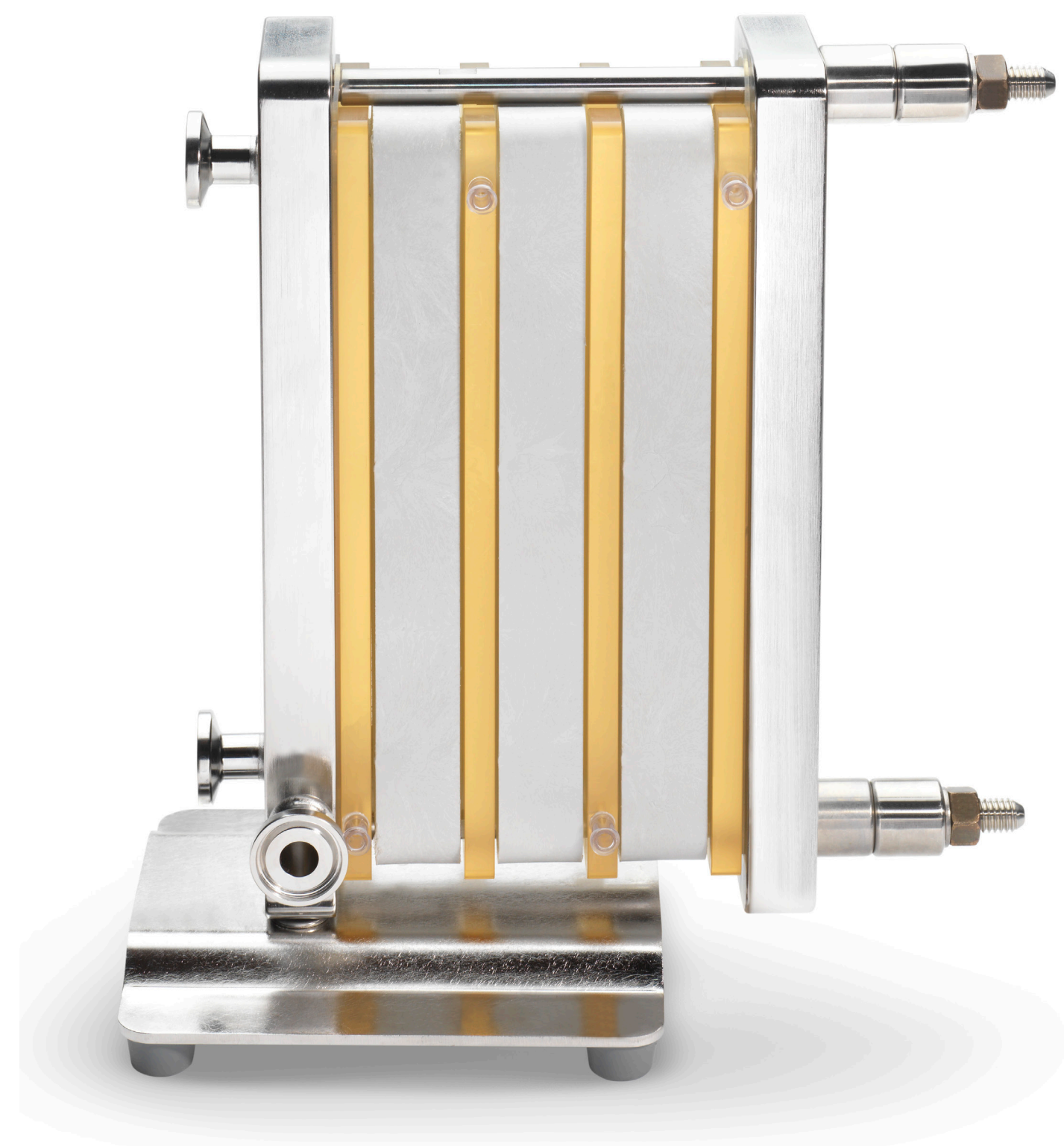


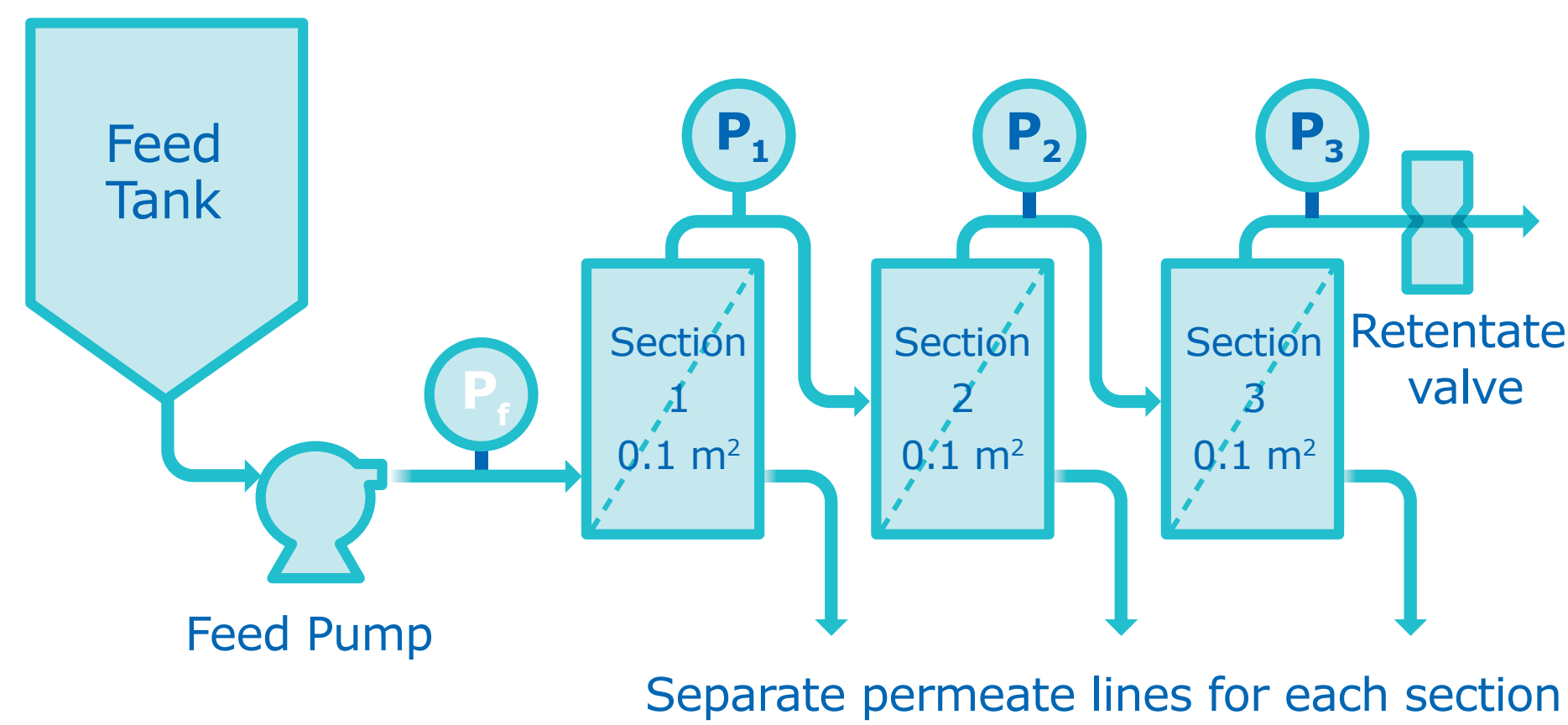
# Single Pass Tangential Flow Filtration (SPTFF)



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## Scale down SPTFF testing



- Three Pellicon® 3 PLCTK 0.1m<sup>2</sup> cassettes
- Diverter plates
- Recycled retentate/permeates
- Feed flow excursions
- Recovery flush
- Cleaning & NWP recovery

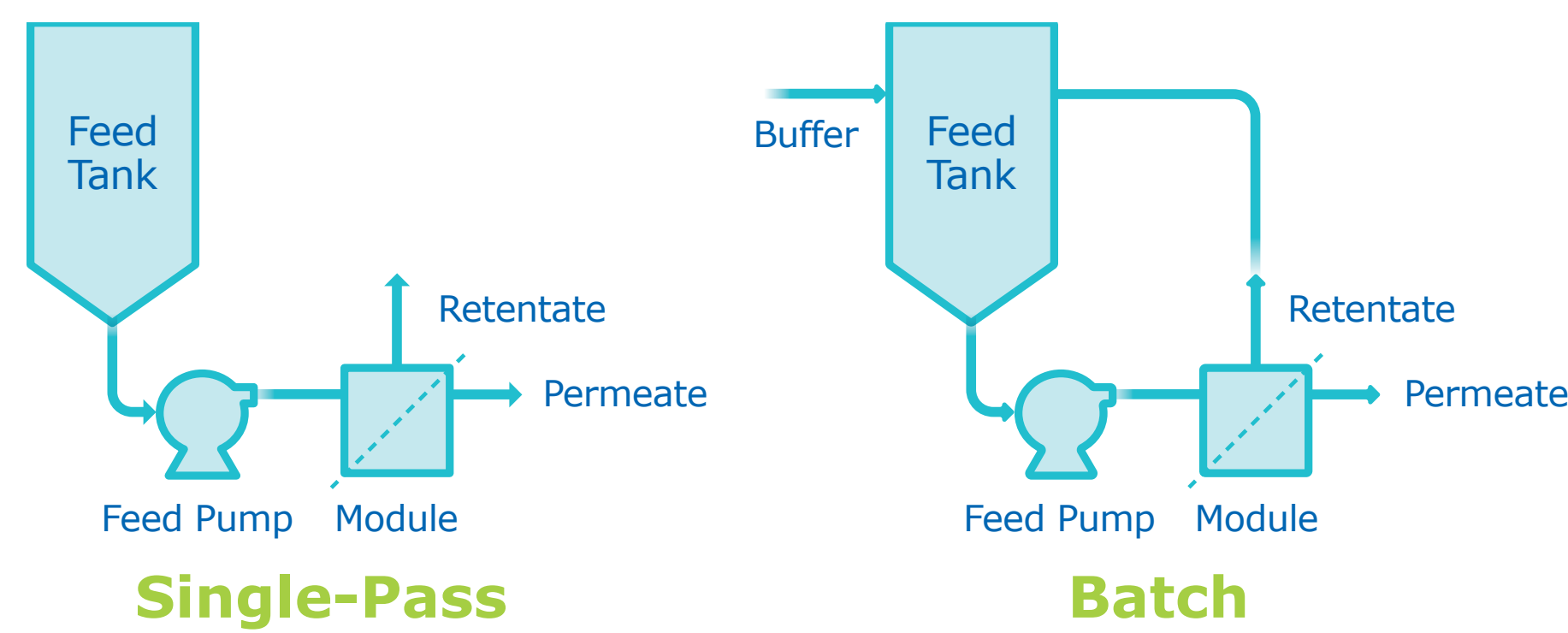
## How does SPTFF compare with current batch UF?

- Both use same cassettes and holders (need diverter plates)
- Simplicity comes at a price: e.g. 1.2 - 3X membrane area versus batch sizing

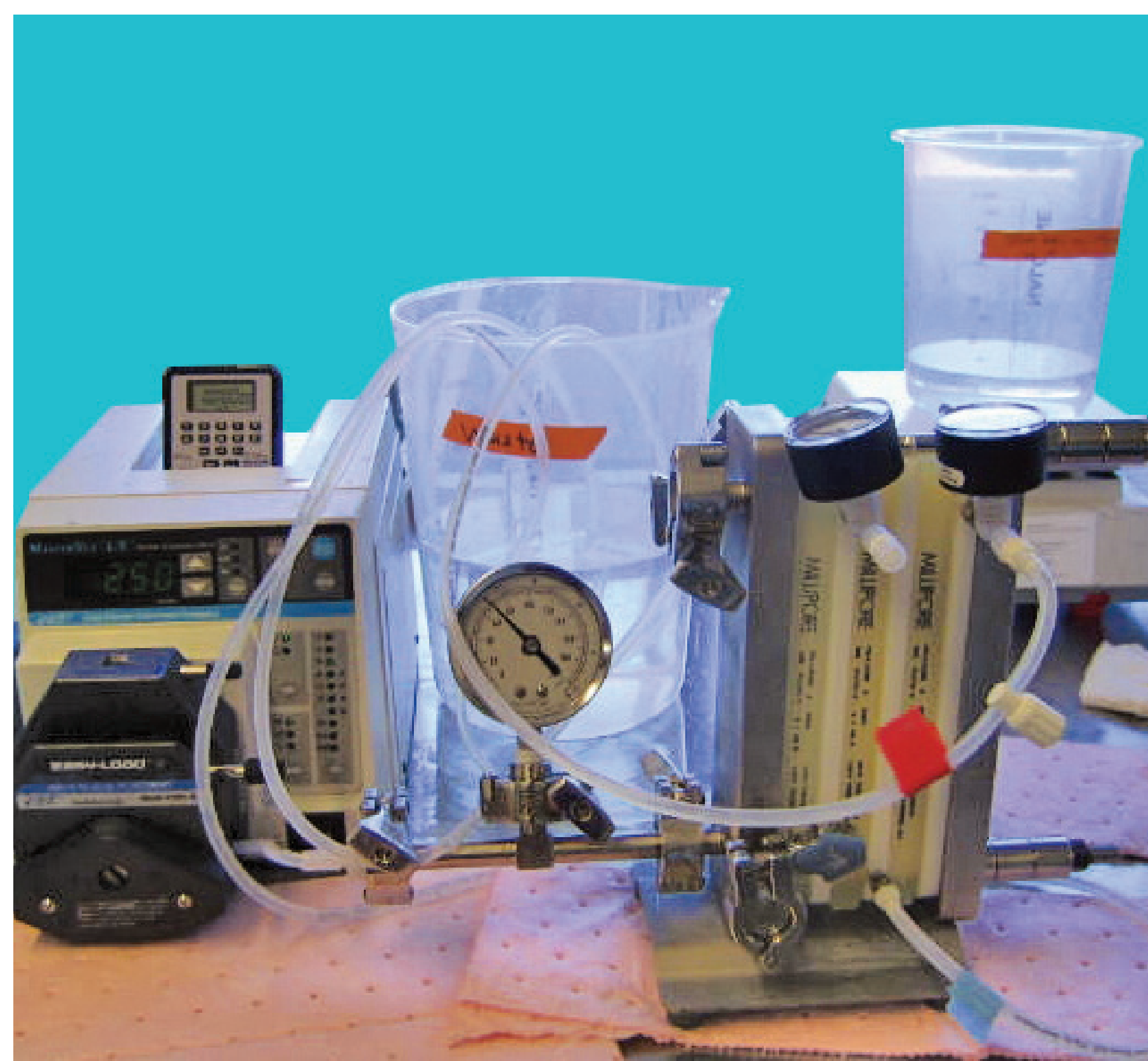
Application	SPTFF
Intermediate UF, 19 g/L to 40 g/L	0.82 LMM*
Final Formulation UF1, 18 g/L to 73 g/L	0.36 LMM
Final Formulation UF2, 77 g/L to 174 g/L	0.18 LMM

\*LMM = feed flow rate in liters per minute per total square meters of membrane area.

## What is SPTFF?



- Product is sufficiently concentrated/diafiltered after a single pass through filter assembly
- No retentate return needed
- Continuous operation
- Product is *not* sufficiently concentrated/diafiltered after a single pass
- Requires retentate return and multiple passes through filter
- Batch operation



## SPTFF sizing with IVIG

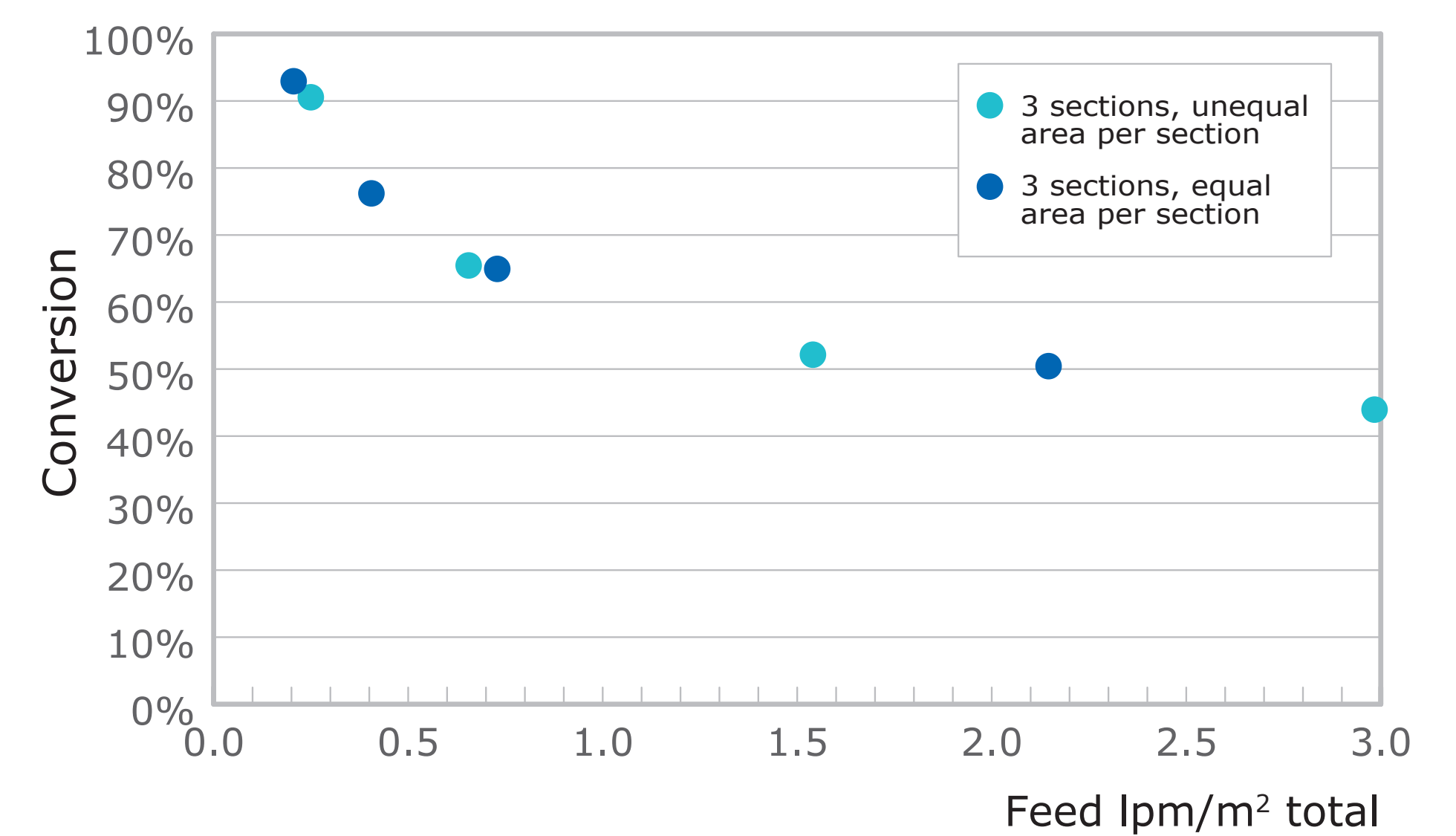
- **Conversion**
  - Decreases with increasing feed LMH
  - Increases with # in series
  - Decreases with feed g/L
- **Sizing**
  - feed flux based on conversion target
  - membrane area based on batch volume and process time

## This is worth it for:

- Plants where product pool volumes have increased beyond available tank capacities
- Limited plant footprint (no room for batch operation)
- Batch holdup limits final concentration (can't get to target product g/L)

## Is there an advantage to using custom SPTFF modules or systems?

- Sizing is comparable between equal area sections & in sections in series
- Equal area sectioning is well known and in the public domain



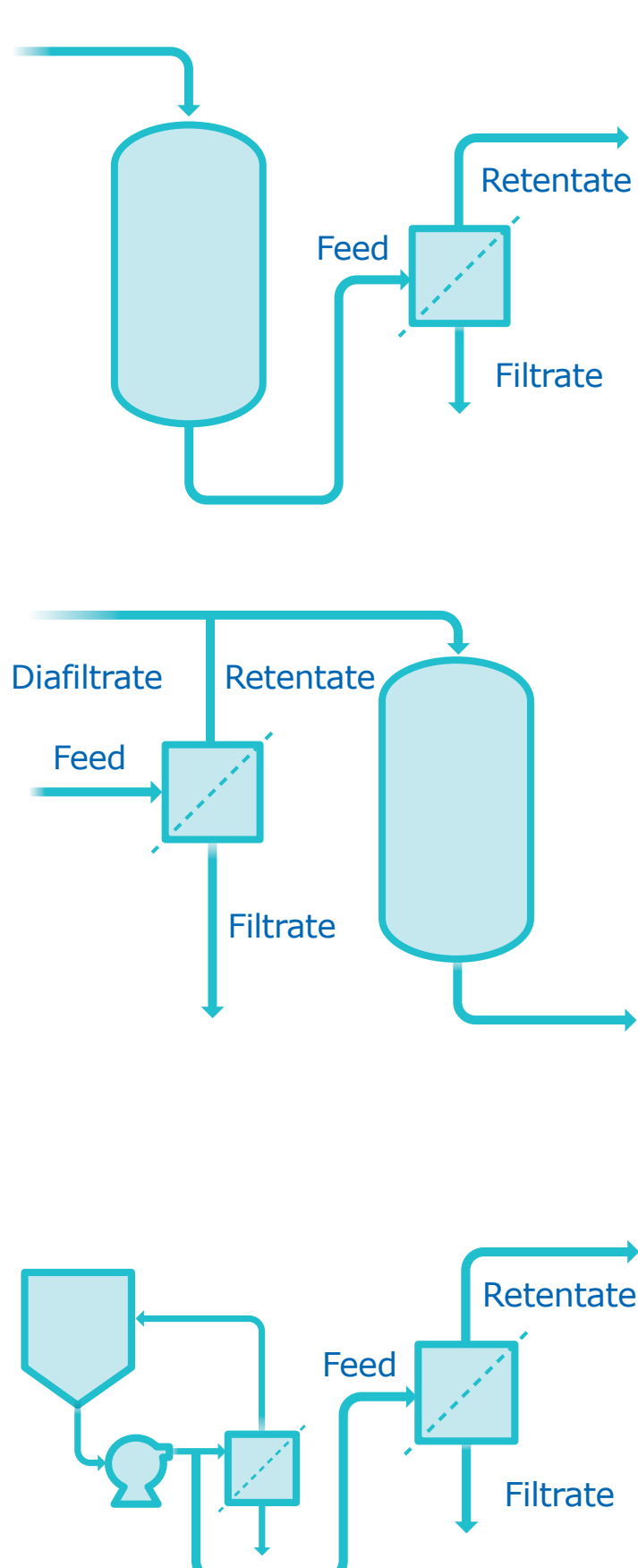
## How does SPTFF work?

- **Batch processing:** High feed flux and TFF devices operated in parallel results in low fluid residence time in membrane channels, hence low conversion
  - 1 device in series
  - feed flux ~ 6 LMM
  - conversion ~ 15 - 20%
- **SP-TFF processing:** Increase conversion by increasing fluid residence time in membrane channels via lower feed flux and longer channels
  - 1 to 3 (or more) devices in series
  - feed flux ~ 0.5 LMM or less
  - conversion ~ 75 - 90+%

## Why use SPTFF?

- **Simple operation**
  - Constant feed flow & retentate pressure
  - Leverage existing holders
- **Simple system design**
  - Smaller pump
  - Smaller footprint
  - Low working volume allows higher final concentrations
  - Simplifies product recovery
- **Once-through flowpath**
  - Run in-line with other unit operations
  - Enables continuous processing
  - Reduces pumping damage for sensitive products

## Where can SPTFF be used?



### Post-column (or other step) concentration

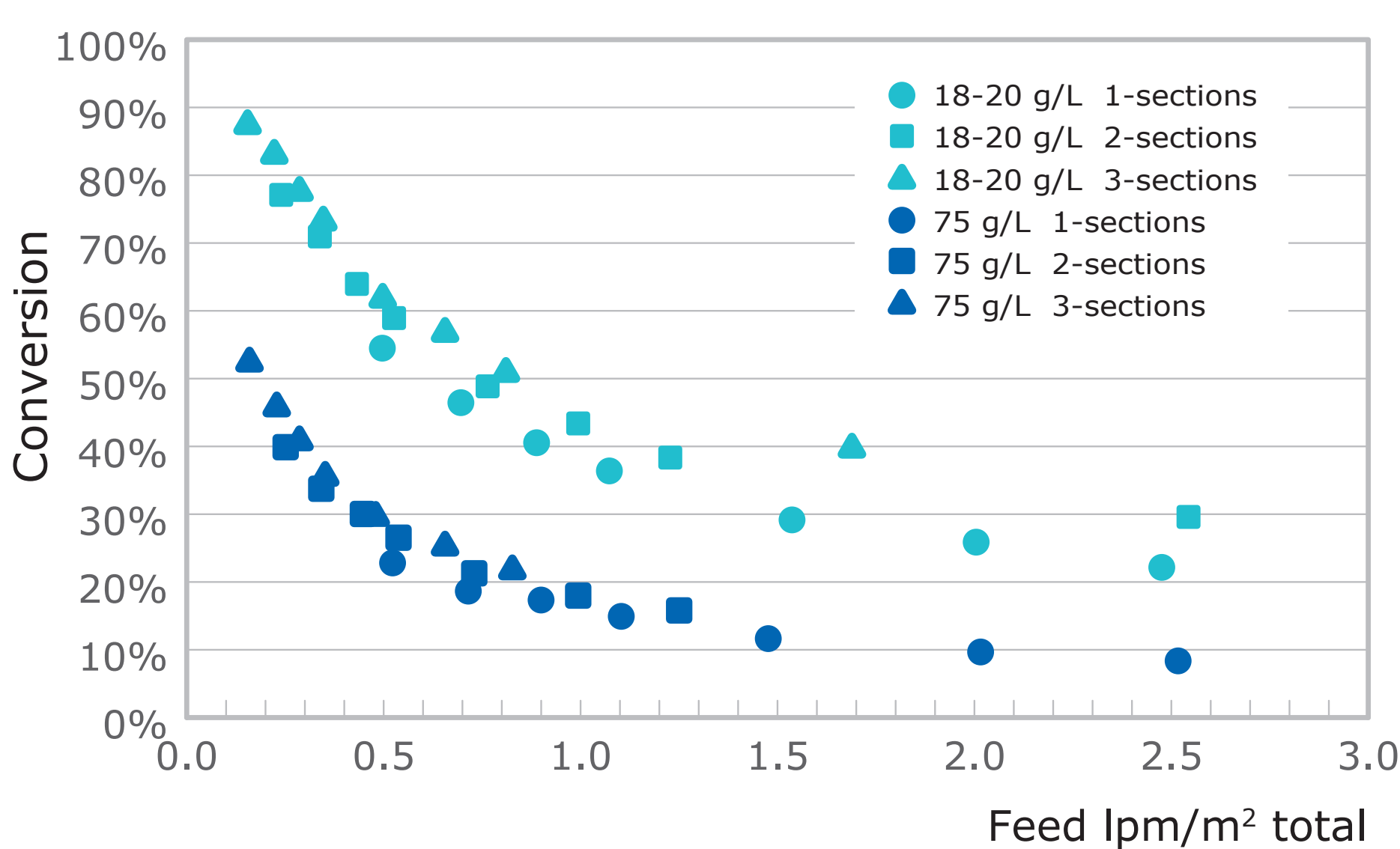
- Reduce or eliminate intermediate pool tank

### Pre-column (or other step) concentration/diafiltration

- Desalt before IEX column or virus prefilter
- Concentrate to increase capacity and reduce time

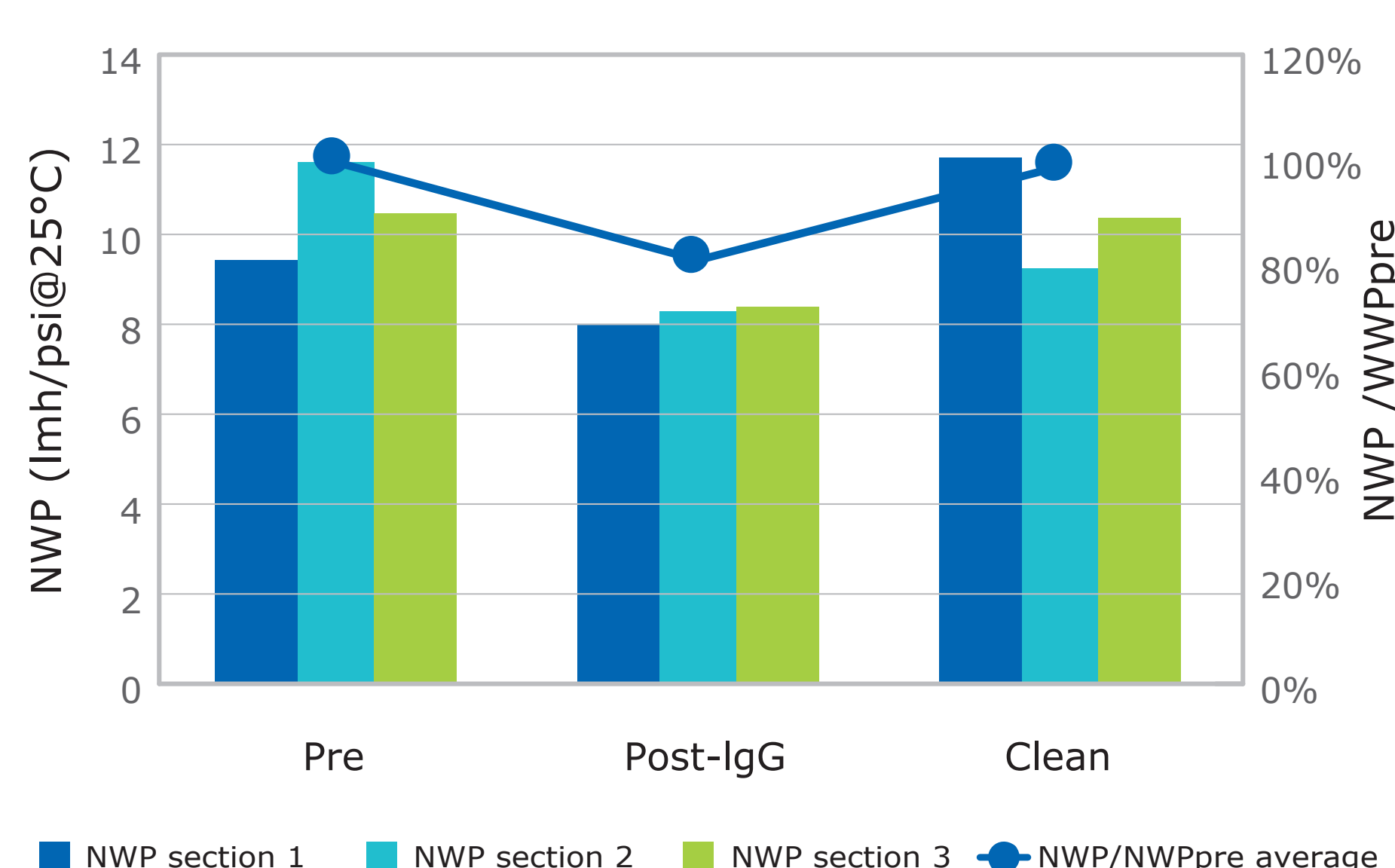
### Final formulation UF2 step (post batch UF/DF)

- Avoid working volume limits
- Maintain product quality, particularly if the product is heated to overcome viscosity effects



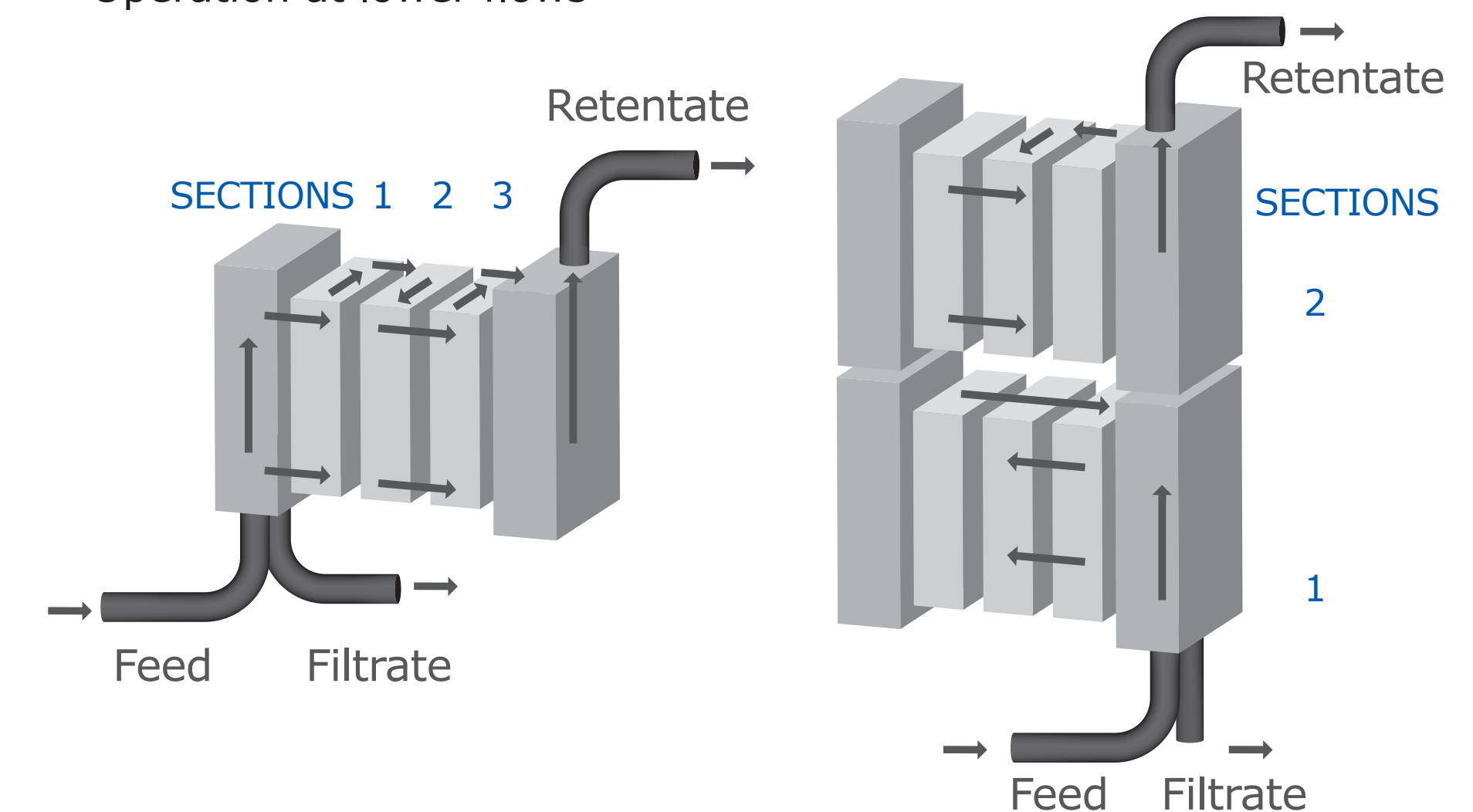
## SPTFF cleaning after IVIG

- Repeatable NWP recovery for all 3 cassettes in series after use with IVIG



## Scaling Options

- Existing holders and cassettes
- Operation at lower flows



### Single level

- Horizontal sectioning
- Separator plates

### Multiple level

- Vertical sectioning

## Acknowledgments

Eva Gefroh, Gisela Ramsey, Elizabeth Goodrich, Willem Kools, Randy Kirilin, Todd Ireland, Dan Dussault