Any Light Particle Search II

Shining light through the magnet string with beam propagation methods

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Background

- Dieter observed interference patterns in his June 2011 measurements

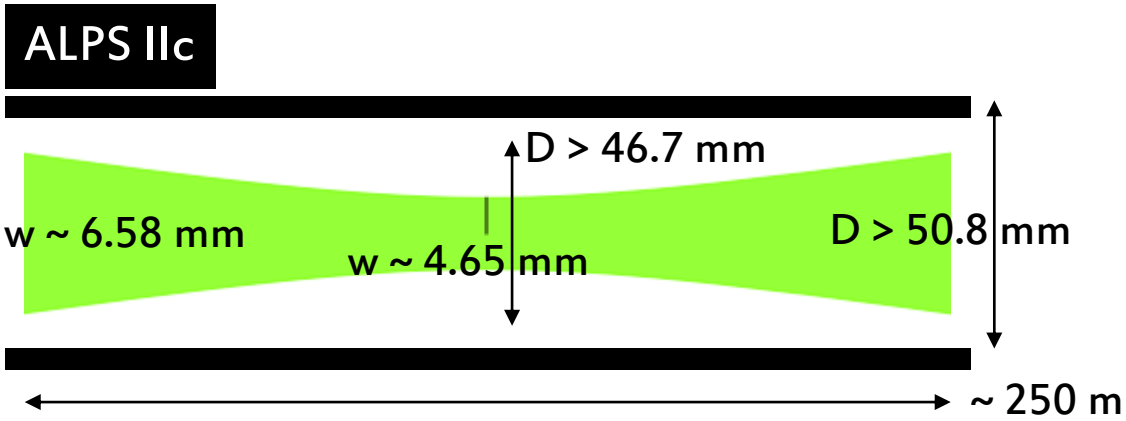
- Does interference invalid the current aperture scanning concept with power drop measurements?
  - Potentially yes
  - But we can simply change the boundary criterion to the observation of interference patterns instead of power drop

- Dieter also tried an imaging measurement back then
  - The results are interesting, but does not meet the 0.5 mm / 5 urad goal
  - Rayleigh criterion: 1.22 * 543nm / 50mm ~ 13 urad

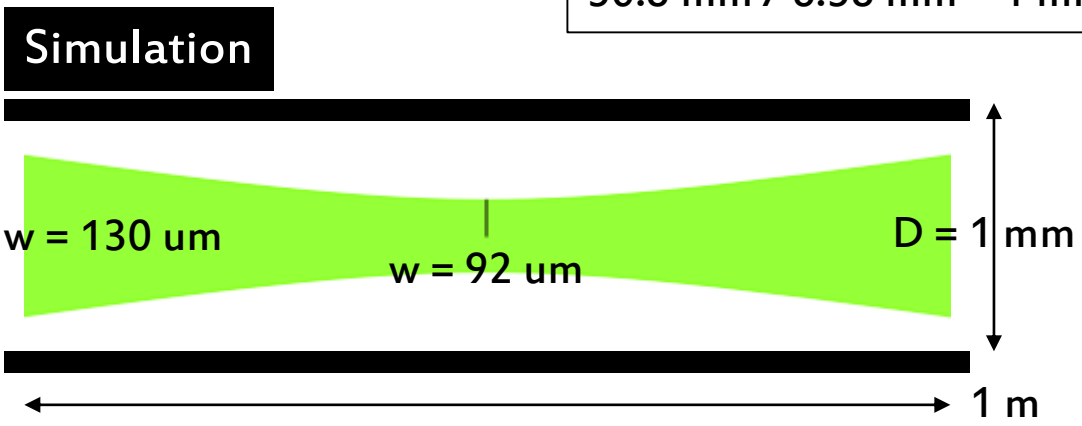
- Ray-tracing?

Simulations

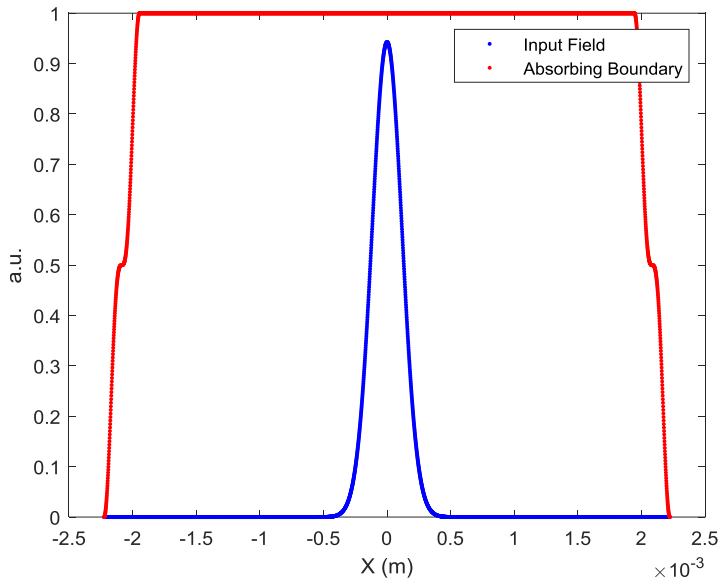
- Split-step FFT beam propagation method, 1D
- Only for a qualitative picture, quantitative results take too long
- Scaled-down analogy

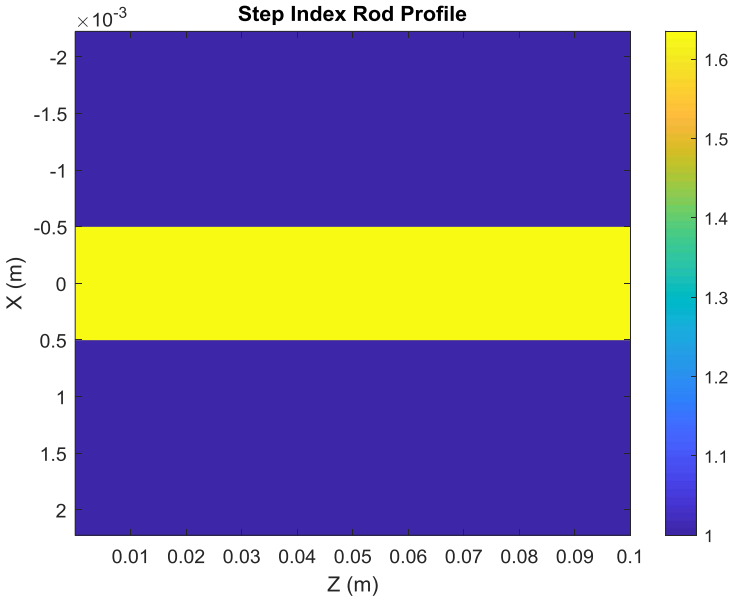


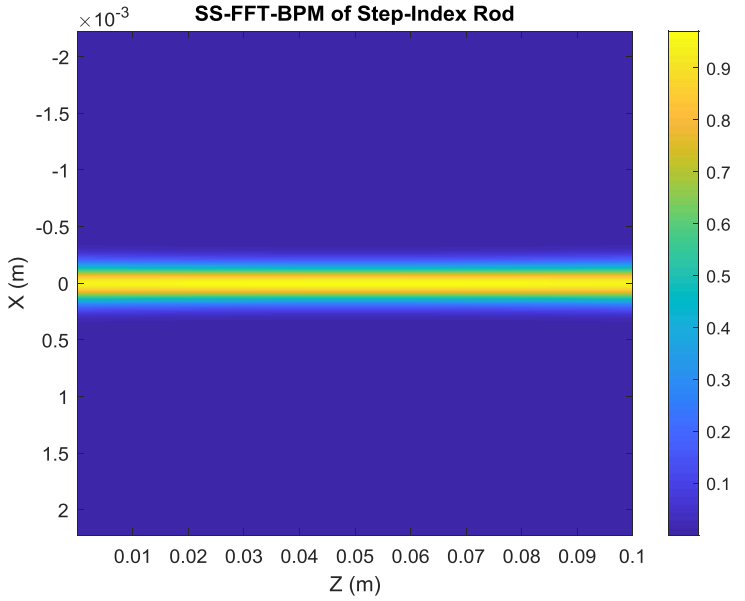
50.8 mm / 6.58 mm ~ 1 mm / 130 um

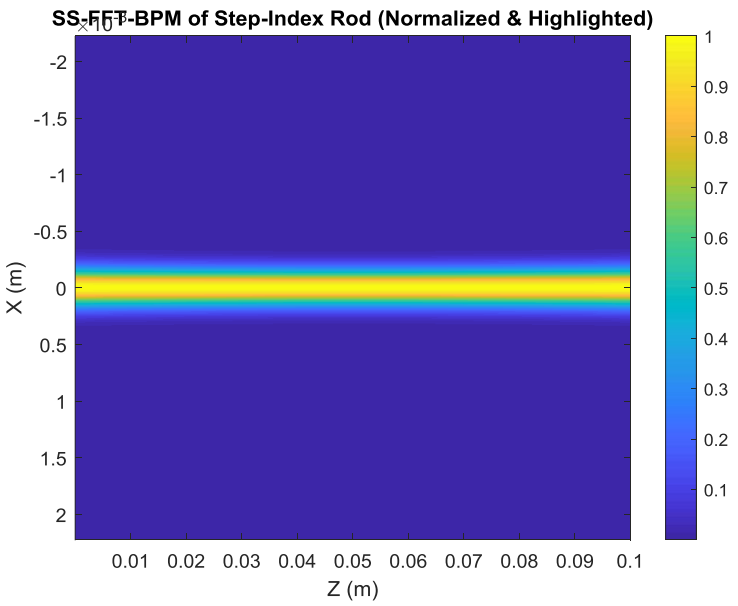


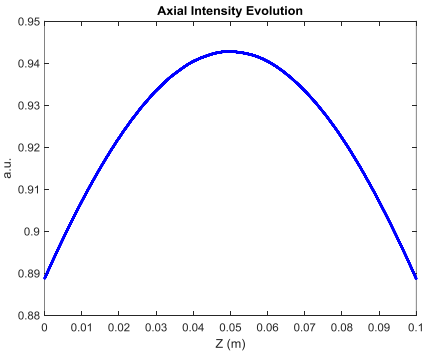
Simulation setup



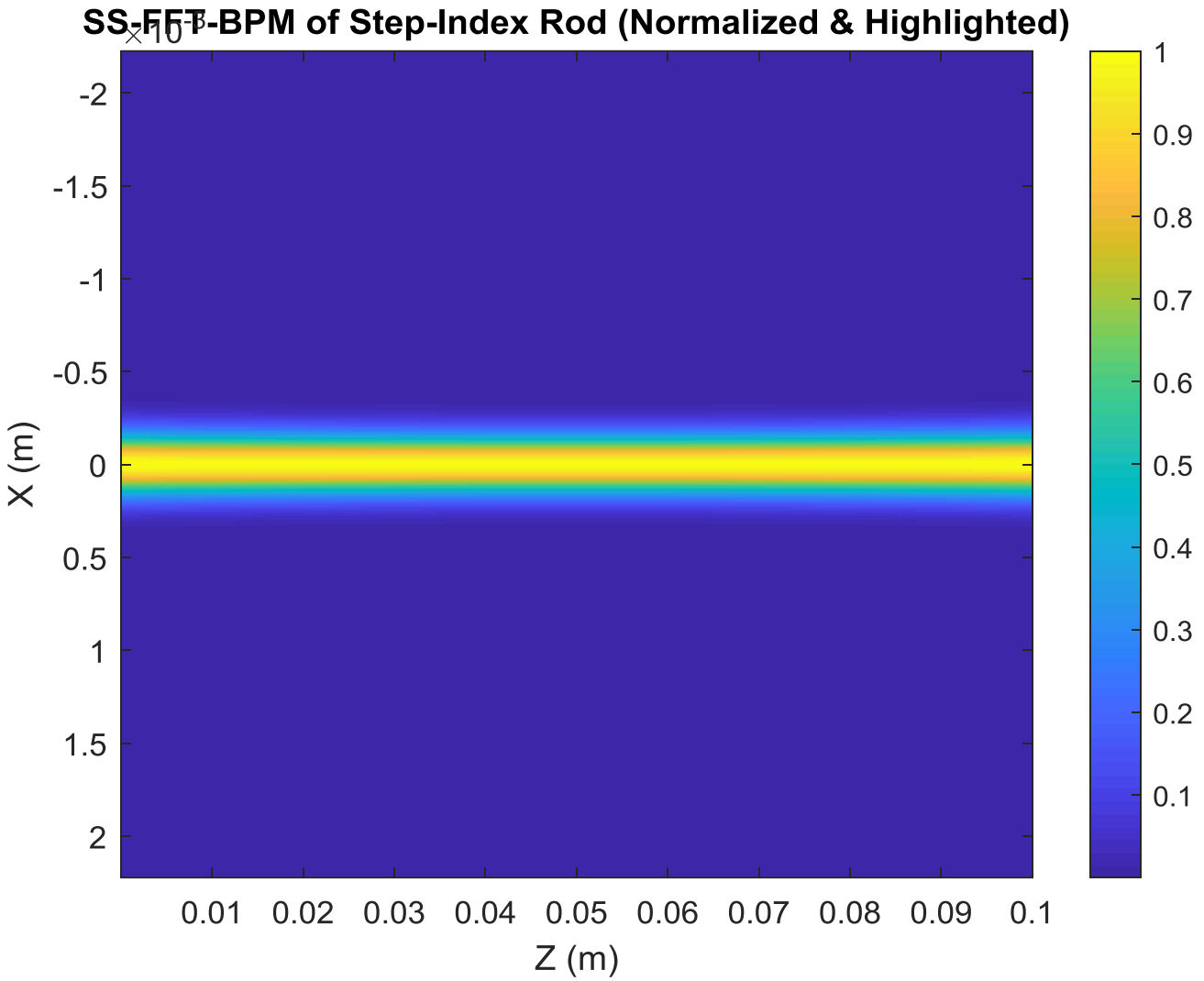




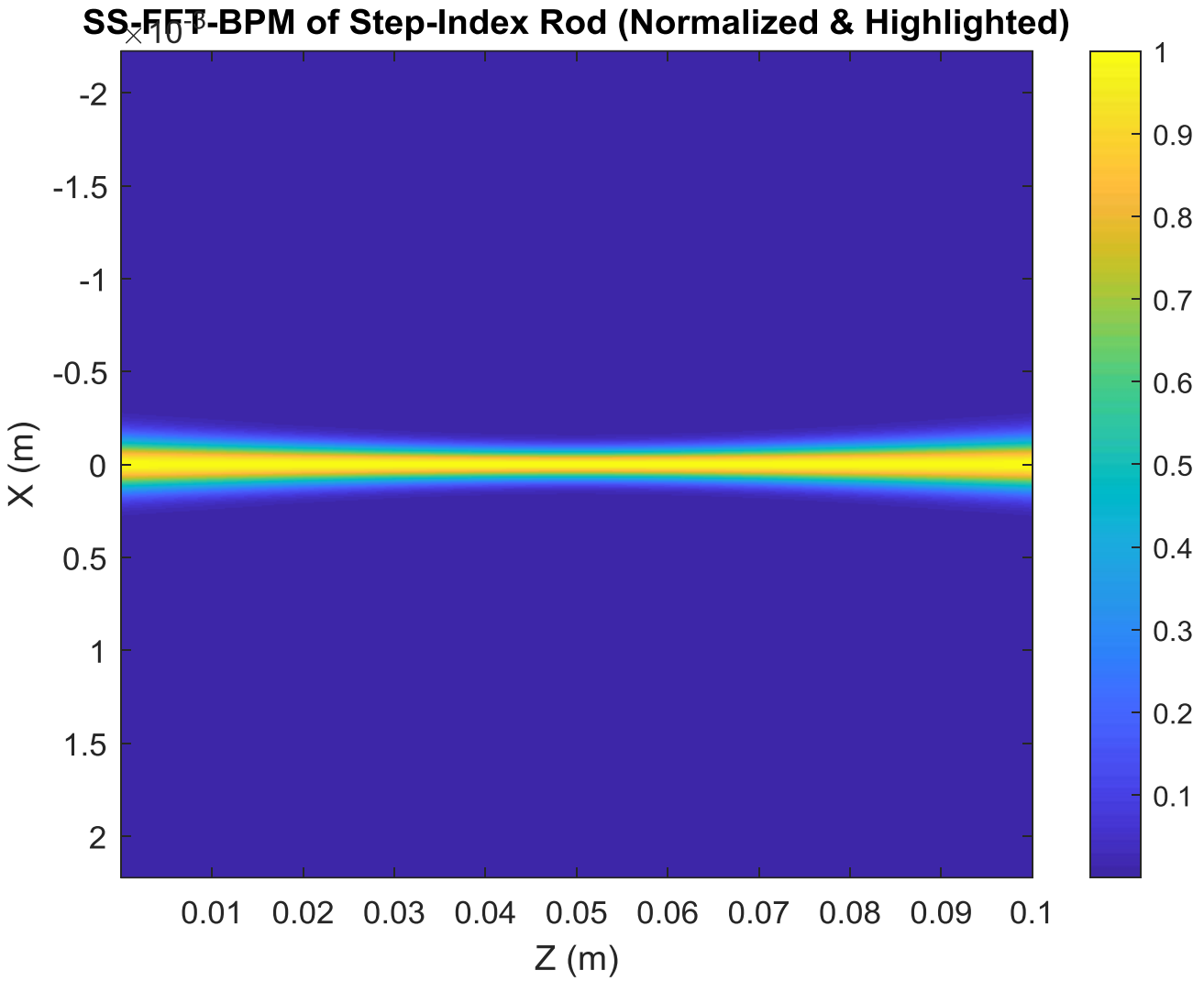




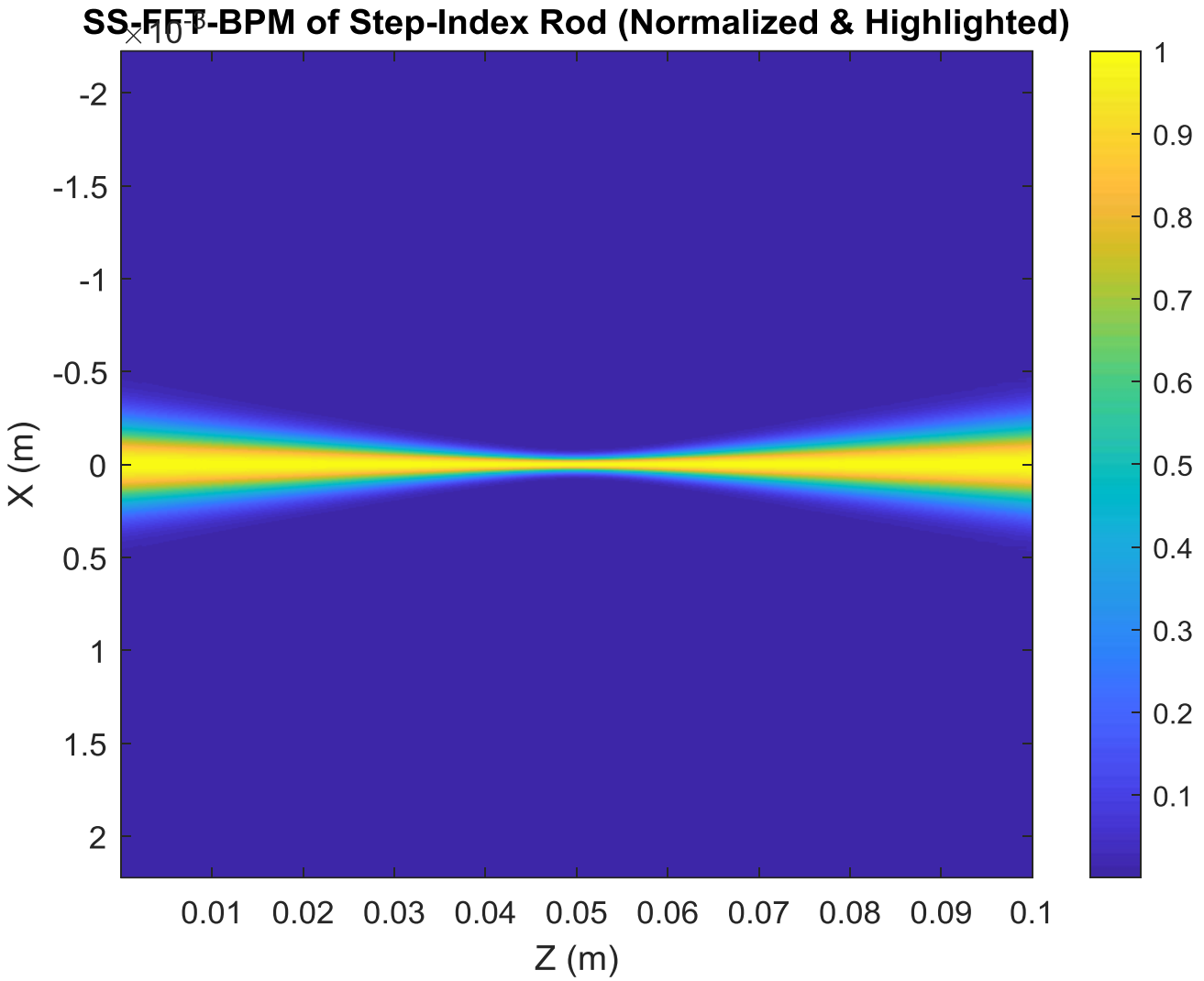
Results: w = 92 um



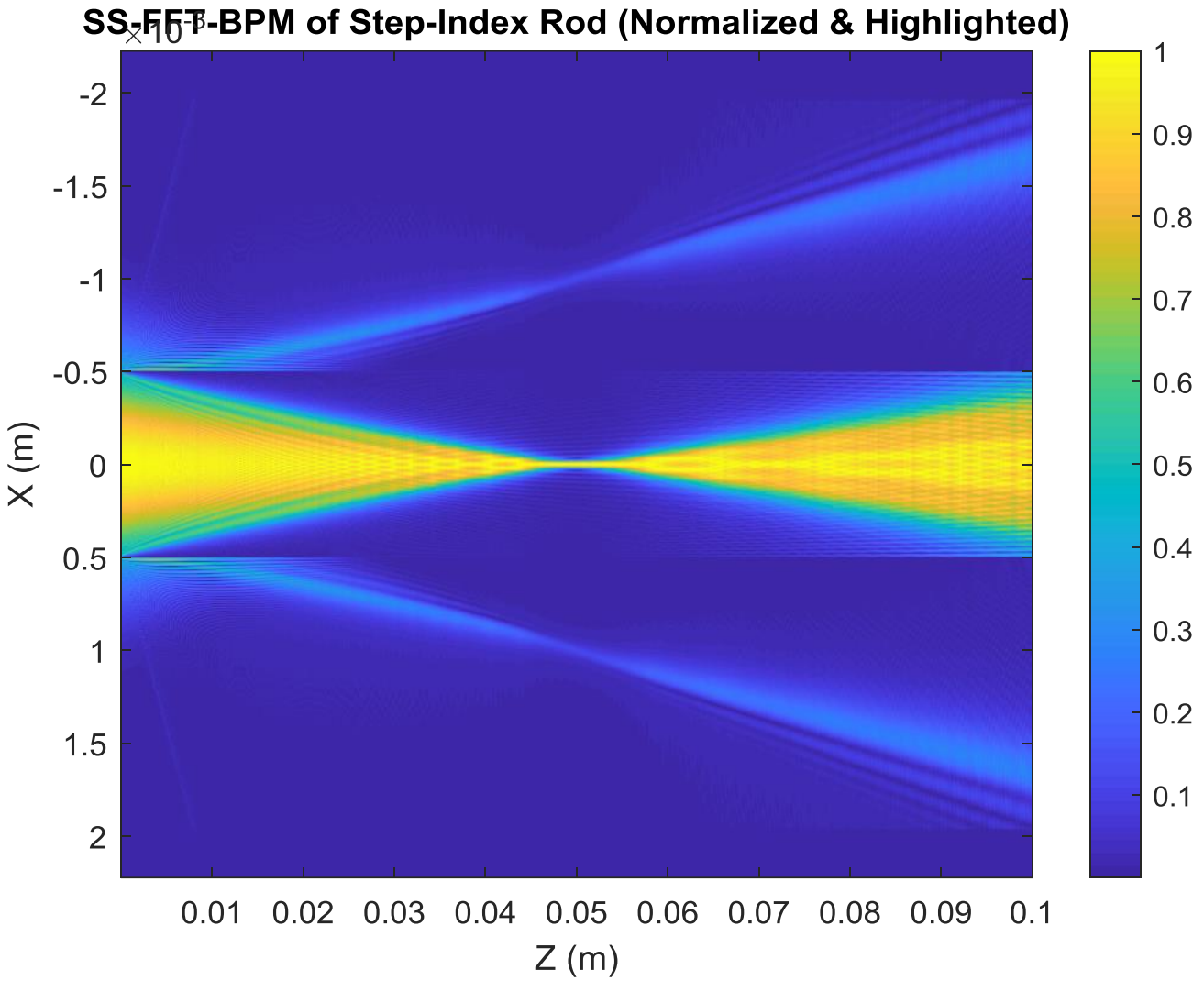
Results: w = 46 um



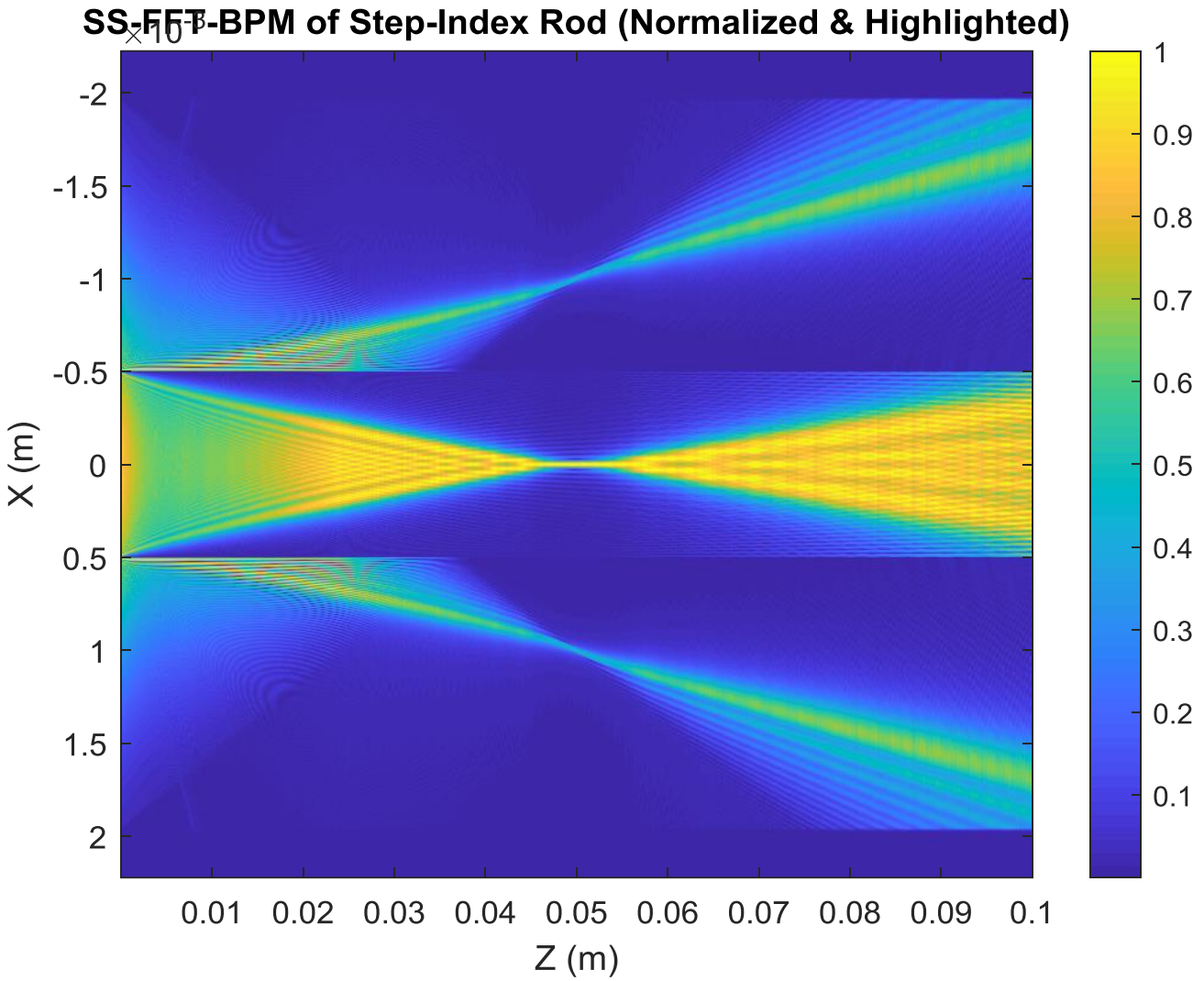
Results: w = 23 um



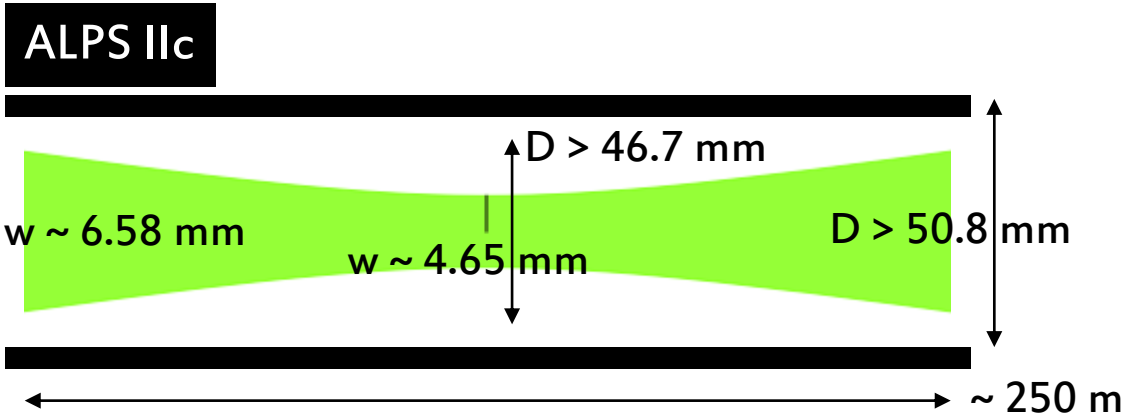
Results: w = 9.2 um



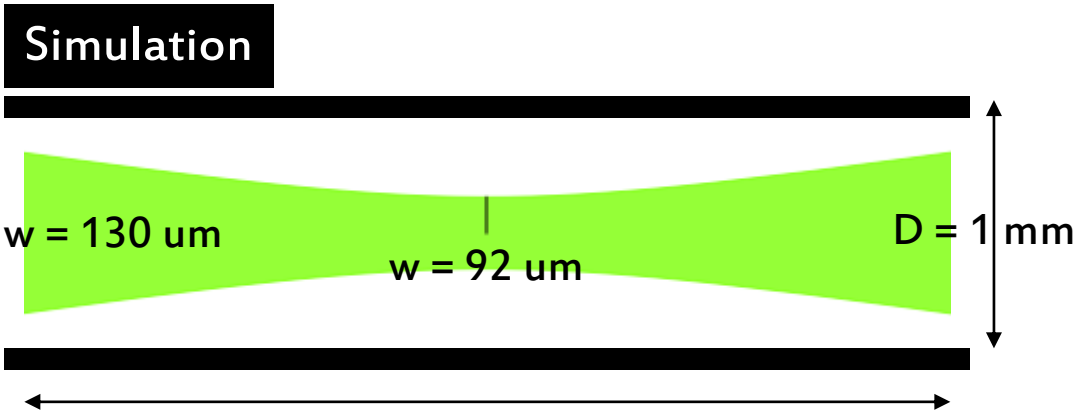
Results: w = 4.6 um



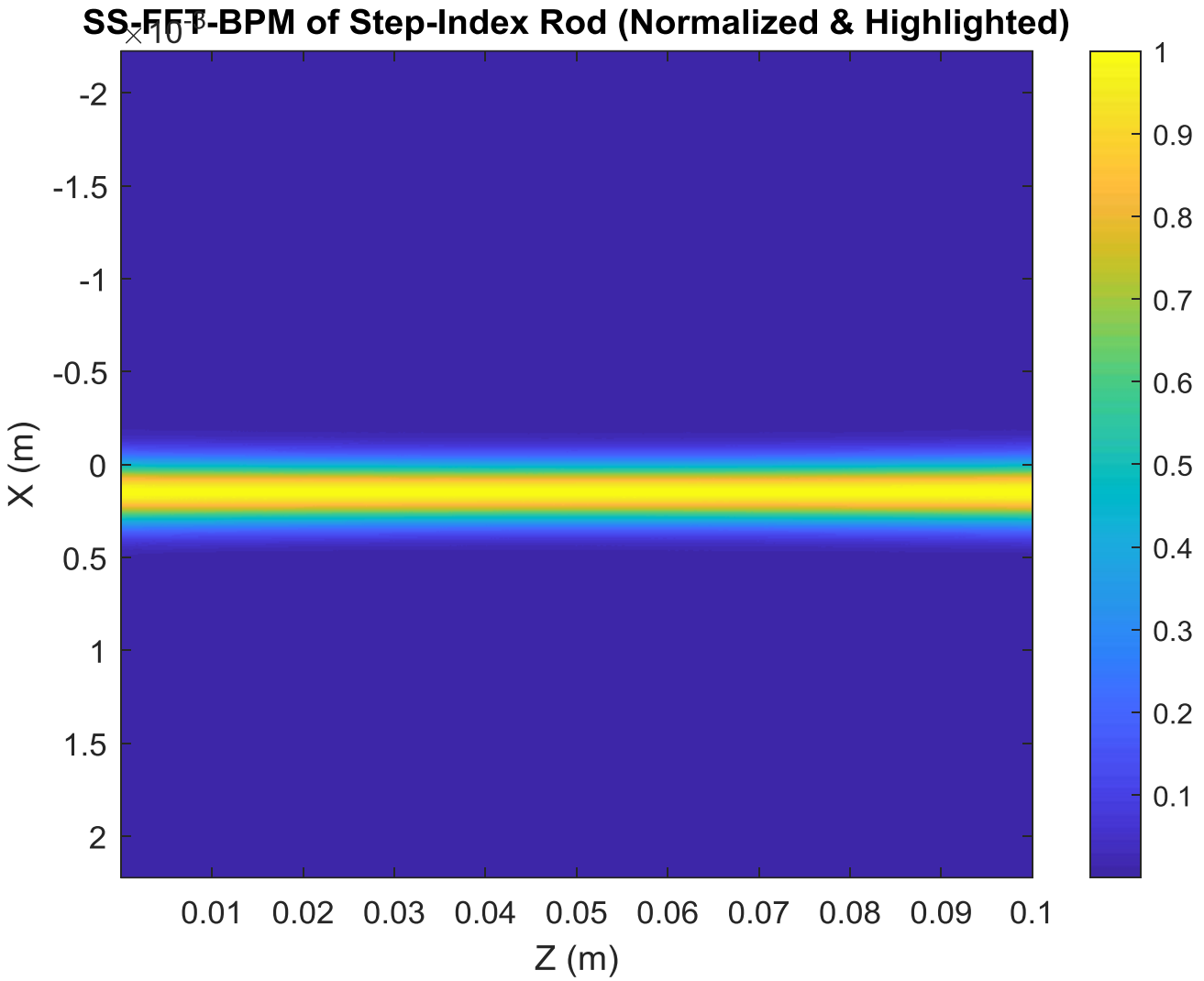
Lateral translation mimic: 50 mm → 1mm



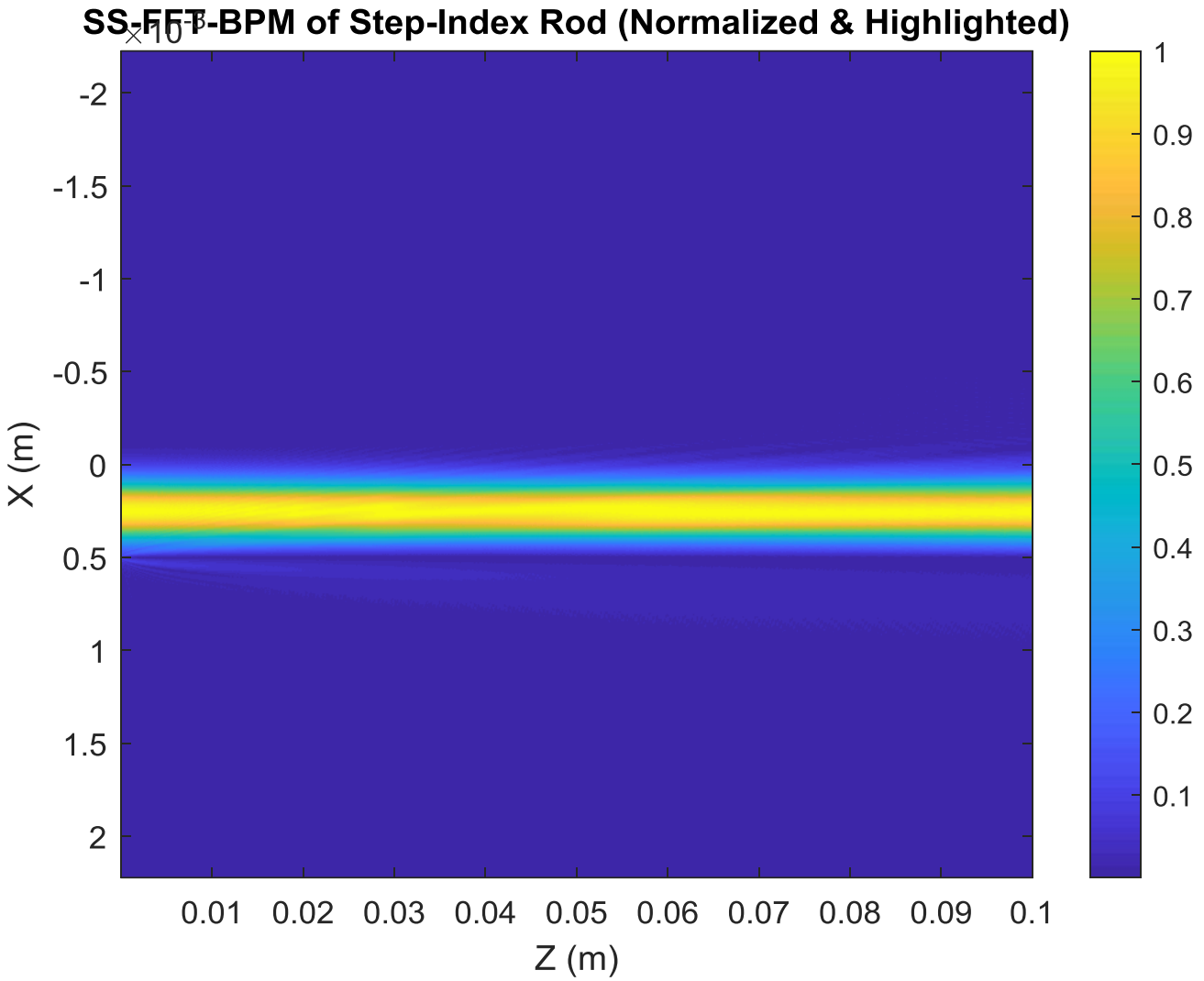
Power drop simulations show a needed offset of ~ 20 mm,
which is ~ 80% of the aperture radius → 0.4 mm in the simulation



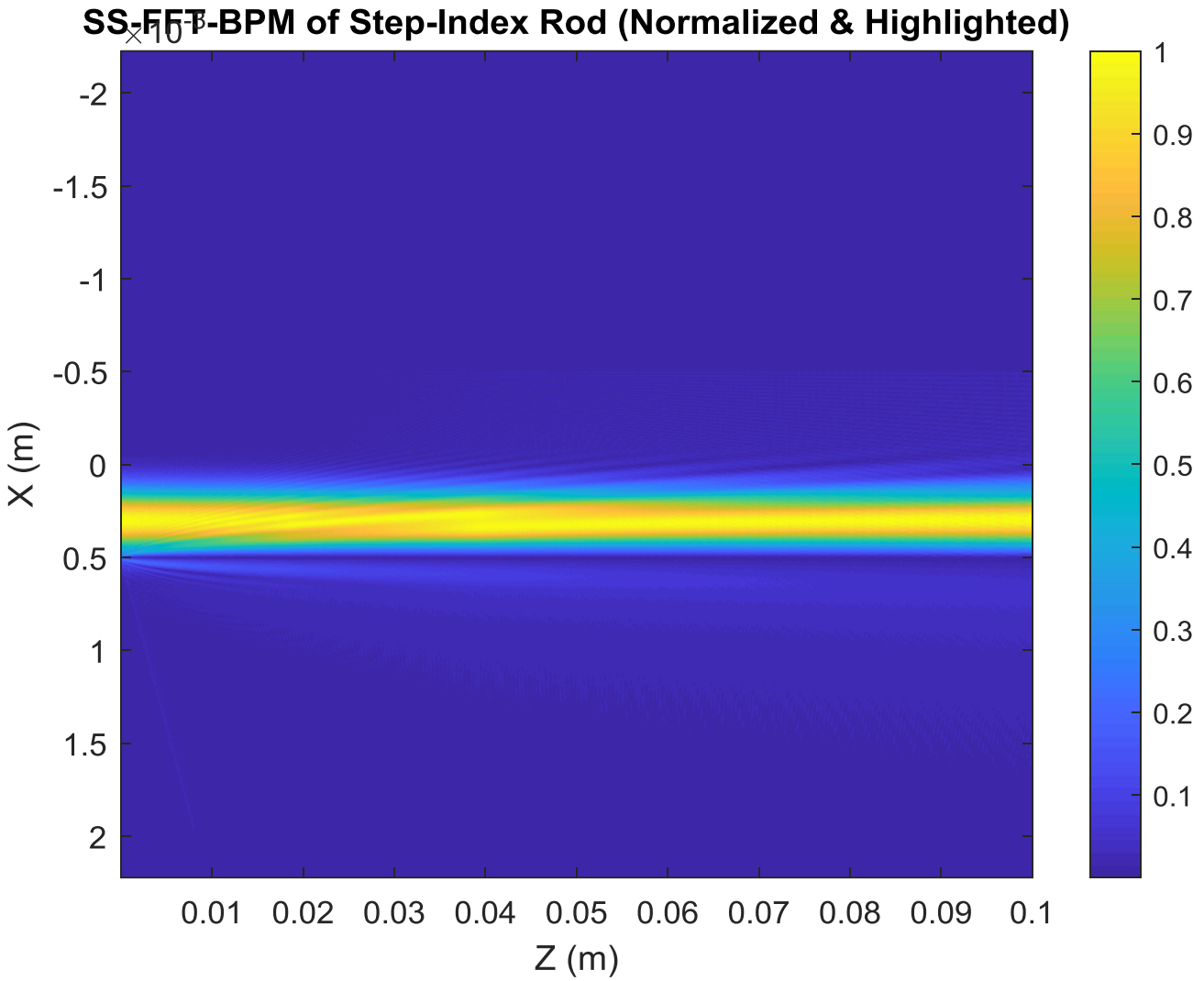
Results: w = 92 um, 0.15 mm offset



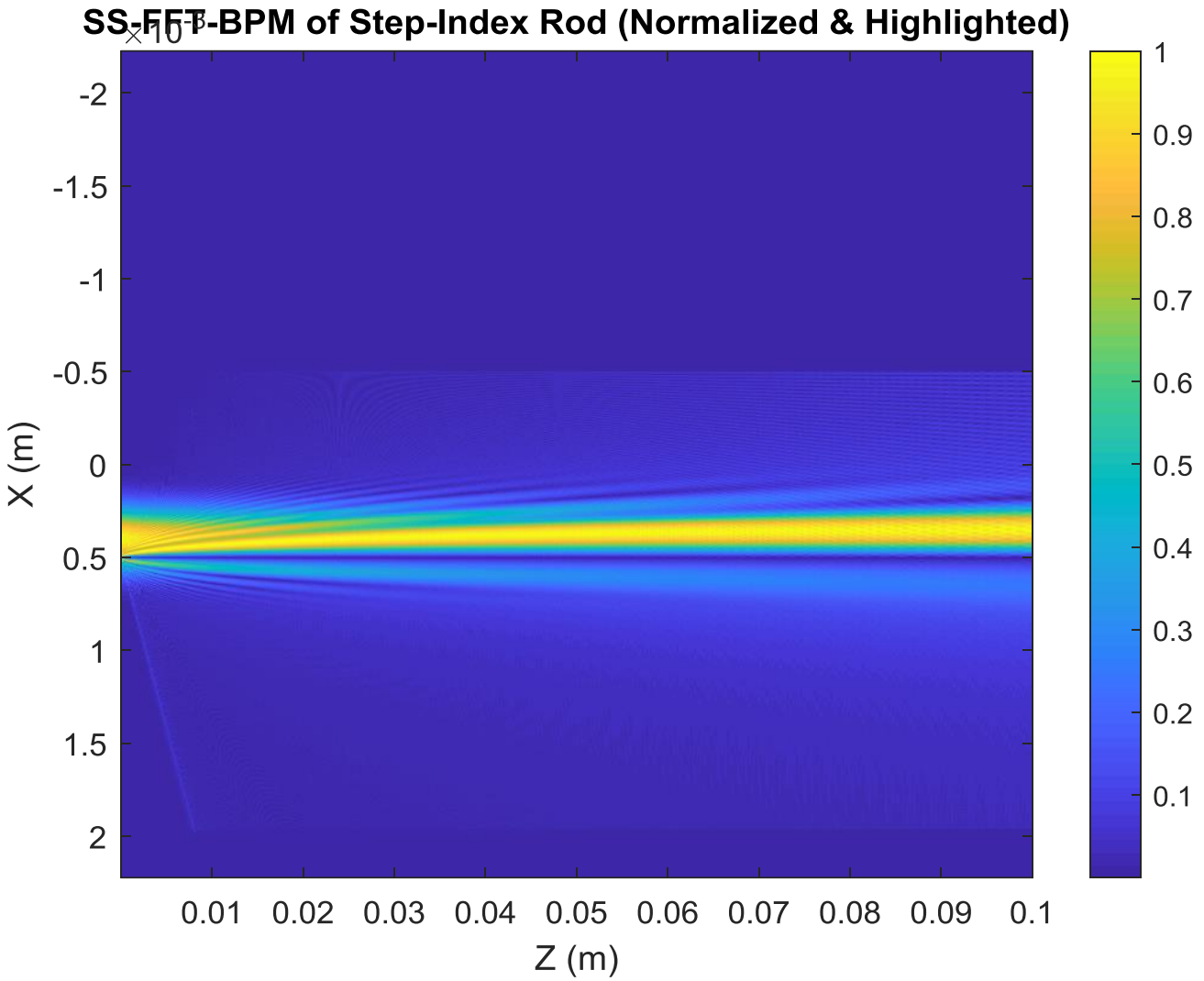
Results: w = 92 um, 0.25 mm offset



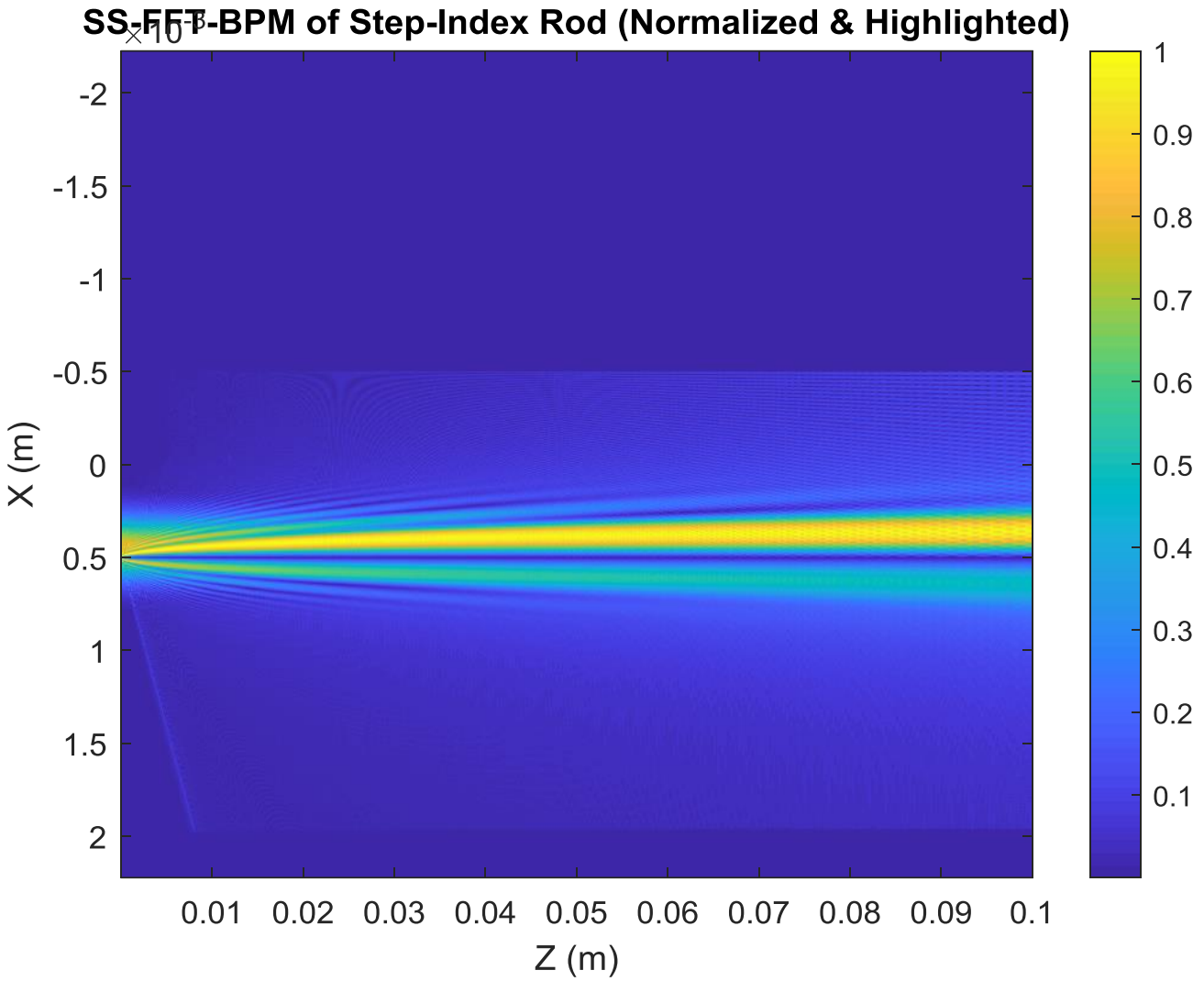
Results: w = 92 um, 0.30 mm offset



Results: w = 92 um, 0.40 mm offset



Results: w = 92 um, 0.45 mm offset



Conclusions

- Simulation is very rough!

- Qualitatively:
  - With decent mode-matching interference pattern shouldn't appear
  - Interference pattern may show up before 1% power drop occurs

- Implications:
  - We make two contours, one with the onset of the interference pattern, and the other with the 1% power drop