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# Event-Based localization with Spiking Neural Networks: How Much is needed ?

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# Event-Based localization with Spiking Neural Networks: How Much is needed ?

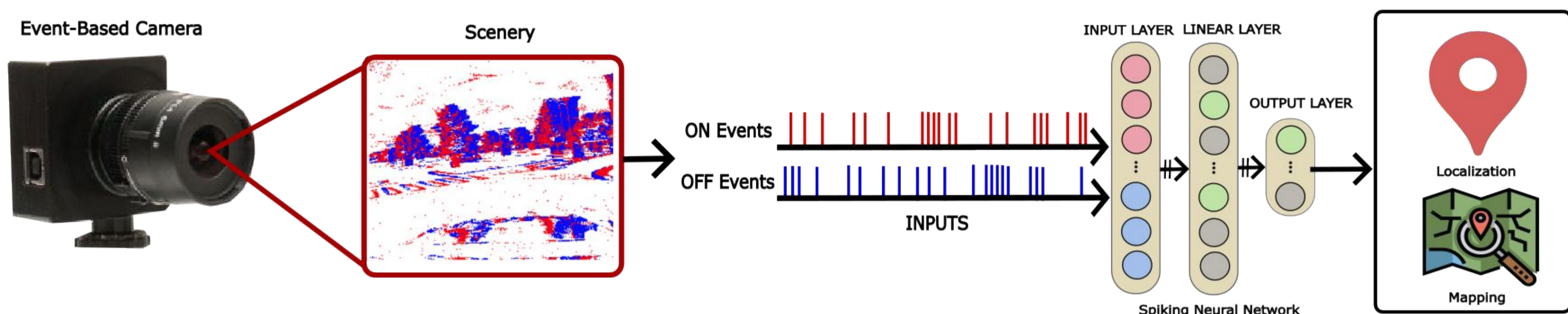
**Geoffroy Keime<sup>1,2</sup>, Nicolas Cuperlier<sup>1,3</sup>, Benoit R. Cottureau<sup>1,2</sup>**

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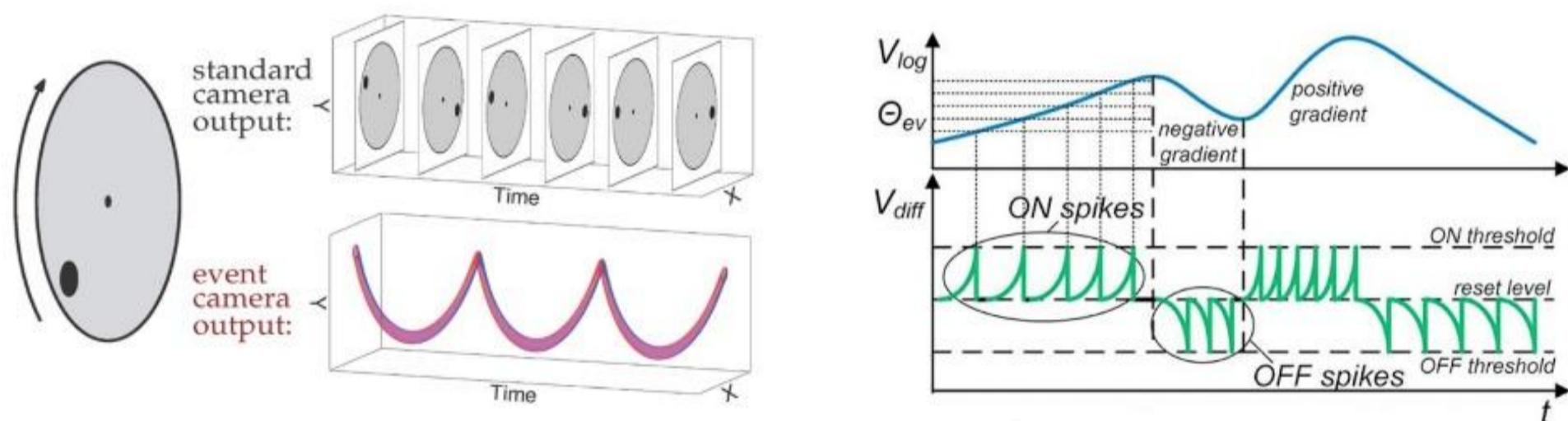
The aim of this project is to develop **bio-inspired** and **energy efficient** computational models for **navigation** in space. These models should be able to achieve **Visual Place Recognition (VPR)**, **Odometry** and finally **Visual Simultaneous Localization and Mapping (V-SLAM)** from **spiking neural networks (SNNs)** processing data collected by an **event-based camera**.

**Keywords:** Navigation, Event-based camera, Spiking Neural Network, Unsupervised learning, Bio-inspiration



**Hypothesis:** Our proposed architecture (SNNs with Events) can provide very good performances while only using a limited number of spikes.

## Event-based cameras

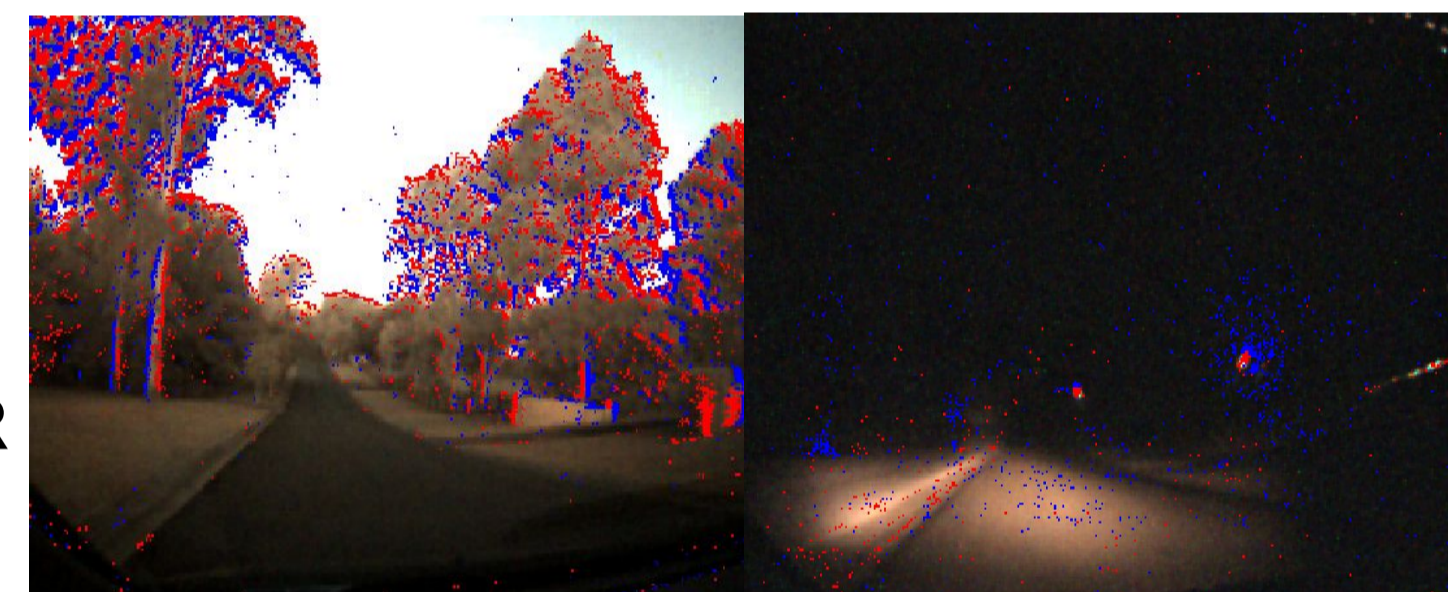


Send an event (**spike**) every time a luminance increment ('**ON**' event) or decrement ('**OFF**' event) is detected in the visual scene.

Very **high temporal resolution** ( $\sim 1\mu s$ ) and **robustness to motion blur**.

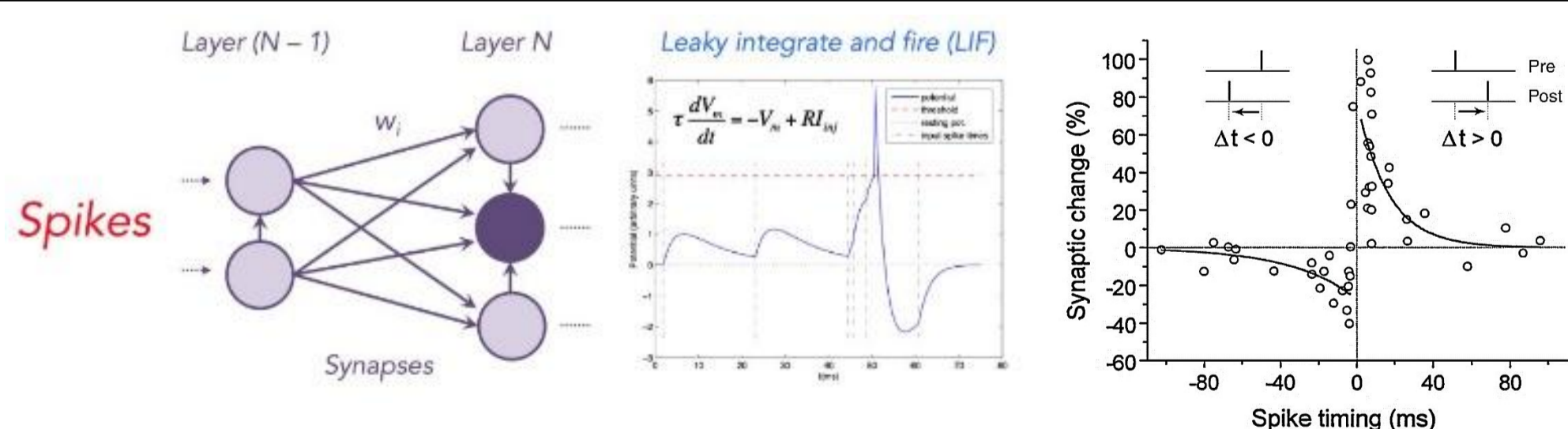
## Datasets

- MVSEC
- Nordland
- Brisbane
- NYC Event VPR



Event Based data captured during navigation with visual changes

## Spiking Neural Network



**Hierarchical Model with Leaky integrate and fire (LIF) neurons.** Unsupervised learning using an Hebbian plasticity rule: the **Spike Timing-Dependent Plasticity (STDP)**

## Preliminary Results on VPR

- **Unsupervised learning** with STDP using different places captured under **variable conditions** (seasons, weather...)
- Training leads to place-selective neurons but **validation on larger datasets is needed.**



Synaptic weights of one place-selective neuron after STDP learning (left) and associated place (right)

## ★ Take Home Message

We aim to develop an **energy-efficient** computational model for navigation based on SNNs processing event data. Preliminary results suggest that this model can achieve **very good performances** at VPR using a **limited number of spikes**.

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## What's Next?

- Finalizing VPR with SNN and Events (**Tests + Validation on different datasets**)
- Comparisons with **neurobiological data** (place cells, conjonctive neurons...)
- Add **Optical Flow** and **Odometry** (event-based extraction of optic flow and inner-motion)
- How to autonomously detect and **sample space**