Engineering and the Environment

UNIVERSITY OF Southampton

Geostationary Microwave Radiometry using Formation Flight

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Introduction and Aim

Microwave radiometers are versatile Earth observation tools. In spite of this, they have never been deployed to the geostationary orbit – only to low Earth orbits.

This is because the geostationary altitude is 50 times higher than low Earth orbits, a large aperture is needed.

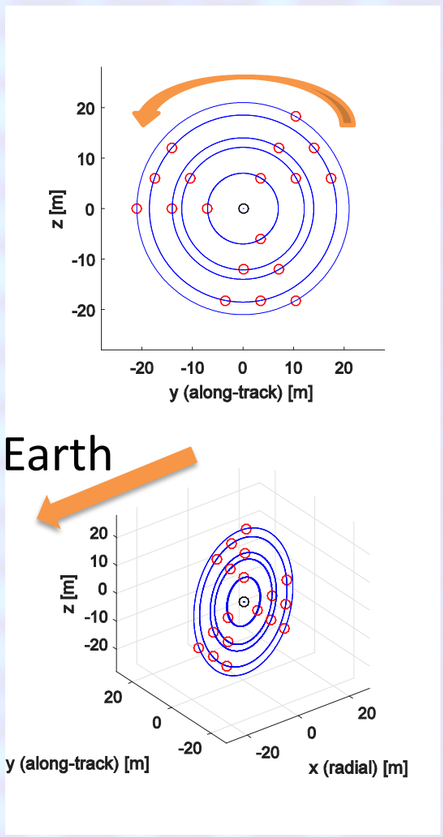
Presented is a novel mission concept applying satellite formation flight to microwave interferometric radiometry. Such a mission would synthesise microwave apertures in tens of metres. These apertures may enable geostationary microwave radiometry for the first time.

Two viable mission concepts have been found.

$$\text{Spatial Resolution} \propto Range \frac{Wavelength}{Aperture\ Size}$$

Relative Orbit

The constellation is placed on a suitable relative orbit, allowing the companion satellites (red) to "orbit" around the central (black) satellite on an elliptical trajectory (blue) once per day. Because all companions orbit in the same plane at the same rate, the circular aperture is maintained pointing at the Earth, which is on the –x axis.



Radiometric Performance

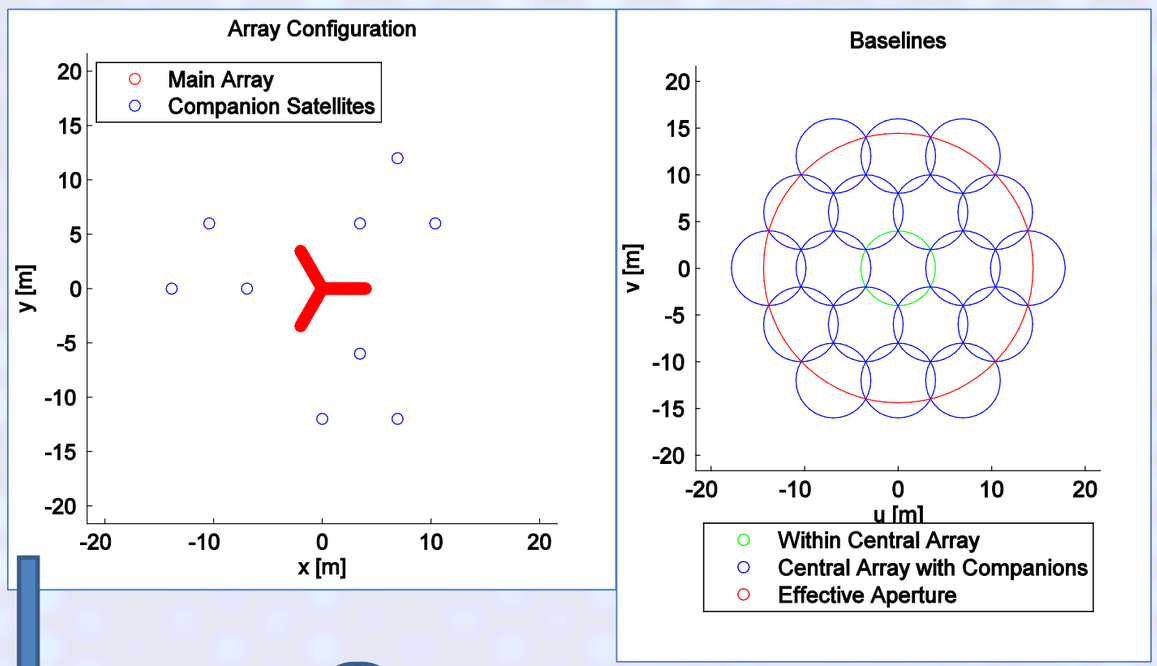
The point-source response of the Single-Element Companion concept was simulated (See background image). The table shows the performance at 10 GHz from the geostationary orbit.

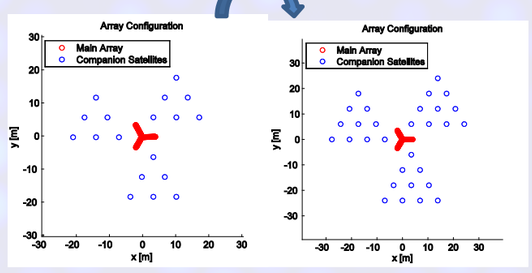
	SEC Concept	AD Concept
-3dB Beam Efficiency	31.3%	
Null Beam Efficiency	70.0%	
-3dB Beam Width	79.5 km	39.8 km
Null Beam Width	194.1 km	97.1 km
Side Lobe Level	-29 dB	

Single-Element Companion Concept

Single rotating Y-shaped interferometer (4 m arms) with nine (or more) accompanying microsatellites.

Constellation layout (left) and its visibility samples (right)





Constellation scalable

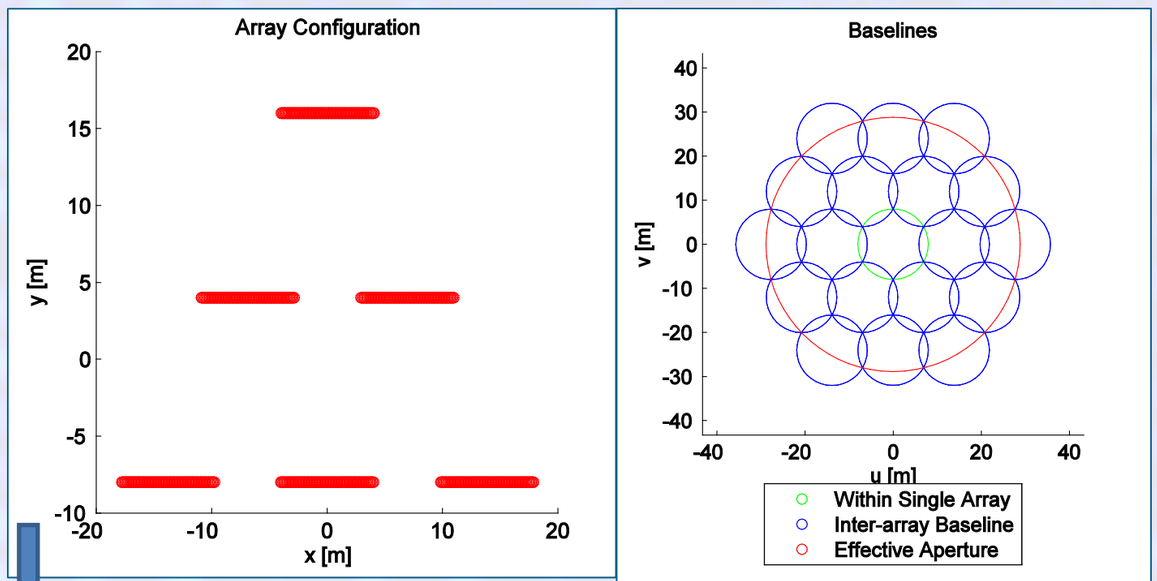
Companions	Aperture	Mass
3	8.0 m	868 kg
9	14.4 m	1288 kg
18	20.0 m	1918 kg
30	32.0 m	2758 kg

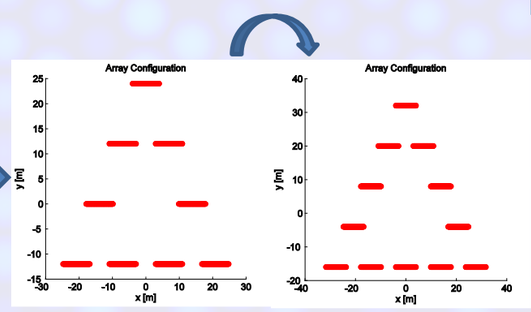
Scaling of the constellation

Array Duplicate Concept

Six rotating two-boom interferometers (4 m arms)

Constellation layout (left) and its visibility samples (right)





Constellation scalable

Satellites	Aperture	Mass
3	16.0 m	1974 kg
6	28.8 m	3948 kg
9	40.0 m	5922 kg
12	64.0 m	7896 kg

Scaling of the constellation

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EPSRC Engineering and Physical Sciences Research Council