European Commission

Open access to JRC research infrastructures

2020

Joint Research Centre

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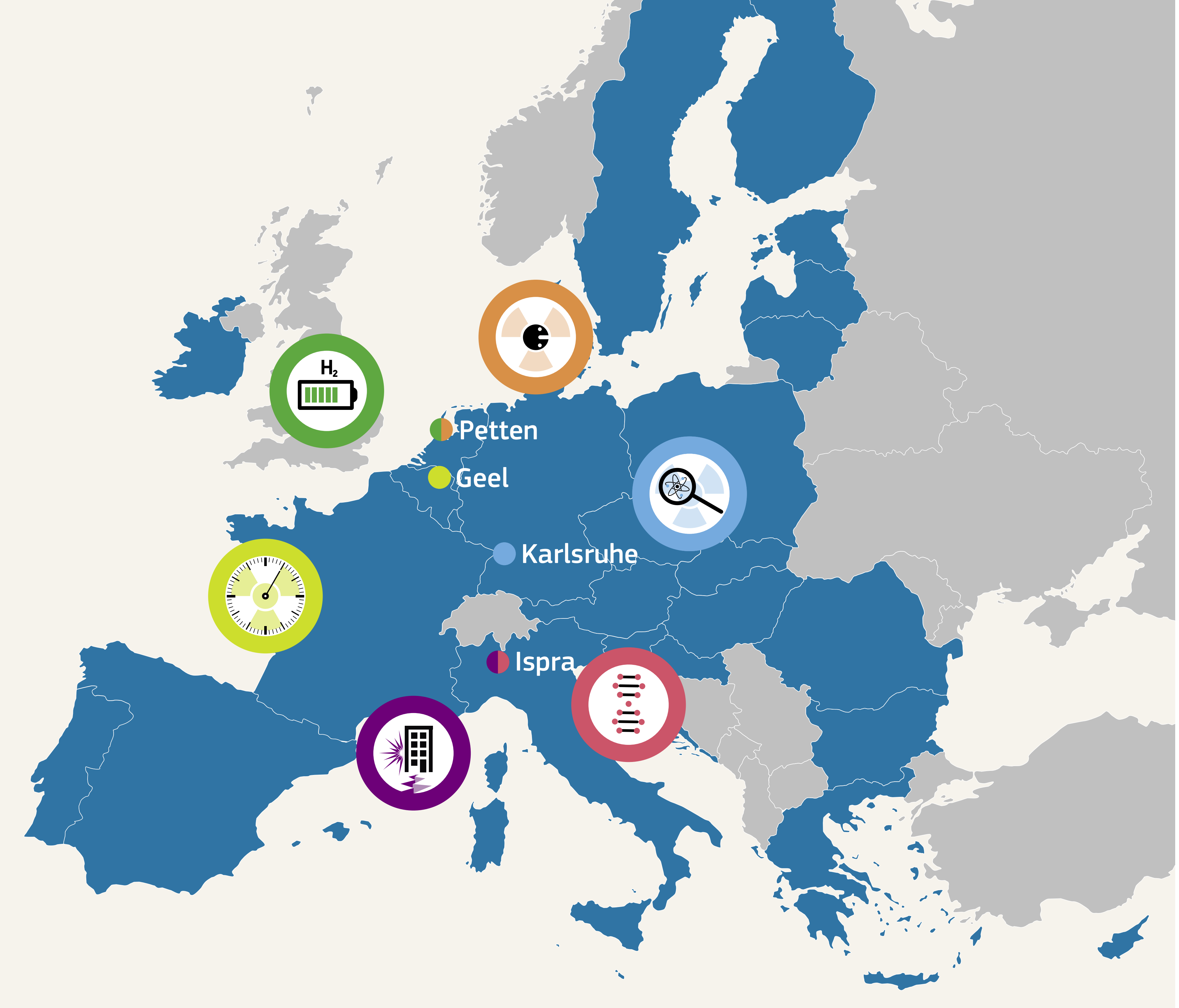
Open access to JRC research infrastructures

The European Commission's Joint Research Centre (JRC) gives leading researchers from across Europe and beyond access to its world-class facilities and laboratories, enabling state-of-the-art experimental research, collaboration and capacity building with a European dimension. It does so through the programme for open access to JRC research infrastructures.

The JRC is the science and knowledge service of the European Commission. The JRC employs scientists to carry out research providing independent scientific advice and support to EU policy, tackling the big challenges our societies are facing today.



The JRC hosts 56 high-value research infrastructures, most of which are unique at European and international level. Of these, 39 can open access to external users in various fields of science: nuclear and radiological; chemistry; biosciences and life sciences; physical sciences and ICT. JRC's research infrastructures are located in Ispra (Italy), Geel (Belgium), Karlsruhe (Germany) and Petten (The Netherlands). These infrastructures (i.e. laboratories) are fit for experimental work generating data for users' analyses.

The main objectives of opening access to JRC research infrastructures are to:

- Establish a fair, clear and transparent procedure for giving access to external users of the JRC's physical research infrastructures;
- Maximise the use to the full potential of JRC physical research infrastructures in collaboration with researchers and industry.

Benefits of accessing JRC research infrastructures

Granting access fulfils scientific needs and provides benefit to the research of external users accessing JRC facilities. These can be summarised as follows:

- Access to JRC research infrastructures based on open calls for competitive access allows European users not traditionally engaged with the JRC to have access through a transparent procedure;
- Research infrastructures attract talent and stimulate innovation and development. Enabling access to JRC research infrastructures enhances competitiveness, through pre- and co-normative research, and contributes to bridging the gap between research to industry, e.g. through the setting up of demonstration projects for product validation;
- Access to JRC research infrastructures contributes to the dissemination of knowledge, improves related methods and skills, provides educa-

tion and training and fosters collaboration at European level;

- Granting access within a structured framework maximises the return on taxpayers' funded investment that the JRC has made on its research infrastructures, making them available to external users in view of the limited resources now existing in Europe.

Modes of access to JRC research infrastructures

The JRC opens its research infrastructures to users from academia and research organisations, industry, small and medium enterprises (SMEs), and more in general to the public and private sector from institutions located in EU Member States[1] and countries associated to the EU Research Programme Horizon 2020 (for nuclear, countries associated to the Euratom Research Programme).

Access is offered in two access modes: relevance-driven and market-driven.

The **relevance-driven mode** is mainly opened to academia and SMEs following a peer review selection of proposals responding to an open call. Users pay the additional costs of access and the generated data is opened for free dissemination after an 18-month embargo period.

Proposals in the relevance-driven access mode are peer-reviewed by a User Selection Committee composed of experts from academia and research institutions at European level. The evaluation is carried out with regard to scientific implementation, collaboration and access to new users, strategic relevance to the JRC and strategic importance for Europe. The procedure for submission and evaluation of proposals is published in https://ec.europa.eu/jrc/en/research-facility/open-access/framework

1 Footnote: The UK shall participate in the Union programmes and activities open to its participation as listed in Protocol I (i.e. Programmes and activities in which the UK participates). Protocol I will be adopted by the Specialised Committee on Participation in Union Programmes, identifying the Union programmes and activities in which the UK shall participate and lay down the duration of participation. The UK will be eligible to participate in 2021 in the open access to JRC research infrastructure programme once its participation in Horizon Europe is included in Protocol I.

Open access to JRC research infrastuctures

The **market-driven mode** is mainly directed to industry. The calls are opened on a continuous basis and proposals are selected by the JRC. Users pay the full costs of access and data are not openly disseminated.

The JRC facilitates access in the relevance-driven mode

The JRC waives the access costs to non-nuclear research infrastructures, under certain conditions, to institutions located in countries eligible for widening actions under the Horizon 2020 specific objective "Spreading Excellence and Widening Participation". Access to nuclear research infrastructure is free of charge.

The JRC also supports the travel and subsistence of users visiting JRC research infrastructures, subject to the availability of funds, personnel and other resources:

- For non-nuclear research infrastructures, to users from institutions located in countries eligible for the widening actions under the Horizon 2020 specific objective "Spreading Excellence and Widening Participation";
- For nuclear research infrastructures, to users from institutions located in Members States and countries associated to the Euratom Research Programme, as part of the pilot action on open access to JRC research infrastructures in the field of nuclear safety.

Training and capacity building at JRC research infrastructures

The JRC provides training and capacity building to researchers and technicians from institutions in Member States and countries associated to the EU Research Programme Horizon 2020. It does so through the opening of calls for proposals internally selected by the JRC.

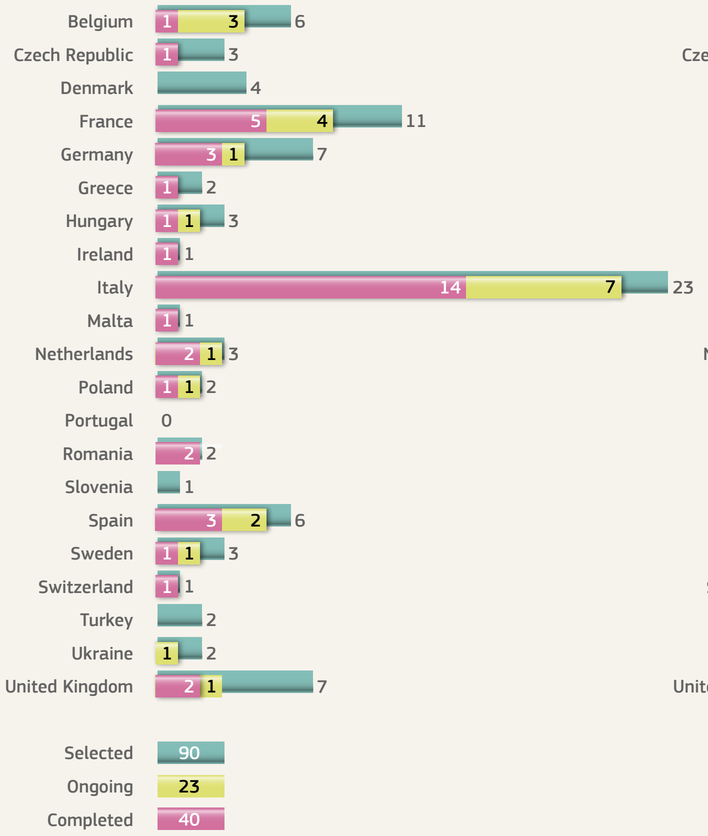
Successful proposals allow users to visit JRC research infrastructures for short periods to be trained by JRC staff on the operation, use and capabilities of its non-nuclear research infrastructures.

The programme enhances the skills of users from institutions operating or planning to build or upgrade research infrastructures similar or complementary to those of the JRC. The programme also creates awareness for potential users to submit proposals to carry out experimental research under the programme for open access to JRC research infrastructures.

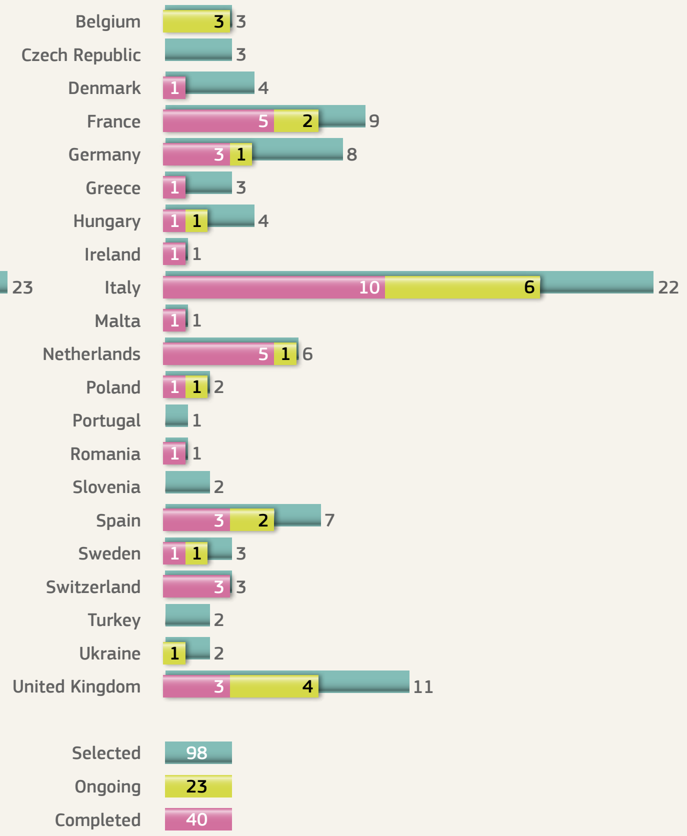
Access for training and capacity building is free of charge and the JRC provides support for travel and subsistence under the same conditions as for the open access programme.

Access to JRC research infrastructures from 2017 until end of 2020

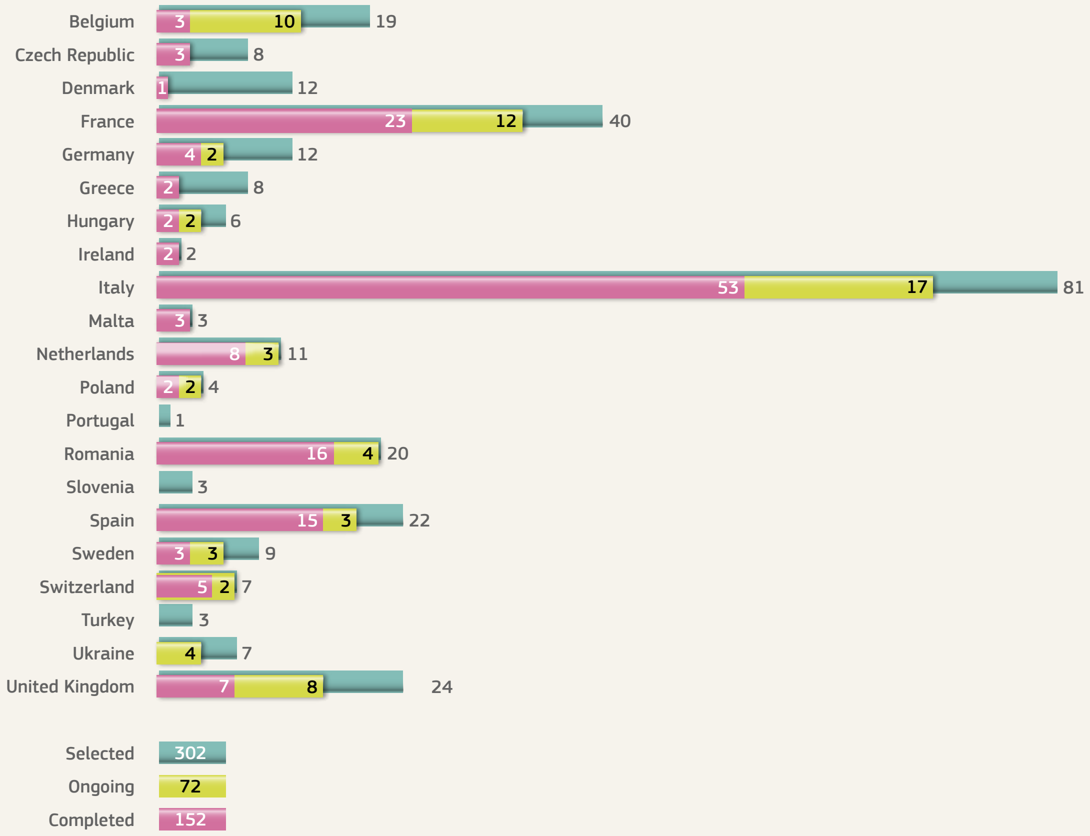
Number of selected, ongoing and completed projects per country



Number of institutions per country



Number of users per country of applicant institutions



Open access to JRC research infrastuctures

Implementing the programme

Since 2017, 17 research infrastructures in the non-nuclear and nuclear fields have opened access to external users at the JRC sites of Ispra, Karlsruhe, Petten and Geel. They are:

Laboratories with expertise in biosciences, life sciences and interdisciplinary sciences (NanoBiotech, Ispra)

- Nanobiotechnology laboratory

European Laboratory for Structural Assessment (ELSA, Ispra)

- Reaction Wall (ELSA-Reaction Wall)
- Hopkinson bar facility (ELSA-HopLab)

Energy storage research infrastructures (Energy Storage, Petten)

- Battery energy storage for safe electric transport (BESTEST)
- Fuel cells and electrolyser testing facilities (FCTEST)
- Gas tank testing facility (GasTef)

European research infrastructure for nuclear reaction, radioactivity, radiation and technology studies in science and applications (EUFRAT, Geel)

- Neutron time-of-flight facility for high resolution neutron measurements (GELINA)
- Underground Laboratory for ultra-low-level gamma-ray spectrometry (HADES)
- Tandem accelerator based fast neutronsource (MONNET)
- Radionuclide metrology laboratories (RADMET)

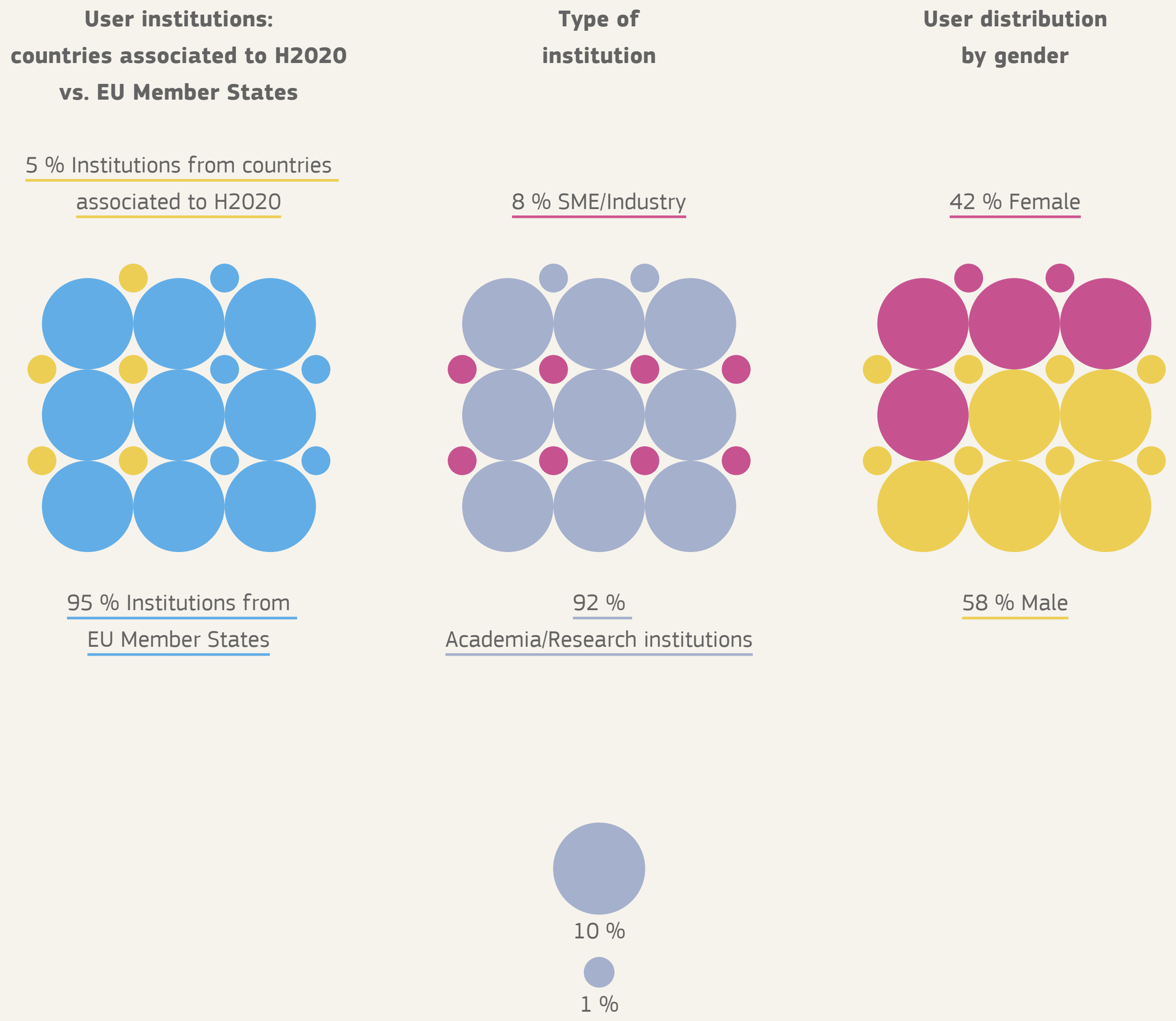
Actinide User Laboratory (ActUsLab, Karlsruhe)

- Properties of actinide materials under extreme conditions (PAMEC)
- Fuels and material research (FMR)
- Hot cell laboratory (HC-KA)

Laboratory for environmental & mechanical materials assessment (EMMA, Petten)

- Assessment of nuclear power plants core internals (AMALIA)
- Liquid Lead Laboratory (LILLA)
- Micro-Characterisation Laboratory (MCL)
- Structural materials performance assessment laboratories (SMPA)

Statistics of the selected projects



To date the JRC has launched 49 calls in the relevance-driven mode and 6 calls in the market-driven mode. Proposals are submitted to the JRC by a consortia of one or more user institutions, each coordinated by a lead user institution. Consortia of selected proposals sign a research infrastructure access agreement with the JRC that regulates the access conditions, rights and obligations between the JRC and the user institutions.

- **104** eligible proposals submitted to the JRC
- **90** selected proposals
- **63** lead users signed agreements with the JRC
- **98** user institutions from the proposals having signed agreements with the JRC
- **224** users from the proposals having signed agreements with the JRC
- **17** countries from the proposals having signed agreements with the JRC
- **40** user access projects that have been completed
- **42** % of female applicants
- **8** % of business participation
- **5** % countries associated with H2020

Training and capacity building

In 2019 the nanobiotechnology laboratory launched its first call under the ‘framework for training and capacity building at JRC research infrastructures’. Seven proposals were selected giving access to 20 users from 7 user institutions from Armenia, Bosnia and Herzegovina, Serbia, Switzerland and Turkey.

A second call from the nanobiotechnology laboratory closed in March 2020, resulting in 9 selected proposals giving access to 29 users from 9 user institutions from Armenia, Bosnia and Herzegovina, Moldova, Serbia, Turkey and Ukraine.

Nanobiotechnology laboratory

The JRC nanobiotechnology laboratory has state-of-the-art facilities for interdisciplinary studies, with a special emphasis on the characterisation of nanomaterials, nanomedicines, advanced materials, and micro(nano)plastics. Our institutional work focuses on developing a science-based understanding of the physico-chemical properties of these materials and their interactions with biological systems.

We have a multidisciplinary team of scientists, including chemists, physicists, biologists, and materials scientists with extensive experience in the fields of physico-chemical characterisation of materials and nanobiosciences.
User institutions can conduct a range of research activities, from experimental proof-of-concept studies to the testing/optimisation of developing technologies. The laboratory is also the pilot facility for the training and capacity building project.

Open access to NanoBiotech: https://youtu.be/HauMN49GAIg

A team from the University of Brescia came to the JRC nanobiotechnology laboratory to characterise SUNSPACE, a new air filtration system that uses industrial waste materials to filter out PM10 and PM 2.5 (particulate matter e.g. dust, car fumes, etc.). Until now, the only sustainable solution for similar air filtration designs is to use vegetation. The team tested the most widely-used air filtration systems against SUNSPACE, finding that SUNSPACE takes longer to become saturated when filtering out air pollution. Thanks to the experiments held at the JRC, the University of Brescia could complete the study on their new and promising air filtration system.

> The two most remarkable aspects of the access to the research infrastructure were, in my opinion, the complementarity of the available techniques and the competences of the researchers/officers. Thanks to this very special combination, the period I spent at the JRC was so fruitful and motivating that I wished I could work more and for a longer period in such a context.

The nanobiotechnology laboratory

Acronym: NanoBiotech

Priority topics

- Nanomaterial characterisation including their interactions with biological systems (culture media, proteins, etc.)
- Detection of nanomaterials and micro(nano)plastics in complex matrices
- Surface chemical analysis of materials, including nanomaterials, surface modification and nano-fabrication
- Characterisation of interactions of nanomaterials/nanomedicines/micro(nano)plastics with biological systems based on in vitro biocompatibility studies
- Biocompatibility studies including cytotoxicity, genotoxicity, immunotoxicity, and uptake studies
- Biomolecular interaction studies, characterisation of antibodies and antigens, bio-interfaces characterisation
- Advanced material characterisation for non-bio-applications (energy, transport, circular economy, environment, etc.)

Virtual tour NanoBiotech: https://visitors-centre.jrc.ec.europa.eu/en/media/virtualtours/take-virtual-tour-nanobiotechnology-laboratory

Nanobiotechnology laboratory

User institutions

- Autonomous University of Madrid
- Basque Research and Technology Alliance - CIDETEC
- British National Physical Laboratory
- Water Research Institute – CNR Palanza
- University of Bologna
- Institute for Genetic and Biomedical Research - CNR Milan
- Institute for Macromolecular Studies – CNR Milan
- Institute of Biophysics – CNR Pisa
- Italian National Institute of Health
- ITENE Packaging, Transport and Logistics Research Center
- Lyon Institute of Nanotechnology - CNRS
- NanGenex - Druggability Technologies
- Polytechnic University of Turin
- University of Nice Sophia Antipolis
- University College Dublin
- University College London
- University of Brescia
- University of Ferrara
- University of Insubria
- University of Kent
- University of Malta
- University of Milan
- University of Milan-Bicocca
- University of Turin
- Utrecht University

Training and capacity building:

- Anadolu University
- Centre of Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy (ICTM)
- Hacettepe University
- Institute of Food Biotechnology and Genomics (NAS)
- Institute of Food Technology in Novi Sad
- Nicolae Testemitanu State University of Medicine and Pharmacy
- Technical University of Moldova
- University of Belgrade
- University of Geneva
- University of Novi Sad
- University of Sarajevo
- Yerevan State University

European Laboratory for Structural Assessment

The European Laboratory for Structural Assessment (ELSA) offers two facilities as part of the programme for open access to JRC research infrastructures:

- the world's largest Hopkinson bar facility (HopLab), which is used to study materials and structural components to very fast dynamic loads, such as those due to blasts and impacts, where knowledge of the material behaviour under high strain-rates is necessary; and
- the ELSA Reaction Wall (Europe's largest), which is used to test the vulnerability of buildings to earthquakes and other threats to structural stability.

ADOBE Finding a safe, strong building solution: https://youtu.be/GypN316FALw

Researchers from the Netherlands came to the JRC to run experiments at the HopLab. They needed this machine to test the resistance of adobe 'mud brick' materials against blasts or explosions. Adobe structures are found all over the world, especially in places involved in military conflicts or prone to natural hazards. With the results of their experiments, the researchers can help give soldiers on peacekeeping missions more information on how well the buildings they are operating in can protect them.

Hopkinson bar facility
Acronym: ELSA HopLab

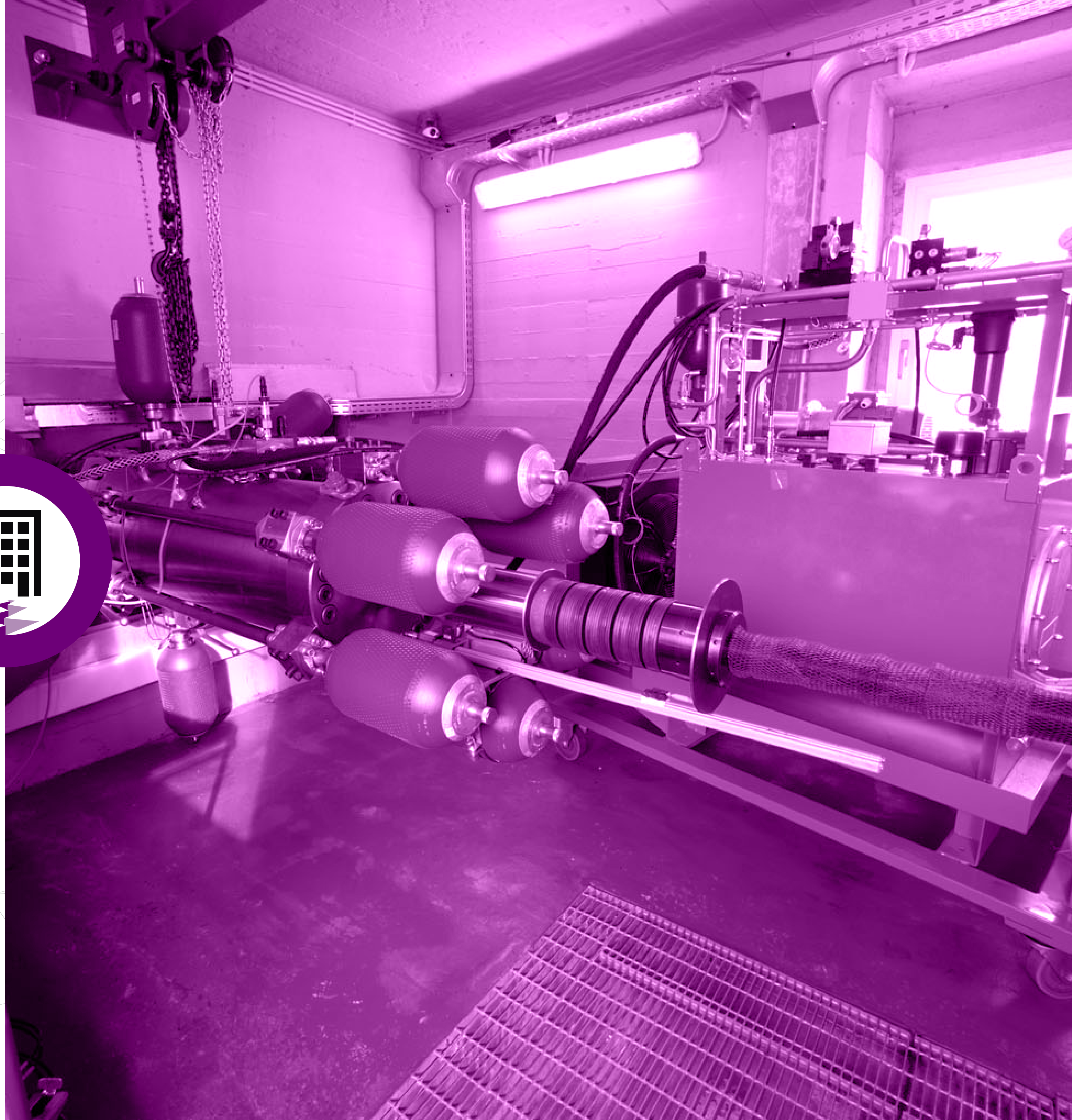
The Hopkinson bar facility is used for the study of materials and structural components to very fast dynamic loads, such as those due to blasts and impacts, where knowledge of the material behaviour under high strain-rates is necessary.
The laboratory has unique features with respect to the magnitude of the applied forces and the large size of the specimens to be tested.

Priority topics

- Security of buildings and protection of public spaces against explosion loads
- Dual-use (defence/security) applications
- Material/structural component testing at high loading-rate conditions (blast, impact) and high/low temperatures

User institutions

- Delft University of Technology
- ENSTA Bretagne
- ETH Zurich
- European Organization for Nuclear Research - CERN
- I-Cube Research
- Imperial College
- Netherlands Defence Academy
- Netherlands Ministry of Defence
- Rolls Royce
- Ruhr-University Bochum
- TNO Defence Safety and Security
- University of Applied Sciences and Arts of Southern Switzerland
- University of Edinburgh
- University of Oxford



Reaction Wall

Acronym: ELSA Reaction Wall

The central feature of the European Laboratory for Structural Assessment is the Reaction Wall. It consists of a reinforced concrete vertical wall and a horizontal floor rigidly connected together to test the vulnerability of buildings to earthquakes and other threats to structural stability.

The unique dimensions and testing capabilities of the Reaction Wall permit bi-directional testing of real size multi-storey buildings and critical elements of even larger structures, such as bridges.

Priority topics

- Safe and green renovation of buildings for the New European Bauhaus
- Design and retrofit for resilience (e.g., modular construction, damage-free structures, influence of non-structural elements, cumulative damage, ageing construction)
- Safety of built infrastructure against multiple hazards
- New materials and technologies (e.g., design for deconstruction, multifunctional building envelopes, structural glass, biodegradable and sustainable materials, advanced manufacturing)

Energy storage research infrastructures

Energy storage has been part of the energy system for decades, but it is with the emergence of new storage technologies and the need to integrate more renewable energy sources into the power system that the sector is faced with new challenges – and opportunities. Research and technological development and innovation are needed to anticipate future trends and to enable the wider application of energy storage technologies. Scientists at the JRC are determined to support these developments to facilitate the transition towards a low-carbon energy system.

The share of renewable energy in the European electricity sector is expected to increase from 27% today to close to 50% in 2030. Large quantities of renewable energy of fluctuating and intermittent nature – like wind and solar power – will need to be produced if Europe is to reach its energy and climate commitments. Energy storage presents one of the solutions to managing the excess energy, making it possible to store electricity during low electricity.

Battery energy storage testing
Acronym: BESTEST

The laboratory is situated at the JRC site of Petten (The Netherlands). It features state-of-the-art equipped facilities for analysing the performance of battery materials and cells. The capabilities include cell preparation, pre- and post-test battery cell tear-down, cell cycling under controlled temperature (in combination with impedance spectroscopy) and post-mortem diagnosis.

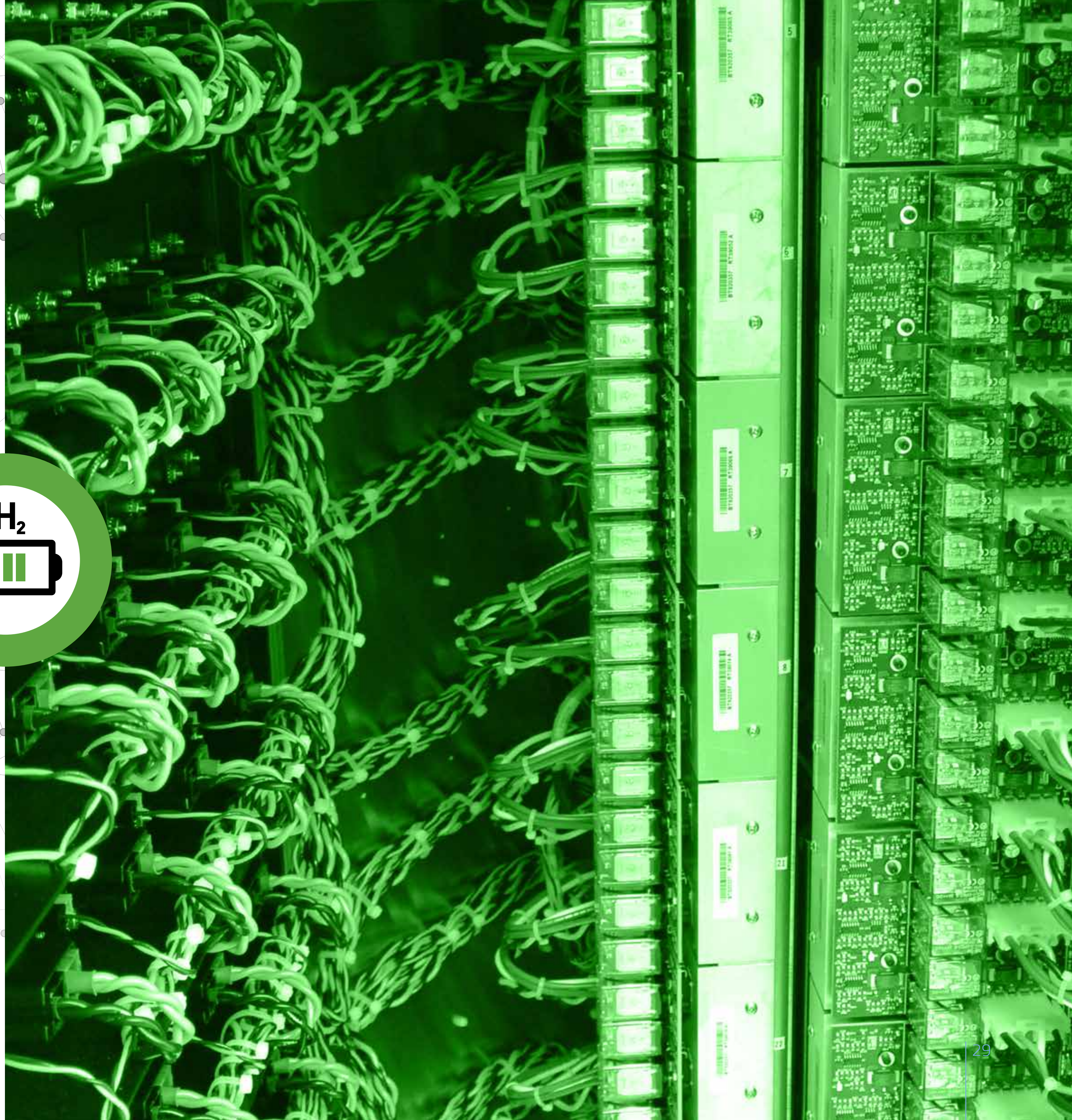
Within the frame of open access, the following facilities may be accessed:

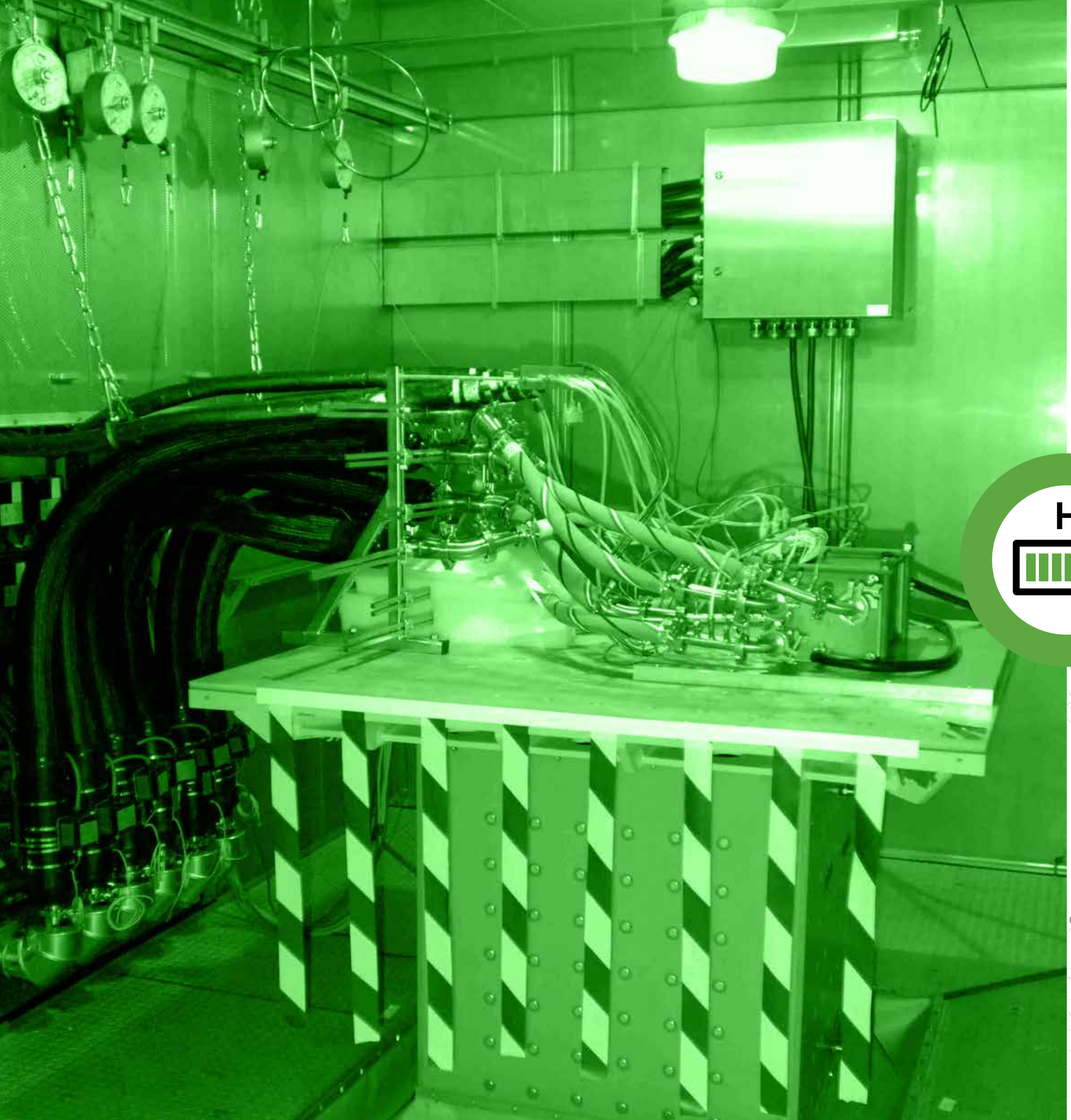
- Temperature (or climate) chambers that allow cell storage and cell cycling under controlled temperature (or controlled temperature and humidity). Battery testers with different specifications and frequency response analysers are available for cell cycling;
- A micro X-ray computed tomography system (including data evaluation) is available for analysis of cells or battery electrodes.

Priority topics

- Performance analysis of cells (in combination with impedance spectroscopy)
- Micro X-ray computed tomography of cells or electrodes

Virtual tour BESTEST: https://visitors-centre.jrc.ec.europa.eu/en/media/virtualtours/take-virtual-tour-battery-testing-facilities-laboratory





Fuel cells and electrolyser testing facilities

Acronym: FCTEST

The fuel cells and electrolyser testing facilities laboratory is situated at the JRC site of Petten. It was established to support developments in regulation, codes and standards through the validation of testing procedures and measurement methodologies for the performance assessment of fuel cells.

It is also used in the fuel cell and hydrogen joint technology initiative for pre-normative research and harmonisation of fuel cell and electrolyser test protocols and testing methodologies and their experimental validation.

The facility allows testing of low and high temperature polymer electrolyte membrane (PEM) fuel cell stacks, components and entire systems for up to 100 kW electrical power in stationary and transport applications. In addition, electrolyser cells and high temperature solid oxide cells and stacks can be tested in fuel cell and electrolyser mode. The facility also has capabilities for testing under simulated environmental conditions including temperature, relative ambient humidity (up to 95 %), and vibrations and shocks.

Priority topics

- Testing of electrolyser and/or fuel cells (single cells, stacks and small systems)
- Environmental testing of system components sub-systems and systems
- Testing of power devices

User institutions

- Fincantieri
- H2Boat S.C.a.r.l.
- Stichting Formula Zero Team Delft
- University of Genoa
- University of Seville

Gas tank testing facility

Acronym: GASTEF

The gas tank testing facility is located at the JRC site of Petten. It is dedicated to perform safety and performance evaluation of full-scale high pressure tanks used to store hydrogen (H2) or natural gas (CH4). GASTEF is designed to:

- conduct "pneumatic cycling performance test" of the type approval regulations for hydrogen and natural gas vehicles (UN Regulation 134-ECE "GTR Nr- 13", EU Regulation 406/2010 and UN Regulation 110); and
- simulate a natural gas or hydrogen refuelling station in its main components (compressor, hydrogen cooler, dispenser, metering devices) and the interaction with high pressure on-board storage, which allows evaluating from a safety point of view the effect of different refuelling conditions on high pressure components.

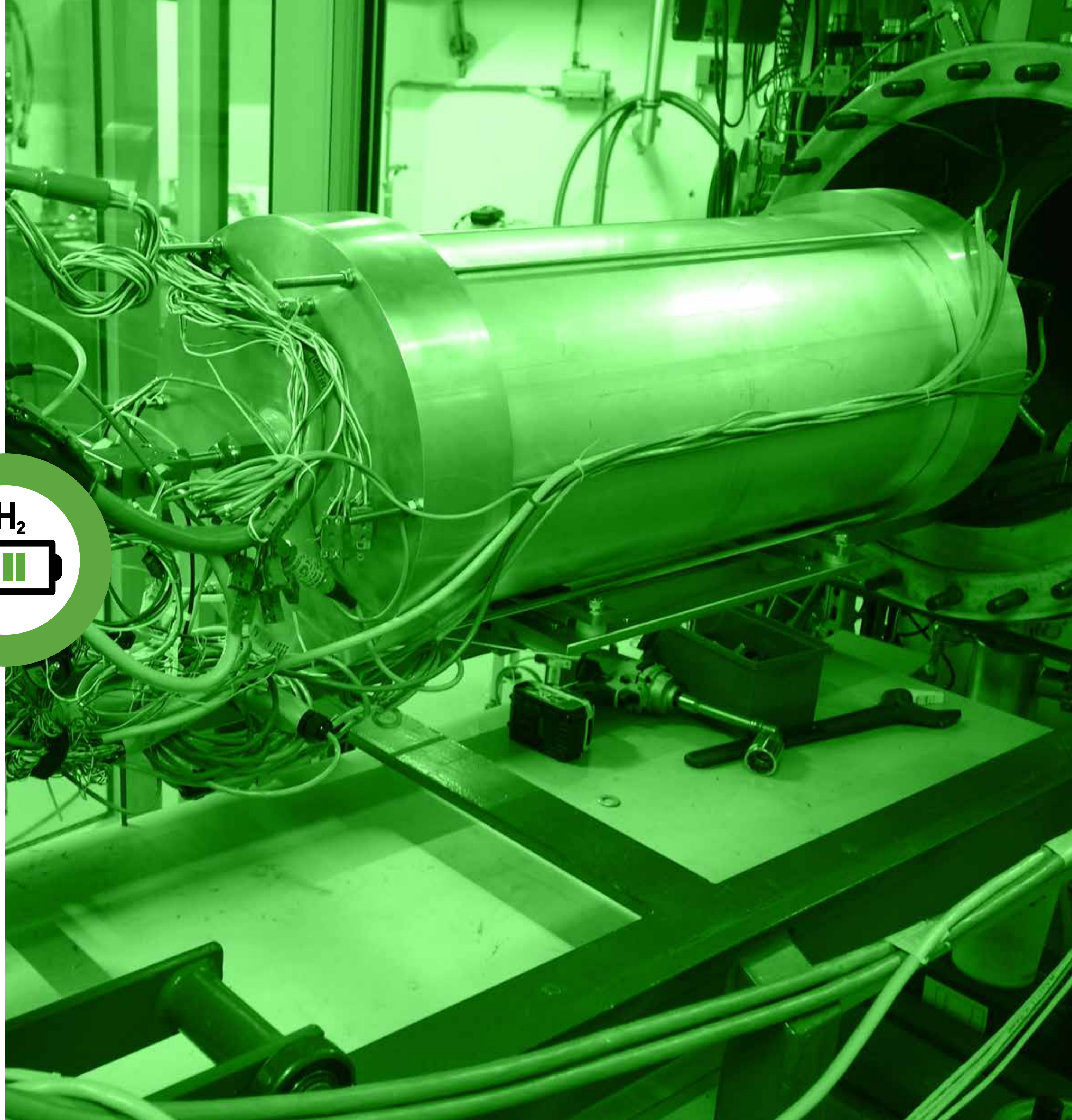
Priority topics

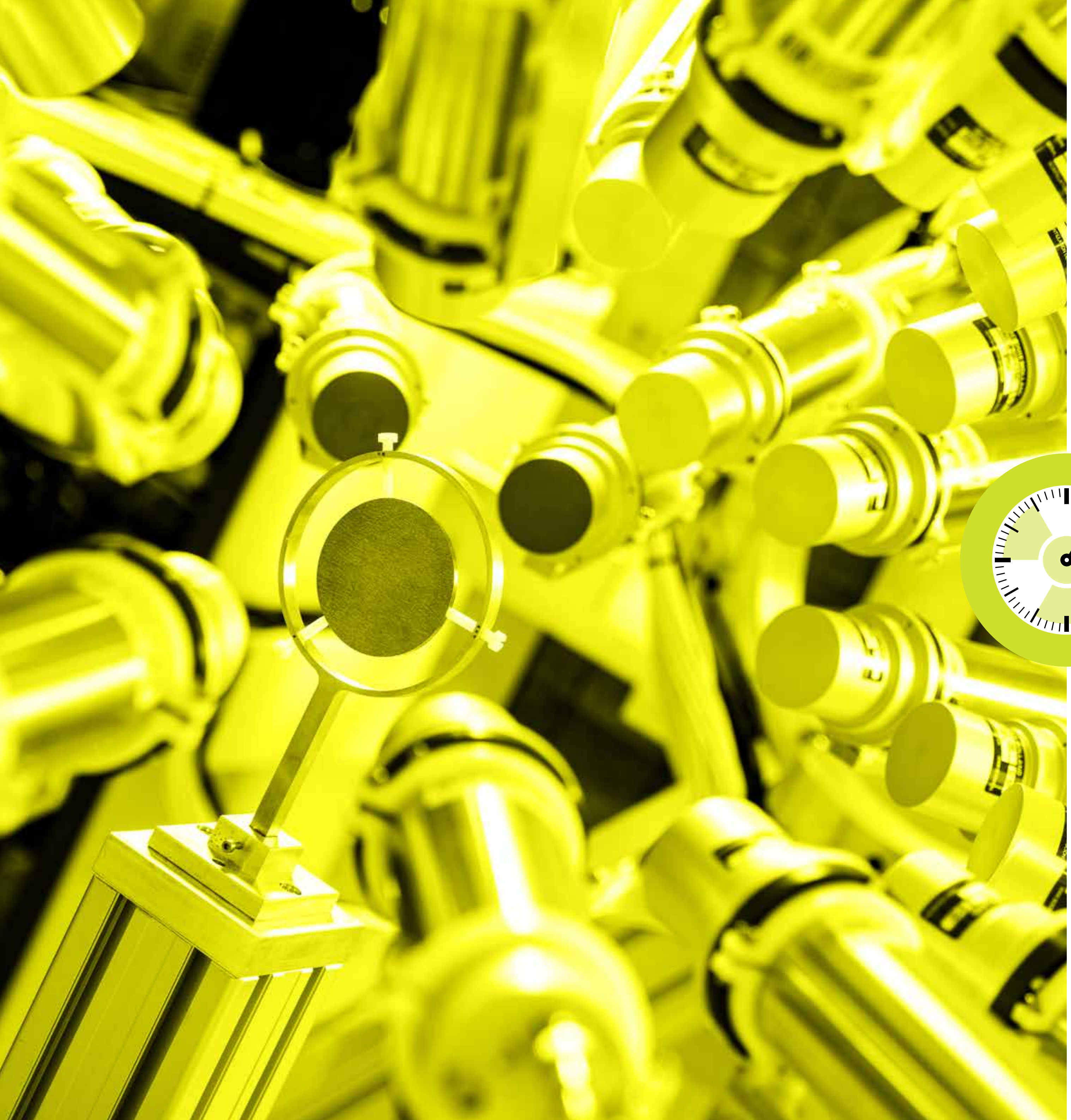
- Safety and performance assessment of new concepts of compressed hydrogen and/or natural gas storage tanks
- Assessment of hydrogen refuelling strategies: optimised fuelling protocols; less demanding pre-cooling needs, consequences of out-of-specification fuelling
- Assessment of tank's material compatibility with e.g. high pressure hydrogen or hydrogen-compressed natural gas mixtures

User institutions

- APRAGAZ
- ULLIT S.A.

Virtual tour GASTEF: https://visitors-centre.jrc.ec.europa.eu/en/media/virtual-tours/take-virtual-tour-gas-testing-laboratory





European research infrastructure for nuclear reaction, radioactivity, radiation and technology studies in science and applications

The JRC offers open access to four nuclear laboratories, which allow studies of neutron-induced reactions, irradiations in well-characterised neutron and gamma fields and accurate measurements of radioactivity for science and technology applications:

- A high-resolution neutron time-of-flight facility (GELINA, Geel)
- An Underground Laboratory for ultra-low level gamma-ray spectrometry (HADES, Geel)
- A tandem-accelerator-based fast-neutron source (MONNET, Geel)
- Radionuclide metrology laboratories (RADMET, Geel)

These EUFRAT laboratories offer unique measurement and training opportunities to both young and experienced nuclear scientists and engineers, as well as to SMEs. So far, more than 100 researchers from EU Member States have participated in experiments from the open access programe, 25% of which were young students.

Neutron Data: https://youtu.be/sI7LnW-Lzyc

A team of scientists from France and Romania used JRC's GELINA facility to study inelastic scattering reactions with high-energy neutrons, which play an important role in fast nuclear reactor systems. Results from these experiments are essential for the successful development of this new generation of reactors. These advanced nuclear systems have the potential to drastically increase the efficiency of nuclear energy production and significantly reduce the level of nuclear waste produced. Researchers from the Belgian nuclear research centre SCK CEN testify that new results at GELINA are helping them to develop new technologies for future reactors, the transmutation of nuclear waste and the production of radioactive isotopes for medical applications.

High-resolution neutron time-of-flight facility
Acronym: GELINA

GELINA is a strong, pulsed neutron source, producing neutrons over a broad energy spectrum. The neutron source is driven by a 150 MeV electron linear accelerator. The excellent timing characteristics of the facility and an array of flight paths up to 400 m long, allow high-resolution neutron time-of-flight measurements. As many as 10 experiments with neutron beams can be carried out simultaneously.

GELINA also allows using the high-intensity neutron and gamma radiation fields close to the neutron source. Direct irradiations with the electron beam are another possibility.

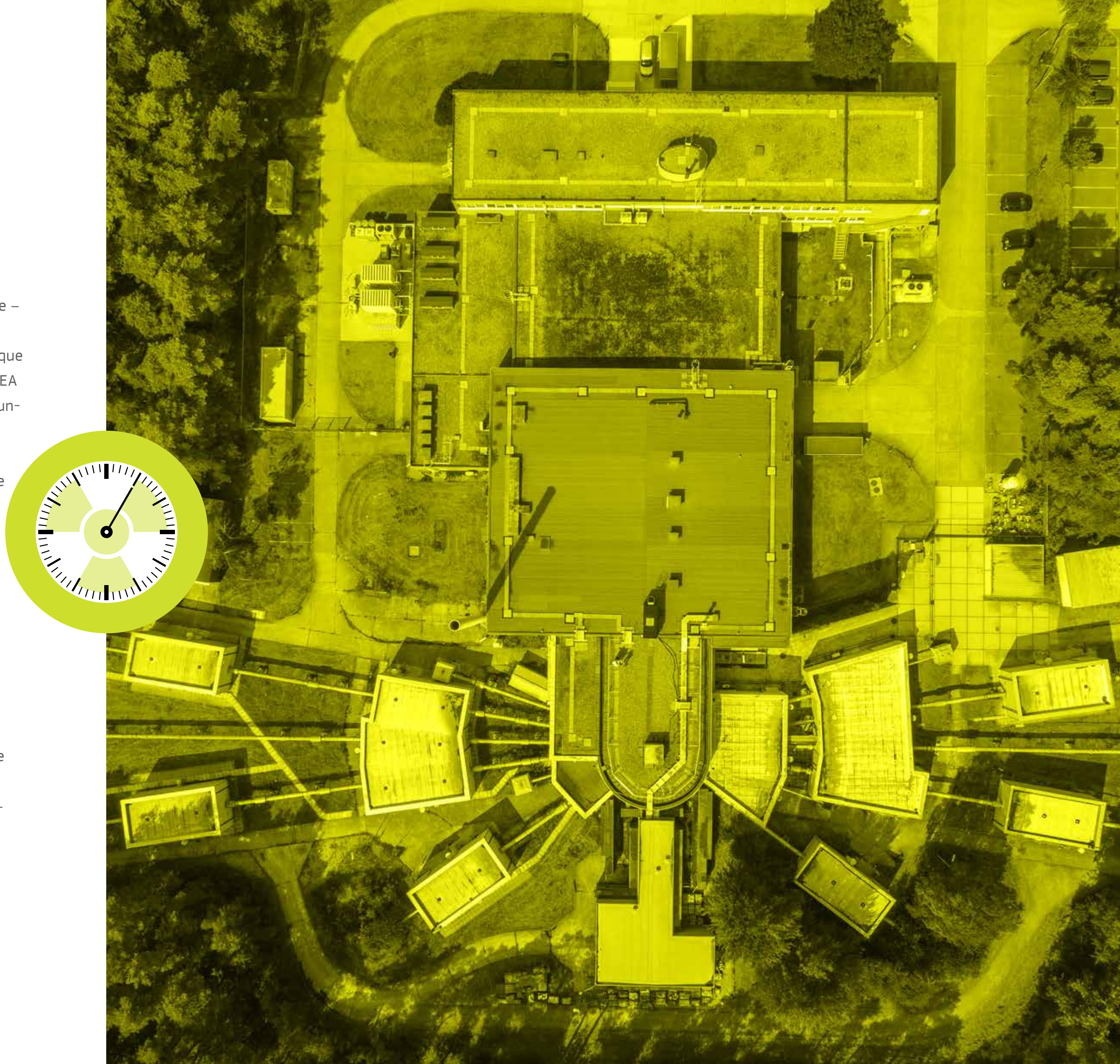
Priority topics

- Neutron cross-section measurements for safety assessments of present-day and innovative nuclear energy systems
- Measurements of nuclear data standards
- Integral experiments for the validation of nuclear data libraries and testing of nuclear transport codes
- Investigations for a better understanding of the nuclear fission process
- Development of advanced detection methods and scientific concepts in nuclear technology
- Basic physics: nuclear reaction theory, nuclear astrophysics
- Characterisation of materials and objects by neutron resonance analysis
- High-intensity neutron and gamma-ray fields for radiation hardness testing and single event upset (SEU) studies
- Cross-section measurements and feasibility studies for medical radionuclide production

> “The most remarkable aspect of the programme is the straightforward way to access the infrastructure and the willingness of the local scientific personnel in helping with the experiment.”

User institutions

- Belgian Nuclear Research Centre – SCK CEN
- Commissariat à l’Energie Atomique et aux Energies Alternatives - CEA
- Centre for Energy Research – Hungarian Academy of Sciences
- National Agency for New Technologies, Energy and Systainable Economic Development - ENEA
- European Organisation for Nuclear Research - CERN
- German National Metrology Institute - PTB
- Helmholtz Zentrum Dresden-Rossendorf
- Horia Hulubei National Institute
- National Institute for Nuclear Physics - INFN
- Institut de Radioprotection et de Sûreté Nucléaire - IRSN
- Orsay Nuclear Physics Insitute – IN2P3



Underground Laboratory for ultra-low level gamma-ray spectrometry
Acronym: HADES

The JRC operates a laboratory for ultralow-level radioactivity measurements inside the 225 m deep underground laboratory HADES, which is located at the premises of the Belgian Nuclear Research Centre. In HADES, the muon flux (secondary cosmic rays) is a factor of 5000 lower compared to above ground, and the flux of protons, neutrons and electrons are reduced to an insignificant level. This reduction of the cosmic ray flux makes the background in gamma-ray spectrometry measurements significantly lower compared to above ground. Therefore, it is possible to detect very low amounts of radioactivity (sub mBq range). Eleven specially designed high purity germanium detectors are used for the measurements. There is also a scanning station by which the homogeneity of deadlayers in HPGe-detectors can be studied.

Examples of topics

Ultra low-level gamma-ray spectrometry for:

- Characterisation of reference materials for their radioactive content: e.g. materials used for environmental monitoring; food control; radioactive waste management; earth sciences; archaeology; biology; dating; electronics; radioecology;
- Tracing processes in nature like ocean currents (input to climate change modelling) and uptake in the food chain;
- Radioecological studies;
- Basic physics experiments in astrophysics and neutrino physics (e.g. search for neutrinoless double beta decay and other rare processes);
- Characterisation of HPGe-detectors for deadlayer homogeneity.

Report with case-stories from HADES: https://ec.europa.eu/jrc/en/publication/jrc-serving-policy-science-hades-underground-research-facility-case-book

User institutions

- Canfranc Underground Laboratory
- Institute of Nuclear Physics - Polish Academy of Sciences
- National Centre for Nuclear Research RC POLATOM
- Swedish Radiation Safety Authority
- Technical University Dresden
- Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

HADES: https://europa.eu/!WX48NU

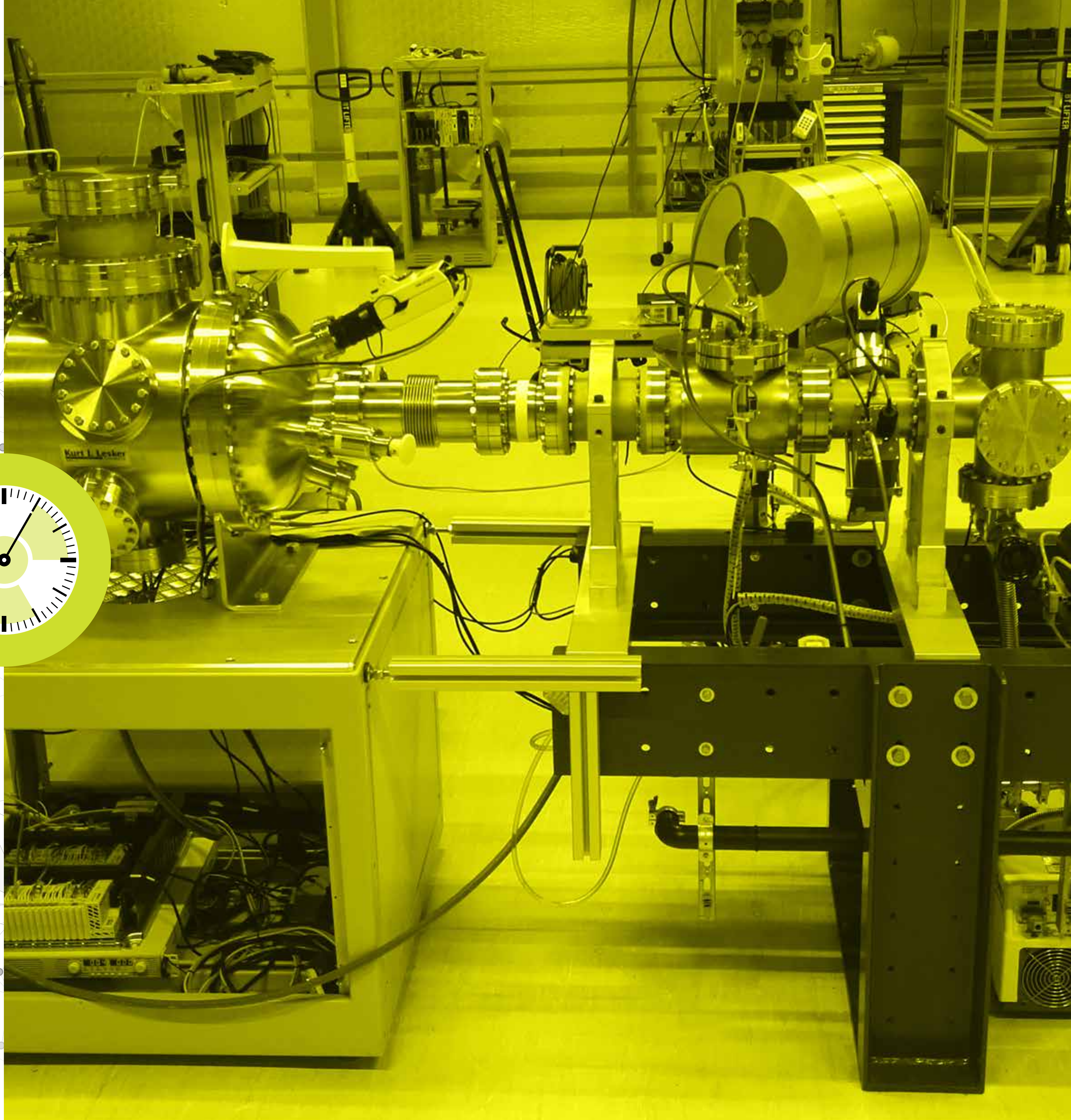
JRC operates a laboratory for ultralow-level radioactivity measurements inside the 225 m deep underground laboratory HADES, which is operated by EURIDICE and located at the premises of the Belgian Nuclear Research Centre.

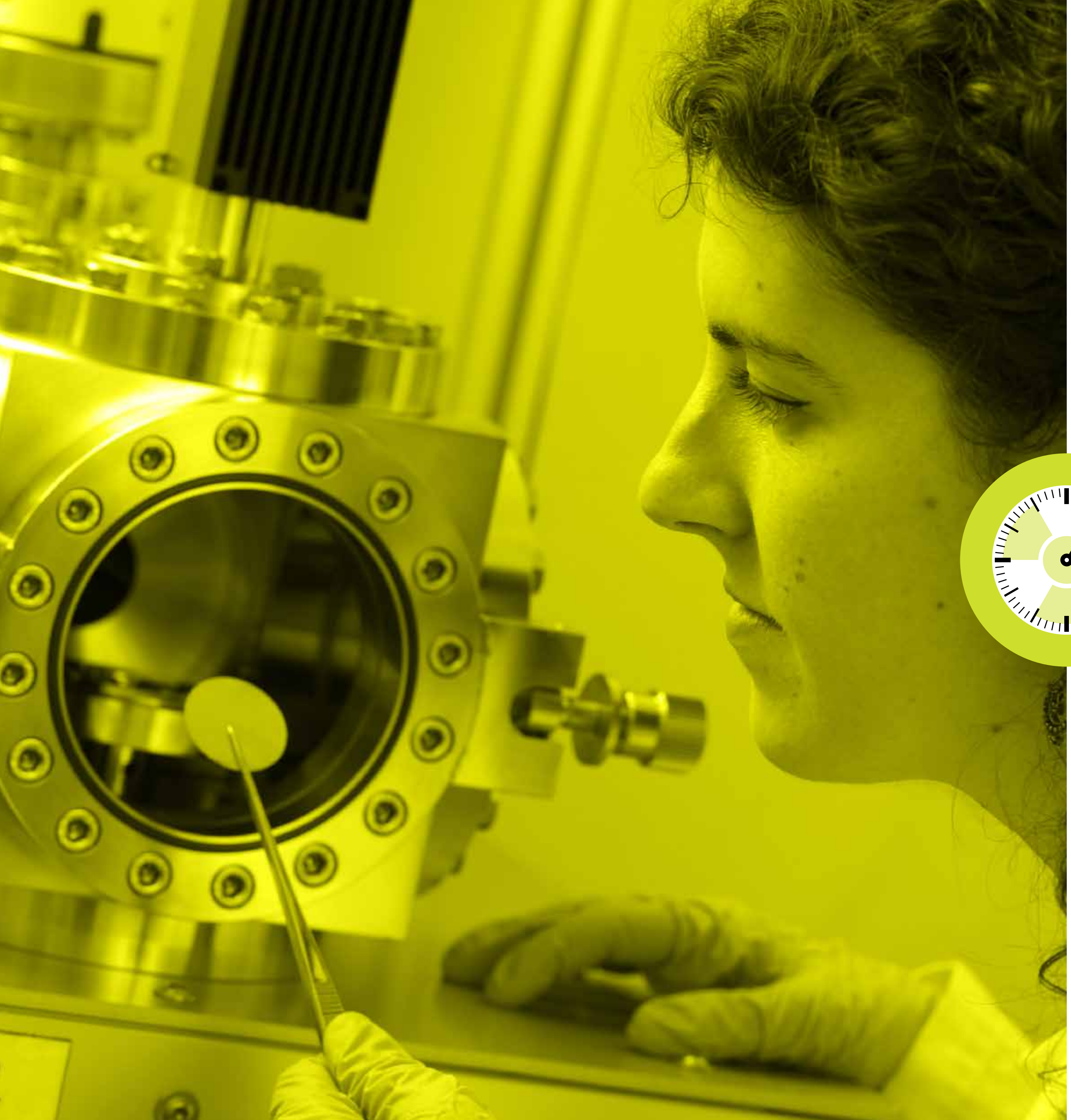
Tandem-accelerator-based-fast-neutron source
Acronym: MONNET

MONNET is a high-intensity fast neutron source, driven by a vertical 3.5 MV Tandem accelerator producing either continuous or pulsed beams of protons, deuterons or helium ions. Quasi mono-energetic neutrons are generated in the energy region 0 - 24 MeV by using lithium, deuterium or tritium targets. MONNET may also be used as a photon source or for studies requiring proton, deuteron or alpha beams without the emphasis on neutron production.

Priority topics

- Neutron cross-section measurements for safety assessments of present-day and innovative nuclear energy systems
- Measurements of nuclear data standards
- Investigations for a better understanding of the nuclear fission process
- Materials research and radiation-induced damage studies
- Advanced methods in nuclear technologies, safety and security
- Development of advanced detection methods and scientific concepts in nuclear technology
- Dosimetry
- Basic physics





Radionuclide metrology laboratories

Acronym: RADMET

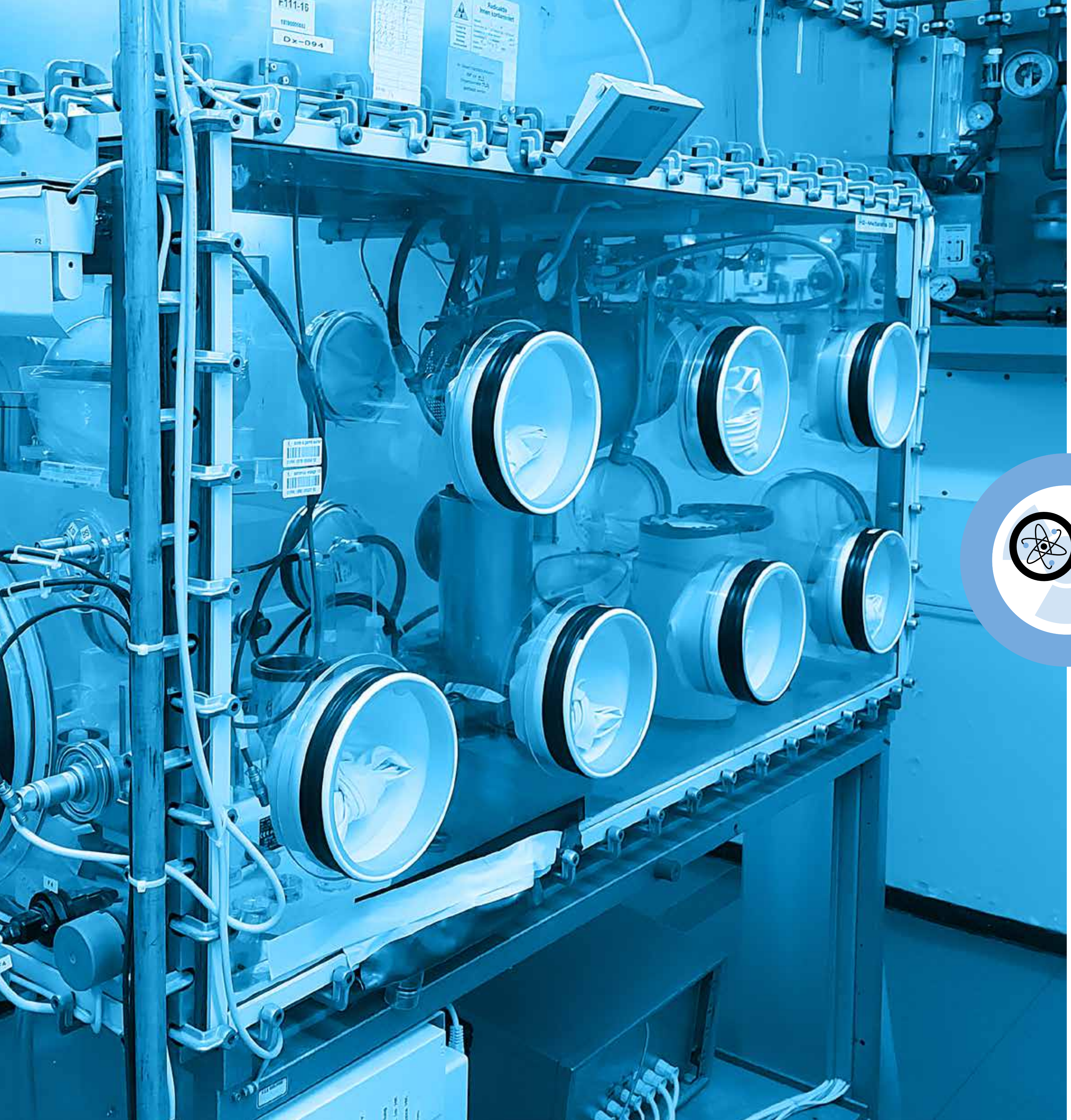
The Radionuclide metrology laboratories are equipped with a broad set of instruments used for nuclear decay measurements, determination of related nuclear data and radiological characterisation of samples and materials. The set-ups, many of them unique in their kind, are used to perform high accuracy measurements of radionuclides in diverse samples ranging from reference materials for environmental monitoring to solutions for primary standardisation of activity. RADMET is among the few laboratories worldwide to provide reference data to the international reference system (SIR) on the most relevant radionuclides. This enables international equivalence and traceability to the SI. In connection to these measurements the lab is well equipped for preparing sources dedicated to specific measurements.

Priority topics

- Primary standardisation of radioactivity (the most accurate type of measurements) independent of any other radioactivity standard
- Radiological characterisation of materials and samples (i.e. determination of radionuclides and their activity), e.g. reference materials
- Decay data measurements that are essential for calibrations in routine laboratories, applications in nuclear medicine and many other scientific uses of radionuclides
- Testing of radiological instruments and methods and standards
- Measurements in support of important policy domains like radioactive waste management, decommissioning of nuclear facilities, metal scrap industry, NORM industry and early warning monitoring networks
- Development and testing of procedures and instruments for nuclear security and detecting illicit trafficking of nuclear materials

User institutions

- National Centre For Scientific Research – Demokritos
- University of Hasselt



Actinide User Laboratory

> "We appreciated the competences and expertise present in the ActUsLab, combined with up-to-date analytical instruments to provide an all-round characterization of the materials produced in the available facilities."

Only a few facilities are available worldwide where actinide materials can be safely investigated. Among these, a prominent position is occupied by the Actinide User Laboratory (ActUsLab) operated by the JRC in Karlsruhe. Actinides are heavy elements at the end of the periodic table. They are the backbone of nuclear fission technologies for electricity supply, with important applications in other strategic fields, from water management to space exploration and human health.

Actinides exhibit very peculiar, diverse and complex chemical and physical properties, they can in particular display multiple allotropes (different structural forms), remarkable orders (magnetic, multipolar, hidden, topological...), unconventional super-conductivity and many other phenomena at the forefront of current scientific knowledge. Besides fundamental science interests, achieving a deep understanding of actinides is vital to ensuring a safe deployment of civil nuclear technologies.

Uranium-Graphene, improved irradiation targets for isotopes production: https://doi.org/10.1038/s41598-018-26572-5

Scientists from the University of Padova and the Legnaro National Laboratories of INFN (Italy) are using the JRC Karlsruhe facilities PAMEC and FMR to develop novel and more efficient irradiation targets for radio-isotopes production at accelerator centres. For the first time, graphene, was used to produce uranium carbide targets. Extensive characterization studies showed that using graphene as starting material affects the target properties in terms of composition, grain size, porosity, thermal diffusivity, and thermal conductivity. A remarkable result is that the thermal conductivity increases substantially. This, in turn, will result in a higher production yield of radio-isotopes of interest for nuclear medicine applications and for fundamental studies in nuclear physics.

Properties of actinide materials under extreme conditions
Acronym: PAMEC

The laboratory consists of an ensemble of state-of-the-art installations designed for preparation and studies of actinide materials.

The facility includes devices for measurements of crystallographic, magnetic, electrical transport, and thermodynamic properties as well as facilities for Np-237 Mössbauer spectroscopy, and a modular surface science spectroscopy station allowing photoemission, atomic force microscopy, and electron scattering measurements.

Several physical properties can be measured under extreme conditions of temperature, pressure, external magnetic field and chemical environment to ensure safety of current and future nuclear civil applications. This allows exploring actinide materials in multiple dimensions with the ambitious aim of building theoretical models that not only account for measured properties but would also predict properties of the material and related materials in any external conditions.

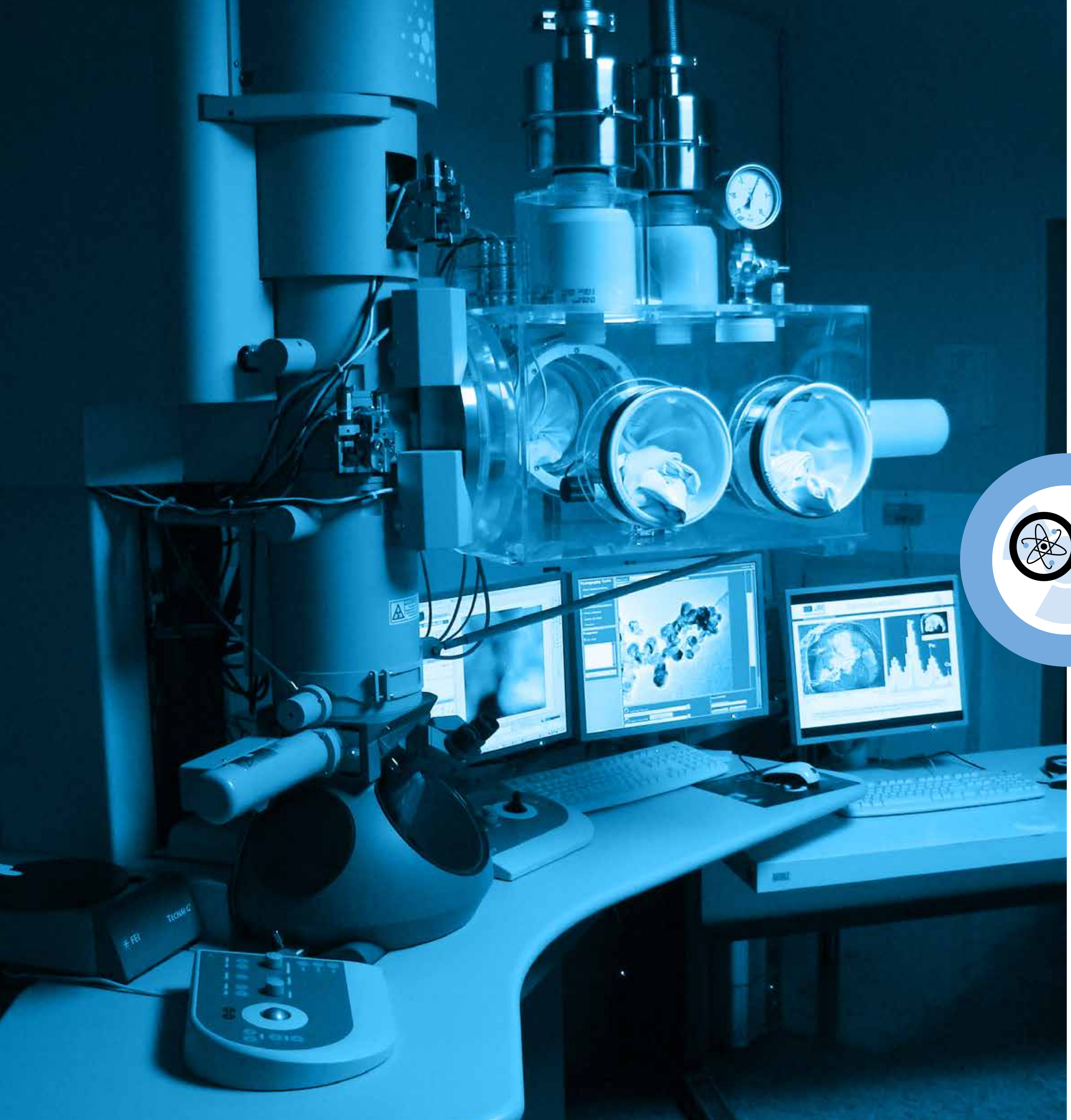
Priority topics

- Preparation of actinide compounds in various forms (thin film, bulk polycrystal, single crystal) and small quantities, suitable for physical measurements
- Characterisation of actinide materials by X-ray diffraction
- Measurements of their physical properties by a large array of microscopic and macroscopic techniques under extreme conditions of temperature, magnetic field and pressure
- Preparation of samples for external measurements in large facilities (synchrotrons, neutron sources, accelerators)
- Fundamental research on materials and methods related to nuclear safety
- Novel technologies for the production and use of radio-labelled compounds in nuclear medicine for the benefit of cancer patients in Europe and worldwide
- Corrosion studies of fuel samples in the frame of nuclear fuel safety or waste management (thin films preparation as model of fuel surface and interaction study with controlled atmosphere)

> “Unique experimental station for sputter deposition and spectroscopy of actinide systems. The local staff, both scientific and technical, is of very high standard”

User institutions

- Charles University
- Forschungszentrum Jülich
- INFN Legnaro
- University of Copenhagen
- University of Ferrara
- University of Padova



Fuels and material research
Acronym: FMR

The FMR laboratories provide the scientific basis for the objective assessment and modelling of the safety-related behaviour of nuclear materials, with emphasis on nuclear fuels under normal and abnormal operating conditions, serving European and international authorities as well as academic and research organisations. The main activities of the FMR laboratories involve the synthesis and characterisation of actinide-bearing materials (including plutonium and minor actinides). Standard and advanced methods are employed, such as sol-gel precipitation, powder blending and pressing, conventional and spark plasma sintering, encapsulation techniques, x-ray diffraction, vibrational spectroscopy (Raman and infrared), electron microscopy (scanning, transmission, and focused ion beam), drop and differential scanning calorimetry, Knudsen effusion mass spectrometry, dilatometry, indentation, laser heating/laser flash for the measurement of thermophysical properties including melting.

Priority topics

- Synthesis and characterisation of actinide-bearing materials relevant for the assessment of nuclear safety standards (oxides, ceramics, etc...)
- Safety characterisation of new forms of nuclear fuels, including molten salts
- Laboratory simulation of nuclear power plant severe accident conditions
- Advanced methods for the synthesis of nuclear material assemblies, for Generation IV nuclear power plants, including transmutation targets, or for space applications
- Exploratory research for the development of new scientific concepts, testing of new equipment or materials

User institutions

- Institut de Chimie Séparative de Marcoule - CEA Marcoule
- University of Hasselt

> “It’s a nice working environment with a lot of technical equipment and experienced workers.”

Hot cell laboratory

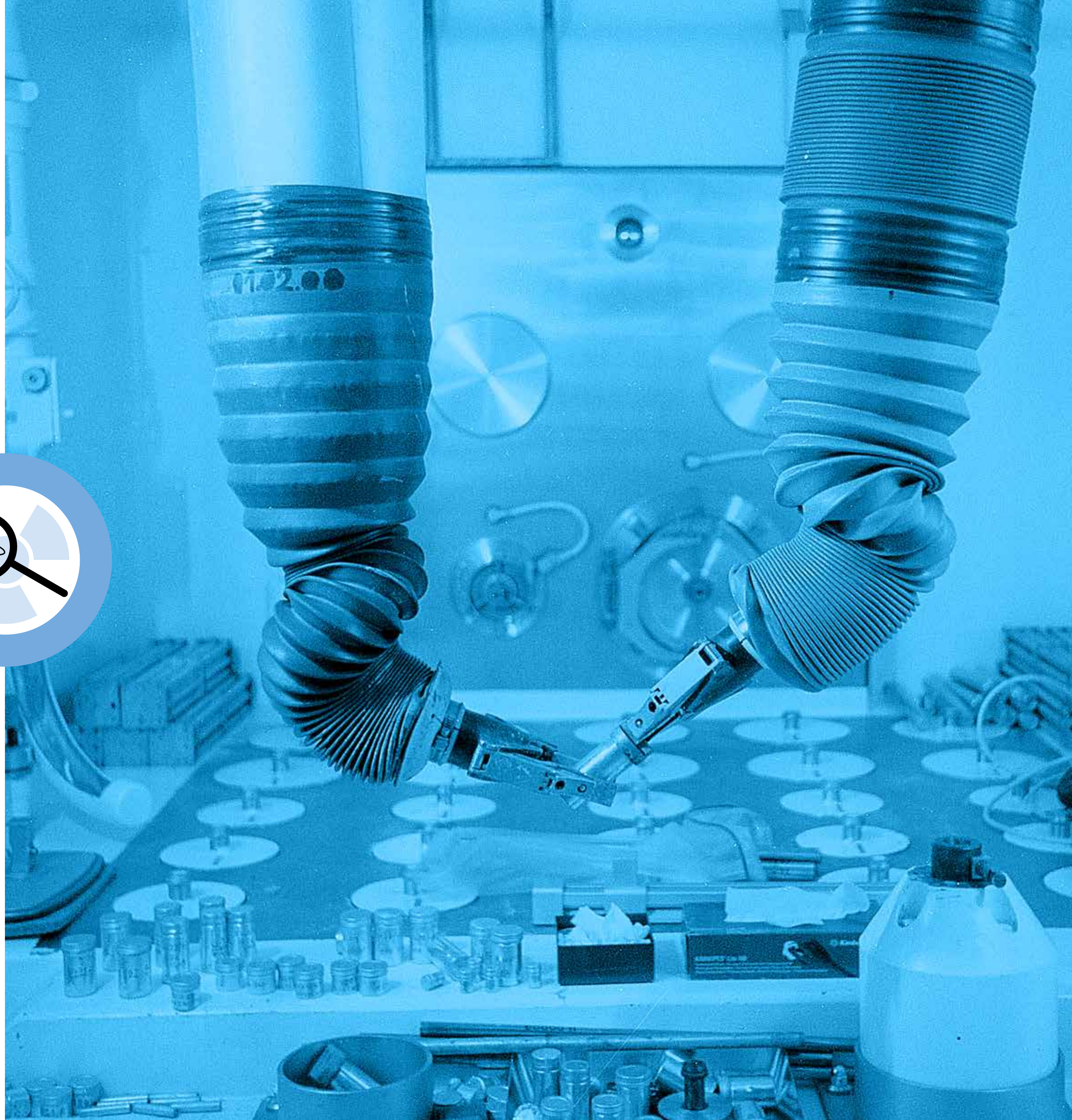
Acronym: HC-KA

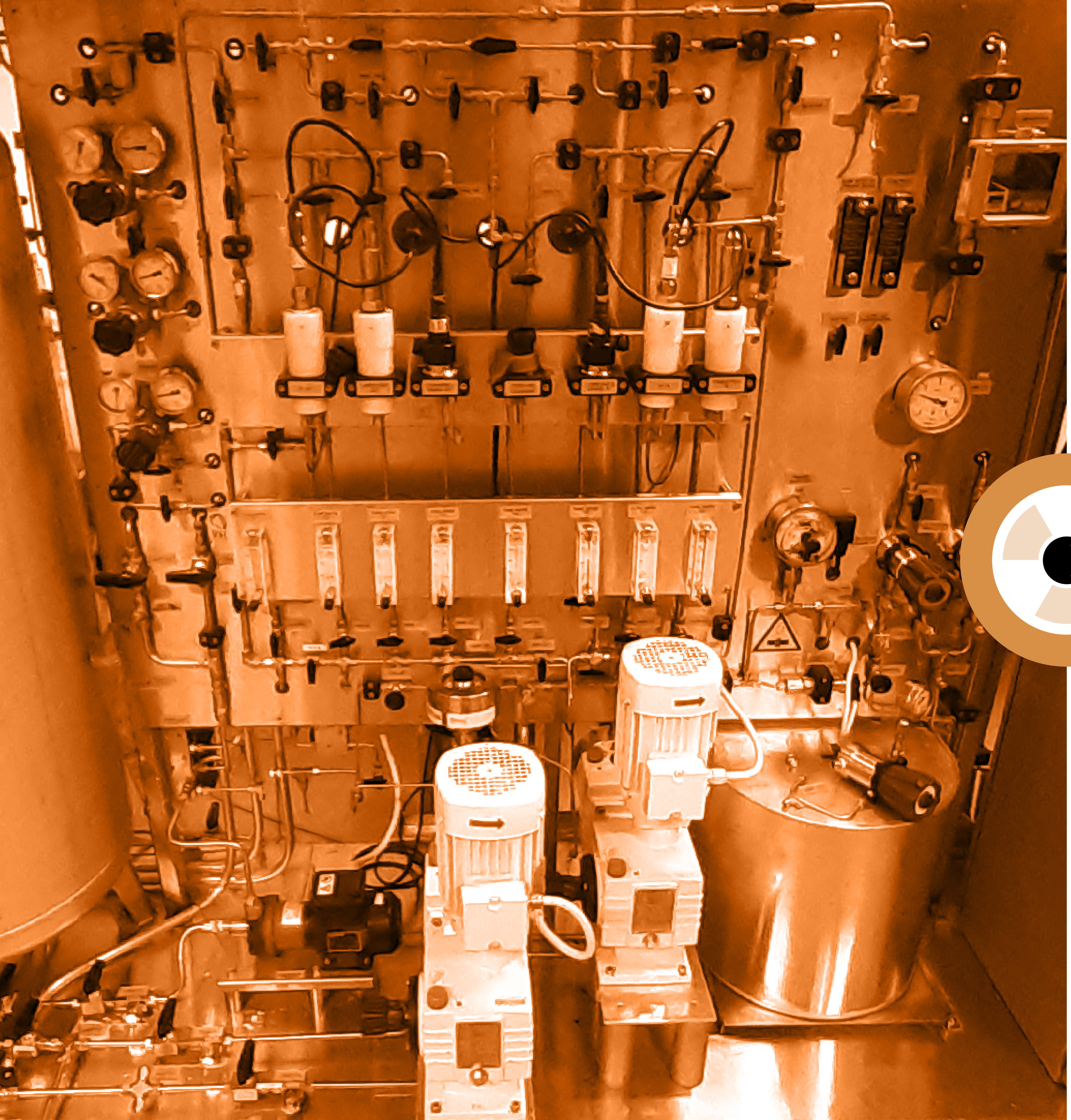
The Hot cell laboratory in Karlsruhe is a unique facility in Europe and an ensemble of state-of-the-art installations designed for research on analyses and behaviour of nuclear spent fuel and radioactive waste. It consists of 24 shielded hot cells where highly radioactive materials can be received, handled, examined and returned to their owners.

The team that manages the Hot cell laboratory conducts R&I activities jointly with the Member States in the field of nuclear safety of spent fuel, radioactive waste and decommissioning. It supports the Member States with frontier infrastructure and scientific-technical expertise, contributing to the implementation of safe, cost effective solutions leading to green field sites, encompassing innovative recycling and robust long-term storage of waste, and providing knowledge transfer to present and future generations.

Priority topics

- Applied research on materials and methods related to the spent fuel nuclear safety
- Spent fuel long term mechanistic release process of interest for geological disposal
- R&I activities for the characterisation of radioactive waste including new waste forms
- R&D on the stability and safe conditioning of damaged fuel (“corium”)





Laboratory for environmental & mechanical materials assessment

To ensure safe operations, it is crucial that nuclear reactor components like reactor vessels, heat exchangers, pipes and fuel claddings are able to function reliably for very long time during operation of a nuclear reactor. Material testing is central to demonstrate safety and is by necessity generally based on accelerated tests with higher loads, temperatures or more aggressive environments than encountered during operation of the reactor, while at the same time using also small material samples.

The JRC's environmental and mechanical materials assessment (EMMA) facilities in Petten, the Netherlands, support the development of European and International codes & standards for components and materials used in current and next-generation nuclear reactors.

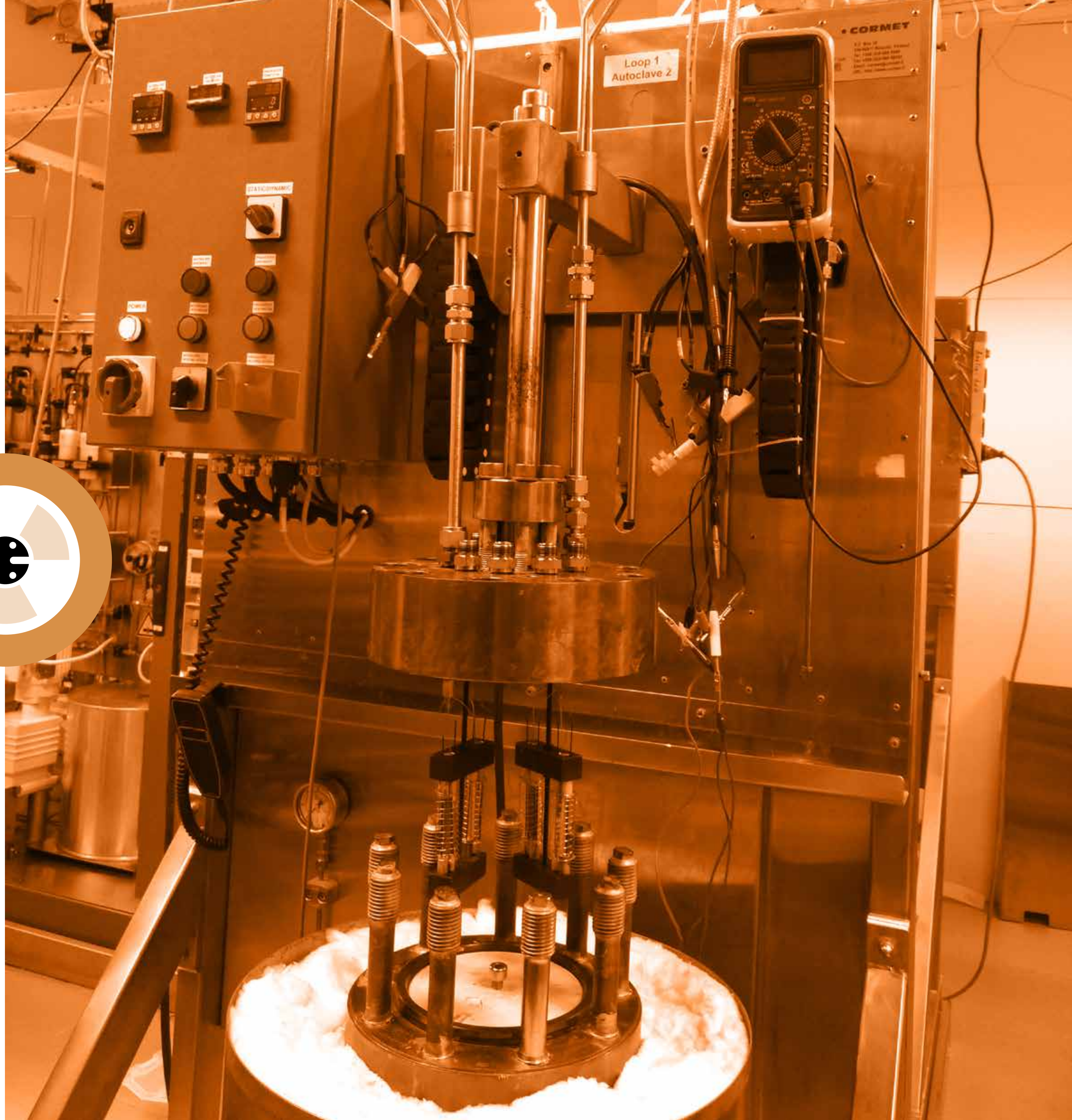
The EMMA facilities focus on material testing at high temperatures and in corrosive environments using test samples from the micro to the macro-scale. Most of the research is linked to international and European projects involving national research laboratories, academia as well as industry. The development of a European standard for the miniature test, "EN 10371 metallic materials — small punch test method", led by EMMA scientists, is an example of a recent achievement. The open access to the EMMA facilities started in 2020.

Assessment of nuclear power plants core internals
Acronym: AMALIA

AMALIA consists of five water loops providing and analysing water for AMALIA autoclave test facilities. The water loops include state-of-the-art water chemistry sensors such as conductivity, pH, dissolved oxygen and hydrogen sensors. Furthermore, it provides a low and high pressure pump including back-pressure regulators and pulsation dampeners to provide water circulation and needed water pressure for test facilities.

Priority topics

- Safety and reliability of nuclear components for current and future nuclear systems
- Support to the development and adaptation of European codes and standards
- Development of advanced test methods for material characterization
- Characterisation of mechanical properties of candidate and new corrosion-resistant high-temperature materials, including surface modifications and welded joints
- Prediction of design life of new materials, remaining life of service-exposed materials including welded joints subjected to operational conditions by mechanical tests, modelling and microstructural analysis
- Characterisation of tensile and creep properties using standard and sub-size specimen and small punch tests
- Characterisation of ageing effects for key material properties



Liquid Lead Laboratory

Acronym: LILLA

Liquid Lead Laboratory is specially designed for mechanical tests of materials in liquid lead with controlled dissolved oxygen concentrations for temperatures up to 650°C.

It gives the possibility to study liquid metal embrittlement phenomena / environmentally assisted cracking, and the effect of stress, temperature and oxygen content in lead on corrosion mechanisms, as well as to test lead chemistry instrumentation.

Supporting 3D profilometry, microstructural analysis (light optical microscope, scanning electron microscope with energy dispersive X-ray spectrometry, and Vickers micro hardness (0.1 kg – 20 kg) are also offered.

Priority topics

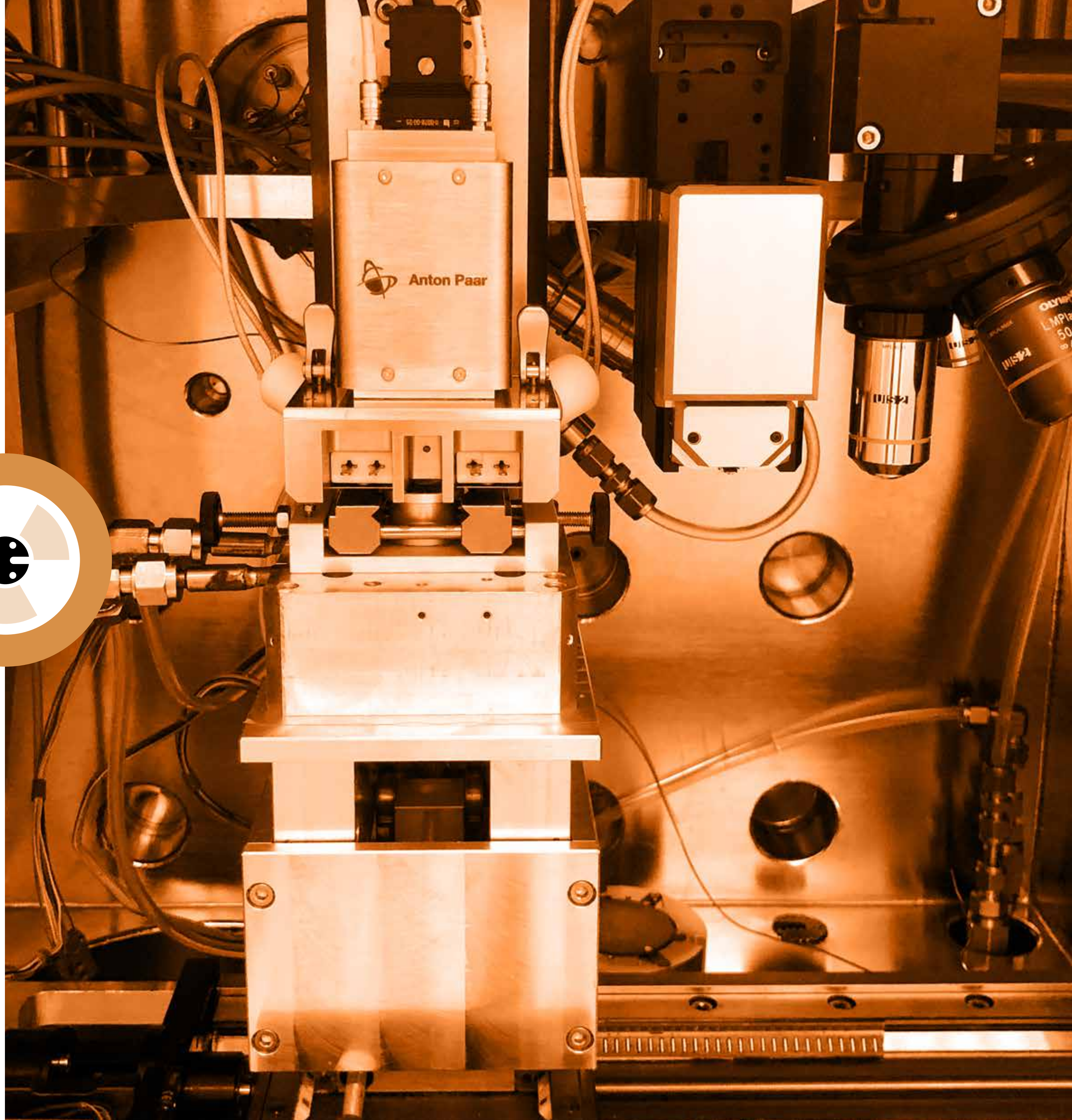
- Safety and reliability of nuclear components for future nuclear systems
- Support to the development and adaptation of European Codes and Standards
- Characterisation of mechanical properties of candidate and new corrosion-resistant high-temperature materials, including surface modifications and welded joints
- Development of test and assessment methods as well as instrumentation to achieve easier and more reliable estimates of material properties using sub-size or miniaturised specimens
- Imaging techniques for opaque medium

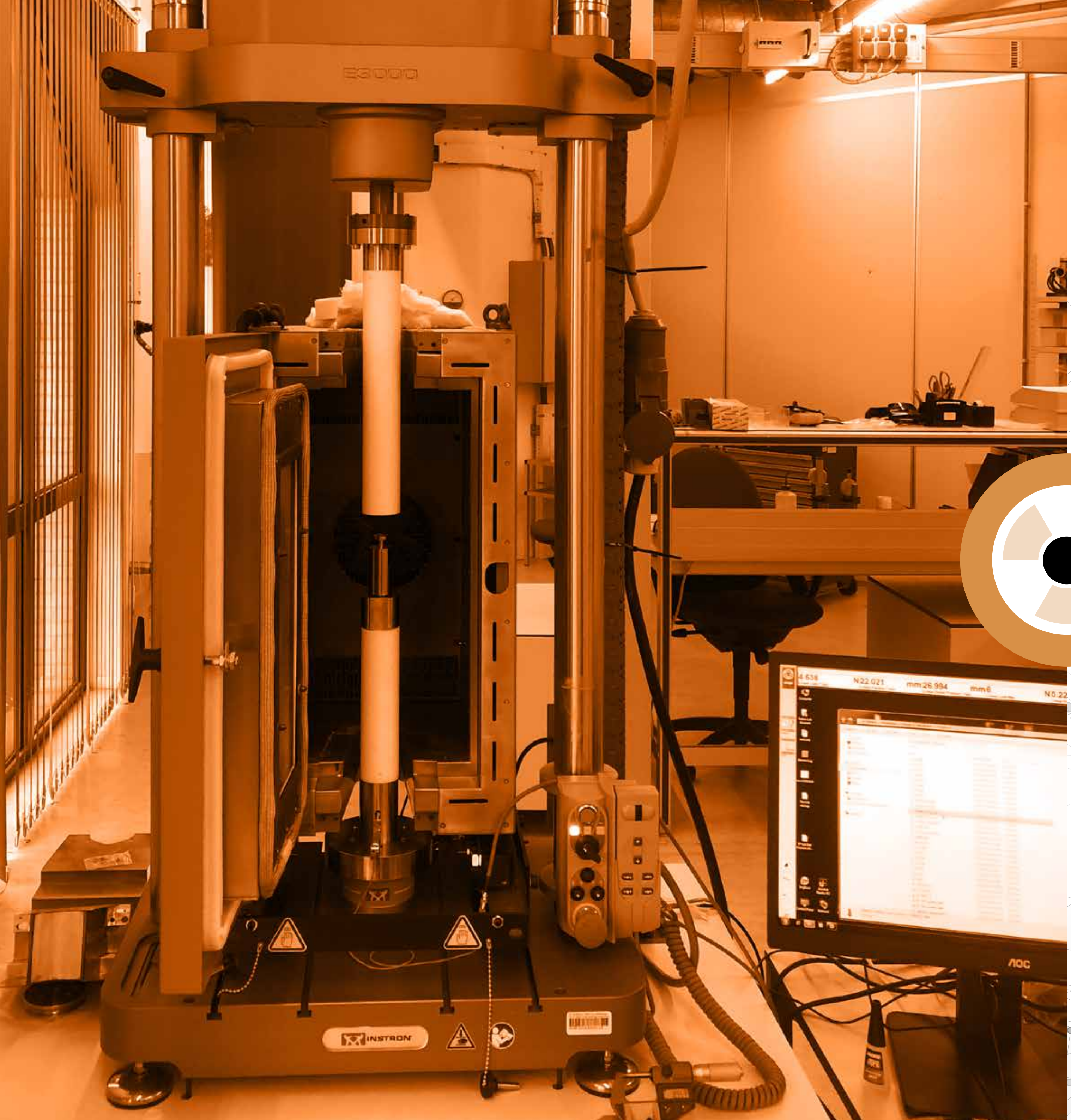
Micro-Characterisation Laboratory
Acronym: MCL

The Micro-Characterisation Laboratory is dedicated to the experimental investigation of materials performance in terms of microstructure and micromechanics. The lab provides insight into the complex coupling between microstructure, its defects and the mechanical behaviour of small volumes of metals, ceramic materials, polymers and composites of interest to the safe operation of nuclear installations. MCL installations also support the production of radio-isotopes for non-power nuclear applications through the development and characterisation of nanomaterials-based irradiation targets prepared via spark ablation technology.

Priority topics

- Microcharacterisation of materials of nuclear interest
- High temperature nanoindentation of metals, alloys and composites
- Development of new micro-mechanical testing methodologies
- Support to the development of predictive mechanism-based multiscale models of material behaviour
- Effects of material degradation sources in nuclear environments (irradiation, high temperature, corrosion)
- Understanding of small scale plasticity
- Physical methods of producing nanoparticles for non-power nuclear applications





Structural materials performance assessment laboratories
Acronym: SMPA

Structural materials performance assessment laboratories include the following test machines: Universal test machines for tensile, fatigue, fracture, creep-fatigue, slow strain rate tensile (SSRT), creep-fatigue crack growth, small punch, and small punch creep testing. The lab also has Charpy impact hammers for fracture toughness testing and uniaxial creep test machines. Moreover, following post-test equipment is available: 3D profilometry, SEM (EDX, WDX), optical microscope, X-ray diffraction (XRD), and Vicker's micro hardness (0.1kg – 20kg).

Priority topics

- Safety and reliability of nuclear components
- Support to the development and adaptation of european codes and standards
- Development of test procedures and instrumentation with available test equipment to achieve simpler, more reliable or non-standard tailored data and estimates of material properties
- Data in support of model development and validation for prediction of design life of new materials and remaining life of service-exposed materials including welded joints
- Characterisation of tensile and creep properties by uniaxial and small punch tests and creep-fatigue properties of new and service-exposed materials using standard and miniaturised specimen tests

More information on open access to JRC research infrastructures and the training and capacity building programme for Enlargement and Integration countries in JRC research infrastructures can be found on the EU Science Hub at https://ec.europa.eu/jrc/en/research-facility/open-access and https://ec.europa.eu/jrc/en/research-facility/open-access/training

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