# UV Sensitive SiC Devices

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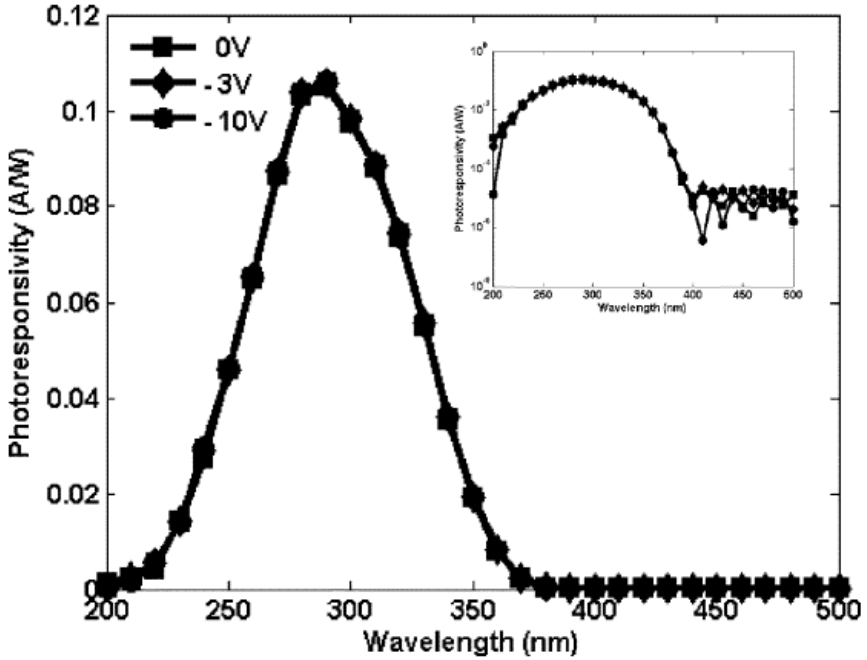
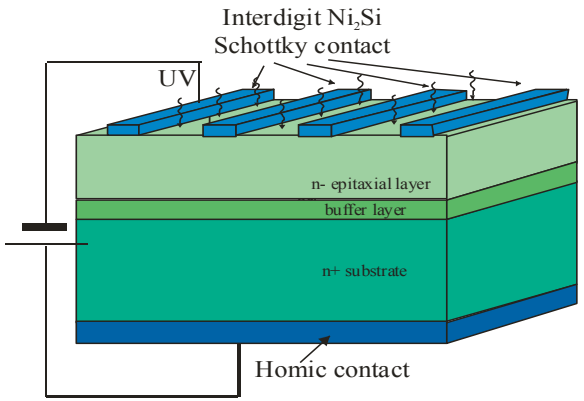
# Cherenkov Detection for Dual Readout Calorimeters

Energy reconstruction in dual readout calorimeter would be advantaged by an efficient detection of the far uv component of Cherenkov light

| Material | Gap (eV) | ε (eV) | υ ($10^6$ cm/s) |
|---|---|---|---|
| Si | 1.1 | 3.7 | 10 |
| 4H-SiC | 3.3 | 7.8 | 22 |

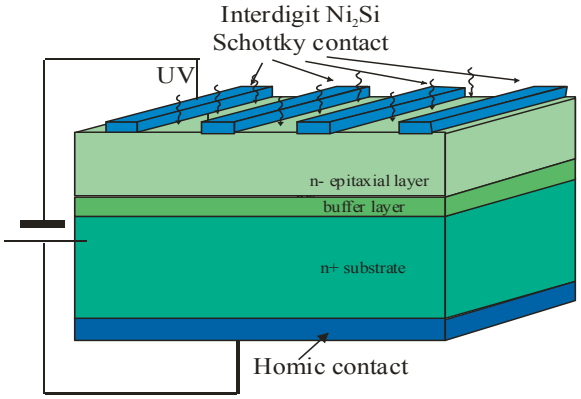


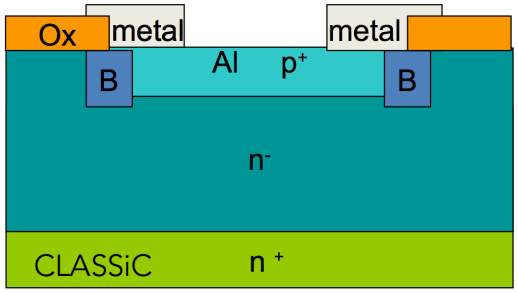

**Solar Blind**

# Realized Devices

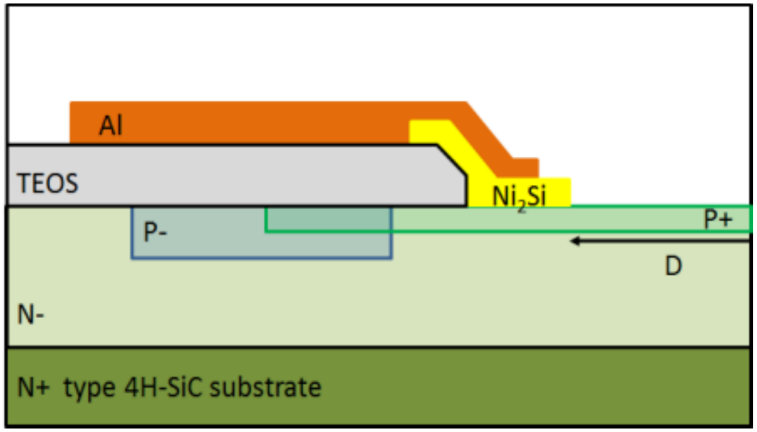
1. Schotky diods (calocube)




2. P.I.N. (classic)



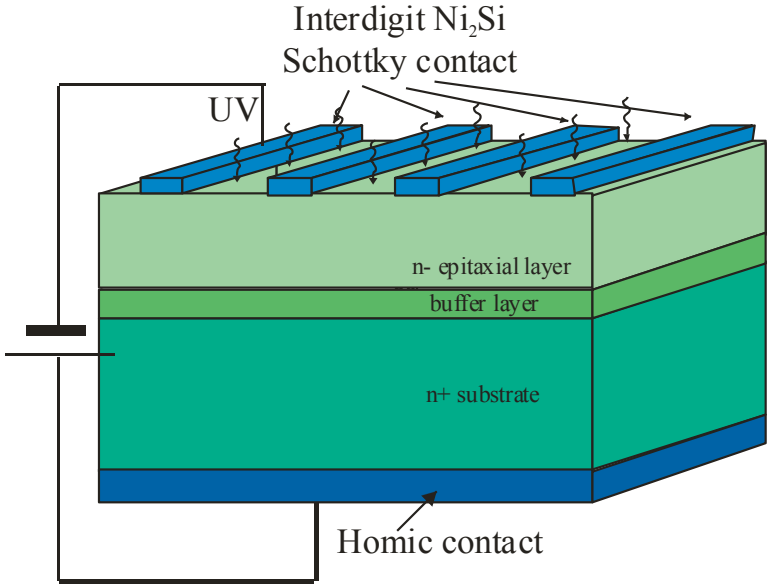

3. APD (classic)

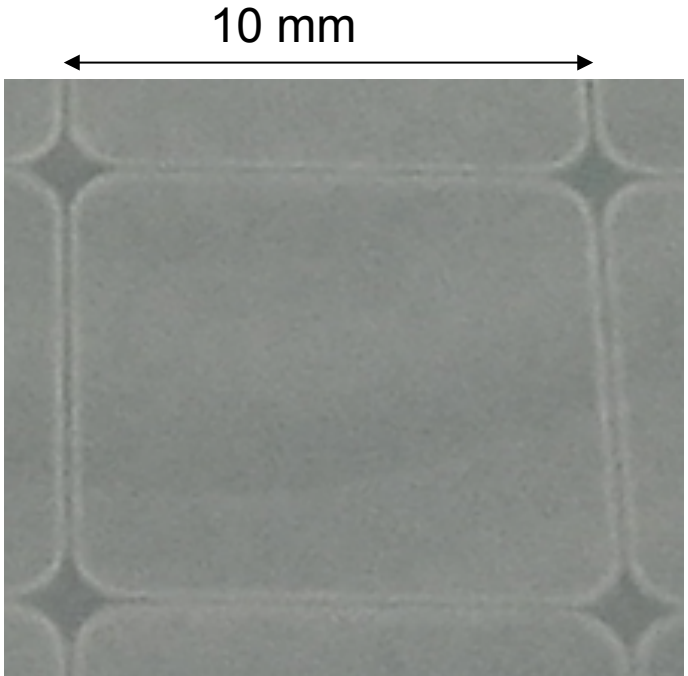


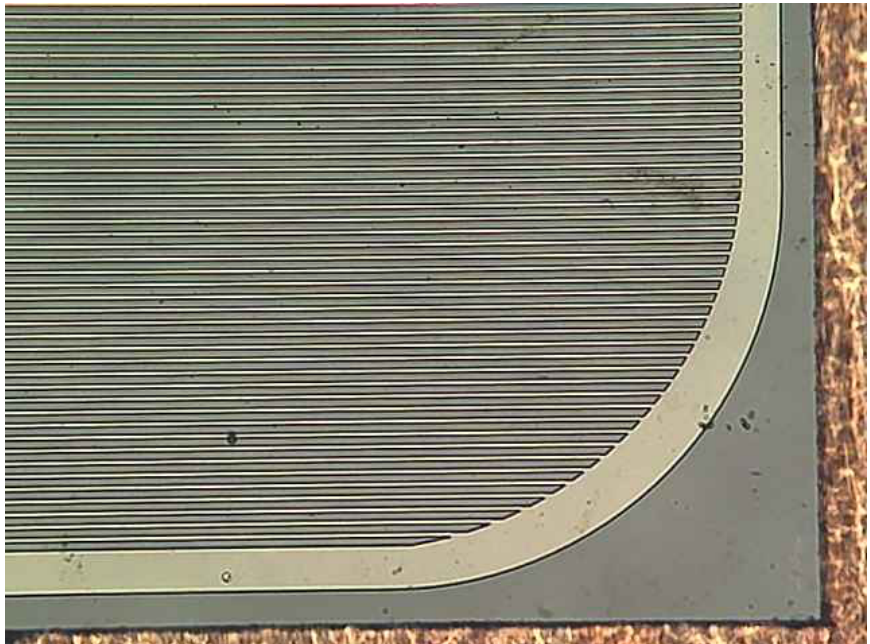
# Devices 1: Schottky diode

Schotky UV photodiode with interdigitated metallization with 2um wide strips separated by 10 um (80% of the area is exposed to incident radiation)

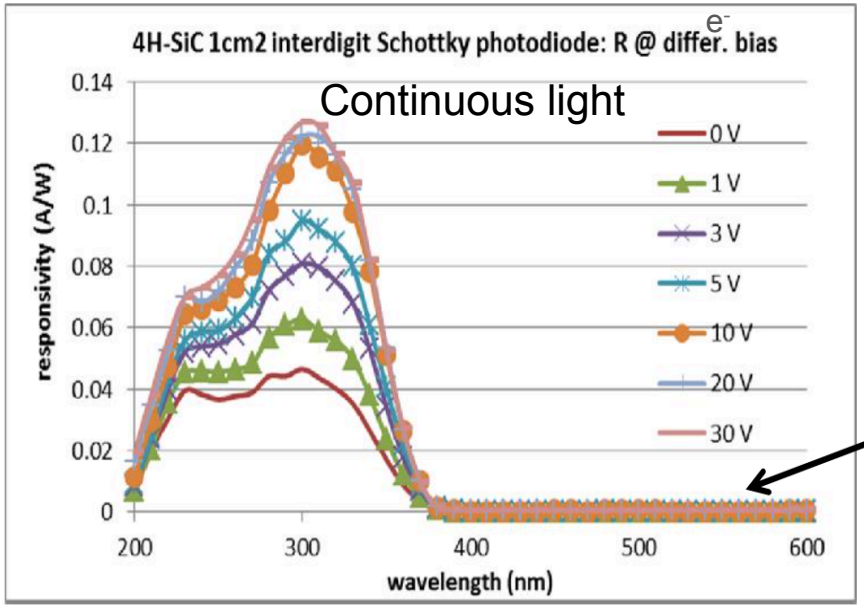
Realized by INFN CNR-IMM CT
Within the CALOCUBE R&D

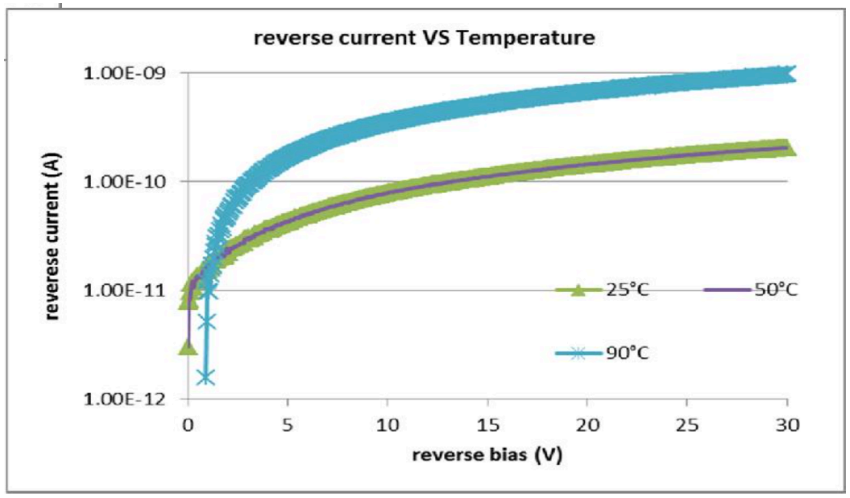


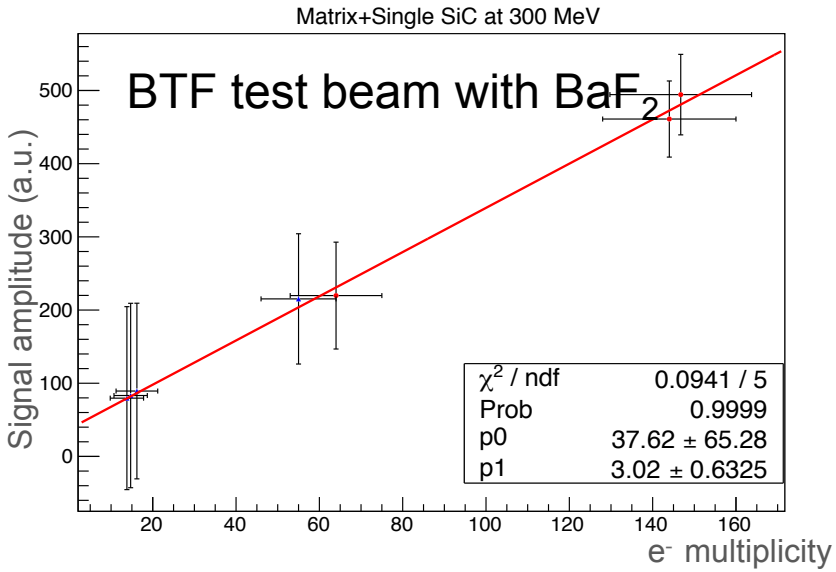



# …Schotky diode



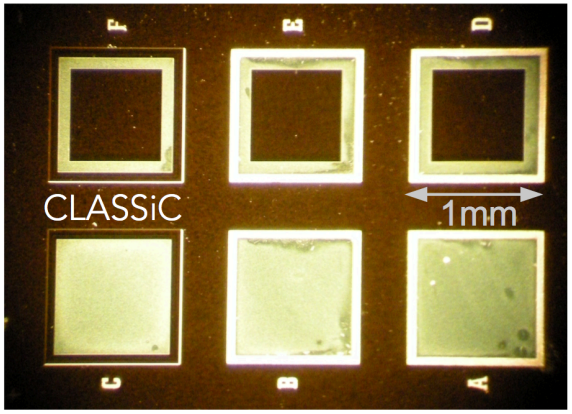



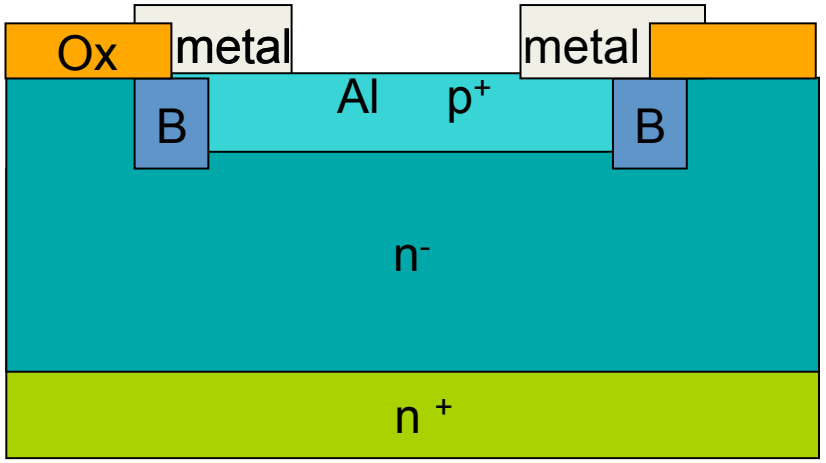



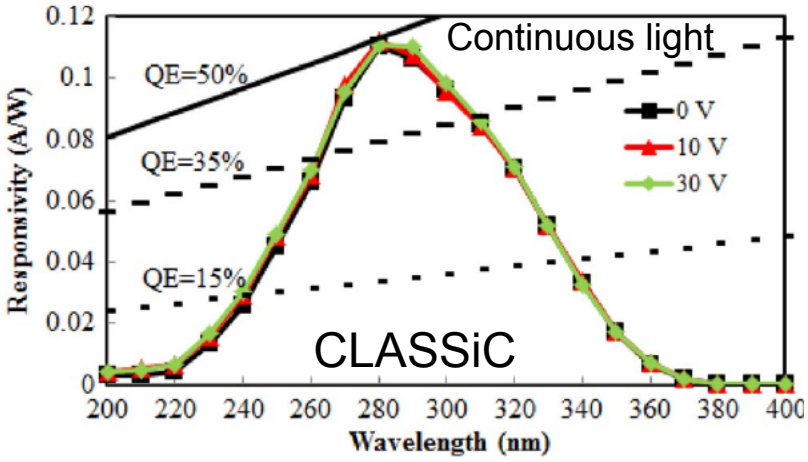

- N-type epilayer: **4 um**
- The device works already at 0 V
- Dark current: **1pA/mm$^2$** @ 25 ºC
- Visible blind
- Peak **QE 45% at 280 nm**

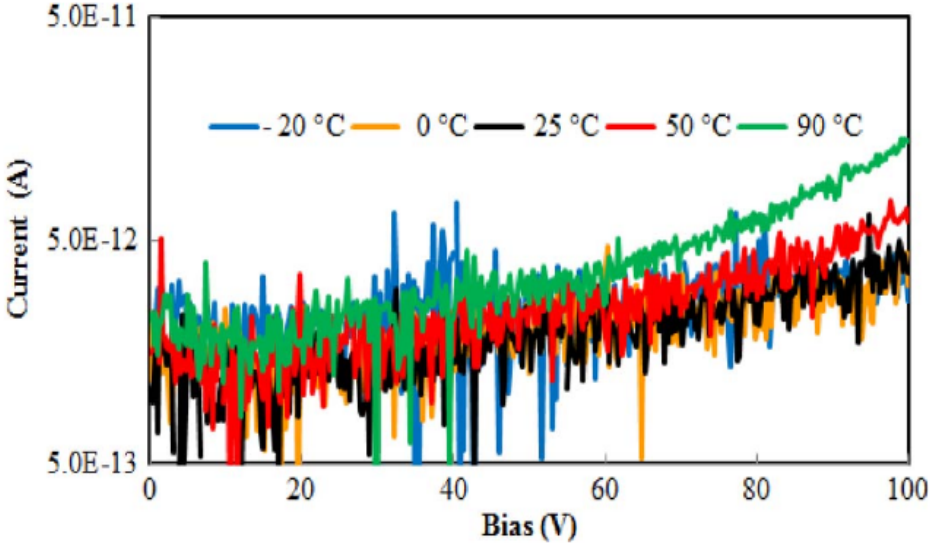
# Devices 2: PIN diode

- Several structures considered: best results obtained with a thin planar junction



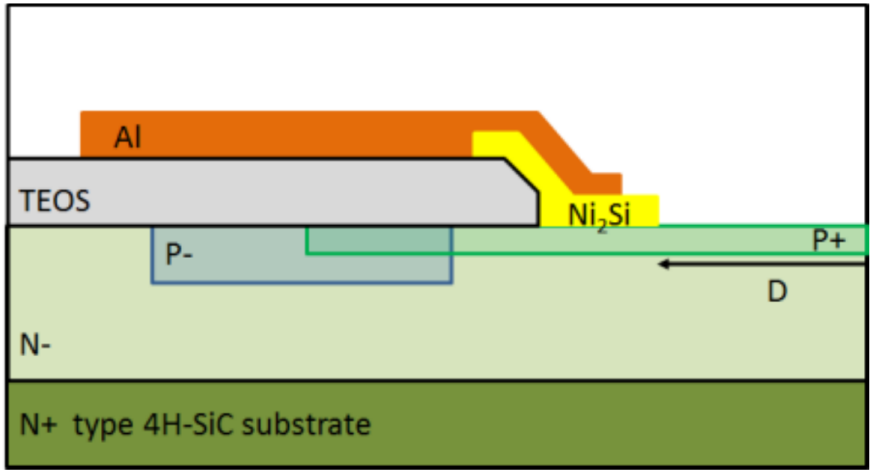



# Devices 3: Avalanche photodiodes

Main design features:

- p+/N/N+ structure
- thin p+ layer by ion implantation
- Simple, non-SAM (Separate Absorption and Multiplication), structure better than SAM due to the short UV absorption length
- Planar structure in view of a future “pixelization” evolution
- Diameters of optically active area from 20µm to 500µm

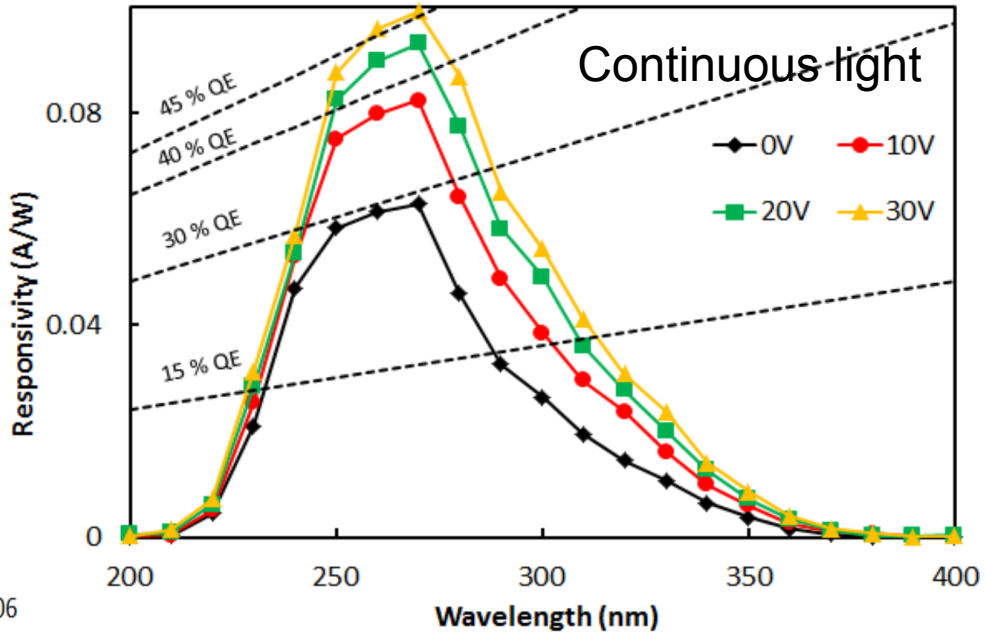


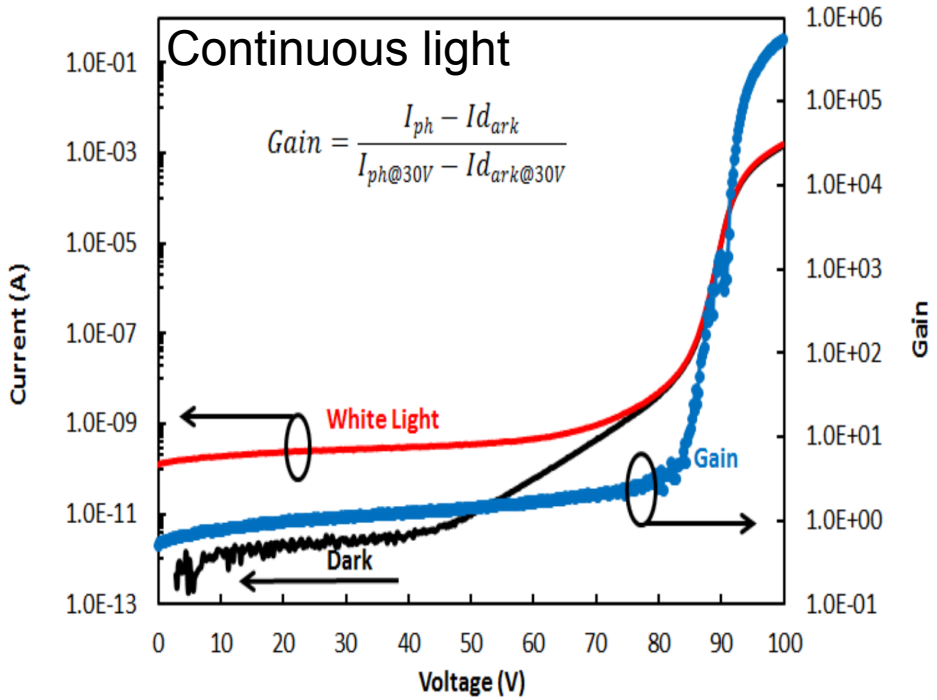


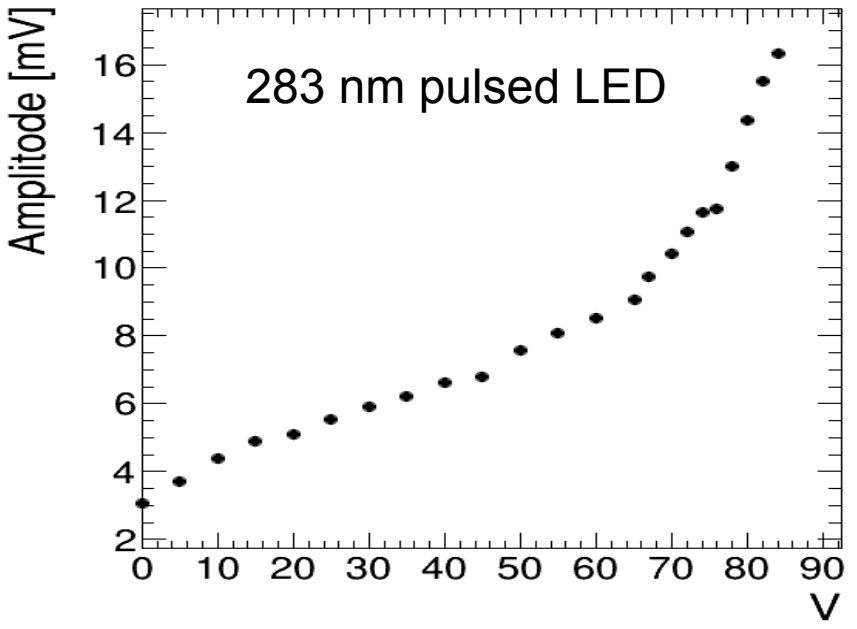
Designed and manufactured at CNR-IMM CT, Antonella Sciuto in collaboration with ST and INFN

# Optical Characterization

- Full depletion around 30 V
- 45% QE at ~280 nm
- blind at 400 nm
- $10^3$ gain at 90 V



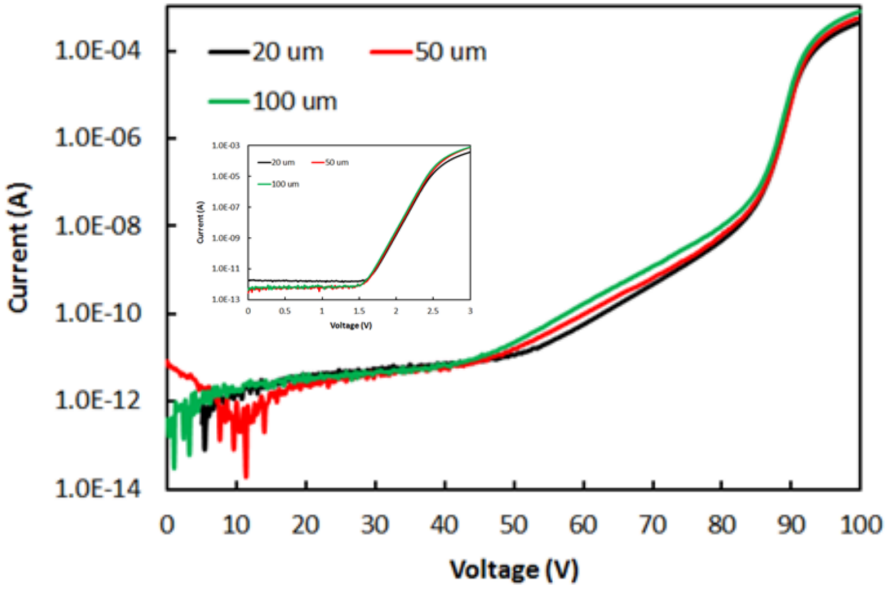
# Electrical Characterization

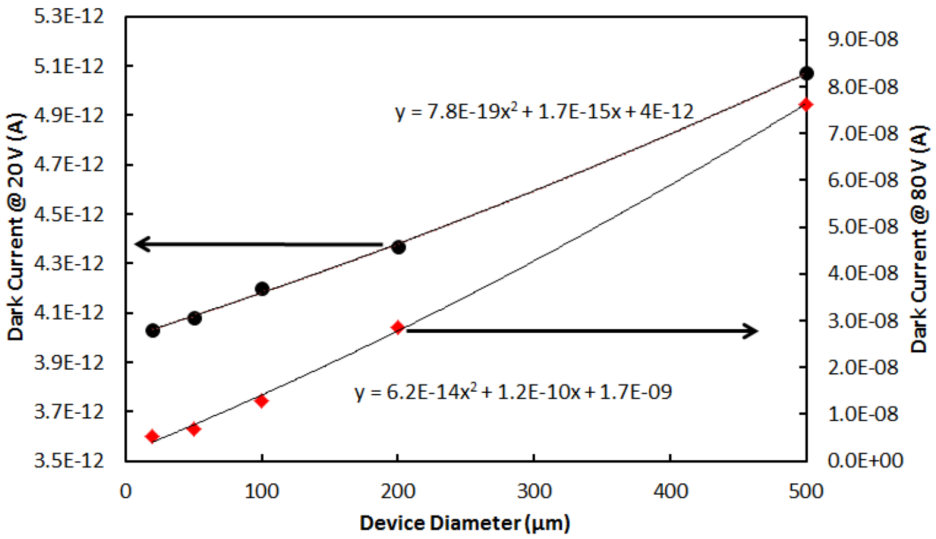
At fixed voltage dark current behaves versus size as:

$I = a\,r^2 + b\,r + c$, where

- **Quadratic** term accounts for **bulk** leakage
- **Linear** term accounts for **edge** leakage

**very useful to work on edge structure**

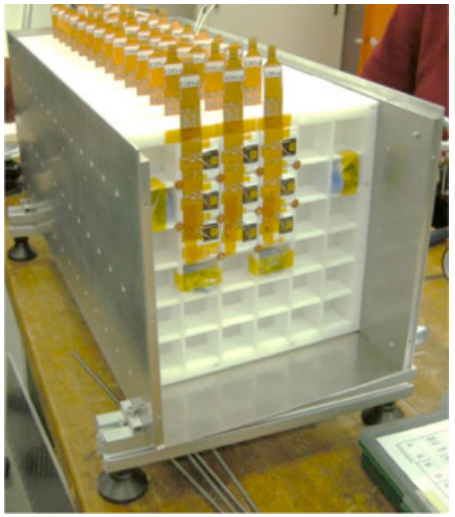


# Forecoming Applications

**August 2017 SPS test beam:**

- Insertion of 10 collinear $BaF_2$ crystals, equipped with schottky SiC diodes, inside CALOCUBE prototype for comparative study of SiC and Si performance



**Italy-China proposal on dual readout calorimetry**

- SiC option included, for cherenkov light detection in uv region

# Conclusion & outlook

Three different SiC planar devices have been developed during the last two years in collaboration with CNR-IMM and with ST support.

The chosen planar technology allows future design of apd matrix with negligible dead regions

The main source of dark current shows to be in edges structures

Test of uv detection are already planned in dual readout calorimetry applications