CHARLES H. CAMP JR.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
BIOSYSTEMS AND BIOMATERIALS DIVISION
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EDUCATION

Georgia Institute of Technology — Atlanta, GA
PhD in Electrical Engineering — *2005-2011*

- Technical Interest Group: Optics and Photonics
- Minor: Chemistry
- Research Adviser: Prof. Ali Adibi
- Dissertation: *Label-Free Flow Cytometry Using Multiplex Coherent Anti-Stokes Raman Scattering (MCARS) Spectroscopy*

University of Maryland — College Park, MD
MS in Electrical Engineering — *2003-2005*

- Specialization: Electrophysics
- Thesis Advisers: Prof. Julius Goldhar and Dr. Christopher Richardson
- Thesis: *Patterned Active Region Multimode Switches for Optical Thresholding: Theory and Simulation*

University of Maryland — College Park, MD
BS in Electrical Engineering with Honors — *1999-2003*

- University Honors Program
- Department of Electrical and Computer Engineering Honors Program
- Honors Thesis Research Adviser: Prof. Julius Goldhar

RESEARCH EXPERIENCE

National Institute of Standards and Technology — Gaithersburg, MD
Project Leader — *2019-Present*
Electrical Engineer — *2013-Present*
NRC Postdoctoral Fellow, Physical Scientist — *2011-2013*
Biomaterials Group, Biosystems and Biomaterials Division

- Developed the world's fastest broadband/multiplexed coherent anti-Stokes Raman scattering spectroscopy (BCARS/MCARS) microscope for label-free analysis of cells, tissues, biosystems, and biomaterials (and their interaction).
- Developed Franson interferometer for first demonstration of time-energy entangled photons surviving propagation through thick biological media and tissue.
- Generating advanced data science and machine learning tools for processing, integration, quantification, and visualization of multidimensional data.

Georgia Institute of Technology Atlanta, GA
Graduate Research Assistant *2005-2011*
Photonics Research Group, School of Electrical and Computer Engineering

- Developed the first label-free flow cytometer using multiplex coherent anti-Stokes Raman scattering (MCARS) for biological and material analysis.
- Coordinated and authored several grant proposals for submission to the National Institute of Health (NIH) and the National Science Foundation (NSF).
- Constructed the first interferometric multiplex coherent anti-Stokes Raman scattering (iMCARS) system using photonic crystal fiber laser source.

University of Maryland College Park, MD
Graduate Research Assistant *2003-2005*
Laboratory for Physical Science, University of Maryland/National Security Agency

- Designed a new class of optical devices for use in all-optical switching and thresholding: patterned active region multimode switches (PARMS).
- Created a robust software package in MATLAB for the analysis of semiconductor waveguides with nonlinearities.

TEACHING AND MENTORING EXPERIENCE

National Institute of Standards and Technology Gaithersburg, MD

Postdoctoral Fellows, Research Associates, and Term Staff
- Meng-Chang Wu, Research Associate: *Quantum correlated light imaging.* (2021 – 2023)
- Daniel Lum, NRC Postdoctoral Fellow: *Photon entanglement survival through biological tissue* (2019 – 2020).
- John Bender, Research Chemist: *BCARS imaging of structural proteins in tissues* (2019-2020).
- Petru Manescu, Research Associate: *Data science challenges in coherent Raman imaging* (2015–2016).
- Brandon Blakely, Research Associate: *BCARS imaging of biomaterial degradation and phototoxicity* (2014–2016).

Postdoctoral Mentees
- Jason Fox, NIST Engineer: *Career development through the NIST PEAR Program* (2016–2017).
- Russell Maier, NRC Postdoctoral Fellow: *Career development through the NIST Postdoctoral Association* (2015–2016).

Graduate Students
- Phillip Alvarez, PhD Student (University of Maryland): *BCARS microscopy for live-cell and live-animal imaging* (2016–2017).

Undergraduate Interns
- Sean McIntyre, Summer Undergraduate Research Intern (SURF): *Quantitative analysis on the effects of noise and Gaussian blur on hyperspectral unmixing algorithms* (Summer 2017).

High School Interns

- Cindy Chen, Summer High School Intern (SHIP): *Seeing a 1,000-color image: unsupervised machine learning with barcoded spectra* (Summer 2017).
- Mona Lee, SHIP Intern: *Development of Raman spectral taxonomy for chemical imaging in biological samples* (Summer 2016).

Georgia Institute of Technology Atlanta, GA
Mentor *2009*
National Nanotechnology Infrastructure Network (NNIN)

- Directed interdisciplinary research project of Hamsa Sridhar (Harvard University, currently PhD student at Stanford University).
- Introduced nonlinear optics, the CARS optical phenomenon, microfluidics, and principle component analysis.

Georgia Institute of Technology Atlanta, GA
Graduate Teaching Assistant *2005-2006*

- Conducted laboratory lectures and demonstrations, graded lab reports and homework, and held office hours for the course *Introduction to Signal Processing*.
- Assisted with course lectures, graded HomeWorks, and proctored exams for the Senior course *Laser Theory and Applications* (awarded university-wide Georgia Tech Outstanding Teaching Assistant Award).

University of Maryland College Park, MD
Teaching Fellow *2001-2002*
A. James Clark School of Engineering

- Presented and developed lectures, laboratory exercises, and exams for *Introduction to Engineering Design*, a competitive lab course in which each team develops a multidisciplinary product.
- Received extensive training in engineering pedagogy through fellowship coursework and mentoring.

HONORS and AWARDS

NIST Human Resources Award	2024
Department of Commerce Bronze Medal	2023
Department of Commerce Bronze Medal	2022
National Research Council (NRC) Research Associate Program (RAP) Postdoctoral Fellowship	2011-2013
Georgia Institute of Technology Outstanding TA Award	2006
Electrical Engineering Honors Program Graduate	2003
University of Maryland Honors Citation	2003
Order of Omega	2002
Introduction to Engineering Design Teaching Fellow	2001-2002
Lockheed Martin Outstanding Scholar Award	2000, 2002, 2003
State of Maryland Distinguished Scholar	1999 - 2003
University of Maryland Presidential Scholar	1999-2003
Chairman of Electrical Engineering Scholar	1999-2003

OUTREACH AND SERVICE

Reviewer: *Nature, Proceedings of the National Academy of Science (PNAS), Optica, ACS, IEEE, Journal of Raman Spectroscopy, Journal of Biophotonics, The Analyst*

Grant Reviewer: Advanced Research Projects Agency for Health (ARPA-H), Cancer UK, Natural Sciences and Engineering Research Council of Canada

Optica Imaging Congress, Imaging Systems and Applications (IS), *Program Chair*	2023
Heidelberg University Chemistry Club, *Speaker and lab tour*	2022
NIST Summer High School Internship Program (SHIP), *Advisor*	2016–2017
NIST Postdoctoral and Early-Career Association of Researchers (PEAR), *Mentor*	2016–2018
NIST Postdoctoral Mentoring Program, *Mentor*	2015
Concordia Preparatory School, *Member of accreditation action committee STEM curriculum*	2014
Marymount University Science Club, *Speaker and lab demonstrator*	2013
Baltimore Lutheran School, *College experience speaker*	2013
Minority Student Pipeline Math Science Partnership [(MSP)2]/Prince George's County Public Schools NIST site tour, *Career and academic panelist*	2012
Morehouse College STEM student tour of Georgia Tech, *Speaker and lab demonstrator*	2011
Atlanta Public Schools STEM student tour of Georgia Tech, *Speaker and lab demonstrator*	2009-2011
Baltimore Lutheran School, *College night speaker*	2005
University of Maryland, College of Arts and Humanities, *Mentor for undeclared majors*	2002

PUBLICATIONS, PRESENTATIONS, AND INTELLECTUAL PROPERTY

Invited Journal Papers (*Corresponding author)

1. S. Xu, **C. H. Camp Jr.**, and Y. J. Lee, "Coherent anti-Stokes Raman scattering (CARS) microscopy for polymers," Journal of Polymer Science **60**, 1244 – 1265 (2022).

2. M. T. Cicerone and **C. H. Camp Jr.**, "Histological coherent Raman imaging: a prognostic review", Analyst **143**, 33-59 (2018). arXiv: 1709.07325

3. **C. H. Camp Jr.*** and M. T. Cicerone, "Microscopy: A larger palette for biological imaging", Nature **544,** 423-424 (2017).

4. **C. H. Camp Jr.** and M. T. Cicerone, "Chemically-sensitive bioimaging with coherent Raman scattering," Nature Photonics **9**, 295-305 (2015).

Journal Papers (*Corresponding author)

1. K. M. Parzuchowski, M. D. Mazurek, **C. H. Camp Jr.**, M. J. Stevens, and R. Jimenez, "A liquid-core fiber platform for classical and entangled two-photon absorption measurements," ACS Photonics (**Accepted, 2025***)*. arXiv: 2410.14828.

2. R. Muddiman, K. O'Dwyer, **C. H. Camp Jr**, and B. Hennelly, "Removing non-resonant background from broadband CARS using a physics-informed neural network," Analytical Methods **15**, 4032-4043 (2023).

3. **C. H. Camp Jr.***, "Raman signal extraction from CARS spectra using a learned-matrix representation of the discrete Hilbert transform," Optics Express **30**, 26057-26071 (2022). arXiv: 2204.00666. ***Editor's Pick.***

4. Z. Wang, K. O' Dwyer, R. Muddiman, T. Ward, **C. H. Camp Jr.**, B. M. Hennelly, "VECTOR: Very deep convolutional autoencoders for non-resonant background removal in broadband coherent anti-Stokes Raman scattering," Journal of Raman Spectroscopy **53**, 1081-1093 (2022).

5. A. Mikhaylov, R. N. Wilson, K. M. Parzuchowski, M. D. Mazurek, **C. H. Camp Jr.**, M. J. Stevens, and R. Jimenez, "Hot-band absorption can mimic entangled two-photon absorption," Journal of Physical Chemistry Letters **13**, 1489-1493 (2022). arXiv: 2111.05946.

6. J. Dunkers, H. Iyer, B. Jones, **C. H. Camp Jr.**, S. Stranick, and N. Lin, "Towards Absolute Viability Measurements for Bacteria," Journal of Biophotonics **14**, e202100175 (2021).

7. D. J. Lum, M. D. Mazurek, A. Mikhaylov, K. M. Parzuchowski, R. N. Wilson, R. Jimenez, T. Gerrits, M. J. Stevens, and **C. H. Camp Jr.***, "Witnessing the survival of time-energy entanglement through biological tissue and scattering media," Biomedical Optics Express **12**, 3658-3670 (2021). arXiv: 2102.12907.

8. K. M. Parzuchowski, A. Mikhaylov, M. D. Mazurek, R. N. Wilson, D. J. Lum, T. Gerrits, **C. H. Camp Jr.**, M. J. Stevens, and R. Jimenez, "Setting bounds on two-photon absorption cross-sections in common fluorophores with entangled photon pair excitation," Physical Review Applied **15**, 044012 (2021).

9. S. Bhadauriya, X. Wang, A. Nallapaneni, Z. Wang, J. Lee, M. R. Bockstaller, **C. H. Camp Jr.**, C. M. Stafford, J. F. Douglas, and A. Karim, "General Entropy-Enthalpy Compensation (EEC) Effect Observed via In-Situ Relaxation of Wrinkled Polymer Nanocomposite Films," Nano Letters **21**, 1274-1281 (2021).

10. K. Choudhary, K. F. Garrity, **C. Camp**, S. V. Kalinin, R. Vasudevan, M. Ziatdinov, and F. Tavazza, "Computational scanning tunneling microscope image database," Scientific Data **8**, 57 (2021**).**

11. **C. H. Camp Jr.***, J. S. Bender, and Y. J. Lee, "Real-time and high-throughput Raman signal extraction and processing in CARS hyperspectral imaging," Optics Express **28**, 20422-20437 (2020). arXiv:2005.07132.

12. W.-W. Chen, G. A. Lemieux, **C. H. Camp Jr.**, T.-C. Chang, K. Ashrafi, and M. T. Cicerone, "Spectroscopic coherent Raman imaging of *C. elegans* reveals lipid particle diversity," Nature Chemical Biology **16** (2020).

13. **C. H. Camp Jr.***, "*pyMCR*: A Python Library for Multivariate Curve Resolution Analysis with Alternating Regression (MCR-AR)," Journal of Research National Institute of Standards and Technology, **124** (124018), 1-10 (2019).

14. M. Tatli. H. J. Chun, **C. H. Camp Jr.**, J. Li, M. T. Cicerone, W.-C. Shih, J. Laane, and T. Devarenne, "Raman spectra and DFT calculations for botryococcene and methylsqualene hydrocarbons from the B race of the green microalga *Botryococcus braunii*," Journal of Molecular Structure **1147**, 427-437 (2017).

15. P. Manescu, Y. J. Lee, **C. H. Camp Jr.**, M. T. Cicerone, M. Brady, and P. Bajcsy, "Accurate and interpretable classification of microspectroscopy pixels using artificial neural networks," Medical Image Analysis **37**, 37-45 (2017).

16. **C. H. Camp Jr.***, Y. J. Lee, and M. T. Cicerone, "Quantitative, comparable coherent anti-Stokes Raman scattering (CARS) spectroscopy: Correcting errors in phase retrieval". Journal of Raman Spectroscopy **46**, 408-415 (2016). arXiv:1507.06543

17. I. S. Ryu, **C. H. Camp Jr.**, Y. Jin, M. T. Cicerone, and Y. J. Lee, "Beam-scanning for rapid coherent Raman hyperspectral imaging," Optics Letters **40**, 5826-5829 (2015).

18. **C. H. Camp Jr.**, Y. J. Lee, J. M. Heddleston, C. M. Hartshorn, A. R. Hight Walker, J. N. Rich, J. D. Lathia, and M. T. Cicerone, "High-speed coherent Raman fingerprint imaging of biological tissues," Nature Photonics **8**, 627-634 (2014). arXiv:1402.3211

19. T. M. Farooque, **C. H. Camp Jr.**, C. K. Tison, G. Kumar, S. H. Parekh, and C. G. Simon Jr., "Measuring cell niche dimensionality in 3D scaffolds," Biomaterials **35**, 2558-2567 (2014).
20. C. M. Hartshorn, Y. J. Lee, C. **H. Camp Jr.**, Z. Liu, J. Heddleston, N. Canfield, and M. T. Cicerone, "Multicomponent chemical imaging of pharmaceutical solid dosage forms with broadband CARS microscopy," Analytical Chemistry **85**, 8102-8111 (2013).

21. **C. H. Camp Jr.**, S. Yegnanarayanan, A. A. Eftekhar, and A. Adibi, "Label-free flow cytometry using multiplex coherent anti-Stokes Raman scattering (MCARS) for the analysis of biological specimens," Optics Letters **36**, 2309 - 2311 (2011).

22. **C. H. Camp Jr.***, S. Yegnanarayanan, A. A. Eftekhar, H. Sridhar, and A. Adibi, "Multiplex coherent anti-Stokes Raman scattering (MCARS) for chemically sensitive microfluidic flow cytometry," Optics Express **17**, 22879-22889 (2009).

Standards

1. ASTM Standard E3275 − 21, "Visualization and Identification of Nanomaterials in Biological and Nonbiological Matrices Using Darkfield Microscopy/Hyperspectral Imaging (DFM/HSI) Analysis," (ASTM International, 2021).

Book Chapters

1. A. L. Plant, **C. Camp**, J. T. Elliott, T. Eskandari, M. Halter, E. Kwee, S. Maragh, A. Peterson, L. Pierce, S. Sarkar, C. Simon, L. Wang, J. Zook, S. Lin-Gibson, "The Role of the National Institute of Standards in Measurement Assurance for Cell Therapies," in Cell Therapy, A. P. Gee, ed. (Springer Nature Switzerland AG, 2022).

2. M. T. Cicerone and **C. H. Camp Jr.**, "Potential Roles for Spectroscopic Coherent Raman Imaging for Histopathology and Biomedicine," in Neurophotonic and Biomedical Optical Spectroscopy, B. Alfano and L. Shi, eds. (Elsevier, 2019).

3. **C. H. Camp Jr.**, "Broadband Coherent Anti-Stokes Raman Scattering," in Imaging in Dermatology, M. R. Hamblin, P. Avci, and G. K. Gupta, eds. (Academic, 2016).

Invited Conference Presentations

1. **C. H. Camp Jr.,** "Live-cell IR microscopy with a benchtop system," International Conference on BioMedical Photonics, Montpellier, France, April 16 – 18, 2025.

2. **C. H. Camp Jr.,** "Using time-energy entangled photons to probe biological samples", Photonics West, San Francisco, CA, January 28 – February 2, 2023.

3. **C. H. Camp Jr.,** "Self-referencing CARS spectroscopy for biological tissue imaging," International Conference on BioMedical Photonics, Montpellier, France, April 16 – 18, 2020. ***Delayed to 2021 due to Covid-19.***

4. **C. H. Camp Jr.,** "Coherent Raman microscopy for biological imaging," American Physical Society Meeting, Denver, CO, March 2 – 6, 2020. ***Canceled due to Covid-19.***

5. **C. H. Camp Jr.,** "Quantitative hyperspectral bio-imaging using broadband coherent anti-Stokes Raman scattering (BCARS) microscopy," Photonics West, San Francisco, CA, February 2 – 7, 2019. **Canceled due to lapse in US Government appropriations.**
6. **C. H. Camp Jr.,** "Quantitative broadband CARS microspectroscopy for histopathology," Photonics North, Montreal, June 5 – 7, 2018.

7. **C. H. Camp Jr.,** "Quantitative coherent Raman imaging with BCARS microscopy," International Conference on BioMedical Photonics, Montpellier-La Grande Motte, France, March 16 – 17, 2018.

8. M. T. Cicerone, **C. H. Camp Jr.**, and Wei-Wen Chen, "Rapid fingerprint coherent Raman imaging and application to histopathology", SPIE Photonics West: BIOS, San Francisco, CA, Febraury 2 - 7, 2018.

9. **C. H. Camp Jr.**, "Broadband coherent-anti-Stokes Raman scattering (BCARS) microspectroscopy for tissue and cellular imaging," Microscience Microscopy Congress 2015, Manchester, U.K., June 29 - July 2, 2015.

10. **C. H. Camp Jr.** and M. T. Cicerone, "Correcting errors in phase retrieval for quantitative coherent anti-Stokes Raman scattering (CARS) spectroscopy," Physics of Quantum Electronics (PQE), Snowbird, UT, January 4-8, 2015.

11. M. T. Cicerone, **C. H. Camp Jr.**, and Y. J. Lee, "Broadband coherent Raman imaging - future and applications," Physics of Quantum Electronics (PQE), Snowbird, UT, January 4-8, 2015.

12. M. T. Cicerone, **C. H. Camp Jr.**, and Y. J. Lee, "Rapid spectroscopic imaging with coherent Raman scattering," International Conference on Raman Spectroscopy (ICORS), Jena, Germany, August 10-15, 2014.

13. M. T. Cicerone, **C. H. Camp Jr.**, C. M. Hartshorn, and Y. J. Lee, "Practical limits of functional, noninvasive coherent Raman imaging," Physics of Quantum Electronics (PQE), Snowbird, UT, January 6-10, 2013.

14. M. T. Cicerone, **C. H. Camp Jr.**, E. Gatzogiannis, C. M. Hartshorn, and Y. J. Young, "Functional broadband coherent Raman imaging," SPIE Photonics West: BIOS, San Francisco, CA, February 2-7, 2013.

15. M. T. Cicerone, Y. J. Lee, K. A. Aamer, C. M. Hartshorn, **C. H. Camp Jr.,** and P. Bajcsy, "Noninvasive Functional Microscopy Using Coherent Raman Methods," Physics of Quantum Electronics (PQE), Snowbird, UT, January 2-6, 2012.

Conference Presentations

1. S. Sarkar, L. Pierce, D. Varisco, **C. Camp**, C. Hebert, M. Lowry, and Z. Evans, "Approach for Establishing Novel and Fit-for-Purpose Cell Viability Methods to Support Cell Manufacturing Process Monitoring," International Society for Cell & Gene Therapy, Vancouver, Canada, May 29 – June 1, 2024.

2. R. Muddiman, K. O'Dwyer, **C. H. Camp,** and B. Hennelly, "Raman signal extraction from BCARS intensity measurements using deep learning with a prior excitation profile," European Optical Society Annual Meeting (EOSAM), Dijon France, September 11 – 15, 2023. Proceedings DOI: 10.1051/epjconf/202328713019.

3. **C. H. Camp Jr.,** "High-speed, quantitative Raman signal extraction from CARS spectra and hyperspectral imagery", Photonics West, San Francisco, CA, January 28 – February 2, 2023.

4. **C. H. Camp Jr.,** "High-Speed, Quantitative Raman Signal Extraction from Broadband Coherent Anti-Stokes Raman Scattering Spectra and Hyperspectral Imagery," Applied Imaging Congress, Vancouver, Canada, July 11 – 15, 2022.

5. M. D. Mazurek, K. M. Parzuchowski, A. Mikhaylov, S. W. Nam, **C. H. Camp Jr.**, T. Gerrits, R. Jimenez, and M. J. Stevens, "Bounding Entangled Two-Photon Absorption with Sensitive Transmittance Measurements," in Conference on Lasers and Electro-Optics (CLEO), OSA Technical Digest (Optical Society of America, 2021), paper FM3N.2.

6. K. M. Parzuchowski, A. Mikhaylov, M. D. Mazurek, D. J. Lum, M. J. Stevens, T. Gerrits, **C. H. Camp Jr.,** and R. Jimenez, "Setting bounds on two-photon absorption cross-sections in common fluorophores with entangled photon pair excitation," Sensing with Quantum Light (SQL20), Berlin, Germany, September 6 – 9, 2020.
7. D. J. Lum, M. D. Mazurek, A. Mikhaylov, K. Parzuchowski, R. N. Wilson, M. T. Cicerone, R. Jimenez, T. Gerrits, M. J. Stevens, and **C. H. Camp, Jr.**, "Verifying the Survival of Time-Energy Entanglement Through Tissue," in Conference on Lasers and Electro-Optics (CLEO), OSA Technical Digest (OSA, 2020), p. FM1C.3, Washington, DC, May 10 – 15, 2020.

8. A. Mikhaylov, K. Parzuchowski, M. D. Mazurek, R. N. Wilson, T. Gerrits, D. J. Lum, **C. H. Camp, Jr.**, M. J. Stevens, and R. Jimenez, "Setting limits on two-photon absorption cross sections in common fluorescent molecules with entangled photon pairs excitation," in Conference on Lasers and Electro-Optics (CLEO), OSA Technical Digest (OSA, 2020), p. JTh3N.4, Washington, DC, May 10 – 15, 2020.

9. D. J. Lum, M. D. Mazurek, A. Mikhaylov, K. M. Parzuchowski, S. W. Nam, M. T. Cicerone, R. Jimenez, T. Gerrits, M. J. Stevens and **C. H. Camp Jr.**, "Bounding the Survival-Depth of Time-Energy Entanglement through Absorptive & Scattering Media for Entangled Two-Photon Absorption," Single Photon Workshop (SPW2019), Milano, Italy, October 21 – 25, 2019.

10. M. D. Mazurek, A. Mikhaylov, K. M. Parzuchowski, D. J. Lum, L. K. Shalm, C. Drago, J. Sipe, S. W. Nam, M. T. Cicerone, **C. H. Camp Jr.**, R. Jimenez, T. Gerrits, and M. J. Stevens, "Using photon statistics to characterize two-photon absorption," Single Photon Workshop (SPW2019), Milano, Italy, October 21 – 25, 2019.

11. K. M. Parzuchowski, A. Mikhaylov, M. D. Mazurek, D. J. Lum, M. J. Stevens, T. Gerrits, **C. H. Camp Jr.**, and R. Jimenez, "Searching for Enhanced Two Photon Absorption of Entangled Photon Pairs," Single Photon Workshop (SPW2019), Milano, Italy, October 21 – 25, 2019.

12. M. D. Mazurek, A. Mikhaylov, K. Parzuchowski, D. J. Lum, L. K. Shalm, C. Drago, J. E. Sipe, S. W. Nam, M. T. Cicerone, **C. H. Camp Jr.**, R. Jimenez, T. Gerrits, M. J. Stevens, "Characterizing Two-Photon Absorption with g(2)," Frontiers in Optics, Washington, DC, September 13 – 17, 2019.

13. P. Alvarez, R. Lee, M. Hourwitz, L. Campanello, **C. H. Camp Jr.**, M. T. Cicerone, J. Fourkas, and W. Losert, "Using topographical guidance to investigate cytoskeletal excitability," APS March Meeting, Los Angeles, CA, March 5 – 9, 2018.

14. **C. H. Camp Jr.,** S. McIntyre, and M. T. Cicerone, **"**From spectroscopy to chemical imaging: machine learning for hyperspectral coherent Raman imagery," SPIE Photonics West: BIOS, San Francisco, CA, February 2 - 7, 2018.

15. **C. H. Camp Jr.** and M. T. Cicerone**, "**Automated processing workflow for broadband coherent anti-Stokes Raman scattering (BCARS) microspectroscopy," SPIE Photonics West: BIOS, San Francisco, CA, February 2 - 7, 2018.

16. **C. H. Camp Jr.** and M. T. Cicerone**, "**A nonlinear concentration effect in coherent anti-Stokes Raman scattering (CARS)," SPIE Photonics West: BIOS, San Francisco, CA, February 2 - 7, 2018.

17. **C. H. Camp Jr.**, Y. J. Lee, and M. T. Cicerone, "Unsupervised, quantitative analysis of coherent Raman imagery," SPIE Photonics West: BIOS, San Francisco, CA, January 28 – February 2, 2017.

18. **C. H. Camp Jr.**, Y. J. Lee, and M. T. Cicerone, "Quantitative, comparable BCARS microspectroscopy for high-speed cell and tissue imaging," SciX, Minneapolis, MN, September 18–22, 2016.

19. **C. H. Camp Jr.**, Y. J. Lee, and M. T. Cicerone, "Quantitative, comparable hyperspectral chemical imaging of biological specimens with broadband coherent anti-Stokes Raman scattering (BCARS) microspectroscopy," Bioimaging Informatics Conference 2015, Gaithersburg, MD, October 14 - 16, 2015.

20. I. S. Ryu, **C. H. Camp Jr.**, Y. Jin, M. T. Cicerone, and Y. J. Lee, "Beam-scanning broadband CARS microscopy for rapid tissue imaging," Biophysical Society Annual Meeting, Baltimore, MD, February 7-11, 2015.

21. **C. H. Camp Jr.**, Y. J. Lee, J. M. Heddleston, C. M. Hartshorn, A. R. Hight Walker, J. N. Rich, J. D. Lathia, and M. T. Cicerone, "High-speed, broadband coherent Raman imaging (CRI) of glioblastomas using broadband coherent anti-Stokes Raman scattering microspectroscopy," SPIE Photonics West: BIOS, San Francisco, CA, February 1-6, 2014.

22. **C. H. Camp Jr.**, Y. J. Lee, C. M. Hartshorn, and M. T. Cicerone, "High-speed coherent Raman imaging (CRI) of cells and tissues with broadband coherent anti-Stokes Raman scattering (BCARS)," SPIE Optics + Photonics, San Diego, CA, August 25-29, 2013.

23. **C. H. Camp Jr.**, Y. J. Young, C. M. Hartshorn, and M. T. Cicerone, "High-speed coherent Raman imaging (CRI) of cells and tissues with broadband coherent anti-Stokes Raman scattering (BCARS)," SPIE Optics + Photonics, San Diego, CA, August 25-29, 2013.

24. C. G. Simon, Jr., **C. H. Camp Jr.**, C. K. Tison, G. Kumar, S. H. Parekh, and T. M. Farooque, "Measuring Scaffold Niche Dimensionality by Analyzing 3D Cell Morphology," Society for Biomaterials, New Orleans, LA, October 4-6, 2012.

25. **C. H. Camp Jr.**, S. Yegnanarayanan, Ali A. Eftekhar, and Ali Adibi, "Label-free flow cytometry using multiplex coherent anti-Stokes Raman scattering (MCARS) for the analysis of yeast," IEEE Photonics 2011 (IPC11), Arlington, VA, October 9-13, 2011.

26. **C. H. Camp Jr.**, S. Yegnanarayanan, Ali A. Eftekhar, and Ali Adibi, "Multiparameter label-free flow cytometry using multiplex coherent anti-Stokes Raman scattering (MCARS) with biological applications," SPIE Photonics West: BIOS, San Francisco, CA, January 22-27, 2011.

27. **C. H. Camp Jr.**, S. Yegnanarayanan, Ali A. Eftekhar, Hamsa Sridhar, and Ali Adibi, "Multiplex anti-Stokes Raman scattering (MCARS) for chemically sensitive, label-free microfluidic flow cytometry," SPIE Photonics West: BIOS, San Francisco, CA, January 23-28, 2010.

28. **C. H. Camp Jr.**, A. A. Eftekhar, and A. Adibi, "Single-source interferometric multiplex coherent anti-Stokes Raman scattering with a photonic crystal fiber light source," Conference on Lasers and Electro-Optics (CLEO), San Jose, CA, May 4-9, 2008.

Invited Seminars, Panelist, Symposia, and Other Presentations

1. **C. H. Camp Jr.,** "Imaging the Chemical Landscape within Cells and Tissues with Light", Laboratoire Charles Coulomb, Montpellier University, France, March 6, 2024.

2. **C. H. Camp Jr.**, "Raman: A Brief Primer," Rapid Microbial Testing Methods (RMTM) Consortium, *Virtual Seminar*, February 14, 2023.

3. **C. H. Camp Jr.,** *Panelist*, NIH Virtual Workshop: Near-term Applications of Quantum Sensing Technologies in Biomedical Sciences, January 5-6, 2023.

4. **C. H. Camp Jr.,** "Quantitative, Directly-Comparable Raman Signal Extraction from BCARS Spectra and Imagery: A Primer," CONTRAST - Coherent Raman Workshop 2022 at University of Exeter, UK, September 12-13, 2022.

5. **C. H. Camp Jr.**, M. Stevens, R. Jimenez, and T. Gerrits, "Survival of Time-Energy Entanglement Through Tissue & Bounding the Two-Photon Absorption Cross-Sections in Common Fluorophores," Big Quantum Biology Meeting at UCLA, June 1, 2021.

6. **C. H. Camp Jr.,** "Quantitative broadband coherent anti-Stokes Raman scattering (BCARS) microscopy," Fresnel Institute, Aix-Marseilles University, Marseilles, France, March 15, 2018.

7. **C. H. Camp Jr.**, "Coherent Raman imaging and flow cytometry," National Eye Institute-National Institutes of Health, February 14, 2017.

8. **C. H. Camp Jr.**, "Changing the currency of information in coherent Raman imaging: Phase retrieval for reliable, universally comparable spectra," School of Physics and Astronomy, Cardiff University, Wales, U. K., June 26, 2015.

9. M. T. Cicerone, **C. H. Camp Jr.**, C. M. Hartshorn, and Y. J. Young, "Practical limits of functional, noninvasive coherent Raman imaging," Institute for Quantum Science and Engineering Workshop, College Station, TX, January 15-16, 2013. Invited.

10. **C. H. Camp Jr.**, Y. J. Lee, C. M. Hartshorn, and M. T. Cicerone, "Coherent anti-Stokes Raman scattering (CARS) for high-speed, label-free imaging," Laboratory for Physical Sciences (LPS) Seminar Series, College Park, MD, February 8, 2012. Invited.

11. **C. H. Camp Jr.**, S. Yegnanarayanan, Ali A. Eftekhar, and Ali Adibi, "Label-free flow cytometry using multiplex coherent anti-Stokes Raman scattering (MCARS)," microCARS, Gothenburg, Sweden, May 9-11, 2010. Invited.

12. **C. H. Camp Jr.**, "Coherent anti-Stokes Raman scattering (CARS): label-free imaging and spectroscopy," presentation to Cold Molecular Ions / Quantum Information Group (Prof. Kenneth Brown), School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, GA, April, 2009.

Seminars, Symposia, and Other Presentations

1. **C. H. Camp Jr.**, "Next Generation Raman and Infrared Microscopy and Spectroscopy", George Mason University Biomedical Engineering Group Meeting, National Institute of Standards and Technology, Gaithersburg, MD, October 7, 2024.

2. **C. H. Camp Jr.,** "Hyperspectral Biological Imaging with BCARS Microscopy: From Data Miner'ing to Data Mining, Machine Learning, and AI", AI for Materials Research Workgroup, National Institute of Standards and Technology, Gaithersburg, MD, March 14, 2019.

3. **C. H. Camp Jr.**, "From Spectroscopy to Chemical Imaging: Towards Quantitative Coherent Raman MicroSpectroscopy," BioForum Seminar Series, National Institute of Standards and Technology, Gaithersburg, MD, December 12, 2018.

4. **C. H. Camp Jr.**, "Coherent Raman Imaging with Molecular Contrast for Precision Histopathology," Machine Learning for Materials Research: Bootcamp & Workshop, University of Maryland, College Park, MD, June 27-30, 2017.

5. **C. H. Camp Jr.**, "Coherent Raman Imaging with Molecular Contrast for Precision Histopathology," Imaging for Precision Medicine, National Institute of Standards and Technology, Gaithersburg, MD, May 3 - 4, 2017.

6. **C. H. Camp Jr.**, "Chemical imaging of cells and tissues with broadband coherent anti-Stokes Raman scattering (BCARS) microspectroscopy," National Institute of Standards and Technology, Boulder, CO, March 6, 2017.

7. **C. H. Camp Jr.**, "Coherent Raman imaging (CRI): Transition from laboratory curiosity to analytical instrument in biology, pharmacology, and medicine," National Institute of Standards and Technology, Gaithersburg, MD, September 28, 2016.

8. **C. H. Camp Jr.**, "BCARS MicroSpectroscopy: The road to label-free chemical imaging," Program director delegation from National Institute of Biomedical Imaging and Bioengineering (NIH/NIBIB), National Institute of Standards and Technology, Gaithersburg, MD, March 30, 2015.

9. **C. H. Camp Jr.**, "Data science in Raman imaging," Biological Data Science Focus Group, National Institute of Standards and Technology, Gaithersburg, MD, March 2, 2015.

10. **C. H. Camp Jr.**, "BCARS MicroSpectroscopy: Molecular vibrational imaging of cells and tissues," American Dental Association Foundation, Volpe Research Center, Gaithersburg, MD, February 27, 2015.

11. **C. H. Camp Jr.**, Y. J. Lee, and M. T. Cicerone, "Broadband coherent anti-Stokes Raman scattering (BCARS) micro/spectroscopy," Delegation from University of Maryland, National Institute of Standards and Technology, Gaithersburg, MD, September 16, 2014.

12. K. Scott, C. Szakal, and **C. H. Camp Jr.**, "Label-free chemical imaging for biological and medical imaging," Delegation from Bundesanstalt für Materialforschung und -prüfung (BAM), National Institute of Standards and Technology, Gaithersburg, MD, January 14, 2014.

13. **C. H. Camp Jr.**, Y. J. Lee, and M. T. Cicerone, "Coherent Raman spectroscopic imaging for rapid, objective cancer identification," National Cancer Institute-National Institute of Biomedical Imaging and Bioengineering Point of Care Technologies for Cancer Conference, National Institutes of Health, Bethesda, MD, January 8-10, 2014.

14. **C. H. Camp Jr.**, Y. J. Lee, C. M. Hartshorn, and M. T. Cicerone, "High-speed coherent Raman imaging across the energy spectrum with BCARS microscopy," BioForum Seminar Series, National Institute of Standards and Technology, Gaithersburg, MD, September 11, 2013.

15. K. Scott, C. Szakal, and **C. H. Camp Jr.**, "Label-free chemical imaging for biological and medical imaging," Administrative delegation from Northern Illinois University, National Institute of Standards and Technology, Gaithersburg, MD, July 23, 2013.

29. **C. H. Camp Jr.**, Y. J. Lee, C. M. Hartshorn, E. G. Gatzogiannis, and M. T. Cicerone, "High-Speed Coherent Raman Imaging with Broadband Coherent Anti-Stokes Raman Scattering Microspectroscopy," NIST Sigma Xi 20th Annual Postdoctoral Poster Presentation, National Institute of Standards and Technology, Gaithersburg, MD, February 27, 2013.

30. **C. H. Camp Jr.**, Y. J. Lee, C. M. Hartshorn, and M. T. Cicerone, "High-speed, functional coherent Raman imaging with BCARS microscopy," Functional Imaging for Regenerative Medicine Workshop, National Institute of Standards and Technology, Gaithersburg, MD, May 31 - June 1, 2012.

31. C. G. Simon, Jr., **C. H. Camp**, C. K. Tison, G. Kumar, S. H. Parekh, and T. M. Farooque, "Measuring Stem Cell Niche Dimensionality in 3D Scaffolds," Global Technology Community Stem Cell Summit, Boston, MA, April 19-20, 2012.

32. **C. H. Camp Jr.**, A. A. Eftekhar, and A. Adibi, "Single-source interferometric multiplex coherent anti-Stokes Raman scattering spectroscopy", Georgia Tech Graduate Student Symposium, Atlanta, GA, March 12, 2008.

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"Top Biophotonics Stories of 2014," Photonics.com. http://www.photonics.com/Article.aspx?PID=1&AID=57009

"Spectroscopy: Vibrant colours," Nature Physics **10**, 624 (2014).

"We Love Faster BCARS," The Analytical Scientist **0814**, 23 (2014). https://theanalyticalscientist.com/

NIST MML Material Matters, Summer 2014. Cover. http://www.nist.gov/mml/material-matters.cfm

"Licence to Trill," Biomedical Picture of the Day (BPoD), August 3, 2014. http://bpod.mrc.ac.uk/archive/2014/8/3

"Enhanced CARS Enables High-Speed Imaging of Tissues," Photonics.com, July 23, 2014. http://www.photonics.com/Article.aspx?AID=56495

"Enhanced NIST Instrument Enables High-speed Chemical Imaging of Tissues," NIST Tech Beat, July 22, 2014. https://www.nist.gov/news-events/news/2014/07/enhanced-nist-instrument-enables-high-speed-chemical-imaging-tissues

"Raman technique could lead to much higher-speed cell and tissue imaging," BioOptics World, July 22, 2014. www.bioopticsworld.com/articles/2014/07/raman-technique-could-lead-to-much-higher-speed-tissue-imaging.html

"Enhanced instrument enables high-speed chemical imaging of tissues," Science Daily, July 22, 2014. www.sciencedaily.com/releases/2014/07/140722142517.htm

"Enhanced NIST instrument enables high-speed chemical imaging of tissues," PhysOrg, July 22, 2014. https://phys.org/news/2014-07-nist-instrument-enables-high-speed-chemical.html

"High-speed coherent Raman fingerprint imaging of biological tissues," nanowerk, July 22, 2014. www.nanowerk.com/news2/biotech/newsid=36641.php

"Enhanced NIST instrument enables high-speed chemical imaging of tissues," EurekaAlert!, July 22, 2014.https://www.eurekalert.org/pub_releases/2014-07/nios-eni072214.php

Software (Publicly-Available, Open-Source)

Hilbert: Discrete Hilbert Transform Implementations. https://github.com/usnistgov/Hilbert

pyMCR: Multivariate Curve Resolution for Python. https://doi.org/10.18434/M32064

CRIKIT2: Coherent Raman Imaging toolKIT: https://github.com/CCampJr/CRIkit2

SciPlot-PyQt: Creating publication-ready scientific figures. https://github.com/CCampJr/SciPlot-PyQt

LazyHDF5: Making H5py easier. https://github.com/CCampJr/LazyHDF5

Orange-Spectroscopy: Spectroscopy plug-in for Orange bioinformatics and machine learning ecosystem, https://github.com/Quasars/orange-spectroscopy **Multinational collaborative team**.