MODE MODELLING of MULTICELL CAVITIES

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JOHN LAWVERE

MULTICELL CAVITIES

- SERIES OR PARALLEL RESONANCE: When is dissipated power maximum?
- COUPLING: INDUCTIVE or CAPACITIVE
- Is IRIS ENERGY magnetic or electric?
- ANALYSIS in TIME or FREQUENCY?
- A FEW EXAMPLES
- CAN MODEL HOMs?
- CONCLUSION

SERIES OR PARALLEL?

- SERIES RLC DISSIPATES MOST POWER WHEN MAGNETIC ENERGY IS MAXIMUM
- PARALLEL RLC DISSIPATES MOST WHEN CAPACITOR (ELECTRIC) ENERGY IS MAXIMUM
- TM-MODE CAVITY DISSIPATES MOST WHEN MAGNETIC ENERGY IS MAXIMUM-> SERIES

COUPLING: INDUCTIVE or CAPACITIVE?

- IS ENERGY IN IRIS RELATED TO DIFFERENCE IN CELL-TO-CELL VOLTAGE OR TO DIFFERENCE IN CURRENTS?

ANALYSIS: FREQUENCY or TIME?

- FREQUENCY DOMAIN:
- WRANGLER, SCHMUSER, PADAMSEE:
- Know eigenvector for PI mode, find frequency.
- Can determine required beam pipe ends.
- Perturbation Theory-> Bead-Pull Tuning.
- TIME DOMAIN:
- System of differential equations
- Need Computer Algebra Software
- Find Frequency, Time Constant, Q

SOME RESULTS

- PADAMSEE: Ends of five-cell, capacitively-coupled cavity needs beam-pipe capacitance twice cavity-to cavity coupling capacitance to make PI mode have flat field

MODES of SYMMETRICAL, 5-CELL, INDUCTIVELY-COUPLED

$$(V_1, V_2, V_{3,}, V_4, V_5) = (1,-1,0,1,-1), \omega = \frac{1}{\sqrt{C(L-M)}}, \tau = \frac{2(L-M)}{R}$$

$$(1,1,0,-1,-1), \omega = \frac{1}{\sqrt{C(L+M)}}, \tau = \frac{2(L+M)}{R}$$

$$(-1, \sqrt{3}, -2, \sqrt{3}, -1), L_{EFF} = L +/- \sqrt{3}M$$

$$(-1,0,1,0,-1), \omega = \frac{1}{\sqrt{LC}}, \tau = \frac{2L}{R}$$

MODIFY:L’=L+M

$$\omega = \frac{1}{\sqrt{(L+2M)C}}, \tau = \frac{2(L+2M)}{R}, (V_1, V_2, V_3, V_4, V_5) = (1,-1,1,-1,1)$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

QUESTION

- CAN MORE COMPLICATED CIRCUIT ANALOGUES MODEL HIGHE-ORDER MODES?

CONCLUSION

- FREQUENCY-DOMAIN CIRCUIT-ANALOGY MODELLING CAN RELATE SINGLE-CELL PROPERTIES TO MODE FREQUENCIES
- FREQUENCY-DOMAIN MODELLING CAN DETERMINE REQUIRED END MODIFICATIONS
- FREQUENCY-DOMAIN MODELLING+PERTURBATION THEORY YIELDS BEAM-PULL FIELD-FLATNESS TUNING METHOD

CONCLUSION

- TIME-DOMAIN CIRCUIT-ANALOGY MODELLING CAN RELATE MODE FREQUENCY, TIME CONSTANT, QUALITY FACTOR, TO CELL PROPERTIES