

Minutes of the 1st EuCARD HFM workshop on insulator irradiation held at CERN on December 2nd 2009

Present: G. de Rijk (CERN), F. Kircher (CEA Saclay), J. Polinski (WUT), F. Rondeaux (CEA Saclay), F. Liberati (CERN, Politecnico di Milano), L. Oberli (CERN), T. Nakamoto (KEK), M. Karpinnen (CERN), F. Cerutti (CERN), F. Broggi (INFN LASA), M. Strychalski (WUT), Y. Kopec (SINS), P.P. Granieri ((CERN), D. Bocian (FNAL), I. Pong (CERN), A. Ballarino (CERN), R. Flukiger (Univ. Geneva), L. Bottura (CERN), S. Canfer (RAL)

Diffusion: Presents, M. Chorowski (WUT), E. Todesco (CERN)

1 Goals of the workshop (J. Polinski)

- The sub-task 2-1 in the task 2 (Support Studies) is devoted to the resistance certification of the electrical insulation. The work can be divided into six points:
 - determination of radiation types, doses and energies
 - determination of irradiated sample test scope
 - selection of the institutes(s) capable of the irradiations
 - preparation of the samples
 - irradiation of the samples
 - tests of the samples

The present state of knowledge must be taken into account.

- Main goals of this workshop are consequently to run information exchange from people experienced in the field, to review the state of knowledge, to start to define a raw program, and to create an ad-hoc radiation working group, which will define the work to be done in this sub-task in a deeper way.

2 Possible layouts for the LHC Phase II insertions (G. De Rijk)

- This presentation was done by G. de Rijk for E. Todesco, unable to attend the meeting
- GdR presented how the magnet parameters for phase I (Nb-Ti magnets) and phase II (Nb₃Sn magnets) have been determined. At this stage, there are still two possibilities for phase II magnet parameters. The final choice will be only possible after more information is obtained from the LHC machine. Nevertheless, the irradiation parameters must be compatible with the two options.

3 Radiation spectra in LHC phase II: effect on superconducting materials (R. Flukiger)

- RF first recalled that most of the results he will present were obtained from F. Cerutti. He will mainly focus on the superconducting materials, where only neutron and protons effects are important
- From calculations, it is possible to determine the radiation spectrum for various particles (photons, neutrons, protons, electrons, positrons, pions +, pions -...)
- Neutron irradiation effects were presented for various superconductors (Nb₃Sn, Nb₃Al, YBCO, MgB₂). For all analyzed systems, for irradiation at 300 K, there is no or little decrease of the superconducting properties (J_c , B_{c2}) up to 10^{22} n/m². Data at 4.2 K are expected to be similar, but no systematic data exist
- For insulating materials, the effect of photons is the most important one, but the effect of other particles must not be forgotten
- Parameters which must not be forgotten for the specifications: safety factor on the calculations, presence of collimators, shielding...

4 Summary of irradiation program on Nb₃Sn (L. Bottura)

- The objectives of this program are to examine the sensibility of new materials (high J_c , new ternary Nb₃Sn, MgB₂, HTS) and stabilizer to LHC radiations (neutrons around 1 MeV and protons around 60 MeV)
- Discussions are going on with Atominstitut in Vienna to perform neutron irradiation, I_c and magnetization measurements, and with Kurchatov institute to set up an I_c test station in the radiation environment of a 35 MeV proton beam line
- This program is scheduled until the end of 2012

5 Definition of samples and tests (F. Rondeaux)

- FR first recalled that besides of the work already done for accelerator magnets, a lot of work has also be done in the frame of ITER R&D
- She presented various possible mechanical and electrical tests, and the relevant values to be used for these tests
- If many parameters have to be studied, a factorial plan must be used.
- Finally, she recalled some precautions to be taken for getting correct results

6 Developments at KEK (T. Nakamoto)

- Two slides were presented by TN, extracted from his previous presentation in the frame of the on-going CERN/KEK development program. They concern:

- the use of an alumina tape for insulation (present thickness 0.125 mm; 0.08 mm thick tape is under development)
- the use of cyanate ester resin for the impregnation (collaboration between 4 institutes and industries for the development and characterization of this resin. In particular, effect of gamma ray irradiation will be studied at JAEA)

7 Experience at the Sultan Institute for Nuclear Studies (J. Kopec)

- SINS is part of the Swierk research Center, located about 30 km from Warsaw
- The irradiation possibilities are:
 - nuclear reactor MARIA: 30 MW, $4 \cdot 10^{14}$ n/cm²*s
 - electron linacs: 4 – 20 MeV electrons, 4 – 15 MeV photons
 - cyclotron: 25 MeV proton beam
- There is no test facility after irradiation for the moment, except for mechanical measurements

After this presentation, some more information is requested (fluence...)

8 Other known irradiation facilities (all)

- Different facilities were mentioned:
 - access seems not easy anymore at the spallation source used by RAL for irradiation studies
 - Atominstitute in Vienna (neutrons)
 - Kurchatov institute (protons): fluence limited to 10^{16} p/cm²
 - PSI: neutrons and protons up to 35 MeV and above 500 MeV
 - Tohoku University (14 MeV neutrons)

9 Conclusions of the presentations (all)

- After these presentations, some conclusions were drawn:
 - insulation to be tested in oxygen free atmosphere
 - even if the irradiation is done at low temperature, the samples must be warmed up before tests (the magnets will be warmed-up during operation)
 - only one mechanical (short beam shear) and one electrical (breakdown) tests to be done
 - 3 kinds of resin to be tested (RAL, CE, FNAL)
 - 5 samples/test
 - irradiation with photons (probably at more than one energy), neutrons, protons (probably at more than one energy), pions
 - look at the possibility to have different doses deposited on several samples during the same irradiation sequence
 - main tasks of the working group: bibliography, type of insulators to be studied, types of irradiations, dose and energy, facilities, irradiation matrix (fluence vs particles)

10 Constitution of the Working Group

- The working group will be composed as follows:
 - Jarek Polinski, chairman (WUT)
 - Françoise Rondeaux (CEA Saclay)
 - Symon Canfer (RAL)
 - René Flukiger (U of Geneva)
 - Miko Karpinnen (to be contacted)?
 - David Tomasini (to be contacted)?
- The first meeting of the working group is scheduled on December 3