

An All-Digital/Reconfigurable CMOS Ground Penetrating Radar System on a Chip

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Program: FY21 R&TD

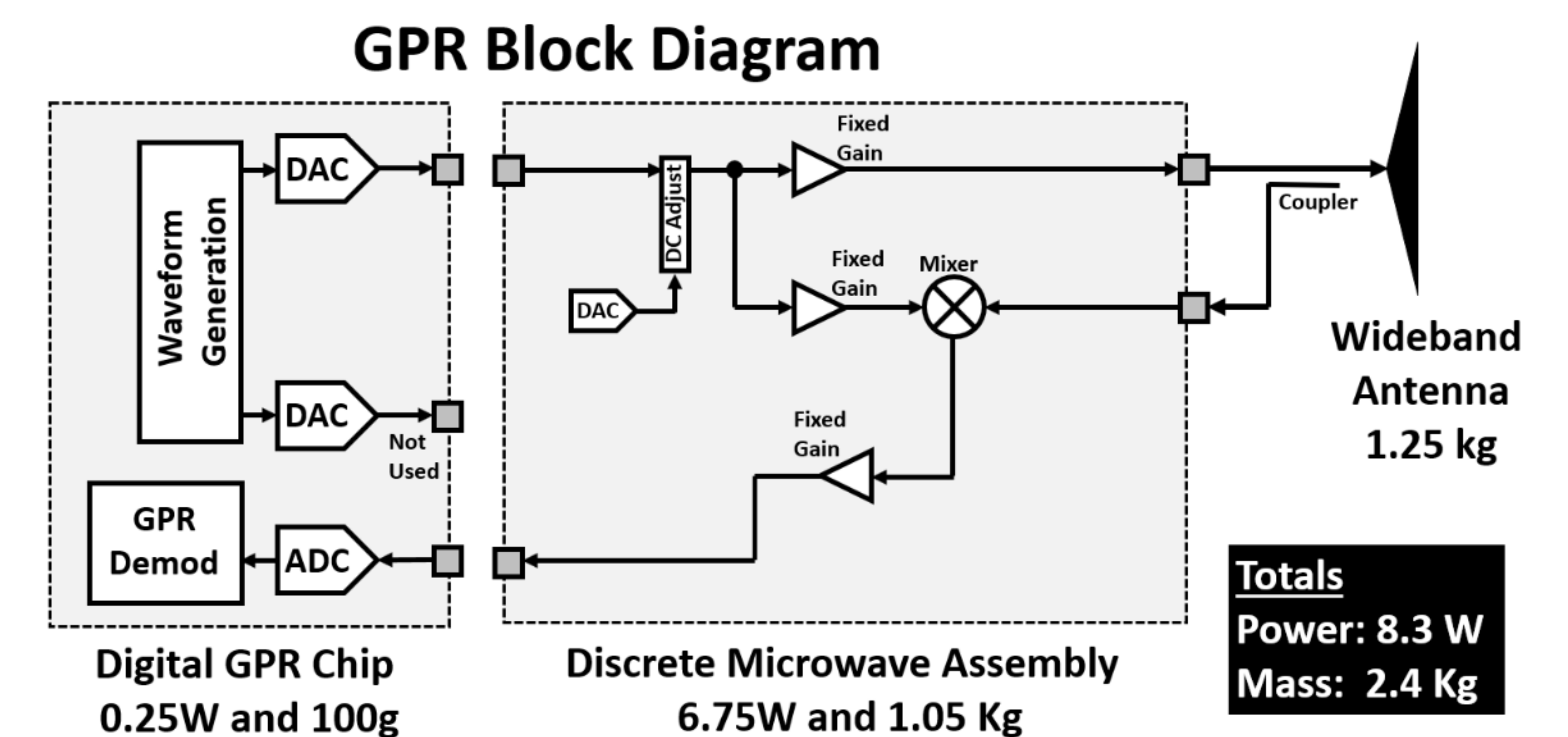
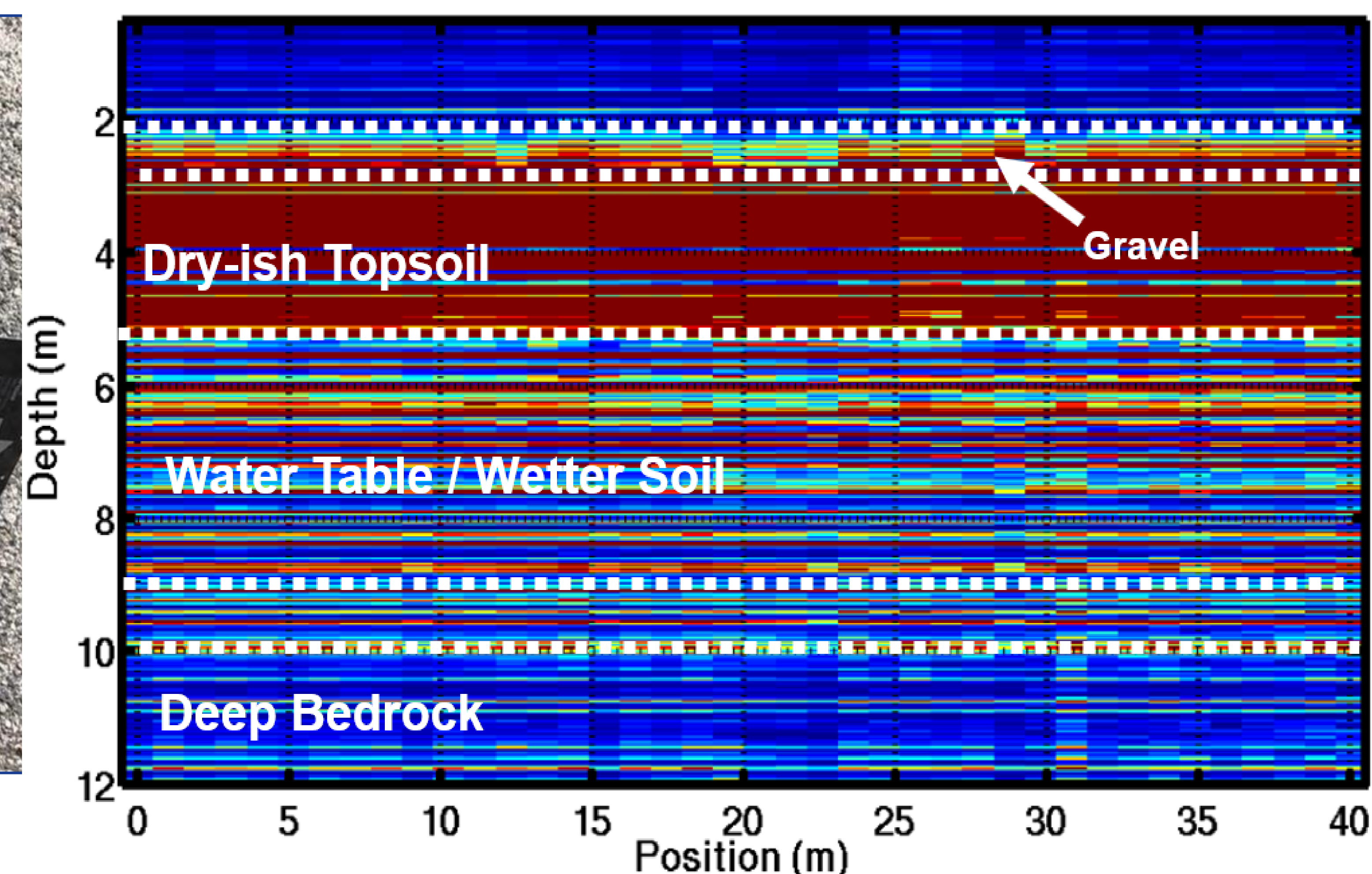
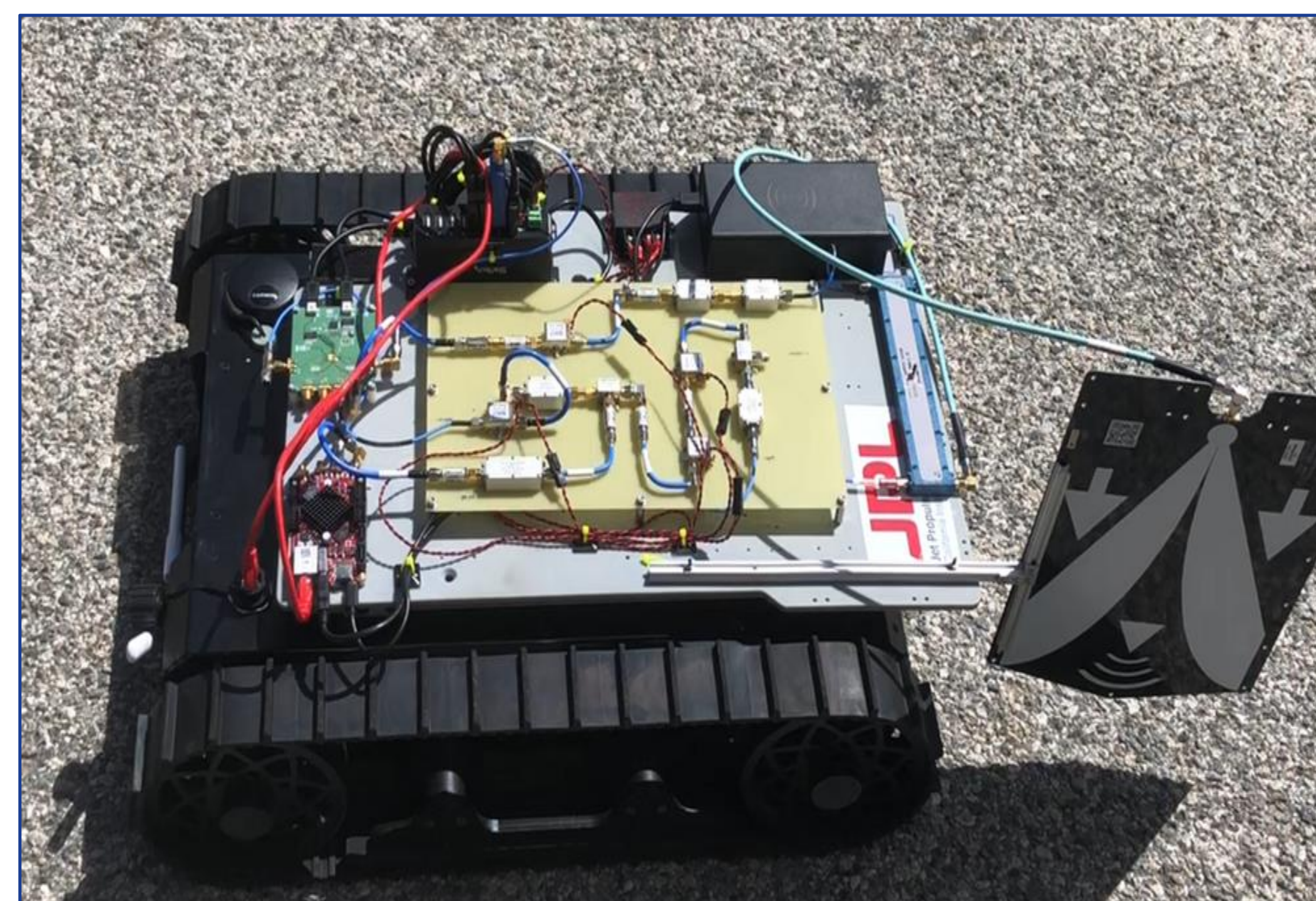
Strategic Focus Area: Electronics, Devices and Sensors

Objectives

The objective of the task is to develop a compact and low power ground penetrating radar (GPR) instrument leveraging system-on-chip technology that can be supported by small rovers or helicopter platforms. The developed GPR is intended to be fully or near-fully implemented with digital circuitry so that it can be highly reconfigurable based on surface conditions encountered.

Approach

A custom GPR chip in CMOS system-on-chip (SoC) technology has been designed, fabricated, and tested which contains an extremely wideband (6GS/s) arbitrary waveform generator, waveform demodulator and necessary A/D and D/A conversion at high speed. The chip was integrated with wideband antennas and placed on a small test rover platform where outdoor subsurface testing was performed.



Significance to JPL/NASA

The demonstrated results enable a GPR system compact and low power enough to be flown from a helicopter or commercial rover platform targeting Mars or Lunar exploration. Additionally the digital nature allows for the radar parameters (resolution, bandwidth, wavelength) to be adjusted in-flight eliminating the need for detailed a priori knowledge of the sub-surface being investigated.

Publications

1. Rulin Huang, Yan Zhang, Emmanuel Decrossas, Anish Seshadri, Chia-Jen Liang, Mau-Chung Frank Chang, and Adrian Tang, "A 0.1-4.0 GHz Inductor-less Direct-Sequence Spread-Spectrum Based Ground-Penetrating Radar System-on-Chip" Microwave Wireless Component Letters (early access). [IMS2021 special edition of MWCL]
2. A. Tang, E. Decrossas, Y. Gim, R. Huang, R. Beauchamp, M-C. Frank Chang, "Surface Cancellation in Wideband Ground Penetrating Radar Employing Genetic Algorithm AI for Waveform Synthesis" International Microwave Symposium 2021.