



# UC4G London Workshop 2011

## B4G Wireless Communication Systems: Industrial and Academic Outlooks

Invited speech: Compact Three-dimensional Polarization Antennas for 4G Mobile Communication Systems

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# Outline

- Motivation & Aim
- WHY 3D?
- Challenges
- Designs reported
- Our prototypes
- Almost final prototype
- Results and discussions

# Motivation & Aim

- Performance requirement
  - High data-rate and high reliability
  - Varying handheld devices orientation
  - Changing surrounding environment
- Useful Methods in terms of antenna designs
  - Pattern, Polarization, Spatial diversities
- Our Aim
  - Propose practical prototypes of compact 3-D polarization antennas for mobile devices, fabricated and evaluated its performance.
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## WHY 3D?

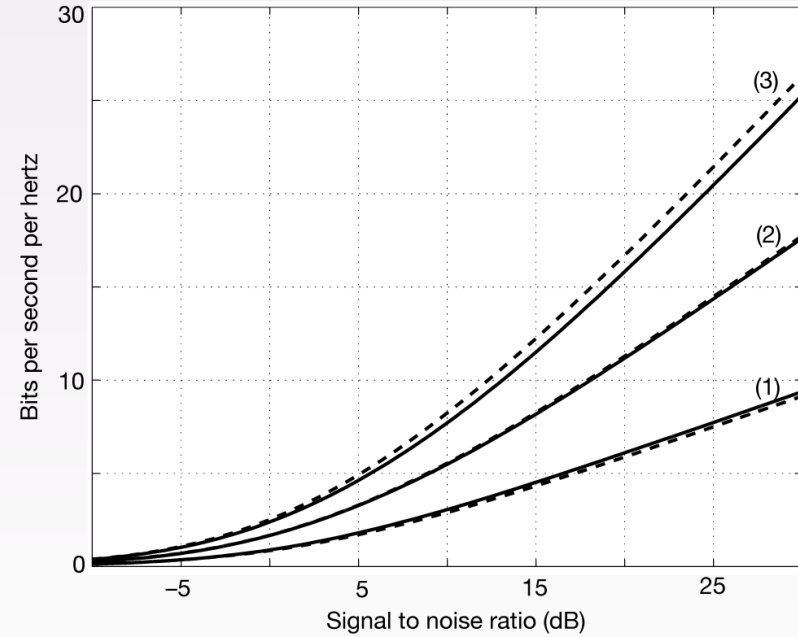
- **The advantages of Polarization Diversity has already been proved.**
- **Dual polarized planar wave allows two orthogonal channels.**
- **We believe 3D polarization will give us even better performance.**

N. Michishita and H. Arai, “A polarization diversity antenna by printed dipole and patch with a hole,” in Proc. IEEE Antennas Propag. Soc. Int. Symp., Boston, MA, Jul. 8–13, 2001, vol. 3, pp. 305–308.

D. Su, J. J. Qian, H. Yang, and D. Fu, “A novel broadband polarization diversity antenna using a cross-pair of folded dipoles,” IEEE Antennas Wireless Propag. Lett., vol. 4, pp. 433–435, 2005.

D. D. Stancil, A. Berson, J. P. Van’t Hof, R. Negi, S. Sheth, and P. Patel, “Doubling wireless channel capacity using co-polarized, co-located electric and magnetic dipoles,” IEE Electron. Lett., vol. 39, no. 14, pp. 746–747, Jul. 2002.

# Challenges

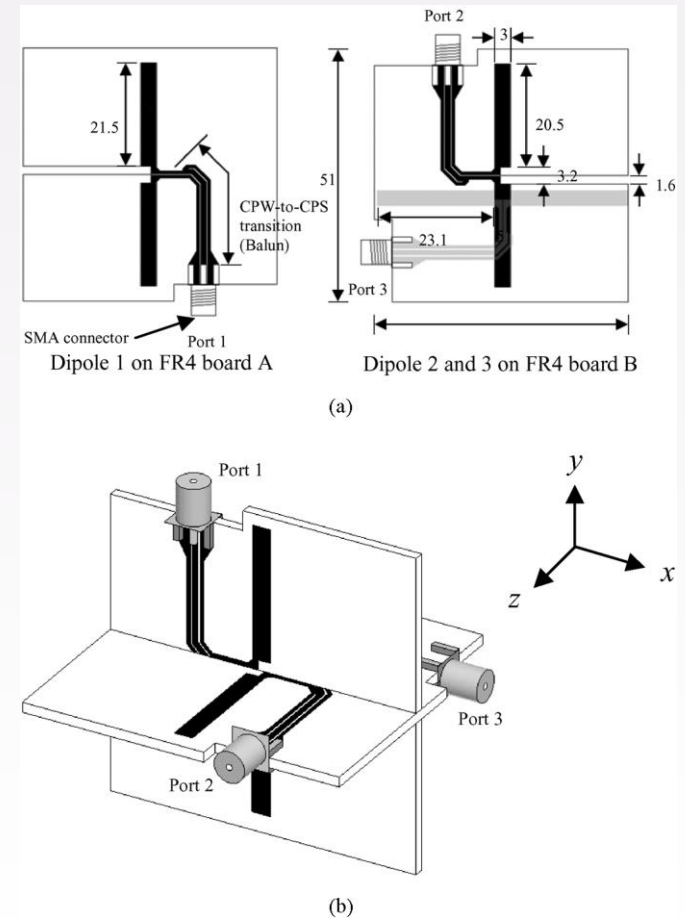
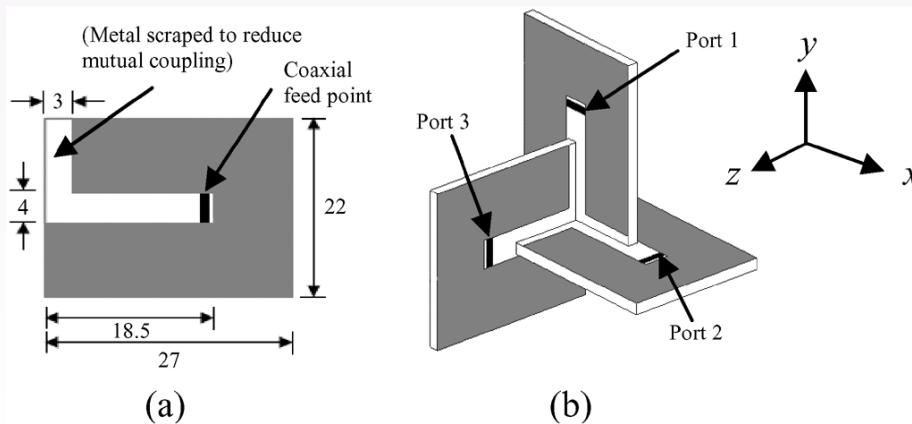


M. R. Andrews, P. P. Mitra, and R. de Carvalho, "Tripling the capacity of wireless communications using electromagnetic polarization," *Nature*, vol. 409, no. 6818, pp. 316–318, Jan. 2001.

- Size restriction in mobile devices
- Mutual coupling between closely located radiating elements

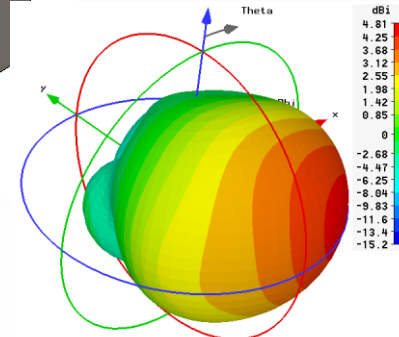
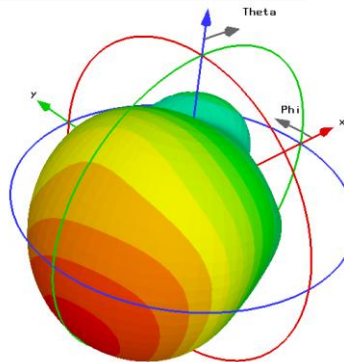
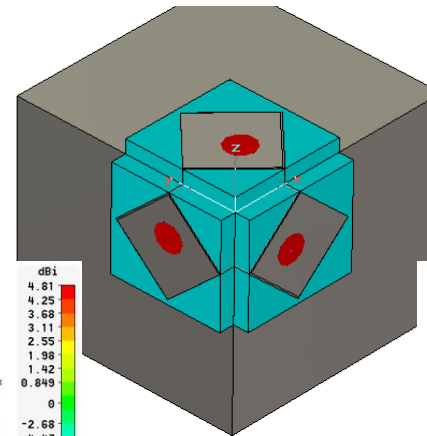
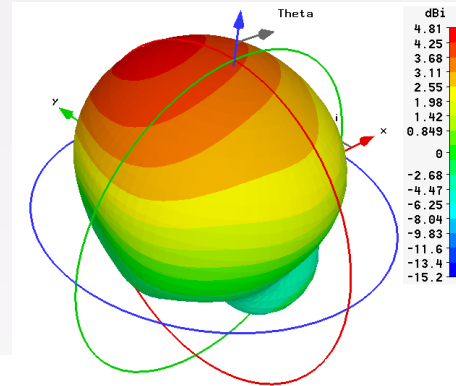
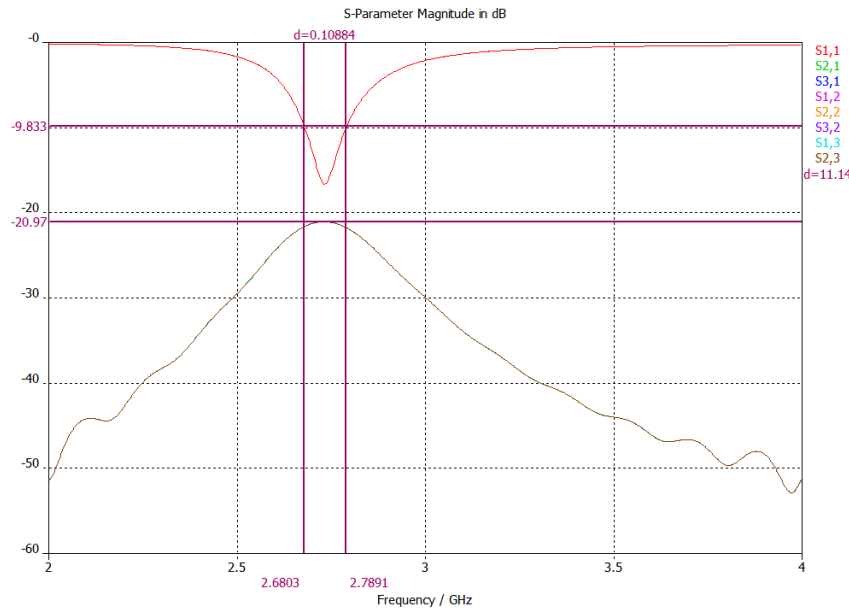
# Better designs

- However, the cubic solid geometry of the designs make them unsuitable for handheld mobile devices.

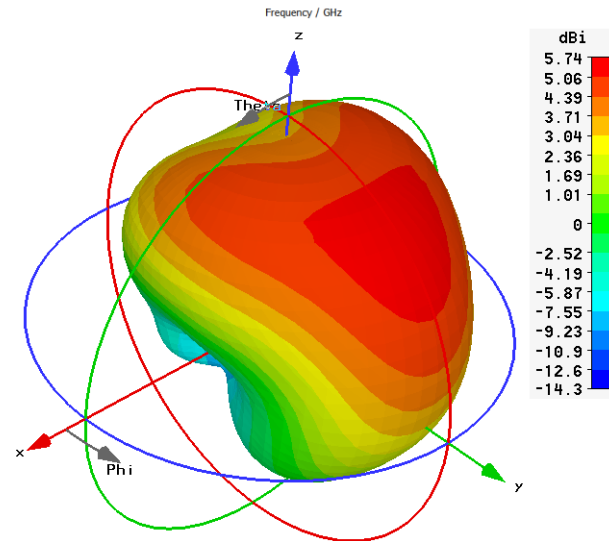
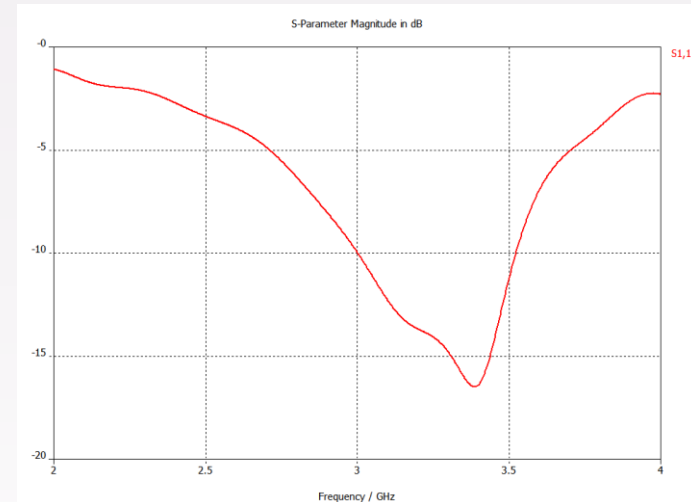
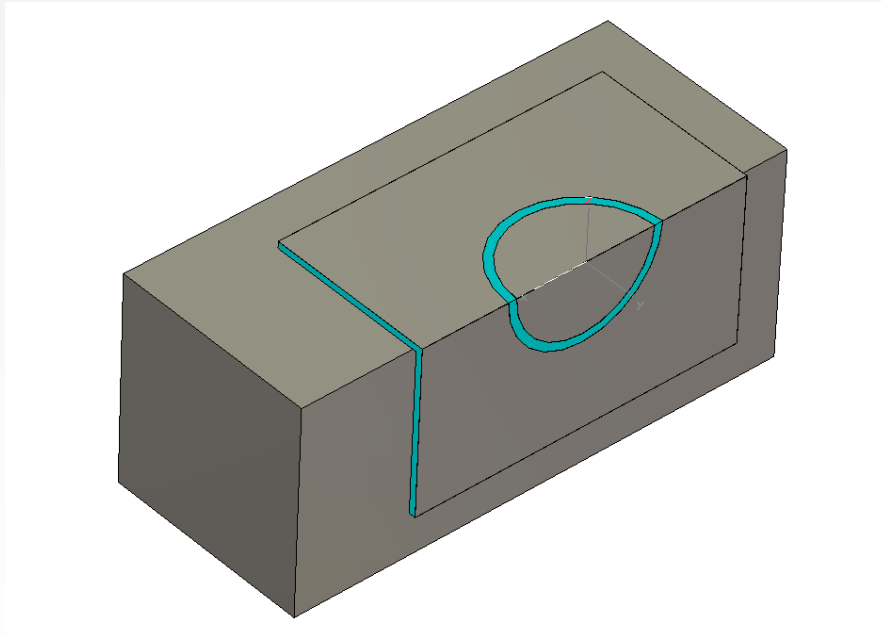


Chi-Yuk Chiu; Jie-Bang Yan; Murch, R.D., “Compact Three-Port Orthogonally Polarized MIMO Antennas” *Antennas and Wireless Propagation Letters, IEEE*, vol. 6, pp. 619 – 622, 2007

# First prototype

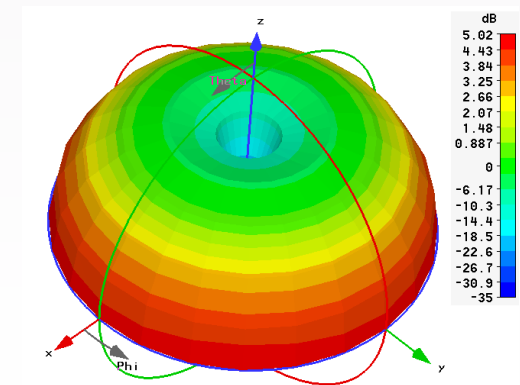
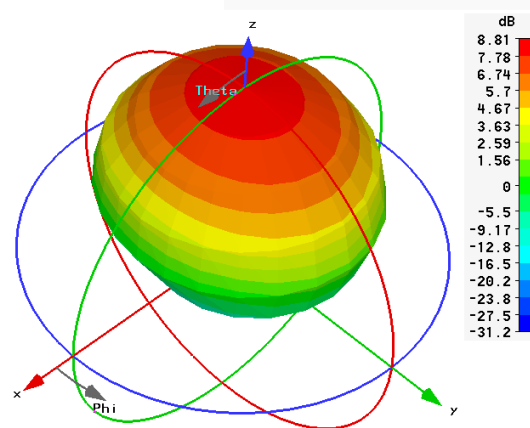
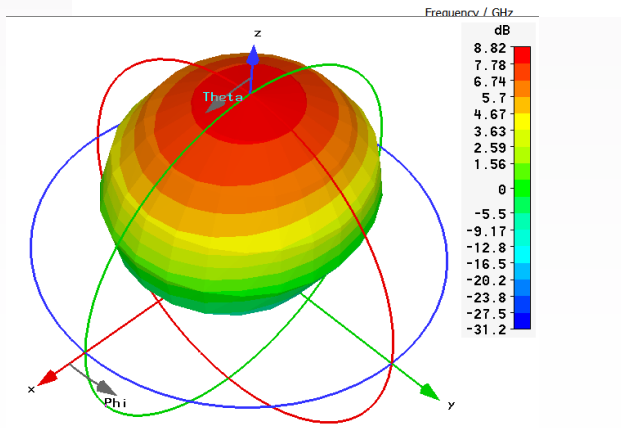
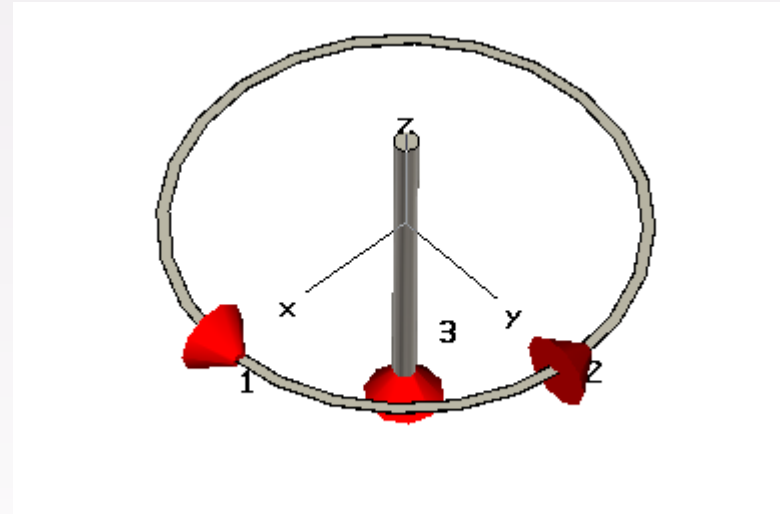
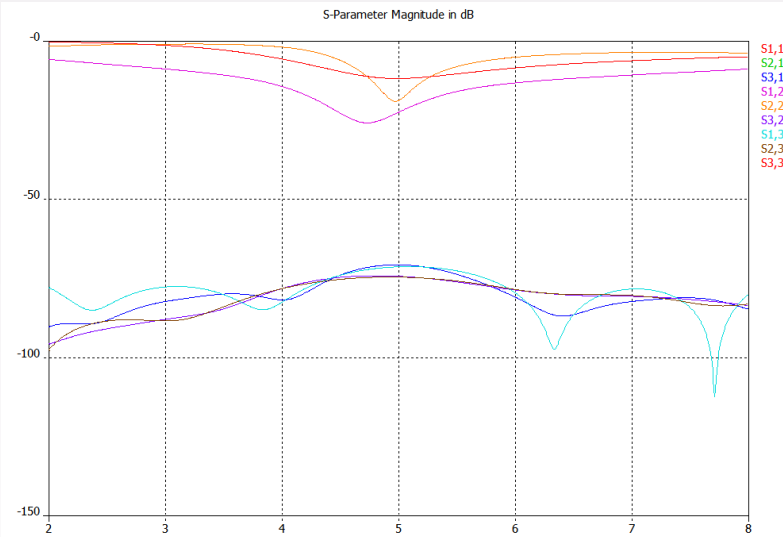


# Second prototype





# Third prototype

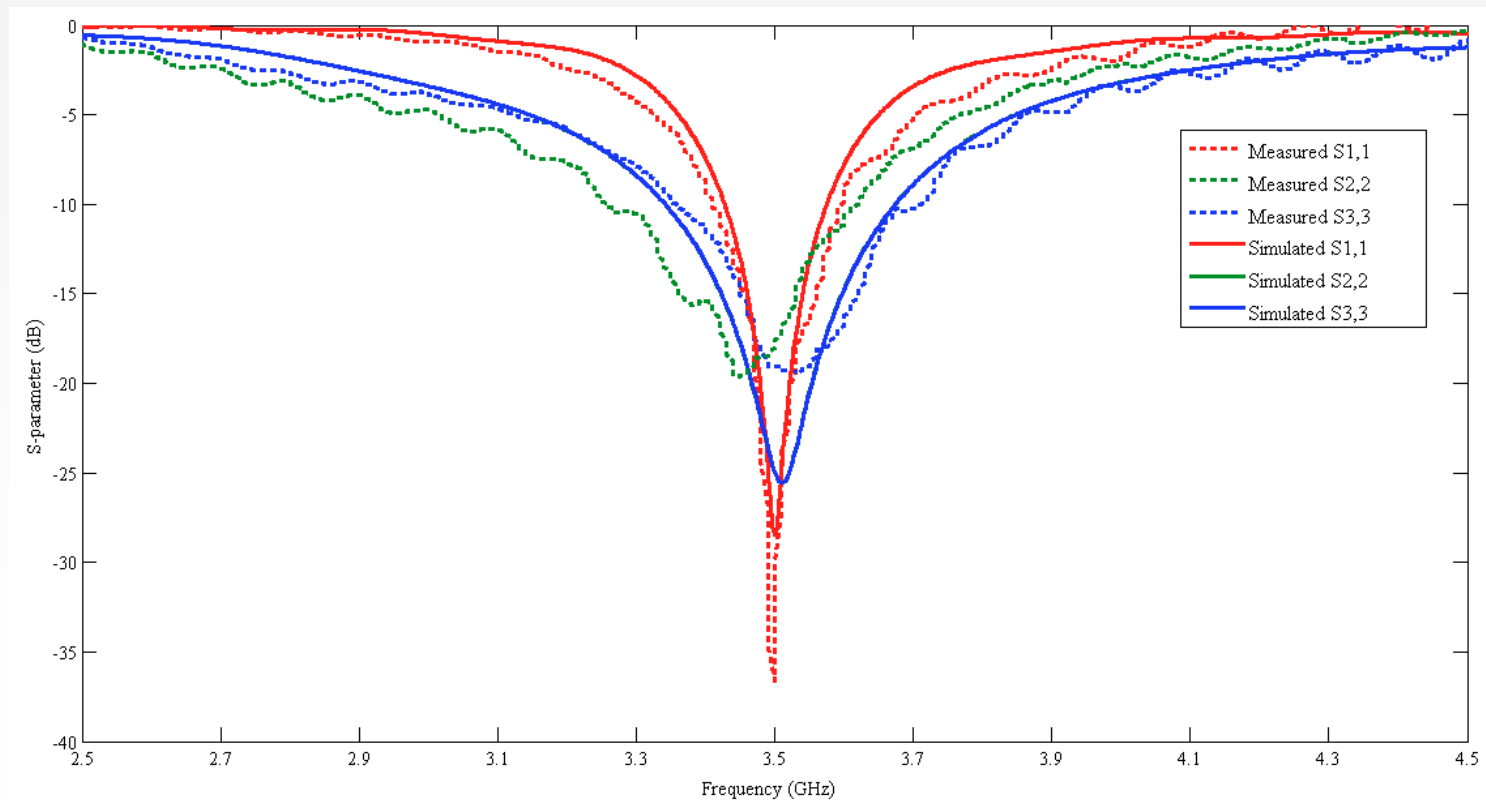


## Almost there design

- Three antennas, each is responsible to one of the three possible linear polarisations
- They co-locate in a L-shaped geometry of size roughly  $40.8 \times 40.8 \times 6.4 \text{ mm}^3$ , can easily sit at the top corner of most mobile phones.

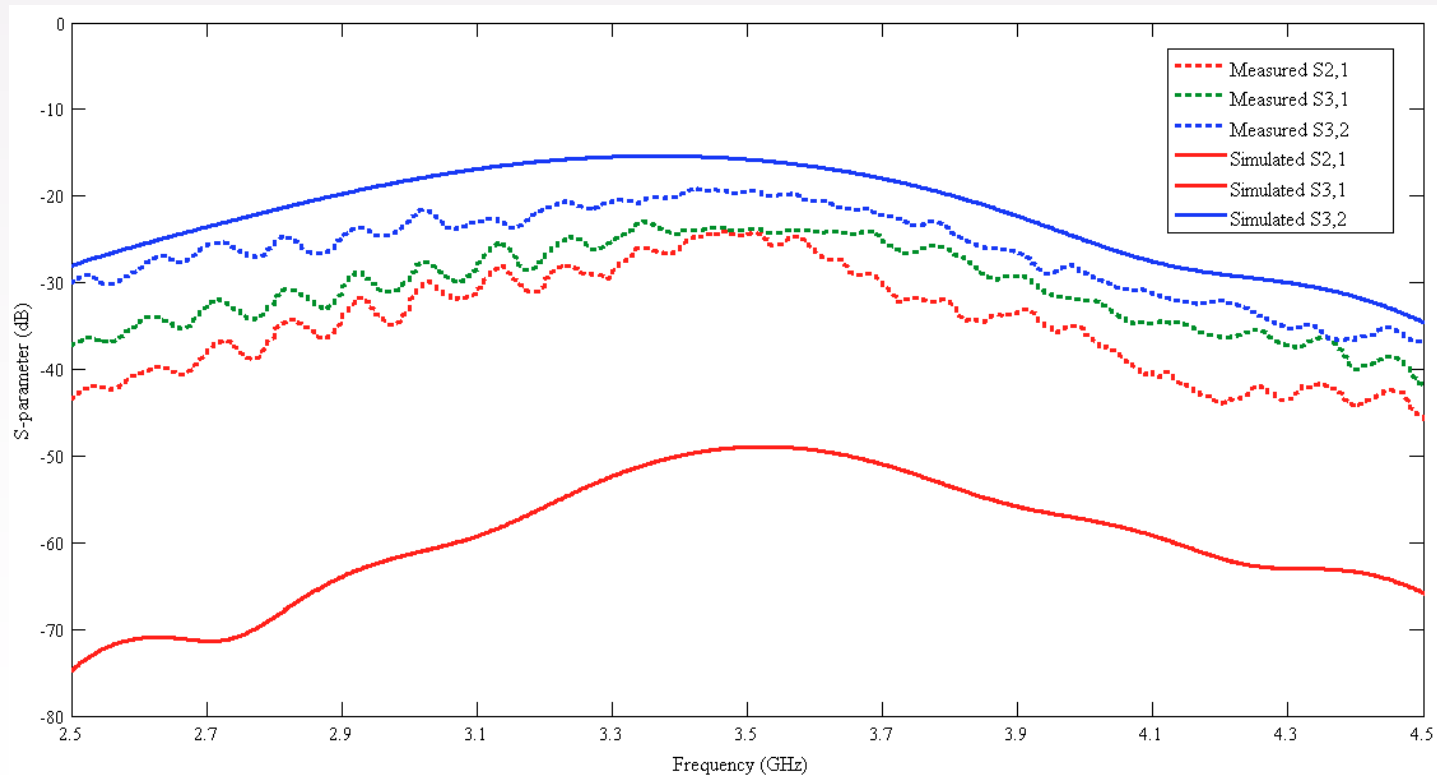
# S11

- Operate at 3.5 GHz with more than 150MHz impedance bandwidth



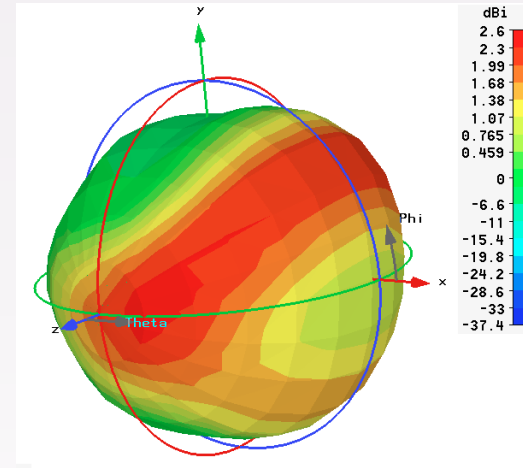
# Isolation

- More than 20dB isolation between the three ports.

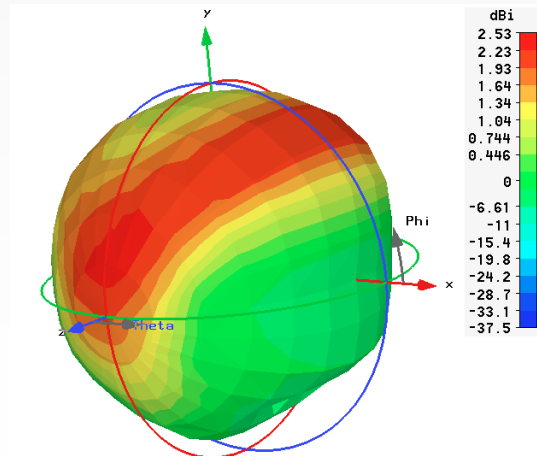


# Radiation patterns

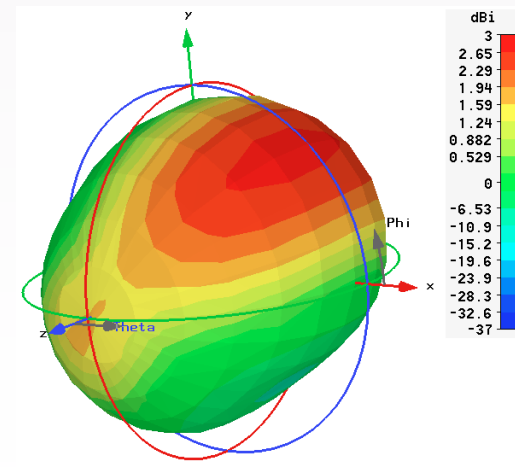
- Gain is around 3dBi



(ii) Port 2 – y-directional linear polarization



i) Port 1 – x-directional linear polarization (iii) Port 3 – z-directional linear polarization



Thanks & Questions?