



GaN for Sealed Tube MCP Detectors?

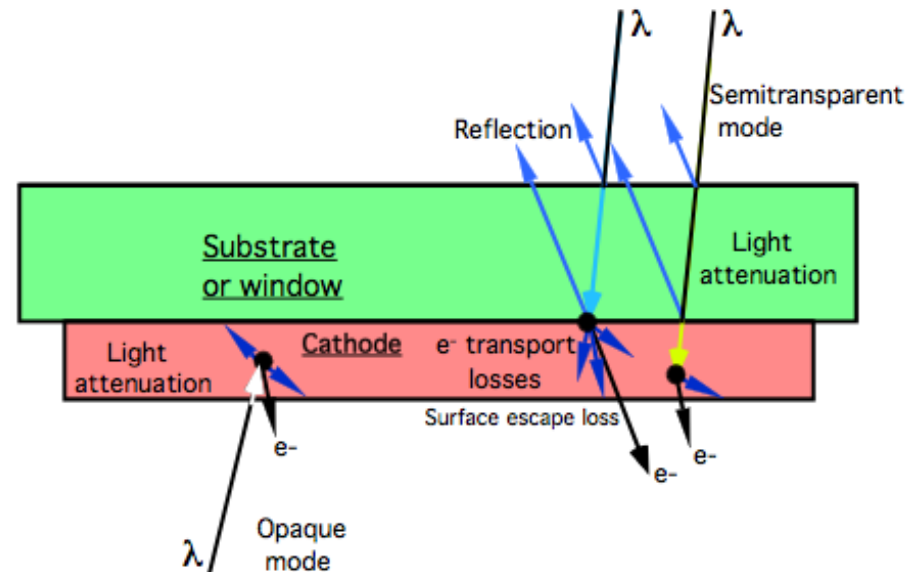




GaN Photocathode Schemes

- “Solar blind” efficient cathode for 100nm-400nm
- Band gap energy 3.5 eV, (~355nm)
- Alloys ($\text{Al}_x\text{Ga}_{1-x}\text{N}$, $\text{In}_x\text{Ga}_{1-x}\text{N}$) can change the bandgap
- Robust, compatible with sapphire substrates/coatings
- p (Mg) doped to promote bulk electron transport
- NEA is established by surface cesiation
- >100nm GaN layers typical
- semitransparent or opaque

- Numerous processes affect the QE



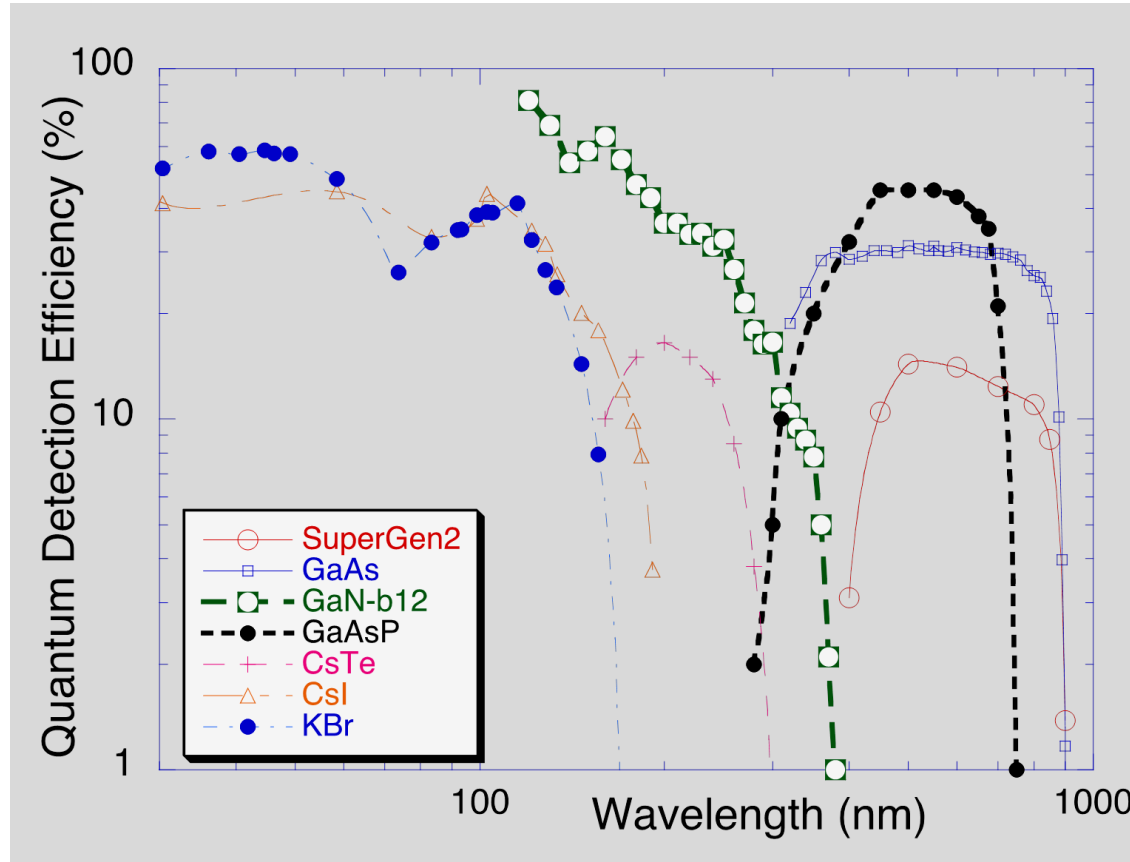


Photocathodes, 10nm - 1000nm

GaN is a robust material with good handling properties.

Samples have been re-cleaned and reprocessed many times achieving same QE

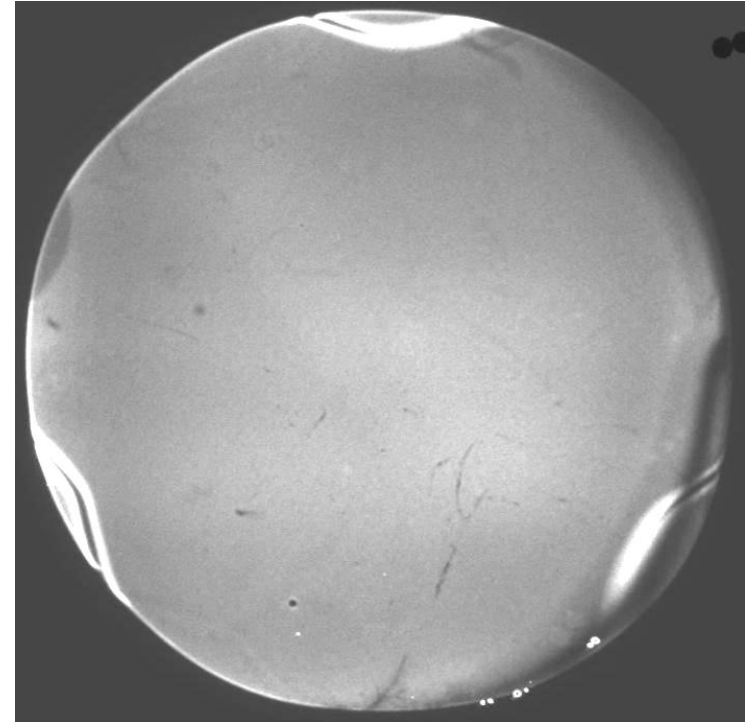
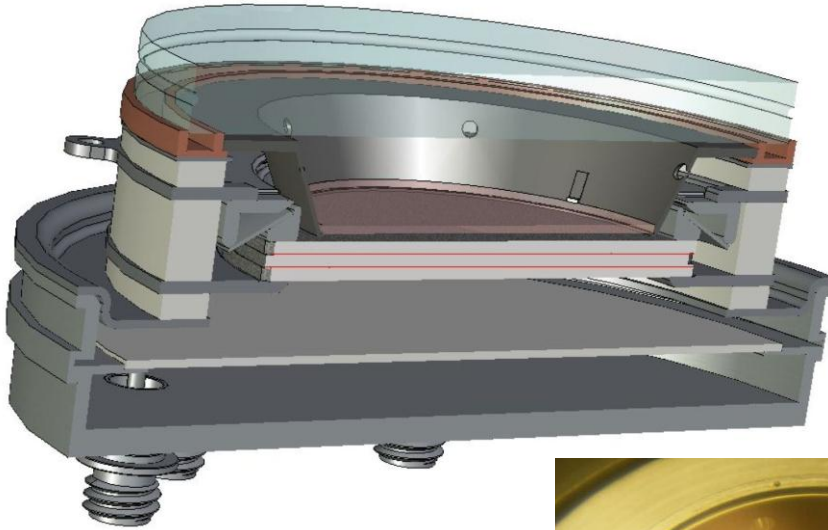
GaN sample in a sealed tube has not changed in QE measurably in over 5.5 years.



General comparison of conventional and GaN photocathodes.



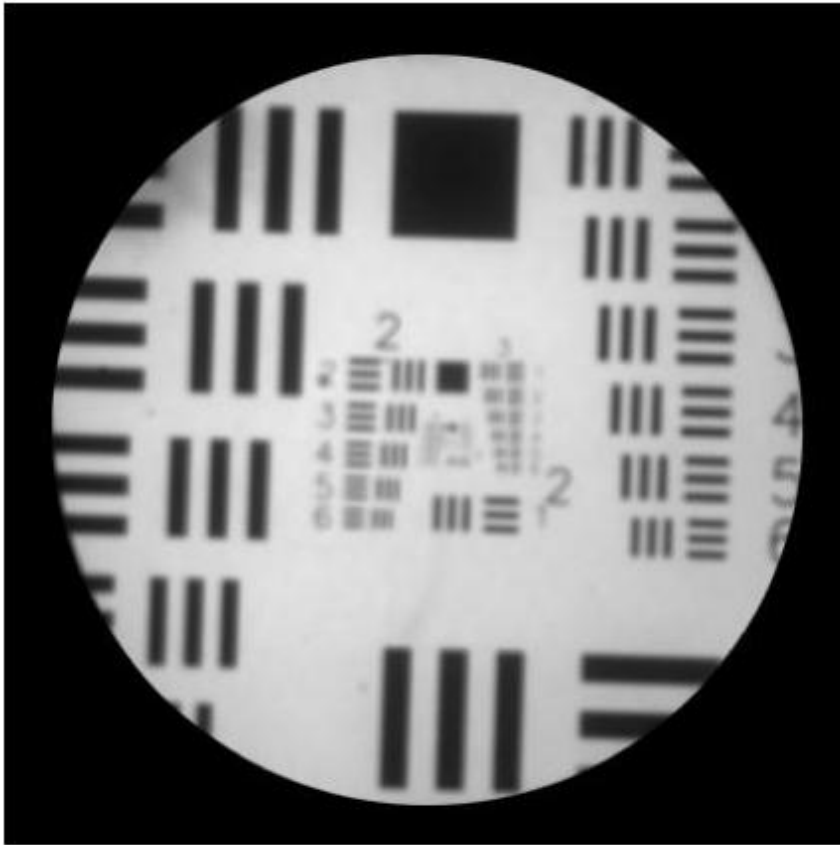
GaN Imaging Detectors



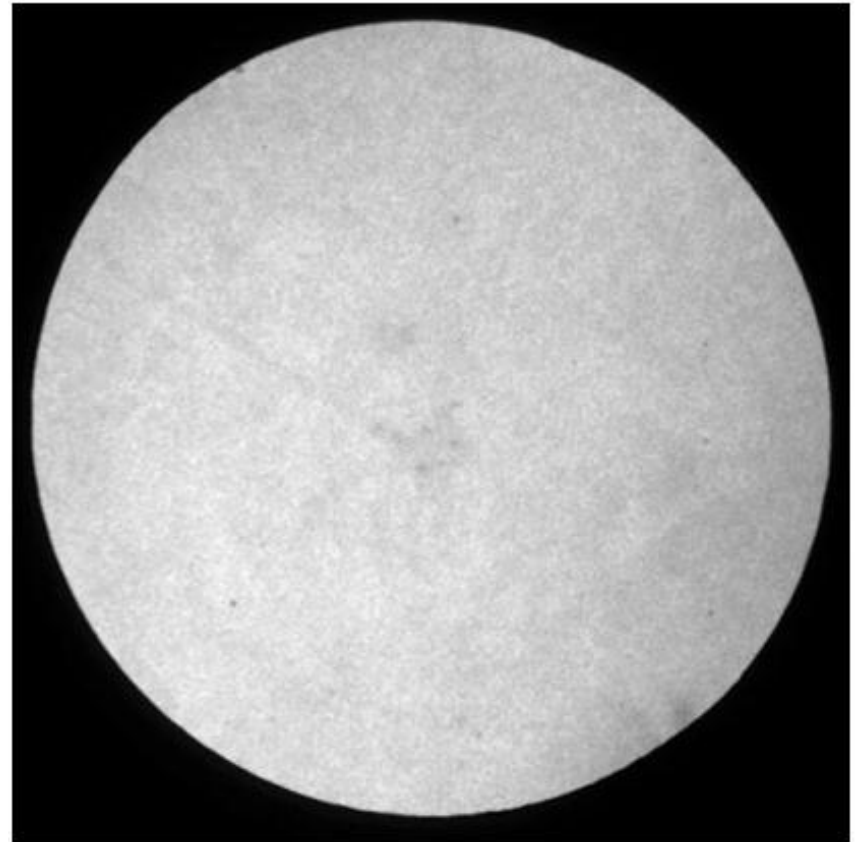
- We have built an imaging detector using semitransparent GaN on sapphire
- Uses a cross delay line anode and a MCP triplet to image individual photon events
- Several GaN cathodes have been evaluated for their imaging properties



GaN Cathodes for Image Tubes



~13 lp/mm

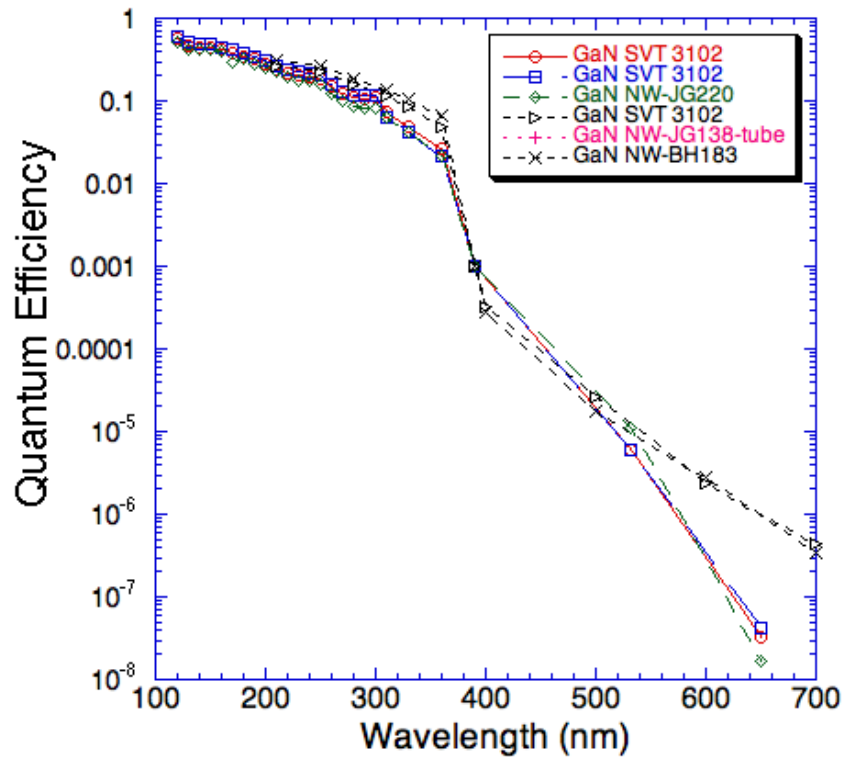


Flat field @240nm

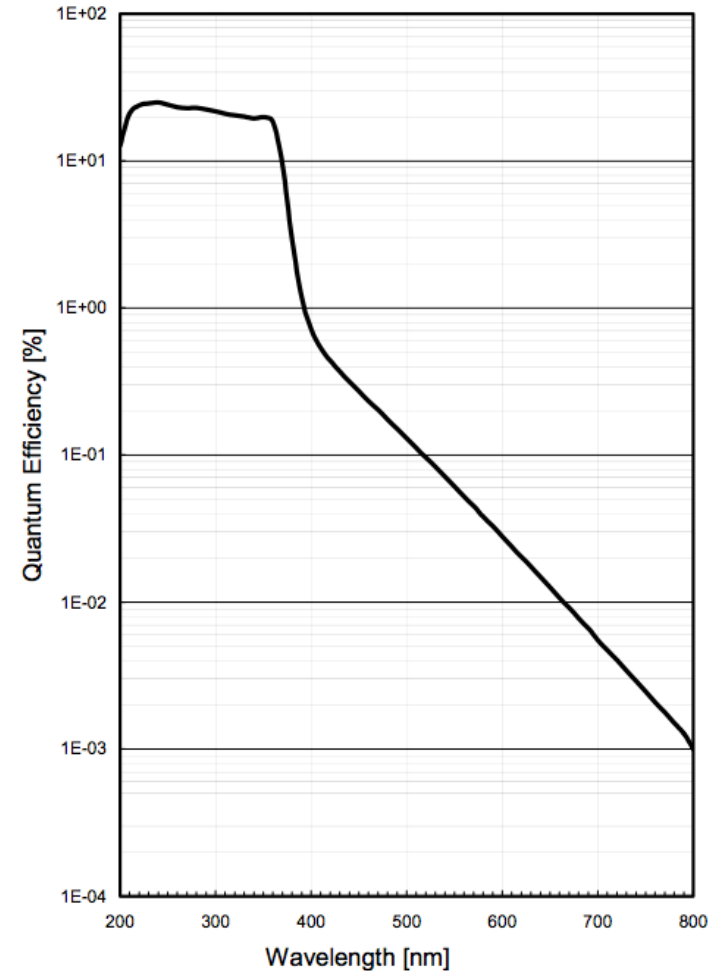
Mizuno et al 2008. **Semitransparent GaN** photocathodes in 20mm, 3 MCP intensifier tube.



GaN Cathode Long Wavelength QE



Various process runs on samples of **opaque** GaN photocathodes on sapphire processed at Berkeley.



Mizuno et al 2008. **Semitransparent** GaN photocathodes in 20mm tube.

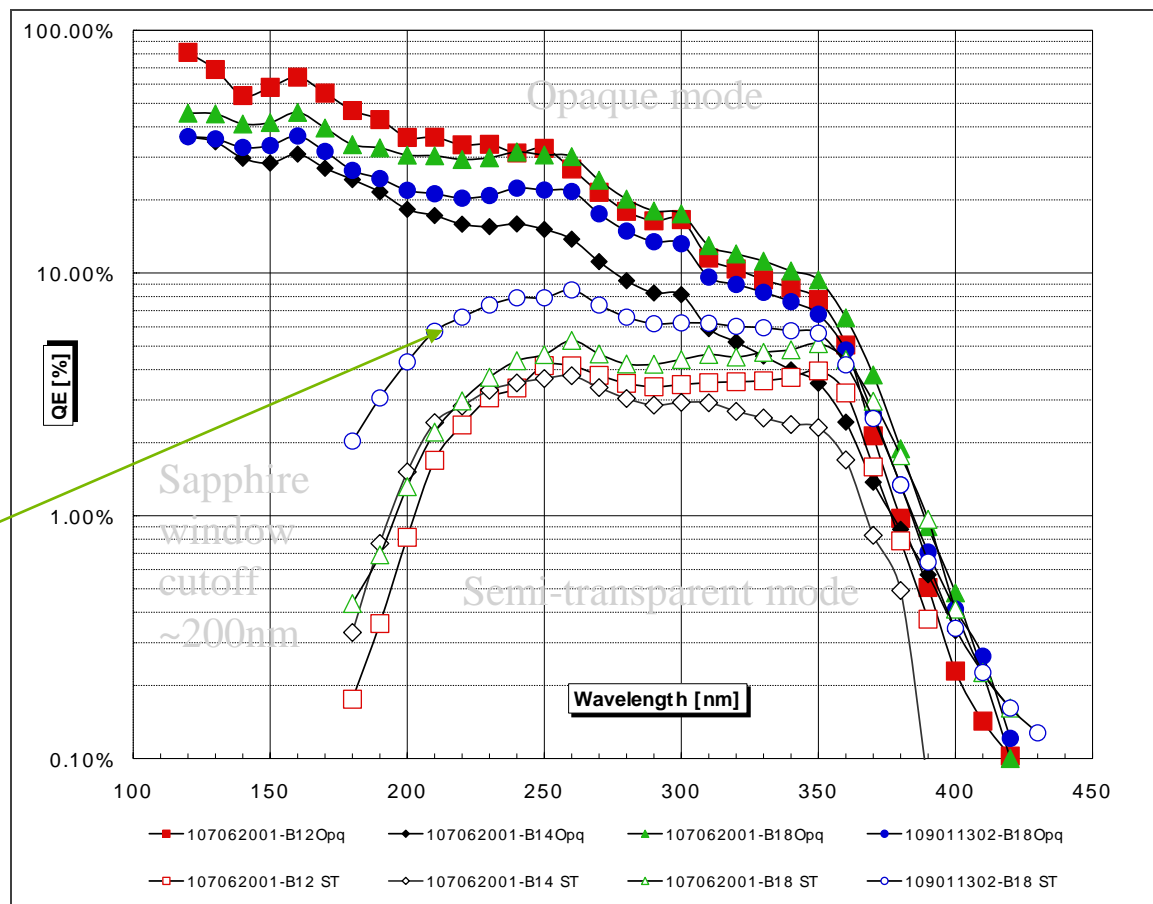
GaN Cathode QE (opaque and semi-transparent)



Response a function of thickness and process techniques (cleaning, heat treatment, cesiation)

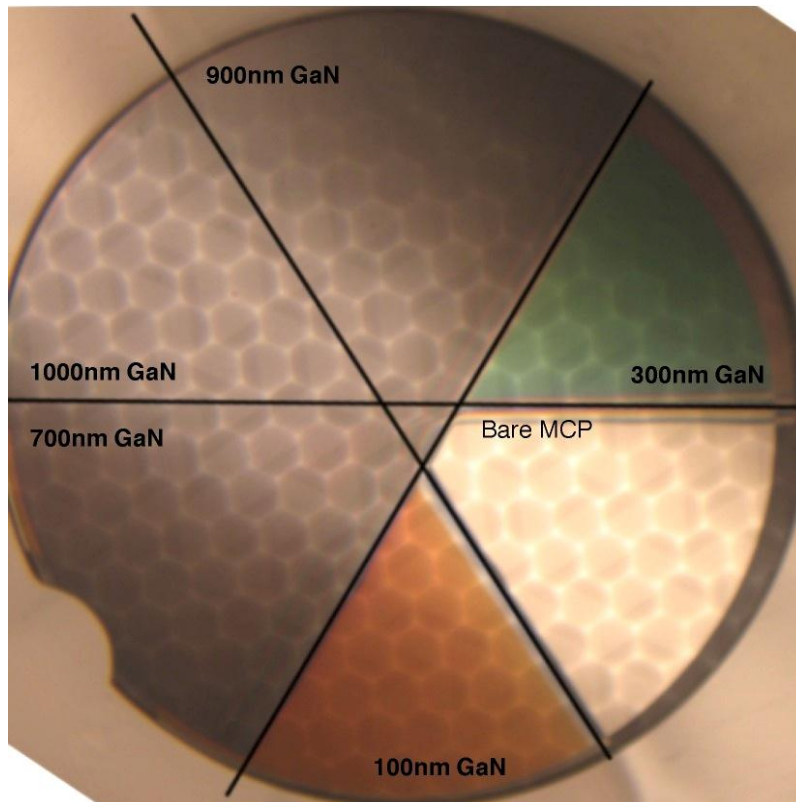
Semi-transparent optimization not the same as opaque

Achievable Semi-Trans cathode QE is actually a factor of two higher than the average measured value here since the high QE is only on 50% of the patterned substrate.

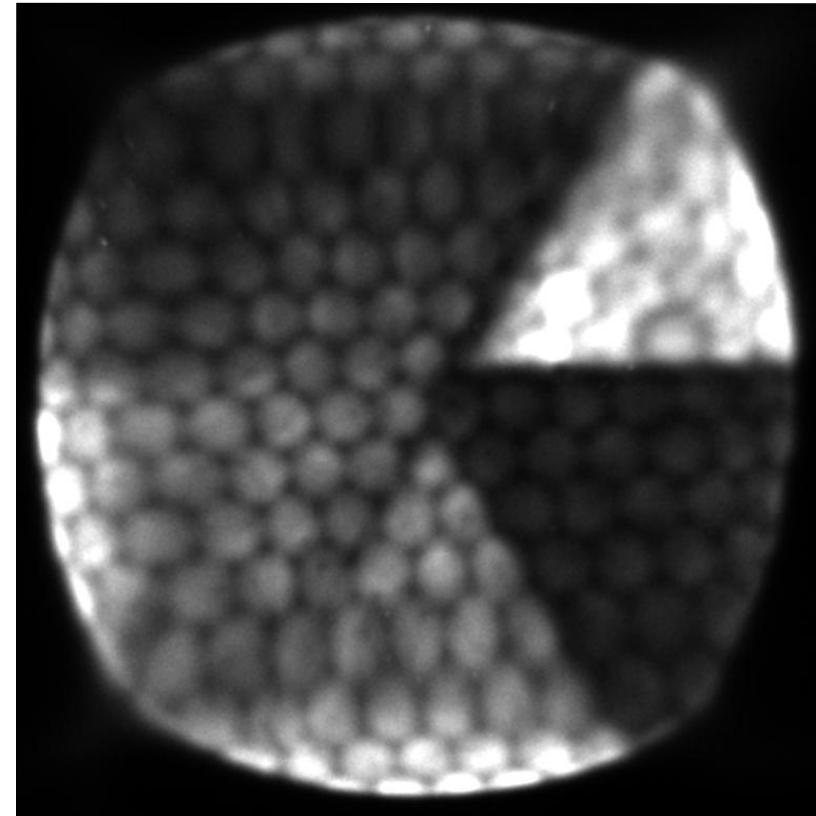


Various process runs and samples of GaN photocathodes on sapphire, measured in both opaque and semitransparent mode.

GaN Cathode on ALD Borosilicate MCP



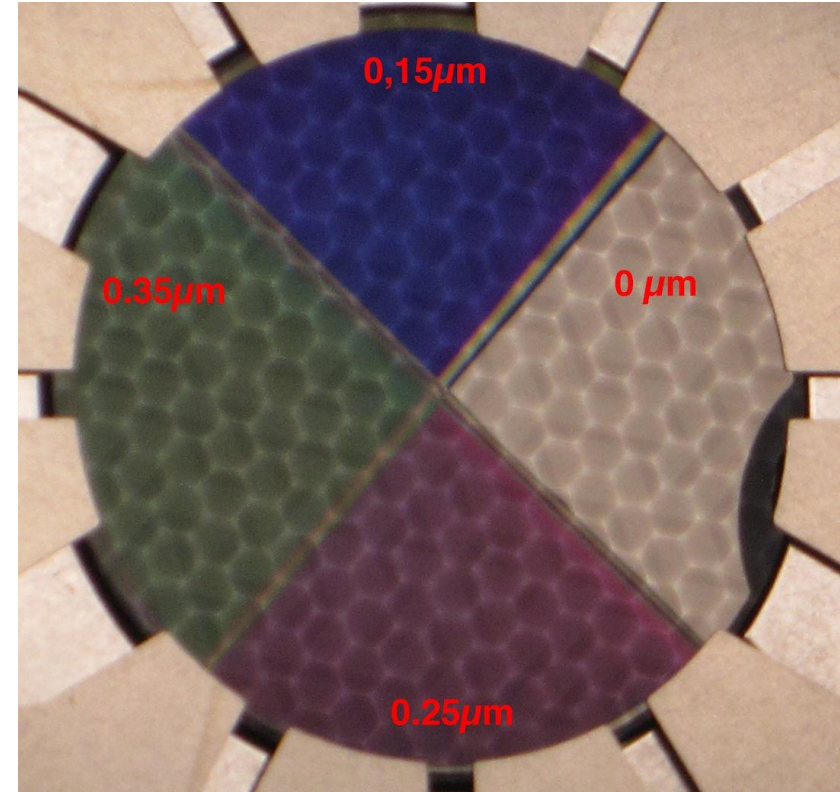
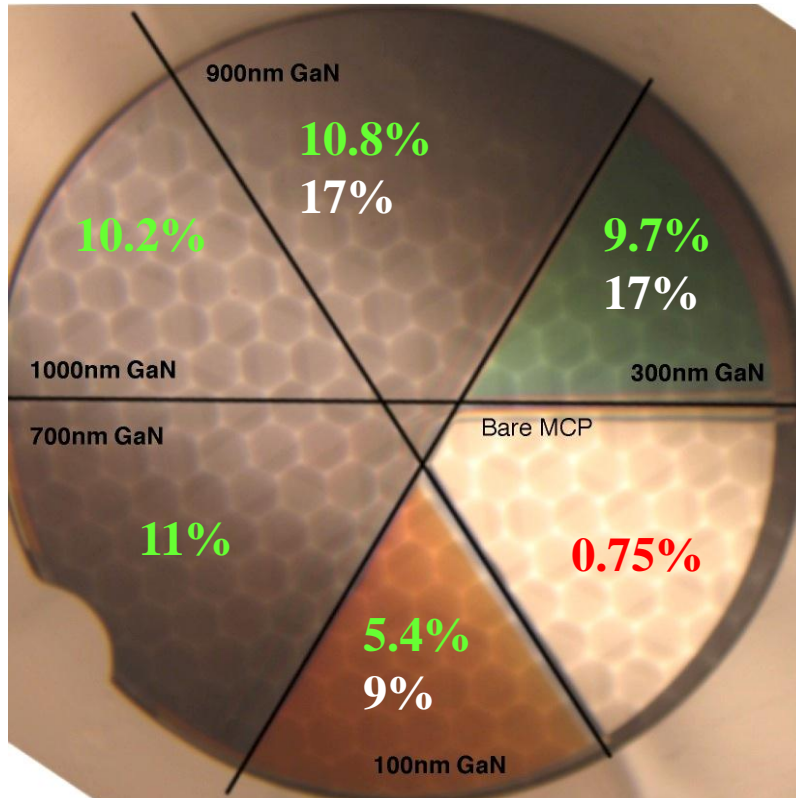
GaN deposition geometry



UV response – without Cs

- Opaque GaN(Mg) on borosilicate ALD MCP, coated onto NiCr layer
- Tested in photon counting cross delay line detector as MCP pair
- Initial tests with no Cs activation show some enhancement
- GaN coated areas generally lower background than bare MCP

GaN Cathode on ALD Borosilicate MCP (NiCr substrate)



QEs measured after Cs (214nm, web)
 10° (green) or 45° (white) graze angle
 Shows typical QE-thickness asymptote for
 opaque cathode

Next sample to be tested
 More samples in fab with ALD
 sapphire on top of MCP as base layer
 for GaN(Mg) deposition.