

Nanobroom for tackling acute
pneumonic syndromes:
at the tip of **LWFA** via **fiber** scope
(only for internal explanation purposes
: working draft)

Explanation of the developing ideas to tackle **COVID-19**

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A. Sahai, G. Mourou, (S. Iijima), (V. Shiltsev),(P. Taborek),

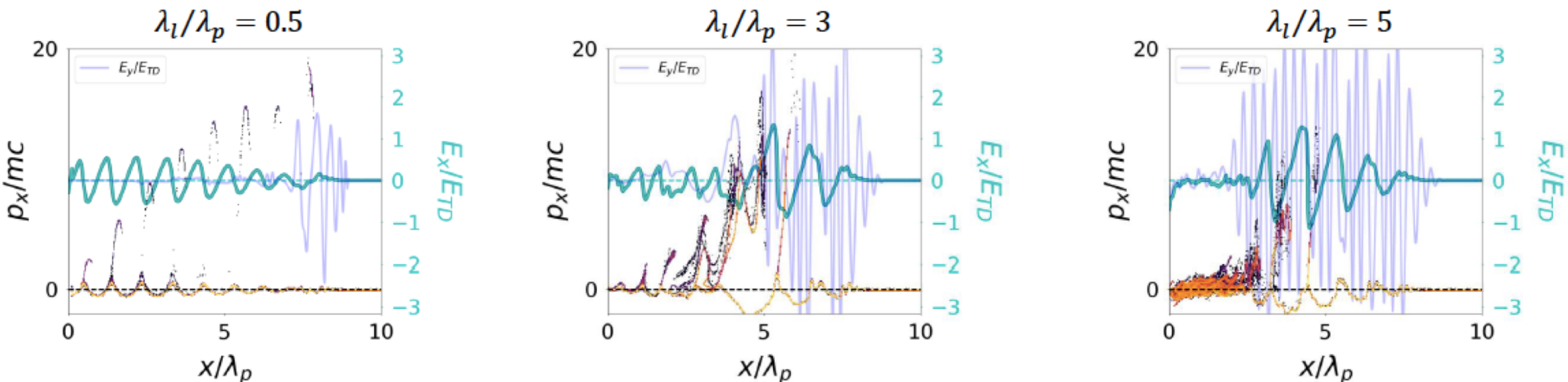
(any errors are solely due to the first author, though all the
works are done by the collaborating authors)

LWFA in low energy high density regime

S. Nicks et al. Int. J. Mod. Phys. A**34**, 1934019 (2019).

Self-Modulation

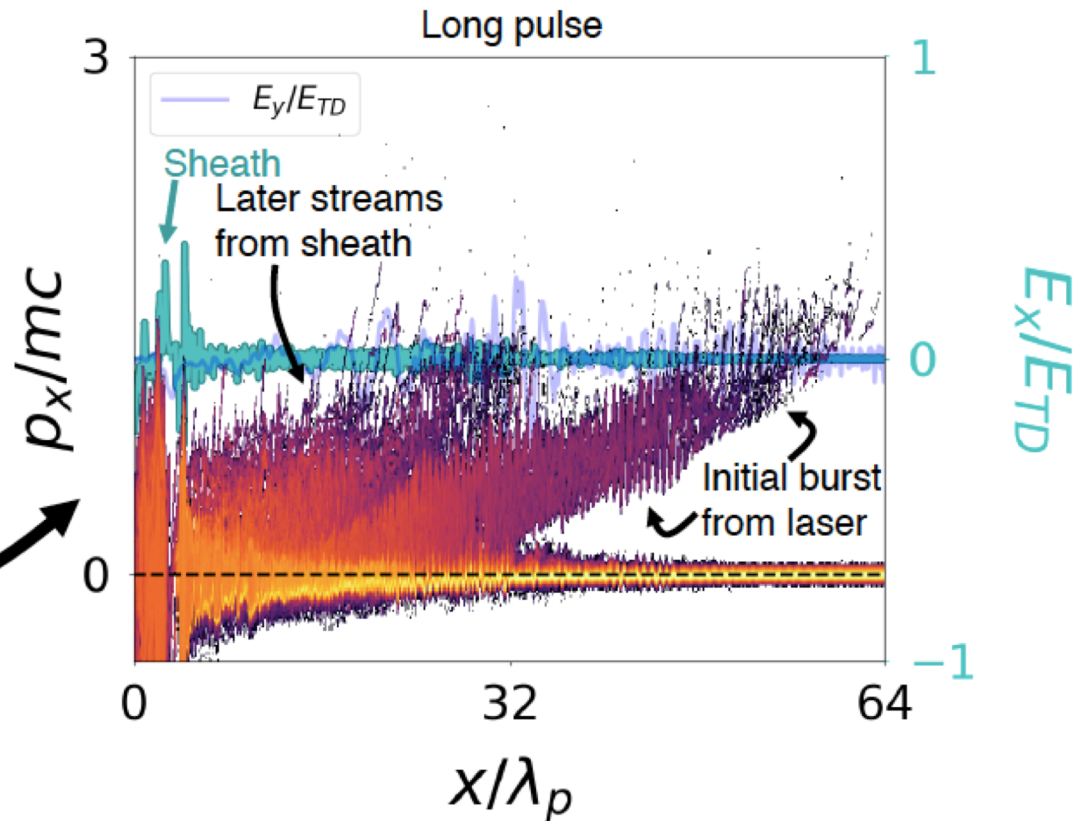
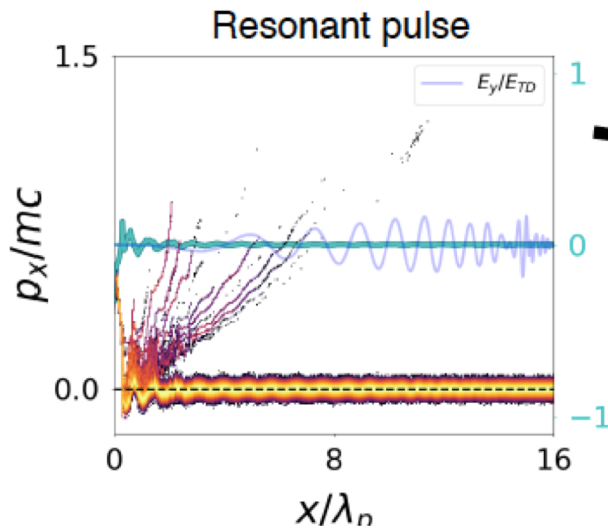
- Fiber lasers \rightarrow long pulse better
- Self-modulation: long pulse breaks \rightarrow small pulses
- Pulse length λ_l/λ_p scanned, $n_c/n_e = 10$, $a_0 = 1$
- Long pulses \rightarrow Laser/wakefield modulated



LWFA in low energy high density regime: #2

Self-Modulation at the Critical Density

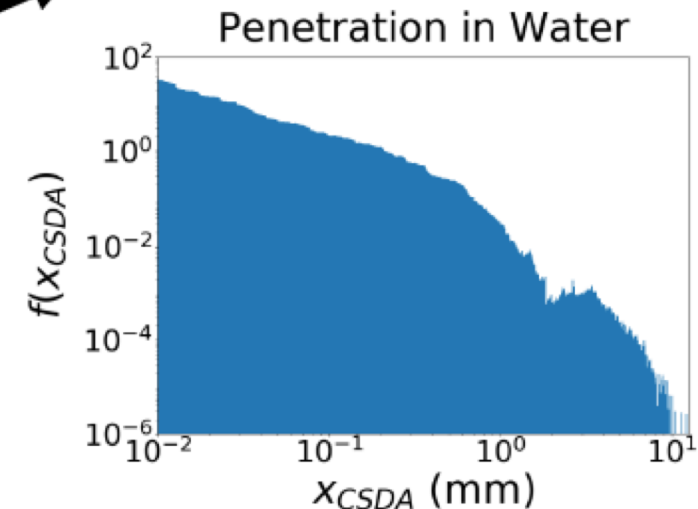
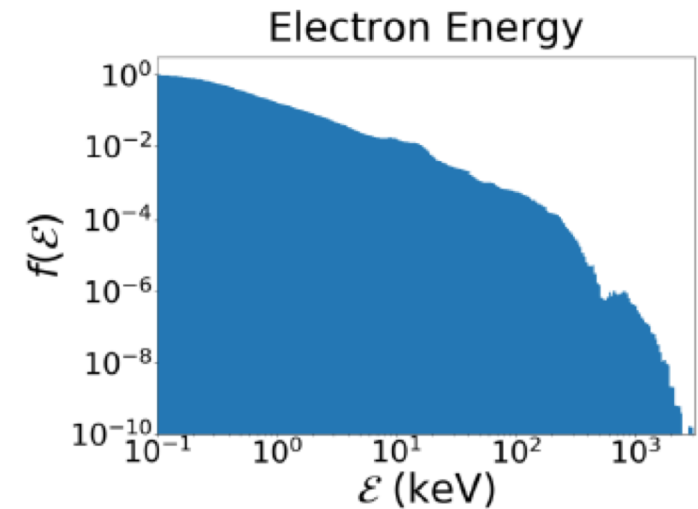
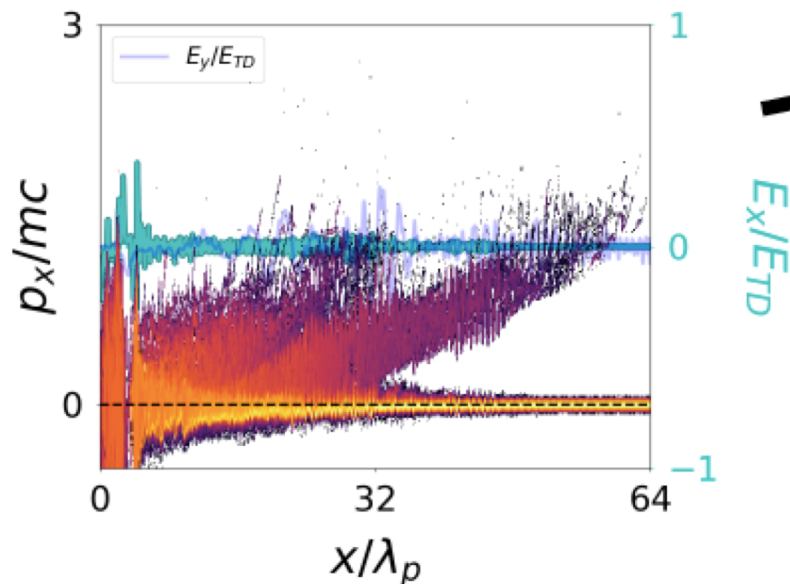
- Critical plasma + long laser pulse ($\lambda_l = 8\lambda_p$)
- $v_g = 0 \rightarrow$ huge sheath oscillation
- Violent sheath \rightarrow huge electron acceleration
- Laser \rightarrow initial burst
- Sheath \rightarrow later streams



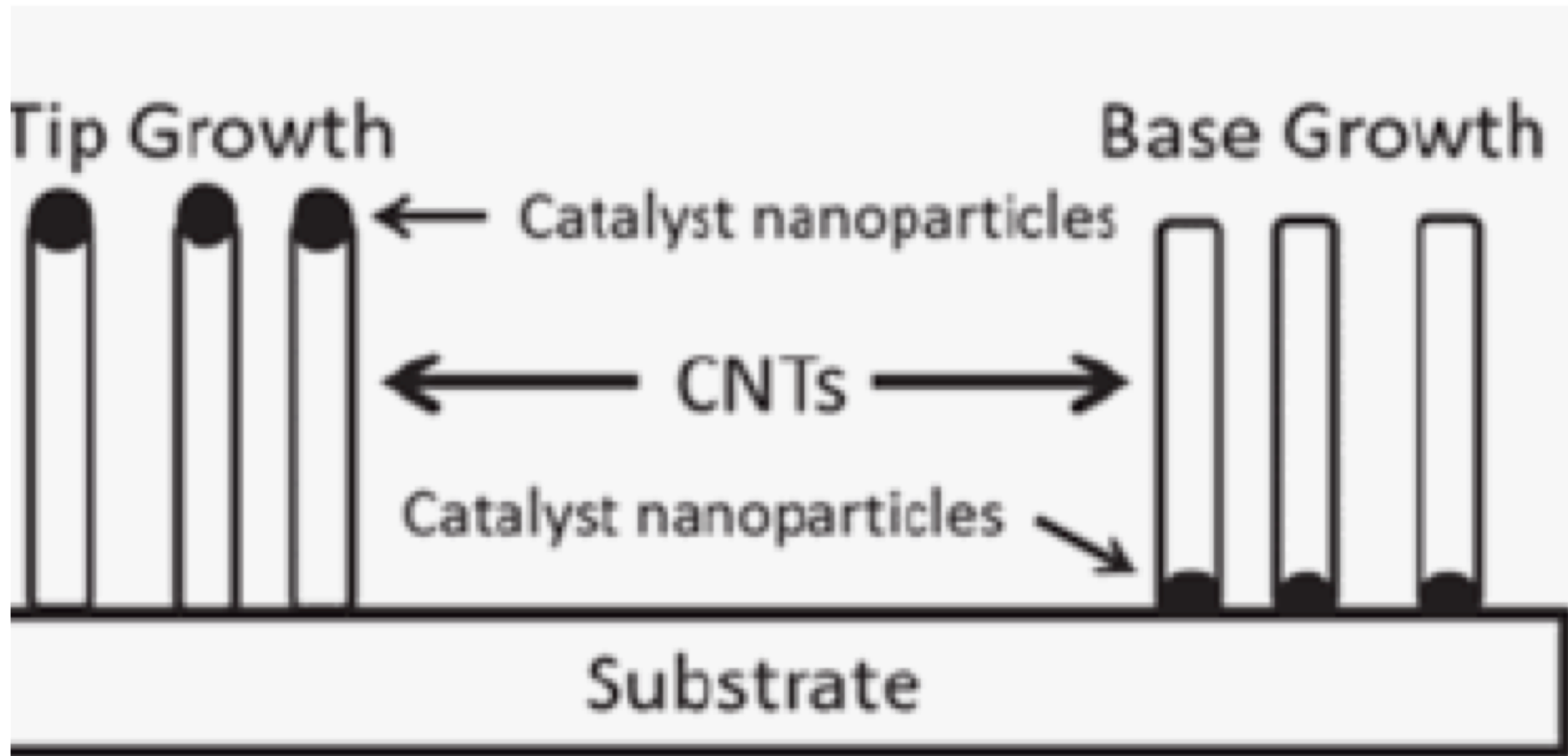
LWFA in low energy high density regime: #3

Electron Tissue Penetration

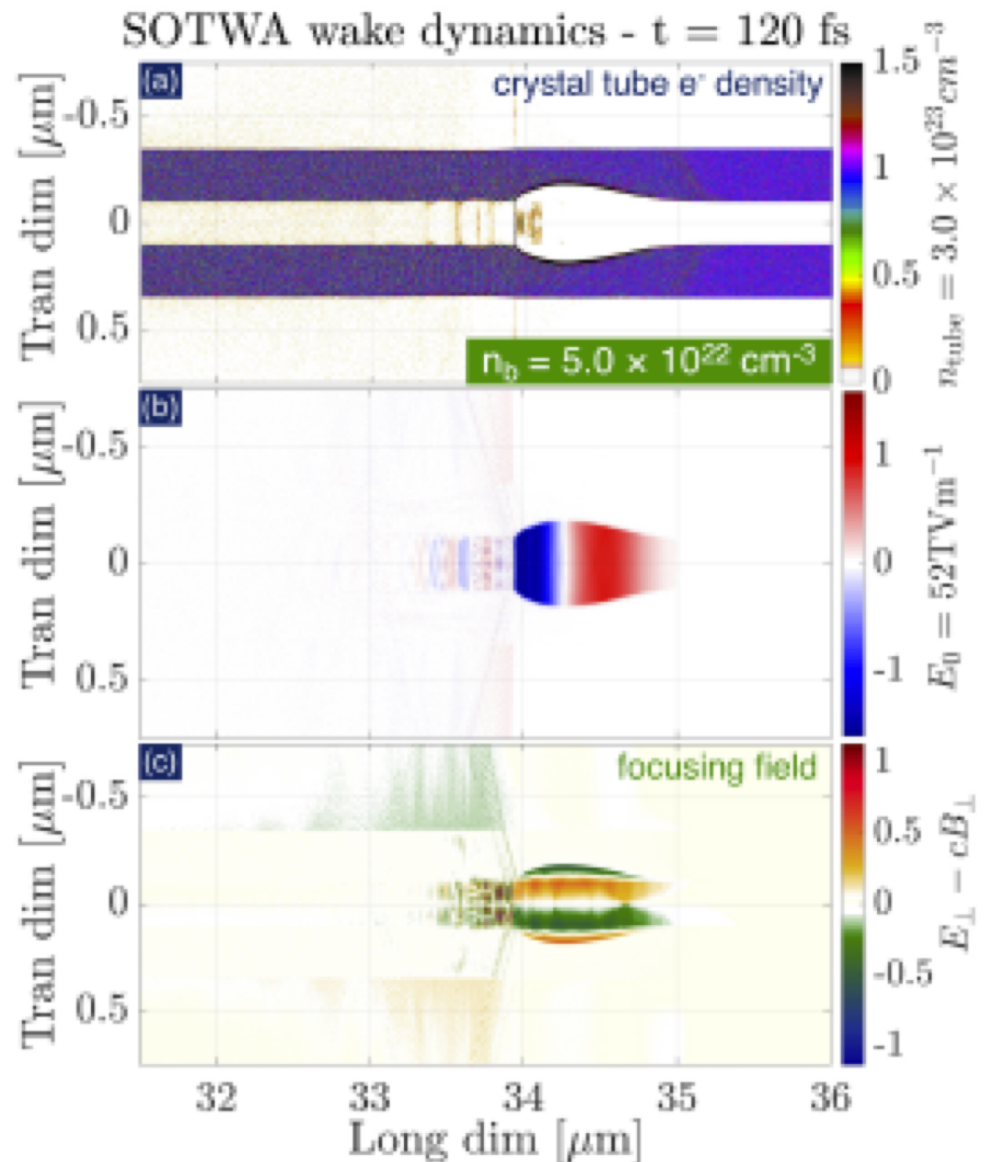
- Critical plasma + long laser pulse ($\lambda_l = 8\lambda_p$)
- Electron energy spectrum \rightarrow tissue penetration
- Continuous slowing-down approximation (CSDA)
- Penetration \rightarrow tuned by $n_c/n_e, a_0$



Nanotubes organized with the substrate



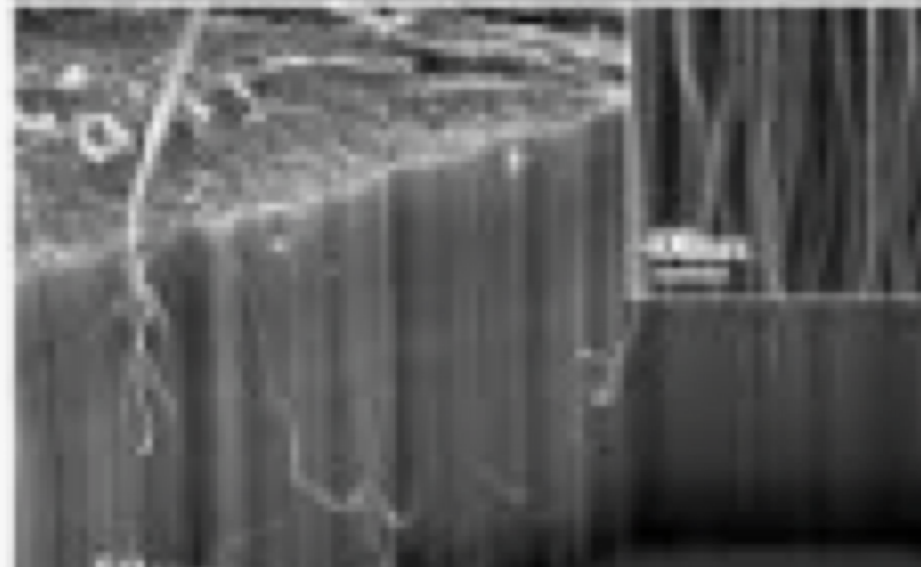
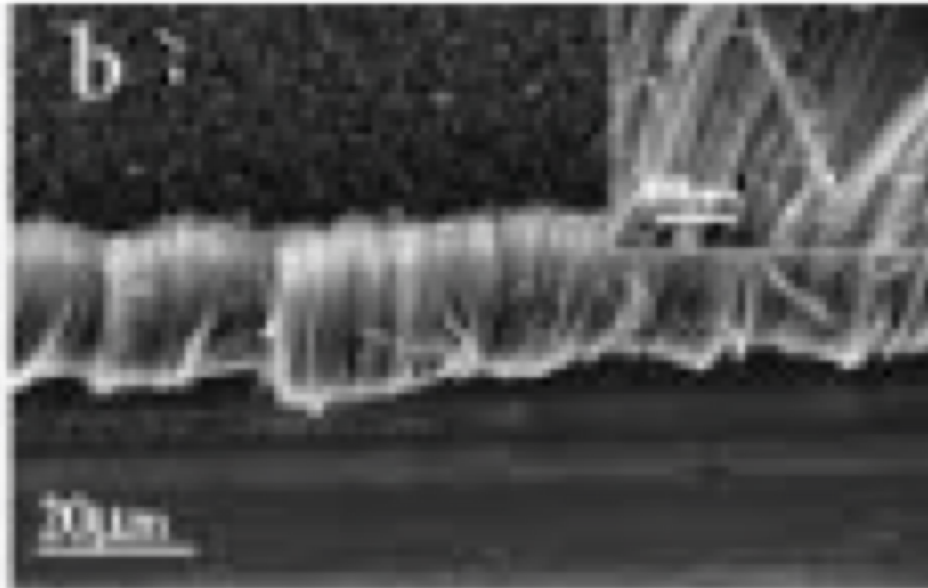
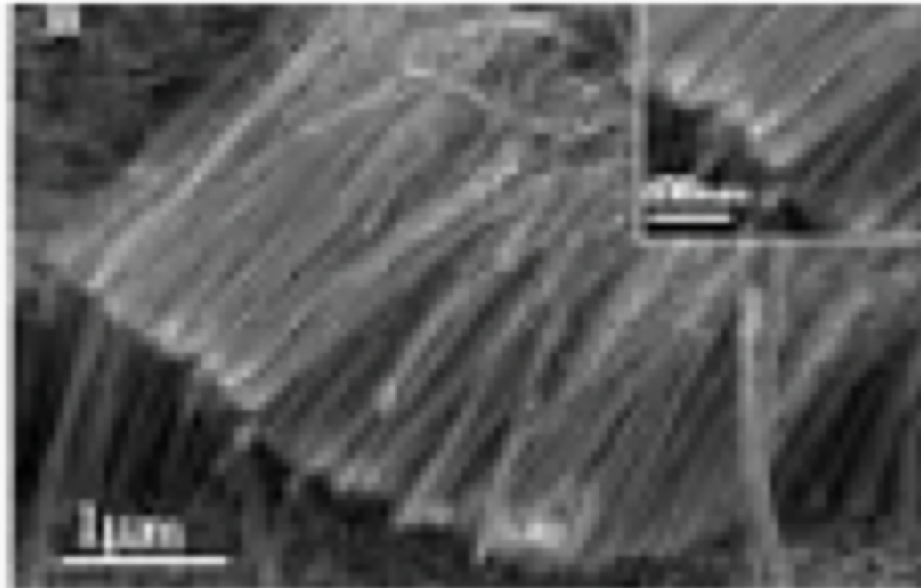
Self-focusing force of electrons in carbon nanotube



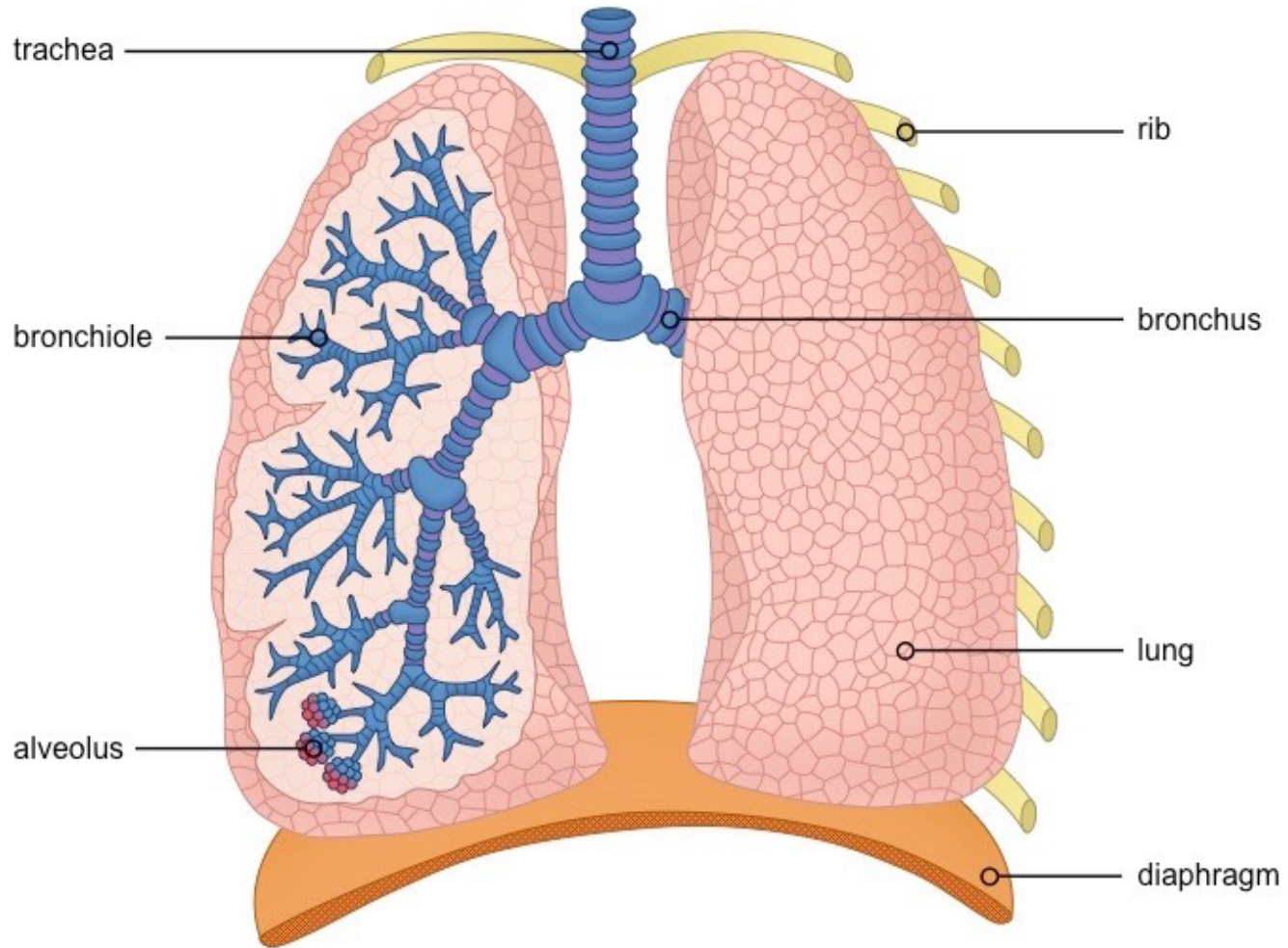
A. Sahai, et al.
Int. J. Mod. Phys. A**34**, 1943009 (2019).

2.5D PIC simulation snapshot of the tube wall electron density (in a)

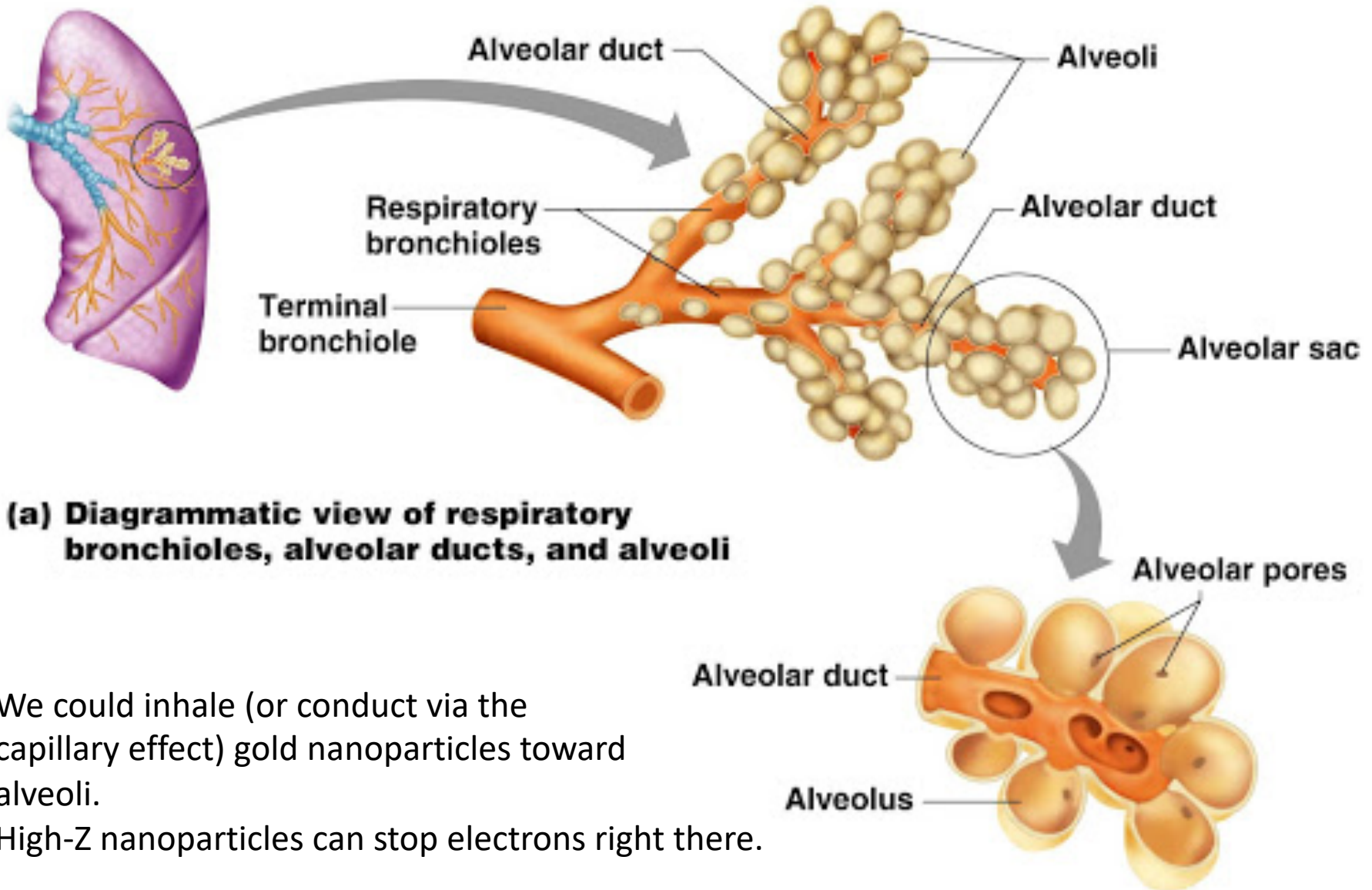
Carbon nanotubes on a substrate:
→ toward **Carbon Nanobroom**



Hierarchy of bronchi



Broncheoli and alveoli



We could inhale (or conduct via the capillary effect) gold nanoparticles toward alveoli.

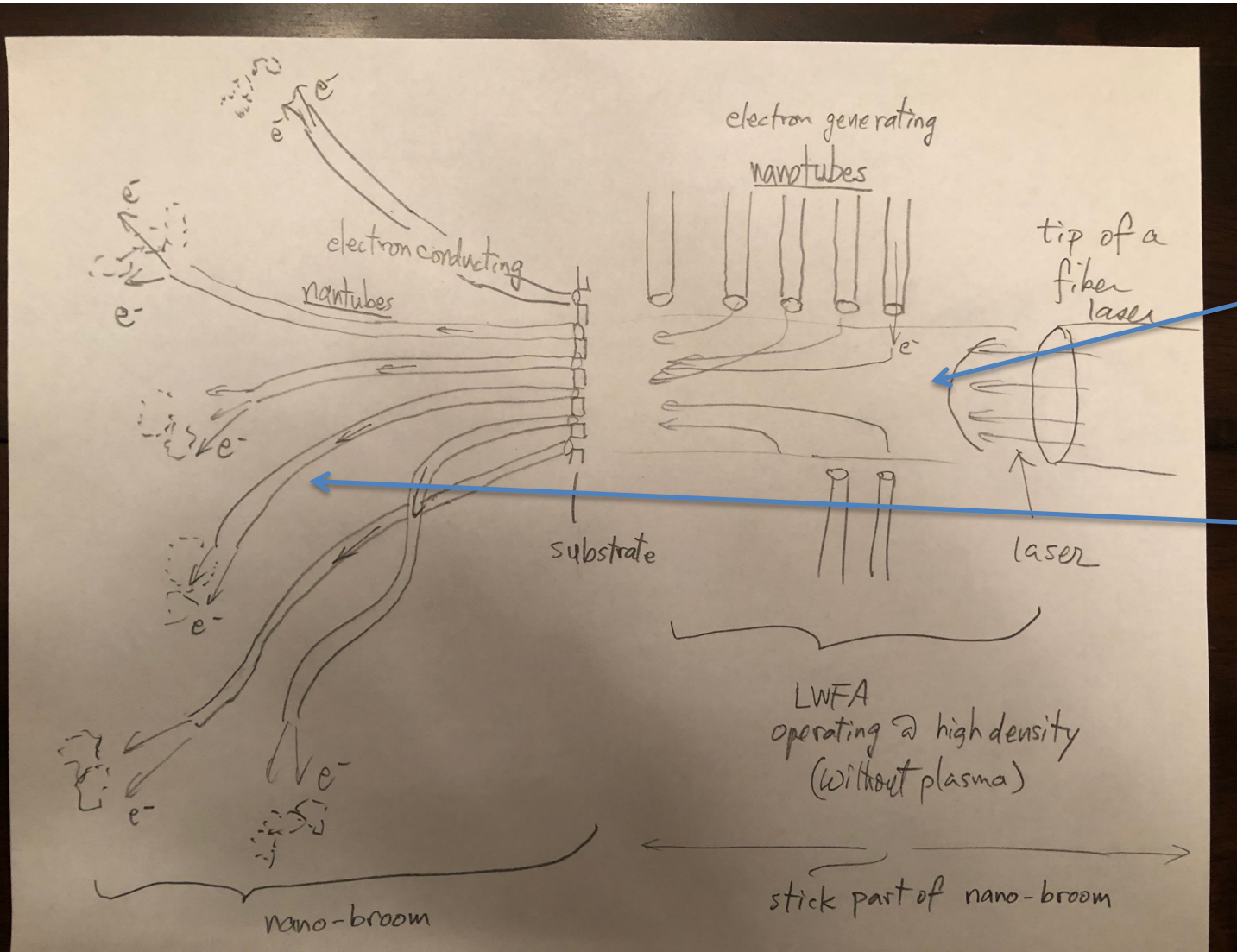
High-Z nanoparticles can stop electrons right there.

Nanobroom at the tip of LWFA

Nanobroom

“bamboo forest” of nanotubes

alveoli bronchioli \leftrightarrow bronchus



Electrons locally into the **bronchus** (till where the **laser fiber** reaches)

Through **bronchioles** (via self-focusing through “boom” nanotubes) and reach **alveoli**

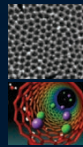
Recent advancements in generation of intense X-ray laser ultrashort pulses open opportunities for particle acceleration in solid-state plasmas. Wakefield acceleration in crystals or carbon nanotubes shows promise of unmatched ultra-high accelerating gradients and possibility to shape the future of high energy physics colliders. This book summarizes the discussions of the "Workshop on Beam Acceleration in Crystals and Nanostructures" (Fermilab, June 24–25, 2019), presents next steps in theory and modeling and outlines major physics and technology challenges toward proof-of-principle demonstration experiments.

Book published (2020)

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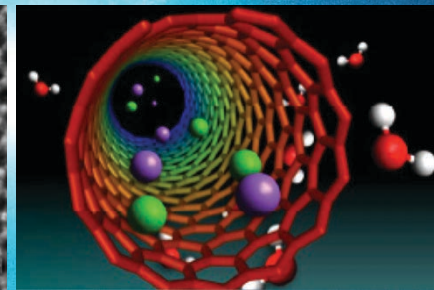
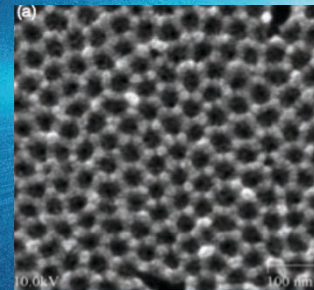



BEAM ACCELERATION IN CRYSTALS AND NANOSTRUCTURES

Edited by

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Vladimir D. Shiltsev • Toshiki Tajima

BEAM ACCELERATION IN
CRYSTALS AND NANOSTRUCTURES



 World Scientific

Community gathered for **nanostucture acceleration** (Fermilab, 2019)

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- <https://faculty.sites.uci.edu/tajima/medicine-physics-team-to-tackle-covid-19/>