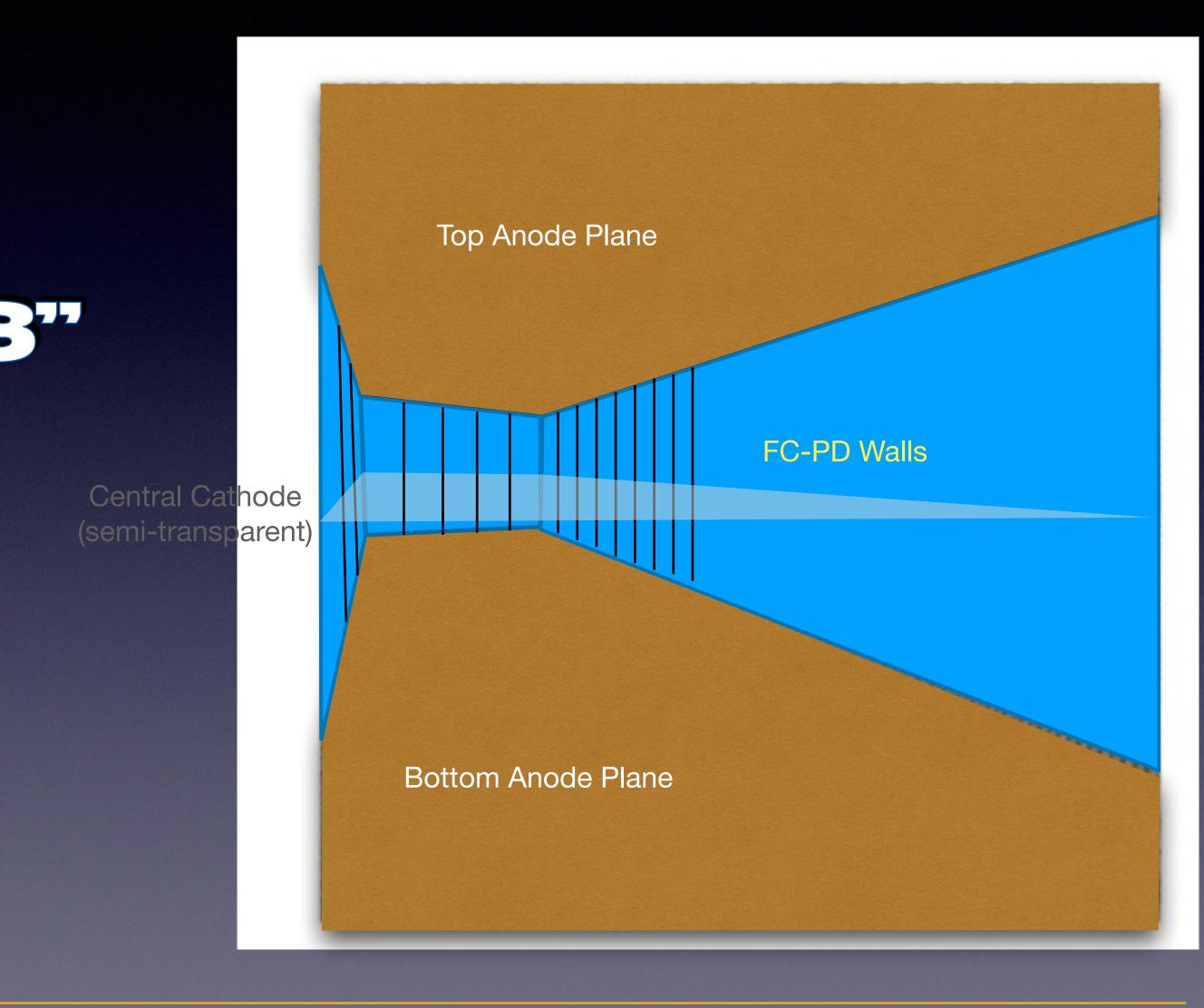
"VD Optimized FD3" w/enhanced PDS Update after SBU WS











DUNE Phase II FD R&D Goals

- thresholds, and 3) lower intrinsic backgrounds,
- Possible expanded physics scope

New/Novel Technical Elements for FD3 are being identified (after MoO and FD3 WS at SBU) Only Few of these are CRITICAL (CTEs - Critical Technical Elements) (the others are optional/incremental wrt to FD2 demonstrated solutions)

Technical Readiness assessment (TRLs) for the Critical Elements (among the New/Novel Elements) under evaluation

Path toward Technical Readiness defined based on a realistic Prototyping Staged program (assuming availability of funds both from EU and US sources)

> Perspectives for DUNE Physics Scope Expansion well identified (LowEn UG Physics [5 MeV-500 MeV] and Background Rejection (to be demonstrated)

• Pursue possible enhancements that make use of recent technological breakthroughs and are well motivated by unique additional physics capabilities.

Enhancements are mainly driven by 1) better energy resolution 2) lower energy

- Supernova Neutrinos and Solar Neutrinos in the LowEnergy range - Possible BSM Physics in the LowEnergy range

For each (WBS) element:

- •Assessment of the criticality to the program
- •New or novel criteria a CTE.

and available, not yet integrated in system)

system)

scale enabling final design)

virtually completed)

If the technology is both critical to operations and employs a new/novel concept, then it is declared as

TRL=3 $\leftarrow \Rightarrow$ Proof of principles for a critical function (active R&D initiated, tech. components identified)

TRL=4 $\Leftrightarrow \Rightarrow$ Basic tech. components integrated in "ad hoc" hw (sub)systems for laboratory scale tests (first step from scientific research to engineering, supports individual components into integration in

TRL=5 $\leftarrow \Rightarrow$ Laboratory scale (almost "prototypical") system successfully tested in relevant environment (basic tech.components integrated in system similar to final, and test results interpreted)

TRL=6 \Leftrightarrow Pilot-scale "prototypical" system validated in relevant operating environment (performs all functions required by the operational system, major step-up in tech.readiness, starts the engineering

TRL=7 \Leftrightarrow Full scale "prototypical" system demonstrated in final operating environment (final design

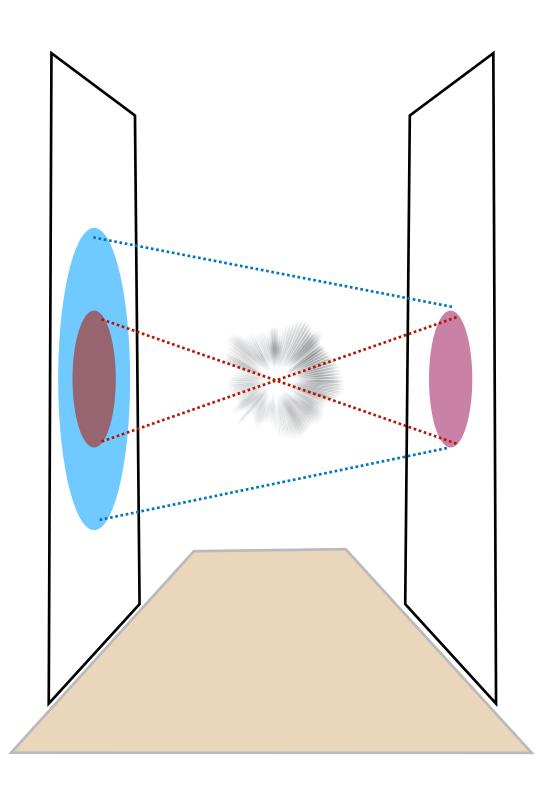


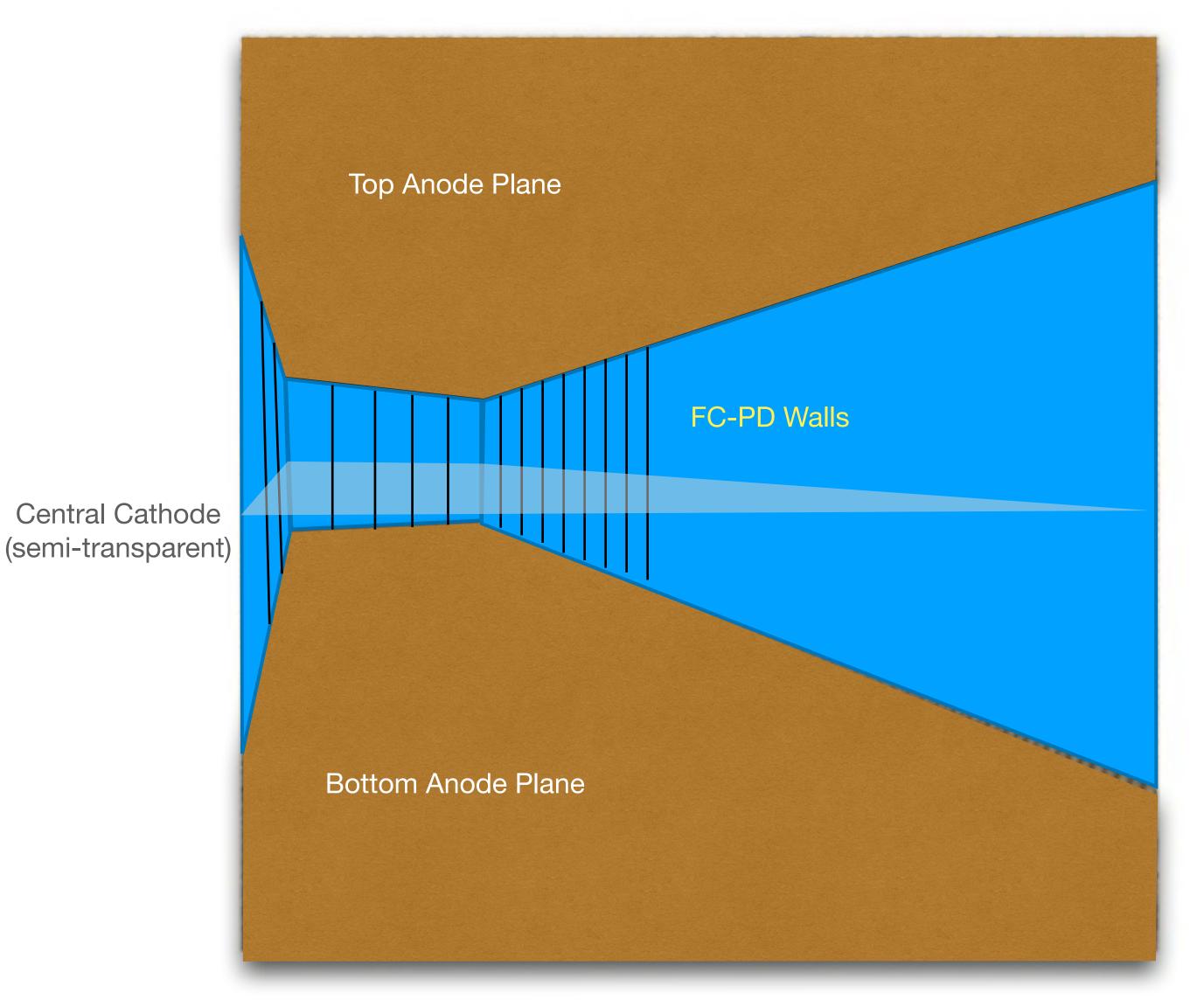
Detection Technology	Detector Spec's Requirements/Goals	Physics Enable	Critical New/Novel Technical Elements (CTE)	Technical Readiness Level (TRL) [today]	R&D Plan (ECFA& CPAD)	Path/ Timeline for TRL=7	Cost	Combine/ Integrate with LArTPC
	Granularity 0.2-0.3 m ² Energy Resolution (5%@10MeV) Position Resolution (O(20cm ³) Time Resolution (O(5ns)) - LY (O(150 PE/MeV) - LY Uniformity (Avg-Min:<20%) - Light-to-Energy Calibration (O(5%)) Electronics S/N (O(10)) RadioPurity <xx kg<="" mbq="" td=""><td>LowEn UG Physics [5 MeV-500 MeV] LowEn Backgd Rejection Trigger Effic (>5MeV): 100% Solar-nu En. Spectrum SN-nu En.Spectrum, SN Time Profile, SN detection sensitivity extension to Magellanic n-capture bkgd identification (and rejection) Alpha bkgd from rad.decay in LAr bulk PSD and rejection LAr Active Veto btw. FC and Membrane Walls</td><td> → (critical ?) High effic. PoF → Cold FE+ADC → (critical ?) LargeBandwidth </td><td> (Today) <i>TRL=4</i> (Tech.component integrated and work together) (Today) <i>TRL=4-5</i> (Tech.component integrated and work together) (Today) <i>TRL=5</i> (Basic tech. tested at lab.scale and full simul) (Today) <i>TRL=5-6</i> (btw lab.scale and pilot-scale prototype validation) (Today) <i>TRL=3</i> (Proof of Concept, Active R&D initiated) (Today) <i>TRL=3</i> </td><td>(50lt@CERN) - started/in progress - larger sized (m² PD, m³ of LAr) - order of 100- channels SoF read-out and PoF</td><td>- 2023-2024 - 2024-2025</td><td>Parameter ValueEstimate FY 23 Prototype FY 23-26 Module-0 FY 25-28 Production FY 31 (start) Commissioning FY 34Average Escalation/ Inflation: 4% Average Procurement Overhead: 10%(Tot. Including prototyping) FD3 PDS M&S Total \$25,436,884 FD3 PDS Labor Total \$9,392,276 FD3 PDS Grand Total \$34,829,160Production M&S Total \$20,971,331 Production Labor Total \$4,068,208 Production Grand Total \$25,039,539</td><td>CRP Ariadne Solar Q-Pix LArPix (SloMo)</td></xx>	LowEn UG Physics [5 MeV-500 MeV] LowEn Backgd Rejection Trigger Effic (>5MeV): 100% Solar-nu En. Spectrum SN-nu En.Spectrum, SN Time Profile, SN detection sensitivity extension to Magellanic n-capture bkgd identification (and rejection) Alpha bkgd from rad.decay in LAr bulk PSD and rejection LAr Active Veto btw. FC and Membrane Walls	 → (critical ?) High effic. PoF → Cold FE+ADC → (critical ?) LargeBandwidth 	 (Today) <i>TRL=4</i> (Tech.component integrated and work together) (Today) <i>TRL=4-5</i> (Tech.component integrated and work together) (Today) <i>TRL=5</i> (Basic tech. tested at lab.scale and full simul) (Today) <i>TRL=5-6</i> (btw lab.scale and pilot-scale prototype validation) (Today) <i>TRL=3</i> (Proof of Concept, Active R&D initiated) (Today) <i>TRL=3</i> 	(50lt@CERN) - started/in progress - larger sized (m ² PD, m ³ of LAr) - order of 100- channels SoF read-out and PoF	- 2023-2024 - 2024-2025	Parameter ValueEstimate FY 23 Prototype FY 23-26 Module-0 FY 25-28 Production FY 31 (start) Commissioning FY 34Average Escalation/ Inflation: 4% Average Procurement Overhead: 10%(Tot. Including prototyping) FD3 PDS M&S Total \$25,436,884 FD3 PDS Labor Total \$9,392,276 FD3 PDS Grand Total \$34,829,160Production M&S Total \$20,971,331 Production Labor Total \$4,068,208 Production Grand Total \$25,039,539	CRP Ariadne Solar Q-Pix LArPix (SloMo)

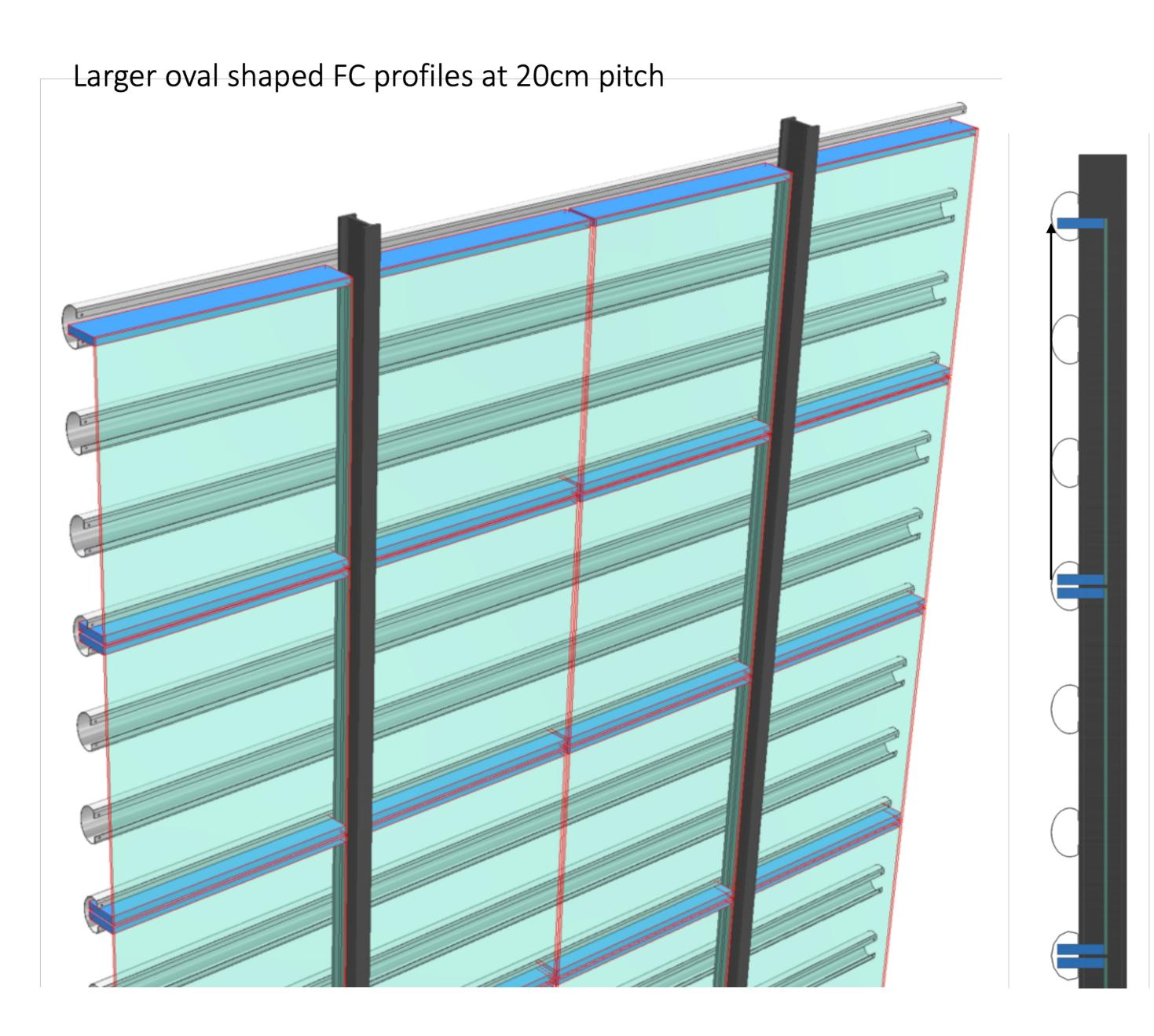
Striking feature of the extended optical coverage:

backward emitted WL-shifted light from a FC wall collected on opposite FC wall

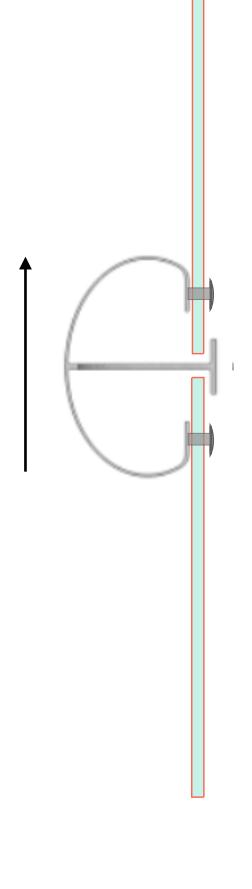
For an ideal \rightarrow 100% (\rightarrow 4 π) Opt.Coverage \Rightarrow PCE x 2 (or can reduce n. of SiPM by 1/2)





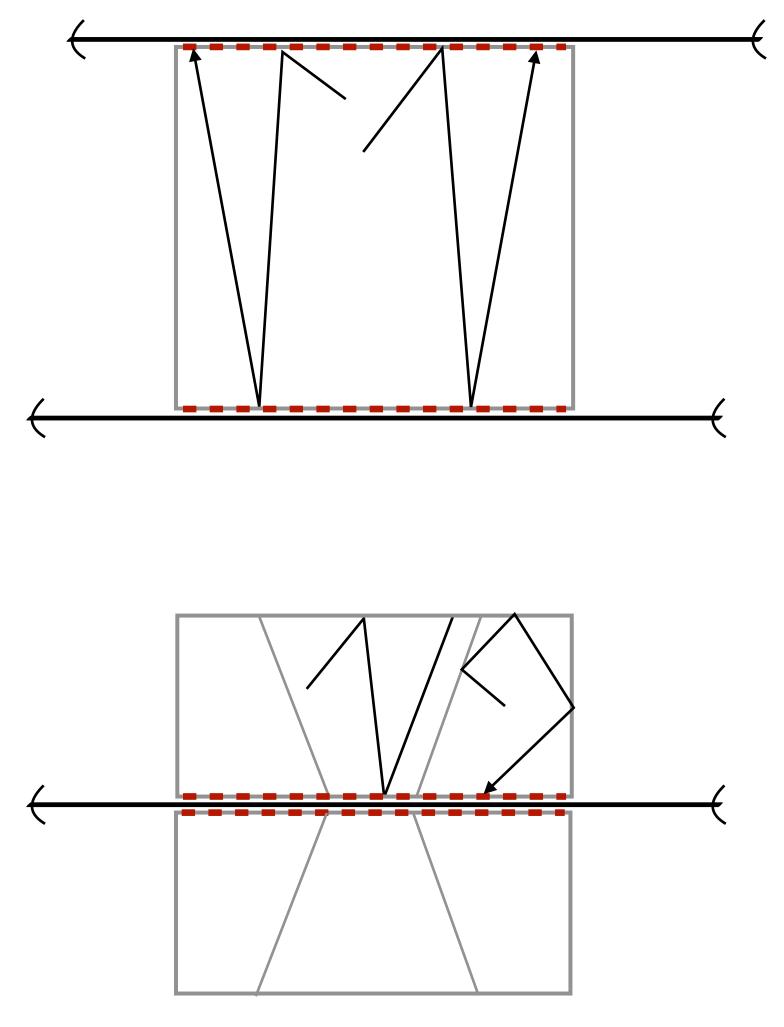


(0.6m x 0.6m) PD module with SiPM/SoF/PoF boards along top and bottom edges

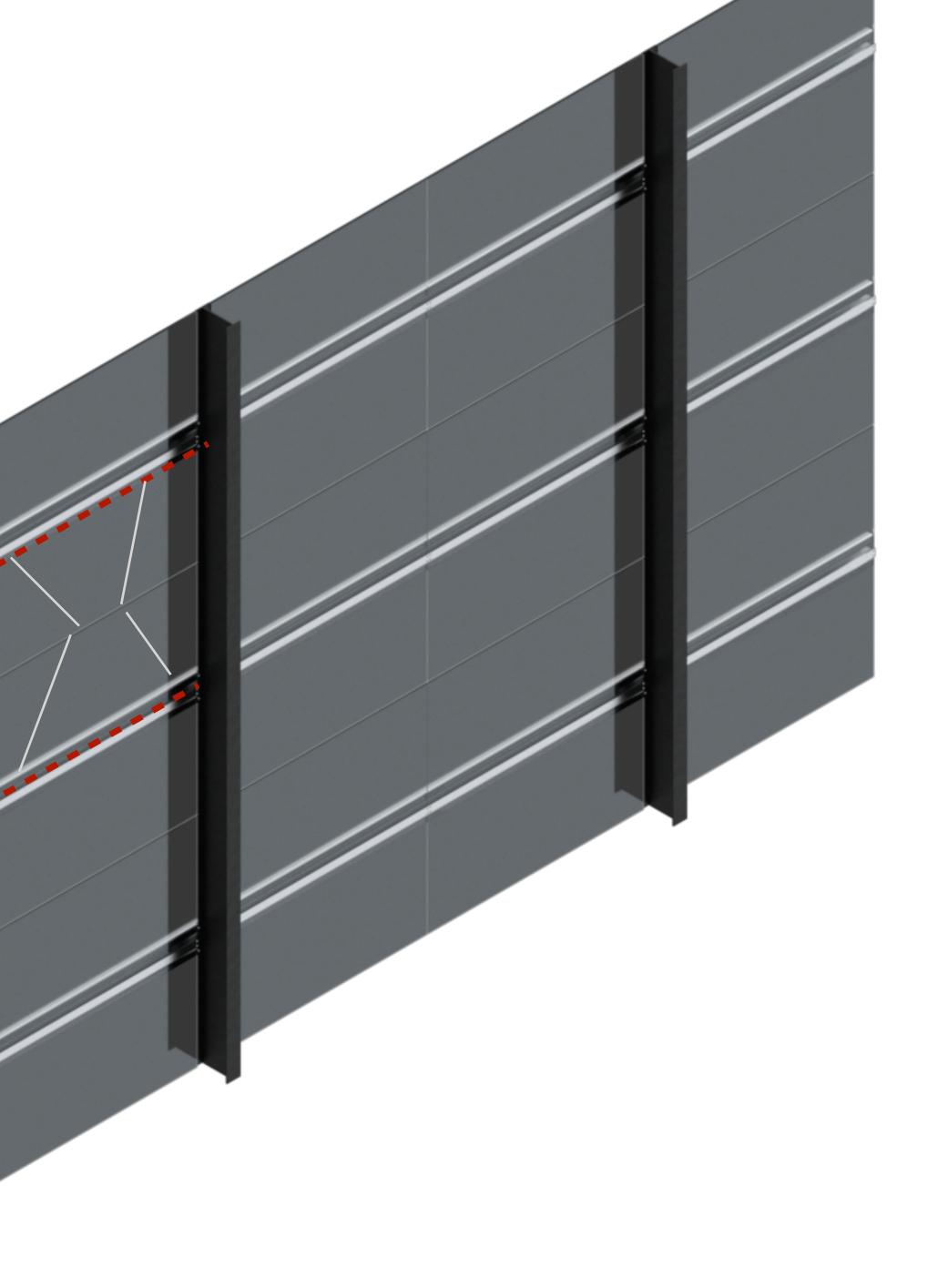


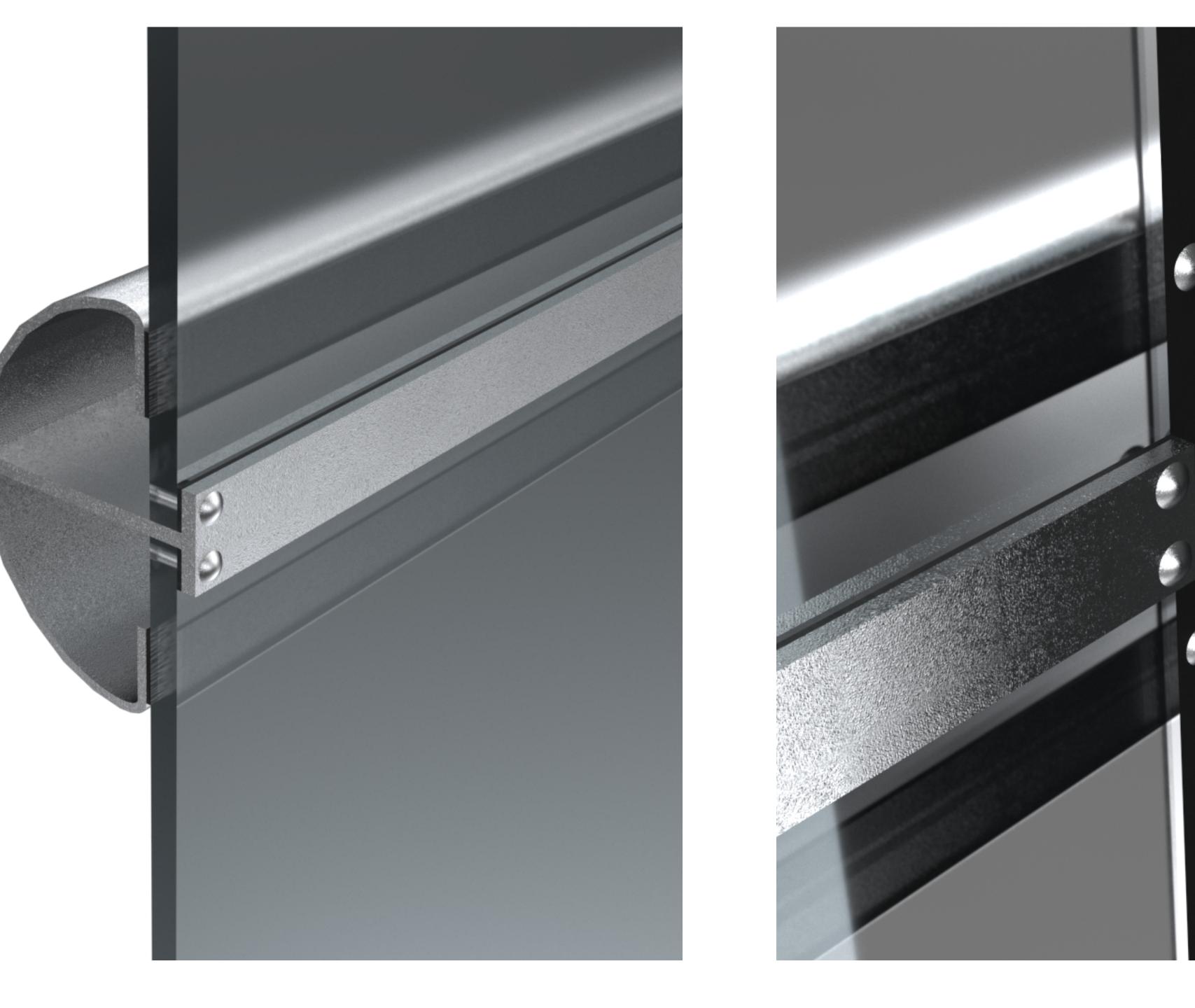


(0.6m x 0.6m) PD module with SiPM/SoF/PoF PCBs along top and bottom edges on two different CH-profiles



2x(0.3m x 0.6m) PD module with SiPM/SoF/PoF PCBs along top and bottom edges on same CHprofile (i.e add a gap w/ reflectors in the WLS)







More pictures from 3D Model to be added - (available .stp)