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EURO-LABS

EUROpean Laboratories for Accelerator Based Science

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MILESTONE REPORT

WP3 FACILITIES READY TO RECEIVE TA REQUESTS

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Abstract:

This report provides an overview of the processes used by the Research Infrastructures participating in the Work Package 3 of EURO-LABS to accept Trans-national Access Requests.

Since the beginning of the project, the application procedures, User Selection Panels, and local administrative procedures have been implemented in each facility. All facilities declared operational, and ready to accept users. Additionally, some facilities have already distributed access units to visiting team. Finally, the steps taken to advertise EURO-LABS and the TAs it offers in order to bring in new users are reported.

For more information on EURO-LABS, its partners and contributors please see https://web.infn.it/EURO-LABS/

The EUROpean Laboratories for Accelerator Based Science (EURO-LABS) project has received funding from the Horizon Europe programme dedicated to Research Infrastructure (RI) services advancing frontier knowledge under Grant Agreement no. 101057511. EURO-LABS began in September 2022 and will run for 4 years.

Delivery Slip

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Executive summary

The key goal of the EURO-LABS project is to provide Transnational Access (TA) to major Research Infrastructures (RI) in Europe. WP3 comprises thirteen unique facilities that focus on High-Energy Accelerator Research.

The document is organized into sections per Task. It provides the status of each RI, along with information on the preparations being made to welcome TA users and distribute access units and funds.

All facilities have declared their readiness to accept users. In some cases, the first TA applications have been received, and access units granted.

The composition and method of work of the User Selection Panels (USP), which are organized per task within WP3 as defined in the project proposal, are also provided.

1 INTRODUCTION

EURO-LABS is a network of 33 research and academic institutions, including 25 beneficiaries and 8 associated partners, from 18 European and non-EU countries. It involves 47 Research Infrastructures within the Nuclear physics, Accelerators and Detectors pillars. In this diverse network, EURO-LABS aims to support researchers from different nationalities, gender, ages, and professional backgrounds.

The primary goal of EURO-LABS is to foster the sharing of knowledge and technologies across scientific fields to enhance synergies and collaborations between the RIs of the Nuclear and High Energy communities. Within EURO-LABS, Work-Package 3 (WP3) will provide Transnational Access (TA) to Research Infrastructures for Accelerator R&D.

WP3 will provide TA to a broad spectrum of installations, for testing concepts for future accelerators, based on improving the present facilities and for R&D studies for future colliders like CERN/FCC or the Muon Collider. These facilities will provide beam lines for testing advanced accelerator materials, superconducting or normal Radio-Frequency cavities, magnets, and acceleration schemes. These tests use different particles and energies, such as low-energy protons, low-energy electrons, ultra-soft electron bunches and high-intensity high-energy electrons and may also have connections to industrial applications.

2 WP3 – TASK 3.1

Task 3.1 includes a unique RI, the HiRadMat@CERN, dedicated to tests of materials or advanced accelerator components to the impact of high-intensity pulsed proton or heavy ion beams. HiRadMat was included in previous projects: EUCARD, EUCARD2 and ARIES as TA offering facility, thus the facility managers are experienced in the handling of TA requests and users.

The User Selection Panel of Task 3.1/HiRadMat is formed specifically for the EURO-LABS project and consists of four members: two representing the facility and two external members, world-known experts in the field, also members of the Scientific Board of the facility.

- Dr. Bernie RIEMER (Oak Ridge National Laboratory, USA)
- Prof. David SPROUSTER (Stonybrook University, USA)
- Dr. Pascal SIMON (HiRadMat operations manager, CERN)
- Dr. Nikolaos CHARITONIDIS (HiRadMat facility coordinator, CERN) - chair

The USP, meets on an ad-hoc basis when informed by the facility management that TA requests have been received. The USP discusses project proposals that have been previously evaluated and accepted by the HiRadMat Scientific and Technical Boards. The experiments are scheduled within the yearly allocated operation slots of the facility, which are defined by the CERN Executive Committee IEFC (Injectors and Experimental Facilities Committee) and Research Board. Information of the panel meetings and minutes is available in the CERN indico[1].

[1] https://indico.cern.ch/category/15888/

2.1 FACILITIES

2.1.1 HIRADMAT

Figure 1- View of the facility during the remote installation of an experiment.

HiRadMat (High Irradiation to Materials) is a facility at CERN designed to provide high-intensity pulsed beams to an irradiation area where material samples as well as accelerator component assemblies can be tested. HiRadMat uses the extracted beam from the CERN-SPS (Super Proton Synchrotron) with up to a few 10^{13} protons/pulse to a momentum of 440 GeV/c. The fast (single turn) extracted beam is transported into the HiRadMat experimental area where the materials test setups are installed. The beam spot size at the focal point at the experiment can be varied from 0.25 to 4 mm^2 to offer sufficient flexibility to test materials at different deposited energy densities. The facility can also provide heavy ion beams like Pb^{82+} with a beam energy of 177.4 GeV/nucleon (36.9 TeV per ion) resulting in a pulse energy of up to 21 kJ. A maximum of $6x10^{16}$ protons per year can be delivered to the facility, due to RP limitations.

HiRadMat as a dedicated facility for material and component testing with LHC type particle beam parameters is unique today.

The facility is fully operational to accept the 2023 experiments. 4 slots have been allocated for this (short) year. Out of the approved experiments, 3 have requested partially Transnational Access support from EURO-LABS. Two EURO-LABS Task 3.1 USPs meetings been already completed since the start-up of the project: USP #1 on 06.09.2022[2] and USP # 2 on 15.02.2023[3]. The minutes from the USP have been attached to the agendas and (electronically) signed by all the USP members. A breakdown of the approved projects and users is shown in Figure 2:

[2] https://indico.cern.ch/event/1200172/
[3] https://indico.cern.ch/event/1229706/

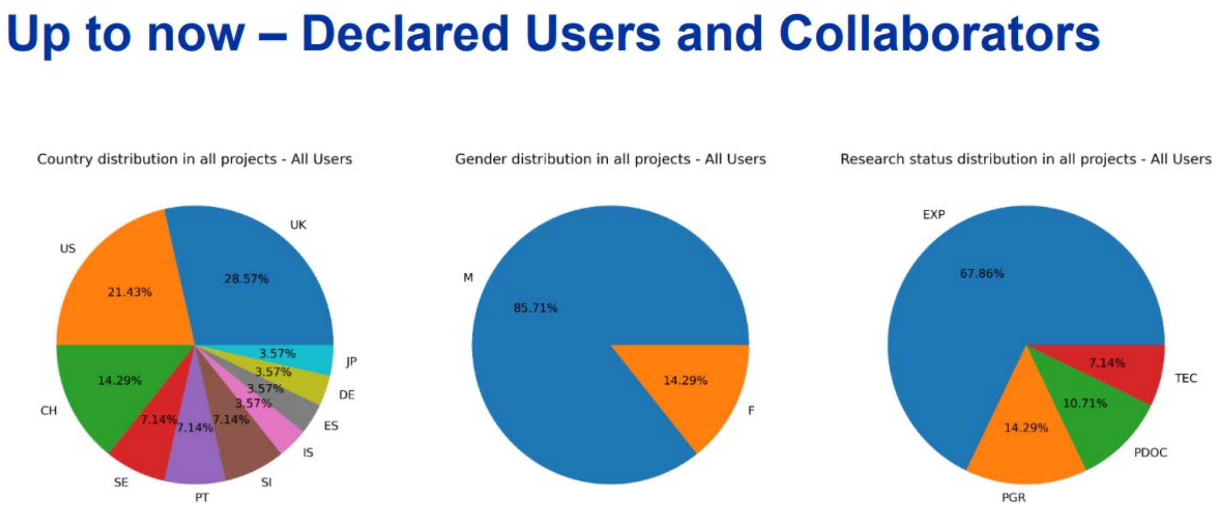


Figure 2 -Statistics on the approved users and collaborators for EURO-LABS TA requests.

Due to COVID19 regulations, conferences and workshops were cancelled or postponed in the last years. New peer-reviewed publications in journals publicised research at HiRadMat supported by EURO-LABS are already being drafted. The ten year anniversary of the HiRadMat facility has been commemorated as a CERN bulletin article[4] and has been covered in the 38th issue of Accelerating News[5]. However, within 2023 two important events for the facility will take place:

- An *in-person* User Selection Panel and Scientific Board, towards the Q3 of 2023.
- Participation to the 8th High Power Targery Workshop, (6-10 Nov 2023, RIKEN Wako Campus, JP)[6] with several presentations and invited talks. The EURO-LABS project and offered TA possibilities in HiRadMat will be presented to the participants, a target group for future users of the facility.

[4] https://home.cern/news/news/experiments/flexible-and-accessible-hiradmat-facility-celebrates-its-tenth-anniversary

[5] https://acceleratingnews.web.cern.ch/news/issue-38/aries-ari/flexible-and-accessible-hiradmat-facility-celebrates-its-tenth-anniversary

[6] https://indico2.riken.jp/event/3102/

3 WP3 – TASK 3.2

The Task 3.2 of EURO-LABS is devoted to Technology Infrastructures and proposes transnational access to a few technical platforms owned by some of the partners of the former AMICI project[7]. The platforms involved in transnational access in the AMICI collaboration are identified by the EURO-LABS logo on the AMICI website. During the last years, this collaboration, established during the AMICI H2020 project supported the use of the existing accelerator and magnet Technology Infrastructure to the benefit of large accelerator facilities in Europe and worldwide. The extremely valuable platforms existing in many laboratories are used in networking R&D activities but also in the frame of service agreements established either between laboratories, projects or with industry.

Part of the activities discussed during the AMICI project are also continued in the framework of the WP13 (European Technology Infrastructure for Accelerators and Magnets) of the H2020 I.FAST European Project[8]. In this framework, four workshops dedicated to a specific category of Technical Platforms were planned with the goal of promoting them towards possible users. Two workshops have already taken place in 2022:

- test benches for SRF cavities organized by DESY, in September 2022,
- a magnet workshop organized by INFN (Milano), in November 2022.

The next one will be organized by CEA in France (March 12-14, 2023), focused on Platforms for characterization, treatments, and test of materials. A last workshop on Facilities for beam tests of accelerator components, organized by IFJ-PAN in Krakow, Poland will be scheduled later in 2023.

By participating in these workshops (funded by I.FAST) the EURO-LABS project and the facilities offering TA can be promoted to the community.

3.1 USP

The User Selection Panel of Task 3.2 is composed of:

- The WP3.2 coordinator, Sylvie Leray - chair,
- The 5 representatives of the platforms:
  - CEA: Thomas Proslier,
  - CERN: Roberto Corsini,
  - CNRS: David Longuevergne,
  - INFN: Dario Giove
  - UU: Rocío Santiago Kern
- 5 external members who confirmed already their availability:
  - Jose Manuel Perez, from CIEMAT,
  - Marc Wenskat, DESY,
  - Robert Zierold , Hamburg University,
  - Bernard Auchmann, PSI,
  - Robert Laxdall, TRIUMF (Canada).

Two additional external members are contacted but not yet confirmed their availability.

The panel will consider applications for transnational access on a case-by-case basis. It may meet if needed, but it will mainly exchange information and decisions by e-mail.

[7] https://amici.ijclab.in2p3.fr

[8] https://ifast-project.eu/home

3.2 FACILITIES

3.2.1 FREIA

FREIA has three different types of cryostats to be used depending on the experiments:

- **Gersemi**: a vertical cryostat that can test bare cavities or superconducting magnets between 4.2 K and 1.8 K
- **HNOSS**: a horizontal cryostat to test maximum two jacketed cavities between 4.2 K and 1.8 K.
- **CoW**: a portable cryostat to test small equipment at 4.2 K

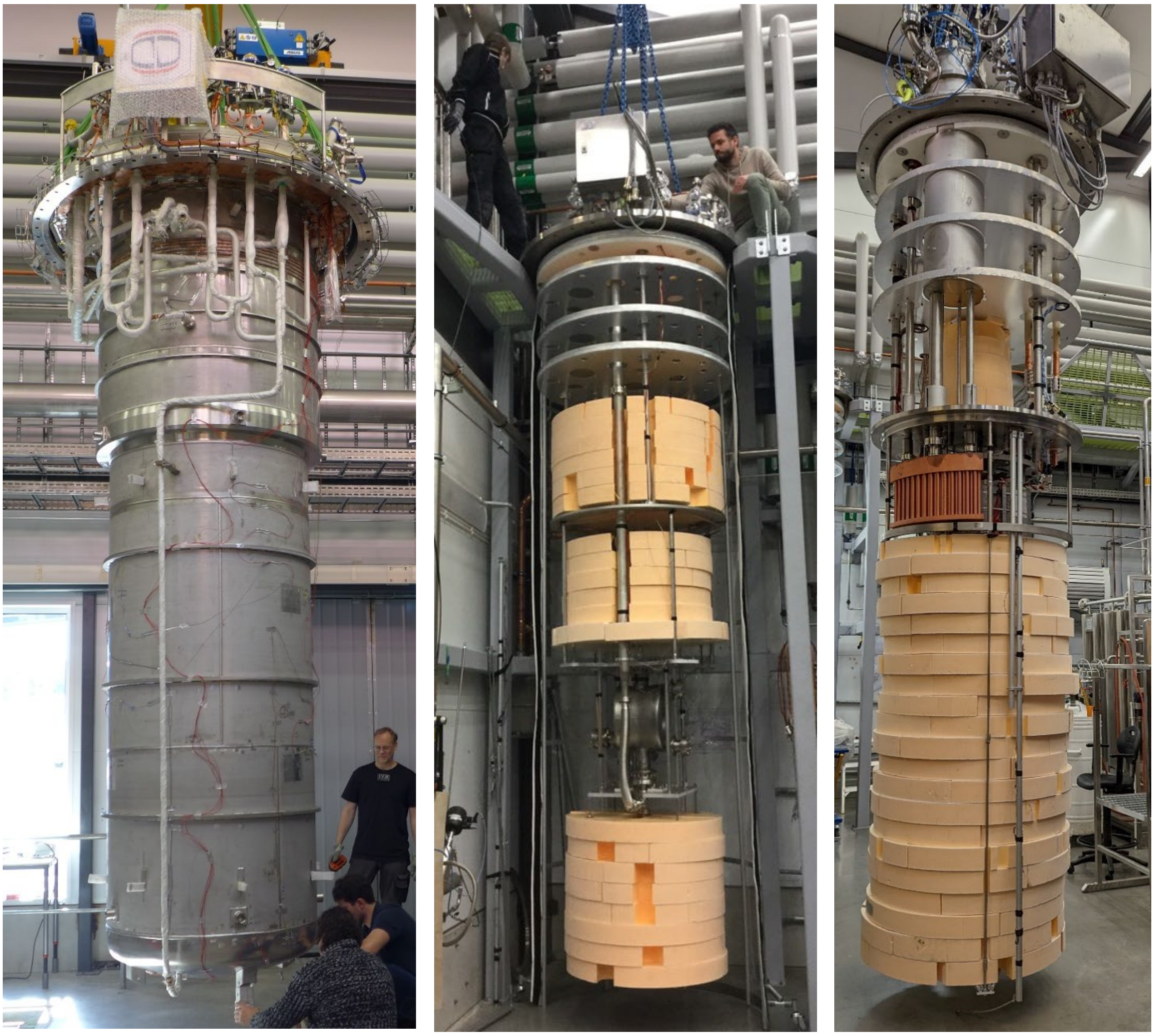


Figure 3 - View of the GERSEMI facility: vertical cryostat with pressure vessel (left), liquid insert (center) and magnet insert (right)

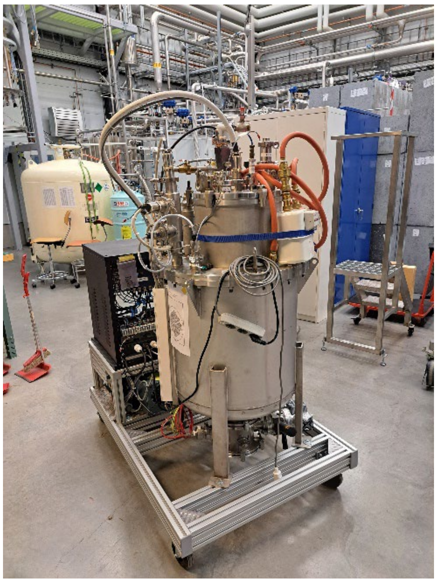


Figure 4- View of the HNOSS hirozontal cryostat (left) and of the CoW portable cryostat on wheels.

All three cryostats of the facility are ready for operation. Being complicated structures the lead time to prepare the cryostats and have them ready for an experiment needs to be considered for project requests as well as the schedule. TA projects will have to fit in the overall schedule of the facility and the be compatible with main projects of the facility. In particular:

- Gersemi: This cryostat is ready for operation since middle of Febraury'23, but its availability is subjectable to slots fitting in between the main projects at FREIA
- HNOSS: For tests at low power 3 weeks would be needed to be prepare it, while at high power it would be closer to 5 weeks preparation time. Its availability is the same as with Gersemi, namely in between the main projects of the lab.
- CoW. Due to it being small and portable, it is ready to be used at any time. Its availability depends only on the quantity of liquid helium available.

The FREIA team is constantly and actively promoting the facility and EURO-LABS TA through invited talks and posters at conferences of the field, and by targeted conversations with colleagues from other institutions or companies with an interest in either superconducting equipment or low temperature cryogenics.

3.2.2 INFN-LASA

LASA is characterized by the presence of four test facilities devoted to:

- Superconducting (SC) Magnets
- Superconducting (SC) RF Cavities
- High Brightness Photocathodes for Electron Sources
- Laser Applications to High Power Fabry Perot Cavities and Advanced Timing Systems.

The two facilities dedicated to SC magnets and RF cavities will allow experimental characterization and test of prototype or full-size magnets and RF cavities (starting from 650 MHz) in a cryogenic environment. The facility devoted to high brightness photocathodes for electron sources provides a suitable environment to characterize the performances of photocathode materials measuring different optical and physical properties. A modern high power, high repetition rate laser is the heart of the facility dedicated to laser applications to high power Fabry Perot Cavities and advanced timing systems. It will allow the study and development of this devices with a well-equipped laboratory.

The four LASA facilities are ready to accept users from external institutions. All the four facilities are operative and in use. We may have the first users in March-April 2023. All the safety device procurements and safety procedures are underway, and this time is the one required to complete these actions.

Service improvements are planned in the framework of EURO-LABS and will be carried out in the meantime we proceed with the first experimental activities.

The facilities above described are of interest for many research activities both in Europe and all around the world. The typical users may be researchers that will improve their knowledge on basic physics after taking their University Degree of to refine their thesis during a PhD. Advanced senior researchers may propose advanced research programs taking advantage of both: the peculiar instrumentation available and of the experience of the people dedicated at each facility.

To further promote the availability of these facilities and the TA within EURO-LABS, we are preparing a dedicated leaflet and a video to show all the opportunities.

3.2.3 INFN-THOR

Test in HORizontal (THOR) is a test facility for superconducting magnets in their horizontal cryostats. The maximum size for the cryostat is approx. 5 m long and weight up to 20 t. The facility is equipped with a cryogenic refrigerator supplying 15 g/s of supercritical He at 4.5 K and 10 bar or 120 l/h of liquid He. The refrigerator is connected to the test feed boxes (a second feed box is foreseen and under procurement) through to a cryogenic transfer line. The Feed Box hosts a set of cryogenic valves for regulating the flow of the cryogenic liquid inside the cooling lines of the magnets. It is also provided with a set of vacuum gauges and a pumping system for the insulation vacuum as well as two cryogenic flow meters for mass flow measurements of the coolant. Accelerator magnets with cryogenic beam pipe integrated can be also installed, as the line is integrated with an End Box where secondary UHV pumping system, vacuum gauges and a residual gas analyser are present for vacuum level and RGA measurements.

The facility is ready. Cryogenic He flow up to 15 g/s @ 4.5 K and 20 g/s @77K is ready. High vacuum pumping systems and leak detectors, as well as diagnostic and data acquisition, are ready. Pressure test and High Voltage insulation test is also available. High current Power Converter (up to 20 kA 25V) is available. Small workshop also supports our activity.

Figure 5 -THOR Lab at University of Salerno - Italy

This is a relatively new facility; thus we are planning to promote the TAs trough conferences communications and disseminations. This year we are also organizing the 4th workshop on Superconducting Magnets Test Facility near the Salerno University[9].

3.2.4 IJCLAB-SUPRATECH

Supratech platform is dedicated to the surface preparation, assembly and cryogenic test of accelerator components as superconducting accelerating cavities, power couplers, frequency tuning systems and, as well, of fully integrated cryomodule. It regroups all the expertise and the infrastructures as chemical etching lab, vacuum furnace, clean-rooms, cryostats and helium liquefier.

Supratech is today fully operational and is continuously being upgraded for new projects.

Supratech is opened to any user (academic or industrial). Supratech platform was fully invested in numerous successful national and international construction projects as Spiral2 (France), XFEL (Germany). It is now delivering fully integrated cryomodules for ESS (Sweden) and accelerator components for MYRRHA (Belgium)

[9] https://agenda.infn.it/event/32061/

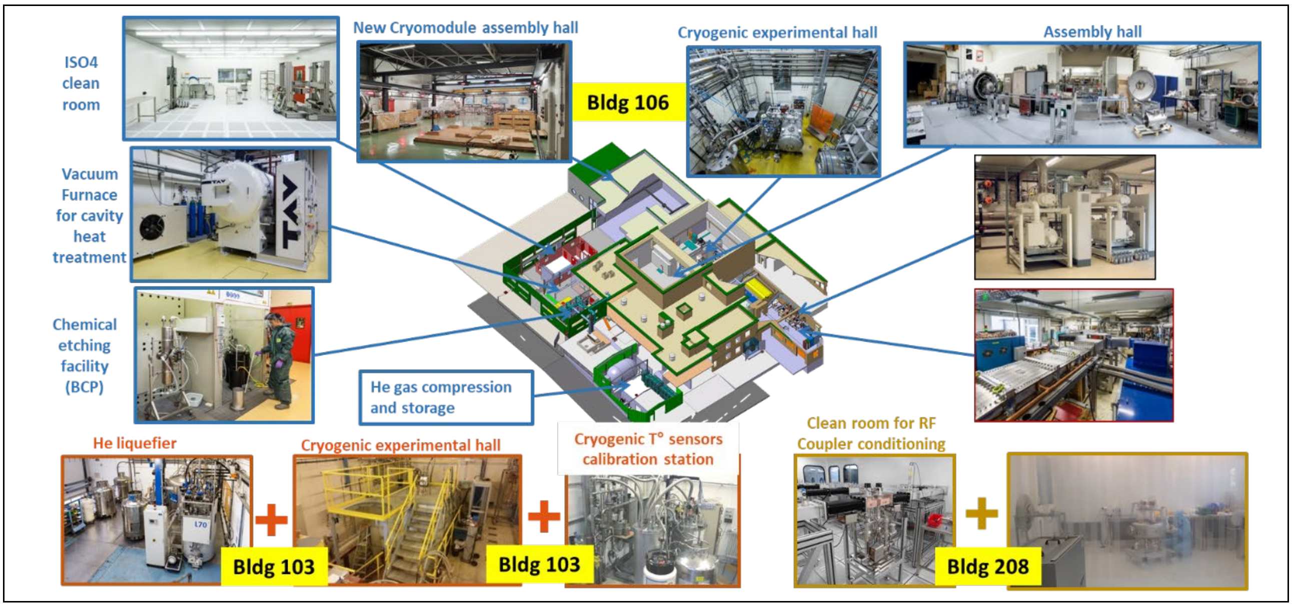


Figure 6- View of the facility

Supratech is today famous for its realizations and is communicating in a regular basis in dedicated accelerator conferences (IPAC, SRF, LINAC, …). The promotion of transnational access to the platform will also be made on the AMICI website.

3.2.5 CEA/IRFU-SYNERGIUM

3.2.5.1 MACHAFILM

The Atomic Layer Deposition (ALD) laboratory is composed of two ALD systems; a first research scale reactor (left in Figure 7) is used to develop and test new compounds and structures on test samples. The second reactor (right in Figure 7) have been developed to scale up optimized processes on large objects. The details of the two ALD systems are given below:

Figure 7- View of the atomic layer deposition facility at CEA.

ALD reactor	Research scale	Development scale
Chamber dimension	5 cm x 50 cm	50 cm x 110 cm*
Temperature range	30-450°C	30-450°C
Number of precursor lines	7 (3 solids, 2 liquids, 2 gases)	8(4 solids, 2 liquids, 2 gases)
In-situ monitoring	RGA, QCM	RGA

The research scale reactor is mostly used for oxides and nitrides growth. The development scale reactor is only used for nitrides synthesis for a foreseeable future.

*Retort dimensions, the object to be inserted will require custom flange adaptors and its size will therefore be smaller.

In addition to these 2 ALD reactors, other lab capabilities are:

- Glove box under N_2,
- Sorbonne,
- Room temperature 4 points measurement,
- optical microscope,
- 3 zones tubular oven under gas (Ar, N2, O2, N2-H2) up to 1100°C (6 cm x 50 cm).

The facility is up and running. Several research projects are already using the reactors daily. The description of the platform and its transnational access are described on the Irfu and AMICI[10] and EURO-LABS websites.

The cryostat setup allows to measure the residual resistivity ratio (aka RRR). The RRR is usually defined as the ratio of the resistivity of a material at room temperature and at 0° K[11]. RRR measurement is a very good indication of the material quality on metals or superconductors. It's a precise measurement tool of the quantity of impurities and other crystallographic defects, it serves as a rough index of the purity and overall quality of a sample. RRR is also one of the properties of interest for low temperature effects like Kondo effect or superconductivity.

[10] https://amici.ijclab.in2p3.fr/technology_infrastructure/category

[11] This in fact corresponds to an estimate near 0K as absolute zero temperature cannot be reached.

Figure 8 - View of the RRR facility at CEA

The cryostat can run from 4.2° K to 293° K. The helium gas is sent to the helium liquefier of the SupraTech facility through recovery line. The inner diameter is 150 mm.

The set-up is now operational for three samples, the temperature is measured with a cernox sensor.

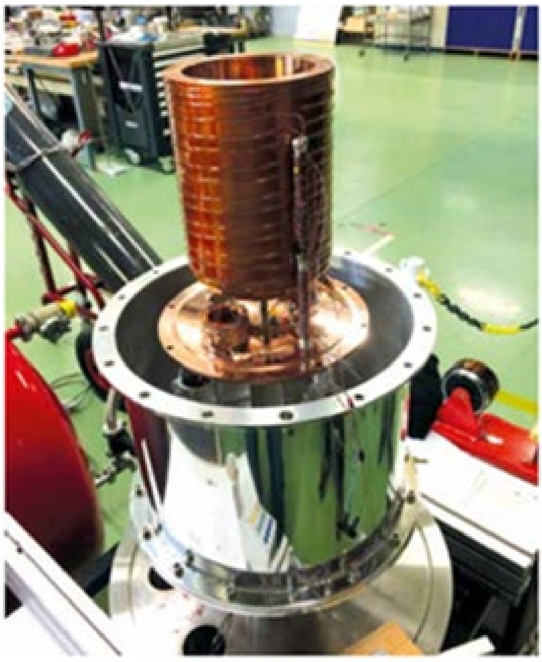
The plan for the facility is to increase the quantity of samples per thermal cycle with a new cryostat and to improve the reproducibility of the electrical contact with spring probes.

Users interested in determining the RRR of conducting material or the critical temperature of superconductor are potential candidates for TA through EURO-LABS. The description of the platform and its transnational access are described on the Irfu and AMICI websites.

3.2.5.2 CRYOMECHA

The CROYMECHA facility in CEA comprises of several test stations, starting with the two shown in Figure 9.:

- The **MectiX** has a cryogenerator-cooled variable temperature measurement cell for carrying out thermal conductivity measurements using either the differential or the integral method on samples of around 10 cm in length in a temperature range from 4.2 K to 300 K.
- The **Thermautonome** is a closed circulation loop with recondensation by means of a cryogenerator for characterizing single-phase and two-phase flows by measuring pressure drops and wall temperature increase along a 30 cm vertical station.


Measuring cell at the MectiX test station.


Thermautonome

Figure 9- View of the test stands of the CRYOMECHA facility in CEA. Left : the measuring cell at the MectiX station, and Thermautonome station on the right.

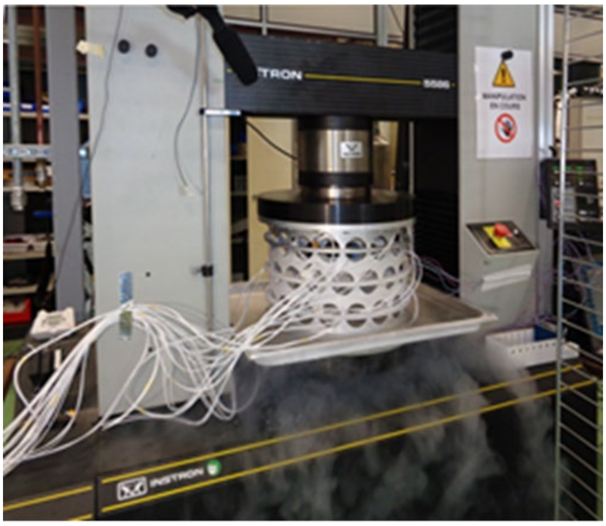
The key parameters of **Thermautonome** station are given in the table below:

Thermautonome	
Cryogenerator	1.5 W @ 4.2 K
Temperature range	3 K – 30 K
Fluid pressure	From a few mbars to 3 bars
Max power in the loop	20 W

In addition to these two test stations, other lab capabilities include:

- an open circulation loop with a reservoir for characterizing single-phase and two-phase flows by measuring mass flow rates and qualities, pressure drop, and wall temperature increase along the wall of a 1.2 m vertical test station and a 0.4 m horizontal test station, and
- a double bath station using the Claudet double bath principle for carrying out thermal studies on static pressurized superfluid helium up to a power of 10 W. AT 1.8 K its useful volume has a diameter of 250 mm and a height of 300 mm.

Last, the lab has a mechanical test laboratory which can perform measurements under traction, compression, flexion, shear, and slippage at 300 K and 77 K (liquid nitrogen). One helium cryostat allows to determine mechanical characteristics (modulus of elasticity, elastic limit, breaking load, rupture elongation, ductility, and sliding coefficient) of metals and composites as well as the behavior of complete assemblies compatible with the size of the test bench at 4.2 K.


Compression test on ferrule for LNCMI Hybrid Magnet


Force transfer system (welded ball and sliding tube) on the Nb_3Sn strand.

Figure 10 - CRYOMECHA - view of the mechanical test stand.

All the test stands of the facility are up and running.

Various components used in the composition of accelerator magnets have been characterized, and further tests are expected from teams interested in determining the thermal properties of conductors and insulators. The mechanical test stand is presently performing a campaign on characterization of superconducting strands. Future users are expected from research teams interested in determining the mechanical properties of metals and composites.

3.2.6 XBOX

The Xboxes are klystron-based X-band RF test stands located at CERN in Geneva, Switzerland. The test stands are dedicated to the testing and development of high-gradient accelerating structures and high-power rf components. There are three testing stations (Xboxes): two are powered by a 50 MW/1.5µs/50 Hz klystron and the third is powered by four 6 MW/5 µs/400 Hz klystrons combined in pairs. Access to a 3 GHz testing station (40 MW/5 µs/10 Hz) located in the CLEAR facility at CERN is also a possibility. This infrastructure was constructed to high-power test the main linac accelerating structures and novel RF components for the Compact Linear Collider (CLIC). The testing stations have been extensively used for such purpose but being just as useful for developing high gradient and power structures for X-band FELs, Compton/Thomson sources and as potential RF units in linacs, they have since their construction being employed also for such aims.

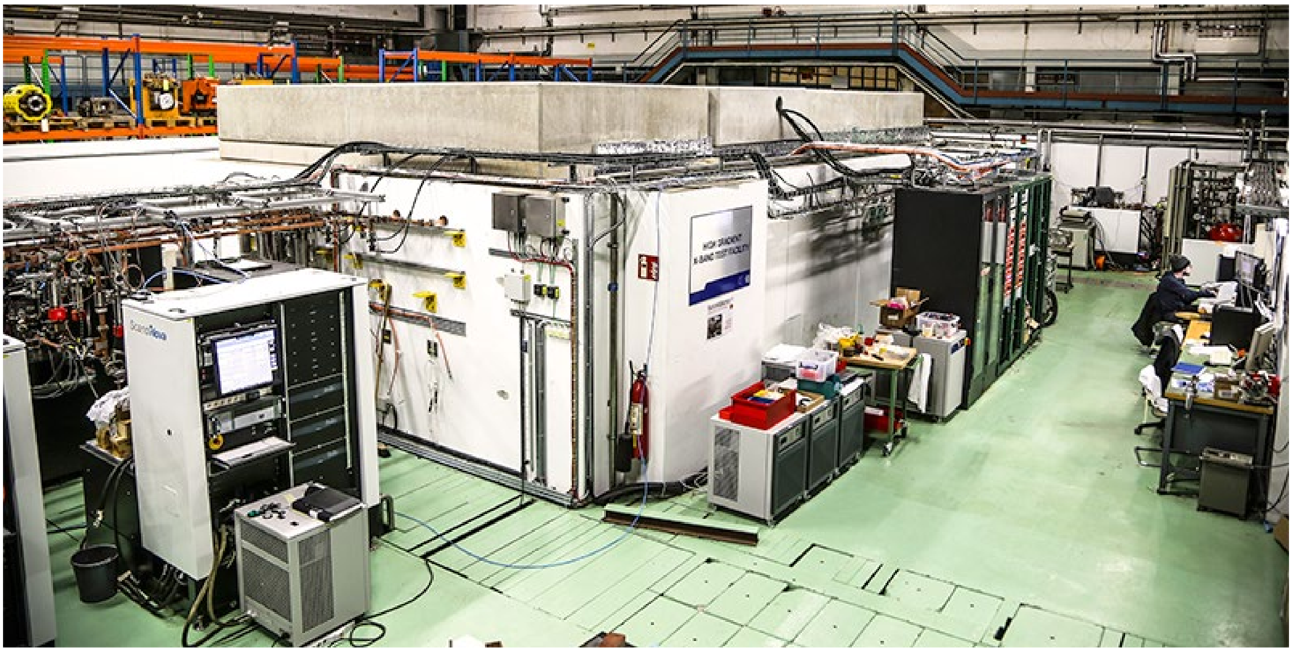


Figure 11- View of the high-gradient X-band test facility at CERN.

The facility provides:

- 3 x klystron-based X-band (11.994 GHz) test stands
- 3 x fully powered and instrumented testing slots
- Support infrastructure eg: radiation shielding, water cooling, vacuum etc
- Additional access to a 3 GHz test stand

The facility is operational and ready to accept proposals for TA. The proposals will be selected and included as soon as possible in the experimental program schedule by the facility coordinator, depending on the availability and on the existing priorities.

The facility is of interest to several accelerator communities, all interested in compact high-gradient acceleration for several application purposes, including linear colliders, X-band FELs, Compton/Thomson sources, medical linacs. The EURO-LABS project and the inclusion of XBOX in it will be publicized to the RF high-power testing community through existing mailing-lists. The possibility to access the test facility through EURO-LABS will also be publicized at the next International Workshop on Breakdown Science and High Gradient Technology (HG2023), which will be held on 16-19 October at Frascati (Italy). Further information is also accessible through the CLEAR web page[12].

[12] https://clear.cern/content/euro-labs

4 WP3 – TASK 3.3

This task groups four RIs with six installations, devoted to the testing of instrumentation, components and acceleration schemes and principles with different particles and energies: low-energy protons, low-energy electrons, ultra-short electron bunches, and high-intensity high-energy electrons, as well as electron beamlines driven by different types of lasers for testing plasma wakefield accelerating cells.

4.1 USP

Following discussion with the Task 3 Facility coordinators and wider EURO-LABS management, the following nominations have been put forward for the composition of the WP3.3 User Selection Panel (USP):

- Florian Burkart (DESY)
- Sandrine Dobosz Dufrenoy (CEA)
- Leonida Gizzi (CNR-INO)
- Anthony Gleeson (STFC)
- Shaukat Khan (Dortmund)
- Riccardo Pompili (INFN-LNF)
- Markus Ries (HZB)
- Robert Ruprecht (KIT)

Ilias Efthymiopoulos (CERN) will monitor USP meetings to provide oversight of the process and ensure compliance with EURO-LABS selection criteria.

Once formally accepted, any subsequent changes to the make-up of the panel (e.g. due to retirement, re-allocation, illness) will be by mutual agreement of the USP. The USP will meet regularly (at least every six months) to review TA applications across all the facilities covered in Task 3.3. Interim ad-hoc meetings may be required if a rapid decision is critical in order to enable a User Group access to a facility. The USP will endeavour to make use of suitable tools to make the review process as efficient and effective as possible.

The USP will be responsible for determining suitability and eligibility for access to EURO-LABS transnational funding to undertake user experiments. Technical suitability, safety assessment and scheduling will remain the responsibility of the individual facilities.Facilities

4.1.1 KIT(ALFA) – KARA-FLUTE

KIT operates the **Acce**lerator **Fa**cilities (ALFA), including **KARA** and **FLUTE**.

FLUTE, the **F**ar-infrared, **L**inac and **T**est **E**xperiment (**F**erninfrarot, **L**inac **u**nd **T**est-**E**xperiment), is a compact linac-based test facility for accelerator R&D and future source of intense THz radiation for photon science. FLUTE serves as an accelerator test facility for a variety of accelerator physics studies, generating pico- down to femto-second long electron bunches of 5 up to 41 MeV (planned up to 90 MeV), also providing coherent radiation in ultra-short, very intense, light pulses spanning the terahertz and far-infrared spectral range and beyond. FLUTE consists of a 5 MeV photo-injector, a 41 MeV S-band linac and a D-shaped chicane to compress electron bunches covering a large bunch charge range, from 1 pC to 1 nC, and bunch lengths from 500 fs down to a few fs.

KARA, the Karlsruhe **R**esearch **A**ccelerator, is an electron storage ring used for the synchrotron of the KIT Light Source and as a test facility, a platform for development and testing of new beam and acceleration technologies, pooling research of new accelerator concepts and development of new detectors. KIT operated KARA for more than 20 years. Accelerator studies at KARA profit from its flexible lattice, large energy range (0.5 - 2.5 GeV), adjustable bunch lengths (50 ps down to a few ps in a dedicated short, single or multi bunch operation mode), and the fully synchronized, fast, transversal, and longitudinal beam diagnostics. The latter includes novel single-shot, high repetition rate electro-optical longitudinal bunch profile monitoring and in-house developed detector systems (e.g., THz detectors) with bunch-by-bunch and turn-by-turn multi-channel readout. KIT-IBPT implemented different operation modes and lattice versions at KARA. Low-a optics are routinely used at 1.3 GeV for studies of beam bursting effects caused by coherent synchrotron radiation in THz frequency range. A specific optic with negative compaction factor was simulated and implemented.

KIT-IBPT also hosts the cryogenic **BE**am **S**creen **T**est-bench **EX**periment (BESTEX) built and operated by CERN and KIT at KARA down to 80 K, to explore photon stimulated desorption, photon reflectivity, photon heat loads, and photoelectron generation originated on vacuum beam screen prototypes under irradiation of the FCC-hh-like synchrotron radiation spectrum.

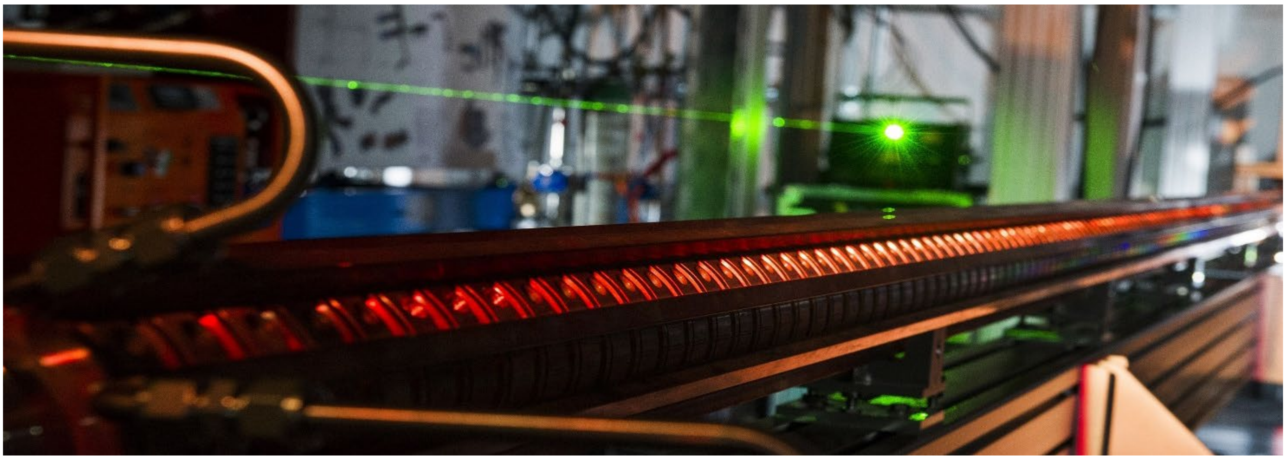


Figure 12 - View on FLUTE as part of KIT-ALFA. (Photo of M. Braig, KIT)

Figure 13 - Overview of the storage ring KARA, the beamlines and infra structure of the KIT Light source. KARA is part of KIT-ALFA. (Photo of M. Braig, KIT)

Within TA of EURO-LABS, KIT-IBPT will provide with the Accelerator Facilities ALFA:

330 hours in total of access to FLUTE for 6 periods of 5 days per experiment (22 hours a day) in the project years Y1 to Y3. (KIT plans to shut down FLUTE in project year Y4 due to a major rebuild).

880 hours in total of access to KARA for 8 periods of 5 days per experiment (22 hours a day for user operation mode) in the project years Y1 to Y4, depending on the actual cost of electrical power (€/kWh).

In addition, a preparation time for each experiment at ALFA of up to 5 days is foreseen for the installation and/or first test runs before the actual experiment.

FLUTE operation started with the 5 MeV section in 2018. This section is under refurbishment with delivered new RF system and RF photo-injector for more stable RF conditions, to be ready for operation in the second half of 2023. The linac is in commissioning since June 2021. The chicane for compressing electron bunches of ps length of about 41 MeV electron energy into the range of a few fs is built and is currently tested out of beam. FLUTE is ready to welcome TA now for experiments with the 5 MeV section to be prepared now and started in summer 2023.

KIT operated KARA for more than 20 years. For 2023 the current costs are double the price and the budget is the same as 2022. Therefore, KIT reduces the operation days for KARA. The user's visit and experiments should fit the operation weeks. Nevertheless, KIT welcomes TA application forms for KARA with the first users already scheduled as explained in the next paragraphs.

KIT-IBPT does marketing for EURO-LABS and promotes TA through various channels. On a webpage of the KIT website[13], EURO-LABS is briefly described, the KIT offer is pointed out and the link to the EURO-LABS process for registering TA requests is presented. Furthermore, the KIT-IBPT uses opportunities at all European and international conferences to refer to the TA offer. In addition, we have already contacted and will continue to contact potential interested parties who we assume might be interested in TA at the KIT-ALFA.

CERN, as the first user of **KARA** within EURO-LABS, has already sent a draft TA application form to KIT, and KIT has confirmed its feasibility in principle for BESTEX. On 23 January 2023, there was a first working meeting of the CERN team at KIT to clarify the ready state of BESTEX after a longer Corona break. This TA application form from CERN will soon be sent to the members of the User Selection Panel (USP) for review via the EURO-LABS office after the signature of the user group leader. The planned experiments are related to the FCC study and will focus on the investigation of prototype vacuum components for FCC-hh, further prototypes related to FCC-ee should follow. The CERN team want to test the BESTEX equipment and -with the wished OK from the USP- will start preparation of the 1st EURO-LABS experiment at KARA with technical support from the KIT-IBPT team in March 2023.

For **FLUTE**, there is a preliminary interest from PSI, Switzerland, in experiments with **S**plit **R**ing **R**esonators (SRR) to develop a diagnostics tool for determining the bunch lengths of sub-ps short electron bunches. To concretise this and to obtain a TA application form, KIT is in exchange with PSI and University Bern, a supplier of SRR microstructures

4.1.2 CLARA

CLARA (Compact Linear Accelerator for Research and Applications) is a high performance, modular injector facility capable of delivering a highly stable, highly customisable, short pulse, high quality electron beam to a series of test enclosures. The principal aim of CLARA is to test advanced free-electron laser (FEL) schemes, which can later be implemented on existing and future short wavelength FELs. CLARA will facilitate research into the underlying beam dynamics and accelerator technology sub-system challenges in photoinjector, RF acceleration, timing and synchronisation, beam diagnostics, accelerator controls and feedback processes. The facility uniquely combines a

[13] https://www.ibpt.kit.edu/project_EURO_LABS.php

highly customisable femtosecond electron beam with fully configurable test enclosures. In addition, access can be offered to the accelerator hall to allow direct adaptation of the accelerator system to trial new accelerator technology solutions or novel concepts

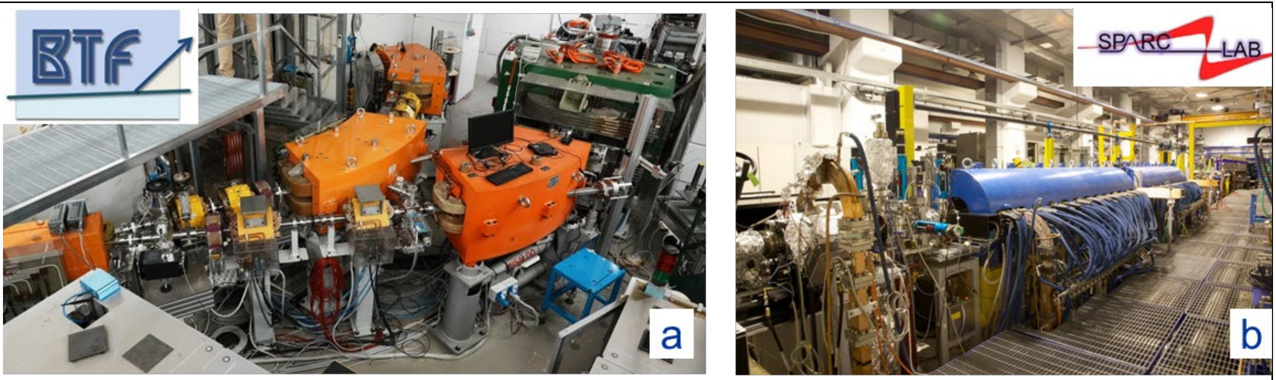
Figure 14- View of the CLARA facility (phase 2 construction).

The CLARA team are currently commissioning the in-house designed high repetition rate electron gun. Other progress is focussed upon preparation for the shutdown to ensure efficient and effective progress through this period and into the subsequent commissioning period. The shutdown is planned between March and October 2023, leading to a twelve-month commissioning period of the entire CLARA facility. The earliest anticipated initial experimental period for CLARA is September 2024.

For each beamtime allocation period (6 months of beamtime), whether academic, industrial or internal R&D is allocated under review by an STFC internal panel against agreed assessment criteria. It can be expected that Transnational Access would be allocated a ring-fenced number of days in each allocation period, dependent on the level of funding provided, for their dedicated use. If the number of allocations fell short of the assigned limit, the days would be left available for short-notice experiments. From an industrial perspective, usage of CLARA is not restricted to any market sector or size of business – all are eligible to apply for access. Academic usage will be broadened through the publication of regular calls for applications. STFC will use its well-developed global presence (web, social media, conferences and workshops) to publicise such calls, as well as notification of the availability of transnational funding schemes to encourage their uptake.

4.1.3 LNF- BTF, SPARCLAB

The Frascati National LABs (LNF) of the Italian Institute for Nuclear Physics (INFN) are participating to the EURO-LABS project through the availability of two electron beam user facilities, namely the Beam Test Facility, that makes use of electron and positron beams of the DAΦNE collider injector complex, and SPARC_Lab, which is a high brightness photoinjector.



INFN Frascati electron facilities: a) Beam Test Facility (BTF); b) SPARC_Lab

Figure 15- View of the facility

BTF:

The LNF Beam Test Facility (BTF) is an infrastructure mainly dedicated to the development and testing of particle detectors, providing primary, fixed energy beam and secondary electron or positron beams with continuously tunable energy from 30 MeV to 780 MeV. The bunch multiplicity can be varied from 10^{10} particles/pulse, down to a single particle per pulse in a Poisson stochastic regime, with a bunch repetition rate up to 50 Hz. The facility was successfully running with an average of 200 beam days/year, 25 experimental groups, 150-200 users booking since 2004 apart from a few minor stops. Since 2020 the BTF has also been used in high-intensity modality to provide experimental runs as an electron irradiation source.

Recently a major BTF upgrade has been completed. The existing beamline positioned at the end of the DAΦNE collider injection linac has been split to add a second experimental hall (BTFEH2) to accommodate on weekly base additional experimental groups of users. The new area BTFEH2 will be not in time-sharing with the already existing BTFEH1: only one at a time could be used and booked. BTFEH2 is currently devoted for external users, since the presence of fixed target experiment in BTFEH1. The standard beam pulse length is 10 ns and the BTF injections regime is available via pulsed magnet, steering away DAΦNE transfer line some of the LINAC bunches. The beam could be pulsed electron and positron bunches: up to 49 pulses/second in relation to DAΦNE injection cycle type and operation mode, down to 1. The facility can be operated either in dedicated mode (only possible when DAΦNE collider is off), exclusive for BTF users, or in time-sharing mode, making use of DAΦNE spare injection pulses with beam parameters defined by DAΦNE injections needs.

BTF offers standard beam line services for users doing tests, including: BTF DAQ and DCS data (BTF standard, delivered on MemCached server), High Voltage (Caen SY5527 crate, 4 slots, some spare board), Networking (BTF standalone DHCP server and ETH switch), Detectors, Timing for beam synchronization, Payload setup logistics and dedicated expert staff. In addition, standard charged particle detection setups are available for the users: pixel detector, lead Glass Calorimeter, ICT (Particle/bunch counting, high multiplicity regime), beam Flags.

SPARC_LAB:

SPARC_LAB is a multidisciplinary facility able to provide unique features in terms of electron beams and laser pulses, especially on the overall resulting beam quality. It is based on two pillars: the SPARC photo-injector and the FLAME high peak power laser system.

The SPARC photo-injector produces electron beams in the range 5-140 MeV energy, 10 pC-1 nC charge and duration tunable in the range 20 fs-5 ps (rms). The beam is provided completely characterized in the 6D phase-space and can be delivered to three different beamlines that have been dedicated so far to Free-Electron Laser (FEL), tests for advanced diagnostics and laser-electron interaction (Thomson scattering). Recently, at the end of the LINAC, a plasma accelerator module has been installed providing accelerating fields up to 1 GV/m.

FLAME is based on a Ti:Sa laser has been produced by Amplitude Technologies and can deliver ultra-short pulses (~20 fs, 60-80 nm bandwidth) with energies up to 6 J in the IR range (800 nm). The resulting peak power is ~250 TW. So far, the facility has been used for solid-target experiments (production of electrons, protons and heaver ions), laser-driven plasma-based acceleration and as a betatron radiation source.

Concerning the services currently offered by the infrastructure, SPARC_LAB offers to the users the possibility to perform innovative experiments involving electron beams and laser pulses. The two pillars are largely interconnected and share some diagnostics and the respective networks. SPARC_LAB is configured as a test-facility, in the framework of the EuPRAXIA project, thus the schedule of the activities can be planned and re-arranged just few months in advance without big constraints. The users are supported by the SPARC_LAB researchers and LNF technical services.

The electron beams provided by SPARC have been employed in experiments concerning the generation of radiation in different ranges (visible, EUV, THz, and Xrays), for the development of advanced diagnostics (based on THz, OTR and Electro-Optical Sampling) and, in recent years, for the development of innovative acceleration techniques based on plasma.

The laser pulses provided by FLAME have been employed in experiments concerning plasma-based acceleration (up to few hundreds of MeVs adopting gasjets in the self-injection regime) and protons/ions generation and acceleration by means of solid-target interactions.

Both facilities have been in shutdown for maintenance at beginning of 2023. The DAFNE linac, which is the particle source of BTF, has been stopped to substitute one of the 4 S-band klystrons powering the accelerating structures and the facility operation is expected to be recovered by the end of March 2023. Meanwhile, the local user committee, which acts as the laboratory selection panel, is fully active with the goal of delivering the user schedule for the whole year.

SPARC_LAB is presently undergoing a major consolidation shutdown, funded by a dedicated program called SABINA co-sponsored by the Lazio regional government, providing renewed hardware (photocathode laser system, Low Level RF systems, C-band HV modulator, …) and a new THz radiation line for user. The complex is expected to resume the operation in May 2023, so that EURO-LABS users could be accommodated in time slots beyond that date.

Presently, the participation of BTF and SPARC_LAB to the EURO-LABS project as INFN-LNF infrastructures open to Transnational Access has been advertised on the facility webpages:

- https://da.lnf.infn.it/projects/btf/ and
- https://sparclab.lnf.infn.it/.

At the moment there are not official applications for access through the EURO-LABS platform yet, but facility coordinators and local user committees have established informal contacts and discussions with eligible international teams in preparation of formal applications. It seems very much probable that applications will arrive soon and the planned access units for 2023 will be finally delivered.

4.1.4 LIDYL – UHI100

The **LPA-UHI100** facility consists of the UHI100 laser which delivers 100TW at 10Hz with 25fs pulse duration and one experimental radioprotected area where **a laser-driven electron source** (around 100MeV) **is available for internal and external users**. Intensities in the 10^{18}-10^{20} W/cm^2 range are accessible on target using a deformable mirror. UHI100 also features a very high temporal contrast obtained thanks to 2 temporal filtering steps. First, a saturable absorber in the front end enables to get temporal contrast as high as 10^9 at the compressor output. Second, a double plasma mirror (DPM) is inserted between the compressor and the experimental chamber to further increase the temporal contrast. The short pulse duration, ultra-high contrast and intensity together with radiation-protected experimental area, fully equipped for ultrahigh intensity experiments under vacuum make this facility unique. A geographic move from CEA-Saclay to CEA-Orme des Merisiers (a few kilometres away) has given the opportunity to optimise and redesign a new experimental area with 2 experimental chambers available, offering the possibility to use two high intensity beams in the same chamber. Available diagnostics include Thomson parabola for ion detection, magnetic spectrometer for electron analysis, ICT for electronic charge characterisation, and CCD cameras for spatial characterisation of the particle beams.

Figure 16 - (left) view of the laser room (UHI100, 100TW class laser) – (right) view of the radioprotected experimental area (© L. Godart /CEA)

The LPA UHI100 installation will be soon accessible for the EURO-LABS users. The new experimental environment has to be certified by the Nuclear Safety Authority, and we are still waiting for a final answer.

The promotion of the TNA on LPA-UHI100 facility will be done through the website of the LIDYL laboratory at CEA, hosting the facility (UHI's recent developments (cea.fr)[14] - work in progress), though EURO-LABS website (WP3-TA to RIs for High Energy Accelerator – EURO-LABS

[14] https://iramis.cea.fr/slic/UHI100.php

(infn.it)[15]) and through advertisement during conferences, workshops in the field of Plasma Physics, Conventional Accelerator, Laser-driven particles sources, Laser –Matter interaction at High intensity

[15] https://web.infn.it/EURO-LABS/wp3-ta/

5 WP3 – TASK 3.4

This TA task groups two RIs, devoted to testing of R&D ideas for applications using powerful electron beams for medical applications or ultra-low energy electron beams for industrial applications and chemistry

5.1 USP

The following persons were invited and agreed to be members of Task 3.4 Users Selection Panel:

- Ilias Efthymiopoulos – coordinator of WP 3
- Urszula Gryczka – RAPID facility coordinator
- Roberto Corsini – CLEAR facility coordinator
- Angeles Faus-Golfe – external expert (CNRS/In2p3-Orsay)
- Rob Edgecock – external expert (HUD)

The members of the USP, apart from the representative of the facilities, are external experts, specialized in development of accelerators and electron beam applications.

The meetings of the USP are planned to be organised every 3 months, or more often, depending on the number of submitted projects. The meetings will be organised virtually, but also evaluation of each project by USP members via emails is considered, to avoid delays in project evaluation. The first USP Task 3.4 meeting is planned to be organised in March 2023.

5.2 FACILITIES

5.2.1 RAPID

The RAPID Centre for Radiation Research and Technology facility is part of the INCT infrastructure localised in Warsaw, Poland. With the EURO-LABS project WP 3 "Access for Accelerators" Task 3.4 "Application" INCT offers access to:

- linear electron beam accelerator LAE 10 with nanosecond pulse radiolysis UV/VIS detection set-up. Pulse radiolysis is an invaluable tool for studying the kinetics and spectra of transient chemical species in chemistry and biochemistry.
- ELEKTRONIKA 10-15 linear electron beam accelerator which emits beam of electrons of energy 10 MeV, beam power up to 15 kW. The processing parameters with the electron beam of energy 10 MeV allows to irradiation bulk materials having high density, with the dose ranging from 0,5 to 40 kGy in one pass or as accumulated dose ranging hundreds of kGy. The installation is used for radiation sterilization and microbial decontamination of solids and liquids, for modification and degradation of polymeric materials.
- A pilot plant facility equipped in ILU 6 accelerator. The accelerator can emit a beam of electrons of energy ranging from 0,15 to 2 MeV, beam power up to 20 kW. The experimental works and demonstration, which can be performed with the use of ILU-6 accelerator and additional systems include irradiation of gas, liquid and solid type of products. The area of research supported by ILU 6 includes environmental applications to eliminate chemical or microbial contaminants from different media.

Additional infrastructure to support experiments: electron spin resonance spectroscopy, gamma cells, infrastructure of the Laboratory for Measurements of Technological Doses (ISO Accredited), apparatus for material characterization – DSC, TGA, GC, DRS, gas chromatography (GC), mechanical and rheological tests, dynamic contact angle measurements.

Figure 17 - View of the RAPID facility: (left) Elektronika 10-10 electron beam accelerator, (right) ILU-6 electron beam accelerator with wire crosslinking installation.

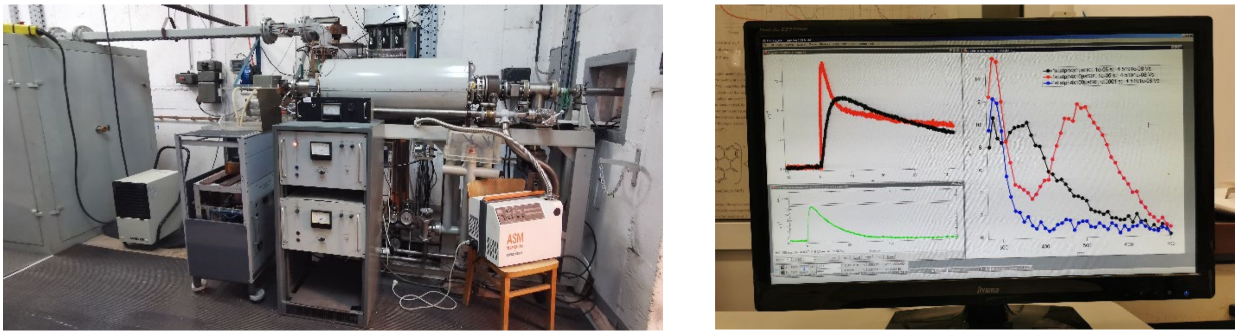


Figure 18 - View of the RAPID facility LAE 10 accelerator for nano-second pulse radiolysis experiments

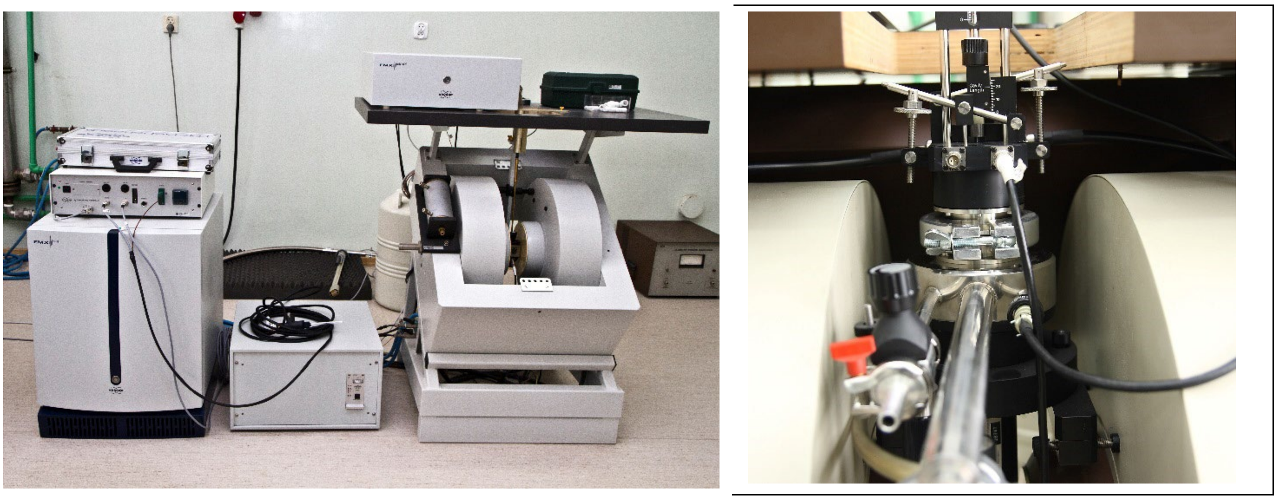


Figure 19- View of the RAPID facility Electron Spin Resonance spectroscopy

The facility is ready to accept proposals for TA. The projects submitted will be evaluated by EURO-LABS INCT Scientific Committee. The members of the committee are representatives of each unit

(4 persons) and facility coordinator. The Scientific Committee is responsible for evaluation of the scientific value of the project and allocation of the beam time.

Information of the EURO-LABS projet, the offered TA opportunities and the application procedure is posted on the INCT web page[16]:

EURO-LABS was further advertised to the community involved in research and development activities in the field of radiation processing as for example to the participants of the IAEA projects (RAR 1021, CRP 61025), and on the webpage of the Polish Nuclear Society[17]: It is also planned to promote EURO-LABS project during NUTECH2023 conference, organised on 20-22 of September 2023 in Cracow, Poland.

5.2.2 CLEAR

The CERN Linear Electron Accelerator for Research (CLEAR) is an electron test facility aimed at developing instruments and components for existing and future accelerators, testing novel concepts as plasma and THz acceleration, investigating medical applications of electron beams including dosimetry and FLASH radiotherapy, studying radiation hardness of electronics for aerospace and high energy applications, and training the next generations of accelerator physicists.

CLEAR is composed by a versatile 200 MeV electron linac + a 20 m experimental beamline, and it is operated at CERN as a multi-purpose user facility.

Additional information is available on the CLEAR web site[18].

[16] http://www.ichtj.waw.pl/drupal/?q=node/1267

[17] https://ptnukleoniczne.pl/2022/10/03/rusza-projekt-euro-labs/

[18] https://clear.cern/

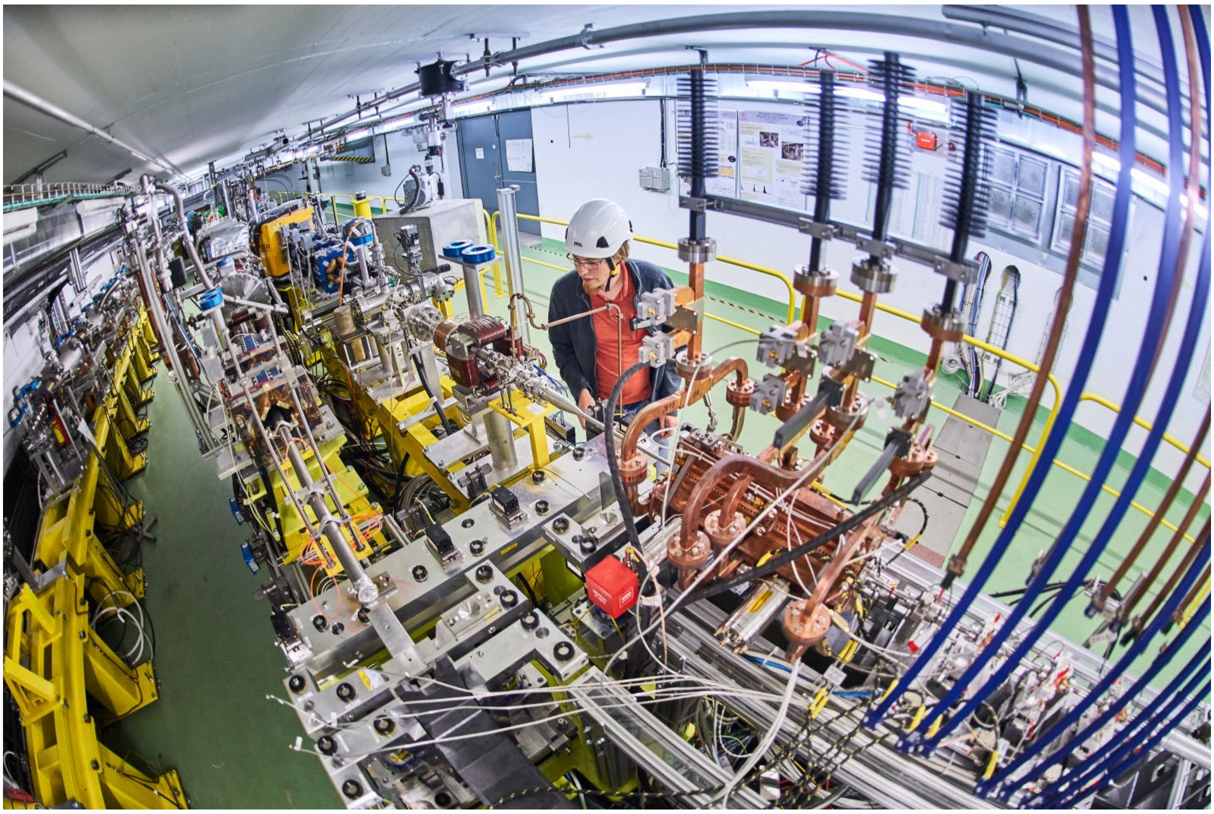


Figure 20- View of the CLEAR facility

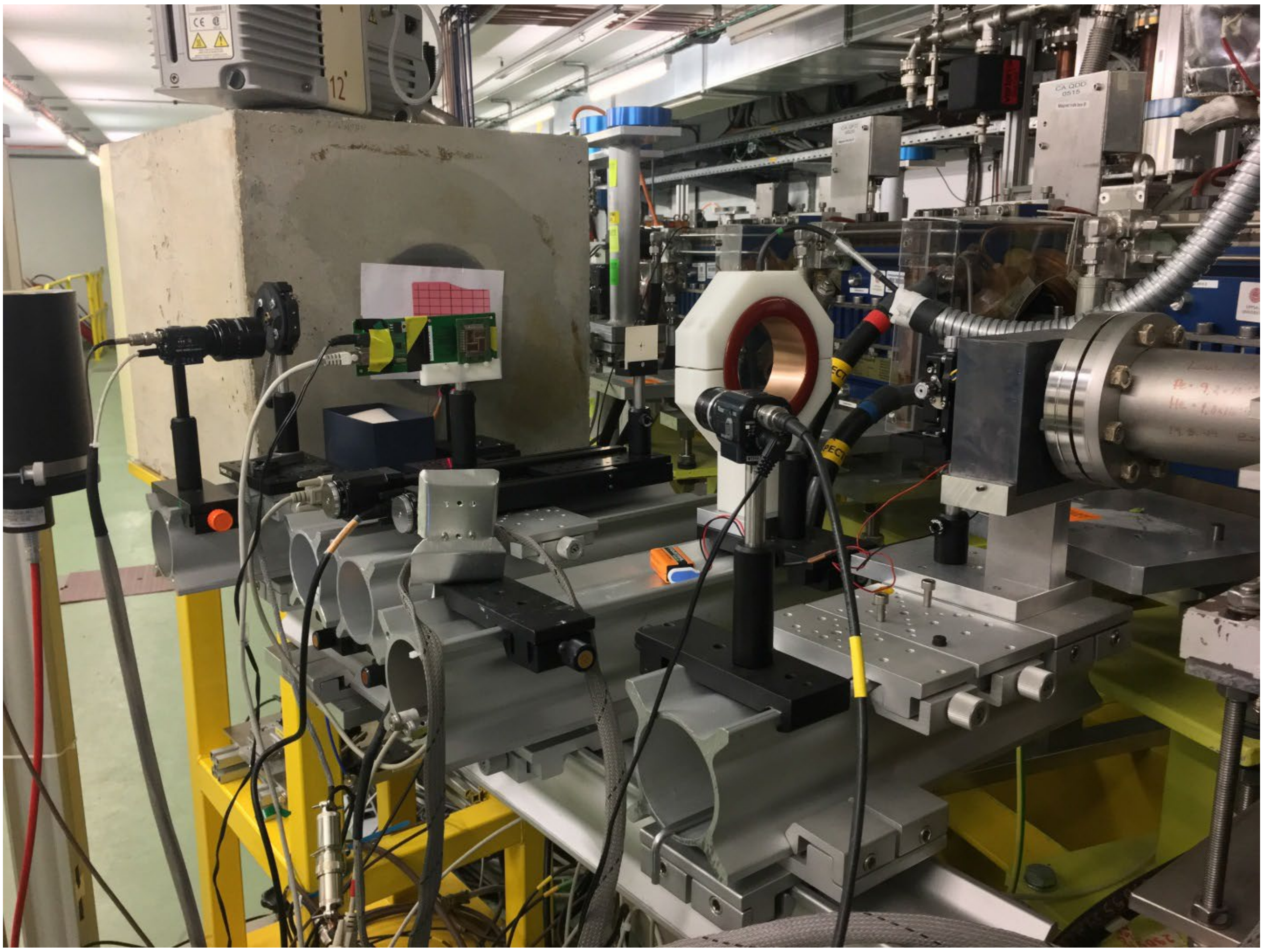


Figure 21 - The VESPER beam line in CLEAR

The facility is ready to accept proposals for TA. The present planning of the facility operation includes:

- Beam Commissioning: ~27/02/2023 - ~03/03/2023,
- Beam for Users: ~06/03/2023 - ~01/12/2023.

Any user willing to access the facility has to fill-up a beam time request form[19] specifying experiment description, scientific aim and justification, needed beam parameters, experimental apparatus and logistics. The CLEAR Scientific Board (CSB) periodically reviews the progress of the experimental program, steers the experimental program, and gives recommendations on proposed experiments and activities based on their scientific interest and the availability of the facility. The Scientific Board members participate to the formal approval process of the beam time requests. The CLEAR Technical Board is responsible to give the final authorization and allocate the beam time in the schedule, after checking technical feasibility and scientific interest and safety and RP issues, following guidelines by the CLEAR Scientific Board.

Effort is made in different fronts to publicize EURO-LABS and the offered TA to the CLEAR user community and wider audience. In particular:

[19] https://clear.cern/content/beam-time-request

- The aim of the project and details about eligibility and application procedure are posted on the CLEAR web page[20] and [21].
- A mail has been sent to the mailing list of the CLEAR User community, including past and projected users, also detailing the project and the application procedure.
- It is planned to promote EURO-LABS during the VHEE/FLASH Workshop, being organised at DESY in June 2023.
- Information on EURO-LABS and application formalities to CLEAR will also be disseminated at the IPAC23 Conference, 7 - 12 May 2023, Venice, Italy.

[20] https://clear.cern/content/euro-labs
[21] https://clear.cern/content/beam-time-request

ANNEX: GLOSSARY

Acronym	Definition
TA	Transnational Access
VA	Virtual Access
RI	Research Infrastructure
HiRadMat	High-Radiation to Materials
AMICI	Acceelerator and Magnet Infrastructure for Cooperation and Innovation
FREIA	Facility for REsearch Instrumentation and Accelerator development
LASA	Laboratory for Accelerators and Applied Superconductivity
THOR	Test in HORizontal
ALFA	Acceletator Facilities at KIT
BESTEX	beam screen test bench experiment at KARA
FLUTE	Ferninfrarot Linac und Test-Experiment
KARA	Karlsruhe Research Accelerator
KIT	Karlsruhe Institute of Technology, Germany
Linac	linear accelerator
RI	Research Infrastructure
SRR	Split Ring Resonator