Set adrift by GPS jamming

GPS interference can be particularly problematic in marine environments but just how bad can it be?

GPS interference at sea

From constructing offshore wind farms and dredging harbours to marine survey and laying underwater cables, GPS receivers have established themselves as a critical element in many offshore and nearshore applications. Any downtime in GPS positioning at sea can have dangerous and expensive repercussions. Increasingly, GPS downtime is being attributed to interference.

Transmitted with a power equivalent to that of a standard light bulb, GPS signals are expected to travel more than 20,000 km and still arrive fit for high-precision position calculations. In most cases, the signals arrive relatively unscathed however, being barely distinguishable above the thermal background noise, they can be sitting ducks for any passing interferer.

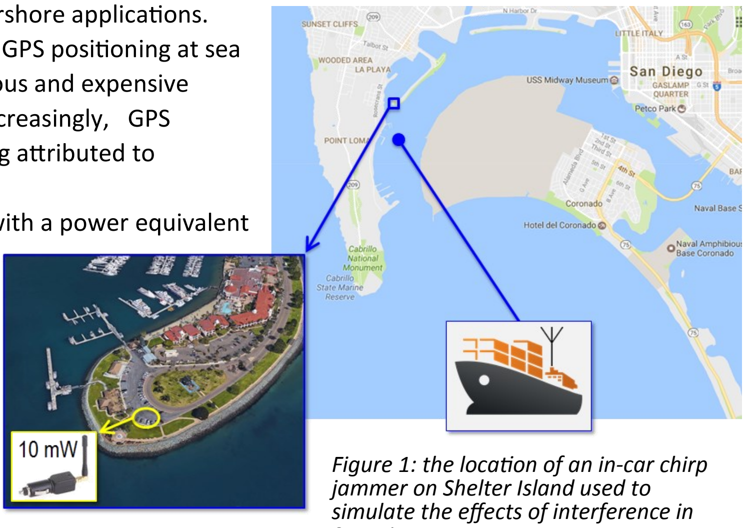


Figure 1: the location of an in-car chirp jammer on Shelter Island used to simulate the effects of interference in San Diego Bay

RTK and PPP are especially vulnerable

Maritime applications are increasingly using high-precision positioning such as RTK and PPP which use not only the code information modulated onto the signals but also the phase of the signal itself. In the presence of interference, these phase-based modes are the first to suffer.

How bad can it be

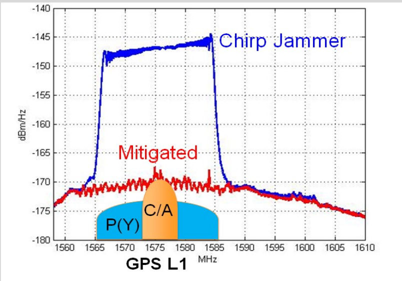
The use of GPS jammers is strictly prohibited but their effect can be estimated using a GPS simulator.

Taking San Diego harbour as an example, a simulator was programmed to generate the GPS signals that a receiver would see on a boat at that location. Interference of the GPS signals was mimicked by mixing the simulator signal with that from a jammer. With the jammer at the location shown in **Figure 1** and the GPS receiver on a boat nearby in the bay, the effect of interference throughout the bay could then be extrapolated using standard

Know your interferer

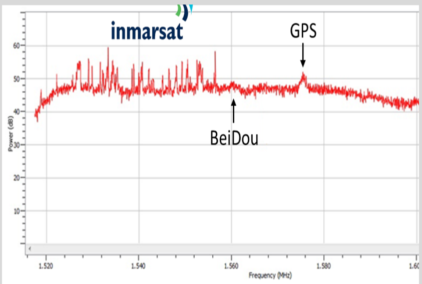
Different interferers leave their own footprint on the RF spectrum. Below are three examples of interferers that have caused problems nearshore, offshore as well as on-board. Find out more about interferes at sea on this recent [white paper](#).

Nearshore



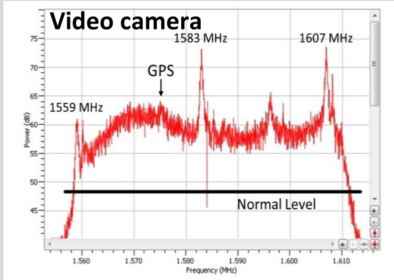
The GPS L1 signal contaminated with a chirp jammer signal both before (blue) and after (red) activation of AIM+ Interference Mitigation

Offshore



Satellite communications signals can interfere with GPS signals in the L1 band

Self interference



L1-band Interference from a GoPro Hero 2 video camera picked up by a GPS antenna

radio wave propagation models.

Effect of a chirp jammer

The results in **Figure 2** show that without [AIM+](#) interference mitigation, one small 10 mW chirp jammer can knock out RTK positioning over several hundred metres. When AIM+ is activated, the *non-RTK* zone is reduced to a few metres in the direct vicinity of the jammer.

Effect of a continuous wave interferer

Repeating the tests with a continuous wave (CW) interferer of the same power, the results using AIM+ are even more dramatic as **Figure 3** shows. Without AIM+, a CW interferer in the car park close to the shore prevents RTK positioning or indeed any GPS positioning over much of the bay and extends several kilometres out to sea in line of sight from the jammer.

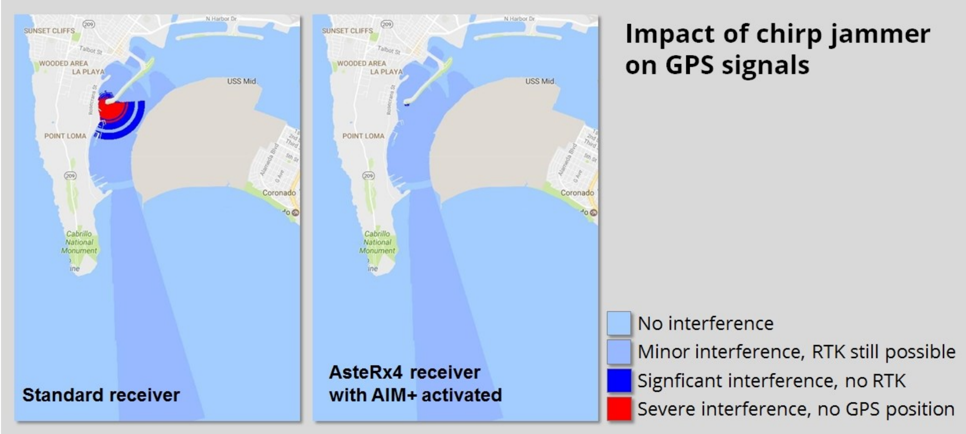


Figure 2: the effect of a 10 mW chirp jammer on GPS positioning in San Diego Bay with and without AIM+ interference mitigation

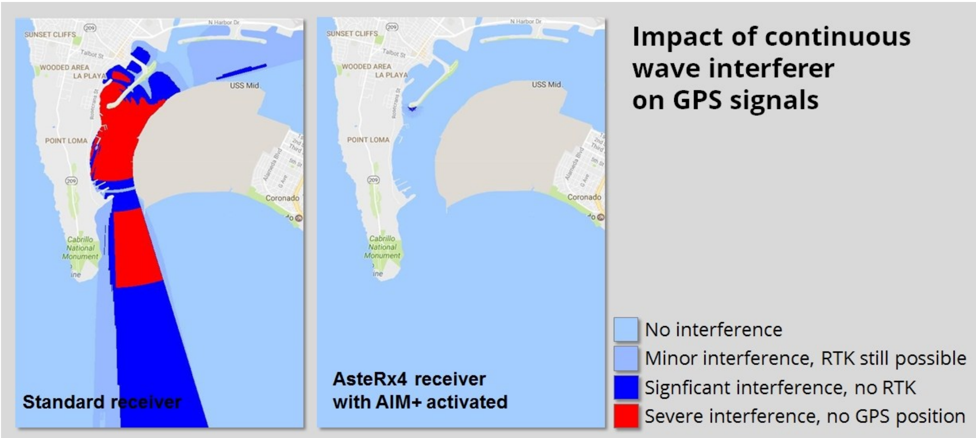


Figure 3: the effect of a 10 mW continuous wave jammer on GPS positioning in San Diego Bay with and without AIM+ interference mitigation

Solving interference

A comprehensive approach puts interference considerations at the forefront of receiver design and incorporates it into every stage of signal processing. In the case of the [AsteRx4](#) and [AsteRx-U](#), the antenna signal is immediately digitised after filtering and automatically cleansed of interference using multiple adaptive band-stop filters.

Depending on the nature of the interference, the stop-band bandwidth is adjusted automatically between a notch of a few kHz to 1 MHz-wide rejection. The notch filters are complemented by an adaptive filter capable of rejecting more complex types of interference such as that from chirp jammers, frequency-hopping signals from DME/TACAN devices as well as high-powered Inmarsat transmitters.

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