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DC and transient current distribution analysis from self-field measurements on ITER PFIS conductor

A. Formisano [a,*], Yu. Ilyin [c], L. Muzzi [b], R. Martone [a], P. Gislon [b], A. Nijhuis [c], M. Polak [d], C. Sborchia [e], B. Stepanov [f]

[a] *Consorzio CREATE, Via Claudio 21, I-80124 Napoli, Italy*
[b] *ENEA Frascati, Frascati, Rome, Italy*
[c] *University of Twente, Enschede, The Netherlands*
[d] *IEE, Slovak Academy of Sciences, Bratislava, Slovakia*
[e] *EFDA Close Support Unit, Garching, Germany*
[f] *EPFL-CRPP, Villigen PSI, Switzerland*

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Abstract

Current reconstruction in cable-in-conduit conductors (CICC) cables is a crucial issue to determine cables performance in working conditions, and must be performed using inverse problem approaches as direct measurement is not feasible. The current distribution has been studied for the ITER Poloidal Field Insert Sample (PFIS) conductor using annular arrays of Hall probes placed in three different locations along the sample during the test campaign at the SULTAN facility. The measurement apparatus is also described in the paper, together with the approach to current reconstruction.

Keywords: Current distribution analysis; ITER PFIS conductor; CICC cables

1. Introduction

A number of studies are presently being performed to investigate the behaviour of "cable-in-conduit conductors" (CICC) superconducting cables under conditions of practical interest for the ITER magnets [1,2]; in particular, the current distribution (CD) amongst the conductor's strands is an important issue as it may influence the performance of a CICC [4,3,5]. Unfortunately, direct measurements of CD inside a CICC are not possible. An indirect approach for the current profile estimate can be based on the measurement of the magnetic self-field around the CICC. The measurement system used for CD reconstruction in Poloidal Field Insert Sample (PFIS), tested in the SULTAN test facility under various working conditions [2], is based on Hall probes (HP) annular arrays (called "heads"), suitably placed around the cable [5]. First results about CD measurement are reported here. Two approaches to the CD reconstruction inverse problem are presented and

* Corresponding author. Tel.: +39 0815010342; fax: +39 0815037042
E-mail address: a.formisano@unina.it (A. Formisano).

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compared [6,7]. Both models are based on magnetostatic equations; the first one takes into account the internal 3D structure of the cable. The second model uses a somewhat simplified 2D geometry of the conductor, thus saving time for modelling and computation.

2. Description of the experimental layout

In the PFIS experiment, six heads with 10 HP each have been placed around the two cable sections to be tested. For construction ease, the heads have been paired in such a way that, at each sample cross-section, two heads simultaneously measure the field produced by the two parallel legs constituting the sample (see Fig. 1). The left leg had insulating tapes wrapped around the highest level substructures of the cable (the "petals"), while the right one had un-wrapped petals. The three couples of heads have been placed close to the upper termination (heads 1 and 2), in the SULTAN field peak region (heads 3 and 4), and close to the bottom joint (heads 5 and 6). The acquisition and signal

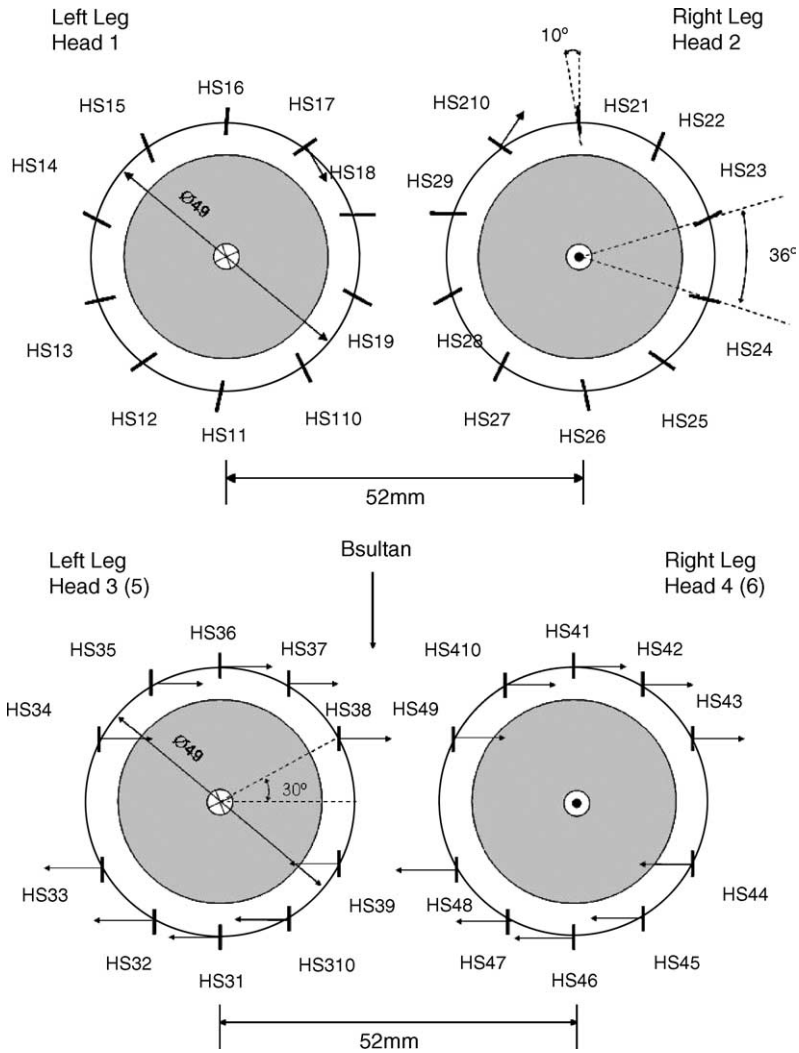

Fig. 1. Layout of heads 1 and 2 (upper) and 3 and 4 (lower). Heads 5 and 6 are identical to heads 3 and 4. Heads 1, 3 and 5 are on the 'Left' (wrapped) leg; heads 2, 4 and 6 are on the 'Right' (unwrapped) leg [2].