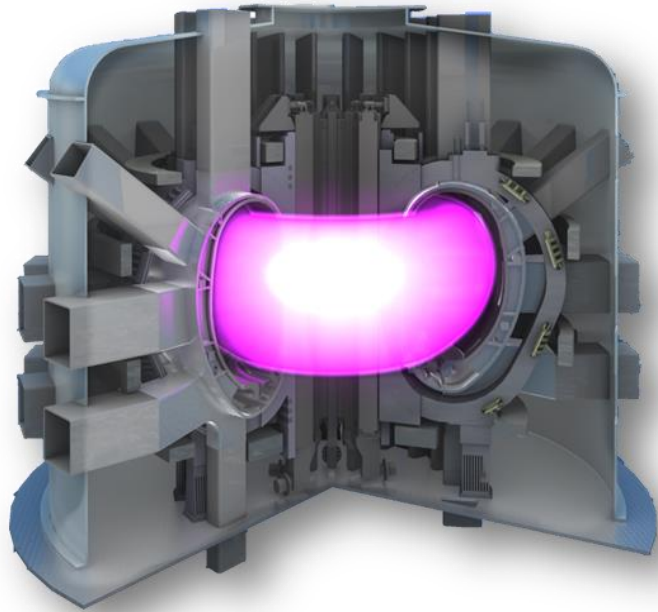
Accelerators for medical treatment

- Development of LINAC for Intra-Operative Radio Therapy, **TOP-IMPLART** being the most advanced

FSN Facilities and Services



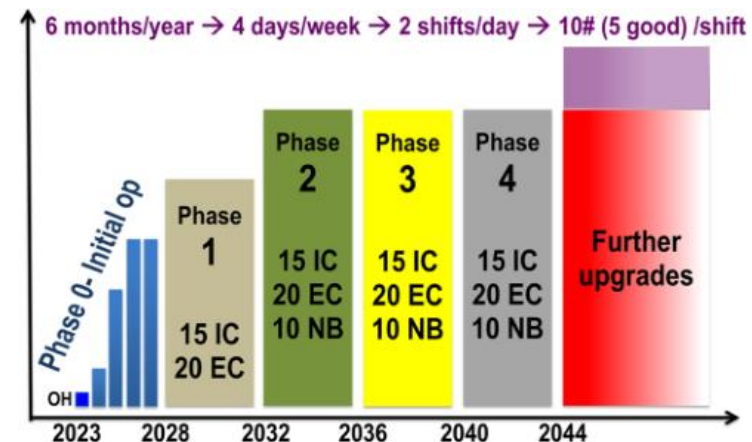
The Divertor Tokamak Test Facility – DTT Frascati Centre



The main objectives :

- demonstrate whether the heat exhaust system proposed for DEMO is able to withstand the strong thermal load acting if the fraction of radiated power turns out to be lower than expected;
- improve the experimental knowledge in the heat exhaust scientific area that cannot be addressed by present devices;
- Prepare the new Scientist generation

DTT received the first part of funds
It is a fairly international infrastructure
Should be ready within 2025.



Fusion Neutron Generator – FNG

Frascati Centre

Frascati Neutron Generator – FNG: 10^{11} n/s; 14 MeV



Data for:

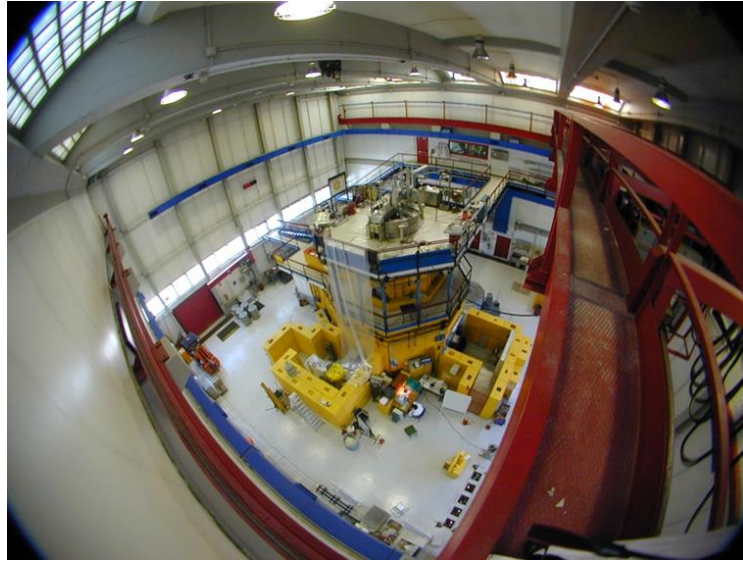
- European Fusion File (EFF)
- European Activation File (EAF)

Benchmark Experiments on:

- shielding
- breeding Blanket

Diagnostics development

Research Reactors - Casaccia Centre



TRIGA RC-1: 1 MW power, $2.7 \cdot 10^{13}$ n cm⁻² s⁻¹ thermal neutron flux nuclear research reactor

- ✓ **Neutron Activation Analysis**
- ✓ **Radioisotopes for Medical Applications**
- ✓ Production of gamma emitters
- ✓ **Neutron irradiation damage:** support to Italian and European Space Agencies
- ✓ Neutron Diffraction

TAPIRO: 5 kW power, $4 \cdot 10^{12}$ n cm⁻² s⁻¹ fast neutron flux nuclear research reactor

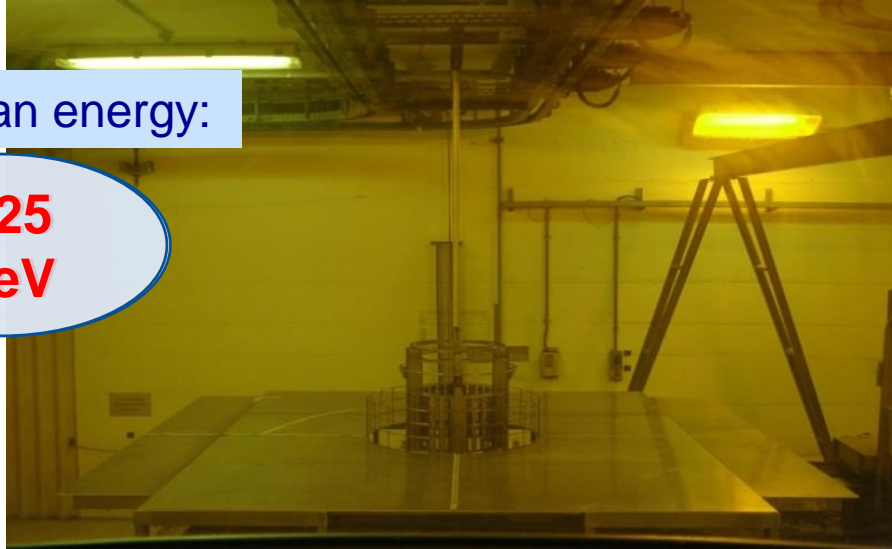
- ✓ Radiation effects damage on functional material
- ✓ **Innovative detectors** calibration and performances
- ✓ **Minor Actinides** capture cross sections integral measurements (AOSTA; NEA-CEA-ENEA)



⁶⁰Co Calliope: Gamma Irradiation Facility – Casaccia Centre

⁶⁰Co mean energy:

**1.25
MeV**



Irradiation tests at different dose rates, atmospheric and temperature conditions.

Certification

Maximum allowed activity:

3.7×10^{15} Bq (100kCi)

Pool-type plant (7×6×3.9 m³)
shielded cell



Activity of around 60kCi with plain sources rack configuration by the end of 2019

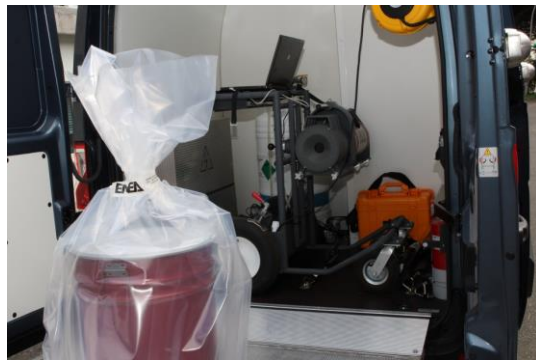
In-situ: Mobile Laboratory and instrumentation



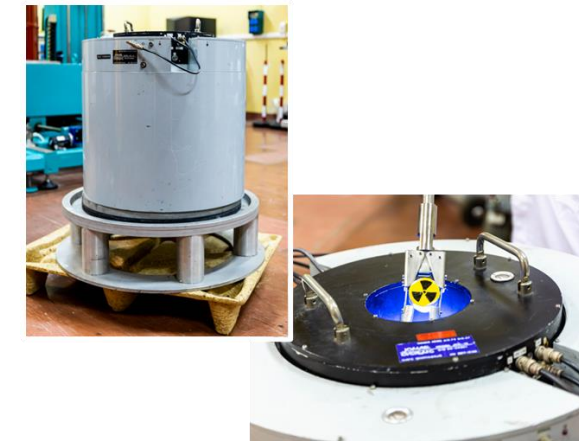
The mobile laboratory covers a wide spectrum of possible cases of intervention, including events in which suspicious radiological materials may be found, such as improper storage at intermodal shipment points (e.g., ports, airports, railway stations), waste controls, or environmental samples containing fissile or radioactive material.



ISOCS – In Situ Object Counting System



The mobile laboratory is equipped with custom-designed housings for the instrumentations and special compartments that allow the confinement of suspected samples.



SSNC - Small Samples Neutron Counters

Radiological Characterization – Casaccia Centre

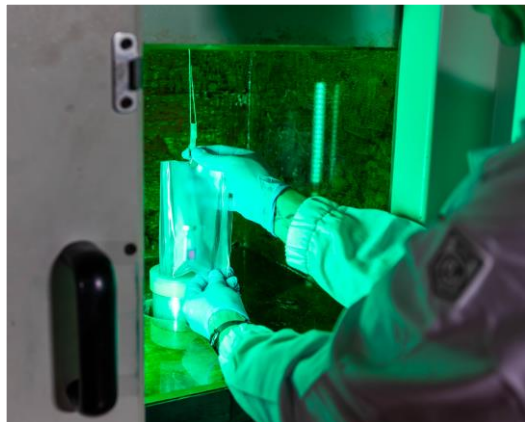
Non Destructive Analysis techniques



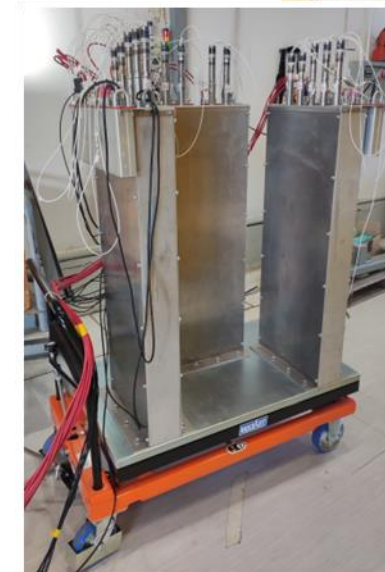
Multi Group Analysis System



**Gamma scanner
Tomographic system**



**Low Background
Gamma Spectrometry - LABSOCS**



**Neutron Active
Interrogation system**

Radiological Characterization – Casaccia Centre

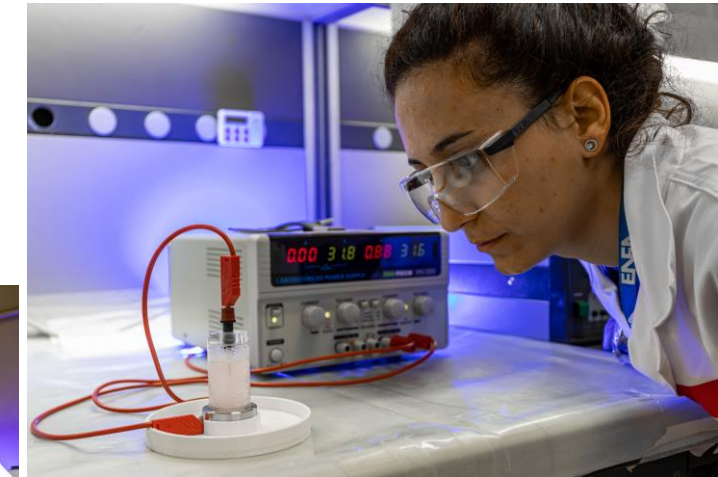
Destructive Analysis techniques



Liquid Scintillation Counting



Inductively Coupled Plasma Mass Spectrometry (ICP-MS)



Alpha spectrometry system

Integrated Service - Casaccia Centre

Management of Non-Electronuclear Radioactive Waste

ENEA has **by law** the responsibility of intervention (including transport, characterization, storage, treatment, and conditioning) "in the sector of low- and medium-activity waste produced at national level, in order to guarantee the collection, safekeeping and management" in particular for "low- and medium-activity waste from industrial and health activities".

In 1986 ENEA established the Integrated Service for the management of non-electronuclear radioactive waste produced at national level.

ENEA plays a major role in the management of low- and medium-level radioactive waste and high-activity sealed radioactive sources originating from medical, industrial, and scientific activities.

ENEA assumes the ownership of the collected waste and takes charge of their final disposal, releasing the waste producer from any legal responsibility.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847641. This text reflects only the author's views and the Commission is not liable for any use that may be made of the information contained therein.



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Thanks for your attention

