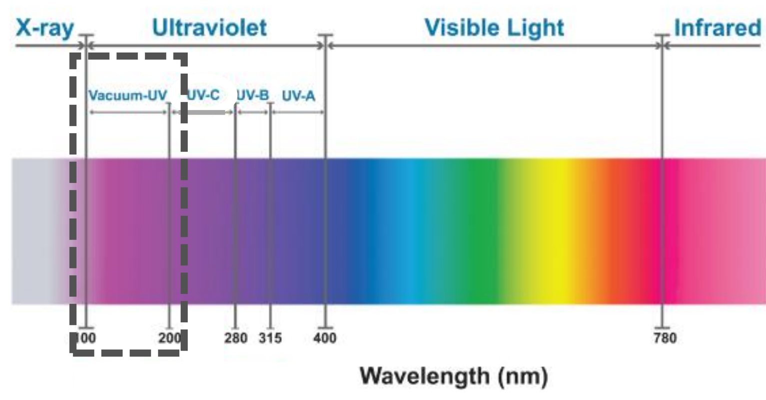
Glass-free SiPMs with Through Silicon Vias for VUV Light Detection

J. Dalmasson[1], L. Parellada-Monreal[1], F. Acerbi[1], A. Ficorella[1], A. Gola[1], S. Merzi[1], M. Ruzzarin[1], N. Zorzi[1] and G. Paternoster[1]

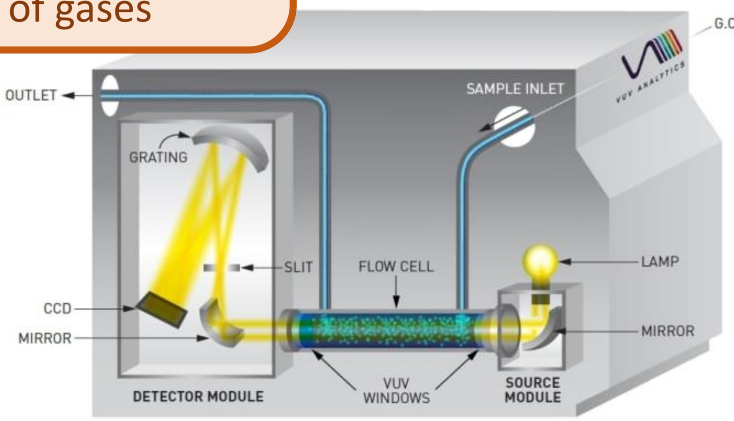
[1] Fondazione Bruno Kessler, via Sommarive 18, Trento, Italy

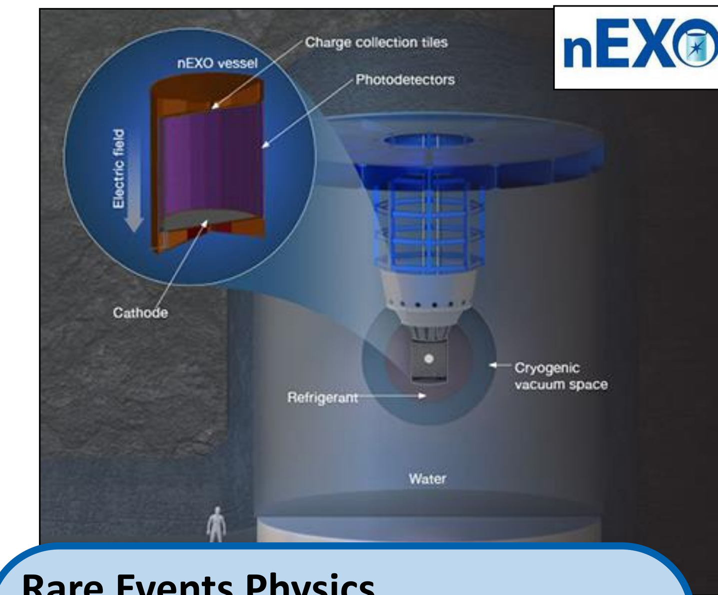
Application of VUV Detection



Industrial Gas Analysis

- Isomer identification
- Interaction with wide variety of gases



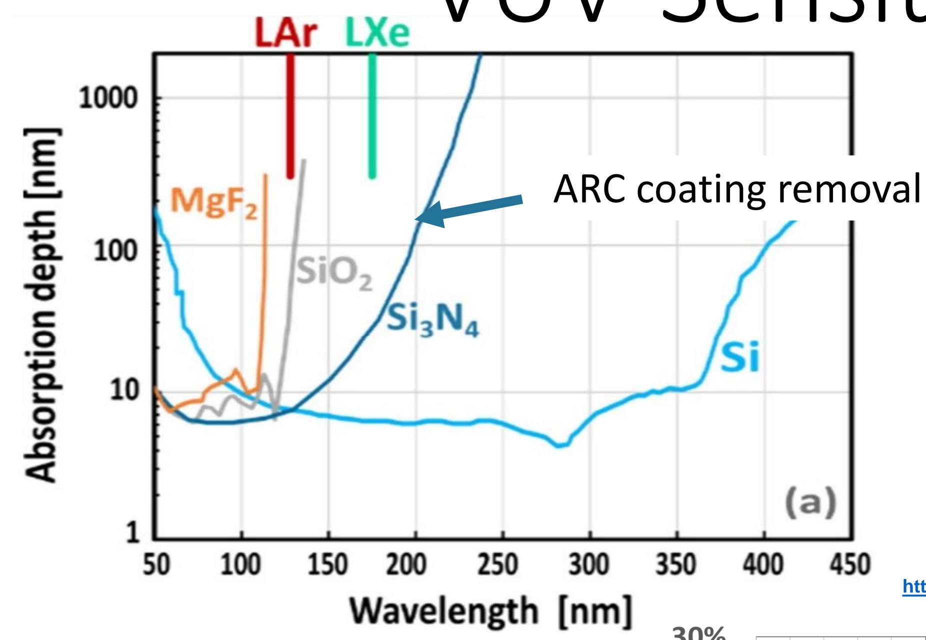


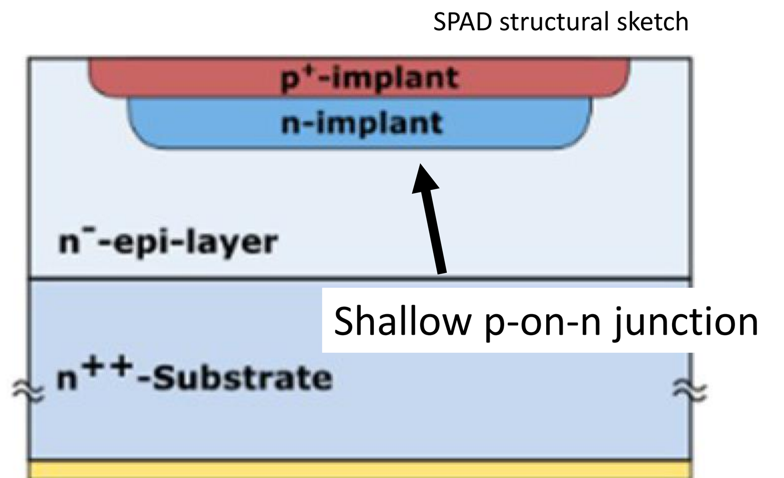
Rare Events Physics

Liquid Xenon (LXe) based experiments:

- Good Absorber
- Chemically Inert
- High Yield Scintillator (178nm)
- Self-Transparent

VUV-Sensitive SiPM





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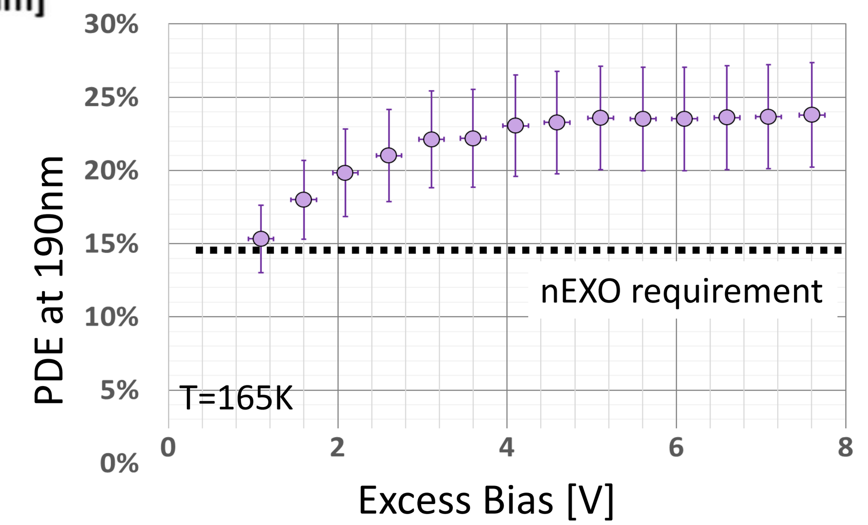
Successful technology exceeding PDE requirements from experiments



Towards High Integration: TSV

Growing interest for:

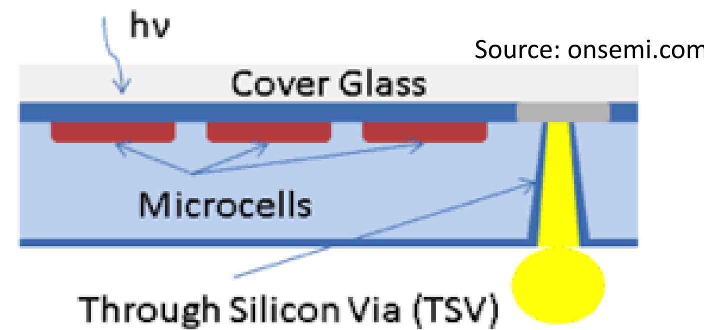
- High density array assembly with reduced non-active area
- Bypass wire-bond connection in application where it is potentially critical

Through Silicon Via (TSV)

Vertical electrical connection <u>that passes completely through a silicon wafer</u>, bringing the signal from the top (normally photosensitive side) to the bottom side of the device tier (interface with the front-end electronics)

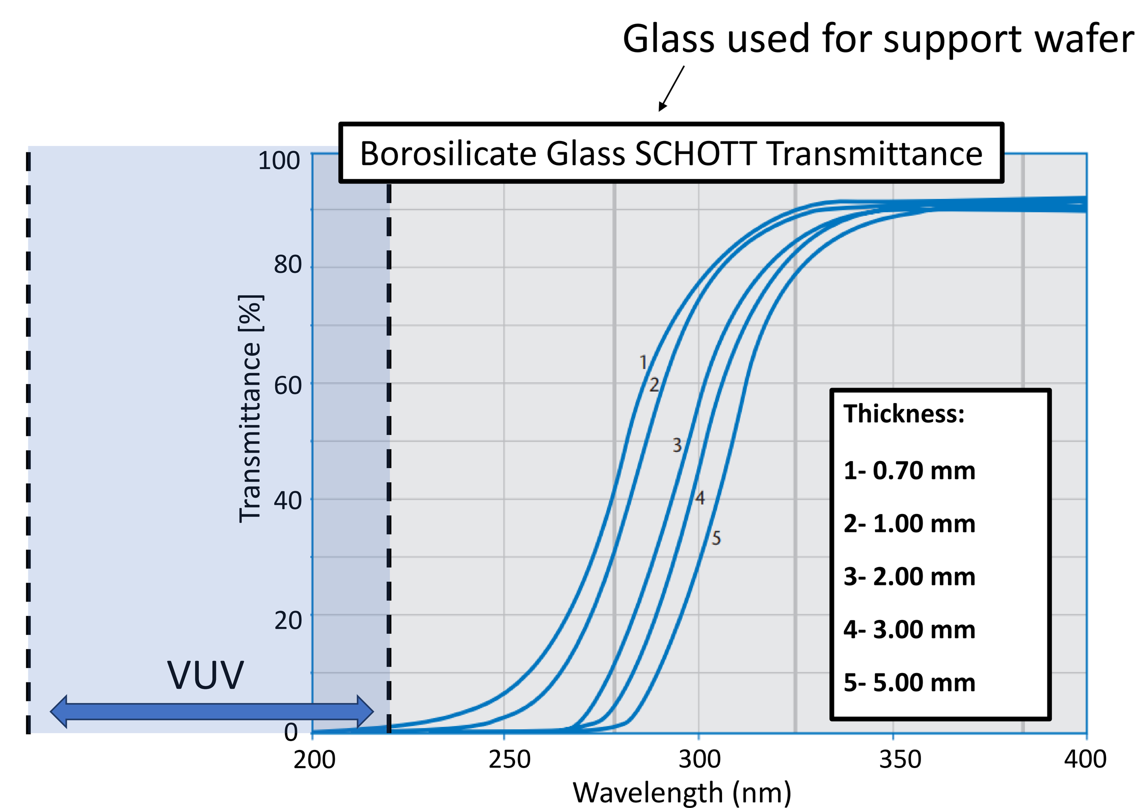
TSV drawbacks for a SiPM

- Device attached to a glass support wafer
- Presence of a permanent bonding adhesive



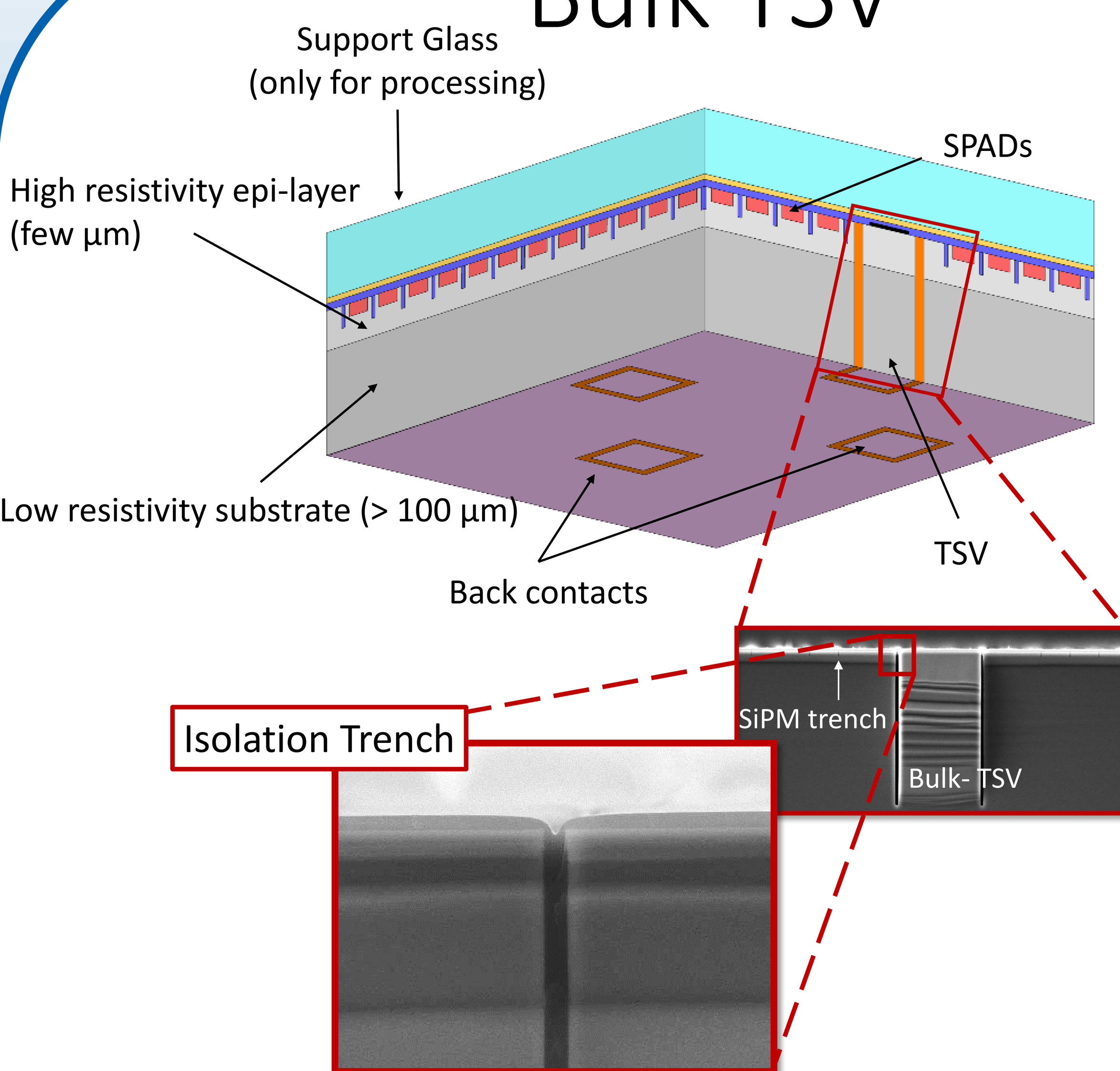
VUV Related Challenges for TSV

Glass used for support wafer



Glass can only be present as support structure during manufacturing and removed afterwards

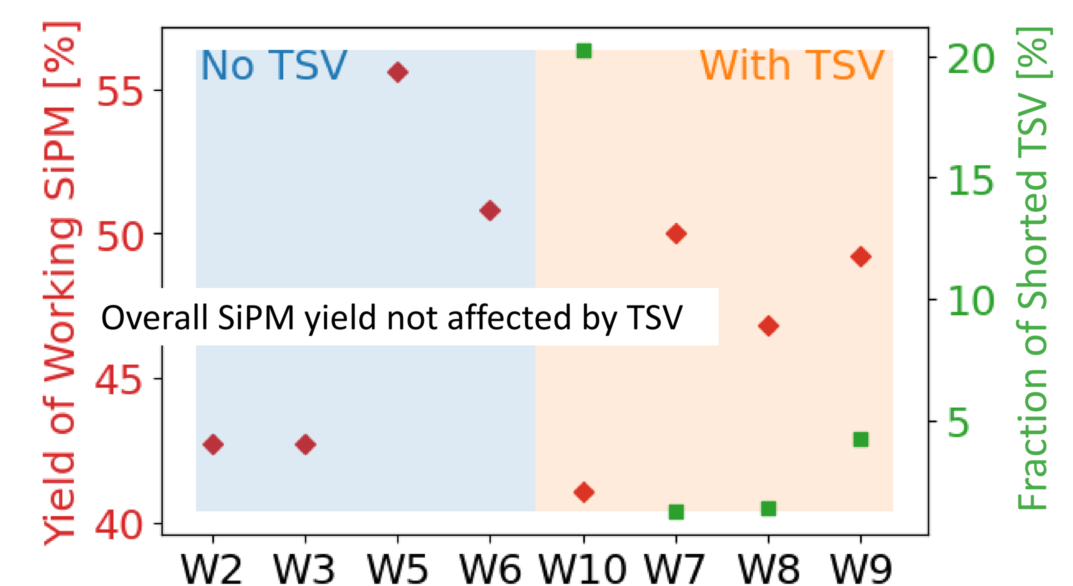
Bulk TSV

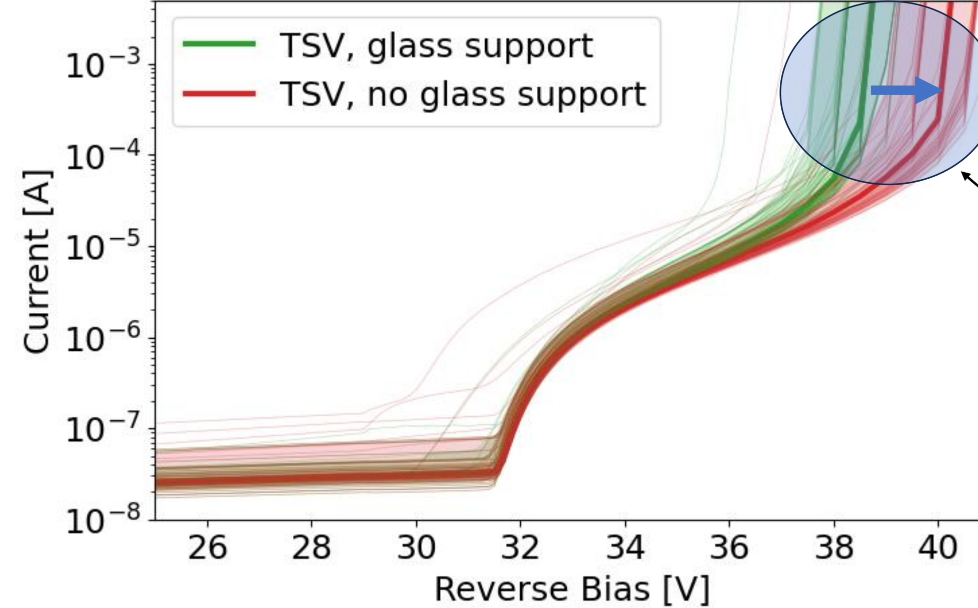


Main Features

- <u>No metallization</u>, exploiting the substrate low resistivity
- Silicon TSV delimited by pass-through trenches.
- TSV density in the range 1-100 vias/mm^2
- Low resistivity (~10 Ω) per via -> 1.5Ω/SiPM
- TSV width 10 µm – 100 µm depending on the final silicon thickness.
- TSV size/Si thickness aspect ratio of ~1

Results

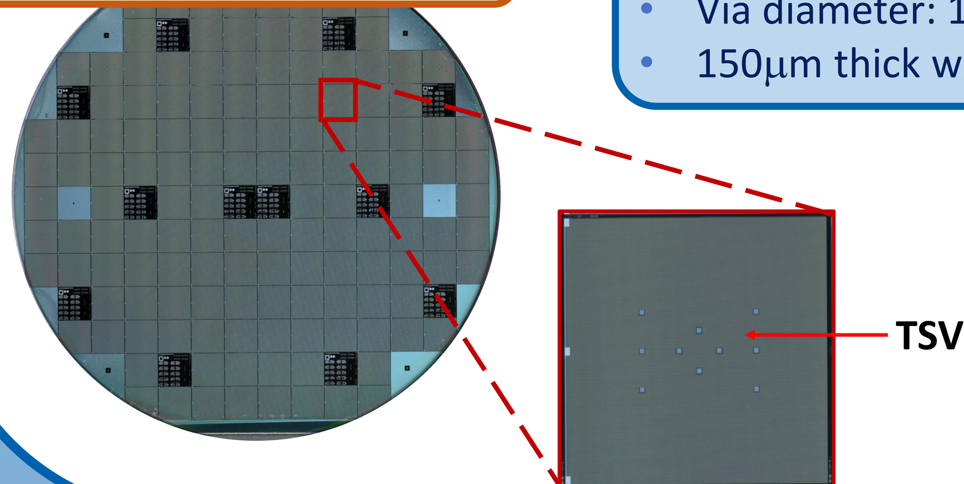




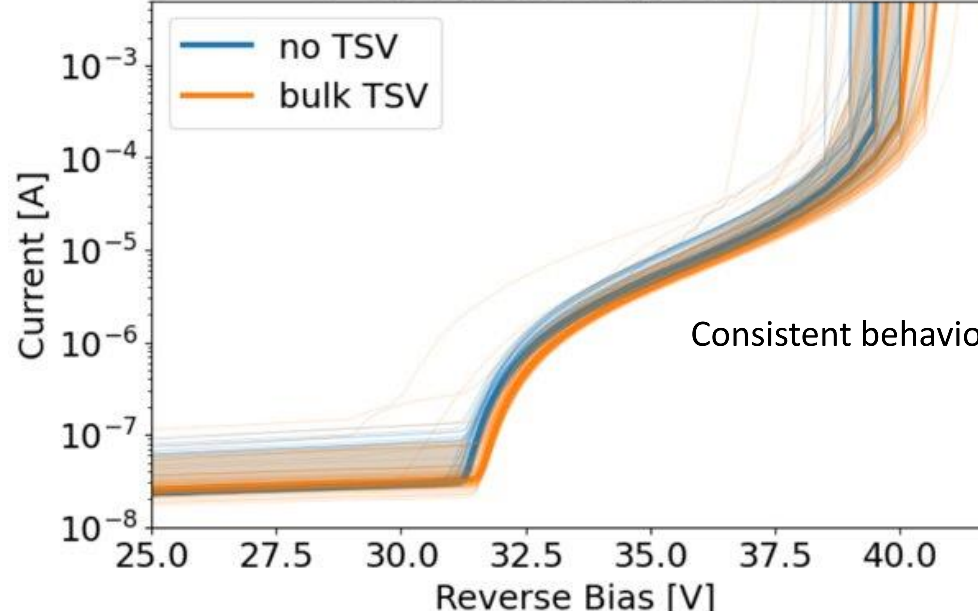
2nd divergence related to the correlated noise

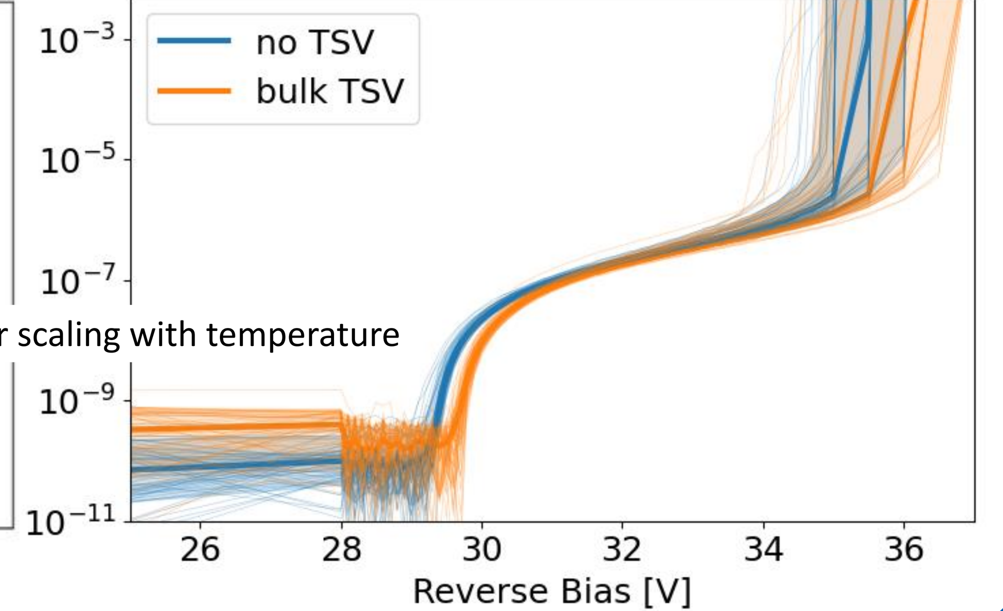
Presence of the glass increases external cross-talk probability

First produced wafer with TSV at FBK



- 10 x 10 mm^2 SiPM
- 10 TSV in parallel per SiPM
- Via diameter: 100 µm
- 150µm thick wafer





Consistent behavior scaling with temperature

jdalmasson@fbk.eu
www.fbk.eu