ENHANCED EUROPEAN COORDINATION FOR ACCELERATOR RESEARCH & DEVELOPMENT

EuCARD-2 is a collaborative project with more than 300 participants coming from 40 partner Laboratories, Universities and Industries. The project is structured into 13 work packages (WP) covering different key technologies for the future of Particle Accelerators and providing access to three advanced test facilities. The project has steadily progressed in its first 18 months, submitting on time its 13 due Deliverables and producing already 152 scientific publications including journal publications, conference papers, notes, presentations and outreach talks and material. The project Networks have organised or co-organised 25 high-level scientific workshops.

During the initial period, the Management and Communication WP has been active in setting up the governance of the consortium, in defining scientific objectives and interfaces with other programmes at national and European levels, in implementing best practice procedures for the production and follow-up of milestones and deliverables, and in starting up a wide range of dissemination and outreach activities. The whole project convened twice during the first period, for a kick-off meeting in June 2013 centred on the “Visions for the Future of Particle Accelerators” workshop, and for the first Annual Meeting at the DESY Laboratory in Hamburg in May 2014.

The main goal of the Catalysing Innovation activity is to maximize the transfer to industry of innovation generated within the various work packages of EuCARD-2. The first priority was to identify the key technological areas that are potentially interesting for industry. Production of medical isotopes using particle accelerators and the development of advanced materials for thermal management were highlighted as high-potential topics that will be the focus for the future “EuCARD-2 meets the industry” events. A key highlight included showcasing materials with outstanding thermal conductivity properties at Hannover Messe, a first result of EuCARD-2 Collimation activities.

The Energy Efficiency work package is an all-new effort starting in EuCARD-2, which aims at developing technologies and methodologies to manage energy consumption in particle accelerator facilities. Its first action was to launch a study on energy consumption and heat inventory in 12 different accelerator laboratories, to assess the situation and to analyse options to improve energy efficiency. Workshops on specific energy saving technologies are providing a better insight into the important energy issue.

The Accelerator Applications Network aims at developing and improving applications of
accelerators to society, mainly towards medicine and industry. Through a series of lively Workshops this WP attracted already more than 50 partners outside of the EuCARD-2 framework, a number that is continuously increasing and indicates the interest of the community in extending the reach of particle accelerators. The initial Workshops focused on the development of compact gantries for cancer particle therapy, on medical applications of neutron beams, and on energy production and nuclear waste transmutation with particle accelerators. A new H2020 proposal on Boron Neutron Capture Therapy directly resulted from these activities, while the activity on energy production with accelerators contributed in defining synergies that resulted in an extended participation to another H2020 proposal. The work package has also produced a “Preliminary List of Accelerator Applications and Candidate Technologies”, an important reference document that will be continuously updated, and is starting preparation of a policy document called “Applications of Particle Accelerators in Europe”, to be supported by an international organising committee.

The work package on Extreme Beams (XBEAM) addresses all accelerator frontiers: luminosity, energy, beam power, beam intensity, and polarization. In the first period, 13 topical workshops were organized or co-organized. Most active in this regard was the task on “Extreme Colliders”, which focuses on the future of particle colliders for high-energy physics. Events were organized related to the upgrade of KEKB in Japan, to crystal channelling and to the future of the CERN facilities. With respect to the latter, not only various upgrades of the LHC were considered, but the WP participated as well in the launch of a new study for a challenging 80-100 km collider, the “Future Circular Collider” for protons and possibly electrons, which could become the leading accelerator for particle physics after the end of the LHC lifetime. Other workshops like “Beam Dynamics Meets Magnets” brought together diverse communities to facilitate magnet optimization; prepared the commissioning of proton linacs, with emphasis on the ESS; and synthesized the key questions for lepton spin polarization to be addressed in the coming years.

The new Network on Low Emittance Rings aims at developing synergies and common strategies between the European synchrotron light facilities, which under the pressure of their industrial and scientific users are undertaking a wide improvement and modernisation effort, and the more science oriented damping rings and electron/positron colliders communities. After structuring the community via a collaboration board open to non-European members, the Network organised two particularly successful general workshops and two topical workshops, on beam instabilities and on technologies. This Network was particularly active in attracting young researchers and in rewarding them with a special student prize awarded to the best student poster presentation.

The European Network for Novel Accelerators 2 (EuroNNAc2) aims at promoting new
plasma-based acceleration techniques. Amongst the highlights of the first period was the first European Accelerator Concepts workshop (EAAC 2013), a foundational event with 145 registered participants from 15 countries, representing 69 institutes. The international steering committee that resulted from this event defined a strategy for a first plasma-based accelerator facility that was submitted as a Design Study under H2020, together with two applications for Future Emerging Technologies (FET) projects.

The ICTF@STFC work package provides access to the Ion Cooling Test Facility at the RAL Laboratory (UK). The allocations made following the first call for applications resulted in enabling and supporting three University groups for the commissioning and operation of the Electron Muon Ranger Detector, a critical component of the Muon Ion Cooling Experiment.

The HiRadMat@SPS and MagNet@CERN work package provides transnational access to two CERN facilities. In HiRadMat two international calls for beam time – in March and September 2014 - resulted in 15 proposals with the first access granted for experimental preparation. At MagNet the Superconducting Magnet Test Stand is in operation, with three projects accepted in the first period. The subjects included the qualification of superconducting solenoids for a medical application, testing of optical fibre based instrumentation for low temperature application, and Nb$_3$Sn magnet testing and thermo magnetic modelling based on experimental data.

The initial phase of the Future Magnets activities was devoted to the review and specification of target performance for the High Temperature Superconductor (HTS) material. In addition, initial material characterization and a selection of cable concept were studied, which resulted in the production of the first length of conductors. The second focus was to study magnetic designs with respect to the cable concept defined. In addition, several tests, including winding, pressure, impregnation, insulation, have been performed on the Roebel dummy cable, taken as the baseline for the 5T dipole cable.

Highlights from the Collimator Materials for fast High Density Energy Deposition activity included the identification and irradiation of advanced collimator materials such as Copper-Diamond (CuCD) and Molybdenum Carbide – Graphite (MoGr) composites. MoGr has recently showed outstanding properties, combining an extremely low thermal expansion coefficient in the temperature range from Room...
Temperature (RT) to more than 2000°C and a world record-breaking thermal conductivity of about 800 W/mK at RT. Its production cycle is being refined, following first results from this work, to achieve best performance also under irradiation.

The Innovative Radio Frequency Technologies activity has seen important progress in the development of new deposition processes for superconducting thin films to be used in accelerating cavities and in the preparation of a deposition infrastructure and testing equipment (Surface Analysis/Preparation Installation, SAPI). A first result enabled high performance qualification of a 1.3 GHz single-cell cavity. A new quadrupole cavity was also developed to test refined deposition processes; additionally the first multi-layer films have demonstrated lower resistance than bulk Niobium. Other highlights included the development of a new klystron bunching scheme that would allow higher efficiencies, and an initial implementation of electro-optical modulators for high-frequency signal acquisition and transport. The design of the electronics for HOM-based beam diagnostics has progressed fast and is now in an advanced stage of testing. Initial signal stability studies and simulations of an eight 3.9 GHz-cavity chain have been performed, looking at monopole modes. The preparation, characterization and test of photocathodes specifically dedicated for high peak current, high average current of normal or superconducting injectors continued. Photocathodes experimental stages were commissioned in partner Laboratories.

The four topics covered by the Novel Acceleration Techniques WP progressed also well. In the development of high brightness electron beams obtained by means of laser plasma accelerators, the first period was dedicated to high precision spatio-temporal synchronization at the femtosecond level between driver laser pulses and injected electron beams. Highlights have also seen developing and characterizing new gas targets with local density gradient. Spatial and temporal synchronization was demonstrated and characterized using laser pulses from the high power DRACO Ti-Sapphire laser system and relativistic electron bunches from the ELBE superconducting linear accelerator. The first deliverable demonstrating the ultra fast longitudinal feedback at FLASH was also reached. This initial period has also been very significant for the investigation of proton-driven plasma wakefield acceleration; the collaboration of scientists and engineers formed to demonstrate this for the first time has received approval from CERN and an experiment called AWAKE is now an officially recognised and funded project.