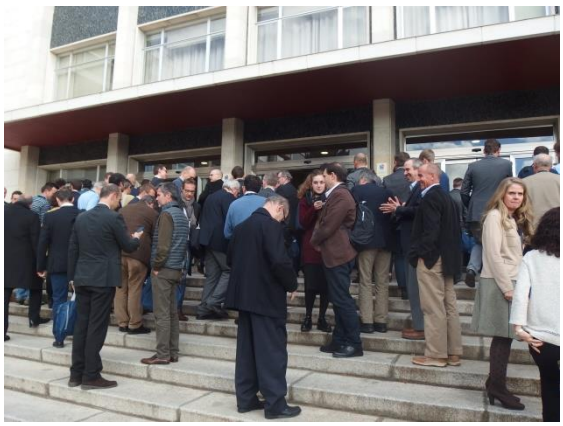
PRESS RELEASE

Superconducting Accelerators – a View into the Future of Medical Applications

In our everyday environment, compact superconducting accelerators produce short-life radionucleides to make diagnoses, and proton and ion beams to treat tumours by hadrontherapy. Superconductivity has hence become a key technology of particle accelerators, helping their progress and taking advantage of their development.



CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas), in collaboration with HEPTech, EUCARD2, CDTI, GSI and EEN (Enterprise Europe Network) brought together experienced researchers and leading companies in the field of superconductivity on 24-25 November 2016, in Madrid, to explore the technical challenges emerging from the design of new accelerator machines and to match them with state-of-the-art medical solutions. A hundred and twenty-five participants from 19 countries, including Japan, China and USA attended the event.

Its programme focused on three main areas of expertise: radioisotope production, particle therapy, and gantries. Industry demonstrated a strong interest in the forum, including by providing significant sponsorship.

The introductory session gave an overview of superconductivity and its applications in energy, medicine, fusion, and HEP sectors. The HEP applications were illustrated by the CERN's high-luminosity LHC, now near construction with superconducting magnet capable of 12 T field, made with advanced Nb3Sn technology. The talk stressed upon the greatly advanced superconducting cavities (SRF) with more efficient and high gradient RF systems, and the development of new devices like the HiLumi LHC crab cavities able to deflect or rotate each single bunch. The improvement of these technologies was illustrated along with the possible strong impact on the future of medical accelerators.

On behalf of industry, Varian Medical systems, one of the sponsors of the event, assured the audience that superconducting technology is ready to go into production for medical applications and demonstrated the high potential of superconductivity applied to cyclotrons. The researchers faced the challenge that one alternative of the future development of the cyclotrons is related to advanced conductor materials for higher fields or higher operating temperatures. In this regard, the following talk on the opportunities of the superconducting materials for different operating temperatures, including for high temperature superconductors, was highly appreciated by the audience.

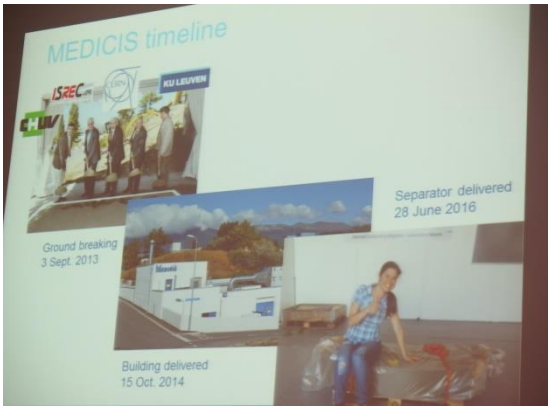
A dedicated session presented novel developments in the cyclotron production, illustrated by examples of compact accelerators for PET production - AMIT (Advanced Molecular Imaging Technologies) project and LOTUS project. A talk from CIEMAT discussed the main aspects of the superconducting technology associated to the AMIT cyclotron - a compact superconducting design, based on a Lawrence-type machine that will be able to produce low to moderate rates of dose-on-demand 11C and 18F. This will be achieved by accelerating 10 microamperes of H – up to 8.5 MeV.

LOTUS project is a French industry-academia partnership project. The LOTUS system features a compact 12 MeV superconducting Helium-free magnet cyclotron, with an external self-shielded beam and targetry system, particularly suitable for the production of Carbon-11, Fluor-18 and Gallium-68 radioisotopes. A microfluidic automated synthesis platform allows the radiolabeling of a wide range of biomarkers for PET molecular imaging.

Antaya Science and Technology reported on the development of a portable high field superconducting cyclotron for the production of unit dose N13 Ammonia (a cardiac imaging agent with much higher resolution images, significantly lower doses to patients and lower dwell times in patients, and essentially no radioactive waste), in near proximity to the PET cameras.

The small footprint of the superconducting cyclotrons was pointed out as an advantage to traditional resistive ones allowing their installation in small hospitals or research institutions. The usage of superconducting cyclotrons in the radiopharmaceutical production process, where the radioisotope production constitutes the first step, was also discussed.

MEDICIS, the new facility under construction at CERN was introduced. It will provide dedicated medical batches for radiopharmaceuticals and develop new accelerator technologies for medical applications. It will extend the capabilities of the ISOLDE radioactive ion beam facility, operated with a 1.4 GeV proton beam and the on-line mass separator, which allows the production of a spread variety of radioisotopes for different aims.



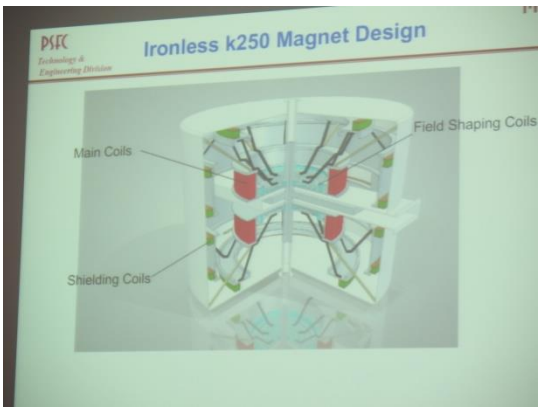
The Research Institute of Technical Physics and Automation, Moscow, Russia reported on the development of a new high power efficient RF generator which is commercially available. The control system of the generator has features specially designed for PET cyclotrons. The institute proposes a compact, modular PET center for low patient traffic which utilizes a cyclotron with the developed RF generator.

The first day of the event concluded with a talk on the challenges posed to nuclear imaging caused by the widespread installation of cyclotrons and production of radiotracers. It was illustrated how this type of medical imaging gains relevance not only for early diagnostic and/or evaluation of the human response to treatment of a variety of diseases but also in pre-clinical and clinical settings, as well as in investigation of mechanistic aspects of physiological, biological and/or medical problems.

At the particle therapy session, industry presented superconducting medical accelerators, such as MEVION S250 - a proton therapy system based on a gantry mounted superconducting synchrocyclotron. The synchrocyclotron is a 250 MeV accelerator weighing less than fifteen tons with magnetic fields in excess of ten Tesla and an extraction radius of only 30 cm. The compact architecture allows delivery of high quality proton therapy without the need for beam lines, magnetic gantries or energy selection systems. The entire system is designed for its intended use as a medical device and is easily operable by a single therapist.

IBA (Ion Beam Applications S.A.), a global medical technology company, made an overview of its two main superconducting cyclotrons for particle therapy - the Cyclone 400 for proton/carbon therapy and the S2C2 dedicated to proton therapy, with a particular emphasis on their superconducting coil systems. IBA also introduced the latest developments concerning ProteusONE - a single-room proton therapy system providing personalized comfort and accessibility while delivering the most clinically advanced form of proton radiation therapy. In fact, it is the only compact center that offers pencil beam scanning, which minimizes radiation exposure to healthy tissue.

IBA has a long history of cooperation with CIEMAT and is one of the sponsors of the event. Eduardo Fuentes from BIOTERRA, S.L., the Spanish distributor of IBA, advertised proudly the outstanding features of ProteusONE and stressed the large number of contacts he made in two days. “I am not looking for customers here – it is not a comercial event. Instead, this is the right place to look for new ideas for further development of our products and technologies, and to see what the other companies in our field are doing”, explained Eduardo.



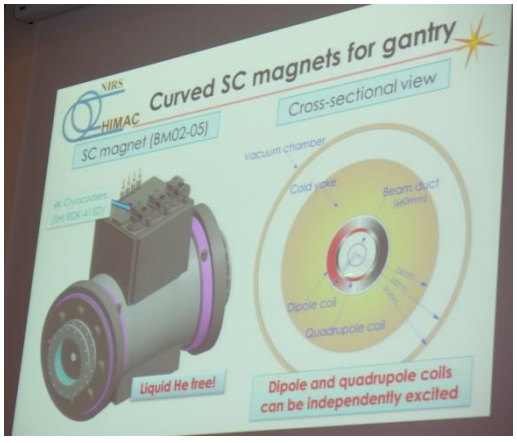
The Massachusetts Institute of Technology (MIT), US, presented a novel compact superconducting synchrocyclotron. By using ironless k250 magnet design, its weight is significantly reduced. Implementation of this design benefits from several important advances in superconducting magnet technology pioneered in the magnetic resonance imaging (MRI) industry during the past 20 years, such as active magnetic shielding.

GSI discussed its compact injector linac concept for hadron therapy pointing out that room-temperature linacs still have advantages for low-duty cycle machines like synchrotron injectors.

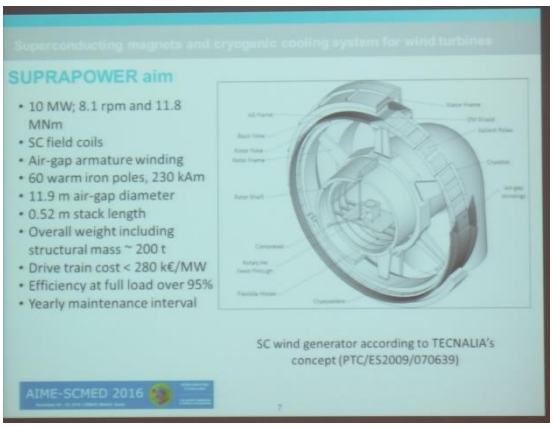
Superconductivity in cyclinacs for ion beam therapy was the focus of the presentation of TERA Foundation (Italy), having more than 20 years' experience in hadron therapy. Cyclinacs are accelerators, which combine the two leading technologies in the medical field: a cyclotron injector and a linac booster. The linac technology offers the unique potential to increase the performance of accelerators for ion beam therapy, through the fast energy modulation and small transverse size of its high repetition rate pulsed beam. This allows to increase the quality of beam delivery for the treatment of moving tumors. The most cost-effective solutions for cyclinacs make use of superconducting cyclotron injectors. Conceptual designs of such cyclotrons were presented.

The session on gantries gave an overview of the state-of-the-art of gantry designs and technologies, focusing on advantages - such as weight, size, and power consumption, and challenges for the superconducting magnets in applications in proton and ion therapy gantries. The options for superconducting material choice, magnet geometry, cooling system and beam optics design were identified and their individual features were reviewed.

Paul Scherrer Institute (Switzerland) presented a design of a superconducting bending magnet section (consisting of three combined function magnets: two dipole, quadrupole and sextupole magnets and a combined quadrupole and sextupole magnet) for future compact iso-centric gantries for medical applications.



The Japanese National Institute of Radiological Sciences (NIRS) introduced its superconducting (SC) rotating gantry for carbon radiotherapy. This isocentric rotating gantry can transport carbon ions with the maximum energy of 430 MeV/u to an isocenter with irradiation angles of over +-180 degrees, and is further capable of performing three-dimensional raster-scanning irradiation. Combined function SC magnets were employed for the rotating gantry now in process of commissioning. To build upon these achievements, an ultra-compact gantry and a SC synchrotron are now being designed at NIRS.



Pros and cons concerning gantry cryogenic design and cryo-cooling methods for rotating SC magnets were also discussed.

To overcome possible considerations on the cryocooling issue, a novel design concept of a cryogen-free cryogenic cooling system for rotating superconducting magnets in medical accelerators was introduced by TECNALIA Research & Innovation - the first privately funded applied research and technology organisation in Spain and one of the leading such centres in Europe. Based on the cooling system developed for a superconducting generator for wind turbines, a similar cryogen-free design was outlined for superconducting gantries.

The event attracted huge interest from both academia and industry demonstrating 45% increase in the overall participation and significant industrial sponsorship, compared to a similar forum in 2013, dedicated to the same topic and hosted again by CIEMAT.

"In 2013 we were still in the pre-procurement phase – this means that industry was not ready to respond to the needs of research yet", explained Jean-Marie Le Goff, Chairman of HEPTech, and proposed to keep up the momentum by organizing regular events on this topic.

The companies that attended the event with the aim to collect valuable ideas for technological development were satisfied by the quality of the presentations and the importance of the contacts they made.

Elytt Energy, one of the sponsors of the event, is an innovative company working in high-technology projects, developing and manufacturing equipment for particle accelerators for scientific research and medical usage. "We are very happy to attend this event as we met the key companies in the medical sector for proton therapy. This is a sector with just a few manufacturers and for us the most important is the quality, rather than the number of the contacts we made. This event opens the door for us and we will be here again next time", said Angel Garcia, Sales Manager of Elytt Energy.

Eleonora Getsova,
HEPTech Communication Officer