Correlation between \( \text{YBa}_2\text{Cu}_3\text{O}_7 \) Nuclei Density and the Grain Orientation of the \( \text{CeO}_2 \) Buffered Ni–W Template of the Second-generation Superconducting Wire

Vyacheslav F. Solovyov (Brookhaven National Laboratory), Dmytro Abraimov (National High Magnetic Field Laboratory), Dean Miller (Argonne National Laboratory), Qiang Li (Brookhaven National Laboratory), and Harold Wiesmann (Brookhaven National Laboratory)

Introduction
Modern 2G wires use two types of substrates: textured Ni–W tape with an epitaxial oxide buffer stack (RABiTS™) or polycrystalline Hastelloy tape with an oxide buffer layer oriented by ion-beam assisted deposition. It is well known that substrate grain misalignment has a negative effect on the performance of YBCO since high-angle grain boundaries act as weak links, reducing the critical current of the conductor. Less well understood is how the substrate grain misorientation, particularly out-of-plane tilt, influences the nucleation of (001) YBCO.

Experimental
To visualize the spatial distribution of crystallographic orientations, we used OIM analysis in which EBSD patterns consisting of Kikuchi bands are formed when a stationary electron beam interacts with a crystalline lattice in a highly tilted sample mounted on the SEM (Zeiss 1540 XB in Shaw bld.). The geometric relationship of the bands holds information about the crystal lattice in the diffracting volume.

Results and Discussion
Panel A in Fig.1 is the out-of-plane misorientation (between the \( c \)-axis and the substrate normal: [100] tilt) and panel is B is the in-plane rotation angle (around [001] direction: [001] rotation). Panel C is the YBCO coverage map derived from an SEM micrograph. Two grains with different tilt angles: grain 1 < 1° and grain 2 \( \approx 4° \) are outlined on each graph to emphasize the effect of the tilt on the nucleation density. The individual data points represent the results of area averaging within 53 Ni–W substrate grains of orientation and coverage maps shown in Fig. 1. The arrow in panel A denotes the tilt angle limit, 8.5°. A grain tilted beyond this limit would not nucleate YBCO.

Conclusions
The relationship between YBCO nuclei density and crystallographic orientation of the underlying Ni–W grains has been determined. The nuclei density decays rapidly as the out-of-plane tilt angle increases. We ascribe this effect to the shortening of (100) CeO2 terraces and crossover between the terrace width and lateral nuclei size.

Acknowledgements
Work at the National High Magnetic Field Laboratory was supported under DOE (Contract No. DE-FC07-08ID14916).

References