

# The 3<sup>rd</sup> I.FAST Annual Meeting

## SAC Report

*Michiko Minty (BNL), Carsten P Welsch (University of Liverpool.)*

*and*

*Akira Yamamoto (KEK/CERN)*

*Scientific Advisory Committee (SAC)*

*17th - 19th April 2024*

## Executive Summary

- The Innovation Fostering for Accelerator Science and Technology Project (I.FAST) continues to very impactfully enable the translation of accelerator technology across scientific fields and to society and in the development of technologies for next generation particle accelerators.
- Compared to one year ago, the objectives of the technical WPs are transitioning (or have already transitioned) from planning, conceptual designs, and prototypes to first articles.
- Many tasks have achieved, or are close to achieving, their deliverables with outstanding results - to mention a few highlights: thin film coatings for Superconducting RF (SRF) cavities, High Temperature Superconducting (HTS) magnets including novel materials and manufacturing methods, high-power/high-efficiency klystrons and power amplifiers, advanced materials for high-power beams, high gradient guns, and much more.
- I.FAST technology developments already having impact on:
  - Future accelerators (e.g. HL-LHC, FCC, etc.),
  - Other scientific fields and society,as promoted also by I.FAST co-sponsorship of many workshops and conferences.
- Since the inception of I.FAST and especially within the last year, collaborations between laboratories, universities, and industry appear to be strengthening.
- Many examples of early and close interactions with industry were presented evidencing progress towards more manufacturable and cost-effective designs and foreseen accelerated “science-to-market”.

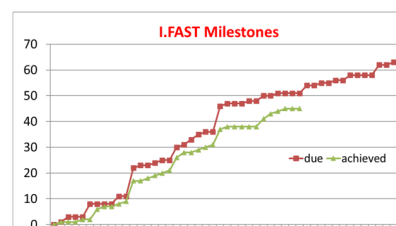
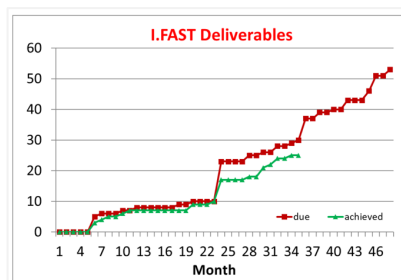
- The SAC very much appreciates the detailed and thorough responses to last year's recommendations.
- The SAC strongly encourages continued planning for support beyond I.FAST for future accelerator-based science and technology developments in coordination with supporting collaborations and co-innovation with Research Institutes (RIs) and industry (technology clusters?).



## Highlights from Plenary Sessions

### Session 1 - Introduction, Communication, Training, Applications

- The Review of the 2nd Periodic Report (with 18-month reporting period) will take place on July 15th and will be led by Sotirios Kakarantzas (REA Agency) and Prof. Mehmet Zeyrek (Ankara University).
  - Task Leaders must submit contributions by the end of April 2024.
  - WP Coordinators must submit their reports by 15 May 2024.
- The I.FAST Project is entering the fourth and final year of the project.
- The schedules for achieving cumulative I.FAST milestones and deliverables are not tracking the goals as closely compared to one year ago. Various reasons were cited, including for example vendor insolvency, lack of availability of beam time, or lack of availability of skilled personnel.
- Affected I.FAST task leaders are proactively reigning in their schedules, and it appears that all milestones and all but maybe one or two deliverables will be achieved within the I.FAST project lifetime.



### Communication

- The SAC commends I.FAST for maintaining clear communication targets and identified target groups. It is noted that these are on track after 3 years.
- There is a good link with established communication outlets, in particular Accelerating News. However, there have been only six articles over the past 12 months and the SAC would expect

the number of articles to increase with project progress. Especially those WPs who had no or few news to date are encouraged to liaise with Antoine and the comms team.

- The SAC notes a clear lack of engagement with the Zenodo platform, a required reporting tool for the project. All project partners are urged to upload their documents as soon as possible and thus help the coordinator maintain this platform.
- There are still relatively few news stories on the I.FAST website for a project of this size. The SAC renews its recommendation of more publications in area of high-level project outcomes and other project-wide news. Several WPs have not been visible to the wider community.
- Further, the SAC recommends engaging the communication expertise and channels at partner organizations more fully.

### **Training**

- The SAC considers Challenge Based Innovation (CBI) an excellent initiative for attracting the next generation of scientists and engineers into accelerator R&D. It connects particularly well with the aims and missions of the ESI.
- The SAC was pleased to see the detailed information about the diversity of applicants, and the good balance amongst the final (selected) participants.
- The I.FAST Academia-Industry Exchange Program has successfully stimulated cross-sector collaboration and triggered several promising interdisciplinary R&D projects.

### **Session 2 - Industry**

- The SAC thanks the speakers for the excellent overview of industry-driven innovation opportunities in this dedicated session. This promotes new ideas, allows knowledge sharing and triggering new collaborations.
- The SAC acknowledges the industry survey and detailed analysis of the impact of industry-related activities in response to last year's SAC suggestions.
- The good potential to de-risk developments through co-innovation and how I.FAST support has been critical for this, was made clear.
- The market potential of specific innovations was not always made clear enough.

### **Session 3 - New Concepts**

- Impressive progress was reported on technology breakthroughs required in several areas including plasma, high-power lasers and novel magnets.
- The I.FAST helps develop a landscape for future accelerators; the events have informed strategic technology roadmaps.
- The SAC would like to commend the speakers for consolidating research and innovation in Europe through highly successful workshop series and by attracting additional funding.
- The SAC considers the continuation of collaborative workshops related to specific areas essential and recommends that these be funded through the respective projects and consortia.

## **Session 4 - Accelerator Technologies**

- The SAC recognizes and acknowledges that I.FAST activities are pioneering and demonstrate innovative cutting-edge accelerator technology, focusing on:
  - HTS magnet, thin-film SRF, and additive manufacturing (AM) technologies, as well as advanced material and high efficiency klystron technologies, well highlighted in the presentations.
- The SAC strongly encourages I.FAST accelerator technology development to adopt good sustainability practices.
- If projects are foreseen to run late, the SAC advises to consider a grant agreement amendment to better reflect expectations.

## **Session 5 - Light Sources / I.FAST Highlights**

- The SAC acknowledges the important successes in light-source development. The SAC is pleased to see that I.FAST-supported events have helped drive innovation and leverage significant funding.
- Several promising new technologies were presented, including:
  - Permanent and superconducting magnets with opportunities for more energy efficient accelerators,
  - Advanced electron guns successfully tested at high power,
  - Machine learning models for which clear performance metrics should be developed as a next step.
- The SAC looks forward to receiving future reports on operational experience with the innovations presented in this session.

## **Session 6 - Sustainability**

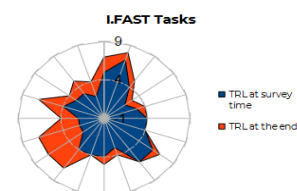
- The SAC recognizes that “sustainability” is increasingly important and should be integrated into each I.FAST activity.
- EC guidance and recommendations including the Life Cycle Assessment (LCA) with the scope for environmental footprint were much appreciated.
- LCA analyses were presented for the RUEDI Project and Linear Collider efforts. Developments within the I.FAST program were also presented.
- The SAC recommends that I.FAST promotes integration of sustainability within each existing project, and to convey the message more widely.

## SAC Comments and Suggestions

-- Comments on the Response to Previous Recommendations, and further Advise

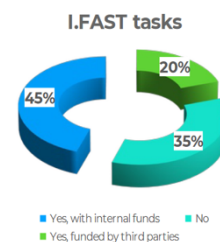
### Previous recommendations:

- For each technology, state TRL.
- These technologies should be critically assessed realistic pathway to identified markets and the time scales required.
- It was not always made clear enough which developments are happening because of I.FAST.



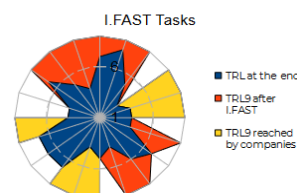
### Comments to the Response:

- The SAC really appreciates the analyses and presentation, which provided:
  - A clearer understanding of the achieved and estimated TRLs, and
  - Insights into funding contributions toward I.FAST activities, and common interests resulting from I.FAST-funded R&D.



### Advice and Suggestions

- If a task is foreseen to run late, the SAC advises to consider a grant agreement amendment to better reflect expectations.
- The SAC strongly encourages I.FAST and its partnerships integrate the methodologies and tools highlighted in the sustainability session into all activities.
- The SAC endorses the industry-academia exchange program and encourages more I.FAST partners to engage with it.
- At the next and final I.FAST annual meeting, the SAC will appreciate for each presentation including:
  - Impact statements achieved to date and projections for the anticipated impact of their work (i.e. foreseen applications), and
  - Elaborating on achieved Technical Readiness Levels (TRLs).
- The SAC strongly supports the 2025 Challenge Based Innovation (CBI) and recommends that I.FAST explore opportunities to continue CBI beyond the lifetime of the I.FAST project e.g. through institutional and industry support.
- The SAC suggests consideration of a post-I.FAST survey, to better understand the time needed to reach TRL9 (highest level) across the innovation portfolio, where relevant.



## ***Acknowledgement and Thanks***

*The SAC very heartily thanks all the I.FAST annual meeting coordinators and organizers for their support in executing this year's highly successful and effective meeting: in particular*

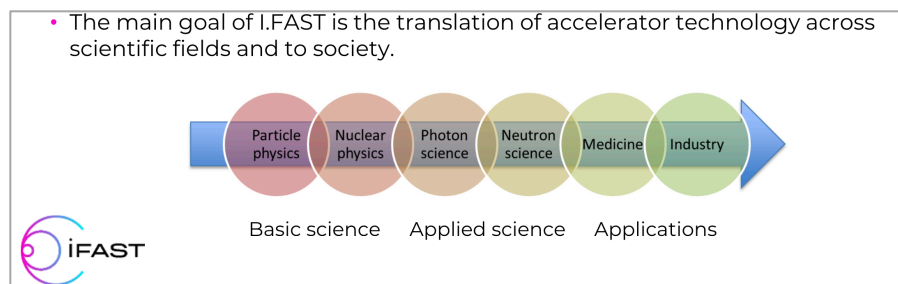
*Maud Baylac, Walid Kaabi, Antoine Le Gall, Sylvie Leray, Anne-Laure Pelé, Lazar Nikitovic, and the team of the Fondation Biermans Lapôtre,*

*Valérie Brunner especially for support of the SAC*

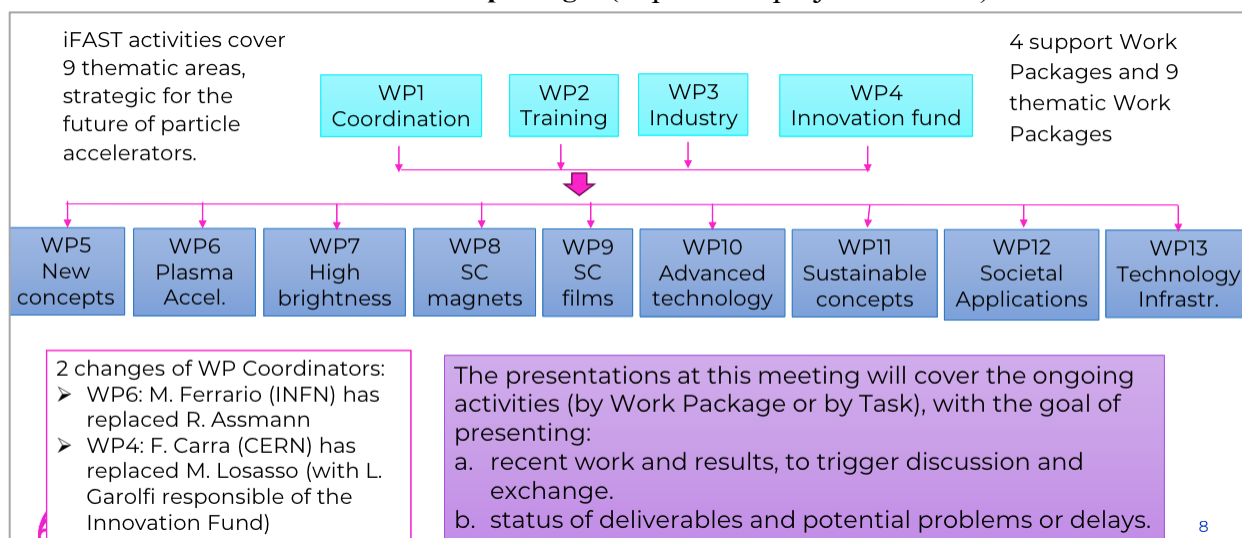
*Maurizio Vretenar for his steadfast and strong leadership overall, every I.FAST presenter and participant for the collaborative and congenial discussions.*

## Appendices

### Appendix 1: Main Goal of I.FAST and the Work Packages:



#### The I.FAST work packages (<https://ifast-project.eu/home>)



WP	Title	Coordinator
1	<a href="#">Management, coordination and dissemination</a>	M. Vretenar (CERN)
2	<a href="#">Training, communication and outreach for accelerator science and technology</a>	Ph. Burrows (UOXF)
3	<a href="#">Industry engagement</a>	M. Morandin (INFN)
4	<a href="#">Managing innovation, new materials</a>	M. Losasso (CERN)
5	<a href="#">Strategies and milestones for accelerator research and technology</a>	F. Zimmermann (CERN), N. Pastrone (INFN), P. Forck (GSI)
6	<a href="#">Novel particle accelerators concepts and technologies</a>	R. Assmann (DESY)
7	<a href="#">High brightness accelerators for light sources</a>	R. Bartolini (DESY)
8	<a href="#">Innovative superconducting magnets</a>	L. Rossi (INFN), L. Quettier (CEA), C. Roux (GSI)
9	<a href="#">Innovative superconducting thin film coated cavities</a>	C. Antoine (CEA), O. Malyshev (UKRI)
10	<a href="#">Advanced accelerator technologies</a>	T. Torims (RTU)
11	<a href="#">Sustainable concepts and technologies</a>	M. Seidel (PSI)
12	<a href="#">Societal applications</a>	R. Edgecock (HUD)
13	<a href="#">Technology infrastructure</a>	S. Leray (CEA)

## **Appendix 2: Plenary Session Agenda of the 3<sup>rd</sup> I.FAST Annual Meeting,**

### **Session 1 - 17 Apr 2024, 14:00 - 15:35 Introduction, Communication, Training, Applications**

1.1	Introduction by the Project Coordinator	Maurizio Vretenar
1.2	I.FAST Communication and Outreach	Antoine Le Gall
1.3	Experience with the I.FAST Challenge Based Innovation	Nicolas Delerue
1.4	A feedback from the I.FAST Industry Training	Luca Garolfi
1.5	Update on I.FAST Internal Communication and Dissemination	Yiota Foka
1.6	Overview of Accelerator Applications	Rob Edgecock

### **Session 2 - 17 Apr 2024, 16:00 - 18:20, Industry**

2.1	I.FAST Industry Related Activities	Mauro Morandin
2.2	Industrial Technologies for the Production of Advanced Ceramics and Composites for Big Science Facilities	Sergio Rivera
2.3	Eliminating Risks by Stern Integration of Control Systems	Rok Hrovatin
2.4	From Science Requirements to Applications in Industry	Michael Pekeler
2.5	Lessons Learned and Perspectives for a More Effective Exploitation of the Industrial Potential in Accelerator Magnet Projects	Wolfgang Walter
2.6	The Win-Win Benefit of Industry-Academia Collaborations in New Solution and Product Development	Etienne Touzain
2.7	Accelerating Science to Market	Hans Priem
2.8	Towards Energy Efficient Accelerator Magnets: Development of Commercial Large-Scale Production of Filamentary HTS Tapes	Anders C. Wulff
2.9	AIPF: The Accelerator-Industry Permanent Forum	Raffaella Geometrante

### **Session 3 – 18 Apr 2024 , 09:00 - 10:25, New Concepts**

3.1	Structure and Progress of the International Muon Collider Collaboration	Nadia Pastrone
3.2	Progress at the Accelerator Frontier	Frank Zimmermann
3.3	Novel Particle Accelerators, EuroNNAAc and EuPRAXIA	Massimo Ferrario
3.4	Lasers for Plasma Accelerators, Targets and Local Spot Stabilization	Leonida Antonio Gizzi
3.5	Slow Extraction Improvements	Peter Forck

### **Session 4 – 18 Apr 2024 , 10:45 - 13:00, Accelerator Technologies**

4.1	Innovative Superconducting Magnets	Ernesto De Matteis
4.2	Development of ReBCO HTS Nuclotron Cable	Tiemo Winkler
4.3	Innovative Superconducting Thin Film Coated Cavities (including PSD)	Cristian Pira et al
4.4	Results with Additive Manufacturing of Accelerator Components	Maurizio Vedani
4.5	AM Manufacturing of Superconducting Cavities	Adriano Pepato et al
4.6	Additive Manufacturing for Accelerators - Outlook and Perspectives	Toms Torims
4.7	Beam Windows and Materials	Federico Carra
4.8	High-Efficiency High-Power Gallium Nitride Amplifier Modules	Allreze Kasael et al
4.9	High Efficiency Klystron Prototype	Nuria Catalan Lasheras



**Session 5 – 18 Apr 2024 , 14:00 - 16:00, Light Sources and I.FAST Highlights**

5.1	Overview of Ultra-Low Emittance Rings	Riccardo Bartolini (DESY)
5.2	Progress with the Longitudinally Variable Dipole	Yannis Papaphilippou
5.3	C-Band Very High Gradient Guns	David Alesini
5.4	Status of CompactLight Prototype Structures	Gerardo D'Auria
5.5	Refractory Materials with Applications in Particle Accelerators	Sergio Rivera
5.6	Energy Saving SC Magnets in Accelerators and Beam Lines	Samuele Mariotto
5.7	ML/AI Marvels for Accelerator Domain	Karlis Bekolds
5.8	The ELBE Accelerator and its Use to Characterize Nb Films	Andreas Wagner

**Session 6 – 18 Apr 2024, 16:00 - 18:30, Sustainability**

6.1	How to Assess the (Environmental) Impact of RIs?	Denise Voelker
6.2	Life Cycle Assessment - Opportunities and Challenges	Serenella Sala
6.3	Design for Sustainability	Kai Heller
6.4	Example: Accelerator Impact Report: RUEDI	Ben Shepherd
6.5	Example: Sustainability Studies for Linear Colliders	Steinar Stapnes
6.6	Example: I.FAST for Sustainable Accelerators and Next Steps	Mike Seidel

**Session 7 – 19 Apr 2024 , 09:00 - 11:10, Innovation Fund, Diversity**

7.1	Overview of the I.FAST Innovation Fund Projects (Programme and Status)	Luca Garolfi
7.2	Presentation of IIF Projects: KAIO Accelerator	Rodrigo Lopez-Martens
7.3	Presentation of IIF Projects: AM Applications of Refractory Metals for ION Source Cavities	Pietro Rebesan
7.4	A New Tunable PMQ Design	Daniel Barna
7.5	Diversity Session: Diversity and Innovation	

**Session 8 – 19 Apr 2024 , 11:40 - 13:00, EU Projects, Conclusions**

8.1	TIARA and Future Horizon Projects for Accelerators	Jose Manuel Perez-Morales
8.2	From AMICI to a New Framework for Support of Technology Infrastructure	Sylvie Leray
8.3	The New iSAS Project	Maud Baylac
8.4	SAC Report and I.FAST Closing Remarks	Michiko Minty (BNL)

**Note:**

*The Appendix 3 is aiming for SAC internal notes to provide the base of the SAC main report, described above. The SAC is pleased with the notes to be shared between SAC the I.FAST management with keeping flexibility for the use in communication with individual WP groups, relying on the judgement by the I.FAST management, if it would be useful.*

**Appendix 3 - SAC Notes for Individual WP Reports****Session 1 – Introduction, Communication, Training, Applications****1.1 Introduction by the Project Coordinator (Maurizio Vretenar)**

- We are presently reviewing the third year of I.FAST.
- I.FAST is the fifth of a 20-year series of general accelerator R&D in the European Programmes. The wider goals include the development of technologies at different TRL level for next generation particle accelerators.
- I.FAST consists of a consortium with 48 beneficiaries with 4-year timelines, starting 1 May 2021, and 10 MEuro EC contribution out of a total project cost of about 19 MEuro.
- I.FAST scope consists of 9 thematic areas, 4 general work packages in 13 total work packages. This third annual meeting has the largest attendance ever with 141 registered participants and 76 registered for the Industry Workshop. This year's meeting comprised a very rich program including, in addition to the presentations on projects and tasks, a session devoted to sustainability challenges for large research institutes, a dedicated panel discussion on diversity and innovation, and a dedicated industry session with 8 speakers from industry.
- Deliverables and milestones not tracking goals as closely as one year ago.
- This presentation highlighted 15 I.FAST achievements reported on in Accelerating News articles in Accelerating News articles to date. The I.FAST Project is entering the fourth and final year of the project.

**Comments:**

- The I.FAST Project continues to very impactfully enable the translation of accelerator technology across scientific fields and to society, and in the development of technologies for next generation particle accelerators.
- The SAC very much appreciates the comprehensive responses to last year's recommendations.
- The SAC is concerned that a significant number of deliverables and milestones are delayed. No underpinning reason was provided, but this is something the project management might wish to track and steer more closely. (Note: The I.FAST management is considering a possible extension of the I.FAST program term for a half-year period for all packages to accomplish the program, to be discussed with EU).

- The SAC looks forward to learning about how I.FAST initiatives will continue (technology clusters?).
- The SAC enjoyed very much the selected ideal venue and the very comprehensive and extended programme.

**Suggestion (S1):**

- The SAC recommends continued efforts towards increased diversity.

**1.2 I.FAST Communication and Outreach (Antoine Le Gall)**

- In I.FAST year 3, outreach focused on communicating to new, specific targets. Communities of concentration of communication and the objectives were presented as 1) project participants, 2) the accelerator and greater scientific community, 3) industry, 4) funding agencies and decision-makers, and the general audience (including students and the media).
- Multiple outreach activities and a few high-impact publications were presented as examples.
- The Challenge-Based Innovation 2024 was announced last December. The upcoming event was advertised well - on beneficiary websites and social media, via direct contact with student associations, UN & EU agencies, IAEA, etc.
- Efforts are underway to broaden the scope of Accelerating News to include articles on sustainability, impact, new contributions from the accelerator community, and will include opinion pieces as well.
- The I.FAST targets and status of publications in Zenodo were listed:
  - Scientific dissemination: 50 publications target, >33 publications to date,
  - General communication and news: 10 article target, 27 articles to date,
  - Other communication: 10 presentations at international physics workshops and 1 thesis,
- The statistics for publications in ZENODE since the last I.FAST annual meeting is unchanged.

**Comment:**

- The SAC acknowledges that *Accelerating News* is the identified key communication channel for the project. However, the number of news items on the main I.FAST website is still surprisingly small and could be improved.
- It was not made clear enough how much the aim was achieved that partners' press offices support central I.FAST communication to disseminate information effectively.

**Suggestions:**

- The SAC supports the stated objective to focus on communicating the impact of I.FAST work in the upcoming year.
- The SAC is aware (as also presented in later talks) of many publications in the last year and urges all I.FAST WP and task leaders to upload their achievements in ZENODE.

**1.3 Experience with the I.FAST Challenge Based Innovation (Nicolas Delerue)**

- Two very successful CBI events took place at the European Scientific Institute in Archamps were held with focus topic "Accelerators for the Environment". The event targets participation mostly by students with some young professionals.
- Brief summaries from CBI 2023 of a few - very innovative - projects were presented.
- Three of the four CBI 2023 teams are continuing their work on their respective projects.
- The I.FAST milestone and deliverable have been achieved. Nonetheless, an initiative was launched to host a CBI 2024 with financial solicitation and support from sponsors and partners

in the accelerator community. This year's focus is "Accelerators to tackle healthcare challenges: How can particle accelerators help improving human health?"

- A total of 174 applications were received for CBI 2024 with about 85% of the applicants coming from countries participating in I.FAST. Responsive to past SAC feedback, the selection committee paid close attention to maximizing diversity (gender, academic, and geography) of the CBI 2024 participants. A total of 24 students were selected with gender diversity of those selected was stated to be exactly half female and half male.
- A CBI 2025, with focus on "Accelerators for Healthcare", is being considered in light of the strong support received with outside contributions in 2024. A decision is expected in fall, 2024.

**Comments:**

- The SAC congratulates on attracting supplementary funding to enable a third CBI in 2024 as testament to the success of this exciting program.
- Excellent initiative for attracting the next generation of scientists and engineers into accelerator R&D.
- CBI connects very well with the aims and mission of the ESI.
- The SAC also congratulates on the sustained positive impact of the students' work (e.g. startup company, engagement of clothing industry with accelerator-based implantation).
- SAC was pleased to receive more detailed information about the diversity of applicants.
- The final (selected) participants have a very good gender and nationality balance.

**Suggestion:**

- The SAC recommends that I.FAST explores opportunities to continue CBI beyond the lifetime of the I.FAST project e.g. through institutional and industry support.

**1.4 The I.FAST Academia-Industry Exchange Programme (Luca Garolfi)**

- The I.FAST Academia-Industry Exchange Programme has successfully stimulated cross-sector collaboration and triggered several promising interdisciplinary R&D projects.
- All submitted proposals were accepted and funding exists for up to 3 more projects.

**Comments:**

- The number of researcher exchanges to date is rather limited, given the size of I.FAST.
- The presentation did not clearly indicate how many projects are currently underway.
- The SAC endorses the programme and encourages more I.FAST partners to engage with it.

**Suggestions:**

- The SAC suggests to better understand the underutilization of this initiative-investigate if potential collaborators were not aware or if there were possibly other obstacles such as availability of personnel within the collaborations with industry, IP-related concerns, or other factors.

**1.5 Update on I.FAST Internal Communication and Dissemination (Yiota Foka)**

- The objective is coordination and consistent implementation of communication tools and activities supported by GSI, CERN, and RTU.
- CERN is migrating from SharePoint to SharePoint ONLINE. All I.FAST participants that use these facilities are encouraged to contact the task leaders.

- Guidance on dissemination of scientific results is given on the I.FAST web page with explicit instruction on how to submit to the I.FAST publication platform ZENODE. Approval of I.FAST monographs is required by the editorial board led by the speaker.
- Contributions to Cernbox (<https://cernbox.cern.ch/s/jMX4mWNq0xb9HLp>) appear to be automatically uploaded to ZENODE (needed to checked). ZENODE also picks up documents by the EU portal.
- I.FAST was highlighted at Medicon (Sarajevo, Sep 2023), at GSI Open Day (Jul 2023), at Beyond & Forward Green (Thessaloniki, 2023), at TIF expos (Thessaloniki, Sept 2022), and Particle Therapy Masterclass with 48 local sessions.

**Comments:**

- The SAC learned that: I.FAST dissemination in ZENODO were few (“few updates under publications”),
- The last update on ZENODE seems to be from April 2023. The SAC was pleased to see that experience in the delivery of Masterclasses is shared between project partners.

**Suggestions:**

- The SAC suggests urgent communication to all project partners to upload their documents as soon as possible.
- The SAC recommends engaging the communication expertise (e.g. public relations offices) at partner organizations more fully.

**1.6 Societal Applications (Rob Edgecock)**

- A wide range of interesting projects with potentially significant society impact were presented. This WP has three focus areas each with multiple sub-tasks:
  - Strategy for implementing novel societal applications of accelerators (WP 12.1)
  - Design of advanced electron accelerator plant for biohazards treatment (WP 12.2)
  - Design of internal RF ion source for cyclotrons (WP 12.3)
- WP 12.1 has stated objectives given below.
  - Study new and important societal applications of accelerators with the aim of developing roadmaps for their innovation.
  - Develop a strategy to deliver these roadmaps.
  - Study barriers which discourage the use of accelerators in industry.
  - Status update and next steps were presented.
- There was no update provided on WP 12.2.

**Comments:**

- Plans for Development of roadmaps for innovation were less clear Identification of barriers for adoption of emergent developments by industry could be better addressed by all WPs.
- It was not made clear enough what role I.FAST funding and funding outside of the project played in each of these developments.
- It wasn't made clear enough what role (if any) the I.FAST Innovation Fund (IIF), the Industry Advisory Board (IAB) and wider I.FAST network played in helping optimize R&D, project implementation and exploitation of R&D results.

**Suggestions:**

- The SAC encourages to continue work towards development of roadmaps for innovative applications of accelerators for societal benefit.

- More effort is needed in evaluating barriers to adoption of societal applications; barriers should be researched and evaluated not generally, but specific for each application identified in this WP.
- The SAC advises that more information be gathered about the respective market opportunities to generate a more solid platform for decisions.

## **Session 2 - Industry**

### **2.1 I.FAST Industry Related Activities (Mauro Morandin)**

#### **Comments:**

- The SAC appreciates the survey and analyses as responsive to last year's SAC's suggestions.
- Industrial cryogenics workshop as part of I.FAST annual meeting has been very productive fruitful to bridge academia and industry, although it would be a special session out of the plenary sessions.

#### **Suggestions:**

- Consider a post-I.FAST survey, to better understand - where relevant - time needed to reach TRL-9.

### **2.2 Industrial Technologies for the Production of Advanced Ceramics and Composites for Big Science Facilities (Sergio Rivera)**

- The sessions seem a result from the Accelerator Industry Permanent Forum. None of these have a milestone/deliverable in I.FAST, so maybe the best we can do is to welcome such a session as a way to showcase of selected industries to the general I.FAST community], to be inclusive of new ideas, share knowledge, and attract new partners?
- Actually, it seems we (the SAC) recommended this last year: "organize a dedicated session at the Annual meeting in 2024 "

#### **Comment:**

- It was not clear to us (SAC), if commenting on this presentation is in the remit of SAC? This seems R&D outside of I.FAST - relevant, no doubt, but we don't see immediately what we could/should comment in the context of I.FAST.

### **2.3 Eliminating Risks by Stern Integration of Control Systems (Rok Hrovatin)**

#### **Comment:**

- It was not clear to us (SAC), if commenting on this presentation is in the remit of SAC? This seems R&D outside of I.FAST - relevant, no doubt, but we don't see immediately what we could/should comment in the context of I.FAST.

### **2.4 From Science Requirements to Applications in Industry (Michael Pekeler)**

#### **Comments:**

- Interesting to learn of RI's demonstrated capabilities in cryogenic engineering and 'mass production' of SCRF cavities / cryomodules for light sources.
- Technology transfer contract, an alternate way for low risk to vendor of doing business than the "work in tandem with labs" approach; heard "give us the recipe". Very successful. On

the other hand, have heard (in past reviews) of industry's interest in being involved during the design stage. Next talk had multiple examples of the latter.

- (from Maurizio -) the Nb<sub>3</sub>Sn cryomodule was suggested by I.FAST

## **2.5 Lessons Learned and Perspectives for a More Effective Exploitation of the Industrial Potential in Accelerator Magnet Projects (Wolfgang Walter)**

### **Comment :**

- Sage advice based on proven 'big science' examples (e.g. share risk, split technical risk into foreseeable portions ...).
- question about shaping our future: in the past, industry invested in R&D. Speaker concurs, must get investment back.

## **2.6 The Win-Win Benefit of Industry-Academia Collaborations in New Solution and Product Development (Etienne Touzain)**

### **Comments:**

- example of instrumentation development by PhD student at GSI, technology transfer (and hiring of the student) by Bergoz
- FAST helping de-risk co-innovation initiative in an area that would otherwise not necessarily pursue by the company.
- Market potential not entirely clear.

## **2.7 Accelerating Science to Market (Hans Priem)**

## **2.8 Towards Energy Efficient Accelerator Magnets: Development of Commercial Large-Scale Production of Filamentary HTS Tapes (Anders C. Wulff)**

## **2.9 AIPF: The Accelerator-Industry Permanent Forum (Raffaella Geometrante)**

## **Session 3 – New Concepts**

### **3.1 Structure & Progress of the International Muon Collider Collaboration (Nadia Pastrone)**

- An update on from this collaboration's structure and progress was presented.
- The Laboratory Directors Group (LDG) initiated the Muon Collider Collaboration (IMCC) in July, 2020 following recommendations from the European Strategy for Particle Physics Update (ESPPU). The objective is, by the time of the next ESPPU update, to determine whether the investment into a full CDR and a demonstrator is scientifically justified.
- A report, "Towards a Muon Collider" was published by the MUon collider SStrategy network (MUST team): Eur. Phys.J.C 83 (2023) 9, 864.
- Both the European Strategy Report and the US P5 Report were released recently and both support technology R&D for a future muon collider. Results from the comprehensive review by the P5 Accelerator Frontier's Implementation Task Force were shown.
- MuCol, an EU INFRA-DEV project, was recently initiated and received funding to perform a design study for a muon collider complex. This includes development of an accelerator R&D

roadmap for which a technically limited timeline has been developed. This was presented to the CERN Council in December 2021.

- Highlights were presented from the IMCC and MuCol Annual Meeting (12-15 Mar 2024).
- Planning for a demonstrator facility, with muon production target and cooling stations, cited at CERN, is underway. A demonstrator located on the FNAL campus is also under consideration in the US.
- Plan to develop evaluation of cost and power consumption in future (evaluation report) for the next European Strategy update.
- Muon4Future workshop held in May 2023.
- Next steps, supported by MUST, were stated to be
  - Establishing an international collaboration
  - Development of an optimized R&D roadmap, including definition of optimum test facilities and possible intermediate steps
- Milestones and deliverables for this were shown.
- The 29 Mar 2024 cover-page of Science highlighted “A radical new particle accelerator concept emerges. Call it physicists’ Muon Shot”.

**Comment:**

- It appears that I.FAST supported international workshops (on muon source design and to define R&D plans). Progress and planning were clearly indicated and on good track.

**3.2 Progress at the Accelerator Frontier (Frank Zimmermann)**

- This work-package has 5 thrusts: novel intense positron sources, extreme beams and ultimate limits, AI for accelerators, applications of machine learning, deep learning, advanced algorithms and neural networks, accelerators for “dark sector” and precision physics, green accelerators and sustainable concepts.
- Multiple I.FAST workshops and co-sponsorship of multiple workshops with synergistic interests to date.
- A topical I.FAST workshop on Gigahertz Rate and Rapid Muon Acceleration (GR2M) workshop was held in Dec 2023. Workshop highlights were published (in Zenodo and in CERN Courier article) and will be presented at IPAC’24 as well. Selected topics included presentations on dielectric laser acceleration (DLA) principle, periodic APF cell, phase-locked plasma acceleration, and gamma-factory based muon and positron sources.
- Five WP5.2 events are planned in 2024.
- The milestone report “Present and Future I Accelerator Applications” was published (5/31/23), two more milestones will be addressed by upcoming workshops: “Roadmap for Future Accelerators” by iBiF, Channeling2024, AHIPS and Ultimate Hadron-Beam Brightness by SC2024.
- This WP has produced 5 journal articles, 8 conference proceedings reports, and 1 CERN Courier article to date.

**Comments:**



- Very impressive and outstanding activities to organize many forward-looking workshops.
- The SAC encourages the brainstorming activities to seek for novel ideas for future advanced accelerators
- The SAC appreciates the slide on the impact of this WP (and makes a general recommendation that all WP leaders elucidate impact of achievements at the next I.FAST Annual Meeting).

**Suggestions:**

- The SAC suggests for future presentations a high-level summary highlighting this WP's alignment with the ESPPU's objectives.

**3.3 Novel Particle Accelerators, EuroNNAc and EuPRAXIA (Massimo Ferrario)**

- Massimo Ferrario is now the WP leader, successor to Ralph Assman.
- This WP consists of 4 main tasks: Novel Particle Accelerator Concepts and Technologies (shared with NPACT-EuroNNAc), Lasers for Plasma Acceleration (LASPA), Multi-scale Innovative Targets for Laser-Plasma Accelerators (MILPAT), and Laser Focal Spot Stabilization Systems (L3S).
- EAAC is an I.FAST and EuroNNAc deliverable.
- An EAAC2023 workshop was held (Sept, 2023) with ~200 participants including 35 student grants and very effectively served to connect expertise in plasma accelerators across Europe. The lifespan for EAAC workshops, sponsored by EuroNNAc and I.FAST will end in Spring 2025.
- The European Plasma Research Accelerator with Excellence in Applications (EuPRAXIA) project is multi-institutional with distributed research infrastructure (54 institutes from 18 countries plus CERN) and funding from the European Union's Horizon Europe research and innovation programme.
- A comprehensive overview of the EuPRAXIA project, a plasma-based accelerator user facility, was summarized.

**Comments:**

- The SAC commends the WP on consolidating plasma accelerator research and innovation in Europe through highly successful workshop series.
- The success in leveraging funding in this important area of accelerator research is excellent.

**Suggestions:**

- The SAC considers the continuation of collaborative workshops related to specific projects essential and recommends that these be funded through the respective projects and consortia.
- Since it was difficult to determine from this presentation the contributions from I.FAST, clearly indicate these in the future.

**3.4 Lasers for Plasma Accelerators, Targets and Local Spot Stabilization (Leonida Antonio Gizzi)**

- This work package, Novel Particle Accelerator Concepts and Technologies, is on track with deliverables and with all listed milestones reported to have been delivered.
- The status of laser driver developments aiming for PW-class systems with high repetition rates were presented: Lasers for Plasma Acceleration (LASPA).

- a roadmap was developed to foster delivery of advanced industrial laser drivers,
- coordination with laser labs and industrial partners is being established - a European Advanced Accelerator Concepts workshop was held in Sept, 2023.
- The EuPRAXIA baseline laser design plans for use of TiSa lasers with multiple R&D objectives (driver for 150 MeV or 1 GeV injector, driver for 5 GeV accelerator). Intermediate EuPRAXIA milestones are in progress with additional funding made available by NextGeneration EU (>4 MEuro). In coordination with industry, developments continue towards demonstration of >30 TW peak power with future goal of demonstrating a PW class laser with 100 Hz repetition rate and multi-kW average power. Further developments include a proposal for Plasma Accelerator Systems for Compact Research Infrastructure (PACRI).
- Progress towards a laser-plasma waveguide (LPW) was presented with references to multiple recent publications on subsystem component developments and advances in controlled injection into the LPW and demonstration (no reference) of achieved mono-energetic beam (time scale not clear from presentation)
- Concerning characterization of beam pointing stability, +/- 3 microrad PTV (within a factor of 2 of goal) was achieved following installation of active stabilization feedback.

**Comments:**

- The SAC finds the progress made in laser driver development very good and is pleased to see an increasing involvement of industry. This will be key to turn concepts into viable technologies.
- It was not clear which of many future developments presented are to be achieved within the scope of I.FAST.

**Suggestions:**

- Since it was difficult to determine from this presentation the contributions from I.FAST, clearly indicate these in the future.

### **3.5 REX: Resonant Extraction Improvements (Peter Forck)**

- This work package task is being executed jointly having successfully solicited involvement with industry and clinical partners.
- The REX efforts are comprised of four workgroups.
- WG1 and WG2 both delivered I.FAST milestones related to technological developments.
- WG3 and WG4 relate to simulation, experiment, and experimental execution based on the i.FAST technological developments.
- The 5<sup>th</sup> slow extraction workshop, organized by MedAustron and GSI, and sponsored by I.FAST was held in Feb, 2024. The program was rich and included 60 talks, 7 discussion sessions, a tutorial and poster sessions with participants from Europe, the US, Japan, and China.
- The achievements of the two I.FAST-REX working groups were presented, are being communicated well with 3 journal articles in preparation or under review, invited (HB2023 conference) and contributed (IBIC 2023).

**Comments:**

- Excellent progress has been made in the past year with demonstrated achievements.
- The SAC reiterates recommendations from 2022 that the activity check the wider market for alternative instrumentation-related products with potentially superior performance, and that the extracted beams' transverse distributions should be studied. The SAC looks forward to an update on these topics at the next meeting.
- The SAC congratulates on the successful integration of industry to date and on the many publications to date with I.FAST acknowledgement.

## **Session 4 – Accelerator Technologies**

### **4.1 Innovative Superconducting Magnets (Ernesto De Matteis)**

- It scopes to explore Canted Cosine Theta (CCT) magnet with HTS superconductor for energy saving (as the main goal),
- The preliminary engineering design studies have been completed.
- preceded by combined function CCT magnet based on LTS.
- The development of the LTS (NbTi) and HTS CCT magnet demonstrators are in progress. The coil winding and magnet assembly followed by the magnet test and validation id to be achieved by early 2025.
- Design a new magnet for medical applications in both LTS (NbTi) and HTS.
- Multiple (7) journal articles and, within the past year, outreach activities

#### **Comment:**

- HTS at 20 K operation will be strongly encouraged for cryogenics thermal efficiency to be improved with 5 times less AC plug-power as an important target.
- The progress in the demonstrator development is slow. The plan seems to be success oriented.

#### **Suggestion:**

- It is suggested to consider the delivery due time to be extended.

### **4.2 Development of ReBCO HTS Nuclotron Cable (Timo Winkler)**

- The idea is to use the CORC/COSRT type cable surrounding LHe cooling pipe, with good cooling properties, and with good wind-ability of SIS100 cable and apply it to HTS (ReBCO) cable.
- The development in progress, but no specific development goal/deliverable was presented.

### **4.3 Innovative Superconducting Thin Film Coated Cavities (Cristian Pira et al)**

- It aims for moving from bulk Nb@ 2K to Nb<sub>3</sub>Sn @ 4.5 K, reducing cryogeni power by a vacot or 3,
- Goal is to realize a prototype of a 1.3 GHz cavity with Nb<sub>3</sub>Sn thin film on Cu to be operated at 4.5K, with Q> 1E10.
- Multiple challenges to manage brittle A15 material, low melting T-point Cu substrate, thin-film coating, and conduction cooling is in progress, with optimum partners collaboration.
- Strongly potential interest of industry is expected.
- The progress is on track to demonstrate the technology.

- Thin Film SRF workshop, sponsored by I.FAST (Sept 2024)

**Comment:**

- The SAC recognize importance of the Nb<sub>3</sub>Sn thin-film coated SRF cavity for ultimate energy saving in the SRF technology applications.
- Development Thin-film SRF in particular Nb<sub>3</sub>Sn coating is strongly encouraged for energy saving toward the application in future.
- The ultimately clean and smooth surface condition should be critical important and needs to prioritized as this WP focusing on it.

**Suggestion:**

- Inter-laboratory and industry collaboration is strongly encouraged

**4.4 Results with Additive Manufacturing of Accelerator Components (Maurizio Vedani)**

- Survey of current additive manufacturing (AM) applications and identification of future development and research actions completed, to be published in PRAB.
- These efforts are supporting the definition of the most strategic direction for future research on AM technologies to enhance their impact on accelerator application, in particular for high-voltage/gradient RF and other applications.
- RFQ structure has been demonstrated., as a starting point for the AM desing of more advanced.

**Comment:**

- It is an excellent AD demonstration of RFQ presented as the I.FAST.

**Suggestions:**

- The SAC strongly encourage the AM technology applications to be extended for future cost-effective, advanced accelerator components and for social applications.

**4.5 AM Manufacturing of Superconducting Cavities (Adriano Pepato et al)**

- Additive manufacturing (AM) applications for SRF cavity and identification of future development and research actions have examined for Cu and Nb substrates.
- Impressive array of AM-produced Nb and Cu SRF cavities are presented.
- Surface treatments - collaboration between ROSLER and INFN; 1 Su and 1 Nb cavity damaged during surface treatments
- One surface-treated Nb cavity assembled in cryostat with measurements performed - achieved 5 times higher loaded Q than as-printed cavity (but still lower than [industry standard])
- New optimized SRF cavity design developed with thicker areas (in region where the other cavities had ruptured), manufacturing improvement, s.t. About AM-method refinements, slide 5.

**Comment :**

- The AM manufacturing for superconducting cavities should be interesting and important future direction for the cost-effective production and applications.

**Suggestion :**

- The SAC encourages the AM technology to be applied to SRF cavity development with the surface treatment conditions to be well understood and mastered.

#### 4.6 Additive Manufacturing for Accelerators - Outlook and Perspectives (Toms Torims)

- All milestones for the perspectives and deliverables have been achieved.
- These efforts were enabled by superb collaboration and “co-creation” with industrial partners.
- Have attracted new collaborators from academia and industry, working also with other I.FAST WPs
- Initial challenges have been addressed, future work (outside of I.FAST scope) entails RF tests, investigation of behavior in ultralow temperatures, in-situ tests, and testing under real conditions.
- Numerous publications have been available.

##### **Comment:**

- As already pointed out, the surface roughness, geometrical precision, vacuum tightness, and voltage holding as well as low temperature performance should be further investigated and demonstrated towards advanced accelerator technology applications.

##### **Suggestion :**

- The SAC strongly encourages the AM technology and the applications to the advanced accelerator technology and innovation.

#### 4.7 Beam Windows and Materials (Federico Carra)

- New WP coordinator, successor to Marcello Lossasso (retired)
- Innovative beam windows for high-power accelerator applications:
  - Milestone achieved in 2022 (presentation last year)
  - Deliverable (demonstrator) delayed due to beam availability, but beamtime expected at different facility (CERN IRRAD) soon,
  - Temperature during irradiation and change in thermomechanical properties simulation underway.
- Carbide-Carbon Materials for Multipurpose Applications
- SAC recommendations and TRLs has been well reflect.
- Multiple publications already managed.

##### **Comment:**

- The SAC acknowledge that the previous recommendations have been carefully implemented.

##### **Suggestions:**

- The technology transfer to other laboratories is highly advised to be extended.

#### 4.8 High-Efficiency High-Power Gallium Nitride Amplifier Modules (Allreze Kasael et al)

- 1 kW GaN at 750 MHz. Build using 6 solid state 200W amplifiers combined, requiring low loss combiner.
- Comprehensive test show 82.45 % drain efficiency and 1148 W output power.
- Binary 6:1 coaxial power combiner and 1:6 power splitter. Developed high power 1:6:1 splitter/combiner at 750 MHz with 0.15 dB insertion loss.

##### **Comment:**

- It seems these excellent achievements were presented already last year.

- The SAC is interested to recognize what would be further progress.

#### **4.9 High Efficiency Klystron Prototype (Nuria Catalan Lasheras)**

- R&D oriented to HL-LHC needs.
- HL-LHC requires 350 kW saturated output per klystron → need minimum of 67% efficiency (up from present 62% efficiency with 300 kW output)
- Achieved 69.84% efficiency with 57.5 kV and 9A beam current, TH2167 HE klystron.
- On power balance:
- Whilst required effort was somehow underestimated, project overall still on track.
- Potential identified for collaboration beyond I.FAST.

#### **Comment:**

- It would be very important progress, particularly the HL-LHC operation benefit.
- Developments likely to benefit FCC-ee (with 80% efficiency requirement), X-Band, and IOTs.

#### **Suggestions:**

- I.FAST look (slide template) not used consistently. In the interest of coherent project representation and to maximize impact, the SAC reminds all project partners to follow central project guidelines.

### **Session 5 – Light Sources and I.FAST Highlights**

#### **5.1 Overview of Ultra-Low Emittance Rings (Riccardo Bartolini)**

- Very active networking activities and supporting R&Ds for beyond the state of the art light source technology.
- Clearly demonstrated benefits from I.FAST through targeted events and joint R&D.
- The SAC congratulates on the successful leveraging of external funding.

#### **5.2 Progress with the Longitudinally Variable Dipole (Yannis Papaphilippou)**

- Demonstrated very good potential for future more energy efficient accelerators.
- Field-tunability is significant improvement over earlier design.

#### **5.3 C-Band Very High Gradient Guns (David Alesini)**

- Very good performance demonstrated for both, TW and SW guns
- Important joint development for future accelerators.

#### **5.4 Status of Compact Light Prototype Structures (Gerardo D’Auria)**

- Aiming for building and testing two prototypes for the X-band (12 GHz) accelerating structure designed for the Compact-light (XLS) project, a new class of linac-driven FEL facility.
- Expecting to braze the second structure within 2024, after validating the procedure.

#### **5.5 Refractory Materials with Applications in Particle Accelerators (Sergio Rivera)**

- Aiming for realizing alternate material to Graphite-metal carbide materials: Graphite-Chromium carbide with lower cost and upscaling.
- The development in progress.

### **5.6 Energy Saving SC Magnets in Accelerators and Beam Lines (Samuele Mariotto)**

- Objecting improvement of energy efficiency: cryogen-free superconducting magnets instead of common resistive magnet for heavy particles beamlines.
- Demonstrating MgB<sub>2</sub> or HTS conductor, at working temperature of 8 – 20 K with MgBe or 50 K with HTS with solid conduction cooling, with development in progress.
- The SAC strongly encourages the energy saving, in application of SC magnet in particular MgB<sub>2</sub> and/or HTS magnets technology.

### **5.7 ML/AI Marvels for Accelerator Domain (Karlis Bekolds)**

- Long term mission is to develop low-latency Machine Learning (ML) techniques to improve performance and availability of high-power facilities at the intensity frontier with a goal to identify signatures of potential errant beam conditions.
- The development in progress, and in cooperation over 30 EU labs and organizations.

### **5.8 The ELBE Accelerator and its Use to Characterize Nb Films (Andreas Wagner)**

- No presentation file available and difficult to provide anticipated comments.

## **Session 6 – Sustainability**

### **6.1 How to Assess the (Environmental) Impact of RIs? (Denise Voelker)**

- I.FAST as a transverse project, from science to society:
  - Particle accelerators are sophisticated instruments used in a wide range of domains, from basic science to applied science to medicine and industry,
  - Traditionally, the strongest demands in terms of technologies and performance are coming from particle physics, from which new technologies extend to other applications and finally reach the society.
  - The main goal of I.FAST is the translation of accelerator technology across scientific fields and to society.
- German newspaper articles shown questioning impact of science on environment.
- Science has positive and negative planet-changing impacts.
- Waste heat at DESY: 129 GW-hours per year.
- Materials used also contribute to greenhouse gases. Permanent magnets are [sustainable] but production using rare earth materials has environmental (and societal) issues.
- Assessments are important to raise awareness / understand impact, identify, comply, and make improvements.
- Two talks later on life cycle assessment and designs for sustainability.
- Then three examples from the community (RUEDI, LC community, and I.FAST WP11).

#### **Comments:**

- The SAC thanks the speaker for organizing this important session.

- It is clear that future big science initiatives must be actively engaged in minimizing impact on the environment.

## **6.2 Life Cycle Assessment - Opportunities and Challenges (Serenella Sala)**

- EC guidance and recommendations including the Life Cycle Assessment (LCA) with the scope for environmental footprint were much appreciated.
  - Challenges for sustainability assessment towards decision support,
  - The relative importance of the various sustainability goals has a socioeconomic dimension.

### **Comments:**

- Very important and executive report, but unfortunately the presentation file not available.

### **Suggestions:**

- The important and executive presentation is encouraged to be uploaded to the indico.

## **6.3 Design for Sustainability (Kai Heller)**

### **Comment :**

- Very interesting report, but unfortunately the presentation file not available.

### **Suggestions:**

- The interesting presentation is encouraged to be uploaded to the indico.

## **6.4 Example (1): Accelerator Impact Report: RUEDI (Ben Shepherd)**

- Question: “What is the carbon footprint of an accelerator?”, and “Can we provide some guidance through?”
- Acc. impact report on Relativistic Ultrafast Electron Diffraction and Imaging (RUIDI).
- TDR completed in early 2024, to be commissioned in 2029, and operational run in 2031 ~.
- Methodology for Carbon inventory investigated and examined:
- Recommendations from the report:
  - i) reuse shielding, ii) temperature stability, iii) permanent magnets, iv) consolidate cooling, v) reuse waste heat, vi) demand shifting, and vii) submetering.

### **Comment :**

- A very interesting and important report covering the accelerator life cycle and sustainability assessment.
- The SAC recognizes the importance of such study.

### **Suggestions :**

- The SAC recognizes the importance of such study and strongly encourage to extend the RUEDI project sustainability study as a very important example.

## **6.5 Example (2): Sustainability Studies for Linear Colliders (Steinar Stapnes)**

- Sustainability and Life Cycle Assessment studies for linear colliders (LCs) primarily focusing on CLIC and ILC programs.
- Importance of High RF efficiency (cavity and power-source) and nano-beam technology to to maximize luminosity / beam-power / AC plug-power.



- Importance of using the “right energy”, re-cycle, and the right time, recovering energy/heat.
- A systematic Life Cycle Assessment (LCA) examined for LCs, through design, R&D, construction (including tunnelling, material, components, and transportation etc), operation, decommissioning.

**Comment :**

- The SAC recognizes the LCA importance for the accelerator program and the sustainability covering the whole life process.

**Suggestion :**

- The SAC strongly encourage to extend the LCA to maximize the sustainability.

**6.6 Example (3): I.FAST for Sustainable Accelerators and Next Steps (Mike Seidel)**

- Sustainability efforts by I.FAST are overviewed:
- The report focusing on Networking & workshops on high efficiency, energy recuperating power system, as well as minimizing the power consumption with permanent magnet and applied superconducting technologies.
- Importance of “Integrating Sustainability” is emphasized: sustainability is not an independent task/category but every technical task (beam dynamics, RF systems, magnets, etc.) to include the “sustainability” for our future efforts.
- Sustainability needs to be balanced against cost and operational complexity. Synergies are welcome, e.g. energy = cost.
- Networking and workshops,

**Comment:**

- The SAC endorse critical importance of the “Sustainability” in particle accelerators and the future, as well as the feedback to the environment and society.

**Suggestions:**

- The SAC strongly encourages the I.FAST’s leading efforts for advances in sustainability of the accelerator science and technology.