

Master Thesis:

Marker Design and Zernike Polynomials-Based Image Correction for Deterministic Quantum Dot Localization

This project aims to improve image correction and marker localization methods for the deterministic integration of quantum dots (QDs) into nanophotonic devices. The student will evaluate periodic and non-periodic alignment-marker designs, complement the existing Zhang-based camera calibration with a Zernike-polynomial distortion correction, and validate the optimized workflow using the hyperspectral-imaging setup and data-analysis routines. The work addresses a central fabrication limitation, as the current mean displacement between the cavities and C-band QDs emitter is approximately 100 nm. Reducing this error is necessary for more accurate spatial positioning of cavities relative to individual emitters, which should improve emitter–cavity coupling and, consequently, Purcell enhancement. Overall, the project will establish a more accurate workflow from QD spatial localization to cavity fabrication, with the goal of increasing the yield of deterministically fabricated QD nanophotonic devices.

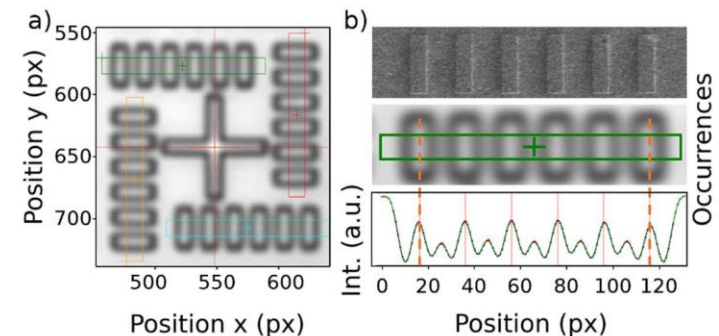
Your tasks:

- Design, fabricate, and benchmark alignment-marker sets.
- Develop and integrate a Zernike-polynomial distortion-correction model.
- Validate end-to-end localization performance in the hyperspectral-imaging workflow.

For detailed information contact:

Dr. Barbara Damasceno
barbara.damasceno@kit.edu
Tel. 0721-608-41848

Prof. Dr. Tobias Huber-Loyola
tobias.huber-loyola@kit.edu
Tel. 0721-608-47182



(a) Reflection image of a periodic alignment marker consisting. (b) Scanning electron microscopy and reflection images, together with the binned intensity profile from one marker quadrant (highlighted in green). The profile is fitted with a multi-Gaussian model using fixed peak spacing. Buchinger *et al. Nano Convergence* (2025) 12:36 <https://doi.org/10.1186/s40580-025-00501-5>