

Minutes of the EuCARD-WP7-HFM collaboration meeting held at Cern on 15th November 2011

Presents (full or part time): G. de Rijk (CERN), F. Kircher (CEA Saclay), J. Polinski (PWR), R. van Weelden (CERN), F. Hornung (KIT), J.M. Rifflet (CEA Saclay), A. Milanese (CERN), P. Tixador (INP Grenoble), F. Rondeaux (CEA Saclay), B. Baudouy (CEA Saclay), G. Ellwood (STFC-RAL), A. Stenvall (TUT), M. Chorowski (PWR), P. Pognat (CNRS-LNCMI), S. Le Naour (CERN), J.M. Rey (CEA Saclay), S. Pietrowicz (CEA Saclay), G. Grasso (Columbus), P. Wanderer (BNL), P. Manil (CEA Saclay), M. Durante (CEA Saclay), H. Bajas (CERN), P. Ferracin (CERN), H. Allain (CERN), B. Strauss (US DOE), F. Broggi (INFN LASA), D. Bocian (FNAL), H. Felice (LBNL), T. Nakamoto (KEK), Q. Xu (KEK), C. Lorin (CERN), G. Kirby (CERN), M. Tropeano (Columbus), R. Piccardo (Columbus), S. Caspi (LBNL), D. Cheng (LBNL), G. Volpini (INFN LASA), J. Clarke (STFC), J. Fleiter (CERN), J.C. Perez (CERN), E. Todesco (CERN), D. Dietderich (LBNL), A. Ballarino (CERN), C. Beduz (U. Southampton), L. Oberli (CERN), G.C. Sabbi (LBNL)

In these minutes, accent is put on the discussions and conclusions rather than in the technical presentations, which can be found on Indico:

<https://indico.cern.ch/conferenceDisplay.py?confid=152511>

Welcome (G. De Rijk (CERN))

GDR indicates that this meeting has an audience larger than usual, as it is held during a full week of meetings dedicated to high field magnets and the LHC luminosity upgrade (WAMSDO 2011, LARP, HiLumi). Four special talks, to be given in the afternoon, have been added to the usual task reviews.

1- Task 1 Status report: management (G. De Rijk (CERN))

- A EuCARD mid term review was held with the EC representative on 21 June 2011. The status of deliverables was presented, with confirmation of date, or justification for delay.
- For task 3, Paolo Ferracin will replace Attilio Milanese, who obtained a new staff position
- The activities for the near future are to organize the specific reviews concerning task 3 as proposed by ESAC during its first meeting, and to visit the other technical tasks
- Two reports, object of milestones, have been delivered but are not yet on the EuCARD database

2-Task 2 status report: support studies

This task is divided into two sub-tasks: radiation resistance certification (sub-task 2.1) and thermal models and design (sub-task 2.2)

2-1 Sub-task 2-1: irradiation studies (J. Polinski (PWR))

- Irradiation tests at SOLTAN

- A formal agreement between PWR and TECHTRA has been signed in October 2011 for the supply of irradiation of materials.
 - The report corresponding to milestone 7.2.1 (Methodology for the certification of radiation resistance of coil insulation material) has been delivered at M24
 - After commissioning tests at the manufacturer site, the irradiation cryostat is now installed in NCBJ, Swierk
 - Start of irradiation with G10 sheets is foreseen for week 47 (21 November)
 - Start of irradiation with the insulation samples is foreseen for week 49 (5 December)
 - The full irradiation campaign is foreseen in 3 phases:
 - Thermal samples until mid May 2012
 - Electrical samples, from mid May to end of June 2012
 - Mechanical samples, from beginning of July to mid of August 2012
 - The design of a micro sample is presented for tensile tests. Other methods are also to be analyzed
 - The conceptual design of the electrical certification cryostat is in progress
- Discussion
 - The validity of making bending tests with so small samples must be carefully studied (ED)
 - A distinction must be made between irradiation area, and sample dimensions (GDR)
 - What is foreseen with such samples is a comparative analysis (JP)
 - The method is still to be validated, Warsaw mechanical laboratory is doing some tests (MC)

2-2 Sub-task 2-2: thermal studies (B. Baudouy (CEA Saclay))

- Presentation
 - Thermal characterization (Saclay): 6 samples measured between 1.6 K and 2.1 K (thermal conductivity and Kapitza resistance). Tests will continue in end of 2011 and in 2012, as soon as the samples are provided
 - Thermal characterization (WUT): some technical problems occurred during the PWR Hell cryostat test. Restart of test expected in mid of December 2011
 - A simplified two-fluid model has been implemented in Ansys at Saclay for Hell modelling. Good agreement between analytical and numerical results. Improvement to the model to be done in 2012
 - New results obtained for FRESKA2 thermal model, in steady state and transient regimes. Calculations on newer version to be done in 2012

3-Task 3: high field magnet

3-1 Status of task 3 (J.M. Rifflet (CEA Saclay))

- The specification was slightly modified in October 2011
- One order for the conductor still to be placed
- Magnet design fixed, in particular mechanical design. Some changes in the insulation thickness. Some points still pending (thermal studies, protection)
- Upside down winding is the chosen configuration
- Several tests done on dishing measurement, jump layer, cable behaviour during heat treatment. Tests done with PIT cable must be repeated with RRP cable
- Assembly test of the mechanical structure with a dummy coils in preparation
- Winding of a Cu double pancake foreseen in March 2012
- Study of interaction dipole-insert for protection should start soon

3-2 Status of conductor procurement and cable development (L. Oberli (CERN))

- Delivery of both PIT and RRP strands continues, with some delay in some cases, in the frame of the qualification phase (19 km already delivered, 15 km more expected in the next few months)
- Delivery of first PIT strand order in the frame of the pilot production expected by February 2012 (15 km)
- All together, 30 km of PIT strand will be available by February 2012, and 25 km of RRP strand by May 2012 (without margin, 42 km of strand is necessary for one FRESCA2 dipole)
- One more production strand order to be placed by CEA (20 km, with an option for 10 km or 20 km more)
- For PIT strands, the results obtained for the 5 billets produced so far are very similar, with a mean value of 2470 A/mm² for J_c at 12 T, 4.2 K, and 1400 A/mm² at 15 T, 4.2 K
- The optimization of the cable parameters will continue, as cabling degradation is presently too high (15 % for the best result)

3-3 Status of construction of FRESCA2 dummy coil assembly (A. Milanese, CERN))

Main points of AM's presentation were the followings:

- Status of FRESCA2 hardware (in progress and to be done)
- Status of the procurements of mechanical components: the order for the Al alloy raw cylinder was placed for about 30 k€, three more procurements to be placed for about 150 k€ (cold mass, coil pack mock up, axial compression system)
- FRESCA2 cryostat: the conceptual design is finished, the engineering design is going on, the call for tender is foreseen beginning of 2012 for a delivery by end of 2012, and the system operational by beginning of 2013
- Feasibility of Al oxide coating done
- Nb₃Sn reaction oven ordered
- Study of spice layout going on

4 Task 4: very high field insert

4-1 Task 4 status report (P. Tixador (INP Grenoble))

Main progress since last meeting:

- HTS conductor (Bi-2212 and YBCO coated):
 - . delamination is an issue with YBCO
 - . development of reinforced Bi-2212 strand, using a tube (200 MPa expected for shear stress)
 - . 2 Roebel cable samples tested in FRESCA at 4.2 K
- Technological implementation:
 - . 20 T facility with the VTI cryostat operational
 - . several double pancake coils wound, and tested at 4.2 K and 18 T. 400 A reached, corresponding to 1 000 MA/m², and 700 MPa. These DP coils have been sent to KIT for test in 2012
 - . A 6 pancake coil from CEA, with a large amount of instrumentation, is to be tested soon at Grenoble
- Quench protection
 - . calculated hot spot temperature: 300 K for 0.2 sec detection time, 400 K for 0.25 sec detection time
 - . quench evolution for YBCO studied by TUT, using Comsol

- . pancake quench modelling done at Saclay and CNRS Grenoble gives a very localized quench ($T_{\max} = 250$ K), inducing high thermal stress
- In conclusion of this part, first successful HTS coils with high performances have been tested, and a lot of progress about quench modelling is going on. Future works to be done: more coil tests, result analysis and comparison with modelling, new coils with improved technology, HTS insert

4-2 HTS insert design progress (J.M. Rey (CEA Saclay))

- JMR went through the following points:
 - . design requirements and consequences
 - . magnetic fields calculations
 - . mechanical structure
 - . strain calculations (max VM stress around 600 MPa in the pole piece and 824 MPa @ 4 K in the 3 mm thick tube)
 - . 2D and 3D coil design (3* 2 double pancakes)
 - . assembly scheme (the external tube is put in place by heating it)
 - . conductor (4*12 mm wide YBCO ribbons, 0.1 mm thick)
 - . internal splices (needed if the unit length of tape is too short. To be put in the straight section of the coil)
 - . co-winding technique
 - . protection (more effort to be done)
 - . winding pack (Insert weight: 42 kg)

5 Task 5: SC links

5-1 Task 5 status report (Amalia Ballarino (CERN))

The task is now moving from step 2 to step 3

- AB went through the activities going on in the different laboratories involved in this task (CERN, SOTON, BHTS, Columbus)
 - . HTS links could be used at Pt 7: 2 links, each about 500 m long, 48 cables rated at 600 A per link
 - . the cable concept, procurement on long lengths of conductor, measurements at 4 K and 77 K were done during step 1
 - . a 5 m long link using MgB2 tapes was successfully tested at SOTON last week at 20 K, 25 K and 30 K (see next § 5.2)
 - . for step 3, which is the assembly of a 20 m long prototype link, the cabling machine is almost completed, and a 20 m long Cryoflex line is installed in SM18. The test station for measurements of 20 m long prototypes will be commissioned in the next weeks

5-2 Electrical tests of HTS twisted pair cables with helium gas cooling (C. Beduz (SOTON))

In his presentation, CB presented the following points:

- Test setup at SOTON
- Difference of temperature between top and bottom (less than 1 K)
- I_c determination with a semi transient protocol using square current pulses
- Stability near I_c
- Quite similar behaviour for the 2 cables

- $T_c = f(I_c)$ for the conductors studied

More work is necessary to understand the current sharing behaviour of MgB_2

6 Task 6 status report: SC Helical Undulator (J. Clarke (STFC, DL))

- Low field performance of desired wire choice (OST) looks to be unworkable because of instability at low field (KIT measurements)
- Supercon has carried out measurements showing that their wire is stable above 3 T. A sample from Supercon is expected, to be tested at low field at CERN to confirm this result
- New design of the undulator done, with Supercon wire
- Alternative: use a Nb-Ti solenoid to stabilize Nb_3Sn
- The viability test of coating of former is underway
- Investigation of using a coating to insulate the wire is also underway
- Conclusion of the present status is that the M36 milestone (300 mm prototype) and the M48 milestone (500 mm prototype) are at risk now. Could these two milestones unified in only one, to save time and resources?

Afternoon presentations

Four presentations were done in the afternoon, and are available on the Indico site:

- HD3 and LD1, D. Cheng (LBNL)
 - 11T DS dipole, M. Karppinen, CERN
 - EDIPO Dipole, A. Portone, F4E
 - ITER Conductor, A. Devred, IO
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