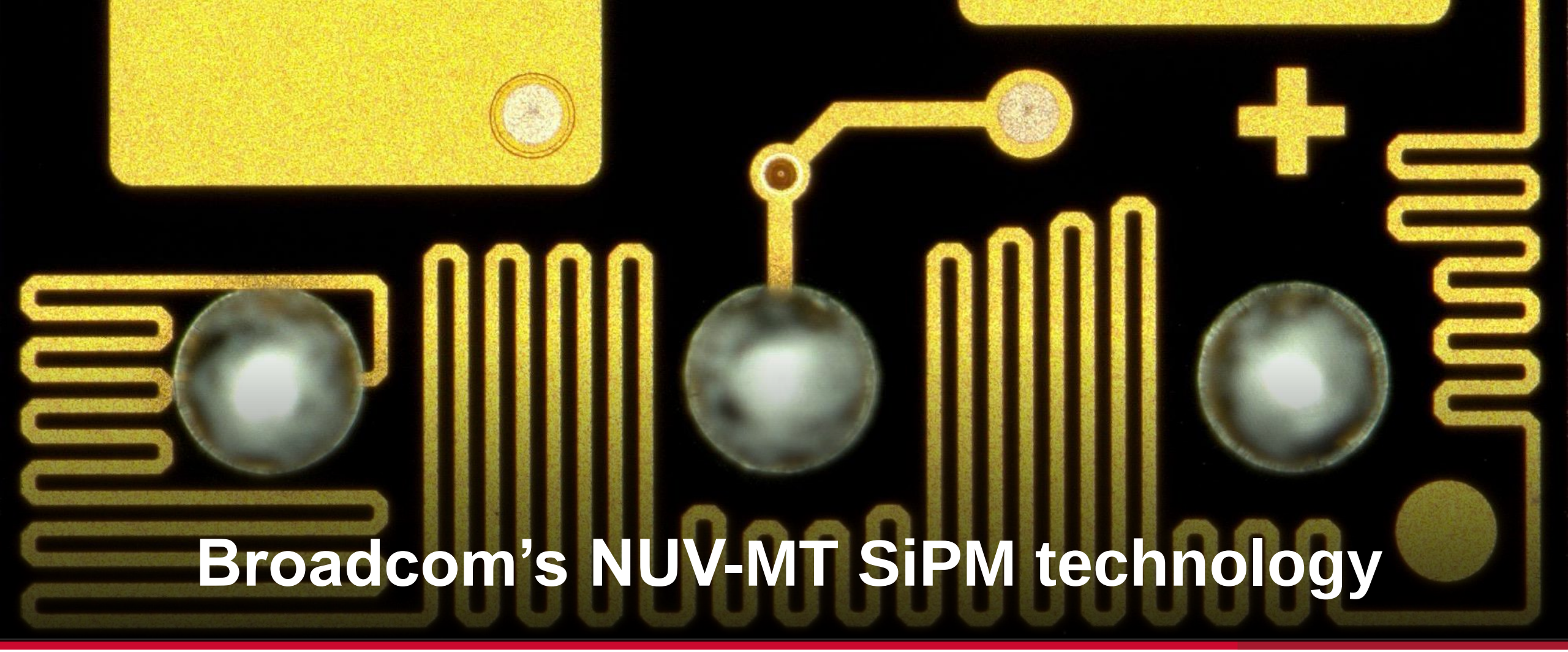

Broadcom’s NUV-MT SiPM technology

Martin Sharratt – Director, AP Technologies

PSD13, September 2023

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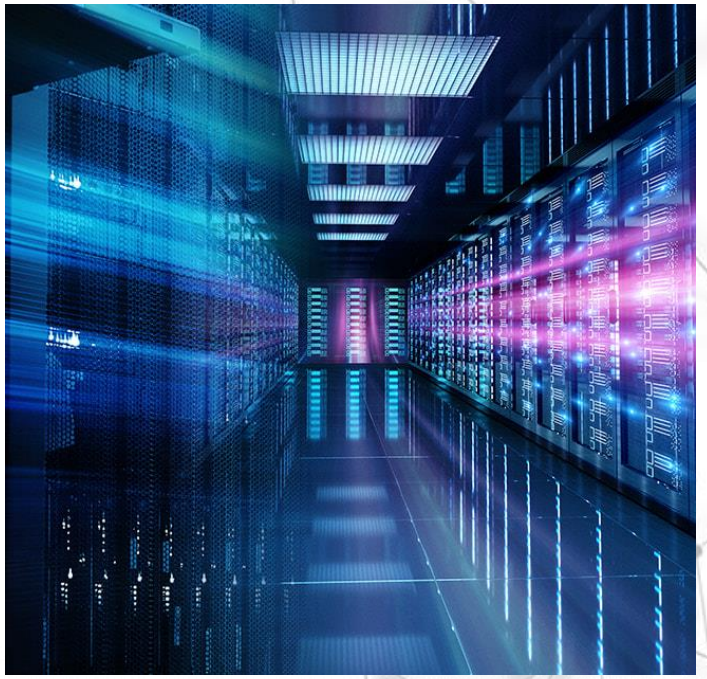
Broadcom at a Glance

FY22 net revenue of **$33.2B**



$4.9B investment in R&D in FY22

One of the industry's broadest IP portfolios with **>17,000** patents in FY22

22 Category-Leading Semiconductor and Infrastructure Software Divisions

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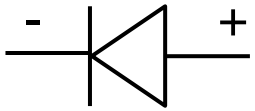
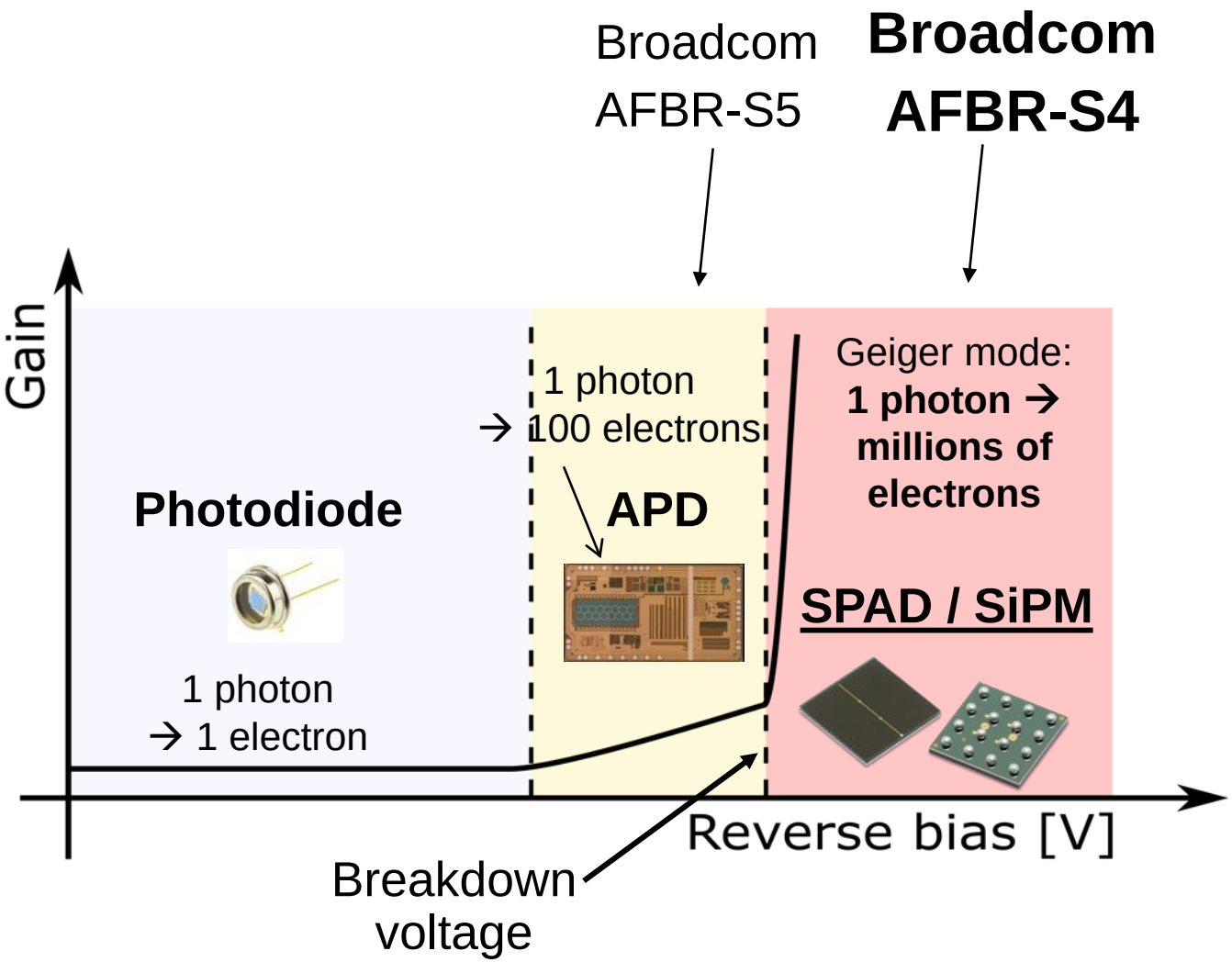
From photodiode to SPAD

- p-n junctions in semiconductors are the basis of
  - **Photodiodes**
  - **APDs**
  - **SPADs**



- Can be differentiated by gain
- Gain can be driven by reverse bias
- **APD:** **A**valanche **P**hoto**d**iode internal gain 10 to 100
- **SPAD:** **S**ingle **P**hoton **A**valanche **D**iode Geiger mode internal gain up to 10M



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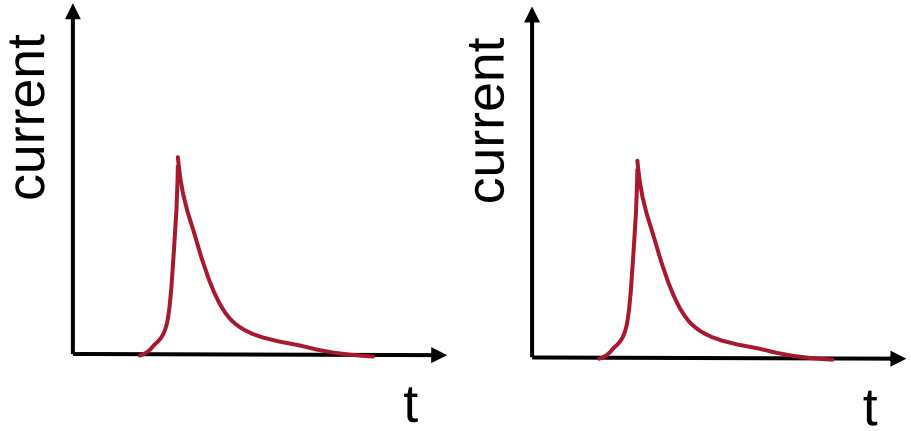
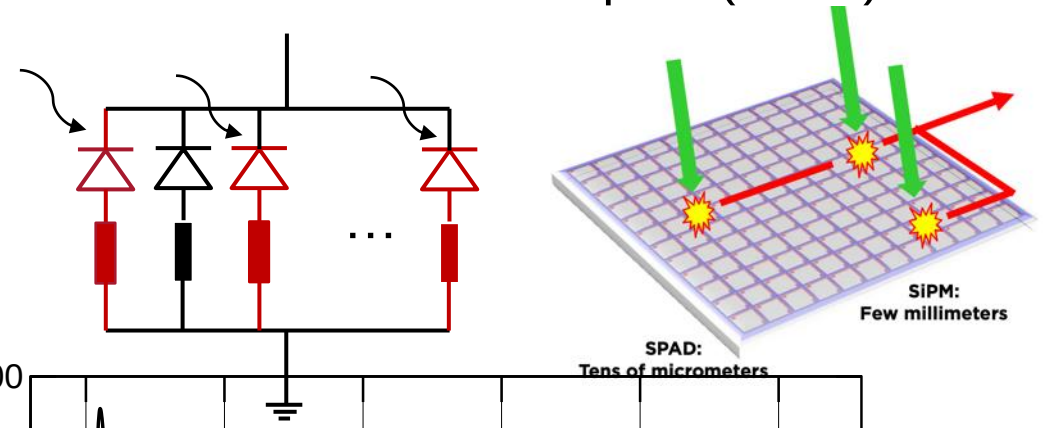
From SPAD to SiPM

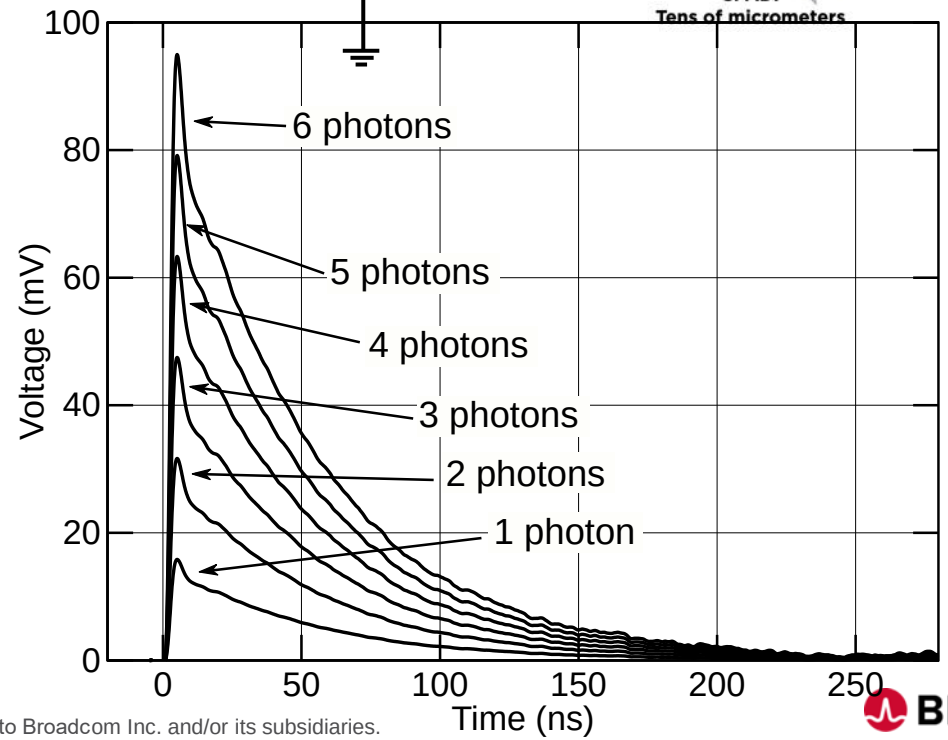
SPAD working in Geiger mode

Single SPAD discharge signal regardless of number of incident photons



Silicon Photomultiplier (SiPM)





Sum of individual SPAD discharge signals

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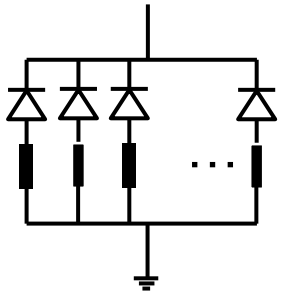
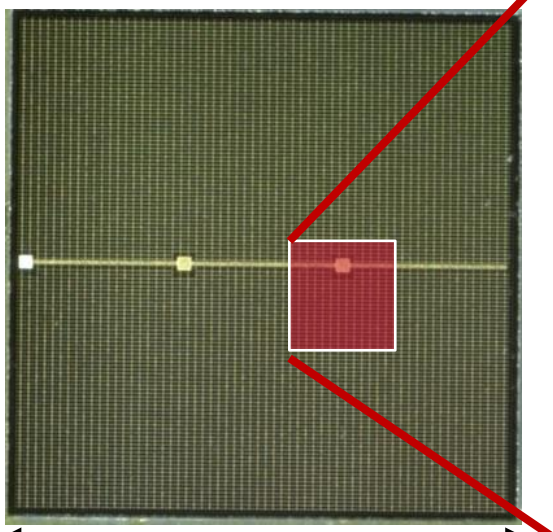
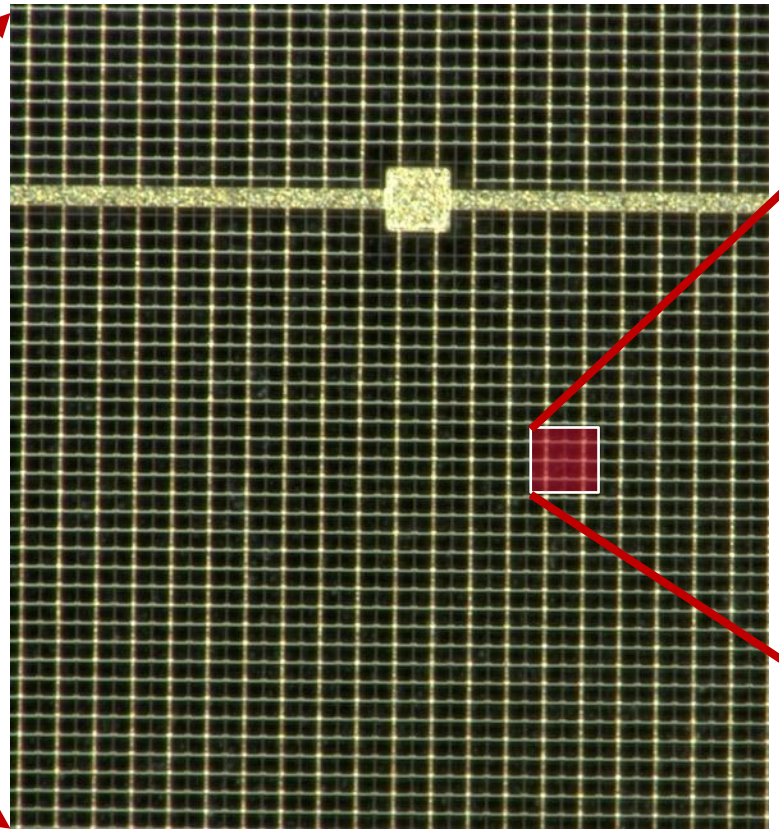
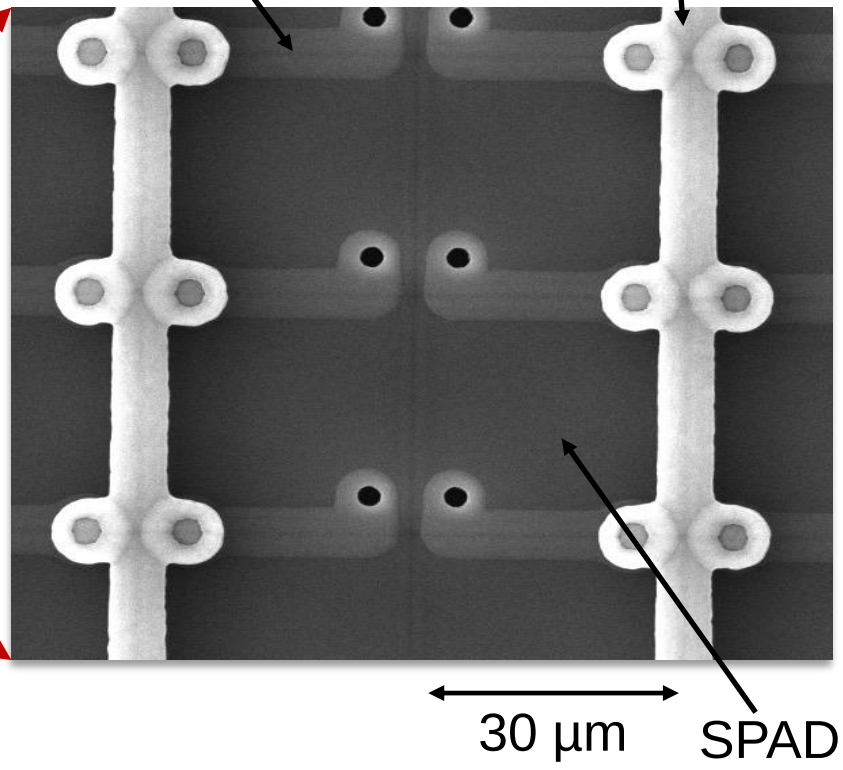
SiPM Images









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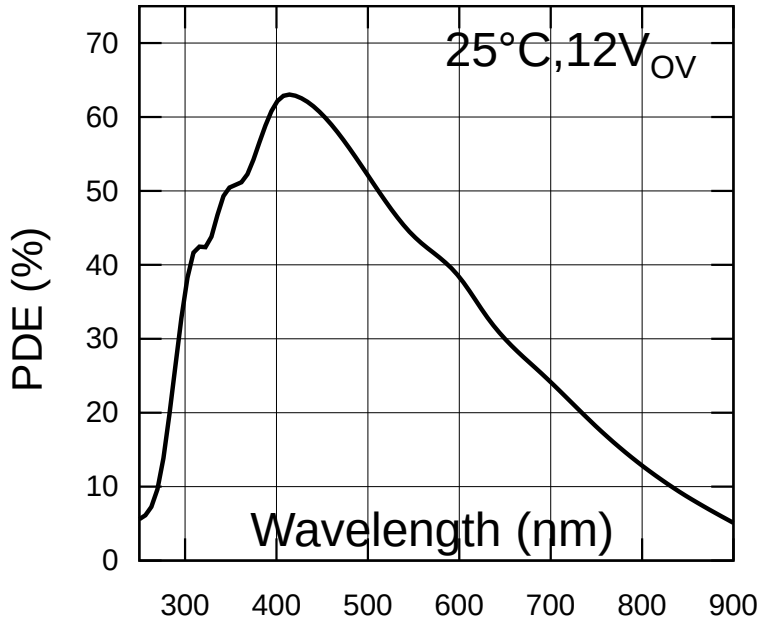
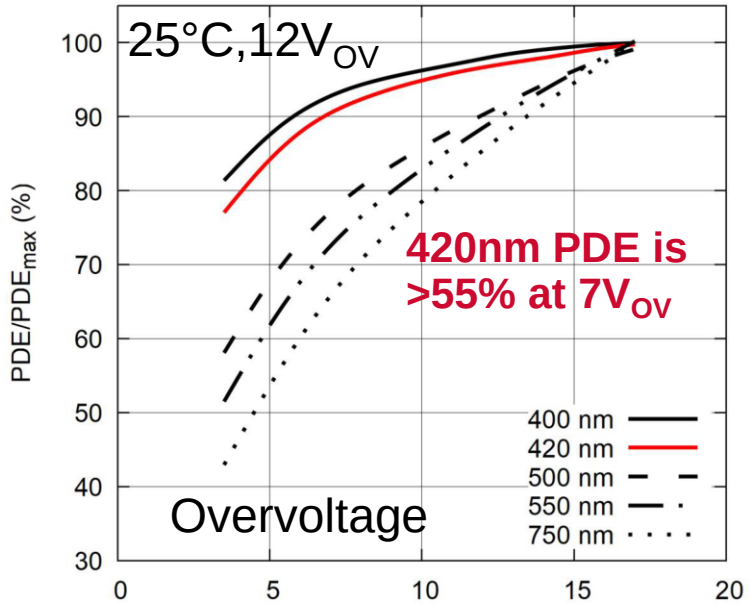
AFBR-S4N: NUV-MT SiPM

NUV-MT – Performance Overview

	NUV-MT
Sensitivity range (nm)	250 to 900
Peak sensitivity (nm)	420
PDE at 420nm (%)	63
Gain (M)	7.3
DCR (kcps/mm^2)	120
SPAD pitch (µm)	40
CT (%)	23
AP (%)	1
$\tau_{recharge}$ (ns)	55
Typ. OV	12
Temp. coefficient (mV/°C)	30
Vbreak (V)	32.5





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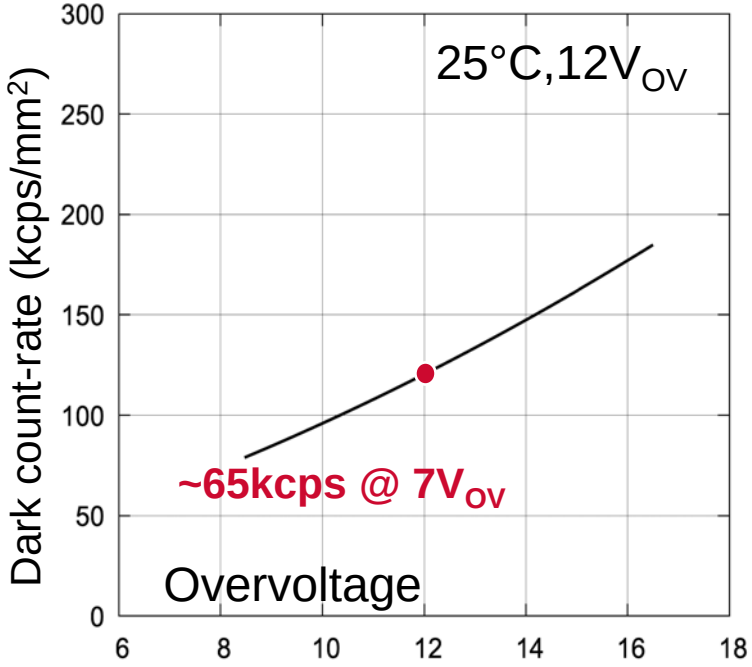

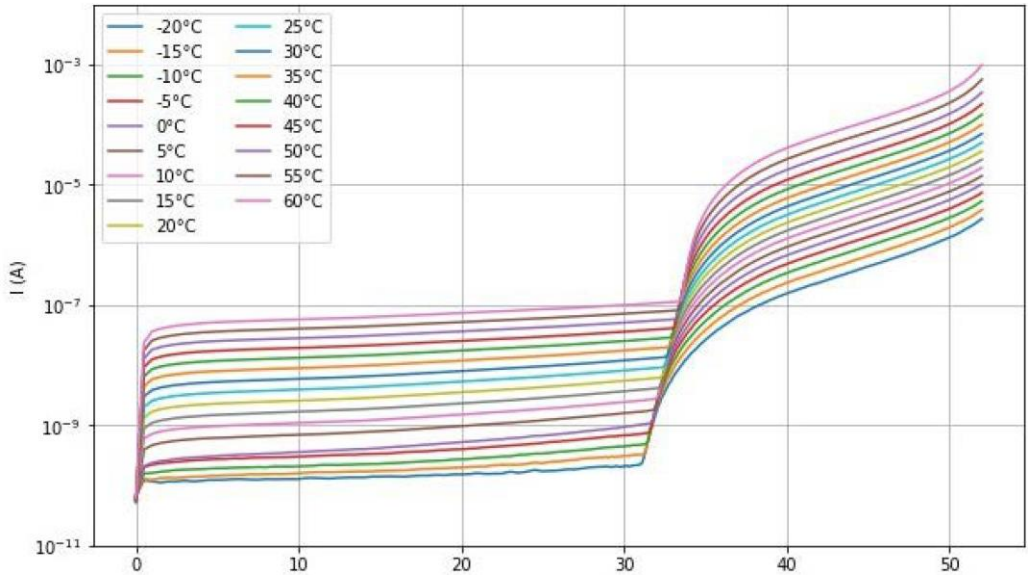

Dark Current
-0V to >50V
-20°C to +60°C

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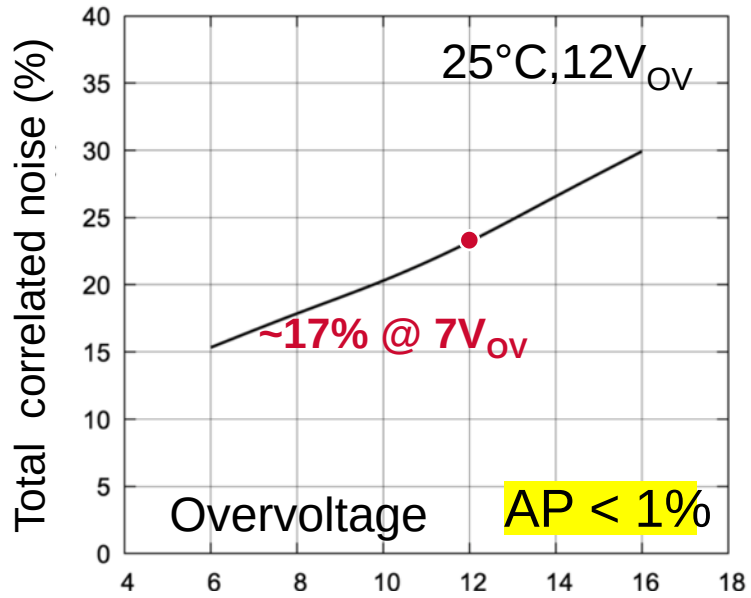

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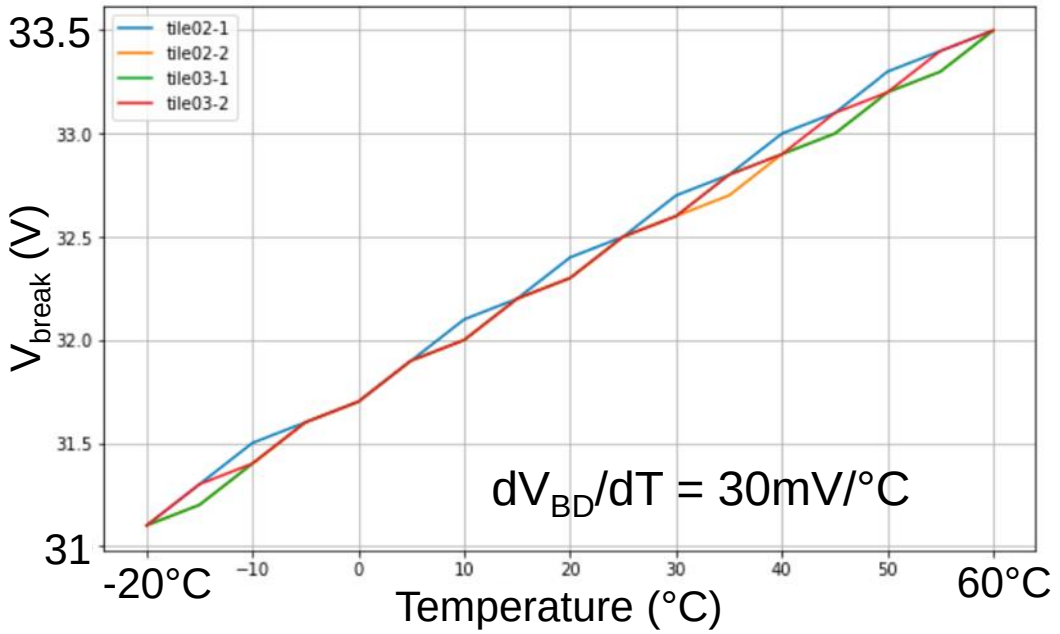

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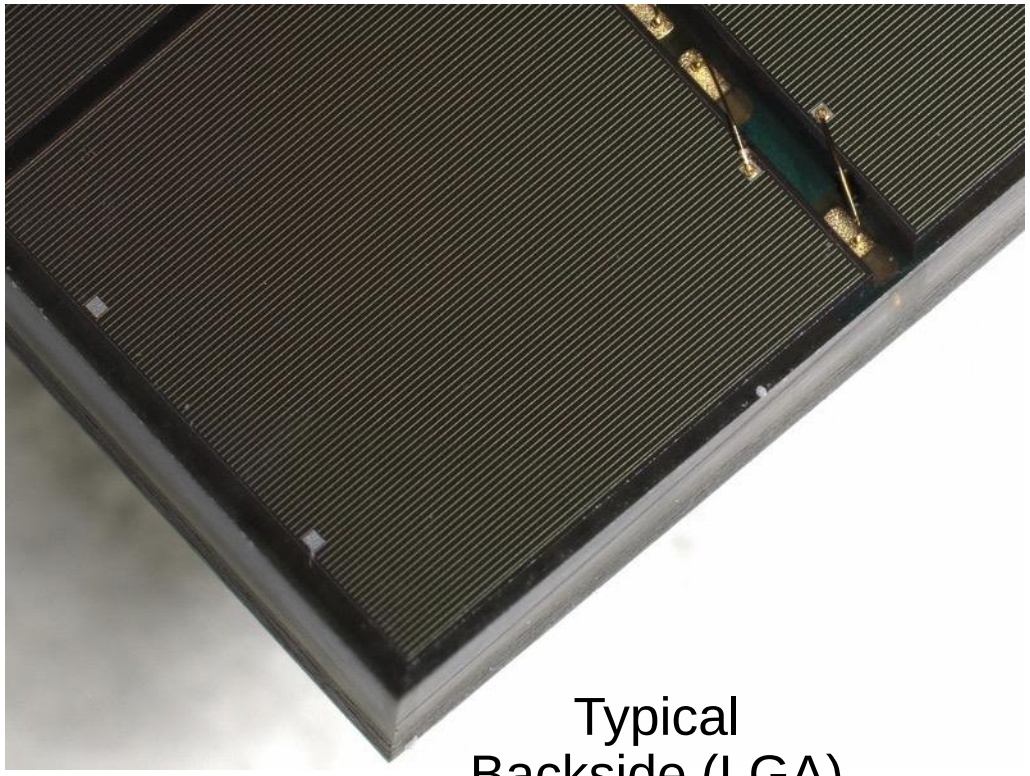
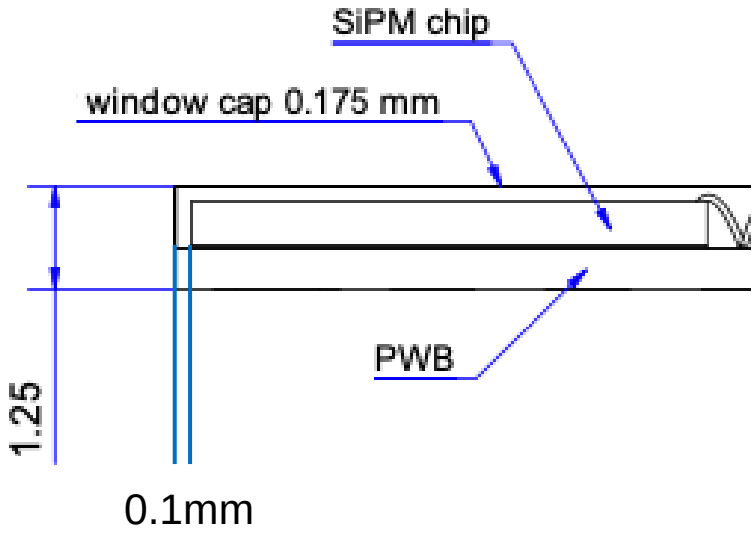
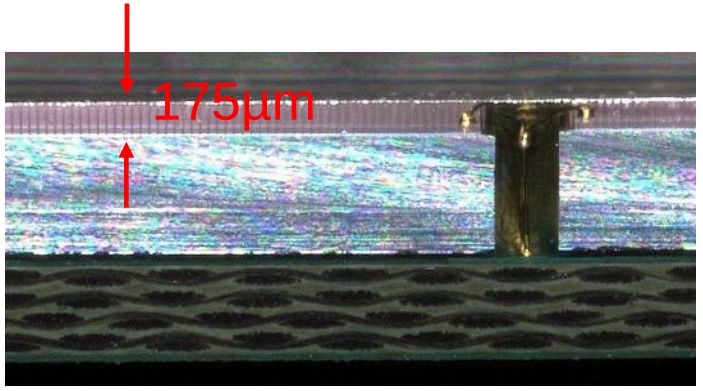
NUV-MT: New Package Design

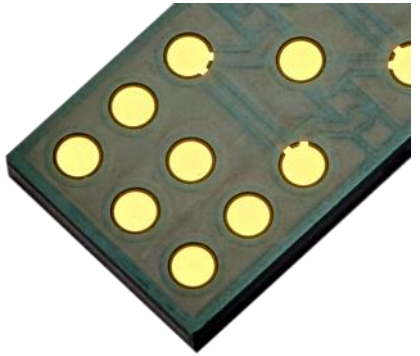
- Overmolded PCB with bond wire
- Focus:
  - Highest transmittance of mold compound in UV-blue
  - Long term stability (no yellowing)
  - High reliability & ruggedness
  - Cost efficiency & Simple + Flexible supply-chain
  - High Package Fill Factor



Typical Backside (LGA)







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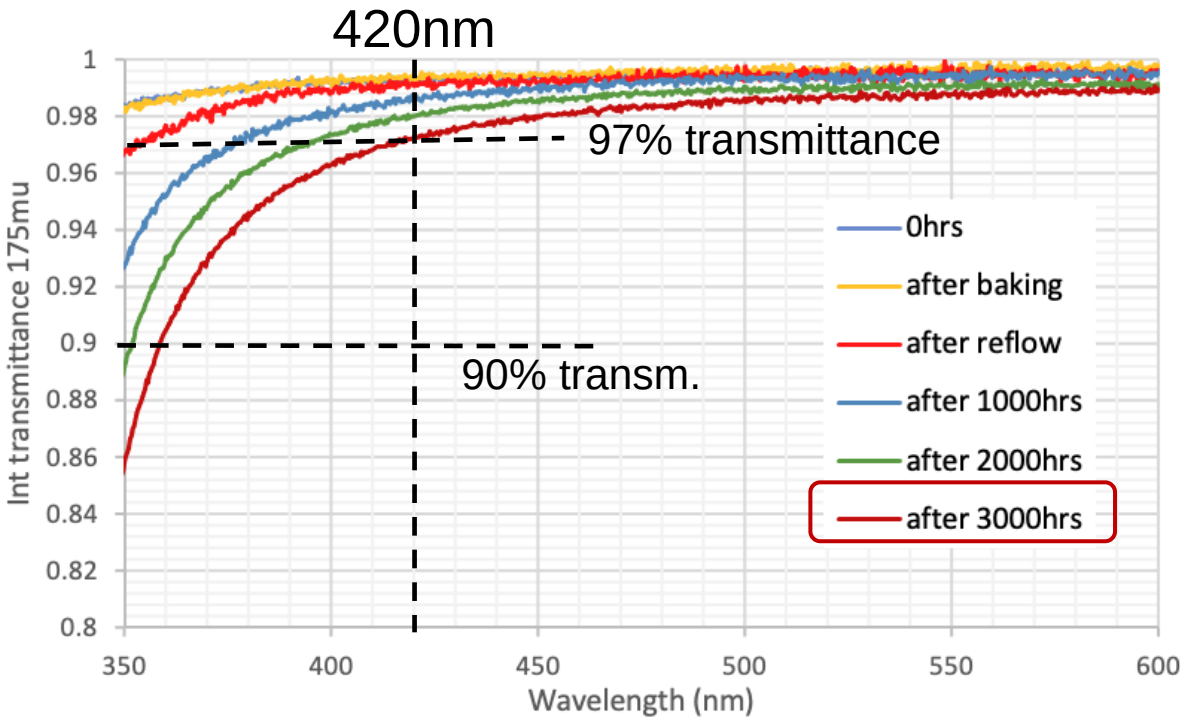
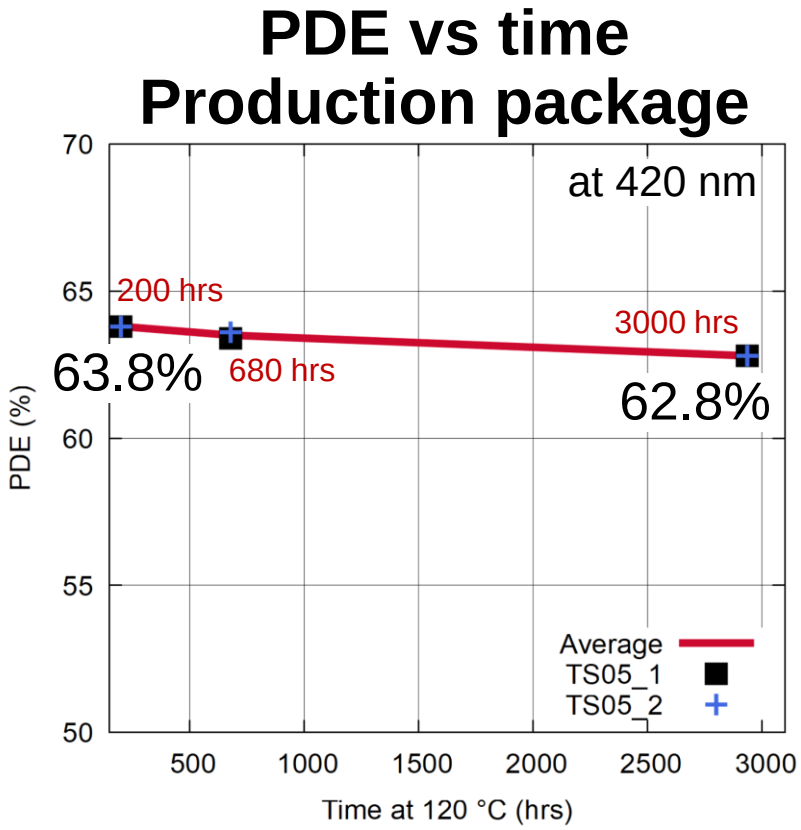
NUV-MT: Overmold Material

- Candidates selected for best optical peformance over lifetime
  - 3000hrs at 120°C correspond to lifetime of about 20 years at 25°C





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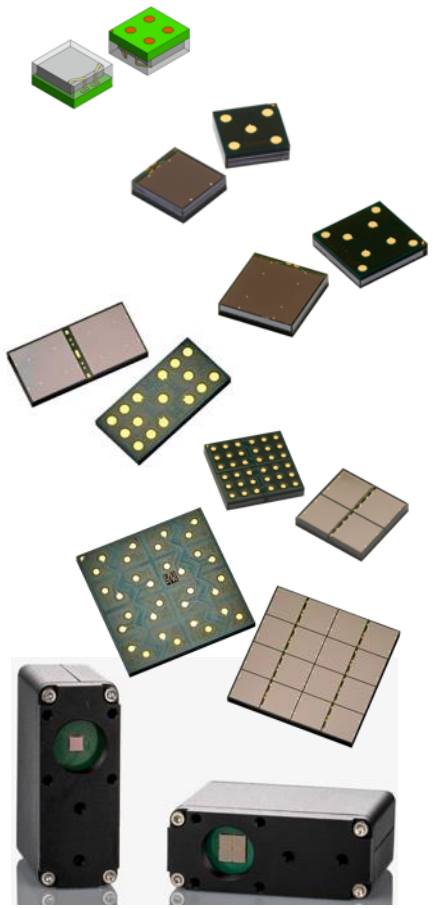
NUV-SiPM Product Summary & Outlook



Part no	Technology	Size (mm^2)	Channels	Package	Status
AFBR-S4N22P014M	NUV-MT	2 x 2	1	Overmolded PCB	E-Samples
AFBR-S4N44P014M	NUV-MT	4 x 4	1	Overmolded PCB	in production
AFBR-S4N66P014M	NUV-MT	6 x 6	1	Overmolded PCB	in production
AFBR-S4N66P024M	NUV-MT	13 x 6	2 x 1	Overmolded PCB	in production
AFBR-S4N44P044M	NUV-MT	8 x 8	2 x 2	Overmolded PCB	in production
AFBR-S4N44P164M	NUV-MT	16 x 16	4 x 4	Overmolded PCB	in production
AFBR-S4KTIA3315B	NUV-B*	3 x 3	1	TIA-module	in production

*TIA module to be upgraded to NUV-MT

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Thank you!

Please come and talk to me in the industrial exhibit

mjs@aptechnologies.co.uk