Advanced Particle Therapy center for the Baltic States

Current status and looking towards the future – Feasibility Study

On behalf of CERN Baltic Group's "Advanced Particle Therapy center for the Baltic States" working group

Prof. **Toms TORIMS** (CERN Baltic Group, RTU)
Kristaps PALSKIS (RTU)

Mandate

On April 12th 2022 within CERN Baltic Group 9th general meeting at CERN the Advanced Particle Therapy Center in Baltic States Working Group has been established

Mandate: **Develop and induce CBG flagship project - construction of a large scale scientific research and clinical particle therapy facility in the Baltic States**

To achieve this initial goal:

- establish Expert Team composed by medical professionals nominated by professional associations in the fields of radiology, therapeutic radiology, nuclear medicine, medical physics and others, researchers from CBG institutional members and experts of the NIMMS collaboration;
- facilitate the work of the Expert Team in order to evaluate the feasibility of the proposed project initiative
- establish Stakeholder Advisory Panel comprised by the relevant stakeholders in political, economical, social and other involved fields, as well as industry partners;
- regularly inform Stakeholder Advisory Panel from Expert Team side, with the inclusion in the decision making process and overall development of the project.

Today – recap of the concept of the initiative, latest status updates regarding stakeholder engagement activities and focusing on the future: Feasibility Study

Outline

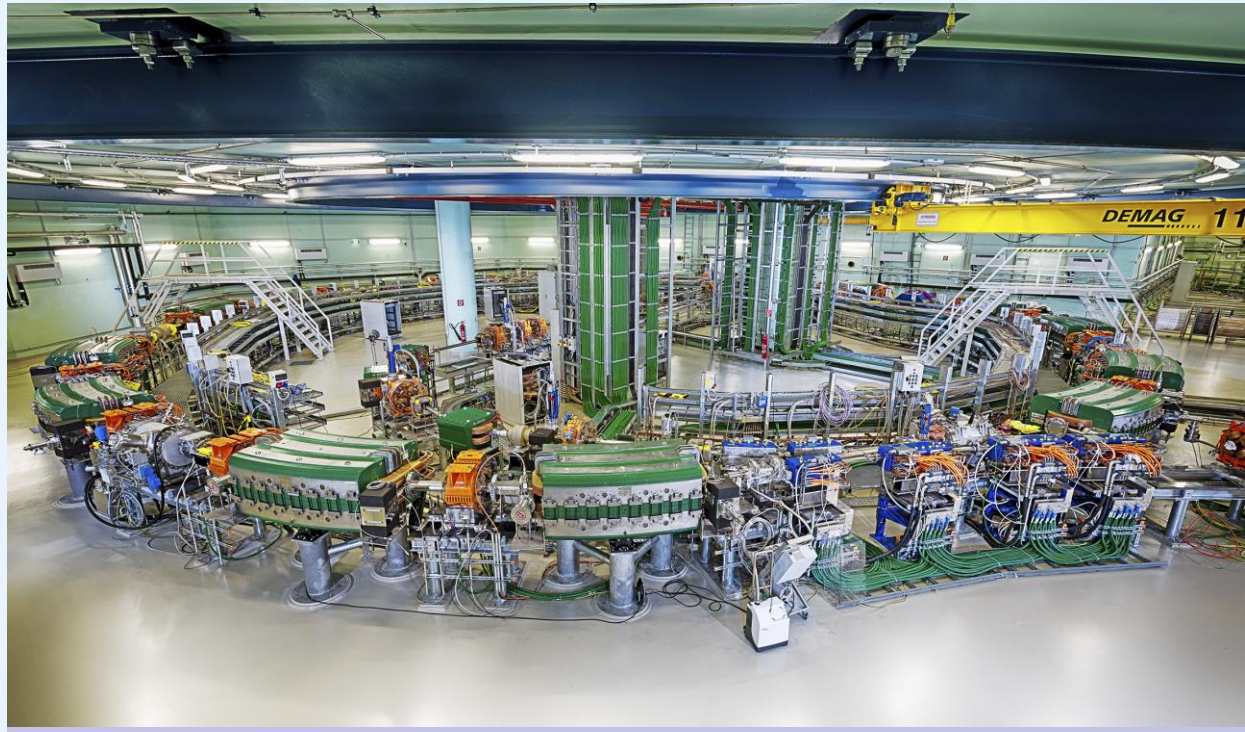
- *Recap*: Advanced Particle Therapy center for the Baltic States initiative overview
- *Status update*: Workshop "*Particle therapy – future for the Baltic States?*" outcomes
- *Status update*: Recent stakeholder engagement activities
- Political support of the initiative
- **Towards the future – Feasibility Study**

Clinical perspective

Particle therapy could provide most optimal type of treatment for certain types of cancer

[1] https://enlight.web.cern.ch/

[2] https://www.medaustron.at/en/therapy-center/



Baltic States do not have yet joint large, scale research infrastructure. Particle accelerator system – broad scientific perspectives and closer collaboration with CERN

Scientific research perspective

Next **I**on **M**edical **M**achine **S**tudy

CERN-based scientific collaboration (*under KT)* for development of next generation particle accelerators for cancer treatment with ion therapy

- Building on experience of PIMMS
- Federating large number of partners for key technology development
- **Partners can use the NIMMS technologies to assemle their own optimized facility**

October 8th, 2021
CBG discussion with NIMMS collaboration on facility options

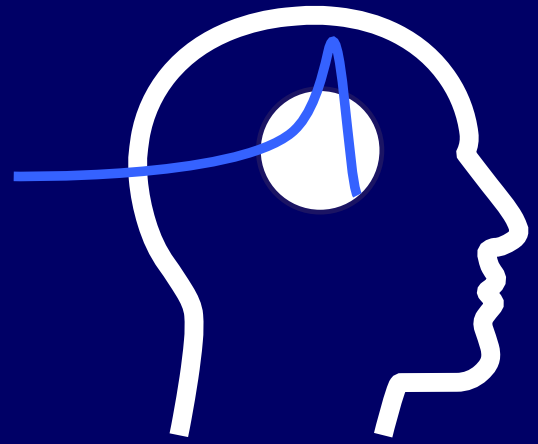
April 12th, 2022
"Advanced Particle Therapy center for the Baltic States" working group established within the CERN Baltic group (CBG)
Convener: Prof. Toms Torims (RTU)
Vice-convener: Prof. Diana Adliene (KTU)

February 2022
NIMMS Helium synchrotron working group establishment with involvement of researchers from the CBG

Spring 2022
Development of a dedicated conceptual design report

Integration of helium synchrotron technology and all the capabilities into a modern clinical treatment center and large scale scientific research infrastructure

Research institution



Clinical cancer treatment facility

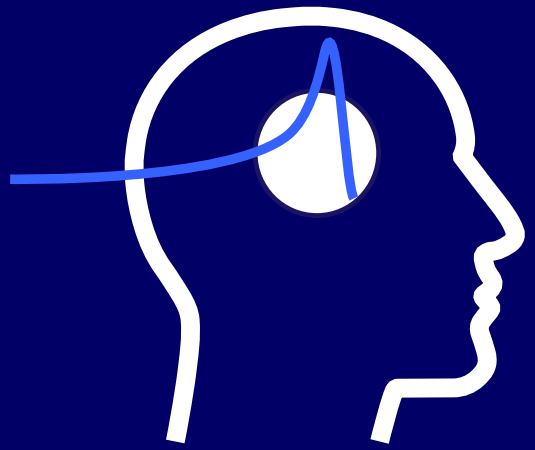
Particle therapy and nuclear medicine

Industry involvement infrastructure

Research institution

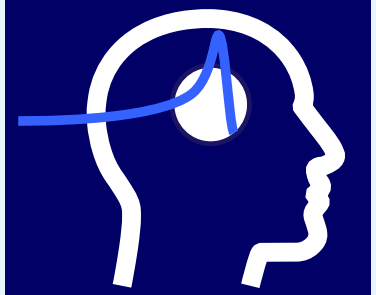
51 % of time for scientific research

49 % of time for clinical treatment



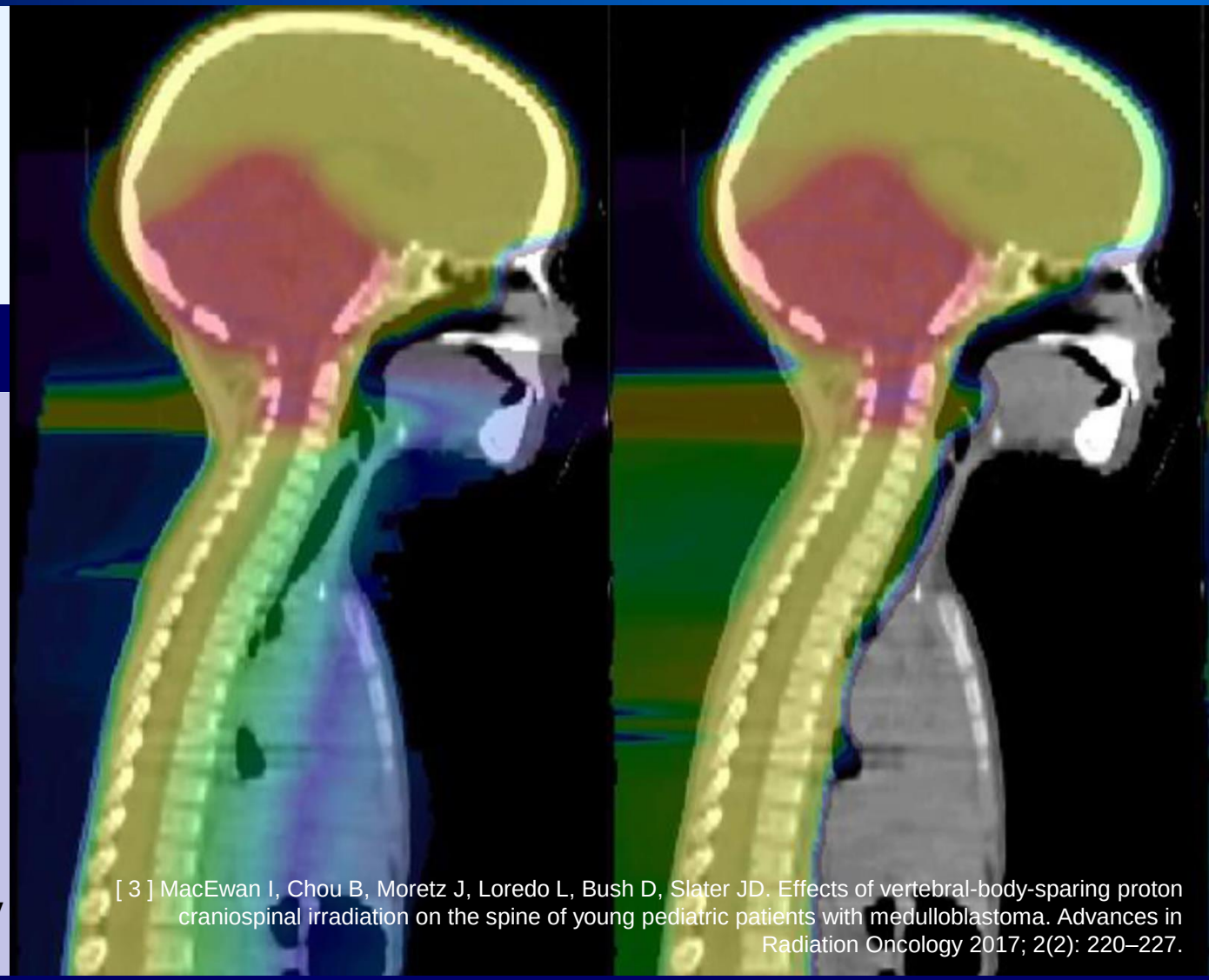
Clinical cancer treatment facility

Particle therapy and nuclear medicine



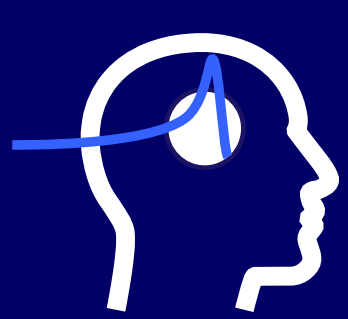
Initially: **proton therapy**

- **Radiation therapy:** use of ionizing radiation to damage DNA of cancer cells
- Radiation therapy for ~ 50 % cancer patients
- **Particle therapy:** specific modality of radiation therapy with improved dose distributions due to physics
- **Clinically most established in particle therapy – proton therapy**
- Proton therapy has shown clinical benefits in complexly localized tumors (*brain, H&N)*, pediatrics, recurrent tumors etc.
- **Reduced radiation induced toxicity and increased quality of life**



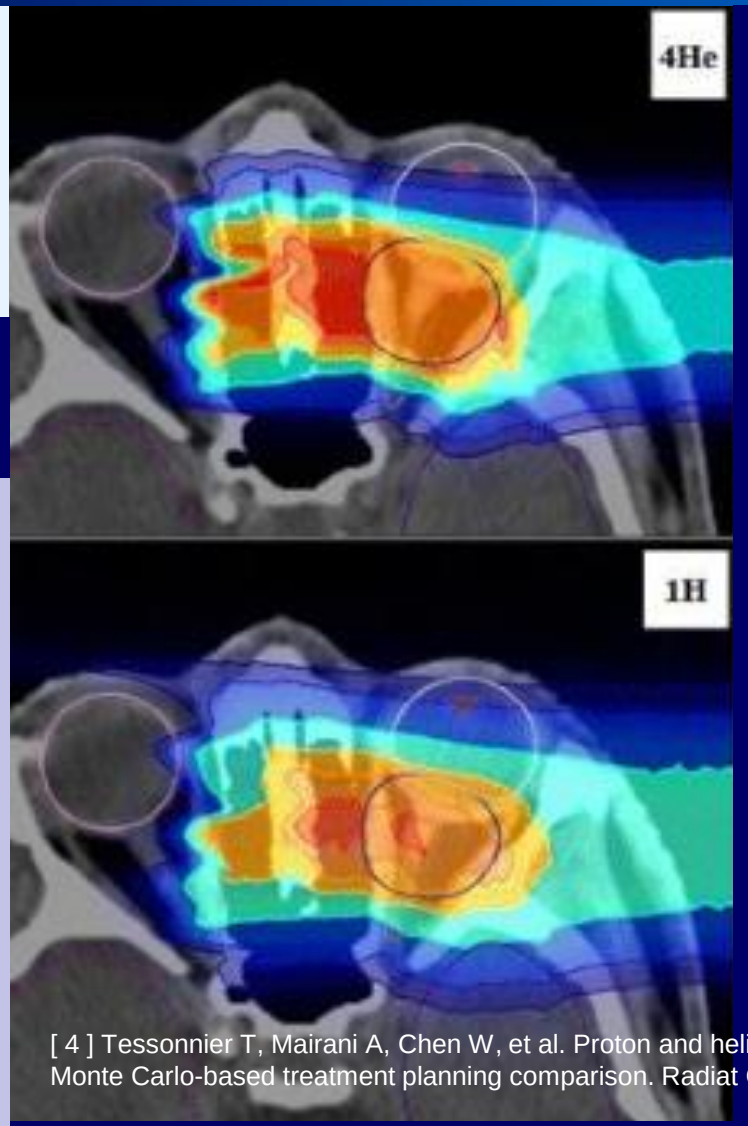
[3] MacEwan I, Chou B, Moretz J, Loredo L, Bush D, Slater JD. Effects of vertebral-body-sparing proton craniospinal irradiation on the spine of young pediatric patients with medulloblastoma. Advances in Radiation Oncology 2017; 2(2): 220–227.

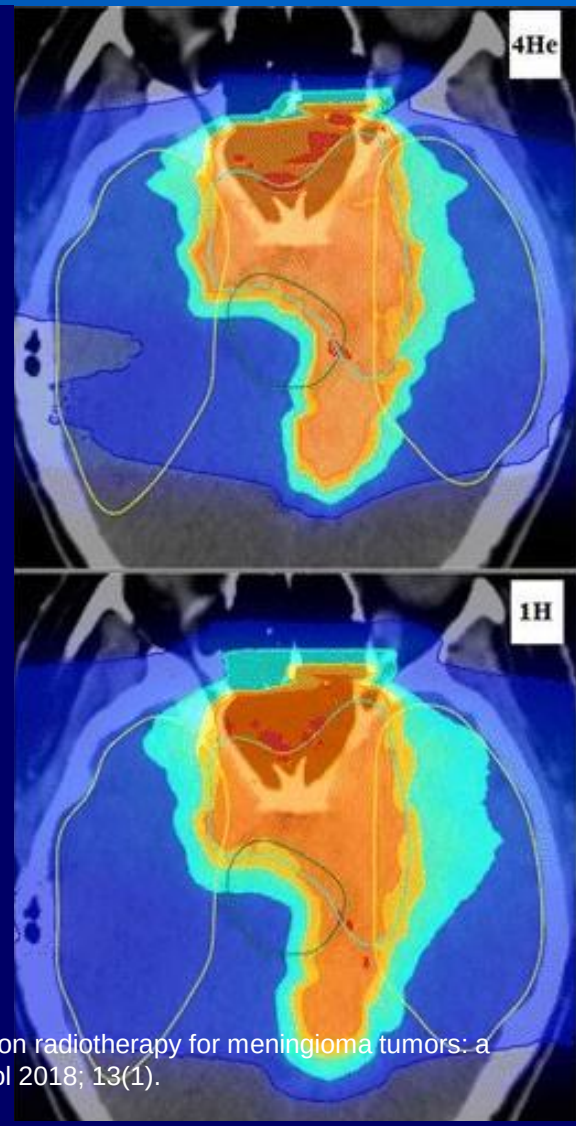
Center could deliver clinically established therapy in early stages . . .



Long term goal: **helium ion therapy**

- Machine is designed for **helium ion therapy delivery** – even more conformal treatment delivery ensuring better tissue sparing and QoL for cancers in proximity to critical organs
- (Semi-)**novel approach having renaissance:** actively researched in Heidelberg Ion therapy center, interest within other centers
- **Clinical trials to start 2024-2025**
- **Evolution of proton therapy, while having reduced costs compared to carbon ion therapy**
- Possibility to take part in an active scientific research endeavor in cancer treatment



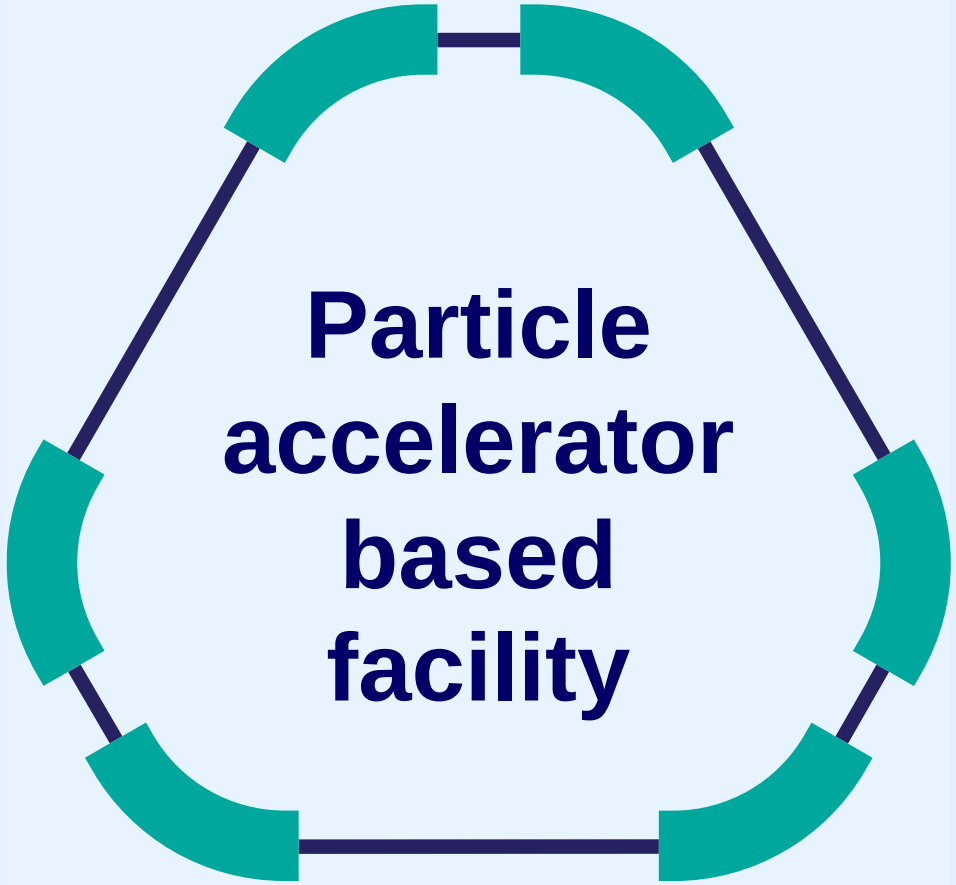


[4] Tessonnier T, Mairani A, Chen W, et al. Proton and helium ion radiotherapy for meningioma tumors: a Monte Carlo-based treatment planning comparison. Radiat Oncol 2018; 13(1).

. . . while contributing for *cutting-edge* future radiotherapy modality

Clinical sciences

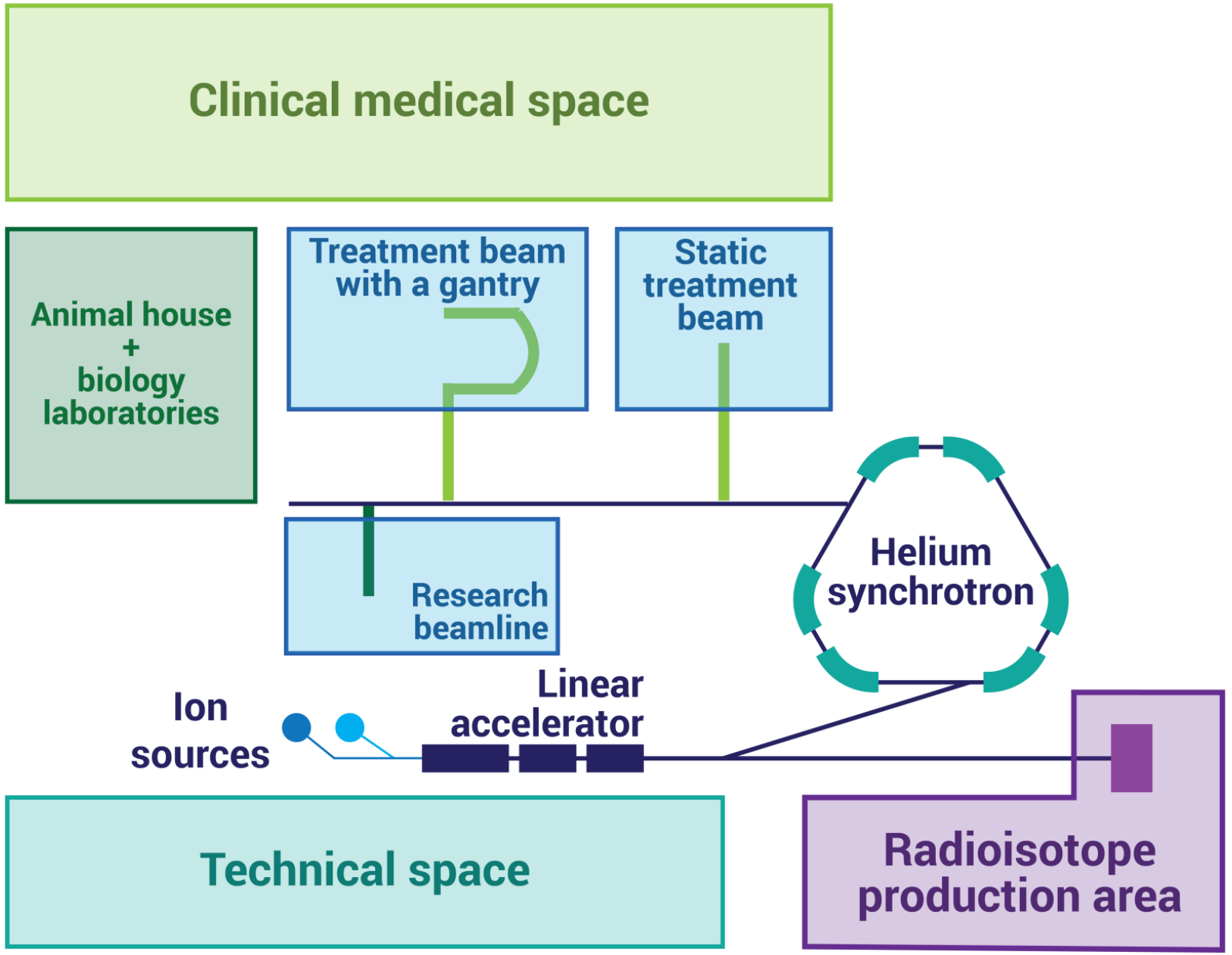
- Pre-clinical research
- Clinical radiation oncology
- Radiobiology
- Nuclear medicine



Natural and technical sciences

- Medical physics
- physics and technologies
- Particle physics
- Radioisotope production – material science, radiochemistry

Possibility of broad research programme and collaboration with CERN


Clinical medical space
Animal house + biology laboratories
Treatment beam with a gantry
Static treatment beam
Research beamline
Helium synchrotron
Ion sources
Linear accelerator
Technical space
Radioisotope production area

Recap: engagement of medical professional societies

- **Oct 2022** Presentation at the 8th Baltic Radiology congress
- **Jan 2023** Presentation at Lithuanian Society of Radiation Therapy conference
- **Mar 2023** Presentation for Latvian Therapeutical Radiology Association
- **Spring 2023** Discussions on conceptual idea with Baltic Nuclear Medicine Association
- **Jun 2023** Presentation at 19th Nordic-Baltic Conference on Biomedical Engineering and Medical Physics
- **Jun 2023** Presentation at Educational course of International Stereotactic Radiotherapy Society held in Latvia

End of 2021
Idea and first discussions

Aug 2022
Baltic Assembly support – letter to 3 prime ministers

Oct 2022
Resolution of Baltic Assembly

May 2023
Baltic implementation – part of IPAC paper by NIMMS

Oct 2023
Report on the workshop findings approved by CERN Baltic Group

Presentations and discussions with relevant professional societies, scientific universities and political stakeholders

Apr 2022
Conceptual design paper and **working group** establishment

Oct-Nov 2022
Bi-lateral **discussions with stakeholders** in all 3 Baltic States

25th of May 2023
Workshop at CERN
Particle therapy - future for the Baltic States? State-of-play, synergies and challenges

Recap: “Particle therapy - future for the Baltic States?”

A joint, dedicated workshop
“Particle therapy - future for the Baltic States? State-of-play, synergies and challenges”

Set-up of the event

- **37 participants** (*mainly on site participants*) – Baltic medical community representatives, CNAO radiation oncologist, CERN and NIMMS experts, members of political bodies – Baltic Assembly
- **5 sessions** dedicated to each of the core discussion areas identified with **reporters on subject matter and moderators of the session**

Cancer statistics and indication profile in the Baltic States. Status of radiotherapy technologies in the Baltic States.	▪ Cancer statistics in the Baltic States – number of patients diagnosed and treated with RT yearly ▪ Most common malignancies, with a correspondence to eligibility for particle therapy ▪ Technological level of currently used radiation therapy techniques, statistics of RT equipment
Clinical indications for proton and particle therapy. Existing clinical evidence and on-going clinical trials.	▪ Main cancer types and oncological indications eligible ▪ On-going clinical trials for evidence-based medicine are to be discussed ▪ Existing consensus statements and alternative approaches for patient selection
The technology of helium synchrotron: technology readiness level and research needed.	▪ Current status of the technology and technology readiness level ▪ Potential challenges in the development and construction stages ▪ Scientific research inputs necessary
Current status of nuclear medicine in the Baltic States. Trends and research pathways going into the future.	▪ Current status of the nuclear medicine field within the Baltic States ▪ Insights gained from PRISMAP project - focus on novel radioisotopes ▪ Technical aspects and scientific research needed to develop production of such isotopes
Educational necessities and possible solution pathways for clinical and technical personnel training.	▪ Key educational necessity areas ▪ International educational opportunities and collaborations ▪ Educational aspect implementation paths early-on within the project initiative

Status update: **Workshop outcomes**

Workshop report

Approved in 12th CERN Baltic Group General meeting (*October 11-12th, 2023*)

CERN Baltic Group

Report on workshop

Particle therapy – future for the Baltic States? State-of-play, synergies and challenges

https://indico.cern.ch/category/16259/attachments/2838075/4960020/REPORT_25_05_2023.pdf

https://link.springer.com/article/10.1007/s12553-024-00875-2

Health and Technology (2024) 14:965–972
https://doi.org/10.1007/s12553-024-00875-2

ORIGINAL PAPER

"Particle therapy - future for the Baltic states?" – synthesis of the expert workshop report

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Received: 8 March 2024 / Accepted: 19 April 2024 / Published online: 6 May 2024

Abstract

Background Baltic States remains one of the few regions in the Europe without a dedicated particle therapy center. An initiative since 2021 has been started by CERN Baltic Group on a novel particle therapy center development in the region in partnership with CERN NIMMS collaboration. With a conceptual design idea in early 2022 and stakeholder engagement activities in late 2022 - next step forward was necessary for the initiative for a more in-depth analysis.

Methods A dedicated workshop "*Particle therapy - future for the Baltic States? State-of-play, synergies and challenges*" was held. The workshop was attended by medical community from the Baltics, as well as CERN technical experts and particle therapy practicing clinicians, with scientific programme split in 5 main areas of investigation.

Results Current cancer epidemiology statistics and RT technological possibilities in the region were analyzed, with first estimates of eligible number of patients calculated. Technological development level of the proposed accelerator complex was discussed, as well the clinical needs and synnergy possibilities with the nuclear medicine field.

Conclusions The current state and calculated first estimates presented here have shown a promising starting point, which prompts even further in-depth work – a feasibility study for development of a novel particle therapy center in the Baltic States.

Publication «*Health and Technology*»

«Hadrontherapy and BNCT: Current Status and Future Trends»

Status update: **Stakeholder engagement activities 2024**

Spring 2024 Semināra rezultātu publicēšana *Health and Technology* speciālizdevumā

January and October *CERN Medical Applications Steering Committee meeting* – **highest engagement level**

April Presentation and discussions with Heidelberg Ion-Beam Therapy center – **potential collaborator**

July Presentation for Latvian Health Minister during visit of RTU

September Workshop with Lithuanian stakeholders

October 11th Short overview within PMNET forum

During 2024 Working towards radiotherapy statistics publication for December 2024
(*M.Dosanjh, E.Korobeinikova, E.Gershkevitsh, K.Palskis*)

November Participation in *The Nordic-Baltics as a European pilot region for cross-country cooperation in health data* conference (*K.Palskis, E.Korobeinikova, E.Gershkevitsh*)

- From the very beginning of the initiative **policy makers were informed,** consulted and engaged:
  - **relevant national research and health authorities**
  - **ministries**
  - **research institutions**
  - **selected government ministers and legislators in all three Baltic States**

- Furthermore, experts from **permanent Representation in Brussels** and **COREPER I Ambassadors** were kept in the loop and advised CERN Baltic Group on the EU policies and priorities.

- At inter-parliamentary-level, initiative has been presented to Baltic Assembly
- **Baltic Assembly has made several resolutions of great relevance for the initiative, addressed to the parliaments and governments of Estonia, Lithuania and Latvia, as well as the Baltic Council of Ministers:**
  - to enable potential for the cooperation with the CERN for the development of science, research and technology in the Baltic States and allocate corresponding financial support within the State budgets;
  - to engage the corresponding ministries, national agencies and relevant stakeholders and to jointly apply for co-financing from the European Union for implementing the joint initiative of Advanced Particle Therapy Center for the Baltic States;
  - **the Baltic Assembly also emphasizes the importance of the initiative as an integrated flagship project for the Baltic States, falling entirely within the scope of the national policies of the Baltic States, Europe's Beating Cancer Plan and the Mission on Cancer of the European Union, especially in the pillars of diagnostics, treatment and quality of life improvement for cancer patients and their families;**
  - **to implement a full-scale feasibility study of the joint initiative of the CERN Baltic Group and CERN on the Advanced Particle Therapy Center for the Baltic States.**

https://indico.cern.ch/category/16259/attachments/2838068/4960374/RESOLUTION%20of%20the%20digital%2039th%20Session%20of%20the%20Baltic%20Assembly.pdf
https://indico.cern.ch/category/16259/attachments/2838068/4960369/RESOLUTION%20of%20the%2040th%20Session%20of%20the%20Baltic%20Assembly.pdf
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https://indico.cern.ch/category/16259/attachments/2838068/4960376/RESOLUTION%20of%20the%2042nd%20Session%20of%20the%20Baltic%20Assembly.pdf

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Future of the initiative

FEASIBILITY STUDY

Presentations and discussions with relevant professional societies, scientific universities and political stakeholders

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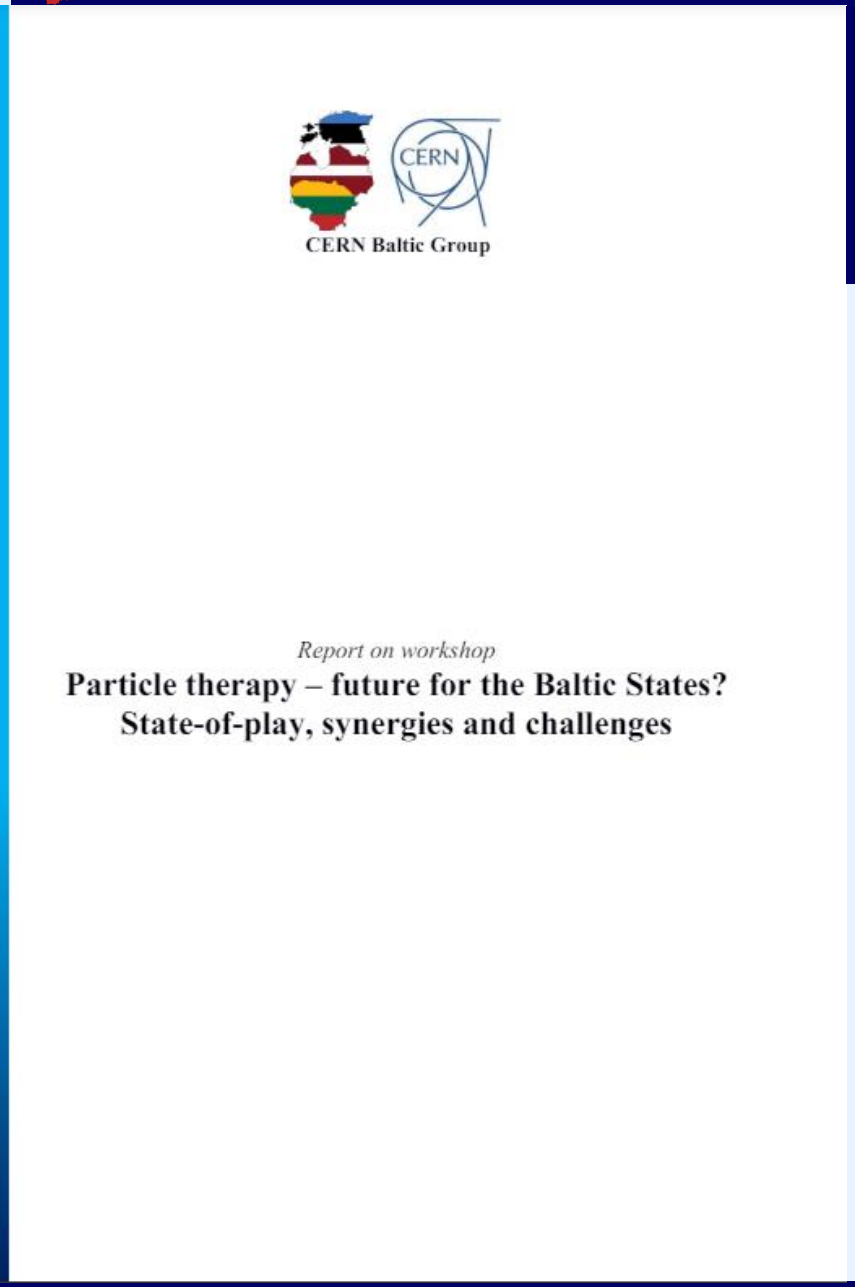


Workshop
«Particle therapy - future for the Baltic States? State-of-play, synergies and challenges»

« . . . In order to proceed with this promising idea, **a full-scale feasibility study of the project is needed.** It shall assess feasibility of the facility of this research infrastructure **from financial** (business case), **clinical** (medical case), **technological** (technical outline, availability and R&D required) **and multi-disciplinary scientific research perspective**. In each of these segments, feasibility study would need to have involvement of experts from every Baltic State and CERN researchers, as well as representatives of European particle therapy centers. The best existing platform for such feasibility study is CERN based NIMMS collaboration **. . . »**

Towards the future . . . Motivation for Feasibility Study

Motivation from **RESEARCH perspective**

- Particle accelerator based scientific centers - broad spectrum of research possibilities and disciplines
- Envisioned scientific activities: clinical, natural and technical sciences, towards helium ion clinical translation
- **Create a regional scientific center of excellence, broad, world-class scientific research attractive to the international community**
- 2/3 economic growth of EU: research and innovation – infrastructure crucial. Aligns with the National Development Strategies, innovation-led economic growth

Motivation from **CLINICAL perspective**

- Proton therapy - shown benefits in the reduction of normal tissue complications in selected types of cancer
- Helium-4: recent re-emergence with a clear research interest in ion therapy centers both in Europe and Asia
- Increased the dose conformality and biological effectiveness.
- **Provide a novel tool for cancer treatment – the clinically established proton therapy with a long-term ambition of developing helium ion therapy for full clinical usage**

Motivation from **ECONOMIC perspective**

- Macro-economic benefits in terms of healthcare cost savings, increased labor productivity and innovation development, job creation and contribution to national economic growth.
- Reduced side effects and increased QoL: increased labor productivity and reduced healthcare costs
- Infrastructure investments lead to the development of local ecosystems, including healthcare clusters and innovation hubs

Motivation from **COLLABORATION perspective**

- Enable potential for the cooperation with CERN for the development of science, research and technology in the Baltic States
- **Excellent demonstration of the impact on society of the particle physics research promoted by CERN**
- Very good example of regional initiatives of CERN Member and Associate Member states
- **CERN has agreed to host this Feasibility Study within its collaborative framework.**

Towards the future . . . Proposal of Implementation Plan

Throughout 2024, part of working group has been working on proposal of Feasibility Study Implementation plan

Plan preparatory Working group:

- Convener of the WG: Prof. **Toms Torims** (Riga Technical University, LV)
- Deputy Convener of the WG: Prof. **Diana Adlienė** (Kaunas University of Technology, LT)
- **Kristaps Palskis** (Riga Technical University, LV)
- Dr. **Erika Korobeinikova** (Lithuanian University of Health Sciences, LT)
- Dr. **Alberto Degiovanni** (Riga Technical University, LV)
- Dr. **Maurizio Vretenar** (CERN, CH)
- Dr. **Andris Ratkus** (Riga Technical University, LV)
- Prof. **Saulė Mačiukaitė-Žvinienė** (Vilnius University, LT)
- Dr. **Eduard Gershkevitsh** (North Estonia Medical Centre, EE)

“Proposal of Implementation plan” – “first iteration” for discussions with CBG member institutions and other relevant stakeholders

Proposal has been finalized, first editions after initial reviews of CBG members

For submission and discussion in 14th CBG General meeting this Thursday

ADVANCED PARTICLE THERAPY CENTER FOR THE BALTIC STATES

SCIENTIFIC RESEARCH INSTITUTION

CLINICAL TREATMENT CENTER

INDUSTRY INVOLVEMENT INFRASTRUCTURE

To envision the facilty and consider any future developments - scientifically and factually driven

FEASIBILITY STUDY

- **Main goal:** investigate the feasibility and possible scenarios of facility's implementation
- **Expected duration:** 2 years
- **Expected launch:** 2025

Main aims of the Feasibility Study

- to investigate the feasibility of the implementation of the APTCB facility to a certain level;
- to provide a factual based Feasibility Study Report to be used as tool for the decision making in the APTCB project continuation;
- through the Feasibility Study Report and associated documents – to provide multiple possible scenarios for implementation at various levels: full, partial or no implementation, with possible alternatives.

FEASIBILITY STUDY IS TO BE DONE WITHIN FRAMEWORK OF CERN WITH INVOLVEMENT OF TECHNICAL EXPERTS

Towards the future . . . Overall structure of the Feasibility Study

CLINICAL AND EPIDEMIOLOGY

Lead: Senior researcher with proven knowledge in field

- Research programme in clinical sciences
- Relevant medical statistics in the region
- Eligibility criteria for proton therapy
- Patient referral, connections with PT community

3 researchers or PhD students from each of the Baltic countries

TECHNOLOGY AND IMPLEMENTATION

Lead: Senior researcher with proven knowledge in field

- Research programme in natural and technical sciences
- Technical requirements of the facility
- Integration study and future upgradability
- Basis of cost estimates for accelerator and facility

3 researchers or PhD students from each of the Baltic countries

ECONOMICS AND INNOVATION

Lead: Senior researcher with proven knowledge in field

- Research on long term funding, business engagement
- Organizational structure and governance model
- Full cost estimation and economic benefit analysis
- Evaluation of revenue streams

3 researchers or PhD students from each of the Baltic countries

TRANSVERSAL TASKS

- Alternative solutions for the facility
- Aspects on regulatory and legal approvals
- Risk analysis and evaluation
- Information flow between pillars for cost estimates
- Education and training necessities

Tool for decision making process

- The main tangible outcome: **the Feasibility Study Report.** The information collected **to be used as decision making tool for the future of the APTCB project**

- Other documents will be created along with the Feasibility Study report:

  - **risk analysis** associated with APTCB proposal and overall **risk management strategy**;
  - finalized and factual-based **proposal for layout of the APTCB facility**;
  - finalized and factual-based **beam-time usage proposal** for the APTCB facility;
  - finalized and factual-based list of **selection criteria for the choice of most suitable APTCB facility construction site**;
  - initial proposal for the **expected staging for full-scale development of APTCB facility**;
  - initial **basis for a business plan** for the APTCB facility.

Multiple possible scenarios

- Feasibility Study report and other accompanying documents: to provide the basis for multiple possible scenarios, not a definitive solution, for the decision making stakeholders. Providing factual basis for comparison of the different alternative options.
  - full-scale implementation scenario, with varying weights of scientific research and clinical treatment functions;
  - partial implementation scenario, limiting certain technical functionalities of the proposed facility;
  - scenario of not implementing the facility, while identifying possible alternatives.

An exciting and unifying opportunity not to be missed!

Thank you for your attention !

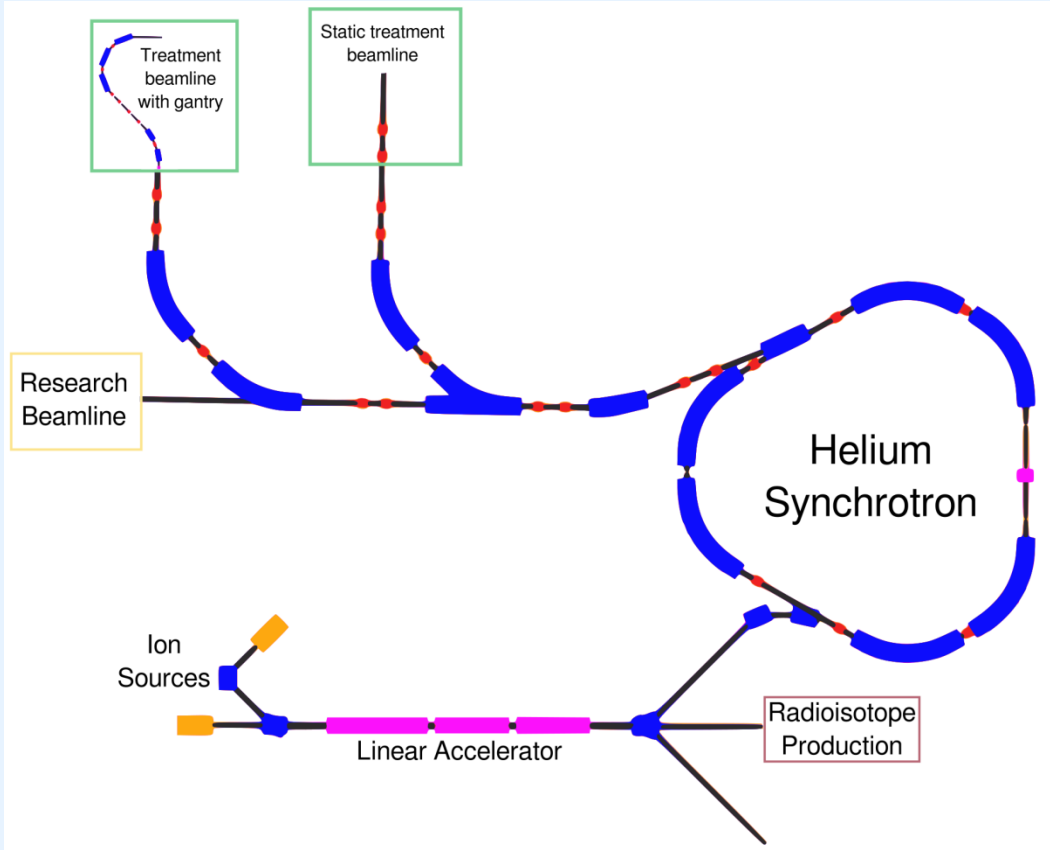
Backup slides

Key outcomes

What does the technology offer?

- protons and helium ions at treatment energies;
- heavier ions at research-suitable energies;
- protons energies for radiography purposes;
- novel, biology-driven deliveries – *FLASH*, mini-beams;
- parallel radioisotope production capabilities.

“An evolution of proton therapy not a revolution in particle therapy”



Reporter slides: **Maurizio Vretenar, Elena Benedetto**
Moderator notes: **Taylor Rebecca**

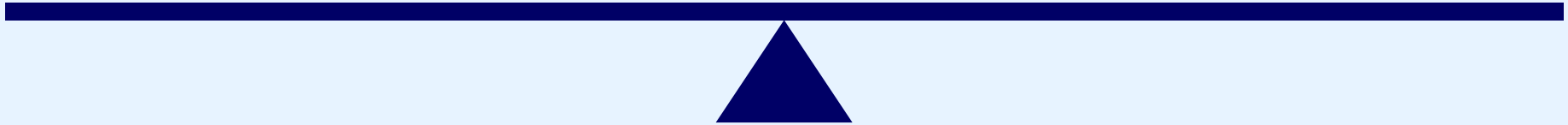
Key outcomes

How ready is the technology?

- **Most of the technologies necessary - proven and existing,** with vast knowledge and expertise at CERN
- **Most of the components – quite standard**
- Part of components – available in industry, **part – manufacturing needed – involvement of Baltic industries**
- Additional R&D and new hardware – necessary for *FLASH* delivery, currently TRL5
- **NIMMS Technical Design Report (TDR)** could be done **by the end of 2025**
- Final design and construction initiative goes into responsibility of the respective institution

Compared to commercial proton cyclotrons:
Improved performance and increased flexibility

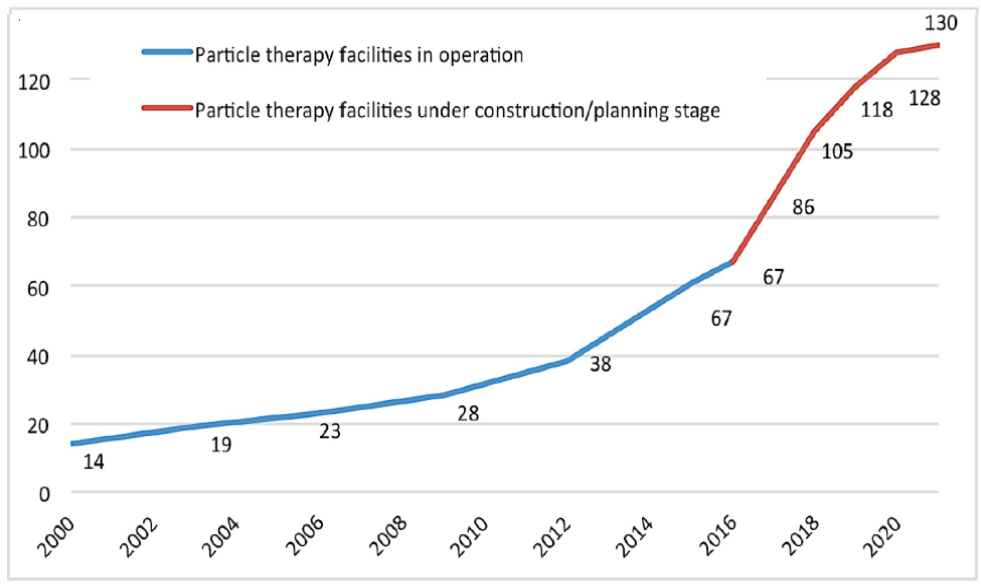
Compared to carbon synchrotron facilities:
Reduced cost and footprint of the facility

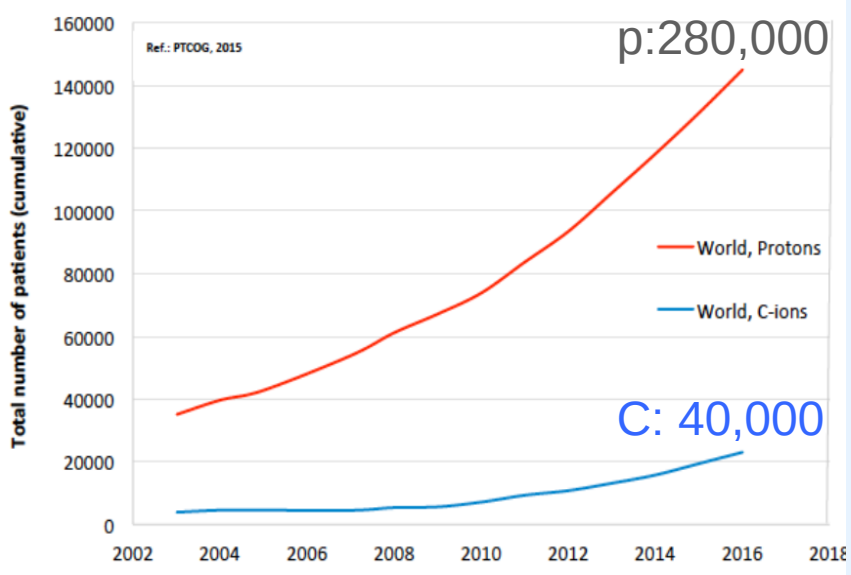


Reporter slides: **Maurizio Vretenar, Elena Benedetto**
Moderator notes: **Taylor Rebecca**

What is the global perspective?

- 2020 - **19.3 million new cases** diagnosed with **9.96 million deaths**
- Predictions by 2040 - **27.5 million new cases** diagnosed and **16.3 million deaths**
- **Focusing on radiotherapy and particle therapy**, in early 2000’s by efforts of ENLIGHT, data were studied in Austria, France, Germany and Italy:
  - 20 000 patients per 10 million inhabitants would receive conventional radiation therapy;
  - **12 % of these patients would largely benefit and be eligible for proton therapy - around 2400 patients per 10 million inhabitants**





Reporter slides: *jointly* **Manjit Dosanjh, Erika Korobeinikova, Kristaps Palskis**

Graphs – courtesy of ***Manjit Dosanjh***

Key outcomes

What is the cancer incidence and mortality in the Baltic States ?

	Lithuania	Latvia	Estonia	**TOTAL**
Registered cancer cases	17 073	12 051	8 907	**38 031**
Registered cancer deaths	8 168	5 892	3 840	**17 900**
Cancer incidence rate *(per 100 000 inhabitants)*	611	637	669	**632**
Cancer mortality *(per 100 000 inhabitants)*	292	311	288	**297**
Patients receiving RT	6343 (37.2 %)	4146 (34.4 %)	2556 (28.7 %)	**13045 (34.3 %)**

Data as of 2020/2021

- Total population in the Baltic States **- 6.02 million**
- Crude, non age-specific corrected **cancer incidence and mortality rates are 632 and 297 per 100 000 inhabitants**, respectively
- in 2020 **a total of about 13045 patients received conventional radiotherapy** as cancer treatment procedure

What about specific data for particle therapy ?

Reporter slides: *jointly* **Manjit Dosanjh, Erika Korobeinikova, Kristaps Palskis**

Outcomes of “Particle therapy - future for the Baltic States?”

Key information reported

Helium synchrotron technology

Indications for particle therapy

Nuclear medicine

Educational pathways

Cancer statistics in the Baltics

How many PT eligible patients could we have in the Baltic States ?

- A literature review done by **dr. Erika Korobeinikova**:

Data of United States, 2021	**2.2 % of all RT patients** – eligible and treated
Data of United Kingdom, 2022	**1.5 % of all RT patients** – eligible and treated
Swedish study, 2005	**14 – 15 % of all RT patients** - therapeutic benefit to justify
United Kingdom study, 2022	**4.3 % of all RT patients** - therapeutic benefit to justify
Norwegian study, 2015	**10 % of all RT patients** - eligible and treated

13045 RT patients in 2020

1.5 % → 195 PT patients

4.3 % → 1950 PT patients

European proton therapy center statistics show on **average 223 adult and 150 pediatric patients receive proton therapy yearly per center** (*data of 2020*)

Preliminary data are promising for further investigations . . .

Reporter slides: *jointly* **Manjit Dosanjh, Erika Korobeinikova, Kristaps Palskis**