Making aliased images from sub-sampled signals, your friends!

N. Frearson, H. Corr

British Antarctic Survey, Cambridge, UK (nfre@bas.ac.uk /Phone: +44 1223 221421)

This paper discusses the use of digital sub-sampling to down-convert high frequency signals to a lower frequency whilst maintaining the integrity of the signal amplitude, phase and bandwidth and applies this method to a real-world case.

Pulsed radar signals of known amplitude, phase and bandwidth are often used to penetrate into and through the ice of glaciers and ice sheets around the world and the effects that the ice has on these same parameters can be used to infer many things about the makeup of the ice and it's surroundings. The British Antarctic Survey had a requirement to develop an airborne ice penetrating pulsed radar that could be used by scientists to 'look through' the very deep ice found in parts of Antarctica but that would also enable them to study the weakly reflecting internal structures of the ice that the signals were passing through. This required the system to be high power but also able to resolve very small signals hidden in the background noise suggesting that extensive coherent stacking of the received signal would be required. Analogue drift within the receiver mixer traditionally used in these systems could not be tolerated.

For these reasons a phase coherent system was proposed with the down conversion of the received signal taking place in the digital domain. Digital sub-sampling of the signal was used to deliberately generate aliased images in the frequency domain whilst keeping the sampling frequency down to an acceptable level. Simple modeling of this process indicated where each alias would occur in the frequency domain for a given sample frequency and carrier frequency. Careful selection of these parameters then enabled us to position the aliased images precisely within the frequency domain from where they could be manipulated to extract the required signals whilst maintaining amplitude, phase and bandwidth information and rejecting any unwanted images. Once the required signals were recovered, further post-processing could be applied in

real-time and the resulting data time-stamped and passed to a data storage system.