



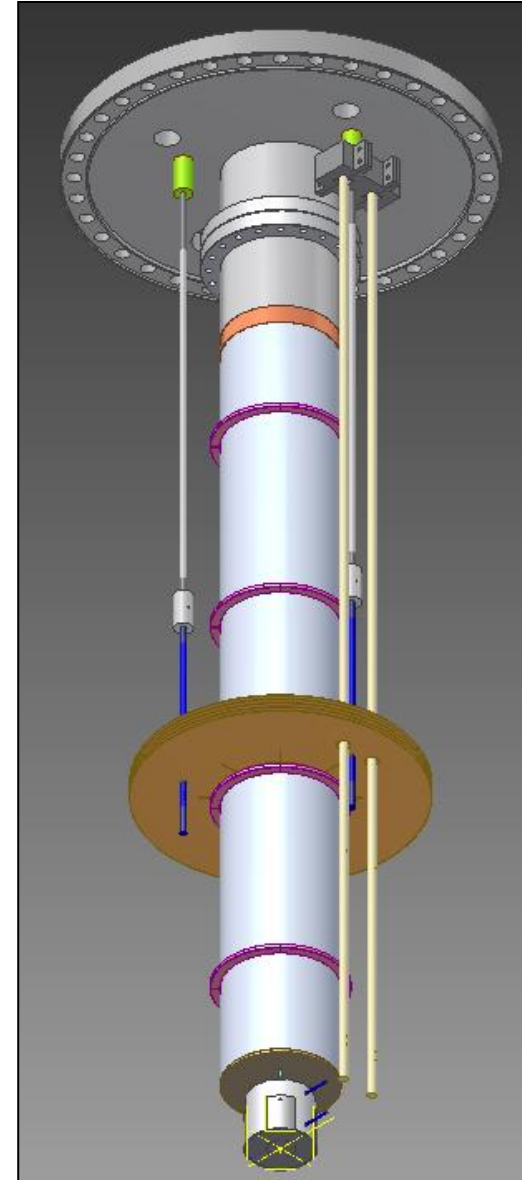
Cornell SRF New Materials Program

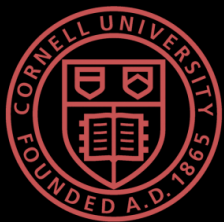
Nb_3Sn Development



**Sam Posen and
Matthias Liepe**
Cornell University

TTC Meeting
6 December 2011
Beijing, China

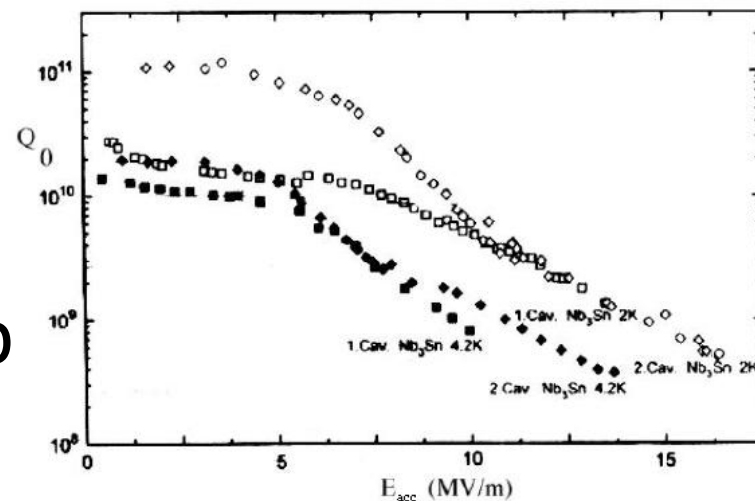




Motivation: Why Coat Cavities with Nb_3Sn ?



- Higher Q_0 than Nb for surface fields $< \sim 30$ mT proven
- Higher RF critical field than Nb predicted from theory
- Great promise shown in experiments at University of Wuppertal in 80s-90s
- We can add techniques that improved the performance of Nb cavities
 - HPR, EP, 120 deg C bake, CBP, single crystal Nb



Coating Mechanism

Vapor Diffusion

Coating chamber in UHV furnace

Sn Vapor

Heater

T_f = furnace temperature
= ~1100 C

T_s = Sn source temperature
= ~1200 C

Sn vapor arrives at surface

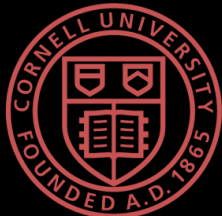
Nb-Sn interdiffusion

Nb

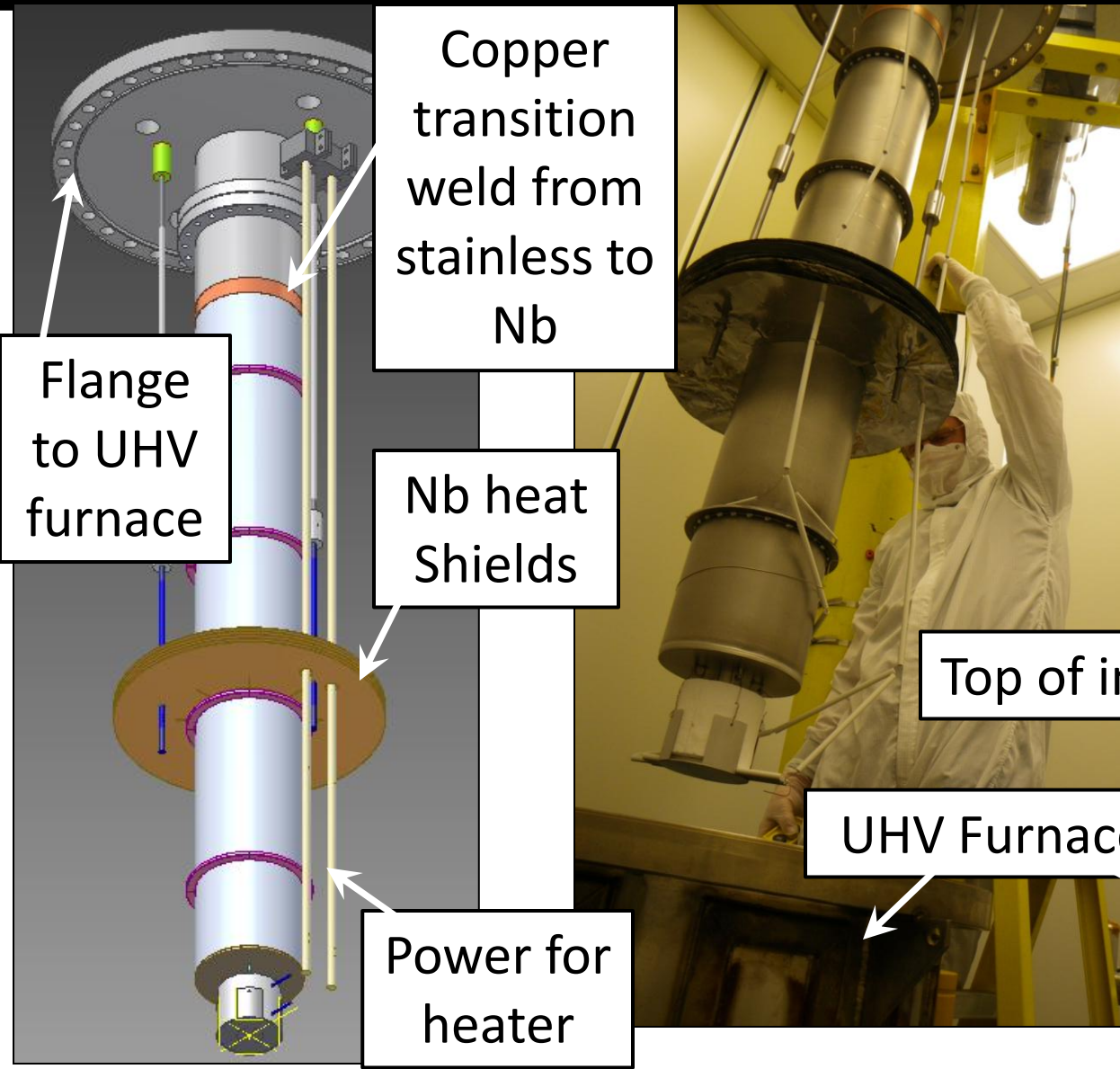
Sn

Nb₃Sn

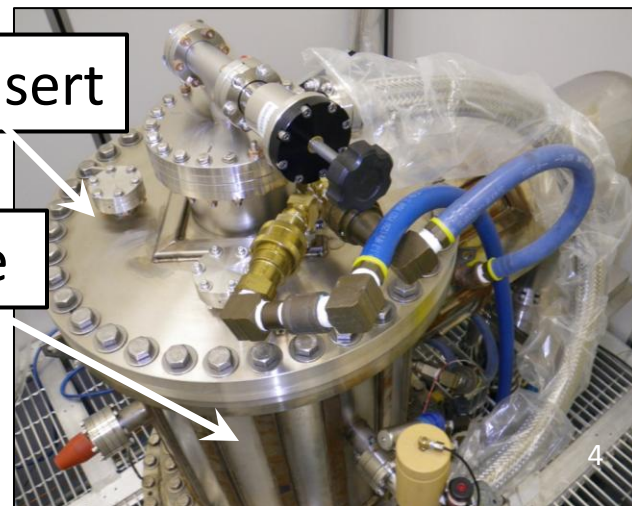
By independently controlling Sn vapor abundance, it can be balanced with Nb-Sn interdiffusion rate to achieve desired stoichiometry

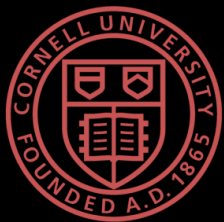


Nb₃Sn Coating Chamber

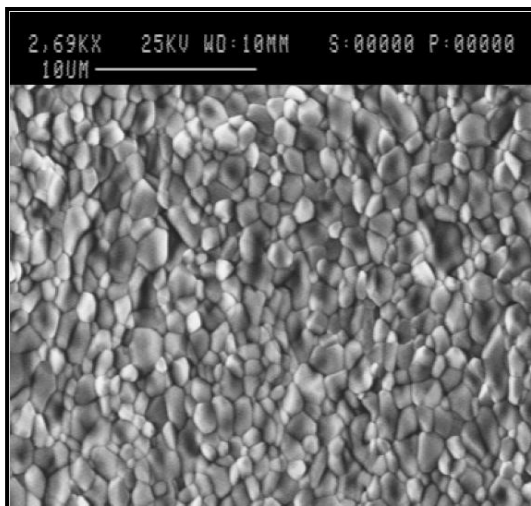


Coating chamber is inserted into UHV furnace. Separate vacuum system keeps cavity furnace free from tin contamination

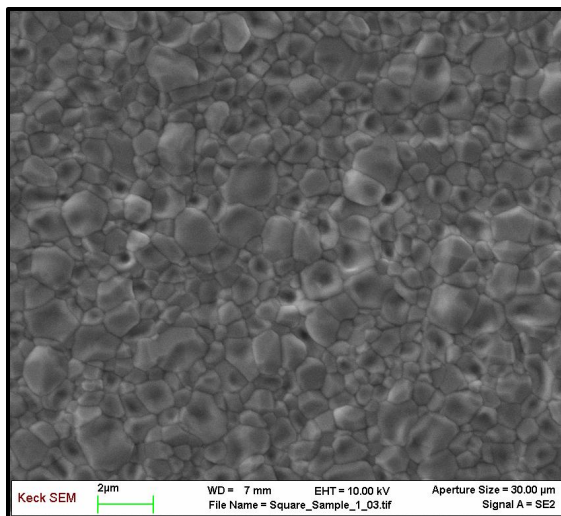




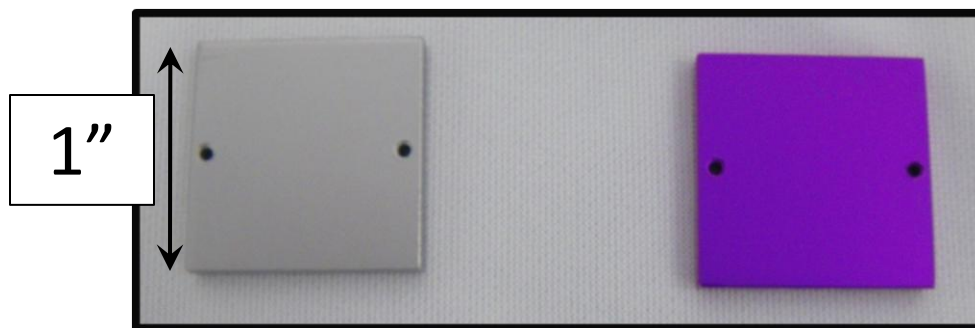
Accomplishments: Surface Studies of Samples



Wuppertal, 1996



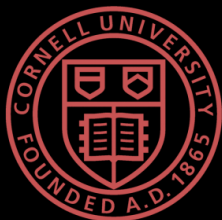
Cornell, 2011



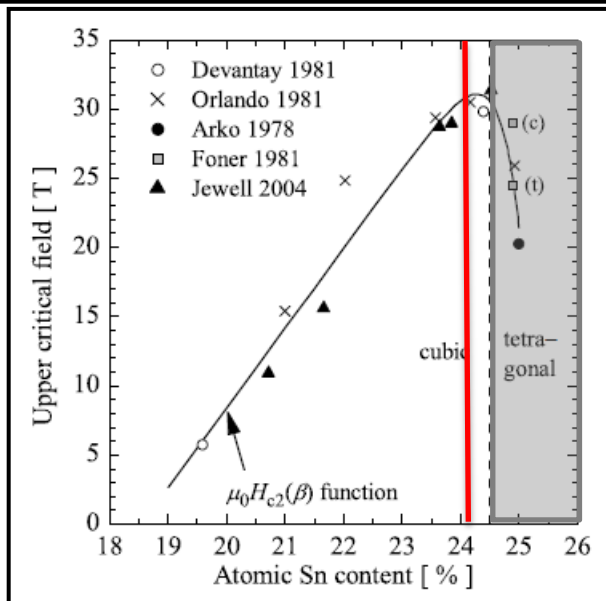
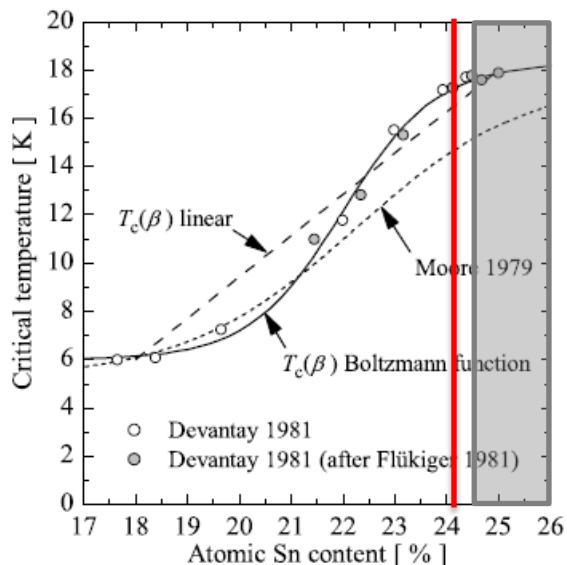
Not anodized

Anodized

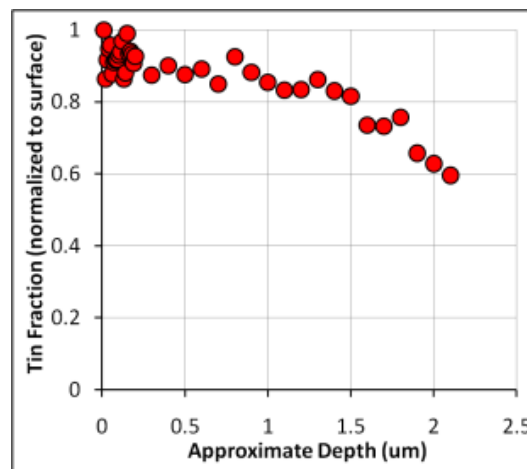
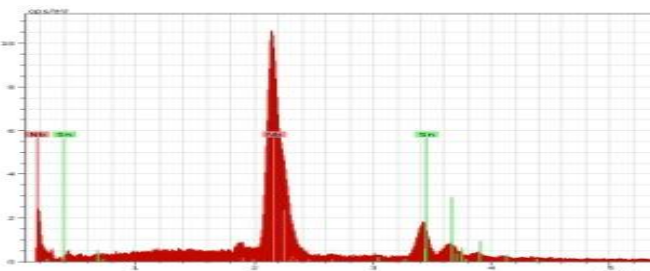
- SEM shows micron sized grains similar to Wuppertal
- Anodization color indicates Nb_3Sn on surface

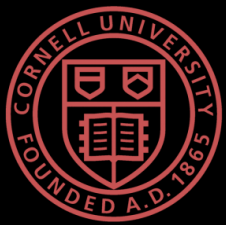


Accomplishments: X-ray Analysis

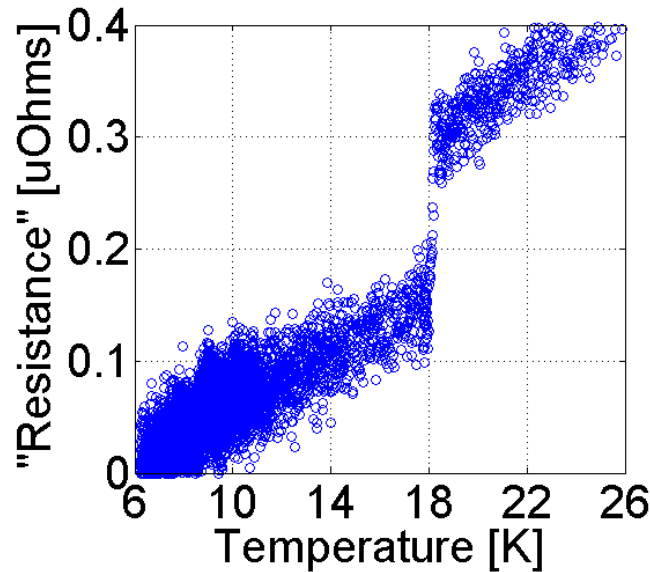


- EDX: uniform composition over surface of 24.2 ± 0.5 atm%Sn
- XPS: uniform composition to a depth of 1.5 μm



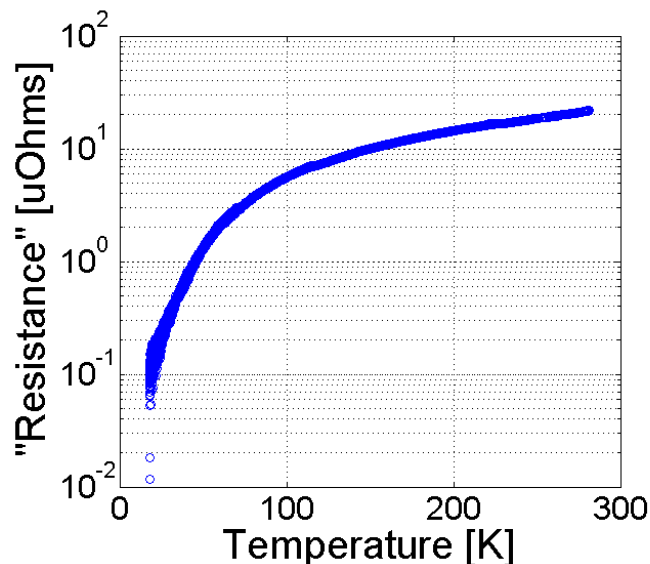


Accomplishments: Low Temperature Tests



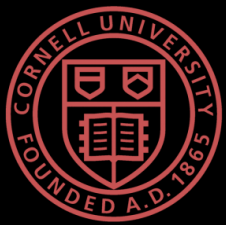
T_c

- Transition at 18.1 ± 0.2 K, close to the highest recorded value of 18.3 K



RRR

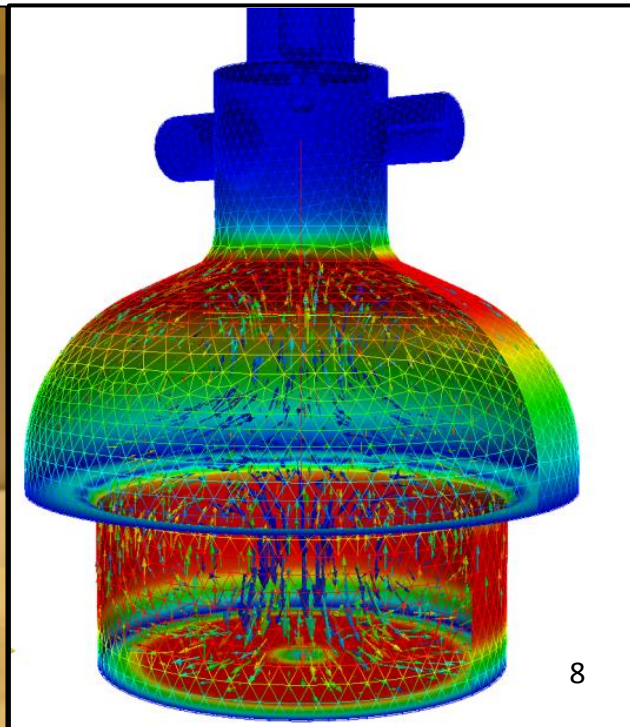
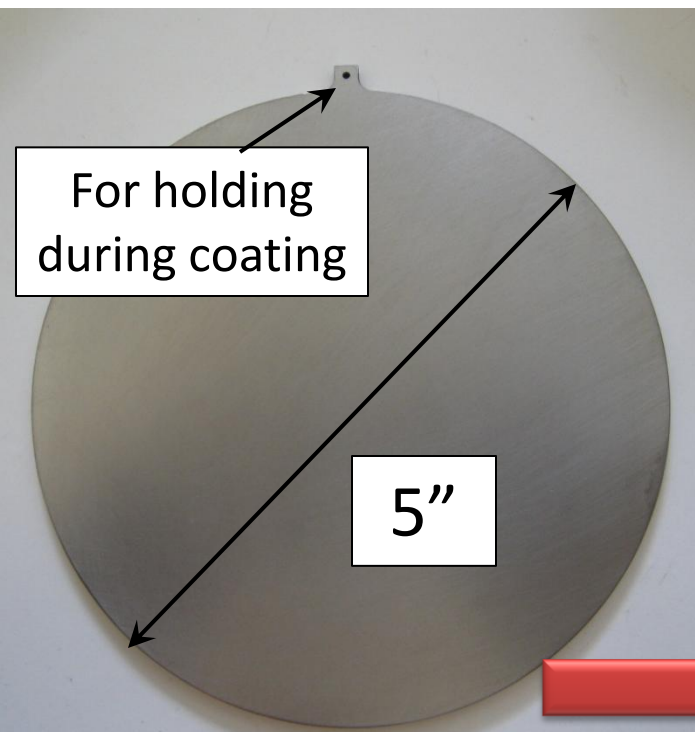
- Negligible RRR degradation from coating process

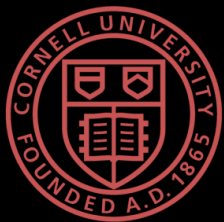


Current Work: Nb_3Sn Samples in TE Mushroom Cavity



- Commissioning is under way of 6 GHz TE mushroom cavity with removable bottom plate
- Plan: EP and coat 5" plate with Nb_3Sn then RF test





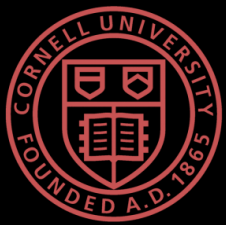
Current Work: Nb₃Sn Coated Single Cell Cavities



- Designed upgraded coating chamber capable of loading full single cell 1.3 GHz cavities
- Parts acquisition and fabrication has begun
- Optimistic estimate for first coating: March

Tube for main
body of coating
chamber
(niobium)





Outlook



- Coat 5" sample with Nb_3Sn and RF test in TE mushroom cavity
- Fabricate and commission new coating chamber
- Coat ILC single cell cavity with Nb_3Sn and RF test with full T-map
- Use RF performance as feedback to improve coating parameters