DEVELOPMENT OF SUPERCONDUCTING UNDULATORS

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SCUs outperform the permanent magnet based undulator and currently, all SCUs in operation are NbTi-based.

**NbTi has reached its limits in terms of achievable on-axis fields, $B_0$.**

**Further increase in $B_0$ is desirable because it:**
- increases brightness of x-ray beams
- increases tunability range
- reduces the FEL undulator lengths
The goal is to develop a double Nb$_3$Sn undulator and install it into the APS’s storage ring to allow for testing and operation as a first Nb$_3$Sn based SCU user magnet.
SHORT MODEL MAGNET (SMM) PERFORMANCES

\[ \text{Max } I_{op} = 875A \]

More than 20% increase in \( J_e \) that is equal to 20% increase in undulator on-axis field

\[ J_e [A/mm^2] \]

\[ \text{Quench Number} \]

\[ 35\% > \text{NbTi} \]

\[ \text{Short sample limit} \]

\[ \text{Max } I_{op} = 875A \]

\[ \text{IEEE/CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), November 2019.} \]

\[ \text{Plenary presentation Wed-Mo-PL4-06 given at MT26, 22 – 27 September 2019; Vancouver, Canada.} \]

\[ \text{Nb}_3\text{Sn offers at least 20% increase in on-axis field, some model magnets reached the short sample limit and demonstrated even more performance increase, >35%!} \]
BEYOND NBTI & Nb$_3$Sn – REALM OF 2G-HTS

\[ J_e \sim 2100 \text{ A/mm}^2, \ 40\% > \text{NbTi} \]
\[ 10-20\% > \text{Nb}_3\text{Sn} \]
\[ J_e \text{ of reduced substrate is } 55\% > \text{NbTi} \]

Remaining Challenges:
- Screening current induced field errors
- Long, uniform, high performance, mechanically robust 2G-HTS tapes
- Uniform electroplated copper
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Thank you for listening!