# Design of Ka-Band Reflectarray for Space


**Student: Tan Xue Wen**

*Department of Electrical & Computer Engineering*

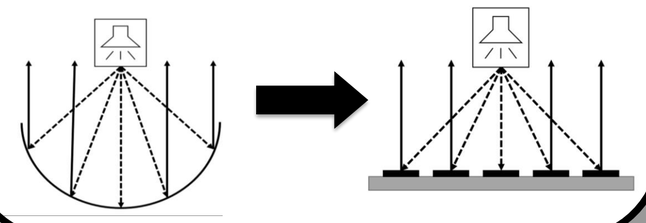
National University of Singapore


## Abstract


This poster presents a design of a Ka-band reflectarray consisting of 2601 (51 × 51) square ring-patch elements, operating at 28 GHz. The elements are printed on a 60mil Rogers 4003C substrate, backed by a ground plane. The element grid size is 4.4 mm (~0.411$\lambda_0$). The square ring-patch element can achieve more than 360° of reflection phase. The proposed reflectarray is fed by an off-set pyramidal horn to reduce aperture blockage.


## Introduction

Instead of using physical curvature, it uses phasing elements to compensate for the phase/path difference to reflect the beam in one direction.



## Motivation

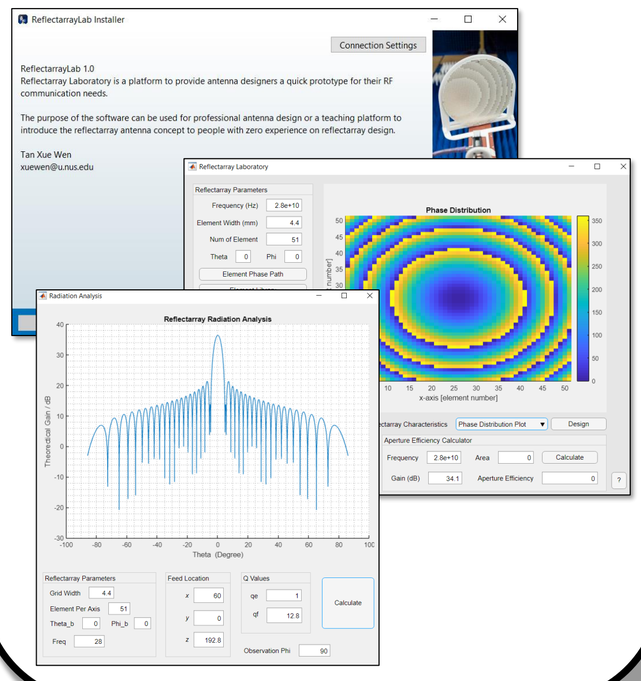
**Hybrid of phased array antenna and parabolic bowl antenna**
**(Best of both worlds)**

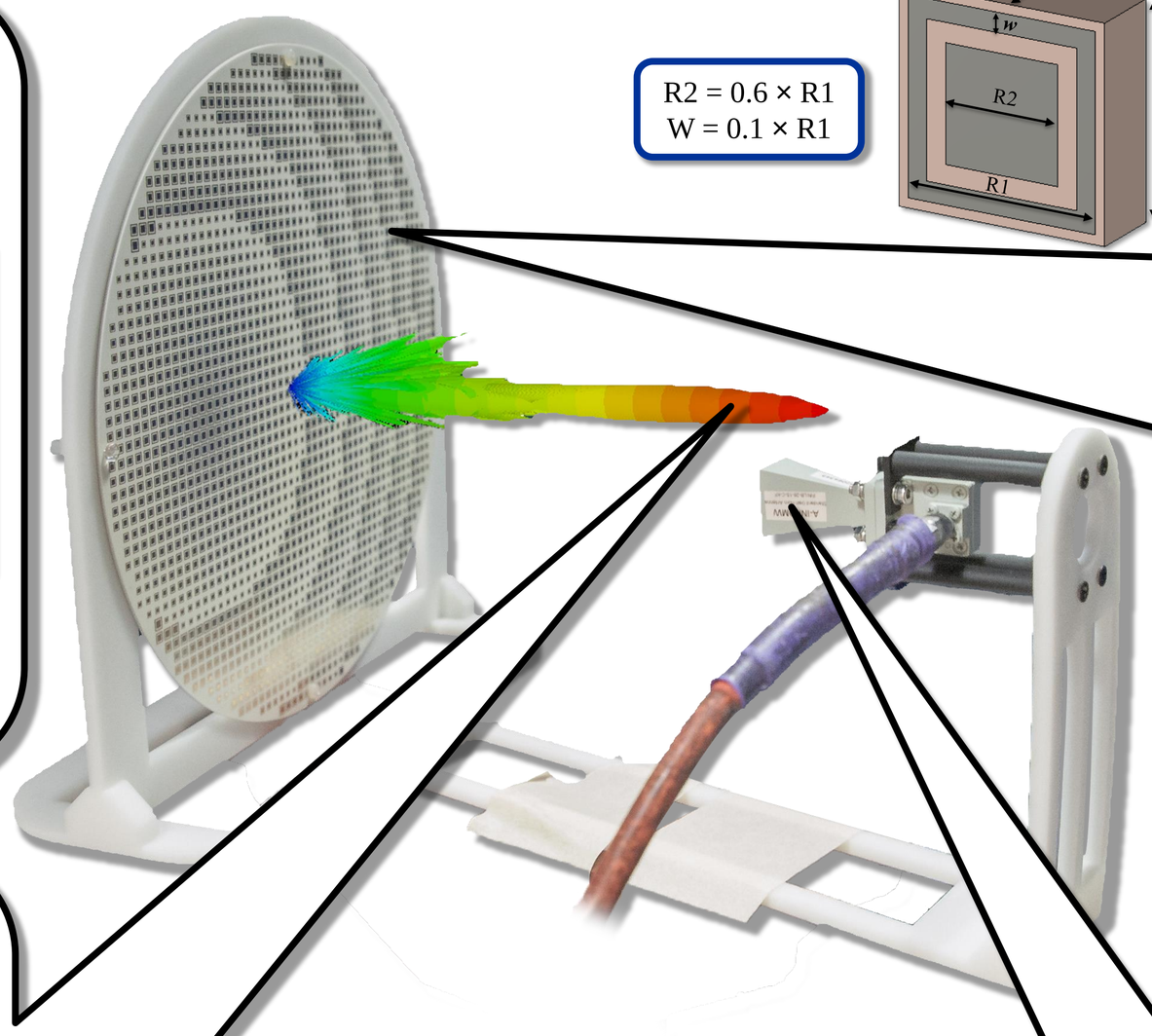
- Overcomes the challenges of precision manufacturing found in parabolic reflector
- Expensive phase shifters found in microstrip array antenna can be avoided
- Low profile & adaptable to most surface suitable for satellite application
- High gain & wide-angle beam scanning

## Design Goal

- Broadside beam with low sidelobe level (-20dB) using offset feed.
- >50% aperture efficiency
- Decent bandwidth (~5%)

## Bonus Software

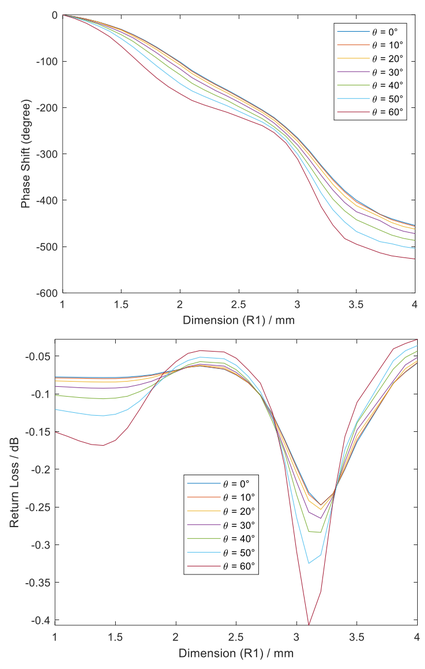


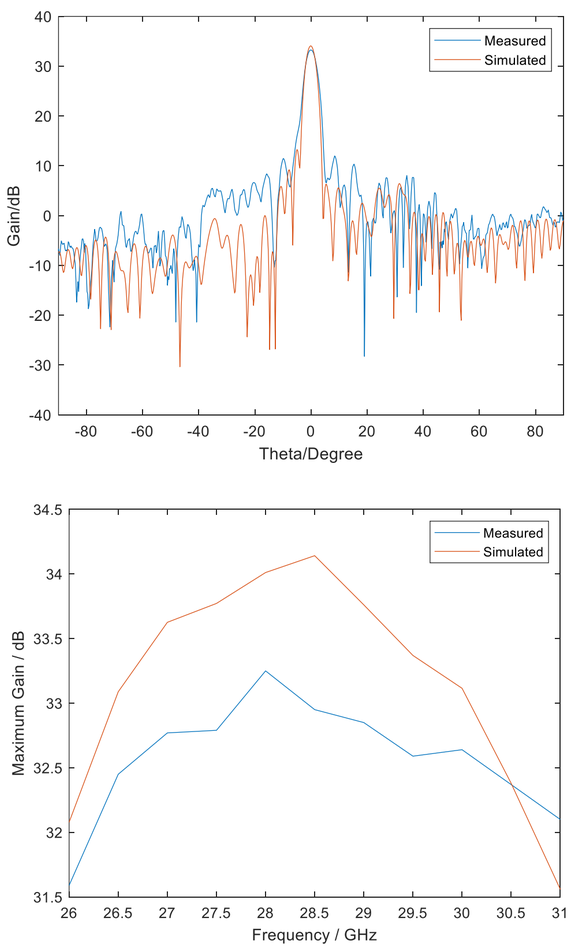
R2 = 0.6 × R1
W = 0.1 × R1



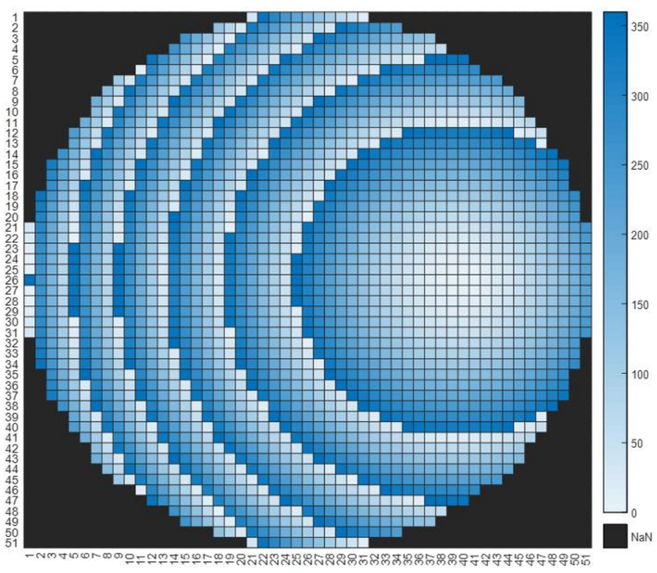

## Element Design




## Experimental Result




## Phase Shift Distribution

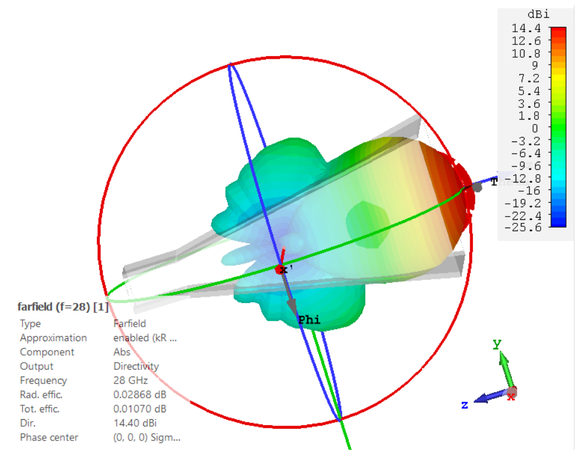


**Phase shift required for each element:**

$$\phi_{RA} = k_0\left(R_i - \sin\theta_o\left(x_i\cos\varphi_o + y_i\sin\varphi_o\right)\right) + \phi_0$$

## Optimized F/D

*Focal length to Aperture diameter




## Conclusion

The proposed reflectarray antenna exhibits **high gain of 33.94dB** and **good aperture efficiency of 57%** with decent **6% bandwidth**. The **sidelobe levels** are well-controlled with **under -20dB on both planes**. The fabricated antenna also agrees with the theoretical simulated result. Lastly, the author has programmed an automated design software to compliment the project. Overall, the project has achieved its objective and purpose.


**Supervisors: Prof. Chen Zhi Ning, Dr Chia Tse Tong**