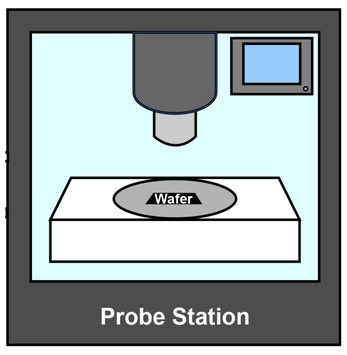
Test Bench for Characterization of CMOS SPADs

Joo-Hyun Kim[1,2,3], Eunsung Park[1,2], Seonghyeok Park[3], Seong-Jin Kim[3], Woo-Young Choi[2], and Myung-Jae Lee[1]

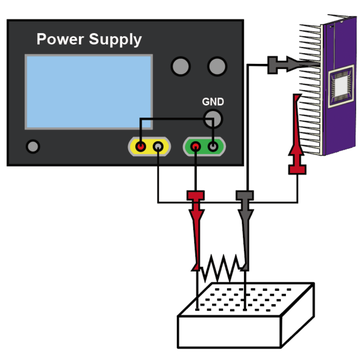
[1]Post-Silicon Semiconductor Institute, Korea Institute of Science and Technology, Seoul, Korea, [2]Department of Electrical and Electronic Engineering, Yonsei University, Seoul, Korea, [3]Department of Electrical and Electronic Engineering, Ulsan national institute of Science and Technology, Ulsan, Korea

Email: mj.lee@kist.re.kr*

Introduction



[Wafer Probing]

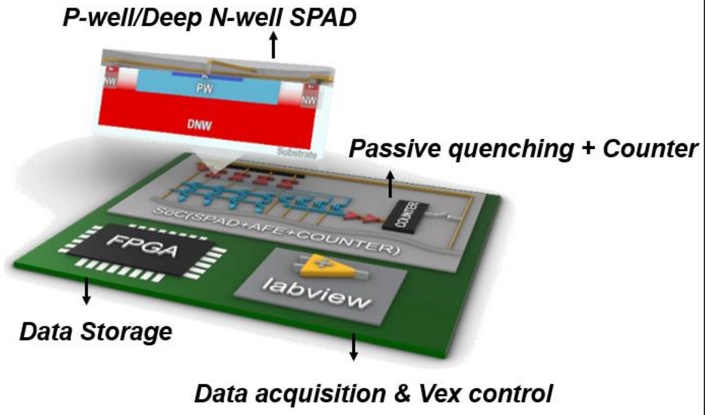


[Pad-SPAD-Pad Package]

Disadvantages

1. **Too long Measurement time**
2. **Requirement of Manual adjustments**

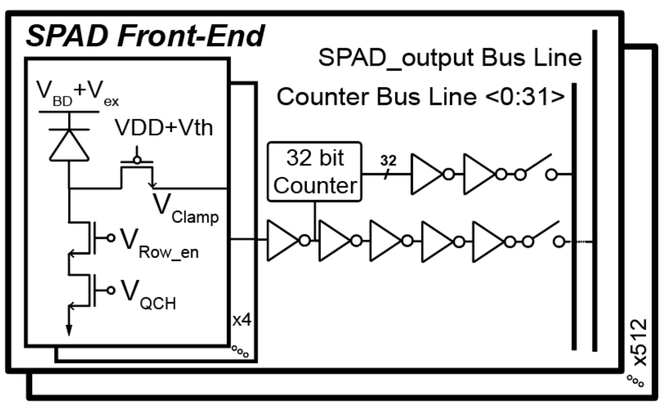
Outline of Test Bench



- **SPAD Farm Measurement: Each different 2048 number of SPADs**
- **Significant time-effective measurement**
- **Automatic adjustment of excess voltage**

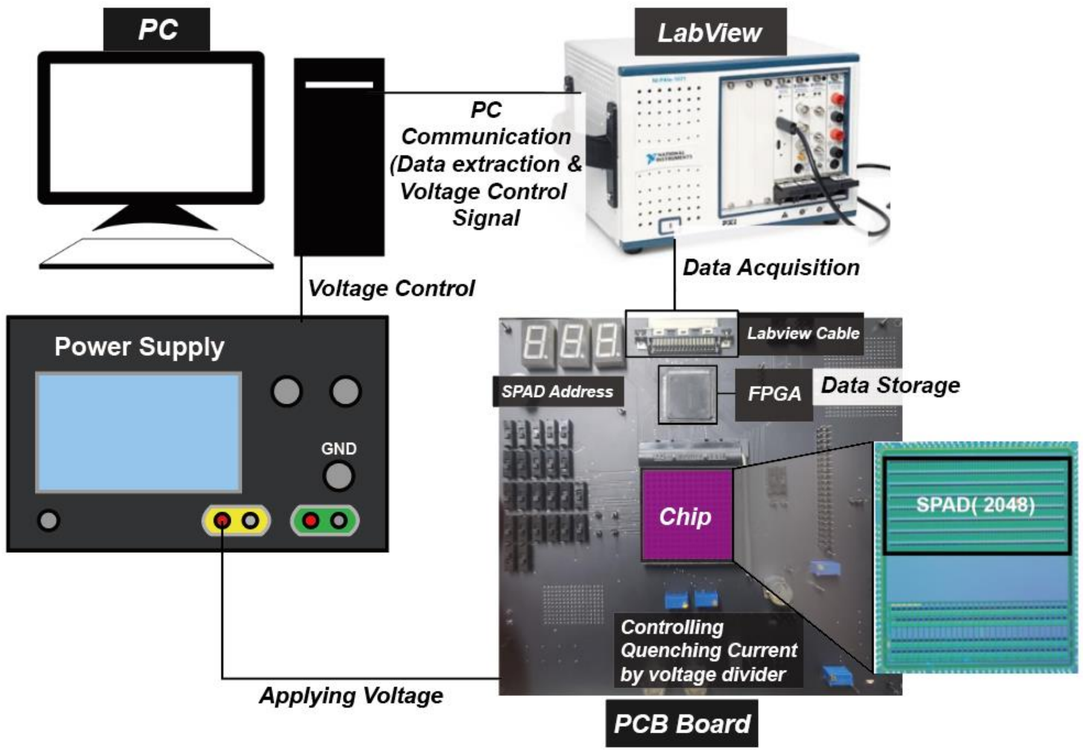
Main Idea

Chip Architecture



- **V_{clamp} : Preventing the circuits from damage by high peak current.**
- **V_{QCH}**
  - ❖ **Passive quenching by current mirror**
  - ❖ **Lowering resistance for a maximum count rate**

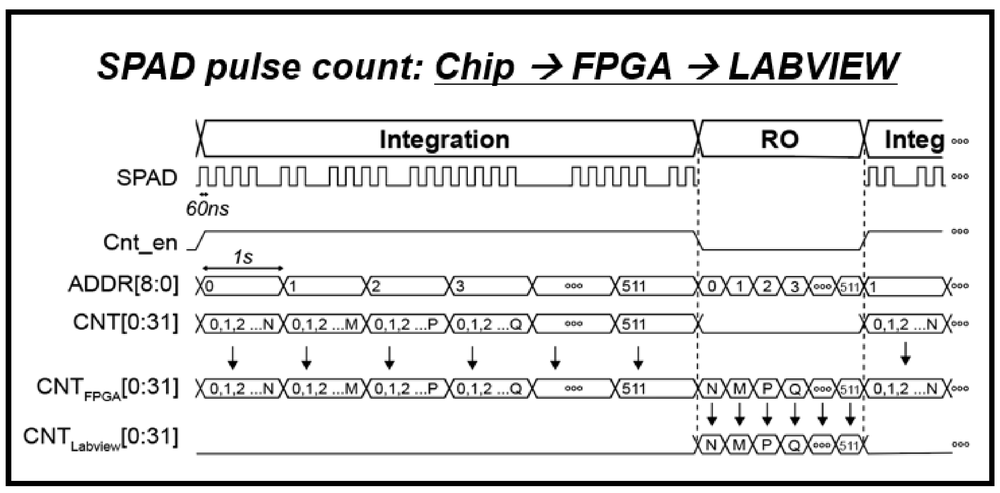
Measurement Set-up



- **FPGA: Control the SPADs and associated circuits while storing the SPAD pulse count in a counter.**
- **LabView: Data extraction, excess voltage control**

Measurement Process & Results

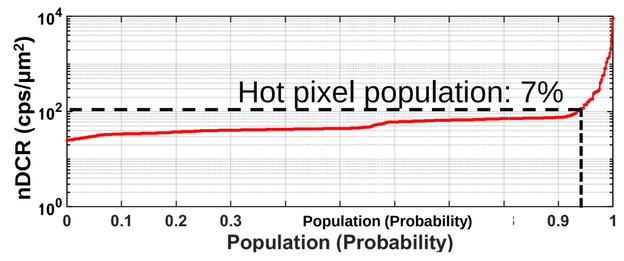
Timing Diagram



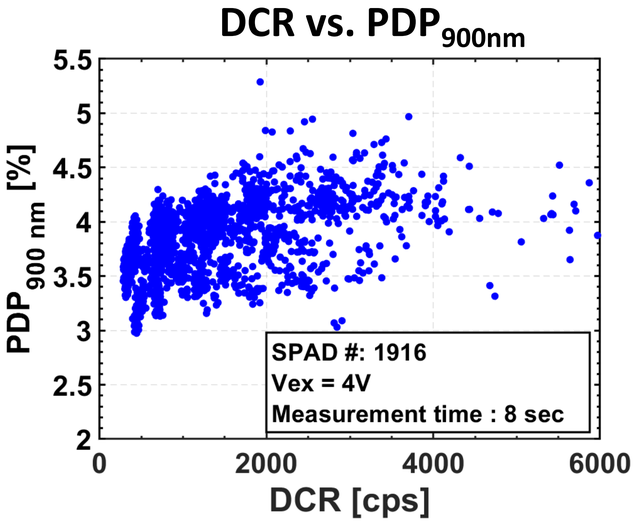
- **FPGA : Making addressing signal, count enable signal and readout signal (strobe).**
- **LabView: Acquisition of counter value to PC using csv file**

Measurement Results

Cumulative distribution of DCR



DCR vs. PDP_{900nm}



Device Under Test			
N-well width	0.7	0.85	1
GR width	1	1.5	2
AA Radius	2.5	3.75	5
P+ Radius	AA	AA -0.5	AA-1
AA shape	R.S	circle	Square
P-well/ deep N-well (VG)			

- **Analysis Procedure**

1. **Cumulative distribution plot**
   - **Sorting the hot pixel population**
2. **DCR vs. PDP measurement plot w/o hot pixels**
   - **Upper-left side points: high performances**

- **Reduction processing time compared to a SPAD w/o integrated circuitry**

Conclusion

1. **The time-effective characterizations of numerous SPADs in a very short time**
2. **Reducing the likelihood of inaccurate measurements due to SPADs' damage and temperature fluctuations**