

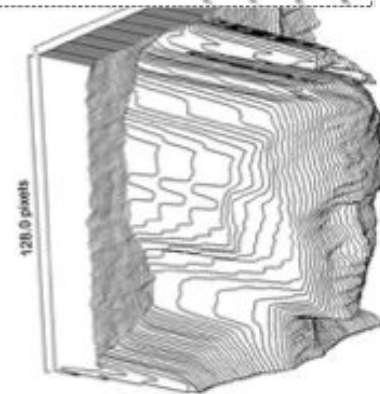
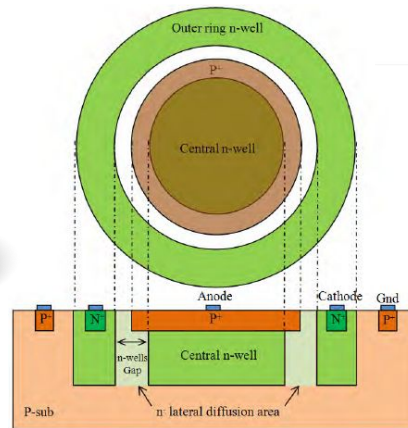
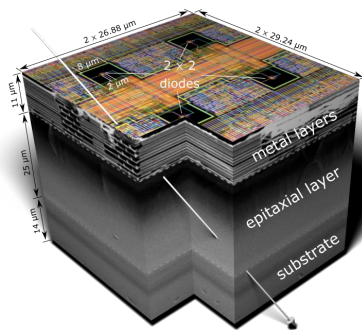
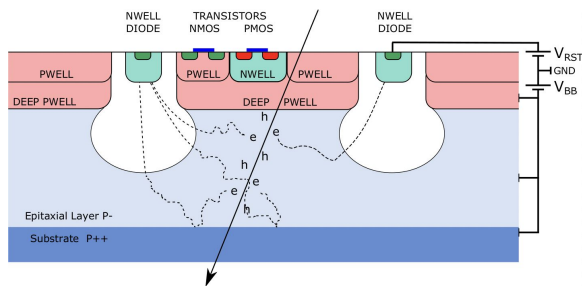
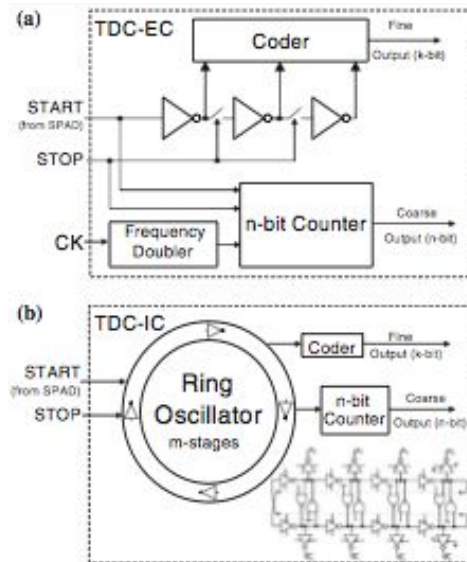
Technology development:

Pixel sensor with ~ 10 picosecond
timing resolution

Yuan Mei

Add ~10ps timing resolution to pixel (2018 proposal)

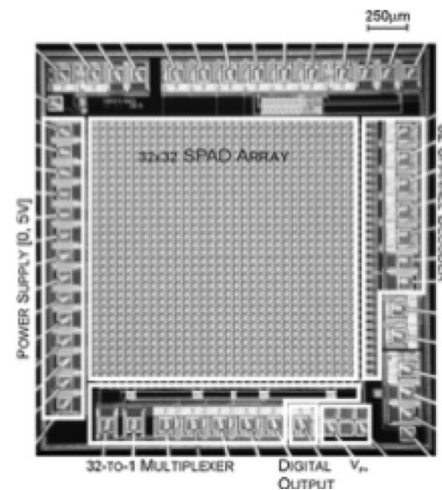
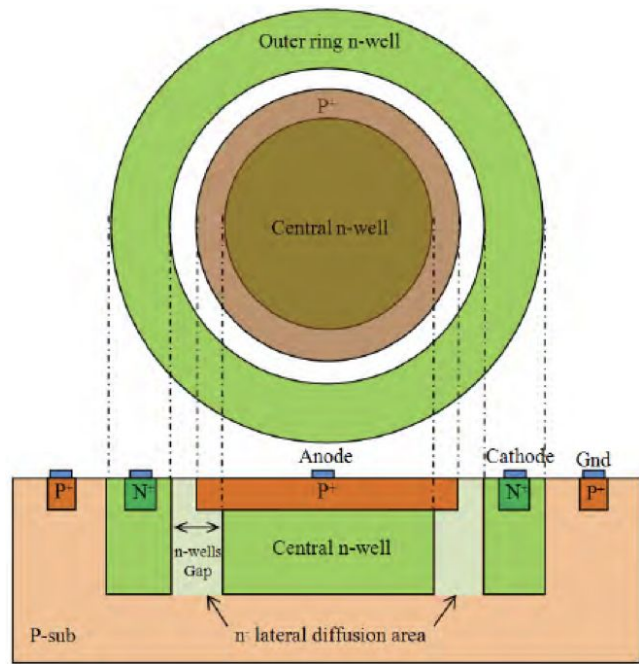
- Keep all nice features of MAPS
 - Low radiation length, good radiation hardness
 - Commercial CMOS manufacturing process
- ~10ps timing: on the verge of possibility
 - Existing fast-timing circuitry implemented in CMOS
 - Existing fast-timing charge/light sensor in CMOS
- Ref: SPAD array 3D imaging sensor



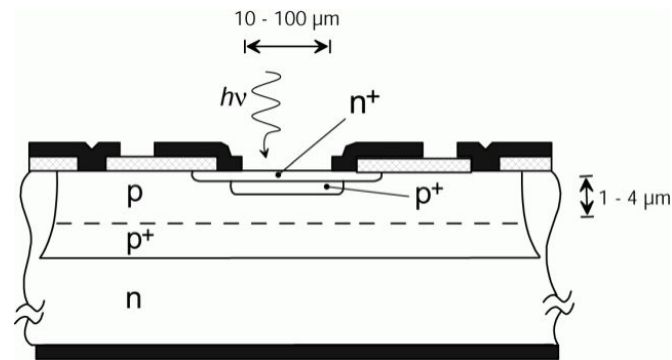
Avalanche Diode in CMOS

SPAD

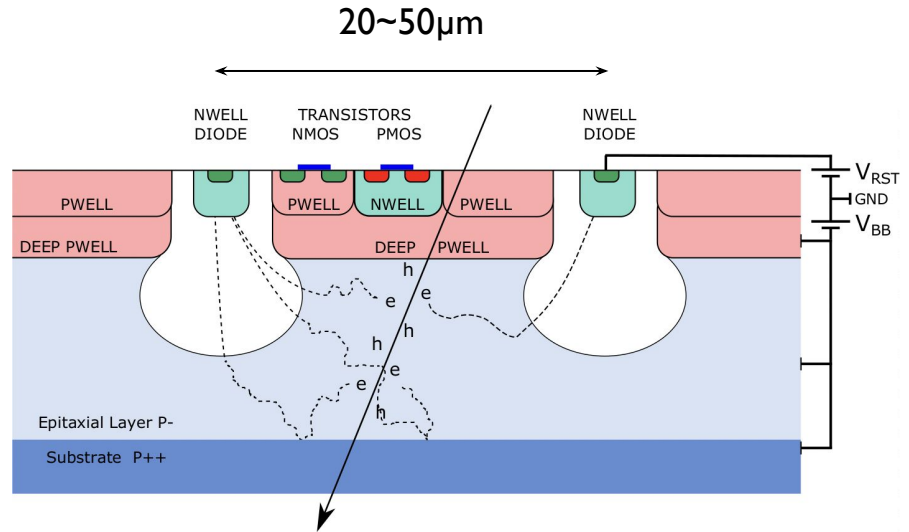
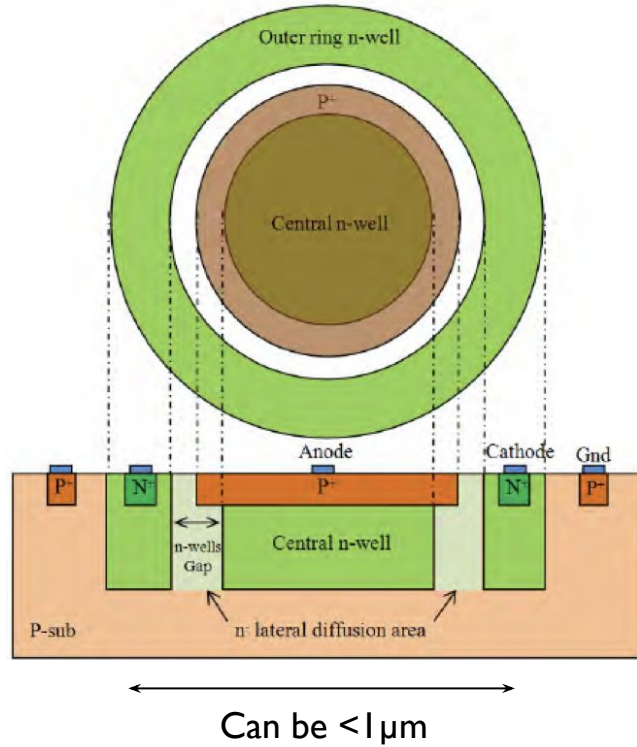
Single-Photon Avalanche Diode



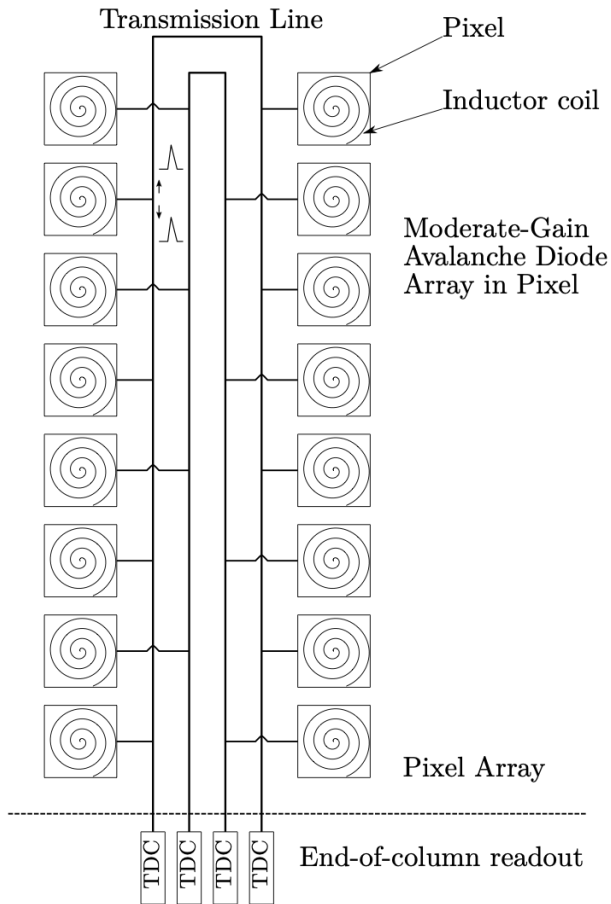
APD
LGAD
MPPC
SiPM



Avalanche Diode improves timing

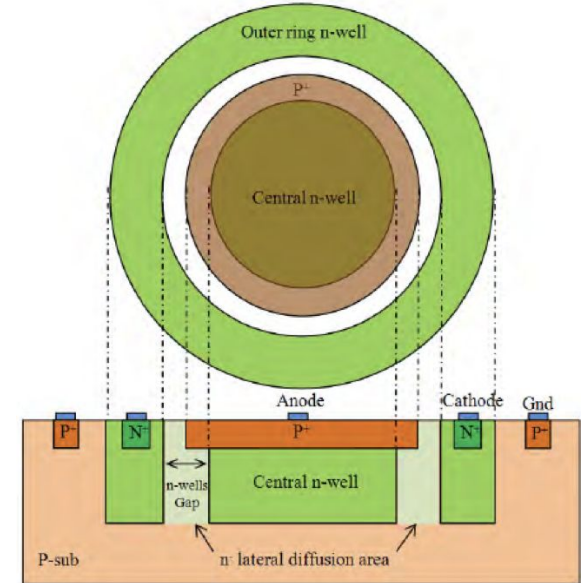
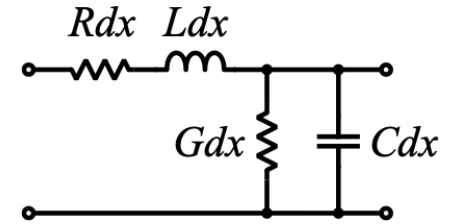
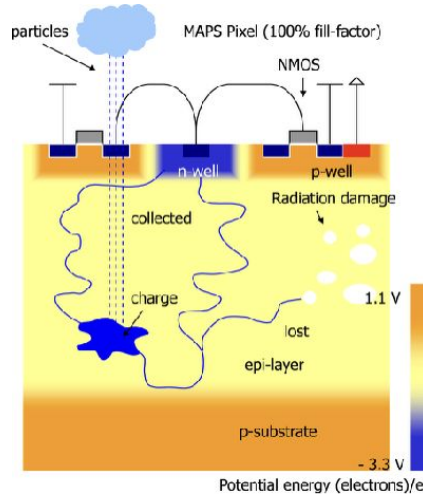


AD-TL pixel array and TDC readout (proposed for LDRD FY20)



$$u = \frac{1}{\sqrt{LC}}$$

$$Z_0 = \sqrt{\frac{L}{C}}$$



Avalanche Diode in CMOS

Recent advancement in the field

Sub-10 ps Minimum Ionizing Particle Detection with Geiger-Mode APDs

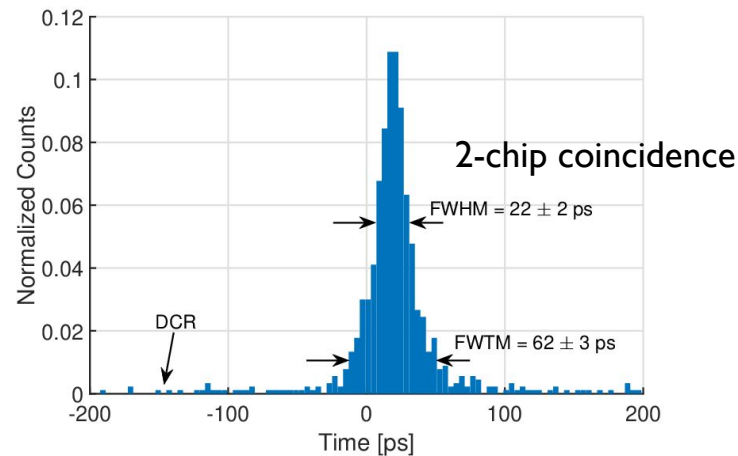
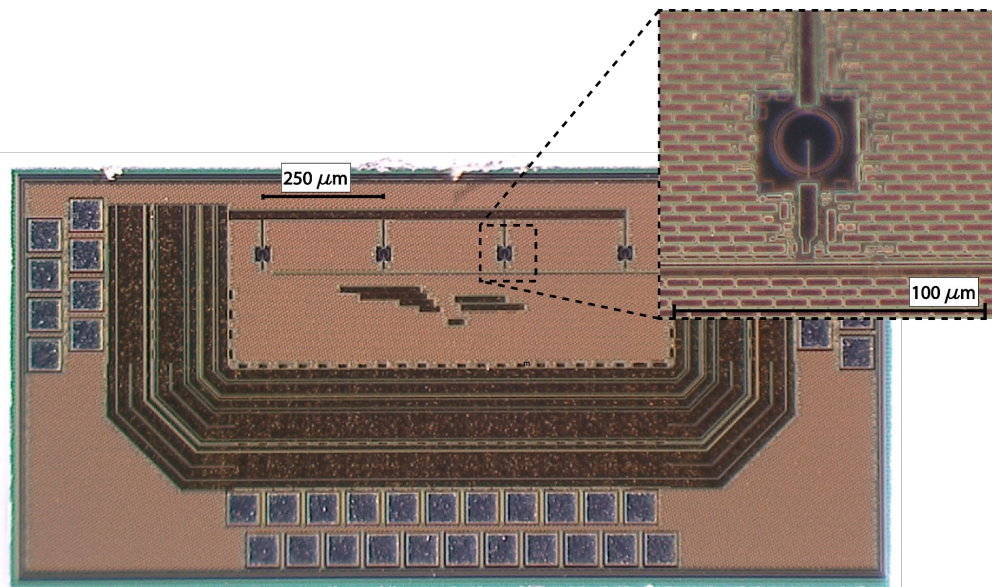
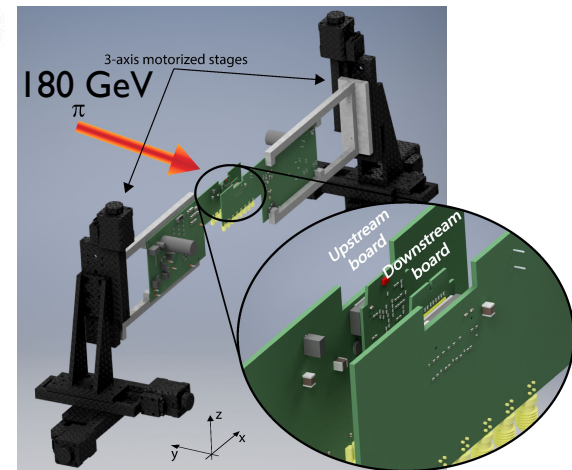
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Ming-Lo Wu,¹ Lorenzo Paolozzi,^{2,3} Claudio Bruschini,¹ and Edoardo Charbon¹

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²*University of Geneva*

³*CERN*

(Dated: November 22, 2021)



Δt , Δl

$\sim 10\text{ps}$, $\sim 10\mu\text{m}$

All-silicon tracker

Support

- Resources
 - Physicists in the group dive into design, testing, etc. 1 FTE.
 - Small but steady stream of money, perhaps \$50k/yr for hardware and manufacturing.
 - Occasional boost with engineering resources.
 - LDRD is insufficient: not timely enough and too restrictive.