NFFA2050 is a distributed infrastructure that strategically integrates the most advanced resources of the PSE Analytical Landscape including ESFRI, national, and academic laboratories to provide **unique integrated workflows** to users addressing curiosity-driven as well as innovation-oriented research in the physics of matter and advanced materials.

KEY MESSAGES

Builds on the over 10 years of operation of integrated Experimental and Theory Services delivered through orchestration by top-academic and national laboratories as well as fine analysis large-scale facilities of the ESFRI PSE Landscape.

Increases productivity and reproducibility of the results as users can exploit the offer of multiple RIs through a single proposal and with an access programme that is re-optimized as new data are generated and fed into the workflow.

Over 3000 European and international researchers have accessed NFFA-Europe exploiting its catalogue of 180 methods and over 600 instruments, demonstrating that integrated access has become a structural asset of the PSE Landscape that should be established as a long-term ESFRI Roadmap service.

Implements headline AI models directly embedded in the experimental and theory research process. Data generated in intermediate steps of the research will feed in the hybrid-workflow for its continuous update, ultimately enabling the user to steer the research process in real-time.

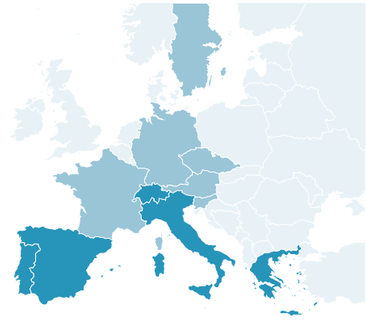
A unique transformative RI offering of hybrid workflows based on a digital catalogue (including digital twins of key instruments and methods) and AI orchestration, optimizing the user effort, the instrument usage time, and automatically generating high-quality FAIR datasets for AI-enhanced analysis and reuse.

Enables the use of the most advanced methods as integrated services for technology-oriented research.

Optimizes investments across its members, focusing on novel capabilities to stay at the frontier, avoiding duplication of efforts beyond functional redundancy.

Bridges the gap between research and technology infrastructures, contributing to structure the value chain of innovation in the ERA Landscape.

nffa2050



NFFA2050 creates an ESFRI-level integrated environment that fosters advanced science in matter and advanced materials, interconnecting the most relevant elements of the PSE-analytical landscape.

NFFA2050 translates into the PSE research domain the EU strategy for increasing Europe's overall competitiveness in line with the policy recommendations of the Letta report (Much more than a market -2024), the Draghi report on EU competitiveness -2024, and the Heitor report (Align, act, accelerate research, technology and innovation – 2024) looking ahead to the next Framework Programme, namely:

- Contributing to the defragmentation of national initiatives in science and technology by creating a coherent European research environment
- Integrating resources and competences to accelerate excellent research and deep-tech development
- Pursuing interoperability of unique advanced resources and methods across TRLs in critical sectors of raw, advanced and quantum materials and technologies
- Realizing a research platform boosting European leadership in key technological challenges of high societal and economic impact, including, e.g., sovereignty in energy (hydrogen, fusion, batteries, solar 3.0), secure quantum communication and precision medicine
- Creating a continuum of services with the technology infrastructures by ensuring support for upscaling and prototyping at the intermediate TRLs
- Strengthening European sovereignty and originality in research-oriented AI for science and technology
- Feeding high-quality scientific FAIR data to community data spaces (EOSC, EHDS, ...)

* Coordinator

POLITICAL SUPPORT

FINANCIAL COMMITMENT

SUPPORTING ORGANIZATIONS

PARTICIPANTS

IMPACT

SCIENTIFIC EXCELLENCE

NFFA2050 strengthens excellence in nanoscience by providing integrated access to Quantum Fab and NanoFoundry facilities, enabling advanced multimodal studies and the combination of multiple “messengers” for a comprehensive analysis of nanoscale systems, supported by automation and AI driven services.

INNOVATION AND COMPETITIVENESS

By delivering FAIR-by-design data, interoperable services and tailored analytical capabilities, NFFA2050 supports the development of a deep-tech innovation environment, acting as a strategic research partner and technology platform for startups, industry and collaborative R&I projects, in line with European competitiveness and innovation policies.

HUMAN CAPITAL AND SKILLS

NFFA2050 contributes to Europe’s skills agenda by training researchers, engineers and RI professionals in advanced instrumentation, data stewardship, AI-assisted research workflows and RI management, strengthening institutional capacities and ensuring long term sustainability of the European Research Area.

SOCIETAL VALUE

Through coordinated dissemination and outreach, NFFA2050 promotes broad uptake of integrated methods and services across research and innovation communities, supporting knowledge transfer, technology maturation and effective use of the infrastructure including medium- to high-TRL activities.

BUSINESS CASE

NFFA2050 as a sound, low-risk and high-impact public investment aligned with ESFRI and ERA sustainability principles.

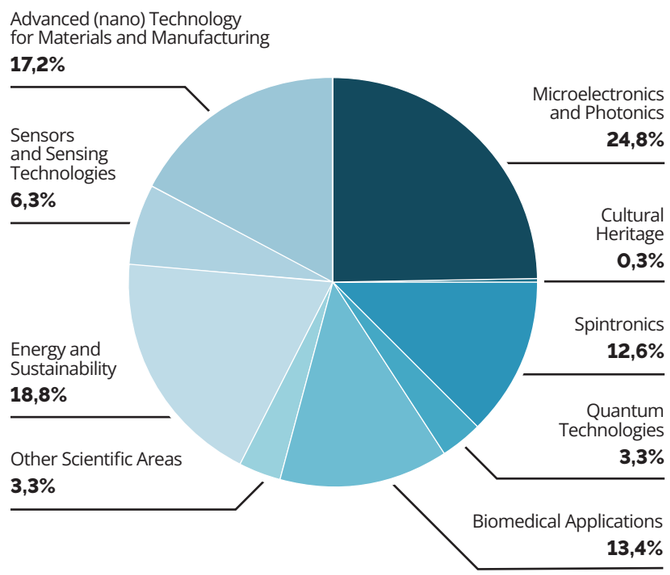
- The infrastructure addresses a structural gap in European nanoscience demonstrated by more than 300 user demands per year.
- Benefits clearly outweigh investments. Every euro invested in NFFA2050 generates €1.9–€2.0 of direct, quantifiable socio-economic benefits, even under conservative assumptions.
- Benefits arises from: proposal-based access (value of research time), virtual access enabled by digital services, scientific publications and knowledge creation, FAIR data repositories with high reuse value, job creation through technological spill-overs, especially in AI-enabled tools.
- Digitalization and FAIR data fundamentally enhance scalability and sustainability of the infrastructure services.
- Bridging services across the research and technology infrastructure gap, i.e. ensuring upscale of research results to meet the uptake by industry-oriented development and test facilities.

CRITICAL RESEARCH FRONTIERS

Europe needs to enhance its competitiveness and technological sovereignty in critical fields to support the consolidation and advancement of the economy and society. All technology domains require going beyond current bottlenecks in materials lifecycle concerning replacement of scarce raw materials, synthesis and testing of novel materials and material architectures, exploitation of nano-structures and quantum materials.

NFFA2050 will be a unique enabler of strategic physics research on matter and materials as the optimal integration of multiple techniques covering the whole research-chain from design and synthesis of materials to their advanced characterization and fine analysis and numerical simulation with the most advanced methods available in Europe.

By implementing the NFFA2050 ESFRI project an unprecedented higher level of RI integration will be reached exploiting Digital Twins, AI and automation to enhance the impact on basic science as well as upscaling projects, bridging the frontier with technology infrastructures. Official support has been expressed by Pilot Lines under the Chips Act.



QUANTUM MATERIALS

Quantum Flagship, EU Chips Act

EuroHPC JU; Chips JU

ADVANCED MATERIALS AND ENERGY

AMI2030 - The EU Advanced Materials Initiative

Strategic energy technologies for a competitive, secure and sustainable Europe

Clean Hydrogen Partnership

The BATT4EU Partnership

The European Solar PV Industry Alliance

BIOTECH

The European Biotech Act

Circular Bio-based Europe Joint Undertaking (CBE JU)

Innovative Health Initiative

AI

RAISE

IAM4EU (Innovative Advanced Materials for Europe)