

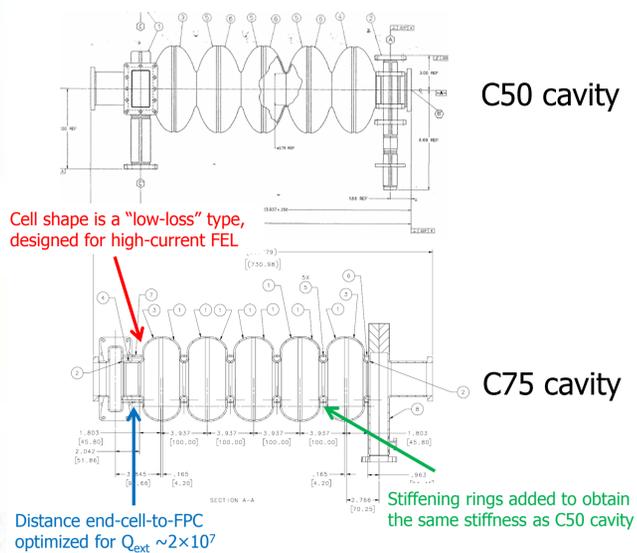
# UPGRADED CAVITIES FOR THE CEBAF CRYOMODULE REWORK PROGRAM

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## Abstract

The CEBAF cryomodule rework program has been a successful tool to recover and maintain the energy reach of the original baseline 6 GeV accelerator. The weakest original modules with eight five-cell cavities assembled in four “pairs”, with a specification when new of 20 MV per cryomodule (5 MV/m), are disassembled, re-cleaned with modern techniques and re-qualified to at least 50 MV (12.5 MV/m), (leading to the acronym “C50”). The cost per recovered MV is much less than building new modules. However over time the stock of weak modules is being used up and the voltage gain per rework cycle is diminishing. In an attempt to increase the gain per cycle it is proposed to rework the cavities by replacing the original accelerating cells with new ones of an improved shape and better material. The original CEBAF HOM and FPC end groups are retained. The goal is to achieve up to 75 MV (19 MV/m) for the reworked module (“C75”). Three C75 5-cell prototype cavities have been fabricated, processed and tested as part of an R&D program aiming at providing cavities to be installed during the refurbishment of some of the original CEBAF cryomodules. We report on the fabrication experience and test results of the first trial pair, containing of two such reworked cavities.

## CAVITY DESIGN



	“C50” cavity	“C75” cavity
$E_p/E_{acc}$	2.83	2.45
$B_p/E_{acc}$ [mT/(MV/m)]	4.62	4.18
$R/Q \times G/\text{cell}$ ( $\Omega^2$ )	26441	28961
k(%)	3.15	3.15

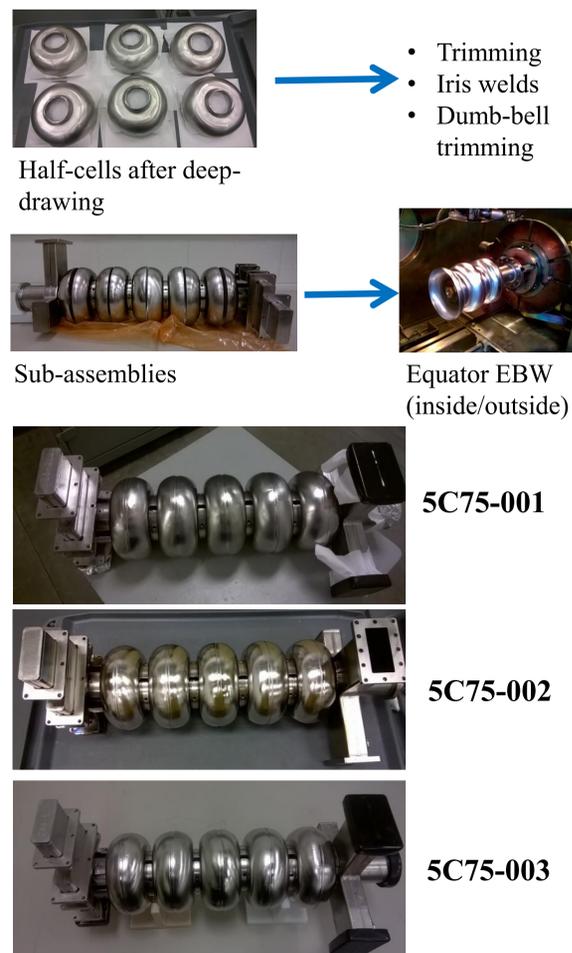
## CAVITY MATERIAL

Materials used for the Fabrication of the Three C75 Prototype Cavities

Cavity	Ingot SN	Supplier	RRR	Ta content (wt. ppm)
5C75-001	2370-5	CBMM	118	1350
5C75-002	2667-5	CBMM	114	670
5C75-003	NC-1654	Tokyo-Denkai	496	29

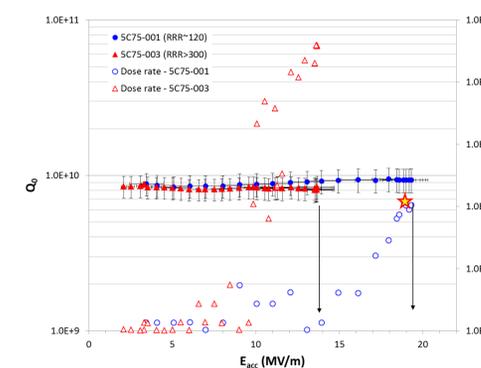
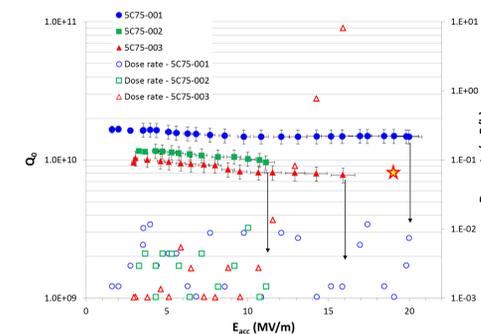


## CAVITY FABRICATION

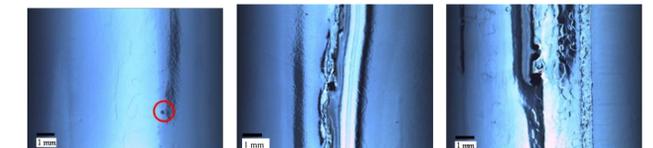


## CAVITY PROCESSING AND TEST RESULTS

5C75-001	5C75-002	5C75-003
70 $\mu\text{m}$ CBP	70 $\mu\text{m}$ CBP	95 $\mu\text{m}$ BCP 1:1:2
30 $\mu\text{m}$ EP	35 $\mu\text{m}$ EP	600 $^\circ\text{C}/3$ h vacuum anneal
800 $^\circ\text{C}/3$ h vacuum anneal	800 $^\circ\text{C}/3$ h vacuum anneal	30 $\mu\text{m}$ EP
30 $\mu\text{m}$ EP	20 $\mu\text{m}$ EP	HPR
HPR	HPR	RF Test
RF Test	RF Test	HPR
		RF Test
		Local grinding
		30 $\mu\text{m}$ BCP 1:1:2
		HPR
		RF Test
		20 $\mu\text{m}$ EP

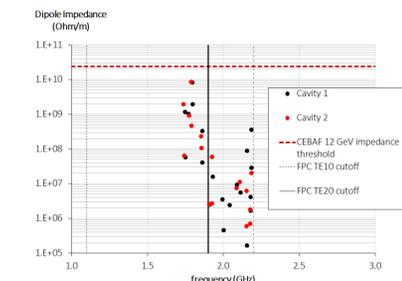


- Cavities tested individually at 2.07 K
- Quenches due to weld defects as found by OST sensors

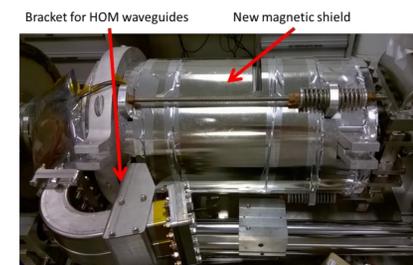


Defects at quench locations (equator welds) for 5C75-001 (left), 5C75-002 (center) and 5C75-003 (right)

- Cavities tested as a pair with HOM elbows and loads, Nb “dog-leg” with RF window and “top-hat”



$TE_{111}$  and  $TM_{110}$  dipole impedances ( $R/Q_{calc} \times Q_{meas}$ ) for the cavity pair at 4 K



## CONCLUSION

- Two “C75” ingot Nb cavities are being installed in the next C50 cryomodule to be commissioned in CEBAF within 2017. The accelerating gradient was limited by defects in some of the equatorial welds. Faulty components found in the EBW machine are the leading cause for such defects.
- The HOM damping of the new cavity shape is adequate for operation of CEBAF at 12 GeV.
- A new magnetic shield was designed and installed
- Additional RF losses by the FPC window need to be further understood and mitigated
- Additional C75 cavities are expected to be built in the following months, either in house or by industry, to be installed in the next cryomodule refurbishment in 2018.