pi imaging

EPFL's spin-off company

Michel Antolovic

Mission: to change the way we count photons

Team

Involved directly
in the EU project

Michel Antolovic
CEO and co-founder

Harald Homulle
Senior design engineer

Augusto Carimatto
Senior design engineer

Tommaso Milanese
Hardware engineer

Thomas Hagger
Optics

Zsófia Sajó
Cleanroom

Claudio Bruschini
Co-founder

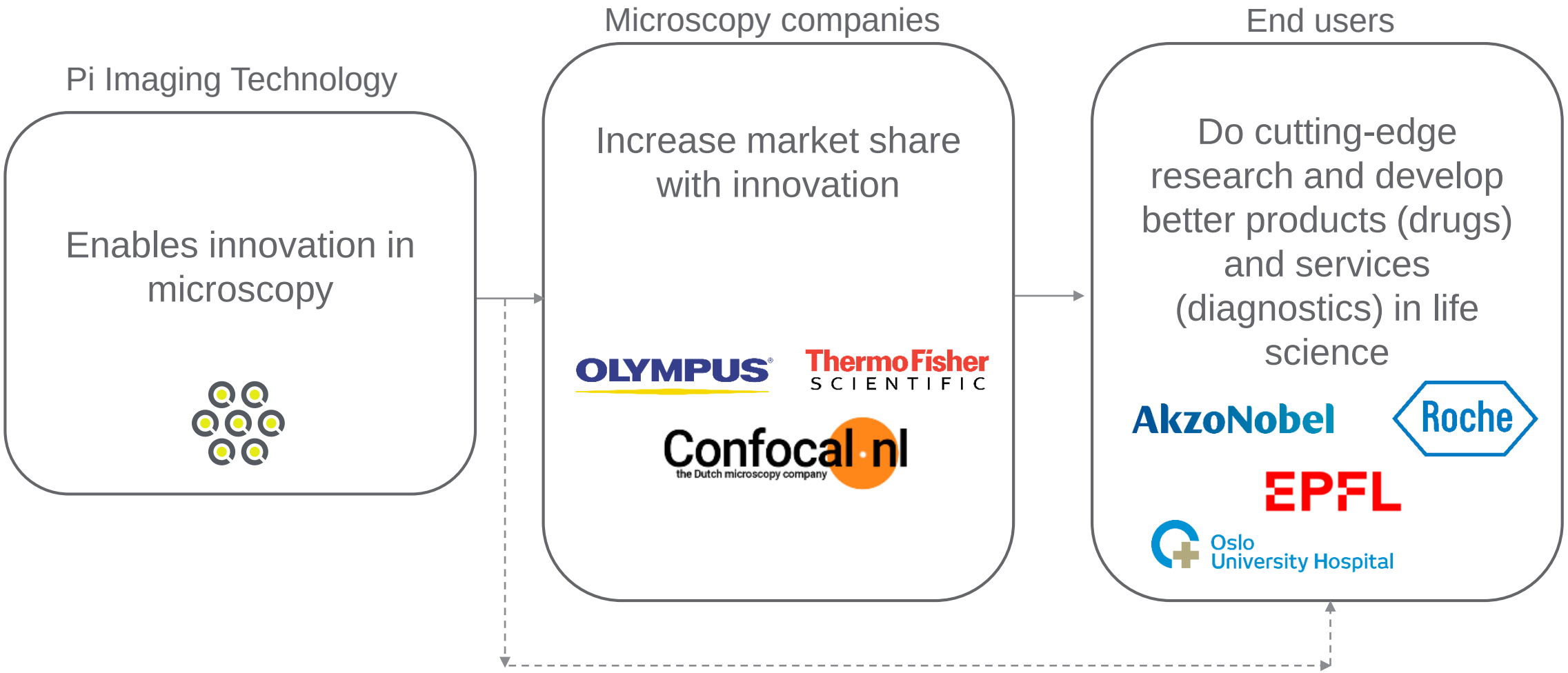
Ron Hoebe
Co-founder

Edoardo Charbon
Co-founder

Robert Gaisch
Industrial advisor

Ralph Schmidhalter
Industrial advisor

Enabling innovation in microscopy

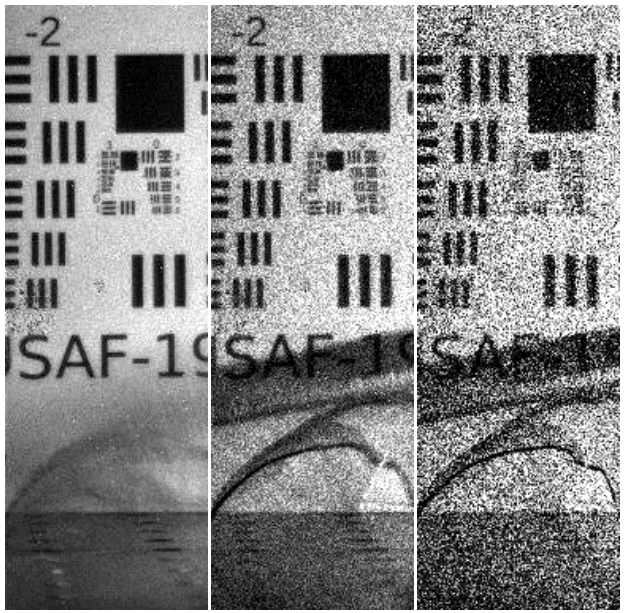


Detector technology: CMOS SPAD

- SPAD/APD chip (+ readout electronics and sample software)

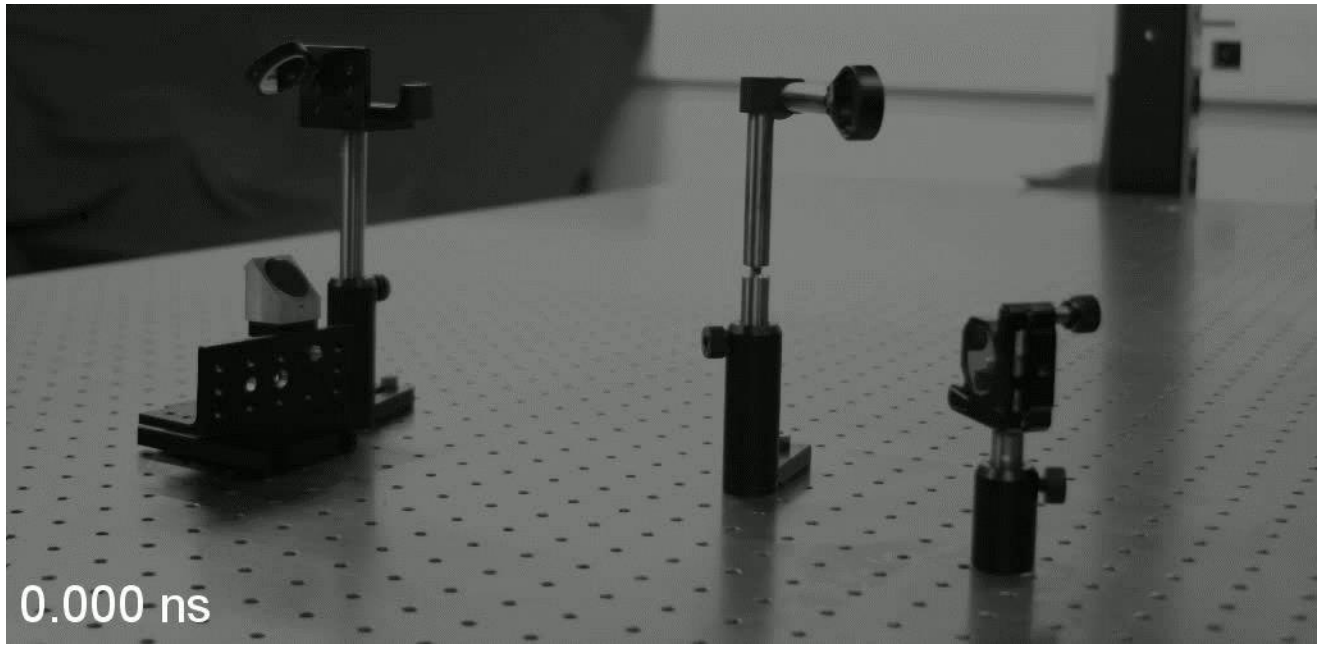
SPAD image sensors

- Unprecedented image quality at low light, high video rate



156 fps 2604 fps 15625 fps

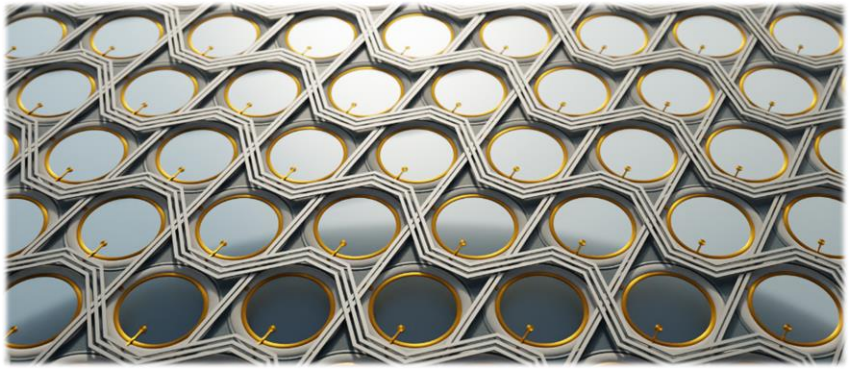
Download full videos



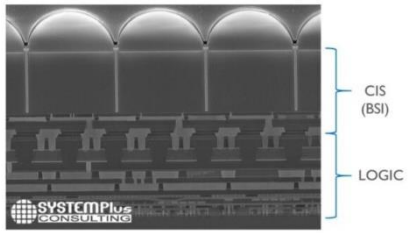
Kazuhiro Morimoto *et al*, 2020

Protected technology – single-photon avalanche diode (SPAD)

- 3 patent applications exclusively licensed to Pi Imaging
- 3 joint patent applications
- Limited number of production facilities capable of producing high quality CMOS SPADs
- SPAD design kept as trade secret



Apple iPad Pro LiDAR 3D sensor cross-section



SPADs in industry:
Proximity sensor
3D sensor

EU project

- Objectives:
  - Tailor the existing detector for MINFLUX microscopes
  - Develop novel SPAD arrays with enhanced red and NIR sensitivity
  - Develop a 10×10 SPAD array with time-gating
- Contribution in the project:
  - Provide direct photon information to the microscopy platform, improve spatial and temporal resolution
  - Improve red and NIR detection

Work package 3

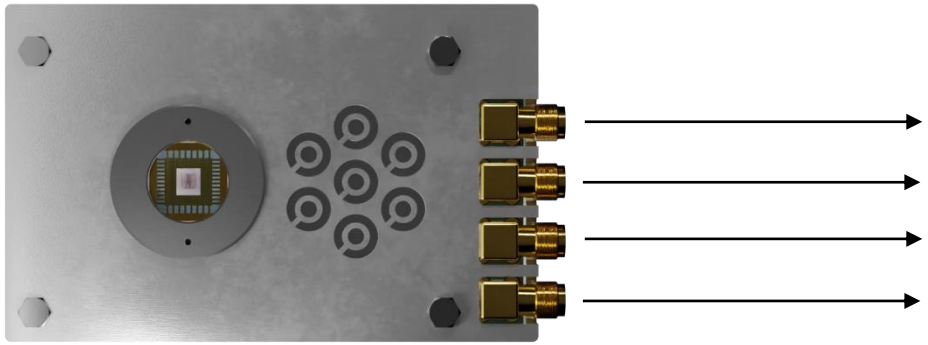
- **Task 3.1:** Gen I detection electronics
  - The Gen I detection electronics will forward software-selectable SPAD array channels with intrinsic jitter through a reconfigurable FPGA. SPAD channels are going to be forwarded to 4 input channels available in the MINFLUX system.
  - **Deliverable:** Two SPAD arrays integrated, tested and delivered to AI for integration (M6).
- **Task 3.2:** Gen II detection electronics
  - Photon counting/time-tagging and microscope control will be merged through a dedicated communication protocol. This will enable utilization of all 23 pixels of the SPAD array with 20 ps timing resolution.
  - **Deliverable**: Upgrade to Gen II detection electronics with time-tagging and 20 ps timing resolution (M30).

Work package 3 (II)

- **Task 3.3:** Enhanced red and NIR sensitivity CMOS SPAD
  - PII will develop SPAD arrays with enhanced red and NIR sensitivity, targeting a peak quantum efficiency (QE) above 50% at 640 nm and specially enhanced QE spectra between 600 nm and 900 nm. The array will be optimized for off-chip time-gating, with a timing jitter of less than 250 ps at 640 nm.
  - **Deliverable**: Replace SPAD arrays with newly designed CMOS SPAD array with enhanced red and NIR sensitivity (M32).
- **Task 3.4:** 10×10 CMOS SPAD array with integrated time-gating
  - Small image sensors with 1 Mframes per second and chip-level time-gating with 1 ns gate
  - **Deliverable**: Characterization of 10×10 CMOS SPAD array (M36)

Gen I detection electronics

- Working plan for the first 6 months:
  - Update software and firmware to pass SPAD pulses from programmable pixels to 4 SMA outputs

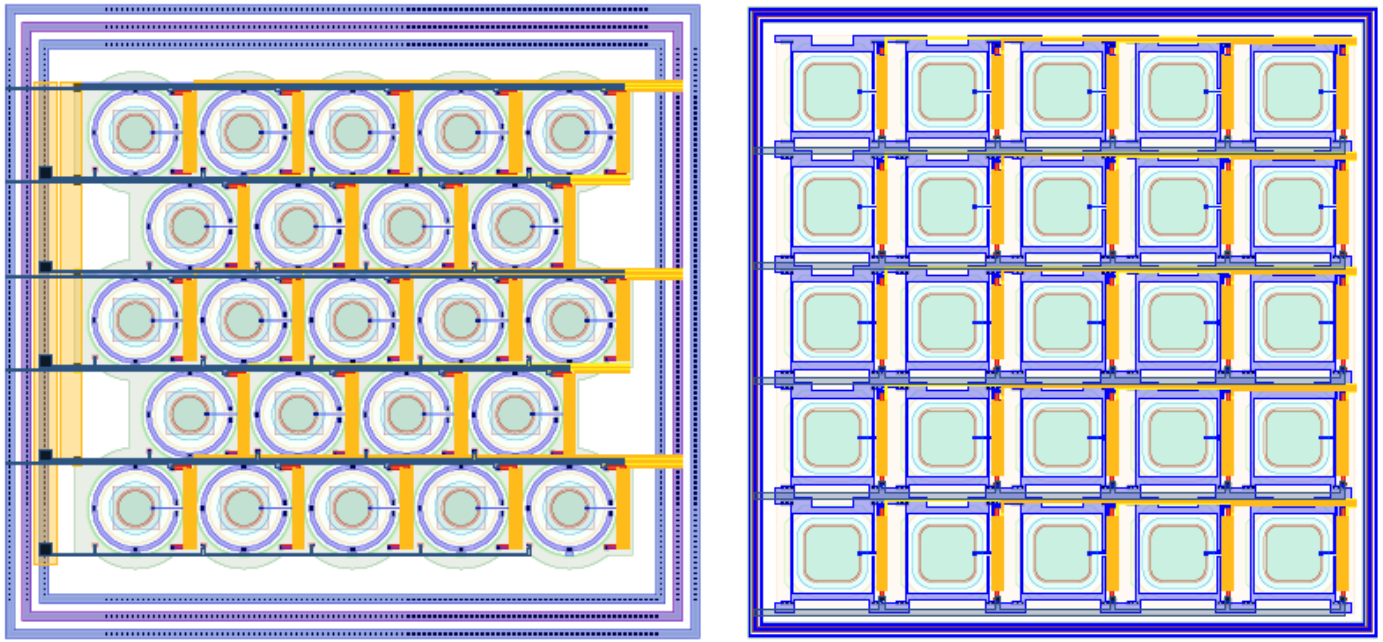


Gen II detection electronics

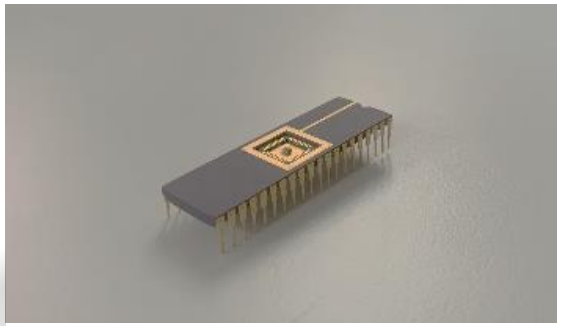
- Working plan for the first 6 months:
  - Determine the hardware platform (FPGA system+connections) for the interface between the detector and the microscope
  - Define a communication protocol (bidirectional high speed, unidirectional high speed)

Enhanced red and NIR sensitivity CMOS SPAD

- Working plan for the first 6 months:
  - Evaluate 5 versions of the red SPAD in terms of fill factor and noise (crosstalk)



pi imaging



Pi Imaging Technology SA
info@piimaging.com
+41 76 5733 314
VAT CHE-496.873.037