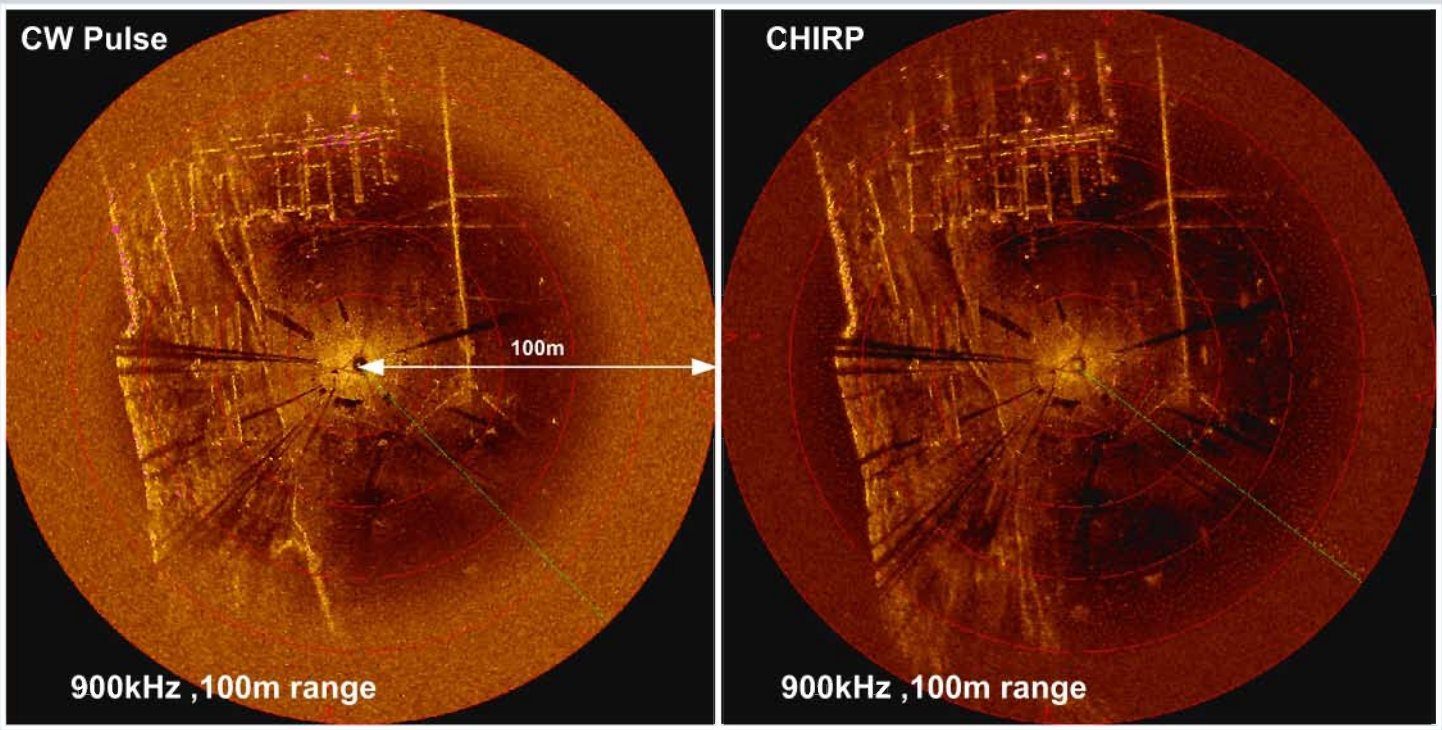
"CHIRP" Sonar Resolution

Another sonar technique that does not use a short duration CW pulse to improve range resolution is called 'CHIRP." This acronym comes from Compressed High Intensity Radar Pulse and was initially associated with RADAR and then adapted to the commercial sonar world in the 1990s.

CHIRP sonar has better range performance and signal to noise ratios over its CW counterpart assuming the system has low-noise electronics, and a wide, equalized amplitude bandwidth that is supported by the transducer and receiver.

Kongsberg Mesotech 1171-series High Resolution Scanning Sonar
(Tunable frequency 675kHz – 1.35MHz)



Range Resolution Formulas:

Range resolution in a CW pulse sonar is defined by the formula: **RR= Speed of sound X Pulse Length*/ 2**

In a CHIRP sonar the range resolution is defined by the formula: **RR= Speed of sound / 2 X Bandwidth**

* where the smallest pulse length to have an effect on range resolution is limited by 1/ receiver bandwidth

CW and CHIRP Range Resolution Example:

CHIRP with a 40kHz receiver bandwidth and 1500m (4921')/sec speed of sound

CHIRP RR = 1500 / 2 X 40
= 1.875cm (0.738")

CW Pulse with a 40kHz receiver bandwidth, 25µs pulse length and 1500m/sec speed of sound

CW RR = 1500 X 25 / 2
= 1.875cm (0.738")

Although the example shows the range resolution of the CW and CHIRP systems is identical, ***the total CHIRP energy is 40X larger!***

THE FULL PICTURE

KONGSBERG

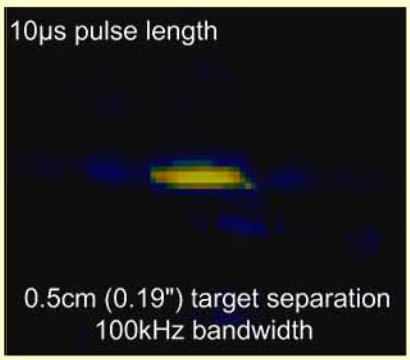
Pulsed/CW Sonar Range Resolution

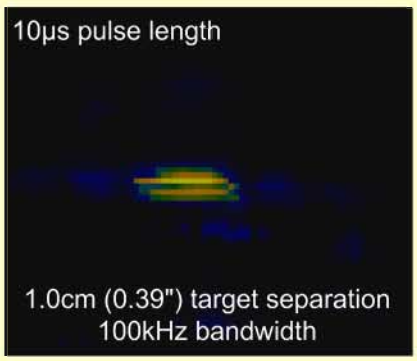
Range resolution is the ability of the sonar to resolve two targets laying parallel in range to the wave front. ***It is not the sonar's capacity to resolve a precise distance from the sonar transducer to a target.***

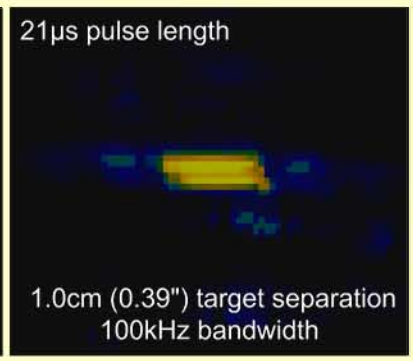
The two most common types of sonar are:

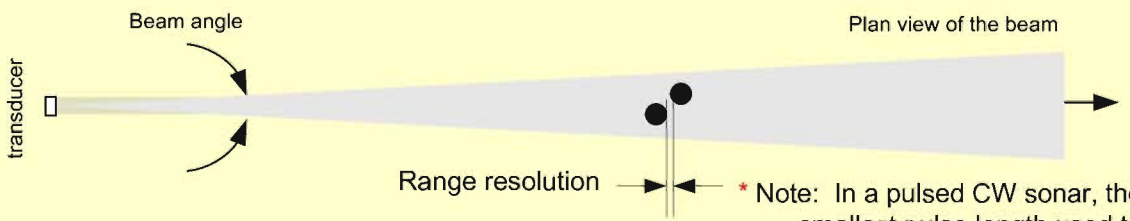
1: pulsed (also called a Continuous Wave or CW) sonar
2: CHIRP (Compressed High Intensity Radar Pulse) or Linear Frequency Modulated (LFM) sonar

With a pulsed sonar, the range resolution is determined by pulse length, the in-water speed of sound and the bandwidth of the sonar receiver. *Changes in the speed of sound affect range resolution.*







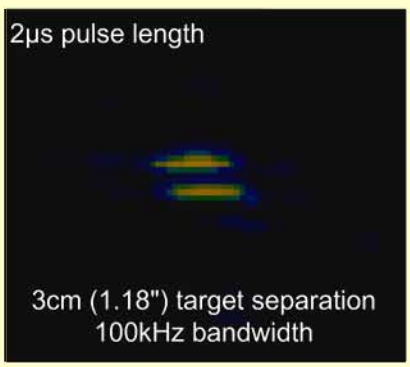


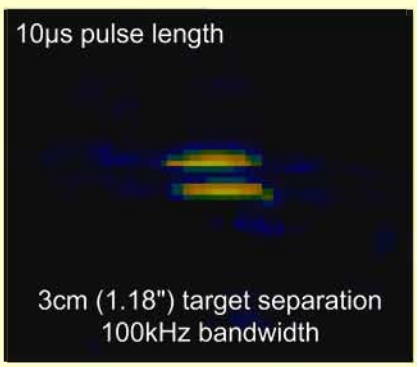
Range Resolution = Pulse Length* X Speed of Sound/2

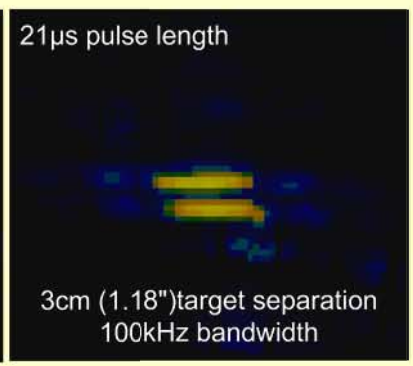
* Note: In a pulsed CW sonar, the smallest pulse length used to improve range resolution is limited by the formula:

1/Receiver Bandwidth

For a pulsed CW system, range resolution (often called cross-track resolution in side-scan operations) is heavily influenced by pulse length, frequency, system bandwidth, and the number of pixels comprising the sonar display. Two targets imaged with a 675kHz scanning sonar show the range resolution formula closely approximates the target resolution achievable in the range dimension given a 100kHz receiver bandwidth.







Drawing courtesy Mark W. Atherton, ***Echoes and Images, The Encyclopedia of Side-Scan and Scanning Sonar Operations***