Device for In-Situ Coating of Long, Small Diameter Tubes
Final Report
Award No. DE-SC0001571

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Outline

- Program goals
- Summary
- Design and results using 2nd generation deposition source
- Coating of RHIC bellows & tubes
- Next steps

Program Goals

- Develop an *in situ* coating method for long, small diameter (2.75” ID) tubes. Goal was accomplished.
- Reduce secondary electron yield (SEY) to suppress electron cloud formation. Goal was accomplished.
- Reduce RF resistivity to reduce ohmic heating. Goal was accomplished.

Approach: Cylindrical Magnetron Sputtering

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Summary

- All project objectives were met and/or surpassed.
- Breakthrough technologies were developed to enable in-situ copper coating of long, small diameter stainless steel tubes with limited number access points, which are about 500 meters apart.
- Coating adhesion met and/or exceeded industrial bonding tests. Two US patents, for newly developed technologies, were applied for.

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Summary

- A magnetron with a 50 cm long copper cathode was designed fabricated (cooling and weight limits the length), and successfully operated to coat an assembly containing a tube of a full-size, stainless steel, cold bore, Relativistic Heavy Ion Collider (RHIC) magnet tubing connected to two types of RHIC bellows.
- To increase cathode lifetime, movable magnet package is used, and thickest possible cathode was made, with a target to substrate distance of less than 1.5 cm.
- The magnetron, mounted on a carriage with spring loaded wheels successfully crossed bellows and adjusted for variations in vacuum tube diameter.

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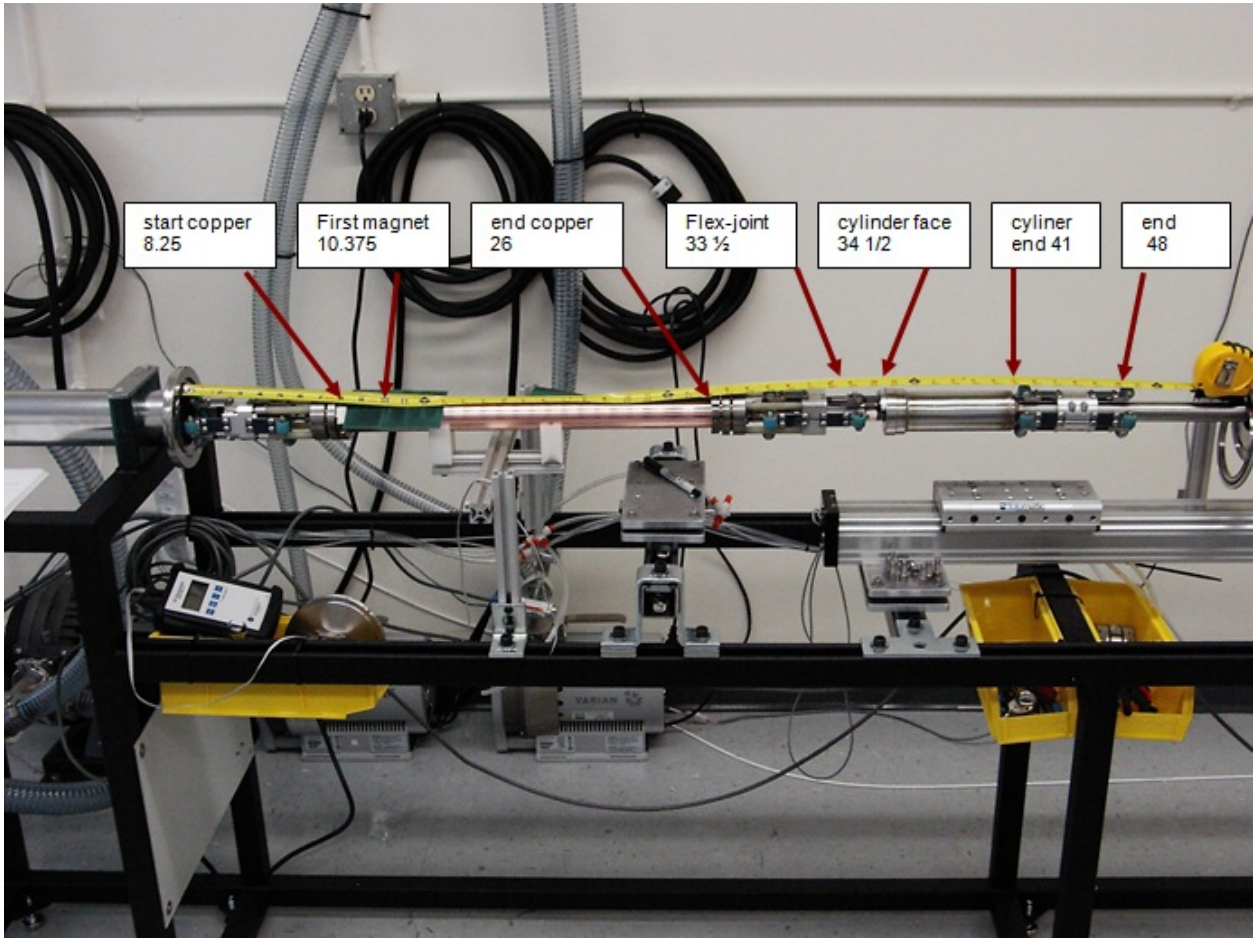
Summary

- Room temperature RF conductivity measurements were made using resonant cavities. These measurements indicated that the conductivity of the copper coating was about 84% of the known value of pure copper. Since joints and connectors reduce experimentally measured Q, conductivity value of coatings may be even closer to pure solid copper.
- RF resistivity measurements must be repeated at cryogenic temperatures. PVI is working on a Phase 1 SBIR project to develop a system to measure RF resistivity at cryogenic temperatures.

Design and Results using 2nd Generation Deposition Source



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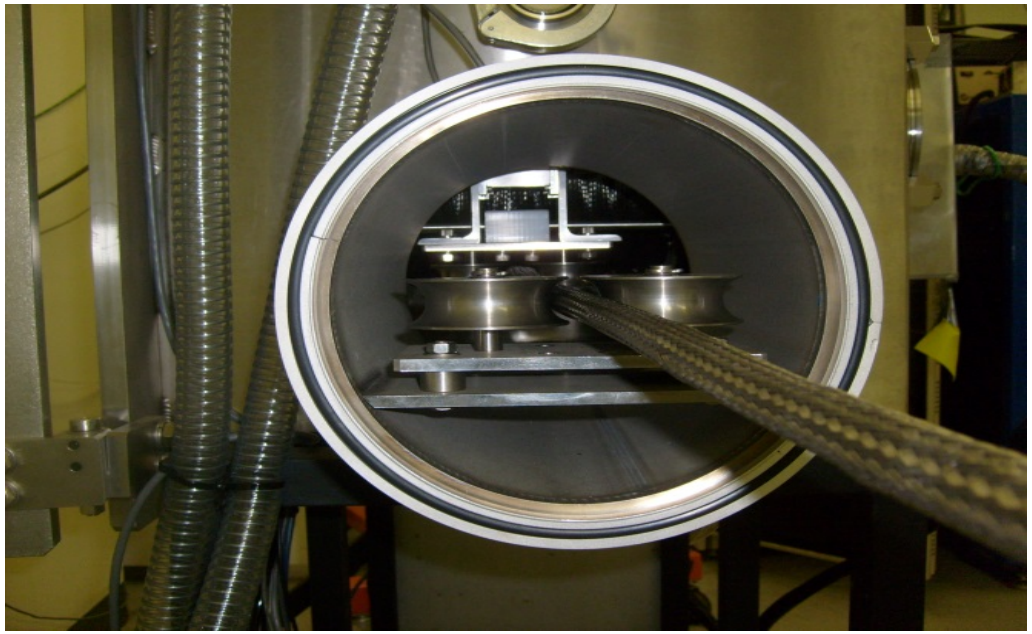
Umbilical drive mechanism



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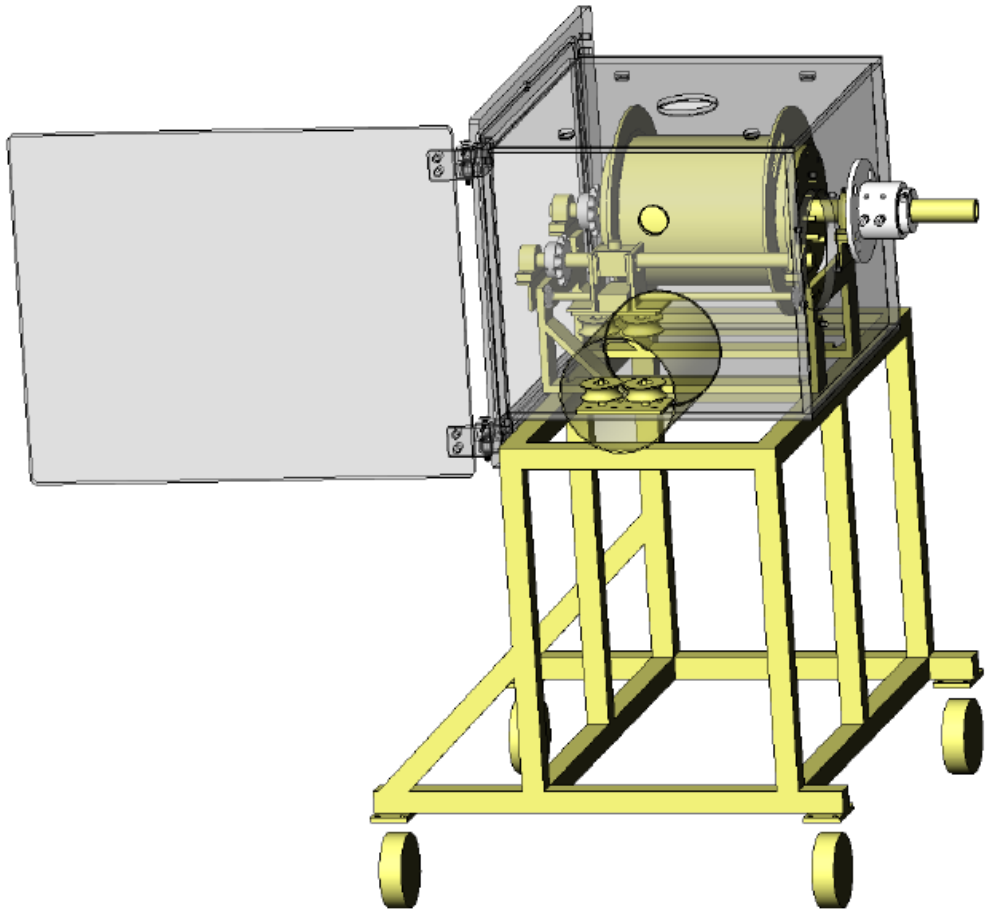
Umbilical drive assembly



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In-situ coating system

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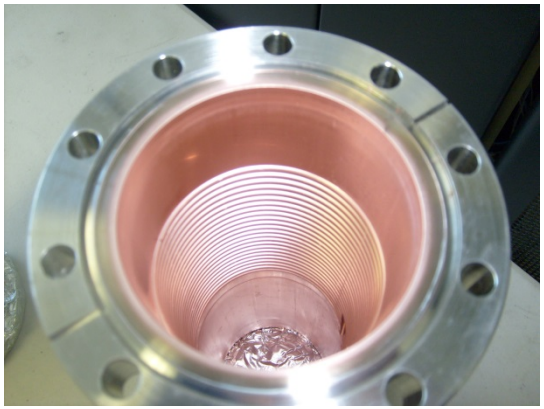
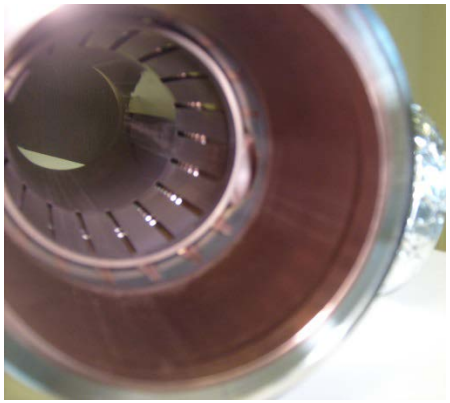
Coating of RHIC Bellows and Tubes





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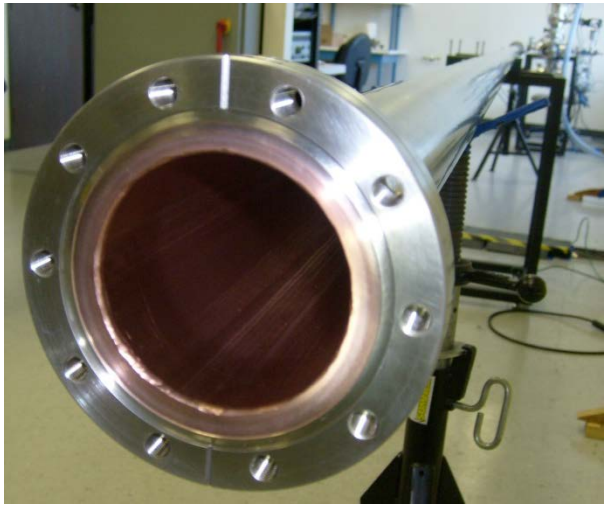
Coating of RHIC Bellows and Tubes (cont.)



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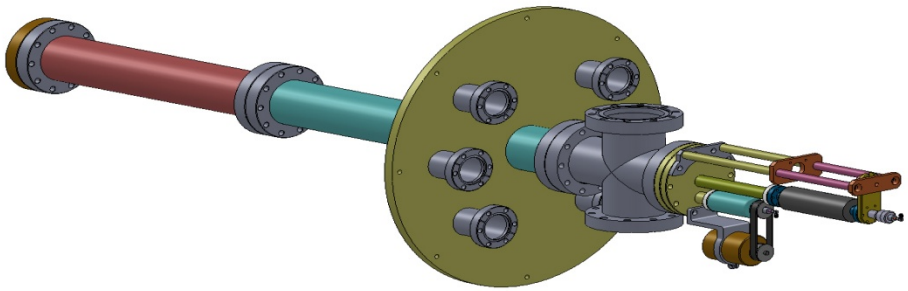
Next Steps

- Ongoing development of thin film coatings for accelerators & related components.
- Development of test system to measure RF resistivity at cryogenic temperatures.



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