



Water4India



Quantifying potential health improvement by household water treatment in rural India

Benedikt Aumeier¹, Patrick Smeets², Xin Jiang¹, Suzana Djeljadini³,
Süleyman Yüce¹, Matthias Wessling^{1,3}




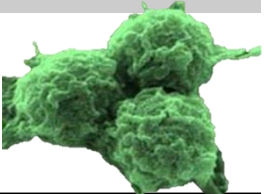
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¹ AVT.CVT RWTH Aachen University

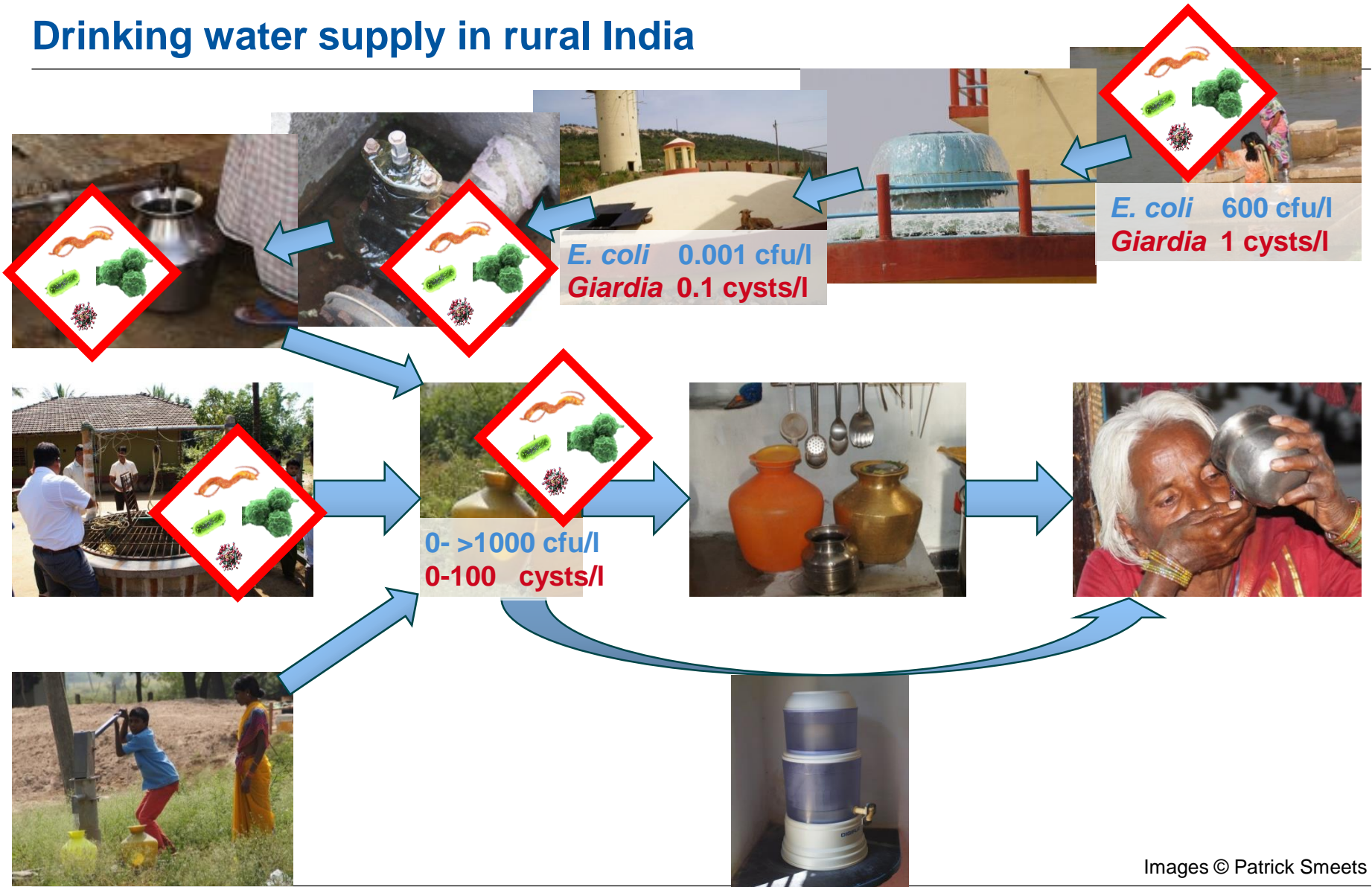
² KWR Watercycle Research Institute

³ DWI Leibniz Institute for Interactive Materials

Microbial water quality and health

| Pathogen type | Source | Characteristics | River (n/l) | |
|---|------------------|--|----------------------|--|
| Indicators <i>E. coli</i> , TTC | Human, Animal | Bacteria, high numbers in feces, Water quality monitoring | 10 - 10 ⁷ |  |
| | | | |  |
| | | | |  |
| | | | |  |

Drinking water supply in rural India

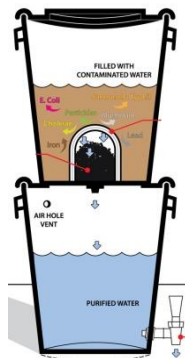
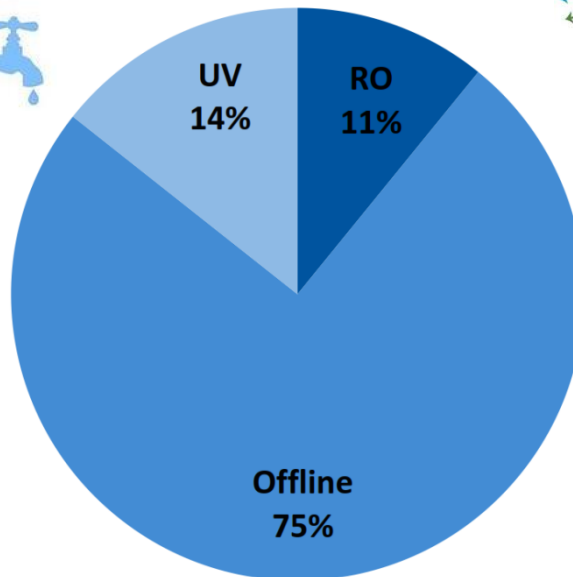
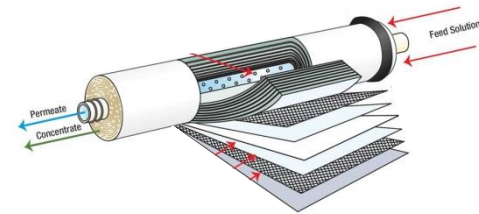
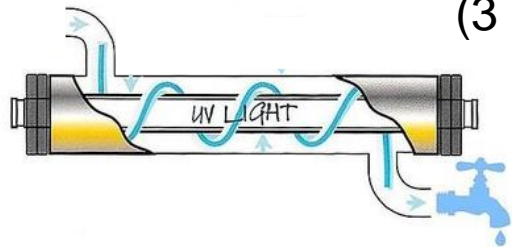


Images © Patrick Smeets

Indian Market for household purifiers

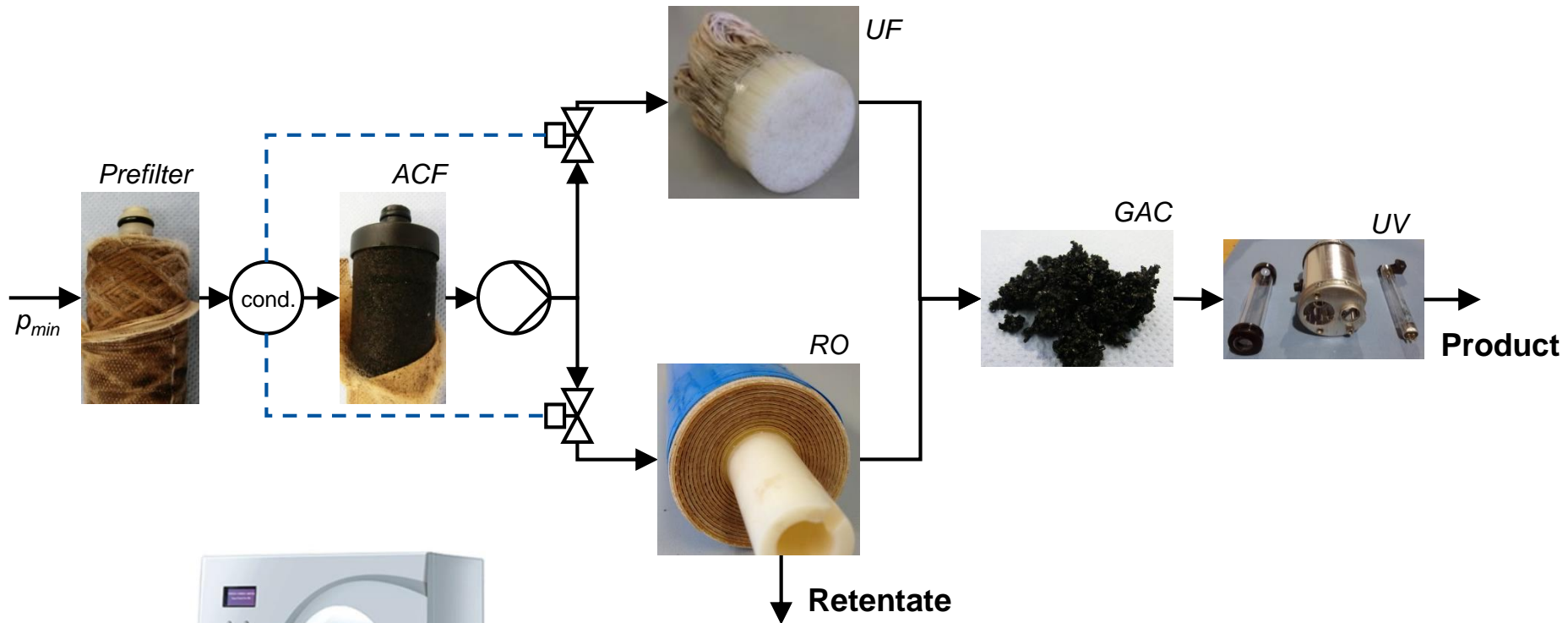
Sales figures 2010-11

Total 3.6 Mio. units¹
(3 per 1000 inhabitants)



¹ TV Veopar (2012)

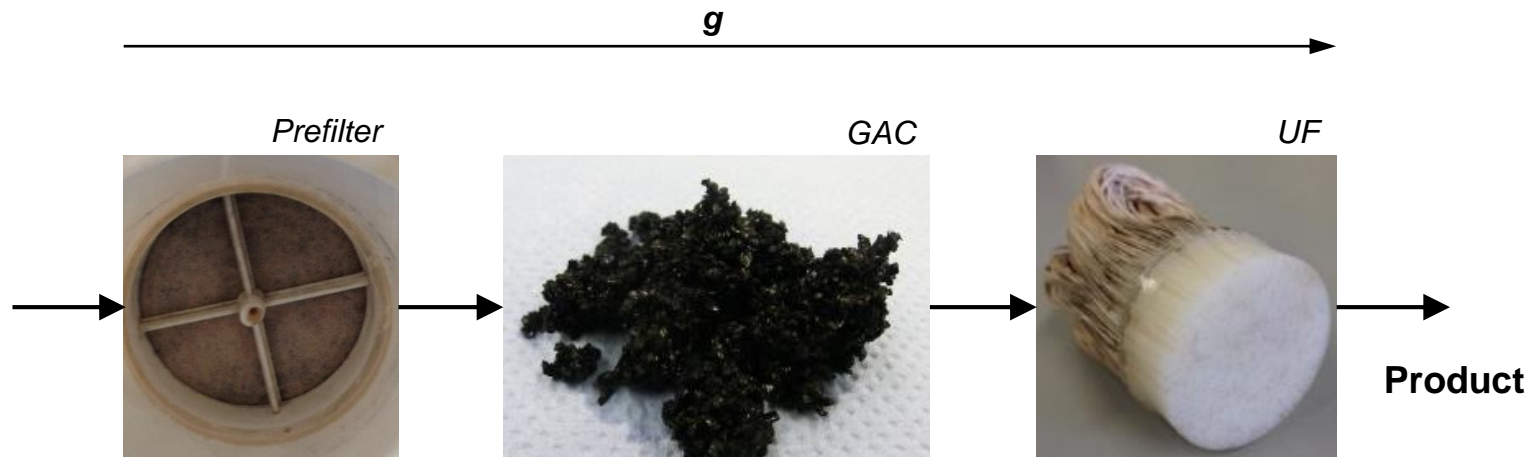
Tested household purifiers - Aquasure Xpert



Aquasure Xpert {RO, UF, AC, UV}

₹ 21,000 (280 €)

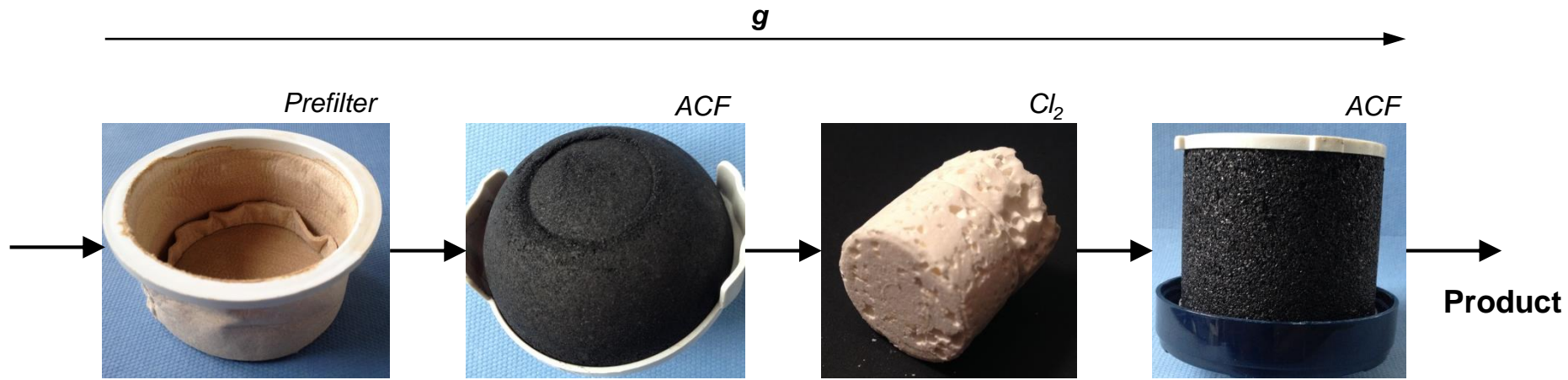
Tested household purifiers - Kent Gold Plus



Kent Gold Plus {UF, AC}

₹ 3,000 (40 €)

Tested household purifiers - HUL Pureit Classic



HUL Pureit Classic { Cl_2 , AC}

₹ 1,700 (23 €)

Challenge test for household purifiers

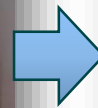
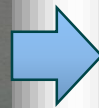
Target

- Is it possible to produce microbially safe drinking water?

WHO:

| Pathogen class | Required \log_{10} -reduction (LRV) | |
|----------------|---------------------------------------|--------------------|
| | Protective | Highly protective |
| Bacteria | ≥ 2 (99%) | ≥ 4 (99.99%) |
| Viruses | ≥ 3 (99.9%) | ≥ 5 (99.999%) |
| Protozoa | ≥ 2 (99%) | ≥ 4 (99.99%) |

- Is this also possible using (synthesized) "monsoon river water" (additional organics and suspended solids)?



Challenge test for household purifiers

2-phase test analogous to USEPA (1987) and WHO (2011)

General phase (G)

Tap water
(Residual chlorine eliminated)

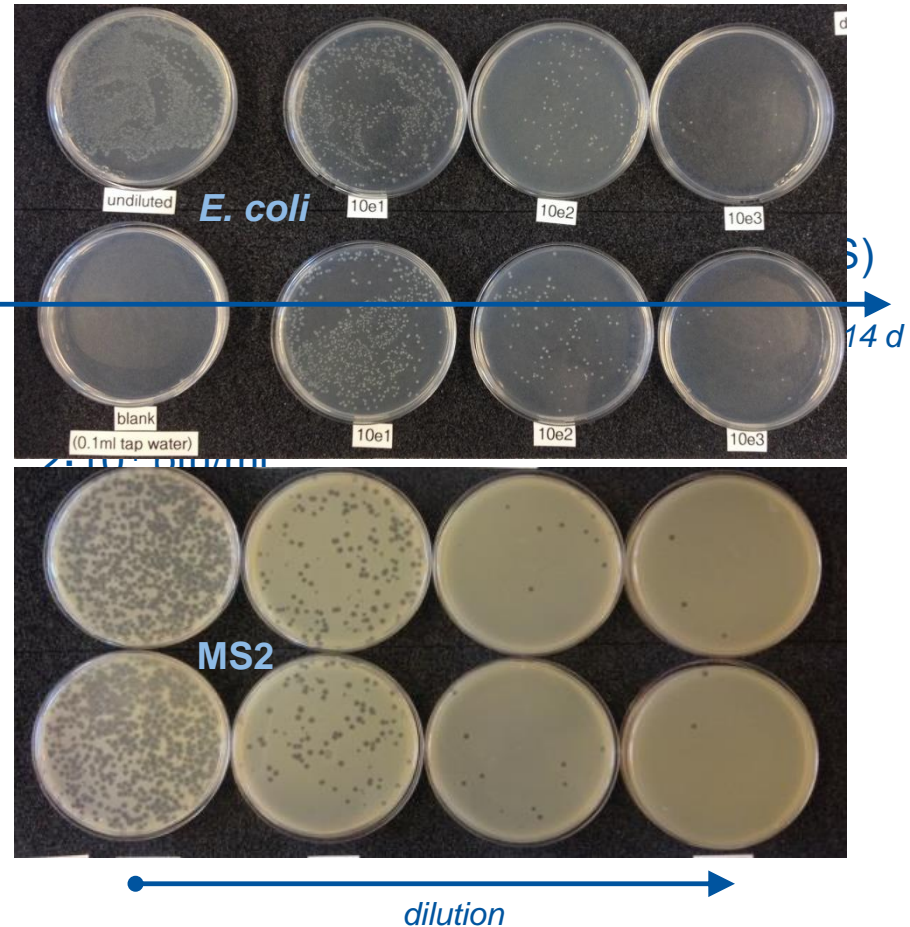
$t_0 = 0 d$

7 d

14 d

| | | |
|----------------|----------------|-----------------------|
| Bacteria | <i>E. coli</i> | 10^5 cfu/ml |
| Bacteriophages | MS2 | $2 \cdot 10^4$ pfu/ml |

Purifiers designed for this task

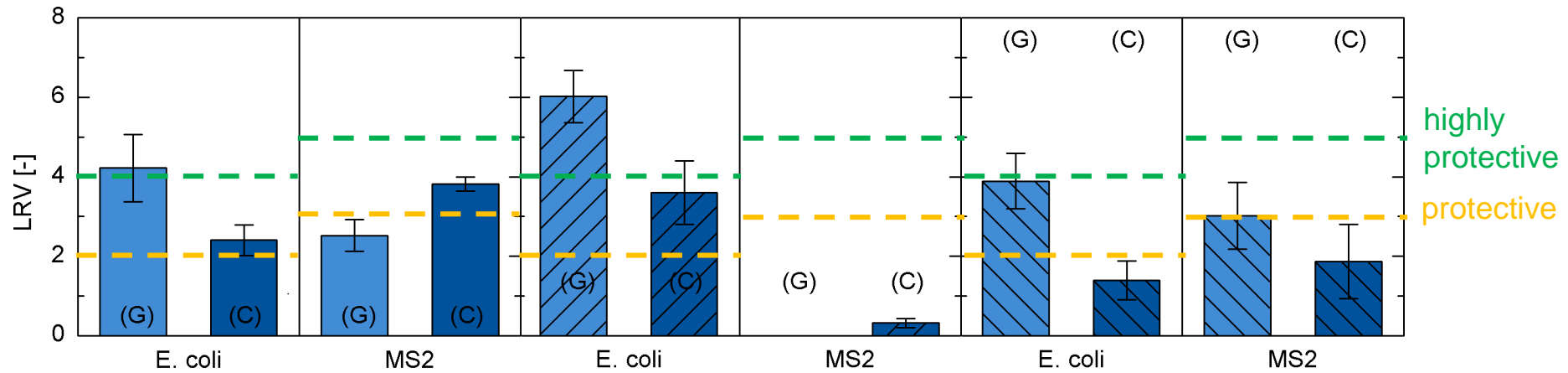


Reduction - microbial

{RO, UF, AC, UV} 

{UF, AC} 

{Cl₂, AC} 



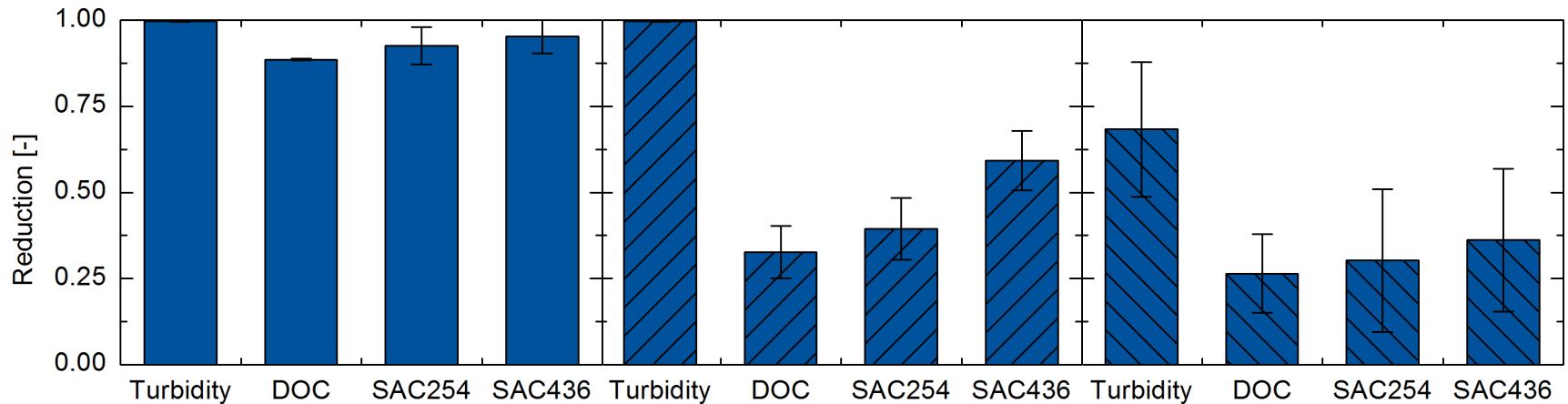
LRV: AVG ± 97.5% CI

Reduction - physico-chemical (C)

{RO, UF, AC, UV} 

{UF, AC} 

{Cl₂, AC} 

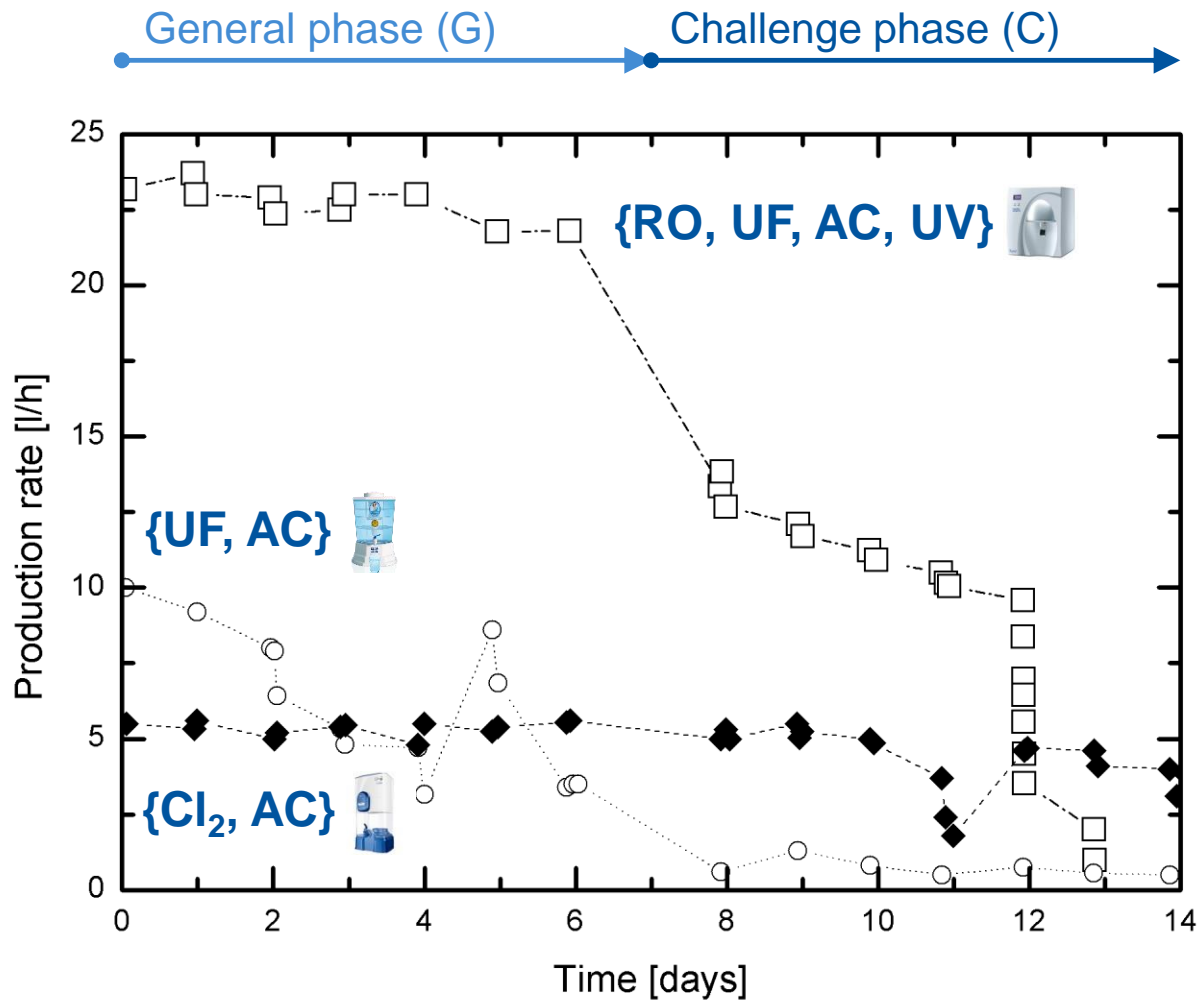


(Feed)



























Reduction: AVG ± SD

Water production



Conclusion

| | {RO, UF, AC, UV}  | {UF, AC}  | {Cl ₂ , AC}  |
|---------------------------|--|--|--|
| Turbidity / solids |  |  |  |
| Organics |  |  |  |
| Salt |  |  |  |
| Bacteria |  |  |  |
| Viruses |  |  |  |
| Production rate | | | |
| Tap water |  |  |  |
| River water |  |  |  |

Thank you for your attention



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Email: benedikt.aumeier@avt.rwth-aachen.de

Reduction

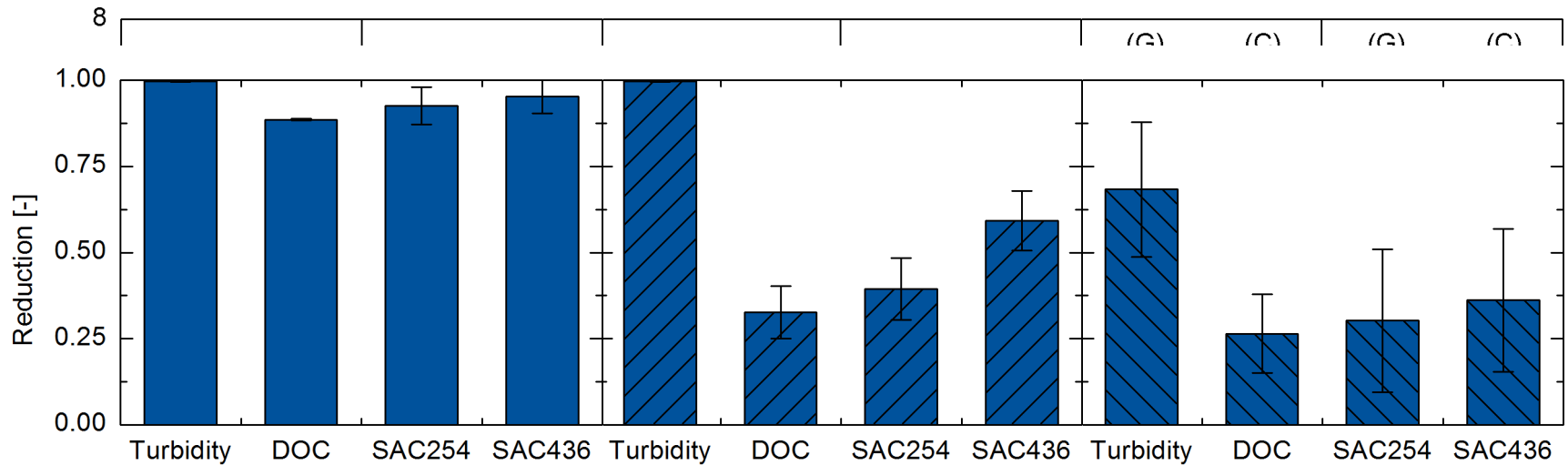
{RO, UF, AC, UV}



{UF, AC}

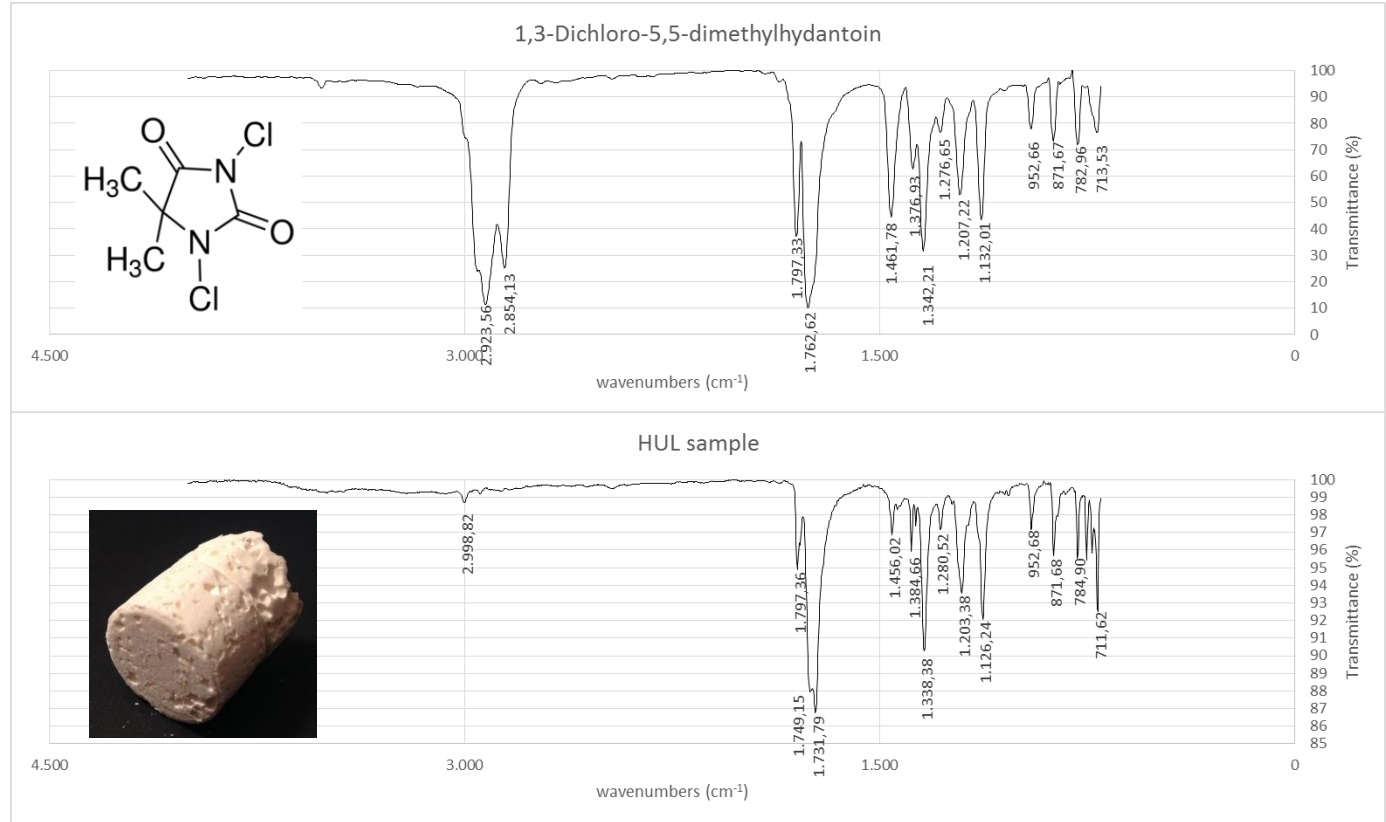


{Cl₂, AC}

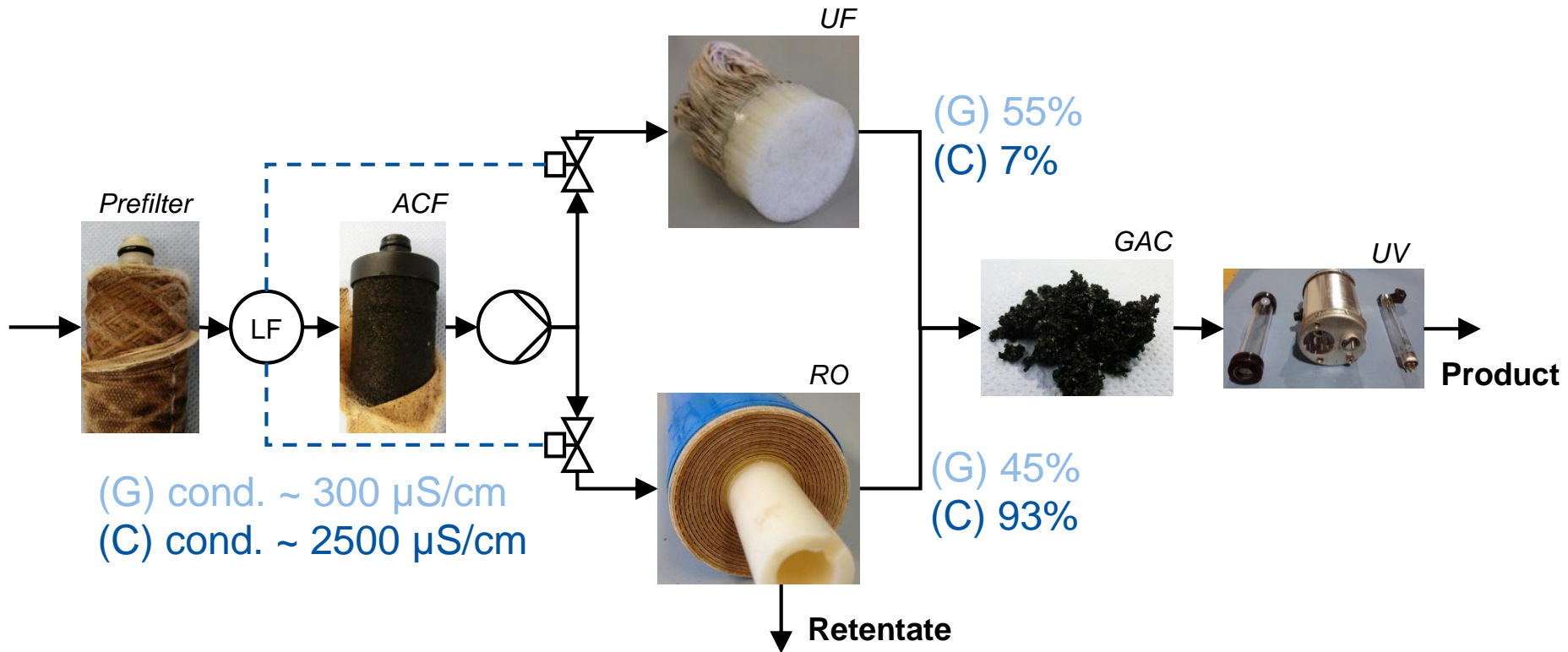


LRV: AVG ± 97.5% CI, Reduction: AVG ± SD

HUL Passive chlorine dosage DCDMH



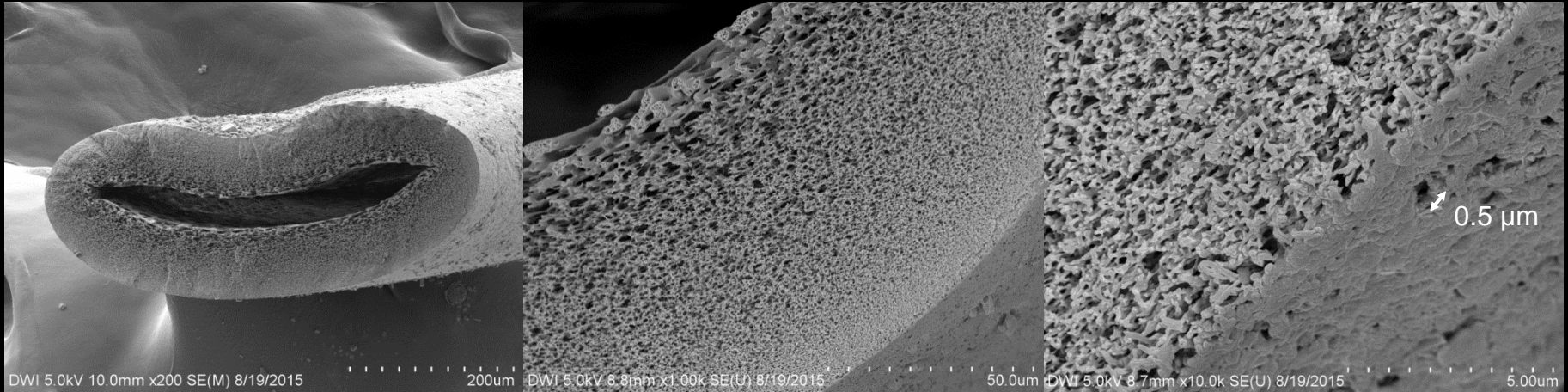
Aquasure Xpert RO / UF - split ratio



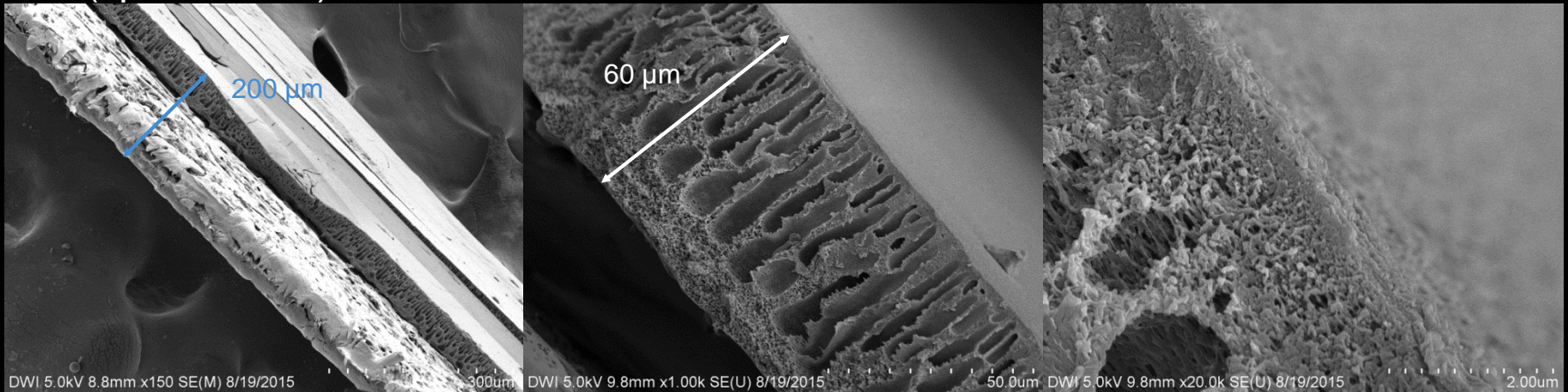
(G) $\Phi_{\text{total}} \sim 40\%$
 (C) $\Phi_{\text{total}} \sim 25\%$

Aquasure SEM

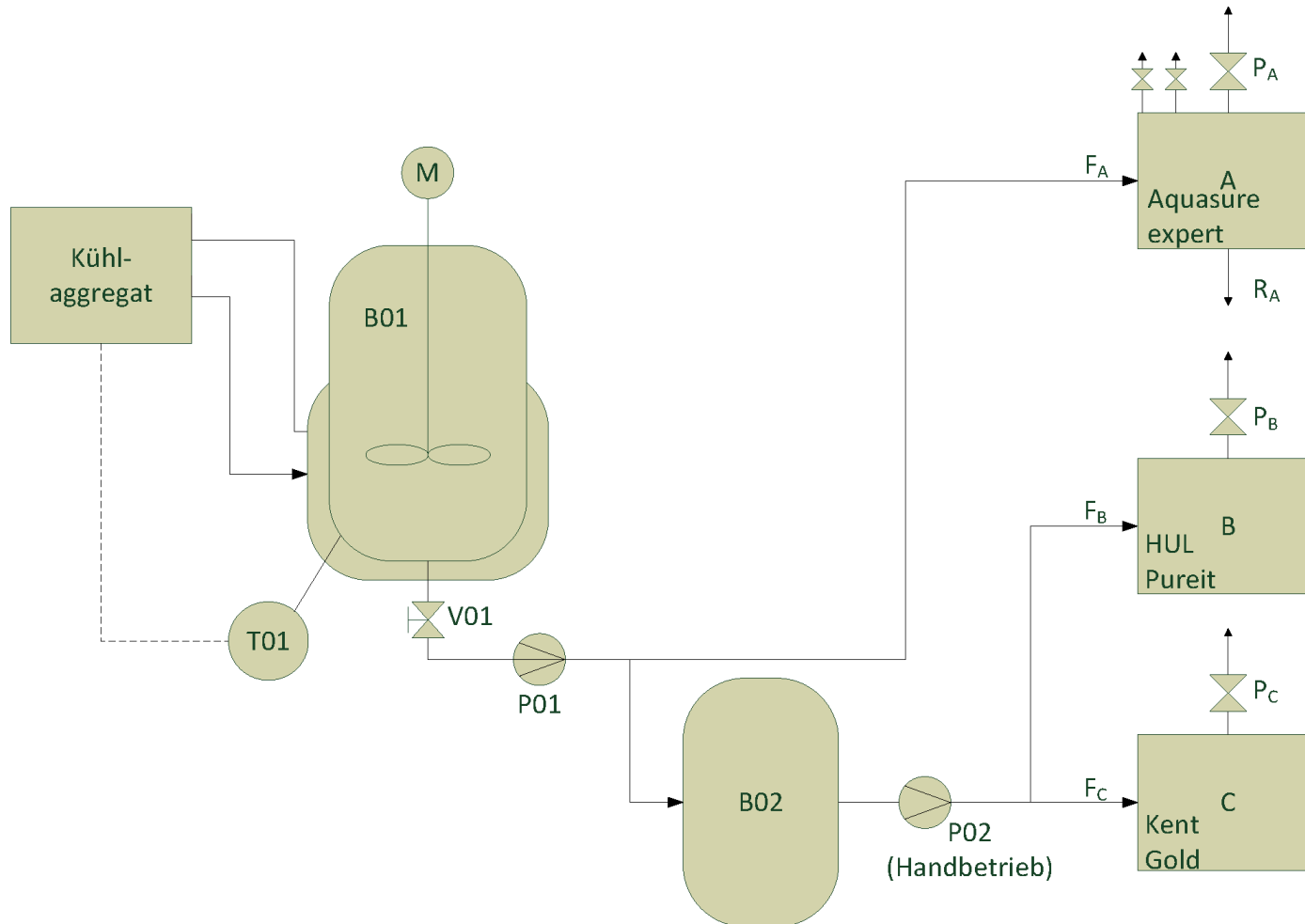
UF (hollow fiber)



RO (spiralwound)



Challenge testing setup



Vergleich mit Herstellerangaben

- **HUL Pureit**
 - "Removes 1 crore virus in 1 Litre [10^7 /l] of water"
geringere Virus-Reduktion im Experiment
- **Kent Gold Plus**
 - NSF/ANSI 53: Reduktion von Zysten
Nicht getestet
 - WQA Gold Seal (S-200): Reduktion von THMs, Herbizide (z.B. Alachlor) etc.
Organik reduziert im Experiment
 - 0,1 μm Membranporen (Rückhalt von Bakterien und Zysten)
- **Aquasure Xpert**
 - TDS Reduktion
Bestätigt
 - "Protection from [...] dangerous water-borne diseases caused by bacteria, viruses and cysts"
 - Protection from harmful chemicals, pesticides and dreaded heavy metals"
Keine Quantifizierung
- Kein System ist speziell designed für Flusswasser (> 15 NTU).