Results: The frequencies of which the small, medium and large size plans were used over the (total of 600) fractions were similar; plans were used at a median of 9, 9.5 and 10 fractions respectively. The median volume ratio of PTV-ART vs. non-ART across the treatment course was 0.70 (range: 0.46-0.89). The median rectal volume receiving 50 Gy or more was 5% (range: 0-41%), compared to 17% (range: 0-62%) if the patients had been treated with standard, non-adaptive RT (Fig 1). For the bowel cavity, the median volume receiving more than 45 Gy was 392 cm³ (range: 84-625 cm³), compared to 487 cm³ (range: 126-710 cm³) if not treated with adaptation (Fig 1).

Conclusions: Daily adaptive plan selection in RT of bladder cancer results in a considerable normal tissue sparing, which is expected to reduce the risk of gastro-intestinal morbidity.

Joint Symposium: ESTRO-EFOMP-AAPM: How to invigorate medical physics research in a clinical environment

SP-0108
Interdisciplinary medical physics research: Connections with academic and commercial partners
A. Torresin¹, S. Evans², G. Hartmann³
¹Azienda Ospedaliera Ospedale Niguarda Ca’Granda, Medical Phys Dep., Milan, Italy
²Northampton, Medical Phys Dep., Northampton, United Kingdom
³German Cancer Research Center, Medical Phys Dep., Heidelberg, Germany

Medical physicists contribute to maintaining and improving quality, safety and cost-effectiveness of healthcare services through patient-oriented activities requiring expert action, involvement or advice regarding the specification, selection, acceptance testing, commissioning, quality assurance/control and optimised clinical use of medical radiological devices. Medical physicists working in a clinical environment are healthcare professionals and those at the highest level (level 8 on the European qualifications framework) are Medical Physics Experts(MPEs) competent to practice independently in one or more of the subfields (specialties) of medical physics; in this way the MPE has the capabilities to tackle clinical problems through strategic multidisciplinary approaches.

Today the multidisciplinary approach with medical physicists in the clinical environment together with those in the commercial industry as well as university research areas is mandatory where dosimetry, dosimetric calculation and medical imaging for planning and verification needs to be approached with a number of different competences. Collaboration on clinical research projects between commercial partners and medical physicists/MPE should therefore be encouraged at all levels. Academic partners have the capabilities to develop new applications of physics in medicine (linear accelerators, new detectors, Monte Carlo simulations, etc.) and have the competences required to support such developments. The experience derived from protosyncrotony and ion and particle accelerator developments in particle research has provided fundamental experience to understand what the correct approach needs to be to tackle the clinical applications.

Companies have the role to develop hardware and software devices for radiotherapy but need medical physics competences for testing and optimization "on the field". Many advanced medical physics departments are “beta-site” for different applications. Pre-release software for treatment planning, new treatment modalities, image processing and registration technique for Adaptive planning, integrated MRI/linear accelerator and high intensity focused ultrasound (HIFU) in oncology therapy are typical examples where a multidisciplinary approach is essential. A PACS solution for radiotherapy is another examples where medical physicists are able to define the functional differences between the PACS required for radiotherapy compared with the requirements for conventional radiology PACS.

New software for image integration and registration techniques must first be validated in clinical practice and the multidisciplinary medical physics department is an essential partner for companies to create optimized protocols for clinical use. Finally the medical physicist/MPE is frequently involved in training activities and these experts can also be used to inform companies on their development profiles. The use of webinar will provide further opportunities for the cooperation and training for all the actors involved in radiotherapy.

In conclusion, in order to ensure that the quality of patient treatments is maintained and further improved while the risk of errors is reduced it is necessary that all these activities are to be carried out in the clinical working environment. In addition many of these activities require further development and improvement within a research environment parallel to the clinical work. However, staff often have to carry out research and development outside normal working hours due to lack of time. This situation is not sustainable and could finally result in unsafe patient treatments. It must be realized that medical physics departments should have at least an additional 0.3 whole time equivalent staffing complement (ref. European Guidelines on Medical Physics Expert (Annex 2)) to carry out these important research and development activities. References: European Guidelines on Medical Physics Expert, Annex 2, Radiation Report No174, European Commission, 2014

SP-0109
Trends in clinical and academic medical physics research in the US
T. Bortfeld¹, R. Jeraj²
¹Massachusetts General Hospital, Radiation Oncology, Boston MA, USA
²University of Wisconsin, Medical Physics, Madison WI, USA

In the past decade the introduction of new technologies such as IMRT has given a strong boost to medical physics and the field of radiation oncology in the US. In the period from 2003 until 2009 alone, the expenditure for radiation oncology has
almost tripled, which is the largest growth rate of any medical specialty in that period. This development has strengthened the standing of medical physics and radiation oncology in the hospitals. However, it has also been recognized that the growth in expenditure has not come with an increase in patient volume or corresponding outcome improvements. More recently the trend has reversed due in part to the overall economical situation and the healthcare reform. Cutting cost is the new theme. The research in medical physics has been hit particularly hard by this development. The budget and time for research is being cut. Funding from government agencies is increasingly harder to get. The trend to more “professionalism” in medical physics with mandatory physics residencies has shifted the focus further away from research.

In this presentation we will report on our efforts within the American Association of Physicists in Medicine (AAPM) Working Group FUTURE (FUTURE of Research and Academic Training) to put medical physics research back on the map. WG FUTURE activities include the definition of research activity roadmaps, organization of “Expanding Horizons” meetings to open doors for medical physics research outside of radiation oncology, support of students aspiring a research career in medical physics, and reaching out to similar activities elsewhere in the world.

We will also report on our own challenges of developing and maintaining a vibrant research environment in academic medical physics (at the University of Madison, Wisconsin) at in a hospital environment (Massachusetts General Hospital).

SP-0110
Medical physics research in a hospital department
N. Jornet
1Hospital de la Santa Creu i Sant Pau, Medical Physics, Barcelona, Spain

I would like to start by adding “small” and “clinical” to the title. It would then read research in a small clinical Medical Physics Department. Two things to define: research and small. Let’s start with research. Research is “serious study of a subject that is intended to discover new facts or test new ideas”. Small applied to a Medical Physics Department is more so than applying the term small to research. Small applied to a Medical Physics Department is more so than applying the term small to research. Small is more than the simple fact that the group is relatively small, it means that you can study a subject and discover and interesting angles to your research topic.

4. Inspiration. Think outside the box. Take risks!
By doing this I think that you can study a subject and discover new facts or test new ideas. This is RESEARCH. It requires effort and enthusiasm, research is fun. Being small does not mean that you can’t think BIG.

Symposium: Proton therapy II: state of the art

SP-0111
Dose calculation accuracy in proton therapy
J. Schuemann1, D. Giantsoudi1, C. Grassberger1, M. Moteabbed1, C.H. Min1, S. Dowdell1, H. Paganetti1 1Mass. General Hospital, Radiation Oncology, Boston MA, USA

The number of facilities proton therapy is increasing all around the world. The benefit of delivering radiation treatment with protons as compared to photons is the reduced integral dose due to the protons stopping inside the patient and delivering a high dose at the end of their range. This leads to highly conformal dose distributions with sharp dose gradients, both laterally as well as at the distal end of a proton treatment field. The distal high dose gradients make accurate dose calculations for proton therapy even more important than for photon therapy. A slight underestimation in proton range can lead to unirradiated sections of the target region.

Clinical dose calculations are generally performed using analytical algorithms, often referred to as pencil-beam algorithms, which propagate protons through the patient geometry. Each field is composed of ‘pencils’ which are separated into a central axis part combined with a Gaussian fluence map to account for the lateral beam spread. The main advantage of this approach is its computational speed. More accurate dose calculation algorithms such as Monte Carlo (MC) simulations are available but have not yet translated into clinical routine for proton therapy treatment planning due to lengthy calculation times. MC simulations are, however, frequently used to estimate the accuracy of analytical dose calculation algorithms.

Analytical algorithms generally fail to describe the effects of multiple Coulomb-scattering of protons. These effects are particularly important along high-density interfaces along the treatment field direction. Incorrect modeling of scattering can result in distortions of the delivered dose distributions. This can affect both the range of the proton field as well as the delivered dose distribution. Both effects will be discussed through comparisons between MC simulations and analytical dose calculations. We investigated the validity of range margins to compensate for range uncertainties and the clinical impact of dose calculation approximations.

In a site-specific analysis looking at 10-24 patients for 7 treatment sites, we find that for liver, prostate and whole brain fields a reduction of currently used uncertainty margins is feasible even without introducing MC dose calculations. Accounting for uncertainties from dose calculation algorithms we recommend a reduction of these margins to 2.8% + 1.2 mm for liver and prostate treatments and 3.1% + 1.2 mm for whole brain treatments, respectively. For some breast, lung and head & neck patients dose calculations current range margins are found to be insufficient, at least if used generically. We recommend a generic margin of 6.3% + 1.2 mm for breast, lung and head & neck treatments if no case specific adjustments are applied. Thus, currently used generic range uncertainty margins in proton therapy should be redefined in a site-specific manner and complex geometries may require a field specific adjustment.

For a dosimetric analysis of clinical used properties in a study containing 10 patients per site for 5 treatment sites, we find that target doses obtained with analytical dose calculation methods are, on average, 1-2% higher compared to those calculated with MC simulations. Both calculation methods agree within 5% for the mean dose, and the dose values covering 95%, 50% and 2% of the target volume. A y-index