

Nanocrystalline Soft Magnetics Workshop 2023

Introduction and AMPED Overview

August 17th, 2023

Prof. Paul R. Ohodnicki, Jr.,
Director, Advanced Magnetics for Power and Energy
Development Consortium (AMPED)
RK Mellon Faculty Fellow in Energy
University of Pittsburgh

Prof. Subhashish Bhattacharya, AMPED Director (NCSU)
Prof. Brandon Grainger, AMPED Co-Director (Pitt)



Part I : Welcome and Introduction

Welcome!

Niobium N₃

Nanocrystalline Soft Magnetic materials Workshop

Advanced technologies for efficient power
electronics systems

REGISTER NOW

Attendance is by invitation only

 **16 -17 August**

Energy Innovation Center, Pittsburgh, PA, USA



Topics Include:

- Increase awareness of the latest technical advances in nanocrystalline soft magnetic materials and their applications in electric power conversion technologies.
- Identify key challenges (technical, business, standards, workforce, regulatory, etc.) that currently are preventing broader commercial adoption of nanocrystalline soft magnetics.
- Establish and strengthen collaborations between the participating institutions focused on advancing and adopting nanocrystalline soft magnetics technologies broadly by addressing the challenges identified by the workshop attendees.

Organizers

FREEDM
SYSTEMS CENTER

AMPED ADVANCED
MAGNETICS
FOR POWER & ENERGY
DEVELOPMENT

 UNIVERSITY OF
CAMBRIDGE

CBMM | Niobium N₃

 **ASPIRE**
NSF Engineering Research Center

PITT | **SWANSON**
ENGINEERING

Agenda (Morning)

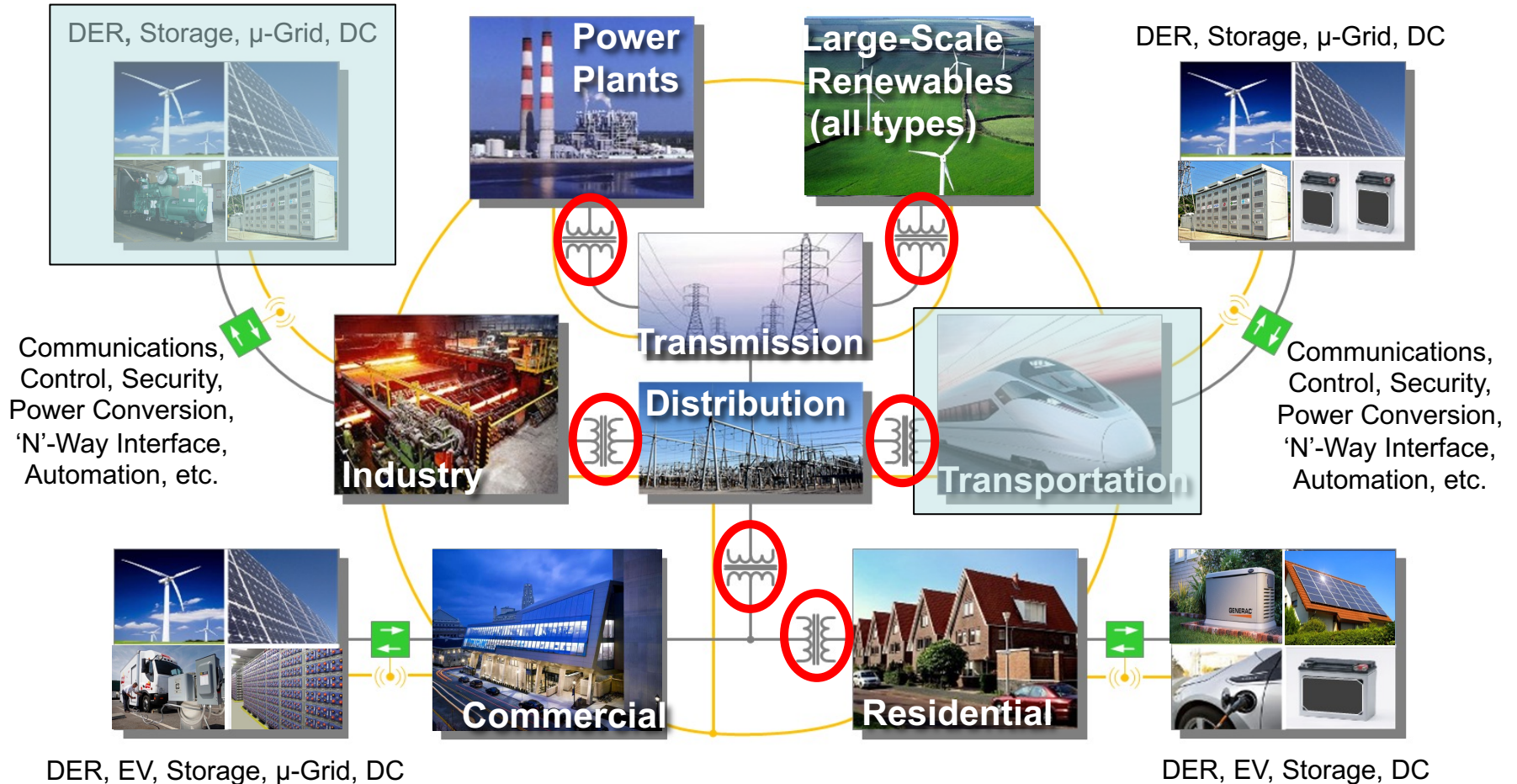
- 8:00 – 9:00 AM : Registration and Networking
- 9:00 – 9:30 AM : Welcome and AMPED Introduction
- 9:15 – 9:45 AM : CBMM Overview on Nanocrystalline
Magnetics (R. Bharadwaj, CBMM)
- 9:45 – 10:15 AM : Keynote (M. Ohta, Proterials)
- 10:15 – 10:30 AM : Break
- 10:45 – 11:45 AM : Nanocrystalline Soft Magnetics
Industrial Perspective - Panel
- 11:45 – 12:45 PM : Lunch

Agenda (Afternoon)

- 12:45 – 1:45 PM : Testing and Measurement Needs
Including Standardization - Panel
- 1:30 – 2:30 PM : Presentations from Meeting Organizers
FREEDM, ASPIRE, Cambridge
- 2:30 – 3:00 PM : Networking and Break
- 3:00 – 4:00 PM : Nanocrystalline Soft Magnetics
Emerging Applications - Panel
- 4:00 – 5:00 PM : Nanocrystalline Soft Magnetics
Industry Next Steps
- 5:00 – 5:30 PM : Closing Remarks
- 5:30 – 6:30 PM : Social Hour and Poster Session

Part II: What is the AMPED Consortium?

Motivation: Electrification in the 21st Century



Challenge: A Need Exists for a Next Generation, Interdisciplinary Workforce and Targeted Research Support of Magnetic Devices (Transformers, Inductors and Electric Vehicle Motors)

Advanced Magnetism for Power and Energy Development (AMPED)

Mission Statement

To develop an innovation ecosystem and educational programs for advancing soft magnetic materials and component technologies spanning fundamental science to end-use application in collaboration with various agencies, offices, and programs.

Example:

Pitt Programs

**Federal Government
(DOE, DOD, NASA)**

**Industry Member
Funding**

**Proposals and
Other Sources**

Engineering
Science
Program

Electric Power
Engineering
Program

Fundamental Research (Materials, Manufacturing, Electromagnetics)
Applied Research (Pilot-Scale Manufacturing / Component Fabrication and Design)
Technology Transition (Student Internships, Industry Sponsored Projects)

Student
Internships and
Coops

**Publications and
Patents for Industry**

**Talent Pipeline
for Industry**

**Sponsor Technical
Research Support**

Overall Vision / Prioritization...

Advanced Magnetism for Power and Energy Development (AMPED)

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To develop an innovation ecosystem and educational programs for advancing soft magnetic materials and component technologies spanning fundamental science to end-use application in collaboration with various agencies, offices, and programs.

Example:

Formalized Participation

Pitt Programs

Federal Government
(DOE, DOD, NASA)

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Proposals and
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Student
Internships and
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Publications and
Patents for Industry

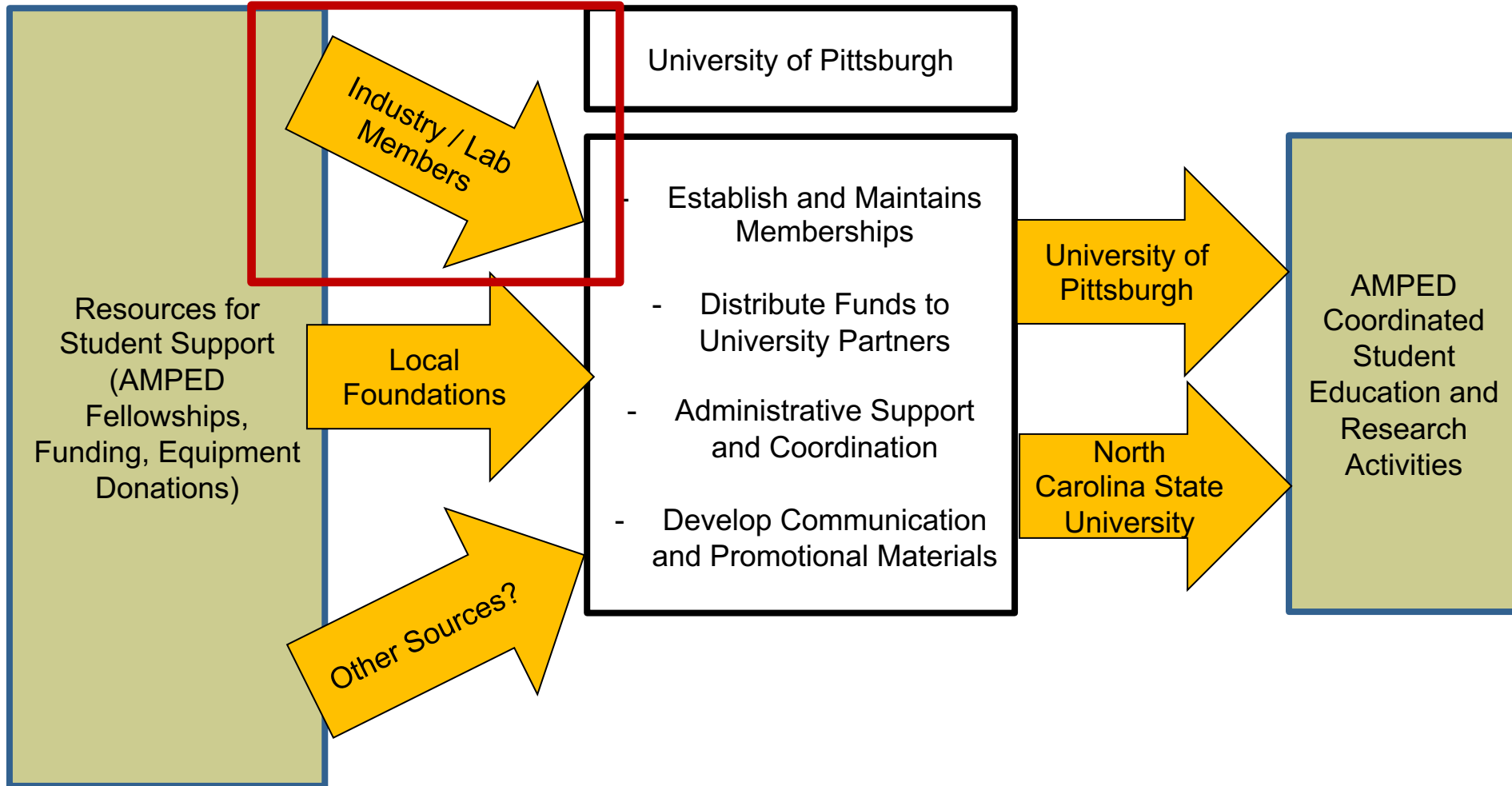
Talent Pipeline
for Industry

Sponsor Technical
Research Support

A Formal Participation Option is Available for Partners

Near-Term Structure and Execution of AMPED

Formalized Participation



Integrated Research Effort with a Single Point of Entry

How Can You Get Involved?

Full Participant - \$10/20k	Consortium Advisor	Charitable Contributors
<ul style="list-style-type: none"> • Participant Agreement Signed along with Participation Fee • Contribution to research road mapping and center initiatives • Project voting rights, helping to direct funds to projects of most interest • Early reports on research results • Attendance at Technical Seminars • Inclusion on AMPED Website as “Founding Participant “ (https://pittamped.github.io/Founding-Participants.html) 	<ul style="list-style-type: none"> • Attendance at Technical Seminars • Input towards research road mapping, but no voting rights • Inclusion on AMPED Website as “Consortium Advisors“ (https://pittamped.github.io/Industry-Advisors.html) 	<ul style="list-style-type: none"> • Tax Benefits • Inclusion in Promotional Materials • Attendance at Technical Seminars • Inclusion on AMPED Website as “Equipment Suppliers“ (https://pittamped.github.io/Equipment-suppliers.html)

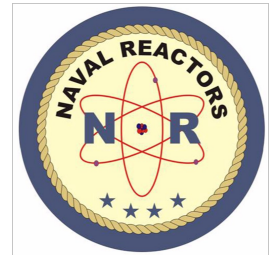
For Information About Joining Contact: amped@pitt.edu

(David Ruvolo, Administrative POC, david.ruvolo@pitt.edu)

Charitable Contributors



Full Participants



L3HARRIS



AMPED Consortium Industry Participants

Core Capability Focus Areas Across Universities Directly Aligned with Industry Needs

Magnetic Materials
and Manufacturing

Component Design
and Optimization

Magnetics Characterization
& Standards
(Including at MV)

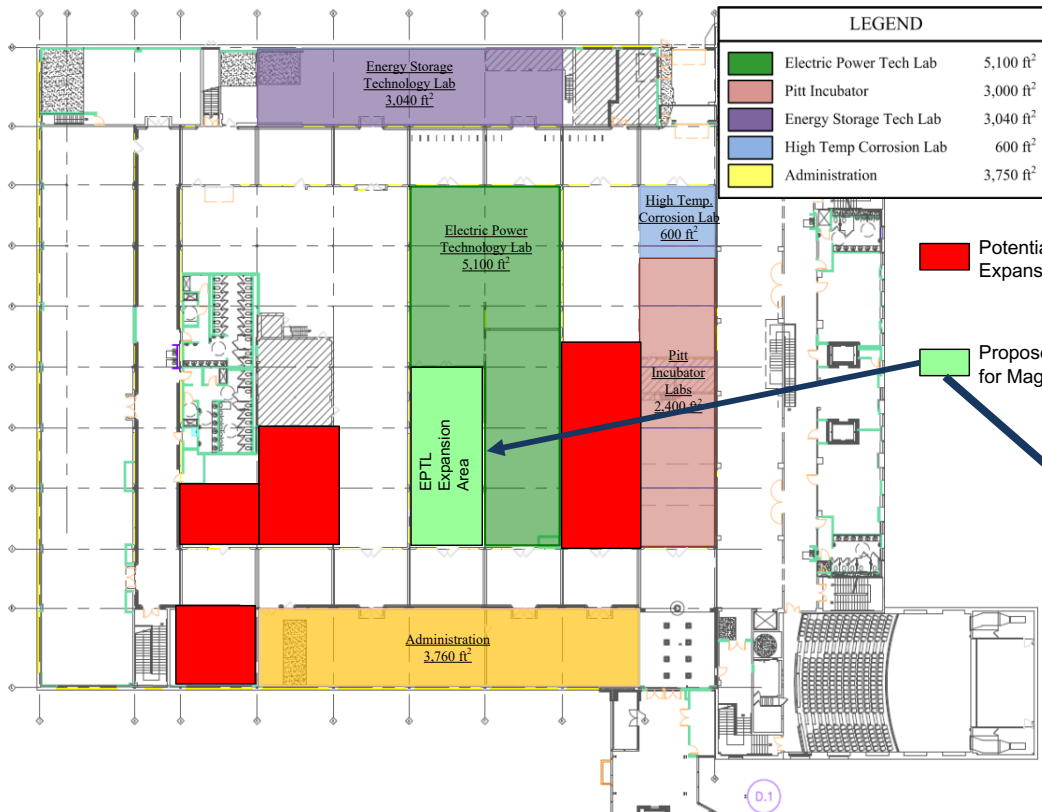
Power Electronics
Converters and Controls

Electric Motors Design
and Controls

Shared R&D Labs for the AMPED Consortium

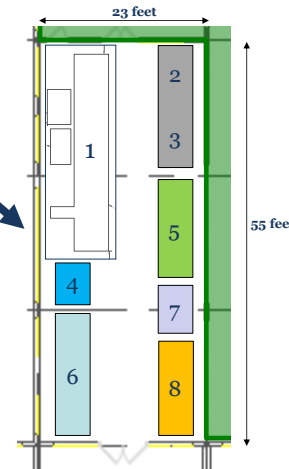
Downtown Pittsburgh Laboratory Facilities

New Magnetics Lab to Support the AMPED Consortium



Potential Near-Term Expansion Areas

Proposed Expansion for Magnetics Lab



Core Prototyping, Manufacturing, and Thermal Processing

Core Loss Testing (LV and MV)

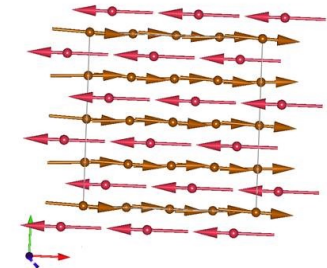
Facilities Established for Education, Research, and Fee for Service

Current Status : Federal R&D Collaborations

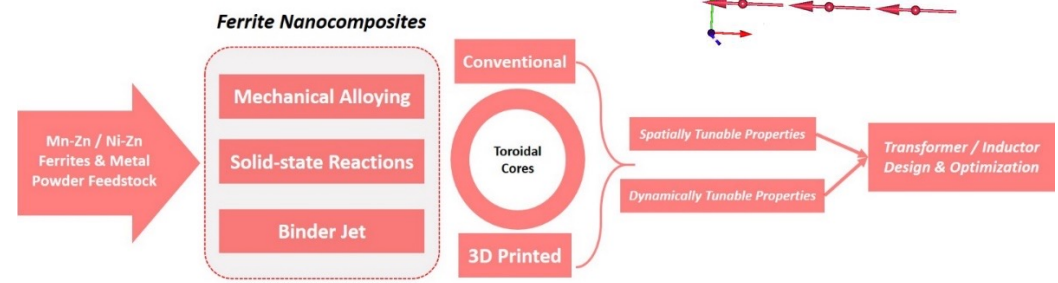
Basic Research : Grant



FASTWATT



- Ravisekhar Raju

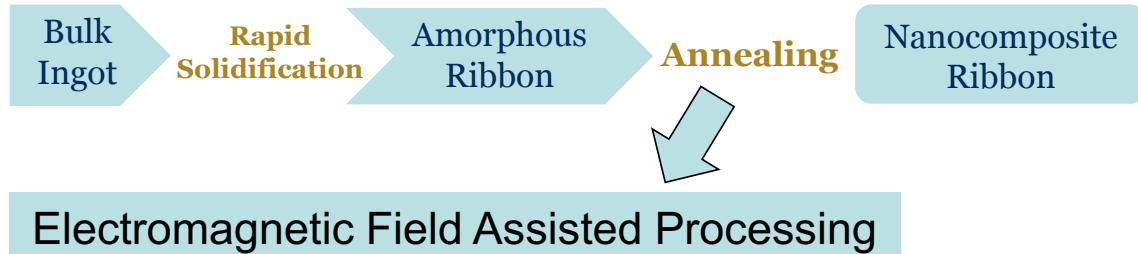
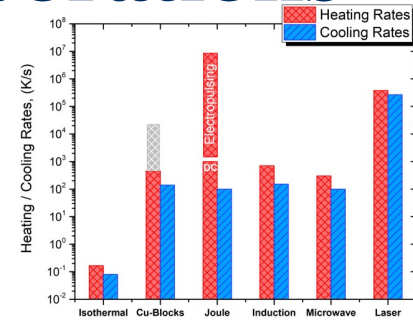


University of Pittsburgh – FastWatt, LLC

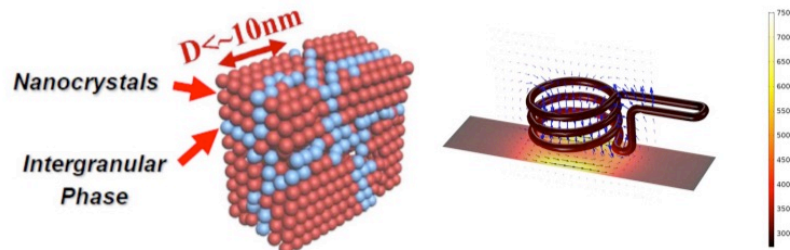
- Exploring New Materials and Manufacturing Techniques for Ferrites
- Inductor and Transformer Design Methods and Applications of Ferrites

Current Status : Federal R&D Collaborations

DOE Laboratory Subcontract



- Jagannath Devkota



Univ. of Pittsburgh – North Carolina State Univ. – NETL

- Developing New Reel-to-Reel Manufacturing Processes of Amorphous Alloys
 - Characterization of Magnetic Cores and Components for Applications

Current Status : Federal R&D Collaborations

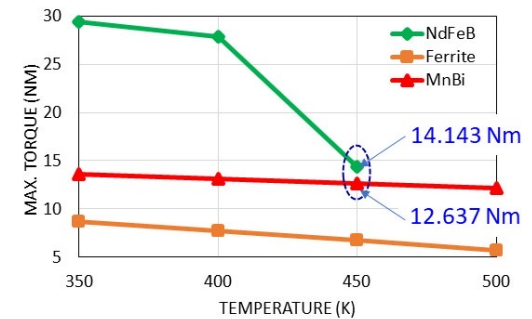
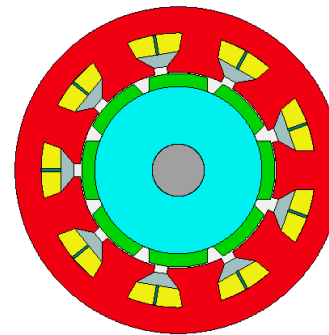
Phase I & II : STTR Program



VEHICLE TECHNOLOGIES OFFICE



- Andrew Sherman
- Nicholas Krywopusk
- Benjamin Pratt



- Jun Cui

Materials	Max. Temp (Real data)	Max. Temp (~vary up to)	Electrical Resistivity (ohm.m)	Br (20 C) (T)	Relative Permeability (ur)	Temp. Coefficient Br (%/C)
NdFeB (N48 AM)	393.15 K (120 C)	500 K (226.85 C)	1.40E-06	1.39	1.04	-0.12
MnBi	373.15 K (100 C)	500 K (226.85 C)	100	0.41	1.08	-0.2
Ferrite (Y32)	453.15 K (180 C)	500 K (226.85 C)	6.85E-06	0.5928	1.057	-0.06965

Powdermet – Ames Laboratory – University of Pittsburgh

- Seeking Commercialization of Ames Lab Developed REE Permanent Magnets
- University of Pittsburgh / AMPED Role : Design of REE-Free PM Motors

Current Status : Federal R&D Collaborations

Basic Research : Grant

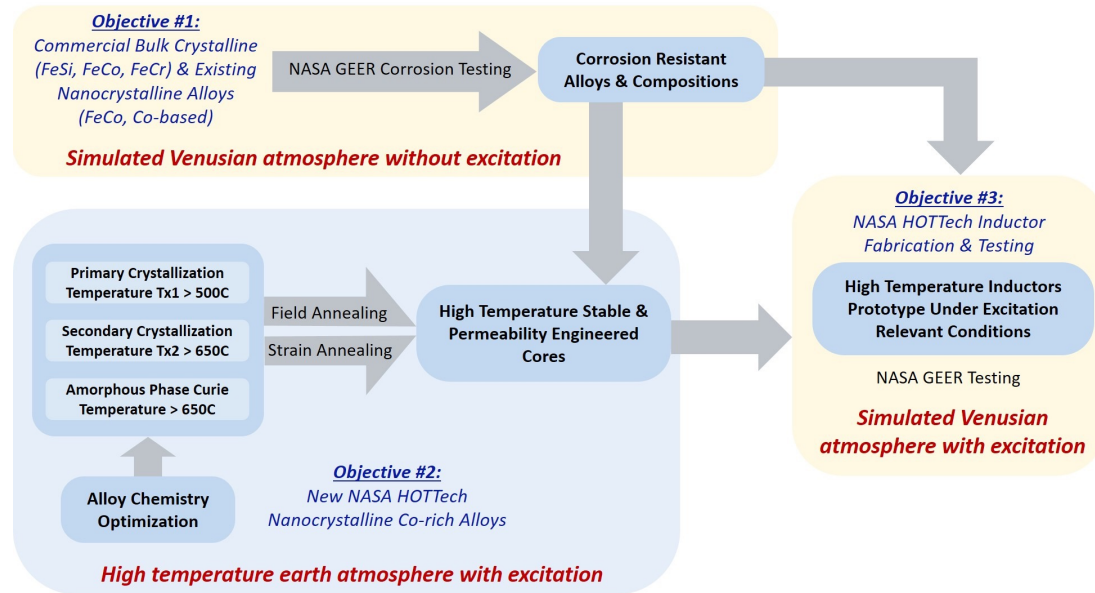


- Alex Leary
- Lei Xing
- Ronald Noebe



- Kevin Byerly
- Sam Kernion

NASA HOTTech Program



NASA – Raytheon – CorePower – Univ. of Pittsburgh

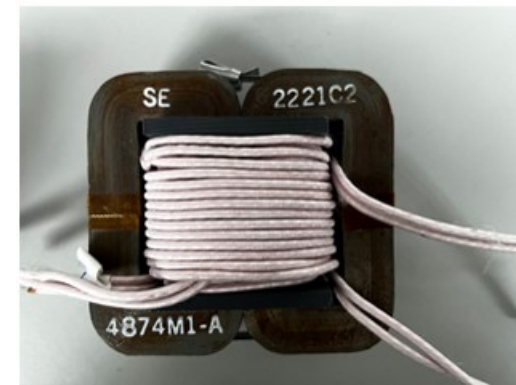
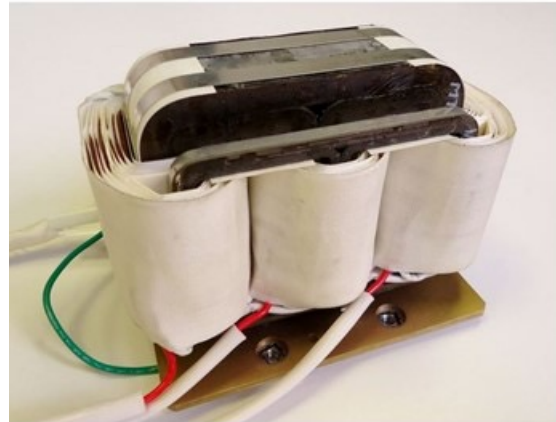
- Extreme Temperature and Extreme Environment Soft Magnetics
- Target Demonstrating Inductor Material and Technology at T=500C

Current Status : Federal Design Collaborations

Magnetic Component Design



- Sean Dowhy



University of Pittsburgh – BPMI

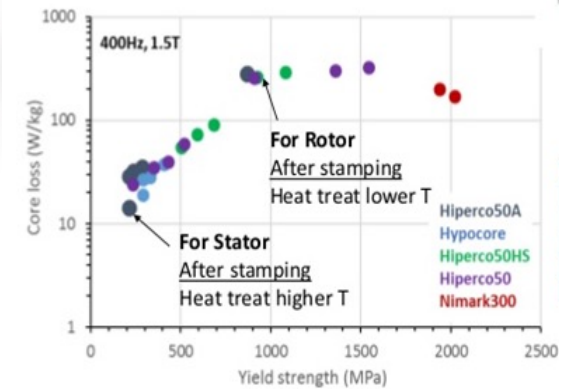
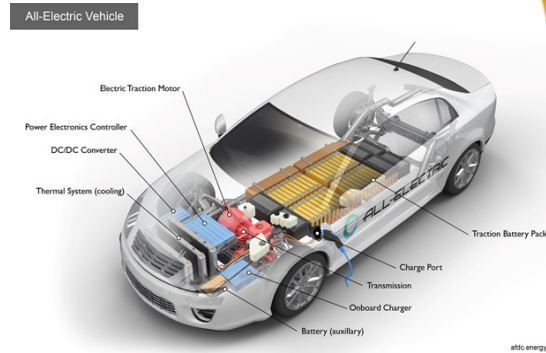
- Advanced Magnetic Component Designs for Naval Applications
- Benchmarking of Existing Technologies and Engaging with Various Vendors

Current Status : State R&D Collaborations

Technology Transfer Program



- Natan Aronhime



University of Pittsburgh – Carnegie Mellon - Carpenter

- Exploring New Processing Methods and Techniques for Hiperco Laminations
 - Intellectual Property Filed at University of Pittsburgh Being Explored

Current Status : Foundation Donations

AMPED Program Support



AMPED



**Workforce Development and Seed
Funding for National Growth**



University of Pittsburgh – Hillman Foundation

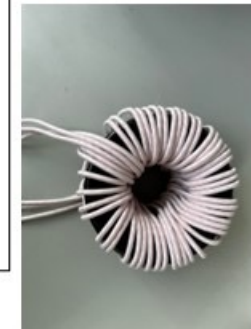
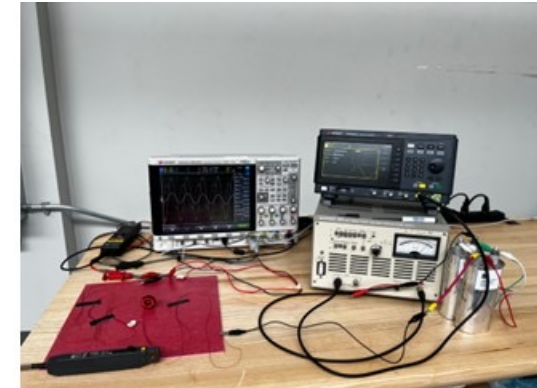
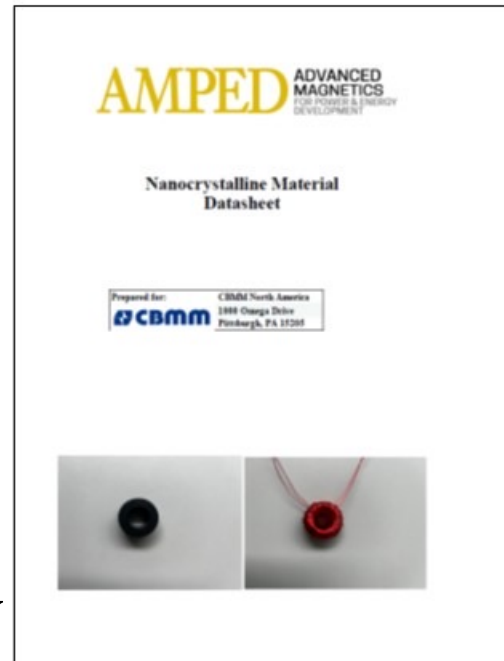
- New Materials and Manufacturing Research of Ferrites and Nanocomposites
- Power Electronics and Motor Technology Design, Development and Testing

Current Status : Industrial Collaborations

Data Sheet Development



- Bharadwaj Reddy Andapally
- Mariana Perez de Olivera



University of Pittsburgh – CBMM

- Standardized Testing of Materials and Electromagnetic Components
- Benchmarking of Nanocrystalline Soft Magnetic Cores vs. Industry Standard

Consider Becoming a Part of Our Community!

AMPED ADVANCED
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FOR POWER & ENERGY
DEVELOPMENT



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Pittsburgh

NC STATE
UNIVERSITY

Email : AMPED@pitt.edu

<http://engineering.pitt.edu/AMPED>



Our Priority is Focused on Workforce Development, Collaborate with Us to Support Your Needs in Talent Development!