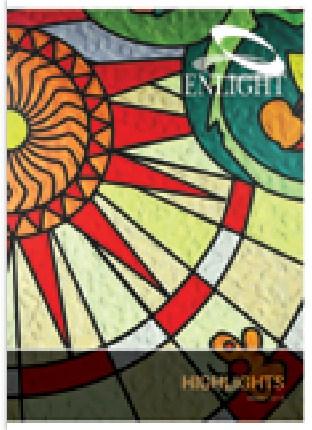
HIGHLIGHTS

December 2015



PAGE INDEX

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http://indico.cern.ch/event/180036/registrations/495

COVER
This edition's cover is the painting on the wall of the children's waiting room in The Bronowice Cyclotron Centre, Krakow, Poland.

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ENLIGHT ENVISIONS ITS FUTURE

Over its 13 years of life, our network has undoubtedly acquired the recognition of our many partners: the European Commission (EC), which supported four big projects; the various institutes involved and let's not forget the members of the community who took the decision to keep the network alive even after the end of our official mandate from the EC.

We should be proud of our most tangible achievement: ENLIGHT succeeded in blending traditionally separate scientific communities with the common goal of more effective treatments against cancer and improving treatment outcome. This is not just a rhetorical sentence we would use to get journalists interested in what we do. Indeed, the 2015 annual ENLIGHT meeting, held in Krakow, featured several presentations that covered the numerous areas where the contribution of the members of the network was really remarkable. The speakers reported on the status of research (in hadron therapy, imaging, radiobiology and data sharing), as well as on the current medical trials using ions. In Europe, with two new dual-ion therapy centres in Marburg (Germany) and Wiener Neustadt (Austria) – and the proton-therapy centre in Krakow (Poland), the members of ENLIGHT have many reasons to celebrate. Marburg started treating patients in October and the other two will start in the coming months.

The annual meeting is, as always, the place where we also discuss and shape our future. The end of ENTERVISION in January 2015 marked a turning point for our network as it's the first time since 2006, we have no research or training projects running with EC funding. We also became fully aware that cancer is no longer considered the highest priority in the European health agenda and that the focus of R&D for hadron therapy has shifted since the birth of ENLIGHT, if only for the simple reason that the number of clinical centres (in particular for protons) has dramatically increased. When times are difficult, it is essential to question the very roots of a community, and to check whether they are still strong. Therefore, in Krakow, we had to address an even more fundamental issue; the very existence of our network. Do we still believe in it? Do we consider it important? Do we want to keep it alive?

The positive response came back loud and clear. There was general agreement on the need for such a broad-umbrella platform, which is highly appreciated by the hadron therapy stakeholders and also admired outside Europe.

Over the years, our community has shown a remarkable ability to reinvent itself, while maintaining its cornerstones of multi-disciplinarity, integration, openness and training of future generations. In a year from now, at the 2016 annual meeting, the new ENLIGHT will be presented, ready to tackle the evolving challenges of a frontier discipline such as hadron therapy.

Manjit Dosanjh

ENLIGHT

Annual Meeting September 2015

The 2015 ENLIGHT annual meeting was held at the Institute of Nuclear Physics in Krakow, Poland and was opened by its Director Marek Jezabek. It was held where the new proton-therapy centre has just been inaugurated and attended by over 140 participants. The detailed agenda and presentations can be found at http://indico.cern.ch/event/392790/

The invited talks started with an overview from Michael Baumann (Dresden, Germany), who described the potential of particle therapy and highlighted the need to establish an extensive Europe-wide collaborative database for joint evaluation and analyses and harmonising data. This is key to sharing information and collecting clinical data on patient, tumour, treatment and outcome parameters.

Since this is a major challenge for the radiation therapy community at large, and in order to start addressing this issue, Baumann reported on the recently held particle therapy strategy meeting organised by ESTRO in Brussels in April 2015. Attended by representatives from each of the prospective particle centres in Europe they presented their facilities and on-going activities and plans. Following this discussion seven work-packages were established to address some of the key aspects and future challenges in the subject for the radiation oncology community:

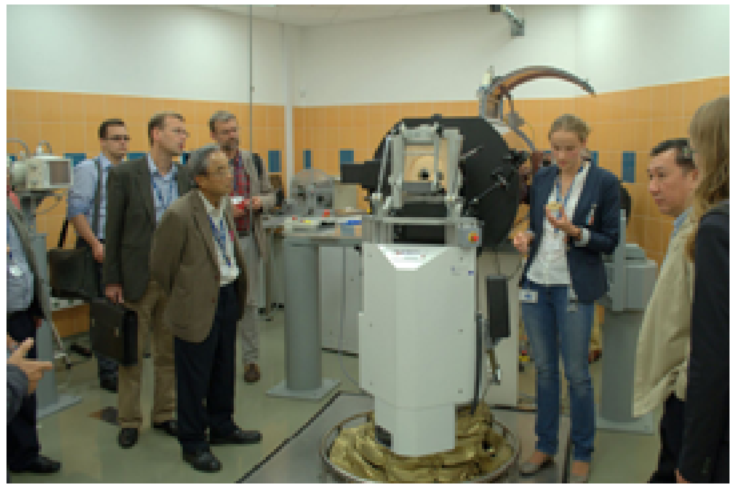
1. Scoring of normal tissue reactions and tumour response particle/photon Radiation Therapy (RT); endpoint definitions, outcome database,
2. Dose assessment, quality assurance, dummy runs, technology inventory,
3. Trials inventory (website); "Towards joint clinical trials",
4. Image Guidance in particle therapy,
5. Treatment planning system (TPS) in particle therapy,
6. Radiobiology, Relative Biological Effectiveness (RBE) and
7. Health Economy.

A first report from the working groups is expected to be submitted for the next ESTRO particle therapy meeting in May 2016.

From Europe, Juergen Debus (HIT, Germany) and Roberto Orecchia (CNAO, Italy) delivered reports on the status of hadrontherapy for each of their clinical facilities. They presented patient data, patient numbers and dose distribution studies with both protons and carbon ions collected mainly in mono-institutional cohort studies. Impressive arrays of present and future clinical trials were shown, along with necessary compromises and assumptions, including 2 phase III randomised studies. The aim is (biological) individualisation of radiation oncology. To achieve this, greater numbers of outcome events will be required for statistical analysis in some cases, which highlights the need for a common particle database system. Progress in commissioning the new particle therapy centre in Wiener Neustadt was reported by Richard Pötter from the Medical University of Vienna (MUW) (in the absence of Ramona Mayer). For translational research at MedAustron, Thomas Schreiner reported on the formation of three university chairs which operate in close cooperation with MedAustron: Medical Radiation Physics (Lembit Sihver (TU Vienna)), Medical Radiation Physics and Oncotechnology (Dietmar Georg, MUW)) and Translational Radiobiology (Wolfgang Dörr, MUW). The organisation, infrastructure and implementation for non-clinical research at MedAustron using a horizontal fixed beam was presented by T. Schreiner in general and D. Georg for Medical Radiation Physics in particular. The first non-clinical research proton beam is scheduled for June 2016. A comprehensive particle translational research programme for MedAustron will be available soon. To add to the European landscape Jacques Balosso pointed out the challenges of establishing a national platform, France Hadron.

ENLIGHT meetings are often attended by participants from beyond Europe. On this occasion Dr Bhadrasain Vikram of the National Cancer Institute, USA (NCI) talked about the on-going and future trials funded by the institute. Several randomised and non-randomised trials have been set-up to investigate either improvement of survival or decrease of adverse effects (protons versus photons) including a pancreatic cancer trial using C ions at a treatment centre outside the USA. Overall survival has been selected by NCI researchers as endpoint for randomized trials (protons versus photons) in glioblastoma, NSCLC, HCC and oesophageal cancer. Adverse side effects are selected as endpoints in phase III trials comparing protons and photons for low grade glioma, oropharyngeal cancer, nasopharyngeal cancer, prostate cancer and post-mastectomy radiotherapy in breast cancer. In order to identify gaps in our current knowledge and research opportunities, NCI plans to conduct a small workshop on particle biology in 2016.

There were two talks on Imaging for particle therapy, where the importance of imaging the Bragg peak position was stressed by Alberto Del Guerra (Pisa, Italy), who reviewed the mechanisms of PET imaging in detail, ending with a firm conclusion that a combination of prompt gamma and PET imaging are required for the best estimations of dose placement. Pawel Moskal (Jagiellonian University, Krakow) gave a detailed account of the Polish design and implementation of Jagiellonian-PET (J-PET) technology for medical imaging, for which several international patent applications have been submitted. J-PET uses long plastic detector elements connected to photomultiplier tubes, arranged to form a hollow tube around the body being imaged. J-PET/MRI and J-PET/CT combined modalities were also discussed.



Centre visit at ENLIGHT Annual Meeting 2015, Krakow, Poland

Registration at ENLIGHT Annual Meeting 2015, Krakow, Poland

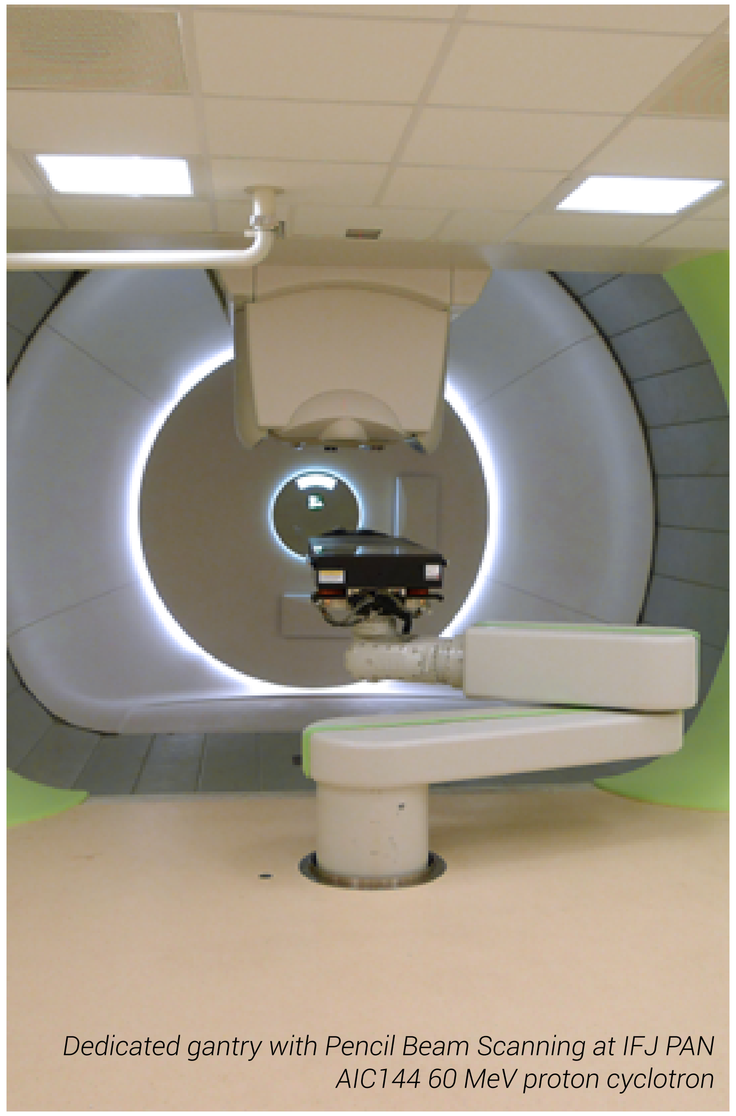
A subject of broad and current interest within the hadrontherapy community is radiobiology. Rolf Lewensohn (Karolinska Institutet, Sweden) described the progress in the comprehension of molecular tumour response to irradiation with ions and photons, and the biological consequences of the complex, less repairable DNA damage caused by ions. Understanding the signalling pathways affected by hadrontherapy will lead to improvements in therapeutic efficacy. A particularly thorny issue is the RBE of protons with respect to photons: currently, proton therapy treatment plans are determined using a spatially invariant RBE of 1.1, both within the tumour and in the normal tissues. Radhe Mohan (MD Anderson, Texas, USA) presented an analysis of unanticipated treatment responses, coming to the conclusion that the use of a variable RBE would offer safer and clinically advantageous proton therapy. Tony Lomax (PSI, Switzerland), while presenting the impressive proton beam physics developments and experience at PSI and imaging and treatment planning techniques, defended the current policy of a 1.1 RBE allocation in all tissues and at all doses. The lively debate that followed highlighted the need for extensive and systematic radiobiology studies with different ions, under standardised dosimetry and laboratory conditions: these could be carried out at the existing and future beam lines of HIT, CNAO, and MedAustron, as well as at the proposed CERN OpenMED facility.

Angeles Faus-Golfe (IFIC, Valencia) described the Applications of particle accelerators in Europe (APAE) initiative report under the EuCARD-2 project, which is presently being written to advise the European Commission and policy makers on the future potential for applications of accelerators for societal benefits, including radiotherapy, security and energy applications. There is a dedicated section on "Health" to which contributions from the ENLIGHT community are very welcome http://apae.ific.uv.es/apae/.

Philippe Lambin talked about the problem of medical data collection and transfer and the need for Big Data solutions in the analysis of clinical data, which especially should apply to radiation therapy with its need to analyse patient and tumour data and complex physical dose arrays and to correlate these with clinical outcomes that may also have genetic determinants. Such Big Data analysis can help to provide support for decision making in the individual patient.

The ENLIGHT coordinator Manjit Dosanjh (CERN) was the final speaker who presented what the ENLIGHT network has done over the years and the current status. This set the stage for the discussion on the future of ENLIGHT. This year, following the one and half days of excellent talks encompassing the wide spectrum of hadrontherapy, both new and long-time members were given the additional challenge to discuss the future of ENLIGHT.

Saturday ended with the host Pawel Olko, Director of the Cyclotron Centre Brononwice, inviting the participants on a tour of the nearby impressive new particle therapy centre.



Dedicated gantry with Pencil Beam Scanning at IFJ PAN AIC144 60 MeV proton cyclotron

Waiting room for children

THE BRONOWICE CYCLOTRON CENTRE

The Henryk Niewodniczański Institute of Nuclear Physics (IFJ PAN) has a long tradition in hadron radiotherapy. Between the years 1976 and 1994, 550 patients with head and neck cancers were treated using the fast neutron beam from the U-120 classical cyclotron. The AIC-144 isochronous cyclotron was designed at IFJ PAN at the end of the 80's and adapted to proton radiotherapy between 2008 and 2010. The beam delivery system and a treatment room were also developed in-house by local engineers, technicians and software developers. Currently at Kraków University Hospital 50 patients with eye-melanoma are irradiated yearly, under contract with the National Health Fund. Based on this, a new proton therapy facility, with 230 MeV Proteus cyclotron from Ion Beam Applications, with two scanning gantries, an eye-line for ocular radiotherapy and an experimental hall have been purchased and recently opened at IFJ PAN. The new centre is under commissioning and will be fully operational by the end of 2015. The centre will also operate as a research facility where experiments in nuclear physics, and development projects in radiation physics, radiobiology and materials engineering will be conducted.

ENLIGHT Annual meeting - CERN Knowledge Transfer prizes

Young researchers were encouraged to prepare posters, which were on display during the meeting. CERN Knowledge Transfer (KT) prizes were awarded to the three best posters by Giovanni Anelli, head of KT at CERN, and Karen Kirkby of The University of Manchester and Christie NHS Foundation Trust. The prize winners were Julia Bauer from Heidelberg Ion Beam Therapy Center (HIT), Martyna Sniegocka from the Jagiellonian University, Krakow, and Simona Giordanengo and team from INFN and the University of Turin, represented by Mohammad Varasteh Anvar. Each of them were given the opportunity to give an oral presentation of their work in the final session of the meeting.

Martyna presented the work done to check the influence of proton beam radiation on the growth of pigmented line of Bomirski Hamster Melanoma (BHM Ma) localized in an anterior chamber of the hamster eye. They have also tested if the combination of proton beam radiation with antiangiogenic drug (Avastin) or vitamin D makes it more effective. Their experiments could show that combination of antiangiogenic and proton therapies effectively prolong animal mean survival most likely due to reduction of lungs metastases and that proton therapy preceded by vitamin D administration increased animal mean survival as a consequence of prolonged growth of primary tumour.

Mohammad, reported on the progress they have made in the development of a new system which integrates very fast forward dose computation into a dose delivery system in order to evaluate on-line the dose distribution of scanning ion beams, in presence of intra-fractional target movements and beam uncertainties. The fast forward planning for both protons and ions has been developed and benchmarked against similar and validated algorithms developed for a Treatment Planning System implemented for execution on CPUs. The preliminary results show a substantial reduction in the required processing speed, for a similar performance.

Julia presented some interesting results on in-vivo verification of the delivered dose distribution through a PET-based method, which measures the spatial distribution of positron emitting radionuclides generated in inelastic nuclei interactions in the irradiated tissue. More than 200 patients have received post therapeutic verification imaging (PT-PET) at HIT, showing the effectiveness of the technique while giving at the same time useful indications on new research lines.

Discussion on ENLIGHT and its **FUTURE**

The final session of the annual ENLIGHT meeting was devoted to an open discussion among the ENLIGHT members to assess the need to continue the network, outline current challenges and formulate the future of ENLIGHT, both in terms of the network structure and scientific priorities. The session was chaired by Richard Poetter (Medical University of Vienna) who reviewed the history of hadrontherapy in Europe, its organisation, the work of ESTRO in the 1990's, the PIMMS initiatives by CERN and effectively the formation of ENLIGHT, which has served the hadrontherapy community well since its birth in 2002 to the present time.

In 2006 the EC-funded ENLIGHT network project came to an end. In spite of this, the network members decided to keep it alive as they found it to be an important vehicle for collaboration. Since then, ENLIGHT has been coordinated by Manjit Dosanjh (CERN). While the network itself flourishes without dedicated funding, R&D activities have been funded primarily through EC projects.

The functions of ENLIGHT include:

- Using the multi-disciplinarity of the ENLIGHT partners as a platform to prepare projects to be funded by the EC both for cutting edge research for improving particle therapy and education and training of young professionals.
- Maintaining and strengthening the network via regular communication channels i.e a dedicated public website, bi-annual ENLIGHT Highlights, and free annual network meetings with talks by world leading experts as well as young researchers in the field.
- Disseminating research results within the scientific community as well as raising awareness among the general public
- Continuing to liase with industry and within the EU.
- Helping with strategic project development for hadrontherapy throughout Europe and beyond.

Between 2007 and 2015, under the umbrella of ENLIGHT, four EC projects - PARTNER, ULICE, ENVISION and ENTERVISION - were successfully coordinated and funded with a total of 24M Euro. All four projects were directed towards different aspects of developing, establishing, and optimising hadrontherapy and training.

The end of ENTERVISION in January 2015 was a turning point for the ENLIGHT network since, as was the case in 2006, there are now no research or training projects funded by the EC. The Horizon 2020 health programme has in fact made it clear that cancer is no longer the highest priority on the European health agenda. In addition, the focus of R&D for hadrontherapy has shifted since 2002, if only for the simple reason that the number of clinical centres, in particular for protons, has dramatically increased. Also, while improvements in technology are still needed to deliver optimal and more cost effective treatments, proton therapy is now solidly in the hands of industry. The advent of single-room facilities will bring proton therapy, albeit with some restrictions, to smaller hospitals and clinical centres.

With an expansion of proton therapy in Europe, there is a need to expand our efforts. In the coming years, the major challenges for the particle therapy community and ENLIGHT will be related to the definition of a roadmap for randomised clinical trials, to cell biology and to the issue of Relative Biological Effectiveness (RBE).

In the area of technology developments, efforts should continue on quality assurance through imaging and on the design of compact accelerators and gantries for ions heavier than protons. Information technologies will take centre stage, as data sharing, data analytics, and decision support systems will become key topics.

The growing number of clinical facilities requires more trained personnel and professionals highly skilled in their specialty will have to become familiar with the multidisciplinary aspects of hadrontherapy.

Therefore, this year's ENLIGHT meeting was the perfect time to discuss and review whether or not we still believe in this network. Do we still consider it important and do we still want to keep it alive?

During the discussion, the participants expressed a strong desire to continue with the ENLIGHT network and to have open annual meetings which should be accessible to all members. They also supported the need for joint/collaborative sessions with ESTRO/EORTC, and PTCOG. Such developments are welcome as this will be of great mutual benefit due to the similar research questions that arise in treatments using protons, carbon and other ions.

The proposal to add a dedicated training day in future annual meetings was very positively supported since training of the new generation of scientists has always been an essential component of ENLIGHT.

The community agreed that it is also time to rethink the organisation of the network itself, in order to sustain it despite the lack of external funding. Several schemes were discussed, including institutional membership with a voting right while maintaining free individual membership or perhaps formally turning ENLIGHT into a not-for-profit organisation/network.

There was also broad agreement on the necessity of having a core group to advise on the functioning of the network. This should include representatives of the technological and clinical disciplines from the diverse geographical membership of the network. Manjit Dosanjh, was given the task of appointing three senior members from the network who will assist her in establishing this core group. The new ENLIGHT will be presented at the next annual meeting ready to tackle the evolving challenges of hadrontherapy.

It became evident during the final discussion that ENLIGHT remains popular, is highly appreciated by the hadrontherapy stakeholders and is much admired outside Europe. It was concluded that a broad umbrella organisation such as ENLIGHT remains necessary and that if it did not exist it would be necessary to invent it.

PARTICLE THERAPY CENTRES IN EUROPE - 2002

P centres
C-Ion centres

PARTICLE THERAPY CENTRES IN EUROPE - 2015

In operation	Under construction	Being planned
Proton	Proton	Proton
Dual Ion	Dual Ion	Dual Ion

Colosseum bunker (painted by Silvio Irilli)

GEMELLI ART: Advanced Radiation Therapy and Art of Rome

BY VINCENZO VALENTINI

Three years ago the Director of our University Hospital invited me to draft the project for a renewed Radiation Oncology Centre. After a couple of days I went back to him with two pages on the vision of the new Centre. I wrote on top of the document the name of the new Centre: 'Gemelli ART', and immediately after the motto: ' Technology to serve knowledge, knowledge to serve patients'.

Why such a name? Agostino Gemelli is the name of the Franciscan friar and founder of the Catholic University; the University Hospital has his name. ART means 'Advanced Radiation Therapy', but also has a liaison with art. Why ART? The idea was to use art to offer relief to our patients. Art is related to beauty, and beauty allows people to look beyond themselves. Our cancer patients are looking inwards and focussing on their fears. Contemplating beauty can help them to look outside of themselves, to feel welcome, and to better establish a relationship with the Gemelli ART staff.

Art is the meaning of Rome. For most of our patients, the beauty of the Rome monuments is part of their life, of their stories, of their emotions. For the patients who don't live in Rome, the city is often perceived as dreams and myths. Therefore, we decided to bring ancient Rome into our Centre. Gemelli ART, a place for the art of Rome, to be in the ART of Rome.

We thought of reproducing in our bunkers two places of Rome: the Aventino Garden and the Colosseum arena. We put forward this idea to our patients and our support community, asking for their opinion on the project, as well as for funding. The success was really impressive: through donations, we raised in a few weeks the several tens of thousands euros necessary for the paintings. A remaining portion of the funding came in small amounts, donated by the general public who wanted to be part of the idea to create a liason from the beauty of Rome and the need for beauty of our patients. Famous Italian artists allowed us to use their songs and performances for the promotion of the initiative. An artist, who works in Rome, decided to offer us a mosaic on the "Tenderness of God", to be positioned in the main corridor in front of our clinical rooms. As patients pass this they have to prepare themselves, deep in their soul, to meet the doctors and afterwards face happiness or sadness depending on the diagnosis. In this place, irrespective of one's faith, the mosaic represents the tenderness of those who try to take care of each and every person and is really anchoring especially for the patients and their families.

For children, a very special tale is depicted. The bunker was transformed into a submarine: the children must reach it, impersonate the captain (a special wheel is available for them), and cross an aquarium surrounded by smiling dolphins.

The motto has the patients at its centre, immediately followed by the word 'Knowledge'. Knowledge has a lot of meanings, but in our perspective represents how to address the complex issue of the clinical decision. We opened two labs (Knowledge Based Oncology: KBO labs) where engineers, mathematicians, and physicists work closely with the Gemelli ART staff on data mining, in order to find signatures in imaging (radiomics) and to model the evidence by prediction models to support clinical decision. One pipeline of our KBO Labs research, to be consistent with our motto, is to capture the patient's perspective. The feelings of the patient, his emotional state, his general condition and his quality of life are captured by an application, called Valeo+ ®. In Latin, valeo means "I have a meaning", and this correctly captures our engagement. The answers are automatically transferred in a protected confidential way to the Hospital data recording archives of the patients, and allow data mining so that the patients' perspective is also included as a variable in the supportive decision models.

Other research addresses the link between modern technology and the data mining process. In May 2015, the Gemelli ART completed step 1 of the plan with three new linear accelerators; in October 2016, step 2 will add one more linear accelerator and an MRI–cobalt treatment unit. All these state of the art machines are linked with the data mining engine to look for the more representative/specific parameters of these innovative radiation oncology technologies.

Three years after the two-page vision document, Gemelli ART (www.gemelli-art.it) is a centre of the oncology network of our University, where patients, beauty, knowledge and innovative technology interplay, attempting to address fears and sadness and put knowledge to work.

Icon of the tenderness of God (accomplished by P.Marko Rupnik)

Submarine bunker (painted by Silvio Irilli)

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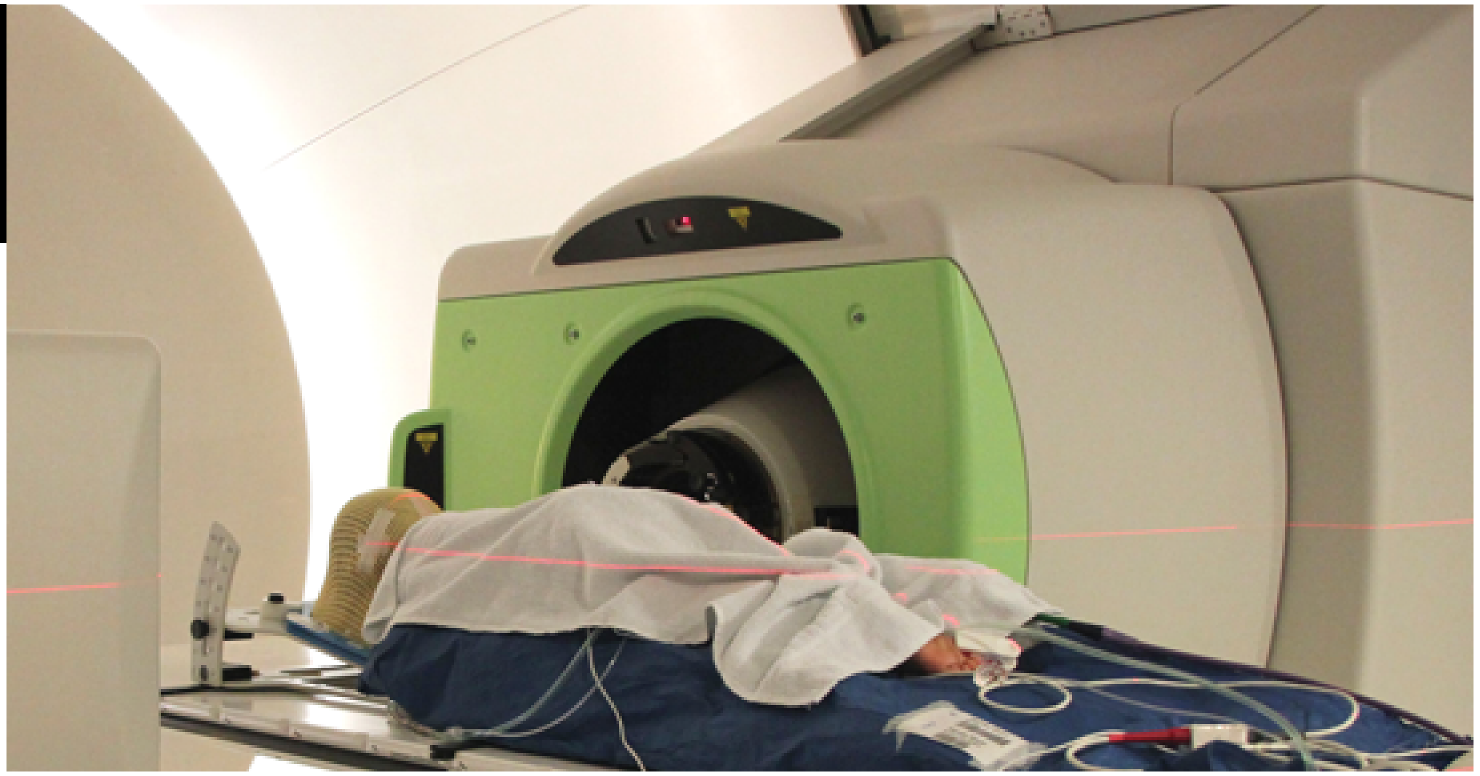


Figure 1: Sedated child under treatment at the Gantry of the WPE

STATUS of the West German Proton Therapy Center Essen (WPE), Germany

BY BEATE TIMMERMANN

START OF THE CLINICAL PROGRAM

After a long period of project planning, extensive measurements and thoughtful testing, WPE finally started clinical operations in early summer of 2013. Beforehand, two major challenges had to be mastered with the recruitment of medical and technical experts as well as with getting numerous employees like Radiation Therapy Technologists (RTTs), clinicians and medical physicists trained in time for clinical operations start.

During the first months of the clinical and technical project many hurdles still had to be overcome. Agreements with medical insurance providers had to be set up, billing processes defined, medical concepts as well as standard operating procedures (SOPs) generated and workflow optimized and re-iterated for fine-tuning. Networking with other disciplines was tightened and participation in tumour boards organized. As the medical team of WPE is part of the university hospital of Essen ("clinic for particle therapy"), medical care in WPE fortunately was rather easy to be linked to all complementary disciplines and experts on the campus. For the technical team, it was not only about getting into a routine but development and eventual commissioning of the facility were further important objectives to be achieved as the clinical start was only the first major milestone within a 4-5 years process of facility completion.

At the time of the first patient treated, only one out of four treatments rooms was operational. As the first modality, uniform scanning was commissioned and clinically used. In-room X-ray systems and laser alignment were used to assure proper treatment positioning. MRI and CT scanners were available to support therapy planning. Commercially marketed planning software was used for treatment planning. WPE staff count was 22 at the time of starting clinical operations. Two prospective patient registries ("ProReg" and "KiProReg") started to enroll patients for treatment at WPE in order to prospectively collect data on patient, diagnosis, treatment, side effects and tumour control.

Until today, major progress has been achieved due to the enormous effort of the WPE team and the University Hospital – both in terms of technical status as well as in research and medical program.

STATUS TODAY

To date, three out of four treatment rooms are in clinical operation. The 4th room is currently under commissioning. All three operational rooms are hosting a 360° rotating Gantry (see figure 1). Two of them have dedicated "Pencil Beam Scanning" (PBS) nozzles, whereas the first room is still operated with uniform scanning. Complementary to in-room verification modalities with X-rays and lasers, out-of-room CT verification is also available and used for 3-D-verification and adaptive planning now. Since 2015, an additional innovative treatment planning tool is also clinically available, allowing for intensity modulated and robust proton therapy (PT) as well as enabling administration of craniospinal intensity modulated proton therapy (IMPT) treatments on a regular basis. The number of full time employees has increased from 22 to 62 since the first treatment. So far, more than 300 patients have been treated and currently about 45 patients are under treatment each day (see details in table 1 overleaf). In cooperation with the campus, 3 major clinical projects were taken into focus so far: CNS tumours, sarcomas and childhood malignancies. About 60% of all patients were below the age of 18 years and more than 30% of all patients required deep propofol sedation for daily treatment, mainly patients younger than 6 years of age. Therefore, WPE offers a highly specialized unique pediatric program collaborating with national and international study boards. Next to proton beam therapy of adult central nervous system (CNS) and sarcoma patients (including chordomas and chondrosarcomas), further clinical adult proton programs were initiated in 2014/15 to provide proton beam therapy for head and neck cancer as well as for prostate cancer patients. In head and neck tumours, optimization of IMPT plans and robustness analysis are an important focus during treatment planning and for further research activities. Patients get referred for PT not only from the region but from all across Germany and Europe. Regarding scientific activities, WPE was embedded into the German Cancer Consortium (DKTK) in which the most important cancer centers in Germany are linked to promote research and cooperative projects. Luckily all academic particle centers in Germany are part of the DKTK today and thus can boost research in clinical, technical and biological fields. Various biological studies are performed at WPE already by local scientists investigating biological effects of proton beams on cell lines and the immune system.

PLANS FOR THE FUTURE

Even after all the extensive work there is still a long way to go. We are awaiting the opening of the 4th treatment room for spring 2016. A nozzle up-grade in one of the PBS room is expected to further optimize beam characteristics especially with regard to our childhood patients. Beside PBS and uniform scanning, passive scattering will also be made clinically available in at least one of the 4 treatment rooms. Moving targets, being an important clinical focus of the West German Cancer Center in Essen, will be the matter of intensive future research programs at WPE in order to offer high-quality PT to lung cancer patients in Essen. Therefore, the impact of robust treatment planning and gating have to be investigated in silico and finally in clinical trials and programs for lung cancer. In 2017, the medical program is planned to occupy 2 full shifts in all 4 rooms and the number of employees will have to be increased up to 120 then. Furthermore, the eye line will be upgraded and commissioned, enabling us to provide proton treatments for choroidal tumour patients in Germany's largest Eye Cancer Center in Essen. Biological and translational research projects will continue as well as the cooperation between the German academic particle centers within the DKTK, constituting a unique national platform for particle therapy science. However, networking with European partners in particle therapy has already a long tradition in Essen too and therefore will continue to promote future developments as well.

BEATE TIMMERMANN

Medical Director of the WPE

Curriculum

1995-2001: Dept. for Radiation Oncology, University Tübingen
2002-2009: Center for Proton Beam Therapy at the Paul Scherrer Institute (PSI), Villigen
2009-2013: Vice Medical Director of WPE, Essen
Since 2011: Medical Director of WPE, Essen
Since 2014: Full Professor for Particle Therapy at the University Duisburg-Essen

Table 1: Characteristics of patients treated since 2013 (May 2013-October 2015)

PATIENT CHARACTERISTICS	N
Total number of patients	307
Female/ male	124 / 183
Adults (≥ 18 y)	132 (43%)
Children (< 18 y)	175 (57%)
-under anaesthesia	98 (56%)
Median age (range)	14.9 y (0.9 – 95.1 y)

DIAGNOSES	N
CNS tumours	136
Sarcomatous tumours (incl. CH/CS)	115
Head and Neck tumours	22
Prostate Carcinoma	21
Miscellaneous	13

TUMOUR SITE	N
Brain/Head and Neck	227
Spinal and paraspinal	38
Pelvis	42

PRE-TREATMENT	N
Surgery	191
-R0	40
-R1	35
-R2	116
Chemotherapy	150
Radiotherapy	25

RADIATION DATA	N / GY
PT completed	267
-PT only (n=257)	
Med. n° of fractions (range)	30 (3 – 41)
Med. total dose (range)	54.0 Gy (12.0-78.0 Gy)
-PT Boost (n=10)	
Med. n° of fractions (range)	11 (8-17)
Med. total dose (range)	19.8 (16.2 -30.6)

ICTR-PHE
2016 Conference

The role of the International Conference on Translational Research in Radiation Oncology and Physics for Health in Europe in the fight against cancer.

15-19 February 2016, CICG, Geneva

Created in 2012 and organized in Geneva every other year, ICTR-PHE conferences are now considered as the main “crosstalk” event for physicists, biologists and healthcare professionals from around the world. In a number of plenary sessions, parallel workshops and poster discussions, with experts in various fields, this Conference has repeatedly shown its capacity to highlight the importance of a multi-disciplinary approach to provide innovative solutions for better healthcare.

ICTR-PHE 2014 brought up an overwhelming number of proposals in both the diagnostic and therapeutic fields. They ranged from new detectors and next-generation imaging techniques, to accelerator-based facilities for making new isotopes such as radiotracers and drugs. In biology, it was shown that a better understanding of biomolecular pathways and interactions between tumours and their micro-environment was key to success, in to increase malignant cell killing. Another example of inter-disciplinary scientific program was brought in the framework of the EORTC Symposium: the Synergy of Targeted Agents and Radiotherapy (STAR), was shown to be a unique quality controlled platform for integrated development of anticancer agents with radiotherapy, through a network of radiotherapy centers in Europe.

ICTR-PHE 2016 will once again be a unique opportunity to gather all scientific communities involved in research programs articulated around the optimization of cancer treatment. Radiochemists, nuclear-medicine physicians and physicists, biologists, software developers, accelerator experts, oncologists, and detector physicists and imaging experts will indeed be asked to “think outside the box” and make innovative proposals to boost further the comprehensive approach of cancer management.

One of the main new themes of the third edition of the conference from the physics aspect is large-scale computing. A wide range of medical applications already rely on computing and simulation tools initially developed for particle physics, but more could be done. CERN, for example, currently provides computing and data services through an efficient cloud-based provisioning model built on open-source software and state-of-the-art data storage and management software. Computing grids originally developed to deal with the enormous amount of data coming from LHC experiments are ideal tools for a wide range of biomedical activities, from screening drug candidates to image analysis, to sharing and processing health records. The physics community has experience in the development of data anonymisation and privacy protection solutions to support privacy compliance, which is key to the safe exchange of medical data.

From the biological side the main theme of the third edition of the conference will range from the biological and physical optimization of radiotherapy delivery to the modulation of normal tissue and tumour cell radio-sensitivity. A particular attention will be paid to the impact of tumour environment and oxygenation conditions on response to treatment. Moreover novel approaches to hit biomolecular therapeutic targets will be presented, and prominent research on genetic predictors of response to radiation will be revisited in depth. Innovations in functional imaging for malignancy diagnosis and radiotherapy planning will also be one of the milestones of the conference.

The high standards set by the ICTR-PHE conferences have not only garnered an impressive scientific community, but also an ever-increasing interest and participation from industry. ICTR-PHE 2016 will offer opportunities for companies to contribute to the success of the conference through sponsorship, and to exhibit their products and services at the technical exhibition, which takes place in the hall of the conference centre. For the first time at this edition, a dedicated start-up and SME corner will be created, to give visibility to innovative, smaller, up-and-coming companies.

If you are interested in the conference, please visit this page: http://ictr-phe16.web.cern.ch/; if you wish to receive additional information on the technical exhibition, please contact ICTR-PHE-exhibitor-sponsor-support@cern.ch. To register, please follow this link: http://indico.cern.ch/event/392209/.

ICTR-PHE 2016 - Industrial Exhibition

ICTR-PHE 2016 is a great opportunity for companies to advertise and exhibit their products and services to the medical and physics communities. Companies can reserve a booth at the technical exhibition and will also have an opportunity to give a presentation to the conference visitors. Several sponsorship opportunities are available for companies to have wide visibility before and during the event, and to contribute to the success of the conference. For the first time, a dedicated spin-off and SME corner will give visibility to innovative smaller up-and-coming companies. Please contact ICTR-PHE-exhibitor-sponsor-support@cern.ch for more information.

ICTR-PHE 2016 - Public Seminar by Domenico Vicinanza

Music and sound as tools for scientific investigation: from astronomy to biomedical sciences

There will be a public seminar on Tuesday February 16, 2016 at 18:30 in the CICG. The seminar will be given in English and open to the general public. A simultaneous translation to French will be available.

Music and science are probably two of the most intrinsically linked disciplines in the spectrum of human knowledge. Science and technology have revolutionised the way artists work, interact and create. The impact of new materials, new communication media, computers and networks is clear to everybody.

What is probably less obvious is how arts, and music in particular, are changing the way scientists operate, model and think. From the early experiments by Kepler to the modern data sonification applications in medicine, sound and music are playing an increasingly crucial role supporting science and driving innovation.

The talk will focus in particular on this last aspect, highlighting the complementarity and the natural synergy between art and science, with a special reference to biomedical sciences.

The presentation will be followed by a couple of demonstrations organised with Dr Genevieve Williams (Department of Life Sciences, Anglia Ruskin University), showing sonification in action.

Domenico Vicinanza is a musician and a scientist. He received his PhD degrees in Physics working at the European Laboratory for Particle Physics (CERN, Geneva) and he is a professional music composer and orchestrator. Dr Vicinanza is a Senior Lecturer at Anglia Ruskin University in Cambridge, where he also leads the Sound And Game Engineering (SAGE) Research Group. He is also a product manager for GÉANT, the pan-European network for research and education.

Always fascinated by how music and science are a continuous quest for harmony, he was one of the pioneers of data sonification for scientific and artistic purposes. Since the end of 1990s he supported scientists in different fields, from hydrobiology to cosmology, from earth science to particle physics providing, through sound, different perspectives on their data.

At the same time he worked on the artistic aspect of writing music from science, creating music pieces by mapping scientific structures to melodies and sounds. He organised several concerts with different ensembles, from solo instruments to chamber and symphonic orchestras, playing music from science. He has an active collaboration with CERN, which commissioned an orchestral piece on scientific data, for their 60th anniversary and with NASA, writing music from data collected by the Voyager 1 and 2 space probes.

Finally, he is also involved in the application of distributed computing and advanced networking technologies to music and visual arts as the founder and technical coordinator of the ASTRA (Ancient instrument Sound/Timbre Reconstruction Application) and the Lost Sounds Orchestra projects for the reconstruction of musical instruments on the Research and Education networks GÉANT and EUMEDCONNECT.

APAE INITIATIVE: Accelerators as tools of discovery & innovation

The largest currently running accelerator R&D project "EuCARD-2" has just launched the "Applications of Particle Accelerators in Europe" initiative. This brings together researchers to show the potential of accelerators in meeting societal needs throughout Europe .

Over 30'000 particle accelerators are currently in use globally. Nevertheless, public recognition of their applications is often limited to the large machines operating in centres of fundamental research. Much work still has to be done to raise the awareness of decision makers and the public at large about the key role of accelerator technology in meeting everyday societal challenges. It is necessary to combine the knowledge, expertise and inputs of accelerators researchers and experts in order to translate more effectively the breakthroughs in accelerator-related technology into applications that directly benefit our society's health, wealth, sustainability and security.

The recently launched "Applications of Particle Accelerators in Europe" initiative aims at responding to these major challenges by bringing together researchers in various scientific fields to share and learn about each other's area of expertise. The focus will be on applications of interest in Europe and for which technology developed for research may have an impact. More specifically, the initiative will bring to the attention of European policy-makers the links between accelerator-related research and advancements in six key areas with great societal impact: Health, Energy, Photonics, Neutronics, Security and Industry & Environment.

As a result of the initiative, a report will be presented to European funding bodies and policy makers. The document, to be released by the end of 2016, will not only offer an overview of the applications of accelerator technologies in the target areas, but will also highlight the main challenges researchers are currently facing – including technical, industrial and policy challenges and technology gaps to overcome. Finally, it will indicate the priority areas needed for R&D and put forward key recommendations for policy makers. The report will be a tool through which accelerator stakeholders can articulate the steps required to transform their vision of future accelerators into reality. In addition to this, a two-page summary of the report, tailored to the special needs and relevant issues of several European countries and translated into the respective national languages, will be distributed to national policy makers and scientific communities.

The APAE initiative has witnessed a successful start in mid-June, when 90 researchers from various scientific fields took part in the kick-off event organized at the Royal Academy of Engineering in London. The event featured expert talks from academia, industry and medical representatives. The next steps are now in the hands of the conveners of the six major areas of interest, which will gather, organize and structure the input from their respective communities demonstrating the impact and challenges of accelerators research and applications. Manjit Dosanjh (Radiotherapy), Hywel Owen (Accelerators) and Ondrej Lebeda (Radioisotopes) are leading the activities in the field of health. Researchers interested in contributing to the initiative can get in touch with the relevant area convener which will provide all information on how to take part. A mid-term meeting, is set to take place in Paris at the IN2P3 headquarters on 16-17 December 2015, with the purpose of sharing the contributions collected so far in each focus area.

With APAE activities currently ongoing, we encourage the ENLIGHT community and all interested researchers to partake in the initiative, sharing your expertise, ideas and knowledge with fellow European colleagues operating in related fields. For further details about the initiative, visit http://apae.ific.uv.es/apae/.

AGENDA

DATE	NAME OF THE EVENT	PLACE OF THE EVENT
February 15 - 19	ICTR-PHE 2016 http://ictr-phe16.web.cern.ch/	Centre International de Conférences Genève 17, rue de Varembé CH 1211 - Genève 20 SWITZERLAND
February 16 18:30	Public Talk "Music and sound as tools for scientific investigation: from astronomy to biomedical sciences"	Centre International de Conférences Genève 17, rue de Varembé CH 1211 - Genève 20 SWITZERLAND
29 April – 3rd May	ESTRO 35	Turin, Italy
July 10-14	The Christie Advanced Radiotherapy Summer School http://www.eventbrite.co.uk/e/the-christie-advanced-radiotherapy-summer-school-tickets-18900873020	Education Centre (Dept 17), The Christie, Manchester, M20 4BX ENGLAND
November 11-13	The 16th Workshop on Ion Beams In Biology and Medicine (IBIBAM)	SRM University, Kattankulathur-Chennai, INDIA

An interactive map of a VIRTUAL HADRONTHERAPY CENTRE has been created.

Navigate around the map by clicking here http://cern.ch/virtual-hadron-therapy-centre

This map was sponsored by the following EC funded projects under the given FP7 grant agreements ENTERVISION (GA 264552), ULICE (GA 228436) and ENVISION (GA 241851)

The SHANGHAI Proton and Heavy Ion Center

GUO-LIANG JIANG, ZHAN YU AND MARCO DURANTE

The Shanghai Proton and Heavy Ion Center (SPHIC) started clinical trial registration in June, 2014, and officially opened in May 2015, following a 10-year endeavour.

SPHIC is equipped with the Siemens particle therapy system: a synchrotron generating 48-221 MeV protons and 85-430 MeV/n carbon ion beams; 4 treatment rooms with 90-degree and 45-degree beams; robotic arms for patient set-up; on-line imagers; raster beam scanning; and Syngo PT planning system. Besides, the modern diagnostic radiology facilities, including CT, MRI, SPECT and PET/CT, are available at the center.

SPHIC has recruited high-level staff from China, United States, Germany and Singapore to form a strong team of radiation physicists and clinical radiation oncologists.

As requested by the Chinese Food and Drug Administration (CFDA), in June 2014 SPHIC registered a clinical trial to verify the toxicity and efficacy of charged particles for cancers already treated in Japan, Europe and USA. 35 patients were needed for this trial which was completed in December 2014.

Thirty-one patients were males and four females, with a medium age of 69 years (36-80). The lesions were inoperable due to residuals after surgery in 17 patients (49%), technically unresectable (14 patients), or for anesthesia contra-indication caused by comorbidity (cardiovascular diseases) (3). There were 10 patients with head and neck cancers (chordoma or chondrosarcoma of the skull-base, adeno-cystic carcinoma of nasal cavity); 4 patients with primary or metastatic lung cancers; and 21 patients with prostate carcinoma, hepatocellular carcinoma or retroperitoneal liposarcoma.

The irradiation was delivered by intensity-modulated raster scanning using either protons (n=13) or carbon ions (n=22). Before starting irradiation a dose verification was performed for each portal in a water phantom. Total doses used for each indication included: 60GyE/30fx of proton for adeno-cystic carcinoma, 70GyE/35fx of proton or 63GyE/21fx of C-ions for chrondoma/chrondrosarcoma, 63GyE/15fx of proton or 60GyE/10fx of C-ions for NSCLC, and 48GyE/15fx for metastatic lung cancer, 40GyE/4fx of C-ions for hepatocellular carcinoma, 63GyE/18fx of C-ions for retroperitoneal sarcoma, and 63-66GyE/23-24fx of C-ions for prostate carcinoma.

Position verification using orthogonal x-ray imaging was performed prior to each and every treatment session. A total of 1,314 digital images were taken resulting in couch adjustments of 0.21-0.9mm at CC, RL and up/down directions, and <20 for pitch and roll. All patients received post-initial-fraction PET/CT for verification of geometric dose distribution.

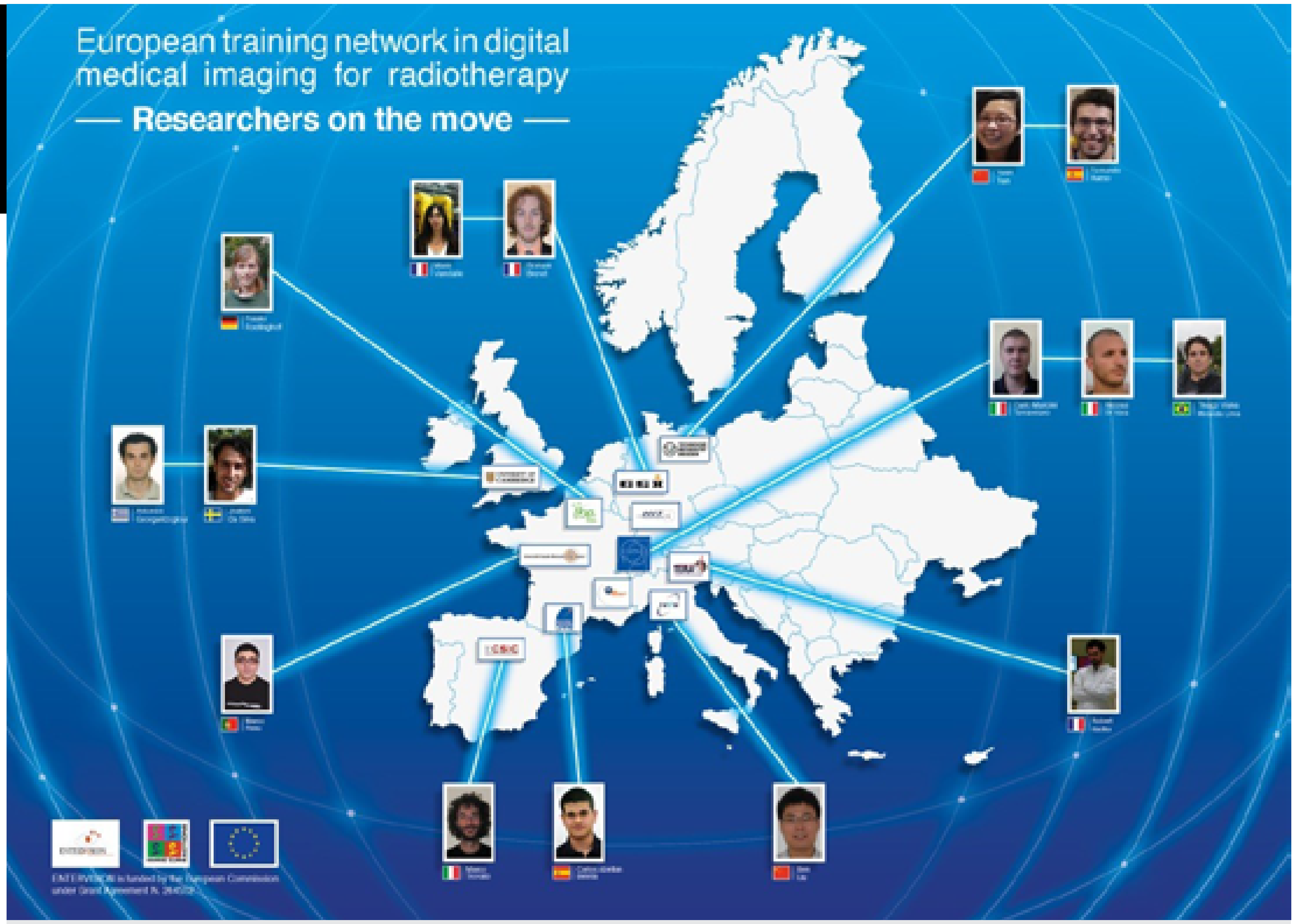
Overall, the patients tolerated irradiation very well and none of 35 patients experienced grade 3 or higher of CTC adverse effects, which were related or possibly related to particle therapy. All patients completed the planned doses with no interruptions due to the acute toxicity.

For head/neck, thoracic and abdominal cancers the response rate was 19% evaluated by RECIST criteria, and for prostate carcinomas, 100% (complete and partial biochemistry-control) by PSA 6 months after irradiation.

For moving targets in the liver and lung abdominal compression, active breath coordinator (ABC) and respiratory gating by Anzai were successfully tested.

SPHIC has been finally approved to routinely use particle irradiation for cancer patients by CFDA in May of 2015. Since then, 65 patients have been treated and 35 are under irradiation as of September 21, 2015. We have enrolled a variety of cancers, besides the cancers we treated in the clinical trial, including brain tumors, nasopharyngeal carcinoma, stage III NSCLC, malignant thymoma, pancreatic carcinoma, melanoma, and soft tissue sarcomas. The radiobiology research laboratory is under construction. SPHIC has the ambition to become one of the leading centers in particle therapy and to treat many patients with diverse pathologies with protons and heavy ions.

SPHIC
4356 Kang Xin Road, Shanghai 201321, China
Web: www.sphic.org.cn



Looking back on **ENTERVISION**

The ENVISION project was co-funded by the European Commission under FP7 Grant Agreement 241851

In January 2015, ENTERVISION researchers and their supervisors met at La Sapienza University in Rome for 2 days of meetings and presentations to reflect on the work achieved during the 4 years and celebrate the conclusion of a successful project.

The ENTERVISION Marie Curie Initial Training Network was funded by the European Commission and launched in 2011, with the aim of educating young researchers in advanced medical imaging techniques for quality assurance during cancer treatment with hadron therapy (HT). Ten academic institutes and research centres of excellence, and a leading European company in particle therapy recruited 15 researchers from a variety of academic backgrounds over the course of four years. Improved Medical imaging is essential to ensure a full exploitation of HT's potential, in particular through quality assurance during treatment. Moreover, as new treatment centres are opening throughout Europe, there is an increasing demand for qualified experts in the multidisciplinary domains connected to HT. It was these issues that were addressed by the ENTERVISION project.

The researchers were assigned individual research projects on topics ranging from in-beam Positron Emission Tomography (PET), Single Particle Tomography techniques, to adaptive treatment planning, optical imaging, Monte Carlo (MC) simulations and biological phantom design. Most of the researchers were also enrolled in a PhD programme at a partner University. In addition to everyday 'on-the-job' training, the researchers took part in the network-wide training courses organised several times a year.

Courses were aimed at building the researchers' scientific knowledge, as well as at enhancing their communication and leadership skills. The ENTERVISION technical training portfolio included Detectors for Medical Imaging, Electronics, Treatment Delivery Systems, and Dosimetry. As health applications need industrial support to be deployed successfully in hospitals and clinics, a course on industrial processes was also run. A course on Intellectual Property management made the young researchers aware of the valorisation chain for their scientific results. The ENTERVISION researchers also had the opportunity to join the courses on the Impact of Gantries and Imaging on HT techniques run by a previous Marie Curie Actions Initial Training Network, PARTNER. Soft-skills courses tackled leadership, curriculum writing, and communication.

The project has been widely disseminated, and the researchers have been encouraged and motivated to take part in outreach activities, at their home institute and elsewhere. Most have attended international conferences where they have presented their work and/or displayed posters and many have had their research work published in scientific journals. In September 2013, several ENTERVISION researchers came to CERN to actively participate in the activities for the European Researchers' night and the laboratory's Open Days.

ENTERVISION co-sponsored a panel at ESOF 2014 in Copenhagen chaired by the project coordinator on "Everything you wanted to know about cancer but were afraid to ask". Two animations and a 3D interactive map of an HT centre were also partially sponsored by the project, with a view to increasing public awareness of the field. The animations show innovative medical imaging tools and a patient's eye view of an HT centre and can be seen at http://entervision.web.cern.ch/ENTERVISION/news.html .

A unique feature of the ENTERVISION project was its connection with the EC-funded R&D project ENVISION, aimed at developing solutions for quantitative real-time non-invasive monitoring of HT for stationary and moving organs, accurate determination of delivered dose, and fast feedback to the Treatment Planning System (TPS) for optimal adaptation strategies. In fact, ENVISION acted as a "hands-on" training platform for the Marie Curie researchers, who had the opportunity to interact directly with senior scientists working at the forefront of research in quality assurance for hadron therapy.

During the four years the researchers attended the annual meetings of the ENLIGHT network and of the other EC-funded projects run under the ENLIGHT umbrella. On these occasions, they have presented their work and listened to and interacted with the experts in the hadron therapy field, leading to unique learning and networking opportunities. A number of them have already used the contacts they established during ENTERVISION to find positions as soon as they finished their Marie Curie projects.

Throughout the project, due to a variety of social and networking activities, the researchers were encouraged to build a multidisciplinary network: this is not only helping them with their future careers, but will ultimately help to improve the transfer of knowledge and build collaboration between the various disciplines of cancer treatment and the respective institutes and partners involved in the ENTERVISION and ENVISION projects. A number of highly valuable and interesting results have been obtained within the framework of ENTERVISION and a special issue of Frontiers in Oncology will be available soon.


Final Meeting in Rome, January 2015


Poster prize, annual ENLIGHT meeting MedAustron 2013


Detectors and Electronics Course September 2013


UCAM Leadership Course, November 2012


CERN open days September 2013


European Researchers Night September 2013

First Annual Meeting April 2012, UCLM

ENTERVISION MARIE CURIE ACTIONS

The fourth and last annual ARDENT workshop was held in Prague from 22 to 26 June 2015, organised by the Czech Technical University

Advanced Radiation Dosimetry European Network Training initiative **(ARDENT)**

ARDENT is a Marie Curie Initial Training Network funded by the European Commission 7th Framework Programme, Grant Agreement 289198

Team building exercise alongside the Allondon river in May 2014: ARDENT scientist-in-charge Marco Silari with some of the ESRs

ESR Vijayaragavan Viswanathan (fourth from the right) at the European researcher's career and mobility conference, Dublin, Ireland organized by the Irish presidency & EU, in May 2013

ARDENT is a Marie Curie project funded under FP7 that started in February 2012 and will end in January 2016. The project enrolled 15 Early Stage Researchers (ESR) on 3-year or nearly 3-year contracts, and three ESRs on short-term (6 months) contracts. ARDENT focused on the development and testing of instrumentation based on advanced technologies for measuring energy distributions and dosimetric quantities in complex radiation fields as well as in the medical field, e.g. the use of monoenergetic particle beams in cancer therapy. Three main technologies were investigated: gas detectors, solid state detectors and nuclear track detectors. ARDENT addressed the potential uses of a class of instruments based on these technologies with three main objectives: 1) disentangle the various components of the radiation field and determine the dosimetric quantities due to each component, 2) measure the radiation quality of the radiation field (microdosimetry) and 3) obtain information on the energy distribution of the various components of the radiation field (in particular for photon and neutron spectrometry).

About half of the individual research projects were partly or fully devoted to development of detector technologies for medical applications. Experimental work has been conducted at CNAO in Pavia, Italy; at HIT in Heidelberg, Germany; at HIMAC in Chiba, Japan; at the INFN Laboratories of Legnaro and Catania, Italy; at the Czech Proton Therapy Center in Prague; at the Klinikum rechts der Isar in Munich, Germany; and at the West German Proton Therapy Centre of Essen, Germany.

ARDENT held four annual workshops in Vienna, Milano, Schwarzenbruck and Prague, during which dedicated training courses were organized for the ESRs on dosimetry, microdosimetry and detector technologies. Additional events throughout the 4-year duration of the project gave the ESRs more opportunities to gather together, such as at a dedicated training course on business and administration held at CERN. A team building exercise took place in the evening of 21 May 2014 alongside the Allondon river close to CERN, which was much appreciated.

ARDENT also put a lot of emphasis on communication towards the general public. A robust outreach program was conducted through the entire project. A major outreach event with the participation of about 200 high-school students was organised during the 2nd annual workshop at the Politecnico of Milan in September 2013. Amongst the many others are participation in CERN's 60th anniversary and in the European researcher's career and mobility conference, Dublin.

The project is near to completion and most of the ESRs have finished or close to the end of their contract. About half of them have already found a job and are looking forward to the next step in their career.

Full information on ARDENT is available at www.cern.ch/ardent

The medical team of MedAustron in June 2015

REFLECTIONS...

by the end of the year, Univ.-Prof. Dr. Ramona Mayer, Msc, longtime Medical Director of MedAustron, will retire. Prof. Dr. Eugen B. Hug will be her successor.

I first encountered MedAustron in 2002, the same year that ENLIGHT was founded and I became a member. At that time, I was the deputy head of the Department of Therapeutic Radiology and Oncology of the Medical University Graz, Austria. Becoming a member of the ENLIGHT network gave me the chance to get to know many of my European colleagues and benefit from knowledge exchange which was extremely important as I had been given the opportunity to participate in the design study for the planned Ion Beam Centre in Austria. Until 2004 I concentrated on epidemiology and gathered results and data which influenced the realisation of the project significantly.

In 2007, I started working full time for MedAustron as the Medical Director. At that time the Austrian Ion Beam Therapy Project really gained momentum. With the foundation of the construction and an operating company, the course to achieve the project had been set.

I feel that I've left my mark in many areas, but especially in one of my main tasks, namely building and training the medical team. Here, the ENLIGHT network proved to be very helpful and we were given the opportunity to participate in the PARTNER project – Particle Training Network for European Radiotherapy - coordinated by Manjit Dosanjh who played an active role in the training of six (medical) physicists – Joanna Gora, Adriano Garonna, Loic Grevillot, Till Böhlen, Jhonnatan Osorio and Daniel Sánchez Parcerisa. Each of them have since been recruited by MedAustron and are now working in the centre in Wiener Neustadt.

First presentation of the project in June 2009

Not only science was taught at the PARTNER meeting in Valencia 2009 but also how to cook a paella

CERN members visiting the MedAustron construction site in August 2011

At the formal handover of the first ion source – Official function on January 11th, 2013

I'm very proud of the team I built. Besides my colleagues from the PARTNER project and other medical physicists, I started training the physicians at a very early stage. The young doctors have been trained in various hospitals in Austria and gained further training in Ion Beam Therapy Centres outside of Austria. Little by little I also completed the team with radiology technologists and a clinical studies manager – all in all a team of smart people, who respect each other and cooperate well.

I've even left my mark on the architecture of the centre. Being involved at a very early stage, I could influence the architectural planning by using the ideas I got from other centres. Short distances for patients and employees, room plans that supports workflows and a pleasant atmosphere with a lot of daylight were very important to me. A Japanese garden awaiting the patients in the foyer pays tribute to the pioneers of particle therapy with carbon ions – an idea which I brought back from my visits to the Japanese centre NIRS in Chiba.

MedAustron tries to live Best Practice not only concerning the therapy. Compared to other centres it stands out with its dedication to research, something which I deeply believe in. The non-clinical research department of MedAustron has its own irradiation room, equipped with the same robotic positioning and positioning verification system as the normal patient treatment rooms, which enables real translational research.

The cooperation of MedAustron and CERN, which had already been signed in 2007, made it possible for me to visit the LHC at the European nuclear research Facility, which was a marvellous experience for me. Generally, I've always found the cooperation of physicians and physicists extremely pleasant and productive despite the different worlds that met there.

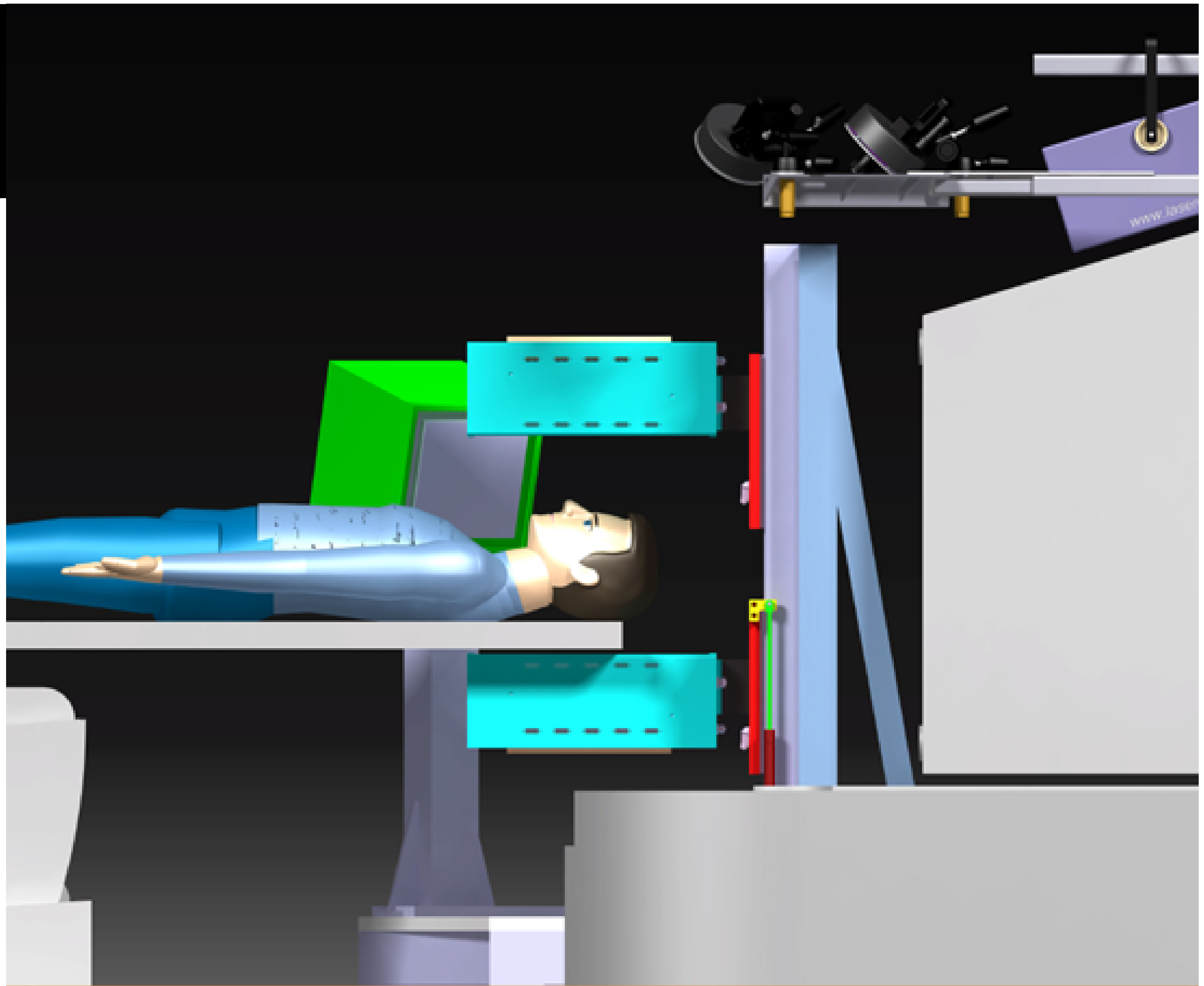
I will still be working for MedAustron until the end of the year to ensure a smooth transition – together with my successor Eugen Hug, who started in early September. Eugen has a longstanding experience in the area of particle therapy, among others he has been working for the Massachusetts General Hospital, the Loma Linda University Medical Centre, The Paul Scherrer Institute in Villigen (CH) and most recently as Medical Managing Director (CMO) for the ProCure Proton Therapy Centres.

Today, just before the treatment of patients starts at MedAustron, I see the centre in a good position. Due to many projects, countless events and meetings, which have been supported, MedAustron is very well connected in the Ion Beam Therapy Network. For MedAustron's future I hope it will become well renowned not only as a relevant centre, but also that it will be known for treating patients with respect.

NIRS – MedAustron Symposium on Carbon Ion Radiotherapy in December 2013

MedAustron's Japanese garden in winter

RAMONA



The INSIDE system: the two PET detectors (in cyan); the particle tracking system (in green) is positioned at an angle between 600 and 900, with respect to the beam direction. The mechanical structure has been designed to accommodate the existing system in the treatment room (in grey) of the National Centre for Oncological Hadron Therapy (CNAO, in Pavia, Italy).

INSIDE

Harnessing the power of bi-modal imaging for on-line verification of particle therapy treatments

Maria Giuseppina Bisogni
INSIDE Scientific Coordinator
University and INFN Pisa

The clinical interest of hadron therapy resides in the fact that it delivers precision treatment of tumours, exploiting the characteristic shape of the Bragg curve for hadrons. In order to fully exploit the advantages of hadron therapy compared to conventional X-ray therapy, the quality assurance techniques and tools should ensure a precise determination of the delivered dose, both in space (e.g. to take into account tumour shrinkage during the course of the therapy), and in time (real-time response to moving organs).

Among the available imaging techniques, Positron Emission Tomography (PET) has been long investigated and then clinically applied to proton and carbon beams.

The most advanced PET monitoring technique is the so-called in-beam PET, where the imaging system is integrated in the beam delivery, and operates during the irradiation to provide an immediate feedback on the dose deposition.

Another method used in nuclear medicine is the detection of prompt photons, protons or neutrons. Single particle imaging is not yet applied in clinical practice in hadron therapy, but is being investigated as an alternative to PET in order to overcome its limitations - such as imaging artefacts and low sensitivity.

In 2013, the INSIDE (Innovative Solutions for In-beam DosimEtry in hadron therapy) collaboration proposed an innovative bi-modal imaging concept that combines an in-beam PET scanner with a particle tracking system to perform single particle imaging. INSIDE was born from the collaboration of a number of Italian Universities (University of Pisa, Polytechnic University of Bari, University of Roma “La Sapienza” and University of Torino) and the Italian National Institute for Nuclear Physics (INFN), and funded by the Italian Minister for the University and Research (MIUR).

The INSIDE system is designed to detect simultaneously the back-to-back gammas from beta+ annihilation, and the prompt charged particles with kinetic energy higher than 20 MeV, with a precision of 2 mm.

The PET scanner is tailored for imaging head and neck tumours, and consists of two planar detectors of (10 x 25) cm2. The PET activity map is complemented by the beam profile, obtained by tracking the single protons coming from the interaction of the primary beam with the target nuclei, and from projectile fragmentation for carbon beams. The tracking system is composed of 6 planes of orthogonal squared scintillating fibres of (19,2 x 19,2) cm2. An electromagnetic calorimeter coupled to position-sensitive Photo Multiplier Tubes is placed downstream from the tracker, and provides the residual energy of the charged particles.

The INSIDE system is presently under construction and its commissioning is scheduled for early 2016. A detailed simulation of the PET and profiler has been implemented in order to optimize the detector design and the overall performance. A prototypal version of the PET device has been recently tested at CNAO by using clinical proton beams of different energies (from 68 to 100 MeV/u) on acrylic (PMMA) phantoms.

Both simulations and beam tests clearly show the capability of the system to operate during the irradiation period and to measure the induced activity build-up.

These results open favourable scenarios for the use of bi-modal imaging with high duty-cycle machines or continuous beams.

The INSIDE project is supported by Ministero dell'Istruzione, dell'Universita e della Ricerca of the Italian government under the program PRIN 2010-2011, project nr. 2010P98A75

PARTICLE THERAPY in the UK

Karen Kirkby, University of Manchester, Christie NHS Foundation Trust.
Adrian Crellin, NHS England National Clinical Lead for protons and Consultant Oncologist at Leeds Teaching Hospitals NHS Trust

Almost a hundred years after Rutherford's ground breaking paper on the structure of the atom, high energy protons will be returning to the UK in the form of three new high energy proton centres for cancer treatment. Currently high-energy proton beam therapy (PBT) does not exist in the UK, although lower energy protons have been available at Clatterbridge for over 20 years (at energies up to 65 MeV). Although not widely known, Clatterbridge was the first hospital-based proton therapy centre in the world. The have treated 2795 patients to date with superficial, mainly eye, tumours with excellent results.

Building on this success and following a careful evaluation of the evidence base, the National Health Service (NHS England) is investing over £250m in two new high energy "state of the art" PBT centres in Manchester and London, which will come on line in 2018 and 2019 respectively. In addition, Oxford has attracted Government funding (HEFCE UKRPIF[1]) and private investment (totalling £110m) for its Institute for Precision Cancer Medicine, which incorporates PBT. There are also a number of private providers who are looking at the feasibility of offering high energy PBT, in the UK, to private patients.

Since 2008 the NHS has provided proton therapy for more than 560 patients by covering the cost of sending them overseas (mostly to the US and Switzerland). This has mainly been for children (420), skull base and spinal sarcomas (140), where there is clear evidence that PBT is the best option. Overseas referral will continue until the both new centres are open. At present the two new NHS centres will aim to treat 1500 patients per annum (roughly 1% of the patients who receive conventional radiotherapy). As well as an expanded range of core indications the strategy will be to deliver treatment within an academic framework of high quality, clinical trials and evaluation. Importantly, treatment will be within a major cancer centre hospital environment where integrated care can be delivered safely.

[1]Higher Education Funding Council for England UK Research Partnership Investment Fund

The NHS went through a very rigorous procurement process where they evaluated a matrix of detailed information supplied by vendors in response to a comprehensive set of questions. They also received advice from an international panel of experts. At the end of this wide-ranging selection process Varian was chosen as the preferred supplier, in early 2015. This means that both NHS centres will have the same equipment; a Varian cyclotron, spot scanning and three 360° gantries. In both centres there will also be a fourth room which could take an additional 360° gantry in the future.

In Manchester, the Christie Charitable Trust has invested over £5m (from public donations) in this fourth room to turn it into a “state of the art” research facility. This facility will provide a research pipeline stretching from basic research to clinical outcomes, with the aim of improving patient benefits and quality of life. This room will have a spot scanning capability and two beam-lines. The beam-lines will be designed to give a flexible research space with a range of detachable research modules (which can by wheeled through the maze). The research room at The Christie aims to be a UK national facility allowing researchers from across the UK (and Europe) to access its facilities. It is likely that University College London NHS Trust will also offer a research capability, which will complement that available at The Christie.

The PBT centre, which is part of the Precision Cancer Medicine Institute in Oxford will involve a partnership with the equipment supplier Pro-Nova and is funded as a research facility. Professor Gillies McKenna, head of the Department of Oncology at Oxford University, said: 'The Precision Cancer Medicine Institute aims to improve outcomes and increase cure rates for cancer patients. It will do this not only by making surgery and radiotherapy more precise and less invasive, but by designing new drug treatments that are more targeted and personalised to the characteristics of a patient's particular tumour, and by using advanced imaging techniques to detect the earliest signs of response. Through the new institute we aim to undertake research that will help doctors get the right treatment, to the right patient, at the right time.'

Dr Ed Smith at the Christie working closely with Dr Yen-Ch'ing Chang at UCLH has been leading the UK activity on the clinical outcomes for proton therapy. This activity allows an easy to use and effective route for the collection of national clinical outcomes to be established across the UK. This will provide a robust evidence base for future proton development.

We are also developing the Malthus tool in the ramp up to proton therapy to model capacity and demand management and allow better links to national conventional radiotherapy pathways.

Training the workforce for the ramp up to proton therapy is another important aspect of the UK PBT programme. Clinicians, medical physicists and radiographers are spending time in PBT centres around the world. In addition we are actively looking at routes to train the next generation of researchers through discussions with research funders and NHS England

Adrian Crellin, who leads the national proton therapy programme, commented “this is an exciting time for the UK with three new high energy PBT centres being built. It also offers the UK an opportunity to undertake a collaborative research programme which spans from basic science to clinical outcomes and builds on our successes in lower energy PBT at Clatterbridge”.

The Christie Advanced Radiotherapy Summer School

Sunday 10th - Thursday 14th July 2016

Education Centre (Dept 17), The Christie, Manchester, M20 4BX

Faculty

Professor Karen Kirkby
Richard Rose Chair in Proton Therapy Physics, The Christie

Professor Marcel van Herk
Chair in Radiotherapy Physics, University of Manchester & The Christie

Professor Peter Hoskin
Professor in Clinical Oncology, University College London

Professor Robert Huddart
Professor of Urological Cancer & Honorary Consultant, Institute of Cancer Research & The Royal Marsden

Professor Robert Jeraj
Associate Professor of Medical Physics, Human Oncology, Radiology and Biomedical Engineering, University of Wisconsin

Dr Nicholas van As
Consultant in Clinical Oncology, The Royal Marsden

More to be confirmed.....

Course organisers

Dr Ran Mackay
Director - Medical Physics & Engineering, The Christie

Dr Ananya Choudhury
Consultant in Clinical Oncology, The Christie

Hazel Pennington
Lead Radiographer - Proton Beam Therapy, The Christie

Further information

Fee: £495 (whole week) or £150 per day
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