LASER & THERMAL MODELLING - EXAMPLES

The available geometries are rod, disk, slab, zig-zag slab. Table I below summarizes the geometries and types of calculations.

Geometry	Energetics	Temperature	Mechanical stress	Wavefront deformation	Thermal depolarization[1]
Rod	X	X	X	X	X
Disk	X	X	X	X	X
Slab	X	X	X	X	X
Zig-zag slab	X	X	X	X	NA

Table I. Available geometries and types of calculations for advanced thermo-optical modeling of lasers.

The HiLASE team, as shown in tables II - IV below, can model a number of different optical materials. Yb:YAG and TGG ceramics can also be modeled, where some material parameters are estimated from single crystals.

Laser material	Energetics	Temperature	Mechanical stress	Wavefront deformation	Thermal depolariz.	Cryo option	Doping
Yb:YAG	X	X	X	X	X	X	0 - 30 at. %
Yb:YLF	X	X	X	X	NA	X	0 - 25 at. %
Ti:Sapphire[2]	X	X	X	X	X	X	0 - 1 at. %

Table II. Available laser materials and types of calculations for advanced thermo-optical modeling.

Nonlinear material	Energetics	Temperature	Mechanical stress	Wavefront deformation	Thermal depolariz.	Cryo option
LBO	X	X	X	X	NA	X
KDP	X	X	X	X	NA	NA
DKDP	X	X	X	X	NA	NA
BBO	X	X	X	X	X	X

Table III. Available nonlinear materials and types of calculations for advanced thermo-optical modeling.

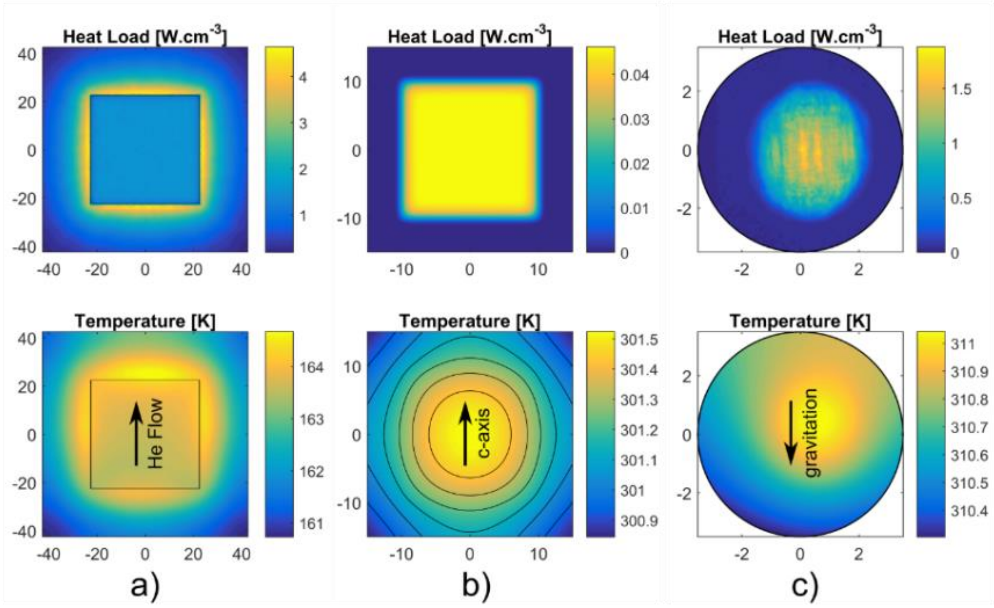
Other materials	Energetics	Temperature	Mechanical stress	Wavefront deformation	Thermal depolariz.	Cryo option
Crystal quartz	X	X	X	X	NA	X
Calcite	X	X	X	X	NA	X
CaF2	X	X	X	X	NA	X
TGG	X	X	X	X	X	X

Table IV. Other available materials and types of calculations for advanced thermo-optical modeling.

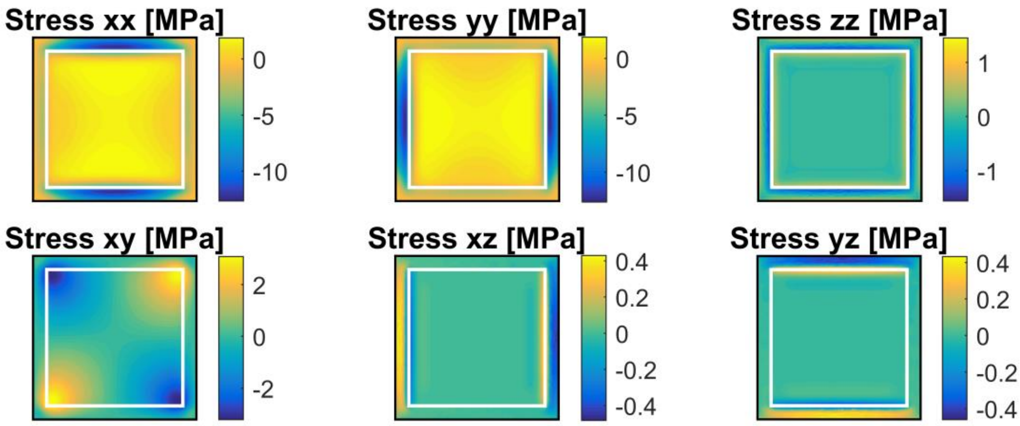
[1] Only normal incidence is available.
[2] Some parameters are taken from pure sapphire.

Some examples of our laser & thermal modeling

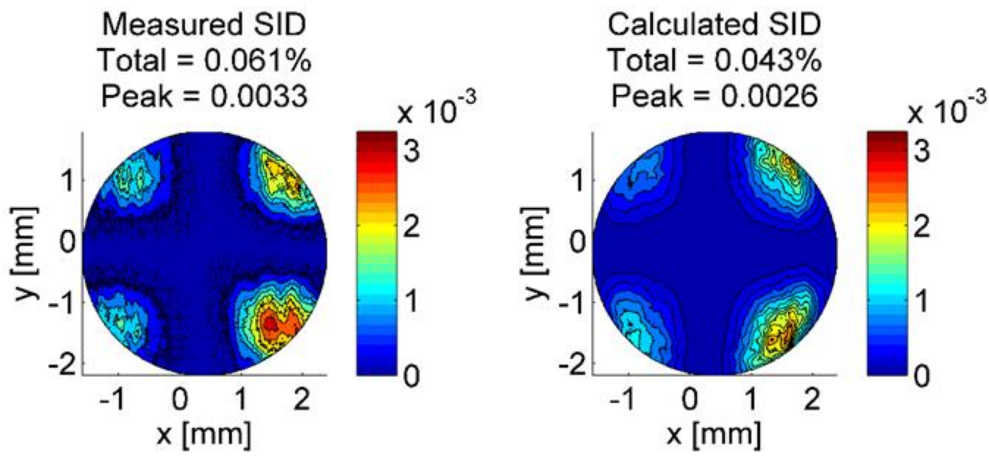
1) Heat load and temperature profiles in Yb:YAG (a), BBO (b) and TGG ceramic (c) optical elements



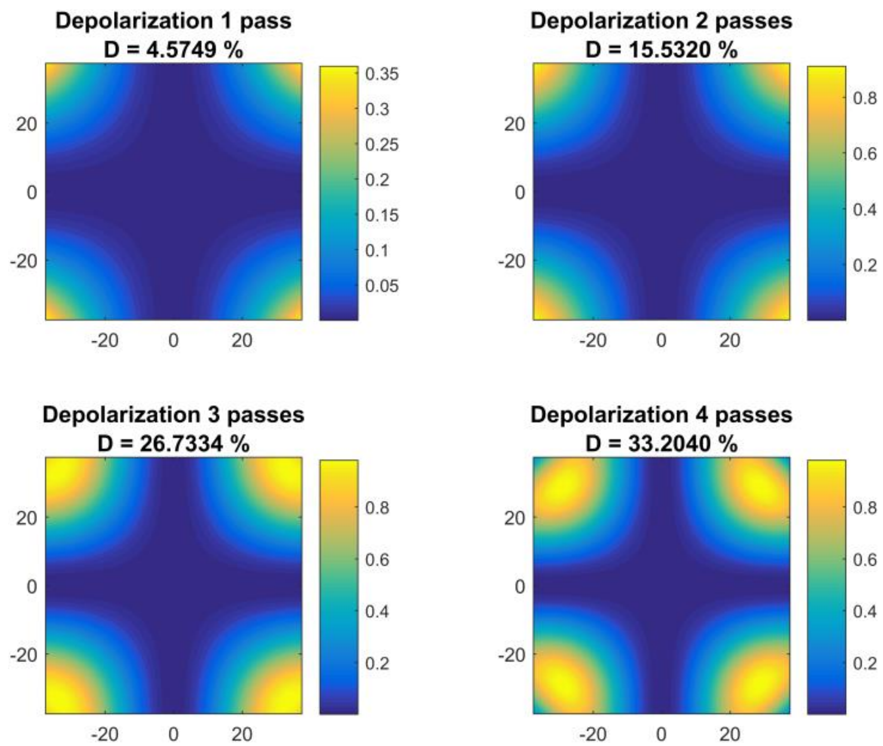
2) Stress tensor components of Yb:YAG ceramic slab amplifier



3) Measured and calculated thermal stress induced birefringence in TGG ceramics rod [7]



4) Calculated thermal stress induced birefringence in Yb:YAG ceramics slab amplifier



Selected publications

[1] M. Sawicka, M. Divoky, J. Novak, A. Lucianetti, B. Rus, and T. Mocek
„Modeling of amplified spontaneous emission, heat deposition, and energy extraction in cryogenically cooled multislab Yb^{3+}:YAG amplifier for the HiLASE project“
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[2] O. Slezak, A. Lucianetti, M. Divoky, M. Sawicka, and T. Mocek
"Optimization of wavefront distortions and thermal-stress induced birefringence in a cryogenically-cooled multislab laser amplifier", I.E.E.E. J. Quantum Electron. 49, No. 11, pp. 960-966 (2013).

[3] M. Sawicka, M. Divoky, A. Lucianetti, and T. Mocek
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Laser and Particle Beams 31, pp. 553-560 (2013).

[4] A. Lucianetti, M. Sawicka, O. Slezak, M. Divoky, J. Pilar, V. Jambunathan, S. Bonora, R. Antipenkov, and T. Mocek
"Design of a kJ-class HiLASE laser as a driver for inertial fusion energy"
High Power Laser Science and Engineering 2, e13 (2014).

[5] O. Slezak, A. Lucianetti, and T. Mocek
"Efficient ASE management in disk laser amplifiers with variable absorbing clads"
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[6] H. Kiriyama, M. Mori, A.S. Pirozhkov, K. Ogura, A. Sagisaka, A. Kon, T.Z. Esirkepov, Y. Hayashi, H. Kotaki, M. Kanasaki, H. Sakaki, Y. Fukuda, J. Koga, M. Nishiuchi, M. Kando, S. V. Bulanov, K. Kondo, P.R. Bolton, O. Slezak, D. Vojna, M. Sawicka-Chyla, V. Jambunathan, A. Lucianetti, T. Mocek
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[7] O. Slezak, R. Yasuhara, A. Lucianetti, D. Vojna, and T. Mocek
"Thermally induced depolarization in terbium gallium garnet ceramics rod with natural convection cooling"
J. Opt 17, 065610 (2015).

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