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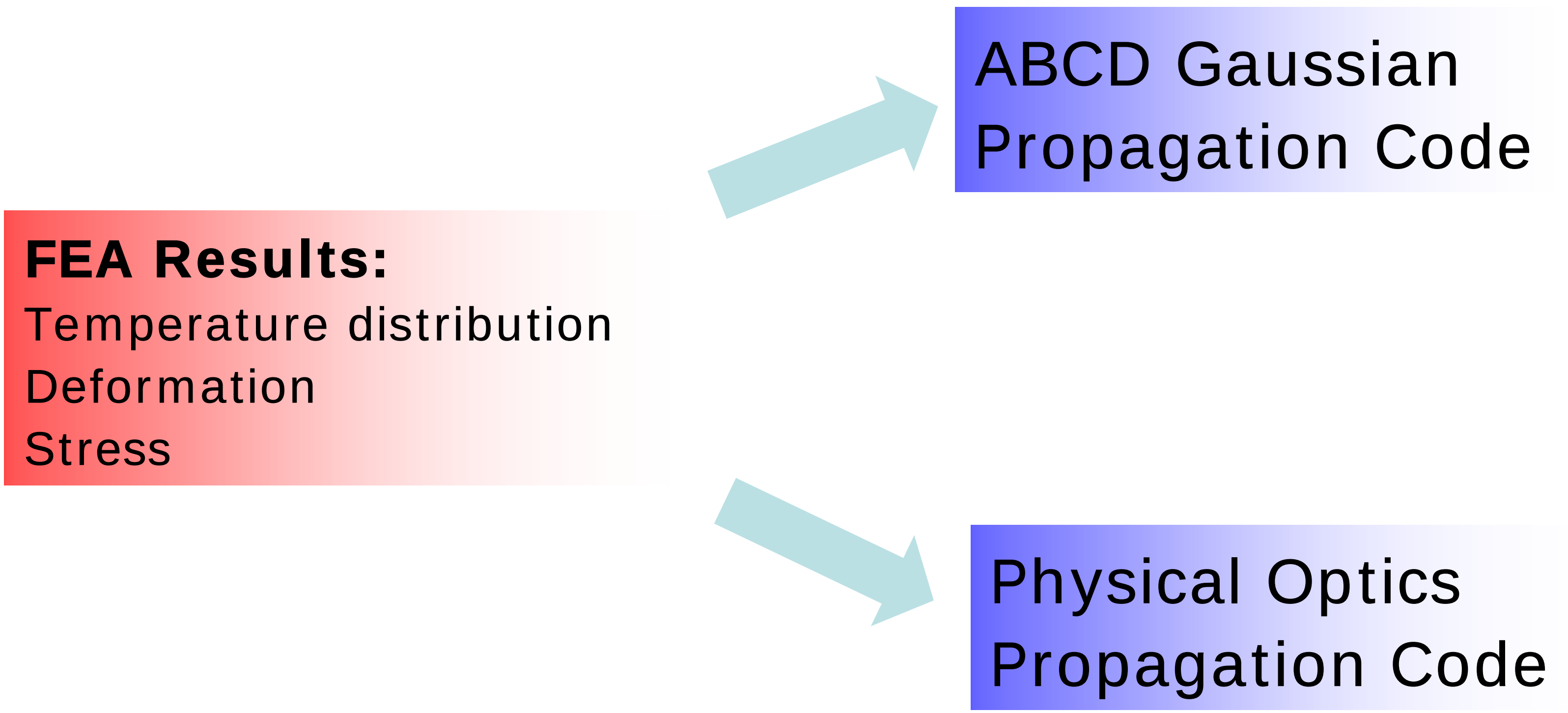
The results of FEA can be used with the ABCD gaussian propagation as well as with the BPM physical optics code.



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For cases where parabolic approximation and ABCD gaussian propagation code are not sufficient, FEA results alternatively can be used as input for a physical optics code that uses a FFT Split-Step Beam Propagation Method (BPM).

The physical optics code provides full 3-D simulation of the interaction of a propagating wavefront with the hot, thermally deformed crystal, without using parabolic approximation.

For this purpose the code propagates the wave front in small steps through crystal and resonator, taking into account the refractive index distribution, as well as the deformed end facets of the crystal, as obtained from FEA.

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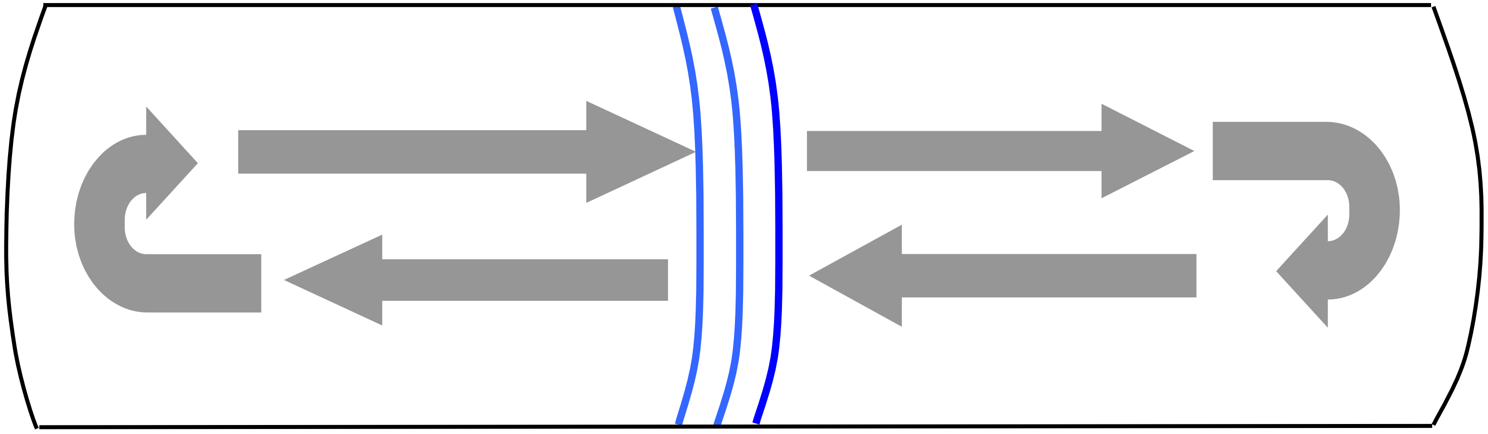
Based on the principle of Fox and Li, a series of roundtrips through the resonator is computed, which finally converges to the fundamental or to a superposition of higher order transversal modes.



$$\gamma \tilde{E}_{nm}(x, y) = \iint \tilde{K}(x, y, x_0, y_0) \tilde{E}_{nm}(x_0, y_0)\, dx_0 dy_0$$

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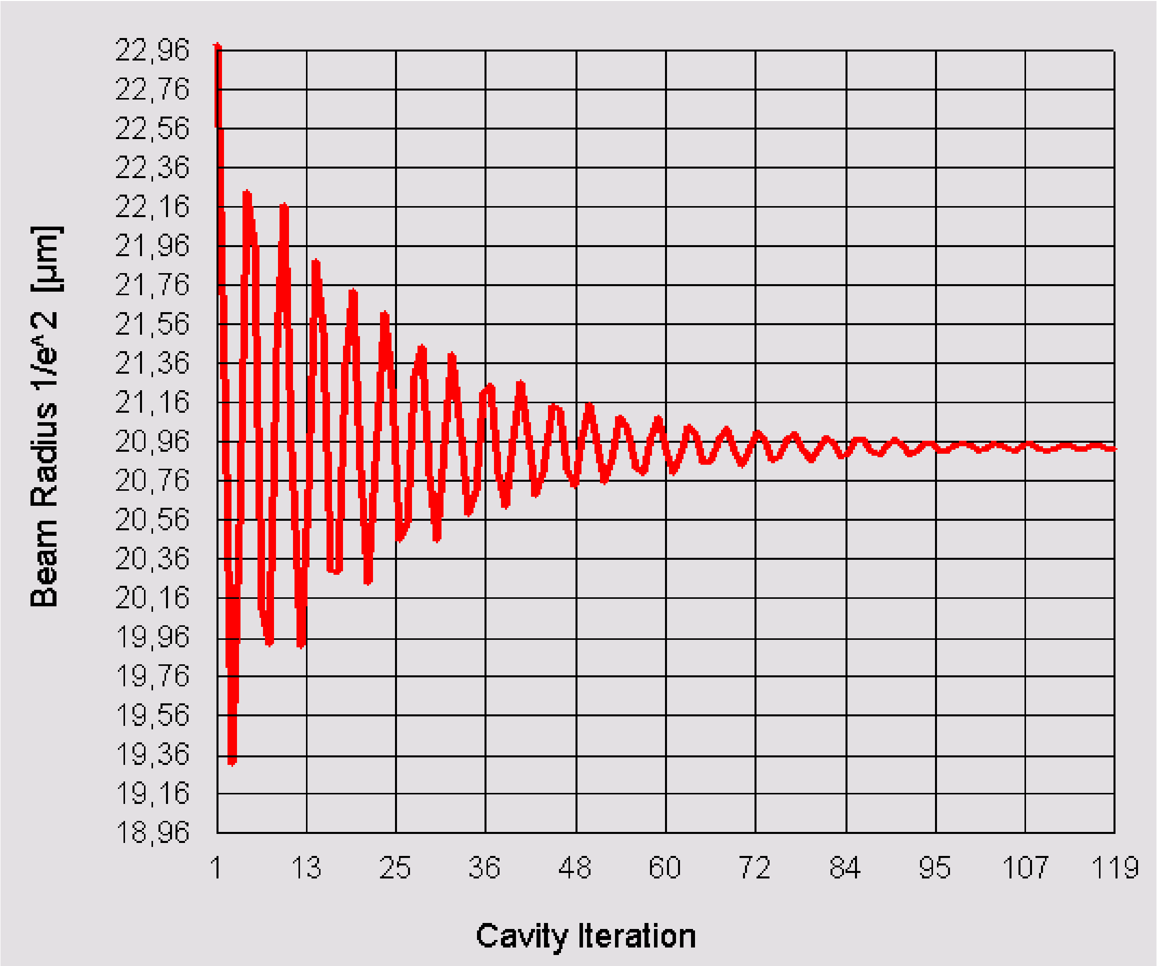

Convergence of spot size with cavity iteration

Different from the ABCD algorithm the wave optics code also takes into account diffraction effects due to apertures. Computation of misalignment and gain guiding effects is under development.

The wave optics computation therefore delivers realistic results for important features of a laser like intensity and phase profile.

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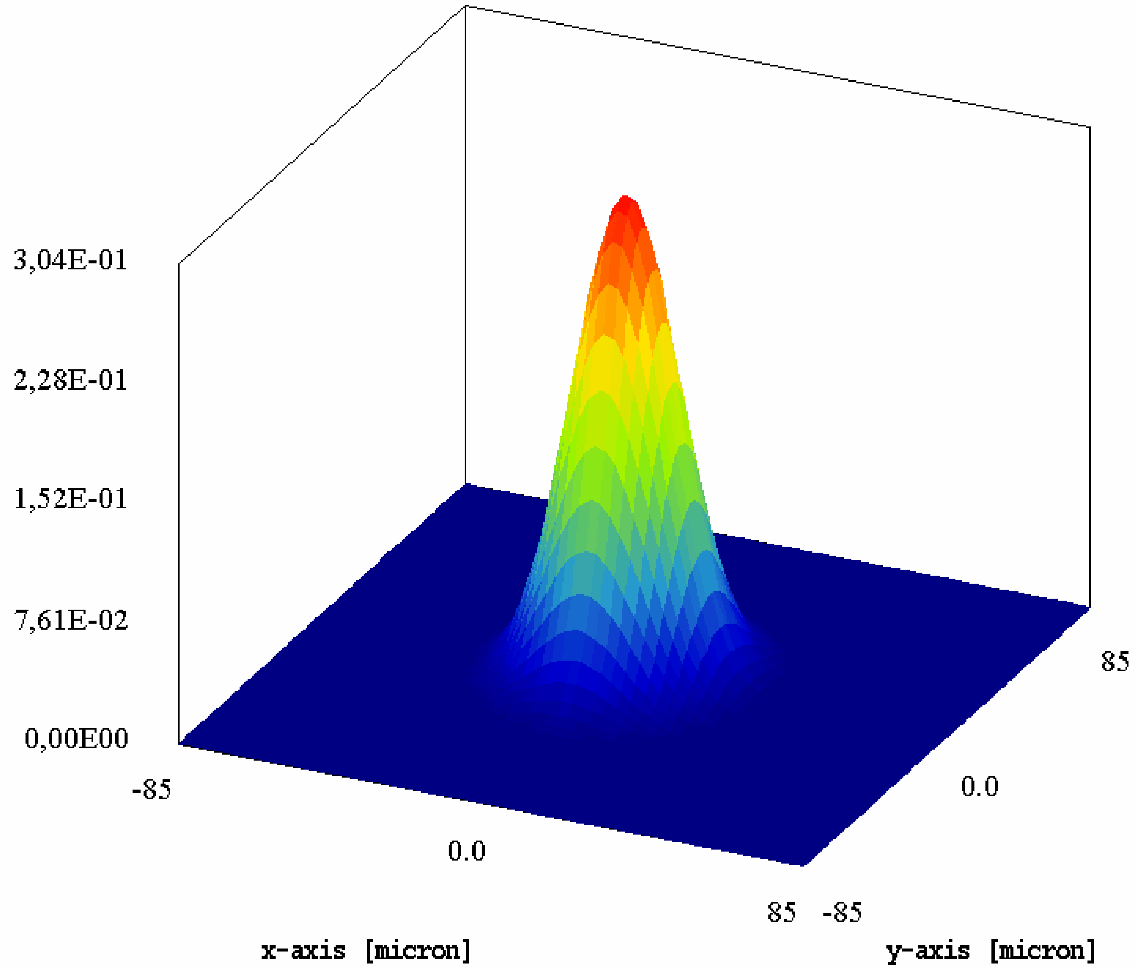

Intensity distribution at output mirror

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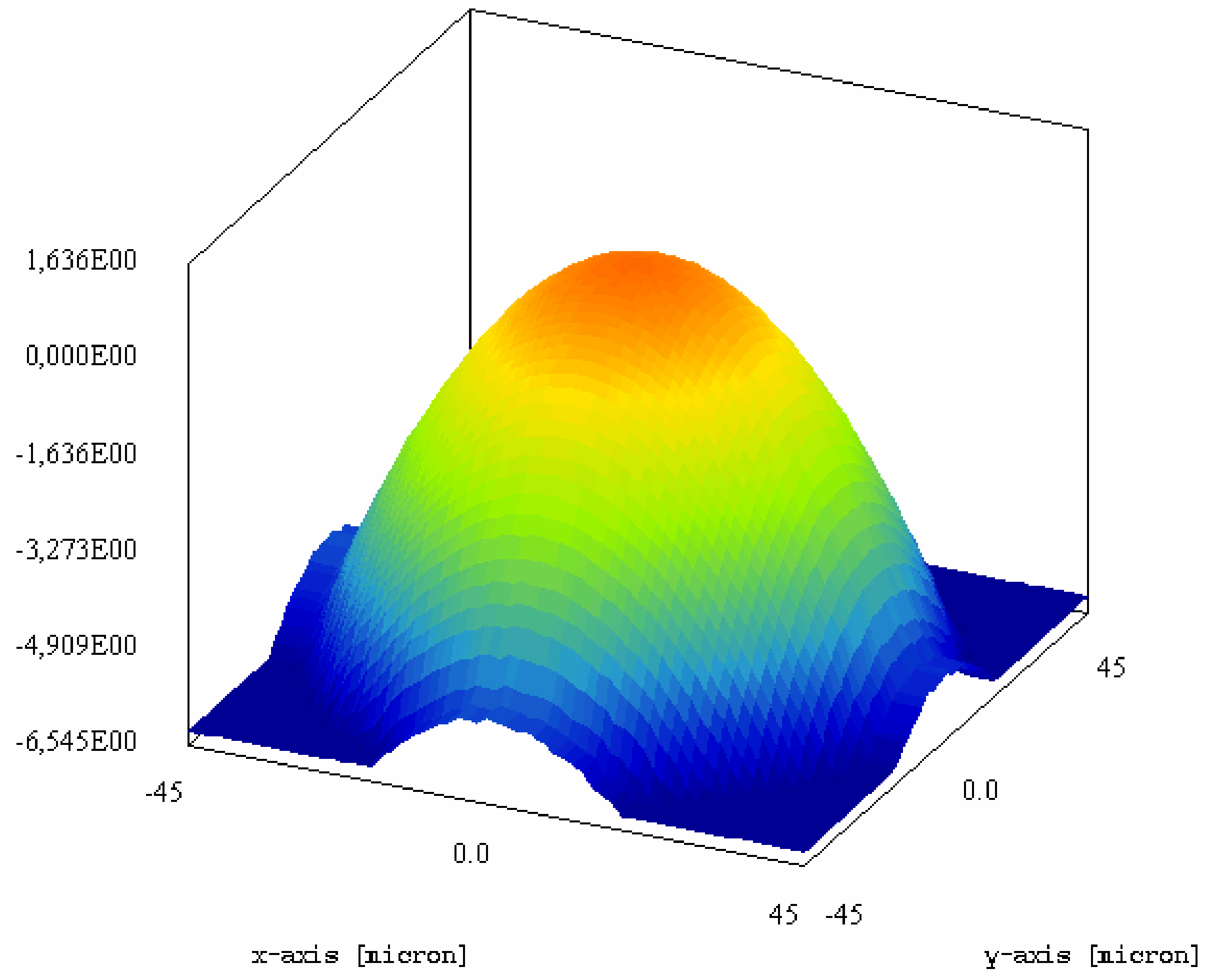

Phase distribution at output mirror

In addition, the wave optics code is capable of numerically computing the spectrum of resonator eigenvalues and also the shape of the transverse eigenmodes. An example for a higher order Hermite-Gaussian mode is shown in the next slide.

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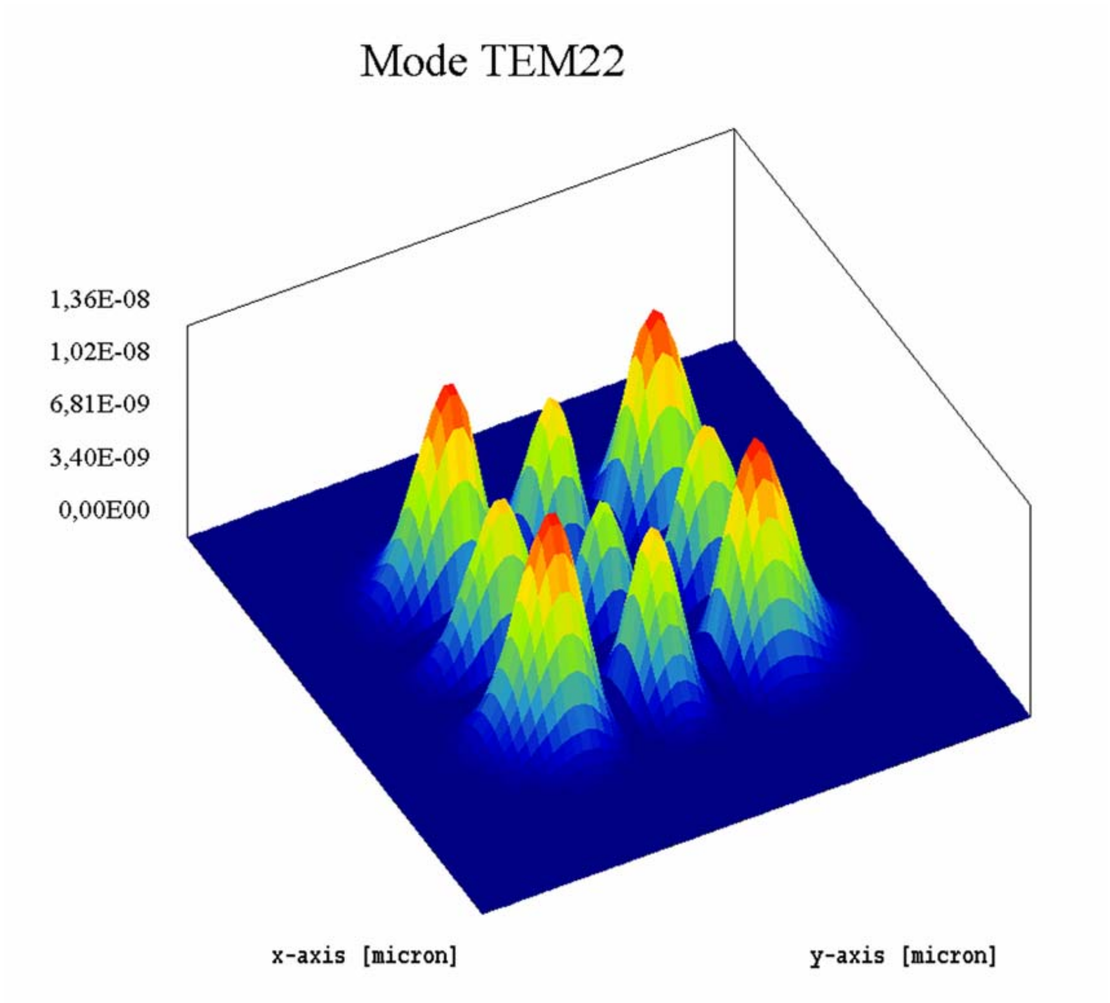

Mode TEM_{22} obtained by numerical eigenmode analysis

M. D. Feit and J. A. Fleck, Jr., "Spectral approach to optical resonator theory," Appl. Opt. 20(16), 2843-2851 (1981).

A. E. Siegman and H. Y. Miller, "Unstable optical resonator loss calculation using the Prony method," Appl. Opt. 9(10), 2729-2736 (1970)