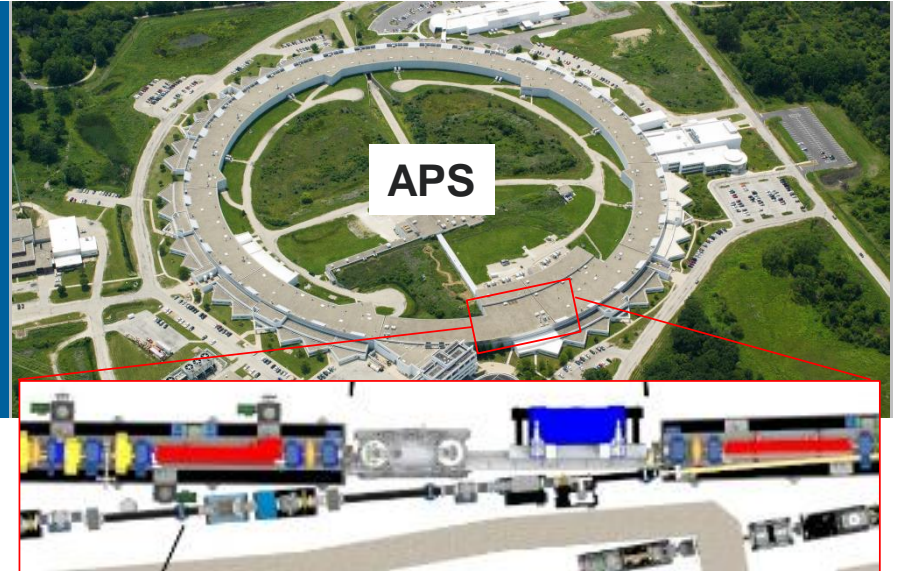


# DEVELOPMENT OF SUPERCONDUCTING UNDULATORS



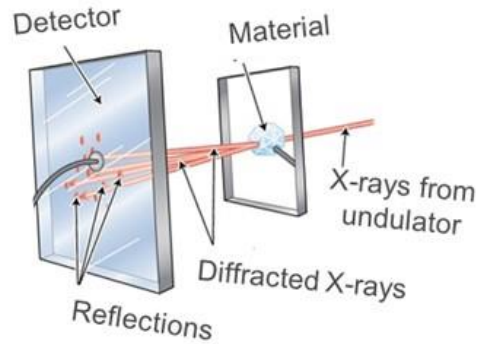
**IBRAHIM KESGIN**

**Advanced Photon Source  
Argonne National Laboratory**

**MT 26 Young Scientist Plenary session, September 25<sup>th</sup>, 2019**

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# SUPERCONDUCTING UNDULATORS (SCUS)

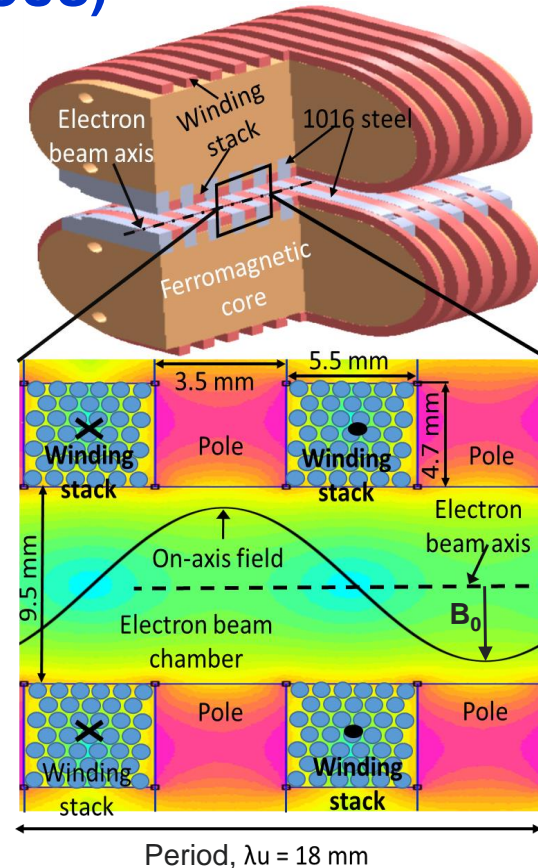


SCUs outperform the permanent magnet based undulator and currently, all SCUs in operation are NbTi-based.

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

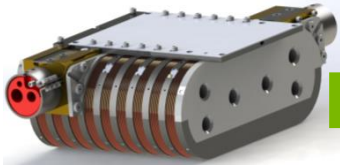
**Further increase in  $B_0$  is desirable because it:**

- increases brightness of x-ray beams
- increases tunability range
- reduces the FEL undulator lengths



# NB<sub>3</sub>SN UNDULATOR PROJECT

Short model studies  
8 cm long



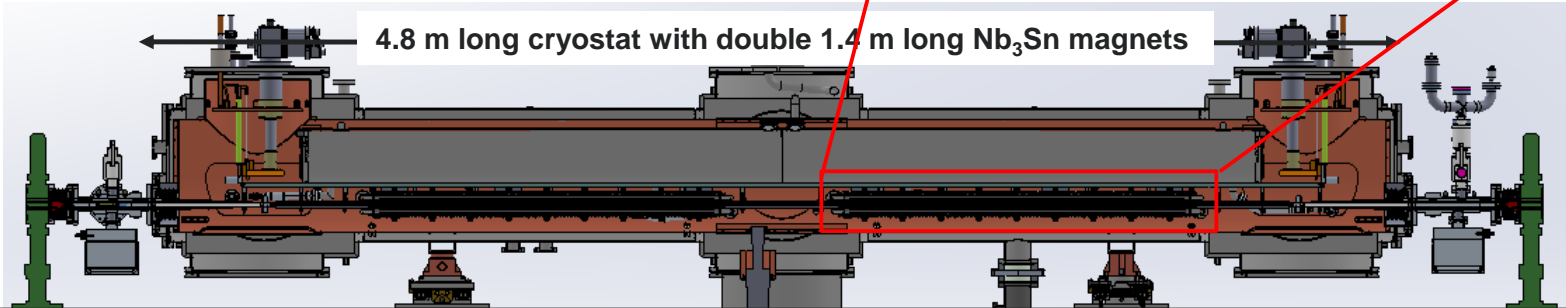
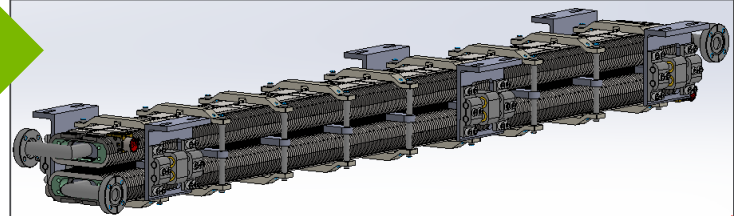
- Design optimization
- Performance confirmation

Scaling short models to 0.5 m  
intermediate lengths  
Ongoing



- Quench Detection & Protection
- Field quality

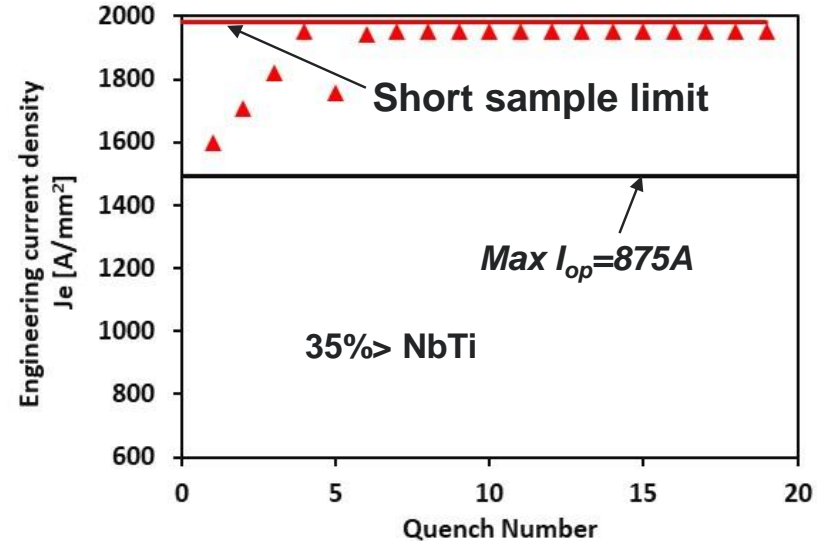
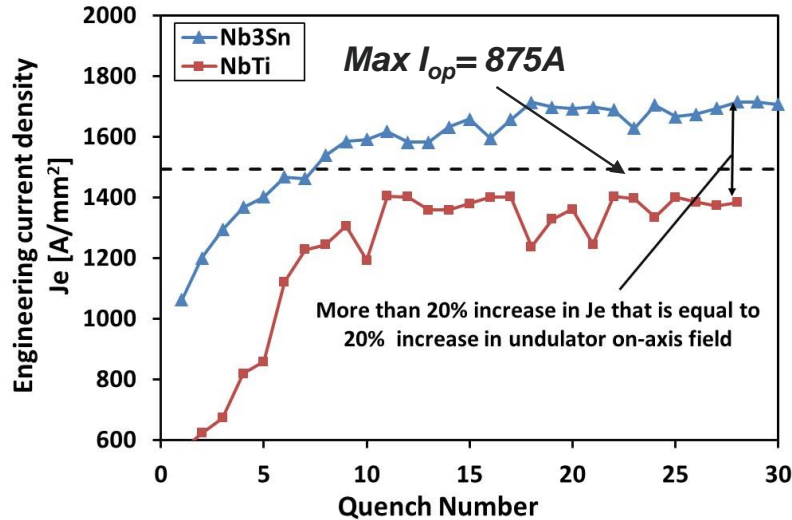
1.4 m long Nb<sub>3</sub>Sn magnets



4.8 m long cryostat with double 1.4 m long Nb<sub>3</sub>Sn magnets

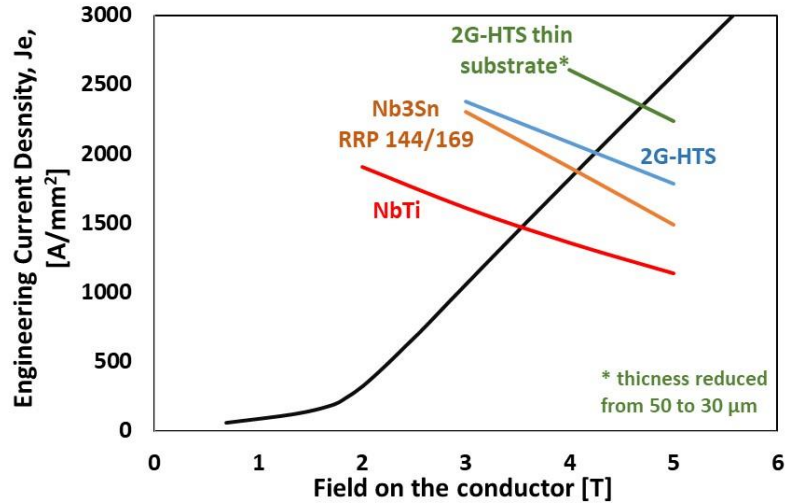
The goal is to develop a double Nb<sub>3</sub>Sn undulator and install it into the APS's storage ring to allow for testing and operation as a first Nb<sub>3</sub>Sn based SCU user magnet.

# SHORT MODEL MAGNET (SMM) PERFORMANCES



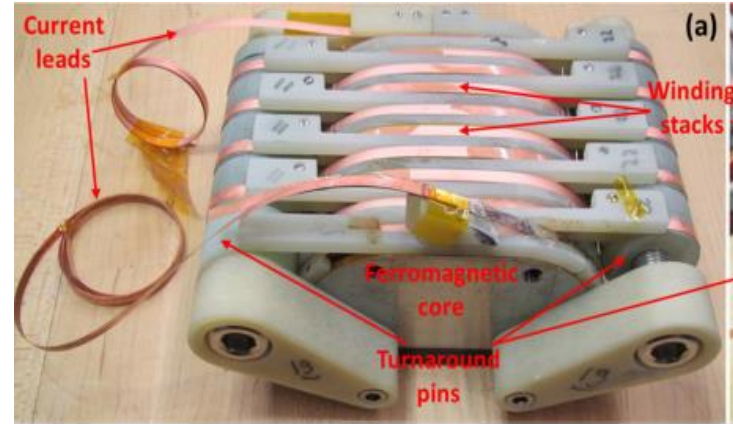
Nb<sub>3</sub>Sn offers at least 20% increase in on-axis field, some model magnets reached the short sample limit and demonstrated even more performance increase, >35%!

# BEYOND NBTI & Nb<sub>3</sub>Sn – REALM OF 2G-HTS



$J_e \sim 2100 A/mm^2$ , 40% > NbTi  
10-20% > Nb<sub>3</sub>Sn

$J_e$  of reduced substrate is 55% > NbTi



*I. Kesgin et al., Supercond. Sci. Technol. 30 04LT01, 2017,*

**Winding scheme developed  
Performance confirmed**

## Remaining Challenges:

- Screening current induced field errors
- Long, uniform, high performance, mechanically robust 2G-HTS tapes
- Uniform electroplated copper

## ACKNOWLEDGMENTS

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Venkat Selvamanickam



Milan Majoros and Michael Sumption



**Thank you for listening!**