

# NINE - CELL TESLA SHAPE CAVITIES PRODUCED FROM HYDROFORMED CELLS

## Abstract

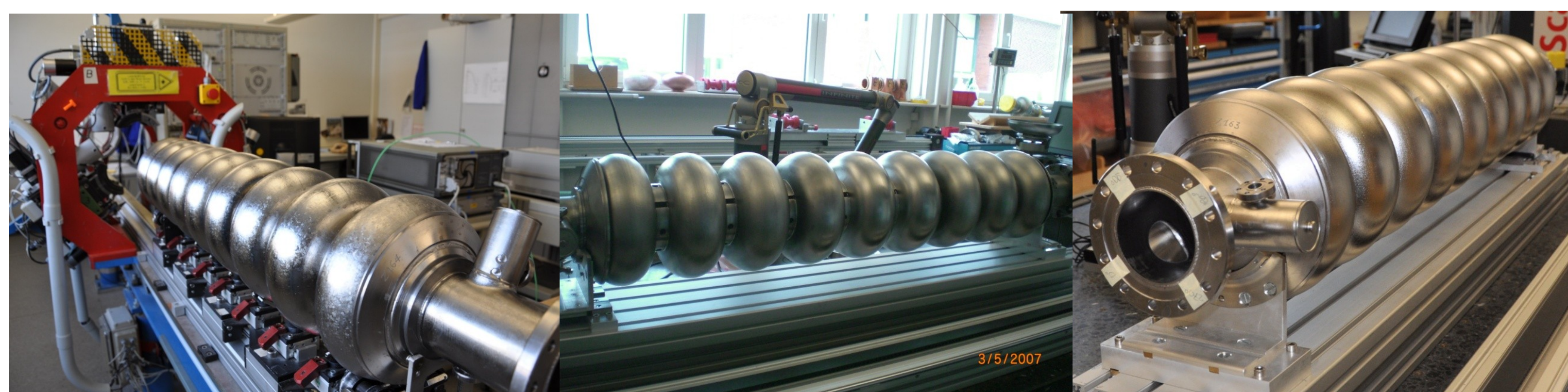
Production of two types of seamless niobium tubes for hydroforming of RF cavities has been developed. The first type of tubes, developed at DESY, have been spun from sheets and flow formed. The second type of tubing was developed by Black Laboratories in collaboration with the company ATI Wah Chang. These longer length tubes were extruded from a heavily deformed billet, processed for a fine-grained microstructure and flow formed.

It was proven that hydroformed single cells reached Eacc up to 35 MV/m after BCP and up to 40 MV/m after EP.

Currently the work is concentrated on multi-cell and 9-cell cavities. Several seamless two- and three-cell units have been produced by hydroforming at DESY. Some of the units have been treated by buffered chemical polishing and RF tested at JLab. The accelerating gradient  $E_{acc}$  of 30-35 MV/m are reached.

3-cell units from the first type of tubing combined to three 9-cell niobium cavities at the company E. Zanon. The 3-cell units from extruded tubing are welded together to the fourth 9-cell cavity at JLab. All cavities in preparation or partially RF tests at DESY and JLab. Reached accelerating gradient  $E_{acc}$  =30-35 MV/m. One cavity is successfully integrated in the cryomodule for FLASH

## Four hydroformed 9 - cell cavities are produced

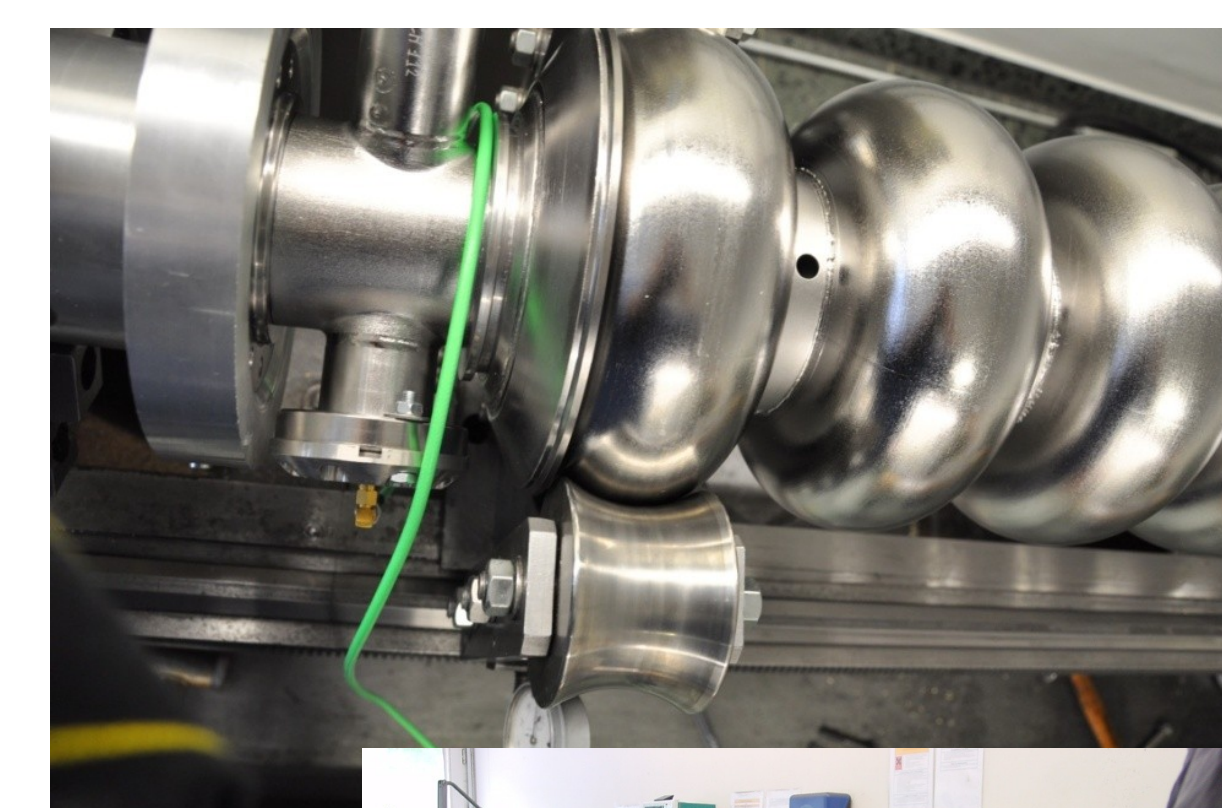
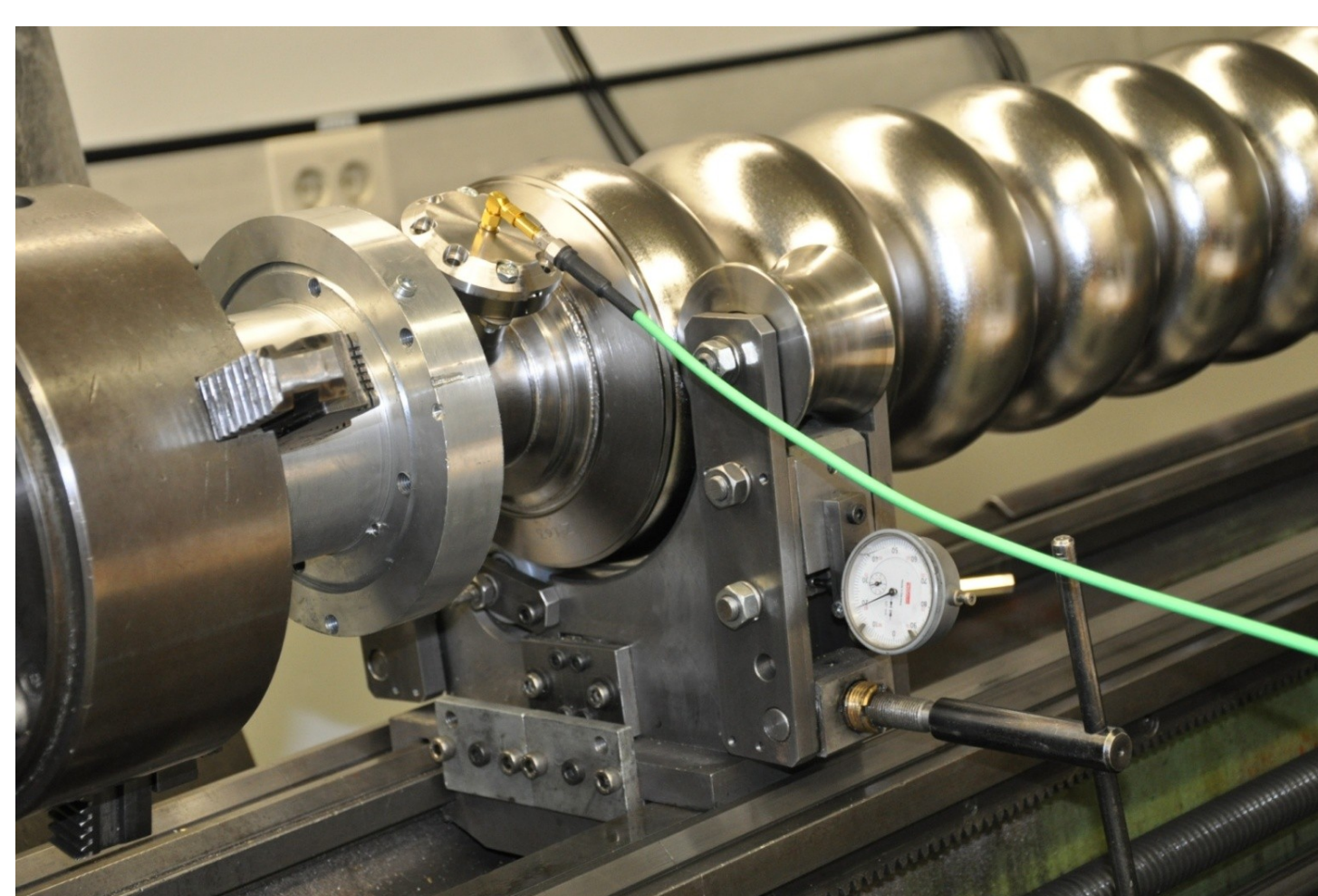


Three 9-cell cavities from hydroformed at DESY from DESY tubes units completed at E.ZANON (Z145, Z163 and Z164)



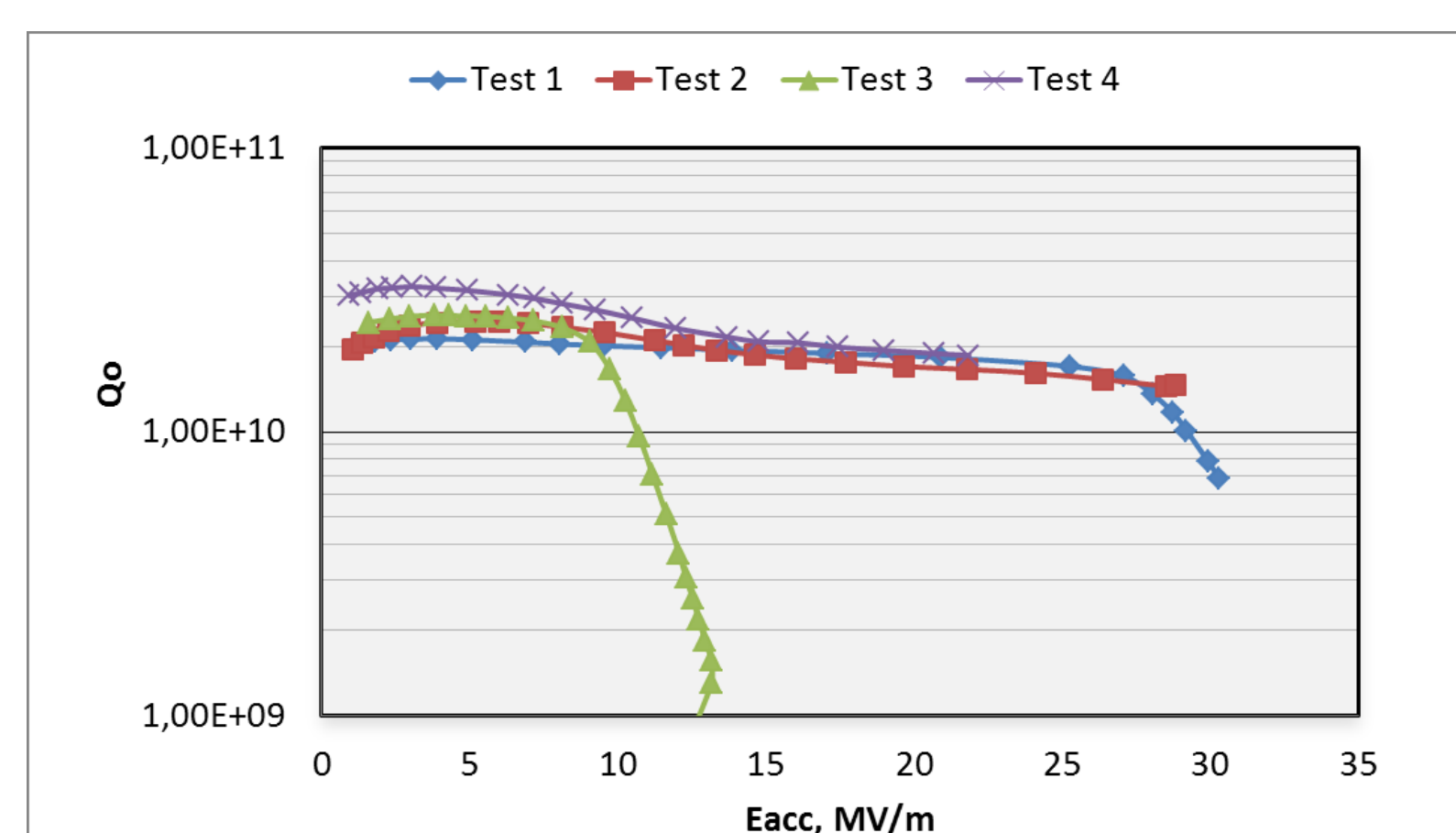
9-cell cavity hydroformed at DESY from Black Lab. tubes completed at JLAB

## Developed at DESY tuning by radial deformation



Allows significant change of the frequency (few MHz) keeping the cavity length. Field flatness after pre-tuning 88%, after standard tuning 99%

## RF test results at DESY



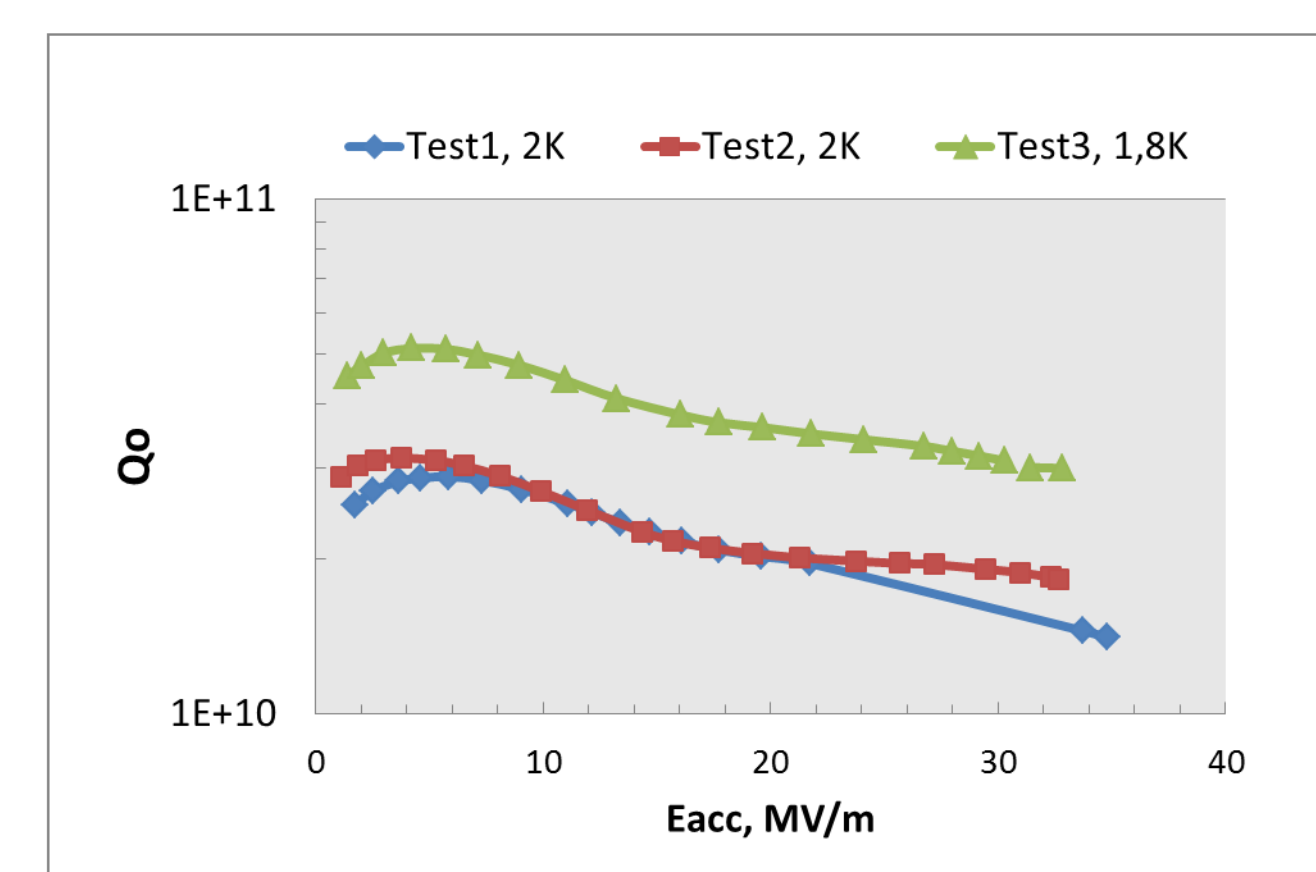
### 9 - cell cavity Z145

Test 1: 40  $\mu$ m BCP, 800 °C, 170  $\mu$ m EP, 800 °C; 48  $\mu$ m EP

Test 2: after integration into helium tank and add. baking at 120°C for 48 h

Test 3: after new feedthroughs and HOM coupler antennas mounted. Limited by field emission

Test 4: after add. 10  $\mu$ m EP and baking at 120°C for 48 h



### 9-cell cavity Z163

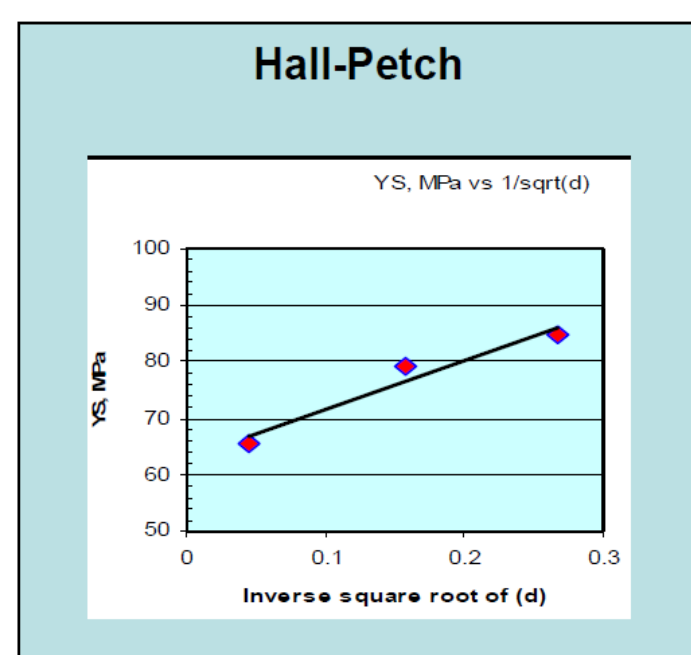
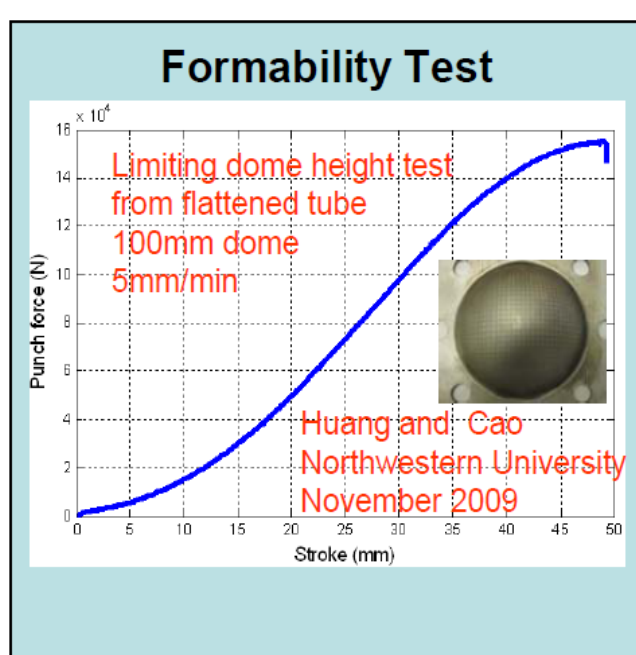
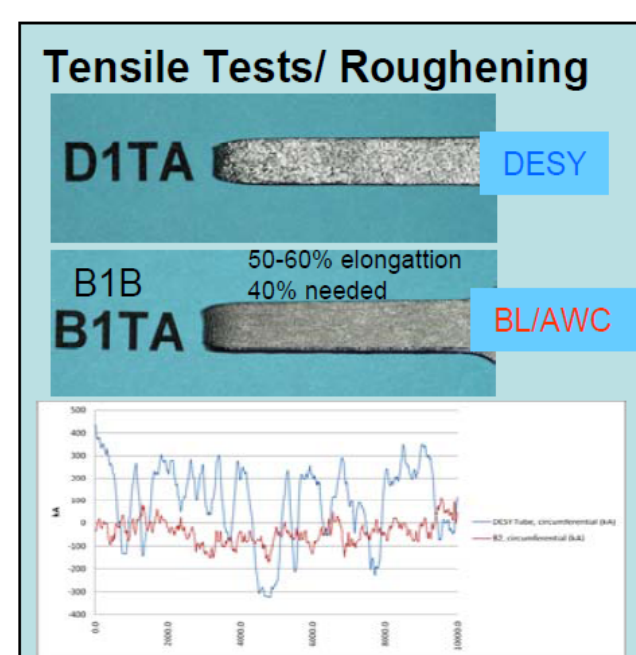
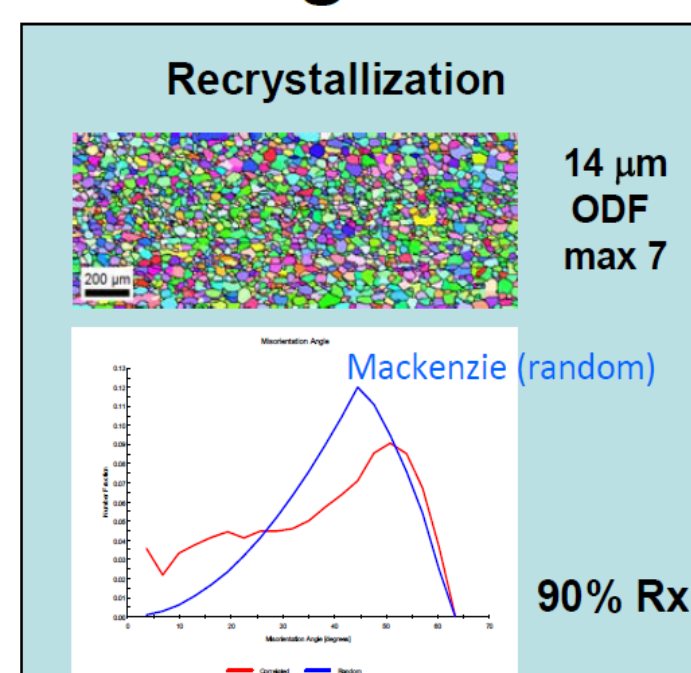
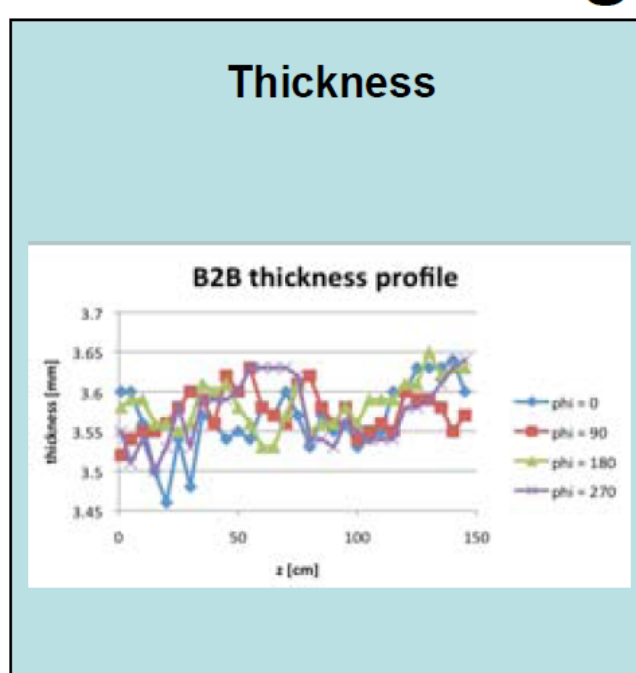
Test1: After 50  $\mu$ m BCP, HT 800 C, 144  $\mu$ m EP, 800 °C; 48  $\mu$ m EP, baking at 130°C for 48 h (vacuum leak during test).

Test2: Limited by quench, no FE. Quench at cell 8 above equator area. Another cells shows Eacc>40 MV/m

RRR Niobium Seamless Cavities; Crooks, Singer

TFSRF 2010, Legnaro, October 4 – 6, 2010

## BL/AWC Tube Processing & Testing

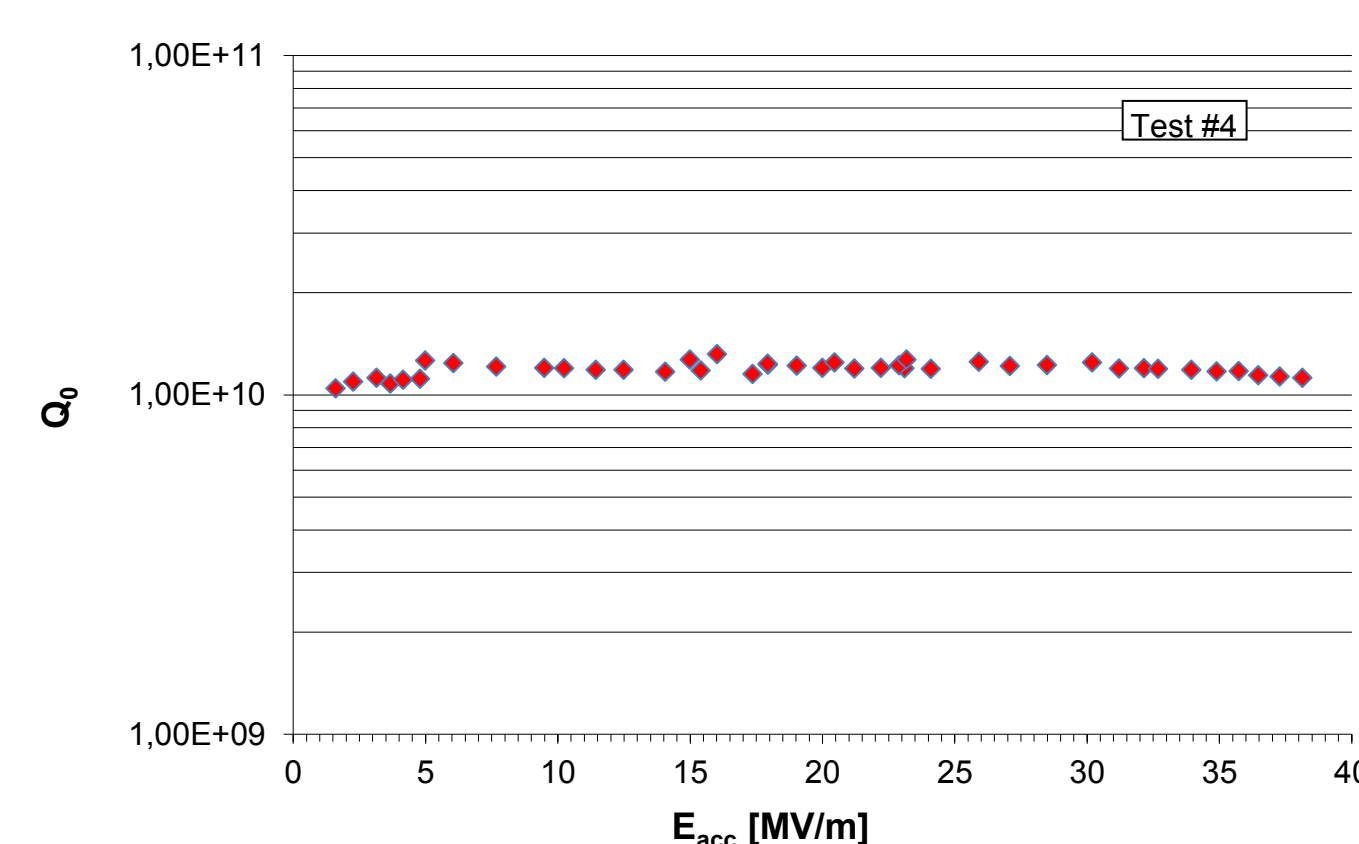


Developed seamless Nb tubes of high length, uniform thickness, small, homogeneous grain and good formability

## Hydroformed 2-cell units completed and tested at JLab

DESY 2-cell seamless cavity- 2H3

$Q_0$  vs.  $E_{acc}$



Hydroformed at DESY and dressed with end tubes at Jlab 2-cell units

Qo(Eacc) performance of the one of 2-cell hydroformed cavity after EP. Vertical EP was done at Cornell by A.Crawford. Typically after ca. 200-250  $\mu$ m BCP or EP and baking Eacc reached 30-40 MV/m

## Summary

- ❑ Fabrication of 9-cell cavities of TESLA like shape by hydroforming is proven.
- ❑ Four 9-cell cavities are produced by hydroforming (on base of 3x3 units).
- ❑ The Eacc on the level of 30-35 MV/m was reached
- ❑ One of the hydroformed 9-cell cavity is in cryomodule in FLASH operation (proof of principle is successful)



## Hydroformed from DESY tubes cavity Z145 is installed in module 3\*\*\*/ACC1 in FLASH

module 3\*\*\*

