Impact of 5G Networks on GPS Navigation – How to Make GPS Receivers Resilient in Congested Environments

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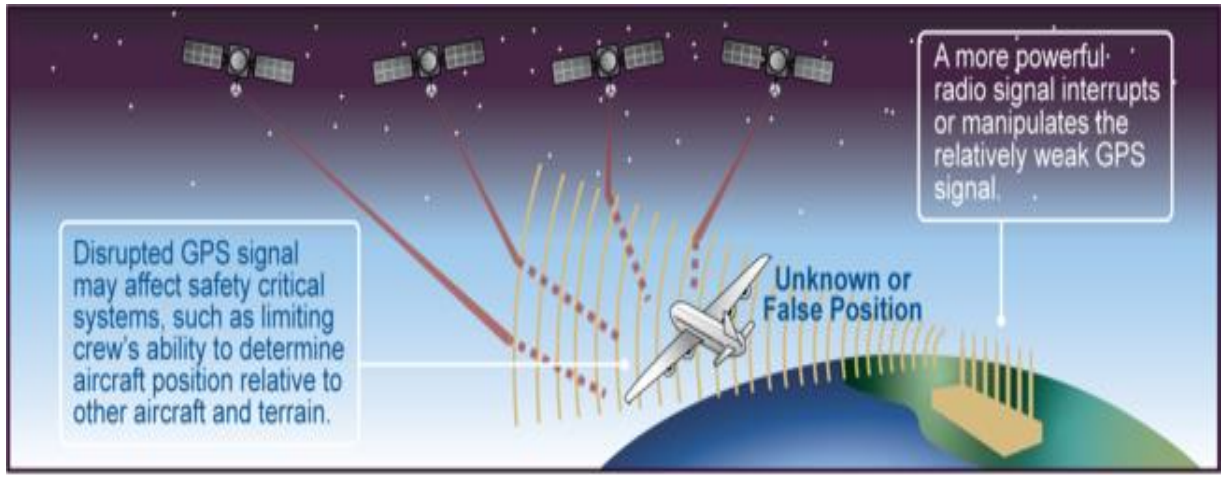
Motivation

- The reliance on global positioning system (GPS) networks represents one of the greatest national security risks today.
- A vast number of consumer, industrial, and military devices rely on GPS as the gold standard for precise positioning, navigation and timing impacting the lives of more than 6 billion users worldwide.
- For example, in 2007, downtown San Diego accidently jammed by a naval training exercise - disrupted GPS systems in the region causing significant damage
  - including malfunction of the regional flight tracking and harbor navigation systems,
  - loss of cell phone service,
  - ATMs to stopped dispensing cash.



Source: GAO analysis of GPS Interference. | GAO-23-105335

NEWS

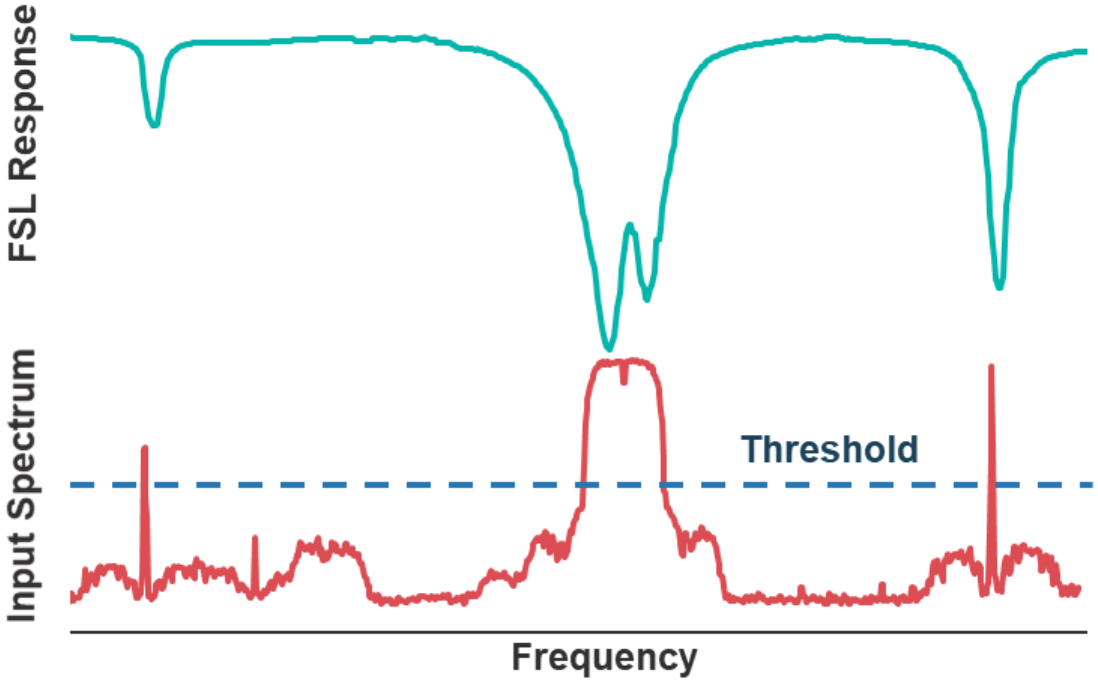
N.J. man fined $32K for illegal GPS device that disrupted Newark airport system

Published: Aug. 08, 2013, 8:28 p.m.

The FCC said an aircraft tracking system at Newark Liberty International Airport experienced interference from a GPS jamming device used by a Readington man who claimed he was simply trying to hide his whereabouts from his employer. The FCC fined the driver $31,875.

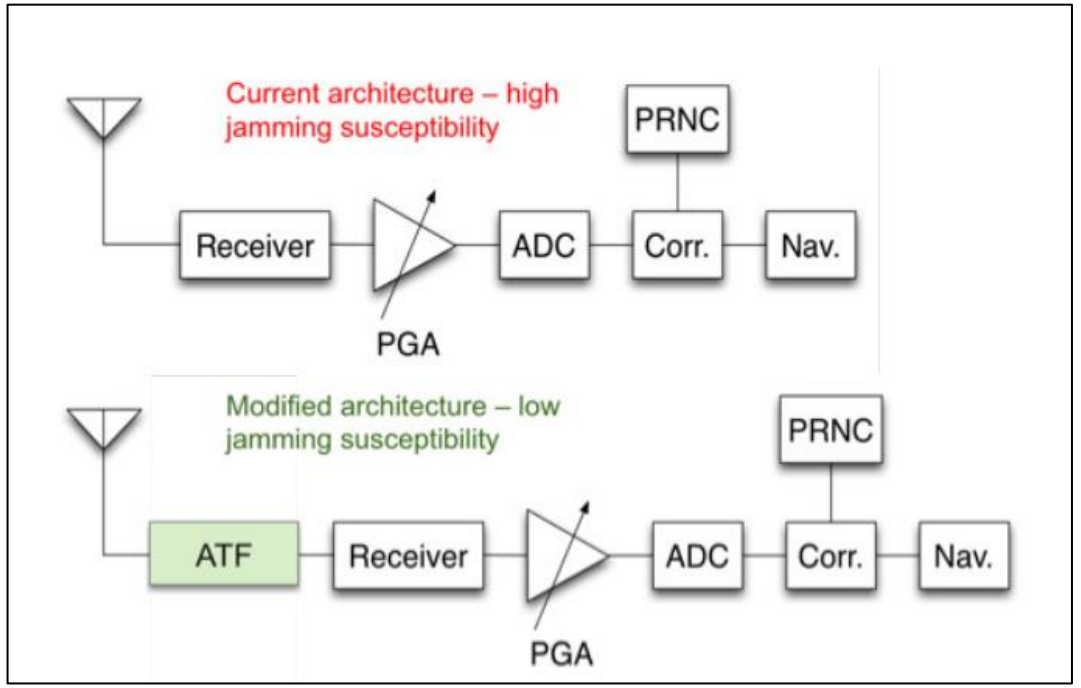
Solution

- Metamagnetics' Auto Tune Filter (AtF) technology can reject unwanted signals, allowing operators continuous access to GPS signals.
- AtF Benefits over Alternatives:
  - *Low SWAP+C*
  - *Passive (zero power consumption)*
  - *Automatic multi-interferer rejection*
  - *Easily Retrofittable*
  - *Automatically suppresses interfering signals that exceed a designed power threshold*
  - *Doesn't have to have a prior knowledge of RF environment*
  - *Operates on any number if interfering signals at the same time*



Technical Approach

- The ATF can be easily incorporated into a GPS module behind the antenna and in front of the receiver
- Signals arriving from the antenna are processed by the receiver that typically contains various fixed filter stages to remove any out-of-band noise and interference and are amplified by the programmable gain amplifier (PGA).
- The signals are then converted to digital format by the analog-to-digital converter (ADC) and are correlated with known pseudo-random noise code (PRNC) sequences to determine if they are authentic and can be used in the calculation of a navigation solution.



A simplified block diagram of a GPS receiver (Figure adapted from U. Hunkeler et al., “Effectiveness of GPS-jamming and counter-measures,” ICL-GNSS 2012.

Metamagnetics GIF Module and Specification

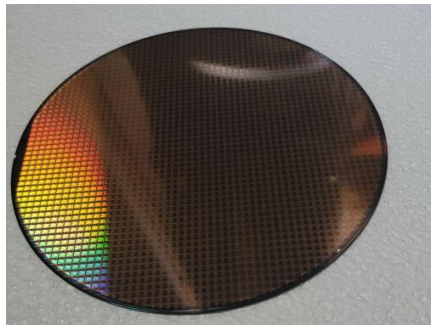
AtF Module for GPS protection	GIF Specification
Frequency	**1164 -1610 MHz** L1, L2 and L5 Bands
Insertion Loss	**5 dB**
Return Loss	**Better than 15 dB**
Effective Power Threshold	**-80 dBm**
Interface	**SMA**

GPS Technology operates in the following frequency bands:

GPS L1 Band: 1575.42 MHz with a bandwidth of 15.345 MHz
GPS L2 Band: 1227.6 MHz with a bandwidth of 11 MHz
GPS L5 Band: 1176.45 MHz with a bandwidth of 12.5 MHz

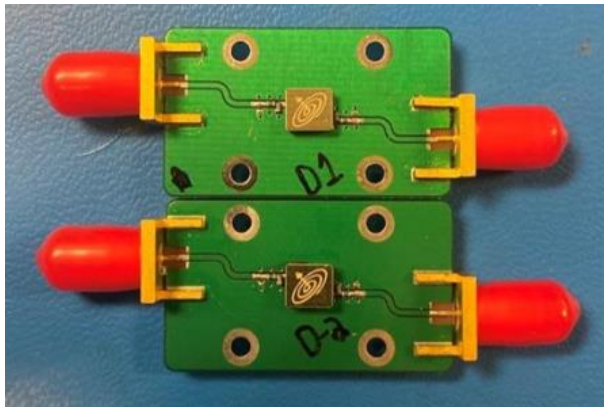
Design and Testing of AtF

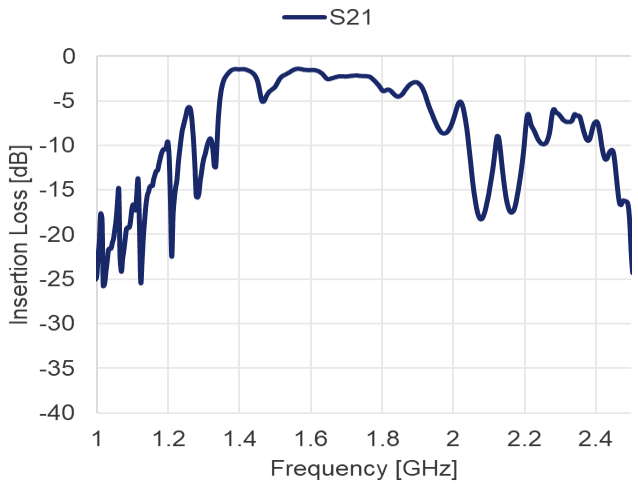
Material Growth

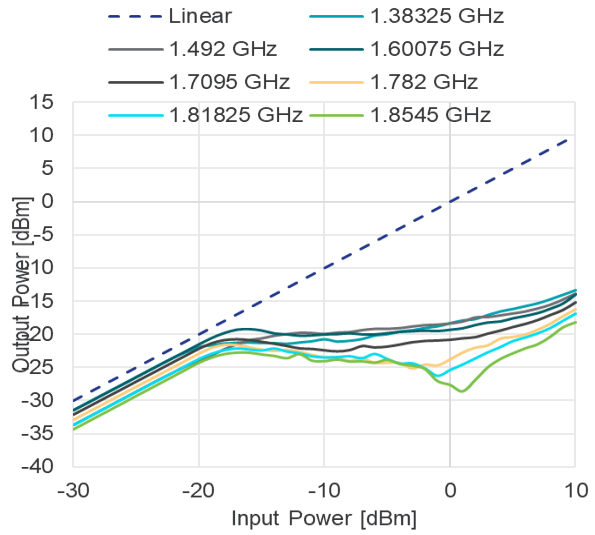


Metallization and patterning

Die attach, wire bonding, and assembly into SMT package



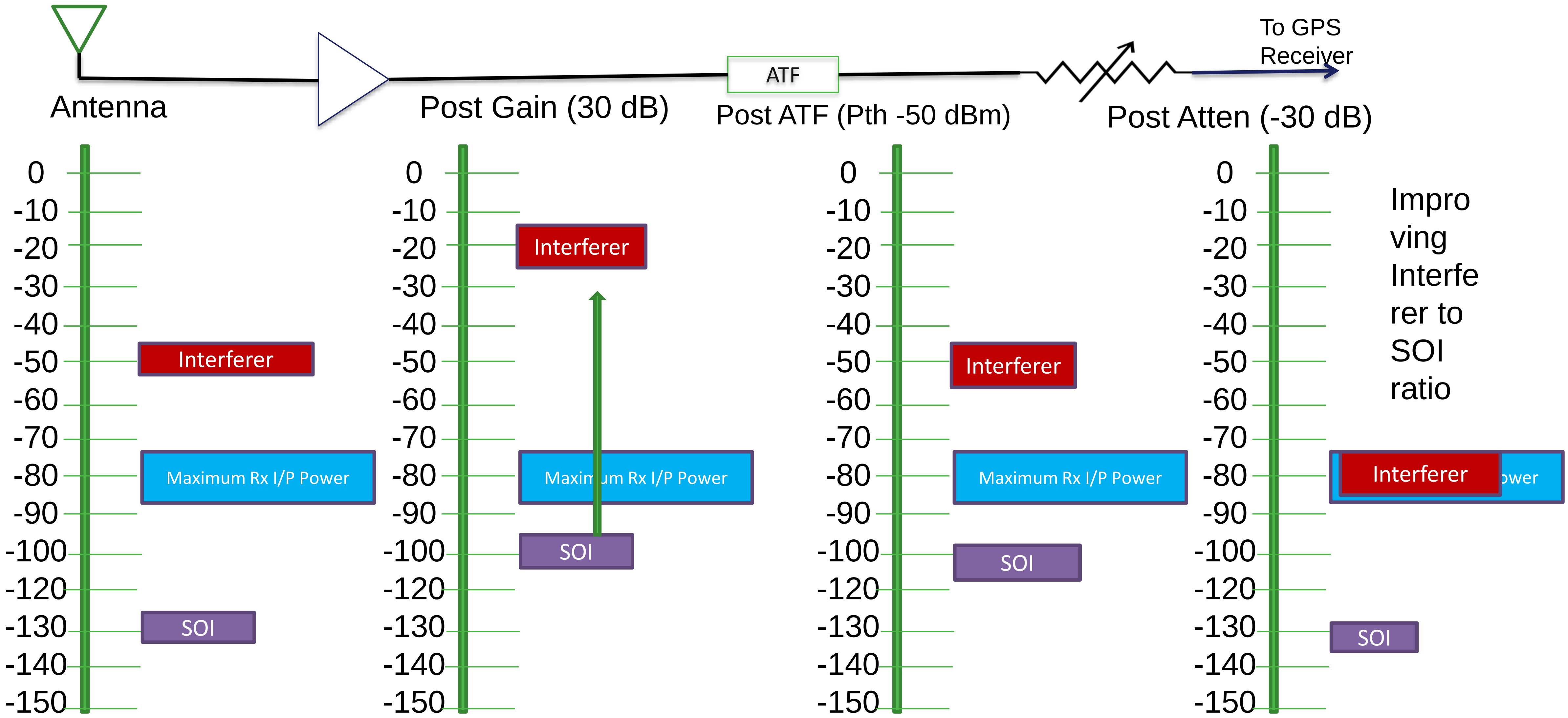




Testing includes:

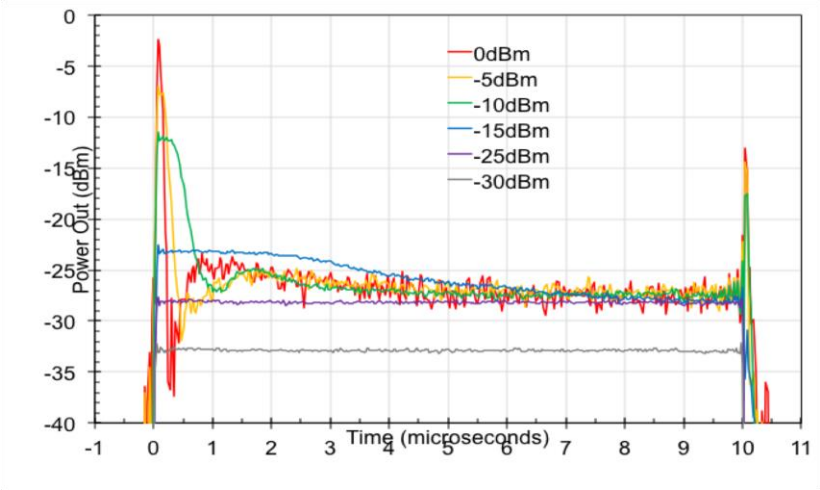
- S-parameters over power
- Limiting profile
- Response Time
- Selectivity

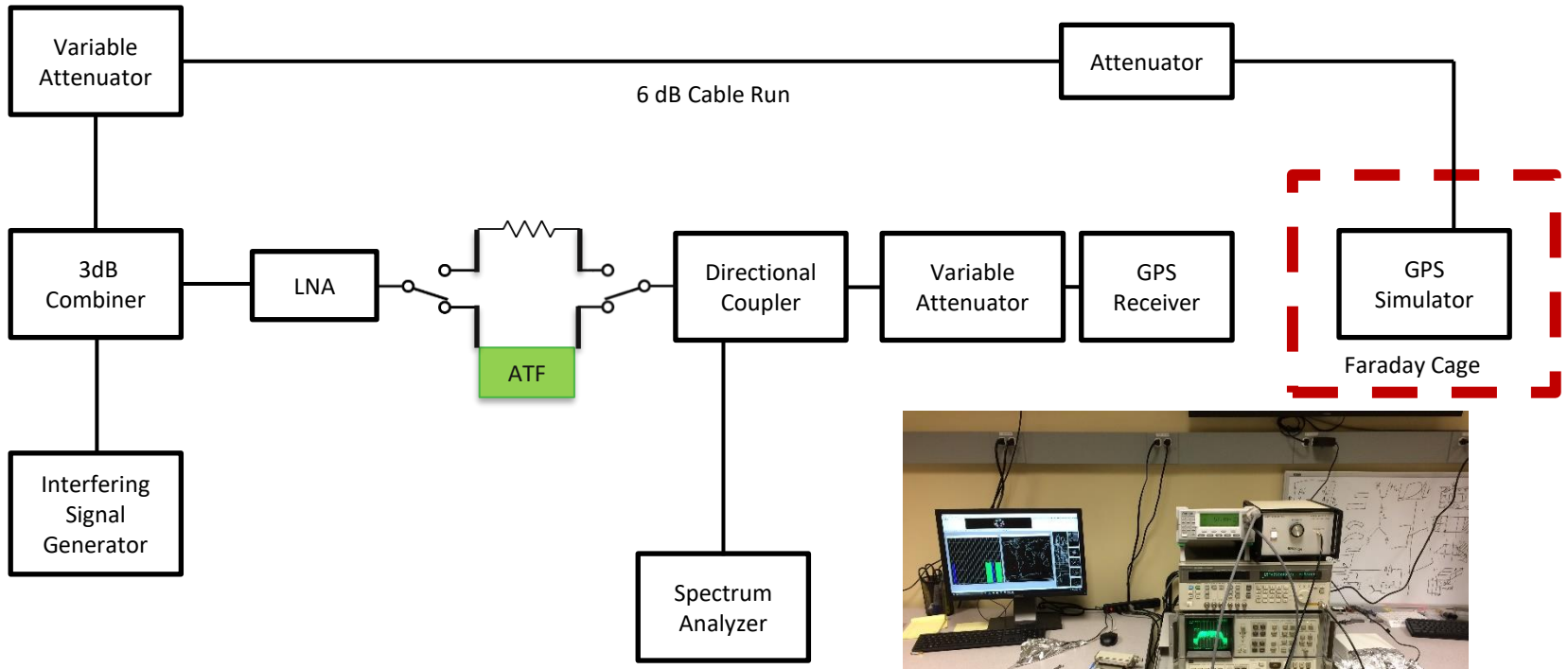
Design and Fabrication of GIF Module



In-House Testing of GIF Module

- Insertion loss
- Return loss
- Power Threshold
- Selectivity
- Response Time
- Interference test





C/A GPS at input to LNA:
-136 dBm (weak signal)
-126 dBm (strong signal)

Interferer:
Starts at -94 dBm and increases
CW and Pulsed CW Signals

Summary

- Susceptibility to GPS jamming attacks continues to grow.
- Metamagnetics' AtF technology is a low cost, compact, passive and highly versatile solution to mitigate a variety of interfering threats to GPS and wireless communications systems.
- AtFs can be retrofit into existing systems and incorporated into new systems being designed today to provide 20dB or more improvement to the threshold signal to noise ratio required by GPS receiver electronics to acquire and process the signals from satellites