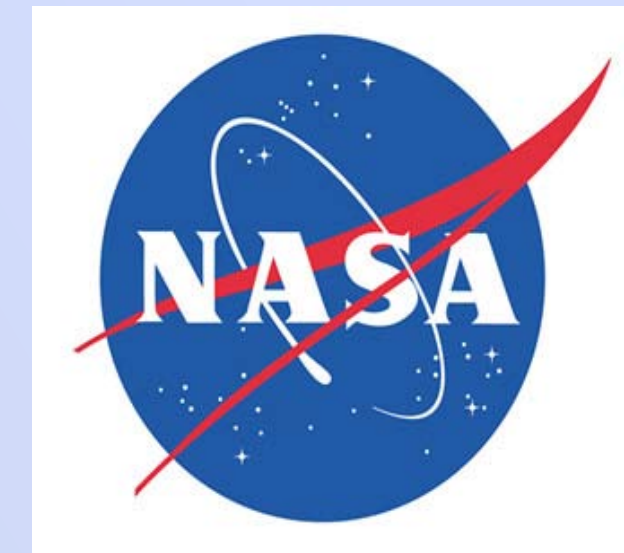


# RFI RISK REDUCTION ACTIVITIES USING NEW GODDARD DIGITAL RADIOMETRY CAPABILITIES



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## INTRODUCTION:

The Goddard Radio-Frequency Explorer (GREX) is the latest fast-sampling radiometer digital back-end processor that will be used for radiometry and radio-frequency interference (RFI) surveying at Goddard Space Flight Center. The system is compact and deployable, with a mass of about 40 kilograms. It is intended to be flown on aircraft. GREX is compatible with almost any aircraft, including P-3, twin otter, C-23, C-130, G3, and G5 types. At a minimum, the system can function as a clone of the Soil Moisture Active Passive (SMAP) ground-based development unit [1], or can be a completely independent system that is interfaced to any radiometer, provided that frequency shifting to GREX's intermediate frequency is performed prior to sampling. If the radiometer RF is less than 200MHz, then the band can be sampled and acquired directly by the system. A key feature of GREX is its ability to simultaneously sample two polarization channels simultaneously at up to **400MSPS, 14-bit resolution** each. The sampled signals can be recorded continuously to a **23 TB solid-state RAID storage array**. Data captures can be analyzed offline using the supercomputing facilities at Goddard Space Flight Center. In addition, various Field Programmable Gate Array (FPGA) - amenable radiometer signal processing and RFI detection algorithms can be implemented directly on the GREX system because it includes a high-capacity Xilinx Virtex-5 FPGA prototyping system that is user customizable.

## The GREX System:

The GREX system was delivered in December 2011. It will be ready for airborne RFI surveying in late 2012. The combination of high sampling rate and storage capacity allows for it to be used in a number of different radiometer configurations. Some configurations include:

- L-band radiometer band survey: 25MHz x 2chan x 2Nyquist x 2byte/sample = 200 MB/s ¼ 30 hrs recording capacity
- L-band radar band survey: 100 MHz x 2chan x 2Nyquist x 2byte/sample = 800 MB/s ¼ 8 hrs recording capacity
- Any receiver that can down-convert signals to 0-200 MHz band

### GREX data collection unit: Signatec DR1400

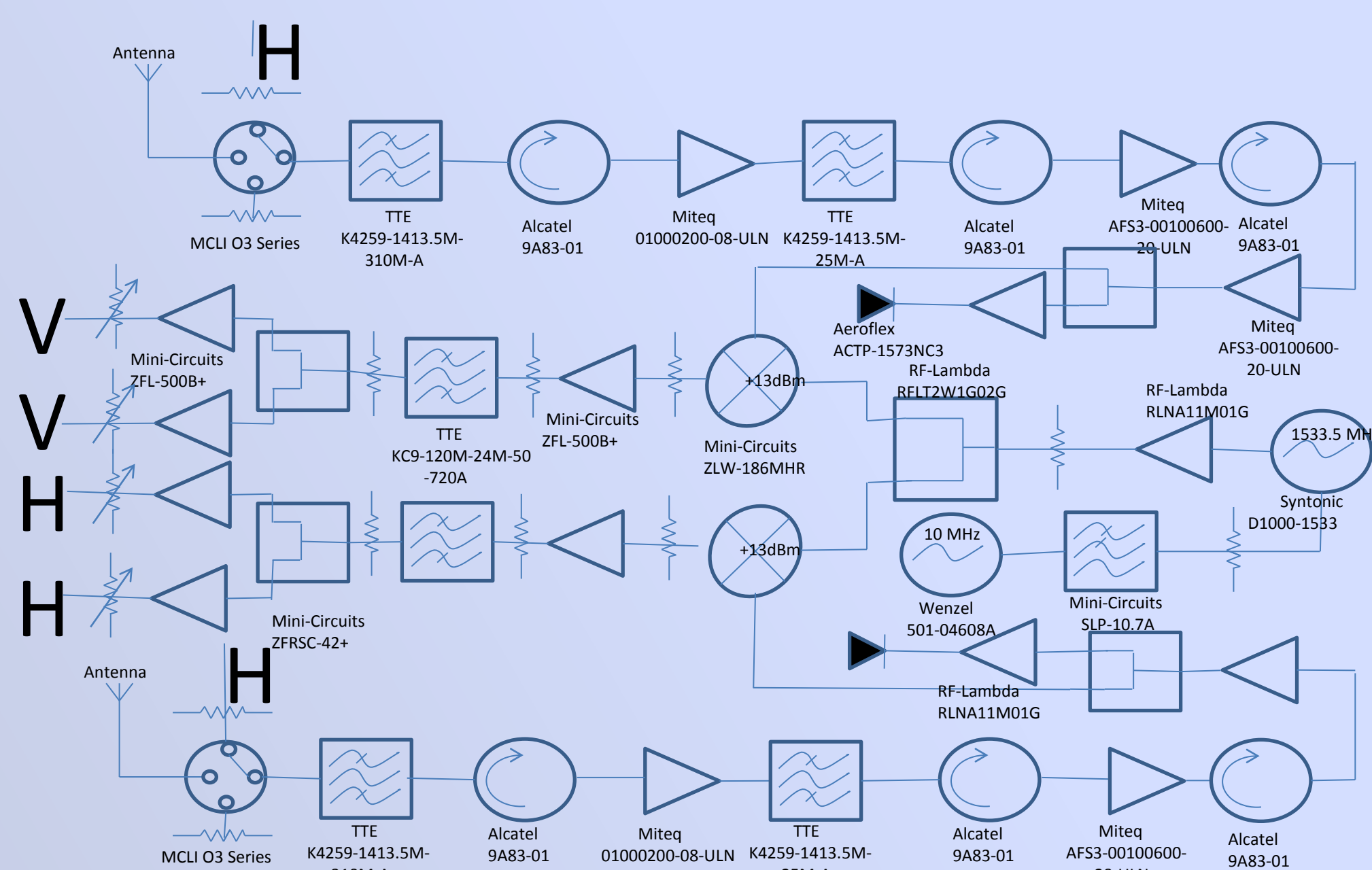


### Specifications:

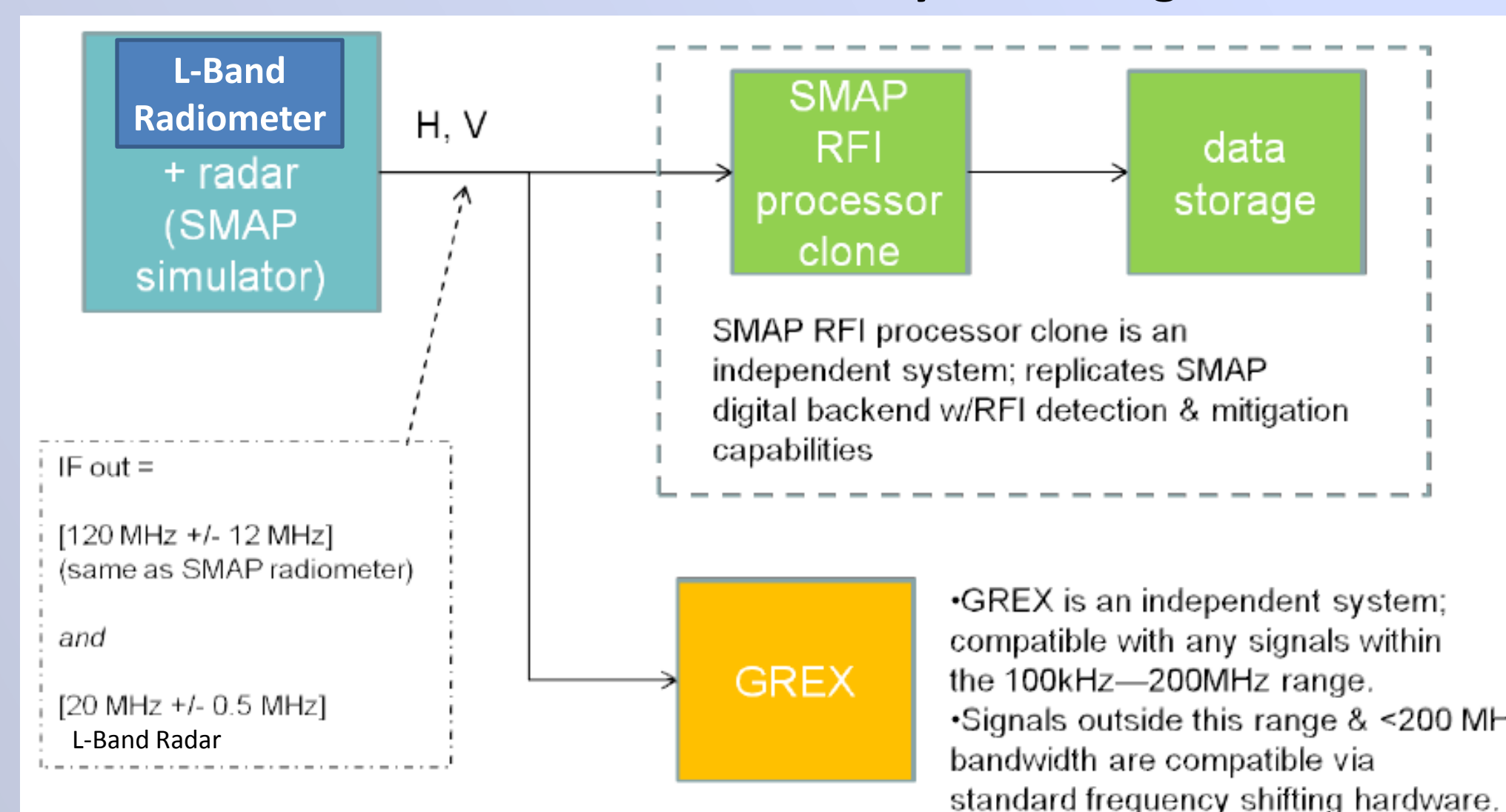
- **Sampling Rate: 400 MSPS x 2 channels**
- **Resolution: 14-bit**
- **ENOB: 11.2-bit**
- **HD storage: 23TB Solid-State RAID**

Besides performing airborne L-band RFI surveys, GREX is useful for trying new RFI detection algorithms currently being developed that utilize both horizontal and vertical polarization signals and their complex baseband representation to take advantage of signal detection tools developed by Adali et. al. [2]

### GREX Antenna and Radiometer Frontend: Based on NASA L-RAD



### GREX and L-band radiometer system Integration



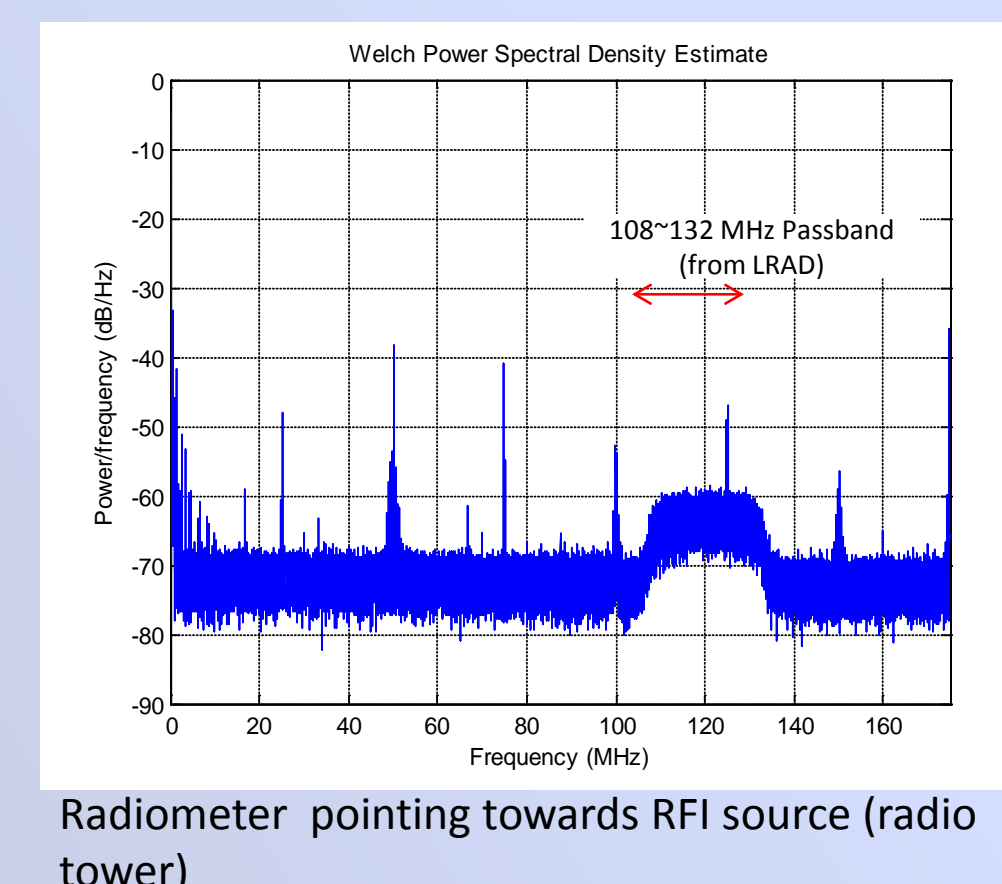
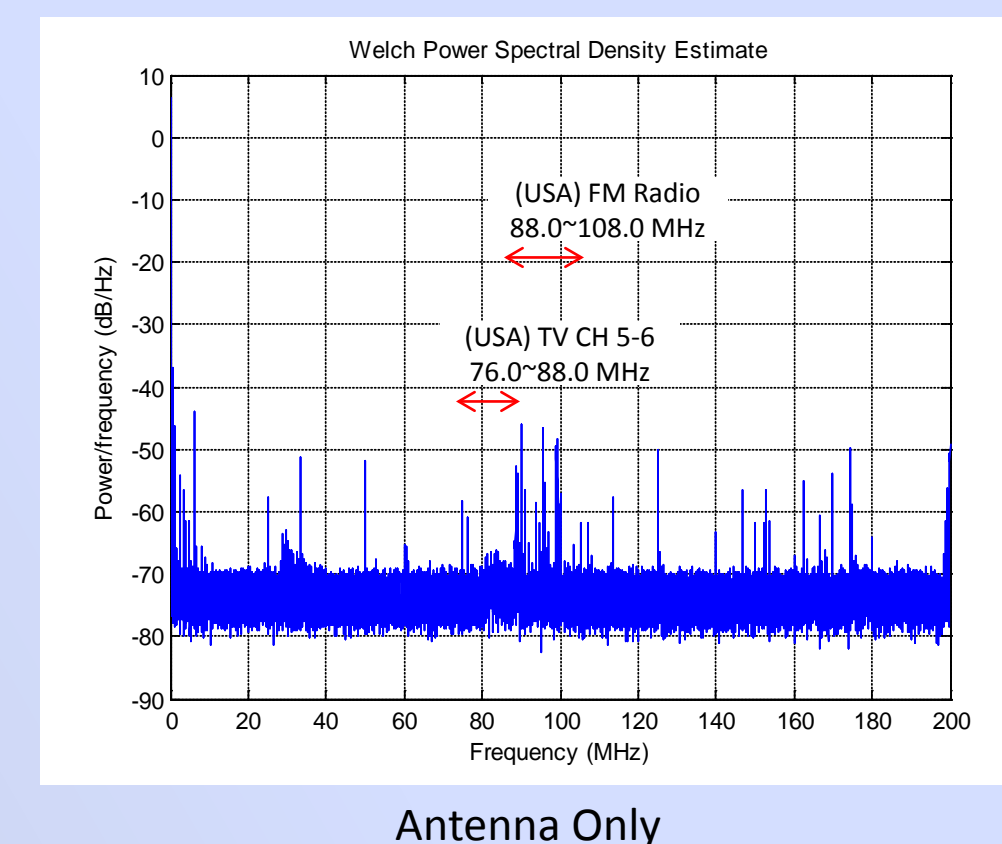
## Preliminary Tests:

A preliminary test had been performed from the top of a building. The sampling rate on the GREX system was set at 350MHz. Two front-end interfaces were used:

- Antenna only
- Radiometer + Antenna

## Preliminary Results:

- System is able to pick up USA FM radio, TV broadcast CH 5-6 and mobile radio frequency.
- The 112--136 MHz pass-band is built in the radiometer frontend and can be viewed at the output spectrum.
- The 125MHz RFI can come from two sources: The 25MHz onboard signal or Local TV broadcast (2<sup>nd</sup> harmonic).



## Future Work:

- Further characterize system noise and RFI to calibrate GREX
- Integrate GREX with generic L - band radiometer for future airborne RFI survey
- Customize software program for RFI detection and mitigation

## REFERENCE:

[1] D. Bradley, C. Brambora, M.E.Wong, L.Miles,D.Durachka, B. Farmer, P.Mohammed, J. Piepmier, J.Medeiros,N.Martin, and R. Garcia, "Radio-frequency interference (rfi) mitigation or the soil moisture active/passive (smap) radiometer," in *Geoscience and Remote Sensing Symposium (IGARSS)*, 2010 IEEE International, July 2010, pp. 2015–2018.  
[2] T. Adali, P.J. Schreier, and L.L. Scharf, "Complex-valued signal processing: The proper way to deal with improperity," *Signal Processing, IEEE Transactions on*, vol. 59, no. 11, pp. 101–5125, nov. 2011.