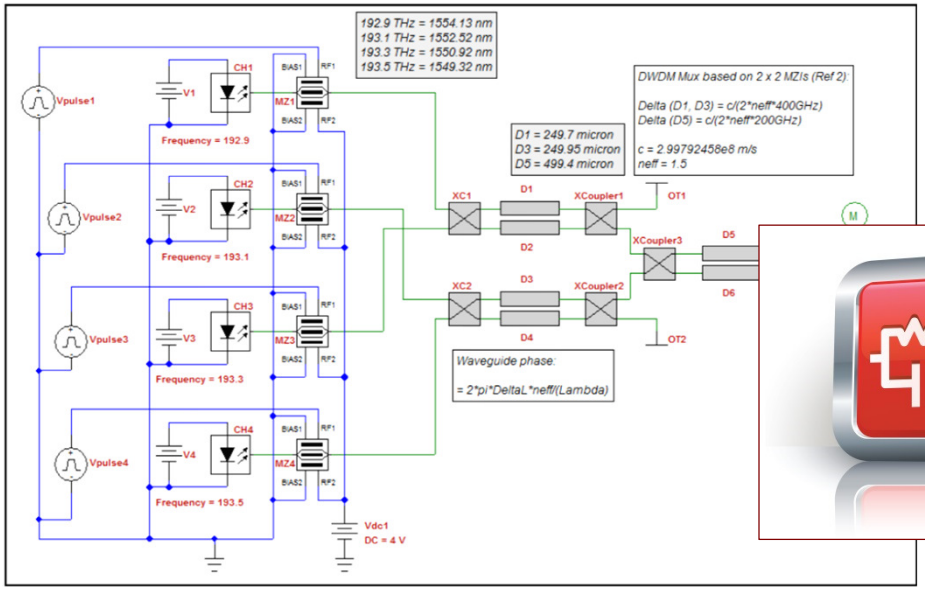

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Nanophotonic Imager Schematic*

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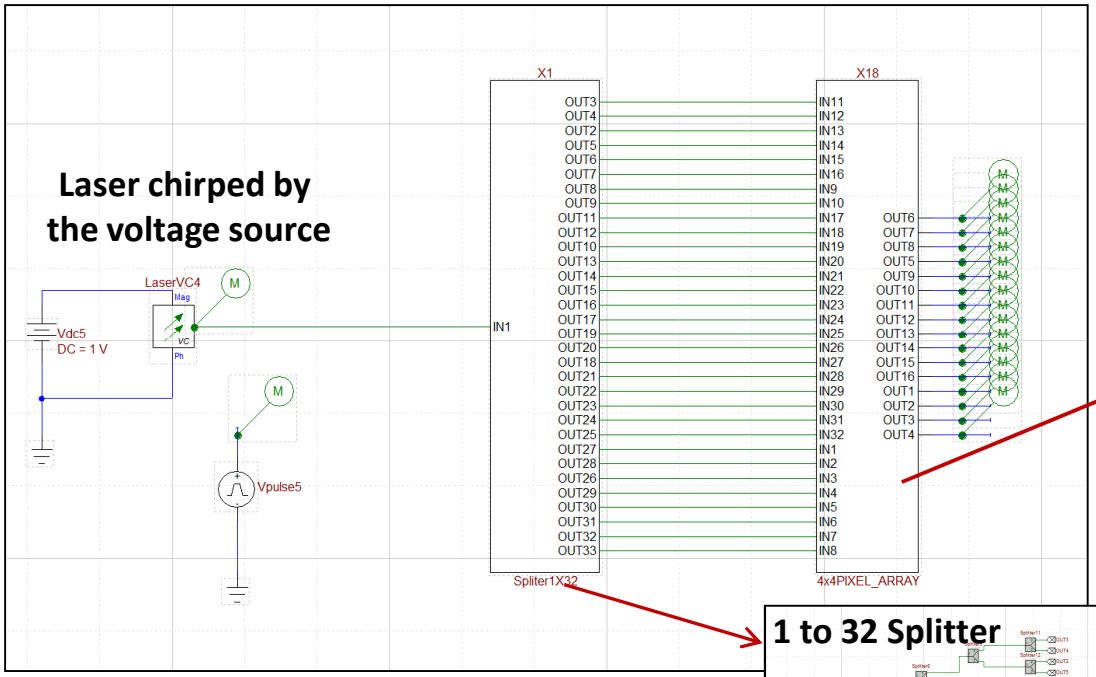
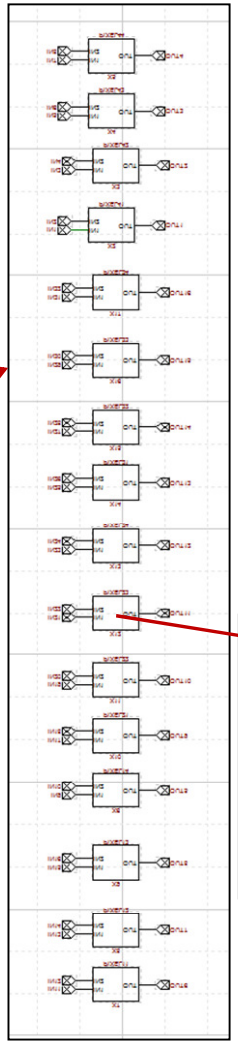


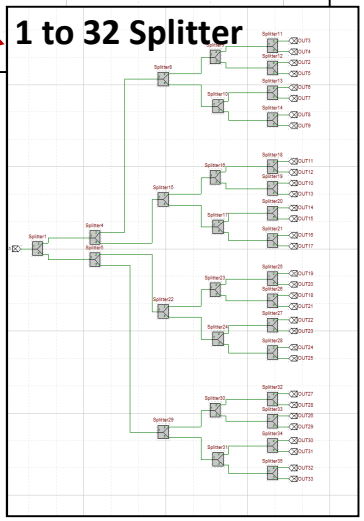
4x4 = 16 Pixels

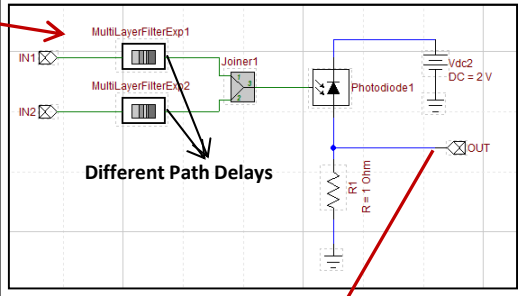


Basic Operation

- This example demonstrates the operation of a nanophotonic coherent imager (4 x 4 pixels)
- The chirped signal coming from the laser is split into reference (16) image (16) signals.
- Each image signal travels through a different path and gets recombined at the pixel with a reference signal.
- Due to the path difference, combined signals produce a different beating frequency at the output of the photodiode.
- With this technique high resolution depth profiles can be measured

1 to 32 Splitter





Simulation Parameters

c = 299792458	Speed of Light (m/s)
PER=500e-6	Chirp Period (s)
tf = 1.02*PER	Total Simulation time(s)
tstep = tf/20000	Time step (s)
fmax = 40e9	Maximum Frequency (Hz)
alpha = fmax/PER	Chirp Rate (Hz/s)
lam0 = 1550	Initial Wavelength (nm)
lam1 = c/(c/(lam0)+fmax*1e-9)	Final Wavelength (nm)

The output of the photodiode is processed using a python script to estimate the time delay difference between two inputs

*Firooz Aflatouni, Behrooz Abiri, Angad Rekhi, and Ali Hajimiri, "Nanophotonic coherent imager," Opt. Express 23, 5117-5125 (2015)

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Principle of Operation

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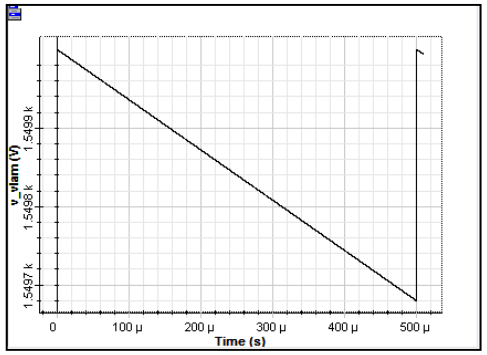
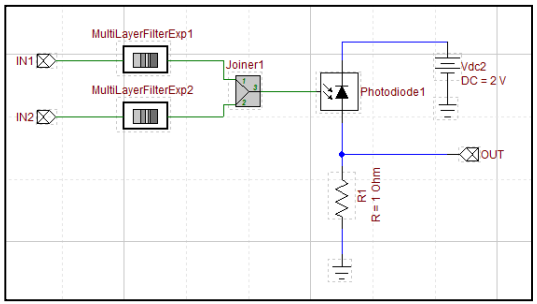
- Laser output is linearly chirped by the voltage source and then split into twice the number of pixels
- Chirped signal goes through 2 different paths with different delays, reference path and object path. These signals are combined before they reach a photodiode
- Each photodiode output oscillates at a different frequency (f) proportional to the delay between two paths (tau) and the chirp rate (alpha),

  f = alpha*tau

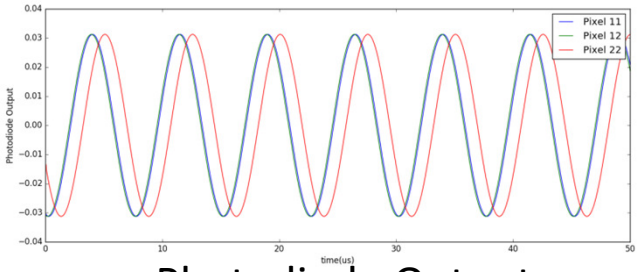
- The frequency of the photodiode output can be calculated as the inverse of the average time between zero crossings multiplied by 0.5
- The delay calculated from each pixel can be used to recreate the depth image of the object
- The minimum resolution depends on various factors such as the maximum frequency, distance from the imager to the object and time step/sampling rate



Linearly Chirped Laser Output



Pixel Subcircuit



Photodiode Output

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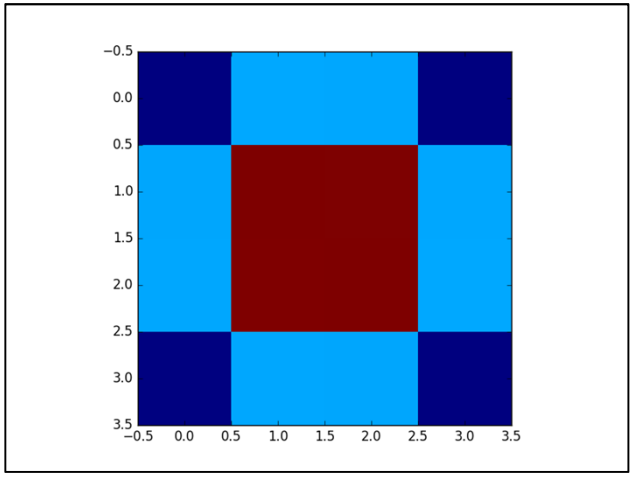
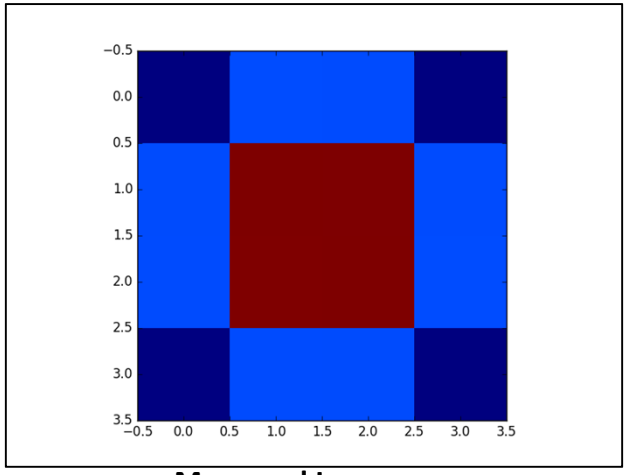
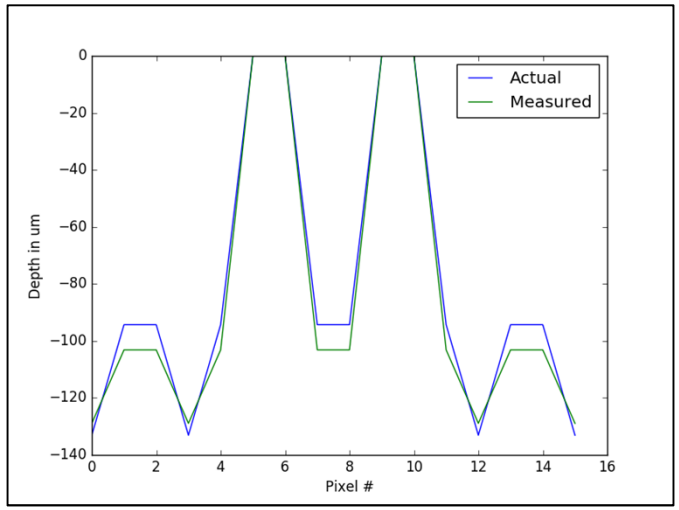
Simulation Results



Input Image



Measured Image



Results relative to pixel 22
Object is at 0.5 m distance

% Error Input vs Measured Delay

Pixel	1	2	3	4
1	0.002100	0.000498	0.000498	0.002100
2	0.000498	0.001268	0.001268	0.000498
3	0.000498	0.001268	0.001268	0.000498
4	0.002100	0.000498	0.000498	0.002100

% Error Input vs. Measured Delay Relative to Pixel 22

Pixel	1	2	3	4
1	3.12459	9.36726	9.36726	3.12459
2	9.36726	0.00000	0.00000	9.36726
3	9.36726	0.00000	0.00000	9.36726
4	3.12459	9.36726	9.36726	3.12459