# Continuous wave optical scanner for small animal molecular imaging

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## Introduction

The QOS-Quidd optical small animal molecular imaging scanner allows acquiring planar bioluminescence and fluorescence images. To endow the QOS with 3D tomographic imaging capabilities and enhance its functionality and sensitivity, an ultra-high sensitivity ultra-low noise electron multiplying CCD (EMCCD) NüVü camera and a custom built rotating quad laser illumination module are integrated to it.

## QOS System

The QOS consists of 6 major components that are controlled via an integrated, but complex and sophisticated software, the QOSoft written in C++ and C# programming languages.

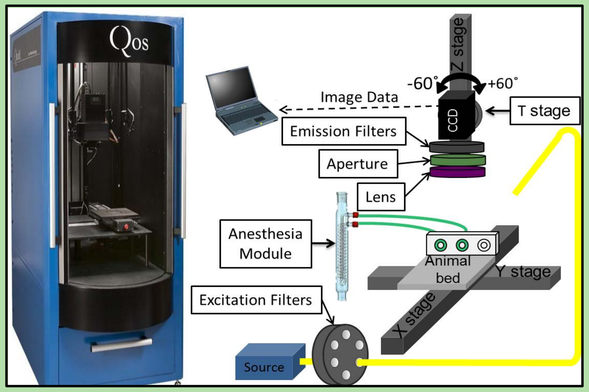


Figure 1. QOS configuration

### Limitations

- Acquisition only in epi-illumination mode
- Planar imaging only
- Lack of sensitivity
- Limited rotation angle (±60˚ from vertical)
- Non homogenous illumination module

## QOS Modifications

### 1. Integration of EMCCD Camera

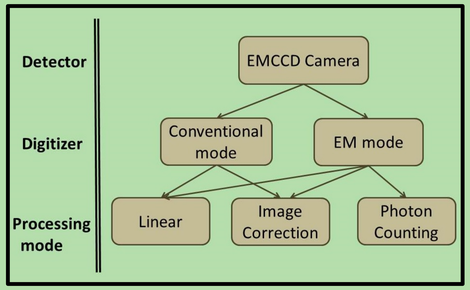


Fig 2. EMCCD processing modes

### 2. Integration of quad laser module

- 4 wavelengths
- Rotary arm
- Tilting head
- Portable
- Animal bed

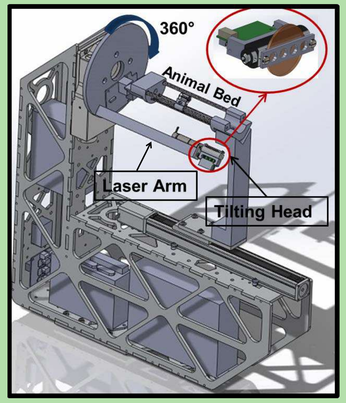


Fig 3. Quad laser module.

### 3. Rotation angle of camera has been extended to cover from -90˚ to +90˚

## Results

- The 4T1-Luc cells were harvested and added to the 96 wells plate (image taken after the addition of luciferine). With the NüVü EMCCD camera, we were able to detect down to 100 cells compared to ~1000 cells with the old camera (Andor).

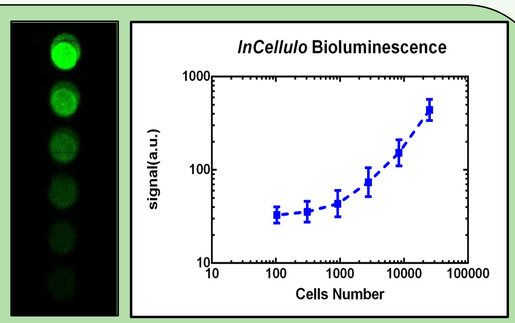


Fig 4. *InCellulo* bioluminescence experiment.

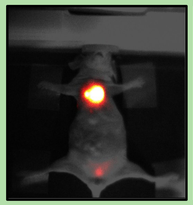

Fig 5.EMCCD Experiment

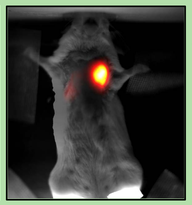

Fig 6.CCD Experiment

- 100 000 of 4T1-Luc cells were injected through the heart of two mice. This was followed by the injection of 200 µl of 40 mg/ml luciferine to activate the bioluminescence. The images were acquired 18 days after the injection.

An SNR evaluation performed on a ROI was drawn manually over the heart. To obtain the same SNR as with the CCD camera (300 s acquisition time for 1 image), three EMCCD images each acquired in 2.5 s needed to be averaged (overall acquisition time of 7.5 s) ➔ acquisition time reduced by a factor of 40!

## Conclusion

By using the EMCCD camera, the acquisition time for having the same SNR as with the CCD is reduced significantly, while it is possible to obtain a higher SNR by taking several images with such a short exposure time. This attests a remarkable improvement on sensitivity.

## Future Work

Exploiting the QOS to acquire fluorescent images all around the subject (animal or phantom) to obtain 3D tomographic images using the laser module.

## References

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## Acknowledgements

Quidd Smart Molecular Imaging
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