VCSEL System Design in High-Volume Applications

EPIC Online Technology Meeting on VCSEL Technology and Applications

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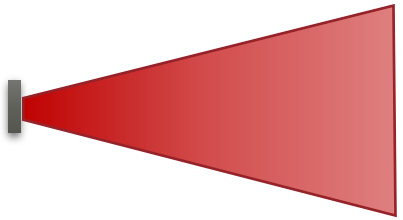
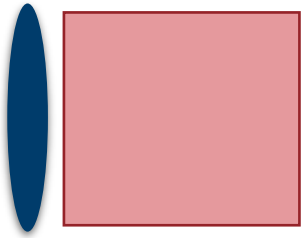
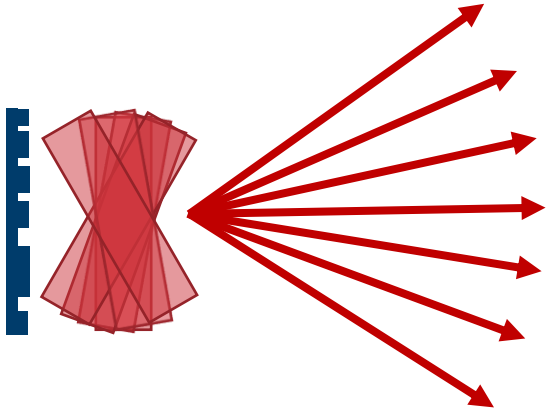
JABIL OPTICS

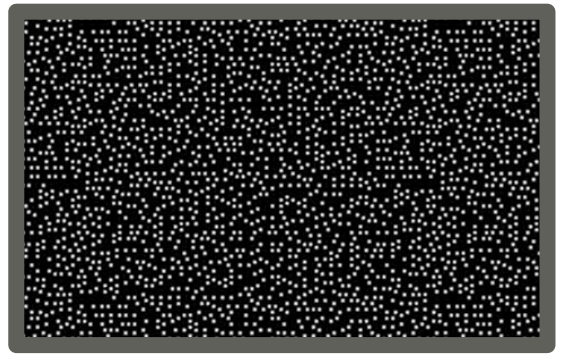
VCSEL System Design in High-Volume Applications
General Design Task

GOAL: smart & small dot projector modules









Light Source
- Number of emitters
- Beam parameters

Edge emitter VCSEL

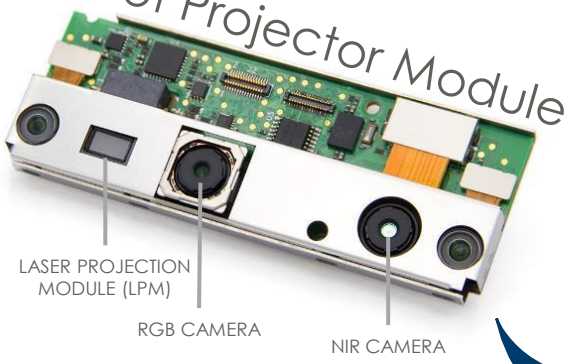
Beam Delivery
- Dot size
- (Angular spread)
- Depth of focus

Diffractive Optics
- Dot number
- Dot density
- Efficiency
- Energy distribution (uniformity)

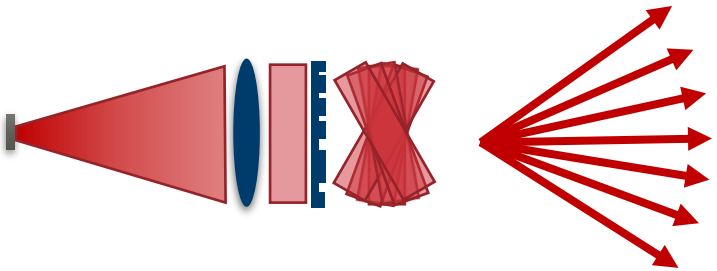
Dot Pattern
- Requirement regarding
  - Spatial distribution of dots
  - Energetic distribution of dots
- Acceptance of distortion

VCSEL System Design in High-Volume Applications
Common Products: Edge Emitter Based

Dot Projector Module

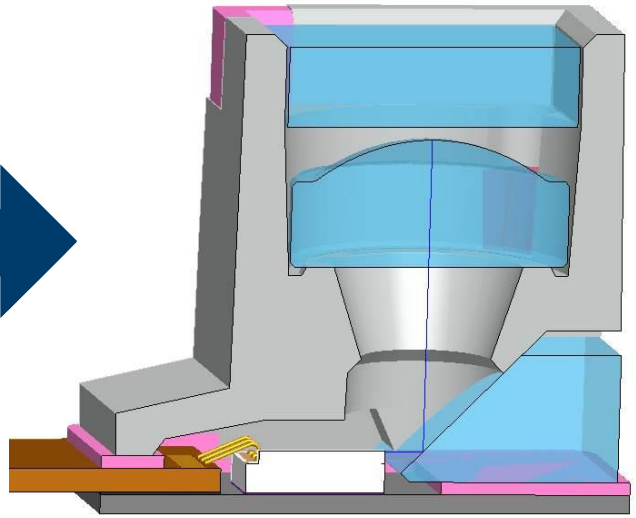


Conceptual Setup



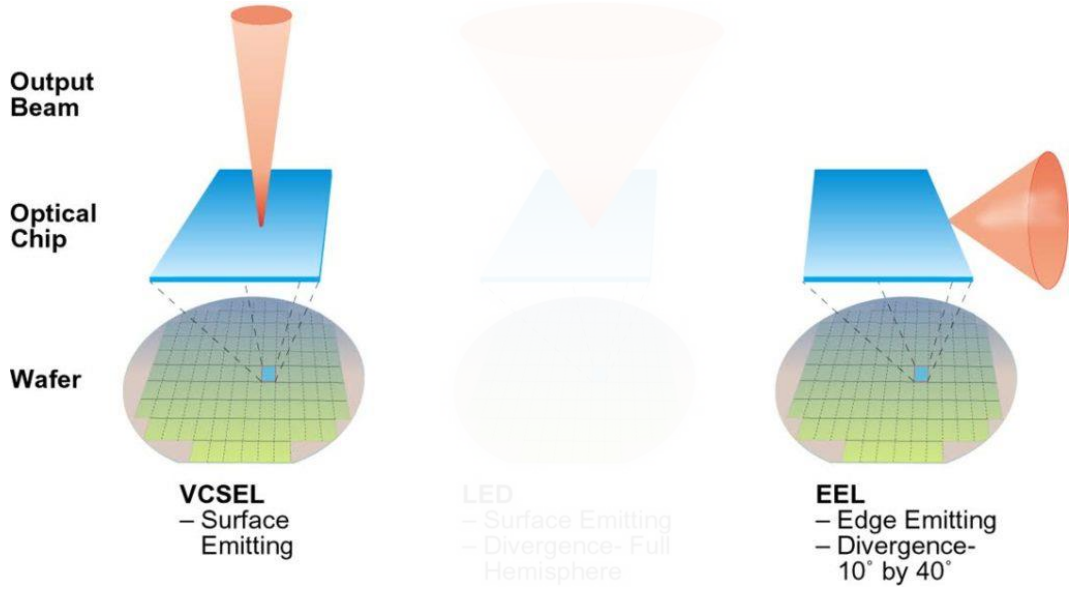
- Laser diode
- Collimation lens
- DOE

Mass Production Setup



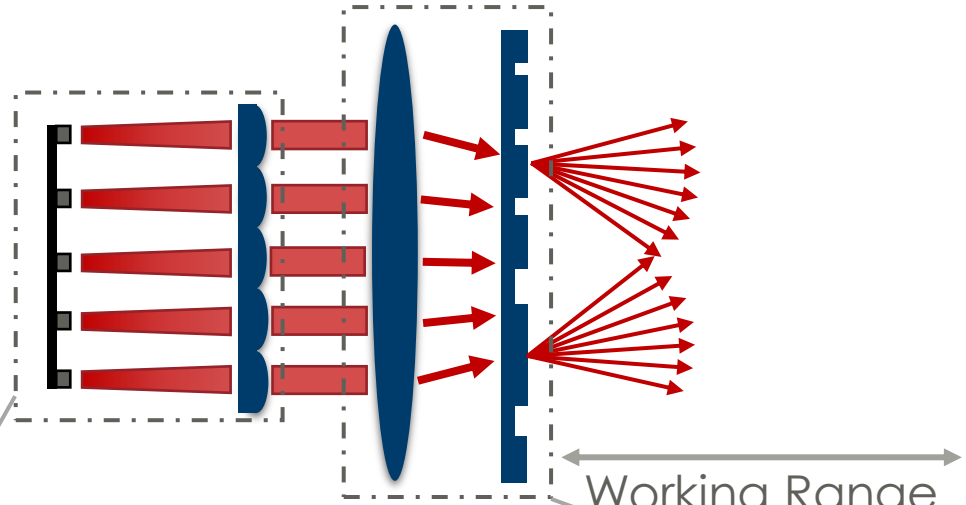
VCSEL System Design in High-Volume Applications
Why VCSEL-Based Solutions?

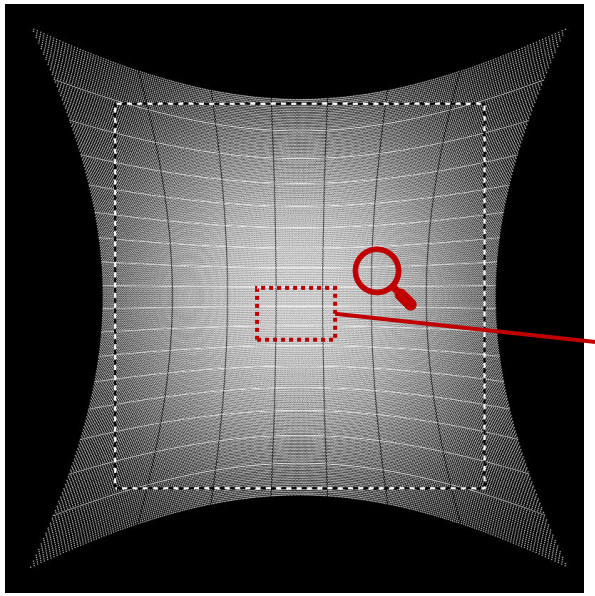
- Higher power chips / arrays available (>100s of mW, + pulsed operation)
- Wavelength stability
  - 0.3nm/K (EE) vs. 0.06nm/K
  - Higher sensitivity
  - Narrow spectral linewidth
- Simplified module design
  - Top-looker (VCSEL)
  - Side-looker (EEL)
- Direct projection possible
- Comparably lower cost at higher powers



Technologies compared: VCSEL / LED / edge-emitting laser, image courtesy of VIXAR, http://vixarinc.com/technology (May 12, 2020)

VCSEL System Design in High-Volume Applications
Conceptual Setup VCSEL





Dot Pattern

Replication of VCSEL array image at detector plane→ field multiplication

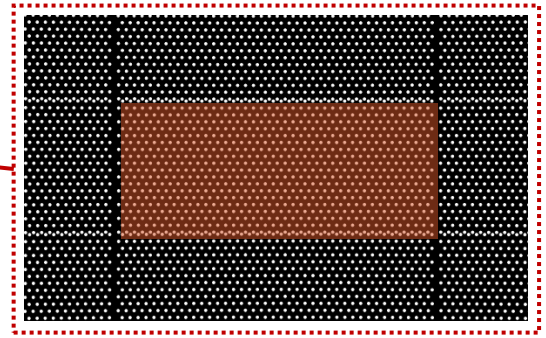


Image of VCSEL Array without DOE

VCSEL Array + MLA

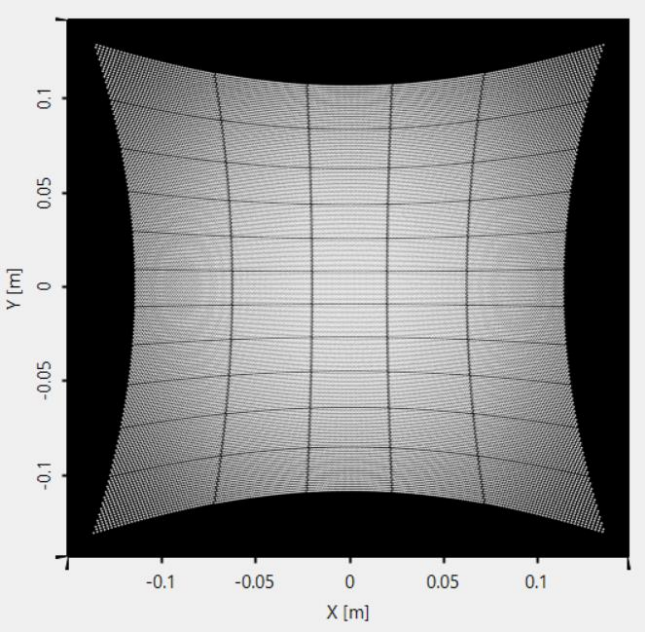
- Collimation of each VCSEL emitter separately by a corresponding micro-optical element → e.g. Micro-lens Array (MLA)
- Micro-optical elements could be stacked directly to the VCSEL array
- Flexible access to new design concepts

Diffractive Optical Elements DOE (+ Fourier Lens)

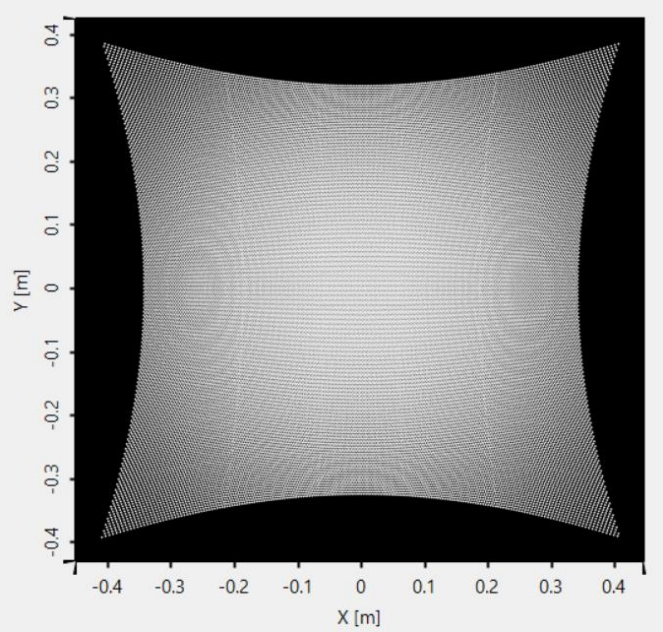
- DOE act as an optical grating
- Angular spread dependent on period
- FoV dependent on feature sizes/gradients of the profile
- Energetic distribution dependent on the height profile of the period
- Optional Fourier lens provides initial angular spread (transformation of spatial coordinate of beam to parabasal direction)

VCSEL System Design in High-Volume Applications
Compensation of Tesselation Effects

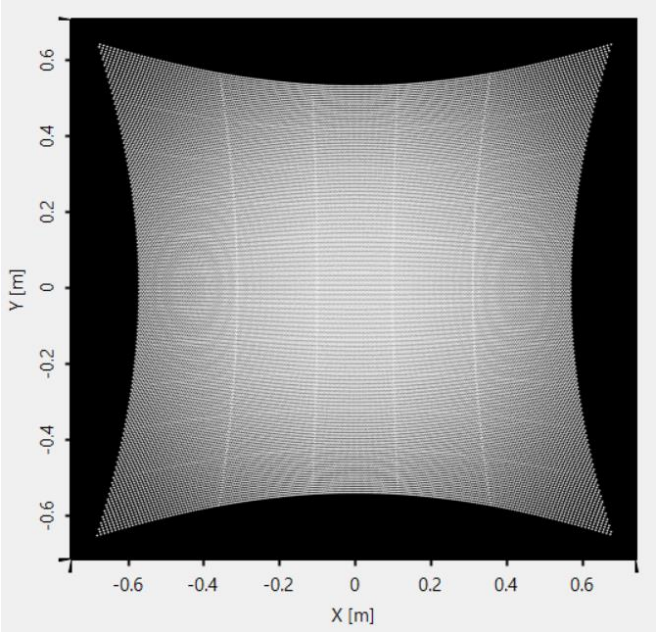
200 mm



600 mm



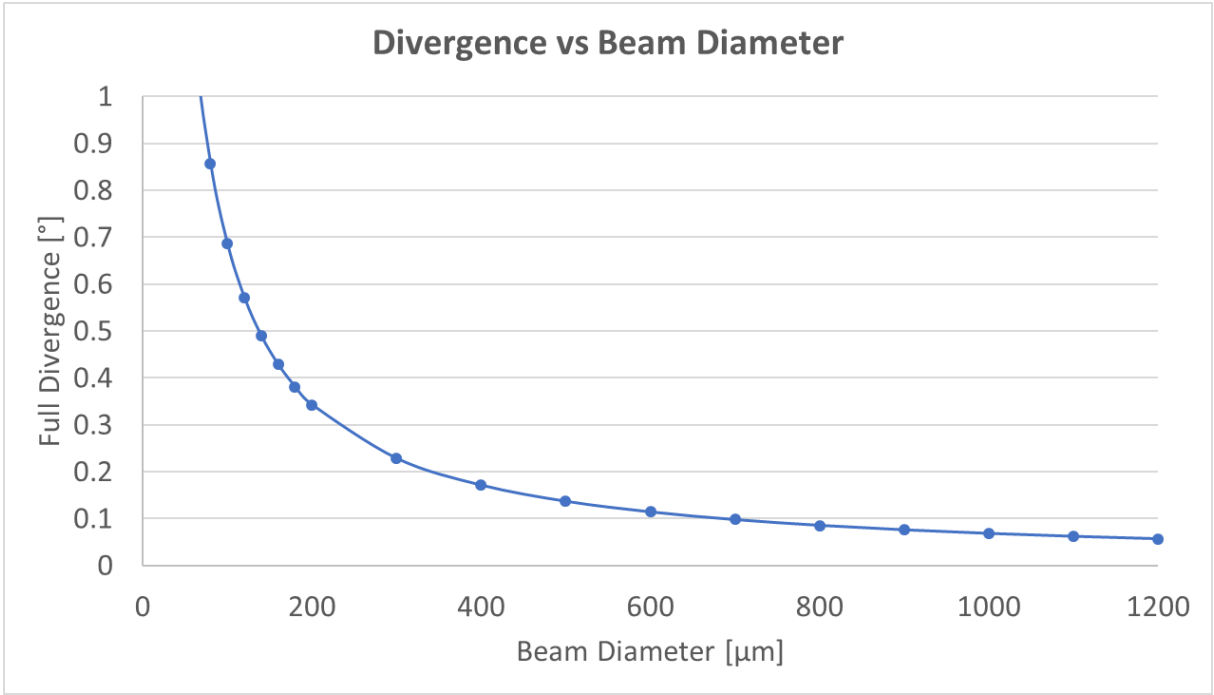
1000 mm



- Tesselation effects originate from the finite extend of the VCSEL source and depend on the working range
- The tesselation effects can be compensated at a specific working distance (geometrical considerations), which is shown above at an exemplary optimal working distance of 600 mm
- For other distances, the effect is still existent

VCSEL System Design in High-Volume Applications
Additional Considerations

- Arrangement of VCSEL offers flexibility regarding point cloud
- Distance used for separation
- Focal length of micro lenses
  → definition of divergence
- Small / low divergence on system level
  → good collimation for good point separation
- Custom design of VCSEL arrays required
  → Cooperation of Optical Design, VCSEL manufacturer & software providers promises best results



VCSEL System Design in High-Volume Applications
Use Cases

- Applications (non-exhaustive)
  - Face ID
  - Gesture recognition / 3D Sensing
  - Distance sensing / automation control
  - (Industrial) LIDAR / Robotics
  - Driver monitoring
  - Collision avoidance
  - Heating systems

- Jabil designs for high volume manufacturing
  - Illumination for Driver monitoring camera
  - Light source for 270° ToF camera
  - Flood light illumination for 3D sensing devices
  - …

OUR VISION

To be the most technologically advanced and trusted manufacturing solutions provider

JABIL

Our Company

50+	$25.3B	200k	100+	52M	27k	330
Years of Innovation	FY19 Revenue	Employees	Sites	Square Feet Manufacturing	Strategic Suppliers	Top Global Brands

Our Markets


Consumer


Packaging


Energy


Printers


Smart Home & Appliances


Retail


Healthcare


Automotive & Transportation


Enterprise, Cloud & Communications


Industrial & Capital Equipment


Defense & Aerospace

Our Reach

INNOVATE › DESIGN › DEVELOP › MANUFACTURE › DELIVER › SERVICE

Our Approach


Empowered Experts


Innovation Acceleration


Engineering Excellence


Manufacturing Agility


Supply Chain Orchestration

Our Difference

Global Operational Excellence	**Workcell Model**		**Sustainability**	**Supply Chain Intelligence & Agility**
Deep Technical Expertise	**Stable & Tenured Management Team**	**Process Innovation**	**Distributed Manufacturing**	**Integrity, Ingenuity & Innovation**

THANK YOU

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