

Steps Towards 8"x8" Photocathode For The Large Area Picosecond Photodetector Project At Argonne

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The Large Area Picosecond Photodetector (LAPPD) Collaboration

- Large, cheap, fast, (tastes great and less filling too!) microchannel-based photodetector;
- Photocathode effort within the LAPPD collaboration is aiming for photocathode with quantum efficiency (QE) better than 25% with acceptable dark currents;
- The effort can be categorized into several interrelated subtasks: (i) production of 8"x8" photocathode; (ii) study of the physics of photocathode to improve performance (QE, reduce dark current, expand absorption bandwidth) (Seon Woo Lee's talk); (iii) growth and characterization of new photocathode candidates (Junqi Xie's talk).
- 2 "parallel" efforts located at Argonne and at Space Science Laboratory at UC-Berkeley. The parallel lines cross often, and we share information, materials, resources, ideas, meals, baby pictures, etc.

Ceramic body of
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photodetector



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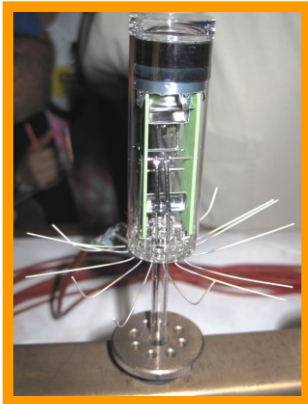
What I will cover in this talk

Ceramic body of the proposed photodetector tile

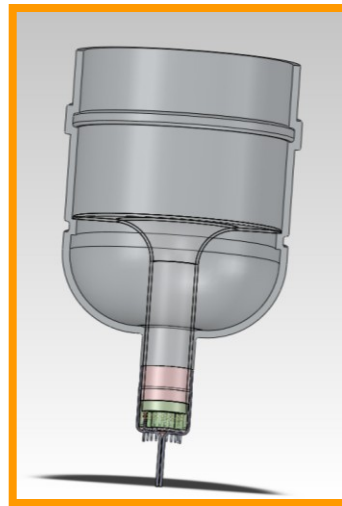


Argonne's Path Towards 8"x8" Photocathode

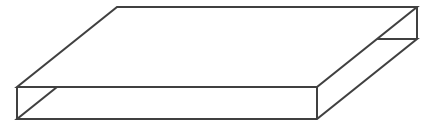
- Learn how photocathodes in PMT are produced
- Study how it can be scaled up



PMT



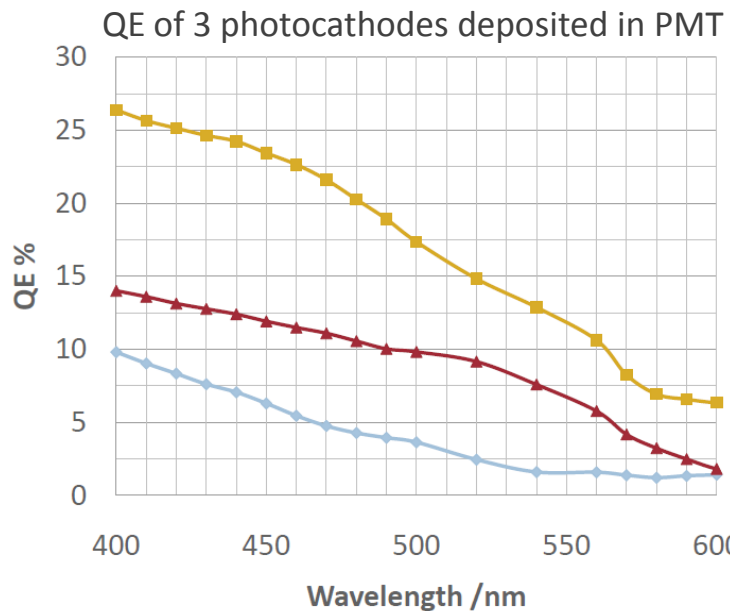
4"x4"
(Chalice)



8"x8" photocathode

Before Going Big, We Go Small

- Learn technique of photocathode growth in PMT (many thanks to Photonis/Burle Industries);
- Acquired one of Burle PMT photocathode growth system;
- Lessons learned from KCsSb photocathode deposition in PMTs – can this be transposed to a large area?



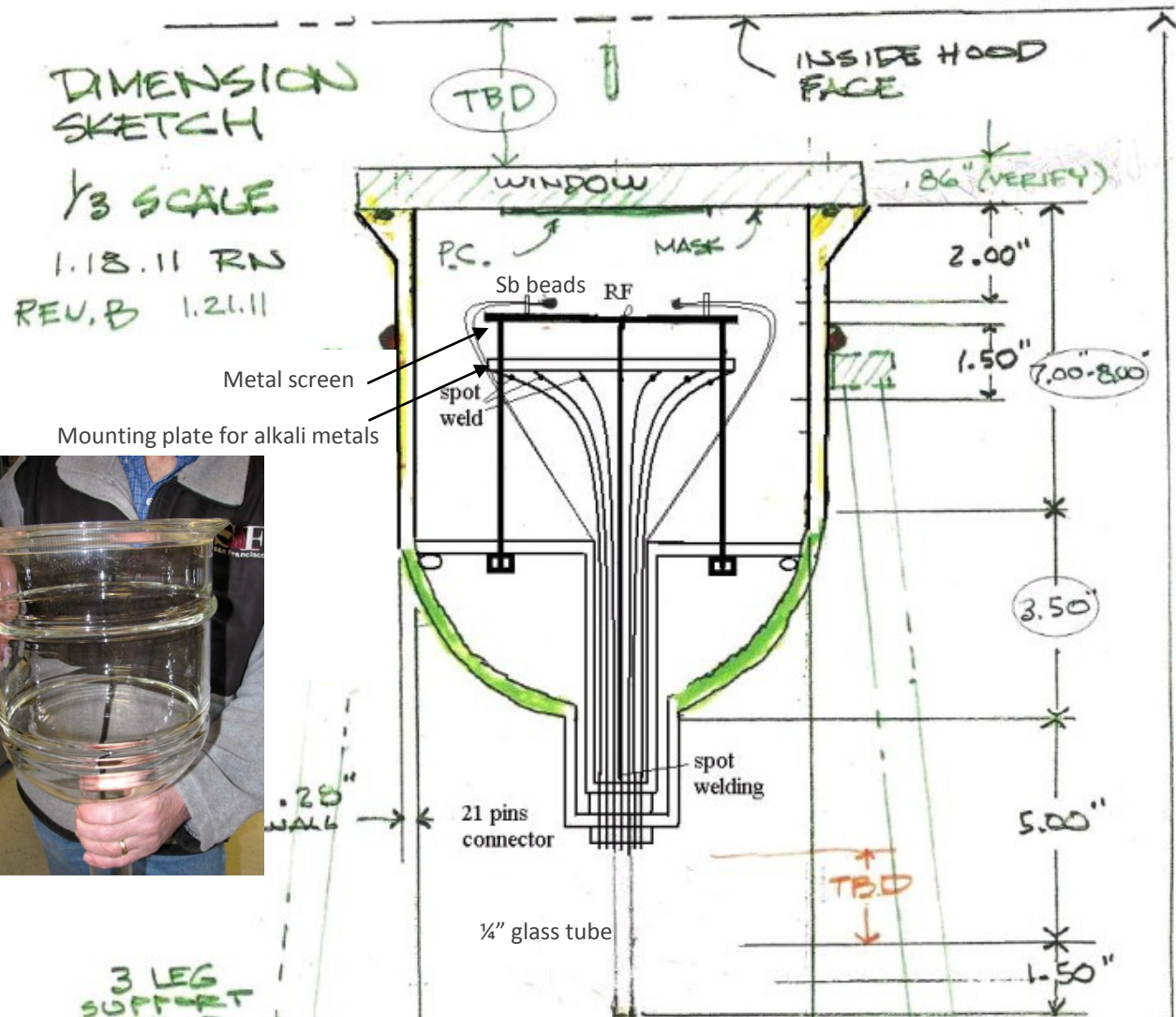
The (Missing) Link Between PMT and 8”x8” Photocathode - The 4”x4” Glass Chalice

- Applying lessons learned from photocathode fabrication in PMT;
- But PMT is a one-use (or one-deposition) object. We need something with a replaceable photocathode glass to enable multi depositions;
- Construct a “giant” PMT – the glass chalice – for 4”x4” photocathode;
- Glass chalice:
 - (i) Removable top glass plate;
 - (ii) Glass body similar to PMT;
 - (iii) Insert easily removed to replenish evaporation sources;
 - (iv) Still uses the Burle equipment;
- Will serve as testing ground to see if the photocathode PMT recipe can be scaled up in size;



The Chalice Design

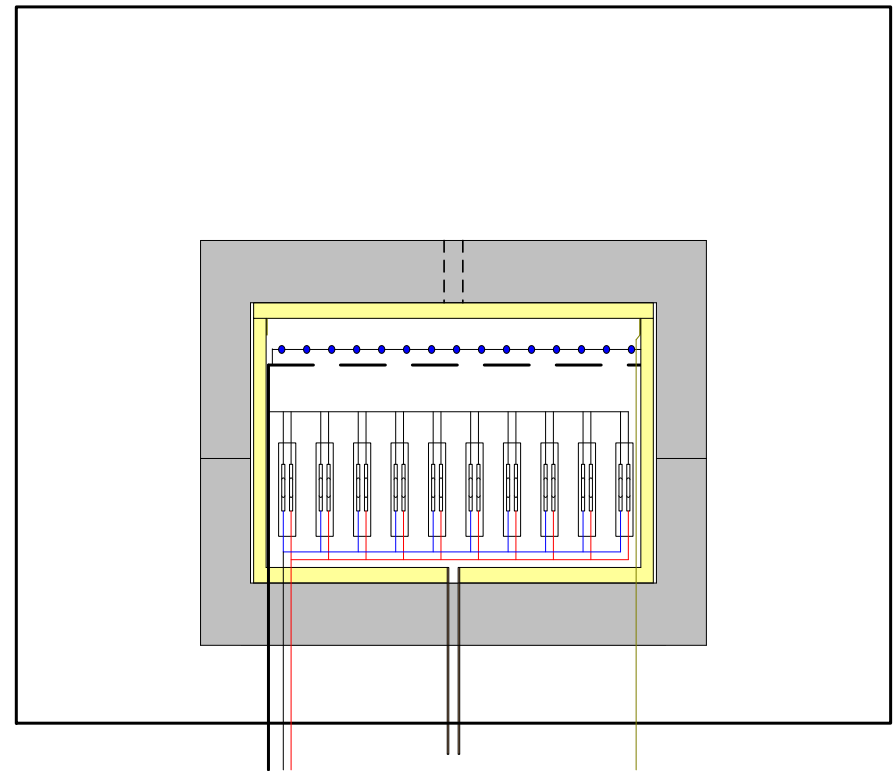
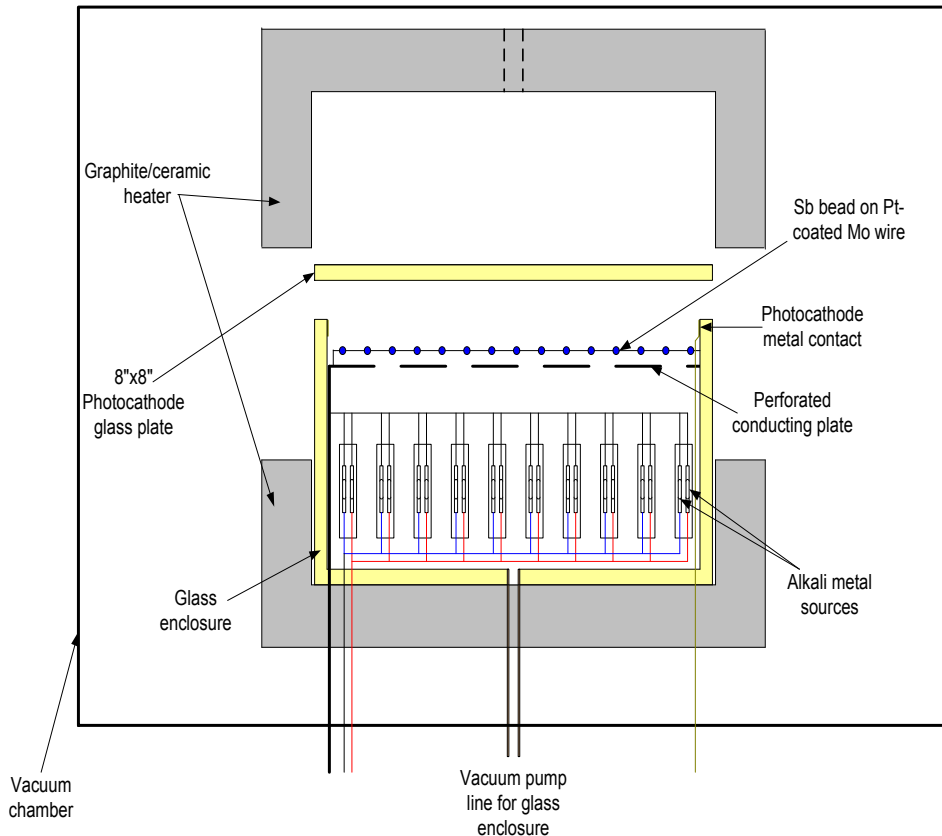
- Inside top window will be the photocathode substrate. Window is sealed with o-rings to chalice's body under vacuum;
- Sb beads mounted on top of metal screen;
- Metal screen acts as RF return during oxygen discharge and as anode during alkali metals deposition;
- Alkali metals mounted on non-conducting plate;
- 21 wires to pin connector allows for insert to be pulled out;
- Vacuum pump-out through $\frac{1}{4}$ " glass tube (!);
- Chalice structure is supported by external legs.



From Chalice To 8"x8" Photocathode

- Can lessons learned from the chalice be transferred to the production of 8"x8" photocathode?; Can it be applied in a photocathode tile-assembly setting?

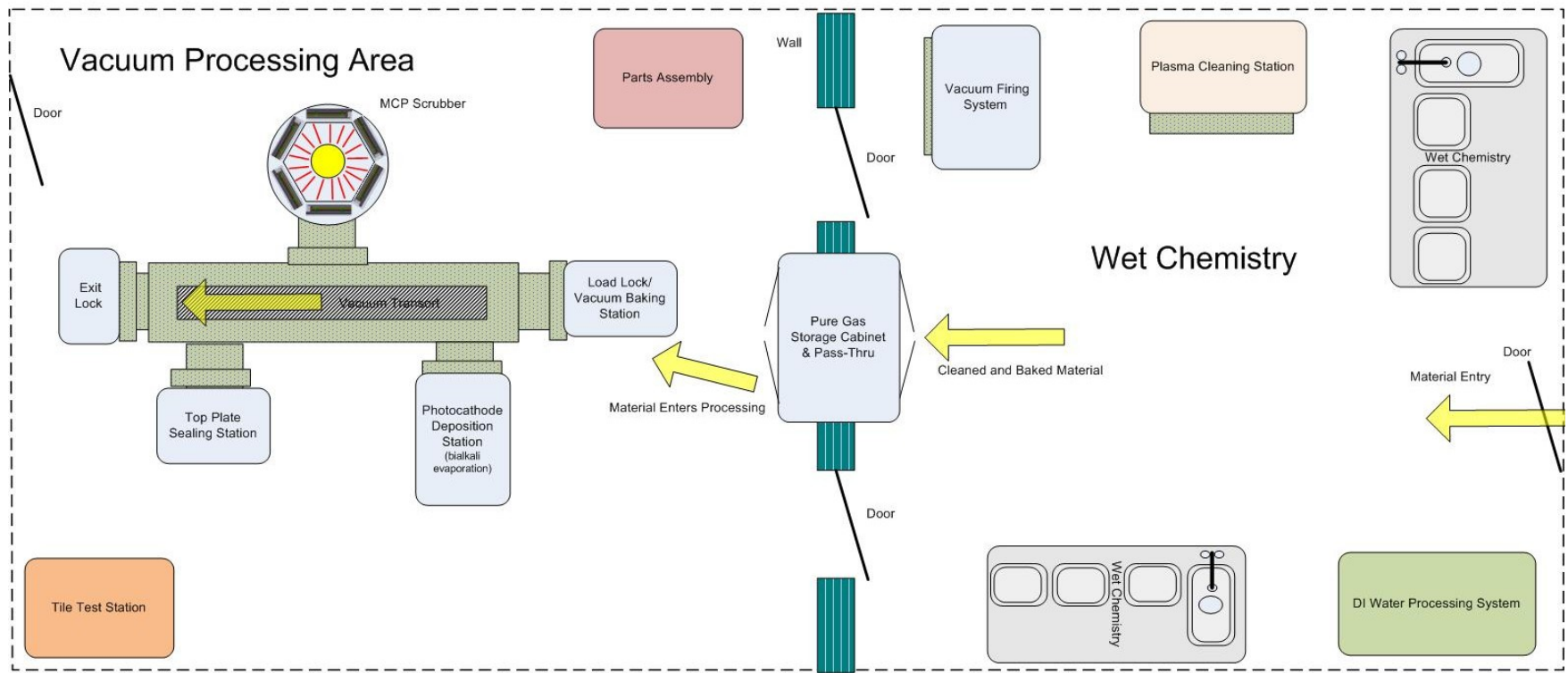
Initial "Strawman" idea on 8"x8" photocathode growth – This process may be done in several vacuum chambers



Configuration when closed for photocathode deposition

Photodetector Tile Production Layout

- The 8"x8" photocathode growth chamber(s) will be part of the photodetector tile production facility.



Not Ready For Prime Time?

- Laboratory dedicated to photocathode physics for photodetector has been established;
- Progress being made towards growth of 8"x8" photocathode;
- 8"x8" photocathode - no fundamental/fatal showstoppers so far;
- We are aware of the challenging technical/engineering issues facing us – to show not only that high-quality 8"x8" photocathode can be produced, but also in a manner compatible with large-scale production;

Life After LAPPD

- Future funding is being sought and explored;
- Tremendous opportunity to continue dedicated work on photocathode for photodetector;
- Infrastructure set up to foster collaboration and users from other institutions and commercial entities;
- Burle system may be used as a “test bed” for prototyping new photocathodes and procedures (especially with feedback from the growth and characterization system); for testing new photocathode candidate for large area photocathode production; for “boutique” PMT production in small-scale applications;
- A facility that has a material science laboratory to study the physics of photocathodes, a system to produce small-scale PMTs for testing, and a facility to make “large scale” production;