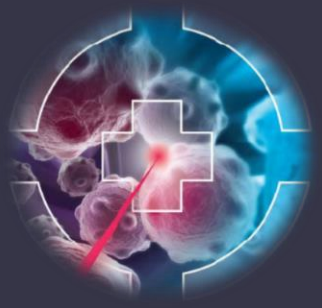


OMA Express
Issue 6 - April 2018

Highlights

An event-ful year has started

We kicked off our series of Topical Workshops with a 2-day event on *Facility Design Optimization for Treatment* **at PSI.** Pierre and his colleagues did a fantastic job in hosting this event. It was an interesting mix of presentations which triggered many discussions and brought up good ideas that can help overcome current limitations. All presentations from the workshop are available via the event indico page. It won't be long now until our 2nd workshop on *Diagnostics for Beam and Patient Monitoring*, which will take place at CERN on 4-5 June 2018. Registration will close end of this month, so make sure you sign up now to secure a place. There is no fee to attend the event, so hopefully I will see many of you at CERN.

There is a significant international push towards high energy proton beam therapy. In the UK alone, a first NHS center will open at The Christie in Manchester this summer, and a second one is under construction at UCLH in London. In addition, several private clinics offering this treatment type have either opened recently or are under construction, including clinics in Wales and Liverpool. These centers are working closely with academic partners and industry to provide the best healthcare for their patients. At the University of Liverpool, Healthcare Technologies has become an independent research theme, linking between faculties and departments. This is exactly the model that OMA has established – enabling dialogue between scientific communities to advance ion beam therapy world-wide. This not 'only' opens up exciting new R&D opportunities, but also excellent career prospects for our Fellows.

Save the date: On 28 June 2019, we will celebrate OMA research through a dedicated **Symposium** which will be held at the Liverpool ACC which has just announced that it won *Best UK Conference Centre* at an industry awards for the sixth consecutive year. A perfect venue for our project!

Prof Carsten P Welsch, Coordinator

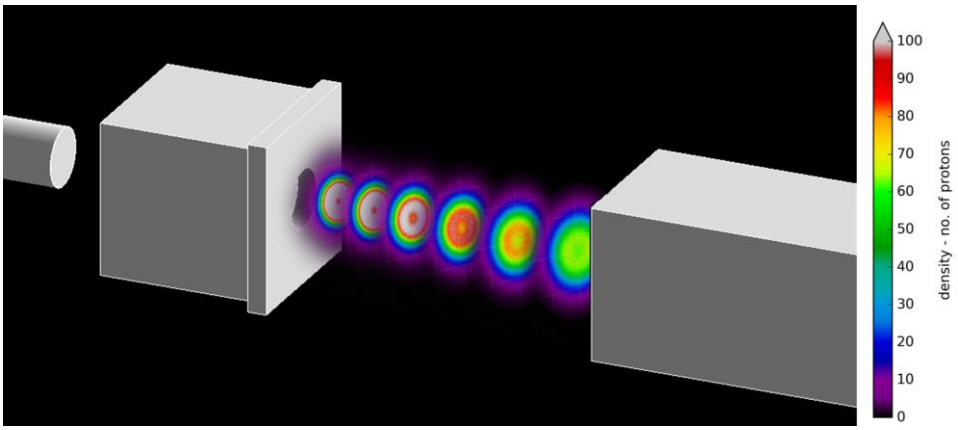
Research News

OMA Research to be showcased at IPAC 2018 in Vancouver

OMA Fellow at the University of Liverpool, Jacinta Yap, is contributing to Optimization of Online Beam Monitor

Fundamental to any accelerator system, beam diagnostics are especially necessary in clinical radiotherapy facilities to monitor and evaluate the delivery of the beam in order to ensure safe but high quality treatment. Typically, ionisation chambers (IC) are placed within the treatment head and intercept the beam before it exits through the nozzle, providing an online measurement of dose during operation. As protons undergo interactions throughout their path, this traversal through the ICs results in a slight degradation to the beam and therefore a minimally destructive method is ideally desired for this task. One such candidate is the VErtex LOcator (VELO) detector, originally used for the LHCb experiment at CERN, consists of position sensitive, opposing silicon sensors which surround a central aperture. This advantageous semi-circular design allows beam intensity measurements by means of the beam 'halo', without any interception to the core of the beam. As such, the QUASAR Group at the Cockcroft Institute and the University of Liverpool are developing an online beam monitor for quality assurance in medical accelerators as based on this LHCb VELO detector technology, MOPML024. Several modifications were necessary for the novel repurpose of these detectors and currently, the system is being optimised for integration into the 60 MeV eye proton therapy beam at Clatterbridge Cancer Centre (CCC), UK.

In collaboration with the University College London, OMA Fellow Jacinta Yap has performed simulations with the Monte Carlo simulation toolkit, Geant4, using a detailed model of the CCC treatment beamline [2]. Initial results offer an overview of the general behaviour of the beam, originating from the partition wall joining the cyclotron bunker to out past the treatment nozzle. These results form the basis for halo maps; for comparison with VELO measurements, correlation of the halo with the beam core and for conversion to absolute dose during active delivery.

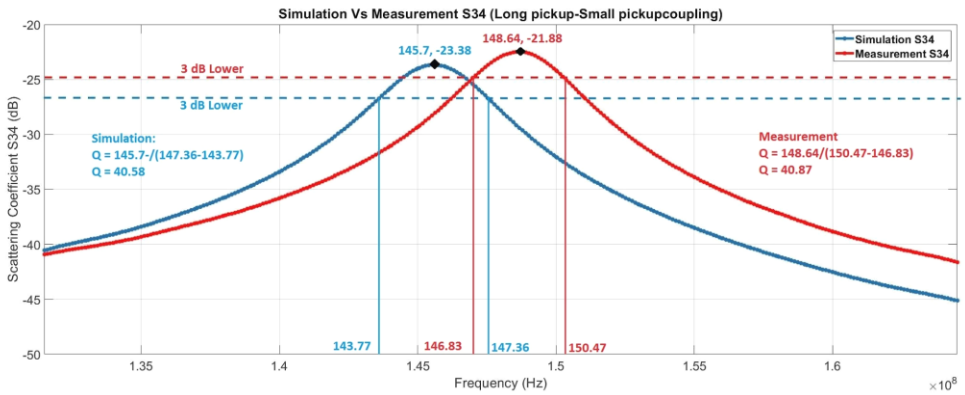


Simulated beam density profile maps overlaid within the VELO integration zone.

This work is part of OMA Deliverable 2.1

Sudharsan Srinivasan, based at PSI, is investigating Low Intensity Proton Beams

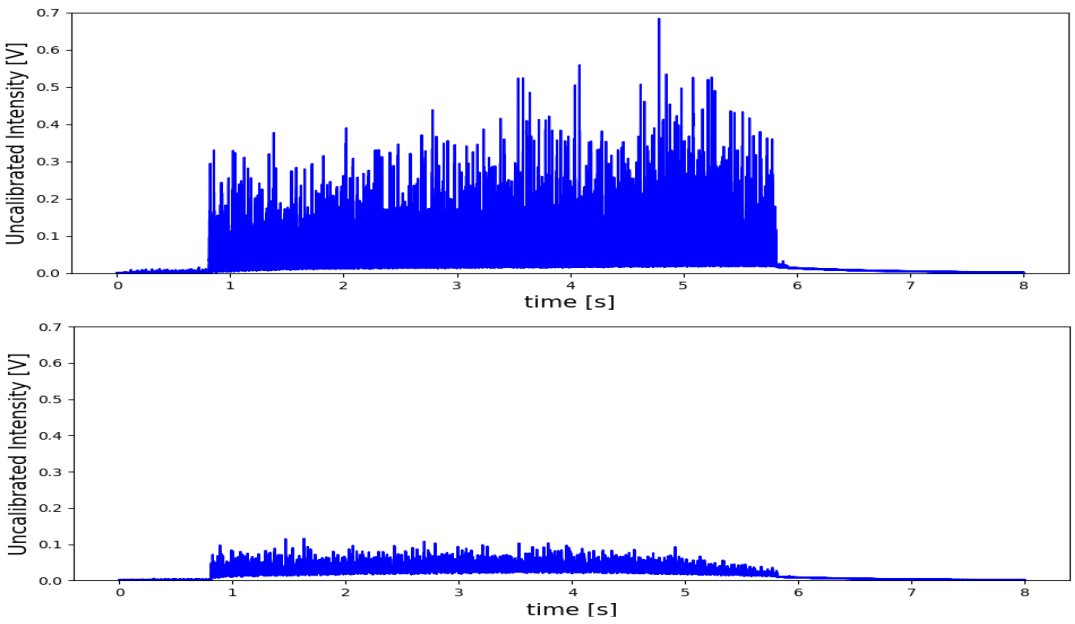
A non-interceptive beam current monitor has been developed to investigate the measurement possibilities of low-intensity beams down to 1 nA for proton therapy machines without the drawback of interceptive monitors. This works on the principle of a reentrant cavity resonator [1] such that its fundamental mode resonance frequency of 145.7 MHz matches the second harmonic of the pulse repetition rate of the cyclotron beam i.e. 72.85 MHz. The Driven Modal analysis from the simulation tool ANSYS HFSS [2] was used for parametric model development and to optimize design parameters such as e.g. the position of the inductively coupled pick-ups. A ceramic plate has been inserted in the resonator gap to relax the precision required during manufacturing. A test bench has been designed and constructed for the characterization tests of the prototype. The simulation and measurement have a good agreement. The deviations in the results will be further investigated. The dielectric constant of the MACOR ceramic is frequency dependent [3]. Hence, the value used in the simulation could be different from the dielectric constant of the MACOR that is used in the construction of the prototype, WEPAL069 .



Comparison of Scattering parameter S34 between a long and a short pickup between simulation and measurement

OMA Fellow Andrea De Franco at MedAustron will be presenting results on slow extraction optimisation

MedAustron is a synchrotron-based ion therapy center allowing tumours treatment with protons and other light ion species, in particular C6+. Commissioning of all fixed lines, two horizontal and one vertical, has been completed for protons and in parallel to the commissioning of a gantry and C6+, a facility upgrade study is progressing. In this context two optimizations of the slow extraction are under development: RF-channeling and RF Knock Out.



Extracted beam intensity over time, 50kHz sampling. (top) Reference (bottom) with RF-channeling. Same integrated intensity, or comparable with shot-to-shot variations.

RF-channeling is a front end acceleration technique that, coupled with the 3rd order resonance driven in momentum by a betatron core, showed a significant spill ripples reduction, fundamental to safely operate the machine at the highest intensities. RF Knock Out is an alternative extraction technique which opens up interesting possibilities for fast beam energy and intensity modulations. Preliminary test demonstrated the feasibility of implementation using the plates of an already installed Schottky monitor as a transverse kicker to increase betatron oscillation amplitudes. Focus of the development is now on beam optics optimization, choice of RF signal pattern to feed the exciter with, relevant electronics chain and main ring low level RF adaptations, MOPML025.

Anna Vnuchenko at IFIC/CSIC in Valencia, Spain will be presenting her work on 'High Gradient Accelerators

The development of low-β high-gradient (HG) accelerating structures is the one of the main requirements for implementation of compact and cost-effective linear hadron accelerators. Cancer therapy accelerator needs to provide particle beams with energies to cover the full penetration depth of the human body. Such linacs need to provide an energy in the range 70-230 MeV for protons and 100-400 MeV/nucleon for carbon ions.

For effective acceleration to higher energies, a HG S-band structure are used. This accelerating structure is part of the TULIP project, a single room facility for proton therapy. The prototype has been designed and built using technology developed by the CLIC collaboration to accelerate protons with

an energy of 70 MeV, and a particle velocity of 38% of the speed of light and reach an accelerating gradient up to 50 MV/m. HG operation of RF cavities is limited by the undesired RF breakdowns (BD) cause beam losses, cavity surface damages, radiation and vacuum deterioration. The breakdown probability of a given RF structure has to be as low as possible, with a limit of order of 10-7 BDs per RF pulse.

The main goal of the study is to define the HG limits of S-band cavities in terms of breakdown rate (BDR). In this paper we present test and data analysis of the structure that include the BD localization within the structure and the study of the BDR dependence on the RF fields and pulse parameters.

The first high-power test of BTW structure is being tested on the S-band test facility at CERN. The computer-controlled algorithm used on the Xboxes, was chosen to test BTW structure. During the tests, the structure reached over above 60 MV/m at 1.2 μs pulse length and breakdown rate of about 5x10-6 bpp. The results presented include ultimate performance, long term behaviour and measurements that can guide future optimization. The structure is still under conditioning and more data is being collected (more breakdowns) to increase the statistics and better understand the effect.

A detailed discussion of the results and future plans is given in: A. Vnuchenko, et al., "High gradient performance of an S-Band backward traveling wave accelerating structure for medical hadron therapy accelerators", Proceedings of IPAC18, Vancouver, Canada (2018), MOPML043.

The OMA contributions will be highlighted in the IPAC paper: 'Enhancing Hadron Therapy through OMA', C.P. Welsch, MOPML069

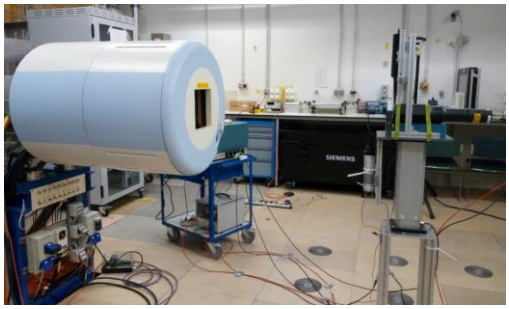
OMA Fellow Giulia Arico' at CERN is investigating FLUKA applications for carbon and helium ion beams.

One aim of the present OMA project is to further improve the accuracy of the FLUKA Monte Carlo code, especially with regard to the primary beam attenuation and to the angular and energy distributions of the secondary radiation in **carbon ion beams**. In addition, this OMA project focuses on nuclear reaction cross section analysis for **helium ion beams**. Although helium ions are not currently used in radiotherapy, the interest on this particle species is growing fast in the last years.

For the carbon ion study, Giulia has benchmarked FLUKA simulations against experimental data available in literature. Fragmentation of carbon ion beam with therapeutic initial energies (50-430 MeV/u) have been investigated in several experiments, using target materials of interest for medical applications (e.g. C, O, Al, Ti, water, PMMA). Based on the experimental data, Giulia has worked on the developments of the FLUKA physics models, and significant improvements on the FLUKA results have been achieved. Some of the changes regards the fraction of particle energy loss during nuclear interactions, the repartition of the excitation energy between the outgoing particles after incomplete fusion, and the cross section values for complete fusion.

The helium ion work has been carried out in collaboration with GSI (Darmstadt, Germany) and HIT (Heidelberg, Germany). Experimental measurements of mass- and charge-changing cross sections for helium ions in graphite, published in Horst et al 2017, were compared by Giulia with FLUKA simulations.

As significant differences between the GSI data and the FLUKA cross section curve were found, improvements on the FLUKA reaction cross section curve were performed in order to better reproduce the experimental data. In February 2018 a new campaign of measurements was organized (figure 1). Besides graphite, other target materials of interest for radiotherapy and detector applications, such as water, Si and SiO2, were used. Measurements with Si and SiO2targets are important to obtain the nuclear reaction cross sections of helium ions in oxygen, which are particular important for dose calculations in the patient tissues.



Experimental setup mounted at HIT (Germany), and used for mass- and charge-changing cross section measurements. The detection system was designed at GSI.

The results achieved in this OMA project on the nuclear reaction cross sections for helium ions in C, O and Si, will be included in the next FLUKA release.

The results achieved, both regarding helium and carbon ions, will be presented at the 15th Varenna Conference on Nuclear Reaction Mechanisms in June 2018:

Development of the nuclear reaction and fragmentation models for heavy ion collisions in the therapeutic energy range (speaker: Giulia Arico')

This work is part of OMA Deliverable 3.1

PAUL SCHERRER INSTITUT

Network News

First OMA Topical Workshop held at PSI

The 1st OMA Topical Workshop took place on 12th – 13th March 2018 at the Paul Scherrer Institute (PSI) in Switzerland. Approximately thirty delegates attended this event, amongst them several OMA Fellows, who presented and discussed the current status of their projects.

This workshop focused on "Facility Design Optimization for Treatment", linking two of the three OMA working packages: Patient Treatment Optimization and Facility Design and Optimization. The workshop programme consisted of invited and contributed talks by experts from OMA partner institutions and talks by OMA Fellows.

The first day workshop was dedicated to review and discuss the state-of-the-art of Monte Carlo techniques applied to medical imaging and dose delivery calculations for treatment planning. Simulation examples using the codes GEANT4 and FLUKA were presented in the morning. Special attention was dedicated to innovative patient scanning systems including 3D motion detection were also presented as well as novel tumour tracking techniques in particle therapy.

During the second day of the workshop most presentations were focused on the design and optimization of facilities, including the design of more compact gantries based on superconducting elements and the design of new high performance and compact proton LINACs. There was also space to talk about the design and optimisation of control software towards a more reliable and friendly facility operation interface and relevant data storage.

During this event, OMA Fellows had the opportunity to meet again to interchange ideas and establish collaborations , having the alpine mountains surrounded PSI as titanic witnesses.

More information:
https://indico.cern.ch/event/697187

Upcoming OMA Events

2nd OMA Topical Workshop - Diagnostics for Beam and Patient Monitoring

4th – 5th June 2018, CERN, Switzerland

The second Topical Workshop will link diagnostics for beam and patient monitoring and hence connect the diagnostics efforts in two OMA work packages WP2 and WP3. In particular, it will discuss the role of online monitoring capability for patient treatment and how information from 3D online and patient tracking systems, as developed in work package 3, needs to be combined with the general accelerator diagnostics, beam control systems and the specific monitors developed in work package 2, to achieve maximum treatment efficiency.

The workshop is mandatory for OMA Fellows from WP2 and WP3; other Fellows are of course more than welcome to attend!

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

Cosylab Academy

6th – 8th June 2018, CERN, Switzerland

OMA Partner Organization COSYLAB is a world-wide leader in accelerator control systems. All diagnostics and detector work, as well as facility optimization studies will benefit from this training. The training will introduce participants to control systems, with hands-on activities based on an example of EPICS.

The Academy is mandatory for all OMA Fellows. Please note this event is not open to external participants.

Other Events

The 9th International Particle Accelerator Conference

29th April – 4th May 2018, Vancouver, Canada

IPAC is the main international event for the worldwide accelerator community and industry. Attendees will showcase cutting-edge accelerator R&D results and gain the latest insights into accelerator facilities across the globe. Over 1,200 delegates and 70 industry exhibits are expected to attend. Fellows and partners from OMA will be at IPAC'18 presenting talks and posters and we look forward to meeting you all at **Booth 400** in the main exhibition hall.
More details are available at:
https://ipac18.org/

AVA School on Antimatter Physics

25th – 29th June 2018, CERN, Switzerland

Antimatter experiments are at the cutting edge of science. They are, however, very difficult to realise. The AVA project aims at enabling new antimatter experiments, probing the fundamental laws of nature.

We are delighted to announce a week-long international School on Low Energy Antimatter Physics which will be held at CERN. It will cover the challenges in antimatter facility design and optimization, beyond state of the art beam diagnostics and advanced detectors, as well as novel antimatter experiments.

In addition to lectures by research leaders, there will be study groups, a poster session and a dedicated industry session. There will also be opportunities for discussion and networking at evening events and a tour of CERN's unique accelerator facilities.

Registration is open now, we recommend to register early to secure a place:

https://indico.cern.ch/event/677170/

Quantum Leap towards the Next Generation of Accelerators

6th July 2018, Liverpool, UK

The EuPRAXIA consortium will be holding a Symposium 'Quantum Leap towards the Next Generation of Accelerators', on 6th July 2018, at ACC Liverpool, UK.

Whether you are a scientist, a manufacturer, or a student, you can now be part of the future of particle accelerators.

World-renowned scientists will present research highlights on the next generation of accelerators and their enormous impact on science and society. They will be joined by scientists from the EuPRAXIA network and relevant industries who will present their innovations and share their fascination for science. **Live streamed talks** will be made available to participants from around the world.

This event is free of charge - advance registration is required.

Registration deadline: 15th May 2018

More information and how to register can be found here:
http://www.eupraxia-project.eu/symposium.html

Fellows Activity

Ewa's secondment at PSI

A new material has been proposed for the proton beam energy degrader currently used in the PROSCAN beamline in the Center for Proton Therapy at Paul Scherrer Institute (PSI) in Villigen, Switzerland. Our Fellow, Ewa Oponowicz, based at the University of Manchester, performed simulations of the new degrader during her secondment at PSI.
Ewa spent a couple of months at the end of 2017 working on the performance of the proposed degrader update. The simulations were done mostly in OPAL, a tool developed at PSI, and FLUKA. This was a great research project, which, in the next steps of her work, will help Ewa to perform beam tracking studies for the superconducting gantry. Additionally, this secondment provided an opportunity to visit one of the leading proton therapy facilities in Europe and network with other researchers in the field.

Ewa is back in the UK, where she continues work on the project and will compare the obtained results with G4Beamline simulations. All the simulations will be then benchmarked with measurements by the end of March 2018 when the new degrader will be installed for testing in the PROSCAN beamline.

OMA Fellow invited to give lecture at ISOTDAQ in Vienna

Dr Andrea De Franco was invited to speak at the International School of Trigger and Data Acquisition (ISOTDAQ), which this year was hosted in Vienna from 14th to 22nd February.

Andrea's lecture reviewed the importance of accelerator technology development for medical applications and motivated the reasons for Optimisation of Medical Accelerator.

A specific focus was given to hadron therapy and the many challenges ahead for the field that OMA and its Fellows are tackling at the moment. Andrea introduced MedAustron, one of the few centres for hadron therapy with light ions (up to Carbon) in the World. An important part of its mission, alongside high quality patient treatment, is to keep developing the technology of tomorrow, which makes it a perfect study subject for a lecture to young bright students.

In connection with the main topics of the school, Andrea explored in detail the timing distribution, data acquisition and control systems at MedAustron that are essential components of the accelerator. On Sunday 18th the school visited MedAustron in Wiener Neustadt, where a tour lead by Dr Claus Stefan Schmitzer complemented the lecture.

Samuele attended the first RADSAGA Workshop

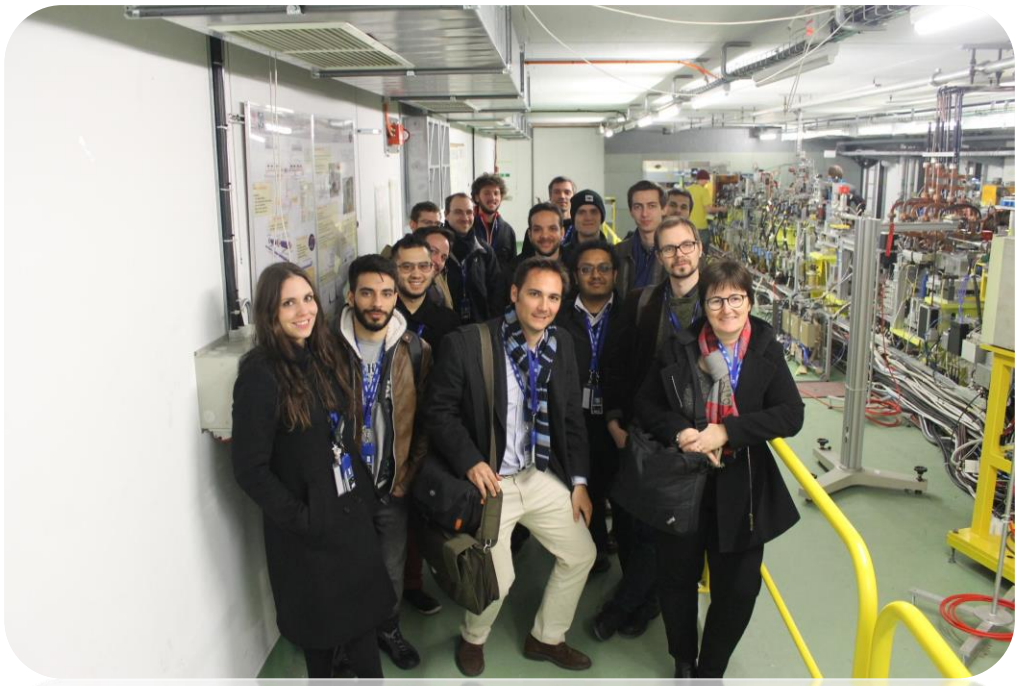
Samuele Cotta, the OMA Fellow based at ViALUX, is currently planning tests to study the radiation hardness of the ViALUX 3d scanners in the radiotherapy environment. In order to gain more knowledge on this topic and to get a feedback about his project, he was in touch with the RADSAGA network, which is a European Training Network dedicated to the effects of the ionizing radiations on the electronics.

Samuele attended the first RADSAGA Workshop, which was held at CERN from the 21st to 23rd March.

During the workshop he had the chance to meet with other students and experts that are working on this topic gaining valuable contacts and ideas on how to improve his work.

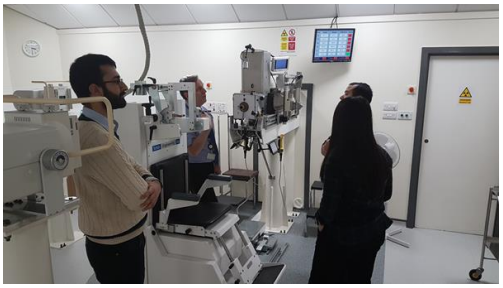
This workshop was an interesting opportunity to find contacts for possible future collaborations and Samuele is looking forward to taking part in other RADSAGA events.

https://radsaga.web.cern.ch/



OMA Fellows join forces to improve cancer treatment beam diagnostics

Last month OMA Fellows Jacinta Yap (University of Liverpool) and Navrit Bal (ASI), along with QUASAR members Roland Schnuerer and Hao Zhang from the Cockcroft Institute visited the Clatterbridge Cancer Centre (CCC), UK to meet with the Head of the Douglas Cyclotron, Dr Andrzej Kacperek. The CCC is treating patients with ocular tumours since 1989.



Building on already existing collaboration with CCC, the addition of ASI (Amsterdam Scientific Instruments) to this group represents another link between partners within our OMA network. This meeting marks the first of multiple intended visits, to carry out joint measurements with the 60 MeV proton therapy beamline.

Discussion during the visit included the current status of GEANT4 beamline simulations and the VELO setup. Further, an initial schedule to take measurements with VELO & Medipix3 with the CCC clinical beam was proposed. As both systems are designed by the same team at CERN, this example shows how both devices are applicable to be transferred from a fundamental research environment to a clinical facility.

Currently, **Jacinta's project** largely focuses on simulation studies; beam behavior, integration of the VELO beam monitor and the correlation of the beam halo to the core. This is necessary to look at the interactions of the beam, sensors and propagation of the halo, as relevant for absolute dose delivery. This compliments Roland's work focusing on the development of the hardware and software aspects of the VELO detector and as such, both work together closely to investigate the development of the VELO detector system into an online beam monitor for quality assurance.

Navrit's project involves characterization and improvement of the Medipix3 chip, the readout and control software and a variety of applications using the chip. Typically x-rays and electrons are used with less than 0.1% of the energy than the protons in CCC and significantly lower flux which presents some challenges.

The Medipix3 chip is meant for very different applications. Thus, it enables direct beam profile measurements complementary to VELO measuring the beam halo. Additionally, it may be possible to measure the Bragg peak of the beam with the same equipment at micro meter resolution instead of mm or cm. These types of measurements have not been attempted before with Medipix3 detectors. If they work as expected, this would be a jump in the level of quality assurance for the CCC.

The group is looking forward to first measurements which are estimated to be performed between this spring and summer.

Partner News

2nd Spanish Workshop on Proton Therapy

The University of Seville held, during the 15th and 16th of March 2018, the 2nd Spanish Workshop on Proton Therapy, which took place at the Higher Technical School of Engineering. This conference was organized to foster collaboration between the different areas of expertise in proton therapy, with the aim of developing a common language and common training strategies to form highly qualified professionals in this field, with a view of a future proton therapy facility to be built in Spain. The workshop gathered around 200 participants, among them were; clinicians, physicists, biologists and engineers. Speakers from well-established proton therapy facilities and research centres in both Europe and the United States were present.

OMA Fellow Anna Baratto Roldán, from the CNA and University of Seville, and her supervisors were among the attendants.

OMA supervisor Dr Miguel A. Cortés-Giraldo and Dr M. Isabel Gallardo-Fuentes from the Universidad de Sevilla (Spain), together with Dr Consuelo Guardiola from IMNC-CNRS (France) and Dr Daniel Sanchez-Parcerisa from the Universidad Complutense de Madrid (Spain), were the members of the organizing committee of this workshop. Their efforts helped to organize a fruitful event, with outstanding scientific content and many valuable contributions. Among other keynote speakers, the workshop included oral presentations by Dr Jean Louis Habrand, Head of Dep. Radiation Oncology of Centre François Baclesse (France), Dr Piero Fossati, director of the Carbon Ion Therapy program at MedAustron (Vienna, Austria) and Dr Alejandro Mazal, Head of Medical Physics at Institut Curie (France). Other keynote speakers were Spanish researchers developing their works at institutions in Europe and in the USA.

In this second edition of the workshop, a call for abstracts was also open: OMA Fellow Anna Baratto Roldán had the possibility to present a poster on the *"Preparation and characterization of a radiobiology beam-line at the 18 MeV proton cyclotron facility at CNA"* and talk with the attendants about the status of her research in OMA.

Collaboration between UCL and MedAustron reaches next level

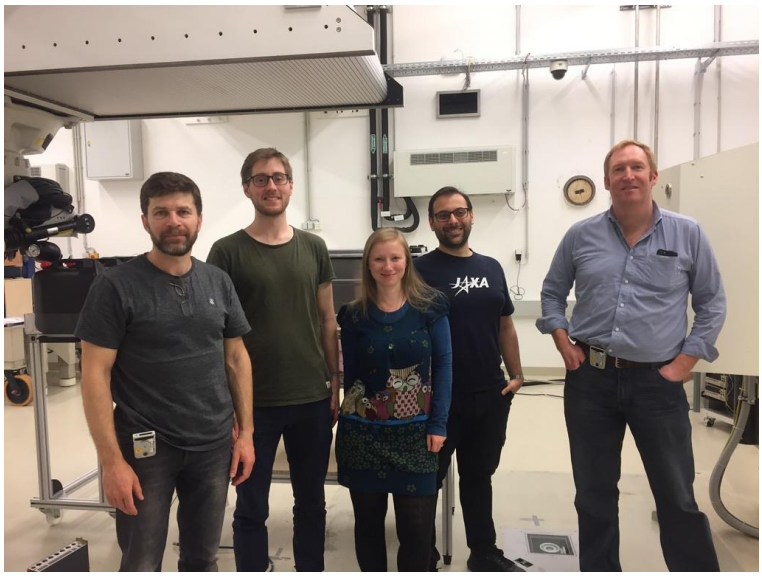
From Wednesday 21st of March to Saturday 24th a delegation from University College London including OMA Fellow Laurent Kelleter visited MedAustron in Wiener Neustadt for a joint beam test. This was the second visit of UCL to MedAustron after the start of the collaboration in early 2017.

The goal of the UCL project is to adapt existing high energy physics detector technology for the precise measurement of proton energy in a clinical setting. This would allow improved verification of the proton beam range during daily Quality Assurance (QA) checks and could also provide the energy measurement stage for a proton CT imaging system. Two detector systems on the basis of a plastic scintillator are currently under development at UCL: a single-module detector for the measurement of single protons and a range calorimeter for proton range measurements at clinical beam intensities.

The first night shift of the two-day beam test was dedicated to the range calorimeter. For the first time proton range measurements at clinical beam intensities have been performed using the range calorimeter. The data is currently being analysed and will be presented at the next OMA topical workshop in Geneva.

During the second night, the single module detector was tested at proton rates of up to one million particles per second. In addition, a proton rate measurement at very low intensities has been carried out in collaboration with OMA Fellow Andrea de Franco. This measurement will help MedAustron to optimize the delivery of a very low intensity beam which will be beneficial to multiple groups doing research at the MedAustron facility.

The UCL delegation is very thankful for the huge support they received from MedAustron staff and is looking forward to an ever closer collaboration in the future.



The UCL delegation at MedAustron including OMA Fellows Laurent Kelleter and Andrea de Franco (MedAustron)

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 positions at the University of Liverpool
including a project on the ALPHA experiment
More information can be found here: https://www.liverpool.ac.uk/quasar/vacancies/vacancies/

Project Manager Position at the University of Liverpool
for the research and training projects `Accelerators Validating Antimatter Physics (AVA) and the Liverpool Centre for Doctoral Training on Big Data Science (LIVDAT). More information and how to apply can be found here.

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

June 4th - 5th 2018	2nd OMA Topical Workshop - Diagnostics for Beam and Patient Monitoring, CERN, Switzerland
June 6th – 8th 2018	Cosylab Academy, CERN, Switzerland

Other Events

April 29th – May 4th 2018	IPAC'18, Vancouver, Canada
June 19th – 21st 2018	Ideas and technologies for a next generation facility for medical research and therapy with ions, ESI, Archamps, France
June 25th – 28th 2018	AVA School on Antimatter Physics, CERN, Switzerland
July 6th 2018	Symposium: Quantum Leap towards the Next Generation of Accelerators, Liverpool, UK
July 23rd - Sept 13th 2018	Summer Student Program, GSI / FAIR, Germany
Oct 15th - 17th 2018	AVA Topical Workshop: Detectors & Diagnostics, CIVIDEC, Vienna, Austria

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 **30th June 2018**

www.oma-project.eu

Project Coordinator
Prof Carsten P. Welsch
carsten.welsch@cockcroft.ac.uk

Newsletter Editor
Alexandra Welsch
alexandra.welsch@cockcroft.ac.uk

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