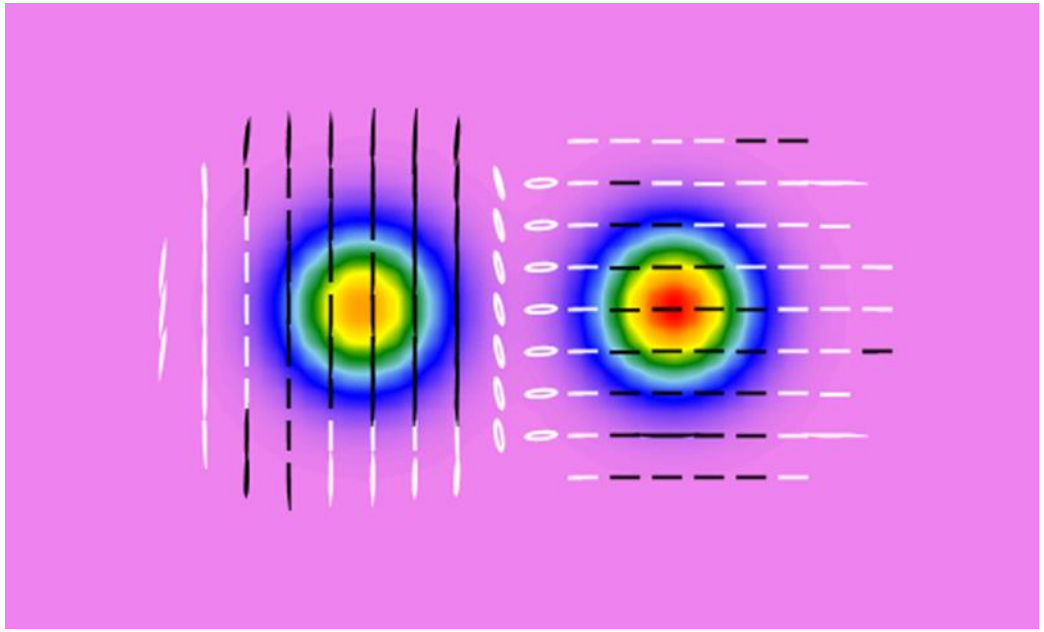
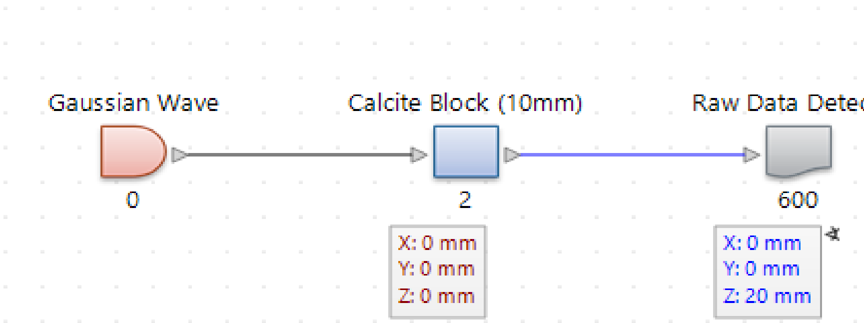
Birefringence Effect of Anisotropic Calcite Crystal

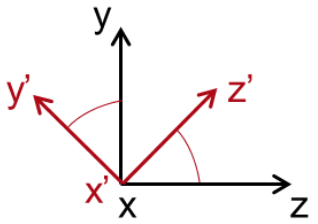
Abstract



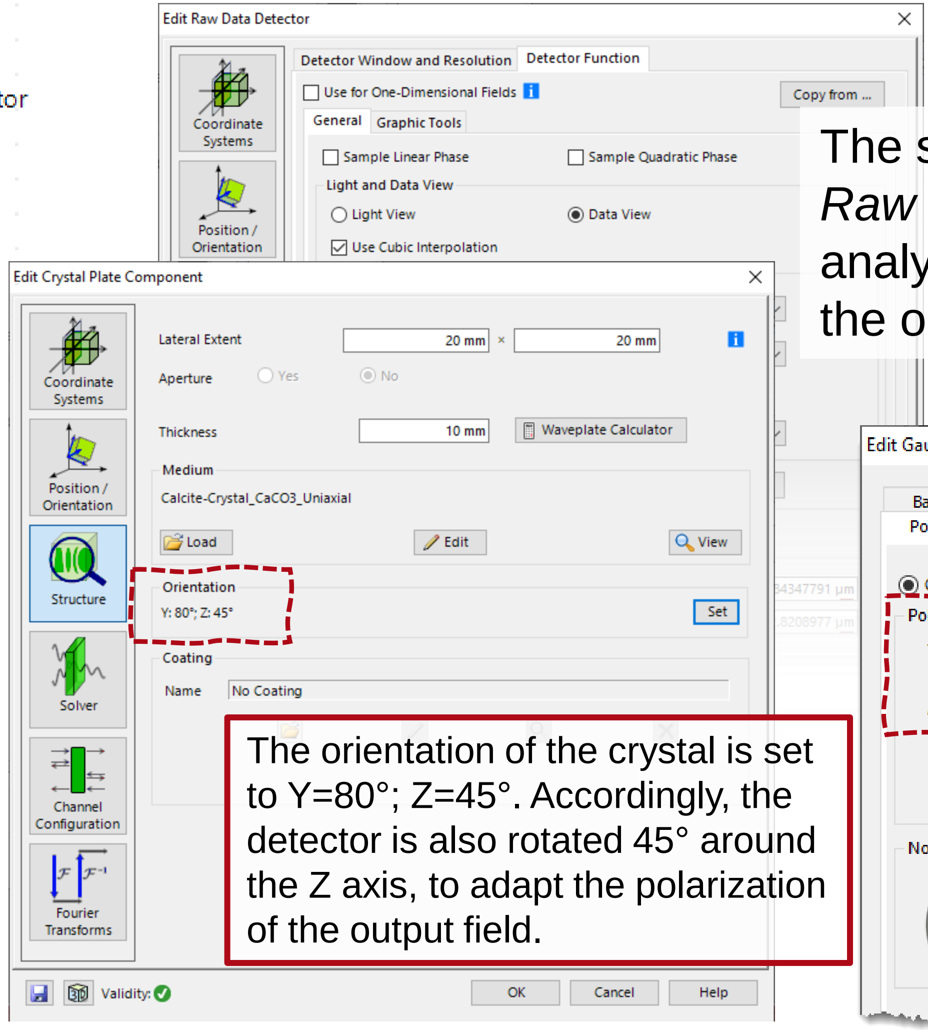
Birefringence is the most famous optical property of anisotropic materials and is widely used in many optical devices. When an input wave impinges upon a birefringent material, it will be split by polarization into two beams taking slightly different paths, known as ordinary beam and extraordinary beam. In this use case, the simulation of the birefringence with VirtualLab Fusion is demonstrated, and the dependence of the effect on input polarization and crystal thickness analyzed.

System Building Blocks



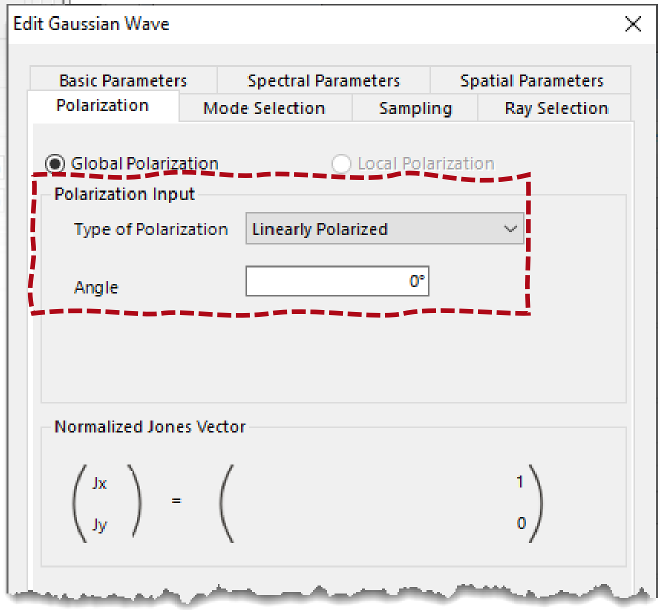


The orientation of the optic axis (marked in red) of the crystal needs to be adjusted in order for the birefringence to be observed.

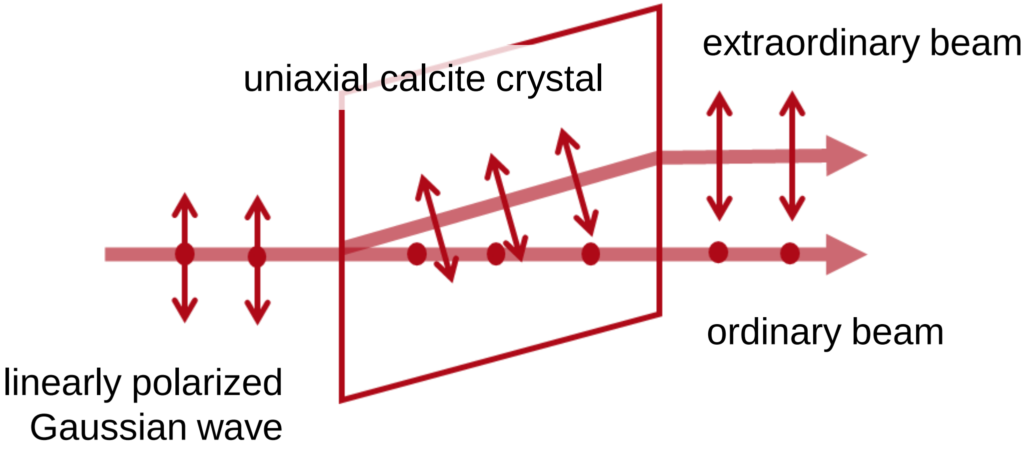


The orientation of the crystal is set to Y=80°; Z=45°. Accordingly, the detector is also rotated 45° around the Z axis, to adapt the polarization of the output field.

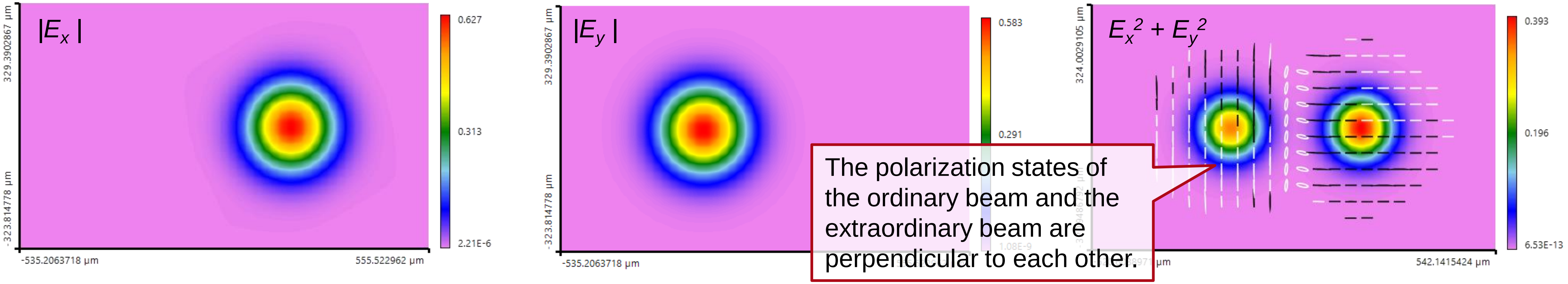
The source is linearly polarized. A *Raw Data Detector* is used to analyze the polarization state of the output field.



Birefringence Effect in Uniaxial Crystals

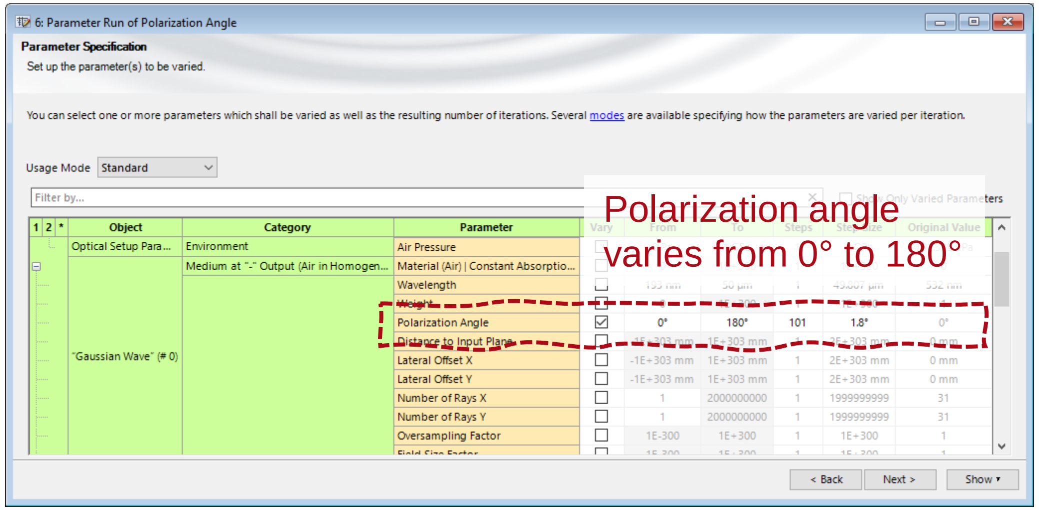


When a beam which propagates along the optic axis of the crystal (and whose field vector therefore lies in the perpendicular plane to the optic axis) impinges on the crystal, it will not “see” the birefringence, and will pass through the crystal at a single velocity. However, when the beam propagates at an angle with respect to the optic axis, it will be refracted into two different modes (ordinary and extraordinary) as it enters the crystal. The two modes propagate with different velocities inside the crystal and their polarization is perpendicular to each other. This is the phenomenon known as double refraction or birefringence.

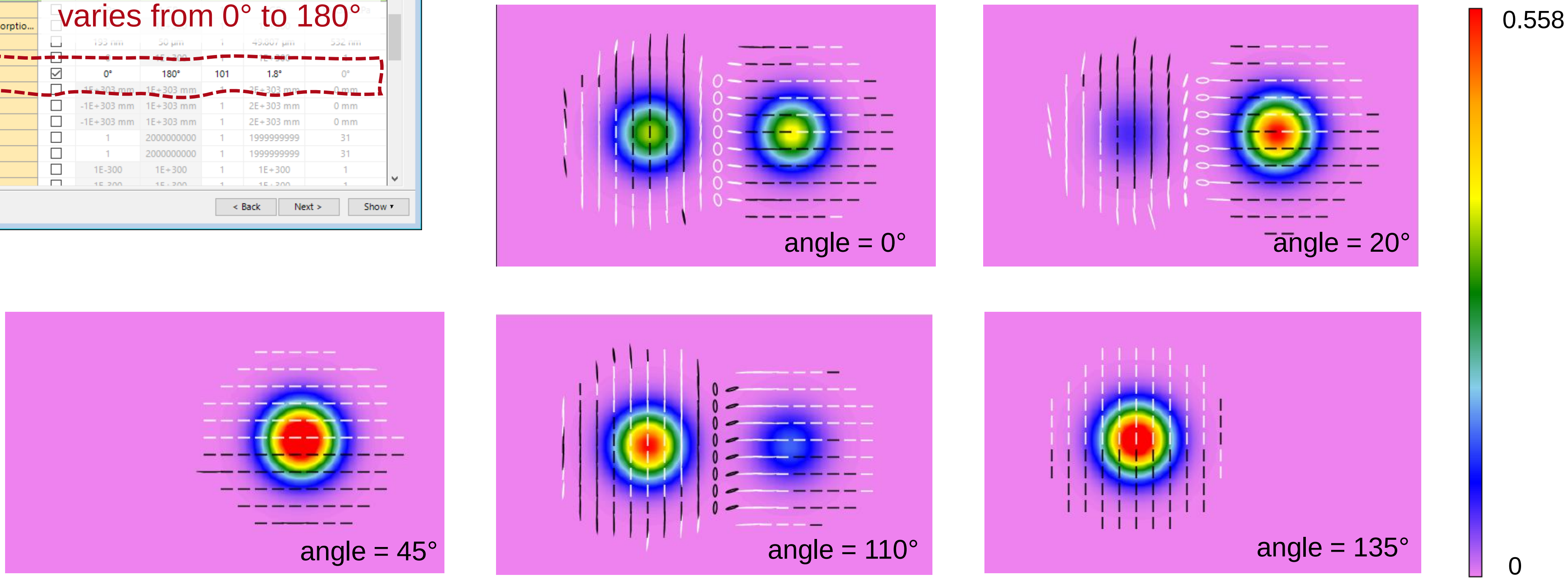


Field tracing result on the detector plane; please note that, the detector window is rotated to adapt the polarization direction.

Birefringence for Different Initial Polarization States

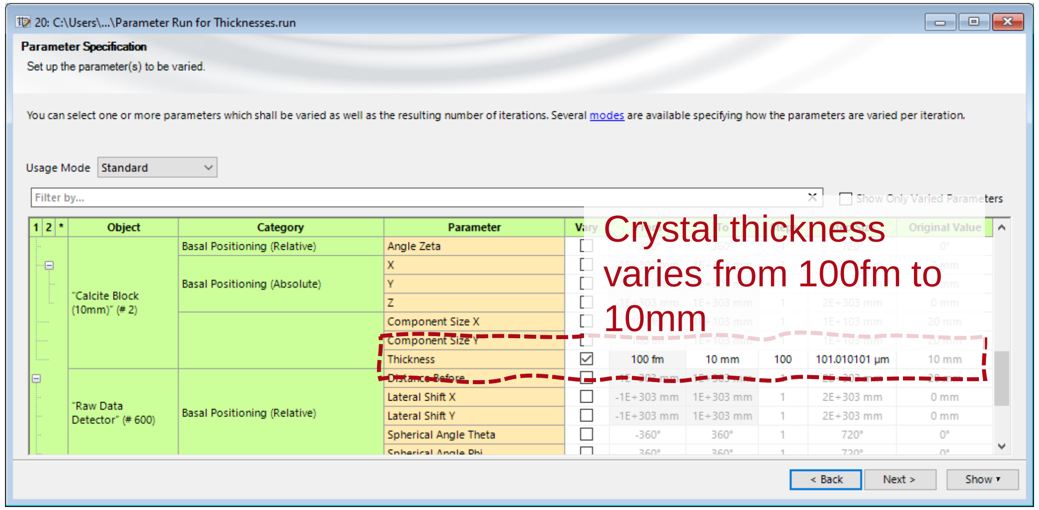


With the orientation of the crystal fixed, the polarization angle of the incident Gaussian wave is scanned with a Parameter Run. As the field tracing results show, the incident beam is distributed into two normal polarization states inside the crystal. When the incident polarization is perpendicular to the optic axis (here, *Polarization Angle* 135º) only the ordinary beam will propagate inside the crystal. When the incident polarization lies along the projection of the optic axis on the entrance plane of the crystal, however, only be the extraordinary beam will be observed (here, *Polarization Angle 45º*).

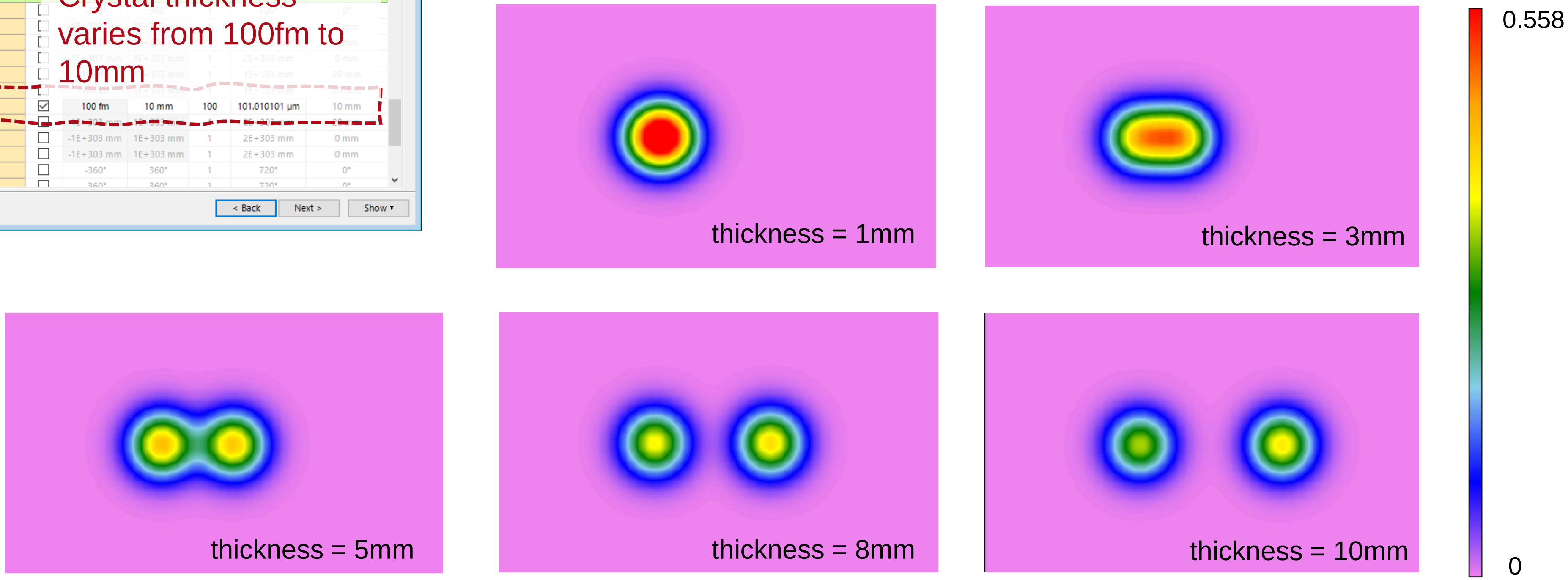


Field tracing results from parameter run, the animation of the varying results is available in the sample file. Please note that the detector is rotated 45° to adjust the polarization direction.

Birefringence for Varying Crystal Thickness



By varying the thickness of the crystal, the shift of the extraordinary beams is observable. As the field tracing results show, the thicker the calcite crystal, the larger the lateral separation between the two beams!



Field tracing results from parameter run, the animation of the varying results is available in the sample file. To be noticed, the detector window is rotated to adapt the polarization direction.

Document Information

title	Birefringence Effect of Anisotropic Calcite Crystal
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