# CHATS on Applied Superconductivity 2015

Monday 14 September 2015 - Wednesday 16 September 2015

Bologna, Italy

# Book of Abstracts

# Contents

Modeling the KSTAR PF magnet system –an engineering work for the optimal operation 1

Numerical Simulation of REBCO pancake coil with No-Insulation Technique . . . . . 1

Opening welcome . . . . . 2

Thermal modelling of the HiLumi Nb3Sn MQXF inner triplet magnets with OpenFOAM – Development of superfluid helium code . . . . . 2

Modelling of transient dynamics leading to crisis in a boiling helium natural circulation loop . . . . . 2

Dynamic simulations of a tokamak cryogenic system . . . . . 2

A Physics-Based Simplified Model for the ITER Cooling Loops . . . . . 2

Process Control Strategy for ITER Central Solenoid Operation . . . . . 2

Characterization of the thermal coupling between the ITER TF coil conductor and the structure cooling circuit . . . . . 3

ITER Side Correction Coil Quench Model and Analysis . . . . . 3

Thermo-hydraulic analyses associated to a design proposal for DEMO TF conductor . . . 3

Predictive 1-D analysis of the prototype HTS current leads for the ITER Correction Coils 3

Quench Analysis of the 11 T Nb3Sn Dipole for the LHC Luminosity Upgrade . . . . . 3

Lumped-Element Dynamic Electro-Thermal model of a superconducting magnet . . . . . 3

Analysis of the quench propagation along Nb3Sn Rutherford cables with the THELMA code . . . . . 4

Stability modeling of the LHC Rutherford cables subjected to beam losses . . . . . 4

Using the HELIOS facility for assessment of bundle-jacket thermal coupling in a CICC . 4

Numerical analysis of propagation of thermal disturbances in REBCO tapes . . . . . 4

Electro-thermal Analysis of quench in High Field HTS coils . . . . . 4

Comprehensive quench analysis of the NHMFL 32T all-superconducting magnet . . . . . 4

Open-source software to model High Temperature Superconductor . . . . . 5

Modeling AC ripples in HTS coated conductors by integral equations . . . . . 5

Ac Loss Calculation of a Dipole Magnet Wound with Coated Conductors . . . . . 5

Test of a prototype large current HTS cable for fusion . . . . . 5

Simulation of current distribution in twisted 2G tapes in terms of the H formulation taking in account the stress induced by torsion . . . . . 5

Numerical Simulation on Magnetic Field generated by Screening Current in REBCO coils 5

Modeling and testing of transverse, axial and torsional strain on REBCO tapes . . . . . 6

Invited presentation: The simulator of FERRARI formula 1 vehicle . . . . . 6

Study on magnetic field deviation due to manufacturing errors of the SIS100 superconducting magnets . . . . . 6

Design and Optimization of a HTS Insert for Solenoid Magnets . . . . . 6

Simulation of the Cabling Process for Rutherford Cables: an Advanced FEM Model . . . 6

Structural Modeling of HTS Tapes and Cables . . . . . 6

**Session I: Thermo-hydraulics and cryogenics / 14**

# Modeling the KSTAR PF magnet system –an engineering work for the optimal operation

**Author:** Dong Keun Oh[1]

**Co-author:** Sangjun Oh [1]

[1] *NFRI*

**Corresponding Author:** spinhalf@nfri.re.kr

Extending the development of a pilot of SUPERMAGNET model of the KSTAR PF magnet, the thermo-hydraulic analysis has been emerged as an essential part to study the performance of the superconducting magnet in KSTAR tokamak. Showing the possibility of a good simulator of superconducting tokamak, we develop a coupled CICC network of the full-scale central solenoids (PF1UL ~ PF7UL of KSTAR) in the framework of SUPERMAGNET code which enables orchestration of the individual solvers in CryoSoft 8.0 package. Into the model of the magnet system, autonomous heat load generation is included with validated two-tau model of coupling loss. It's a work for the physical simulator whose attempt is the reliable analysis when investigating the parametric model for real-time application. Hence, the feasibility and shortcoming is discussed as the performance issue of simulation comparing with the experimental data. The numerical stability, which is related to the 1-D flow connection to the volume node, is carefully investigated on the preliminary work to upgrade the cryo-network solver. For an attempt at a similar type of modification, we also present the applicability of user-defined component (compressor) and its connection scheme paying attention to the consistence of its dynamical behaviour.

**25**

# Numerical Simulation of REBCO pancake coil with No-Insulation Technique

**Author:** So Noguchi[1]

**Co-authors:** Aika Ikeda [2]; Atsushi Ishiyama [2]; Hiroshi Ueda [3]; Katsutoshi Monma [1]; Takahiro Oki [2]; Tao Wang [2]

[1] *Hokkaido University*

[2] *Waseda University*

[3] *Osaka University*

**Corresponding Author:** noguchi@ssi.ist.hokudai.ac.jp

The No-Insulation (NI) technique has the prospect of high thermal stability and high current density. A REBCO pancake coil with NI technique has no insulation between turns, so that the current can flow directly to the adjacent turns escaping from a local hotspot or a local normal transition. It enhances the thermal stability. The high thermal stability of REBCO pancake coil with NI technique was confirmed in many experiments. The NI REBCO pancake coil did not burn out even though an extremely high current exceeding the critical current was applied. In addition, the absence of insulation increases the current density as well as the thermal stability. Indeed, the electrical phenomenon in the NI REBCO pancake coil is complicated, and the stability is affected by the coil specifications, such as the contact resistivity, the coil size, the number of turns, and so on. However, it is hard to experimentally investigate the electromagnetic and thermal behavior of various NI REBCO pancake coils.

For clarifying the electrical and thermal behavior of NI REBCO pancake coils, we have developed the partial element equivalent circuit (PEEC) model as an electric circuit simulation method. It is combined with the finite element thermal analysis. The simulation results agree with the measurements well. The mechanism of the high stability is clarified through the simulation of the overcurrent test

and the sudden discharge test. We will show the simulation method and the comparison between the simulation and measurement results.

This research was partially supported by the Ministry of Economy, Trade and Industry of the Japanese Government, and Grant-in-Aid for Scientific Research(C), the Ministry of Education, Science, Sports and Culture (No. 25350558).

**41**

## Opening welcome

**Corresponding Author:** marco.breschi@unibo.it

**Session I: Thermo-hydraulics and cryogenics / 42**

## Thermal modelling of the HiLumi Nb3Sn MQXF inner triplet magnets with OpenFOAM –Development of superfluid helium code

**Corresponding Author:** rob.van.weelderen@cern.ch

**Session I: Thermo-hydraulics and cryogenics / 43**

## Modelling of transient dynamics leading to crisis in a boiling helium natural circulation loop

**Corresponding Author:** hernan.furci@cea.fr

**Session I: Thermo-hydraulics and cryogenics / 44**

## Dynamic simulations of a tokamak cryogenic system

**Corresponding Author:** roberta.cirillo@cea.fr

**Session I: Thermo-hydraulics and cryogenics / 45**

## A Physics-Based Simplified Model for the ITER Cooling Loops

**Corresponding Author:** luca.bottura@cern.ch

**Session I: Thermo-hydraulics and cryogenics / 46**

## Process Control Strategy for ITER Central Solenoid Operation

**Corresponding Author:** ryuji.maekawa@iter.org

**Session I: Thermo-hydraulics and cryogenics / 47**

## Characterization of the thermal coupling between the ITER TF coil conductor and the structure cooling circuit

**Corresponding Author:** florent.gauthier@iter.org

**Session I: Thermo-hydraulics and cryogenics / 48**

## ITER Side Correction Coil Quench Model and Analysis

**Corresponding Author:** sylvie.nicollet@cea.fr

**Session I: Thermo-hydraulics and cryogenics / 50**

## Thermo-hydraulic analyses associated to a design proposal for DEMO TF conductor

**Corresponding Author:** roser.vallcorba-carbonell@cea.fr

**Session I: Thermo-hydraulics and cryogenics / 51**

## Predictive 1-D analysis of the prototype HTS current leads for the ITER Correction Coils

**Corresponding Author:** reinhard.heller@kit.edu

**Session III: LTS quench / 52**

## Quench Analysis of the 11 T Nb3Sn Dipole for the LHC Luminosity Upgrade

**Corresponding Author:** susana.izquierdo.bermudez@cern.ch

**Session III: LTS quench / 53**

## Lumped-Element Dynamic Electro-Thermal model of a superconducting magnet

**Corresponding Author:** michal.maciejewski@cern.ch

**Session III: LTS quench** / **54**

## Analysis of the quench propagation along Nb3Sn Rutherford cables with the THELMA code

**Corresponding Author:** fabrizio.bellina@uniud.it

**Session III: LTS quench** / **55**

## Stability modeling of the LHC Rutherford cables subjected to beam losses

**Corresponding Author:** marco.breschi@unibo.it

**Session III: LTS quench** / **56**

## Using the HELIOS facility for assessment of bundle-jacket thermal coupling in a CICC

**Corresponding Author:** benoit.lacroix@cea.fr

**Session III: HTS quench** / **58**

## Numerical analysis of propagation of thermal disturbances in REBCO tapes

**Session III: HTS quench** / **60**

## Electro-thermal Analysis of quench in High Field HTS coils

**Corresponding Author:** lorenzo.cavallucci3@unibo.it

**Session III: HTS quench** / **61**

## Comprehensive quench analysis of the NHMFL 32T all-superconducting magnet

**Corresponding Author:** gavrilin@magnet.fsu.edu

**Session IV: HTS Electromagnetics** / **62**

## Open-source software to model High Temperature Superconductor

**Corresponding Author:** ftrillaudp@pumas.ii.unam.mx

**Session IV: HTS Electromagnetics** / **63**

## Modeling AC ripples in HTS coated conductors by integral equations

**Corresponding Author:** francesco.grilli@kit.edu

**Session IV: HTS Electromagnetics** / **64**

## Ac Loss Calculation of a Dipole Magnet Wound with Coated Conductors

**Corresponding Author:** amemiya.naoyuki.6a@kyoto-u.ac.jp

**Session IV: HTS Electromagnetics** / **65**

## Test of a prototype large current HTS cable for fusion

**Corresponding Author:** pierluigi.bruzzone@psi.ch

**Session IV: HTS Electromagnetics** / **66**

## Simulation of current distribution in twisted 2G tapes in terms of the H formulation taking in account the stress induced by torsion

**Corresponding Author:** gsotelo@id.uff.br

**Session IV: HTS Electromagnetics** / **68**

## Numerical Simulation on Magnetic Field generated by Screening Current in REBCO coils

**Corresponding Author:** hueda@rcnp.osaka-u.ac.jp

**Session V: Design methods and mechanics / 69**

## Modeling and testing of transverse, axial and torsional strain on REBCO tapes

**Corresponding Author:** a.nijhuis@utwente.nl

**71**

## Invited presentation: The simulator of FERRARI formula 1 vehicle

**Session V: Design methods and mechanics / 72**

## Study on magnetic field deviation due to manufacturing errors of the SIS100 superconducting magnets

**Corresponding Author:** k.sugita@gsi.de

**Session V: Design methods and mechanics / 79**

## Design and Optimization of a HTS Insert for Solenoid Magnets

**Corresponding Author:** giordano.tomassetti@enea.it

**Session V: Design methods and mechanics / 80**

## Simulation of the Cabling Process for Rutherford Cables: an Advanced FEM Model

**Corresponding Author:** jaime.cabanes.aracil@cern.ch

**Session V: Design methods and mechanics / 81**

## Structural Modeling of HTS Tapes and Cables

**Corresponding Author:** nathaniel.allen@tufts.edu