



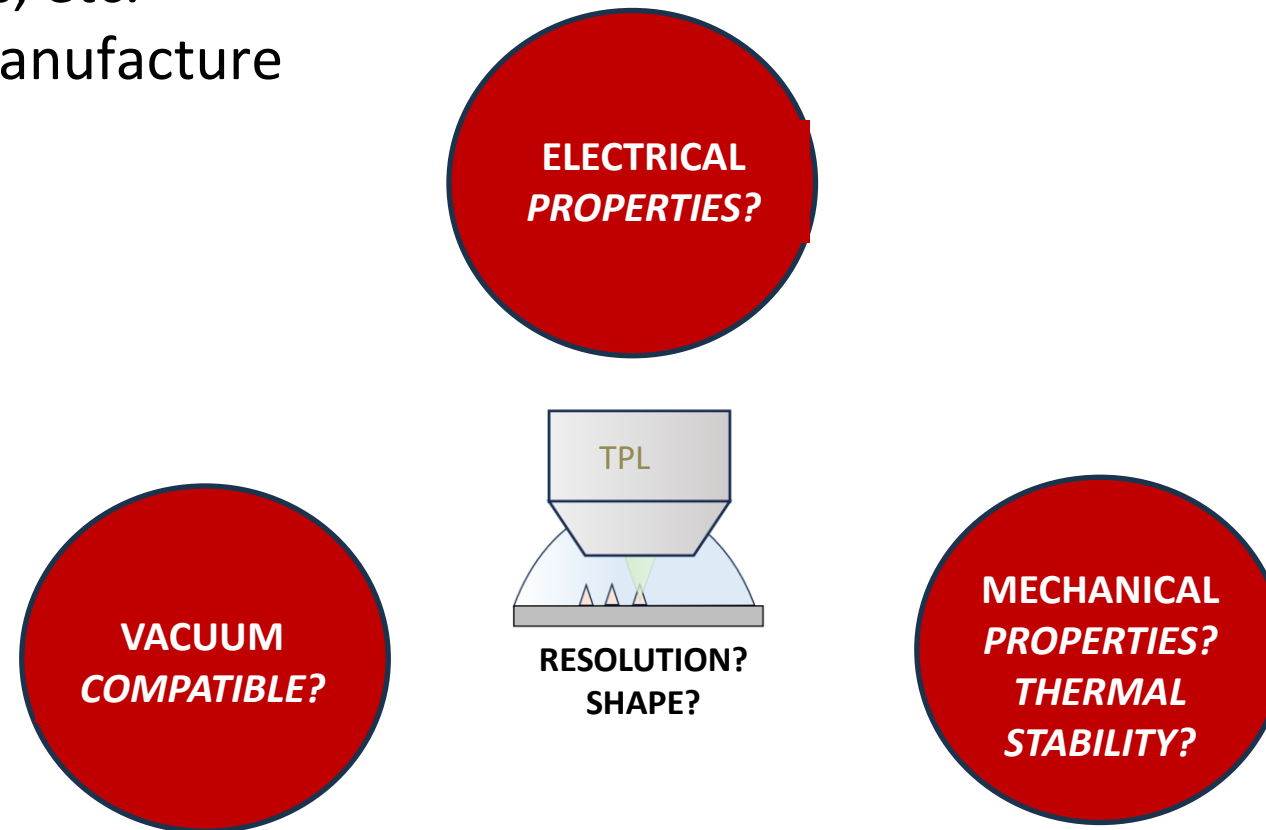
THE MANUFACTURE OF ELECTRON EMITTERS USING MODIFIED PHOTSENSITIVE RESINS

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10th VDE ITG International Vacuum Electronics Workshop (IVEW) 2026
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Goals

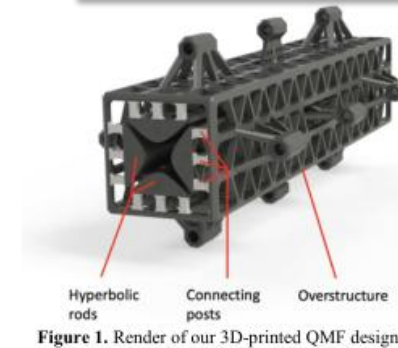
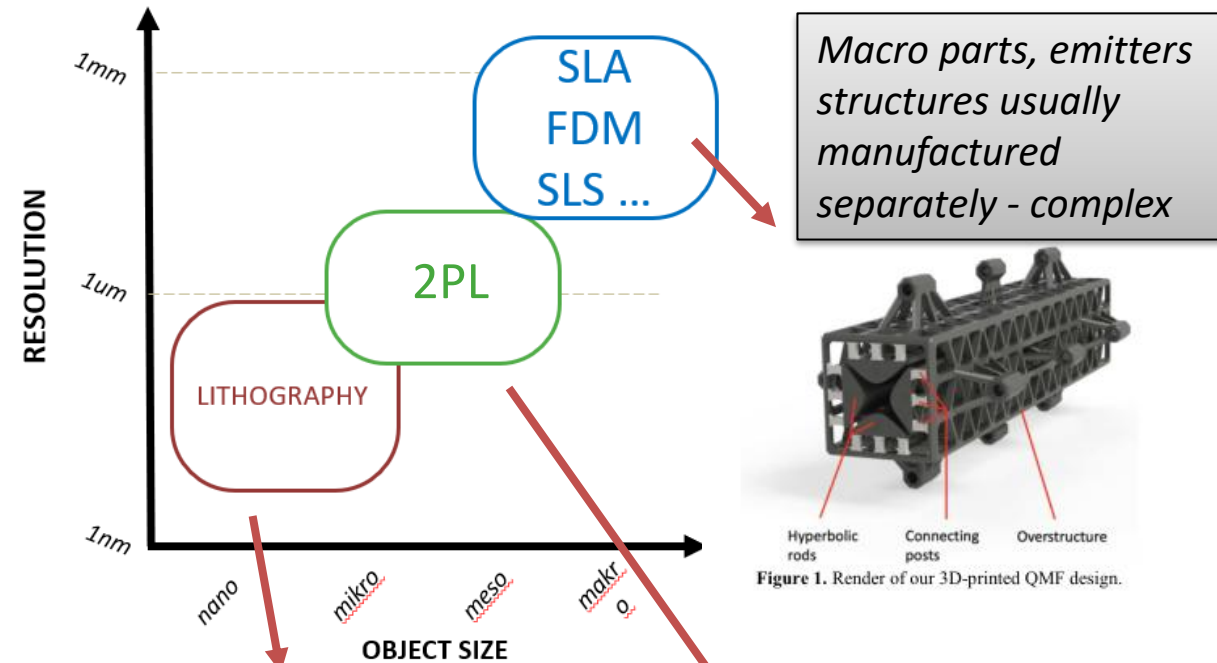
- Miniaturized electron sources – for X-Ray generation, handheld instruments, etc.
- Affordable, easy to manufacture



--> 2-Photon Lithography

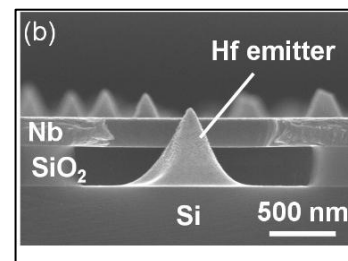
Motivation for 2-Photon Lithography

IQ Nano 3D 2PL printer



Complex lithography steps, more time and equipment heavy

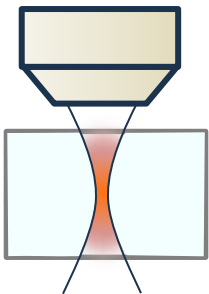
Middle ground, faster prototyping + acceptable resolution



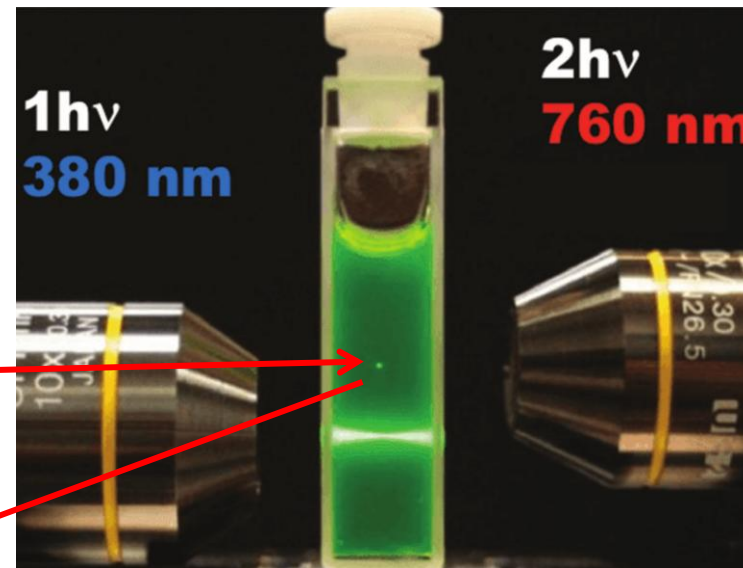
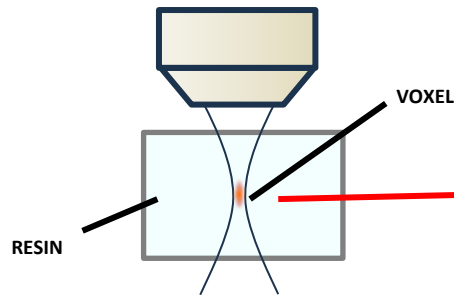
IQ NANO 3D Key technology

2-Photon Absorbtion (2PA)

1-PHOTON
ABSORPTION



2-PHOTON
ABSORPTION

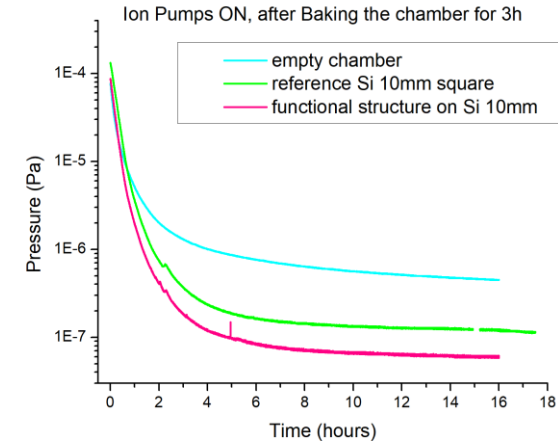
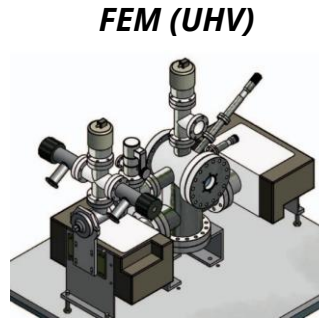


2PA create nonlinear dose distribution in photo resin

Source: *Jonas G. Croissant, et al.*
Adv. Healthcare Mater. 2018

Study of material: Vacuum and Mechanical

**VACUUM
COMPATIBLE?**

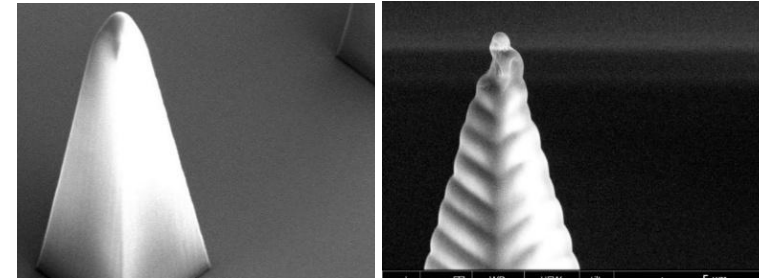
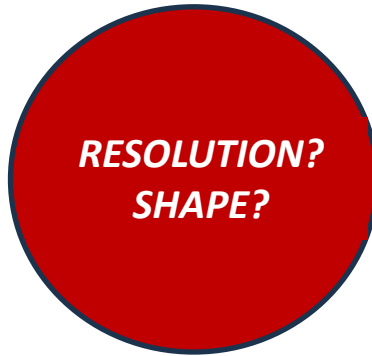


Examples of different resulting shape based on printing parameters

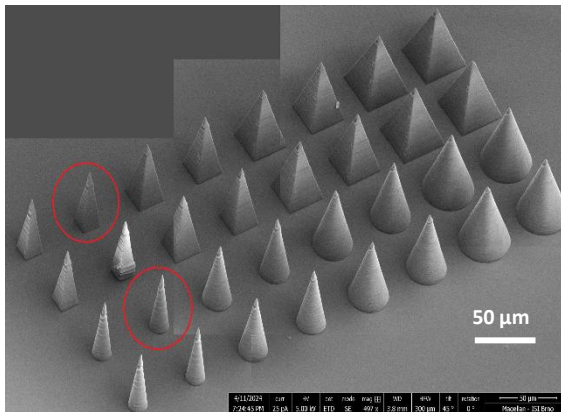
**MECHANICAL
PROPERTIES?
THERMAL
STABILITY?**

- Structures survive during 2PL steps and development
- Note: Sensitive to melting due to ion bombardment i.e. evaporator functionalization

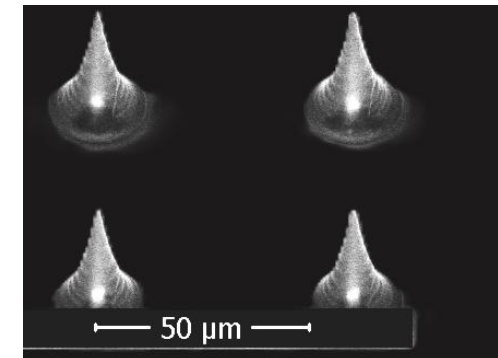
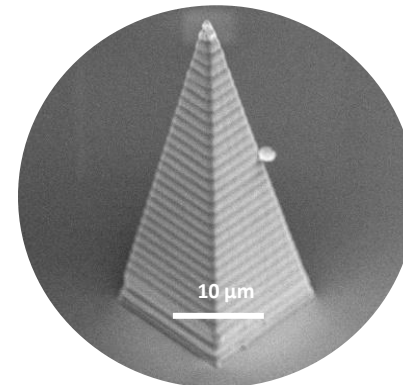
Study of Size, shape and resolution of 2PL



Examples of different resulting shape based on printing parameters

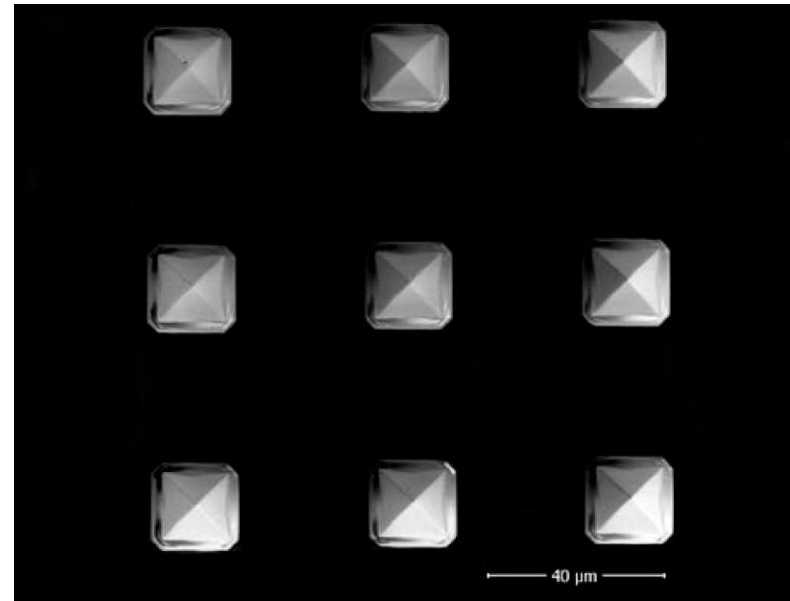
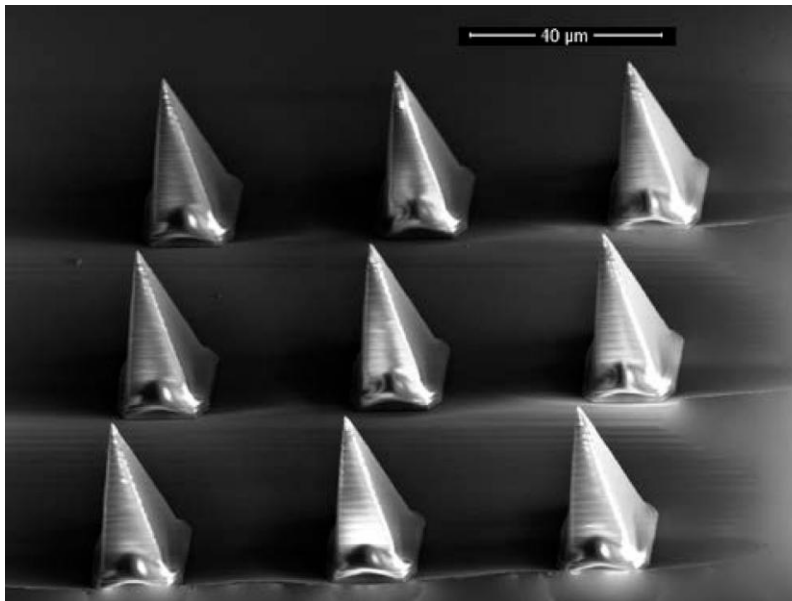
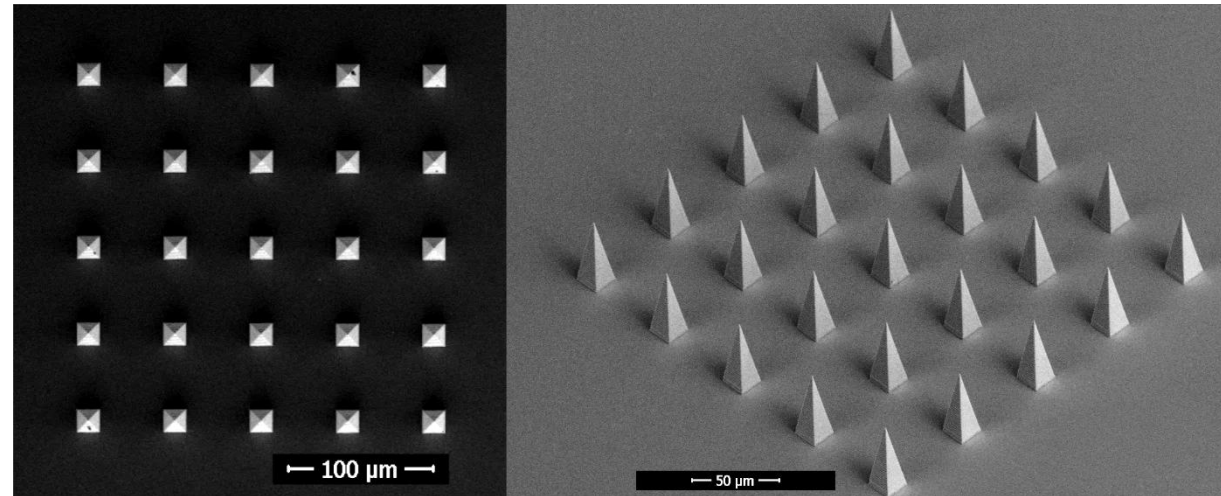
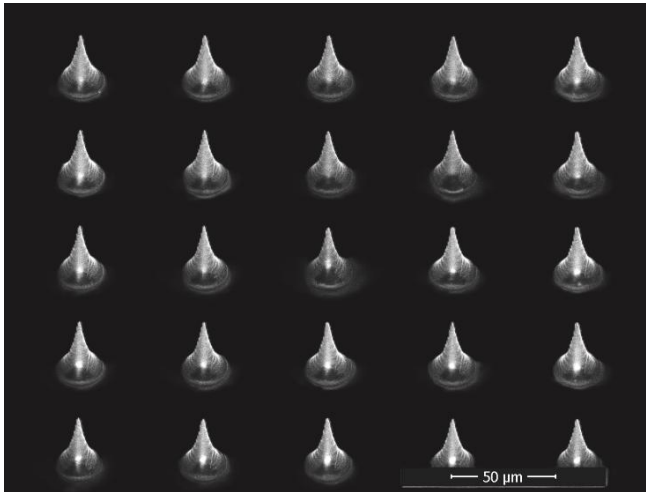


Size and shape benchmark, on Si substrate



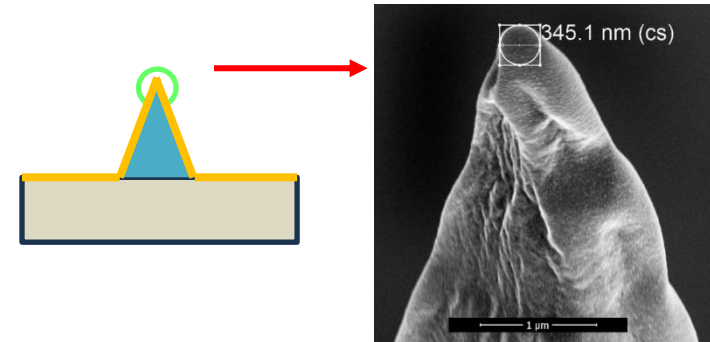
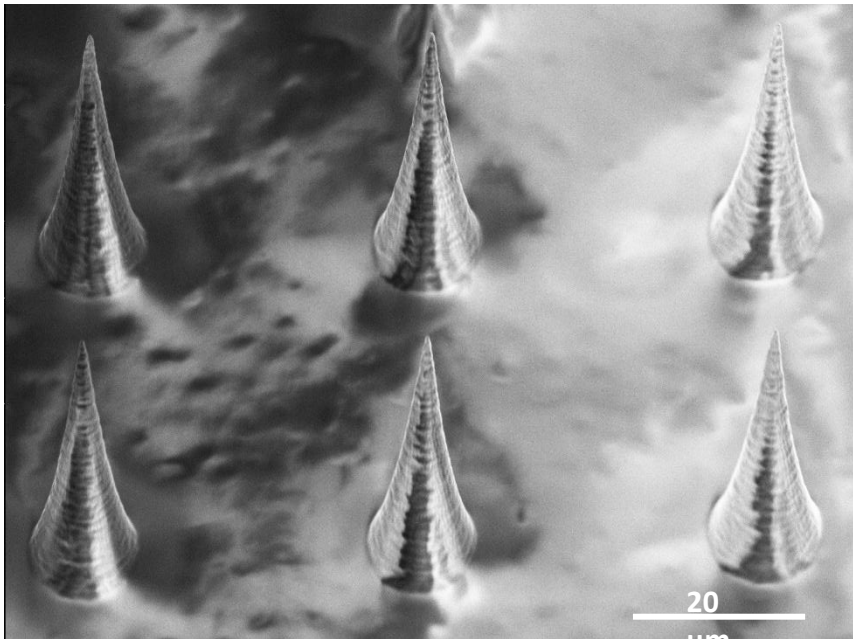
Resulting structures to be tested

Study of reproducibility



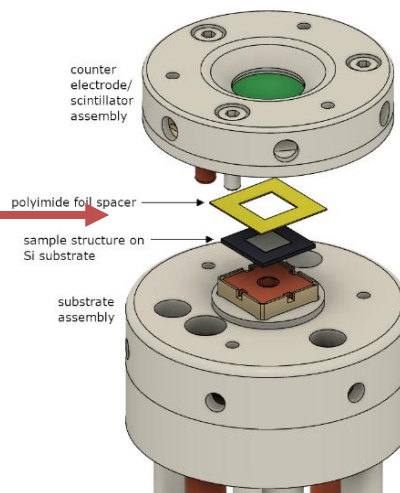
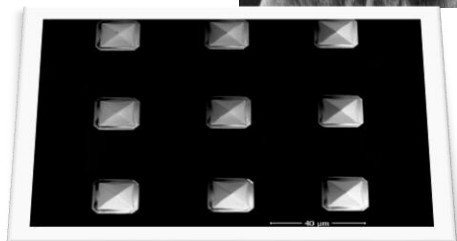
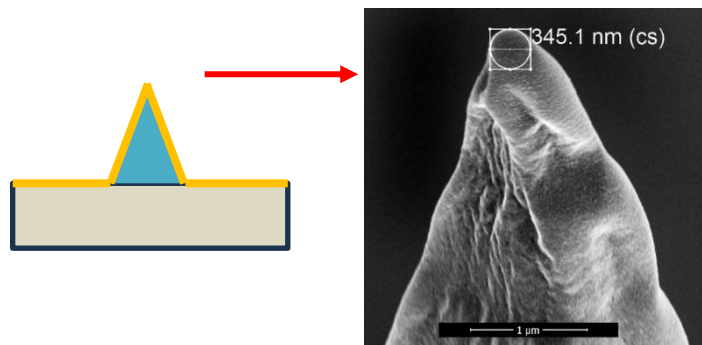
Functionalization and testing

- Model structure for functionalization
- Metalization: Ni, Au, Cr
- Modification by carbonization
- Functionalization: CNT, graphene

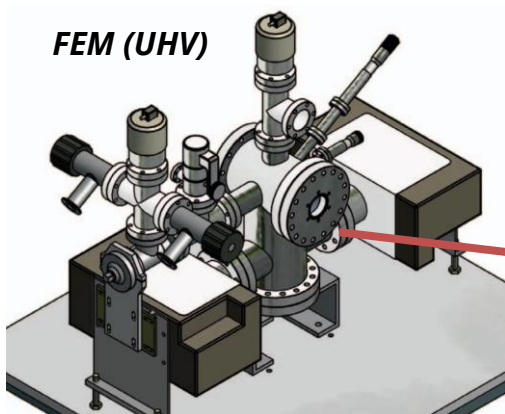


40 nm Cr layer on top

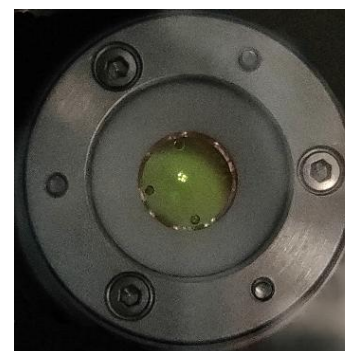
Emission chamber and sample mounting



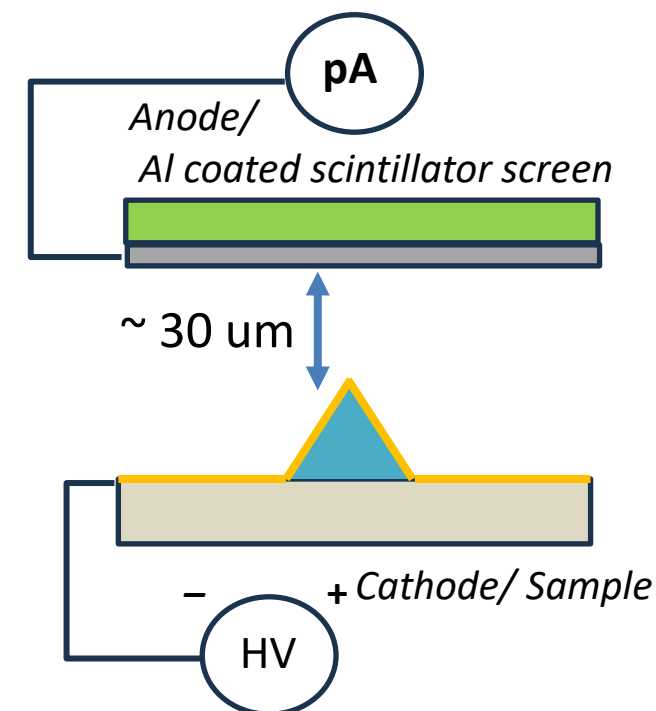
Sample mounted on UHV holder



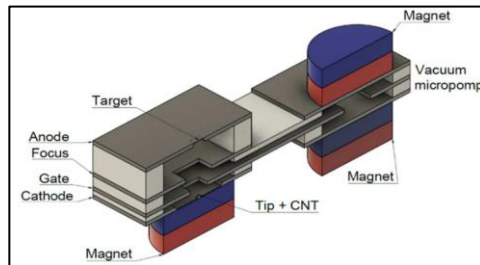
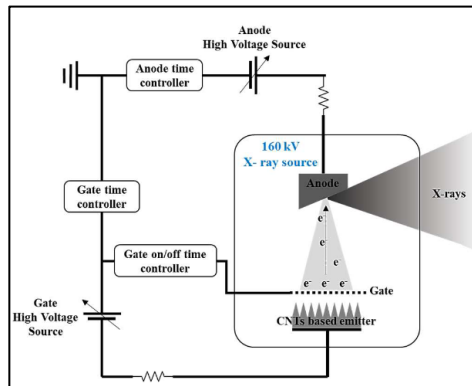
UHV pressure prior experiment: $5 \cdot 10^{-7}$ Pa



Emission observed on Scintillator plane through vacuum windows



Krysztof Group @PWR, Wroclaw:
Field emission based X-Ray sources



Velasquez Group @MIT, Boston:

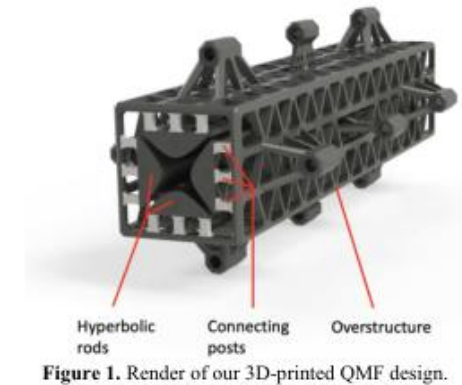
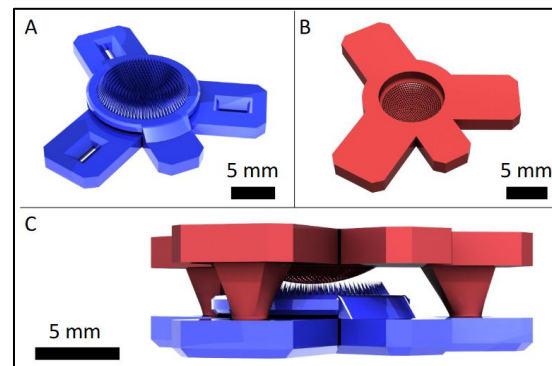
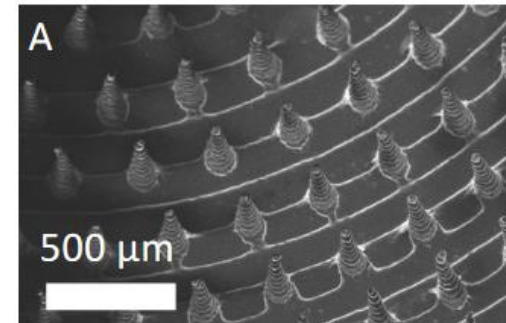


Figure 1. Render of our 3D-printed QMF design.

3D printed EBL source, 3D printed Quadrupole Mass Filter

Thank you for attention

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