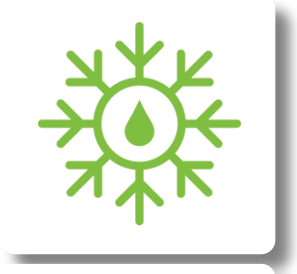
Cooling Environments





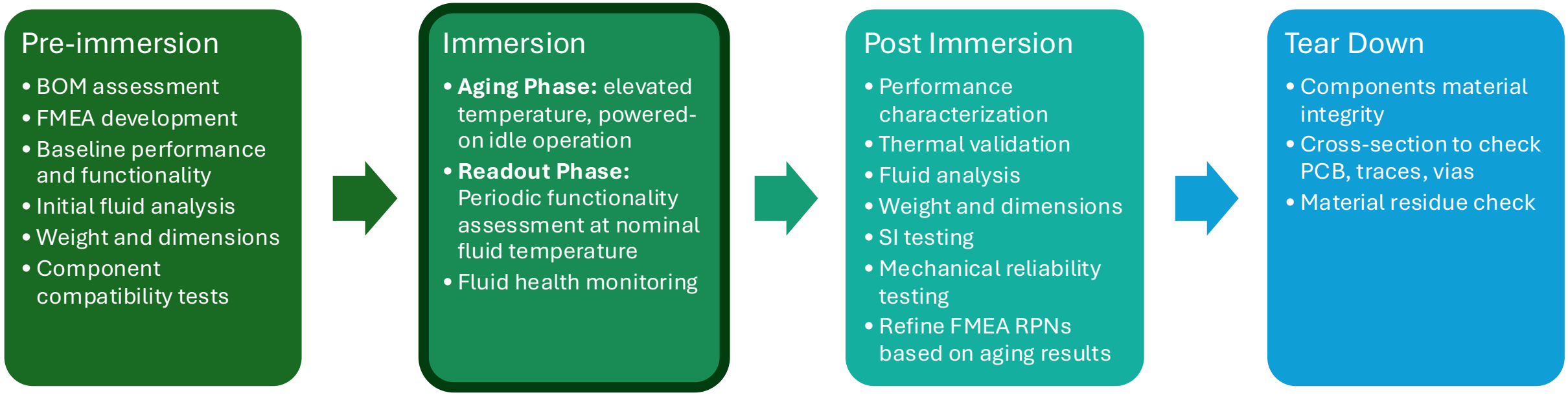
Immersion Project

A Practical Framework for SSD Qualification in Single-Phase Immersion Cooling

Jason Brand *Thermal Validation Engineer, Solidigm Inc.*

Justin Boldrini *Thermal Validation Engineer, Solidigm Inc.*

SSD Thermochemical Reliability Methodology



This methodology combines elevated-temperature aging, periodic functional verification, and fluid analysis to evaluate the thermochemical aging behavior of SSDs in single-phase immersion environments.

SSD Thermochemical Reliability Methodology

Immersion Test Parameters

Parameter	Aging Phase	Readout Phase
Fluid Temperature	Elevated (e.g., >60°C)	Nominal (30-40°C)
SSD State	Powered-On Idle	Powered-On
Workload	None	Functional & Performance Tests
Duration	Long-term Exposure	Periodic Readout Intervals
Fluid Monitoring	Continuous / Periodic Sampling	Continued Monitoring
Primary Objective	Accelerate Thermochemical Aging	Verify Functionality & Performance

Immersion Tank Landscape

- Deployment Environment - Large tanks



- Edge Environment



- Experimental Immersion



- Component Level Tank



Where do we test SSD form factors in isolation?



Why not use Deployment Environment?

Deployment environments and accelerated aging environments have different objectives.

Deployment Environment	SSD Thermochemical Reliability Testing Environment
Designed to maximize system performance and cooling efficiency	Designed to accelerate thermochemical aging mechanisms through controlled elevated-temperature exposure
Operates near customer operating temperatures	Requires elevated temperatures to accelerate thermochemical interactions and degradation mechanisms
Multiple components contribute materials and contamination sources	Controlled BOM simplifies assessment of materials-fluid interactions
Difficult to isolate SSD-specific effects	SSD-only testing enables assessment of SSD-specific thermochemical aging effects
Larger volumes of fluid	Smaller fluid volumes support operational ease while maintaining sufficient volume for fluid aging analysis

From Testing Challenges to Design Requirements

Design Goal

Develop a dedicated SSD-only immersion platform capable of supporting accelerated thermochemical reliability evaluation while reducing the cost and complexity of full-system immersion infrastructure.

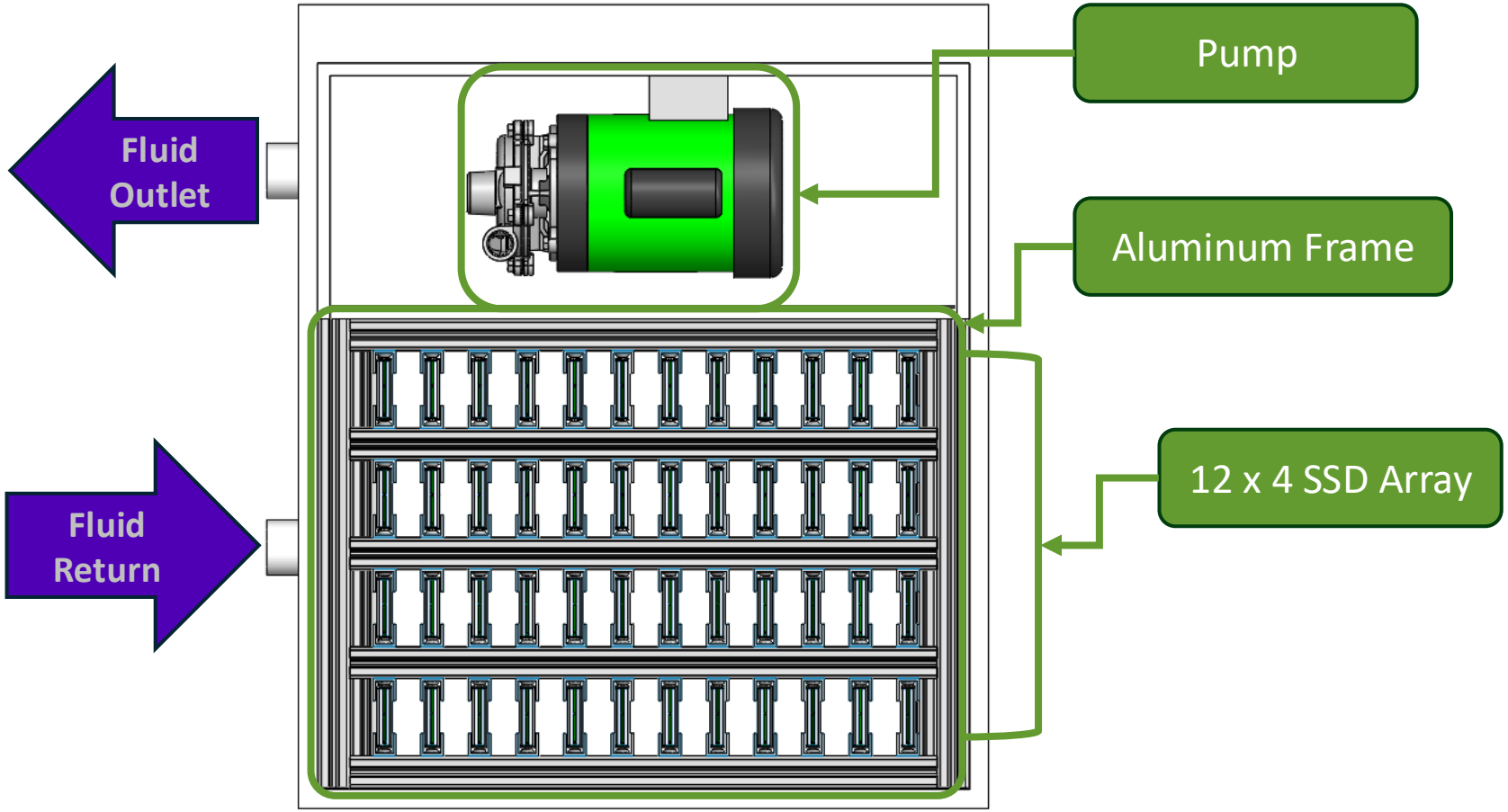
Key Requirements	
□ Support elevated temperature operation (up to ~80°C)	
□ Maintain sufficient sample size of SSDs in a powered-on state during aging	
□ Enable periodic functional and performance assessments	
□ Support fluid property and chemistry analysis	
□ Control wetted materials and contamination sources	
□ Minimize fluid volume while maintaining sample density	

Resulting Design Need

A dedicated SSD-only immersion platform rather than a conventional deployment tank

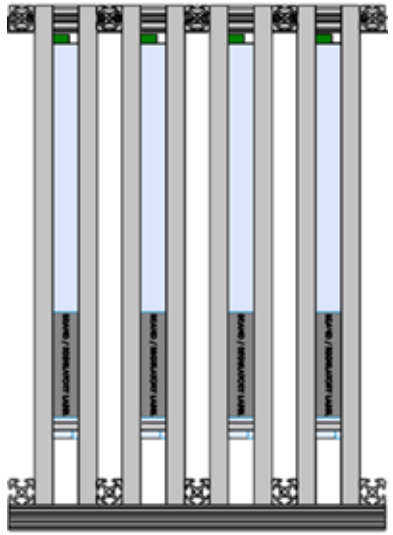
SSD Immersion Platform

Top-view



Isometric-view



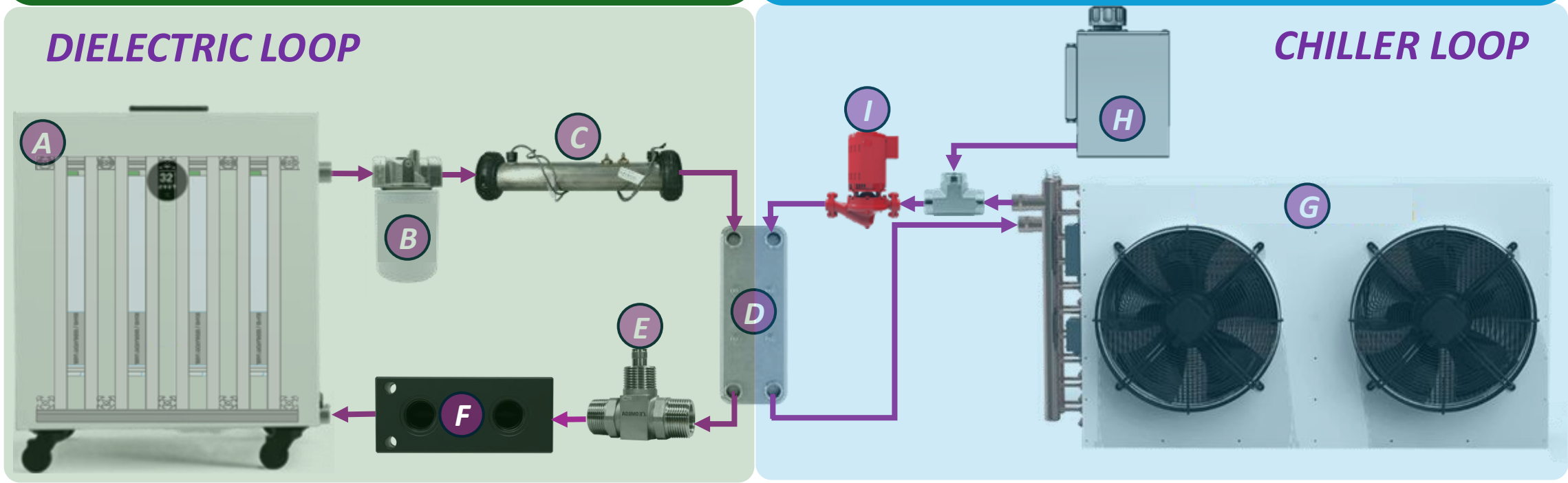


Side-view

SSD Immersion Platform Architecture

A. Immersion Test Tank
B. Filtration Assembly
C. Flow-Through Heater
D. Plate Heat Exchanger (primary side)
E. Flow Meter
F. Sensor Manifold

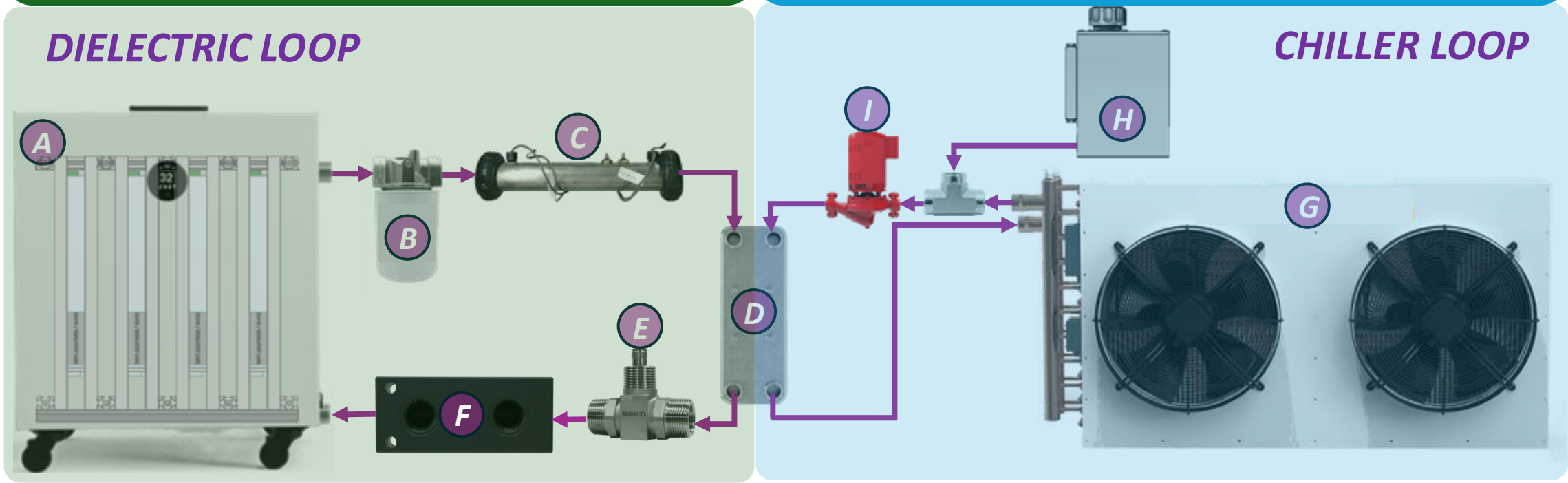
D. Plate Heat Exchanger (secondary side)
G. Liquid to Air Heat Exchanger
H. Expansion Tank
I. Pump



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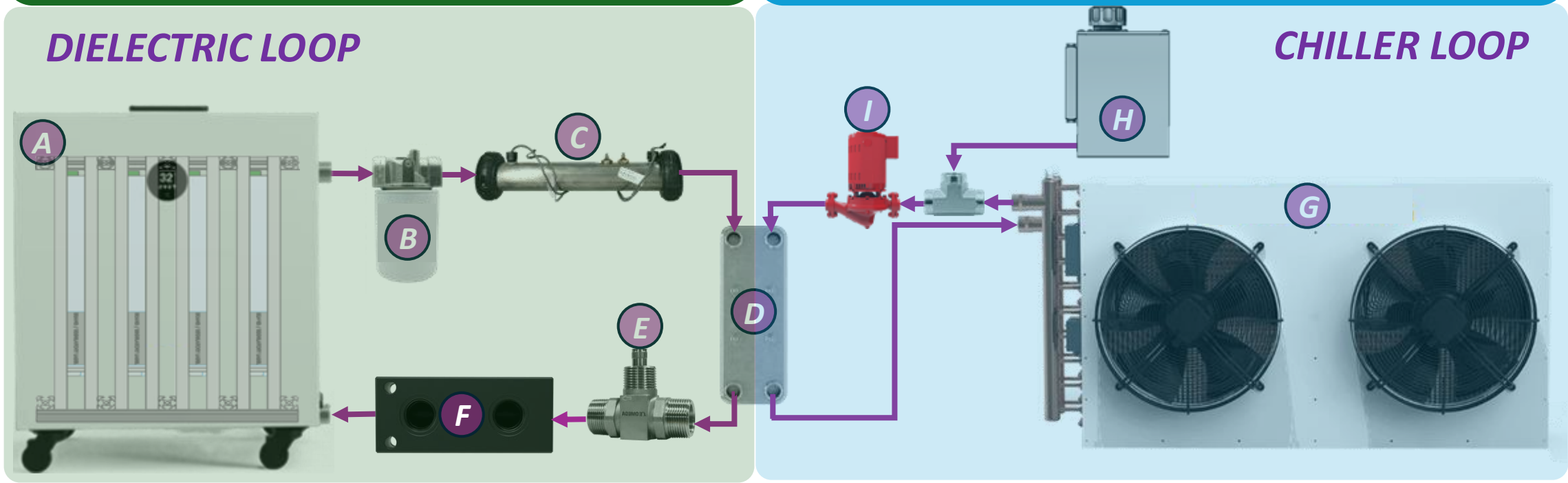
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Key Requirements	
☐ Support elevated temperature operation (up to ~80°C)	Achieved
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☐ Support fluid property and chemistry analysis	Achieved
☐ Control wetted materials and contamination sources	Achieved
☐ Minimize fluid volume while maintaining sample density	Achieved

Resulting Design Need

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Call to Action

Call to Action: Join the Thermochemical Reliability Workstream

- Advance component qualification for immersion cooling environments
- Share reliability data, test methodologies, and qualification criteria
- Benchmark approaches and learnings across the industry
- Collaborate on common qualification frameworks for components in immersion
- Help address the challenge of qualifying components across diverse fluids, tank designs, and deployment conditions



Thank You!

