

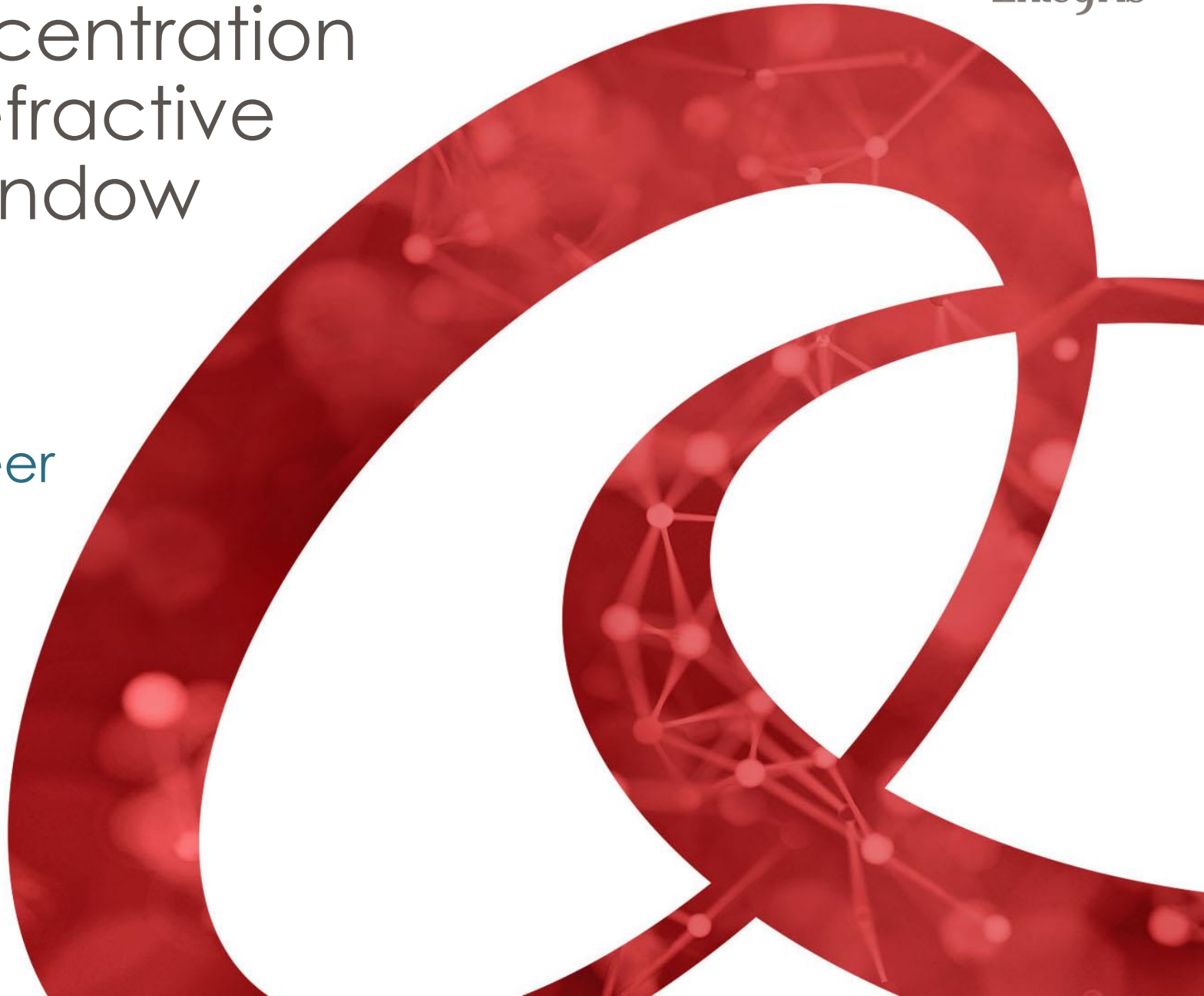


CMPUG Spring Virtual Meeting
April 22, 2021:
Advances in CMP Consumables, Materials and Tools

Effective Slurry Concentration Monitoring Using Refractive Index with In Situ Window Cleaning

Tracy Gast

Global Applications Engineer



Agenda

Refractive Index Overview

InVue® GV148 Overview and Features

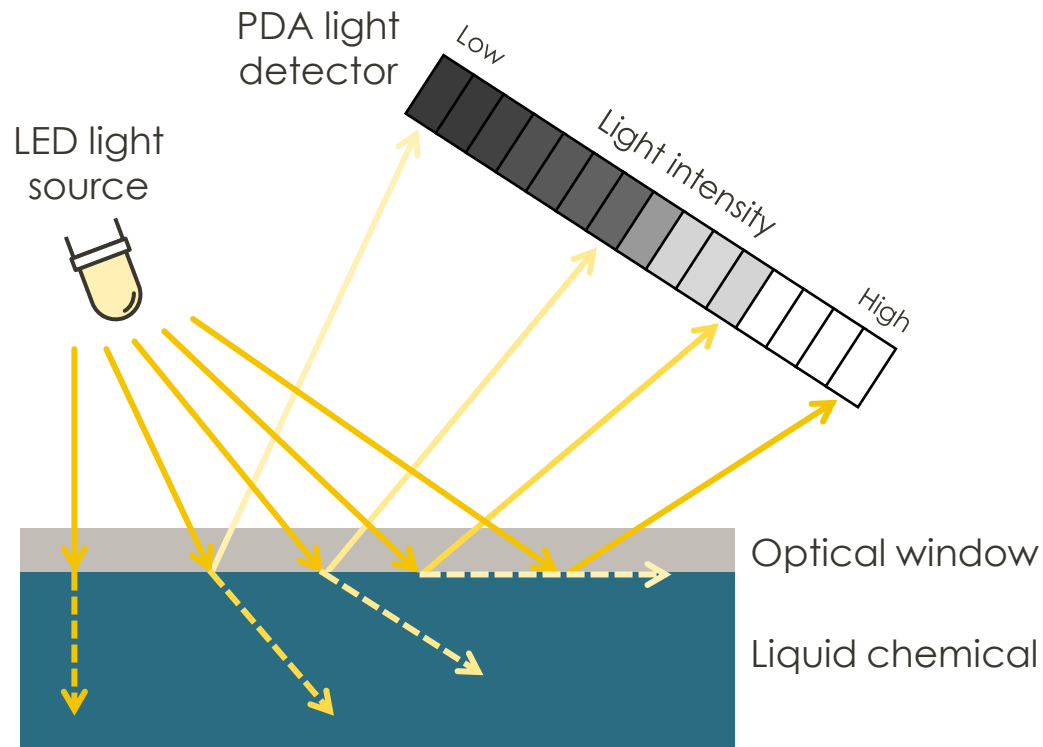
Performance Testing in Slurry

Slurry Baseline Testing with
Automated In Situ Window Cleaner

Conclusions

Acknowledgments

Refractive Index Overview: How it Works



Light reflects off window/liquid interface into the PDA

Angle of reflection determined by refractive index ratio between liquid and window

Entegris algorithm measures small changes in reflected light intensity

Reflection geometry and miniaturization enable unique concentration monitoring performance

Functions in turbid media (CMP slurry), as well as non-conductive fluids (H_2O_2)

Refractive index offers a robust measurement technology over various types of media

InVue® GV148 Liquid Concentration Monitor

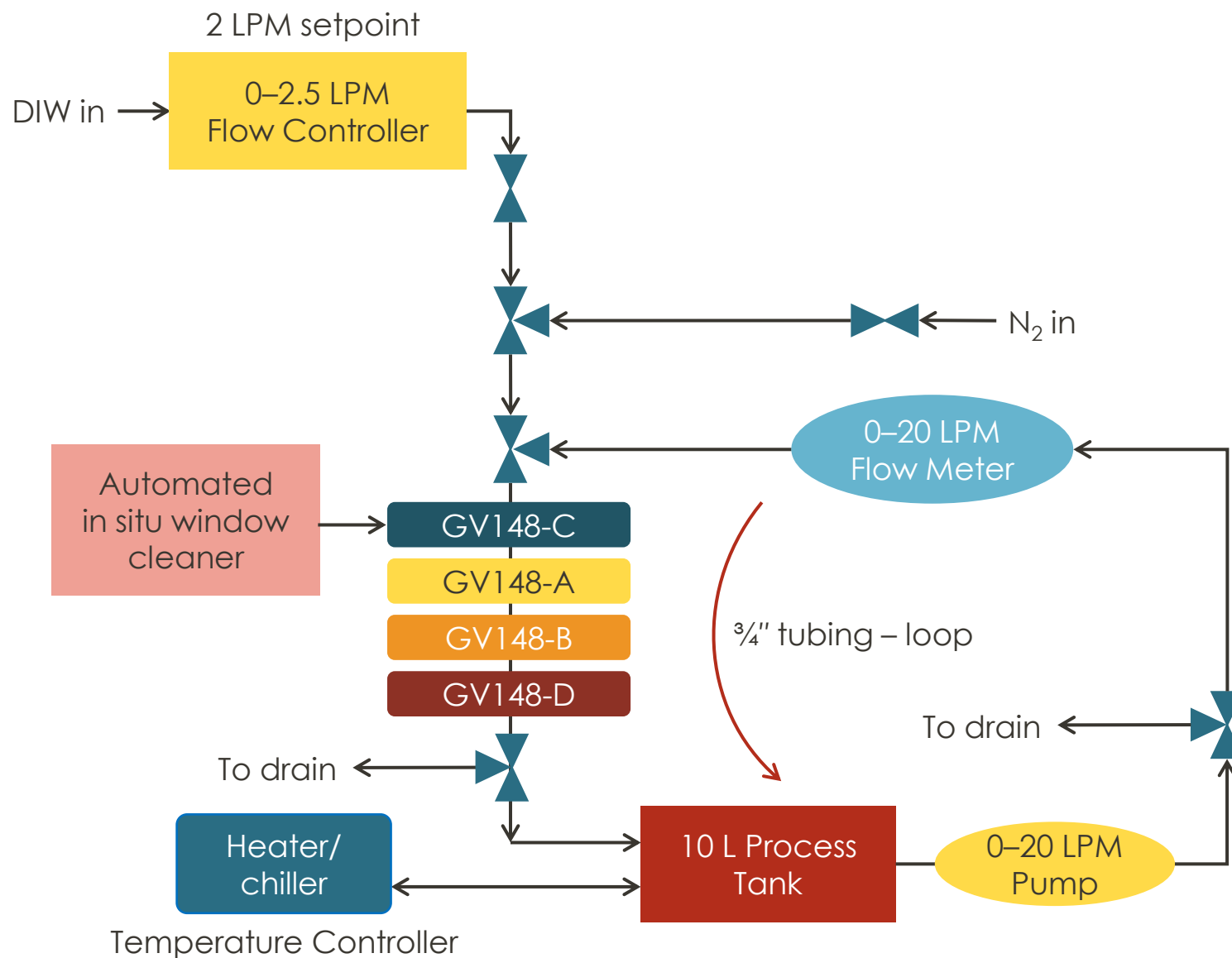
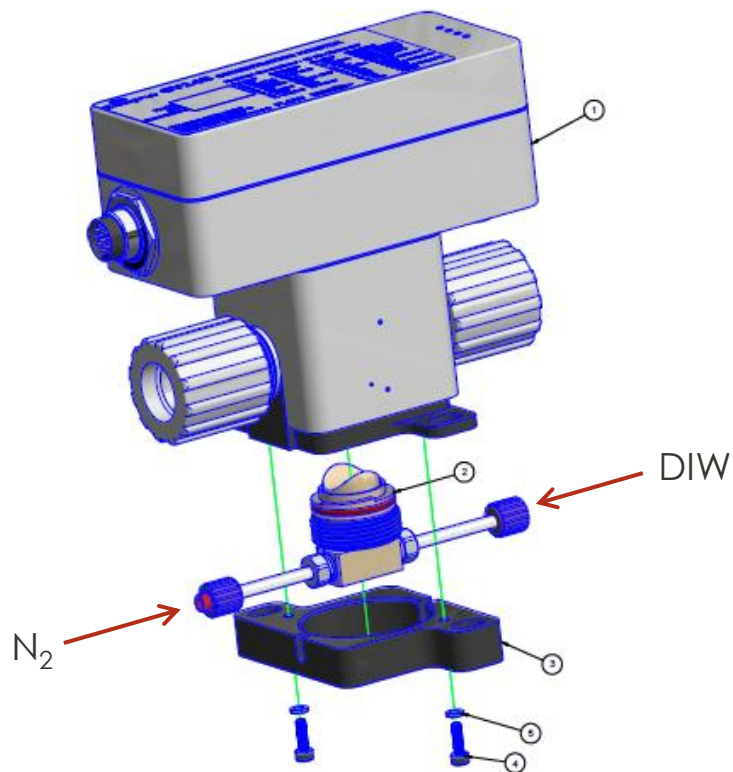


Product Advantages

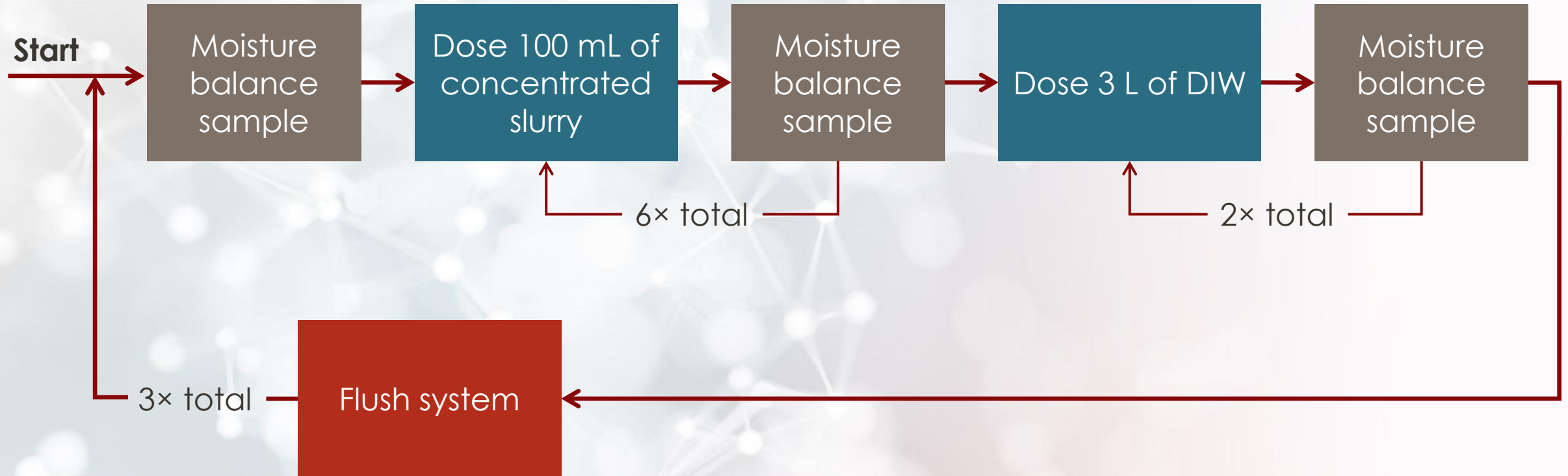
- Measurements based on Index of Refraction
- Ultrapure wetted surfaces of fluoropolymers and sapphire
- Small footprint with integral electronics
- Stable and proven Human Machine Interface (HMI)
- Multiple communications options
- No consumables
- Standard ambient light cancellation algorithm
- Window cleaning port
- Optional automated in situ window cleaning option

Real-time process monitoring in an integrated, compact package

Setup (P&ID)



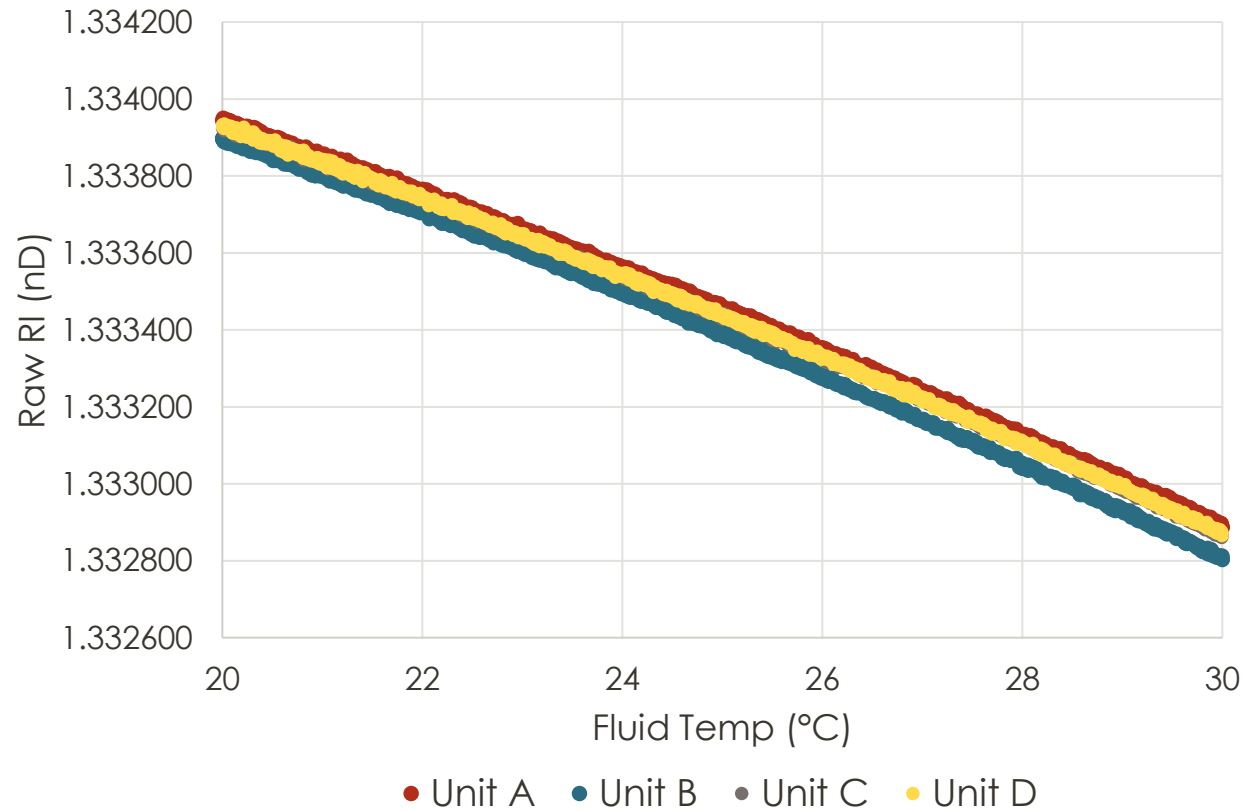
Process Flow



Temperature Compensation

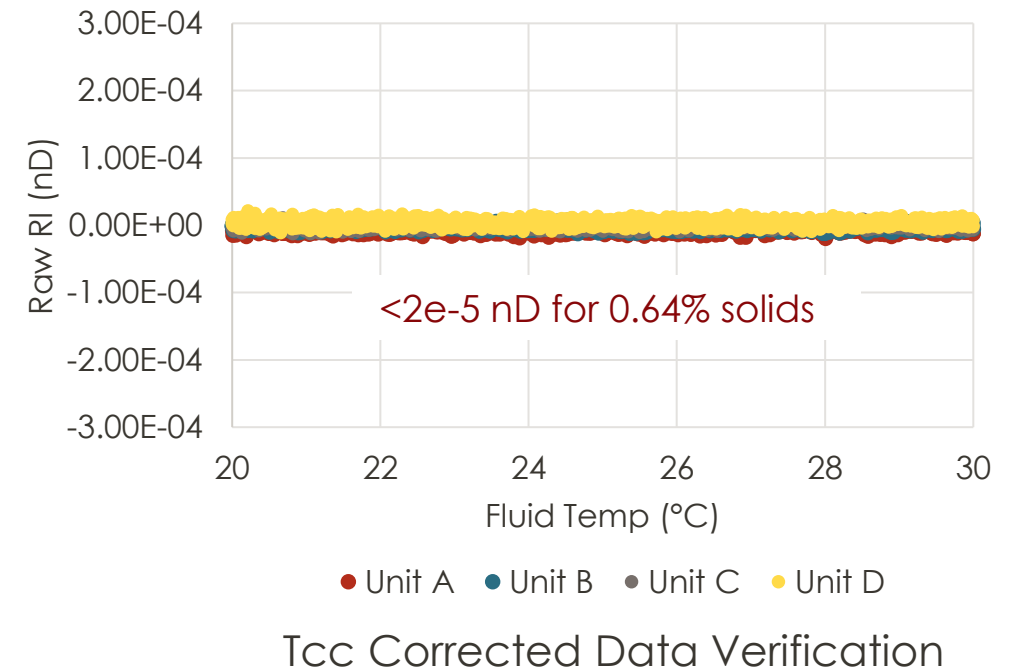
Raw RI vs. Temperature Curve

Raw RI vs. Temperature
(Slurry 0.64% Solids)



Method: Expose units to different concentration of slurry at varying temperatures to extract compensation coefficients (Tcc).

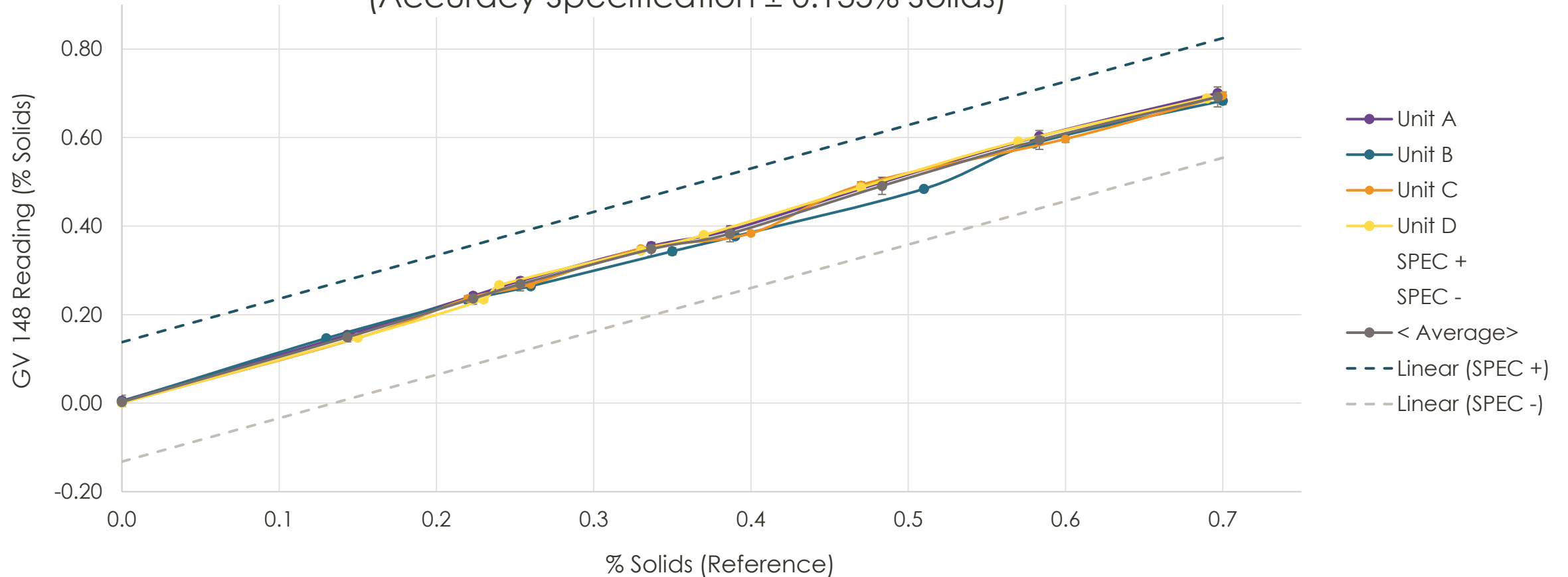
2nd Degree Correction RI Residual –
Over Temp (Slurry 0.64% Solids)
Individually Calculated Temp Comp



Entegris GV148 provides real time temperature compensation

Verification RI vs. Concentration

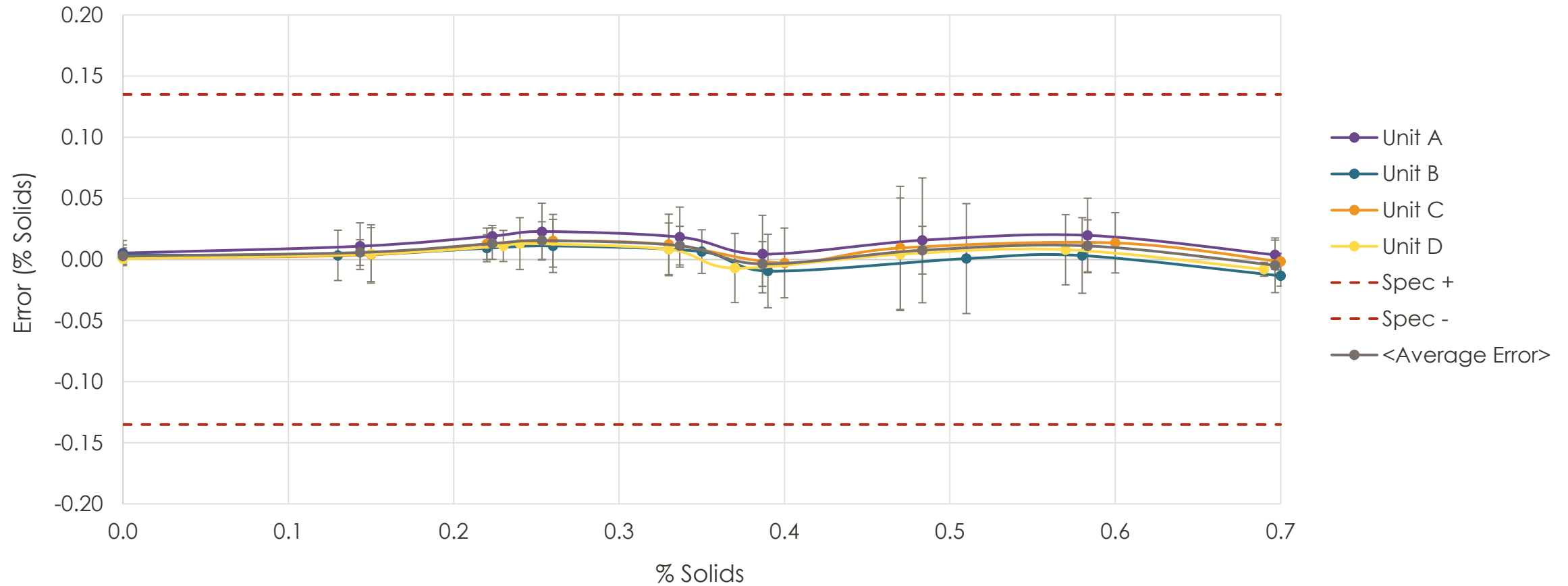
Slurry GV 148 Readings (3 Runs) vs. Reference
(Accuracy Specification $\pm 0.135\%$ Solids)



Entegris GV148 concentration measurements correlate well with moisture balance measurements

Accuracy: % Solids

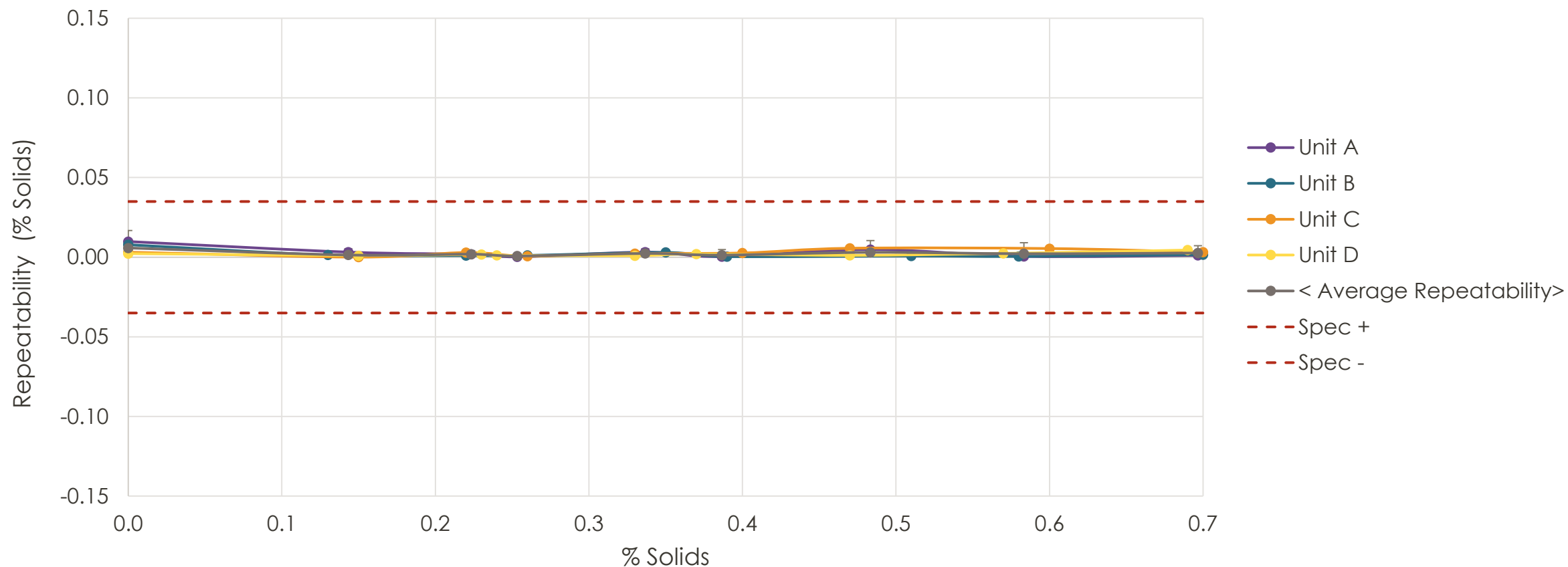
GV 148 Accuracy in Slurry
(Accuracy Specification +/- 0.135 % Solids)



**Accuracy: concentration measured by GV148 –
reference concentration measured by moisture balance**

Repeatability: % Solids

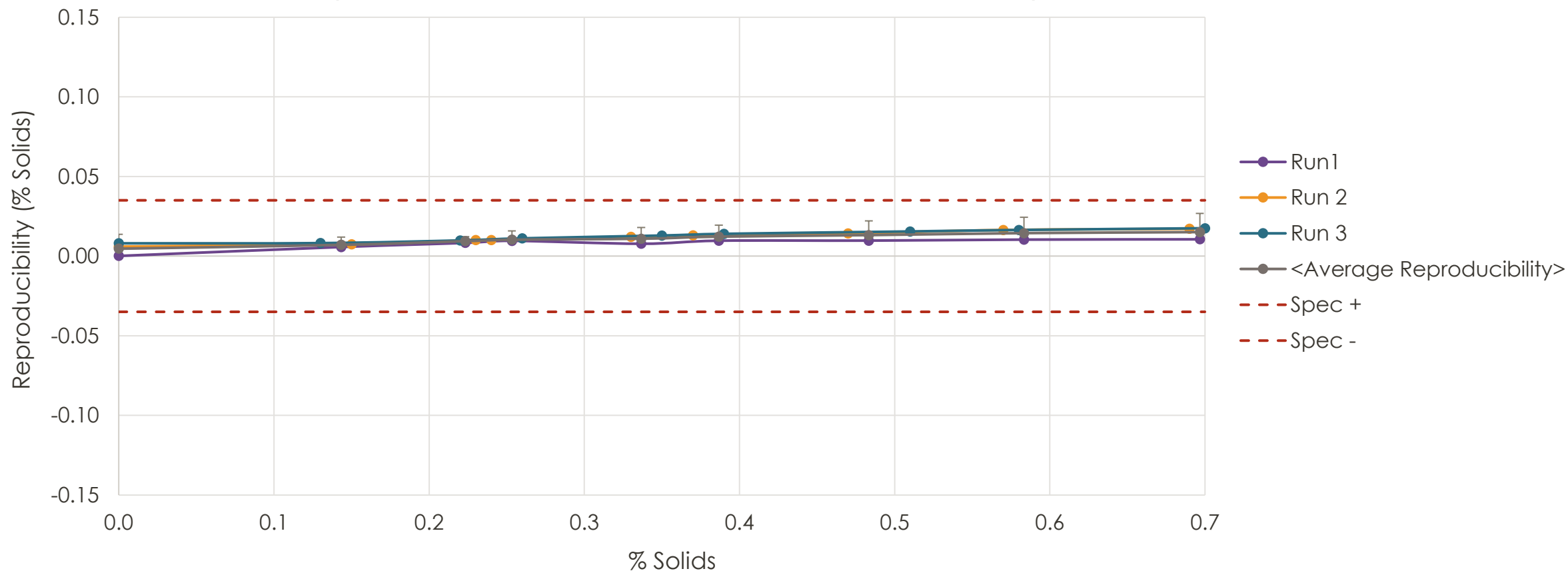
GV 148 Repeatability in Slurry
(Repeatability Specification $\pm 0.035\%$ Solids)



**Repeatability: difference in concentration among runs for same unit
= (max – min concentration of 3 runs)**

Reproducibility: % Solids

GV 148 Reproducibility in Slurry
(Reproducibility Specification $\pm 0.035\%$ Solids)

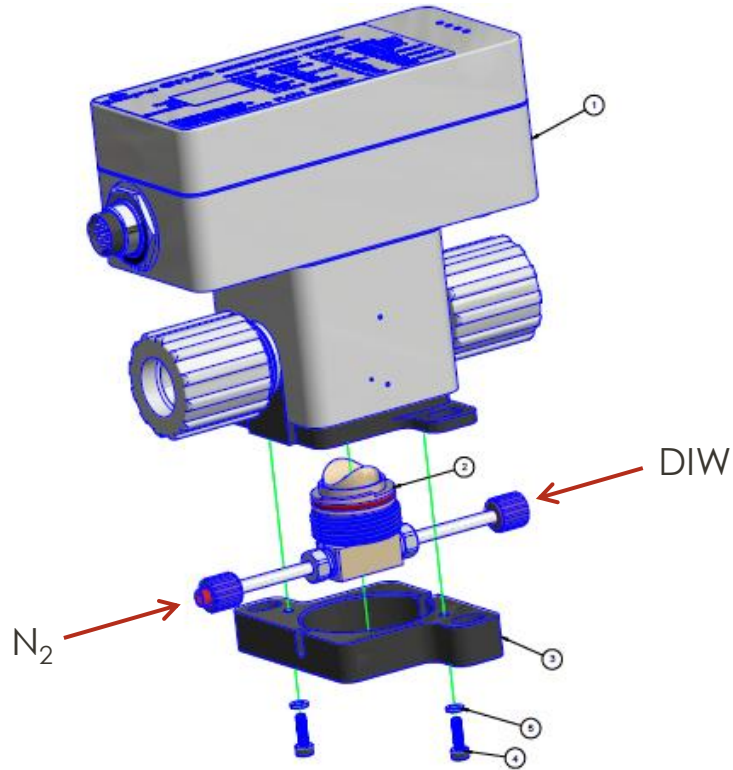


Reproducibility: unit to unit variation. Difference in concentration among units for same run = (max – min concentration of 4 units)

Slurry Baseline Testing

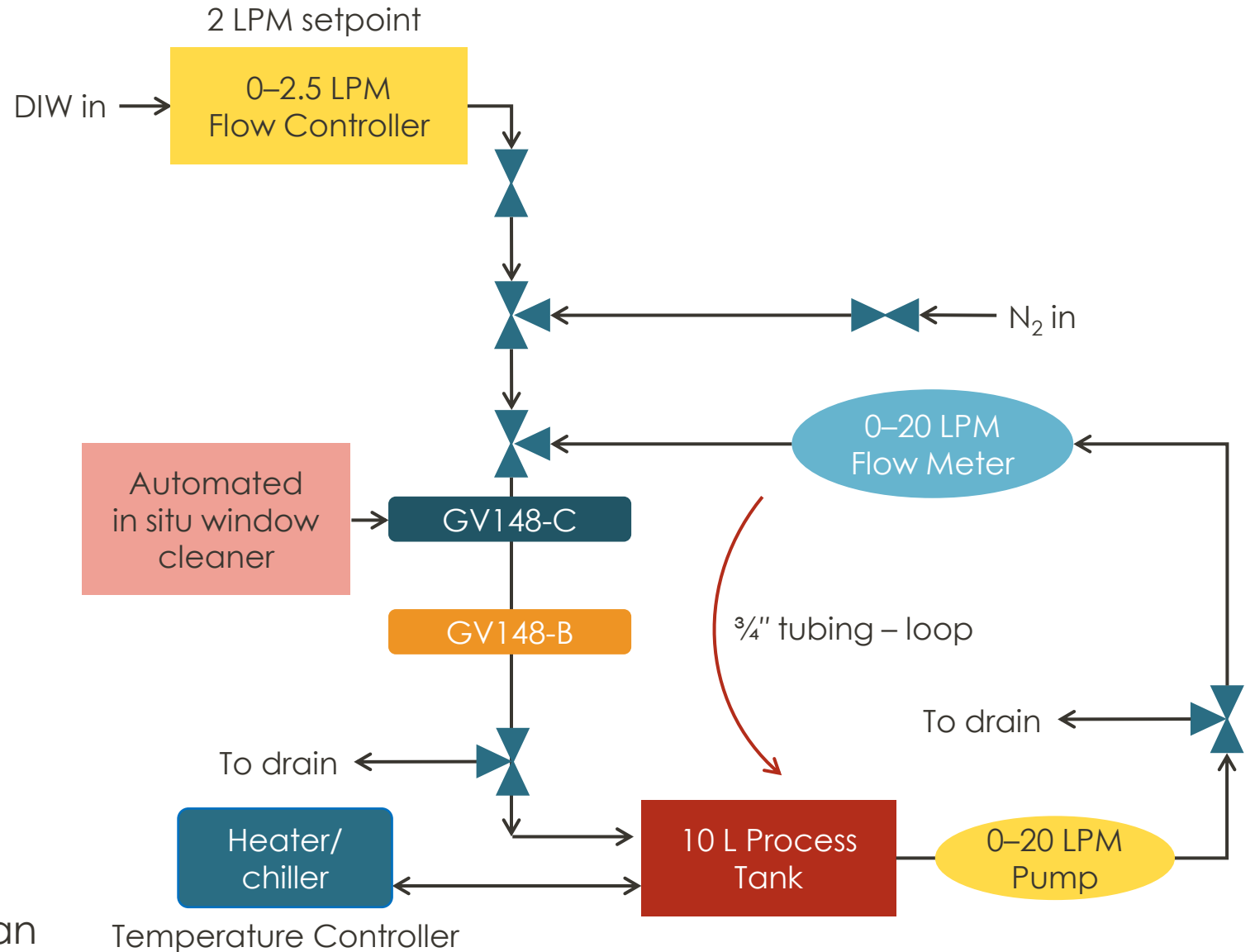


Setup (P&ID)



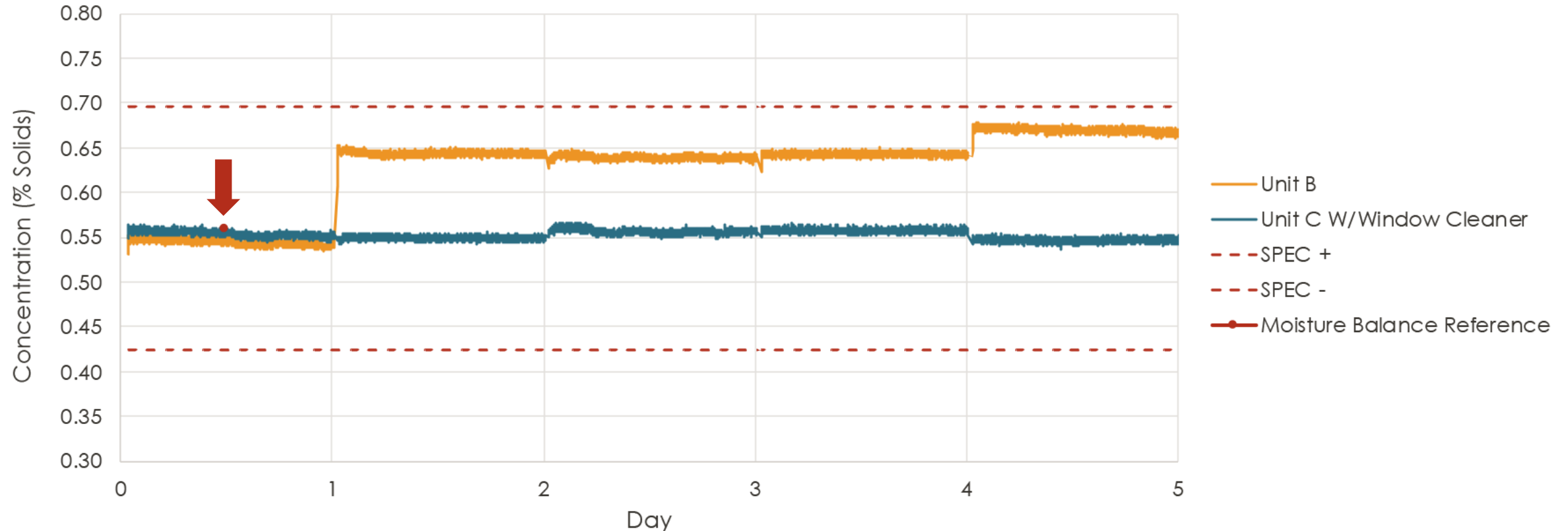
Daily PM – Both Units Under Test

- 300 sec manifold rinse to drain
- 30 sec N₂ purge to drain
- Unit C automated in situ window clean



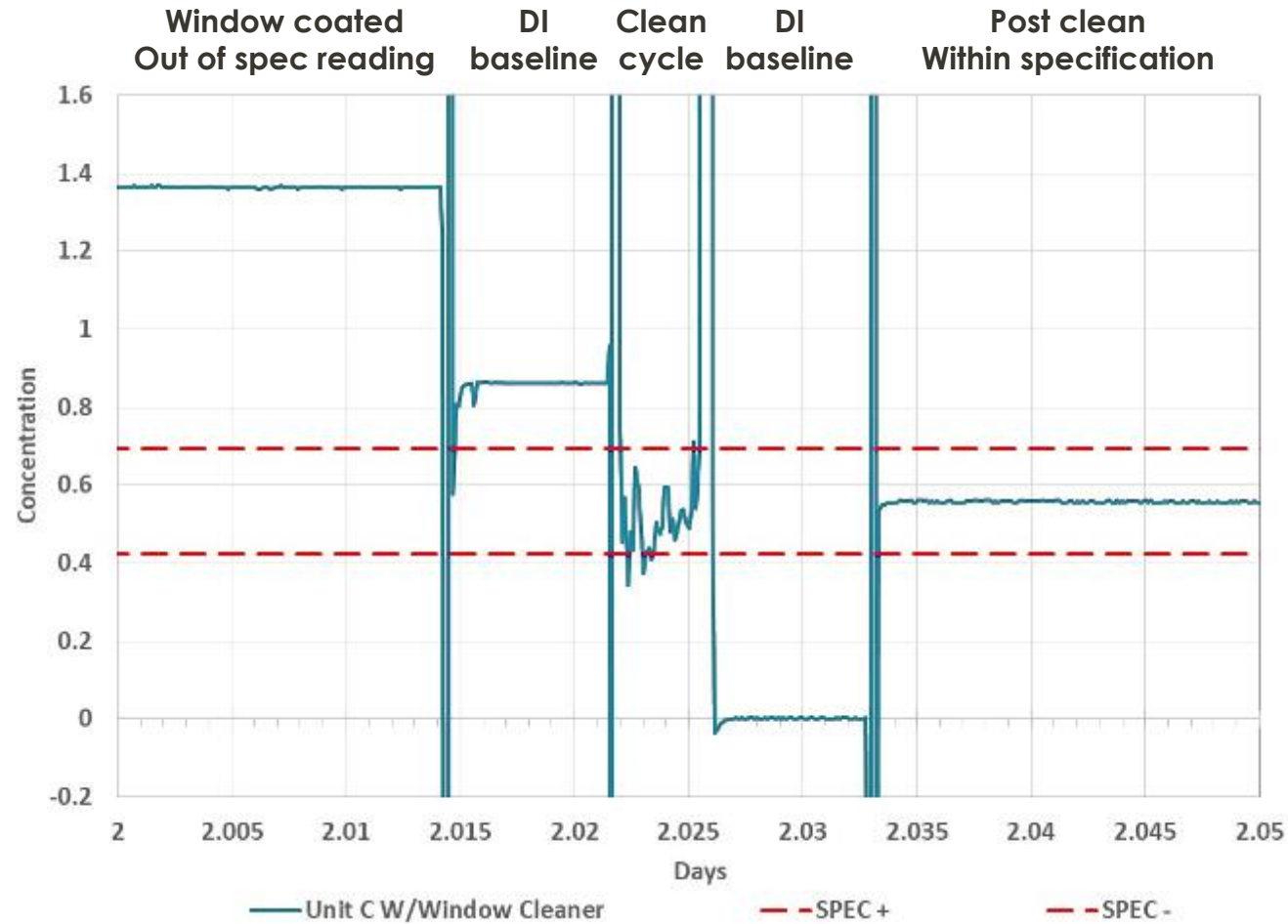
5-Day Slurry Exposure Test

Slurry Exposure Test GV148
5 Liter flow @ 25°C



Periodic window cleaning prevents refractive index measurements from drifting out of specification

Slurry Exposure Test – Cleaning Cycle



Even significantly slurry-fouled IoR windows can be recovered via GV148 automated in situ window cleaner

Conclusions

Refractive index offers a robust measurement technology for CMP slurries and often required H_2O_2 additions

Entegris' GV148 provides real-time process monitoring in an integrated, compact package well suited for semiconductor CMP applications

GV148's automated in situ window cleaner provides a benign and aggressive means to remove slurry fouling films and return the monitor to the original established baselines.

Automated in situ window cleaning prevents the need for intrusive cleaning procedures, subsequent costly tool downtime and lengthy re-qualification procedures

Acknowledgments



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- Ian McGuire – Engineering Technician
- Ryan Gerou – Engineering Manager
- Ken Mattsen – Software Engineer

Thank you!