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Executive Summary of The Quantum Light-Matter Cooperative

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Author

Carbajo, Sergio

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1. Brizuela, F. *et al.* Imaging at the Nanoscale With Practical Table-Top EUV Laser-Based Full-Field Microscopes. *JSTQE* **18**, 434–442 (2012).
2. Carbajo, S., Wu, X., Ahr, F. & Kärtner, F. X. Terahertz conversion efficiency scaling by optical rectification in the 800 nm pump-wavelength range. in *Conference on Lasers and Electro-Optics Europe - Technical Digest* vols 2014-Janua (2014).
3. Kärtner, F. X. *et al.* AXSIS: Exploring the frontiers in attosecond X-ray science, imaging and spectroscopy. *Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip.* **829**, 24–29 (2016).
4. Carbajo, S. & Bauchert, K. Power handling for LCoS spatial light modulators. in *Laser Resonators, Microresonators, and Beam Control XX* vol. 10518 105181R (International Society for Optics and Photonics, 2018).
5. Lemons, R. *et al.* Carrier-envelope phase stabilization of an Er:Yb:glass laser via feed-forward technique. *arXiv* (2019).
6. Carbajo, S. Light by design: emerging frontiers in ultrafast photon sciences and light–matter interactions. *J. Phys. Photonics* **3**, 31001 (2021).
7. Carbajo, S. *et al.* On extracting the maximum terahertz conversion efficiency from optical rectification in lithium niobate. in *Conference on Lasers and Electro-Optics Europe - Technical Digest* vols 2015-Augus (2015).
8. Brizuela, F. *et al.* Imaging at the nanoscale with practical table-top euv laser-based full-field microscopes. *IEEE J. Sel. Top. Quantum Electron.* **18**, (2012).
9. Grebenschchikov, S. Y. & Carbajo, S. Attosecond nonlinear Fourier transformation spectroscopy: Quantum mechanical theory and applications. *J. Chem. Phys.*
10. Arnold, C., Inhester, L., Carbajo, S., Welsch, R. & Santra, R. Simulated XUV photoelectron spectra of THz-pumped liquid water. *J. Chem. Phys.* **150**, 44505 (2019).
11. Wu, X. *et al.* Terahertz generation in lithium niobate driven by Ti : sapphire laser pulses and its limitations. *Opt. Lett.* **39**, 5403–5406 (2014).
12. Carbajo, S. *et al.* On Extracting the Maximum Terahertz Conversion Efficiency from Optical Rectification in Lithium Niobate. in *CLEO: 2015 SM2H.3* (Optical Society of America, 2015). doi:10.1364/CLEO_SI.2015.SM2H.3.
13. Ruddock, J. M. *et al.* A deep UV trigger for ground-state ring-opening dynamics of 1,3-cyclohexadiene. *Sci. Adv.* **5**, (2019).
14. Lemons, R. & Carbajo, S. Reconstruction and Optimization of Coherent Synthesis by Fourier Optics Based Genetic Algorithm. *arXiv:2005.13671 [physics.optics]* (2020).
15. Carbajo, S. *et al.* Single-shot imaging of nanoscale dynamics by extreme ultraviolet microscopy. in *2011 Conference on Lasers and Electro-Optics: Laser Science to Photonic Applications, CLEO 2011* (2011).
16. Salamin, Y. & Carbajo, S. *A simple model for the fields of a chirped laser pulse with application to electron laser acceleration.* (2019) doi:<https://doi.org/10.3389/fphy.2019.00002>.
17. Carbajo, S. *et al.* Movies of Nanoscale Dynamics by Soft X-Ray Microscopy. in *2011 Ieee Photonics Conference* 698–699 (2011). doi:10.1109/PHO.2011.6110741.
18. Carbajo, S. *et al.* On extracting the maximum terahertz conversion efficiency from optical rectification in lithium niobate. in *CLEO: Science and Innovations, CLEO-SI 2015* (2015). doi:10.1364/CLEO_SI.2015.SM2H.3.
19. Carbajo-Pescador, S., Mauriz, J. L., García-Palomo, A. & González-Gallego, J. FoxO proteins: regulation and molecular targets in liver cancer. *Curr. Med. Chem.* **21**, 1231–46 (2014).
20. Mauriz, E. *et al.* On-line surface plasmon resonance biosensing of vascular endothelial growth factor signaling in intact-human hepatoma cell lines. *Analyst* **139**, 1426–35 (2014).
21. Fang, S. *et al.* High-energy carrier-envelope phase-stable optical waveforms compressible to >1 fs using induced-phase modulation in an argon-filled hollow-core fiber. in *Optics InfoBase Conference Papers* (2014).
22. Wu, X., Carbajo, S., Ravi, K., Ahr, F. & Kärtner, F. X. Terahertz generation and its limitations in

- lithium niobate by optical rectification. in *Advanced Solid State Lasers, ASSL 2014* (2014).
23. Carbajo-Pescador, S. *et al.* Melatonin induces transcriptional regulation of Bim by FoxO3a in HepG2 cells. *Br. J. Cancer* **108**, 442–9 (2013).
24. Gerez, C. L., Carbajo, M. S., Rollán, G., Torres Leal, G. & Font de Valdez, G. Inhibition of citrus fungal pathogens by using lactic acid bacteria. *J. Food Sci.* **75**, M354-9 (2010).
25. Wolff, A. M. *et al.* Comparing serial X-ray crystallography and microcrystal electron diffraction (MicroED) as methods for routine structure determination from small macromolecular crystals. *bioRxiv* (2019) doi:10.1101/767061.
26. Carbajo, S. *et al.* Efficient narrowband terahertz generation in cryogenically cooled periodically poled lithium niobate. *Opt. Lett.* **40**, 5762–5765 (2015).
27. Carbajo, S. *et al.* Laser based aerial microscope for at-wavelength characterization of extreme ultraviolet lithography masks. in *2010 23rd Annual Meeting of the IEEE Photonics Society, PHOTONICS 2010* (2010). doi:10.1109/PHOTONICS.2010.5699022.
28. Carbajo, S. *et al.* Direct longitudinal laser acceleration of electrons in free space. *Phys. Rev. Accel. Beams* **19**, 21303 (2016).
29. Lemons, R. & Carbajo, S. Coherent Optics Propagation and Modeling. <https://github.com/slaclab/CCPM/tree/1.0.0%0A>.
30. Carbajo, S. *et al.* Single-shot imaging of nanoscale dynamics by extreme ultraviolet microscopy. in *Optics InfoBase Conference Papers* (2011).
31. Grünbein, M. L. *et al.* Effect of X-ray free-electron laser-induced shockwaves on haemoglobin microcrystals delivered in a liquid jet. *Nat. Commun.* **12**, 1–11 (2021).
32. Carbajo, S. *et al.* Movies of nanoscale dynamics using soft x-ray laser illumination. in *Optics InfoBase Conference Papers* (2011).
33. Carbajo, S., Wong, L. J., Nanni, E., Schimpf, D. N. & Kärtner, F. X. Ultra-intense few-cycle radial polarization source for vacuum laser acceleration. in *Optics InfoBase Conference Papers* (2014).
34. Yun, J.-H. *et al.* Early-stage dynamics of chloride ion–pumping rhodopsin revealed by a femtosecond X-ray laser. *Proc. Natl. Acad. Sci.* **118**, (2021).
35. Liu, W. *et al.* Full Polarization Vector and Phase Control of Femtosecond Structured Light. in *Laser Congress 2018 (ASSL)* ATu6A.5 (Optical Society of America, 2018). doi:10.1364/ASSL.2018.ATu6A.5.
36. Tang, J. *et al.* Laguerre-Gaussian mode laser heater for microbunching instability suppression in free electron lasers. in *Optics InfoBase Conference Papers* vol. Part F129- (2019).
37. Wu, X. *et al.* Efficient generation of terahertz radiation at 800 nm wavelength. in *IRMMW-THz 2015 - 40th International Conference on Infrared, Millimeter, and Terahertz Waves* (2015). doi:10.1109/IRMMW-THz.2015.7327586.
38. Liu, W., Robinson, J., Fry, A. & Carbajo, S. 4D Pulse Shaping of Discretized Beam Arrays. in *Conference on Lasers and Electro-Optics* JTh2A.169 (Optical Society of America, 2018).
39. Carbajo, S. *et al.* Efficient generation of ultra-intense few-cycle radially polarized laser pulses. *Opt. Lett.* **39**, 2487–2490 (2014).
40. Kartner, F. X. *et al.* AXSIS: Exploring the frontiers in attosecond X-ray science, imaging and spectroscopy. *Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip.* **829**, (2016).
41. Yong, H. *et al.* Determining Orientations of Optical Transition Dipole Moments Using Ultrafast X-ray Scattering. *J. Phys. Chem. Lett.* **9**, 6556–6562 (2018).
42. Brizuela, F. *et al.* Table-top extreme ultraviolet laser aerial imaging of lithographic masks. in *Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference: 2010 Laser Science to Photonic Applications, CLEO/QELS 2010* (2010).
43. Wong, L. J. *et al.* Monoenergetic relativistic electron pulses by laser-driven linear acceleration in free space. in *2016 Conference on Lasers and Electro-Optics, CLEO 2016* (2016).
44. Fang, S. *et al.* High-Energy Carrier-Envelope Phase-Stable Optical Waveforms Compressible to <1 fs Using Induced-Phase Modulation in Argon-Filled Hollow-Core Fiber. *Res. Opt. Sci.* (2014),

Pap. HW1C.2 HW1C.2 (2014) doi:10.1364/HILAS.2014.HW1C.2.

45. Nass Kovacs, G. *et al.* Three-dimensional view of ultrafast dynamics in photoexcited bacteriorhodopsin. *Nat. Commun.* **10**, (2019).
46. Ordoñez, R., Carbajo-Pescador, S., Mauriz, J. L. & González-Gallego, J. Understanding nutritional interventions and physical exercise in non-alcoholic fatty liver disease. *Curr. Mol. Med.* **15**, 3–26 (2015).
47. Brizuela, F. *et al.* Table-top extreme ultraviolet laser aerial imaging of lithographic masks. in *Optics InfoBase Conference Papers* (2010).
48. Carbajo, S. Transient Work Function Gating: A New Photoemission Regime. *arXiv* (2020).
49. Carbajo, S., Nanni, E. A., Wong, L. J., Dwayne Miller, R. J. & Kärtner, F. X. Relativistic few-cycle cylindrical vector beams for table-top particle accelerators. in *CLEO: Science and Innovations, CLEO-SI 2015* (2015). doi:10.1364/CLEO_SI.2015.STu2L.1.
50. Nass Kovacs, G. *et al.* Three-dimensional view of ultrafast dynamics in photoexcited bacteriorhodopsin. *Nat. Commun.* **10**, 3177 (2019).
51. Stankus, B. *et al.* Ultrafast X-ray scattering reveals vibrational coherence following Rydberg excitation. *Nat. Chem.* (2019) doi:10.1038/s41557-019-0291-0.
52. Carbajo, S., Wong, L. J., Nanni, E., Schimpf, D. N. & Kärtner, F. X. Ultra-intense Few-cycle Radial Polarization Source for Vacuum Laser Acceleration. *Res. Opt. Sci.* HTu2C.6 (2014) doi:10.1364/HILAS.2014.HTu2C.6.
53. Jolly, S. W. *et al.* Narrowband terahertz generation with broadband chirped pulse trains in periodically poled lithium niobate. in *Optics InfoBase Conference Papers* vol. Part F42-C (2017).
54. Nogly, P. *et al.* Retinal isomerization in bacteriorhodopsin captured by a femtosecond x-ray laser. *Science (80-.).* **361**, eaat0094 (2018).
55. Carbajo, S. Advances Towards the Development of Compact Relativistic Electron and Bright X-ray Sources: Key Scientific and Technological Demonstrations. (2015).
56. Schulte, J., Carbajo, S., Ravi, K., Schimpf, D. N. & Kärtner, F. X. Efficiency scaling of narrowband terahertz wave generation in PPLN by optimizing the pump-pulse format. in *CLEO: QELS - Fundamental Science, CLEO_QELS 2015* (2015). doi:10.1364/CLEO_AT.2015.JW2A.57.
57. Hirschman, J., Lemons, R., Coffee, R., Belli, F. & Carbajo, S. Towards Real-time Adaptable Machine Learning-based Photoinjector Shaping. in *Conference on Lasers and Electro-Optics* (ed. Kang Tomasulo, S., Ilev, I., Müller, D., Litchinitser, N., Polyakov, S., Podolskiy, V., Nunn, J., Dorrer, C., Fortier, T., Gan, Q., and Saraceno, C., J.) STh1B.7 (Optica Publishing Group, 2021). doi:10.1364/CLEO_SI.2021.STh1B.7.
58. Carbajo, R. S., Carbajo, E. S., Basu, B. & Mc Goldrick, C. Real-Time Autonomous Structural Change Detection Onboard Wireless Sensor Platforms. *Damage Assess. Struct. X, Pts 1 2* **569–570**, 970–977 (2013).
59. Cesar, D. *et al.* Electron beam shaping via laser heater temporal shaping. *Phys. Rev. Accel. Beams* **24**, 110703 (2021).
60. Carbajo, S., Wong, L. J., Nanni, E. A., Dwayne Miller, R. J. & Kärtner, F. X. First observation of direct laser on-axis acceleration of electrons in vacuum. in *Frontiers in Optics, FiO 2014* (2014).
61. Ruddock, J. M. *et al.* Simplicity beneath Complexity: Counting Molecular Electrons Reveals Transients and Kinetics of Photodissociation Reactions. *Angew. Chemie* (2019).
62. Yong, H. *et al.* Scattering off molecules far from equilibrium. *J. Chem. Phys.* **151**, 84301 (2019).
63. Carbajo, S. *et al.* Single-shot imaging of nanoscale dynamics by extreme ultraviolet microscopy. in *Optics InfoBase Conference Papers* (2011).
64. Carbajo, S. *et al.* Movies at the nanoscale using extreme ultraviolet laser light. in *Optics InfoBase Conference Papers* (2010).
65. Ahr, F. *et al.* Narrowband terahertz generation with chirped-and-delayed laser pulses in periodically poled lithium niobate. *Opt. Lett.* **42**, (2017).
66. Carbajo, S. *et al.* Multi-photon Excitation Reveals Wavepacket Interference in Carbon Production from Carbon Dioxide. *Nat. Chem.* (in preparation) (2019).

67. Wong, L. J. *et al.* Laser-Induced Linear-Field Particle Acceleration in Free Space. *Sci. Rep.* **7**, (2017).
68. Graves, W. S. *et al.* Compact x-ray source based on burst-mode inverse Compton scattering at 100 kHz Comact X-ray source based on burst-mode.. W.S. Graves et al. *Phys. Rev. Spec. Top. - Accel. Beams* **17**, (2014).
69. McGoldrick, C., Clear, M., Carbajo, R. S., Fritsche, K. & Huggard, M. TinyTorrents - Integrating Peer-to-Peer and Wireless Sensor Networks. in *Wireless On-Demand Network Systems and Services, 2009. WONS 2009. Sixth International Conference on* 119–126 (2009). doi:10.1109/WONS.2009.4801851.
70. Jingyi, T. *et al.* Laguerre-Gaussian Mode Laser Heater for Microbunching Instability Suppression in Free Electron Lasers. *Phys. Rev. Lett.* accepted.
71. Schulte, J., Carbajo, S., Ravi, K., Schimpf, D. N. & Kärtner, F. Efficiency scaling of narrowband terahertz wave generation in PPLN by optimizing the pump-pulse format. in *CLEO: Applications and Technology, CLEO-AT 2015* (2015). doi:10.1364/CLEO_AT.2015.JW2A.57.
72. Ravi, K. *et al.* Theory of terahertz generation by optical rectification using tilted-pulse-fronts. *Opt. Express* **23**, (2015).
73. Wu, X. *et al.* Terahertz generation in lithium niobate driven by Ti:sapphire laser pulses and its limitations. *Opt. Lett.* **39**, 5403–5406 (2014).
74. Carbajo, S., Wu, X., Ahr, F. & Kärtner, F. X. Terahertz conversion efficiency scaling by optical rectification in the 800 nm Pump-wavelength range. in *Optics InfoBase Conference Papers* (2014).
75. Hirschman, J., Lemons, R., Chansky, E., Steinmeyer, G. & Carbajo, S. Long-term Hybrid Stabilization of the Carrier-Envelope Phase. *Opt. Express* **28**, 34093–34103 (2020).
76. Liebster, N. *et al.* Laguerre-Gaussian and beamlet array as second generation laser heater profiles. *Phys.Rev.Accel.Beams* vol. 21 90701 (2018).
77. Ahr, F. *et al.* Pulse-train pumping for efficient narrowband terahertz generation in periodically poled lithium niobate. in *2016 Conference on Lasers and Electro-Optics, CLEO 2016* (2016).
78. Arnold, C., Inhester, L., Carbajo, S., Welsch, R. & Santra, R. Simulated XUV photoelectron spectra of THz-pumped liquid water. *arXiv* (2019).
79. Wei, L. *et al.* The Universal Light Modulator. *Nat. Photonics* (in preparation).
80. Hirschman, J. *et al.* Towards Real-time Programmable Laser-based Photoinjector Shaping for LCLS-II and Beyond. *Bull. Am. Phys. Soc.* (2021).
81. Lemons, R. *et al.* Carrier-envelope phase stabilization of an Er: Yb: glass laser via feed-forward technique. *Opt. Lett.* **44**, 5610 (2019).
82. Lemons, R. *et al.* Temporal shaping of narrow-band picosecond pulses via noncollinear sum-frequency mixing of dispersion-controlled pulses. *Phys. Rev. Accel. Beams* **25**, 13401 (2022).
83. Sierra, R. G. *et al.* The Macromolecular Femtosecond Crystallography Instrument at the Linac Coherent Light Source. *J. Synchrotron Radiat.* **26**, 346–357 (2019).
84. Robinson, J. S., Fry, A., Carbajo, S. & Liu, W. Generation of arbitrary time-space distribution phase-coherent discretized laser beams. (2018).
85. Carbajo, S. Transient work function gating: A new photoemission regime. *J. Appl. Phys.* **128**, 23102 (2020).
86. Menoni, C. S. *et al.* Visualization of rapid dynamic interactions by flash soft X-ray microscopy. in *Springer Proceedings in Physics* vol. 147 (2014).
87. Carbajo, S., Wong, L. J., Faure, J. & Fallahi, A. Editorial: Lasers in Accelerator Science and Secondary Emission Light Source Technology. *Front. Phys. - Opt. Photonics* (2019).
88. Schulte, J., Carbajo, S., Ravi, K., Schimpf, D. N. & Kärtner, F. X. Efficiency scaling of narrowband terahertz wave generation in PPLN by optimizing the pump-pulse format. in *CLEO: Science and Innovations, CLEO-SI 2015* (2015). doi:10.1364/CLEO_AT.2015.JW2A.57.
89. Ravi, K., Huang, W. R., Carbajo, S., Wu, X. & Kärtner, F. Limitations to THz generation by optical rectification using tilted pulse fronts. *Opt. Express* **22**, (2014).

90. Yong, H. *et al.* Observation of the molecular response to light upon photoexcitation. *Nat. Commun.* **11**, 2157 (2020).
91. Ruddock, J. M. *et al.* Simplicity Beneath Complexity: Counting Molecular Electrons Reveals Transients and Kinetics of Photodissociation Reactions. *Angew. Chemie - Int. Ed.* **58**, (2019).
92. Carboj, S. *et al.* Single-shot imaging of nanoscale dynamics by extreme ultraviolet microscopy. in *Optics InfoBase Conference Papers* (2011).
93. Howlett, I. D. *et al.* Assessment of illumination characteristics of soft x-ray laser-based full-field microscopes. in *X-ray Lasers and Coherent X-ray Sources: Development and Applications IX* (2011). doi:10.1117/12.892927.
94. Yong, H. *et al.* Scattering off molecules far from equilibrium. *J. Chem. Phys.* **151**, (2019).
95. Carboj, S. *et al.* Sequential single-shot imaging of nanoscale dynamic interactions with a table-top soft x-ray laser. *Opt. Lett.* **37**, 2994–6 (2012).
96. Dods, R. *et al.* From Macrocrystals to Microcrystals: A Strategy for Membrane Protein Serial Crystallography. *Structure* (2017) doi:10.1016/j.str.2017.07.002.
97. Carboj, S. *et al.* Femtosecond Dynamics in Generalized Aqueous Chemistry. *Nat. Chem.* (in preparation).
98. Carboj-Pescador, S. *et al.* Inhibition of VEGF expression through blockade of Hif1 α and STAT3 signalling mediates the anti-angiogenic effect of melatonin in HepG2 liver cancer cells. *Br. J. Cancer* **109**, 83–91 (2013).
99. Carboj, S. *et al.* Efficient narrowband terahertz generation in cryogenically cooled periodically poled lithium niobate. *Opt. Lett.* **40**, (2015).
100. Kärtner, F. X. *et al.* Terahertz accelerator technology. in *Optics InfoBase Conference Papers* vol. Part F54-N (2017).
101. Carboj, S., Nanni, E. a, Wong, L. J., Miller, R. J. D. & Kärtner, F. X. Direct laser acceleration of electrons in free-space. *arXiv* 2–7 (2015).
102. Tang, J. *et al.* Laguerre-Gaussian Mode Laser Heater for Microbunching Instability Suppression in Free-Electron Lasers. *Phys. Rev. Lett.* **124**, 134801 (2020).
103. Ravi, K. *et al.* Self-limiting property of terahertz generation by optical rectification using tilted-pulse-fronts. in *Optics InfoBase Conference Papers* (2014).
104. Liebster, N. *et al.* Laser Heater Shaping for Microbunching Instability Suppression in Free Electron Lasers. *CLEO OSA* (2018).
105. Lemons, R. *et al.* Integrated structured light architectures. *arXiv* (2020).
106. Coquelle, N. *et al.* Chromophore twisting in the excited state of a photoswitchable fluorescent protein captured by time-resolved serial femtosecond crystallography. *Nat. Chem.* **10**, (2018).
107. Heimann, P. *et al.* Laser power meters as an X-ray power diagnostic for LCLS-II. *J. Synchrotron Radiat.* **25**, (2018).
108. Lemons, R. & Carboj, S. Reconstruction and Optimization of Coherent Synthesis by Fourier Optics Based Genetic Algorithm. *arXiv* (2020).
109. Brizuela, F. *et al.* Extreme ultraviolet laser-based table-top aerial image metrology of lithographic masks. *Opt. Express* **18**, 14467–14473 (2010).
110. Stankus, B. *et al.* Ultrafast X-ray scattering reveals vibrational coherence following Rydberg excitation. *Nat. Chem.* **11**, (2019).
111. Lemons, R. *et al.* Integrated structured light architectures. *Sci. Rep.* **11**, 796 (2021).
112. Menoni, C. S. *et al.* Reflection microscope for actinic mask inspection and other progress in soft x-ray laser nano-imaging. in *Springer Proceedings in Physics* vol. 136 (2011).
113. Schulte, J., Carboj, S., Ravi, K., Schimpf, D. N. & Kartner, F. X. Efficiency scaling of narrowband terahertz wave generation in PPLN by optimizing the pump-pulse format. in *Conference on Lasers and Electro-Optics Europe - Technical Digest* vols 2015-Augus (2015).
114. Ruddock, J. M. *et al.* A deep UV trigger for ground-state ring-opening dynamics of 1,3-cyclohexadiene. *Sci. Adv.* **5**, eaax6625 (2019).
115. Sierra, R. G. *et al.* The macromolecular femtosecond crystallography instrument at the linac

- coherent light source. *J. Synchrotron Radiat.* **26**, (2019).
- 116. Lemons, R. *et al.* Programmable control of femtosecond structured light. in *Optics InfoBase Conference Papers* vol. Part F129- (2019).
 - 117. Grebenschikov, S. & Carbajo, S. Quantum mechanical study of the attosecond nonlinear Fourier transform spectroscopy of carbon dioxide. *arXiv Prepr. arXiv2102.05136* (2021).
 - 118. Carbajo, S., Stephen Robinson, J., Fry, A. & Liu, W. Generation of arbitrary time-space distribution phase-coherent discretized laser beams.
 - 119. Lemons, R. *et al.* *Dispersion-controlled Temporal Shaping of Picosecond Pulses via Non-colinear Sum Frequency Generation*. *arXiv preprint arXiv:2012.00957* (2020).
 - 120. Carbajo, S. *et al.* Efficient generation of ultra-intense few-cycle radially polarized laser pulses. *Opt. Lett.* **39**, 2487–90 (2014).
 - 121. Seaberg, M. H. *et al.* Nanofocus characterization at the Coherent X-ray Imaging instrument using 2D single grating interferometry. in *Proceedings of SPIE - The International Society for Optical Engineering* vol. 11038 (2019).