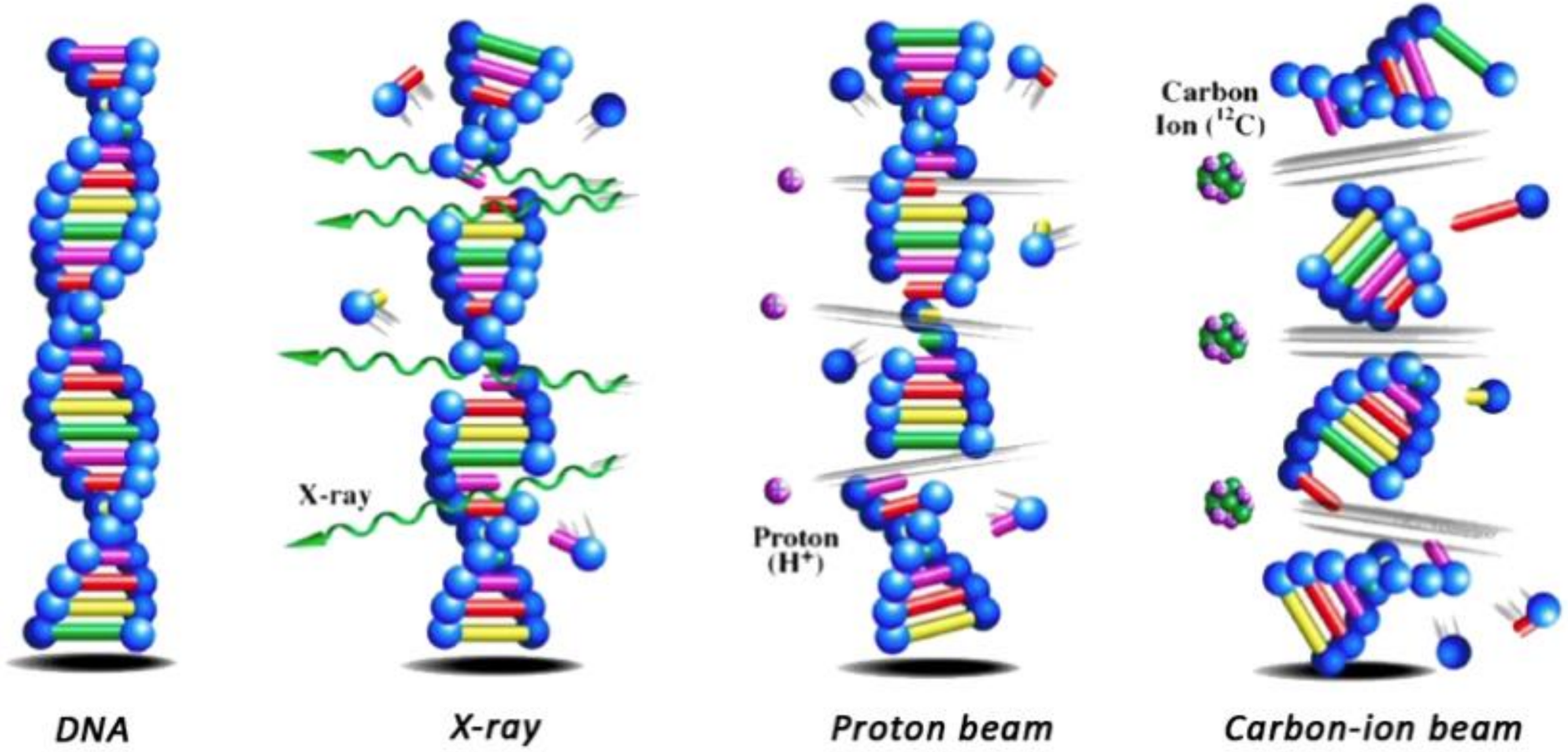
Hardon Therapy Center in Kutaisi, Georgia

Revaz Shanidze

(for the Handron Therapy Group)

28 October 2021

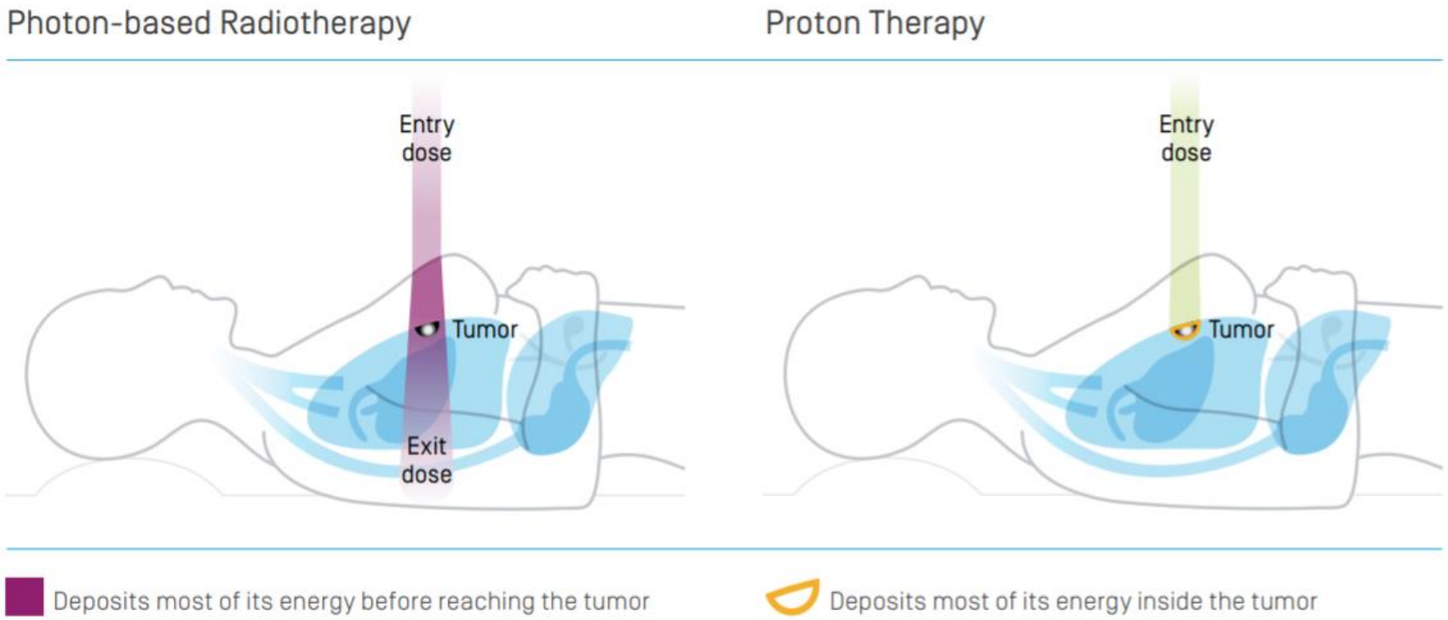
Radiation Therapy

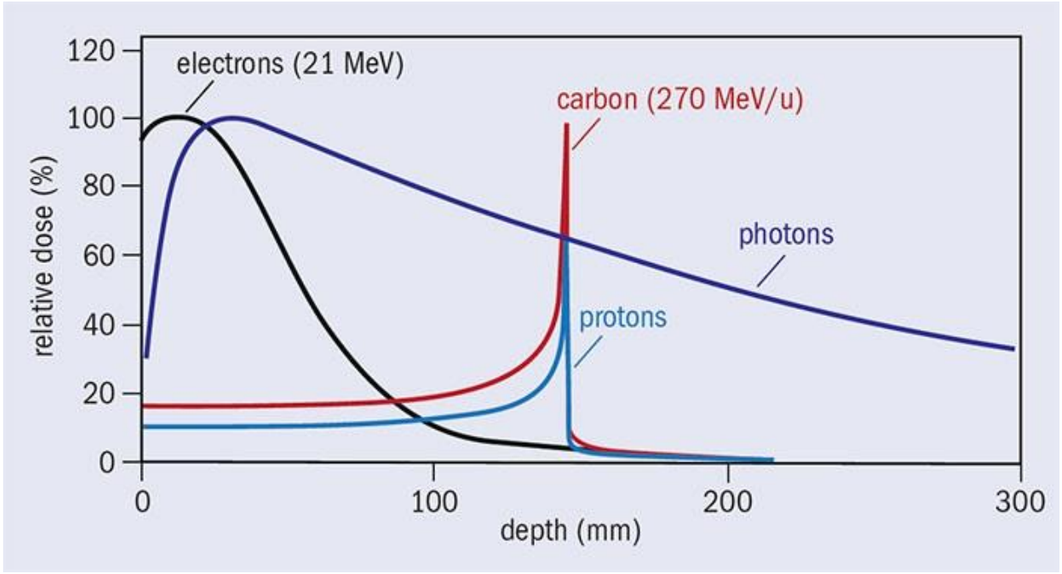


- Brachytherapy
- Teletherapy (EBRT)
  - X and γ radiation
  - Charged particles:
    - protons
    - C-ions

V. Marx., **Narure 508(2014), 133–138**

Therapy with Photons and Protons



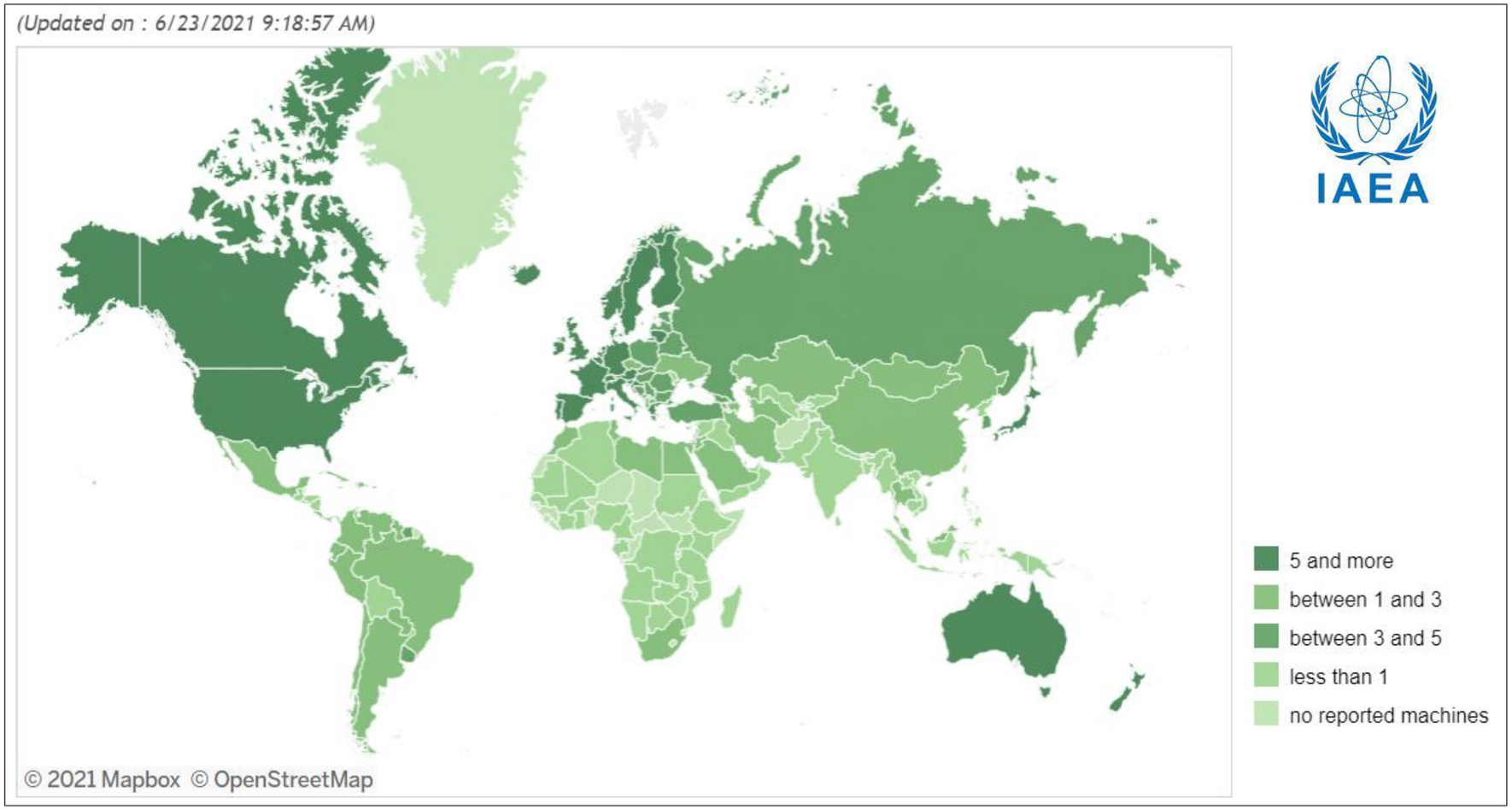


https://www.annualreports.com/HostedData/AnnualReportArchive/i/iba-proton-therapy_2019.pdf

https://physicsworld.com/a/the-changing-landscape-of-cancer-therapy/

DIRAC: DIrectory of RAdiotherapy Centers

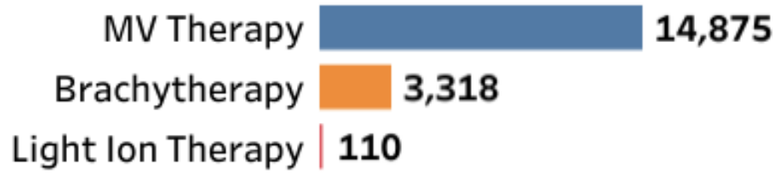
Number of radiotherapy machines per million people



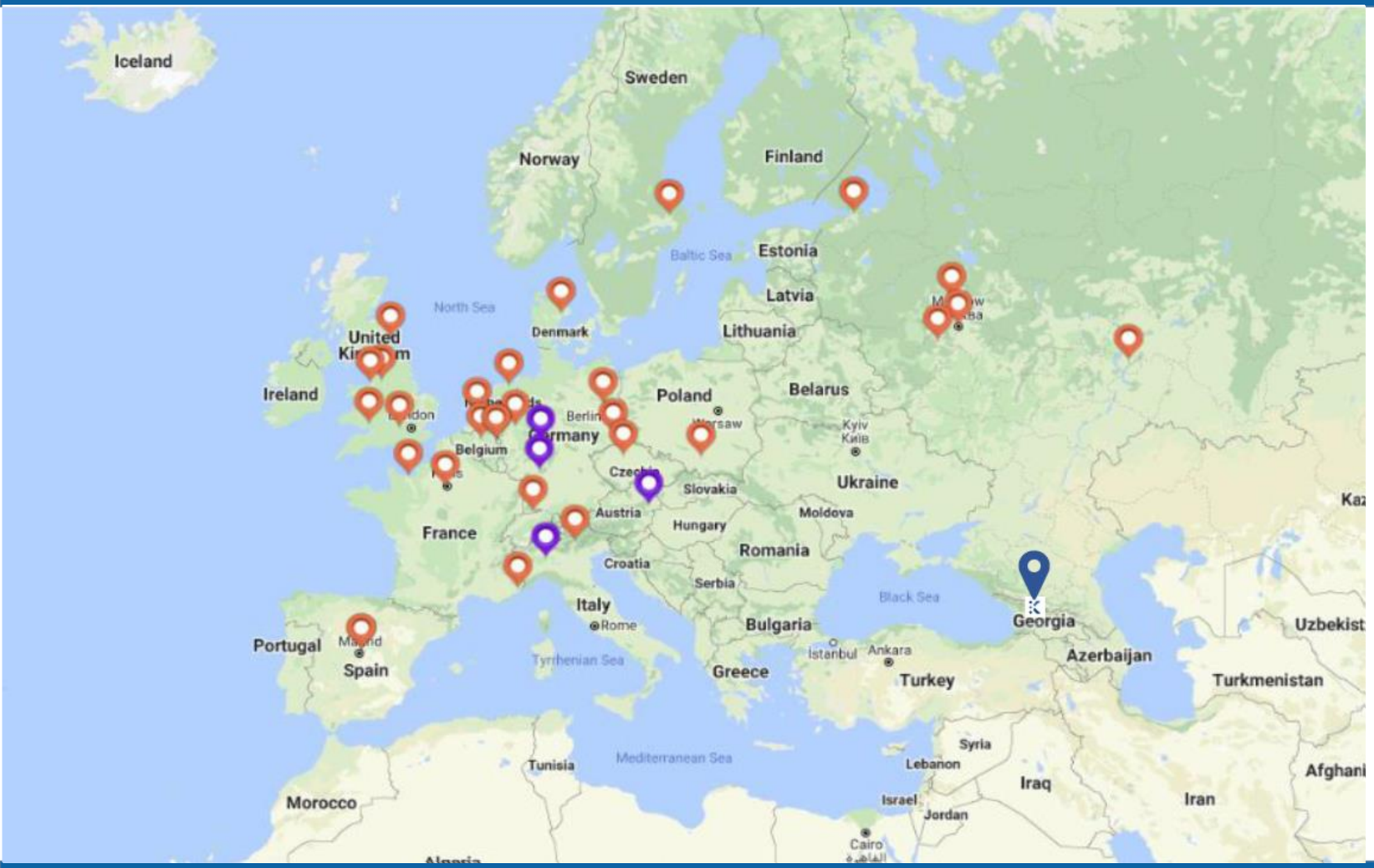
World's most comprehensive database on radiotherapy resources.

https://dirac.iaea.org/

Data on radiotherapy centres:
- teletherapy machines
- brachytherapy units
- treatment planning systems
- computed tomography systems and simulators



Hadron Therapy Centers in Europe



Particle Therapy Co-Operative Group

PTCOG (www.ptcog.ch)

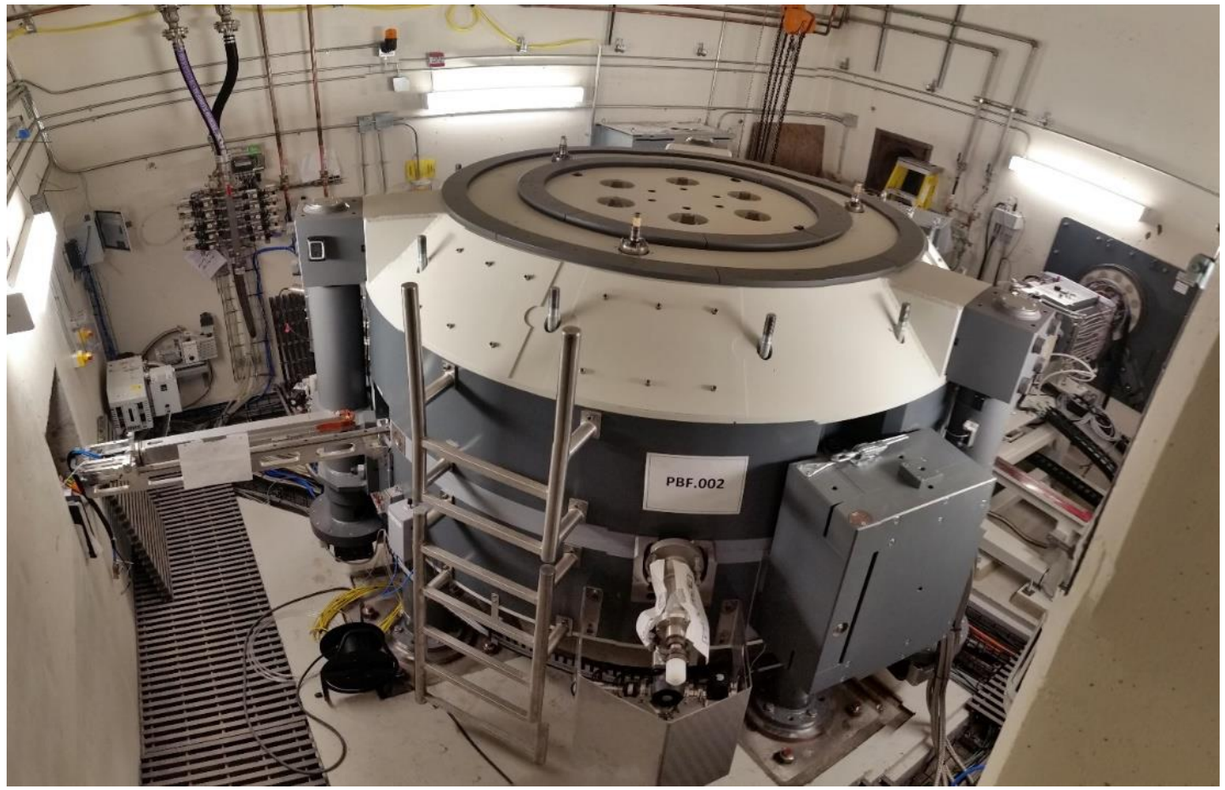
Hadron therapy centers in Europe:

Red: protons only

Purple: proton and carbon ions

- Austria (MedAustron)
- Germany (HIT, MIT)
- Italy (CNAO)

Particle Accelerators for the Radiation Therapy



Cyclotrons: commercial production (IBA, . . .)
Fixed particle type (protons) and energy (250 MeV).
Energy variation by passive elements (degraders)

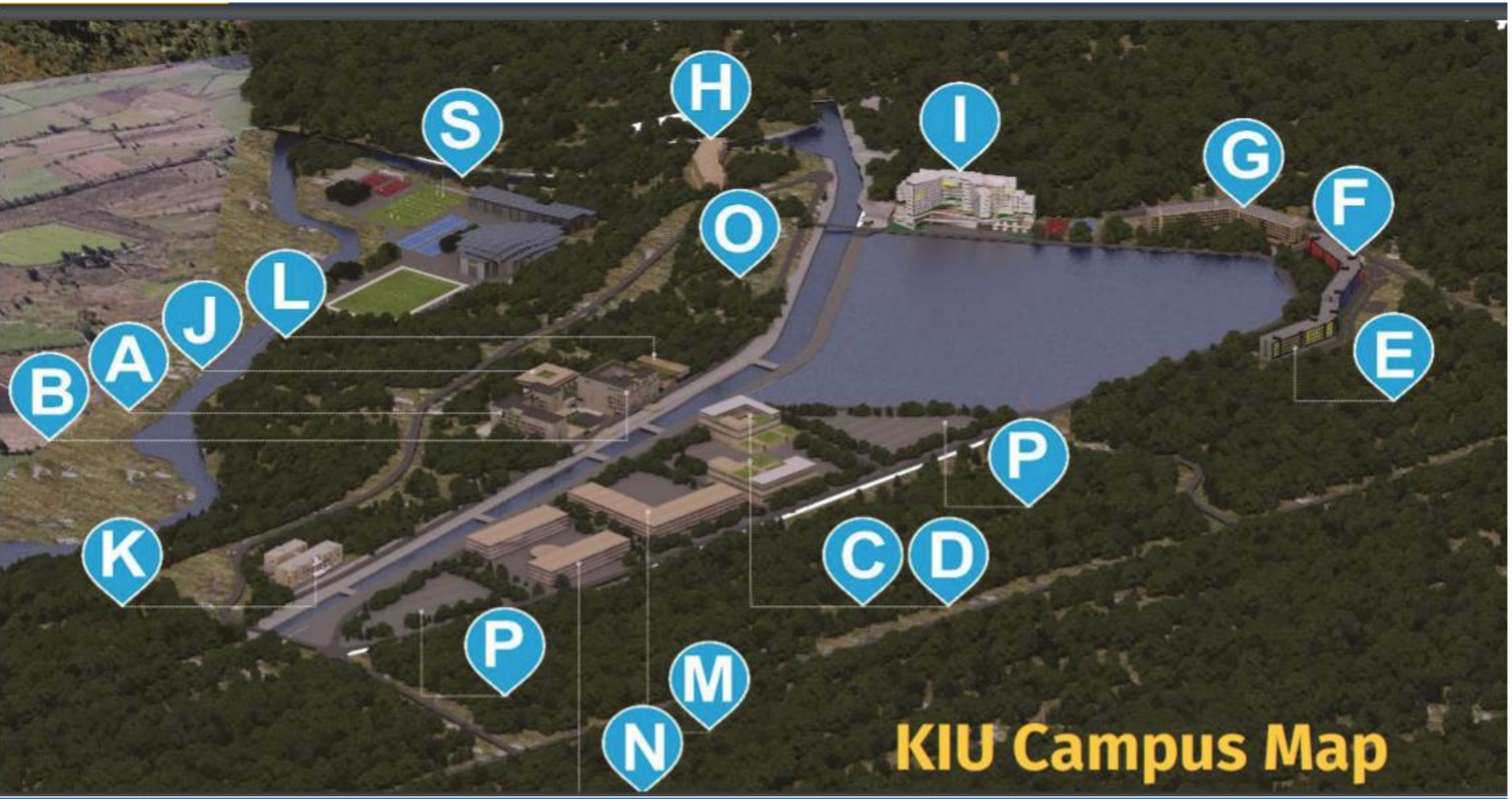
Synchrotrons:
Protons or ion acceleration. Variable energy.
CERN PIMMS (Proton-Ion Medical Machine Study)

Accelerator Beam Parameters

		synchrotron (CNAO, HIT)		cyclotron (IBA, Varian)	synchro-cyclotron (S2C2, IBA)
		C ions	Protons		
Typical intensity (ions/s)		10^7	10^9	10^{10}	$\sim 10^{10}$
Macrostructure	Period (s)	$1 - 10$			10^{-3}
Microstructure	Bunch width (ns)	$20 - 50$		$0.5 - 2$	8
	Period (ns)	$100 - 200$		10	16 (at extraction)
	Ions/bunch	$2 - 5$	$200 - 500$	200	4000

A. Wronska, D. Dauvergne , “Range verification by means of prompt-gamma detection in particle therapy”, hal-03085504

Kutaisi International University



- New public university in Georgia funded by CARTU foundation

>1 G€

- New international education space
- International hub of education, research and innovations in the South Caucasus
- Hadron Therapy Center

Kutaisi International University Campus

Kutaisi International University Advisory Board

KUTAISI INTERNATIONAL UNIVERSITY

International Advisory Board and Hononary President

Prof. Dr.
Wolfgang A. Herrmann

PROF. DR. SEBASTIAN SCHMIDT (CHAIR OF THE BOARD)
SCIENTIFIC DIRECTOR, HELMHOLTZ-ZENTRUM DRESDEN-ROSSENDORF (HZDR), GERMANY

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Hadron Therapy Center

Hadron Therapy Center of Kutaisi International University.

CARTU Foundation contracts with:

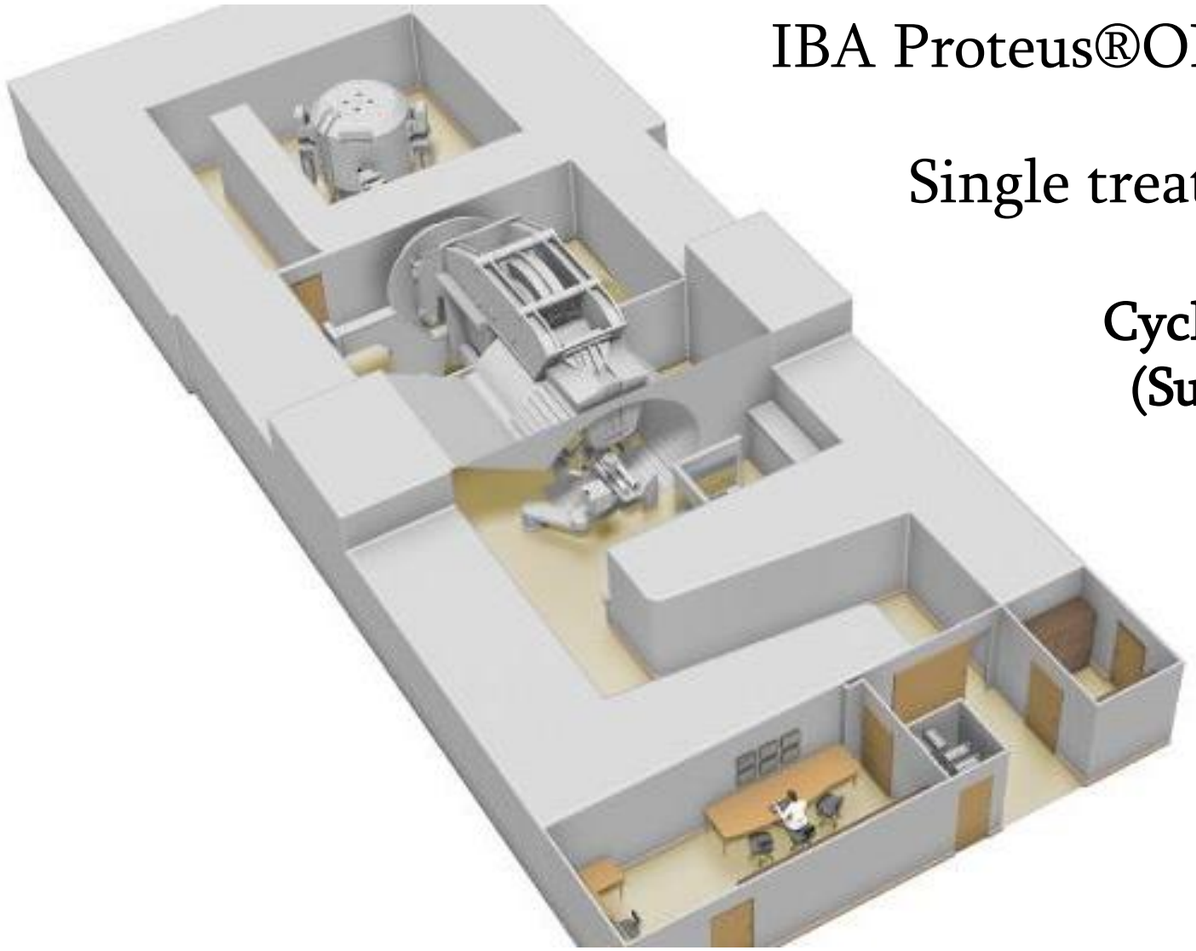
IBA (cyclotrons)

IDOM (design)

Construction starts: 2022

HTC commissioning: 2024

IBA ProteusONE



IBA Proteus®ONE

Single treatment room proton therapy system

Cyclotron IBA S2C2
(Super Conducting Synchro Cyclotron)

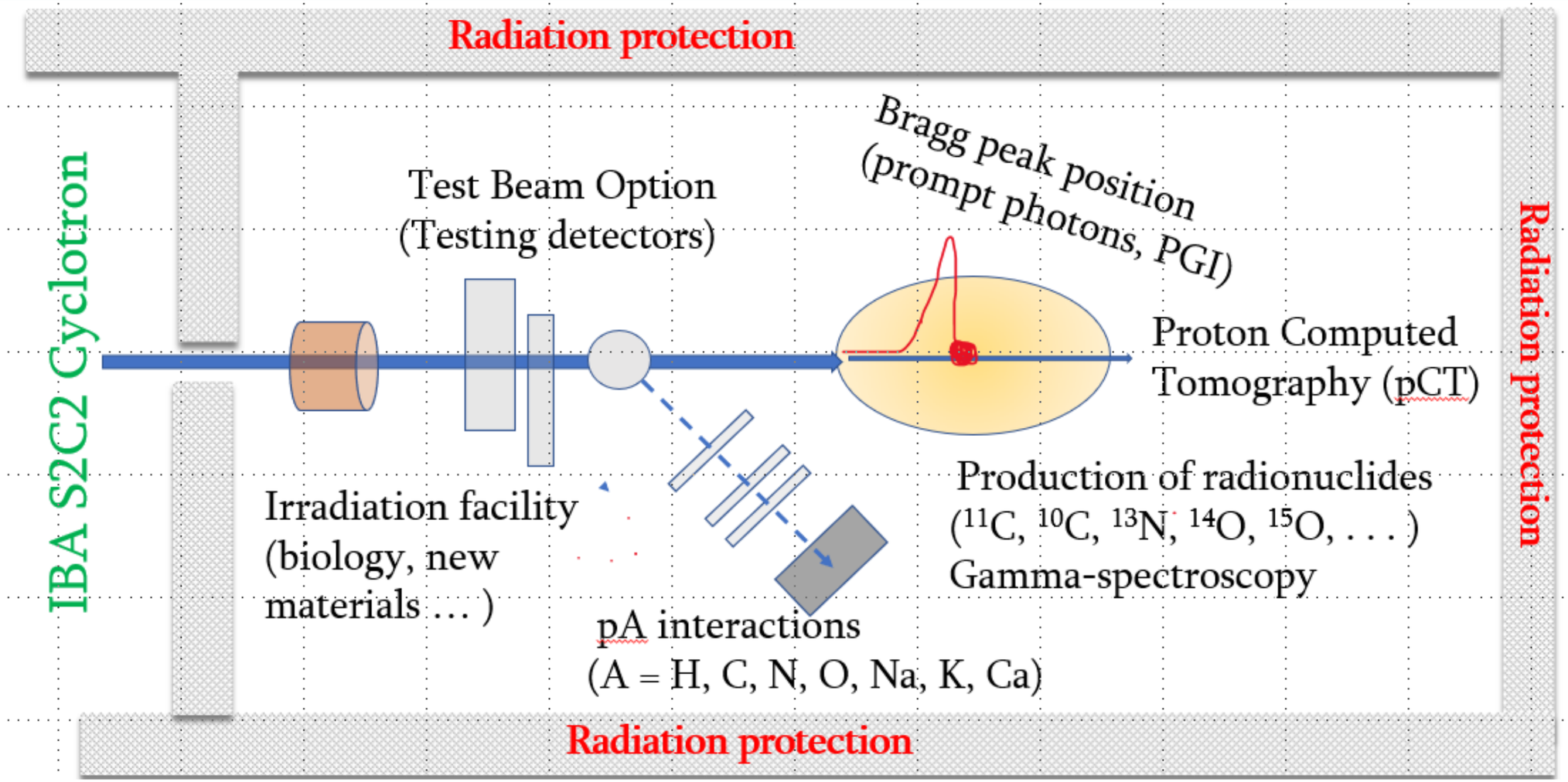
Compact accelerator with 5 Tesla field

Proton energy: 230 MeV

Software for treatment planning:

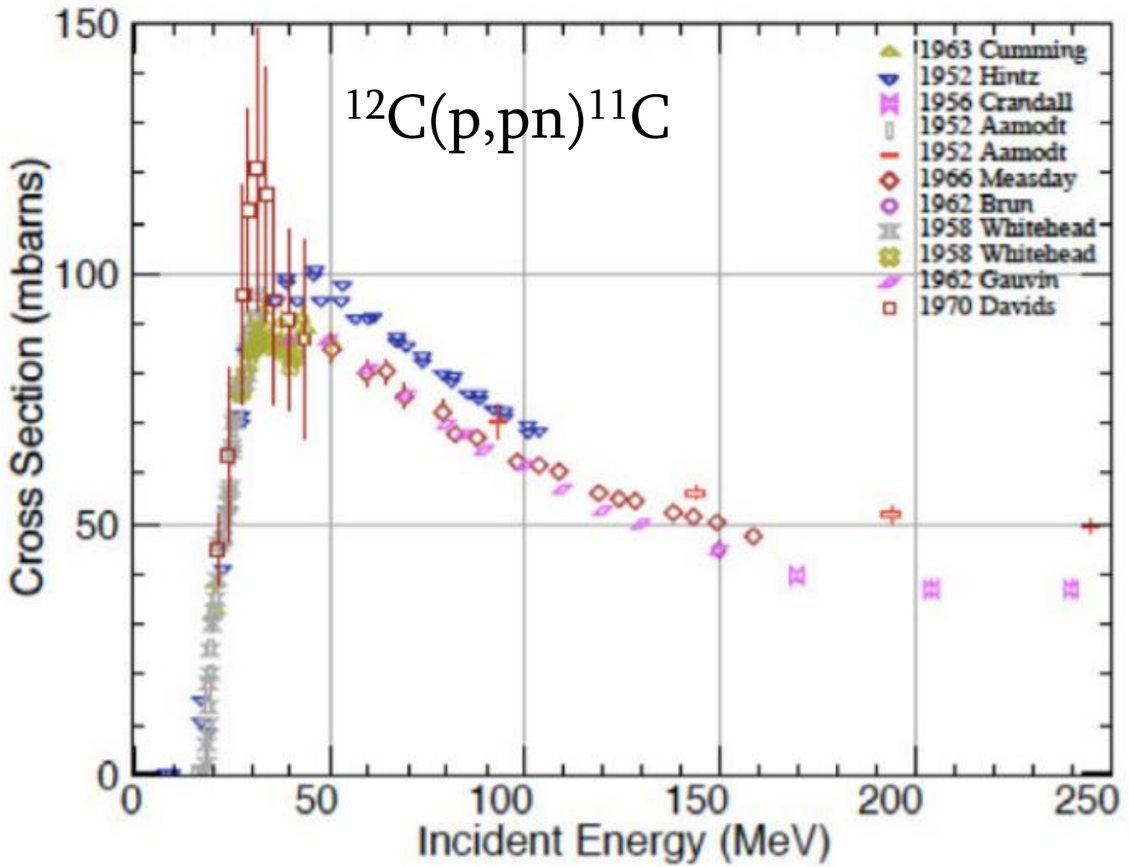
RaySearch Laboratories

Research with IBA S2C2



Isotope Production in Human Tissue

	Reaction			
C	$^{12}C(p,pn)^{11}C$ $^{12}C(p,p2n)^{10}C$	^{11}C ^{10}C	20.33 m 19.29 s	
N	$^{14}N(p,2p2n)^{11}C$, $^{14}N(p,pn)^{13}N$ $^{14}N(p,n)^{14}O$	^{13}N	9.96 m	
O	$^{16}O(p, pn)^{15}O$, $^{16}O(p,3p3n)^{11}C$ $^{16}O(p,2p2n)^{13}N$ $^{16}O(p,p2n)^{14}O$ $^{16}O(p,3p4n)^{10}C$	^{15}O ^{14}O	122.24 s 70.61 s	
P	$^{31}P(p,pn)^{30}P$	^{30}P	2.50 m	
Ca	$^{40}Ca(p,2pn)^{38}K$	^{38}K	7.64 m	



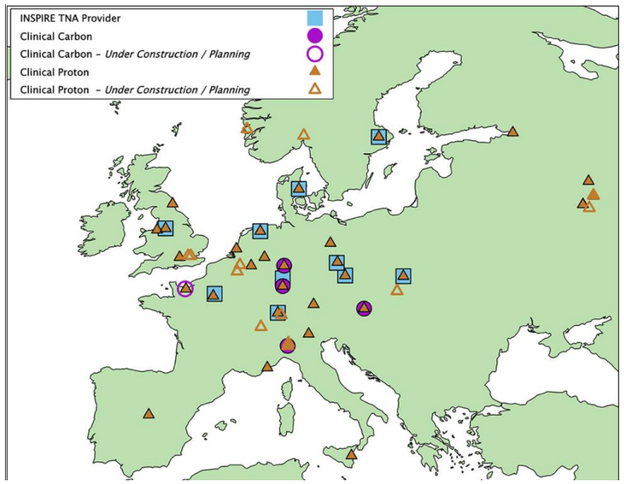
E. Palomares et al. Phys. Med. Biol. 56(2011) 2687–98 2011
Study of the reliability of the cross sections used to model the production of PET isotopes with proton beams

International Cooperation

- Knowledge transfer to KIU HTC
- Joint projects for developing KIU HTC infrastructure
- Joint research projects
- European collaborations in the proton therapy and related research

Georgian-German ScienceBRIDGE
CONNECTING PEOPLE AND KNOWLEDGE

JARA Jülich Aachen Research Alliance



The INSPIRE Project:
Mapping the Future of Particle Radiobiology in Europe

https://protonsinspire.eu/

Cooperation with RWTH Aachen University

Group of prof. Achim Stahl

RWTH AACHEN UNIVERSITY

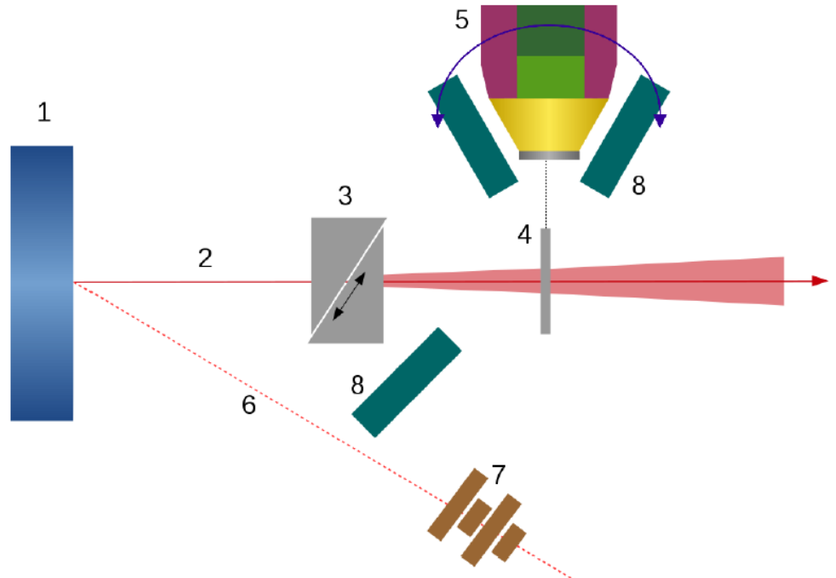
Development of instrumentation (and related simulations) for proton therapy: Compton camera for PGI

- ✓ Access to RWTH-Aachen computer cluster and software
- ✓ Access to data collected in the experiments with the proton beams
- ✓ Geant4 based simulations; Data/MC comparison
- ✓ Evaluation impact of the proton therapy

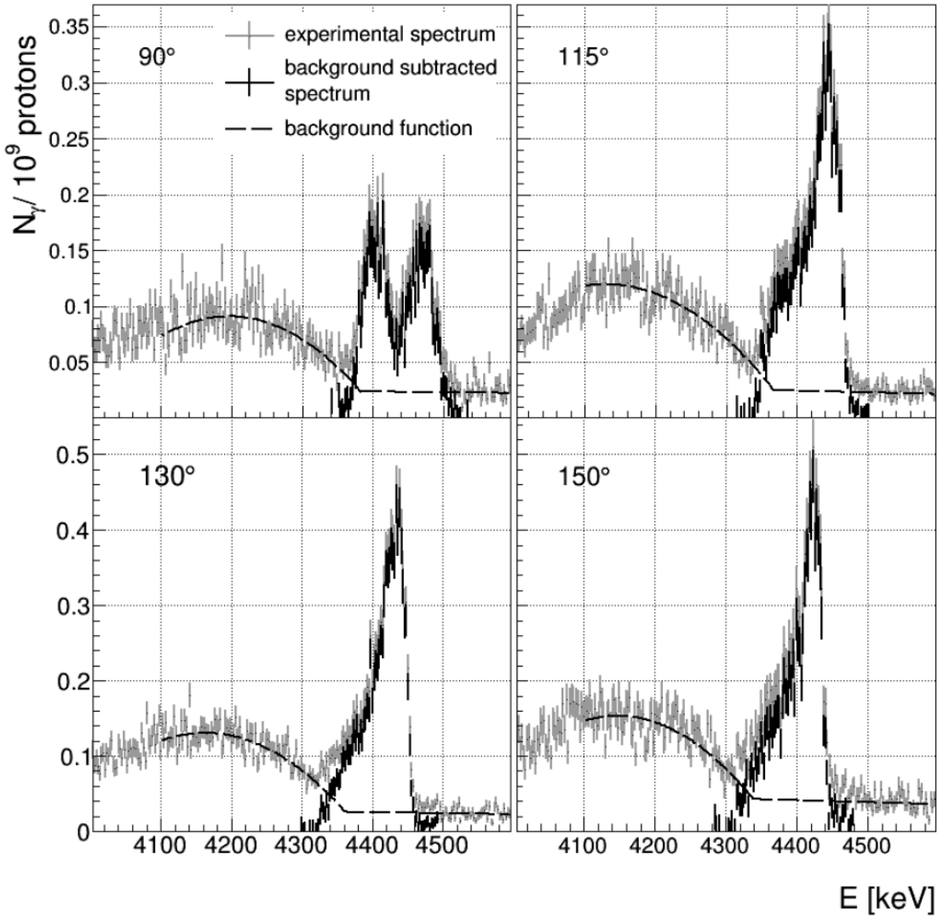
- Be-weekly meetings RWTH / KIU / TSU

$^{12}C(p, p\,\gamma_{4,4\,MeV})^{12}C$ Experiment at HIT

Heidelberg Ion-Beam Therapy Center (HIT) experiment with 71 or 131 MeV kinetic energy protons.

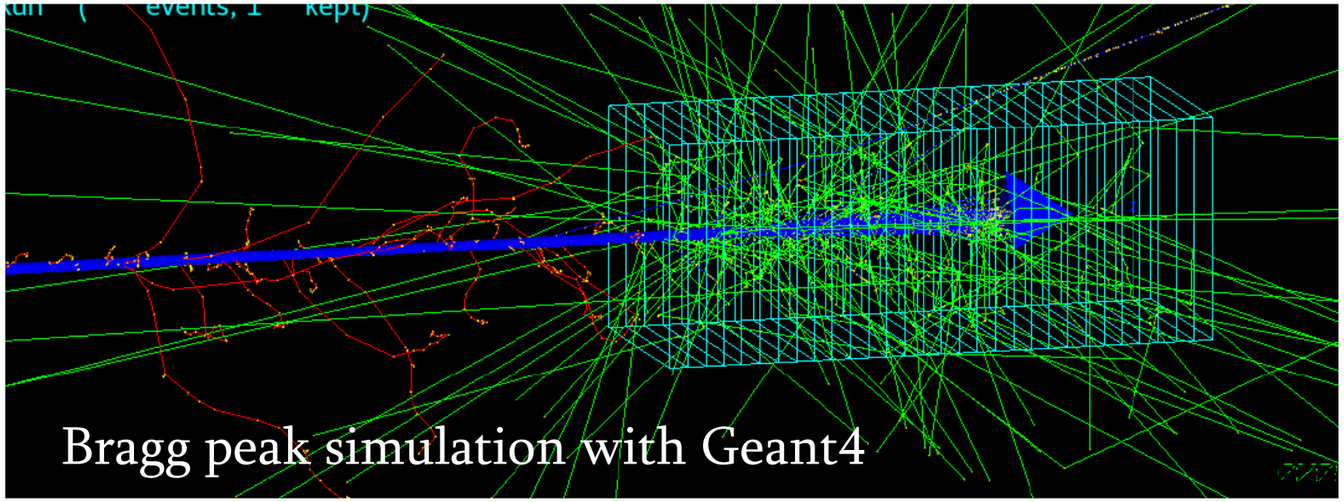


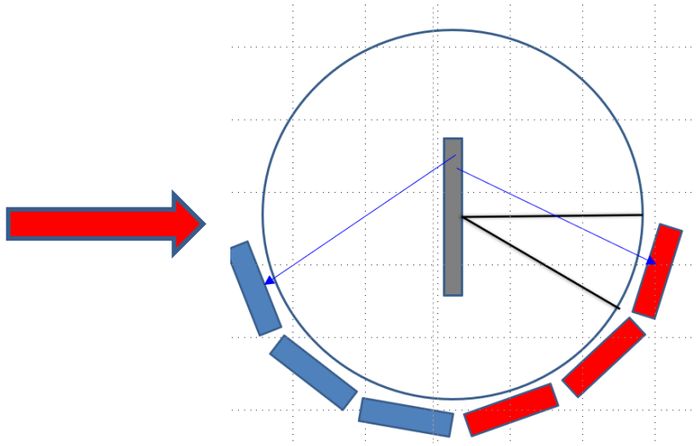
(1) Beam pipe nozzle, (2) beam trajectory, (3) thick part of the phantom (wedges, arrow indicates direction of motion), (4) thin phantom slice, (5) HPGe detector, (6) trajectory of protons scattered on the exit nozzle material, (7) beam current monitors, (8) lead shield.



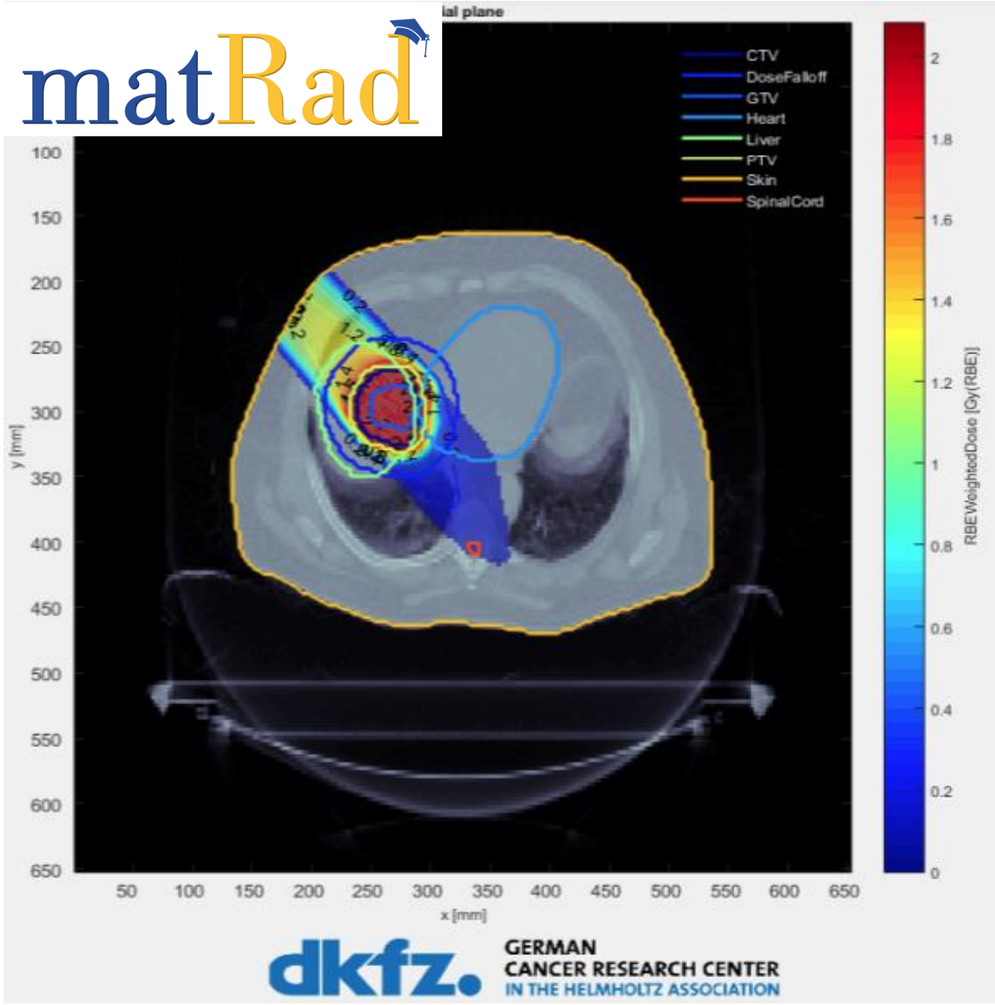
ACTA PHYSICA POLONICA B49 (2018) 1637

Simulations: Geant4 and matRad





HIT experiment model
for Geant4 simulation



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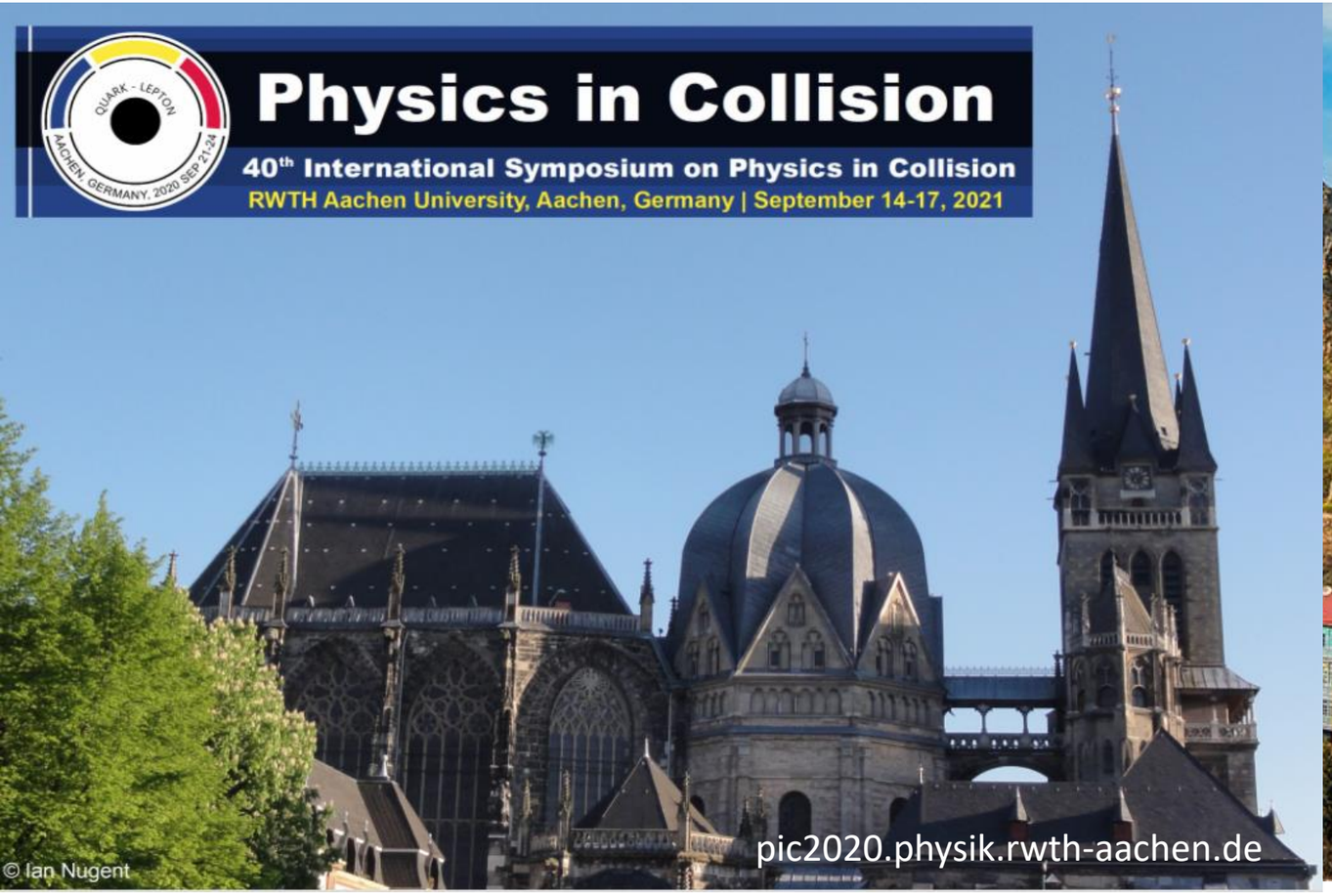
Nikoloz Totogashvili

Revaz Shanidze

Vakhtang Tsagareli

Summary and Outlook

- Kutaisi International University (KIU) - a new educational and research center in Georgia was opened in 2020.
- Hadron Therapy Center at KIU will host 2 cyclotrons for therapy and research
- HTC infrastructure and research projects are currently under development with a help from international partners.
- Construction of KIU HTC starts in 2022
- Proton beams for treatment and research are expected for 2024.



The International Symposium on Physics in Collision is a conference series that began in 1981 in Blacksburg, Virginia, USA. The program of the symposium is composed of invited talks and contributions in poster sessions. Invited speakers will review and update key topics in particle physics and related topics in which new results have been published in the last year or are reasonably expected to be so before the next symposium. The aim of presentations is to encourage informal discussions of new experimental results and their implications. The topics at the symposia cover a wide range of physics subjects from accelerator-based particle physics to astroparticle physics

End of the presentation

Merci beaucoup!

Дуже тобі дякую!

დიდი მადლობა!