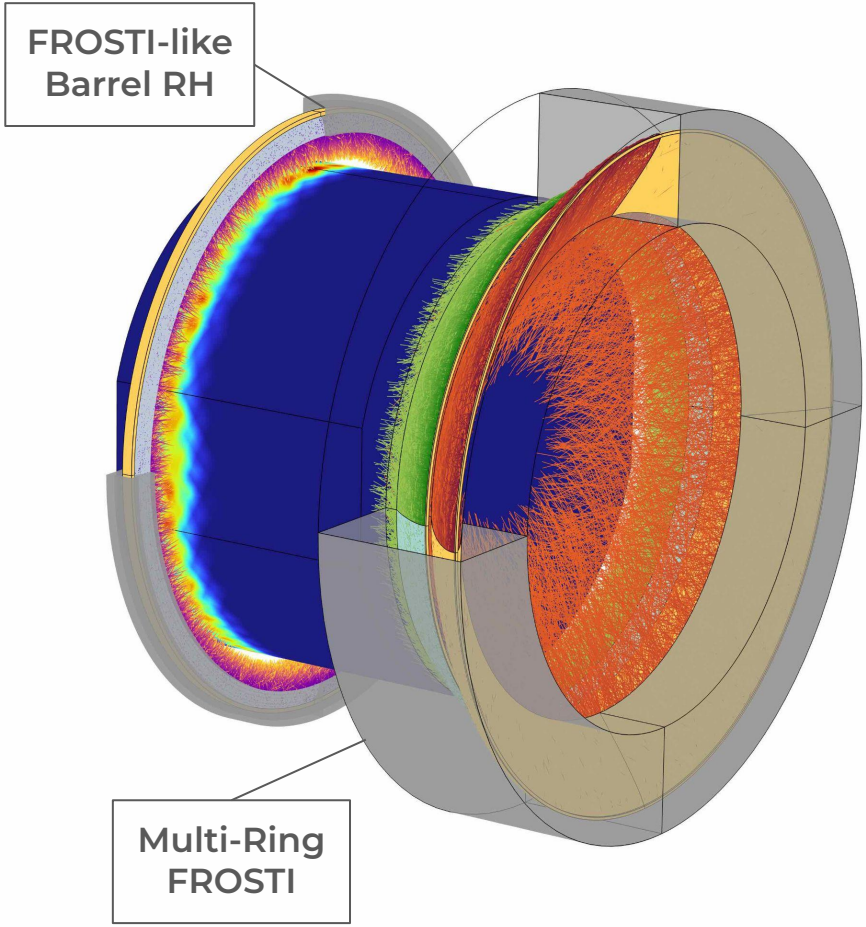
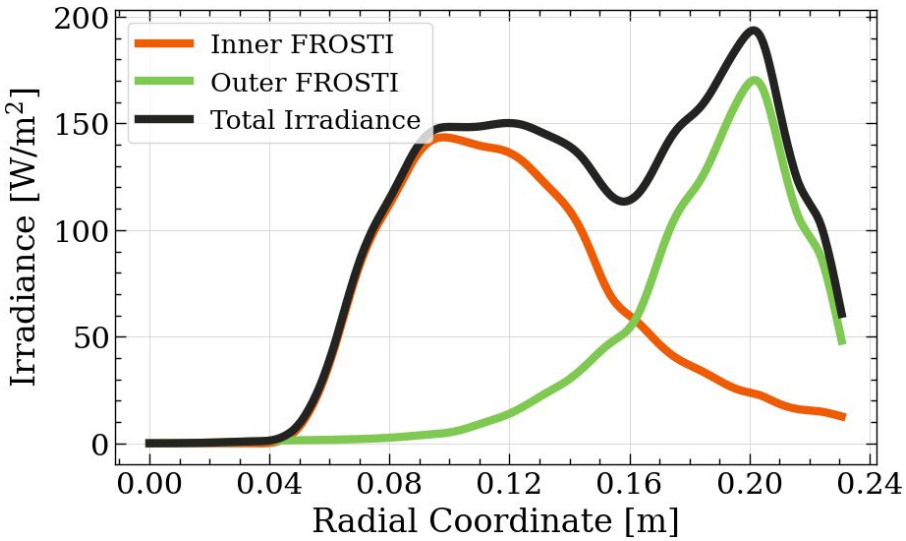
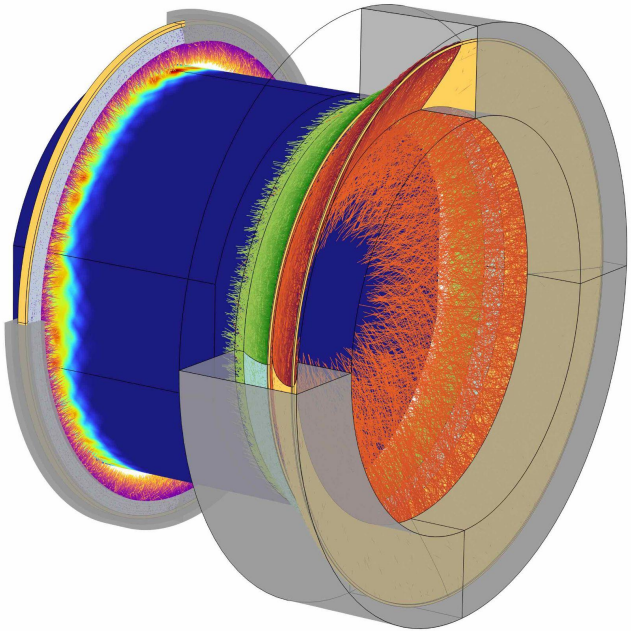
Multi-Ring FROSTI for Finer Actuation





Complex total irradiance profile
→ more precisely targeted
wavefront corrections for A#

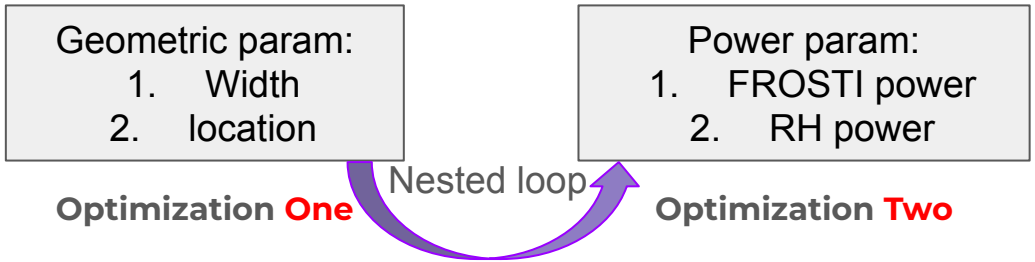
Multi-Ring FROSTI Design for A# and CE



Design parameter space optimization

To minimize both the surface and subtract wavefront RMSE, with at least two FROSTI-like heater rings, we have

1. Width, location and individual power for each irradiance ring, DoF=2*3=6;
2. Ring heater power, DoF=1;
3. In total 7D parameter space exploration.



For each step in optimization loop one, we need to run an FEA model over the width and locations.

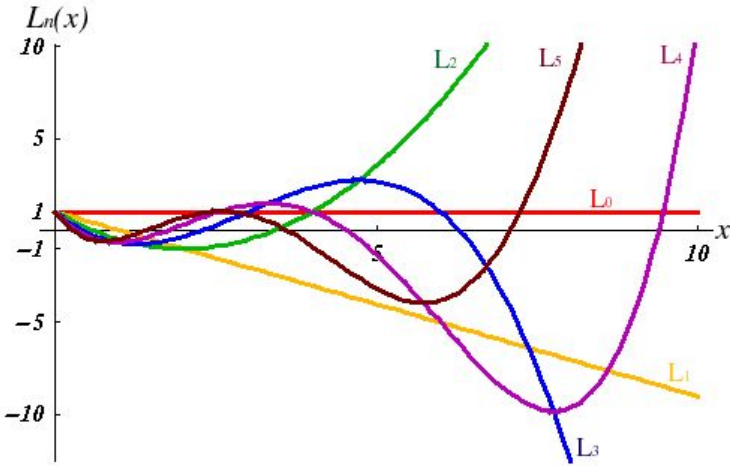
Laguerre-Based Surrogate Optimization

Laguerre decomposition:
1. You only compute once.
2. No need to simulate FEA model at **every** step.

Geometric param:
1. Width
2. location

Power param:
1. FROSTI power
2. RH power

Optimization One Nested loop **Optimization Two**



Surrogate model via interpolation/ML for the thermal response over the entire geometric space.

FEA on the fly →→ Look up table

$$\vec{c}_{\text{total}} = \sum_{k=1}^{K} P_k \cdot \vec{c}(r_{0,k}, \sigma_k) + P_{\text{RH}} \cdot \vec{c}_{\text{ring}}$$

Radially symmetric, Laguerre polynomials, larger n → higher spatial frequency

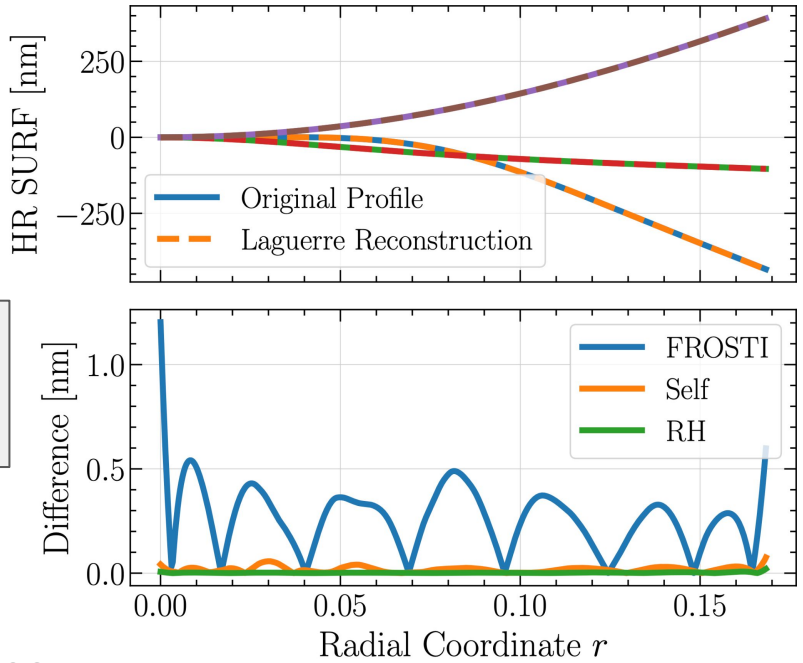
Laguerre-Based Surrogate Optimization

Laguerre decomposition:
1. You only compute once.
2. No need to simulate FEA model at **every** step.

Geometric param:
1. Width
2. location

Power param:
1. FROSTI power
2. RH power

Optimization One Nested loop **Optimization Two**



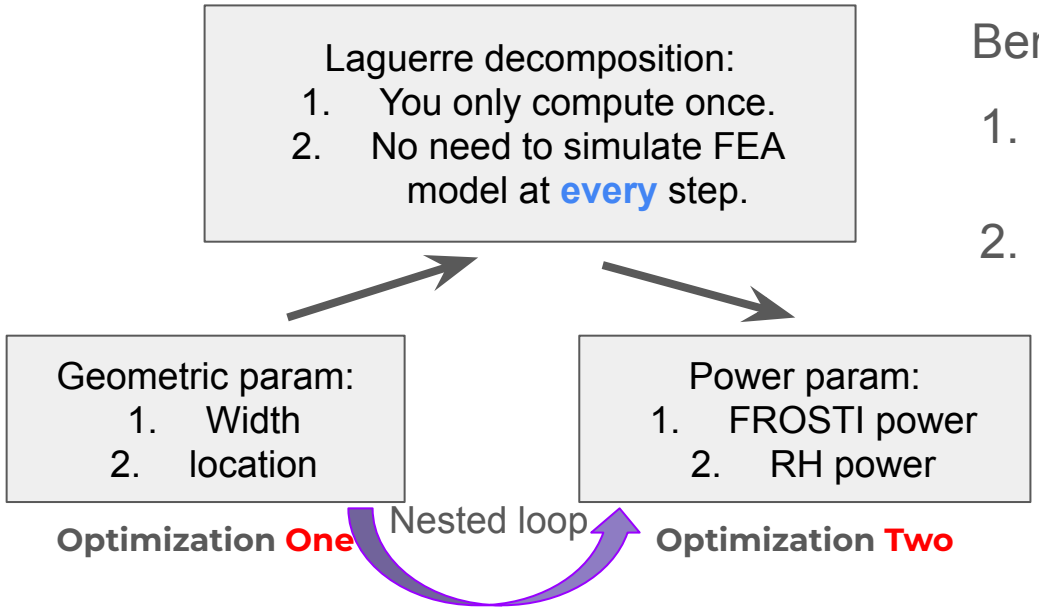
Surrogate model via interpolation/ML for the thermal response over the entire geometric space.

FEA on the fly →→ Look up table

$$\vec{c}_{\text{total}} = \sum_{k=1}^{K} P_k \cdot \vec{c}(r_{0,k}, \sigma_k) + P_{\text{RH}} \cdot \vec{c}_{\text{ring}}$$

Example Laguerre decomposition (n<=10) for the thermal deformation due to FROSTI, Self heating and RH

Laguerre-Based Surrogate Optimization



Surrogate model via interpolation/ML for the thermal response over the entire geometric space.

FEA on the fly →→ Look up table

$$\vec{c}_{\text{total}} = \sum_{k=1}^{K} P_k \cdot \vec{c}(r_{0,k}, \sigma_k) + P_{\text{RH}} \cdot \vec{c}_{\text{ring}}$$

Benefit of this approach:

1. Less computation time and much more efficient parameter search.
2. More flexible loss function. E.g. emphasize the suppression of low-order aberrations.

$$\mathcal{L}_{\text{total}} = \mathcal{L}_E + \beta\, \mathcal{L}_{\text{RMS}}$$

$$\mathcal{L}_E(\{r_{0,k}, \sigma_k, P_k\}, P_{\text{RH}}) = \sum_{n=0}^{N-1} w_n \cdot (c_{\text{res},n})^2$$

$$\mathcal{L}_{\text{RMS}} = \sqrt{\int_0^R [h_{\text{res}}(r)]^2\, r\, dr}$$