



- 1 Photograph of the 32 x 32 Fabricated FrontSPAD Array.
- 2 0.35  $\mu\text{m}$  HV-CMOS Processing.
- 3 Examples of SPAD Layouts.

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## SPAD PERFORMANCE

### Single Photon Detection Applications

- Optical time-domain reflectometry
- Fluorescence lifetime spectroscopy
- Laser ranging
- Quantum cryptography
- Quantum computing

### Results

- Front-side illuminated Single-Photon Avalanche Diodes (FrontSPADs) fabricated in the HV 0.35 $\mu\text{m}$  CMOS Technology at the Fraunhofer IMS
- Breakdown Voltage  $V_{\text{BD}} = 26 \text{ V}$

- Dark Count Rate:
  - < 2 kcps @ 50  $^{\circ}\text{C}$  ( $\varnothing = 30 \mu\text{m}$ )
  - < 50 cps @ room temp. ( $\varnothing = 30 \mu\text{m}$ )
- Negligible DCR @ low temperature
- Good Timing Response:
  - FWHM < 100 ps ( $\varnothing = 10 \mu\text{m}$ )
  - FWHM < 140 ps ( $\varnothing = 30 \mu\text{m}$ )
- High Fill-Factor, using Microlenses:
  - FF = 80%
- Very High Uniformity
- Temperature drift: 37.8 mV/K
- Low Afterpulsing Probability:
  - < 1% @  $T_{\text{HOLD-OFF}} > 50 \text{ ns}$
- Maximum Count Rate = 50 Mcps



"Microelectronic Single-Photon 3D Imaging Arrays for low-light high-speed Safety and Security Applications"



The research was funded by the ICT theme of the EU Seventh Framework Programme under grant agreement n° 257646

