DLC Surfaces for Photon Detection with THGEMs

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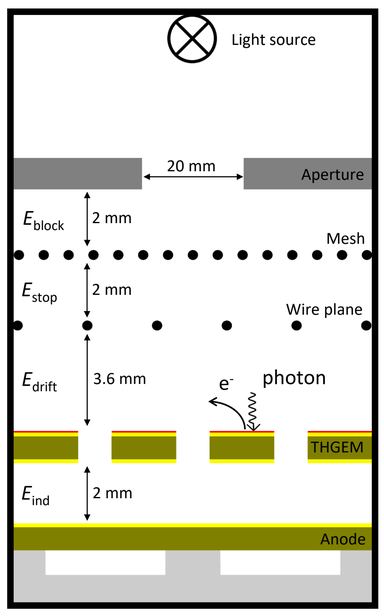
Introduction

- Motivation: Build a scalable photon detector with MPGDs for visible light range
- Production and commissioning of a test chamber for measurements with different photocathode materials
- Measure Quantum Efficiency (QE) of different photocathode materials for various light ranges
- Use CsI photocathode for setup commissioning
- First measurements with DLC layers (enhanced robustness against environmental influences)

Setup

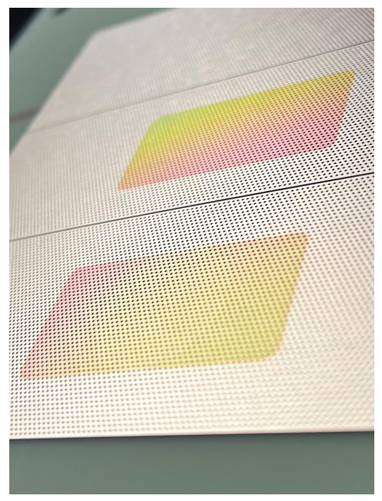
- Aluminum vessel with two operational modes
  - Vacuum down to O(10^{-6} mbar)
  - Flush with gas
- Deuterium lamp as a light source in VUV region
  - Narrow down the spectrum to mainly 161 nm with filter
- Aperture for illumination of a defined area
- PicoLogic pA-meter for current measurements [1]
- Currently operated with reflective photocathodes



Reference studies with CsI photocathode

- THGEM with gold surface
  - 500 µm thickness, 400 µm hole diameter, 800 µm hole pitch
- CsI coating procedure at TUM
  - Electron evaporation technique
  - Typical thickness: 190 µg/cm^2
- GaP photo diode for QE reference
  - QE = 8% at 161 nm
- Measure current on the photocathode
- Ratio of photo diode and photocathode current equals ratio of QEs
- Reached **QE of 7% at 161 nm**
  - In the expected range (O(10%)) [2]

⟶ New detector setup operational



"TUM DLC" – Laser Pulse Ablation Carbon

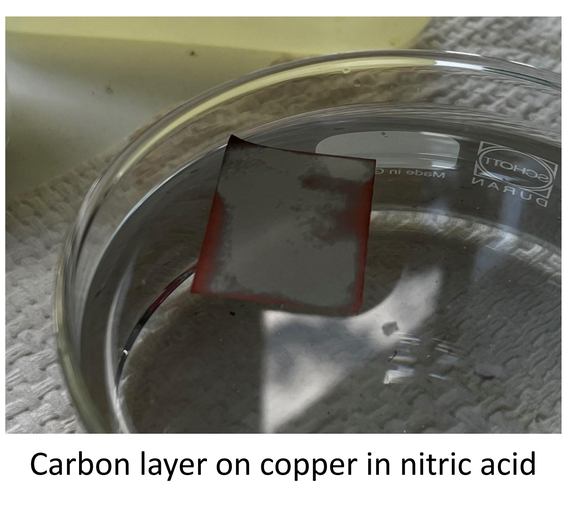
Production process

- Prepare carrier for DLC layer
  - Glass plate covered with betaine and 100 µg/cm^2 copper
- Shoot pulsed Nd:YAG laser at graphite target in vacuum
- Single atoms deposited on carrier in mixture of sp2 and sp3 hybridized carbon
- sp3 ⟶ diamond like structure

Deposition of carbon layer on a carrier for QE studies

- Au surface PCB for first studies
- Remove carrier materials to extract carbon layer
  - Immerse glass plate into water to dissolve betaine layer, then into nitric acid to dissolve copper
- Apply remaining carbon layer to the PCB

Glass plate in water



Carbon layer on copper in nitric acid

DLC QE results

Preliminary results

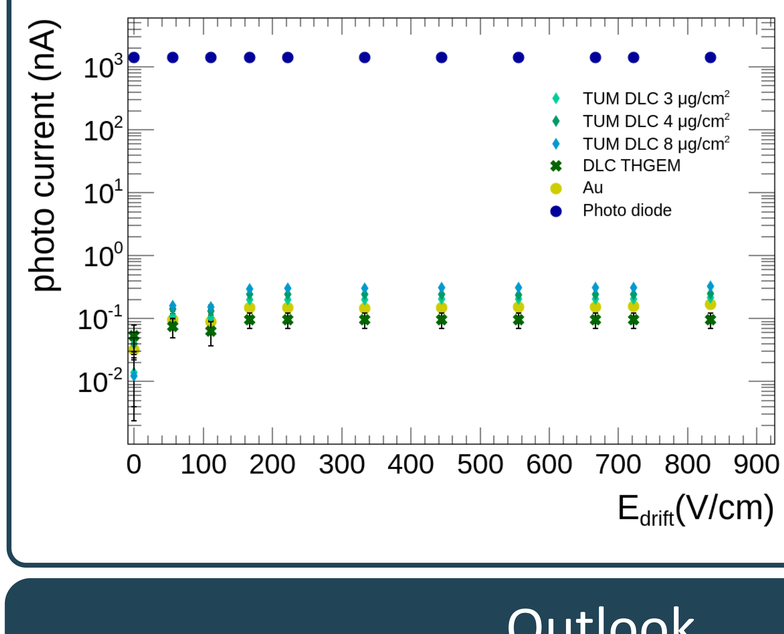
TUM DLC

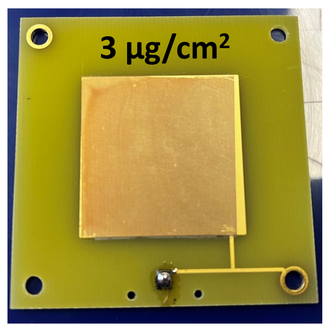
Different thicknesses of DLC layers studied

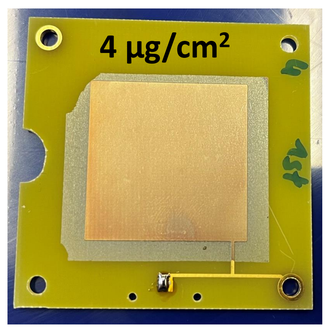
- 3 µg/cm^2 ⟶ QE = (1.2 ± 0.3)×10^{-5}
- 4 µg/cm^2 ⟶ QE = (1.3 ± 0.3)×10^{-5}
- 8 µg/cm^2 ⟶ QE = (1.8 ± 0.4)×10^{-5}

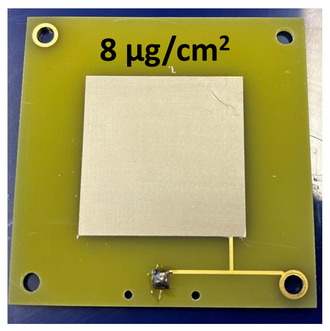
DLC THGEM from CERN

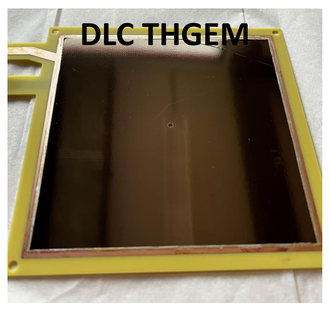
- DLC produced in China [3]
- THGEM produced by CERN PCB workshop
- QE = (5 ± 2)×10^{-6}











Conclusions

- Successful commissioning of new setup
- Measured QE for available DLC at 161 nm
  - Not usable for UV range

Outlook

- Produce and characterize a THGEM coated with TUM DLC
- Expand setup to study different light ranges
- Different photocathode materials (next: CsTe, can be coated at TUM)
- Move towards the visible light range

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[1] A. Utrobicic et al. NIM A 801 (2015) 21
[2] K. Zeitelhack et al., NIM A 433 (1999) 201-206
[3] State Key Laboratory of Particle Detection and Electronics, University of Science and Technology of China