# An easy way of combining high spatial resolution micro-CT with fluorescence lifetime for in vivo small animal molecular imaging

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## Introduction

- The present study focuses on providing the optimum solution for the fusion of the images from a micro-CT and a small animal optical imaging system (Optix MX3).
- The specimen carrier was designed to image the same mouse in both systems with a highly repeatable and reproducible positioning.
- For optical-CT fusion the carrier design was optimized for having a maximum radiologic transparency and homogeneity for allowing the micro-CT to reveal the smallest contrast possible using the minimum dose.
- Fiduciary markers, with the size correlated with the spatial resolution of the micro-CT and the contrast optimized for maintain its maximum dynamic range, are used as supplementary reference for easy spatial correlation using common software such as Amira or MicroView.
- In vivo imaging experiments were performed to compare the 3D structure of the liver that was imaged with optical and micro-ct scanner.

## Animal imaging bed

### 1. Animal carrier

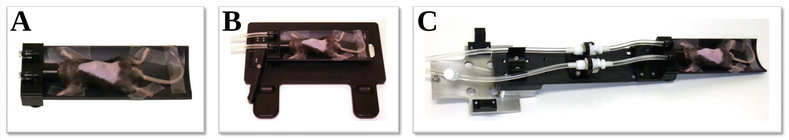


Figure 1. The optical-CT-bed consists of three parts: **A)** the mouse bed made of a material that is X-ray transparent and has a low autofluorescence background. It includes a nose cone for anesthetic gas. The bed interface allows rapid and highly repeatable installation for imaging either on Optix plate **(B)** or micro-CT adapter **(C)**.

### 2. Micro-CT adapters

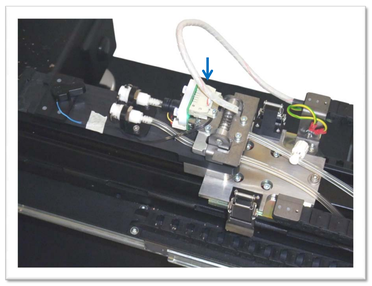

**Figure 2.** The micro-CT adapter was specifically designed for the Skyscan model 1076. For this model, the adaptor has a handle where the camera and temperature module (blue arrow) can be fixed and used with the Optix-CT bed. The adaptor can be customized to fit any other commercial micro-CT and their accessories.

### 3. Fiduciary markers

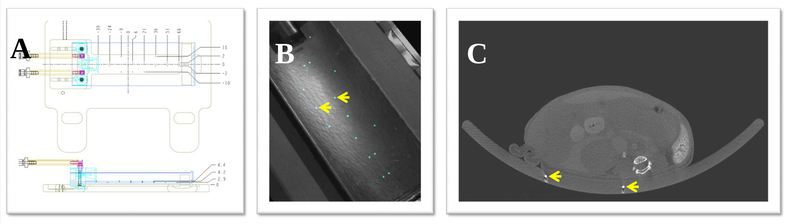


**Figure 3**. The bed contains pairs of fiducials installed following a pattern that confers uniqueness and could be used for automated analysis, (**A**) and (**B**). The optimized contrast of fiducials - similar level with the bones (**C**) - maximizes the visibility of the soft tissue contrast in the image.

## In vivo multi-modality imaging results

### 4. Optical imaging with Optix

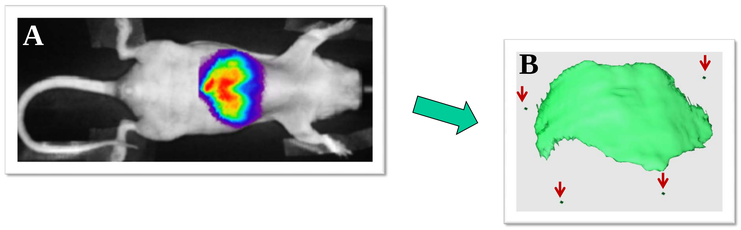


**Figure 4**. Time-domain fluorescent signal from the liver of a mouse (**A**) acquired by Optix was tomographically reconstructed to generate a 3D volume including the fiducials (red arrows) (**B**) by using the OptiView Software. The 3D image was saved in DICOM format for co-registration using Amira. This mouse received an i.v injection of 10 µg of ICG and was imaged 10 minutes after [(1)].

### 5. Micro-CT imaging

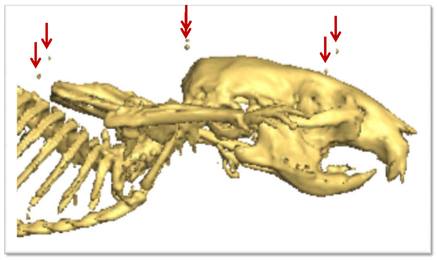

**Figure 5**. The same mouse as shown in Figure 4 was also imaged in a micro-CT. The fiducials are easily visible (red arrows) in the 3D view that was exported in DICOM format for co-registration using Amira.

### 6. Image co-registration

**Figure 6**. DICOM files from Optical and micro-CT imaging were loaded to Amira. Fiducials were used as landmarks to superimpose the two volumes for an accurate co-registration.

### 7. Precisely analyzing ICG distribution in the liver with Fenestra LC and ICG

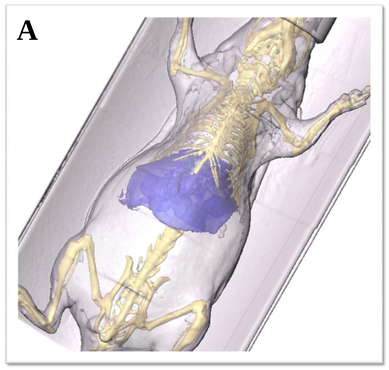


**Figure 7**. The same mouse received an injection of 400 µl of Fenestra LC, a hepatic CT contrast agent (**A**). With the liver structure obtained from the micro-CT (blue), one could analyze the distribution of ICG in liver obtained in optical imaging (green), as it can be seen in three different angles (**B**).

## Summary and Conclusions

- We reported here the use of a new optical-CT bed that allows to readily image the same mouse in the Optix system and a micro-CT system with high precision image co-registration.
- Fiducials incorporated inside the bed were used as landmarks to accurately superimpose the 3D images obtained from the two modalities.
- In the case presented here, the liver was imaged using ICG and Fenestra LC. The simplicity of the procedure and the overlapping boundaries of the reconstructed liver regions confirm that the solution could be used on a daily basis for precise optical-CT co-registration.

## Acknowledgments

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- Pictures were taken by Peter Kadelbach.

## References

1. Piché *et al. WMIC poster presentation* (2011)