Brian Charles Claus

Ph.D, EIT

Phone: 778-877-8763
E-mail: bclaus@whoi.edu
Web: www.whoi.edu/people/bclaus

EDUCATION

Ph.D. **Doctor of Philosophy in Engineering and Applied Science with Distinction**
Memorial University, St. John's, Newfoundland, Canada, 2015
Supervisor: Dr. Ralf Bachmayer

M.Eng. **Master of Engineering in Ocean and Naval Architectural Engineering**
Memorial University, St. John's, Newfoundland, Canada, 2010
Supervisor: Dr. Ralf Bachmayer

B.Eng. **Bachelor of Engineering in Electrical Engineering with Distinction**
University of Victoria, Victoria, British Columbia, Canada, 2008
Specialization in Mechatronics

PROFESSIONAL EXPERIENCE

Jul 2017 – Present **Subsea Project Engineer**
Ocean Floor Geophysics, Burnaby, B.C.
- Field operations of subsea systems
- Subsea system development and integration
- Project management, planning and control

May 2017 - Present **Postdoctoral Investigator**
Applied Ocean Physics and Engineering – Woods Hole Oceanographic Institute
- Next generation hybrid propulsion system
- Magnetic instrumentation and validation for persistent ocean observing platforms

Sep 2015 – May 2017 **Postdoctoral Scholar**
Applied Ocean Physics and Engineering – Woods Hole Oceanographic Institute
- Developing methods for multi-parameter constraints on persistent heterogeneous groups of ocean vehicles
- Instrumentation and calibration of persistent ocean observations

Apr 2015 – Sep 2015 **Postdoctoral Scholar**
Ocean and Naval Architecture Engineering – Memorial University
- Development and testing of field oriented controller for low speed sensor-less control of direct drive underwater propulsion systems
- Design and prototyping of a low impact amphibious robotic vehicle suited to traversing ice-snow-water interfaces

Sep 2007 - Dec 2007 **Undergraduate Research Assistant**
Northern Research in Nano Optics − University of Victoria
- Research involving surface plasmon resonances due to nanohole array structures
- Research investigating the uses of laser diodes in external cavities for ultra fast pulse laser applications

Jan 2007 - Apr 2007 **Electrical Co-op Student**
Honeywell Process Solutions − North Vancouver, British Columbia
- Research and development for next generation inductive heating product
- Design of prototype involving building up of schematics, PCB layout and testing of high power circuitry
- Cost reduction of support circuitry for LVDT position sensors

May 2006 - Sep 2006 **Electrical Co−op Student**
AMEC Americas Limited − Trail, British Columbia
- Responsible for creating and checking drawings, generating lists, creating and updating calculations as well as several small design projects
- Assisted in the completion of a low level nuclear waste processing facility
- Worked under a professional engineer on a high voltage substation upgrade

Jan 2005 - Mar 2005 **Mechanical Engineering Co−op Student**
Allnorth Consultants Limited − Prince George, British Columbia
- Worked under professional engineer during the final stages of a pulp mill co−generation project
- Maintained drawings and records using AutoCAD

PUBLICATIONS

Theses or Dissertations

B. Claus, "Energy Efficient Navigational Methods for Autonomous Underwater Gliders in Surface Denied Regions" Ph.D. thesis, Ocean and Naval Architectural Engineering, Memorial University, 2015.

B. Claus, "Design of an Underwater Glider Equipped with an Auxiliary Propulsion Module." M. Eng. thesis, Ocean and Naval Architectural Engineering, Memorial University, 2010.

Peer Reviewed Journal Articles

In Preparation

[] A. Branch, E. Clark, S. Chien, M. Flexas, A. Thompson, **B. Claus**, J. C. Kinsey, D. Fratantoni, Y. Zhang, B. Hobson, B, Kieft and F. P. Chavez, "Front Delineation and Tracking with Multiple Underwater Vehicles," Submitted to Journal of Field Robotics Dec. 2017

[] T. Howatt, J. Palter, R. Matthews, B. deYoung, R. Bachmayer and **B. Claus**, "Freshwater and Oxygen Transport Across the Labrador Shelf-Break: Insights from Gliders," Journal of Physical Oceanography, Submitted June 2016, Major Revisions July 2016, re-submitted July 2017, major revisions Sept 2017, re-submitted Dec. 2017.

[] Kepper, J, **Claus, B.,** Kinsey, J. A Navigation Solution using a MEMS IMU, Model-Based Dead-Reckoning, and One-Way-Travel-Time Acoustic Range Measurements for Autonomous Underwater Vehicles, Journal of Oceanic Engineering, submitted Sept 2017, Major Revisions Dec 2017.

Published

[J7] **B. Claus**, J. Kepper, S. Suman, J. Kinsey, "Closed Loop One-Way-Travel-Time Navigation using Low-Grade Odometry for Autonomous Underwater Vehicles," Journal of Field Robotics, 2017;00:1–14. doi, 10.1002/rob.21746.

[J6] A. Thompson, Y. Chao, S. Chien, J. Kinsey, M. Flexas, A. Branch, S. Chu, M. Troesch, **B. Claus**, J. Kepper, J. Farrara, D. Fratantoni, "Satellites to the Seafloor: Towards Fully Autonomous Ocean Sampling," Oceanography 30(2):160–168, 2017. doi, 10.5670/oceanog.2017.238.

[J5] **B. Claus**, R. Bachmayer, "A Parameterized Geometric Magnetic Field Calibration Method for Vehicles with Moving Masses with Applications to Underwater Gliders," Journal of Field Robotics, 2016. doi: 10.1002/rob.21660

[J4] **B. Claus**, R. Bachmayer, "Energy Optimal Depth Control for Long Range Underwater Vehicles with Applications to a Hybrid Underwater Glider", Autonomous Robotics, Special Issue in Long-Term Autonomy in Marine Robotics, 2016. doi: 10.1007/s10514-016-9555-3

[J3] **B. Claus**, R. Bachmayer, "Terrain Aided Navigation for an Underwater Glider", Journal of Field Robotics, 2015. doi: 10.1002/rob.21563

[J2] **B. Claus**, R. Bachmayer, C. D. Williams, "Development of an Auxiliary Propulsion Module for an Autonomous Underwater Glider", Proc. IMechE, Part M. Journal of Engineering for the Maritime Environment, 2010. doi: 0.1243/14750902JEME204

[J1] Q. Min, **B. Claus**, P. Marthandam and R. Gordon, "Plasmonic Bragg Reflectors: Optimization and Application to Isolation", IEEE J. Selected Topics in Quantum Electronics, 2008. doi: 10.1109/JSTQE.2008.920039

Peer Reviewed Conference Proceedings

[CR1] **B. Claus***, R. Bachmayer, "A Parameterized Geometric Magnetic Field Calibration Method for Vehicles with Moving Masses with Applications to Underwater Gliders," in Proc. Field and Service Robotics 2015, Toronto, ON, 2015. doi: 10.1007/978-3-319-27702-8_6

Full Length Conference Proceedings

[CA17] J. Kepper*, **B. Claus**, J. C. Kinsey, "MEMS IMU and One-Way-Travel-Time Navigation for Autonomous Underwater Vehicles," in Proc Oceans 2017, Aberdeen, UK, 2017.

[CA16] **B.Claus***, J. Kinsey, Y. Girdhar, "Towards Persistent Cooperative Marine Robotics", in Proc. Autonomous Underwater Vehicles 2016, IEEE/OES, Tokyo, Japan, 2016.

[CA15] **B. Claus***, R. Bachmayer, "Towards Online Terrain Aided Navigation of Underwater Gliders," in Proc. Autonomous Underwater Vehicles 2014 IEEE/OES, Oxford, Mississippi, 2014. doi: 10.1109/AUV.2014.7054410

[CA14] **B. Claus***, R. Bachmayer, "Towards Navigation of Underwater Gliders in Seasonal Sea Ice," in Proc. Oceans 2014 , St, John's, Newfoundland, 2014. doi: 10.1109/OCEANS.2014.7003224

[CA13] L. MacNeil*, R. Bachmayer, **B. Claus**, "Design and testing of a magnetically-geared underwater propulsion system for autonomous underwater and surface craft," in Proc. Oceans 2014, St, John's, Newfoundland, 2014. doi:10.1109/OCEANS.2014.7003218

[CA12] A. Ratsimandresey*, S. Donnet, R. Bachmayer, **B. Claus**, P. Goulet, "Variation in the structure of the water column as captured by Slocum glider CTD and by CTD from a research vessel and assessment of internal waves," in Proc. Oceans 2014, St, John's, Newfoundland, 2014. doi: 10.1109/OCEANS.2014.7003283

[CA11] **B. Claus***, R. Bachmayer, "Towards Online Navigation of Underwater Gliders in GPS Denied Regions," in 6th EGO Meeting and Final Symposium of the COST Action ES0904, Kiel, Germany, 2014.

[CA10] **B. Claus***, R. Bachmayer, "A Modified Particle Filter Suitable for Embedded Systems," in Proc. NECEC 2013, St. John's, Newfoundland, 2013.

[CA9] **B. Claus***, R. Bachmayer, L. Cooney, "Analysis and development of a buoyancy-pitch based depth control algorithm for a hybrid underwater glider," in Proc. Autonomous Underwater Vehicles 2012 IEEE/OES, Southampton, UK, 2012. doi: 10.1109/AUV.2012.6380742

[CA8] **B. Claus***, R. Bachmayer, "A Magnetically Geared Marine Thruster for Long Term Ocean Deployments and Operations," in Proc. NECEC 2012, St. John's, Newfoundland, 2012.

[CA7] **B. Claus**, L. MacNeil*, R. Bachmayer, "Development of a Magnetometry System for an Underwater Glider," in Unmanned Untethered Submersible Technology, 2011.

[CA6] **B. Claus***, R. Bachmayer, "Progress in the Development of a Navigation Solution for Underwater Gliders," in Proc. NECEC 2011, St. John's, Newfoundland, 2011.

[CA5] **B. Claus**[1*], R. Bachmayer, C. D. Williams, "Experimental Flight Stability Tests for the Horizontal Flight Mode of Hybrid Glider," in Proc. Autonomous Underwater Vehicles, Monterey, CA, USA, Sept. 2010. doi: 10.1109/AUV.2010.5779680

[CA4] **B. Claus***, R. Bachmayer, "Hybrid Glider Performance Characterization," Everyone's Gliding Observatories Meeting and Glider School, Larnaca, Cyprus, Nov. 2009.

[CA3] **B. Claus*** "Hybrid Glider Propulsion Module Implementation and Characterization," in Proc. Unmanned Untethered Submersible Technology, Durham, NH, USA, Aug. 2009.

[CA2] **B. Claus***, N. P. Riggs, H. P. Sekeran, R. Bachmayer, "Development of a Low Cost Instructional Platform for Submersible Design," in Proc. Canadian Conference on Electrical and Computer Engineering, 2009. doi: 10.1109/CCECE.2009.50900902

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1 Presenter

[CA1] **B. Claus**, Q. Min*, P. Marthandam, R. Gordon, " Characterization of plasmonic bragg reflectors with implementation in isolation applications," in Proc. Conference on Lasers and Electro-Optics, 2008 and 2008 Conference on Quantum Electronics and Laser Science. CLEO/QELS 2008., vol., no., pp.1-2, 4-9 May 2008.

Book Chapters

[B1**]** **B. Claus**, R. Bachmayer, "Hybrid Glider: Motivation, Design and Evaluation," in Further advances in unmanned marine vehicles, eds. Roberts, Geoff N., and Robert Sutton, (p. 283-307). Vol. 77. IET, 2012.

Patents

[P1] **B. Claus**, R. Bachmayer, L. MacNeil, "A Magnetically Geared Electric Drive," Provisional Patent No. 61936656, Feb. 6, 2014, USPTO.

Other contributions

[O20] **B. Claus**, J. Kepper, J. C. Kinsey, S. Suman, "Scalable Acoustic Navigation for Groups of Low-Cost Autonomous Underwater Vehicles," Ocean Sciences, Accepted 2017.

[O19] **B. Claus**, "An Ocean Full of Robots: How to Have them be Useful and Not Exhaust People," University Rhode Island, Graduate School of Oceanography, April 2017. (Invited Talk)

[O18] **B. Claus**, "Towards Scalable Long Duration Groups of Ocean Observing Platforms," Woods Hole Oceanographic Institution, Applied Ocean Physics and Engineering Department, March 2017. (Invited Talk)

[O17] **B. Claus**, "Towards Scalable Long Duration Groups of Ocean Observing Platforms," University Rhode Island, Ocean Engineering Department, Feb 2017. (Invited Talk)

[O16] **B. Claus**, J. Kinsey, M. Tominaga, M. Tivey, "Observing Crustal Magnetic Anomalies in Remote Ocean Regions: Filling in the Gaps," submitted to Proc. American Geophysical Union Fall Meeting, San Fransisco, CA, 2016.

[O15] T. Howatt, J. Palter, R. Matthews, **B. Claus**, "Freshwater and Oxygen Transport Across the Labrador Shelf-Break: Insights from Gliders," submitted to Proc. American Geophysical Union Fall Meeting, San Fransisco, CA, 2016.

[O14] **B. Claus**, "Extending the Utility of Long Duration Ocean Observing Platforms," Applied Ocean Physics and Engineering 2-Min Talk, Woods Hole, MA, July 2016.

[O13] **B. Claus**, "Robotic Explorers for the 21st Century," Visiting High School Seminar, Woods Hole, MA, May, 2016.

[O12] **B. Claus** and R. Bachmayer, "Underwater Glider Terrain Relative Navigation for use in Surface Denied Regions," Ocean Science, New Orleans, LA, USA, Feb. 2016. (Poster)

[O11] A. Thompson, J. C. Kinsey, M. Coleman, R. Castano, & study participants, "Satellites to the Seafloor: Autonomous Science to Form a Breakthrough in Quantifying the Global Ocean Carbon Budget," Keck Institute for Space Studies, 2015.

[O10] **B. Claus** and J. Kinsey, "Towards Persistent Cooperative Marine Robotics," North Eastern Robotics Colloquium, Worcester, MA, USA, Nov. 2015. (Poster)

[O9] **B. Claus,** "Localization and Mobility of Underwater Gliders in Strong Currents and Sea Ice," CSAIL Seminar Series, MIT, Boston, MA, USA, Nov, 2015.

[O8] **B. Claus,** "Localization and Mobility of Underwater Gliders in Strong Currents and Sea Ice," AOPE Department Seminar Series, WHOI, Woods Hole, MA, USA, Oct, 2015.

[O7] **B. Claus**, "Gliders, Newfoundland and Labrador, and Sea Ice," Robotics Seminar, Memorial University, Sept. 2014. (Presentation, Ph.D.)

[O6] **B. Claus**, "Glider Navigation Under-Ice," Autonomous Ocean Systems Lab Workshop 2013. (Presentation, Ph.D.)

[O5] **B. Claus**, R, Bachmayer, "Navigation for Underwater Gliders," NSERC Field Robotics Network Field Trials 2013. (Poster, Ph.D.)

[O4] **B. Claus**, "Mag-648-Magnetic anomaly mapping using an underwater glider equipped with a low power fluxgate," Bartington Instruments Case Study 2012. (Case Study, Ph.D.)

[O3] **B. Claus***, R. Bachmayer, "Hybrid Glider Progress and Future Directions," at Dalhousie University Workshop and Meetings on Autonomy for Maritime Robotics 2010. (Presentation, M. Eng)

[O2] **B. Claus***, R. Bachmayer, "Hybrid Glider Progress and Future Directions," at 6th Biannual NRC-IOT Workshop on Underwater Vehicle Technology 2010. (Abstract and Presentation, M. Eng)

[O1] **B. Claus**, "Brushless DC Motor Design for a Miniature Autonomous Underwater Vehicle Thruster," University of Victoria, Faculty of Engineering Technical Report, 2008. (B. Eng)

PROFESSIONAL AFFILIATIONS

Member, American Geophysical Union
Member, IEEE Ocean Engineering Society, Robotics and Automation Society
Engineer-in-training (EIT),Association for Professional Engineers and Geoscientists (APEGBC)
Member, British Columbia Geophysical Society

PROFESSIONAL ACTIVITIES

WHOI Postdoctoral Association Committee AOP&E Representative (September 2016 to July 2017)
Founding member of MUN Sailbot Team (2008 to 2012)
Reviews – Journal of Field Robotics, Journal of Geophysical Research: Oceans, Journal of Atmospheric and Oceanic Technology, IEEE Journal of Oceanic Engineering, Mechatronics, Robotics and Autonomous Systems, Underwater Technology, IEEE Oceans Conference

EDUCATIONAL ACTIVITIES

Woods Hole Oceanographic Institution, Woods Hole, MA, USA
Semester at WHOI Advisor for:

- Laura Chobrak, 2016 SAW (Undergraduate Student at U.C. Berkley, Co-advised with J. Kinsey)

Memorial University, St. John's, NL, CA
Teaching Assistant:

- Fall 2013 Engineering 6055 Marine Cybernetics
- Winter 2011 Engineering 5951 Mechatronics
- Fall 2010 Engineering 1040 Mechanisms and Electric Circuits
- Winter 2010 Engineering 1040 Mechanisms and Electric Circuits Head TA
- Winter 2010 Engineering 8058 Submersible Design
- Fall 2009 Engineering 1040 Mechanisms and Electric Circuits
- Winter 2009 Engineering 8003 Small Craft Design
- Winter 2009 Engineering 8058 Submersible Design

Co-op Students:

- Levi MacNeil (Mechanical Engineering Coop Student, now a research engineer in Autonomous Ocean Systems Lab at Memorial. Results of research informed patent [P1])

FIELD EXPERIENCE

Summer 2016 through Spring 2017 — **Ashumet Pond Trials**
Ship: RHIB
Responsibilities:

- Testing of navigation, acoustic and satellite communications software
- Integration of precision clock references

Equipment:

- Two Ecomapper AUVs with DVL, CT, Sidescan, YSI sonde
- Iver AUV with dual phased array DVLs, fluxgate, CT

May 2017 — **KISS Satellites to the Seafloor Year 2 Santa Cruz Field Program**

Responsibilities:
- Operation of shipside acoustic equipment
- Daily mobilization and demobilization of IVER2 AUVs
- Launch and recovery of IVER2 AUVs
- Lead on near real time data processing, display and retasking

Equipment
- Two Ecomapper AUVs with DVL, CT, Sidescan, YSI sonde 350 meter
- Iver AUV with dual phased array DVLs, fluxgate, CT
- Two Seaglider AUGs with CTD
- Tethys LRAUVs
- High resolution regional ocean model (300m) of Monterey Bay.

Aug-Sept 2016 **KISS Satellites to the Seafloor Year 1 Santa Cruz Field Program**

Responsibilities:
- Operation of shipside acoustic equipment
- Daily mobilization and demobilization of IVER2 AUVs
- Launch and recovery of IVER2 AUVs
- Lead on near real time data processing and display

Equipment
- Two Ecomapper AUVs with DVL, CT, Sidescan, YSI sonde 350 meter
- Iver AUV with dual phased array DVLs, fluxgate, CT
- Two Seaglider AUGs with CTD
- A Tethys LRAUV
- High resolution regional ocean model (300m) of Monterey Bay.

June 2016 **R/V Neil Armstrong Science Verification Cruise V**

Responsibilities:
- Performing a magnetic tow
- Ballasting, sealing and writing missions for underwater gliders
- Re-design, testing and installation of magnetic fluxgate sensor
- Launch and recovery of underwater glider

Equipment
- Marine Magnetics Sea Spy towfish
- 350 meter Slocum with CTD, O2 Optode and magnetic sensor
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Jun 2015 **NSERC Canadian Field Robotics Network, Kelowna Field Trials**

Responsibilities:
- Testing amphibious robotic platform
- Integration of magnetic sensor, survey planning and collection of towed magnetic data
- Packaging and shipping of equipment to and from testing location

Equipment
- Prototype amphibious vehicle
  Clearpath Robotics Kingfisher ASV

Jun 2014 - Sept 2014 **Deployment of three gliders to the Labrador Sea as part of the VITALS project and to collect magnetic data for my Thesis**

Responsibilities:
- Ballasting, sealing and writing missions for underwater gliders
- Installing magnetic fluxgate sensor
- Training new Postdoc and Masters student on their operation and use
- Deployment from CCGS Hudson and piloting from lab

Equipment

- 1000 meter Slocum with CTD, RDI 600 kHz DVL and Aanderaa O2 Optode
- 1000 meter hybrid Slocum with CTD and Aanderaa O2 Optode
- 200 meter Slocum with CTD and magnetic fluxgate

Dec 2013 **Magnetic calibration and data collection for Ph.D. Thesis in Bonne Bay, NL**

Responsibilities:

- Ballasting, sealing and writing missions for underwater glider
- Installing magnetic fluxgate sensor
- Deployment and recovery and piloting from lab at marine base

Equipment

- 200 meter Slocum with CTD and magnetic fluxgate

Mar 2012 **Winter observations with an underwater glider in Fortune Bay, NL in partnership with Department of Fisheries and Oceans, aquaculture group**

Responsibilities:

- Ballasting, sealing and writing missions for underwater glider
- Deployment from DFO patrol boat and piloting from lab

Equipment

- 200 meter hybrid Slocum with CTD and Aanderaa O2 Optode

2010-2015 **Engineering field trials in Holyrood Arm and Conception Bay, NL**

Trials:

- 2010 trials of ice profiling sonar on underwater glider
- 2010-2011 trials of hybrid thruster on underwater glider
- 2011 preparations for ice island deployment with underwater glider
- 2012 trials with Lotec fishtags on underwater glider
- 2012-2013 trials with magnetic fluxgate sensor

Responsibilities:

- Ballasting, sealing and writing missions for underwater glider
- Deployment and recovery from small craft and piloting from shore

Equipment

- 200 meter Slocum with CTD with various equipment
-