Editorial

Welcome to the third issue of the PAB Group Newsletter. This issue features reports on the PAB Group Annual Conference and AGM at Glasgow University in April, and an article describing the activities of Elekta Ltd, who manufacture linear accelerators for radiotherapy.

We always welcome communications about forthcoming accelerator-related events, lectures, meetings and conferences. It is very useful for the community to have brief summaries of relevant events, and in many cases an appropriate link is the optimum solution. Please send any items you wish to submit to the Newsletter to me at: w.a.gillespie@dundee.ac.uk

Report on PAB Group Annual Conference and AGM

Our Annual Conference is a highlight for the PAB Group. It brings together our community, ranging from senior professionals through to our many students, and it also is an opportunity to present both some subject reviews and individual project achievements. This year we agreed to integrate our Conference with other Groups in the IOP Nuclear and Particle Physics Division, a large gathering held at Glasgow University in April. The attraction of this was to provide a showcase for particle accelerator topics to the wider physics fraternity, especially those closest to ourselves (e.g. particle physicists). Unfortunately this meant increased costs for participants, together with a significant time commitment enhanced by travel demands. The PAB Committee fully understands that this was unwelcome to many of our members and it is unlikely to be repeated. Next year we will revert to our more standard format as we organise our own event again.

However we did achieve a number of major highlights. These included whole-conference plenary talks that met our showcasing objective. Phil Burrows gave a splendid sweeping presentation on the impact of advances in our technology and Chris Prior comprehensively reviewed the various accelerator solutions at the intensity frontier, a talk requested by the Particle Physics Group (Brian Foster covered the energy frontier in an adjacent talk). Then we had our own Group plenary sessions with five interesting talks from Riccardo Bartolini (Light Source prospects), Andrei Seryi (New accelerator applications), Peter McIntosh (Technology R&D), Susan Smith (EMMA commissioning) and Andrew Taylor (Future Neutron Sources). In addition there were two parallel sessions with short talks on a wide range of topics, together with a poster session; this latter allowed us to make a selection for best student awards, based on content plus presentation skills, and congratulations are due to Androula Alekou, Dave Brett and Sam Tygier.

During the Conference we also held our Group AGM and elected a new Secretary, Peter Williams. I wish to thank Ken Long for his many efforts in this position during our founding years. Riccardo Bartolini has also now joined the Committee.

On the last day the Conference hosted a Town Meeting at which STFC strategy was presented and discussed. It is very important that such a line of communication between scientists and funders is maintained as a regular feature. There is currently an intensive UK debate underway about accelerator science R&D strategies, including potential investment in experimental infrastructures.
We all must work to sustain our hard-won reputation for innovation and successful delivery of projects and programmes, and the PAB Group will continue to sponsor activities and to represent all of you as effectively as possible.

Mike Poole
Chairman

Elekta Linear Accelerators for Radiotherapy: Caring for Life through Innovation and Collaboration

Giulia Thompson, PhD
Physics Team Leader and Senior Research Physicist, R&D
Elekta Ltd

Every day, Elekta systems contribute to help more than 100,000 patients in over 5,000 hospitals throughout the world.

Elekta is dedicated to human care, providing treatment delivery systems and comprehensive clinical solutions for oncology and neurosurgery applications. These include radiotherapy linear accelerators. Medical Linacs have been in clinical use since the 1950’s and, although the fundamental principles of operation remain the same, significant technological advances have been introduced over the years. With the help of research partners and clinical customers, Elekta has pioneered many innovations that have become an integral part of today’s radiotherapy accelerators.

For example, Elekta introduced a fully integrated digital control system for its radiotherapy linear accelerators in 1985, installing the very first system of this kind at the Royal Marsden Hospital, UK. The Elekta digital accelerator control system has now reached its 6th generation and continues to enable fast, accurate and safe treatment delivery.

Elekta digital accelerators are manufactured in Crawley, West Sussex. The electron source for Elekta Linacs is a diode gun, to which high-voltage pulses are applied and synchronized with a Radio-Frequency pulsed electromagnetic field. The RF source is a fast-tuning magnetron. This has the advantage of compact size and lower power requirements compared to the klystrons that are used in other high-energy radiotherapy machines. The electrons are accelerated in a ‘traveling waveguide’ structure.

Fig. 1: Illustration of beam generation and transport in the Elekta digital accelerator.

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Focusing and steering coils ensure that the beam maintains a small divergence and is aligned with the central axis of the waveguide. An achromatic bending magnet assembly is employed to direct the electron beam towards the patient plane. Elekta Linacs employ a unique ‘slalom’ bending system, which lowers the point of treatment and therefore provides easier access for patient set-up.

The Linac can operate in X-ray or electron mode. The majority of radiotherapy treatments are performed using X-rays, with the use of electrons limited to low-seated tumors. Elekta’s beam generation technology provides triple-energy machines in the 4-25 MV X-ray energy range, with nine electron energies (4-22 MeV). Elekta also supplies a single-energy (6 MV) Linac based on standing waveguide technology (Elekta Compact™, manufactured by Elekta in Beijing, China).

Therapy X-rays are produced by directing the electron beam on a tungsten target. Due to the peaked distribution of the bremsstrahlung radiation, special beam modifiers (flattening filters) are employed to make the intensity of the beam uniform. An internal ionization chamber monitors and controls the total dose, the dose rate, the beam position and its uniformity, while movable tungsten collimators provide optimum beam shaping.

In the early 1990’s, Elekta introduced the first Multi-Leaf Collimator (MLC), a beam shaping device that was integrated in the digital control system of the Elekta Linac. This achievement was recognized in 1994 with the Queen’s Award for Enterprise - Innovation. A series of tungsten blades (leaves) within the MLC move independently and enable the generation of irregular beam shapes. This improves conformity of the radiation field to the tumour. Today, the MLC is a standard component of radiotherapy machines and is fundamental to the application of modern treatment techniques.

In 1992, Elekta founded the IMRT Consortium. This international group, consisting of nine University Hospitals, collaborated to research Intensity Modulated Radiation Therapy, a technique that uses sequenced static MLC shapes or dynamic MLC control to modulate beam intensity and achieve high dose conformity. Recently, this concept was extended to the implementation of VMAT (Volumetric Modulated Arc Therapy). In VMAT, intensity-modulated dynamic delivery occurs in continuous arcs around the patient, which significantly reduces treatment time.
In 2005, Elekta pioneered the idea of combining the Linac with X-ray Cone-Beam Computed Tomography and introduced the first Image-Guided Radiotherapy (IGRT) system in the world (Elekta Synergy®). This integrated 3D volume imaging technology enables accurate visualization of the tumour target and surrounding healthy tissues. This was the result of close collaboration with several centres of excellence for radiotherapy research in the UK, The Netherlands, Canada and USA.

Elekta and its research partners are still stretching the boundaries of IGRT. The University Medical Centre in Utrecht, The Netherlands, is presently developing a research prototype Linac system with integrated Magnetic Resonance Imaging. This is a powerful concept, since such a system could potentially enable real-time soft tissue visualization and tracking of tumour motion.

Elekta has been supporting its research partners in the investigation of Linac developments and the implementation of new treatment modalities for over 30 years, and continues today to encourage collaborative innovation. Many examples of this cooperative research were recently presented at the 11th Biennial ESTRO Conference on Physics and Radiation Technology for Clinical Radiotherapy (London, 8th-11th May 2011). Together with Elekta, researchers all over the world are leading innovation in order to improve, prolong and save lives.

IoP PAB Meeting
The Status and Challenges of Simulation and Computing for Accelerators
Rutherford Appleton Laboratory

On Friday 25th February 2011 the Institute of Physics, Particle Accelerators and Beams Group hosted a meeting on ‘The Status and Challenges of Simulation and Computing for Accelerators’ at the Rutherford Appleton Laboratory. The meeting was free to attend and was supported by
the IET Electromagnetics TPN. It was attended by over 50 delegates. Ten speakers were invited by UK researchers and a guest talk was given by the author of GPT, Bas van de Geer of Pulsar Physics, Netherlands.

Talks were also presented by:
Chris Prior “Simulations Overview”.
Chris Rogers “MICE Experimental Software Framework”.
Dan Faircloth “Modelling the CERN S-LHC Source”.
Graeme Blair “The BDSIM Code”.
Julian McKenzie “Modelling of the ALICE Injector”.
Lawrence Campbell “3D Unaveraged FEL Code”.
Peter Williams “Start-to-End Simulations for Fourth Generation Light Sources”.
Ricardo Bartolini “Numerical Analysis of Collective Effects in Electron Storage Rings”.

For more information contact bryan.jones@stfc.ac.uk or ben.pine@stfc.ac.uk.

Other News and Links

Congratulations to Mike Poole who has been elected a Fellow of the European Physical Society
http://www.cockcroft.ac.uk/news/mike_poole.htm

Daresbury had first acceleration in EMMA
http://www.stfc.ac.uk/ASTeC/News+and+events/24686.aspx

First demonstration of continuous wavelength tuning on the ALICE IR-FEL
http://www.stfc.ac.uk/ASTeC/News+and+events/24039.aspx
IoP PAB Committee

**Chair:** Prof. Mike Poole (Daresbury)

**Secretary:** Dr. Peter Williams (Daresbury)

**Treasurer:** Prof. Phil Burrows (Oxford)

Prof. Allan Gillespie (Dundee); **Newsletter**

Dr. Hywel Owen (Manchester); **Web Manager**

Dr. Dan Faircloth (RAL); **Web Manager**

Dr. Brian McNeil (Strathclyde)

Mr. Aled Jones (AWE)

Dr. Ricardo Bartolini (Diamond Light Source)

Dr. Adina Toader (Manchester)

Mark Ibison (Liverpool); **student representative**

Useful Links

[http://www.scitech.ac.uk/](http://www.scitech.ac.uk/)

[http://www.cockcroft.ac.uk/](http://www.cockcroft.ac.uk/)

[http://www.adams-institute.ac.uk/](http://www.adams-institute.ac.uk/)

[http://www.desy.de/index_eng.html](http://www.desy.de/index_eng.html)


Deadline for submissions to the next newsletter is 31 October 2011

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