

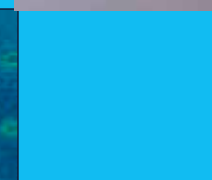
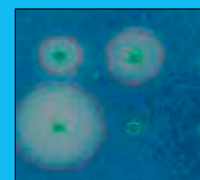
SpectraSeed: Seed phenotype database through spectral imaging

Jens Michael Carstensen

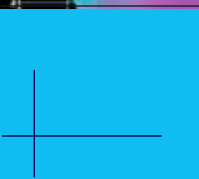
CTO, Videometer A/S

Assoc. Prof. DTU Compute

Affiliated professor of organism imaging,
University of Copenhagen



Coworker acknowledgement
Karsten Hartelius, Videometer A/S
Kåre Jensen, Videometer A/S





SpectraSeed

Funded by:



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AARHUS
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DLF
TRIFOLIUM
SEEDS & SCIENCE



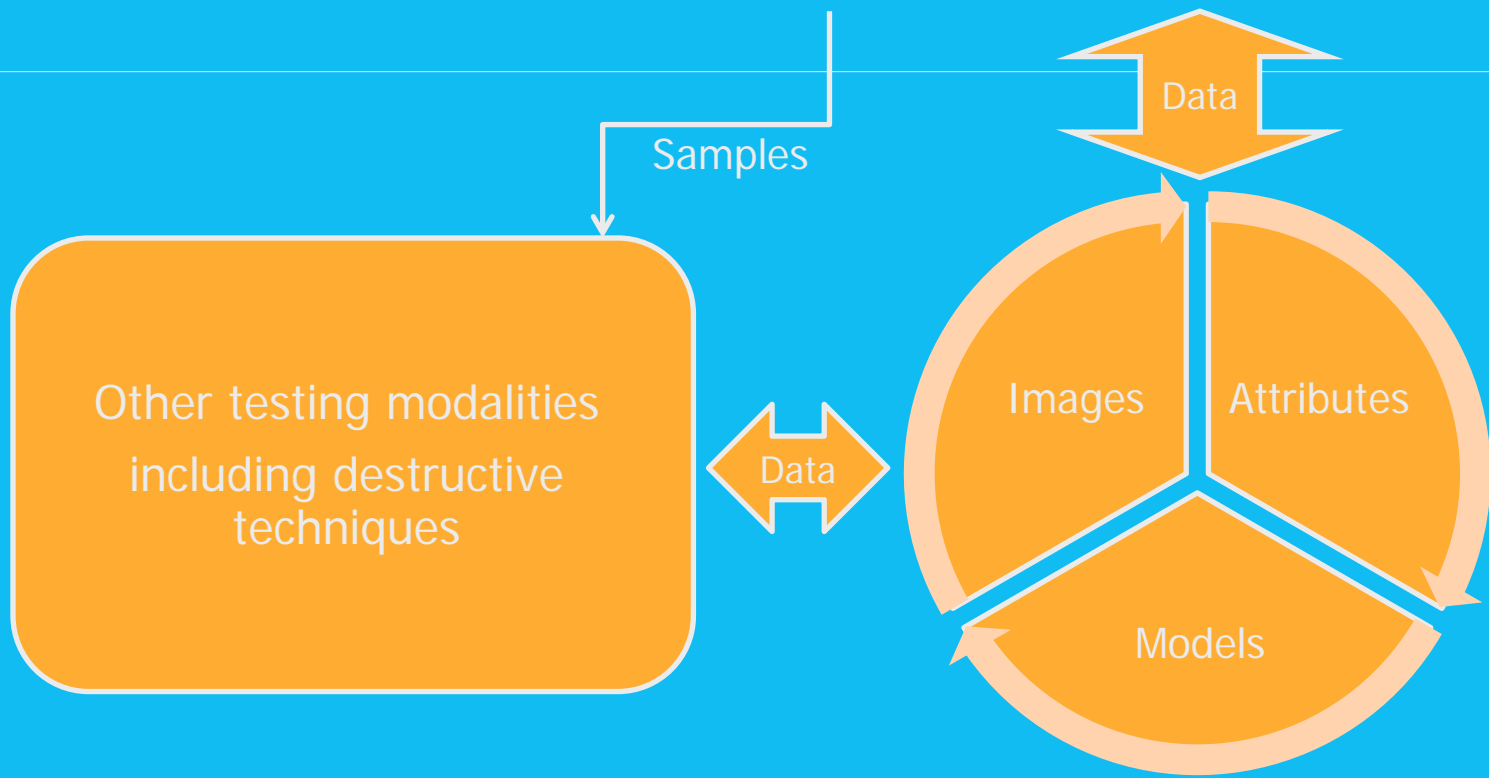
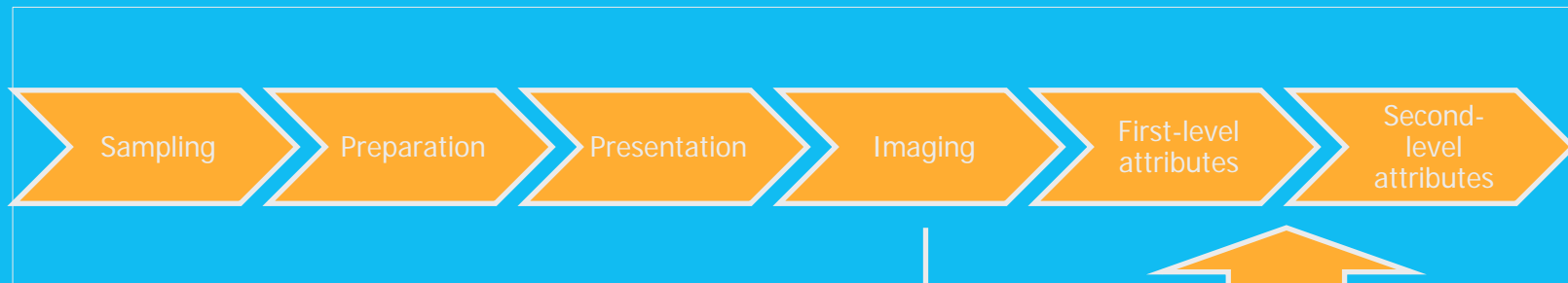
westrup



Jensen Seeds A/S 

Concept

Spectral imaging seed testing protocol



On-line phenotype database

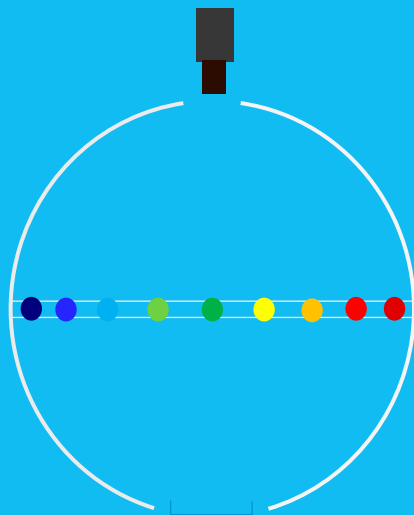




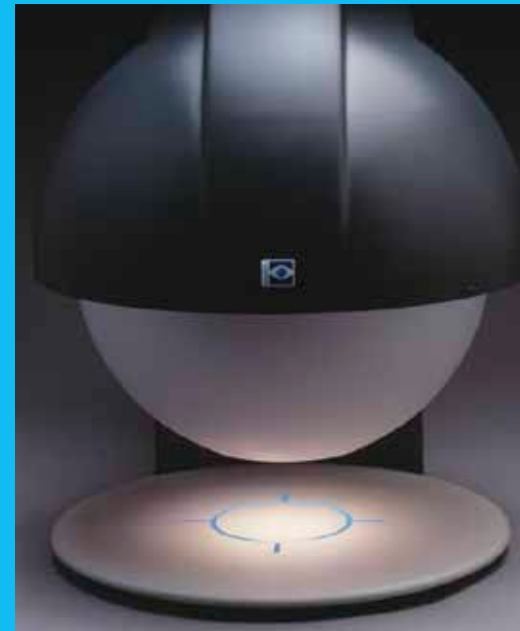
Use case in malting industry



Videometer BSQ Spectral Imaging



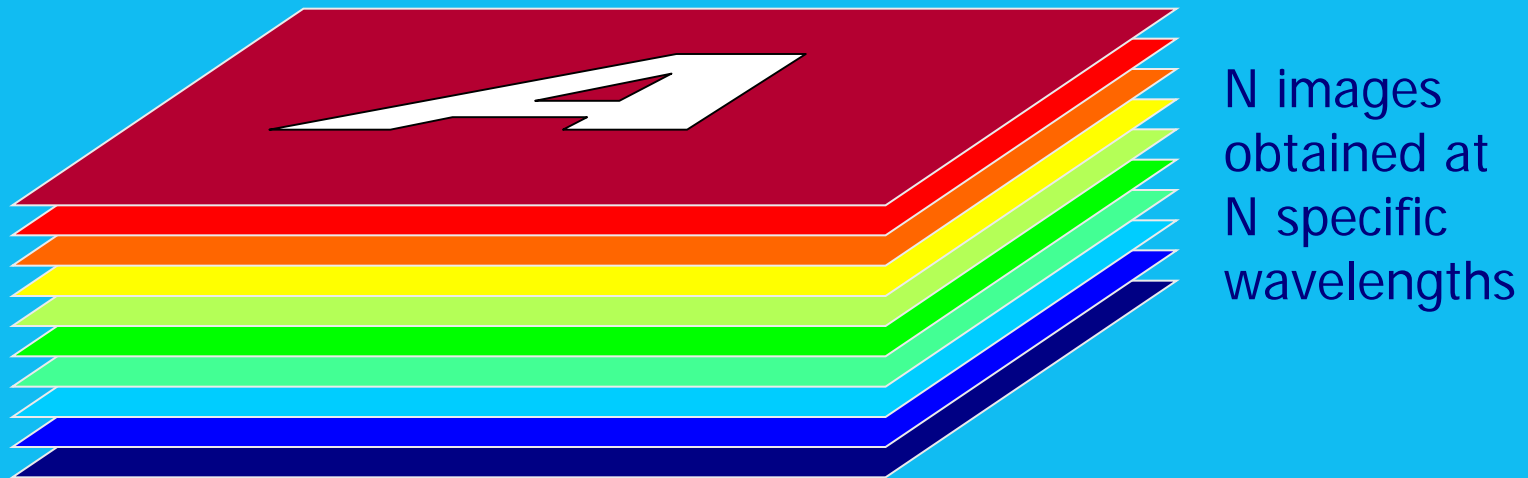
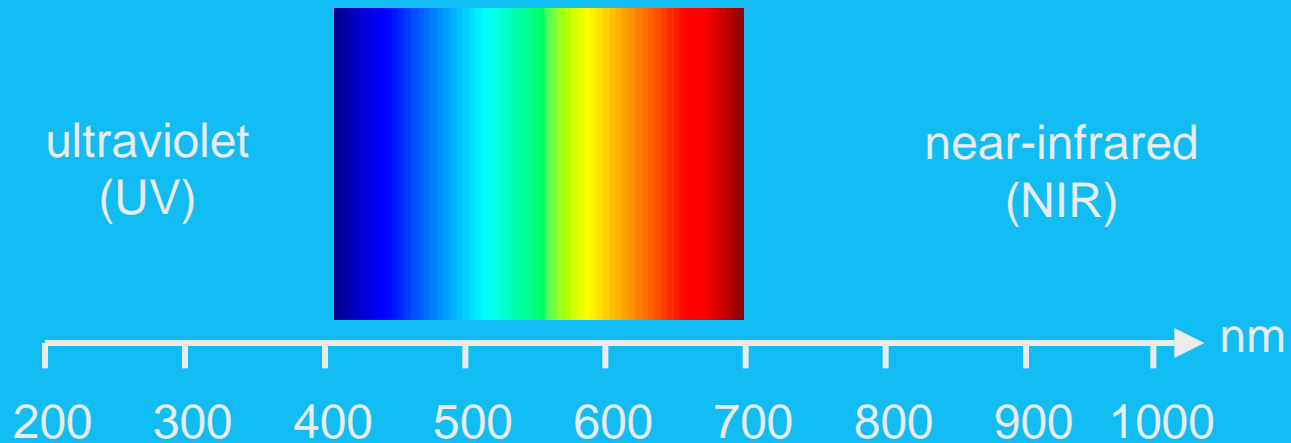
Camera
Lens
Integrating sphere
LEDs of multiple wavelengths
Sample is placed in target opening



- LEDs: Stable, durable, large selection, rapidly developing technology
- Up to 20 different high-resolution bands acquired sequentially in 0.5-1.5 seconds depending on camera
- May be combined with emission filters, backlight, and darkfield illuminant



Band-sequential spectral imaging



Imaging

- Rapid, non-destructive measurement
- 10-20 seconds per sample including handling
- May easily be combined with other measurements – even destructive techniques
- High versatility measurement
- Focus on
 - Reproducibility
 - Traceability
 - Robustness
 - Transferability



First-level attributes

Spectral and morphological seed characteristics

- Size
- Shape
- Color
- Topographical texture
- Spectral texture
- Spectral components related to surface chemistry
- Count



Second-level attributes

- Seed purity
- Germination percentage
- Germination rate
- Seed vigour
- Seed health
- Seed maturity
- Seed longevity
- ...



On-line phenotype database

- Seed images
 - Tagged with origin data
- First-level attributes
 - Calculated from spectral images
- Second-level attributes
 - Measured by a number of different techniques including destructive techniques and subjective scoring
- Modelling algorithms to link first-level and second-level attributes
- Background services: sanity check, novelty detection etc.

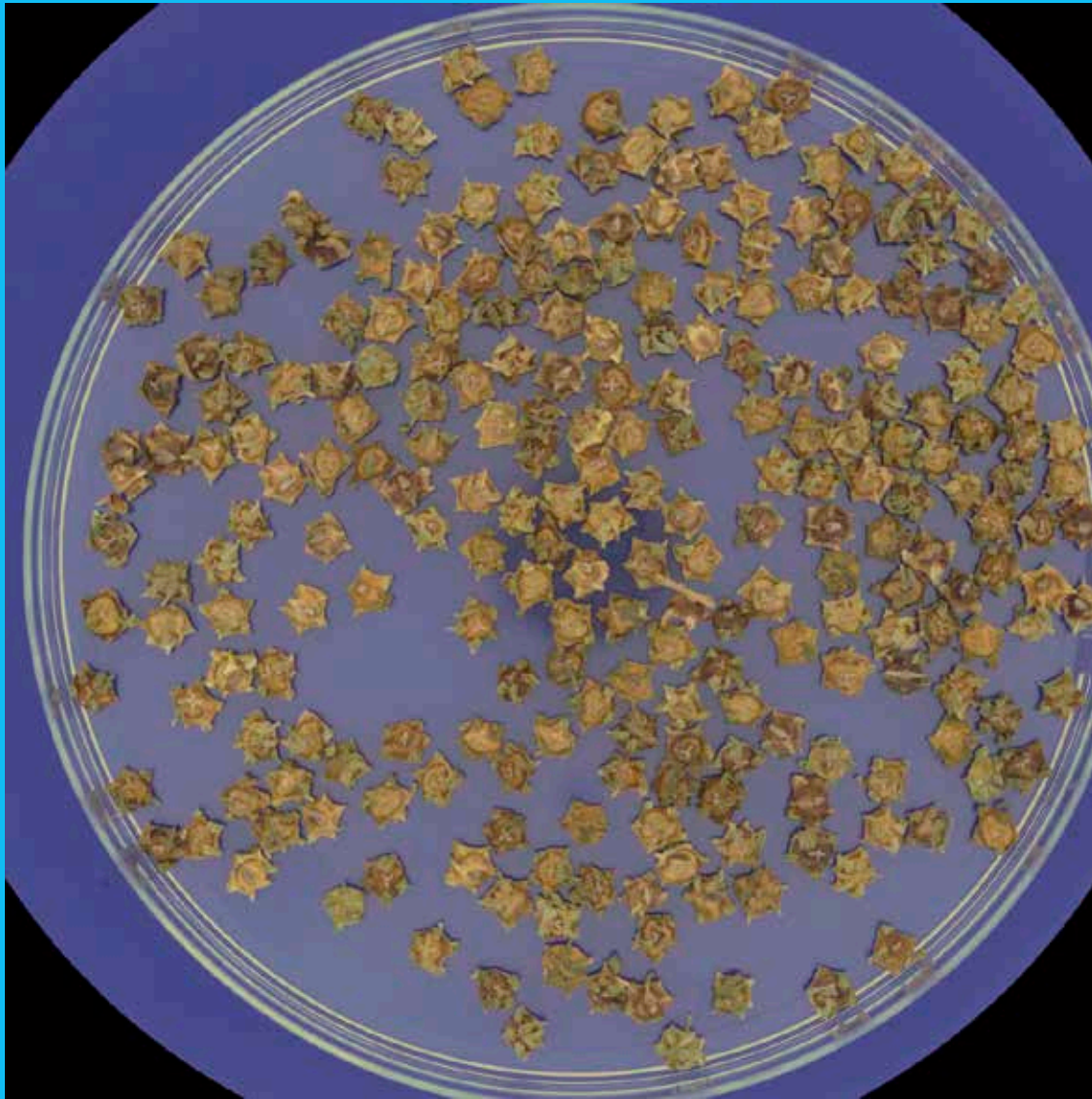


Database use cases

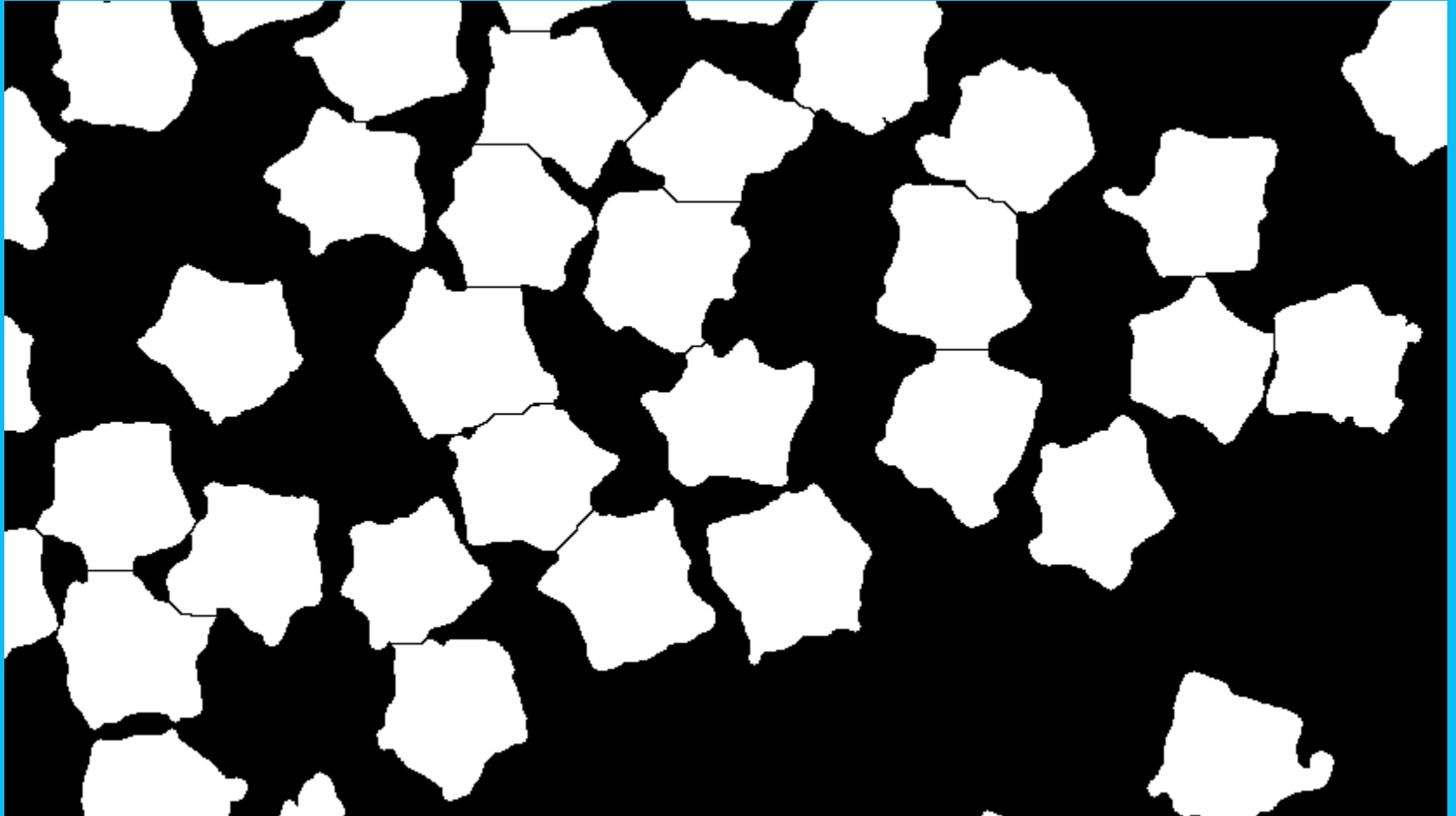
- Data support for parameterized generation of first-level attributes e.g.
 - Segmentation and identification of single seeds in a single layer presentation with touching seeds
 - Feature generation adapted to seed orientation like germ end orientation, dorsal/ventral/side presentation
- Dynamic generation and updating of prediction models for second-level attributes. These are based on a data support selected on e.g. crop, season, geographical region, instrument, data supplier and user.
- Data mining resource



Sugar beet seed example



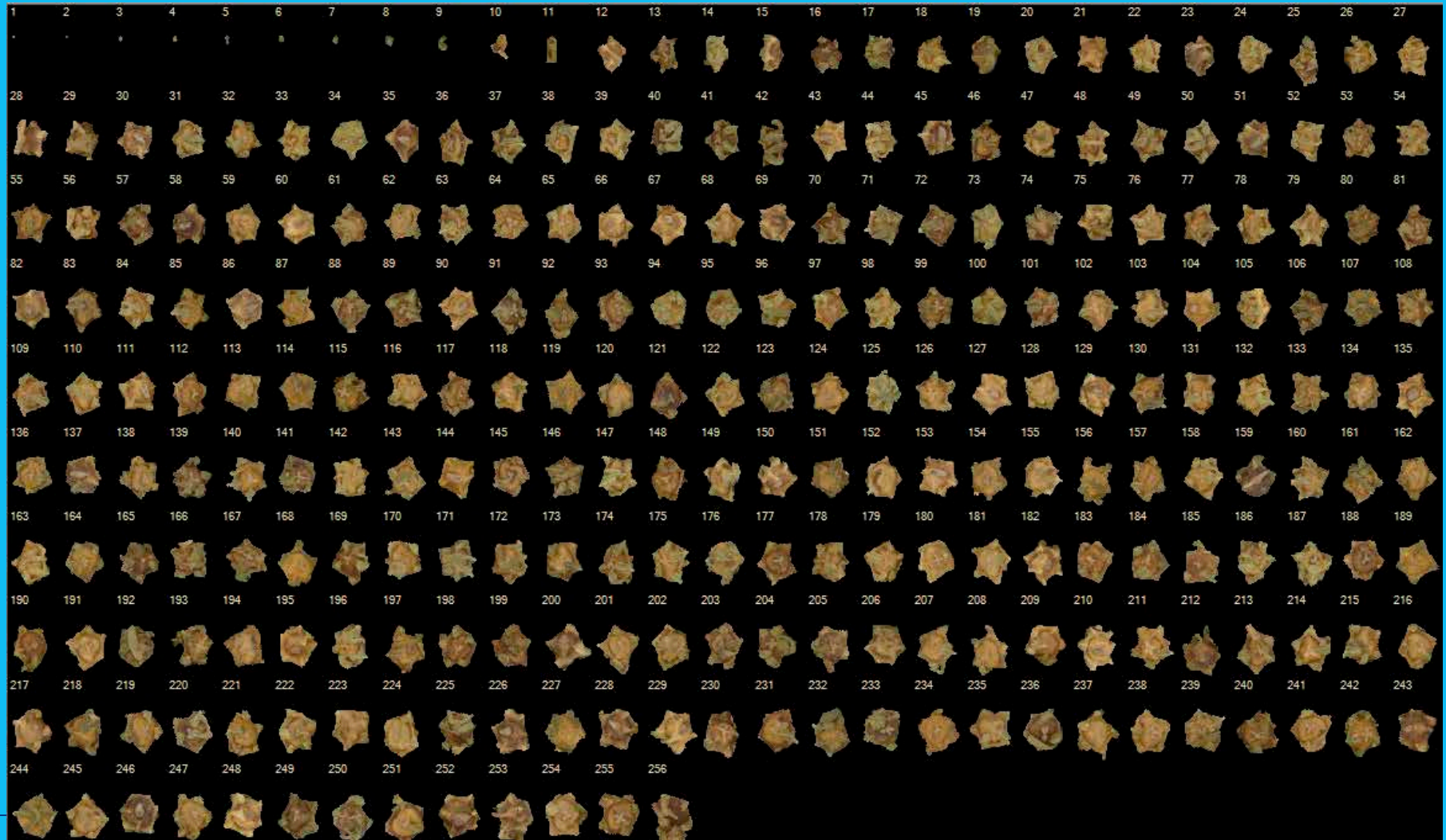
Sugar beet single seeds segmented



Segmentation is automated based on seed characteristics drawn from the database



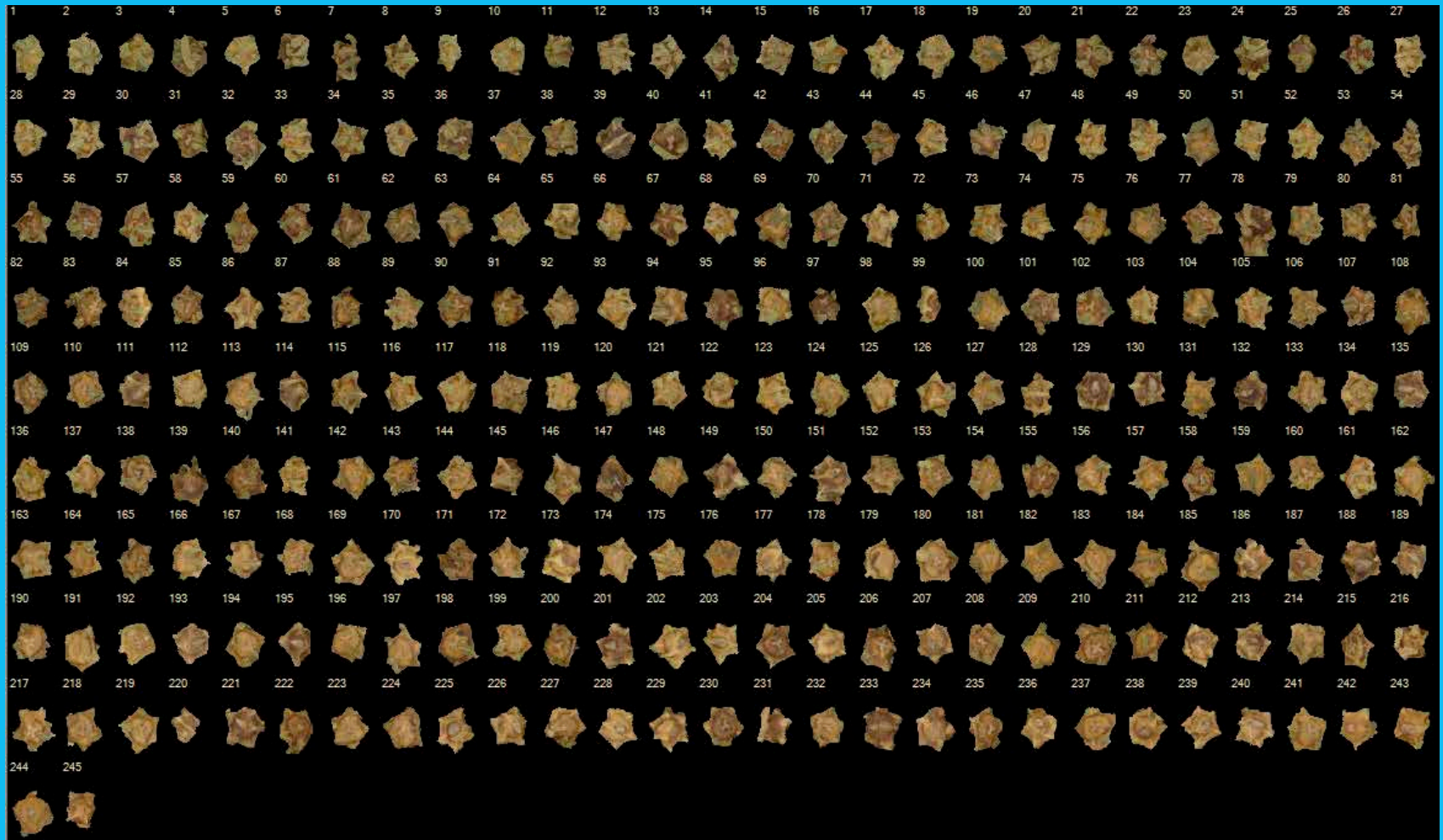
Seeds sorted by area



First-level attribute



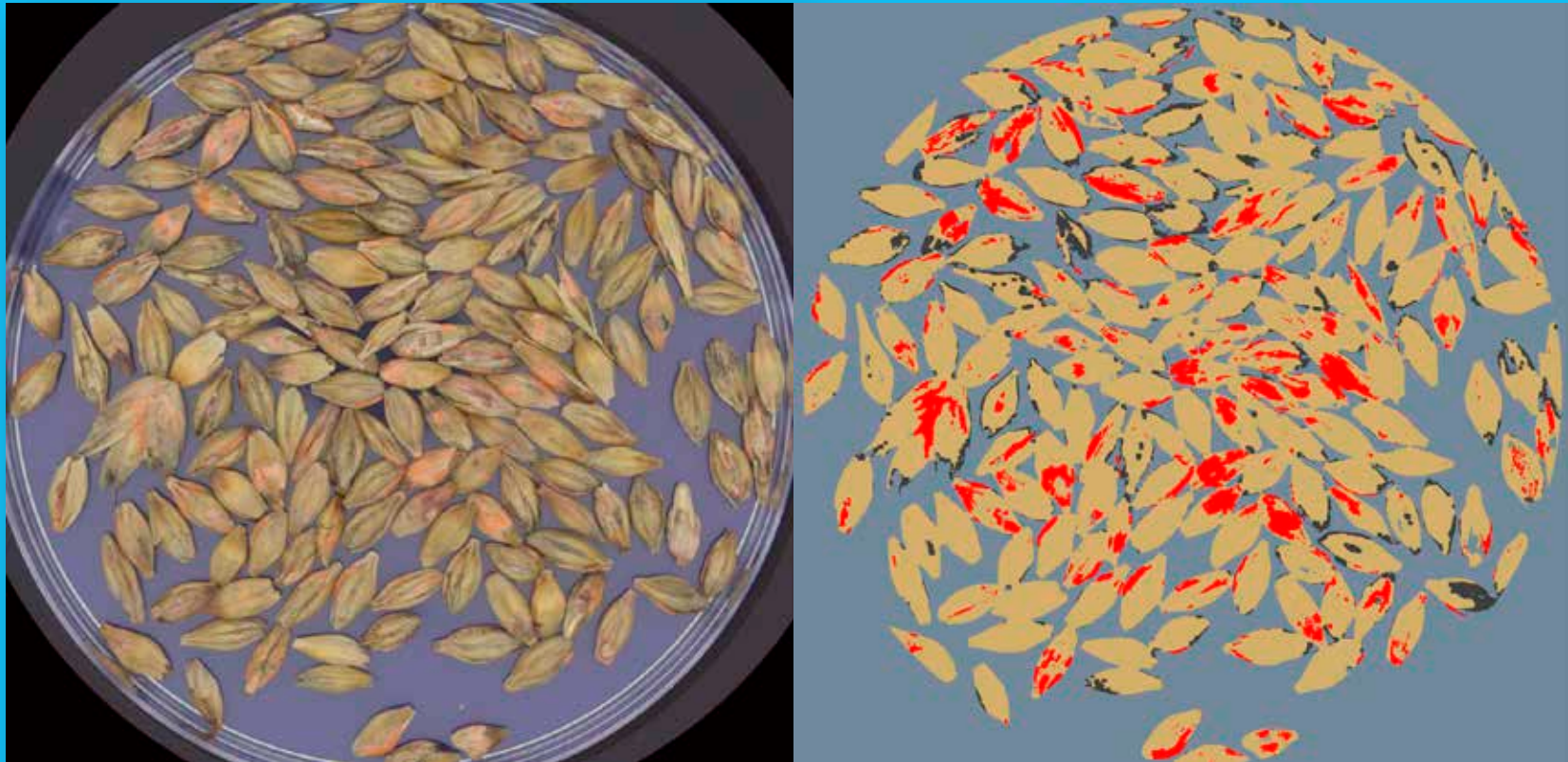
Seeds sorted by chlorophyll/maturity



Second-level attribute



Seed health: Fusarium and gray molds detection



The red color = red, orange or purple area on kernels

The dark gray color = grey and black molds

Brownish = Barley without molds

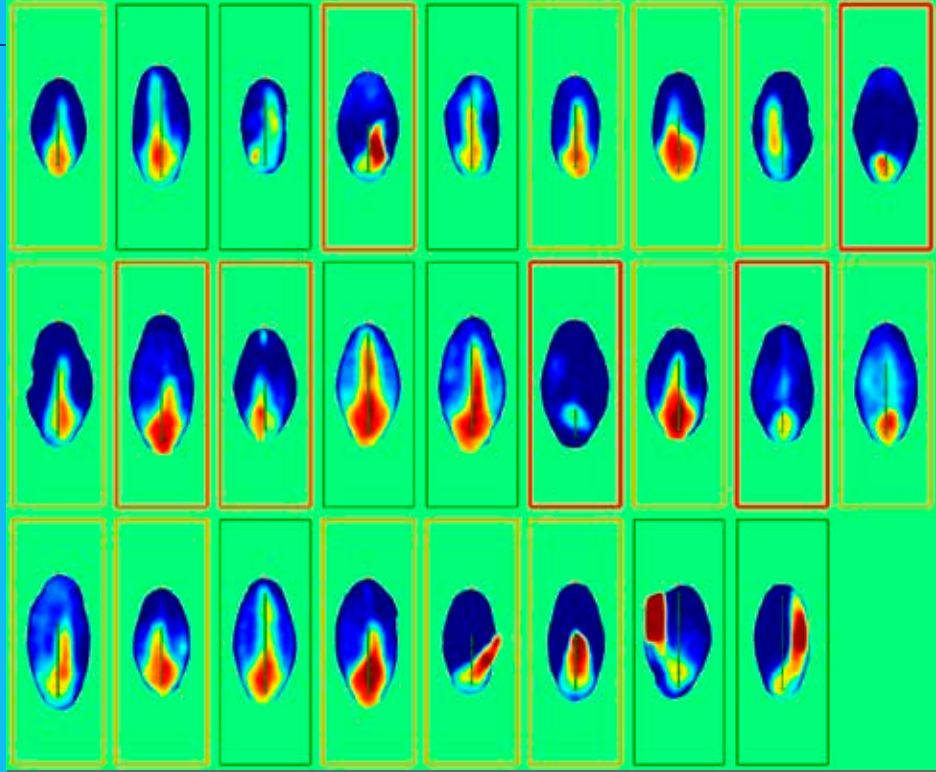


Seed germination: Acrospire length

Session: New Acrospire length bm 2003

Recipe: New Acrospire length bm 2

Plan: No Plan



Sample ID	Note	#Total	Mean Relativ	#Group1	#Group2	#Group3	#Group4	#Gro
Prøve0_1		25	0,575	2	5	15	3	0
Prøve0_2		26	0,5576923	0	10	13	3	0
Prøve0_3		25	0,585	0	9	11	5	0
Prøve0_4		26	0,6298077	0	7	13	5	1
Prøve1_1		26	0,677884638	1	6	6	13	0
Prøve1_2		26	0,7692308	0	0	11	15	0
Prøve1_3		26	0,7355769	0	2	12	11	1
Prøve2_0		26	0,7019231	0	1	16	9	0
Prøve2_1		26	0,6923077	0	1	17	8	0
Prøve2_2		26	0,721153855	0	3	10	13	0
Prøve2_3		26	0,711538434	0	2	13	11	0
Prøve2_4		26	0,7355769	0	2	12	11	1



Resume

Finish Sessio



Conclusions and outlook

- Seed phenotyping is BIG DATA
- Systematic and automated generation and updating of models linking first-level and second-level attributes are necessary
- SpectraSeed plan:
 - 2013 Local databases running specific applications
 - 2014-2015 Parameterized analysis, automated modelling, more applications
- Launch of SpectraSeed on-line database

