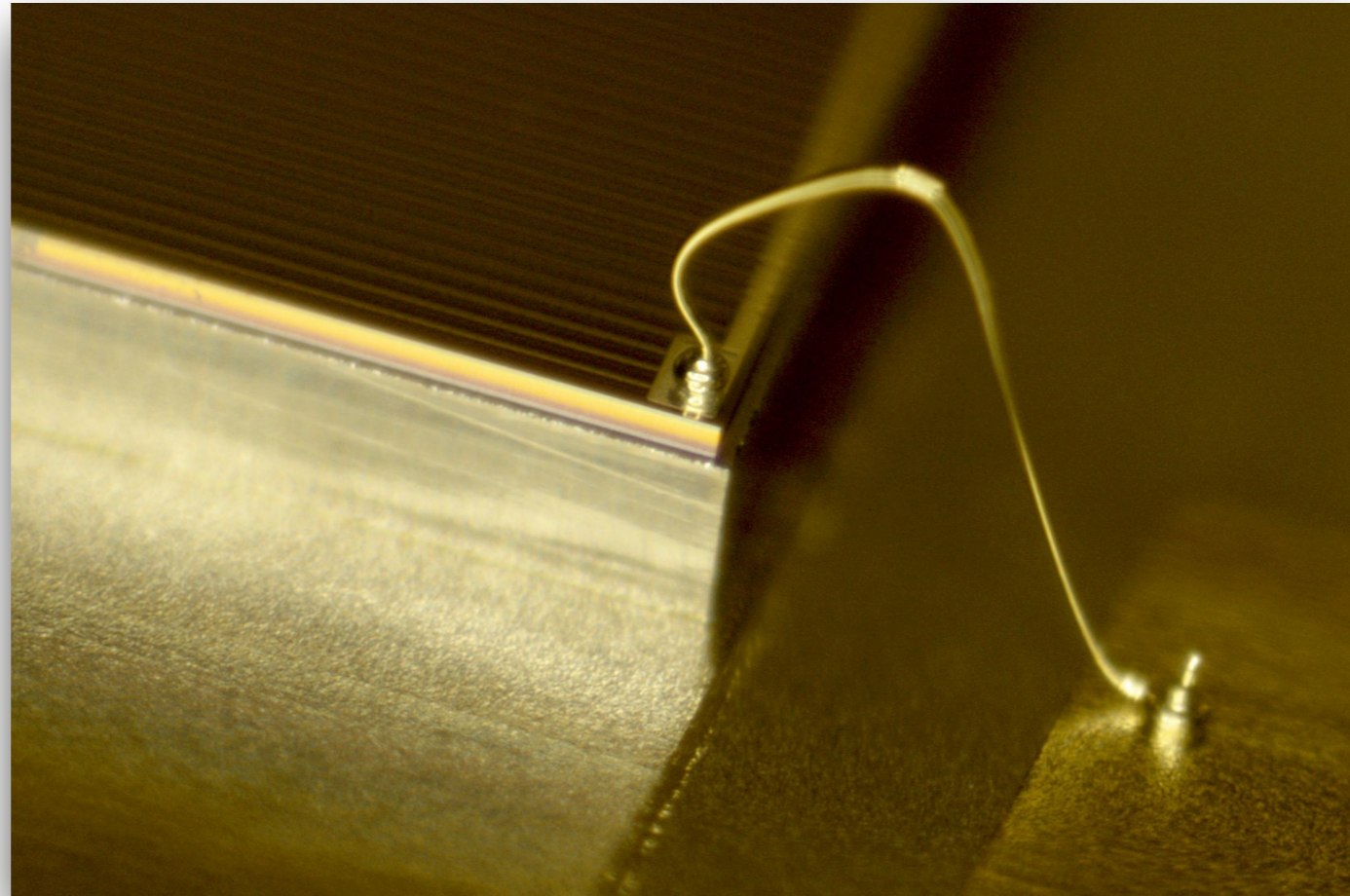


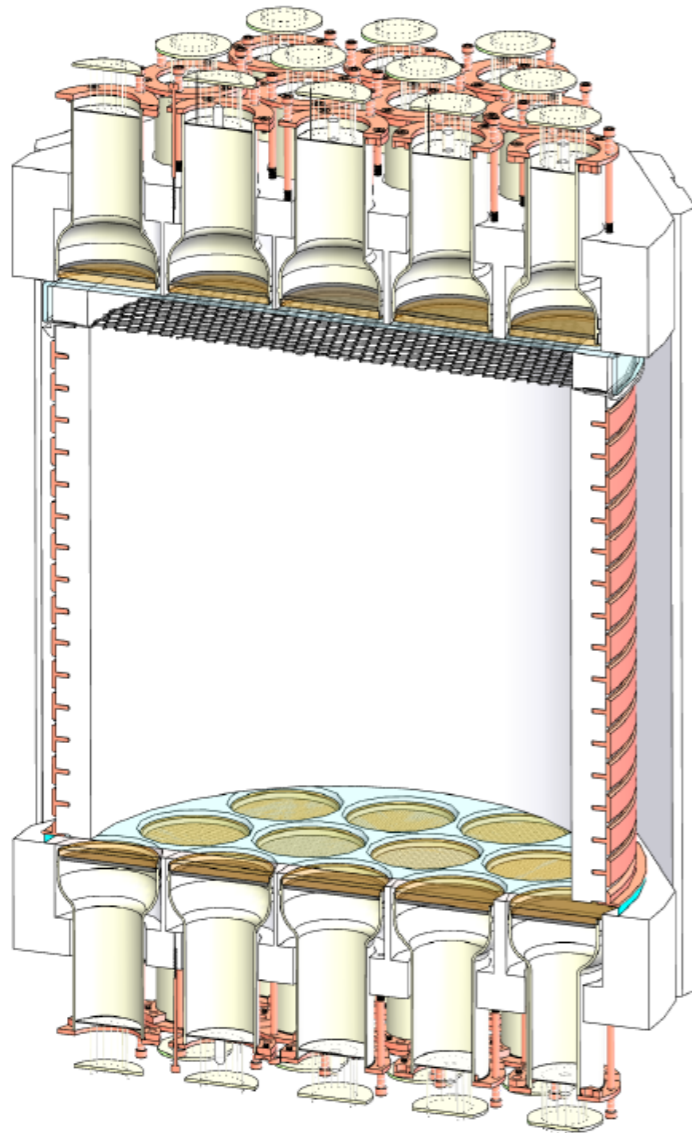
SiPMs for DarkSide-20k



*Graham Giovanetti
Princeton University*

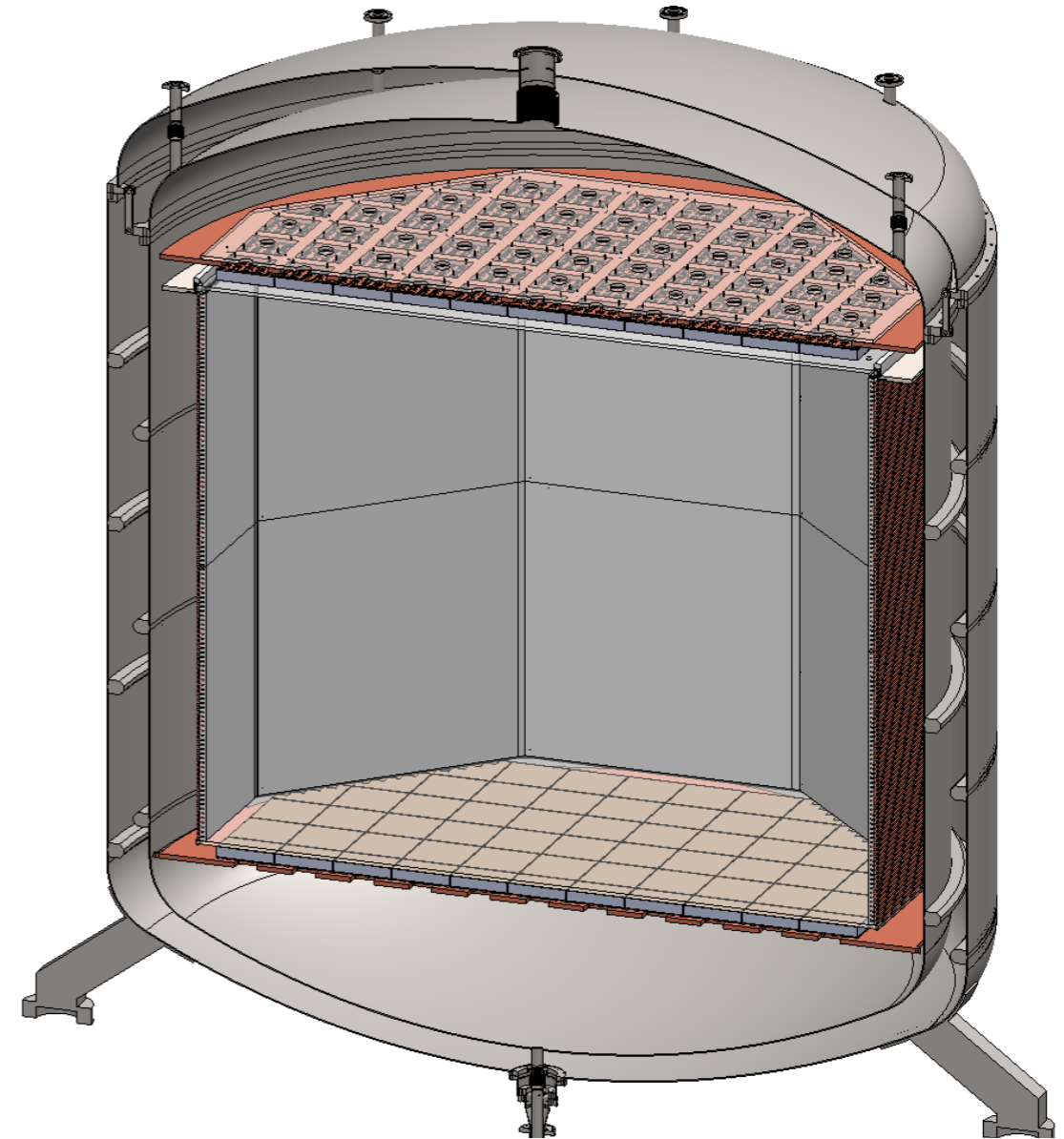
From DarkSide-50 to DarkSide-20k

38 3" PMTs



← ~35 cm →

13 m² of SiPMs

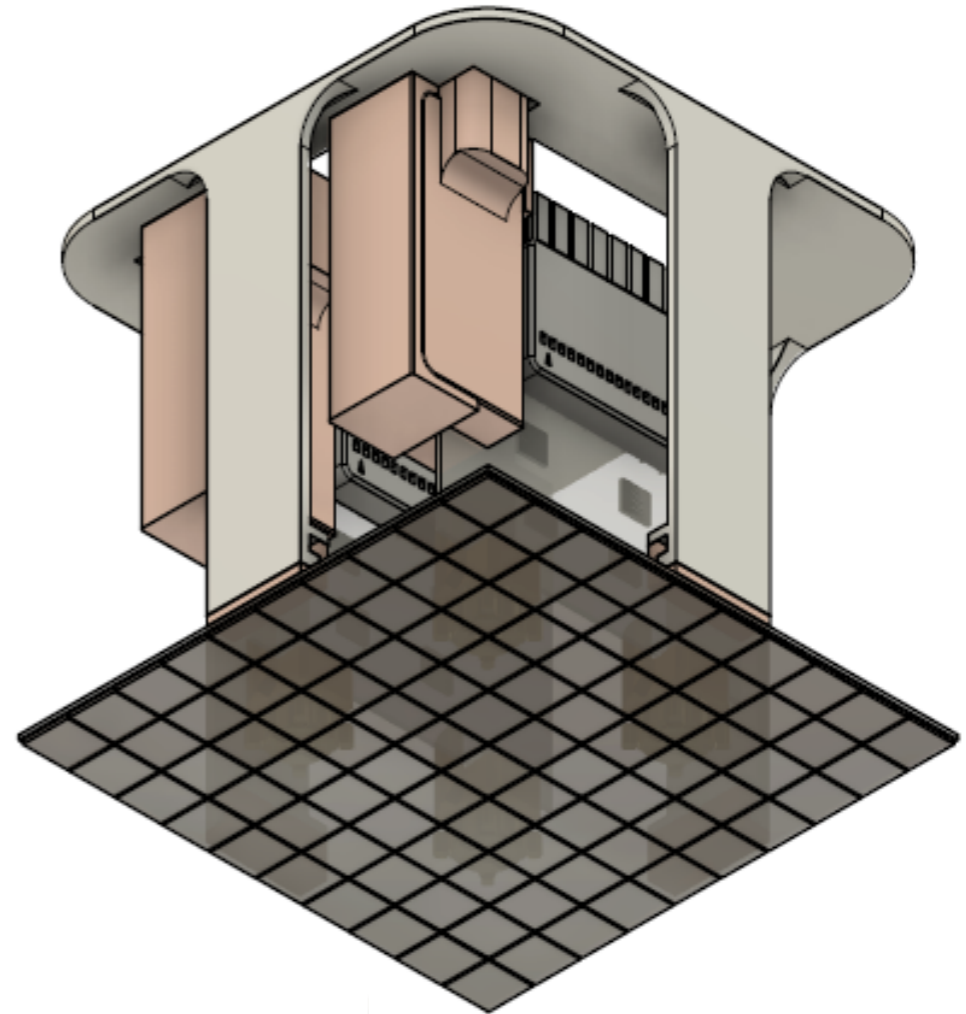


← ~290 cm →

Why transition from PMTs to SiPMs?

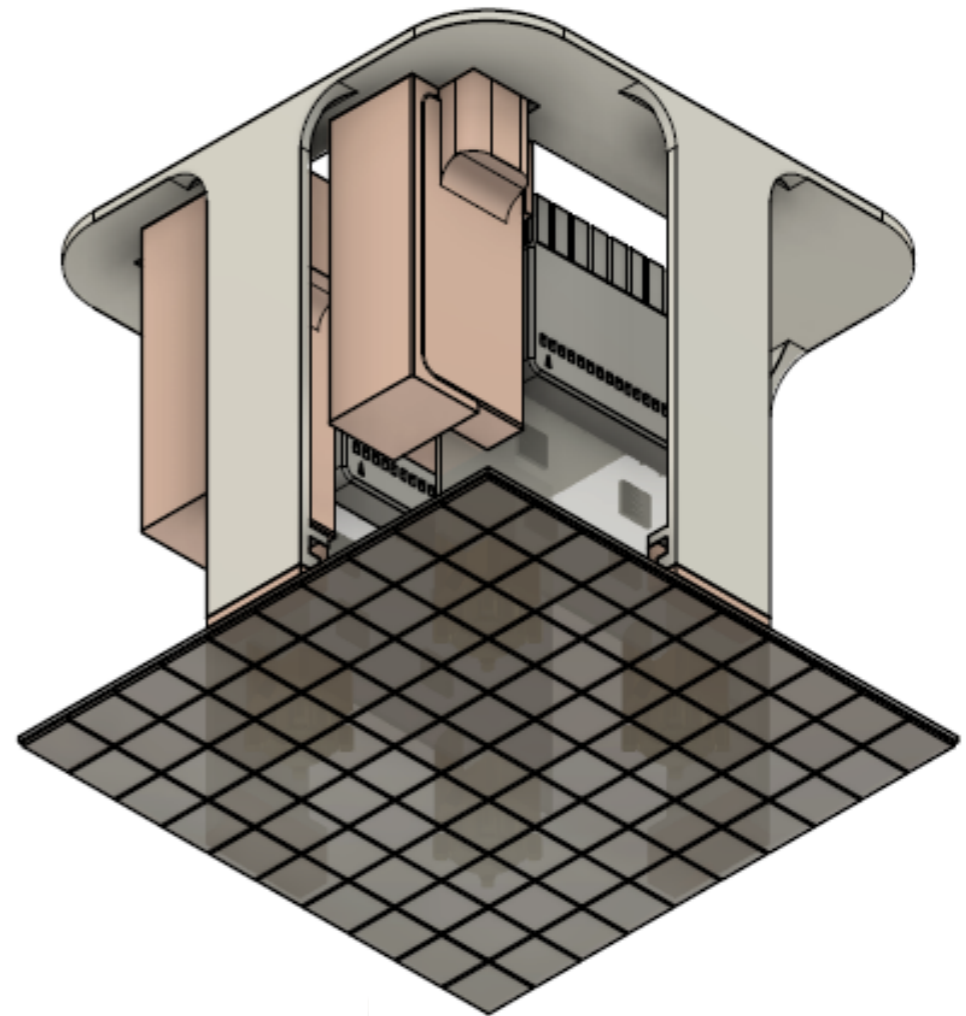
- Higher photo-detection efficiency
- Better single photon resolution
- Lower background
- Lower cost

- High dark rate
- Small area → large number of preamps/cables/feedthroughs
- High capacitance per unit area



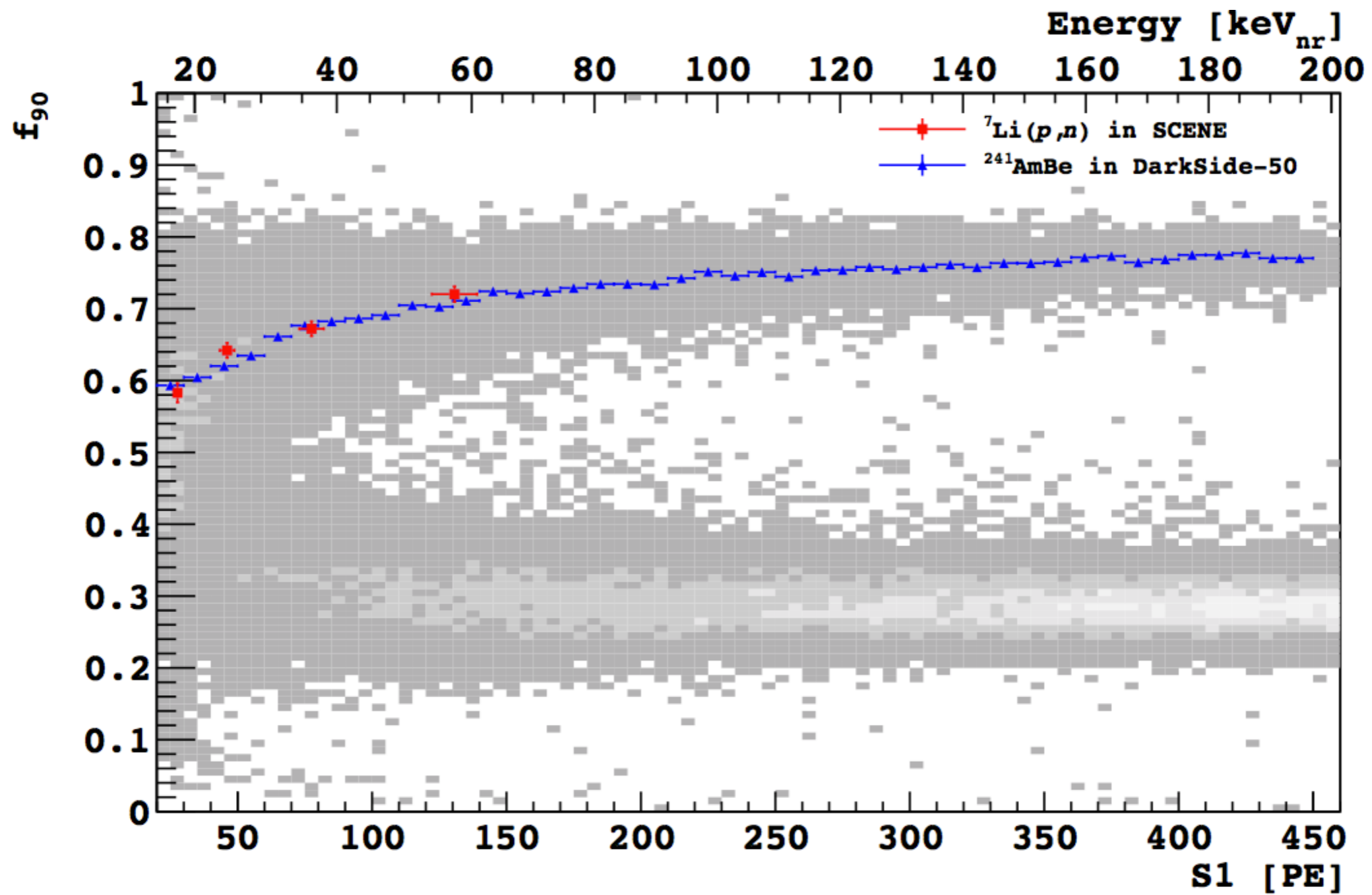
Why transition from PMTs to SiPMs?

- Higher photo-detection efficiency
- Better single photon resolution
- Lower background
- Lower cost
- High dark rate
- Small area → large number of preamps/cables/feedthroughs
- High capacitance per unit area



**Group the SiPMs
and contend with**

Pulse shape discrimination in liquid argon



Requirements for DS-20k photodetector modules

pulse shape discrimination



- Detection efficiency $> 40\%$
- Timing resolution $< O(10)$ ns
- Dark rate + noise trigger rate < 0.1 Hz/mm²



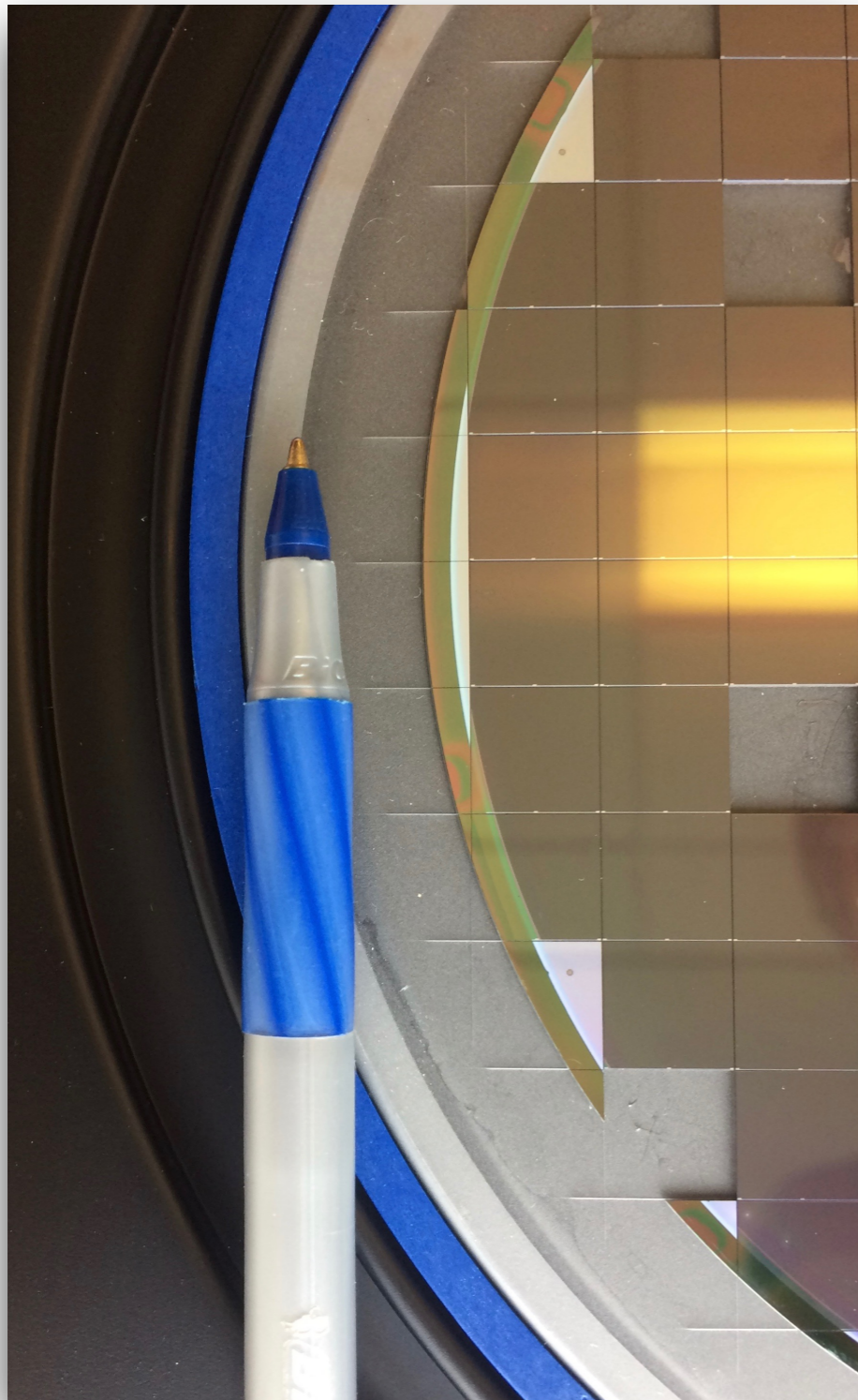
SNR > 7

practical constraints

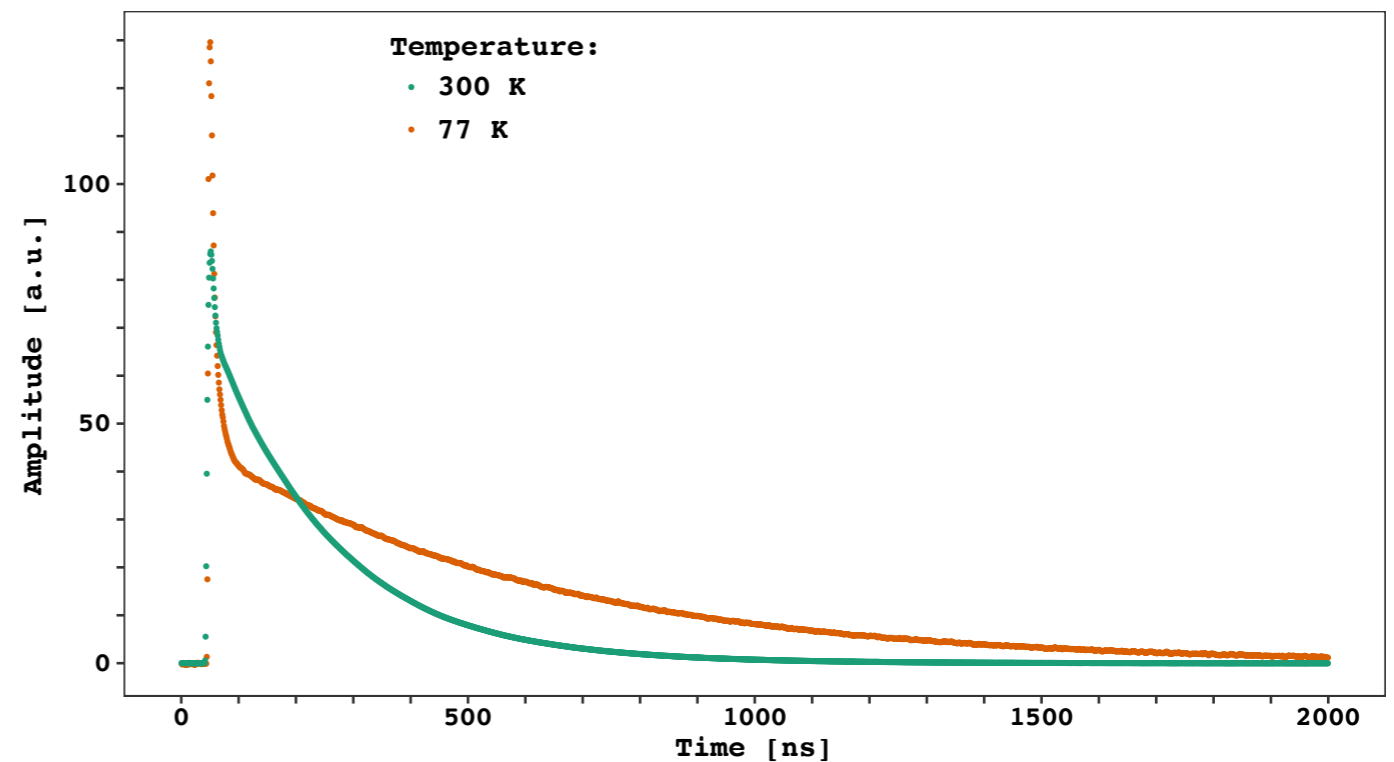


- Operation at 87 K
- 5 x 5 cm² area per channel
- Power dissipation < 250 mW

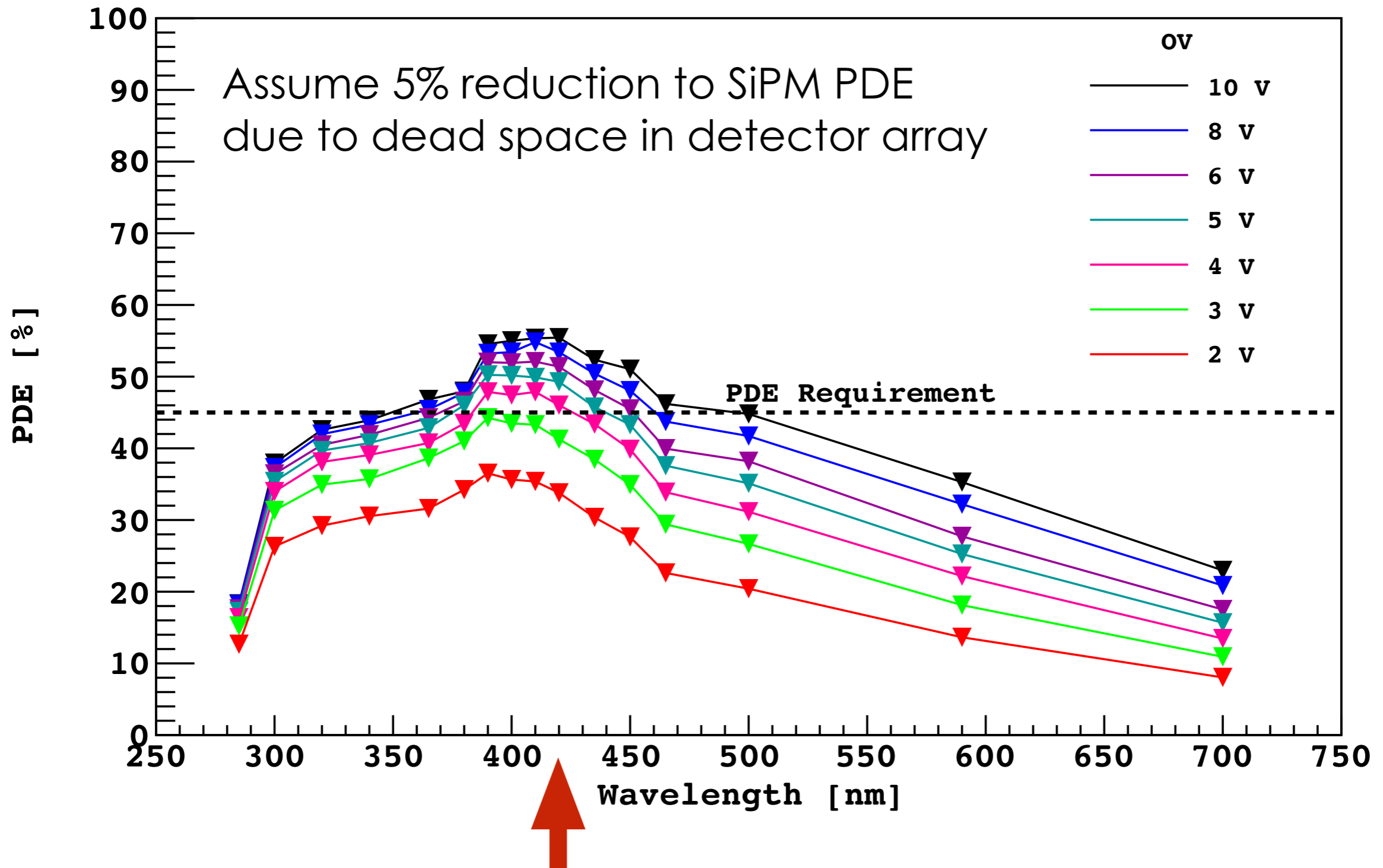
FBK NUV-HD low field SiPMs optimized for 87 K



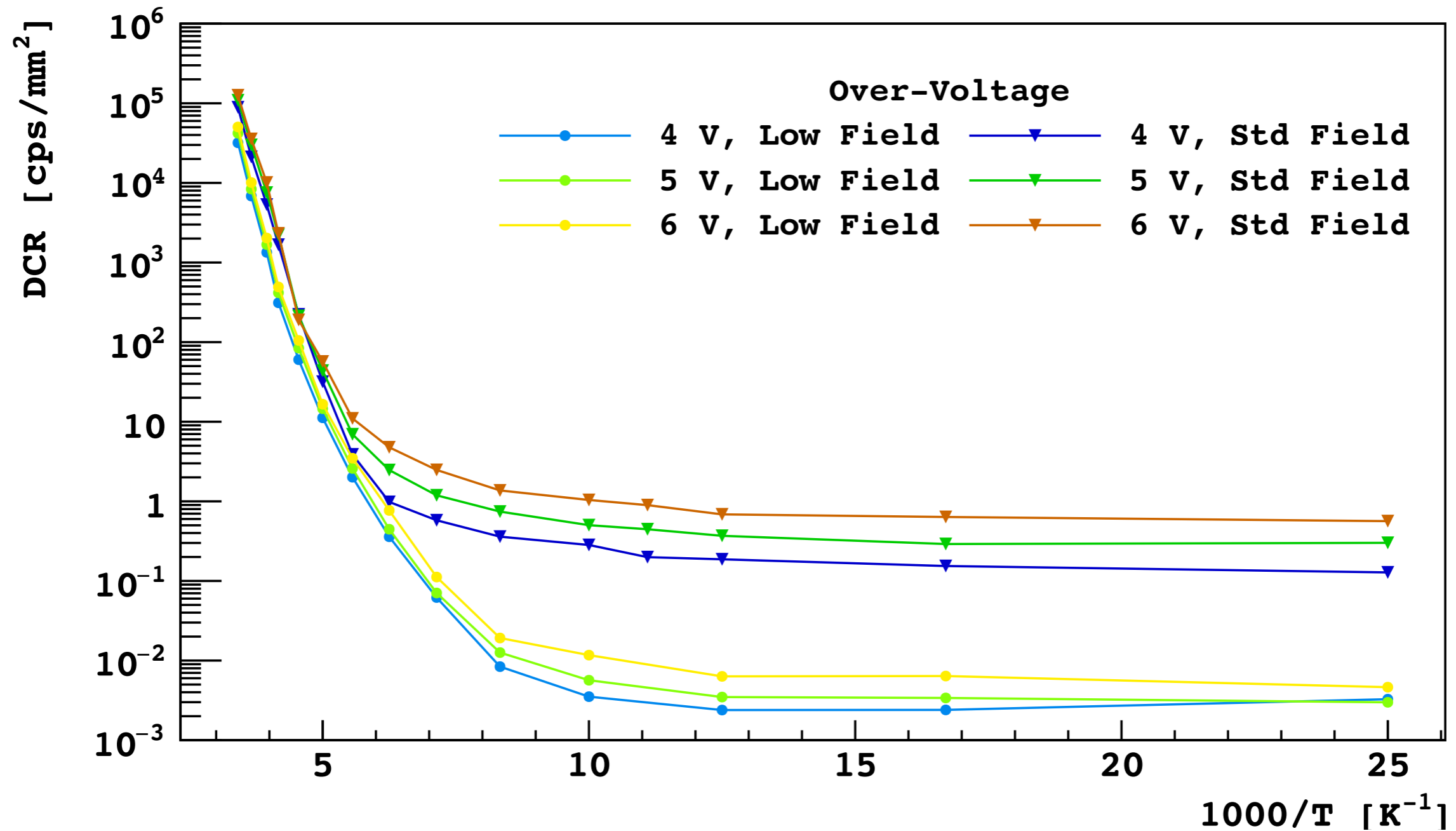
- 10 x 10 mm² SiPMs
- Peak efficiency in near UV
- Low field reduces dark rate



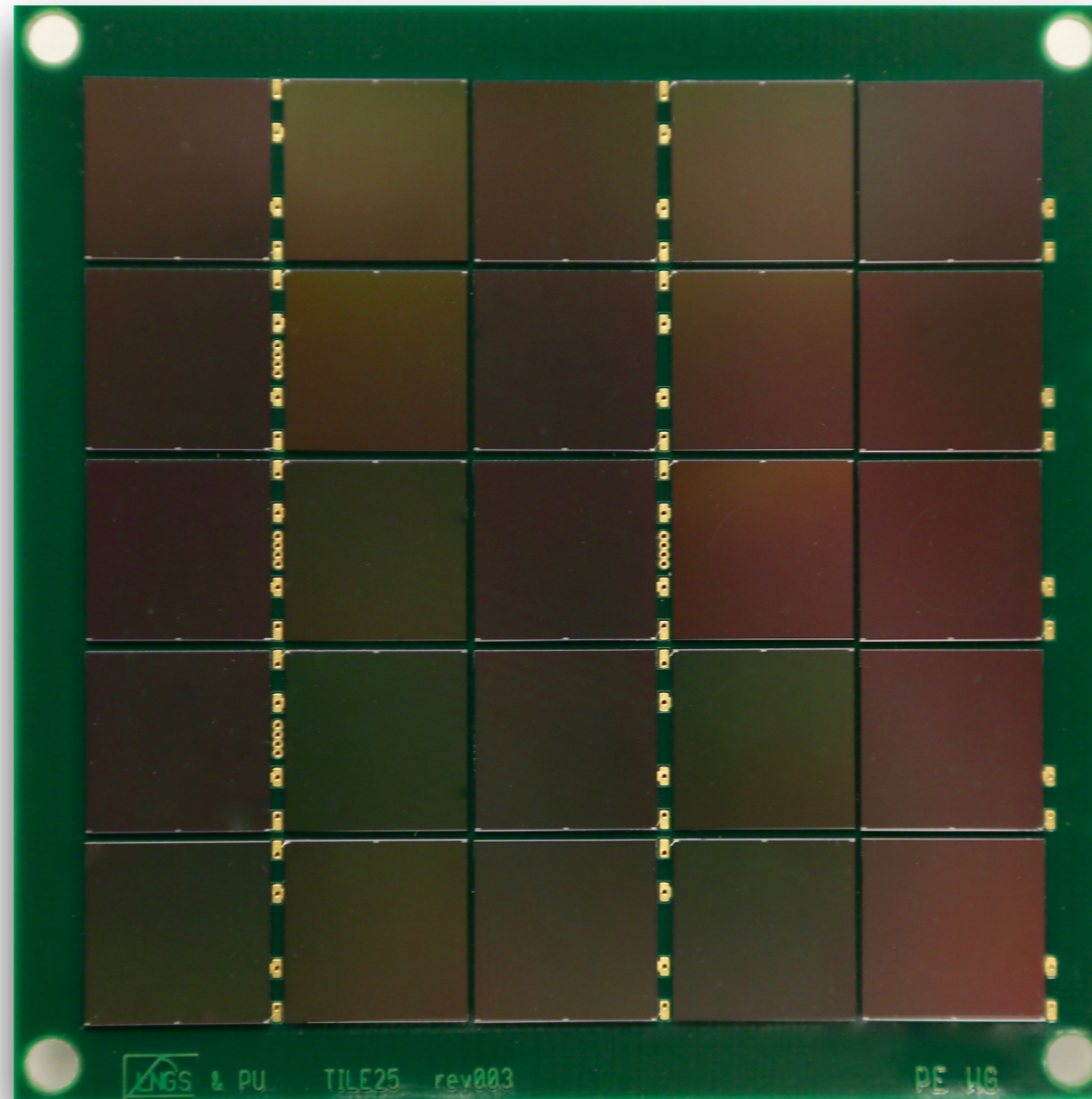
FBK NUV-HD low field PDE at 300 K



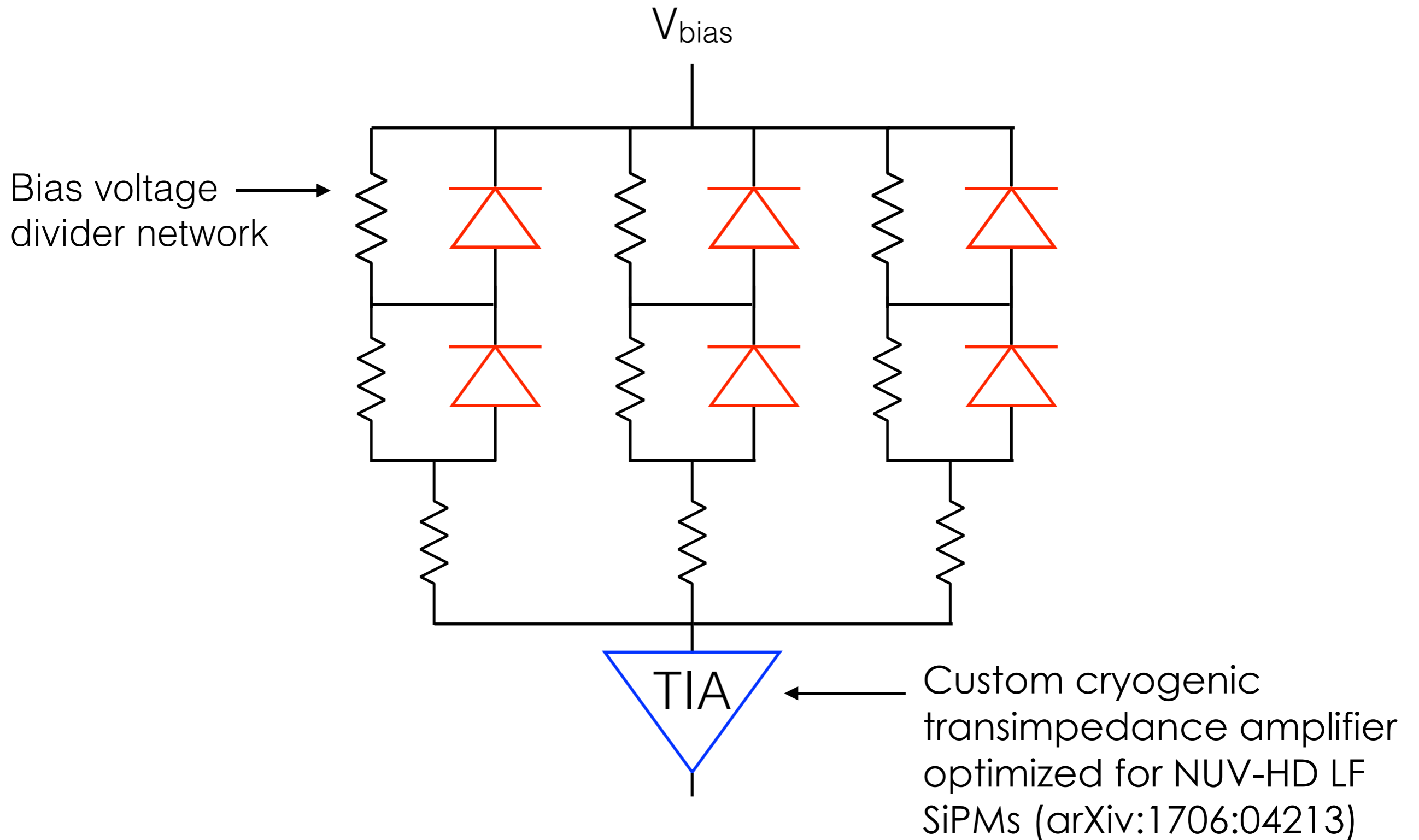
FBK NUV-HD low field dark rate vs temperature



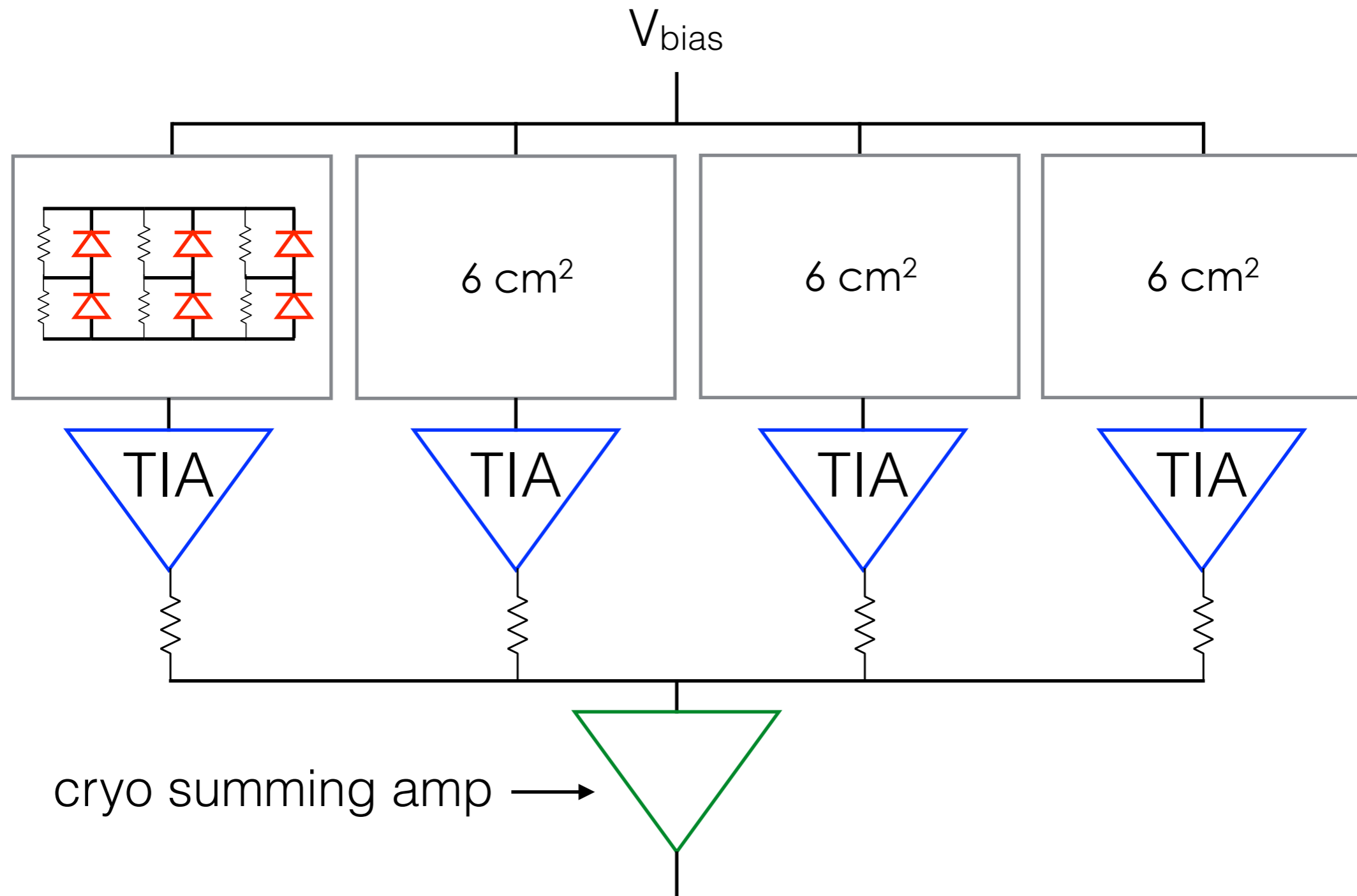
24 cm² single-channel detector



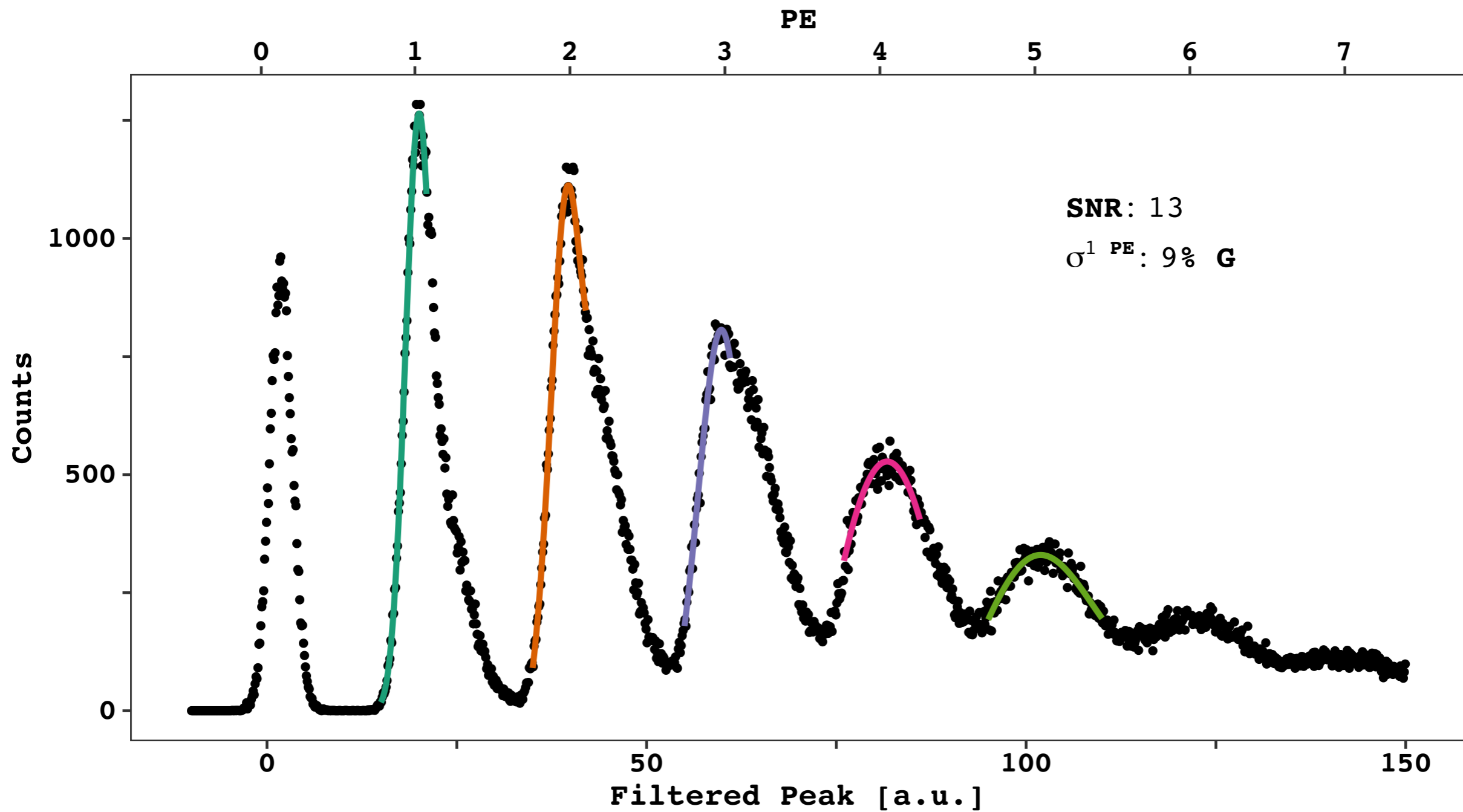
SiPM topology - 6 cm²



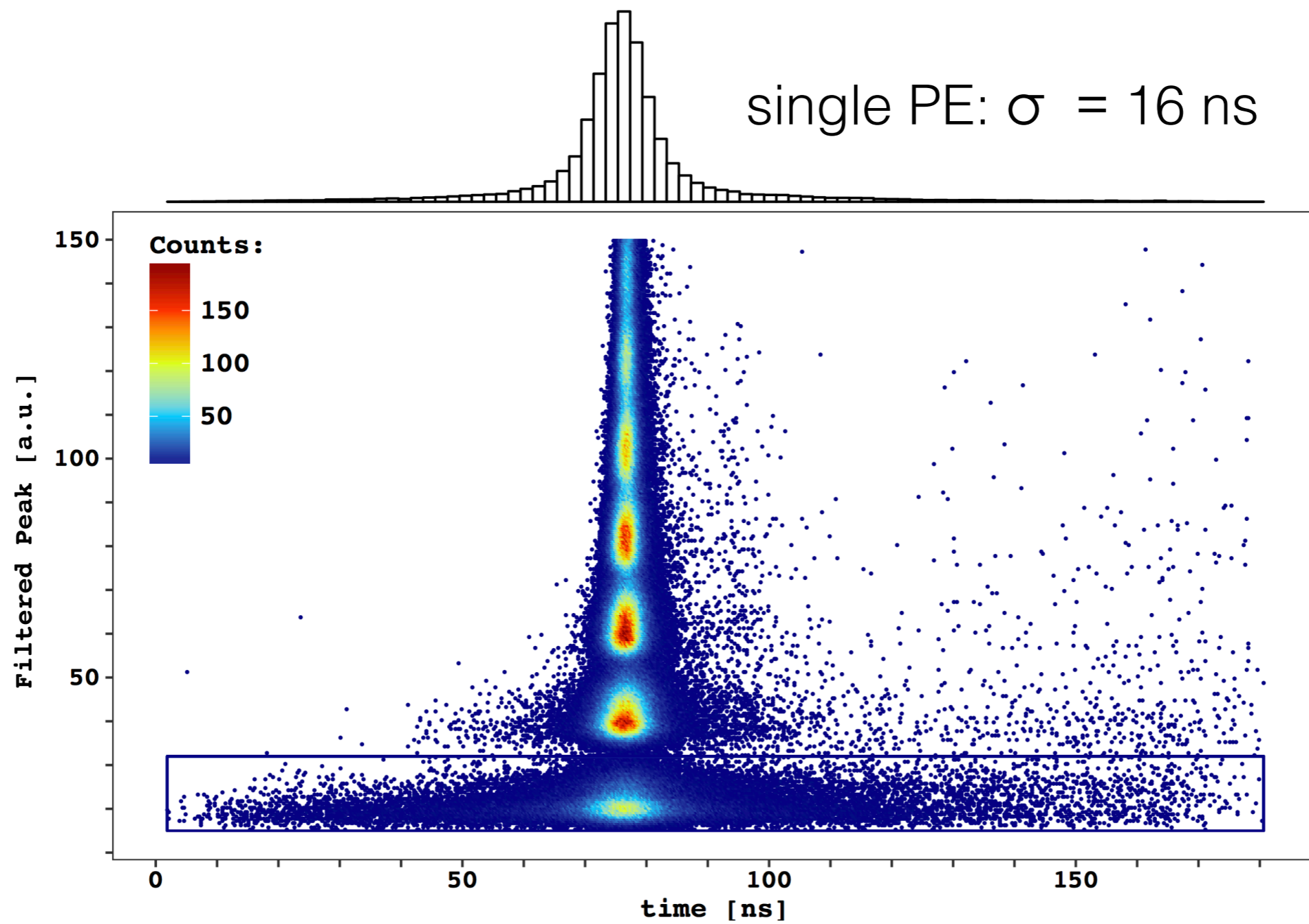
SiPM topology - full detector



24 cm² detector energy spectrum



24 cm² detector timing resolution



Requirements for DS-20k photodetector modules

pulse shape discrimination



- Detection efficiency $> 40\%$ ✓
- Timing resolution $< O(10)$ ns ✓
- Dark rate + correlated noise + noise trigger rate < 0.1 Hz/mm² ✓

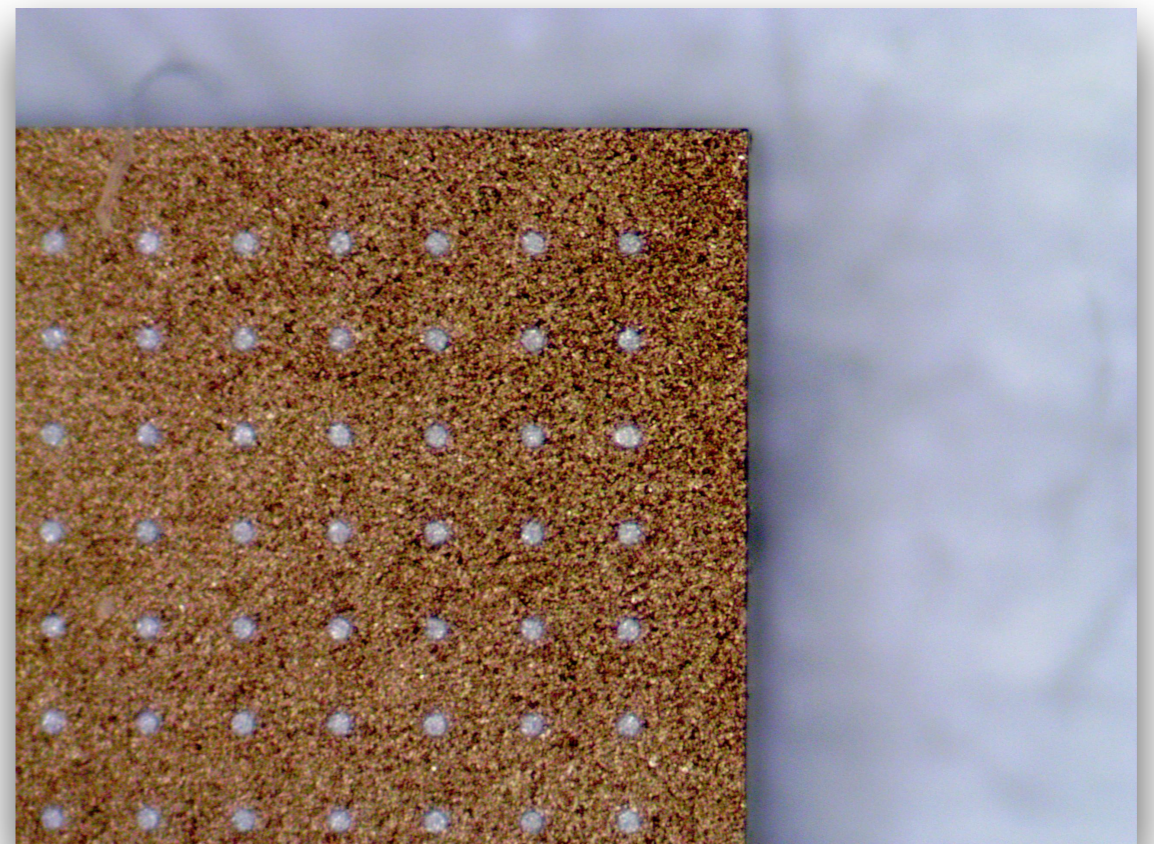
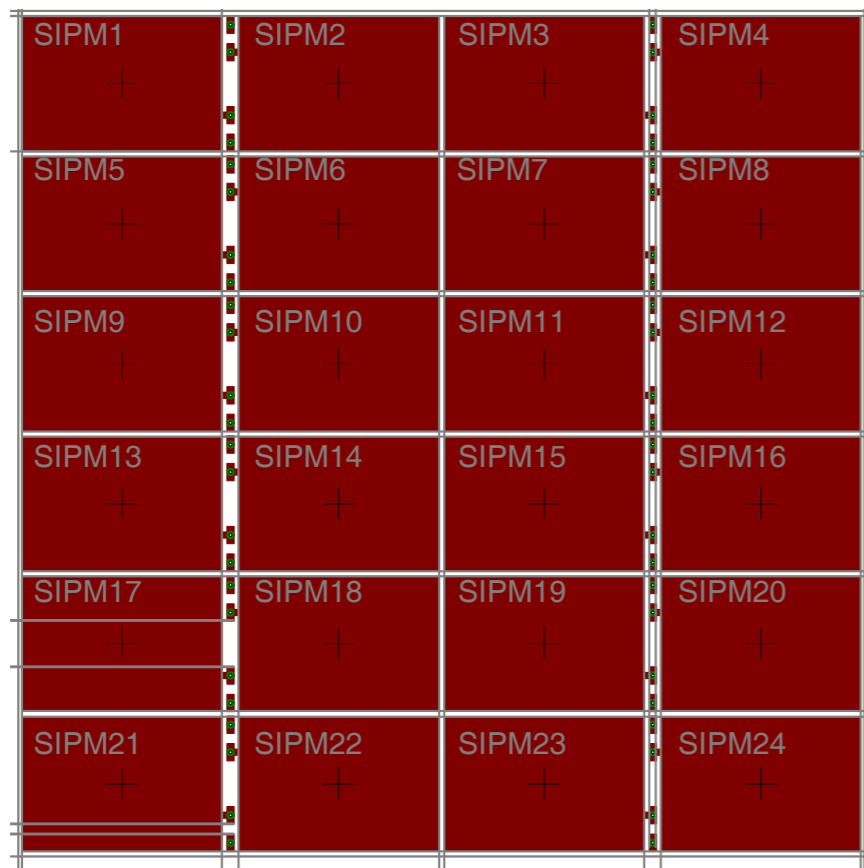
practical constraints



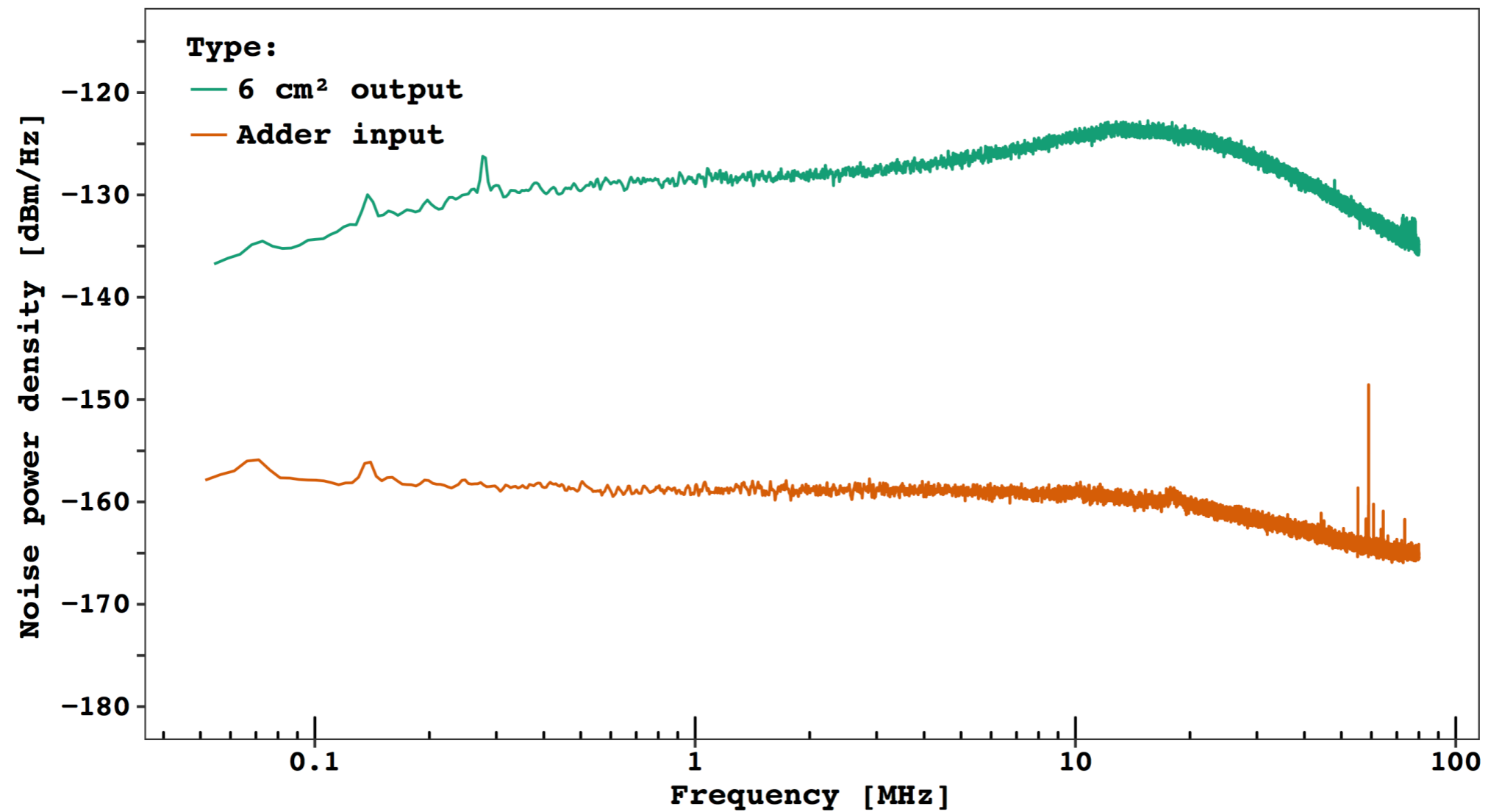
- Operation at 87 K ✓
- 5 x 5 cm² area per channel ✓
- Power dissipation < 250 mW ✓

From prototype to production - ongoing work

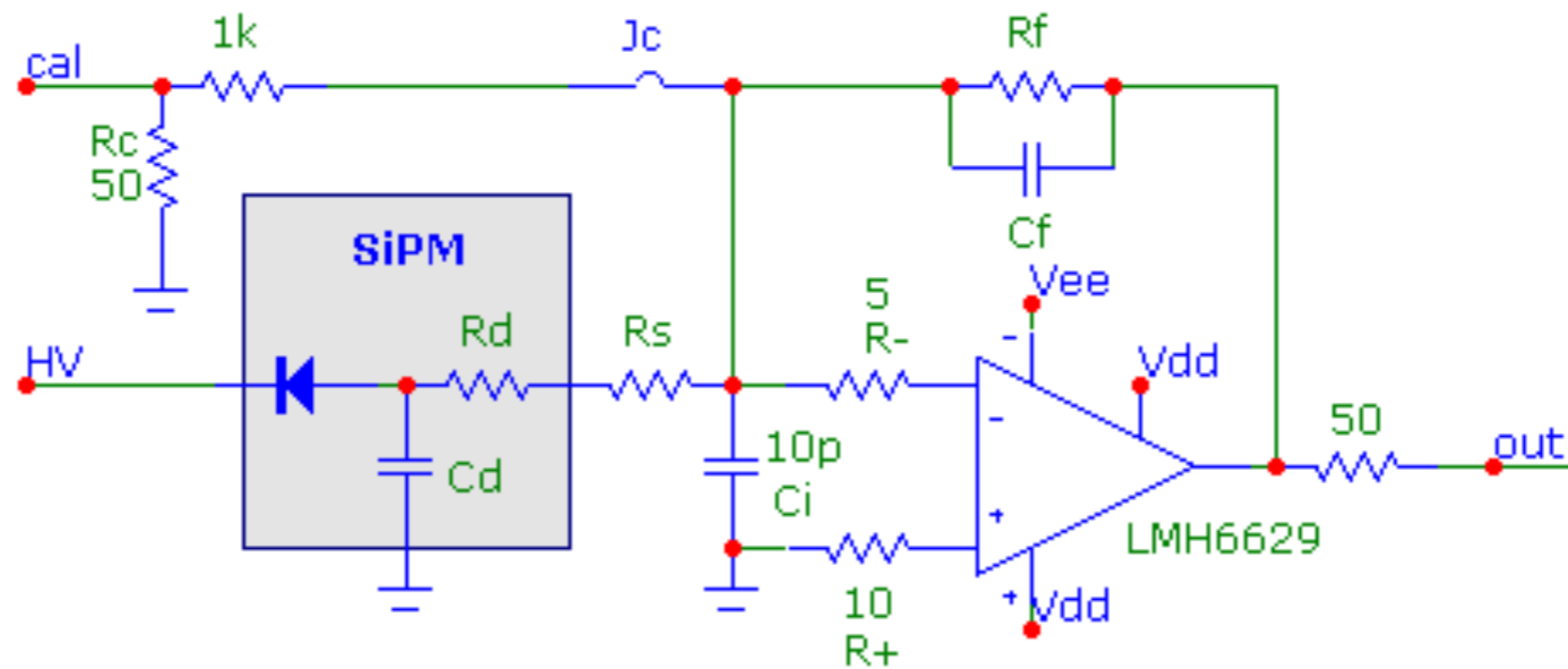
- New run of NUV-HD-LF SiPMs with optimized form factor and performance improvement
- Low-background packaging R&D
- Construction of a dedicated packaging facility at LNGS



Output noise density of summing amp and 6 cm² quadrant



Cryogenic transimpedance amplifier



Pulse shape discrimination in liquid argon

