

## Amiel A. Ishaaya

### CURRICULUM VITAE AND LIST OF PUBLICATIONS

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#### Personal details:

Date & place of birth: Dec. 14, 1966, Canada

Address (office): Dept. of Electrical and Computer Engineering  
Ben-Gurion University of the Negev  
P.O.B 653, Be'er-Sheva, 84105, Israel  
+972-8-6461841 ; +972-8-6428464  
ishaaya@ee.bgu.ac.il  
<http://www.ee.bgu.ac.il/~lnod>

Address (home): 20A Hazamir St., Nes Ziona 74115, Israel  
+972-77-3230107

#### Education:

1986: B.Sc. in Physics and Computers, Tel-Aviv University, Israel.

1995: M.Sc. in Physics, Tel-Aviv University, Tel-Aviv, Israel. Subject of Thesis: "Measurement of the velocity and spatial distribution of cathode spots on the cathode surface of a vacuum arc as a function of the magnetic field", conducted under the supervision of Prof. S. Goldsmith. Cum Laude.

2005: Ph.D in Physics, Weizmann Institute of Science, Rehovot, Israel. Subject of Thesis: "Laser configurations for high-order transverse mode selection and coherent beam combining", conducted under the supervision of Prof. A. A. Friesem.

#### Employment history and experience:

2012- Associate Professor – Ben Gurion University

2007-2012 Senior Lecturer – Ben Gurion University

Laser sources and nonlinear optical devices based on photonic crystal fibers and semiconductor waveguides. Developing efficient high-power fiber-based laser designs, investigating synchronization and coherent combining of multiple laser sources, extending the wavelength range of lasers into the UV and infrared by various non-linear optical processes, and developing compact on-chip optical devices.

2005-2007 Postdoctoral research associate – Cornell University

Experimental research of nonlinear optical interactions in bulk Kerr media and in photonic crystal fibers. In bulk Kerr media, this includes studying the collapse dynamics and filamentation of special beams in the femto-second regime, such as super-Gaussian, phase vortex, necklace, and radially-azimuthally polarized beams, as well as the interaction and collapse dynamics of coupled beams. In photonic crystal fibers, studying nonlinear interactions in gas filled hollow core photonic band gap fibers, such as harmonic

generation within these fibers and various other nonlinear processes (Electromagnetic induced transparency, slow light, etc.).

- 2001-2005      Ph.D research - Weizmann Institute of Science  
Investigated laser configurations for phase locking and coherent addition of laser beams, as well as high-order transverse mode selection in various laser configurations utilizing novel phase elements. These configurations included Q-switched pulsed solid-state lasers, microlasers and fiber lasers. Furthermore, investigated laser beam shaping techniques and transverse mode transformations for improving and controlling the beam quality of laser beams.
- 1999-2001      Project Manager / System Engineer - Laser Products Operation, El-Op Electro-Optics Industries Ltd.  
▪ Project manager of the APACHE Switchable Eyesafe Laser Rangefinder Designator.  
▪ Led and coordinated a large-scale proposal concerning laser development and production.
- 1994-1999      Laser Physicist - Laser Products Operation, El-Op Electro-Optics Industries Ltd.  
Performed and led various laser R&D projects and feasibility studies. Conducted laboratory development of new solid state lasers. Actively involved also in system-level R&D including transmitter-receiver-observation systems, LIDAR, simulations and modeling for performance evaluation, and field tests of prototype systems. These included activities with Nd:YAG lasers, unstable resonators (Hard edge, GRM), MOPA schemes, nonlinear processes and nonlinear crystals, beam analyzing and characterization, and high power Q-switched laser systems. The work also involved preparation of technical proposals and reports, and presentation in numerous Design Reviews (Concept, PDR, CDR etc.).
- 1991-1994      Master's research - Tel-Aviv University  
Investigated high current (500A DC) vacuum arc discharge systems. Specifically, measurement of cathode spot retrograde motion under various transverse magnetic fields.
- 1986-1991      Research Officer - Planning Branch, The Center for System Analysis, Israeli Defense Forces  
Rank: *Major*  
Conducted Operations Research and system analysis studies. These included planning the assimilation of new technical systems, cost-effective evaluation of systems, optimization models and simulations. All these exploited physics, mathematics and computers.

### **Professional activities:**

#### Positions in academic administration

- 2017-present      Deputy Dean, Faculty of Engineering, BGU
- 2016-present      Member of the university Ethics Committee, BGU
- 2016-2017      Member of the Engineering Faculty Teaching Committee.

2013-2016	Head of the undergraduate teaching committee in the ECE department (~1000 students).
2012-2016	Coordinator of undergraduate Physics courses for ECE students.
2012-2013	Undergraduate second year advisor.
2011-2013	Undergraduate advisor for pre-military students (Atuda program).
2011-2013	Member of ECE department committee for projects and Industry relations.
2010-2013	Member of ECE department Undergraduate Teaching committee.

#### Professional functions outside the university

- Part of the team leading the establishment of the Israeli Center of Advanced Photonics, Yavne, Israel (2014-present).
- The local organizer of 2nd Annual Conference of COST Action MP1401, Tel Aviv University, Israel (March 2017).
- A member of the organizing committee of the “International Meeting on Fiber Lasers and Applications”, Tel Aviv, Israel (Feb. 2017).
- A member of the organizing committee of the OASIS 2015 and OASIS 2017 conferences (Tel Aviv, Israel).
- Chairman of the “Lasers and Applications” session at OASIS 2017, the 16<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2017).
- Chairman of the “Lasers and Applications” session at OASIS 2015, the 15<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2015).
- A member of the organizing committee of the “International Meeting on Fiber Lasers and Applications”, Bar Ilan University, Israel (June 2014).
- Chairman of the “Lasers and Applications” session at OASIS 2013, the 14<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2013).

#### Reviewer for journals

Optics Letters, Optics Express, J. of the Optical Society of America B, Applied Optics, Optics Communications, Physical Review Letters, Physical Review A, Applied Physics B.

#### Reviewer for grant proposals

Israel Science Foundation (ISF), German Israeli Foundation (GIF)

#### Membership in scientific societies

2001-present	Optical Society of America (OSA).
2002-present	IEEE Photonics Society.

#### **Educational activities:**

2012-present	Assoc. Professor in ECE at Ben Gurion University, Israel.
2007-2012	Senior Lecturer in ECE at Ben Gurion University, Israel.
1995-1998	Lecturer of Statistics, Ramat-Gan College, Ramat-Gan, Israel.
1992-1994	Physics teaching assistant at the Raymond and Beverly Sackler Faculty of Exact Sciences, Tel-Aviv University, Tel-Aviv, Israel.
1985-1986	Physics teaching assistant at the Raymond and Beverly Sackler Faculty of Exact Sciences, Tel-Aviv University, Tel-Aviv, Israel.

### Courses taught at Ben-Gurion University

1. Laser Engineering – for senior undergraduate and graduate students.
2. Infrared Engineering – for senior undergraduate students.
3. Nonlinear optics – for graduate students.

Teaching load- three courses per year (one course waiver due to high level research funding)

### Research students

2008-2010	Boris Shulga – MSc, “High peak power photonic crystal fiber laser”.
2008-2009	Amir Gilad – MSc, “Self-phase modulation in gas filled hollow core photonic crystal fibers”. Did not complete thesis. (secondary supervisor – Prof. Bar from Ben Gurion University)
2008-2013	Eitan Ronen – PhD, “Phase locking of large laser arrays”. (in the last two years additional supervisor Prof. Davidson from the Weizmann Institute).
2009-2011	Amir Hertzog – MSc, “Wavelength conversion of nano-second pulses to the mid-IR in optical fibers and waveguides”.
2010-2014	Boris Rosenstein – PhD, “Coherent combining of high peak power pulsed fiber lasers”.
2010-2011	Avishay Shamir – MSc, “Wavelength conversion in photonic crystal fibers and femtosecond material processing”
2010-2012	Oleg Shnieder – MSc, “Spectral narrowing in a system of coherently combined fiber lasers”.
2011-2013	Moshe Vanohozker – MSc, “Single mode lasing and amplification in a highly multimode active fiber”.
2011-2013	Lior Kedar – MSc, “Stimulated Raman scattering in gas filled hollow core photonic crystal fibers”.
2012-2014	Avry Shirakov – MSc, “High peak and average power flexible PCF laser”.
2012-2014	Zeev Montz – MSc, “Hollow core photonic crystal fibers with special spectral characteristics”.
2012-2016	Amir Herzog – PhD, “Biological tissue ablation using laser- sources, delivery and applications”.
2012-present	Avishay Shamir – PhD, “Non-linear applications of photonic devices fabricated with femtosecond laser pulses”.
2012-present	Yehuda Benudiz – PhD, “Ultrashort pulse amplification in active PCFs”.
2013-present	Ted Frumkin – PhD, “Silicon based photonic nanostructures”.
2014-2016	Ziv Alperovich – MSc, “Misalignment sensitivities in an intra-cavity coherent combining crossed-Porro resonator configuration”.
2014-present	Avry Shirakov – PhD, “Co <sup>2+</sup> doped materials for ultra-short pulsed lasers”.
2014-present	Zeev Montz – PhD, “Conversion to the UV in gas filled kagome and antiresonant fibers”.
2015-2016	Harel Hecht – MSc, “Passive Q-switching of a Tm:YLF laser with a Co <sup>2+</sup> doped silver halide saturable absorber”.
2015-present	Aviran Halstuch – PhD, “Transient Bragg gratings in waveguides based on Kerr and free carriers”.

2016-present	Ziv Alperovich – PhD.
2016-present	Shachar Edelstein – MSc, “Wavelength conversion schemes for a high peak power PCF laser”.
2017-present	Igor Sakaev – PhD.

#### **Awards and Fellowships:**

2016	NTU Tan Chin Tuan Exchange Fellowship in Engineering FY2017, awarded by Nanyang Technological University, Singapore.
2005	Fulbright Post-doctoral Scholar Award, awarded by the United States – Israel Educational Foundation (USIEF).
2004	New Focus Travel Grant, awarded by the Optical Society of America.
2004	LEOS Travel Grant, awarded by the IEEE Lasers and Electro-Optics Society.
2001/2/3	High-Technology Research Prize for excellence in research, awarded by the Israeli Council for High Education, VATAT.
2002-2005	Eshkol Excellence Fellowship, awarded by the Israeli Ministry of Science.
1994-2001	Several internal awards of excellence, El-Op Electro-Optics Industries Ltd, Israel.
1995	M.Sc. degree with distinction, Tel-Aviv University, Tel-Aviv, Israel.
1985	Second year physics undergraduate studies with distinction, Tel-Aviv University, Tel-Aviv, Israel.

## Scientific publications:

h-index: 15 (ISI), 17 (Google Scholar)

Total number of citations: 615 (ISI), 938 (Google Scholar)

Total number of citations without self references: 536 (ISI)

## Book chapters

1. "Coherent addition of laser beam distributions", V. Eckhouse<sup>S</sup>, **A. A. Ishaaya**<sup>C</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>C</sup>, to be published in ICO Book VI on Information Optics, Edited by R. Danliker and A. Friberg (SPIE press 2008).

## Refereed articles and letters in scientific journals (ISI data in parenthesis)

[S- student; C- collaborator; PI- principal investigator; PD-postdoc; T- technician. (\*) – after last promotion]

1. **A. A. Ishaaya**<sup>S</sup>, R. Oron<sup>S</sup>, N. Davidson<sup>C</sup>, E. Hasman<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Improving the beam quality of high-order laser modes", *Optics & Photonics News – Optics in 2001*, **12**(12), 55-55 (2001).
2. G. Machavariani<sup>C</sup>, N. Davidson<sup>C</sup>, E. Hasman<sup>C</sup>, S. Blit<sup>C</sup>, **A. A. Ishaaya**<sup>S</sup> and A. A. Friesem<sup>PI</sup>, "Efficient conversion of a Gaussian beam to a high purity helical beam", *Optics Communications* **209**, 265-271 (2002). [IF 1.488, JR 17/54, Q2, CI 28].
3. G. Machavariani<sup>C</sup>, N. Davidson<sup>C</sup>, **A. A. Ishaaya**<sup>S</sup>, A.A. Friesem<sup>PI</sup> and E. Hasman<sup>C</sup>, "Efficient formation of high-quality beam from a pure high-order Hermite-Gaussian mode", *Optics Letters* **27**, 1501-1503 (2002). [IF 3.511, JR 3/54, **Q1**, CI 18].
4. **A. Ishaaya**<sup>S</sup>, R. Oron<sup>S</sup>, N. Davidson<sup>C</sup>, E. Hasman<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Efficient mode conversion of laser beams", *Optics & Photonics News - Optics in 2002*, **13** (12), 43-43 (2002).
5. **A. A. Ishaaya**<sup>S</sup>, N. Davidson<sup>C</sup>, G. Machavariani<sup>C</sup>, E. Hasman<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Efficient selection of high-order Laguerre-Gaussian modes in a Q-switched Nd:YAG laser", *IEEE Journal of Quantum Electronics* **39**, 74-82 (2003). [IF 2.716, JR 5/76, **Q1**, CI 36].
6. **A. A. Ishaaya**<sup>S</sup>, G. Machavariani<sup>C</sup>, N. Davidson<sup>C</sup>, E. Hasman<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Conversion of a high-order mode beam into a nearly Gaussian Beam using a single interferometric element", *Optics Letters* **28**, 504-506 (2003). [IF 3.395, JR 4/53, **Q1**, CI 34].
7. G. Machavariani<sup>C</sup>, **A. A. Ishaaya**<sup>S</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup>, A. A. Friesem<sup>PI</sup> and E. Hasman<sup>C</sup>, "Efficient mode transformations of degenerate Laguerre-Gaussian beams," *Applied Optics* **43**, 2561-2567 (2004). [IF 1.799, JR 14/54, Q2, CI 15].
8. **A. A. Ishaaya**<sup>S</sup>, N. Davidson<sup>C</sup>, L. Shimshi<sup>S</sup> and A. A. Friesem<sup>PI</sup>, "Intra-cavity coherent addition of Gaussian beam distributions using a planar interferometric coupler", *Applied Physics Letters* **85**, 2187-2189 (2004). [IF 4.308, JR 4/79, **Q1**, CI 31].
9. G. Machavariani<sup>C</sup>, N. Davidson<sup>C</sup>, **A. A. Ishaaya**<sup>S</sup> and A. A. Friesem<sup>PI</sup>, "Improving the stability of longitudinal and transverse laser modes", *Optics Communications* **239**, 147-151 (2004). [IF 1.581, JR 19/54, Q2, CI 4].
10. **A. A. Ishaaya**<sup>S</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Coherent addition of spatially incoherent light beams", *Optics Express* **12**, 4929-4934 (2004). [IF 3.797, JR 4/54, **Q1**, CI 26].
11. V. Eckhouse<sup>S</sup>, **A. A. Ishaaya**<sup>S</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Imposing a Gaussian distribution in multichannel laser resonators", *IEEE Journal of Quantum Electronics* **41**, 686-693 (2005). [IF 2.452, JR 13/83, **Q1**, CI 5].
12. **A. A. Ishaaya**<sup>S</sup>, V. Eckhouse<sup>S</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Improving the output beam quality of multimode laser resonators", *Optics Express* **13**, 2722-2730 (2005). [IF 3.764, JR 2/55, **Q1**, CI 15].

13. **A. A. Ishaaya<sup>S</sup>**, V. Eckhouse<sup>S</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Intra-cavity coherent addition of single high order modes", *Optics Letters* **30**, 1770-1772 (2005). [IF 3.599, JR 3/55, **Q1**, CI 11].
14. **A. A. Ishaaya<sup>S</sup>**, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Very high-order pure Laguerre-Gaussian mode selection in a passive Q-switched Nd:YAG laser", *Optics Express* **13**, 4952-4962 (2005). [IF 3.764, JR 2/55, **Q1**, CI 34].
15. V. Eckhouse<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Intra-cavity coherent addition of sixteen laser distributions", *Optics Letters* **31**, 350-352 (2006). [IF 3.598, JR 2/56, **Q1**, CI 32].
16. L. Shimshi<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, V. Eckhouse<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Passive intracavity coherent addition of nine laser distributions", *Applied Physics Letters* **88**, 041103 (2006). [IF 3.977, JR 6/84, **Q1**, CI 4].
17. L. Shimshi<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, V. Eckhouse<sup>S</sup>, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Passive intra-cavity phase locking of laser distributions", *Optics Communications* **263**, 60-64 (2006). [IF 1.480, JR 18/56, **Q2**, CI 7].
18. L. T. Vuong<sup>S</sup>, T. D. Grow<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, A. L. Gaeta<sup>PI</sup>, G. W. 't Hooft<sup>C</sup>, E. R. Eliel<sup>C</sup>, and G. Fibich<sup>C</sup>, "Collapse of optical vortices", *Physical Review Letters* **96**, 133901 (2006). [IF 7.072, JR 5/68, **Q1**, CI 69].
19. T. D. Grow<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, L. T. Vuong<sup>S</sup>, A. L. Gaeta<sup>PI</sup>, N. Gavish<sup>S</sup>, G. Fibich<sup>C</sup>, "Collapse dynamics of Super-Gaussian beams", *Optics Express* **14**, 5468-5475 (2006). [IF 4.009, JR 1/56, **Q1**, CI 63].
20. **A. A. Ishaaya<sup>PD</sup>**, T. D. Grow<sup>S</sup>, S. Ghosh<sup>S</sup>, L. T. Vuong<sup>S</sup> and A. L. Gaeta<sup>PI</sup>, "Self-focusing dynamics of coupled optical beams", *Physical Review A* **75**, 023813 (2007). [IF 2.893, JR 5/64, **Q1**, CI 13].
21. T. D. Grow<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, L. T. Vuong<sup>S</sup> and A. L. Gaeta<sup>PI</sup>, "Collapse and stability of necklace beams in Kerr media", *Physical Review Letters* **99**, 133902 (2007). [IF 7.37, JR 5/84, **Q1**, CI 20].
22. L. Shimshi<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, N. Davidson<sup>C</sup> and A. A. Friesem<sup>PI</sup>, "Upscaling coherent addition of laser distributions", *Optics Communications* **275**, 389-393 (2007). [IF 1.314, JR 21/64, **Q2**, CI 8].
23. R. Rabinovici<sup>S</sup>, **A. A. Ishaaya<sup>PD</sup>**, I. Peer<sup>C</sup>, L. Shimshi<sup>S</sup>, N. Davidson<sup>C</sup>, and A. A. Friesem<sup>PI</sup>, "Increasing output energy from a passively Q-switched Er:glass laser", *Applied Optics* **46**, 7426-7431 (2007). [IF 1.701, JR 17/64, **Q2**, CI 5].
24. **A. A. Ishaaya<sup>PD</sup>**, L. T. Vuong<sup>S</sup>, T. D. Grow<sup>S</sup> and A. L. Gaeta<sup>PI</sup>, "Self-focusing dynamics of polarization vortices in Kerr media", *Optics Letters* **33**, 13-15 (2008). [IF 3.772, JR 4/64, **Q1**, CI 27].
25. **A. A. Ishaaya<sup>PI</sup>**, C. J. Hensley<sup>S</sup>, B. Shim<sup>PD</sup>, S. Schrauth<sup>S</sup>, K. W. Koch<sup>C</sup> and A. L. Gaeta<sup>PI</sup>, "Highly-efficient coupling of linearly- and radially-polarized femtosecond pulses in hollowcore photonic band-gap fibers", *Optics Express* **17**, 18630-18637 (2009). [IF 3.278, JR 3/71, **Q1**, CI 16].
26. **A. A. Ishaaya<sup>PI</sup>**, N. Davidson<sup>PI</sup> and A. A. Friesem<sup>PI</sup>, "Passive laser beam combining with intra-cavity interferometric combiners", **special issue** on Laser Beam Combination and Fiber Laser Systems, *IEEE Journal of Selected Topics in Quantum Electronics* **15**, 301-311 (2009). [IF 3.780, JR 5/71, **Q1**, CI 15]. **[INVITED PAPER]**
27. B. Shim<sup>PD</sup>, S. E. Schrauth<sup>S</sup>, C. J. Hensley<sup>S</sup>, L. T. Vuong<sup>S</sup>, P. Hui<sup>C</sup>, **A. A. Ishaaya<sup>C</sup>**, and A. L. Gaeta<sup>PI</sup>, "Controlled Interactions of Femtosecond Light Filaments in Air", *Physical Review A* **81**, 061803(R) (2010). [IF 2.861, JR 9/78, **Q1**, CI 28]. **[rapid communication]**
28. **B. Shulga<sup>S</sup>** and **A. A. Ishaaya<sup>PI</sup>**, "Off-axis pumping of a photonic crystal fiber laser", *Applied Physics B* **101**, 701-704 (2010). [IF 2.240, JR 15/78, **Q1**, CI 2]. **[rapid communication]**
29. **E. Ronen<sup>S</sup>** and **A. A. Ishaaya<sup>PI</sup>**, "Phase locking a fiber laser array via diffractive coupling", *Optics Express* **19**, 1510-1515 (2011). [IF 3.587, JR 6/79, **Q1**, CI 9].
30. **E. Ronen<sup>S</sup>** and **A. A. Ishaaya<sup>PI</sup>**, "Phase clusters induced by degeneracy in a phase locked fiber laser array", *IEEE Journal of Quantum Electronics* **47**, 1526-1530 (2011). [IF 1.879, JR 22/79, **Q2**, CI 2]. **[appeared on cover page]**

31. A. Herzog<sup>S</sup>, A. Shamir<sup>S</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Wavelength conversion of nano-second pulses to the Mid-IR in photonic crystal fibers", *Optics Letters* **37**, 82-84 (2011). [IF 3.399, JR 7/79, **Q1**, CI 22].
32. E. Ronen<sup>S</sup>, **A. A. Ishaaya<sup>PI</sup>**, "Frequency, phase, and polarization locking of evanescent coupled lasers", *Journal of the Optical Society of America B* **29**, 1226-1230 (2012). [IF 2.210, JR 16/80, **Q1**, CI 1]
33. E. Ronen<sup>S</sup>, **A. A. Ishaaya<sup>PI</sup>**, M. Nixon<sup>S</sup>, A. Godel<sup>C</sup>, A. A. Friesem<sup>C</sup>, and N. Davidson<sup>PI</sup>, "Phase locking of lasers with self-stabilized minimal coupling", *Optics Express* **27**, 28163-28170 (2012). [IF 3.546, JR 5/80, **Q1**, CI 0]
34. (\*) O. Shneider<sup>S</sup>, B. Shulga<sup>S</sup>, **A. A. Ishaaya<sup>PI</sup>**, "Imposing spectral content when coherently combining laser channels", *Optics Letters* **38**, 603-605 (2013). [IF 3.179, JR 10/83, **Q1**, CI 2].
35. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya<sup>PI</sup>**, "Large volume ablation of Sapphire with ultra-short laser pulses", *Applied Surface Science* **270**, 763-766 (2013). [IF 2.538, JR 29/136, **Q1**, CI 2]
36. (\*) E. Ronen<sup>S</sup>, B. Rosenstein<sup>S</sup>, E. Grinvald<sup>PD</sup>, N. Davidson<sup>C</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Single large mode cladding amplification in active double-clad fibers", *Laser Physics* **23**, 105102 (2013). [IF 1.025, JR 53/83, Q3, CI 0]
37. (\*) T. Frumkin<sup>S</sup>, H. Genish<sup>S</sup>, **A. A. Ishaaya<sup>PI</sup>**, and Z. Zalevsky<sup>PI</sup>, "Silicon nano photonic multi taper for efficient light coupling between fiber and silicon waveguide", *Journal of Nanophotonics* **7**, 073084 (2013). [IF 1.448, JR 38/83, Q2, CI 0]
38. (\*) B. Rosenstein<sup>S</sup>, A. Shirakov<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "0.7 MW output power from two arm coherently combined Q-switched photonic crystal fiber laser", *Optics Express* **22**, 6416-6421 (2014). [IF 3.488, JR 10/87, **Q1**, CI 4]
39. (\*) B. Rosenstein<sup>S</sup>, A. Shirakov<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Experimental characterization of an off-axis scheme for pumping high power photonic crystal fiber lasers", *Applied Physics B: Lasers and Optics* **114**, 327-331, Rapid Communication (2014). [IF 1.856, JR 32/87, Q2, CI 1].
40. (\*) L. Ben Yehud<sup>S</sup>, D. Belker<sup>T</sup>, G. Ravnitzki<sup>C</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Competition between stimulated Raman and Brillouin scattering processes in CF<sub>4</sub> gas", *Optics Letters* **39**, 1026-1029 (2014). [IF 3.292, JR 11/87, **Q1**, CI 0].
41. (\*) A. Herzog<sup>S</sup>, B. Hadad<sup>C</sup>, V. Lyubin<sup>C</sup>, M. Klebanov<sup>C</sup>, A. Reiner<sup>C</sup>, A. Shamir<sup>S</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Chalcogenide waveguides on a sapphire substrate for mid-IR applications", *Optics Letters* **39**, 2522-2525 (2014). [IF 3.292, JR 11/87, **Q1**, CI 2]
42. (\*) B. Rosenstein<sup>S</sup>, A. Shirakov<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Single-channel Q-switching in a system of coherently combined fiber lasers," *Appl. Phys. B: Lasers and Optics* **117**, 995-999 (2014). [IF 1.856, JR 32/87, Q2, CI 0]
43. (\*) Z. Montz<sup>S</sup> and **A. A. Ishaaya<sup>PI</sup>**, "Dual-bandgap hollow-core photonic crystal fibers for third harmonic generation," *Optics Letters* **40**, 56-59 (2015). [IF 3.04, JR 15/90, **Q1**, CI 2]
44. (\*) A. Herzog<sup>S</sup>, D. Malka<sup>S</sup>, Z. Zalevsky<sup>C</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "The effect of spatial-coherence on damage occurrence in multimode optical fibers," *Optics Letters* **40**, 415-418 (2015). [IF 3.04, JR 15/90, **Q1**, CI 1]
45. (\*) B. Rosenstein<sup>S</sup>, A. Shirakov<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "Highly efficient 10-cm long fiber laser," *Optics Letters* **40**, 407-410 (2015). [IF 3.04, JR 15/90, **Q1**, CI 0]
46. (\*) A. Herzog<sup>S</sup>, S. Bogdan<sup>C</sup>, M. Glikson<sup>C</sup>, **A. A. Ishaaya<sup>PI</sup>**, and C. J. Love<sup>PI</sup>, "Selective tissue ablation using laser radiation at 355 nm in lead extraction by a hybrid catheter; a preliminary report," *Lasers in Surgery and Medicine*, doi: 10.1002/lsm.22451 (2015). [IF 2.135, JR 64/200, Q2, CI 0]
47. (\*) A. Herzog<sup>S</sup>, I. Steinberg<sup>S</sup>, E. Geinsberg<sup>C</sup>, R. Nomberg<sup>C</sup>, and **A. A. Ishaaya<sup>PI</sup>**, "A route to laser angioplasty in the presence of fluoroscopy contrast media, using a nanosecond-pulsed 355 nm laser," *IEEE Journal of Selected Topics in Quantum Electronics* **22**, 1-6 (2016). [IF 3.466, JR 11/90, **Q1**, CI 0]
48. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya<sup>PI</sup>**, "Effect of femtosecond photo-treatment on inscription of fiber Bragg gratings," *Optics Letters* **41**, 765-768 (2016). [IF 3.04, JR 15/90, **Q1**, CI 0]



49. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya**<sup>PI</sup>, "Femtosecond inscription of phase-shifted gratings by overlaid fiber Bragg gratings," *Optics Letters* **41**, 2017-2020 (2016). [IF 3.04, JR 15/90, **Q1**, CI 1]
50. (\*) Y. Sivan<sup>PI</sup>, S. Rozenberg<sup>S</sup>, A. Halstuch<sup>S</sup>, and **A. A. Ishaaya**<sup>C</sup>, "Nonlinear wave interactions between short pulses of different spatio-temporal extents," *Scientific Reports* **6**, 29010; doi: 10.1038/srep29010 (2016). [IF 5.228, JR 7/63, **Q1**, CI 1]
51. (\*) H. Herzog<sup>S</sup>, I. Steinberg<sup>S</sup>, and **A. A. Ishaaya**<sup>PI</sup>, "Shaping photomechanical effects in tissue ablation using 355 nm laser pulses", *J. Biophotonics* 1–9, DOI 10.1002/jbio.201600094 (2016). [IF 3.818, JR 16/72, **Q1**, CI 0]
52. (\*) A. Herzog<sup>S</sup>, G. Oszkinis<sup>C</sup>, D. Planer<sup>C</sup>, K. Ziaja<sup>C</sup>, Ł. Kruszyna<sup>C</sup>, M Goran Stanisic<sup>C</sup>, D. Ziaja<sup>C</sup>, **A. A. Ishaaya**<sup>C</sup>, and W. Kuczmik<sup>PI</sup>, "Atherectomy using a solid-state laser at 355 nm wavelength", *J. Biophotonics* 1–8 /DOI 10.1002/jbio.201600209 (2017). [IF 3.818, JR 16/72, **Q1**, CI 0]
53. (\*) H. Hecht<sup>S</sup>, Z. Burshtein<sup>C</sup>, A. Katzir<sup>C</sup>, S. Noach<sup>C</sup>, M. Sokol<sup>S</sup>, E. Frumker<sup>C</sup>, E. Galun<sup>C</sup>, **A. A. Ishaaya**<sup>PI</sup>, "Passive Q-switching of a Tm:YLF laser with a Co2+ doped silver halide saturable absorber", *Optical Materials* **64**, 64-69 (2017). [IF 2.183, JR 25/90, **Q2**, CI 0]
54. (\*) Z. Alperovich<sup>S</sup>, O. Buchinsky<sup>C</sup>, S. Greenstein<sup>C</sup>, and **A. A. Ishaaya**<sup>PI</sup>, "Misalignment sensitivities in an intra-cavity coherent combining crossed-porro resonator configuration", accepted for publication in *Laser Physics Letters* (2017).

(articles submitted for publication or in preparation are listed in a following section)

#### Classified articles and reports (internally reviewed)

- Several operations research and system analysis technical reports dealing with R&D of new systems, performance assessment of systems in various field scenarios, cost effective studies, modeling and simulations. IDF-Planning Branch, 1986-1991.
- **20 first author technical reports** dealing with novel laser designs, laser lab experiments, models and simulations, evaluation of system performance and field experiments of lasers. El-Op Inc. proprietary, 1994-2001.

#### **Lectures and presentations at meetings and invited seminars:**

##### Invited conference presentations

1. A. A. Friesem, N. Davidson, E. Hasman, **A. A. Ishaaya**, G. Machavariani, R. Oron and L. Shimshi, "Laser mode selection with intracavity phase elements", Conference on Lasers and Electro-Optics Europe, Munich, Germany (2003).
2. **A. A. Ishaaya**, N. Davidson, V. Eckhouse, L. Shimshi and A. A. Friesem, "Laser configurations for high-order transverse mode selection and coherent beam combining", Conference on Laser and Fiber-Optical Networks Modeling (LFNM), Kharkov, Ukraine (2004).
3. A.A. Friesem, **A.A. Ishaaya**, N. Davidson, V. Eckhouse and L. Shimshi, "Intra-Cavity Coherent Addition of separate laser distributions", 5th Iberoamerican Meeting on Optics and 8th Latinoamerican Meeting on Optics, Lasers and Their Applications, RIAO/OPTILAS, (Oct. 2004).
4. **A. A. Ishaaya**, L. Shimshi, V. Eckhouse, N. Davidson and A. A. Friesem, "Intra-cavity laser beam combining", Electro-optics conference, Hi-Tech Technologies 2005, Tel Aviv, Israel (March 2005).
5. A. A. Friesem, **A. A. Ishaaya**, N. Davidson, V. Eckhouse and L. Shimshi, "Intra-cavity phase locking and coherent addition in lasers", International Conference on Optics and Optoelectronics (ICOL 2005), Dehradun, India (Dec. 2005).

6. **A. A. Ishaaya**, T. D. Grow, L. T. Vuong and A. L. Gaeta, "Spatial collapse dynamics in self-focusing Kerr media", International Conference on Coherent and Nonlinear Optics (ICONO 2007), Minsk, Belarus (May 2007).
7. V. Eckhouse, **A. A. Ishaaya**, M. Fridman, N. Davidson, A. A. Friesem, "Passive coherent addition of lasers using planar interferometric combiners", Photonics West - SPIE Symposium on Lasers and Applications in Science and Engineering, San Jose, CA, USA (Jan. 2008).
8. **A. A. Ishaaya**, "Lasers and wavelength converters based on photonic crystal fibers", IPS Conference 2012, Jerusalem, Israel (Dec. 2012).
9. (\*) L. Ben Yehud and **A. A. Ishaaya**, "Efficient Raman lasing in gas-filled photonic bandgap fibers", Optical Engineering 2014, Natanya, Israel (Feb. 2014).
10. (\*) **A. A. Ishaaya**, "Intracavity coherent combining of ns pulsed PCF lasers", International Meeting on Fiber Lasers and Applications - IFLA, Bar Ilan University, Israel (June 2014).
11. (\*) **A. A. Ishaaya**, "High peak power, compact, PCF lasers", "Light in Defense", Ben-Gurion University of the Negev, Israel, (May 2015).
12. (\*) A. Shamir, Z. Montz, A. Halstuch, and **A. A. Ishaaya**, "Femtosecond inscription of Bragg gratings in various fibers and planar transparent materials using a phase mask", IFLA conference within OASIS6, Tel-Aviv, Israel (Feb. 2017).

#### Contributed conference presentations

13. **A. A. Ishaaya**, R.L. Boxman and S. Goldsmith, "Measurement of cathode spot velocity and distribution on a disk cathode in a radial magnetic field", Conference on Metallurgical Coatings and Thin Films, San Diego, California, USA (1992).
14. **A. A. Ishaaya**, G. Ravnitzky and I. Shoshan, "Axial amplified spontaneous emission measurements in Nd:YAG oscillator-amplifier laser configurations", 11<sup>th</sup> International Meeting of Electrooptics and Microelectronics, Tel Aviv, Israel (1999).
15. G. Machavariani, N. Davidson, A. A. Friesem, **A. A. Ishaaya**, S. Blit and E. Hasman, "Efficient formation of pure helical beams from a gaussian beam", Conference on Lasers and Electro-Optics (CLEO), Long Beach, California, USA (2002).
16. **A. A. Ishaaya**, N. Davidson, G. Machavariani, A. A. Friesem and E. Hasman, "High-order mode selection in Q-switched Nd:YAG lasers", Conference on Lasers and Electro-Optics (CLEO), Long Beach, California, USA (2002).
17. G. Machavariani, N. Davidson, **A. A. Ishaaya**, A.A. Friesem and E. Hasman, "Transformation of a high order HG mode to a nearly Gaussian beam", Conference on Advanced Laser technologies, Adelboden, Switzerland (2002).
18. **A. A. Ishaaya**, G. Machavariani, N. Davidson, A. A. Friesem and E. Hasman, "Compact optical mode converter", Conference on Lasers and Electro-Optics (CLEO), Baltimore, Maryland, USA (2003).
19. G. Machavariani, **A. A. Ishaaya**, N. Davidson, A. A. Friesem, S. Blit and E. Hasman, "Effect of phase errors on laser mode selection with binary phase elements", Conference on Lasers and Electro-Optics Europe, Munich, Germany (2003).
20. G. Machavariani, **A. A. Ishaaya**, N. Davidson, A. A. Friesem and E. Hasman, "Compact and simple configurations for converting laser beam distributions", Conference on Lasers and Electro-Optics Europe, Munich, Germany (2003). [**post-deadline presentation**]
21. L. Shimshi, **A. A. Ishaaya**, N. Davidson, A. A. Friesem and E. Hasman, "Second harmonic generation with a high-order mode laser beam", Frontiers in Optics, OSA Annual Meeting, Tucson, Arizona, USA (2003).
22. **A. A. Ishaaya**, N. Davidson, L. Shimshi and A. A. Friesem, "Intra-cavity coherent addition of Gaussian laser beam distributions", Conference on Lasers and Electro-Optics (CLEO), San Francisco, California, USA (2004).

23. **A. A. Ishaaya**, L. Shimshi, V. Eckhouse, N. Davidson and A. A. Friesem, "Coherent addition of single mode and multimode laser beam distributions", EPS-QEOD Europhoton Conference, Lausanne, Switzerland (2004).
24. **A. A. Ishaaya**, N. Davidson, A. A. Friesem, E. Galun, M. Sirota, V. Krupkin and I. Shoshan, "Very high-order transverse mode selection in a passive Q-switched Nd:YAG laser", EPS-QEOD Europhoton Conference, Lausanne, Switzerland (2004).
25. L. Shimshi, **A. A. Ishaaya**, N. Davidson and A. A. Friesem, "Intra-cavity phase-locking of several laser distributions", EPS-QEOD Europhoton Conference, Lausanne, Switzerland (2004).
26. V. Eckhouse, **A. A. Ishaaya**, L. Shimshi, N. Davidson and A. A. Friesem, "Novel laser resonator configurations for achieving high power and brightness", CLEO/Europe-EQEC Conference, Munich, Germany (2005).
27. **A. A. Ishaaya**, N. Davidson and A. A. Friesem, I. Pe'er, E. Galun, M. Sirota, E. Luria, V. Krupkin, and I. Shoshan, "Stable selection of very high transverse modes in passive Q-switched lasers", CLEO/Europe-EQEC Conference, Munich, Germany (2005).
28. L. Shimshi, **A. A. Ishaaya**, V. Eckhouse, N. Davidson and A. A. Friesem, "Efficient intra-cavity passive coherent addition of nine laser channels", CLEO/Europe-EQEC Conference, Munich, Germany (2005).
29. L. T. Vuong, A. L. Gaeta, G. Fibich, G. W. t'Hooft, E. Eliel, T. D. Grow, **A. A. Ishaaya**, "Collapse of optical vortices", CLEO/QELS 06, Long Beach, California (May 2006).
30. G. Machavariani, N. Davidson, **A. A. Ishaaya**, A. A. Friesem, "Phase element can improve stability of longitudinal and transverse laser modes", XVI International Symposium on Gas Flow and Chemical Lasers & High Power Laser Conference, Gmunden, Austria (Sept. 2006).
31. **A. A. Ishaaya**, T. D. Grow, S. Ghosh, L. T. Vuong, A. L. Gaeta, "Optical collapse of coupled beams in Kerr media", Frontiers in Optics 2006/Laser Science XXII conference, Rochester, New York (Oct. 2006).
32. L. T. Vuong, **A. A. Ishaaya**, T. D. Grow, A. L. Gaeta, E. R. Eliel, "Orbital angular momentum switching of optical vortices", Frontiers in Optics 2006/Laser Science XXII conference, Rochester, New York (Oct. 2006).
33. **A. A. Ishaaya**, T. D. Grow, L. T. Vuong and A. L. Gaeta, "Multiple-beam collapse in Kerr media", CLEO/QELS 07, Baltimore, Maryland (May 2007).
34. T. D. Grow, **A. A. Ishaaya**, L. T. Vuong and A. L. Gaeta, "Collapse and stability of necklace beams in Kerr media", CLEO/QELS 07, Baltimore, Maryland (May 2007).
35. **A. A. Ishaaya**, L. T. Vuong, T. D. Grow and A. L. Gaeta, "Stability of polarization vortices in self-focusing Kerr media ", CLEO/QELS 07, Baltimore, Maryland (May 2007).
36. L. Shimshi, V. Eckhouse, **A. A. Ishaaya**, N. Davidson, and A. A. Friesem, "Upscaling Coherent Addition of Laser Distributions", CLEO/QELS 07, Baltimore, Maryland (May 2007).
37. L. T. Vuong, **A. A. Ishaaya**, T. D. Grow, E. R. Eliel, G. t'Hooft, A. L. Gaeta, "Experiments showing orbital angular momentum exchange with optical vortices", CLEO/Europe - IQEC 2007, p. 1181, (2007).
38. **A. A. Ishaaya**, B. Shim, C. J. Hensley, S. E. Schrauth, A. L. Gaeta and K. W. Koch, "Efficient excitation of polarization vortices in a photonic bandgap fiber with ultrashort laser pulses", CLEO/QELS 08, San Jose, Ca, USA (May 2008).
39. B. Shim, S. E. Schrauth, C. J. Hensley, P. Hui, A. D. Slepko, **A. A. Ishaaya**, L. T. Vuong, and A. L. Gaeta, "Controlled interactions of femtosecond light filaments in air", FiO, OSA Annual Meeting, Rochester, NY, USA (Sept. 2008).
40. E. Ronen and **A. A. Ishaaya**, "Phase locking a fiber laser array via diffractive coupling", FiO, OSA Annual Meeting, Rochester, NY, USA (Oct. 2010).
41. E. Ronen and **A. A. Ishaaya**, "Phase locked clusters in laser arrays and a novel method for detecting them", FiO, OSA Annual Meeting, Rochester, NY, USA (Oct. 2010).

42. A. Gilad and **A. A. Ishaaya**, "Self phase modulation of chirped ultrashort pulses in gas filled hollow core photonic bandgap fibers", FiO, OSA Annual Meeting, Rochester, NY, USA (Oct. 2010).
43. B. Shulga and **A. A. Ishaaya**, "Off-axis pumping of air-clad photonic crystal fiber based systems", Oasis 2011, The 13th Meeting on Optical Engineering and Science in Israel, Tel Aviv, Israel (March 2011).
44. B. Shulga and **A. A. Ishaaya**, "Off-axis pumping of air clad photonic crystal fiber lasers and amplifiers", CLEO/Europe, Munich, Germany (May 2011).
45. B. Shulga and **A. A. Ishaaya**, "High Power Photonic Crystal Fiber Lasers and their Intracavity Coherent Combining", Advanced Solid-State Photonics (ASSP), San Jose, California, USA (Feb. 2012).
46. O. Shneider, B. Shulga and **A. A. Ishaaya**, "Spectral Narrowing in a System of Coherently Combined Fiber Lasers", 5th EPS-QEOD Europhoton Conference (Europhoton 2012), Stockholm, Sweden (Aug. 2012).
47. A. Herzog, A. Shamir, and **A. A. Ishaaya**, "Wavelength conversion of nanosecond pulses to the mid-IR using four wave mixing in photonic crystal fibers", 5th EPS-QEOD Europhoton Conference (Europhoton 2012), Stockholm, Sweden (Aug. 2012).
48. A. Shamir and **A. A. Ishaaya**, "Large-scale Sapphire etching with ultrashort laser pulses", IEEE 27-th Convention of Electrical and Electronics Engineers in Israel (IEEEI 2012), Eilat, Israel (Nov. 2012).
49. A. Shamir, A. Herzog, and **A. A. Ishaaya**, "Inter-modal cascaded four-wave-mixing with ns pulses in photonic crystal fibers", IEEE 27-th Convention of Electrical and Electronics Engineers in Israel (IEEEI 2012), Eilat, Israel (Nov. 2012).
50. (\*) B. Shulga and **A. A. Ishaaya**, "Passive Coherent Combining of High Power Photonic Crystal Fiber Lasers", OASIS 2013, the 14<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2013).
51. (\*) L. Kedar and **A. A. Ishaaya**, "Competition Between Stimulated Raman and Brillouin Scattering Processes in CF<sub>4</sub>", OASIS 2013, the 14<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2013).
52. (\*) A. Shamir and **A. A. Ishaaya**, "Cascaded Four-Wave Mixing with ns Pulses in Photonic Crystal Fibers", OASIS 2013, the 14<sup>th</sup> International Meeting on Optical Engineering and Science in Israel, Tel-Aviv, Israel (Feb. 2013).
53. (\*) B. Shulga and **A. A. Ishaaya**, "Imposing Temporal and Frequency Characteristics in a System of Coherently Combined High Peak Power Photonic Crystal Fiber Lasers", CLEO/Europe, Munich, Germany (May 2013).
54. (\*) M. Vanholsker, B. Shulga, and **A. A. Ishaaya**, "Fundamental Mode Amplification in 140  $\mu$ m Core Diameter Fiber", CLEO/Europe, Munich, Germany (May 2013).
55. (\*) B. Rosenstein, A. Shirakov, **A. A. Ishaaya**, "Characterization of Coherently Combined High Peak Power Photonic Crystal Fiber Lasers", Workshop on Specialty Optical Fiber and their Applications (WSOF), Sigtuna, Sweden (Aug. 2013).
56. (\*) B. Rosenstein, A. Shirakov, **A. A. Ishaaya**, "High Power Off-axis Pumping of a Flexible Photonic Crystal Fiber Laser", Workshop on Specialty Optical Fiber and their Applications (WSOF), Sigtuna, Sweden (Aug. 2013).
57. (\*) E. Ronen, B. Rosenstein, E. Grinvald, N. Davidson, **A. A. Ishaaya**, "Cladding Amplification of Very Large Area Modes in a Novel Double-Clad Fiber", Workshop on Specialty Optical Fiber and their Applications (WSOF), Sigtuna, Sweden (Aug. 2013).
58. (\*) B. Rosenstein, A. Shirakov, **A. A. Ishaaya**, "Efficient Off-axis Pumping of a High Power Flexible Photonic Crystal Fiber Laser", Advanced Solid State Lasers (ASSL), Paris, France (Oct. 2013).
59. (\*) B. Rosenstein, A. Shirakov, **A. A. Ishaaya**, "0.7 MW Output Power from Coherently Combined Q-Switched Fiber Lasers", Advanced Solid State Lasers (ASSL), Paris, France (Oct. 2013).

60. (\*) B. Rosenstein, A. Shirakov, D. Belker, **A. A. Ishaaya**, "0.7 MW Output Power from Coherently Combined Q-switched Photonic Crystal Fiber Laser", CLEO/QELS 08, San Jose, Ca, USA (June 2014).
61. (\*) L. Ben-Yehud, **A. A. Ishaaya**, "Highly efficient wavelength conversion in CF<sub>4</sub>-filled hollow-core photonic bandgap fibers", CLEO/QELS 08, San Jose, Ca, USA (June 2014).
62. (\*) A. Herzog, **A. A. Ishaaya**, "The influence of spatial-coherence on damage occurrence in multimode optical fibers", International Meeting on Fiber Lasers and Applications - IFLA, Bar Ilan University, Israel (June 2014).
63. (\*) Z. Montz, **A. A. Ishaaya**, "Dual bandgap hollow-core photonic crystal fibers for third harmonic generation", International Meeting on Fiber Lasers and Applications - IFLA, Bar Ilan University, Israel (June 2014).
64. (\*) B. Rosenstein, A. Shirakov, D. Belker, **A. A. Ishaaya**, "Efficient operation of extremely short 10 cm long photonic crystal fiber laser", International Meeting on Fiber Lasers and Applications - IFLA, Bar Ilan University, Israel (June 2014).
65. (\*) Z. Montz and **A. A. Ishaaya**, "Hollow-core photonic bandgap fiber cladding designs for third harmonic generation," JTU3A.8, SOF Conference, Spain, Barcelona, Specialty Optical Fibers & Applications (2014).
66. (\*) L. Ben Yehud and **A. A. Ishaaya**, "Efficient wavelength conversion in CF<sub>4</sub>-filled photonic bandgap fibers," SoTh2B.5, SOF Conference, Spain, Barcelona, Specialty Optical Fibers & Applications (2014).
67. (\*) A. Herzog, B. Hadad, V. Lyubin, M. Klebanov, A. Reiner, A. Shamir and **A. A. Ishaaya**, "Chalcogenide waveguides on a sapphire substrate for 3-5  $\mu\text{m}$  wavelengths applications," JM5A.31, Nonlinear Photonics (NP): All-Optical Devices and Applications, Spain, Barcelona, (2014).
68. (\*) A. Herzog and **A. A. Ishaaya**, "Spatial-coherence effect on damage occurrence in multimode optical fibers using nanosecond pulses," JM5A.13, SOF Conference, Spain, Barcelona, Specialty Optical Fibers & Applications (2014).
69. (\*) A. Herzog, I. Steinberg, E. Geinsberg, R. Nomberg, and **A. A. Ishaaya**, "A route to laser angioplasty in the presence of fluoroscopy contrast media using a nanosecond-pulsed 355nm laser", 9706-27, Photonics West - SPIE Symposium on Lasers and Applications in Science and Engineering, San Francisco, CA, USA (Feb. 2016).
70. (\*) A. Herzog, S. Bogdan, M. Glikson, **A. A. Ishaaya**, C. Love, "Lead extraction by selective operation of a nanosecond-pulsed 355nm laser", 9706-28, Photonics West - SPIE Symposium on Lasers and Applications in Science and Engineering, San Francisco, CA, USA (Feb. 2016).
71. (\*) A. Shamir and **A. A. Ishaaya**, "Femtosecond photo treatment effects on fiber Bragg grating inscription", 9886-21, SPIE Photonics Europe, Brussels, Belgium (April 2016).
72. (\*) Z. Alperovich, G. Bialolenker, Z. Montz, **A. A. Ishaaya**, "Fabrication of a multicore coupler for phase locking of fiber lasers", Europhoton 2016, Vienna, Austria (August 2016).
73. (\*) H. Hecht, A. Katzir, Z. Burshtein, M. Sokol, S. Noach, E. Frumker, E. Galun, and **A. A. Ishaaya**, "Passive Q-switching of a Tm:YLF laser with a cobalt doped silver halide saturable absorber", Europhoton 2016, Vienna, Austria (August 2016).
74. (\*) S. Noach, D. Sebbag, A. Korenfeld, U. Ben Ami, A. Herzog, and **A. A. Ishaaya**, "Passively Q-Switched 2 $\mu\text{m}$  Lasers, for Medical and Industrial Applications", OASIS 6, Tel-Aviv, Israel (Feb. 2017).
75. (\*) A. Herzog, G. Oszkinis, D. Planer, K. Ziaja, Ł. Kruszyna, M. G. Stanisić, D. Ziaja, W. Kuczmik, and **A. A. Ishaaya**, "Laser atherectomy using a nanosecond pulsed laser at 355 nm: a first-in-human study", CLEO Europe, Munich, Germany (June 2017).
76. (\*) A. Halstuch and **A. A. Ishaaya**, "Femtosecond laser inscription Bragg gratings formed on a thin GaN film grown on a sapphire substrate", CLEO Europe, Munich, Germany (June 2017).

### Seminar presentations at universities and institutions

- 2004 Dept. of Applied Physics, Stanford University, USA
- 2004 Nuclear Research Center, Israel
- 2004 Ariel University Center of Samaria, Israel
- 2005 Dept. of Engineering, Bar-Ilan University, Israel
- 2005 Elop Electrooptics Industries Ltd., Israel
- 2006 Dept. of Applied Physics, Hebrew University, Israel
- 2006 Dept. of Engineering, Bar-Ilan University, Israel
- 2006 Dept. of Electrical and Computer Engineering, Ben-Gurion University, Israel
- 2006 Dept. of Physics of Complex Systems, Weizmann Institute of Science, Israel
- 2006 School of Electrical Engineering, Tel-Aviv University, Israel
- 2006 Nuclear Research Center, Israel
- 2007 Dept. of Physics, Ben-Gurion University, Israel
- 2008 ILEOS meeting, Bar-Ilan University, Israel
- 2012 Nano center, Bar-Ilan University, Israel
- 2013 Xlim Laboratory, University of Limoges, France (\*)
- 2015 2nd Working Group Meeting, COST Action 1401, Dresden, Germany (\*)
- 2016 Dept. of Applied Physics, Hebrew University, Israel (\*)

### **Patents:**

1. **A. A. Ishaaya**, N. Davidson, A. A. Friesem and L. Shimshi, "Resonator cavity configuration and method", US patent No. 7,933,301.
2. **A. A. Ishaaya**, N. Davidson, A. A. Friesem and L. Shimshi, "Resonator cavity configuration and method", US patent No. 7,555,024.
3. **B. Shulga** and **A. A. Ishaaya**, "Fiber laser pumping configuration and method", US patent application, first submitted July 2010 (PCT/IL2011/000502).
4. **E. Ronen** and **A. A. Ishaaya**, "Single large mode cladding amplification in active double-clad fibers", provisional US patent application (2012).
5. (\*) **B. Rosenstein** and **A. A. Ishaaya**, "Multi-pump-pass scheme of fiber based lasers and amplifiers", provisional US patent application (2014).
6. (\*) **A. A. Ishaaya** and Y. Sivan, "Transient Bragg gratings in optical waveguides and their applications", provisional US patent application (2014).

### **Research grants:**

- 2007 University startup/seed funding for setting up a lab; total - \$550,000. PI
- 2008 Chief Scientist (Ministry of Labor, Trade, and Industry, Israel), "Advanced Fiber Lasers" (consortium); total – \$384,000. 2008-2011. PI
- 2008 Israel Science Foundation (ISF) personal grant 1205/08; "Lasers and wavelength converters based on photonic crystal fibers"; total – \$204,000. 2008-2012. PI
- 2008 Israel Science foundation (ISF) New Faculty Equipment Grant 1626/08; "Lasers and nonlinear optical devices laboratory"; total – \$400,000 (50% matching). PI
- 2011 Israel MOD (Mafat); "multicore fibers"; total budget – \$276,000. 2011-2014. PI
- 2012 Chief Scientist (Ministry of Labor, Trade, and Industry, Israel) Kamin Grant; "Low cost, compact, PCF laser"; total budget – \$222,000. 2012-2014. PI

2012	Chief Scientist (Ministry of Labor, Trade, and Industry, Israel) Magneton Grant; "Novel UV High Power Fiber Laser Technologies"; total budget – \$142,000. 2012-2013. PI
2013	Israel MOD (Mafat); High power laser + OSA equipment; cost – \$250,000. PI
2013	M.F.S grant (internal BGU); "Transient gratings in fibers and waveguides for ultrafast applications"; total budget – \$90,000. 2013. PI
2014	Israel Chief Scientist (Ministry of Labor, Trade, and Industry) Magneton Grant; "Passive coherent combining of solid-state lasers"; total budget – \$166,000. 2014-2016. PI
2014	Israel MOD (Mafat); "High power laser processing"; total budget \$320,500. 2014-2017. PI
2014	Israel Ministry of Science, MOST, "Wavelength conversion to the UV with gas-filled Kagome and antiresonant fibers"; total budget \$200,000. 2014-2017. PI
2016	Chief Scientist (Ministry of Labor, Trade, and Industry, Israel), "Advanced Lasers technologies for Industrial Applications" (consortium); First year – \$162,000; 2016-2019. PI

### **Present and planned academic activities:**

#### Research topics in progress \ planned

- Laser operation in active multicore fibers.
- Amplification of pico and femto second pulses in an active rod type PCF.
- Investigating various pump couplers and fiber end caps fabricated by tapering.
- Phase locking and coherent combining in two dimensional fiber laser arrays.
- Wavelength conversion (DFWM) to the mid-IR in Chalcogenide and Fluoride fibers.
- Wavelength conversion via Raman in gas filled hollow core PBGFs.
- Precision femtosecond ablation of specific optical materials.
- Biological tissue ablation with UV and IR pulsed laser sources.
- Permanent and Transient Bragg gratings in fibers and semiconductor waveguides.
- Novel large mode area fiber based on cladding amplification.
- Novel lasers in the mid-IR.

#### Journal articles submitted for publication or in preparation

1. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya**<sup>PI</sup>, "Ns-duration transient fiber Bragg gratings", submitted for publication.
2. (\*) A. Halstuch, O. Westreich<sup>S</sup>, N. Sicron<sup>C</sup>, Y. Paltiel<sup>C</sup>, and **A. A. Ishaaya**<sup>PI</sup>, "Femtosecond laser inscription of Bragg gratings with a phase mask on a thin GaN film grown on a sapphire substrate", submitted for publication.
3. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya**<sup>PI</sup>, "Controlling the switching time of thermal fiber Bragg gratings", in preparation.
4. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya**<sup>PI</sup>, "Femtosecond Fiber Bragg grating inscription through the coating using low NA lens", in preparation.
5. (\*) A. Shamir<sup>S</sup> and **A. A. Ishaaya**<sup>PI</sup>, "Cascaded four-wave mixing with ns pulses in photonic crystal fibers", in preparation.

6. (\*) L. Ben Yehud<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya**<sup>PI</sup>, "Stimulated Raman scattering in CF<sub>4</sub>-filled hollow-core photonic bandgap fibers", in preparation.
7. (\*) A. Shirakov<sup>S</sup>, B. Rosenstein<sup>S</sup>, D. Belker<sup>T</sup>, and **A. A. Ishaaya**<sup>PI</sup>, "High peak power, efficient, flexible PCF laser oscillator", in preparation.

## **Additional information:**

### News coverage

1. "Multimode lasers get brighter", Opto & Laser Europe 128, May 2005.
2. "Multimode lasers get brightness boost", Optics.org, April 2005.  
(<http://optics.org/articles/news/11/4/12>)
3. "Simple scheme combines multiple beams", Optics.org, Jan. 2006.  
(<http://optics.org/articles/news/12/1/11>)
4. "LASER OPTICS: Sixteen laser beams combined with 88% efficiency", Laser Focus World, March 2006.
5. "Overcoming peak-power limitations of fiber lasers", SPIE Newsroom, Feb. 2014.  
(<http://spie.org/x106177.xml>)

## **Synopsis of research:**

The following summarizes the main research conducted at Ben-Gurion University since the lab was active (2009):

### 1. Single solid core fiber laser configurations based on PCFs

In this research topic we focused on designing, building, and investigating high power PCF lasers based on a rod-type, very large core, active (Yb) double clad fiber. We investigated various resonator configurations and managed to demonstrate in CW TEM<sub>00</sub> operation more than 72W with 79% slope efficiency, and in high repetition Q-switched pulsed operation 38W average power with 76% slope efficiency and 192kW peak power. To the best of our knowledge these results represent a record with regard to pulsed fiber lasers. During the design we came up with a new off-axis pumping method of PCF double clad fibers with significant advantages over standard on-axis pumping. We also submitted a patent application on this method.

### 2. Phase locking and coherent combining of multiple fiber lasers

Here we investigated several sub topics. In the first we focused on phase locking of a linear array of 8 low power fiber lasers via diffraction coupling (Talbot effect). With the experimental setup that was built we demonstrated anti-phase locked operation and characterized it. We measured an exponential phase decorrelation between distant lasers in the array, and discussed its fundamental limitation on scalability of this and similar local coupling methods. When the output coupler was positioned half a Talbot distance from the laser channels we showed that phase clustering occurs in the array whereby the array separates into two different phase locked clusters. Further theoretical analysis and experimental measurements showed that these clusters result from an incoherent superposition of the in-phase and out-of-phase super-modes of the array. By inserting selective loss in the resonator we managed to demonstrate operation in a nearly single pure in-phase super-mode. Finally, with this experimental setup we studied and demonstrated experimentally different system states: full coherent lasing, polarization-locked lasing, frequency locked lasing without phase-locking, and independent incoherent lasing.

In the second subtopic we investigated in detail phase locking and coherent addition of two fiber laser channels connected with an interferometric coupler. Specifically, we investigated the possibility to spectrally narrow the operation of two coherently combined fiber lasers. To the best of our knowledge, we show for the first time that by placing a narrowband spectrally



selective element in only one of the channels, the spectral content is efficiently imposed on the other channel, and both channels operate with a narrow bandwidth.

In the third subtopic we are currently investigating phase locking and coherent addition of two Q-switched pulsed high peak power PCF laser channels. We achieved already 0.7 MW of peak power with 10ns pulses by intracavity coherent addition of two laser channels. This is a new record in fiber oscillators and shows great potential for further scaling of peak power.

3. Raman amplification in gas filled hollow core photonic bandgap fibers

Here we built a dedicated vacuum/pressure system that allowed us to evacuate air out of the fibers, and fill the hollow core bandgap fiber with a suitable gas. With  $\text{CF}_4$  and  $\text{SF}_6$  gases we did not observe any Raman shift of the Ti:sapphire ultrashort (fs) laser pulses after propagation within the fiber, but we did observe self phase modulation and characterized it compared to focusing ultrashort pulses in high pressure free space gas cells. Recently, we investigated Raman conversion of ns pulses in a  $\text{CF}_4$  filled PBGF. We obtained a record of more than 35% conversion efficiency in a 35cm-long, weakly pressurized, fiber at a peak power of only 2.6kW. This is still work in progress.

4. Wavelength conversion in solid core PCFs

Here we investigated degenerate four wave mixing with ns pulses in fused silica photonic crystal fibers. Phase matching curves were calculated, followed by experiments with a ns pulsed Nd:YAG pump laser and relatively short fiber lengths that showed more than an octave spanning conversion to idler and signal wavelengths at 3.105  $\mu\text{m}$  and 0.642  $\mu\text{m}$ , respectively. These results represent a new stretch towards the limit of the silica transmission window in the mid-IR.

5. Design of new active and passive fibers

We proposed two novel fiber designs. In the first we proposed and investigated theoretically a new concept for single-large-mode amplification in double-clad active fibers. The concept is based on exploiting a very small fiber core, guiding only a single transverse mode that has large overlap with a doped active cladding. We show that the guided mode can have very large area with good modal discrimination. This simple structured fiber can be used in an 'all-fiber' configuration. We further investigate the sensitivity to small refractive index changes of the doped area and to bending of the fiber. Our proposed fiber concept could lead to fibers with very large mode area with advantages over current commercial fibers.

The second design focuses on hollow core photonic bandgap fibers that have two highly separated bandgaps. Using the Plane Wave Method we have recently found two rather simple PBGF designs that support two highly separated transmission bandgaps that are suitable for THG. These designs are based on silica without any doping, and the smallest features in both designs are more than 30 nm. To the best of our knowledge, this has not been reported so far, and is an excellent starting point for achieving THG in gas filled fibers.

6. Waveguides on chip

Here we managed to fabricate and characterize optical quality Chalcogenide waveguides. This will enable future experiments for efficient on-chip wavelength conversion to the mid-IR. Furthermore, we managed to improve the coupling into Silicon waveguides by using a novel multi-taper technique. This is still work in progress.

7. Fs inscription of fiber Bragg gratings with phase masks

This is work in progress. We already inscribed high quality permanent FBGs in silica fibers with both 800 and 266 nm fs pulses. Furthermore we managed to locally erase FBGs, "immune" fibers against FBG writing, inscribe phase-shifted gratings, inscribe two different gratings on the same fiber section, obtain Bragg center wavelength tunability by adding spherical phases to the inscribing beam, and obtained preliminary results showing reflections from transient fiber Bragg gratings.