

# HIPPOPLAST

How rigid and plastic circuits contribute to hippocampal function



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Judith Makara

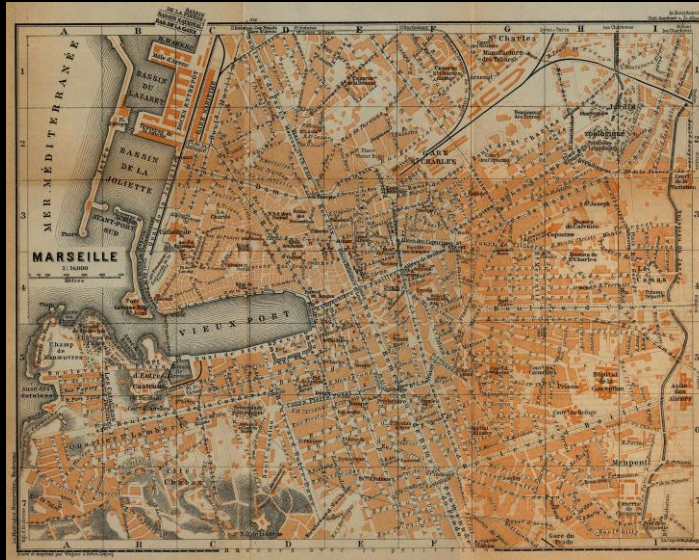
Institute for Experimental  
Medicine  
Hungary



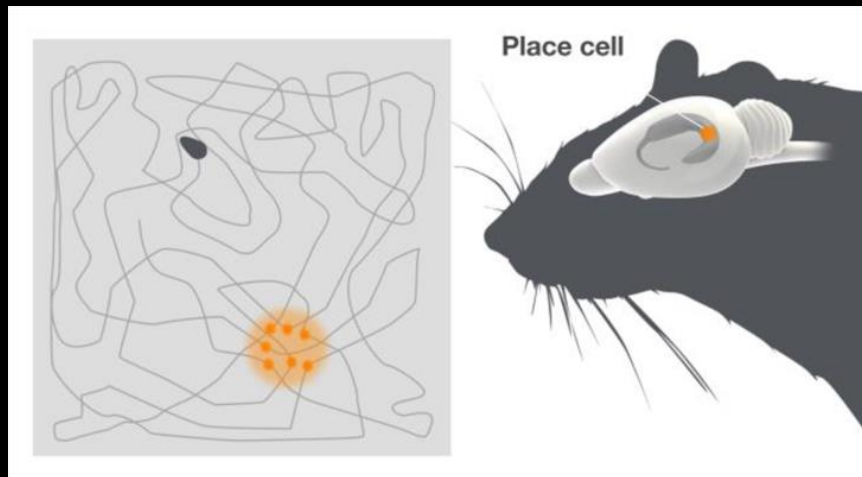
Axel Roxin

Centre de Recerca  
Matemàtica  
Spain

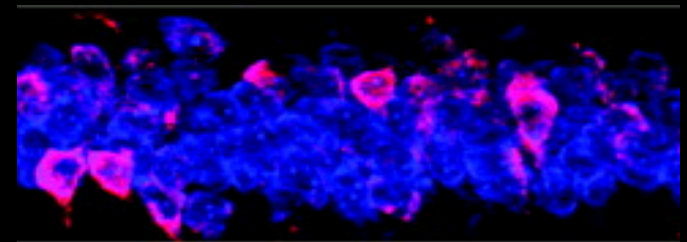
# Navigating using a cognitive map of our environment



*Tolman, 1949*



Place cell



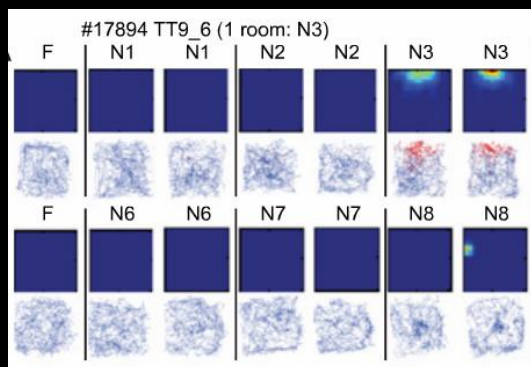
*Kitanishi T et al., Cereb. Cortex 2009*

*O'Keefe and Dovstrosky, 1971*

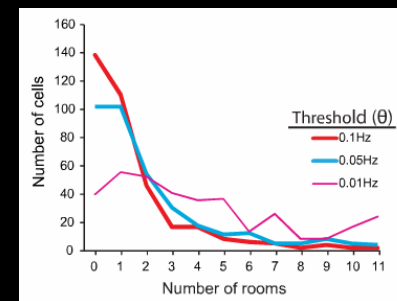
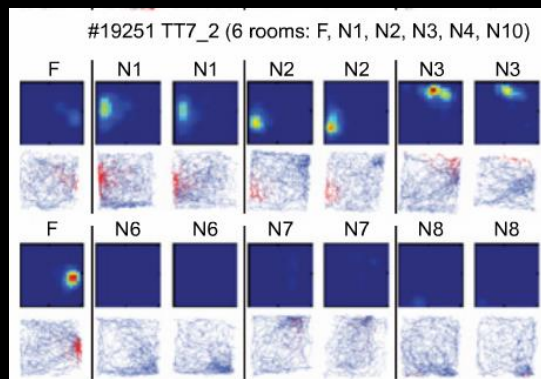
*O'Keefe and Nadel, 1978*

# Functional heterogeneity of place cells: a small rigid minority

Most cells active in one or two rooms

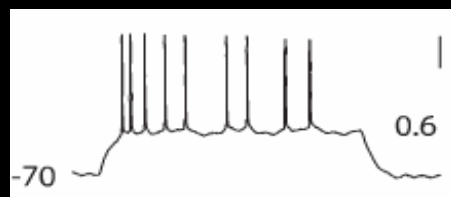
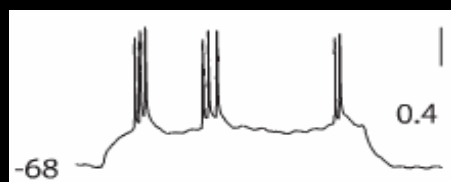


A minority of cells active in more than 6 rooms

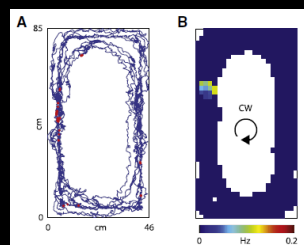
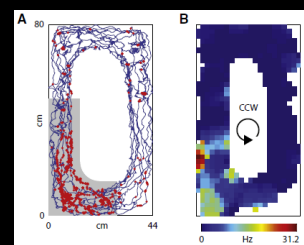


Alme et al., PNAS 2014

Behavior of the minority of highly firing/bursting cells might rely on intrinsic properties



Anesthetized



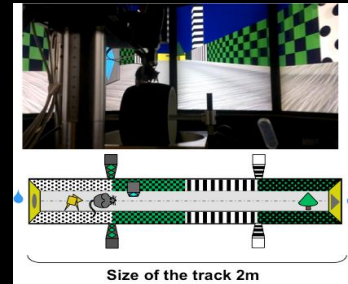
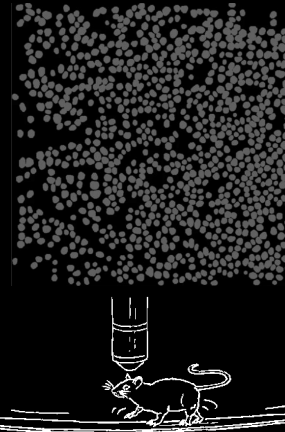
Awake

Epsztein et al., Neuron 2011

# Specific aims

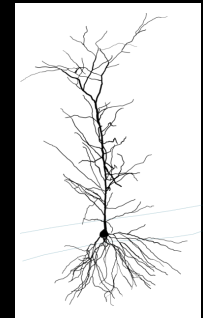
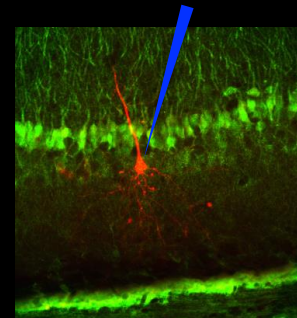
## WP 1- Identify rigid cells across time and context (Cossart lab/Epszstein lab)

- Large scale two photon imaging in navigating mice
- Lifespan of rigid cells across time and contexts
- Early developmental origin of these cells



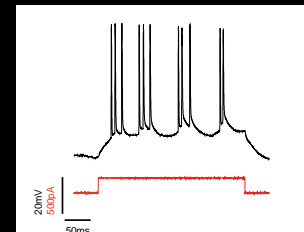
## WP 2- Target rigid cells to decipher their intrinsic/synaptic properties (Cossart lab/Epszstein lab/Makara lab)

- Targeted patch-clamp recordings *in vivo* and *in vitro*
- Linear/supralinear synaptic integrative properties
- Intrinsic/synaptic plasticity of rigid vs plastic cells



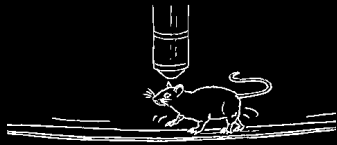
## WP 3- Modelling to understand key parameters of rigidity And computational benefits (Roxin lab with results from other labs)

- Computer simulation

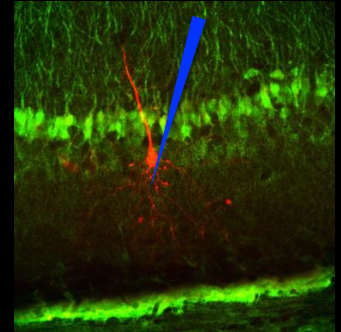




# Implementation/interaction with HBP platforms/projects



SP4, WP 4.1.4, "Modelling brain signals"



SP6: "Detailed hippocampal models using morphologically reconstructed cells «

**WP1: Rigid neurons across time and context**

T1.1: plasticity in time  
T1.2: set-up design  
T1.3: plasticity in context  
T1.4: origin of rigid neurons

**WP2: Cellular determinants of plasticity**

T2.1: intrinsic properties of rigid neurons  
T2.2: in vivo plasticity of intrinsic firing  
T2.3: impact of induced firing plasticity on rigid neurons  
T2.4: input integration by rigid neurons

**WP3: Rigid neurons across time and context**

T3.1: modeling rigid assemblies  
T3.2: plasticity and place coding  
T3.3: plasticity and replay

Adaptive exponential (AdEx) single-cell model / neuromorphic hardware (SP9).



WP4.5 "Linking model activity and function to experimental data"

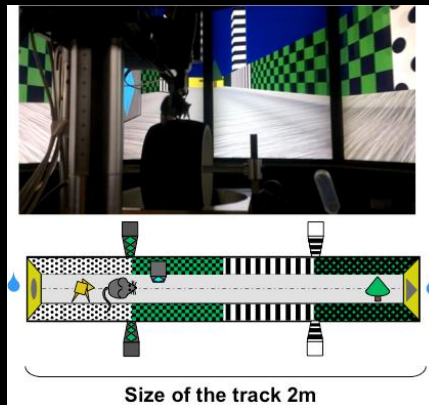
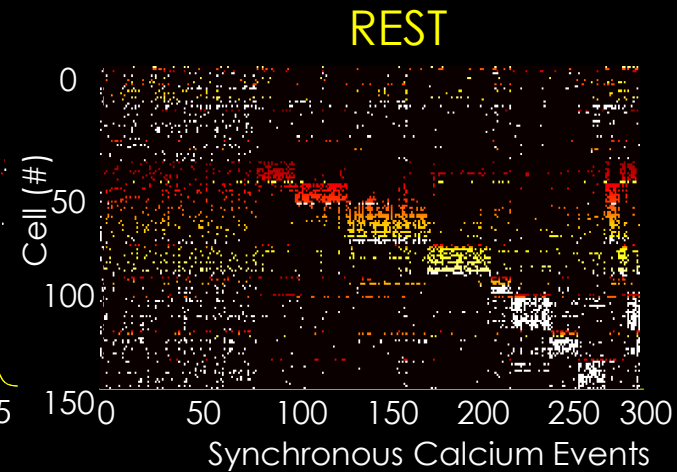
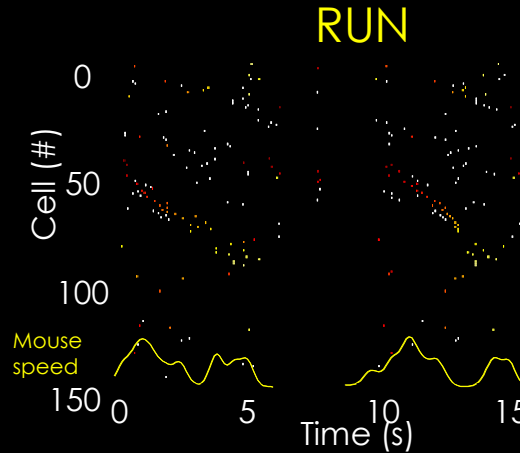
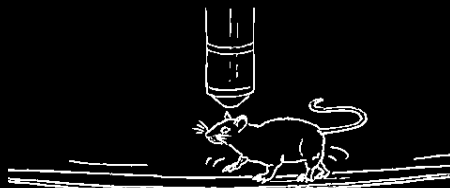
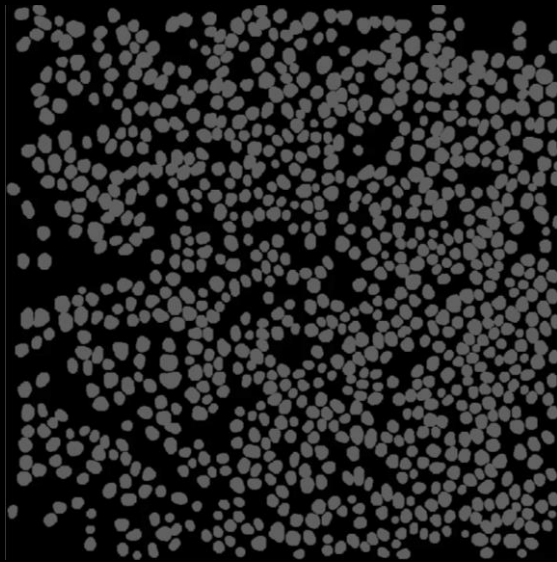
Shared through the HBP ICT platform



# Experimental approaches

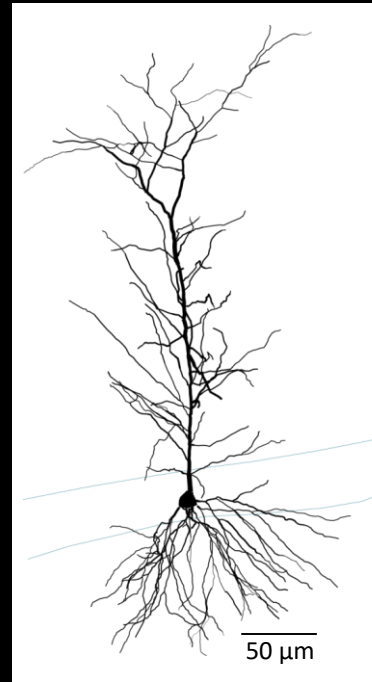
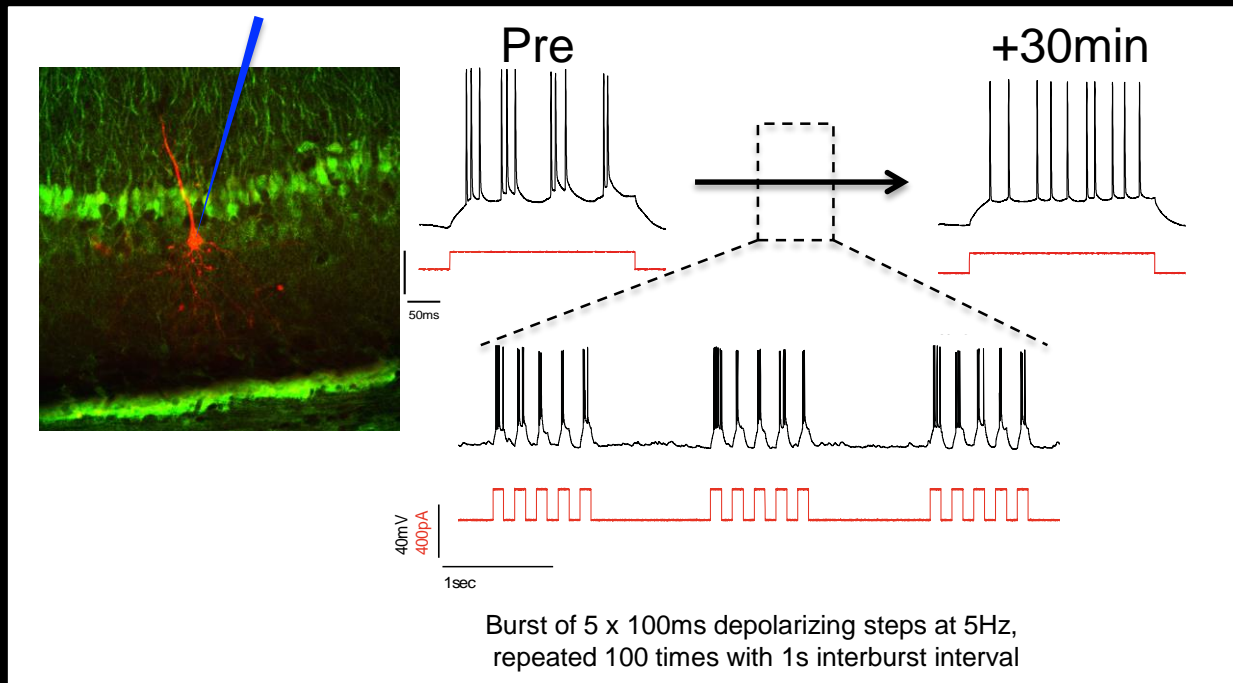
Aim 1- Anatomical identification /developmental origin of plastic vs rigid cells  
(Cossart lab/Epszstein lab)

Experimental approaches



- Developmental origin of rigid cells (early born ?)
- Rigidity of place cells across time
- Rigidity of place cells across contexts

## WP 2- Intrinsic/synaptic properties of rigid vs plastic cells (Cossart lab/Epszstein lab/Makara lab)



Peter Morgan(Epszstein lab)

Targeted patch-clamp recordings of CA1 pyramidal cells *in vivo* and *in vitro*

- ➡ Intrinsic properties of rigid vs plastic cells
- ➡ Linear/supralinear synaptic integrative properties of rigid vs plastic cells
- ➡ Intrinsic/synaptic plasticity of rigid vs plastic cells



## WP 3- Computational benefit of place cells heterogeneity for spatial navigation (Roxin lab with results from other labs)

- Relative contributions of network versus single-cell properties in generating plastic and rigid assemblies
- How diversity affects the fidelity of the place-cell code: an information theoretic study
- Potential effect of neuronal diversity on memory consolidation

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