

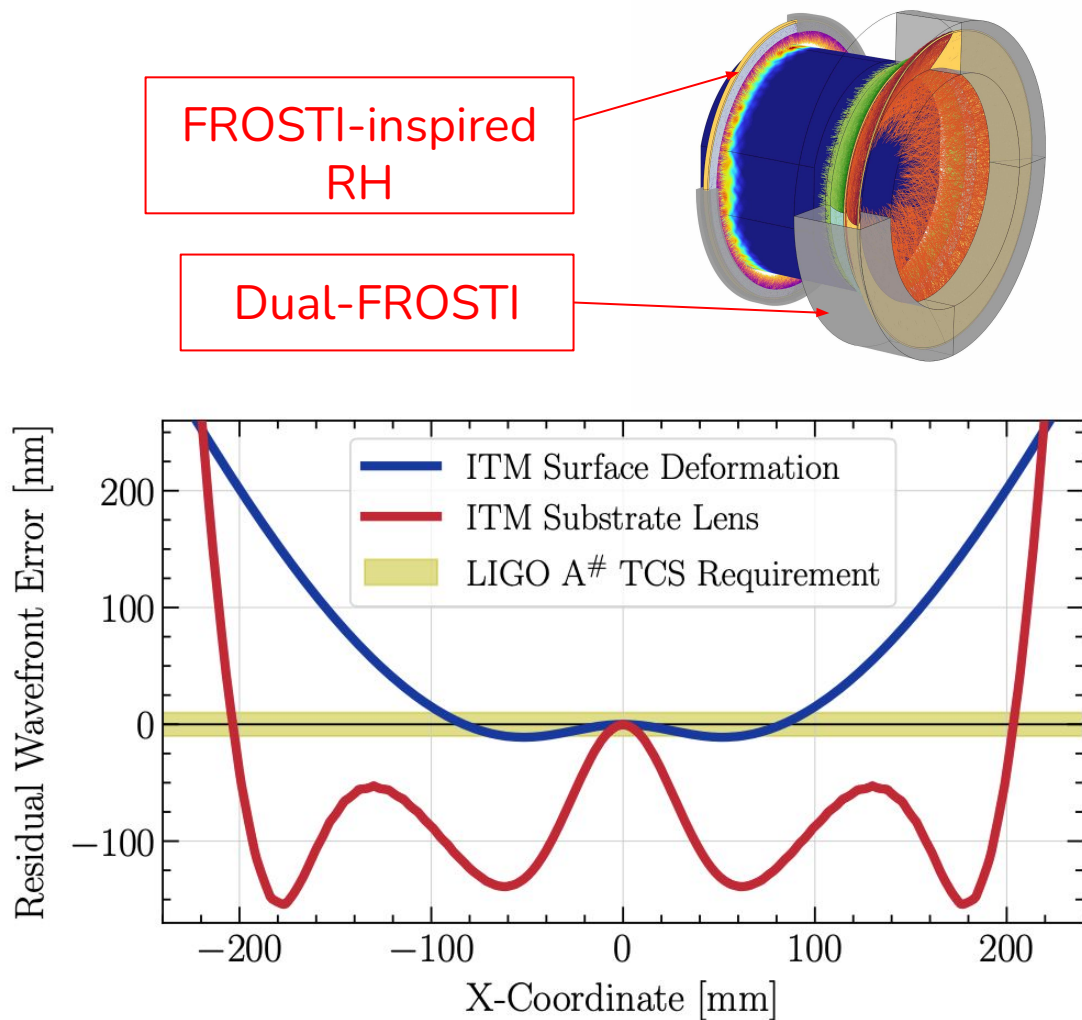
Updates 11/19/25

A# FROSTI Optical Profiles/Element Size Constraint Analysis

FROSTI A# Analysis

Approach

- Goal: Determine optimal FROSTI profile
- Local metric optimization
 - SURF/OPD residual RMS of ITM
 - Self-heating, RH, and FROSTI
 - Minimize SURF, leave quadratic OPD residual
- Context: Preserve squeezing!
 - Residual substrate lensing can reduce our capability.



Local Metric Optimization

- Loss function:

$$\mathcal{L} = \text{RMS}_{\text{SURF}} + (\text{RMS}_{\text{OPD}} - \alpha r^2)$$

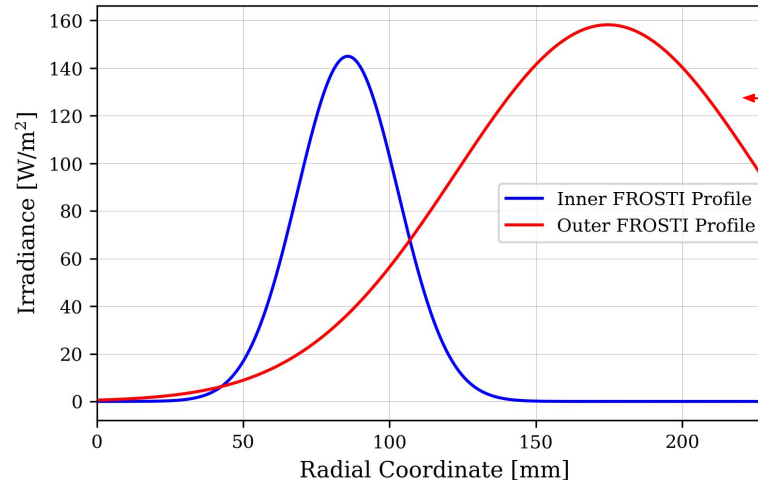
- For OPD: best fit quadratic trend subtracted from residual, then compute RMS
- If needed, can scale SURF RMS by constant to “balance” loss function.

- Multi-FROSTI Free Parameters:
 - Radial positioning on HR surface (for each)
 - Profile width (for each)
 - Power (Multi-FROSTI, RH)
- For second pass (to be implemented):
 - RH longitudinal positioning
- Particle Swarm Optimization

Initial Results

Fixed RH: 95 mm from AR surface (85.54 W)

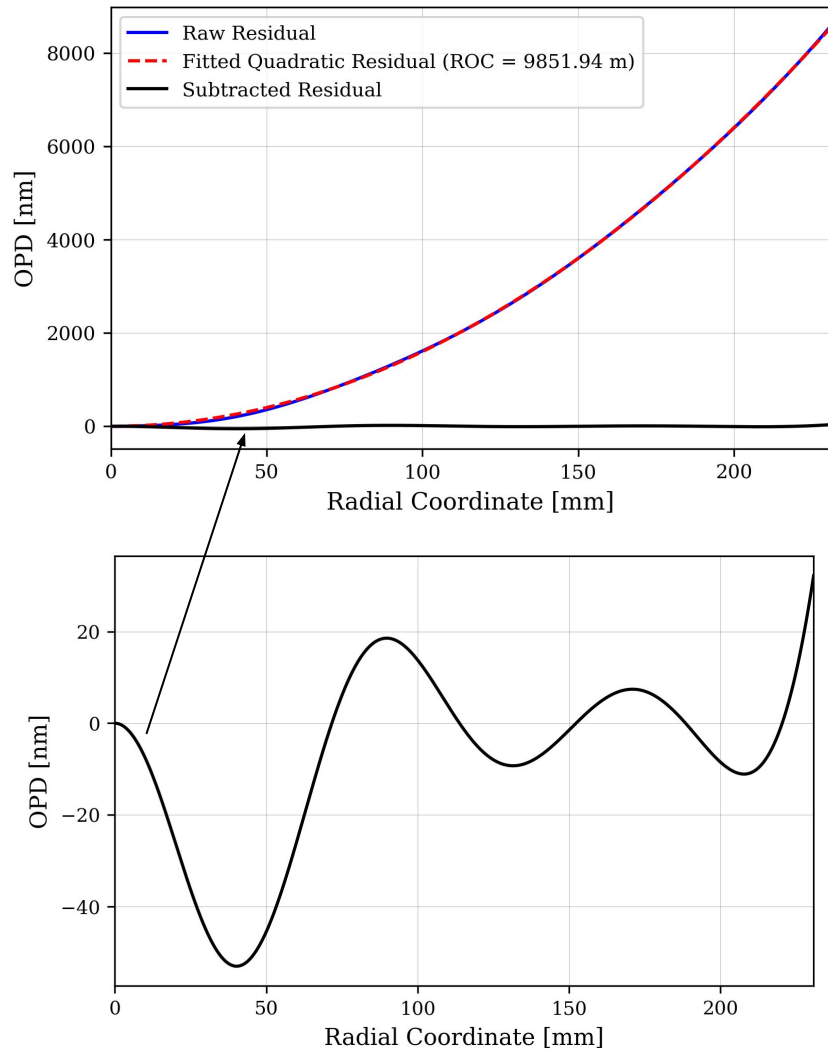
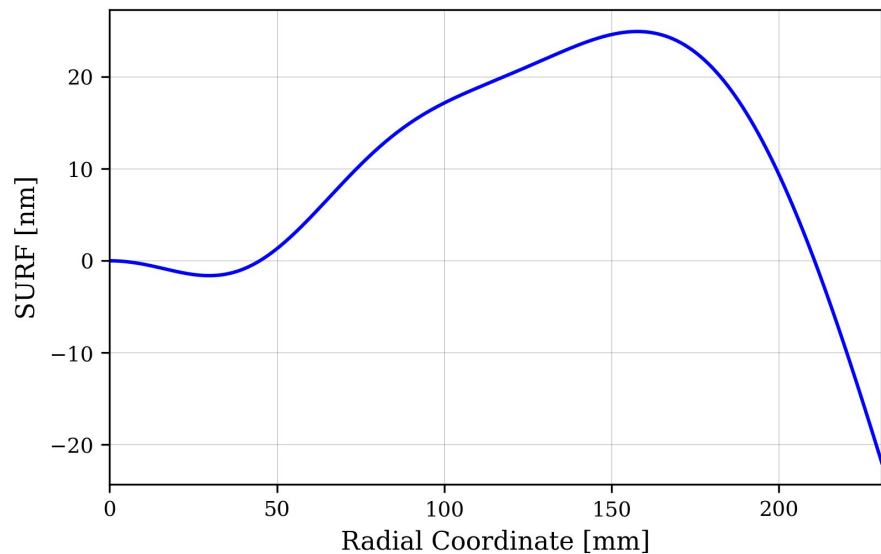
Profile	HR Location (mm)	Profile Width (mm)	Power (W)
Inner	76.599	42.037	5.09
Outer	186.131	94.014	46.69



Too wide?

SURF/RMS Profiles

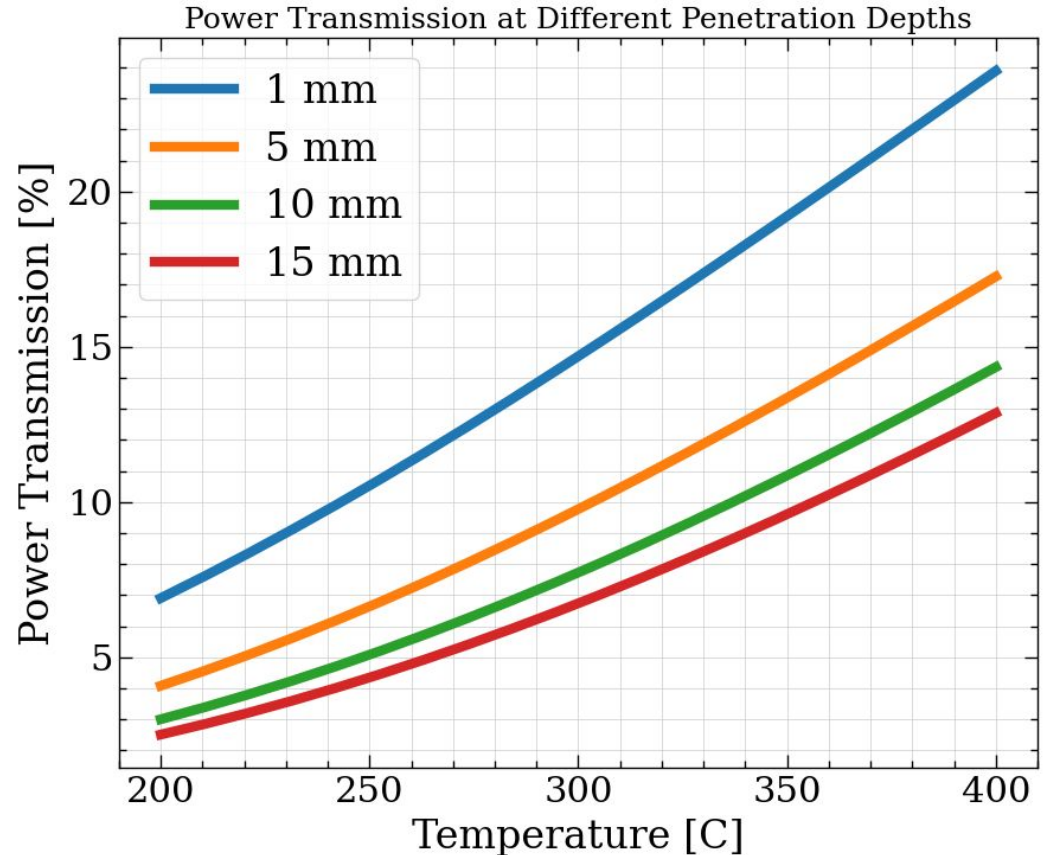
- Initial observation: OPD too large?
 - Change weighting in loss function for optimization?



Element Width Constraint

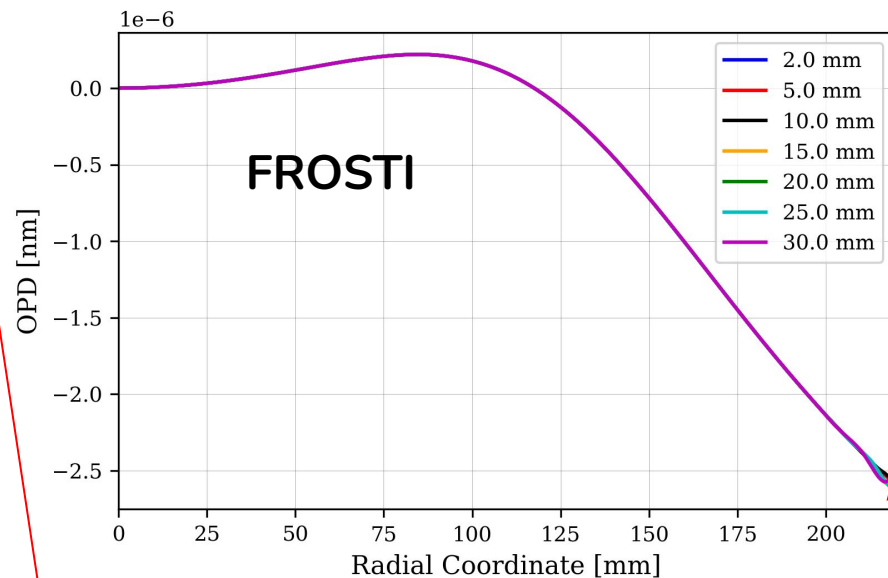
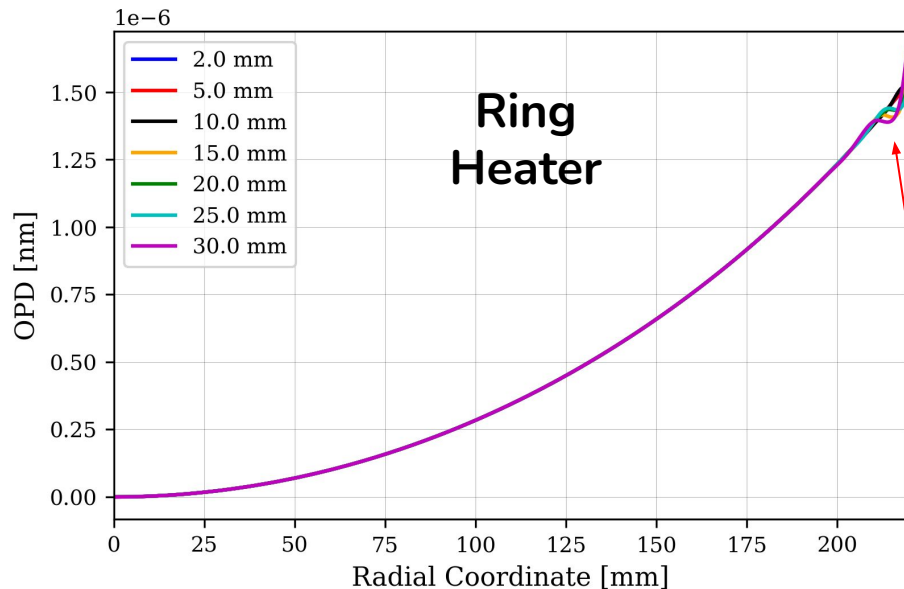
Penetration Depth

- Can we continue using surface absorption assumption?
 - Mesh convergence analysis can answer this question
- Less than 10% power transmission at 1 cm for temperatures beneath ~340 C.
- If we can use a resolution coarser than this, and simulation results converge, our surface assumption should be valid.
 - Metric: SURF, OPD residual RMS



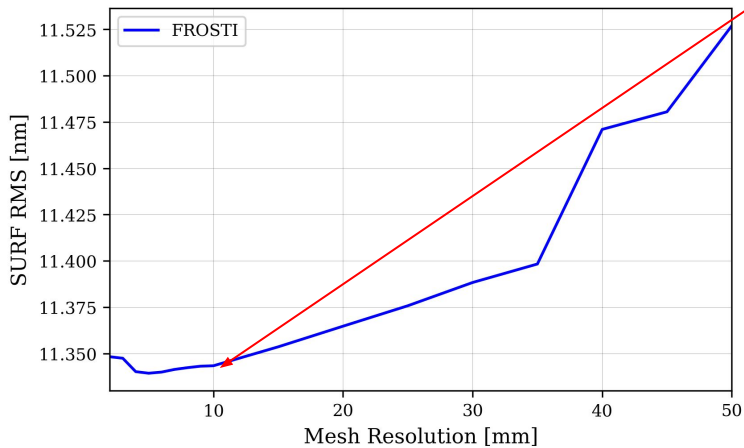
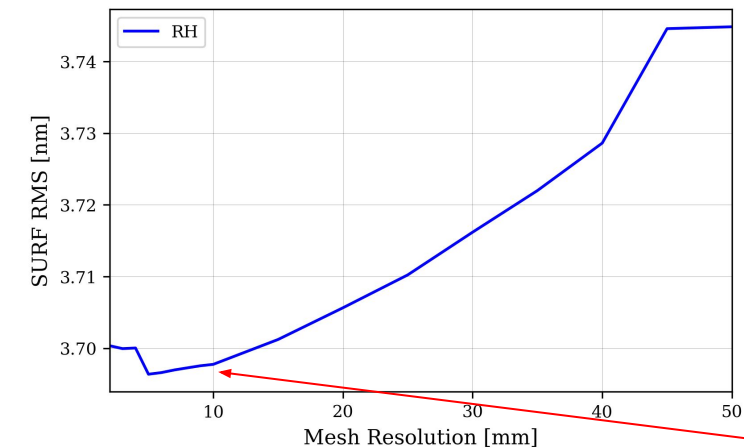
COMSOL Residual OPDs for Different Resolutions

Insert RH and FROSTI Irradiances, compute response, get RMS

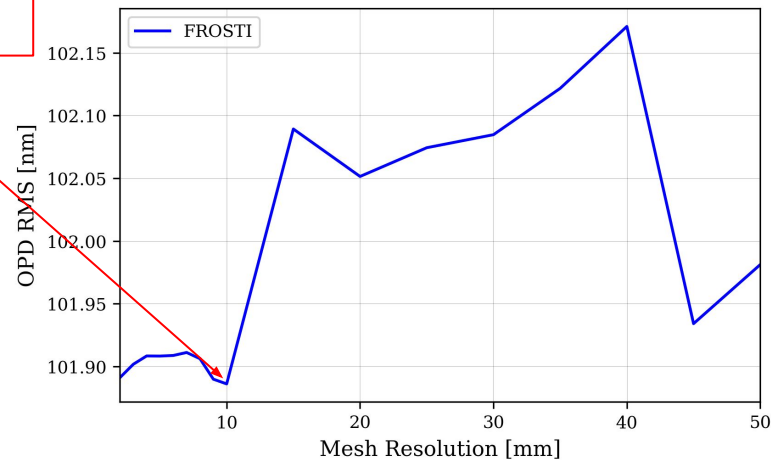
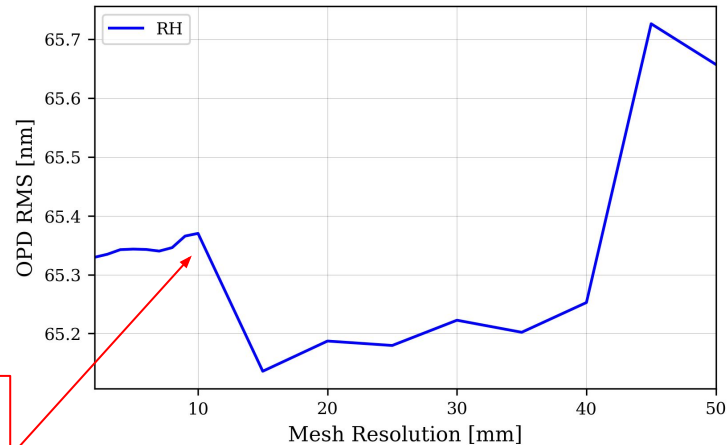


Edge artifacts worsen with
coarser resolutions!

RMS Results

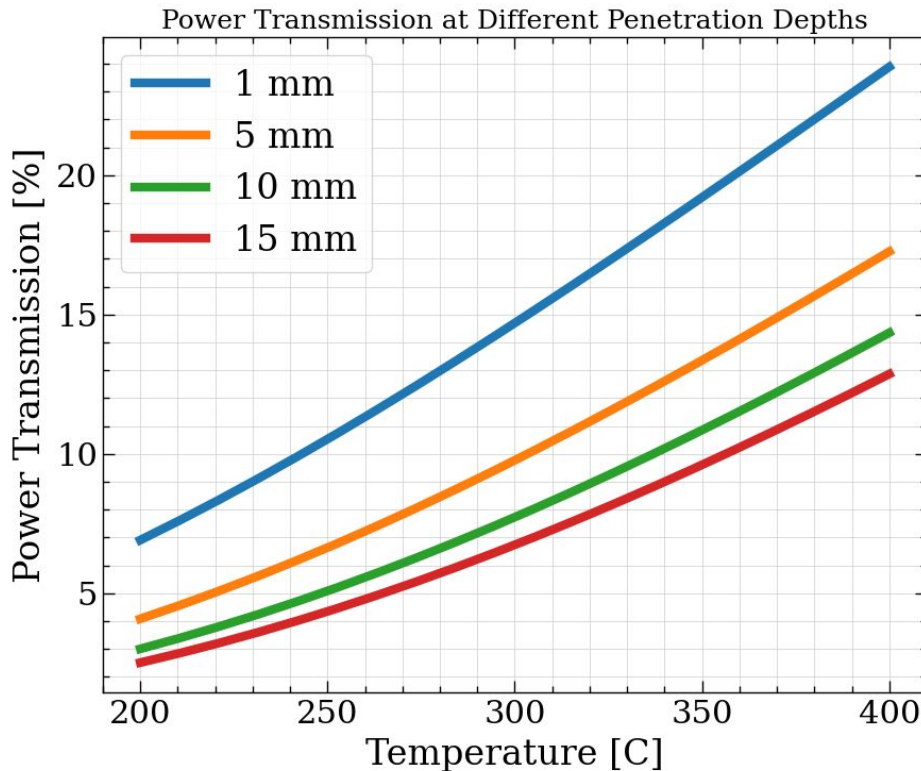
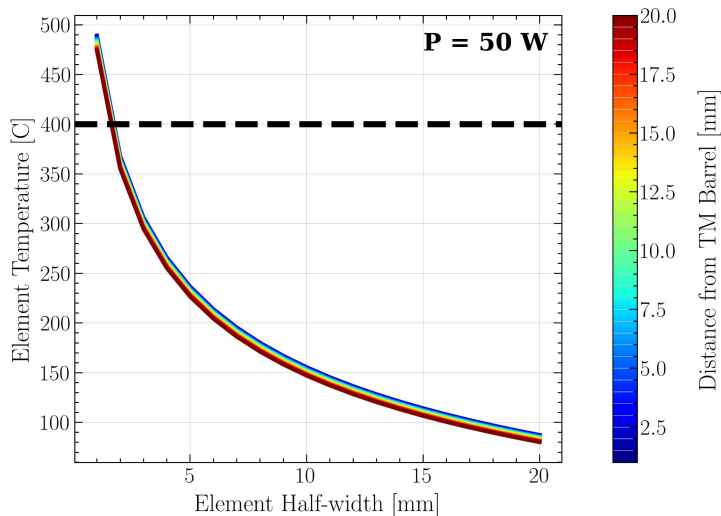


Convergence
roughly around
~10 mm



Penetration Depth

- 300 C: Less than 10% transmission at 10 mm (1 cm) depth.
- If 10% is too high, we can make element width larger to compensate for lower emitting temp.



Extra Slides

Power Transmission at Different Depths

