

* fastree 3D

System on Chip LiDAR

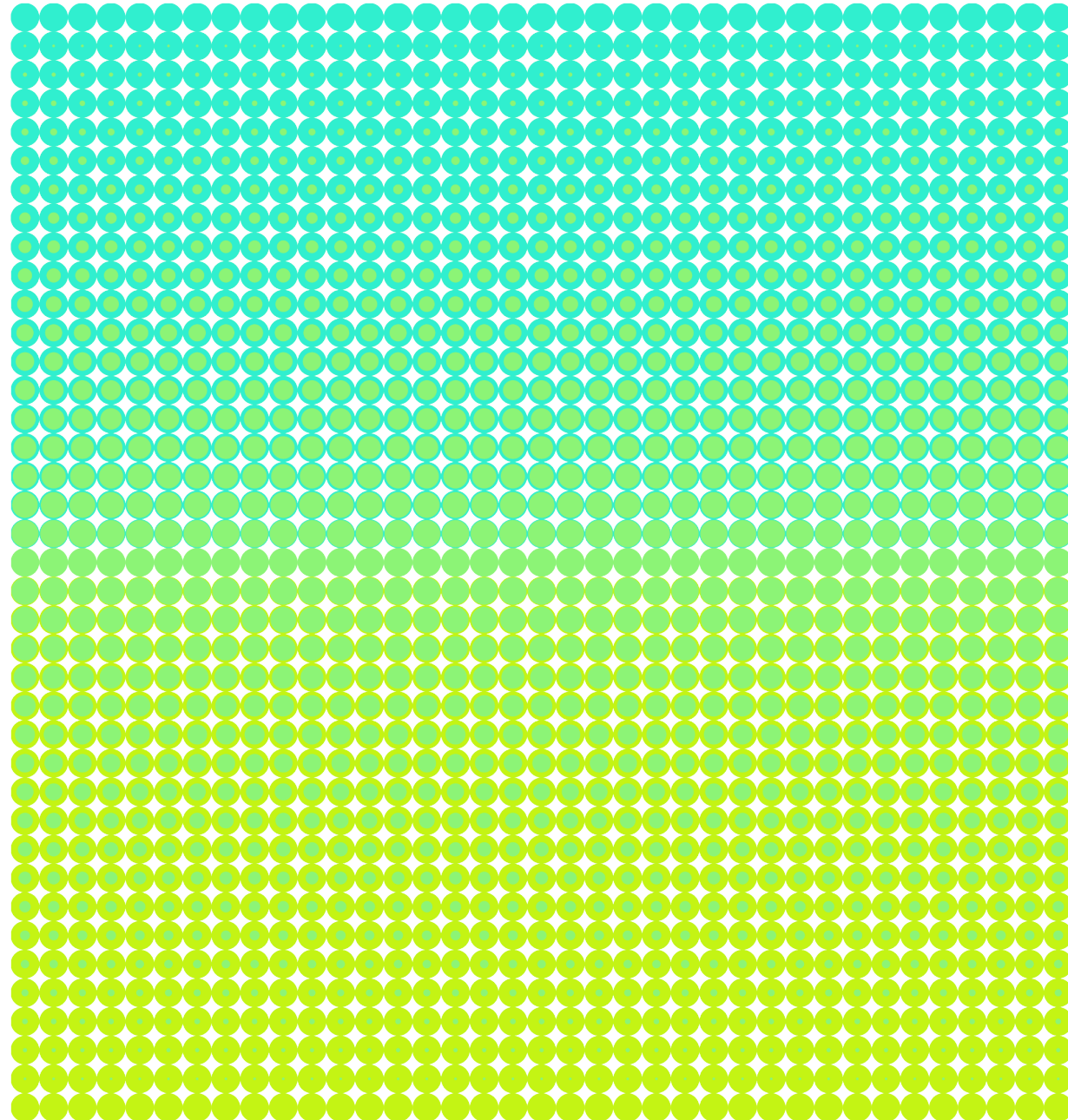
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21.06.2018

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Outline

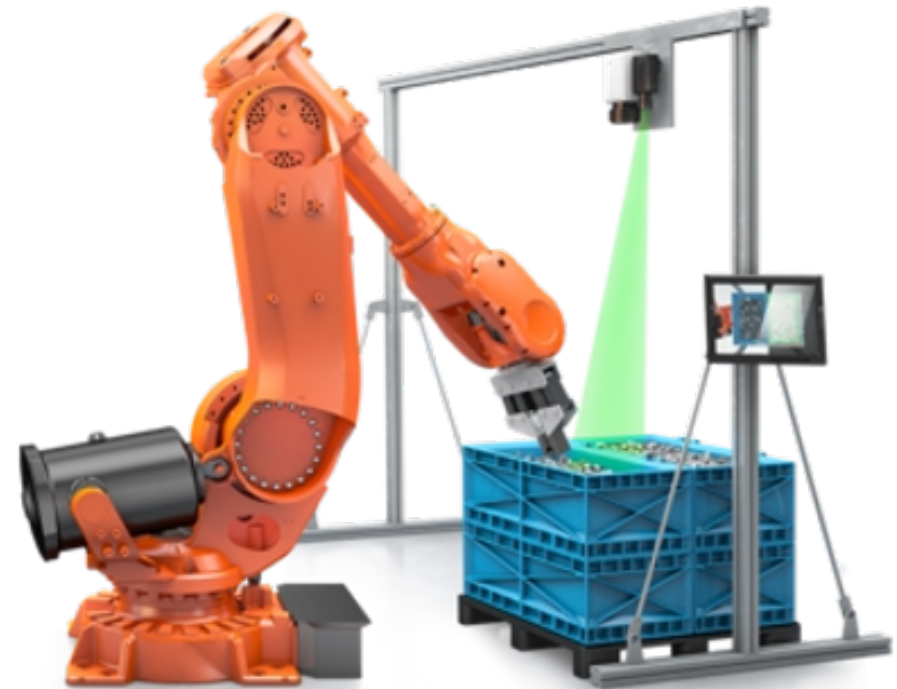
- 1 Set the problem**
(define characteristics)
- 2 Rationale of a complete solution**
(Flash LIDAR SoC)
- 3 Conclusions**
(Lidar solution is collaborative)

Outline

- 1** **Set the problem**
(define characteristics)

Key issues: speed, reliability

Automate the “sense, think and act” cycle



Current solutions

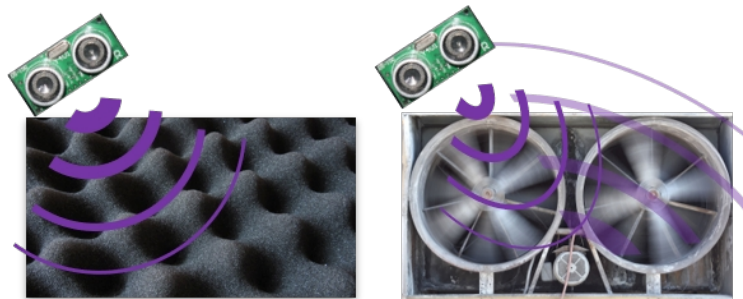
2D imaging

- Extreme illumination conditions
- Low contrast
- No direct depth information



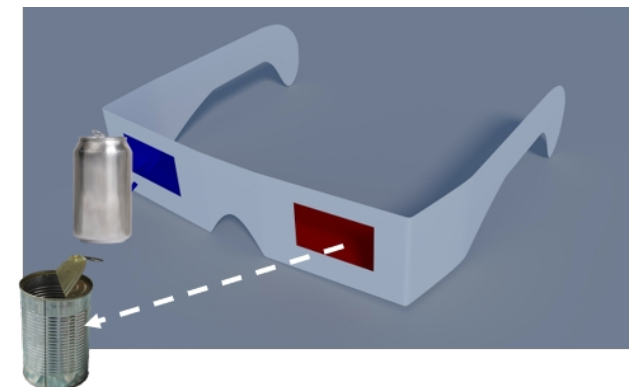
Ultrasounds

- Slow, short range, poor spatial resolution (x,y)
- Environmentally sensitive (wind, temperature and humidity)
- No direct image



Stereoscopy

- Form-factor vs depth resolution
- Shadowing (correspondence problem)
- Heavy computation (low speed, correlation problem)



Improving machine vision solutions



Reliability of data

Quality of result



Acquisition speed

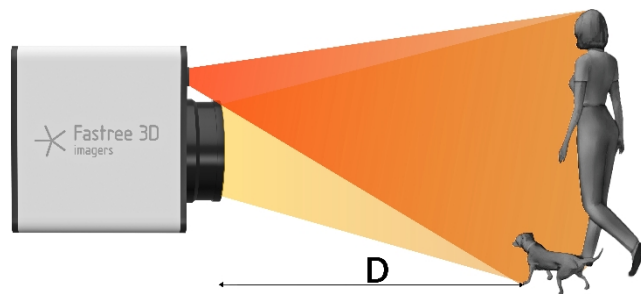
Low latency

Complementary to image processing and stereo

Flash Lidar

Flash Lidar

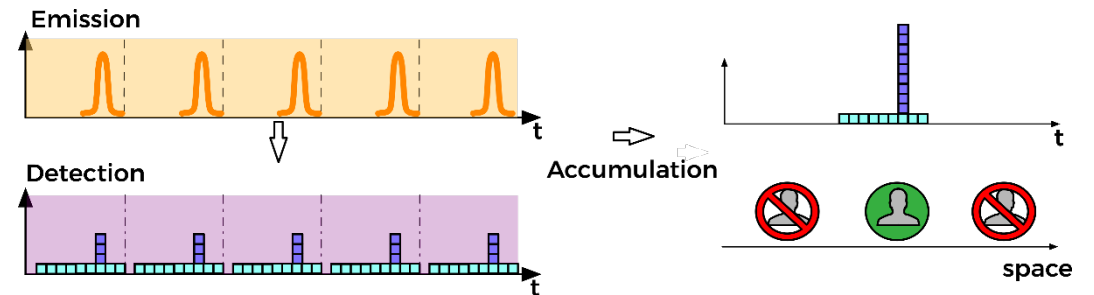
Single-Photon imaging



- High sensitivity
- High data throughput

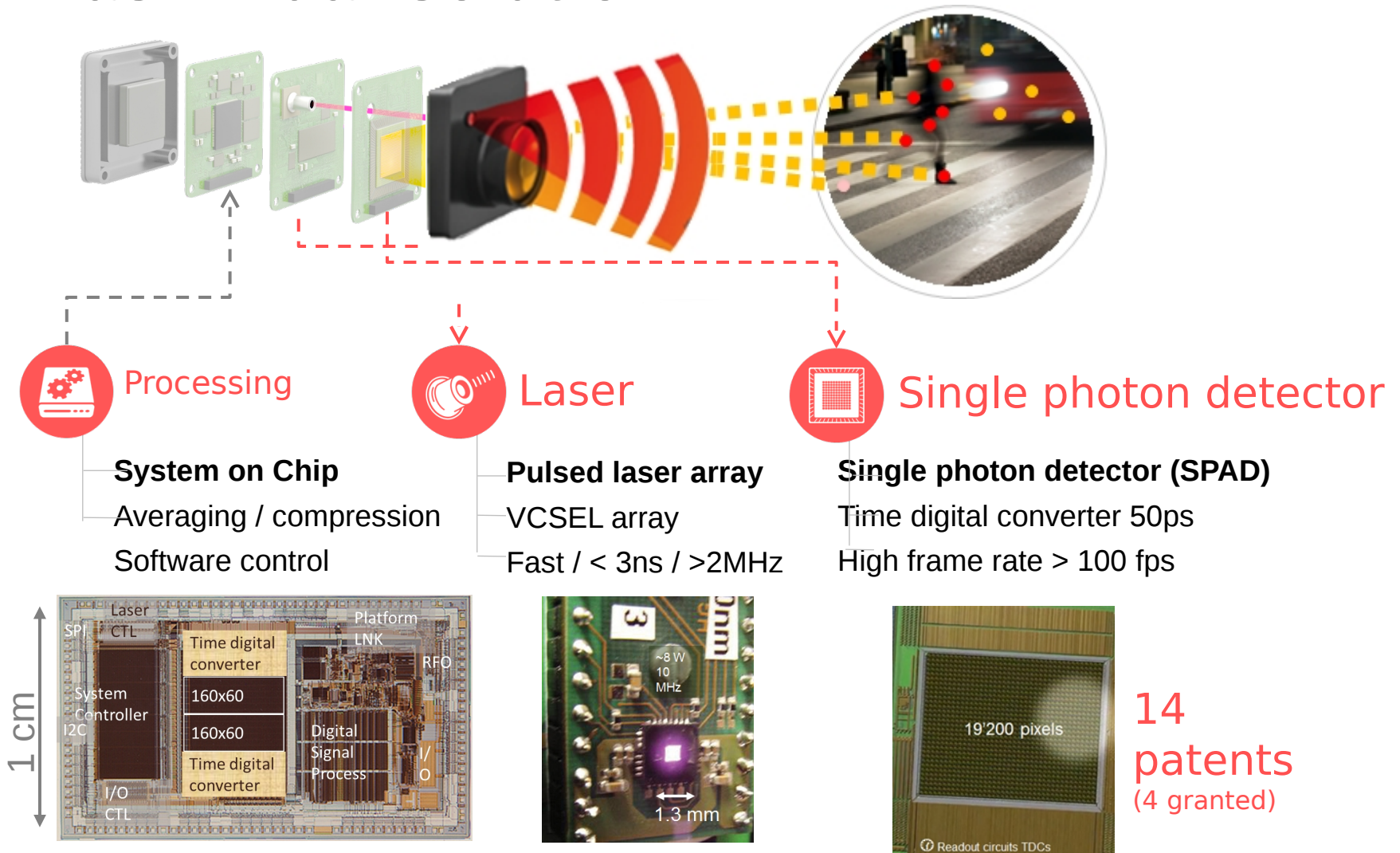
TCSPC

Time correlated measurements



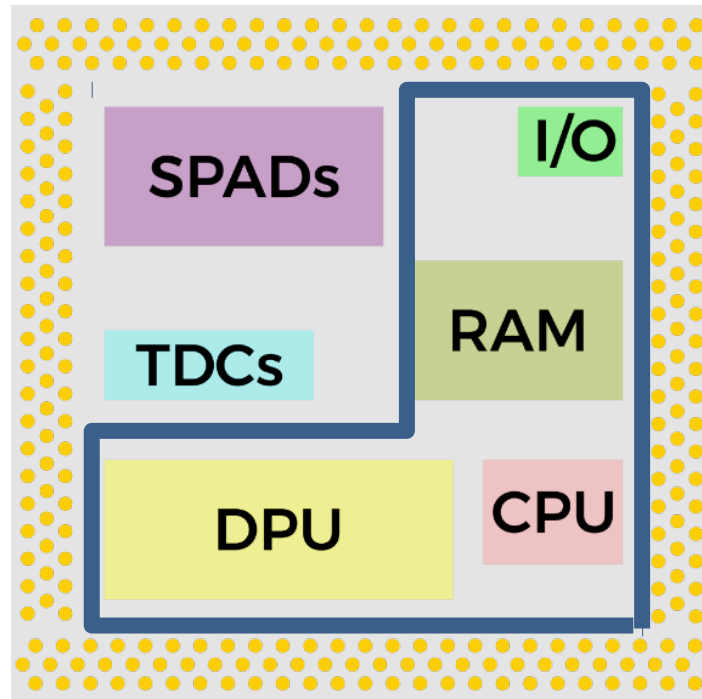
- Statistical approach
- **Quality of results**

Fastree3D flash Lidar solution



System on a Chip (SoC)

Monolithic integration



↑ Processing

Compression of 99.84%

↑ Reliability

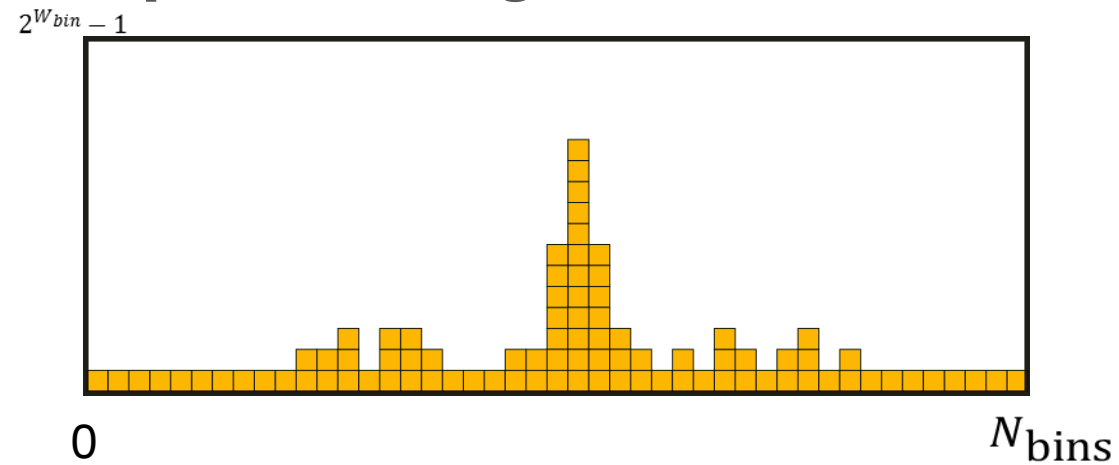
Point-cloud tagged with quality information

↑ Flexibility

Software control over sensor

Processing: compression

Compressed distance processing



e.g. pure histogram:

$$W_{ts} = 13 \text{ bit}$$

$$N_{bins} = 2^{W_{ts}} = 8192$$

$$W_{bin} = 8 \text{ bit}$$

$$M_{px} = N_{bins} * W_{bin} = \mathbf{65'536 \text{ bits}}$$

$$M_{QQVGA} = M_{px} * 160 * 120 = \mathbf{1.26 \text{ GB}}$$

Fastree3D processing algorithm:

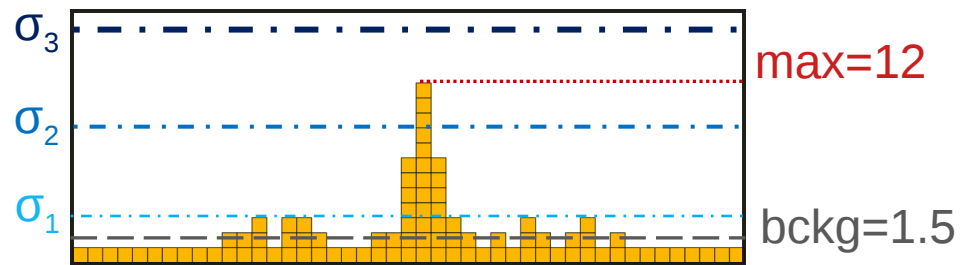
$$M_{px} = 104 \text{ bit} \Rightarrow M_{QQVGA} = M_{px} * 160 * 120 = \mathbf{1.99 \text{ MB}}$$

2 PATENTS

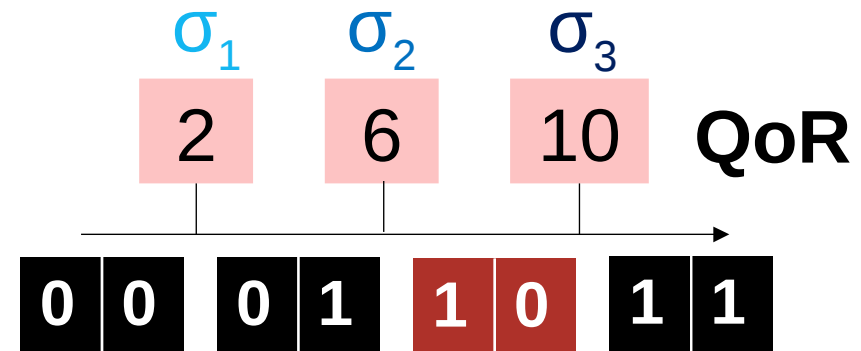
Reliability: Quality of Result

Distance- QoR

2-bit encoded \rightarrow 4 possibilities

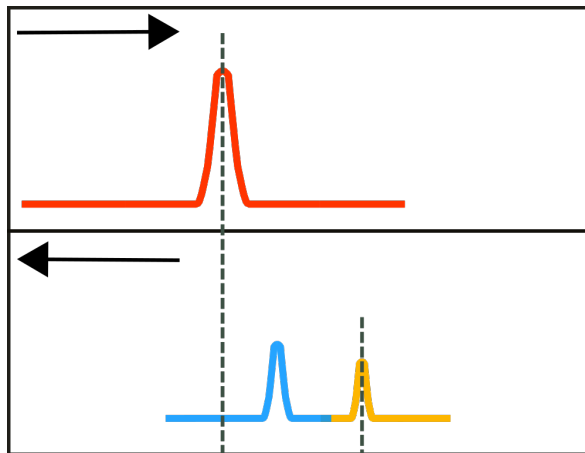
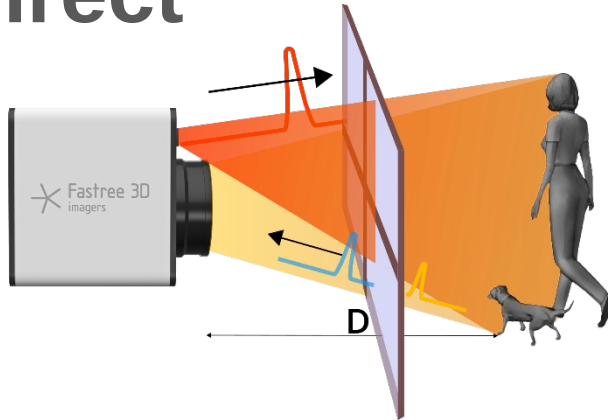


$$\text{e.g. QoR} = \frac{\text{max}}{\text{bckg}} = \frac{12}{1.5} = 8$$



Reliability: interference suppression

Direct



Multiple reflection effect:

- Create a sequence of pulses
- The back-scattered pulses are spaced over time (no overlap)
- Their intensity is proportional to the reflectivity of the objects.

Flexibility: data format (1)

Distance



- Point cloud
- Quality of result

Flexibility: data format (2)

Distance

Intensity



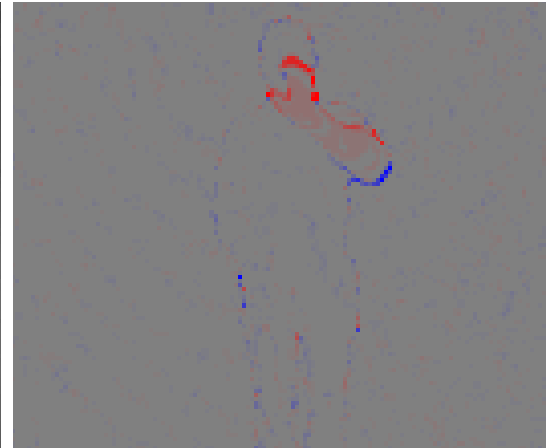
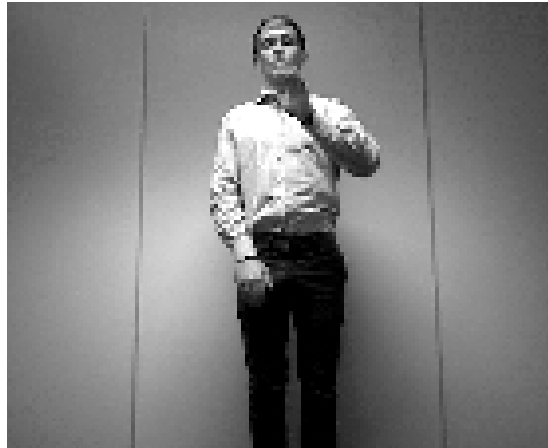
- Photon counting
- Quality of result

Flexibility: data format (3)

Distance

Intensity

Speed



- Distance differential
- Quality of result

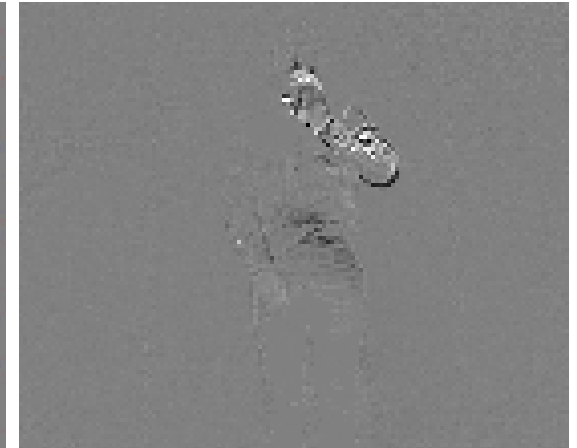
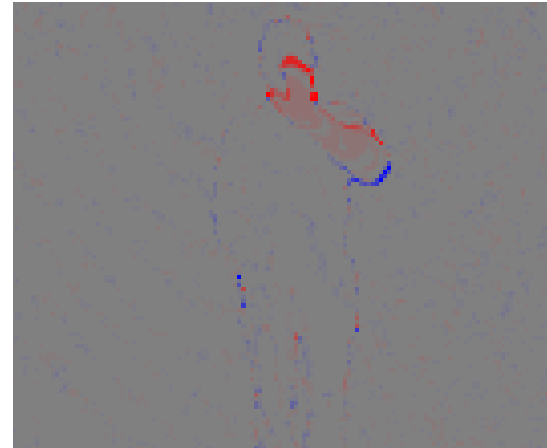
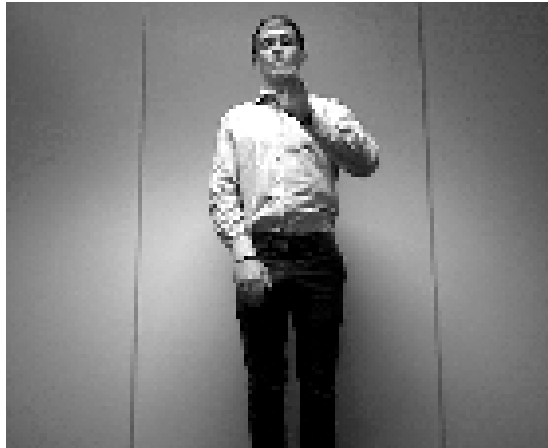
Flexibility: data format (4)

Distance

Intensity

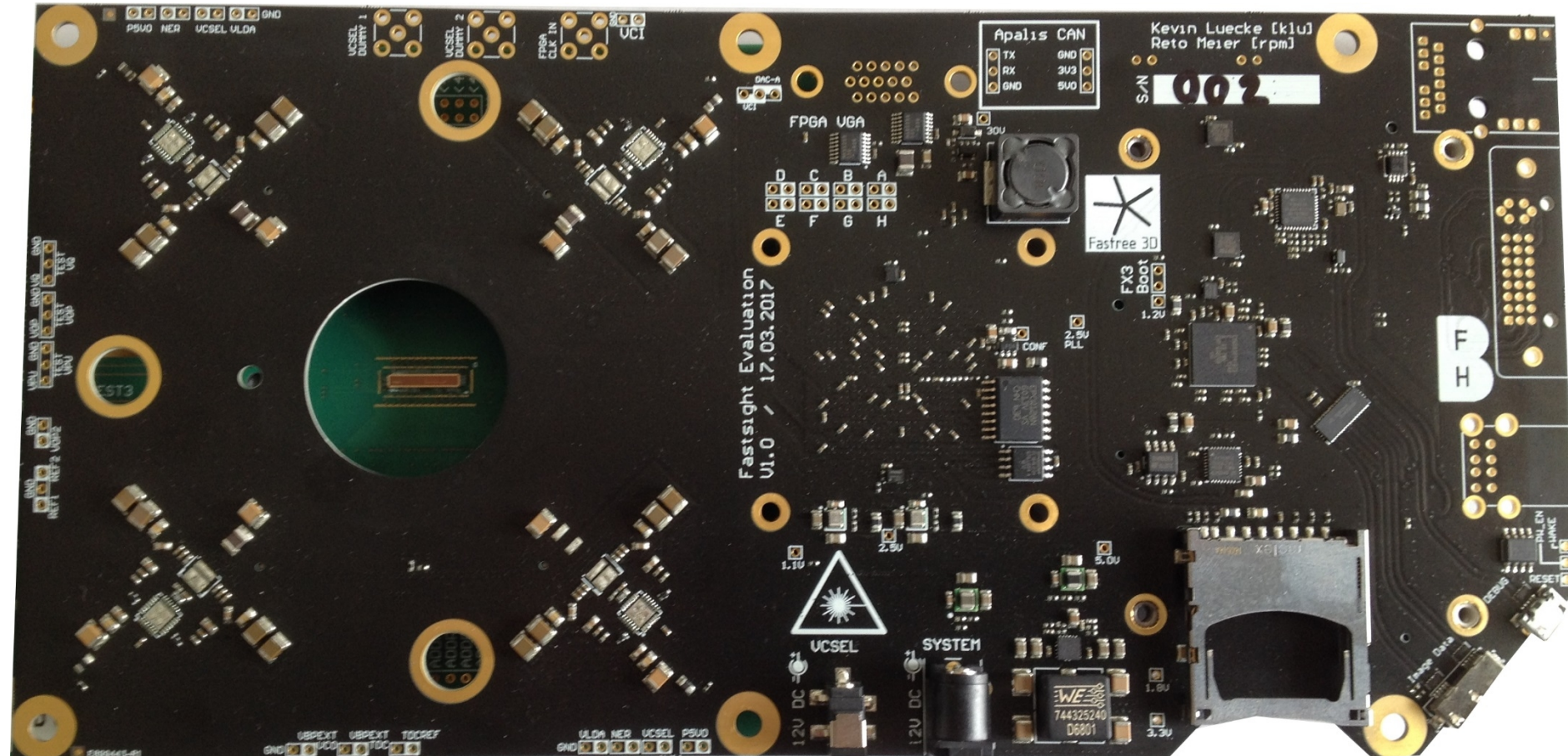
Speed

Motion

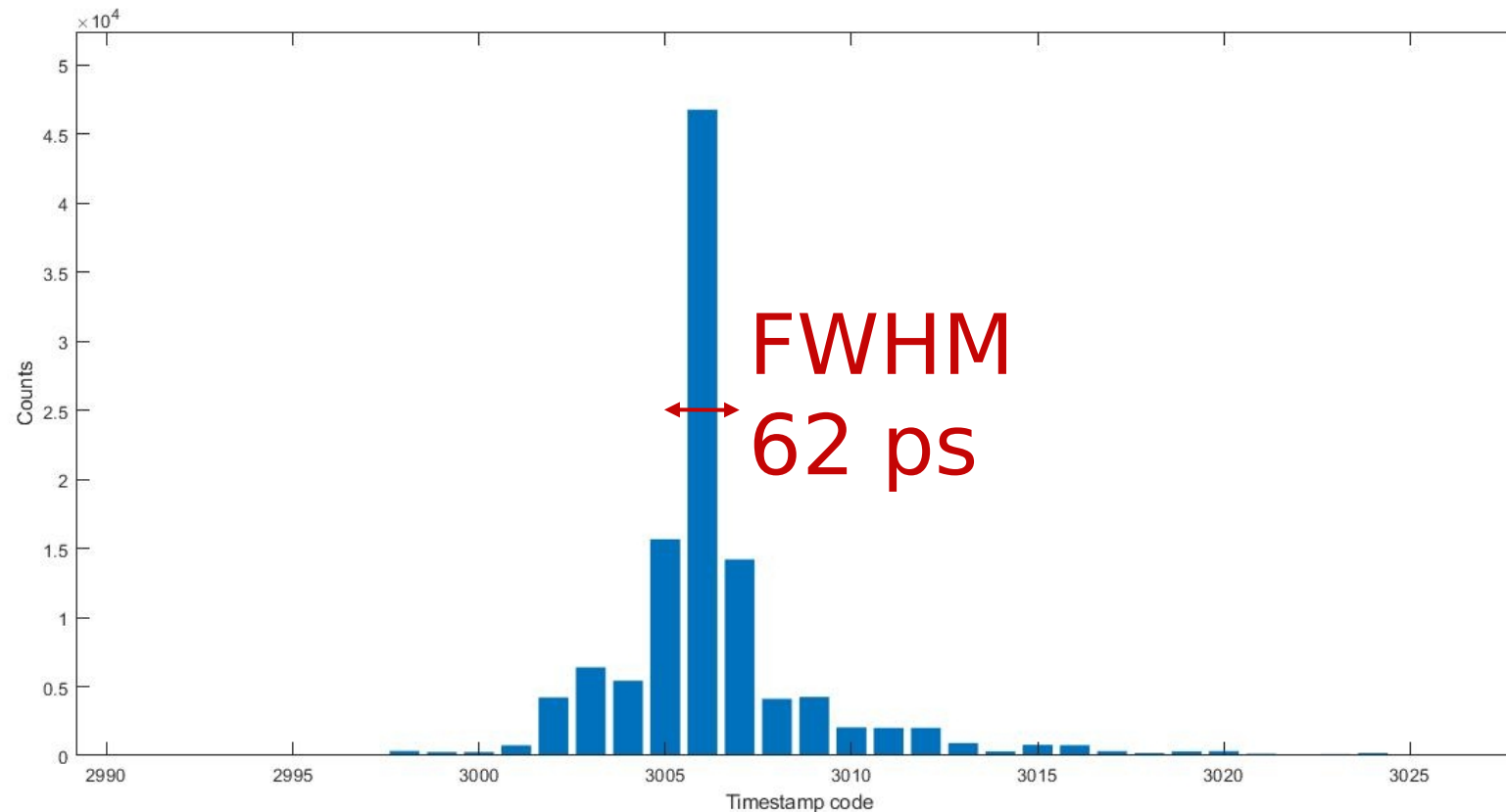


- Intensity differential
- Quality of result

Fastree3D – Hardware Development Kit (HDK)

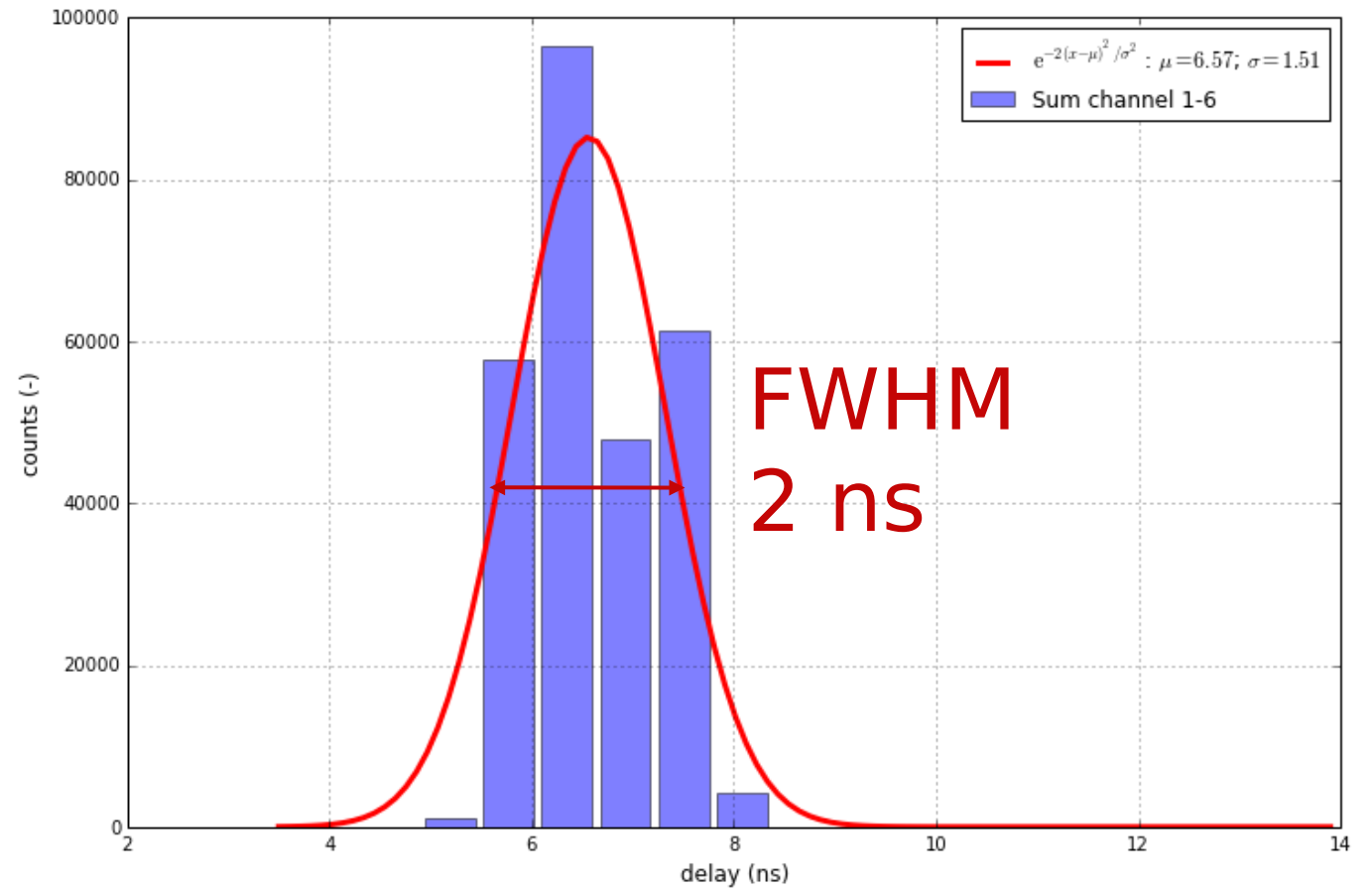
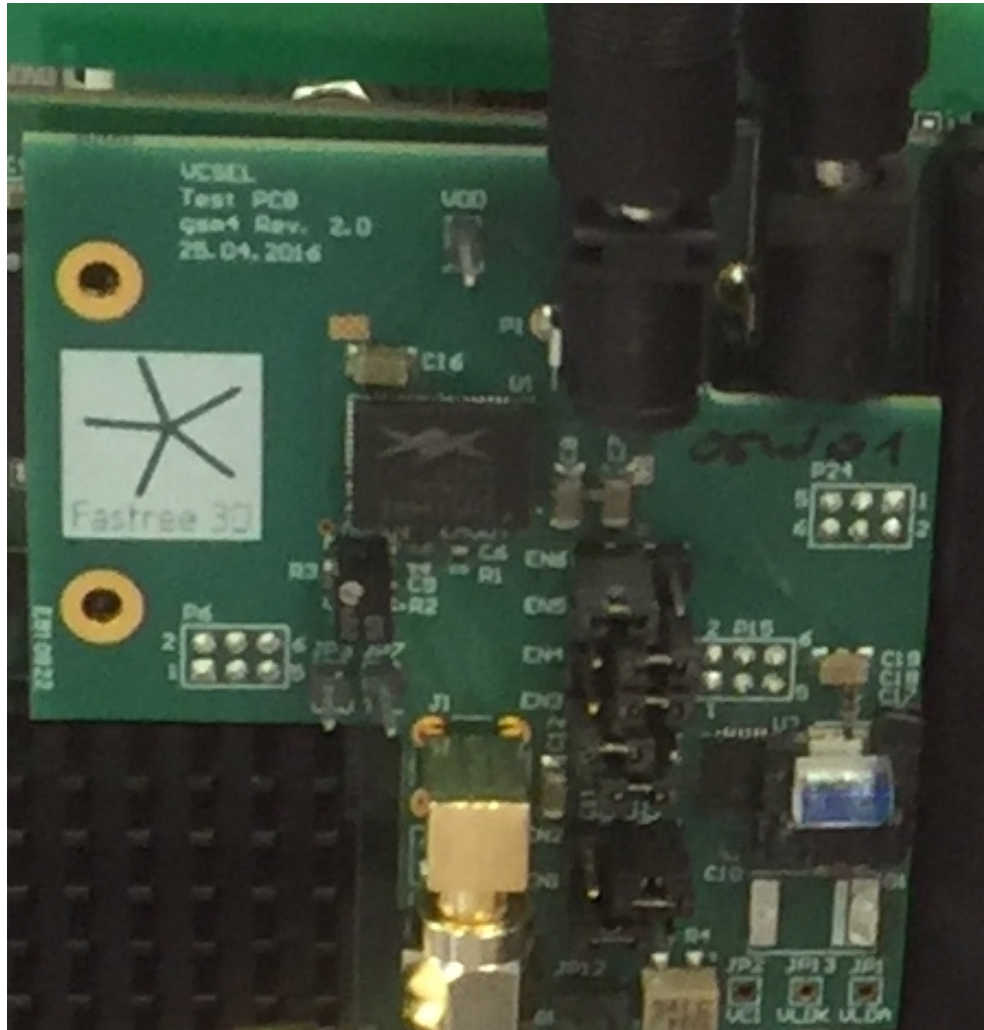


Fastree3D – Sensor jitter



- 30ps laser pulse
- Gaussian
- Pixel + TDC
- FWHM:
 - Median: 62 ps
 - Worst: 260 ps

Fastree3D – Digitally controlled laser



Lidar technology roadmap

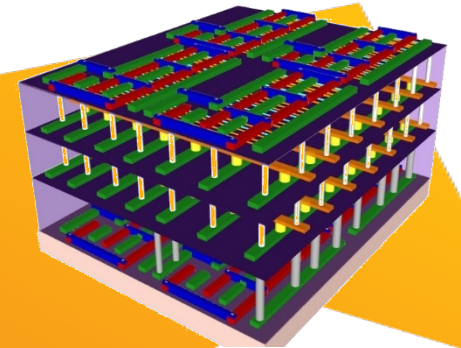
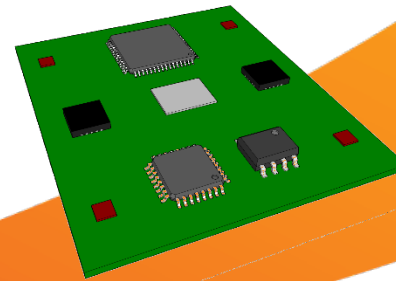
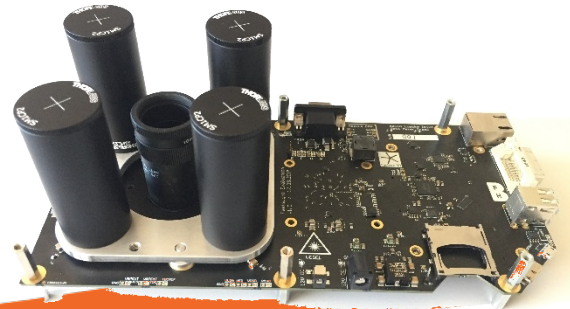
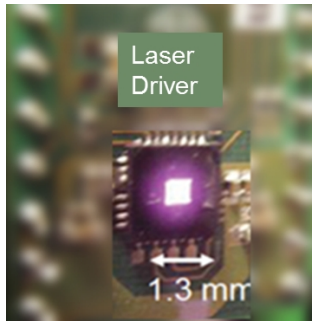
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Line sensor 60x2 px
TDC / readout
Illuminator
Algorithms / system

Hardware development kit
Partner engagement
Integration
System development
ASIC → array

Camera module
LIDAR SoC
- Up to QQVGA
Flexible illuminators
- Up to 4 sources
Single board

3D stacking
Performance optimization
NIR → SWIR
Eye safety
Background rejection



2017

2018

2019

2020+

THANK YOU!

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