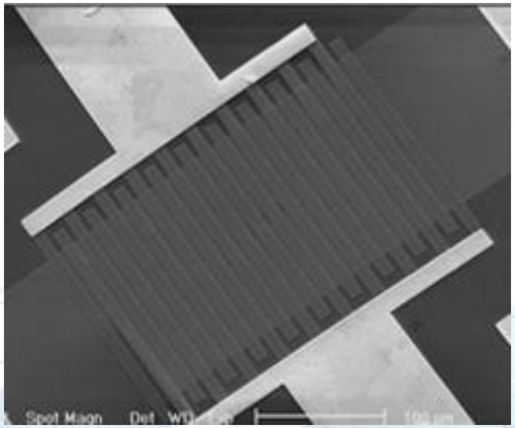
Analysis of Spiral Resonator Filters

S. Yushanov, J.S. Crompton
and K.C. Koppenhoefer
AltaSim Technologies, Columbus, OH

Motivation

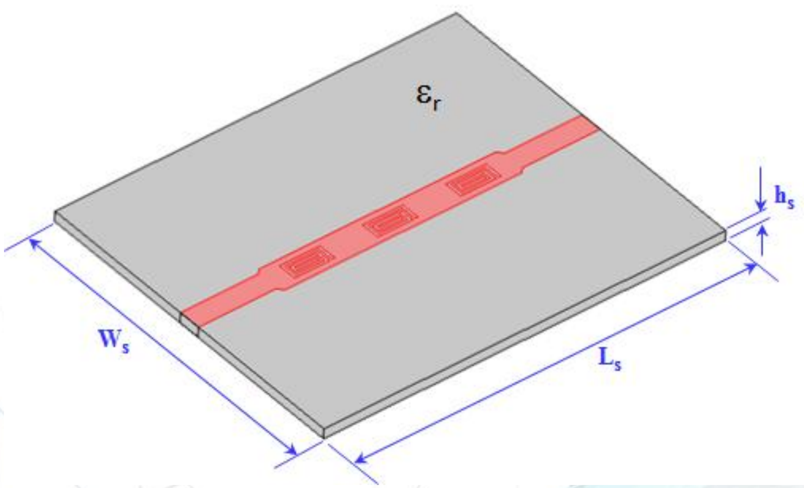


- **Compact wireless systems**
- **Smaller form factor**
- **Multiple functionality**
- **High rate data transmission**
- **Filter arrays with high quality factors and minimal volume**

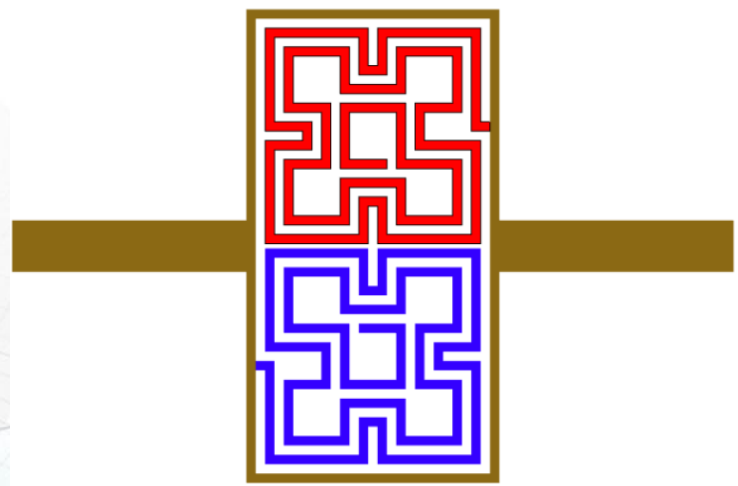
ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Problem description

- **Microstrip spiral resonator**
  - Etched microstrip
  - Dielectric substrate



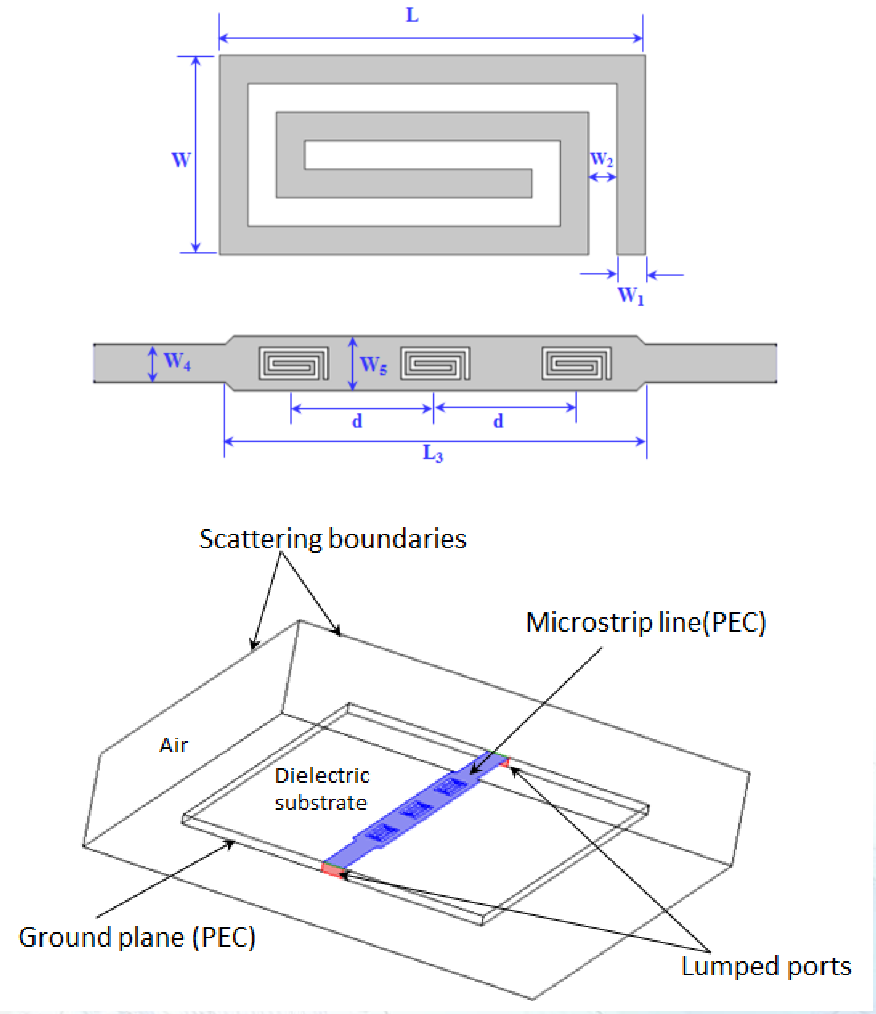
- **Fractal spiral resonator**
  - Two concentric Hilbert fractal curves
  - Magnetic metamaterials



ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Model definition

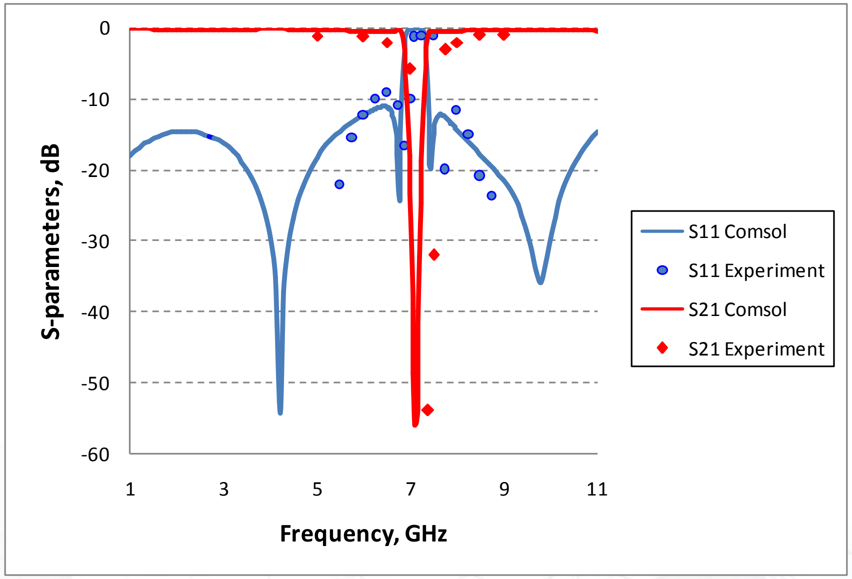
- **Microstrip treated as PEC**
- **Dielectric substrate of known permittivity**
- **PEC ground plane**
- **Lumped ports**
- **Air domain with scattering BC**



ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Microstrip Spiral Resonator

- S_{11} reflected signal and S_{21} transmitted signal agree with experimental data
- Resonant frequency of 7.2GHz
- Low insertion losses with narrow stopband ~ 0.5 GHz

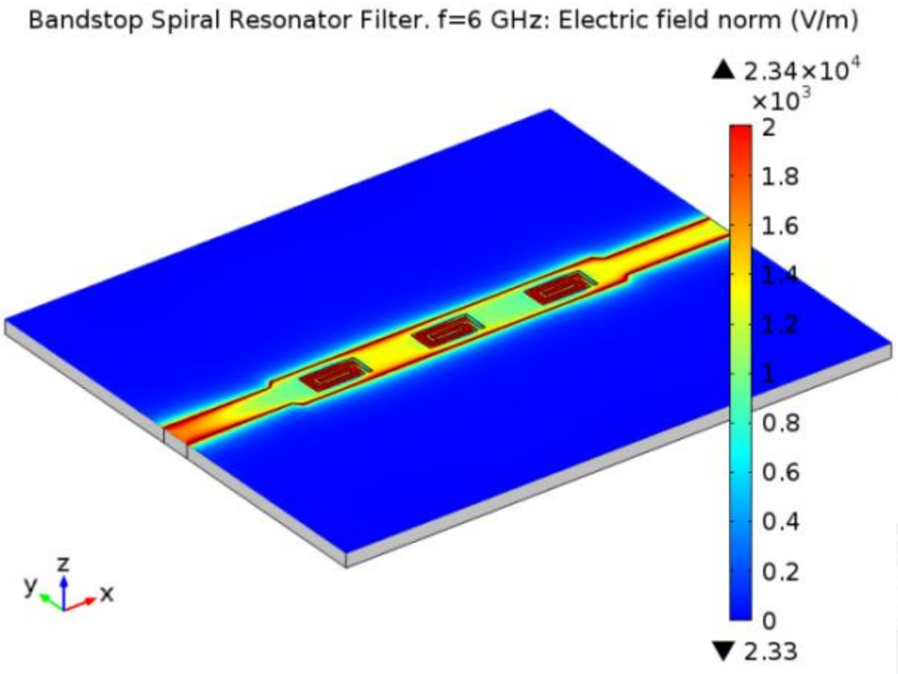


ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Microstrip Spiral Resonator

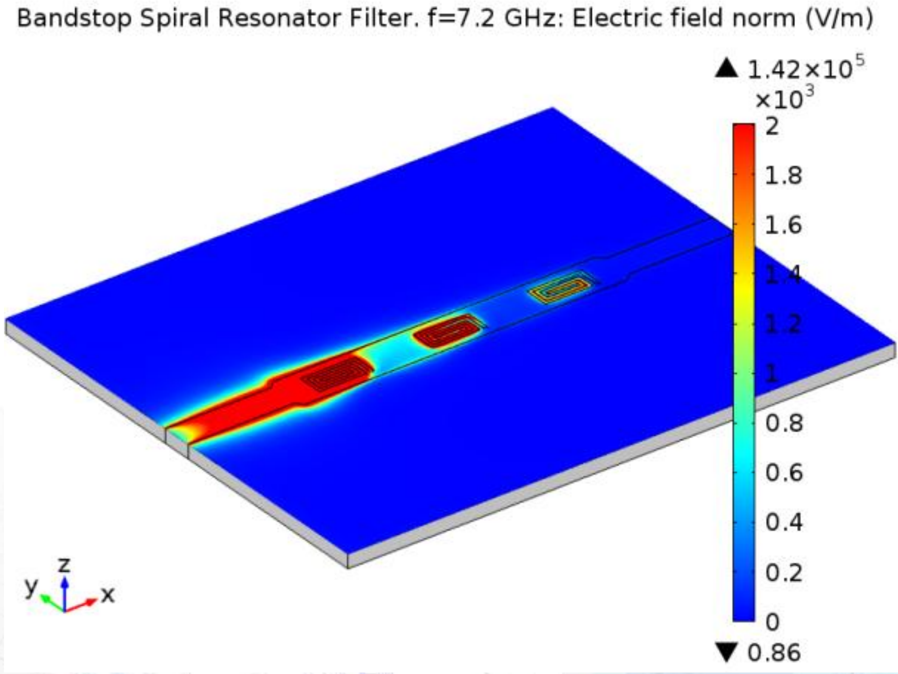
Electric field distribution

Below resonance



High transmission

At resonance

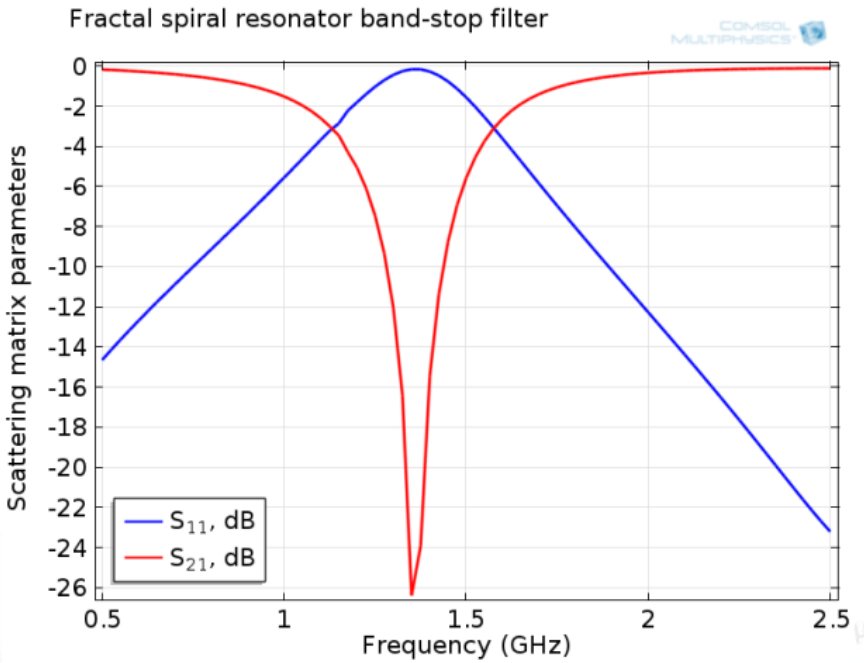


High attenuation

ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Fractal Spiral Resonator

- **Highly attenuated signal**
- **Selectivity of the filter is 100 dB/GHz with a 3 dB reference insertion loss**

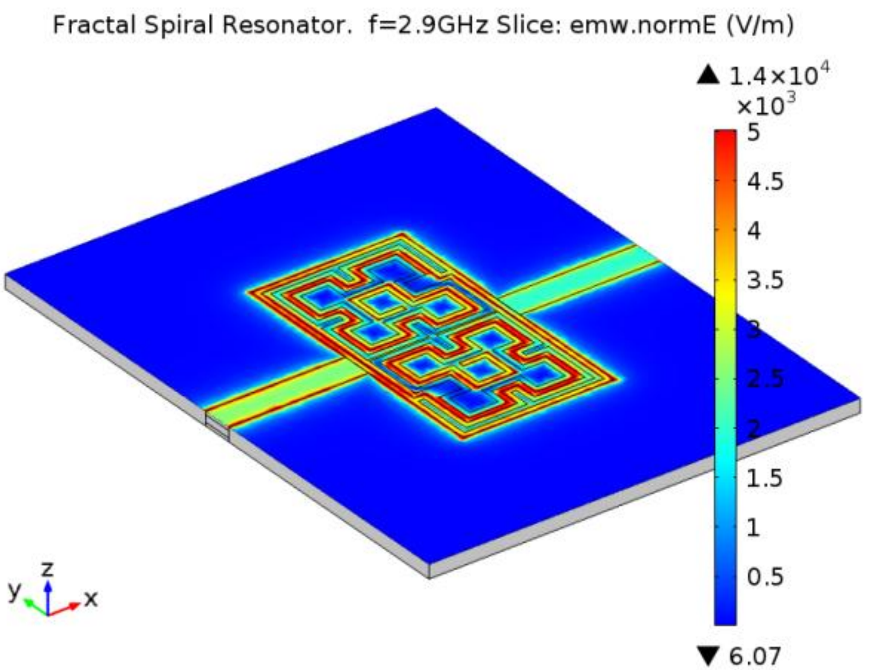


![ALTASIM TECHNOLOGIES - REALIZING TOMORROW'S TECHNOLOGY]

Fractal Spiral Resonator

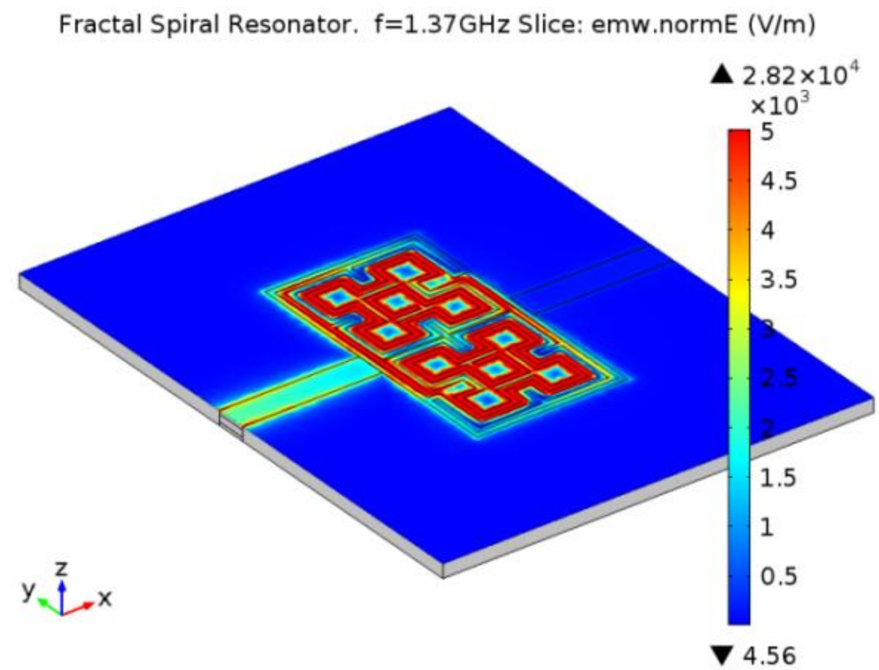
Electric field distribution

Below resonance



High transmission

At resonance



High attenuation

ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Summary

- **Analyses of two spiral resonator designs:**
  - **Microstrip**
  - **Fractal**
- **Analysis of microstrip spiral resonator agrees with experimental measurements**