1 Shape Optimization of a Photo Gun

1.1 Current approach with a C^∞ NURBS

- original geometry and electrode boundary in Figure 1
- inside of the electrode is discretized as well, to compute the volume constraint, see Figure 2

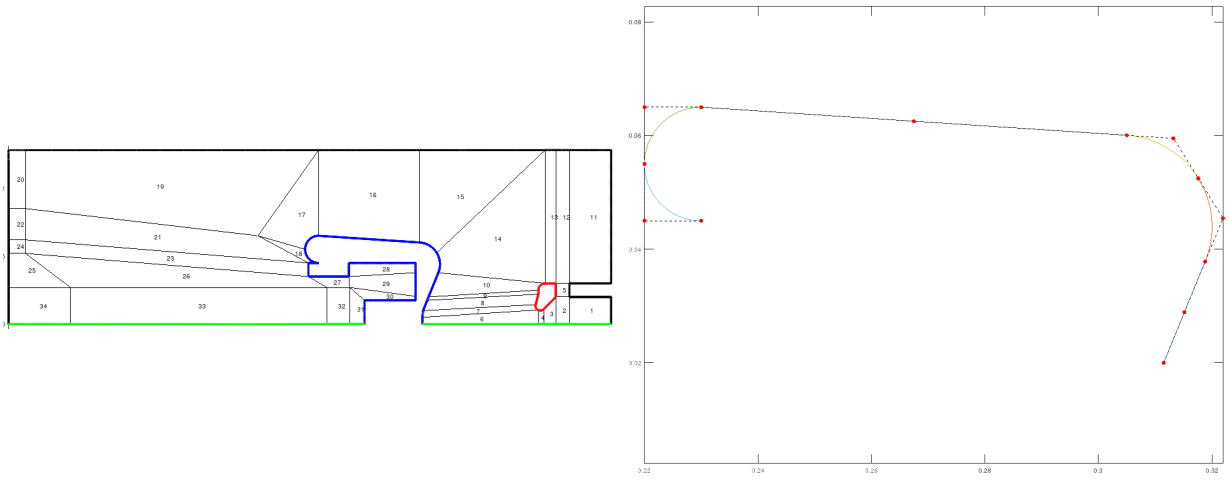

Figure 1: Original geometry and electrode boundary.

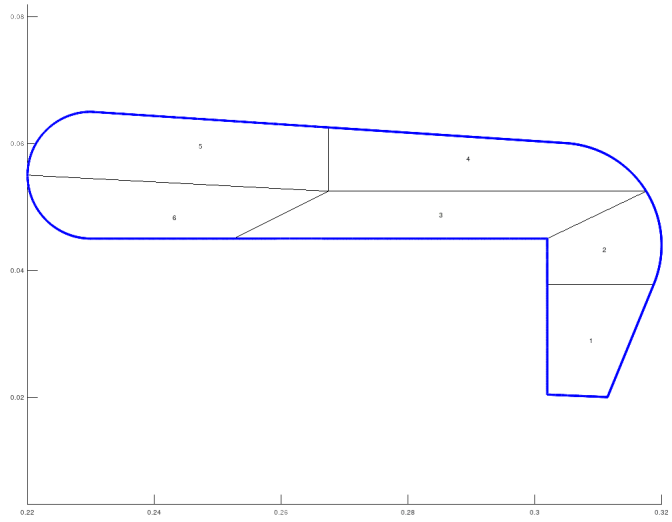

Figure 2: Discretization of the electrode.

- initial NURBS is formed by taking a subset of the control points of the original boundary, see Figure 3
- patch boundaries are chosen by finding the intersections of the original patch boundaries with the deformed NURBS (based on bisection method)
- bounds for the optimization are based on the patch boundaries (seemingly does not affect the results, since no control point is very close to any of the bounds), see Figure 4

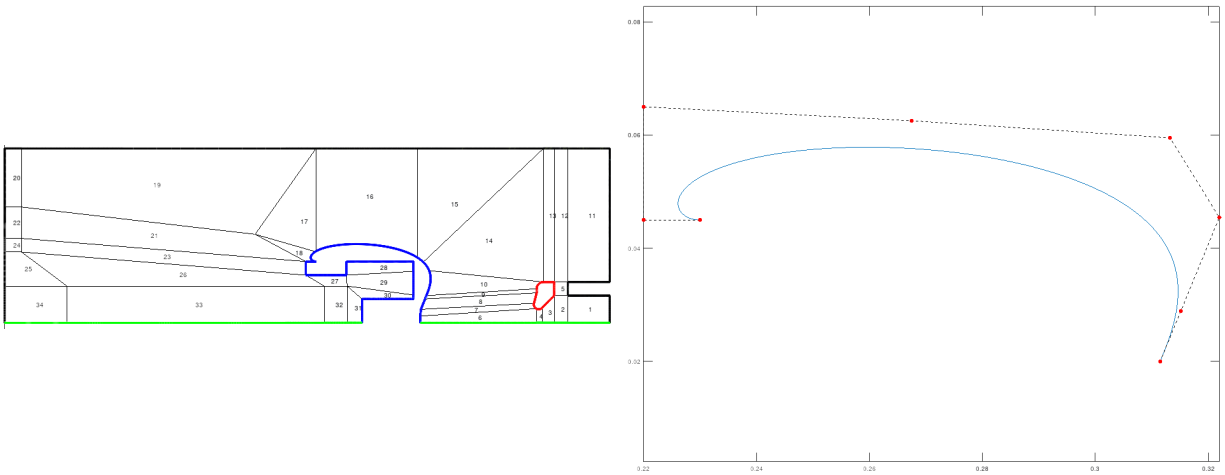

Figure 3: Initial geometry and NURBS.

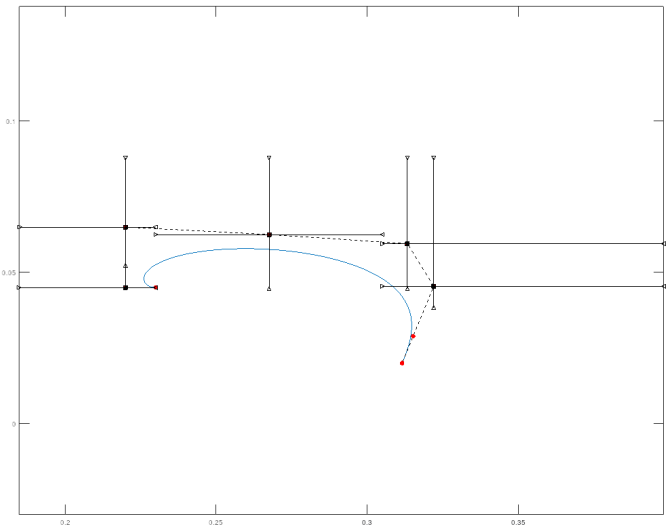

Figure 4: Bounds on the control points during the optimization.

- cost function looks at patches $14, \ldots, 18$
- cost function for the optimization is only based on the absolute maximum, i.e. $\max_{\mathbf{x}\in\Omega} \|\mathbf{E}(\mathbf{x})\|_2$
- optimized geometry and NURBS in Figure 5
- **results**:

	$(V_{\text{el}} - 625)$ in cm^3	$\max_{\mathbf{x}\in\Omega} \|\mathbf{E}(\mathbf{x})\|_2$ in $\frac{\text{MV}}{\text{m}}$ (IGA)	$\max_{\mathbf{x}\in\Omega} \|\mathbf{E}(\mathbf{x})\|_2$ in $\frac{\text{MV}}{\text{m}}$ (CST)
initial	-310.945	13.528	13.056
optimized	-69.551	9.203	9.335

- corresponding electric field (IGA) for $p = 3$, $n_{\text{sub}} = 16$, $V_{\text{el}} = -300$ kV and $V_{\text{ar}} = 1$ kV, see Figure 6
- corresponding electric field (CST) for second order tetrahedral elements, see Figure 7

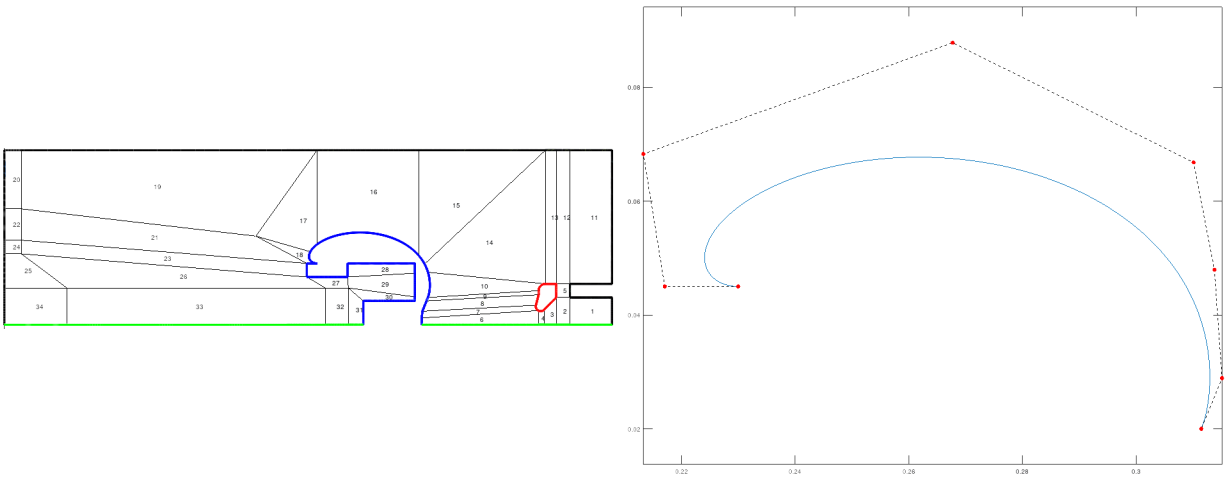

Figure 5: Optimized geometry and NURBS.

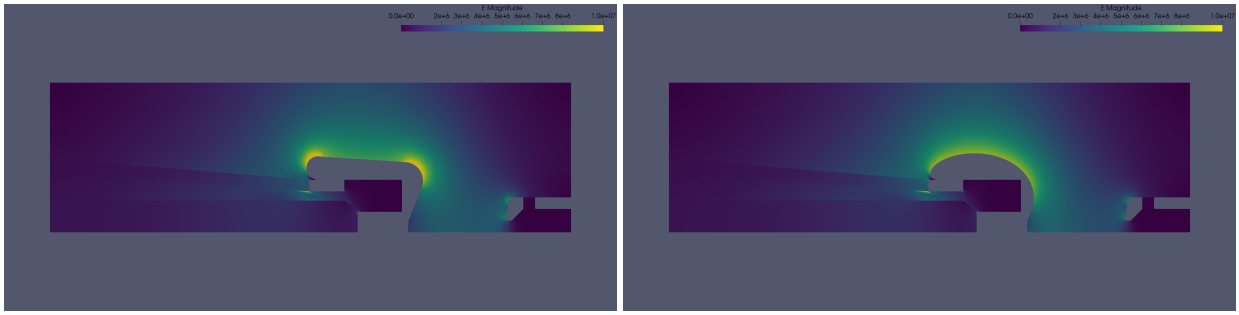

Figure 6: Electric field of original and optimized geometry computed with GeoPDEs.

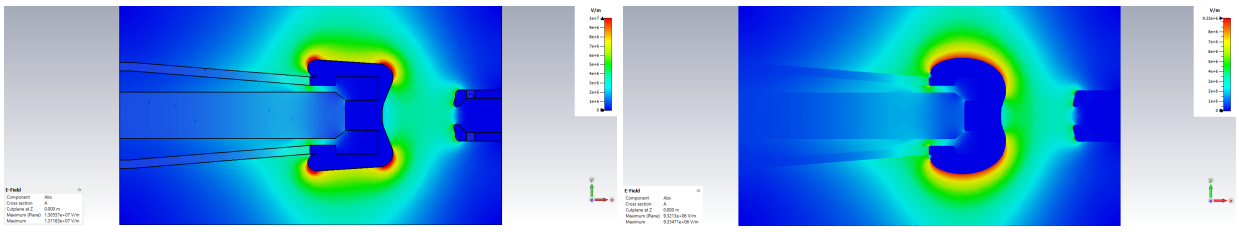

Figure 7: Electric field of original and optimized geometry computed with CST.

References

[1] Markus Wagner. “Production and investigation of pulsed electron beams at the S-DALINAC”. PhD thesis. Technische Universität Darmstadt, 2013.