Overview of the LAPPD Single Tile Facility

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1. Introduction

1.1. Components of a Large Area Photodetector Tile

The Single Tile Facility is intended to produce glass capillary microchannel plate (MCP) photodetectors in an all-glass package one detector at a time. The initial goal is to make detectors with the baseline 8" active area. The glass capillaries are functionalized into MCPs using atomic layer deposition (ALD) to coat resistive and secondary emissive layers. The detector, show in figure 1 contains the following components:

- A $9.02'' \times 8.66''$ glass bottom plate on which is silk-screened a stripline anode readout. The 30 striplines run along the long dimension of the plate.
- An $8.66'' \times 8.66''$ 9mm high sidewall with wall thickness of 0.2"(5mm). The sidewall is glass-frit bonded to the bottom plate producing what is termed the Tile Base.
- Hollow glass rectangular tubing pieces of 13mm length either attached to the sidewall or simply placed against the sidewall; two pieces per side. These serve two purposes: locators for the microchannel plates and grid spacers, and holders for the strips of getter material.
- A "matched" pair of $8'' \times 8'' \times 1.2mm$ MCPs. The MCPs are matched in the sense of having similar resistances in the range of $7 - 13M\Omega$. Each MCP contains $\sim 78 \times 10^6$ 20-micron pores giving the plate and $L/D = 60$. The open area ratio is about 60%. Each MCP will be operated at about 1000V. bias voltage producing a pair gain of a few times 10^6. Electrical contact to the MCPs is provided by an evaporated $1000\AA$ thick nichrome electrode on the top and bottom surfaces. The MCPs are separated by 2mm by a glass grid spacer.
- Three $8'' \times 8''$ grid spacers with 0.1" ribs in a lattice arrangement. The grid spacers are located between the top photocathode window and the upper MCP, between the upper and lower MCP, and between the lower MCP and the bottom anode plate. In

addition to supporting the sealed, evacuated tile from implosion due to the atmospheric pressure load, the grid spacers will be ALD-coated with a resistive layer to produce the desired voltage biasing of the MCPs. The thickness of the upper two grid spacers has been chosen as 2mm. The lower grid spacer between the lower MCP and the anode will be about 2.6mm thick. It's actual size will be determined so as to allow the top photocathode window to be in compression with the grid spacer/MCP stack. The stack height must allow a small gap between the top window and the sidewall to accommodate the indium material bonding the top window to the sidewall. In order to provide good electrical contact between the grid spacers and either the MCPs or the top photocathode window, a metal electrode will be sputtered onto the grid spacer top and bottom surfaces before ALD coating. The bottom grid spacer will have an electrode only on its upper surface to avoid shorting the anode signal lines together.

- A photocathode window with a bialkali (K, Cs) photocathode. The window will have a metalized border providing contact between the photocathode surface and externally applied biasing high voltage. The windows have a tab in each corner allowing a larger area for attachment of the high voltage wire. Presently the windows have a silver metal border silk-screened on. Aluminum or nichrome border material may replace the silver for purposes of making a dependable indium seal.

- An indium seal between the top window and the sidewall. This seal will be the last step in the photodetector production process and must be made at a relatively low temperature to avoid damaging the photocathode. Presently, test seals are being made with a hydralic press at room temperature using 2mm 99.995% pure indium wire. Provision for heating the indium to $\sim 100°C$ has been included in the system.

Note that essentially the entire detector is composed of borosilicate glass. Non-glass materials include the silver anode strips, the photocathode and its window border, the indium seal, and the electrodes and ALD coatings on the grid spacers and MCPs.

1.2. The Single Tile System

We distinguish between what we call the Single Tile System (STS) which consists of the vacuum transfer system, its pumps, manipulators, gauges, and internal subsystems; and the Single Tile Facility which includes the STS plus the labs and infrastructure such as gas and water lines, roughing vacuum line, etc. The Single Tile System is a four chamber vacuum transfer system:

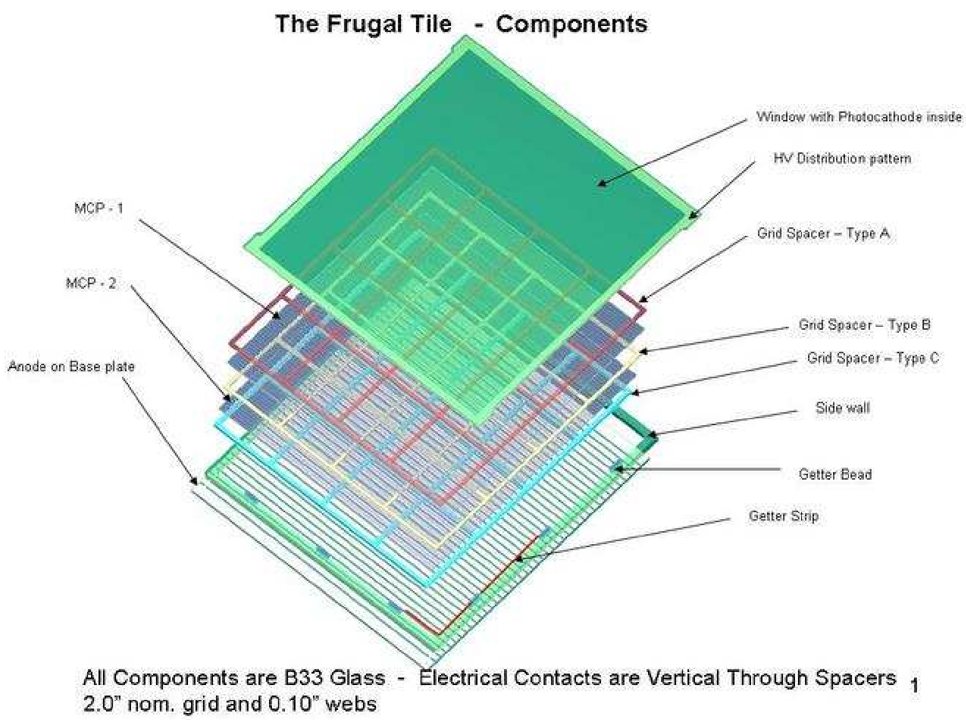

Fig. 1.— Exploded view of the all-glass single tile photodetector.

- An area with a load-lock for loading the top window and baking it before photocathode deposition

- An chamber for photocathode evaporation that can be isolated by means of gate valves on either side.

- A chamber for making the final seal of the top window to the assembled tile base and internal stack of MCPs and grid spacers. This will contain a load lock for tile removal.

- A chamber with a load-lock for loading the assembled tile base and internal stack. This chamber will allow baking and scrubbing of the tile before the top window is sealed to sidewall to complete the detector.

Baking of components in the STS will be done with internal local heaters to avoid having to heat entire chambers. The design is intended to allow modification or replacement of components for a given process as we gain experience fabricating actual tiles or we move to a different detector footprint, e.g. 2" square MCP photodetectors. The conceptual design of each subsystem is described in other documentation.

1.3. The Single Tile Facility

As noted above, we use the term Single Tile Facility (STF) to describe the STS plus the labs and required infrastructure. The labs consist of the following:

1. Photocathode Lab in which the transfer photocathode methodolgy is being developed. The equipment germane to the sealed tile photocathode is the Burle oven/vacuum assembly and the optical quantum efficiency measuring apparatus. The Burle equipment is being used to fabricate 4" square bialkali photocathodes using antimony beads and alkali metal dispensers contained in a sealed glass vacuum container, the "Chalice". Future glass windows for photocathode fabrication in the Chalice will be configured to allow somewhat larger than a 4" square active area. This methodology will be transferred to the design of the photocathode fabrication subsystem in the STS.

2. Wet Chemistry Lab where cleaning and storage of tile components will done. The lab contains two hoods.

3. The Tile Fabrication Lab where the STS will be located.

Gas, water, compressed air, and vacuum lines along with ethernet cables are or will be routed through all three labs to provide a common services infrastructure. Currently provision has been made for nitrogen, oxygen, and argon lines. Compressed air lines ports are located in the Wet Chemistry lab and are in the process of being routed to the other two labs. Recirculating chilled water ports are also available and will be routed in the future. Overhead cable trays have been installed for the routing of the various piping systems and for a soon-to-be-installed computer network. Each lab will have a minimum of four ethernet ports. The necessary electrical service is in place in each lab.