Developing the next generation of the BNL/AES 704 MHz beta=1 cavity: HOM damping ideas

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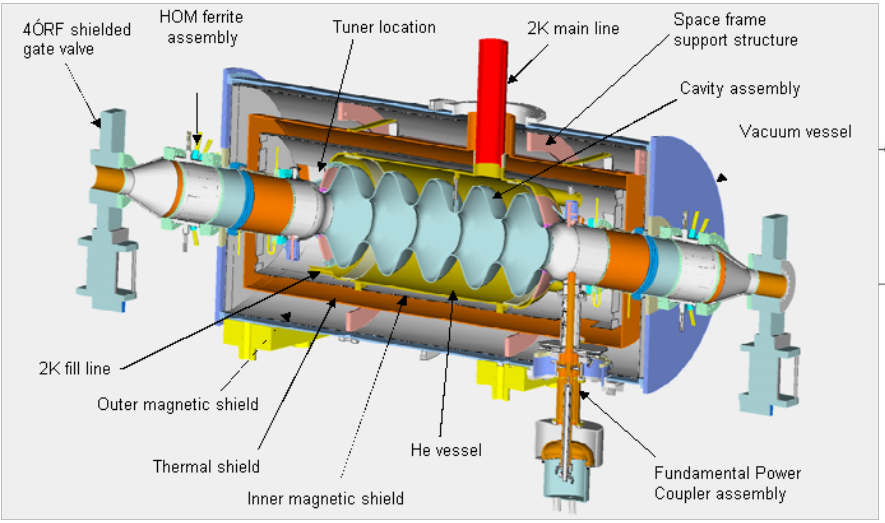
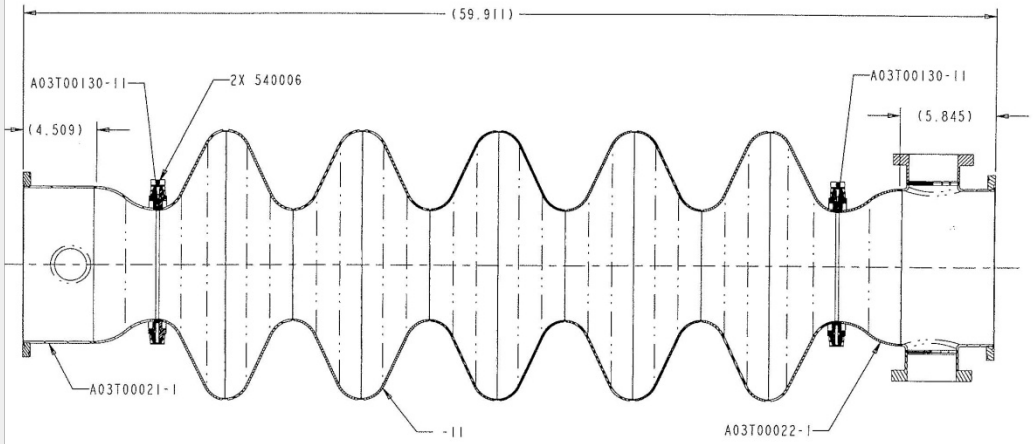
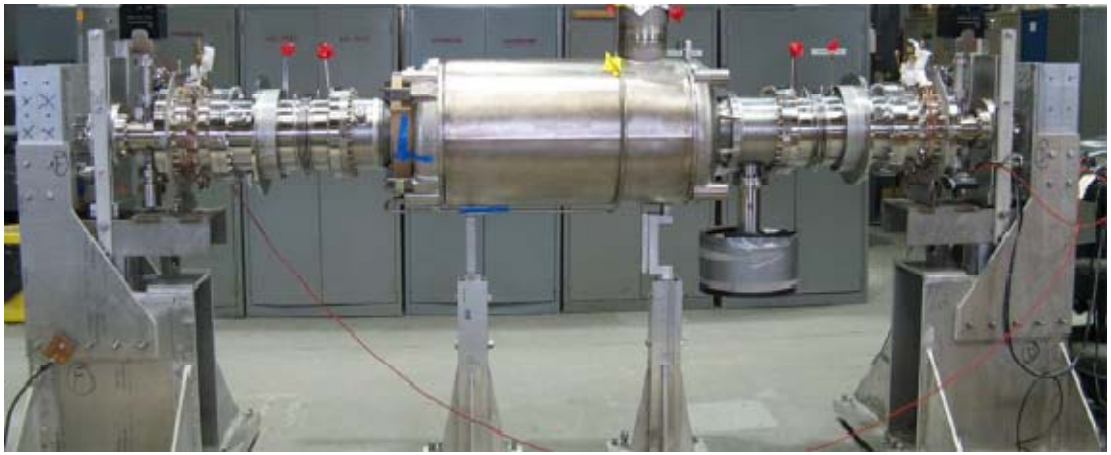
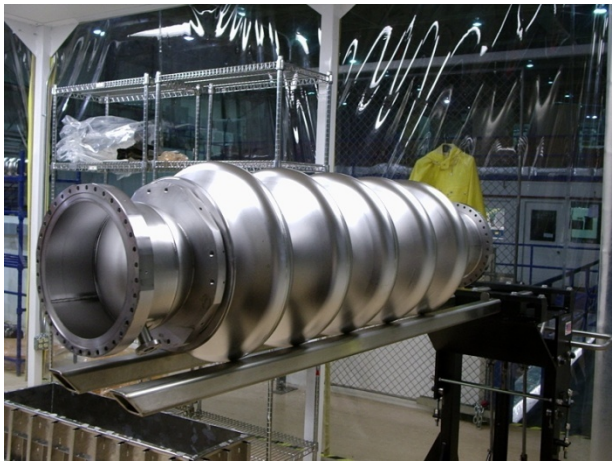
The BNL I cavity

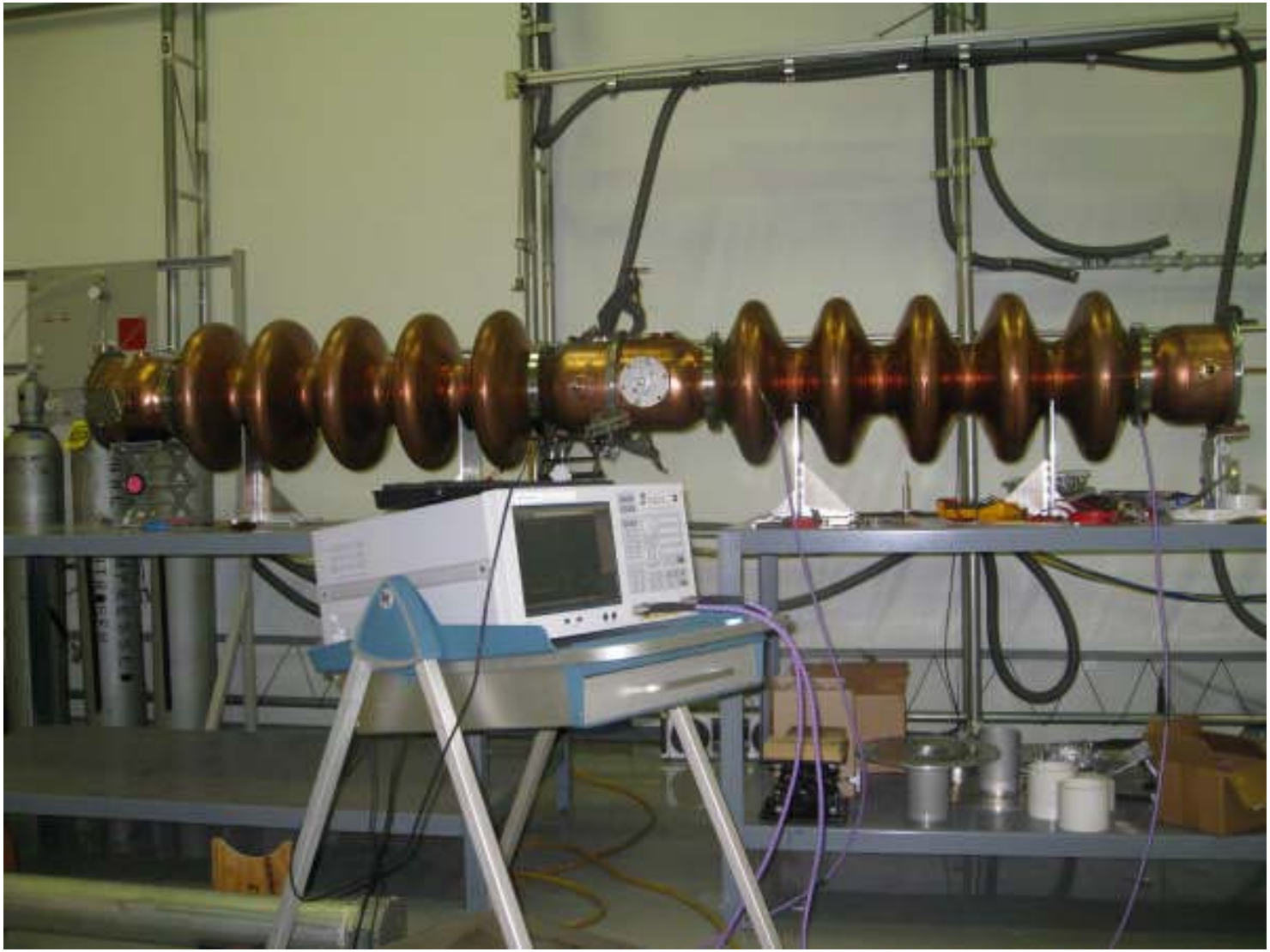








Measurements on copper models



HOM damping

- All HOMs couple well to the beam tube.
- The fundamental is attenuated in the tube.
- Thus one can preferentially damp the HOMs.
- In BNL I, this damping is done with ferrites.
- In principle, one can use pick-up probes in the beam tube to damp the HOMs.
- Thus, one may combine the advantages of the probes with the attenuation of the fundamental achieved in the BNL I cavity.

Preliminary damping measurements (Harald Hahn)

f [MHz]	Q (ECX)	R/Q [Ω]	Q (wo)	Q{left}	Q{right}	Q {BPM}
808.06	870	0.06	24880	8120	8300	8700
808.69			23750	8680	6300	17500
809.26			23350	8750	?	9330
824.33	330	0.76	19500	11500	8860	11750
					2100	8440
845.85	143	4.3	14900	3270	?	3760
866.1		43.91	11400	1453	1075	2780
882.9		74.35	12250	2330	1700	3120
900.79		13.76	8850	276	4700	6910
958.82		0.01	32700	22100	28600	30350
958.98		0.01	34800	33100	32300	
964.23		0.62	16100	5200	23700	18400
965.51		? 13.14	29900	26160	18400	
973.55		? 13.44	3470	1540	1720	2870
977.58	921	6.5	21100	9520	9500	10300
984.33			2030	960	1214	1850
995.01	331	0.1	11200	1600	1390	9200
999.56			4050	1599	740	1128

Q_{21}

Coupling of the fundamental to the HOM probes

The purpose of the dampers is the reduction of HOMs, but they interact unavoidably with the fundamental mode. As a result, the damper has an “external Q”. The unloaded O_0 of the cavities is ~28500 at resonance.
A direct way of measuring Q_X consist in establishing critical coupling in the respective cavity and finding the S21 to the damper, from which follows

$$Q_x = Q_0 / S_{21}{}^2$$

The measured results are listed in Table 3.3, with the Q_X of the dampers around .
Values at this level indicate low power loading of the notch filters. At 20 MV/m a Q of 10^8 corresponds to 10 kW.

Damper	(linear)	(left)	(linear)	(right)
top	22.46 E-3	0.55 E8	20.86 E-3	0.63 E8
front	13.38 E-3	1.54 E8	21.25* E-3	0.61 E8
Probe back	11.55 E-3	2.06 E8	8.413 * E-3	3.9 E8
Probe down	9.62 E-3	3.0 E8	12.67 E-3	1.7 E8

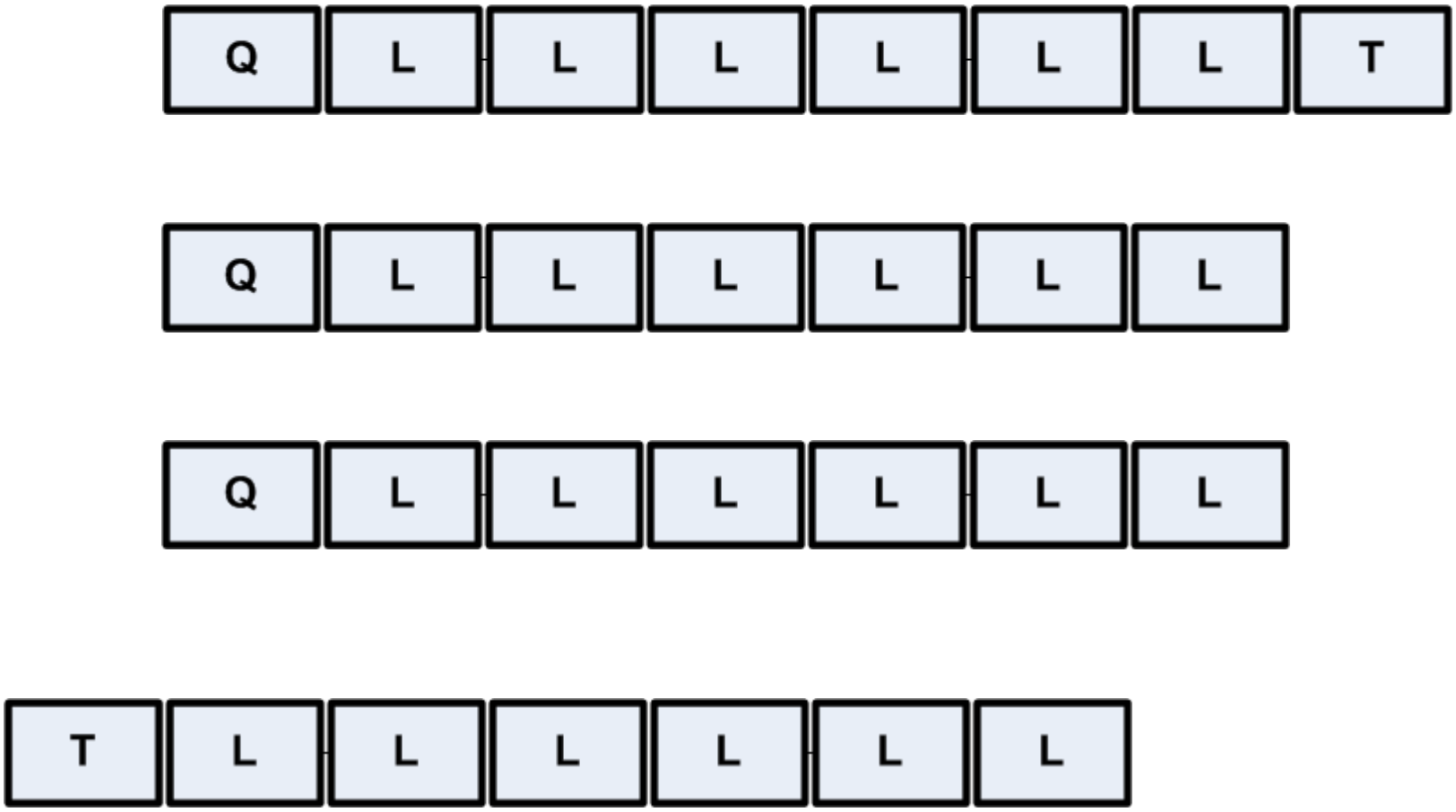
Cross coupling of the two cavities

- Cross coupling between cavities must be considered in the design of the RF control system.
- Cross coupling is given as the signal level in the neighboring cavity with respect to the level of the excited cavity.
- The result of the measurement:
  - without spacer (cavities connected directly) 27 dB
  - with the addition of the 5 in. spacer, 42 dB.

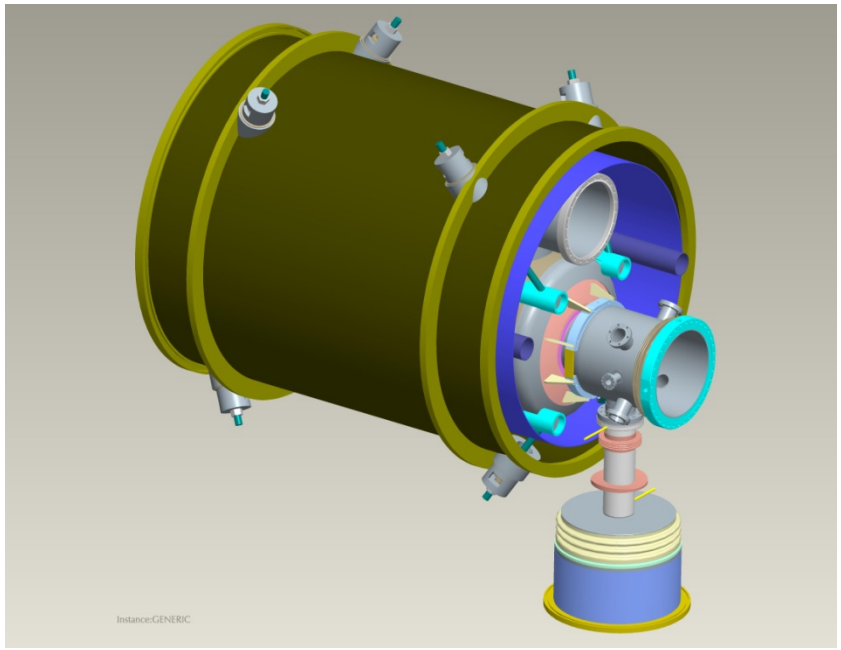
Really modular cryomodule?

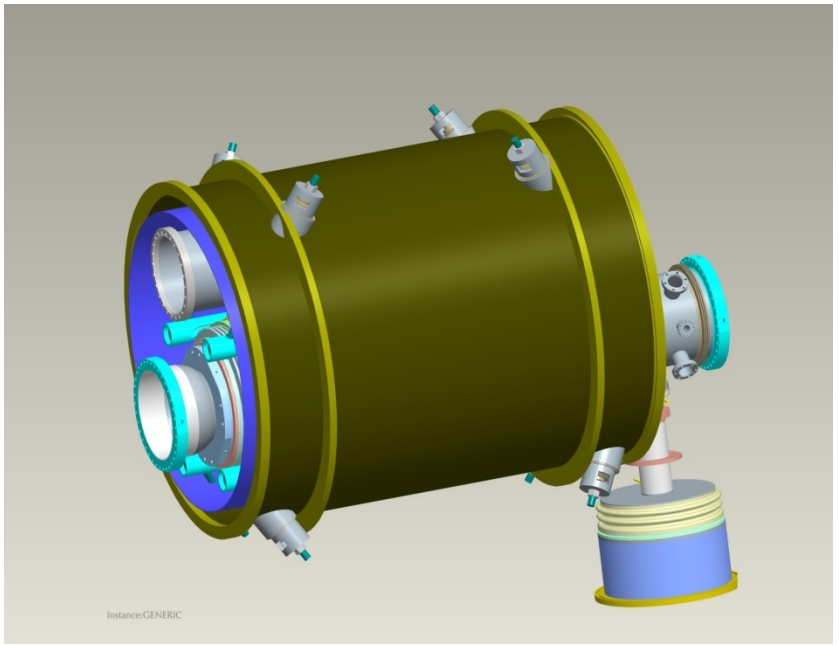
- For efficient real-estate gradient, keep the linac at 2K all along the machine.
- For easy assembly, alignment, interconnections and removing HOM power, assemble a single cavity in a cryomodule unit, to be designated as an “L” unit.
- Quadrupole units , or “Q” units, will house quadrupole lenses, helium connections and beam instrumentation.
- A termination unit, or “T” unit, connects to romm temperature at each end.

Linac structure

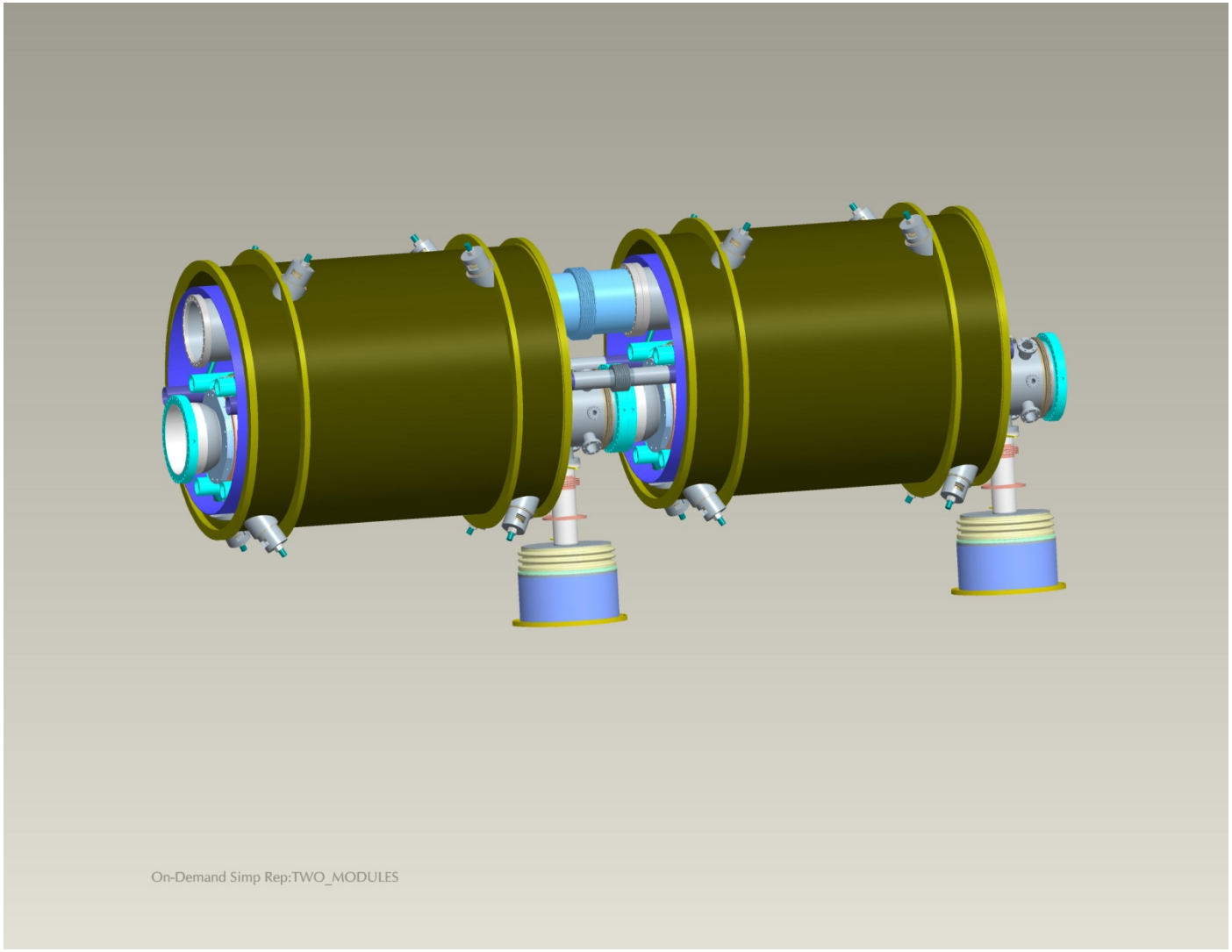


A single L unit

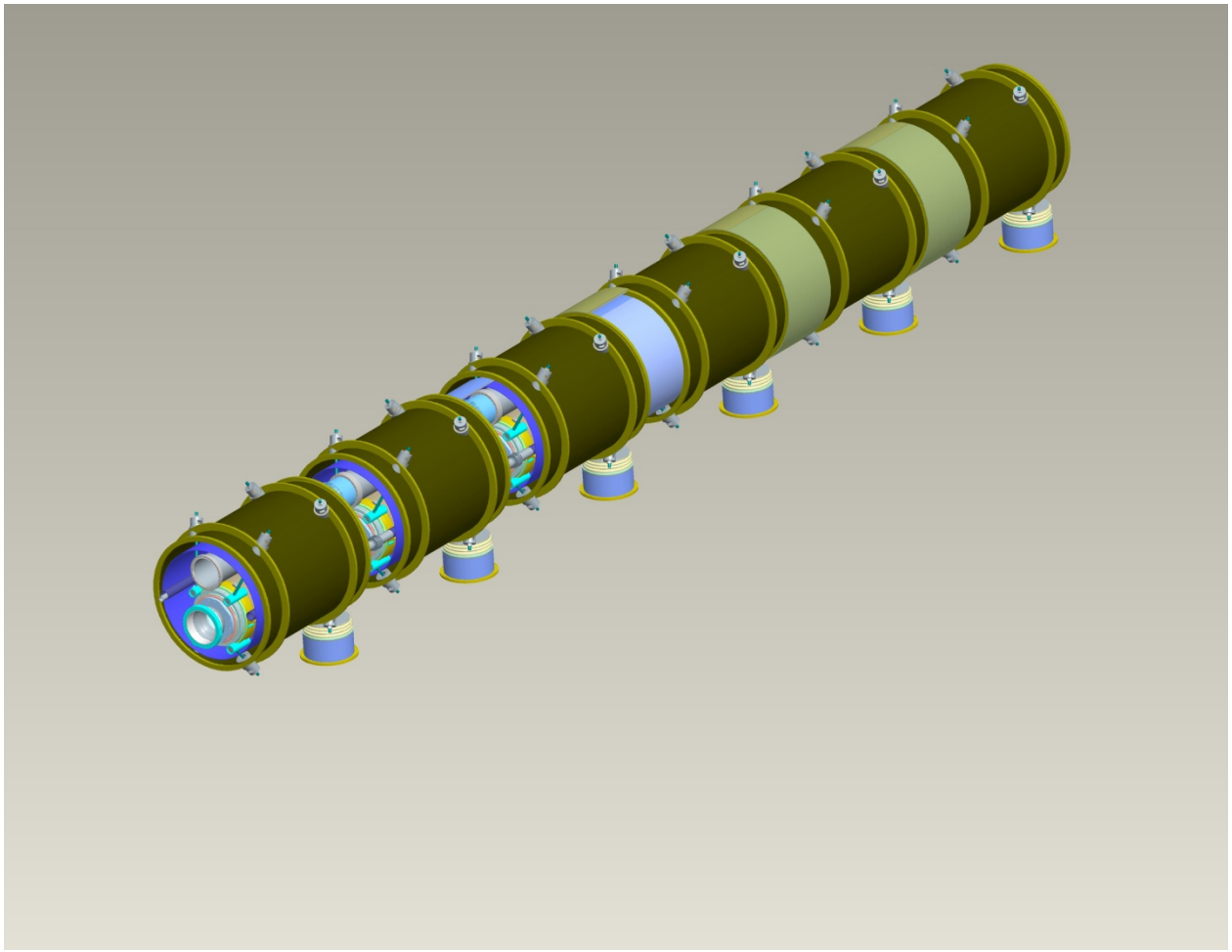




Connecting two L units



A string of “L” units, some joined



Work on 704 MHz connections

“Dry-tent” technique at Berkeley’s ALS