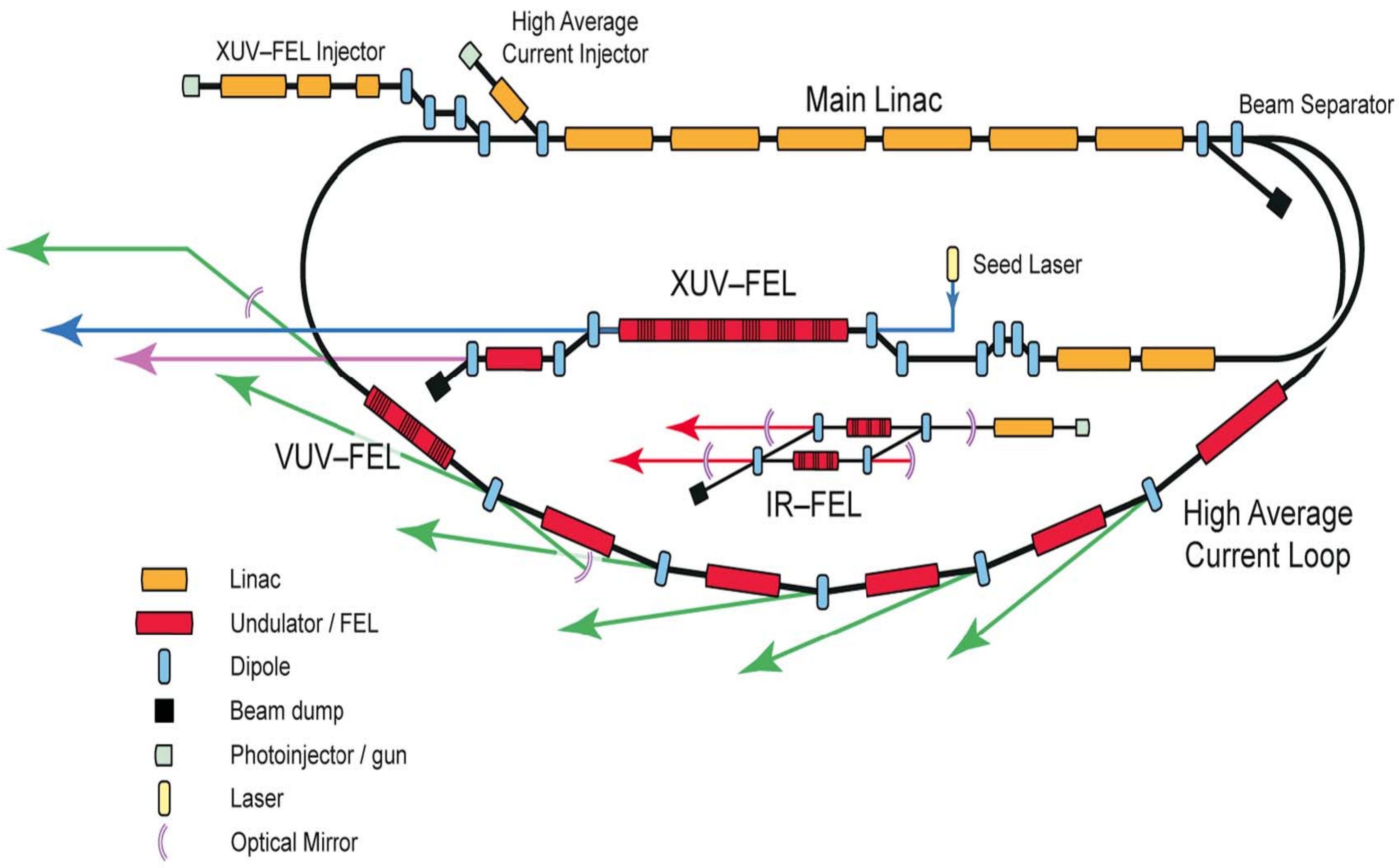
What are the Optimal Parameters for Superconducting Cavities of an ERL Light Source?

Mike Dykes

Contents

- Gradient & Qo
  - Frequency
  - Operating Temperature
- HOMs
- Coupling Q_{Ext}
  - Couplers
- Tuners
  - RF Control
  - Microphonics

4GLS

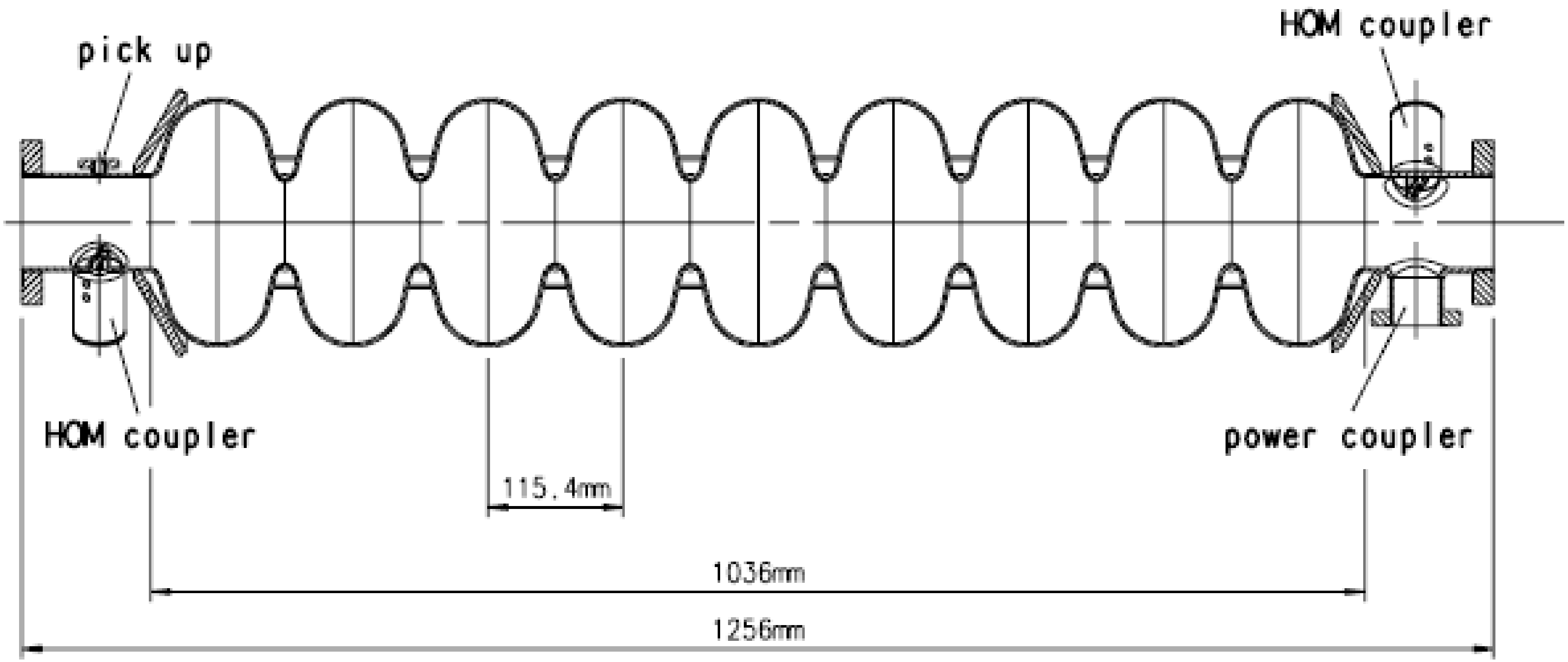


High Average Current Injector
XUV–FEL Injector
Main Linac
Beam Separator
Seed Laser
XUV–FEL
VUV–FEL
IR–FEL
High Average Current Loop
Linac
Undulator / FEL
Dipole
Beam dump
Photoinjector / gun
Laser
Optical Mirror

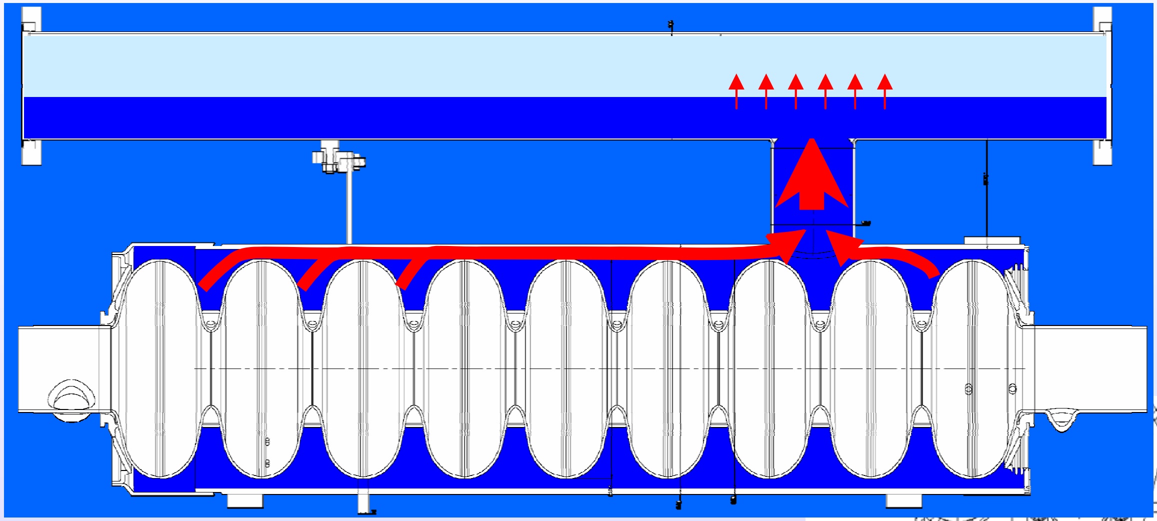
Gradient and Qo

- Need 20MV/m with Qo = 10^{10}
- Why?
  - Dynamic losses
  - Cost ptimisation

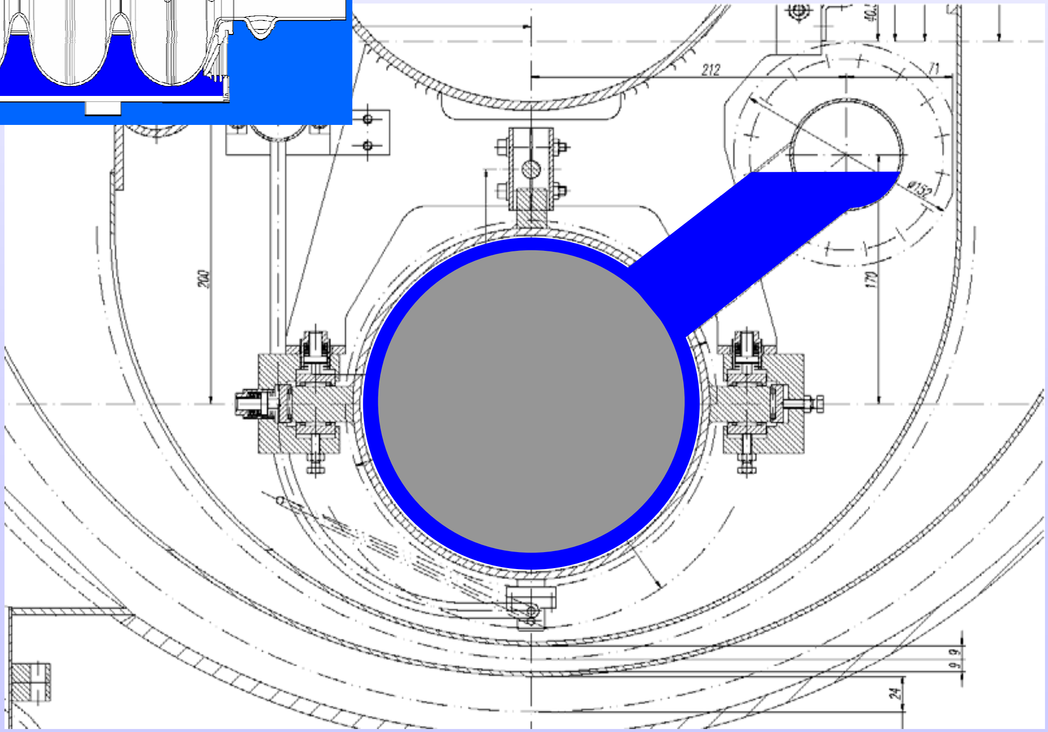
Gradient


pick up
HOM coupler
HOM coupler
power coupler
115.4mm
1036mm
1256mm

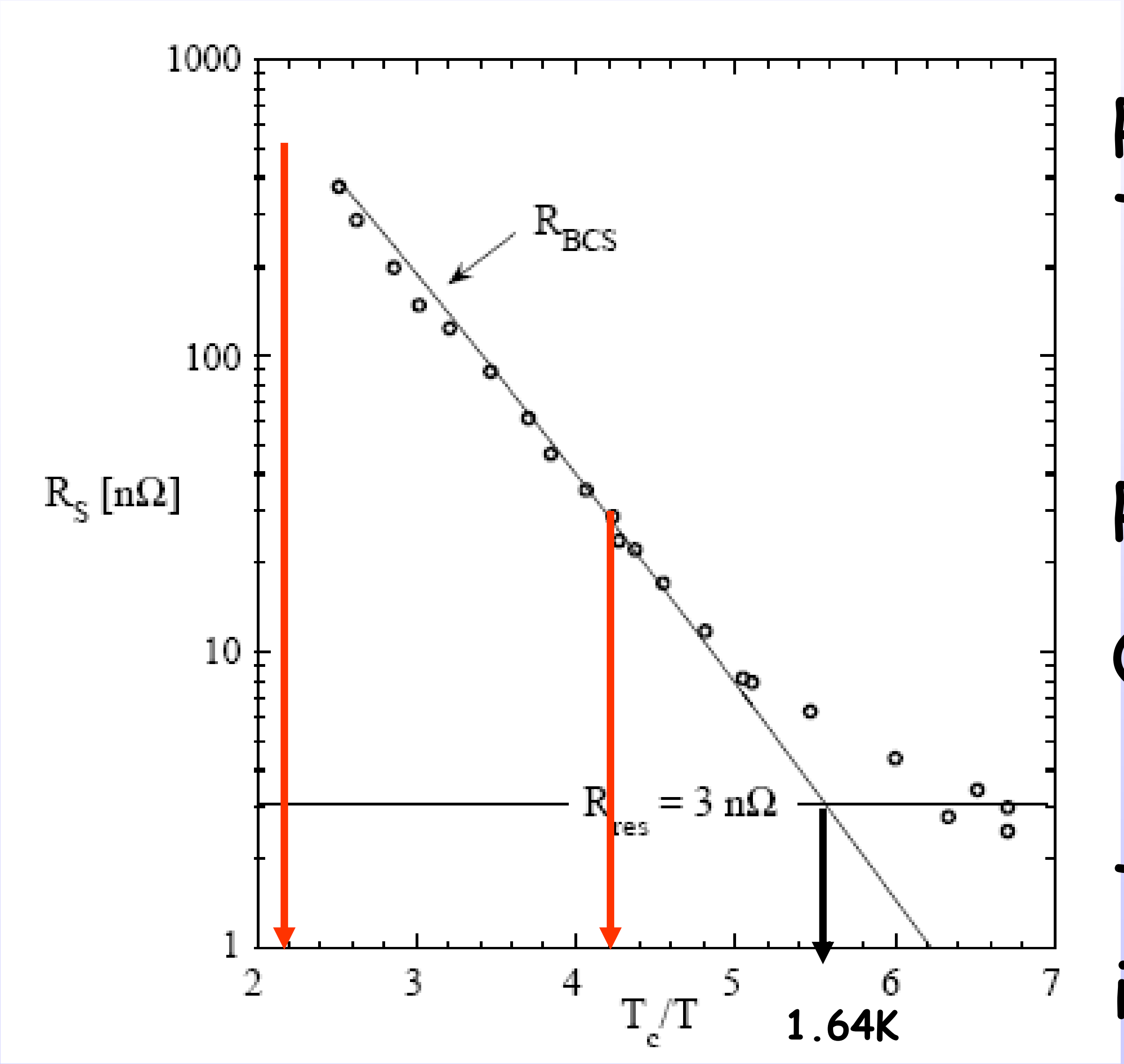
Accelerating Gradient



For CW operation, TESLA module needs to be modified to give more LH_2 flow. Need larger diameter spout and two phase line



Frequency & Temperature 1



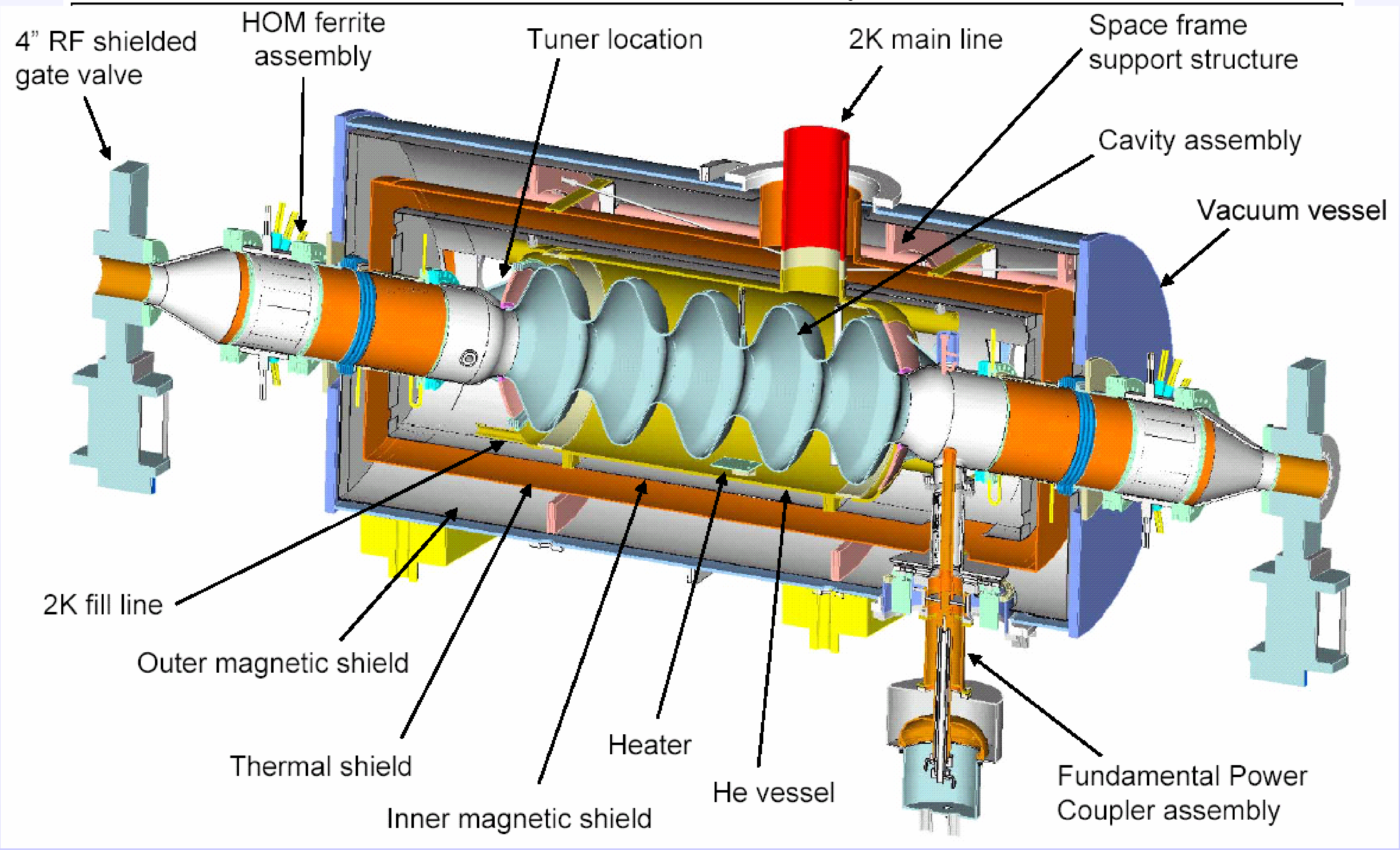
R_{BCS} for 9 cell TESLA Cavity

$R_{res} = 3n\Omega$;

$Qo = 10^{11}$

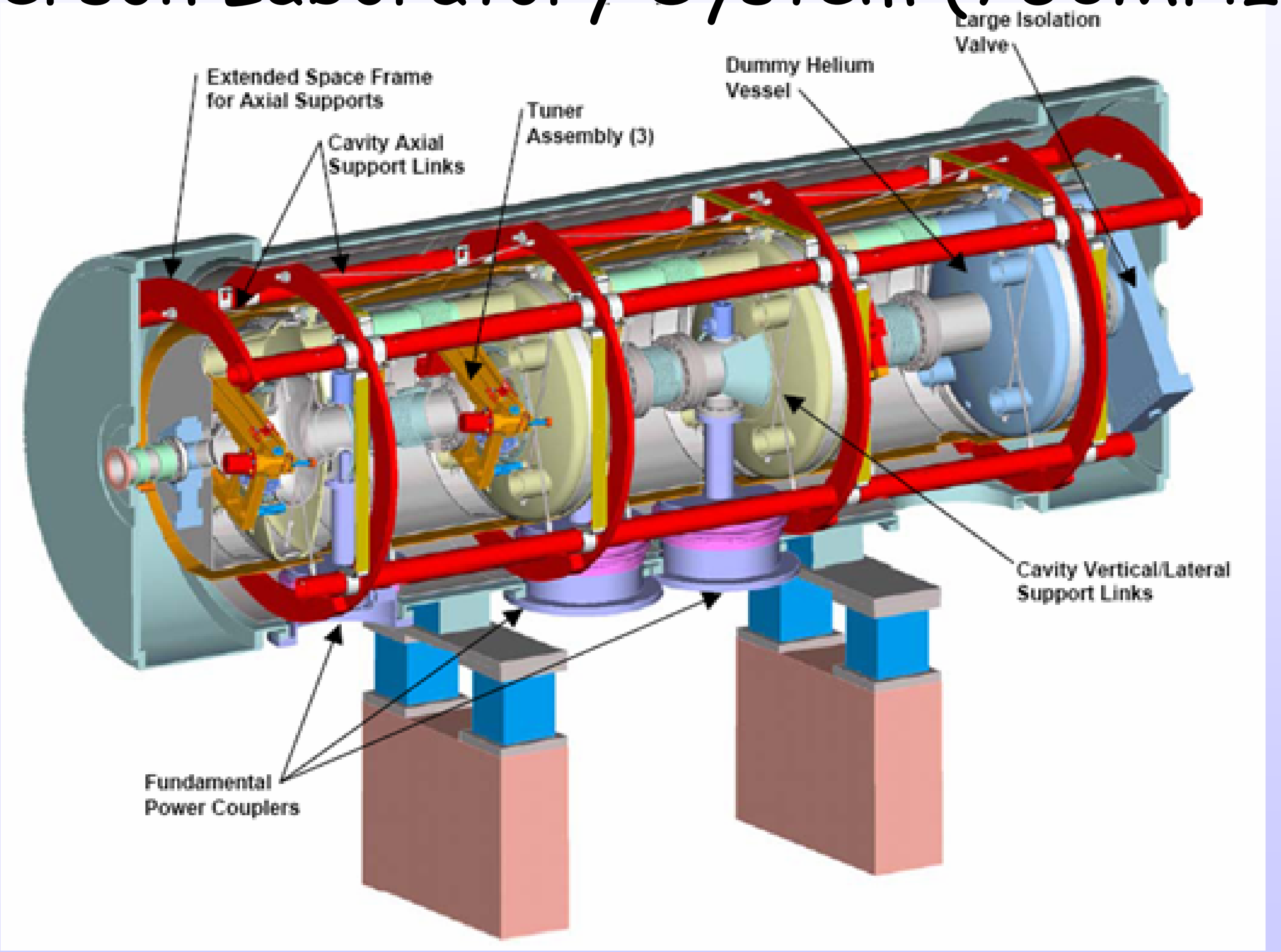
Tc for niobium is 9.2 K

Brokhaven National Lab System (700MHz)



Frequency Options 2

Jefferson Laboratory System (750MHz)



HOM Damping

- Many schemes will work equally well, (except for loop couplers). Based on simulation and initial experiments
- Q = 10^3 to 10^4 which is good enough for 1 A machines.
- HOM power is a concern

HOM Power

Average HOM losses per cavity given by

P = loss factor x single bunch charge x beam current

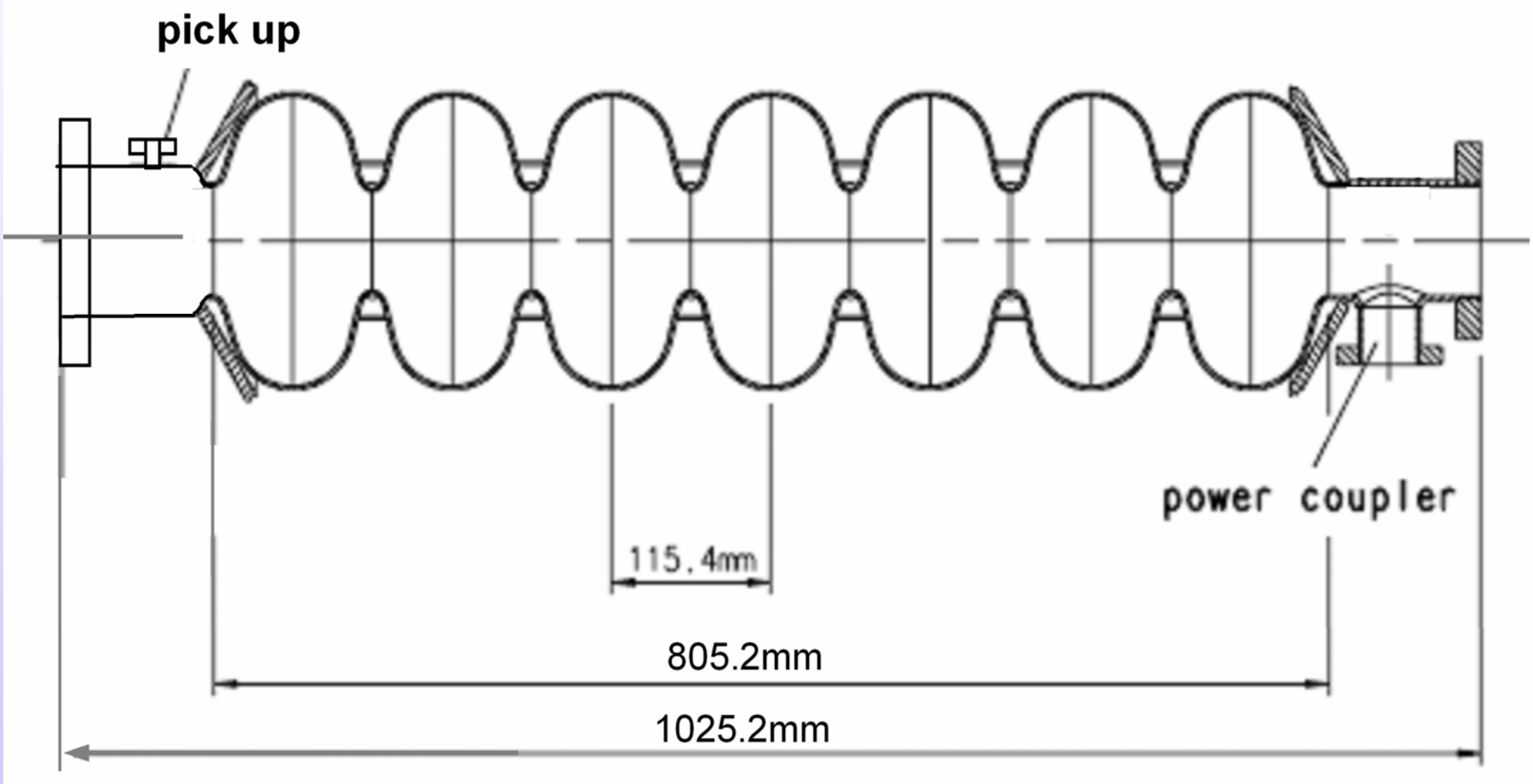
= 176 watts

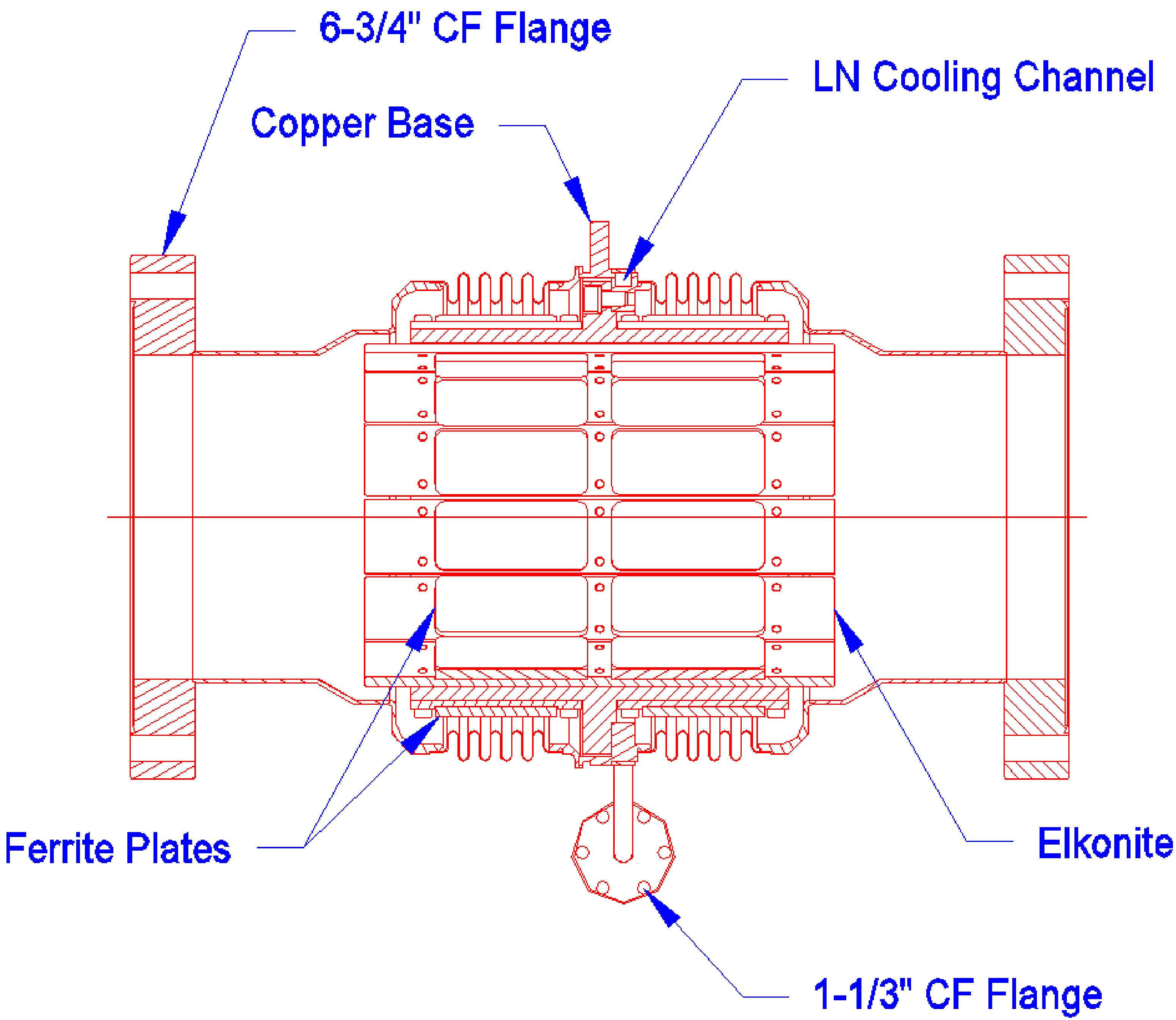
If monopole mode excited could be

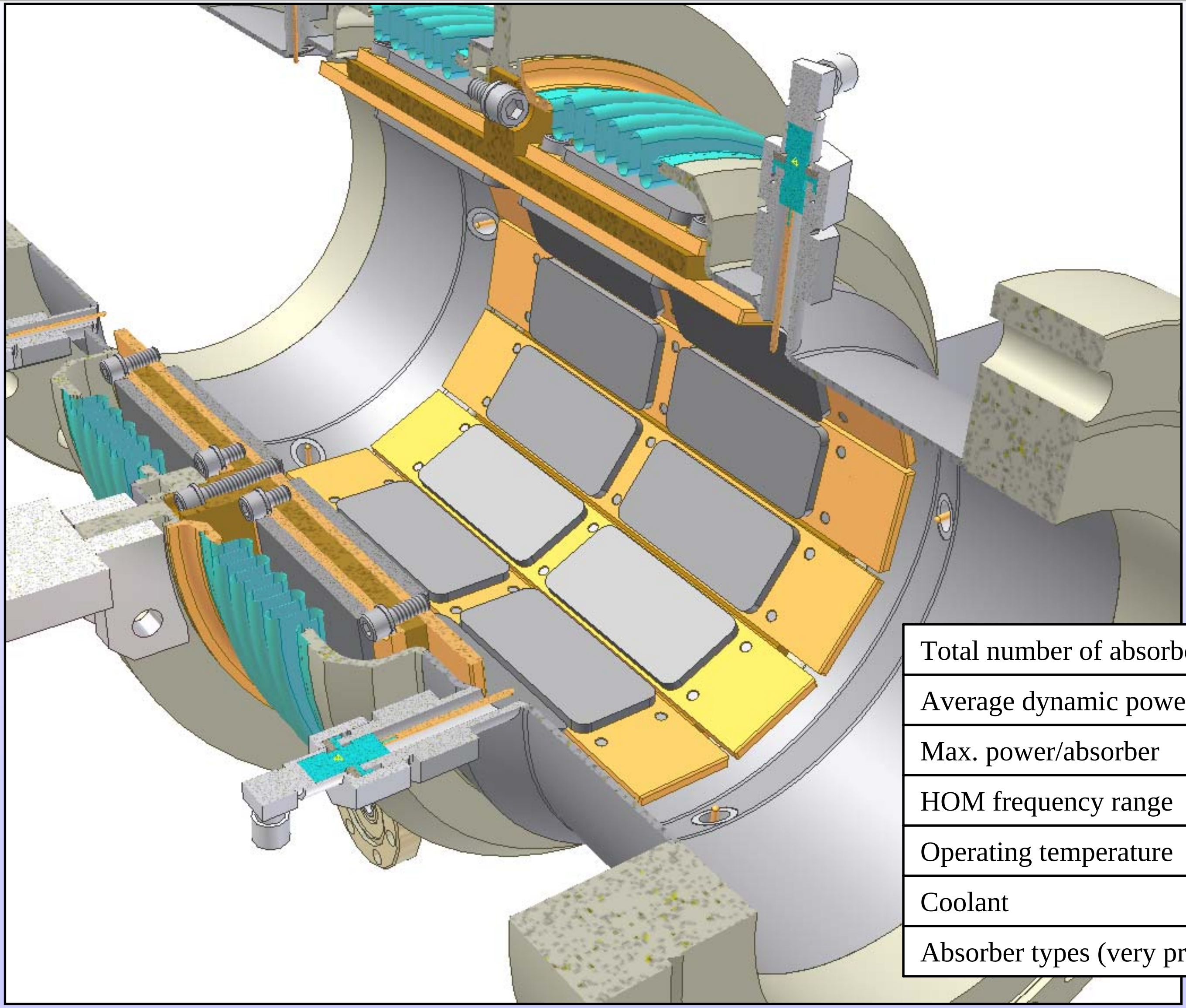
$P = (R/Q)QI^2$

Could be as much as 1 kW

HOMs

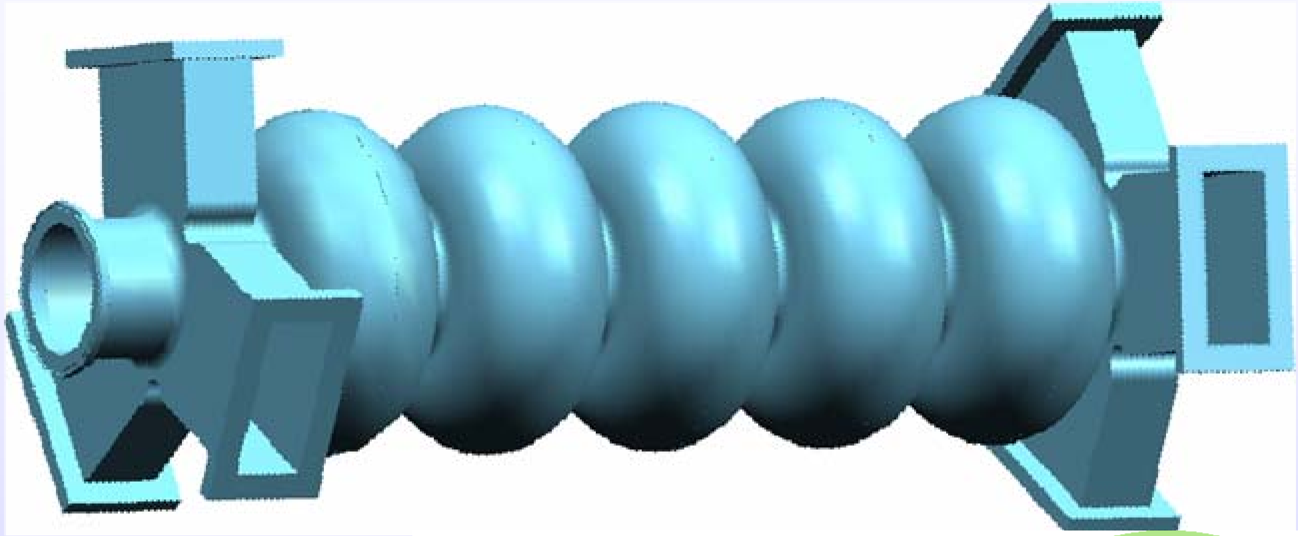


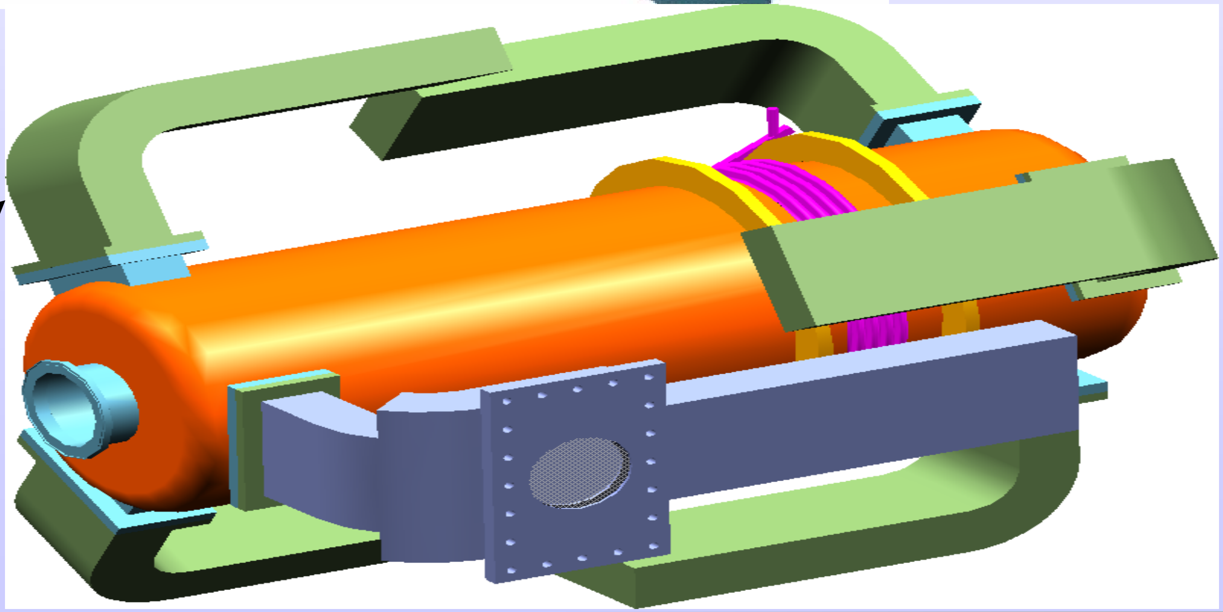

6-3/4" CF Flange
LN Cooling Channel
Copper Base
Ferrite Plates
Elkonite
1-1/3" CF Flange



Total number of absorbers	3+3
Average dynamic power per absorber	26 W
Max. power/absorber	200 W
HOM frequency range	1.4 – 100 GHz
Operating temperature	80 K
Coolant	Helium Gas
Absorber types (very prelim.)	TT2, hex Z, C10

Waveguide Damping

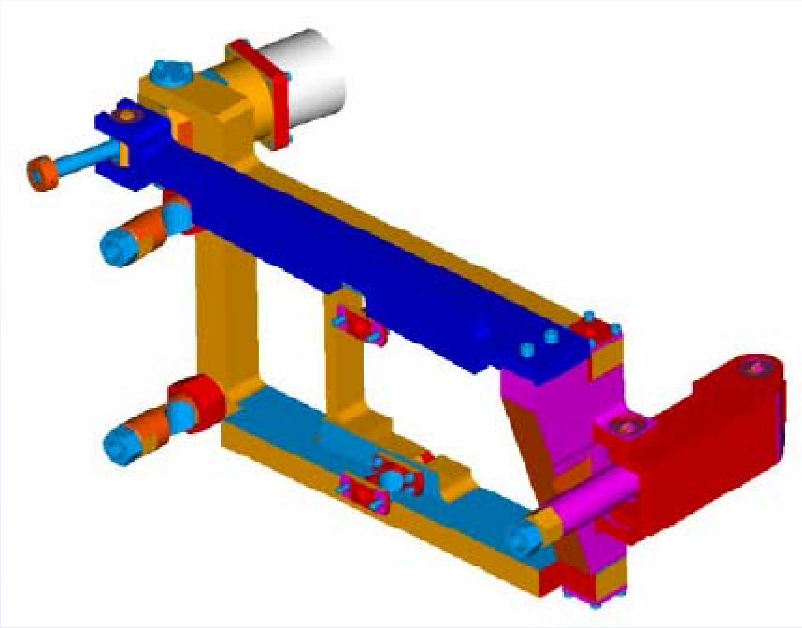


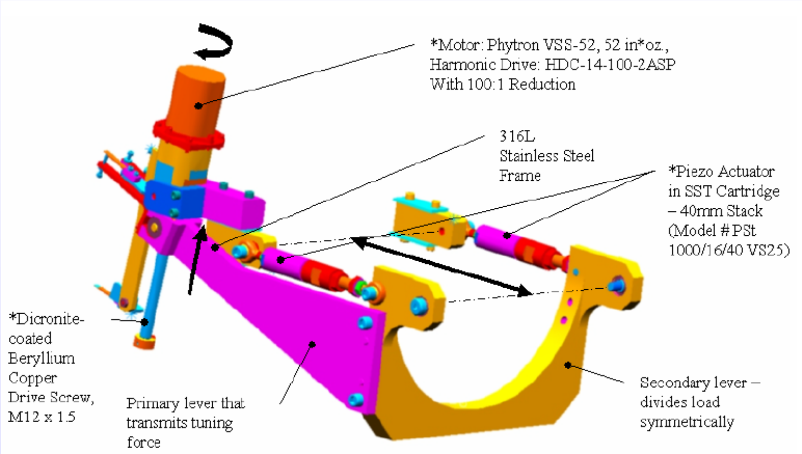


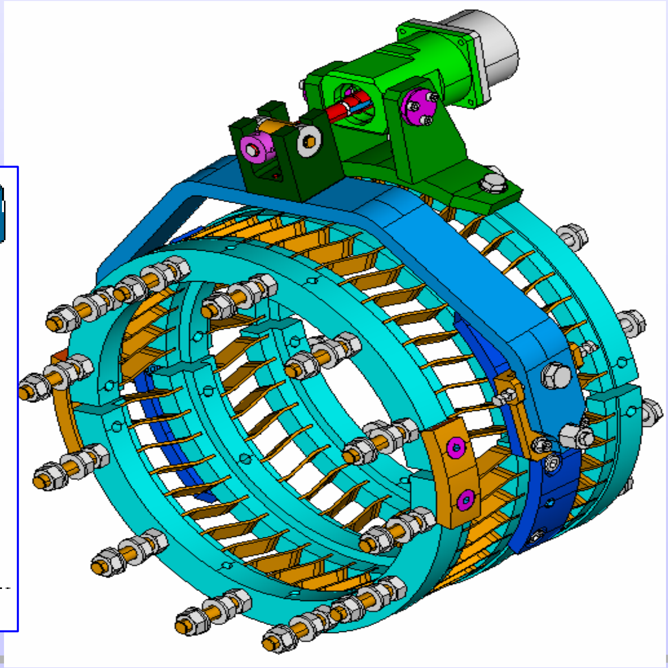
JLab 750 MHz design

HOM Dampers at 80K

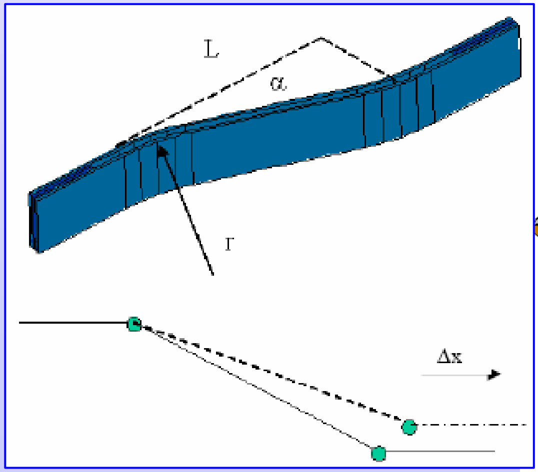
Tuning - Slow



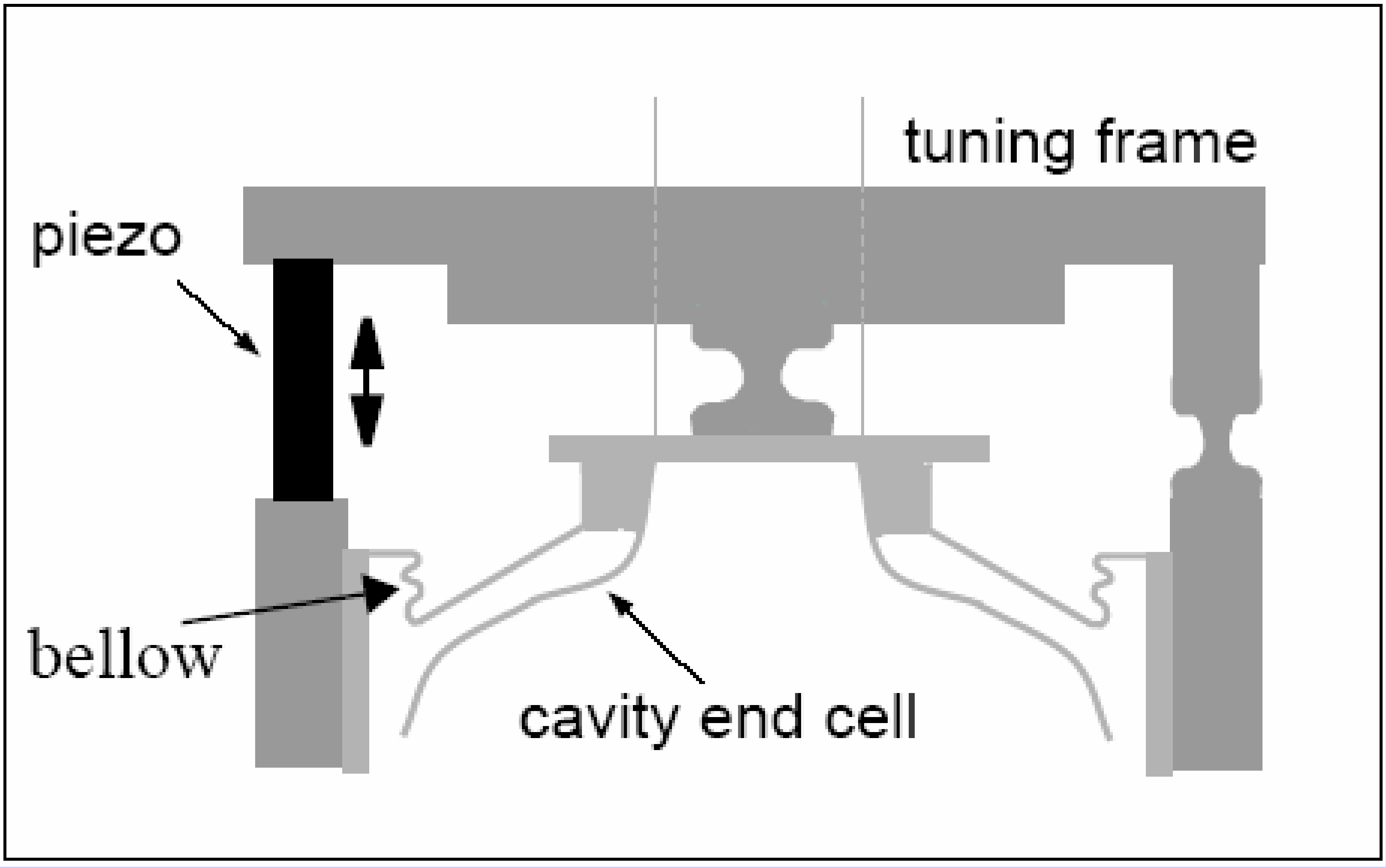




	Lever	Blade
Tuning range [mm]	1.9	1.0
Tuning range [kHz]	820	440
Sensitivity[Hz/step]	0.74	0.38
Δf. warm/cold [MHz]	2.3	2.3
ΔF (4.2K/2K) [kHz]	30	70



Tuning - Fast



Conclusions