

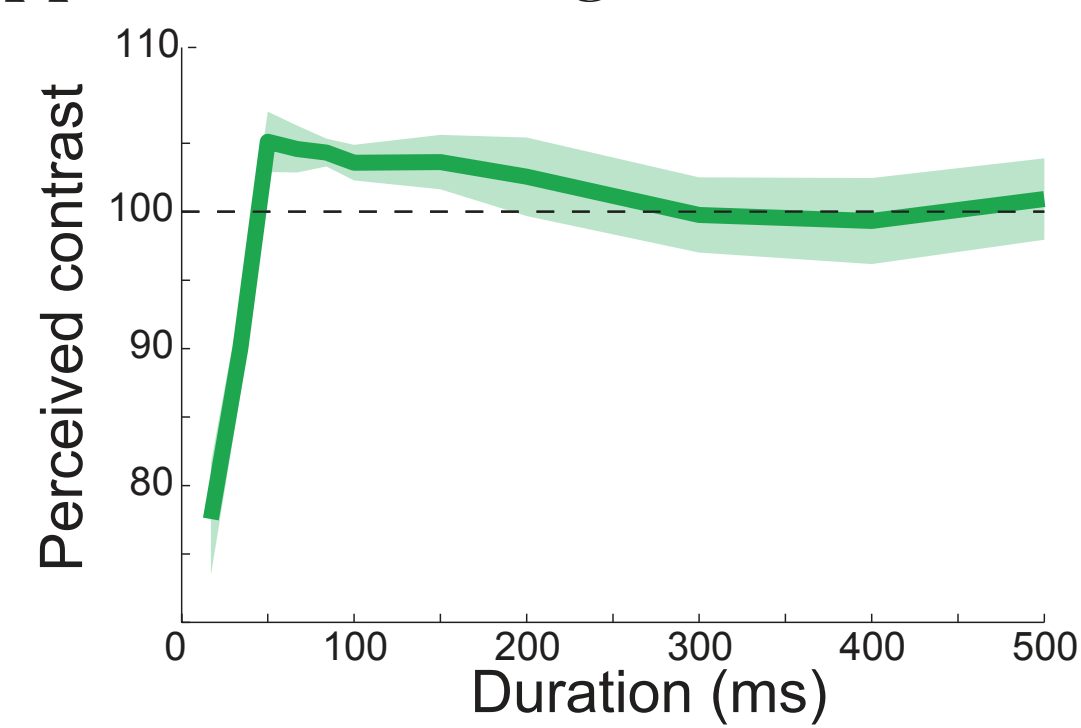
# STUDY OF TEMPORAL VISION AND BLOOD FLOW REGULATION

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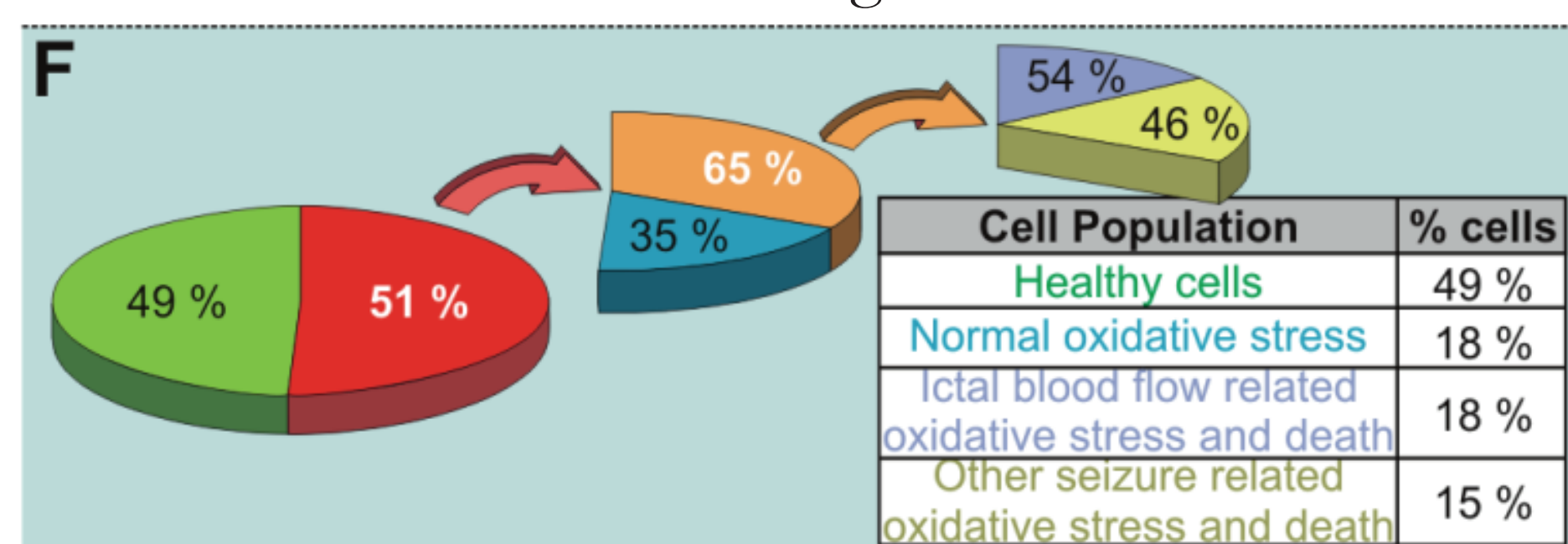
## Motivation

- Light sources are not tuned to human vision
  - Temporal parameters such as stimulus timing influence important phenomena: contrast perception (1), flicker fusion
  - Neural mechanisms unknown
  - Immediate application to design of illumination system



- Epilepsy patients are specially sensitive to temporal factors of light stimuli

- Functional activation produces changes in blood flow
- Increased neural activity during seizures also causes changes in blood flow activity that leads to neural degeneration (2)
- Need to understand blood flow regulation mechanisms better



## Objective

- Study temporal effects on visual perception
  - Electrophysiological studies
  - Effect on brightness perception: is there an optimal set of temporal parameters that maximizes perceived contrast? What is the neurological basis?
  - Effect on flicker fusion: why and how flicker fusion happens?
- What are the mechanisms that produce blood flow regulation?
  - Hypothesis: existence of a blood flow reserve (2)
  - Not testable in vivo due to limitations of recording systems. Need to study in vivo blood flow regulation and ex vivo microvasculature structure
  - Development of an algorithm for registration of microvasculature microscopy images.
    - Multimodal capabilities: two-photon and confocal microscopy

Studies of temporal vision provide insight in the development of illumination and display systems.

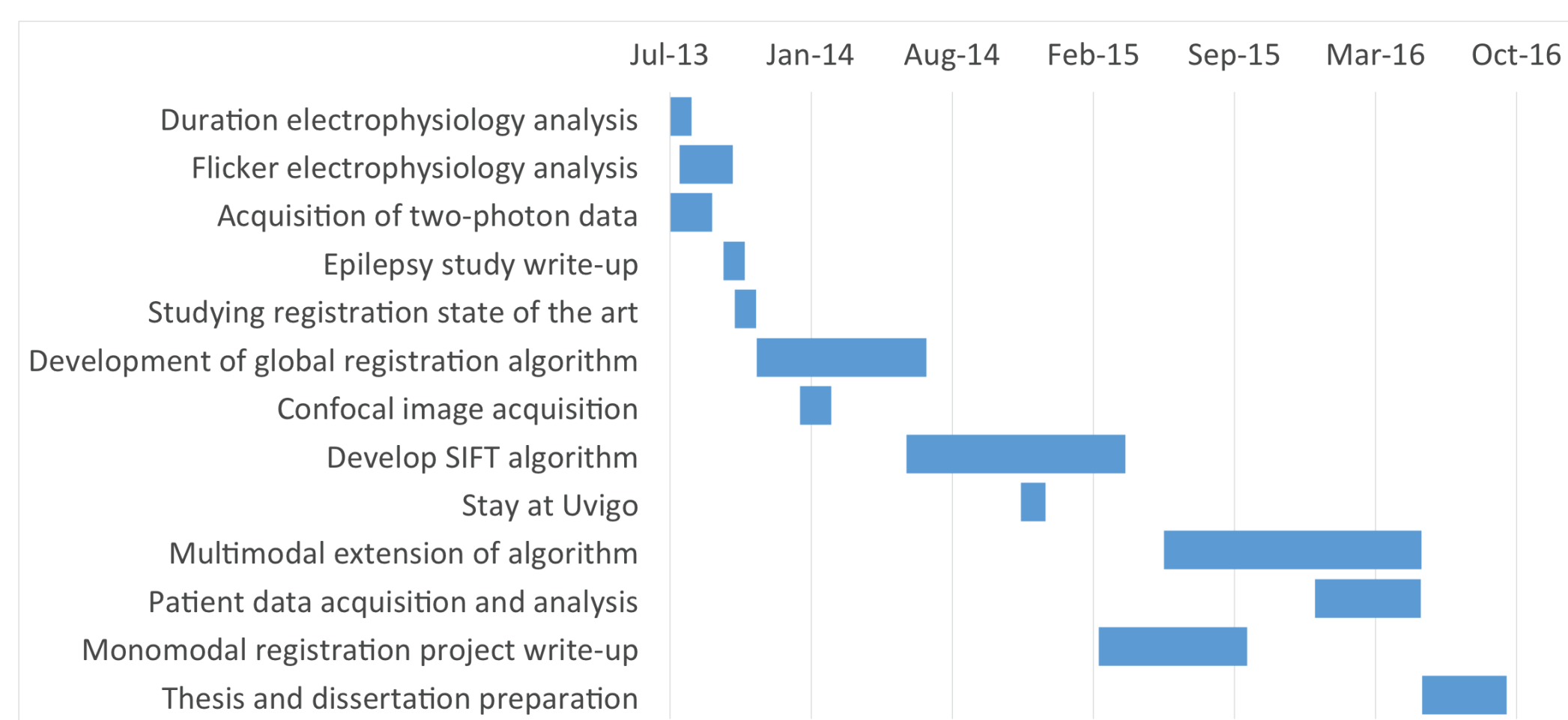
Understanding blood flow regulation helps understanding regulation on disease conditions.

Together: framework to study the effect of temporal factors of visual stimulation in brain activity and neural degeneration.

Registration tool will help to scientists perform complex imaging experiments.

## Research Plan

The thesis goals related to studies of visual perception consists on the analysis of one-dimensional signals obtained through single-cell electrophysiological recordings, and the development of mathematical models. Studies of bloodflow and microvasculature involve image processing of microscopy data.



## Next Year Planning

- Multimodal extension of registration algorithm
- Finish writing up all the current results and submit to journals
- Prepare thesis and dissertation

## References

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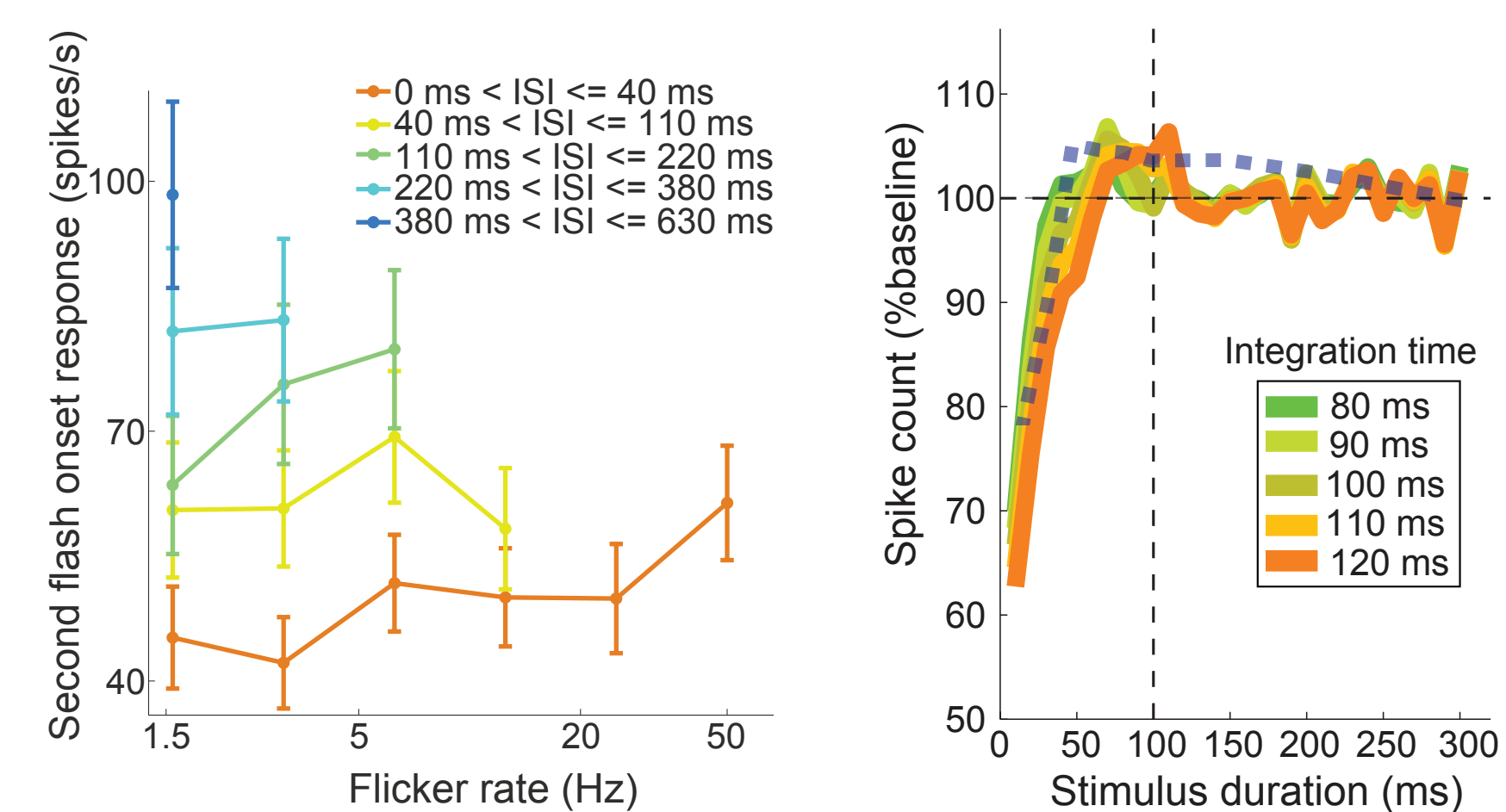
## Results and progress

- Flicker fusion is depending on interstimulus interval, not on rate (left). Mutual information analyses suggest that flicker fusion is caused by lateral inhibition circuits

- Peak in brightness perception with duration, physiologically explained by integrator circuits early in the visual hierarchy (right)

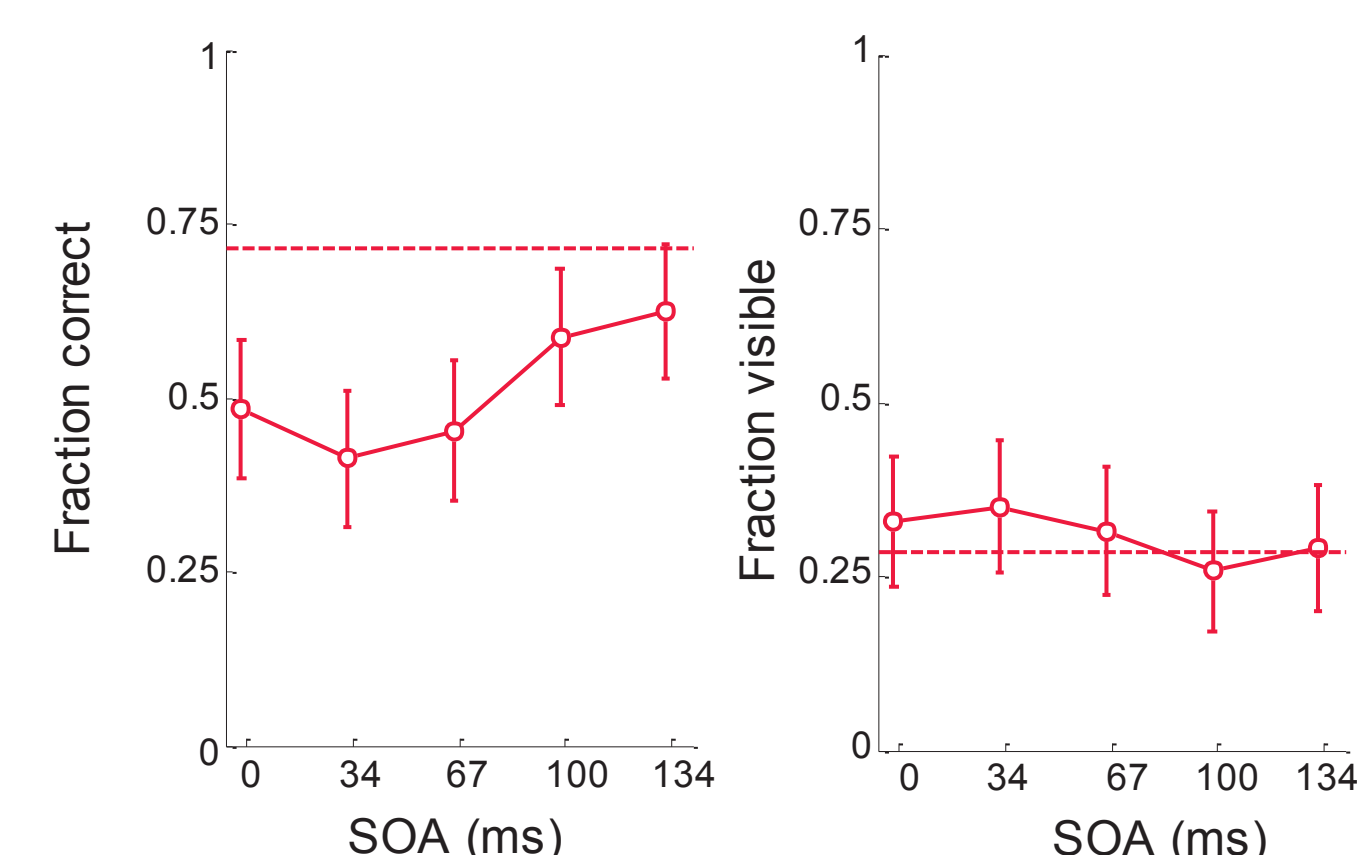
- Application: design of new, efficient illumination and display systems, since these rely in temporal properties of the visual system. Funding already received for this research.

- Results presented in abstract form and ready for journal submission



- Additional testing carried in a patient with missing frontal lobe supports our hypothesis:

- Effect of lateral inhibition early in hierarchy causing metacontrast masking
- No effect in perceived (subjective) visibility



- Abnormal blood flow contributes to neural degeneration in epilepsy (2). Newly developed biomarker suggests anomalous behavior of pericytes as a cause. Results submitted for publication.

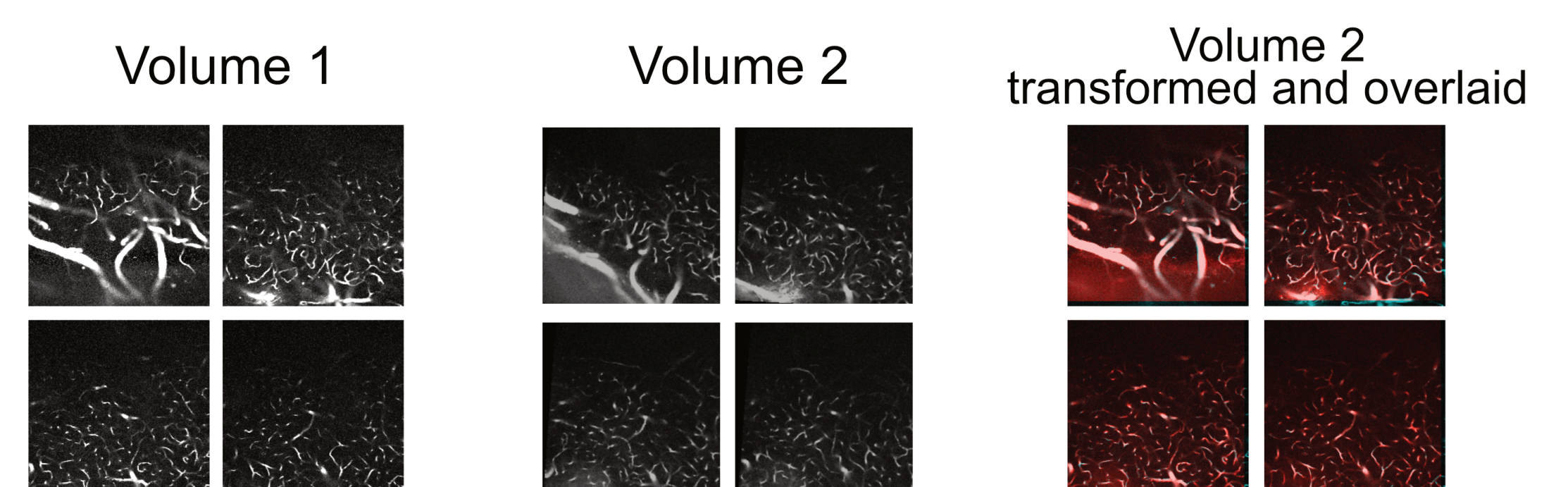
- Development of microvasculature registration algorithm:

- Satisfactory results in monomodal situations.

- Synthetic testing (3)

- Practical case: image acquired different at timepoints

- Testing different approaches to combine local and global information to help in multimodal registration



- Summary of activities and publications:

- Electrophysiology results presented at Society for Neuroscience Meeting 2013
- Performed a stay at Universidade de Vigo with director J.L. Alba Castro to finalize the registration algorithm. This stay was partially funded by a doctorate travel award from Universidade de Vigo.

- Epilepsy results submitted to *Nature Communications*

- Author in accepted articles in *PLoS ONE* (4) and *Surgical Endoscopy* (5)

- Results presented at European Conference on Eye Movements (6)

- Monomodal results from registration presented at *VipImage* (3)

- First author publication submitted to *Journal of Neural Engineering*

- Lobotomy patient results accepted at European Conference on Visual Perception