UK INDUSTRIAL DEVELOPMENT OF MANUFACTURING
TECHNIQUES FOR SUPERCONDUCTING RF CAVITIES

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Abstract
An STFC Industrial Programme Support (IPS) Scheme grant, funding Daresbury Laboratory and Shakespeare Engineering Ltd to develop the capability to fabricate, process and test a 9-cell, 1.3 GHz superconducting RF cavity in support of enabling UK industry to address the large potential market for superconducting RF structures. At the heart of the development are the repeatability and the reproducibility of the manufacturing process in an effort to reduce the costs. Effort has been spent on developing the techniques to fabricate the niobium half-cells and the beam-pipes and this paper discusses the manufacturing processes and the results obtained.

Introduction
The aim of the IPS project is to develop the capability of UK industry in the manufacturing of superconducting RF cavities.
Deliverables:-
Fabrication of 1.3 GHz of 9-cell niobium superconducting RF (SRF) cavity
- Target gradient of >20 MV/m with a Q_e > 1 x 10^10 at 2K after BCP
- Target gradient of >30 MV/m with a Q_e > 1 x 10^10 at 2K after EP and CB
- Evaluation of processing techniques
- Expanded process capabilities
- Knowledge transfer – Documented processes and assured quality control

Cavity Design

Press for frequency measurements

- A 2-cell copper cavity has been fabricated
- Excellent equator and iris interfacing of half-cells
- Spring-back and thickness variability controlled
- CMM measurements have been performed
- Within tolerances of ±0.2 mm
- Consistency seen when comparing each of the end-cells and each of the mid-cells with each other
- Profiles of dies verified


Electron Beam Welding
- Electron beam welding trials have been performed at Bodycote PLC using a 150 kV 160 mA electron beam welder
  - Welding bay cleaned to improve welding pressure so as to meet the target pressure of 2 x 10⁻⁶ mbar
  - Welding parameters are being optimised with further trials continuing on both flat plate and beam-pipe samples
- Jigs are being currently designed and manufactured

Facilities
To enable the step from processing a single-cell cavity to that for a 9-cell cavity the facilities have been expanded to include a fully automated BCP etching facility and an automated HPR stand.

Mechanical Cavity Tuning:
- A manual mechanical cavity tuning fixture has been designed and built to provide a tuning range of 4.5 mm
  - A floating yoke is supported by 2 precision linear bearings
  - Cell tuning is achieved by adjusting the position of the floating yoke with respect to the fixed yoke
  - Split tuning plates slot into the yokes and clamp around the iris of the cavity
  - Tuner mechanism has inter-connecting actuators, ensuring equal and opposite rotation for even tuning
  - The positions of the cavity supports are adjustable to enable the tuning of the different cells.

Summary and Future Plans
- Prototype 2-cell copper cavity successfully produced
- Profile of pressing dies confirmed for the centre and end-cells
- Pressing of the niobium half-cells has been performed and cells are currently being machined
- Spinning of the niobium beam-pipes has been successfully completed with 4 mm niobium and beam-pipes are to be machined
- A 2-cell niobium cavity will be fabricated, so tuning trials can be performed with the mechanical cavity tuning fixture
- Fabrication of the 9-cell components will commence soon