

# Curriculum Vitae of Matthias Fuchs

updated 2017

Assistant Professor of Physics  
University of Nebraska  
Department of Physics & Astronomy  
Jorgensen Hall, Rm 087  
855 N 16<sup>th</sup> Street  
Lincoln, NE 68588  
email: mfuchs@unl.edu  
web: <http://physics.unl.edu/fuchs>

## Education

**Dr. rer. nat., Physics (2010)** **University of Munich (LMU Munich) & Max-Planck Institut für Quantenoptik, Germany**  
2006 - 2010  
summa cum laude  
*Research subject:* Laser-driven soft-X-Ray undulator source  
*Research advisor:* Prof. Florian Grüner  
*in the group of:* Prof. Ferenc Krausz

**M.Sc., Physics (2006)** **University of Oregon, Eugene, OR, USA**  
2004-2006  
*Graduate student*  
*Research topic:* Development of a high-power stabilized diode-laser system  
*Research advisor:* Prof. Daniel Steck

**Vordiplom, Physics (2003)** **University of Stuttgart, Germany**  
2001 - 2004  
*Undergraduate student, physics*

## Employment

**1/2013 - present** **Assistant Professor at the University of Nebraska, Lincoln**  
Department of Physics & Astronomy

**2010 - 2012** **Postdoctoral Scholar at Stanford University and SLAC National Accelerator Laboratory**  
Peter-Paul Ewald Fellow of the Volkswagen Foundation at the Stanford PULSE Institute  
(Fellowship included a total grant amount of \$ 400,000)  
*Research subject:* Ultrafast and high-field X-ray experiments using X-ray free-electron lasers (XFELs)  
*Research advisor:* Prof. David Reis

## Research Interests

- Ultrafast X-ray sources and Ultrafast X-ray science
- Ultrafast electron diffraction
- Nonlinear quantum electrodynamics (QED), high-field science
- Nonlinear X-ray optics
- Laser-wakefield acceleration
- THz radiation

## Awards and Honors

- AFOSR Young Investigator Award (2015)
- Peter-Paul Ewald Fellow of the Volkswagen Foundation (2011)
- John Dawson Thesis Prize of the American Physical Society (APS) (2011)
- Scholar of the International Max-Planck Research School for Advanced Photon Science (IMPRS-APS) (2006-2010)
- Scholar of the Baden-Württemberg Program (2004-2005)

## Peer-reviewed Publications

[1] **Roadmap of Ultrafast X-ray Atomic and Molecular Physics: Hard X-ray Nonlinear Optics**

M. Fuchs and D. A. Reis.  
*J. Phys. B* **51**, 3 (2018)

[2] **Single-shot structural analysis by high-energy X-ray diffraction using an ultrashort all-optical source**

R. Rakowski, G. Golovin, J. O'Neal, J. Zhang, P. Zhang, B. Zhao, M. D. Wilson, M. C. Veale, P. Seller, S. Chen, S. Banerjee, D. Umstadter, and M. Fuchs  
*Scientific Reports* **9**, 043418 (2017)

[3] **Nonsequential two-photon absorption from the K shell in solid zirconium**

S. Ghimire, M. Fuchs, J. Hastings, S.C. Herrmann, Y. Inubushi, J. Pines, S. Shwartz, M. Yabashi, D. A Reis  
*Physical Review A* **94**, 043418 (2016)

[4] **Anomalous nonlinear X-ray Compton scattering**

M. Fuchs, M. Trigo, J. Chen, S. Ghimire, S. Shwartz, M. Kozina, M. Jiang, T. Henighan, C. Bray, G. Ndabashimiye, P. H. Bucksbaum, Y. Feng, S. Herrmann, G. A. Carini, J. Pines, P. Hart, C. Kenney, S. Guillet, S. Boutet, G. Williams, M. Messerschmidt, M. Seibert, S. Moeller, J.B. Hasting, D.A. Reis  
*Nature Physics* **11**, 964–970 (2015)

*Media Coverage of this publication:*

- a. UNL press release
- b. SLAC press release
- c. A. Pálffy, "X-ray physics: Straight outta Compton", *Nature Physics News and Views Nature Physics* **11**, 893–894 (2015)
- d. M. Conway, "Excellence in Education: UNL professor leads groundbreaking experiment", TV Channel 8
- e. F. Mackenroth, "Der doppelte Compton sieht rot", *Physik Journal* 01/2016

[5] **X-Ray second harmonic generation**

S. Shwartz, M. Fuchs, J. B. Hastings, Y. Inubushi, T. Ishikawa, T. Katayama, D. A. Reis, T. Sato, K. Tono, M. Yabashi, S. Yudovich, and S. E. Harris  
*Phys. Rev. Lett.* **112**, 163901 (2014)

[6] **Below gap optical absorption in GaAs driven by intense, single-cycle coherent transition radiation**

J. Goodfellow, M. Fuchs, D. Daranciang, S. Ghimire, F. Chen, H. Loos, D. Reis, A.S. Fisher, A.M. Lindenberg  
*Opt. Express* **22**, 17423-17429 (2014)

[7] **Fourier-transform inelastic x-ray scattering from time and momentum dependent phonon-phonon correlations**

M. Trigo, M. Fuchs, J. Chen, M. P. Jiang, M. Cammarata, S. Fahy, D. M. Fritz, K. Gaffney, S. Ghimire, A. Higginbotham, S. L. Johnson, M. E. Kozina, J. Larsson, H. Lemke, A. M. Lindenberg, G. Ndabashimiye, F. Quirin, K. Sokolowski-Tinten, C. Uher, G. Wang, J. S. Wark, D. Zhu, D. A. Reis  
*Nature Physics* **9**, 790-794 (2013)

- [8] Intense terahertz pulses from SLAC electron beams using coherent transition radiation**  
Z. Wu, A. S. Fisher, J. Goodfellow, M. Fuchs, D. Daranciang, M. Hogan, H. Loos, and A. Lindenberg  
*Rev. Sci. Instrum.* **84**, 022701 (2013)
- [9] X-ray and optical wave mixing**  
T.E. Glover, D.M. Fritz, M. Cammarata, T.K. Allison, S. Coh, J.M. Feldkamp, H. Lemke, D. Zhu, Y. Feng, R.N. Coffee, M. Fuchs, S. Ghimire, J. Chen, S. Shwartz, D.A. Reis, S.E. Harris & J.B. Hastings  
*Nature*, **488**, 603-608 (2012)
- [10] Ultralow emittance electron beams from a laser-wakefield accelerator**  
R. Weingartner, S. Raith, A. Popp, S. Chou, J. Wenz, K. Khrennikov, M. Heigoldt, A. R. Maier, N. Kajumba, M. Fuchs, B. Zeitler, F. Krausz, S. Karsch, and F. Grüner  
*Phys. Rev. ST Accel. Beams* **15**, 111302 (2012)
- [11] Single-cycle terahertz pulses with  $>0.2 \text{ V/\AA}$  field amplitudes via coherent transition radiation**  
D. Daranciang, J. Goodfellow, M. Fuchs, H. Wen, S. Ghimire, D.A. Reis, H. Loos, A. Fisher, A.M. Lindenberg  
*Appl. Phys. Lett.* **99**, 141117 (2011)
- [12] Imaging laser-wakefield accelerated electrons using miniature magnetic quadrupole lenses**  
R. Weingartner, M. Fuchs, A. Popp, S. Raith, S. Becker, S. Chou, M. Heigoldt, K. Khrennikov, J. Wenz, T. Seggebrock, B. Zeitler, Zs. Major, J. Osterhoff, F. Krausz, S. Karsch, and F. Grüner  
*Phys. Rev. ST Accel. Beams* **14**, 052801 (2011)
- [13] Density measurement in a laser-plasma-accelerator capillary using Raman scattering**  
T. Weineisen, B. Göppner, K. Schmid, M. Fuchs, H. Schröder, S. Karsch, F. Grüner  
*Phys. Rev. ST Accel. Beams* **14**, 050705 (2011)
- [14] All-optical steering of laser-wakefield-accelerated electron beams**  
A. Popp, J. Osterhoff, Zs. Major, R. Hörlein, M. Fuchs, R. Weingartner, T. P. Rowlands-Rees, J. Vieira, M. Marti, R. A. Fonseca, L. O. Silva, S. M. Hooker, F. Grüner, F. Krausz, and S. Karsch  
*Phys. Rev. Lett.* **105**, 215001 (2010)
- [15] Laser-driven soft-X-ray undulator source**  
M. Fuchs, R. Weingartner, A. Popp, Zs. Major, S. Becker, J. Osterhoff, I. Cortrie, R. Hörlein, G. D. Tsakiris, U. Schramm, T. P. Rowlands-Rees, S. M. Hooker, D. Habs, F. Krausz, S. Karsch and F. Grüner  
*Nature Physics* **5**, 826-829 (2009)
- Media Coverage of this publication:*
- Geoff Brumfiel, "Physicist shrink X-ray source", *Nature News*
  - Marie Freebody, "Affordable X-ray source shrinks to fit", *Photonics Spectra*, December 2009
  - James Dacey, "'Supermicroscope' shrunk down to lab-size", <http://physicsworld.com>
  - Articles in the newspapers: *Frankfurter Rundschau*, *Berliner Zeitung*, *Neue Zürcher Zeitung (NZZ)*, *Süddeutsche Zeitung (SZ)*
  - "Our choice from the recent literature", *Nature Photonics* **3**, 678 - 679 (2009)
  - Selected for the December 2009 issue of the *Virtual Journal of Ultrafast Science*
- [16] Characterization and Tuning of Ultra High Gradient Permanent Magnet Quadrupoles**  
S. Becker, M. Bussmann, S. Raith, M. Fuchs, R. Weingartner, P. Kunz, W. Lauth, S. Schramm, M. El Ghazaly, F. Grüner, H. Backe and D. Habs  
*Phys. Rev. ST Accel. Beams* **12**, 102801 (2009)
- [17] Generation of stable, low-divergence electron beams by laser-wakefield acceleration in a steady-state-flow gas cell**  
J. Osterhoff, A. Popp, Zs. Major, B. Marx, T. P. Rowlands-Rees, M. Fuchs, M. Geissler, R. Hörlein, B. Hidding, S. Becker, E. A. Peralta, U. Schramm, F. Grüner, D. Habs, F. Krausz, S. M. Hooker, and S. Karsch  
*Phys. Rev. Lett.* **101**, 085002 (2008)

**[18] GeV-scale electron acceleration in a gas-filled capillary discharge waveguide**

S. Karsch, J. Osterhoff, A. Popp, T. P. Rowlands-Rees, Zs. Major, M. Fuchs, B. Marx, R. Hörlein, K. Schmid, L. Veisz, S. Becker, U. Schramm, B. Hidding, G. Pretzler, D. Habs, F. Grüner, F. Krausz, S. M. Hooker  
*New Journal of Physics* **9**, 415 (2007)

**[19] Design considerations for table-top, laser-based VUV and X-ray free electron lasers**

F. Grüner, S. Becker, U. Schramm, T. Eichner, M. Fuchs, R. Weingartner, D. Habs, J. Meyer-ter-Vehn, M. Geissler, M. Ferrario, L. Serafini, B. van der Geer, H. Backe, W. Lauth, S. Reiche  
*Applied Physics B* **86**, 431-435 (2007)

**[20] Miniature magnetic devices for laser-based, table-top free-electron lasers**

T. Eichner, F. Grüner, S. Becker, M. Fuchs, D. Habs, R. Weingartner, U. Schramm, H. Backe, P. Kunz, and W. Lauth  
*Phys. Rev. ST Accel. Beams* **10**, 082401 (2007)

## Popular-Science Articles

**Röntgenstrahlung mit einem Laserplasma Beschleuniger (in German)**

M.Fuchs & F.Grüner  
*Physik in unserer Zeit* **41**, 11-12 (2010)

## Invited Conference Contributions

- **LCLS-II-HE “First Experiments” workshop**, subgroup leader, SLAC National Accelerator Laboratory, CA (2017)
- **Second community self-organization workshop on HEDP**, University of California, San Diego (2017)
- **Advances in Free-Electron Laser Science**, Hamburg, Germany (2017)
- **Symposium on Imaging and Controlling Ultrafast Dynamics of Atoms, Molecules, and Nanostructure**, Kansas State University, Manhattan KS (2017)
- **Future Electron Source Workshop**, SLAC National Accelerator Laboratory, CA (2016)
- **X-ray Free-Electron Laser Oscillator XFEL Science Workshop**, SLAC National Accelerator Laboratory, CA (2016)
- **Ultrashort Pulse Laser-Matter Interactions Program Review**, Arlington, VA (2016)
- **OSA High-Intensity Lasers and High-Field Phenomena (HILAS)**, Long Beach, CA (2016)
- **Ultrashort Pulse Laser-Matter Interactions Program Review**, Arlington, VA (2015)
- **Advances in Free-Electron Laser Science**, Hannover, Germany (2014)
- **Frontiers of Intense Laser Physics**, KITP, Santa Barbara (2014)
- **OSA High-Intensity Lasers and High-Field Phenomena (HILAS)**, Berlin, Germany (2014)
- **4th Ringberg Meeting on Science with FELs**, Castle Ringberg, Germany (2013)
- **32<sup>nd</sup> International Free Electron Laser Conference (FEL2010)**, Malmö Sweden (2010)
- **High brightness electron beams workshop (HBEB)**, Maui, USA, (2009)
- **DELTA Seminar**, Dortmund, Germany (2009)
- **John Adams Institute Lecture series**, Oxford, U.K. (2009)
- **MLL Kolloquium** Munich, Germany (2009)
- **SPIE Symposium on Optics and Optoelectronics**, Prague, Czech Republic (2009)
- **DPG Frühjahrstagung**, Darmstadt, Germany (2008)

## Conference Proceedings

- **Anomalous Nonlinear X-ray Compton Scattering**  
M. Fuchs, M. Trigo, J. Chen, S. Ghimire, S. Shwartz, M. Kozina, M. Jiang, T. Henighan, C. Bray, G. Ndabashimiye, P. H. Bucksbaum, Y. Feng, S. Herrmann, G. A. Carini, J. Pines, P. Hart, C. Kenney, S. Guillet, S. Boutet, G. J. Williams, M. Messerschmidt, M. M. Seibert, S. Moeller, J. B. Hastings, and D. A. Reis  
*High-Brightness Sources and Light-Driven Interactions, OSA Technical Digest* (online) (Optical Society of America, 2016)

- **Separation of Joule Heating and Peltier Cooling via Time-Resolved X-Ray Diffraction in Si/SiGe Superlattice**

Michael Kozina, Matthias Fuchs, Jian Chen, Mason Jiang, Pice Chen, Paul Evans, Bjorn Vermeersch, Je-Hyeong Bahk, Ali Shakouri, Dale Brewe, David Reis  
APS March Meeting (2012)

- **First milestone on the path toward a table-top free-electron laser**

M. Fuchs, R. Weingartner, A. Popp, Zs. Major, S. Becker, J. Osterhoff, R. Hörlein, G. D. Tsakiris, U. Schramm, T. P. Rowlands-Rees, S. M. Hooker, D. Habs, F. Krausz, S. Karsch and F. Grüner  
*AIP Conference Proceedings*, Vol. 1228, 295-299 (2010)

## Professional Services

### Journal Referee for:

- Nature Physics, Nature Communications, Physical Review Letters, Contributions to Plasma Physics, Journal of Plasma Physics, Nuclear Instruments and Methods, Structural Dynamics, Scientific Reports

### Research Proposal Referee for:

- The Leverhulme Trust, Department of Energy (DOE): SBIR/STTR and AMO program, Air Force Office of Scientific Research (AFOSR), National Science Foundation (NSF)

### Program Committee:

- CLEO Laser Science to Photonic Applications conference FS7 subcommittee
- Conference for undergraduate women in physical sciences (WOPHY)

### Session Chair:

- Free-electron laser and ultrahigh field physics session, DAMOP (2015)
- Symposium on ultrafast dynamics of atoms, molecules & nanostructures (2015)

### Thesis Supervisor:

- B. Senfftleben (MSc Thesis)  
Title: "Angle-resolved observation of X-ray second harmonic generation in diamond" (2017)
- J. O'Neal, (Honors Thesis)  
Title: "Limiting Energy Spread Towards a Laser Wakefield Acceleration Driven Free-Electron Laser" (2016)

### Students supervised:

- Yunhao Fan (1/2016 – present), PhD
- K. Jensen (1/2017 – present), PhD
- Priyanka Chakraborti (8/2017 – present), PhD
- Björn Senfftleben (8/2016 – 12/2017), MSc 2017
- Alexandra Hotchkiss (temporary 5/2015 – 5/2016), PhD
- Travis Hutchins (temporary 8/2015 – 5/2016), PhD
- N. Ray (UCARE program, 1/2016- present), undergraduate
- V. Michelle-Nixon (UCARE program, 1/2017- present), undergraduate
- P. Pombrio (1/2017 – present), undergraduate
- G. Minnick (1/2018 – present), undergraduate
- J. Chrostek (UCARE program, 1/2016- 1/2017), undergraduate
- J. O'Neal (UCARE program 2013-2016), undergraduate, now at Stanford University
- C. Newlun (NSF REU 06-09/2016), undergraduate
- A. Schulte (UCARE program 2013-2015), undergraduate

**Recognized for Contributions to UNL Students:**

- from the UNL Parents Association and the Teaching Council (2016, 2017)

**Teaching Experience****Lecturer:**

- PHYS 211H General Physics I: Classical Mechanics (Fall 2014, Fall 2015)
- PHYS 211 General Physics I: Classical Mechanics (Fall 2016, F 2017)
- PHYS 212H General Physics II: Electricity and Magnetism (Spring 2013, Spring 2014)
- PHYS 343 Lasers and Modern Optics (Spring 2015, Spring 2016, Spring 2017, S 2018)

**Summer Schools:**

- 2017 High Energy Density Science Summer School, University of California, San Diego  
Subject: "Laser Particle Acceleration: Electrons and Photons"
- Ultrafast X-ray Summer Seminar (UXSS) 2016, SLAC National Accelerator Laboratory, CA  
Subject: "Nonlinear X-ray Optics"
- Terascale Accelerator School 2009, Dortmund, Germany,  
Subject: "Advanced Accelerator Concepts"

**Grants**

- "Phase-space investigation of laser-driven weakly relativistic electron beams", National Science Foundation (NSF), beginning 08/01/2017. Total award: \$420,000 over three years.
- "Nonlinear X-ray Optics", Department of Energy (DOE) Office of Basic Energy Sciences, beginning 08/01/2016. Total award: \$594,760 over three years.
- "Next-Generation X-Ray Lightsource and First Applications," Air Force Office of Scientific Research Young Investigator Program, beginning 03/2015. Total award: \$ 370,000 over three years.
- "Imaging and Controlling Ultrafast Dynamics of Atoms, Molecules, and Nanostructures", National Science Foundation EPSCoR, beginning 08/2014. Total award: \$2,450,000 over three years. One of 13 named participants, co-PI on projects: "X-ray Experiments with Laser-driven X-ray Sources" and "Ultrafast Electron Diffraction with Laser-accelerated MeV Electron Pulses"
- "Relativistic Optics: Interactions of Electrons with Laser Light at Highly Relativistic Intensities," Air Force Office of Scientific Research, beginning 09/2014. Total award \$1,500,000 over three years. One of 15 named participants.