Simultaneous Recording of Cortical Spikes

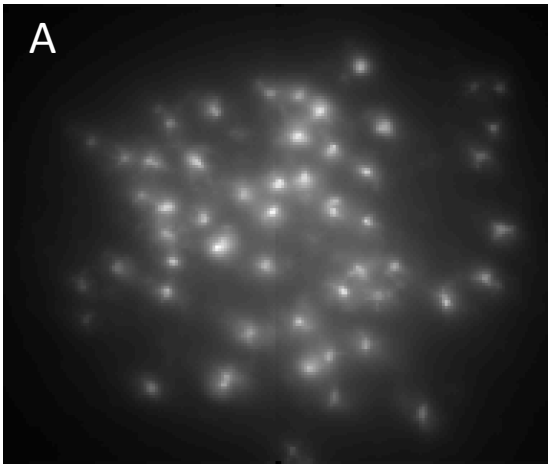
Using

GEVI Voltron and DaVinci-1K Camera

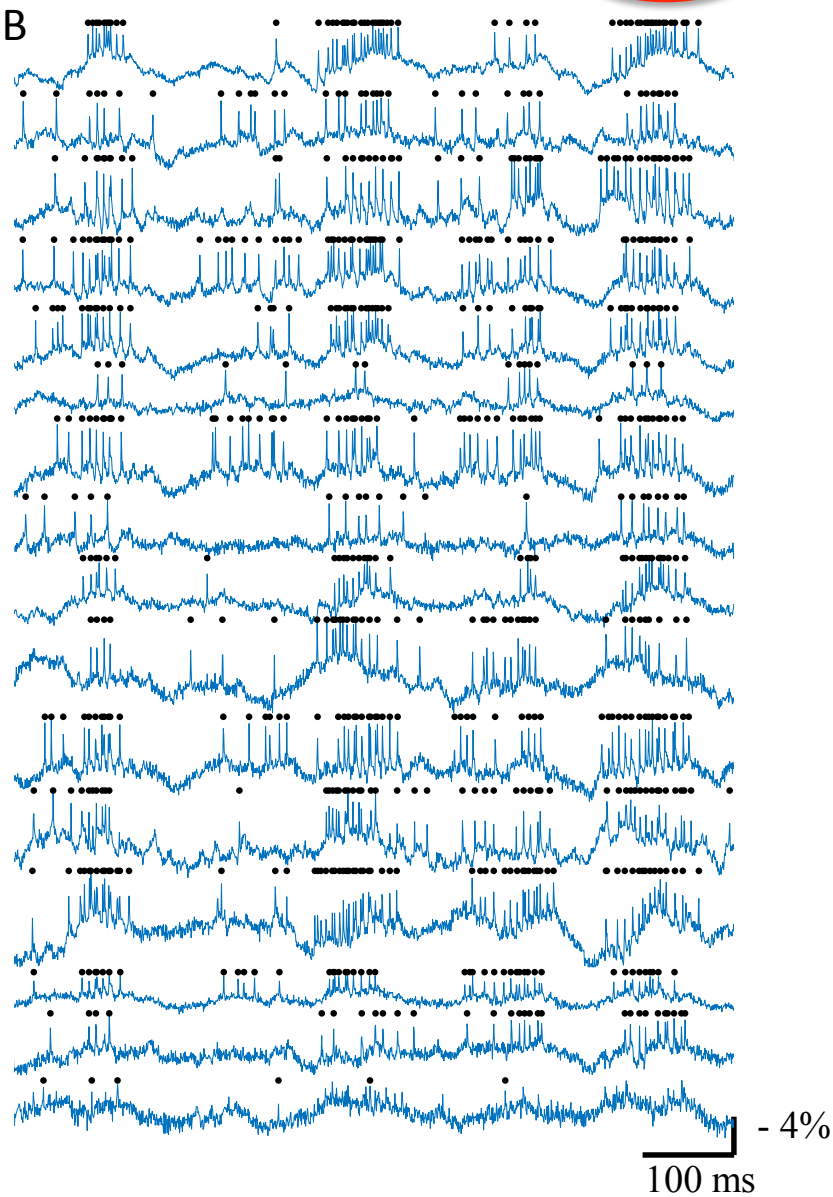
From

Many Cells in a Large Field

2kHz!



1.4 mm



(A) CA1 parvalbumin neurons expressing Voltron imaged at 2kHz *in vivo* (Davinci 1k, CDSBIN2 mode)

(B) Example fluorescence signals of simultaneously imaged cells

SFN2019 Poster 336.11

In vivo imaging of membrane potential dynamics in populations of hippocampal interneurons during network oscillation

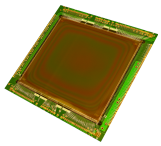
Yi-Chieh Huang, Bei-Jung Lin, Tsai-Wen Chen, National Yang-Ming University, Taipei, Taiwan

Reference: Abdelfattah et al (2019) *Science* 16 Aug 2019: Vol. 365, Issue 6454, pp. 699-704

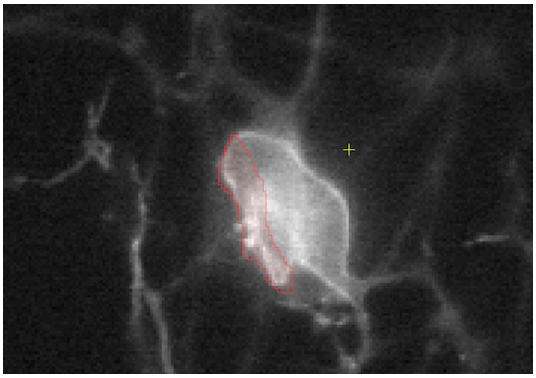
ULTIMATE SOLUTION FOR
HIGH SPEED ACTIVITY IMAGING

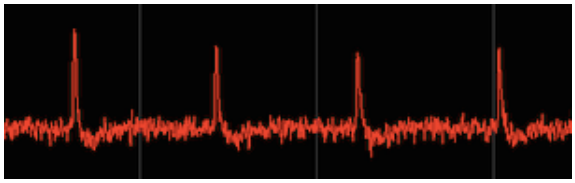
LIGHT SHEET MICROSCOPY ◆ VSD & ION IMAGING ◆ TIRF IMAGING ◆ MOLECULE TRACKING

DaVinci-1K CMOS Camera



- **High Speed**
  - >400fps NDR, 200fps CDS at 1024x1024
  - >1280fps NDR, 640fps CDS at 512x512-bin2
  - >2,000fps NDR, 1,000fps CDS at 512x320-bin2
  - 2500fps NDR, >1000fps CDS at 1024x180 & more
- **On-chip Bin** - Unique true on-chip binning with 15Ke$^-$ well depth and 65Ke$^-$ at 2X2 binned.
- **Low Noise** - 2.8e- read noise without pixel correction
- **High QE** - 65% without micro- lenses, 15um pixel with high MTF
- **Monotonic** - Single A-D per channel, no dual-A-D stitching
- **NDR Mode** - Double the maximum speed with over-sampling that offers significant advantages for post-analysis

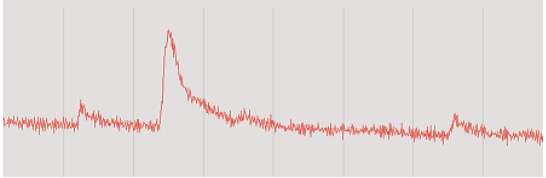




AP from dorsal root ganglion neurons
(ASAP-1, 2000 fps, Single Trial)
Courtesy of Dr. Laurent Ferron and Professor Annette Dolphin of UCL, UK

How do we achieve better uniformity and linearity, and higher speed than sCMOS?

- Off-chip CDS – Correlated Double Sampling subtraction is performed after amplification and digitization.
- Single A-D converter – One A/D per channel instead of two A/Ds per column, no stitching of two different A-D converters, therefore monotonic and more linear output.
- Large pixels & no micro-lenses for higher MTF – better pixel QE.
- Unique NDR (Non-Destructive Read) mode more than doubles the readout speed.
- On-chip binning (2X horizontal, >64X vertical) significantly increases frame rate and well size.



Spontaneous Calcium Sparks
from disassociated rabbit cardio myocytes
(Frame Interval: 2 msec, Single Trial)
Courtesy of Dr. Smith of U. Glasgow, UK

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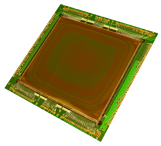
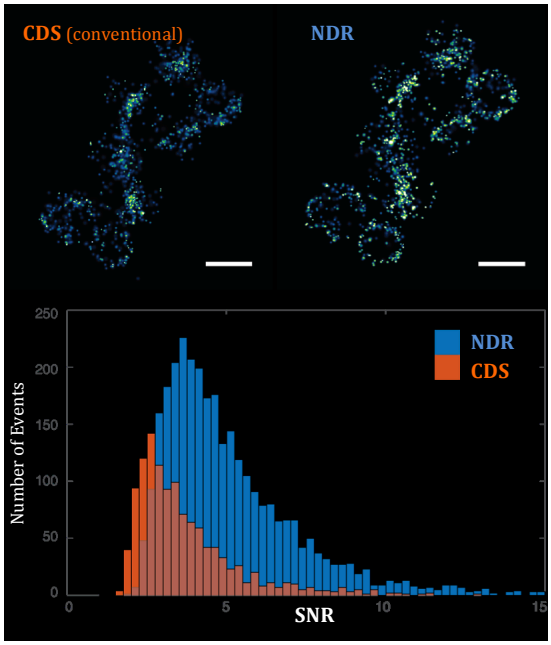
ULTIMATE SOLUTION FOR
SUPER RESOLUTION MICROSCOPY

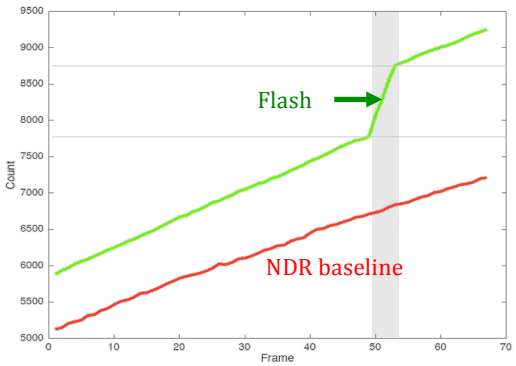
LIGHT SHEET MICROSCOPY ◆ VSD & ION IMAGING ◆ TIRF IMAGING ◆ MOLECULE TRACKING

DaVinci-2K CMOS Camera



- **High Speed**
  - >200fps NDR, 100fps CDS at 2048x2048
  - >400fps NDR, 200fps CDS at 2048x1024
  - 1000fps NDR, >400fps CDS at 2048x456
  - 2500fps NDR, >1000fps CDS at 2048x180 & more
- **On-chip Bin** - Unique true on-chip binning
- **Low Noise** - 2.8e- read noise without pixel correction
- **High QE** - 65% without distorting micro-lenses (15um pixel)
- **Monotonic** - Single A-D per channel, no dual-A-D stitching
- **NDR Mode** - Double the maximum speed with over-sampling that offers significant advantages for post-analysis





Data courtesy of Sam Barnett and Dr. Ashley Cadby at Sheffield University UK, and Cairn Research.

Advantages of NDR for STORM imaging at high frame rate:

1. **2x SNR, >3x events** detected within the same time period.
2. Acquire 10,000 frames in 4 seconds rather than minutes.
3. Less laser suppression is needed, less bleaching.
4. Greatly reduced sample drift.

How do we achieve better uniformity and linearity, and higher speed than sCMOS?

- Off-chip CDS – Correlated Double Sampling subtraction is performed after amplification and digitization.
- Single A-D converter – One A/D per channel instead of two A/Ds per column, no stitching of two different A-D converters, therefore monotonic and more linear output.
- No micro-lenses for uniform and flat image.
- Unique NDR (Non-Destructive Read) mode more than doubles the readout speed.

Why is it better than EMCCD?

- No square root of two shot noise penalty from Electron Multiplication (EM).
- No spurious charge artifact.
- Much higher frame rate.

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