

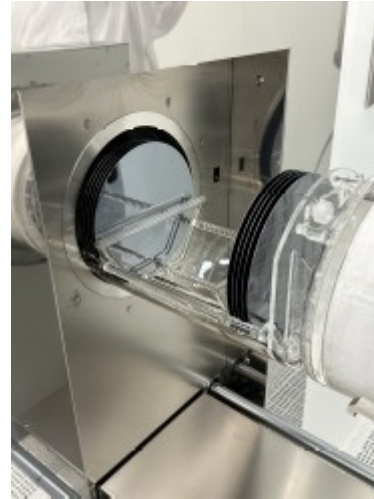


## Ultra Fast and High Sensitive Spectral Sensing

Beat De Coi  
ESPROS Photonics

Author(s): Beat De Coi

# About ESPROS



**Foundation 2006**  
**HQ Sargans, Switzerland**

## Activities

- Mixed signal / photonics chip design
- Camera module design
- Manufacturing
- Marketing & Sales

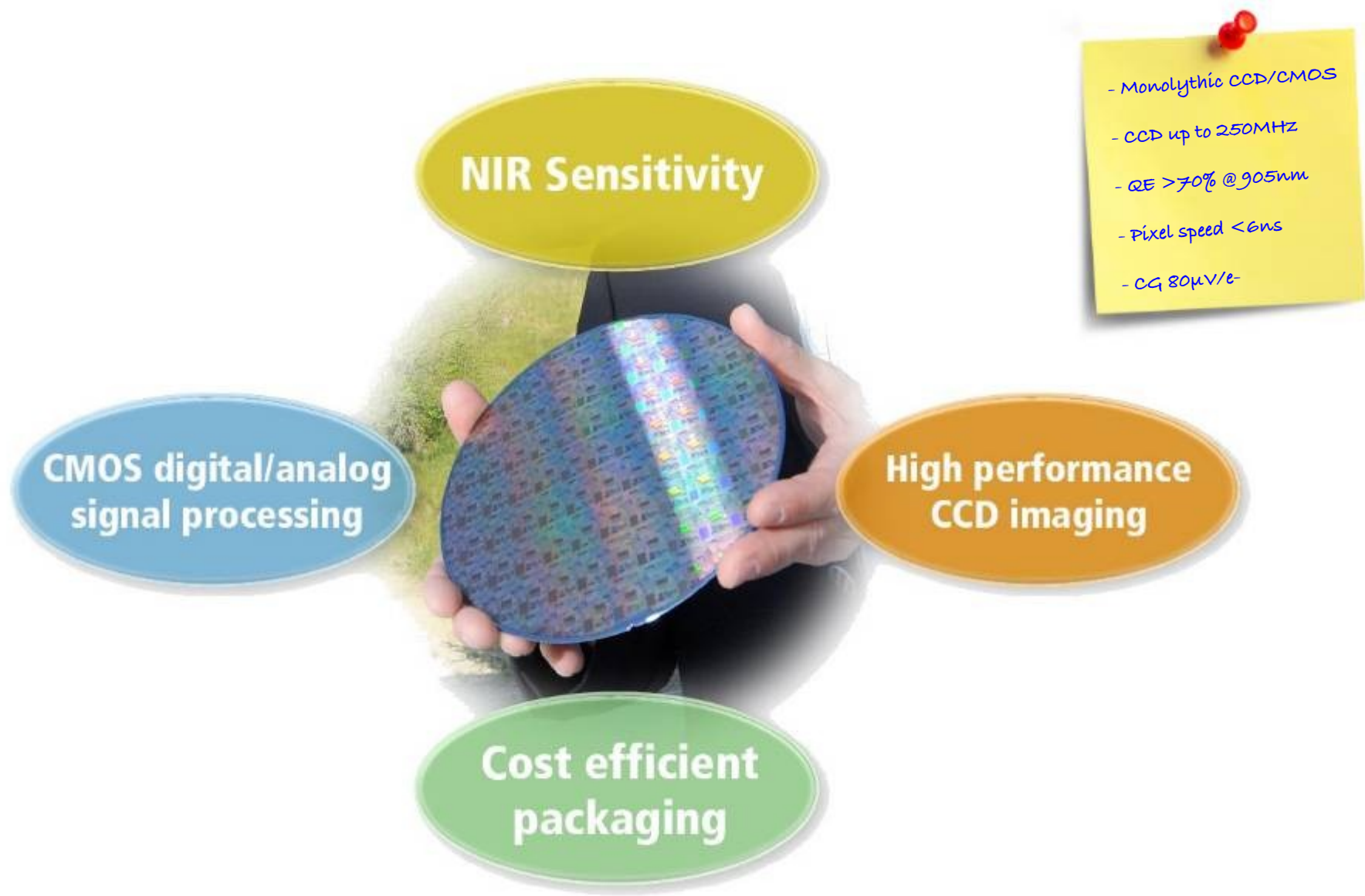




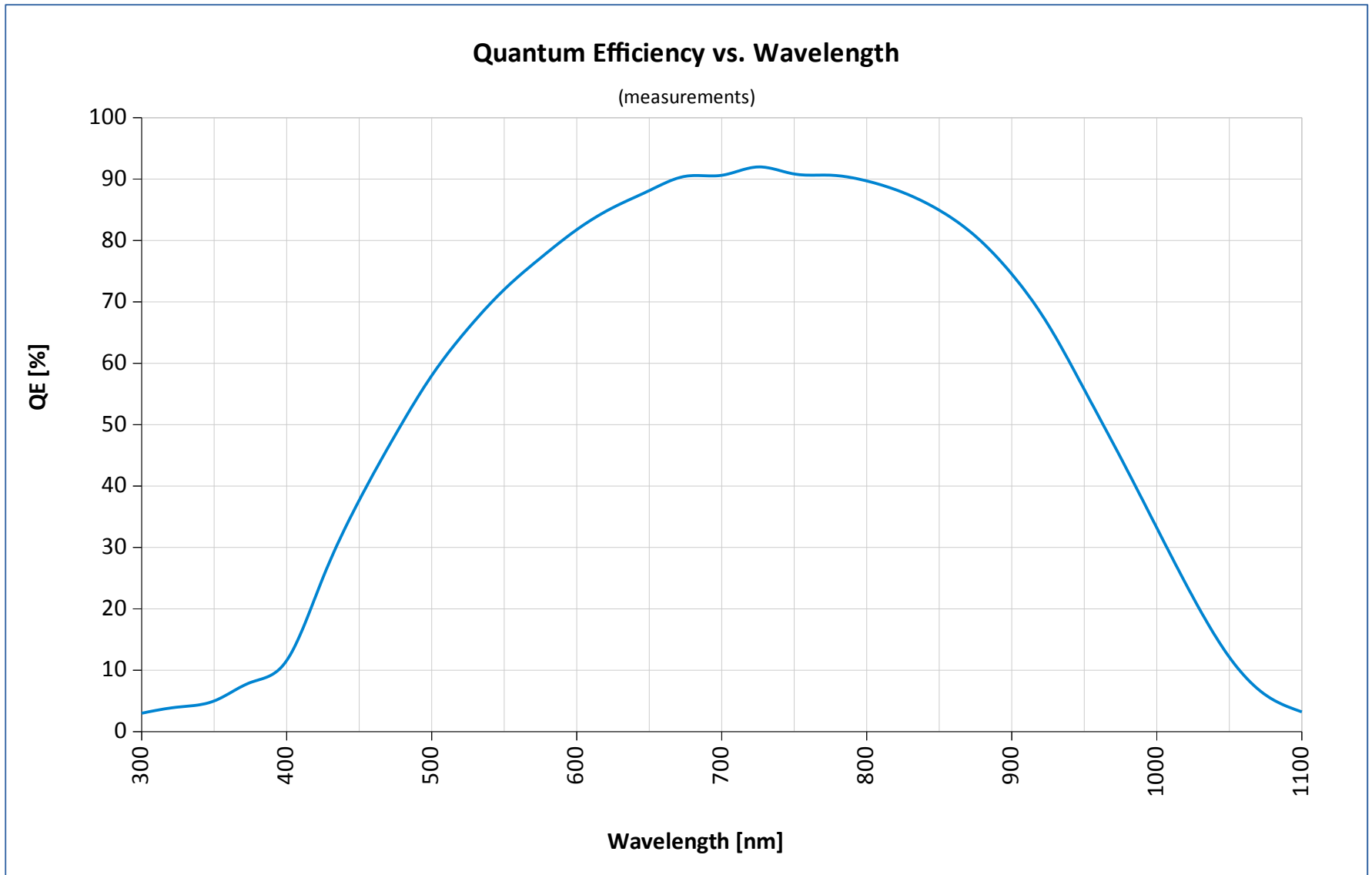
# Products & Applications

<p><b>epc 660</b></p> <ul style="list-style-type: none"> <li>Check it out!</li> <li>100 / 1000x</li> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660</b></p> <p>People counting</p> <ul style="list-style-type: none"> <li>Check it out!</li> <li>TDF camera</li> </ul>	<p><b>epc 660</b></p> <p>Try to fix it!</p> <p>TDF camera</p>	<p><b>epc 660</b></p> <p>Cable monitoring</p>	<p><b>epc 611</b></p> <ul style="list-style-type: none"> <li>Cliff detection</li> <li>High performance</li> <li>2m of distance</li> </ul>	<p><b>epc 611</b></p> <p>Check it out!</p> <ul style="list-style-type: none"> <li>Zoom range</li> <li>Low accuracy</li> <li>Low power / Low cost</li> </ul>	<p><b>epc 611</b></p> <p>TDF range finder chip</p> <ul style="list-style-type: none"> <li>Long range</li> <li>Low accuracy</li> <li>Low power</li> <li>Low cost</li> </ul>	<p><b>epc 611</b></p> <p>Check it out!</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>
<p><b>TOF cam - 660</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660 NFL</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660</b></p> <p>TDF camera</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 611</b></p> <p>French-style</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 611</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 611</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>
<p><b>epc 660</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 901</b></p> <p>The imager</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 860</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <p>Check it out!</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>
<p><b>epc 901</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 901</b></p> <p>Check it out!</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 901</b></p> <p>Line imager chip</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 138 + epc 200</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>TOF cam - 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>TOF cam - 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>
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<p><b>epc 611</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>TOF cam - 635</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660</b></p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 901</b></p> <p>The imager</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>	<p><b>epc 660</b></p> <p>People counting</p> <ul style="list-style-type: none"> <li>Check it out!</li> <li>TDF camera</li> </ul>	<p><b>epc 901</b></p> <p>Line imager chip</p> <ul style="list-style-type: none"> <li>1000x magnification</li> <li>Zoom</li> <li>Low Power</li> </ul>

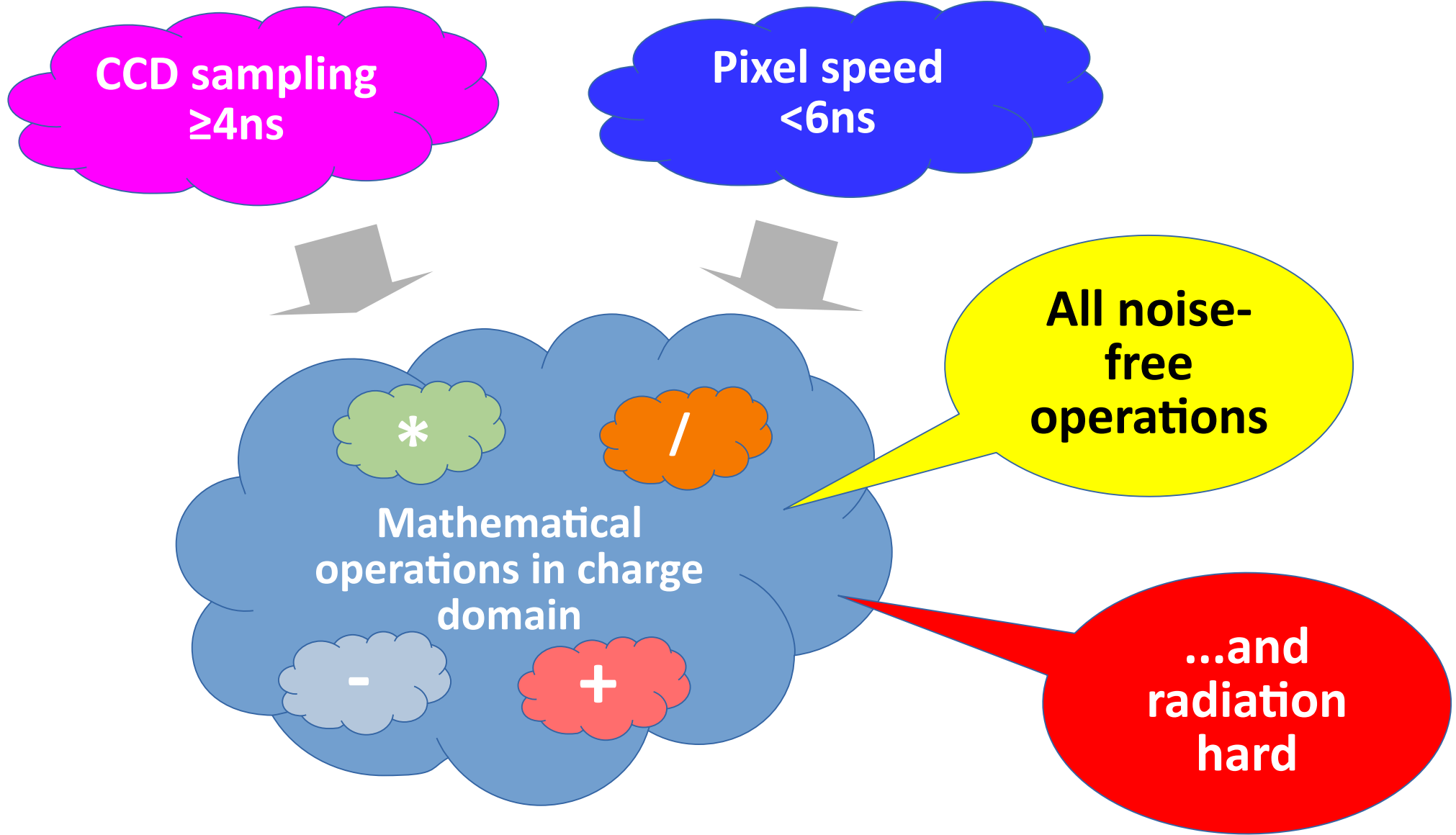
# Key ingredients for high performance TOF & LiDAR imaging



# ...lead to incredible properties: QE

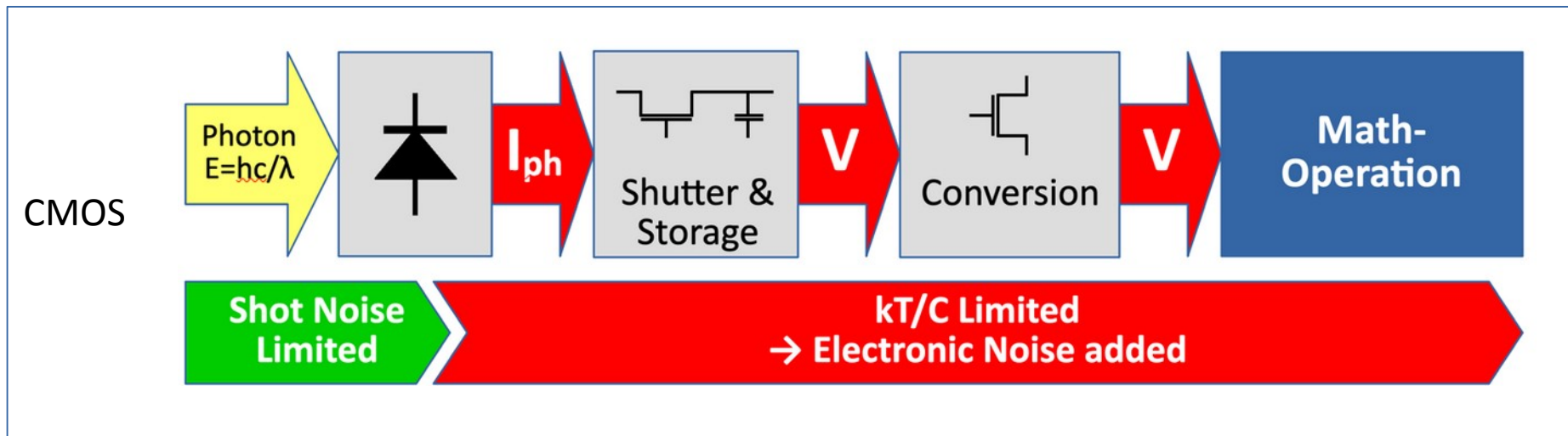


...lead to incredible properties: Speed and math ops in charge domain

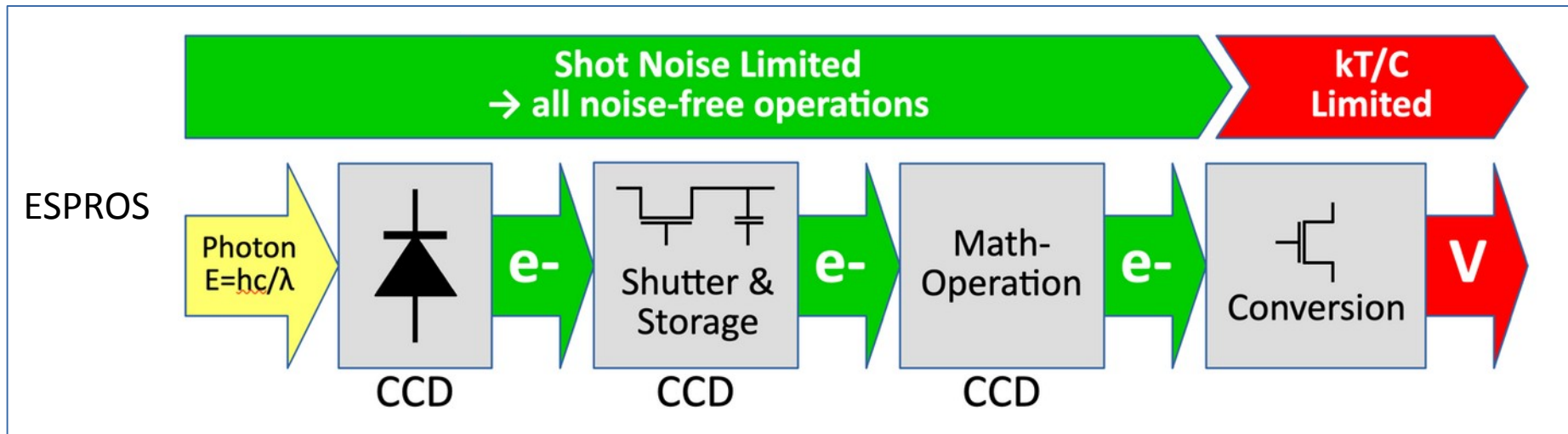
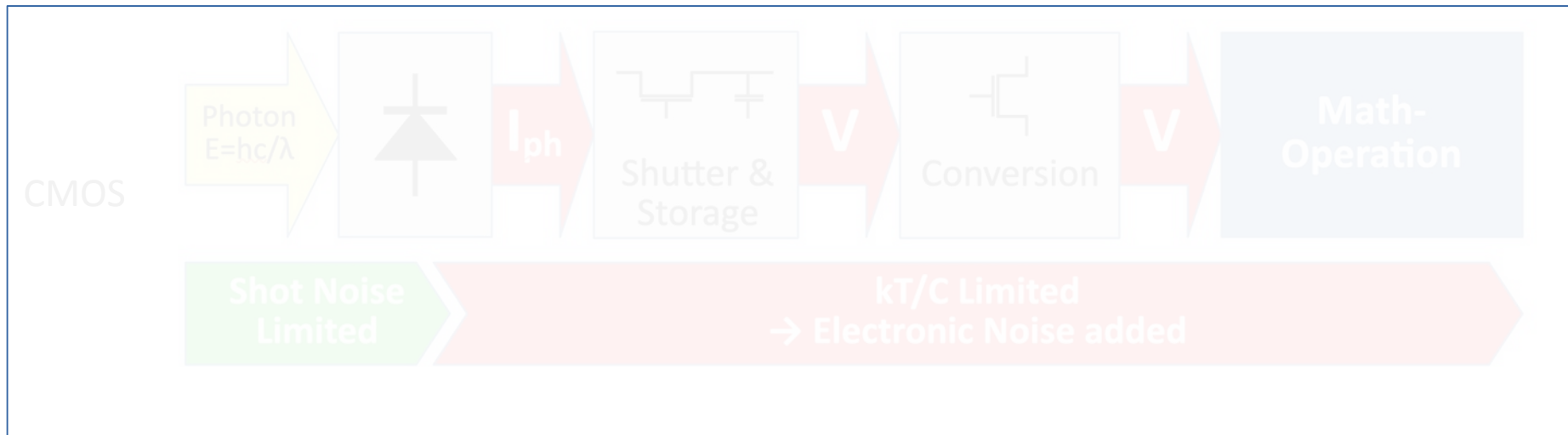




# Signal flow in a **typical** photonics chip

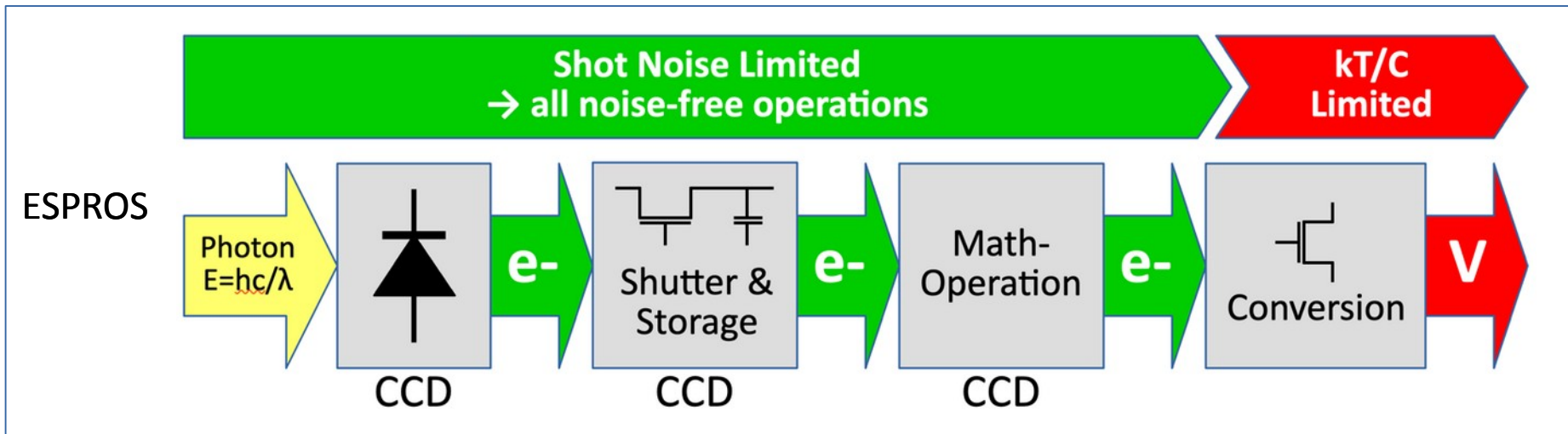
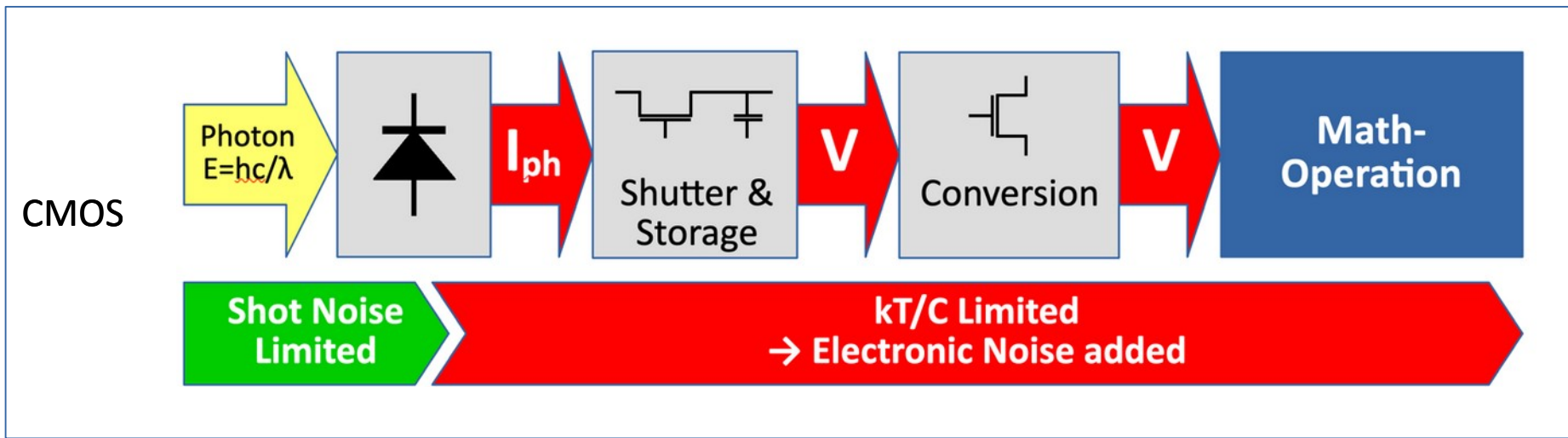


# Signal flow in **ESPROS** photonics chip

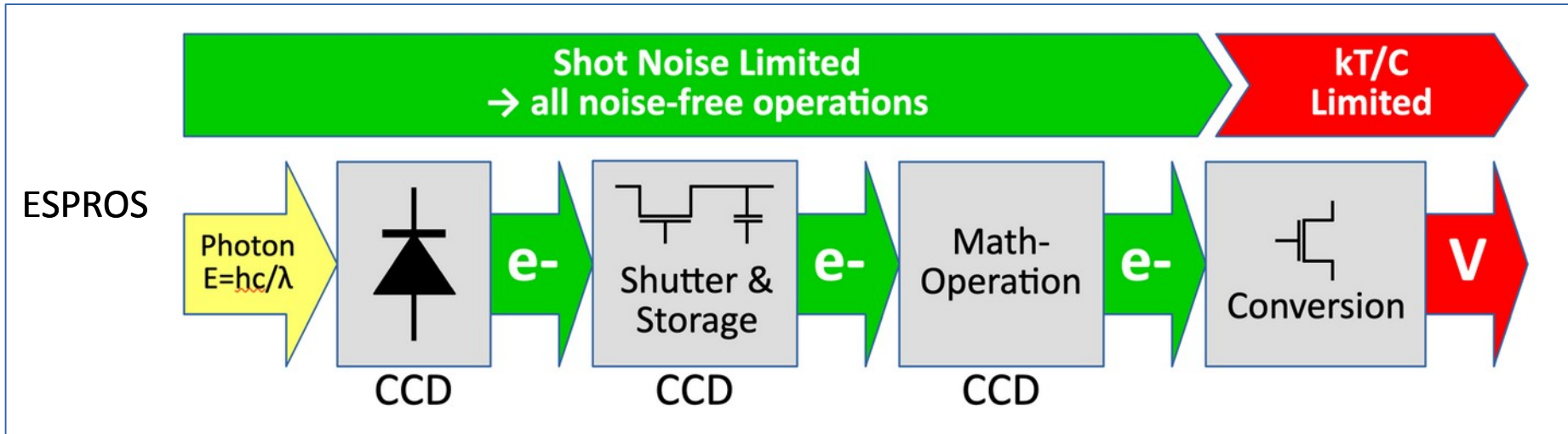
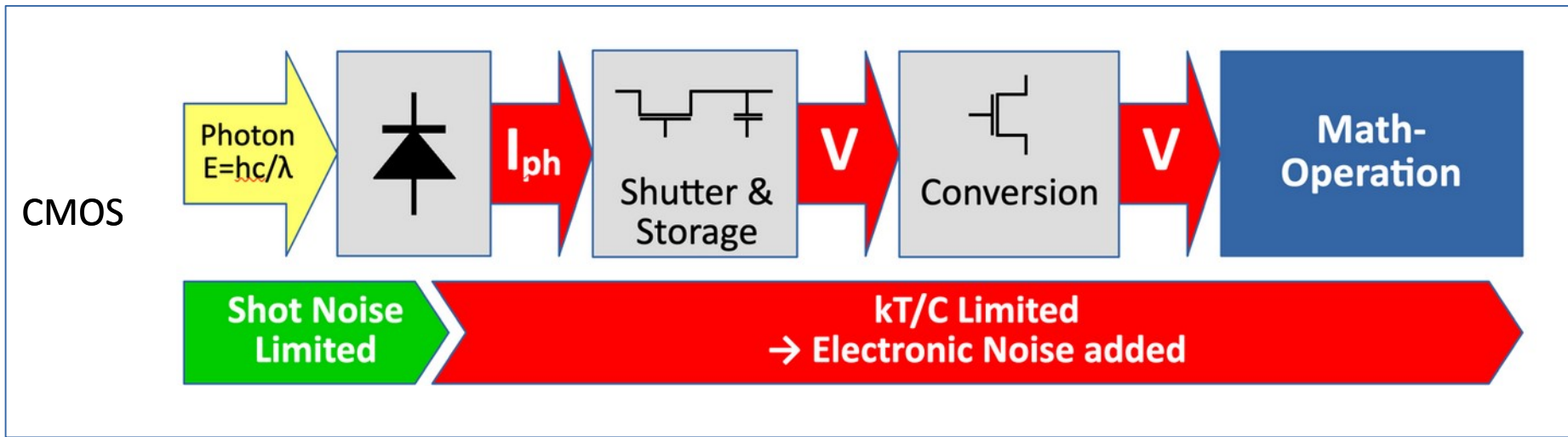




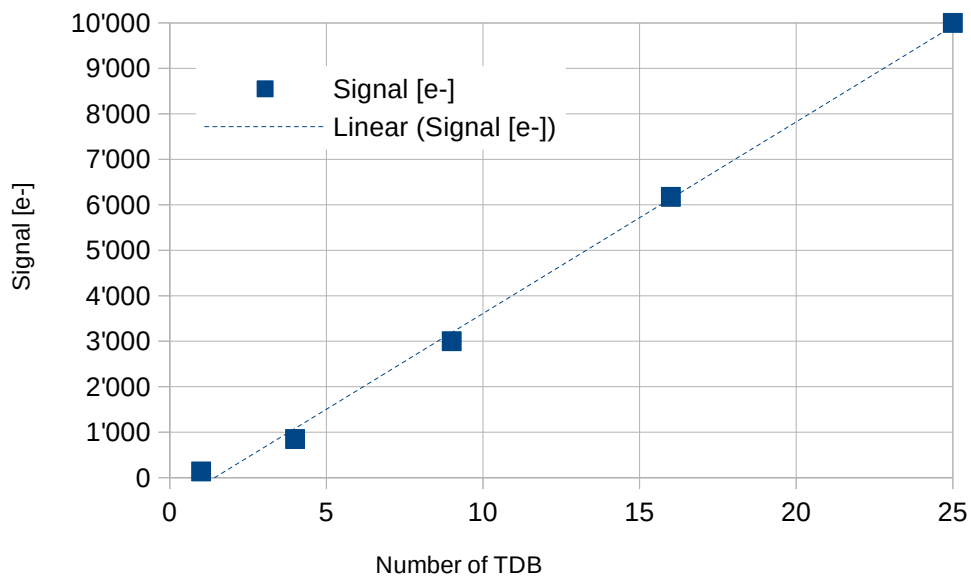
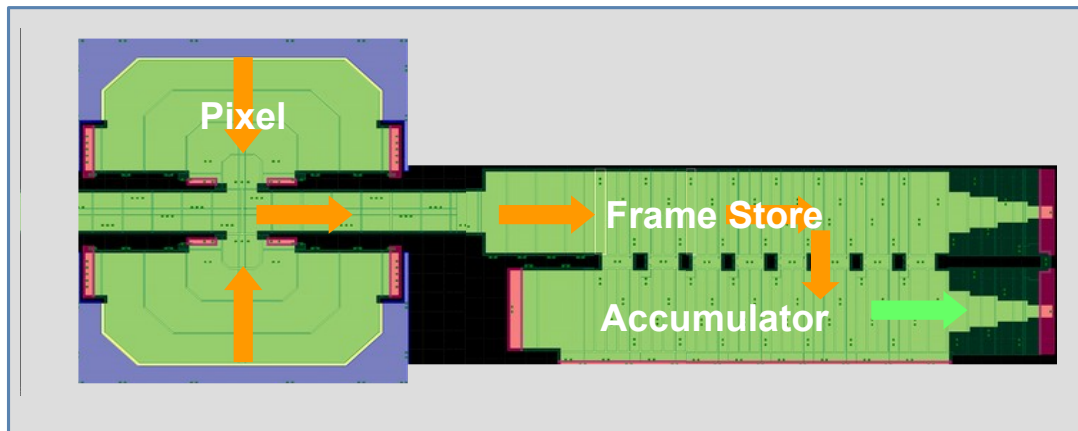
# Signal flow comparison



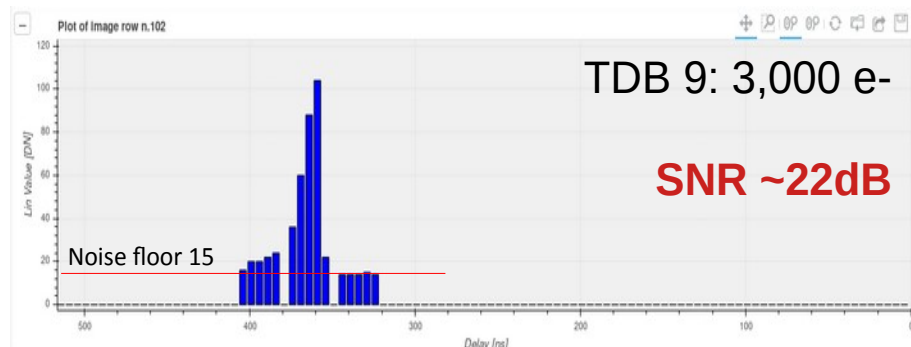
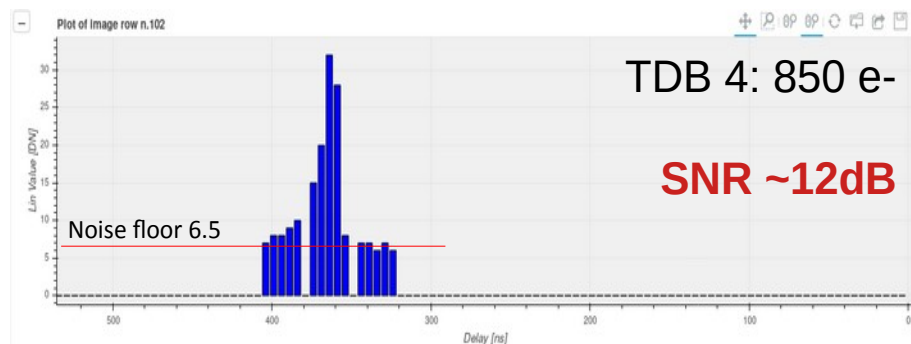
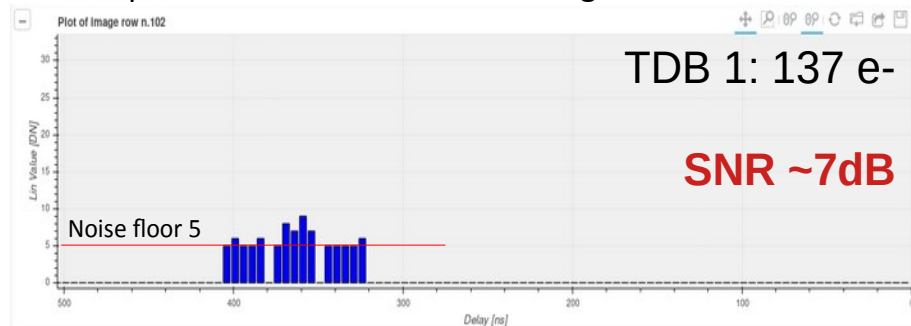
# Signal flow comparison



# Example: Time Domain Binning (TDB)

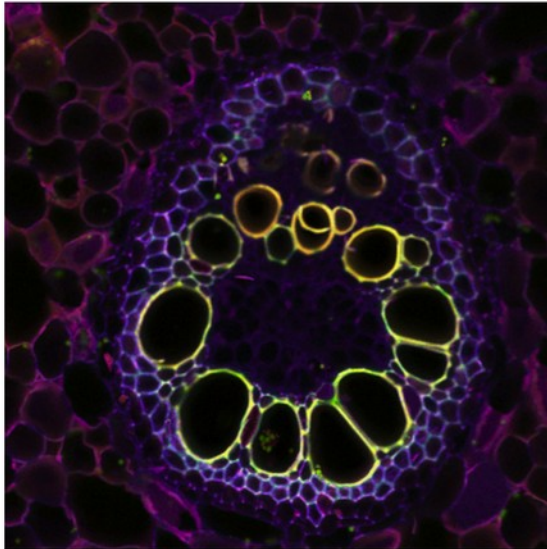


pTOF Measurement on 75% target at 30 meters

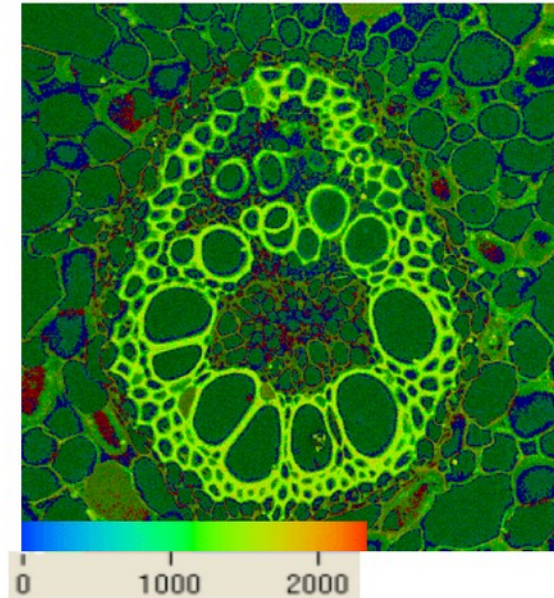


## Example: Fluorescent Lifetime Imaging (FLIM)

- Analysis of the lifetime of the excited state of fluorescent molecules
- Spatially resolved distribution of fluorescent lifetimes
- Needs a ultra fast imager



**Conventional confocal intensity image**



**Fluorescence lifetime image /ps**

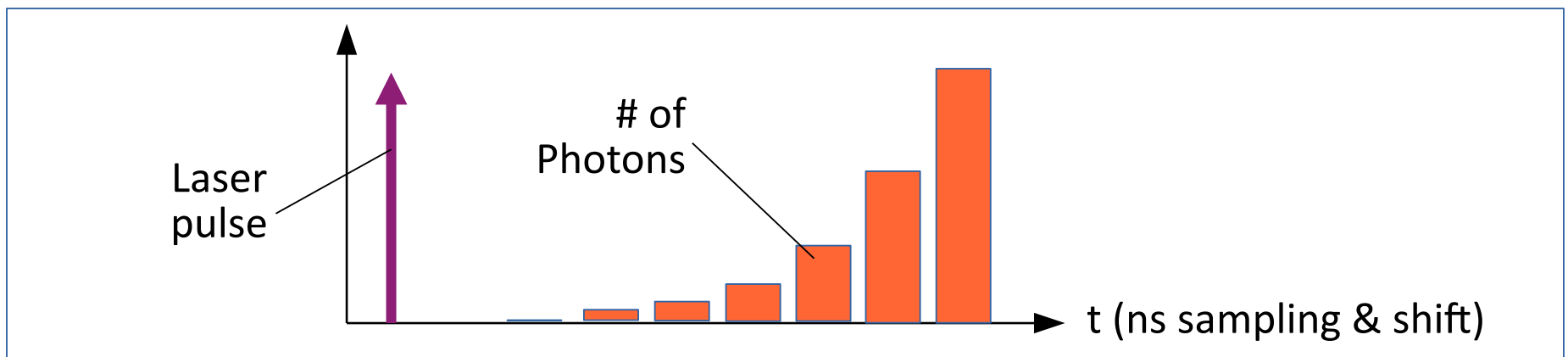
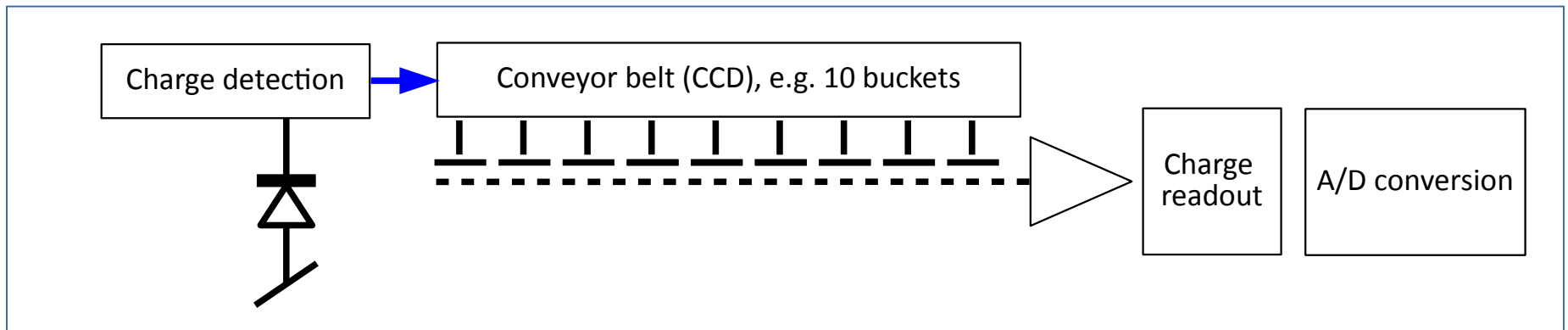
**Sample: Prionium,  
stained with Safranin  
and Fast green**

Source: Haridas Pudavar, PhD, Application and Technology Support, Leica Microsystems Inc., 10/25/09

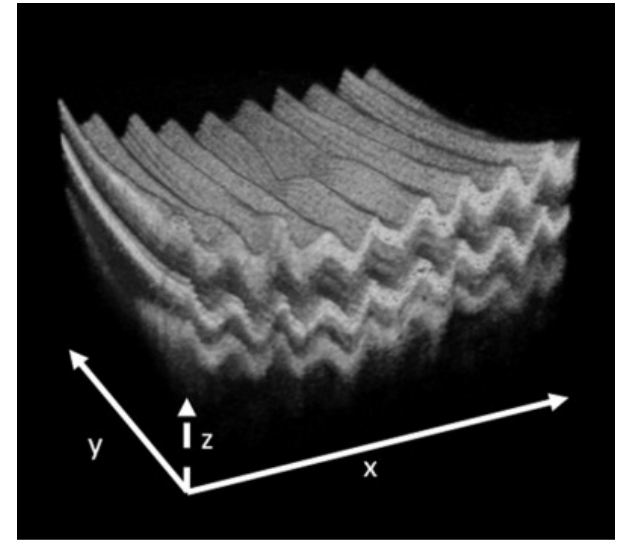
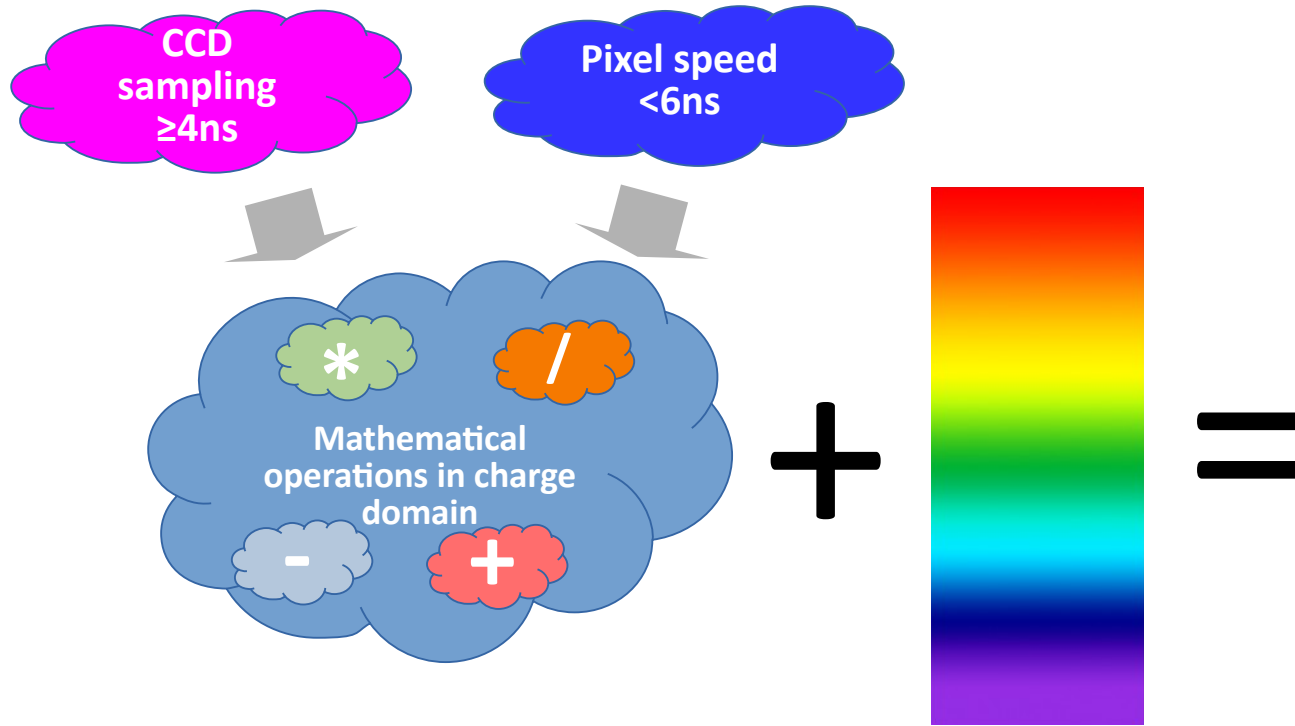


## Example: FLIM Implementation

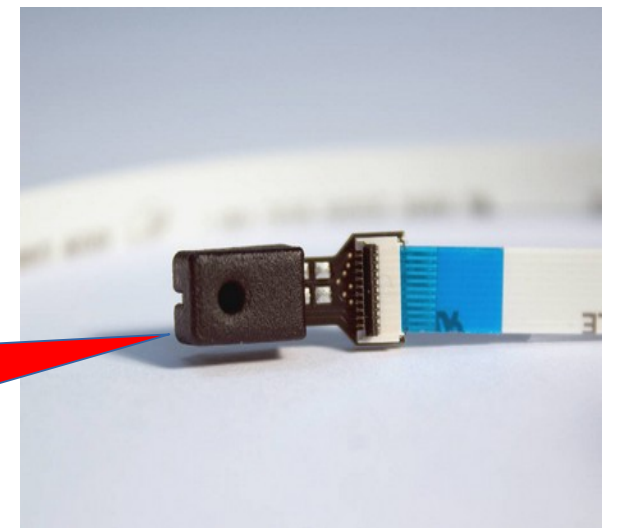
- Photo gate for charge detection
- Charge sampling on a conveyor belt
- Sampling in 4 ns steps (or more)
- Conversion gain  $80\mu\text{V}/e^-$
- 250 Million frames per second



# Summary



OCT image of a human retina  
Source: Philophos, Inc., 2023



Spectral sensor (ESPROS)

**...for  
radiation  
exposed  
applications**

# Thank you for your attention!

<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>15m range / low accuracy</li> <li>4mm module / 1 channel</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>30m range</li> <li>cm accuracy</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>long range</li> <li>cm accuracy</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <p>SLAM!</p> <ul style="list-style-type: none"> <li>15m range / low accuracy</li> <li>4mm module / 1 channel</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>up to 15m range</li> <li>cm accuracy</li> <li>15mm measurement interval</li> <li>low power / small size / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>Touch-less Button</p> <ul style="list-style-type: none"> <li>30 TOF range-finder</li> <li>15mm</li> </ul>	<p><b>epc 611</b></p> <p>3D TOF touch-less button</p>	<p><b>epc 611</b></p> <p>3D TOF touch-less button</p>
<p><b>epc 635</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>door protection</li> <li>low power</li> <li>people counting</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>TOF Camera</p> <ul style="list-style-type: none"> <li>Start/stop</li> <li>Direction of location</li> <li>Accidental prevention</li> </ul>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>SLAM</li> <li>direction</li> <li>classification</li> </ul>	<p><b>epc 635</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>10m x 6m pixel</li> <li>15m range</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>3D TOF Camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>15m range</li> <li>30 frames per second</li> </ul>	<p><b>epc 635</b></p> <p>3D TOF Camera</p> <ul style="list-style-type: none"> <li>data opening</li> <li>moving direction</li> <li>low range</li> <li>depth tracking</li> </ul>	<p><b>epc 611</b></p> <p>Cliff</p>
<p><b>epc 660</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>fast</li> <li>low power</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <p>People counting</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>door protection</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>up to 50m</li> <li>0.2m x 0.2m pixel</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <p>Cabin monitoring</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <p>Object detection &amp; classification</p> <ul style="list-style-type: none"> <li>up to 50m pixel</li> <li>up to 50m</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>3D TOF camera</p> <ul style="list-style-type: none"> <li>0.2m x 0.2m pixel</li> <li>15m range</li> </ul>	<p><b>TOF cam 660</b></p> <p>TOF camera</p>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m range</li> <li>0.2m x 0.2m pixel</li> <li>SLAM</li> </ul>
<p><b>epc 901</b></p> <p>Line imager chip</p> <ul style="list-style-type: none"> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / s</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>Line imager</p> <ul style="list-style-type: none"> <li>1024 pixel</li> <li>0.15µm pixel</li> <li>50,000 frames / s</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>Line imager</p> <ul style="list-style-type: none"> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / second</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>Line imager chip</p> <ul style="list-style-type: none"> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / second</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>Line imager</p> <ul style="list-style-type: none"> <li>1024 pixel</li> <li>0.15µm resolution</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>Smart touch screen</p> <ul style="list-style-type: none"> <li>Multi touch</li> <li>high resolution</li> <li>proximity detection</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m range monitoring</li> <li>0.2m x 0.2m pixel</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p>
<p><b>epc 860</b></p> <p>LiDAR imager</p> <ul style="list-style-type: none"> <li>LiDAR imager</li> <li>30m pixel vertical</li> <li>20,000 lines / second</li> </ul>	<p><b>TOF cam - 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m range</li> <li>0.2m x 0.2m pixel</li> <li>10 fps</li> </ul>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>10m x 6m pixel</li> <li>10 fps</li> <li>Collision avoidance</li> </ul>	<p><b>epc 660 NFL</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m</li> <li>high brightness</li> <li>10 fps</li> <li>30mm range @ 15m</li> </ul> <p>near field laser</p>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>high accuracy</li> <li>10 fps</li> <li>collision</li> </ul>	<p><b>epc 138 + epc 200</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>Miniature &amp; amplifier</li> <li>low power</li> <li>extremely cost effective</li> <li>extremely powerful!</li> </ul>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>high brightness &amp; high accuracy</li> </ul>	

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