National Aeronautics and Space Administration

Design of a K/Q-band Beacon Receiver for the Alphasat Technology Demonstration Payload (TDP) #5 Experiment

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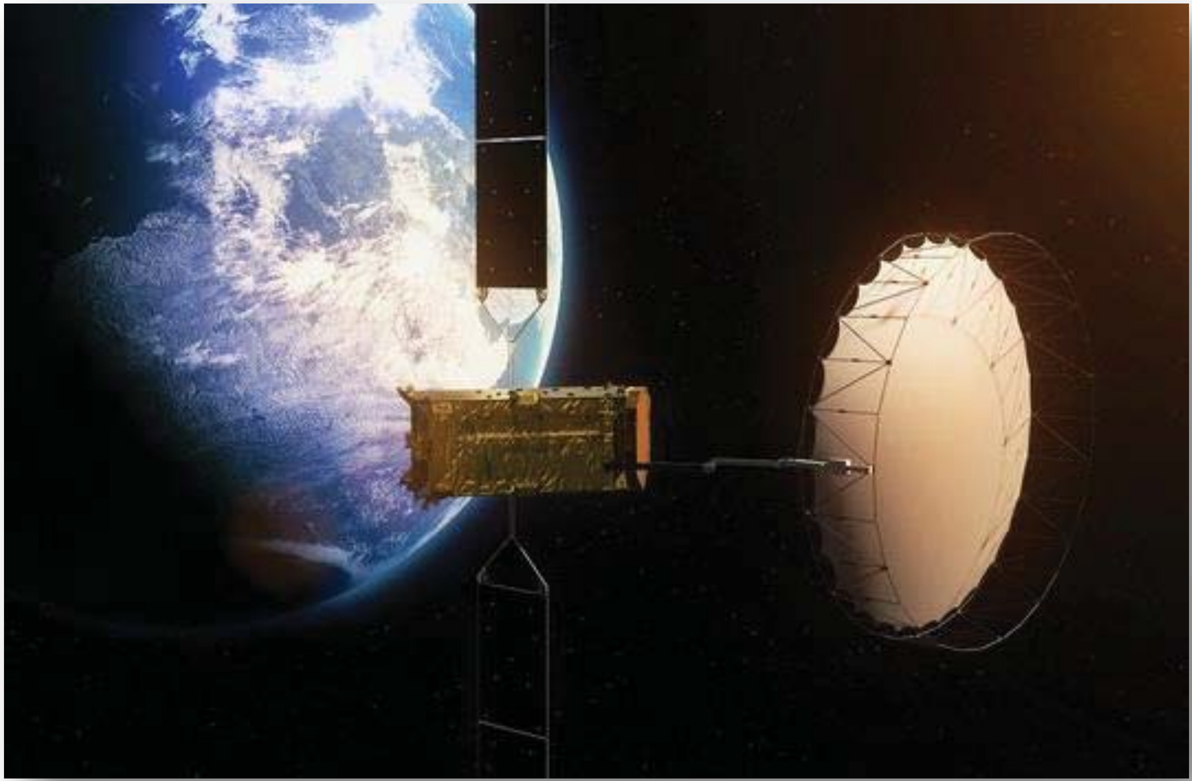

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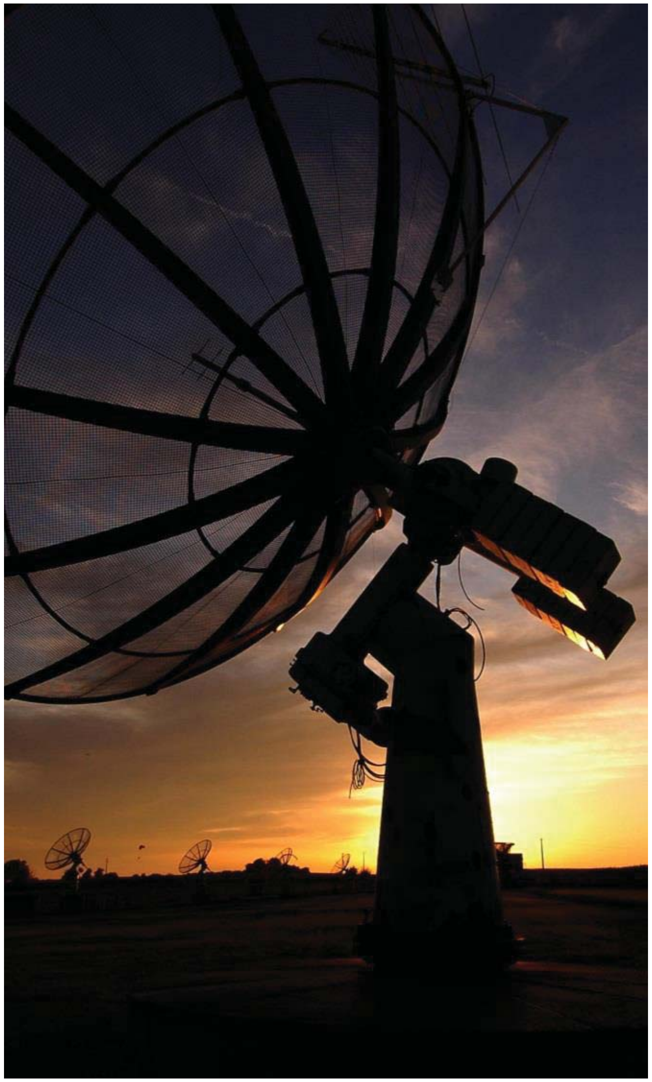
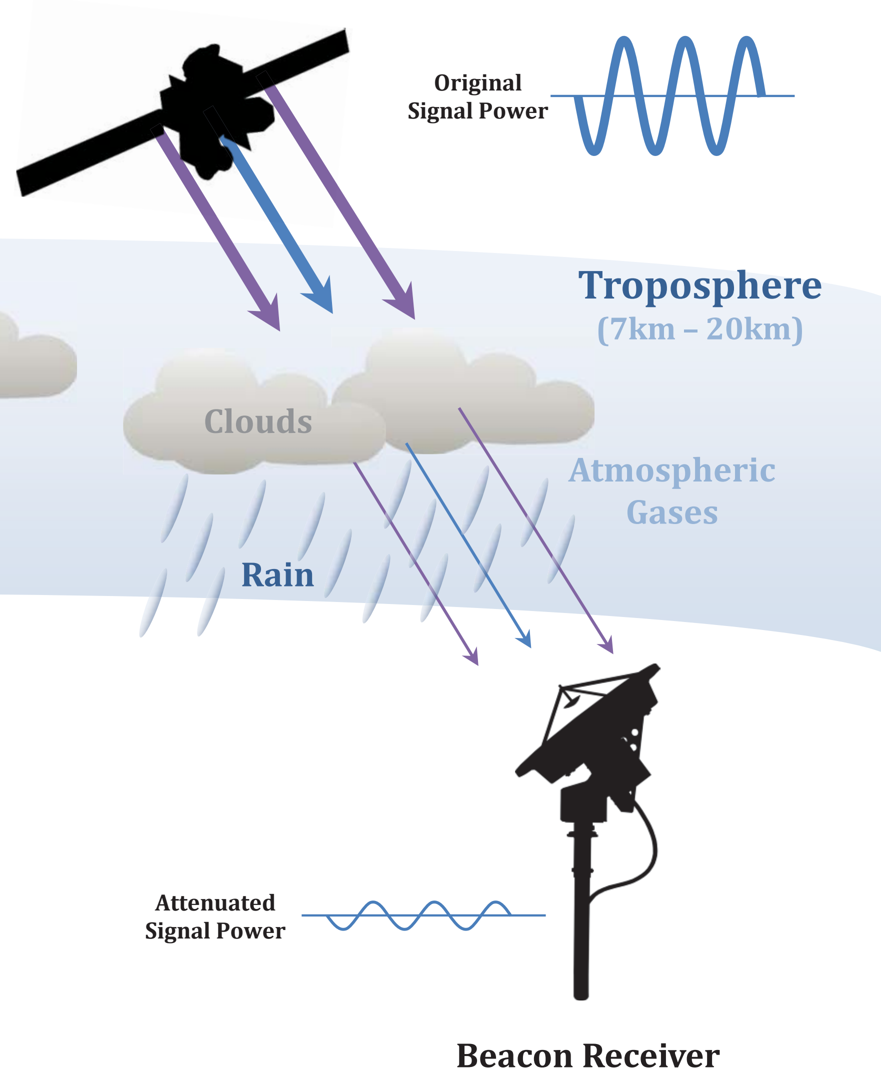
Presentation Overview



1. Technical Motivation
2. Site Information
3. Receiver Design
4. Receiver Performance
5. Measurement Resolution
6. Initial Results
7. Conclusions & Future Work

Technical Motivation

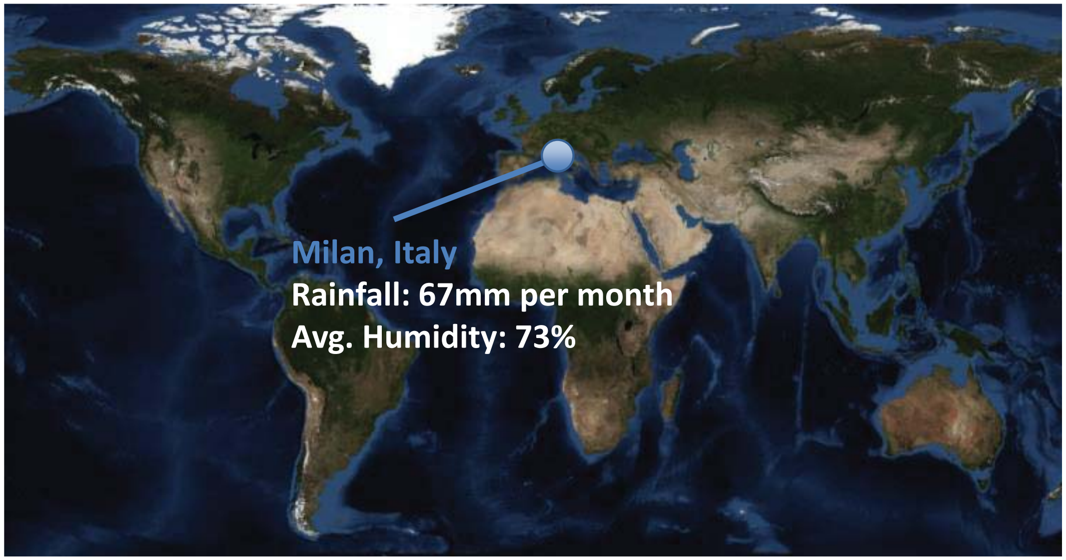
Propagation studies at a given site are valuable in designing efficient, cost effective ground stations without sacrificing performance or availability. [1]

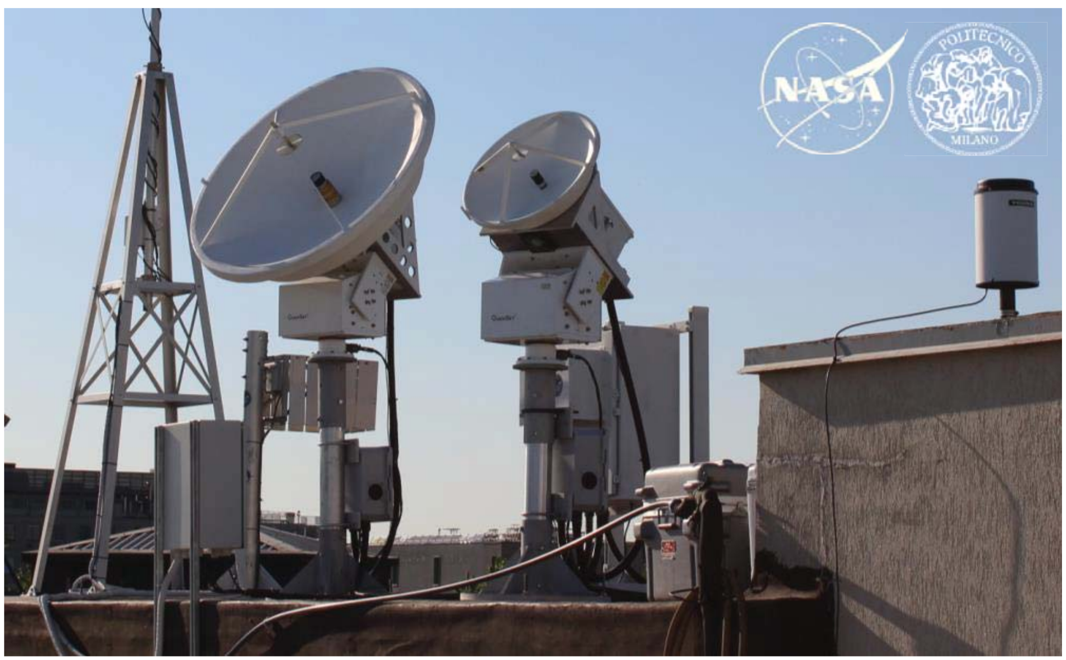


Attenuation measurements characterize the attenuation of a link due to rain, clouds, and gases in the troposphere.[1] The total attenuation can be measured on the ground via a beacon receiver.

The beacon transmits a signal, and the power is measured on the ground. This power measurement will fluctuate with atmospheric conditions, yielding a characterization of the total atmospheric attenuation.

Site Information



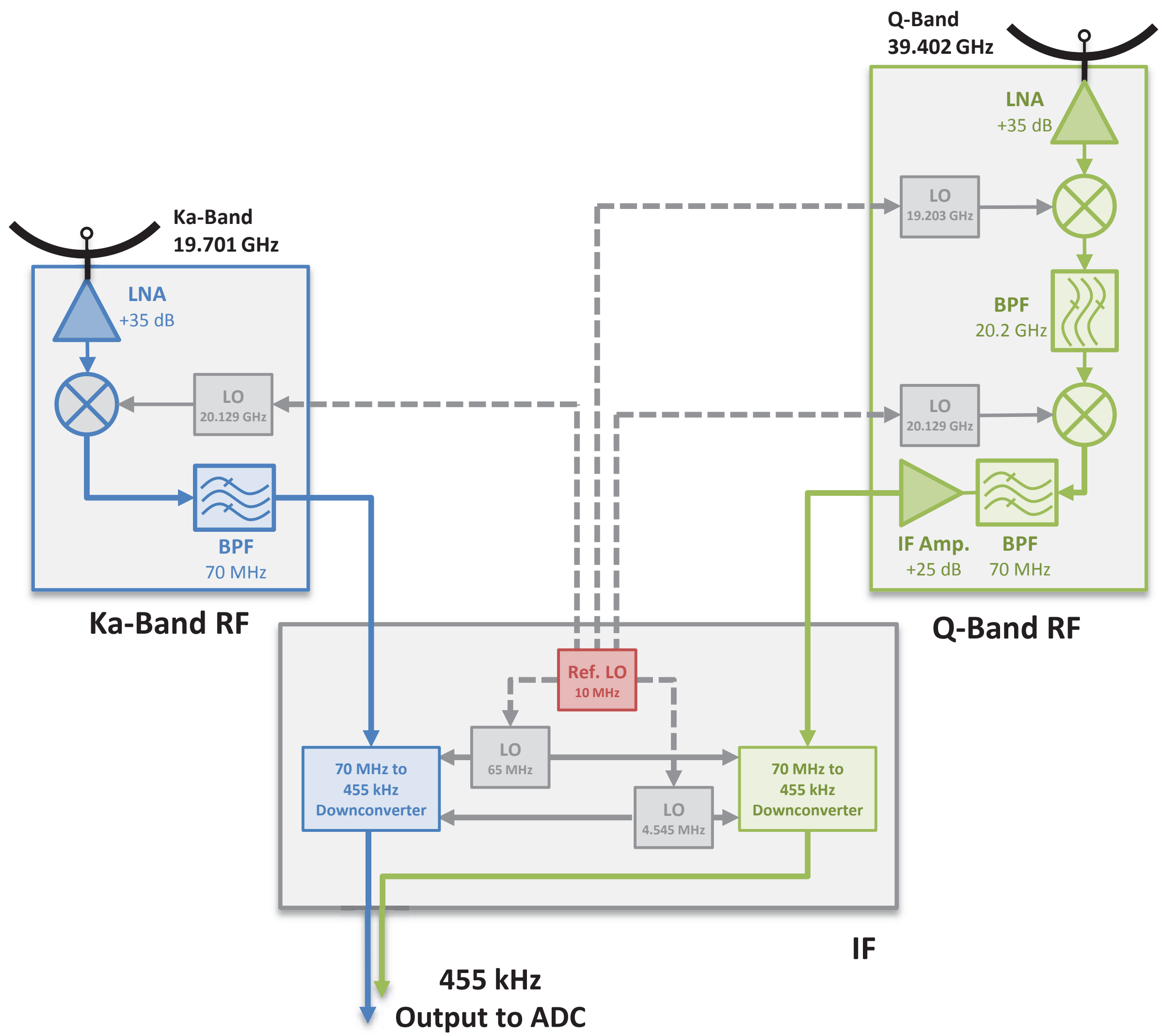


		Milan, Italy
Site	**Installation Date**	April 2014
	Latitude	45.4787° N
	Longitude	9.2327° E
	Altitude	121 m
Satellite	**Name**	Alphasat
	Elevation	48.6°
	Azimuth	170.2°
	Beacon Freqs.	19.701 GHz 39.402 GHz

This work was performed as part of the development of a beacon receiver terminal deployed to **Milan**, Italy in collaboration with the Politecnico di Milano.

Receiver Design

System Specifications	
Downconversion (Ka)	3-step down to 455 kHz
Downconversion (Q)	4-step down to 455 kHz
Sampling Rate	1.111 MHz
Number of Points	2^{17}
Integration Time	125 ms
Time Series Output Rate	8 Hz
Dynamic Range	35 dB



Receiver Performance

Laboratory Performance

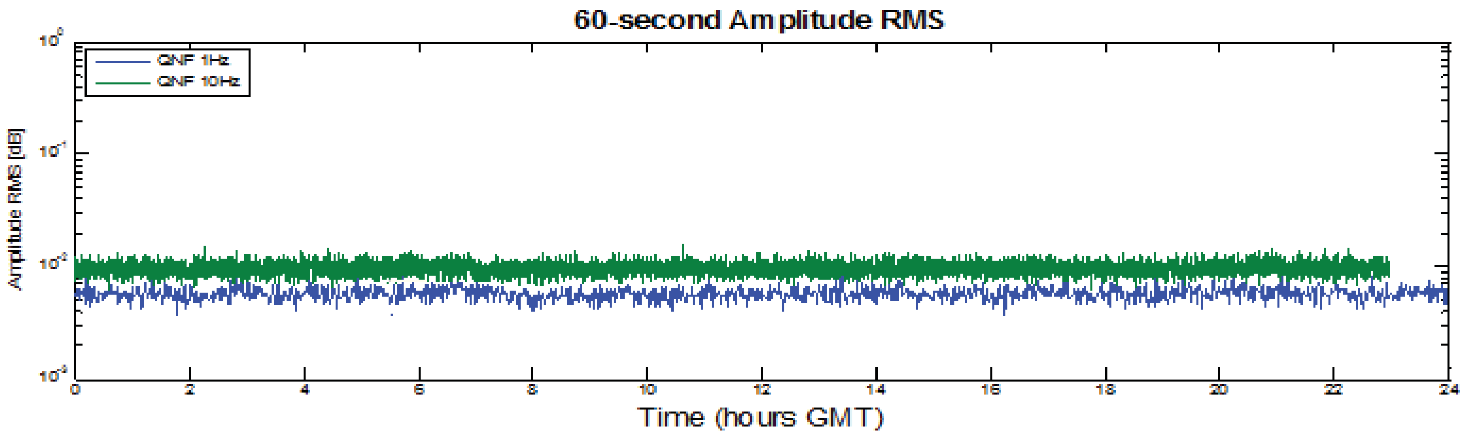
System Performance		
	Ka	Q
System Temperature	504K	720K
Dynamic Range at 1 Hz	58dB	58dB
Dynamic Range at 8 Hz	48dB	48dB

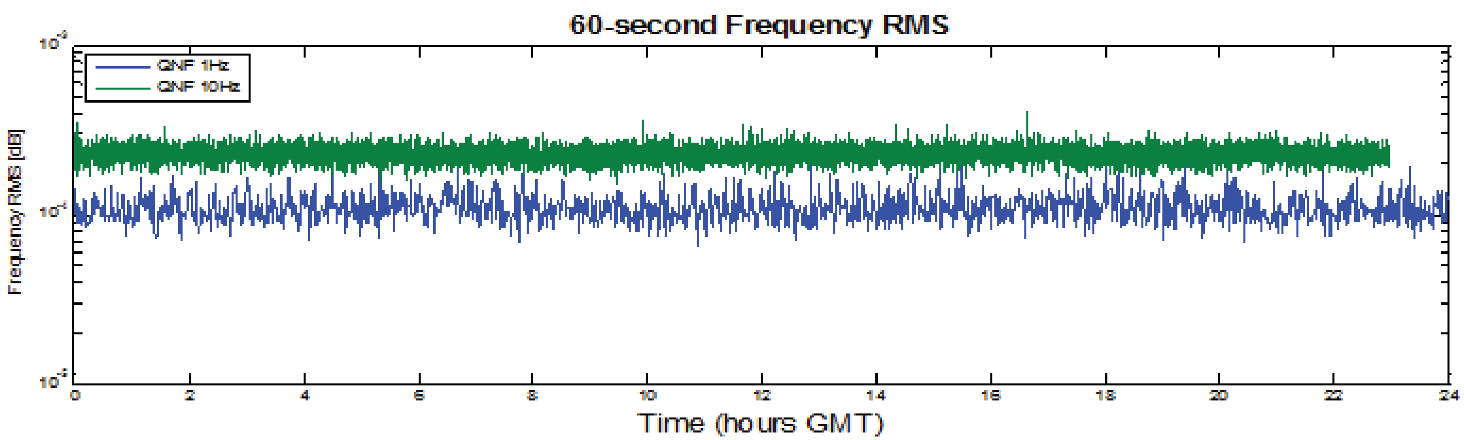
Actual Performance

System Performance		
	Ka	Q
System Temperature	504K	720K
Dynamic Range at 1 Hz	40dB	40dB
Dynamic Range at 8 Hz	37dB	37dB

In laboratory testing the system achieved a dynamic range of 58/48dB for the 1Hz and 8Hz measurements. This was based on the link budget calculations that estimated the power at the flange to be ~-115dB. The actual power is lower than expected reducing the dynamic range, additionally the phase stability of the satellite is worse than expected. The phase instability made the 1Hz measurements noisy due to the long integration time. The 1Hz measurements are now made by averaging the 8Hz measurements over the 1Hz integration time further reducing the dynamic range.

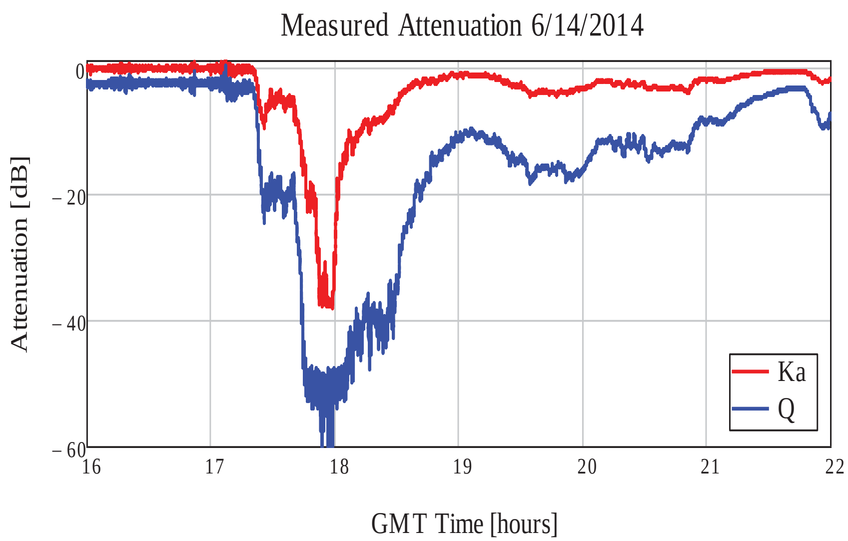
Measurement Resolution

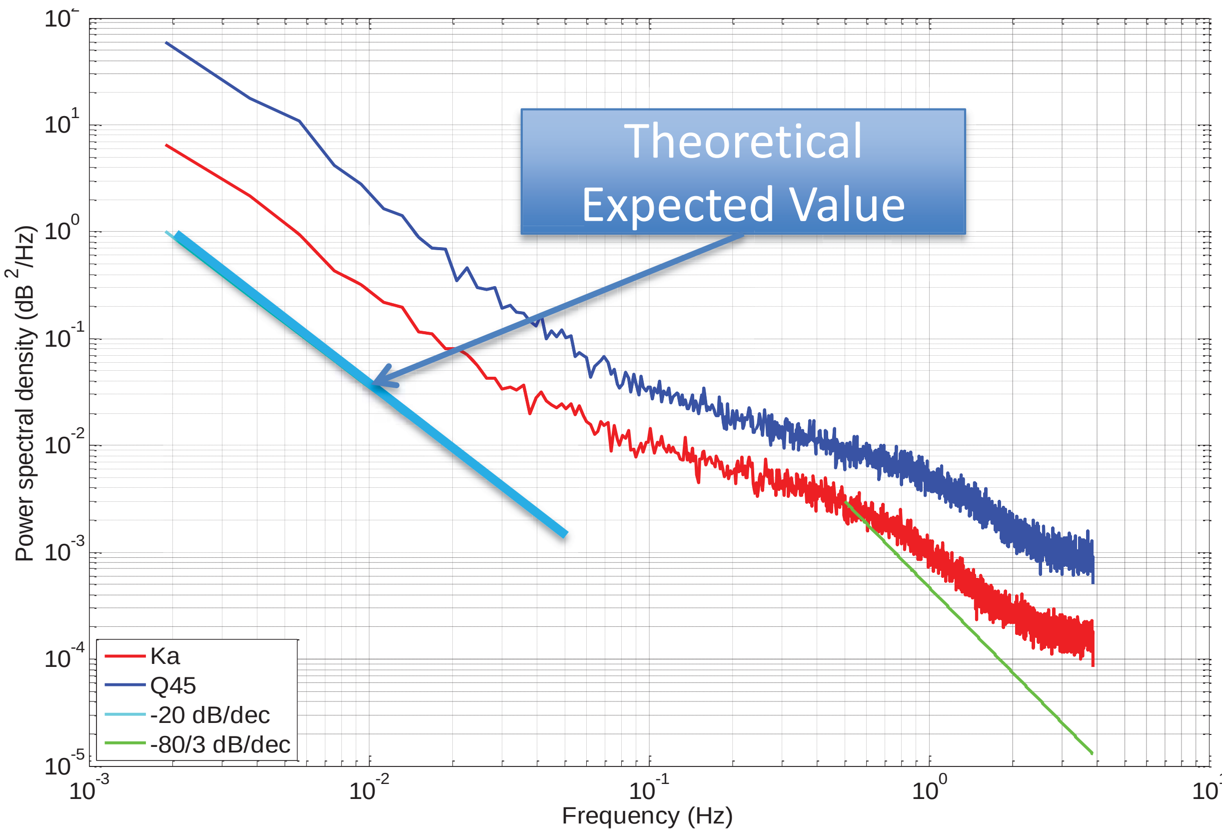




The above figure shows the system performance in clear sky conditions. The measurement resolution of the system during this condition is .009dB root-mean-square (RMS) at 10Hz and .005dB RMS at 1Hz

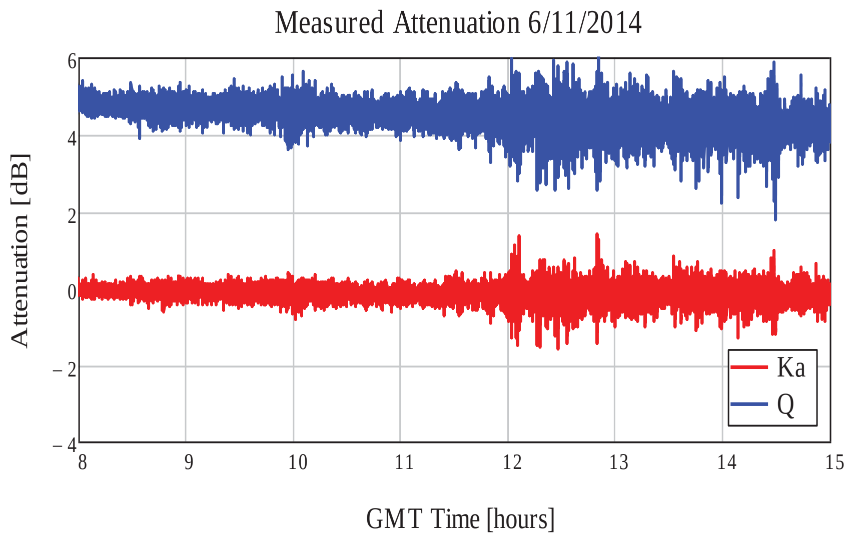
Initial Results – Rain Event

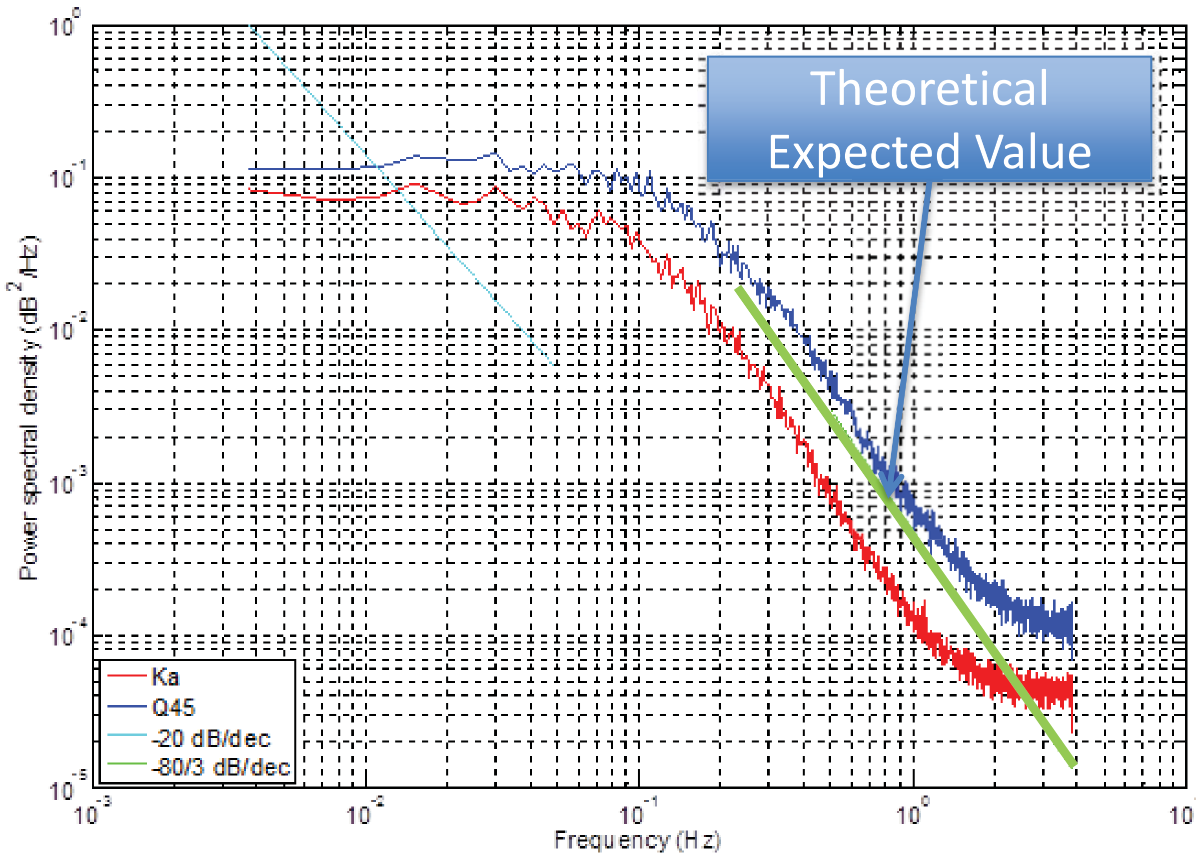




Data collection officially began 6/1/2014. It is too soon for full statistical analysis but several major rain events have been recorded by the system. During a deep fade event the rain slope corresponds very well with theory at the low frequencies.

Initial Results – Clear Sky





During a events such as atmospheric heating the scintillation slope corresponds very well with theory at the high frequencies.

Conclusions/Future Work

The AlphaSat terminal was installed in Milan Italy in April of 2014 with the official data collection starting on June 1st, 2014. The goals of the campaign will be to study the atmospheric effects at Ka/Q band and to investigate site diversity at these frequencies using a second terminal located in Spino d'Adda, Italy approximately 30km away.

Current Plans:

- **Continued Data Collection**
  - *≥ 5 years per site*

Long-Term Goals:

- **Adaptive Compensation Techniques**
- **New Frequency Bands**
  - *Q/V/W Band*
- **Additional Sites**

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