Drift-tube Cavities for RIA

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THP05, THP06
Speaker: Mike Kelly

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Other RIA papers from ANL:
MOP01 – Beam Intensity Adjustment in the RIA Driver Linac
MOP90 – Superconducting Linac Cryostat for RIA
TUP26 – Alternating Phase Focussing in Low-Velocity Heavy-Ion Superconducting Linac
THP15 – Spoke-loaded SC Cavities for the RIA Driver Linac

Argonne National Laboratory

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago
ANL Developed Cavities for $0.1 < \beta < 0.5$

- **115 MHz**
  - Quarter-wave
  - Cold Tested May 2004

- **172 MHz**
  - Half-wave
  - Cold Tested February 2004

- **345 MHz**
  - Double-spoke
  - Cold Tested August 2003
RIA Drift-tube Cavity Team/Collaborators

JLab
- Microphonics, fast tuning – Jean Delayen
- Materials, processing – Peter Kneisel

LANL
- Clean Techniques - Tsuyoshi Tajima
- Design – Dale Schrage

LLNL
- Coupler/Tuner design - Brian Rusnak

ANL SRF Group
- Coordination
- Nb procurement, QA
- Mechanical & EM design
- Chemistry
- Clean processing & assembly
- Testing

AES
- Niobium tooling and forming – Ed Peterson, John Rathke
- FEA – Tom Schultheiss

Sciaky
- Electron beam welding – Ted Hejna

ANL Shops
- Meyer Tool
- Brazing – Bill Toter
- Stainless machining

Coupler/Tuner design - Brian Rusnak
An Outline of the Fabrication Process

- Designed using Micro-wave Studio and ProE
- 3 mm RRR=250 niobium sheet
- Niobium-to-stainless steel braze → stainless-steel helium vessel
- Hydroformed, EB-welded, and electropolished
Facilities: Clean Processing for SRF Cavities

- Clean techniques from DESY and Jefferson Lab
- Ultrapure high pressure water rinse in clean area
- Clean room assembly of cavity, couplers, vacuum systems
Electropolishing at ANL

Electropolishing yields:
• A smoother surface
• Lower rf losses and less “Q slope” at 4 K

Co-axial half-wave

Quarter-wave

Double spoke
Test Performance of the RIA Mid-beta Cavities

Microphonics at accelerating field
\[ \sigma = 3 \text{ Hz RMS} \]

\[ \sigma = 2 \text{ Hz RMS} \]

\[ \sigma = 5 \text{ Hz RMS} \]
Summary

• Cavities substantially exceed the RIA performance goal

• Low rf losses ($R_{\text{RES}} \sim 5-10$ n$\Omega$), little “Q-slope”, no significant field emission

• Established the team & techniques needed to build the RIA cavities

• Current prototype cavities, couplers and tuners are realistic production designs

• Clean techniques may be used to repeatably achieve high gradients in drift-tube cavities

• All cavity Q values at or above $10^9$ in 4 K operation over the full operating range