Low-resistance Joint Development for Segment-fabrication of High-temperature Superconducting Fusion Magnets
Satoshi ITO1*, Hitoshi TAMURA2, Nagato YANAGI2, Hidetoshi HASHIZUME1
1Tohoku University, 2National Institute for Fusion Science
*satoshi.ito.e3@tohoku.ac.jp

ABSTRACT
Two designs have been proposed as segment-fabrication of the HTS helical coils in FFHR-d1 helical fusion reactor, joint-winding of the HTS coils wound by connecting conductor segments, and the “remountable” HTS magnet (here “remountable” means being able to mounted and demounted repeatedly) assembled from coil segments with remountable joints. Bridge-type mechanical lap joint and mechanical edge joint are planned to be applied to those two designs, respectively.
This poster presents progress in electrical and mechanical performances of the mechanical joints of high-temperature superconducting (HTS) conductors and methods to evaluate those quality for segment-fabrication of HTS helical coil. R&D of Joint performance have been progressed during this decade and it shows acceptable performance for the HTS helical coils. Contact-probing CTL method and X-ray CT scan are promising for quality assessment of the joints and HTS tapes.

1. INTRODUCTION
Two designs of segment-fabrication of HTS helical coils
(1) Joint-winding [1,2]
- Feature: Simplify construction
- Joint: Bridge-type mechanical lap joint
(2) Remountable magnet [3-5]
- Feature: Simplify construction
- Enable to replace failed segments
- Joint: Mechanical edge joint
- Indium foil is inserted between joint surfaces to increase real contact area.
- The electric and mechanical performances of the joints and those quality assessment are important technical issues for the designs.

2. ELECTRIC PERFORMANCE OF JOINT
Bridge-type mechanical lap joint [5,6]
- Permanent joint
- Remountable joint
- Conductors segments
- C4u jacket
- HTS jacket
- Joint force
- Bridge-type mechanical lap joint of the HTS helical coil

3. MECHANICAL PERFORMANCE OF JOINT
Structural Analysis [5,9,10]
- Normal strain along the winding direction:
The maximum tensile strain: 0.145%<Irreversible strain
- Shear stress in the REBCO tapes region:
The maximum shear stress: 32-35 MPa

4. QUALITY ASSESSMENT OF JOINT
Evaluation of interface resistance of REBCO tape [12]
- Contact resistance: controlled by joint process
- Interface resistance: varied depending on batch of REBCO tape

Evaluation of contact area based on X-ray CT scan [13,14]

5. CONCLUSION
(i) Joint resistance for bridge-type mechanical lap joint and mechanical edge joint have been reduced to be acceptable value for HTS helical coils in FFHR-d1 helical fusion reactor.
(ii) The bridge-type mechanical lap joint with inductum insertion is preferable for use in joint-winding of the HTS helical coil because of its mechanical behavior.
(iii) X-ray CT scan and contact-probing CTL method are promising to predict joint resistance, and quality control of the joints during fabrication process at room temperature before applying current.

REFERENCES