Findings about the photocathode position inside the cathode electrode

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Puck

GaAs + Ta cup

- We inserted each photocathode into the cathode electrode and measured the recessed length.
- Then took out the puck and measured the distance from Ta cup to the outer crown of the puck.
- Then took out the GaAs wafer and measured the thickness.

Photocathode type	Distance from GaAs surface to front of the cathode surface (full recessed length) [mm]	Distance from Ta cup to the outer crown of the puck [mm]	Substrate thickness [mm]
60 min	0.9525	0.3175	0.457
90 min	0.8255	0.5334	0.330
30 min	0.6985	0.5715	0.356
Moly	Didn't measure. It has a small curvature that comes out of the surface due to the polishing.	0.0000	0.889

- Due to the Pierce geometry, it is hard to measure the recessed length.
- Also, the activated area could be a bit expanded due to the oxidization (~0.01 mm).
- The photocathode we used for the beam size and rotation angle measurements is a full activated one which we don't have anymore.



GaAs 90 min



There is a visible space in between photocathode and cathode front

Moly





Thickness of the Pierce geometry front



- Thickness of the Ta cup = 0.3505 mm
- Therefore, Ta cup + Pierce geometry front thickness = 0.5926 mm
- When a photocathode perfectly fits with the cathode electrode without any space in between, the photocathode is 0.5926 mm recessed from the cathode surface which we have to modify in our CST model.





This discrepancy is not a problem for the simulations as long as we know the recessed length.

How beam size varies with the recessed length

From 0 - 0.5 m







This is non-magnetized beam

1 mm recessed





 E_z at the cathode - 2.19 MV/m for -300 kV



E_z at the cathode - 1.67 MV/m for -300 kV

Beam size variations with the solenoid current (Measured value on the three viewers, 1 mm recessed and 0.6 mm recessed)



Considering the GaAs layer

Modified the GaAs layer as a semiconductor

Epsilon = 13.1 (from literature – not accurate because of the Zn doping) Mu = 1 (from literature – not accurate because of the Zn doping) Electric cond. = 11214 [S/m] (from the company)

Without considering GaAs as a semiconductor Considering GaAs as a semiconductor 1.0e+6 1.0e+6 0.5e+6 0.5e+6 0.0e+6 0.0e+6 -0.5e+6 -0.5e+6 -1.0e+6 -1.0e+6 -1.5e+6 -1.5e+6 -2.0e+6 -2.0e+6 ₩ -2.5е+6 ₩ -2.5e+6 -3.0e+6 -3.0e+6 -3.5e+6 -3.5e+6 -4.0e+6 -4.0e+6 -4.5e+6 -4.5e+6 -5.0e+6 -5.0e+6 -5.5e+6 -5.5e+6 -6.0e+6 -6.0e+6 0.20 0.25 0.20 0.05 0.10 0.15 0.30 0.35 0.05 0.10 0.15 0.25 0.30 0.35 GPT GPT z z Min(Ez) = -5.49152e+06 Min(Ez) = -5.49454e+06

	Beam size [mm]		
	Viewer 1	Viewer 2	Viewer 3
Without considering GaAs as a semiconductor	3.521	4.792	9.213
Considering GaAs as a semiconductor	3.551	4.832	9.288

With the material details I could found, looks like the photocathode material doesn't change the electric field much.

For the flat cathode front



E_z at the cathode – 6.70 MV/m for -300 kV

 E_z at the cathode – 6.21 MV/m for -300 kV

How beam size varies with the recessed length for flat cathode front





This is non-magnetized beam