



AI assisted Cobot potential for meat cutting procedures



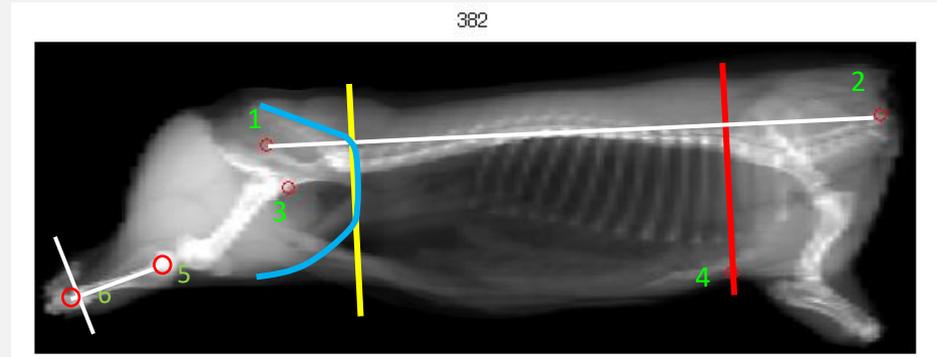
68th INTERNATIONAL CONGRESS
OF MEAT SCIENCE AND TECHNOLOGY
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Current primal cutting of pig carcasses



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Virtual Cutting into primals



The present procedure (in yellow) leaves tissue from top sirloin and crotch on ham

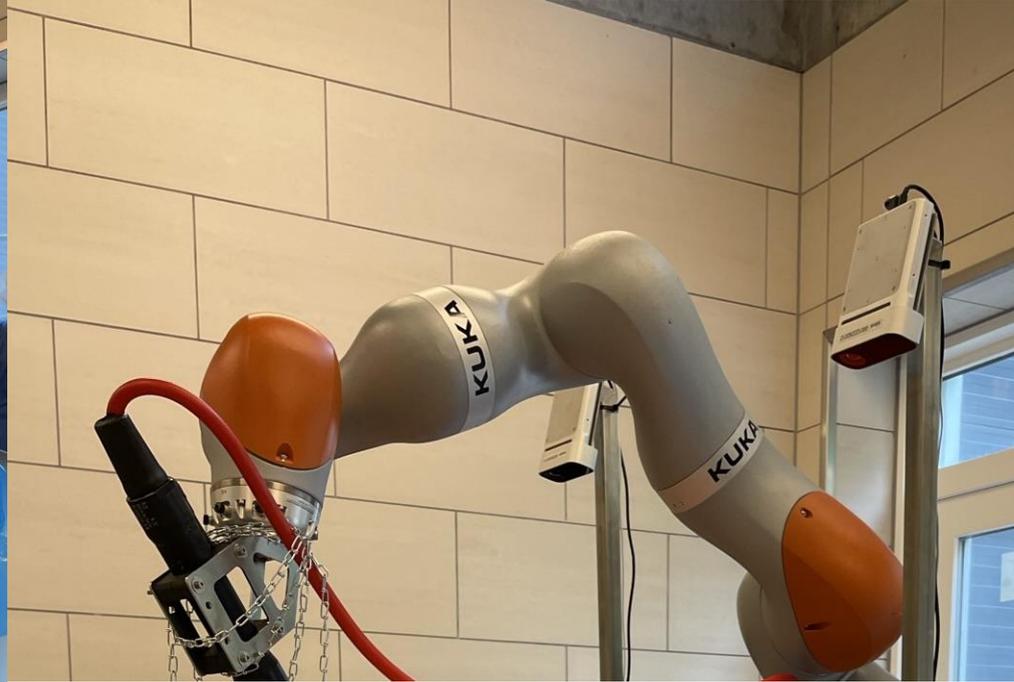
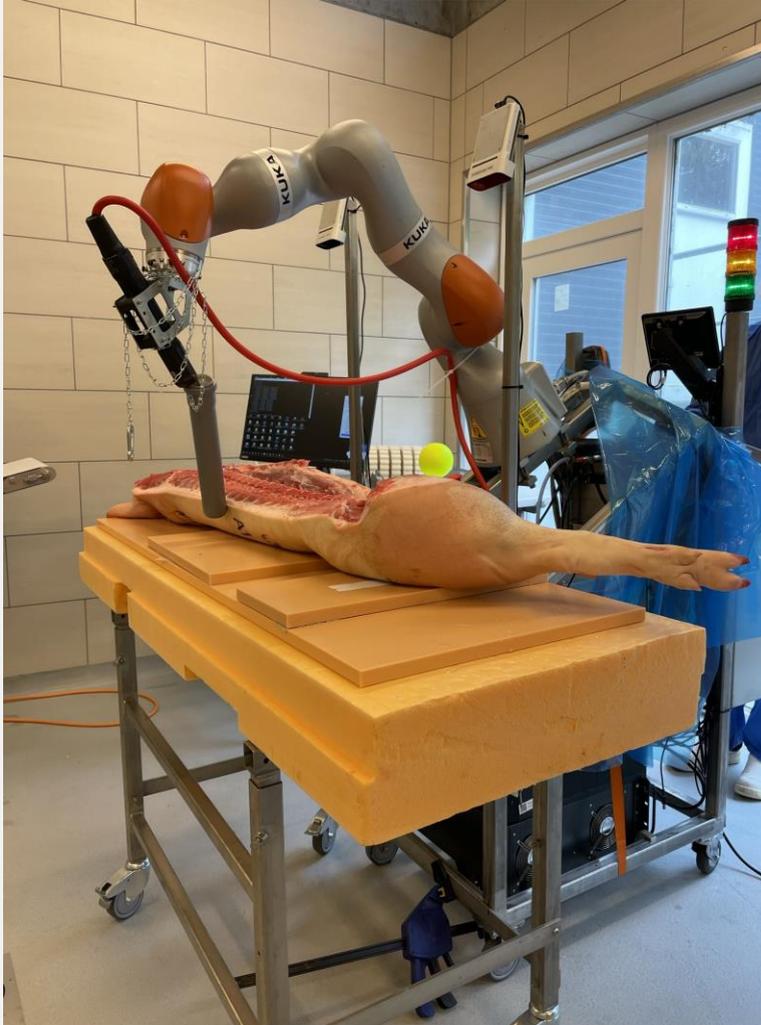
New procedure (in blue) improves yield on middle part



Set-up of work zone



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Surveying the work zone with two 3D cameras

Moving the yellow sphere in the work zone

Calibration procedure



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Color model (yellow)

Find sphere in color in depth image

Convert to 3D point cloud

Fit spherical model to yellow sphere

Find center

Rotation – align vectors

Using all 11 points

Scaling

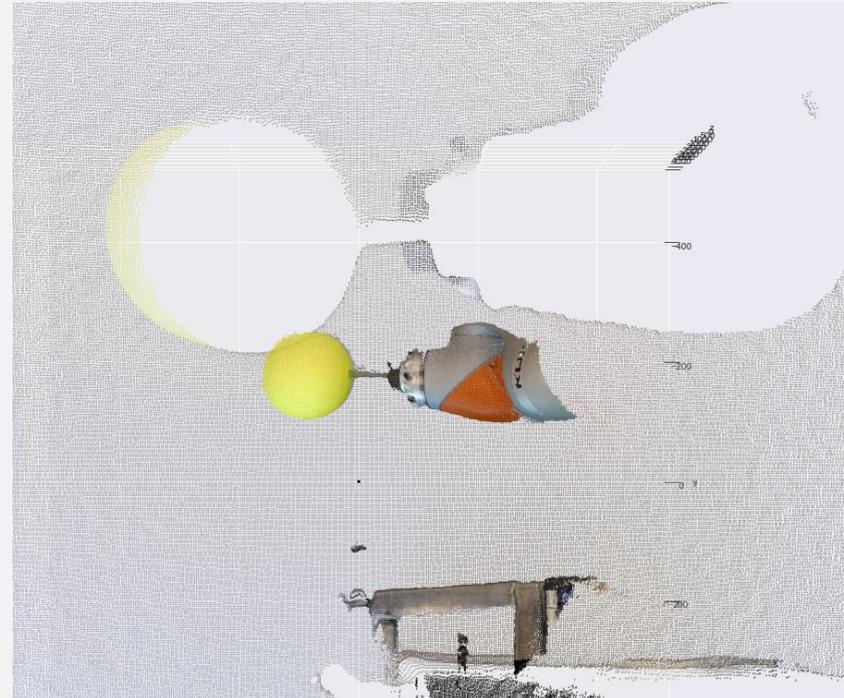
Translation

+/- 8 mm

Affine transformation

Only 4 points

+/- 6 mm



Yellow sphere in point cloud



Yellow sphere in RGB

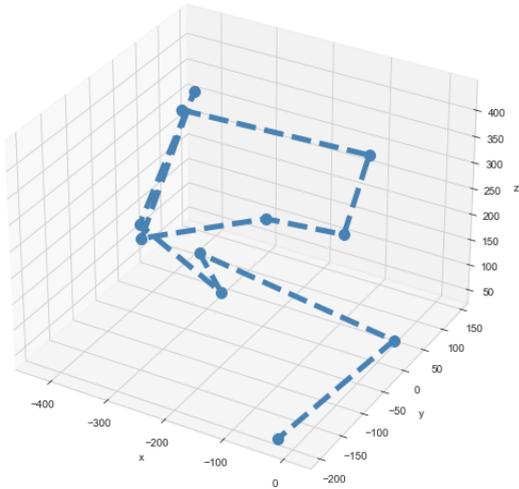
Coordinate transformation



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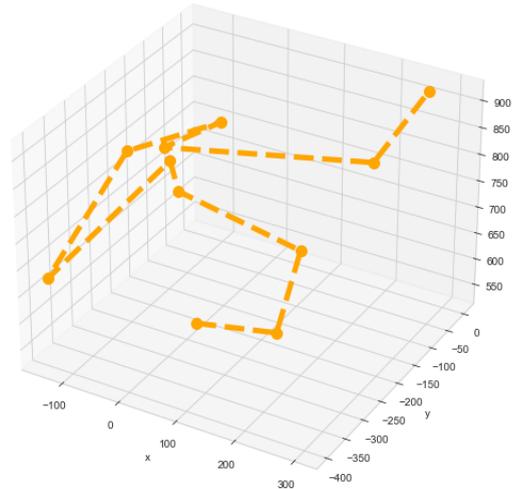
Coordinates from Cobot

Robot calibration coordinates



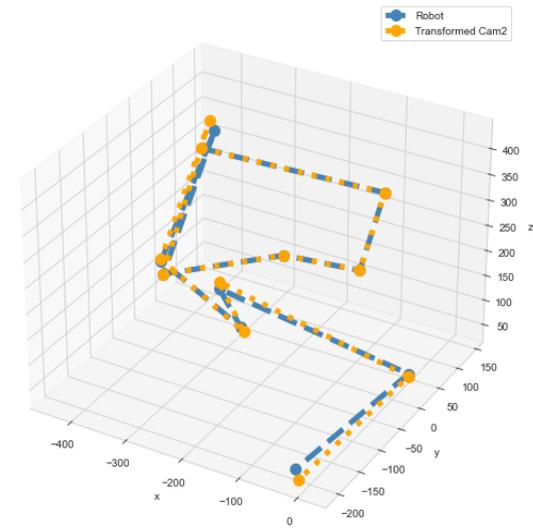
Coordinates from camera

Yellow Ball coordinates



Camera transformed to Cobot

Yellow Ball transformed coordinates



Cutting forces



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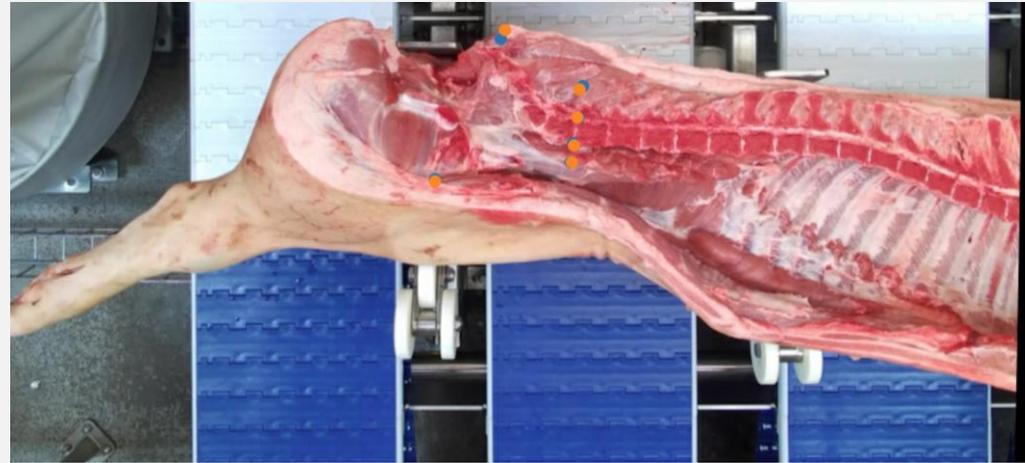


Billede af den nyeste kniv, monteret
i driveren sammen med flere
billeder af selve trolleyen

Initial experiments - left sides only



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Annotation of anatomical landmarks are supported by bone position

Cutting a carcass with removed spinal bones to demonstrate the reciprocating knife mounted as end-of-arm tool on a KUKA iiwa LBR820 cobot.



Splitting the vertebrae



A reciprocating saw makes its way through a spinal bone

Force impact (top) < 10N

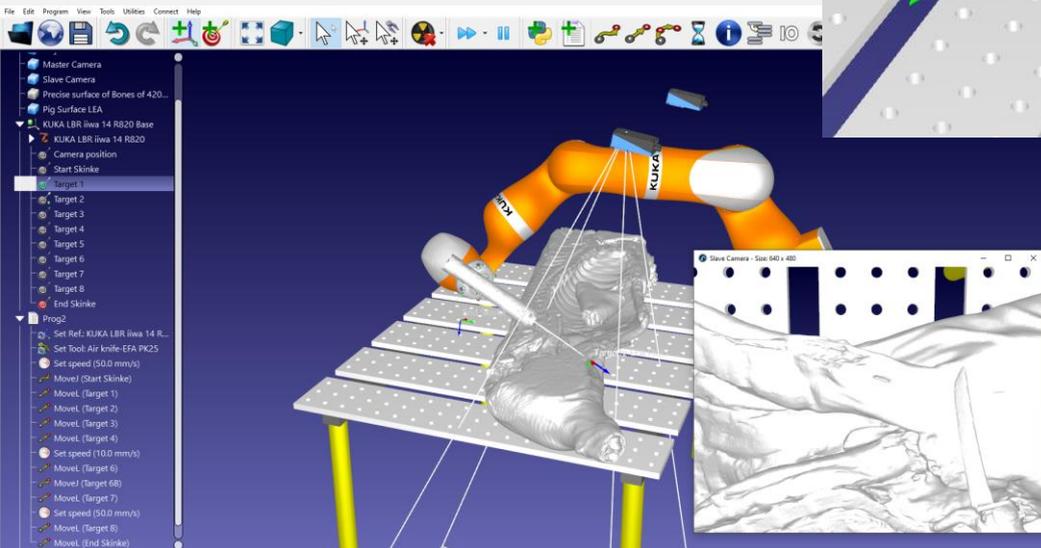
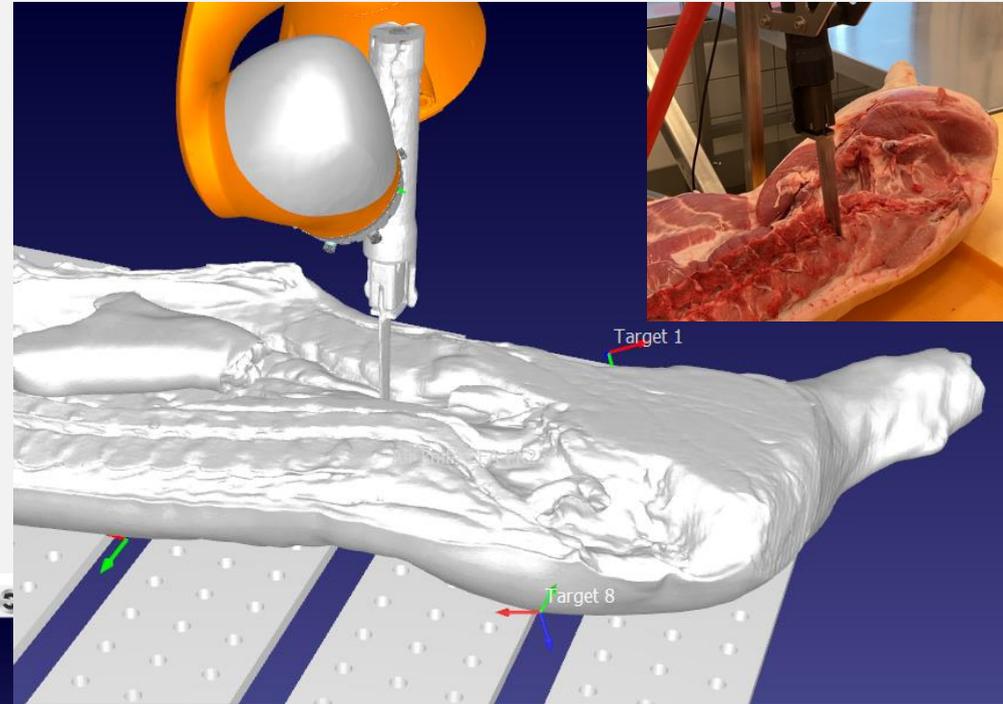
Inferior cutting face appearance from sawing in fresh meat



Generating the generic trajectory



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RoboDK offers several simulation tools for optimizing the generic trajectory

The RGB images illustrates the real cutting

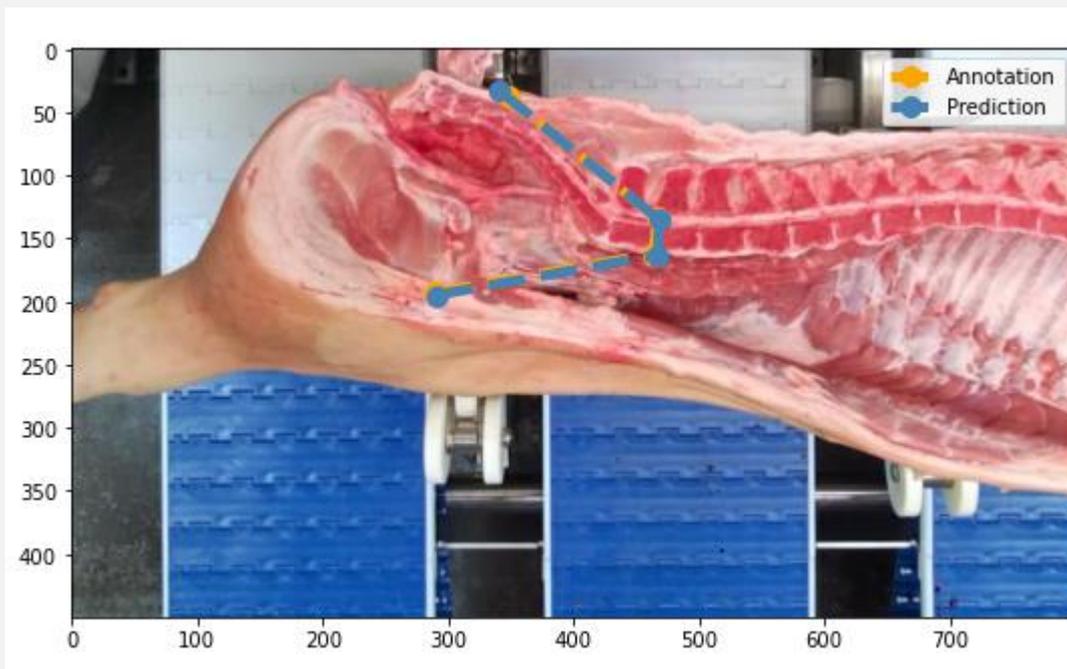
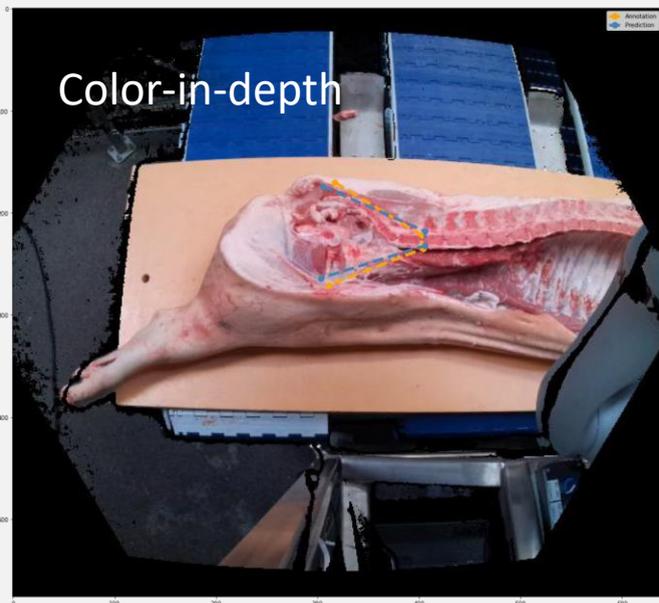


Prediction of landmarks - training



Prediction (blue) on different backgrounds

Annotation (orange) is best on spinal vertebra

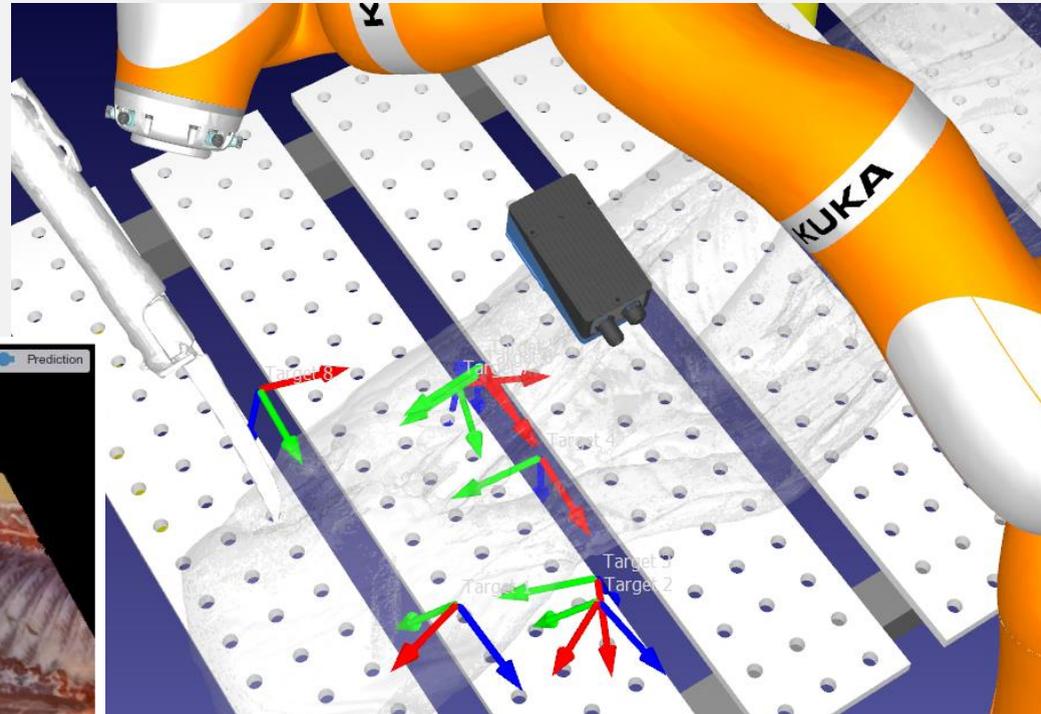


Interfacing the trajectory



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Four primary landmark predictions



Eight generic target points
Including the TCP pose for each
target point
The CT carcass surface is shown
transparent

Demonstration



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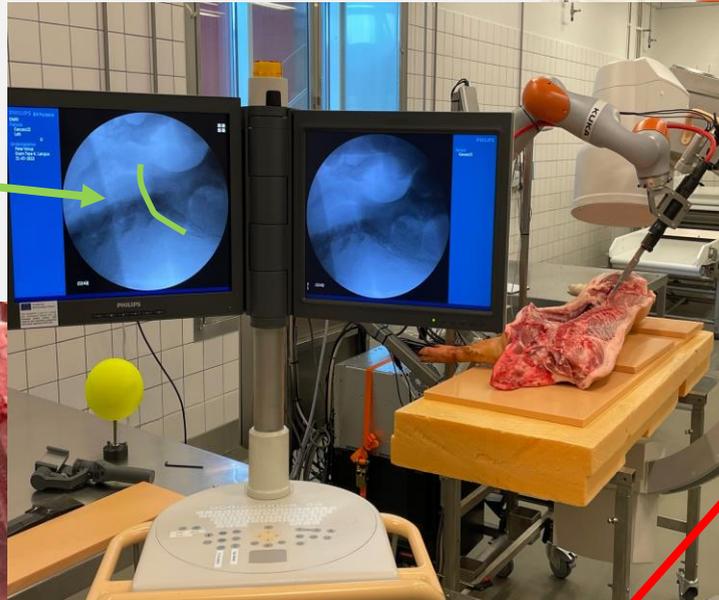
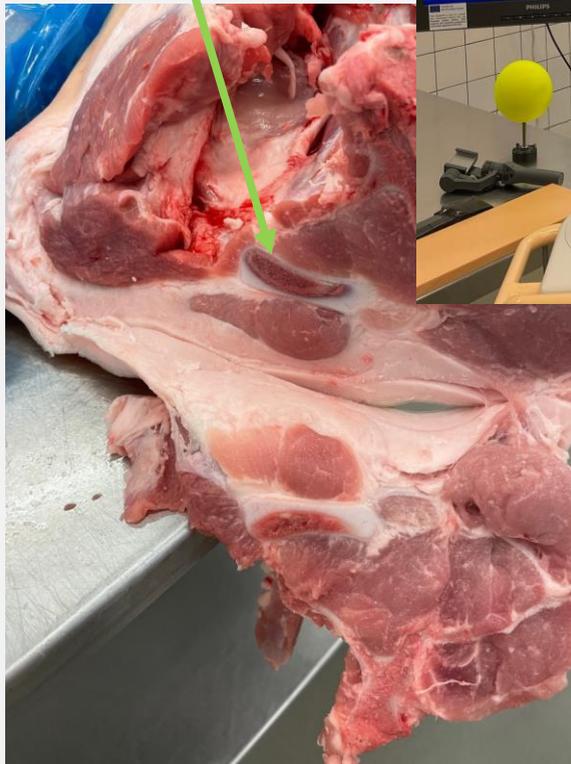


Next step: Cutting with X-ray support



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Hip bone



X-ray
detector





Take home messages

- Reciprocating cutting reduce the need for fixation
- Combined cutting blades to cope with bones
- 3D vision and AI for real-time detection of landmarks
- The automated procedure opens for X-ray assistance
- Cobots with knives may conflict safety regulations