EPFL

Bruker Nb_3Sn Strands under Bending Strains

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Motivation

To understand the tolerance of the Bruker strands to bending strain after reaction

Method

1. React strands on steel cylinders with different radii

2. Transfer reacted strands to ITER barrels, that have an outer radius of 15 mm

3. Measure I_C

Method

There will be a distribution of bending strain through the thickness of the strand. The largest strain values are given by [1]:

$$\varepsilon_{\mathrm{B}}(R_{\mathrm{HT}}) = \pm\frac{t}{2}\left(\frac{1}{R_{\mathrm{B}}} - \frac{1}{R_{\mathrm{HT}}}\right)$$

ε_{B}	**Heat Treatment Radius**
± 0.1458%	16 mm
± 0.2745%	17 mm
± 0.3888%	18 mm
± 0.4912%	19 mm

ε_{B} = bending strain

$t = 0.7$ mm (strand diameter)*

$R_{\mathrm{B}} = 15$ mm (ITER barrel radius)

R_{HT} = heat treatment cylinder radius

Current Status

- The stainless steel cylinders for reacting the strands have been ordered. Test schedule to follow.

- Abstract submitted to ASC.

[1] See, e.g., G. Ambrosio *et al.*, *Study of the React and Wind Technique for a Nb3Sn Common Dipole* IEEE TAS **10**:1 (2000)

* Filamentary zone diameter is ~0.45 mm

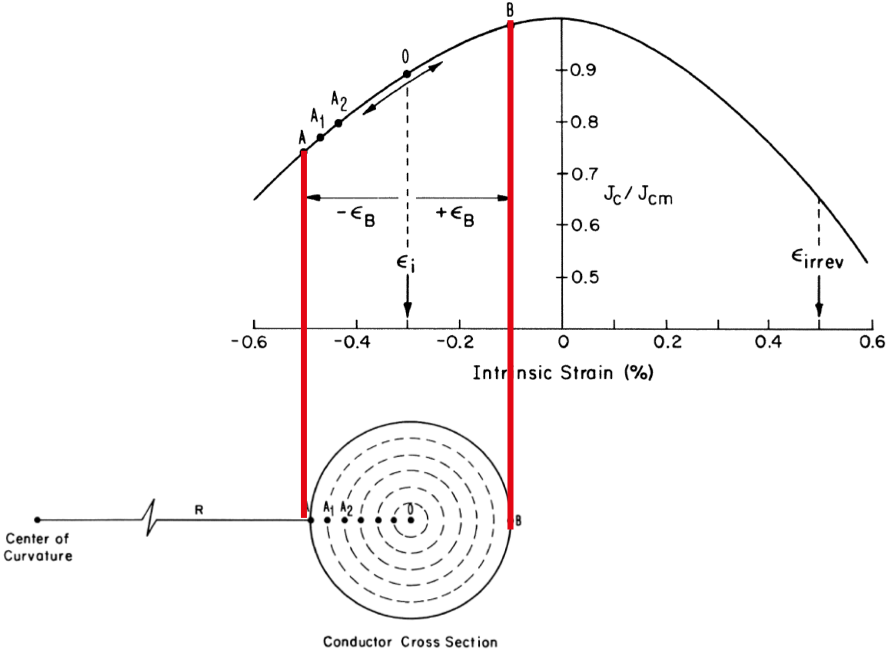
Extra: Distributions of Bending Strain

From a **physics** perspective:

Distributions of bending strain will lead to distributions of J_C in the strand.

For strands where the interfilamentary current transfer length L is much shorter than the filament twist pitch l (which is *usually* a valid assumption* for Nb_3Sn), one can calculate the strand's I_C using**:

$$\frac{I_c}{I_{cm}} = \frac{2}{\pi \varepsilon_B^2} \int_{-\varepsilon_B}^{\varepsilon_B} (\varepsilon_B^2 - x^2)^{1/2} \frac{J_c(\varepsilon_i + x)}{J_{cm}} dx$$



*The *assumption* is valid if the Cu matrix RRR is reasonably high
**The *equation* requires knowledge of the axial strain behaviour.

[1] J. W. Ekin, *Strain Scaling Law and the Prediction of Uniaxial and Bending Strain Effects in Multiflimentary Superconductors,* Filamentary A15 Superconductors (Suenaga & Clark) 1980, p187-203