The OCTOPUS Project:
Development of a Monolithic Active Pixel Sensor for Future Lepton Colliders

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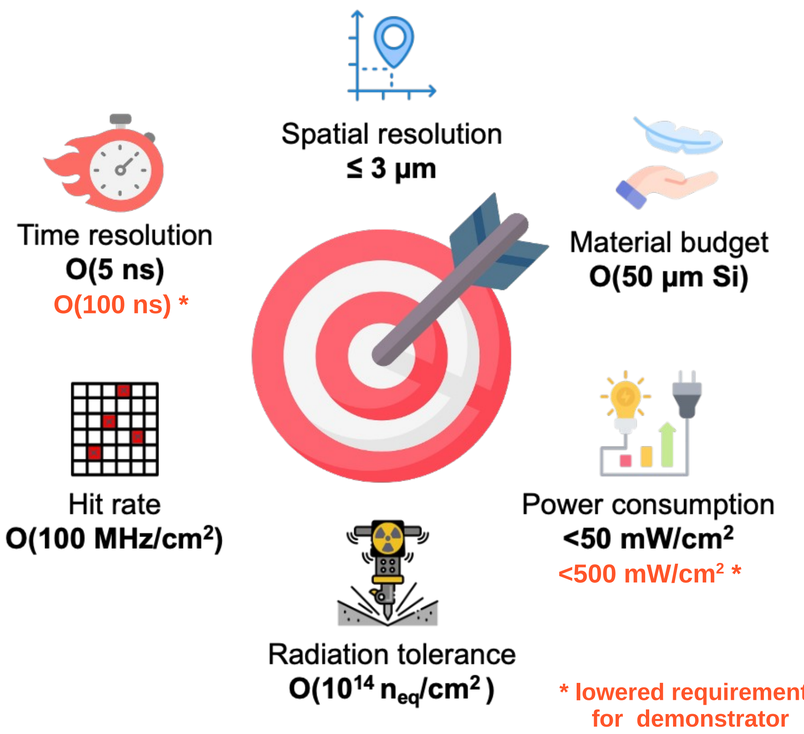
FACULTY OF NUCLEAR SCIENCES AND PHYSICAL ENGINEERING CTU IN PRAGUE

What is OCTOPUS

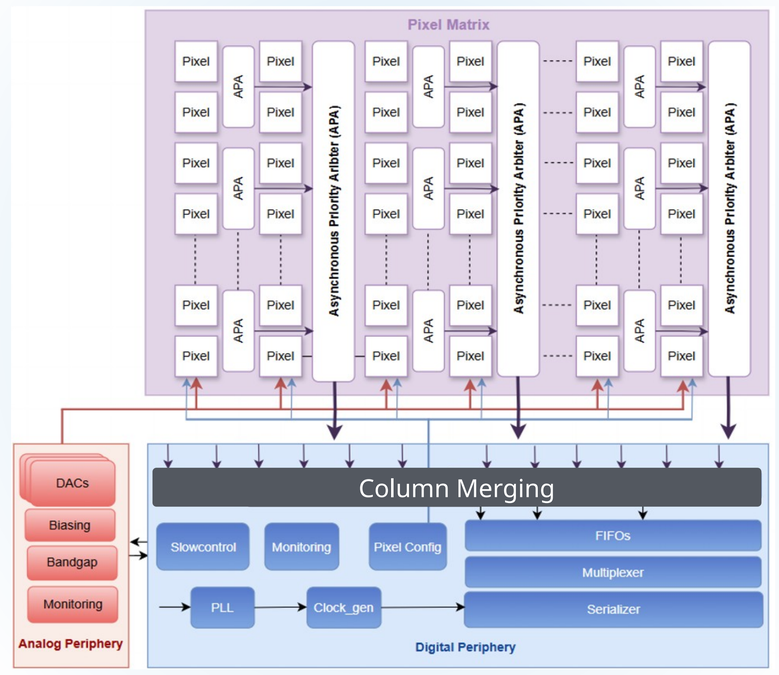
- **O**ptimized **C**MOS **T**echnology f**O**r **P**recision in **U**ltra-thin **S**ilicon
- R&D program towards a **vertex detector** for the **future lepton colliders**
- **Full-reticle size CMOS sensor** in **TPSCo** 65 nm process
- Full R&D chain performed by 13 institutes across Europe

Final target

- Development of a full-reticle size MAPS sensor for future $e^+ e^-$ collider vertex detectors
- Pixel pitch ≤ 20 µm
- Target vertex-detector requirements outlined in the ECFA detector roadmap
- Simulate, develop, and test fine-pitch pixel sensors prototypes
- Exploiting synergies with related R&D activities
- Staged approach: adapting to the decision about the future $e^+ e^-$ collider expected in 2028

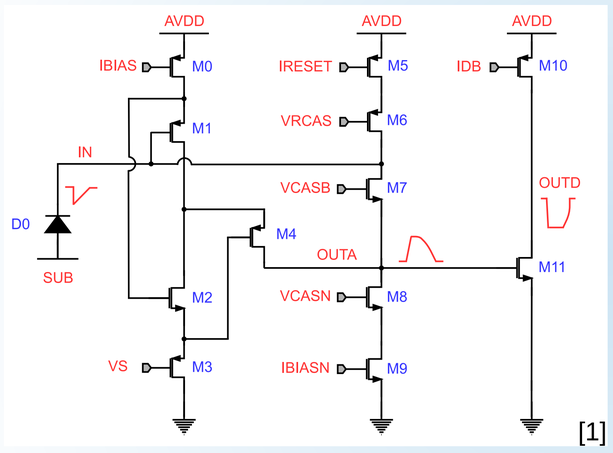


Schematic chip view



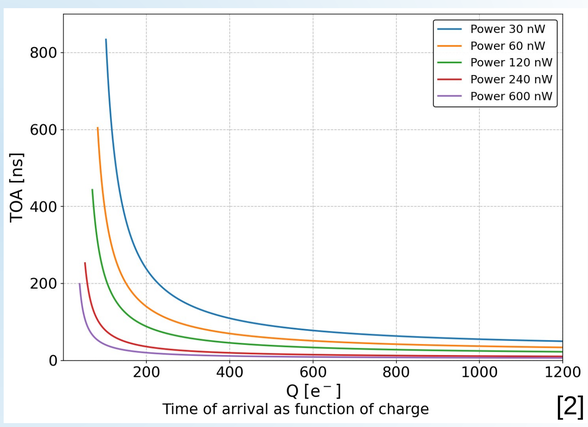
Front-End

- FE based on MOSAIX (ALICE ITS3)



[1]

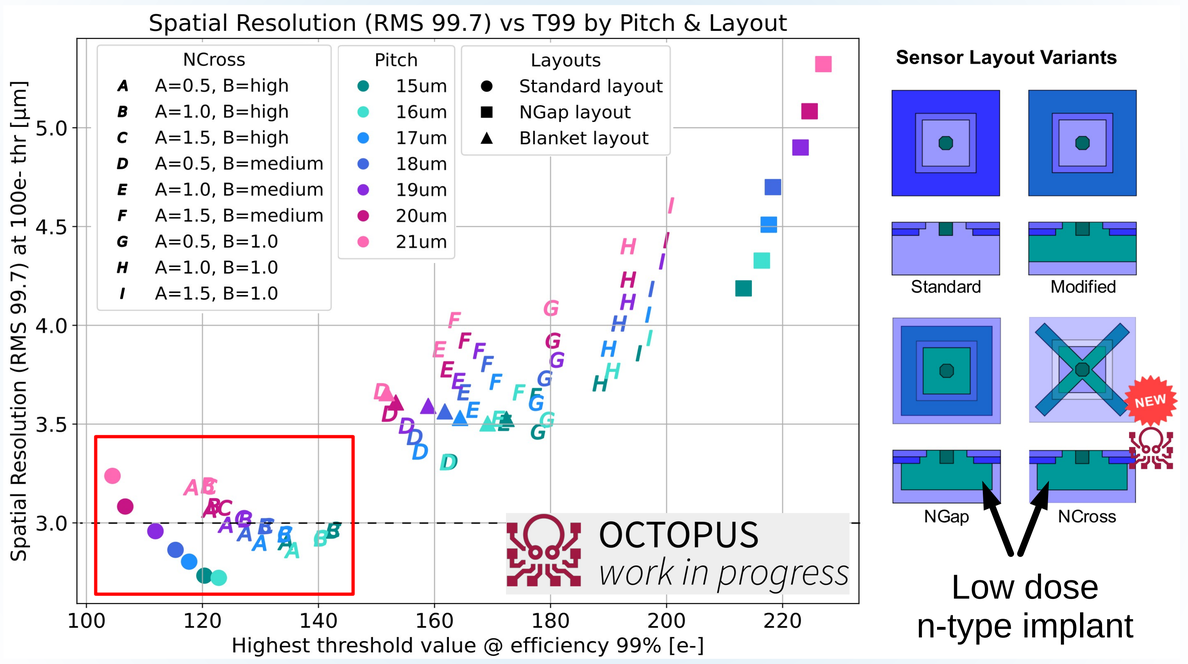
- Simulation shows significant time walk



[2]

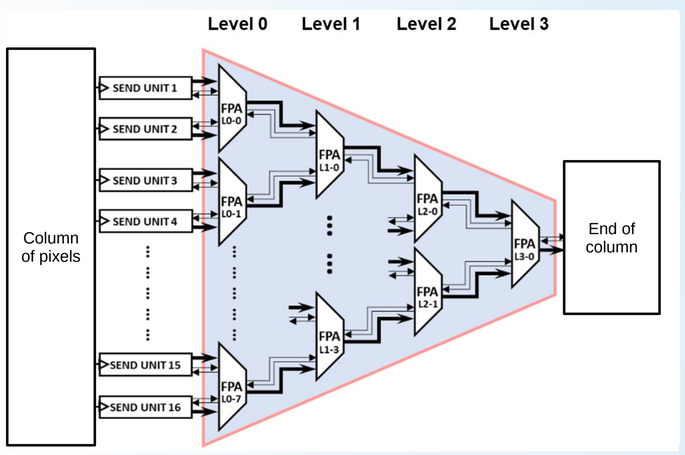
- Requires charge measurement
  - Sample rising and falling edge for ToT
  - Correction for time walk
  - Improves spatial resolution by charge interpolation

Pixel layout comparison

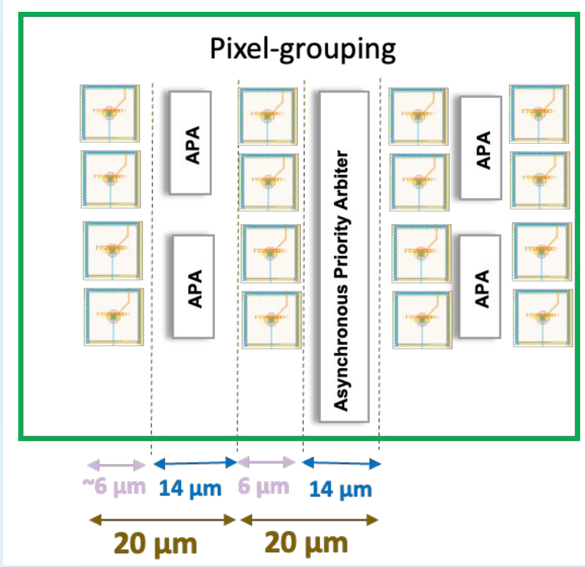


Matrix readout: Asynchronous Priority Arbiter

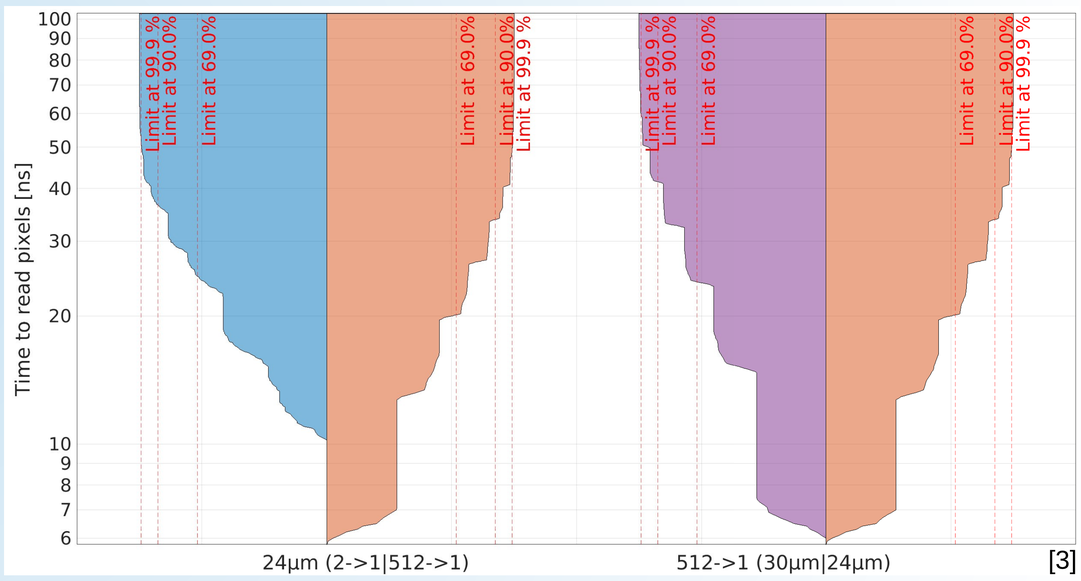
- High rate readout possible at low power
- Moderate impact on time resolution
- No time stamping clock in matrix
- Resolution ≤ 5ns feasible



- Will fit in ≤ 20µm pitch



- High hit rate capability (up to 100 MHz/cm²)



[3]

Conclusions

- OCTOPUS targets challenging requirements for future lepton collider vertex detector
- Staged approach, profiting from previous TPSCo 65 nm work and exploiting synergies
- Exploring innovative options for sensor layout and matrix readout to achieve goals
- First OCTOPUS prototype WOLFI, a beam-telescope demonstrator, targets submission in 2027

[1] W. Snoeys, CMOS (Monolithic) Active Pixel Sensors challenges and perspectives, 06.12.2024, Detector Seminar, CERN
[2] J. Hensler, Master Thesis 2025, IPHC, ALICE Group
[3] J. Soudier, Ph.D. thesis, Univ. de Strasbourg, 2024

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