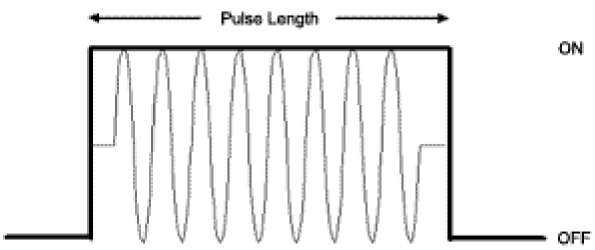
Learn More about CHIRP Sonars

CHIRP is an acronym for **Compressed High Intensity Radar Pulse**.

CHIRP techniques have been used for a number of years above the water in many commercial and military RADAR systems. The techniques used to create an electromagnetic CHIRP pulse have now been modified and adapted to commercial acoustic imaging sonar systems. Tritech International Limited has now introduced CHIRP as its core acoustic engine for all its new range of Digital Sonar Technology (DST) sonars.

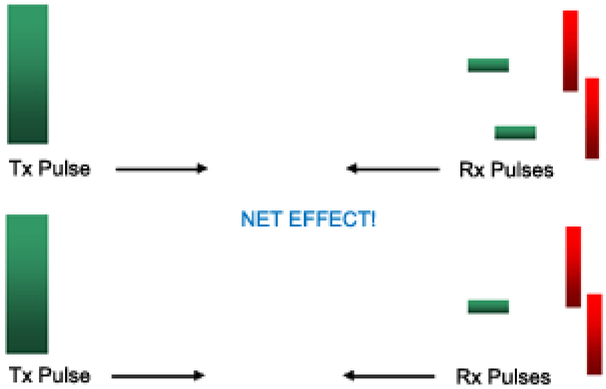
To understand the benefits of using CHIRP acoustic techniques, we need to analyse the limitations using conventional monotonic techniques. An acoustic pulse consists of an on/off switch modulating the amplitude of a single carrier frequency.



The ability of the acoustic system to resolve targets is determined by the pulse length; this, however, has its drawbacks. To get enough acoustic energy into the water for good target identification and over a wide variety of ranges, the transmission pulse length has to be relatively long. The equation for determining the range resolution of a conventional monotonic acoustic system is given by:

Range resolution = (pulse length x velocity of sound) / 2

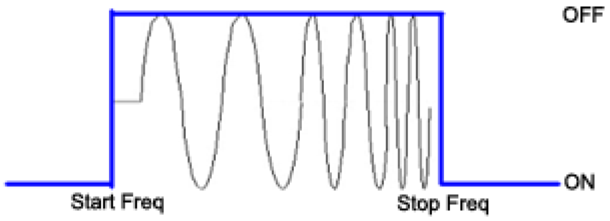
In a conventional Tritech system the smallest pulse length is 50 micro seconds and velocity of sound in water (VOS) 1500 metres/second (typical). Therefore our range resolution = 37.5mm.
This result effectively determines the range resolution (or ability to resolve separate targets) of our monotonic acoustic imaging system.



Using the example above, if two targets are less than 37.5mm apart then they cannot be distinguished from each other. The net effect is that the system will display a single large target, rather than multiple smaller targets.

CHIRP signal processing overcomes these limitations.

Instead of using a burst of a single carrier frequency, the frequency within the burst is swept over a broad range throughout the duration of transmission pulse. This creates a 'signature' acoustic pulse; the sonar knows what was transmitted and when. Using 'pattern-matching' techniques, it can now look for its own unique signature being echoed back from targets.



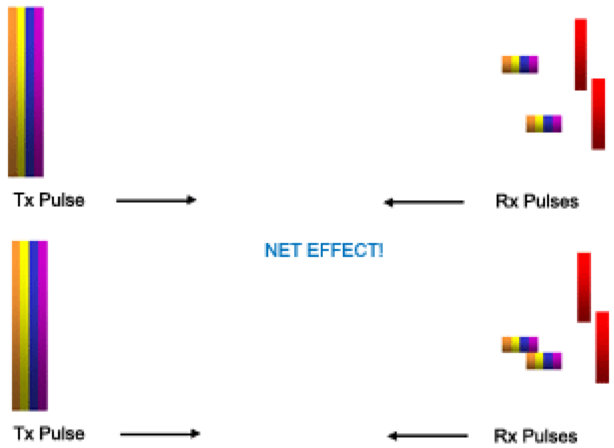
In a CHIRP system, the critical factor determining range resolution is now the bandwidth of the CHIRP pulse. Now the range resolution is given by:

Range resolution = (velocity of sound) / (bandwidth x 2)

The bandwidth of a typical Tritech CHIRP system is 100kHz.

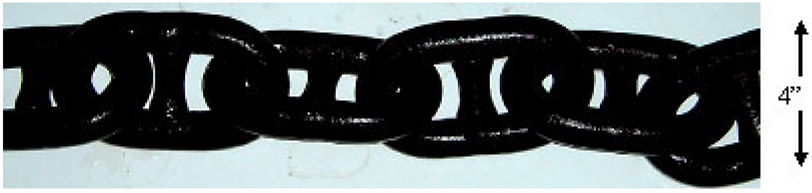
With velocity of sound in water (VOS) 1500 metres/second (typical), our new range resolution = 7.5mm... **a theoretical improvement by a factor of 5!**

This time, when two acoustic echoes overlap, the signature CHIRP pulses do not merge into a single return. The frequency at each point of the pulse is different, and the sonar is able to resolve the two targets independently.

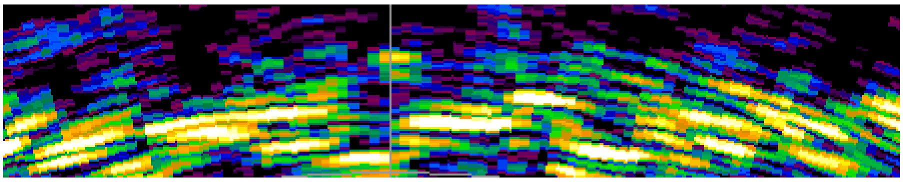


The response from the 'pattern-matching' algorithms in the sonar results in the length of the acoustic pulse no longer affecting the amplitude of the echo on the sonar display. Therefore, longer transmissions (and operating ranges) can be achieved without a loss in range resolution. Additionally CHIRP offer improvements in background noise rejection, as the sonar is only looking for a swept frequency echo, and removes random noise or out-of-band noise.

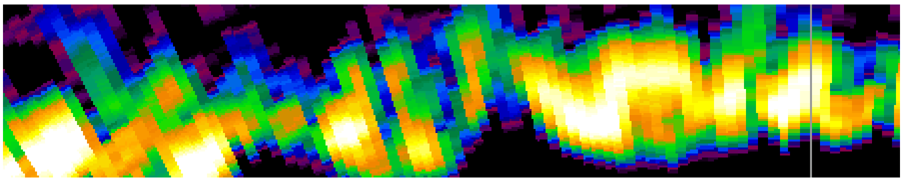
To demonstrate the benefits of CHIRP an experiment was conducted using a sample of chain in a test tank:



CHIRP Sonar image - chain links clearly visible:



Monotonic Sonar image - difficulty identifying individual chain links:



In summary, CHIRP techniques combined with Tritech's DST design gives.

- Greatly improved range resolution compared to fixed-frequency sonars
- Larger transmission pulse lengths for increased operating ranges
- Improved discrimination between closely spaced targets
- Improved noise rejection and signal-to-noise ratios
- Reduced power consumption, from high speed digital circuitry