Charlie SANABRIA

http://www.chasanabria.com/

Key terms

Mechanical engineering •
Materials science •
Superconducting cables •
Magnets for fusion energy •
Metallurgy and microscopy •
Science communication •

My Career Mission Statement

I believe science is absolutely necessary for the advancement of humankind, and I'm passionately driven towards initiatives that expand its capabilities. Throughout my career, I have consciously involved myself in major scientific R&D projects such as ITER, the Large Hadron Collider, and most recently SPARC—acquiring skills that range from hands-on labor, to experimental design, systems engineering and project management. My career goal is to keep acquiring whatever skills necessary to render myself useful in scientific projects aimed to improve human conditions and accelerate the future. Additionally, I'm always on the lookout to disseminate and popularize science & technology through writings, seminars, social media, etc.

Education

- **PhD** in Material Science and Engineering at The Florida State University (2017).
  Watch PhD thesis presentation here, download thesis document here, or purchase a copy here.
- **Bachelor's Degree** in Mechanical Engineering at The Florida State University (2011).

Work Experience

1. **Institution**: Commonwealth Fusion Systems
   - **Position: Magnet Systems Engineer.**
   - **Dates of employment: June 2019 – present.**
   - **Description of duties and accomplishments:**
     - R&D towards the magnet technology required for a 20 T compact tokamak central solenoid.
     - Execute other R&D initiatives that inform future tokamak design.
       - **Supervisors:**
         Brandon Sorbom
         Elle Allen

2. **Institution**: Lawrence Berkeley National Laboratory.
   - **Position: Postdoctoral Researcher.**
   - **Dates of employment: November 2017– June 2019.**
   - **Description of duties and accomplishments:**
     - Cable task deputy leader of the Accelerator Upgrade Program (AUP) aimed to upgrade the LHC magnets.
     - Led the development of a cryogenic resistivity measurement system used to monitor cable quality.
     - Developed image analysis algorithms for in-line dimensional measurements of superconducting cables.
     - Developed a small-magnet project aimed to understand the issue of "training" in accelerator magnets.

- **Supervisors:**
  Ian Pong (**ipong@lbl.gov**)
  Soren Prestemon (**soprestemon@lbl.gov**)

3. **Institution:** The Applied Superconductivity Center at the National High Magnetic Field Laboratory.
   - **Position:** PhD candidate Research Assistant (RA).
   - **Dates of employment:** July 2014– October 2017.
   - **Description of duties and accomplishments:**
     - Under a grant provided by the US Department of Energy my team was to improve the wire technology for the future upgrade of the Large Hadron Collider (LHC).
     - My metallographic characterization and microscopy led to an improved heat treatment, and a 28% increase of the critical current density of the wires.
     - Co-author of a provisional patent application for a new wire design, and first author of a provisional patent application for a heat treatment process.

     - **Supervisors:**
       David Larbalestier (larbalestier@asc.magnet.fsu.edu)
       Peter J. Lee (lee@asc.magnet.fsu.edu)
       Michael Field (Michael.Field@bruker.com)

4. **Institution:** Oxford Superconducting Technology (OST), now Bruker.
   - **Position:** Visiting scientist.
   - **Dates of employment:** April 2014 – July 2014.
   - **Description of duties and accomplishments:**
     - Performed exploratory metallography and image analysis of OST's wire production.
     - My diagnosis led to a process improvement that increased the magnetic stability of the wires by 30%.

     - **Supervisor: Michael Field** (Michael.Field@bruker.com)

5. **Institution:** The Applied Superconductivity Center at the National High Magnetic Field Laboratory.
   - **Position:** Graduate Research Assistant (RA).
   - **Dates of employment:** May 2011 – April 2014.
   - **Description of duties and accomplishments:**
     - As part of the ITER crash R&D program (aka the 'dream team') our responsibility was to understand the mechanical failure of the ITER conductor prototypes.
     - My analysis reinforced our understanding of the mechanical integrity of the 'short twist pitch' approach taken by ITER on its Cable-in-conduit conductors.
     - Published seven scientific journals and gave eight talks at international conferences.

     - **Supervisors:**
       David Larbalestier (larbalestier@asc.magnet.fsu.edu)
       Peter J. Lee (lee@asc.magnet.fsu.edu)

Publications

- **Peer reviewed journal articles**
  - C. Sanabria, B. Sorbom, and M. Segal, "Commercial fusion power: a killer app for HTS" an invited section in "A Roadmap for Superconductors for Fusion" Edited by Neil Mitchell, Submitted to SuST.

- C. Sanabria, Michael Field, P. J. Lee, and D. C. Larbalestier, "Controlling Cu-Sn mixing so as to enable higher critical current densities in RRP® Nb_3Sn wires" Supercond. Sci. Technol., vol. 31, no. 6, p. 064001, 2018. This manuscript was awarded the first place of the 2018 Jan Evetts award.
- C. Sanabria, P. J. Lee, W. Starch, A. Devred, and D. C. Larbalestier, "Metallographic autopsies of full-scale ITER prototype cable-in-conduit conductors after full cyclic testing in SULTAN: II. Significant reduction of strand movement and strand damage in short twist pitch CICCs," *Supercond. Sci. Technol., vol. 28, no. 12, p. 125003, 2015.*
- C. Sanabria, P. J. Lee, W. Starch, T. Blum, A. Devred, M. C. Jewell, I. Pong, N. Martovetsky, and D. C. Larbalestier, "Metallographic autopsies of full-scale ITER prototype cable-in-conduit conductors after full testing in SULTAN: 1. The mechanical role of copper strands in a CICC," *Supercond. Sci. Technol., vol. 28, no. 8, p. 085005, Aug. 2015.*
- A. Nijhuis, R. P. P. van Meerdervoort, H. J. G. Krooshoop, W. a. J. Wessel, C. Zhou, G. Rolando, C. Sanabria, P. J. Lee, D. C. Larbalestier, A. Devred, A. Vostner, N. Mitchell, Y. Takahashi, Y. Nabara, T. Boutboul, V. Tronza, S.-H. Park, and W. Yu, "The effect of axial and transverse loading on the transport properties of ITER Nb_3Sn strands", *Supercond. Sci. Technol., vol. 26, no. 8, p. 084004, Aug. 2013.*
- N. Mitchell, A. Devred, D. C. Larbalestier, P. J. Lee, C. Sanabria, and A. Nijhuis, "Reversible and irreversible mechanical effects in real cable-in-conduit conductors," *Supercond. Sci. Technol., vol. 26, no. 11, p. 114004, Nov. 2013.*
- C. Sanabria, P. J. Lee, W. Starch, I. Pong, A. Vostner, M. C. Jewell, A. Devred, and D. C. Larbalestier, "Evidence that filament fracture occurs in an ITER toroidal field conductor after cyclic Lorentz force loading in SULTAN," *Supercond. Sci. Technol., vol. 25, no. 7, p. 075007, Jul. 2012.*

Peer reviewed conference papers

- C. Sanabria, I. Pong, L. LaLonde, S. Prestemon, "Further Heat Treatment Optimizations for Nb_3Sn Conductors: From Wires to Cables" *IEEE Transactions on Applied Superconductivity*, vol. 29, no. 5, pp. 1–4, Aug. 2019.
- C. Sanabria, P. J. Lee, A. Devred, and D. C. Larbalestier, "Metallographic autopsies of full-scale ITER prototype cable-in-conduit conductors after full cyclic testing in SULTAN: III: The Importance of Strand Surface Roughness in Long Twist Pitch Conductors", *Supercond. Sci. Technol., vol. 29, no. 7, p. 74002, 2016.*

Chapters

- C. Sanabria and P. J. Lee, "An Introduction to Digital Image Analysis of Superconductors" a chapter in the *"Handbook of Superconductivity: Fundamentals and Materials"*, Volume One (2nd ed.). Edited by Cardwell, D.A., Larbalestier, D.C., & Braginski, A. (Eds.). (2021). CRC Press. https://doi.org/10.1201/9780429179181.

Books

- C. Sanabria "A new understanding of the heat treatment of Nb_3Sn superconducting wires", Thesis Document self-published using CreateSpace Independent Publishing Platform. April 19th, 2017 ISBN: 978-1-5447-7013-0

Patents

- M. Field, H. Miao, C. Sanabria, J. Parrell, "A method for producing a multifilament Nb_3Sn superconducting wire", EP3420565

- C. Sanabria, M. Field, H. Miao, J. Parrell, "Improving strand critical current density in Nb_3Sn superconducting strands via novel heat treatment" US2018212136A1.

Honors and Awards

- Annual Early Career Best SUST Paper Award in memory of Jan Evetts, 1st place (2018).
- Victor Keilin Memorial Prize (Materials) Best Paper for "Development of Superconducting Materials for Large Scale Applications". Award presented at the Applied Superconductivity Conference in Denver, CO, September 4th-9th 2016.
- Best Student Paper, Materials 1st Place. Award presented at the Applied Superconductivity Conference in Denver, CO, September 4th-9th 2016.
- 2016 Academic Leadership Award at the Florida State University.
- Best Student Paper, Large Scale 2nd Place. Award presented at the Applied Superconductivity Conference in Charlotte, NC, August 10th-15th 2014.
- Institute of Electrical and Electronics Engineers (IEEE), Council on Superconductivity (CSC) Graduate Study Fellowship in Applied Superconductivity. Award presented at the 23rd Magnet Technology Conference at The Westin Copley Place in Boston, MA July 14th-19th, 2013.

Scientific talks at international conferences

- Click here to watch video recordings of some of these talks.
- C. Sanabria, I. Pong, L. LaLonde, and S. Prestemon, "Further Heat Treatment Optimizations for Nb_3Sn Conductors – From wires to cables" presented at the Applied Superconductivity Conference in Seattle WA, October 28th-November 2nd 2018.
- C. Sanabria, I. Pong, S. Prestemon, "Understanding the dangers of skipping the 215°C step in RRP wire heat treatment", presented at the Low Temperature High Field Superconducting Workshop at the Omni Jacksonville Hotel, Jacksonville FL, February 12th-14th, 2018.
- C. Sanabria, M. Field, P. J. Lee, H. Miao, J. Parrell, and D. C. Larbalestier, "Reexamining the heat treatment of RRP® Nb_3Sn and the potential for further improvements", presented at the Cryogenic Engineering Conference and the International Cryogenic Materials Conference (CEC-ICMC) at the Monona Terrace Community and Convention Center, Madison, WI, July 10th-July 13th, 2017.
- C. Sanabria, M. Field, P. J. Lee, H. Miao, J. Parrell, and D. C. Larbalestier, "Heat treatment optimization of RRP® wires", presented at the Low Temperature High Field Superconducting Workshop at La Fonda on the Plaza Hotel in Santa Fe, NM, February 27th-March 1st, 2017.
- C. Sanabria, M. Field, P. J. Lee, H. Miao, J. Parrell, and D. C. Larbalestier, "Significant improvement of J_c in small D_s RRP® wires through heat treatment changes and phase control" presented at the Applied Superconductivity Conference in Denver, CO, September 4th-9th 2016.
- C. Sanabria, P. J. Lee, A. Devred, D. C. Larbalestier, "What is the deal with the Russians? – The Importance of Strand Surface Roughness in Long Twist Pitch Conductors", presented at the 8th Workshop on Mechanical and Electromagnetic Properties of Composite Superconductors at The Doubletree Hotel in Tallahassee, FL. March 21st-23rd 2016.
- C. Sanabria, Michael Field, P. J. Lee, and D. C. Larbalestier, "A self-assembled Sn-Nb-Cu membrane regulating high Sn phases in RRP® wires", presented at the Low Temperature High Field Superconducting Workshop at La Fonda on the Plaza Hotel in Santa Fe, NM, February 8th-10th, 2016.

- C. Sanabria, Michael Field, P. J. Lee, and D. C. Larbalestier, "The Role of a Cu-Sn-Nb Membrane on the Reaction Pathway of Nb_3Sn wires", presented at the Materials Research Society Spring Meeting at the Moscone West, the Marriott Marquis and the Park Central Hotels in San Francisco, CA, April 6th-10th 2015.
- C. Sanabria, Michael Field, P. J. Lee, Michael Gerace and D. C. Larbalestier, "Reaction Pathway Issues for Nb_3Sn", presented at the Low Temperature High Field Superconducting Workshop at the Embassy Suites in Napa, CA, February 16th-18th 2015.
- C. Sanabria, P. J. Lee, W. Starch, T. Blum, A. Devred, D. C. Larbalestier, "To Slip or Not to Slip, The Importance of Strand Surface Roughness in Long Twist Pitch Conductors", presented at the Applied Superconductivity Conference in Charlotte, NC, August 10th-15th 2014.
- C. Sanabria, P. J. Lee, W. Starch, N. Thakker, A. Atchison, A. Devred, M. C. Jewell, I. Pong, N. Martovetsky and D. C. Larbalestier, "Metallographic Autopsies on Central Solenoid SULTAN Samples", presented at The 23rd Magnet Technology Conference at The Westin Copley Place in Boston, MA July 14th-19th, 2013.
- C. Sanabria, P. J. Lee , W. Starch , T. Blum , J. Gavin , I. Pong, M. C. Jewell, A. Devred, N. Martovetsky and D. C. Larbalestier, "Autopsy results on CSIO1 SULTAN samples", presented at The 7th International Workshop on Mechanical–Electromagnetic Properties of Composite Superconductors at the Hotel Aquabella in Aix-en-Province, France, March 12th-14th, 2013.
- C. Sanabria, A. Nijhuis, R. van Meerdervoort, P. J. Lee, A. Vostner, I. Pong, M. C. Jewell, A. Devred and D. C. Larbalestier, "Filament fracture in ITER Nb_3Sn strands after controlled load simulations", presented at The Applied Superconductivity Conference at the Doubletree Hotel Portland in Portland, OR, August 7th-12th, 2012.
- C. Sanabria, P. J. Lee, and D. C. Larbalestier, "Metallography of post-TARSIS strand samples and SULTAN tested conductors", presented at the ITER Conductor Design Reconciliation Workshop of 2012 at the Aquabella hotel in Aix-en-Province, France, June 2012.
- C. Sanabria, P. J. Lee, W. Starch, J. Diaz, I. Pong, A. Vostner, M. C. Jewell, A. Devred, and D. C. Larbalestier, "Evidence for Filament Fracture During SULTAN Testing of ITER TFEU5 CICC," presented at The 6th International Workshop on Mechanical–Electromagnetic Properties of Composite Superconductors at the Okinawa Convention Center in Okinawa, Japan, December 5th-7th, 2011.
- C. Sanabria, P. J. Lee, W. Starch, J. Diaz, I. Pong, A. Vostner, M. C. Jewell, A. Devred, and D. C. Larbalestier, "Evidence for Filament Fracture During SULTAN Testing of ITER TFEU5 CICC," presented at the Low Temperature High Field Superconducting Workshop at the Biltmore Hotel in Providence, RI, November 7th-9th 2011.
- C. Sanabria and P. J. Lee, "Metallography on TARSIS tested ITER Strands", presented at the ITER Conductor Design Reconciliation Workshop of 2011 at the Aquabella hotel in Aix-en-Province, France, June 2011.

Invited Talks

- C. Sanabria, "Pushing the boundaries of superconducting wires for the future circular collider", given at the Tuft's University Mechanical Engineering Colloquium Series on September 22nd, 2017.
- C. Sanabria, "A new understanding of the heat treatment of Nb_3Sn superconducting wires", a Special Plenary Session given at the 25th International Conference on Magnet Technology, at the RAI – Amsterdam, August 30th, 2017.

- C. Sanabria, "Image Analysis for Large Scale Projects", an invited talk given at the Lawrence Berkley National Laboratory at the University of Berkeley, CA, February 29th, 2015.
- C. Sanabria, "Hot Fusion, Cold Magnets, and a Plan to Save the World", an ITER related talk given at the Thomas University in Thomasville, GA, October 29th 2013.
- C. Sanabria, "The Power of the Sun in a Magnetic Bottle", an ITER related talk given to a group of eight graders from the Charlie A. Gray High School in Moultrie, GA, May 20th 2013.
- C. Sanabria, "A Star is Born", an ITER related talk for a series sponsored by the NHMFL called "Science Café", aimed to familiarize the general population of Tallahassee with current scientific discoveries and projects. May 1st, 2012.

Service

- Peer reviewed dozens of articles submitted to several scientific journals.
- Reviewed over five Small Business Innovation Research (SBIR) proposals submitted to the Department of Energy.
- Technical Editor for the International Conference on Magnet Technology 24, Seoul, Korea.
- Participated actively in the National Magnet Laboratory Open House Day aimed to expose the public to the exciting science happening at the MagLab.
- Writing tutorial documents and videos aimed to train new hires at the Applied Superconductivity Center.
- Volunteer scientist at the Bay Area Scientists in Schools (BASIS) program aimed to inspire schoolchildren to pursue a career in science.

Professional Skills

- **Scientific/engineering**
  - I am a driven, resourceful, and disciplined scientist. Always approaching the problems in an objective and skeptic manner—without falling into prejudice or careless thinking.
  - I am a team player. I thrive in multidisciplinary environments, and have an ease to communicate issues, ideas, and solutions effectively.
  - I can teach myself techniques rapidly and have an outstanding adaptability to changes.
- **Image Analysis**
  - Prolific at using Photoshop, Illustrator, FIJI, ImageJ, and other image analysis software.
  - Developing several image analysis automated macros for complex image analysis.
- **Metallography and microscopy**
  - Capable of performing complex metallographic preparations.
  - Scanning Electron Microscopy (SEM).
  - Energy-dispersive X-ray spectroscopy (EDS).
  - Focused ion beam milling (FIB).
  - Transmission Electron Microscopy (TEM).
- **CAD and 3D design**
  - Inventor.
  - Pro-E.
  - Solid Edge.

- **Video editing and animation**
  - Blender (3D computer graphics software and video editing).
- **Miscellaneous Software**
  - Outstanding MS Office skills and an ability to teach myself any software.

Personal Skills

- **Communication**
  - Good ability to communicate ideas across language and cultural barriers.
  - Excellent writing skills.
  - Creative, clear, and articulate public speaker.

Professional associations

- **IEEE Membership to the following**
  - IEEE Magnetics Society Membership