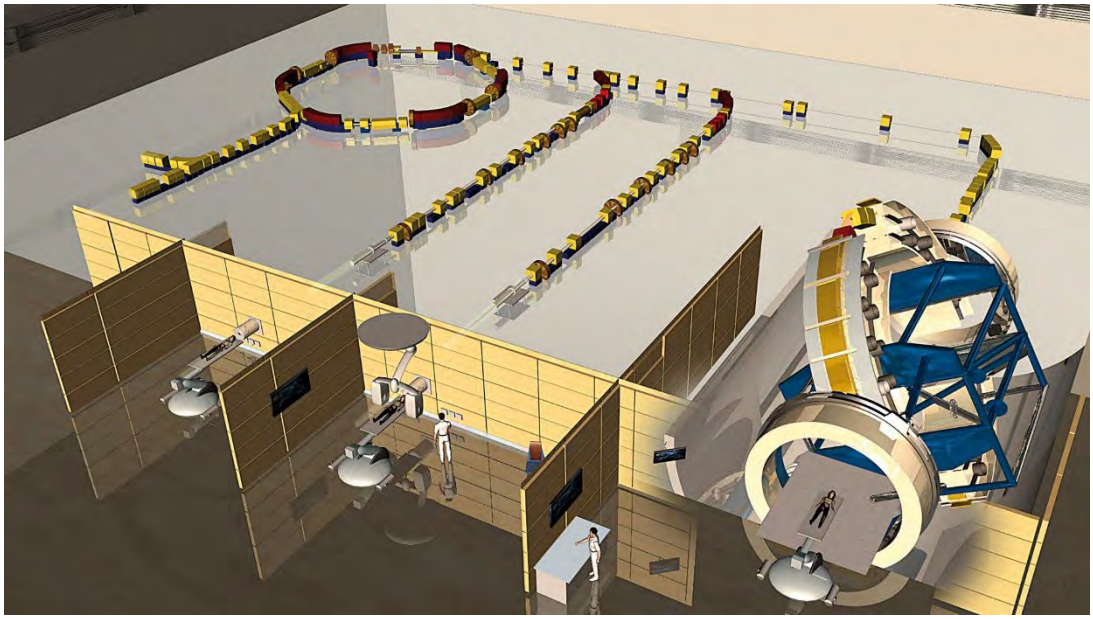
RCR-Cyclotron Trust Visiting Fellowship



Heidelberg Ion Beam Therapy Centre (HIT)

Dec 4th – 8th 2023

Report - Physics/Technical Perspective

Bill Nailon

Edinburgh Cancer Centre

Report - Physics/Technical Perspective

The aim of RCR-Cyclotron Trust Visiting Fellowship is to promote a greater understanding of heavy ion therapy in the wider context of advanced radiotherapy and the Heidelberg team could not have been more helpful in making this happen and hosting us for what was a very enjoyable visit.

Day 1 began with attendance at the 8 am morning meeting where we were warmly welcomed by Professor Jurgen Debus and introduced to the wider clinical team. This was followed by a very thorough overview of the HIT facility including a tour of a horizontal beam treatment room and the more technically complicated gantry-based treatment room. With the facility on a scheduled non-clinical maintenance day we had the rare opportunity to look behind the scenes at the 700 tonne electro-mechanical structure required for iso-centric heavy ion treatments, which is shown in Figure 1.

Figure 1: **Left**: Cut-away of the massive gantry at the Heidelberg ion therapy centre. **Middle**: Picture taken at approximately point **A** looking inside the gantry structure where the door opening to the treatment area is visible in the distance. **Right**: Picture taken at approximately point **B** with Dr Noble standing next to the magnets. Note that the gantry in the middle and right pictures has been rotated 90 degrees from the cut-away schematic on the left.

A further advantage of being present on a non-clinical day and having a unique view of the underpinning technology required for heavy ion therapy was an appreciation of the expertise and scale of the different teams and technical staff required to maintain the smooth operation of the facility. We were also able to visit the experimental beamline at the facility where we saw a range of equipment, including a full-size magnetic resonance imaging (MRI) machine that was being used to investigate the impact of a strong magnetic field on charged ions used for treatment. Whilst this was purely investigative it left us in no doubt of the technological challenges of seamlessly integrating MRI with charged ions and importantly of the opportunity that the HIT facility has to contribute towards knowledge in this area (Figure 2).

Although every aspect of the gantry-based heavy ion treatment room was remarkable, the technology used in the two horizontal treatment rooms with computerised tomography (CT) on rails and six degree (6D) of freedom robotic treatment couches for accurate patient positioning was equally impressive (Figure 2). Throughout various teaching sessions with radiation oncologists and physicists it was clear that those involved in the direct planning of treatments have an appreciation of the performance of the well-established Local Effect Model (LEM) for deriving the biological effects of heavy ion radiation. It was very educational listening to HIT staff discussing different aspects of treatment plans where LEM-specific factors might be worth considering and the improvements between LEM 1 and LEM 3, which once again highlighted the unique training and skills required for safe and effective heavy ion treatments.

The HIT team use RayStation (RaySearch Laboratories, Stockholm, Sweden) for treatment planning and it was particularly interesting to see, during a range of teaching sessions, how they are routinely making use of sophisticated tools such as automatic segmentation and registration within the treatment planning and review pathway. It was also helpful to see the close cooperation required between clinicians and physicists in producing treatment plans. The Edinburgh Cancer Centre is working towards implementation of similar tools for photon treatments and the experience gained at HIT will be very helpful in commissioning these tools for clinical use.

The opportunity to attend two early morning quality assurance/run-up sessions with members of the physics team, the first on a horizontal beamline room and the second on the gantry-based room, was a good opportunity to learn more about the specific checks required for heavy ion therapy. Whilst there are many unique checks and tests carried out it was reassuring to see many similarities between the checks performed in gantry-based photon treatments and the similar range of equipment used at HIT. For example, surface guided radiotherapy has recently been installed at HIT, once again a system that Edinburgh is very interested in. It was helpful to learn about the specific challenges that were faced installing and configuring this system within the gantry-based treatment room and whilst many of the challenges faced may be specific to heavy ion treatment rooms many are applicable to photon treatments (Figure 2).

Being embedded within the HIT team was also a good opportunity to learn more about the way that medical physicists are trained at the facility. As deputy scheme lead for the Scottish Medical Physics and Clinical Engineering (SMPCE)

training scheme I am always keen to learn from other institutions and look for ways to improve training in Scotland. I was very grateful for the opportunity to speak informally to the head of the physics team and learn about the approach used at HIT for training new staff. Of particular interest was the structure of the two-year training programme for new staff and the opportunities to study for higher degrees, which I am very keen to explore in Edinburgh. Another advantage of being embedded within the HIT team was the opportunity to briefly see the Cyberknife (Accuray, Sunnyvale California, US) robotic treatment system and a combined MRI linear accelerator system known as MRIdian (ViewRay, US, which recently filed for bankruptcy). The Edinburgh Cancer Centre previously expressed interest in the Cyberknife system and is currently interested in learning more about MRI-based radiotherapy treatments including MRI simulators and combined MRI linear accelerator systems. The opportunity to see these systems being used clinically within an adaptive radiotherapy workflow, and speak to the clinicians, physicists and radiographers involved in the planning and delivery of treatment, was extremely valuable.

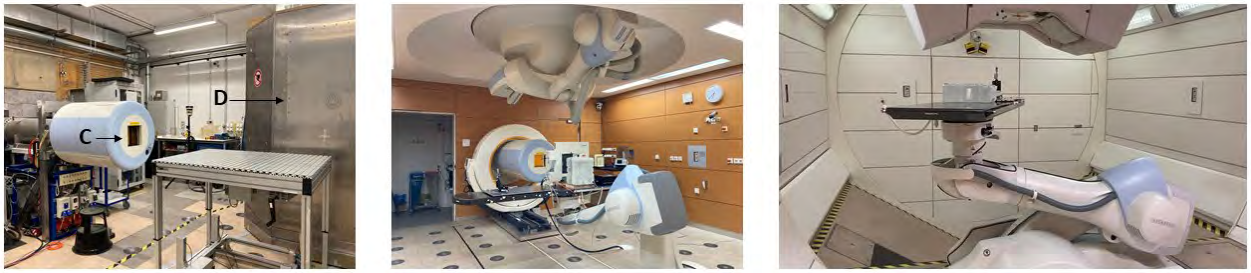


Figure 2: **Left**: Experimental beamline room showing the exit window of the horizontal beamline (position **C**) and the full-size experimental MRI scanner on rails (position **D**) used to investigate the impact of a strong magnetic field on charged ion beams. **Middle**: Clinical horizontal treatment room showing quality assurance setup with the CT on rails visible around the beamline exit window. **Right**: Gantry treatment room where the floor has collapsed to accommodate the moving gantry. The robotic couch is seen placing the quality assurance equipment at a pre-determined position. It is interesting to note that unlike photon treatments the patient is 2.5 m above the floor when the floor is collapsed.

Quite simply this was an amazing opportunity that would not have been possible without the financial support of the RCR/Cyclotron Trust Visiting Fellowships scheme and the open and friendly support of the HIT team, for which I am incredibly grateful. I wholeheartedly agree with the vision of the RCR that these visits will contribute towards achieving the highest possible standard for a modern, world-class radiotherapy service in the UK and feel that the visit has given me a much better understanding of the scale, complexity and daily challenges of running a heavy ion centre. And whilst there is no such centre in Scotland, nor indeed to my knowledge planned in the foreseeable future, I feel that the experience will have a long-lasting impact both professionally and personally. On a professional level my experience will not only be helpful in my daily practice but in future discussions on heavy ion therapy should these take place. On a personal level I established new connections with the staff at HIT, which I hope will continue and may eventually lead to future collaborations.

Finally, I must once again express my deepest gratitude to the RCR for supporting this visit and their continuing support for this initiative.

With many thanks and best regards,

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Professor William Henry Nailon
Chair of Oncology Physics, NHS Lothian & University of Edinburgh
Lead Clinical Scientist, Research and Development, Edinburgh
Professor of Biomedical Engineering, University of Dundee
NHS Lothian Training Coordinator, Medical Physics and Clinical Engineering
[1]Department of Oncology Physics, Edinburgh Cancer Centre,
Western General Hospital, Edinburgh, EH4 2XU, UK.
[2]The Institute for Imaging, Data and Communications (IDCOM,
School of Engineering, The University of Edinburgh, Edinburgh EH9 3BF, UK
[3]The Department of Biomedical Engineering, Fulton Building
University of Dundee, Dundee DD1 4HN, UK.
Tel: 0131 537 3560
Email: Bill.Nailon@nhslothian.scot.nhs.uk W.Nailon@ed.ac.uk

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