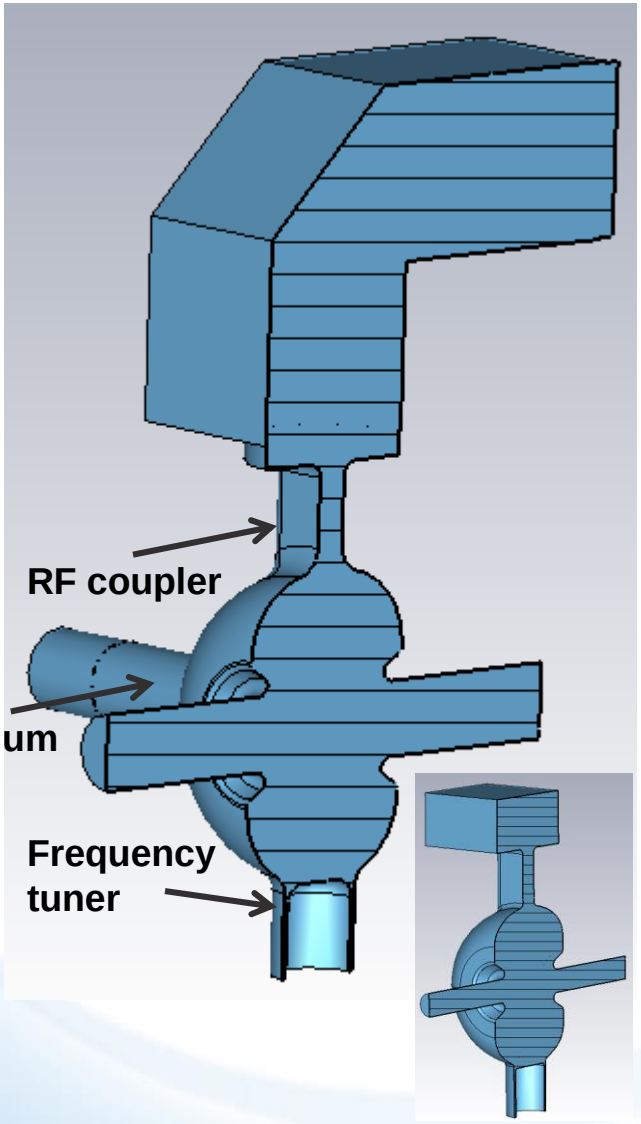
704 MHz warm cavity



Original design

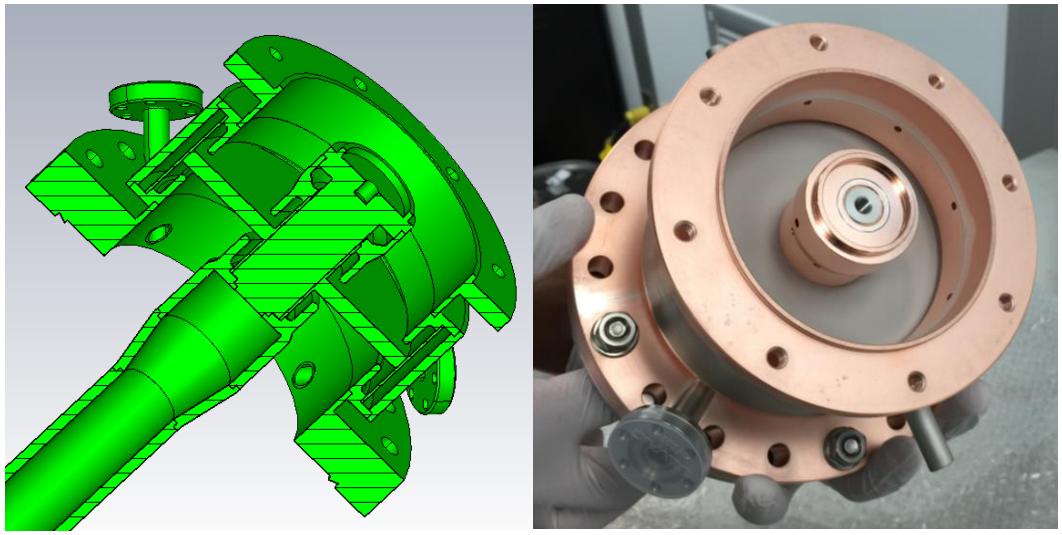
- A single cell 704 MHz warm cavity is used to correct the beam energy spread.
- The cavity is designed for an accelerating voltage up to 430 kV.
- The design was influenced by the 714 MHz cavity developed at LBNL for the NLC damping ring.
- There will be a choke-type frequency tuner.

Compare to the original design, this version has:

- Round cavity surface instead of elliptical surface to simplify the cooling channel machining.
- Bigger blending on tuner to lower the localized heat flux.
- Bigger beam pipe to allow HOM leaking out of the cavity to lower the voltage fluctuation brought by HOM.

704 MHz warm cavity parameters and major RF components

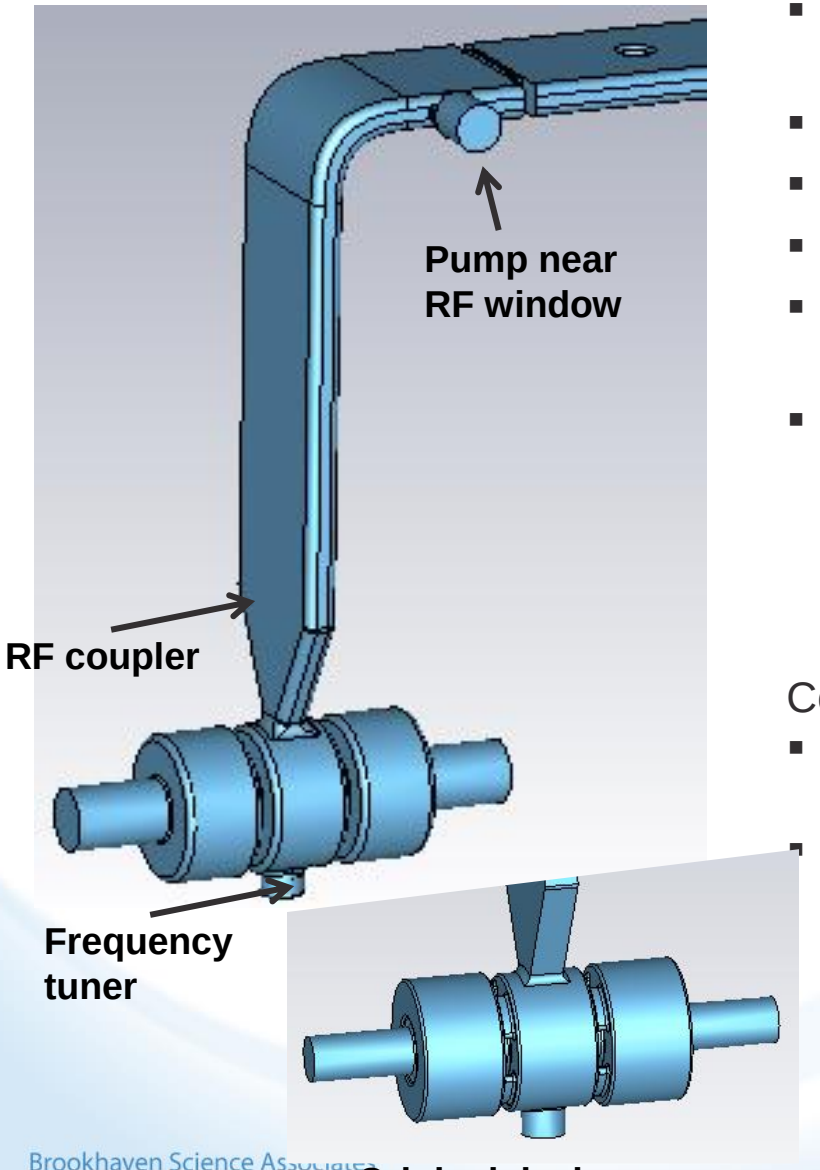
RF window



Frequency	703.6 MHz
No. of cells	1
R_{sh}	5.0 MOhm
R/Q	178 Ohm
Cavity voltage	430 kV
Required RF power	37.0 kW
Installed RF power	50 kW

- The cavity will be ordered from industry. This is a safe design, well within state of the art.
- The RF window from Toshiba Electron Tubes & Devices Co. is in stock, originally for 704 MHz 5-Cell SRF cavity.
- The RF amplifier is a 50 kW, 500 MHz IOT amplifier for CeC PoP re-tuned to 704 MHz.
- WR1150 components, coaxial line, circulator, RF load will be ordered.

2.1 GHz warm cavity



Original design

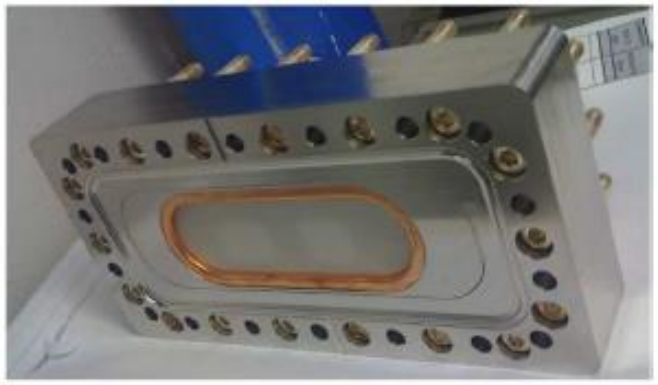
- The third harmonic cavity is used to “fine-tune” the beam energy spread.
- This is a 3-cell copper structure.
- The maximum voltage is 250 kV.
- We plan to use a CEBAF-type RF window.
- There will be one choke-type frequency tuner on the center cell.
- One ion pump connected to the beam pipe using a Tee will be used to maintain the cavity vacuum. Another small pump will be located near the RF window.

Compare to the original design, this version has:

- Center pipe coupling between cells instead of magnetic slots coupling.
- Bigger beam pipe to allow HOM leaking out of the cavity to lower the voltage fluctuation brought by HOM.

Major RF components for the 2.1 GHz cavity

CEBAF RF window



Frequency	2.11 GHz
No. of cells	3
R_{sh}	3.5 MOhm
R/Q	350 Ohm
Cavity voltage	250 kV
Required RF power	8.9 kW
Installed RF power	15 kW

- The cavity will be ordered from industry.
- Fundamental power coupler will use a CEBAF RF window, available from Jlab, high power tested at 1.3GHz.
- A new 15 kW RF amplifier will be based on the solid state technology, a less expensive option.
- WR430 components, circulator, RF load will need to be purchased.

HOM consideration of 2.1 GHz and 704 MHz warm cavities

The LEReC electron beam is soft, at 2MV for phase I. In this case the voltage fluctuation brought by the wake field of the longitudinal HOMs needs to be considered. This effect will get accumulated if those dangerous HOMs beat the train resonance frequency at ~9 MHz.

For 2.1 GHz cavity, in the worst case HOMs will bring 1.57kV voltage fluctuation. If we can manage to shift the 3.2808 GHz mode 0.5 MHz away from the harmonic of the 9 MHz, it will change to 0.57 kV, corresponding to ±2.9e-4 dp/p (peak to peak).

For 704 MHz cavity, in the worst case HOMs will bring 2.04kV voltage fluctuation. If we can manage to shift the 1.807 GHz mode 1.0 MHz away from the harmonic of the 9 MHz, it will change to 0.62 kV, corresponding to ±3.1e-4 dp/p (peak to peak).

Dangerous HOMs and corresponding voltage fluctuation
Left: 2.1 GHz cavity, right: 704MHz cavity.

Freq [GHz]	Q_0	R/Q [Ω]	Voltage [kV]
3.2574	15882	10.5	0.12
3.2808	17602	73.8	1.10
3.3034	15265	34.6	0.36

Freq [GHz]	Q_0	R/Q [Ω]	Voltage [kV]
1.087	24250	75.4	1.52
1.811	46102	6.87	0.12
2.360	46365	5.99	0.26