EuCARD² Work Package 10

MINUTES

14th June 2013
EuCARD '13 Workshop - Friday Morning session

Attendees

CERN : Marta Bajko, Amalia Ballarino,Bernardo Bordini, Luca Bottura, Jerome Fleiter, Glyn Kirby, Jeroen van Nugteren, Juan Perez, Gijs de Rijk, Lucio Rossi, Christian Scheuerlein, Agnesz Szeberenji,
Maurizio Vretenar, Gerard Willering
CEA : Maria Durante, Philippe Fazilleau, Jean-Michel Rifflet
LASA : Massimo Ferrario *(by phone),* Giovanni Volpini
INPG : Arnaud Badel
KIT : Wilfried Goldacker, Anna Kario, Andrea Kling
Bruker : Reinhard Dietrich
UTwente : Marc Dhallé, Herman ten Kate
ASC : David Larbalestier
UniGe : Marco Bonura, Carmine Senatore
DTI : Nikolaj Zangenberg
TUT : Antti Stenvall (*by phone*)
LBNL : Shlomo Caspi, Dan Dietderich
NRC : Alexander Ryazanov

Minutes prepared by G. Willering, reviewed by L. Rossi.

1. EuCard² WP10 – Kick-Off (Maurizio Vretenar)

Eucard 2 is getting half the money as Eucard, so we need to be flexible and efficient in our goals. After the discussion with the EC commissioner it was clear that we need to look on the bright side: The glass is half-full, not half-empty. No complaints – Just go for it !

Keywords for this workpackage are:

1. Deliverables should be done in time. It just needs to be a small note of a few pages, with links to detailed reports.
2. Communication is most important, make an effort.
3. Keep in mind what can be impact of our work on society and industry.

Comments: 50 % of pre-funding has been paid to CERN of which 60 % has already been distributed. 15 % will be paid only after the finishing of the project.

2. Task 10.1 Coordination: general plan, MS and Dlvs (L. Rossi)

L. Rossi opens the session with a general presentation.
First bottom line: 1.3 M€ EC requested funding, which is not so much. The EU commissioner was not easily to speak to and in addition he did not feel welcome to the social dinner event... It is most important that the deliverables are achieved in time. The deliverable is not a magnet, but a report, typically of a few pages (with reference to a larger report or document or paper). Milestone report could be a few pages only.
In the presentation the task coordinators are presented for the different sub task.
L. Rossi underlines that the task leader (and co-leader) is the person that drives the project and this should be clearly recognized (but they should also act as driver…)
For collaboration it is better to co-author persons than to exclude them to keep up the spirit of good work together.

L.Bottura comments: For the intellectual properties it is important that one tries to recognize when we need to check with other collaborators for the Collaboration Agreement. It is noted that Nexans is only a "beneficiary" (not in the sense of FP7) and will not sign the CA. Also concerning the collaboration with US institutes and industry more discussion may be needed on specific topics.

Clarification on IP for cable is needed in the USA collaboration: Luca and Lucio to follow this.

P. Fazilleau presents the schedule of WP10 for which he is responsible to keep it. It starts with cable concepts deliverable in 2014, at the end of 2014 the magnet design, up to the beginning of 2016 the cable production and in 2017 the magnet cold test.
Milestone 62 to 68 are official EU milestones and need to be on time and the coordinator will give an alarm 2 months before the deliverable, these can be 1-4 pages. The deliverables for the main projects should be 5-10 pages (shorter will need to reference to a more complete document) and will be alarmed 3 months before the deadline.

a. Technical program 1

YBCO is primary choice because our program wants to be in continuity of the outcome of EuCARD 1 and also to favour EU-industry (that only produces YBCO as finished product, not

Bi-2212). G.de Rijk indicates that during EuCARD 1 the YBCO came up as first choice because major steps where made. We should also not jump from one design to another, since each jump costs a lot of time. L. Rossi emphasizes that we need to work with large current cable (not just 1 kA) for 20 T magnets.
It is made clear that a Bi-2212 magnet should be made with a cored Rutherford cable. When the material is ready the magnet can be built relatively quickly. The insulation that needs to cope with the high temperature during the wind and react process.

b. Technical program 2

This is the main time to look at crazy ideas on cable design! G. de Rijk indicates that he knows that A. Ballarino and H. ten Kate have some ideas that may be exploited.
For the *reaction furnace* we need one year at least to acquire them.
D. Larbalestier indicates at ASC a 17 cm diameter, 50 cm length homogeneous 100 bar overpressure furnace is ordered, which takes 5 months delivery time and about 3 months additional installation time. System costs about 250 k$ including gas handling, which is the most important cost. He indicates that he would be perfectly happy to share the furnace with the collaboration, but probably the 100 bar is not necessary, see a later presentation.
C. Senatore: at Unige we have 40-50 mm length, no overpressure possible.
G. Volpini; at Lasa 150 mm diameter, length 1 meter furnace available, no overpressure. Characteristics to be checked.
L. Rossi: 400 mm length, 40 mm bore is needed. For the moment there is no interest in long length magnets, also not for the cost. Better make 2 shorter coils for practice, than 1 bigger coil.
G. de Rijk: Practical issues are important for testing as well, since it will be difficult to insert it in long magnets.
N. Zangenberg: There is a CERN tender for a furnace if I am correct.
G. de Rijk replies; There is a tender for a furnace, but this is only for Nb_3Sn. A second tender is running for a longer version of this (2.5 meter), limited in temperature and pressure. The complications to make it compatible also for Bi2212 are very big.
A. Stenval: Protection is also difficult for long magnets, so this is in considerations.

3. Task 10.2 Cable (Luca Bottura)

L. Bottura introduces his view on the WP10.2 HTS conductor.
Objective is having HTS cable (about 50 meter) with about 5 unit lengths at 600 A/mm^2 cable engineering current density on the conductor, which converges to 400 A/mm^2 overall.
Magnetization should be below 300 mT, D. Larbalestier adds: This means sub-bundle diameter of 100 μm, while the filaments are 15 μm in Bi-2212. Decoupling by twisting seems to work well to reduce the magnetization.
The cable should carry 10 kA at 20T, 4.2 K with effective contact interstrand resistance of 5 μΩ (equivalent R_c in Rutherford design). The 5 μΩ is higher than what is the result of sintering.
For October 2013 a cable design should be ready, which is easy for Bi and more difficult for YBCO.
A. Ballarino comments after a question of G. de Rijk that finding a time slot for a test in FRESCA is no problem, but the availability of the material seems to be more difficult.
The ideas for a work-split of testing, as presented by Luca is commented on by the institutes involved.
L. Rossi: Southampton can do characterization well in gas.
A. Bladel: Angular dependence measurements in Grenoble can get up to 18 T.

G. Volpini: In Lasa 15 T is possible and maximum current in gas of 300 A, but only limited contribution since the test station is overbooked already.
L. Bottura invites everybody to email him the considerations from each institute for further considerations.

A. Bladel: Is the 10 kA a set value? A. Ballarino comments that smaller cables are critical to protect. H. ten Kate considers that we need to stick to 10 kA, otherwise all cable design have to be done double. L. Rossi comments that for upgrades in the LHC we go already well above 13 kA and this is needed for magnets in series anyhow.

In it note that insulation research should be connected WP 3, because it is done by the magnet constructor.

a. Cable option for EuCard² (A. Ballarino)

A. Ballarino introduces the subject with the requirements of cables for accelerator magnets. We need high J_c material and high current cables. The dimension, interstrand resistance, magnetization, twist and transposition need to be very well controlled.
Comment by L. Rossi: use the J_E as definition for the strand cross-section, not the cable cross-section. Then for the strand the required J_E is going up by 10 % to 660 A/mm^2, compared to 600 A/mm^2 for cable current density.
A.Ballarino emphasizes that there are actually 2 tasks: Bi 2212 conductor program and a YBCO program, which are very different one from the other and as well different from known LTS conductors.
In the slides an overview of the various type of HTS cables are shown. A. Ballarino concludes that CORC and twisted stacked tape cables are not practical for accelerator magnets and all of them are not fully transposed. The only cable that is transposed and highly compact is the Roebel, with its own difficulties, see the presentation this afternoon.
In the slides the research on the Roebel cable by J. Fleiter is shown: one of the difficulties is the peak pressure on the cable.
G. de Rijk comments on the anisotropy that a standalone magnet will generate much more field than inside a background field. D. Larbalestier notes that it is difficult to predict at what spot the coil is limited and indeed the c-axis current density is most important.
W. Goldacker indicates there is space for improvement, but D.Larbalestier indicates that this is mainly possible at 77 K.

b. Bi2212 conductor technology (David Larbalestier)

D. Larbalestier introduces the topic with a statement that the improvement in Bi2212 the last years improved by a factor of 3-7 and has now a higher J_E than SuperPower REBCO CC.
It was shown that overpressure reaction of 25-100 Bar is needed to prevent de-densification of 2212 driven by internal gas pressure.
The 2212 development is going fast and long lengths will be available and allow much easier up scaling than YBCO.
The in-situ imaging work by C. Scheuerlein at ESRF during reaction of Bi-2212 was eye-opening that all the reaction steps are mainly due to bubble formation and this has given the understanding that is change quickly the reaction procedure.
D. Larbalestier emphasizes that in the various DOE-US labs and industry there is an important development program on Bi-2212, but YBCO is not forgotten as is shown with the construction of the 32 T magnet in the NHMFL.
The overpressure process can and will boost 2212 to get longer, stronger and cheaper.

D. Larbalestier: It is extremely important to get industry more involved by buying conductor. OST is very interested and they have already bought inline furnaces.

4. Task 10.3 HTS accelerator magnets (Maria Durante)

M. Durante introduces the task objectives.
The main part of the HTS magnet design should be ready for April 2015, with a magnet built and ready for test at the end of 2014.
L. Rossi notes that it important to advance with the Bi2212 development, because it will be extremely difficult to make to magnets in parallel. M.Bajko does not see how both magnets can go in parallel within 3 years. G. Kirby comments that winding the coil can be done in an afternoon, but acquiring the cable is the most difficult part. M. Durante replies that Bi-2212 is mainly in US hands and CEA has more YBCO.
G. de Rijk: What makes us think that we can make these two magnets that quickly, compared to the HTS insert for FRESCA 2. J-M. Rey: It is completely unrealistic. L. Rossi: The small racetracks of Bi2212 are very quickly wound because it is Nb_3Sn technology with Rutherford cables (if suitable furnace is available). A. Ballarino stresses that magnet and cable design need to work together, much more than with LTS, and interaction during the design phases is necessary.
M. Durante indicates that a brainstorming meeting is needed to get a start. It may be done during the MT-conference or the week after. The must-list should be created and some parameters need to be fixed, like outer diameter for testing in a test station.
H. ten Kate: The coil does not need to be perfect. You should jump quickly on making a magnet and do perfection studies in parallel. L. Bottura notes in that case we deliver not the highest quality, but the question I how this fits in the deliverable for EuCard.

5. Tasks 10.3 and 10.4 Magnet stand-alone test (Giovanni Volpini)

G. Volpini introduces the schedule for the magnet testing. It is clearly challenging to perform all the tests in time and a strict schedule. One of the most difficult deliverables is the testing of the magnet and G. Volpini does not want to "play the bad man" when the magnet is not delivered in time.
In the schedule by M. Durante the magnet testing should take only 3 months what is extremely tight.
The test station main features are listed in the presentation.
If a current above 10 kA is required, a major upgrade of the test station should be foreseen soon too.
M. Bajko adds that upgrading the switch to solid state switch may be important to compensate for slow detection. David indicates that a precursor before the quench of an HTS coil is seen by voltage build-up and even with a mechanical switch so far no coils where lost.
G. de Rijk: it is important to invest now time to be open to quench detection and protection means.
L. Rossi: maybe we have to see in the master schedule if the delivery of the magent can be slightly advanced…

S. Caspi: putting a bore in a magnet is the limiting factor for a magnet. Berkely definitely will pursue the canted coil and promotes it as possibility. L. Bottura: Don't forget CERN is focussed still on Nb3Sn and we cannot invest our resources in all technologies, therefore I am happy that LBNL is working on the canted coil. It can be the solution and it is important to compare later on. D. Dietderich: the point is that the stress management system

6. Gijs de Rijk comments on the lessons learned from EuCARD (no presentation)

The lessons learned technically were already discussed in presentations. Most important are:

- From Care and EuCARD 1 you can see that the schedules are impossible to keep, and looking at the schedule of EuCARD 2 doesn't seem to be different.
- Flexibility on budgets is necessary, because things will change. The budget distribution should be a guess and adapted during the project.
- Everything slides in time.
- Although tasks are well documented, the WP leader needs to get after them at the institutes, since everybody has priorities with other tasks at their institute.

For the technical part: Procurement is slow, for instance for a furnace. Start buying things early on is important. In addition procurement procedures with rules for competition can be a nightmare.
The main point is: The organization and resources are most difficult to handle.
J-M. Rey : The short-list for the essential target is not set during this meeting and this is what we need as a common guideline.