RAPTOR- LOOP REQUIREMENT
Speaker and contribution

DAY 1 – September 4th, Sunday

Dr. Mark Plesko, co-founder and CEO of Cosylab.

Dr. Mark Pleško (co-founder and CEO of Cosylab), MBA, born 1961, is a world renown expert for nuclear accelerators and particle cancer therapy, a successful entrepreneur and a respected leader and counsellor in business, government and the society at large. He is an angel investor and board member in both startups and mature companies. He received several national and international awards for his work in research and in business. https://www.linkedin.com/in/markplesko/)

Entrepreunership

A famous physics professor once said »if you want to make money, don't go through physics. Go the direct way, study economics«. This may have been true in his time, but it certainly isn't now. I will demonstrate with myself as example, how a "simple" physicist and a couple of physics students, like "you and me", started on an entrepreneurial journey 20 years ago and are now running the world's leading company in their field. By honestly explaining what we had (actually, it would be more correct to use the expression "didn't have") to become successful, I will try to generalize and give some common sense useful advice in case you want to start your own company. An important point will be the comparison of the academic and business cultures – where are the differences and what are the similarities.

DAY 2 – September 5th, Monday

Prof. Gitta Kutionik (LMU)

Gitta Kutyniok currently has a Bavarian AI Chair for Mathematical Foundations of Artificial Intelligence at the Ludwig-Maximilians Universität München. She received her Diploma in Mathematics and Computer Science as well as her Ph.D. degree from the Universität Paderborn in Germany, and her Habilitation in Mathematics in 2006 at the Justus-Liebig Universität Gießen. From 2001 to 2008 she held visiting positions at several US institutions, including Princeton University, Stanford University, Yale University, Georgia Institute of Technology, and Washington University in St. Louis. In 2008, she became a full professor of mathematics at the Universität Osnabrück, and moved to Berlin three years later, where she held an Einstein Chair in the Institute of Mathematics at the Technische Universität Berlin and a courtesy appointment in the Department of Computer Science and Engineering until 2020. In addition, Gitta Kutyniok holds an Adjunct Professorship in Machine Learning at the University of Tromso since 2019. Gitta Kutyniok' research focusses on mathematical foundations of artificial intelligence. For this, she has received various awards such as a Heisenberg-Fellowship in 2006, and the von Kaven Prize by the DFG in 2007. She was invited as the Noether Lecturer at the ÖMG-DMV Congress in 2013, a plenary lecturer at the 8th European Congress of Mathematics (8ECM) in 2021, and the lecturer of the London Mathematical Society (LMS) Invited Lecture Series in 2022. She also became a member of the Berlin-Brandenburg Academy of Sciences and Humanities in 2017, a SIAM Fellow in 2019, and is currently acting Vice President-at-Large of SIAM.

Deep Learning meets Imaging Science: Explainable Hybrid Solvers for Medical Imaging

Deep neural networks have already been tremendously successful in real-world applications, ranging from science to public life. The area of imaging sciences has been particularly impacted by deep learning-based approaches, which sometimes by far outperform classical approaches for particular problem classes. This talk shall give an introduction into this exciting research field. We will first discuss deep neural networks in general, their set-up as well as their advantages and disadvantages. Then we will focus on the application of deep neural networks to problems in imaging sciences. Due to their success, we will pay particular attention to so-called hybrid methods, namely those which optimally combine traditional model-based methods with deep learning-based approaches to not neglect known and valuable domain knowledge. As a numerical illustrative example, we will discuss the application of limited-angle computed tomography. Finally, we will also touch upon the issue of how to interpret the results of such algorithms, and present a novel, state-of-the-art explainability method based on information theory.

Prof. Zoltan Perko, Delft University of Technology.

Zoltán Perkó is a recognized expert of computational physics and deep learning, and their use in radiation applications. He received his master's degree in physics from Budapest University of Technology and Economics in 2010 and his PhD with cum laude distinction from Delft University of Technology (TU Delft) in 2015. After 2 years as postdoctoral fellow at Massachusetts General Hospital and Harvard Medical School he established his own research group at TU Delft, pursuing unique research by leveraging state-of-the-art physics simulations with the power of artificial intelligence (AI), focusing on unsolved computational challenges in cancer care. Zoltán and his team are working on improving all aspects of the radiotherapy workflow, paving the way towards realizing the full potential of cutting-edge charged particle therapies: clinically feasible online - and ultimately real-time – adaptive treatments offering maximal efficacy with minimal side-effects. Within the new Biological Intervention Optimization AI Lab he is also looking beyond the state-of-the-art, developing AI tools to biologically tailor and truly personalize patient irradiations.
Zoltán has successfully raised >1.7MEur funding for his research and his work is being regularly published in top journals. Via close collaborations with Dutch, European and international radiotherapy and proton centers his computational methods are already being used clinical settings, enabling multi-center studies and having direct societal impact. His algorithms allowed deriving practical robustness recipes, ensuring safe and effective proton treatments, and his group's latest result - an AI-based millisecond speed proton dose engine - represents the current state-of-the-art in proton transport calculations.

AI in Radiotherapy – Machine Learning and Deep Learning for Treatment Planning.

Over the last century radiotherapy has had a remarkable success in cancer treatment. After the early years of trial-and-error, the evidence based use of radiation has established fractionated photon treatments as standard of care for most patients. Decades of research has led to novel machinery and procedures – such as charged particle treatments, image guidance and adaptive treatments – that allow targeting tumors with unprecedented precision today. Computational tools and sophisticated mathematical modelling played an undeniably crucial role in this success, and Artificial Intelligence (AI) methods are increasingly the key drivers behind further improvements, holding the promise for breakthroughs via enabling real-time adaptive and biologically optimized treatments.

In this presentation I will give an overview of the current state-of-the-art in the use of AI methods in various steps of the modern radiotherapy treatment planning workflow. I will explain how Deep Learning (DL) based convolutional and transformer networks can speed up dose calculations, both for photons and for charged particle therapies. I will review AI's role in imaging, segmentation and registration, and we will learn about traditional machine learning (ML) and current DL approaches to plan optimization and quality assurance. I will also describe how AI can help modelling the dynamics between breathing motion and dose delivery, which is crucial for the most advanced particle beam scanning techniques. Last, I will talk about the limitations and outstanding challenges of AI in radiation oncology clinical practice.

Prof. Giorgio Ruffa, data engineer RaySearch Laboratories AB.

Dr. Giorgio Ruffa is a data engineer and ETL functionality owner for the RayIntelligence project at RaySearch Laboratories AB. He studied Physics at Università degli Studi di Milano and holds a double master's degree in Data Science from Universidad Politècnica de Madrid (UPM) and the Swedish Royal Institute of Technology (KTH) under the European Technology Institute Digital program (EIT-Digital). His master thesis focused on ROI label standardization using machine learning models based on geometrical features. He has multiple years of experience in backend and data engineering in different industries. His interests lie within the fields of machine learning, automation, distributed systems, cloud computing, and their application to the radiation therapy field. In his spare time, he volunteers as a mentor for the Women in AI Sweden mentorship program.

Big data: acquiring and using large (patient) datasets/ Big Data in a Clinical Context.

The rise and widespread adoption of internet technologies in the last twenty years have triggered the generation and storage of massive amounts of data. This abundance has fostered the development of systems able to perform distributed computations on a large scale that later came to be known as "big data technologies". As often happens in the medical technology field, digital innovations that have matured in other industries eventually make their way into the research and clinical workflow.
This talk will give a brief introduction to the distributed computing core principles, providing a historical perspective on which technologies have developed over time and which are the most commonly used nowadays. It will then focus on how these technologies can be applied to data generated during the radiation therapy treatment course, addressing the unique challenges arising during data extraction, transformation, and analysis. Lastly, it will present how oncology analytics platforms like RayIntelligence have been developed to address the specific needs of radiation therapy data analysis.

Prof. Maja Pohar Perme

Maja is a professor in Biostatistics at the University of Ljubljana, she is the head of the department of biostatistics and medical informatics. She teaches statistics to students of medicine and related fields at the undergraduate and postgraduate level. She is highly involved in the eduction of future statisticians in Slovenia, she leading the masters programme of Applied Statistics at the University of Ljubljana and teaching several courses at both masters and PhD level.
Being based at the Ljubljana Medical faculty, she cooperates regularly with researchers and medicine and is involved in a wide range of research. She is one of the editors of the Slovenian Medical Journal.
Her research focuses on survival analysis with particular interest in relative survival methodology. She is researching properties of the methods traditionally used in the relative survival setting and has made several contributions to the field by introducing methodology for non-parametric estimation, semi-parametric modelling, goodness of fit testing, etc. Her current research focuses on

the different measures of interest in relative analysis and the use of pseudo-observations in this field. She is the author of the relsurv package in R.

Biostatistics

The talk will present the basic concepts of biostatistics and statistical inference in general. We will start with the estimation of the population mean and explain the terms like sampling distribution and the standard error. We will explain why and how the central limit theorem plays a central role in the underlying statistical theory. We shall then turn to hypothesis testing and give an intuitive presentation of its main steps. The example of testing the mean value will be used to present the ideas and to discuss the duality between testing the hypotheses and parameter estimation. The presentation will focus heavily on the ideas as well as the interpretation of the obtained estimates, intervals and the statistical hypothesis results, to give an overall picture of the key ideas of statistical inference. The talk will be wrapped up by a brief discussion on the most frequent methodology used in biostatistics.

Dr. Matthias Schindler, IP Counsel at Siemens Healthineers

My name is Matthias Schindler and I have studied physics at the University of Erlangen-Nuremberg. During my PhD in the field of accelerator physics I have investigated the coupling of chromatography to accelerator mass spectrometry in order to enable component-specific C14 dating. Subsequently, I looked for a profession that would allow me to use my technical and scientific knowledge as well as my communication and writing skills. Therefore, I started as an IP professional in a law firm and completed my training as a German patent attorney and European patent, trademark and design attorney. While working in a law firm requires working with inventions of different technical fields in a German and European framework, working in an IP department of a company allows focusing on a specific technical field within the framework of a global IP strategy. Hence, I switched to Siemens Healthineers after several years at the law firm. At Siemens Healthineers I and my colleagues effectively protect, defend and exploit intellectual property rights from different areas of medical technology and promote innovation.

Inventions, patents and crime – What a researcher needs to know about IP

Intellectual property (IP) helps to protect creations of the mind that include technological inventions, designs, images, symbols, slogans etc. If you create a product, publish a book, or find something new in your research, intellectual property rights ensure that you benefit from your work. These rights protect your creation or work from unfair use by others and can be a catalyst to attract cooperation partners. In this talk, we will discuss different types of intellectual property rights (patents, trademarks, designs) and learn how they can help researchers, developers and entrepreneurs.

Dr. Lucia Martinelli, Ph.D, Senior Researcher at MUSE – Science museum and President of the European Platform of Women Scientists –EPWS.

She received a Laurea in Biological Sciences from the Bologna University, an MS in Science Journalism and Communication from the Ferrara University, and a PhD from Wageningen Agricultural University (NL).
During a decennial experience as researcher in Italian and foreign public and industrial research institutes, she developed and coordinated research in the field of biotechnology, on gene transfer, GMO traceability and risk communication. In the field of genetics, for her pioneering research on gene transfer into grape, she was awarded with first prize 1994 by the 'Rudolf Hermanns Stieftung' (D).
Since June 2011, she has been carrying on research in the area of Science within Society and RRI at MUSE. The topics also include gender issues. Her activity counts on international multidisciplinary networks and projects. She is curator of special exhibitions. She is involved as a teacher in courses of science communication for the UniMORE University; has experience in text writing and in hosting programs for the radio, both public (RAI) and private nets, and as author of science-theatre texts.
Her publications are available on Research Gate: https://www.researchgate.net/profile/Lucia-Martinelli.
In the board of the Italian Association Women Scientists, since June 2021 she is the President of the European Platform of Women Scientists-EPWS (www.epws.org).

Gender, Inclusion and Gendered Innovation

Aim: to create awareness about gender issues and to stimulate practices for a good behavior.
Main Topics: (After a short presentation about myself and my involvement in science and in EPWS)
(I) State of the art of the participation of women in research with particular focus on Europe.
(II) overview about the most crucial gender issues:
-the stereotypes and the unconscious bias;
-the stereotypes in science and specifically about gender;
-who are the women scientists? (role models and mentoring);
-stereotypes and scientific communication;
(III) the European policies of ERA (European Research Area) to overcome the gender gap in science (evolution from 1999 to 2022):
-the projects for supporting the presence of girls in science;
-the Gender Equality Plans (GEP);
    -the gendered innovation;
    -the inclusive language.

Suggested texts:
(i) Schiebinger, L., Klinge, I., Sánchez de Madariaga, I., Paik, H. Y., Schraudner, M., and Stefanick, M. (Eds.) (2011-2021). Gendered Innovations in Science, Health & Medicine, Engineering and Environment. URL: https://genderedinnovations.stanford.edu/

(ii) Toward an inclusive communication: example in the English language. "Toolkit on gender-sensitive communication" by EIGE, 3/3/22.
URL: https://eige.europa.eu/print/publications/toolkit-gender-sensitive-communication

DAY 3 – September 6th, Tuesday

Prof. Jasna Hengovic

I am a mathematics graduate from the Faculty of Mathematics and Physics in Ljubljana and have 12 years of experience in software development, including three years in medical software development for radiotherapy. I work as a senior software developer and project manager at Cosylab, where I focus on the development of software products for radiotherapy. Currently, my main work is TreatmentOne – a treatment control system for proton therapy.
In 2020, I was named "Slovenian Female Engineer of the Year", which makes me an ambassador for the engineering profession among young people, especially girls. The Slovenian Female Engineer of the Year project addresses this issue by finding and presenting inspiring role models to encourage young women to select STEM studies.

Control system for ART

I will introduce our product TreatmentOne. which was developed with the future in mind, specially to support the evolution towards adaptive methodologies. It is in fact a three-in-one solution: A Record and Verify (R&V), a treatment session manager, and a treatment control system that synchronizes the operation of all devices and subsystems and enables users to perform clinical and QA workflows. It was designed and developed according to strict medical standards and the latest best practices for usability. It provides streamlined workflows and the features needed to address the challenges of operating and integrating modern radiotherapy devices. TreatmentOne is modular and configurable, making integration easy and a perfect fit for customer-specific radiation therapy devices.
I will walk you through a treatment workflow and explain the features and configurations.

Prof. Kristin Stützer, PhD, Physicist, operative group leader Oncoray

Prof. Caterina Brusasco, Compliance Domain Expert at IBA

I have worked for more than 20 years in protontherapy in an international landscape from fundamental research to industrial applications.
My research experience took place in Italy and Germany. In Italy, I was a researcher for the Italian National Institute of Nuclear Physics, where I participated in the development of the particle-therapy technology later implemented in CNAO, Pavia.
In Germany, I was a researcher in the German National Research Center of GSI, Darmstadt, where I participated to the development of the Carbon-therapy prototype technology later on acquired by Siemens.
My experience in industry came from IBA, Belgium where I participated to Research & Development, product and quality management and international regulatory affairs and I am currently Compliance Domain Expert in R&D.In IBA I am also engaged in policy development with the European trade association COCIR and in international standardization. In particular, I represent Belgium as CEB-BEC chairperson of TC 62 and Belgian national expert to CENELEC TC 62, as NBN Belgian expert of CEN/CENELEC TC3 and as expert to IEC SC 62C/WG 1, ISO TC 210 WG1, JWG1 and IEC TC45.

Industrialization

Placing on the market a Medical Device is subject to regulation in most of jurisdictions to ensure safety for patients and health care personnel. A new medical device needs to undergo a conformity assessment before being placed on the market and is subject to surveillance during its lifetime to ensure its safety and correct performance. According to the potential risks posed by the medical device, the conformity assessment follows different routes and can involve or not external accredited organisms. Additionally, the manufacturer is responsible to maintain the safety and performance of the medical device for its whole lifetime once it is placed on the market. This talk focus on the medical device regulations of the United Stated and Europe by going through the steps for placing and maintaining a medical device on the market and clarifying the role and responsibilities of the different stakeholders.

Dr. Thomas Stibor, GSI Helmholtz Centre for Heavy Ion Research

Thomas Stibor received his PhD in computer science from TU Darmstadt, Germany.
During his doctoral studies, he spent six months as a visiting researcher at the University of Kent, England, where he worked on artificial immune systems and machine learning. After that, he was a Postdoctoral researcher at UC Davis, USA and later a lecturer at TU Munich, Germany. He was an invited lecturer at Gulbenkian Institute of Science, Portugal, and taught machine learning in the PhD program of computational biology. His research interests are machine learning and scalable data transfer for big data. Currently, he is with GSI Helmholtz Centre for Heavy Ion Research, Germany as a scientific employee, where novel particle collider rings are constructed which will provide antiproton and ion beams with unprecedented intensity and quality.

Big data: fast access, transfer, storage

Data acquisition in high energy physics is a challenging task in terms of reliability and scalability. We present a framework for transferring raw acquisition data to the large-scale distributed file system Lustre and additionally archive the data in an archiving system in near real-time. The framework employs multiple queue data-structures and exploits producer-consumer paradigm to leverage reliable and scalable asynchronous data transfer. Latest 2022 beam time of the HADES experiment underpins the effectiveness of the framework.

Prof. Yolande Lievens, Chair of the Radiation Oncology Department, Ghent University Hospital, Ghent Belgium

Chair of the Radiation Oncology Department, Ghent University Hospital, Belgium. Associate Professor in Radiation Oncology, Ghent University, Belgium. Former president of the European Society for Radiotherapy and Oncology and of the Belgian College of Radiotherapy and Oncology. Co-chair of the ESTRO-HERO project (Health Economics in Radiation Oncology). Chair of the ESTRO-GIRO project (Global Impact of Radiotherapy in Oncology)

Her clinical focus lies on radiotherapy for thoracic malignancies, with a special attention for the role of radiotherapy in hematology and in breast cancer. Apart from the clinics, she has always been closely involved in the organizational aspects of radiotherapy, in the position of radiotherapy within multidisciplinary oncology and in the financial and health economic aspects of cancer care. Last but not least, she has a vested interest for quality issues in radiation oncology, not only in terms of quality assurance but also regarding the impact of radiation treatments on quality of life.

In view of providing state-of-the-art radiotherapy to all cancer patients who need it, she is convinced that evidence - clinical as well as economical - is key to sustain innovation in and improve access to radiotherapy within the nowadays often-limited health care budget.

Health Services Research: why does it matter for radiation oncology?

Health Services Research (HSR) is defined as the multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviours affect access to health care, the quality and cost of health care, and ultimately our health and well-being. In contrast to clinical research, focusing on patients, HSR addresses a broad range of domains, from individuals to populations. Together with the closely linked implementation research, HSR is key to guarantee access to innovations in health care.
Over the last decade, the Health Economics in Radiation Oncology project of the ESTRO (European Society for Radiotherapy and Oncology) has addressed a series of HSR topics with a focus on radiation oncology: it provided a blueprint of radiotherapy availability across Europe, defined the need for radiotherapy and developed a costing model. More recently, it has focused on one of the key drivers of the implementation of innovation in daily practice, i.e. reimbursement, and how to generate the evidence required to support appropriate financing. Moreover, it investigates how to define the value of radiotherapy innovation, acknowledging that the available value frameworks in oncology, typically developed for drugs, are not readily transferable to loco-regional cancer therapies such as radiotherapy. Through examples from the HERO project and other HSR with a focus on radiotherapy, the lecture aims to provide a general introduction to the topic.

DAY 4 – September 7th, Wednesday

Prof. Ye Zhang

Dr. Ye Zhang is a research scientist at Center for Proton therapy (CPT) in Paul Scherrer Institute (PSI). Her main research lie in the developments of 4D treatments for scanned proton therapy, especially for 4D treatment planning and optimization, motion mitigation, image guidance and motion modelling. She recently starts to explore the applications of artificial intelligent and online MR guidance for real time adaptive proton therapy.

Ye received her PhD degree from ETH Zurich (Switzerland) in 2013, and obtained the B.Sc and M.Sc in major of biomedical engineering from Xi'an Jiaotong University (China) in 2008 and Royal Institute of Technology (KTH, Sweden) in 2010. She worked as research scientist in Varian Medical Systems, before re-joining PSI as postdoc researcher in 2016. Since summer 2018, she has been holding a scientific position with tenure-track in PSI-CPT.

Currently, she is engaging as PI for two funded research projects, and has been supervising 4 PhD students and more than 30 master or bachelor theses. She is the author or co-author of over 30 peer reviewed articles in the major journals of medical physics, and has contributed more than 70 oral/post presentations in the well-established conferences (e.g. ESTRO, PTCOG, AAPM and etc). She was honored to receive the Chinese Government award for outstanding student abroad (2012). She is a member of PTCOG thoracic subcommittee and served a regular reviewer for more than 15 journals in the field. She will contribute as Scientific Advisory Group member for ESTRO 2023.

Logfile-based 4D dose reconstruction

The interplay of motion with a highly dynamic dose delivery process like Pencil Bean Scanned (PBS) proton beam is inherently complex. Although by using four-dimensional (4D) dose calculation, the foreseen 4D dose distributions can be estimated prospectively, their accuracy to which extent can be predicted a priori is questionable, due to the large number of variables involved. Therefore, reconstructing 4D dose retrospectively instead, based on the machine logfiles, allows for the re-assessment of the applied plan quality after patient treatment. However, besides considering the logged info on the actual beam delivery (e.g. spot positions, fluences, and time stamp), it is also important to incorporate the actual patient motions, ideally during delivery of the day. The conventional approach to reconstruct 4D dose relies on a single pre-treatment 4DCT, which subjects to the uncertainty of motion variabilities in frequency and amplitude both intra- and inter-fractionally. By phase-binning the delivered pencil beams according to the timings contained in the machine log-files, it only partially accounts for these variabilities during delivery. In order to achieve a more accurate 4D dose distribution towards reality, the motion model driven approach is beneficial, which can provide more realistic 4D patient representation for dose reconstruction by the predicting the time-resolved 3DCT images from the real-time measured respiratory surrogate during the dose delivery.

Dr. Fritz DeJongh, CHIEF EXECUTIVE OFFICE and co-founder of ProtonVDA

Fritz DeJongh received the B.S. degree in physics and mathematics from the Ohio State University in 1983, and the Ph.D. degree in physics from the California Institute of Technology in 1990. From 1990 to 2012, he was a Research Associate, Wilson Fellow, and Scientist at Fermilab, conducting research in particle physics and particle astrophysics. In 2014, he co-founded ProtonVDA, focusing on developing instrumentation to optimize proton radiation therapy. He currently serves as CEO of ProtonVDA as well as Principal Investigator for the grant funding this work.

New Product Development: Systems engineering approach for Regulatory compliance

ProtonVDA was funded by the USA National Cancer Institute to develop a clinically realistic proton radiography and tomography prototype system. This funding also requires a commercialization plan, including for regulatory certification. Our research team includes several medical physicists and radiation oncologists to help ensure the clinical applicability. This talk will provide an overview of our system, and how we designed it to efficiently integrate with treatment rooms and clinical workflows using pencil beam scanning.

Prof. Karen Kirkby, Richard Rose Chair in Proton Therapy Physic

Professor of Proton Therapy Physics - This is a joint post between the University of Manchester and The Christie Hospital , Karen is responsible for developing a programme of international leading proton research and innovation to deliver direct patient benefits. This goes from basic research, through pre-clinical and translational research to clinical trials. Chair of National Proton Physics Research and Implementation Group. Chair Work Stream 4 for NCRI Clinical and Translational Radiotherapy Research (CTRad) Working Group

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Public lecture - “Innovation in medical physics".

This year's public lecture will be given by Prof. T. Rockwell Mackie focusing on “Innovation in medical physics".
The most important milestones in the history of medical physics will be outlined, followed by a presentation of the current state of the art and future goals of the field. In addition, the key roles in bringing together the physical sciences and clinical medicine will be discussed.

Prof, T. Rockwell Mackie, Ph.D., Board of Visitors Vice Chair, Emeritus Professor, Medical Physics and Human Oncology; Director, Medical Devices Focus Area, Morgridge Institute for Research.

Prof, T. Rockwell Mackie is a medical radiation expert, serial entrepreneur, board advisor, entrepreneurial coach in the field of medicine, investor, medical provider administrator, and emeritus medical school professor.

Prof. Marjetka Kralj Kuncic, Timian Founder.

Marjetka Kralj Kunčič, PhD graduated in 2005 in Microbiology from the Biotechnical Faculty of the University of Ljubljana and started working as a microbiologist at a manufacturer of medical devices (Tosama d.o.o.). She completed her PhD in Biomedicine/Microbiology from the Faculty of Medicine, University of Ljubljana, in June 2010. She has published several research papers in peer-reviewed journals and participated in national and international conferences, presenting research topics as antimicrobial efficiency of different natural substances, efficiency of antimicrobial wound products, antimicrobial textiles, toxicology and antimicrobial effect of nanoparticles, microscopy techniques for research of organisms from extreme environments. Her research work was focused on development of modern dressings with honey for chronic wounds (including clinical trials) and antimicrobial textiles produced with atmospheric plasma. At the manufacturer of medical devices, she was as a Head of Quality Control Department. Within her responsibilities were quality and regulatory affairs for medical devices, hygienic products, and cosmetics; she has knowledge on sterilization processes, risk management and biocompatibility acc. EN ISO 14971, EN ISO 10993-1, EN ISO 13485, MDD 93/42/EEC, 21 CFR 820, 1223/2009... She is the founder of the company Timian and her recent work is devoted to quality and regulatory consulting for medical devices and cosmetics. She is a Lead Auditor for ISO 9001:2015, EN ISO 13485:2016, MDD /MDR QMS and a sterilization expert at SiQ, a notified body of IQNet group and a member of Technical Committee of Slovenian Institute for Standardization SIST/VAZ.

Certification standards: Health, Safety, Environmental

Certification standards are worldwide recognized as a path to business excellence. They enable to companies a lot of benefits across every aspect of business operation. Certification standards are not just a frame for building a quality management standard that improve efficiency and performance across the board but also enable regulatory requirements and also fulfil the customer needs. Certification standards on Health area, such as medical device field are of great help in proving of products' safety and performance. Compliance with environmental standards indirectly open the range of additional possibilities for the company to do a step forward of protecting the environment and develop a sustainable product. Safety standards enable safer work environment with practical risks management principles. The short overview and practical principles of the widely known standards from the field will be conducted.

Prof. Hanne Kooy, Department of Radiation Oncology, Massachusetts General Hospital & Harvard Medical School

I studied Engineering Physics at the Technical University Delft (Netherlands) where I reached a BS equivalency. I transferred to Syracuse University in NY State for a PhD in High-Energy Physics working at the Cornell 10 GeV (COM) e^+e^- synchrotron. After my PhD, I briefly worked in industry but quickly transferred to a new Medical Physics program at the University of Rochester in 1982. In 1987, I was offered a position at the Joint Center for Radiation Therapy at Harvard Medical School in Boston. At the JCRT, I worked on treatment planning problems (electrons, stereotactic treatments) and became the Director of Treatment Planning. In 1999, I joined the MGH and quickly got sucked into the effort in building the Northeast Proton Therapy Center under the direction of Michael Goitein. I never left protons. My efforts focused on completing the construction of the center and clinical validation and deployment. The initial phase used double-scattered fields. Our ability to use SOBP fields was only possible through our experience from the Harvard Cyclotron and new efficiencies and innovations in field dosimetry. The next phase introduced pencil-beam scattering in 2001 (after MDACC). PBS required many new innovations given the lack of commercial support. We developed new dose algorithms (including now a(n almost) 1 p.GHz Monte Carlo - GMC!) and QA procedures to meet the new demands. We developed the astroid treatment planning system which is the first truly cloud designed TPS and which uses MCO to optimize our plans.

Data Constructs and Computations in Adaptive Radiotherapy

Radiotherapy workflow assumed a linear sequence from intake to last treatment. Tasks were decoupled, without feedback and data was sparse. Adaptive radiotherapy (ART) presents data increase with feedback anywhere. Changes need to be processed within this changing context. Complexity management requires the use of up-to-date computing concepts.

We define two levels. The first concerns task automation given patient and objectives context. We ensure sequencing within context and return results to update the context. The second concerns task

computations with changed inputs. Computational graphs model these and ensure minimal re-computations. DICOM Second generation real-world model and IHE-RO are specifications for our model.
The workflow collects data generated in task execution into a DICOM 2G RT Course instance which models the patient state. An interpreter uses the RT Course and objectives to produce new tasks. Tasks are posted on the network and accepted by compatible task providers. The task produces data, returned and added to the RT Course. DICOM models the correct interment of results in the RT Course and ensures data traceability. ART requires automation of, typically repetitive, tasks executions. This requires traceability of the computation chain and processed data. We use computational graphs to record these details. The graphs allow for sparse, optimal, re-computations given antecedent property changes.
We deployed a workflow environment and a task automation model consistent with ART requirements. Requirements include data immutability, traceability to antecedents and of computations. The environment uses a service-oriented architecture that allows for extensibility and complexity by decomposition into ``small'' tasks.

Prof. Christian Richter, Medical Radiation Physics at the Technische Universität Dresden

Christian Richter is Professor for Medical Radiation Physics at the Technische Universität Dresden and Dean of studies for the Medical Physics Master program, which is combined with a MPE certification. At OncoRay in Dresden he is heading the Medical Radiation Physics Department. The focus of Medical Physics research at OncoRay is on the development of online-adaptive proton therapy, enabled by on AI-supported closed feedback-loop of imaging, adaption, QA and verification. His research group High Precision Proton Therapy works on the improvement of the precision and accuracy of proton therapy – on the one hand by increasing the range prediction accuracy by means of Dual-Energy CT (DECT) and on the other hand with in-vivo range verification by making use of prompt gamma ray imaging. Christian Richter has a strong track record in multidisciplinary and translational research projects in Medical Physics, always aiming to bring the research innovations to where they really matter – to the patient. He is member of the Physics Committee of ESTRO and also active within the European Particle Therapy Network (EPTN). Within RAPTOR Christian Richter is organizing one of three scientific workpackages, the one on Treatment Verification.

Prompt gamma particle imaging

The lecture will give an overview of the utilization of prompt-gamma (PG) radiation, emitted from the patient's body during fractionated particle therapy treatment, for range and treatment verification. After the nuclear physics basics of the emission of prompt gamma rays have been refreshed, the three fundamental approaches for PG-based particle range determination will be discussed, which use either spatial, temporal or spectroscopic information of PG - namely prompt gamma imaging (PGI), prompt gamma timing (PGT) and prompt gamma spectroscopy (PGS), respectively. Special emphasis will be on the interpretation of the complex PG data for the distinction of clinically relevant from irrelevant treatment deviations, necessary for the clinical application of PG for treatment intervention in an online-adaptive PT realization. Results from the evaluation of clinically acquired PGI data will be presented.

DAY 5 – September 8th, Thursday

Dr. Lars Glimelius, Head of physics group at RaySearch Laboratories.

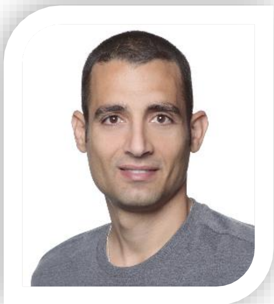
My name is Lars Glimelius, physicist from Stockholm, Sweden. I am the head of a physics group at RaySearch Laboratories, and work as product manager for the development of light ion treatment planning.
My background is a M.Sc. in applied physics at Uppsala University, where I did my master thesis on the Gamma knife at Elekta. After a bit of skiing, I joined RaySearch in 2007 where we started up the development of treatment planning for protons. It was my main focus for many years, but I have since also worked with photon and electron physics, optimization and other areas. Since 2015, I have mainly been focusing on research and development of carbon and helium planning, RBE modelling and related topics. I am proud to say that protons, carbon and helium ions are used clinically with our software at more than 80 centers around the world.

Clinical Monte Carlo for particles

Monte Carlo is the golden standard for computing dose in radiotherapy, but has traditionally been burdened with long computation times compared to analytical dose algorithms. Due to its superior accuracy in complicated geometries, and the possibility to score additional components in addition to dose (e.g. LET), Monte Carlo can be a very useful tool for the optimization and final dose computation of treatment plans, given that it can be fast enough.
The RayStation TPS (RaySearch Laboratories) has had a clinical Monte Carlo dose computation for proton PBS since 2016. In 2020, it was reimplemented on GPU, bringing major improvements to the computation speed. I will present the general algorithms for a clinical Monte Carlo, and the special considerations necessary to make it fast without compromising on the accuracy for clinical radiotherapy purposes.
Development of the Monte Carlo dose computation for carbon and helium ions is ongoing. Many features, e.g. transport mechanics, are the same, but there are multiple challenges specific to heavier

ions. Primary ions will fragment into multiple lighter particles, and heavier target recoils will also have an impact. This requires a large set off cross sections for all interactions having a significant contribution to the dose. Furthermore, clinical practice requires that RBE-weighted dose is computed, typically using the Local Effect Model (LEM) or the Mikrodosimetric Kinetic Model (MKM). In order to do this, it is necessary to score additional quantities like the dose-averaged alpha and beta, putting additional challenges to performance and memory consumption. Because of the beamline contribution to the fragmentation of the initial beam, this will also have to be taken into account.

Prof. Aviv Gibali, Head of Mathematics Department at ORT Braude College of Engineering, Karmiel, Isarel.



In 2012 I was awarded a Ph.D. from the Technion (Israel Institute of Technology, Haifa, Israel) under the supervision of Professors Simeon Reich and Yair Censor. My dissertation was focused on modeling, algorithms developments and analysis, in particular for systems of linear and nonlinear equations or inequalities and optimization techniques in radiation therapy treatment planning and image and signal processing.
In 2012 I joint the Optimization department in Fraunhofer Institute for Industrial Mathematics (Kaiserslautern, Germany), first a postdoc and then as an employee.
Since 2014 I am a faculty at the Mathematics Department at ORT Braude College of Engineering, Karmiel, Isarel and since 2020 I'm its head.
Due to my training I am oriented towards industrial problems solving, including treatment planning and active in the organization conferences/workshops/brain storming events in this field as well as member of mathematics-industry consortiums such as the

- COST Management Committee member – COST Action CA19130 - Fintech and Artificial Intelligence in Finance – Towards a transparent financial industry
- COST Management Committee Member - COST Action TD1409 - Mathematics for Industry Network (MI-NET)

Among the journals I serve as an associated editor are

- Journal of Optimization Theory and Applications
- Journal of Applied and Numerical Optimization
- Communications in Optimization Theory
- Numerical Algorithms
- Symmetry
- Fixed Point Theory and Algorithms for Sciences and Engineering
- Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A. Matemáticas
- Journal of Industrial and Management Optimization

Projection Methods, Superiorization and Applications

Projection methods are iterative algorithms that use projections onto sets while relying on the general principle that when a family of sets is present, then projections onto the given individual sets are easier to perform than projections onto other sets that are derived from the given individual sets.

Their robustness, low computational effort and their ability to handle huge-size problems make them very useful for many convex and non-convex real-world problems such as Intensity-Modulated Radiation Therapy (IMRT) Treatment Planning as well as Sudoku and 8 Queens Puzzle.

The Superiorization Methodology is a heuristic tool and its goal is to find certain good, or superior, solutions to feasibility and optimization problems. In many scenarios, solving the full problem can be rather demanding from the computational point of view, but solving part of it, say the feasibility part is, often, less demanding.

fbeen developed and applied successfully to feasibility, single and multi-objective optimization.

In this talk I will provide an overview on the above concepts, present several theoretical and practical results and also potential direction for future research.

Dr. Chiara Paganelli, PhD, Assistant Professor at the Department of Electronics, Information and Bioengineering at Politecnico di Milano, Italy.

Chiara Paganelli, PhD, is currently Assistant Professor at the Department of Electronics, Information and Bioengineering at Politecnico di Milano, Milano, Italy.

She obtained the Master degree in Biomedical Engineering at the Politecnico di Milano (Italy) in 2011 and the PhD degree in Bioengineering (with honours) at the same institution in 2016. Her research interests are focused on advanced image processing and image-guidance in radiation oncology to improve cancer treatment.

Her main activities include image-guided radiotherapy, with a specific focus on MRI-guidance for organ motion management and treatment personalization and optimization in both conventional and particle radiation therapy, and imaging biomarkers and Artificial Intelligence for personalized medicine. Her dedication and experience on the topics are confirmed by a productive publication record in high impact journals and her involvement in different national and international projects.

She is Professor of the course “Progetto [Informazione]” 5ECTS for Bachelor students and of the course “Technologies for sensors and clinical instrumentation [2]” 5ECTS for Master students, in Biomedical Engineering at Politecnico di Milano.

Deformable Image registration

Over the last few decades, deformable image registration (DIR) has gained popularity in image-guided adaptive radiotherapy for a number of applications, such as contour propagation, dose warping, and accumulation. The variety of proposed DIR algorithms is vast, ranging from well-known image-based iterative optimization processes to novel machine learning solutions.

However, proper validation of the available DIR algorithms from both a geometrical and dosimetric standpoint is mandatory to properly adopt this methodology into the clinical practice. This is even

more evident in case of particle therapy were steep dose-gradients are presents and where DIR inaccuracies need to be properly assessed.
In this talk, basic concepts of image registration will be presented along with different algorithms available in the literature. A specific focus will be also put on DIR validation to provide robust, reliable and accurate patient-specific strategies for DIR application in adaptive particle therapy.

Dr. Jan-Jakob Sonke, team leader Adaptive Radiotherapy, Netherlands Cancer Institute

Dr. Jan Jakob Sonke aims to develop and clinically validate adaptive radiotherapy strategies to individualize treatment.

Prof. Dr. med. Dr. Esther Troost Division Head of ‘Image-guided Radiooncology‘ of Helmholtz-Zentrum Dresden-Rossendorf, Dresden Co-Chair of Department of Radiotherapy and Radiation Oncology of University Hospital and Faculty of Medicine Carl Gustav Carus of the Technische Universität Dresden (UKD)

Esther Troost is an expert in image-guided high-precision therapy and contributes to the advancing field of individualized medicine in photon- and proton-based radiotherapy. To further promote and improve the impact of radiotherapy, it is essence of her work to foster interdisciplinary collaborations as well as bring new research findings into clinical application. Networking and outreach have been crucial for her success and numerous publications in international high-ranking journals as well as a couple of renowned prizes, such as the ESTRO Varian Award, reflect her clinically relevant and patient-oriented research.