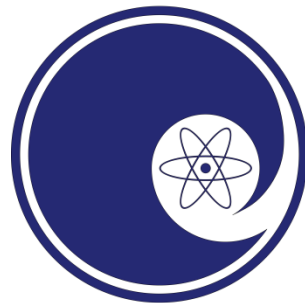


Commercial Superconducting Linacs

Jerry Hollister
Chief Operating Officer

July 24, 2011



NIOWAVE

www.niowaveinc.com



Outline

- Company Details & Leadership
- Superconducting Electron Linacs
- Primary Customers and Uses of Superconducting Particle Accelerators
- Products for Superconducting Particle Accelerators
- Industrial Growth Potential
- Summary



- Privately Owned
- 45,000 square feet
 - Engineering & design
 - Machine shop
 - Fabrication & welding
 - Chemistry facility
 - Class 100 Cleanroom
 - Cryogenic test lab
 - Accelerator test facility



Lansing, Michigan Headquarters



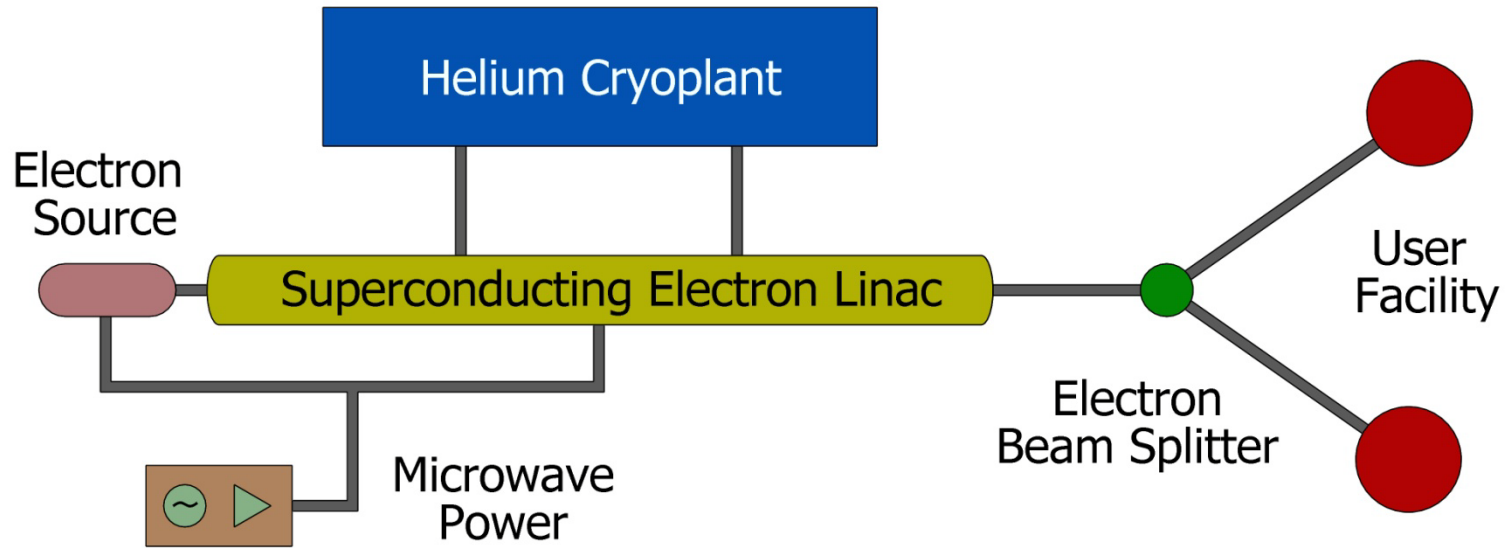
Dr. Terry Grimm President & Senior Scientist

- PhD from Massachusetts Institute of Technology
- 20 Years experience in Department of Energy
 - Superconducting Super-Collider
 - National Superconducting Cyclotron Laboratory at MSU
 - Numerous contracts with DOE at Niowave



Jerry Hollister Chief Operating Officer

- Bachelors in Engineering from University of Michigan
- Active duty Naval Officer for 6 years
- Warranted Contracting Officer for US Navy
- Current Trustee at Lansing Community College



Turn-key Systems

- Superconducting Linac
- Helium Cryoplant
- Microwave Power
- Target / User Facility
- Licensing

| | |
|-----------------------|--------------|
| Electron Beam Energy | 0.5 – 50 MeV |
| Electron Beam Power | 1 W – 1 MW |
| Electron Bunch Length | ~50 ps |



Primary Customers and Uses of Superconducting Particle Accelerators

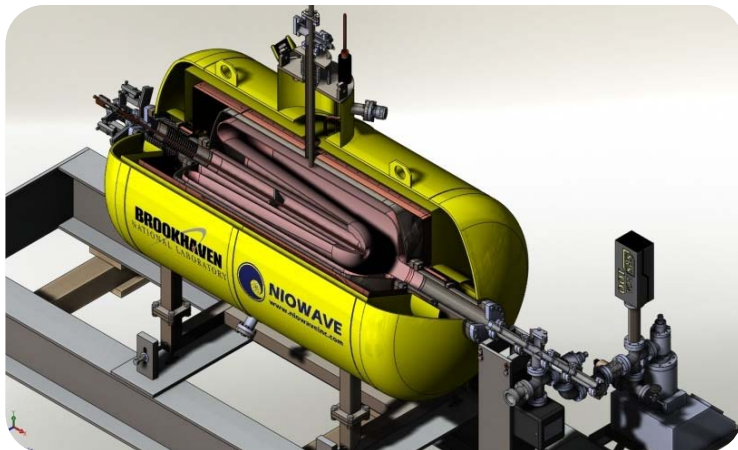
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- Large accelerators
 - Current DOE projects: Brookhaven, Fermi, Jefferson Lab, Large Hadron Collider
 - Future: FRIB, eRHIC, Project-X, ILC & many more
- X-ray sources
 - Defense, Medical and Industrial
- Free electron lasers
 - Defense, Medical and Industrial
- Radioisotope production
 - Medical and Industrial

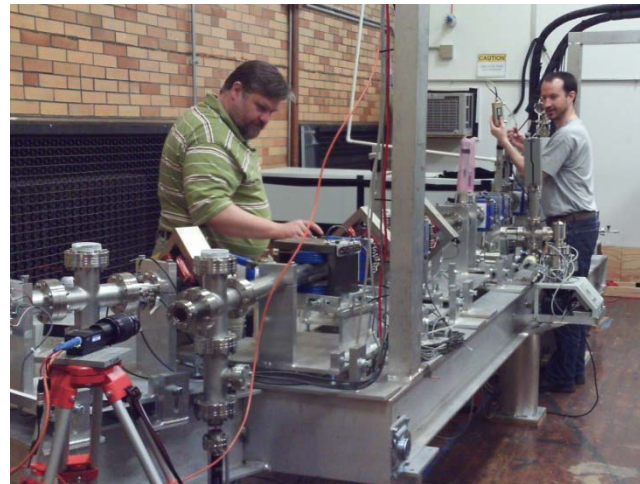


Niowave Products for Superconducting Particle Accelerators

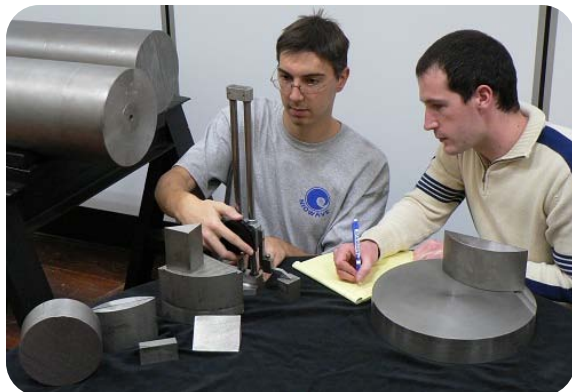
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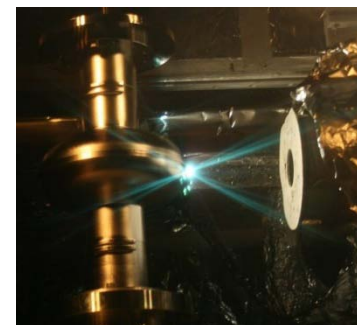
- Electron Guns & Injectors



- Cryomodules & Turn-key Accelerators



- Niobium (In Stock)



- Niobium Superconducting Cavities



Superconducting Cavities

Niowave produces superconducting cavities at a broad range of frequencies and geometries, and will customize to meet specific applications.

- Elliptical cavities
- Quarter-wave cavities
- Deflecting structures
- Single and Multi-spoke cavities



Single spoke cavity



80.5 MHz
Quarter-Wave
resonator

Cavity frequencies

28 MHz to 9.5 GHz



1.3 GHz 9-cell cavities for ILC



Entry Level Niobium Superconducting Cavities

NIOWAVE
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Niobium Superconducting Cavities 1.3 GHz 9-Cell ILC/TESLA

Niobium
in stock
for quick
delivery!



\$49,999*

***Entry level niobium cavity delivered in
3 months (other options available).**

**Let us help you customize the exact
niobium structure you need from
28 MHz to 3.9 GHz and beyond.**



NIOWAVE
Accelerating Your Particles

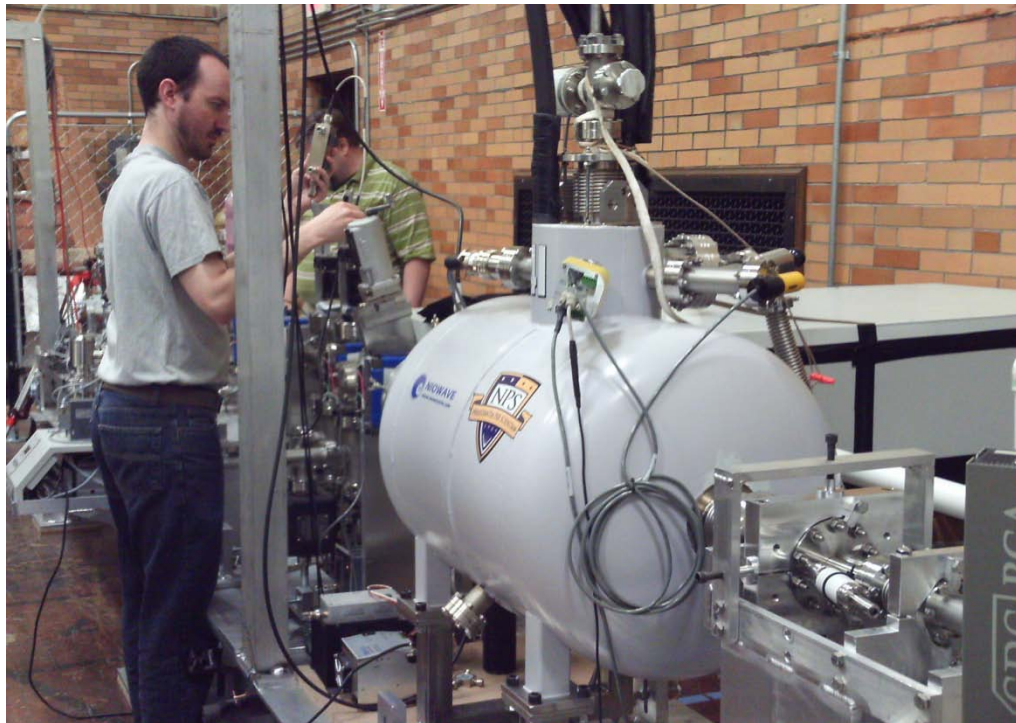
www.niowaveinc.com
sales@niowaveinc.com
517.999.3475

Contact us to discuss your needs



- **NPS-Niowave 500 MHz SRF Injector**

- First superconducting linac designed, fabricated and tested entirely within industry
- First delivery of an SRF beam source to a US Navy facility
- First cool-down and characterization of an SRF beam source at a US Navy facility
- First industrial delivery and acceptance of an SRF beam source in the US



Published Results:
Harris, et al,
“Design and operation of a
superconducting quarter-
wave electron gun,”
Phys Rev STAB 14 (2011)



Helium Cryogenics

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Niowave offers several options, depending on the required cooling load and planned operating schedule.

- Batch filling
 - Use liquid helium Dewars
 - Standard sizes: 100, 250 and 500L
- 5W Cryocooler at 4.4K
 - Smaller systems or low duty cycle
 - Integrated into linac
- 100W Refrigerator/Cryoplant at 4.4K
 - Larger systems or high duty cycle / CW operations
 - 24 hrs / 7 day operations



Batch filling with a 250L helium Dewar



100 W Cryoplant



RF / Microwave Sources

NIOWAVE
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Niowave offers a broad range of options, depending on the frequency, power and electrical efficiency requirements.

- Solid State Amplifiers
 - Low power : ~ 1 kW
 - High reliability
- Tetrodes
 - Intermediate power: ~10 kW
- Inductive Output Tubes (IOTs)
 - Medium power: ~100 kW
- Klystrons
 - High power: ~1000 kW (1 MW)



10 kW Tetrode



90 kW IOT



- Niobium Supplier

- Large and fine grain niobium in a variety of RRR values.

- Sheets from 1mm to 35mm
 - Ingots and rods
 - Niobium-Titanium also in stock



- Residual Resistivity Ratio (RRR) measurements

- Only company in the world that offers service
 - Qualified materials for: Cabot, HC Starck, ATI Wah Chang, Heraeus, Plansee and CBMM (Brazil)



- **Commercial Superconducting Linac Opportunities**
 - Numerous applications are now viable to be commercialized
 - X-ray sources & sterilization
 - Isotope production
 - Free Electron Lasers
 - New commercial enterprises are emerging
- **The US Industrial Accelerator Research Hub**
 - Niowave is the US Industrial leader
 - Only company in the world capable of testing superconducting linacs in-house
 - Two of three operational superconducting injectors in the world built by Niowave
 - International 2010 IEEE Award for Research & Entrepreneurship in Superconductivity
 - Department of Energy 2010 Small Business of the Year
 - MSU/NSCL is a national laboratory with a world-wide reputation



Michigan's Competitive Advantage

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- Michigan Intellectual Capability
 - Niowave research
 - MSU Cyclotron Lab (NSCL/FRIB)
 - U of M and MSU partnerships
 - Lansing Community College

MICHIGAN STATE
UNIVERSITY

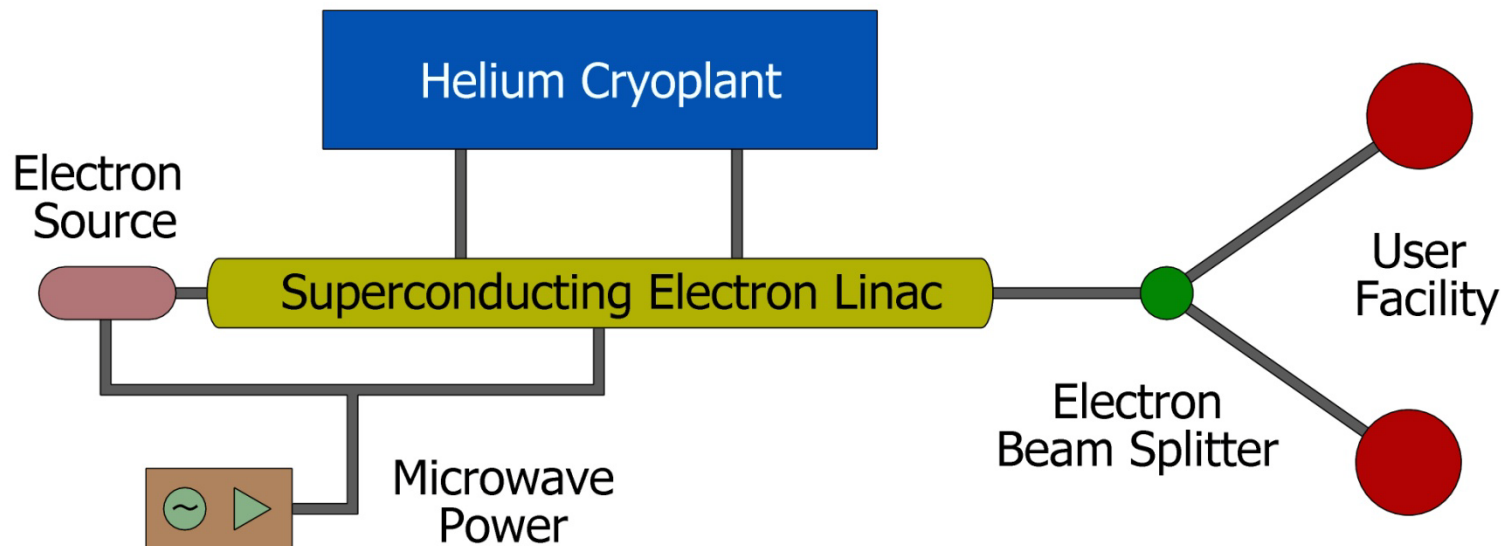


- Michigan Industrial Capability
 - *Niowave is the ONLY company worldwide capable of building and testing superconducting linear accelerators*
 - License from State of Michigan & Nuclear Regulatory Commission
 - Highly skilled and available workforce
 - Manufacturing expertise & capacity
 - Facility & equipment availability
- Autos to Accelerators
 - Making Mid-Michigan the “Silicon Valley” for superconducting accelerators





Summary



Niowave is developing the compact superconducting linacs needed for the emerging applications of our industry

