

# Qu3D – Quantum 3D imaging at high speed and high resolution

Partners: INFN (Italy) - Milena D'Angelo

Palacky Univ. (Czech Repub.) - Bohumil Stoklasa



Planetek Hellas epe (Greece) - Maria Ieronymaki

EPFL (Switz.) - Claudio Bruschini



## Goal

Design and implement novel correlation plenoptic imaging devices exploiting both momentum-position and photon-number correlations to enable the refocusing and ultra-fast, scanning-free, 3D imaging capability of plenoptic devices, but with dramatically enhanced performance:

- ✧ diffraction-limited resolution,
- ✧ an unprecedented depth of focus versus resolution compromise;
- ✧ ultra-low noise, aiming at sub-shot noise performance.

## Main challenge of CPI:

Large number of frames required ( $10^3$ - $10^4$ ) → long acquisition (10 s - 10 min), data transferring (1-30 min), and elaboration (10 hours for retrieving the 3D image and/or refocusing a 2D image) time.

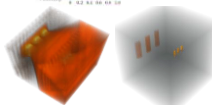
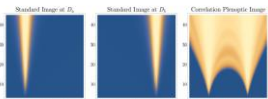
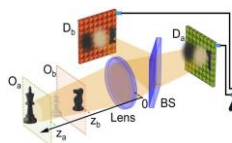
## The outputs of Qu3D:

Ready to play a transformational role in technology and society (biomedical and clinical imaging, space imaging, security and industrial inspection,...) !

### ✓ Correlation plenoptic imaging

10 volumetric images per sec

10x resolution enhancement



### ✓ Hardware speed-up

Ultra-fast sensors:  
SwissSPAD2 (100 kHz, 512x512)



### ✓ Software speed-up:

- Quantum tomography
- Compr. sensing & machine learn. (speed-up 20x)

### ✓ Super-resolution:

Quantum Fisher infor. inspired protocols



Ultra-fast computing: **Parallel computing** + streaming interface (speed up: 10x - 100x)

## 4 most relevant publications (over 16):

- Towards quantum 3D imaging devices, Appl. Sci. **11**, 6414 (2021)
- Light-field microscopy with correlated beams for high-resolution volumetric imaging, Sci. Rep. **12**, 16823 (2022)
- Correlated-photon imaging at 10 volumetric images per second, Sci. Rep. **13**, 12813 (2023)
- Deep learning approach for denoising low-SNR correlation plenoptic images, Sci. Rep. **13**, 19645 (2023)

## Website:

<http://web2.ba.infn.it/qu3d/>

## Training school:

Sept. '22 @ Trani, Italy (150 participants !!)

## Workshop & Closing event:

May 2024 @ University of Olomouc (CH)

## Topical issue on EPJ plus:

to be advertised soon