Rigid-Flexible Antenna Array (RFAA) for Cost-Effective Deployable Scanning Apertures

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Space-based radars demand large, high-gain scanning apertures, particularly for Moving Target Indicator (MTI) functionality. Size and weight of these apertures can be a significant driver of launch costs for satellites hosting these radars. This work presents the Rigid-Flexible Antenna Array (RFAA) concept, an array realized in a very thin and physically flexible realization. This can enable ultra-lightweight (1-2 kg/m^2) arrays that can be rolled or folded, then compactly stowed for space payloads or other size-constrained systems.

As seen in Figure 1, the RFAA contains a flexible circuit that spans the area of the array, with regularly-spaced "islands" of rigid material. Distribution of RF, control, and power take place within the flexible circuit. The islands of rigid material serve two purposes. First, they provide a substrate for the array's antenna elements. While the flexible circuit is too thin (<0.005") to support a ground plane backed (uni-directionally radiating) antenna of substantial bandwidth and efficiency, an island of rigidized substrate that is only 0.04" thick can support low-loss antennas with roughly 5% bandwidth, within X-band. The second function of the rigid area is to provide a space for reliable attachment of active components. As depicted in Figure 1, it is envisioned that active components are attached to the underside of the rigidized area. It is noted that the rigidized area is made as small as possible, to minimize impact on mass and flexibility

To validate the RFAA concept, a 16x16 element prototype operating from 9.6-10.4 GHz was built and tested (see Figure 1). The array's patterns were measured before and after multiple roll-unroll cycles. These results and related discussion will be presented at the conference. Each of the prototype's unit cells has a BGA package with resistor networks affixed to its underside to assess durability of a component attached to unit cell's rigid area. Observed effects of rolling and unrolling will be presented at the conference.

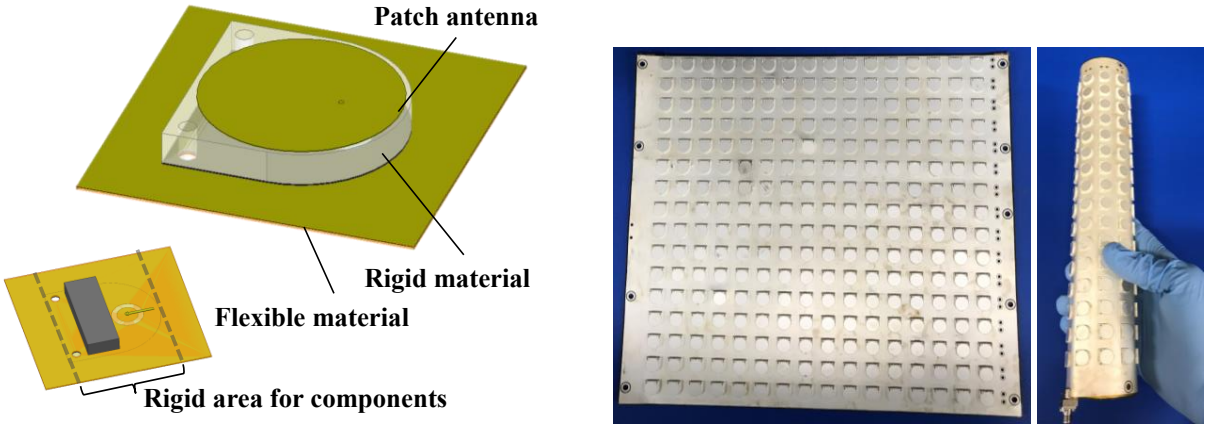

Figure 1. Left: unit cell for Rigid-Flexible Antenna Array (RFAA) concept. Right:16x16 element X-band prototype antenna.

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