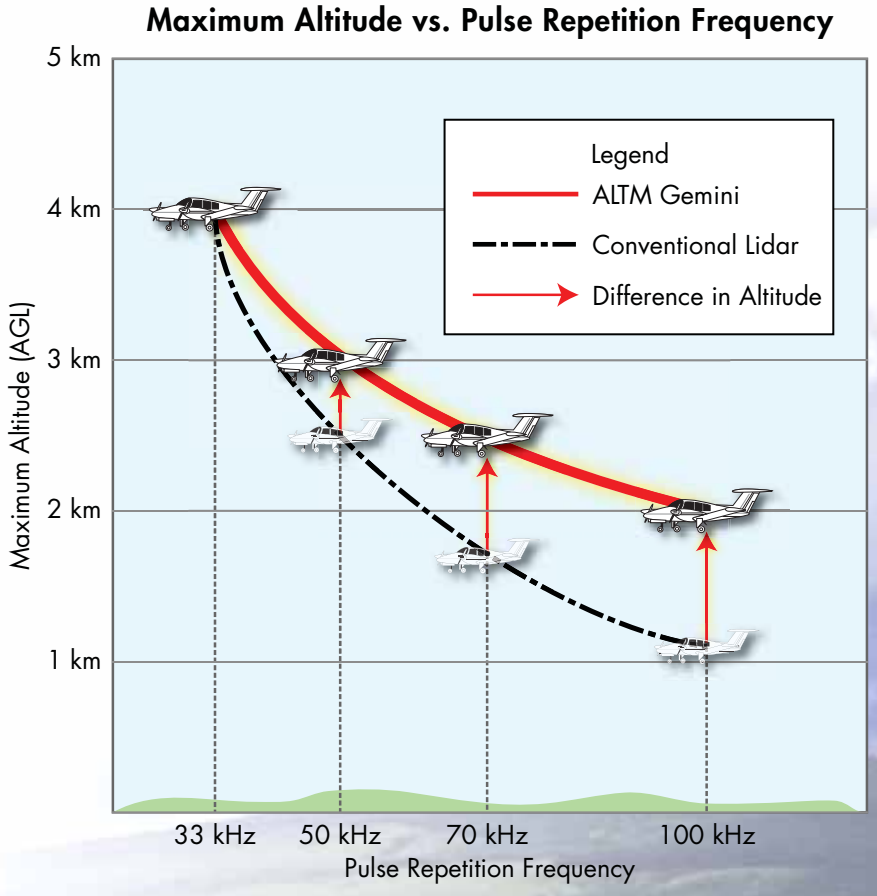
# Field Notes

## Overcoming the Timing Limit with Multipulse Technology
## ALTM Gemini

"We're not actually *breaking* the laws of physics — we're just bending them to your advantage."
*Donald Carswell, President, Optech Incorporated*

With its revolutionary multipulse technology, Optech's new ALTM Gemini raises the bar on operating at maximum altitudes—nearly doubled to 2,000 m at a laser pulse repetition frequency (PRF) of 100 kHz.

The key to the Gemini's high-flying performance is a revolutionary new technology called multipulse. Multipulse provides a brilliant solution to a fundamental challenge confronting airborne lidar technology: the timing limit, a constraint imposed by the laws of physics.




### What is the Timing Limit?

The timing limit refers to the time it takes for a pulse of light to travel from the laser transmitter, to the target, and back to the laser receiver. Currently, all airborne lidar systems wait for the transmitted pulse to return to the laser receiver before firing the next shot. Consequently, the laser PRF directly limits the operating altitude.

Take the case of an ALTM laser firing at a PRF of 100 kHz (100,000 pulses per second). This leaves 10 microseconds between two consecutive laser shots. In this exceedingly brief span, light can travel about 3 km. Dividing the number by 2 (to account for transmission and reception), gives us the maximum altitude defined by the timing limit. Factoring for atmospheric interference, the actual timing limit at a PRF of 100 kHz is 1.1 km.

The timing limit still defines the maximum altitude for all lidar systems. However, since the ALTM Gemini can operate in multipulse mode, returns that arrive *after* a subsequent laser shot are still recorded. The laser can keep firing even while pulses are in flight to the receiver. Multipulse technology—exclusive to the ALTM Gemini—overcomes the timing limit on maximum altitude.

## What is the True Maximum Altitude?

The absolute maximum range of any airborne lidar system, timing aside, is based on signal strength.

Signal strength is affected by two factors: laser PRF and altitude.

The laser PRF determines the initial energy of the pulse. Slower repetition frequencies have higher pulse power, faster repetition frequencies have lower pulse power.

From the moment the pulse leaves the laser, it loses energy. The farther the pulse travels, the more energy it loses. Optical signal strength decays with the square of the altitude: a pulse fired from 3 km is 9 times weaker than the same pulse fired from 1 km.

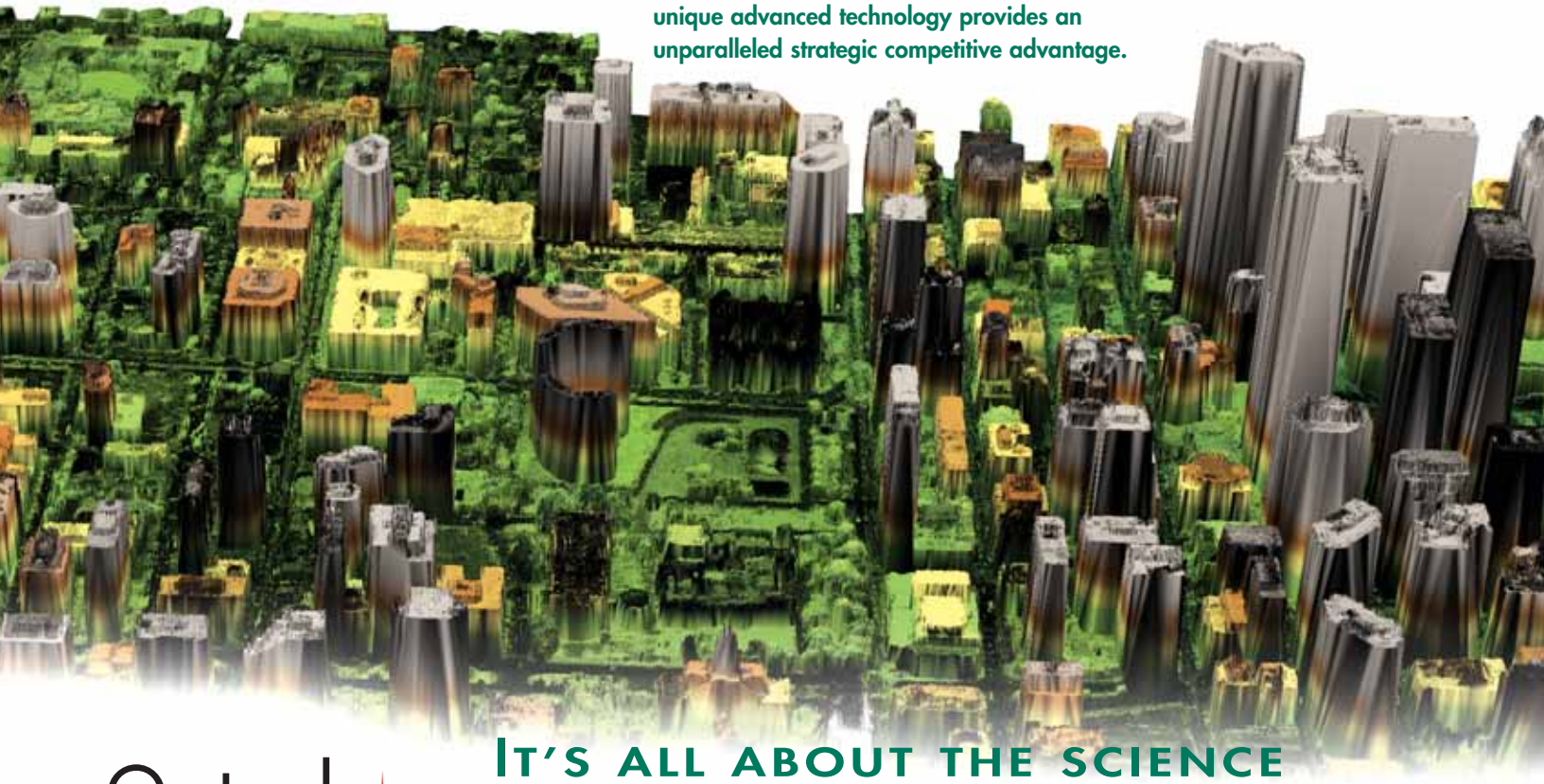
If the signal strength is below the detection threshold of the receiver, no pulse is detected. For an ALTM Gemini laser firing at 100 kHz, the signal strength reaches this threshold at roughly 2 km; if firing at 33 kHz, the laser can go up to 4 km, where the timing limit and signal limit are nearly the same.

In other systems, the signal strength limit is never reached because the timing limit occurs at a lower altitude. With the ALTM Gemini, the signal strength limit defines the maximum operating altitude.

**In summary, two excellent reasons to choose Optech's ALTM Gemini multipulse technology are:**

- **ALTM Gemini overcomes several functional operational barriers that other competing systems cannot. Timing limitations due to maximum altitude are no longer an issue because of the ALTM Gemini's unique ability to continue firing laser pulses while other pulses are in flight to the receiver.**
- **ALTM Gemini's advanced technology has pushed the altitude capability envelope to its limit. Timing limits and signal limits are now virtually the same - thereby ensuring maximum signal strength at maximum operating altitudes.**

**Given these two clear capabilities, ALTM Gemini's unique advanced technology provides an unparalleled strategic competitive advantage.**



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