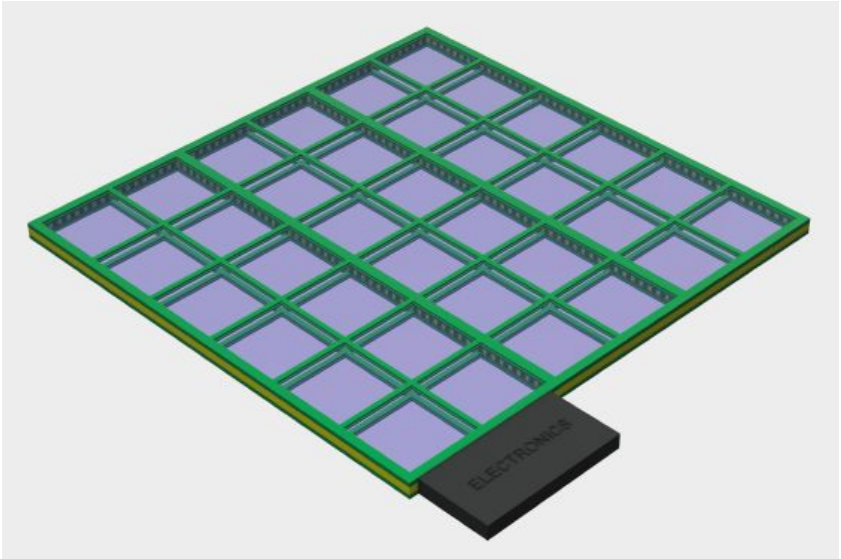
X-Arapuca Tiles for VD PDS and Prototypes



DUNE Collaboration Meeting
20 May 2021

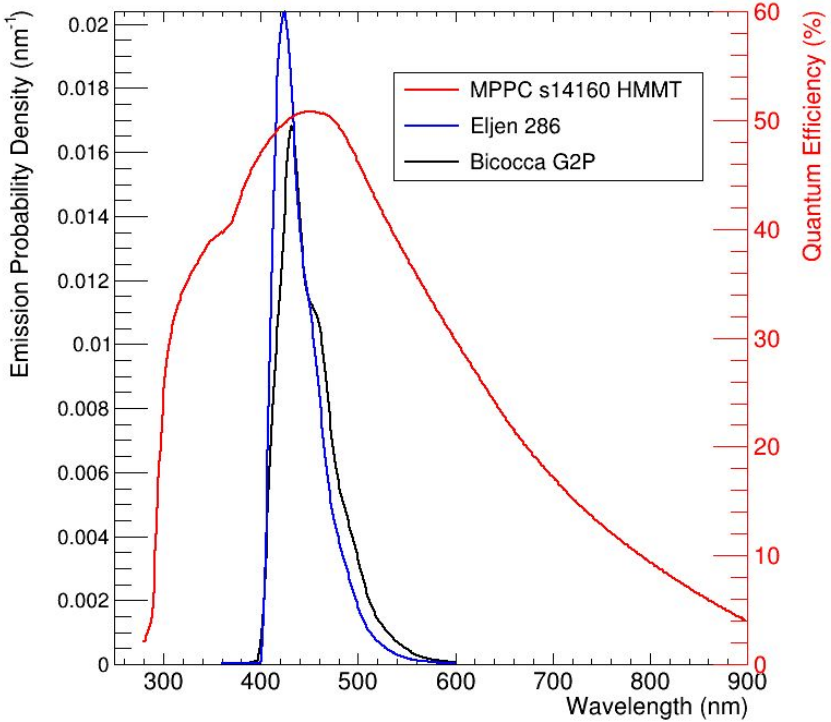
Carla Cattadori, Ana Machado on behalf of the working group

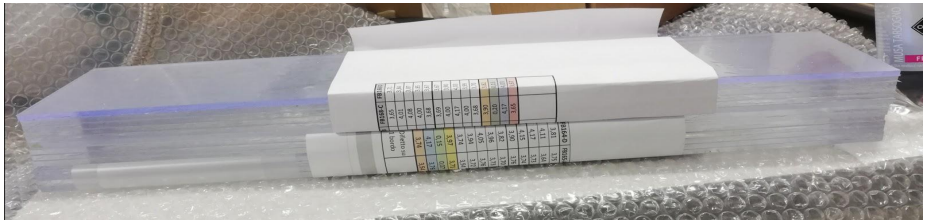
The Concept of the VD Megacell Photon Collector

- Megacell (MC) Photon Collector Size: 647 X 675 X 22.5 mm^3
- Readout by 160 SiPMs (40 SiPMs/Side)
- Passive & Active ganging implemented (passive on SiPMs flex boards, active at the CE level)
- SiPMs boards are no longer FR4 rigid PCBs
  - Two 300 mm long Kapton flex circuits on each side to better accomodate the CTE and the flatness of the WLS
- SiPMs are
  - surface mounted onto flex circuits
  - optically bonded (proper glue) to the WLS edges
- Differences with the HD SuperCell (SC) design
  - Size of the WLS: (600 x 600 x 4) mm^3 vs (480 x 93 x 4) mm^3
  - In HD SC the SiPMS are fixed to the mechanical frame → thermal shrinking may open gaps between SiPMs and WLS
  - → In VD MC the SiPMs are solidal with the photon collector to enhance the PDE

	CTE [ppM/K]
G10 FR4	120
Kapton	20
PMMA	70-77

Status of the WLS production



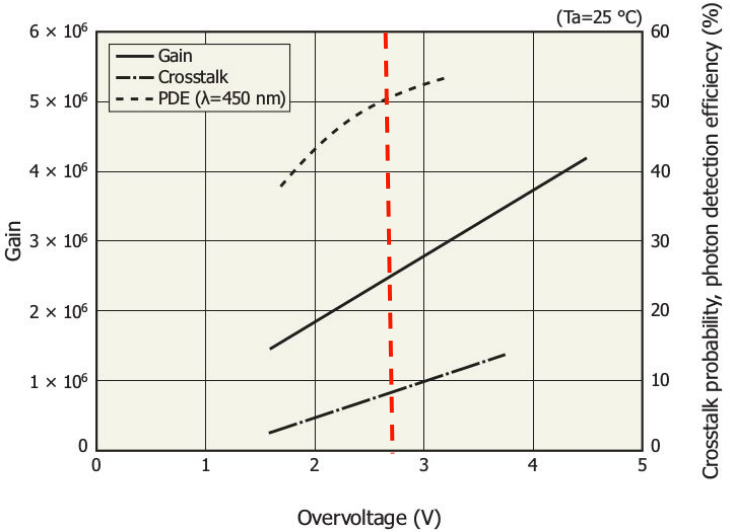


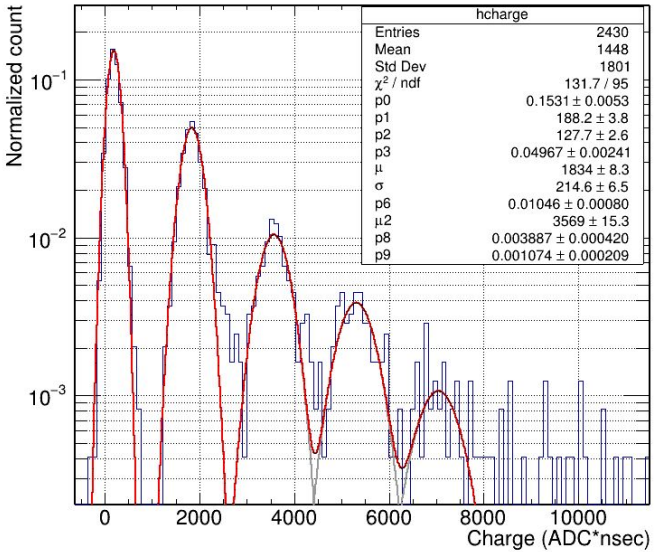
Two manufacturers
- Eljin ?
- G2P (a spinoff of UniMIB)

G2P
- **End of 2020 delivered 12 x (480 x 93 x 4 mm) for the HD SuperCell tests** at (Spain, Italy, Campinas)
- End of April 2021: issued by INFN the purchase order for 6 VD-MC x (600 x 600 x 4) mm.
- Refurbishment of the casting reactor completed by 10 june→ commissioning → expected production by mid july 2021
- Measurements of the attenuation length of the SC WLS ongoing: (preliminar results ≥ 1 m).
- Possible to optimize the chromophore concentration.

The SiPMs

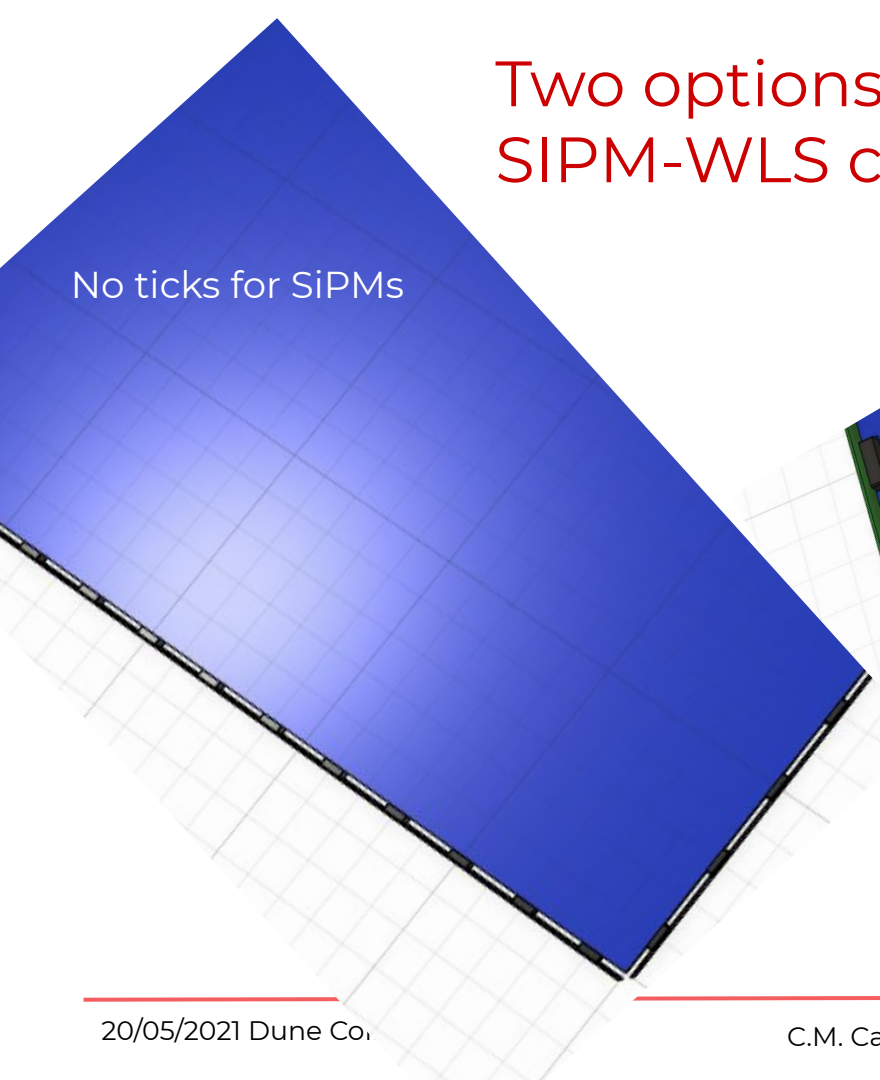
DUNE custom production of HPK SiPMS doesn't match the MC prototyping schedule → adopt the **S14160-6050HS:** 16 pcs have been succesfully used in the X-Arapuca (200 x 75 mm^2) characterization at MiB with cold amplifier and satisfactory S/N. Purchase order for 500 pcs (to be) issued by FNAL



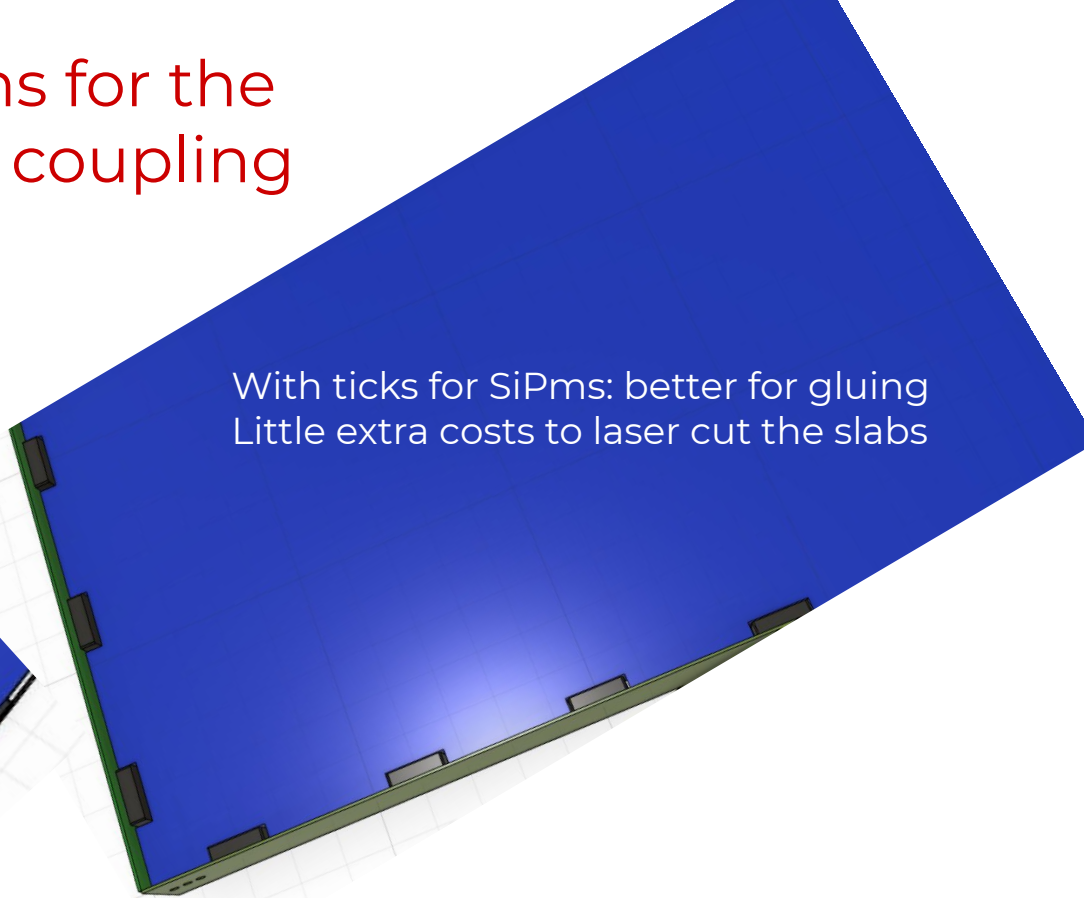


Two options for the SIPM-WLS coupling

No ticks for SiPMs



With ticks for SiPms: better for gluing
Little extra costs to laser cut the slabs



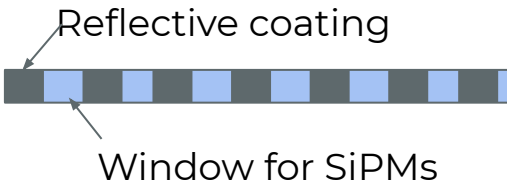
Plans for optimization of the light trapping/extraction from the WLS

SiPms optical bonding

- ✓ Two optical cryoresilient epoxy resins have been selected.
- ✓ Purchase order not yet issued
- ✓ Cold test of bonded SiPMs + thermal cycles.

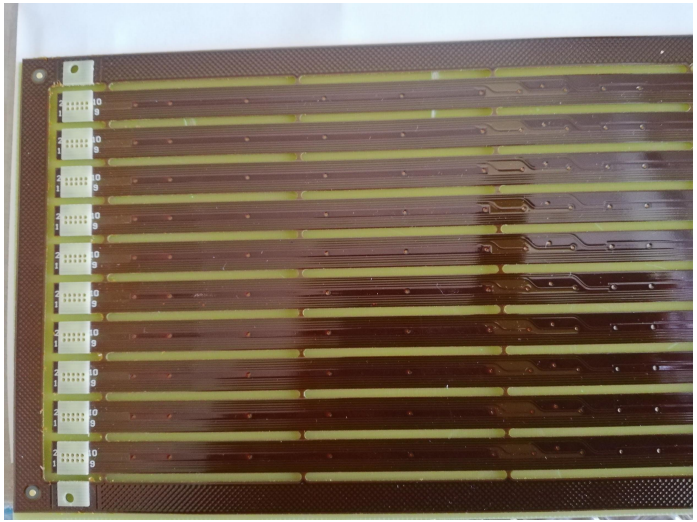
Optimization of Reflector coating to the WLS slab edges

- ✓ Define adequate coating technology (ongoing) to replace ESR on edges
- ✓ Coat the slab edges (between consecutive SiPMs)
- ✓ Cold Test and thermal cycles



The flex circuits

- First design and production of flex circuit with 24 SiPMs on board, no passive ganging. The flex integrate the SiPM boards & the Signal Routing Boards
- Waiting for 50 SiPMs from FNAL purchase order→ test at MiB in the framework of the SC tests



Dichroic Filters - (OPTO Electronics company)

Coating specification:	Cut-off: 400 nm – It transmits between 300nm and 400nm, and reflects between 400nm and 500nm. • Incidence angle – 45 degrees
Substract:	Optical glass with the following specs: - Transmission τvD65 (d = 2.0 mm) = 91.7% - Expansion coefficient (20 °C; 300 °C) (static measurement) = 9.4 · 10^{-6} K^{-1} - Melting Temperature= T_g 542 °C -Dielectric Constant ε_r at 1 MHz = 7.5 -Refraction Index n_D = 1.5229 -Density ρ = 2.56 g/cm^3
Dimension:	Width: 100,0 +0/-0,2mm Length: 100,0 +0/- 0,2mm Thickness: 1,0 +0/-0,2mm
Commercial Proposal:	-100 pieces à R$ 519,22 each (~U$ 98,00) - Production time -> 1 month after the order

It is possible to add a reflective band in correspondence of the wavelength of the lasers. The total cost of production will be increased around 10% - 20%

Dichroic Filters - WLS deposition

* Wavelength shifter deposition @ Campinas: p-Therphenyl
* Thickness of deposition : ~ 400μg/cm^2
* Cleaning protocol well established and tested (protoDUNE and X-ARAPUCA tests)

Criticity

1) Personnel for cleaning and pTP deposition

2) Shipping (special boxes need to be developed)

Conclusions

- The production of 6 WLS slabs for the MC prototypes is ongoing at G2P - UniMiB. Delivery is expected for mid july 2021 as required by the taught prototype schedule
  - **Critical to define now the size specs**
- First, test production of flex circuits (no passive ganging) delivered: they will be tested in the SC test context
  - **Waiting for the order/delivery of 50 pcs of S14160-6050HS SiPMs from FNAL purchase order of 500 pcs**
- R&D on the SIPMs optical bonding to the WLS slab starting soon at MiB
- The Dichroic filter technology & manufacturer will not change w.r.t. HD-SC and pDune XA (Opto-Brazil). Offer available. Delivery: 1month from the order