UNIVERSITEIT GENT

imec

PHOTONICS RESEARCH GROUP

IMEC in Navolchi

Warwick Meeting July 2012

imec in NAVOLCHI

WP3 – transmitter

- Provide bonding to TU/e
- Provide passive silicon circuits through http://epixfab.eu/ platform

WP4 – amplifier for receiver

- Design and fabricate amplifier on silicon platform using UGent QDOTS
- Investigate possibilities for electrical injection

WP5 – interfaces

- WP-leader
- Design and fabricate passive filter for amplifier noise suppression
- Design and fabricate optical beam-steerer

WP4 - work

Objective: design and fabrication of QDOT amplifier

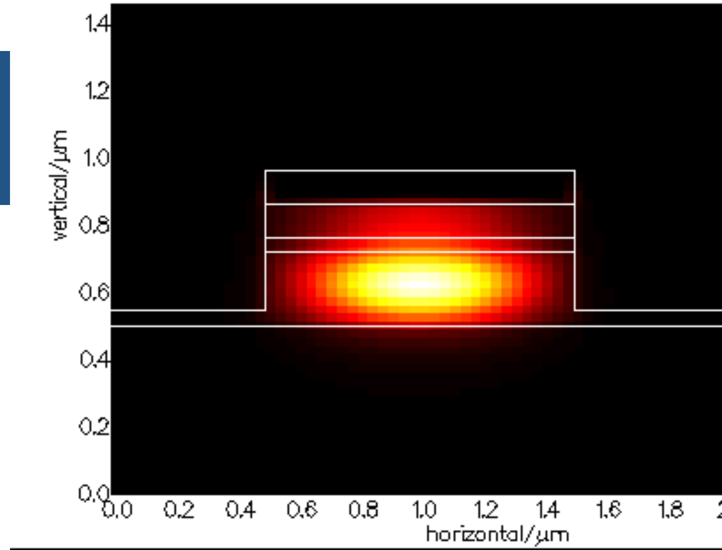
- Integrated with silicon waveguides
- Electrical injection

Timeline:

- Month 12 (M4.1) : decision on design
- Month 15 (M4.3) : conductive QD layers
- Month 18 (M4.6) : electroluminescence from QD-stack
- Month 21 (M4.8) : optically pumped amplifier (10dB gain)
- Month 30 (M4.9): electrical pumped amplifier 10dB/cm gain

Main input required: UGent QDOTS

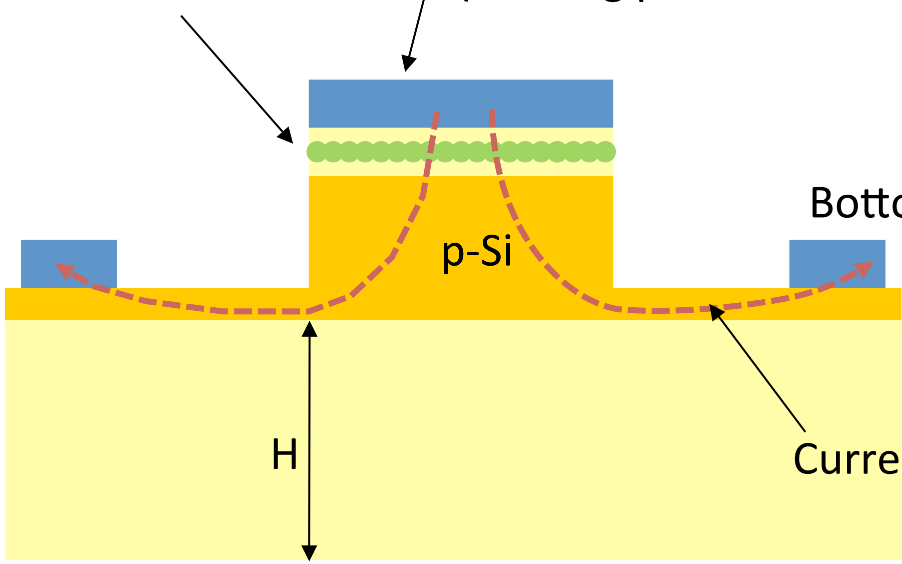
WP4 - work



General approach (cross-section):

Gain stack with QDot

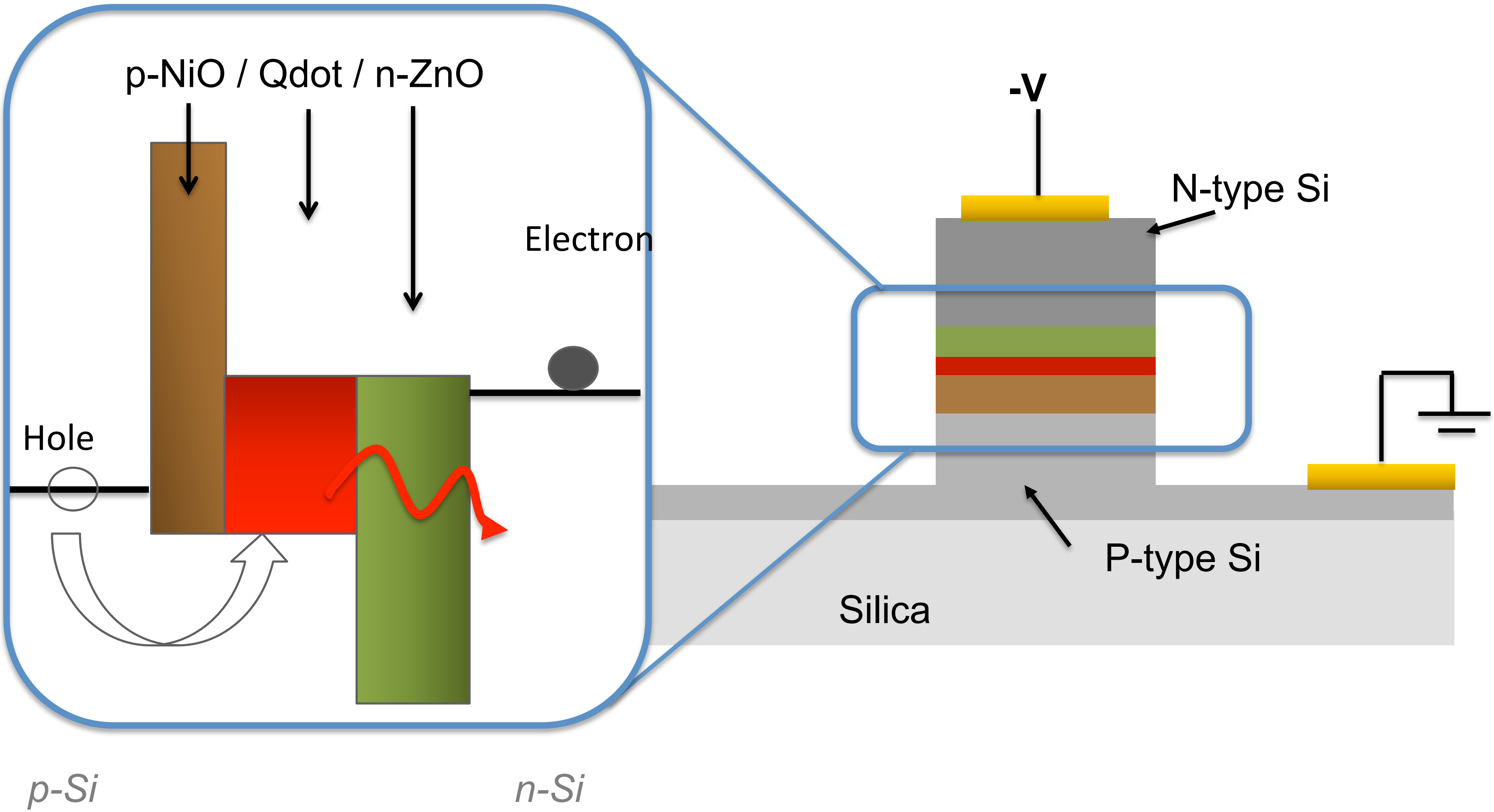
Top-electrode
(forming plasmon waveguide)



Bottom Electrode

Current flow

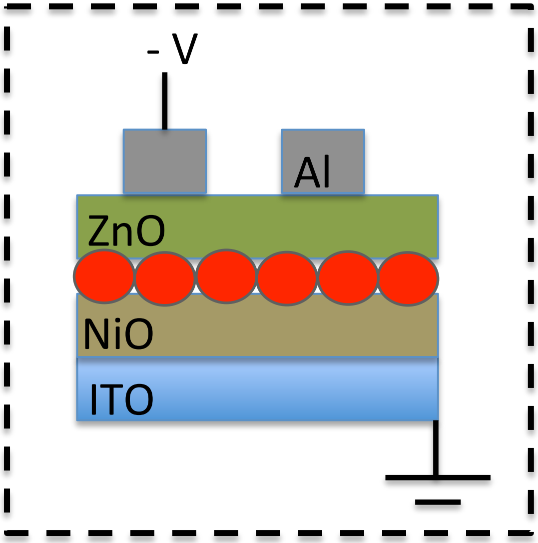
Integrated light source for silicon photonics

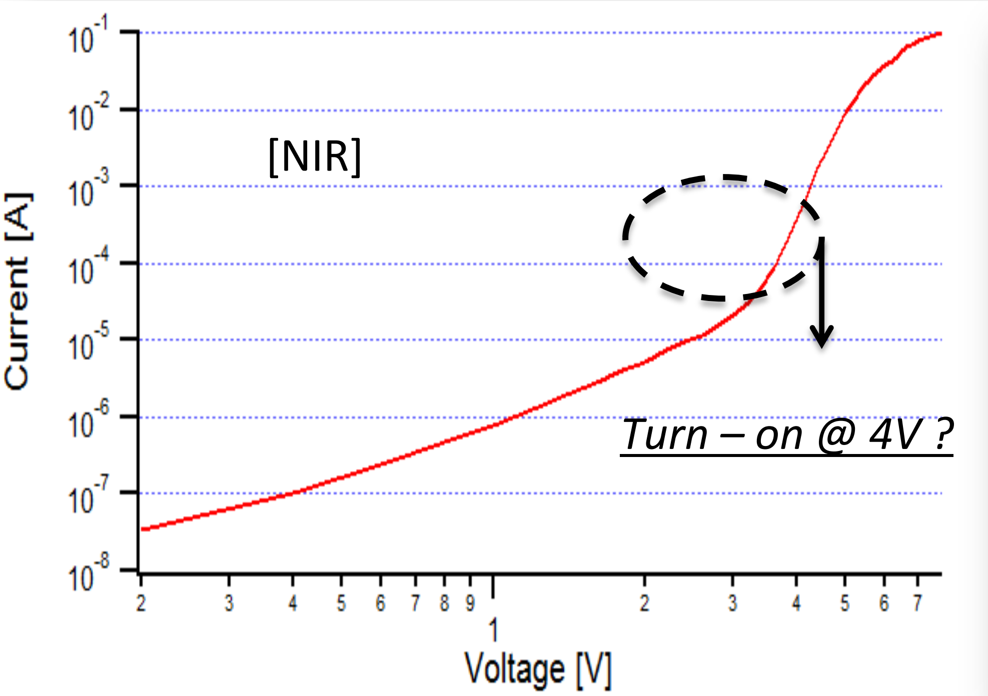


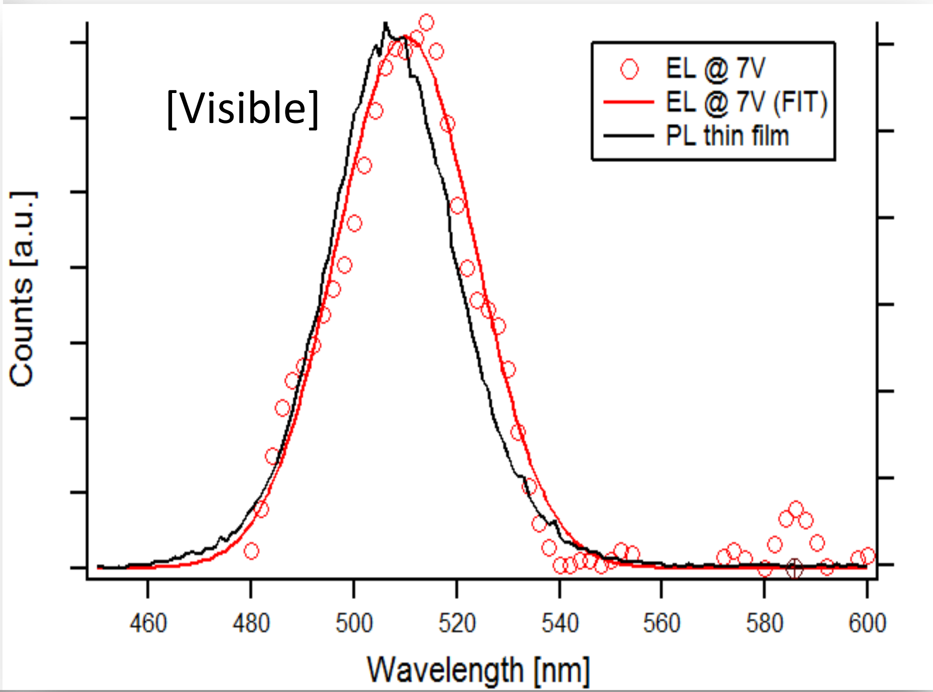
Metal oxides for charge transport

Sputter	Spincoat	ALD	E-beam

" ITO / NiO / PbS(nc) / ZnO / Al "







Metal oxides for charge transport

Considerable effort in optimizing injection layers

- ZnO (electrode transport layer)
- NiOx/CuOx (hole transport layer)

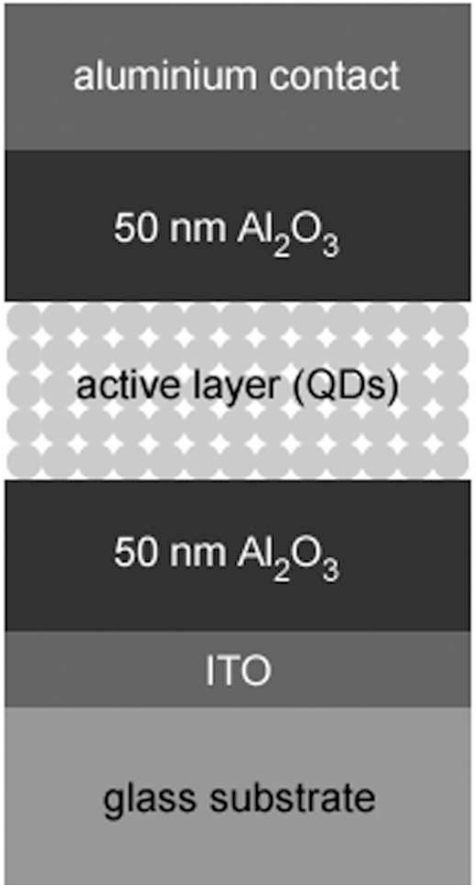
Characterisation material properties in terms of depositon paramters

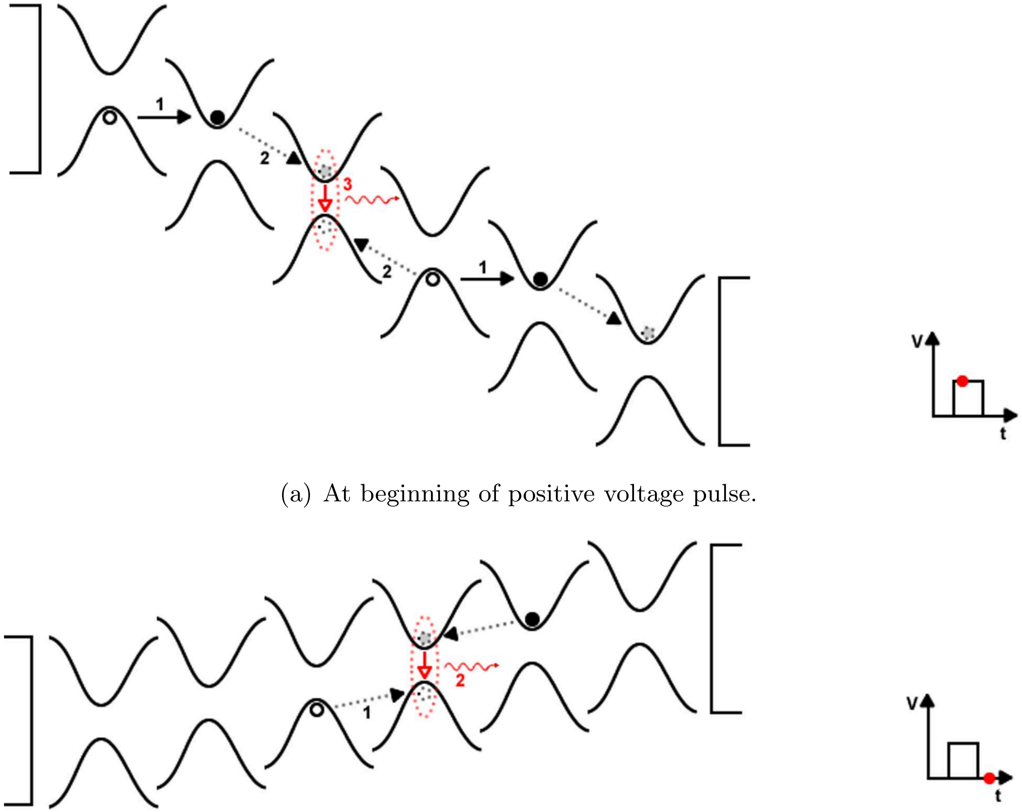
- Conductivity, optical losses, grain size …

BUT: Could not reproduce initial electro-luminescence success

(Possible side project: AZO as replacement for ITO in modulator?)

Alternative for current injection: AC-stack



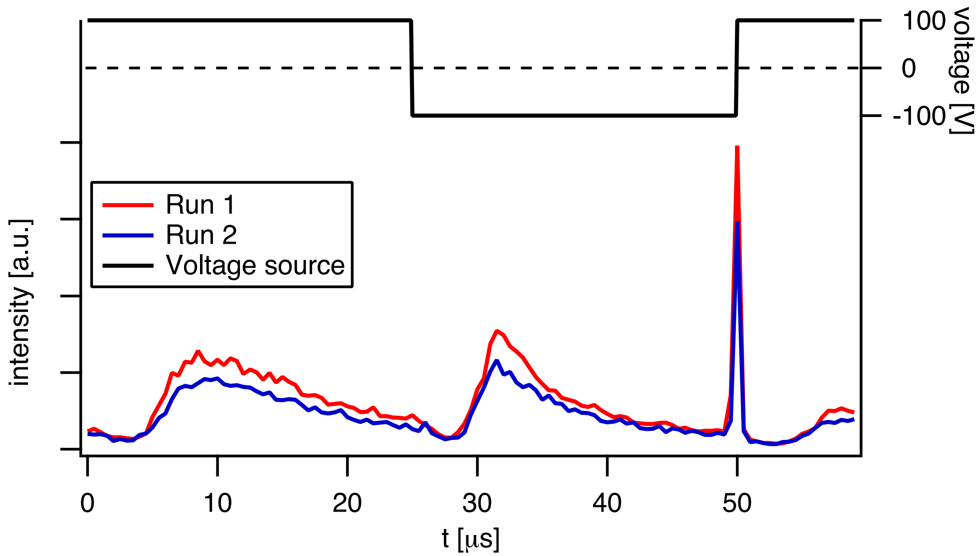


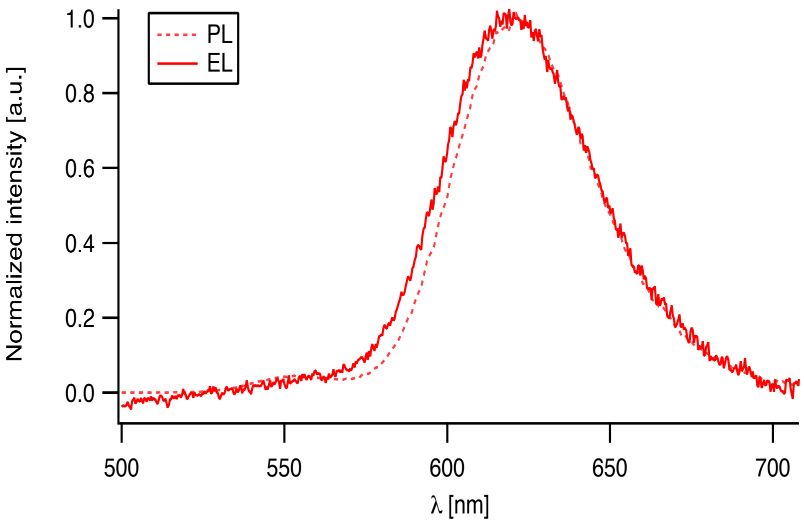
(a) At beginning of positive voltage pulse.

(b) After the positive voltage pulse.

Originally proposed by V. Wood (ETHZ)

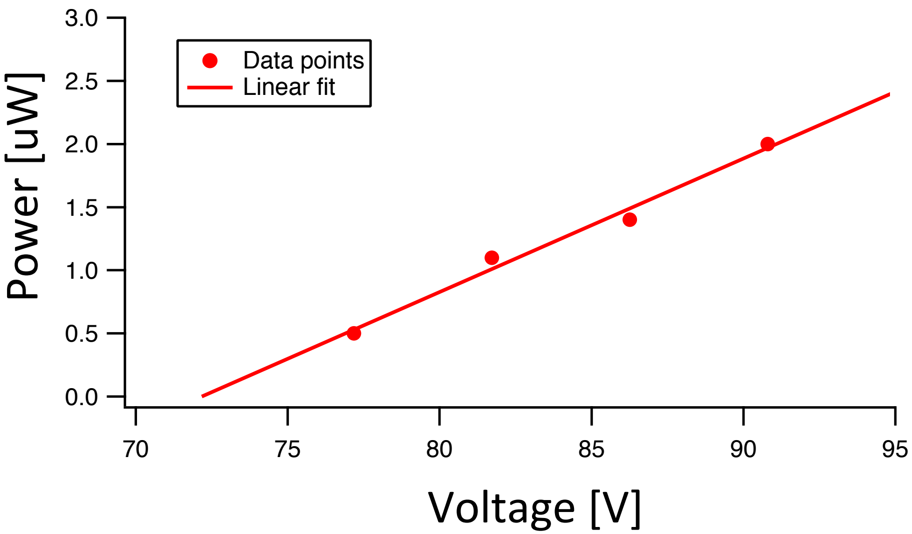
Light emission from AC-stack

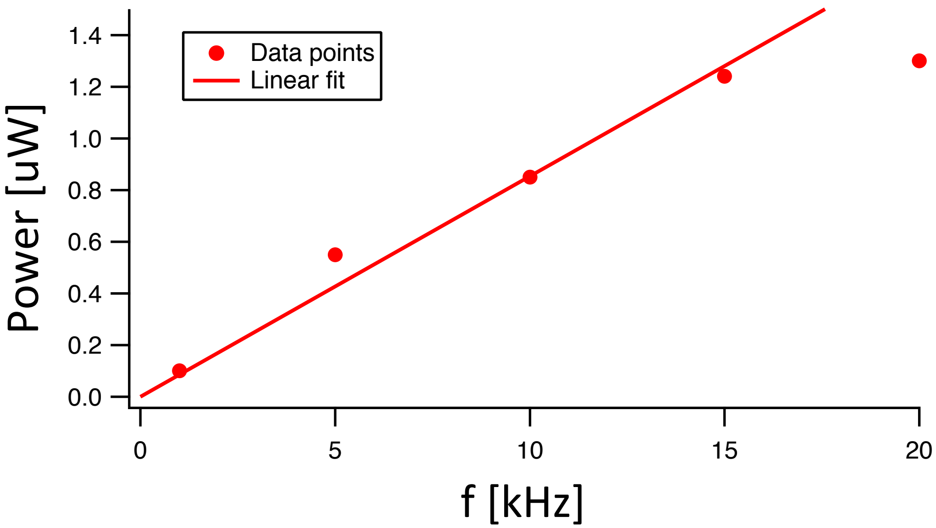




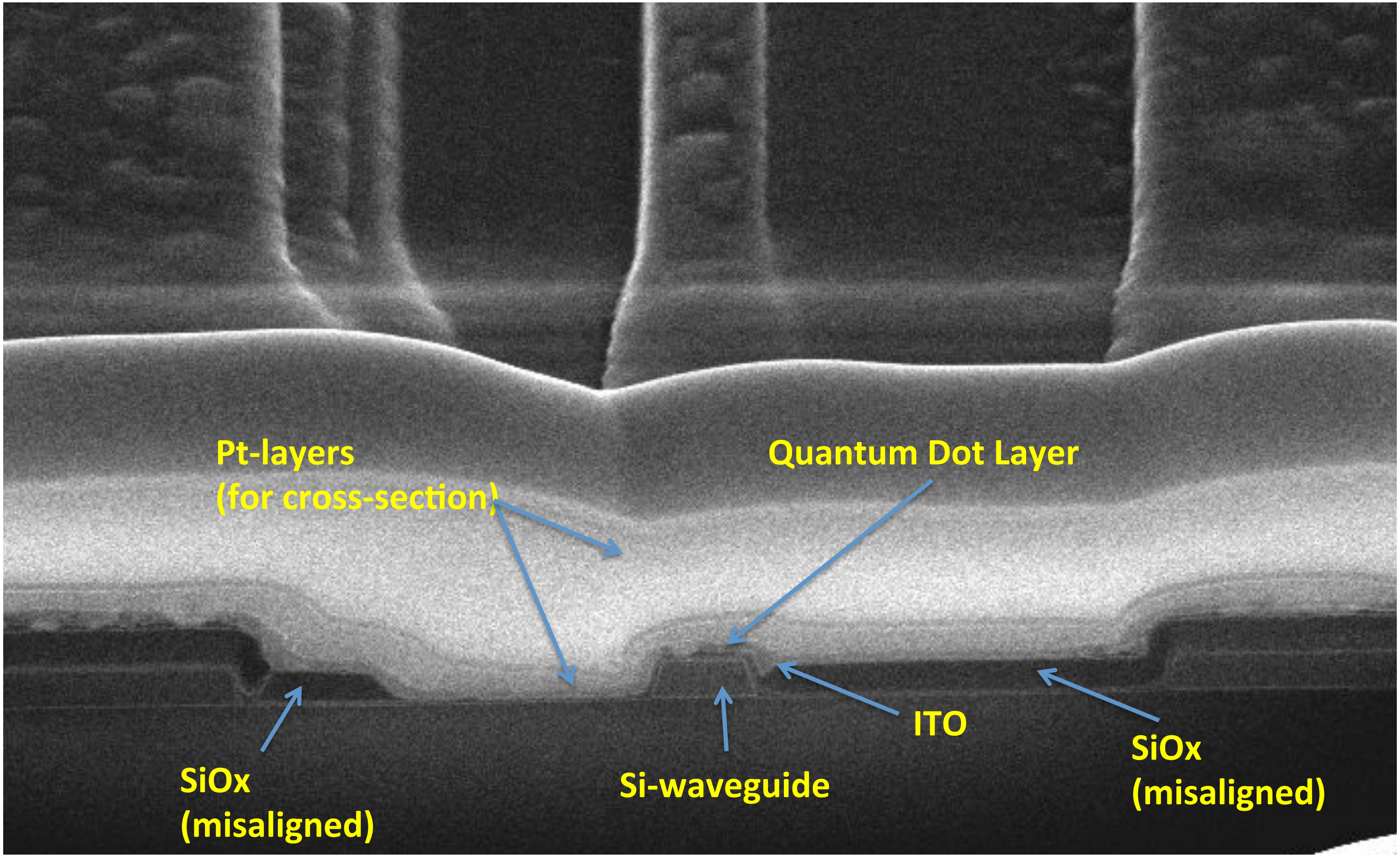
Demonstrated both in visible and NIR

Power vs. Voltage/Frequency





First attempt at integrating with silicon waveguide



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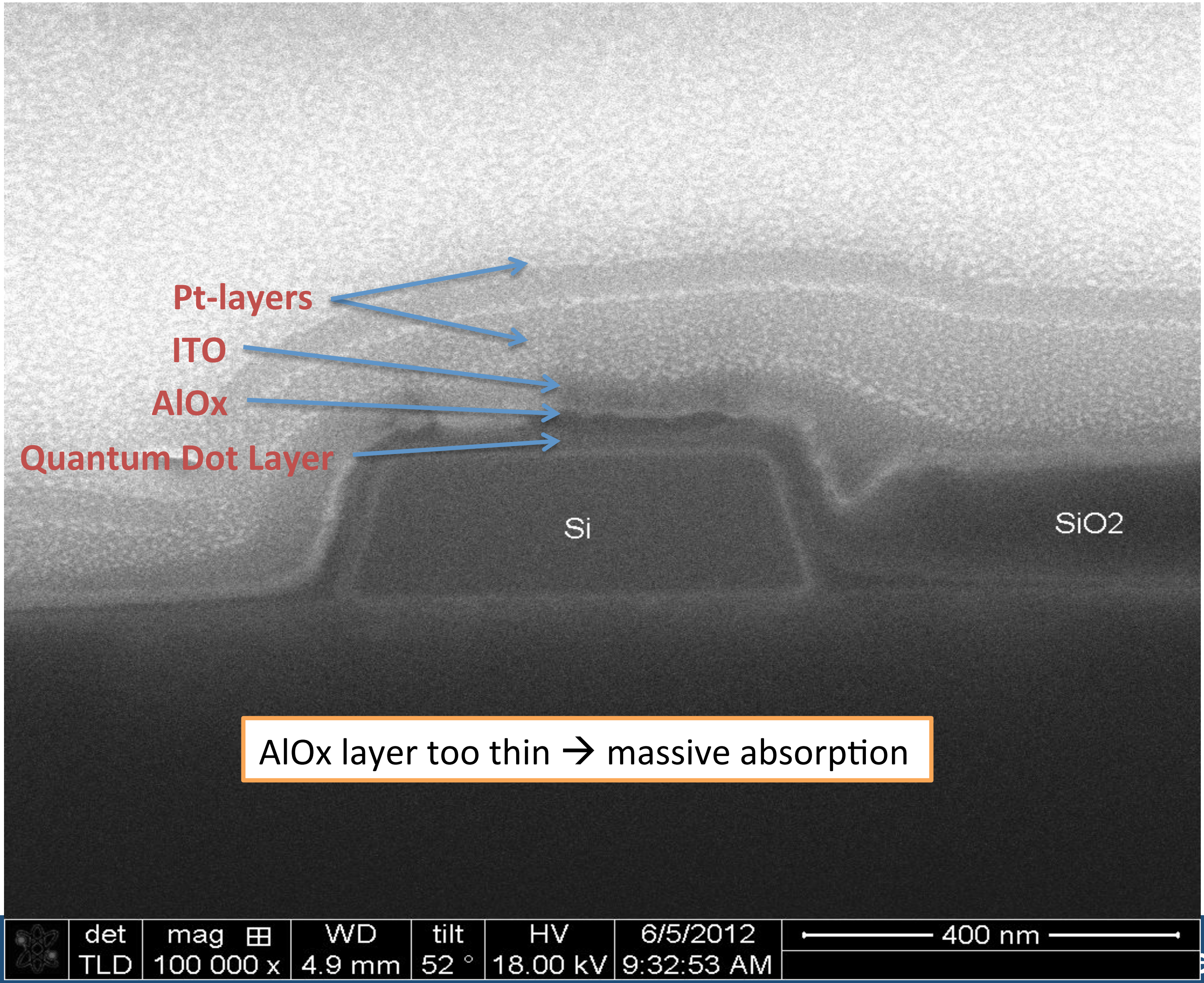


AlOx layer too thin → massive absorption

WP5 - work

Sukumar Rudra

Passive filter:

- 1st gen: 3nm bandwidth, 10dB suppression, 30nm FSR
- options: ring resonator, AWG, PCG …

Beam steerer:

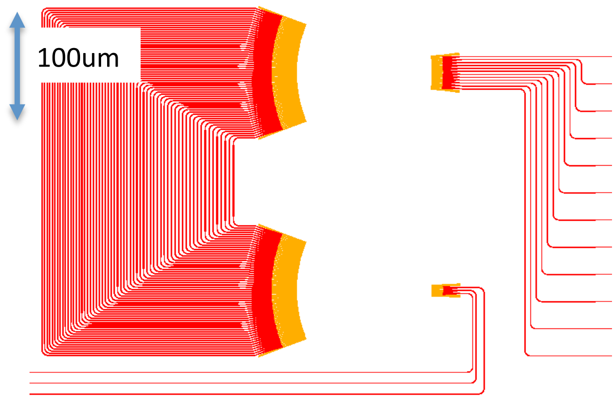
- 1st gen: 5dB loss, 100um distance
- 2nd gen: 3dB loss, 1mm distance, 10nm bandwidth
- “Challenging”

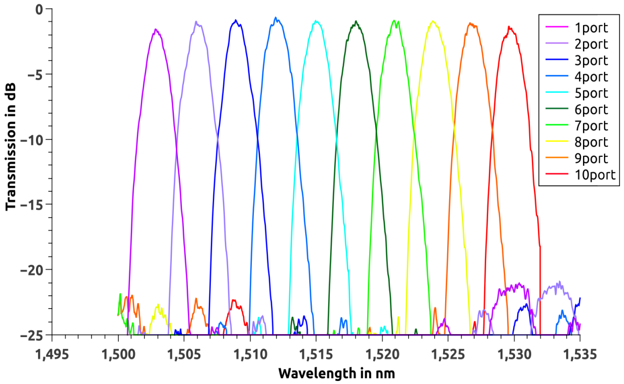
Time line:

- 1st gen: Design (month 12, M5.3)→ Fabrication (month 18, M5.7) → characterisation (month 21, D5.3)
- 2nd gen: Design (month 24, M5.9) → Fabrication (month 30, M5.11) → Characterisation (month 33, D5.7)

Passive filter

AWG based version





Device Details:
10x400 GHz AWG - size: 370x330 um2 - design FSR = 42 nm

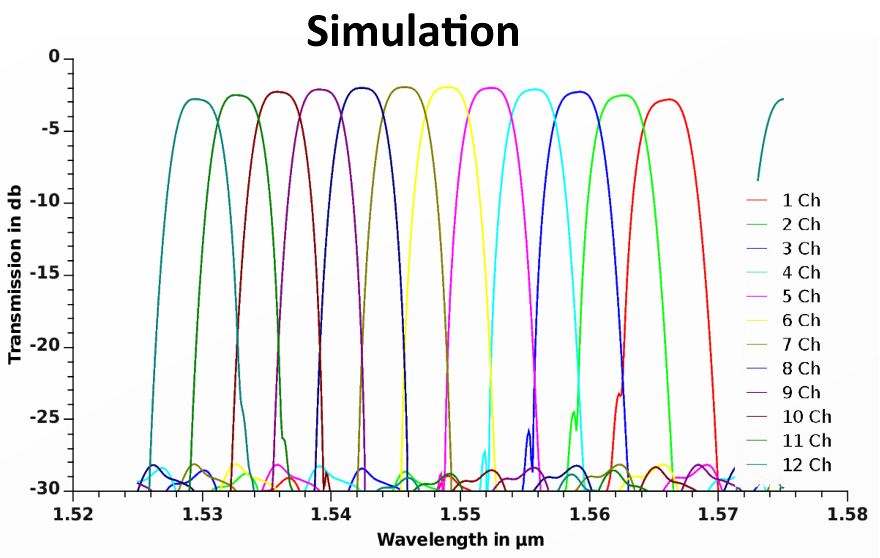
Measurement details:
Insertion Loss: -.90dB non_uniformity: 0.8 dB
Crosstalk: 22 dB
1dB Bandwidth: 1.01 nm - 3dB Bandwidth: 1.75 nm - 10dB Bandwidth: 3.19 nm

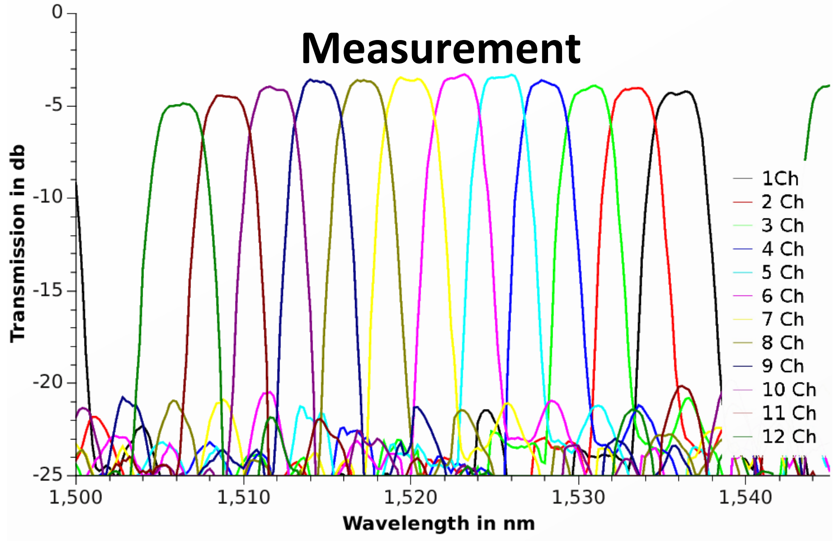
Passive filters

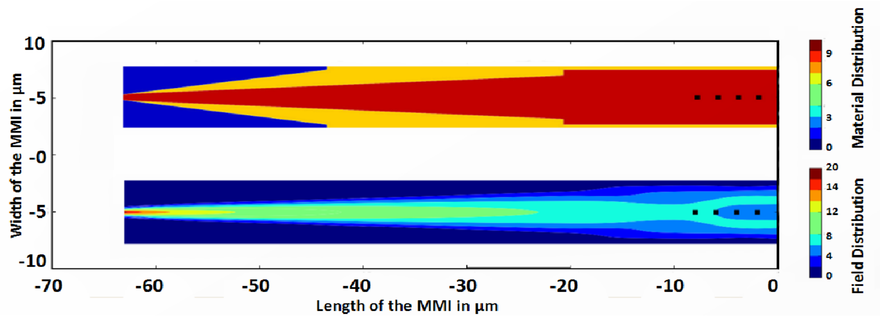
Alternative (if larger bandwidth is needed)

Use passband flattened AWG ?

- Using MMI
- Extensive design effort
- 1dB los (on top of intrinsic loss)







Passive filters

Alternative design: use ring based filters

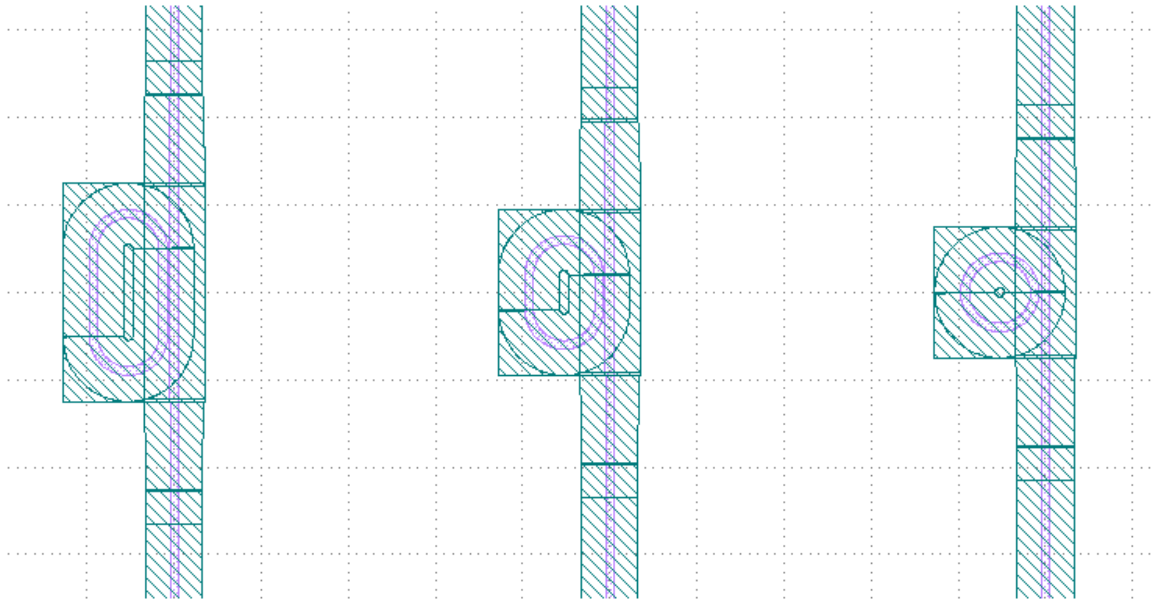
Large FSR → small radius

Range of parameters:

R = 2um, Lc = [0,2,5]um, FSR = [47, 36,26.6] nm

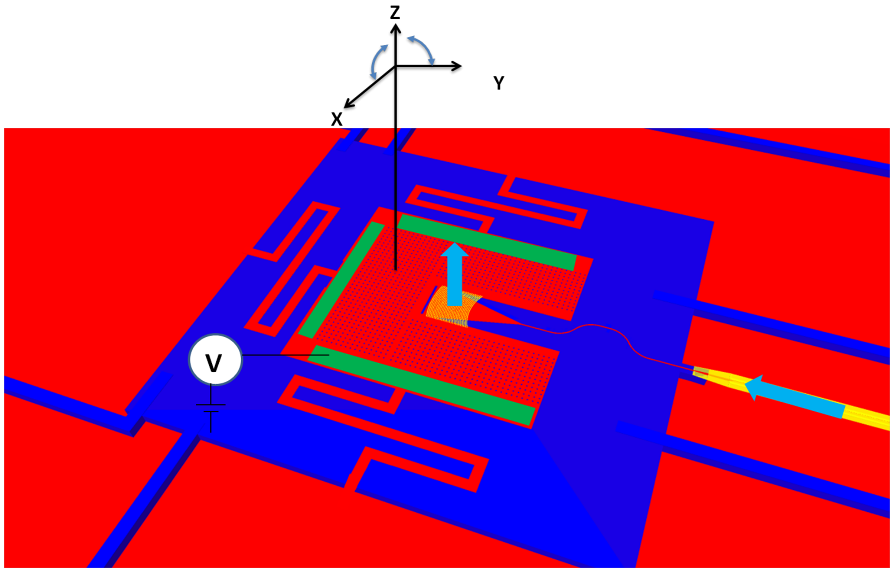
R = 3um, Lc = [0,2,5]um, FSR = [31.8,26.2,20] nm

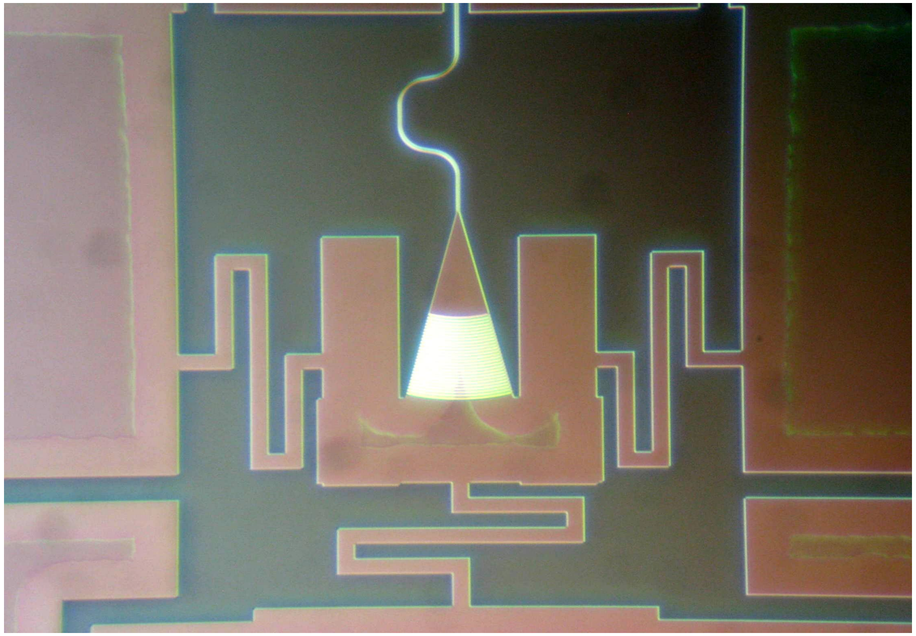
➡ Design completed
Under fabrication



Beam steerers

Use movable gratings ?

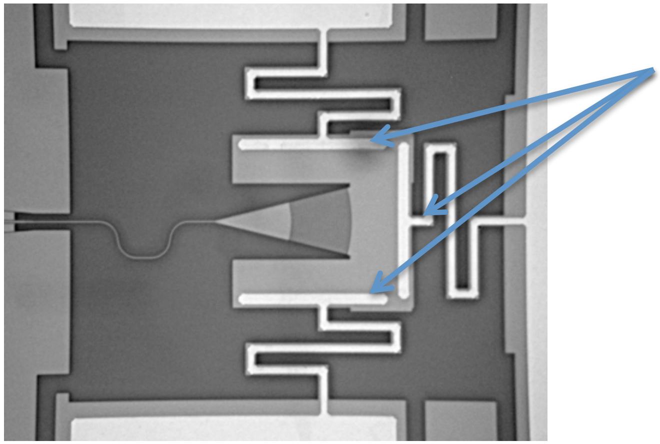




To be combined with focusing grating

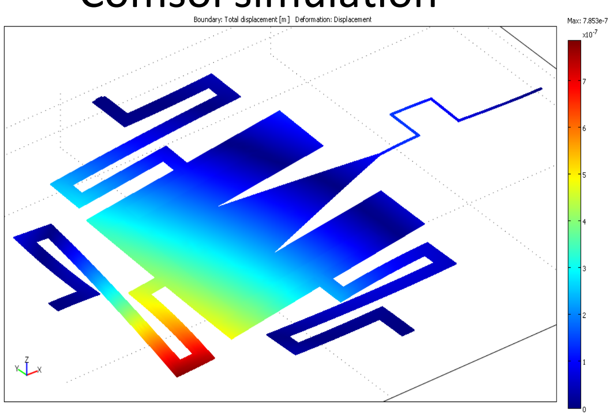
Beam steering

Proposed structure: grating coupler on movable MEMS platform

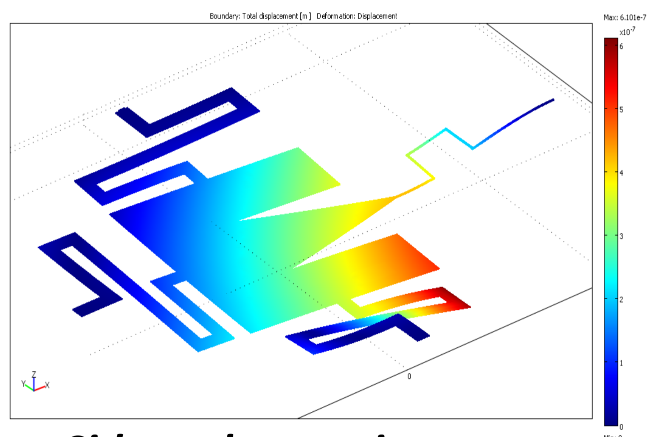


3 electrodes allow applying force in 3 directions

Comsol simulation



Back pad actuation



Side pad actuation

Beam steering

Processing:

Underetching initially not controllable – currently OK

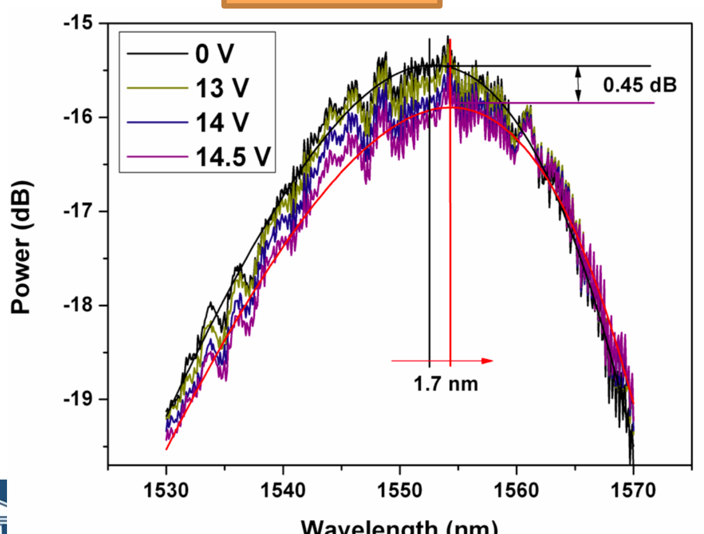
Fiber Characterisation:

Change in power + central wavelength measured when applying voltage

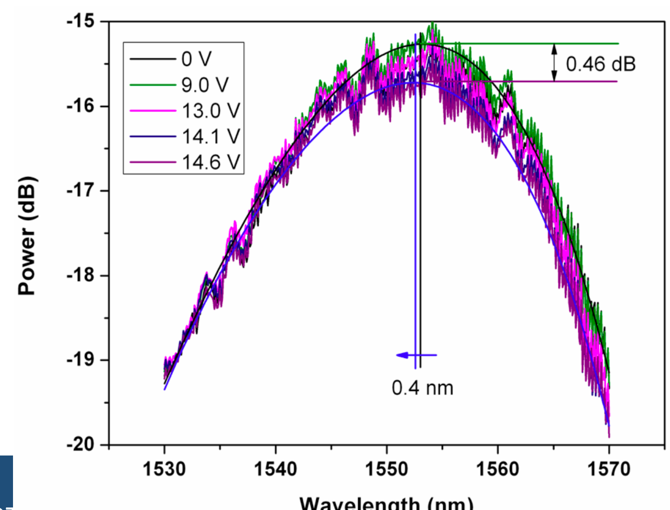
Device dependent (sometimes increase, sometimes decrease)

Change not in line with predictions

Back pad



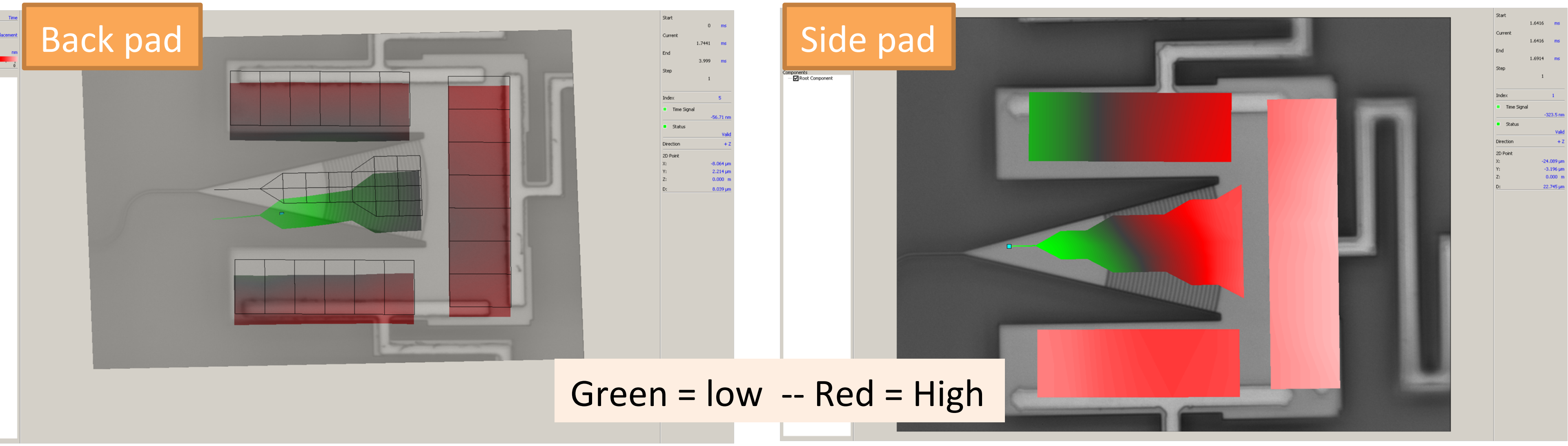
Side pad



Beam steering

Measurements using Laser Doppler Vibrometry

- Gives image of displacement
- No difference seen between side and back pad actuation
- Always tilt to front – Discrepancy with fiber based measurements



Next step

- Reprocessing current samples
- Designed new version with simpler structure