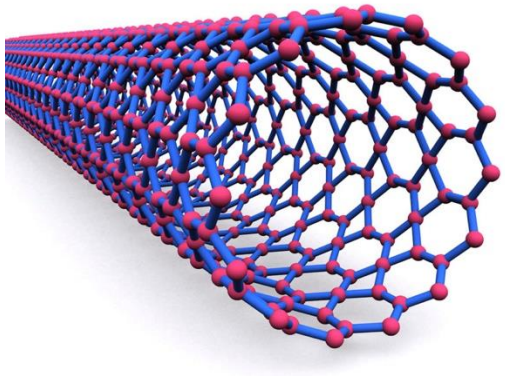
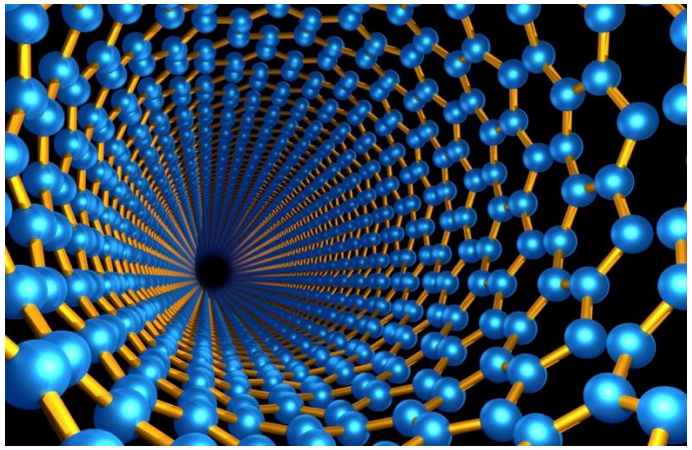
NanoAc Research---

What is the next step?





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Current status

- We have gained much better understanding about electron acceleration in laser/beam driven carbon nanotubes and graphene layers.
  - TeV gradient observed from simulation
  - Coherent synchrotron radiation observed from simulation
  - high quality electron beam generated (100s pC-nC charge and low emittance)
- 10+ papers have been published since 2018 including Scientific Reports, New Journal of Physics, Physics of Plasmas, Physical Review Letters, etc.
  - Highlights including effective density method,
  - Catapult acceleration mechanism,
  - Hydrodynamic model approach,
  - Surface plasmons, coherent synchrotron radiation, etc.
- NanoAc Collaboration formed
  - Expertise/skills available for experiment
  - Valencia Uni., UFCSPA, Liverpool Uni., Manchester Univ., INFN, …

Funding schemes

Horizon Europe

- **Overview:** The EU's main research and innovation program for 2021–2027, with a budget of over €95 billion.
- **Pillars:**
  - **Pillar I: Excellent Science:** Focuses on basic research, including funding from the ERC and Marie Skłodowska-Curie Actions.
  - **Pillar II: Global Challenges and European Industrial Competitiveness:** Funds research to tackle societal challenges and strengthen industrial competitiveness.
  - **Pillar III: Innovative Europe:** Supports innovation through the European Innovation Council (EIC).

European Research Council (ERC)

- **Mission:** To fund high-risk, high-reward frontier research in all fields on the basis of scientific excellence.
- **Grant Schemes:**
  - **Starting Grant:** For early-career researchers establishing their own research group (2-7 years post-PhD).
  - **Consolidator Grant:** For researchers looking to consolidate their independence (7-12 years post-PhD).
  - **Advanced Grant:** For established researchers.
  - **Synergy Grant:** For groups of 2-4 principal investigators to work together.
  - **Proof of Concept Grant:** For ERC grant holders to explore the innovation potential of their research.

European Innovation Council (EIC)

- **Mission:** To support individual companies and innovation-driven SMEs to develop and scale up breakthrough innovations.
- **Grant Schemes:**
  - **EIC Pathfinder:** For advanced research on breakthrough, game-changing technologies.
  - **EIC Transition:** For transforming research results into innovation opportunities.
  - **EIC Accelerator:** For individual SMEs to develop and scale up breakthrough innovations with high potential.

Proposal for ERC 2026 (2026-2039)

- **NanoAc – Towards a new paradigm in TeV/m acceleration in nanotubes**.
  - Laser driver (ELI, Spanish research institute? Laser specifications, wavelength, energy, pulse length, focal spot size, etc, Support letter from laser institute needed)
  - Targets preparation (carbon nanotube, single or multiple layers, graphene? INFN, Manchester, industry support)
  - Diagnostic (energy spectroscopy, Integrating current transformer for charge measurement, others to characterize the targets-SEM, TEM)
  - Simulation/Theory Support (PIConGPU, WARP-X, FBPIC, AI/ML assisted optimisation…), using effective density method to predict the experiment results?

ERC Synergy grant 2027-2031

- Once the PoC experiment starts, we can apply for synergy grant
- €10M, 4 PIs from different institutions
- Aim for big experiment and applications
- Mention the sustainability in future accelerators, European strategy for particle physics, how to benefit other research areas
- Potential applications, compact electron accelerators, radiation sources (x-ray, gamma-ray), VHEE
- Collaboration with FACET II

Possible experiments

- **Laser driven solid-state plasmas:**
  - Laser facilities from SIOM
  - Laser facility from CLPU
  - ELI ALPS
  - CLARA 120 TW laser (surface plasmon)
  - …

- **Electron beam driven solid-state plasmas:**
  - FACET II beam from SLAC (100kA drive e- beam)
  - Some LWFA facility generated e-beam

- **X-ray driven solid-state plasmas:**
  - European XFEL
  - LCLS II

(https://lasers4.eu)

First experiment to be defined and conducted next year

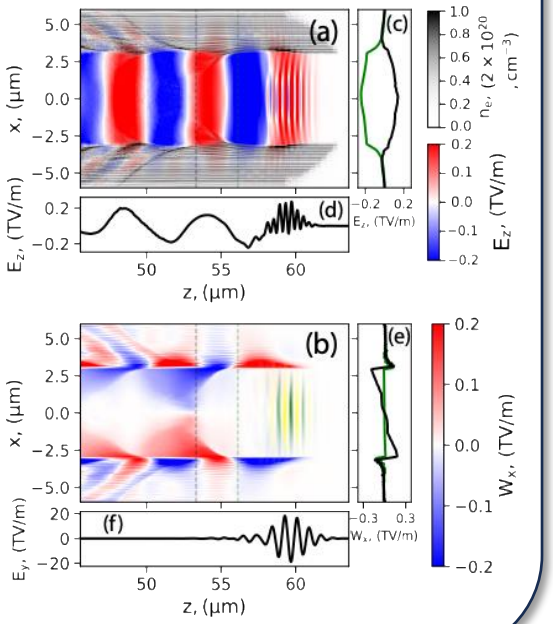
- Simple structures-carbon nanotube bundle/forest
- Targets needs to be characterized before installation
- Damage test under high power lasers
- Replaceable/changeable targets/rotation target
- Measurable parameters-energy gain, bunch charge, profile, bunch length, etc.

Other related topics to be discussed

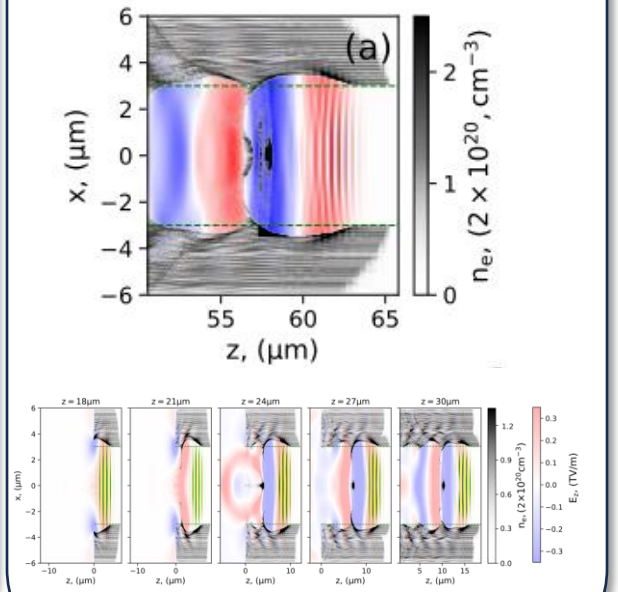
- Theoretical necessary-new schemes
- Simulation demands-PIC, MHD codes
- Target design, preparation, manufacture and characterization
- Parameter optimization
- Experimental layout and plans
- Diagnostic requirements

New Concepts

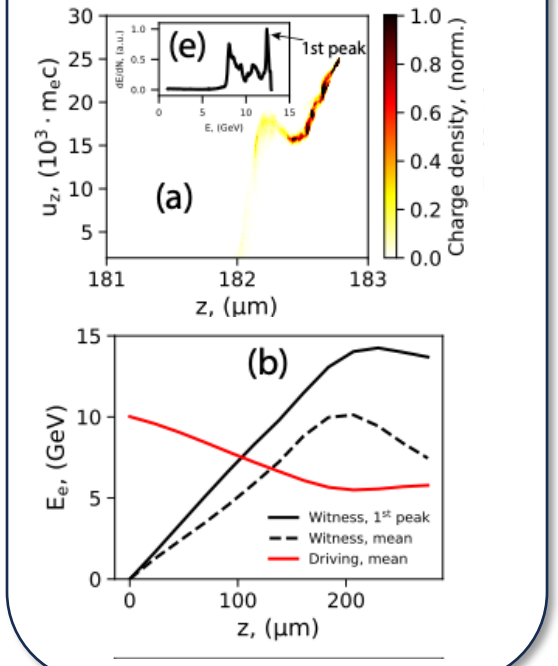
Relativistic surface plasmon



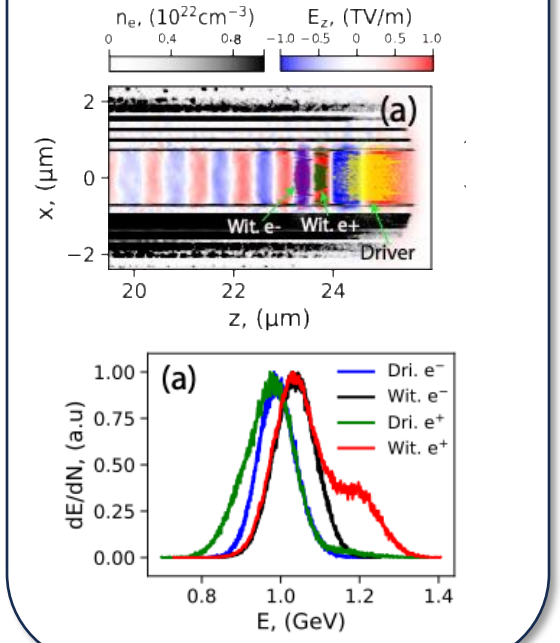
Bubble wakefield and self-injection in solid plasma



Unprecedented high accelerating gradient



Both e^+ and e^- acceleration

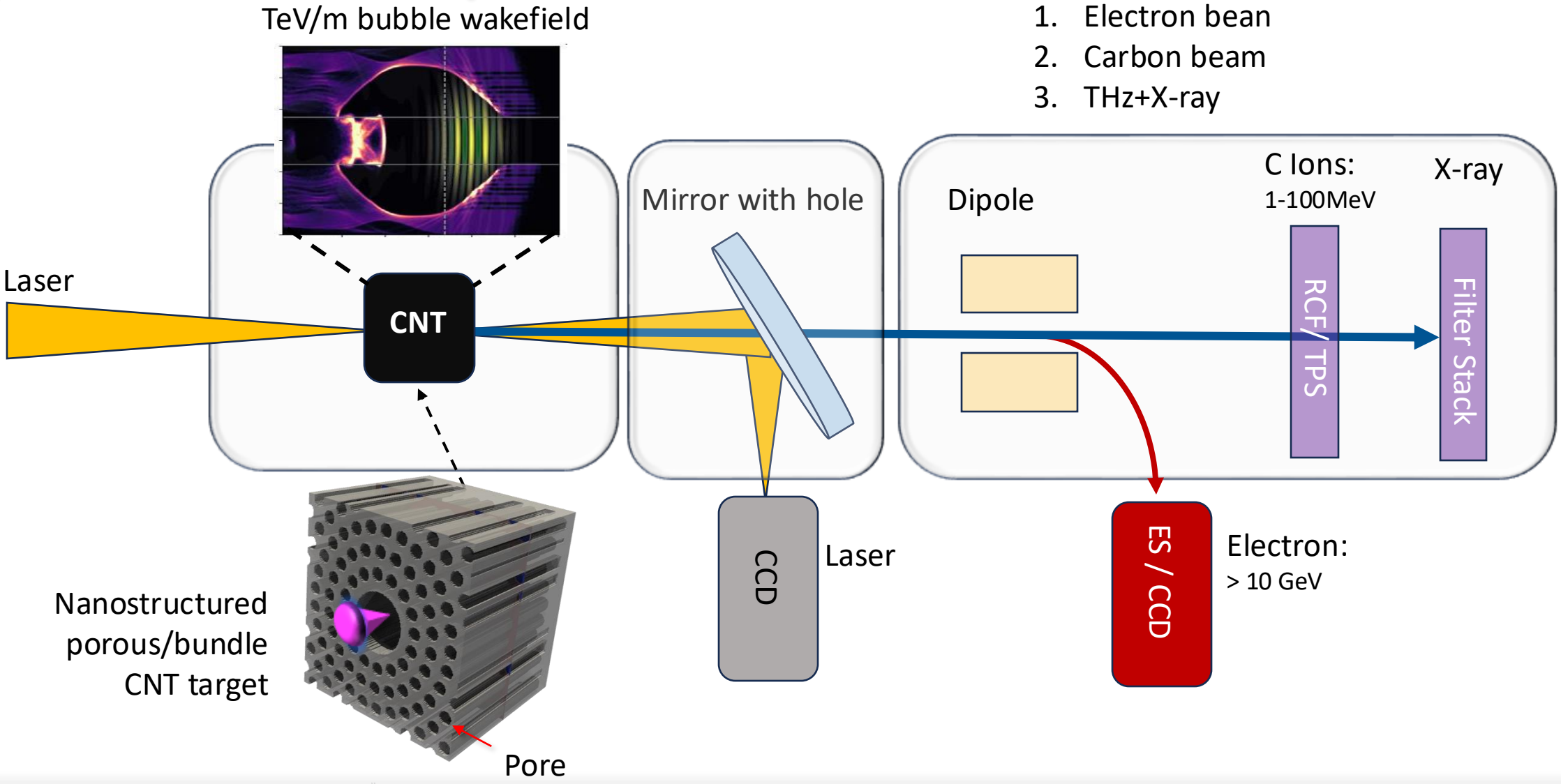


tested at FACET II?

Experimental Setup

Secondary sources diagnose:

1. Electron bean
2. Carbon beam
3. THz+X-ray



NanoAc workshop 2026

NanoAc 4th Workshop next year? Combined with Channeling 2026?

(Manchester, Vanencia, Frascati, Liverpool…)

Invites Toshi Tajima and other researchers on board

Laser people, nanotube experts?

Thanks !