# Test-chip design for radiation-hard photodiodes for medical applications in 0.18µm ams technology

Filip Segmanovic
ESR 15, WP4

# Outline

- Introduction
- I-V Simulation
- Test-chip design
- Initial measurements
- Conclusion and next steps

# Introduction

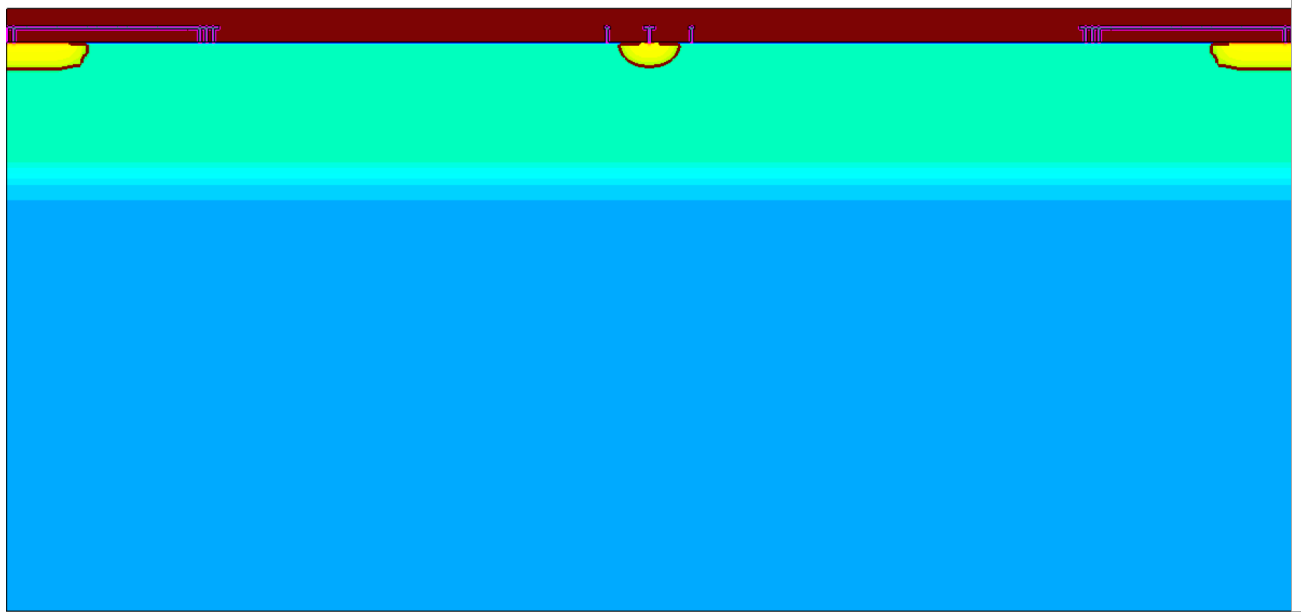
- Simulation setup:
  - Calibration of simulations with measurements of the prototype (golden) device from 0.35µm technology
  - Spectral responsivity, I-V (MIPRO conference)
  - Trap implementation in simulations (PATMOS conference)

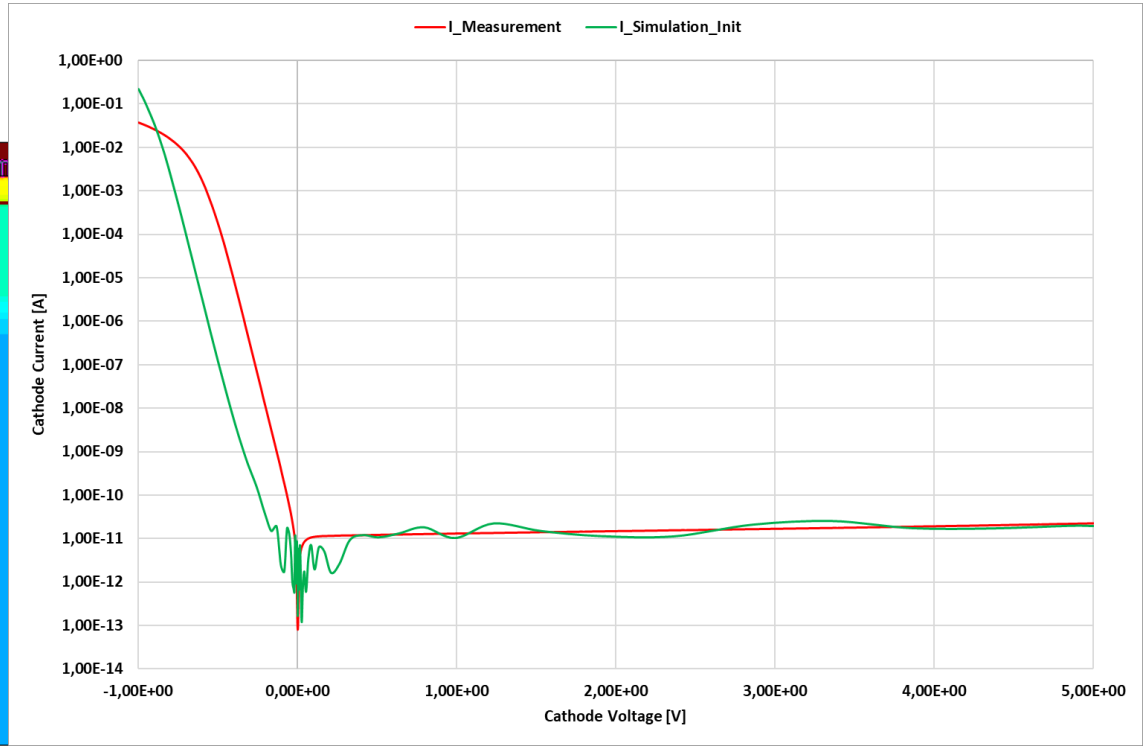
- Test-chip design:
  - Design a device in 0.18µm technology with increased spectral responsivity and radiation hardness compared to the reference golden device from 0.35µm technology
    - Relevant wavelength region is from 400nm to 900nm (VIS)

  - Variations of the device in order to test:
    - Geometry impact – layout variations
    - Process variations

# I-V Simulation (1)

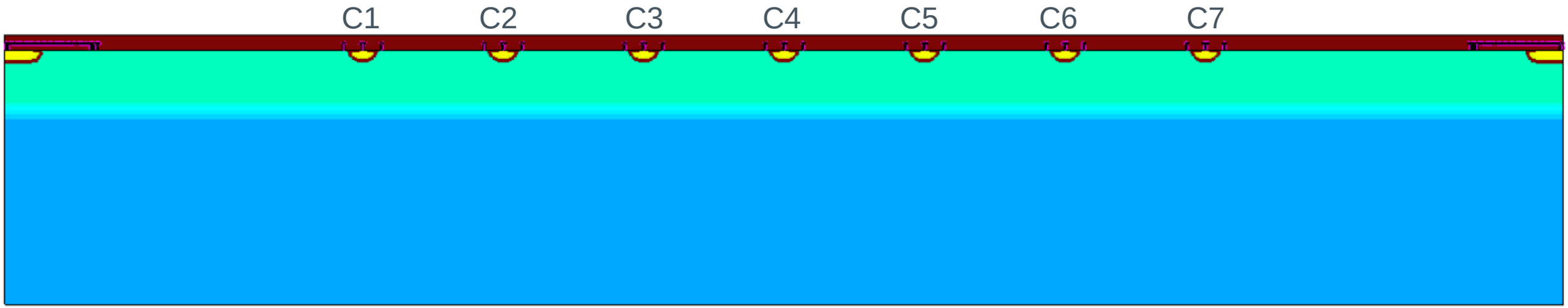
- Initial structure consisted of only 1 island
- First results showed inconsistency in forward bias with the measurements after normalizing the the simulation to 242 islands and after applying island area normalization
- Next step – investigate the impact of island perimeter





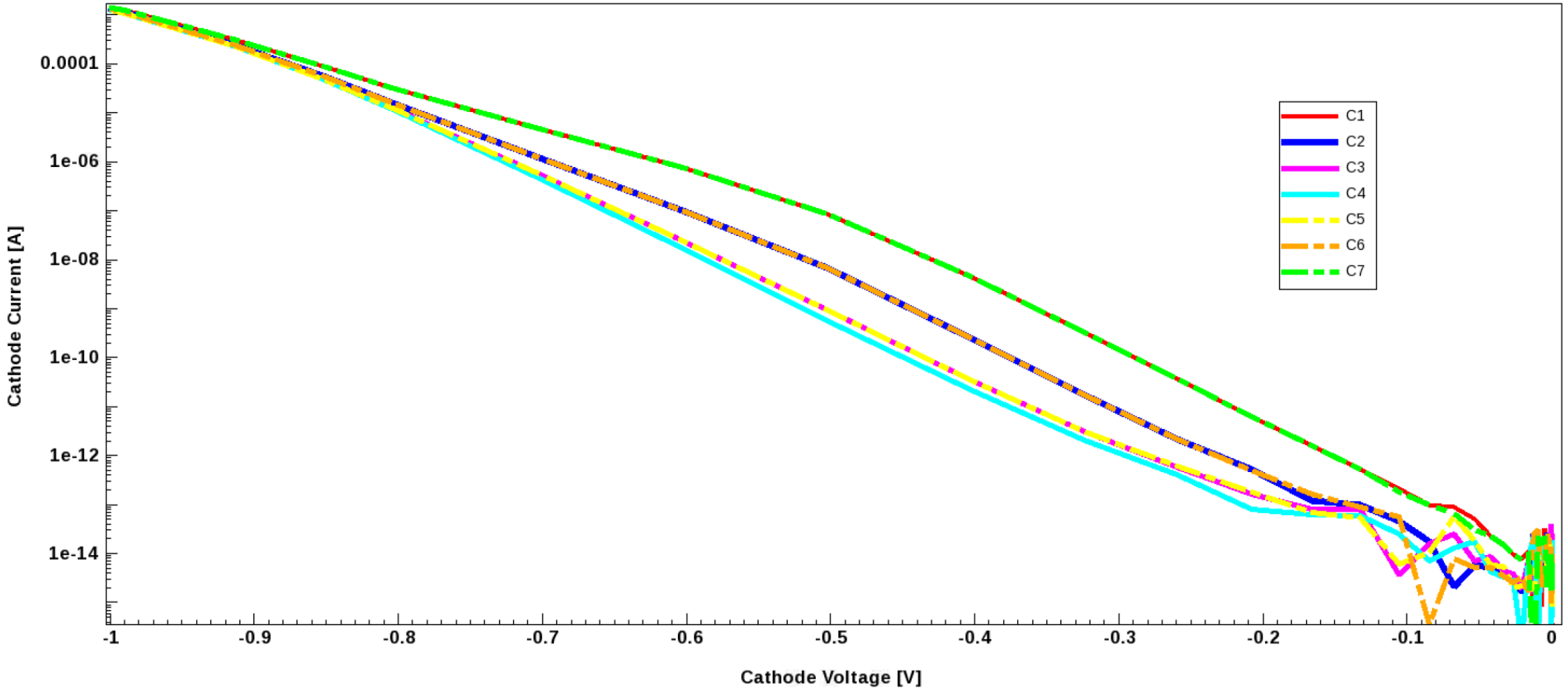
# I-V Simulation (2)

- Impact of island perimiter:
  - Simulation of 7 islands
  - Contribution of each island towards the total forward current



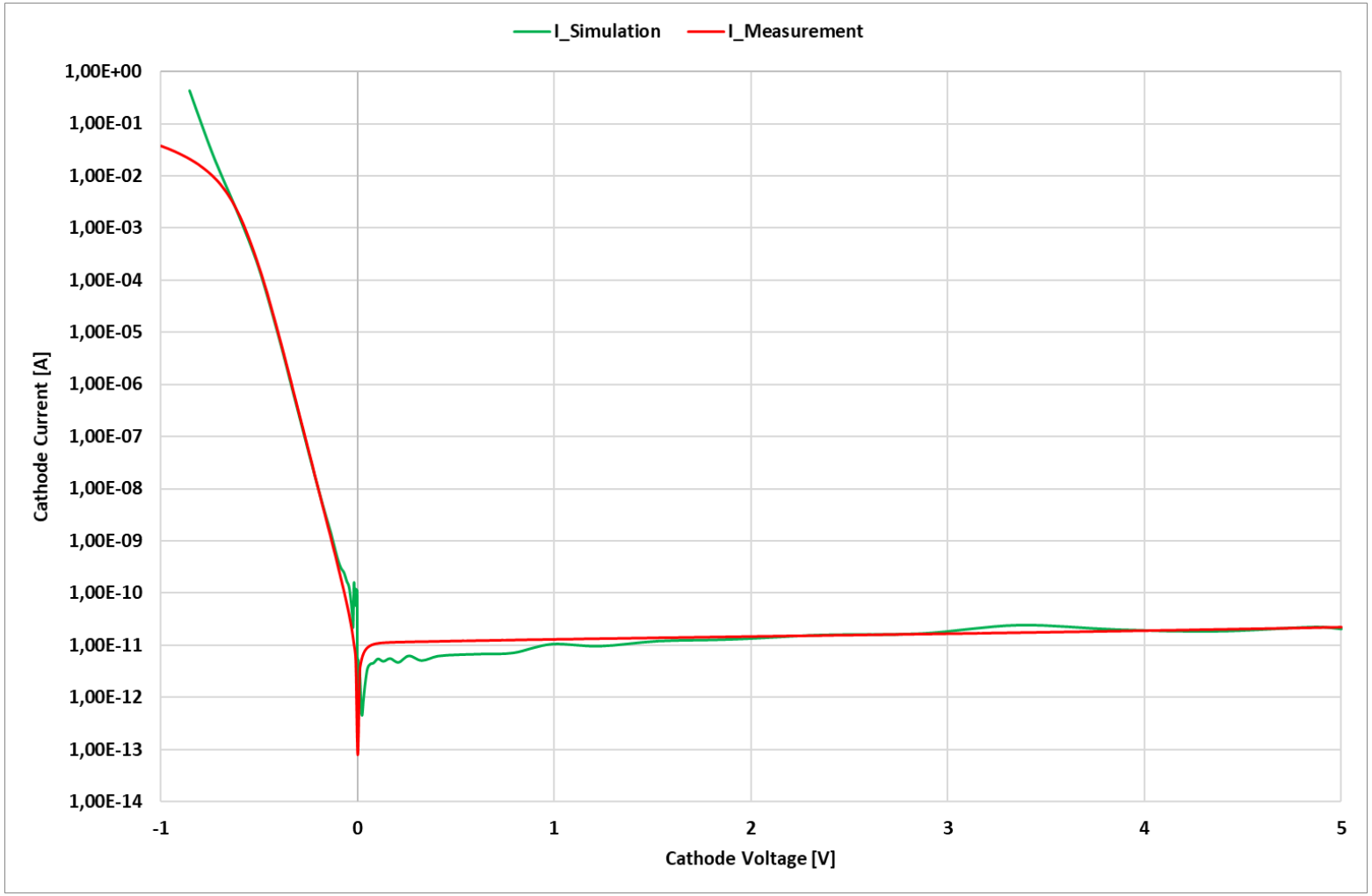
# I-V Simulation (3)

- Difference in island current, depending on their position to the guard ring



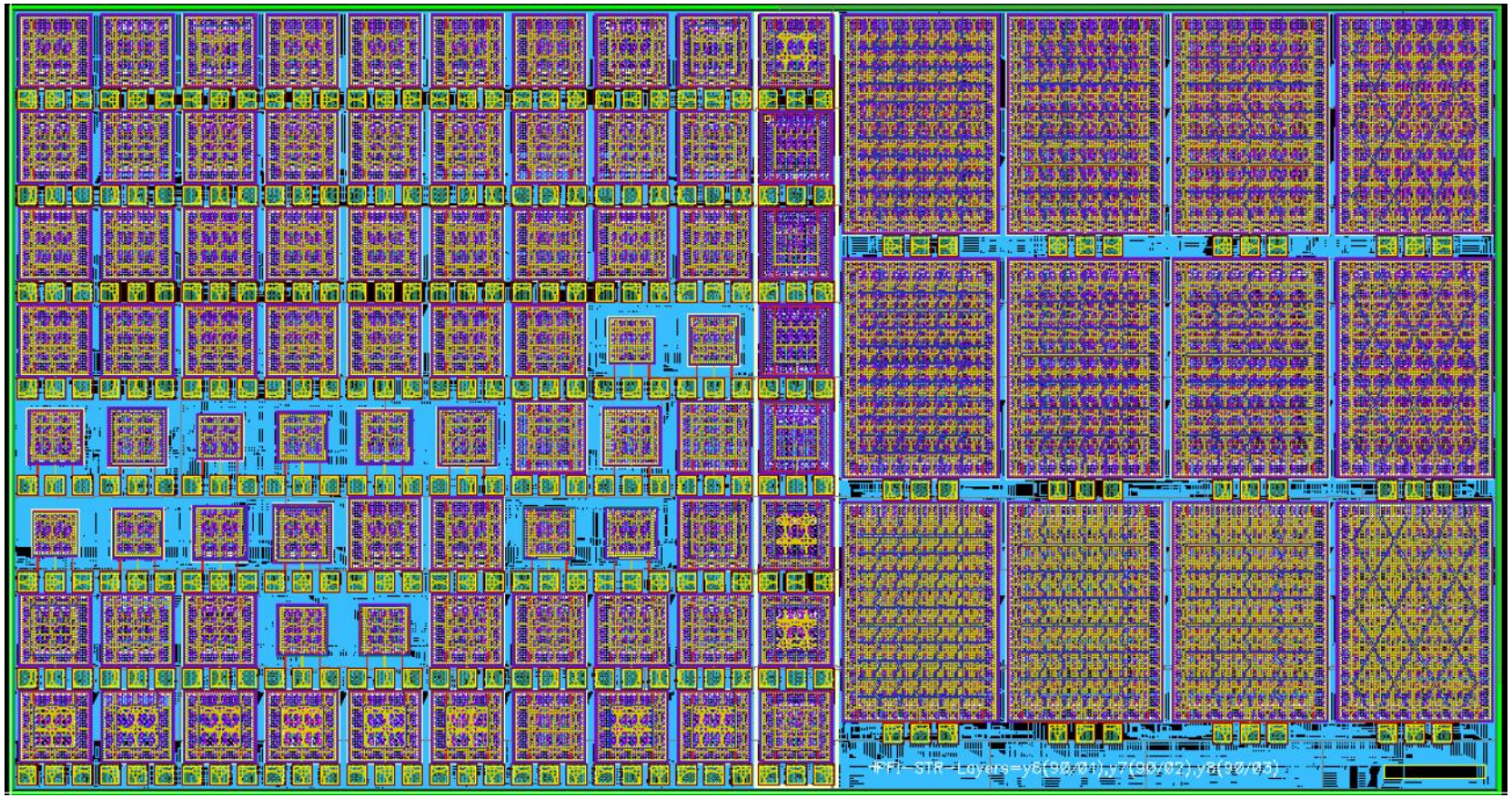
# I-V Simulation (4)

- Final calibration achieved after summing all current contributions



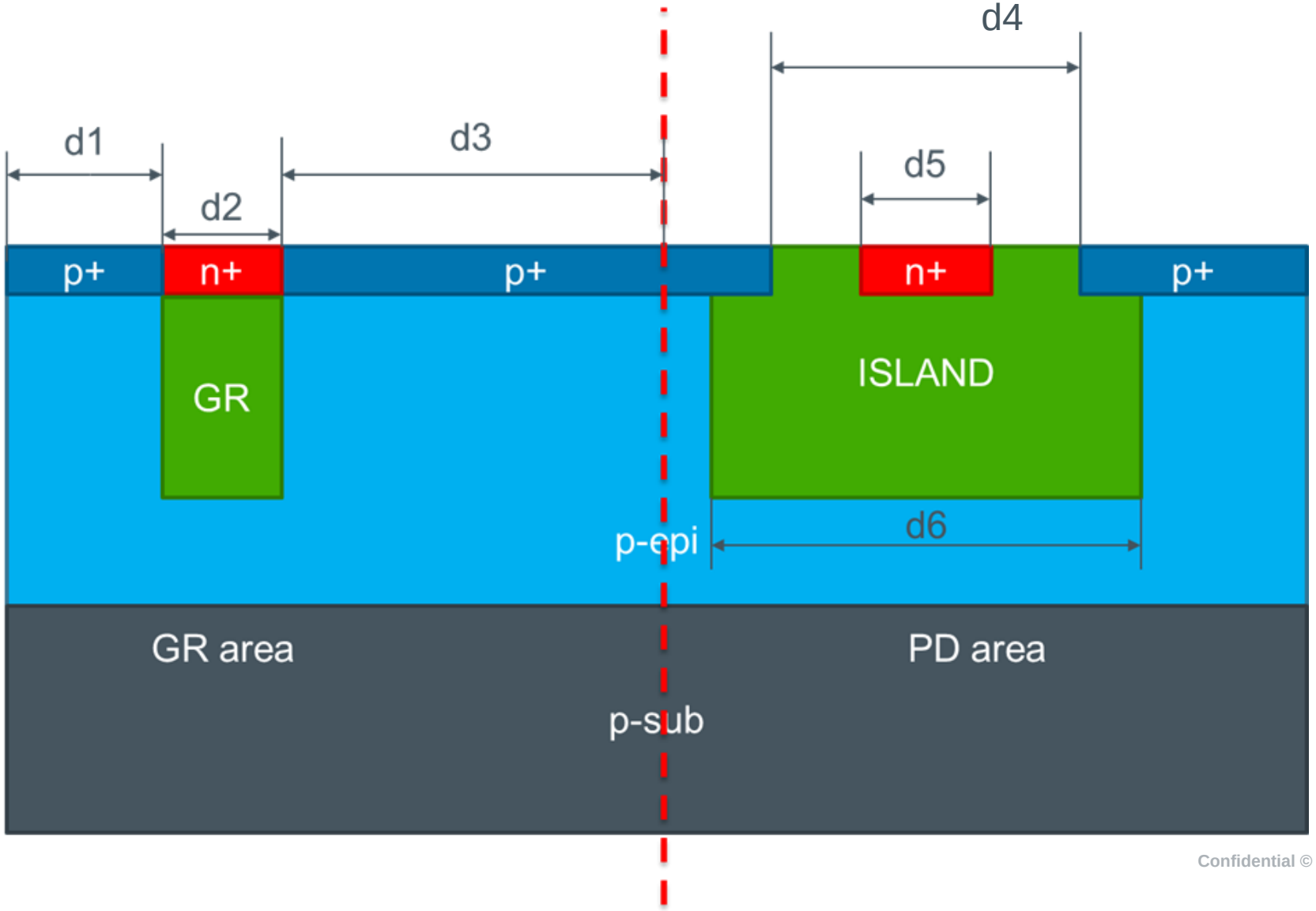
# Test-chip design (1)

- Special high-lifetime starting material is used
- 92 different photodiode structures:
  - Island density
  - Different passivation layers
  - Different GR dimensions
  - Different island dimensions
  - Different GR concept
  - Different island concept



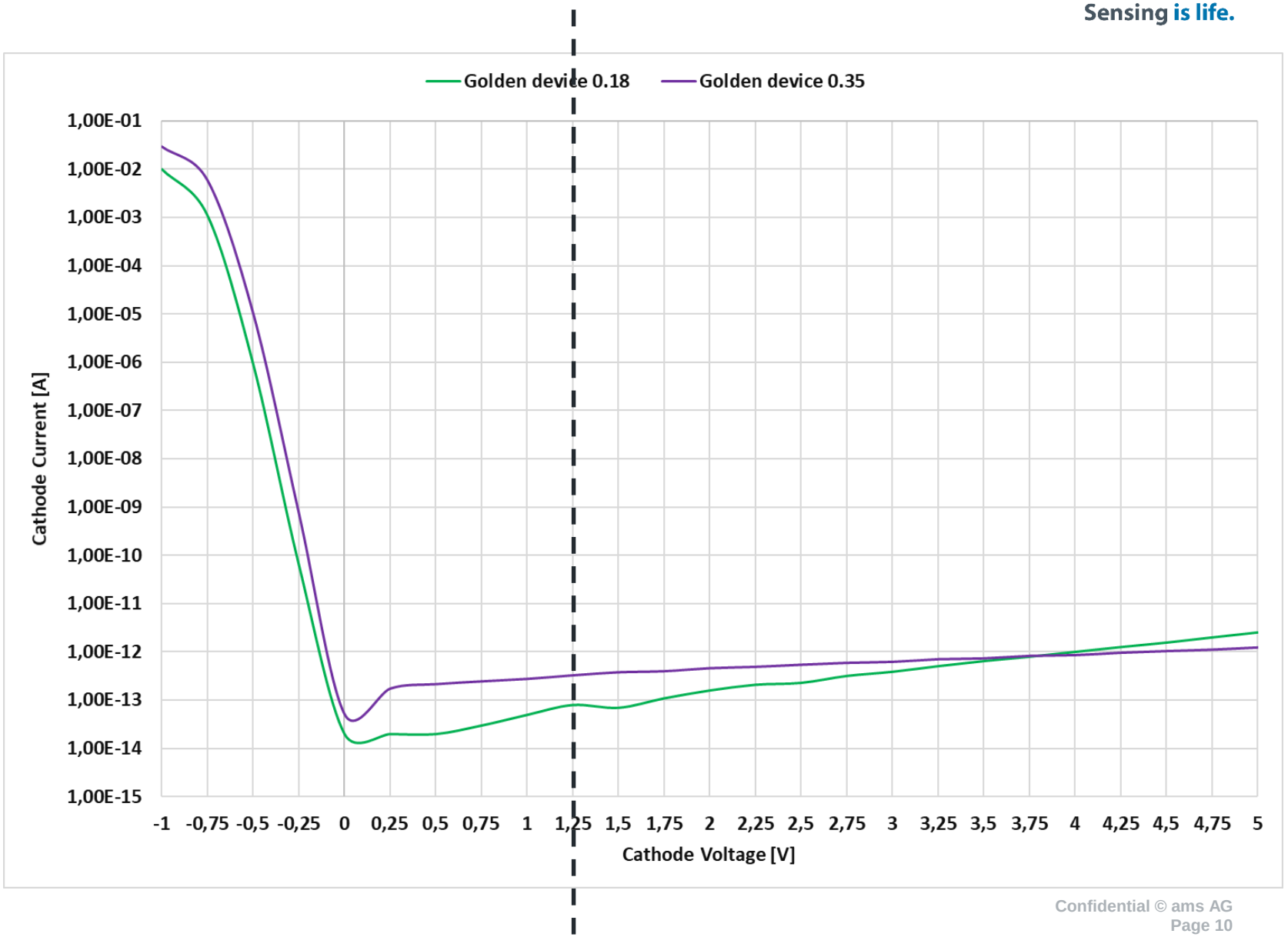
# Test-chip design (2)

- Examples of dimension variation, both in the guard ring area and in the island area



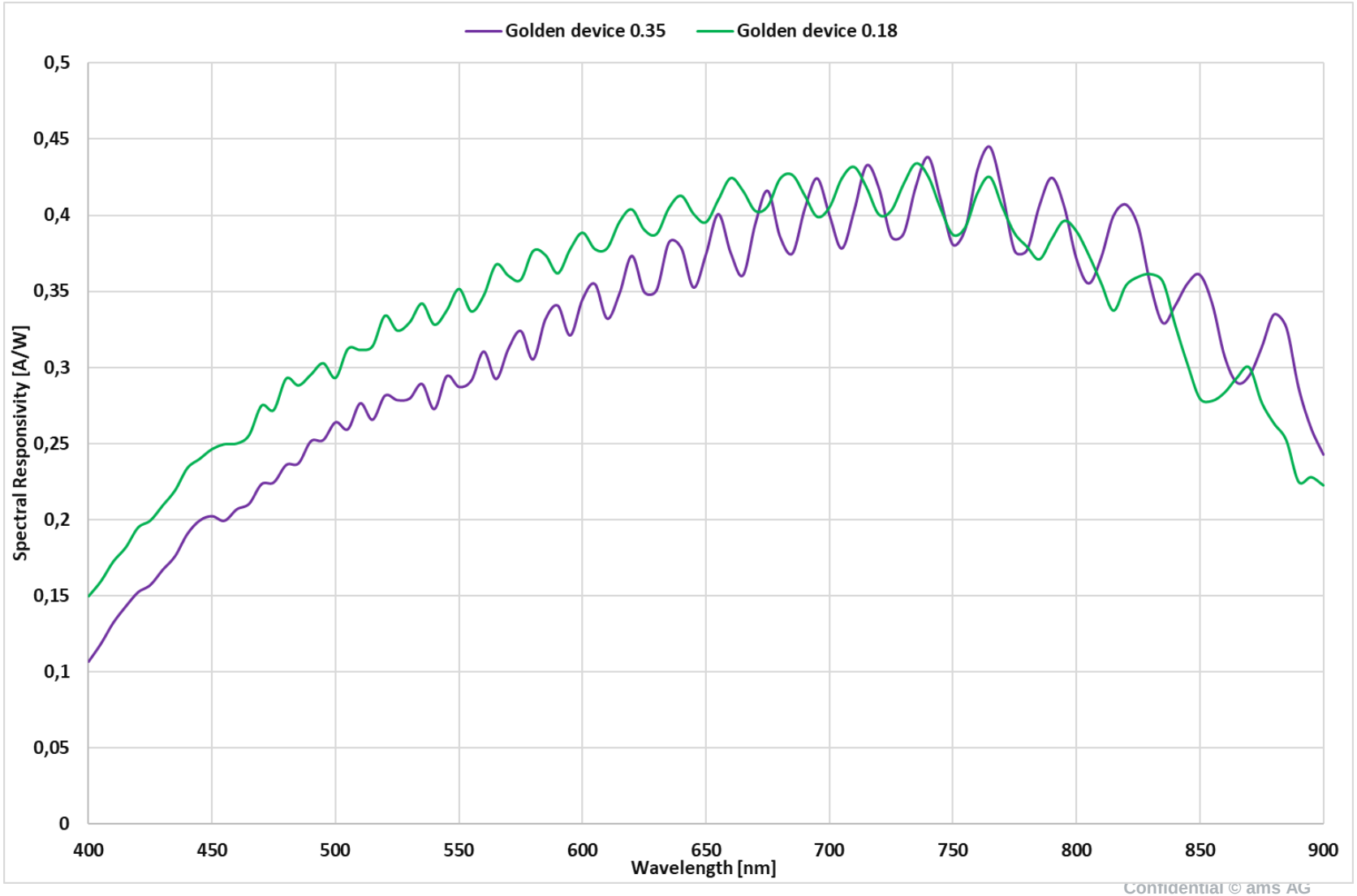
# Initial I-V measurement

- Operating reverse voltage: 1.25V
- Lower reverse current in 0.18 golden device due to lower amount of islands
- STI is used instead of FOX



# Initial Spectral Responsivity measurement

- Operating reverse voltage: 1.25V
- Increased SR for 0.18µm device, compared to the device from 0.35µm in range from 400 to 750nm
- Analysis is still on-going



# Next steps

- Wafer level measuerments of electro-optical parameters on all devices:
  - IV, SR, CV, Transient measurements
- Analysis of layout and process impact on device characteristics
- X-ray irradiation (TID radiation hardness)
  - Energy = 17keV
  - Dose = 200Gy (20krad)
- Post-radiation measurements
  - Also includes DLTS and Raman spectroscopy for trap characterization

# Conclusion

- I-V simulation
  - Islands contribute different to the total forward current, depending on their position in respect to the guard ring
  - Summing all current components, and normalizing the island area and the number of island to the real device situation provided fitted simulation data to the measurement data

- Test-chip design:
  - Important to understand technology restrictions and differences between 0.18µm and 0.35µm technologies

# Thank you!

Please visit our website
www.ams.com