A MULTILAYER DIELECTRIC HALOSCOPE
SEARCHING FOR DARK PHOTONS USING

The dark photon (DPh) can be called QHaloS (Quantum Haloscope Search).

**THE DARK PHOTON**

- Measurement of thickness of the layers via Transmission Electron Microscope
- Deposition via plasma-enhanced chemical vapour deposition (PECVD)
- Optimisation of the number of layers and their thicknesses

The boost factor of the stack can be described as the "conversion power" of the haloscope and is a function of the wavelength of the dark photon.

The plot to the right shows the expected boost factor spectra for different stack configurations. Each boost factor spectrum has been optimised to peak where the quantum efficiency of the photosensor is at its maximum. The solid black curve represents the QE of the QSensei SPD that was employed in the final configuration.

The actual boost spectrum depends on the measured QE and the QE of the QSensei SPD that was employed in the final configuration.

The plots to the right show the QSensei SPD evaluation at 20 °C and 15 °C. The QE of the QSensei SPD increases with decreasing temperature.

In its idle state, the SPD is reverse-biased at a voltage V_b, above the breakdown voltage V_b and is operated at 10 °C. A photon impinging on the silicon can excite an electron from the valence band to the conduction band, leaving a hole behind. Thanks to a high electric field region, the electron-hole pair may trigger a diverging avalanche to produce a detectable electric pulse. Below our SPD characterisation.

**PLACE LIMITS**

- Experiment conducted in a 14 T magnet.
- Fabrication of a new stack on a smoother substrates. Ex situ ellipsometer measurements to evaluate the layer thicknesses.

**CONCLUSION**

- Fabrication of a new stack on a smoother substrates. Ex situ ellipsometer measurements to evaluate the layer thicknesses.

**THE FUTURE IS QUANTUM**

This work was published on March 30th 2022 on Physical Review D: "Search for dark photons using a multilayer dielectric haloscope equipped with a single-photon avalanche diode". L. Manenti et al, Phys. Rev. D 105, 052010

**CURRENTLY...**

- Working on an axion prototype which will be tested in a 14 T magnet field.
- Characterising a new sensor QSensei@MINOS, a dual stage Photo cell that allow to optimise the cooling temperatures and more stably.

**OBSERVED UPPER LIMITS**

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**DIIELECTRIC HALOCOPE**

- Current and projected bounds are satisfied by a vast number of candidates that span the alternative DM models.
- Among the most favourable DM candidates are WIMPs!
- Their electroweak interactions give the correct relic abundance—hence the so called "WIMP miracle!"

**SUMMARY**

-Muon Dark Halo experiment will be called QHaloS (Quantum Haloscope Search).
- The first dark matter detector being operated in the Middle East.
- The plan is to extend the search for DPs to weaker couplings and to deeper mass ranges.

**REFERENCES**

- Nyuad to analyse the stack samples prepared via focused ion beam (FIB) sample preparation procedures.
- Recent and projected limits at 90% CL dark grey the conservative limit 90% CL black the converted limit.