

LiDAR Miniaturisation from the laser perspective

EPIC Online Technology Meeting on LiDAR Miniaturization

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EPIC Online Technology Meeting on LIDAR
Miniaturization

LiDAR Miniaturization – System requirement engineering examples

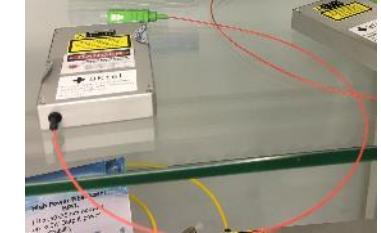
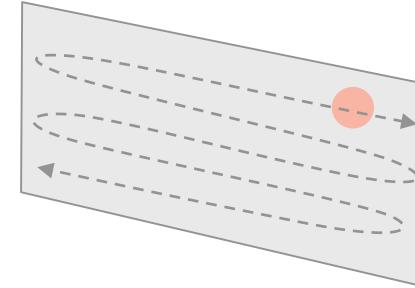
Don't over-specify – go with good enough for the application



Maximum specification for autonomous driving

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

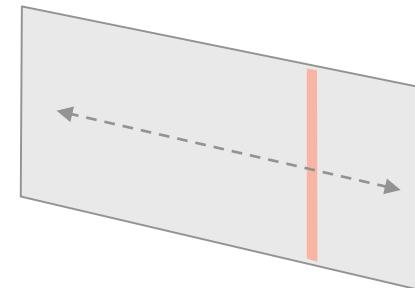
$2\text{kW} \times 1\text{ns} \times 120^\circ \times 20^\circ / 0.01^\circ / 0.01^\circ \times 25\text{Hz} \times 10\% = 10\text{kW}$ electrical power



Low end specification for high way pilot

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

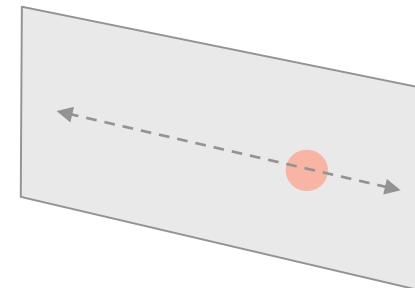
$350\text{W} \times 4 \times 1\text{ ns} \times 21\text{ shots} \times 120 / 0.1^\circ \times 25\text{Hz} \times 15\% = 6\text{W}$ electrical power



Specification for vacuum cleaning robot

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

$15\text{W} \times 5\text{ns} \times 360 / 0.05^\circ \times 10\text{Hz} \times 20\% = 30\text{mW}$ electrical power



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

The diagram illustrates the relationship between light source properties and LiDAR optics. It shows three scenarios:

- smaller spot size requires larger optics:** The first section shows a light source with aperture a emitting light through a lens with focal length f onto a target with spot size d . The divergence angle α is indicated. The second part shows a side view of the lens emitting parallel dashed lines onto the target, which is represented as a grey rectangular block with a red dot. This configuration is associated with the part number SPL DS90A_3 / SPL TL90AT08 and a 125W power rating with a 220μm aperture. It includes two small images: a yellow rectangular component and a gold-colored detector with three leads.
- smaller aperture allows smaller spot size with same optics:** The second section shows a light source with a smaller aperture $< a$ emitting light through a lens with focal length f onto a target with a smaller spot size $< d$. The divergence angle $< \alpha$ is indicated. The second part shows a side view of the lens emitting parallel dashed lines onto the target. This configuration is also associated with SPL DS90A_3 / SPL TL90AT08, 125W power, and a 220μm aperture. It includes the same two small images.
- Vacuum cleaner example:** The third section shows a light source with a very small aperture $< a$ emitting light through a lens with focal length f onto a target with a very small spot size $< d$. The divergence angle $< \alpha$ is indicated. The second part shows a side view of the lens emitting parallel dashed lines onto the target. This configuration is associated with SPL DP90_3 / SPL TL90AT03 and 65W power with a 110μm aperture. It includes the same two small images.

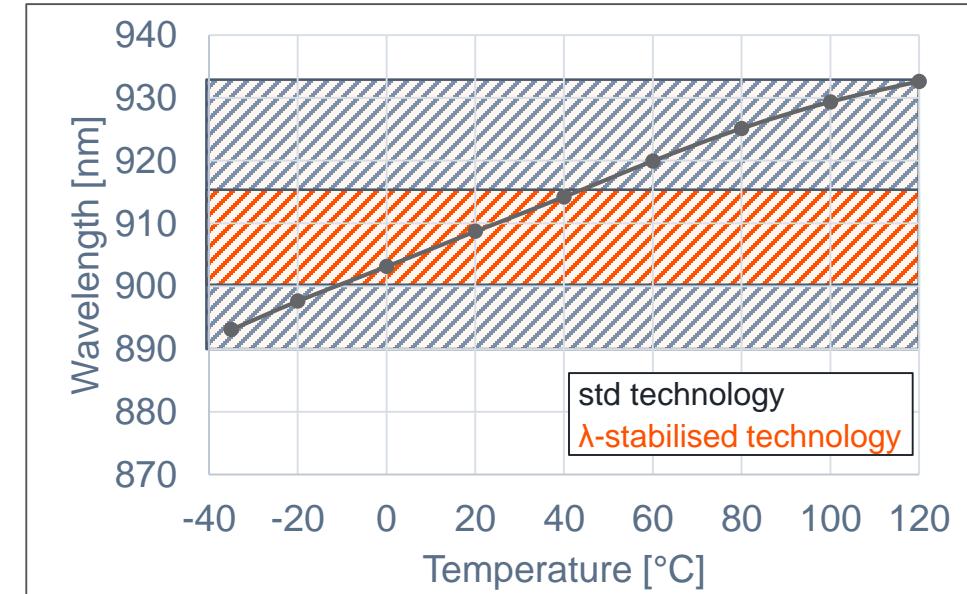
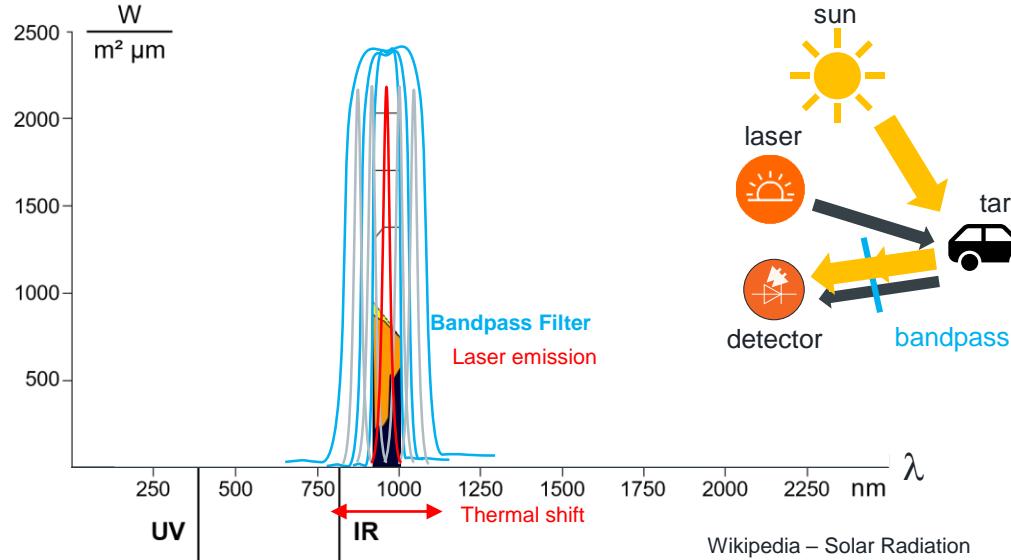
a: aperture
f: focal length
 α : divergence
d: spot size

220μm aperture → 110μm aperture

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- 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



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

Sensing is life

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