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AUTOMATED PIG GUT SEGMENTATION IN CT IMAGES USING DEEP LEARNING

Theatre Session D 05/06/2025



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Partner for your innovations !

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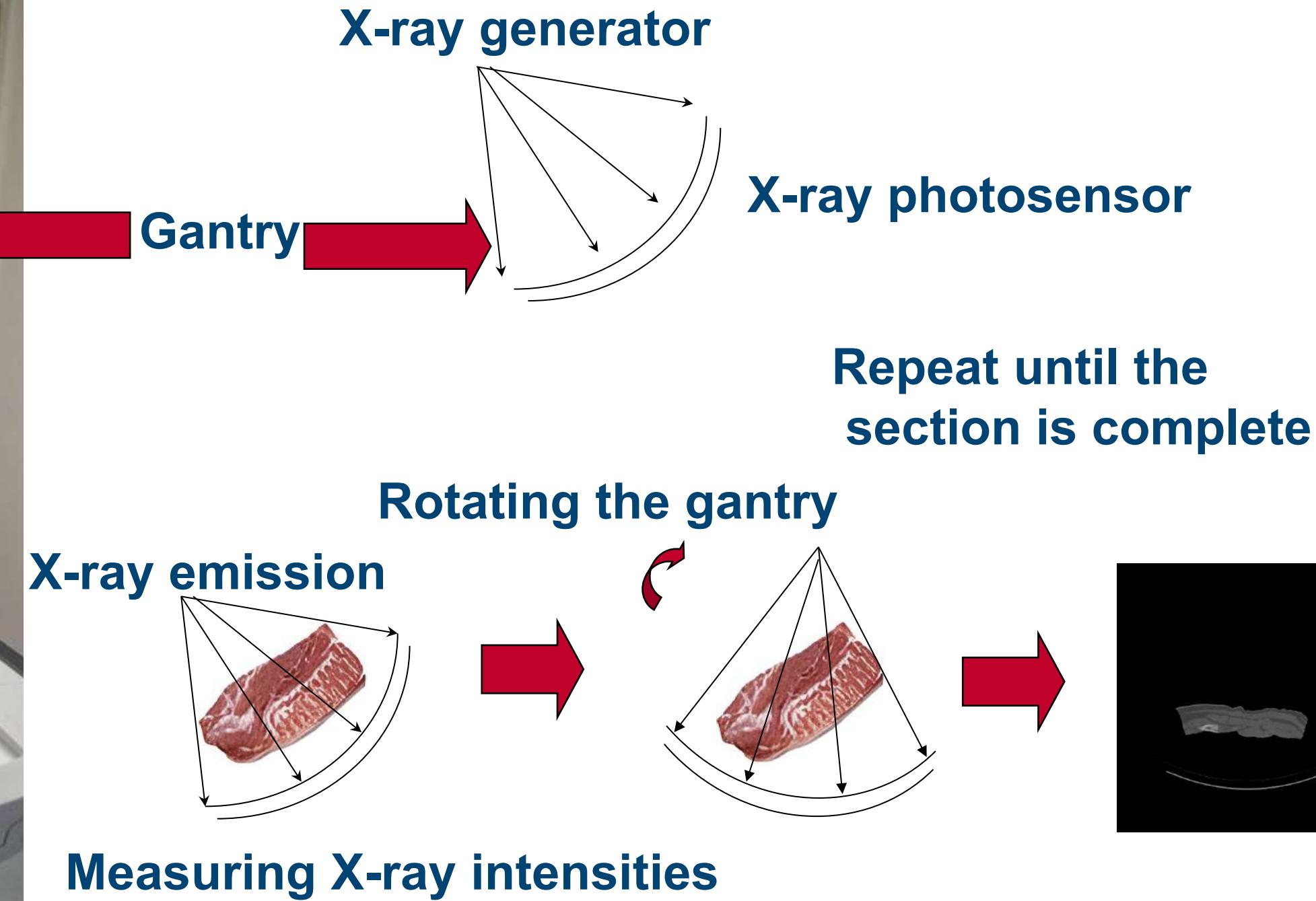
- From dissection to image processing

Cannot be repeatable for the same animal



Multiple scans possible over time

II. MATERIALS - X-RAY SCANNER ACQUISITION



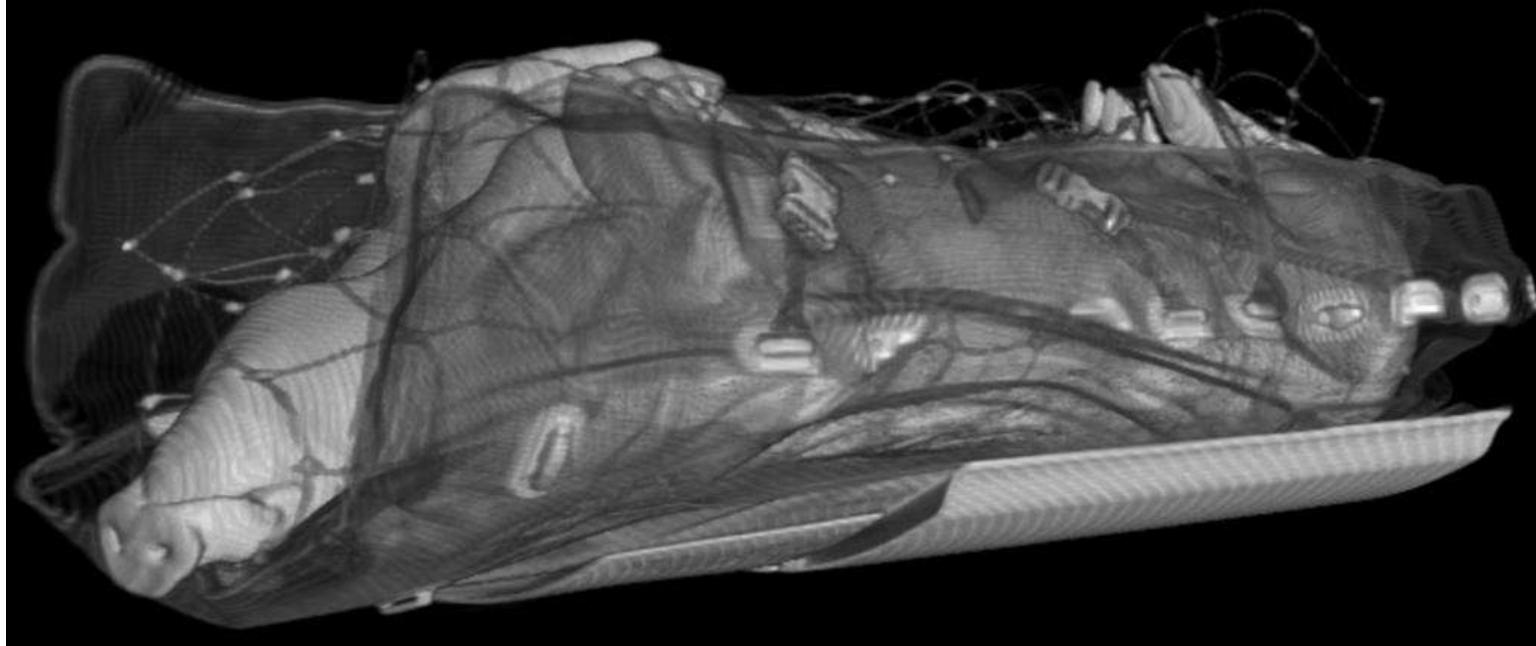
II. MATERIALS - Dicom pictures



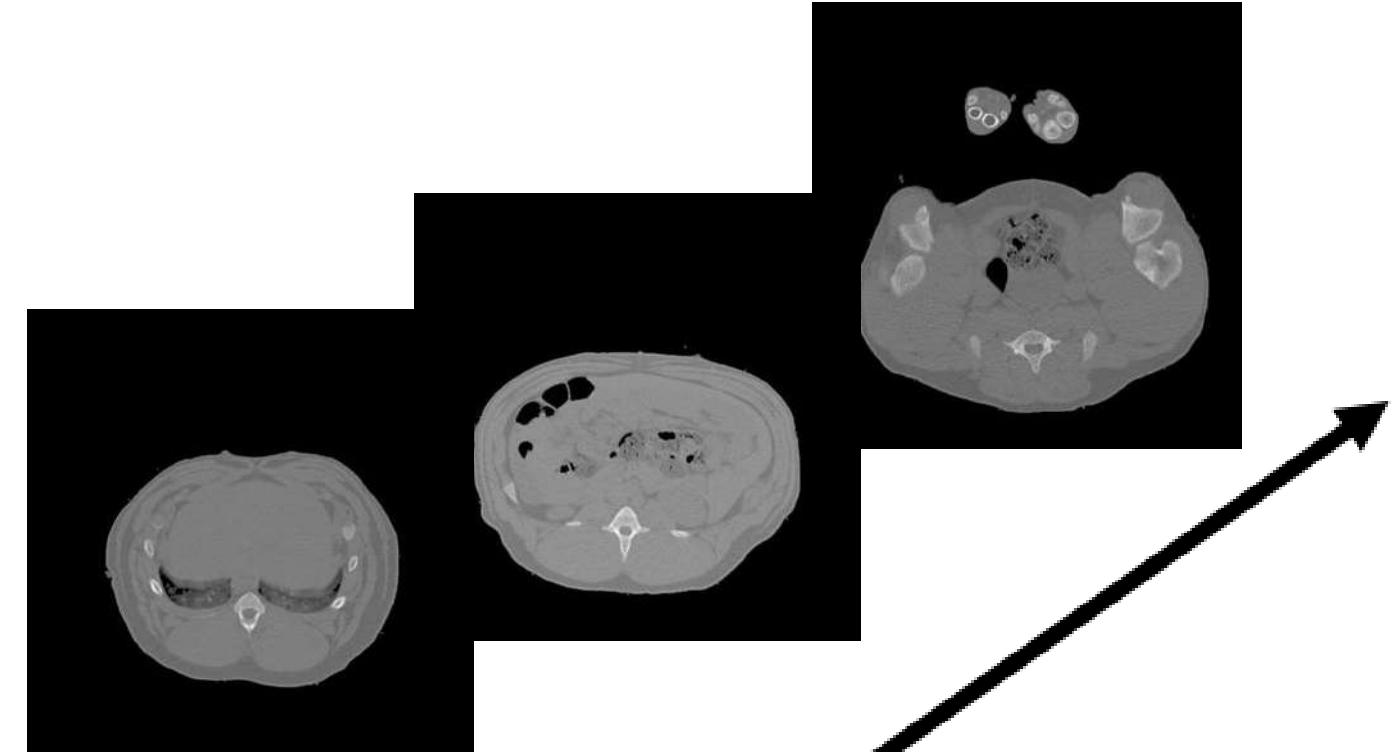
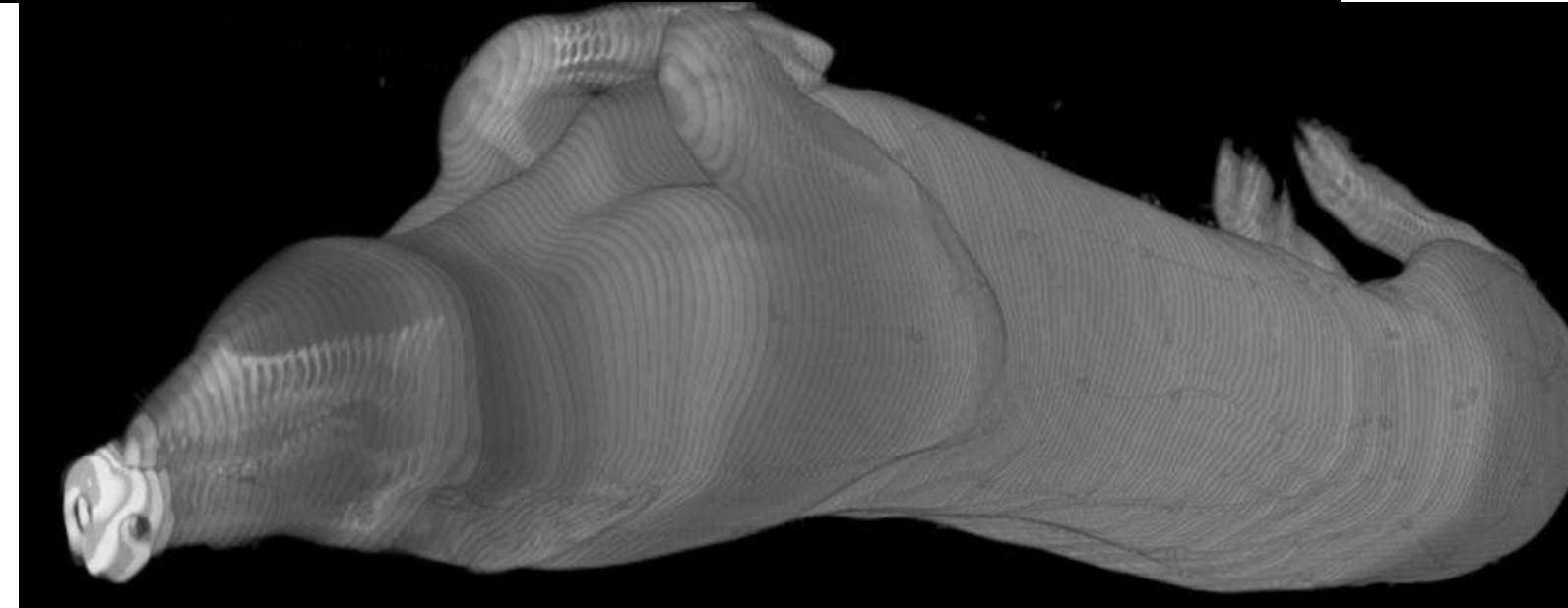
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3D visualization
of pork (raw)



3D visualization
of pork
(filtered)



350 slices

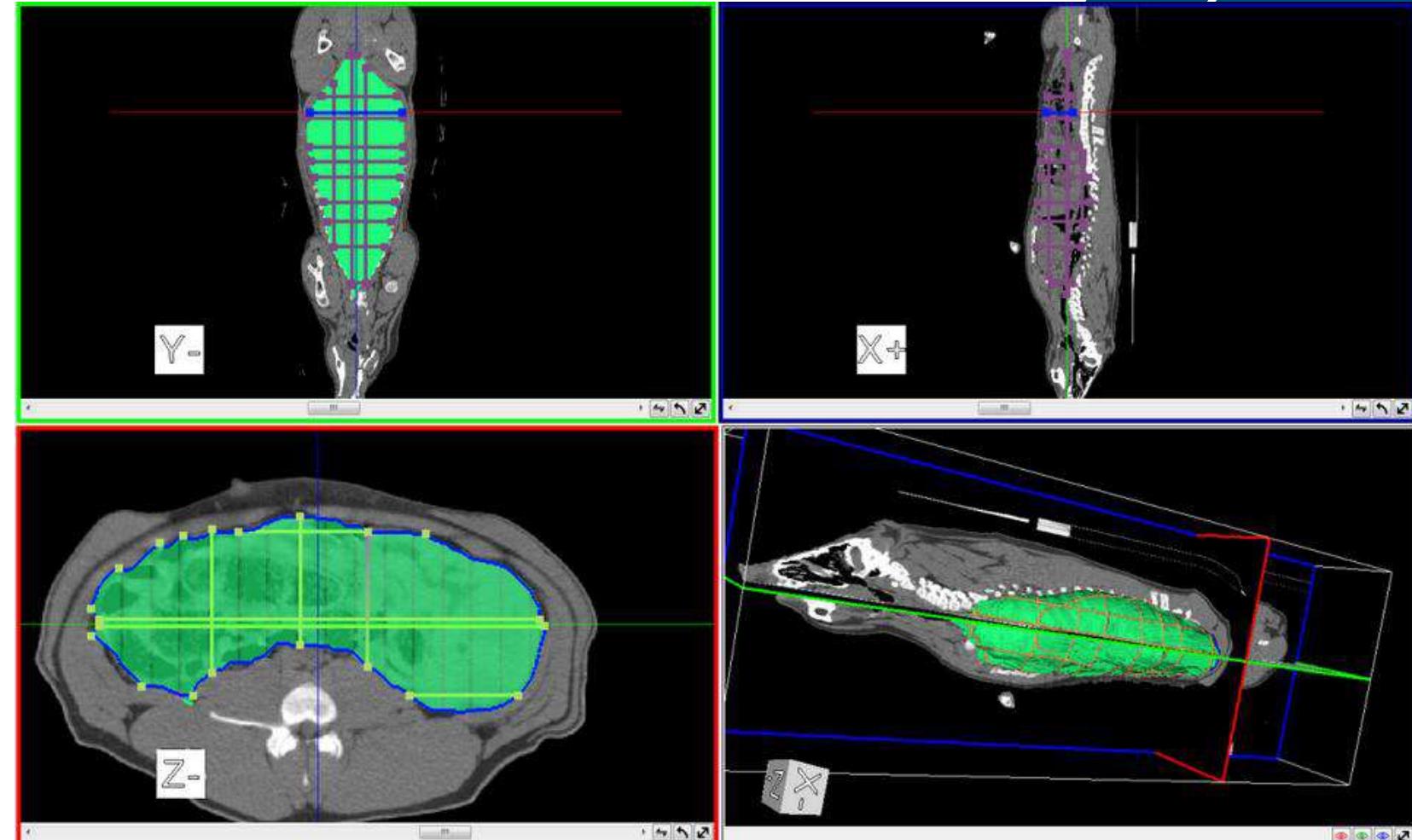
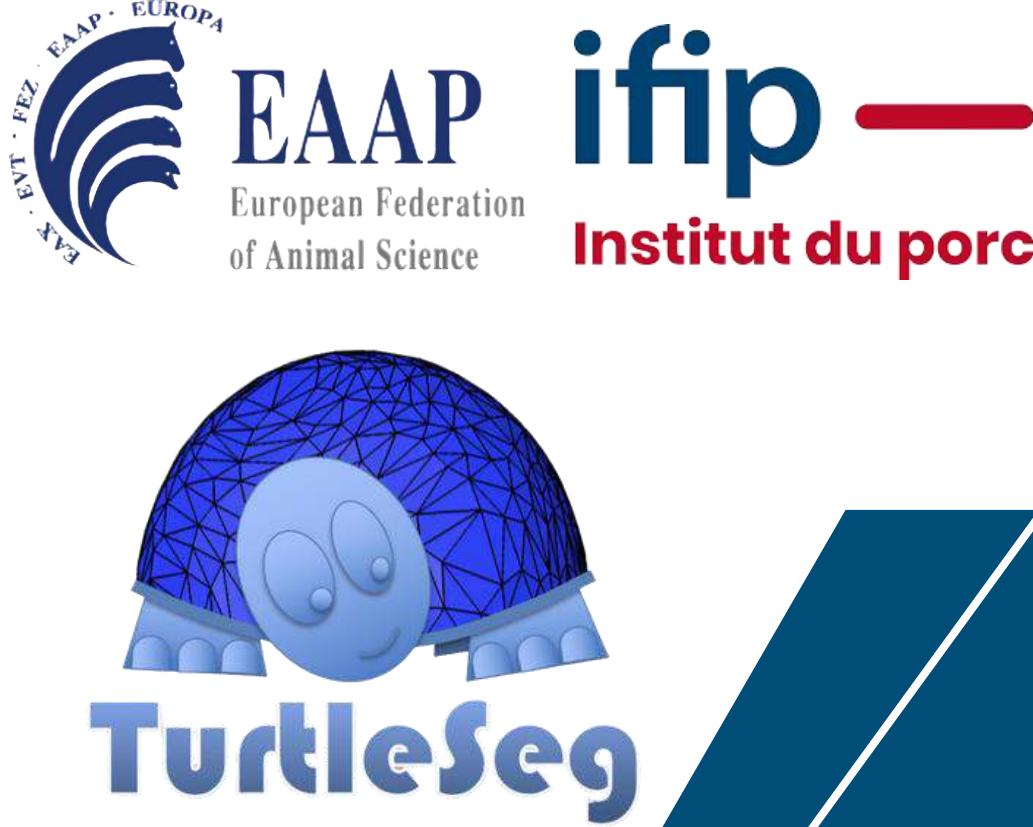
III. Semi-automatic method

- TurtleSeg

TurtleSeg[1] is an interactive segmentation tool designed for 3D medical images.

Main features :

- ▶ Natural 3D navigation with support for oblique slice planes.
- ▶ Multi-level undo/redo support.
- ▶ Support for many popular 3D image formats.
- ▶ Export the segmentation as an image mask or surface mesh.
- ▶ Full contour editing support makes fixing mistakes easy.

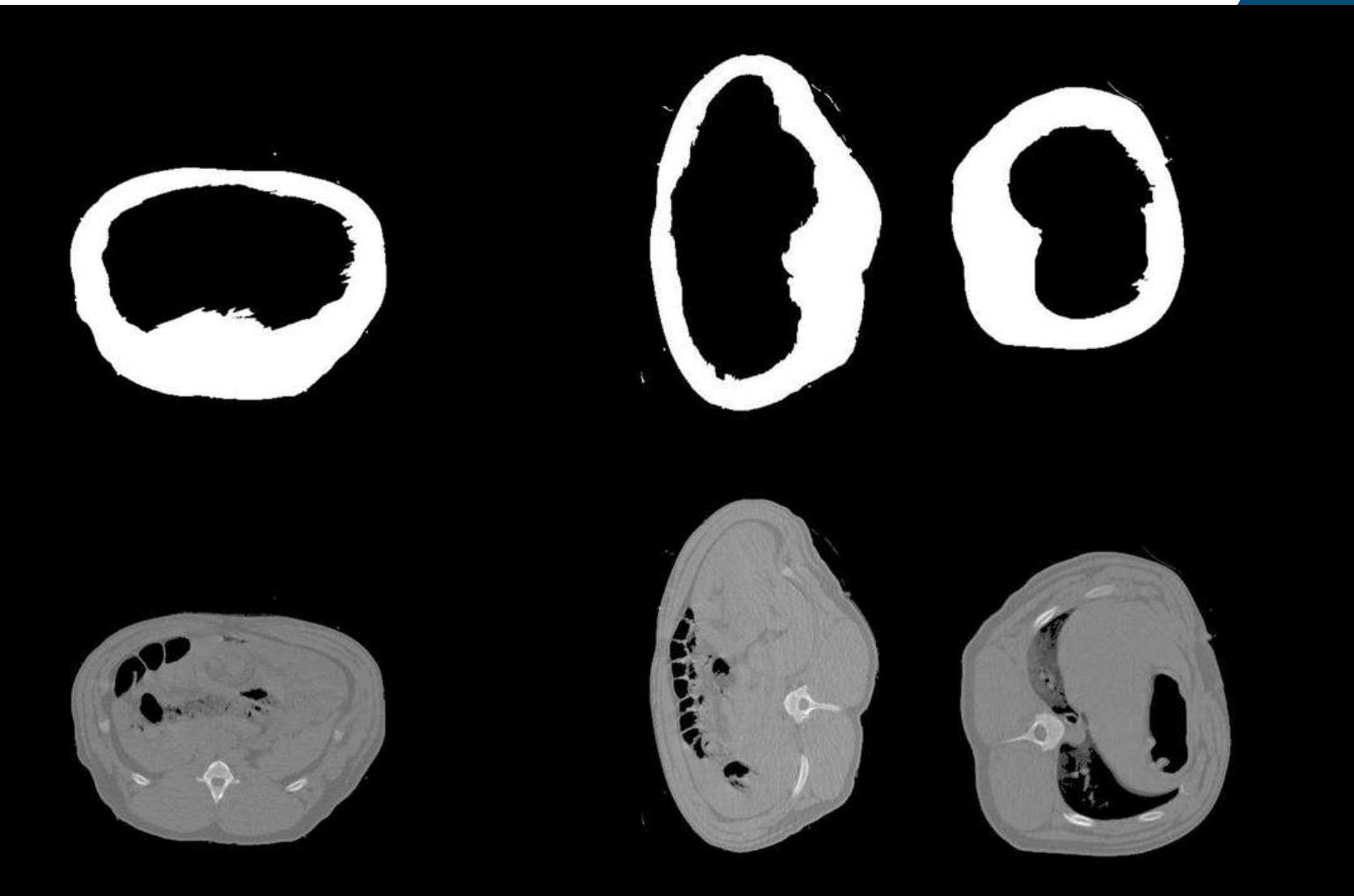


[1] A. Top, G. Hamarneh, and R. Abugharbieh, "Active Learning for Interactive 3D Image Segmentation," in *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*, vol. 6893, LNCS, pp. 603–610, 2011, Springer Berlin / Heidelberg.

IV. DEEP LEARNING METHOD - DATASET



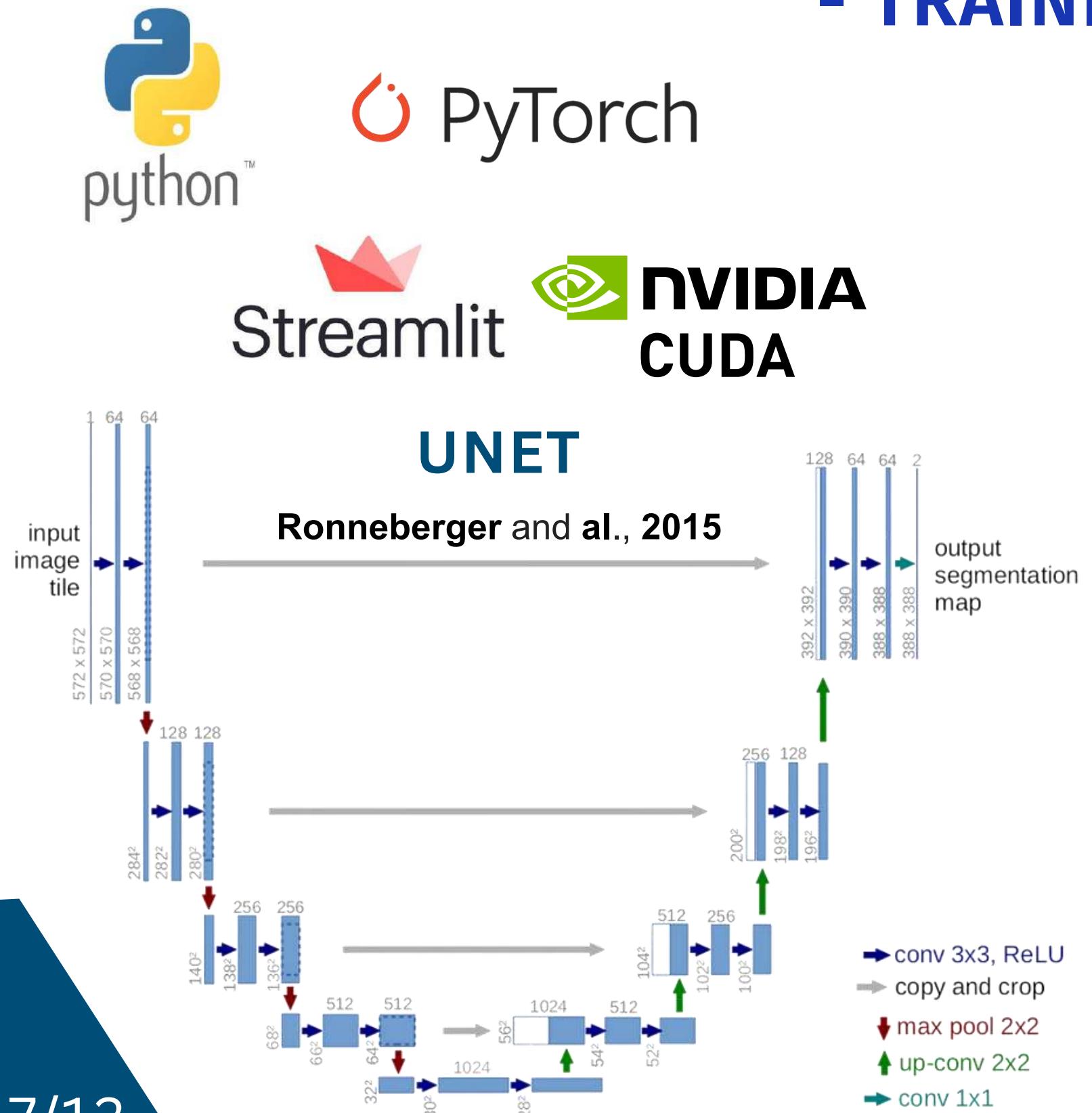
| Categories | Descriptions |
|-----------------|--|
| Encoding | JPEG |
| Format | 8 bits |
| Canal | 1 |
| Range of values | 0 to 255 |
| Visualization | Grayscale |
| Number of pairs | 276 087 |
| Angle | $0 ; \frac{\pi}{2} ; -\frac{\pi}{2}$ (rad) |



**Dataset 262 pigs + dataset augmentation (276 087 paires)
252 real pigs for training
10 real pigs for testing**

IV. DEEP LEARNING METHOD

- TRAINING CONFIGURATION



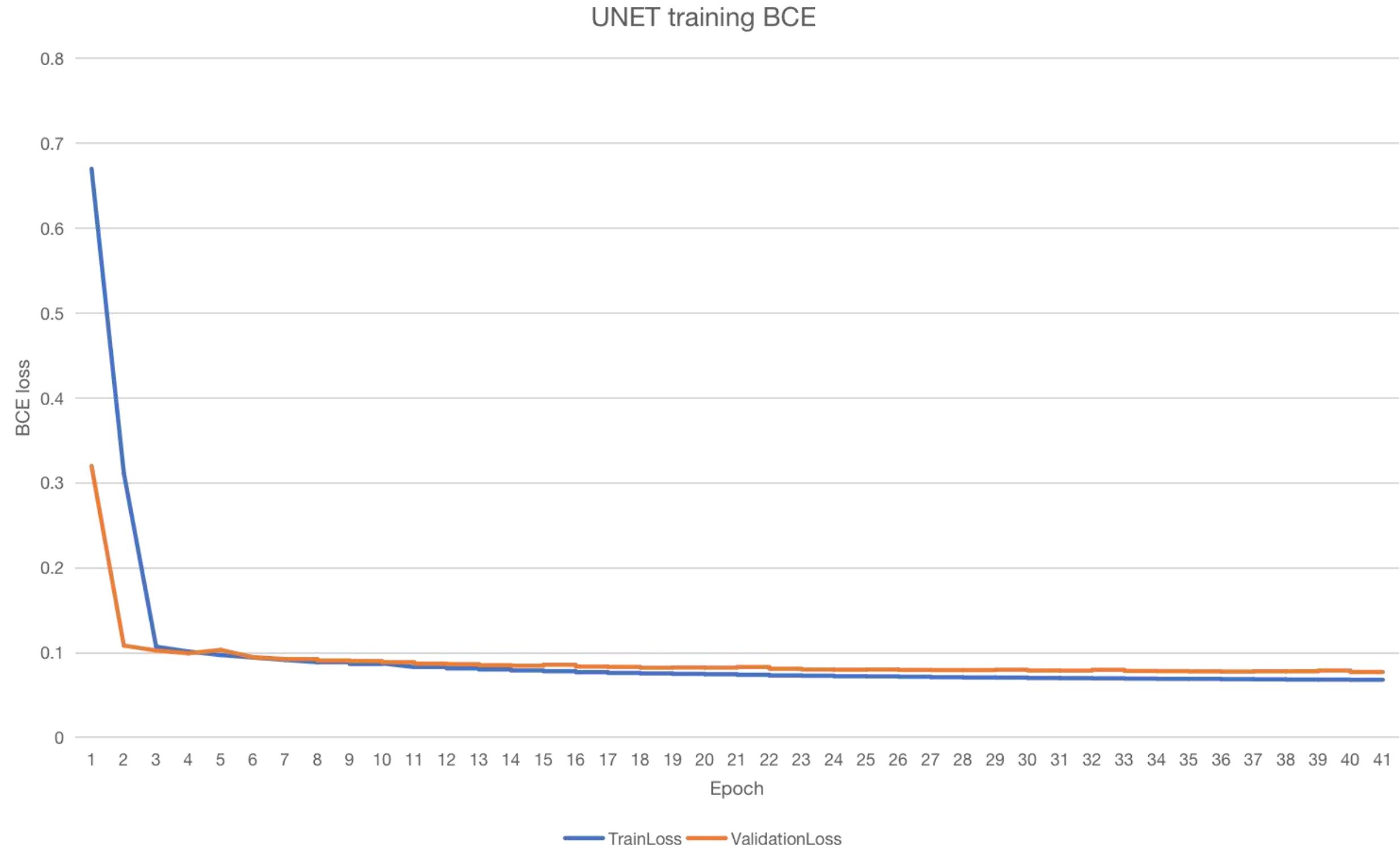
| Librairies/Frameworks | Version |
|-----------------------|---------|
| Python | 3.12 |
| Pytorch | 2.6.0 |
| Streamlit | 1.42.0 |
| Cuda | 12.4 |

| Training specs | Descriptions |
|--------------------------------|----------------------------|
| Loss function | Binary Cross Entropy* |
| Time | 28 hours |
| Graphics Processing Unit (GPU) | Nvidia RTX 4080 SUPER 16GB |
| Epochs | 40 |

$$*BCE = -\frac{1}{N} \sum_{i=0}^N Y_i \cdot \log(\hat{Y}_i) + (1 - Y_i) \cdot \log(1 - \hat{Y}_i)$$

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IV. DEEP LEARNING METHOD - DEEP LEARNING RESULTS



IV. DEEP LEARNING METHOD - DEEP LEARNING RESULTS



| Model | Metrics | Values |
|-------|-------------------|--------|
| UNET | DICE | 0.927 |
| UNET | IoU | 0.876 |
| UNET | Accuracy | 0.997 |
| UNET | Recall (F1-Score) | 0.915 |



[Model_Unet.pth](#)

$$\text{Dice}(A, B) = \frac{2 \cdot |A \cap B|}{|A| + |B|}$$

$$\text{IoU}(A, B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

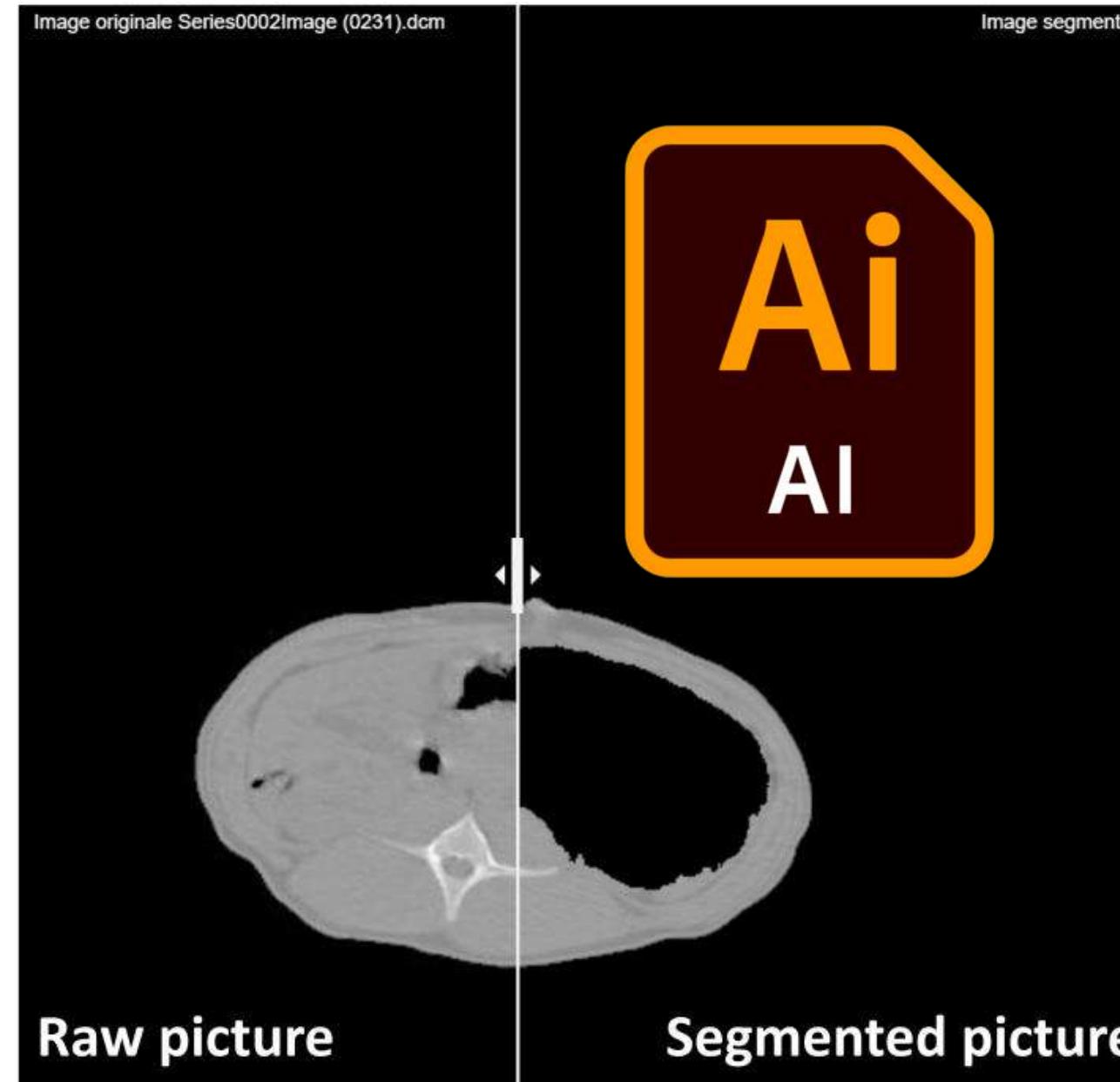
$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} = \frac{|A \cap B|}{|A|}$$

- TP = True positive
- TN = True negative
- FP = False positive
- FN = False negative

V. INTEGRATION OF THE AI SOLUTION

- BASIC WORKFLOW FOR AI INTEGRATION



Acquiring full-body X-ray images of live pigs

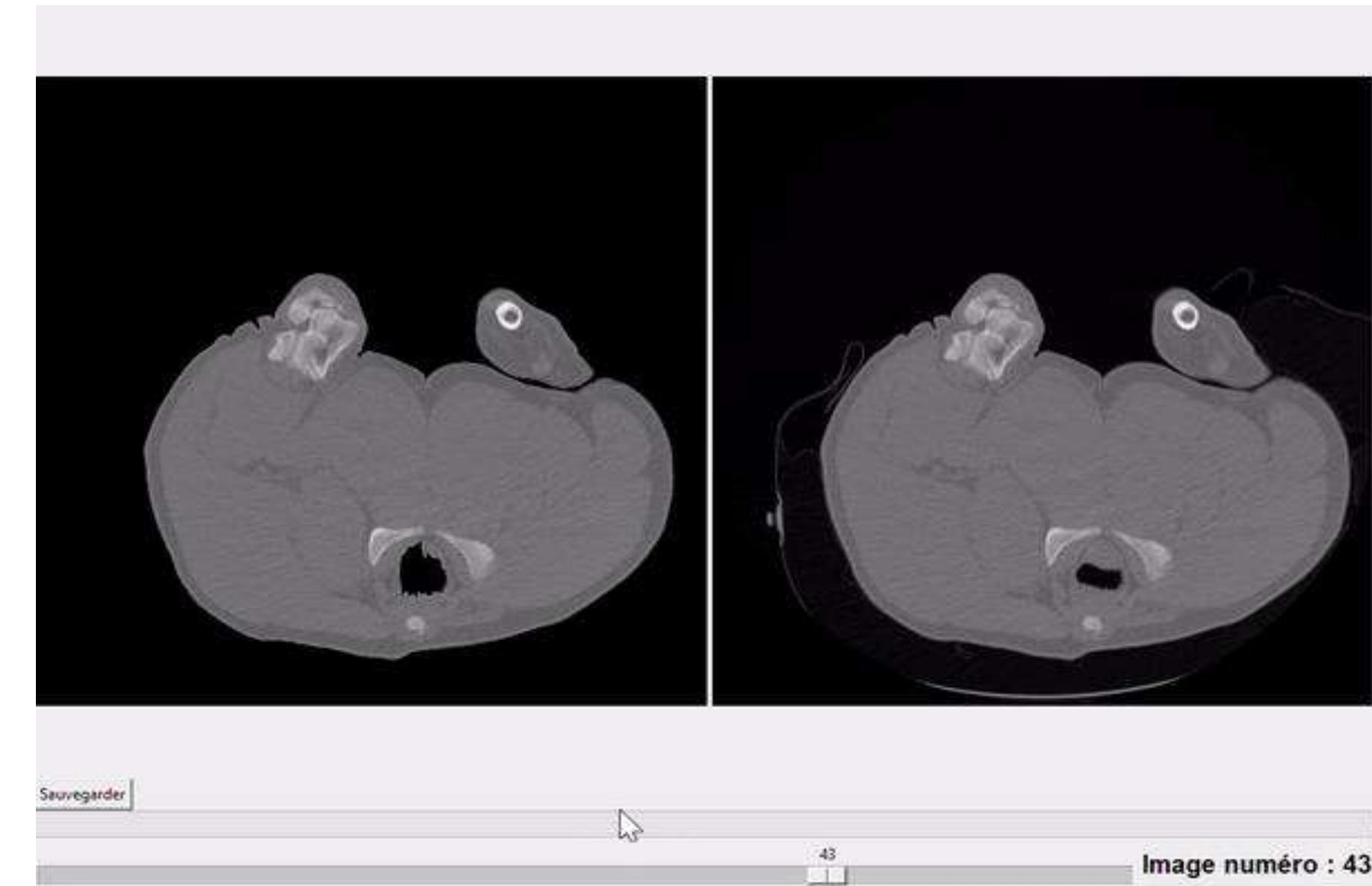
Inputting slices sequentially into our deep learning model

Analyzing body composition

V. INTEGRATION OF THE AI SOLUTION - SEGPIG DEMO



The screenshot shows a web-based application interface. At the top, there are buttons for "Ajouter les images segmentées" and "Supprimer les images segmentées". Below this, a section titled "Patients traités:" displays a list of 345 DICOM images. The list includes columns for "Image DICOM originale", "Image DICOM segmentée", and "Nombre d'image". The images are listed with names like "SegmentImage 00001.dcm", "SegmentImage 00002.dcm", etc. On the left side of the interface, there is a thumbnail image of a modern building, likely the conference venue. The bottom of the interface contains various configuration options and developer information.



SEGPIG

SEGPIG CORRECTOR

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VI. CONCLUSION - TAKE-HOME MESSAGE



Deep learning offers a fast, objective, and fully automatic alternative to semi-manual segmentation tools like TurtleSeg.

By accurately separating viscera from pig's body in X-ray images, our model enables non-invasive, scalable analysis of pig body composition across growth stages paving the way for efficient and ethical livestock research without dissection.

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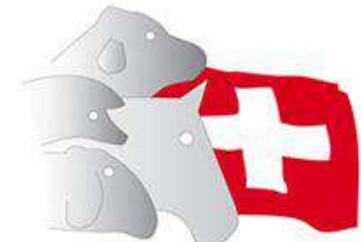
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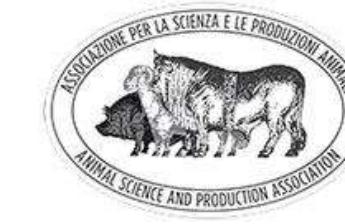
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THANK YOU FOR YOUR ATTENTION !

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