MgB_2 and CED Nb Films

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LA-UR-11-12190

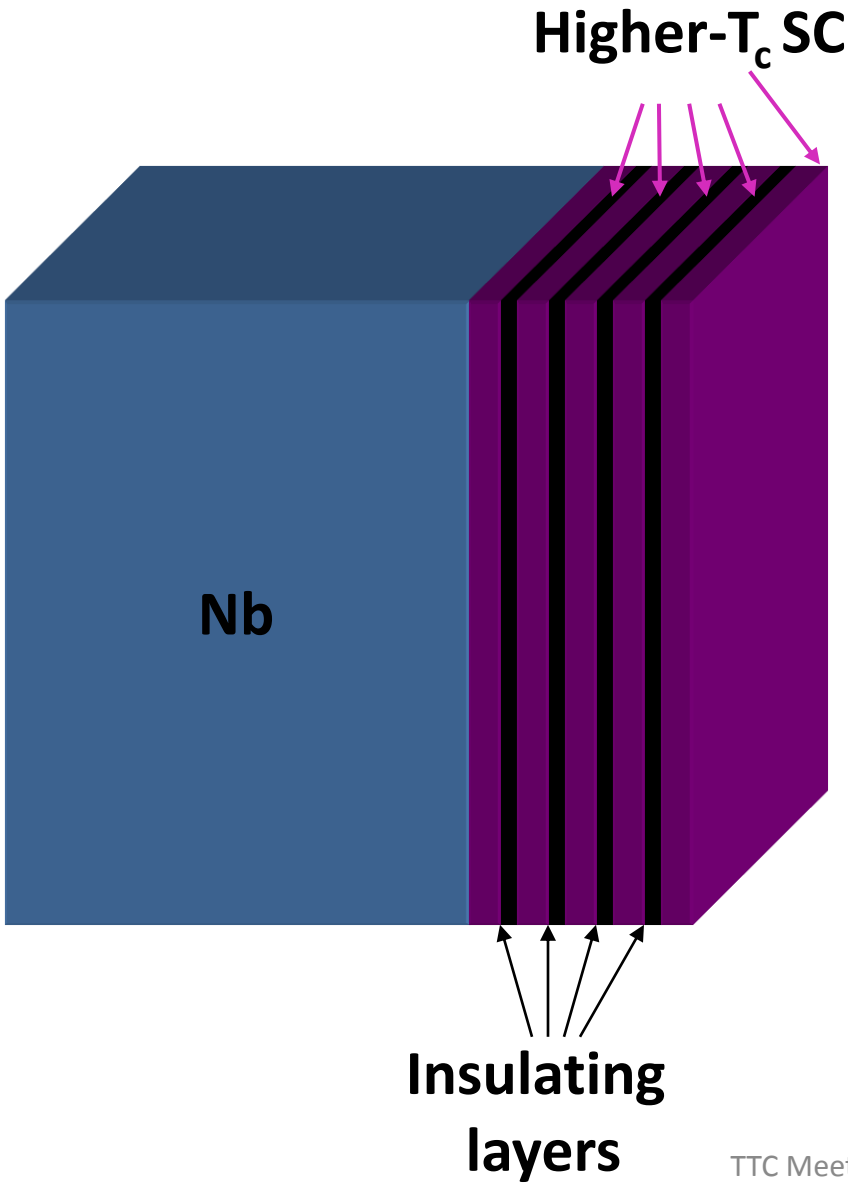
Outline

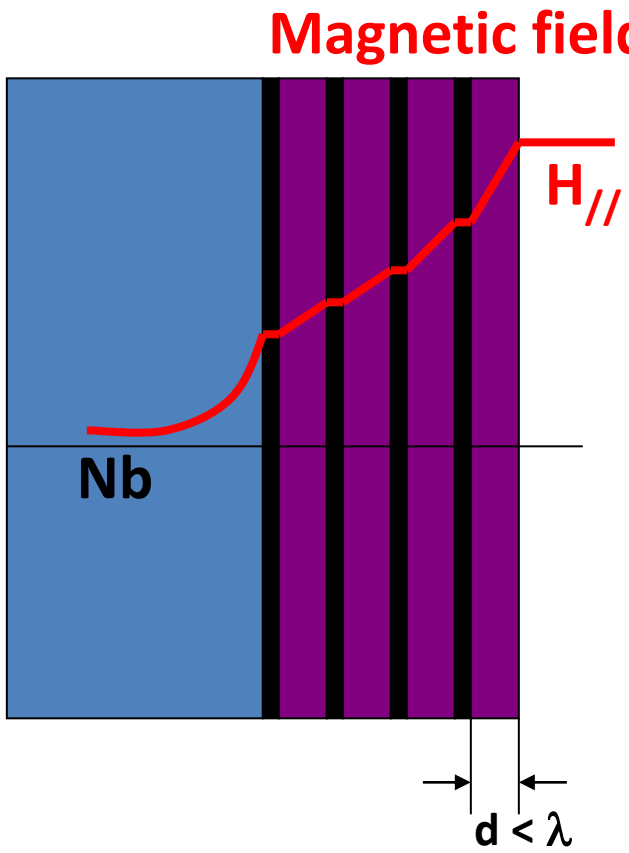
- Today, we will focus on new results after SRF2011, Chicago, 25-29 July 2011
- New MgB_2 results (Tsuyoshi)
- New results on Nb films deposited with Coaxial Energetic Deposition (CED), a variant of cathodic arc deposition, by Alameda Applied Sciences Corporation (AASC) (Tsuyoshi)

Many thanks to our co-investigators and collaborators!

- LANL
  - Roland Schulze, MST-6 (surface analyses)
  - Dave Devlin, MST-7 (coating)
  - Marilyn Hawley, MST-7 (AFM, STM, etc.)
  - Nestor Haberkorn, MPA-STC (superconducting properties measurements)
  - Leonardo Civale, MPA-STC (theory and superconducting properties measurements)
  - Eric Olivas, AOT-MDE (mechanical and thermal simulations)
- Superconductor Technologies, Inc. (STI), California, USA
  - Brian Moeckly and Chris Yung (MgB_2 coating)
- Temple University
  - Xiaoxing Xi, Chenggang Zhuang and Teng Tan (MgB_2 coating)
- Alameda Applied Sciences Corporation, California, USA
  - Mahadevan Krishnan, Enrique Valderrama and Colt James (CED Nb and Nb_3Sn coatings)
- KEK
  - Hitoshi Inoue, Mechanical Engineering Center (sample preparations, vacuum baking, etc.)
  - Yasuo Higashi, Mechanical Engineering Center (preparation of copper substrates for CED coating)
- NIMS (National Institute for Materials Science, Tsukuba)
  - Akiyoshi Matsumoto, Eiichiro Watanabe (dielectric coatings and surface analyses)

Encouraged by Gurevich's multilayer idea [1, 2], thin film SC materials have been studied





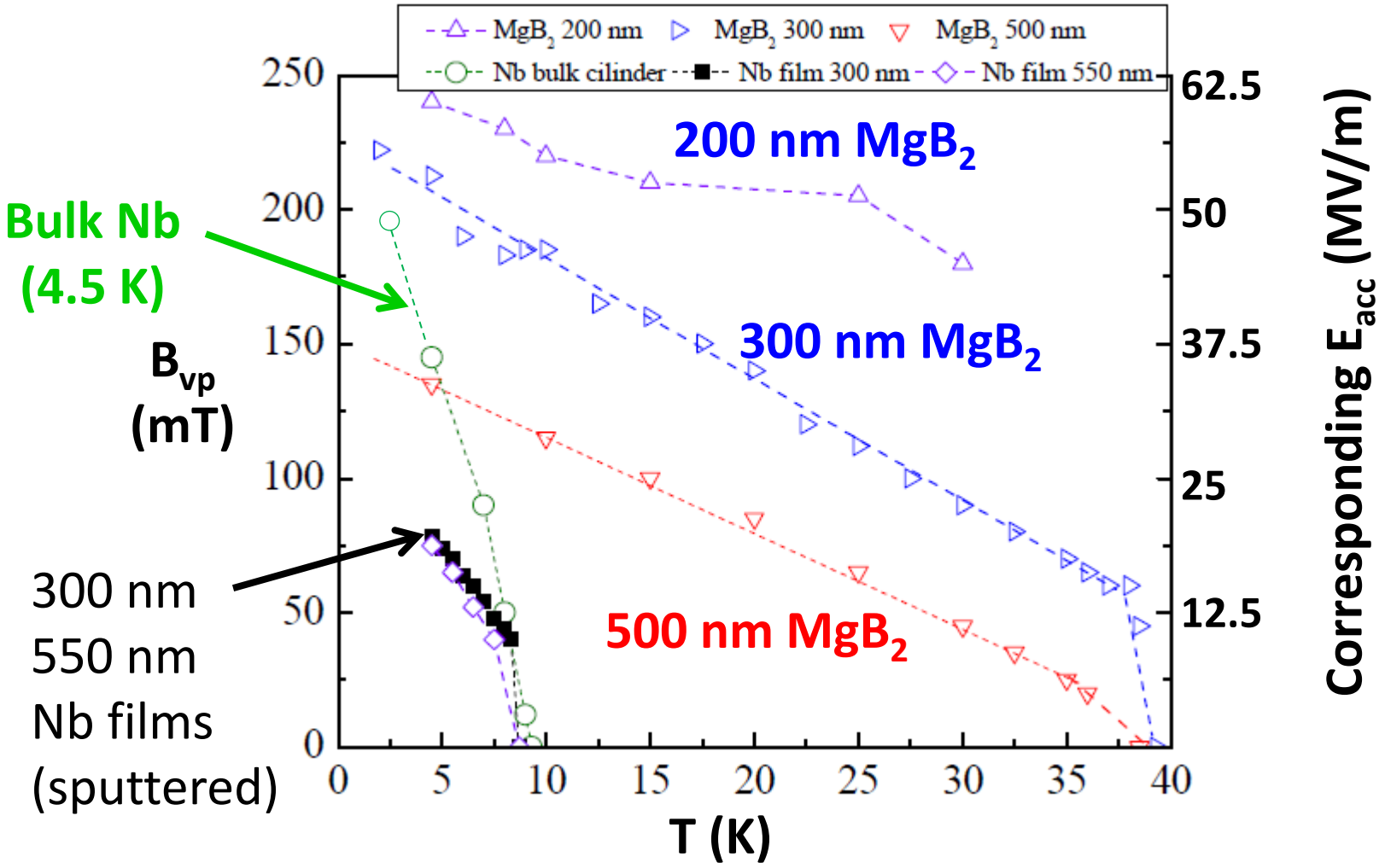
[1] A. Gurevich, APL **88** (2006) 012511

[2] A. Gurevich, SRF Materials Workshop, FNAL, 23-24 May 2007

Fundamental limit of thin-film MgB_2 has been measured to be significantly higher than that of Nb

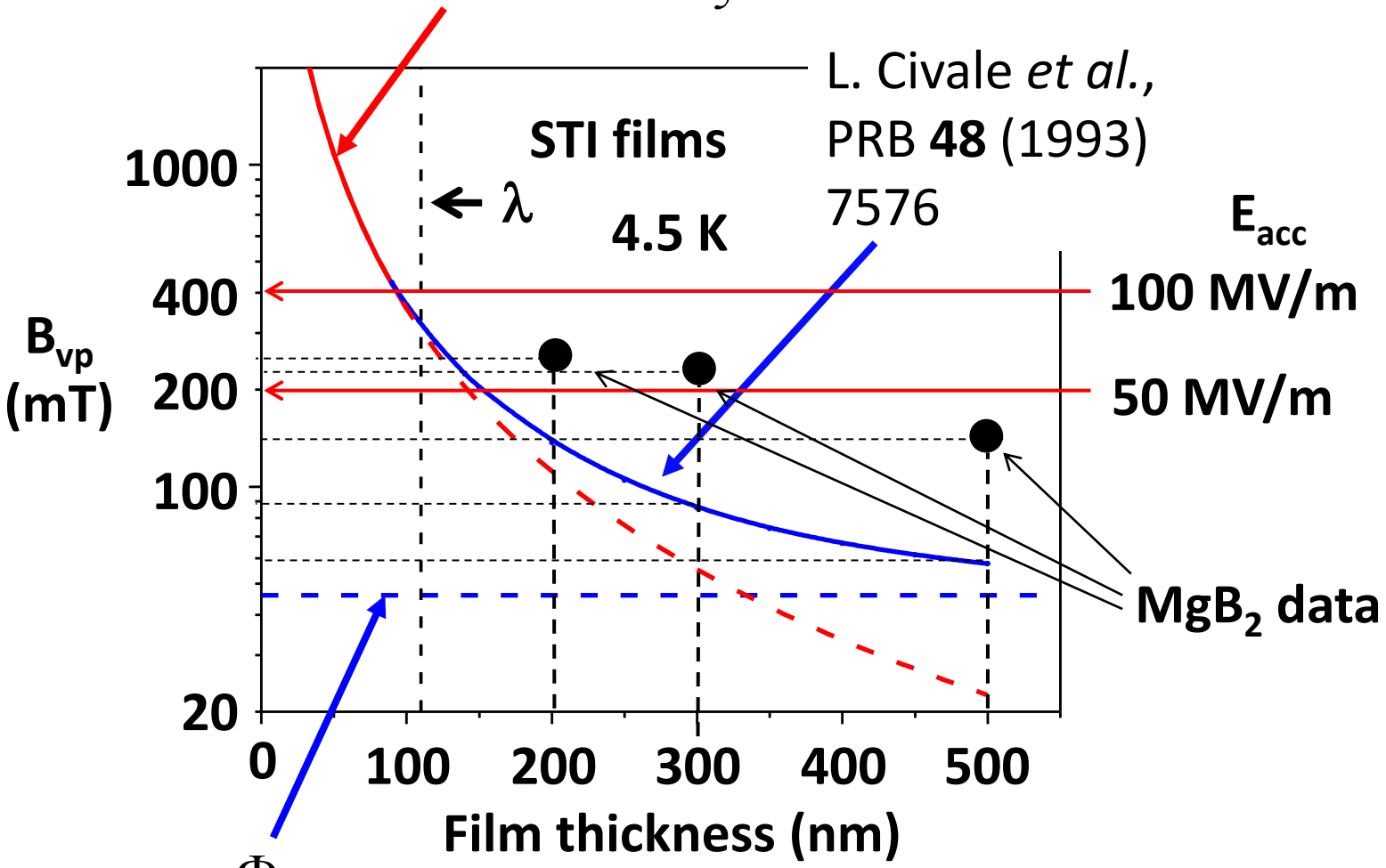
- It has been said that thin films thinner than its magnetic penetration depth (λ) posses higher vortex penetration field (B_{vp})
- So, we thought 500 nm or 300 nm films would not show any increase of B_{vp} with $\lambda \sim 110$ nm.
- However, we found that they show considerably higher B_{vp} than that of bulk B_{vp}

DC magnetization measurement results: MgB_2 thin films (<500 nm) prepared by STI show higher B_{vp} than that of Nb



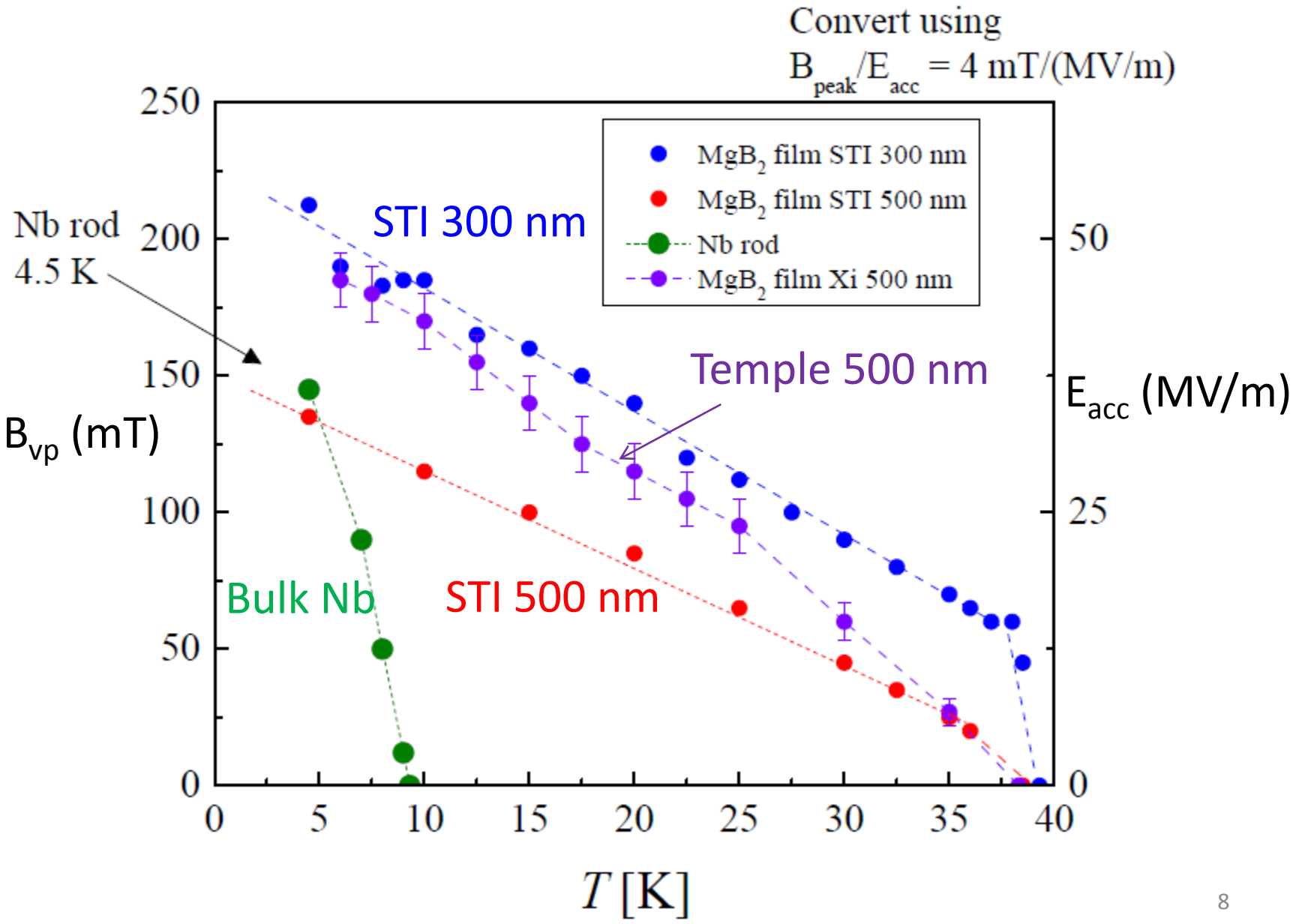
Measured B_{vp} were higher than expected B_{c1} (λ=110 nm, ξ=6 nm)

$$H_{c1}(d << \lambda) \approx \frac{2\Phi_0}{\pi d^2} \ln \frac{d}{\tilde{\xi}}$$ Gurevich, APL **88** (2006) 012511



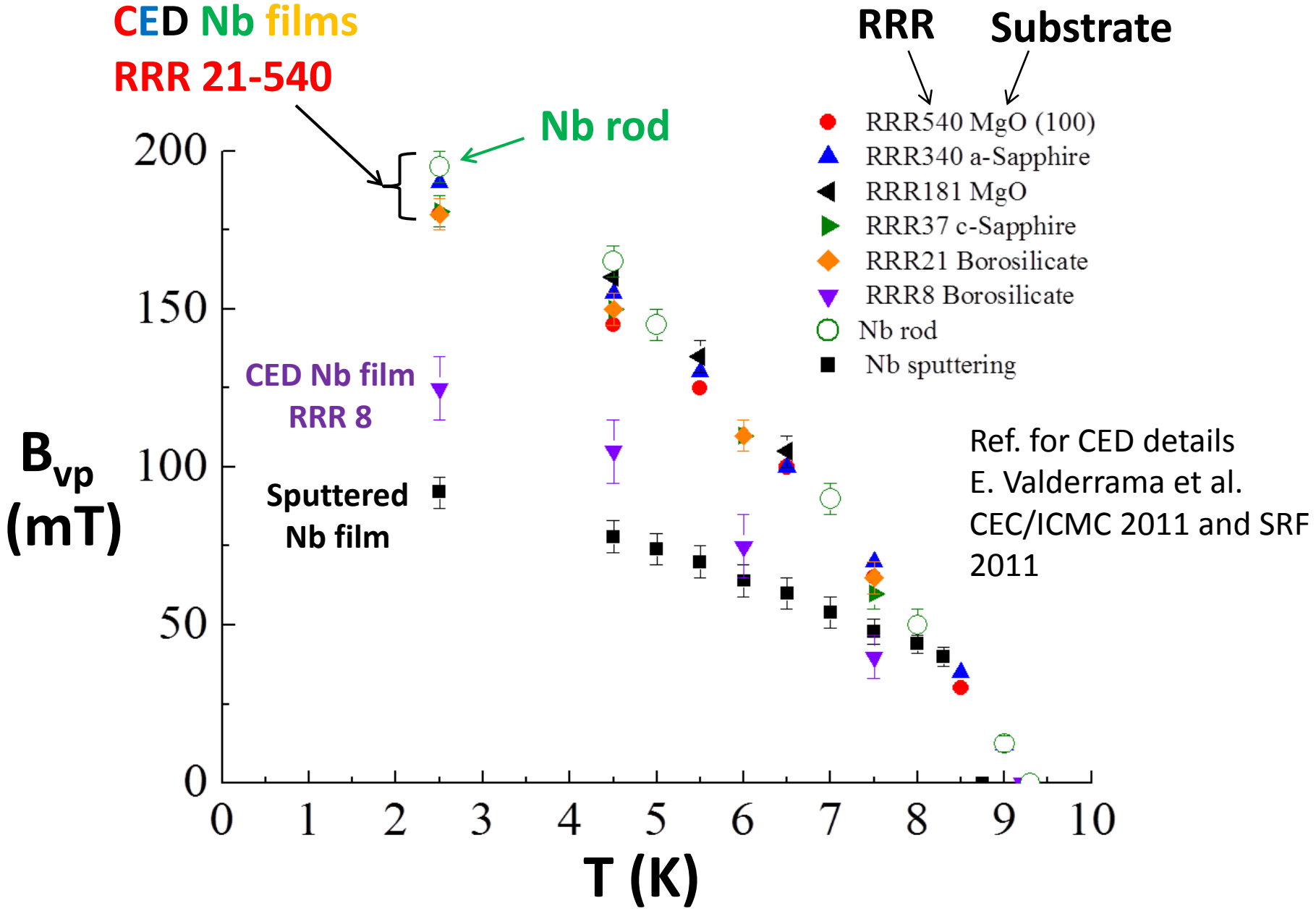
$$H_{c1}(d >> \lambda) = \frac{\Phi_0}{4\pi\lambda^2} \ln \kappa \sim$$ **46 mT**

Temple University (X. Xi) samples prepared with hybrid physical chemical vapor deposition (HPCVD) compared with STI samples



News on thick (a few μm) Nb films

- Nb films have been considered to be inferior to high-purity bulk Nb at high gradient due to strong Q_0 drop with higher fields.
- Sputtered films have shown B_{vp} about half of bulk Nb
- However, when we measured B_{vp} of some Nb films prepared by Coaxial Energetic Deposition (®CED at Alameda Applied Sciences Corporation in California), we found that most samples show as high B_{vp} as bulk Nb! This implies that we can fabricate high-gradient SRF cavities with Nb coated on a cheaper material such as Copper (about x100 cheaper than Nb).



CED Nb on Cu at 300 °C has also shown B_{vp} ~ 170 mT at 2.5 K so far.