

Development of Coherent Electron Emitters

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Alireza Nojeh (UBC, nano-carbon materials)

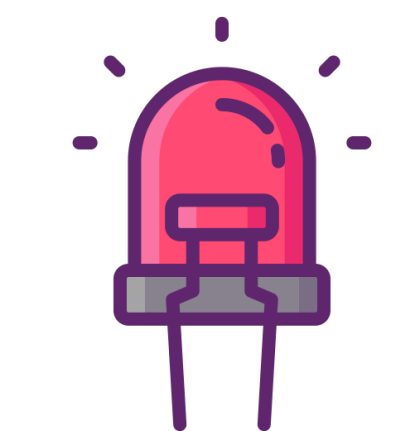
Tatiana Latychevskaia (UZH and PSI)

Motivation and Background



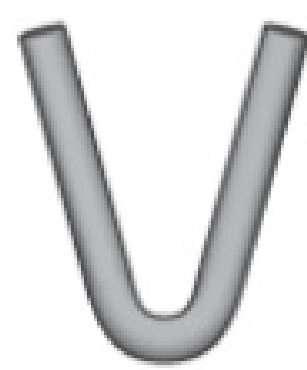
Incandescent light bulb

- No Temporal Coherence
- No Spatial Coherence



Light Emitting Diode

- High Temporal Coherence
- Low Spatial Coherence



Thermionic Emitter

- Low Temporal Coherence
- Low Spatial Coherence



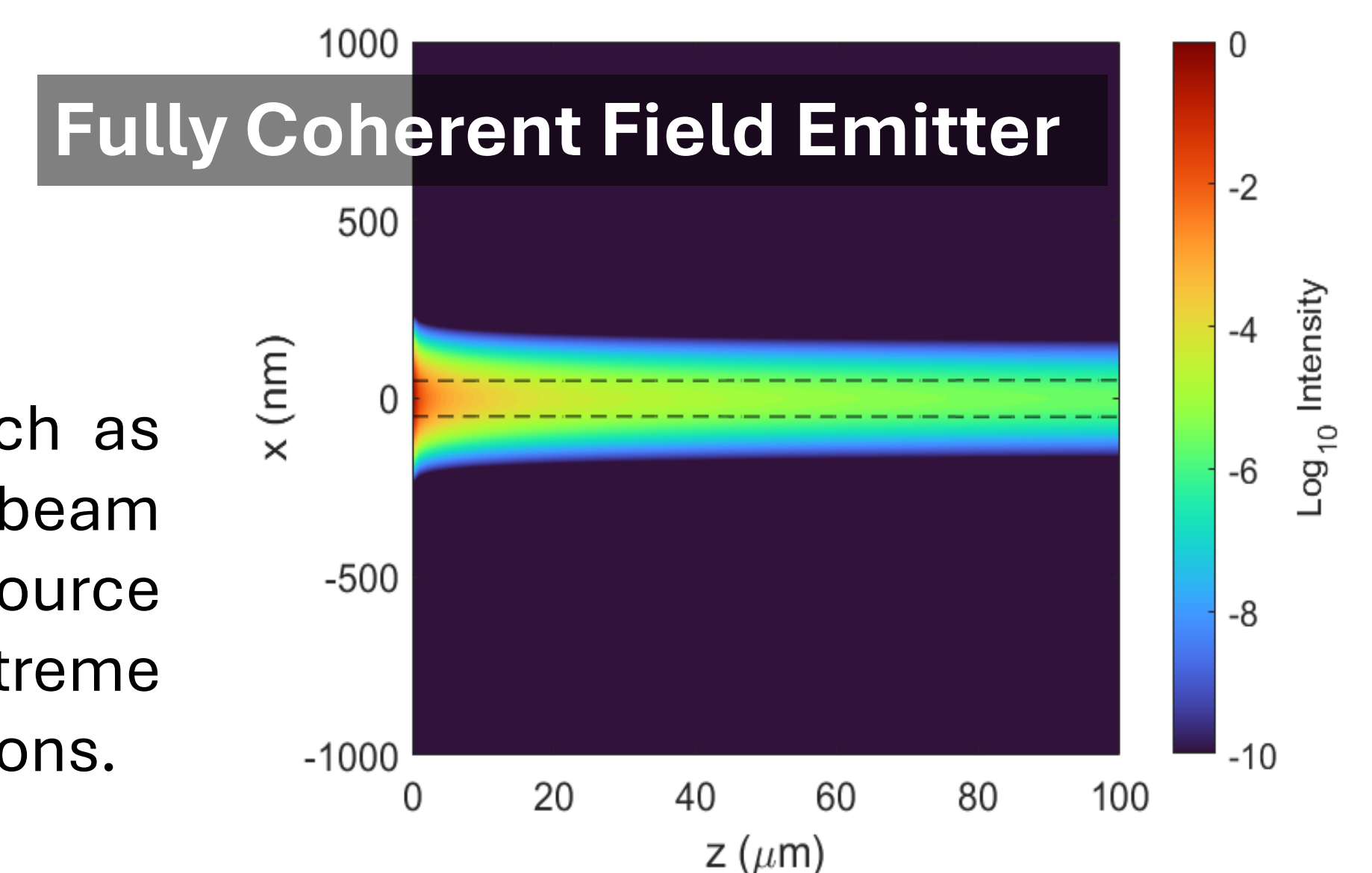
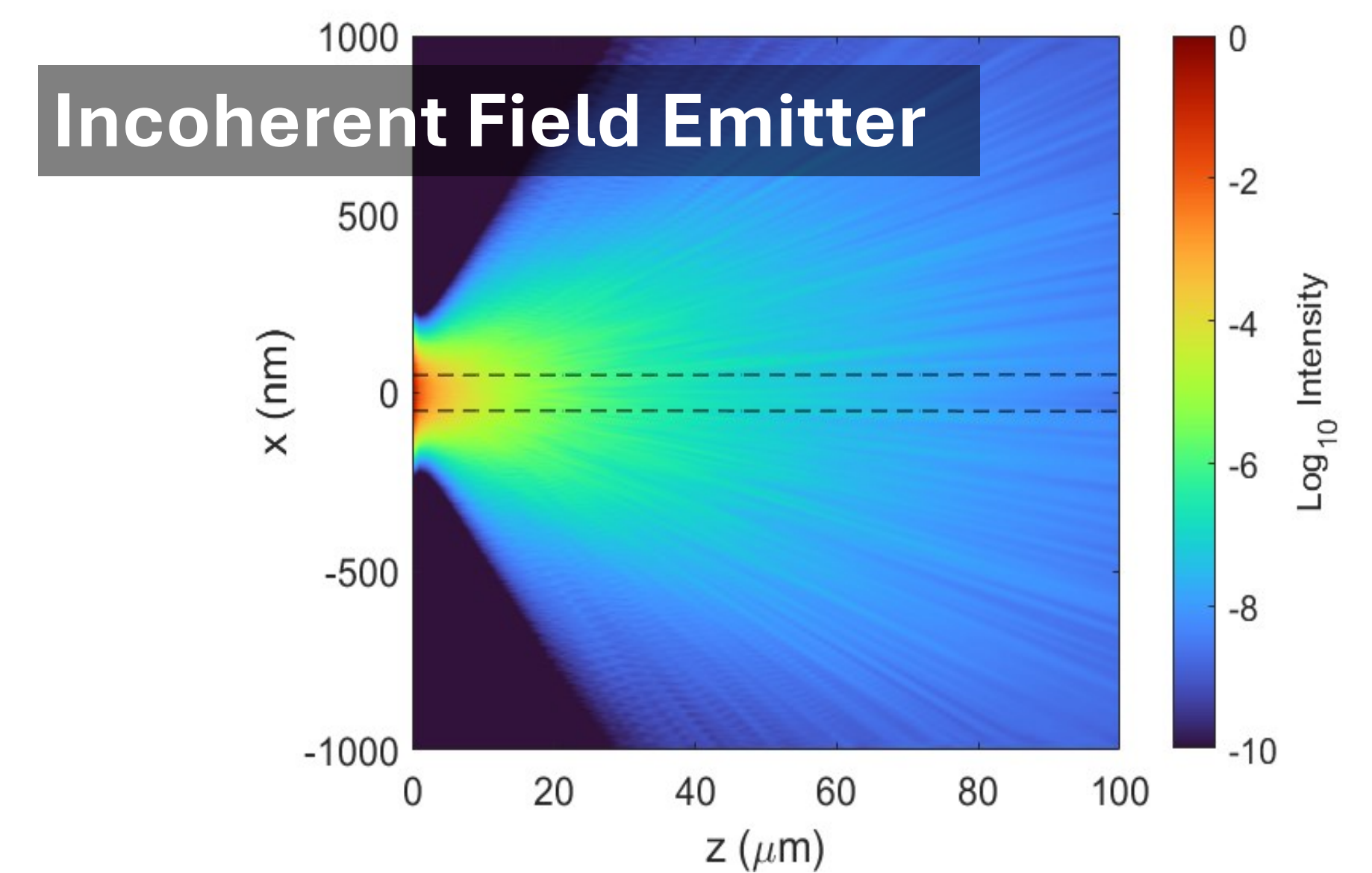
[Cold] Field Emitter

- High Temporal Coherence
- Low Spatial Coherence



Coherent Field Emitter

- High Temporal Coherence
- High Spatial Coherence



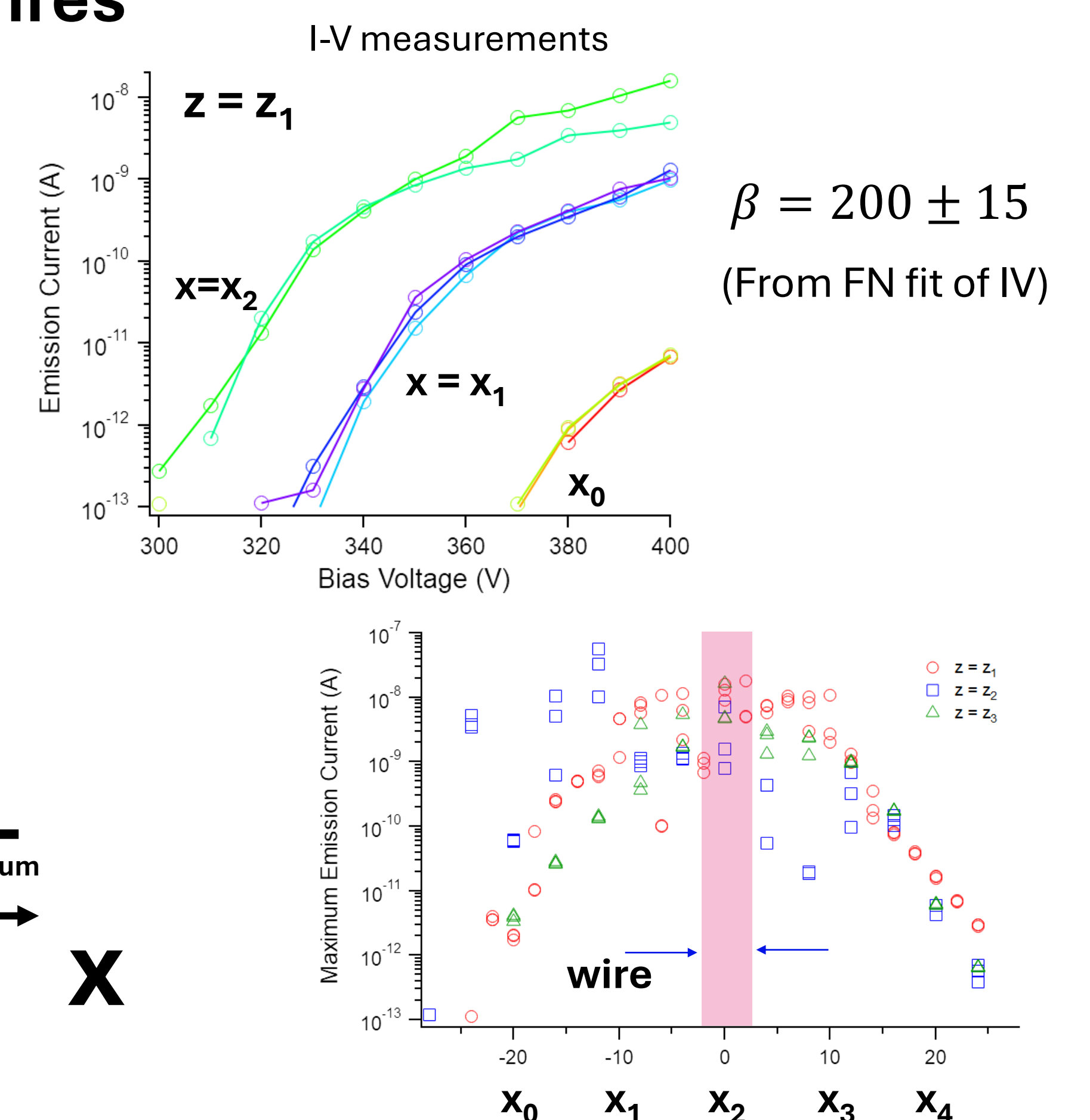
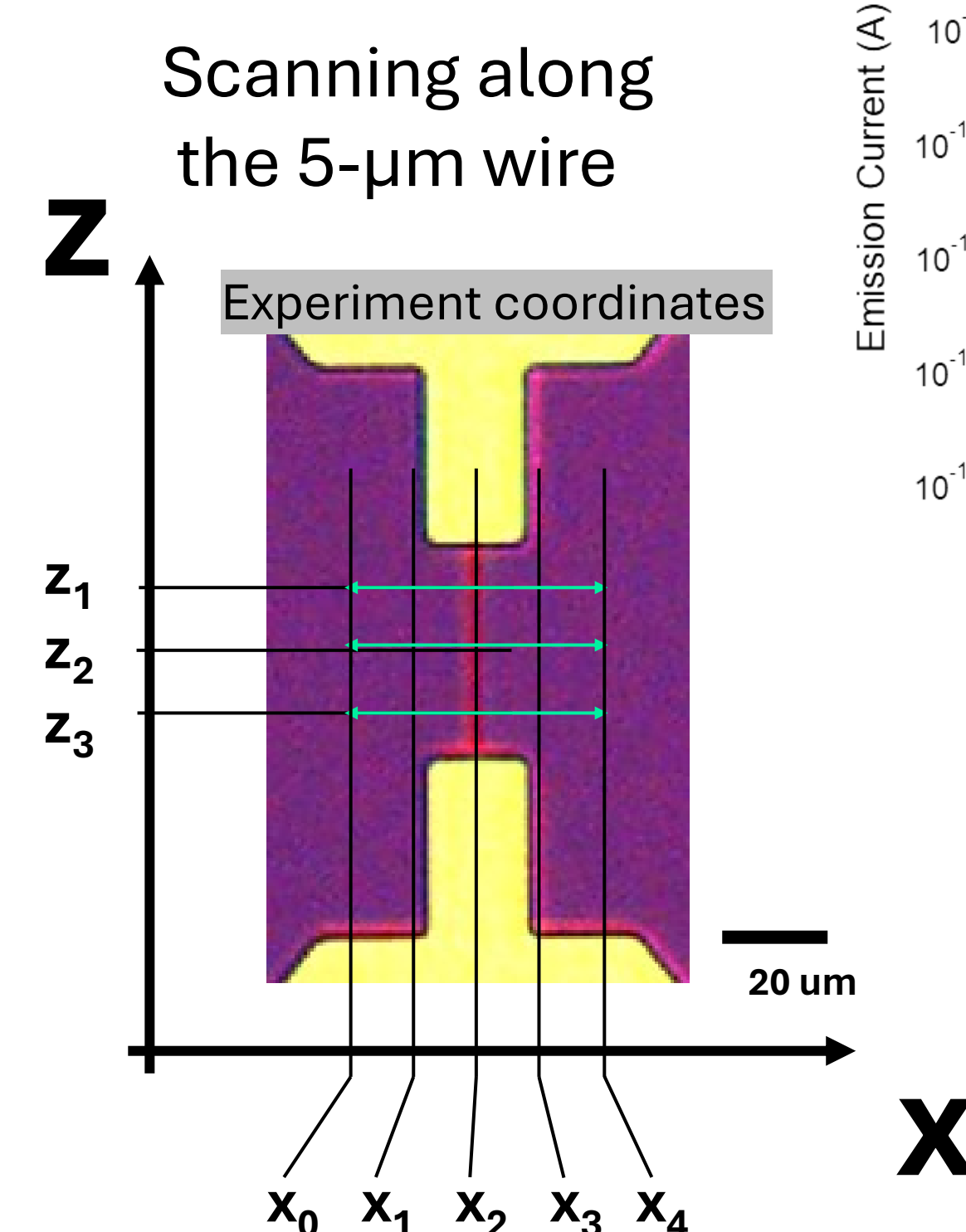
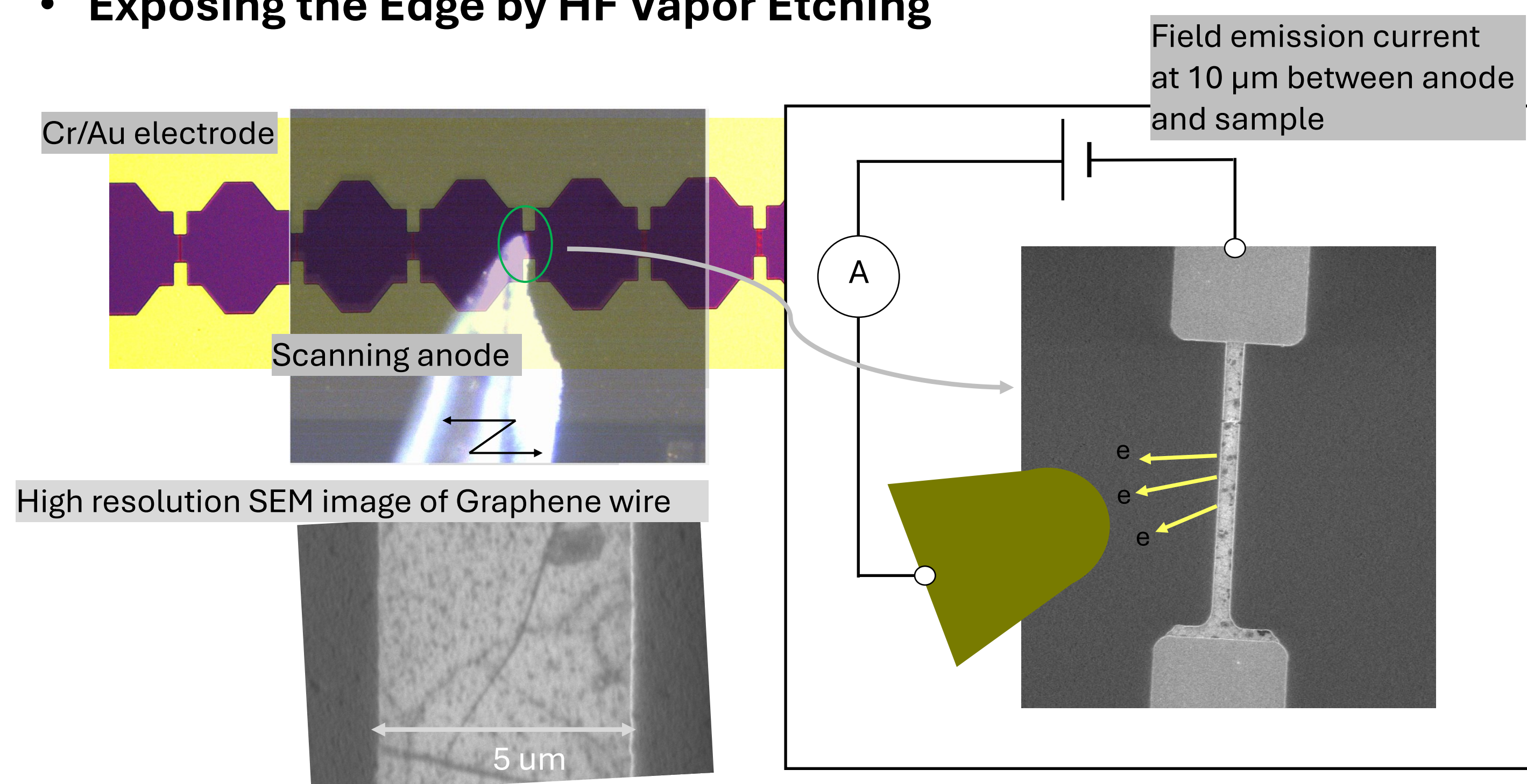
A field emitter with **finite spatial coherence** offers significant advantages for applications such as *electron microscopy* and *diffraction imaging*: In the case of normal metals, achieving a coherent beam requires extremely small source sizes—down to single-atom emitters. In contrast, if the electron source itself is intrinsically coherent over a finite area, it can produce a coherent beam without requiring extreme spatial confinement. This makes **coherent emitters** highly desirable for advanced imaging applications.

Field Emitters fabricated from Dirac materials: an ultimate spatially coherent electron source?

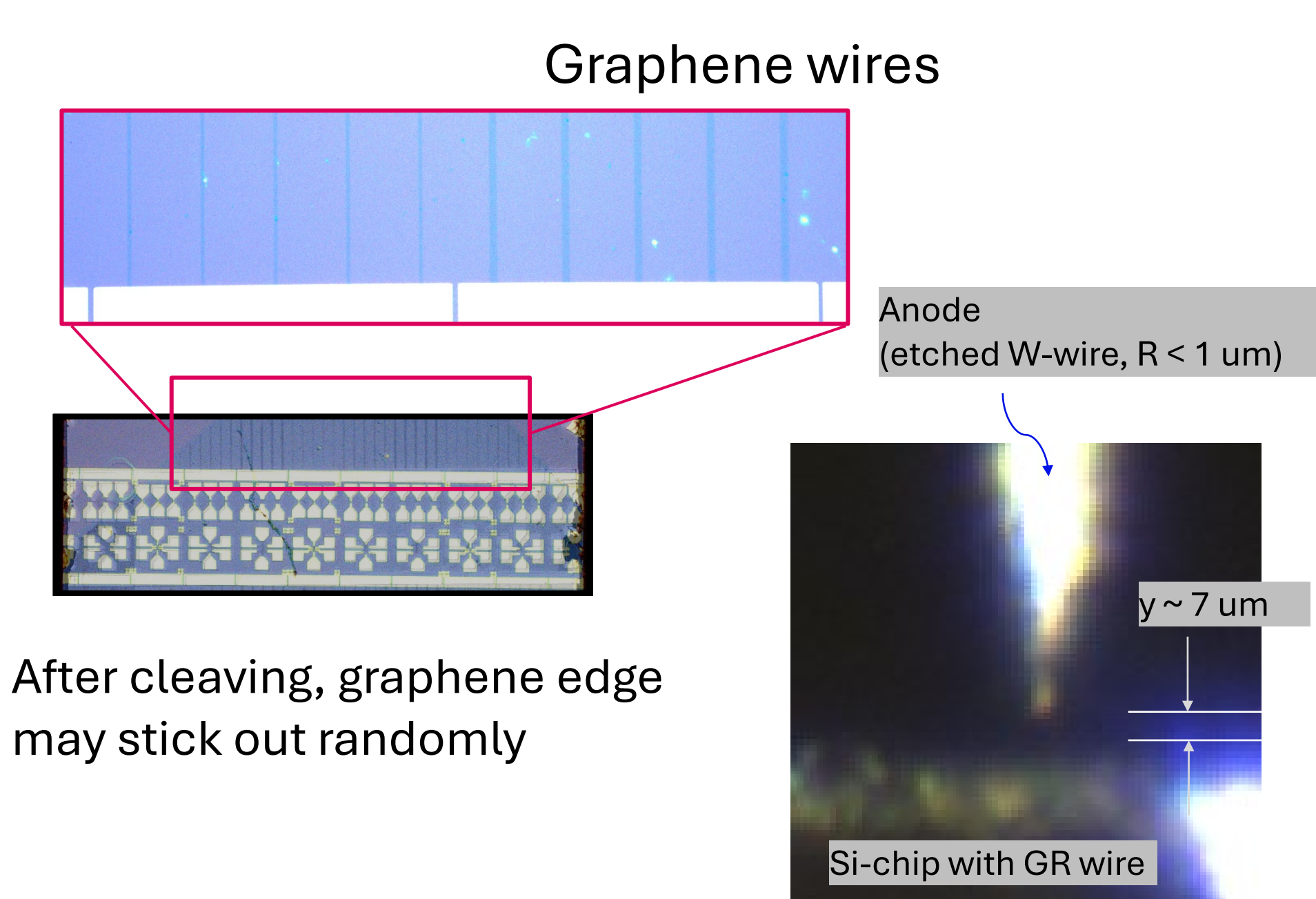
Graphene is a promising candidate for such a coherent field emitter due to its high electrical conductivity, long phase coherence length, and atomically thin structure. In particular, emission from graphene edges is of interest due to their sharp geometry and potential for coherent electron emission.

Scanning Anode Field Emission Measurements of Patterned Graphene Wires

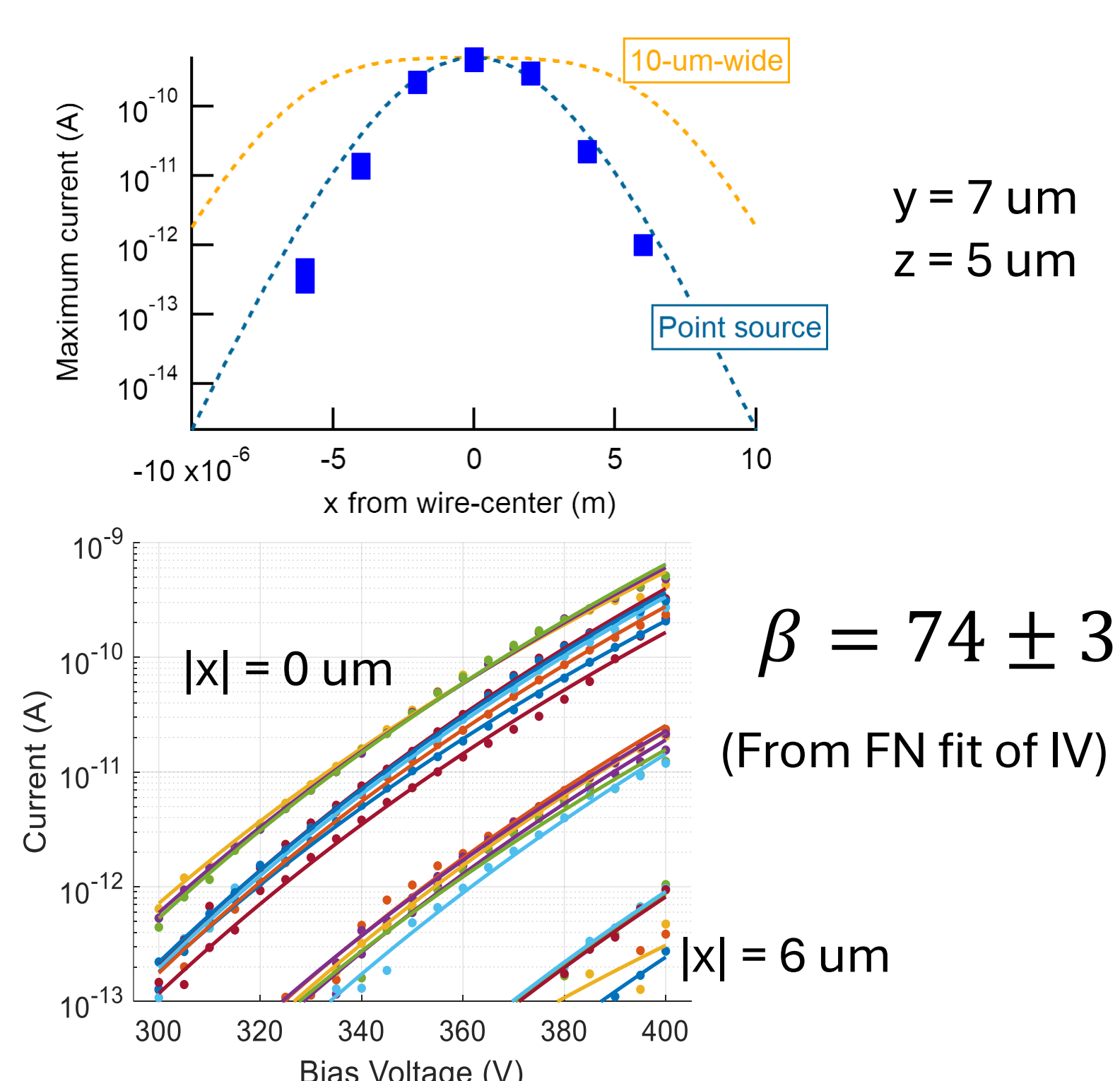
- Fabrication of Graphene Wires by Lithography and O₂ Reactive Ion Etching
- Exposing the Edge by HF Vapor Etching



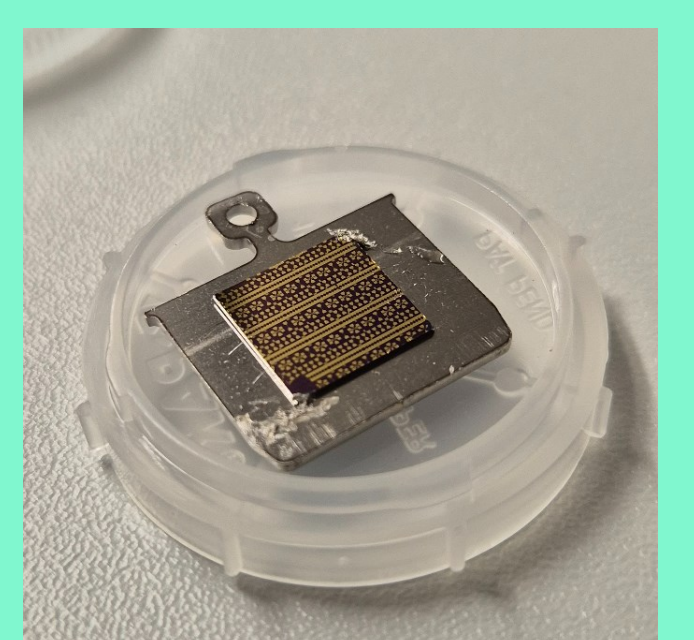
Field emission from patterned GR wire at cleaved edge



Scanning along the edge of a 10-μm wire



Graphene edge is a good field emitter and is a promising candidate for fabrication of a coherent field emitter.



Next steps:

- Electron beam measurement
- Spatial coherence measurement