

Membrane Development

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Consistency by design

1) Introduction to air cast membranes

2) Consistency by design, with respect to:

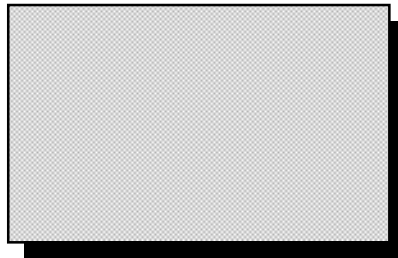
- The business unit
- Membrane development
- Process capability

Consistency by design

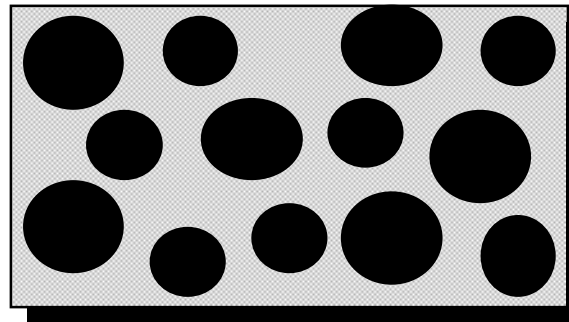
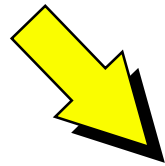
Introduction to air cast membranes: From Wood to Membrane



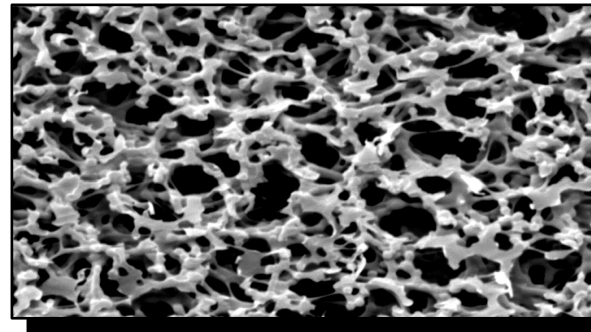
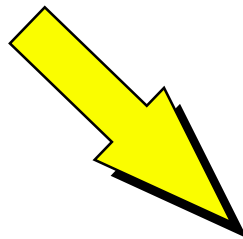
Liquid-Liquid Demixing



homogeneous
polymer solution

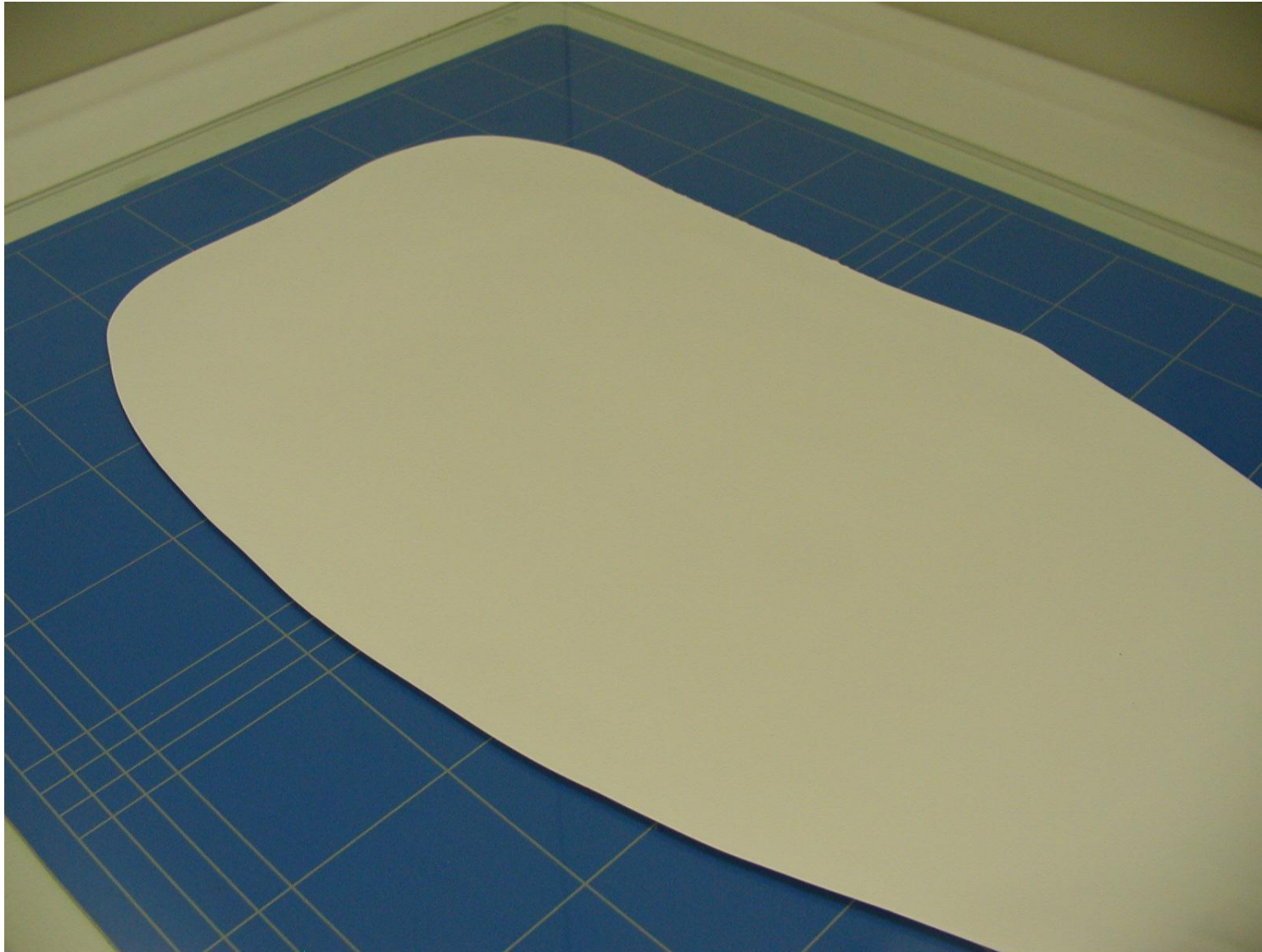


phase inversion:
polymer-rich phase
polymer-lean phase

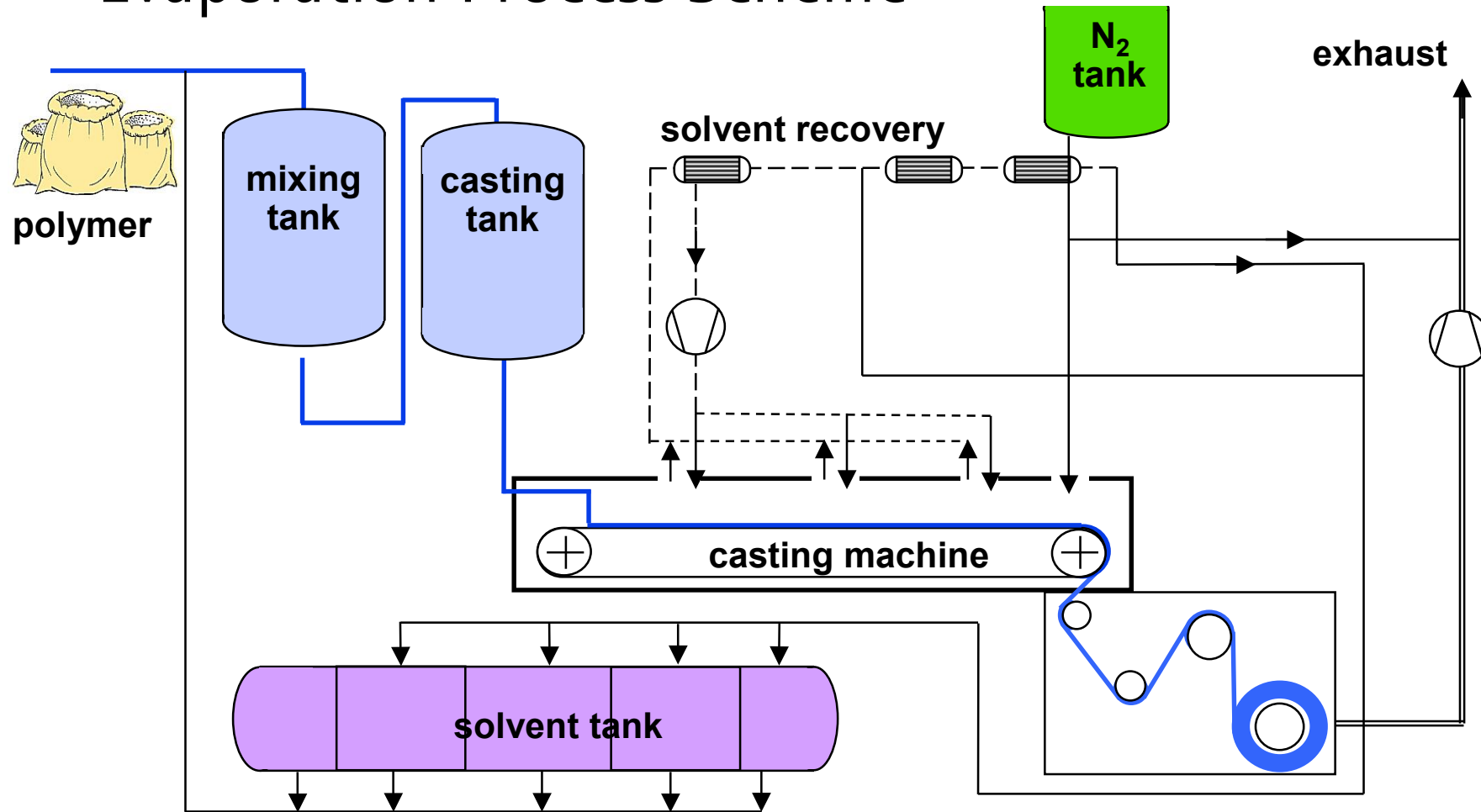


porous
structure

Consistency by design



Evaporation Process Scheme



Consistency by design
=> The diagnostic team

The Diagnostic Team,

R&D, Production, Engineering, QA, Customer Support and Management are located within the Göttingen Headquarters

- Effective communication: short ways, fast decisions
- Input of 35 membrane scientists
- Team spirit

....Your reliable partner

Consistency by design
=> Membrane development

Objective of diagnostic membrane development:

Membrane test performance (in-house hcg & customer testing)

- Protein line printability
- Line intensity
- Line quality (width and shape)
- Flow front
- Background

Physical Membrane properties

- Wicking speed
- Protein binding capacity
- Wettability
- Storability
- Surface quality

Membrane casting process

- Cross- and down-web homogeneity: intra lot consistency
- Interlot reproducibility
- Process capabilities (cpk > 1.3)

Steps of Membrane Development:

1. Develop basic solution recipe
choice of suited solvent system, cellulose nitrate grades, additives, mixing, etc.

=> determination of phase diagrams, Statistic Design of experiments
2. Develop casting process on lab machine
=> key parameters of drying process; reproducible results
3. Scale-up to production scale
Proof of processability of promising recipes

Consistency by design

Steps of membrane development (cont.):

4. Evaluate significant control parameters, determine process windows
5. seek external evaluation: alpha (pre-beta) site testing
6. Several large scale reproductions: beta-site samples for external testing
7. Launch 😊

How can consistency be designed into the membrane by raw material?

analytical selection of raw material

- Define physical key parameters that influence casting solution
- Define and audit your strategic suppliers regularly
- Rigorous incoming quality control steps
- Recheck influence of lot to lot variations of raw material on membrane properties before release

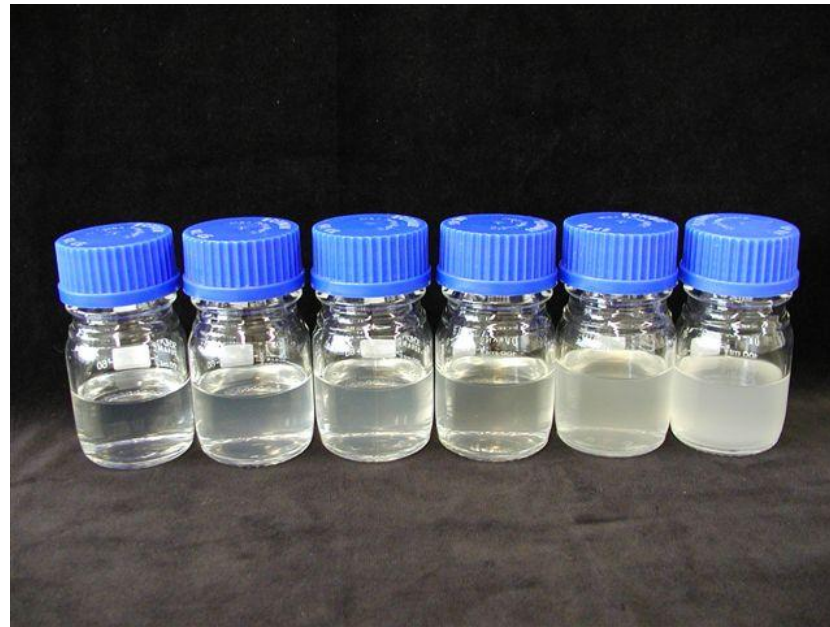
How can consistency be designed into the membrane by casting solution?



Trübung Video.MOV

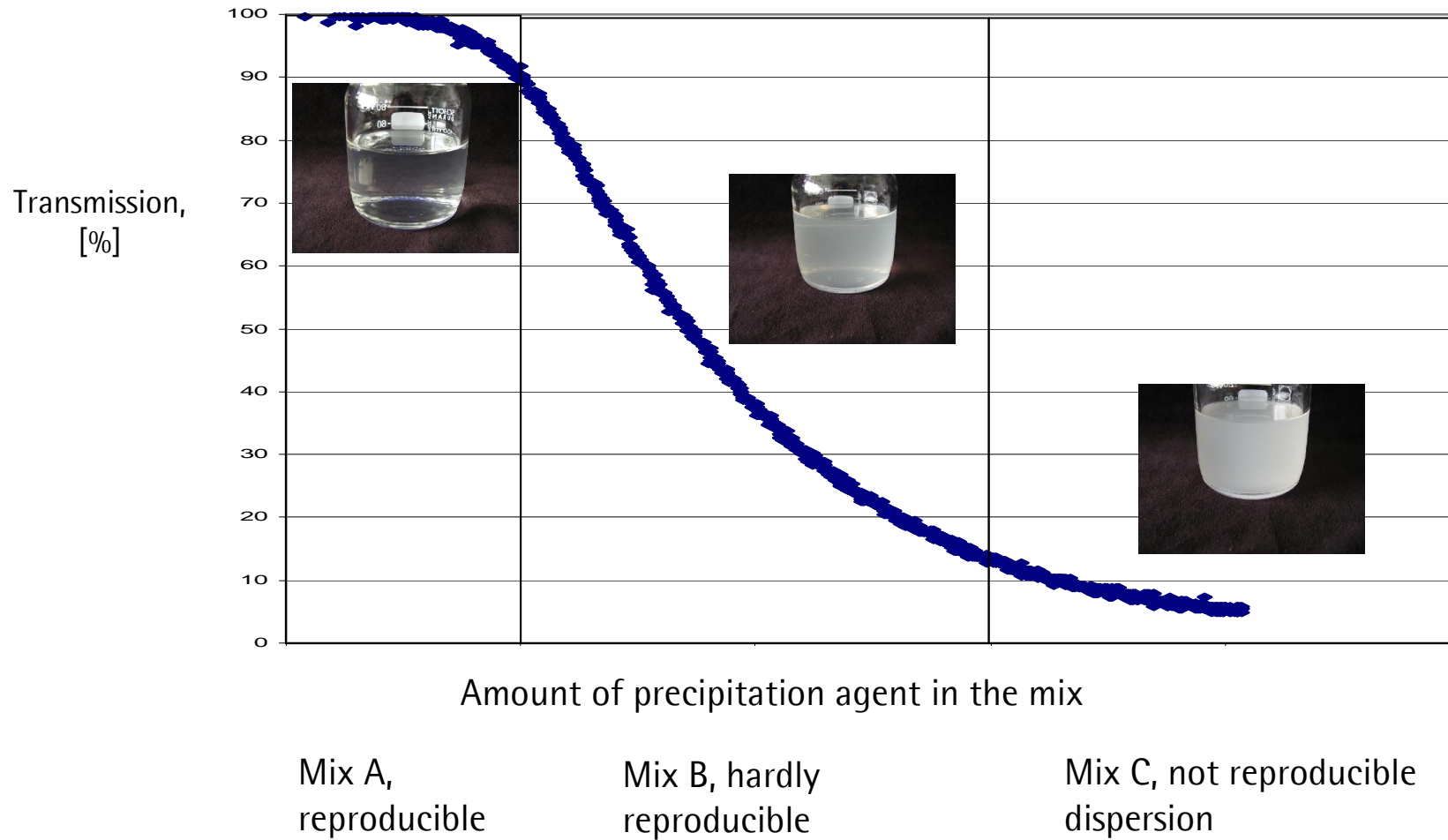
Consistency by design

What is the ideal casting solution for a consistent membrane production,
clear or turbid?

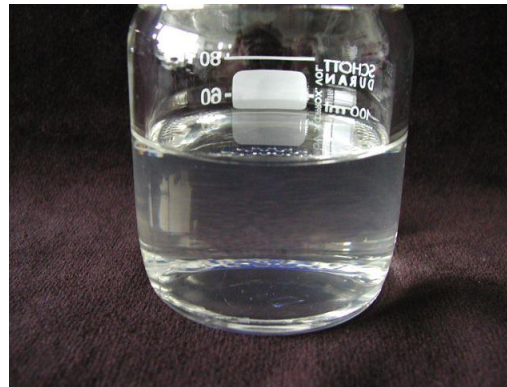


Consistency by design

Characterization of casting solutions: Light transmission



Our philosophy of consistency: Start the process on the plateau of a clear solution



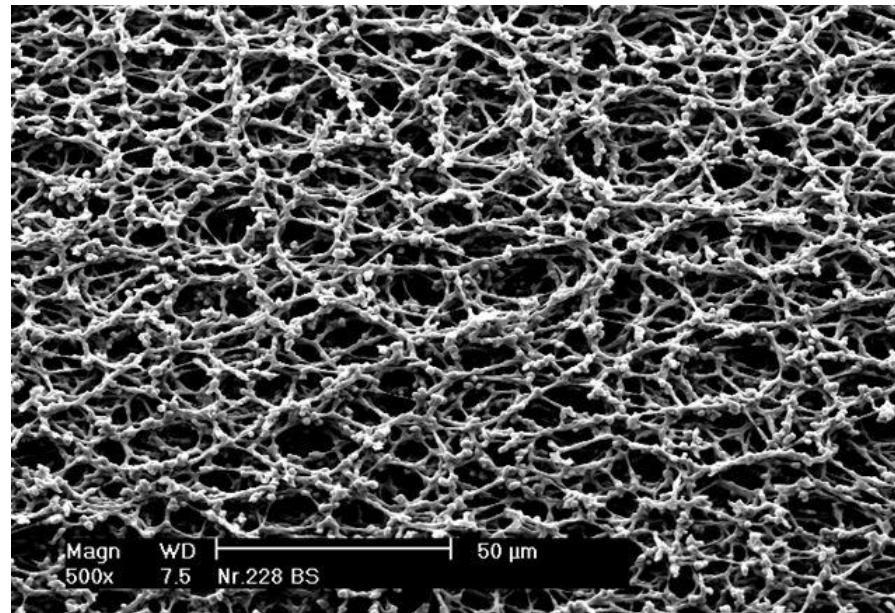
Benefits of clear casting solutions

- Stable solutions, no kinetic influence
 - Reproducible solutions: transmission plateau
 - Longer time for pore growth and membran formation: homogenous structure
- ⇒ outstanding intra- and inter lot consistency

Membrane structure as an indicator for consistency

- Consistent structure: networklike membrane resulting from a clear casting solution

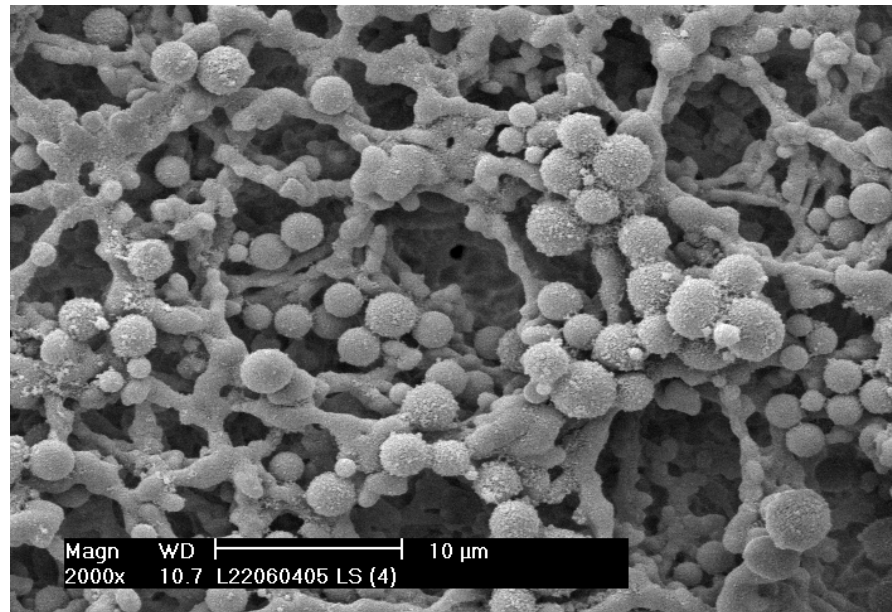
⇒ High intra and inter lot consistency



Membrane structure as an indicator for consistency

- inhomogenous globular structure resulting from a turbid casting solution

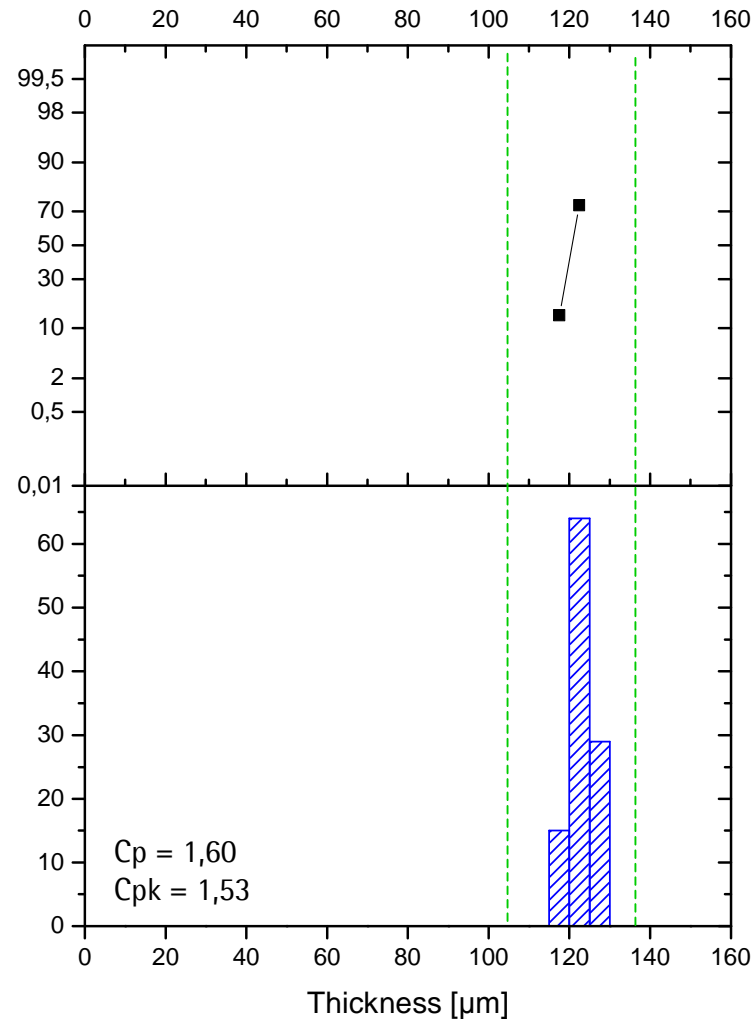
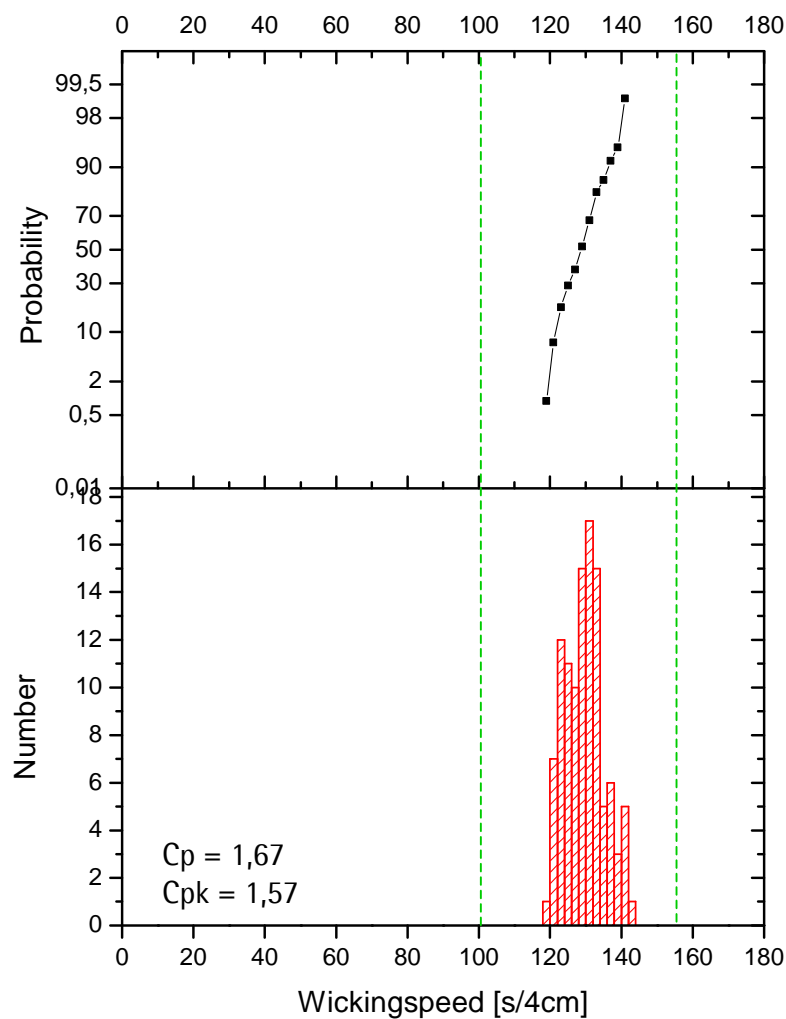
⇒ Lower consistency



Consistency by design
=> Process capability

Consistency by design

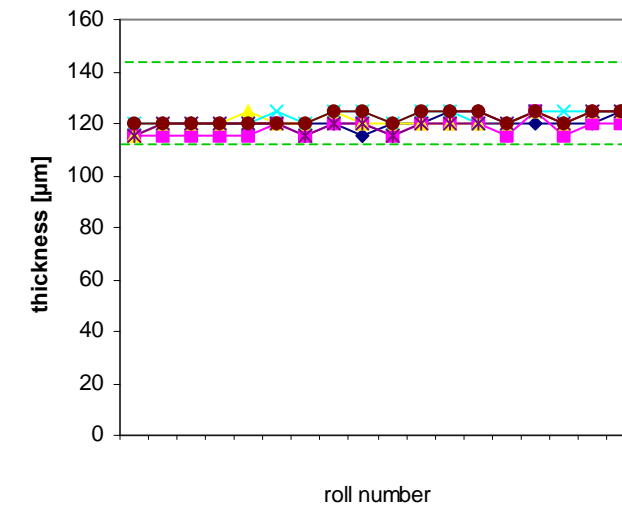
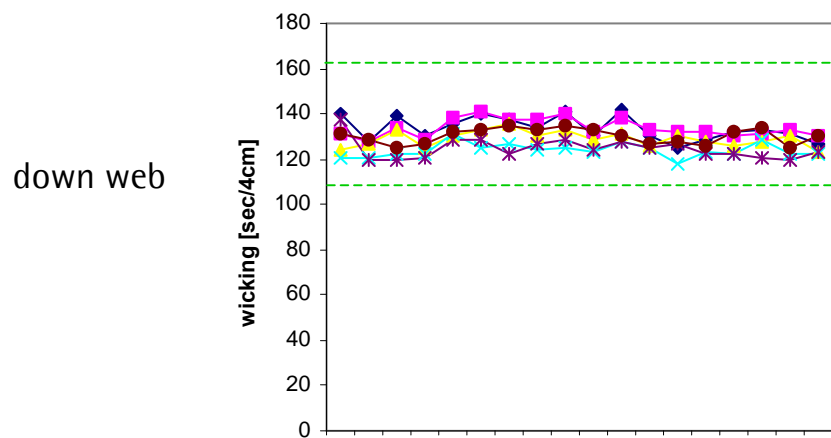
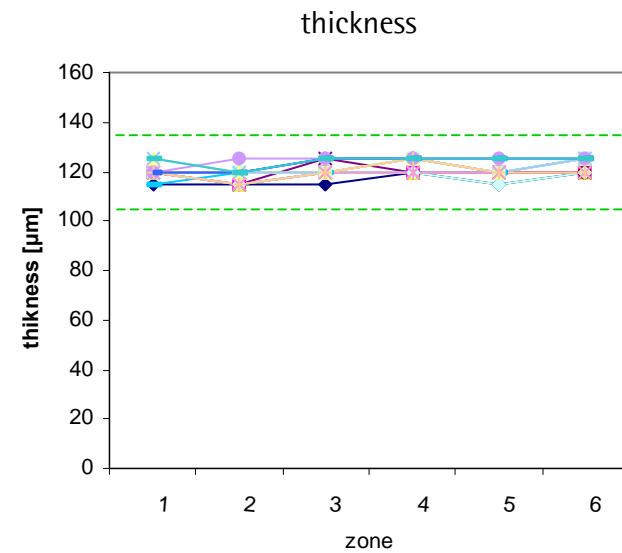
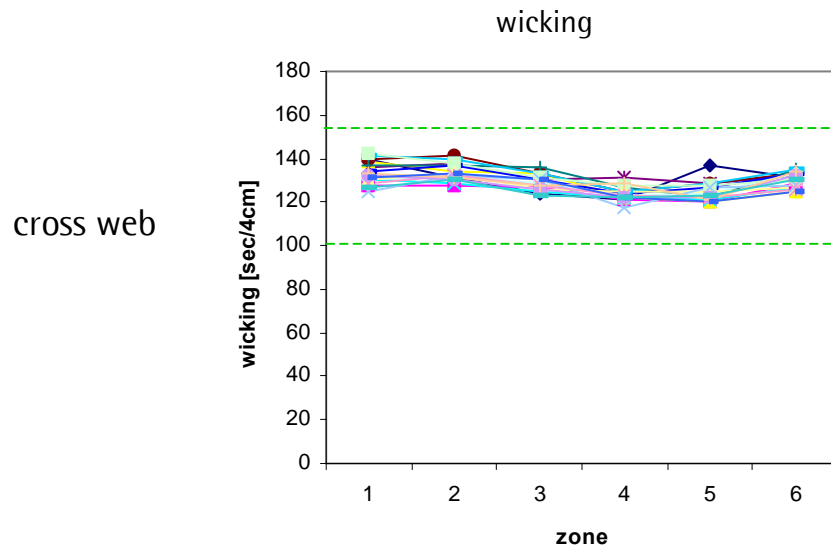
In-house data for diagnostic membrane production type CN 135 => wicking speed & thickness values (lot:0502854) => very good process capabilities (cpk > 1,3)



----- preliminary upper and lower spec.

Consistency by design

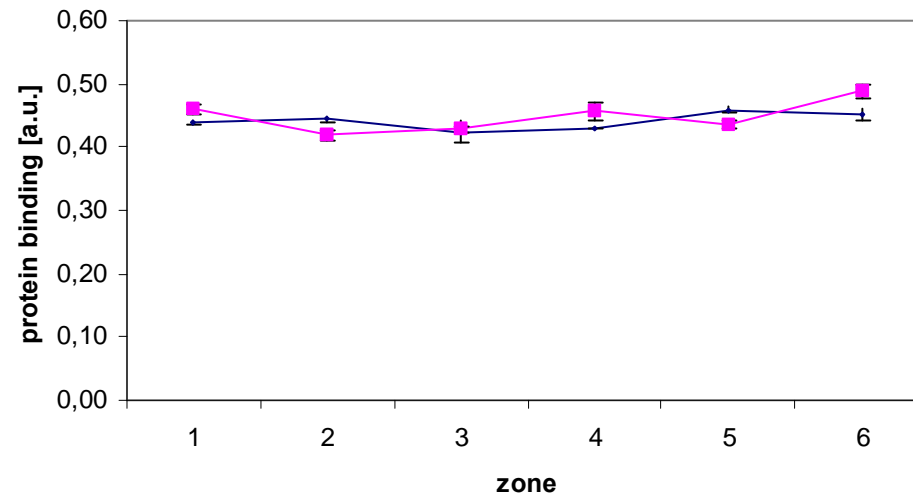
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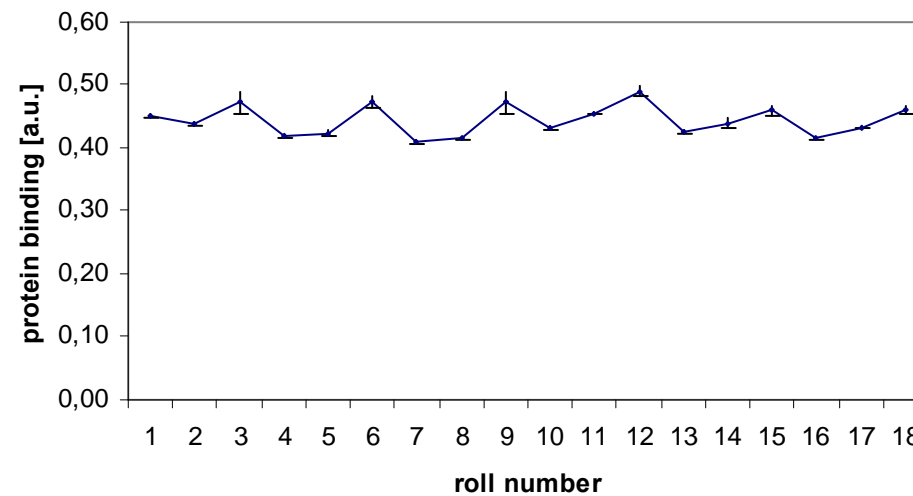
Consistency by design

In-house data for diagnostic membrane production type CN 135
=> protein binding (lot:0502854)

cross web
(first & last roll)

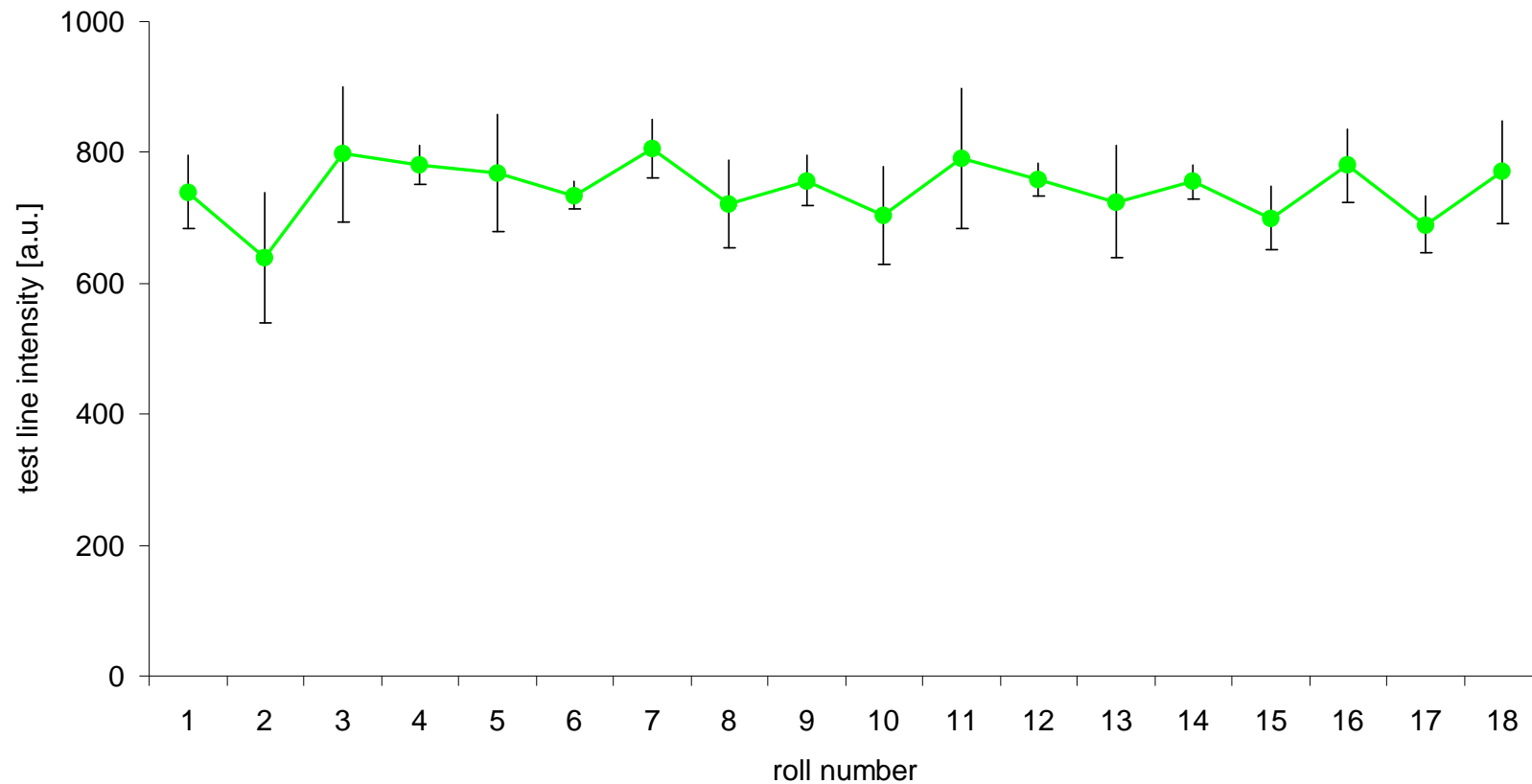


down web
(one zone)



Consistency by design

In-house data for diagnostic membrane production type CN 135
=> test line intensity (lot:0502854)



Consistency by design

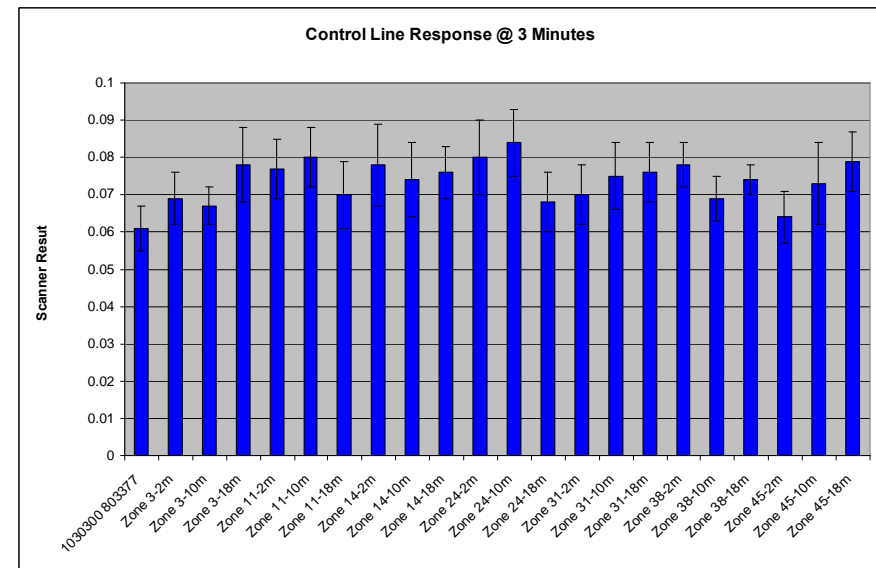
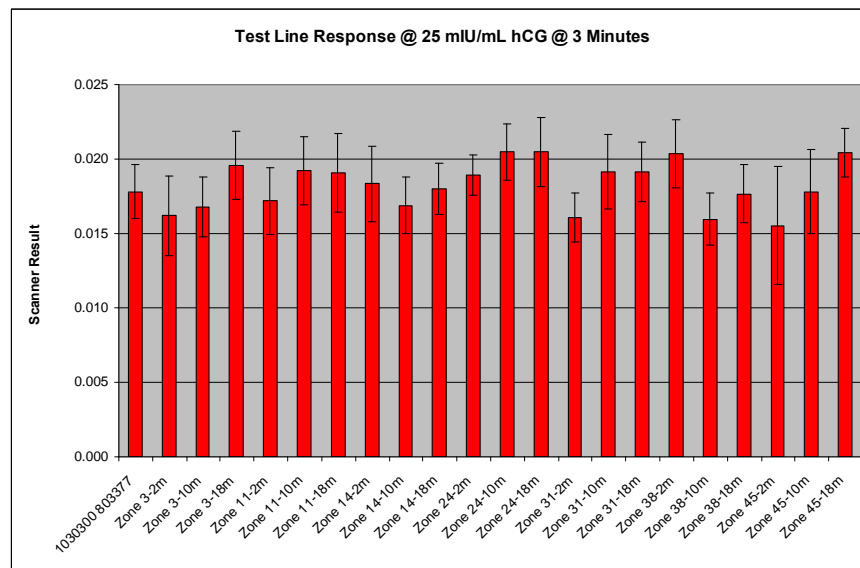
=> Production process

Membrane performance: customer data

Consistency by design

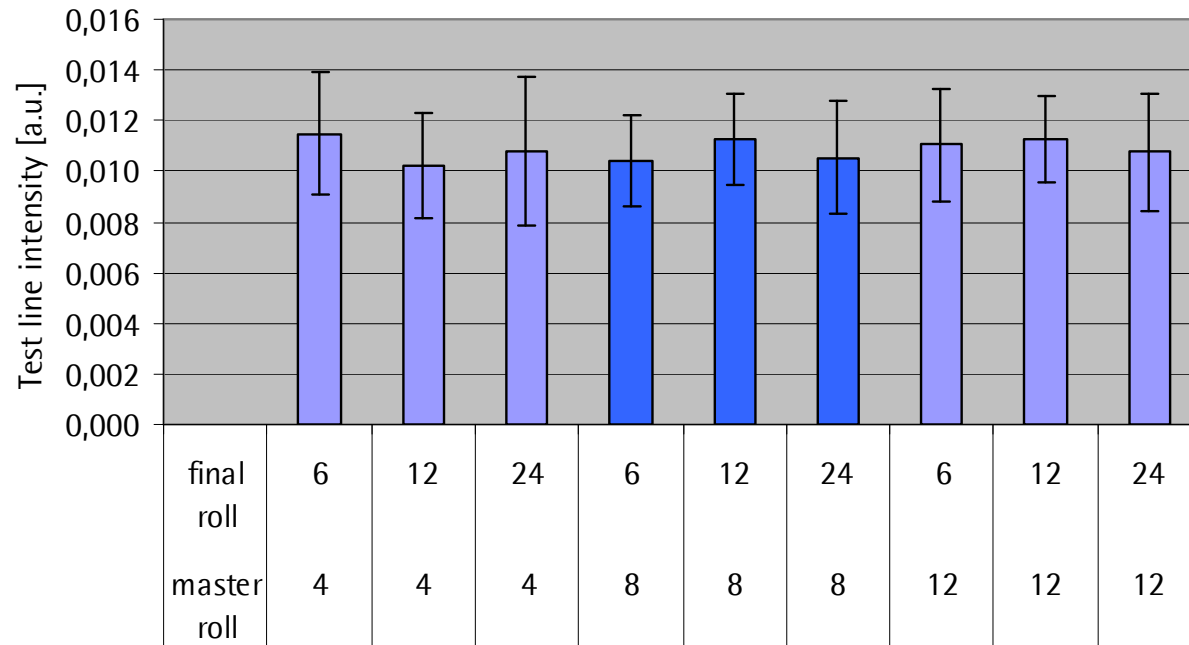
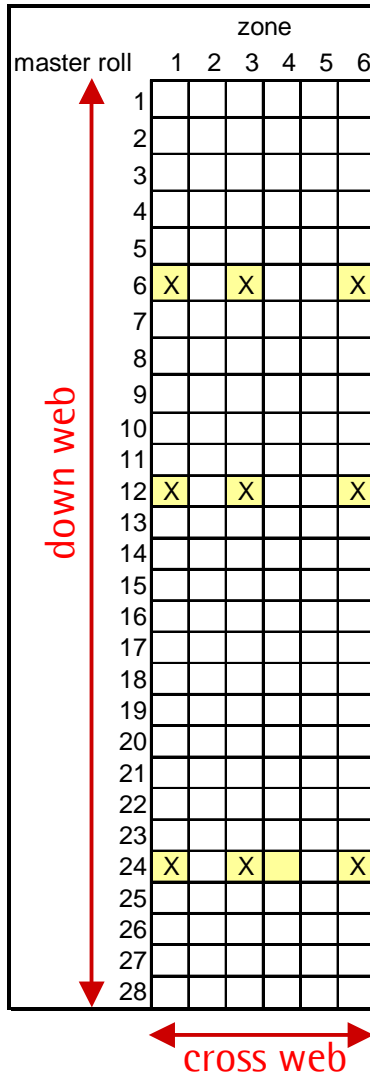
Consistent hcg test performance across a master roll: customer data

		zone = final roll																																																				
position		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47						
start																																																						
3 m				X								X		X										X								X								X										X				
10 m				X								X		X										X								X									X									X				
18 m				X								X		X										X							X										X									X				
end																																																						

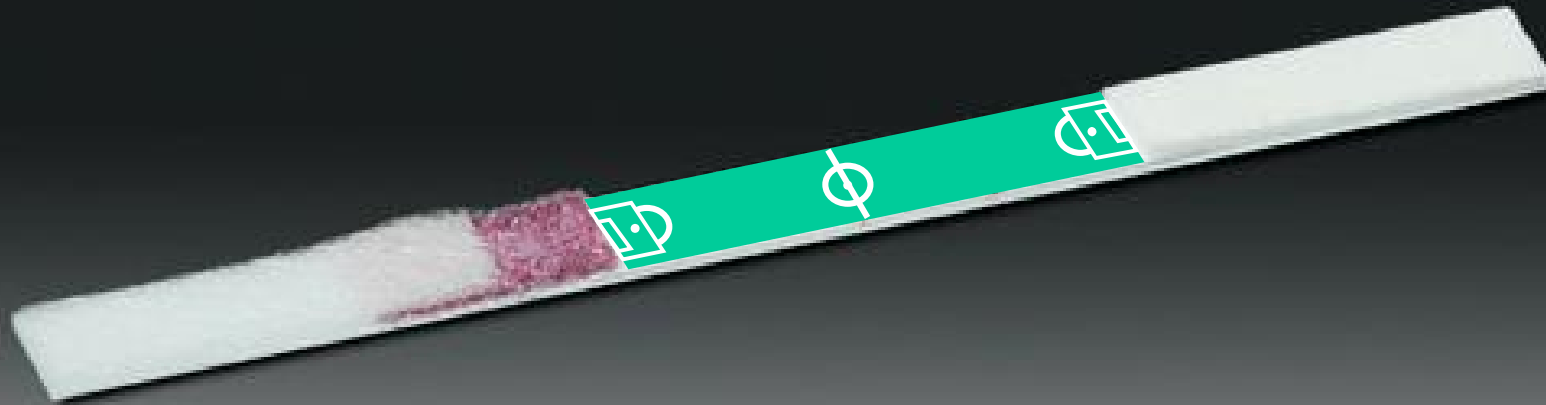


Consistency by design

Consistent performance across a lot: customer data



Thank You!!



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