LABORATORIUM FÜR HOCHENERGIEPHYSIK
LHEP
UNIVERSITÄT BERN

LArPix light readout

1st DUNE Module of Opportunity workshop
BNL, USA

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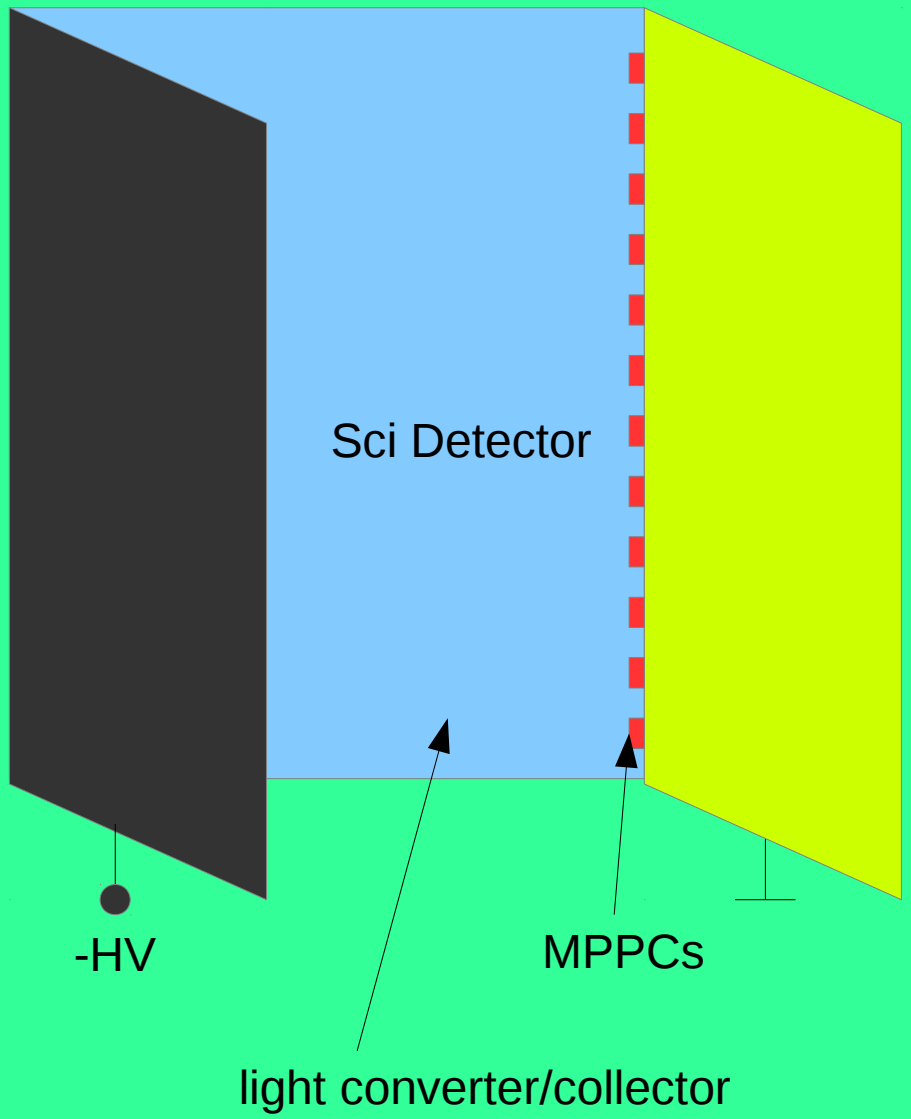
ALBERT EINSTEIN CENTER
FOR FUNDAMENTAL PHYSICS

Off-anode scintillation detectors



Pros:
- Large area available
- Easy readout at the edge

Cons:
- (partly) screens field cage

Features:
- must be dielectric
  (except the edge)

Off-anode scintillation detectors technologies available single WLS

PDE ~ 1%

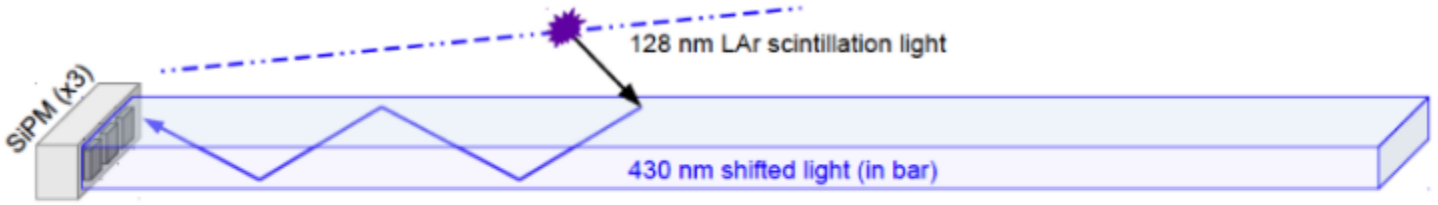


Figure 2: Example schematic photon detector panel design, showing the light-guide bar and the SiPMs of the IU or LBNL designs. The light-guide bar has dimensions of 50.8 cm × 2.54 cm × 0.6 cm.

D. L. Adams et al., Photon detector system timing performance in the DUNE 35-ton prototype liquid argon time projection chamber, arXiv:1803.06379v3

Off-anode scintillation detectors technologies available double WLS

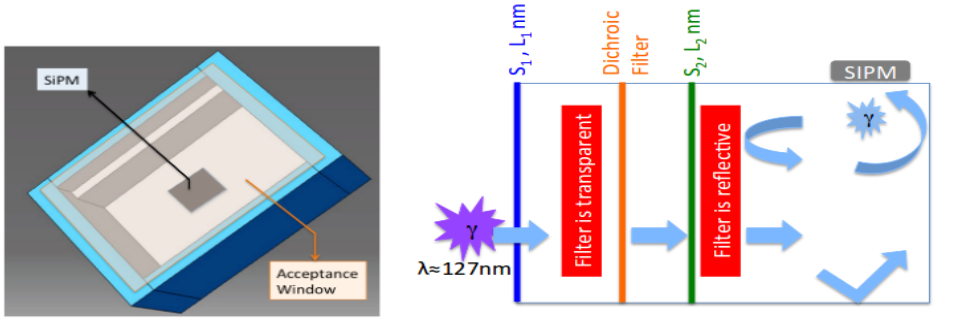
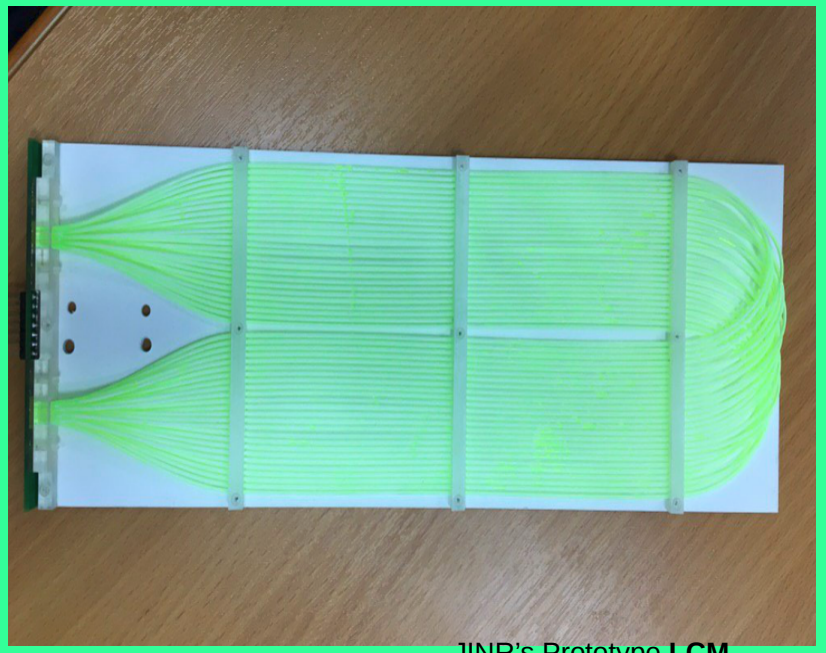


Figure 1. Left: pictorial representation of the ARAPUCA. Here are represented the box with internal reflective surfaces (in blue), the dichroic window and the photo-sensor (SiPM). Right: operating principle of ARAPUCA.

A.A. Machado and E. Segreto 2016 JINST 11 C02004

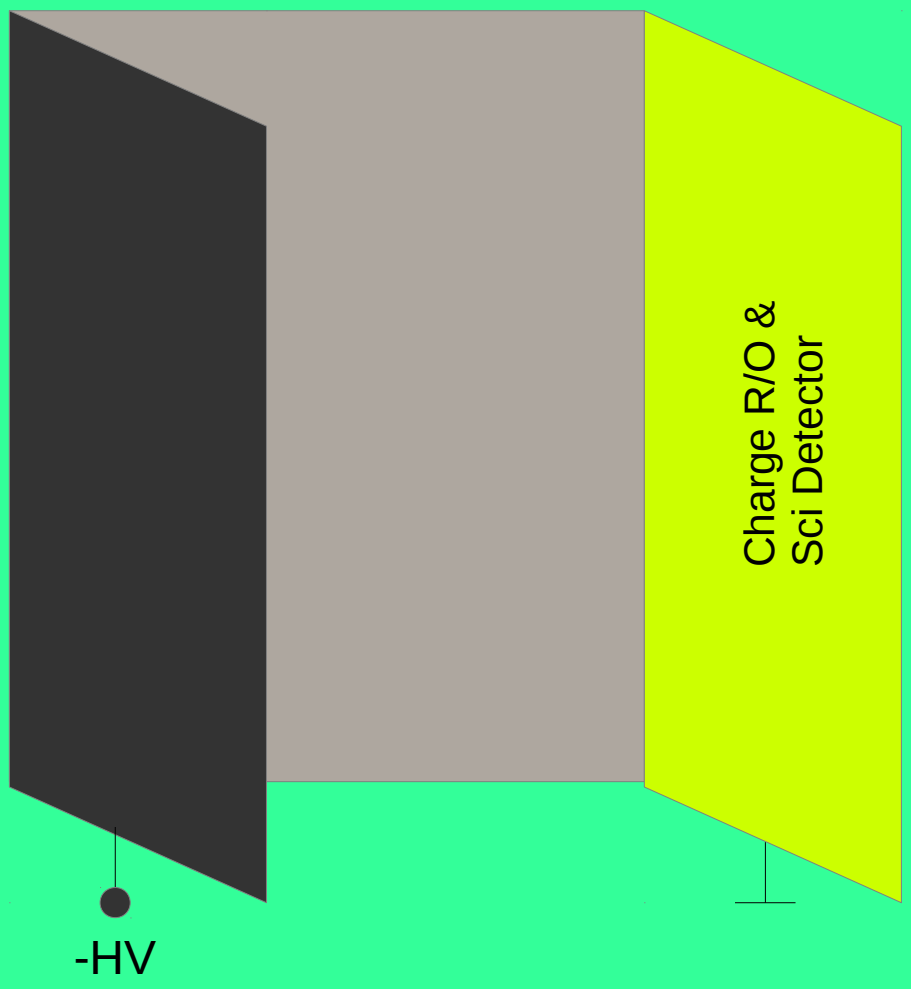
PDE ~ 1%
(up to 10% ?)

Prototype **ArCLight** tile (Instruments 2 (2018) no.1, 3).



JINR's Prototype **LCM**

On-anode scintillation detectors (pixelated anode

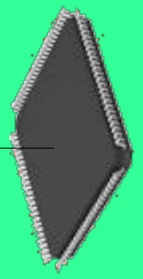


Pros:
- Large area available
- Easy readout at GND potential
- No screening of the field cage

Cons:
- Partial loss of charge collecting area (not necessarily ?!)

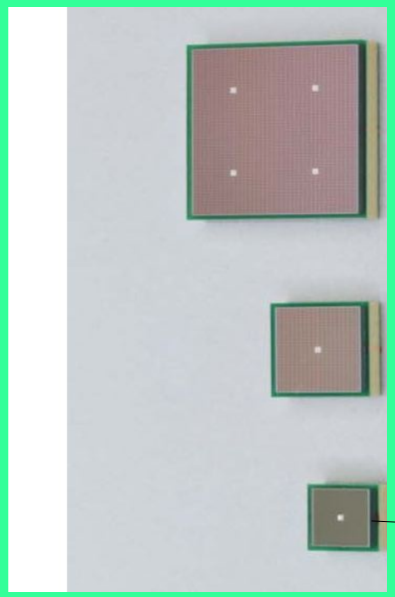
LArPix pixelated anode with LArPix ASIC

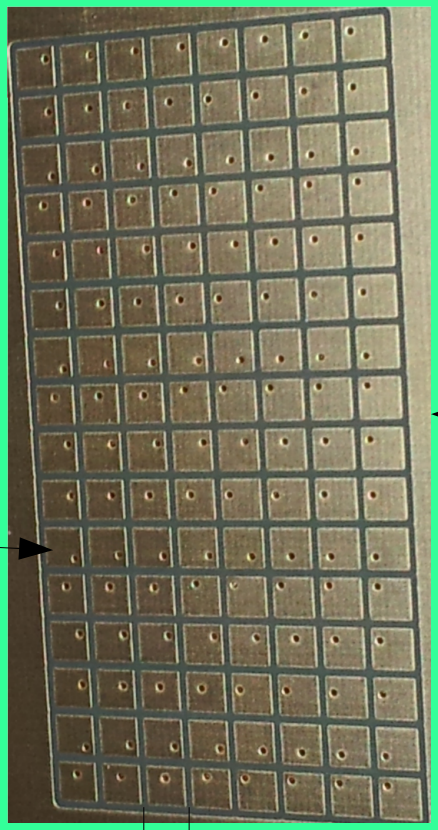
LArPiX ASIC
(LBNL, D.Dwyer)

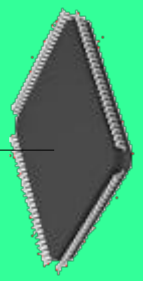


3-5 mm

On-Anode: Conventional MPPC with WLS







LArPiX ASIC
(LBNL, D.Dwyer)

MPPC coated with TPB
(PEN?)

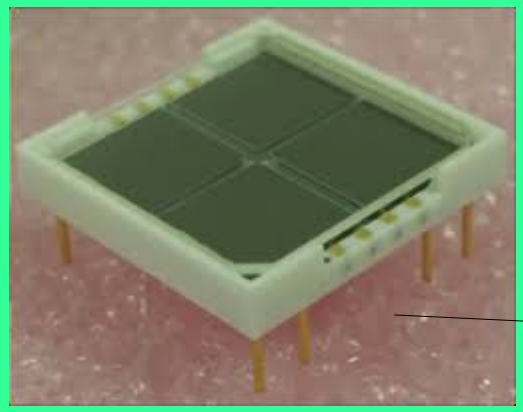
PDE ~ 40%

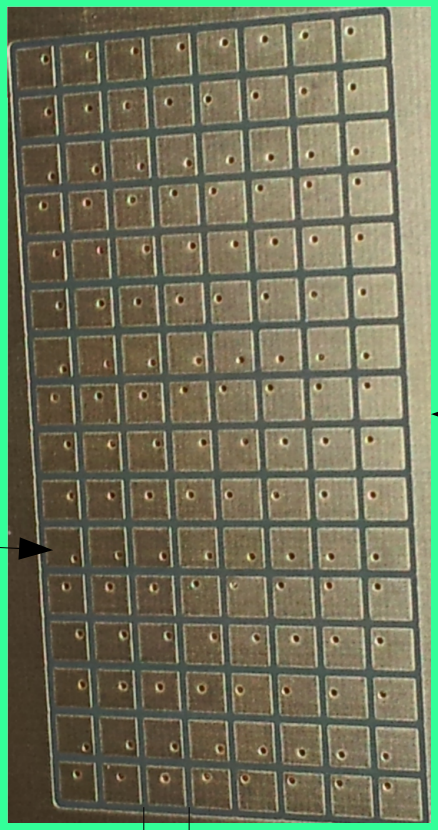
Surface fraction ~ 2%

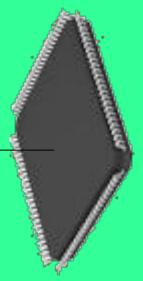
Overall PDE ~ 1%

3-5 mm

On-Anode: VUV MPPC







LArPiX ASIC
(LBNL, D.Dwyer)

VUV MPPC

PDE ~ 12% (21% for LXe)
https://arxiv.org/pdf/1809.08701.pdf
https://arxiv.org/pdf/1505.00091.pdf

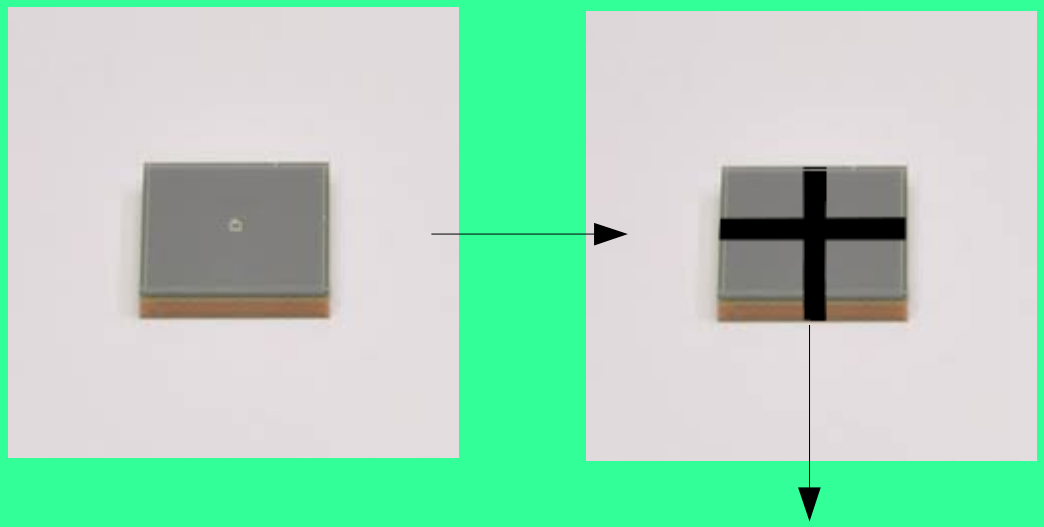
Surface fraction ~ 2%

Overall PDE ~ 0.3%

3-5 mm

On-Anode: Pixel with combined capabilities with hypotetic hybrid MPPC

Cons:
- Partial loss of charge collecting area (not necessarily !!)



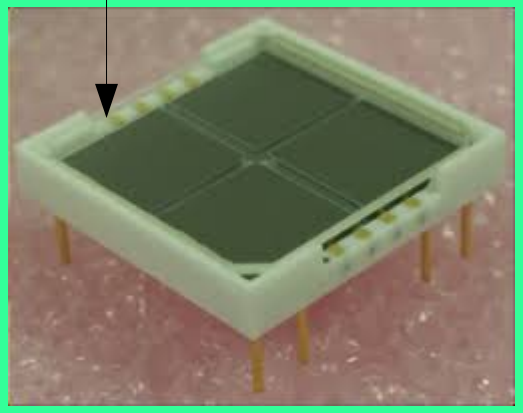
charge readout
from added Al pattern

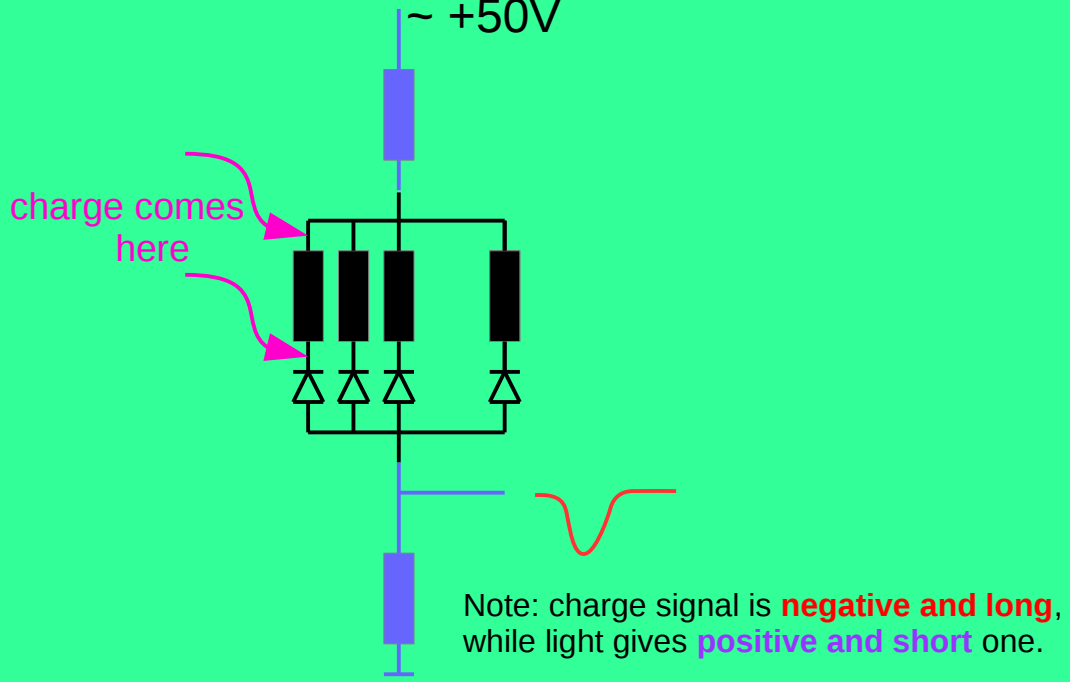
On-Anode: Pixel with combined capabilities with commercial VUV MPPC

VUV MPPCs: made sensitive to VUV by removing/ minimizing surface layers

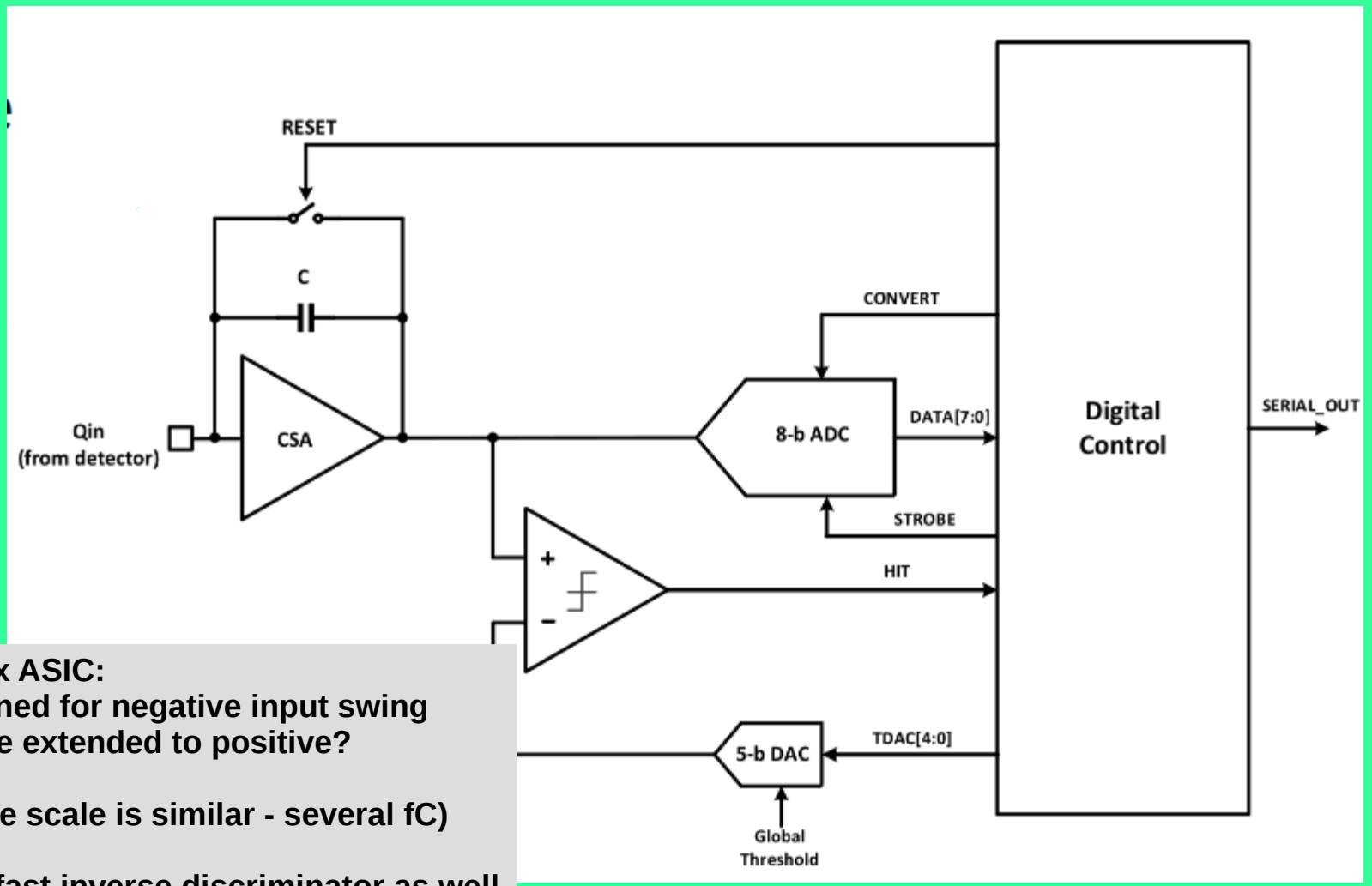
VUV-transparent window for surface protection.

If removed, conductive structure can be directly exposed to LAr ?





On-Anode: Pixel with combined capabilities readout (with LArPix V3?)



LArPix ASIC:
Designed for negative input swing
Can be extended to positive?

Charge scale is similar - several fC)

Need fast inverse discriminator as well

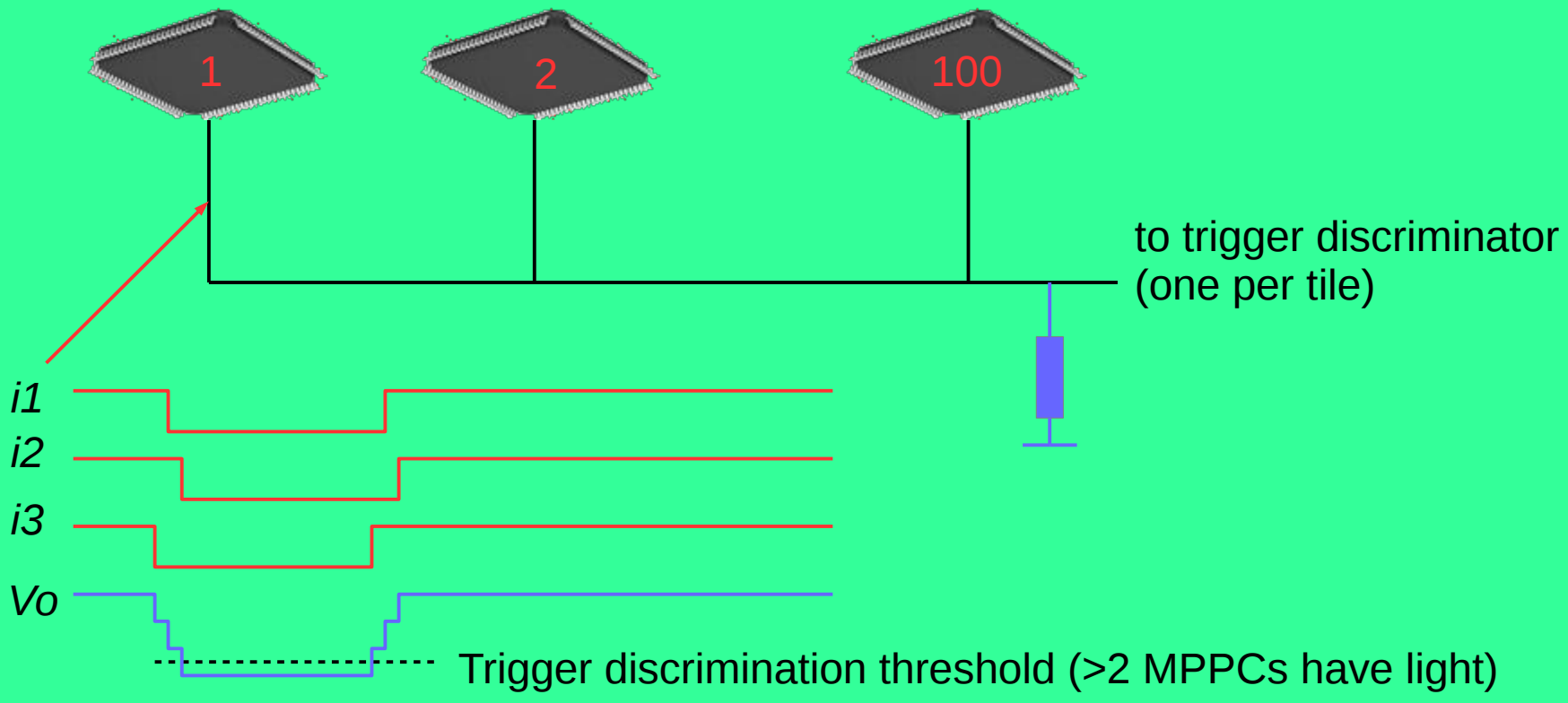
Input amplifier bandwith is an issue!

On-Anode: Pixel with combined capabilities triggering (with LArPix V3?)

Assuming fast input preamp and discriminator is available in LArPix V3...

MPPC dark count rate at 87K is low, but still noticeable (10-100 Hz at 0.5 p.e.)
Need basic in-situ coincidence before sending trigger out...

Solution: analog summation of digital signals within one tile



Summary

- Off-anode and/or On-anode schemes can be considered

- Choise of technologies available for both, PDE ranging from fraction of % to tens of %

- Large room for R&D

- Need strong links to industry (MPPCs, ASICs, WLS, Dichroic reflectors)