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Valencia, April 26,2023

Outline:

I.FAST in a nutshell
role of I.FAST in accelerator research
challenges, opportunities and priorities
where I.FAST is right now
highlights from 2y of project implementation
common initiatives

I.FAST in a nutshell

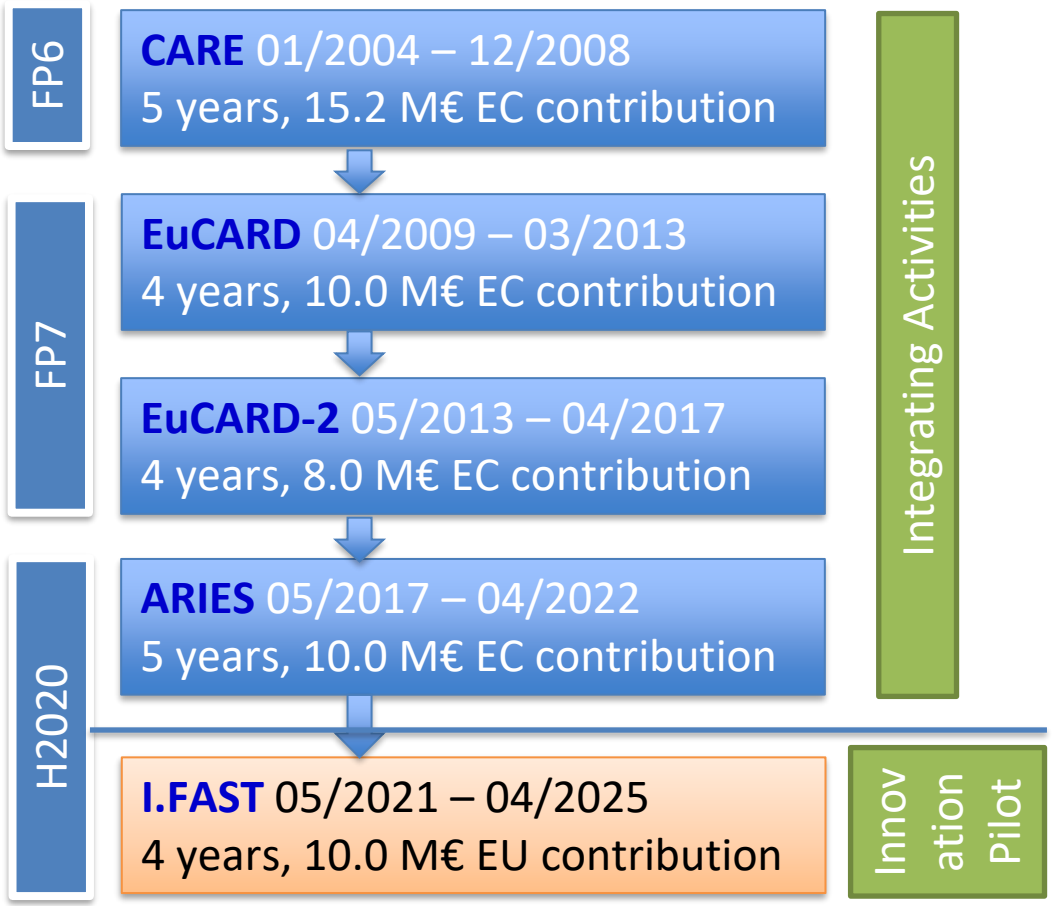
Innovation Fostering in Accelerator Science and Technology

Innovation Pilot, A new pilot instrument to demonstrating the role of Research Infrastructures in the translation of Open Science into Open Innovation, an evolution of our R&D programmes towards more industry participation, supported by the European Commission.

- **48 beneficiaries of EC funding:** 8 large RI operators, 12 national research centres, 12 universities, 15 industrial partners (**1/3**, including 11 SMEs) - from 15 European Countries, supported by 12 partner organisations and >20 collaborating institutions.
- **40 R&D** Tasks to develop a portfolio of technologies for the next generation of particle accelerators, 15 with industry participation.
- Timeline: **4 years**, starting 1 May 2021.
- Resources: **10 M€** EC contribution, total project cost **19 M€.**

With 15 industrial partners, industry makes up 1/3 of the consortium.

Integrating Activities for accelerators and the new Innovation Pilot I.FAST



Long tradition of EC support to **particle accelerator R&D**: four successful Integrating Activities have raised 43 M€ EC funding over **16 years** (2.7 M€/yr).

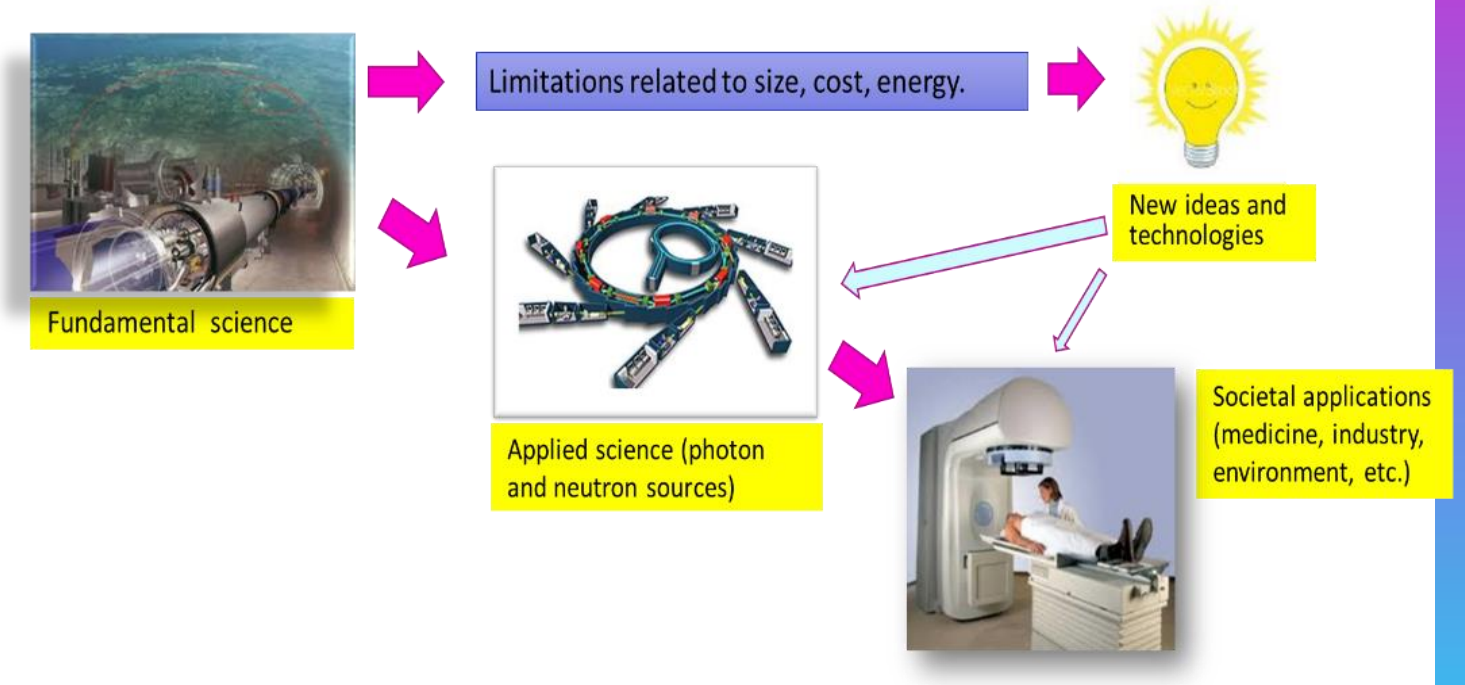
Integrating Activities (and Innovation Pilot): Development of cross-boundary subjects, not directly followed by large laboratories, with added value coming from collaboration and sharing of resources.

I.FAST is a new step in this progress, including for the first time a large industry representation (1/3 of participants!)

The role of I.FAST in accelerator research

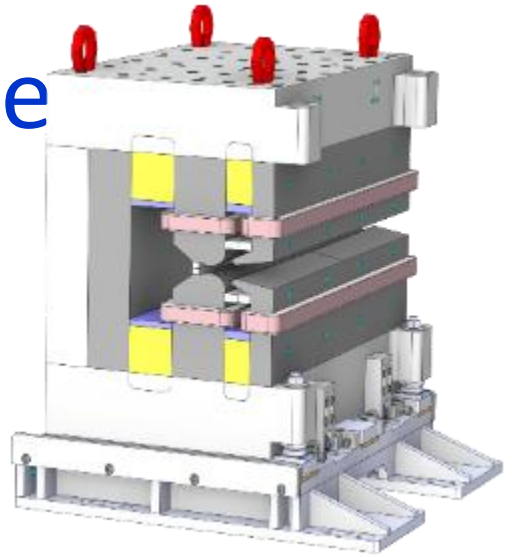
- For the entire XX century, **fundamental science** as driving force for the development of new accelerators, with its continuous quest for higher energies required to discover new particles.

- Today, **extrapolating** present technologies to reach new physics goals may soon bring accelerators towards the **limits of sustainability** (dimensions, complexity, cost, energy consumption).
- In parallel, increasing demands are coming from accelerators for **applied science** (photon and neutrons) and **healthcare**, while new **societal applications** are appearing.



The scientific goal of I.FAST is to **support the development of new more sustainable technologies** for basic and applied science, promoting at the same time the **transfer of these technologies to society and to a wider accelerator market**.

Challenges and opportunities for particle accelerator R&D: the need for industry

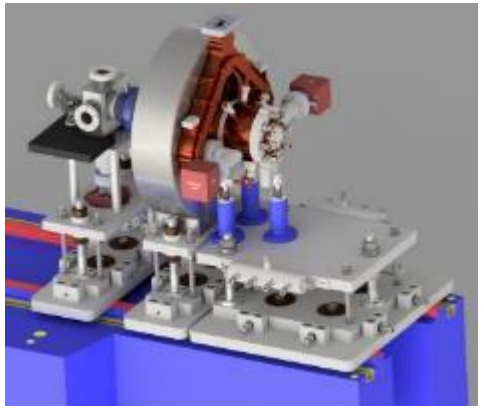


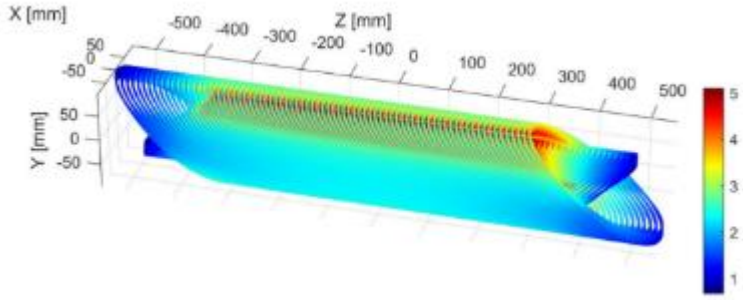
Opportunities:

- Strong demand for R&D: accelerators are crucial tools in the progress of modern science and technology (physics, biology, medicine, material science, etc.).
- Mature technology, with large industry involvement.
- Supported by a wide, motivated, and rapidly expanding scientific and technological community, spanning across continents.

Challenges:

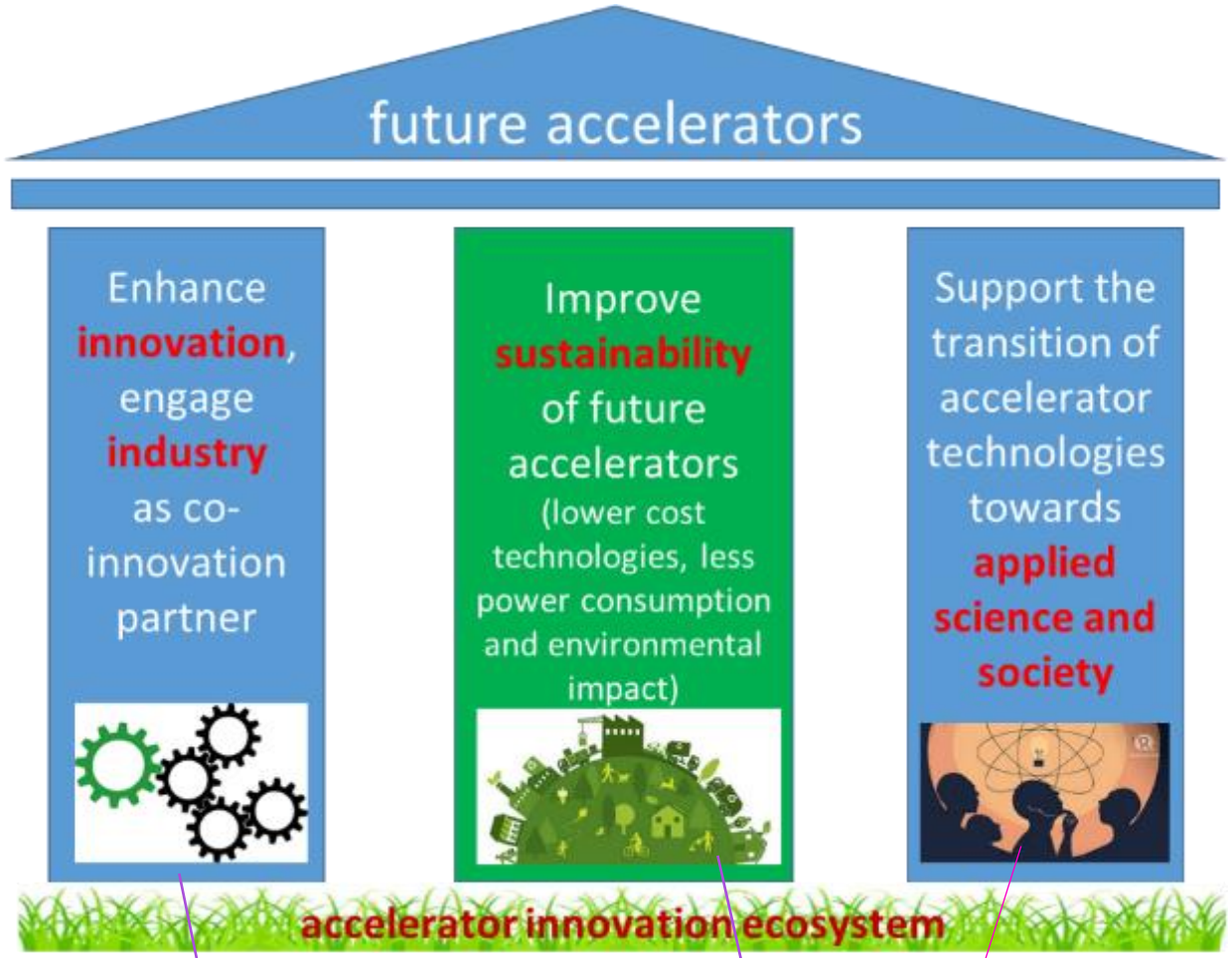
- Presence of many actors, many projects, many technologies, with different priorities and time-scales.
- Long time scale and high cost of accelerator R&D, well beyond the capabilities of single EU projects.
- Strong dependence on post-ww2 technologies increasingly faraway from modern industry's focus.
- Needs coordination and sharing of resources.





iFAST

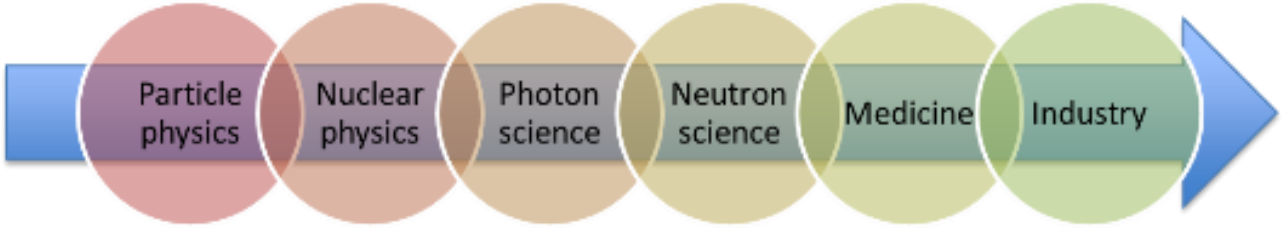
The three I.FAST pillars



- Three «pillars» defined the priorities given in the selection of I.FAST activities following a bottom-up call.
- Additional focus areas: training and management of technology infrastructure.
- This strategy is coherent with the priorities announced in the 2020 Update of the European Strategy for Particle Physics, and more at large with the priorities of the particle accelerator user communities, as overseen by the TIARA Collaboration.

I.FAST Priorities

- A project largely made of "**co-innovation**" R&D activities (prototyping) with industry, at different Technology Readiness Levels (TRL) – 15 Tasks / 40.
- On three priority lines:
  1. **Transversality,** exploiting synergies between accelerators for different users: particle and nuclear physics, photon and neutron science, medicine and industry.
  2. **Collaborative schemes** involving laboratories, university and industry.
  3. Priority to **long-term R&D** topics, beyond the specific needs of approved projects and developments.



The I.FAST vision of industry's role: times have changed

We observe that over the last years around particle accelerators has grown a network of companies, most of them SME's, often created and operated by scientists or by people with a scientific background, that are creative, flexible, innovative, continuously looking for new markets and new applications.

We believe that our scientific laboratories should help these companies to grow and to compete in the global market, to:

a) sustain the virtuous circle of scientific innovation, and

b) demonstrate the social and economical impact of accelerator-based research.

The virtuous circle of scientific innovation

A long term vision

Programmes like I.FAST have to help industry to grow by expanding the particle accelerator market, in three main directions:

1. Production by industry of increasingly standardized **components for accelerators**, possibly develop in co-innovation with academia.
2. Access with components made for accelerators to **other industrial or "Big Science" markets**.
3. Production by industry of complete accelerator set-ups for **applications in industry, medicine, environment, etc.**

I.FAST Industry participation

Beneficiaries (15):

RHP Technologies (Austria)

Bergoz Instrumentation, Thales (France)

BNG, Barthel HF-Technik, ILK (Germany),

COMEB, KYMA (Italy)

VDL-ETG (Netherlands)

CYCLOMED, Elytt, Nanoker (Spain)

GEMS, Scanditronix (Sweden)

TMD Technologies (UK)

Partners (2):

Amplitude (France)

INEUSTAR (Spain science industry association)

Industry Advisory Board (11)

Total of 28 companies represented in I.FAST

I.FAST Industry initiatives – 2021/23

- **230** registered participants in the 1st I.FAST Accelerator-industry co-innovation workshop at CERN (May 2022), **91 from industry**.
- Proposed creation of the "**Accelerator Science and Technology Permanent Industry Forum**", to continue after I.FAST. The Terms of reference are in preparation.
- Presentations on **I.FAST industrial strategy** at the 2022 International Particle Accelerator Conference in Bangkok, at EPS Forum in Paris, and at Big Science Business Forum in Granada.
- Initial applications for the I.FAST **Industrial Training** (exchange programme academia/industry), start of programme in 2023.
- One more company (TRUMPF) **joining** on their own funds, two more companies (Ceraco, SBI) participating in I.FAST Innovation Fund (total of **18 industrial partners**).
- Co-organisation with AIDAinnova of the Workshop on **advanced mechanics** during Annual Meeting in Valencia (27.04).

Industry at Annual Meeting 2023 in Trieste

- 27 participants from industry, out of 122 registered at 27.03 (22%).
- Industry Workshop on High Temperature Superconductivity developments and applications, Tuesday 18/4.
- Workshop on Roadmap for Technology Infrastructure, Wednesday 19/4.
- Meeting of Industry Advisory Board

Plenary sessions: Wednesday 19/4-Friday 21/4

Work Packages and Tasks

WP	
1	Coordination, dissemination
2	Training, communication, outreach
3	Industry engagement
4	Managing Innovation, new Materials
5	New concepts, performance improvements
6	Novel particle accelerators concepts and technologies
7	High brightness synchrotron light sources
8	Innovative superconducting magnets
9	Innovative superconducting cavities
10	Advanced accelerator technologies
11	Sustainable concepts and technologies
12	Societal applications
13	Technology Infrastructure
14	Ethics Requirements

9 thematic areas

9 “thematic areas” plus 4 general WP’s (coordination, training, industry, innovation).

58 Tasks

WP1	Management, coordination and dissemination	M. Vretenar (CERN)	Task 1.1	Project management, external coordination, sustainability
			Task 1.2	Information flow management and cross-coordination
			Task 1.3	Internal communication and dissemination
			Task 1.4	Relation with other innovation pilots
WP2	Training, communications and outreach for accelerator science and technology in Europe	P. Burrows (UOXF)	Task 2.1	Management
			Task 2.2	Communication and outreach
			Task 2.3	Challenge-based innovation (CBI) with particle accelerators
			Task 2.4	Industrial Training associated with knowledge transfer
WP3	Industry engagement	M. Morandin (INFN)	Task 3.1	Coordination and industrial partnership support
			Task 3.2	Knowledge transfer and business opportunities in accelerators R&D
			Task 3.3	Extended participation of industry in collaborative R&D activities
WP4	Managing innovation, new materials	M. Losasso (CERN)	Task 4.1	Innovation management and committee
			Task 4.2	Management of the Innovation Fund
			Task 4.3	Innovative beam windows for high-power accelerator applications
			Task 4.4	Large scale Carbide-Carbon Materials for multipurpose applications
WP5	Strategies and Milestones for Accelerator Research and Technologies	F. Zimmermann (CERN), N. Pastrone (INFN), P. Fork (GSI)	Task 5.1	MUon colliders STrategy network (MUST)
			Task 5.2	Pushing Accelerator Frontiers (PAF)
			Task 5.3	Improvement of Resonant slow EXtraction spill quality (REX)
WP6	Novel Particle Accelerators Concepts and Technologies	R. Assmann (DESY), …	Task 6.1	Novel Particle Accelerators Concepts and Technologies
			Task 6.2	LASers for PLasma Accelerators
			Task 6.3	Multi-scale Innovative targets for laser-plasma accelerators
			Task 6.4	Laser focal spot stabilization systems
WP7	High Brightness Accelerators for Light Sources	R. Bartolini (DESY), …	Task 7.1	Coordination & communication
			Task 7.2	Enabling Technologies for Ultra-Low Emittance Ring
			Task 7.3	Variable Dipole for the upgrade of the ELETTRA storage ring
			Task 7.4	Very high gradient RF Guns operating in the C-band RF technology
			Task 7.5	CompactLight Prototype Accelerating Structure
WP8	Innovative superconducting magnets	L. Rossi (INFN), L. Quettier (CEA), C. Roux (GSI)	Task 8.1	Coordination and HTS Strategy Group
			Task 8.2	Preliminary Engineering design of curved CCT magnet
			Task 8.3	Preliminary Engineering design of HTS CCT
			Task 8.4	Construction of curved CCT magnet demonstrator
			Task 8.5	Construction of HTS CCT magnet demonstrator
			Task 8.6	Development of ReBCO HTS nuclotron cable
WP9	Innovative superconducting thin film coated cavities	C. Antoine (CEA), O. Malyshev (UKRI)	Task 9.1	Coordination and Strategy for Innovative Superconducting Accelerating Cavities
			Task 9.2	Innovative Superconducting Accelerating Cavities
			Task 9.3	Optimisation of process parameters and target development for SRF cavity coating wit
			Task 9.4	Surface Engineering by Atomic Layer Deposition (ALD)
			Task 9.5	Improvement of mechanical and superconducting properties of RF resonator by laser
			Task 9.6	Optimization of flat SRF thin films production procedure
WP10	Advanced Accelerator technologies	T. Torims (RTU)	Task 10.1	Coordination and communication
			Task 10.2	Additive Manufacturing – Survey of applications and potential developments
			Task 10.3	Refurbishment of accelerator components by AM technologies
			Task 10.4	Development of AM-manufactured superconductive RF cavities
			Task 10.5	Photon Stimulated Desorption (PSD) from NEG coatings for accelerator vacuum chamb
			Task 10.6	Machine learning techniques for accelerator and target instrumentation
			Task 10.7	Development of electro-optical waveguide sensors as beam electric field sensors
WP11	Sustainable concepts and technologies	M. Seidel (PSI)	Task 11.1	Sustainable Concepts for Accelerator driven Research Infrastructures
			Task 11.2	High Efficiency Klystron Industrial Prototype
			Task 11.3	Permanent Magnet Quadrupoles & Combined Function Magnets for Ultra Low-Emittar
WP12	Societal Applications	R. Edgecock (HUD),	Task 12.1	A Strategy for Implementing Novel Societal Applications of Accelerators
			Task 12.2	Design of advanced electron accelerator plant for biohazards treatment
			Task 12.3	Design of Internal Rf Ion Source for Cyclotrons
WP13	Technology Infrastructure	S. Leray (CEA)	Task 13.1	Strategy for the development of the AMICI TI
			Task 13.2	Developing and promoting services to industry in AMICI TFs
			Task 13.3	New RF amplifiers based on GaN Semiconductors
WP14	Ethics Requirements	P. Foka (GSI)	Task 14.1	Protection of Personal Data: POPD Requirements
			Task 14.2	Ethics Position Requirements: EPQ Requirements Nr 2

iFAST

Where are we after 2 years?

Successfully completed the 1st EC Periodic Review (1.5.2021-30.10.2022):

- Periodic Report prepared in October-December 2022, submitted in January 2023.
- Scientific Review by external reviewer on 9 February.
- Periodic Report resubmitted with financial information on 9 March.
- Acceptance letter from EC for Period 1 payments received on **12 April**.

Many achievements but also many delays, partly due to the complex environment.

Comments from the EC Reviewer:

1. Overall assessment

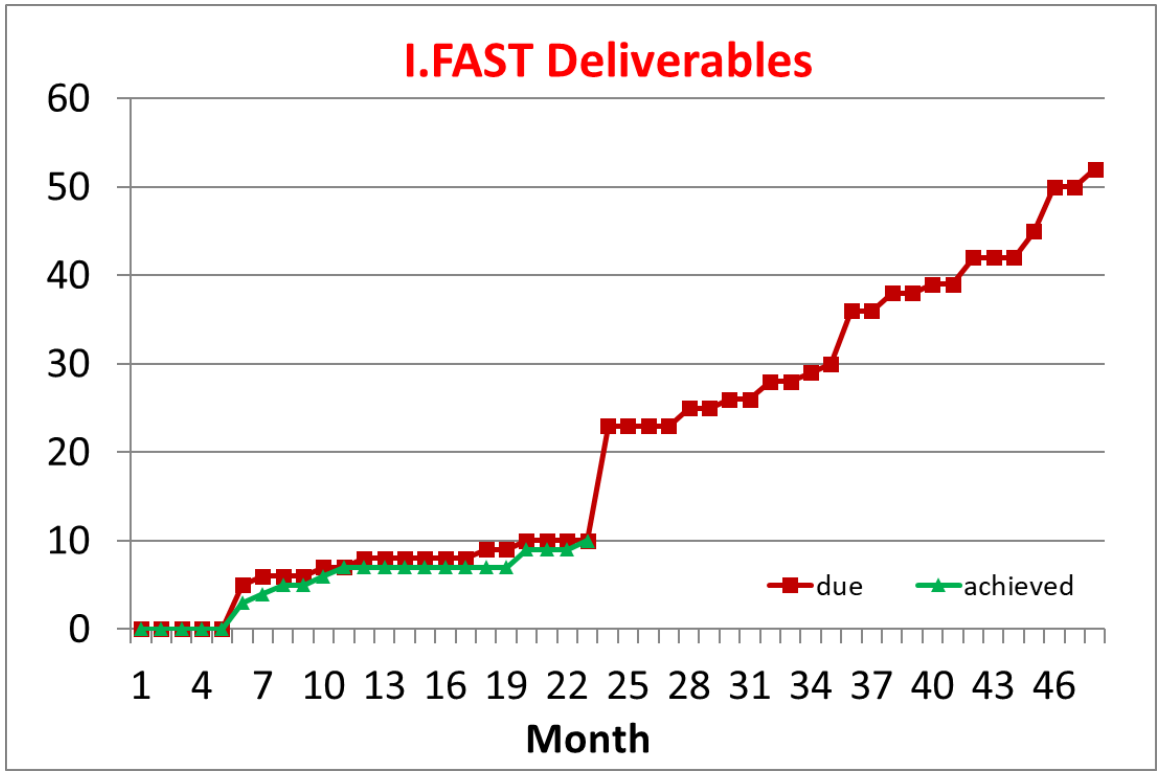
Project has achieved most of its objectives and milestones for the period with relatively minor deviations.

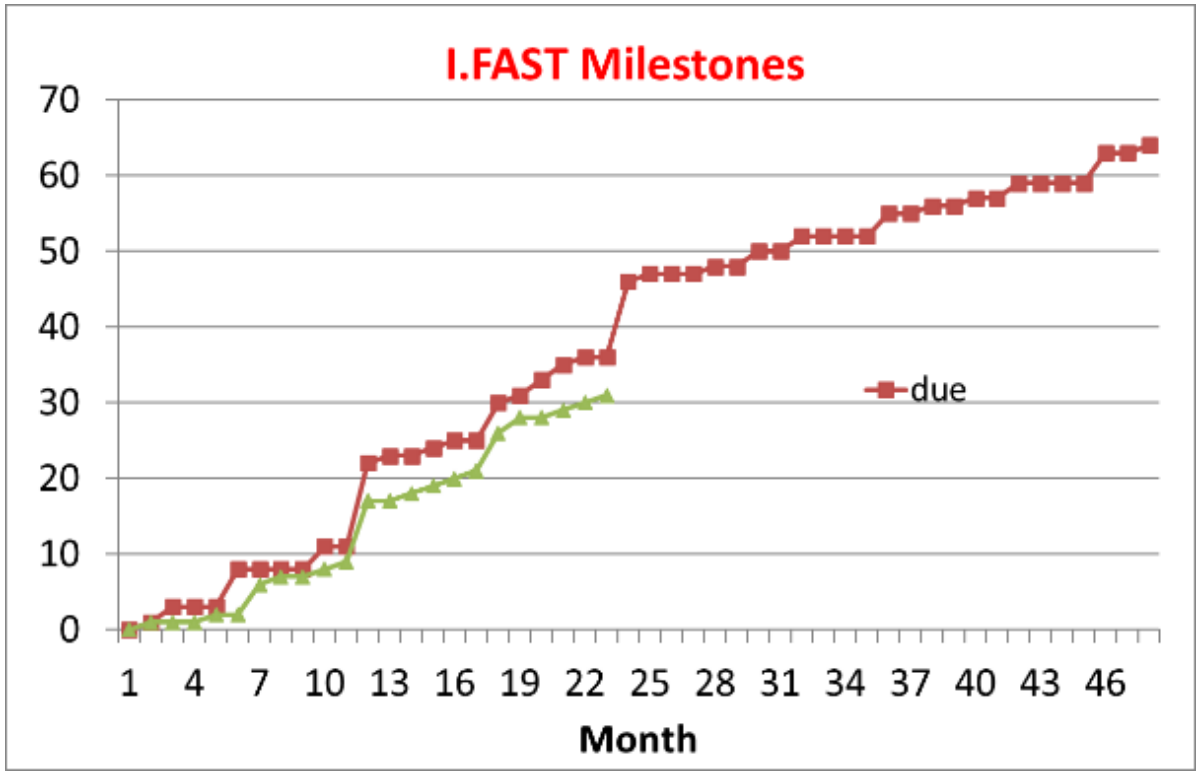
The project has already delivered some significant results in both accelerator developments (additive manufactured RFQ) and also in training and networking activities (challenged based innovation with particle accelerators, management of innovation fund, industry participation) are all very good achievements.

5. Recommendations concerning future work, if applicable

The delayed milestones and deliverables should be achieved and delivered. The number of significant results in accelerator developments from the thematic Work Packages should be increasingly delivered. As one of the main objectives of the project is to promote co-innovation with industry, it is expected that efficient networking, training and also innovation fund management are critical during the future work.

Status of I.FAST - Deliverables





Navigating in a changing world

We are all facing the increase of material and energy costs (and related inflation and delays in deliveries) due to the ongoing worldwide crisis.

This is particularly affecting a project like I.FAST with a large quantity of prototype production often made in industry, for which budget estimates were made at the end of 2019!

We are conscious of the problems encountered by some partners and we are ready to discuss solutions, remaining in the limit of the strict budgetary and time limitations of an EU project.

Mitigations: redistribution of work between partners to reduce costs (but increase risks), descoping of some activities (e.g. smaller prototypes), …

Highlight's of the firsts 2y of I.FAST: AM RFQ

Task 10.2, **Additively-Manufacturing (AM)** survey and potential developments.

Aimed at identifying specific needs for AM (3D printing) in accelerators, no prototyping foreseen. At the start of work, the **Radio Frequency Quadrupole** (RFQ) compact copper linear accelerator for medical and industrial applications was identified as a component that could greatly profit from AM in terms of production time and cost.

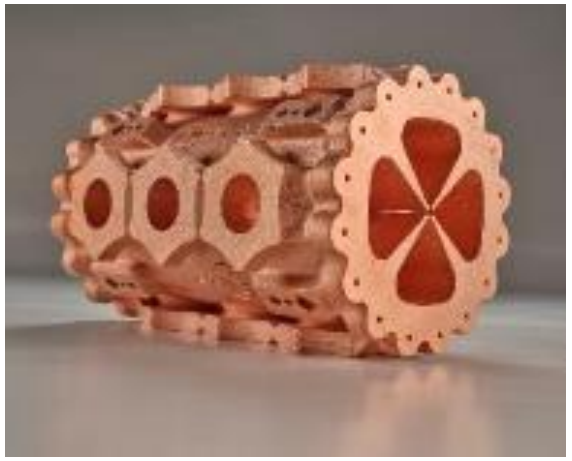
The Task has contacted industrial partners, and Trumpf AG has agreed to produce at no cost for the project a full-scale prototype that is being tested by the Task. Trumpf is joining the Consortium as Partner Organisation.

Wide impact: articles, exhibitions, press release, CERN Bulletin, Accelerating News, CNRS newsletter, CORDIS.


Accelerating NEWS

First 3D-printing of crucial component to bring accelerators closer to society

The first additive manufacturing of a critical accelerator component paves the way toward more affordable and versatile particle accelerators



The 3D-printed RFQ


cnrs

I.FAST présente le premier accélérateur de particules produit en synthèse 3D métal

Dans le cadre du programme européen I.FAST de R&D sur les accélérateurs de particules conduit par le CERN, un quadrupôle radiofréquence (RFQ), élément parmi les plus complexes des accélérateurs de particules, a été synthétisé d'un seul tenant en impression 3D métal. La pièce présentée lors du salon de Francfort Formnext du 7 au 10 novembre dernier, doit prendre le chemin d'IJCLab où elle va subir un certain nombre de tests. Nicolas Delerue, chargé de recherche et spécialiste des accélérateurs l'attend avec impatience.

Highlight's of the firsts 2y of I.FAST : Challenge Based Innovation

Task 2.3, **Challenge-Based Innovation (CBI)** with particle accelerators.

Residential challenge for 24 master students with different backgrounds organised in 4 teams to propose new applications of accelerators for the environment.

Winner: project CYAN for stopping eutrophication (harmful algal bloom) in lakes.

Strong success, projects will be followed-up, articles on CERN Bulletin, Accelerating News and other newsletters, CORDIS. Will be repeated in 2023.

Highlight's of the firsts 2y of I.FAST: Innovation Fund

Task 4.2, **Management of the Innovation Fund**.

1 M€ funding to an internal competitive call for innovative projects, starting early 2023, for a duration of 2 years. In advance on schedule (awarding at M20 instead of M24)

1. Funding between 100 and 200 k€ per project;
2. Consortium: at least one I.FAST beneficiary and one industry;
3. Initial TRL 3 or higher (from proof-of-concept to laboratory/environment validation);
4. Project contributes to improving sustainability of particle accelerator technologies;
5. Project must have potential for industrialisation or commercialisation.
6. Project must have potential to attract more resources than what deployed by IFAST alone.

18 projects submitted, 8 selected by a 10-member Evaluation Committee:

Smooth selection procedure and excellent quality of the selected projects.
Budget allocations approved by the Governing Board by e-mail vote.

IIF: aim and objective

Within WP4, tool to promote innovative initiatives of I.FAST community

Set up to manage and support new proposals in the phase 2 of project

→ Based on ARIES acquired experience and from the 1st phase of I.FAST

Looking for intersections of I.FAST thematic areas and EC priority agenda, contributing in tackling similar priorities of enlarged communities

→ To connect accelerator community and society at large

Distribute and protect generated IP with particular attention to those WPs where industrial companies are involved.

IIF Projects

1. **Permanent magnet solenoid for High efficiency Klystron** (CERN, ELYTT) - design and build a permanent magnet solenoid for an available klystron.

2. ***High-Temperature High-Gradient Superconductors*** *(CERN, CSIC, CERACO) - develop and optimize a 3D coating technology and demonstrate its scalability to make practical RF high power devices.*

3. **Field Emission Cathode for a Travelling-Wave RF gun for High Brightness Beams** (PSI, VDL) - develop a versatile high brightness MeV electron source based on a field emission cathode.

4. **KAIO Accelerator** (CNRS, CNR) - industrially develop a cost- efficient and stable high-power laser technology in the kHz class, apt to be used in radiobiology and testing applications.

5. **Development of Highly Efficient MW Class Cross Field Vacuum Tube Amplifier for Particle Accelerators Driven by a Solid-State Power Amplifier at 750 MHz** (UU) - develop a megawatt class cross-field amplifier (CFA) based RF system for particle accelerator applications.

6. **Millisecond flash lamp treatment for SRF accelerating cavities** (INFN, HZDR, PICCOLI) - develop a novel thermal process to improve performances of superconducting (SC) coating by suppressing (reducing) Cu substrate heating.

7. **AM applications of refractory metals for Ion Source cavities** (INFN, CNR) - develop new Refractory Metals Alloys specifically designed for Additive Manufacturing (AM) to improve the physical performance of the ion sources (Ta-based and/or Nb- based alloys).

8. **Demonstration of additive manufacturing for large and complex shaped vacuum chambers by Plasma Metal Deposition** (RHP, SBI) - demonstrate the Plasma Metal Deposition (PMD) as AM of a large and complex vacuum chamber geometry.

Working together with other advanced communities to implement a RI Co-Innovation Platform

With LEAPS and AIDA-Innova:

- Discussion on the recent reviews of INFRA-INNOV projects Period 1

- Review ongoing and future collaborations with industry

- AIDA/IFAST Academia-Industry events: topics and future programmes, and options for future joint events

- Industry engagement in the three projects, status and plans to improve

Options and strategies for Innovation in the Research Infrastructures Work Programmes
Status of RI WP23/24 calls and proposals
Options for RI WP25+
Actions to be foreseen and strategy to approach the EC.

Thank you for your attention !

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.