Impact sociétal de la recherche au CERN

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CERN, ATS/DO

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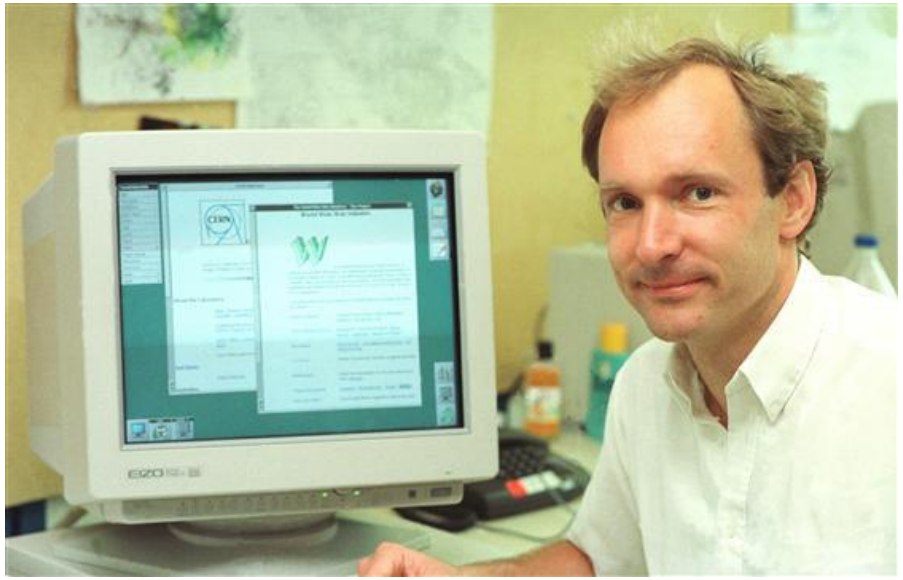
Rencontres Accélérateurs 2022 de la SFP

CERN impact on society: a long history

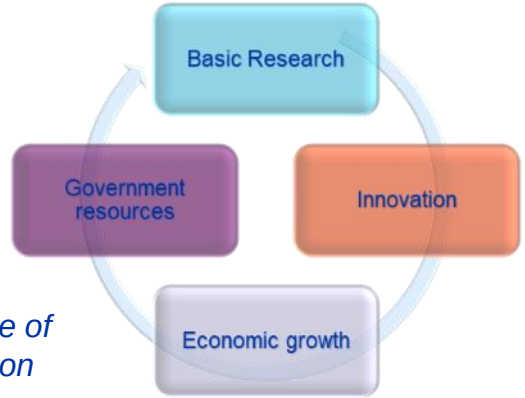


- Tim Berners-Lee invents the WWW) in 1989
- In 1993, CERN puts the WWW software in the public domain.

But we cannot live on our past success!

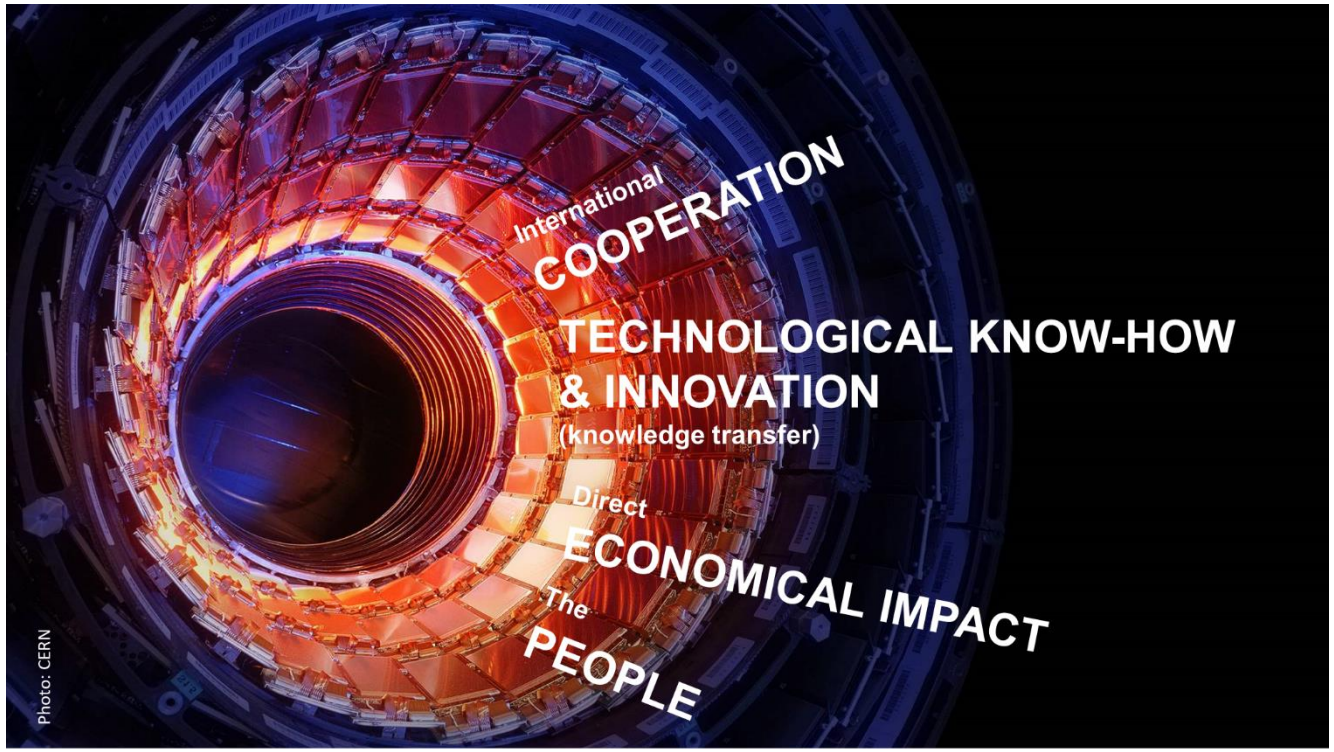
The WWW was long ago…

Today more than ever, highlighting the impact of our research on society is **vital for our community and for CERN** – *even if at CERN we don't experience the direct pressure from governments*.



The virtuous circle of scientific innovation

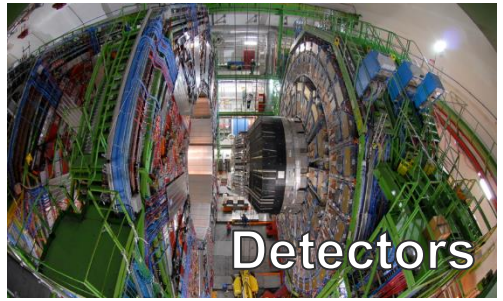
Highlighting and maximising impact



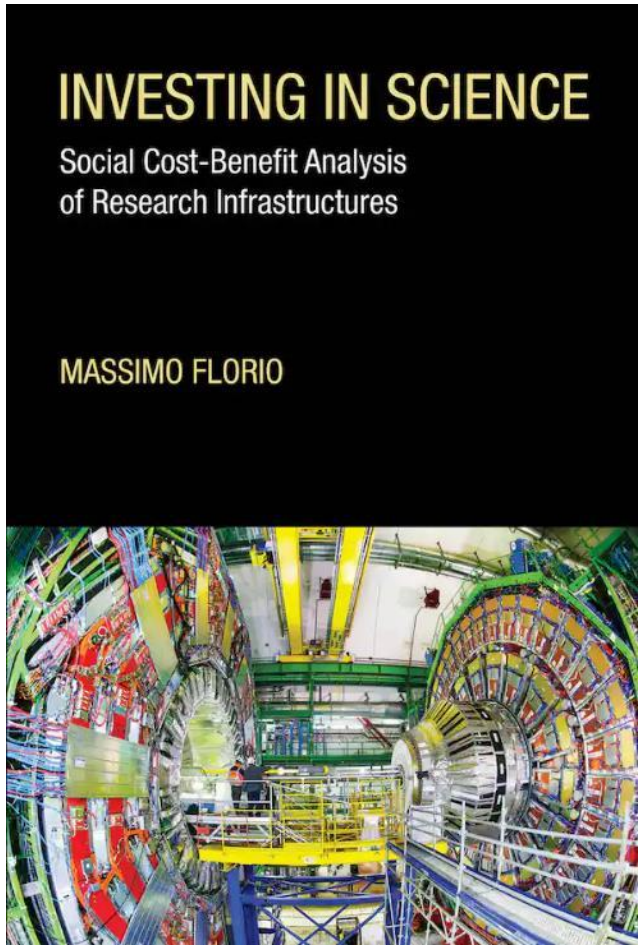
CERN is progressing on 2 main avenues:

1. Highlighting the **wider impact** of particle physics and its associated technologies on economy, education, cooperation;
2. Promoting some **direct societal applications** of particle physics technologies, in particular in the field of medicine.

CERN technologies and know-how



Impact on economy and society evolution



Several recent studies have used CERN or its projects as case studies to underline the impact on society of large research infrastructures and in particular of physics research

Cost-Benefit Analysis of the Large Hadron Collider to 2025 and beyond

Massimo Florio[1], Stefano Forte[2], and Emanuela Sirtori[3]

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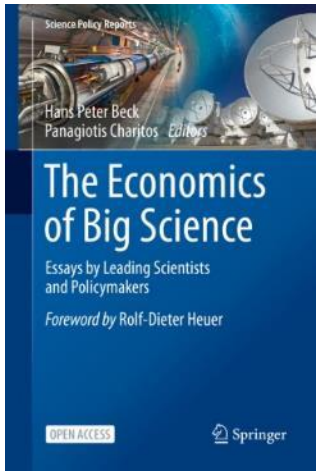


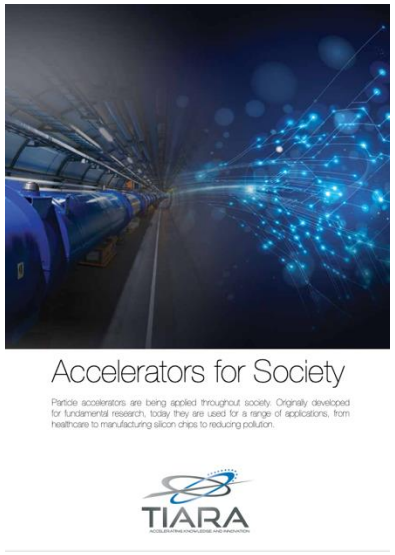
Prof. Florio (Milan University), Social Cost-Benefit Analysis (CBA) of the LHC to 2025 and beyond.

4 classes of contributions to users:

1. Knowledge output (procurement, OS software, …)
2. Human capital development
3. Technological spillovers
4. Cultural effects

Impact through CERN technologies

http://apae.ific.uv.es/apae/



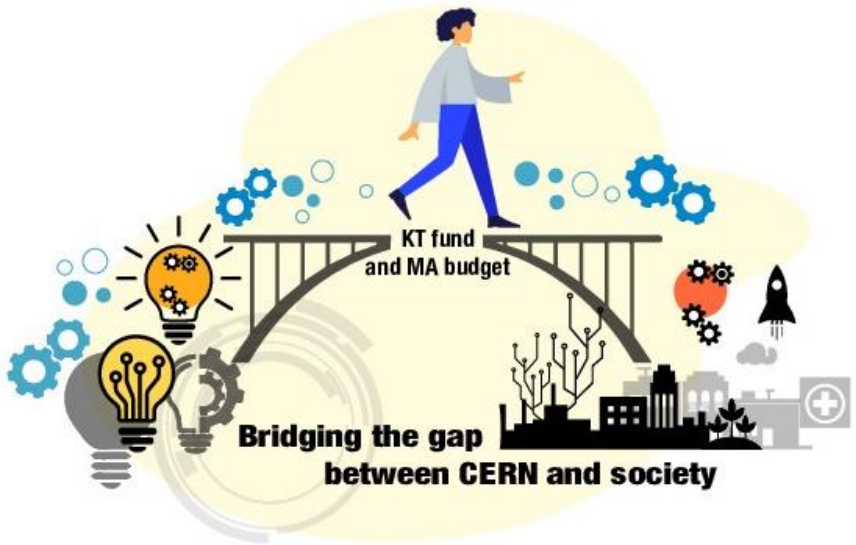
Accelerator and detector technologies have many rising **applications in fields of interest for society**: medicine, industry, environment, energy, cultural heritage, …

See for example the networking and R&D activities promoted by TIARA and the EU Projects for Accelerator R&D EuCARD2, ARIES, I.FAST

- Huge portfolio of CERN technologies with potential impact on society, some with related commercial interest;
- But technologies as such (optimized for particle physics) have little or no direct interest;
- **An additional R&D step is needed,** to adapt CERN technologies to what is required by society and by the market.

The CERN KT and MA Funds

Two competitive funding mechanisms to promote innovations for society



	Number of awards	Amount awarded
KT fund (2011-2021)	56	5 357 796,00 CHF
MA budget (2014-2021)	53	8 766 246,00 CHF
Total	109	14 124 042,00 CHF

~500 k/year
~1,250 M/year

KT Fund

- For cases with a business, startup, or commercial potential
- Should be market need driven
- 'Self-funding' mechanism

MA Budget

- For projects using CERN tech for medical
- More early stage research oriented
- CERN funded

Well-defined scheme for Medical Applications at CERN: **2017 Council Document: Strategy on KT for Medical Applications** (focus on R&D projects, using technologies uniquely available at CERN, complementary to work in other labs – receiving from CERN seed-funding to collect external funding)

Experience with KT and MA Funds

Amount per project varies greatly (from a few 10k to several 100k)

Relatively “young” tools: stories rather than statistics

Impact in different ways:

- Spin-off companies
- Agreements with external partners
- Job creation
- Publications (in particular on journals not HEP-related)
- Grants/Funding to continue projects, obtained thanks to seed money from the KT Fund/MA Budget

Limitations:

- Fragmentation of budget into many small activities
- Not all projects successful in attracting external funding
- Reluctance from line management to contribute internal personnel resources

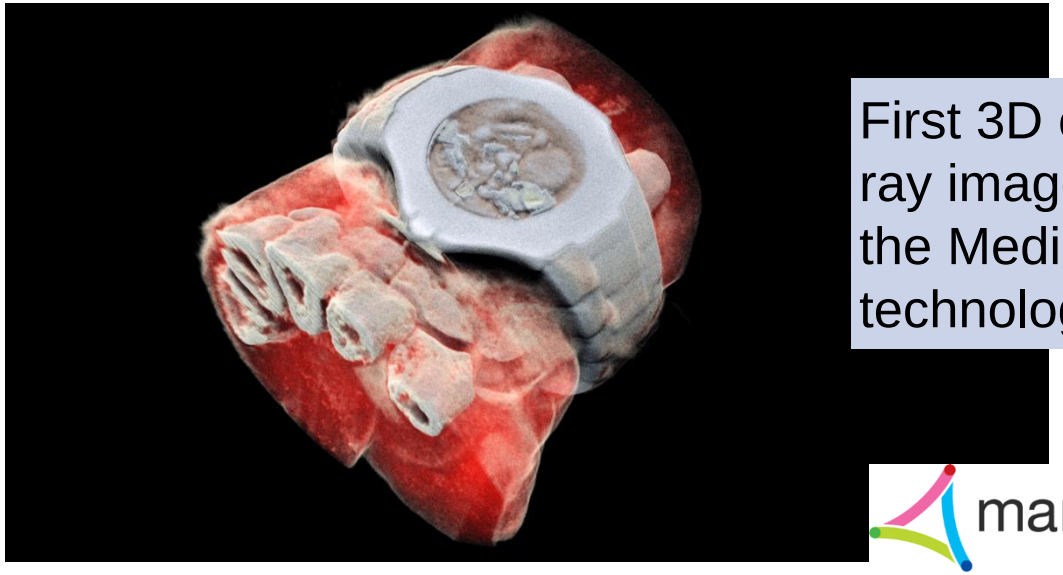
Key point is **collaboration** – the goal is to prototype technologies in collaboration with external partner (industrial or scientific) that will contribute to the development and to its future exploitation

Highlights - Medipix

Family of pixel detector read-out chips for particle imaging and detection

MA Contribution to Medipix4 built on the success of previous chips (showcased here)

Medipix Collaboration: 16 partners from Europe, USA, New Zealand



First 3D colour X-ray images using the Medipix3 technology

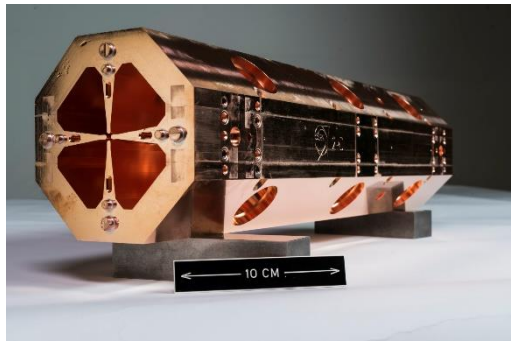
mars

Timepix helps rediscover lost painting from Raffaello

Highlights – The high-frequency RFQ

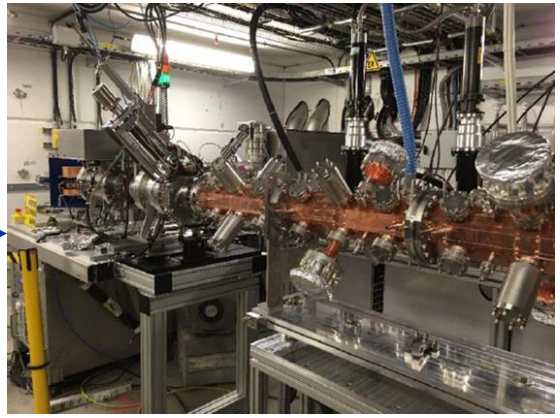
2007
LINAC4 RFQ
352 MHz
1MeV/m
Weight : 400kg/m
Ext. diameter : 29 cm

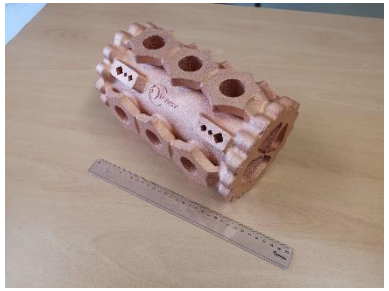
2014
High-Frequency RFQ
750MHz
2.5MeV/m
Weight : 100 kg/m
Ext. diameter : 13 cm



From **Linac4 technology**, new mini-RFQ design at 750 MHz:

1. Injector for proton therapy linac (ADAM-AVO), built
2. PIXE analysis of artworks (INFN-OPD), in commissioning.
3. CERN exhibition, in construction.
4. Carbon and Helium for ion therapy (CIEMAT), in construction.
5. Isotope production (CNPEM, Brazil), being designed.





New Additive-Manufactured version, being developed by a wide collaboration within the I.FAST project

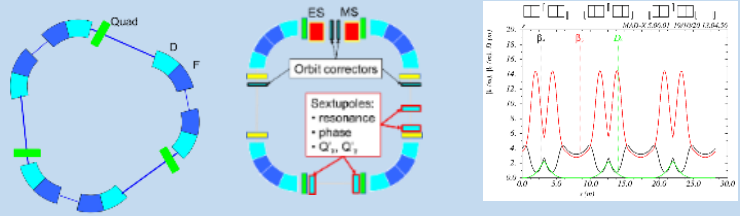
Highlights – The Next Ion Medical Machine Study

Interest at CERN for a new strong initiative in the field of hadrontherapy, after the success of the PIMMS (Proton Ion Medical Machine Study) at the end of the 1990's, leading to the construction of CNAO and MedAustron.

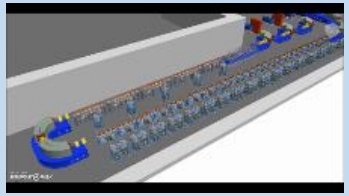
- **Proton** therapy is now commercial, 4 companies on the market, in competition with IMRT therapy with X-rays.
- **Ion** therapy (**carbon** and other ions) is still in an early phase (13 facilities worldwide, 4 in Europe) despite its advantages. Its diffusion limited by:
  - ✓ **Size and cost of the accelerator**;
  - ✓ **Lack of experimental data**.

Next Ion Medical Machine Study to develop a **portfolio of technologies** to be used in a next generation facility. International collaborations started in 2018 (10 partners, embedded in the EU project HITRIplus))

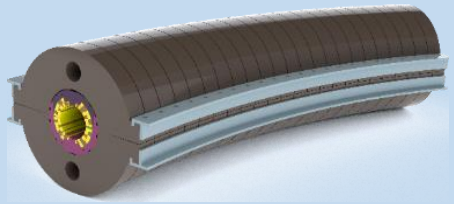
1. Small synchrotron accelerators

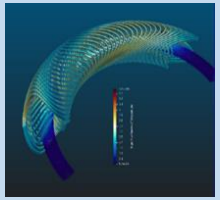


1. Compact Carbon linacs

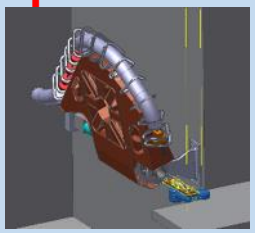


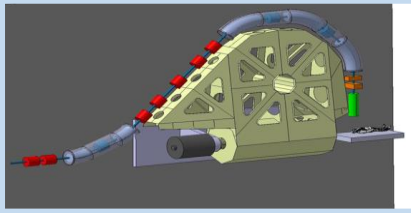
2. Superconducting curved magnets for small accelerators

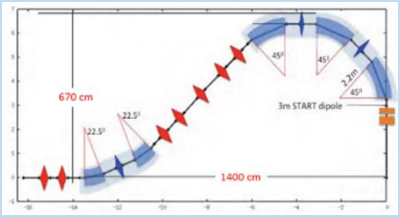




3. Superconducting rotating gantries for ions







Highlights – The SEEIIST facility

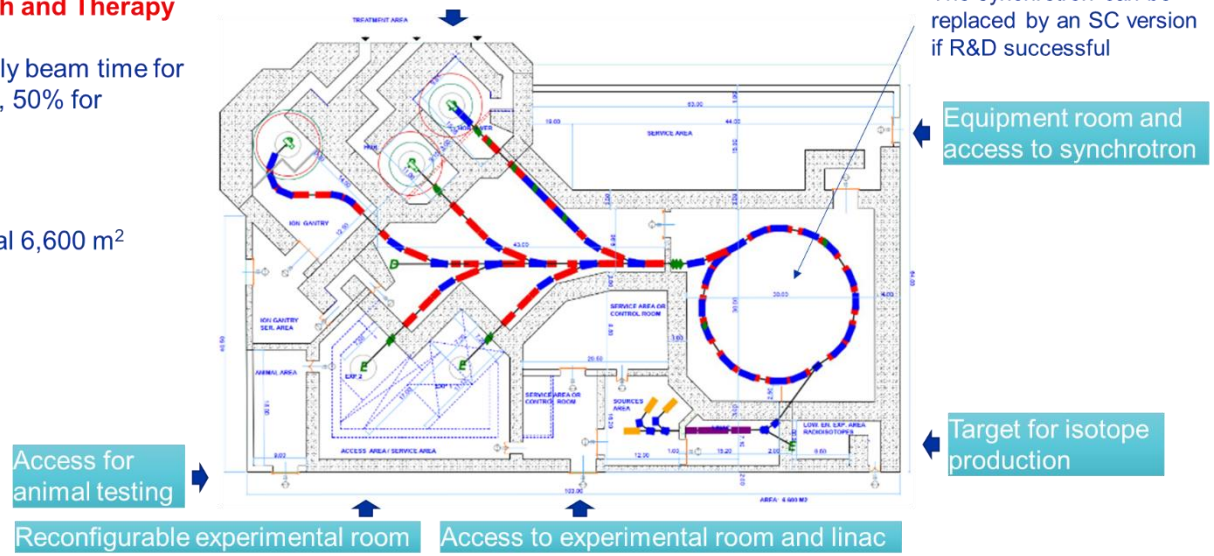
SEEIIST, partner and reference user

- The **SEEIIST** (South East Europe International Institute for Sustainable Technologies) is a new international partnership aiming at the construction of a new Research Infrastructure for cancer research and therapy in South East Europe (8 member countries and 2 observers).
- Supported by the European Commission, to develop the facility design in collaboration with CERN.
- Goals are to develop a new advanced design and to build international cooperation and scientific capacity in a region that will join EU but is less develop and still divided, in the line of “science for peace”.

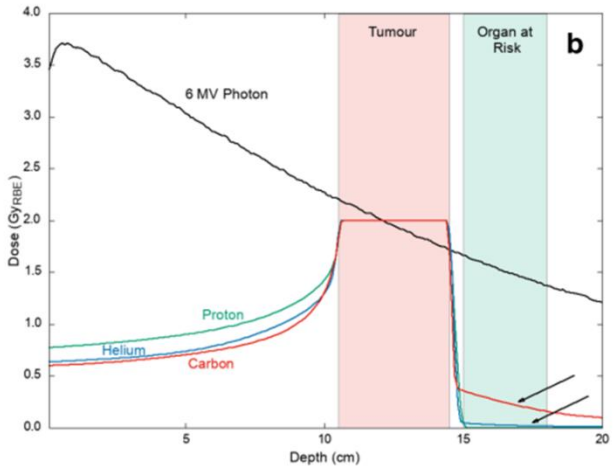
SEE IIST
South East European International Institute for Sustainable Technologies

Research and Therapy Facility
(50% daily beam time for research, 50% for therapy)

Total 6,600 m^2



Highlights – The Helium synchrotron



Helium ions for therapy can provide maximum conformality with effectiveness only slightly below carbon.

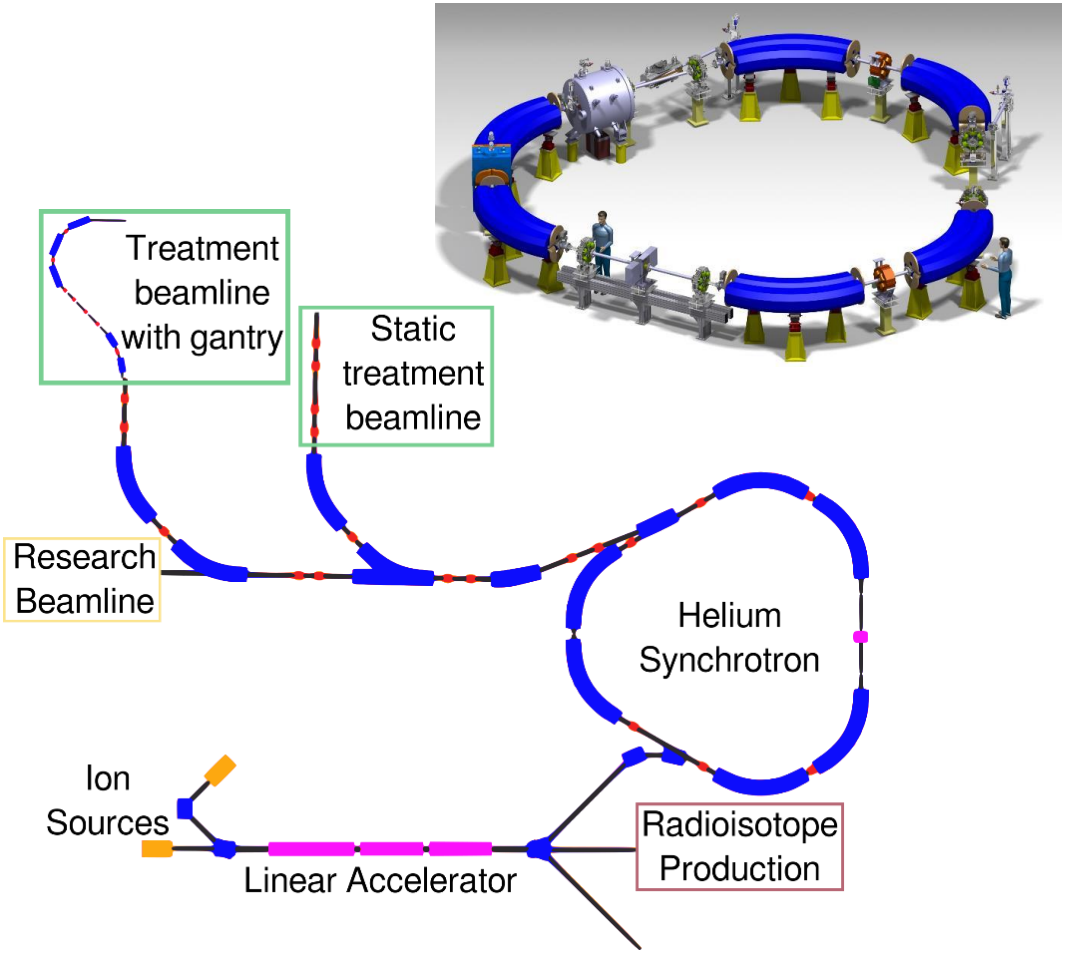
Ideal in particular for paediatric patients (lower neutron dose).

Recent ground-breaking work at Heidelberg, 1st patient treated in Sept. 2021.

A facility for cancer research and therapy with helium ions*

- 2 beamlines for treatment, 1 for research.
- Slow and FLASH-type extraction.
- On-line proton radiography.
- Rotating superconducting gantry (HITRIplus/SIG collaborations).
- Linac for parallel radioisotope production (211At)
- Synchrotron circumference 33m
- Surface ~1,600 m2

** M. Vretenar et al., IPAC2022*



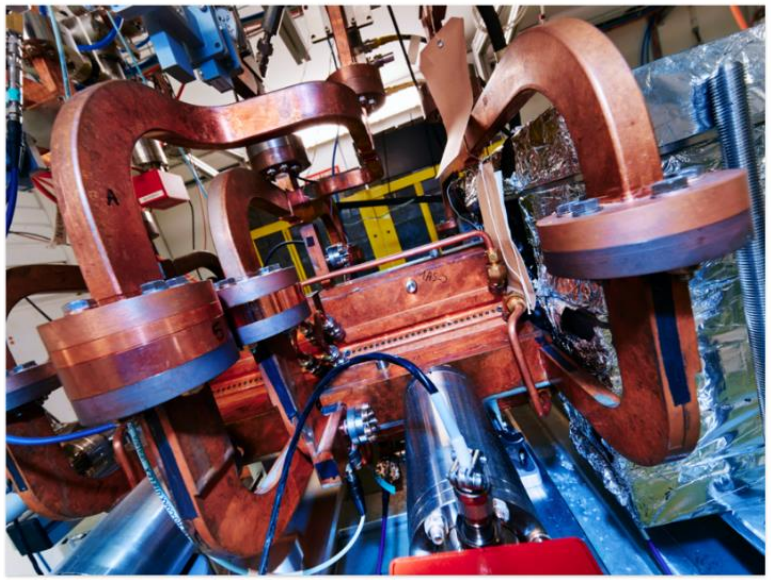
Proposed for construction as an Advanced Particle Therapy Centre for the Baltics

Highlights – FLASH and GaToroid

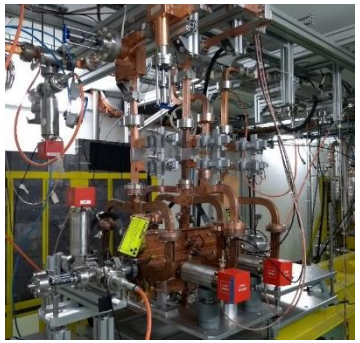
Collaboration CERN – Centre Hospitalier Universitaire Vaudois (Lausanne) for the construction of a prototype compact linac based on CLIC technology for cancer treatment with high-energy electron beams at FLASH rates.

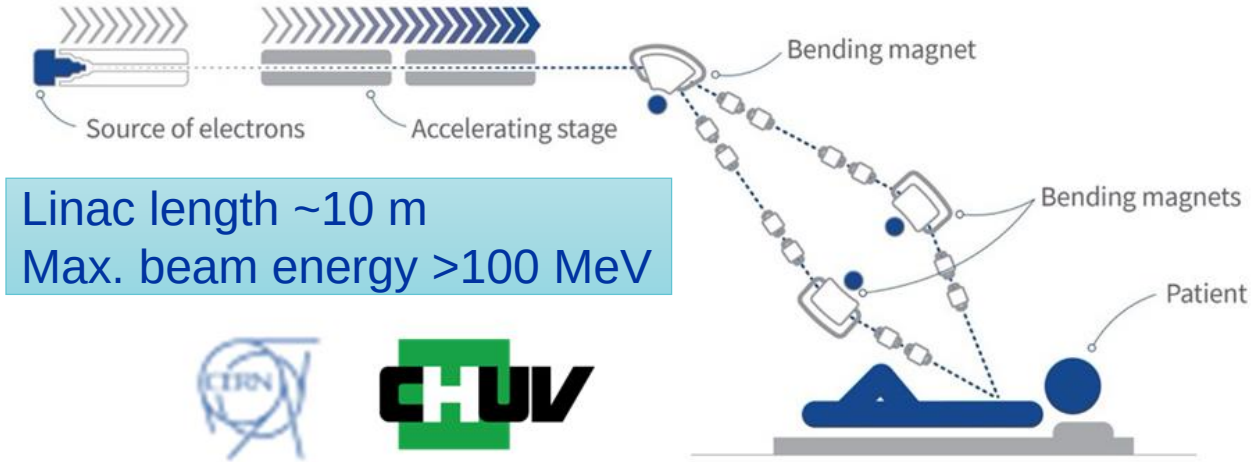
Discussions ongoing with industrial partners.

Start early 2019, construction start in 2022.

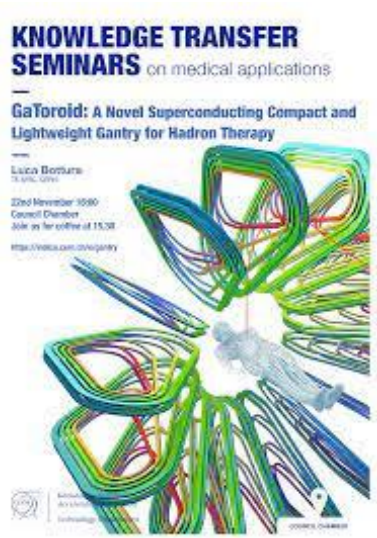


Close-up of the Compact Linear Collider prototype, on which the electron FLASH design is based (Image: CERN)



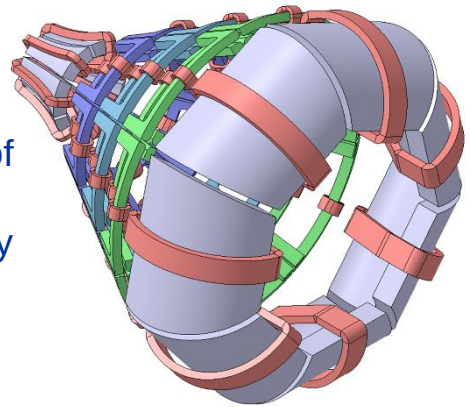


Linac length ~10 m
Max. beam energy >100 MeV



Excellent match with the GaToroid development (fixed toroidal gantry)

VHEE version of the Gatoroid gantry, presently under study
(image courtesy T. Lehtinen, L. Bottura)



Conclusions

Les grandes Infrastructures de Recherche tels le CERN ont un **impact notable sur notre société** en termes économiques, d'éducation et de formation, et de culture général et scientifique.

Un impact plus directe est étroitement lié au **technologies développées pour la physique des particules**, et en particulier dans le domaine des accélérateurs (médecine, détection).

Maximiser cet impact nécessite la mise en place de **structures de soutien** aux développements technologiques et de **collaborations** qui puissent intégrer progressivement l'industrie et/ou les utilisateurs finaux.

Le **CERN** est bien engagé dans cette direction, même si beaucoup reste encore à faire.

Avec mes remerciements au groupe KT du CERN et en particulier à M. Cirilli pour leur contribution à cette présentation