
CERN

The IT Department Innovation Model

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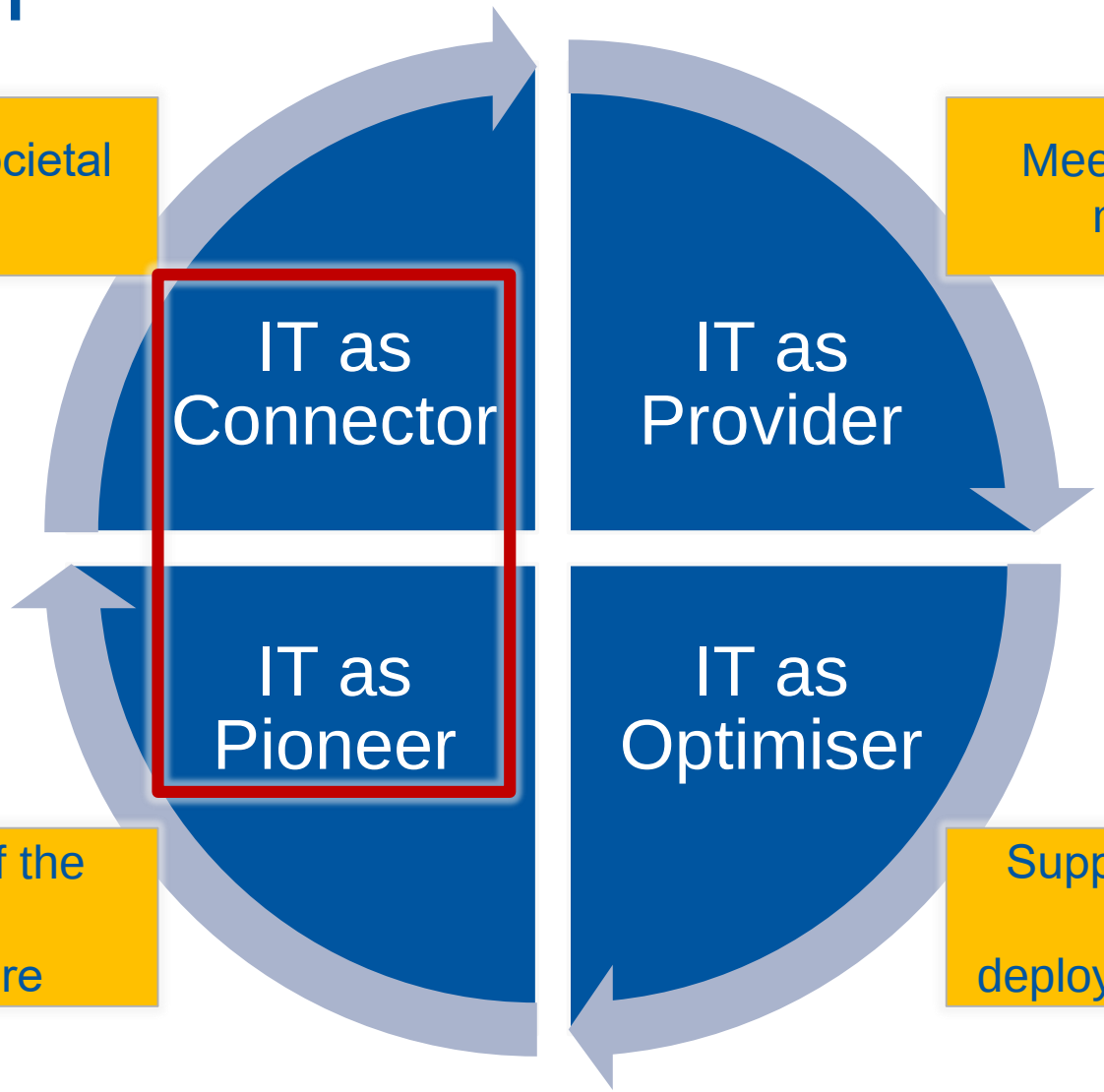
CERN IT Department Core Missions

Increase CERN's scientific, societal and economic impact

Meet the Information Technology needs of the Organization



R&D Innovation

Operations Engagement

Prepare for the challenges of the scientific programmes' evolution and the lab's future

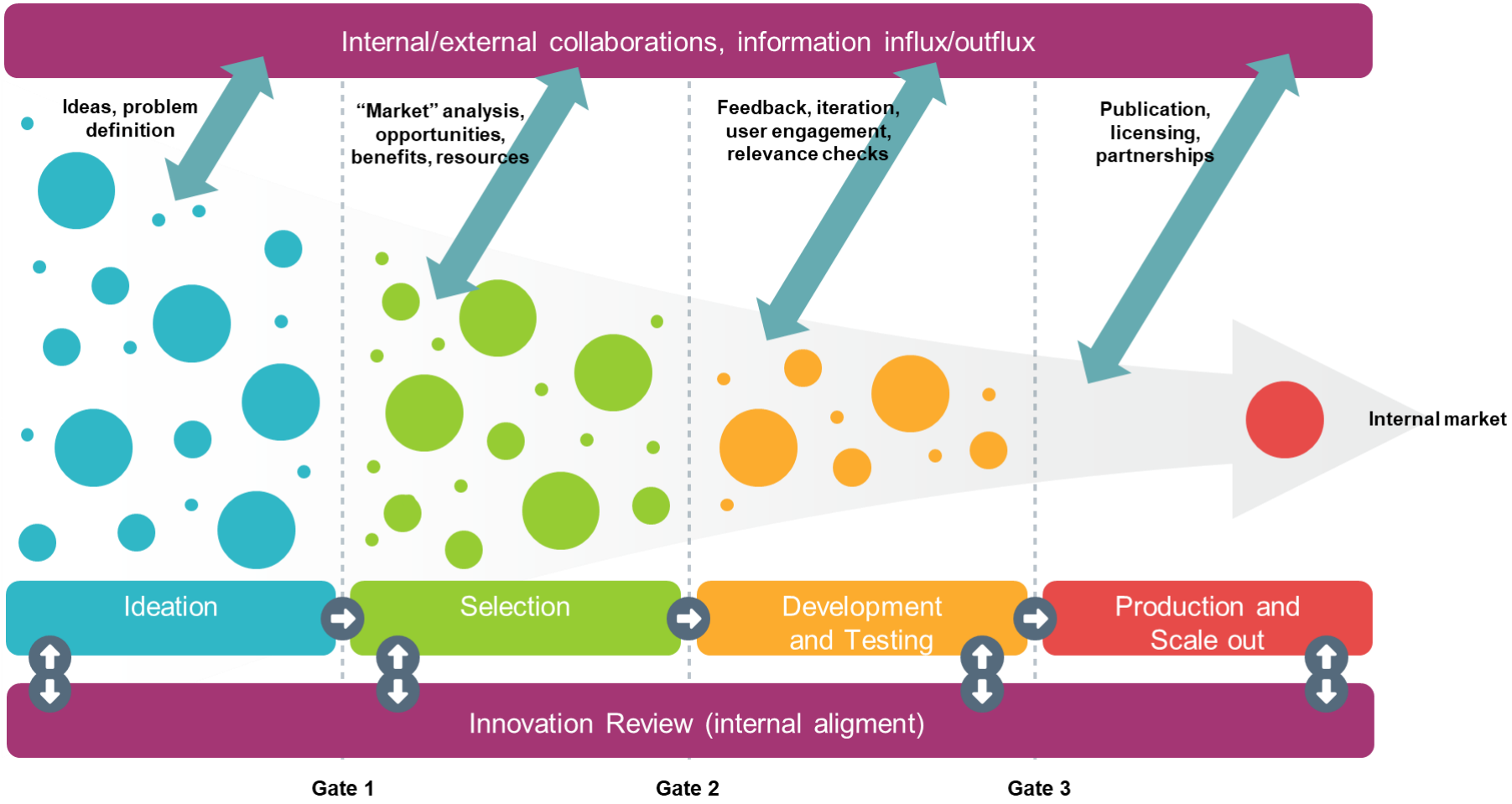
Support CERN's existing scientific programmes by deploying production quality services

Open Innovation

"Innovation is the process of turning ideas into solutions to generate value"

There are several models of Innovation developed in the past 40+ years

The one we take as base model is the **Open Innovation** framework



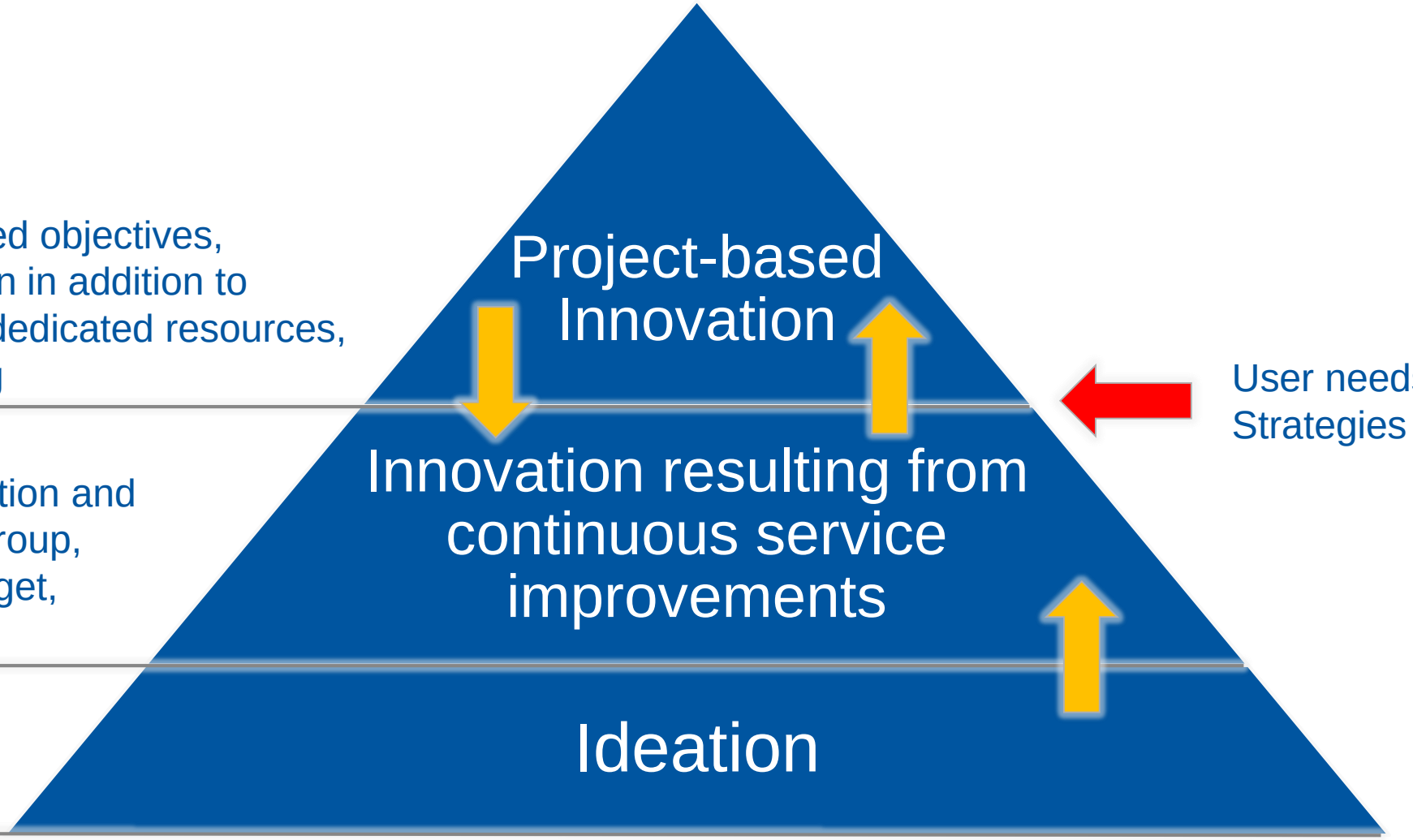
Chesbrough, Henry William (1 March 2003). *Open Innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press. ISBN 978-1578518371.

Innovation scopes

Innovation activities within stated objectives, expected results, transformation in addition to evolution, longer-term impact, dedicated resources, formal monitoring and reporting

Part of the continuous optimisation and evolution of services in each Group, within standard operations budget, standard reporting

Informal channels and discussions, multiple formats



Innovation and collaboration channels

IT Projects

From Engagement, Technical Delivery, IT Ideation

Core strategic activities

KT Projects

KT Funds
Medical Apps
CIPEA
Impact Fund
CERN & Society Foundation,
etc.

CERN Programmes

Quantum Technology Initiative

DS&AI Initiatives

Open Science

CERN openlab

Industrial and academic projects

Short/Medium-Term Public/private R&D partnerships

Strategic Partnerships

Ex. other international organisations (ex. WHO, ESA)

Long-term industrial collaborations

EC Programmes

Horizon Europe

EOSC
EuroHPC
EQF

Open Science

Internal funding

Co-development, investments, external funding
IT invests in supervision, knowledge, infrastructure

Programmes complementarity and alignment

IT Innovation Roadmap


ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

IT Department

Innovation Roadmap

V. 0.1

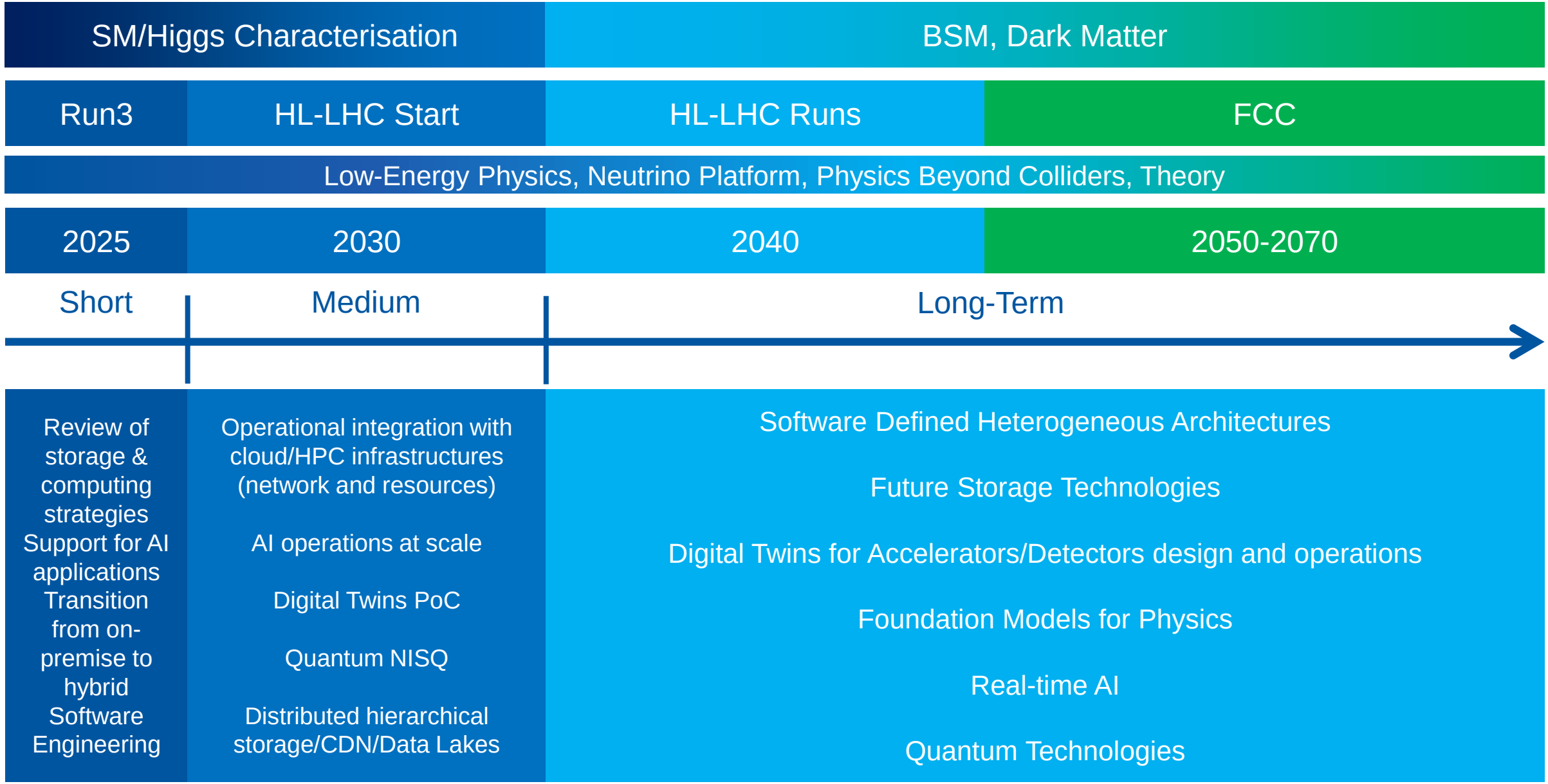
14 March 2023

Formal document describing the Innovation strategy, objectives, processes, collaboration channels, etc.

Being developed in collaboration across the the IT Department functions and technical groups and the CERN community

Internal draft being review now before broader review across the community in April-May 2023

A version of this Roadmap will also be published a white paper building on and extending the traditional CERN openlab white paper published at the beginning of each new phase


SM/Higgs Characterisation
BSM, Dark Matter
Run3
HL-LHC Start
HL-LHC Runs
FCC
Low-Energy Physics, Neutrino Platform, Physics Beyond Colliders, Theory
2025
2030
2040
2050-2070
Short
Medium
Long-Term
Review of storage & computing strategies
Support for AI applications
Transition from on-premise to hybrid
Software Engineering
Operational integration with cloud/HPC infrastructures (network and resources)
AI operations at scale
Digital Twins PoC
Quantum NISQ
Distributed hierarchical storage/CDN/Data Lakes
Software Defined Heterogeneous Architectures
Future Storage Technologies
Digital Twins for Accelerators/Detectors design and operations
Foundation Models for Physics
Real-time AI
Quantum Technologies

Objectives at a glance

Open Science and Impact
Technology and services
Scale-up, collaborations

Artificial Intelligence
Algorithms, Platforms and Services

Computing
Heterogeneous Infrastructures and Software

Data Storage and Management
Hierarchical storage and data distribution

Long-term investigation

SDIs

Digital Twins

Foundation Models

Quantum Technologies

Objective 1: Introduce heterogeneous computing infrastructures and software engineering services and tools

Why (Impact)	What (Results)	Examples (activities)
CERN and experiments computing needs are evolving towards new computing architectures and services beyond what can be provided only from on-premise	Integrate heterogeneous resources on-premise, cloud, and HPC Analysis Facilities Support development of software able to exploit such resources Performance and energy consumption	Assessment of performance and portability libraries (Intel oneAPI Intel) ML/DL development, performance benchmarks (RAISE) Partnerships and agreements with commercial Cloud providers and HPC centres for testing, validation, integration, software development (CERN openlab, EC projects, EuroHPC) Software engineering, optimisation, benchmarks with experiments (MadGraph and AdePT) Devel, test, training on GPUs, FPGAs, CUDA, C++ (E4, Nvidia, Micron, HSF)

Objective 2: Scale-up data management, data storage, databases towards HL-LHC requirements

Why (Impact)	What (Results)	Examples (activities)
HL-LHC comes with severely scaled-up requirements in terms of data volumes and analysis requirements and additional flexibility in moving data across the infrastructure but also across interactivity scopes (cold/warm/hot)	Analysis facilities Assess CDNs, Data Lakes, different topologies and architectures. Set up PoCs Interact/integrate with international data management initiatives and services	Synch&Share, ScienceMesh development (CS3MESH4EOSC) DAOS evaluation for caches and databases (Intel) Replication, cloud-enabled BC/DR (Oracle) Data archival technologies and applications (ARCHIVER)

Objective 3: Support the introduction of AI in the community

Why (Impact)	What (Results)	Examples (activities)
AI has become an essential tool in all research activities, the IT department needs to support it and provide the necessary services. AI services require close coordination of networking, computing, storage and platforms	Revise the IT services portfolio and design new services based on best-of-breed technologies on-premise, cloud and HPC. Work in close collaboration with users and technology infrastructure providers. Take part in common algorithm development and optimisation	Generative Models for detector simulation (Intel, Nvidia) AI models lifecycle, model repositories (Oracle) Data acquisition denoising (IBM, Dune) Event classification with Kubernetes (Google) Network traffic optimisation (CS) Graph networks for Reconstruction (CMS) Neural Architecture Searches, hyperparameters tuning (various collaborations with HPC centres in EU and US)

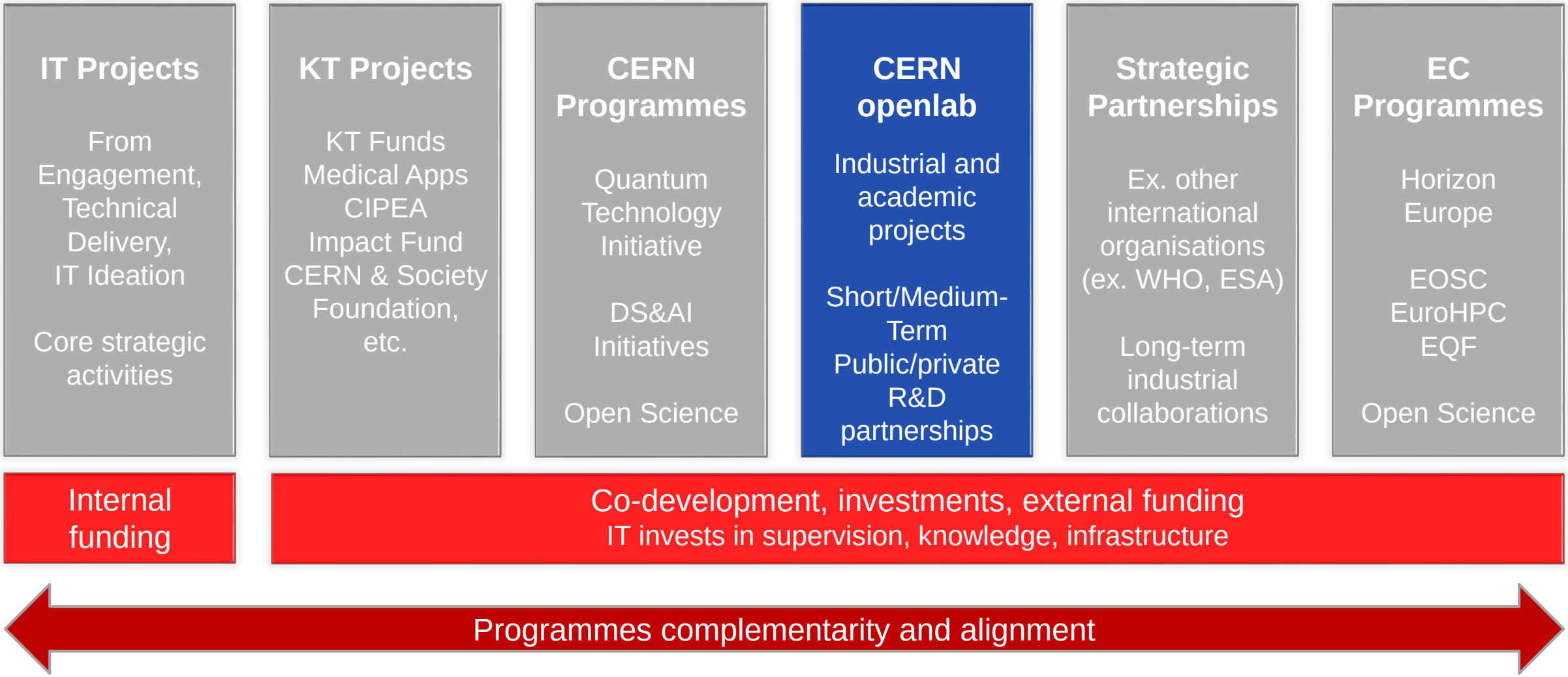
Objective 4: Keep the IT Department at the forefront of R&D

Why (Impact)	What (Results)	Examples (activities)
CERN objectives as part of the HEP community are long term. Future programmes such as HL-LHC, Physics Beyond Colliders or the FCC require technologies not yet available today. CERN and CERN IT need to keep a leading role.	Investigate and set up PoC projects in emerging technologies like advanced AI and Foundational Models, Digital Twins, quantum computing, future network and storage technologies; collaborate with other labs and industry	Quantum Computing algorithms development and characterisation for various HEP applications (experiments and theory) Long-term network & infrastructures technology co-development (classic and quantum) Digital Twins design and development for HEP detectors, robotics, industrial systems (InterTwin) Foundation models for physics Evaluation of emerging storage technologies (cristals, DNA-based storage)

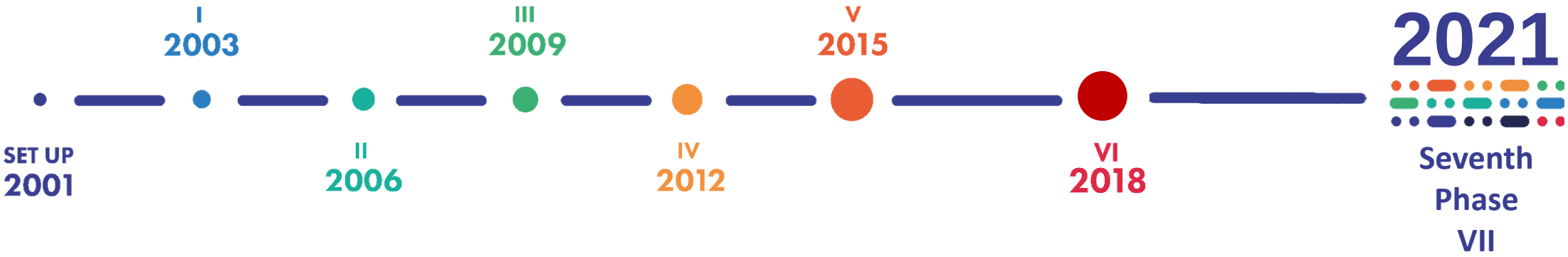
Objective 5: Enable and Support Open Science and Societal Impact

Why (Impact)	What (Results)	Examples (activities)
CERN mission goes beyond HEP research, the broad objective of societal impact is an explicit part of such mission. Generating and sharing knowledge and supporting open science has a critical positive impact on CERN reputation	Engage in selected multi-disciplinary activities supporting the impact strategies defined by CERN (industry, medical, climate, aerospace/Earth observation) Advance knowledge, contribute to open tools and policies, support other scientific communities	Innovation in digital asset management, reproducibility, collaboration tools where CERN technologies have measurable impact (Invenio, Zenodo, REANA, Onboard, etc.) Digital Twins and Federated Learning for climate and social sciences, medical applications (InterTwin) Contributions to open search tools and intelligent semantic analysis of scientific text and data (OpenWebSearch, CAiMiRA) Innovative AI-based modelling and prediction of extreme whether phenomena (EMP2) Quantum-safe and post-quantum applications (Quantumacy)

Innovation and collaboration channels



DRIVING INNOVATION FOR 20 YEARS



Thanks!

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