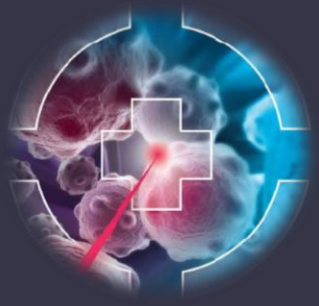


OMA Express
July 2018
Issue 7

Highlights

Identifying solutions for most pressing research challenges

The OMA scientific work packages beam imaging & diagnostics, treatment optimization and facility design & optimisation build bridges between research communities that should readily communicate with one another. Our network is actively helping establish new contacts and reinforce existing ones through a series of Topical Workshops. Our most recent one took us to CERN where participants discussed the challenges in beam and patient imaging. The 2-day event was ideal to review the state-of-the-art and identify the many overlaps in research challenges. The workshop saw excellent discussions and first collaborative R&D projects have already resulted from the event. All presentations are available online and can be accessed via the event indico page.

Our next workshop will now focus on the question how a treatment beam can best be imaged and how the required diagnostics can be best integrated into the machine. The dialogue between the instrument developers and accelerator designers will be important to further enhance the performance of existing and future treatment facilities. This topical workshop will be held at GSI in Germany on 11-12 December 2018. Registration will open shortly via our website.

Finally, I would like to say a big "thank you!" to COSYLAB for providing a special Academy to our Fellows between 6-8 June 2018. Whilst most of our Fellows are unlikely to become control systems specialists in the future, the detailed insight and opportunity for discussion with COSYLAB experts, provided a very welcome addition to the overall OMA training programme.

Prof. Carsten P. Welsch
OMA Coordinator

Research News

Radiobiological effectiveness of protons

OMA Fellow Anna Baratto Roldán, will present in August 2018 her first report on the status of her project "*Radiobiological effectiveness of protons*". This project aims to set up a new system for the irradiation of biological samples at the IBA cyclotron installed at the National Centre of Accelerators in Seville (Spain). This cyclotron is mainly used for the production of radioisotopes for Positron Emission Tomography (PET), but it is also equipped with an external beamline for interdisciplinary research, producing an 18 MeV proton beam or a 9 MeV deuteron beam.

The rationale behind Anna's project is given by the necessity of performing studies of proton Relative Biological Effectiveness (RBE) at low energies, which would help reaching a consensus on the variation of proton RBE near the Bragg peak. In current clinical practice, the RBE of protons is considered to have a constant value of 1.1, which means that protons are considered to be 10% more effective than photons [1] in the determination of the same biological effect. The use of a constant RBE value is an approximation, generally supported by the fact that the available biological data are insufficient to justify clinically the use of other proposed approaches [2-3]. There is, however, a large amount of data demonstrating that proton RBE is a complex variable, which depends on many factors, including tissue type, biological endpoint, dose and radiation [4], and which varies towards the distal Bragg peak region. Therefore, not taking into account the variations in RBE along the proton beam may have important clinical consequences [2-3][5].

To perform studies of proton RBE at low energies, dedicated beamlines are required, for which special beam optimization and dosimetric techniques are needed. At the National Centre of Accelerators (CNA) beamlines of this kind are available at the 3 MV tandem and the 18 MeV cyclotron facilities, which can be adapted to allow reliable measurements and cell irradiations at low proton energies. The spatial configuration of the two beamlines allows the irradiation of cells, growing in monolayer cultures placed in Petri dishes and mounted at the exit of the beamline, orthogonally with respect to the beam axis. With this configuration, two are the major constraints when irradiating biological samples: low beam intensity, of the order of some pA, to control properly the fluence within suitable irradiation time scales; and the irradiation field, which has to be broad enough, of the order of few cm to cover the whole sample, and homogeneous in both energy and spatial distribution.

In the case of the 18 MeV cyclotron external beamline, a simple beam line diagnostic and irradiation scheme, based on a completely defocused beam, external scattering foils and an ionization chamber coupled with EBT3 radiochromic films, has been used for the determination and measurement of the optimal beam parameters for radiobiology experiments. Measurements of the intensity profile have been performed using EBT3 radiochromic films and a transmission ionization chamber for proton fluence evaluation. Experiments have been done in different irradiation conditions, degrading the beam with tungsten scattering foils of different thicknesses, from 50 to 200 µm, and varying the distance between the exit window and the sample.

A homogeneous irradiation field, with maximum deviations around 8% in the whole sample area (3.5 cm of diameter), has been achieved for a beam energy of around 11 MeV and below, and with a feasible beam intensity. In parallel, Monte Carlo simulations of the beamline have been performed with the SRIM and Geant4 codes, to be compared and matched with experimental data.

These simulations reproduce quite well experimental data in what concerns beam profiles measured with EBT3 radiochromic films, with maximum deviations of about 13% and 9%, respectively. Future improvements of the beamline are still under study; different solutions such as changes in the collimation system or the installation of a system for the dispersion of the beam inside the beamline vacuum pipe are currently being considered.

References:
[1] International Commission on Radiation Units and Measurements, Prescribing, Recording and Reporting Proton-Beam Therapy, (ICRU Report 78), J ICRU (2007); 7.
[2] G. Giovannini et al., Variable RBE in proton therapy: comparison of different model predictions and their influence on clinical-like scenarios, Radiation Oncology (2016); 11:68.
[3] A. Carabe et al., Range uncertainty in proton therapy due to variable biological effectiveness, Physics in Medicine and Biology (2012); 57:1159-1172.
[4] H. Paganetti, Relative biological effectiveness (RBE) values for proton beam therapy. Variations as a function of biological endpoint, dose, and linear energy transfer, Physics in Medicine and Biology (2014); 59:R419-R472.
[5] M. Wedenberg et al., Disregarding RBE variation in treatment plan comparison may lead to bias in favor of proton plans, Medical Physics (2014); 41:091706.

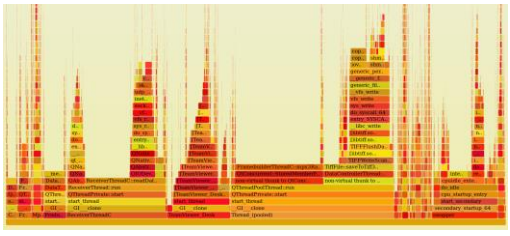
This work is related to OMA deliverable 2.14

Progress with Medipix3: Maximum readout and saving frame rate achieved

OMA Fellow Navrit Bal, who is based at ASI in the Netherlands, has carried out studies to increase the clock frequency of the readout system, SPIDR (Speedy PIxel Detector Readout) of the Medipix3 detector. He was able to demonstrate that the system can run at 200 MHz, resulting in a maximum frame rate for typical settings (12 bit frames, continuous RW mode) of 2,000 Hz. Previously, the readout software, Dexter, was operating at ~1,000 Hz without frame loss and could not save more than ~100 Hz, thus a very significant improvement was demonstrated.

A higher frame rate has a number of advantages for the application of the sensor: It allows imaging of fast moving objects or processes, imaging at very high flux or, if the flux is low enough and each radiation event makes clusters and not single pixel hits, super-resolution imaging.

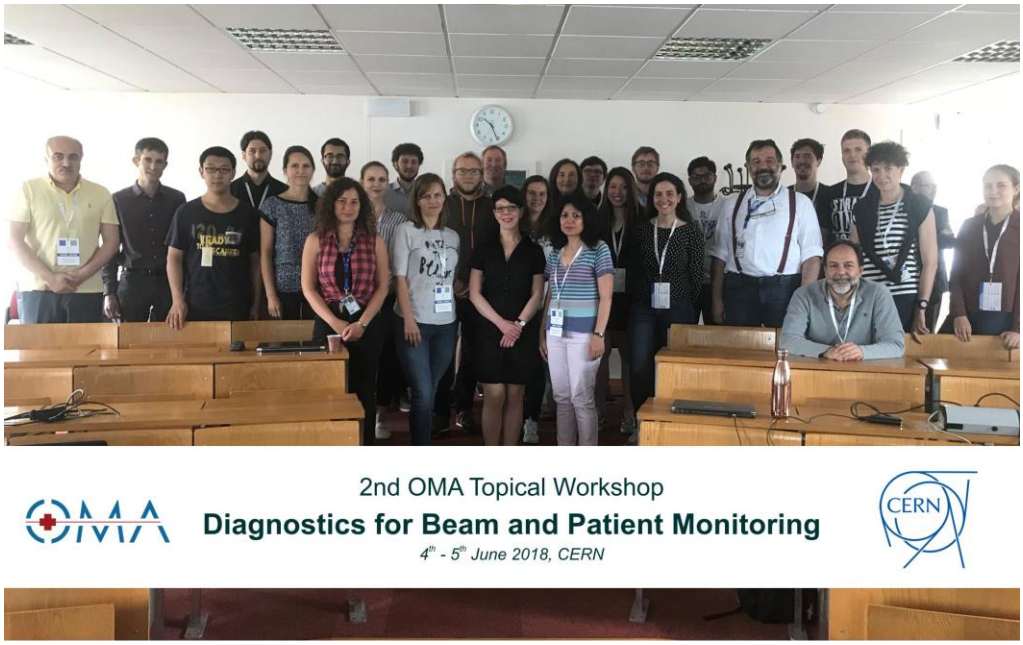
In his studies, he used the Linux tool 'perf' for profiling and made 'flamegraphs'. He optimized the readout chain by narrowing down and eliminating or reducing various performance bottlenecks. After performance optimization, he showed that an increased maximum readout and saving rate of up to 2,000 Hz is now possible. The sustained network traffic rate in these tests was 6.9 Gbit/s! An additional side effect from this performance tuning was that the CPU usage was massively reduced from 60-100% to 15-40%. Future investigations will focus on additional performance gains through fine-tuning of these new settings.



'Flamegraphs' generated from 'perf' data were found to be an exceptionally useful tool to understand where CPU time is spent

Network News

2nd Topical Workshop held at CERN



The 2nd OMA Topical Workshop on 'Diagnostics for Beam and Patient Monitoring' took place at CERN on 4th and 5th June 2018. Over 40 delegates attended the two-day workshop, including many OMA Fellows, who presented and discussed updates on their respective research projects. This workshop linked together two OMA work packages: WP2: Beam Imaging Diagnostics and WP3: Patient Treatment Optimization. The program included a mix of invited and contributed talks from various OMA partners and external participants. Technologies for non-invasive particle beam imaging were presented, showing very promising results from OMA Fellows. Innovations based on prompt gamma imaging were also discussed as a method of treatment monitoring.

Invited talks linked research and development with state-of-the-art clinical treatments. Several industry-based talks gave insight as to the latest developments in clinical hadron therapy. Along the main workshop topic there was a session on knowledge exchange, discussing how expertise at CERN and in wider research can be developed into partnerships with Industry.

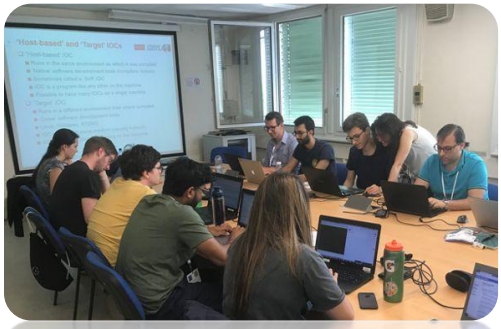
The workshop included lively discussion and cross collaboration opportunities between OMA Fellows in the fascinating research environment of CERN.

Professor Carsten Welsch, OMA Coordinator, says: "*There is a growing need of collaboration between different research communities to address some very challenging questions in ion beam therapy. In this workshop we brought together experts specialized in monitoring patients with those developing technologies for imaging the particle beam used for the treatment. We saw lively discussions throughout the event and many ideas of how to enhance existing monitoring systems. OMA organizes a number of challenge-based workshops and it is a pleasure to see the interesting research ideas emerging from these discussions.*"

CosyLab Academy held at CERN

From the 6th – 8th June, COSYLAB organized an academy for the OMA Fellows to introduce them to a control system architecture widely used in research institutes and proton treatment facilities across the world. COSYLAB, a company with more than 150 based in Ljubljana, Slovenia provides system integration and customer adapted products and solutions, covering the complete area of control systems and instrumentation, specialized in accelerators, both for particle therapy and scientific research, as well as tokamaks and radio telescopes.

The Fellows received training in EPICS. EPICS is a worldwide collaboration that shares designs, software tools, and expertise for implementing large-scale control systems. The software toolkit is a Control System Architecture with an efficient communication protocol (Channel Access) for passing data and distributing real-time database of machine values.



The teaching included getting to know the structure and vocabulary of EPICS as well as hand on programming to develop a small EPICS application on temperature monitoring and cooling of a room.

It was a good opportunity to see the interface between diagnostics that are being developed within the OMA project and the integration in a system network of a facility that is crucial for a smooth and safe working environment.

Upcoming OMA Event

3rd OMA Topical Workshop - Accelerator Design and Diagnostics

11th - 12th December, GSI, Germany

The 3rd and Final two-day Topical Workshop on 'Accelerator Design & Diagnostics' will look into the efficient integration of the devices developed in Work Package 2 (Beam imaging and diagnostics) into the facilities, beam lines and gantries from Work Package 4 (Facility design and optimization). The discussion will focus on how to improve the use beam and patient diagnostics to design (and operate) ion beam treatment facilities.

The workshop is mandatory for all OMA Fellows in WP2 and WP4; all other Fellows are welcome to attend.

A limited number of places will be offered to external participants.

More information and how to register will soon be available via our webpage.

Other Events

AVA topical workshop CIVIDEC

15th - 17th October 2018, Cividec, Vienna

The AVA project is delighted to announce a three-day Topical Workshop on diagnostics and detectors in storage rings, beam lines and experiments.

The event will be hosted by AVA partner CIVIDEC in Vienna, 15th - 17th October 2018. It will cover the challenges in the design and operation of advanced detectors and beam instrumentation to optimize the performance of the AD and ELENA, as well as experimental output.

This research challenges-focused event will combined talks by research leaders, opportunities for early stage researchers to present their work, and panel discussions.

Further information can be found here:

https://indico.cern.ch/event/726019/

Fellows Activity

Broadening the OMA training through expert courses

Sudharsan Srinivasan, OMA Fellow based at PSI, attended a two day certified NI LabVIEW course with hands on experiments and programming. The course focused on data acquisition using NI-MAX; a measurement and automation explorer tool and LabVIEW programming to remotely control and acquire data from measurement instruments that were provided by National Instruments. This course will come handy for the test bench characterization of beam diagnostic devices that Sudharsan is currently developing for the PROSCAN facility at PSI.

Sudharsan also took part in a Research Integrity course that focuses on ethical science and research activities. This course emphasizes the importance of fairness, honesty, reliability, openness, confidentiality, non-discrimination, responsible mentoring and publication, and objectivity to name a few and hence covered a number of skills that are not normally covered in PGR training programs.

PSI

Combining BIANCA with FLUKA improves understanding of Biological Effects of Radiation

In March 2018 OMA Fellow Giulia Arico' spent 2 days at the University of Pavia, Physics Department, to work with Prof F Ballarini and Dr M Carante on some development of the FLUKA Monte Carlo code for biophysics applications. In particular, this project aims at offering the possibility of performing biological studies on the Relative Biological Effectiveness (RBE) and cell survival curves for hadron therapy with FLUKA. FLUKA has been used at CNAO (Pavia, Italy), HIT (Heidelberg, Germany) and MIT (Marburg, Germany) for similar studies using the LEM model developed for heavy ions at GSI (Darmstadt, Germany). In the case of LEM, the dependency of the RBE on the particle energy is crucial, and the alpha and beta parameters, which vary for different tissues and tumours, are calculated for heavy ions using data from conventional photon radiotherapy. The alpha and beta terms determine the curvature of the cell survival curve.

The research group at the University of Pavia is developing an alternative approach for cell death studies, called BIophysical ANalysis of Cell death and chromosome Aberration (BIANCA). As the name suggests, in the BIANCA simulations the cell death is linked to the chromosome aberrations and experimental data are used for comparison. The results obtained with BIANCA can be used to complement and as comparison to the results obtained with the LEM model. Moreover, coupling of BIANCA with FLUKA could allow to predict cell survival curves and RBE for hadron therapy.

This experience was useful and very satisfying for the Fellow Giulia. She gained a deeper knowledge on radiation damage and biophysical models. Moreover, the initial results achieved are promising for a fruitful collaboration between BIANCA and FLUKA developers.

CREAM-1 Hackathon in Belfast

OMA Fellow Jacinta Yap and LIVDAT Fellow Selina Dhinsey attended the Computing Radiation Effects to Advance Medicine (CREAM) workshop at Queen's University, Belfast from the 3rd – 6th April 2018.

Supported by the UK Global Challenge Network+ in Advanced Radiotherapy, it was a week of exciting discussion and budding collaborations starting with an introductory workshop to TOPAS (Tool For Particle Simulation). TOPAS is an innovative software built on top of Geant4, allowing users similar capabilities but in a computing environment which is more user-friendly and easy to learn; an advantageous feature particularly for a clinical setting. Step by step exercises demonstrated the capabilities of the tool, allowing users to simulate particle beams in various setups and interactions with a range of materials.

Invited talks were also given by Joseph Perl and Jan Schuemann who have worked on the Geant4 collaboration and development of TOPAS and TOPAS-nbio respectively. Professor Schuemann introduced TOPAS-nBio, an extension of TOPAS which works down at the micro- and nanometre scales, allowing beam-cell interactions to be modelled. The latter 2 days focused on a 'hackathon' in which small projects and discussions of mutual research interests were setup. It also facilitated future collaborations, bringing together institutions with complimentary research and allowing experience to be shared between those in the fields of radiobiology and medical physics.

Jacinta's project focuses on simulation studies of beam behaviour to correlate the beam halo to the core for integration of the VELO online beam monitor. These studies will provide a good understanding of the physics and the beam, linking to Selina's LIVDAT project exploring the radiobiological aspects of proton therapy. The week was an insightful experience for both University of Liverpool PhDs, providing the opportunity to network and also learn more about this Monte Carlo tool relevant to their research in simulating a proton therapy beam and cell interactions.

Jacinta Yap at PTCOG57

Jacinta Yap presenting a talk at PTCOG57.

Last month PTCOG57 was held in Cincinnati, Ohio, USA from 21st – 26th May. Organized by the Particle Therapy Co-Operative Group, this annual conference is a major international meeting which brings together those in the field of particle radiotherapy; physicists, medical professionals, specialized vendors, scientists and researchers alike. The week started with the educational session for the first three days, providing a good overview of relevant themes such as the physics, radiobiology, technology and clinical aspects in particle therapy. This was followed by the scientific meeting which included numerous talks from experts and researchers as well as a poster session.

OMA Fellow Jacinta Yap had the opportunity to give a talk on "Implementation of a Non-invasive Online Beam Monitor at a 60 MeV Proton therapy beamline" during the second quality assurance session. She presented preliminary simulations, results and the development of the LHCb VELO detector as a standalone online beam monitor for particle therapy applications. This work contributes to her research as part of the OMA project, to develop and optimize beam diagnostic tools for particle accelerators. For the VELO beam monitor, Jacinta's work focuses on the integration of the system and in particular, the particle transport and tracking of the beam as transported through to the delivery system.

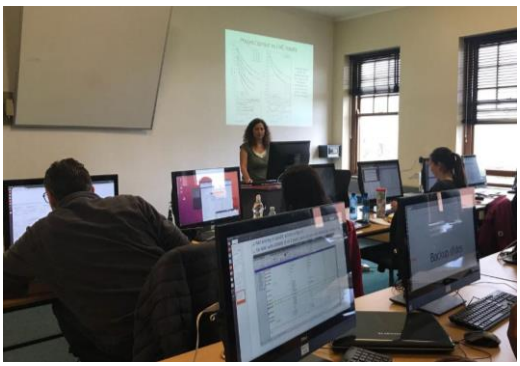
This is essential to be able to ultimately correlate halo measurements to the core of the beam in order to monitor the proton beam dose delivery in real time.

The conference was also joined by several OMA network partners, including Fellow Laurent Kelleter from UCL. It was a great platform to learn more about the current landscape of particle therapy, recent innovations, technology and clinical advances. The significant international involvement also showed what work is being done in the field across the world to address the challenges associated with particle radiotherapy.

Giulia Arico' as a teacher at the 20thFLUKA beginners' course in South Africa

The last FLUKA beginners' course, hosted by the Stellenbosh University in South Africa, attracted 30 students, mainly from South Africa and Europe, but also Zimbabwe, Brazil, China, Qatar. OMA Fellow Giulia Arico' was one of the co-organizers and one of the speakers of the course.

This experience was demanding but also ambitious for Giulia. She needed to refine her planning skills: students registration, scheduling of the course program, search of the event's venue and organization of the students' accommodation are just some of the tasks in which Giulia was involved. Moreover, planning time and respecting deadlines, managing costs and expenses according to the available budget are some of the responsibilities that Giulia had to deal with during the organization process. Preparation of the lectures and exercises for the course was another challenge Giulia encountered. Moreover, she needed to deepen her learning and to gain some expertise on fields beyond her research area, like high energy physics, induced radioactivity and neutrino physics.



Giulia presenting a talk at FLUKA beginners' course in South Africa.

A visit to the iThemba Labs was also organized for all participants as part of the course. The control, experimental and clinical areas were visited under the guide of local scientists, who showed themselves to be very hospitable and willing to answer to the many arising questions.
This course was an amazing experience for Giulia, and gave her the possibility of training her abilities and performance under pressure. It was also a valuable opportunity for enhancing her general knowledge on physics, and for expanding her professional network. Giulia was impressed by the strong desire to learn and high motivation of most of the students in the course. After so much hard work, the positive feedback and attitude of the participants was thrilling and gratifying.

Proton therapy in focus during 'Long Night of the Sciences' in Dresden

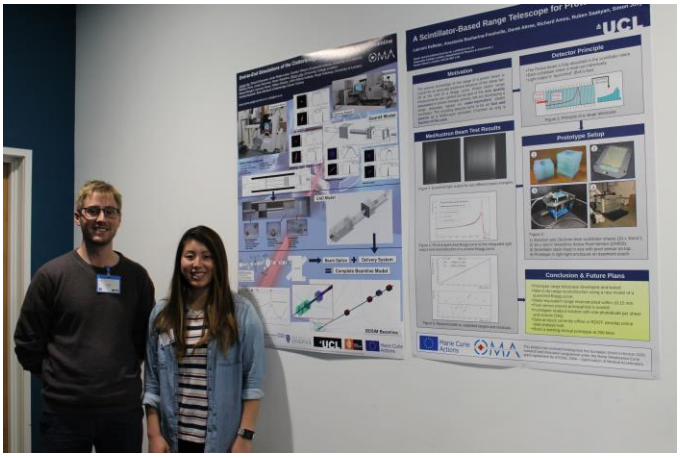
For one night a year, research institutes, museums and university faculties in Dresden are opening their gates to welcome everyone to learn more about the latest research and science projects. This so-called 'Long Night of the Sciences' attracts every year thousands of "small and big researchers" to visit the different research facilities of the city. With its unique particle therapy system and the special emphasis on research, OncoRay is also opening its gates for everyone who would like to have a look on proton therapy and the different research projects performed. On 15th of June this year, it was again possible to learn more about principles of particle therapy and to visit the proton treatment facility – a unique opportunity, as it is usually not accessible for the public.
Johannes Petzold, OMA Fellow based at IBA, took the opportunity to join the 'Long Night of the Sciences' at OncoRay to discuss and present the basic principles of proton therapy. During the whole evening, he explained the basics of dose deposition, patient treatment, and his own research within OMA.

The general idea behind protons was of most interest, especially the question about the differences to conventional radiation therapy but also the necessity of research to further improve the therapy. Furthermore, the visitors had the chance to win small prizes by solving a small quiz with the help of the experts or by accelerating marbles in a mechanical cyclotron.

Johannes explaining his research to participants at the 'Long Night of Sciences'.

The event was a great success and several hundred visitors came during the evening to OncoRay to learn more about the latest research.

OMA Fellows at ENLIGHT 2018



OMA Fellows Jacinta and Laurent presenting their posters at ENLIGHT2018.

From 25th to 27th of June, the annual ENLIGHT Meeting and Training took place at the OMA beneficiary institution University College London (UCL). ENLIGHT is an acronym for European Network for Light Ion Hadron Therapy. The network has been established at CERN in order to coordinate the European efforts in hadron therapy. Two OMA Fellows, Jacinta Yap (University of Liverpool) and Laurent Kelleter (UCL) had the opportunity to participate in the 16th annual ENLIGHT meeting since its foundation in 2002.

Jacinta contributed to the conference with a poster on the simulation of the Clatterbridge beam line, which has been developed in collaboration with Simon Jolly and Mathieu Hentz from UCL. Laurent presented a poster and gave a talk about the development of a scintillator-based range telescope for quality assurance in proton therapy.

The first day of the meeting was dedicated to hands-on training on proton therapy. It included talks on the clinical and physics potential of proton therapy, quality assurance in clinical trials and the public perception of proton therapy in the UK, to name just a few. The day was rounded up by a demonstration of the Eclipse treatment planning system by Varian.

The second day focused on dosimetry, imaging and patient selection. Clinicians and scientists from multiple proton and ion centres across Europe and the USA reported about their experience and practise. After a long day of interesting talks and lively discussions, the conference participants enjoyed a boat cruise on the river Thames through the British capital.

On the final meeting day, there were sessions on combined radio- and immunotherapy, the differences of treatment with different light ions and paediatrics.

The whole meeting was live-blogged on Twitter where details on the talks can be found under the hash tag #ENLIGHT2018 or by following the PART group @ProtonAdvancedRT. The full program can be looked up under https://indico.cern.ch/event/659363/. The next year's meeting will be hosted by the then brand new proton therapy facility of Caen, France.

Partner News

Dr Miguel A. Cortés-Giraldo receives research award

Credit: Diario de Sevilla

Dr Miguel A. Cortés-Giraldo, OMA supervisor, has been awarded with the 2017 Young Researcher Prize by the Royal Academy of Science of Seville in a ceremony which took place on 23rd May 2018. This prize is given to researchers under the age of 35 whose affiliation and/or research activity is related with Seville.

Dr Cortés-Giraldo earned his PhD in Nuclear Physics in 2011 and is one of the supervisors of the project carried out by OMA Fellow Anna Baratto, focused on the preparation of a beam line setup optimized for radiobiology experiments with proton beams at the 18/9 MeV cyclotron facility at CNA (Seville). His main research interests are related with the application of Monte Carlo simulations to the fields of proton and ion radiation therapy, especially in what concerns modelling of treatment plans including radiobiological effects and radiation quality description. Some of these works are carried out with the Roberts Proton Therapy Center of the University of Pennsylvania (Philadelphia, PA, USA). He is also a member of the Geant4 and n_TOF collaborations.

Congratulations!

France chooses CNAO as a scientific partner

A partnership has been created between Italy and France in order to study tumours which non-operable and resistant to radiation therapy.

Italy is one of the 4 countries in the world together with China, Japan and Germany, to have the accelerator for the production of carbon ions used in oncology, which can be used to treat cancers which are inoperable and resistant to X-ray radiotherapy. French patients will come to CNAO to receive treatments with carbon ion therapy.

France, which does not yet have this technology, has decided to launch an international study to compare the effectiveness of carbon ion therapy (adrotherapy) with that of radiotherapy with photons and protons and has chosen Italy and CNAO, Centro National Oncological Adrotherapy as scientific partners.

fondazione CNAO

The research, which takes the name of "Etoile", involves the enrollment of patients in France that will be divided into 2 groups, one of which will be treated with more advanced and precise forms of radiotherapy on the target (radiation therapy with protons or with photons) and the other with a further evolution of anti-cancer therapies, that is, the adrotherapy with carbon ions. The people of the second group will be treated at CNAO, which has already welcomed over 1800 patients since 2011.

At the centre of the study are the non-operable or non-fully operable cases of tumours such as cystic adenoid carcinomas of the head and neck, soft tissue sarcomas, osteosarcomas, chondrosarcomas and chordomas of the spine or sacrum. The study, funded by Assurance Maladie, the French Ministry of Health and French organizations NetSarc-ResOs and Refcor, will last 7 years. The international research coordinator is Pascal Pommier, radiotherapist, of the Centre Léon Bérard of Lyon.

Dr Christian Graeff honoured for his scientific achievements

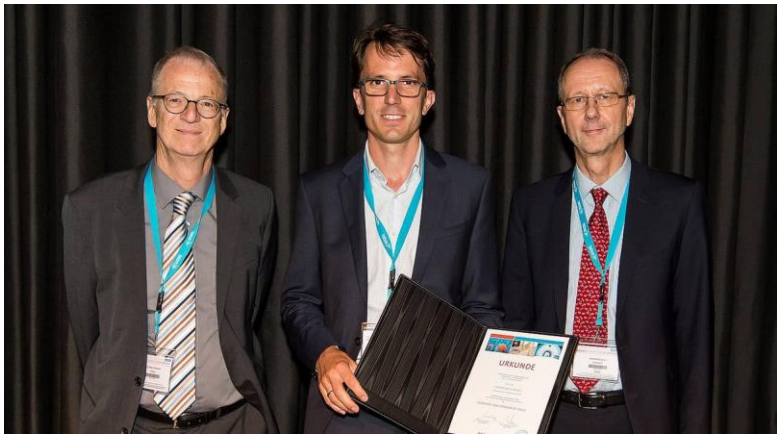
OMA Steering Committee member Dr Christian Graeff (GSI) has been honored for his scientific achievements with the Günther von Pannewitz Award of the German Society of Radiation Oncology (DEGRO). The award was presented in recognition of his research on the use of ion beams to treat cardiac arrhythmia.

The Günther von Pannewitz Award, which is endowed with €1,000, is presented in recognition of outstanding research work devoted to radiation therapy for non-malignant diseases, including radiation biology, radiation physics, and clinical research. The presentation of this award honours the lifetime achievement of the Freiburg-based radiologist Günther von Pannewitz.

Dr Graeff accepted the award at the DEGRO annual congress in Leipzig.

Congratulations!

Full article can be found here
https://www.gsi.de/en/start/news/



Award ceremony Photo: MCI

Medical Experts discuss future R&D directions

A workshop on "Ions for cancer therapy, space research and material science" took place from June 19th -21st 2018 in Archamps, France, in the vicinity of Geneva. The event was hosted by the European Scientific Institute (ESI) and organized within the framework of ARIES and ENLIGHT. It highlighted the increasingly important interface between fundamental physics research and medical applications.

Over recent decades many important developments have been built on either basic physics principles or the tools developed to conduct physics research. Notable examples are diagnostic and therapeutic techniques such as particle therapy or innovations in space and material sciences. CERN and GSI, two laboratories that pioneered ion beam based cancer therapy since the early '90s, co-organized this workshop which attracted more than 60 experts from all over the world. On the first day, reports from leading clinical facilities such as OMA partners CNAO and Medaustron in Italy, as well as the Heidelberg Ion Therapy center HIT in Heidelberg, Germany were given. This formed an excellent basis for discussion of specific technical and technological challenges, such as efficient ion sources, different technology choices for linear and circular accelerators, as well as challenges related to beam delivery systems. Two sessions then focused on the particular R&D challenges related to synchrotrons and gantry design with discussions continuing until 19:00 on the second day. OMA Steering Committee member Dr Christian Graeff, who was also member of the Programme Committee, gave a talk on "Helium as a range probe".

The final day of the workshop focused on future directions in ion therapy, as well as accelerator development. OMA Coordinator Professor Carsten Welsch talked about *"European medical accelerator networks and design perspectives"* where he emphasized the role OMA can play.

The event provided an ideal opportunity to exchange ideas, share current experiences and explore future possibilities for the design of a next generation medical research and therapy facility with ions in Europe. All presentations are now available via the workshop homepage.

Vacancies

PhD position at the University of Liverpool
Dielectric laser acceleration of relativistic beams
More information can be found here:
https://www.liverpool.ac.uk/quasar/vacancies/vacancies/

Early Stage Researcher Fellowship within the AVA project at Cosylab d.d.
Development of a versatile control system
More information can be found here:
https://www.liverpool.ac.uk/ava/projects/cosylab/

PhD Position at OncoRay
Helmholtz-Zentrum Dresden-Rossendorf, Germany https://www.hzdr.de/ is gladly welcoming applications for a new PhD position in medical physics at its Institute of Radiooncology – Oncoray https://www.oncoray.de/, a leading proton therapy research centre in Germany and adjunct partner of the OMA project.
Interested candidates should email the lead researcher Dr Richter Christian.Richter@OncoRay.de

OMA Events

December 11th - 12th 2018	3rd OMA Topical Workshop - Accelerator Design and Diagnostics, GSI, Germany
March 2019	3rd OMA School – Particle Therapy, MedAustron, Vienna, Austria
June 24th – 25th 2019	Advanced Researcher Skills and Technology Transfer Workshops, Liverpool, UK
June 28th 2019	Symposium: Accelerators for Science and Society, Liverpool, UK

Other Events

July 23rd - Sept 13th 2018	Summer Student Program, GSI / FAIR, Germany
Oct 15th - 17th 2018	AVA Topical Workshop: Detectors & Diagnostics, CIVIDEC, Vienna, Austria
May 19th – 24th 2019	Melbourne Convention & Exhibition Centre, Australia
June 10th - 15th 2019	PTCOG58, Manchester, UK
July 1st - 3rd 2019	ENLIGHT Annual Meeting and Training, Caen, France

NOTICE BOARD

This newsletter is published on a quarterly basis. Help us keep it interesting by providing your news and updates.

DEADLINE FOR THE NEXT NEWSLETTER **15th September 2018**

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