Knowledge and Technology Transfer

Richard Brenner on behalf of the ESG group

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ESG Group

- ESG group on knowledge and technology transfer
- ESG members: Thomas Bergauer (AT), Richard Brenner (SE), Boros Grynyov (UA), Beate Heinemann (DESY, chair) Andrius Juodagalvis (LT), Martti Raidal (EE), Zafar Yasin (PK)
  - Additional experts: Ilka Mahns (DESY), Manuela Cirilli (CERN), Thomas Schörner (DESY), Giovanni Anelli (CERN), Joosep Pata (NICPB/KBFI)
- There was very little (concrete) input via the submissions. Only four inputs tagged for the KT stream!
- We had so far only one meeting and decided on a structure for the report we want to propose.

Last European Strategy

Environmental and societal impact

C. Particle physics has contributed to advances in many fields that have brought great benefits to society. Awareness of knowledge and technology transfer and the associated societal impact is important at all phases of particle physics projects. ***Particle physics research centres should promote knowledge and technology transfer and support their researchers in enabling it. The particle physics community should engage with industry to facilitate knowledge transfer and technological development.***

Proposed Structure of Output Document

1. Introduction
2. ESG submissions / national inputs
3. Innovation and Impact: general aspects
4. KT potential of accelerators
5. KT potential: detectors and computing aspects
6. Conclusion

ESG submissions/national inputs

Submissions to the KT stream:

ID=18: CERN openlab
ID=176: UK national input (this is covered by table below)
ID=186: MEDICIS Isotope Facility
ID=256: Superconductivity Global Alliance

National inputs:

Country	Knowledge transfer	Technology transfer	Applications	Innovation	Industry
Austria			X		
Belgium					
Brazil			X	X	
Canada			X	X	
Czechia			X		
Denmark					
Finland		X		X	X
France			X	X	X
Germany		X	X		
INFN			X		
Japan					X
LNF/Italy			X		X
Norway	X		X		
Pakistan	X		X	X	
Poland			X		
PSI/Switzerland			X		X
Romania			X		X
Serbia			X		
USA		X			
UK				X	X

Innovation and Impact: general aspects I

- In general: Knowledge Transfer (KT) means, in our context, **from HEP to society**
- Important: coherent within the labs and across labs for future collider projects (built in conflict between national interests and HEP common)
- Goals of KT activities:
  - create concrete impact, and contribute to the development of industry and capacity building
  - demonstrate the socioeconomic impact and long-term usefulness of basic research and thus gain support for continued public funding.
- Relevance of research programs becomes visible through successful transfer of technologies developed in the collider projects

Innovation and Impact: general aspects II

- In the case of CERN: direct link with the needs of companies and entrepreneurs in the member and associate member states to identify more opportunities.
  ➡New concept to connect CERN with member states Innovation Hubs;
    (DESY ITT is involved in the conceptional phase)
- Provide incentives for scientists and engineers to engage in KT activities
- Create a shared culture of KT in the HEP community
- Protection of IP (intellectual property) enables the targeted dissemination of technologies while protecting them from obvious misuse
- Find balance between open-source dissemination and the need for technological sovereignty

Innovation and Impact: general aspects III

- Measuring and tracking the socioeconomic impact of HEP in a holistic and structured way, including:
  - KT through technology-intensive procurement contracts
  - entrepreneurial activities of the labs
  - HEP alumni: what impact do they make in the World?
  - indirect influence on industry e.g. inhouse research in industry after HEP scientists have demonstrated the feasibility of a technological development, training of scientists in accelerator, computing and instrumentation schools.
- Communicating about the impact of KT activities, using an appropriate mix of quantitative indicators and good stories.
- KT activities must be internally supported and encouraged at the right strategic level.

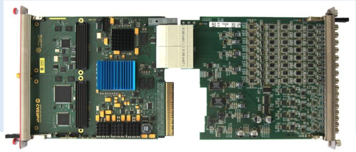
Industry as partner in future collider projects

1. Industry as supplier:
   - Important to build collider and instrumentation components
   - Exchange of knowhow necessary to fullfil the requirements/specifications

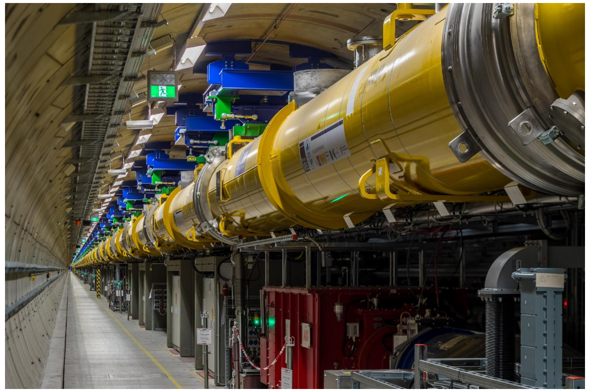
2. Industry as cooperation partner
   - Joint R&D with companies
   - Synergistic use of expertise from science and industry
   - Active involvement of companies also means significantly faster transfer of expertise and thus transfer to other fields of application through industrial partners
   - Career development for young scientists, easier entry into the world of work
   - Suppliers can develop into knowledge carriers

➡ Suppliers can become cooperation partners, which creates added value for industry and science, leads to long-term strategic partnerships, and strengthens technological sovereignty in individual countries.

Transfer from research to application – Example: MicroTCA



Develoment for European XFEL



- Control system of the accelerator and experiment: ~ 250 MicroTCA crates installed;
- Fast diagnostics and the high precision controls for the more than 700 accelerating cavities are controlled by MicroTCA
- **Ratification of the standard was 2006**

Transfer to Large-scale accerlators

In Europe, America, Asia:

CERN

FAIR

ess

Argonne NATIONAL LABORATORY

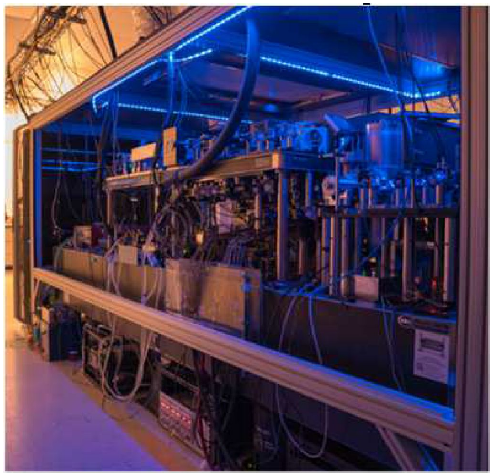
SNS SPALLATION NEUTRON SOURCE

SPring-8

PAL OHANG ACCELERATOR LABORATOR

- **After the operation of EuXFEL in 2014**
- Outreach and dissemination of MicroTCA to other large-scale accelerators on-going process until today

Appplication: e.g. Quantum Computing



- need for precise clocks, low electronic noise emissions, strong synchronization across multiple boards
- capacity to scale along with qubit count
- **New application outside of accelerators are identified in the 2020s**

MicroTCA: Micro Telecommunications Computing Architecture: modular, open electronic standards

KT Potential of Accelerators

- The development, design and construction of large accelerators is a prime focus of this strategy update
- The different proposed future accelerators offer varying (large!) potential for knowledge and technology transfer
  - It is important this potential is harvested as well as possible
  - Important: creating awareness for knowledge and innovation transfer opportunities inside the projects / collaborations from the start; create structures for that.
- We will prepare a questionnaire to understand how the various projects are approaching this issue, and what the (up to 3) key technologies are that are expected to have a large potential
- Projects on the radar: e.g. FCC-ee/hh, ILC, CLIC, LCF, HALHF, MUCOL, C3, CEPC, SppC, PERLE, …
- Questionnaire will be evaluated w.r.t. structures inside the projects, innovation potential, industrialisation potential.
  - Goal should be to derive recommendations and guidelines for the KT setup within projects

KT Potential of Detectors

- The recently formed DRD collaboration offers a huge knowledge and innovation potential.

➡️ 157 Towards instrumentation for future HEP experiments

- Many inputs to ESPP show strong interest and need for detector R&D (and connections to DRD developments).

➡️ in 100+ subisssions!

- A recommendation on KT in connection to detector development may be appropriate result from the ESPP process.

Conclusion

- It is important to harvest the technologies developed by the brilliant people in HEP wherever possible so that society at large benefits
- The potential is large but a systematic approach to maximising it is needed
- Unfortunately, there were very few submissions on this topic.
- The first questionnaires related to accelerator technologies will be sent shortly and then the work of this group will start
  - We are considering doing the same for the DRDs

Backup

KT Potential of Accelerators: Questionnaire (1)
DRAFT

Questions on innovation and industrialisation potential of future collider projects

The following set of questions will be posed to the future collider projects with dedicated input to the European Strategy for Particle Physics Update (ESPPU).
Please consider how the future collider project is structured in terms of its innovation and industrialisation potential.

General remarks:

- "Technologies" includes hardware, firmware and software.
- When answering the questions, focus on maximum three technologies.

General transfer questions

1. Is knowledge transfer and innovation structurally embodied in your project?
2. Which transfer mechanism have you implemented in your project?
3. How do you realise IP protection like identification of inventions and confidential knowhow?

KT Potential of Accelerators: Questionnaire (2) DRAFT

Innovation Potential

4. **What are the unique conceptual and implemented technologies this project has already brought or will bring compared to existing solutions?**
   Prompt: Explore novelty in design, materials, processes, or technology.

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5. **What unmet needs or problems do these new technologies address, and how are the new or foreseen solutions superior to current practices?**
   Prompt: Identify the pain points the technology solves and describe the innovative step compared to the state-of-the-art existing technologies.

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6. **Have the technologies resulted in any intellectual properties rights (IPR) like patent filings, proprietary methods, confidential knowhow or novel applications of existing technologies?**
   Prompt: Include formal IPR protection or procedure to protect intellectual properties (IP) like knowhow for example of software developments.

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7. **How do you integrate utilization strategies for specific technologies and components in the collider project?**
   Prompt: Identify of innovation potential with structured process.

KT Potential of Accelerators: Questionnaire (3)
DRAFT

8. **How adaptable are these technologies across different types of construction projects or geographical contexts?**
   In what other fields of research or economy can they be applied?
   Prompt: Explore how applications besides your project were identified and which tools and methods are used.

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9. **Which IP strategy do you have with respect to hardware, firmware and software?**
   Prompt: Identify the pain points the innovation solves.

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10. **How do you describe the technologies resulting from your project in terms of their contribution to the current societal challenges? Please highlight what specific contribution your innovations can make?**
    Prompt: Identify of innovation potential from transition to climate neutrality, new digital world to strengthening the EU's global pioneering role, etc.

KT Potential of Accelerators: Questionnaire (4)
DRAFT

Industrialisation Potential

11. **Have you involved industrial partners in the project or do you plan to involve them with an active role?**
    And for which technologies is cooperation with industrial partners specifically encouraged and what are the contribution of the industrial partners?
    Prompt: Specify technology fields as well as role of industrial partners in your project.

12. **What elements of the project or of the discussed technologies are modular, standardisable, or suitable for prefabrication, automation or mass production in industry?**
    Prompt: Look at design, construction methods, or materials.

13. **What are the main barriers to scaling these technologies for widespread use (e.g., cost, training, logistics, regulation, legal frameworks, legal binding standards and norms)?**
    Prompt: Consider both internal and external constraints.

14. **Have the solutions demonstrated performance at scale or undergone testing in a real-world or simulated environment?**
    Prompt: Reference pilots, digital twins, or field trials in the project research setup or beside the project in an additional application environment for example to an industrial partner.

15. **What partnerships, supply chain inputs, or systems are required to industrialise the technologies?**
    Prompt: Highlight dependencies and implementation needs.

16. **To what extent are the solutions repeatable across different projects, and how much site-specific adaptation is needed?**
    Prompt: Assess standardisation vs. customisation.