

# Mukhtar Hussain, Ph.D.



Biodesign Institute, Beus CXFEL Laboratory, Arizona State University, Tempe, USA.

Emails: [awanchep@gmail.com](mailto:awanchep@gmail.com) [mukhtar.hussain@asu.edu](mailto:mukhtar.hussain@asu.edu)

ResearcherID: <http://www.researcherid.com/rid/U-8491-2017>

ORCID: <http://orcid.org/0000-0003-3142-9945>

Google Scholar <https://scholar.google.com/citations?user=q7WjyPgAAAAJ&hl=en>

Home page: <https://search.asu.edu/profile/4948165>

Research Gate: [https://www.researchgate.net/profile/Mukhtar\\_Hussain4](https://www.researchgate.net/profile/Mukhtar_Hussain4)

Linkedin: <https://www.linkedin.com/in/dr-mukhtar-hussain-1a175092>

## Education

1. **Ph.D. Technological Physics Engineering** (2017-2021): Instituto Superior Técnico, University of Lisbon, Lisbon, **Portugal**.

**Thesis title:** Controlling the microscopic and macroscopic aspects of high harmonic generation in solids.

The novel solid-state HHG generation in semiconductors, wide bandgap dielectrics, and thin films has been studied. We have also explored the non-linear propagation effects of the driving field inside the bulk crystal and its impact on the emitted HHG spectrum. The self-emission of harmonics has been used to image the nano-objects and nanostructures through ptychography by a single solid-state source and probe beam. Furthermore, the ultrafast high energy density states have been created and measured using femtosecond laser pulses and measured the ultrafast changes in the XUV optical properties and electronic structure using ultrafast HHG spectroscopy.

2. **MS Physics** (2010-2012): COMSATS University Islamabad, Lahore, **Pakistan**.

**Thesis title:** Design and Fabrication of Prototype Transversely Excited Atmospheric (TEA) Nitrogen Laser. <http://nitrogenlaser.weebly.com/n2-thesis.html>

## Jobs Experiences

1. **Laser Scientist (Associate Research Scientist)** (October 2023---): Biodesign Institute, Beus CXFEL Laboratory, Arizona State University, Tempe, USA.

- Leadership roles in laser science at CXFEL Labs.
- The design, development, and operation of advanced laser setups, femtosecond synchronization of multiple laser amplifiers with accelerator RF systems, and integration of sophisticated controls and diagnostics of photon and electron beams with optical techniques.
- Implementing plans for OPA/OPCPA schemes to generate tunable ultrashort laser pulses spanning UV, visible, and mid-infrared spectral regions.
- Conducting time-resolved X-ray studies in solid, gas, and liquid targets.
- Work in multidisciplinary teams and with future facility users in different research areas or academic units to perform cutting-edge experiments.
- Train and supervise students and postdocs, develop protocols and prepare reports. Review scientific literature to develop research plans, interpret results, and publish scientific findings.

2. **Laser Optical Engineer** (July 2022- October 2023): Extreme light laboratory, Department of Physics and Astronomy, University of Nebraska Lincoln, Nebraska, **USA**.
  - Responsible for the reliable daily operation of 3 state-of-the-art high-power (100-999 terawatt) solid-state laser systems ([Diocles](#)) and their associated pump laser for the following research fields: **(1)** Laser-accelerated protons for cancer therapy, **(2)** Controlled release of energy from nuclear isomers by laser-driven x-rays, **(3)** Relativistic Optics – Interactions of Electrons with Laser Light at Highly Relativistic Intensities, **(4)** Ultra-Low Emittance Electron Beams from Laser-Plasma Photo-Cathodes, **(5)** Laser-Produced Coherent X-Ray Sources, x-ray spectroscopy or imaging experiments, and data analysis. I am also responsible for advanced laser diagnostic systems used to confirm the acceptable quality required for user experiments and ensure that lasers are operated per approved operating procedures for DOE and LaserNet USA users.
3. **Postdoctoral Scholar:** Department of Physics, University of Central Florida, **USA**. (Oct 2021-July 2022)
  - Surface electron and molecular dynamics by using femtosecond ultraviolet (XUV) pulses generated through high harmonics in gases and solids in conjunction with photoemission spectroscopy.
  - Preparation and characterization of sub-monolayer surface on substrates in an ultra-high vacuum environment.
  - Static photoemission spectroscopy by using XUV pulses generated through high harmonic generation in gases to map the transition from non-metal to metal by measuring the valance band structure.
4. **Early-Stage Researcher:** Extreme Light Infrastructure-Attosecond Light Pulse Source (ELI-ALPS), Szeged, **Hungary**. (Jan 2017-Aug 2017).
  - I was part of the SYLOS group and contributed my part in the assembly, commissioning, testing, and optimization of the second implementation phase of the SYLOS laser of the ELI-ALPS, Szeged Hungary.
  - My tasks and responsibilities covered beam distortion characterization for a new design of thermal lens compensation in a Ti: S-based preamplifier system and experimental preparation of a pump-probe setup based on the transient diffraction method.
5. **Lecturer:** Dept. of Physics, Govt. College University Faisalabad (**GCUF**), Sahiwal Campus, Sahiwal, **Pakistan**. (Oct 2015-Nov 2017).
  - I was instructing Nuclear Physics, Quantum Mechanics 1, Classical mechanics, Waves and oscillations, Relativity, and Cosmology to undergraduate students along with the development of an undergraduate physics lab.
6. **Research Assistant:** Dept. of Physics & Astronomy, College of Science, King Saud University (KSU) Riyadh, **Saudi Arabia**. (June 2014-July 2015).
  - **Development of low-cost prototype electrical pump source and prototype Transversely excited (TE) Nitrogen laser. (2016-2017)**  
I worked as a Co-PI in the Developmental Research Grants Program (DRGP) having grant no. **M Y-36-2** funded by the **KACST, Saudi Arabia**.
  - The basic aim of this work was to develop a prototype electric pump source and TE Nitrogen laser for energetic laser pulses, optimization of laser, and its applications in laser-matter interaction.
  - **Engineering of Semiconductor-Sensitized Nanostructured Solar Cells (2013-2015)**

The main contribution was the fabrication of thin films by the Atomic Layer Deposition (ALD) technique for Solar cells and membranes for water treatment. Atomic layer deposition of TiO<sub>2</sub> film on a polyethersulfone membrane and their UV-VIS NIR spectrometry, XRD, SEM, AFM, TEM, and optical and electrical investigation of TiO<sub>2</sub> thin films have been carried out.

7. **Lecturer:** School of Science and Technology, Department of Basic Sciences, University of Management and Technology (**UMT**)-Lahore, **Pakistan**. (Oct 2012-Oct 2013).
  - I have been teaching Applied Mechanics, Applied Physics, Laser Physics, and Applied Mechanics & Applied Physics lab (undergraduate level) and contributed my part to the development of the Optics lab for the undergraduate level.
8. **Research Assistant:** Dept. of Physics, School of Science & Engineering, Lahore University of Management Sciences (**LUMS**). Lahore, **Pakistan**. (Feb 2012-Oct 2012).
  - Design and development of TEA Nitrogen laser (<http://nitrogenlaser.weebly.com/>). This research work was carried out at the Lahore University of Management Sciences (LUMS), Pakistan.
9. **Visiting Lecturer:** University of Education, Division of Science and Technology, Township, Lahore, **Pakistan**. (Jan 2010-Feb 2012)
  - I taught the following courses: Mechanics, Electromagnetic theory, Wave and Oscillation, Heat, and Thermodynamics as a visiting lecturer at the undergraduate level.

### Publications

32. Gareth O. Williams, **Mukhtar Hussain**, Patricia Estrela, Jayanath Koliyadu, Thomas Wodzinski, Swen Kunzel, Marta Fajardo, "Imaging the solid to plasma transition in laser-heated titanium", **In preparation**.
31. **Mukhtar Hussain**, André Mesquita Antunes, Gonçalo Vaz, Joana Alves, Hugo Pires, Tayyab Imran, Marco Peres, et al. "Anisotropic below bandgap harmonic generation in  $\beta$ -gallium oxide." **Optics Express** (2024). <https://doi.org/10.1364/OE.525696>
30. **Mukhtar Hussain**, Gareth O. Williams, Tayyab Imran, Marco Peres, Katharina Lorenz, and Marta Fajardo. "Disentangling the low-order harmonic generation from bulk and thin films." In *CLEO: Fundamental Science*, pp. FW4C-5. Optica Publishing Group, 2024. [https://doi.org/10.1364/CLEO\\_FS.2024.FW4C.5](https://doi.org/10.1364/CLEO_FS.2024.FW4C.5)
29. **Mukhtar Hussain**, Gareth O. Williams, Tayyab Imran, and Marta Fajardo, "Non-linear propagation effects of intense femtosecond pulses on low order harmonics in solids" **Journal of Modern Optics**, 2023: <https://doi.org/10.1080/09500340.2023.2219773>
28. M. Naeem, T. Imran, A. S. Bhatti, **Mukhtar Hussain**, "Design, Construction and Characterization of Sealed Tube Medium Power CO<sub>2</sub> Laser System" " **Instruments** 6, no. 4 (2022): 72. <https://doi.org/10.3390/instruments6040072>.
27. Naeem, M.; Imran, T.; **Hussain, M.**; Bhatti, A.S. Design Simulation and Data Analysis of an Optical Spectrometer. **Optics** (2022), 3, 304-312. <https://doi.org/10.3390/opt3030028>
26. G. Vaz, H. Pires, **M. Hussain**, G. O. Williams, M. Fajardo, and G. Figueira, "Investigation of spectral broadening in different dispersion regimes and low-order harmonic generation in the mid-infrared," in *The International Conference on Ultrafast Phenomena (UP) 2022*, F. Légaré, T. Tahara, J. Biegert, T. Brixner, and N. Dudovich, eds., Technical Digest Series (Optica Publishing Group, 2022), paper Tu4A.24. <https://doi.org/10.1364/UP.2022.Tu4A.24>
25. Sven Fröhlich, Xu Liu, Aimrane Hamdou, Alric Meunier, **Mukhtar Hussain** et al., "Self-probed ptychography from semiconductor high-harmonic generation" **Opt. Lett.** 47, 4865-4868 (2022). <https://doi.org/10.1364/OL.471113>

**24. Mukhtar Hussain**, Fernando Lima, Willem Boutu, Hamed Merdji, Marta Fajardo, and Gareth O. Williams, "Demonstration of nonperturbative and perturbative third-harmonic generation in MgO by altering the electronic structures", *Phys. Rev. A* **105**, 053103, (2022).

<https://doi.org/10.1103/PhysRevA.105.053103bnjyhngjhgby>

**23. M. Naeem**, Noor-ul ain Fatima, **Mukhtar Hussain**, T. Imran, A. S. Bhatti, "Design Simulation of Czerny-Turner Configuration-based Raman Spectrometer using physical optics propagation algorithm" *Optics* **3**(1), 1-7 (2022). <https://www.mdpi.com/2673-3269/3/1/1>

**22. Mukhtar Hussain**, S. Kaassamani, T. Auguste, W. Boutu, D. Gauthier, M. Kholodtsova, J-T. Gomes, L. Lavoute, D. Gaponov, N. Ducros, S. Fevrier, R. Nicolas, T. Imran, P. Zeitoun, G. O. Williams, M. Fajardo, and H. Merdji, "Spectral control of high order harmonics through non-linear propagation effects", *Appl. Phys. Lett.* **119**, 071101 (2021); <https://doi.org/10.1063/5.0053152>

**21. Patrícia Estrela**, Ermelinda Maçôas, Gareth Williams, **Mukhtar Hussain**, And Marta Fajardo, "Lithium fluoride detectors for high spatial resolution imaging of tabletop XUV from high harmonic generation in gases", *JOSA B.*, **38**(7), 2234-2238 (2021). <https://doi.org/10.1364/JOSAB.422767>

**20. M. Naeem**, R. Munawar, **Mukhtar Hussain**, T. Imran, A. S. Bhatti, "Simulation and analytical analysis of the Blumlein discharge circuit for the generation of coherent UV pulses in air", *Majlesi Journal of Electrical Engineering*, **15**(2), 65-71 (2021).

<https://doi.org/https://doi.org/10.52547/mjee.15.2.65>

**19. Mukhtar Hussain**, Hugo Pires, Willem Boutu, Dominik Franz, Rana Nicolas, Tayyab Imran, Hamed Merdji, Marta Fajardo and Gareth O. Williams, "Controlling the non-linear optical properties of MgO by tailoring the electronic structure," *Appl. Phys. B* **126**, 46 (2020). <https://doi.org/10.1007/s00340-020-7393-7>

**18. Thomas Wodzinski**, Swen Künzel, Jayanath C. P. Koliyadu, **Mukhtar Hussain**, Barbara Keitel, Gareth O. Williams, Philippe Zeitoun, Elke Plönjes, and Marta Fajardo, "High-harmonic generation wave front dependence on a driving infrared wave front," *Appl. Opt.* **59**, 1363-1370 (2020). <https://doi.org/10.1364/AO.59.001363>

**17. Mukhtar Hussain**, Tayyab Imran, Adam Borzsonyi, "Thermal lensing measurements of Ti: sapphire crystal by an optical wavefront sensor." *Microw Opt Technol Lett* **61.12**, 2901-2909 (2019). <https://doi.org/10.1002/mop.31962>

**16. Qaid, S. M., Mukhtar Hussain**, Hezam, M., Khan, M. M., Albrithen, H., Ghaithan, H. M., & Aldwayyan, A. S. Structural and optical investigation of brookite TiO<sub>2</sub> thin films grown by atomic layer deposition on Si (111) substrates. *Materials Chemistry and Physics*, **225**, 55-59 (2019). <https://doi.org/10.1016/j.matchemphys.2018.12.067>

**15. T Imran, Mukhtar Hussain** and C P João "Pulse compression of white-light continuum generated at 1053 nm in bulk sapphire: an experimental study." *Laser Phys. Lett.* **15** 116101 (2018).

<https://doi.org/10.1088/1612-202X/aadf60>

**14. Mukhtar Hussain**, Imran T. "Design and characterization simulation of Ti: Sapphire-based femtosecond laser system using Lab2 tools in the NI LabVIEW," *Microw Opt Technol Lett.* **60**:1732–1737 (2018). <https://doi.org/10.1002/mop.31232>

**13. T. Imran, Mukhtar Hussain**, "An overview of LabVIEW-based f-to-2f spectral interferometer for monitoring, data acquiring and stabilizing the slow variations in carrier-envelope phase of amplified femtosecond laser pulses", *Optik-International Journal for Light and Electron Optics* **157** (C), 1177-1185 (2018). <https://doi.org/10.1016/j.ijleo.2017.11.175>

**12. T. Imran, Mukhtar Hussain**, "Thermal Lensing Compensation in the Development of 30 fs Pulse Duration Chirped Pulse Amplification Laser System and Single-Shot Intensity-Phase Measurement", *Acta Physica Polonica A*, **133**(1), 28-31, (2018). <http://dx.doi.org/10.12693/APhysPolA.133.28>

11. T. Imran, **Mukhtar Hussain**, and G. Figueira. "Computer-controlled multi-shot frequency-resolved optical gating diagnostic system for femtosecond optical pulse measurement." *Microw Opt Technol Lett* 59(12), 3155-3160, (2017). <https://doi.org/10.1002/mop.30894>
10. T. Imran, **Mukhtar Hussain**, and G. Figueira, "Cross-correlation frequency-resolved optical gating of white-light continuum (500-900 nm) generated in bulk media by 1053 nm laser pulses," *Laser Phys. Lett.* 13, 066101 (2016). <https://doi.org/10.1088/1612-2011/13/6/066101>
9. Alam Javed, Mansour Alhoshan, Lawrence Arockiasamy Dass, Arun Kumar Shukla, M. R. Muthumareeswaran, **Mukhtar Hussain**, and Abdullah S. Aldwayyan. "Atomic layer deposition of TiO<sub>2</sub> film on a polyethersulfone membrane: separation applications." *Journal of Polymer Research*, 23, no. 9: 183 (2016). <https://doi.org/10.1007/s10965-016-1063-9>
8. **Mukhtar Hussain** and T. Imran, "Design and construction of prototype transversely excited atmospheric (TEA) nitrogen laser energized by a high voltage electrical discharge," *Journal of King Saud University – Science* 27, 233–238 (2015). <https://doi.org/10.1016/j.jksus.2015.02.008>
7. **Mukhtar Hussain**, and T. Imran, "Investigation of Voltage Variations Across Spark Gap and Laser Discharge Channel of Homemade Transversely Electrical Excited Atmospheric (TEA) Nitrogen Laser," *International Journal of Advanced Scientific and Technical Research (IJASTR)*, 7(1), January–February 2017.
6. **Mukhtar Hussain**, and T. Imran, "Experimental investigations of an efficient electric pump source for Blumlein-based TEA nitrogen laser," *International Journal of Scientific & Engineering Research (IJSER)*, 8, 1214 (2017).
5. **Mukhtar Hussain**, T. Imran, "Simulation of pulse DC high voltage source and Blumlein based Nitrogen laser" *IOSR Journal of Applied Physics (IOSR-JAP)*, Volume 9, Issue 1 Ver. I PP 30-33, (Jan. – Feb. 2017). DOI: 10.9790/4861-0901013033
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3. T. Imran, and **Mukhtar Hussain**, "Optimization and fine-tuning of controlled white-light continuum generation in transparent solid medium by 1-kHz repetition rate femtosecond laser pulses," *Iraqi Journal of Applied Physics (IJAP)*. 12, 27 (2016). <https://www.iasj.net/iasj/article/121208>
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#### References: Names and Addresses

##### 1. Prof. Dr. Marta Fajardo

VOXEL Group leader, Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa. <http://xgolp.tecnico.ulisboa.pt/team/>

E-mail: [marta.fajardo@ist.utl.pt](mailto:marta.fajardo@ist.utl.pt) [marta.fajardo@tecnico.ulisboa.pt](mailto:marta.fajardo@tecnico.ulisboa.pt)

Contact number: +351218419202

##### 2. Dr. Hamed Merdji

Head of the Ultrafast Nanophotonics Group, LIDYL/Attophysics Labs, CEA Saclay 91191 Gif Sur Yvette, France.

<http://iramis.cea.fr/LIDYL/en/Phoceia/Page/index.php?id=99>

Email: [hamed.merdji@cea.fr](mailto:hamed.merdji@cea.fr)

Contact number: +33169085163

##### 3. Dr. M. Ashiq Farid

Assistant Research Professor, Extreme light laboratory, Department of Physics and Astronomy,

University of Nebraska Lincoln, NE 68588-0299, USA.

Email: [mfareed2@unl.edu](mailto:mfareed2@unl.edu)

Phone number: +15103457834

**4. Dr. Gareth O. Williams**

Research Scientist, Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa. Lisbon, Portugal.

<http://xgolp.tecnico.ulisboa.pt/team/>

E-mail: [gareth.williams@tecnico.ulisboa.pt](mailto:gareth.williams@tecnico.ulisboa.pt)

**5. Dr. Tayyab Imran**

**Ultrafast Laser Physicist**

Extreme Light Infrastructure Nuclear Physics (ELI-NP), Romania.

Email: [tayyabmrn@gmail.com](mailto:tayyabmrn@gmail.com)