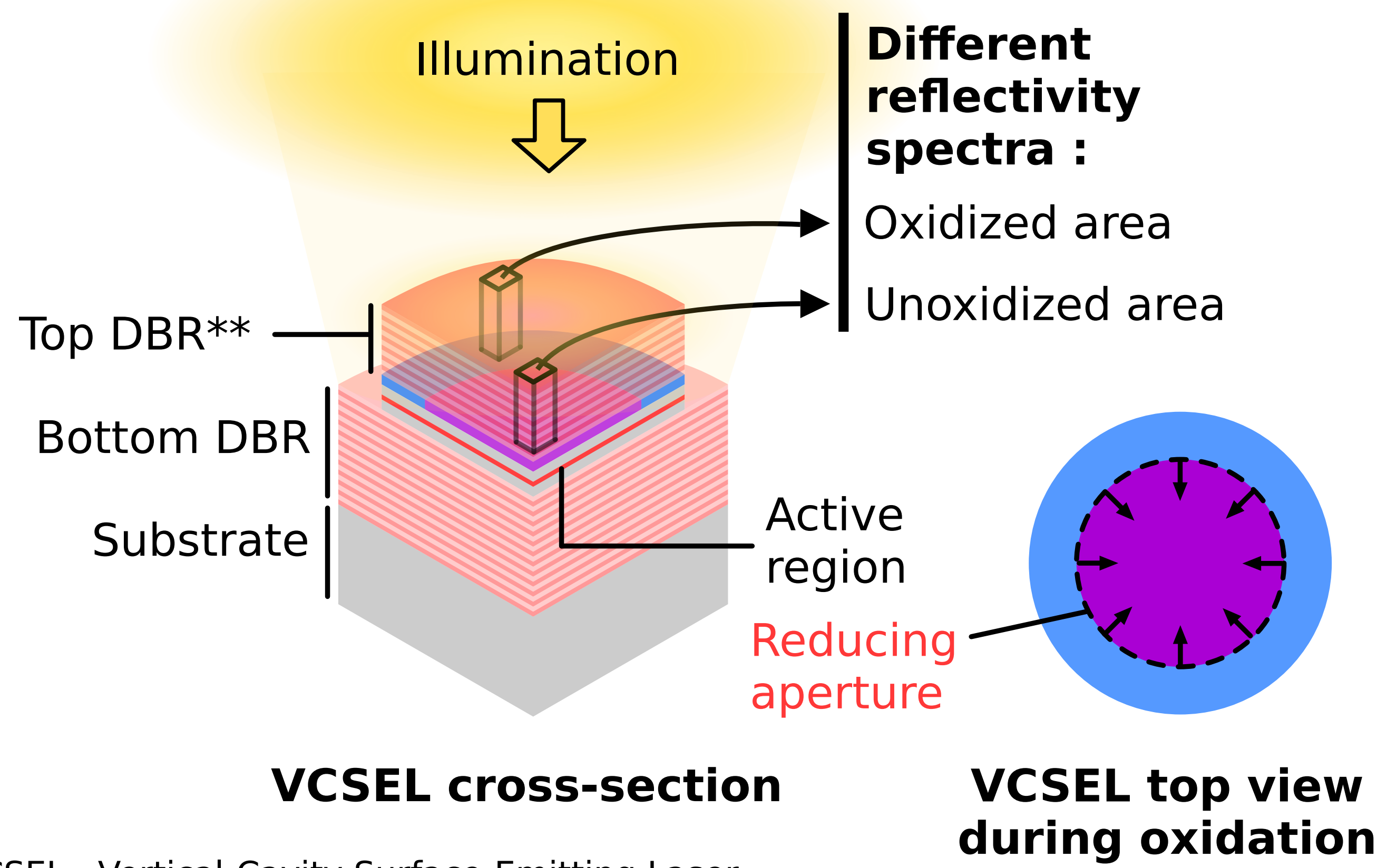


Inspection of buried oxide aperture in VCSEL* fabrication



* VCSEL : Vertical-Cavity Surface-Emitting Laser

** DBR : Distributed Bragg Reflector

Oxide aperture in VCSELs

Optical confinement + Electrical confinement

Defines transverse mode distribution
Injected current flows through the aperture

Key parameter for final VCSEL performances

Oxidation process requires accurate control of aperture dimensions

Optical in-situ monitoring

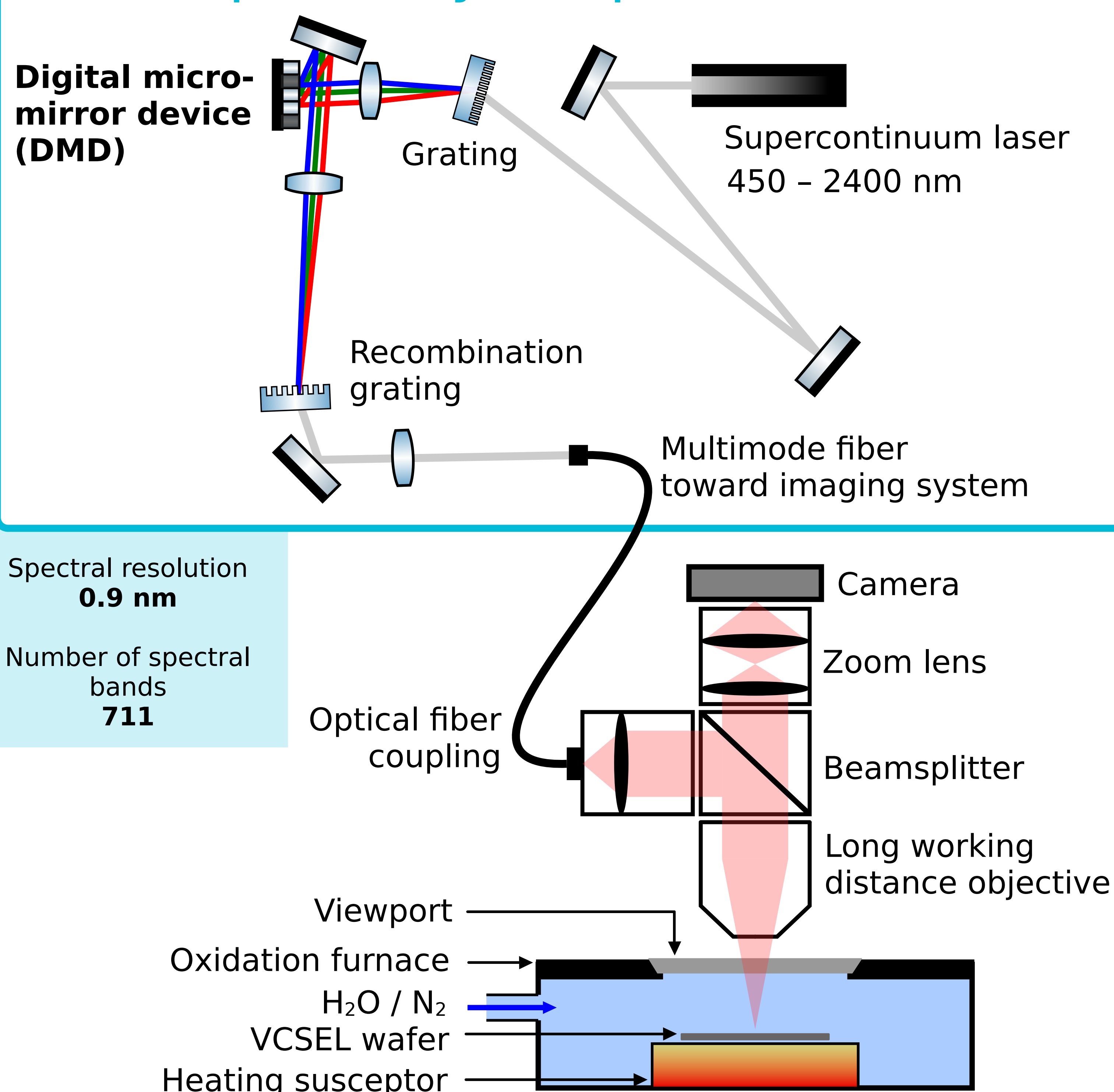
Very thin oxide layer (~30 nm) under DBR stack

Low effective refractive index contrast between unoxidized and oxidized areas

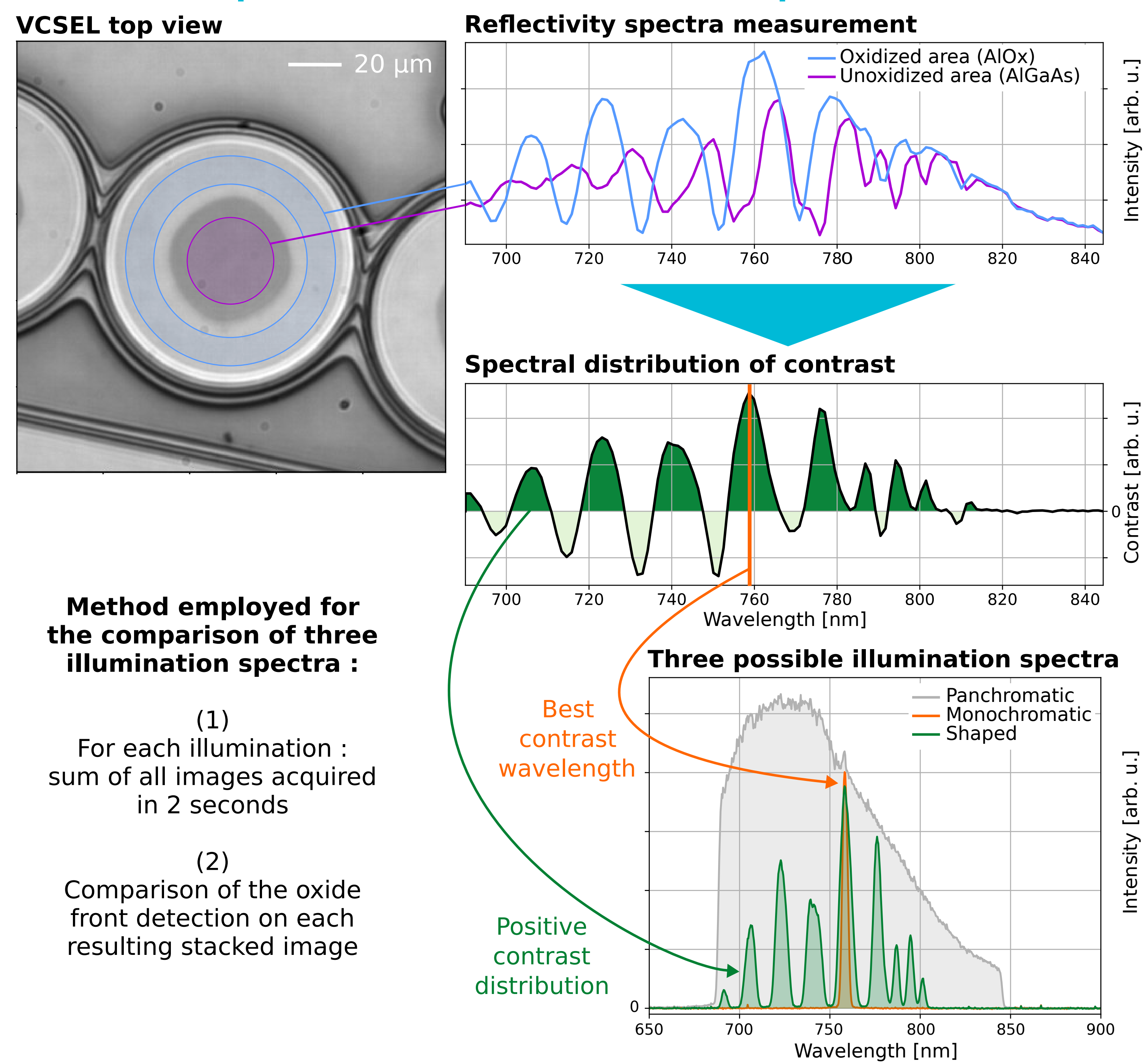
Oxidation process runs at high temperature (~400°C)

Degraded optical contrast due to redshifted absorption

Spectrally-shaped source

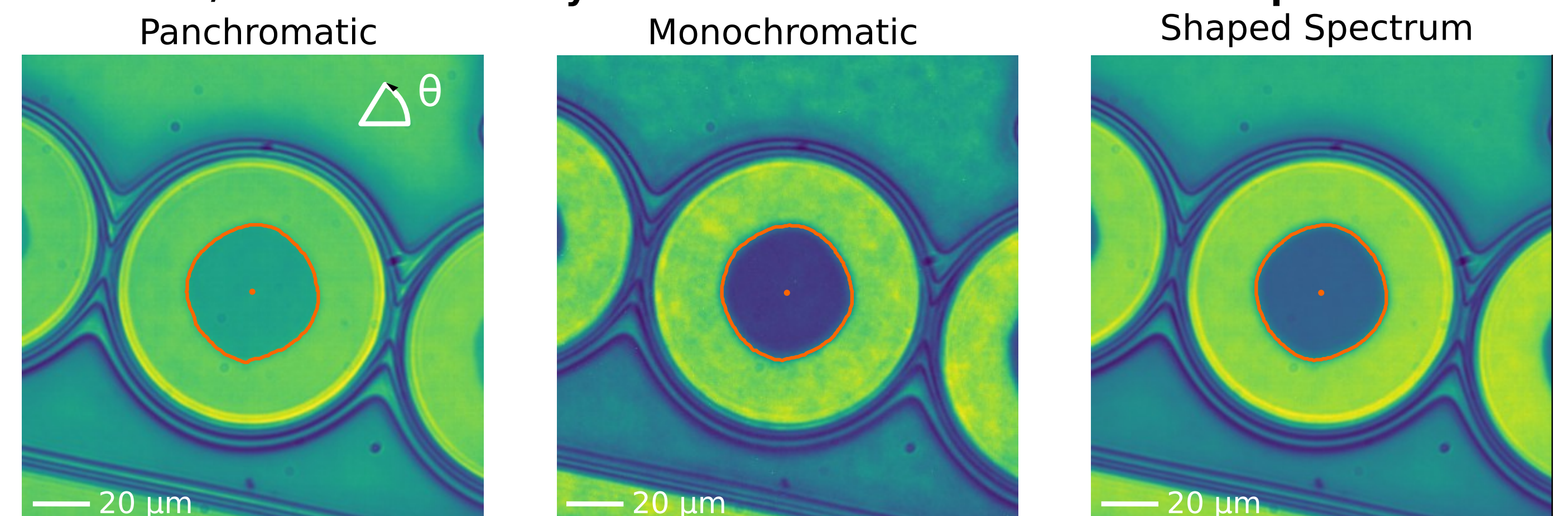


Shaped illumination spectrum

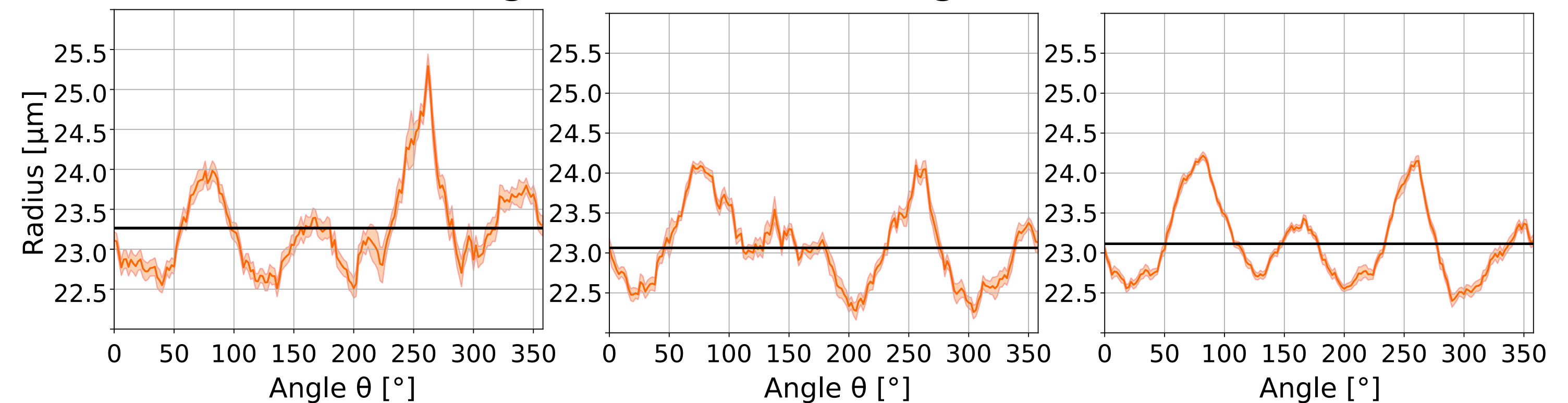


Results

Oxide/unoxide boundary detection for three illumination spectra



Detected radius (orange line) in polar coordinate together with the confidence interval (orange area) and the average radius (black line)



Spectrally-shaped illumination :

- **Improves the detection of the oxide/unoxide boundary.** It combines the high flux and low noise from the panchromatic imaging with the high contrast from the monochromatic illumination.
- Is a **versatile solution** with regard to VCSEL spectral response : arbitrary tailored spectrum, temporal reconfigurability.
- Is **compatible with real-time monitoring** : embedded DMD system, synchronization DMD-camera, multiplexed reflectivity spectrum measurement (Hadamard).

N. Monvoisin et al. "Spectrally-shaped illumination for improved optical inspection of lateral III-V-semiconductor oxidation," Opt. Express (2023)

<https://doi.org/10.1364/OE.480753>



Futur work

- Implementation of real-time monitoring.
- More advanced illumination spectrum optimization techniques : Fisher Discriminant Analysis (FDA), Principle Component Analysis (PCA).

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