
European Coordination for Accelerator Research and Development

**PUBLICATION**

# EuCARD Newsletter Issue 2

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EuCARD Newsletter

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**Online version available at http://cern.ch/EuCARD/news/newsletters/issue02**

# European Coordination for Accelerator Research and Development Newsletter



**Issue 2: July - September 2009**

## A word from the Governing Board Chairman

Professor Tord Ekelof, Upssala University, talks about his role as EuCARD Governing Board chairman and his hopes for the outcomes of the EuCARD project.

***Read more >>***

## Amassing the neutrino community

Silvia Pascoli explains the motivation behind EuCARD's accelerator neutrino physics network NEu2012, as well as the network's involvement in the NuFact09 workshop among others. ***Read more >>***

## Start by probing the crab cavities

Frank Zimmermann talks about how the AccNet Accelerator Networking activities have begun with the recent crab cavities workshop at CERN.

***Read more >>***

## Breaking news for Proton "Surfatrons"

Exciting and promising findings published by Allen Caldwell and others call for a demonstration experiment for proton driven plasma wakefield acceleration.

***Read more >>***

## For EuCARD members

The first six months of the project are now complete, which means time for internal reporting. Read our FAQ for project members of who needs to do what, when and how.

***Read more >>***

## Upcoming events

**01 - 03 Oct 09 European Strategy for Future Neutrino Physics**, Switzerland
**09-11 Oct 09 NNN09** workshop, USA
**12-13 Oct 09 Anti e-Cloud Coatings** (AEC'09) workshop, Switzerland
**12-16 Oct 09 CLIC09**, Switzerland
**12-16 Oct 09 ICALEPCS 2009**, Japan
**18-23 Oct 09 MT21**, China
**19-22 Oct 09 LLRF09**, Japan
**2-4 Dec 09 Neutrino, Neutron, Nuclear, Medical and Muon Physics at ESS**, Sweden

***Read more*** >>

## Project Results

**Publications** include wakefield suppression in CLIC, IP photon calculations, ATF2 spot size tuning, crab cavities and LLRF for FLASH.

**Events** include workshops on neutrino physics, crab cavities and electron-cloud suppression.

**Deliverables** and **milestones** have been successfully completed.

***Read more >>***

**Please contact the EuCARD editor with news, events, achievements, images and ideas that you would like added to the public website, newsletter or Intranet.**

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# A word from the Governing Board Chairman

EuCARD has three different fields of activities on its agenda; technical development work organized in *Joint Research Activities*, coordinating and structuring work through *Networking* and provision of *Open Access* to certain test facilities.

For each of these activity fields particular areas have been selected in which there are leading and urgent problems in accelerator research and development.

Technical development work will be done in the areas of high field magnets, collimators, linear colliders, superconducting rf technologies and innovative accelerator concepts.

Coordinating and structuring work will be done for accelerator based neutrino facilities, for normal and superconducting rf technologies and for accelerator performance, bridging the gap between the physics, the technologies and the usage of accelerators.

Professor Tord Ekelof, EuCARD Governing Board Chairman.
*Image courtesy:* ***University of Uppsala***

Open access will be provided through EuCARD to the usage of the Muon Ionization Cooling Experiment MICE at RAL and to the High Power Radiation Facility HiRadMat at CERN.

These specific programs of work promise to deliver concrete and important technical results within the four years of the EuCARD project. They represent the substance of the EuCARD project and constitute specific technical contributions to - as its acronym reads - the European Coordination for Accelerator Research and Development during this period.

However, as I see it, EuCARD also contributes, in a wider perspective, to the development of a longer term coordination of accelerator research and development in Europe. The background to my statement is outlined below.

The CERN Council approved in July 2006 a long term strategy for particle physics, the fourth point of which reads “In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D program; *a coordinated program should be intensified, to develop the CLIC technology and high-performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.”*

In July 2009 CERN and the European Commission signed a Memorandum of Understanding to cooperate in the area of research programming and, in particular, in the implementation of the European Strategy for Particle Physics.

A model for how to achieve sustained accelerator R&D in Europe, called TIARA (“Test Infrastructure for Accelerator Research Area”) was presented and unanimously approved at the European Strategy Session of the

CERN Council on Friday 18 September 2009.

The TIARA model will serve as a basis for a so called Preparatory Phase project proposal to be submitted by the end of November to the EC 7th Framework Programme. The aim of this 3-year Preparatory Phase project is to elaborate a sustainable European framework TIARA, to be implemented in 2013, within which a coordinated program for research and development of particle accelerators is organized.

The aim of TIARA is to stimulate and strengthen leading developments of new accelerator technologies by integrating the European technical test-infrastructures required for this purpose and by enhancing education and training in accelerator technology.

EuCARD and TIARA appear to me as a two very important complementary efforts under the combined auspices of the European Commission and CERN.

EuCARD has launched technical work on a selected set of leading problems in accelerator technology that correspond to the projected future needs of, primarily, particle physics. TIARA proposes to implement a European framework to coordinate and support the different kinds of accelerator test-infrastructures available in Europe and to enhance education and training with the aim to enable and strengthen further such technical work in future.

The program of concrete technical work in EuCARD thus constitutes the prime current example of the kind of European collaboration for accelerator development that TIARA wants to elaborate a sustainable framework for. In this way EuCARD is indeed contributes to the European Coordination for Accelerator Research and Development also in a longer term perspective.

I believe that the stated aim of the TIARA project is something that EuCARD, in particular it's Governing Board, should keep in mind when monitoring the progress of the EuCARD programme.

- *Tord Ekelof, University of Uppsala*

# Amassing the neutrino community

"Neutrino physics gives a different point of view to the fundamental laws of nature." says Silvia Pascoli, deputy coordinator of NEu2012. "It provides a unique perspective that complements other particle physics searches."

This philosophical approach underpins the role of the EuCARD accelerator neutrino physics network. The network name NEu2012, Neutrinos for Europe in 2012, refers to the date set by the European Strategy for Particle Physics, by which time the network should deliver an agreed programme of neutrino experiments, based on upgrades of existing infrastructures and/or on the proposal of a new one.

The NEu2012 network had strong participation at the NuFact09 workshop including plenary talks from Alain Blondel, UNIGE and Ken Long, Imperial College London (bottom photos 4th and 5th from the left). *Image courtesy Yagmur Torun, Illinois Institute of Technology, see* ***NuFact09 photos****. Thumbnail image main page courtesy of Sanja Gjenero, stock.xchng*

## Scientific exchanges

Within EuCARD, the NEu2012 network is working towards this date by enhancing collaborative work and scientific exchanges.

These scientific exchanges have been happening throughout 2009, following on from the **CARE** FP6 network BENE, Beams for European Neutrino Experiments that NEu2012 is rooted in.

In particular, on 1-3 October 2009, the **European Strategy for Future Neutrino Physics workshop** will take place at CERN and via video-conference. NEu2012 has helped set up and will support this event, including providing funding for a number of young physicists to attend. In addition, NEu2012 members have been active in organising, attending or presenting at some of the leading particle physics events, including **NuFact09**, **EPS-HEP**, **WIN09** and the coming **NNN09 workshop**.

## The facts about NuFact09

NuFact09, the 11th International Workshop on Neutrino Factories, Superbeams and Beta Beams, took place at Fermilab and IIT, Chicago, 20-25 July 2009. "As one of the most important events for accelerator neutrino physics, NuFact09 was a key opportunity for EuCARD," says Pascoli, "NEu2012 members had a strong presence

there, giving talks and leading or participating in discussions."

"The annual workshop gives a unique common forum where a world-wide community of neutrino and accelerator physicists can discuss the possibilities of traditional and novel neutrino beam concepts at the same time as the theoretical, phenomenological and experimental aspects of the corresponding experiments. Evaluating scientific potential as well as design work and R&D on accelerator and detector components."

"The latest experimental developments were presented, reviewed and discussed to work towards future improvements. The relevance of a 5-8 GeV multi-mega-watt linac of the **Project X** or High Power Superconducting Proton Linac (HP SPL) type is more and more apparent. The option of a Lithium-Mercury (Li-Hg) jet target in 15 Tesla solenoidal magnetic field is supported by the results of the **MERIT** prototype at CERN. An improved design of the neutrino factory front end emerged. The plan of the betabeam second round of design study, notably for more effective production of ion neutrino parents, were presented."

"These discussions are all very timely and crucial in shaping the future neutrino program worldwide" explains Pascoli. "With the discovery of neutrino oscillations and consequently of the existence of neutrino masses and mixing in the past decade, neutrino physics has entered a new era. New questions are open for the future: we need to understand what the new physics theory is that is responsible for neutrino masses and for mixing in the leptonic sector."

"This is a major challenge from the theoretical and experimental points of view and requires a precise knowledge of neutrino properties" states Pascoli. "To this aim, future precision neutrino facilities, such as the long baseline neutrino experiments on which NEu2012 focuses, will play a crucial role in shedding new light on the values of neutrino masses, the presence of CP-violation (whether neutrinos and antineutrinos behave in the same way) and on the values of the mixing angles."

## Worldwide collaboration

"A very strong effort is underway to work towards 2012. Theorists and experimentalists are collaborating to establish the physics reach of the various options under consideration (Neutrino Factories, Superbeams and Beta Beams) and optimise the experimental configuration(s) of neutrino source, detector technology and detector location (baseline) and site. The European community represented by NEu2012 in EuCARD works with other EU co-funded FP7 projects such as the **EUROnu Design Study** of accelerator neutrino beam options and the **LAGUNA Design Study** of large underground experimental sites."

"The European community is tightly connected to the US Neutrino Factory Collaboration, the Japanese Working Groups on muon beams, the **INO** detector Collaboration in India and more. Many common R&D projects (**HARP**, **MERIT**, **MICE**, **MuCool**, **EMMA**) or Design Studies, such as the **IDS-NF** (International Design Study of a neutrino factory), have been taking shape, often in the context of the NuFact and/or NNN workshops series. It really is a worldwide effort."

*- Silvia Pascoli, IPPP Durham University; Kate Kahle, CERN; Vittorio Palladino, INFN*

# Start by probing the crab cavities

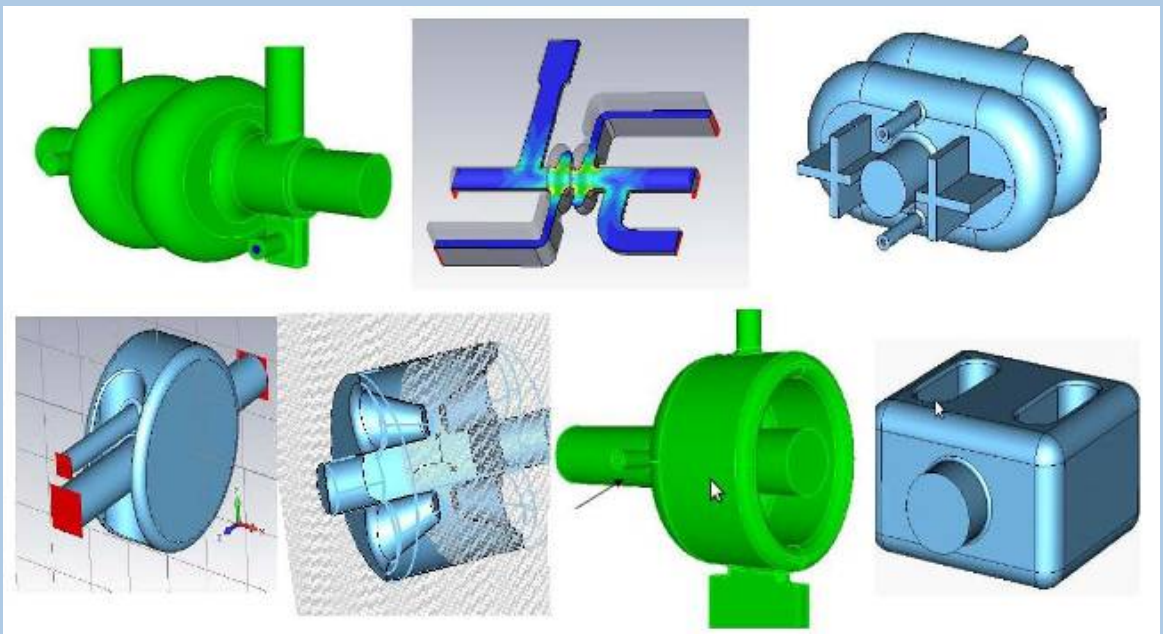
Crab cavities could hold the key to significant luminosity increases in particle colliders. With this in mind, the EuCARD Accelerator Science Network, “AccNet” co-organised the **LHC-CC09** workshop at CERN from 16-18 September 2009.

"The recent success of the first-ever crab cavity operation, at the KEK B-Factory in Japan, has given a boost to the pursuit of crab cavities" says Frank Zimmermann of AccNet, "the LHC-CC09 workshop gathered together international experts to discuss whether these cavities could be used in the LHC and SLHC to improve luminosity".

AccNet is guiding upgrades of existing European accelerators and preparing the ground for new projects. *Image courtesy: **AccNet**. Thumbnail image main page courtesy of Ralph Kiesewetter, stock.xchng*

## Happy Crabbing

Crab cavities are a type of electromagnetic cavity that can be used in particle accelerators. They get their name from the effect they have on the particle bunches of a beam. When colliding beams cross each other at an angle, there tends to be poor overlap of particle bunches, fewer collision events and hence lower luminosity. But crab cavities, placed either side of the collision point, use a time varying magnetic field to give a spinning kick to the particle bunches. With this kick the bunches move towards the collision point in a side-stepping crab-like motion. This sideways motion of colliding beams gives better overlap, many more collision events and hence greater luminosity.



Different crab-cavity designs were presented at the LHC-CC09 workshop. Top row left to right: from the US, UK and Japan. Bottom row left to right: from Japan, UK, US and US. *Image courtesy: Frank Zimmermann on behalf of **LHC-CC09***

## Workshop outcomes

LHC-CC09 was jointly organized by AccNet, CERN, US-LARP, Daresbury Laboratory / Cockcroft Institute, and KEK. At the end of the workshop its outcome and the future LHC strategy for LHC crab cavities were assessed through a dedicated Advisory Board, headed by CERN Director of Accelerators, Steve Myers.

Discussions shaped the future strategy by directing the R&D effort towards compact crab cavities, with a possible demonstration experiment using a KEKB crab cavity with a proton beam in the CERN SPS, and examining modifications of the LHC layout and infrastructure for accommodating future crab cavities. The workshop identified machine protection in case of a cavity trip as the only possible showstopper, deserving immediate attention.

The LHC-CC09 workshop's international participants, from CERN, the US, UK, KEK, INFN, DESY, etc. *Image courtesy: Frank Zimmermann*

## Upcoming events of AccNet, EuroLumi and RFTech

Throughout the lifetime of the EuCARD project, the AccNet Accelerator Science Network will be organising numerous events. Participation in these events is open to the worldwide accelerator community, to laboratories and individuals from both inside and outside the consortium. Some events will be organised by AccNet as a whole and other more targeted topics will be dealt with by one of AccNet's two tasks: EuroLumi or RFTech.

EuroLumi is the European forum for discussing performance limitations of high-intensity high-brightness accelerators. It will help analyze and optimize the proposed upgrades of these facilities, and will also explore advanced future schemes such as proton driven plasma acceleration (see **Surfatron article**).

RFTech seeks to exploit synergies in the developments of high and low power RF systems for new accelerator projects. It encompasses all aspects of RF technology, e.g. klystron development, RF power distribution system, cavity design, and low-level RF system, for linear accelerators and storage rings, including transversely deflecting (crab) cavities and financial aspects such as costing tools.

The next event foreseen is a topical AccNet EuroLumi workshop on anti electron-cloud coatings, "**AEC'09**," planned for 12-13 October 2009 at CERN. This workshop will address the proposed electron-cloud solution for the SPS upgrade. A large international participation is expected and, in particular, important information exchange with several American and Japanese laboratories on plans and beam experiences.

For more information about the network see the AccNet website **http://accnet.lal.in2p3.fr/**, linked from the EuCARD website via **http://cern.ch/EuCARD/activities/networks/WP4/**.

*- Frank Zimmermann, CERN; Kate Kahle, CERN*

# Breaking news for Proton "Surfatrons"

It has been known for some time that plasmas (gases of free ions and electrons) can support very large electric fields. This property enables plasmas to accelerate particles to relativistic energies over shorter distances than current technologies, paving the way for future high performance, smaller accelerators.

## The driving seat

Research into plasma acceleration centres on creating waves within the plasma by shooting a "driver" laser or bunches of negatively or positively charged particles into the plasma itself (see table).

In the same way that a surfer picks up speed in the wake of a wave, so particles subsequently injected into the plasma are rapidly accelerated by travelling across the driver's "wakefield". This surfing analogy has led to the colloquial name of "surfatrons" for accelerators using plasma wakefield acceleration.

| Type of plasma wakefield acceleration | Advantages |
|---|---|
| Laser driven | High electric field (100 GV/m) over distances of a few cms |
| Electron driven | Electric field of 50 GV/m over 1 metre |
| Proton driven | Can accelerate electrons to the TeV scale in one stage |

Initially, laser driven plasma wakefield acceleration was proposed and experimental verification of the ideas followed. In recent experiments, electric field gradients of 100 Gigavolts per metre (GV/m) have been achieved. These have so far been limited to distances of a few cm, but the progress has been very impressive, for example, a recent **milestone report** "Requirements for electron beam diagnostics" from EuCARD **WP11** shows the work the project is doing within this field. In order to accelerate an electron bunch to 1 TeV, these gradients would have to be maintained over distances of tens of metres, or many acceleration stages would have to be combined.

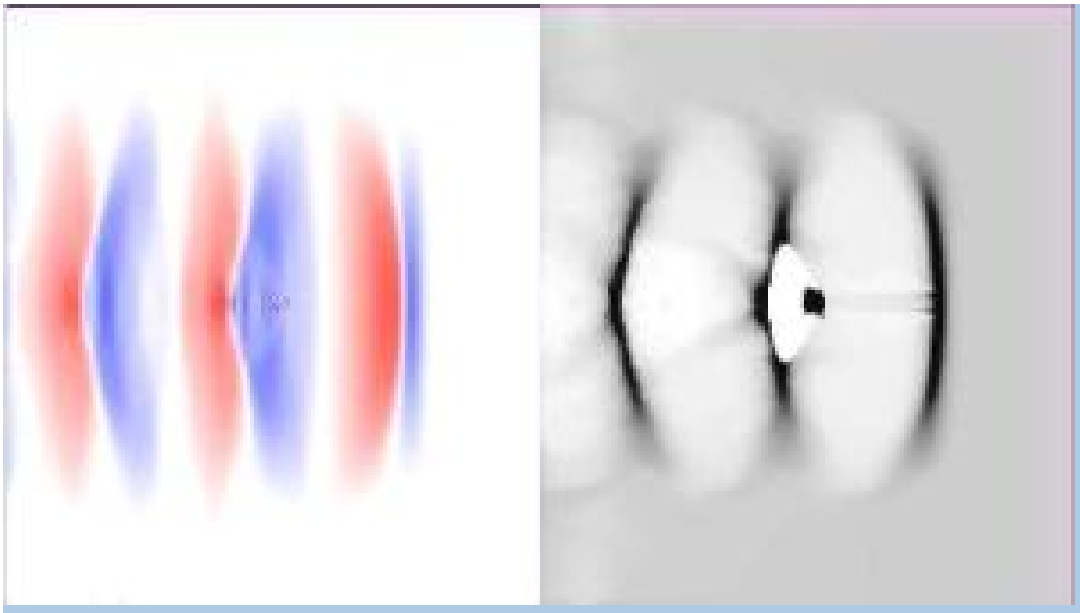
It was later recognized that the plasma could also be excited by an electron bunch. Given an intense enough bunch of electrons, the plasma is both created and excited by the passage of the bunch. In the case of electron driven plasma wakefield acceleration, a gradient of 50 GV/m was achieved and sustained for almost one metre in experiments at SLAC. However, the energy given to the accelerated bunch is limited to a maximum of twice the energy of the driver bunch.

## Positive new findings

In contrast to plasmas driven by electrons, only limited investigations of the plasma wave excitation by a positively charged beam (mainly positrons) have been performed.

Importantly, there have not yet been any beam tests with proton-driven plasmas. The electric field distribution should be similar to that created by electrons.

Physically, the negatively charged electron driver "blows out" the background plasma electrons creating a low density region behind the driver. For proton drivers, instead of "blowing out" plasma electrons, they "pull them in" to the centre of the bunch.



The electric field strength (left) and electron density (right) in the plasma from simulation studies of proton driven field acceleration. The accelerating field ranged from +2 GV/m (red) to -2 GV/m (blue). The accelerated bunch is seen as a black spot in the right-hand image.

*Image courtesy: A. Caldwell et al. Thumbnail image main page courtesy of Timo Balk, stock.xchng*

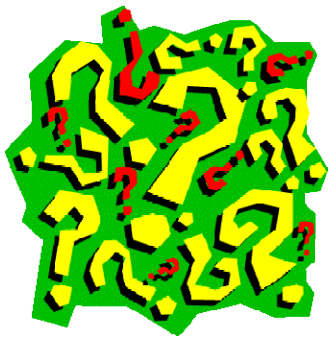
However, given that protons can be accelerated to TeV energies in conventional accelerators, it is conceivable to accelerate electron bunches in the wake of the proton driving bunch (e.g. in the wake of an LHC proton beam) to up to several TeV in one pass through the plasma.

The plasma wake produced by a 1 TeV proton bunch has been investigated and reported in a recent publication (A. Caldwell, K. Lotov, A. Pukhov, F. Simon, Nat. Phys. 5 (2009) 363). The electric fields are a factor of 100 higher than those considered for the International Linear Collider (ILC), and could lead to the acceleration of a bunch of electrons to several hundred GeV within a few hundred metres (starting with a 1 TeV proton bunch).

These exciting results have spurred discussions of the need for a demonstration experiment. A Letter of Intent for experimentation at CERN centred on studies of proton bunch interactions with plasmas and subsequent electron acceleration is currently being planned. Possible beams include the PS and SPS beams at CERN. In a first round of measurements, modulations of a long (20 cm root mean squared (rms)) proton bunch would be searched for. This effect is predicted in particle-in-cell simulations and their observation would provide an excellent test of the simulations. The goals for subsequent rounds of experimentation would include generating stronger electric fields in the plasmas by first longitudinally compressing the proton bunch, and eventually demonstrating acceleration of an electron bunch in the wake of the proton bunch. A collaboration aiming at carrying out these experiments will be formed in the near future. Anyone interested in participating should contact **Allen Caldwell** for more information. A future topical workshop might be organized with the support of **EuCARD WP4 AccNet**.

*- Ralph Aßmann, CERN & EuCARD WP8; Allen Caldwell and Guoxing Xia, Max-Planck-Institut für Physik München; Konstantin Lotov, Budker Institute of Nuclear Physics and Novosibirsk State University; Alexander Pukhov, Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf; Frank Zimmermann, CERN & EuCARD WP4; Kate Kahle, CERN & EuCARD WP2*

# For EuCARD members



It's time for six-month internal reports. See below for who needs to do what, when and how. If you have further questions, please **contact us**.
See also **Newsletter Issue 1 FAQs** *Image courtesy: clipart*

**Q. What reporting is needed now?**

**A.** 30 September 2009 is the end of the project's first "semester" (6 months). As outlined in the **Internal Guide for Reporting**, **Interim Activity reports** are needed from task leaders and work package leaders, and **Interim Resource Utilisation Summaries** are needed from the administrative contacts of each EuCARD participant.

**Q. What is included in the reporting?**

**A**. The **Interim Activity reports** contain summaries of work in progress for each task in each work package. They cover work done, deliverables and milestones, plans for the next semester and a summary of the man-power efforts. The **Interim Resource Utilisation Summaries** give an overview of the budget situation of each participant e.g. personnel, materials, travel etc.

**Q. Why is the reporting needed?**

**A**. The EuCARD project will deliver contractual periodic reports to the EC at month 18 (September 2010), month 36 (March 2012) and month 48 (March 2013). To work towards these periodic reports, and to have a regular monitoring of project progress, internal reports will be required every 6 months.

**Q. What do task coordinators need to do?**

**A.** At the end of each semester (6 months), each Task Coordinator should prepare an **Interim Activity report**, gathering information from the people working in their task and submit the report to the relevant Work Package Coordinator. A template for the report is available on the Intranet and the submission deadline is 10 days after the semester i.e. 10 October 2009 for the 1st semester report, see **agenda**.

**Q. What do work package coordinators need to do?**

**A.** Each WP Coordinator should produce a consolidated **Interim Activity report** for his/her Work Package, based on the reports received from the task coordinators. They should then submit this report to EDMS, using instructions available on the **Intranet**. The deadline is 20 calendar days after the semester i.e. 20 October 2009 for the 1st semester report, see **agenda**.

**Q. What do administrative contacts at each participant need to do?**

**A.** At the end of each semester (6 months), the **administrative contacts** at each participant should complete an **Interim Resource Utilisation Summary** report outlining the budget situation. A template and further guidance are available via the link in the previous sentence. The deadline is 15 calendar days after the semester i.e. 15 October 2009 for the 1st semester, see **agenda**.