# OCULI

## SEIZE TIME

# CVPR 2021 Workshop on Event-based Vision
## 2021-06-19

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4 Mpixel

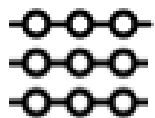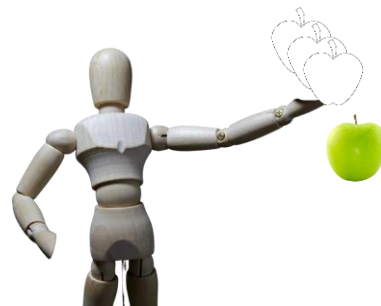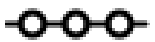2 Gb/s

W's

0.4~1 sec
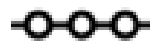
Vision Intelligence

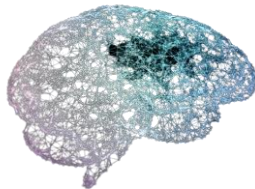500 Mpixel

10 Mb/s

mW's

13 msec
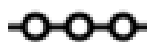
# OCULI ENABLES BIONIC VISION™
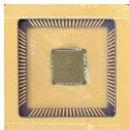
**OCULI S11 SPU™ (Sensing and Processing Unit)**
A single chip vision solution

## Real Time Vision Intelligence (VI) At The Edge
> 30 x more efficient than alternatives

Integrated sensing + processing
Parallel sensing + processing
Saliency/features (smart events) output
Sparse processing
Bi-directional communication

Oculi SPU is the first practical silicon that closely mimics biology in selectivity, parallel processing, and efficiency but outperforms in speed

# OCULI SPU™ ARCHITECTURE

SPU™ = Sensing and processing unit
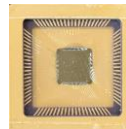
**Oculi SPU**

**Integrated neuromorphic sensing & processing**

Oculi IntelliPixel™

Photon

**Detector Agnostic**

Photon

| Sensor | Front-end | ALU |
| | | Memory |

Patented digital pixel, processing and memory architecture

IntelliPixel

Read-Out Control — I/O

Pixel Array — ISP

Events
Smart-Events
Actionable Signal
Full-frame
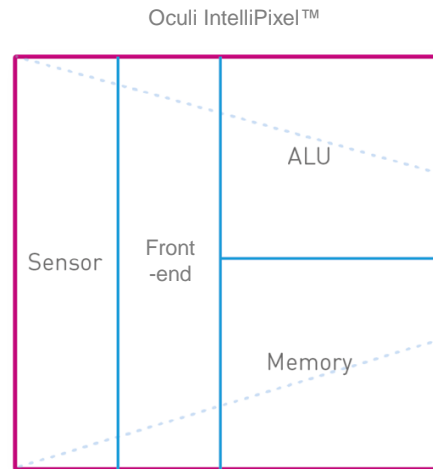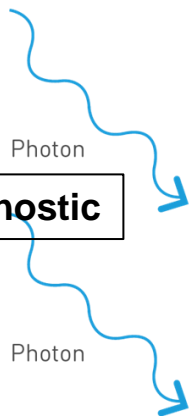
**No data transfer**
**Parallel memory and processing**
**One-to-one match for sensing and processing**

# OCULI SPU™ IR

SPU™ = Sensing and processing unit

**Oculi SPU**

Demonstrated SPU IR:
SWIR, MWIR and LWIR

SWIR   MWIR   LWIR

Oculi IntelliPixel™

IR Sensor

ALU

Front-end

Memory

IntelliPixel

Read-Out Control

I/O

Pixel Array

ISP

Events

Smart-Events

Actionable Signal

Full-frame
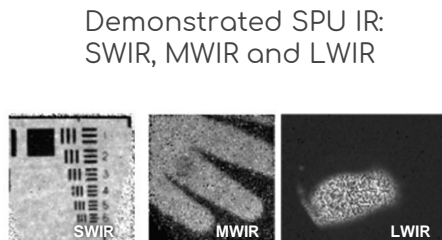
**Works with infrared sensors**

Patented digital pixel, processing and memory architecture
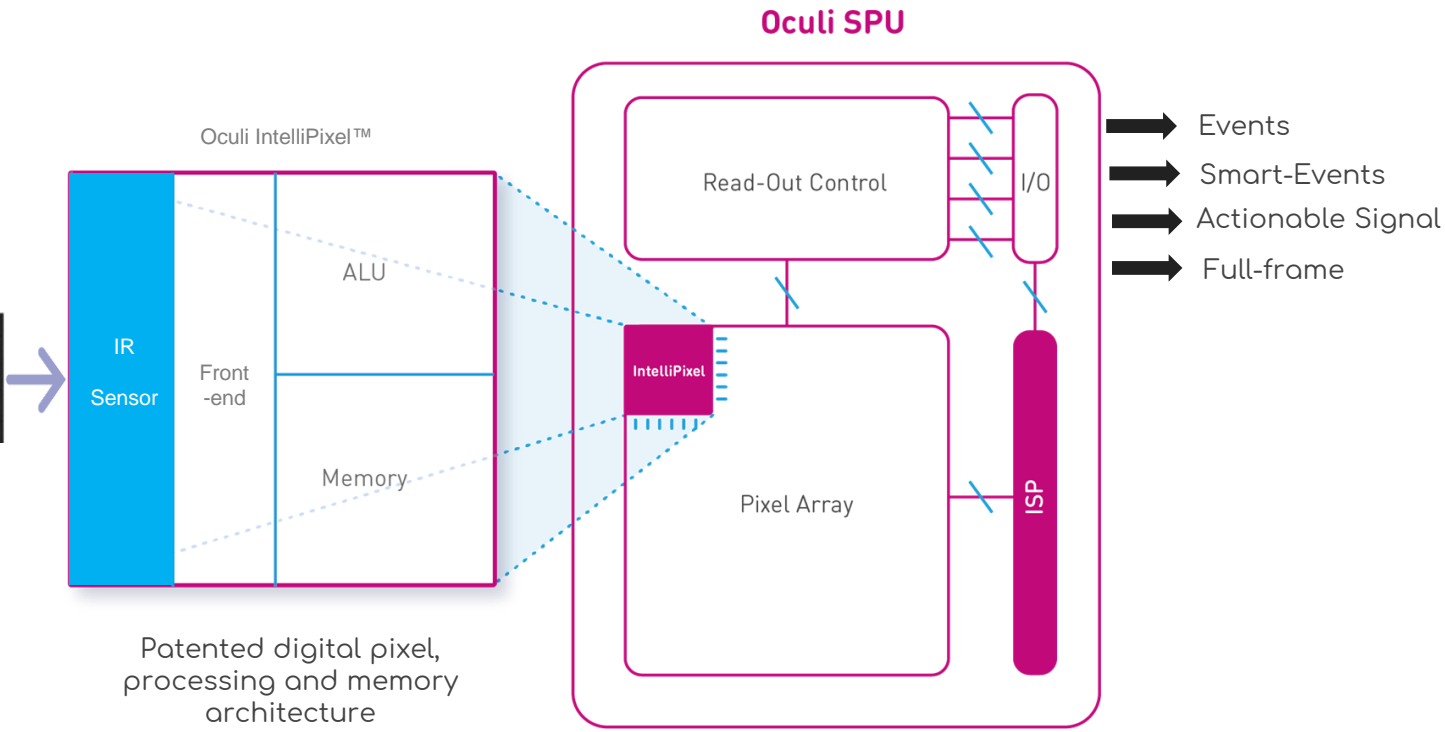
# OCULI SPU™ PROVIDES A REAL-TIME UNDERSTANDING OF THE SCENE

3% bandwidth

0.001% bandwidth

Full Frame

Smart Events

Actionable Signal

GB/s

MB/s

KB/s

Detections = 5

size = 59x35

size = 23x1

Direction

Speed

Size

Intensity

Signal Magnitude

Image Location
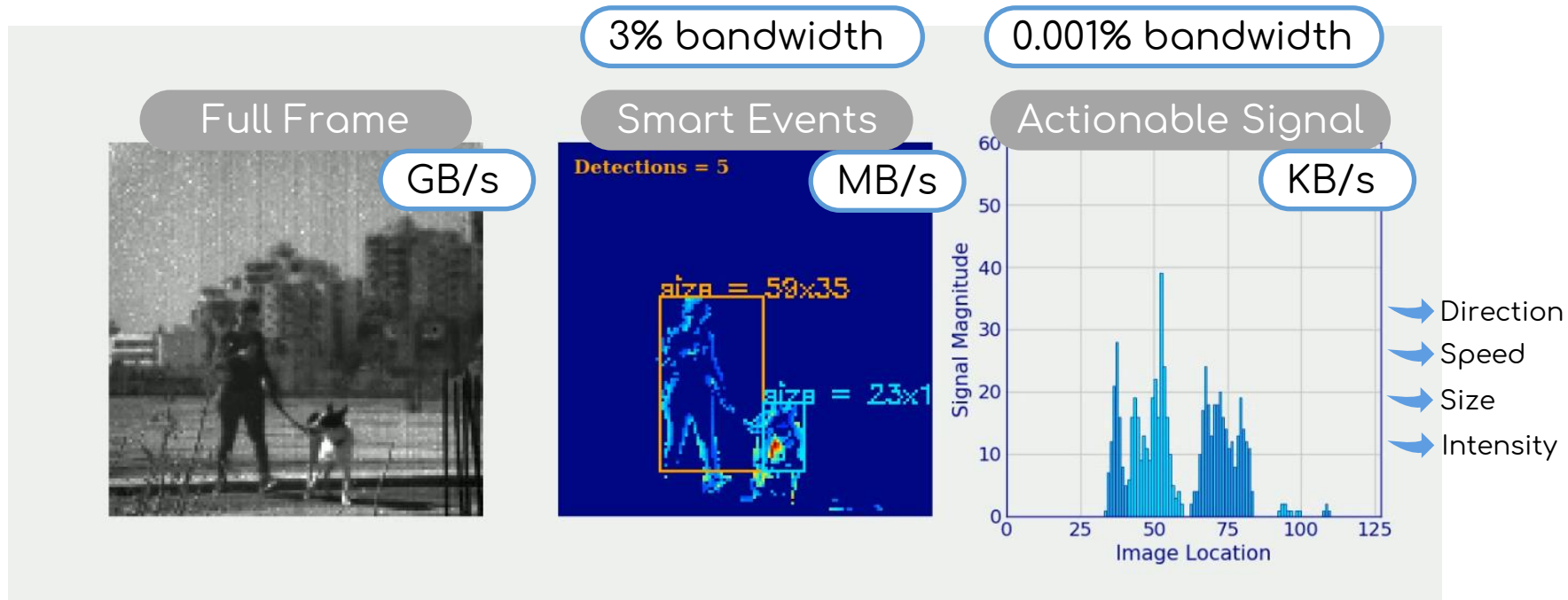
The Oculi SPU™ reduces bandwidth and external processing by up to 99% with zero loss of relevant data making it ideal for IoT and Edge Applications.

# OCULI SPU™ CAN OUTPUT <u>ALL</u> OF THESE MODES

The Oculi SPU™ is can be programmed to deliver a signal of interest



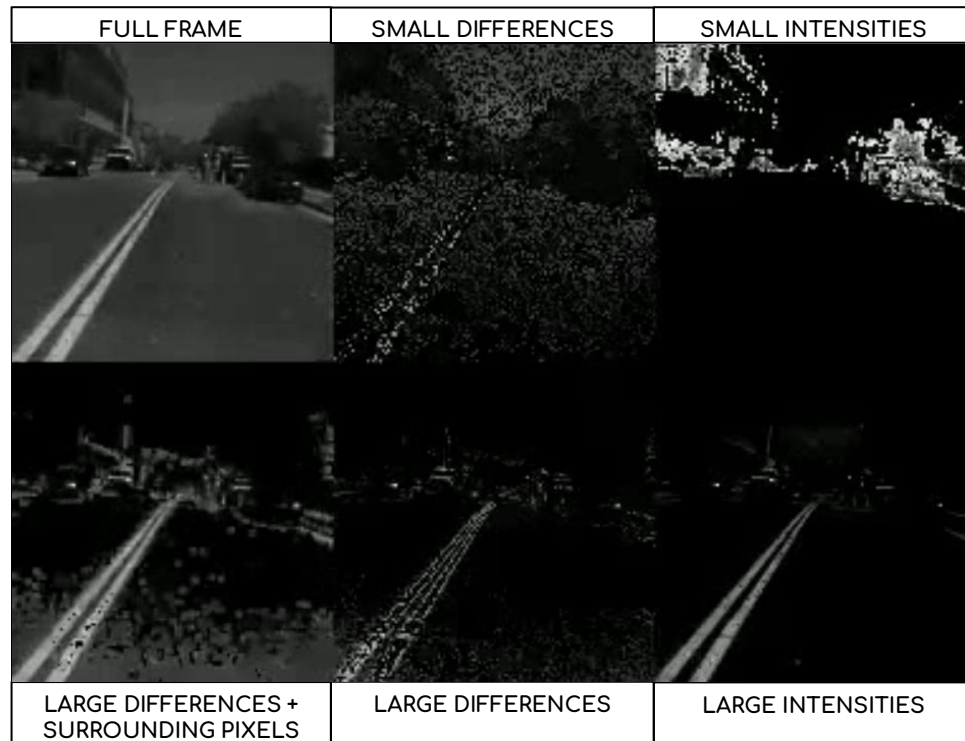| 30% bandwidth | 3% bandwidth | 0.001% bandwidth |
|---|---|---|
| GB/min | MB/s | KB/s |
| Full frame | Events | Edges | Billable Events |
| 26-bit grayscale intensity value on all pixels | -1 \| 0 \| +1 Positive or negative spike on events | 26-bit grayscale intensity value on events | <metadata> In this case: Axle detected |
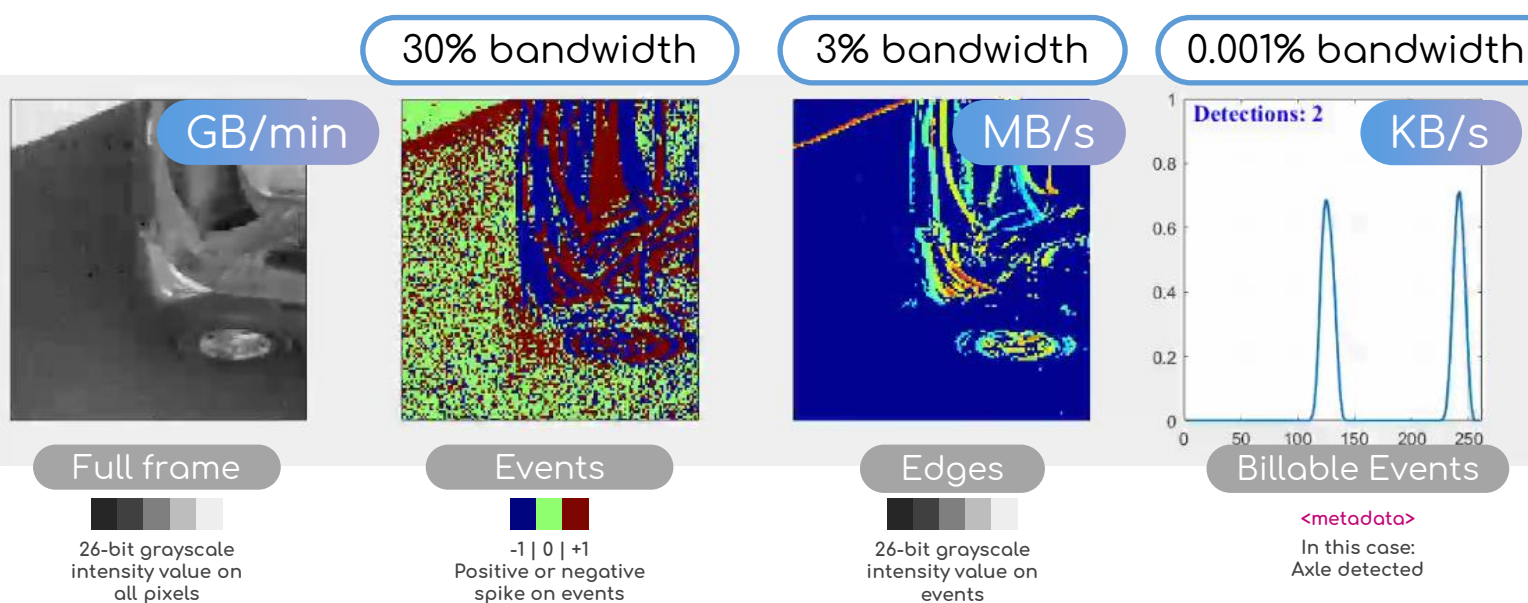
Oculi SPU™ is a complete vision solution on a single chip, ideal for edge applications

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# OCULI SPU ™ HAS SOFTWARE-DEFINED FEATURES

## Oculi SPU™ Output Modes



Oculi Detector Layer — Oculi Vision Processing

- Dynamic Differencing
- Intensity
- Foreground extraction
- Correlation
- Full frame
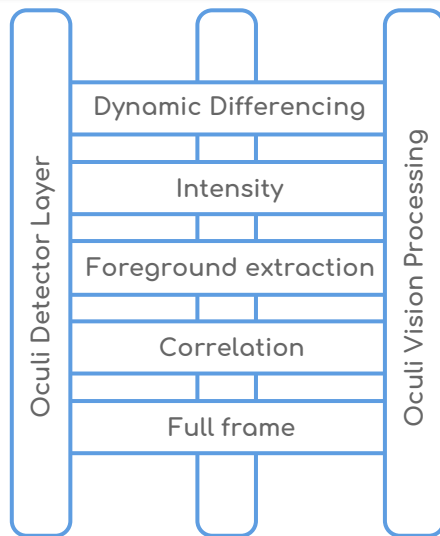
The Oculi SPU™ is a <u>versatile chip incorporating software-defined features</u> that can be configured to only extract the relevant features from the scene.



| FULL FRAME | SMALL DIFFERENCES | SMALL INTENSITIES |
| --- | --- | --- |
| LARGE DIFFERENCES + SURROUNDING PIXELS | LARGE DIFFERENCES | LARGE INTENSITIES |

# FULL FRAME GENERATION FROM EVENTS IN REAL-TIME

**Real-time**　**Low Bandwidth**

**Low Power**　**Low Processing**



Oculi SPU Smart Events @1kHz

Full Frame @1kHz

The output of the SPU™ is a fully formed signal that is <u>compatible with standard AI algorithms and general-purpose processors.</u>

The Oculi technology is a novel vision architecture that is <u>agnostic to both the sensing modality on the front-end and the post-processing that follows.</u>

# OCULI SPU™ CAN DETECT ULTRA-FAST MOTION AND ENABLE FAST REACTION TIMES



Flash: 1
Time: 0.5462 seconds
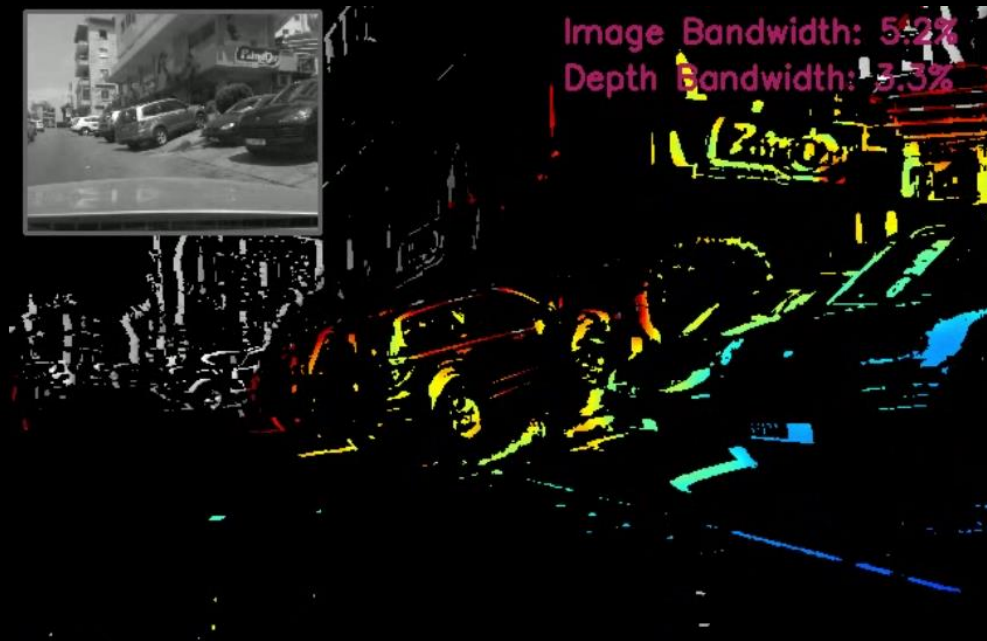Bandwidth: 0.36%
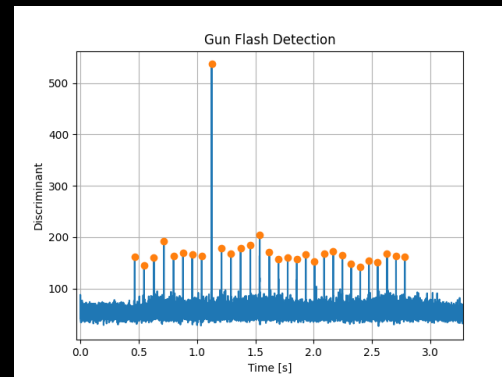


Raw output of the SPU™

## Oculi SPU™

✅ Continuous real time gun flash tracking

✅ Sampled entire scene @ >30kHz

✅ Ran with < 300mW

## Military Grade System

❌ Could not keep up with continuous fire

❌ Required server rack

❌ Required 5kW power generator

# OCULI SPU™ IS FITTED WITH FusionSensor™ TECHNOLOGY

# BACKGROUND

REAL-TIME VISION INTELLIGENCE AT THE EDGE WITH SOFTWARE-DEFINED FEATURES

> 30x more efficient than alternatives

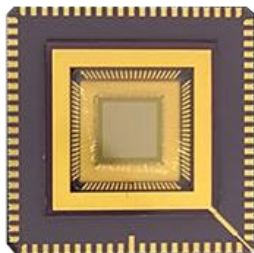18 years of R&D at Johns Hopkins University

Unique and patented SPU™ technology

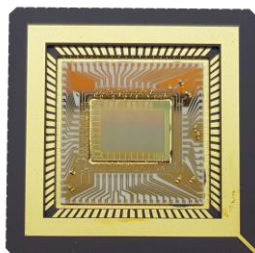World class expertise in BionicVision™ for machines

# OCULI SPU™ PRODUCT LINE



| | S11 | S41 |
|---|---|---|
| Resolution | 127 x 127 pixels | 480 x 320 pixels |
| Pixel Size | 40 x 40 um | 15 x 15 um |
| Fill Factor | 78.7% | TBD |
| CMOS Technology | 90 nm | 32 nm |
| Active Area | 5.1 x 5.1 mm | TBD |
| Pixel Clock | Up to 24 MHz | Up to 40 MHz |
| Supply Voltage | 1.2 V | 1.8 V |
| Power Consumption | 20 - 300 mW | 5 - 300 mW |

## REAL-TIME VISION INTELLIGENCE AT THE EDGE WITH SOFTWARE-DEFINED FEATURES

- **IntelliPixel™**: In-pixel digital processing reducing external post-processing

- **Versatile multimodal technology**: event, smart event, frame, signal

- **Agnostic** to both the sensing and post-processing

- **Single chip mimicking eye+brain**: Industry's closest neuromorphic architecture to human vision

# OCULI P11B VI PLATFORM
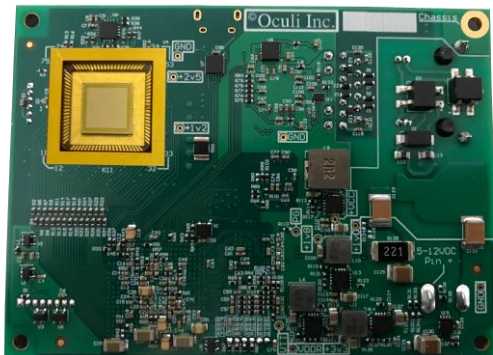


| | |
|---|---|
| Host Connection | Ethernet |
| GPIO | Configurable I/O pins |
| Clock | Input through GPIO |
| Removable Media | Up to 32GB, data logging & recording |
| Companion Processor | Xilinx SoC |
| Input Voltage | PoE / 5V, 2A Power Supply |
| Power Consumption | 2.5W (typical) |
| Operating Temperature | -25°C to +85°C |
| Dimensions | 85 x 62 x 22 mm |

# SOFTWARE TOOLKIT

## GUI
Interactive User-Friendly Application

## CLI
Comprehensive Command-Line Application

## SDK
Libraries, codes samples, and documentation

# REAL-TIME VISION INTELLIGENCE AT THE EDGE WITH SOFTWARE-DEFINED FEATURES

## THANK YOU !

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