導入事例

PRIOR Scientific

タフツ大学医学部　マグワイア研究室
カメラ3台を用いた革新的な神経生物学観察システム構築

【要約】

タフツ大学医学部マグワイア研究室では、脳内にまばらに存在する介在ニューロンが、どのようにそのネットワークを形成していくのかを観察したいと考えていました。しかしこれを実現するためには、複数の細胞タイプを同時に記録すること、複数のカメラを使い異なるスペクトルを観察すること、低倍で高分解能を維持することなど、様々な困難を克服する必要がありました。

このためマグワイア研究室は、プライアー・サイエンティフィックをはじめとするパートナー企業と協力し、課題を全て解決し、マグワイア研究室の研究能力をさらに促進する全く新しいシステムを構築しました。

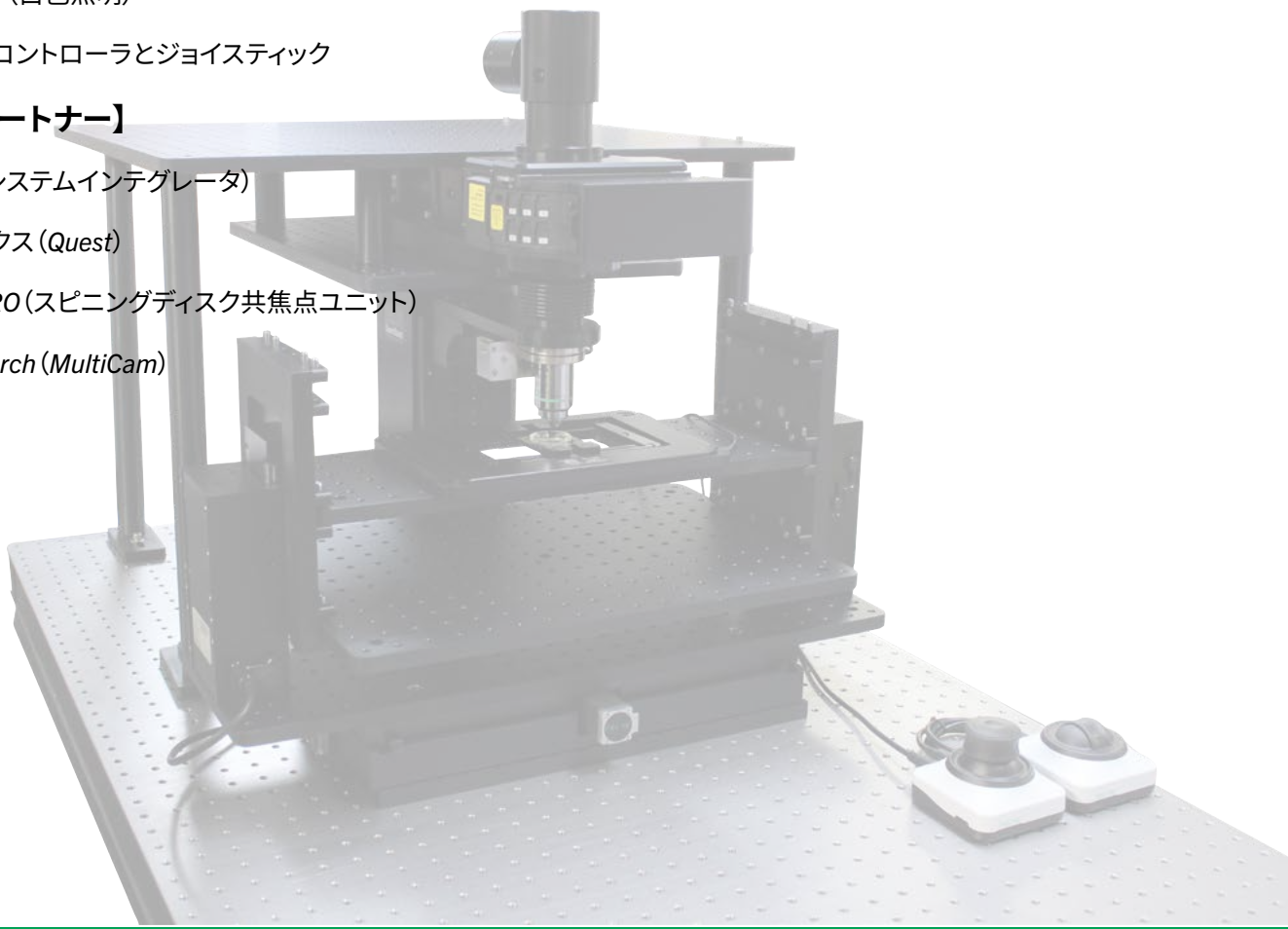
（ご興味お持ちいただけましたら、次ページ以降の英文原稿をご参照ください）

【使用されたプライアー製品】

- H189（3軸ブリッジステージ）
- オープンスタンド
- OP800（対物上下ピエゾ）
- HH106UG（エピ照明、フィルターホイール内蔵）
- LEDBKWHT（白色照明）
- ProScanIIIコントローラとジョイスティック

【その他のパートナー】

- *BioVision*（システムインテグレータ）
- 浜松ホトニクス（*Quest*）
- *Crest CICERO*（スピニングディスク共焦点ユニット）
- *Cairn Research*（*MultiCam*）



Corporate Case Study

PRIOR®
Scientific

Tufts University School of Medicine
Advanced three-camera system for neurobiology

When The Maguire Lab at Tufts University School of Medicine needed a specialized system to capture simultaneous images for its research, Prior Scientific helped develop a unique three-camera widefield and confocal scanner for fluorescent imaging.

The Challenge

The Maguire Lab faced a complex challenge in studying how interneurons coordinate network activity in the brain.

The specific difficulty lay in observing and analyzing sparse neural populations. Interneurons make up only 20% of neuronal cell types in any brain region, with specific subtypes comprising just 5% of cells in a given area.

Traditional imaging approaches, including fiber photometry and in vivo microscopic imaging, proved insufficient for capturing these sparse cell populations with the breadth and detail needed, so a more customized solution was required.

About The Maguire Lab

The Maguire Lab is a research program at Tufts University School of Medicine in Massachusetts that investigates the underlying neurobiology of numerous disorders, with a focus on epilepsy and postpartum depression.

The lab's research investigates the role of GABAergic signalling and stress in the control of neural networks and the contribution to both physiology and pathophysiology.

It aims to bridge critical knowledge gaps and contribute to the development of effective treatment options.

"It felt like everyone was working as part of a team to build this together and it was a really great experience from the start to end."

All quotes from: Jamie Maguire, Ph.D; Kenneth and JoAnn G. Wellner Professor; Director, Building Diversity in Biomedical Sciences (BDBS) program

The Requirements

The Maguire Lab needed a sophisticated imaging solution that could simultaneously observe multiple cell types across a wide field of view to see the whole population structure, while also maintaining single-cell resolution.

Ultimately, their goal was to observe how the cells behave and coordinate amongst themselves in different circumstances and they needed a system that could record from multiple different cell types at the same time.

After exploring various approaches, the team identified several critical requirements for their ideal imaging system:

- Capability to record multiple cell types simultaneously.
- Wide-field view to observe entire structures.
- High-speed image acquisition.
- Multiple cameras for capturing different emission spectra.
- Low magnification while maintaining high resolution.
- Large working distance to accommodate electrophysiological chamber and equipment for simultaneous imaging and electrical recording.
- Flexibility to integrate with electrical recording equipment.

The Solution

Development of a stable, repeatable, and functional system that would operate with three separate cameras for more accurate and efficient data capture was the primary objective.

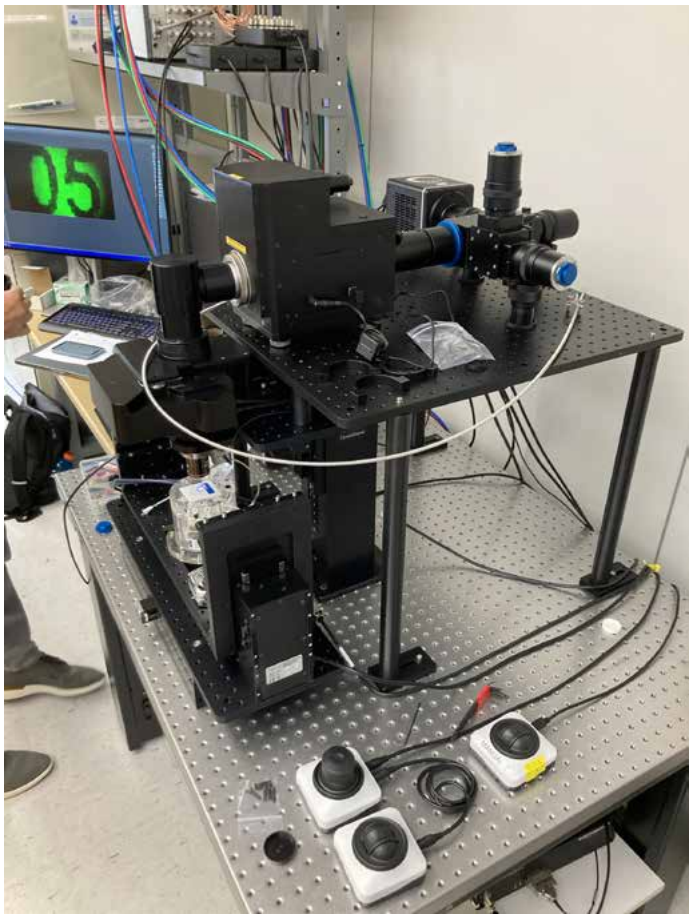
The typical solutions of using a single camera with fast filter switching via a motorized filter wheel or using a single triple-bandpass dichroic filter plus spectral unmixing were inadequate for their needs.

After evaluating multiple options, including systems from major manufacturers, the Maguire Lab determined that no off-the-shelf solution could meet its requirements.

Instead, they partnered with Prior Scientific to develop a custom imaging system built around Hamamatsu Quest cameras.

The highly collaborative implementation process saw Prior Scientific working closely with the research team to understand and meet their specific requirements.

Through collaboration with BioVision, a microscope imaging systems integrator, Prior developed a customized stand to support an upright microscope, integrating three cameras in conjunction with a Crest CICERO spinning disc confocal unit.



The specialized system included:

- **Platform and Mounting:** The setup uses a large 600 mm x 600 mm platform that houses the Crest Cicero unit and Prior's EPI illuminator to facilitate wide-field fluorescence, crucial for identifying precise sample locations.
- **Camera System:** Although the Crest system typically isn't designed for multi-camera setups, by using a high specification 4x magnification objective and the MultiCam from Cairn Research, it gathers sufficient light and data to provide enough signal for the three Hamamatsu Quest cameras to operate simultaneously.
- **Faraday Cage:** To minimize electrical noise during experiments, the system is enclosed in a Faraday cage, critical for supporting electrophysiology. Prior's ability to design and manufacture the system frame ensured that the entire system fitted within the volume of the cage.
- **Precision Positioning:** The inclusion of Prior's Queensgate Instruments OP800 Piezo objective positioner, known for its precision and speed, ensured accurate positioning and stacking over 800 µm, essential for the researchers' image acquisition.
- **Adjustable Shelving:** Prior's H189 physiology platform features adjustable shelf heights for imaging various sample types, from brain tissue to smaller specimens. This adaptability enables the researchers to easily reposition samples and perform a variety of experiments with the same instrument, minimizing variables between comparable datasets. Additionally, Prior's OpenStand, which forms the core of the system's frame, provides a precise motorized focusing axis with an additional 40 mm travel, further increasing flexibility.
- **Enhanced Illumination:** In addition to providing fluorescence illumination, Prior also included a flat field, white light illuminator with the system for transmitted light. This illuminator, mounted directly onto the H189, was a distinct improvement over the previous fiber bundle system.
- **Operation and Control:** The system is controlled via two ProScan III controllers and CS200 joysticks, managing up to four Z-axes. This setup enables precise manual control over sample positioning, ensuring flexibility for various experiments and sample types. Prior's multiaxis ProScan III controller and CS200 joysticks allowed Maguire Lab scientists to control all the system's axes manually and via software, ensuring flexibility for various experiments and sample types. This setup helps to keep even a complex system like this user friendly and future-proof.

"It's a beautiful system.

I love it."