HD Supercell efficiency measurements in Liquid Argon @ Milano-Bicocca: dimples and dichroic filters

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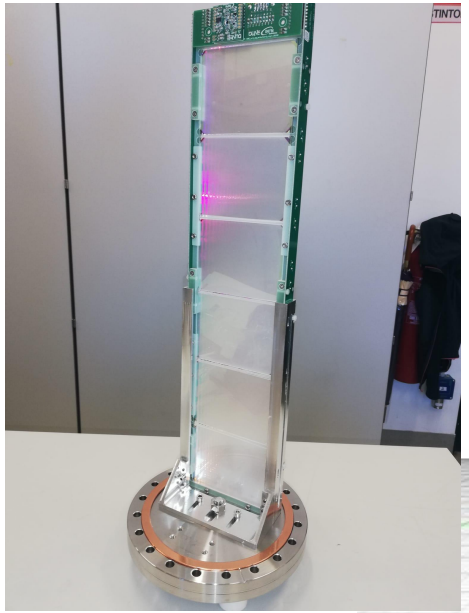
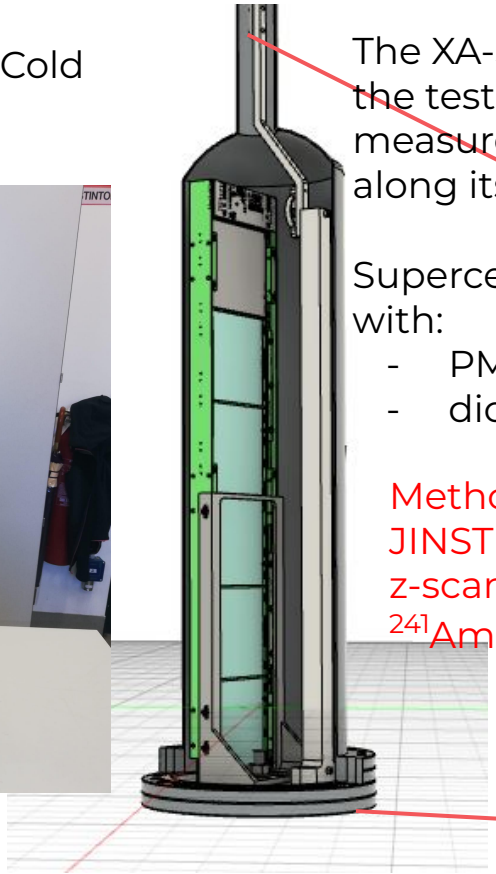
Setup to measure the XA-HD-SC PDE in LAr

The XA-HD-SC w. Cold FE circuit (top)





The XA-SC installed in the test chamber to measure the PDE along its z-axis.

Supercell equipped with:

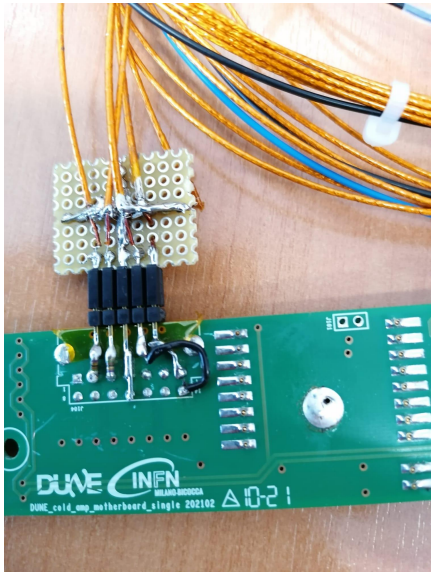
- PMMA WLS (G2P)
- dichroic filters

Method as published in JINST 16 (2021) 09027: z-scanning with an ^{241}Am exposed α source

Features of the XA HD Supercell under tests

Size/type of the WLS slab Dichoics (sipm/WLS) area	**G2P** 480 x 93 mm^2, NO Vikuiti on short edges 6 x dichroics (Opto-Campinas) 3.9%
SIPMs	HPK DUNE-75um-HQR, +3V OV (50% PDE) FBK TT, +4.5V OV (45% PDE)
Ganging	x 48 SiPMs by MiB cold Amplifier
# electronic channels	1
SiPMs -Cold Amp. Cold Amp dyn. range	AC 2000 ph.e.
s.ph.e. (50 Ω, 45 V)	~ 2.0 mV on 50 Ω for both HPK and FBK
Chamber volume	~ 10 l
Digitizer	CAEN 14-bit 250 MS/sec, 4 ns/sample

Hardware

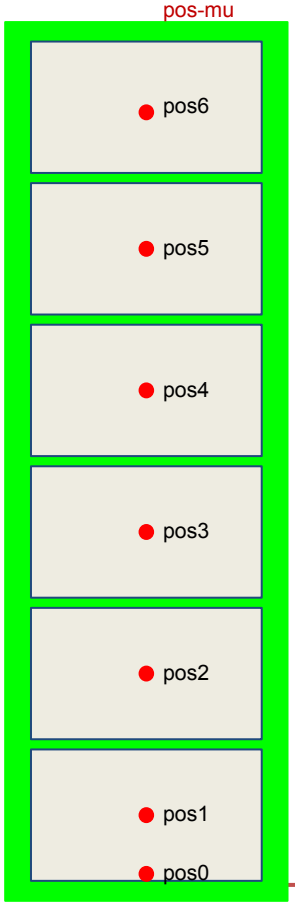


- Cold cables: a bundle of five Kapton RG178 coaxial cables. No DUNE blue cable & Hirose connector due to mechanical (dimension, stiffness) constraints of the setup

- Warm cables: 2.5 m, 50 Ω LEMO cables

- Cold-to-warm flange: 10 contacts vacuum/pressure connector mounted on a CF40 flange - No Hirose:
  - **the chamber and its payload are pumped down to 10^{-4} mbar prior filling →**
  - **high LAr purity achieved with high reproducibility**
  - **the purity is maintained w.o. any recirculation along several days from filling**

Method & Data taking



z-scanning of the SC with the ^{241}Am α (5.480 MeV) source at the following positions:

1. **pos0**: (the lowest possible): ~2 cm above the flange.
2. **pos1, 2, 3, 4, 5, 6**: the center of each dichroic filter.
   Acquired: 10^4 x 4 wfms; 20 μs length; ~5 μs pretrigger.

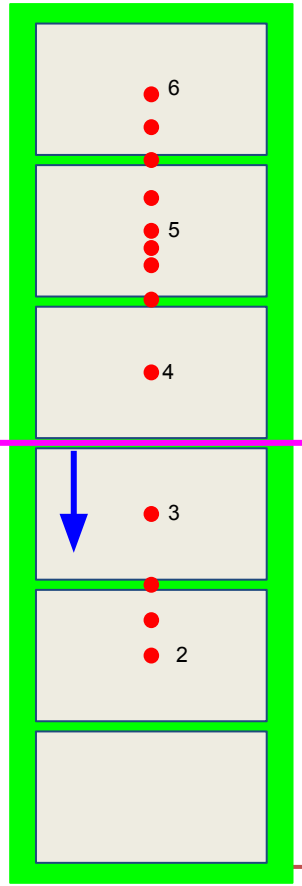
3. Source at the topmost position (~49 cm from the flange) and ~ out of LAr:
   - one **μ run** (10^4 x 4 events; 20 μs, 5 μs pretrigger)
   - one **s.ph.e. run** (10^4 x 8 events; 20 μs length; 1.6 μs pretrigger)

Source-to-dichroic filter distance: (55 +/- 1) mm.

List of measurements

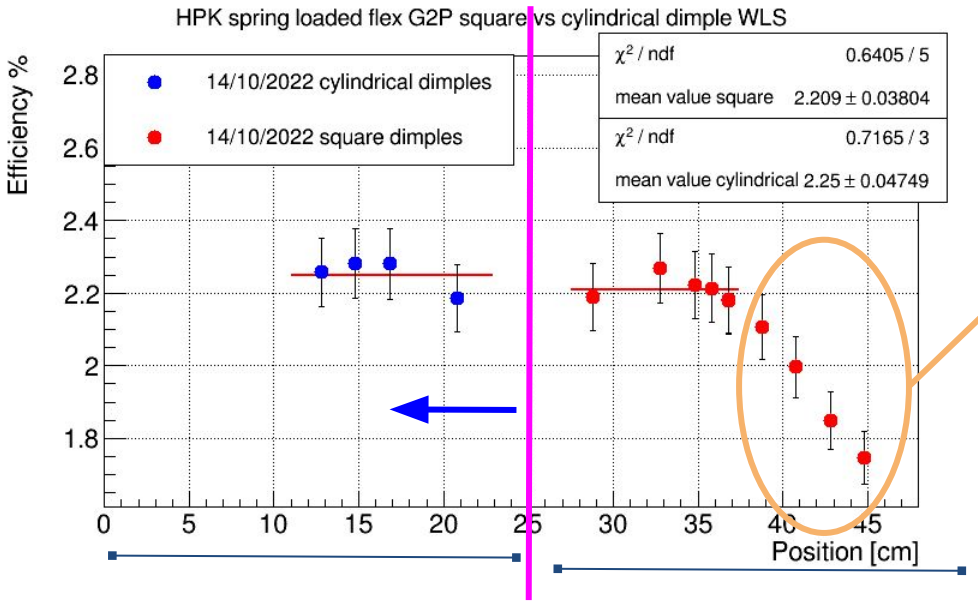
- Square vs cylindrical dimples on WLS bar + spring loaded SiPM flex circuit boards (14/10/2022)
- Flat WLS bar + spring loaded SiPM flex circuit boards (4/11/2022)
- OPTO vs ZAOT dichroic filters (8-9/11/2022)

Square and cylindrical dimples



Square dimples

Cylindrical dimples



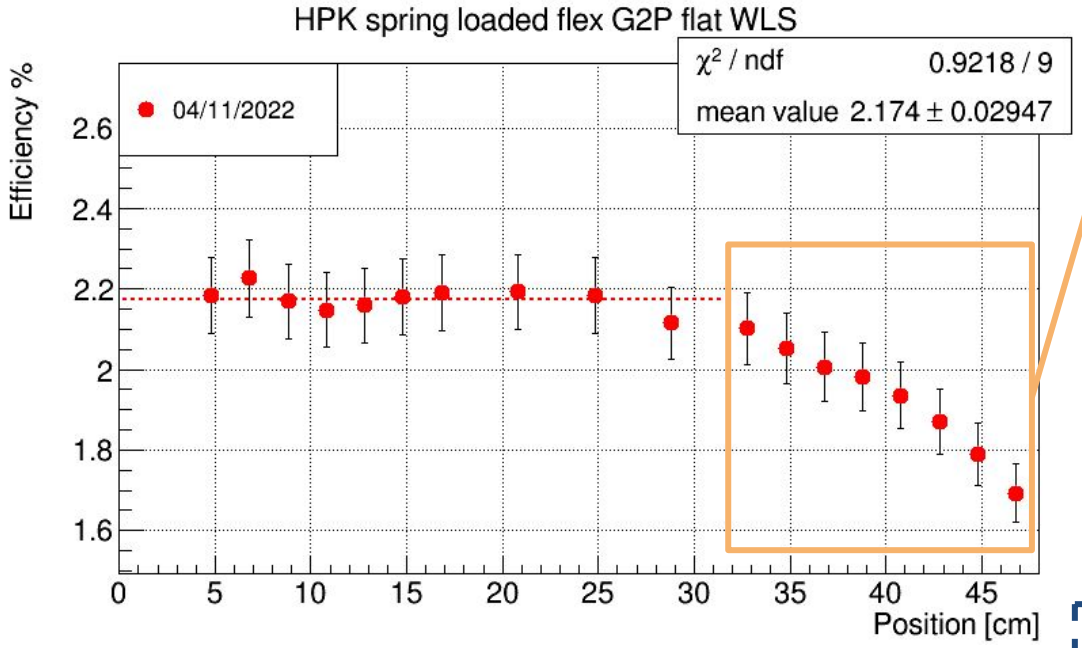
Cylindrical dimples

Square dimples

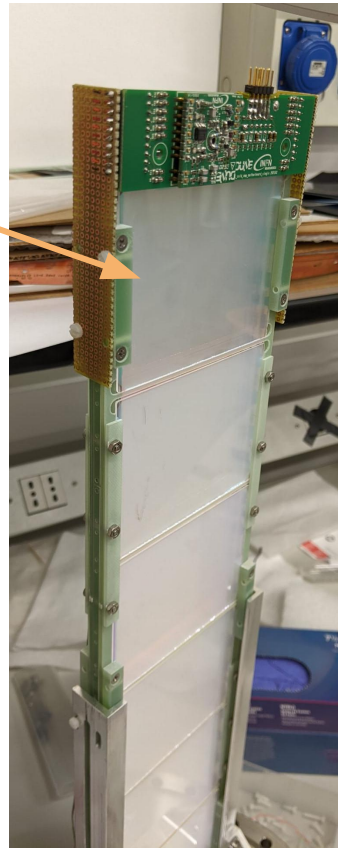
Lower positions inaccessible due to stuck cable

LAr surface well above 6th dichroic

Flat G2P WLS bar + HPK SiPMs on flex circuit boards + springs

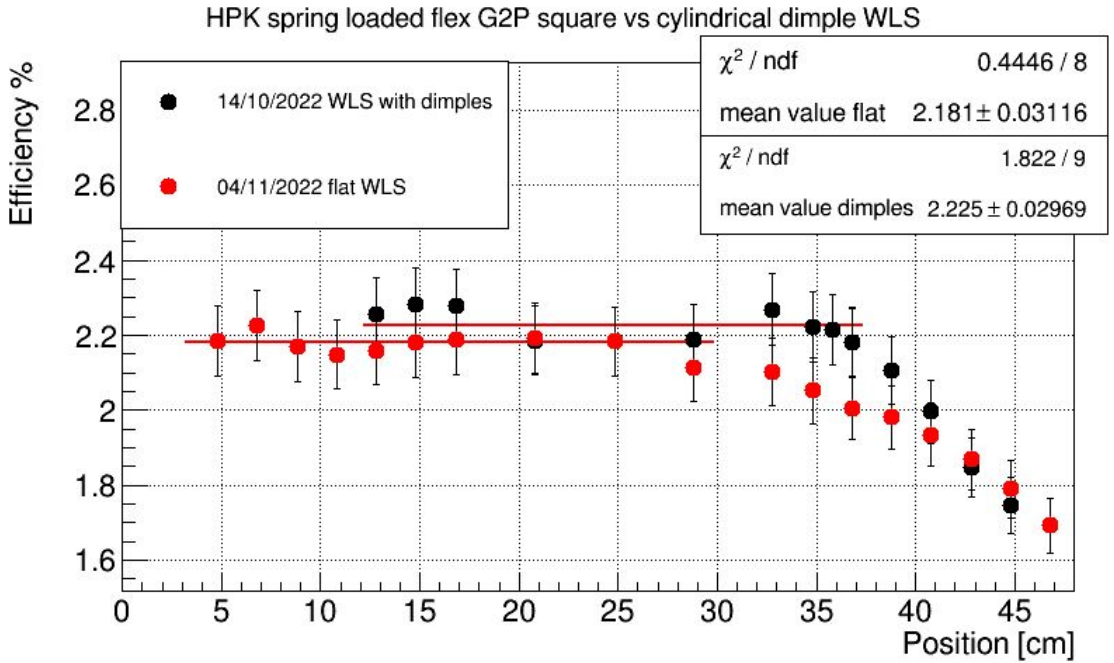


Filter from CB1, thinner pTP deposit



LAr surface well above 6th dichroic

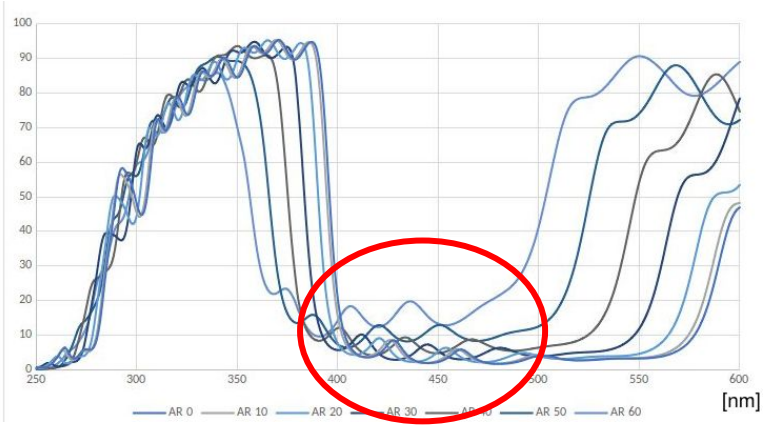
Flat vs Dimples

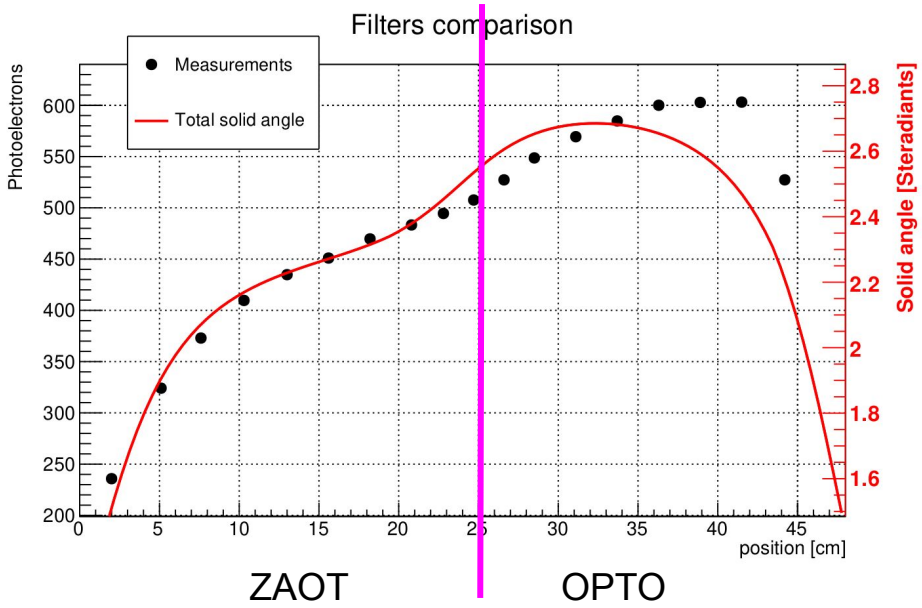


- No strong indication that dimples are better than flat bar edge (within errors)
- Square dimples are still useful in case we decide to glue the SiPMs
- An uniform but thin pTP coating is worse than a thicker but damaged / highly uneven one?

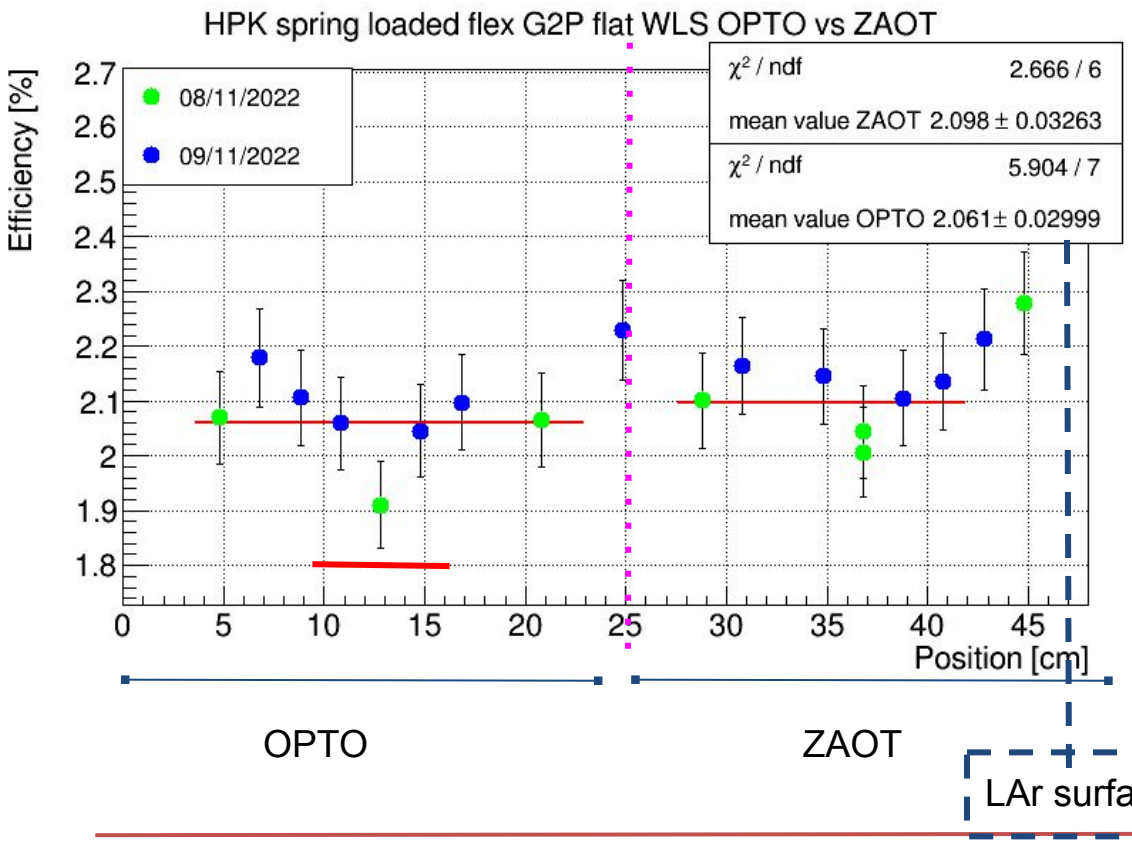
ZAOT filters: first production (end of 2021)

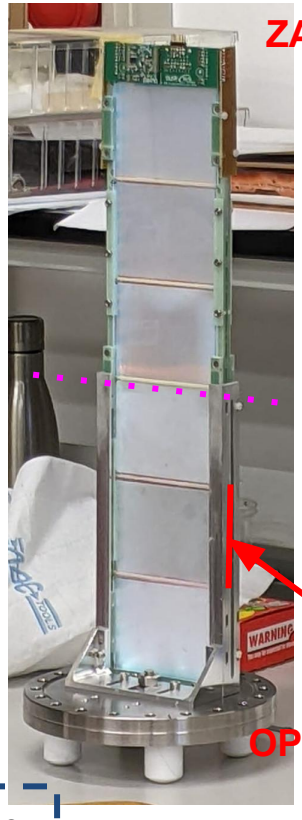
Poor optical density at AOI = 45°





ZAOT filters: second production 22/05/2022 V4-V5





- Optical density at AOI = 45° fixed
- LAr purity improves overnight? (effect already observed in prev. measurements)

This dichroic is the CB1 one that was in 6th position in the previous measurement

Conclusions

- Our setup is very sensitive to the quality of the components and their positioning
- No strong indication that one type of dimple is better than the other
- No strong indication that dimples are better than flat bar edge (within errors)
- ZAOT filters of second production improved wrt first production, performance in line with OPTO
- A third production, with optimized AOI = 45° in LAr, is in progress (see Carla's talk)