

Towards a physically realistic computationally efficient DVS pixel model

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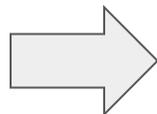
Tobi Delbruck

2025 International Image Sensor Workshop

Why do we need DVS models?

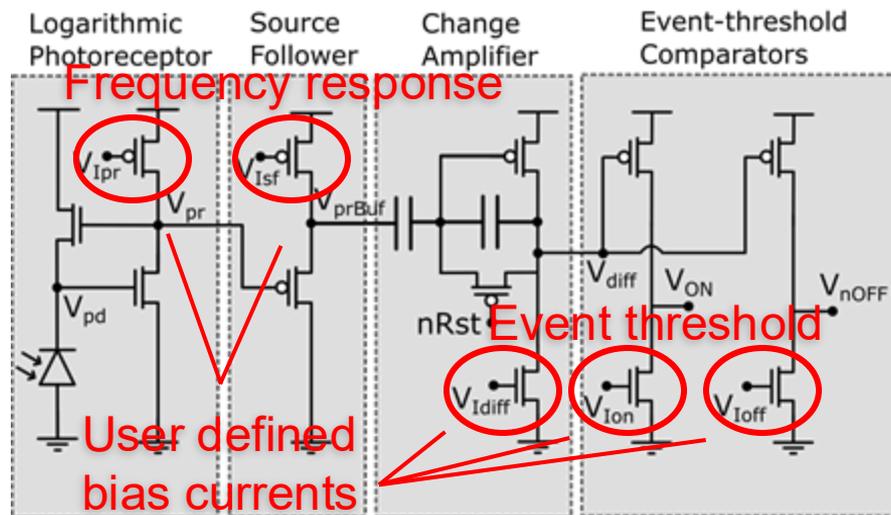
Models allow prediction of DVS response

Generation of simulated datasets



DVS event cameras generate **asynchronous events** instead of **periodic frames**

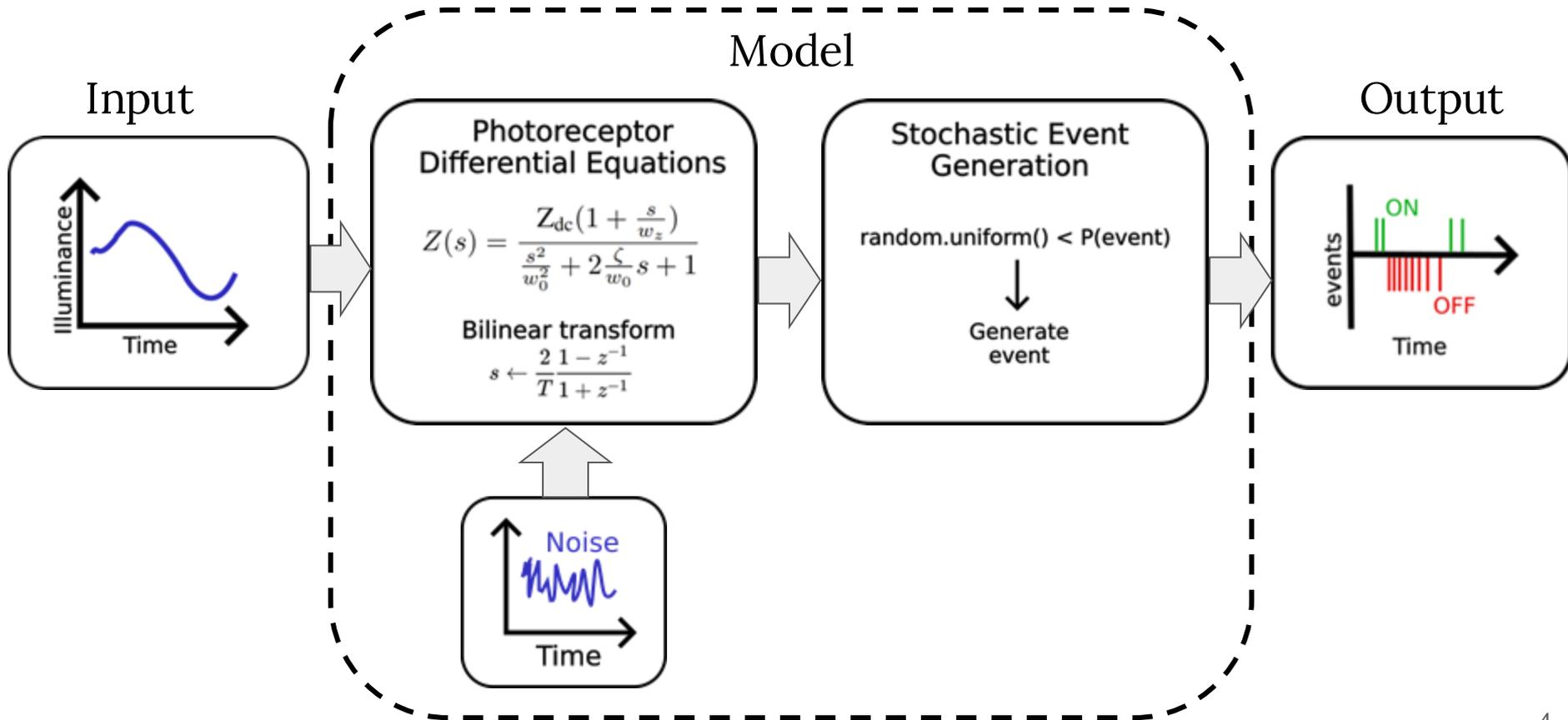
Off-line bias optimization



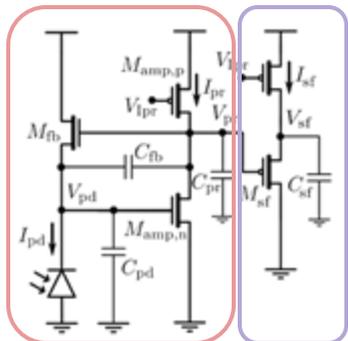
State of the art

Efficient models [v2e (2021), ESIM (2018)]	We want:	Physically accurate models [Suess et al. (2021)]
<ul style="list-style-type: none">● Fast enough to generate array-level data● Accurate enough for low-noise scenes	<ul style="list-style-type: none">● Enough accuracy for challenging conditions● Enough accuracy for bias optimization● Fast enough to generate array-level data	<ul style="list-style-type: none">● Accurate noise modelling● Accurate temporal response
<ul style="list-style-type: none">● Not accurate enough for challenging conditions● Not accurate enough for bias optimization		<ul style="list-style-type: none">● Too slow to generate array level data (require small timesteps)

Our DVS pixel model



Photoreceptor differential equations

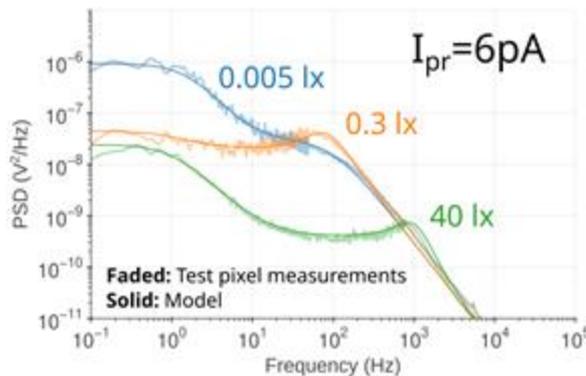
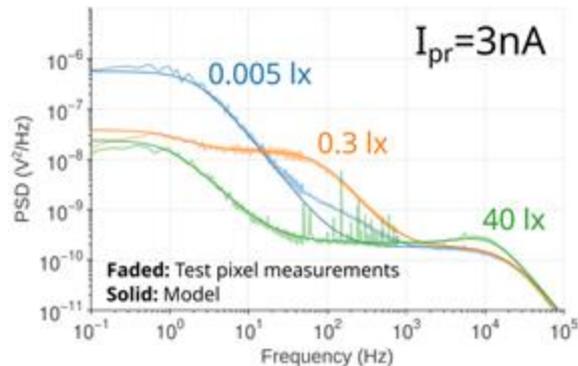


Photoreceptor

$$Z(s) = \frac{Z_{dc}(1 + \frac{s}{w_z})}{\frac{s^2}{w_0^2} + 2\frac{\zeta}{w_0}s + 1}$$

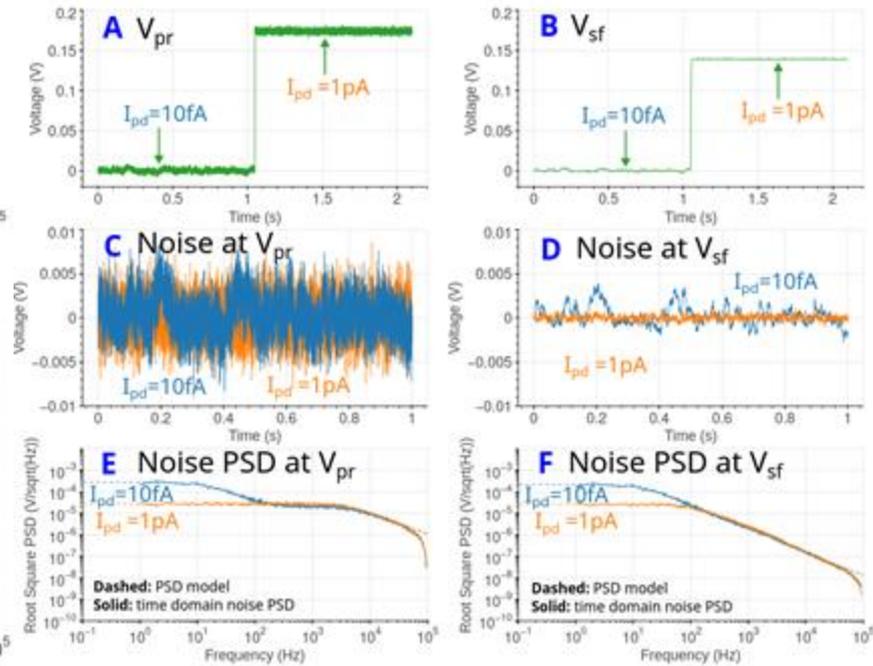
Source-Follower

$$A_{sf}(s) = \frac{K_{sf}}{1 + s\frac{C_{sf}}{g_{sf}}}$$



Transient simulation

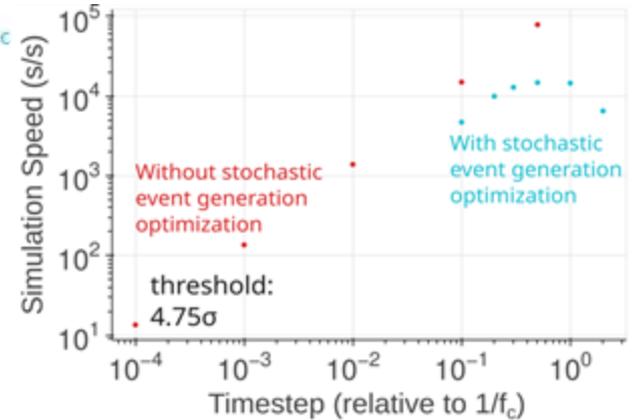
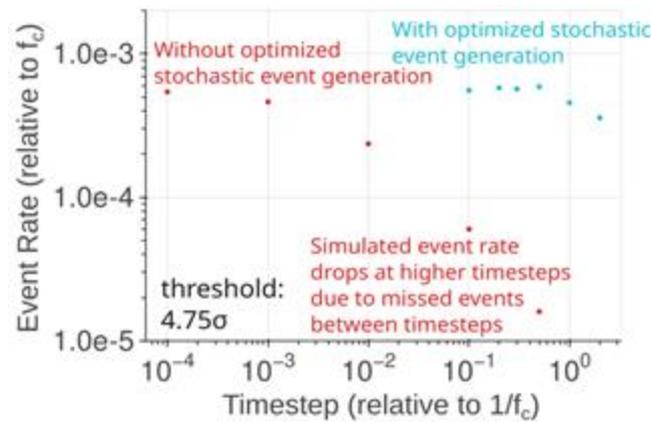
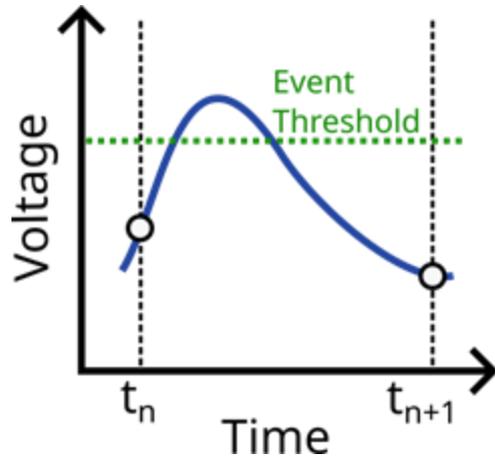
- Linearized at each timestep



Stochastic Event Generation

Large timestep can cause **missing events**

Our solution:
Probability of a **hidden event** calculated at each timestep



Thank you!



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