

Filtration & Purification Impact to Cleans Contamination Control Management

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Agenda

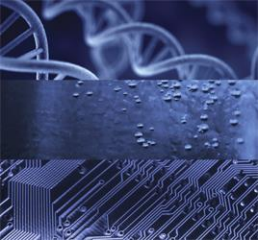
Contamination Control and Yield

Cleans Transformation

Cleans Contamination Control Model

Collaboration Example

Closing Thoughts



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Contamination Control and Yield

Table 111b Yield Model and Defect Budget MPU Technology Requirements—Long-term Years

<i>Year of Production</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>2019</i>	<i>2020</i>
<i>DRAM ½ Pitch (nm) (contacted)</i>	28	25	22	20	18	16	14
Plasma etch	63	50	42	30	25	19	15
Plasma strip	29	23	20	14	11	9	7
RTP CVD	19	15	13	9	7	6	5
RTP oxide/anneal	12	10	8	6	5	4	3
Test	5	4	3	2	2	2	1
Vapor phase clean	44	35	29	21	17	14	10
Wafer handling	2	2	1	1	1	1	0
Wet bench	28	23	19	14	11	9	7

Table 112b Yield Model and Defect Budget DRAM Technology Requirements—Long-term Years

<i>Year of Production</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>2019</i>	<i>2020</i>
<i>DRAM ½ Pitch (nm) (contacted) [A]</i>	28	25	22	20	18	16	14
Plasma etch	214	109	107	107	57	56	54
Plasma strip	164	84	82	82	43	43	42
RTP CVD	107	55	53	53	28	28	27
RTP oxide/anneal	79	40	39	39	21	21	20
Test	15	8	8	8	4	4	4
Vapor phase clean	227	116	113	113	60	60	58
Wafer handling	6	3	3	3	2	2	2
Wet bench	163	83	81	81	43	43	41



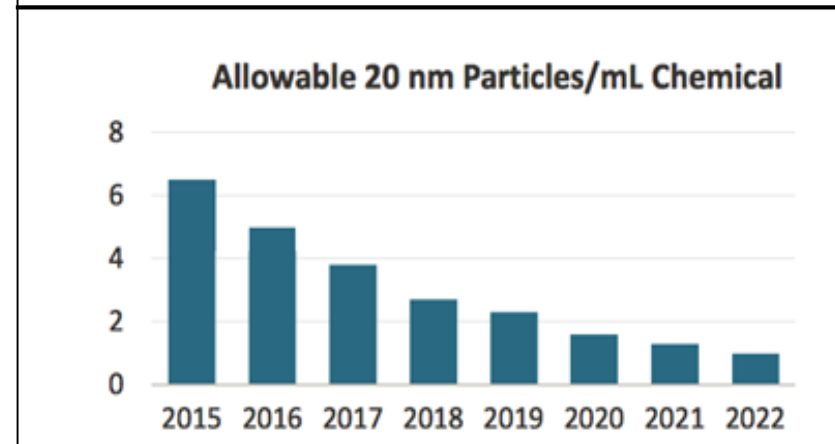
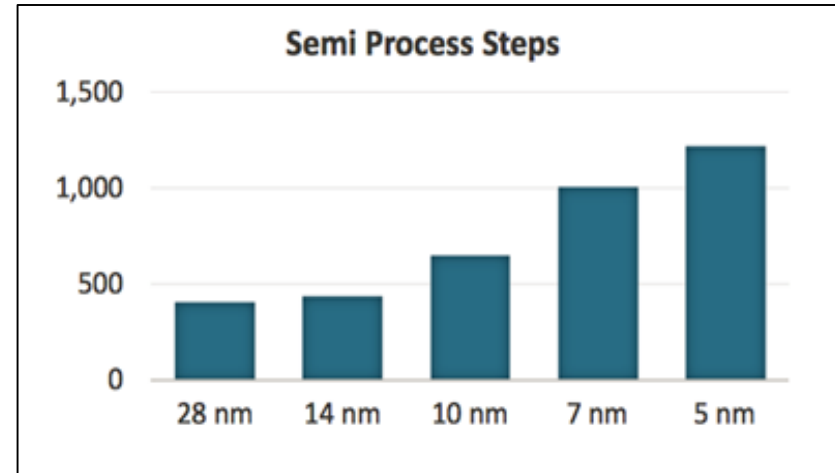
Contamination Control and Yield

The need for contamination control to mitigate the formation of defects and the resulting impact on Yield is not a new problem.

The industry continues to evolve to mitigate the ever increasing requirements on contamination control, however the economic landscape has put increasing pressure on materials and consumables suppliers....

Enable technology roadmaps by minimizing the negative impact of process defects and maximizing Yield...

Particularly true for the Cleans space





Contamination Control Financial Impact

#1 source of wafer Yield loss = \$MM / Yr of lost revenue

Cost of tool process qual failures can exceed \$20K / Hr

Major detractor to tool availability - can approach 10%

Adds \$MM of extra unscheduled annual Opex & Capex

Wafer level contamination related Yield detractors

Particles	What size, how many, What are they
Metals	Which ones, what level
Organics / NVR	What quantity

Employing filtration & purification is an option to address these challenges



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Cleans Transformation

200mm Wet Etch

Bay and Chase configuration

Batch wafer processing

Recirculated Chemical batch

Line width / Killer particle size of 4:1

Open to cleanroom

Limited factory automation

Chemical based

20-40 Steps (Manage & Control)

Etch + particle removal

300mm Cleans

Ballroom configuration

Single wafer processing

Single pass single wafer chemicals

Line width / Killer particle size of 1:2

Controlled atmosphere

Advanced capabilities

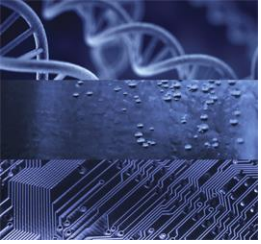
Chemical and Gas based Cleans

200-300+ (Enabling)

Surface preparation

Contamination control driven

The evolution of Cleans processing forces greater attention to contamination control a method to mitigate potential effects to wafer yields



Agenda

Contamination Control and Yield

Cleans Transformation

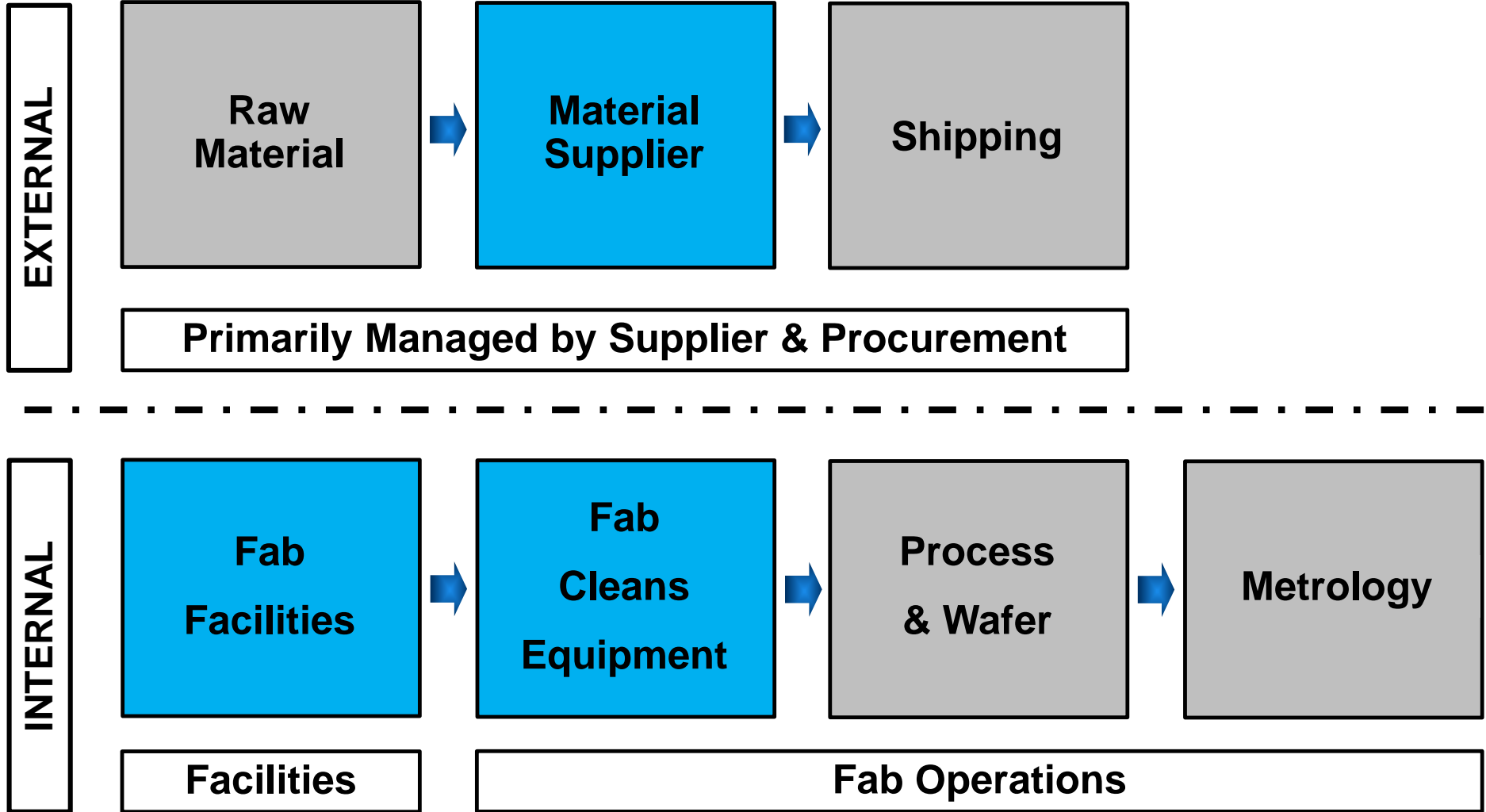
Cleans Contamination Control Model

Collaboration Example

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Cleans Contamination Control Model





Strategy for Success

Goal #1

NEVER disrupt the Supply Chain

		Key Drivers
Materials	Chemical Consumables	Quality, Quantity, Cost
Facilities	Services	Quality, Quantity, Availability
Cleans	Wafers	Quality, Quantity, Delivery

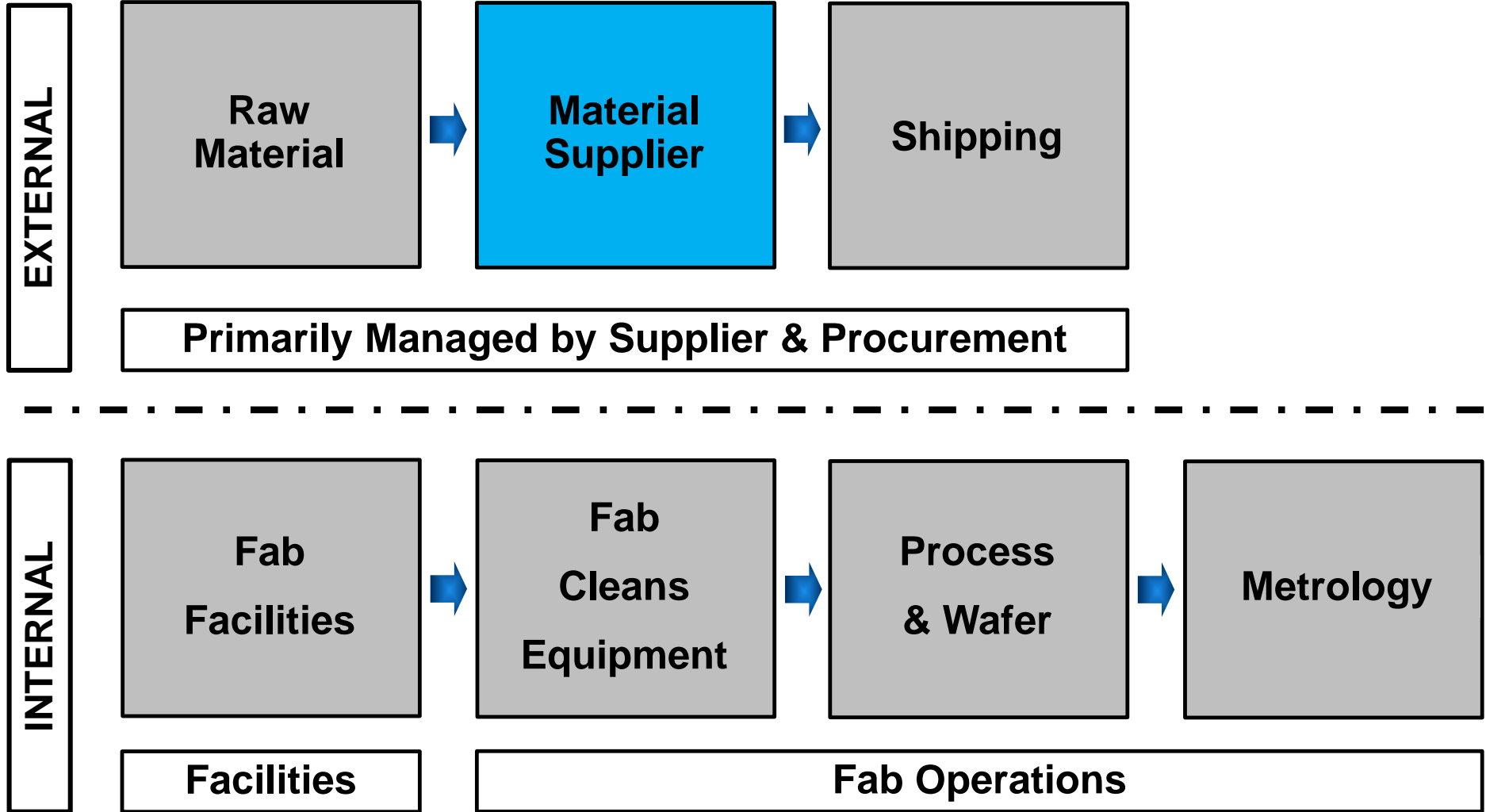
Goal #2

Collaboration and Alignment between the external and internal parties of the control contamination model

“In union, there is strength.” – Aesop

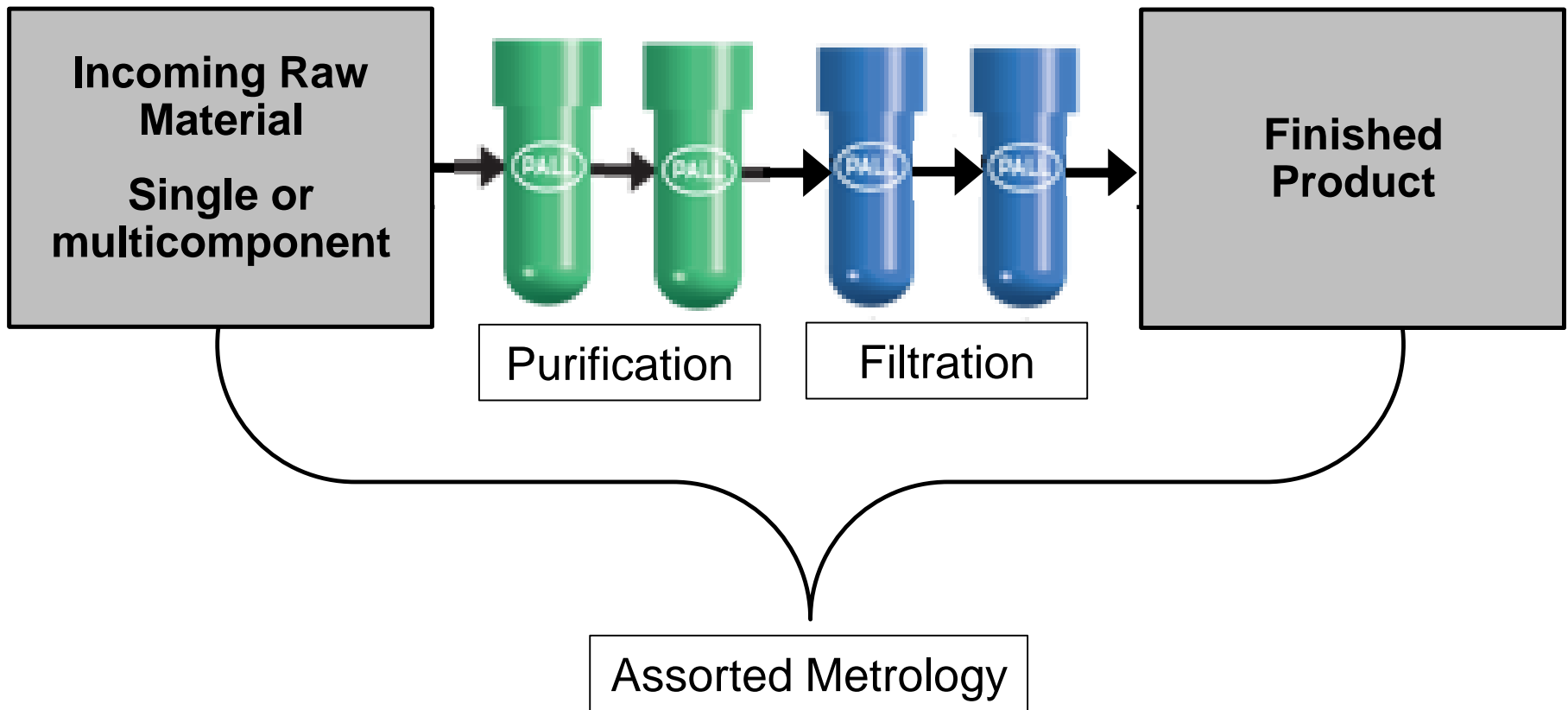


Materials Supplier Element



Chemical Manufacturing Schematic

Simplified Material - Chemical Manufacturing Flow





Case Study: Material Role in Contamination Control

Goals

Minimize impact to Supply chain and mitigate burden to established contamination control

Provide quality chemical that does not negatively impact Cleans Operations

How

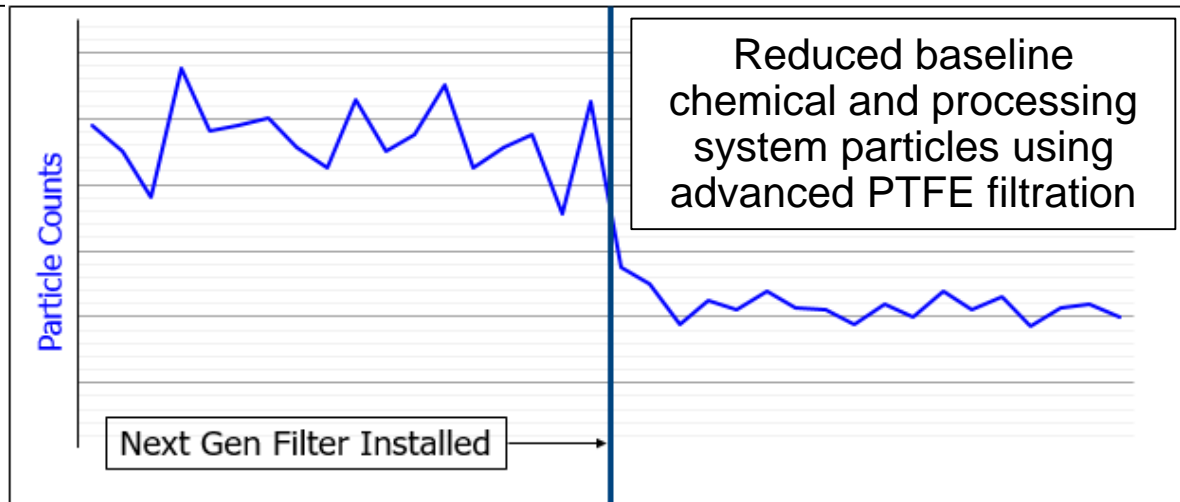
Implementation of filtration and purification at the material supplier site

Case #1

A chemical supplier is trying to reduce on-wafer 32nm particles as a part of a CIP activity

Results

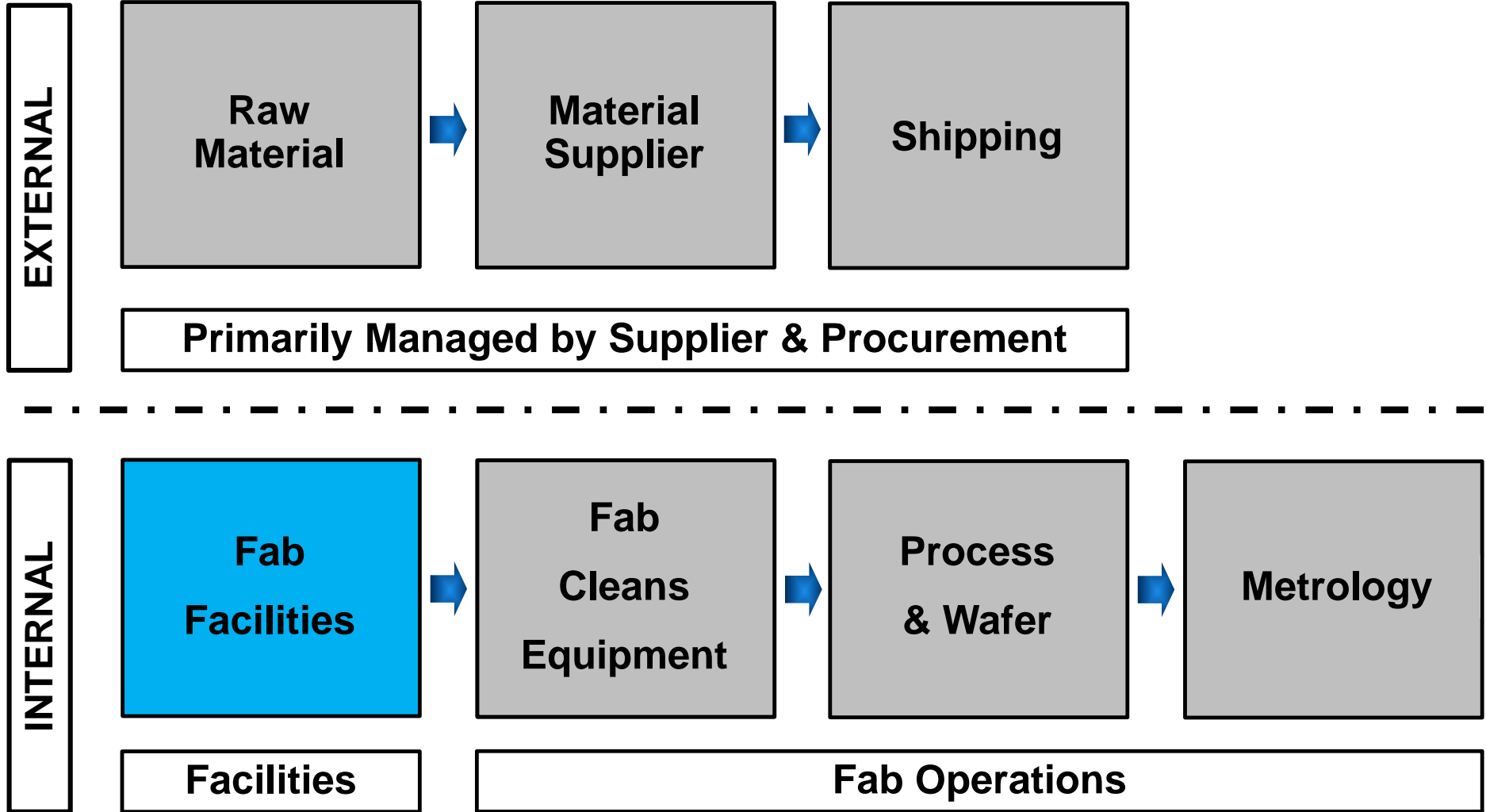
>30% particle reduction



Particle control is a driver for improved yield, but has the potential to increase cost if increased processing is needed



Fab Facilities Element

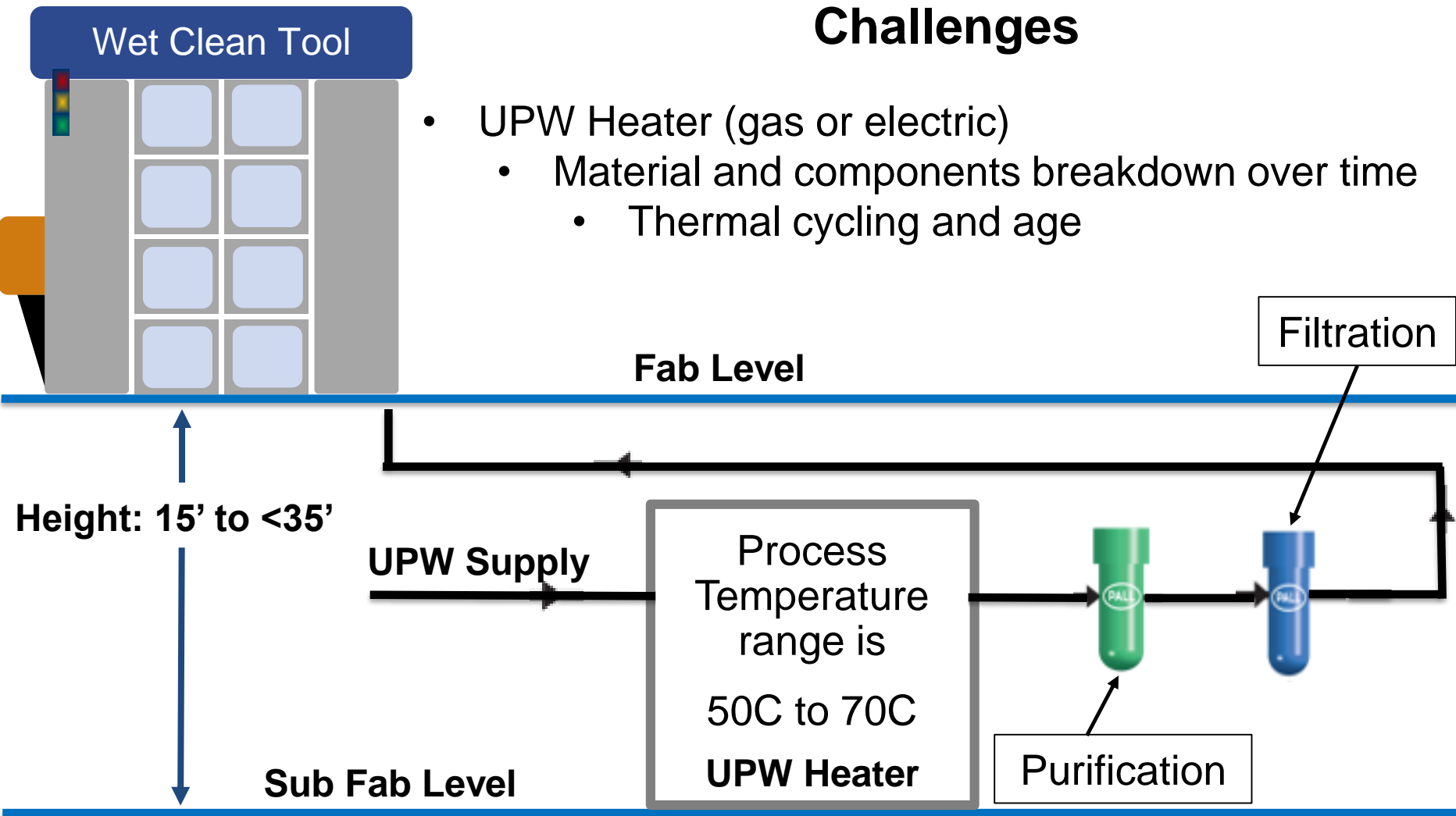




UPW POU Heater System

Challenges

- UPW Heater (gas or electric)
 - Material and components breakdown over time
 - Thermal cycling and age





Case Study: Facilities Role in Contamination Control

Goals

Provide Hot UPW at the necessary quality requirements

UPW is the #1 chemical for wafer processing

How

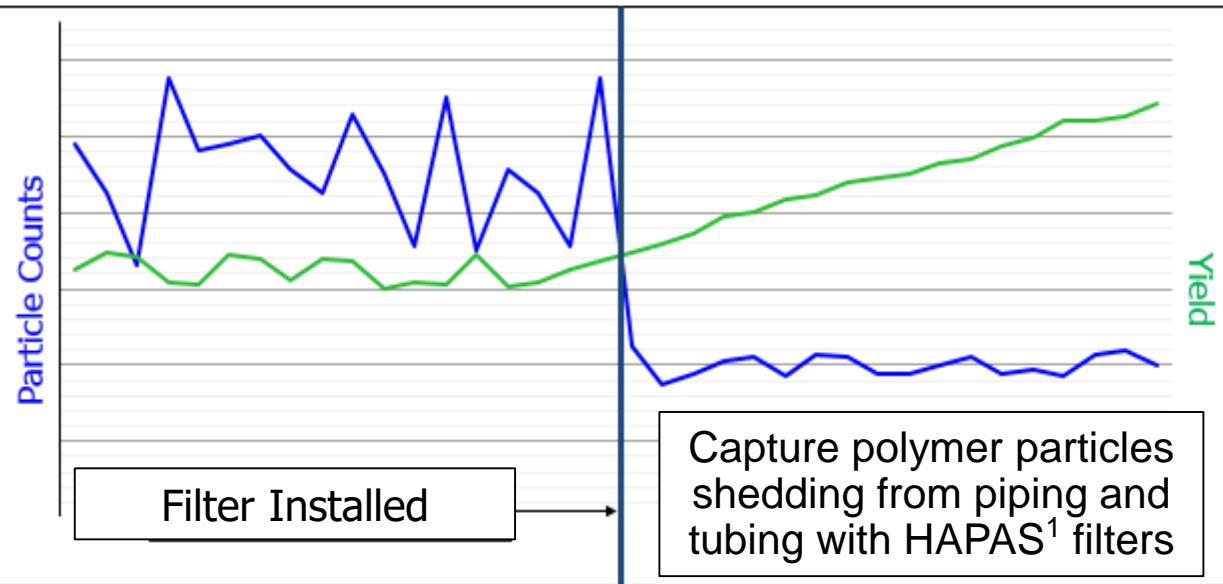
Implementation of filtration and purification at the UPW pou heater

Case #2

A 200mm fab is running a 180nm process with 100nm particle size sensitivity and experiencing a particle excursion

Results

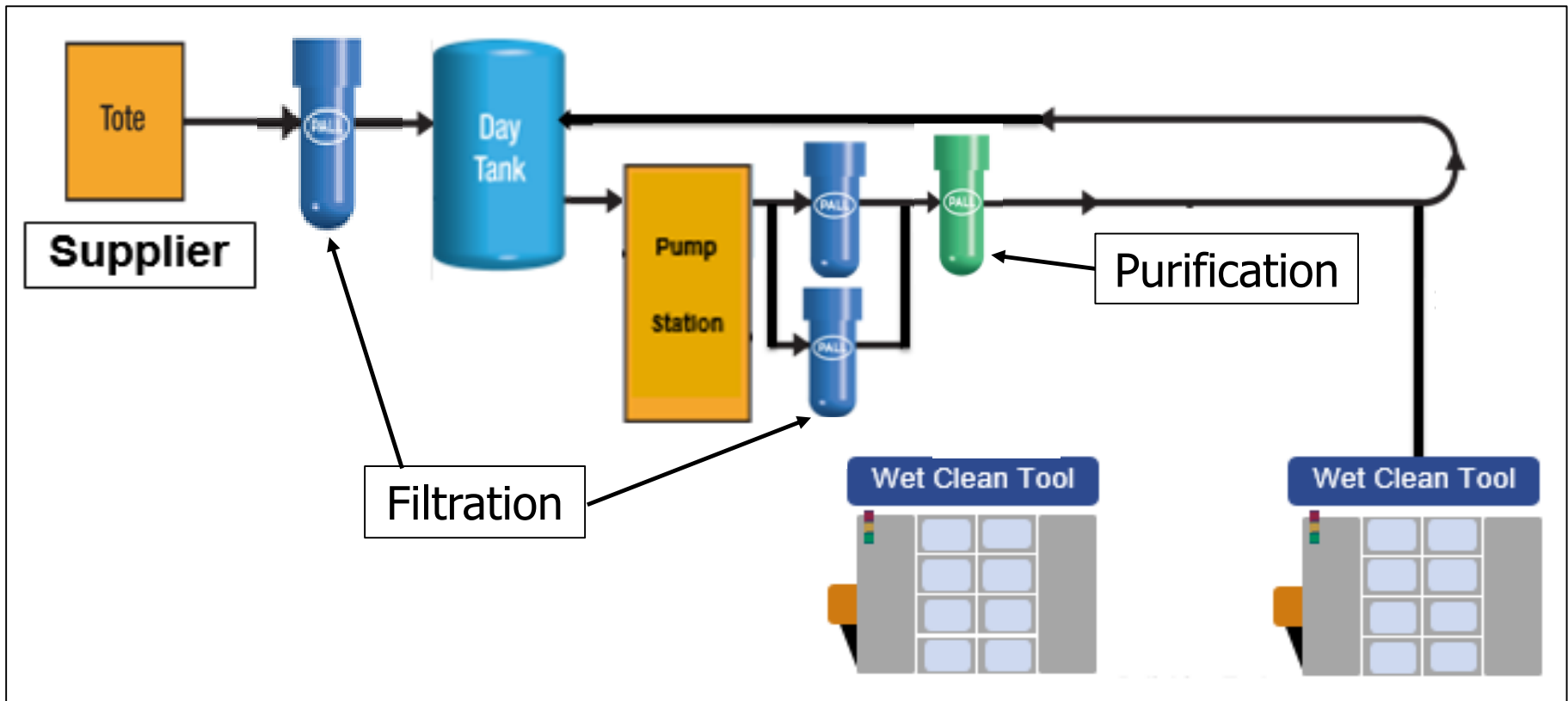
>40% Particle reduction
0.5% Yield increase



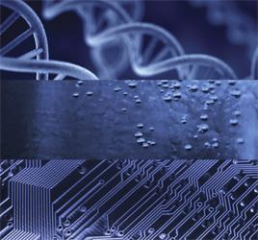
Potential Yield increase <1%, but this equates to a potential \$MM increase in revenue

Bulk IPA Distribution System

Typical Distribution system*



*Contamination risk increases with time (age) and repurposing



Case Study: Facilities Role in Contamination Control

Goals

Provide IPA with an improved contamination level profile

Provide chemical with the necessary quality specs without impact to Fab

How

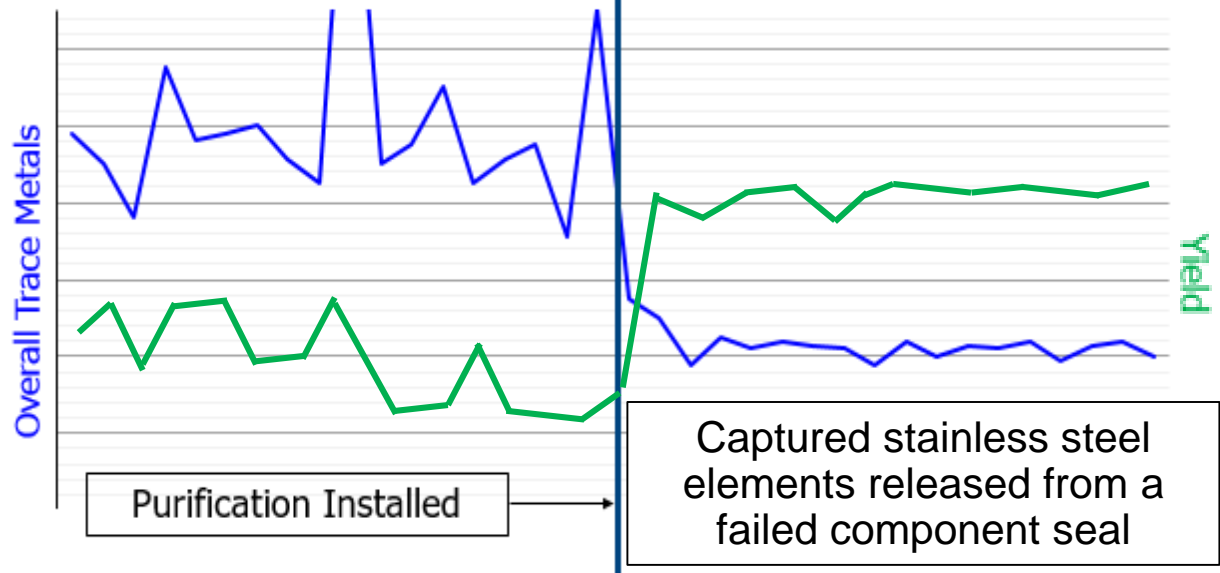
Implement purification on the chemical delivery system

Case #3

A 300mm fab running a 45nm process and encounters an OOC metals event resulting in **~8% Yield loss**

Results

Containment provided
Failed item replaced



Contamination control provides mitigation for process excursions and yield recovery



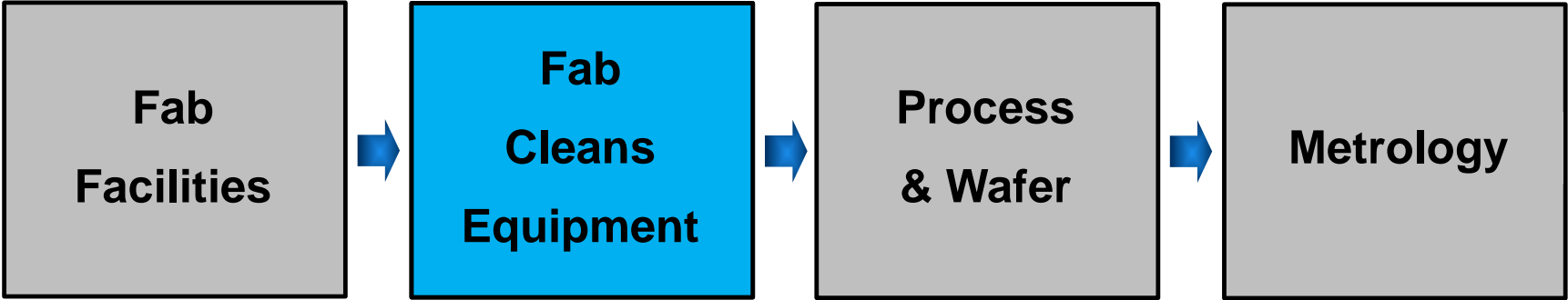
Equipment Element

EXTERNAL



Primarily Managed by Supplier & Procurement

INTERNAL

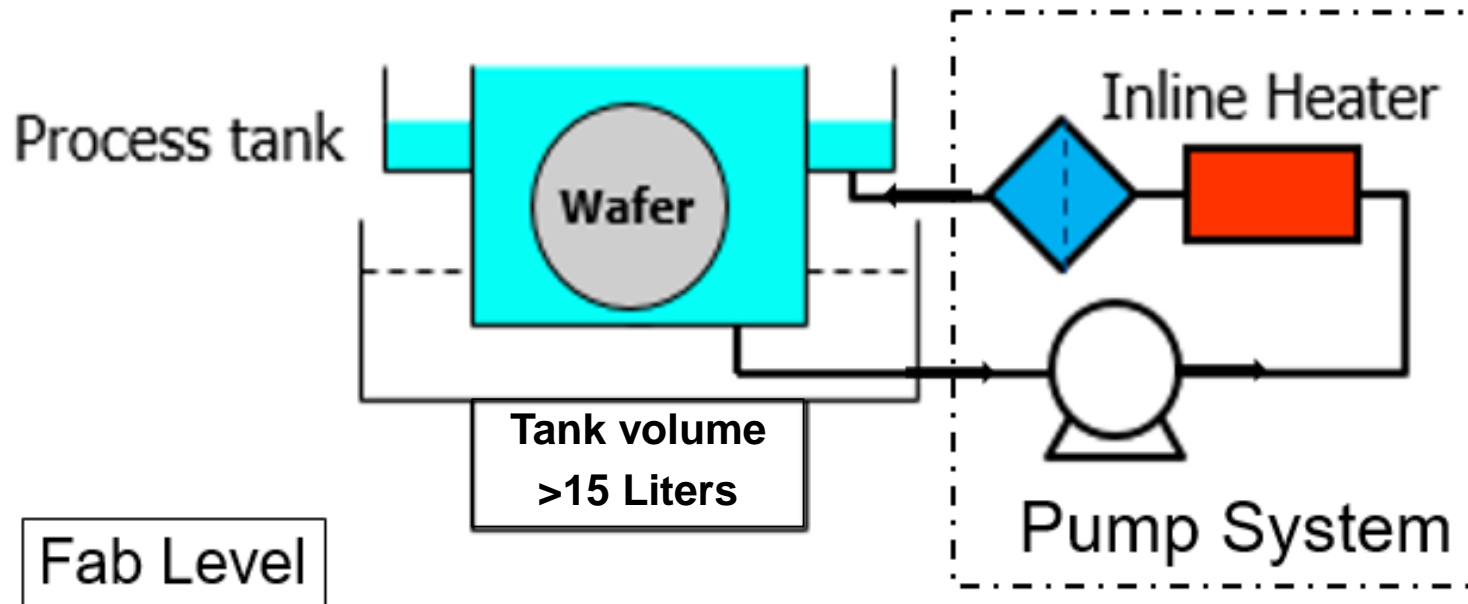


Facilities

Fab Operations

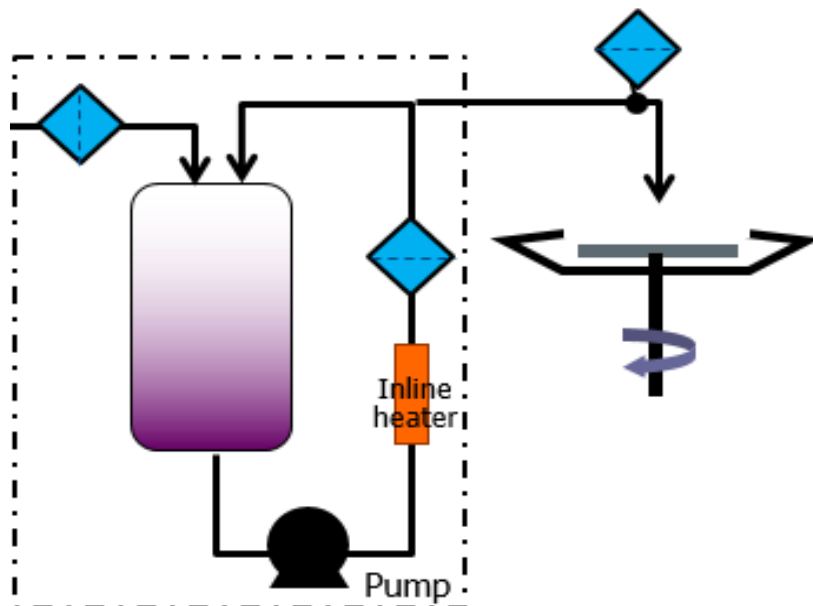
Typical Batch Wafer Process Overview

- Multiple process tanks
- 25-50 wafers / tank
- Wafers travel
 - Process tank chemical lifetime is hours to days
- Potential cross-talk: wafer to wafer, in-bath, and batch to batch

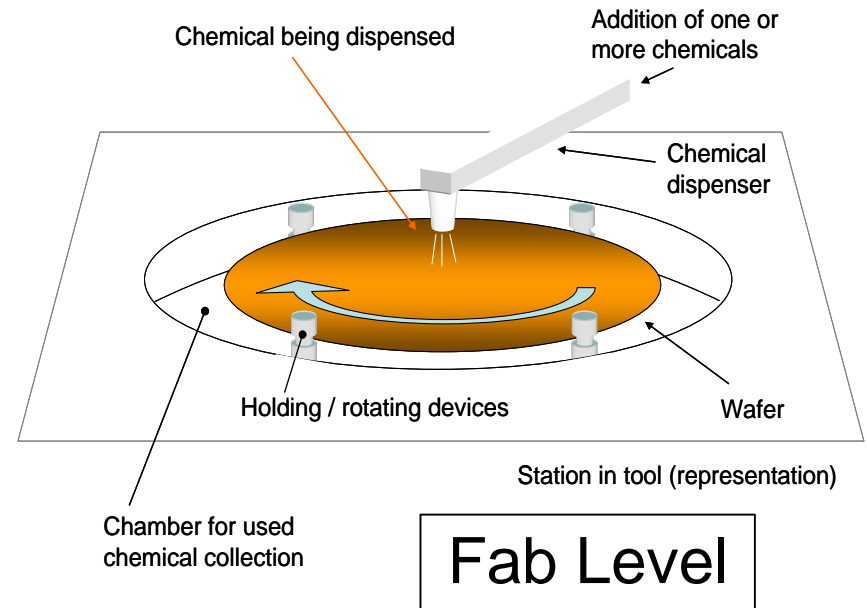


Typical Single Wafer Process Overview

- Chamber processes single wafer
- Multiple chemicals in chamber
- One pass chemical usage ranges from 50-200 ml per wafer
- Advanced wafer handling / automation



Fab / Sub-Fab Level



Fab Level



Case Study: Cleans Role in Contamination Control

Goals

Process wafers with an improved wafer level contamination profile
Provide wafers with the necessary quality to the Fab

How

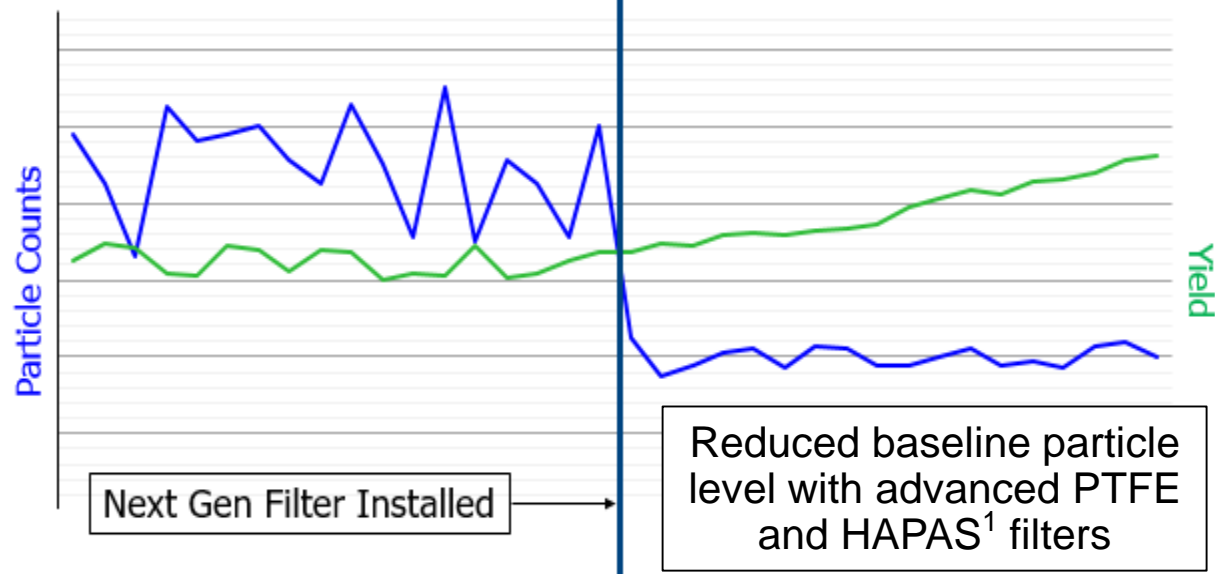
Implementation of improved filtration on the Cleans process tools

Case #4

A 300mm Fab is running a 28nm process and is trying to reduce on-wafer 40nm particles as a part of a CIP activity

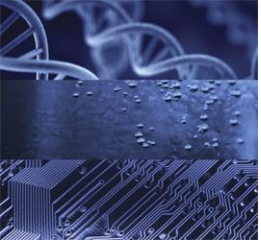
Results

>50% Particle reduction
0.5% Yield increase



Reduced baseline particle level with advanced PTFE and HAPAS¹ filters

Contamination control provides an opportunity maintain and improve wafer yield



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Contamination Control and Yield

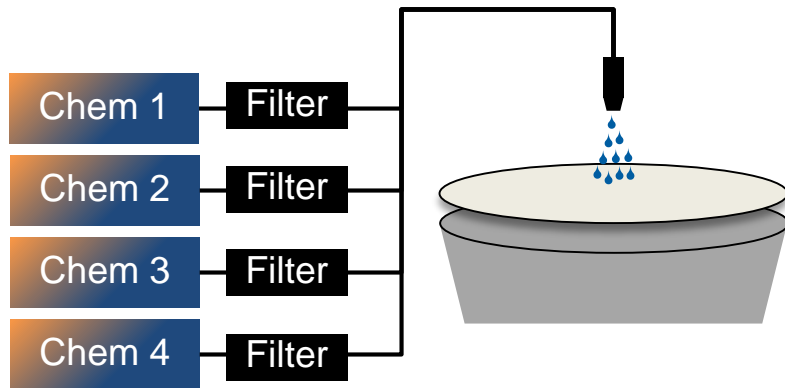
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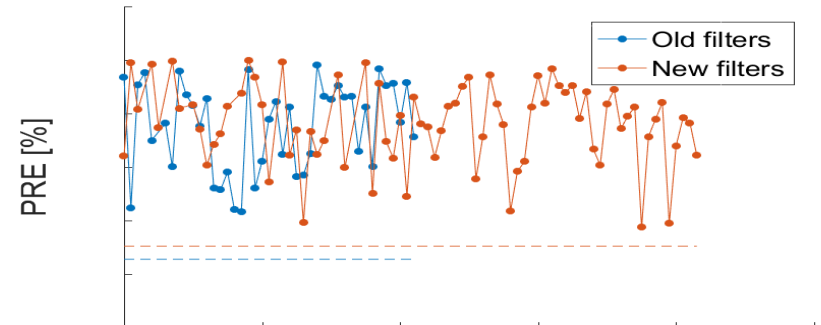
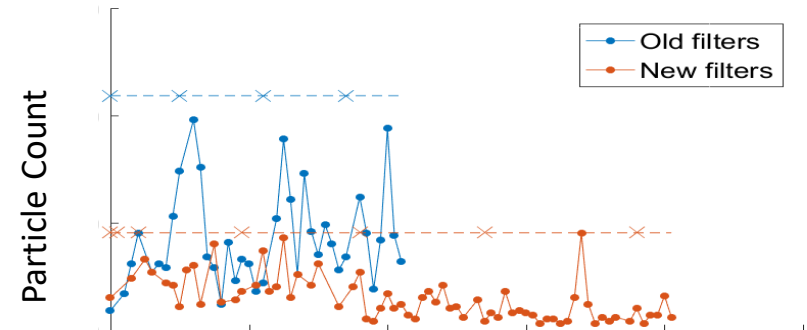
Collaboration: 5nm PTFE Filter Evaluation



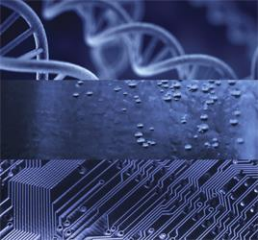
Previous 10nm filters replaced by next generation 5nm filters on all chemical lines

5nm PTFE filter provided improved defect levels and particle removal efficiency (PRE)

All evaluation elements in one place at the same time: wafers, tool, chemical, filters, metrology, and technologists



Collaboration expedited the filter qualification by weeks and reduced expenses (\$KK)



Agenda

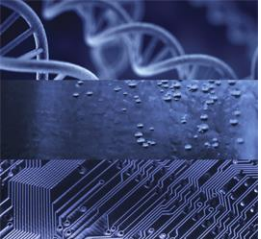
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Closing Thoughts

Cleans contamination control risks are very real.....

Collaboration is critical factor to being successful.....

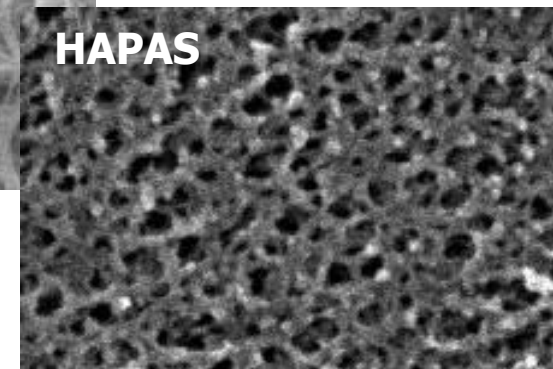
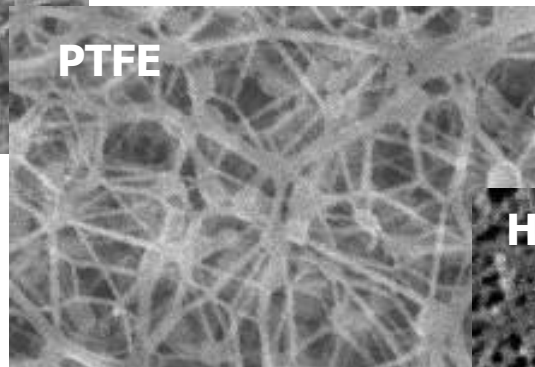
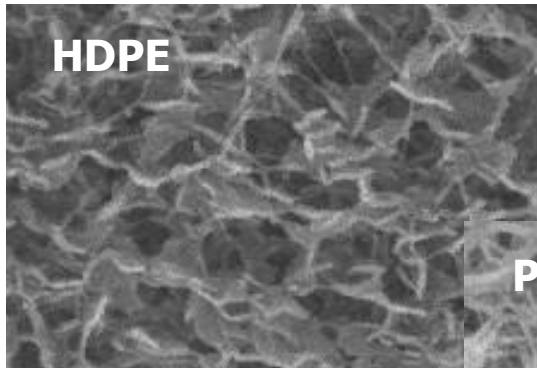
Partner with a reputable and experienced team of filtration experts

State of the art products and technical consultation services

Proven 200mm & 300mm products (backwards compatible)

Cleans Membrane Products

3 typical membranes which are optimized for WEC applications





Cleans Filter Products

Chemical		PTFE	HAPAS	HDPE
UPW	<70 °C	✓✓	✓✓✓	✓
	>70 °C	✓✓✓		
SC1 / SC2	<70 °C	✓✓	✓✓✓	
	>70 °C	✓✓✓		
DHF / BOE / FPM		✓✓	✓✓✓	✓
SPM		✓✓✓		
DSP		✓✓	✓✓✓	
Non-oxygenated Chemicals		✓✓	✓✓✓	✓
Oxygenated Chemicals		✓✓✓		
IPA		✓✓✓		
Organic solvent		✓✓✓		✓
H ₃ PO ₄		✓✓✓	✓✓✓ (Dilute)	

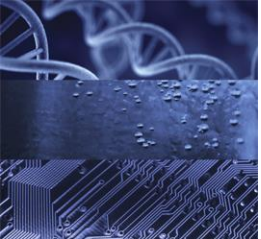
✓✓✓ Excellent
 ✓✓ Good
 ✓ Limited



Two new product announcements

XpressKleen™ XP 2 nm Filter

IonKleen™ IPA Purifier



Acknowledgements

Tony Shucosky
Makonnen Payne
Christian Besendorfer
Rao Varanasi

