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EMS

Process of the Modeling of ITER Main Busbar JointBox

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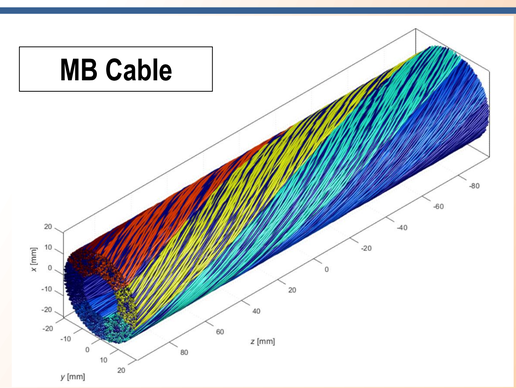
Introduction

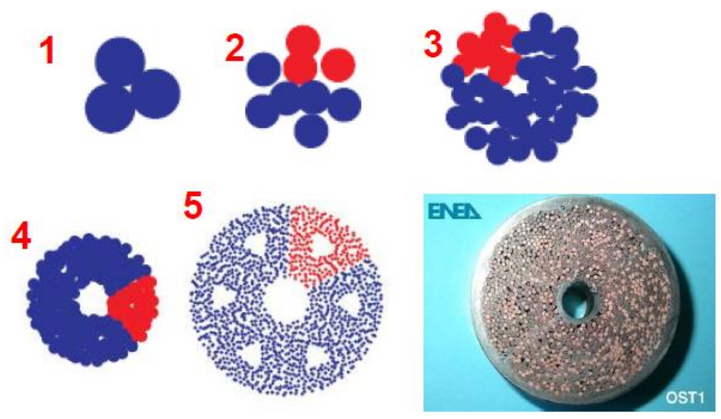
The Main Busbar (MB) is one kind of Feeder in ITER magnet system, provided electrical as well as cryogenic connection of Toroidal Field(TF), Central Solenoid(CS), and Poloidal Field(PF) coils to the current leads. The MB Joint with a praying hands configuration, although that is recognized for its proven reliable and its suitable assembly, however, the unavoidable steady state Joule heating in the joint resistance combined with the possibility of large coupling currents in steady state and pulsed operations represent a potential threat for the stability of lap-type joints,

The design and performance analyses of the MB NbTi Cable-in-Conduit Conductor (CICCs) and the joint are based on the code JackPot-ACDC. The modeling applied the SULTAN measurement condition, the results could provide an optimization for the ITER full size MB jointbox.

JackPot AC/DC: JointBox modeling

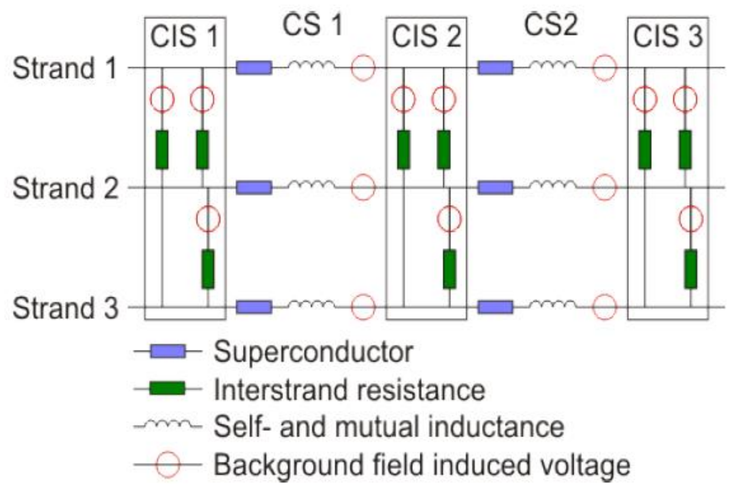
The code Jack-Pot AC/DC is able to reproduce the complete geometry of a full Cable-In-Conduit-Conductor (CICC) and it calculates the trajectories of all the strands (>1000). JackPot creates a network of superconducting and resistive elements, whereby it calculates mutual inductances, contact resistances and coupling with the background field and self-field; all the quantities are obtained from the geometry and the experiments thus there are no free parameters in the model. Benefit from the implementation of the Multi-Level Fast Multipole Method(MLFMM), JackPot can cope with the computation of the large number of mutual couplings between strand sections, and then could a full-size ITER CICC joint.

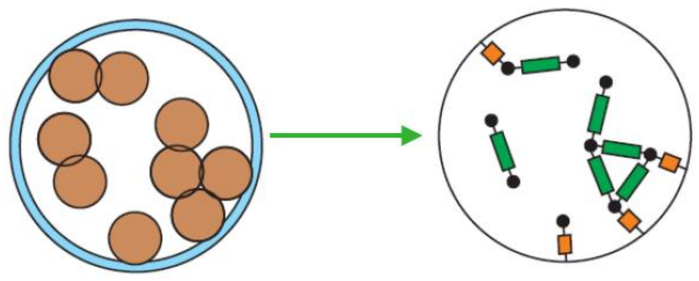




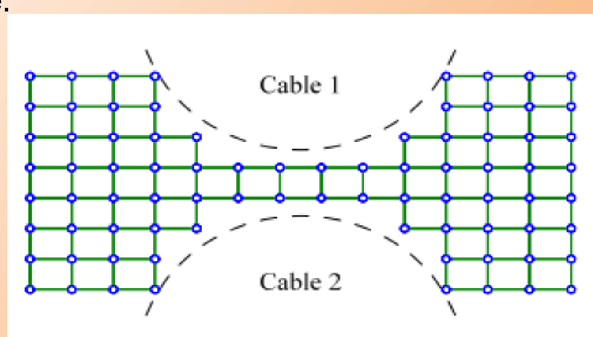
Cable-In-Conduit Conductors (CICCs) are made by hundreds of superconductive strands twisted and compacted together around a spiral into a stainless steel jacket. The code JackPot AC/DC is able to reproduce the complete geometry of a CICC and it calculates all the trajectories of all the strands (>1000).

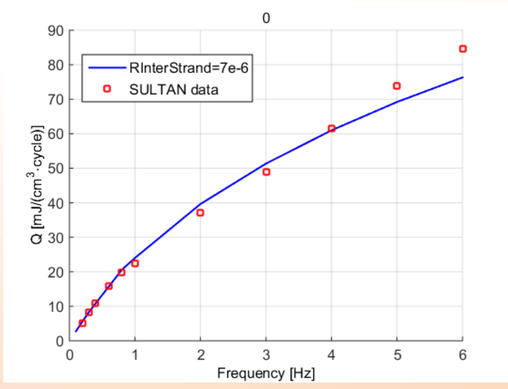
JackPot creates a network of superconductor and resistive elements, whereby it calculates mutual inductances, contact resistances and coupling with the background field and self-field; all the quantities are obtained from geometry and experiments, thus there are not free parameters in the model.



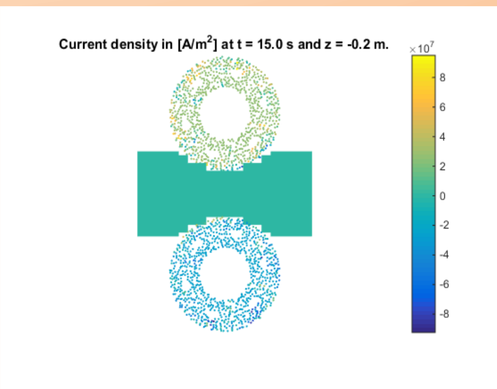


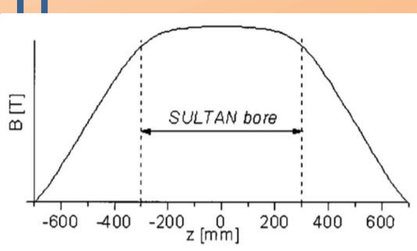
JackPot is able to model lap-type joints between CICCs as a network of regular voltage nodes created across the Cu sole.





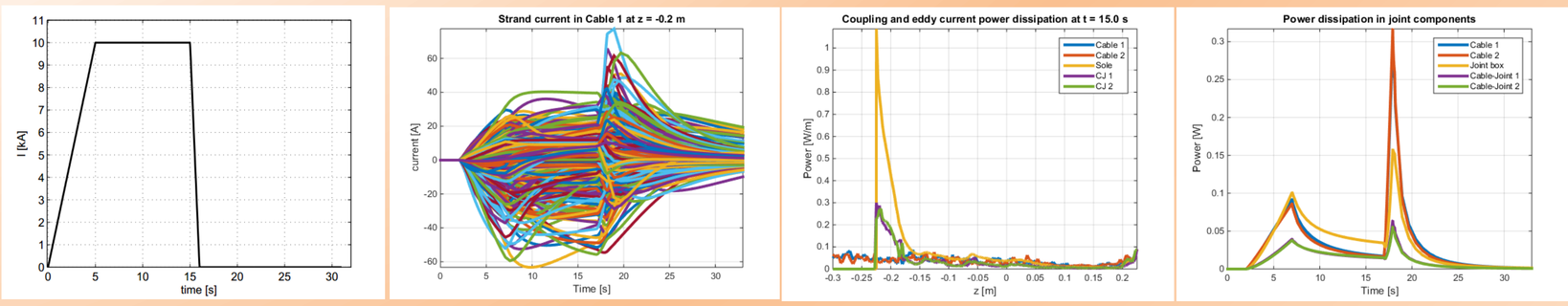
Inter-strand resistivity and Inter-petal resistivity parameters *R_inter_strand and R_inter_petal* are derived from the AC Loss simulation fitting the SULTAN AC loss measurements.



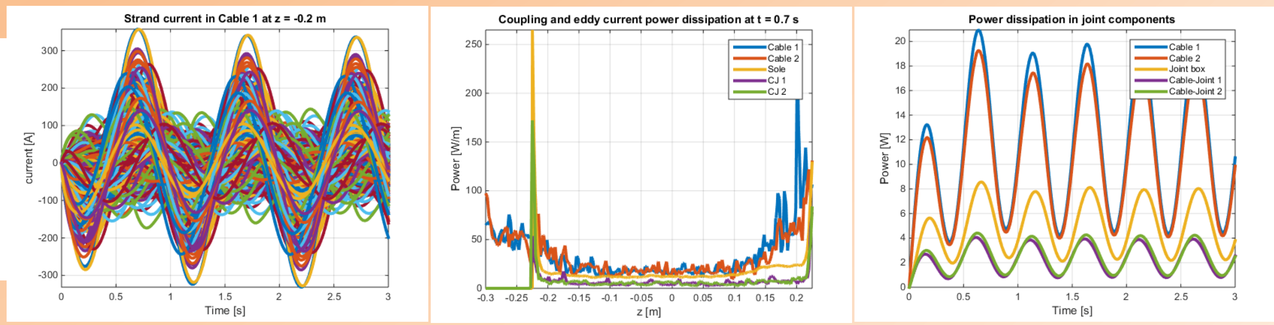


Power dissipation simulation

(1). The electromagnetic behavior of the joint under constant background magnetic field(2T) and ramp current.



(2). The electromagnetic behavior of the joint under the background magnetic field of SULTAN facility.



Under the SULTAN configuration magnetic field, the frequency of the induced current in joint is 1Hz, the power dissipation of all the components are higher, this mechanism behind this phenomenon is one of the important research points in the next step.

Conclusions

- The modelling of the praying hands of ITER full size MB jointbox under SULTAN magnetic field is first time studied in University of Twente.
- At the first stage, the sub-sized jointbox model with two short MB CICCs applied with the ramp current and AC loss magnetic field have finished and validated.
- For the 3.6m full-sized joint under SULTAN nonhomogeneous field, due to the enormous coupling inductances, it's still a big challenge for the JackPot to deal with.

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