ATMI AutoClean®

Predictable Process. Extended Source Life.

The First and Only In-Situ
Implanter Cleaning Process.

Agenda

- Issues Impacting Implant Efficiency
- ATMI AutoClean Demonstrated Benefits
- System Features

Problems Caused by Dirty Implanters

- Short and unpredictable source life
- Beam instability due to glitching or arcing
- Extended set-up time from beam instability
- Undesired personnel exposure to toxic waste
- Lost productivity due to decreased tool availability

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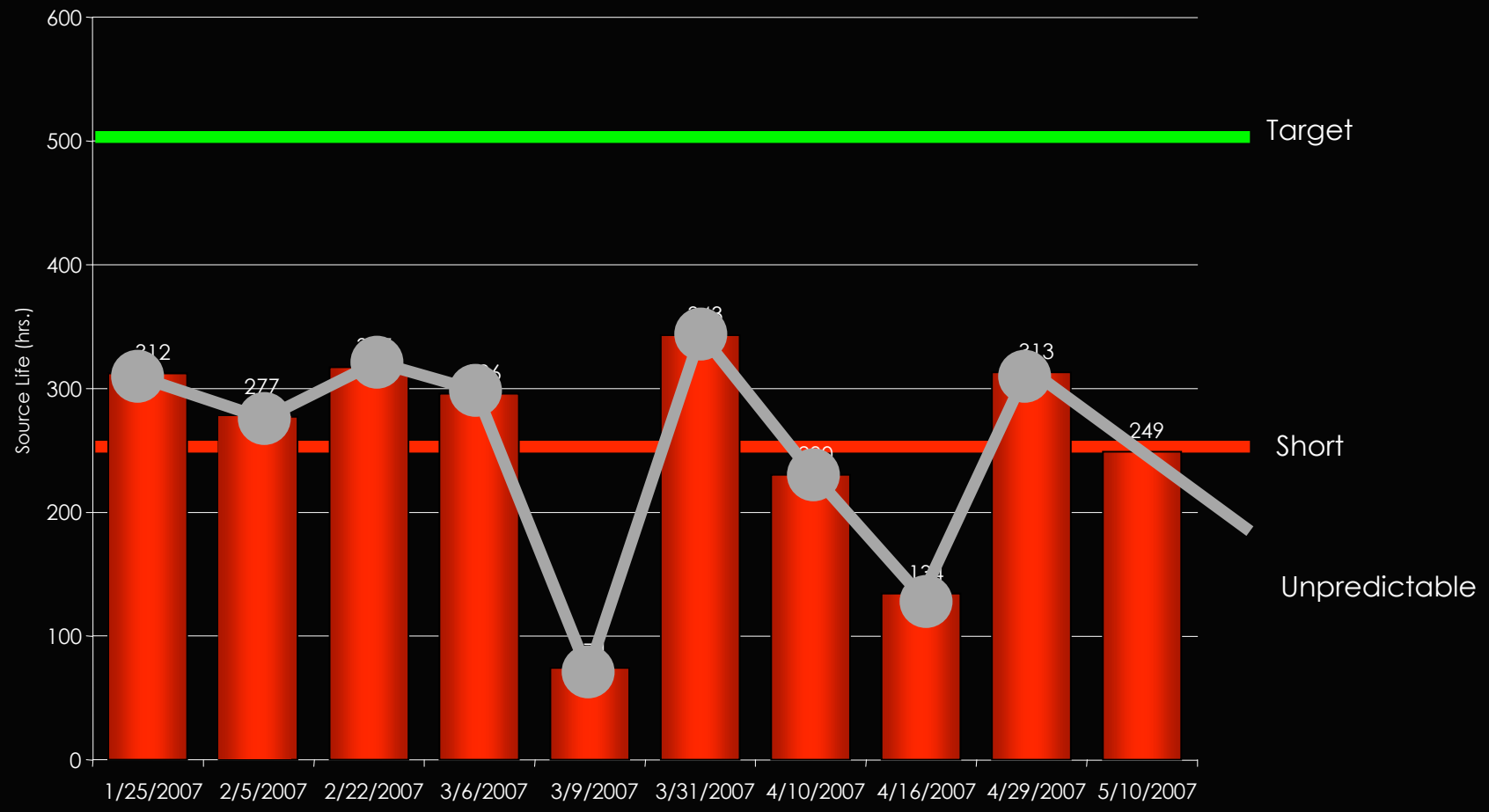
Short and Unpredictable Source Life



Data Courtesy of Atmel

150mm Applied Materials
XR80 with IHC source

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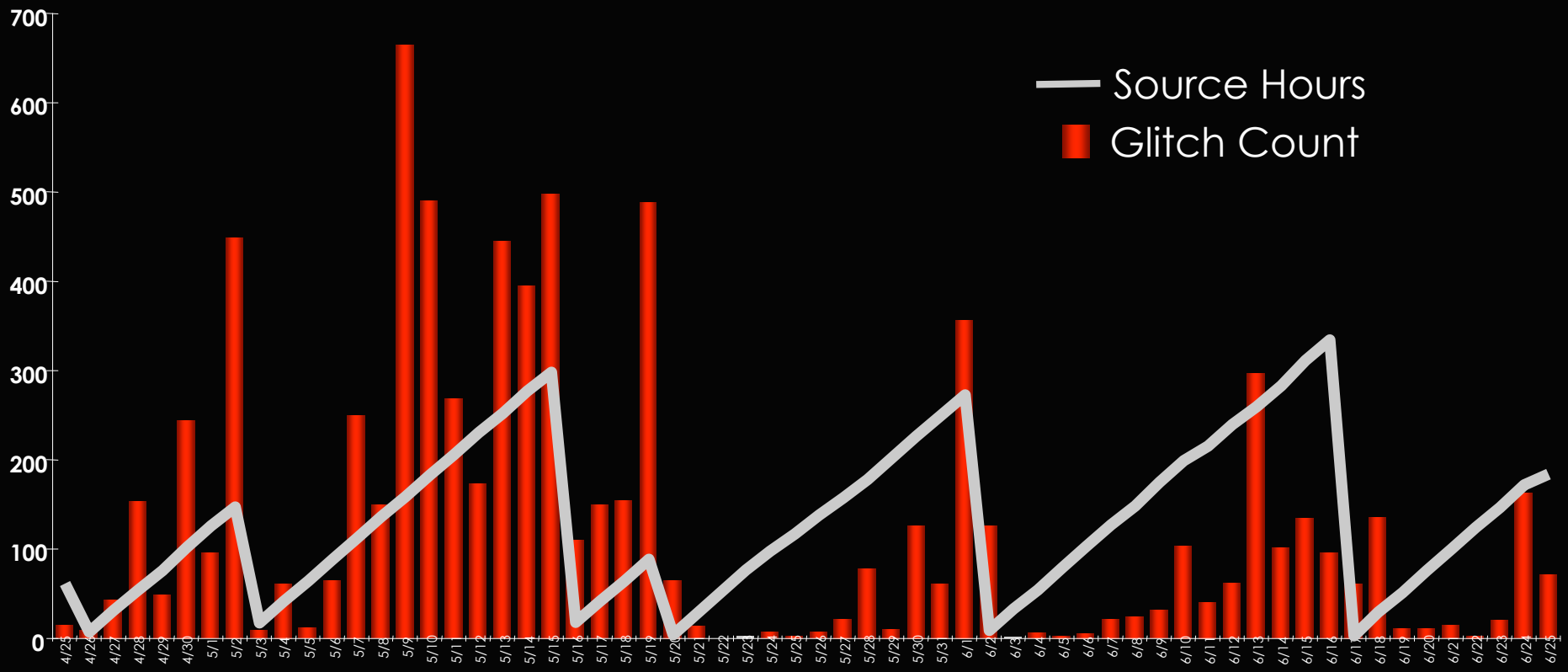
Beam Instability due to Glitching or Arcing



Data source: Implanter Source Life and Stability Improvement using In-Situ Chemical Cleaning

Terry Romig, Michael Mitchell, Texas Instruments Inc

David Eldridge, Jim Mayer, ATMI

http://ismi.sematech.org/ismisymposium/abstracts/08051924424.pdf

Glitch occurrence increases as the source ages

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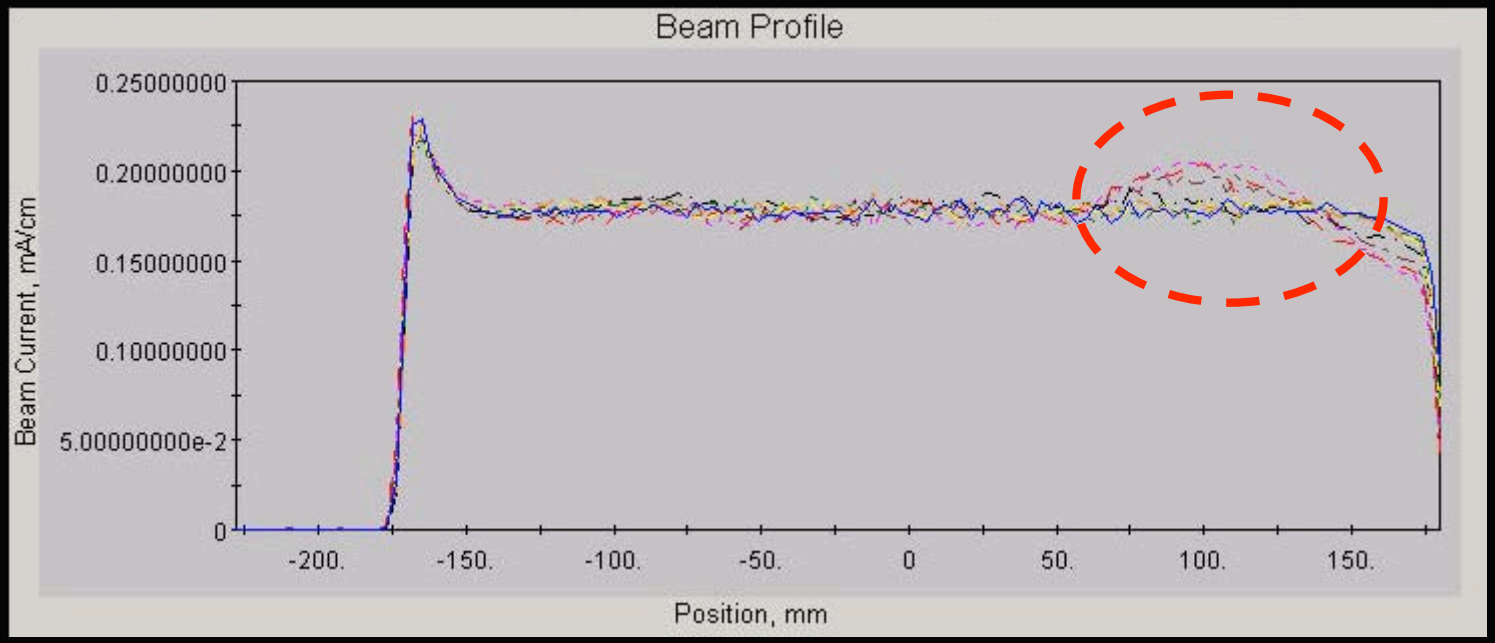
Extended Recipe Set-Up Time due to Beam Instability



300mm Varian VIISta HC with IHC source

Beam non-uniformity requiring multiple recipe set-ups & potential / frequent manual intervention

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Undesired Personnel Exposure to Toxic Waste

Operator exposed 2-3 times per month, per implanter

Problems Caused By Dirty Implanters

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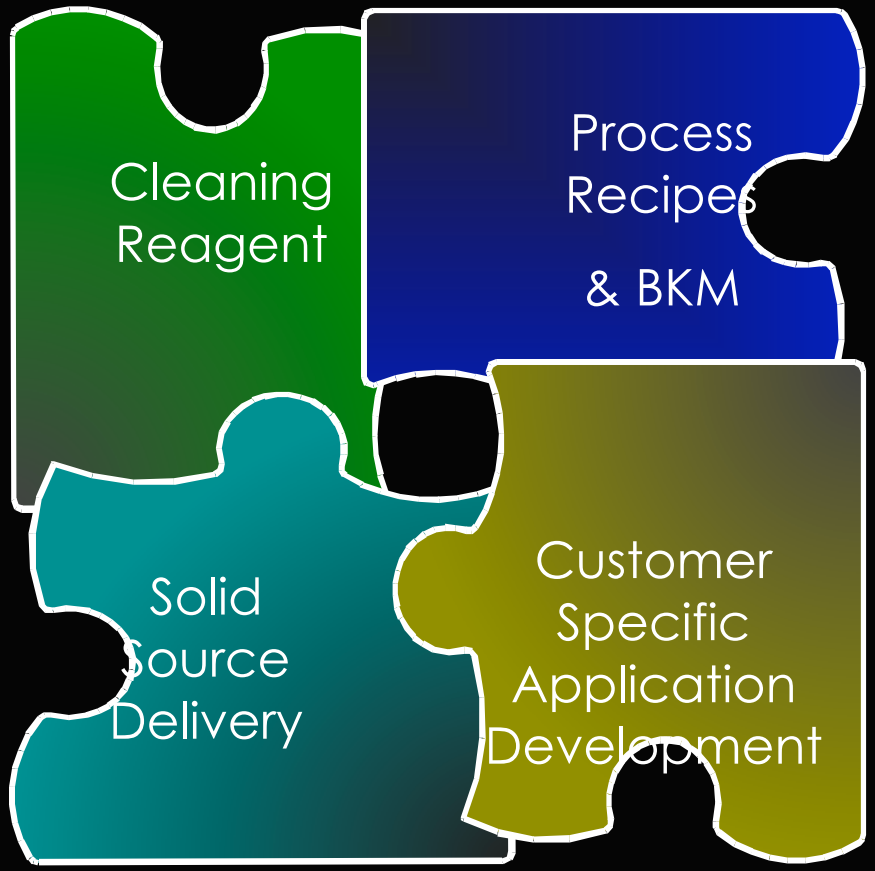
ATMI AutoClean®

Complete System Solution to Implanter In-Situ Cleaning



Predictable Process.

Extended Source Life.

ATMI AutoClean Demonstrated Process Benefits

- >40% increase in source life
- >15% reduction in recipe set-up time
- >80% reduction in glitching
- >40% reduction in PM frequency
- Dramatic reduction in toxic waste and cleaning time
- 7% improvement in implant productivity
- Up to $100K annual cost savings per implanter
  - Implanter &/or process dependent

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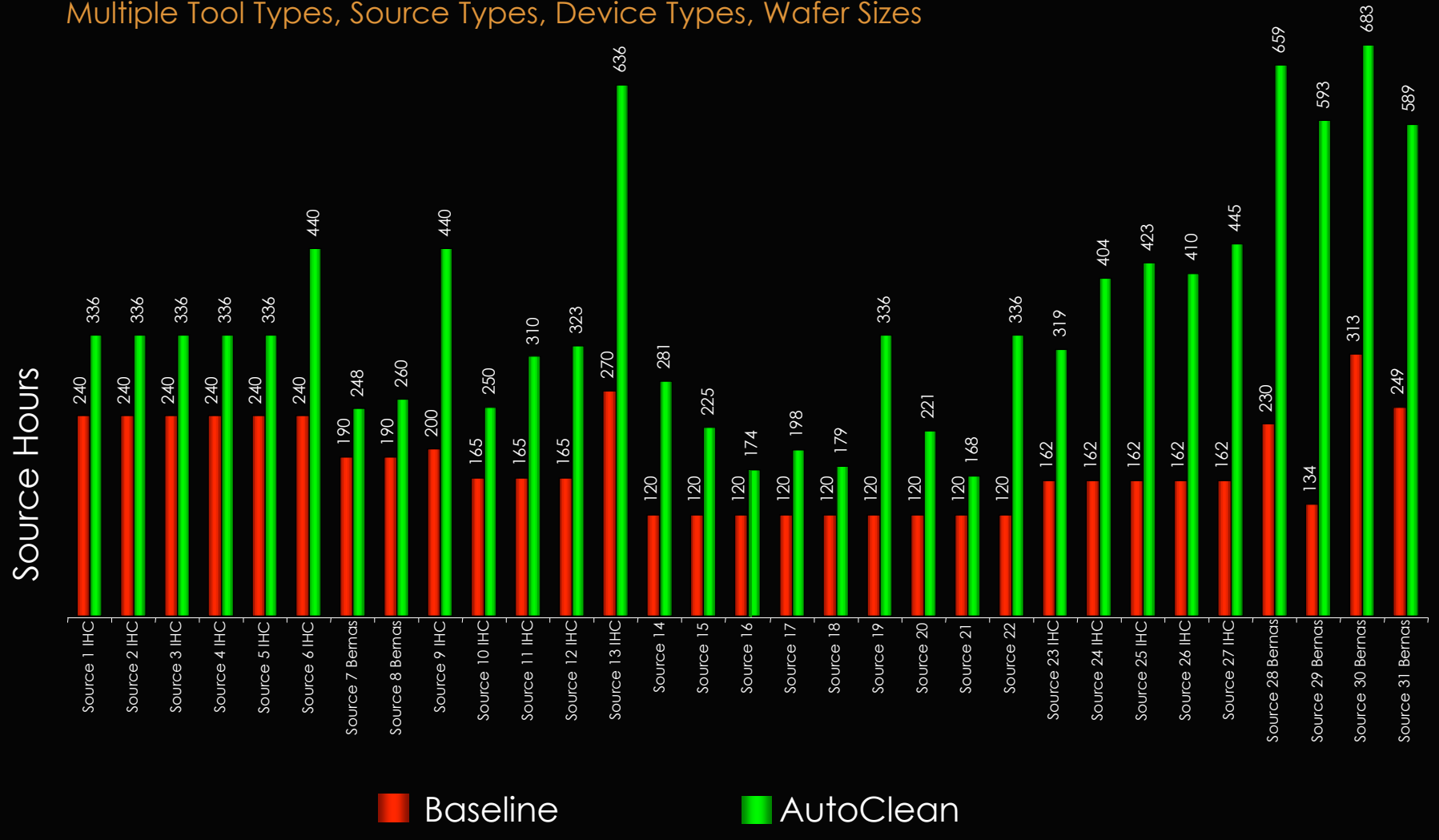
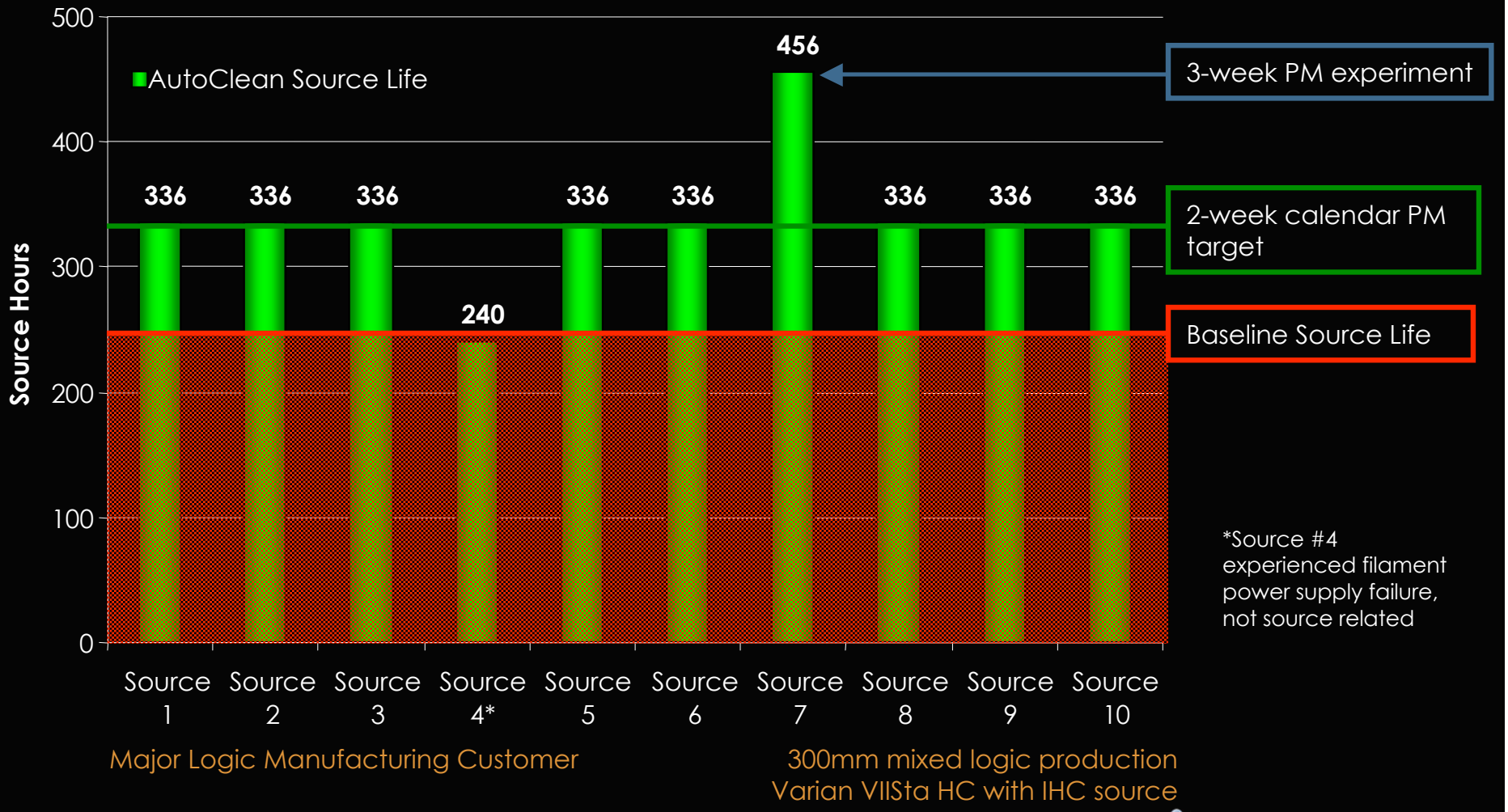
>40% Increase in Source Life

Field Data

Multiple Tool Types, Source Types, Device Types, Wafer Sizes



Opportunity to Reduce PMs By 50%



*Source #4 experienced filament power supply failure, not source related

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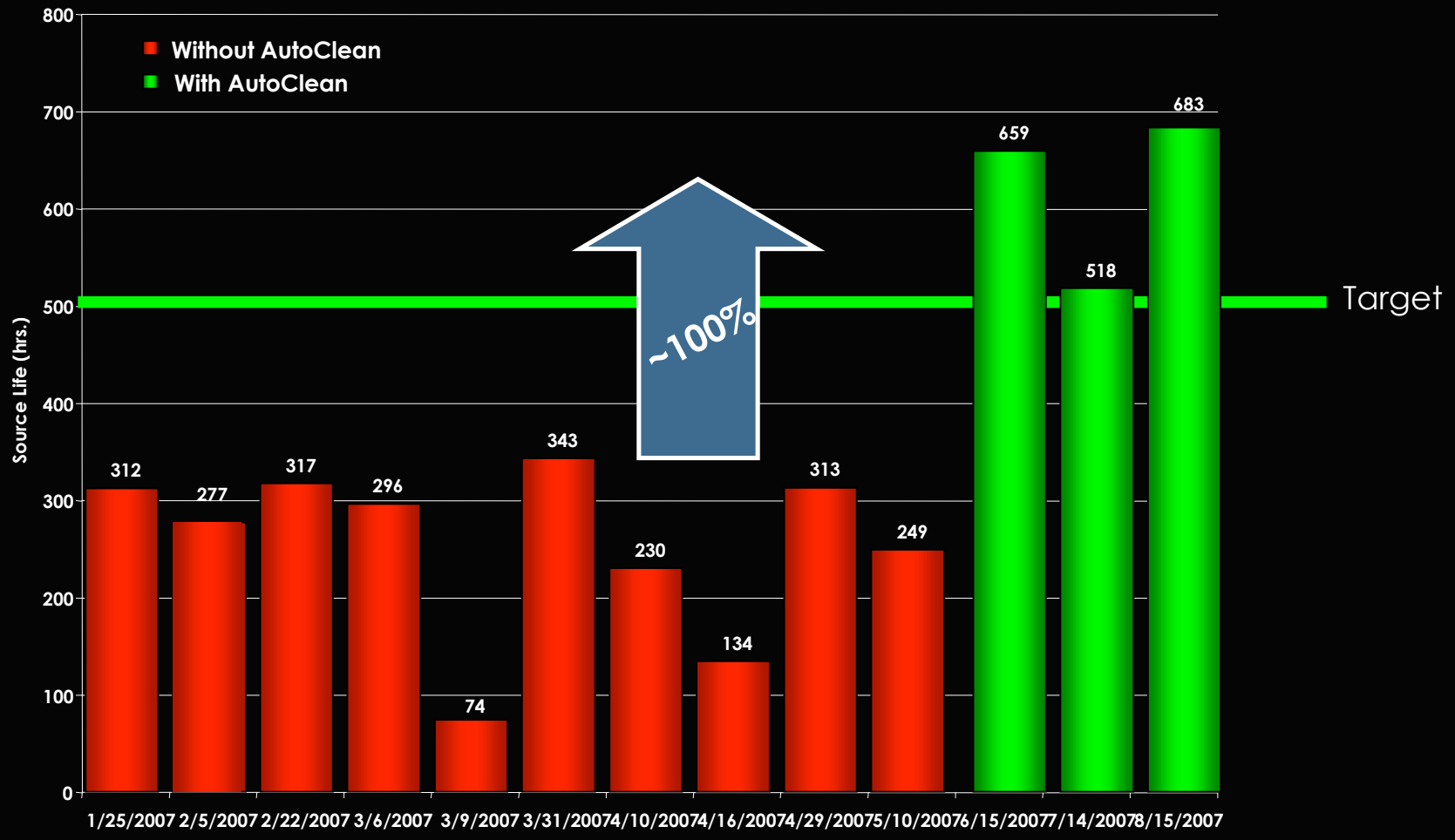
>2X Increase in Source Life



Data Courtesy of Atmel

150mm Applied Materials
XR80 with IHC source

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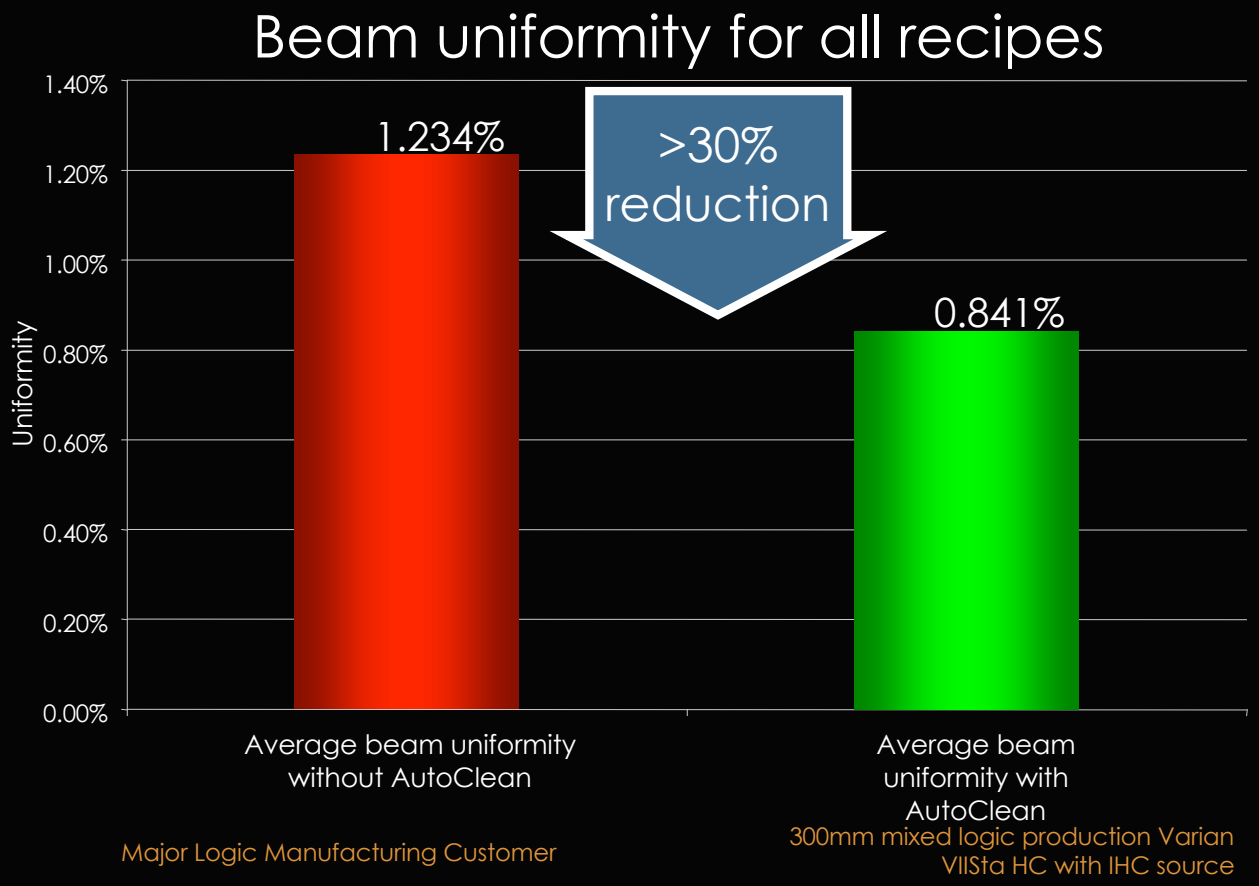
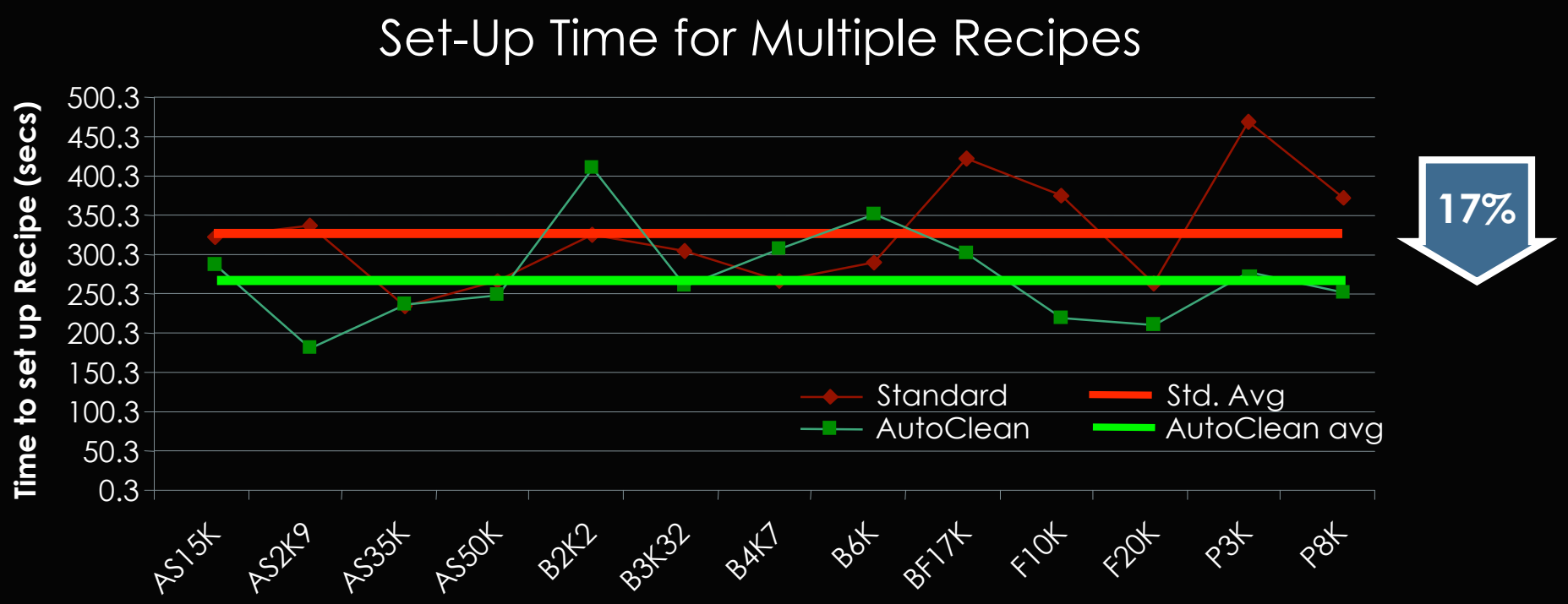
>30% Improvement in Beam Uniformity



32% improvement in beam uniformity on the wafer

>15% Reduction in Recipe Set-Up Time



Major Logic Manufacturing Customer

300mm mixed logic production Varian VIISta HC with IHC source

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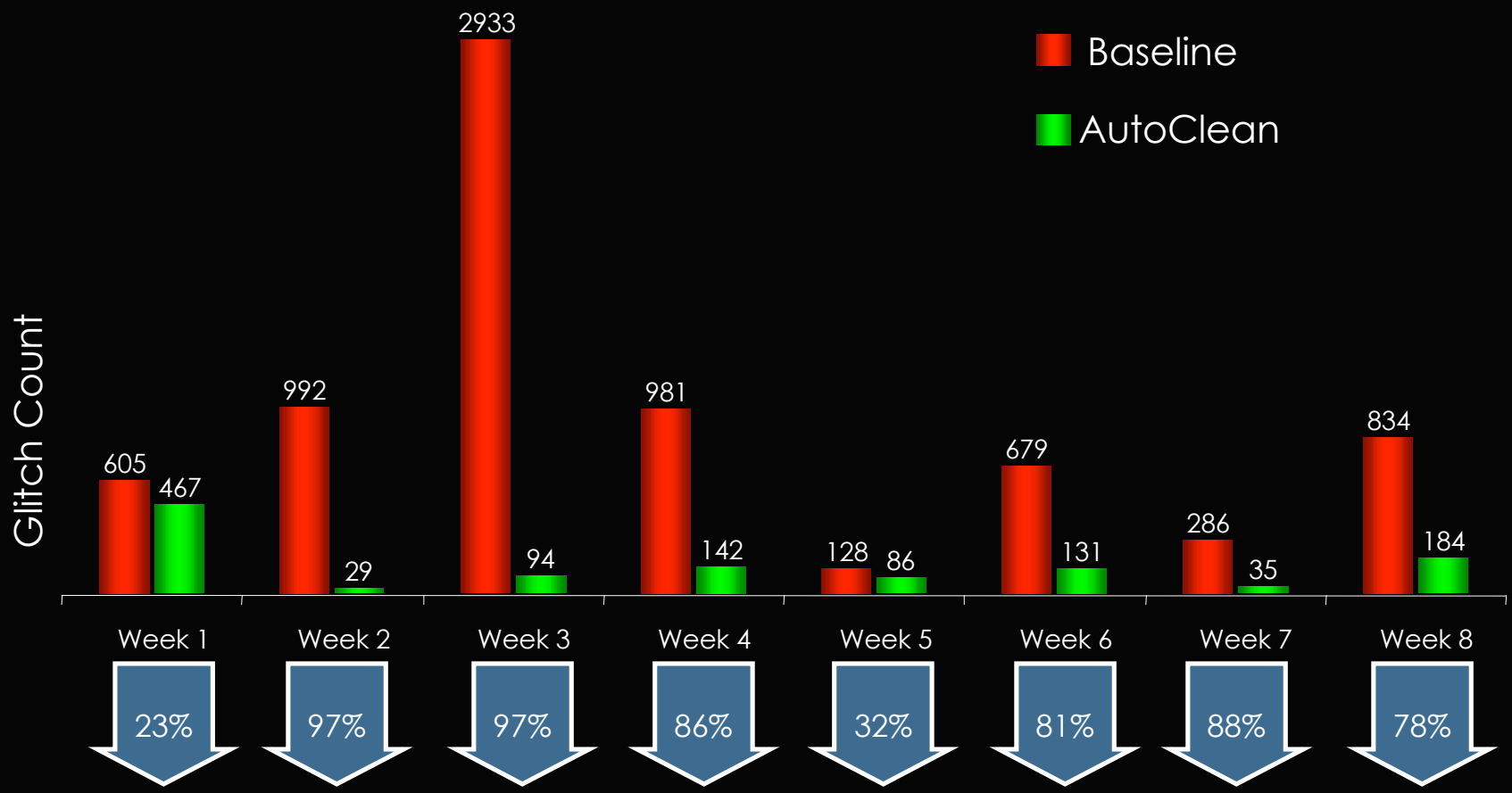
>80% Reduction in Glitching



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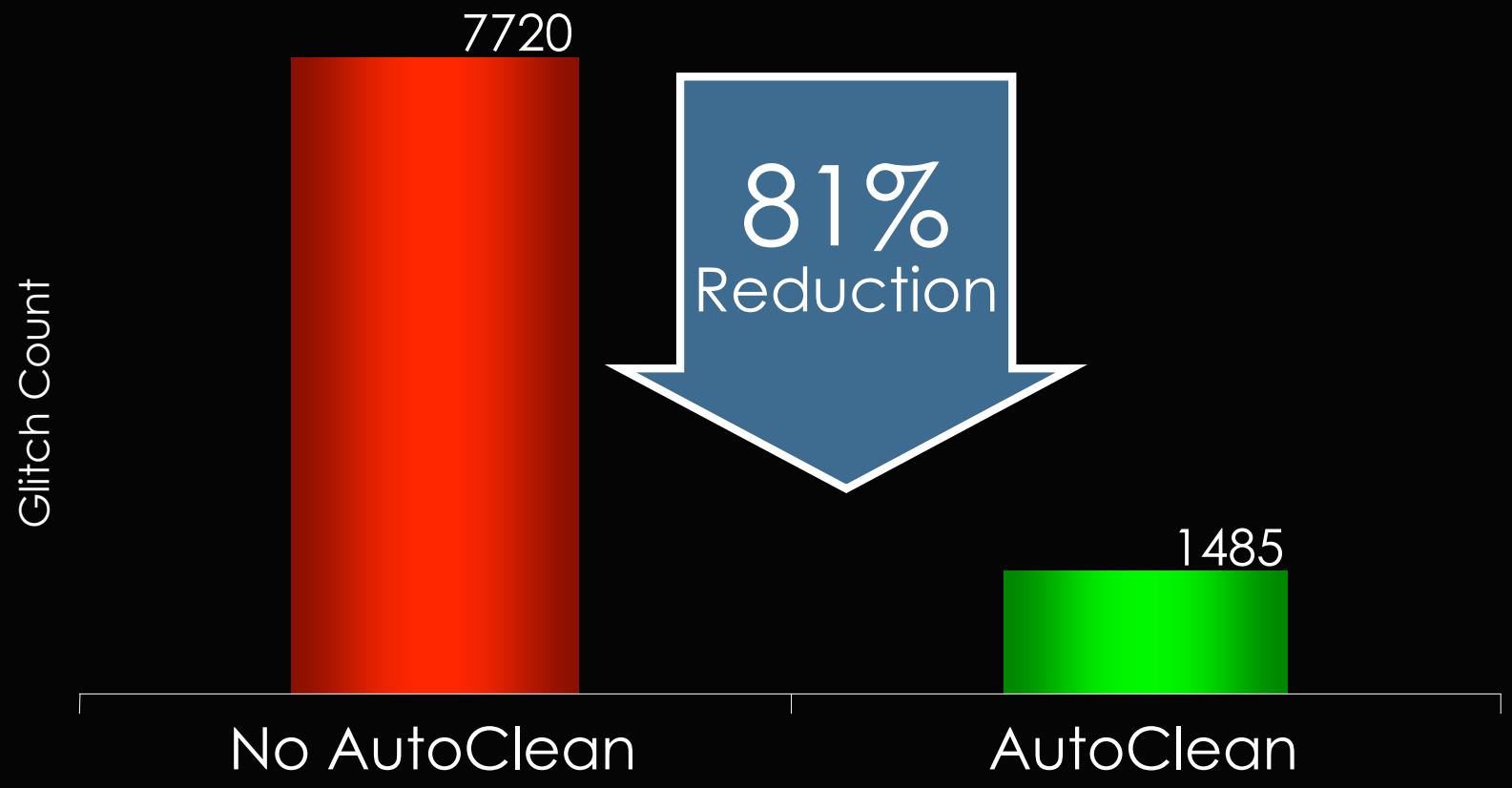
>80% Reduction in Glitching



Major Logic Manufacturing Customer

300mm mixed logic production Varian VIISta HC with IHC source

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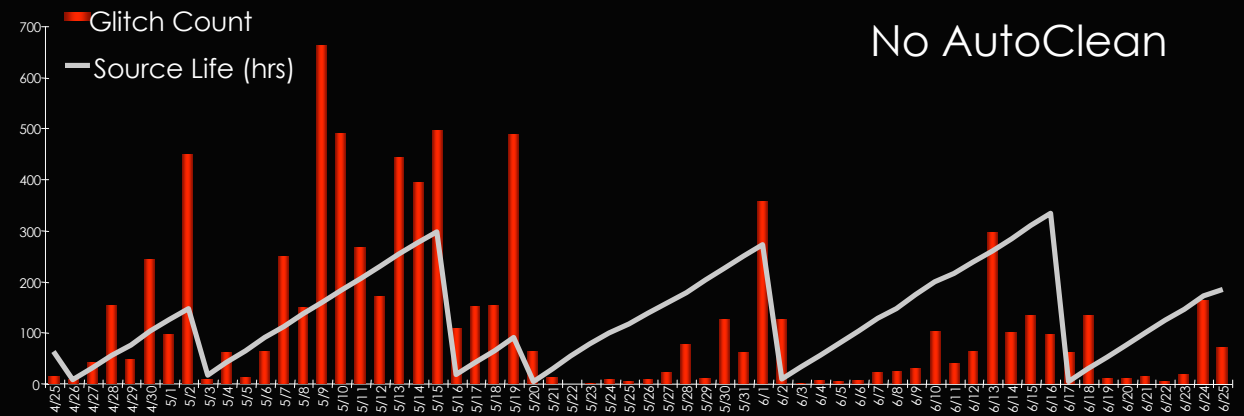
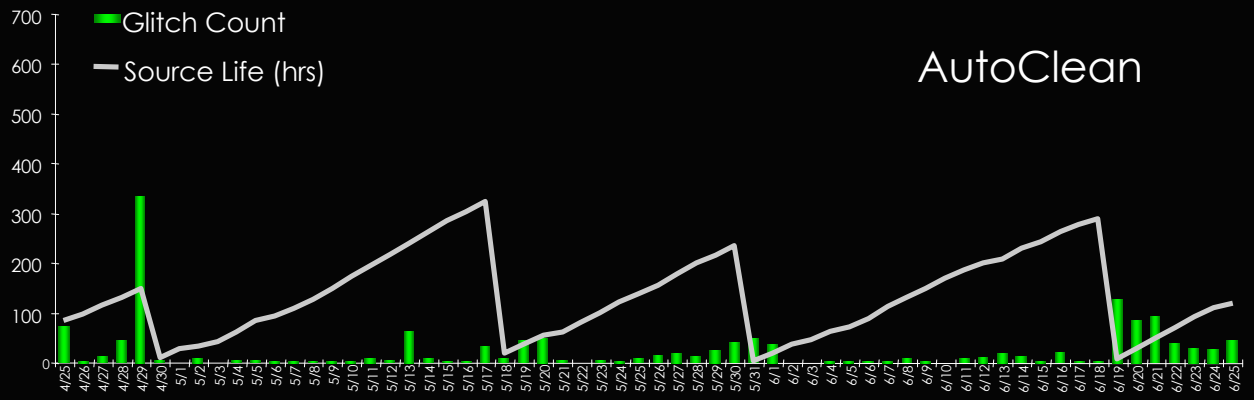
With AutoClean Glitching Decreases As Source Ages



6 Source Changes



4 Source Changes

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>40% Reduction in PM Frequency

Maintenance frequency is determined by source life

Without AutoClean

February

S	M	T	W	Th	F	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

March

S	M	T	W	Th	F	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

April

S	M	T	W	Th	F	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

With AutoClean

June

S	M	T	W	Th	F	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

July

S	M	T	W	Th	F	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

August

S	M	T	W	Th	F	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

- Unscheduled maintenance now becomes scheduled maintenance.
- More predictable fab operations.
- Less personnel exposure.
- Increased implanter availability.

Data Courtesy of Atmel

150mm Applied Materials XR80 with IHC source

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Predictable Process. Extended Source Life.

Source Stays Cleaner… Longer

270 hours without AutoClean

636 hours with AutoClean

Photos courtesy of Atmel
Mid-current source chamber at source PM

In many cases only requiring a DI-H20 wipe

ATMI®

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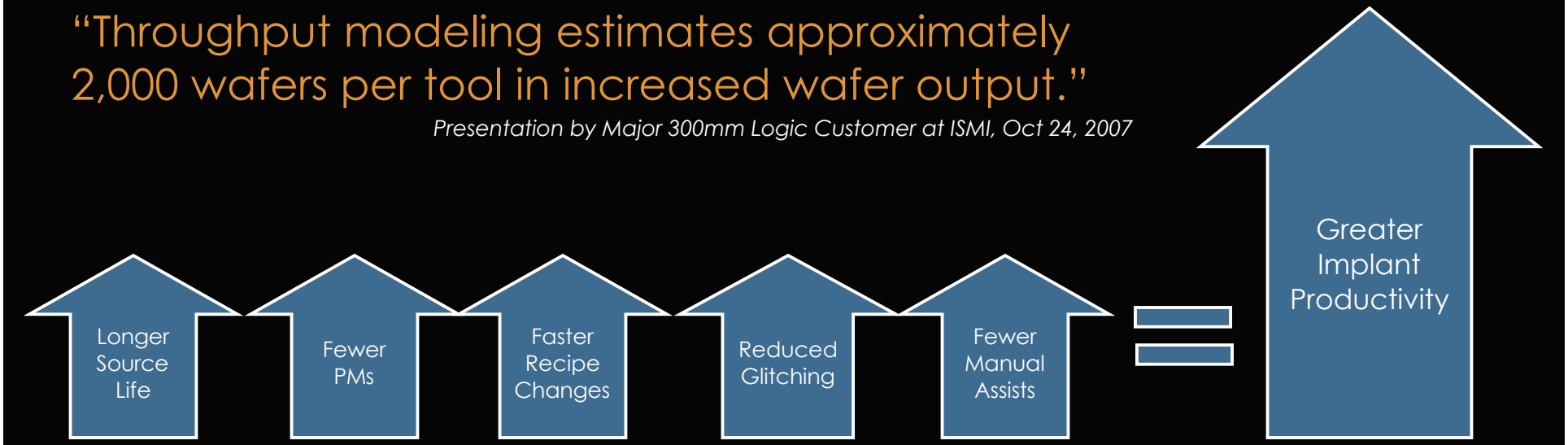
7% Improvement in Implant Productivity

"Throughput modeling estimates approximately 2,000 wafers per tool in increased wafer output."

Presentation by Major 300mm Logic Customer at ISMI, Oct 24, 2007



What's a 13th month of production worth?

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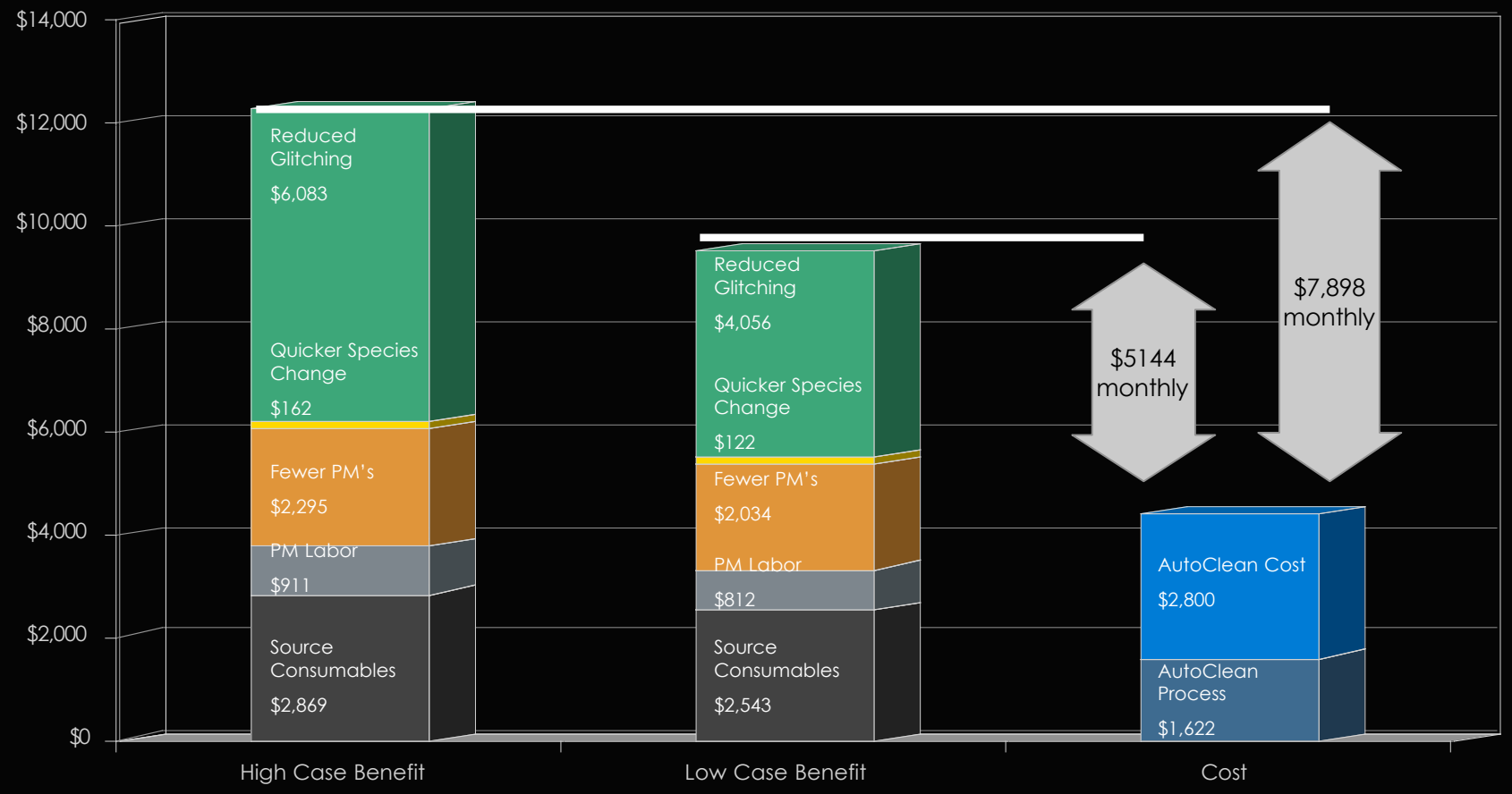
- Up to $100K annual cost savings per implanter

Implanter &/or process dependent

$61,728 - $94,776 Savings Annually per Implanter



High Case Improvements Target:

+60% life time source, -20% source PM time, -20% species change time, +60% glitch reduction.

Implanter Assumptions:

20 min of cleaning/day each implanter, Base Source life=240h, uptime 80%, Ion Source cost= $1,500, Source PM: 4h

Low Case Improvements Target:

+40% life time source, -15% source PM time, -15% species change time, +40% glitch reduction.

Implanter Assumptions:

20 min of cleaning/day each implanter, Base Source life=240h, uptime 80%, Ion Source cost= $1,500, Source PM: 4h

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ATMI AutoClean

Complete system solution to implanter in-situ cleaning

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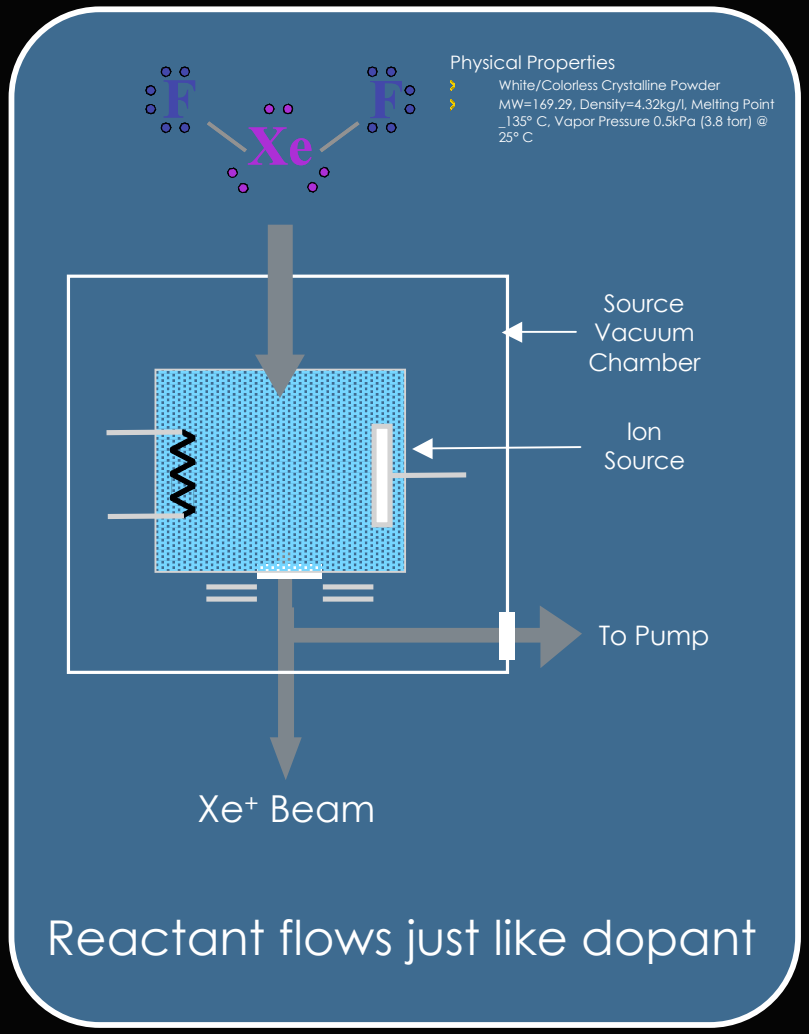
AutoClean Process using XeF2

Engineered cleaning reagent first introduced by ATMI



Increased effectiveness

- Strong fluorinating agent → volatile fluorides of As, P, B, Si, W
- No need for plasma activation (NF_3 requires plasma activation)

Ease of Use

- Can use a simple, pressure-based, delivery system (SDS® gas stick)

Enhanced safety

- No need for dangerous high pressure gas
- Always sub-atmospheric for enhanced safety
- High density fluorine source; likely the safest source of fluorine

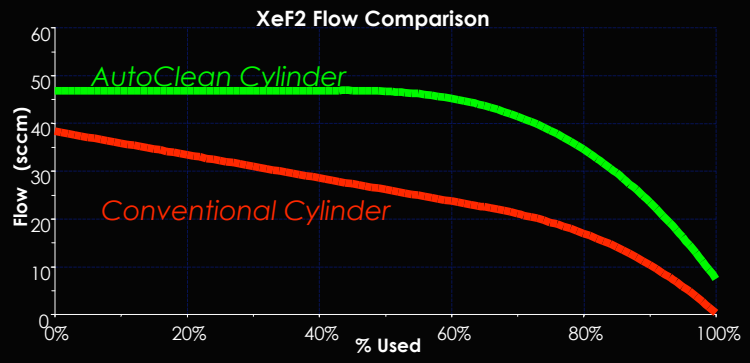
ATMI®

XeF2 Solid Delivery System

Tailored delivery system developed by ATMI

Vapor is delivered at room temperature. No heating means no condensation inside the implanter.

Ensures that vapor delivery from the solid material is consistent and reliable (no lumps!)



- 75g fill weight
- Smaller than SDS ® cylinder
- Installs on any spare SDS slot
- _" MVCR connector

ATMI®

XeF2 Solid Delivery System

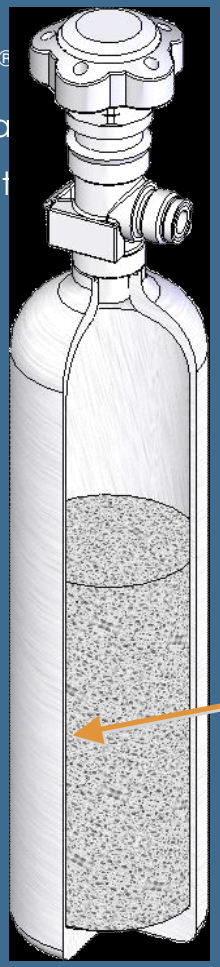
Tailored delivery system developed by ATMI

Vapor is delivered at room temperature. No heating means no condensation inside the implanter.

Ensures that vapor delivery from the solid material is consistent and reliable (no lumps!)

XeF_2 powder is distributed within the matrix of a porous aluminum material, ensuring good thermal contact and maximum solid surface area for vaporization.

- 75g fill weight
- Smaller than SDS ®
- Installs on any spa
- _" MVCR connect



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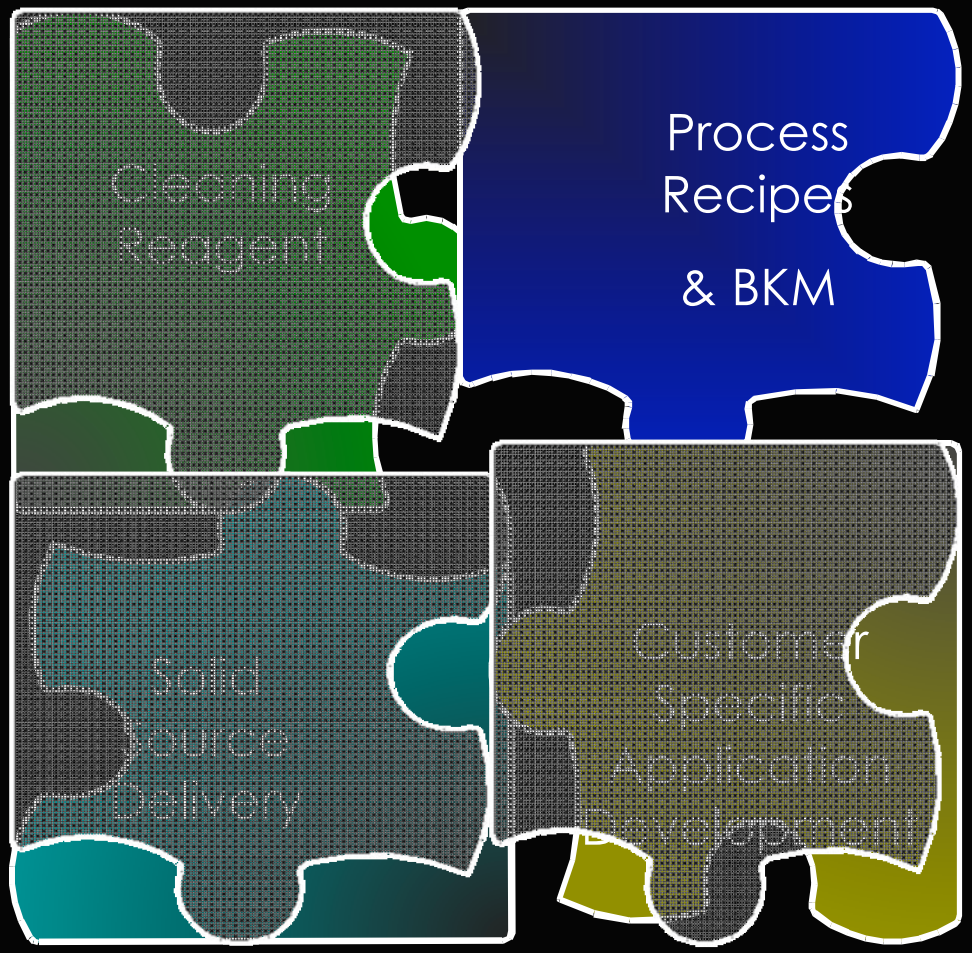
AutoClean

Complete system solution to implanter in-situ cleaning



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Process BKM's and Recipes

Implementation Strategy

Running multiple species on same implanter requiring lengthy set-up or prep.	Short source life, high glitch-rate, or high consumable costs.	Unstable source performance due to process by-product accumulation or…?
Implement AutoClean to replace Argon recipe between dopant changes.	Implement AutoClean recipe to automatically run for 10-15 minutes every 8 hours.	Implement AutoClean "recovery" recipe to recover from source instability.

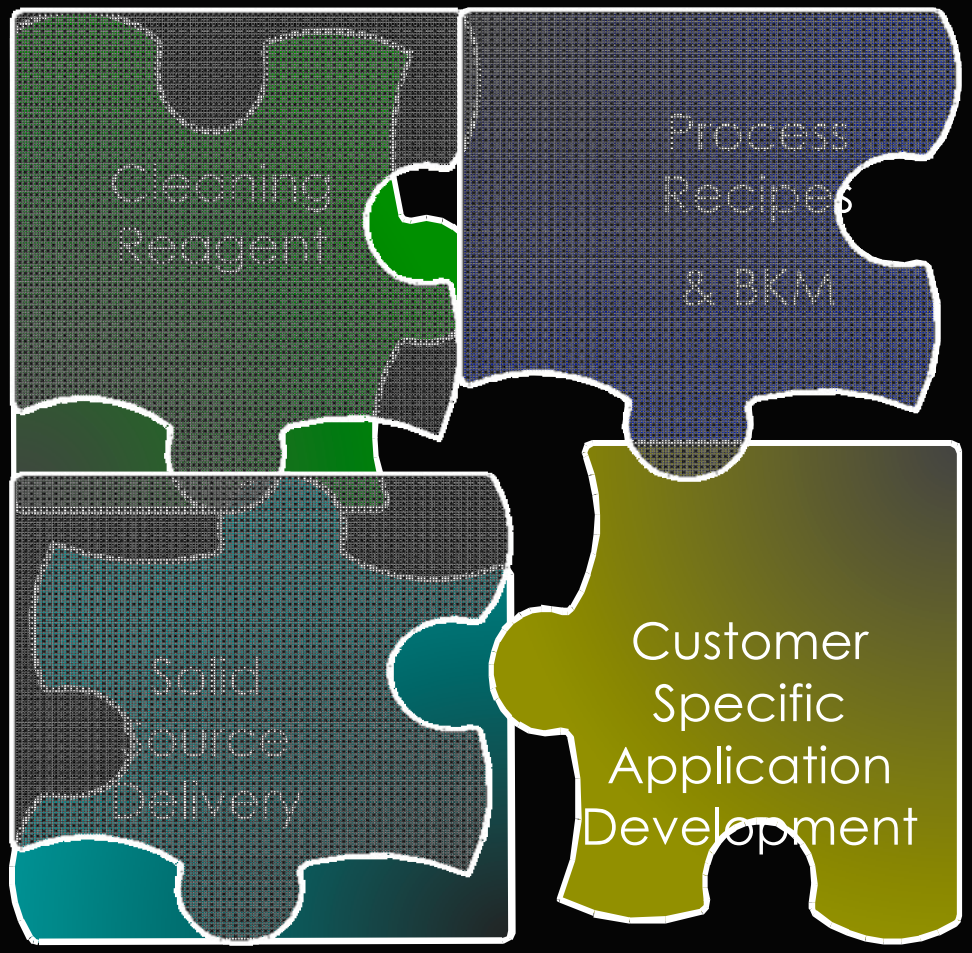
Multiple approaches to address variety of customer issues

Process BKM's and Recipes (Customer Examples)

- Implement AutoClean recipe to automatically run for 10-15 minutes every 12 hours.
- Implement AutoClean "recovery" recipe to recover from source instability.
- Replace Argon recipe with AutoClean.

AutoClean™

Complete system solution to implanter in-situ cleaning



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Customer Specific Considerations

Situational Considerations

- Tool types in installed base
- Implant process types
- Manufacturing protocols
- Production Mix

Situational Response

- Flow of XeF2
- Duration of clean process
- Plasma intensity & source parameters
- Frequency of Clean

Customer Specific Applications
Major 300mm Logic Customer

Needs
- Improved PM cycles on IHC source (less frequent)
- Improved Beam instability recovery
- High consumable costs – throwing away costly 300mm parts because there is no way to clean up

Situation
- 300mm mixed logic production
- Varian VIISta HC with IHC source
- 2 week PM schedule interrupted by early source failure (240 hours average)

Solution
- AutoClean 15 mins every 12 hours

Results / Proof
- >336 hour source life on 6 sources
- 40% improvement
- PM schedule changed from 2 weeks to 3 weeks
- Beam instability after 100 hours recovered and source run to 2 weeks
- Customer noticed cleaner manipulator and bushing
- Glitching (beam interruption) reduced 80%

Customer Specific Applications
Major 300mm Memory Customer

Needs
- Improved PM cycles on IHC & Bernas sources
- Improved Beam instability recovery

Situation
- 300mm memory production
- Varian VIISta HC with IHC and Bernas sources
- Average source life 240 hours

Solution
- Autoclean10-15 minutes every 8-12 hours

Results / Proof
- 1st source (IHC) ran 450 hrs (average life without AutoClean 200 hrs)
- AutoClean then moved to VIISta with Bernas source
  - 1st source (Bernas) was glitching after 200 hrs.
    - Source life extended to 248 hrs with 30 mins AutoClean conditioning recipe.
  - 2nd source (Bernas) ran to 260 hours, well above average life (190 hrs).

Customer Specific Applications
Atmel

Needs

- Improved PM cycles on IHC source (less frequent)
- Improved Beam instability recovery

Situation

- 150mm simulated production
- Applied XR80 HC with IHC source
- Average source life was 165 hours

Solution

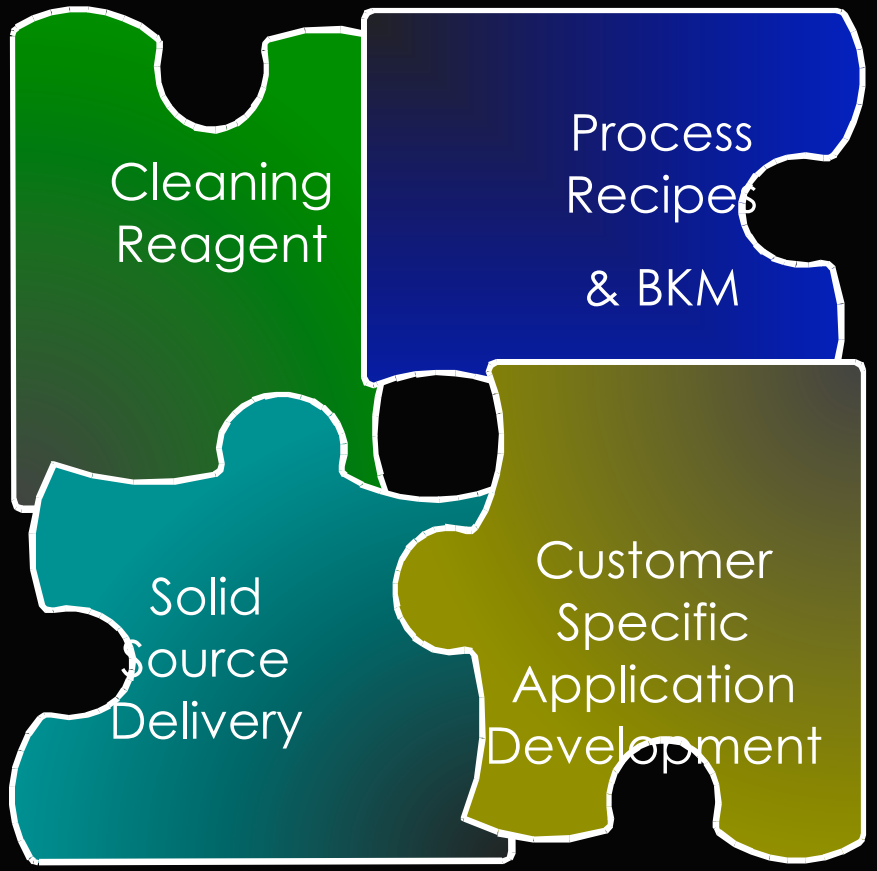
- AutoClean 15 minutes every 8 hours

Results / Proof

- Source lifetimes with AutoClean were 250, 310 and 323 hours
- 78% average improvement

AutoClean

Complete system solution to implanter in-situ cleaning



Predictable Process.

Extended Source Life.

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AutoClean Process Development

1) Dynamic clean – ion source focused
   (currently released for customers)

2) Static clean – scheduled with PM; focus on
   source housing, extraction assembly, etc.
   (currently in field alpha testing, not released)

3) Ex-situ – stand alone process chamber for
   cleaning parts, validating capabilities and
   materials compatibilities

   (currently in R&D use, exploring customer interest;
   not released)

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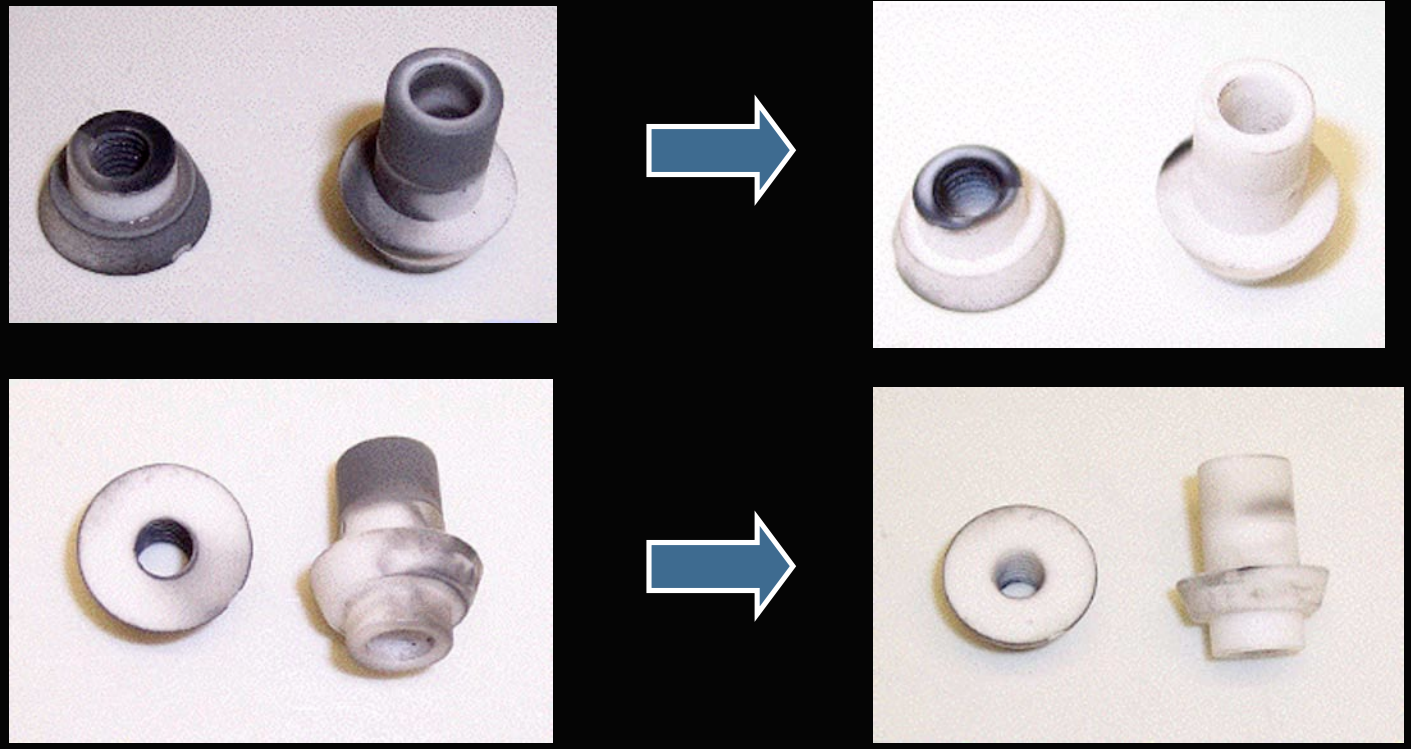
Predictable Process. Extended Source Life.

Cleaning of Bernas Source Alumina Insulators with XeF_2

Before AutoClean

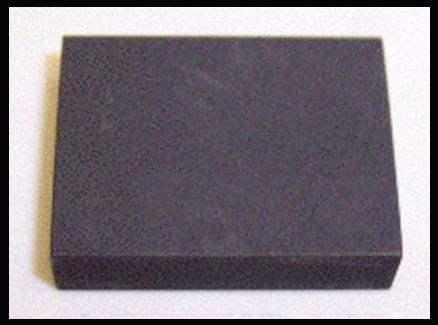
After AutoClean



Predictable Process. Extended Source Life.

Cleaning Bernas Source Repeller Plate With AutoClean

New / Unused



Used, before AutoClean

After AutoClean

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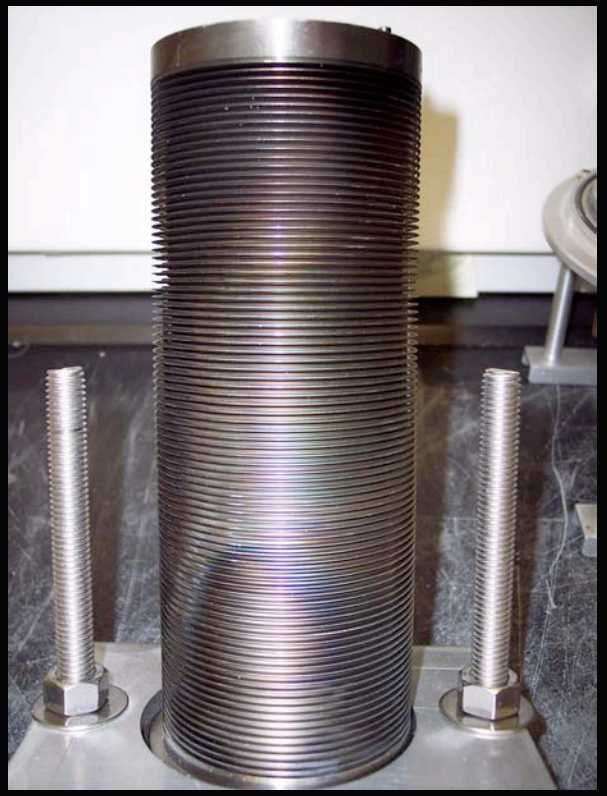
AMAT Extraction Manipulator Bellows

Pre-Clean

XeF2 Clean
1 Cycle



XeF2 Clean
4 Cycles

ATMI®

XeF_2 Material Compatibility Studies Viton, Vespel, Teflon

Conclusions:

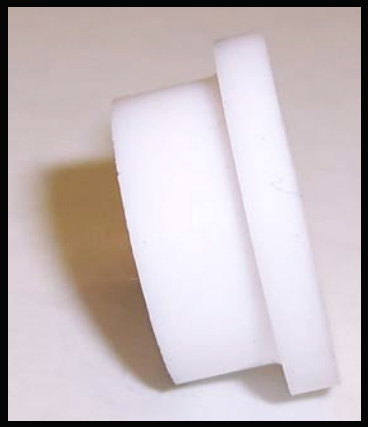
Viton, Vespel and Teflon are inert with XeF_2 – no weight loss, visual surface degradation or RGA / IR reaction products were observed.

Viton O-ring

Before

After

Teflon Sample



Before

After

Vespel Sample

Customer Feedback
Atmel

"Our initial testing demonstrated the outstanding cleaning properties of ATMI's AutoClean system."

"Regular periodic use of AutoClean for in-situ cleaning of the ion source resulted in a 40% - 50% increase in source life."

"It also improved fab predictability and productivity by eliminating ion source failures due to beam instability and high suppression leakage current."

"In addition, based on our initial data, our regular preventative maintenance activities will be easier and require less tool downtime as a result of using AutoClean."

Jim Dunn
Implant Equipment Engineering Section Manager
Atmel
Colorado Springs, CO

Customer Feedback
Major 300mm Logic Customer

"AutoClean operation resulted in consistent source performance with zero unscheduled downtime caused by early source failure"

In side-by-side testing, the AutoClean system experienced 25-30% fewer source changes than the standard system."

"Data shows clearly that the AutoClean process significantly reduced the glitch rate as the source ages, producing glitch rates at the end of source life that are comparable to new source performance."

"Enhanced Safety with reduction in personnel exposure to hazardous materials & process byproducts = parts were cleaner and required less scrubbing during PMs."

"Throughput modeling estimates approximately 2000 wafers per tool in increased wafer output."

Implant Platform Experience

- AMAT, XR80, Quantums X, 1-3

- Axcelis, GSD E^2, Ultra, Optima MD
- Hi Energy tools – moving towards evaluations

- Japan - SEN, Nissin – initiating evaluations

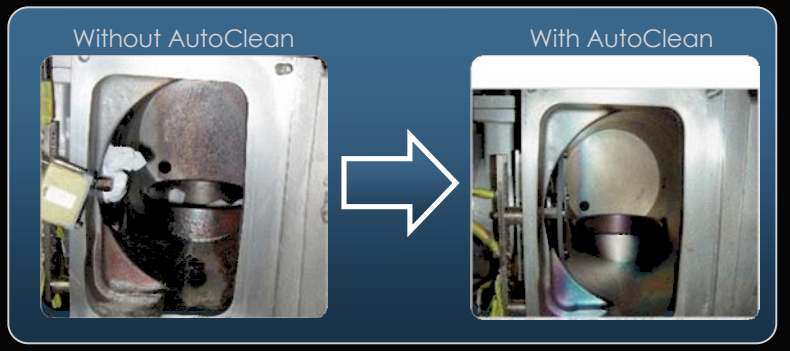
- VSEA, VIISta's - 80, HCP, HCS, 810, 900, etc
- VSEA, E500/220, VIISion 80/200

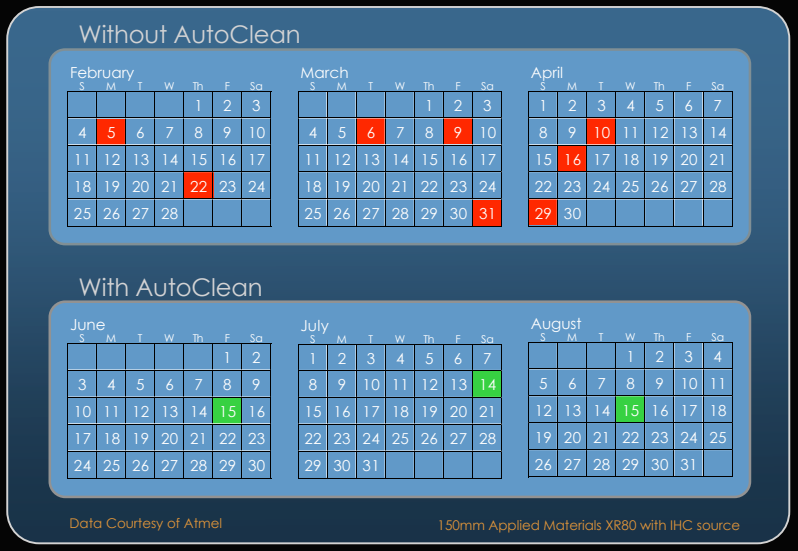
- Note: ion source types, both IHC and Bernas.

AutoClean®

Predictable Implant Process.
Extended Source Life.

- 30% increase in Beam uniformity
- 80% reduction in glitching
- 40% reduction in PM frequency
- Increased implanter availability
- More predictable fab operations
- Less personnel exposure
- Unscheduled maintenance now becomes scheduled maintenance





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