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Towards High Volume Production of LAPPDs Using Air-Transfer Process

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LAPPD detectors have the unique properties of large-area, low noise, high gain, and high-precision time and space resolving power [1]. Consequently, LAPPDs have been proposed as the basis of innovative techniques in determining fundamental properties of matter [2, 3, 4, 5, 6, 7, 8, 9] and the nucleus [10].

We propose to use lessons learned at Fermilab, UChicago, and Incom Inc. to design and test an industrial-scale production system that can bridge the current limited commercial manufacturing yield of LAPPDs and the high-volume demand of the potential applications of LAPPD technology.

LAPPDs are being currently produced commercially by Incom Inc. at a rate of 4 LAPPDs/month with projected increase in production rate up to 6 LAPPDs/month by the end of 2020 [14]. Commercial manufacturing of LAPPDs is done by a vacuum transfer method, a well established method to manufacture MCP-PMTs that Incom was able to scale up to unprecedented 20×20 cm^2 format.

While further increase in production yield of the vacuum transfer process could be possible, we suggest to explore if an air-transfer manufacturing method could be a cost effective solution for very high production yields (e.g. 100 LAPPDs/week).

The air-transfer method is being used in industry for manufacturing regular PMTs [11, 12]. Recently, feasibility of this technique has been demonstrated for LAPPD fabrication using a single-device assembly chamber [13].

The left-hand panel of Fig 1 shows a LAPPD ceramic tile body component pre-assembly where a window with pre-deposited Sb layer is being transferred in air. An assembled tile clamped in place in the compression fixture prior to sealing is shown in the right-hand panel.

Figure 2 shows both a commercial conventional photomultiplier batch production station and the corresponding proposed LAPPD batch production station. The proposed batch production station would replicate the single-unit fixture shown in Fig. 1 vertically to form a 3-tile fixture that holds 3 tiles connected to the UHV manifold, with six 3-tile fixtures sharing a common LV outer vessel. The station would process 18 tiles per one-week thermal cycle. Six stations would process 108 tiles per week.

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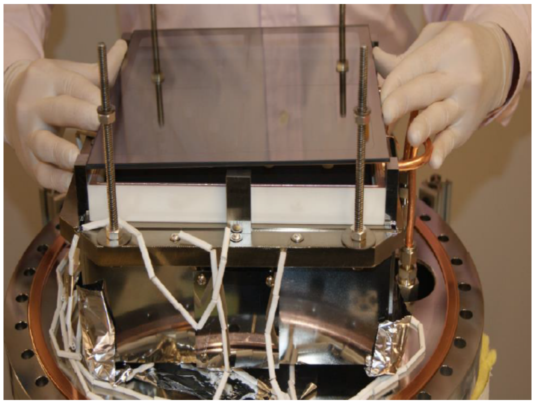


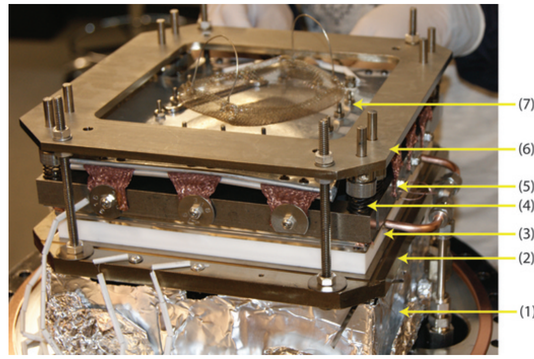
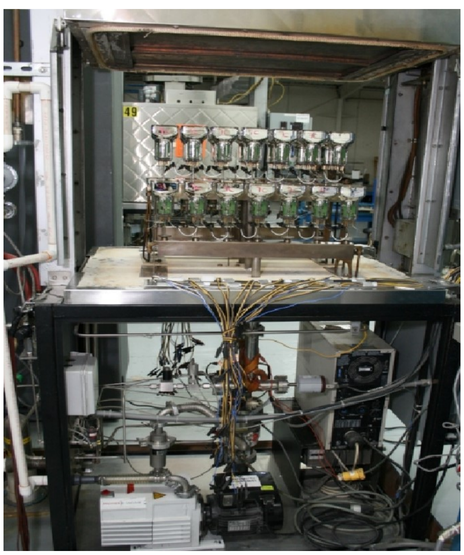


Figure 1: Left: Air-transfer pre-assembly. A window with pre-deposited Sb layer is placed on to the lower tile assembly with MCPs and anode. Right: An assembled tile clamped in place in the compression fixture prior to sealing. Heaters above and below the tile couple to the top and bottom fixture plates. The indicated components are: (1) the lower NiCr heater assembly; (2) the bottom compression fixture plate; (3) the tile assembly; (4) the compression mechanism; (5) floating rigid press bars; (6) the upper compression fixture plate; and (7) the upper NiCr heater assembly.



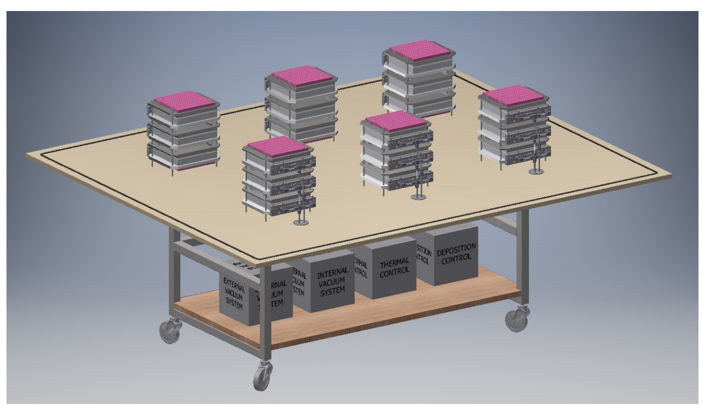


Figure 2: Left: The photomultiplier batch production station purchased from the Photonis Lancaster plant that served as the model for development of the LAPPD batch production process. Right: The proposed LAPPD batch production station. Six production stations ('carts') would process 100 LAPPD modules per week.

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