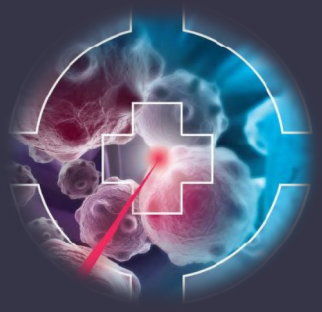


OMA Express
November 2021
Issue 17

## Highlights

- First Medipix3 tests at a 60 MeV proton therapy facility
- New *JetDose* project set to optimise proton beam cancer therapy
- Quality Assurance Detector for Proton Beam Therapy

# OMA goes from strength to strength…

**One of the main goals of OMA has been to build bridges between the clinical and accelerator communities.** During the lifetime of our network, we have organized numerous schools and workshops that have attracted many experts from both communities. This has stimulated a range of interesting discussions, collaborative studies and knowledge exchange. It turns out that is has also build an excellent basis for new initiatives.

**OMA has been a catalyst for establishing new and successful collaborations.** In this *OMA Express* you will read about a technical report which was just published in the *Journal of Instrumentation*. OMA's very own former Fellows, Dr Jacinta Yap and Navrit Bal, present the outcomes of their studies into the Medipix3 detector. This was the first time that the performance of this pixel detector was tested in a clinical, high proton flux environment and the results are very interesting. The report describes the capabilities of the detector in very good detail and this a study that would likely not have happened without our network.

**There are also entirely new projects starting on the basis of OMA.** Here in Liverpool for example, we just got a project called *JetDose* supported by the STFC. The project received more than £300k in funding and targets R&D into non-invasive beam characterization using a supersonic gas jet. *JetDose* is a collaboration between Liverpool and the Clatterbridge Cancer Center, supported by CNAO and IBA – it is great to see so many OMA partners working together on a new and closely related challenge. The fact that the project is based on OMA is reflected also in the project's logo - which I hope you will like. A second project, also funded by STFC, at UCL was enabled by collaboration with COSYLAB and MedAustron, see page 11.

It is great to see that so many good things are still coming out of our network. If you have news based on OMA that you would like to share, please send it to us for inclusion in our next *OMA Express!*

Prof Carsten P Welsch, Coordinator

## Research News

# First Medipix3 tests at a 60 MeV proton therapy facility

*Experimental setup for the Medipix3 measurements.*

**Former OMA Fellows Jacinta Yap, now at University of Melbourne, and Navrit Bal from NIKHEF, have just published a technical report in the Journal of Instrumentation presenting measurements of the Medipix3 detector in the 60 MeV ocular proton therapy beamline at the Clatterbridge Cancer Centre, in the U.K.**

The Medipix3 is a hybrid pixel detector able to count individual protons at clinical flux, with millisecond scale time resolution, linear count rate, and almost instantaneous readout time.

The experimental measurements performed at the Clatterbridge 60MeV proton therapy beamline were compared with standard film dosimetry methods. Simultaneous irradiation of the film and detector placed at multiple locations in the delivery system allowed a direct comparison of the transverse beam distributions. The researchers found a general agreement between both methods, particularly at the lateral edges of the beam, although some irregularities were observed depending on the beam quality on the day.
This was the first time that the performance of the Medipix3 detector was tested within a clinical, high proton flux environment.

The exceptional capabilities of the Medipix3 technology made possible to resolve otherwise unknown information about the Clatterbridge Cancer Centre's beam and accelerator, undetectable with typical instruments.

These results demonstrates the capabilities and versatility of Medipix3 for charge particle therapy, suggesting its suitability as a fast and efficient, future tool for routine dosimetry, commissioning and beam monitoring.
The successful outcome of the work carried out jointly by the Fellows Jacinta Yap and Navrit Bal highlights the benefits of collaborative research fostered by training networks such as OMA.

**Medipix3 for dosimetry and real-time beam monitoring: first tests at a 60 MeV proton therapy facility**
J.S.L. Yap, N.J.S. Bal, A. Kacperek, J. Resta López, and C.P. Welsch, Journal of Instrumentation 16, T11001 (2021)
https://doi.org/10.1088/1748-0221/16/11/T11001

## Network News

# Liverpool experts help shape the training of the next generation of researchers


*Theun van Veen (University of Liverpool) presented a talk about 'Researcher training – benefits from a cohort approach'.*

**Marie Skłodowska-Curie Actions (MSCA) target the development of excellent researchers through international and cross-sector mobility.** MSCA networks support joint doctoral programmes, implemented by European partnerships of universities, research institutions, industry (incl. SMEs) and other non-academic organisations. An expert workshop on 'MSCA Networks - Training the next generation through collaborative programmes' was held on 29 September 2021, hosted by the University of Liverpool's QUASAR Group. The online event attracted staff at academic and non-academic organisations from across Europe, who are planning to participate in one of the next MSCA Doctoral Networks.

Since 2008 OMA Coordinator, Prof Carsten P Welsch, has led no less than five MSCA and has been in charge of the training of almost 100 Fellows. The OMA project has been one of these and received nearly 4M€ funding from the European Union's Horizon 2020 research and innovation programme back in 2015.

Professor Welsch and his QUASAR Group have extensive experience in the specific needs of large-scale collaborations and are responsible for the day-to-day management of research and training projects, partner contracts, science communication and outreach. Formal project evaluations have commended the communication and outreach coordinated by the T.E.A.M. in Liverpool as "exemplary" and "outstanding in disseminating project results to the general public".

This places the Group in an ideal position to share best practice and provide participants at the workshop with a detailed understanding of the opportunities (and challenges) that the MSCA Doctoral Networks scheme offer.
The workshop programme included speakers from UK Research Office (UKRO), several experts from CERN and experts from the QUASAR Group.

Professor Welsch said: *"MSCA networks are ideal to enable cutting edge collaborative research. They are based on close collaboration between universities, research centres and industry. We have clearly seen that the innovative and extensive training, development and research opportunities our MSCA Fellows received could simply not be offered by a single university."*

MSCA networks shall provide doctoral students with excellent research skills, coupled with experience outside of academia to develop their innovative capacities and boost their employability. The training concept developed in OMA is expected to benefit future generations of MSCA Fellows.

## Helmholtz-Zentrum Berlin joins OMA as Adjunct Partner

**Helmholtz-Zentrum Berlin (HZB) has become the latest member of the OMA family after the Steering Committee accepted unanimously their request for admission as an adjunct partner.**

The **Proton Therapy group at HZB**, led by Prof Dr Andrea Denker, is routinely treating eye tumours with a 70-MeV cyclotron in collaboration with the Charité hospital in Berlin, where they have treated more than 4,000 patients so far with 97% tumour control.

The proton irradiation centre at the HZB is Germany's first proton therapy facility and unique in its technical capability.

Their current R&D activities focus on **FLASH studies**, mixed/cocktail ion beams, dosimetry, minibeam therapy and developing a dedicated cyclotron for eye tumours.
The partnership of HZB with OMA will open the possibility to establish new collaborations and research activities.

**Welcome!**

HZB Helmholtz Zentrum Berlin

## Fellows Activity

### New recruit at Bergoz Instrumentation

**Sudharsan Srinivasan following his successful completion of the OMA project at Paul Scherrer Institute (PSI), has joined Bergoz Instrumentation.** In his new role as a Project leader, Sudharsan will further develop his competencies in beam instrumentation and will complement the product portfolio and expert support provided by Bergoz Instrumentation.

BERGOZ Instrumentation is a French SME, founded in 1981, focusing on non- destructive beam instrumentation for particle accelerators. Always moving forward, the company design, develop, and manufacture high-precision Current Transformers and Analog RF Electronics, leveraging our worldwide leadership in this domain.
Its non-intercepting measurement systems allow a characterization of low current particle beams without disturbing beam quality. This exceptional strength is recognized throughout the particle accelerator landscape. 99% of the world's high-energy particle accelerators of all technologies use these instruments: Colliders, Synchrotron Light Sources, Laser-Plasma Wakefield Accelerators, Free Electron Lasers..., as well as medical accelerators.
Bergoz is no stranger to OMA, as it was an associated partner in sister training networks oPAC and AVA, and maintains strong relationships with partner institutions such as GSI, CERN, and other leading laboratories in the field.

Apart from networking opportunities, OMA provided its fellows with a state-of-the-art training in accelerator research that is allowing them to obtain positions at top institutions. Sud says: “With the OMA project at PSI, I could develop the necessary skill set in beam instrumentation which has helped me land the job with Bergoz instrumentation.”

**Congratulations!**

*Sudharsan Srinivasan*

## Partner News

# New *JetDose* project set to optimise proton beam cancer therapy

**Experts from the University of Liverpool have been awarded Science and Technology Facilities Council (STFC) funding to develop a novel monitoring system to help optimise proton beam cancer therapy.** The new *JetDose* project will involve close collaboration between Liverpool, the company D-Beam, experts from the Clatterbridge Cancer Centre (CCC), Fondazione CNAO, and IBA in Belgium. It is a direct result from the successful research collaboration between those institutions within OMA.

Proton beam cancer therapy relies upon knowledge of the detailed beam properties to ensure effective dose delivery to the patient. Clinical settings currently use interceptive ionization chambers which require daily calibration and suffer from slow response times. With new and emerging treatment techniques using ultra high dose rates, there is a demand for the development of novel beam monitors, which are fast, non-invasive and calibration-free.

The Liverpool experts will carry out a cutting-edge research program into a novel monitor that will enable non-invasive in-vivo beam dosimetry in hadron beam cancer therapy. The project is led by OMA Coordinator Professor Carsten P Welsch and is supported by a £330k award from STFC's Challenge Led Applied Systems Programme (CLASP).

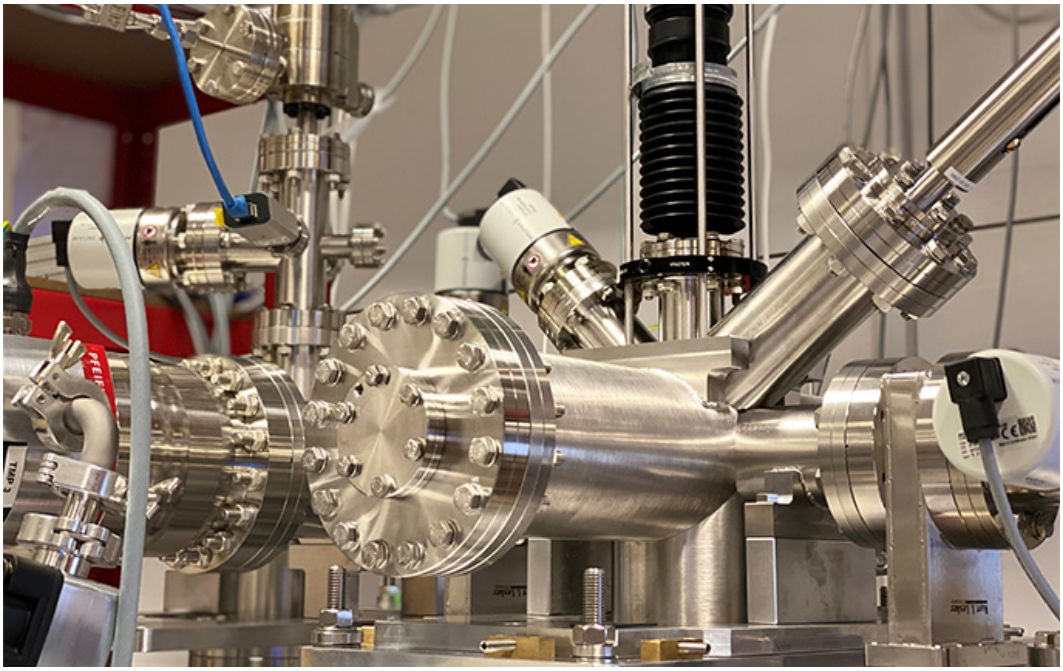
Current methods to carry out beam characterisation require multiple systems each imparting a slight disturbance to the particle beam as it passes by. This disturbance can alter the intended transverse dose profile of the beam, ultimately creating slight deviations from a patient's treatment plan. Quality assurance methods are mostly disruptive measurements and do not allow treatment to take place at all whilst they are being conducted. *JetDose* will develop a new in-vivo dosimetry system based on the re-application of technologies pioneered by Professor Welsch's QUASAR Group.

The underpinning technology was originally developed for use with low energy antiproton beams and most recently adapted for gas jet profiling for the high luminosity upgrade of the Large Hadron Collider at CERN. In this system, a supersonic gas jet is fired across the high intensity proton beam at the LHC.

The gas molecules have little-to-no effect on the proton beam, however the proton beam excites the gas molecules; this excitation can be imaged, which is turn provides a complete non-invasive two-dimensional profile image of the proton beam.

*JetDose* will redirect this technology at the medical accelerator sector, by optimising it for the different challenges found in a treatment facility. The non-invasive means of producing a profile image will allow the monitor to be run online alongside treatment operation. As the intensity in the images directly depends upon the beam intensity, and therefore the dose, an image collected with this system provides an in-vivo dose map of the beam being delivered to the patient.

Professor Welsch said: "*JetDose will produce a novel monitoring system which addresses the growing need for in-vivo dosimetry in medical facilities across the world. This technology also shows good promise for application at other high intensity, high energy particle accelerators and this wider market will be assessed as part of the business plan that will be developed. The project marks an important step in the physics department's impact strategy*."



*Gas jet-based beam monitor prototype at the Cockcroft Institute.*

## Dr Christian Graeff receives professorship at TU Darmstadt

**OMA member Dr Christian Graeff, who leads the Medical Physics group at GSI Biophysics, has been appointed professor at the Department of Electrical Engineering and Information Technology (ETIT) of TU Darmstadt.**

Christian's teaching is centred on the Master's program in Medical Technology, which provides knowledge and skills in engineering and human medicine.

After studying medical engineering at the Technical University of Hamburg-Harburg, Christian Graeff received his doctorate with a study on computer tomography-assisted diagnostics of osteoporosis. He worked as postdoc in the Medical Physics group of the Biophysics Department at GSI, before taking over as head of this group in 2012.

His research has focused on innovative applications of ion beams (for example, research on the treatment of cardiac arrhythmias with the use of carbon ions), the development of methods for irradiating moving targets with scanned ion beams and the development of new therapy control systems for raster scanning. For his scientific achievements, Christian Graeff was awarded the Günther von Pannewitz Prize of the German Society of Radiation Oncology (DEGRO) and the Behnken-Berger Prize for young scientists.

Christian Graeff joined OMA as representative for GSI, where he supervised fellow Michelle Lis, and was elected as a member of the Steering Committee of OMA in its first supervisory board meeting.

**Congratulations!**

*Dr Christian Graeff*

## OMA partner MedAustron reaches milestone of 1,000 cancer patients treated

**Just over 1,000 cancer patients, including many children and adolescents, have completed particle therapy at MedAustron since the start of operations at the end of 2016.**

The MedAustron Ion Therapy and Research Center is one of only six centers worldwide that uses this form of cancer treatment with two types of charged particles – namely protons and carbon ions.

Charged particle therapy offers a lower risk of side and long-term effects, better tumor control in complex indications, and improved quality of life.

The analyses already show that patients with head tumors, for example, retain their neurocognitive performance and resilience after completing their therapy. This includes visual-motor coordination, verbal short-term memory, and word fluency. Tumor control in very complex cases is also promising. In that group of patients whose brain tumors recurred after previous other irradiations and who were irradiated with protons at MedAustron, late effects occurred in less than 10% of those affected. Tumor control, i.e. the absence of new tumor growth, was 87% after two years (example meningiomas).

*Treatment room at MedAustron.*
*(Image © Thomas Kästenbauer)*

About 17% of the patients treated at MedAustron are children and adolescents between one and 18 years of age. They benefit particularly from particle therapy: their growing tissue reacts especially sensitively to radiation, and the risk of long term effects in adulthood is high. Therefore, the lower the radiation exposure, the better the chances of normal tissue development and thus preservation of quality of life for many years to come. The treatment of pediatric indications with protons is now very well established, and particle therapy is often routinely used as the preferred form of radiation.

Eugen B. Hug is a pioneer in the treatment of children with protons. As MedAustron's Medical Director, he comments on the results of the first 1,000 treatments: "*I am very pleased with the promising results we have achieved with the first thousand patients, because they show us that the promises we made at the start of operations were not mere empty words. We can effectively combat many difficult-to-treat cancers while preserving the quality of life of those treated in the longer term. The longer we are in operation and the more data we collect, the stronger we can back this up and generate evidence for the benefits of particle therapy.*"

Currently, the most frequently treated conditions differ depending on the type of particle applied. Protons are most frequently used to treat head and neck tumors, pediatric tumors and tumors of the central nervous system. Carbon ions, which are used primarily for tumors that do not respond or respond insufficiently to other types of radiation, are currently used primarily for re-irradiation, sarcomas and also for head and neck tumors. The overall spectrum of indications also includes, to a lesser extent, tumors at the skull base, in the gastrointestinal area, and urogenital and gynecological tumors.

Thanks to the development of innovative new treatment concepts and new clinical studies, the range of cancers that can be treated at MedAustron will continuously expand in the coming years.

Find out more:
https://www.medaustron.at/en/node/533

# Slovenia's engineer of the year 2020 talks about her career journey into Cosylab

**A top Slovenian women's magazine has published an inspiring interview with Cosylab's engineer Jasna Hengovic.** Jasna, who was selected Slovenia's top female engineer of 2020, explains in the interview how she became a programmer at Cosylab, developing software for cancer treatment and promoting STEM profession amongst new generations.

Jasna's career was strewn with obstacles. When she wanted to join a computer club in elementary school she was turned down, being told that it wasn't for girls. At that age, children are just learning what the world around is like and they accept anything they are given, so she accepted it as a general social fact.


*Jasna Hengovic*

Jasna finally got into computer science more or less by accident. She wanted to study architecture but wasn't accepted there. As a second option, she chose mathematics where she eventually enrolled, but that experience from elementary school had stayed with Jasna and she was actually scared of programming.

It was during her studies of maths that she saw the light and began to understand programming. "*You just tell the computer what to do and it's going to do it. No more than that. It's like you've learned another language*", she says. Only then she discarded those social clichés that almost ended her journey into computing. This realization opened up the world of programming for her. Jasna joined the company Cosylab, where she is involved in the development of proton therapy software, which enables more effective cancer treatment, because she would like to contribute to the common good in her profession.

The title of engineer of the year 2020 has given Jasna the chance to hear many stories from women and girls and some have been really discriminated against along the way.
The quotation for her title reads "*With her curious and courageous spirit and inner strength to listen to herself, she is an example and inspiration to young people*". As she says, in this role, she wants to encourage more girls to take the path.

You can read the whole interview here: https://micna.slovenskenovice.si/moja-sluzba/jasna-hengovic-inzenirka-leta-programiranja-me-je-bilo-tako-strah-da-nisem-mogla-normalno-studirati

# Quality Assurance Detector for Proton Beam Therapy

**A team of researchers from University College London, led by Professor Simon Jolly, has obtained a research grant from the UK's Science and Technology Facilities Council (STFC) to fund the project *QuADProBe*: Quality Assurance Detector for Proton Beam Therapy.**

In order to ensure that Proton Beam Therapy treatment is carried out safely, a range of quality assurance (QA) procedures are carried out each day before treatment starts. This means checking that the proton beam is in the correct position, is the right shape and size, and travels the correct depth: this must be checked for a range of different beam positions and energies to ensure treatment is safe. These QA measurements take significant time to set up and adjust for different energies: the full procedure can take over an hour.

*QuADProBe* is developing a detector that can make faster and more accurate measurements of the proton beam size, position and range than existing systems.
The detector is made of two parts. The first is a profile monitor made of two arrays of scintillating optical fibres, mounted at right angles to each other, which emit light when the proton beam passes through. This light can be measured with photodiodes to determine the beam size and position.
The second part, behind the profile monitor, is a detector built from layers of plastic scintillator. Protons passing through this scintillator stack deposit energy in each layer that is converted into light: by recording the light from each layer, the amount of energy the protons deposit along their path can be measured. Such a system provides a direct measurement of the range of protons in tissue, since the absorption of the plastic is virtually identical to human tissue.
This detector could allow the full morning beam QA procedure to be carried out in a few minutes, with an accuracy well below a millimetre in size, position and range. This would translate into being able to treat an extra 12 – 18 patients every day at the two new UK centres for Proton Therapy (at University College Hospital in London and The Christie in Manchester).

The *QuADProBe* project builds on the success of the QuARC scintillator range calorimeter, which was funded by an STFC grant and was originally developed through the work of OMA fellow Laurent Kelleter. The project also benefited immensely from several OMA partners, including Cosylab and MedAustron.
The grant was awarded through the Challenge Led Applied Systems Programme (CLASP), which was established to support the application and commercialisation of STFC research in four key global research challenge areas: Energy, Environment, Healthcare, and Security.

*Campus of University College London (Image credit: UCL)*

## Upcoming Events

### FLASH Radiotherapy and Particle Therapy Conference (FRPT 2021)

1st – 3rd December 2021, Vienna and Online

**FRPT 2021 looks to build a worldwide organisation of scientists and professionals interested in FLASH Radiotherapy (RT) using protons, electrons, heavier charged ions and photons.** The conference will gather researchers and students (from academia and industry) with professionals working in clinical oncology, and provide a multidisciplinary forum to discuss the latest developments in FLASH RT.

FRPT 2021 goes from basic science, through preclinical research and combines these with translational applications and clinical trials and treatment. The ultimate goal of the conference is to harness the potential for FLASH RT in a rigorous scientific and quality assured environment and to act as a forum for the very latest advancements in this rapidly developing field.

More information:
https://www.liverpool.ac.uk/oma-project/news/stories/title,1250187,en.html

Conference homepage:
https://frpt-conference.org/

Follow on Twitter @FlashRPT

## 13th International Particle Accelerator Conference (IPAC'22)

12th – 17th June 2022, Bangkok, Thailand

**The 13th International Particle Accelerator Conference (IPAC'22) will be held in Bangkok, Thailand on 12-17 June 2022 at IMPACT Exhibition and Convention Center, located in Muang Thong Thani, Nonthaburi Province in the northern part of Bangkok, Thailand.** The Center is Thailand's largest and one of Asia's biggest and most modern exhibition and convention centers. It is a world-class commercial complex consisting of an arena, convention center and exhibition halls. Surrounded by a wide range of hotel options with standard of service and facilities, choices of top restaurants, food courts, cafes and fast food outlets, supporting facilities, and its convenient location for local transport, the Center is the most appropriate and best option for the IPAC'22.

IPAC is the main international event for the worldwide accelerator community and industry. Attendees will be presented with cutting-edge accelerator research and development results and gain the latest insights into accelerator facilities across the globe. Over 1,000 delegates and 70 industry exhibits are expected to attend this remarkable and noteworthy event. This is a unique opportunity to meet, interact and network with accelerator scientists, engineers, students and industrial vendors.

**For registration and more information visit:**
https://www.ipac22.org/

## LINAC2022 will take place in Liverpool

28th August – 2th September 2022, ACC Liverpool, UK

**In 2022, the linear accelerator conference (LINAC) will come to England, the birthplace of accelerator science, and take place at the Arena and Convention Centre in beautiful Liverpool, UK on 28 August - 2 September 2020.**

LINAC is the main bi-yearly gathering for the worldwide community of linear accelerator experts. The conference will provide a unique opportunity to hear about the latest advances in research and developments on hadron and lepton linacs and their applications.

Following a long and successful tradition, LINAC2022 will feature invited and contributed talks, as well as poster sessions and an industry exhibition. The scientific programme will be complemented by social events that promote informal knowledge exchange. There are a number of sponsorship opportunities for all those who would like to support the event and gain visibility.

LINAC encourages in particular students to participate and a number of scholarships will be offered.

Registration will open soon
https://linac2022.org/

## 20 years of CNAO

**On 24th November 2021, CNAO (Centro Nazionale di Adroterapia Oncologica) hadrontherapy centre in Pavia, Italy**, opened its doors to institutions, scientists, doctors and researchers to celebrate twenty years since its birth and ten years since the start of cancer treatments at the CNAO facility. Since then, more than 3600 patients have been treated at this state-of-the-art centre, one of only six in the world able to perform hadrontherapy with both proton and carbon ions.

**Congratulations to CNAO on reaching this important milestone!**


*Image credit: CNAO*

## Selected Publications

**Medipix3 for dosimetry and real-time beam monitoring: first tests at a 60 MeV proton therapy facility**
J.S.L. Yap, N.J.S. Bal, A. Kacperek, J. Resta López, and C.P. Welsch
Journal of Instrumentation 16, T11001 (2021)
https://doi.org/10.1088/1748-0221/16/11/T11001

**3D chest tomosynthesis using a stationary flat panel source array and a stationary detector: A Monte Carlo proof of concept**
T.G. Primidis, S.G. Wells, V.Y. Soloviev, and C.P. Welsch
Biomedical Physics & Engineering Express, in press (2021)
https://doi.org/10.1088/2057-1976/ac3880

## Upcoming Events

| | |
|---|---|
| 1st – 3rd Dec 2021 | FLASH Radiotherapy and Particle Therapy Conference (FRPT 2021) , Vienna and Online |
| 12th – 17th June 2022 | IPAC'22, Bangkok, Thailand |
| 28th Aug - 2th Sept 2022 | LINAC2022, Liverpool, UK |
| 11th – 15th Sept 2022 | IBIC'22, Krakow, Poland |

## NOTICE BOARD

DEADLINE FOR THE NEXT NEWSLETTER **28th February 2022**

www.oma-project.eu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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 675265.