Research Consortium in Speckled Computing

Emitters and Detectors for Inter-Speck Communication

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Overview

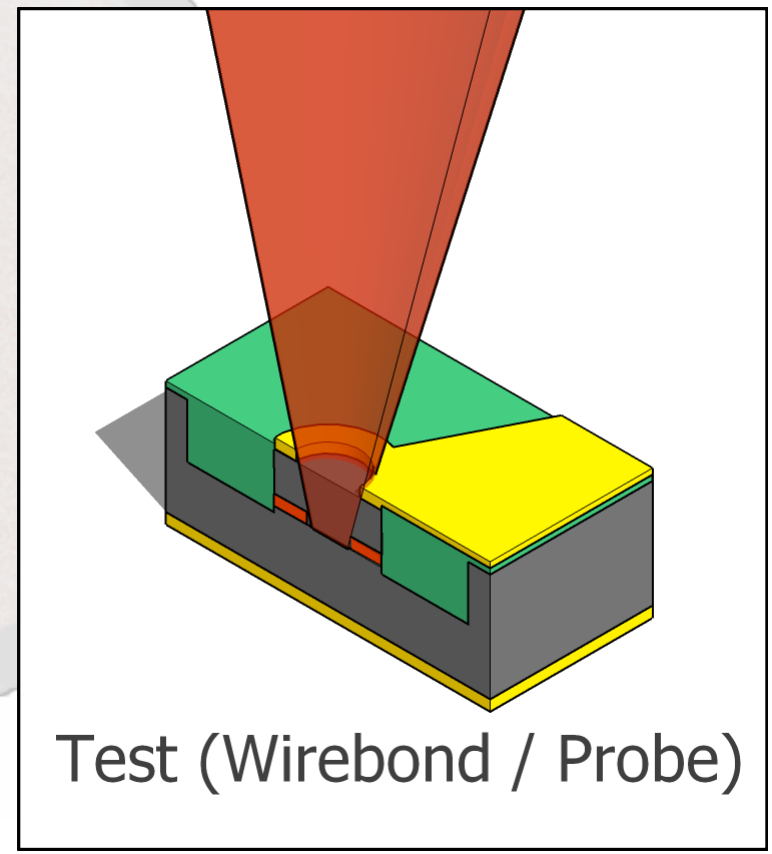
- The VCSEL
  - Top / Bottom emitters
  - Fabrication
- Beam Steering
  - Microprism development
  - Results
- The Detector
  - Silicon or Gallium Arsenide
  - Performance
- Future Work
  - Gratings
  - Dynamic Steering
  - Polarisation control

The VCSEL

Both top and bottom emitters available:

- Top emitting – passive elements
- Bottom emitting – active elements

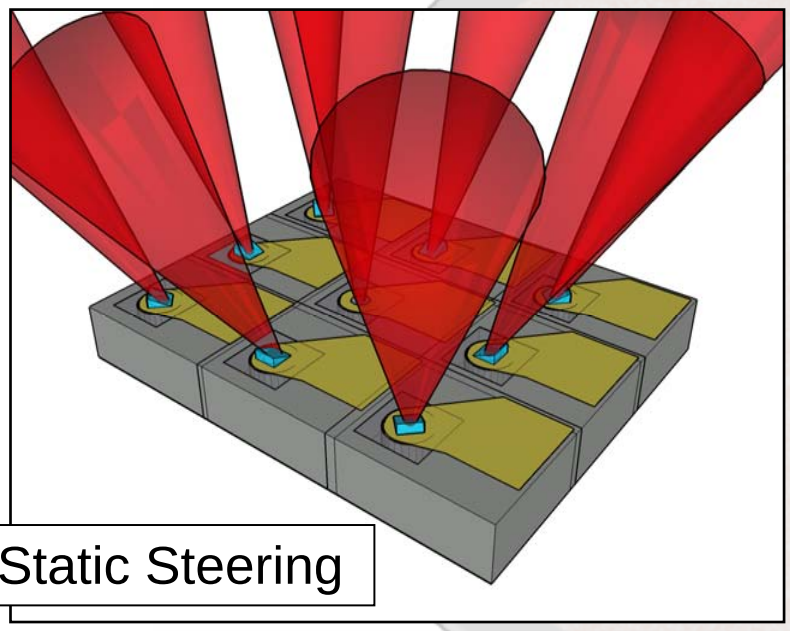
1. Bulk material
2. Mesa etch
3. Resist removal
4. Oxidation
5. SU8 insulation
6. Top and bottom contacts
7. Define top contacts
8. Test (Wirebond / Probe)



Beam steering

Two ways to think of steering:

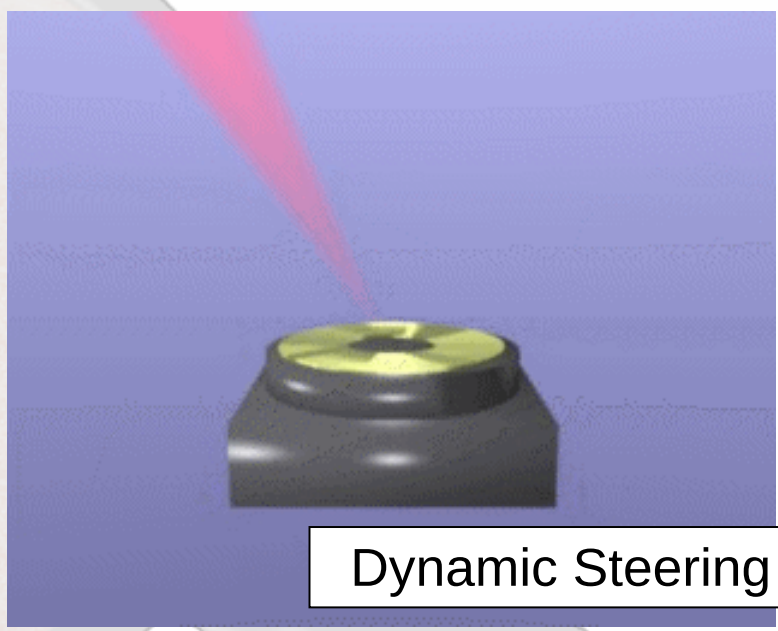
Discrete



Static Steering

Multiple emitters
Fixed power

Continuous

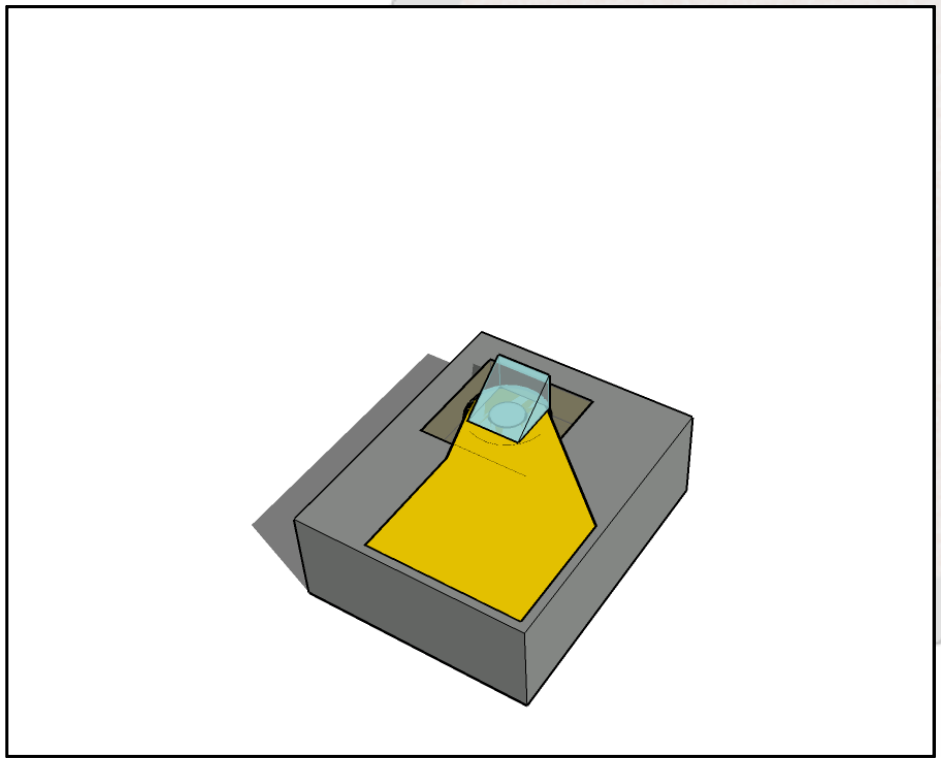


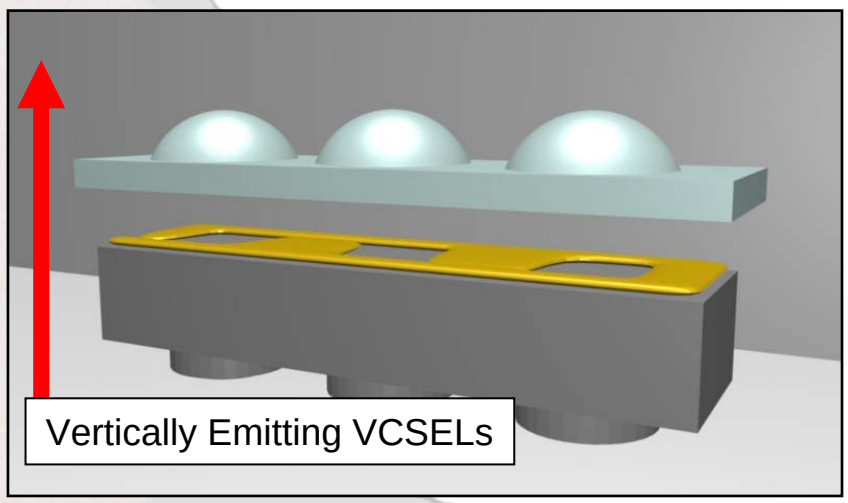
Dynamic Steering

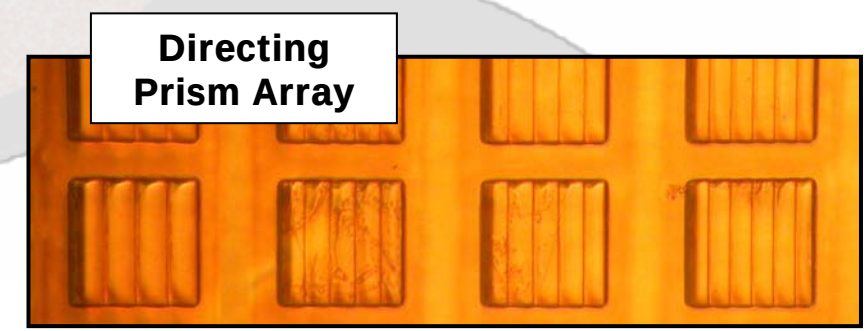
Single emitter
Variable power

Microprisms

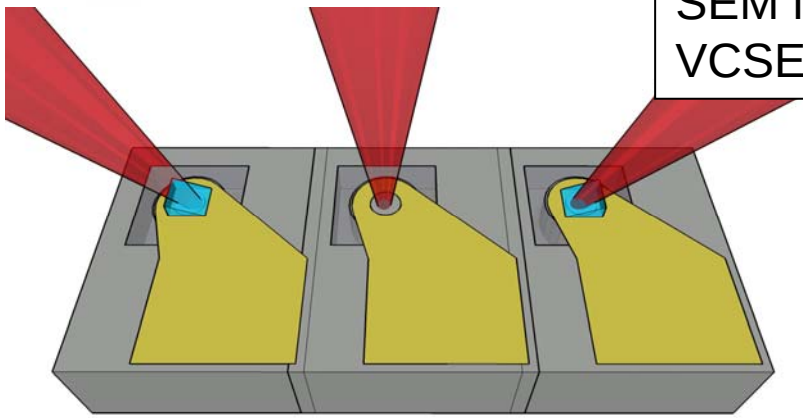
- Fabrication:
  - SU8 layer spun
  - Greyscale e-beam lithography, development



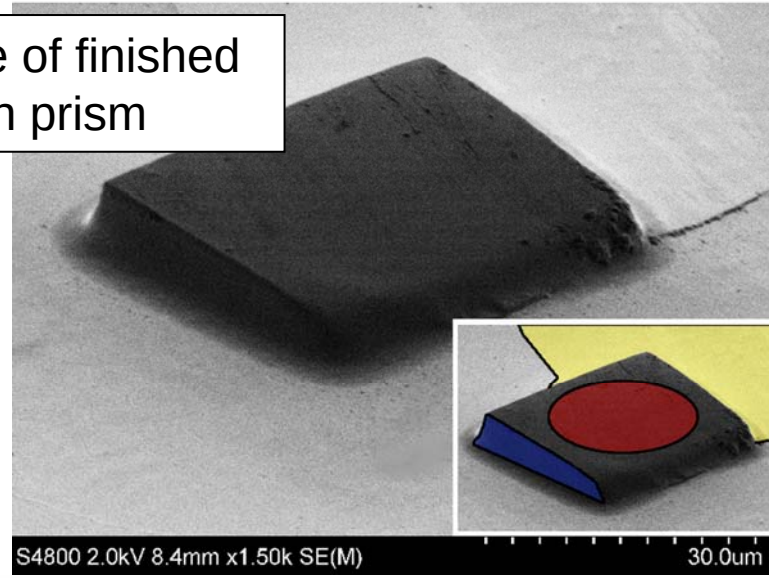


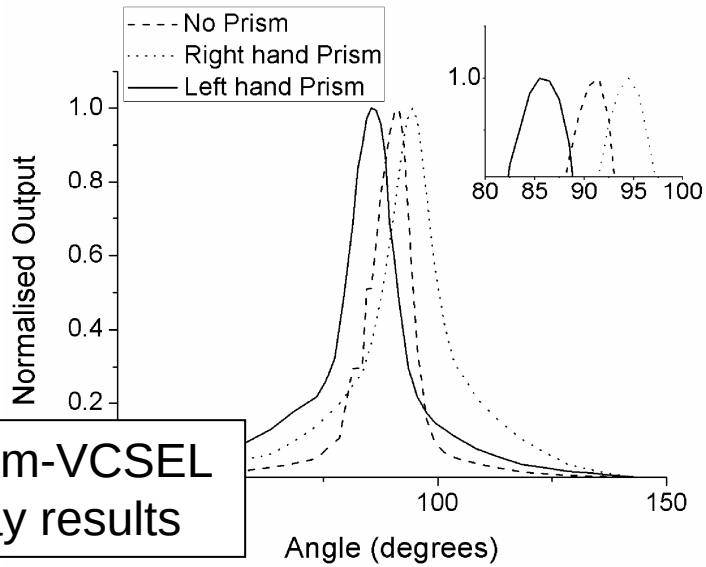


Prism array results

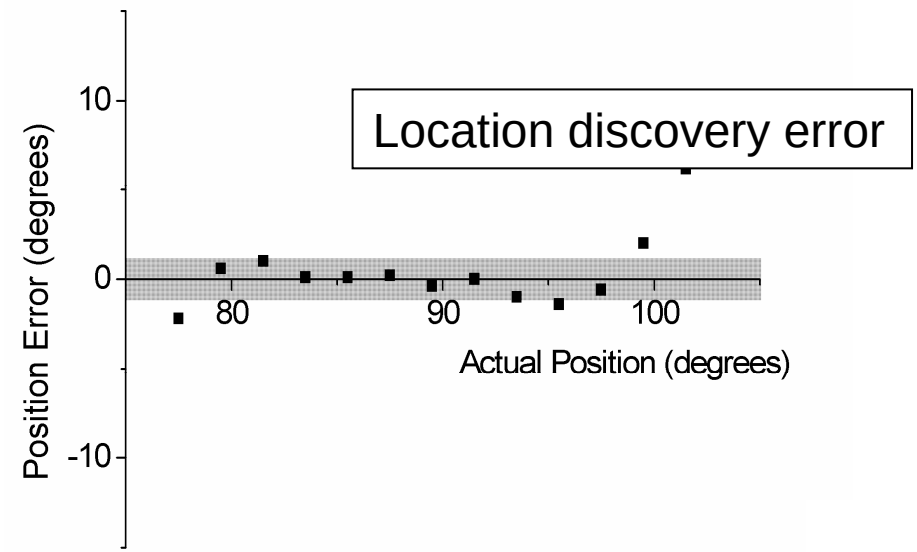


SEM image of finished VCSEL with prism





Prism-VCSEL array results

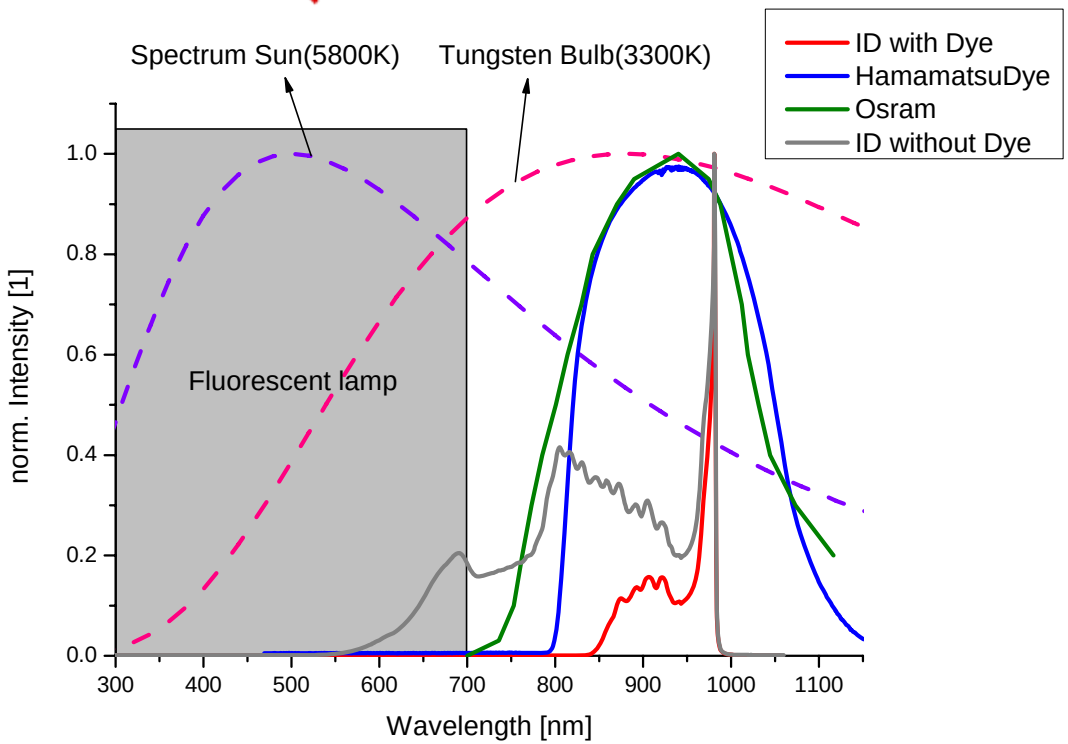


Location discovery error

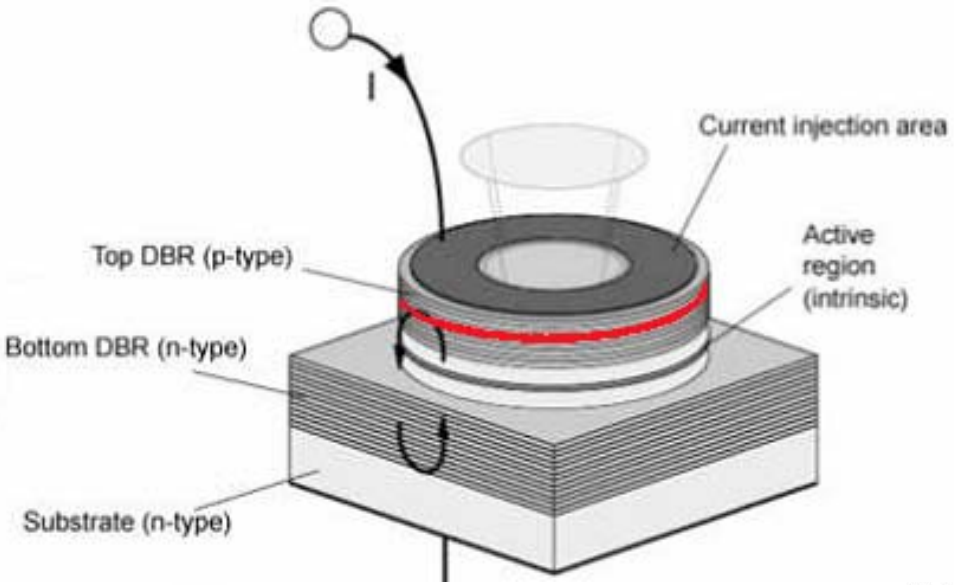
The detector

Two approaches looked at:

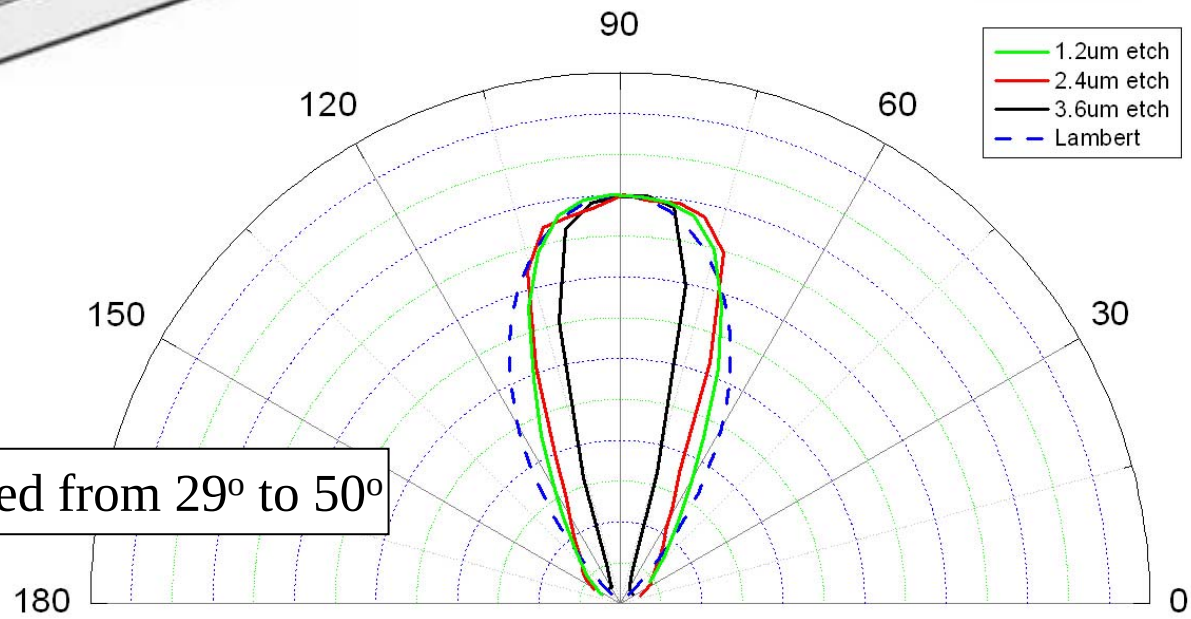
- Silicon
  - Cheap, reliable ✓
  - Different processing required ✗
  - Broad absorption spectrum ✗
- Gallium Arsenide (VCSEL)
  - Same processing as VCSEL ✓
  - Narrow absorption spectrum ✓
  - Narrow acceptance angle ✗



Acceptance angle engineering

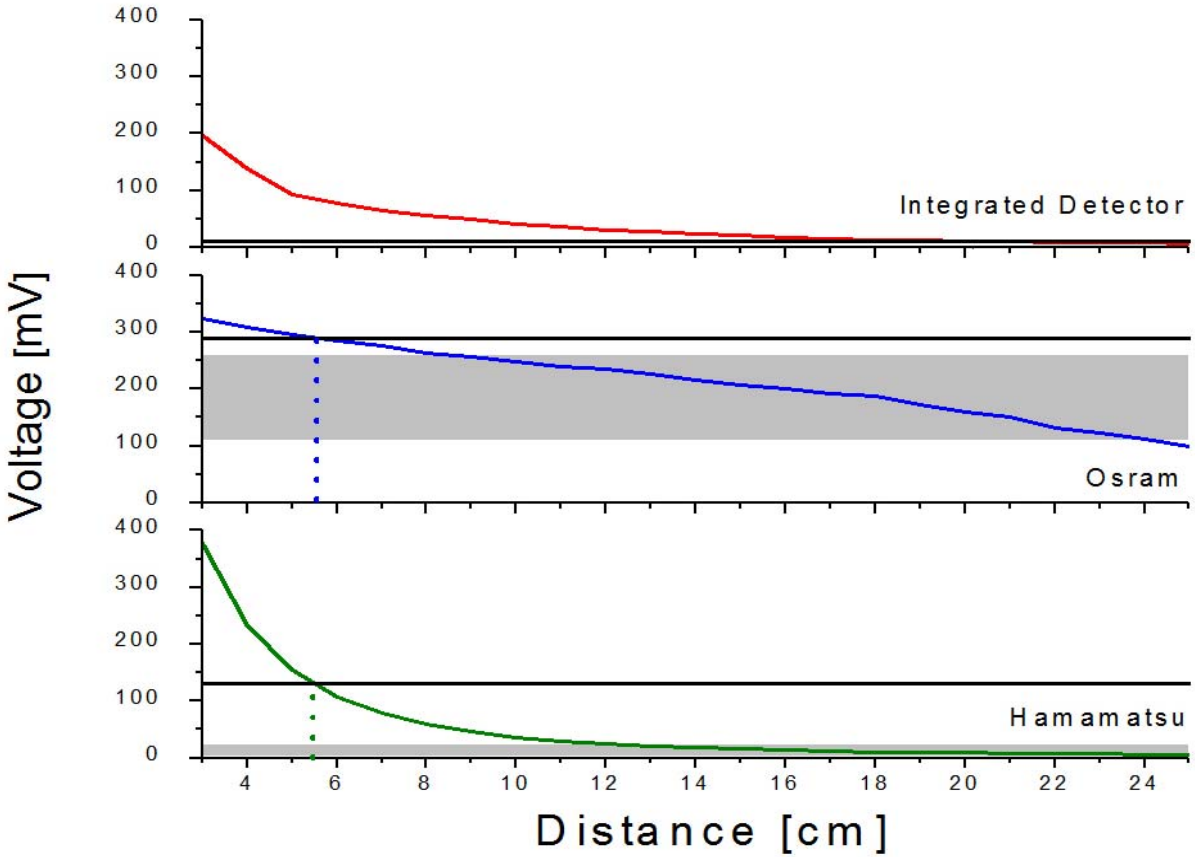


By etching some of the DBR layers away from the detector the acceptance angle can be increased



Emission angle increased from 29° to 50°

VCSEL detector comparison



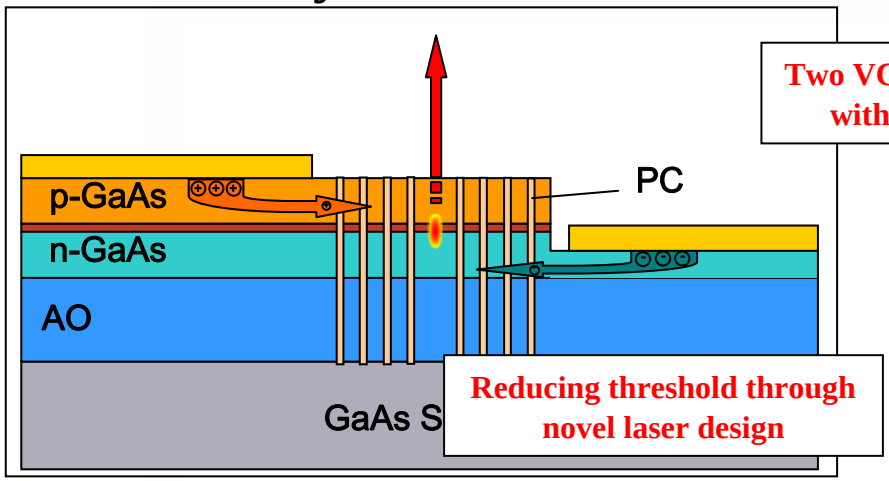
Using our own integrated optical filter it is possible to remove almost all background noise

Black solid line shows worst case scenario

Grey box delineates sunlight maximum and minimum

Future work

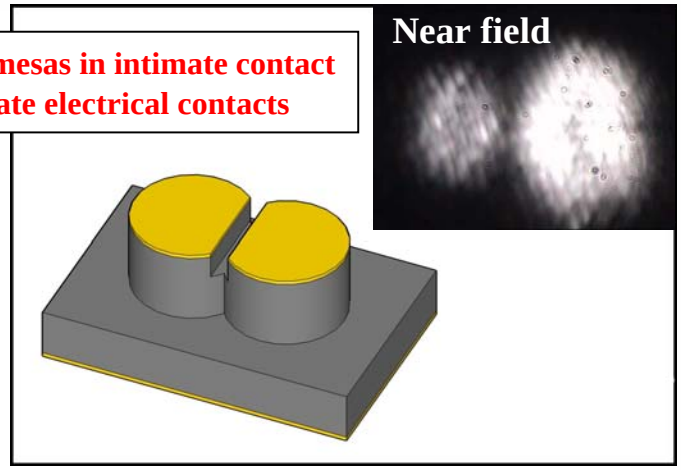
Photonic Crystal Laser



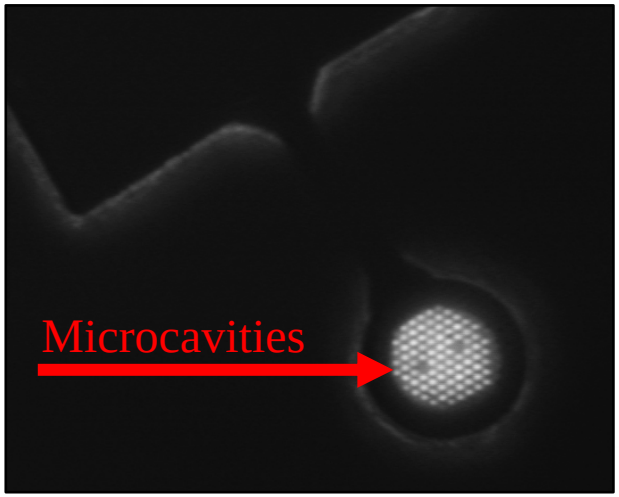
Reducing threshold through novel laser design

Coupled VCSELs

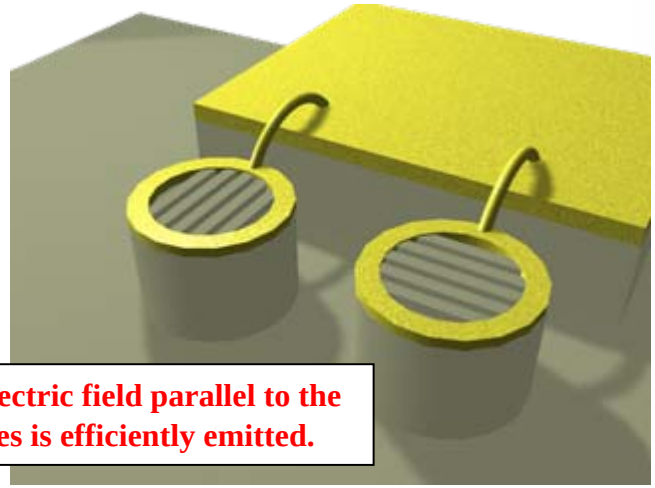
Two VCSEL mesas in intimate contact with separate electrical contacts



Coupled Microcavities



Polarisation Stable VCSELs



Only Electric field parallel to the grooves is efficiently emitted.

Conclusions

- Both Top and Bottom emitting VCSELs available
- Passive beam control already good can be improved further
- GaAs detectors available
  - Integrated onto same VCSEL chip
- Optical communication between Specks – with an all SpeckNet transceiver array achieved
- Dynamic beam control under investigation with promising results