

Development of Event-based Sensor and Applications

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Omnivision Sensor Solutions (Shanghai) Co. Ltd
(former name: CelePixel Technology Co. Ltd)

Jun 2021

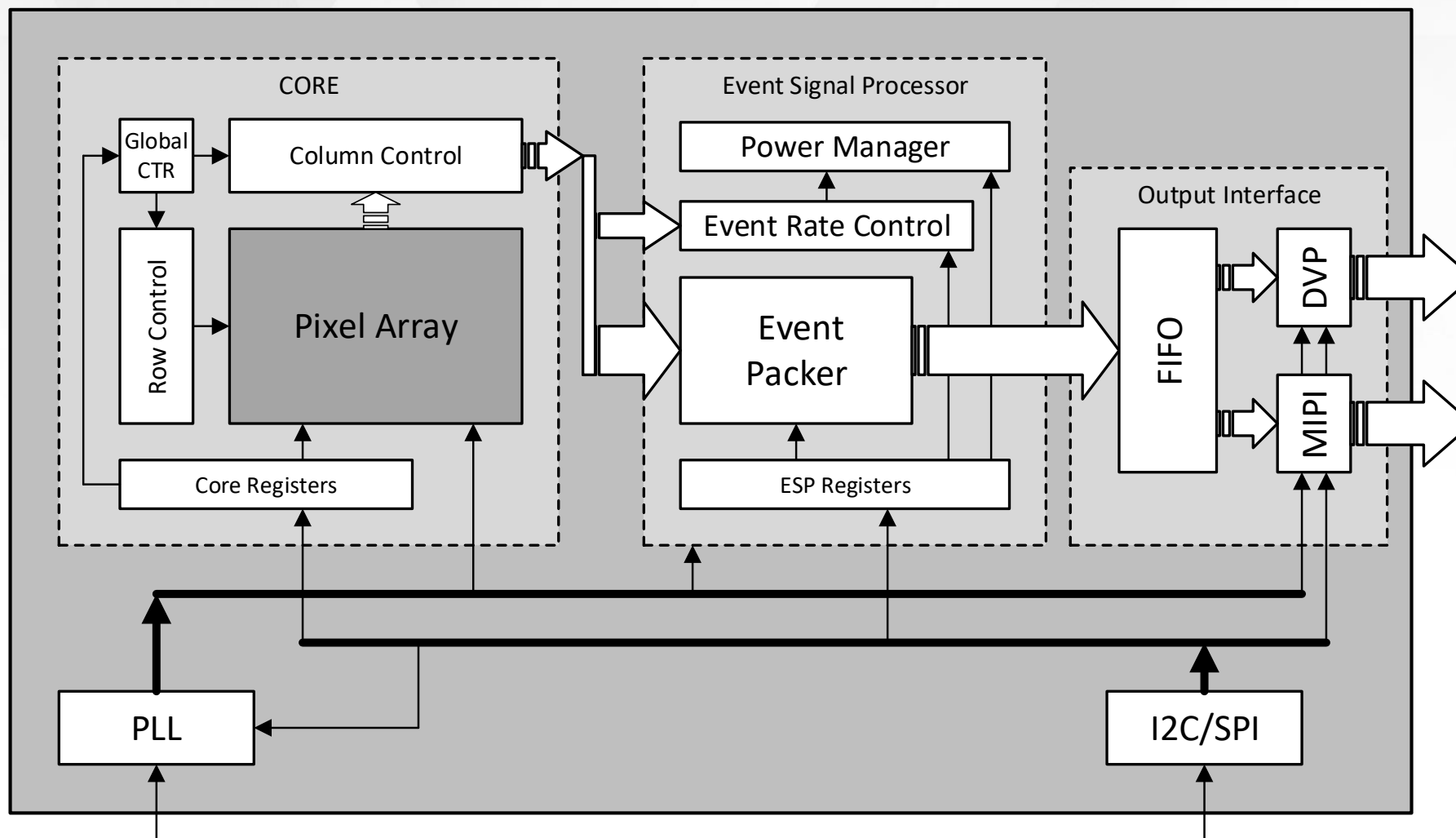
Outline

- ✓ Status on EVS development
 - Overview, key features
 - Time-stamp accuracy in EVS
- ✓ Application development
- ✓ Conclusion

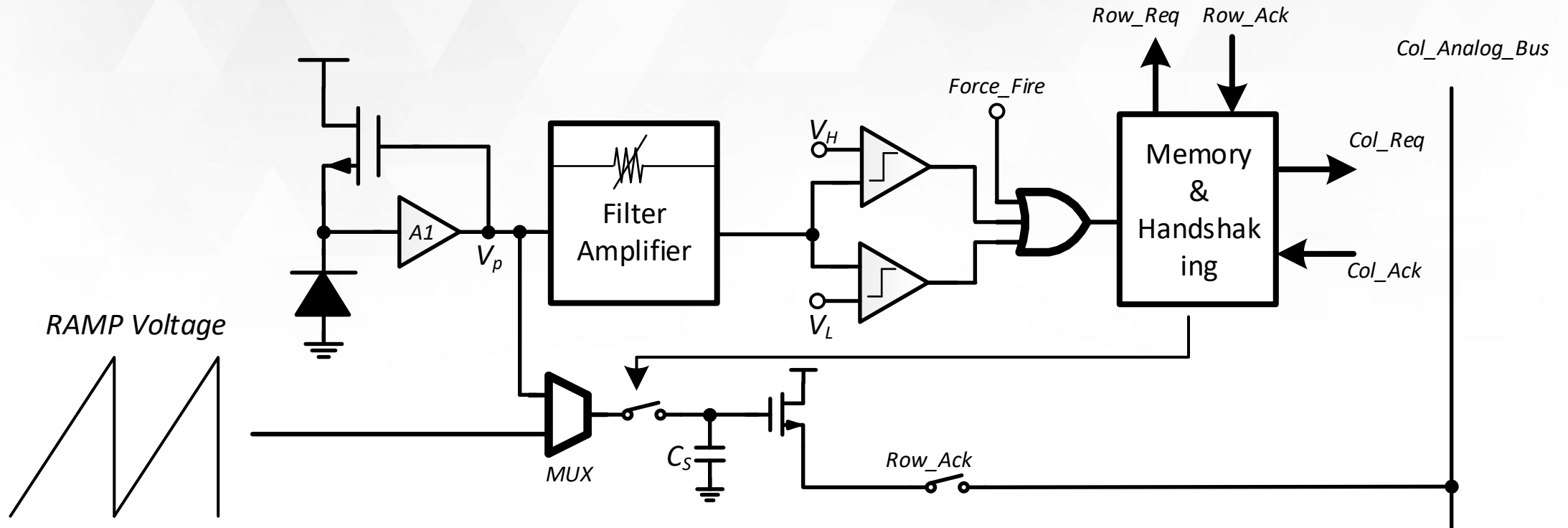
CeleX-Family Sensors

	CeleX-IV	CeleX-V	CeleX-VI
Resolution	768 x 640	1280 x 800	1920x1080
Process	0.18um	65nm	65nm 3D Stack
Pixel Size	18 x 18 um	9.8 x 9.8 um	5.6 x 5.6 um
Max Readout	200 MEPS	100 MEPS	200 MEPS (1G EPS @ extreme scenario)
Operation Mode	Motion mode (in/off pixel time-stamp) Log-intensity full-pic mode Optic flow mode		Motion mode (off pixel time-stamp)
Dynamic Range	Motion mode > 120dB Picture mode > 120dB		Motion mode > 120dB
New Features	1) Picture mode use logarithmic direct readout; no need exposure time, (X,Y,A,T) event packet; (A) and (T) always matched; high dynamic range. 2) On-chip optical flow 3) In-pixel time-stamp		1) Event rate control 2) Advanced power management

Sensor Architecture



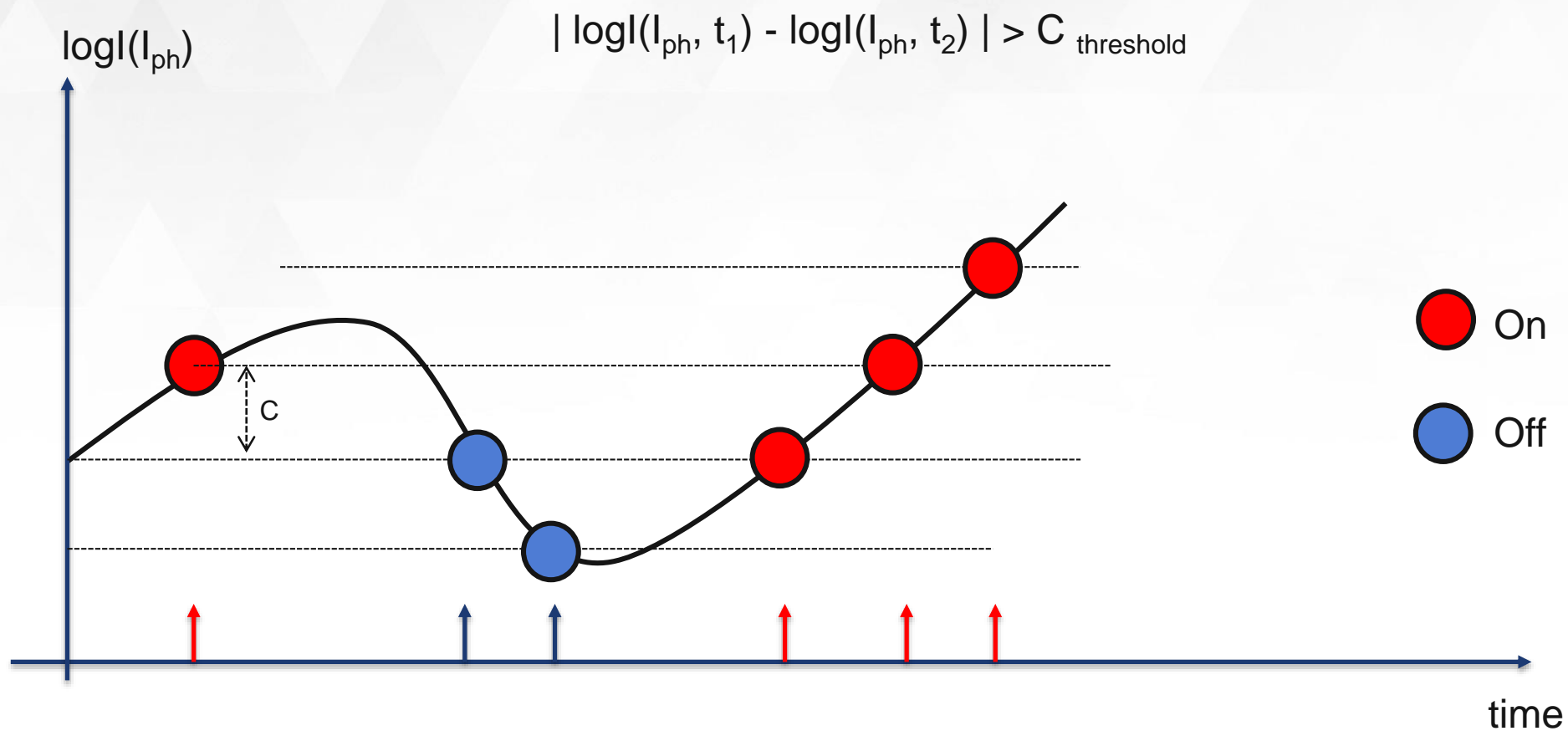
CeleX-5 Pixel Overview



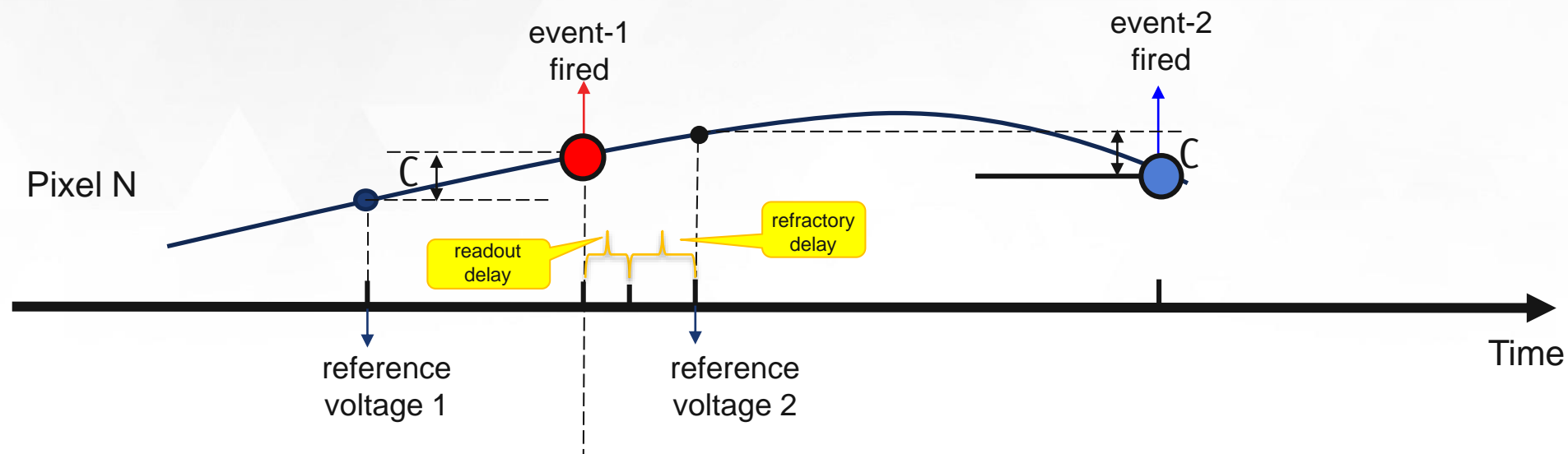
Features:

- 1) Log intensity frame (un-conditional readout all pixels)
- 2) Log intensity event (X,Y, A, T)
- 3) In-pixel time stamp

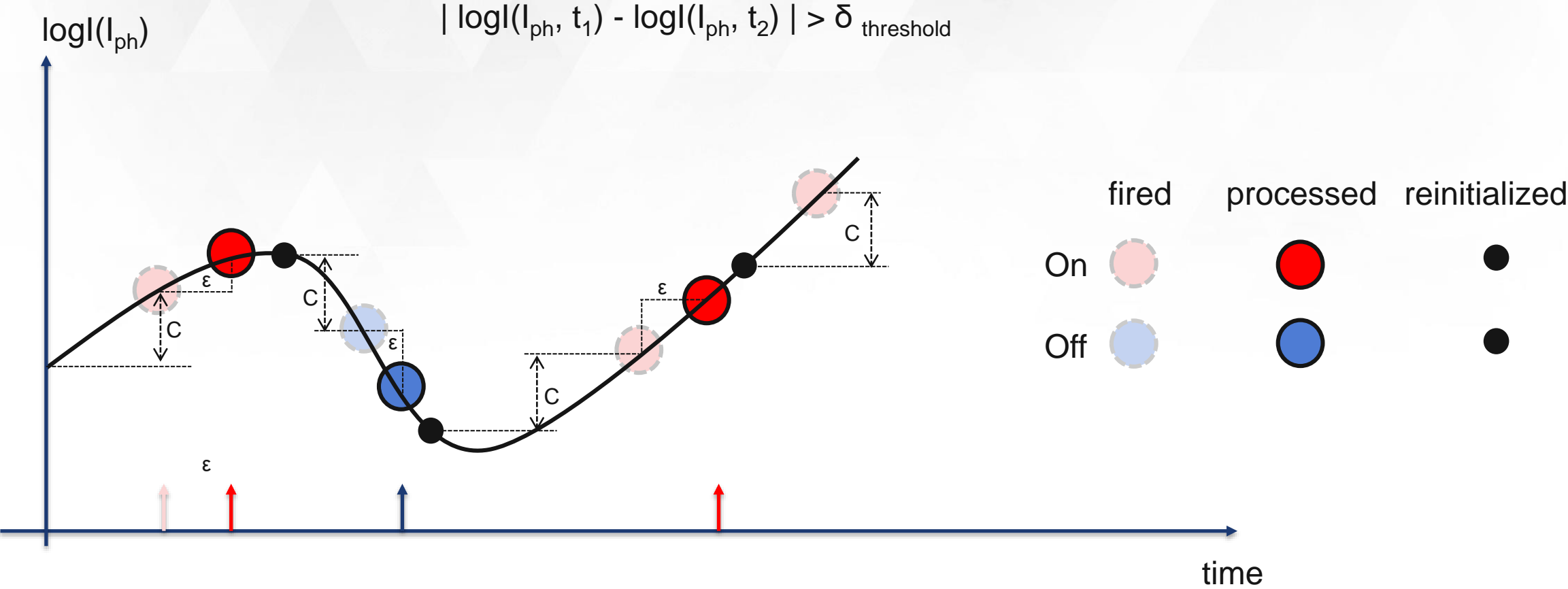
Ideal Event Model



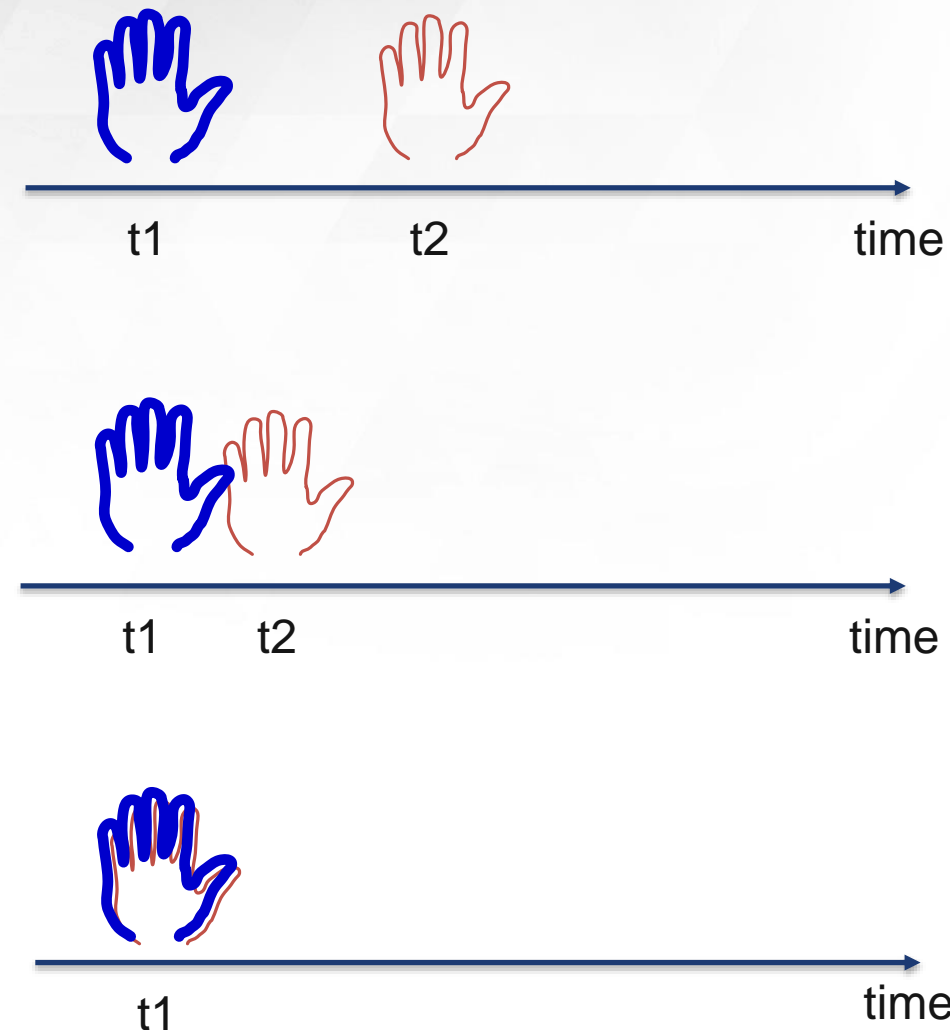
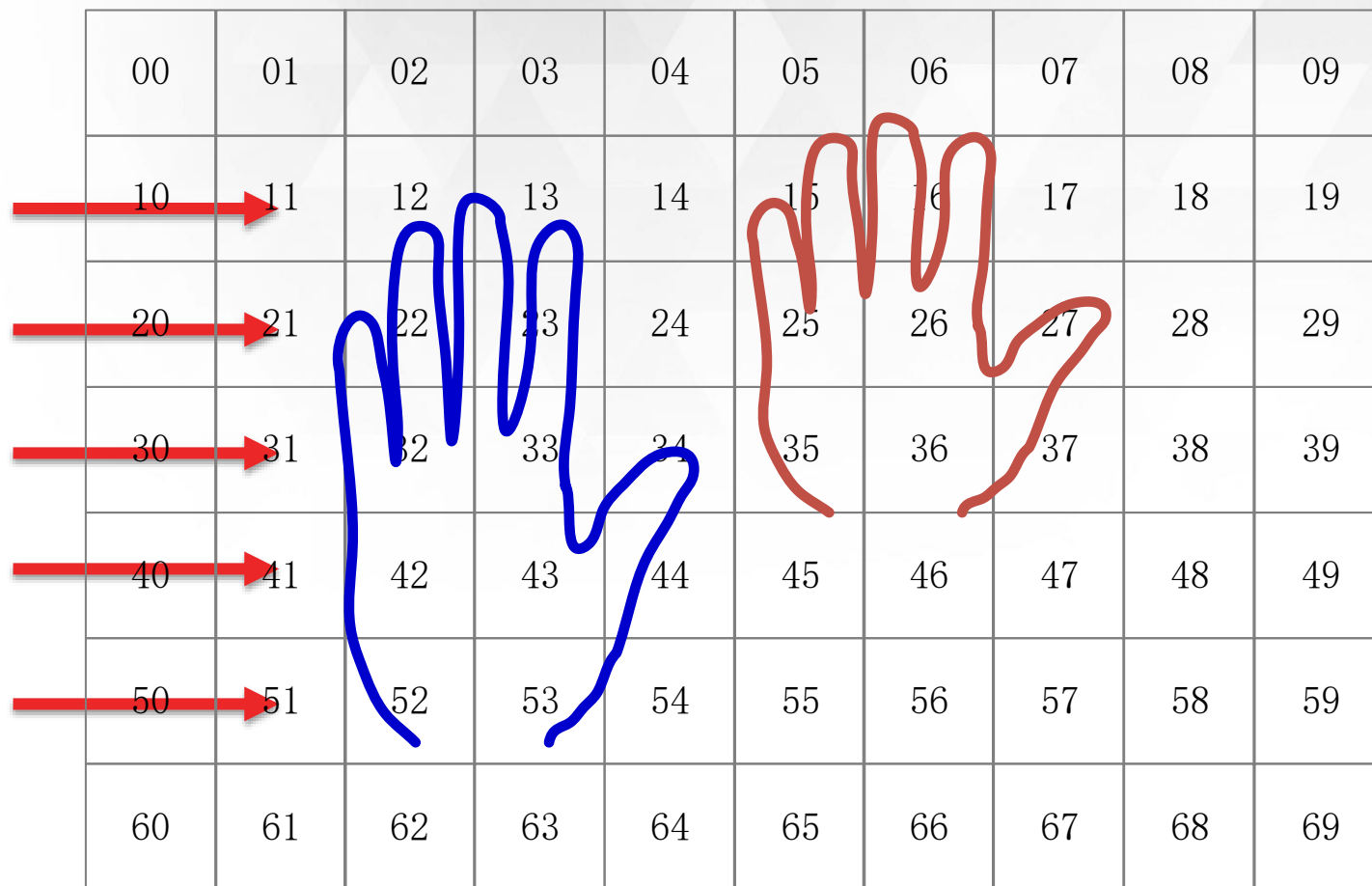
Ideal Event Model



Real Event Model



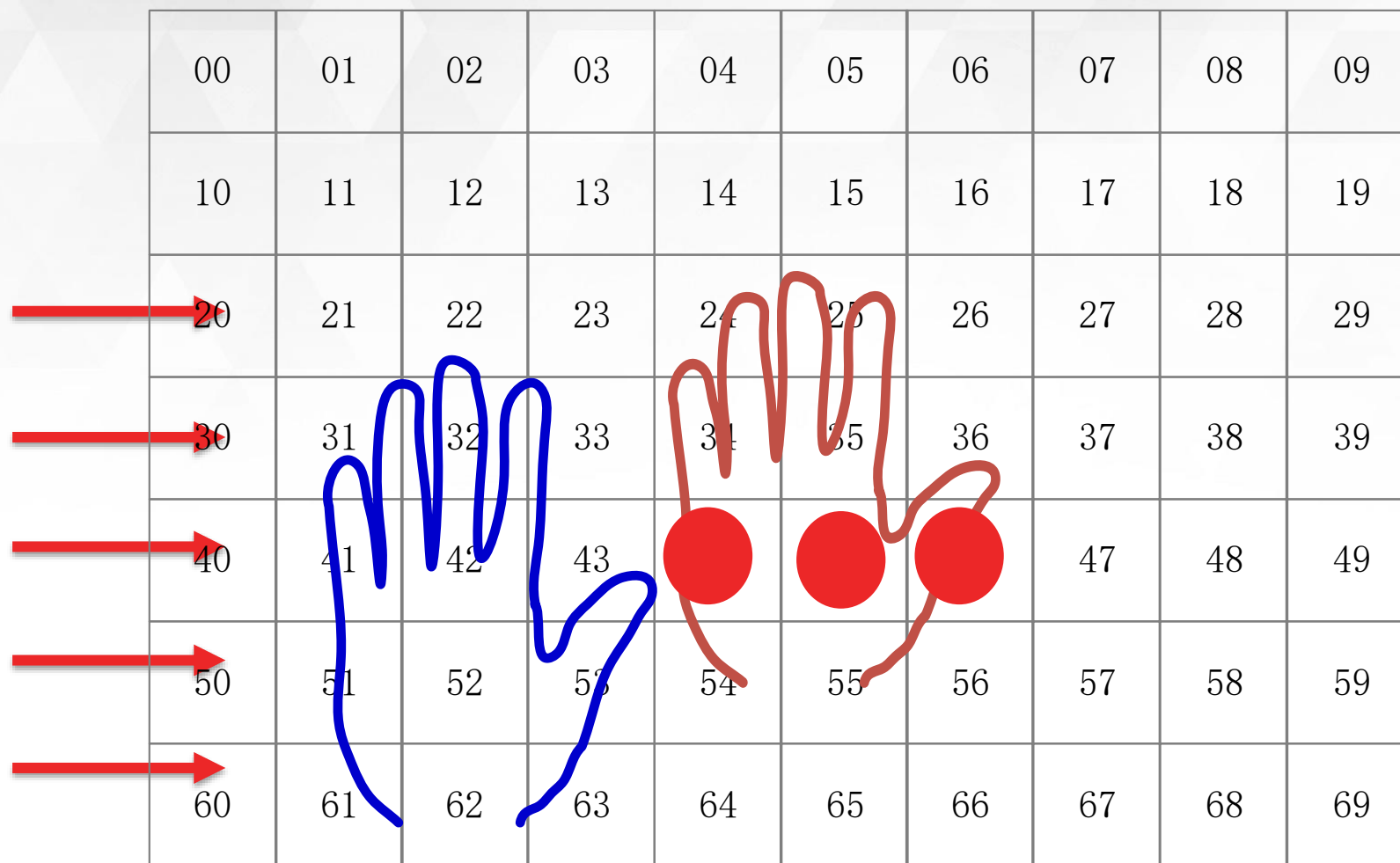
Time-stamp Accuracy



Time-stamp error

- event detection, depends on light intensity
- readout latency, depends on scene activity, readout speed, readout method

Time-stamp Accuracy



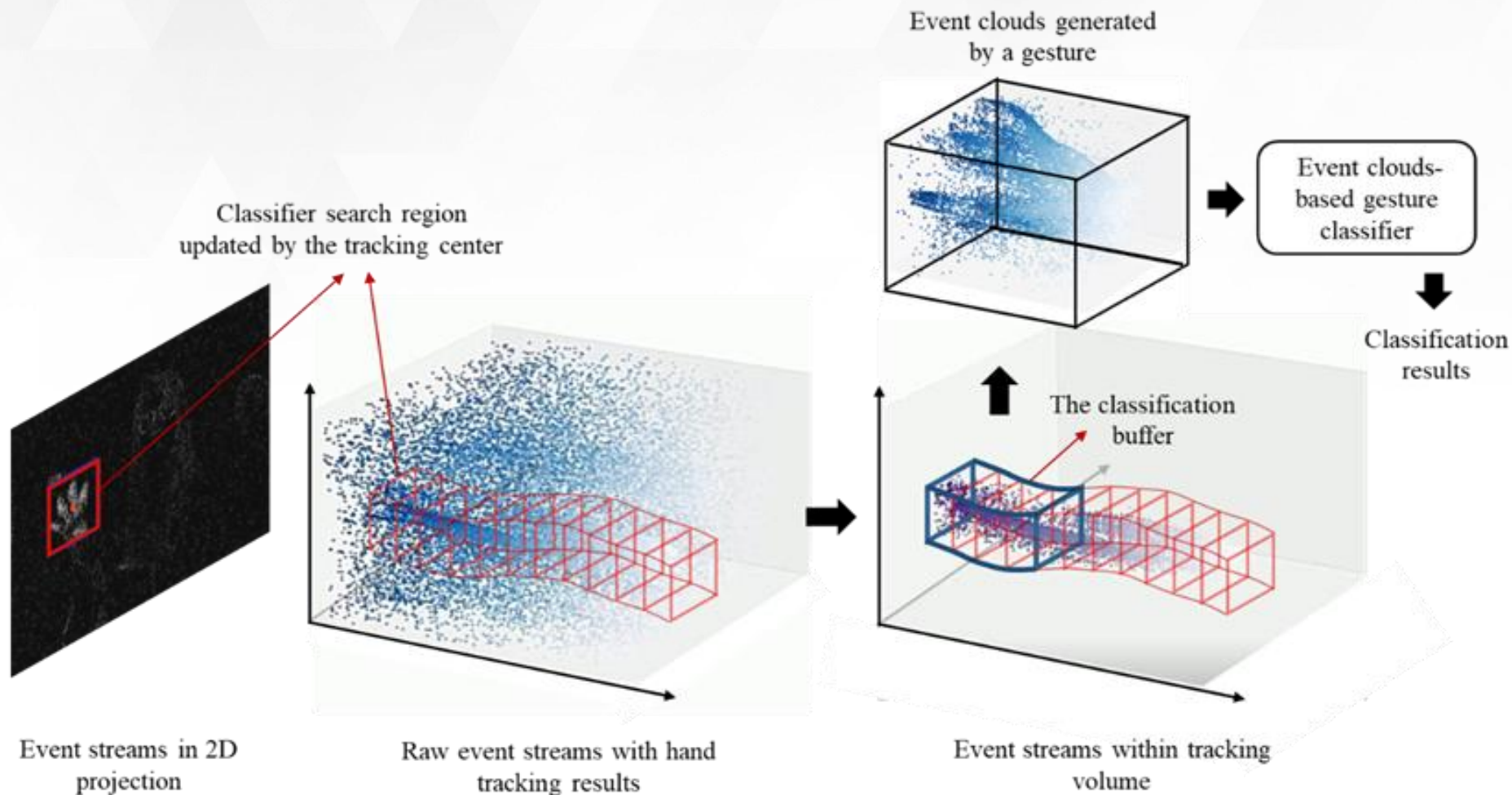
For better accuracy

-- faster readout speed

-- sequential scanning (vs. random scanning)

A Portable Event-Driven HCI System

- This is a portable real-time HCI system for edge computation.
- Fully event-driven solution achieves extremely low latency and low computational cost.



Temporally Ordered Space-time Event Clouds (ST-EVNet)

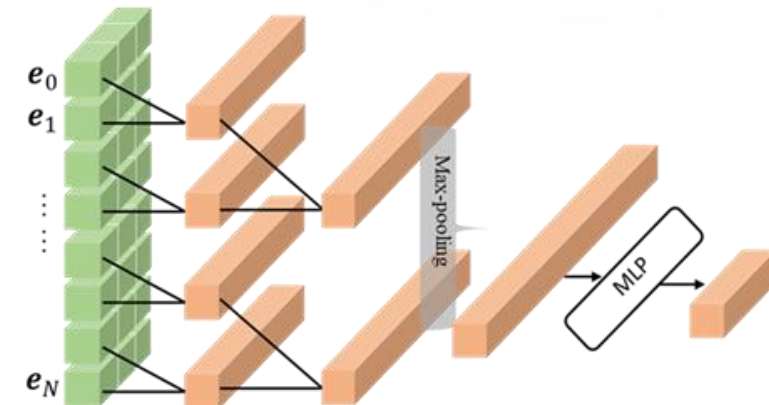
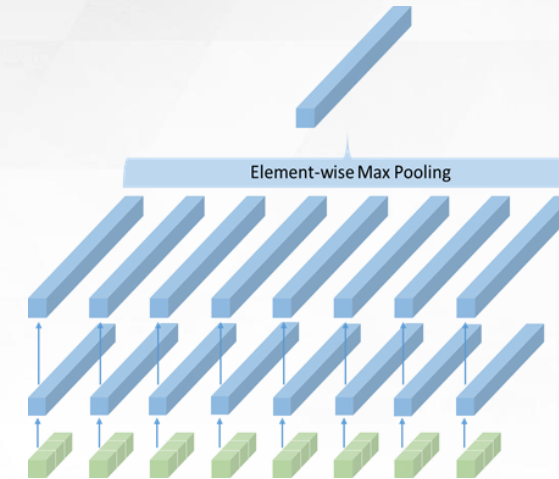
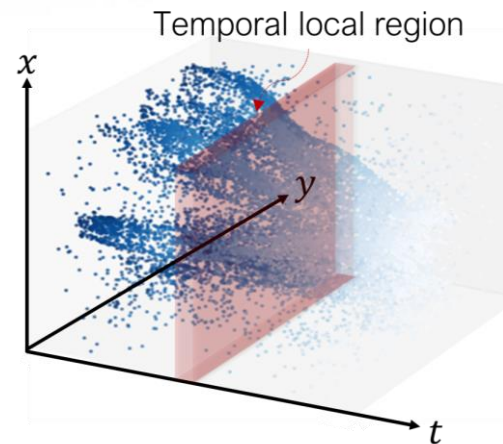
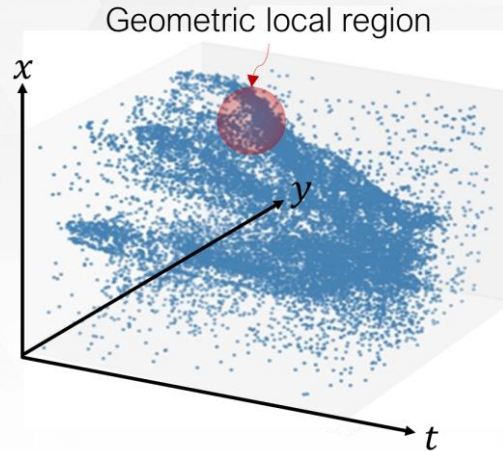
Unorder set of 3D
space-time events

$$S^T = \{e_i | t_i \in T, i = 1, 2, \dots, N\}$$



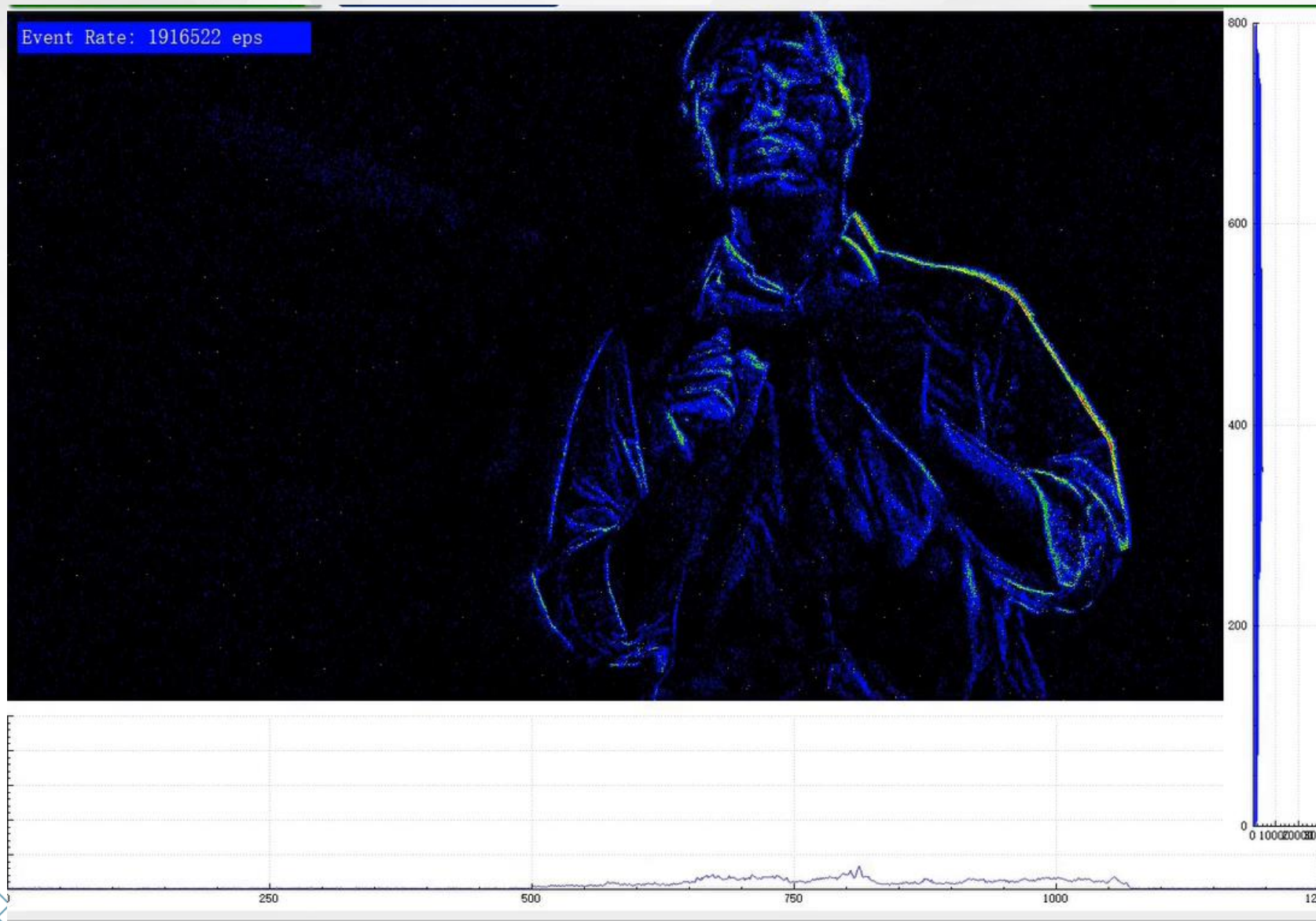
Temporally ordered 3D
space-time events

$$G^T = (e_i)_{i=1}^N = (e_1, e_2, \dots, e_N)$$

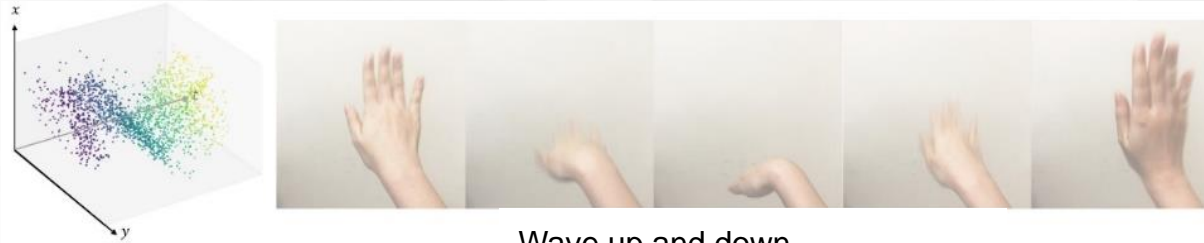


Wang, Qinyi, et al. "Space-time event clouds for gesture recognition: From RGB cameras to event cameras." 2019 IEEE Winter Conference on Applications of Computer Vision (WACV). IEEE, 2019.

Tracker based on Maximum Event Density



Real-time Gesture Control



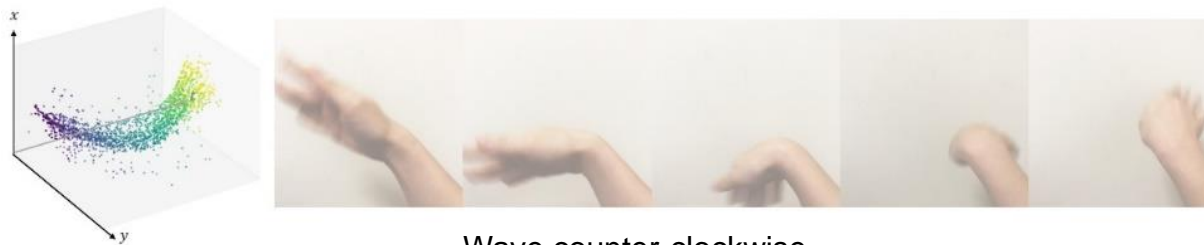
Wave up and down



Wave left and right



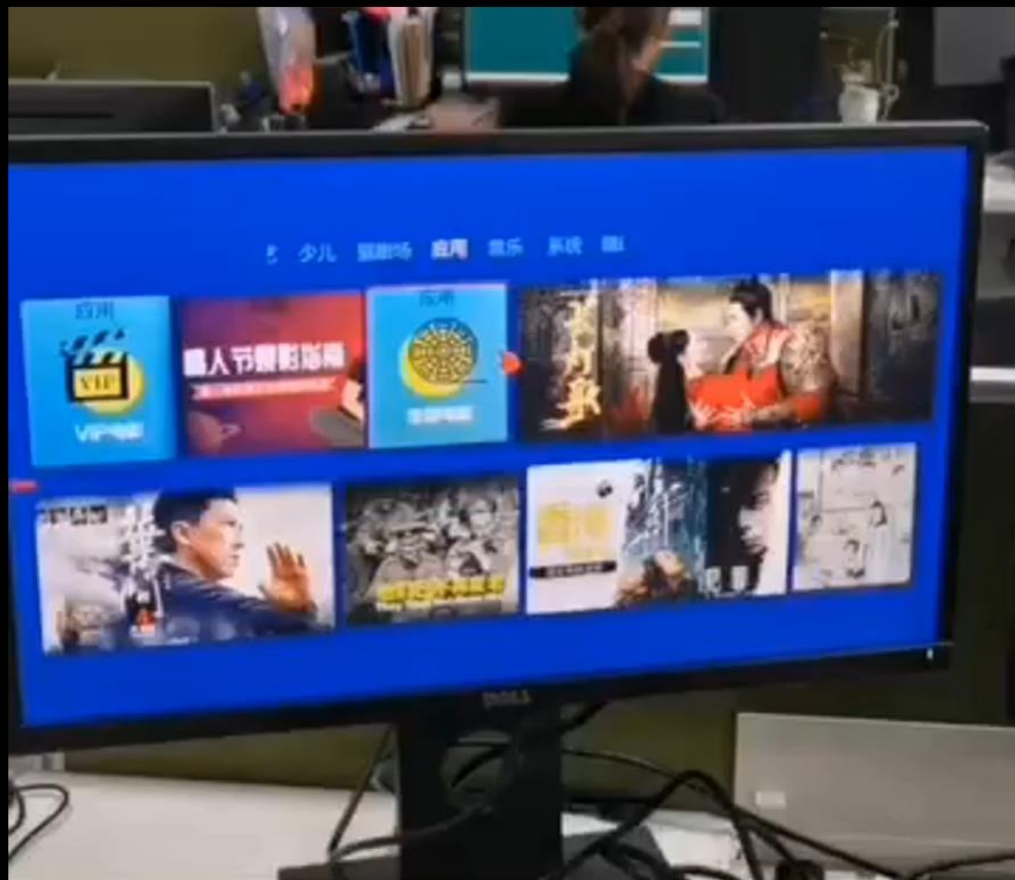
Wave clockwise



Wave counter-clockwise

Gesture	Accuracy
Wave up-down	0.923
Wave left-right	0.99
Wave clockwise	0.98
Wave counter-clockwise	0.982
Others	0.939

Real-time Gesture Control - Demo



Camera A



Camera B

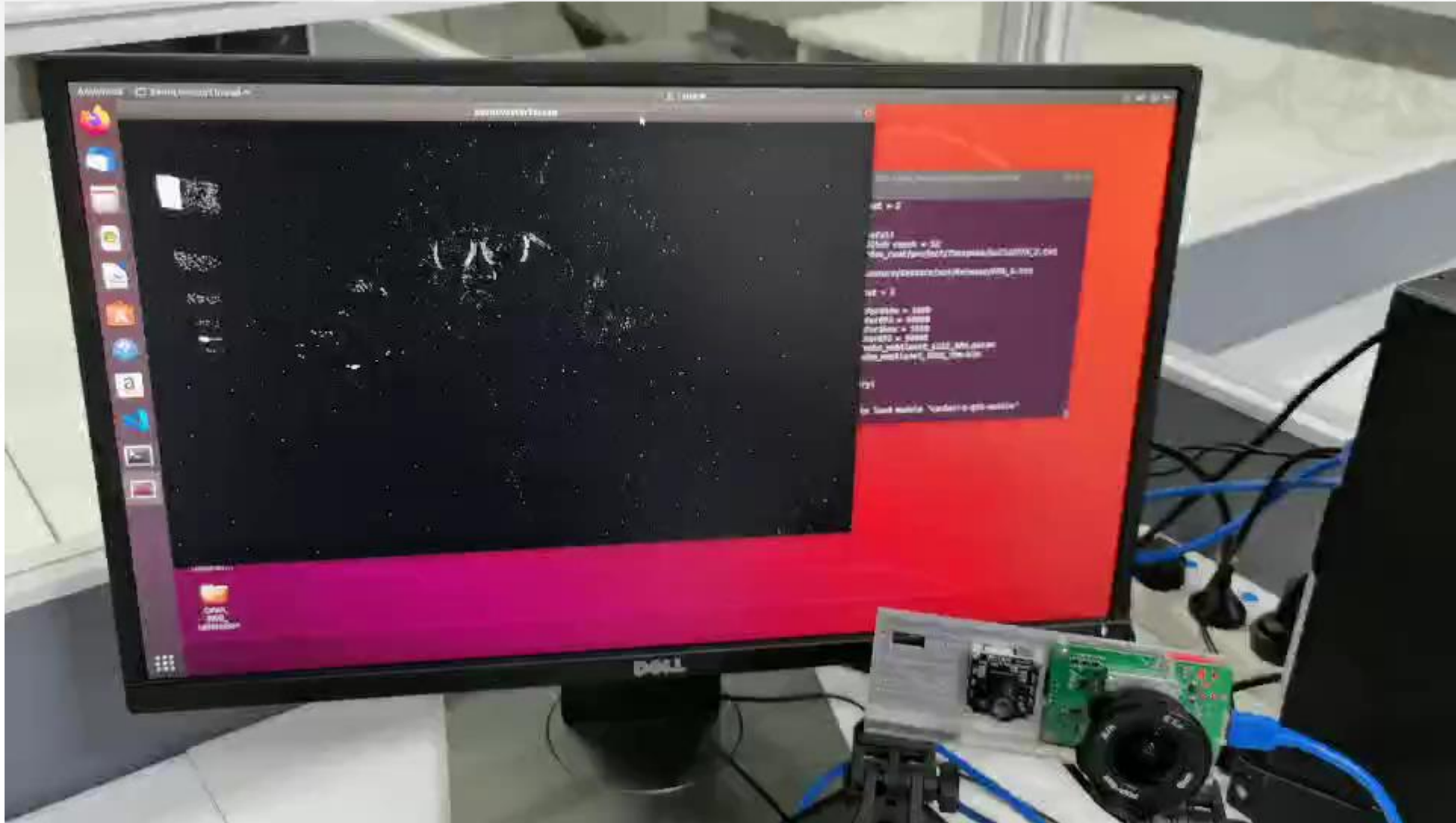
Wave up-down to enter a program.

Wave left-right to quit a program.

Wave counter-clockwise to awake a hidden menu.

Wave clockwise to awake a volume bar.

Attention Assessment System with EVS and CIS Data Fusion



Thank you

For inquiries on evaluation kit, please contact evs_sample@ovt.com