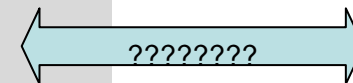
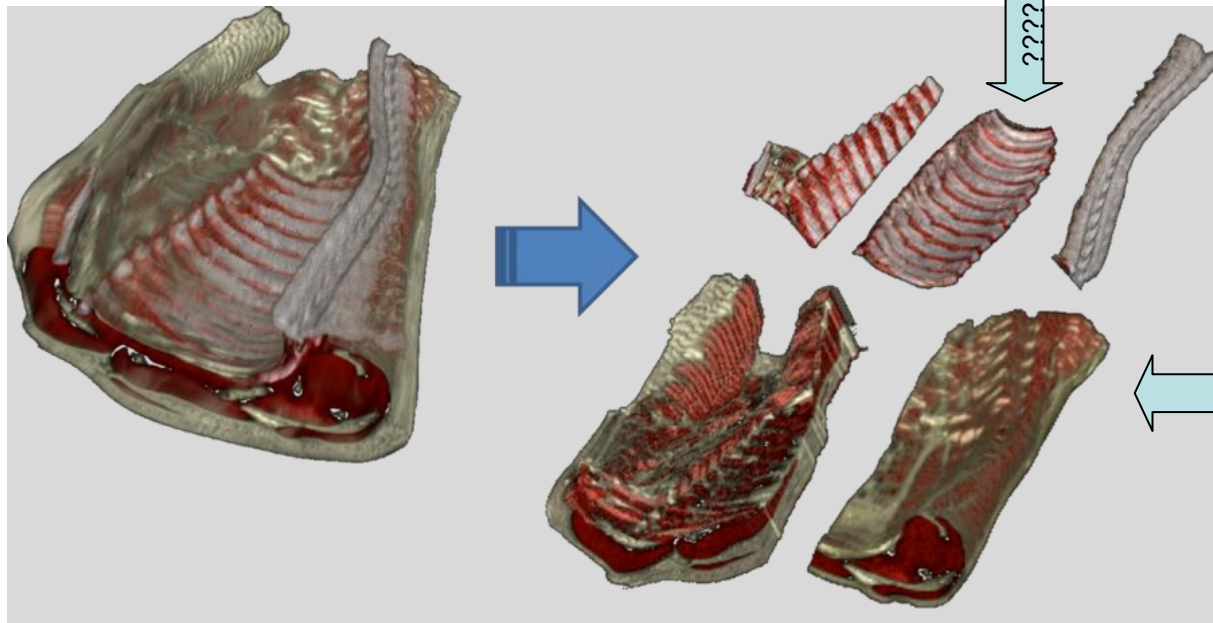
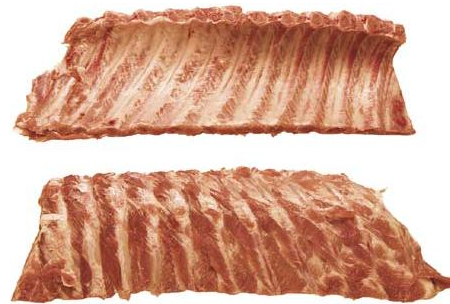
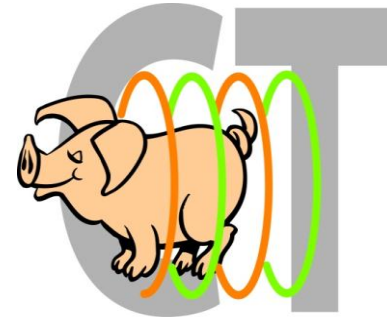


Accuracy in Biology



Application of
CT Scanning in (Meat) Industry

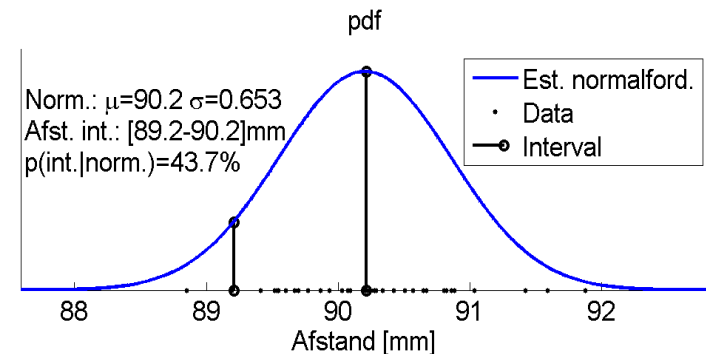
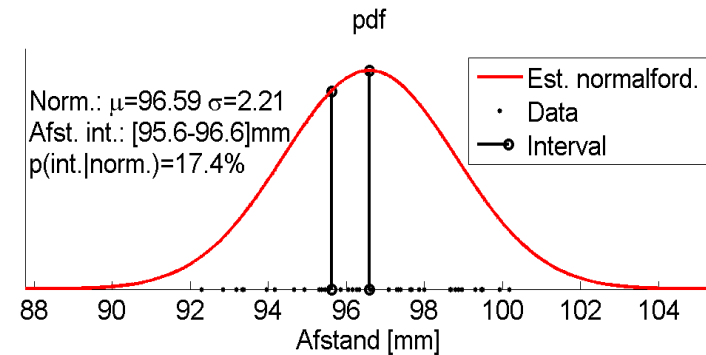
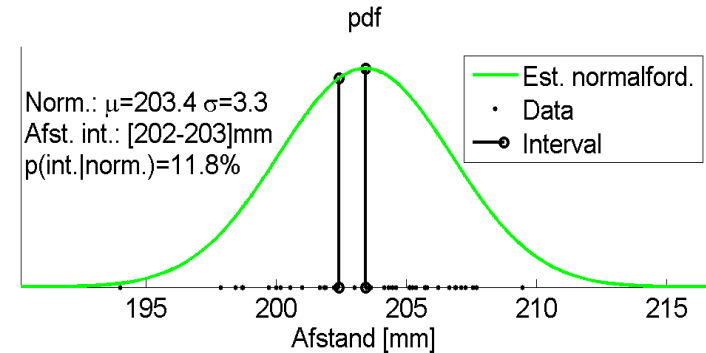
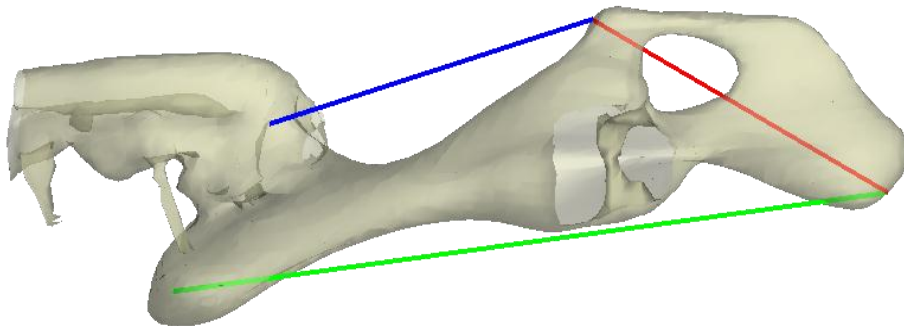


Motivation

- statistics of rigid anatomy

Quantify anatomic variation

- Geometric reference
- Rigid structure
- Design tool



Motivation

- statistics of yield



$$\text{Yield} = \frac{\text{Final product [kg]}}{\text{Raw material [kg]}}$$

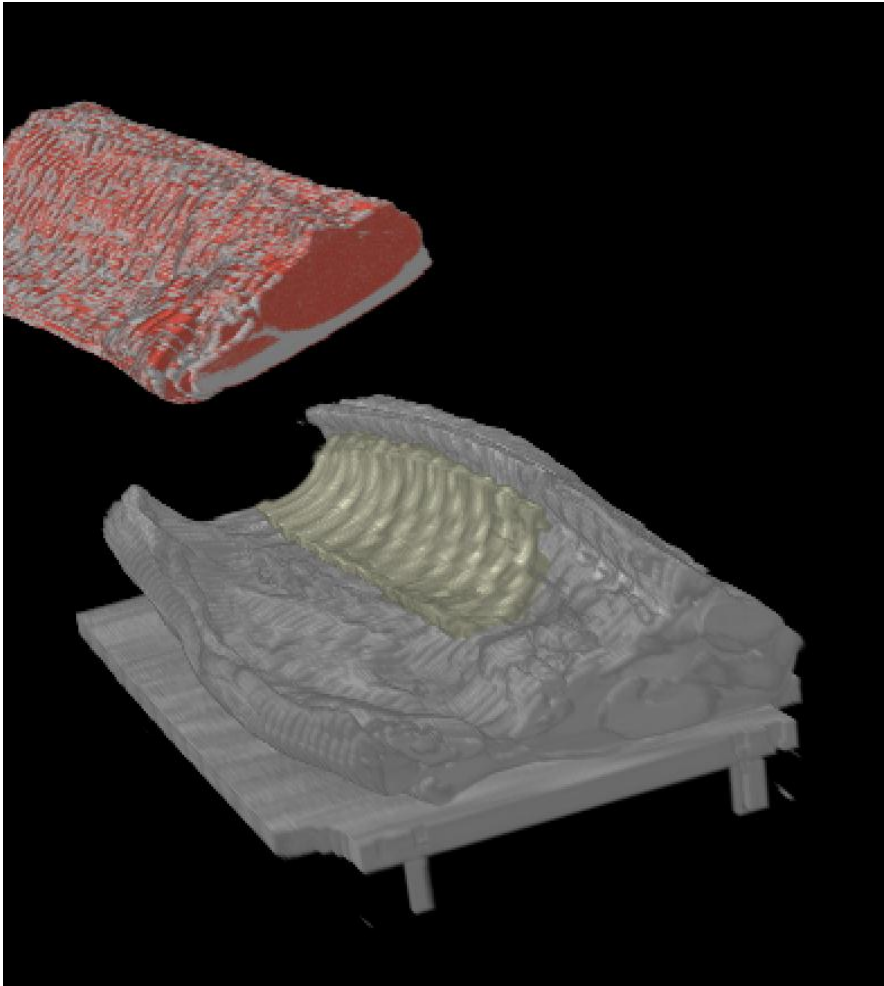
Use the right raw material
for a specific final product

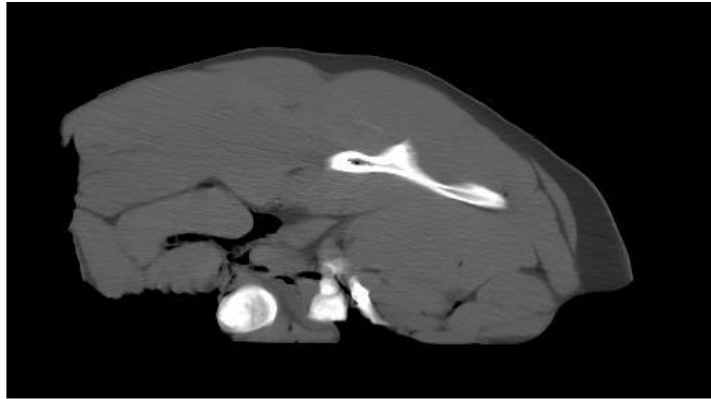
Challenge:

- Elastic structure

Benefits:

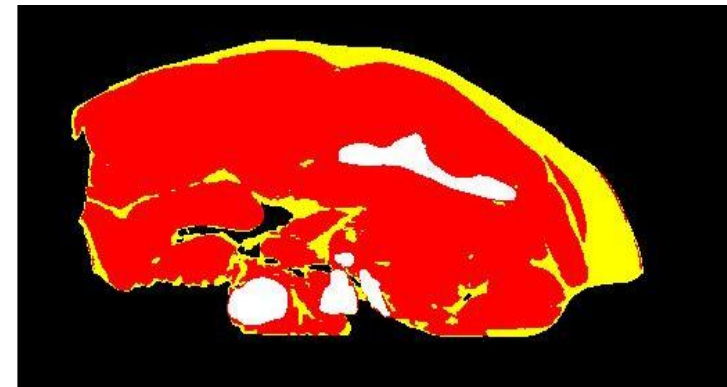
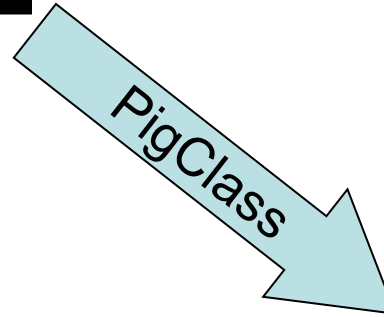
- Product planning
- Cost estimation
- Controlling machines





$$W_{\text{total}} = V_{\text{fat}} \cdot \beta_{\text{fat}} + V_{\text{meat}} \cdot \beta_{\text{meat}} + V_{\text{bone}} \cdot \beta_{\text{bone}}$$

- Based on weight measurement
- Objective & reproducible
- Warm or chilled carcass



Primal cutting

OPUS+ Cutting

Menu
Dataset
Upload
Cutting
Logged in as lbc
Log out

Cutting Yield
Current Dataset: Grp 1

Primal	Average	Std.
Leg	0.3181905	0.0093580
Middle	0.3858009	0.0150542
Fore-end	0.2960086	0.0150645

Cutting Yield
Current Dataset: Grp 1

Primal	Average	Std.
Leg	0.3286186	0.0094702
Middle	0.3751728	0.0149970
Fore-end	0.2960086	0.0150645

Apply
Export



Real vs. virtual

OPUS+ Cutting

Menu
Dataset
Upload
Cutting
Logged in as lbc
Log out

Cutting Yield
Current Dataset: Grp 1

Primal	Average	Std.
Leg	0.3181905	0.0092937
Middle	0.3858009	0.0149507
Fore-end	0.2960086	0.0149610

© Danish Meat Research Institute 2010 - Version: 1.6 29-03-2010

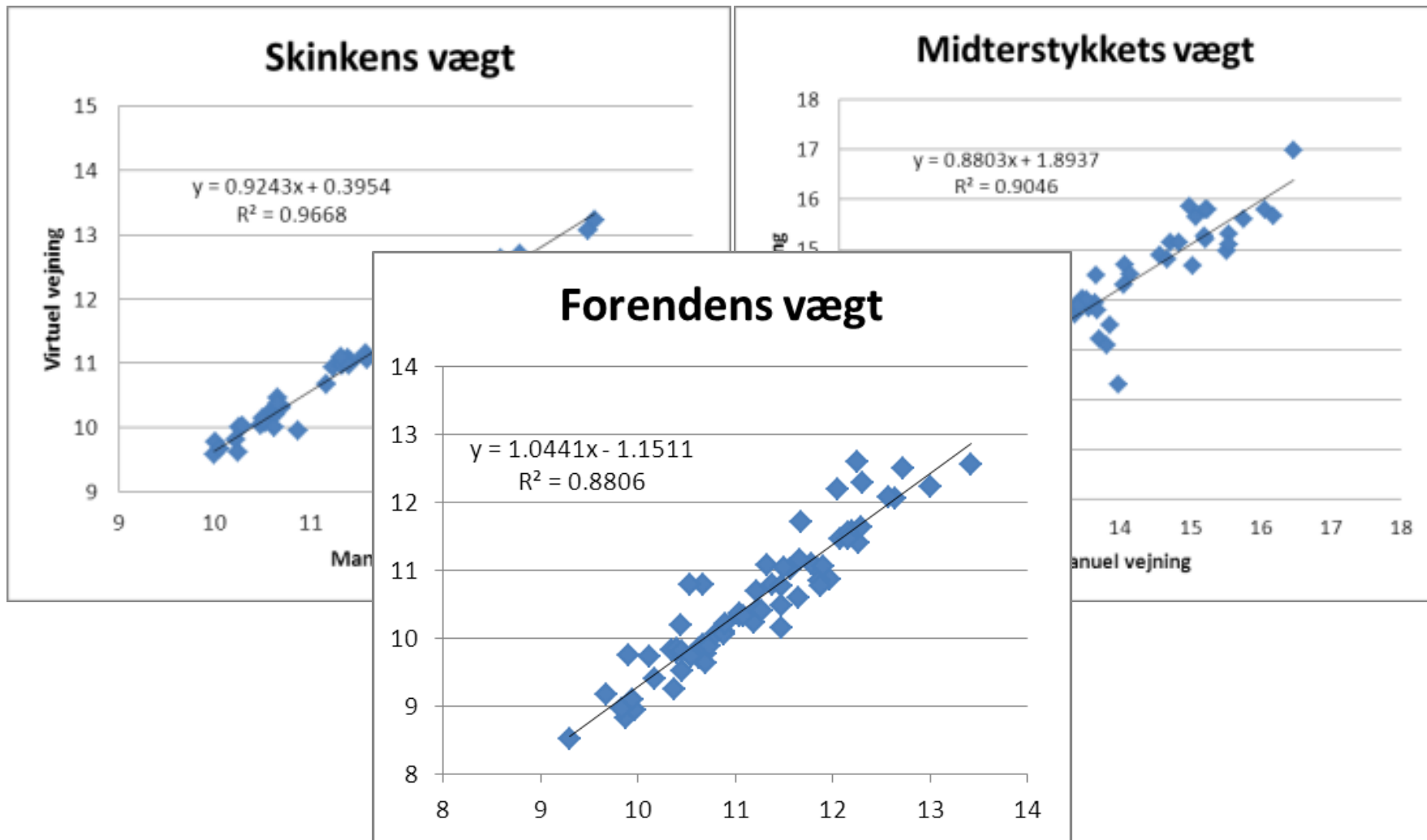
- Cutting yield by expert points

- Cutting yield by algorithm points

- Mean and SD of difference

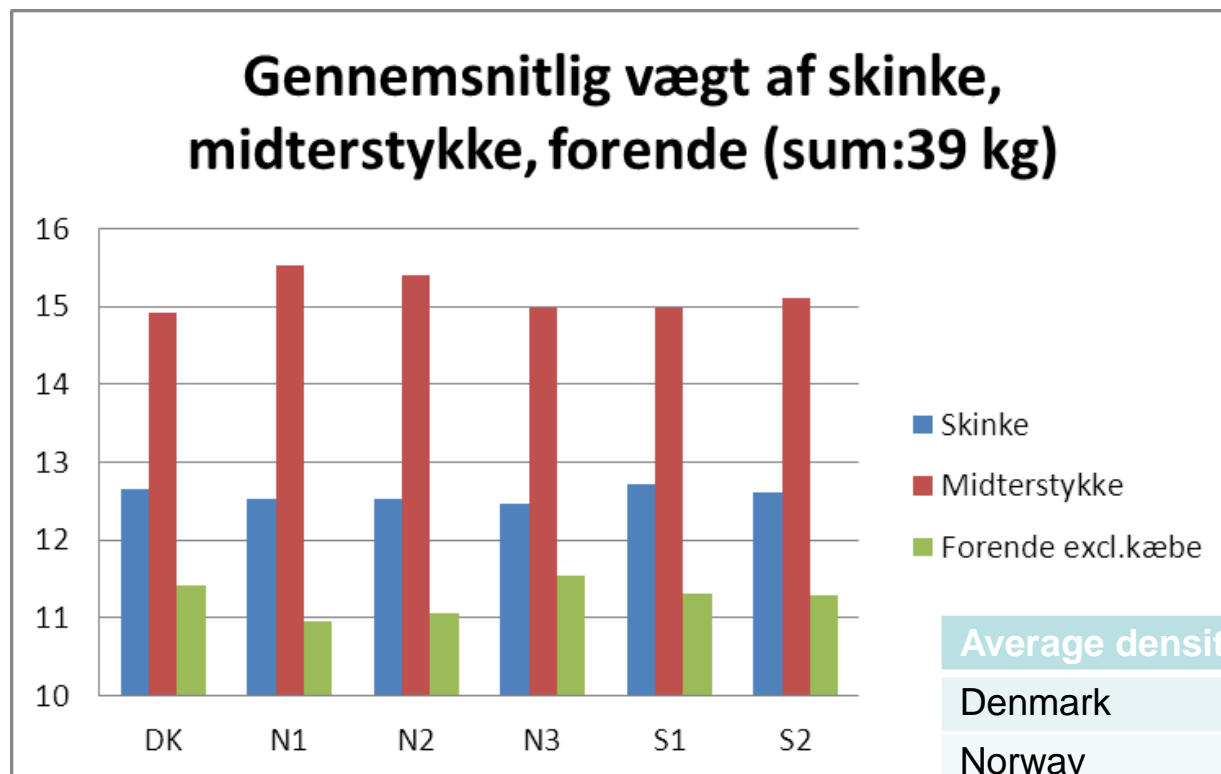
Cutting into Primals	Ham	Middle	Shoulder
Mean difference	-0.0023	-0.0027	0.005
Rel. mean difference	-0.71%	-0.73%	1.6%
Standard deviation	0.0028	0.0083	0.0068

Cutting level I



Estimating primal yield

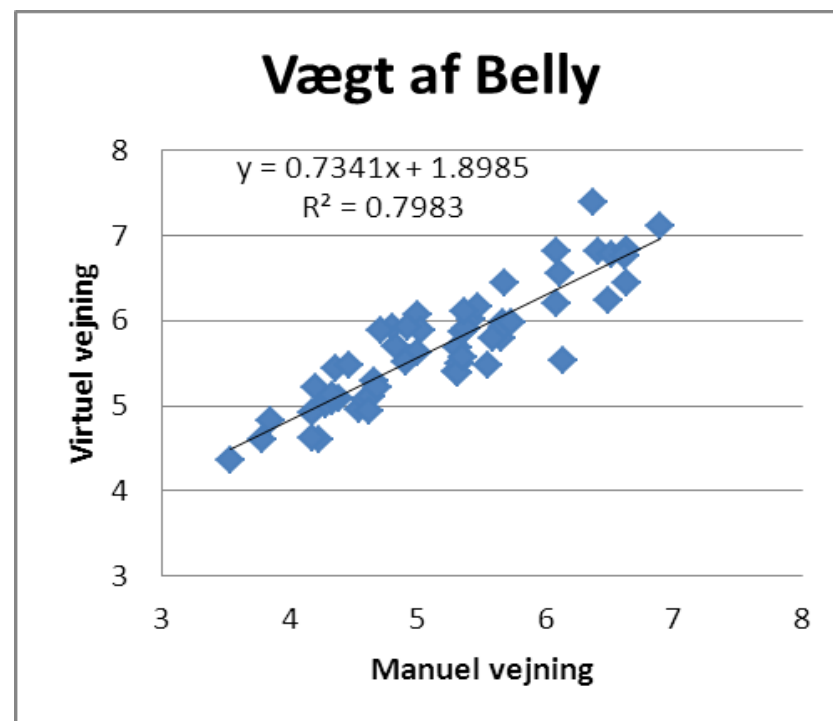
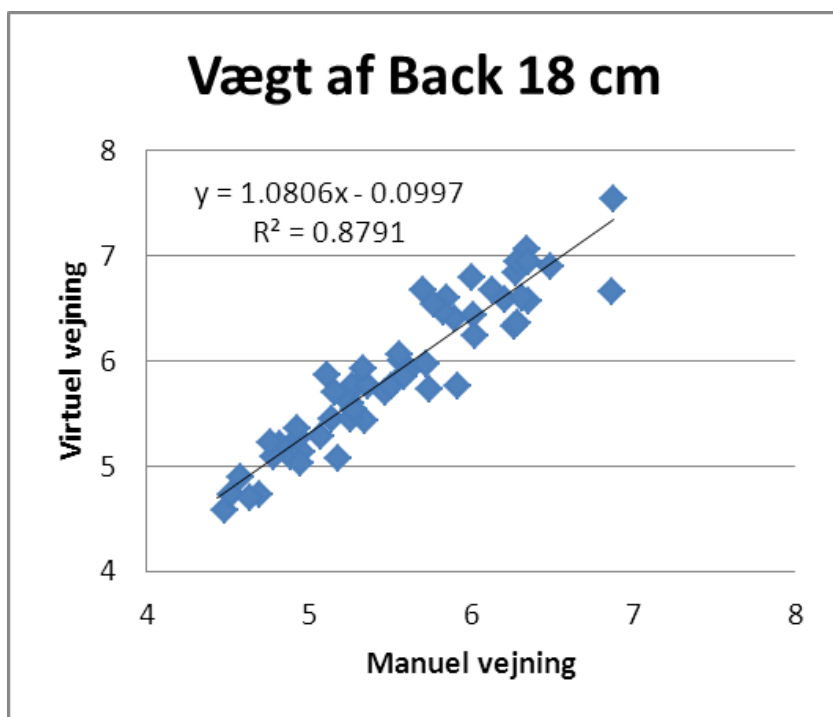
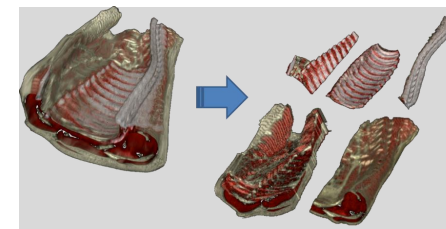
Cutting level I



Average densities	Fat	Meat	Bone
Denmark	0.997	1.117	1.433
Norway	0.976	1.105	1.434
Germany	0.984	1.108	1.463
Sweden	0.990	1.120	1.419

✓ Objectivity in benchmarking

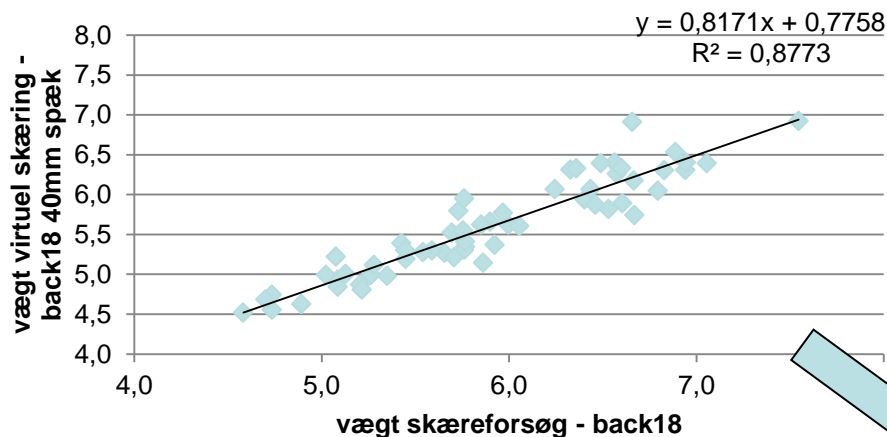
Cutting level II



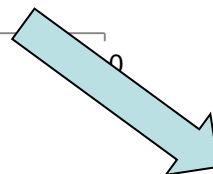
Estimating final
product yield

Cutting level III

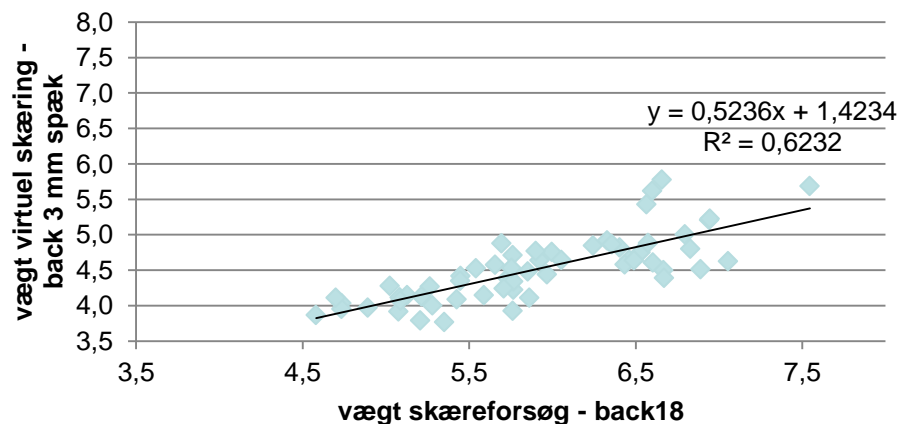
**Virtuel skæring vs. skæreforsøg
back18 40 mm**



Cutting complexity increases
- for algorithm and operator



**Virtuel skæring vs. skæreforsøg
back18 3 mm**

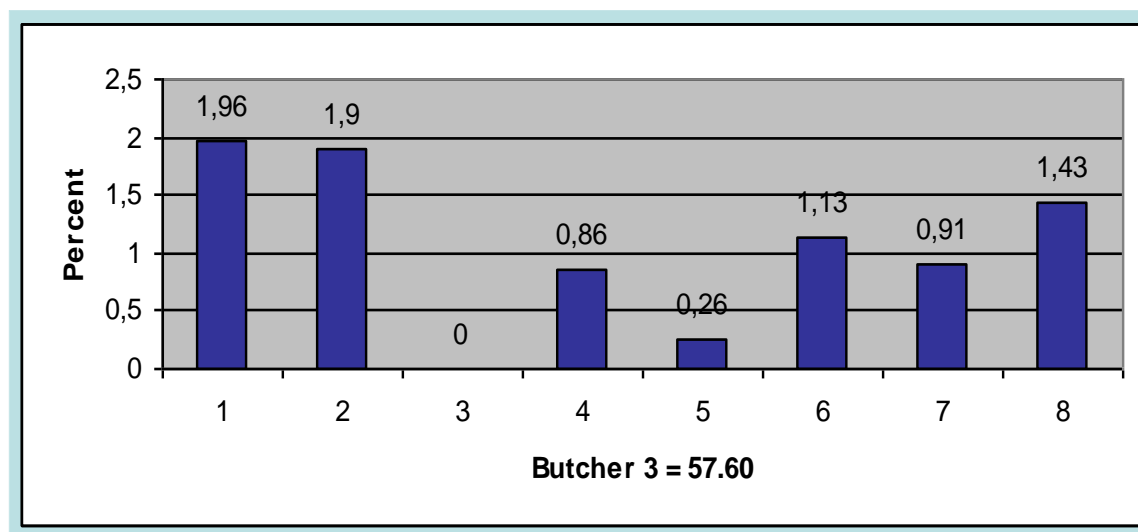


Accuracy chain

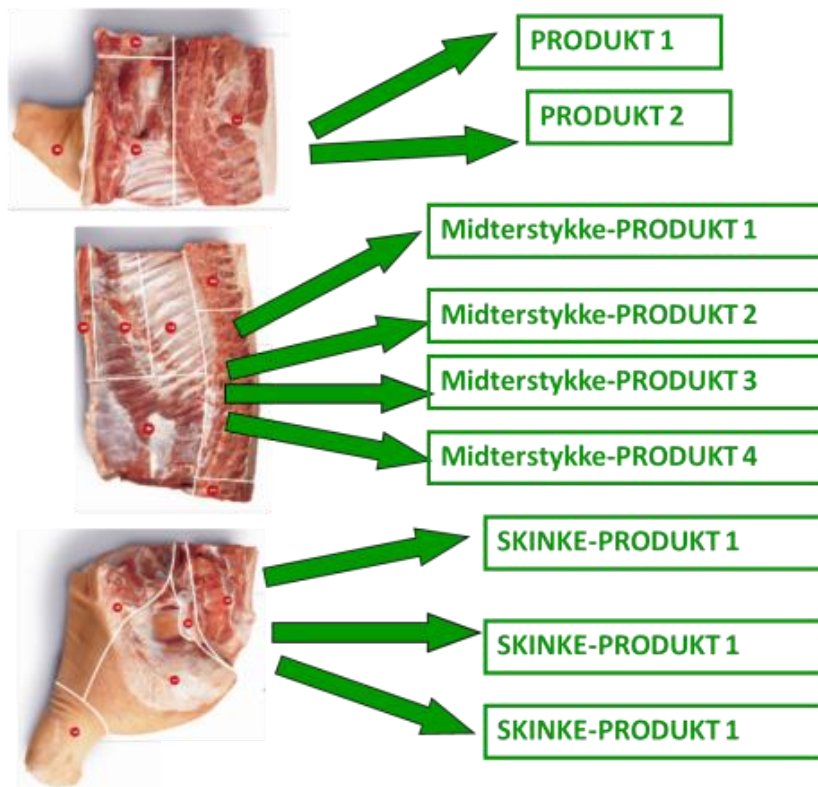
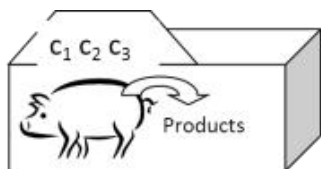
- Virtual cutting

Process	Scanning protocol	Assessment	Tissue density	Cutting level
Primary contributions	Manufacturer	Algorithm	Age	Recipe
	Reconstruction		Breed	Alignment
	Slice thickness		Feeding	
	Energy			
Range	0.1% - 1.0%	0.1% - 1.3%	Approx. 1 %	In progress

- Expert cutting



Questions??



Lars Bager Christensen
lbc@teknologisk.dk

Thanks to:

Allan Lyckegaard, Peter Stanley, Hans Henrik Thodberg, Mads Fogtmann, Martin Vester-Christensen, Søren Erbou, Thomas Mosbech, Lasse Farnung Laursen, Bjarne Ersbøll, Rasmus Larsen, Michael Judas, Jesper Blom-Hanssen, Claus Borggaard, Eli V. Olsen, Marchen Hviid, Ronald Sørensen, Claus Søndergård, Peter Vorup, Torben Kvamm, Mianne Darré, Bo Jespersen, Mikkel Engbo Jørgensen, Omar Gamarra, Niels Chr. Kjærsgaard,