ENLIGHT

HIGHLIGHTS

December 2018

PAGE INDEX

HIGHLIGHTS EDITORIAL TEAM
Petya Georgieva
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ENLIGHT COORDINATOR
Manjit Dosanjh

COVER:
2018 ENLIGHT meeting, London, UK

DESIGN & LAYOUT
Media Frontier

OUR LEGACY

FROM THE ENLIGHT COORDINATOR

Manjit Dosanjh

ENLIGHT is young but the success of our network can already be measured in terms of the legacy that we are leaving behind us. Indeed, since the beginning, this network has opened the way to initiatives that have contributed to shape the current scenario of radiooncology. Among the projects that have left a more visible mark is PARTNER, the EU-funded project we run ten years ago. PARTNER gave research and training opportunities to 29 young biologists, engineers, physicians and physicists and allowed them to go on developing modern techniques for treating cancer. Today, these researchers are spread world-wide and have very interesting stories to tell (pages 8-17). Their stories remind us of one of the pillars of our mission: educating the next generation of experts in particle therapy and expose them to state-of-the-art technologies as early as possible in their career.

Undoubtedly, another important achievement of our network are the strong links we have created among the different communities that compose ENLIGHT. They seem very "natural" and routinely applied now but, as Roberto Orecchia emphasises in his interview (page 22), they were definitely not a given when we started all this. What Roberto Orecchia describes in the article reminds us of what we need to accomplish our vision: traditionally separate communities can work together if they stay curious and creative but also pragmatic. A really exclusive blend of skills! Roberto's idea of a machine all radiooncologists are dreaming of will certainly trigger your curiosity.

In this issue we also report news from our Annual Meeting (page 4) that took place in London with a special emphasis on our young participants and their research, the meeting that was held in Archamps (France) to discuss the PIMMS 2 study, which is being supported by CERN (page 24), the workshops in Australia, home of Bragg the magic ingredient for hadron therapy (page 28), and in Lyon, the birthplace of very first use of radiation therapy for cancer treatment (page 30).

Since this issue goes out at Christmas time, I would like to extend my best wishes to all our members and their families for a Merry Christmas and a Happy New Year! Next year is already full of events for our community (page 27) and of course let me remind you of our next annual meeting, which will be held in Caen (France) from 1 to 3 July, 2019.

As usual, I would like to conclude by thanking all the contributors and people in my team for their continued support, which makes it possible for us to share information among the members. I wish all of you an interesting reading! ■

Manjit Dosanjh

NEWS

2018 ENLIGHT LONDON MEETING IN FOCUS

NEWS

ENLIGHT TRAINING DAY 2018

ENLIGHT dinner on the River Thames

This year, the European Network for Light Ion Hadron Therapy Annual Meeting and Training was hosted at University College London Hospital (UCLH) in the UK. UCLH, one of only two centres supported by the UK National Health System that will be offering proton beam therapy (PBT) in the near future, recently had its cyclotron lowered in to one of the deepest holes in central London.

At the beginning of the Training Day, we were guided to the Cruciform Building, a stunning Grade II listed building located in the heart of London. Greeted with delicious pastries, biscuits and coffee, the morning session began with an eloquent and welcoming introduction from Prof Manjit Dosanjh. This was promptly followed by talks from Richard Amos and Dr Yen-Ching Chang on the physics and clinical potential of protons, and their context in ion therapy treatment.

The Operational Lead of proton therapy physics at UCLH, Andrew Poynter, proceeded to give us an exciting update on the UCLH project: the developments in the construction of the new proton centre, and the required training of the staff to deliver the new modality of treatment.

Over the extended lunch break was the poster session. Within the Cruciform Building was a showcase of a variety of scientific posters submitted by attendees of the meeting presenting particle therapy related research projects. This proved to be an excellent opportunity to network, learn first-hand about other groups' exciting research and quiz the authors.

Following lunch, the practical session of the day involved a hands-on demonstration of Eclipse treatment planning software, provided by Reynald Vanderstraeten from Varian Medical Systems. This session covered the impact and handling of range uncertainty in proton therapy planning, and the differences between robust and planning target volume optimisation. This exercise was a particularly valuable experience for myself as I am a medical physics PhD student with research interests in uncertainties in treatment planning.

The final workshop of the day was centred around the important topic of clinical trials in proton therapy. We had an introduction to the CTRad strategy for PBT trials in the UK from Prof Phil Evans and Maria Hawkins, and Gemma Eminowicz presented us with the design and challenges of proton vs. photon clinical trials. Helen Bulbeck gave us a particularly thought-provoking review of patient perspectives of proton therapy, and what it means to the general public following media coverage.

Johnny Lee of Radiotherapy Trials Quality Assurance (RTTQA) then gave us an entertaining and engaging understanding of the role of quality assurance in clinical trials, and Rush Patel provided an overview of the big data platforms and analysis in radiotherapy trials.

The day ended with a beautiful welcome reception in the cloisters of the main UCL campus, with angelic choral entertainment provided by local organiser Dr Simon Jolly. The sun set gracefully over UCL's signature Corinthian portico, and we were very excited for the next two days of the meeting. ■

Megan Zoë Wilson, University College London | UCL

Young women scientists who took part in the ENLIGHT meeting

Discussions after the training day

The Fortress of Caen, Wikipedia

ENLIGHT ANNUAL MEETING JULY 1-3, 2019 FRANÇOIS BACLESSE CENTRE, CAEN, FRANCE

Organisers : Jacques Balosso, Daniel Cussol, Manjit Dosanjh, Siamak Haghdoost, Yannick Saintigny, Juliette Thariat, Samuel Valable

NEWS

Mont-Saint-Michel, Normandy, France

July 2019 will see the annual ENLIGHT meeting taking place in Caen in Normandy, France, hosted by the University and the Cancer Centre François Baclesse of Caen. This location has been chosen because Caen is hosting the third particle therapy centre of France, which opened to patient treatments in protontherapy at the end of July this year. Two other centres, in Orsay and Nice, have been operating for 27 years. So, at the time of the meeting in Caen we will have a one-year experience to share with the participants.

This Centre, named CYCLHAD has a "one room protontherapy equipment" with a half revolution gantry of the Proteus®One type. Actually, it is a far more ambitious project since the building has been sized and built to host a second accelerator the C400, of a new type, to provide light ions in three different experimental rooms by the year 2023. It will by an isochrone super conducting cyclotron able to accelerate protons, He, Li, B, C, N, O and Ne. Associated to the 4 beams/rooms of CYCLHAD, five hundred square metre laboratories will be equipped to welcome local and visiting scientific teams. The CYLHAD centre will hopefully become a valuable centre for experimental and clinical application of light ions over a large scale of variety.

The new CYCLHAD centre in Caen

Caen and the Normandy Region are managing this project in a rather favourable landscape including two university hospitals and two cancer centres in Caen and Rouen, the well-known research centres GANIL and CYCERON respectively for nuclear physics and medical imaging of brain diseases.

The ENLIGHT meeting will start on Monday 1st July with a training day focusing on "How to produce clinical data to demonstrate the medical efficacy and utility of hadrontherapy". This will be followed on Tuesday 2nd and Wednesday 3rd July by the two-day ENLIGHT meeting.

The training day will present topics on the currently most critical item in particle therapy: the need for medical clinical data. Principles of clinical trials and advanced techniques for medical assessment will be presented and discussed.

The two meeting days will include fundamental topics on physics, radiobiology including RBE determination, biology of radioresistance, quality assurance of beam path, advanced cyclotron technology, advanced positioning, ongoing clinical trials, etc.

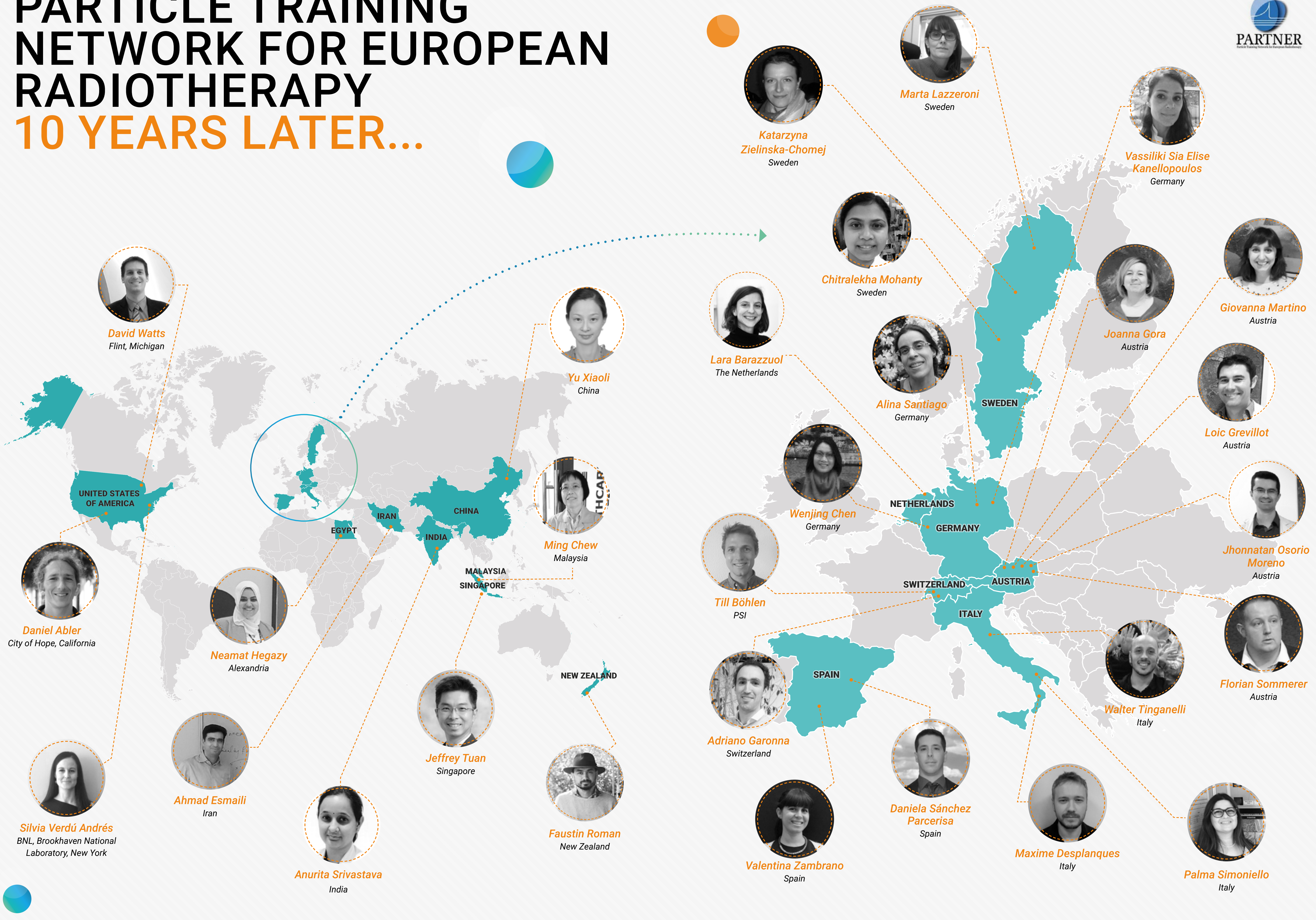
The ARCHADE organising team is very happy to welcome the ENLIGHT community to Normandy and looks forward to an informative, productive and friendly discussion. ■

Jacques Balosso, Archade

PERSPECTIVE

PARTICLE TRAINING NETWORK FOR EUROPEAN RADIOTHERAPY

10 YEARS LATER...



PERSPECTIVE

PARTNERing in South-East Europe

One of the early projects of ENLIGHT was PARTNER, a 4-year Marie Curie Training project funded by the European Commission. For the first time, ten academic institutes and research centres and two leading companies were collaborating under the PARTNER umbrella to form a unique multidisciplinary and multinational European network. The project had the challenging goal of offering research and training opportunities to 25 young biologists, engineers, physicians and physicists and allow them to go on developing modern techniques for treating cancer.

Today, 10 years after the beginning of the project, the young researchers trained within PARTNER have become leading experts in various European hospitals, hadrontherapy centres or research institutes. Over the years, they have established a long-lasting network of specialised collaborators and they have continued to build expertise and train new researchers. In addition, the PARTNER's heritage is now becoming a model, which can be used to build expertise in other parts of the world and, in particular, in South-East Europe.

In many aspects, the current situation in the South-East Europe area presents analogies with the rest of Europe when, more than 10 years ago, ENLIGHT contributed to build the future of hadrontherapy. Today, in South-East European countries there is a strong political and scientific motivation to build a hadrontherapy centre which will allow patients in the region to be treated locally. However, similarly to central Europe several years ago, there is a lack of local expertise and the difficulty to create links with experts spread across the rest of the world. To address the situation, the PARTNER project introduced a novel approach: starting building expertise by training young researchers.

Indeed, the common aim of the countries involved in the project of the South-East European hadrontherapy centre is to build competence, stop the brain drain, collaborate for a common good and, also, bring unity and peace. The ultimate goal is to bring state-of-the-art cancer treatment in a region where even conventional radiation therapy is not so common. The current vision for the new hadrontherapy centre includes its use as a particle accelerator for research for 50% of the beam time. This is an important aspect of the project as it will help the whole scientific community to grow and develop. In addition, such a potential would attract scientists from other regions where beam time is entirely devoted to treatment and research cannot be carried out on site. The centre will become a powerful network hub to connect the South Eastern European countries with the rest of Europe.

Looking back at the ideas that the PARTNER project brought in and the path shown by visionary scientific endeavours such as SESAME, one can be confident that the centre will be a fantastic opportunity for the entire region to benefit the whole society, including patients, physicians and scientists, with one common initiative.

LARA BARAZZUOL

THEN → **NOW**
University of Surrey → *University Medical Center Groningen, the Netherlands*

In 2016 Lara Barazzuol established her own group within the Department of Radiation Oncology at the University Medical Center Groningen (UMCG), in the Netherlands. Her research focuses on assessing the effect of radiation on the brain and aims to achieve an improved biological and molecular understanding of radiotherapy-induced neurocognitive dysfunction. Highlights from her career to date comprise several peer-reviewed articles and young investigator awards, including the 2012 Mercia Award in Medical Engineering, the 2015 British Institute of Radiology Nic McNally Award, the 2017 Adrian Begg Award and the 2017 Bas Mulder Award. Lara Barazzuol is currently project leader on grants from ZonMW and KWF (Dutch Cancer Society).

TILL BÖHLEN

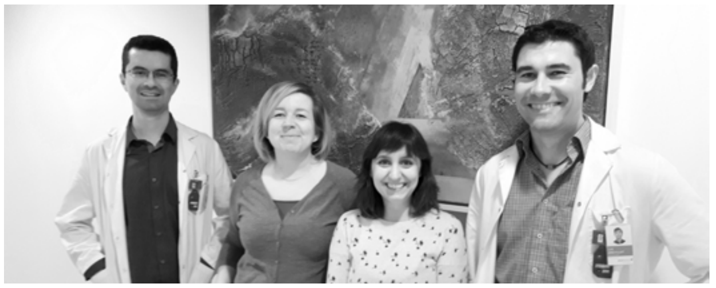
THEN → **NOW**
CERN → *PSI, Switzerland*

Till Tobias is a Swiss certified Medical Physicist (SGSMP), after having already the Austrian certification. He is working as Medical Physicist at PSI, specialized in TPS and workflow and lead in scripting. He is also lecturer at Applied University Wiener Neustadt. Till Tobias has contributed to the successful commissioning of three proton rooms (the first two rooms at MedAustron and Gantry 3 of PSI).

NEAMAT HEGAZY

THEN → **NOW**
Ebg MedAustron → *Alexandria University, Egypt*

Neamat is currently lecturer of clinical oncology department at Alexandria University, Egypt. She is also consultant of brachytherapy in Future hands Hospital, Alexandria. In her words: "The knowledge acquired from my supervisors during training in Vienna in the different areas of light ion beam therapy, and radiotherapy in general has been very important to me! The PARTNER program has been a very important starting point in my career. This is a very unique experience and I am very grateful to ENLIGHT for that!" Today, Neamat shares her knowledge with her juniors' colleagues in her home university and has started new research projects in proton therapy.



We are working at the MedAustron light ion beam therapy facility, located in Wiener Neustadt, Austria and we are all part of the Medical Physics department. Patient treatments started at the end of 2016 with the first horizontal proton beam line. Today we are routinely treating about 25 patients per day in two rooms with three proton fixed beam lines (two horizontal and one vertical). We are involved in all aspects of medical physics: beam delivery, treatment planning, medical software, patient positioning and imaging systems. Currently, on top of ensure routine proton treatments, we are starting-up the commissioning phase of the first horizontal carbon ion beam line. This is a very exciting time and we are looking forward to the first carbon ion treatments in summer 2019! The PARTNER program has been an amazing starting point in our careers. The knowledge acquired by each of us in the different areas of light ion beam therapy and the PARTNER network developed have been very useful! It allows us today to implement light ion beam therapy treatments at MedAustron. This is a very unique experience and we are very grateful to ENLIGHT for that!

JOANNA GORA
THEN *University of Surrey*

LOIC GREVILLOT
THEN *IBA (Ion Beam Applications)*

GIOVANNA MARTINO
THEN *GSI*

JHONNATAN OSORIO MORENO
THEN *CNAO*

NOW: *MedAustron - Austria*

JEFFREY TUAN

THEN → **NOW**
CNAO → *National Cancer Centre Singapore*

Upon returning from CNAO, Jeffrey went back to his usual routine of managing patients in the National Cancer Centre in Singapore, which takes care of 60% of the country's cancer patients. The center will relocate to a new, bigger and better cancer center in 2022, which will also include a state-of-the-art Proton Beam Therapy Centre. Jeffrey's current role as proton beam therapy technical lead includes selecting the equipment as well as developing clinical treatment protocols for patient treatment. In his own words: "The training that I received with PARTNER really helped to prepare me for this current role. It is also through this same network that we can forge future training and collaboration connections."

DAVID A. WATTS

THEN → **NOW**
TERA Foundation → *McLaren Health Care, Flint, Michigan, USA*

David is currently working as an independent consultant in the United States. He collaborates with companies to develop proton therapy systems. One of the facilities David is currently working on is scheduled to treat a first patient before the close of 2018. It makes use of a compact proton synchrotron which can deliver protons up to 330 MeV to three patient treatment rooms, each with a 180-degree gantry. David has recently started his own consulting company in Canada and has developed a particle physics card game whose rules mimic the principles of Particle Physics and the Standard Model. ■

DANIEL ABLER

THEN → **NOW**
CERN → *Beckman Research Institute, City of Hope hospital, Southern California (USA)*

After his Phd, Daniel joined the computational bioengineering group in the medical faculty of the University of Bern (CH) as post-doctoral research fellow. His work integrates approaches from mathematics, physics, and engineering to build patient-specific computational models. In June 2017, Daniel joined the Glims project (http://glims.ch) as Marie Skłodowska-Curie Global fellow. The project aims to investigate the effect of biomechanical forces on formation and development of brain tumors using image-based computational models of tumor growth and tissue mechanics. Daniel is currently based in Southern California (USA) and works in the Mathematical Oncology group of the Beckman Research Institute / City of Hope hospital in Duarte. ■

WALTER TINGANELLI

THEN → **NOW**
GSI → *Trento Institute of Radiological Sciences (TIFPA), Italy*

After completing his Ph.D., Walter moved to Japan where he worked at the National Institute of Radiological Sciences (NIRS), in the Framework of the International Open Laboratory. For the last three years he has been working in Italy, at the Trento Institute of Radiological Sciences (TIFPA). He coordinates with my TIFPA colleagues, various projects, among which a hibernation project that could have relevant applications also in radioprotection. About his participation in PARTNER, Walter remembers his days as PARTNER researcher in Germany: "PARTNER Project was an opportunity to establish a network of friends, first of all, and colleagues, which still today are an important radiobiology European network." ■

PALMA SIMONIELLO

THEN → **NOW**
GSI → *University of Naples Parthenope, Italy*

Palma is a senior Research Scientist at the Department of Science and Technology (DiST) of University of Naples and she is expecting to start a permanent position as associated professor in Cytology and Comparative anatomy. Her current research focuses on radiobiology and particle therapy. She is currently involved in international projects with Walter Tiganelli, another PARTNER researcher. When Palma is not in the lab or behind a microscope, she is in the classroom teaching "Developmental Biology and Animal phylogeny" and "Cytology and Histology" to students of the Degree Course of Biology at University Parthenope in Naples. ■

CHITRALEKHA MOHANTY

THEN → **NOW**
Karolinska Institutet → *Human Protein Atlas, Sweden*

Chitralekha works as production engineer at Atlas Antibodies, the commercial part of Human Protein Atlas project. The company handles the production, marketing and sales of research tools developed by the Swedish-based Human Protein Atlas program. Chitralekha works with recombinant protein expression and purification with affinity chromatography. In her own words: "I believe that the knowledge and experience gained during the project is going to help me in all my future endeavors. It has been a wonderful learning program to be in this multidisciplinary project where, I got the opportunity to interact with brilliant scientists of different scientific background." ■

DANIEL SÁNCHEZ PARCERISA

THEN → **NOW**
Siemens Healthcare → *Universidad Complutense de Madrid, Spain*

Daniel is currently a MSCA IF Fellow at the Universidad Complutense de Madrid working on ionoacoustic range verification of proton beams and development of contrast agents for PET and PG proton range verification. He also teaches several courses at the Faculty of Physics of the University and collaborate with the particle therapy centers under construction in Madrid. ■

MING CHEW

THEN → **NOW**

University of Surrey → *Centre for Biomedical Physics, School of Healthcare and Medical Sciences, Sunway University, Malaysia*

Ming Chew is currently employed as a Lecturer at the Centre for Biomedical Physics, School of Healthcare and Medical Sciences, Sunway University, Malaysia. As a lecturer, Ming Chew teaches undergraduates, does research related work, supervises postgraduates' students, deals with funding applications and proposes new undergraduate degree courses. For research work she collaborates with public and private hospitals, local and international nuclear agencies and local private institutes that deals with radiation equipment. Although, she does not have the opportunity to be directly be involved in particle radiation due to the country economy, she is still inspiring and motivating students to pursue particle radiation. ■

ADRIANO GARONNA

THEN → **NOW**

CERN → *TERA Foundation, Switzerland*

After the PARTNER programme, Adriano went on to design a new LEIR slow extraction system and beamlines for biomedical research. In 2014, he moved to the MedAustron therapy center in Austria, where he led the accelerator commissioning activities for proton medical therapy until 2016. Back to CERN, Adriano became the Technical Director for the TERA Foundation. In the last two years he was involved in several studies including the mechanics and optics design of a normal conducting gantry for protontherapy and a feasibility study for the expansion plan of CNAO. Adriano thinks that the knowledge acquired during the PARTNER project was instrumental to his career. ■

ALINA SANTIAGO

THEN → **NOW**

CNAO → *University Hospital Essen, Germany*

Alina joined the PARTNER project only for three months. And yet, those three months that she spent at CNAO in 2012 allowed her to get an excellent insight in all relevant aspects of Medical Physics for particle therapy. When she came back to Marburg, Germany, Alina did her PhD in particle therapy treatment planning for lung tumors. In the beginning of 2019 she will move to Essen, in order to join the team setting up the clinical programme for proton therapy treatment of thoracic tumors at the University Hospital, in cooperation with The West German Proton Therapy Centre Essen. ■

AHMAD ESMAILI

THEN → **NOW**

CNAO → *Graduate University of Advanced Technology, Iran*

Within the PARTNER project, Ahmad worked at the Clinical Bioengineering Unit of CNAO Foundation in Italy to assess the performance of Patient Verification System and the Patient Positioning System. After that, he came back to his hometown in Iran and became a member of Medical Radiation Division as assistant professor. At Kerman Graduate University of Advanced Technology (KGUT) he did serious efforts to establish two new courses as Medical Radiation Engineering course and Application of Radiation course by taking required permissions from Ministry of Sciences, Research and Technology. Ahmad also was as head of Medical Radiation Division at Graduate University of Advanced Technology for almost 2 years. ■

SILVIA VERDÚ ANDRÉS

THEN → **NOW**

TERA Foundation → *Broohkaven National Laboratory (BNL), New York, USA*

After completing her PhD, Silvia joined the Collider-Accelerator Department of Broohkaven National Laboratory (BNL, New York, USA) to work on the crab cavities for the High Luminosity upgrade of LHC (HL-LHC). Since 2016 she is in tenure-track at BNL developing crab cavity systems for the future particle colliders HL-LHC and eRHIC. In this time, she have supported the design, fabrication and testing of several radio-frequency, superconducting crab cavity prototypes. For Silvia, "PARTNER was a nurturing platform that provided me with great tools to work on international projects involving multi-disciplinary, culturally diverse teams." ■

VASSILIKI SIA ELISE KANELLOPOULOS

THEN → **NOW**

CNAO → *University Hospital of the Technical University Munich, Germany*

After her fellowship at CERN, Vassiliki stayed at home for three years enjoying her two wonderful little girls (the first was born during, the second at the end of her time at PARTNER). In 2015, she started working at the university hospital of the Technical University Munich (Klinikum rechts der Isar) in the department of radiooncology. Today, she is a senior medical physicist and hold a permanent position working mainly in clinical routine which includes treatment planning, patient and machine quality assurance, commissioning of new machines/software and imaging. For her: "PARTNER was an amazing experience and I have met so many wonderful people and friends during that time." ■

VALENTINA ZAMBRANO

THEN → **NOW**

Ebg MedAustron → *Aragon Institute of Technology (ITAINNOVA), Spain*

Valentina is currently holding a Post-Doc position, started one year ago, at the Aragon Institute of Technology (ITAINNOVA), in Saragossa (Spain). ITAINNOVA is a non-profit public institution that directly depends on the Innovation Research and University Department of the Aragon Government, mainly focused on research and innovation for both public and private areas. Valentina is currently focusing on data analysis and model order reduction strategies, combining software development together with tensor and matrix decomposition methods applied to different fields, such as fluid-dynamics, thermodynamics or mechanics. ■

MAXIME DESPLANQUES

THEN → **NOW**

CNAO → *Varian Medical Systems - Italy*

After the PARTNER project, Maxime went on to do a PhD in bioengineering focused on particle therapy, based at the CNAO (Pavia, IT). After his PhD, Maxime left the research field to work for Varian Medical Systems in Milan (IT) where he am still working as a medical physicist for the physics European Helpdesk. More specifically, he is covering the physics customer support for the dose calculation algorithms inquiries, related to the Varian's Treatment Planning System (Eclipse), for photons and also protons. In his words: "The experience and background I gathered during the PARTNER project has been very helpful to resolve practical and clinical issues." ■

FAUSTIN LAURENTIU ROMAN

THEN → **NOW**

CERN → *Medical IT Advisors/Patients First, New Zealand*

Faustin is currently in Auckland, New Zealand, enjoying life with his wife and his 3 kids. He is Director of Medical IT Advisors, a company he founded 2 years ago, and CIO of Patients First, a not-for-profit company that focuses on health information governance, risk and compliance, information security, digital transformation and emerging technologies. He also recently initiated and now chairs the first New Zealand Health Cybersecurity and Privacy industry group and won the first Maori hackatron with one of his other idea/start-up on blockchains. He is convinced that "none of this would have happened without the awesome PARTNER multi-disciplinary training and network!" ■

MARTA LAZZERONI

THEN → **NOW**

Karolinska Institutet → *Stockholm University/Karolinska Institute, Sweden*

Marta is a lecturer and researcher at Stockholm University and Karolinska Institute. After finishing the PhD within the PARTNER project, she worked four years as Post-Doc within another European network called cancerARTFORCE. Meanwhile, she also studied to be a licensed Medical Physicist. Functional imaging has been the leading thread of her research ever since the PARTNER project. Currently, her research focuses on the assessment of the tumour responsiveness to radiation and aims at identifying parameters to predict the treatment outcome at an early stage of radiotherapy in order to contribute to the development of a practical solution for a truly optimized and adaptive treatment planning strategy. ■

ANURITA SRIVASTAVA

THEN → **NOW**

CNAO → *Maulana Azad Medical College, India*

Anurita is currently working at Maulana Azad Medical College in Delhi, a teaching public hospital where she trains young radiation oncologists the 'art' of radiotherapy. Anurita also helped establish framework for data entry and record keeping, initiated a systematic academic programme, supervised the establishment of brachytherapy services apart from the regular clinics and treatments. In her words: "Being part of PARTNER project helped me realise and appreciate the immense effort put in by each individual involved in establishing different aspects of a 'new' technology. Earlier, I had not worked with biologists or engineers or computer geeks, and I can only thank my PARTNER friends for enriching my knowledge." ■

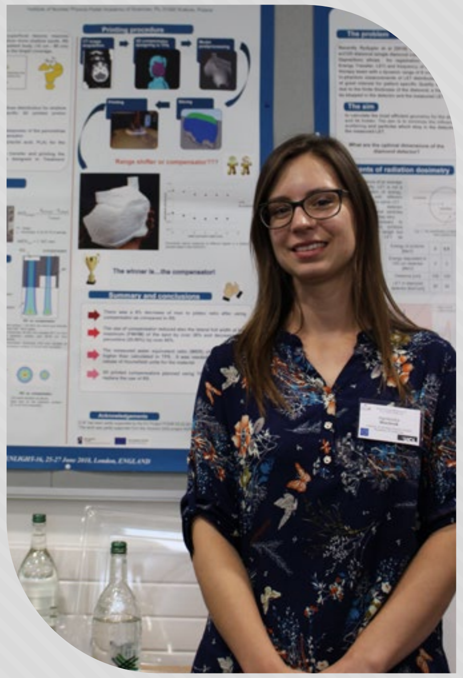
WENJING CHEN

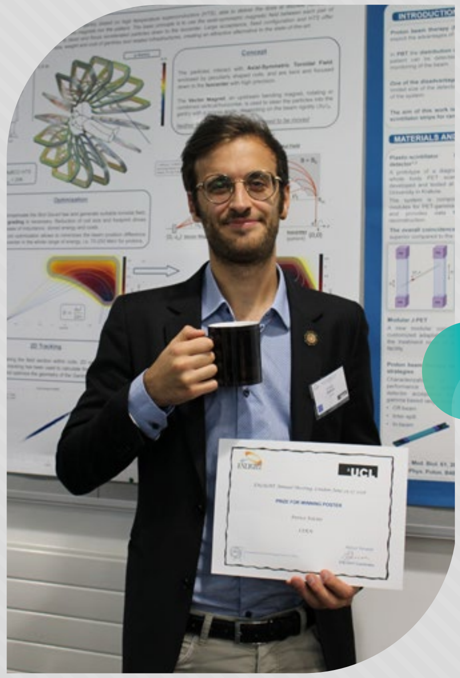
THEN → **NOW**

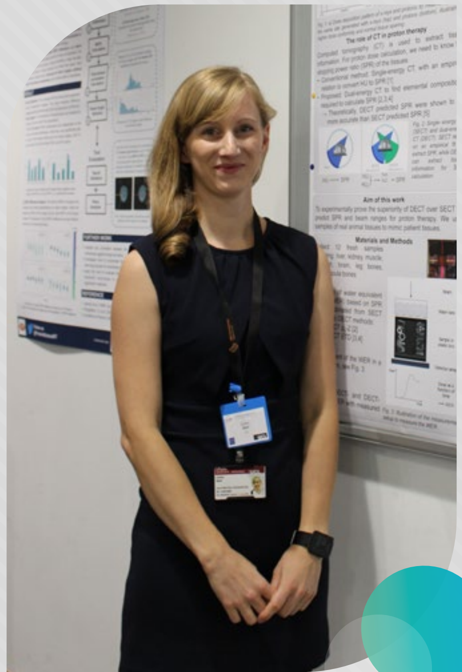
Siemens Healthcare → *DEXIN Med GmbH, Germany*

After the PARTNER project, Wenjing left Siemens and moved to Heidelberg where she continued to work as a PhD student and with a PostDoc until the end of 2016. Meanwhile, she enrolled in a part-time MBA programme to add some new skills. Since 2017, she has been working on a startup project for medical tourism. The company became a partner of Heidelberg University Hospital to develop the Chinese market, and provide non-medical services to Chinese patients. More recently, Wenjing has been working on an association (Sino-Europe Startups Association e.V.) to help new entrepreneurs in expanding network. ■

POSTER WINNERS







AGNIESZKA WOCHNIK

PhD student at the Institute of Nuclear Physics Polish Academy of Science (IFJ PAN), Krakow, Poland

FOCUS ON

PATIENT-SPECIFIC 3D PRINTED COMPENSATORS FOR PROTON PENCIL BEAM SCANNING OF SHALLOWLY SITUATED TUMOURS

"Like many young people in Krakow, who were involved in physics during their studies, I became fascinated with proton therapy. It was inevitable - day after day, a modern cyclotron center was being established in Krakow, the only such a center in Poland. During my studies I carried out my master's thesis in the subject connected with proton therapy. After graduation, I started my PhD programme in Proton Radiotherapy Group at the Institute of Nuclear Physics. That's how my adventure with protons and radiotherapy began, from the beginning combined with 3D printing technology.

Cyclotron Centre Bronowice (CCB) – as a part of IFJ PAN - is the national center of hadrontherapy in Poland. This is the only place in our country where patients are treated with protons. In 2011 the first ocular patient was treated with 60 MeV protons from the self-developed AIC-144 60 MeV cyclotron. In 2015 the new facility with the IBA proton cyclotron (70-230MeV) and two gantries with Pencil Scanning Beam (PBS) technology started the operation.

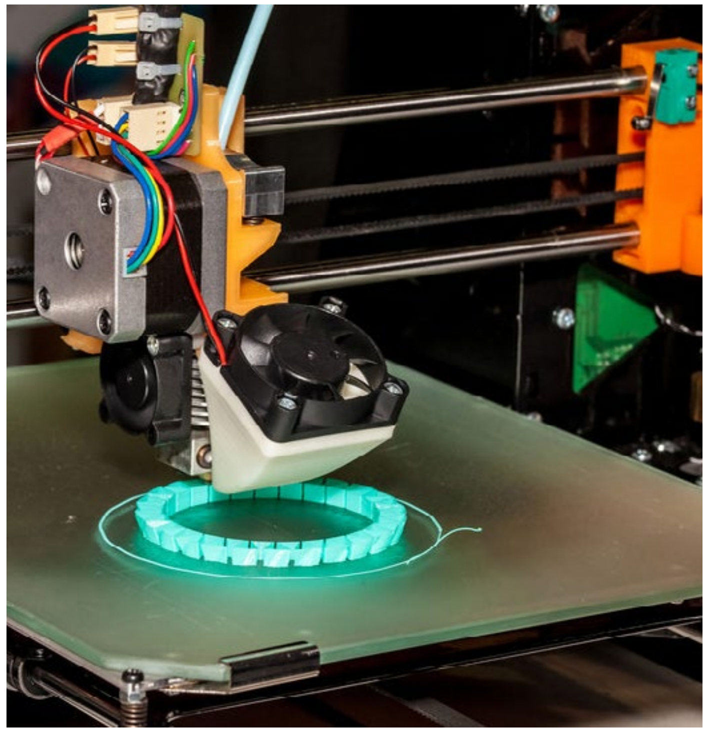
The irradiation of superficial lesions, especially in children, requires application of a range shifter (RS) to deliver more shallow spots. RS is situated at a certain distance from the patient's body. However, the scattered beam is not conformal enough. Despite the potential advantages of using protons, such treatment plans could not be applied.

Then, being under time pressure, we started to think about how to better compensate the energy of protons. Maybe the range shifter could be placed directly on the patient's body or even exactly matched to it? Such a solution would significantly reduce the beam spread after passing through the absorber and would improve the dose distribution. As a result of this discussion, a new way of treatment planning for such cases was started – application of patient-specific 3D printed compensators for proton PBS of shallow situated tumors.

At the ENLIGHT 2017 meeting I presented very early results of the first study – an established procedure for designing and printing the compensator. The use of the 3D printed proton compensator, attached to the immobilization mask reduced the spot size and in consequence the lateral penumbra (20-80%) by over 40%.

So far, two children have been treated with such compensators and the next compensator is in preparation. It is a great feeling to know that I have helped to provide treatment for young patients with difficult cases of shallow tumors.

We intend to conduct further research in this direction in order to better understand the properties of the materials used for printing. This will be the next stage of my adventure with protons and 3D printing technology."



Patient-specific 3D printed compensators for proton pencil beam scanning of shallow situated tumours

ESTHER BÄR

PhD student at University College London
UCL, Department of Medical Physics and Bioengineering

FOCUS ON

DUAL-ENERGY CT TO ESTIMATE PROTON STOPPING POWERS: A VALIDATION USING REAL TISSUES

"Proton therapy caught my interest during my training as a clinical scientist in Heidelberg, Germany. Since I first became aware of it, I was convinced that proton therapy is the future of radiotherapy. Although I strongly believed in it, I knew that there was room for improvement in order to make treatments better for the patients. While there are many ways to improve proton therapy, I chose to work on the imaging side.

Radiotherapy treatment planning, in general, requires a certain knowledge of the tissues that are in the beam's path. For radiotherapy with X-rays, the electronic densities of tissues are required for dose calculation. For proton therapy, however, the required tissue quantity is the stopping power (SP) of the material the beam is traversing.

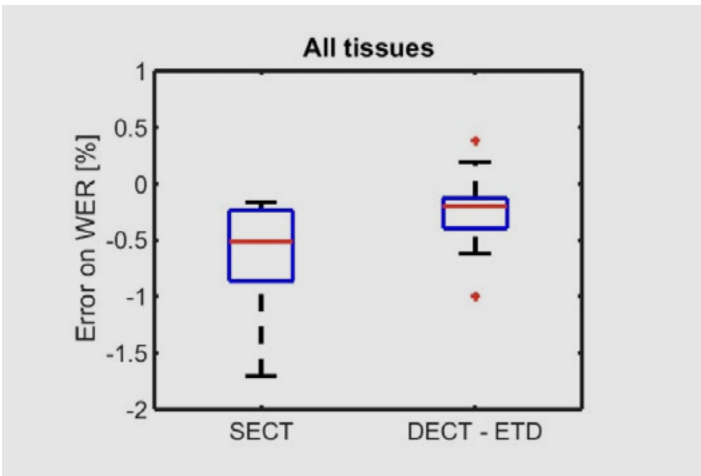
In current clinical practice, the SPs of human tissues are estimated from a single-energy CT (SECT) scan of the patient. The CT numbers are converted into an estimate of the SP by the use of a lookup table. This procedure, although robust, cannot consider inter- and intra-subject tissue variations, because there is no one-to-one relation between the CT numbers and the SPs.

To improve SP estimation, dual-energy CT (DECT) was suggested. With DECT, two CT images of the patient are taken simultaneously at two different energies. In this manner, more information about the tissues is available and it can be used to estimate the SPs of tissues. Several groups have suggested mathematical models to estimate SPs from dual-energy CT and proven their mathematical consistency as well as their theoretical superiority over SECT.

Before DECT-estimated SPs can replace SECT-estimated SPs for proton treatment planning in a clinical environment, the accuracy of DECT predicted SPs needed to be demonstrated. Also this proof needed to be performed in a realistic clinical situation with tissues instead of phantoms, precise measurement techniques and accurate beam simulation.

Together with researchers from the University College London (UCL), the University of Montreal and the Massachusetts General Hospital, we decided to take on this challenge. Under the supervision of Hugo Bouchard, Hsiao-Ming Lu, and Gary Royle, we developed an efficient measurement technique to measure the water equivalent range (WER) of a proton beam passing through animal tissue samples. We used twelve different soft tissue and bone samples and compared measured WER values to SECT- and DECT-predicted WER values. With this setup, we were able to show that DECT is superior to SECT in predicting SPs and beam ranges. In soft tissues, the errors on the predicted beam range were as small as 0.2% (as opposed to 0.5% with SECT), and in highly inhomogeneous bones we achieved an accuracy of 1.1% (1.4% with SECT). This strongly indicates that we should use DECT instead of SECT for proton therapy planning.

This project presents a necessary step towards implementing DECT for proton therapy planning and thus improving the accuracy of proton therapy. A continuous effort will be necessary in the future to improve imaging techniques for therapy planning and adaption. It's an exciting and inspiring field, with many challenges still to tackle and new imaging technologies emerging."



WER tissues

ENRICO FELCINI

CERN PhD student EPFL
Ecole Polytechnique Fédérale de Lausanne

FOCUS ON

MAGNETIC DESIGN OF NOVEL TOROIDAL GANTRY FOR HADRONTHERAPY

"I discovered superconductivity during my studies at the University of Bologna. I literally fell in love with this amazing physics phenomenon and its applications. After my master's thesis at CERN, supervised by the magnet group leader Luca Bottura, I had the chance to join Prof. Amaldi and his research group at TERA, working on hadron therapy: I fell in love for the second time. Could you imagine what happened when Luca proposed me to design and develop his new concept of superconducting Toroidal Gantry? The possibility of combining my passion and experience in superconductivity, with my interest and knowledge in medical applications? A dream come true!

Nowadays, the concept of proton and hadron therapy gantries is based on magnetic transfer lines rotating around the patient. The established technology results in bulky and massive structures, especially for heavy ions. Wonderful examples of engineering are the gantries of HIT, Germany, and Chiba, Japan. The latter uses superconducting magnets to increase the achievable magnetic field and reduce the size of the machine. However, the rotating nature of the gantry introduces significant complexity in terms of cryogenics and mechanical stability.

GaToroid is a new concept of gantry, based on fixed toroidal configuration, able to deliver the dose at discrete number of angles with neither rotation of the magnets nor the patient[1]. The basic principle is to use axial-symmetric magnetic field between each pair of coils constituting the torus to bend and focus accelerated particles down to the isocentre. The patient is placed inside the torus bore, similarly to an MRI configuration, but in null magnetic field. A single upstream bending magnet, rotating or combined vertical/horizontal, is used to steer the particles into the gantry with a proper angle, depending on the beam rigidity.

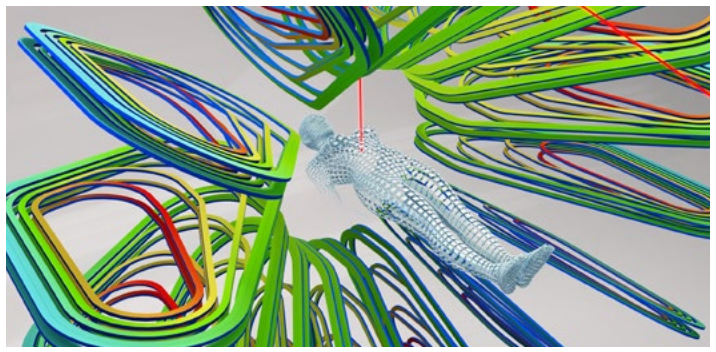
GaToroid works in complete steady state configuration: no rotation of mechanical parts and no variations of magnetic field. This feature allows one to push the potential of superconductivity to its limits, simplifying, at the same time, the cryogenics and the mechanics. Better conditions for superconductors means higher magnetic field and, therefore, strong reduction of size and weight. GaToroid can claim a very compact footprint, with a diameter of 3 metres for protons and 5 for carbon ions: less than half of the existing gantries!

Furthermore, GaToroid can accept incoming particles in a broad range of energies, covering the complete treatment of proton and carbons ions. The beam can be delivered at very high speed, without mechanical or electrical limitations of the gantry.

Large acceptance, fixed configuration and use of superconductors offer interesting reduction in size, weight and cost of gantries and related infrastructures, creating an attractive alternative to the state-of-the-art. The GaToroid concept opens the door to different approaches to therapy, creating new opportunities for imaging, monitoring and treatment.

After one year of PhD work, based on intense study and hard work, the dream of GaToroid is now more solid, becoming day by day closer to reality. What I am learning during these years has inestimable value: I am very thankful to Luca for this unique opportunity of technical and human growth."

[1] L. Bottura, "A Gantry and apparatus for focussing beams of charged particles," Patent, EP 18173426.0., May 2018



Novel gantry

MULTIDISCIPLINARY APPROACH: NOW IT WORKS, BUT...

Roberto Orecchia (next to the patient) in a treatment room at CNAO, where he is Scientific Director.

FEATURE

New clinical strategies often require accepting different ideas and approaches. This is not always easy and it might not be immediately successful but Roberto Orecchia, Scientific Director of CNAO and IEO, has never been afraid of introducing novel solutions into the clinic. "Any new drugs, tools or techniques need to demonstrate their positive effect on the patient," he clarifies. "This can be in terms of purely medical effects or even global sustainability. We have to remain open to new proposals but we also need to stay constructively critical in order to preserve the patient's right to have the best cure available for the specific disease."

This is true for common drugs such as antibiotics or painkillers, but also for huge paradigm changers such as hadrontherapy and high-tech imaging. The field has been developing fast in recent years but when ENLIGHT was established, the success of this approach was not a given. "On one side, we had physicists who were literally "in love" with the pure technology and could not see the big challenges it represented for the medical community and the reality of hospitals distributed world-wide. And, on the other side, we had the clinicians, biologists and life science experts who were sceptical towards new techniques that had not come out of the medical sector," says Orecchia.

Medical doctors are used to having a very pragmatic approach to new technologies, they measure feasibility in terms of actual outcome on patients. Fundamental research works on the assumption that physics laws govern the Universe and will, sooner or later, bring progress and development to society. Both approaches are valid and work for the good of people but they deal with different timescales, procedures and constraints. "In my career I have faced many times questions from colleagues who were not convinced that we should use a new technique or a novel technology," confirms Orecchia. "However, medicine is science and scientists must stay curious in whatever field they are. Curiosity is not always a given in the medical field but I was lucky enough to be able to create the "critical mass" needed to nurture new ideas and let them grow. Conservative approaches are not wrong as long as they ensure high standards to the patients. But innovation is only possible if we try to go beyond what we feel comfortable with because we have been doing it for many years."

Having an open-minded approach doesn't mean forgetting about the fundamental steps that medical doctors have to go through before they can possibly accept to change established treatments. "We need to make sure that the scientific rationale is strong, that we perform an accurate technology assessment and that we evaluate and validate the new technique by performing comparative clinical studies," points out Orecchia. "This is what we call evidence-based medicine and it's the irreplaceable guideline for all doctors."

When creating something totally innovative, the key to success is an inclusive strategy. The example of hadrontherapy is a very good one. "The use of protons in oncology was introduced by physicists who were doing their tests in their laboratories because they were sure that the fundamental gain introduced by the Bragg peak would have resulted in a positive outcome," explains Orecchia. "However, it took us several decades before the technique could really be accepted by the medical doctors and eventually brought to a large number of patients. And this happened effectively only after the two communities – physicists on one side and clinicians on the other – had been brought together and had talked to each other. ENLIGHT was instrumental to this strategy and we should be very proud of it."

Roberto Orecchia, Scientific Director of the CNAO Foundation (Italian National Centre for Hadrontherapy) Pavia, Italy

Because we now have learned many things from the past and the two communities have established solid links, we can design the future in a better way. "Medical doctors should be included "in the loop" at a much earlier stage by scientists who are developing new technologies for the medical field," confirms Orecchia. "For example, the dream machine of every radio-oncologist of today would be a multi-ion device. With such a device, we would ideally be able to select the most suitable type of beam for the specific tumour we have to treat and we would be able to tune the energy, set the most precise angle and choose the right dose to depose in the cancerous area."

We don't know whether such a machine will ever be built but, also thanks to multidisciplinary platforms such as ENLIGHT, we are now sure that we are well equipped to take on the common challenge and continue working together. ■

Antonella Del Rosso, CERN

NEW IDEAS FOR THERAPY WITH IONS

MA synchrotron

A virtual particle therapy centre

Particle therapy with ion beams is attracting increasing interest and new facilities for treatment and research are being planned. However, the cost, size, and complexity of these facilities are indeed hampering the widespread adoption of this treatment modality. The few centres operating with ions are collecting a wealth of invaluable information to advance the field, but they are based on technology developed in the past century. Can we consider making the accelerator smaller and possibly less expensive by adopting new accelerator technologies? Can the wider ion therapy community – accelerator and medical experts - agree on a set of parameters and basic requirement for a new generation of ion facilities? What is the experience from the present ion therapy centres and how can this be translated into the requirements for new facilities? To find answers to these questions sixty experts from all over the world met from 19-21 June 2018 at the European Scientific Institute (ESI) in Archamps, France, for a Workshop on "Ideas and technologies for a next generation facility for medical research and therapy with ions".

The workshop, jointly organised by CERN, GSI and ESI, focused on possibilities to advance towards the design for a next generation medical and research facility for ion therapy in Europe, devoted to both research with different ions and patient treatment.

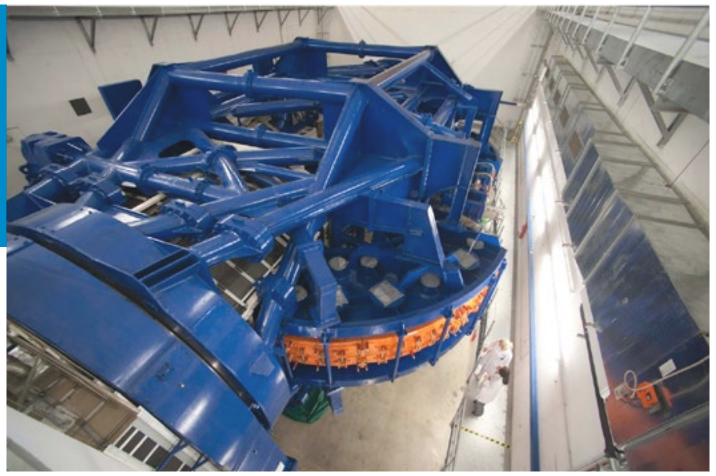
This workshop allowed experts of different related disciplines to share current experiences, identify potential directions for improvement, discuss synergies between medical accelerators and other accelerator projects, and exchange ideas for future facilities. Overall, the general requests for increased clinical efficacy and cost-effectiveness could be addressed with further research on radiobiology, accelerator and medical physics, with the needs of the patient being at the focal point.

The finite range of particle therapy offers superior conformity as opposed to conventional photon therapy. Tailored dose escalation and also the specific advantages of heavier particles are important to overcome radioresistant or hypoxic tumours, as has already been shown in a number of albeit rare head-and-neck cancers.

A major new field in all of cancer therapy is immune therapy. An important characteristic of tumour cells is their ability to hide from the immune system – but with recent advances in molecular biology, targeted drugs can re-activate the immune system and cause it to attack the tumour cells throughout the body. Ideally, this will defeat even smallest metastases, offering the potential of a true cure at least for a certain subset of cancer entities. A combination with radiotherapy can in principle enhance this immune stimulation, as the cells damaged by irradiation release DNA fragments, which can in turn lead to a targeted immune response. As the action especially of heavier ions on the DNA is fundamentally different to photons, more and more complex DNA fragments are produced, providing potentially a better immune stimulation. First hints on this increased synergy between immune stimulation and densely ionizing irradiation were already discovered, but this specific interaction and clinical implementation will be a major research field of the coming years. Research facilities offering flexible conditions for radiobiological research of immune-stimulating agents in animal models are needed. Ideally, these facilities will provide different ion species such as protons, Helium, Carbon and even heavier ions to study interactions with a wide variation in energy density.

There are clinical demands for faster, more efficient and flexible therapy that could also open up the possibility for routine treatment of the 'big killers' such as lung cancer. This includes availability of technically still challenging gantry systems for ions. Technical options for increased irradiation speed such as dynamic intensity control or the extraction of multiple energies from a single synchrotron cycle were already realized at HIT in Heidelberg and HIMAC, Chiba, Japan. The Japanese facility in particular demonstrates a highly efficient workflow for the therapy of moving organs, combining very fast irradiations with effective rescanning and marker-less gating for motion control.

While for protons and Carbon ions by far the most clinical experience exists, other ion species could be of interest. In the past, Neon ions were used at Berkeley, but were apparently too heavy, with projectile fragmentation leading to a worse ratio



Carbon Beam Gantry at HIT

of the dose in the entrance channel to the Bragg peak region. Oxygen on the other hand could offer a higher energy density in the Spread-Out Bragg Peak to combat hypoxia with acceptable entrance dose. The most interest currently focuses on Helium as the 'heavier proton'. Helium has a significantly minimised scattering compared to protons, far less fragmentation and less complex radiobiology than Carbon. It could thus possibly provide an ideal combination of small accelerators but still highly precise irradiation with especially a better lateral dose fall-off. Both species are available at the HIT facility for research purposes.

Large deficits in imaging exist especially in contrast to state-of-the-art photon therapy, where 3D imaging is seamlessly integrated in virtually every treatment. New options for image-guided therapy must be accommodated in the overall facility design but also by the accelerator. While in-room cone beam CT and CT-on-rails becomes more and more available in particle facilities, it is still not the standard as in photon therapy. This is true in spite of the fact that the precise irradiation with pencil beam scanning requires also more precision in patient setup and especially control of the beam range. Beam range estimation and monitoring of the beam itself in the patient is a major research topic. In-beam PET imaging of projectile and target fragments has been in use for several years, pioneered during the GSI pilot project. Faster imaging with at least the potential for adaptive therapy is offered by prompt emissions from nuclear reactions. First prototypes of a prompt gamma slit camera for range monitoring are in a clinical test phase, but also research on prompt particles is ongoing. How to incorporate such data into the treatment workflow is a further topic of medical physics research. The pinnacle of this development could be fast, adaptive particle therapy combined with online MR imaging and monitoring of prompt emissions to assess the beam range. This would finally enable a new realm of precisely eliminating tumours also in complex anatomical locations or moving organs.

As participants remarked, one could feel enthusiasm in the room, and could project on the enthusiasm at GSI where ion therapy has been pioneered since the early '90s. Leading figures of this initiative commented on their experience and recalled the day that the first patient was admitted for treatment – when, as an extra IT security measure, GSI switched off Internet connection across the site in order to prevent any external disturbance of the patient treatment.

The available designs of very compact single-room installations for proton facilities was presented as a good example for future developments for ion beams. These facilities were designed to be installed into existing buildings, fitting for example into two conventional photon therapy bunkers.

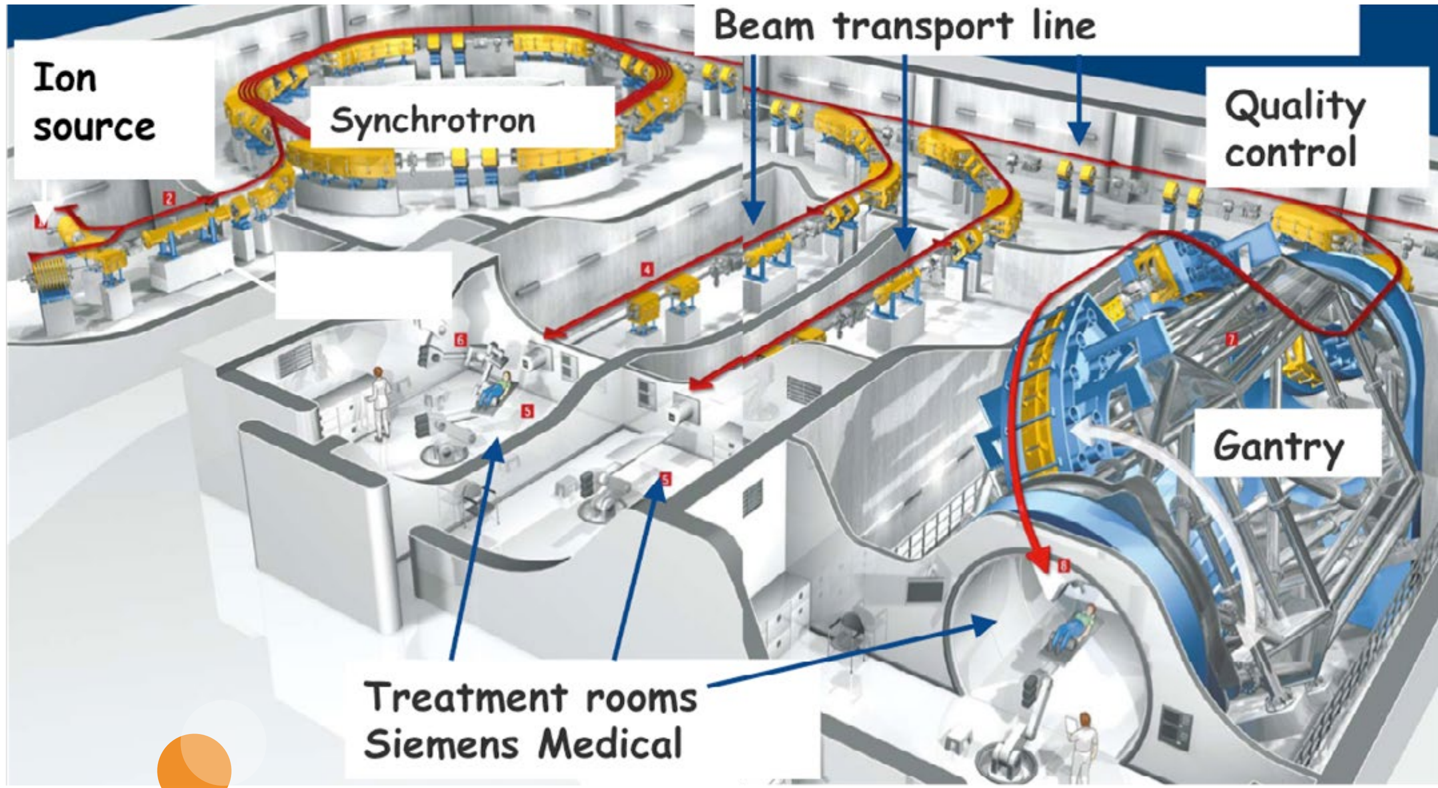
Two approaches for a next generation accelerator were discussed. An option relying on proven delivery schemes could be based on a super-conducting synchrotron. First design studies have already been conducted in Europe and in Japan, where experience from the design of a super-conducting gantry clearly indicated the possible reduction in size. Another option could be to explore novel approaches such a high repetition frequency Linac-based design. Also, for this second option, theoretical studies and proposals exist, showing the potential of this solution. Especially intriguing could be the very fast change in beam energy in a Linac-design, which could even enable compensation of motion-induced range changes. Both avenues offer solutions, with potentially superior, but also more uncertain, results expected from revolutionary approaches.

The closing discussion session clearly showed that the workshop addressed important issues on ion therapy in a timely manner. In particular, the community sees the need for and is eager to proceed towards establishing a dedicated collaboration resulting in a proposal to the European Commission. Discussing the outline of a possible R&D programme brought up the benefits of a study comparing the linac- or synchrotron-based designs.

To further pave the way towards this goal, a dedicated meeting is proposed in 2019 with the aim to define a common set of parameters and to receive feedback from different potential contributors. The success story of particle therapy in general and also ion beams in particular with more than 20,000 patients treated will continue with further innovations driving the field. A continuing expansion of ion beam facilities in the world will depend - not exclusively, but to a high degree – on our ability to make it also a commercial success, with smaller, less expensive and patient-oriented facilities designed to tackle the challenges of future cancer therapy. ■

Maurizio Vretenar[1], Yota Foka[2], Christian Graeff[3]
[1] CERN, [2] GSI, [3] GSI

CNAO treatment room



HIT facility

NIRS Japan

AGENDA

NAME OF THE EVENT	DATE	PLACE OF THE EVENT
26 - 30 April 2019	ESTRO 38 Annual Meeting	*Milan, Italy*
10 - 15 June 2019	PTCOG 58 Annual Meeting	*Manchester, UK*
01 - 03 July 2019	ENLIGHT 2019	*Caen, France*
15 - 18 September 2019	ASTRO's 61st Annual Meeting	*Chicago, IL, USA*
27 October - 03 November 2019	2019 IEEE Nuclear Science Symposium and Medical Imaging Conference	*Manchester, UK*

AUSTRALIAN NATIONAL PARTICLE THERAPY SYMPOSIUM

Westmead Hospital in Sydney was the venue of the Australia's second national particle therapy symposium. The hospital is currently undergoing major transformation works.

The second Australian National Particle therapy Symposium was held in Sydney in early July. Delegates represented consumers, government agencies, regulatory and training bodies, health services, research organisations (including Trans Tasman Radiation Oncology Group Cancer Research) and universities across Australia, New Zealand and overseas. The Symposium aimed to make the clinical case for carbon ions as well as protons, and to explore the non-clinical as well as clinical research opportunities that a particle therapy facility including one with carbon ions, could bring Australia. National and international collaboration amongst the clinical and research communities was a strong theme throughout the Symposium.

The first proton therapy facility in Australia will be the Bragg Centre for Proton Therapy in Adelaide, expected to treat its first patients in 2022. Consortia of universities, Australia's Nuclear Science and Technology Organisation and academic teaching hospitals in Sydney, Brisbane and Melbourne have well developed business cases for particle therapy facilities, with the Westmead precinct in western Sydney aiming to include carbon ions as well as protons. There has been no national tender for a particle therapy facility in Australia and initiatives are being driven primarily by clinicians.

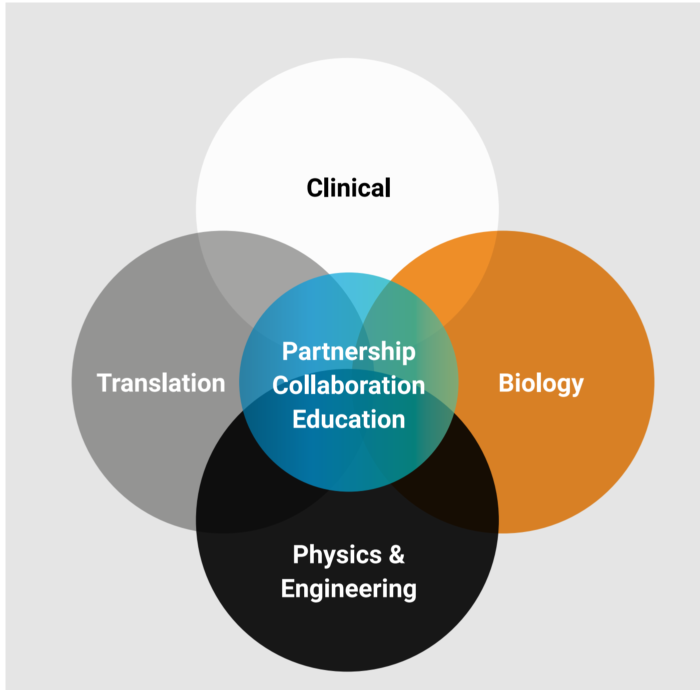
Evidence of benefit for particle therapy is accumulating and as slow adopters, Australian patients are missing out on this treatment. Professor Peter Choong (Chair of the Bone and Soft Tissue Sarcoma Service at the Peter MacCallum Cancer Centre in Melbourne) presented the reasons their service now refers some patients to Japan for carbon ion therapy. Professor Shannon MacDonald from Massachusetts General Cancer Center and Harvard Medical School and Dr Piero Fossati from MedAustron presented updates on the indications for treatment by proton therapy and selecting patients for treatment by carbon ion therapy, and well as the clinical research potential for these therapies. Dr Peter Urschutz provided an overview of how the MedAustron facility developed – from concept to clinical operation.

CERN was at the foundation of the Symposium. Professor Emmanuel Tsmeslis, CERN's Head of Relations with Associate Members and Non-Member States, explained CERN's role as a gateway to science, technology and innovation, and its mission to push back the frontiers of knowledge, develop new technologies for accelerators and detectors, train scientists and engineers of tomorrow and unite people from different cultures and countries. Professor Tsmeslis demonstrated Australia's existing links to CERN through the involvement of scientists from the Universities of Melbourne, Sydney and Adelaide in the ATLAS experiment. Professor Manjit Dosanjh, CERN's Medical Applications Senior Advisor and ENLIGHT Coordinator, illustrated CERN's involvement in medical applications through accelerating particle beams, detecting particles and large-scale computing. She also explained how ENLIGHT has leveraged physics collaboration into a multidisciplinary medical environment to identify challenges, share knowledge and best practice, harmonise data, provide training and education, innovate to improve and lobby for funding. Professor Dosanjh advised there is still need for radiobiology studies due to the paucity of long-term clinical data and gave practical advice on the requirements for a radiobiology facility as well as a wish-list for accelerator requirements. She informed the Symposium participants about the six work packages of the recently formed European Particle Therapy Network (EPTN). The mission statement of EPTN "to promote clinical and research collaboration between the rapidly increasing number of European particle therapy centres and toensure that particle therapy becomes integrated in the overall radiation oncology community" represents the vision for particle therapy in Australia. ■

Verity Ahern, Western Sydney Local Health District, Australia

COLLABORATION

- Training
- Peer review; recognise expertise and concentrate it
- Common treatment protocols
- Patient data linkages
- Research
- Establishing the next facility – lessons learnt
- Facility cost savings



The vision

Group photo of the participants

PROTON IMAGING WORKSHOP LYON 2018

On June 14-15 this year, a workshop focused on ion imaging took place in Lyon, France. It was attended by about 50 researchers from around Europe, the USA, and Southeast Asia. Attendance was free of charge thanks to funding through the EU's Marie-Curie fellowship program as well as the LabEx Primes network financed by the ANR. The participants ranged from medical physics experts from major proton therapy facilities, engineers and particle physicists with experience in detector design, to mathematicians specialized in inverse problems and image reconstruction. The event attracted experienced researchers as well as PhD students sharing their recent work. It was organized by Nils Krah and Simon Rit, both from the Creatis lab in Lyon, France.

The workshop setting was overall rather informal, with room for discussion, thus creating a very constructive atmosphere and facilitating a rich exchange of ideas. The first day was rounded up by a dinner in the beautiful center of Lyon with the interesting twist that the restaurant was actually part of a reputable gastronomy school. With the waiters bustling around everyone, it felt as lively as in some experimental hall at CERN.

A first session, dedicated to proton imaging setups, demonstrated that hardware is already quite advanced, with proton CT scanner prototypes being assembled in a clinical environment in the USA and a new generation prototype under development in the United Kingdom. An interesting alternative approach from Norway made use of hardware which was formerly used for a detector in a high energy physics experiment at CERN.

Several speakers presented work focused on data processing and tomographic image reconstruction. While the basic methodology is already established, several innovative approaches were proposed. To reconstruct more detailed information about the properties of the patient's tissue than is currently the case or to optimize the irradiation procedure in order to lower the dose to the patient while keeping the image quality at a sufficient level, being only two examples.

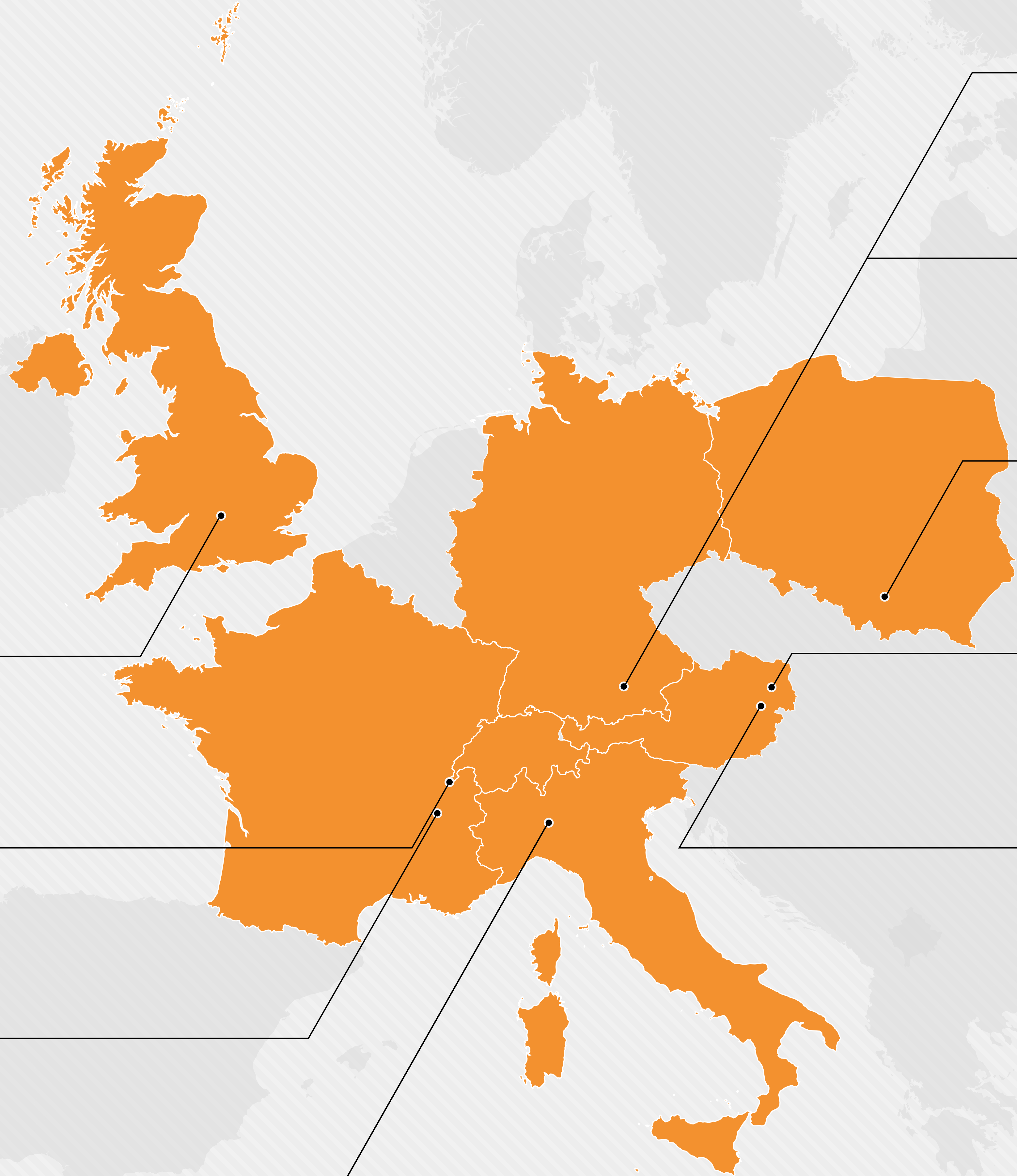
One session was dedicated to imaging with heavier ions, such as helium, carbon or oxygen, that are available in a few facilities around the world. When compared to protons, these particles have a more complex interaction with the human tissue and this brings along the need for dedicated post-processing methods. Recent developments in this direction were shared. It is noteworthy that some of the presented experimental work made use of the Medipix/Timepix detector which was originally developed at CERN.

A final session focused on efforts to realize proton imaging at comparatively low cost. Such systems make use of detector hardware that is often already available in proton therapy facilities and researchers showed that two-dimensional proton radiographic images can be obtained which could complement the currently available arsenal of X-ray imagery.

Motivated by the success of this year's workshop, a second edition is in preparation for 2019, in Manchester, UK. The event will take place during the educational session of the PTCOG conference and is therefore expected to attract the attention of even more experts in the field of hadrontherapy. More details will be announced through the newly created website ionimaging.org and interested people are invited to sign up for the ion-imaging mailing list (instructions can be found on the website). ■

Nils Krah, Simon Rit, Creatis lab - CNRS, Lyon, France

ENLIGHT Advisory Committee



Stephanie Combs
Radiation Oncologist,
Munich

Katia Parodi
Medical Physicist,
Munich

Pawel Olko
Physicist,
Krakow

Richard Poetter
Radiation Oncologist,
Vienna

Piero Fossati
Radiation Oncologist,
MedAustron,
Wiener Neustadt

Bleddyn Jones
Radiation Oncologist,
Oxford

Manjit Dosanjh
Biologist, CERN
ENLIGHT Coordinator,
Geneva

Jacques Balosso
Radiation Oncologist,
Centre François
Baclesse, Caen and
CHU, Grenoble

Marco Durante
Physicist and
Radiobiologist, Trento

THE EUROPEAN NETWORK FOR LIGHT ION HADRON THERAPY

A multidisciplinary platform aimed at a coordinated effort towards ion beam research in Europe.

The European Network for Light Ion Hadron Therapy (ENLIGHT), which had its inaugural meeting at the European Organization for Nuclear Research (CERN) in February 2002, today has more than 600 participants from nearly 25 European countries. Harnessing the full potential of particle therapy requires the expertise and ability of physicists, physicians, radiobiologists, engineers, and information technology experts, as well as collaboration between academic, research, and industrial partners.

The ENLIGHT network has been instrumental in bringing together different European centres to promote hadron therapy and to help establish international discussions comparing the respective advantages of intensity modulated radiation proton and carbon therapies. A major success of ENLIGHT has been the creation of a multidisciplinary platform bringing together communities that were traditionally separated, so that clinicians, physicists, biologists, and engineers work side-by-side. Special attention is also given to the training of young researchers and professionals of oncologic radiotherapy.

For more information and contact details please visit the ENLIGHT website at **cern.ch/enlight** (or scan the QR code)

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