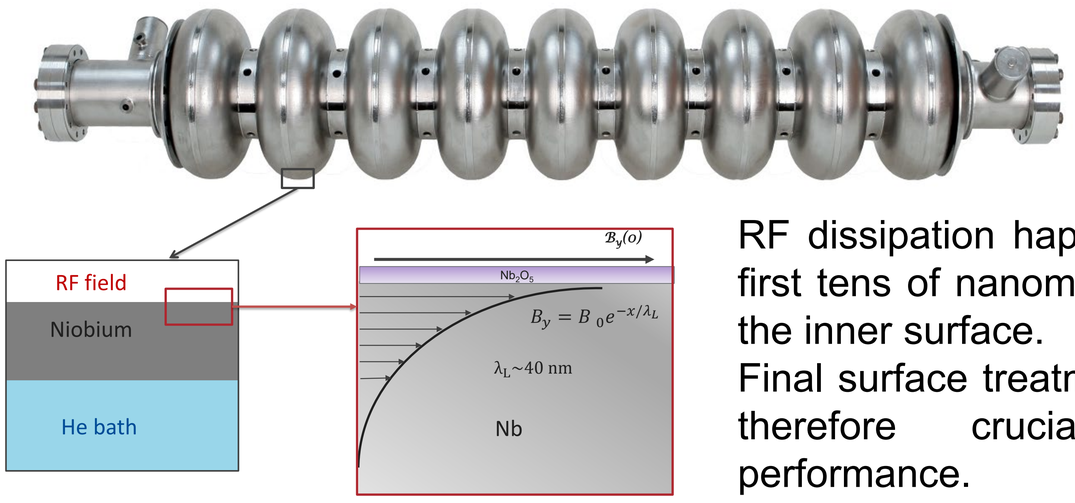
FERMILAB-POSTER-20-027-TD

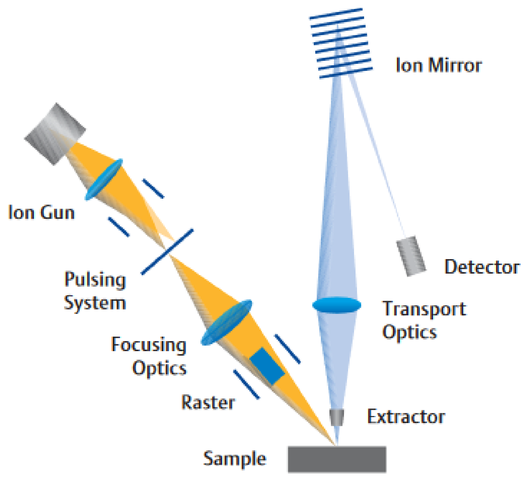
Tailoring impurity profile to maximize cavity performance

SRF Cavities Dissipation in Surface Nanometric Layer

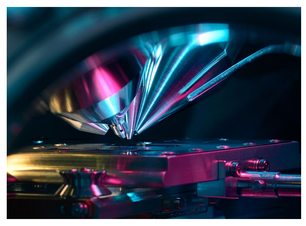


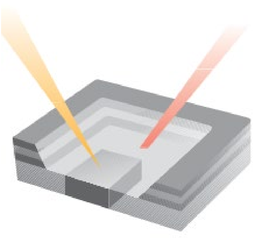
RF dissipation happen in first tens of nanometer of the inner surface.
Final surface treatment is therefore crucial to performance.

TOF-SIMS to perform detailed elemental analysis



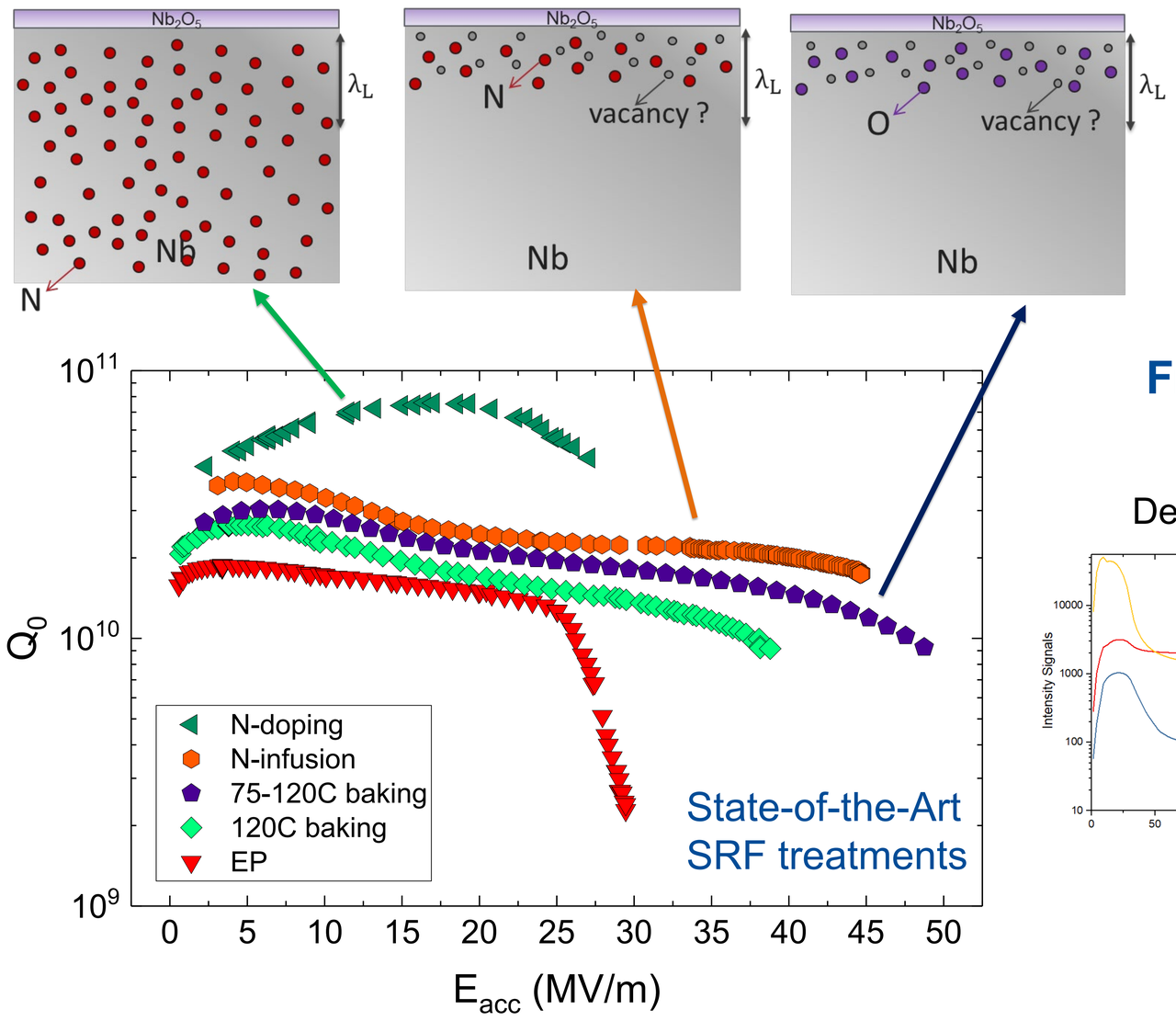
- An ion beam bombards the sample causing ions to be emitted from its surface;
- These ions are extracted and travel through the analysis column to reach the detector;
- The mass of the ions is calculated from their time-of-flights.



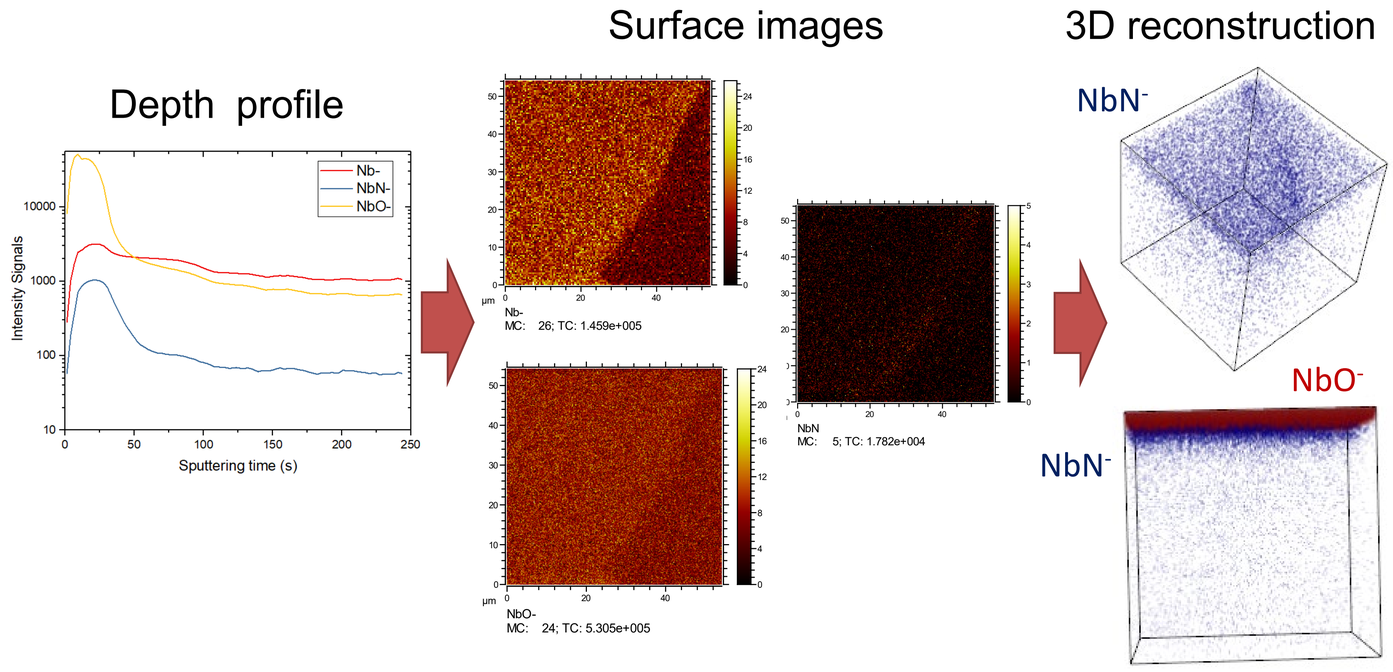


- A primary ion beam (O2 or Cs) provides elemental information of the outer monolayers → surface spectroscopy and surface imaging;
- Dual Beam Mode: the secondary beam is sputtering a crater, the primary beam is progressively analyzing the crater bottom → depth profiling and 3D imaging reconstruction.

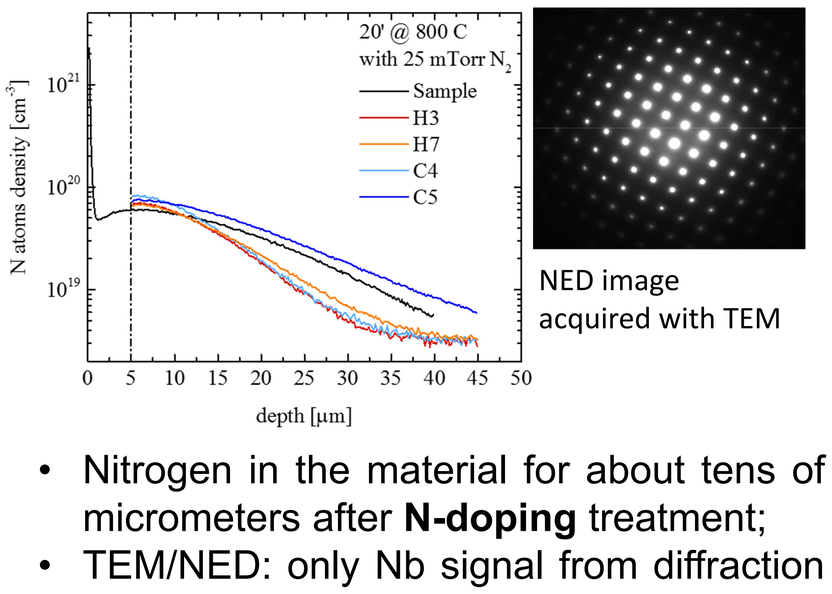
Impurity Content Defines SRF Performance



From depth profile to 3D reconstruction image

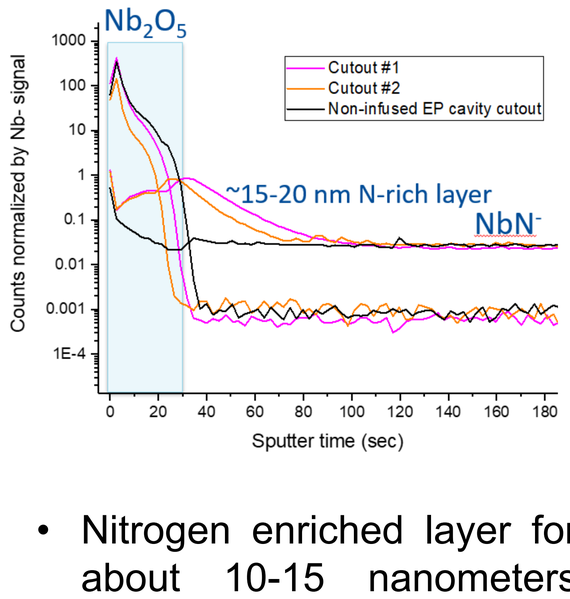


Examples of Progress in Understanding Enabled by SIMS Analysis

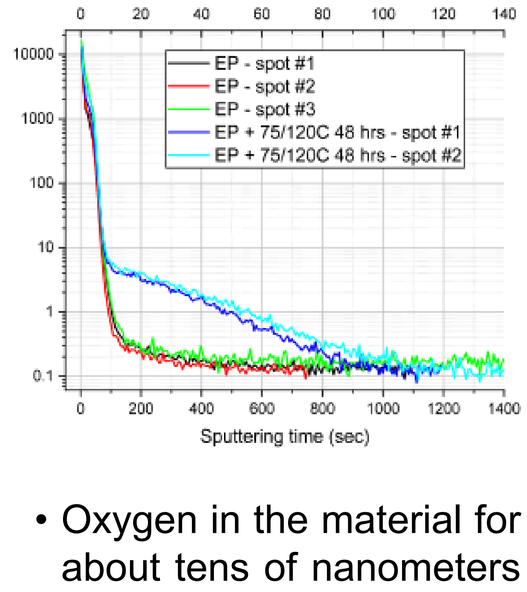


NED image acquired with TEM

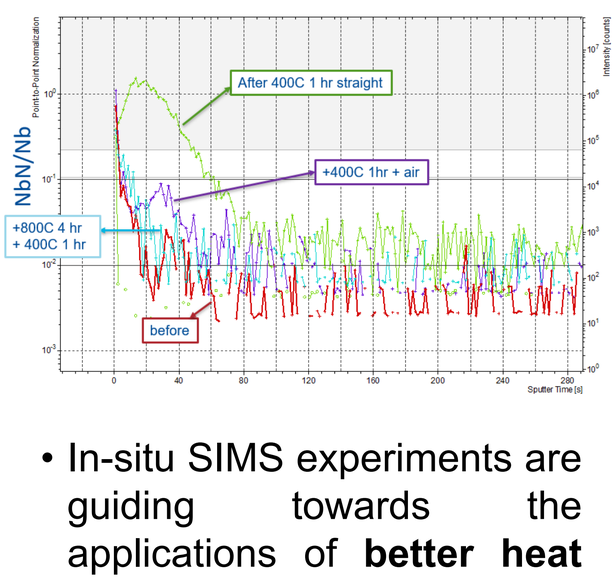
- Nitrogen in the material for about tens of micrometers after **N-doping** treatment;
- TEM/NED: only Nb signal from diffraction pattern;
- ➢ The two analysis together underline that N is interstitial after doping treatment!!



- Nitrogen enriched layer for about 10-15 nanometers below the oxide in **N-infused cavities cut-outs**.



- Oxygen in the material for about tens of nanometers in **low-T baked cavity cut-outs**.



- In-situ SIMS experiments are guiding towards the applications of **better heat treatments** that lead to SRF cavities with improved performance

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