Sensing is life

LiDAR Miniaturisation from the laser perspective

EPIC Online Technology Meeting on LiDAR Miniaturization

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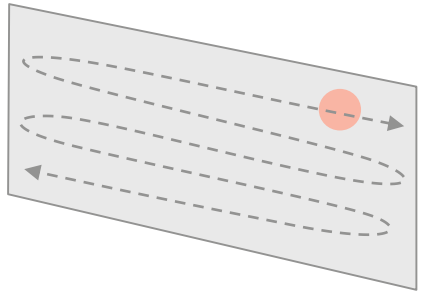
LiDAR Miniaturization – System requirement engineering examples

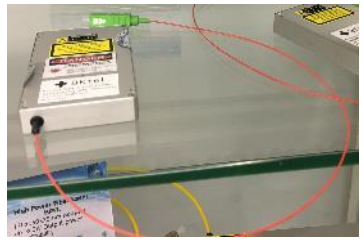
Don’t over-specify – go with good enough for the application

Maximum specification for autonomous driving

2D scanning – 1550nm fiber laser – >>500m range (200km/h)

2kW x 1ns x 120° x 20° / 0.01° / 0.01° x 25Hz x 10% = **10kW** electrical power

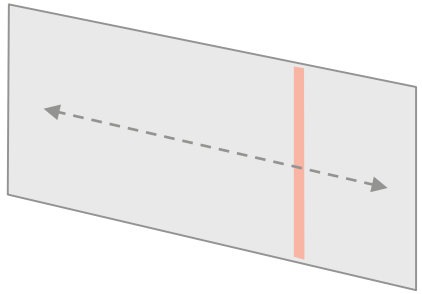




Low end specification for high way pilot

1D scanning – 905nm EEL – ~200m range* (130km/h)

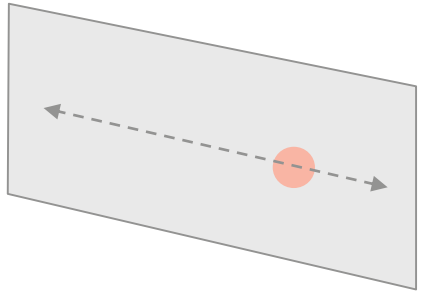
350W x 4 x 1 ns x 21 shots x 120 / 0.1° x 25Hz x 15% = **6W** electrical power



Specification for vacuum cleaning robot

IND – 360° scanning – 905nm EEL – ~10m range

15W x 5ns x 360 / 0.05° x 10Hz x 20% = **30mW** electrical power

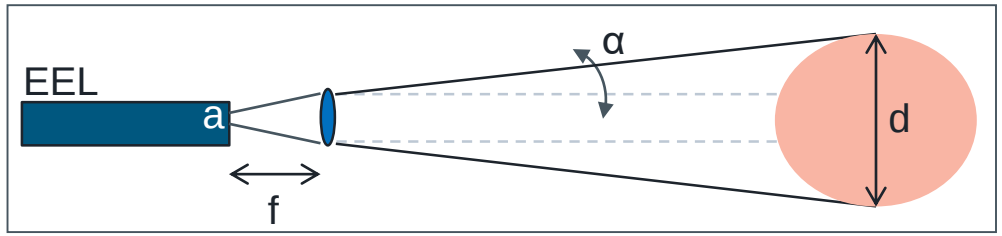


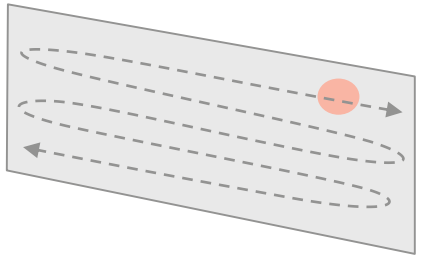
*Range estimation 905nm EEL from: https://www.eetimes.com/demystifying-lidar-an-in-depth-guide-to-the-great-wavelength-debate/

LiDAR Miniaturization – Optics and resolution

Optics size scales with increasing angular resolution. Light source and detector choice can mitigate the size increase.

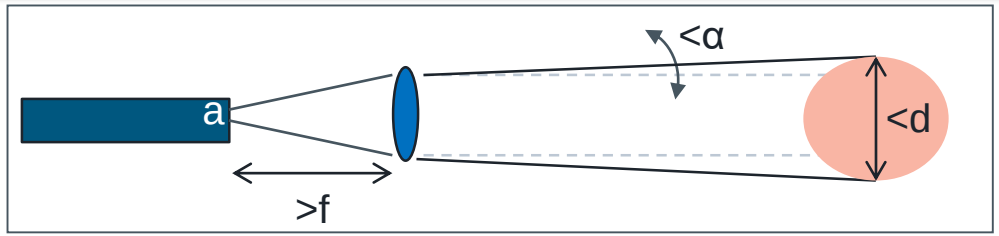
Influence of Light Source properties

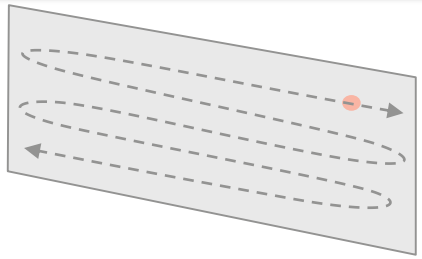




SPL DS90A_3 / SPL TL90AT08
125W – 220µm aperture

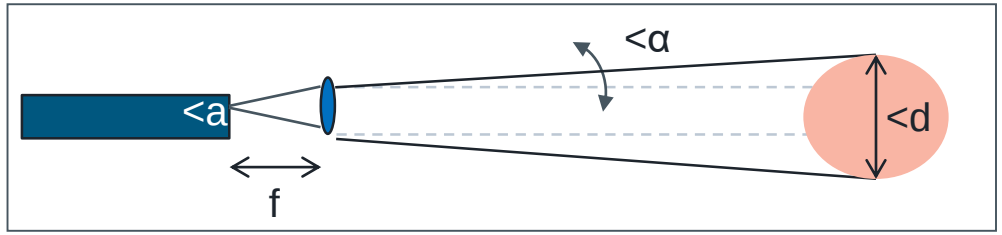
smaller spot size requires larger optics

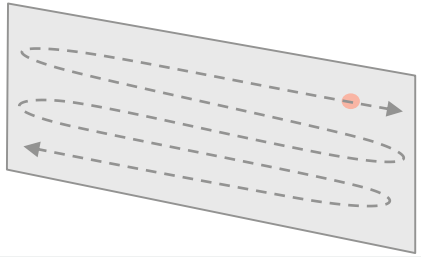




SPL DS90A_3 / SPL TL90AT08
125W – 220µm aperture

smaller aperture allows smaller spot size with same optics





SPL DP90_3 / SPL TL90AT03
65W – 110µm aperture

a: aperture
f: focal length
α: divergence
d: spot size

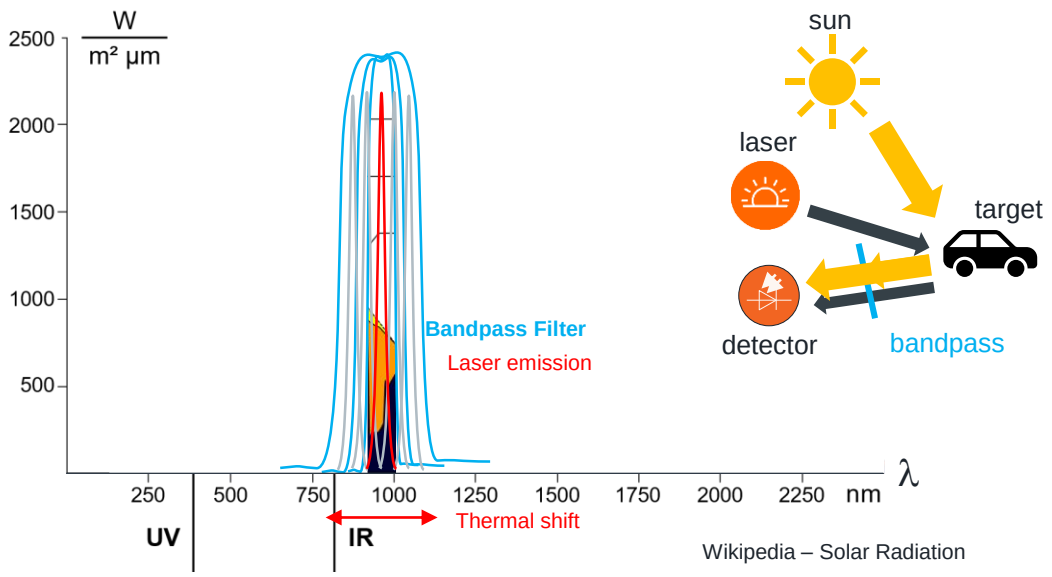
Vacuum cleaner example

220µm aperture → 110µm aperture

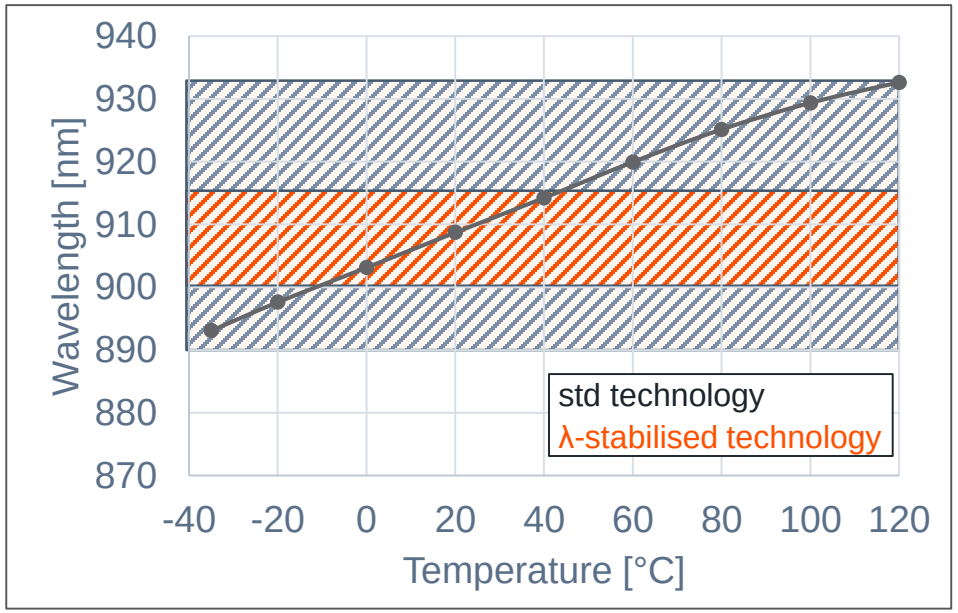
- half the focal length for same resolution
- twice the resolution for same focal length

LiDAR Miniaturization – Technology Improvement

New λ-stable technology will offer LiDAR systems several key advantages



Wikipedia – Solar Radiation



Bandpass filter

A reduced thermal shift allows a narrower bandpass filter and thereby reduces the solar noise.

- **Increase range:** bandpass width half & same laser power → 15%-30% more range
- **Improve efficiency:** bandpass width half & same range → 25%-40% lower laser power needed
- **Reduce system cost and size:** removing TEC → system cost and size reduction

LiDAR Miniaturization – Summary

Pick the right requirements and technology to minimize LiDAR size

System requirement engineering

- Don’t over-specify – go with good enough for the application

Optics and resolution

- Pick the right light source. Optics size scales with increasing angular resolution and laser aperture

Technology improvements

- Go with technology. New technologies will allow LiDAR systems to shrink in size

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