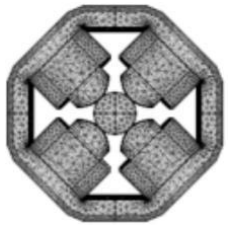


LABORATORIO DE SUPERCONDUCTIVIDAD APLICADA

UNIVERSIDAD DE GUANAJUATO

EIC Workshop – Promoting Collaboration on the Electron-Ion Collider

Superconducting magnet design in Mexico, challenges and opportunities

Daniel Chavez

Mauro Napsuciale, Giovanni García-Valdivia, Yemby Huamani-Tapia, Arnold Mullisaca and Marco Ortiz

Universidad de Guanajuato, León, Guanajuato, 37150, México.

Outline

- Group introduction.
- Previous efforts towards the development of 3 and 6 T super-ferric magnets for the JLEIC.
- Present projects at the Applied Superconductivity lab of Universidad de Guanajuato, and collaborations with Texas A&M University and Accelerator Technology Corp.
- Challenges and opportunities.

 email: dchavezmagnetlab@gmail.com

Group introduction

 email: dchavezmagnetlab@gmail.com

APPLIED SUPERCONDUCTIVITY LAB

August 2019

Dr. Daniel Chávez

Dr. Mauro Napsuciale

Collaborators

Dr. Gustavo Basurto
Neuroscientist

Dr. Alejandro Puga
Dynamical Systems

Yemby Y. Huamani
PhD. Student

Arnold F. Mullisaca
PhD. Student

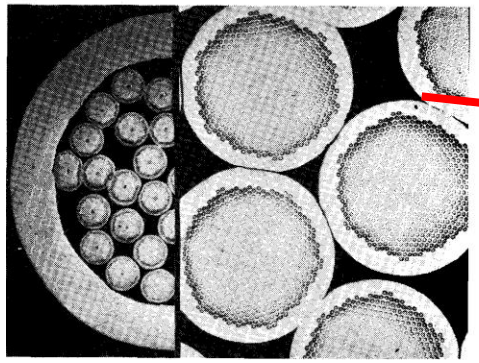
Marco A. Ortiz
PhD. Student

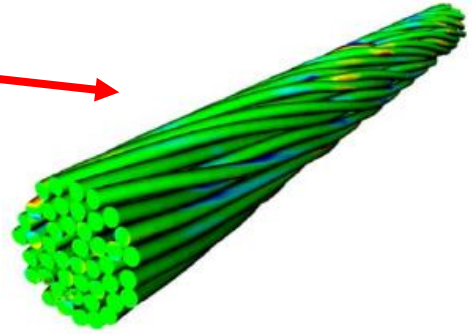
Giovanni D. Valdivia
PhD. Student

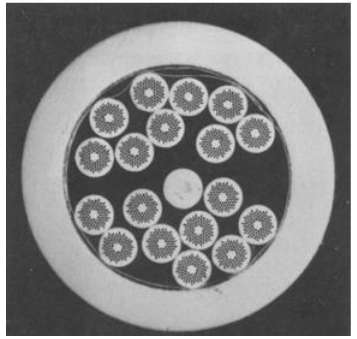
Previous efforts towards the development of a 3 and 6 T super-ferric magnets for the JLEIC, using Cable-in-conduit technology

 email: dchavezmagnetlab@gmail.com

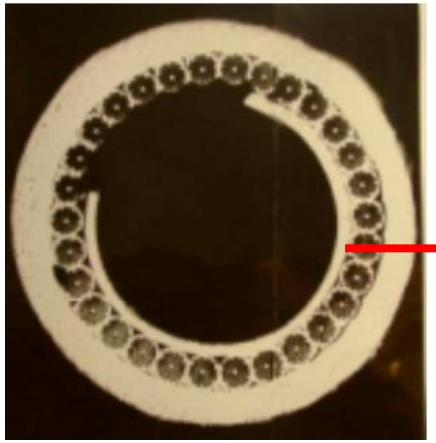
Cable-In-Conduits development UG-TAMU







Some of the problems of previous designs



Current degradation

Restrictions on the bend radius and winding capabilities

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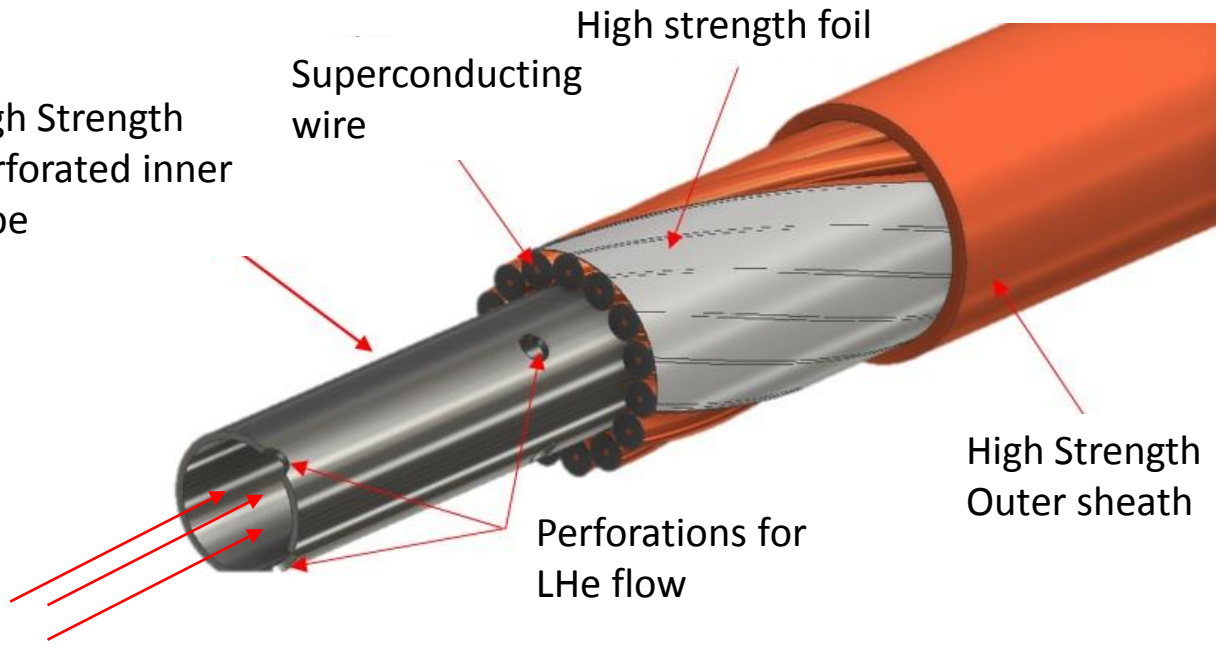
Cable-In-Conduit Technology

2013-2018

Components



Features

Is its own cryogenic-vessel

↓

Superconductor is bathe in LHe, adding thermal stability

↓

Rigid structure

↓

Full azimuthal contact between wires. (Current sharing)

↓

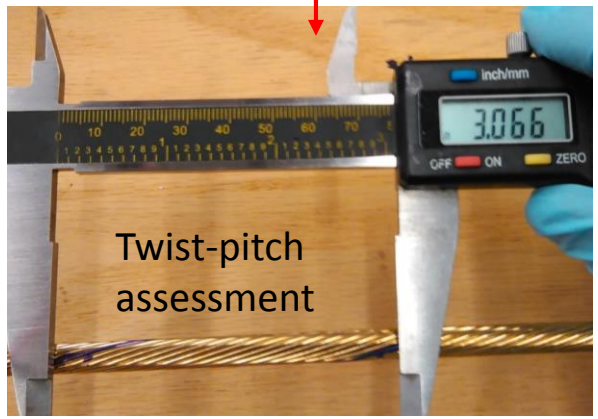
Allows for precise and complex bends, in relatively small bend radius (25 mm)

This technology is readily expandable to wind & react superconductors

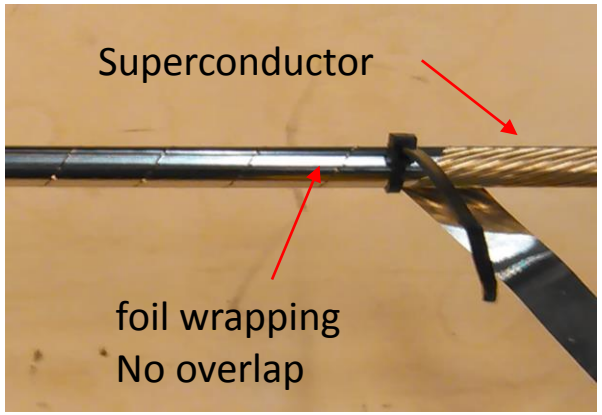
 email: dchavezmagnetlab@gmail.com

How is made?

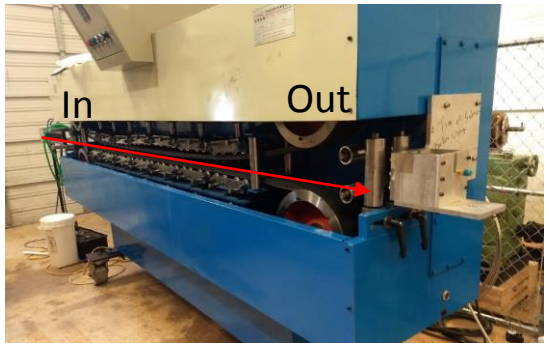
Cabling



High strength foil



Drawing



Core insertion into a
High strength inner tube

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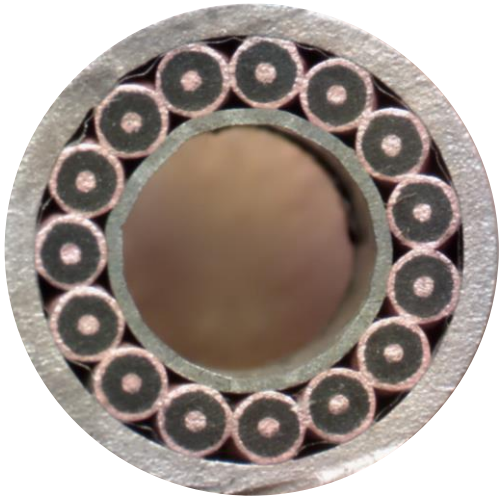
Quality Control

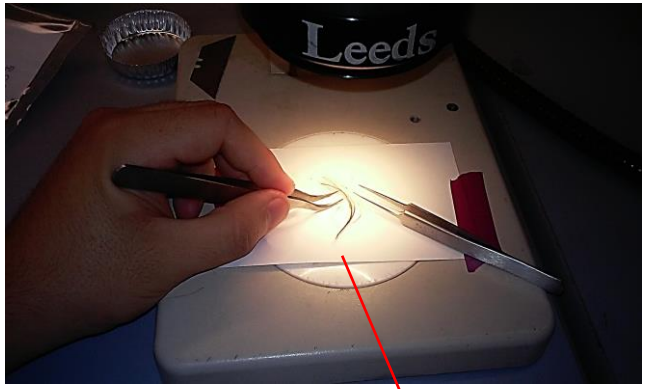
Superficial inspection

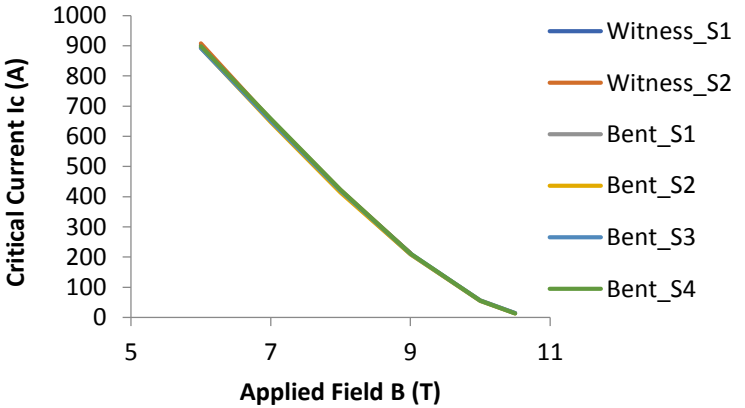
Filament Breakage
$FeCl_3$ solution

Current Degradation
Measurement

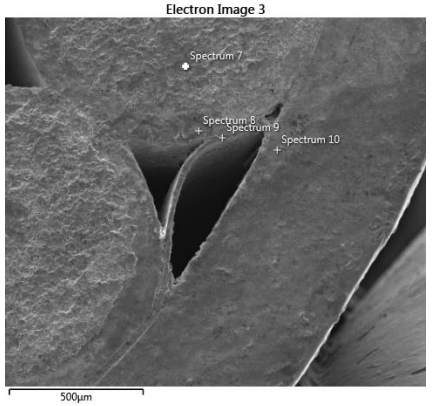
14 kA CABLE
7600 filaments

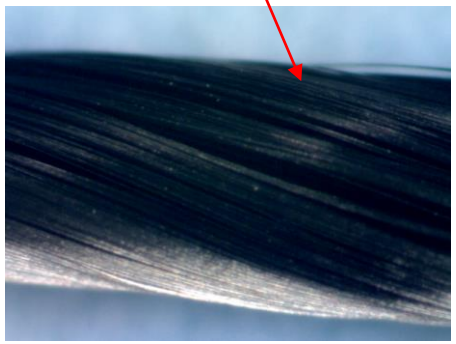




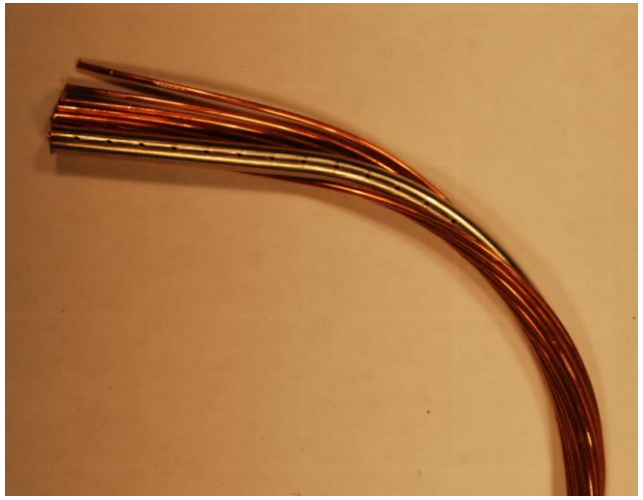


- Compaction
- Spacing
- Ovalness
- Deformations





7400 Fil, 9 µm
1.5 Cu:Sc
1.2 mm OD

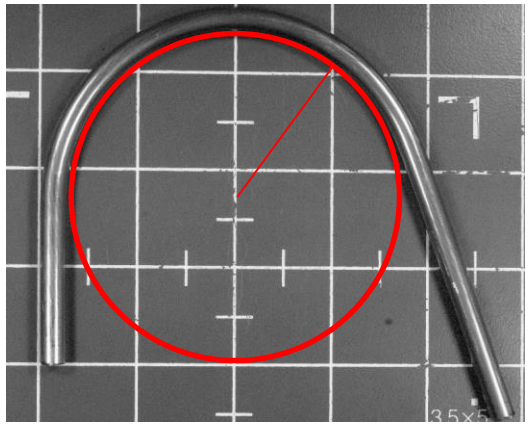


Short sample development

- No damage to the CIC components
  - Wire integrity
  - Outer sheath
  - Inner tube
- Mechanical behavior (Bends)
- QC of samples (Etching, Current degradation)

Wind & React superconductors

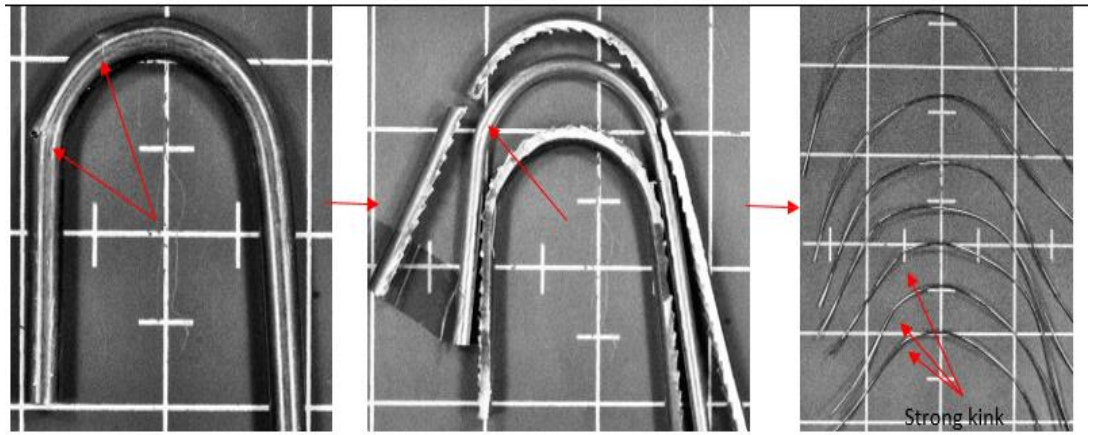
1.745” (44.45 mm) bend radius (Nb_3Sn, MgB_2)



No superficial deformation were found at any level: outer tube, superconducting wire, Or inner tube.

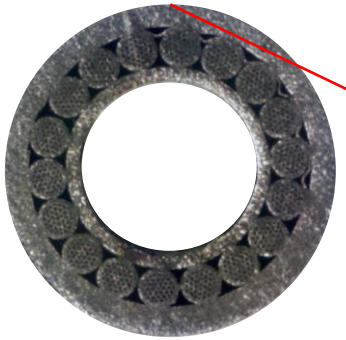
1” (25.4 mm) Bend radius

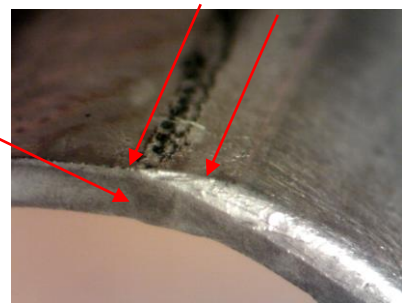
(Superconductor experienced too much strain!)



- **Outer tube tared at various locations**
- **Superconducting wires tare or bottle-necked**

Standard Procedure (quality control) to assess performance of weld line





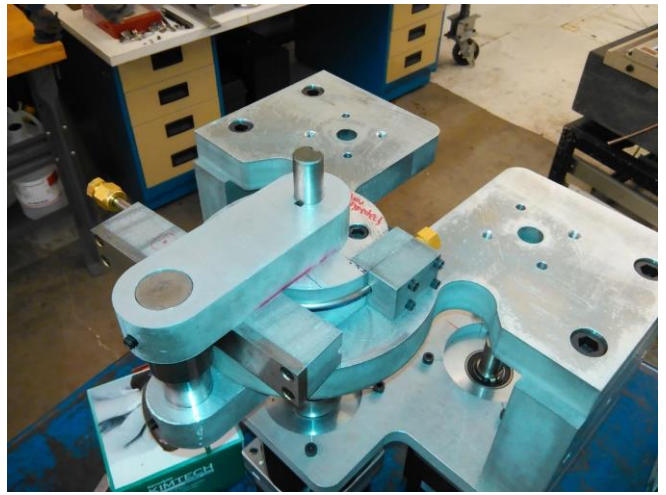
Weld line on
Nb3Sn CIC

HLC
As
received

Pressurize at
600 Psi
for 10 min

Thermal shock
from
300 k to 77 k

Bend the samples 180° with weld line facing different directions



<1.0x10-12 atm*cc/s
3x10-3 Torr

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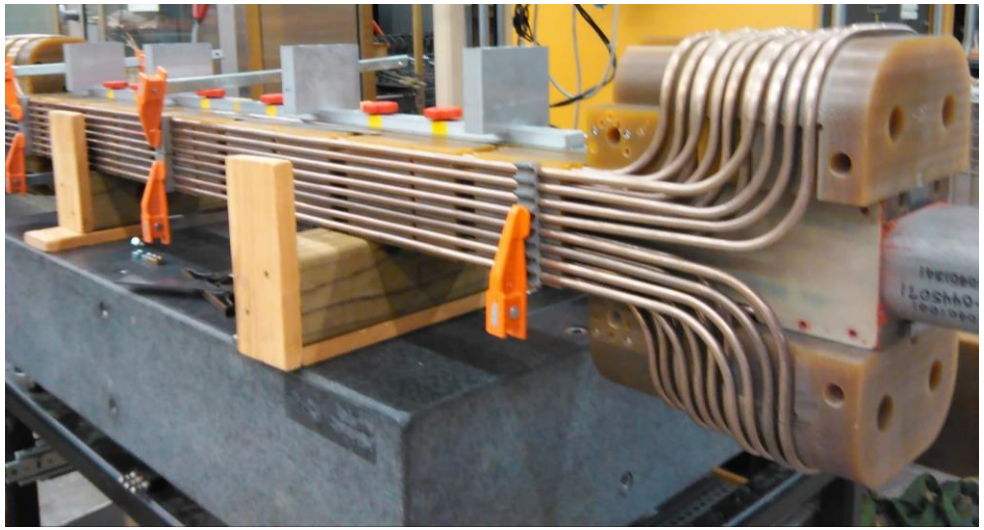
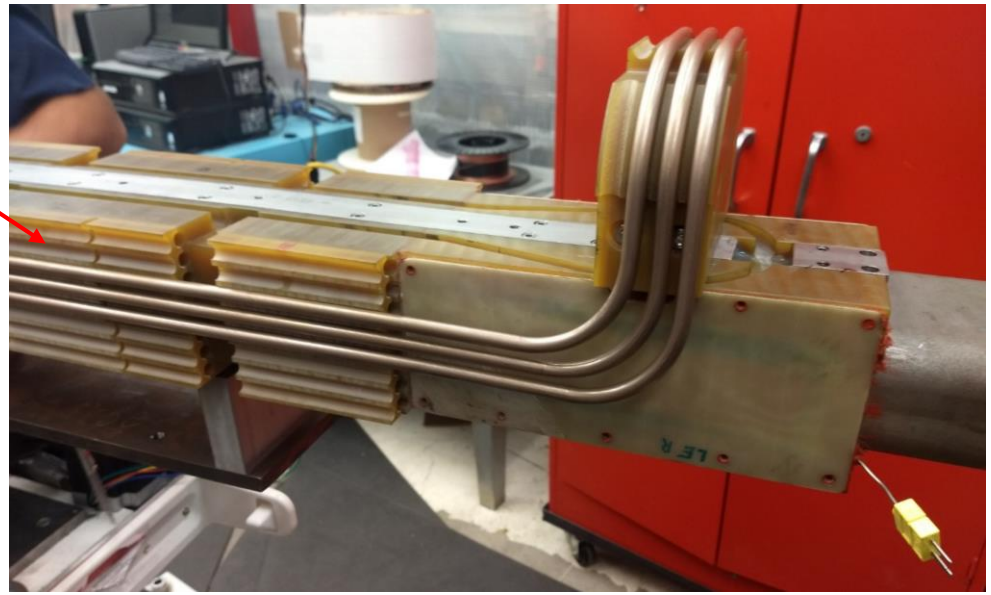
Complex Winding

140 m of NbTi Seamless CIC

3T Superferric CIC dipole
for the Ion Ring of the JLEIC





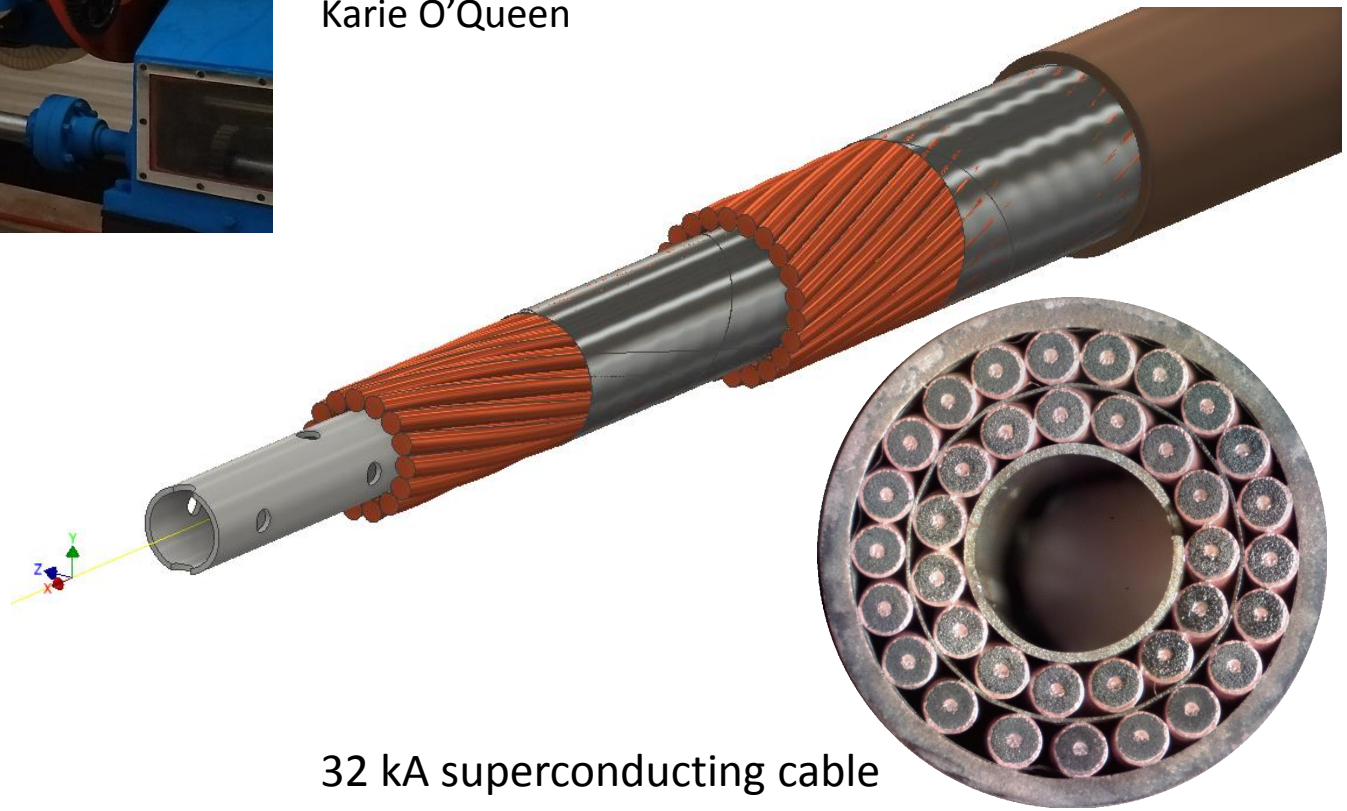
 email: dchavezmagnetlab@gmail.com

Texas A&M / ATC Team

Magnet Lab Team

Dr. Peter McIntyre
Dr. Akhdiyor Sattarov
Tim Elliot
Ray Blackburn
Joshua N. Kellams
James Gerity
Jeffrey Breitschopf
Karie O'Queen

We devoted 5 Years of our live towards the development of a scale prototye for a 3 T superferric dipole



32 kA superconducting cable

 email: dchavezmagnetlab@gmail.com

Present projects at the Applied Superconductivity lab of Universidad de Guanajuato, and collaborations with Texas A&M University and Accelerator Technology Corp.

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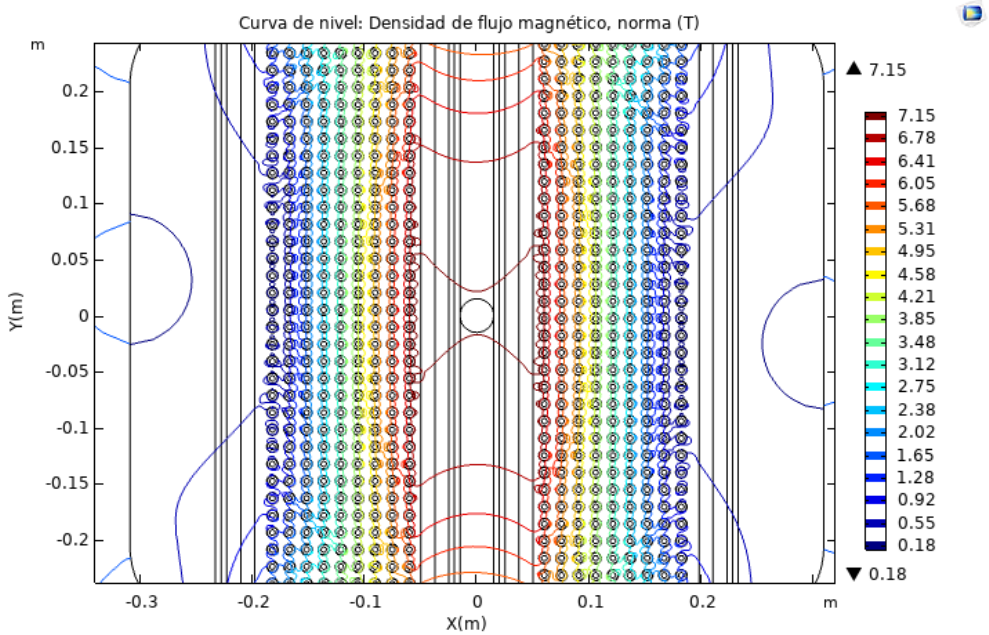
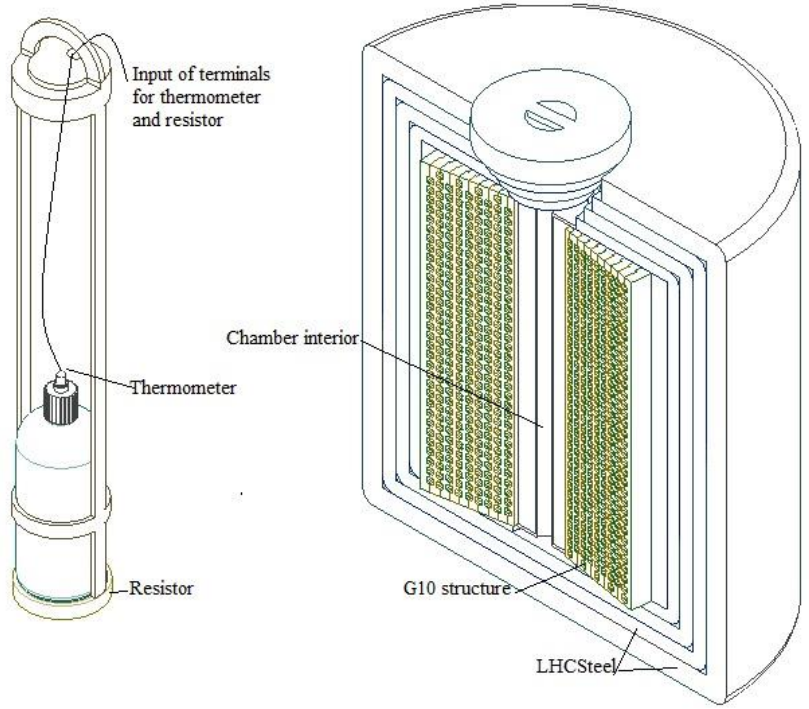
Research topics

- 7 T solenoid for material science applications
- Superconducting Electron Cyclotron Resonance Ion-Source
- 5 T Bi2212 CIC research dipole
- Magnetic stimulation for Alzheimer deseas
- Magentic field for agricultural research (Beans, corn, soy, jalapeño)

7 T solenoid for material science applications (Patent pending)

Yemby Y. Huamani
PhD. Student





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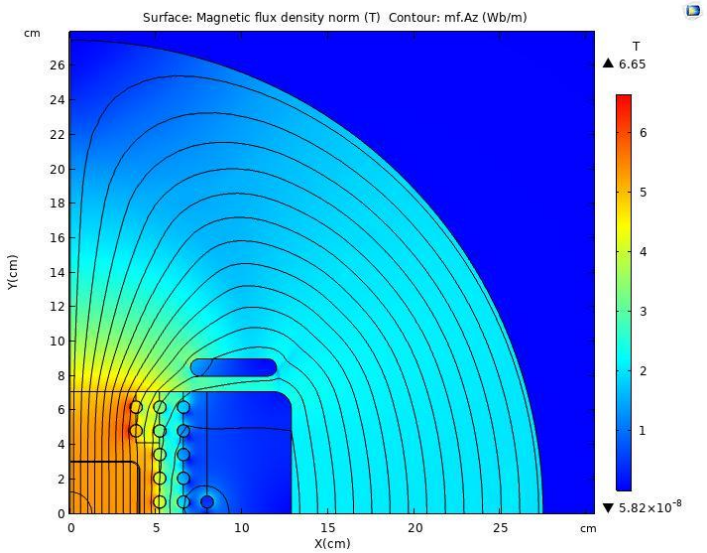
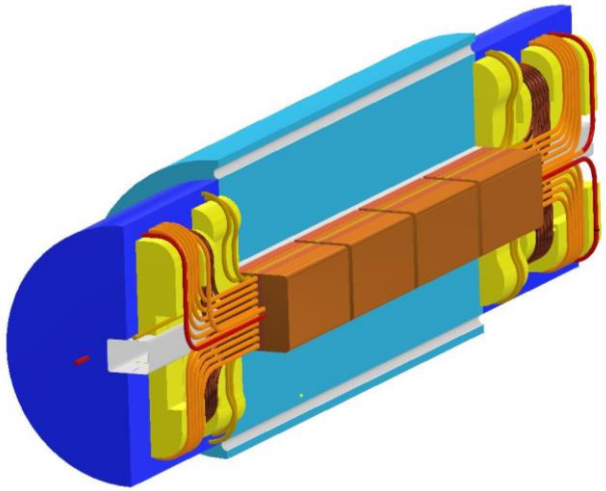
5 T Bi2212 CIC research dipole

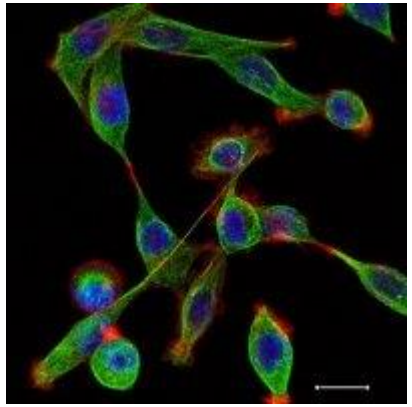
Arnold F. Mullisaca
PhD. Student

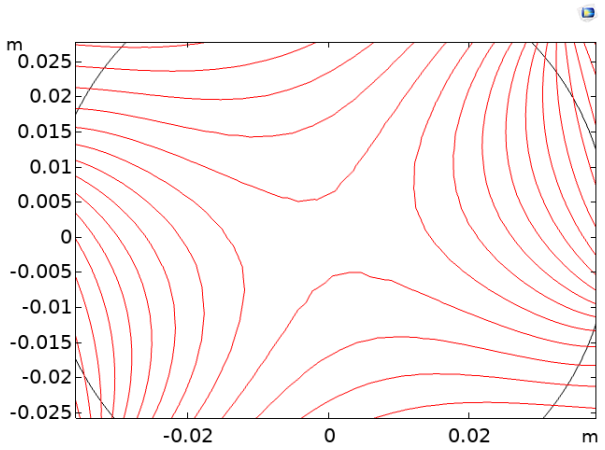


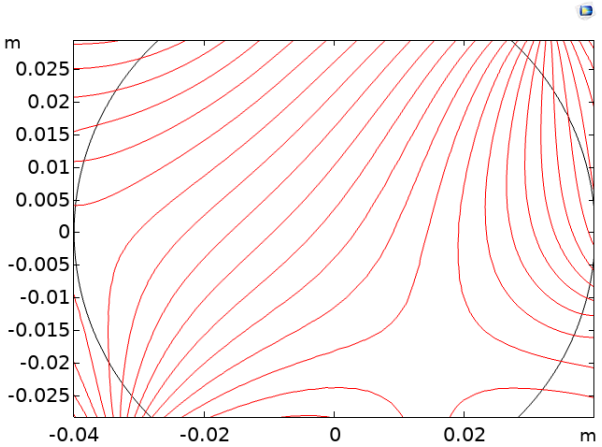


Magnetic stimulation for Alzheimer deseas (Patent pending)

Giovanni D. Valdivia
PhD. Student



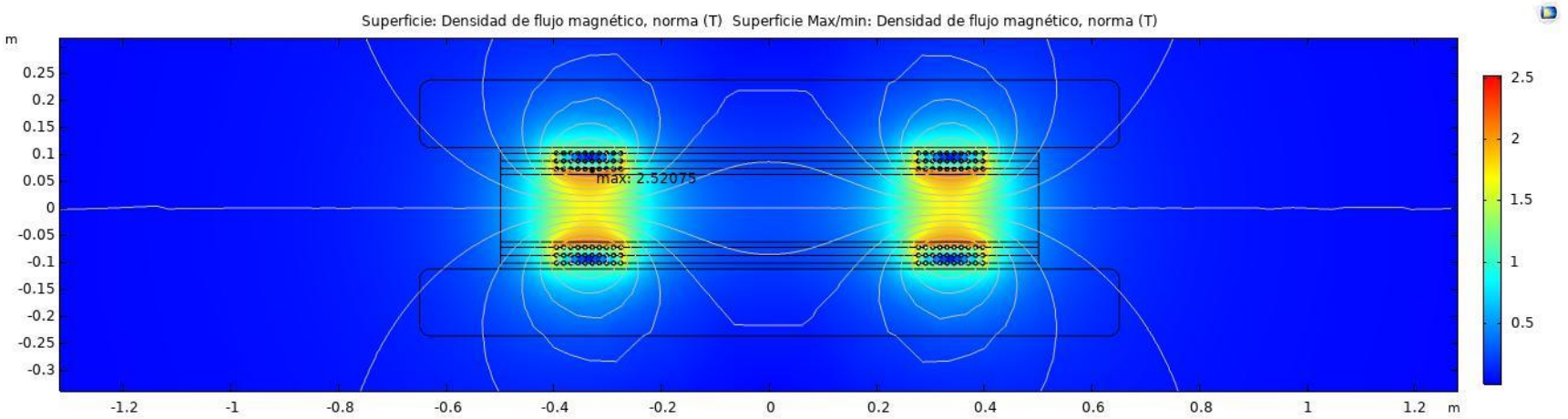




More tan 1.8 million diferent configurations for magnetic fields

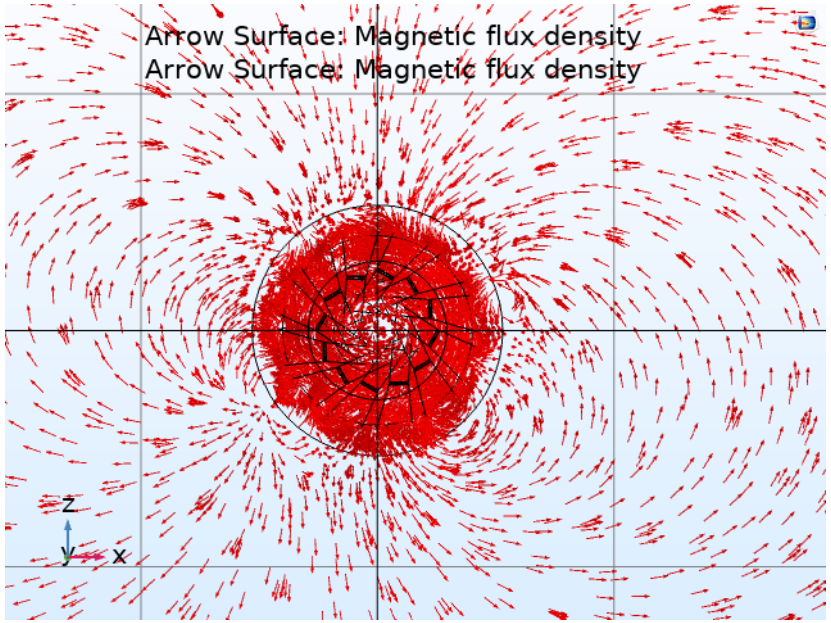
Superconducting Electron Cyclotron Resonance Ion-Source

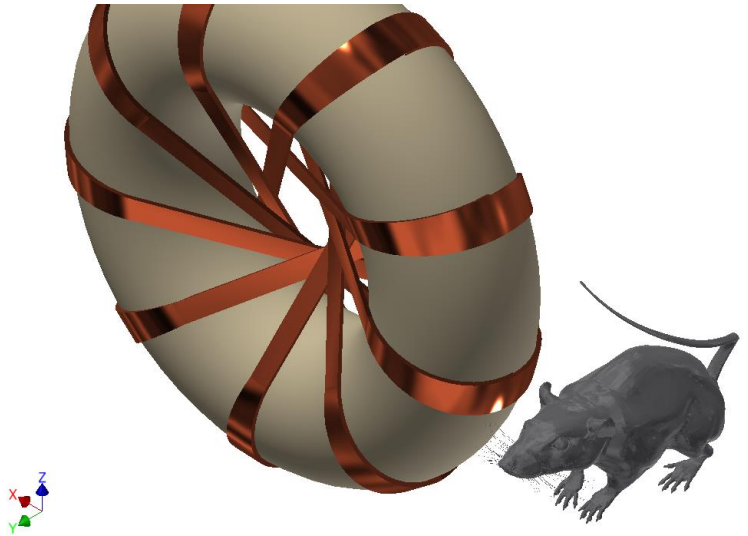
Marco A. Ortiz
PhD. Student



Magnetic stimulation for Alzheimer deseas (Patent pending)

Dr. Gustavo Basurto
Neuroscientist





 email: dchavezmagnetlab@gmail.com

Challenges and opportunities

 email: dchavezmagnetlab@gmail.com

Challenges

- Applied superconductivity is a relatively new area in Mexico, and skepticism is inherited in innovation.
- Specialized equipment.
- Research Funds.

Opportunities

- We are training specialized students in magnet desing and modeling, and production of new technology.
- A lot of human resources eager to learn
- It’s a new a research topic to Mexico.
- Moving towards technology independence.

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Thank you!

 email: dchavezmagnetlab@gmail.com