

SRF for FCC-ee

Snowmass Community Planning Meeting, 5-8 October 2020

Frank Gerigk, 6 October 2020

FCC-ee, 2019 Conceptual Design Report

- Is built on SRF technology that is available basically today: 400 MHz coated Cu cavities 1-4 cells with 10 MV/m (LHC cavities nominal 5.3 MV/m, in tests up to 8 MV/m).
- 800 MHz 4-cell cavities with conservative gradients (20 MV/m).
- New power couplers with up to 1 MW CW and adjustable Q_{ex} . A back-up version is 2 couplers of 0.5 MW/cavity.

FCC-ee, 2019 Conceptual Design Report

ee-machine/booster HOM limited

Configuration	gradient [MV/m]	frequency [MHz]	cells/cav	N _{cav}	P _{cav} [MW]
Z	5.1/8	400	1/4	52/12	0.96
WW	9.6	400	4	52/52	0.96
ZH	9.8	400	4	136/136	0.37
tt-bar1	10	400	4	272/136	0.18
	20	800	5	296/400	0.18
tt-bar2	10	400	4	272/136	0.16
	20	800	5	372/480	0.16

FPC limited

room for improvement

.. room for improvement

Coating Techniques

Coating materials

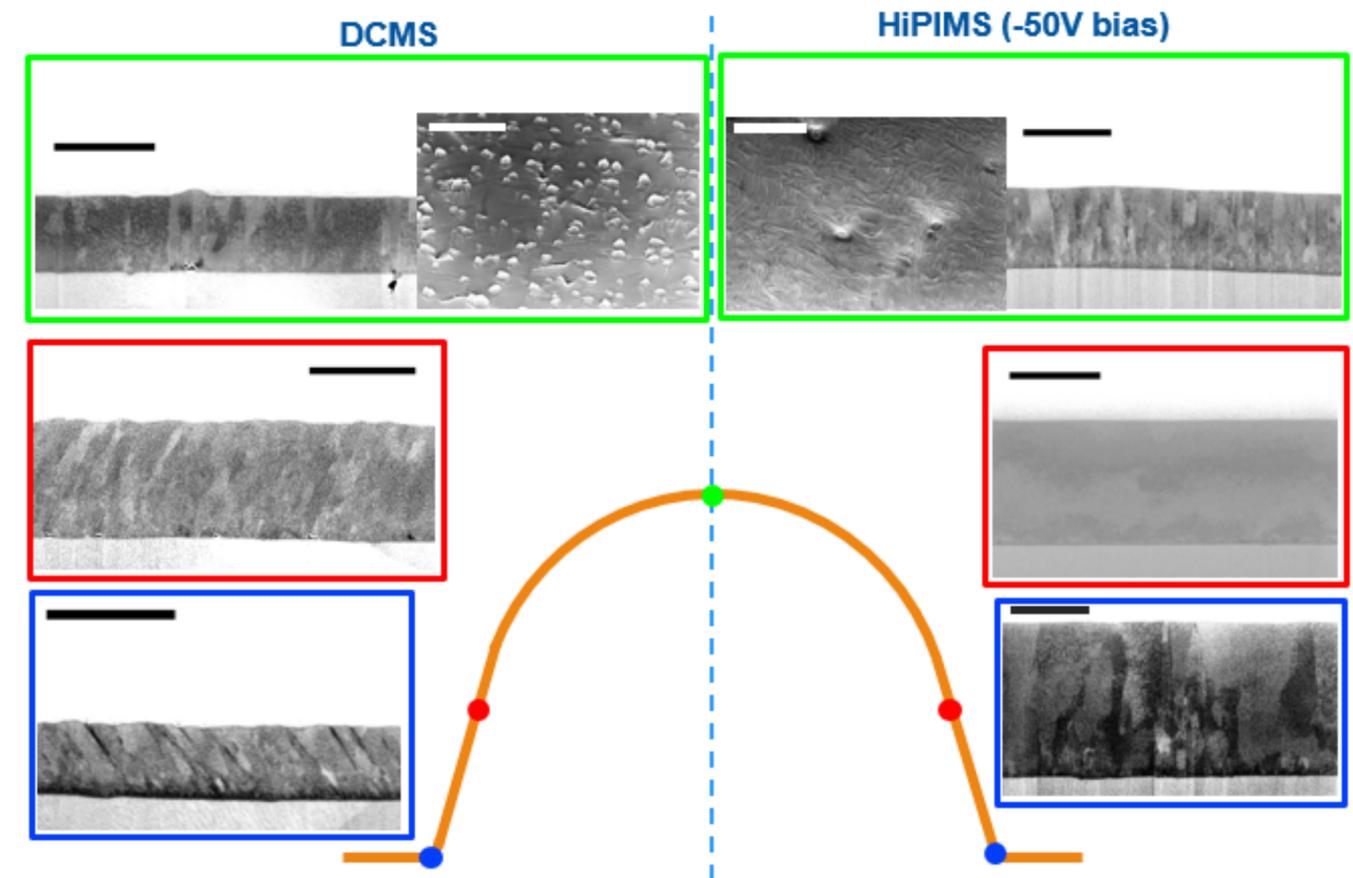
Cu substrate
fabrication

Cavity shapes

.. room for improvement I

HIPIMS coating

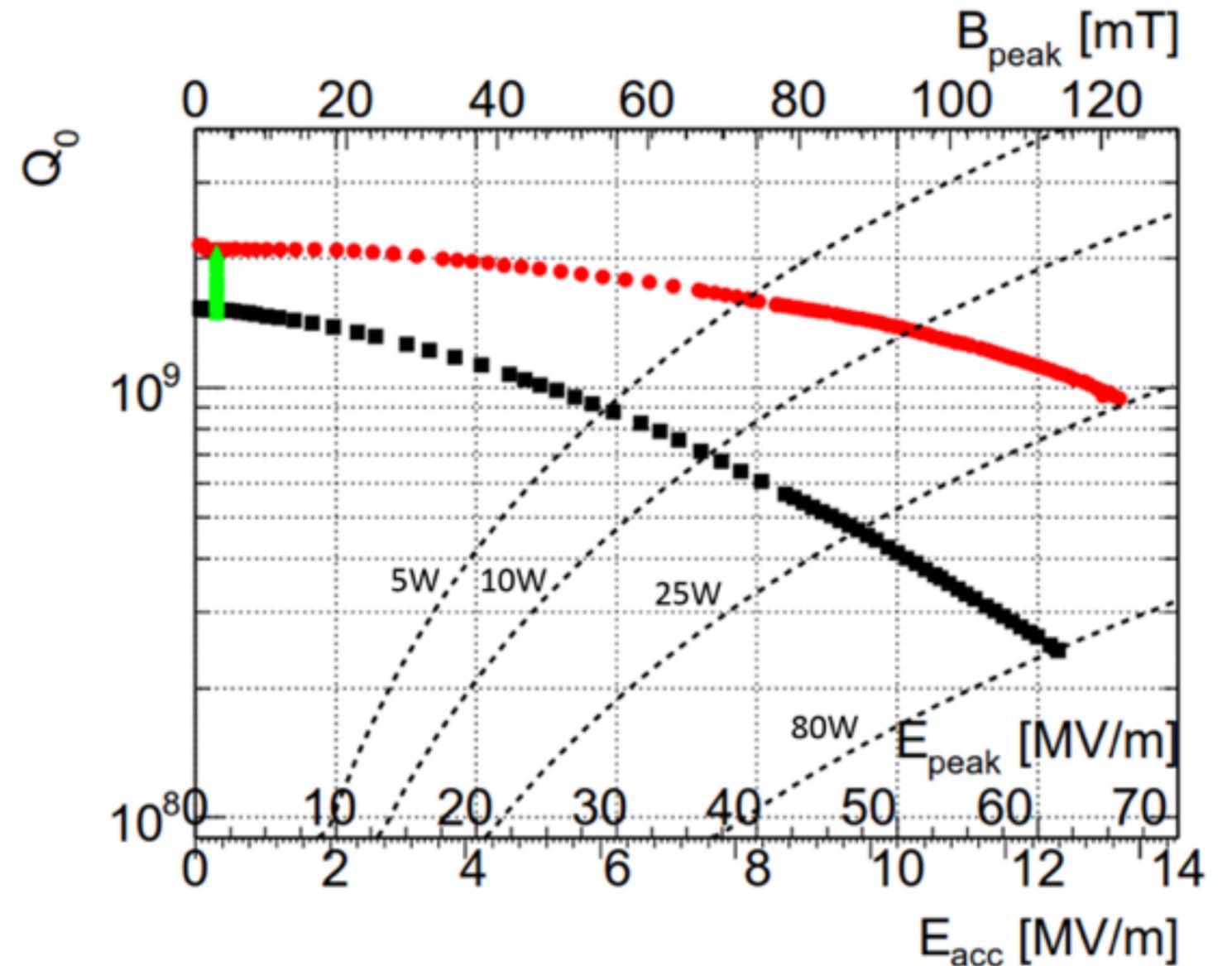
- Much denser layer in all orientations.
- Sample tests showed much flatter Q-curves than for DCMS sputtering.
- First 1.3 GHz seamless cavity with HIPIMS coating is waiting for its test.



.. room for improvement II

Fabrication of Cu substrates, understand the influence of the weld

- Can the results of seamless 100 MHz Nb coated HIE-ISOLDE cavities be extrapolated to 400 MHz seamless elliptical cavities?
- Currently preparing tests with seamless and welded 1.3 GHz cavities, which are coated by HIPIMS.



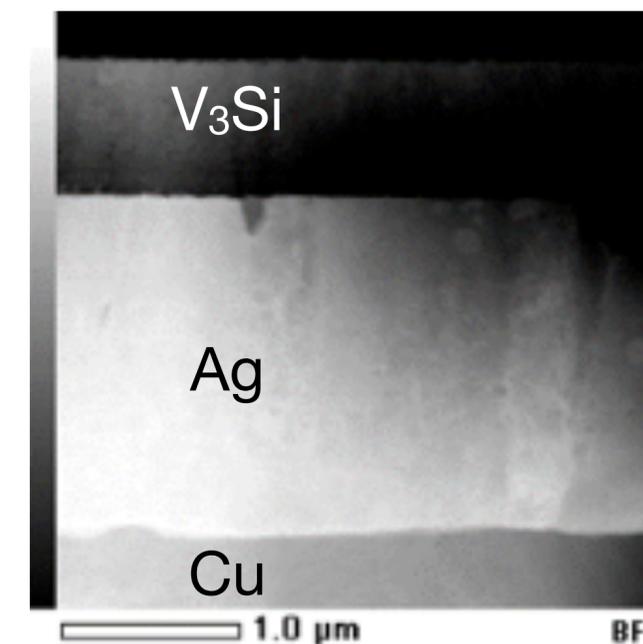
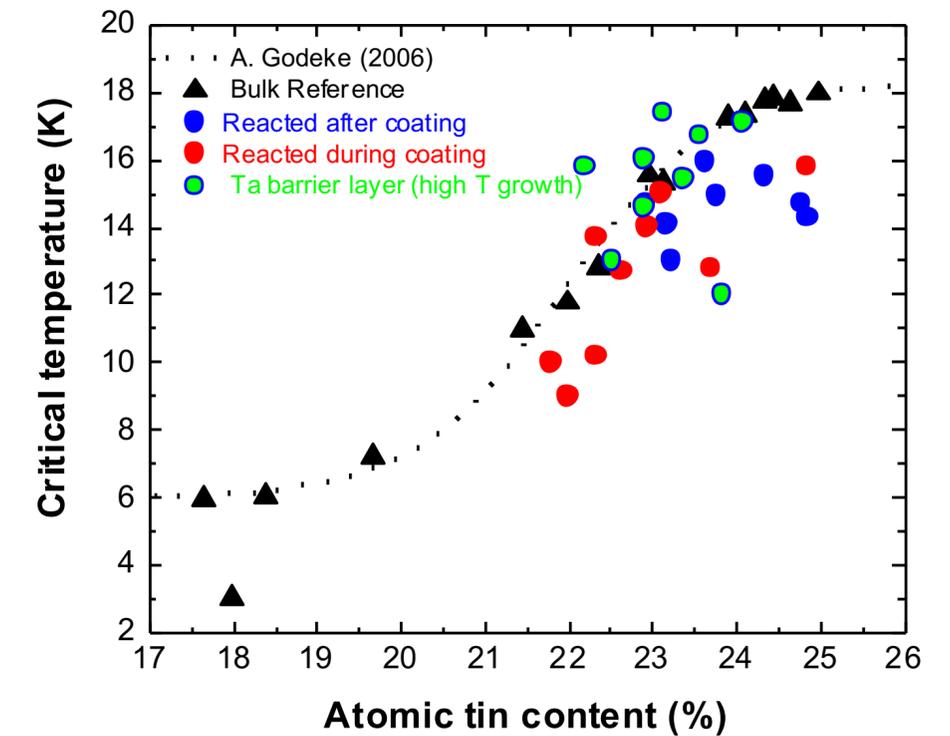
.. room for improvement III

A15, operating at higher temperature?

Sputtering of A15 onto a copper substrate.

- **Nb₃Sn**: promising results with intermediate Ta layer to avoid intermixing of Cu and Nb₃Sn
- **Vn₃Si**: more stable than Sn, promising results with intermediate Ag layer.

Both methods still require a long-term effort before having complete cavities.

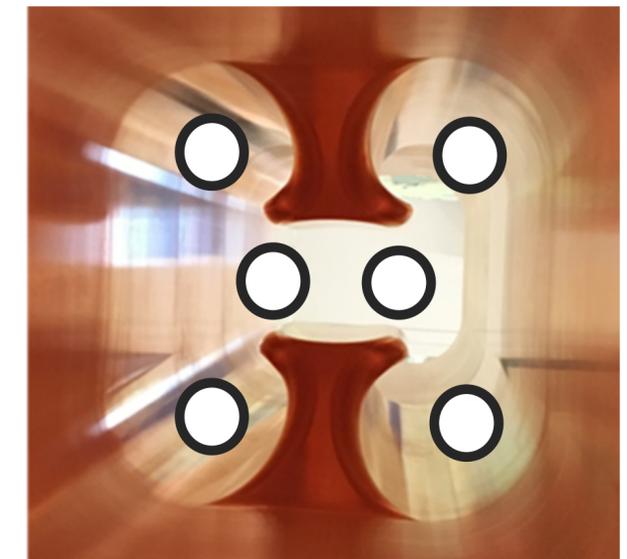


.. room for improvement IV

Cavity shapes

The present choice of cavity shapes may not be optimum. Consider also:

- 2-cell 400 MHz elliptical,
- 400 MHz quarter-wave or half-wave, 1/4-wave may be small enough to use bulk Nb and has a favourable HOM spectrum.
- Wide-open-waveguide crab cavities, ...



WOW cavity with 6 coating cathodes

SRF R&D outlook for FCC

for the next ~5-10 years

- Parallel development of cavities, cryo-modules and power couplers (+HOMs)
- A 2-cavity 400 MHz cryo-module with low static loss, 2 FPCs/cavity, cavity tuners, improved alignment, low fabrication cost, ...
- Cavities: understand if seamless elliptical cavities can lift the performance of coated cavities.
- Fabrication technologies for seamless elliptical cavities (e.g. hydroforming)
- Power coupler development towards 1 MW CW adjustable...
- 800 MHz bulk Nb cavities
- Alternative cavity shapes
- High-efficiency klystrons