Photocathodes, MCPs and Reduced Risk Sealed Tube Development at UCB-SSL

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UCB/SSL – ANL Coordinated Efforts

ALD functionalized microchannel plates

- Coordinate with ANL/INCOM to establish ALD/capillary MCPs
- Test 33mm sample imaging, gain, background, PHD, uniformity
- For tube compatibility tests,- high temp vac bake, burn-in process
- Investigate optimization of MCP pair spacings & bias, anode bias, charge footprint, imaging and timing tests
- Full up evaluation/optimization of 8” MCP configurations

Photocathodes

- Demonstrate techniques for >15% QE and window compatibility
- Establish high QE bialkali photocathodes on LAPPD 8” windows

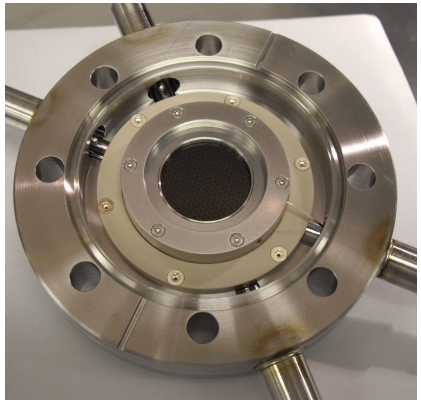
Sealed tube Implementation of Prototype LAPPD Detector

- Implement LAPPD detector using ceramic body/hot indium seal/transfer photocathode technology that we have used for NASA/Homeland Security/NIH/NSF detector systems
- Fabricate prototype 8” sealed tube devices for ANL tests.

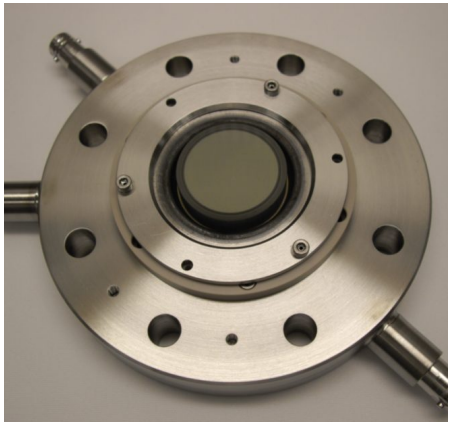
33mm MCP Performance Test Facilities

Double chamber UHV test station

Phosphor detector on the left
XDL detector on the right
Both have support electronics
Amp/TDC and PC Acq/display
for XDL (imaging, gain, timing)
Nikon camera (imaging) or
electrometer (gain)
for Phosphor detector

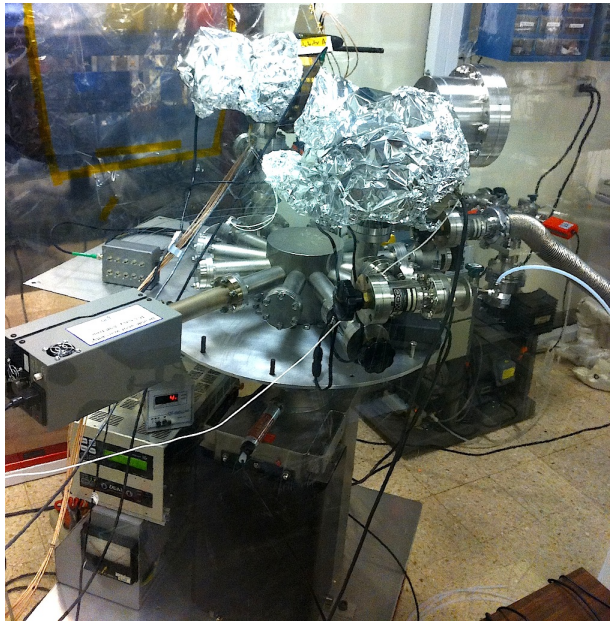


25mm XDL photon counting
detector on 4.5” flange



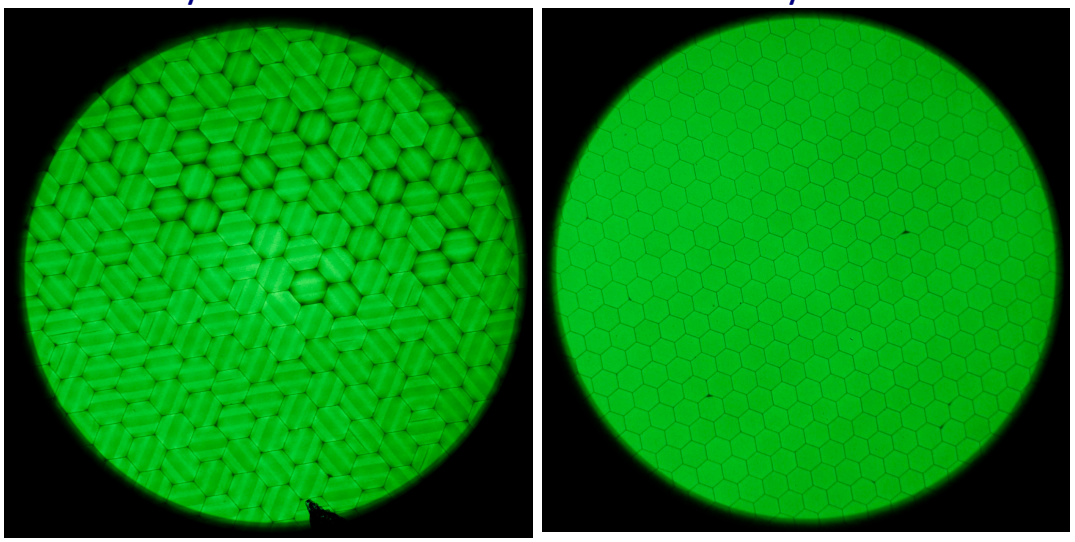
25mm phosphor screen
detector on 4.5” flange

Preconditioning and
Lifetest UHV Station



Ion pumped UHV station with 3
chambers for 350°C bakeout, RGA
head, detector burn in, for any
detector type with full diagnostics.

Imaging Performance of ALD MCPs



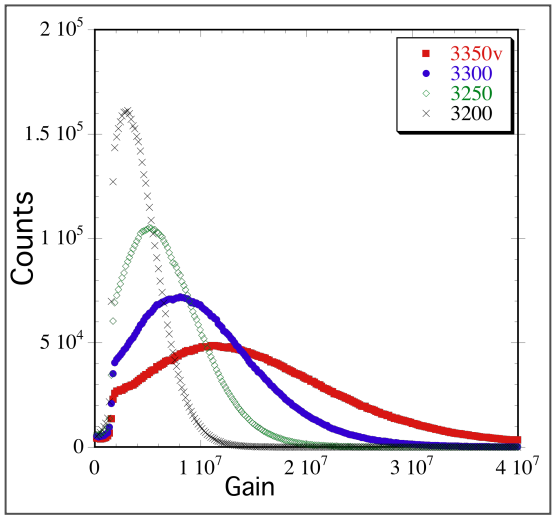
MCP substrates, and ALD have been evaluated in detail in detector systems appropriate to LAPPD.

Observations have been shared and discussed with LAPPD team enabling process changes to be implemented.

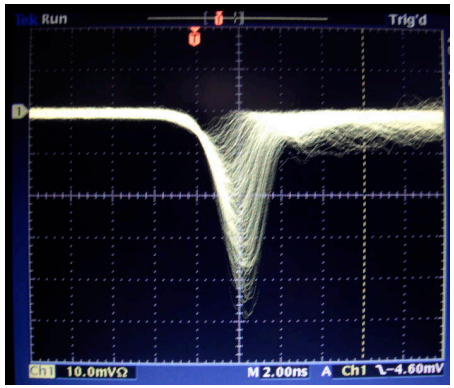
Sample performance has improved dramatically over the last 12 months.

Imaging performance using 33mm sample MCPs is in accord with LAPPD goals.

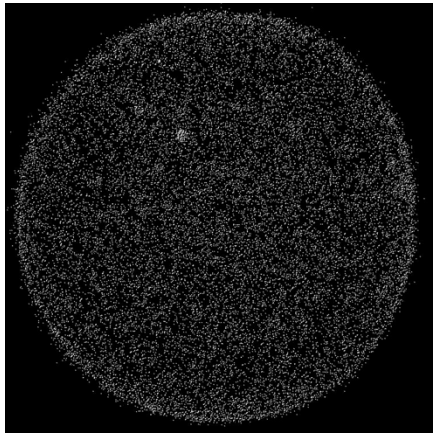
33mm ALD-MCP Performance Tests



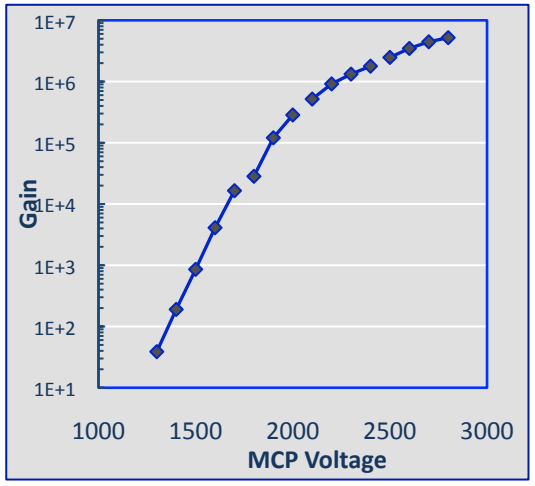
Pulse amplitude distributions for a 33mm ALD MCP pair



Single event pulses are ≤2ns wide



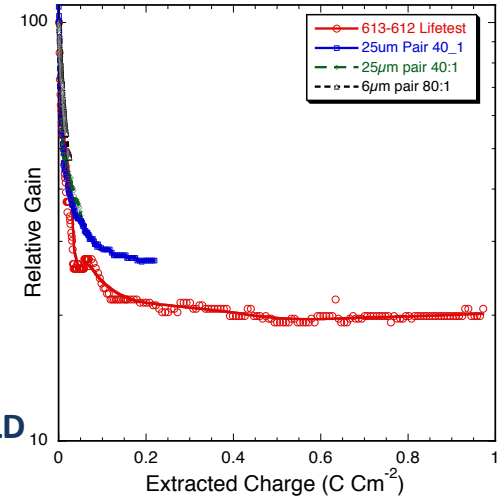
Background rate is uniform and a few events sec^{-1} cm^{-2} for an MCP pair



Gain for a pair of 33mm ALD MCP's

Pulse speed and uniform background rates with a pair of capillary MCPs functionalized by ALD are similar to commercial MCPs

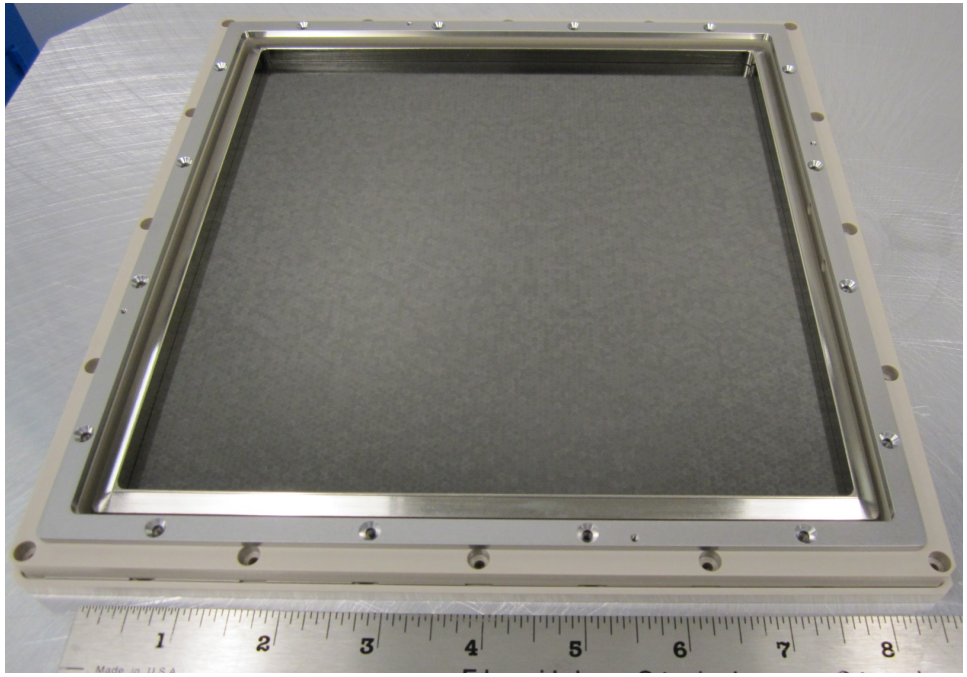
Demonstration of gain of $>10^6$ & aging performance comparable to that of commercial MCPs with a pair of capillary MCPs functionalized by ALD



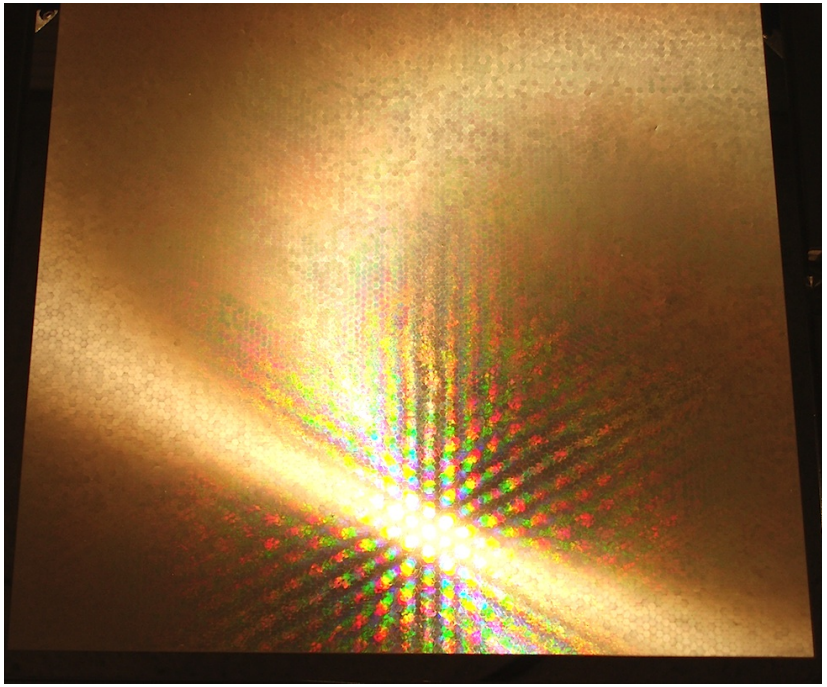
Lifetest of ALD MCP pair compared with conventional MCPs

Progress with 8” MCP Development

A small number of 8” MCP substrates (20µm pore) have been functionalized by ALD at ANL and electroded at UCB-SSL. One has been tested in a detector specifically built to allow single MCPs, or pairs, to be evaluated in conditions like the LAPPD configuration(s).



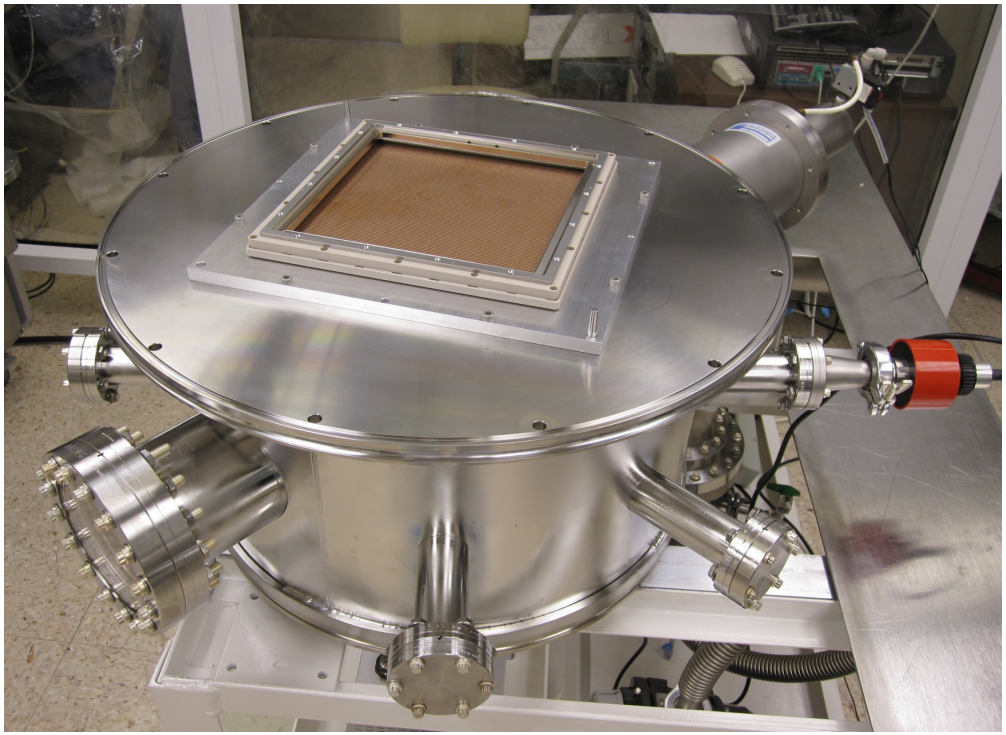
8” electroded ALD MCP in detector assembly with a cross delay line imaging readout



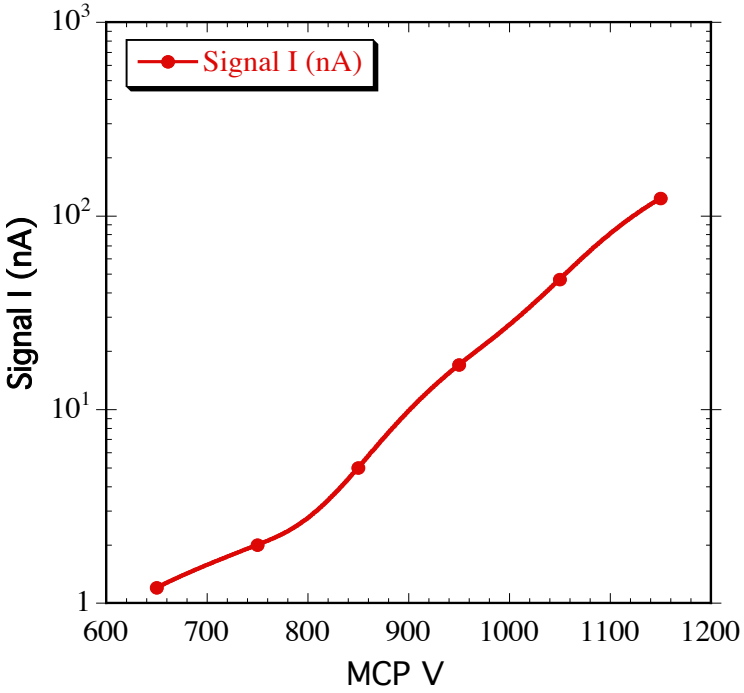
8” un-electroded MCP substrate showing the multifiber stacking arrangement

Testing of 8” ALD-MCPs at UCB-SSL

A UHV test chamber system for testing the 8” MCPs is finished and operational.



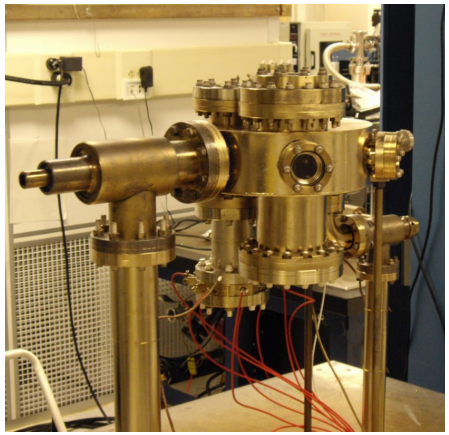
8” MCP test chamber and detector with XDL readout

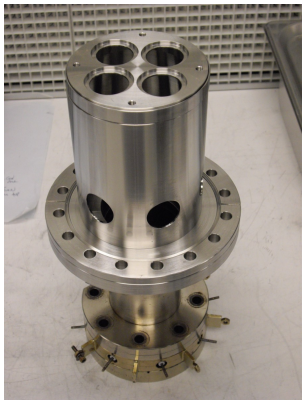


8” MCP output signal v.s. V for UV input

The cross delay line detector accepts 2 MCPs and spacers. It will allow <200µm spatial resolution for MCP pairs, and permit full parameter evaluation of 8” MCPs. An initial test with one 8” 20µm pore ALD-MCP shows a normal gain curve.

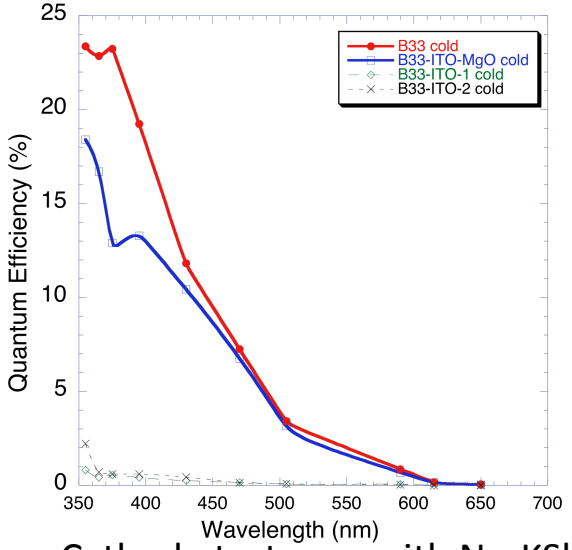
Bialkali Photocathode Sample Tests

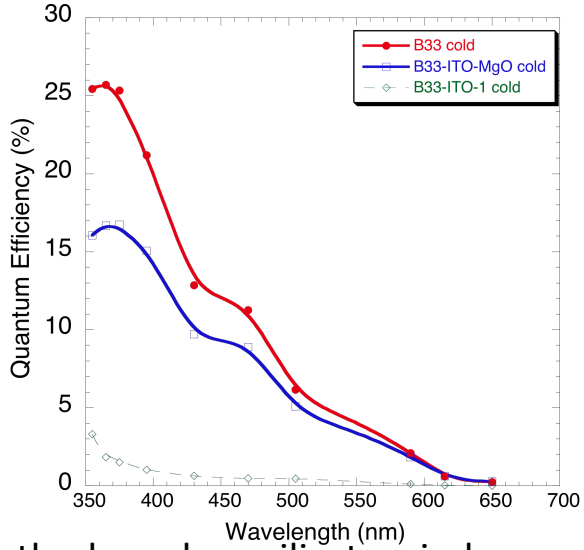




Substrate holder and alkali source for 1.2” samples, 3.5” overall.

UHV tank for processing alkali cathodes and tubes of small area. Can take 4-8 samples/run. 7 runs done. Quantum efficiency optimizations, substrate material and under-coating tests.

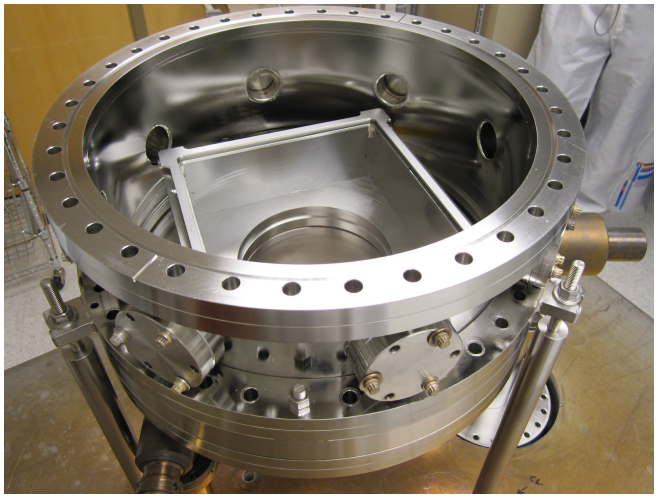




>20% QE achieved at 300 – 400nm
B33 borosilicate shown to be good substrate
QE uniformity better than ± 12% (relative)

Cathode test runs with Na_2KSb cathode on borosilicate windows

8” Photocathode, and Window Seals



14” Diam UHV test process chamber with capability to process cathodes and seal 8.7” windows to brazed housings, just completed and being commissioned

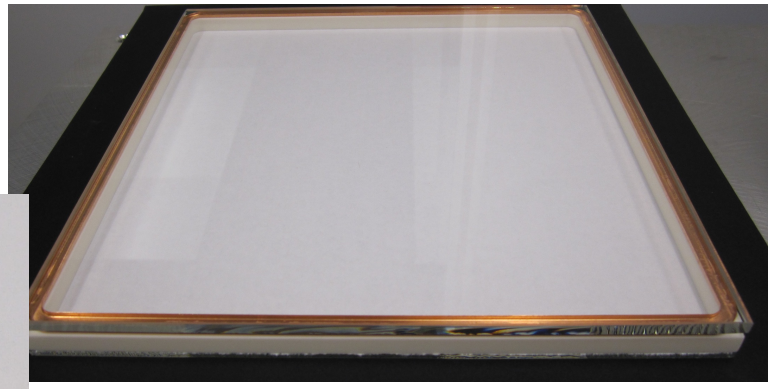
New UHV photocathode processing tank. Allows 8” photocathode depositions on B33 substrates to establish bialkali QE, uniformity and longevity.

UHV tank has second function:- Accommodates detector body to allow trial indium seals to be done and assessed for vacuum integrity

14” UHV test process station showing chamber, pump and process controls.

8” Window Hot Indium Seals

Indium seal well

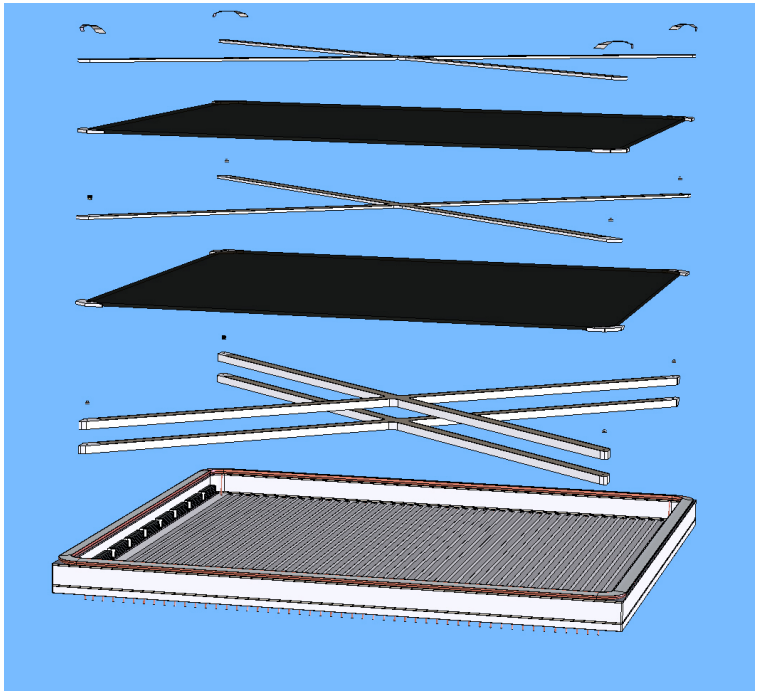


Ceramic body with Cu Indium well, 5mm thick B33 window and “blank” anode.

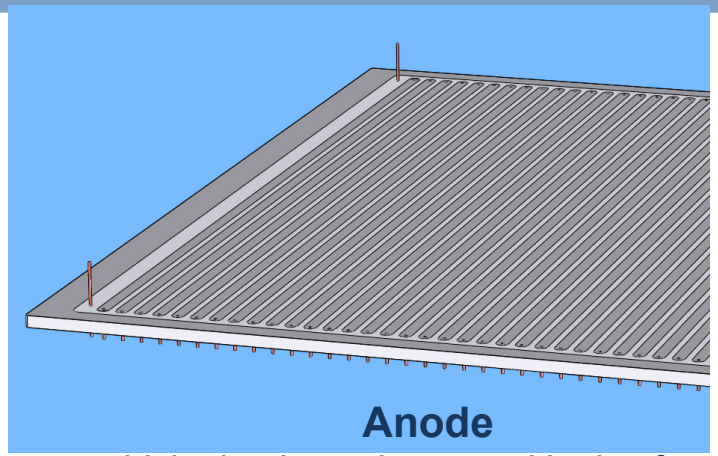
Have previously sealed 2” x 2” and 7” round devices
Now use 8” LAPPD ceramic brazed body design with Cu or Kovar Indium well, and alumina anode.
Will metalize 8.7” B33 windows and make Indium seals on a brazed frame (Indium well and body sidewall).
Utilize standard Indium eutectic alloy(s), NiCr metalization
Test leak tightness of the seal.

Ceramic Brazed housing design

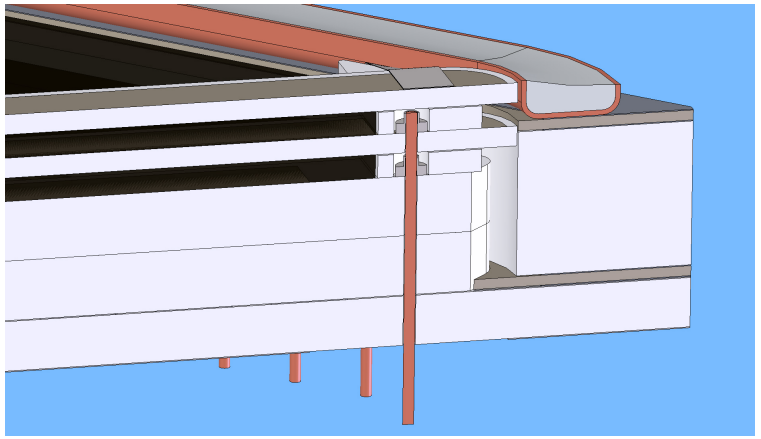
Brazed Body Assembly and Preparation
Single-step InCuSil braze bonds anode with bottom Kovar flange, alumina frame, top Kovar flange, and indium well (Cu or Kovar) into a hermetic package



Brazed Body Internal Parts Assembly
Into body, stack up getters and X-grid spacers and MCPs. X-grids register on HV pins, hold down MCPs, and distribute HV (via metallization contacts).



Anode
2.5 mm thick alumina substrate with vias for signal/HV pins. 48 signal strips inside, complete GND plane outside. Signal & HV pins brazed in with CuSil.



Process Chamber for LAPPD Sealed Tube Prototyping

Process chamber designed to condition assembled detector, deposit photocathode, and accomplish final seal, allowing “in process” tests to be done to verify the detector condition prior to completion.

Main UHV process chamber.

Chamber on process cart with one of two ion pumps. Most parts and equipment in-house

Next Tasks and Goals for LAPPD at UCB

- Optimization of 33mm sample test MCP performance.
- Testing and verification of optimized 8” ALD-MCPs.
- Demonstration of an operational 8”-square photo-cathode with a viable path to QE ≥ 15% for wavelengths between 300 and 450 nm.
- Demonstration of the window-to-body 8” seal solution.
- Assembly/testing of ceramic 8” detector bodies.
- Commissioning of the vacuum-transfer/assembly facility for the 8”-square MCP module.
- Full sealed tube processing.