



# Baltic particle therapy center initiative

## Status report and workshop overview

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

Prof. Toms TORIMS (RTU) and Kristaps PALSKIS (Riga Technical University, CERN)





**April 12<sup>th</sup>, 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)

**October 8<sup>th</sup>, 2021**

CBG discussion with NIMMS collaboration on facility options

**February 2022**

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

**Spring 2022**

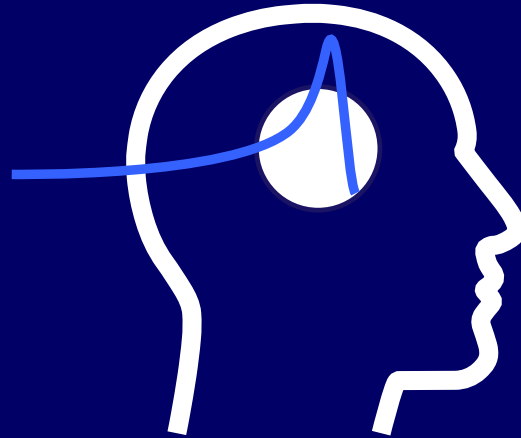
Development of a dedicated conceptual design report



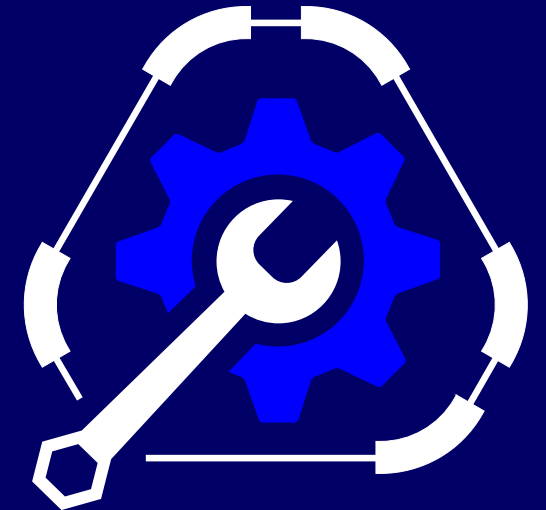
**Integration of helium synchrotron technology and all the capabilities into a modern clinical treatment center and large scale scientific research infrastructure**



**Research  
institution**



**Clinical cancer  
treatment facility**  
*Particle therapy and  
nuclear medicine*



**Industry  
involvement  
infrastructure**

For more details on conceptual idea, refer to: [Conceptual design idea report](#) and [Presentations from last bi-lateral meeting](#)



# Addressing medical community: professional societies

**October 2022** Presentation at the 8<sup>th</sup> Baltic Radiology congress

**Autumn of 2022 Bi-lateral meeting in each of the Baltic states**

**January 2023** Presentation at Lithuanian Society of Radiation Therapy conference

**March 2023** Presentation for Latvian Therapeutical Radiology Association

**June 2023**

- Presentation at 19<sup>th</sup> Nordic-Baltic Conference on Biomedical Engineering and Medical Physics
- Brief introduction to initiative ISRS Educational Course

- Conceptual idea has been discussed with Baltic Nuclear Medicine Association
- Seminars are foreseen with the 3 medical physicist associations in the Baltic States, as well participation in 16<sup>th</sup> International Conference & Workshop “*Medical Physics in the Baltic States 2023*”

**General support on the conceptual idea and initiative with reasonable comments and thoughts – what should be explored in more depth**



**March 2023** Enhanced Dialogue on R&I System with European Commission – presented as one of the scientific research facility initiatives in the region

**May 2023** The helium synchrotron design status presented at IPAC'23  
“*CONCEPTUAL DESIGN OF A COMPACT SYNCHROTRON-BASED FACILITY FOR CANCER THERAPY AND BIOMEDICAL RESEARCH WITH HELIUM AND PROTON BEAMS*” with a dedicated section on possible development and implementation of the design in the Baltic States “*A FACILITY FOR THE BALTIC STATES*”

**Updates** from working group at CBG General meetings

## Conceptual design of a compact synchrotron-based facility for cancer therapy and biomedical research with helium and proton beams

M. Vretenar,<sup>1</sup> M.E. Angoletta,<sup>1</sup> J. Borburgh,<sup>1</sup> L. Bottura,<sup>1</sup> R. Taylor,<sup>1</sup> G. Tranquille,<sup>1</sup> E. Benedetto,<sup>2</sup> T. Torims,<sup>3</sup> K. Pajskis,<sup>3</sup> M. Sapinski,<sup>4</sup> D. Adliene,<sup>5</sup> E. Korobeinikova,<sup>7</sup> M. Kalniņa,<sup>5</sup> E. Gershkevitch<sup>8</sup>

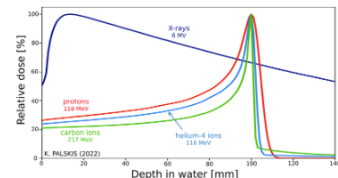


### Helium Ions for Cancer Therapy

Helium radiotherapy trialed since 1975 at LBL, USA.

- Sharper Bragg peak compared to protons
- Reduced fragmentation compared to carbon ions
- Increased RBE and reduced OER to protons
- Reduced neutron risk compared to carbon ions

- Compromise of dose conformity & biological effectiveness.
- High potential for helium ion FLASH therapy treatments.

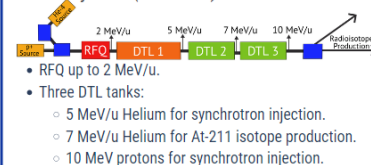


### Accelerator Design

#### Ion Source

- Two ECR ion sources: >2 mA for protons and <sup>4</sup>He<sup>2+</sup>.
- Delivering 8 x 10<sup>10</sup> ions from synchrotron (2 Gy/l).

#### LINAC Injector (352 MHz)



#### Compact Synchrotron

Triangular ring, 33m:



## Implementation in the Baltic States

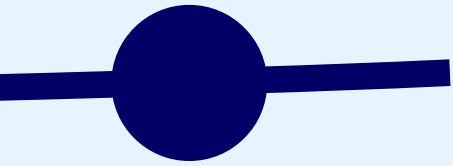
- The Baltic States are without a particle therapy centre. Support is growing in the region to construct such a facility.
- Incidence rate of 630 cases per 100 000 inhabitants: 34% receiving radiotherapy.
- 28 radiotherapy LINACs in region: **Sufficiently developed to move towards particle therapy.**
- Plans for head and neck tumours, sarcomas, complex localisations & paediatric cancers.
- Above treatment, provides **opportunities in accelerator technology, medical physics and (pre-)clinical research.**



Courtesy of: NIMMS collaboration



# What was reported last general meeting ?



May 4<sup>th</sup>, 2022

11<sup>th</sup> CERN Baltic Group General meeting

## Status update and planned events

- Status update on bi-lateral meetings and other events
- **2 workshops related to the project initiative**
- Update on preliminary cancer epidemiology statistics



## Planned events: educational aspects

28<sup>th</sup> of June, 2023

As part of the annual HITRI<sup>plus</sup> project meeting in Riga, a dedicated workshop will be held:  
**"Clinics and research: considerations to create a novel particle therapy center"**

*Conceptually:* Educational lectures by the leading experts from European ion therapy centers (CNAO, HIT, MedAustron) on clinical indications, medical physics, scientific research and practical experience.

We welcome your participation by registering here:

<https://indico.cern.ch/event/1256528/>

Session I  
**Clinical aspects and rationales of particle therapy**

Session II  
**Medical physics and quality assurance in particle therapy**

Session III  
**Helium ion therapy. Heavy ion therapy research**

Session IV  
**Practical experience of setting up a treatment center**

<https://www.hitriplus.eu/>



11<sup>th</sup> CERN Baltic Group General Meeting

04/05/2023, Kaunas, Lithuania

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## Planned events: *Main event*

25<sup>th</sup> of May, 2023

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

*Conceptually:* Representatives and experts from involved professional associations from the Baltic States to discuss and find solution for 5 of the main identified "problem-areas". Non-Baltic clinical and technical experts to take part as well.  
*Hosted at CERN*

Questions for today:

- Representation of Estonia
- As we have key-people on site – are we OK to announce hybrid for others interested?

Cancer statistics in the Baltic States region

Clinical indications for proton therapy

Technology readiness level of the accelerator

Synergies with the nuclear medicine field

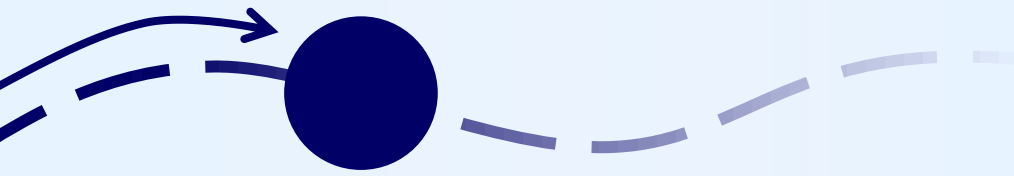
Educational pathways for personnel

11<sup>th</sup> CERN Baltic Group General Meeting

04/05/2023, Kaunas, Lithuania

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# “Considerations to create a novel particle therapy center”

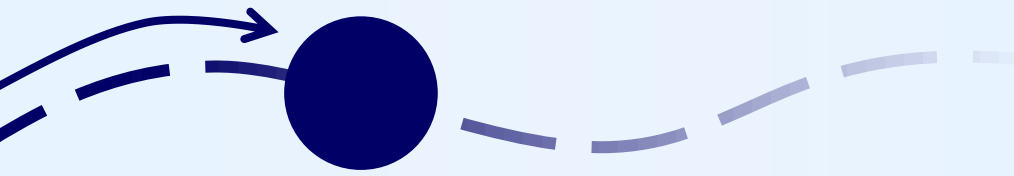


An educational workshop  
“Clinics and research: considerations to create a novel particle therapy center”

## Set-up of the event

- Conceptually – Educational lectures by the leading experts from European ion therapy centers (CNAO, HIT, MedAustron) on clinical indications, medical physics, scientific research and practical experience
- **Event was held on 28<sup>th</sup> of June, 2023 as part of the annual HITRI<sup>plus</sup> project meeting in Riga, Latvia**
- Event was open to everyone interested, with invitations to professional associations and societies, as well as reaching out to relevant university study programmes to reach students as well
- **57 registered participants**

<i>Clinical aspects and rationales of particle therapy</i> <b>Dr. Ester Orlandi (CNAO)</b>	<ul style="list-style-type: none"><li>▪ Rationales and clinical gains of particle therapy compared with conventional radiation therapy</li><li>▪ Oncological indications and cancer types eligible for particle therapy</li><li>▪ Current clinical evidence, community consensus statements, on-going clinical trials . . .</li></ul>
<i>Medical physics and quality assurance in particle therapy</i> <b>Dr. Markus Stock (MedAustron)</b>	<ul style="list-style-type: none"><li>▪ Differences and key-aspects for particle therapy treatment planning compared to conventional</li><li>▪ Role of radiobiology for particle therapy treatment planning - LET and RBE.</li><li>▪ Aspects of quality assurance procedures for particle therapy and particle accelerator complex</li></ul>
<i>Helium ion therapy. Heavy ion therapy research</i> <b>Prof. Thomas Haberer (HIT)</b>	<ul style="list-style-type: none"><li>▪ Rationales and current status of the novel helium ion therapy for cancer treatment</li><li>▪ Important considerations before starting the use of a new particle therapy modality clinically</li><li>▪ Main research directions in various scientific fields for the heavy ion therapy</li></ul>
<i>Practical experience of setting up a treatment center</i> <b>Dr. Sandro Rossi (CNAO)</b>	<ul style="list-style-type: none"><li>▪ Experience and “lessons learned” by current European ion therapy centers</li><li>▪ Process of working with CERN-based projects like Proton Ion Medical Machine Study (PIMMS)</li><li>▪ Considerations to make in the designing and project development stage</li></ul>



## Set-up and feedback

- The current status and findings of the workshop were presented at *NIMMS Collaboration Meeting #98*, 29<sup>th</sup> of September, and at 3<sup>rd</sup> CERN Baltic Conference
- **Support from NIMMS collaboration and appraisal of the approach of the project initiative with systematic steps in working with the various stakeholders**
- Comments and discussions in NIMMS meeting:
  - beamtime separation between research and clinics
  - reimbursement and referral mechanisms in healthcare system are as important as indications
  - integration of medical licensing in design
  - research possibilities with the complex and scientific programme of the activities
- Discussions in CBC:
  - having irradiation facility function from scientific research perspective
  - time/ workflow separation – beamtime dedicated for research and clinical use



### “Advanced Particle therapy center in the Baltic States” initiative:

status report and future outlook

On behalf of the CERN Baltic group's “Advanced Particle therapy center for the Baltic States” working group

Dr. Andris RATKUS (Riga Technical University)  
Kristaps Palskis (Riga Technical University, CERN)



### Baltic particle therapy center initiative Status report, lessons learned and next steps

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

Prof. Diana ADLIENE (KTU)  
Dr. Erika KOROBENIKOVA (LSMU, Lithuanian Society of Radiation Therapy)  
Kristaps PALSIS (Riga Technical University, CERN)  
Prof. Toms TORIMS (RTU)  
Dr. Maurizio VRETENAR (CERN)





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

Relevant findings and discussion points

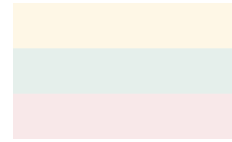
**Report of the event for approval**

**Next steps to take for the initiative**

**Outline for feasibility study**



## Baltic cancer statistics



## Cancer types eligible



### Do we have enough patients?

### Training and experience from other centers

### Involvement of nuclear medicine

### Clinical evidence of proton therapy



### Radioisotope production

### Lack of specialists

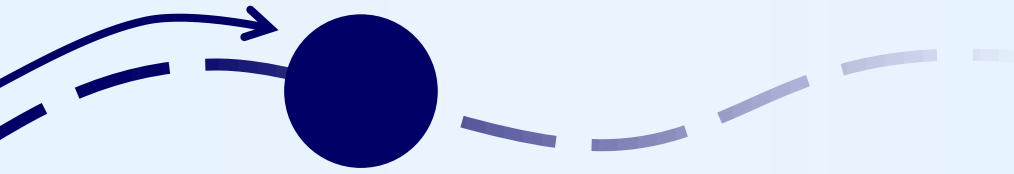
### How developed is the technology?

### TRL of helium synchrotron

For more details, all 3 reports can be found: [Meeting summaries](#)



# “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

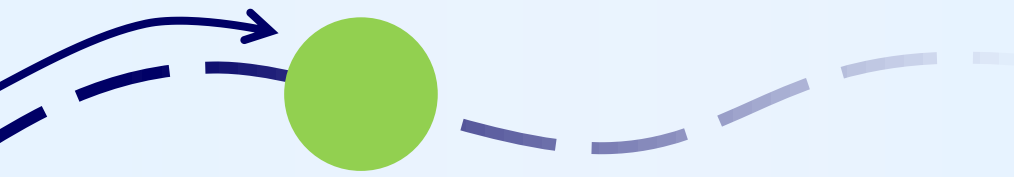
- Conceptually – **workshop and discussion with professionals and experts representing professional societies from all 3 Baltic States**
- Invitations to professional associations and societies of radiologists, nuclear medicine specialists, radiation oncologists and medical physicists for **nominated representatives**

**25<sup>th</sup> of May, 2023 at CERN**

- Main goals of the event:
  - *To bring together high-level professionals, experts and stakeholders from the Baltic States, nominated by the corresponding professional associations to discuss and work on ideas for development of key aspects of the initiative.*
  - *To provide fact-based and scientifically driven reasoning for each of the key aspects of the initiative based on the aforementioned stakeholder opinion.*
  - *To build multi-disciplinary synergies between the different fields and specialties involved in cancer treatment and three Baltic States at large.*
  - *To reach a joint consensus and vision of future development of the “Advanced Particle Therapy Center in the Baltic States” initiative based on the conclusions reached within the workshop.*



# “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.*

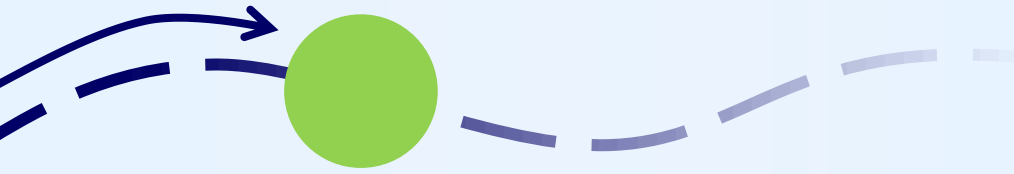
- Current status of the nuclear medicine field within the Baltic States
- Insights gained from PRISMAP project - focus on novel radioisotopes
- Technical aspects and scientific research needed to develop production of such isotopes

*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



# “Particle therapy - future for the Baltic States?”



## Set-up of the event

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

## There would be no workshop without the reporters and moderators

Erika Korobeinikova (*Lithuanian Society of Radiation Oncology, LSMU, Clinic of Kaunas*)

Anna Maria Camarda (*CNAO*)

Dace Bogorada-Saukuma (*Latvian Association of Therapeutic Radiology*)

Maija Radziņa (*Latvian Radiology Association, University of Latvia*)

Andrejs Ērglis (*University of Latvia*)

Manjit Dosanjh (*University of Oxford, CERN*)

Maurizio Vretenar (*CERN*)

Elena Benedetto (*SEEIIST Association, CERN*)

Taylor Rebecca (*Imperial College, CERN*)

Edgars Mamis (*University of Latvia, CERN*)

Diana Adlienė (*KTU, CERN Baltic Group*)

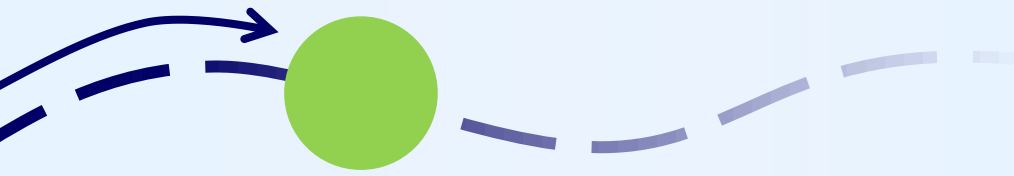
Toms Torims (*RTU, CERN Baltic Group*)

Kristaps Palskis (*RTU, CERN*)





# “Particle therapy - future for the Baltic States?”



## Report of the workshop

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

A report has been prepared by the Convener of the working group (*and team*) and reviewed by the group of moderators and speakers

This General meeting, we as “*Advanced Particle Therapy center for the Baltic States*” working group submit this report for CERN Baltic Group approval

**This presentation serves as outline summary of the report**



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

Helium synchrotron technology

Indications for particle therapy

Nuclear medicine

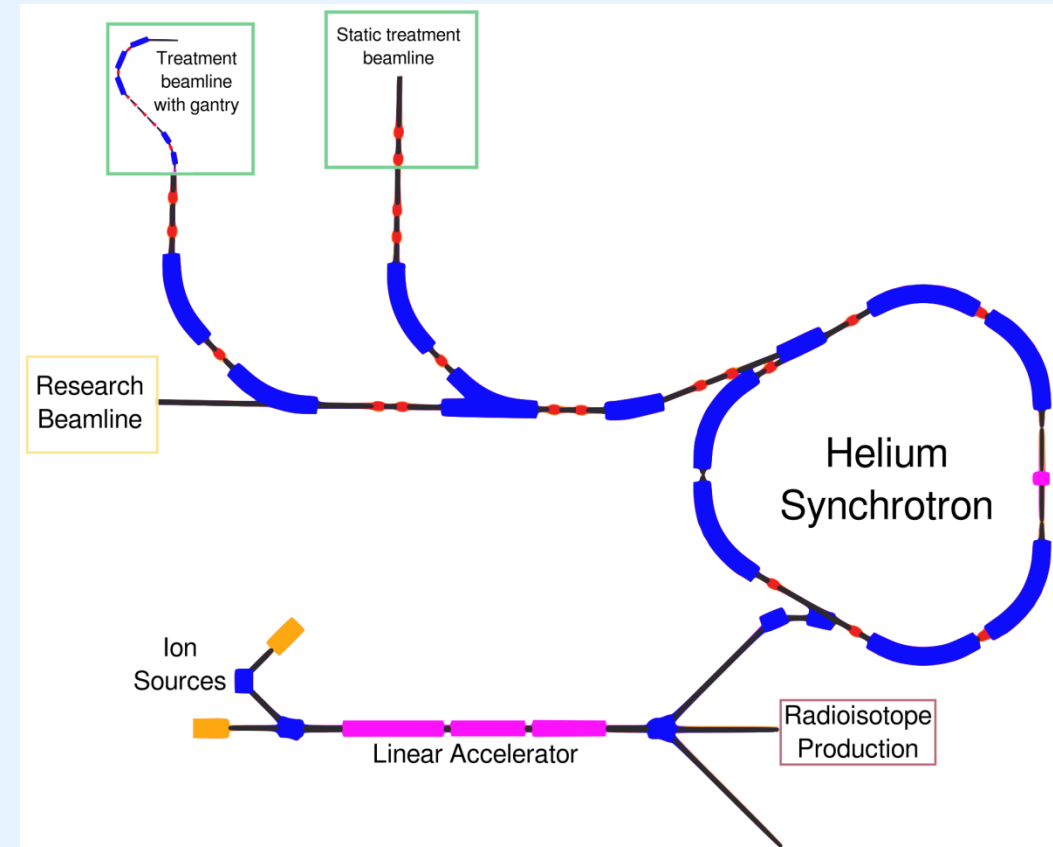
Educational pathways

Cancer statistics in the Baltics

## 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”**





### How ready is the technology?

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics

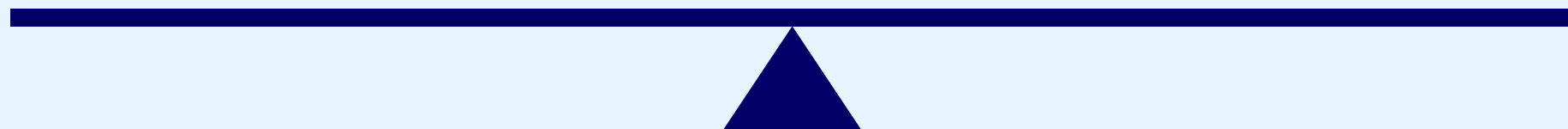
- **Most of the technologies necessary - proven and existing**, with vast knowledge and expertise at CERN
- **Most of the components – quite standard**
- Part of components – available in industry, **part – manufacturing needed – involvement of Baltic industries**
- Additional R&D and new hardware – 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**



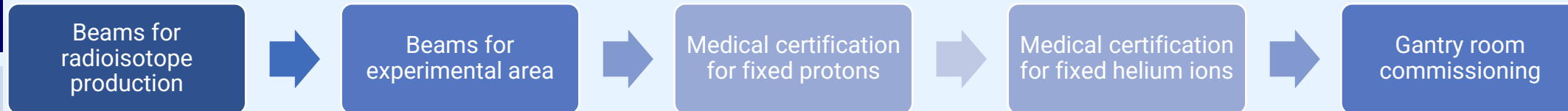


# Outcomes of “Particle therapy - future for the Baltic States?”

## Key outcomes

### What should be considered?

- Medical licensing – crucial and considerations should be implemented in initial design stages already
- To allow activities at earlier stages – stages commissioning approach



- For final design – *MedAustron* approach with PIMMS could be followed
- Helium ion therapy itself - appealing from physics, but the biggest challenge - **synergy between the cutting-edge technology and the end users – radiation oncologists**. Therefore - **clinically established proton therapy after certification and commissioning**

**NIMMS helium synchrotron design provides vastly larger customizability and adaptability compared to a commercially available systems**

**Design gains translate to larger opportunities in scientific research, personnel training, capacity building and *brain-drain* prevention**

**Scientific research programme – crucial in the plan of machine usage**

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics

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



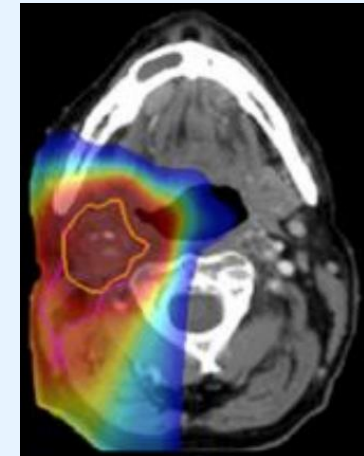
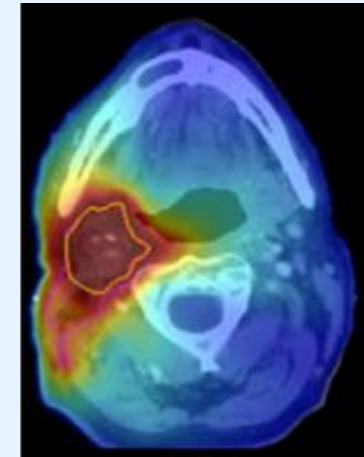
### Primary clinical gains of particle therapy?

reduced dose to organs at risk

optimized tumor dose escalation

### What are the clinical indications for particle therapy?

- Most common indications in international guidelines - **central nervous system (CNS), skull base, head and neck and paranasal sinus tumors, pediatrics**
- Clinically established with **enough clinical evidence** and **included in cancer management strategies: skull base chordoma, chondrosarcoma, sinonasal carcinoma** and others
- Brain tumors and head and neck tumors – **improved QoL**
- Radioresistant tumors (*various types of melanoma, head&neck, chordomas and sarcomas*) – **benefit from particle therapy – carbon ions**
- Ongoing clinical trials – evidence needed in certain cancers (liver, esophageal and others)

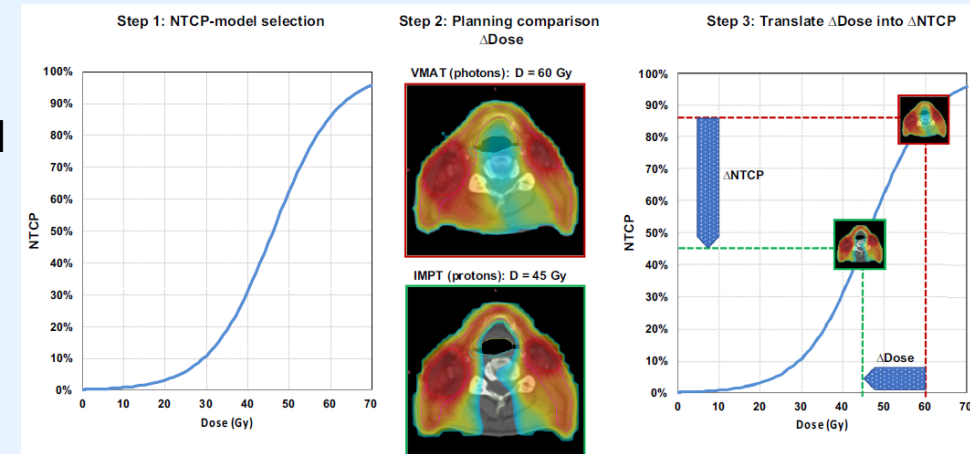


- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics

Reporter slides: **Anna Maria Camarda**  
 Moderator notes: **Erika Korobeinikova**

### What are alternatives for patient selection?

- With limited clinical evidence – other approaches could be considered:
  - Cost-benefit analysis
  - Dosimetric selection
  - NTCP-model based: effective use in head & neck patients, interest to develop for brain tumors, approaches in breast cancer**



Safe, effective and recommended - **pediatric, ocular melanomas, chordomas, chondrosarcomas and others**

Could provide clinical benefits, clinical evidence needed - **lymphoma, lung, breast and prostate**

**Starting point - development of state-of-art national cancer registries – crucial to estimate the national cancer epidemiology, treatment capacity and for patient selection criteria development**

Helium synchrotron technology

Indications for particle therapy

Nuclear medicine

Educational pathways

Cancer statistics in the Baltics

Reporter slides: **Anna Maria Camarda**

Moderator notes: **Erika Korobeinikova**



### What are the trends and clinical interests in nuclear medicine?

PRISMAP Consortium Working Package 5 “Industrial and clinical collaboration” deliverable  
“Questionnaire on industrial and clinical key players and needs”

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine**
- Educational pathways
- Cancer statistics in the Baltics

Europe (114 respondents)	
Current clinical practice	Clinical interests for near future (2 - 5 years)
Apart from conventional, $^{68}\text{Ga}$ and $^{177}\text{Lu}$	Increasing for TAT, particularly $^{225}\text{Ac}$ For theranostics – isotopes from <b>copper, scandium and terbium families</b> ( <i>and others</i> )
Baltic States (7 respondents)	
Current clinical practice	Clinical interests for near future (2 - 5 years)
Diagnostics – $^{18}\text{F}$ , $^{99\text{m}}\text{Tc}$ and $^{123}\text{I}$ Therapy – $^{177}\text{Lu}$ , $^{223}\text{Ra}$ , $^{131}\text{I}$ and East Tallinn Central: $^{89}\text{Sr}$ , $^{90}\text{Y}$ , $^{153}\text{Sm}$ and $^{186}\text{Re}$	More widespread usage of $^{177}\text{Lu}$ $^{68}\text{Ga}$ , $^{68}\text{Ga}$ , $^{68}\text{Ga}$ , <b>terbium family isotopes</b> ( <i>and others</i> )

### Baltic States – clinical interest in expansion of oncological applications in near future

Reporter slides: **Maija Radzina** (clinical), **Edgars Mamis** (technical)  
Moderator notes: **Diana Adliene**

For more details on questionnaire, refer to: [Deliverable report](#)



### What are the technological possibilities? What about the Baltics?

- Nuclear medicine diagnostic equipment in the Baltics – **14 SPECT and 8 PET units**
- Experience in MEDICIS – mass separation technology allows production of some unique radioisotopes – **inclusion of mass separator within the facility could be considered**
- Radioisotope production with helium-4 beam:
  - possible pathway for **scandium-47** and **terbium family** isotopes
  - for TAT – no nuclear cross section data for **actinium-225** and for **astatine-211** – careful production route
- Research possibilities:
  - developments in radiochemistry
  - radiopharmaceutical labelling studies
  - optimization of synthesis methods
  - nuclear physics – precision measurements for half-life time, cross-section data with helium-4 beams

### Two cyclotron facilities (*in Latvia and Lithuania*) to start radioisotope production in the near future – how to approach?

Conventional isotopes	Future production possibilities
PET isotopes: $^{18}\text{F}$ , $^{15}\text{O}$ , $^{11}\text{C}$ ( $^{68}\text{Ga}$ via generator)	$^{44}\text{Sc}$ , $^{47}\text{Sc}$ , $^{64}\text{Cu}$ , $^{67}\text{Cu}$ , terbium isotope family

Reporter slides: **Maija Radzina** (clinical), **Edgars Mamis** (technical)

Moderator notes: **Diana Adliene**

Helium synchrotron technology

Indications for particle therapy

Nuclear medicine

Educational pathways

Cancer statistics in the Baltics



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

Key outcomes

## What should be considered?

Parallel radioisotope production in the proposed facility

Complementary

Production at existing cyclotron centers

### ▪ Not competing with existing facilities:

- low quantities of PET imaging isotopes for particle therapy treatment planning
- for larger export – non-conventional, complementary isotopes of interest in the community

### ▪ Radioisotope distribution challenges should be taken into consideration as multi-national facility

▪ Cooperation of nuclear medicine societies and manufacturing facilities – **balancing production in facilities**

### ▪ Export pathways as business plan for non-conventional isotopes

▪ Larger focus in nuclear medicine – **targeted therapies not just diagnostics** (*as other competing imaging modalities as spectral CT and specific MRI sequences*)

**Preparatory activity - explore the existing cyclotron facilities for research activities beyond commercial production**

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics

Reporter slides: **Maija Radzina** (clinical), **Edgars Mamis** (technical)

Moderator notes: **Diana Adliene**



### What are the core personnel numbers in the region?

Radiation oncologists	RTTs	Medical physicists ( <i>RT specialized</i> )
10 to 40 per country	30 to 50 per country	20 to 30 per country

*ART study – see following slides*

- Academic degrees for core specialties exist at various levels
- Dedicated residency exists for radiation oncologists, but **no clinical residency for medical physicists**
- Engagement in ESTRO and EFOMP, possibilities of **ESTRO and IAEA courses – state funding limited**

### What knowledge and additional specialties are needed in PT ?

Medical physics and technical perspective	Clinical perspective
<ul style="list-style-type: none"> <li>▪ Exchange visits/courses – <b>treatment planning and QA</b></li> <li>▪ In academic curriculum – <b>focus on radiobiology, Monte Carlo, beam modelling, TPS algorithms and development</b></li> <li>▪ <b><u>Self-assembled facility – accelerator physicists and engineers are crucial to start and operate the facility</u></b></li> <li>▪ <b>Not commercial machine</b> – responsibility of personnel on maintenance, repairs etc.</li> <li>▪ <b>IT specialists</b> – medical data analysis and data systems</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b><u>Development of state-of-art cancer registries</u></b></li> <li>▪ <b>Clinical and scientific network</b> creation at early stage</li> <li>▪ In academic curriculum – <b>introduction on proton and particle therapy</b></li> <li>▪ <b>Increase of radiation oncology residency vacancies</b></li> <li>▪ Hands-on <b>long-term exchanges</b> to ion therapy centers</li> <li>▪ Political structure involvement – <b>straight-forward and clear reimbursement pathway development</b> for all the novel diagnostic and therapeutic procedures</li> </ul>

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Moderator notes: **Andrejs Erglis**



- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways**
- Cancer statistics in the Baltics

## What can be learned from European experience ?

- From experience of ENLIGHT – large, thematical networks are necessary for such large-scale projects
- Young scientist and medical doctor training - one of key priorities – specialized staff for operation of a particle therapy center is necessary**
- Marie Curie Initial Training Network** – ideal for capacity building (*examples: PARTNER and ENTERVISION*)

## What can be done now and what should be considered ?

- Now:**
  - Clinical team – radiation oncologist and medical physicist – exchange visits under HITRIplus project
  - Knowledge base and skill expansion on the existing material, courses etc. (as HITRIplus project)
- For future:**
  - Marie Curie Initial Training Network project proposal** development for capacity building
  - Long term exchange (at least 6 month) visits** to re-specialize personnel for particle therapy
  - As focus on pre-clinical/clinical research – educational activities on **clinical trial design, organization, ethical issue considerations and associated legal procedures**
  - “Think bigger and longer” – particle therapy workshops in highschool, lectures in undergraduate studies and general support in STEM subjects

**Not just university** – globally there are no dedicated degree programmes in particle therapy

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

## Side note: The ART study

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics**



A study started in 2022 to assess the basic cancer statistics, RT equipment availability and personnel capacity

Huge “thank you” to **Manjit Dosanjh** for asking for Baltic States participation – **this is our first *up-to date* data set for further investigations**

**Coordination of data collecting:**  
Erika Korobeinikova (Lithuania)  
Eduard Gershkevitch (Estonia)  
Kristaps Palskis (Latvia)

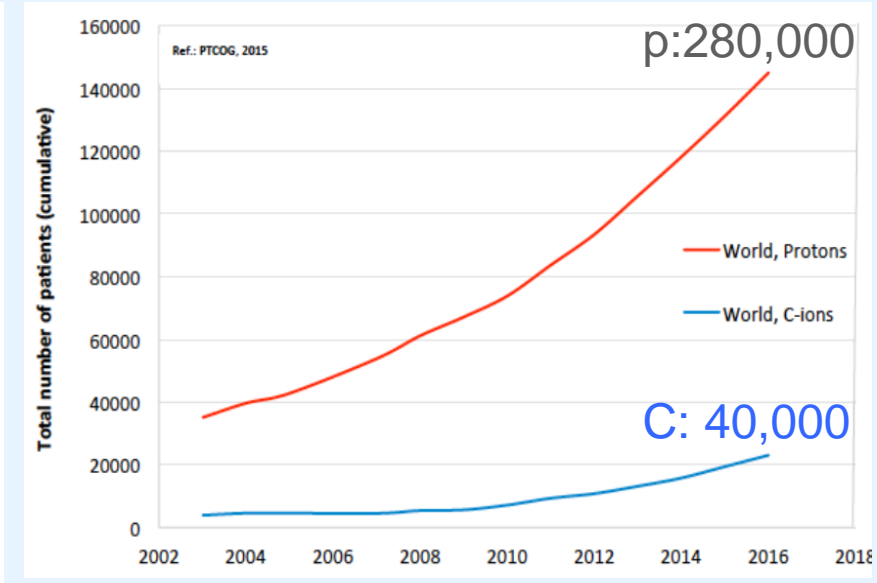
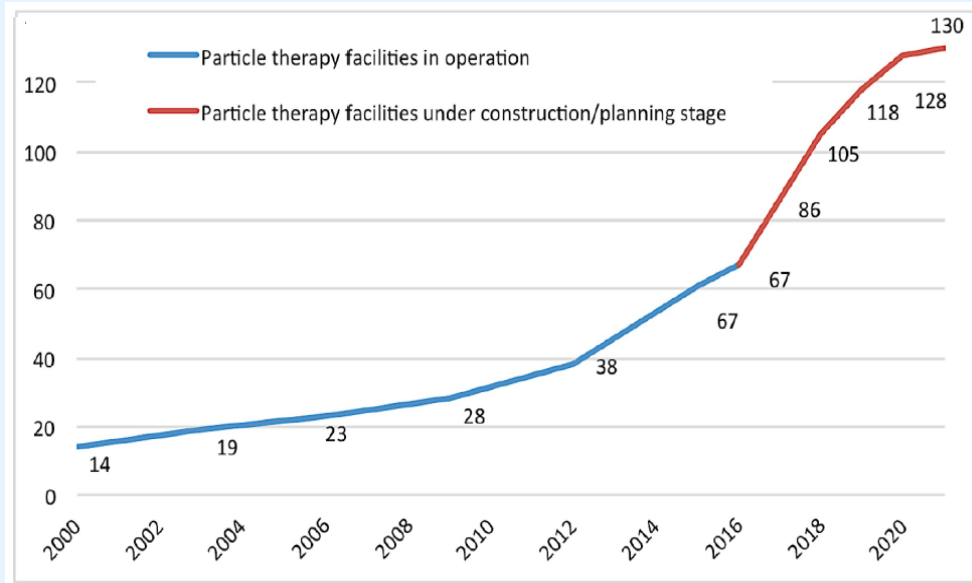
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Moderator notes: **Dace Bogorada-Saukuma**



### 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**

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics**



Reporter slides: *jointly* **Manjit Dosanjh, Erika Korobeinikova, Kristaps Palskis**  
 Moderator notes: **Dace Bogorada-Saukuma**

Graphs – courtesy of *Manjit Dosanjh*



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

## Key outcomes

### What technologies are available for cancer care in the Baltic States?

Helium synchrotron technology
Indications for particle therapy
Nuclear medicine
Educational pathways
Cancer statistics in the Baltics

Diagnostic imaging units (data as of 2022)				
	Lithuania	Latvia	Estonia	TOTAL
CT	70	71	28	169
Mammography	42	51	18	111
MRI	46	30	18	94
SPECT	8	2	3	13
PET	2	3	3	9
Radiotherapy treatment units (data as of 2022)				
	Lithuania	Latvia	Estonia	TOTAL
LINACs	11	9	6	26
Brachytherapy	4	1	2	7

- Well shaped technical resources, can be deemed sufficient according to international guidelines
- Focusing on conventional radiotherapy – state-of-art LINACs, delivering IMRT, VMAT, SRS, SBRT, as well – dedicated machines such as GammaKnife, CyberKnife and on-going MR-LINAC installation

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 Moderator notes: Dace Bogorada-Saukuma



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

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

*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 ?

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Moderator notes: **Dace Bogorada-Saukuma**



### 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, 2013	1.5 % of all RT patients – eligible and treated
Swedish study, 2010	1.7 % of all RT patients – therapeutic benefit to justify
United Kingdom study, 2022	4.3 % of all RT patients - therapeutic benefit to justify
Korean study, 2018	10 % of all RT patients – eligible and treated

**Preliminary data are promising for further investigations . . .**

13045 RT patients

in 2020



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

- Helium synchrotron technology
- Indications for particle therapy
- Nuclear medicine
- Educational pathways
- Cancer statistics in the Baltics



Today we are “messengers” of collaborative work and we want to acknowledge:

## Support on technical details

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NIMMS collaboration and especially **Maurizio Vretenar, Elena Benedetto, Giovanni Bisoffi and Mariusz Sapinski** for providing technical expertise and materials in the development stage of the conceptual idea design last year

## Medical community support

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- Core support and involvement in the activities of initiative by **Erika Korobeinikova** and **Maija Radzina**
- **Everyone involved** in preliminary data collection, providing contacts with professional associations and valuable thoughts on how to proceed, especially **Diana Adliene, Eduard Gershkevitch, Dace Bogorada-Saukuma, Marika Kalnina, Sergei Nazarenko, Andrejs Erglis** and others

## For sharing experience

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To **Manjit Dosanjh** for involving the Baltic States in the ART study, helping to develop questionnaires, sharing her experience from ENLIGHT network, providing materials for the workshops and will to actively collaborate further in cancer and RT statistics investigations

## Speakers and moderators of the workshops

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- Moderators and speakers of “*Particle therapy - future for the Baltic States? State-of-play, synergies and challenges*”
- Speakers of “*Clinics and research: considerations to create a novel particle therapy center*” and HITRIplus community for crucial help in organizing this educational workshop



# Open for discussion on contents of the report



## I Medical case in the Baltic States and outlook of particle therapy

- Baltic region – state-of art conventional radiotherapy practices.
- Total of **6.02 million inhabitants**, the crude **cancer incidence and mortality rate** is **632 and 297 per 100 000 inhabitants**.
- In 2020, **out of all cancer patients 13045 had received radiation therapy** treatment.
- Different studies generally indicate between **1.5 to 15 % patients receiving conventional radiation therapy would be eligible for particle therapy**. In the Baltic States – corresponds to **about 500 to 2000 patients annually**.
- There exists a clinical evidence base for various cancer types for treatment with particle therapy, with a number of clinical trials on-going. In the situation of lacking clinical evidence, different approaches can be used for patient selection (NTCP-model based).

**Baltic medical community representatives - general support for further developments and investigations of the initiative**





## II Technology of helium synchrotron

- **NIMMS helium synchrotron design would provide larger flexibility of the design, as well as training of personnel and vast scientific research programme. Helium synchrotron would allow proton therapy before commissioning and clinical trials of helium ion therapy.**
- **Most of technologies and components used in the helium synchrotron design are standard, so R&D risk is limited.**
- **NIMMS collaboration - a Technical Design Report by the end of 2025 -> Final design by institution -> Developed facility**

## III Perspective of parallel isotope production

- **New pathways in radioisotope production for nuclear medicine and associated research, though coordination with existing cyclotron facilities and research activities with current infrastructure should be considered.**



## IV Capacity building and education

- For capacity building and personnel training a **Marie Curie Initial Training Network project proposal** could be considered, as well as involvement in *HITRIplus* and ENLIGHT network activities – from which **a clear support on the initiative has been shown**

**Baltic Assembly representatives have indicated a clear support for the initiative** as unifying and long-term project for the Baltic States, expressing willingness to be involved in the project initiative from the political perspective - engaging with the parliaments and relevant ministries in each of the Baltic States.



- Serious consideration for joint actions or project proposal application in capacity building for particle therapy personnel.
- Support the educational visits of Baltic medical community representatives from radiation therapy departments to European particle therapy centers – short term. Create long term plans for exchange visits of personnel education.
- Continued activities to raise awareness of the initiative in various communities relevant for the success of the project, such as patient organizations. Active full-spectrum stakeholder engagement is crucial for any further steps.
- Relevant findings from the workshop are foreseen to be published as a scientific paper (*for example, the cancer statistics*)

In order to proceed:

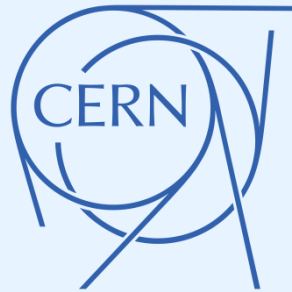
**A full-scale feasibility study of the project**



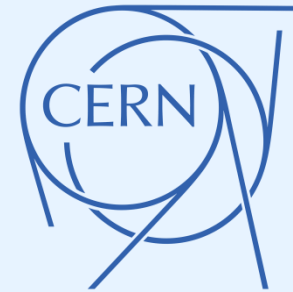
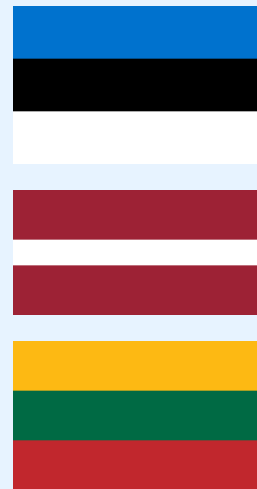
In order to proceed:

## A full-scale feasibility study of the project

Clinical case and epidemiology



Technical aspects



Business case



## Within the framework of CERN

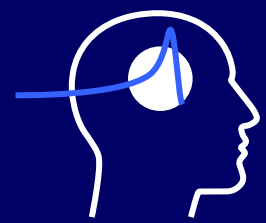


**Thank you for  
your attention !**





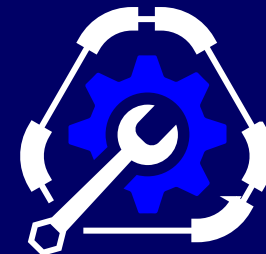
# Backup



- Clinical treatment with proton therapy
- Clinical research and future treatment with helium ion beams
- Novel delivery methods – *FLASH*, mini-beams. Possibilities of proton radiography
- Possibility of parallel radioisotope production – diagnostics for radiotherapy treatment planning, theranostics approaches and targeted alpha therapy



- Pre-clinical and clinical research work necessary for novel therapy integration
- Particle therapy research fields – medical physics, radiobiology, dosimetry, accelerator physics and technologies
- Complementary research fields – material science, radiation chemistry, particle physics aspects . . .
- Possibility of heavier ion research (carbon, oxygen)

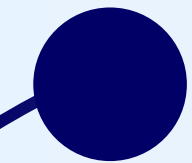


- Involvement of relevant industry sectors in delivery of center – capacity and “*know-how*” in accelerator technologies
- Infrastructure provides possibilities of future R&D activities in particle therapy technology developments, addressing the global needs of the community

For more details on conceptual idea, refer to: [Conceptual design idea report](#) and [Presentations from last bi-lateral meeting](#)



# The bi-lateral meetings with medical and other stakeholders



## Set-up of the events

- Invitations to professional associations and societies of radiologists, nuclear medicine specialists, radiation oncologists and medical physicists as well as representatives of involved universities, research institutions and political bodies
- Meetings were aimed to be in-person for maximum engagement

## Meeting relevant stakeholders in all 3 of the Baltic countries

- 18<sup>th</sup> of October – Latvian stakeholders, Riga
- 16<sup>th</sup> of November – Lithuanian stakeholders, Kaunas
- 22<sup>nd</sup> of November – Estonian stakeholders, Tallinn

**20 – 30 participants in each of the meetings**

