# Mixed Coupling Wireless Power Transfer

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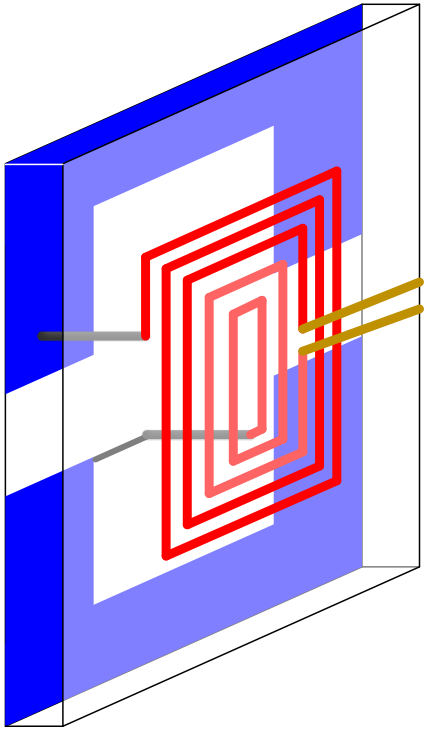
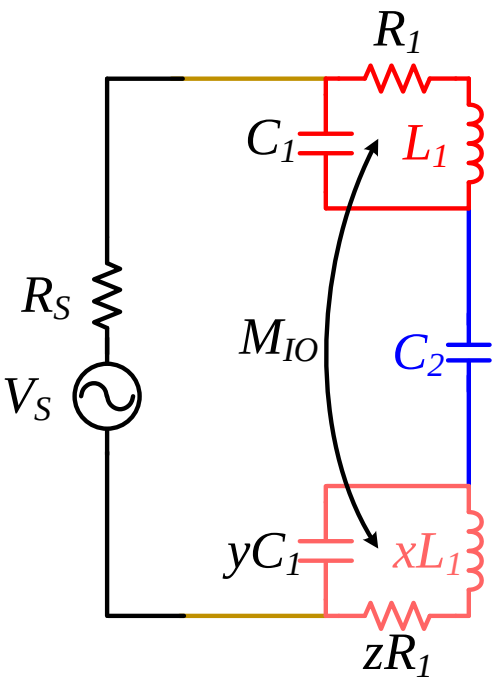
# MIXED COUPLING COILS

◆ Equivalent circuit can be modeled as below:





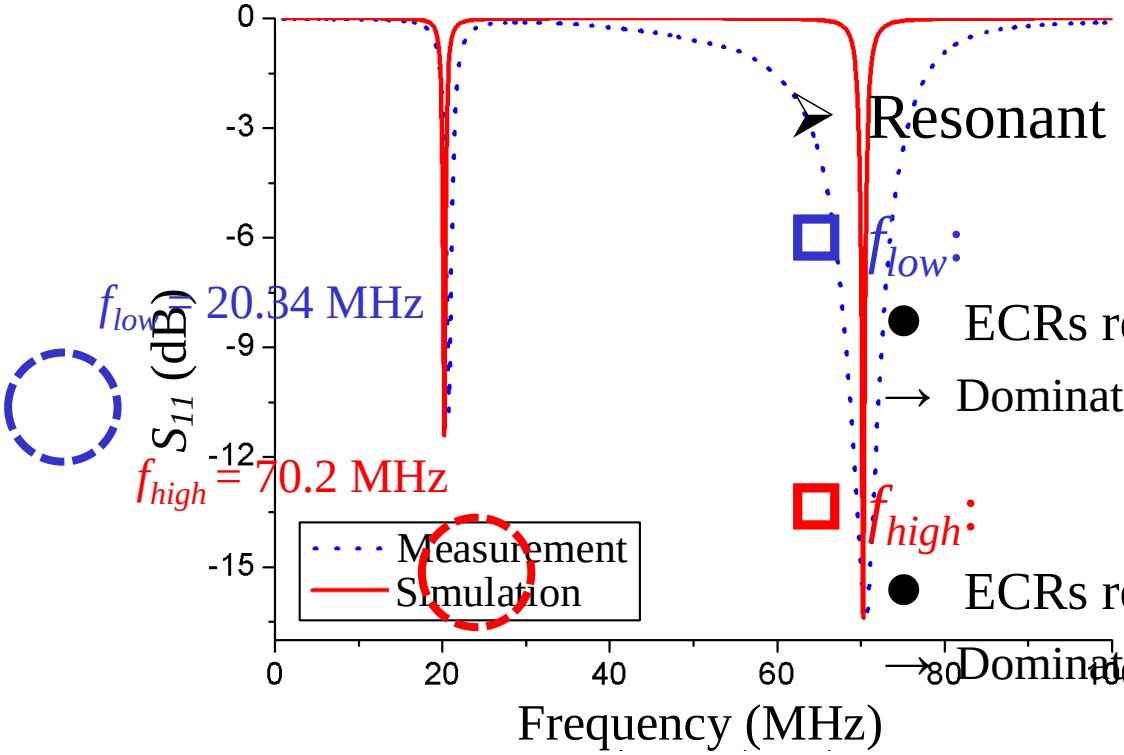

➢ Circuit parameters:

- Printed Spiral Coil (PSC):
  - Inductance ($L_1$)
  - Capacitance ($C_1$)
  - Resistance ($R_1$)
- Electric Coupling Ring (ECR):
  - Capacitance ($C_2$)

- Circuits parameters of inner PSC can be modeled as having ratio *x*, *y* and *z* with outer PSC

# MEASUREMENT AND SIMULATION RESULTS

- Measurement $S_{11}$ by E5071C ENA of proposed mixed coupling coils and ADS simulation of proposed equivalent circuit:




➢ Resonant Frequencies:

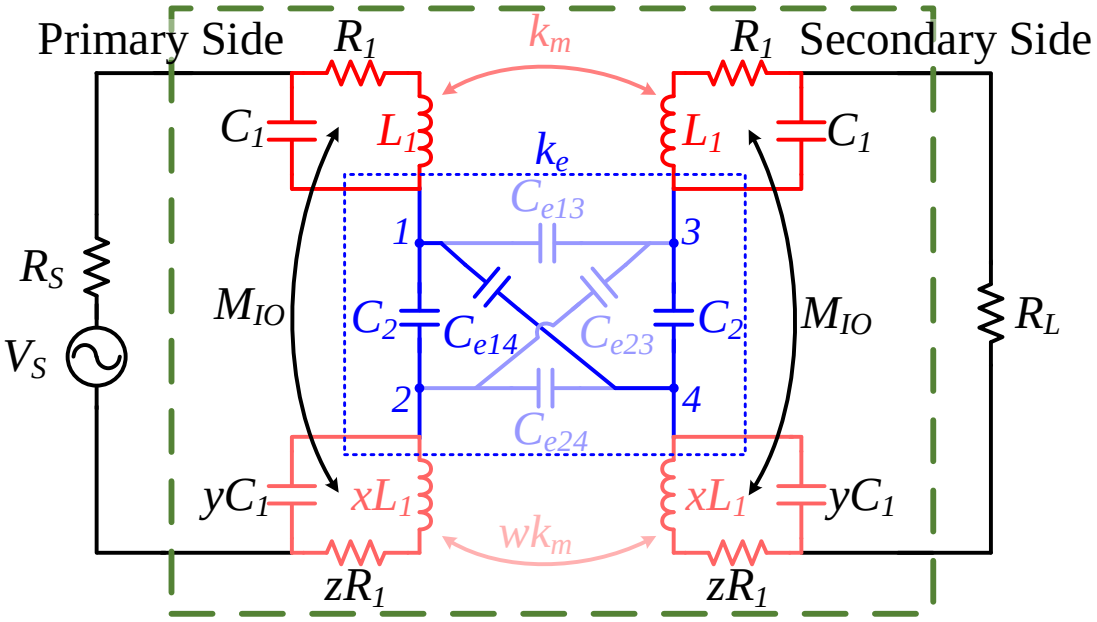
$f_{low}$:
- ECRs resonate with outer coil
  → Dominated by magnetic coupling

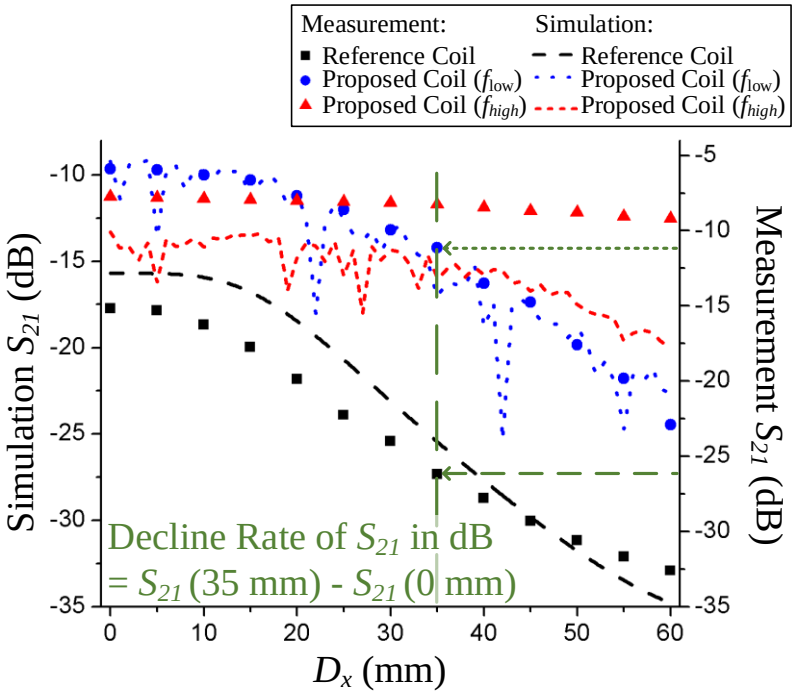
$f_{high}$:
- ECRs resonate with inner coil
  → Dominated by electric coupling

➢ Frequency band at $f_{high}$ is wider due to skin effect.
- ADS does not support skin effect simulations.

# Measurement and Simulation Results

- Measurement and simulation results of lateral misalignment:



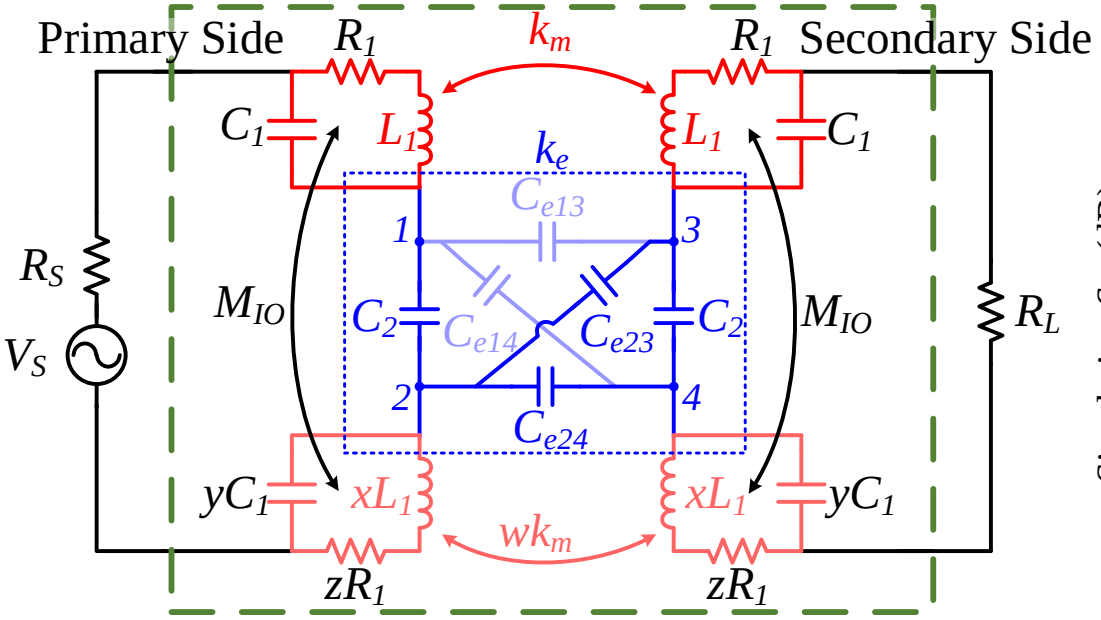



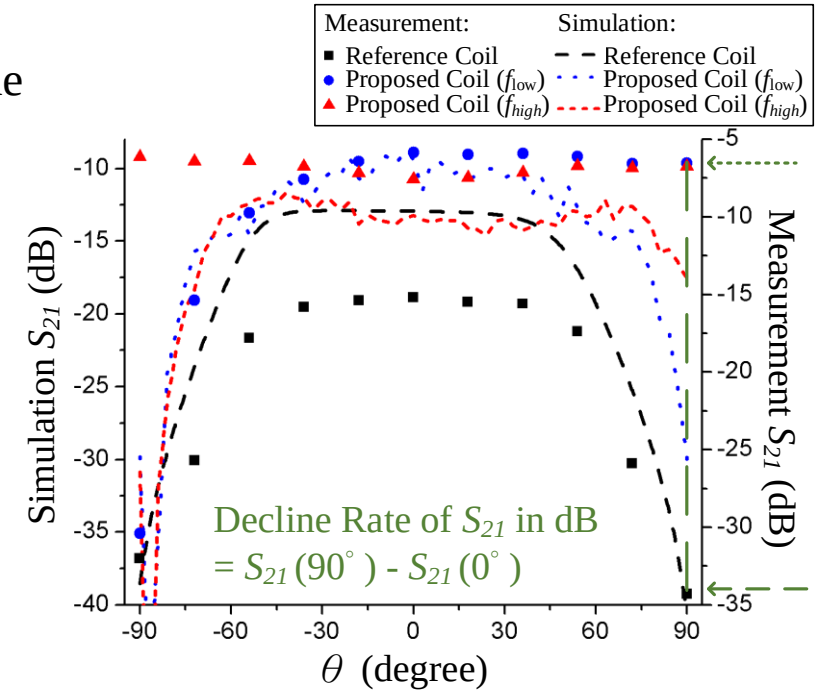

- Proposed MCC improves decline rate by 26.4 % at $f_{low}$.
- $S_{21}$ of proposed MCC has only 16.5 % drop while misaligned 60 mm laterally at $f_{high}$.
- $f_{high}$ is **much** dominated by electric coupling.

→ $k_m$ has better compensation by $k_e$.

# MEASUREMENT AND SIMULATION RESULTS

- Measurement and simulation results of angular misalignment:




- Proposed MCC improves decline rate angularly misaligned 90˚ by 78.1 % at $f_{low}$.
- $S_{21}$ of proposed MCC has **no drop but raise** at wide angular misalignment at $f_{high}$.