Everything you always wanted to know and never dared to ask about Nitrogen infusion

Outline

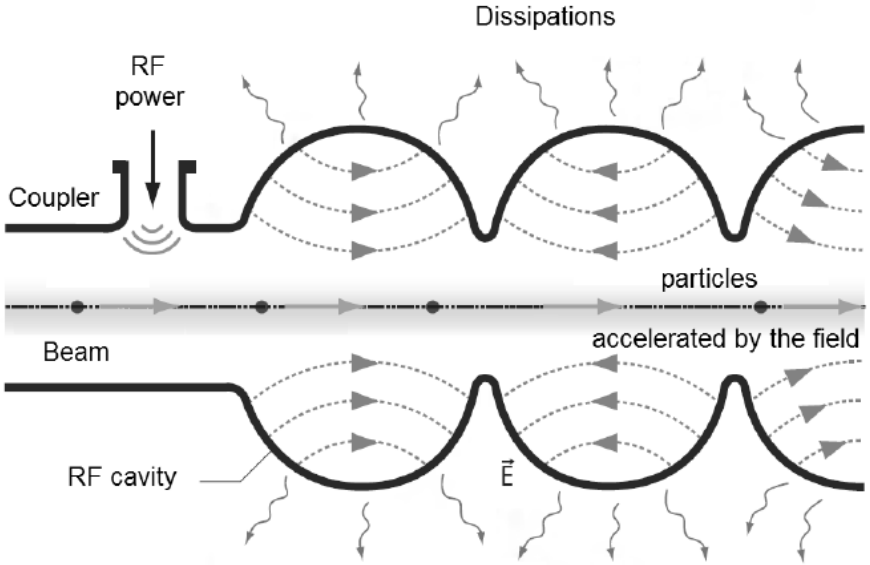
1. Reminder of SRF
2. “Path to Nitrogen treatment”
3. Nitrogen Doping
4. Nitrogen Infusion
5. Summary

Marc Wenskat (FLA)
ILC@DESY Seminar
10.02.2017

HELMHOLTZ ASSOCIATION

DESY

Superconducting TESLA Cavities



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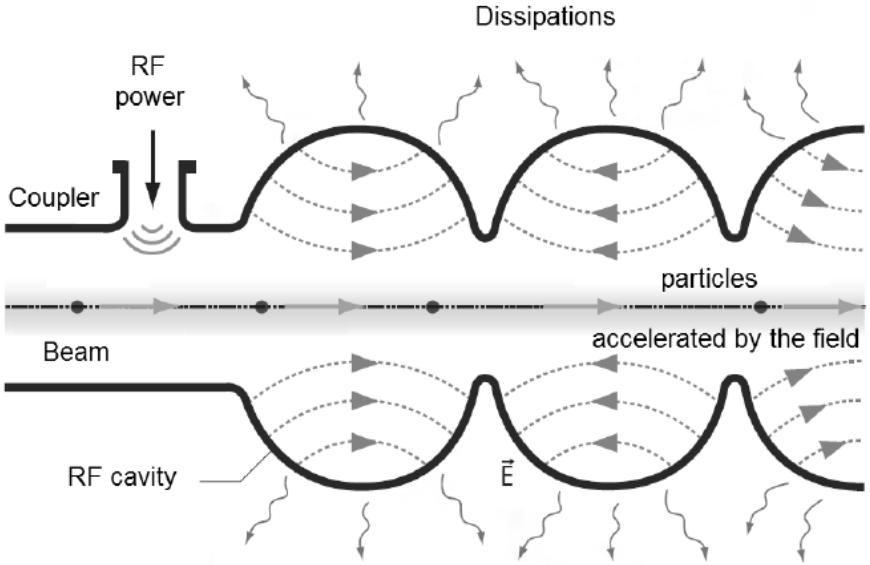

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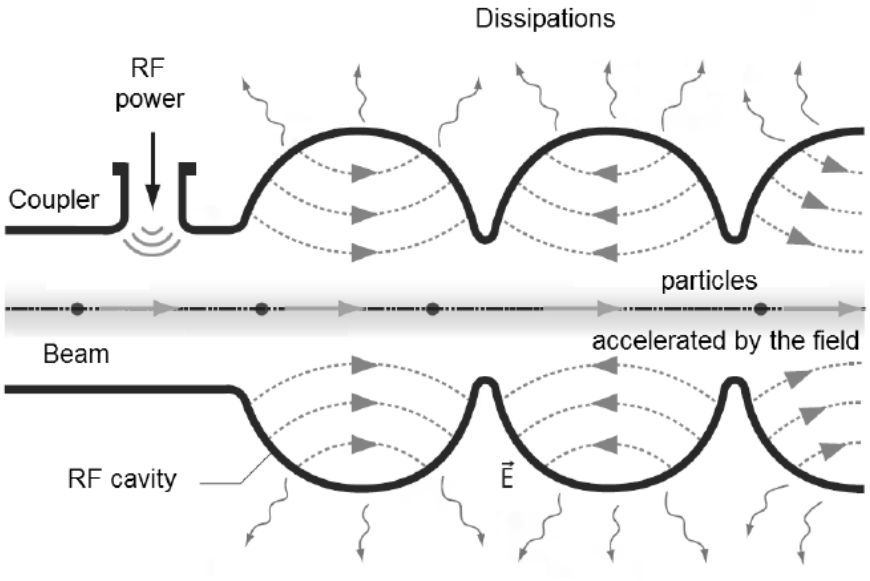

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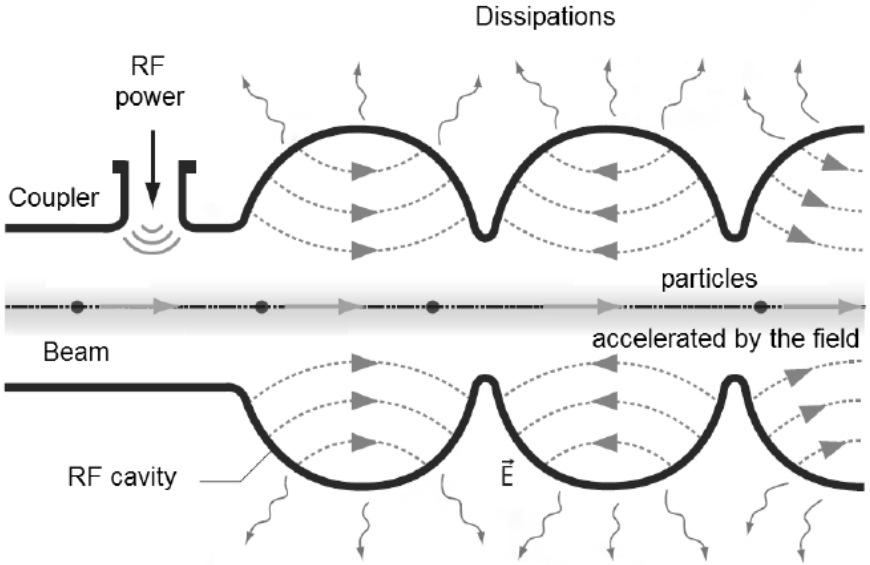

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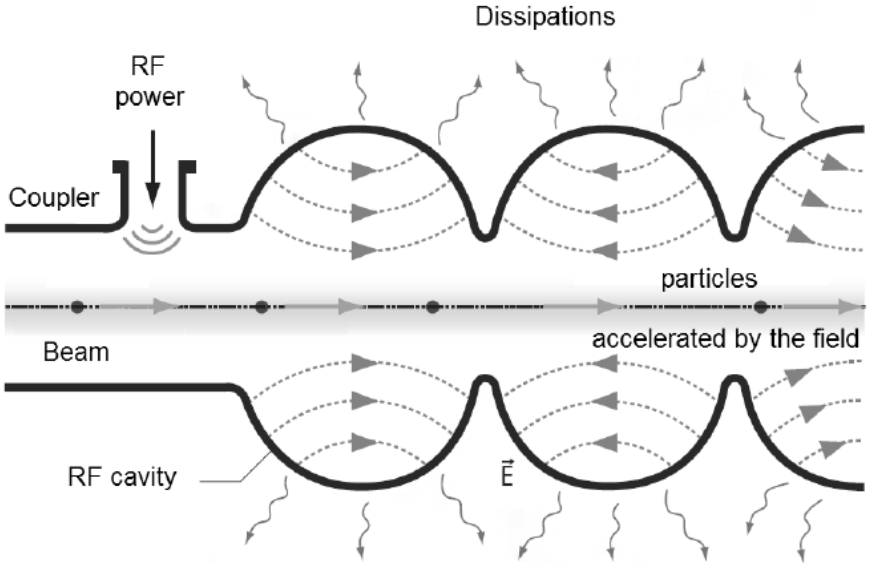

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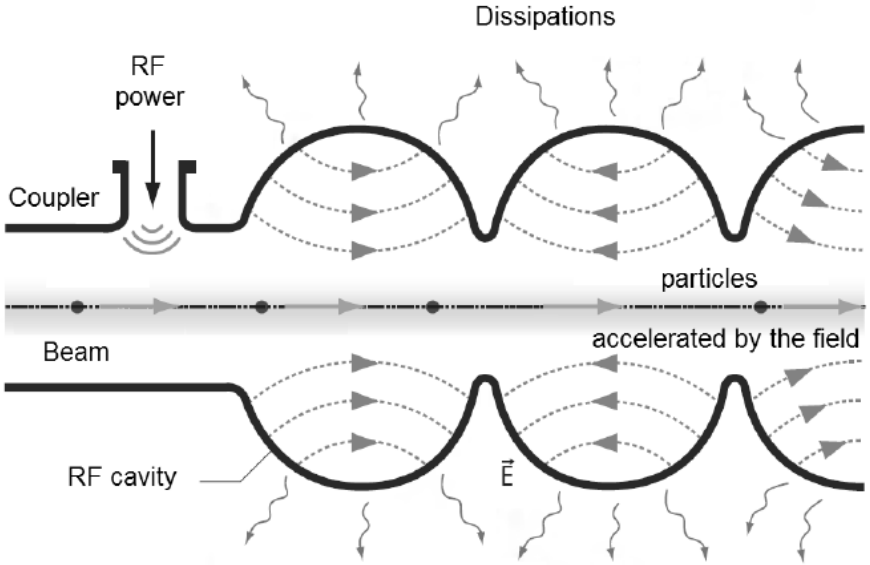

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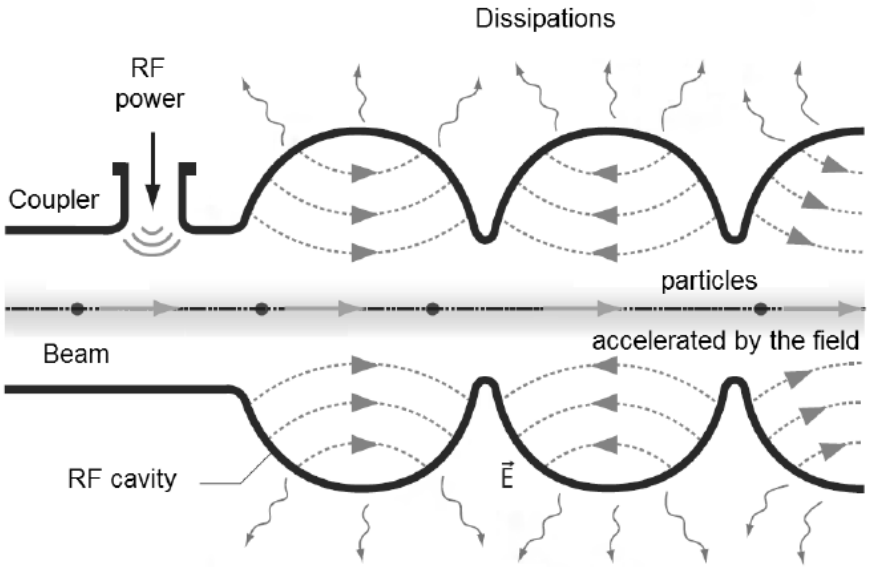

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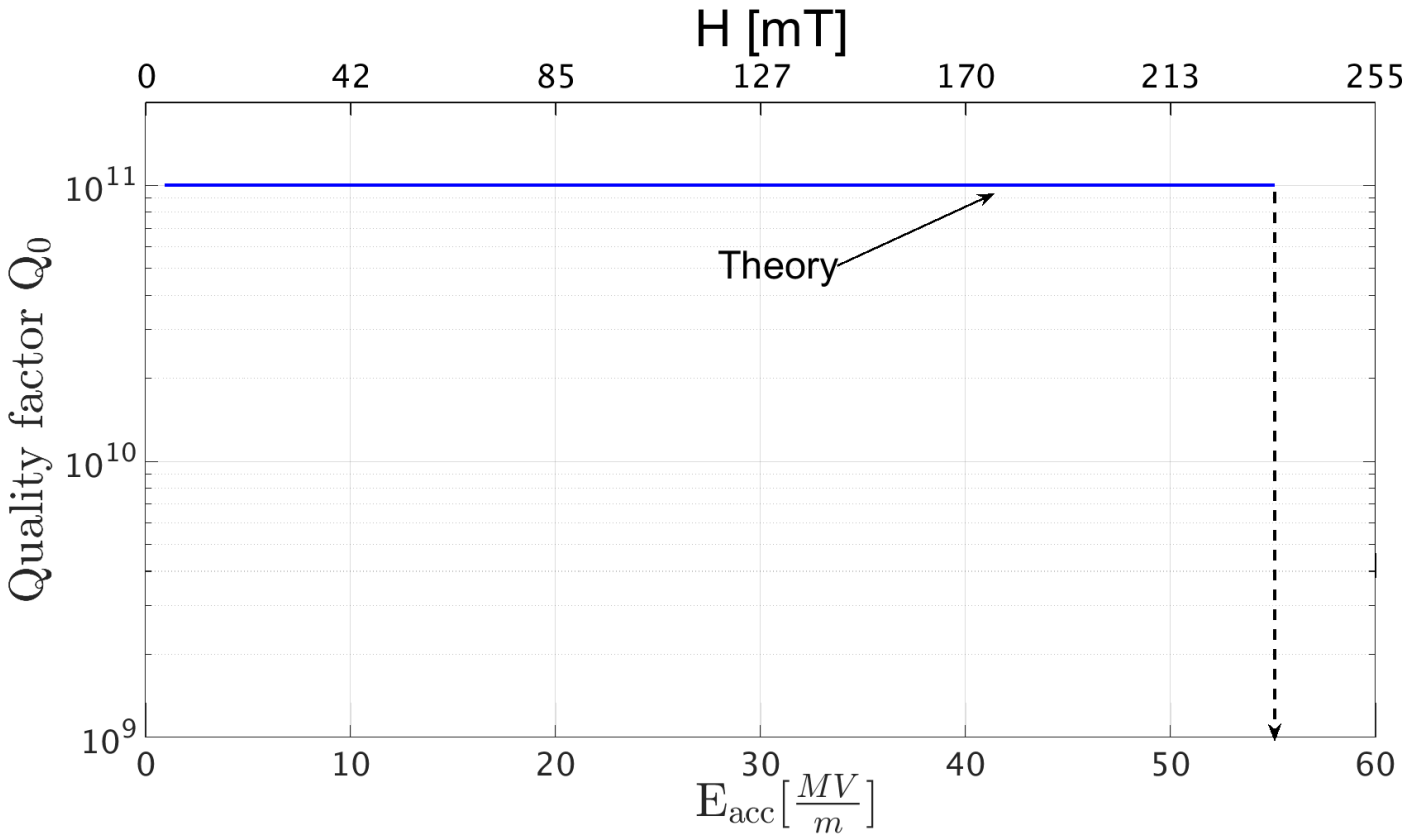
The “Q vs. E” curve



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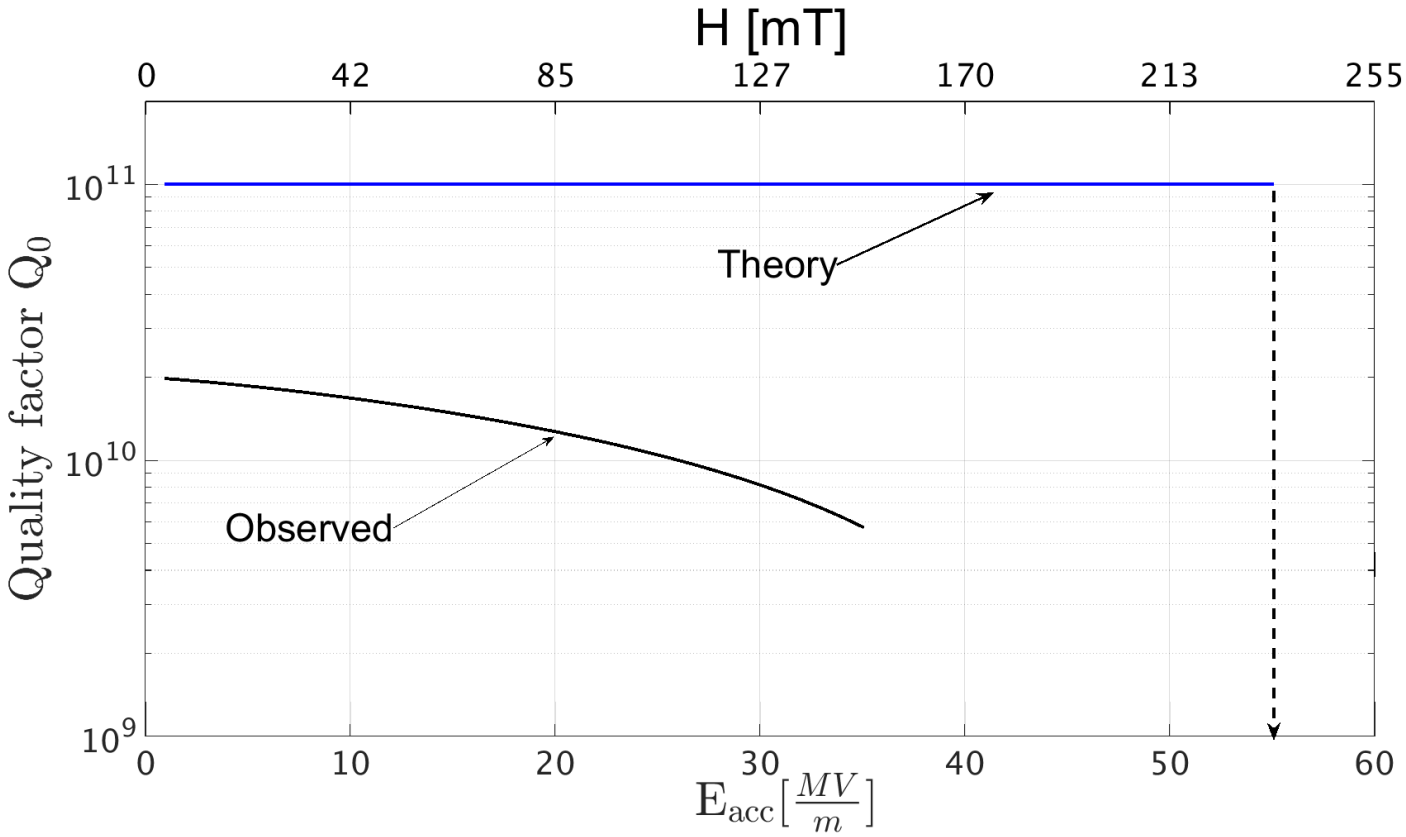
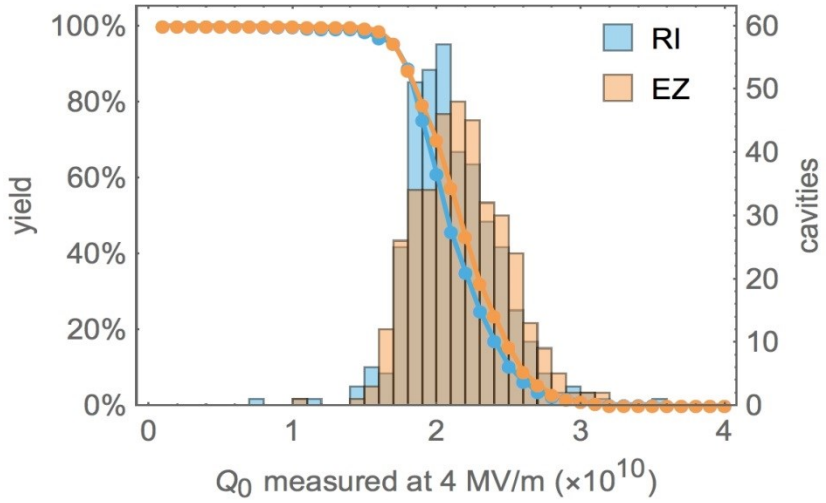


European XFEL Cavities - R_s



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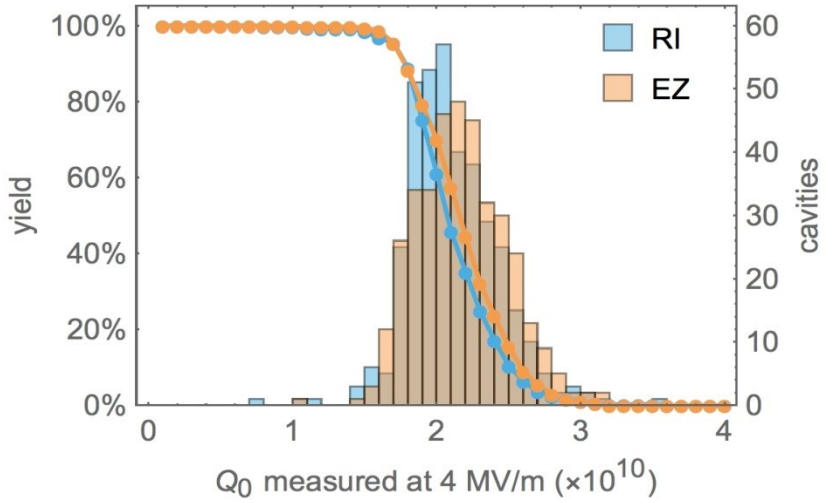

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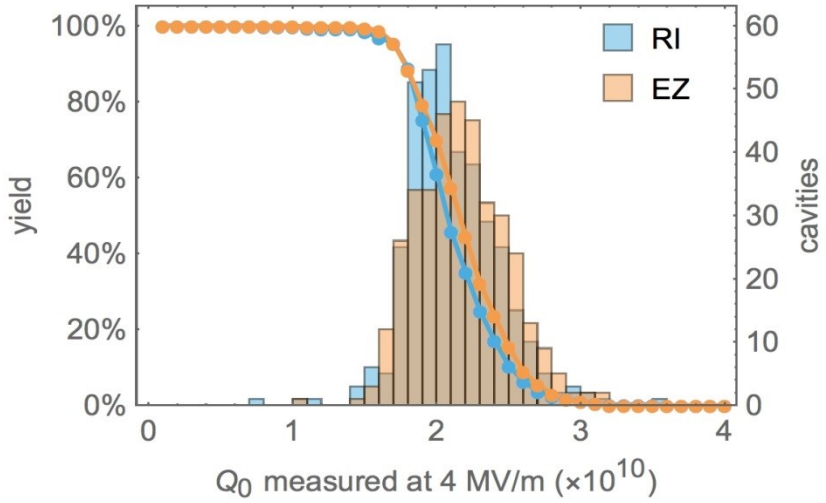

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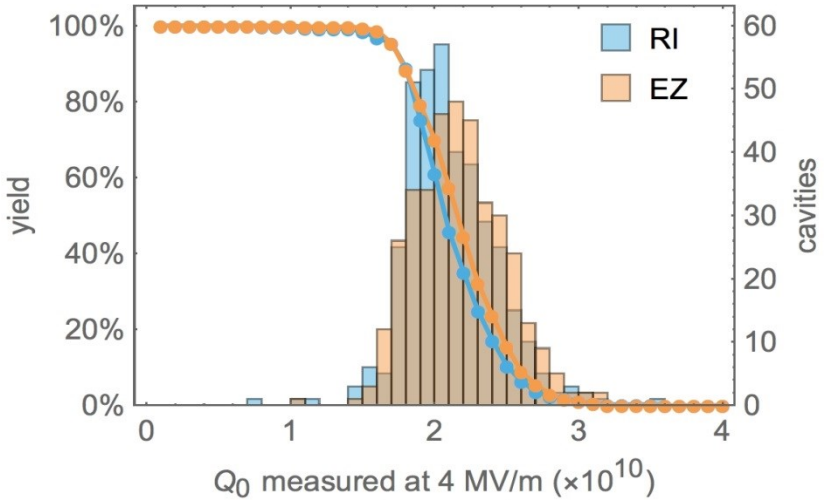

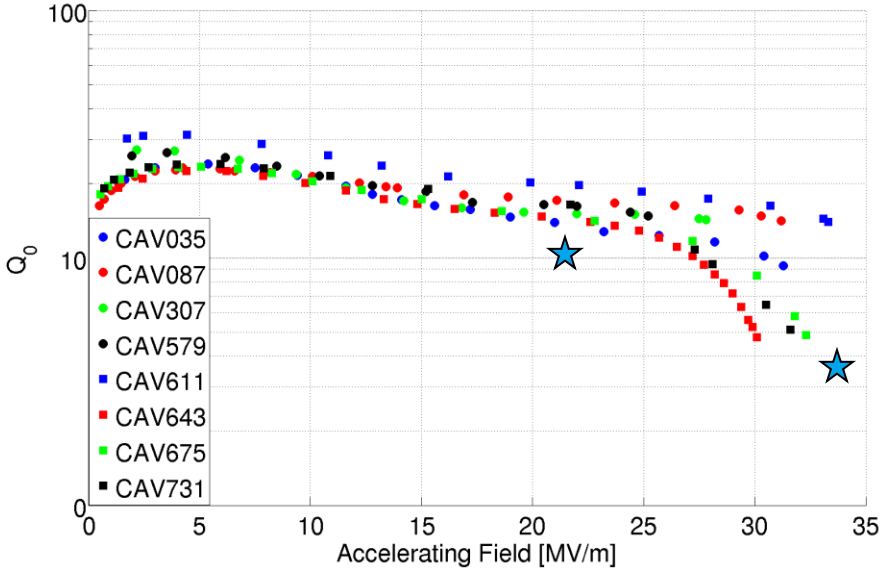

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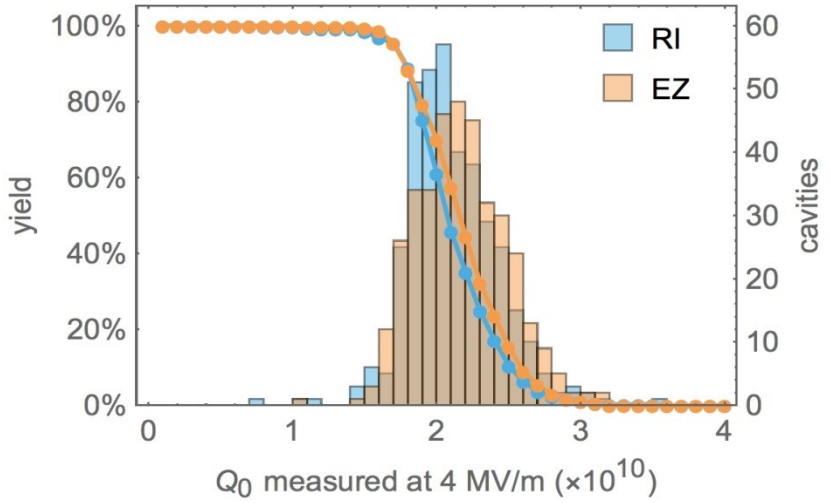

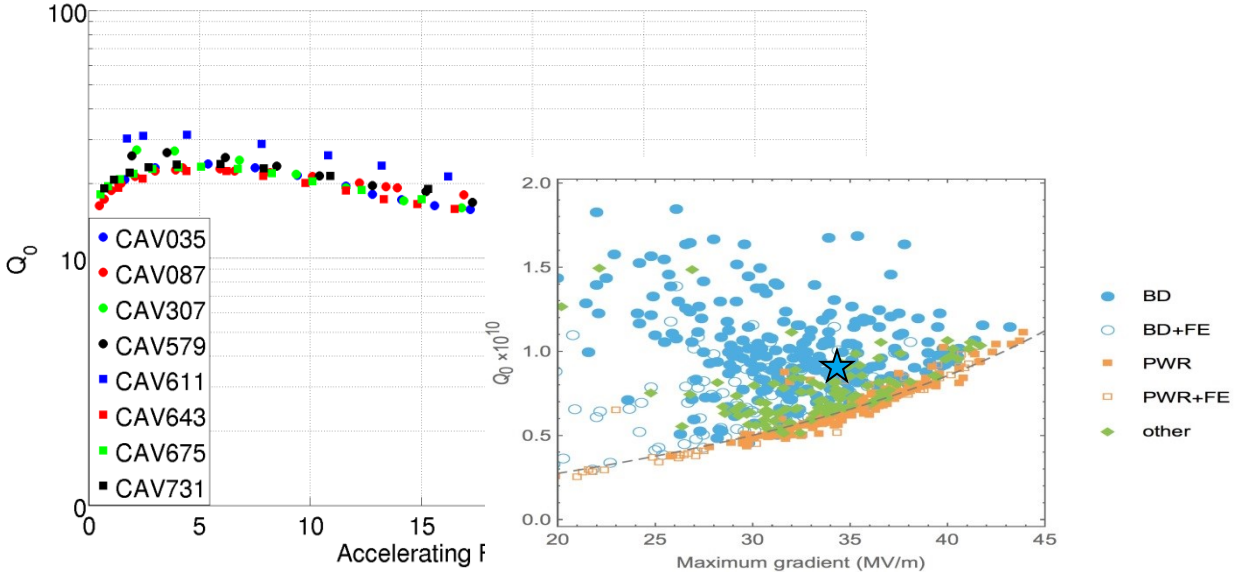

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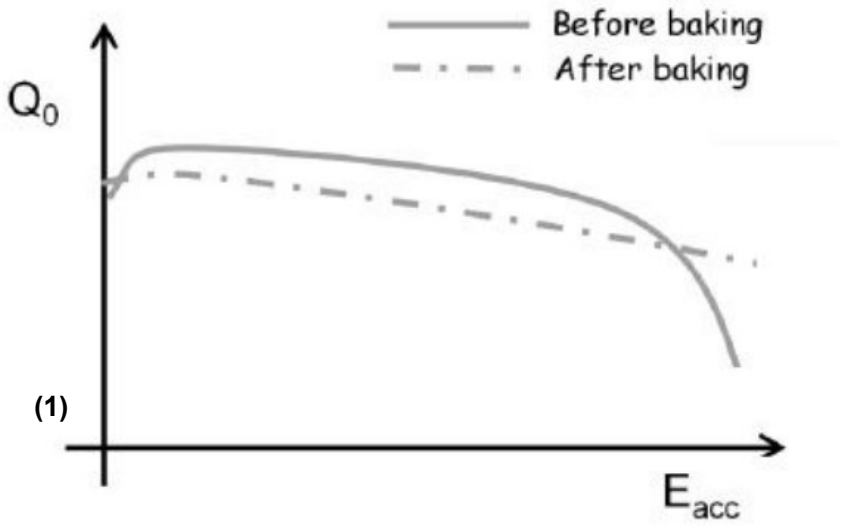

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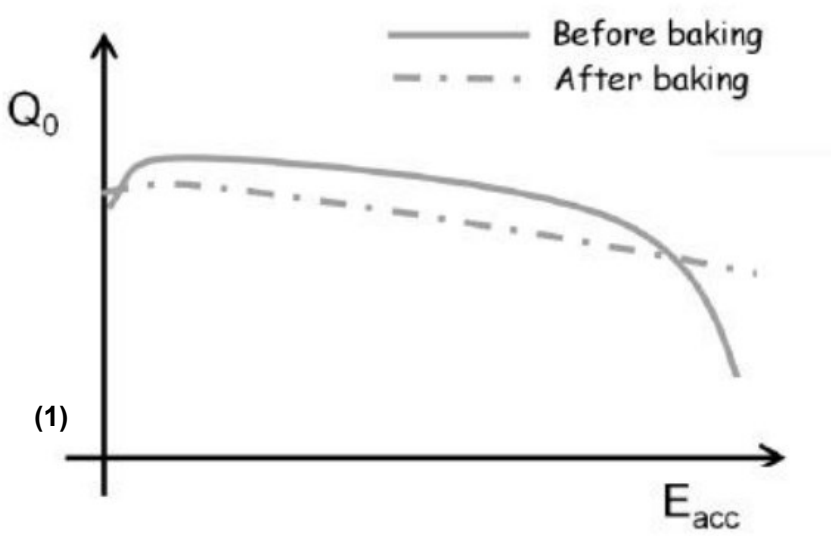

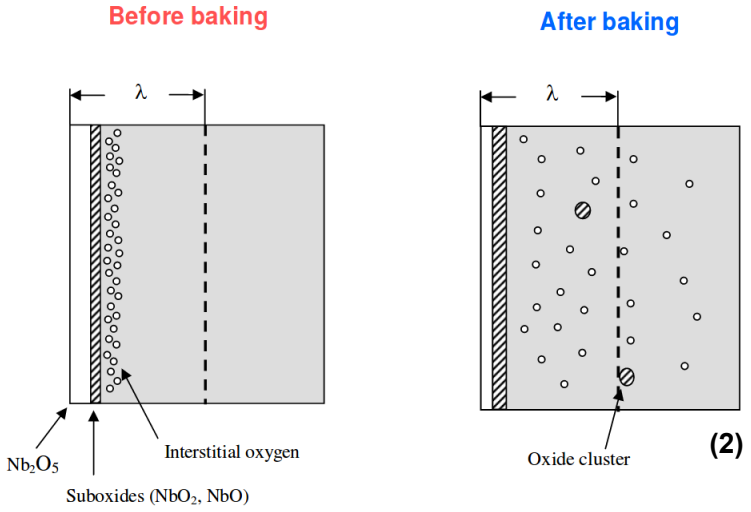

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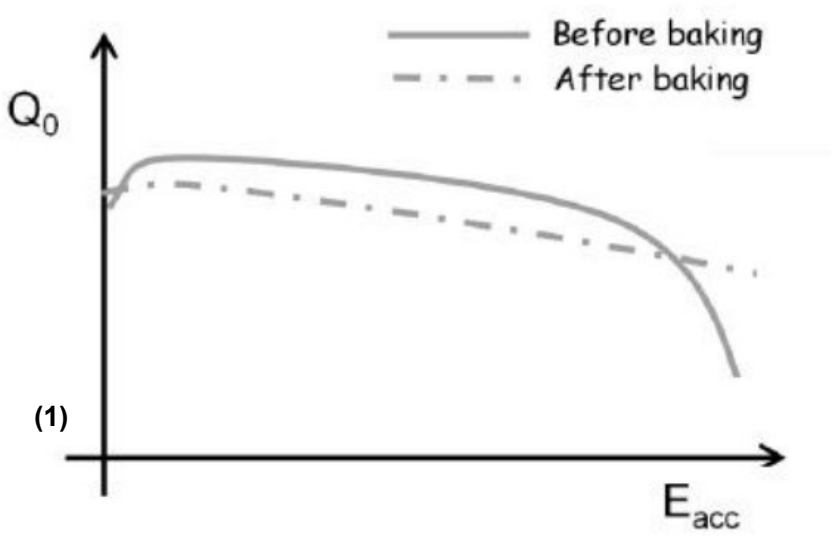

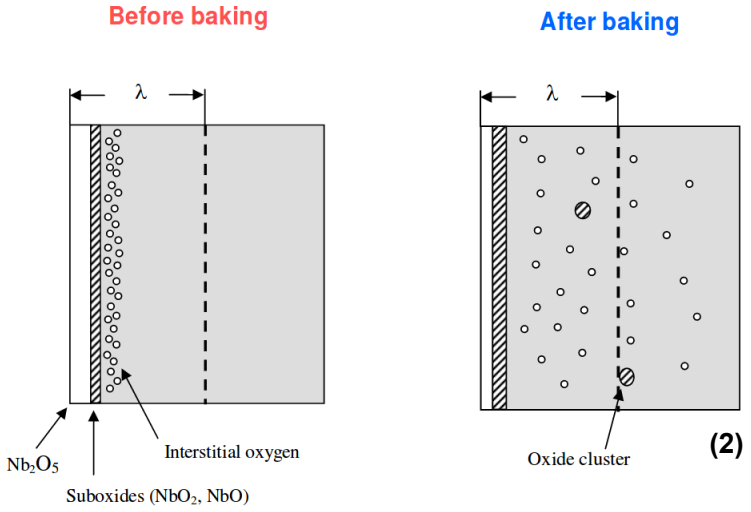

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Baking has an influence on rf performance

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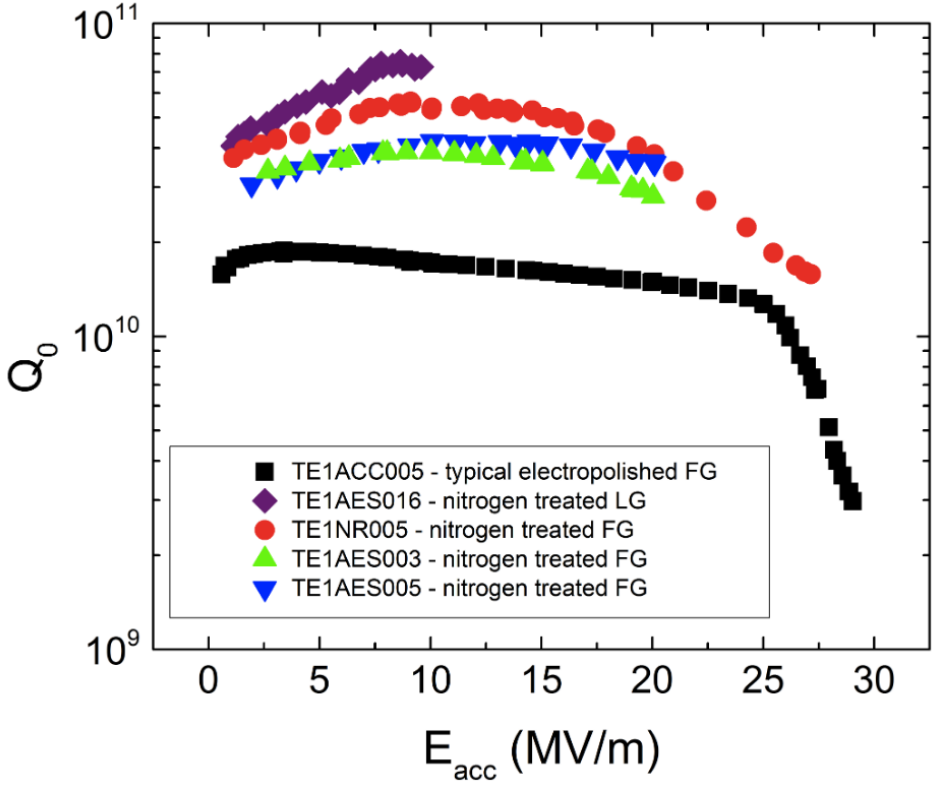

Doping Recipe

[P. Bishop et al., “LCLS-II SRF Cavity Processing Protocol Development and Baseline Cavity Performance Demonstration”, Proc. SRF2015]

Doping Recipe

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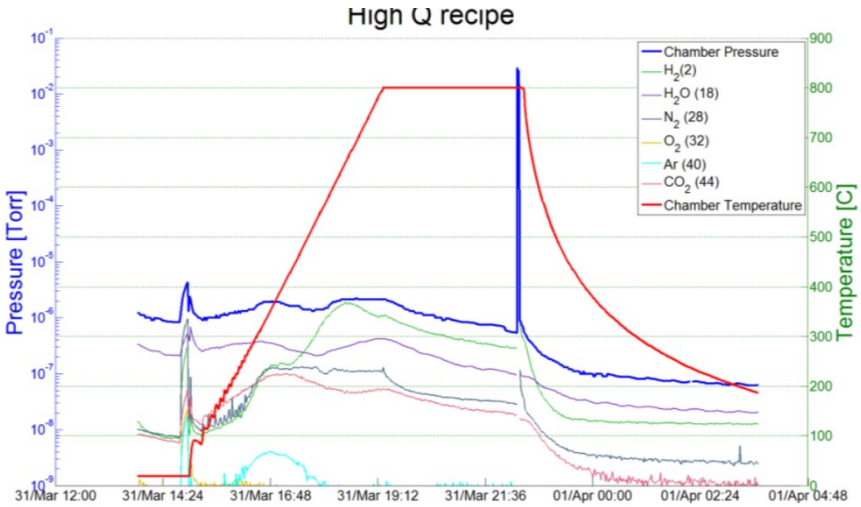

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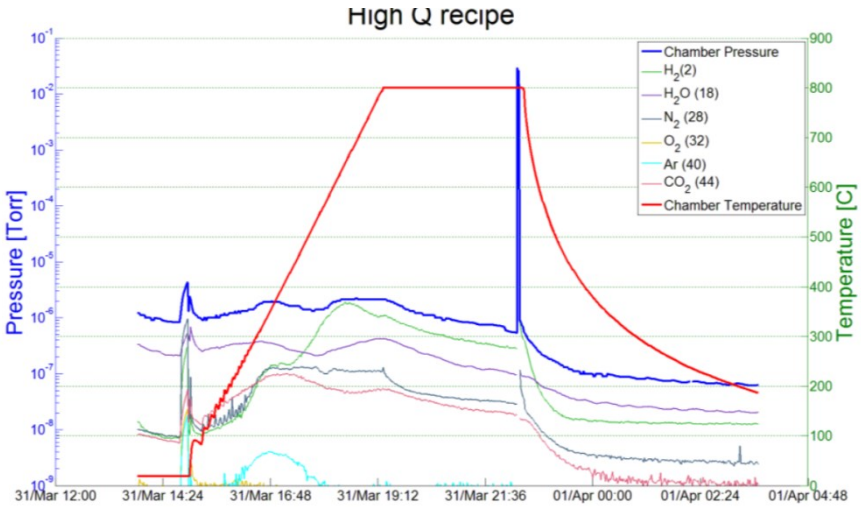

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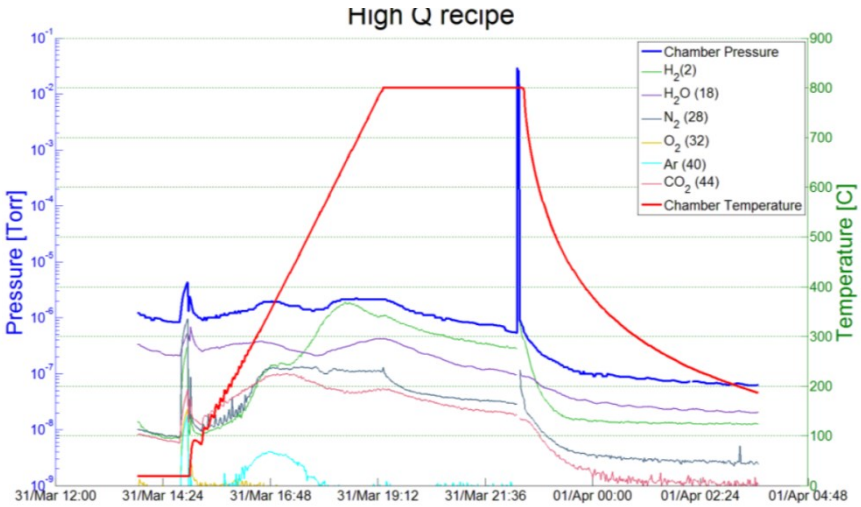

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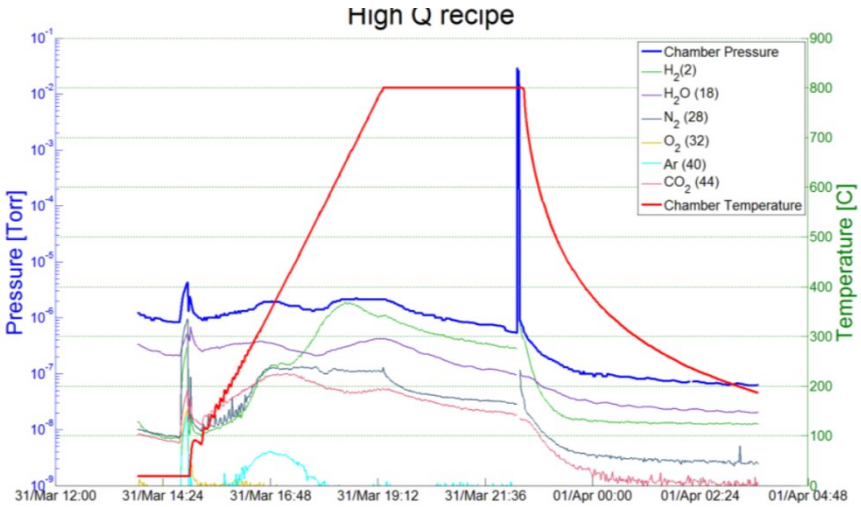

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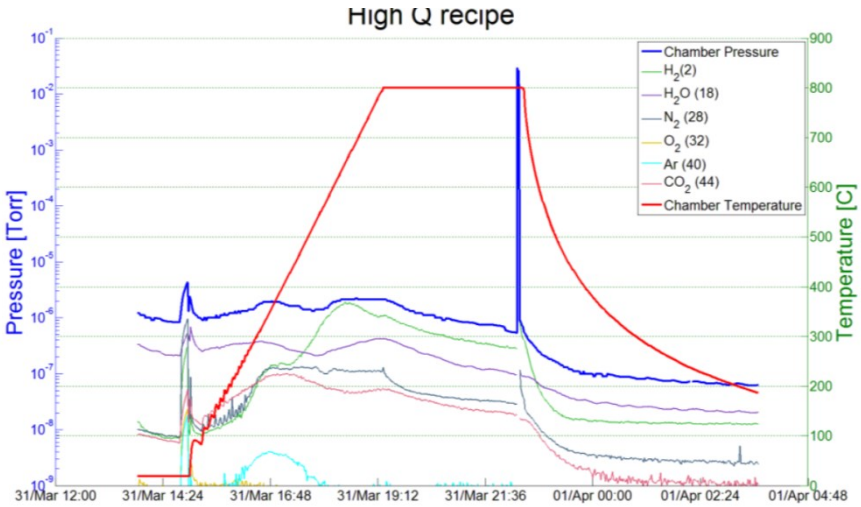

- 800C – 3h
- 2min @ 800C + 25mTorr N2
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- Cool down

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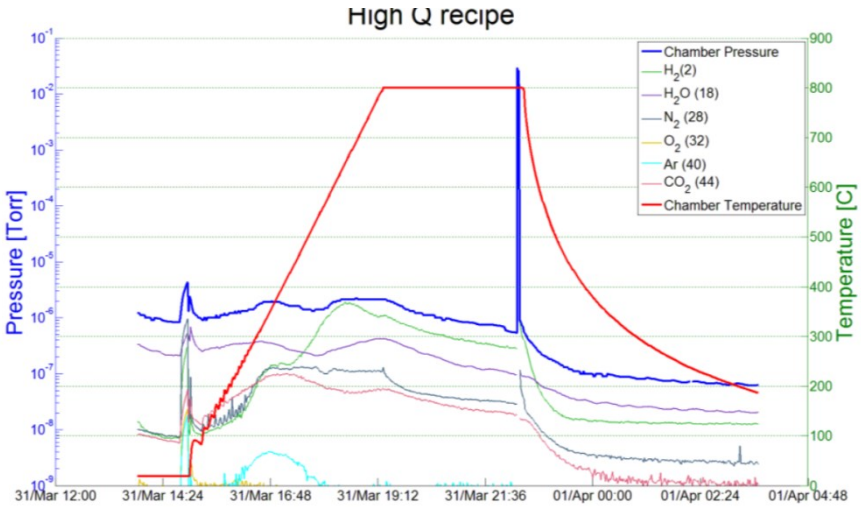

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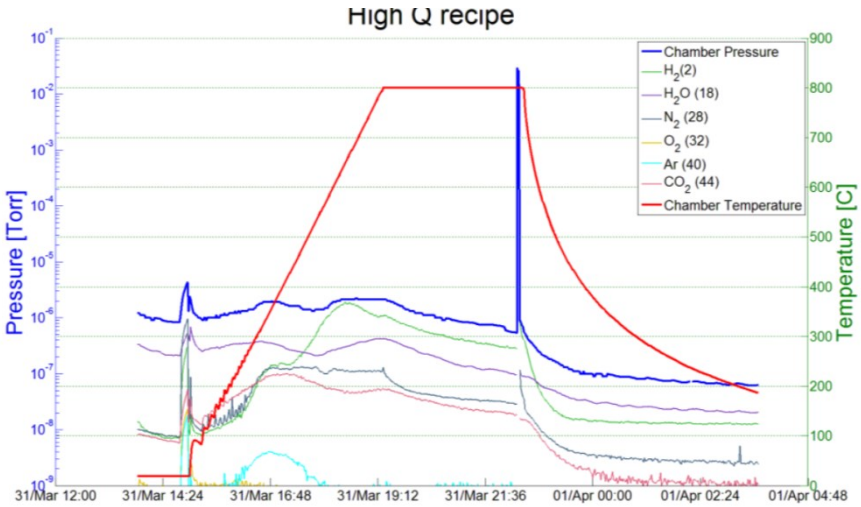

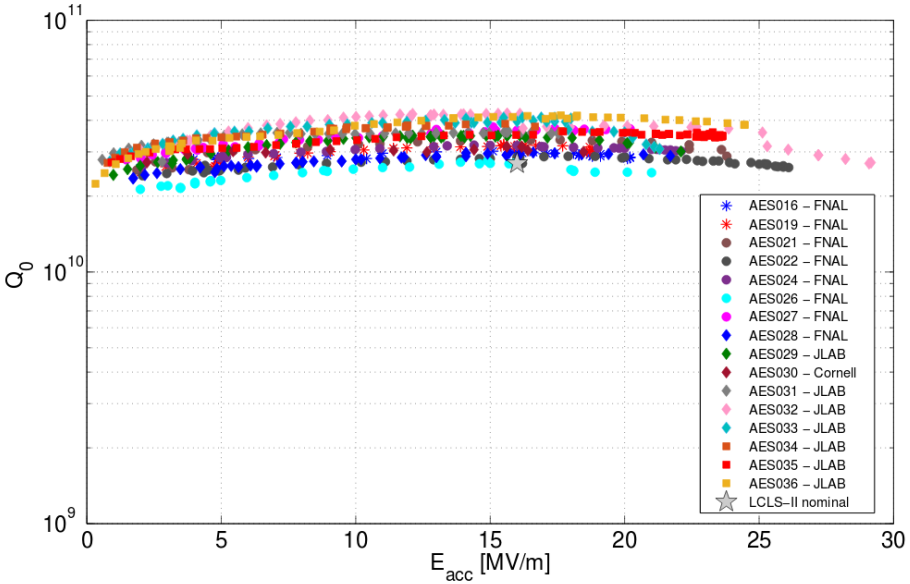

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What is happening?

[Y. Trenikhina et al., J. of Appl. Phys., 117, 154507 (2015)

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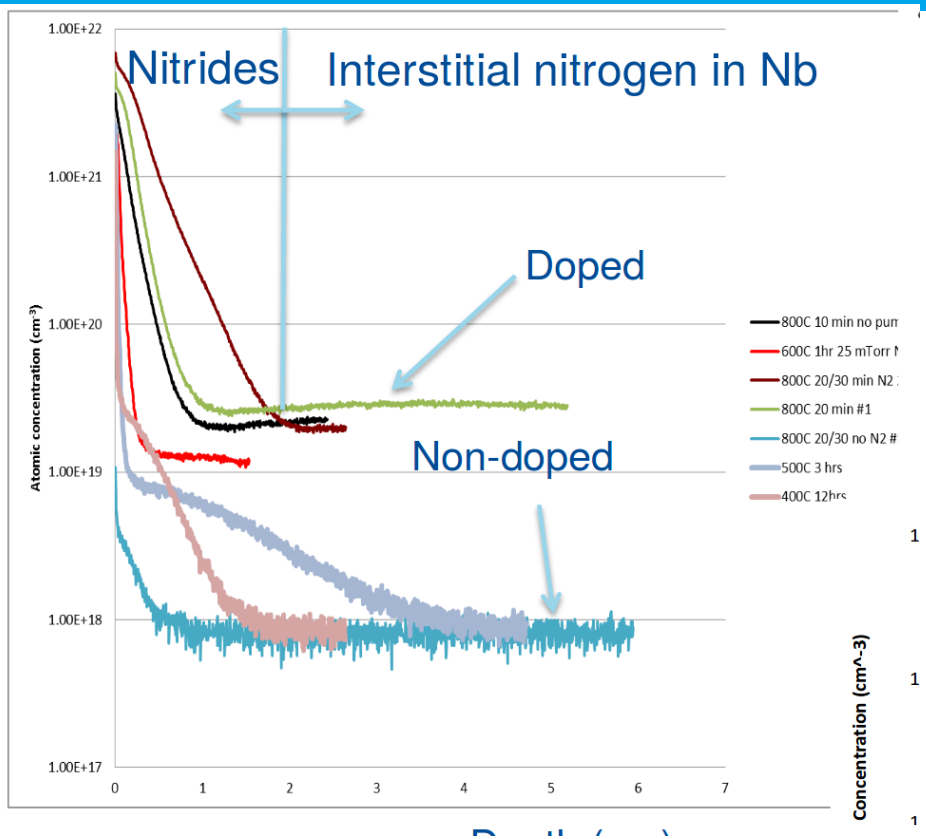

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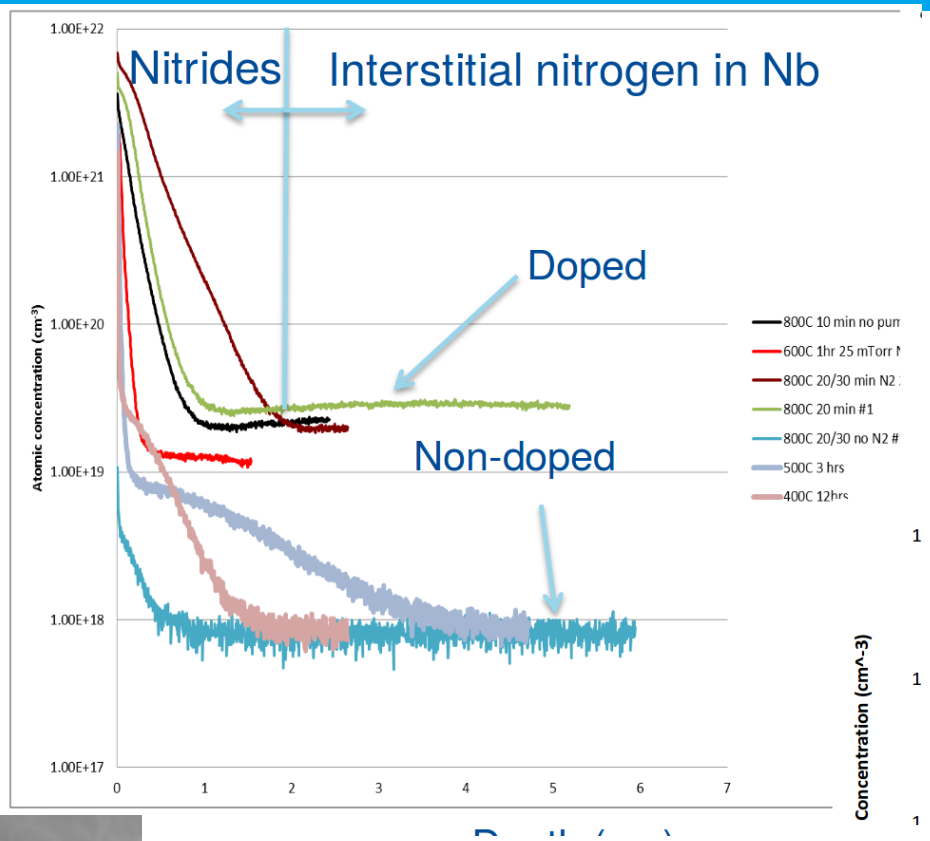

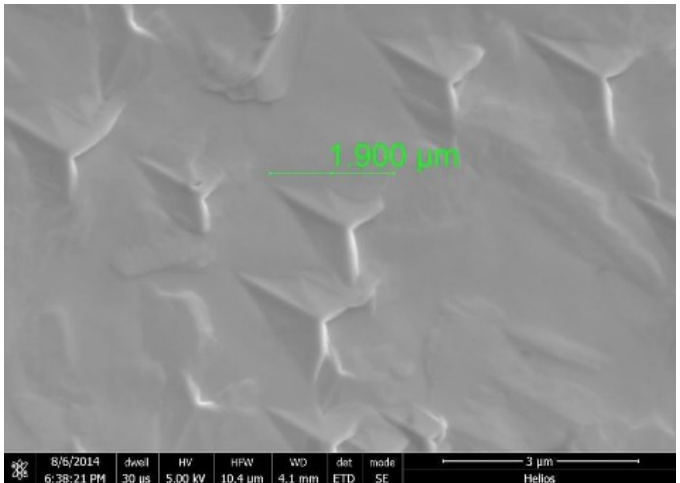

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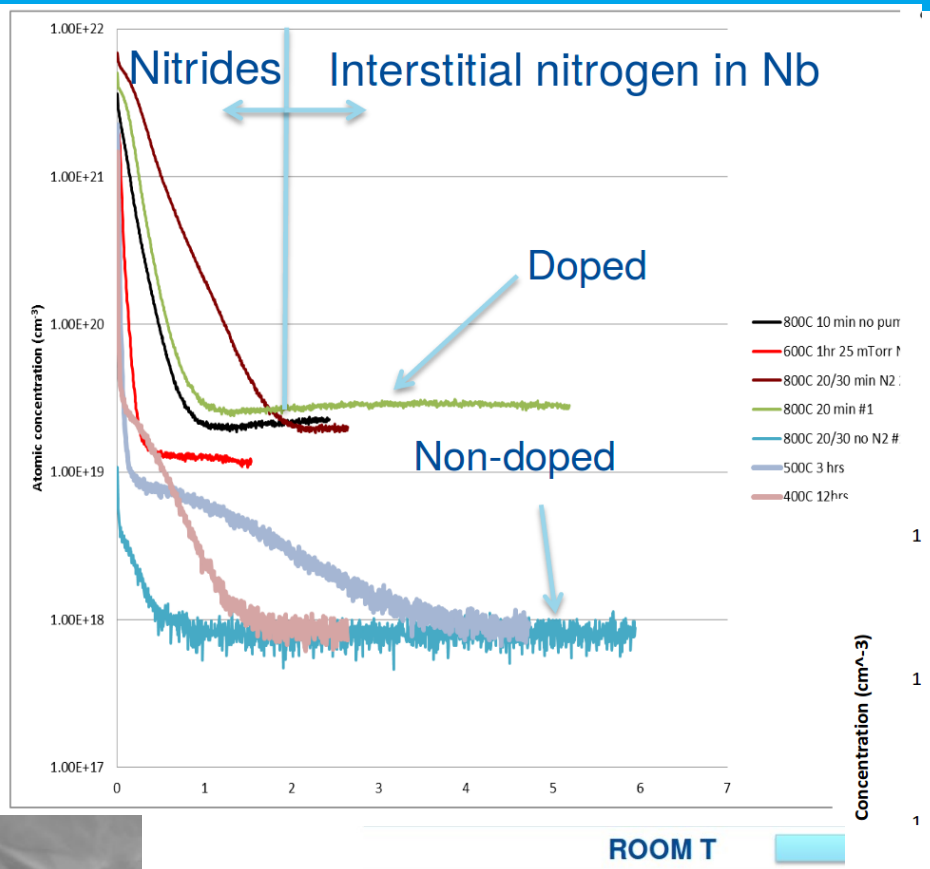

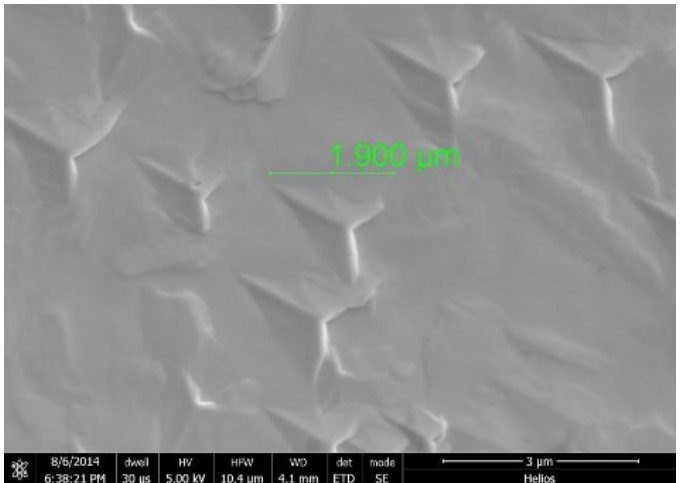

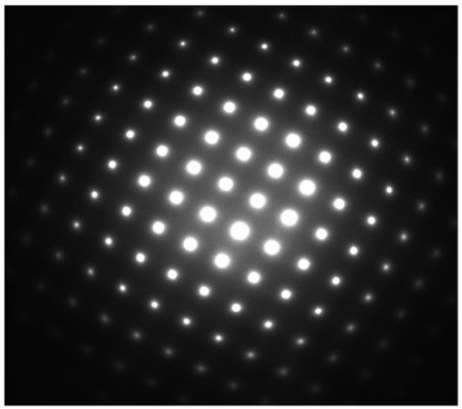

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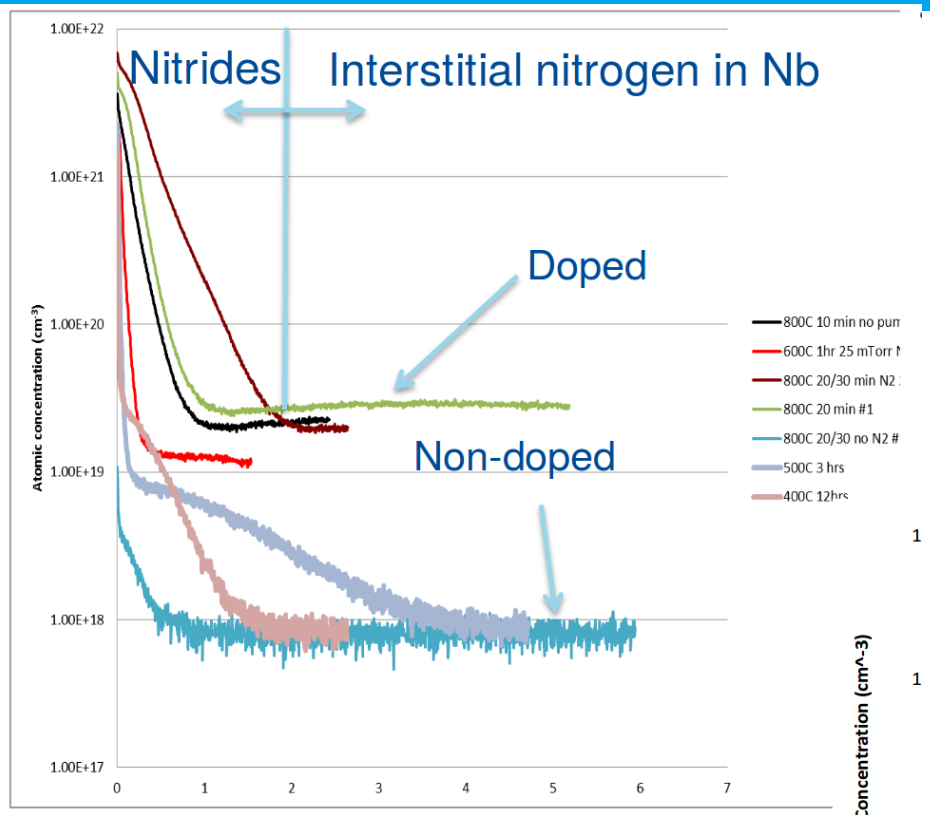

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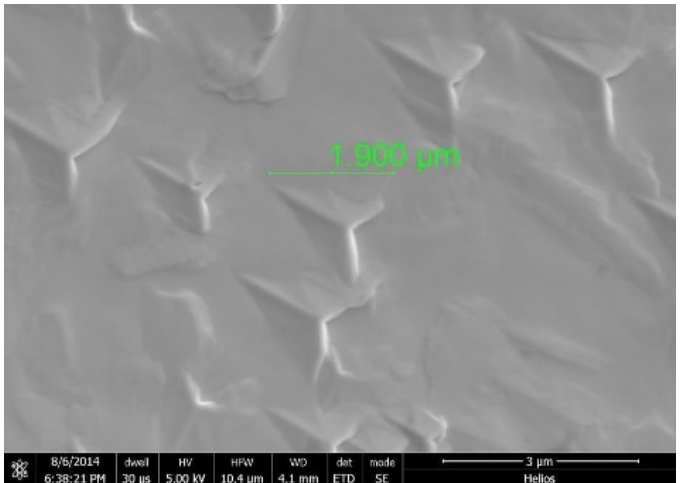

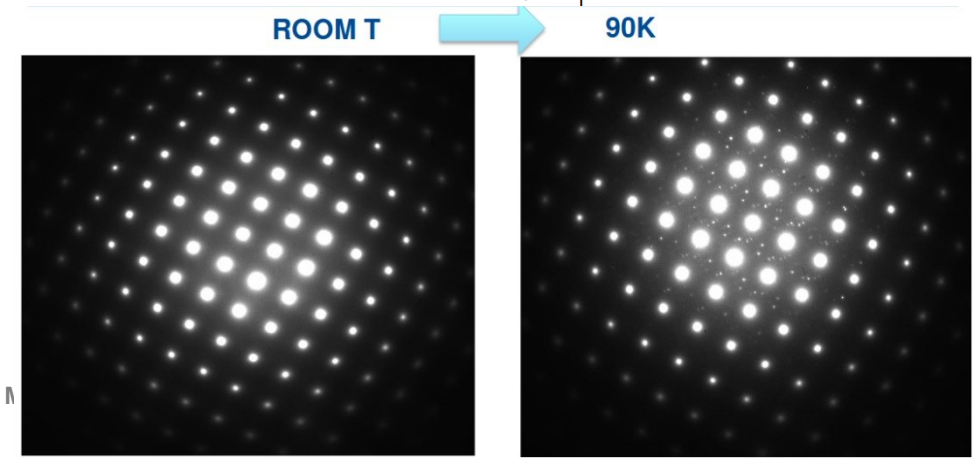

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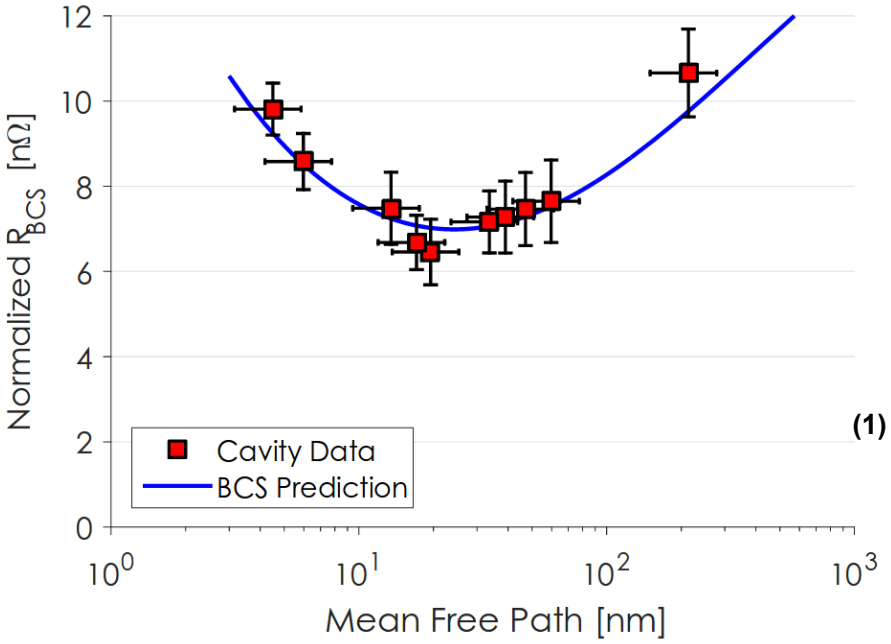

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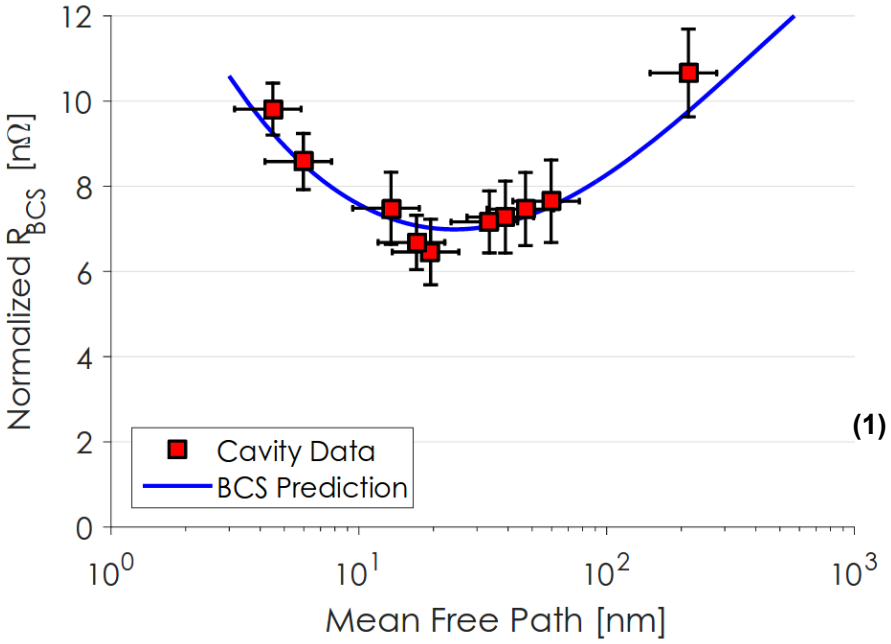

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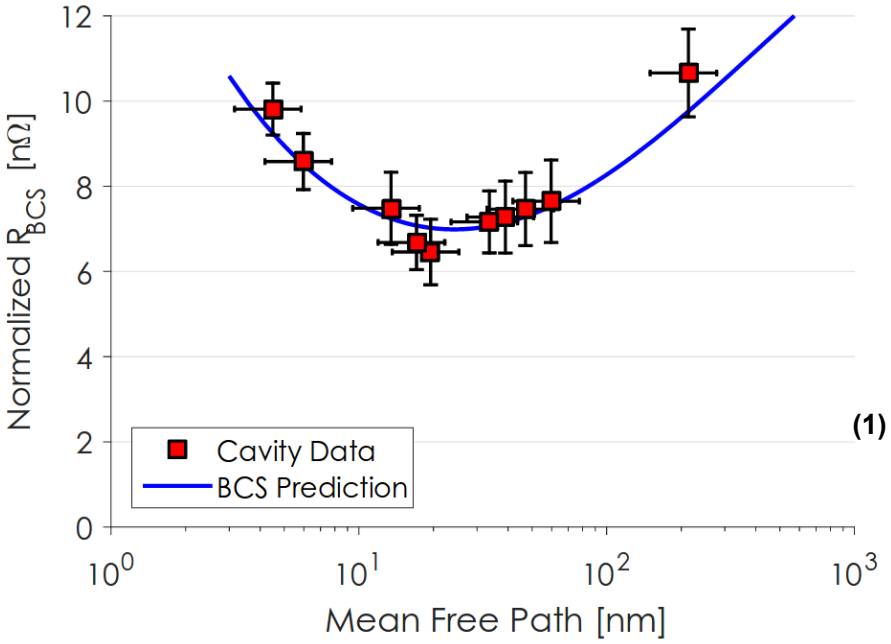

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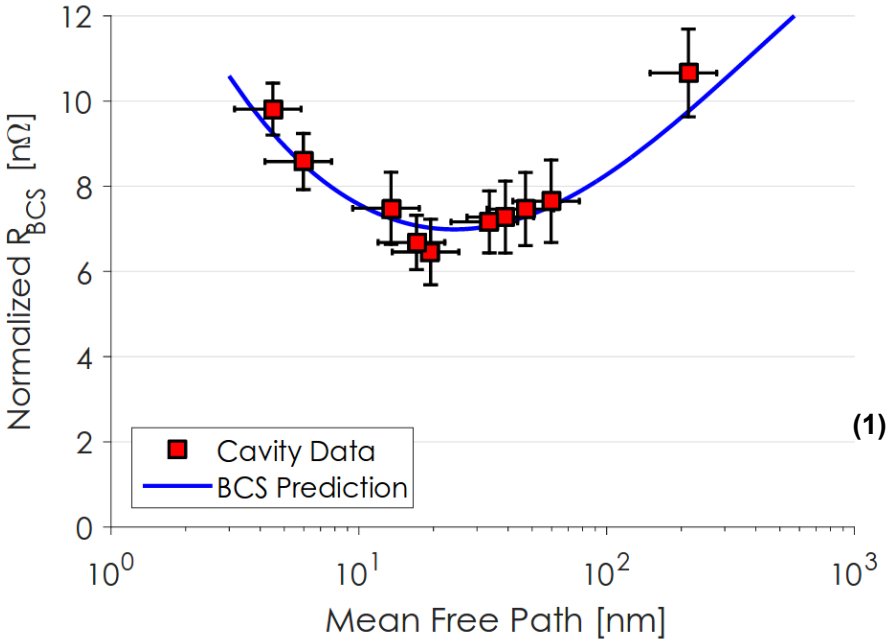

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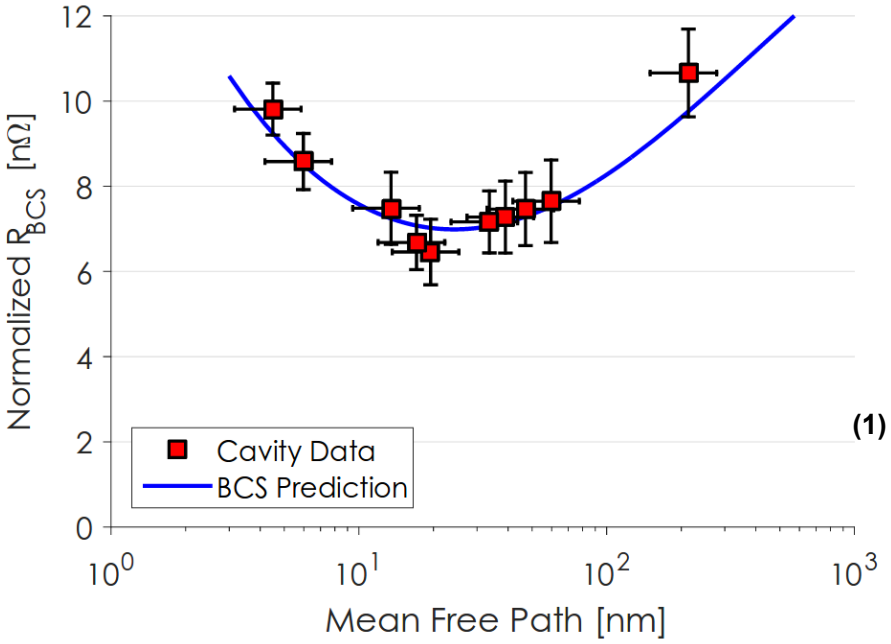

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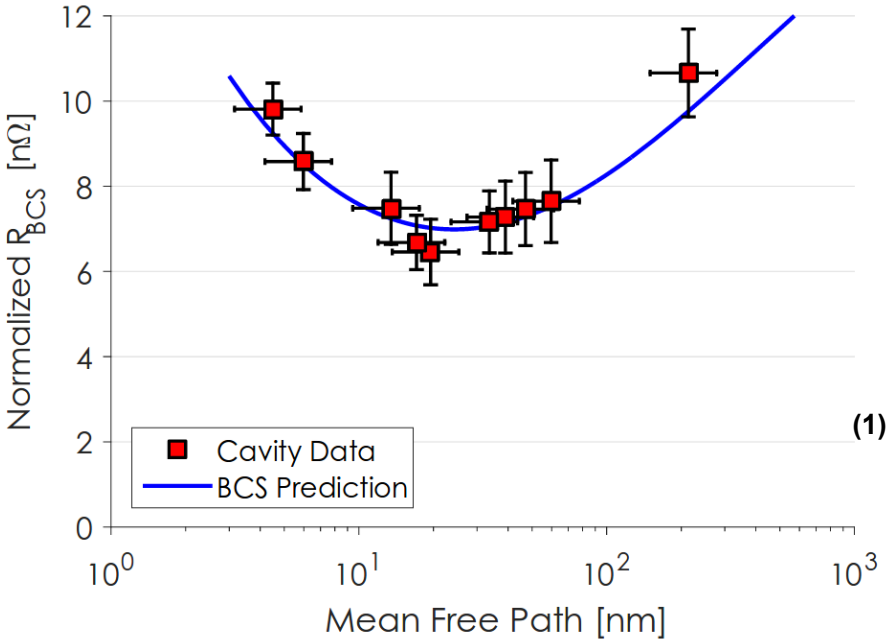

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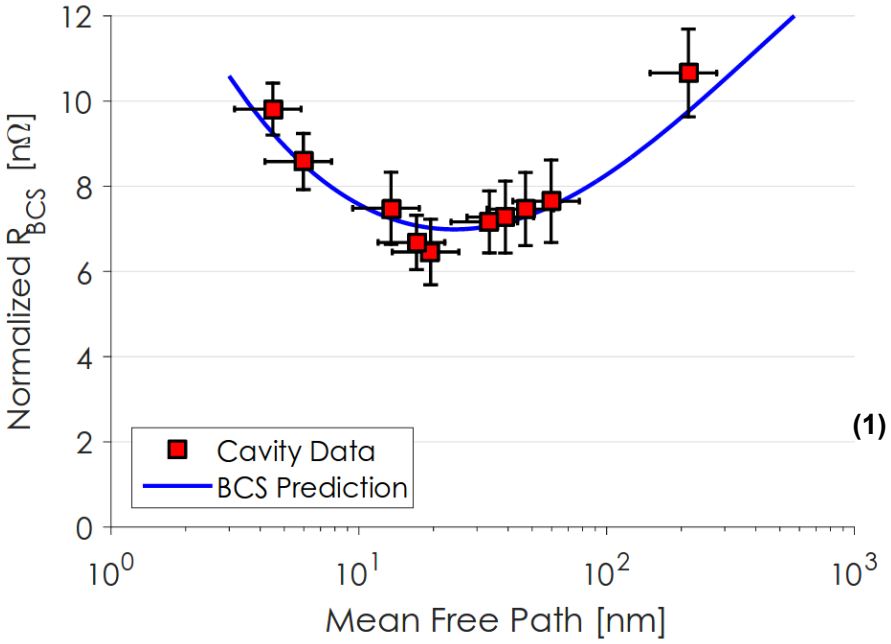

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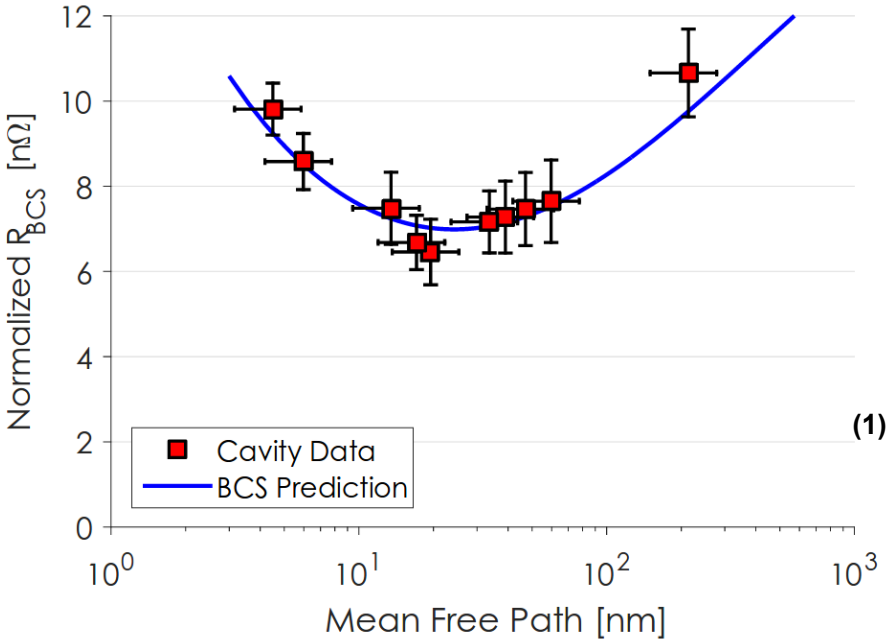

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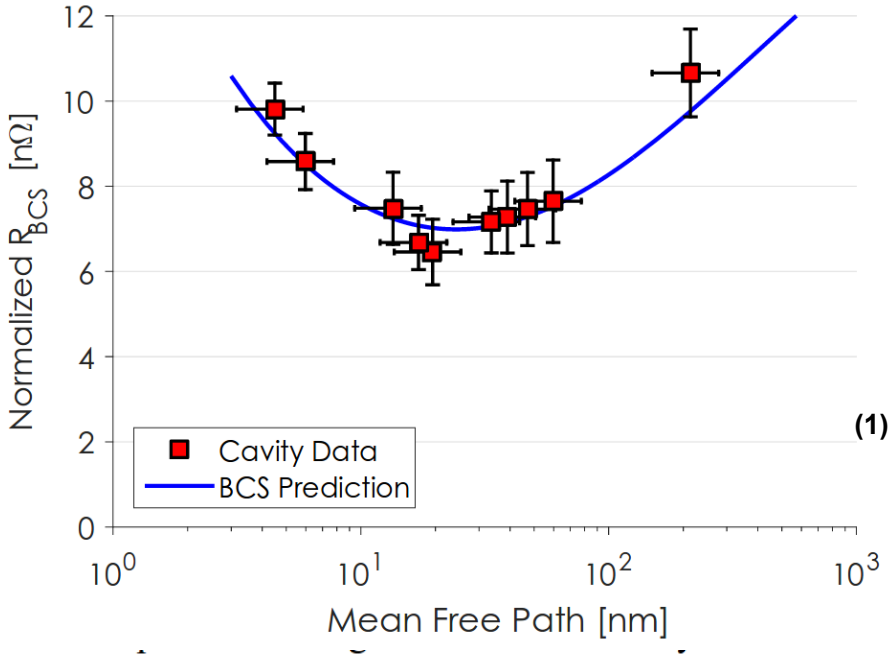

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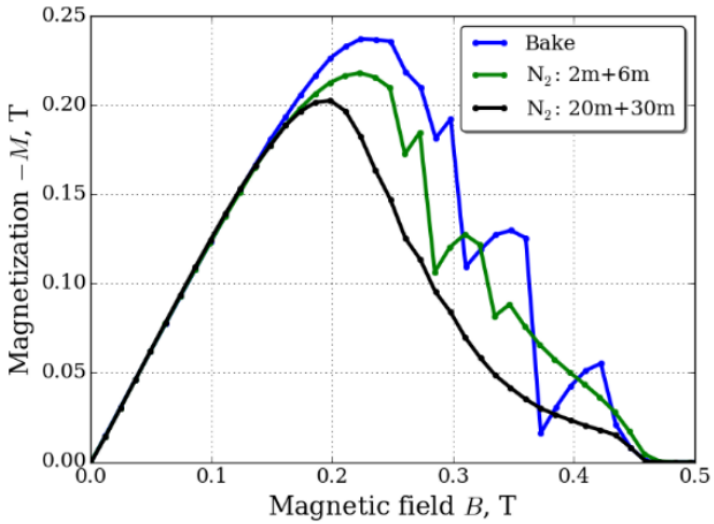

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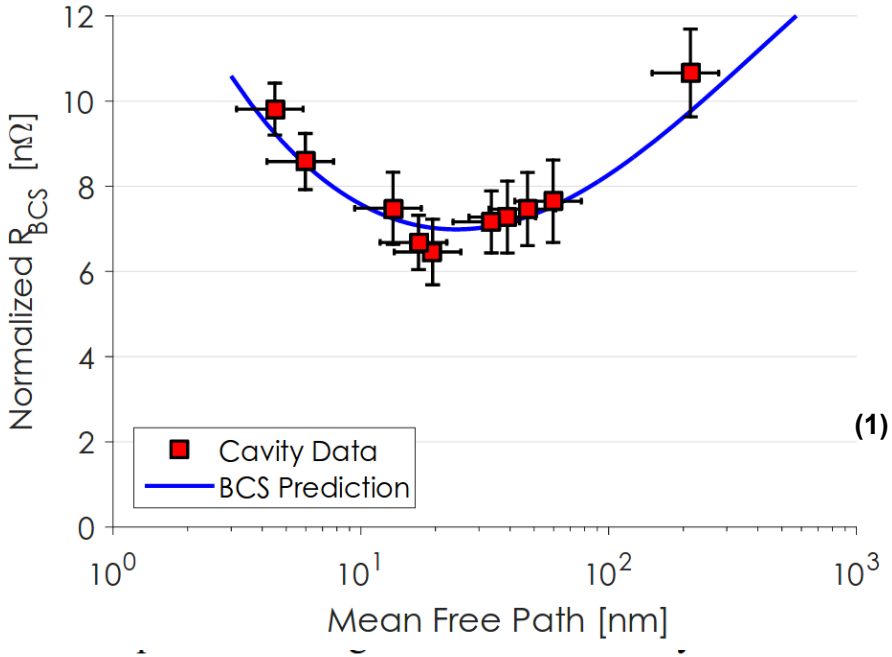

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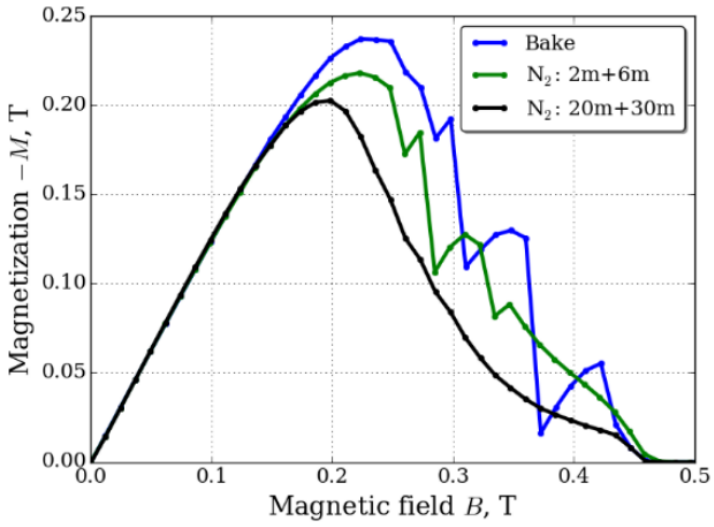

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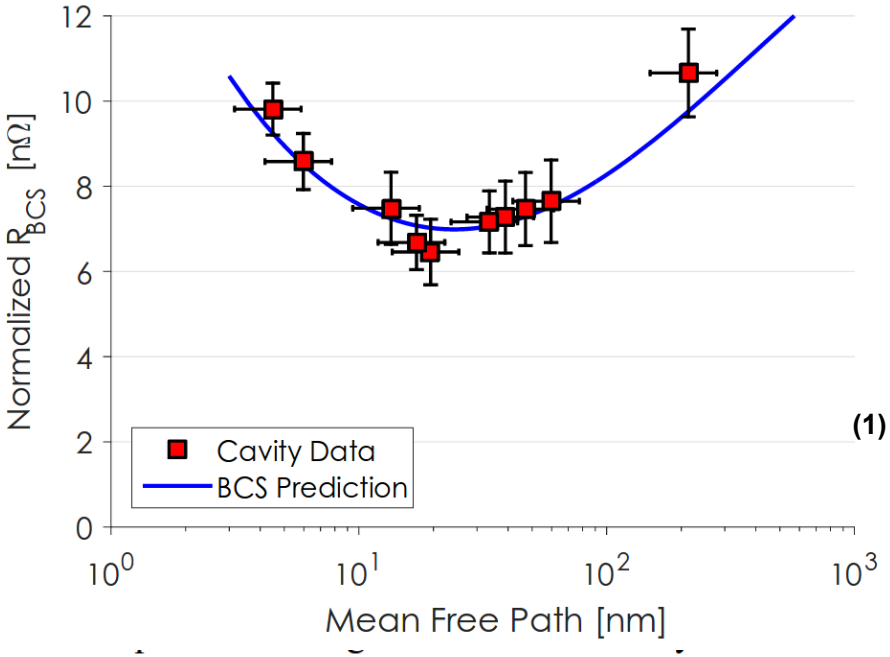

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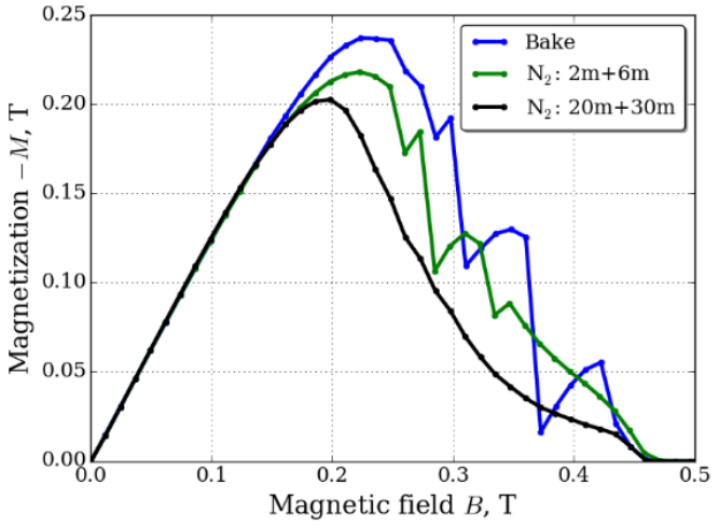

(2)

Marc W

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Nitrogen Infusion (02.2016)

[A. Grassellino et al., arXiv:1701.06077]

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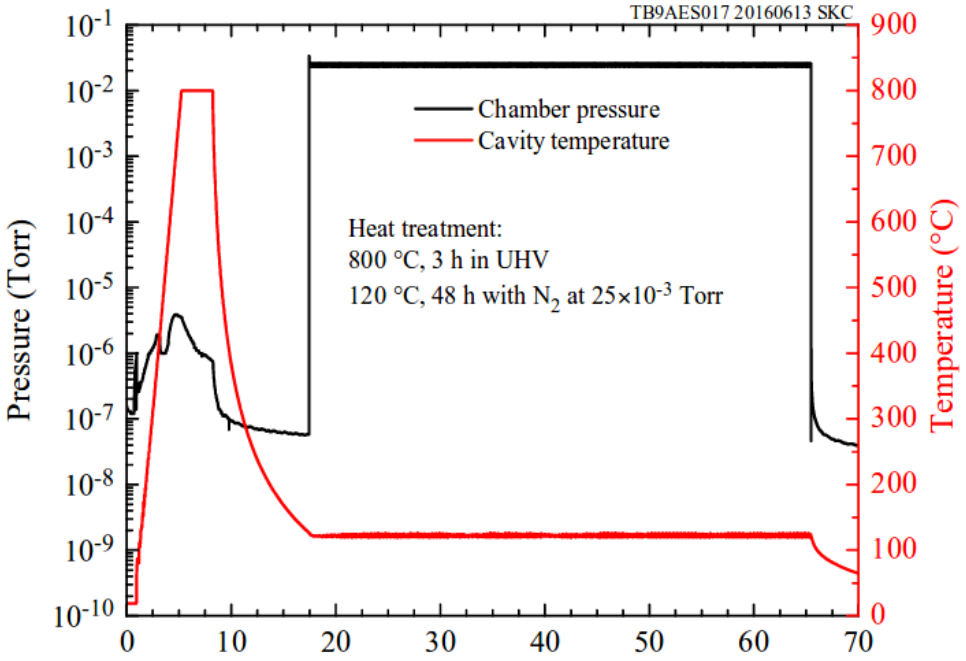

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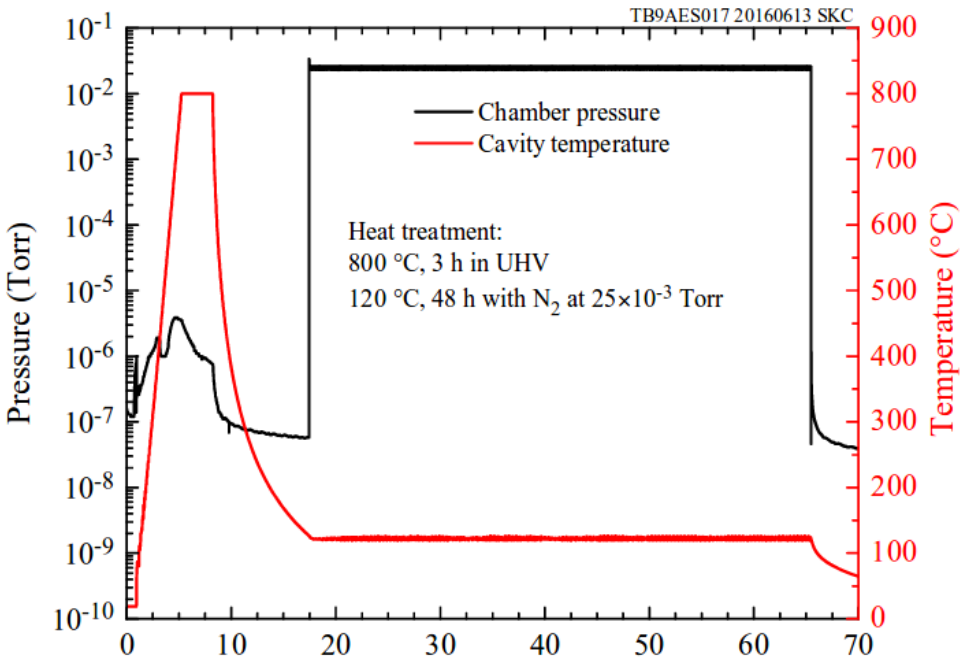

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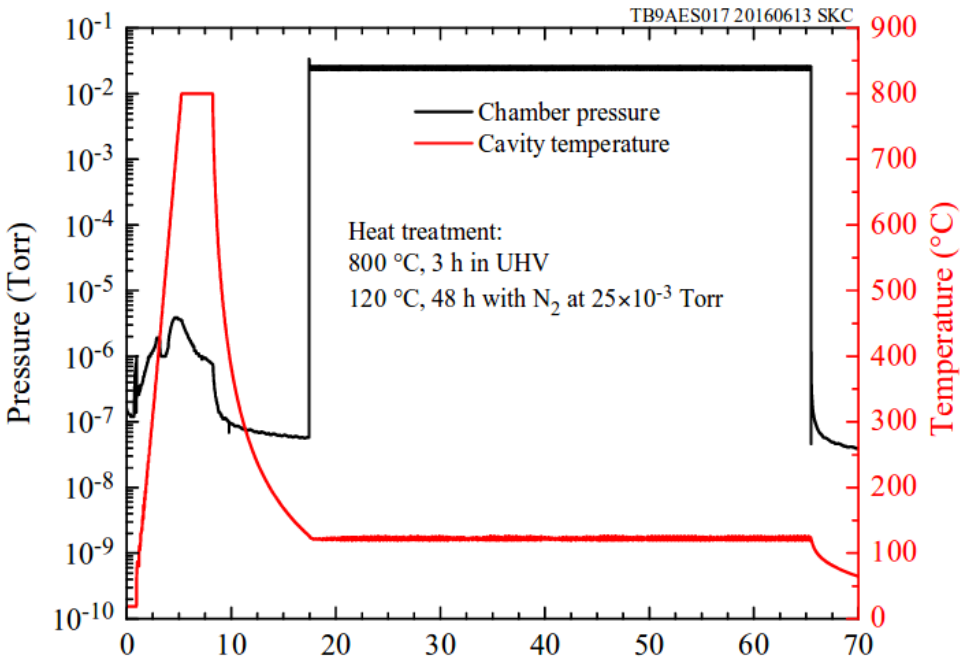

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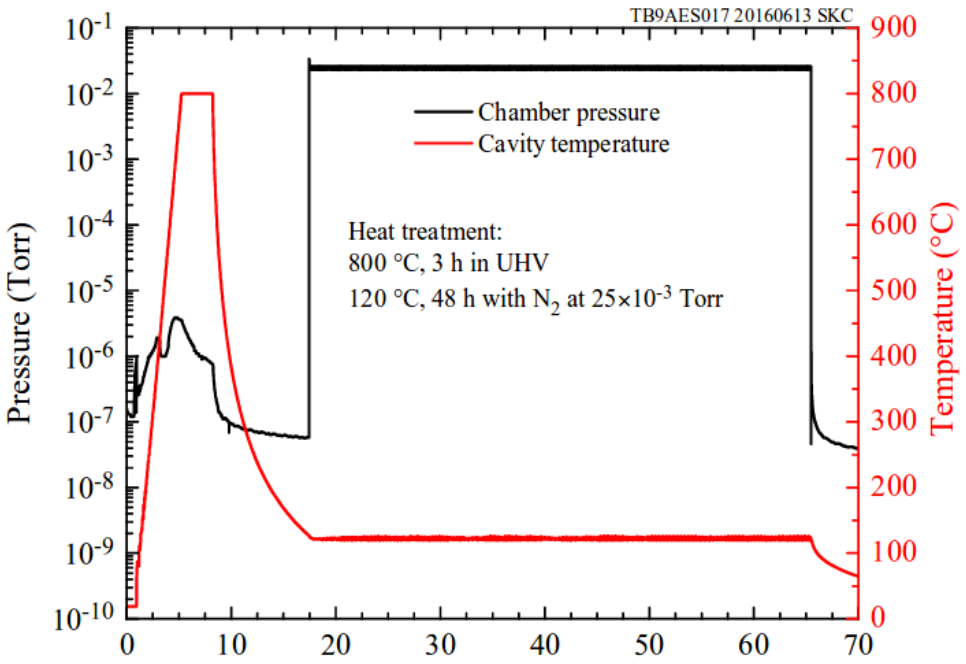

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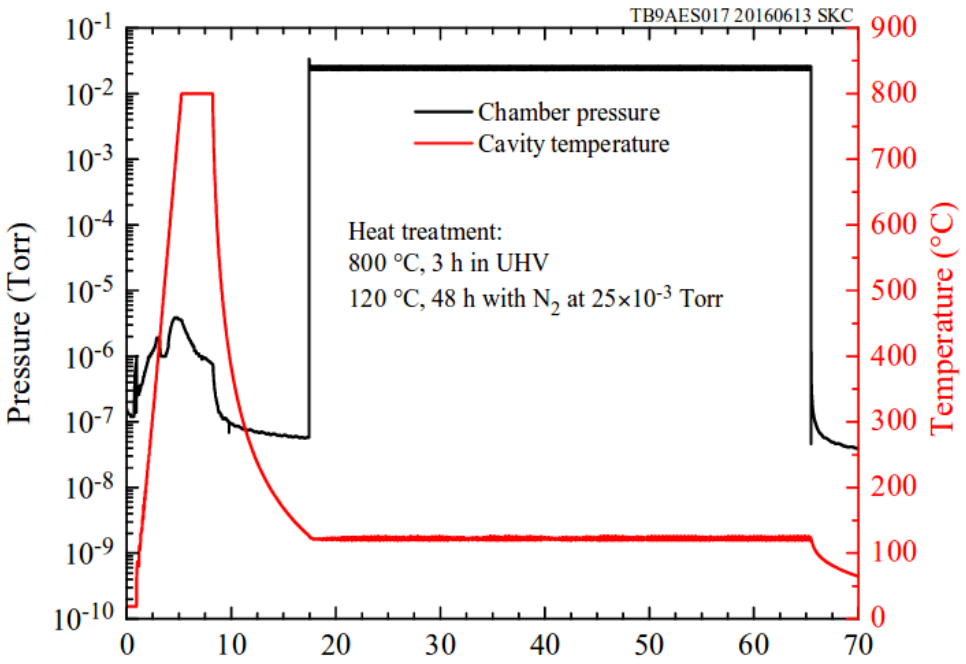

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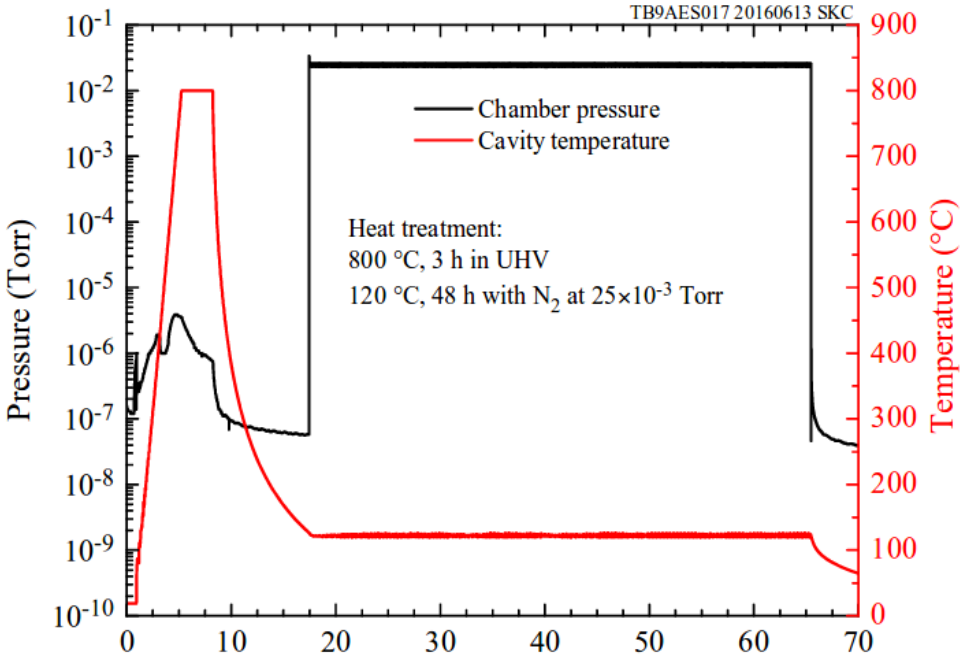

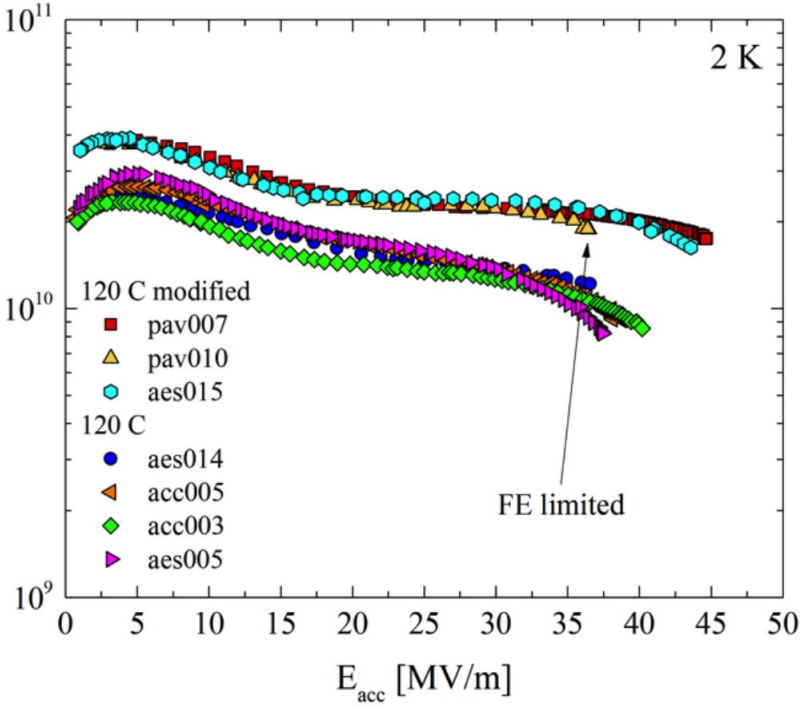

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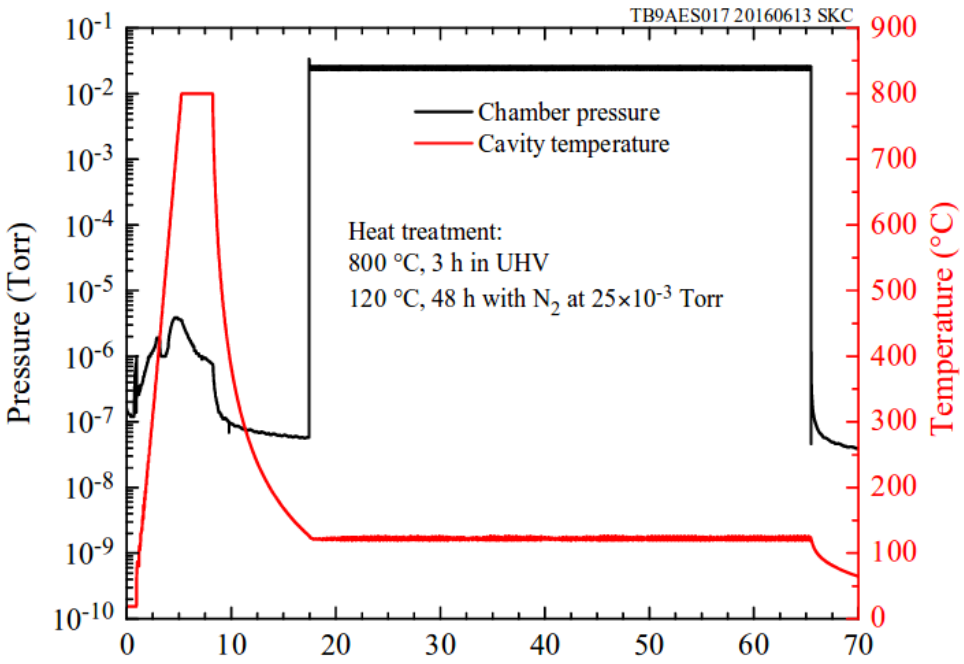

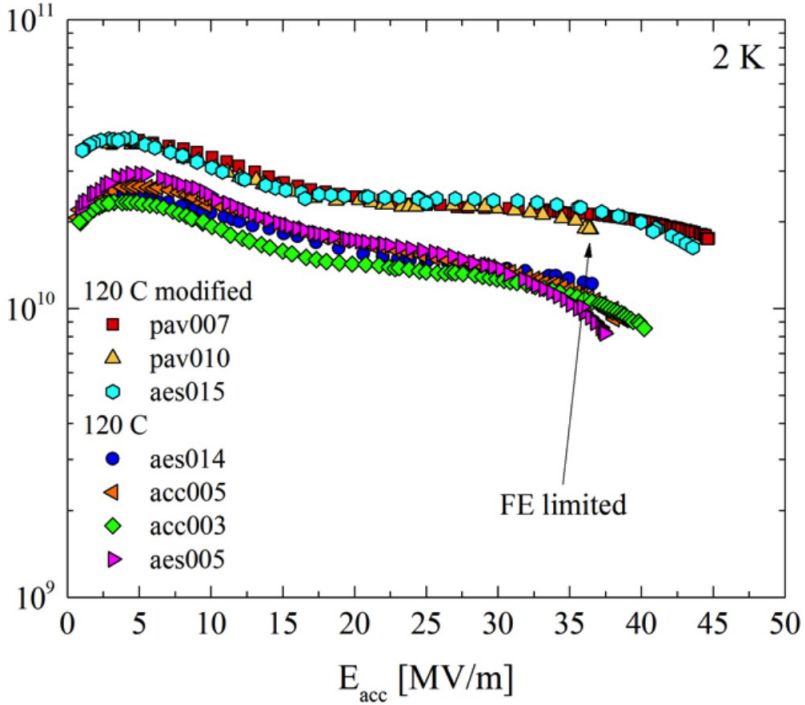

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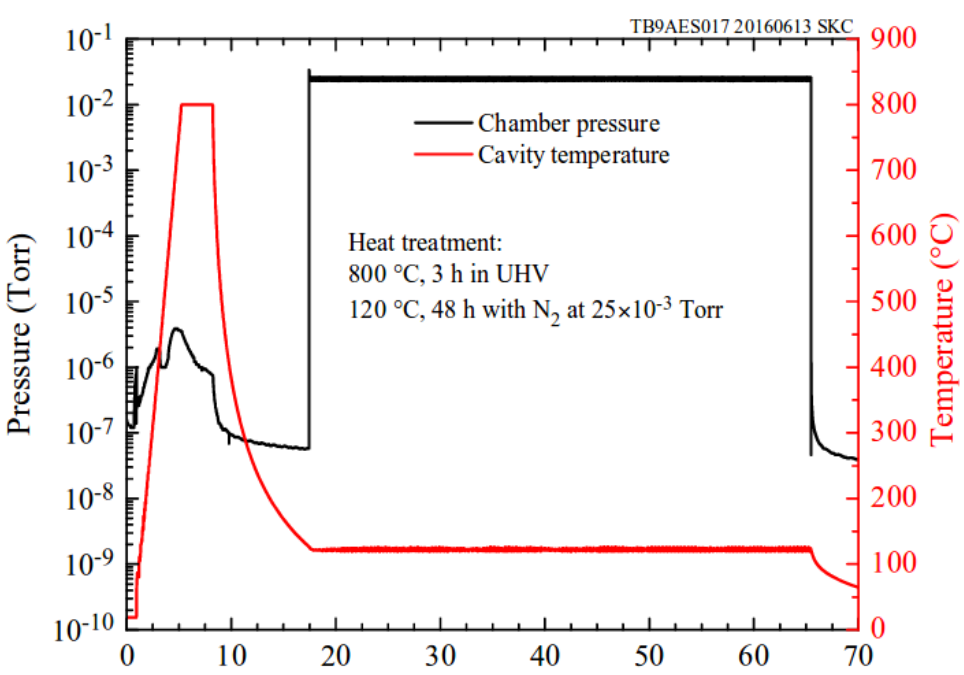

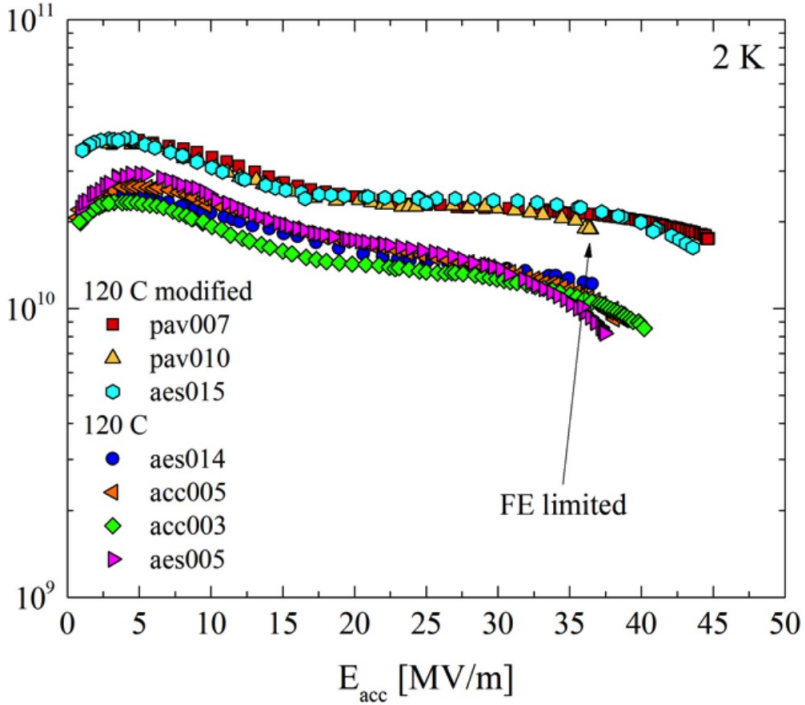

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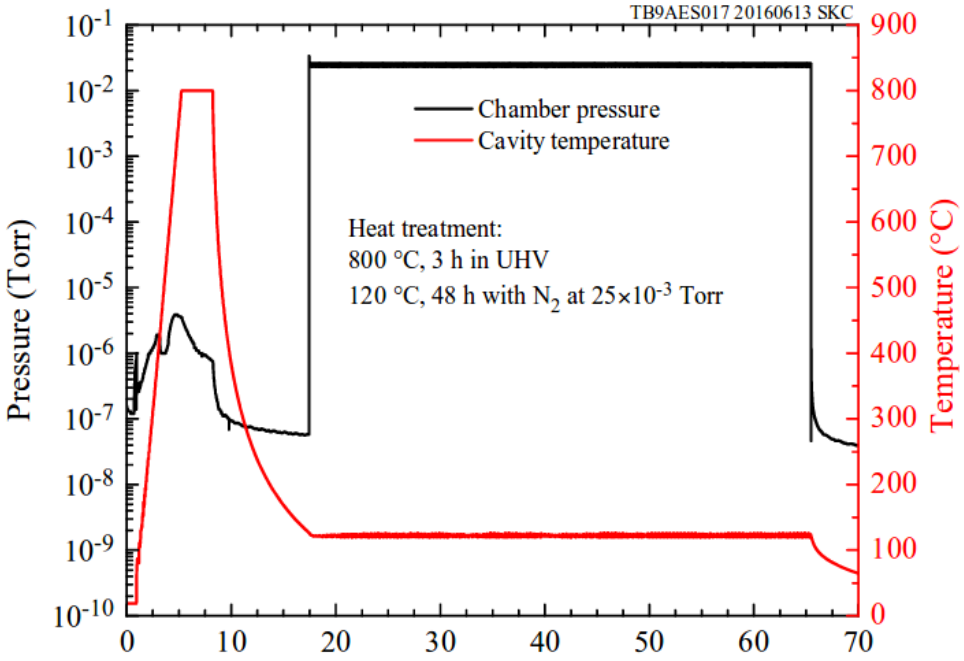

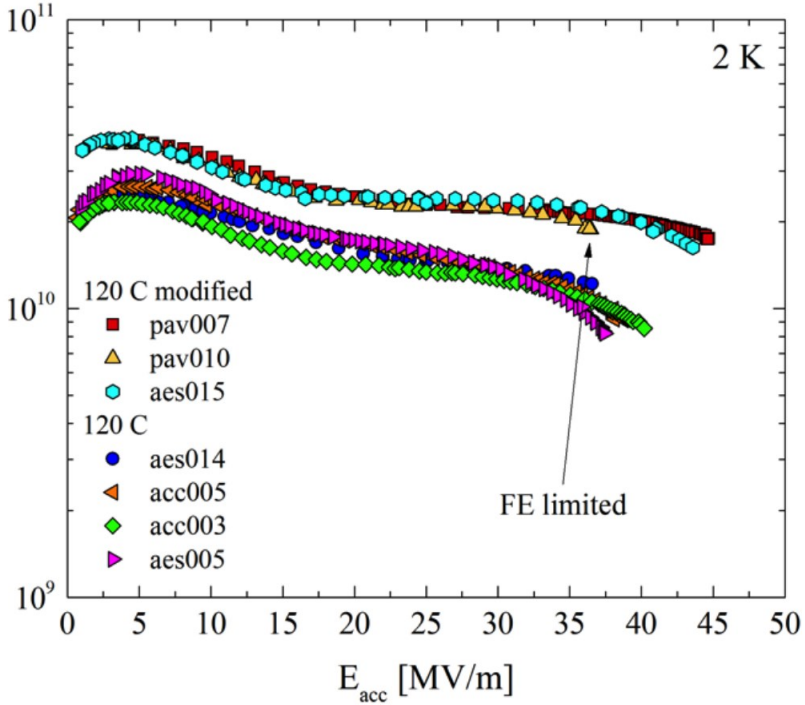

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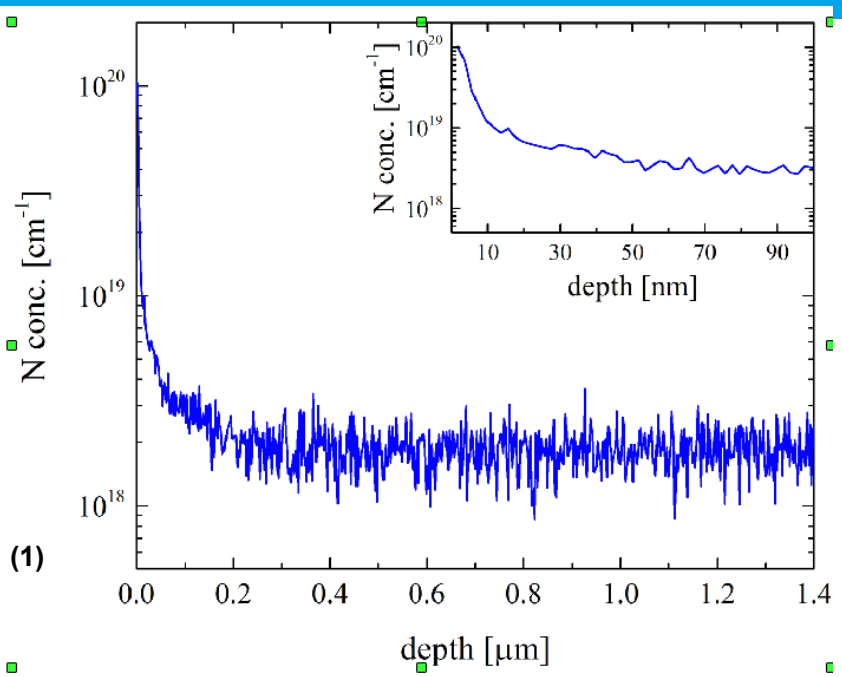
SIMS – Depth Profile of Nitrogen



(1)

(2)

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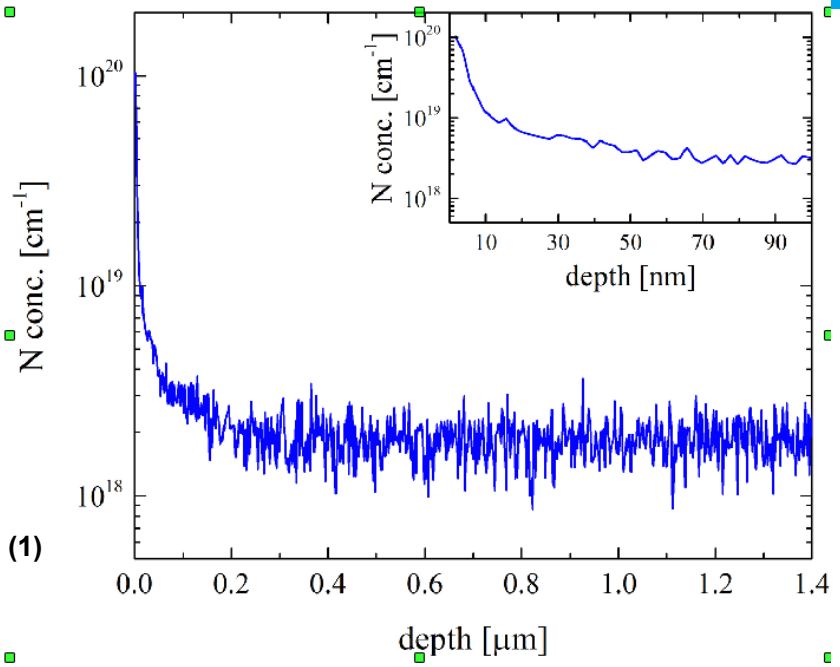

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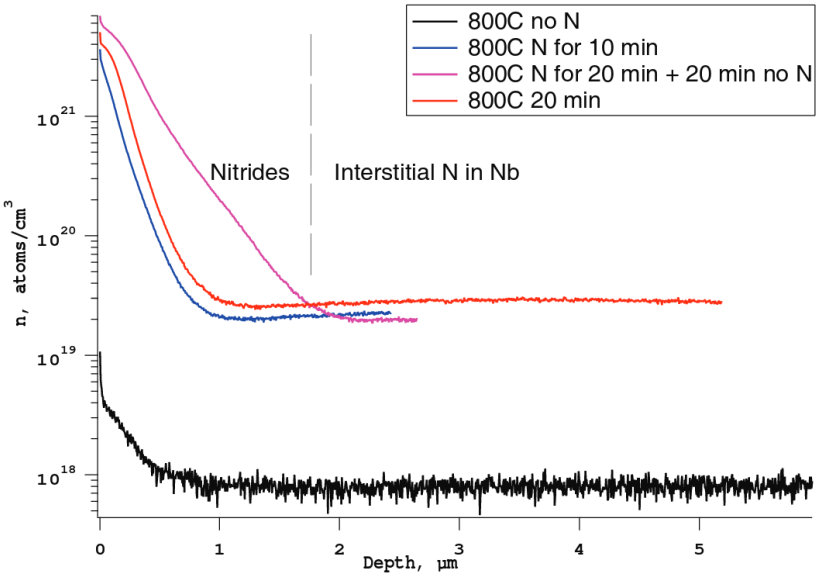

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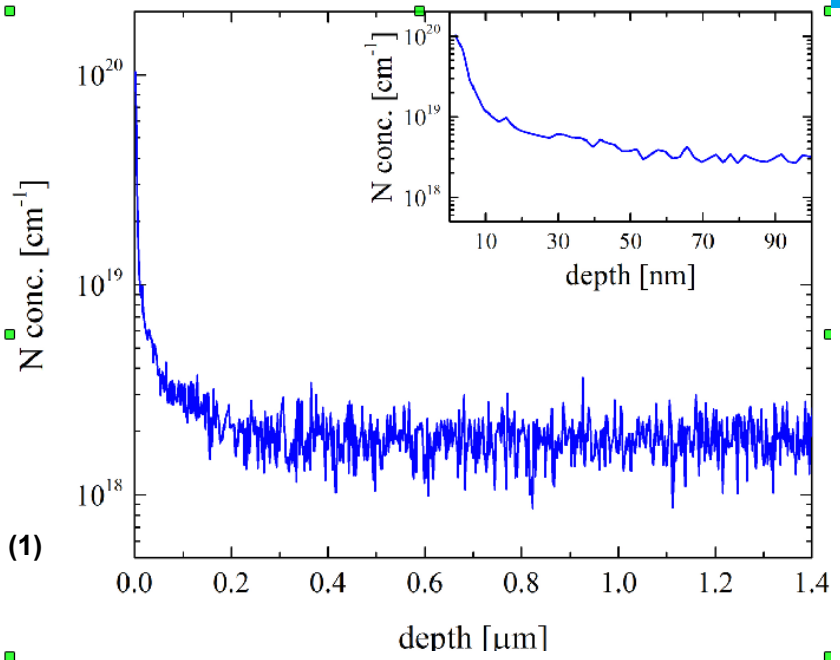

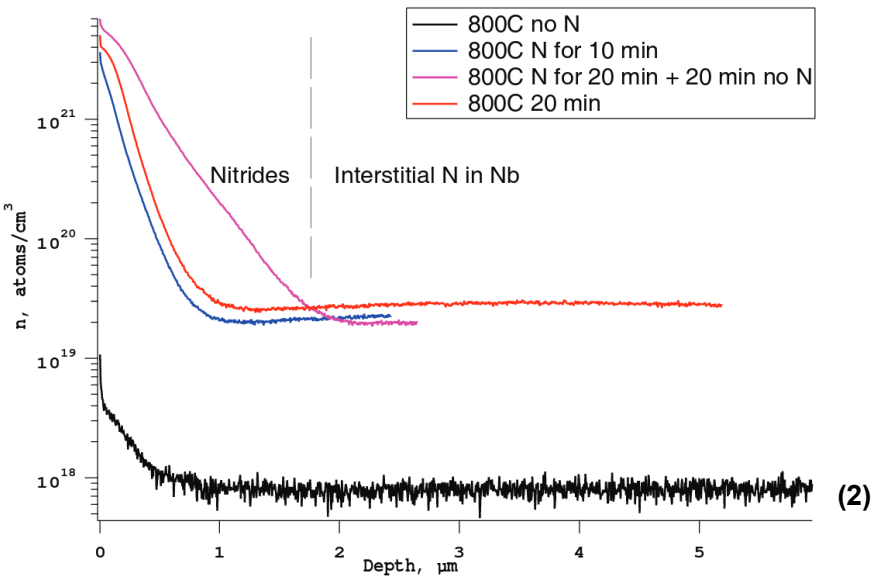

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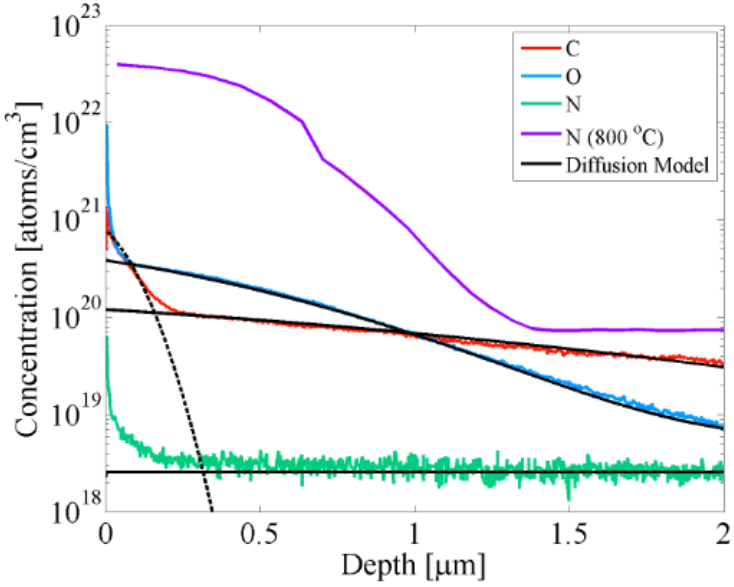

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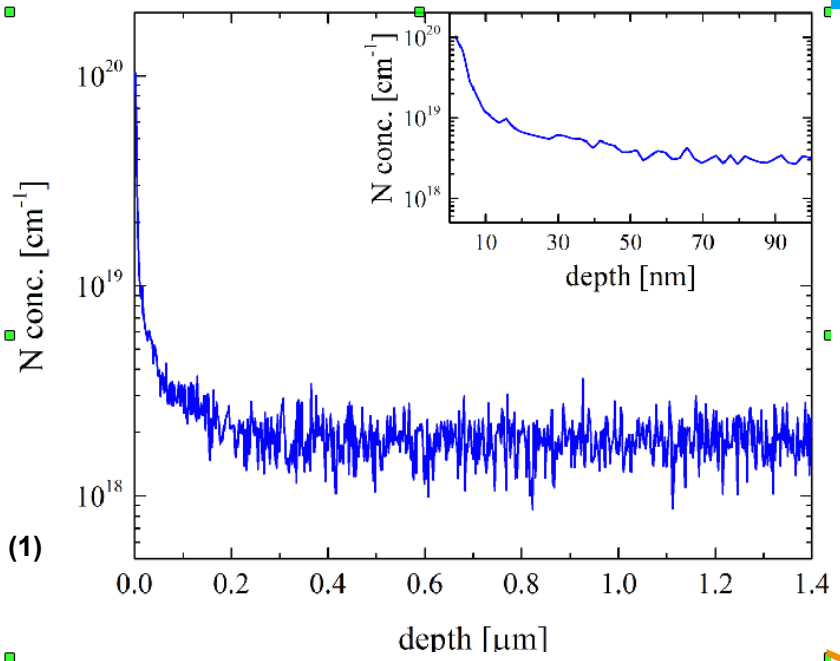

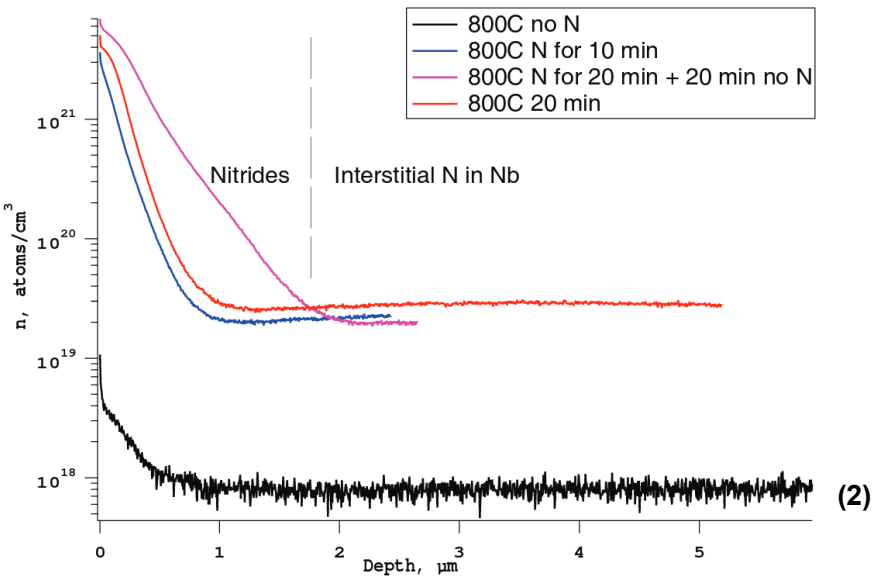

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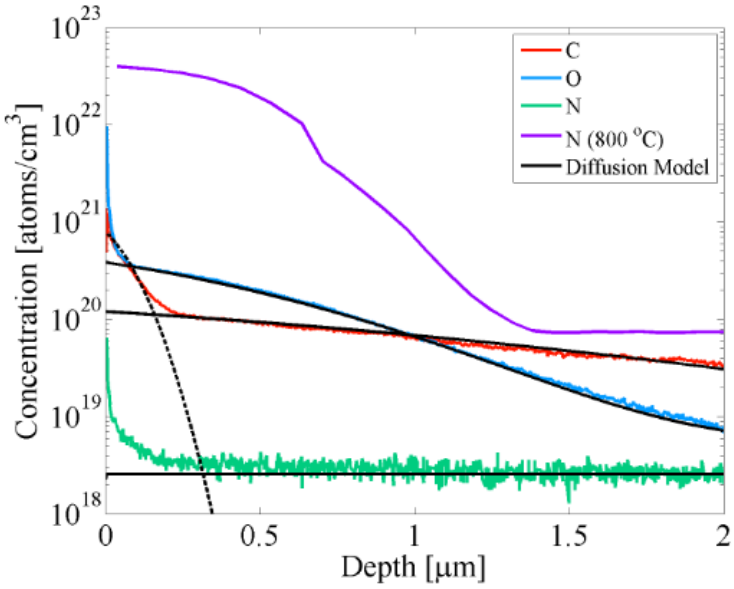

- Small increase visible (8-10x)

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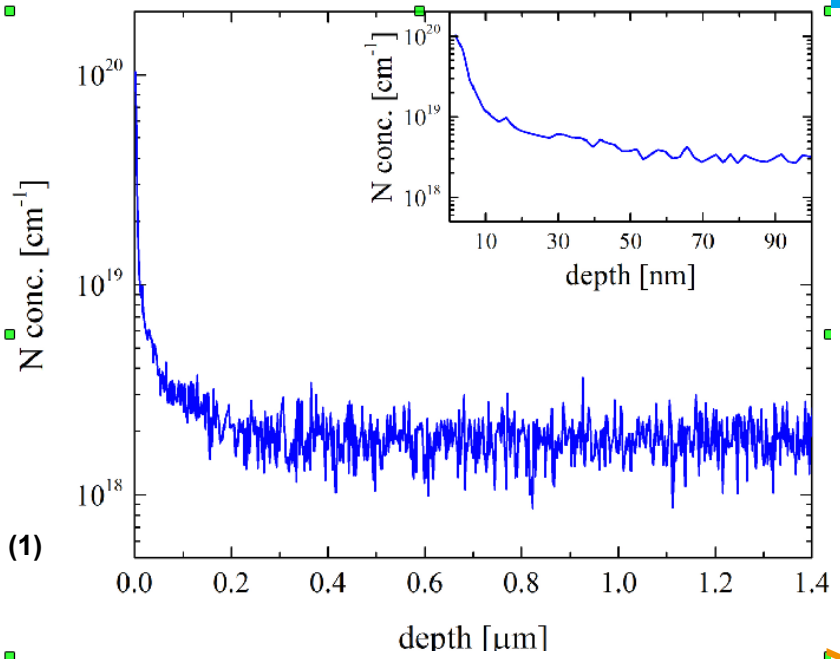
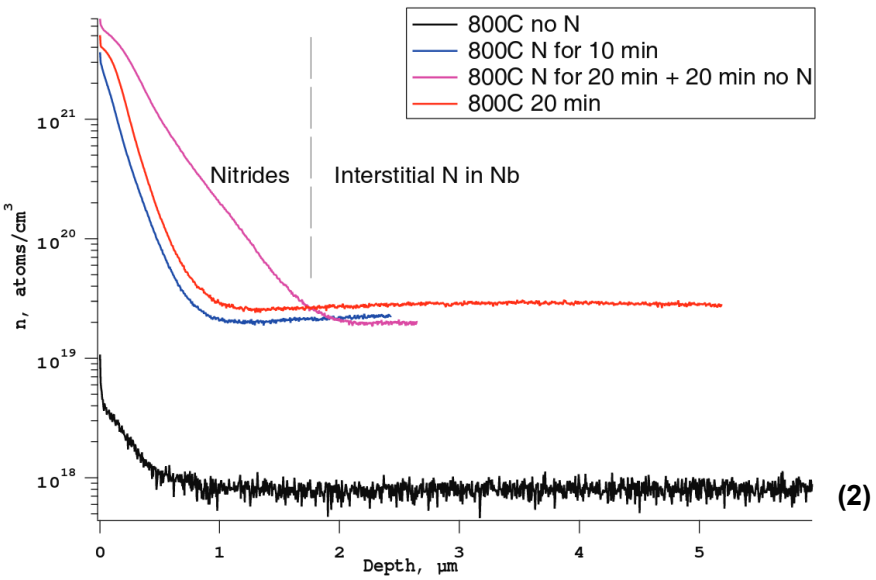
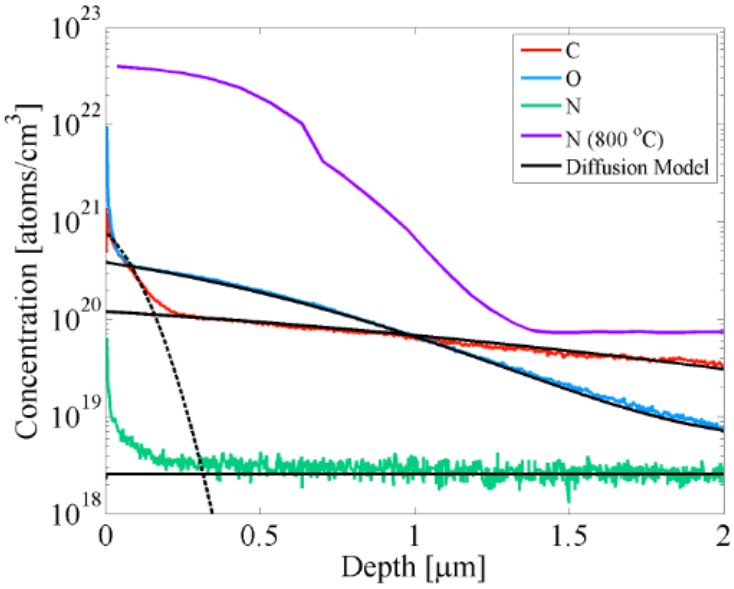




(2)

(3)



- Small increase visible (8-10x)
- Peak of diffusion close to floor of doping

(1) [S. Aderhold, TTC Workshop Saclayl, 2016]
(2) [[Y. Trenikhina et al., J. of Appl. Phys., 117, 154507 (2015)]
(3) [P. Koufalis et al., arXiv: 1612.08291]
(4) [F. Boratto et al, Metallurgical Transactions A 8.8 (1977): 1233-1238]

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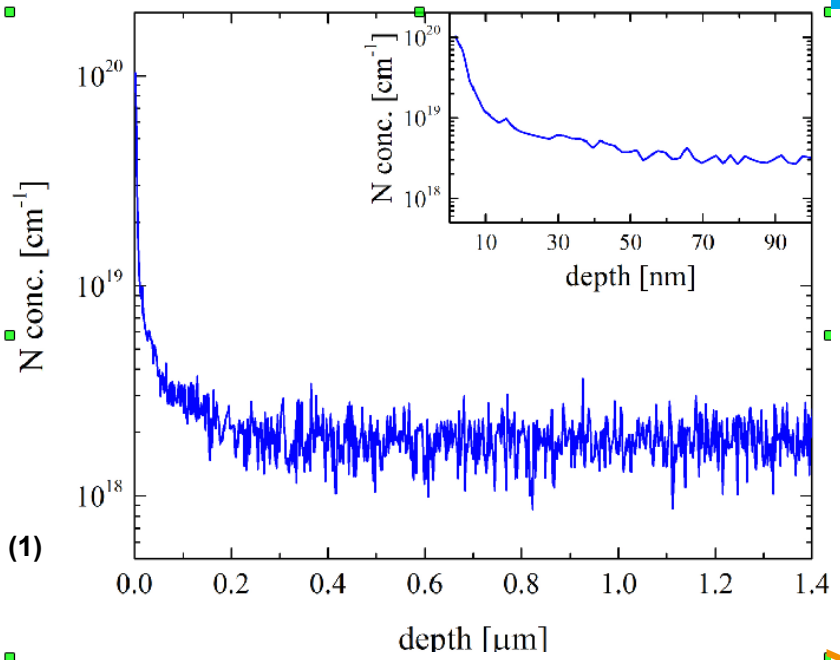

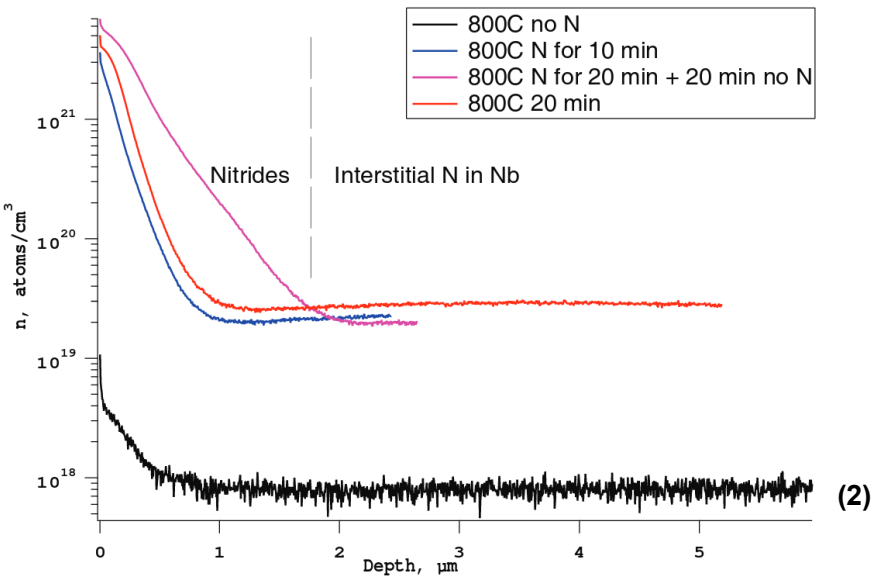

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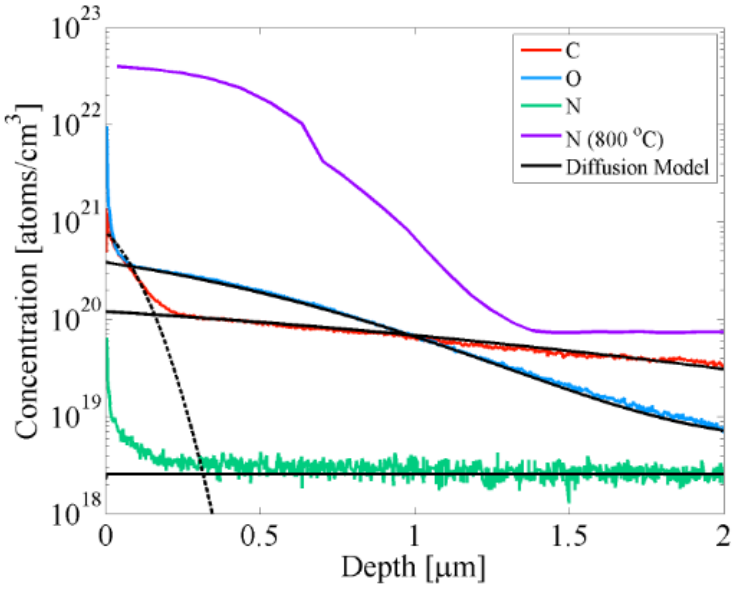

- Small increase visible (8-10x)
- Peak of diffusion close to floor of doping
- Diffusion length
  - for 120C and 48h is 0.03 nm or 30 Å (4)
  - Nb lattice Constant is 3.3 Å

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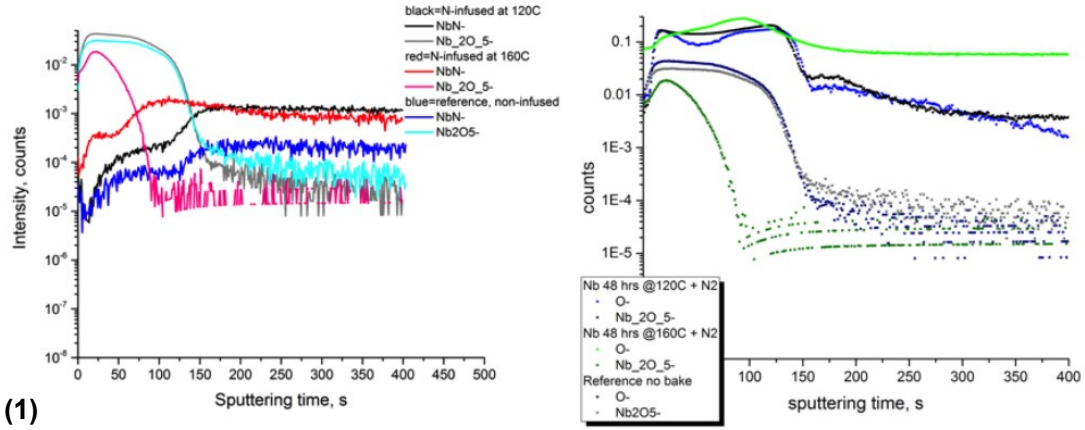
Contradictions



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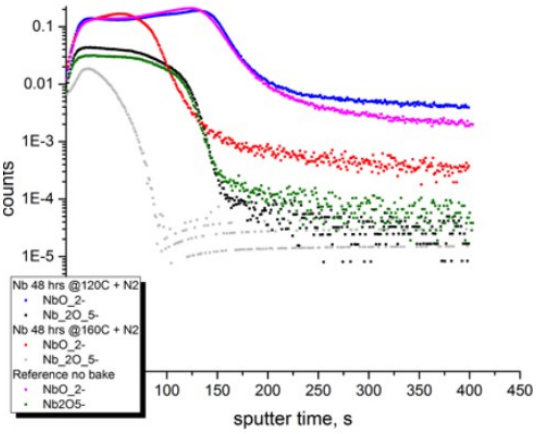

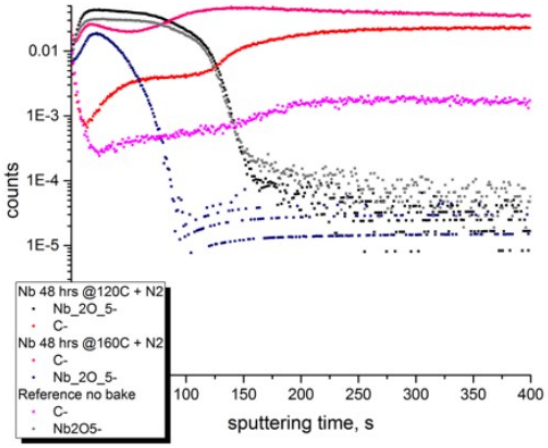

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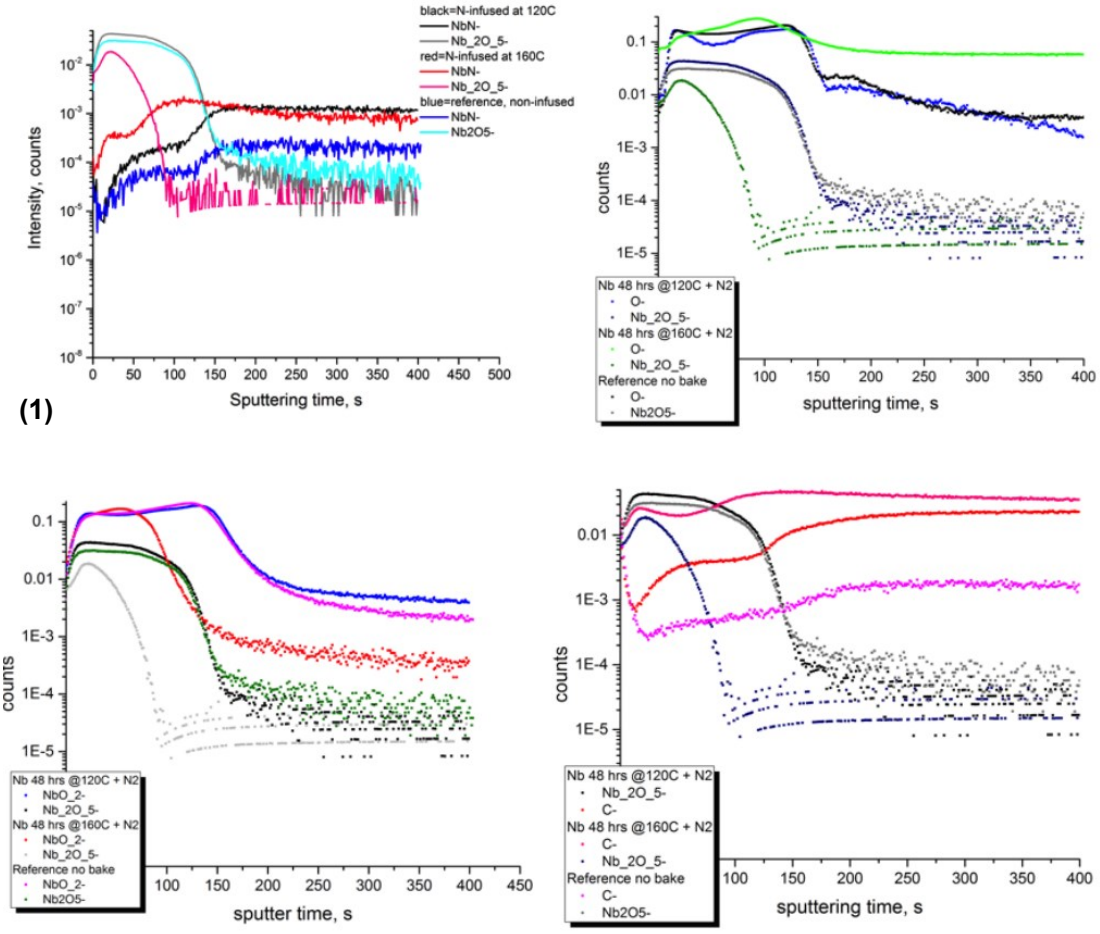

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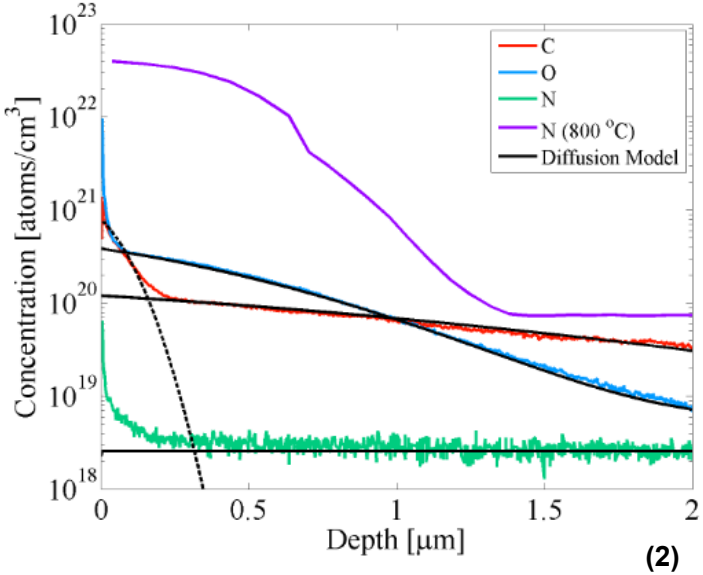

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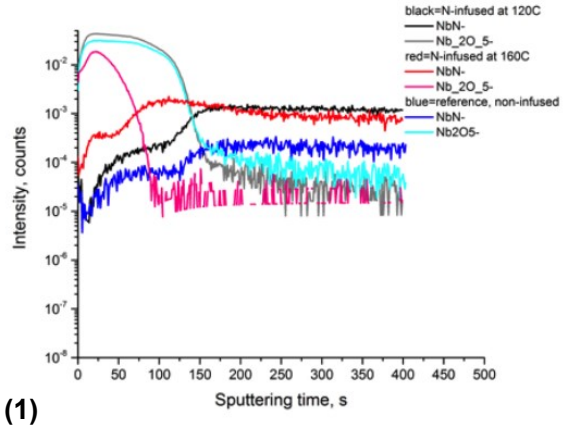

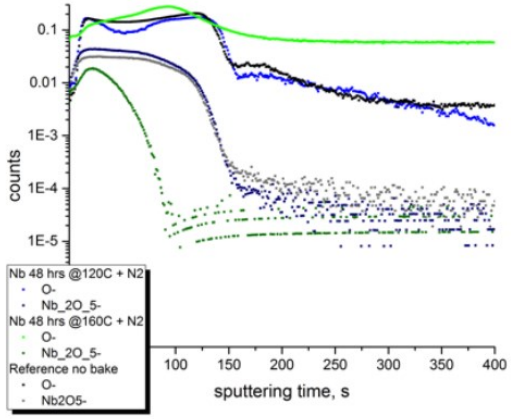

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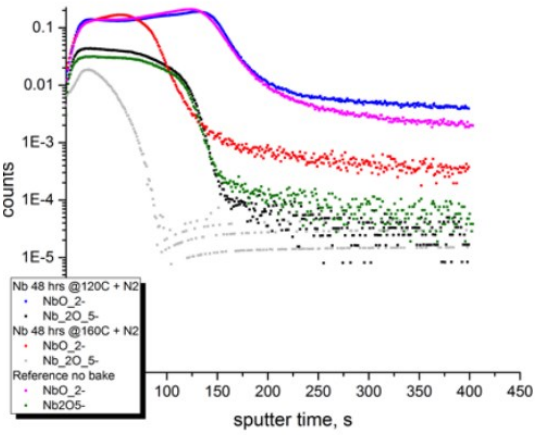

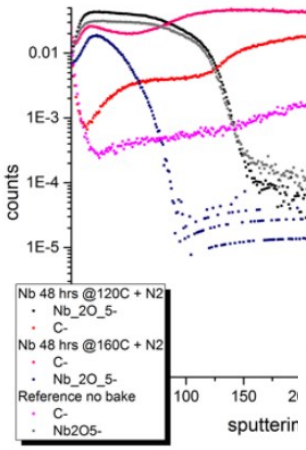

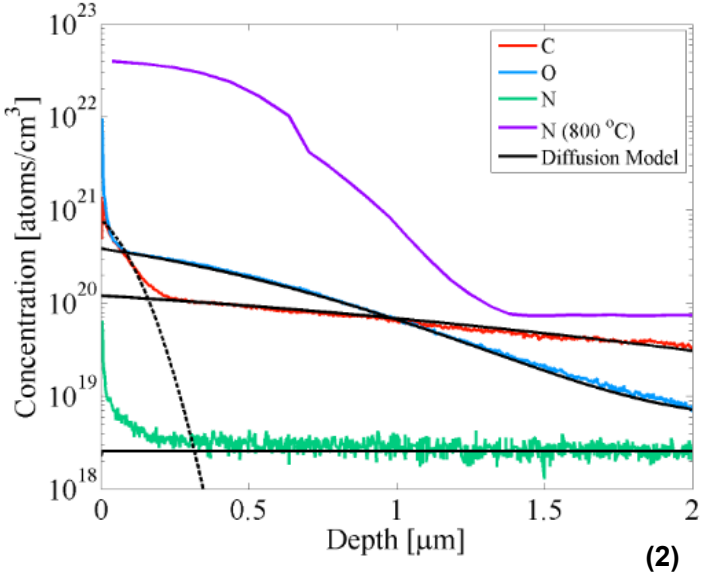

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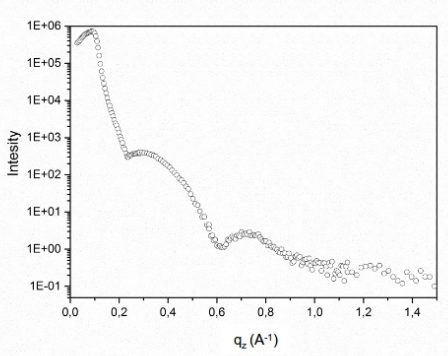

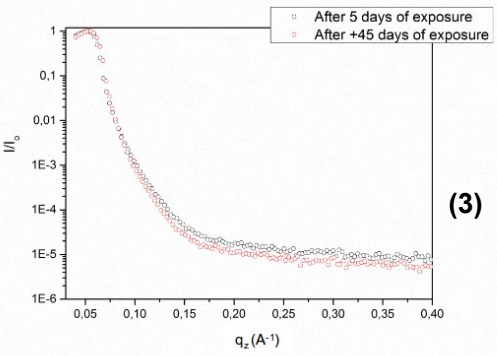

(3)

Natural oxide layer grows again

Natural oxide layer suppressed

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  - Do a 900C baking before doping at 800C and higher removal before baking helps