Hanford and Livingston Contamination Control Update

Calum Torrie and Kate Gushwa
On behalf of the Contamination Control Working Group
January 30th 2013

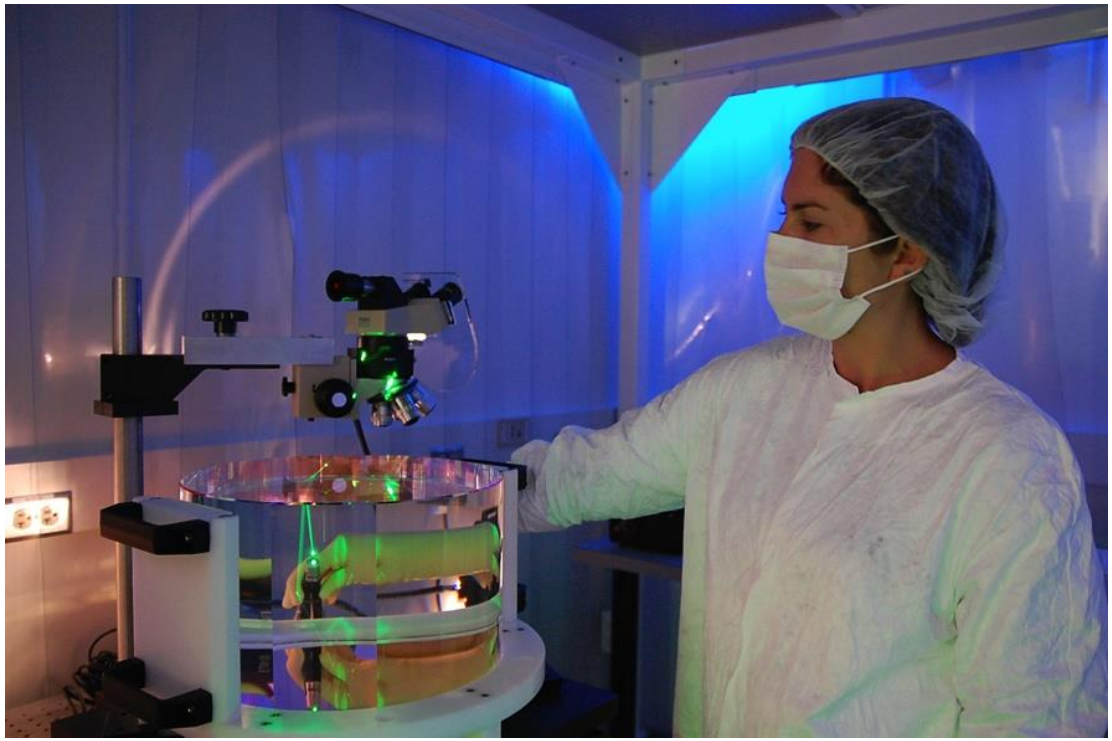
LIGO

Outline

- Why do we care about contamination?
- What is “clean”?
- Diagnostic Tools
- Mitigation & Protection

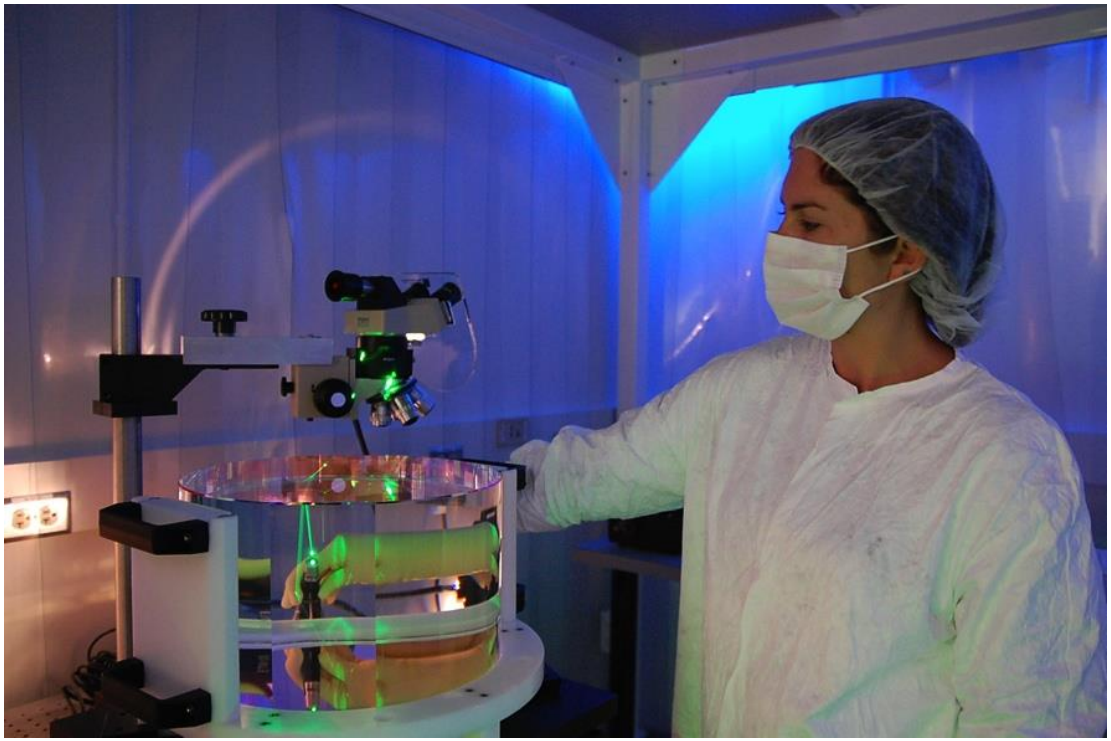
It's All About Optics

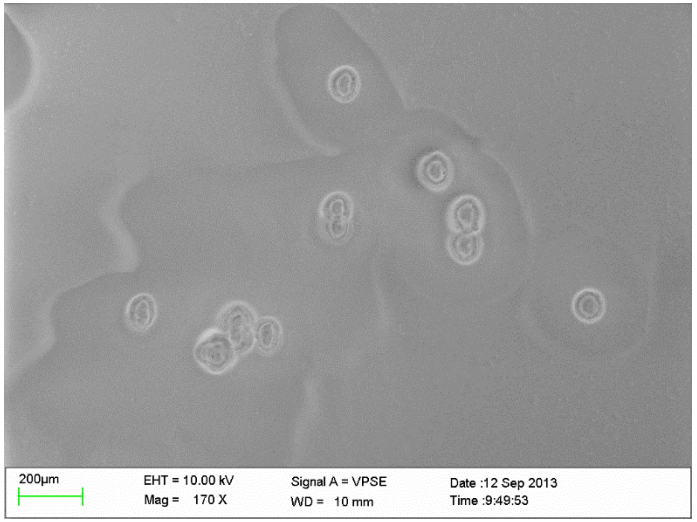
- Performance limited by optics

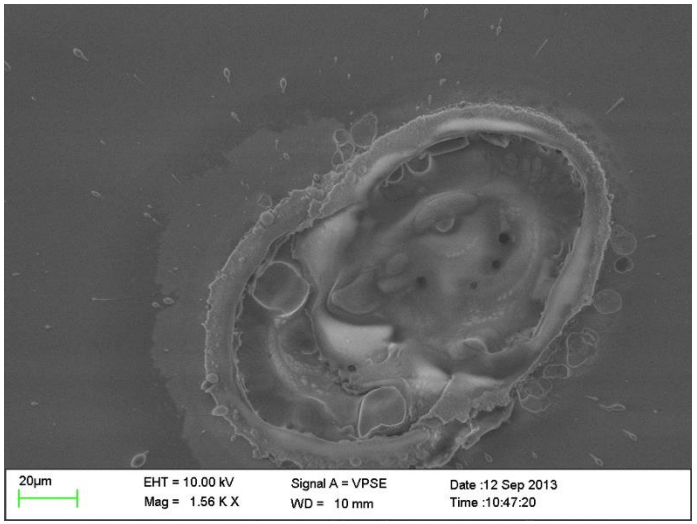


It's All About Optics

- Performance limited by optics
- If optics are dirty…







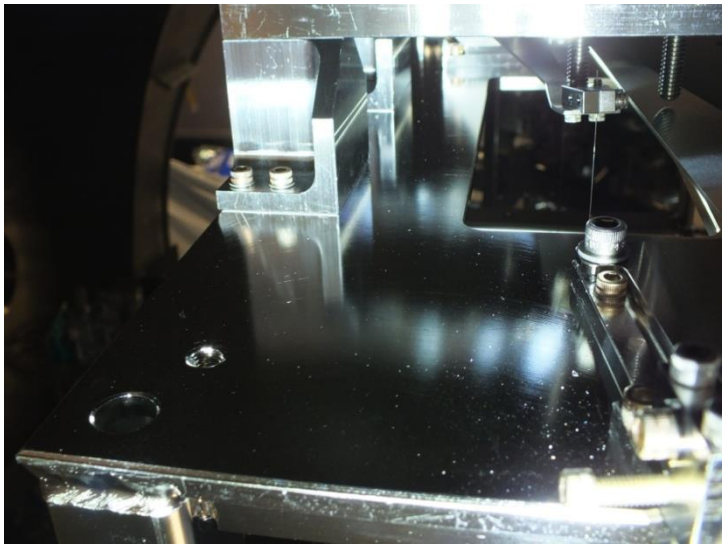
Defining Clean

Defining Clean

	Cleanroom Class
Particles per:	Volume of air
Tool:	Particle Counter
Requirement:	ISO 5 (Class 100)

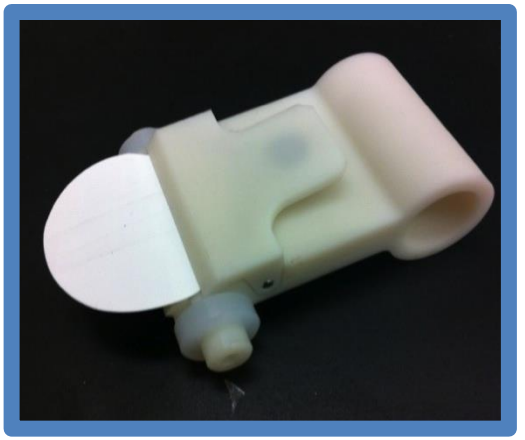
Defining Clean

	Cleanroom Class	**Particulate Cleanliness Level (PCL)**
Particles per:	Volume of air	Area of surface
Tool:	Particle Counter	???
Requirement:	ISO 5 (Class 100)	Level 65 (optics at full power) Level 100 (chambers)



How bad is it?

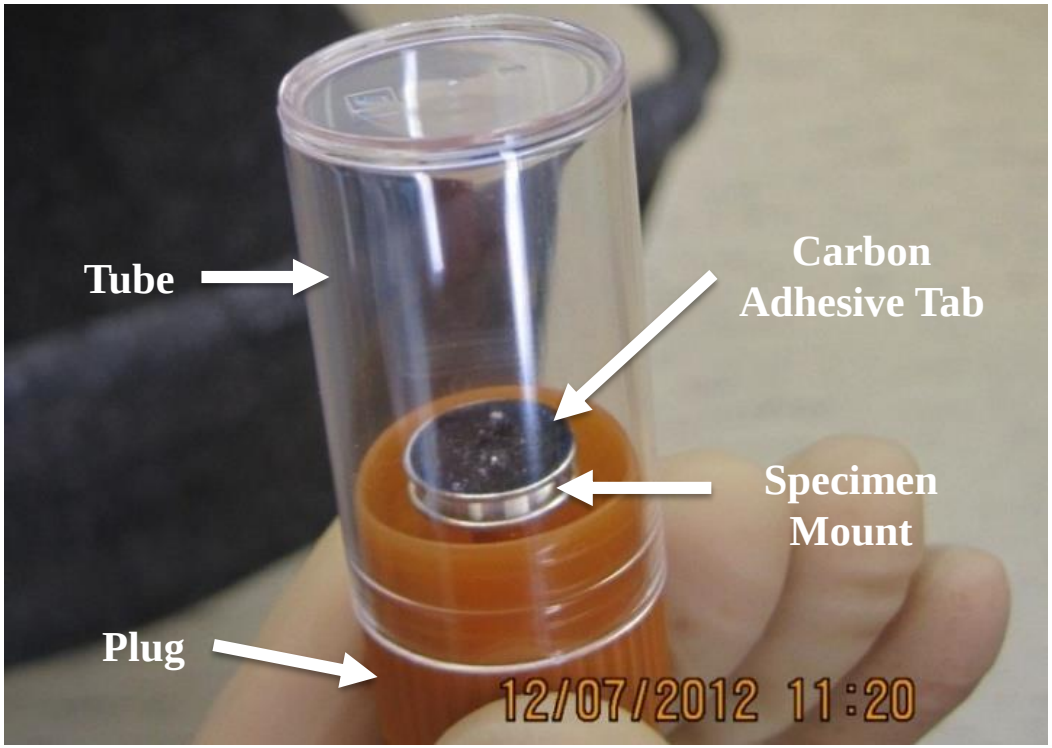


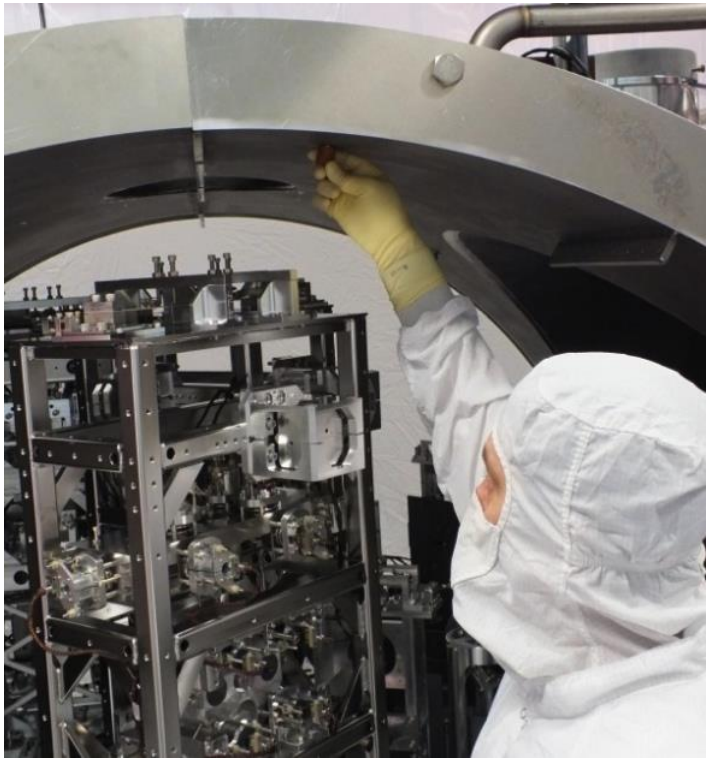



Where is it coming from?

DIAGNOSTIC TOOLS

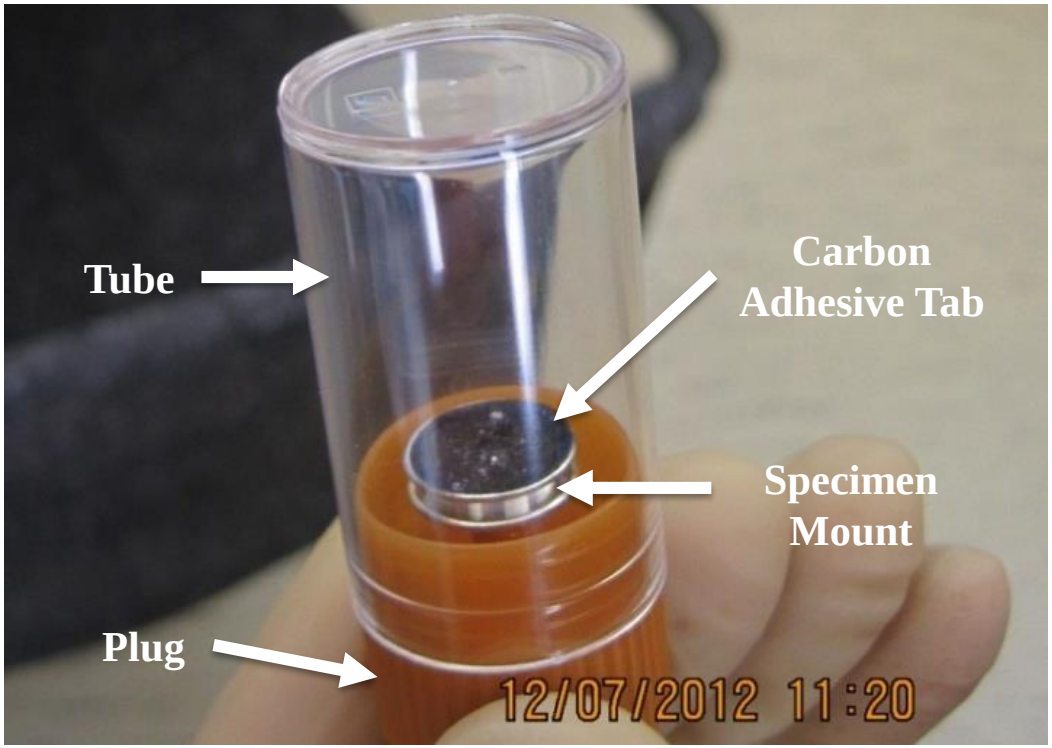
FBI Samples


Tube
Carbon
Adhesive Tab
Specimen
Mount
Plug
12/07/2012 11:20

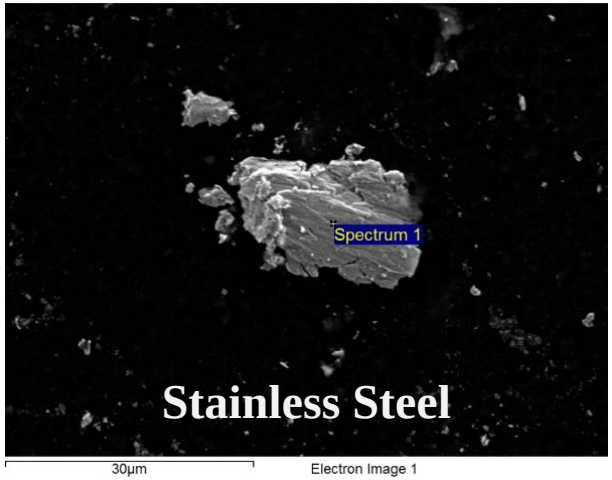


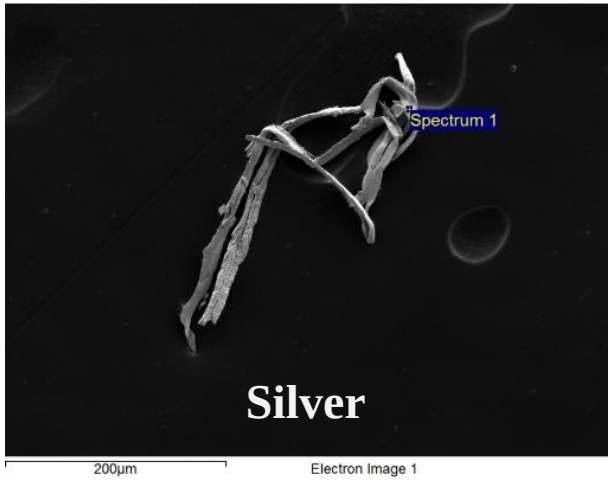
FBI Samples

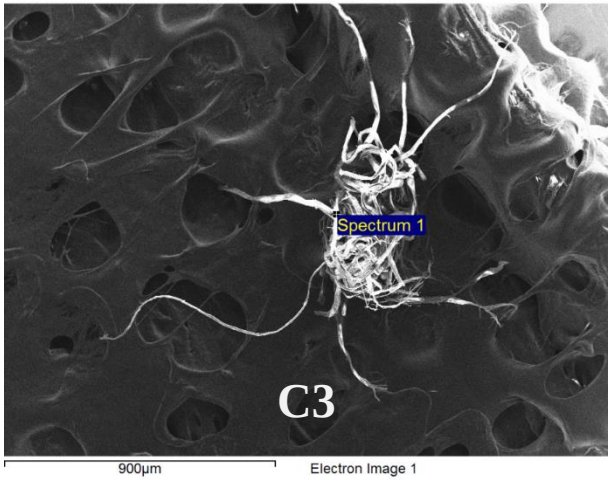
- Elemental analysis with Scanning Electron Microscope
- “Criminals” vs. “Known Suspects”



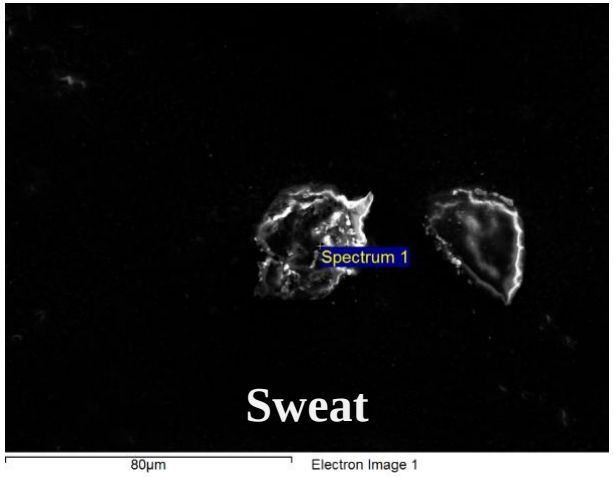
FBI Samples

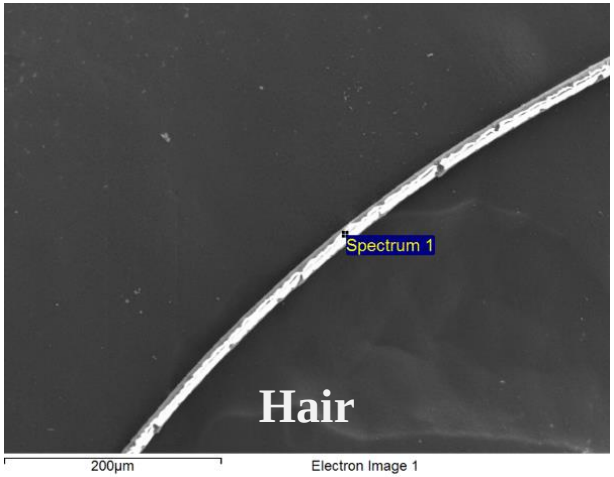

Spectrum 1
Stainless Steel
30µm
Electron Image 1


Spectrum 1
Silver
200µm
Electron Image 1

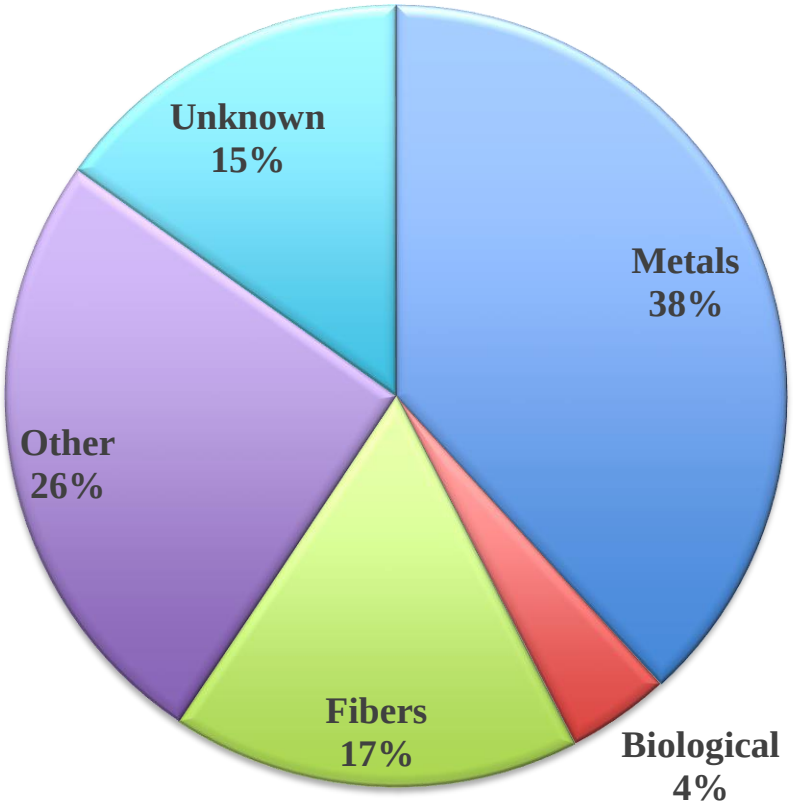

Spectrum 1
C3
900µm
Electron Image 1


Spectrum 1
Glove
80µm
Electron Image 1


Spectrum 1
Sweat
80µm
Electron Image 1


Spectrum 1
Hair
200µm
Electron Image 1

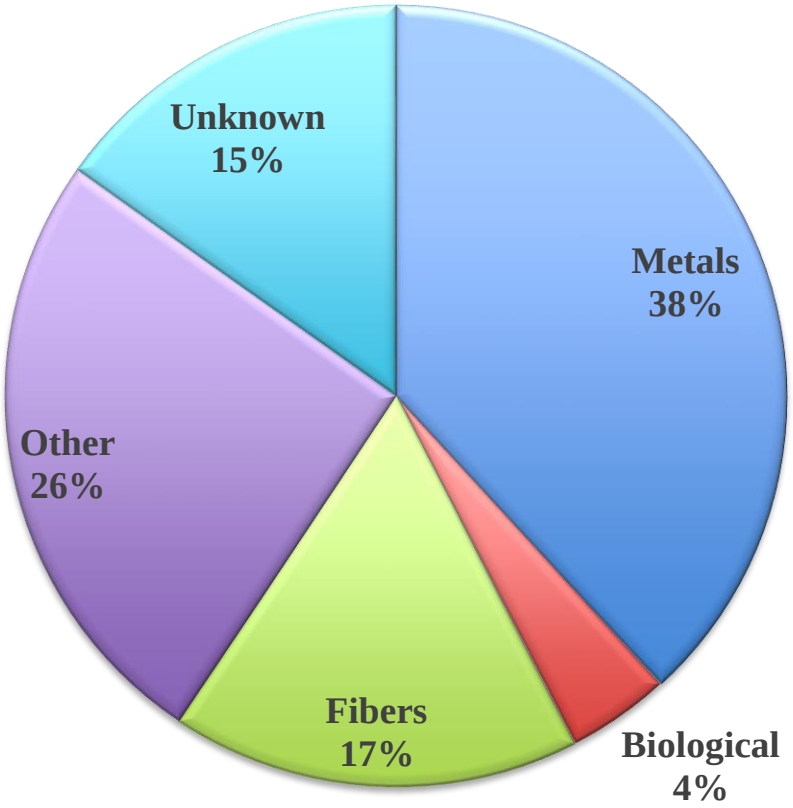
FBI Samples on Instrument Surfaces



Group	Material	Specimen	Total
Metals	Any Metal	63	63
Biological	Hair	1	7
	Skin, Sweat, Saliva	6	
Fibers	C3	9	28
	Glove Liner	2	
	Jeans	1	
	Unknown Fiber	4	
	Wipe	12	
Other	In-Vacuum Cable	2	42
	Carbon	21	
	Fused Silica	4	
	Glove	15	
Unknown	Unknown	25	25

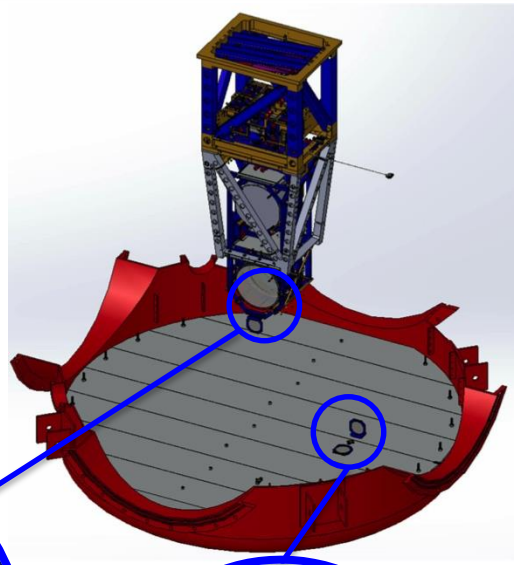
FBI Samples on Instrument Surfaces

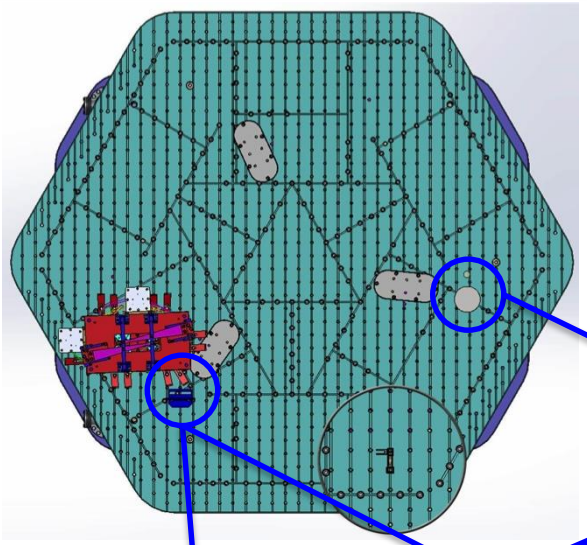
➢ *Finding: no smoking gun*

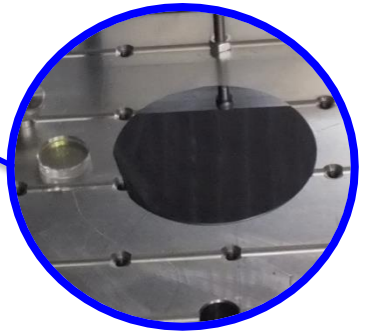


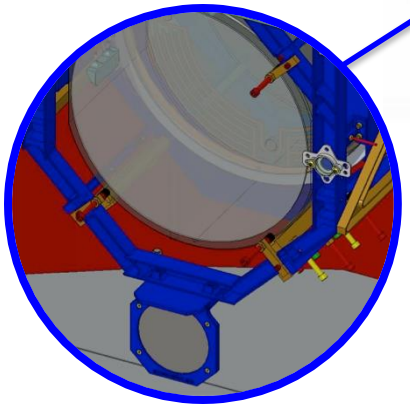
Group	Material	Specimen	Total
Metals	Any Metal	63	63
Biological	Hair	1	7
	Skin, Sweat, Saliva	6	
Fibers	C3	9	28
	Glove Liner	2	
	Jeans	1	
	Unknown Fiber	4	
	Wipe	12	
Other	In-Vacuum Cable	2	42
	Carbon	21	
	Fused Silica	4	
	Glove	15	
Unknown	Unknown	25	25

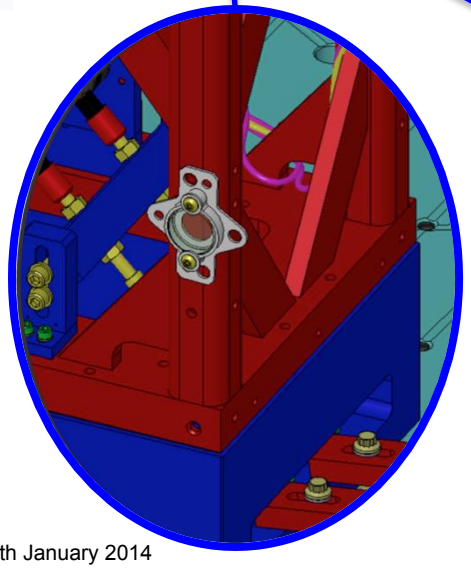
4” Wafers & 1” Optics

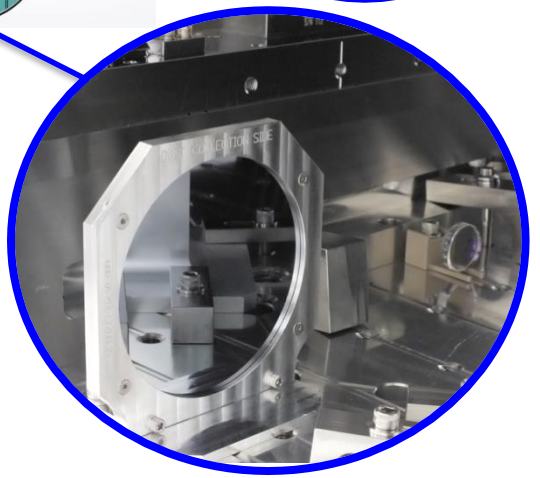










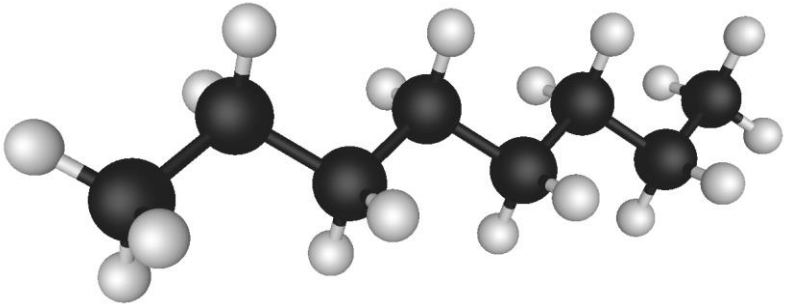


HAM3 Wafers & Optics

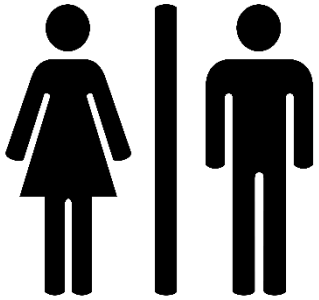
- Molecular & chemical analysis

HAM3 Wafers & Optics

- Molecular & chemical analysis



Complex mix of hydrocarbons



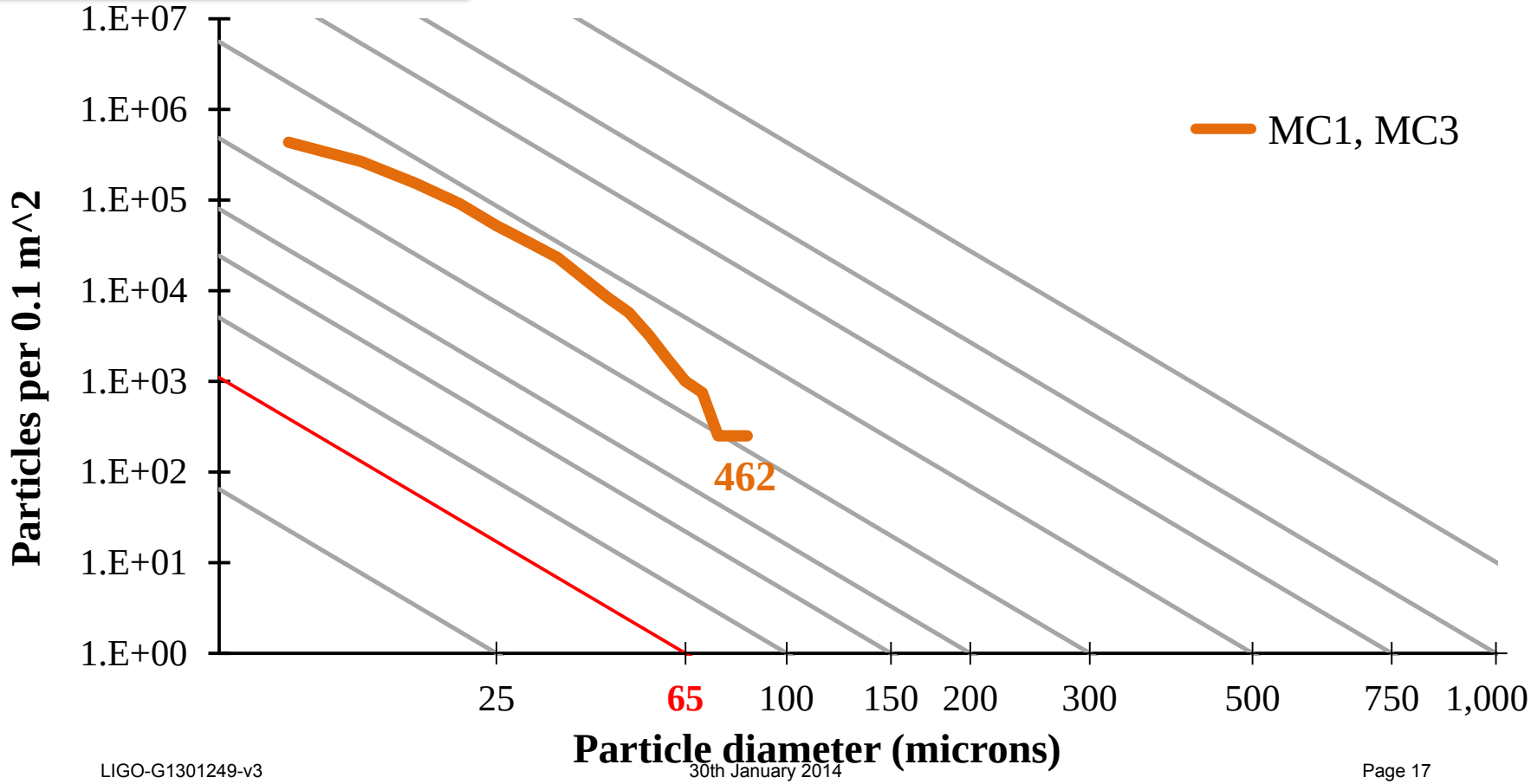
Skin dander

Polyester & cotton fibers

Mixed silicates (soil)

LHAM2 Wafer PCLs

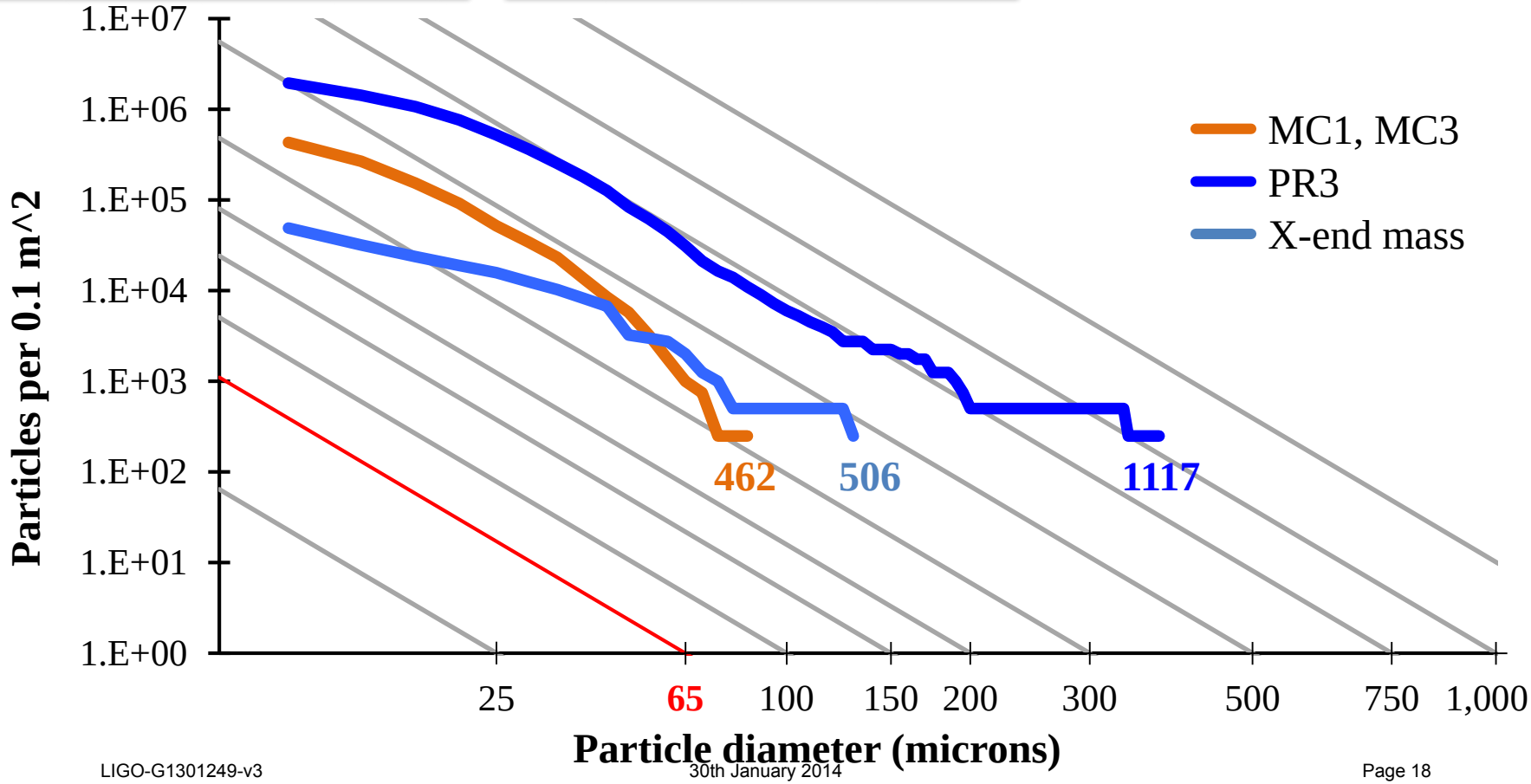
1st pump down – Aug 2012
Most components installed
1 hr basic wipe down



LHAM2 Wafer PCLs

1st pump down – Aug 2012
Most components installed
1 hr basic wipe down

2nd pump down – Dec 2012
Minimal work (baffles)
2 weeks of clean-as-you-go

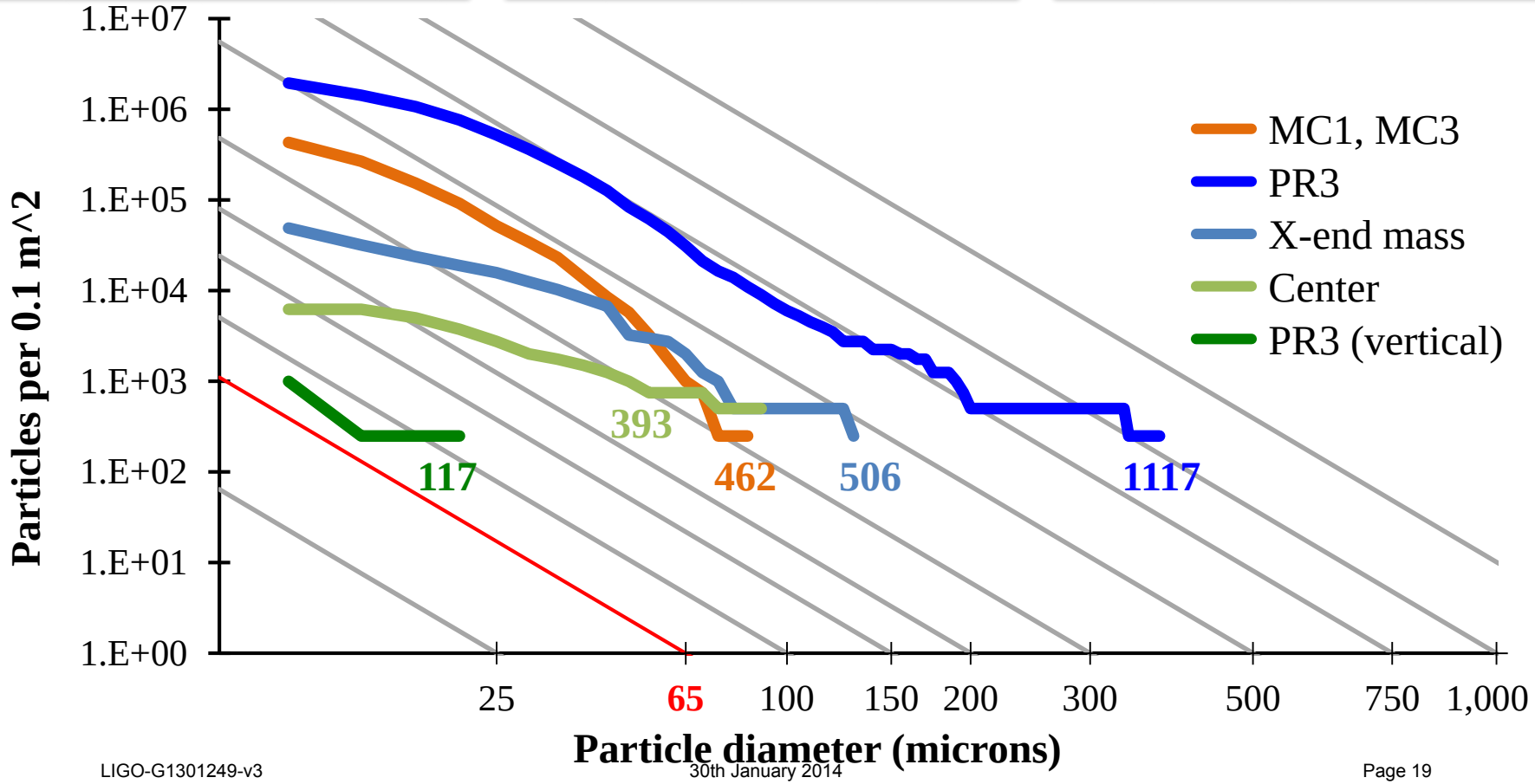


LHAM2 Wafer PCLs

1st pump down – Aug 2012
Most components installed
1 hr basic wipe down

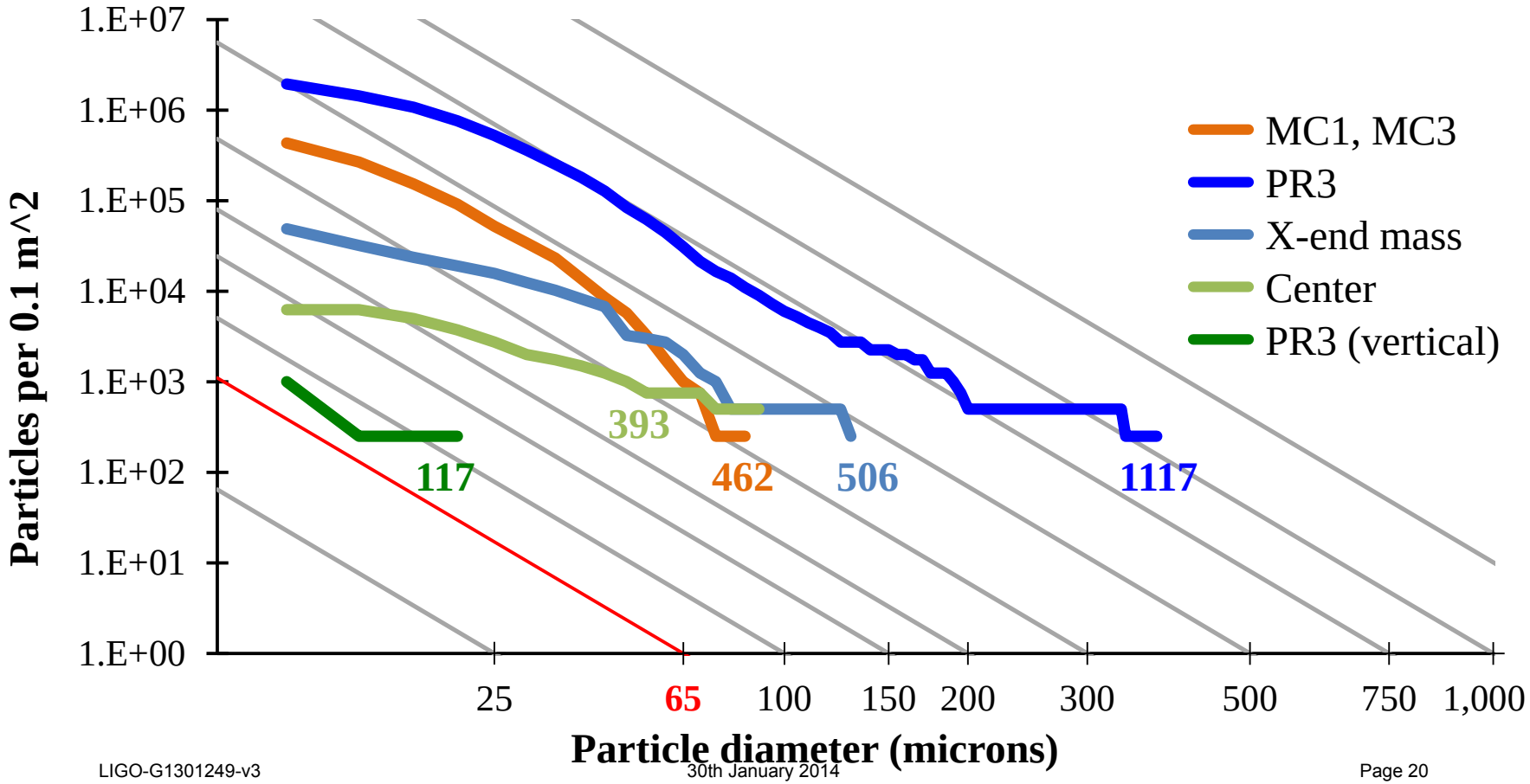
2nd pump down – Dec 2012
Minimal work (baffles)
2 weeks of clean-as-you-go

3rd pump down – June 2013
Balancing, gluing
1.5 hr wipe down



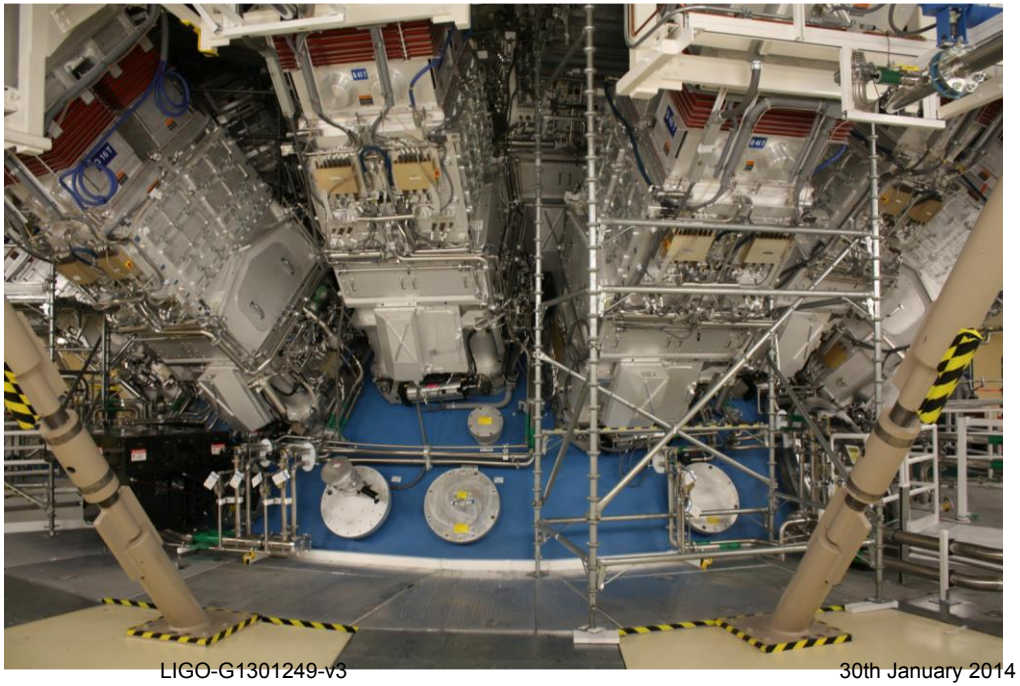
LHAM2 Wafer PCLs

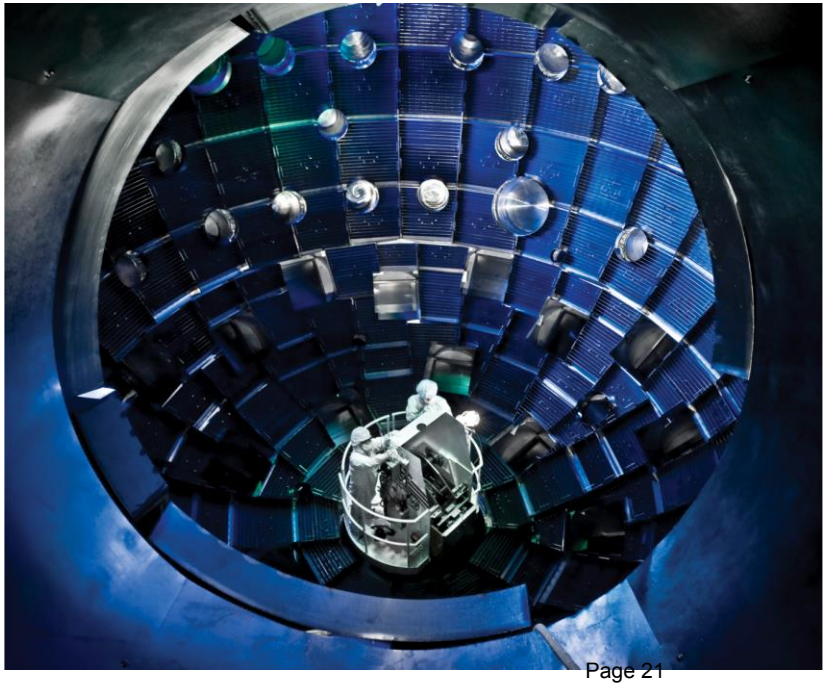
➢ *Iterative cleaning works.*



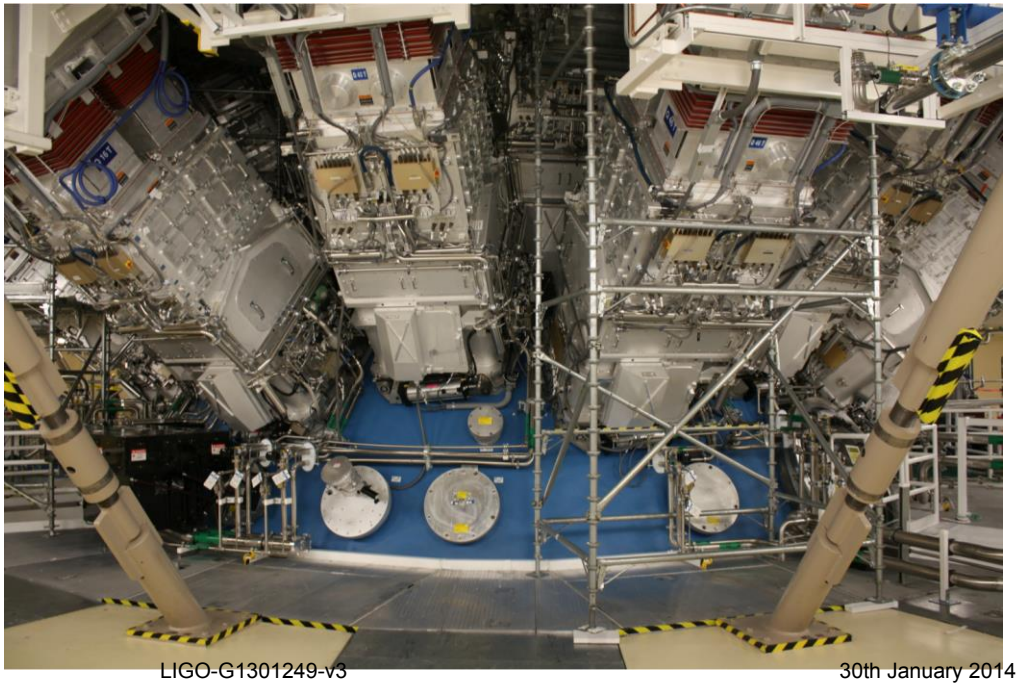
Particle Evaluation Tool (PET)

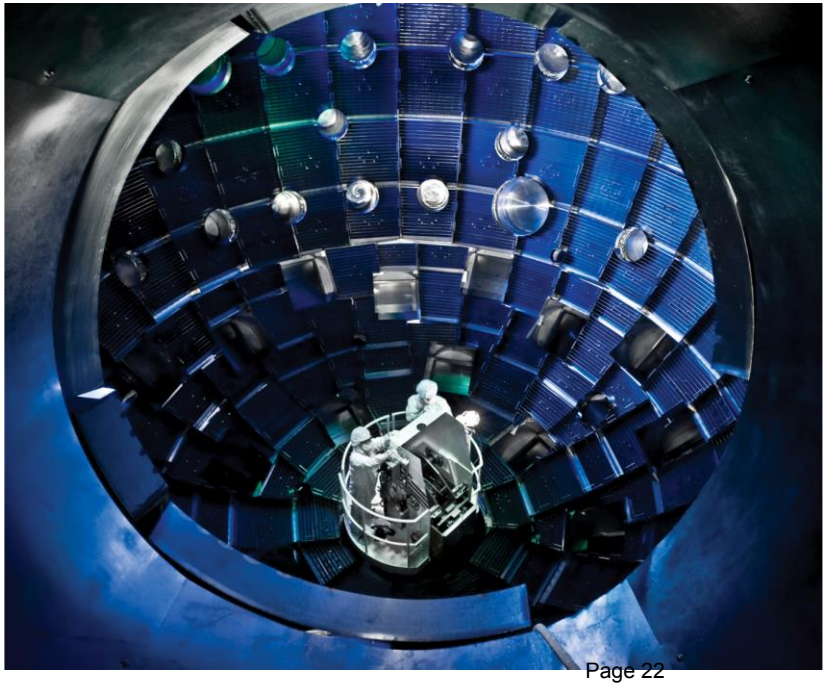
- Visited National Ignition Facility





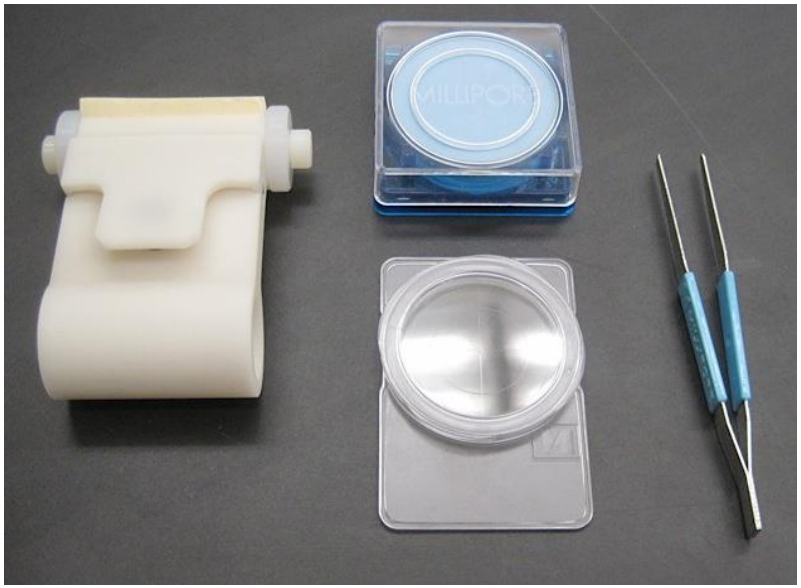
Particle Evaluation Tool (PET)



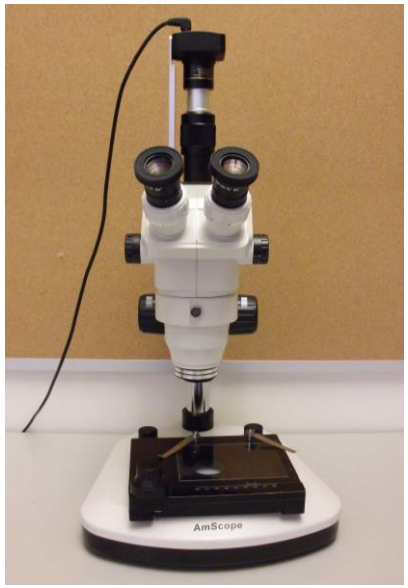


Particle Evaluation Tool (PET)

- Visited National Ignition Facility
- New system based on NIF's design



1. Swipe Tool

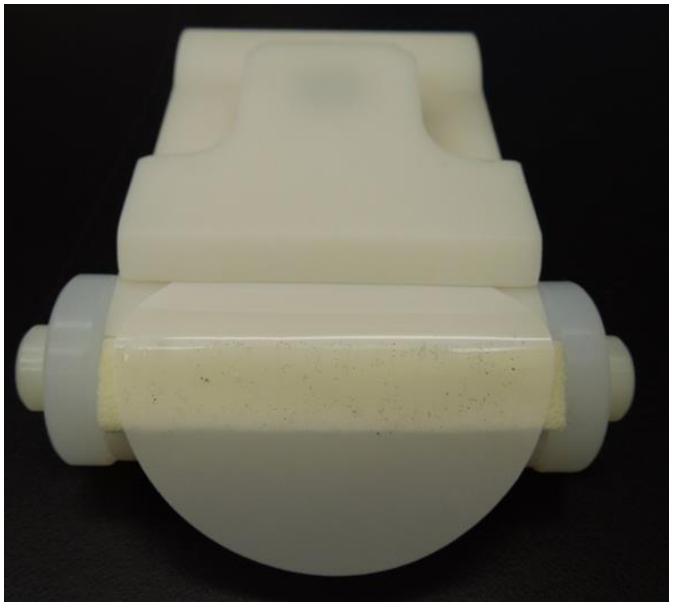


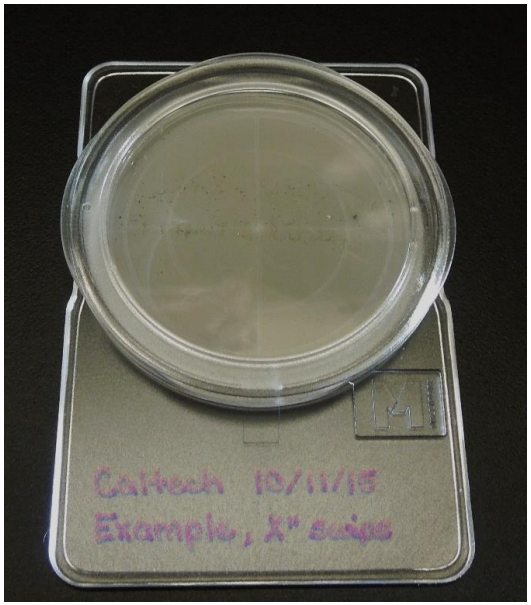
2. AmScope

3. Excel template

Particle Evaluation Tool (PET)

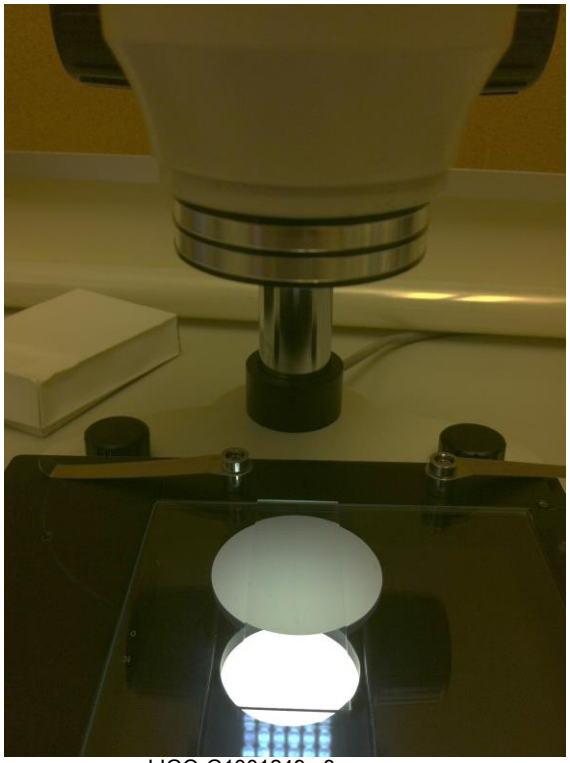
- Visited National Ignition Facility
- New system based on NIF's design

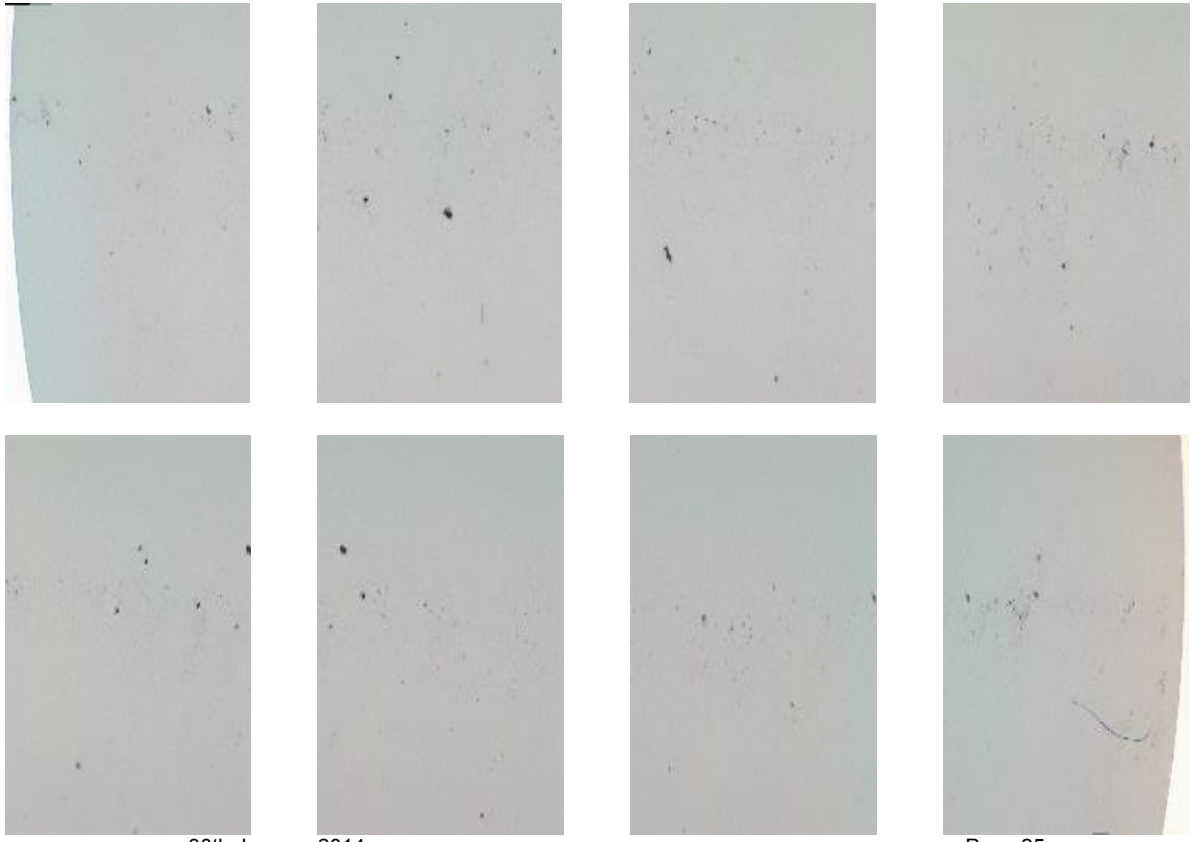




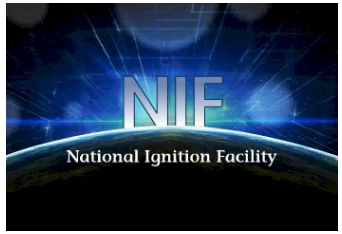
Particle Evaluation Tool (PET)

- Visited National Ignition Facility
- New system based on NIF's design

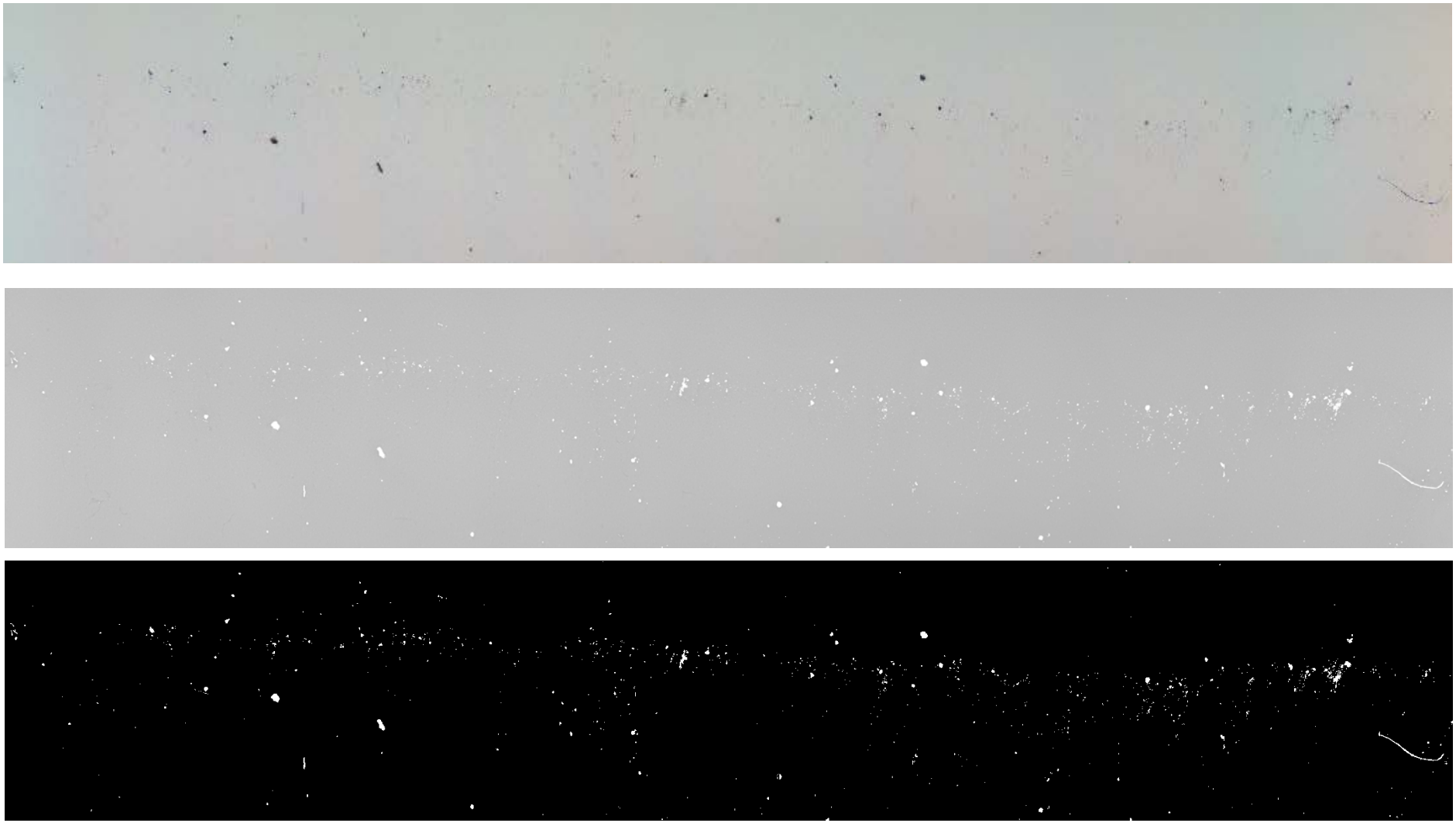




Particle Evaluation Tool (PET)



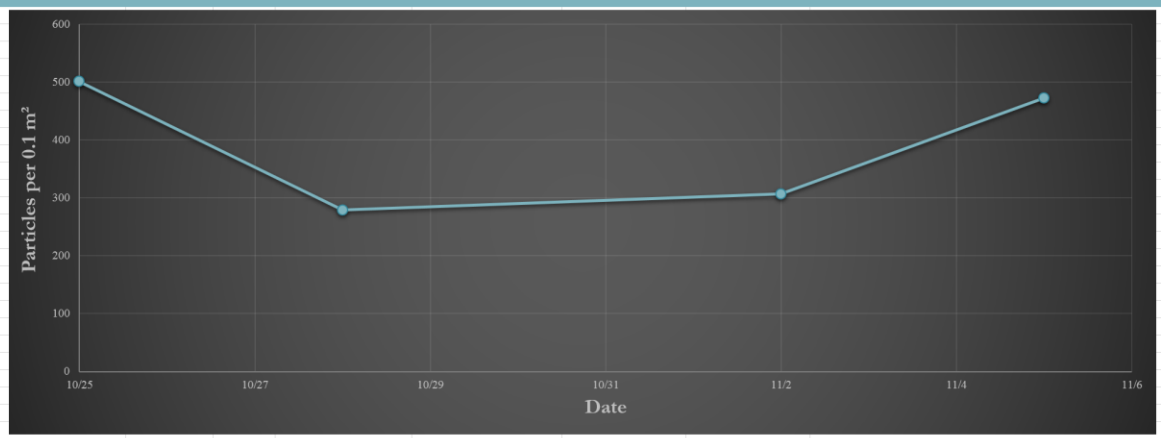
- Visited National Ignition Facility



Particle Evaluation Tool (PET)

- Visited National Ignition Facility
- New system based on NIF's design

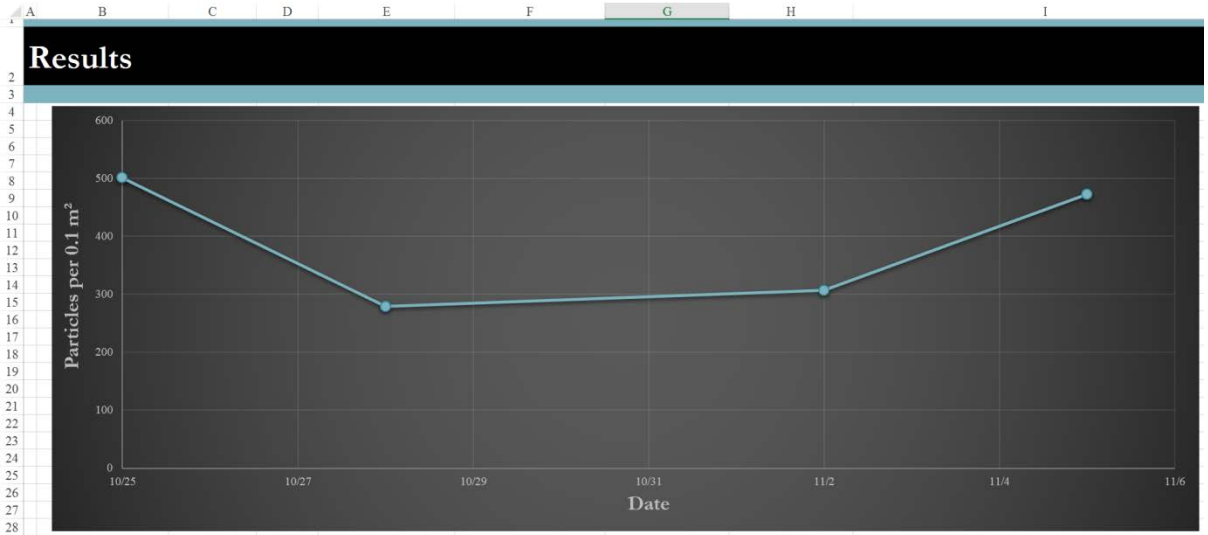
Results



Sample Name	Date	PCL	Min Diameter (µm)	Max Diameter (µm)	Swipe Area (m²)	Image Area (m²)	Notes
Example #1	10/25/13	501	4	339	1.42E-02	3.47E-04	HLTS structure, near M1
Example #2	10/28/13	279	13	116	2.88E-03	3.67E-05	Optics table, left side
Example #3	11/2/13	307	4	128	2.23E-03	3.26E-05	Optics table, left side
Example #4	11/5/13	473	4	315	1.41E-02	3.45E-04	HLTS structure, near M2

Particle Evaluation Tool (PET)

- Visited National Ignition Facility
- New system based on NIF's design
- Entire process performed on-site
- Phased implementation starts now
  - Refer to LIGO-T1300665 The LIGO Particulate Evaluation Tool (PET)

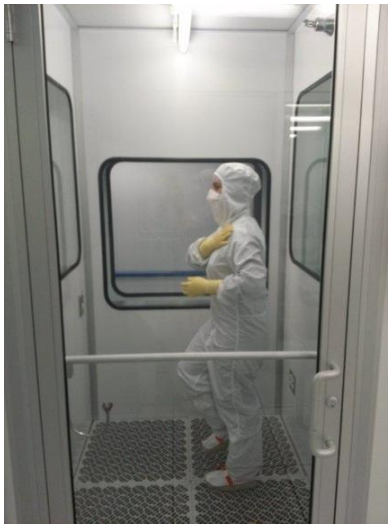


Sample Name	Date	PCL	Min Diameter (µm)	Max Diameter (µm)	Swipe Area (m²)	Image Area (m²)	Notes
Example #1	10/25/13	501	4	339	1.42E-02	3.47E-04	HLTS structure, near M1
Example #2	10/28/13	279	13	116	2.88E-03	3.67E-05	Optics table, left side
Example #3	11/2/13	307	4	128	2.23E-03	3.26E-05	Optics table, left side
Example #4	11/5/13	473	4	315	1.41E-02	3.45E-04	HLTS structure, near M2

MITIGATION & PROTECTION

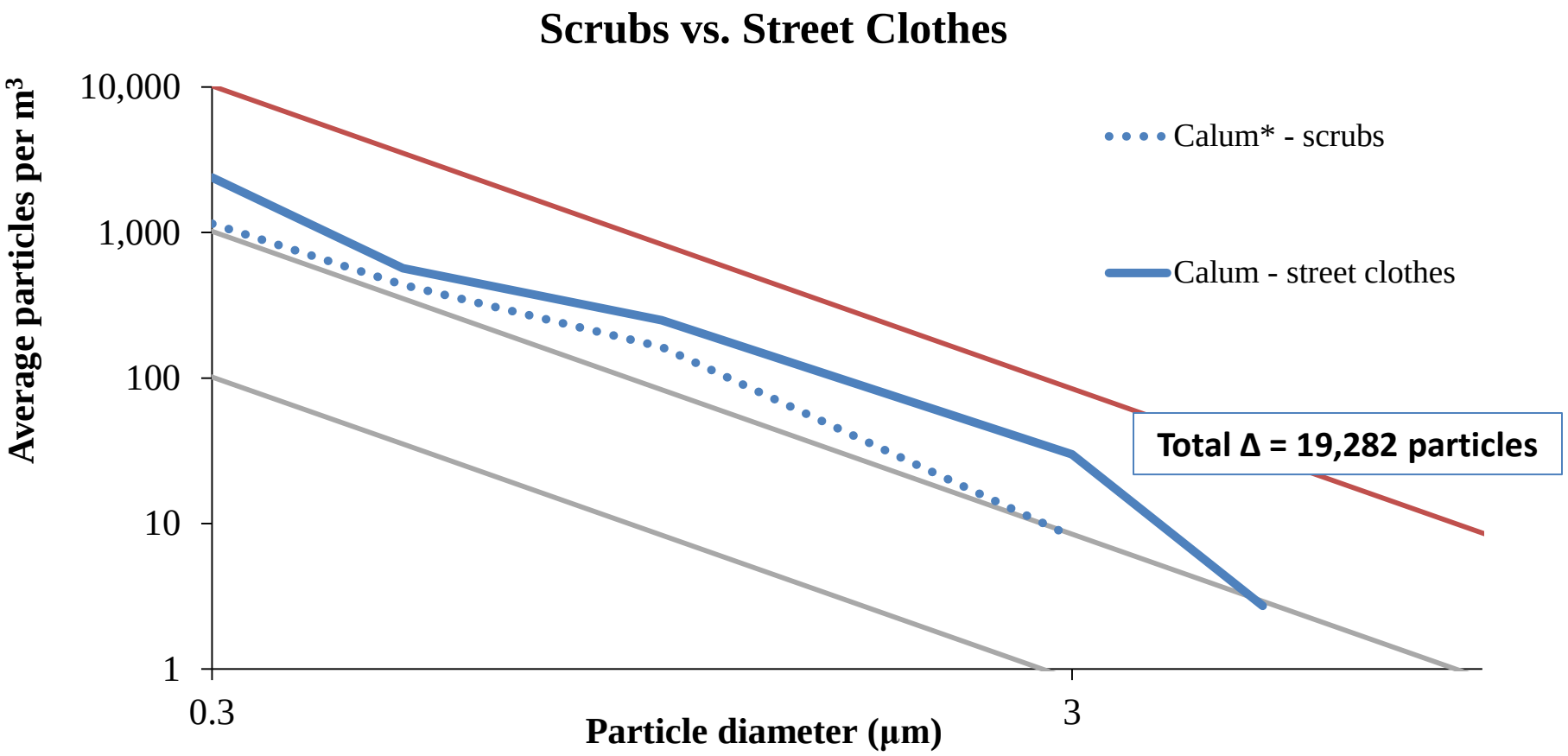
Scrubs

- Body Box testing
  -



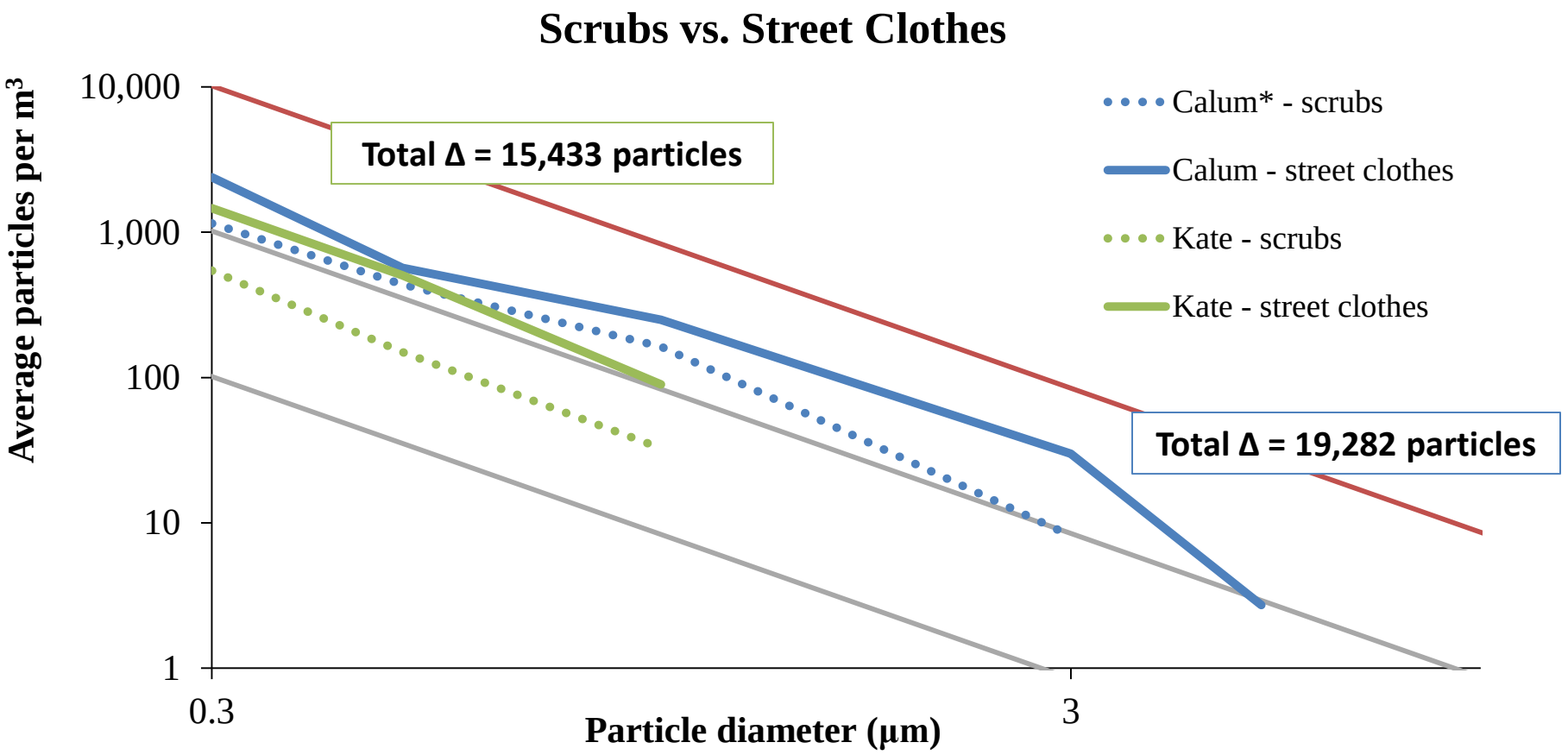
Scrubs

- Body Box testing



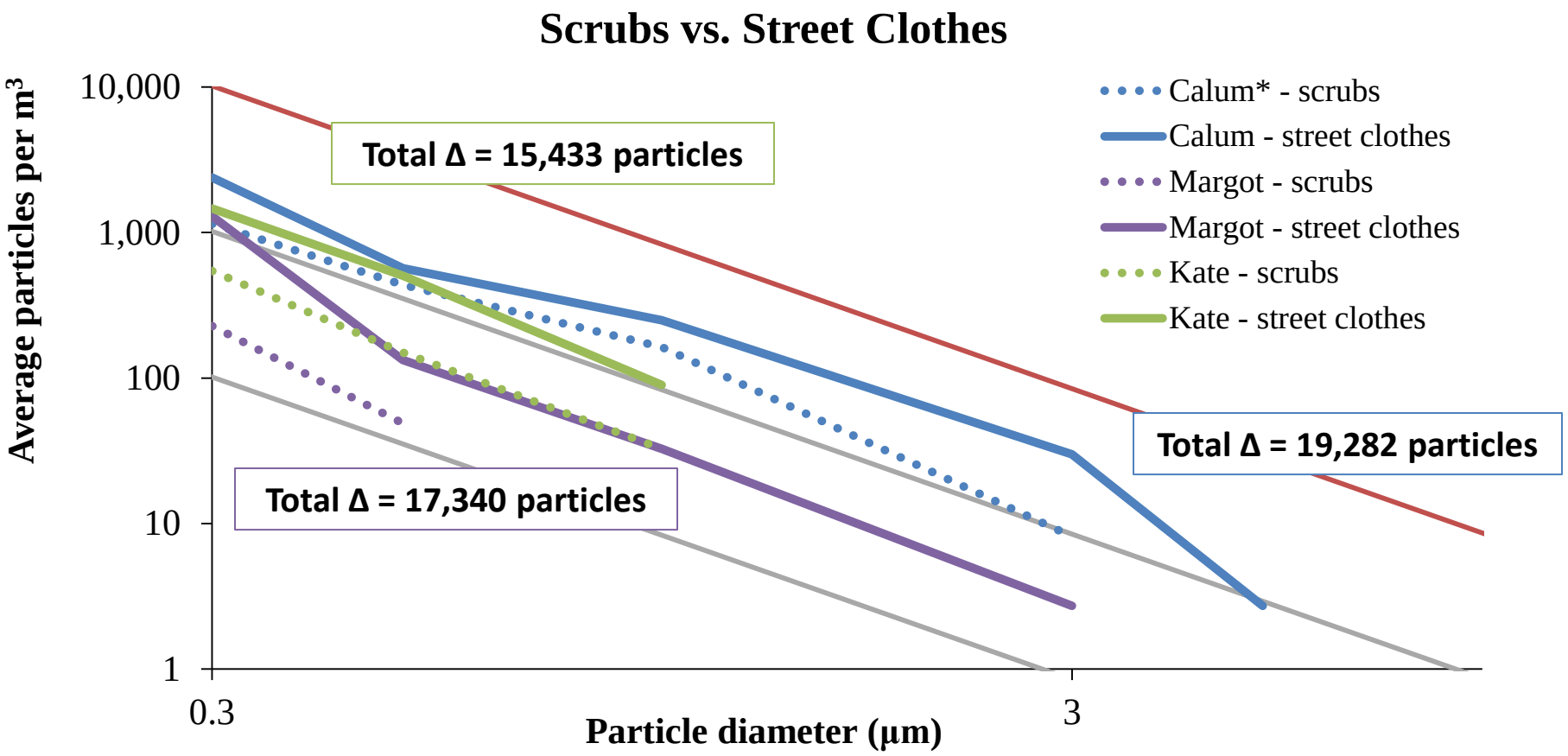
Scrubs

- Body Box testing



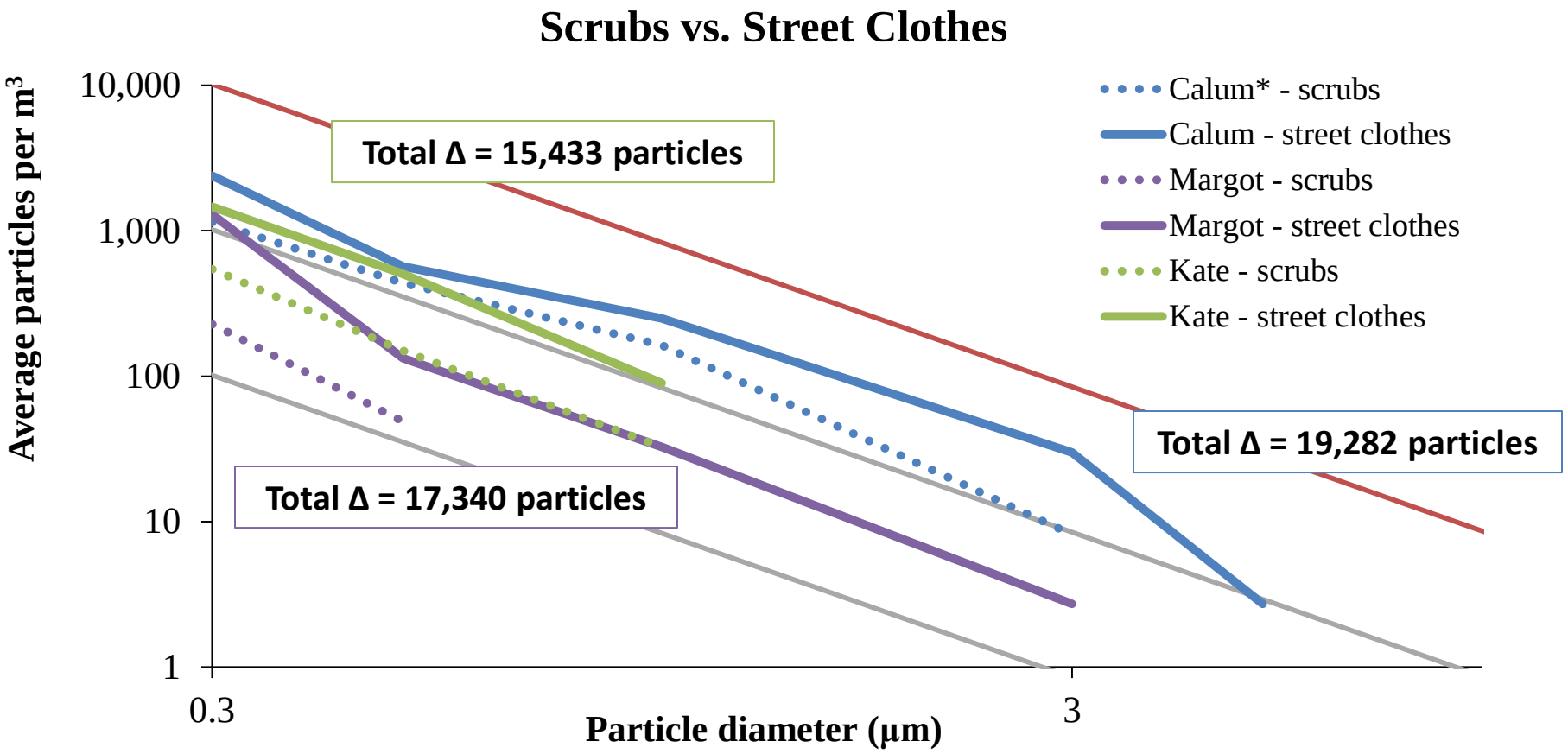
Scrubs

- Body Box testing



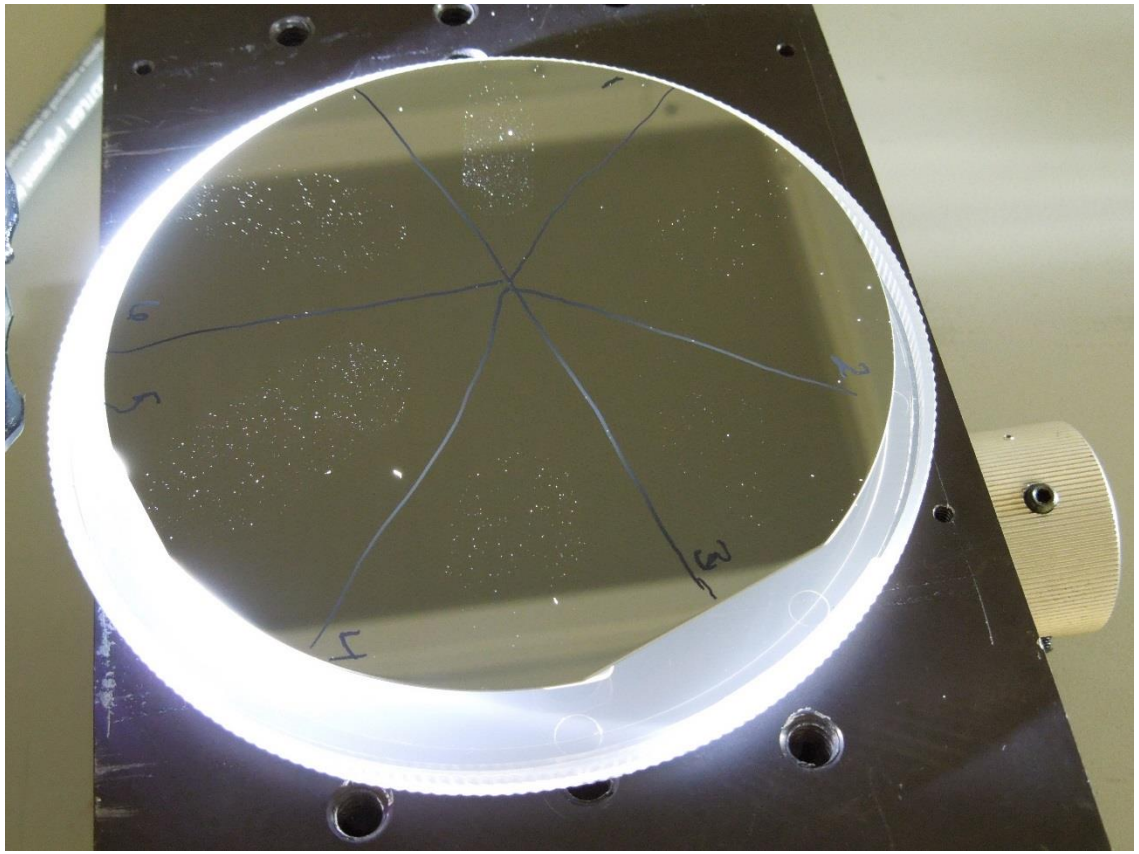
Scrubs

- Body Box testing
  - ➢ *Finding: At least ½ class improvement with scrubs*



Glove Washing

- Glove testing
  -



Glove Washing

- Glove testing
  - *Finding: IPA wash reduces contamination.*

Glove Washing

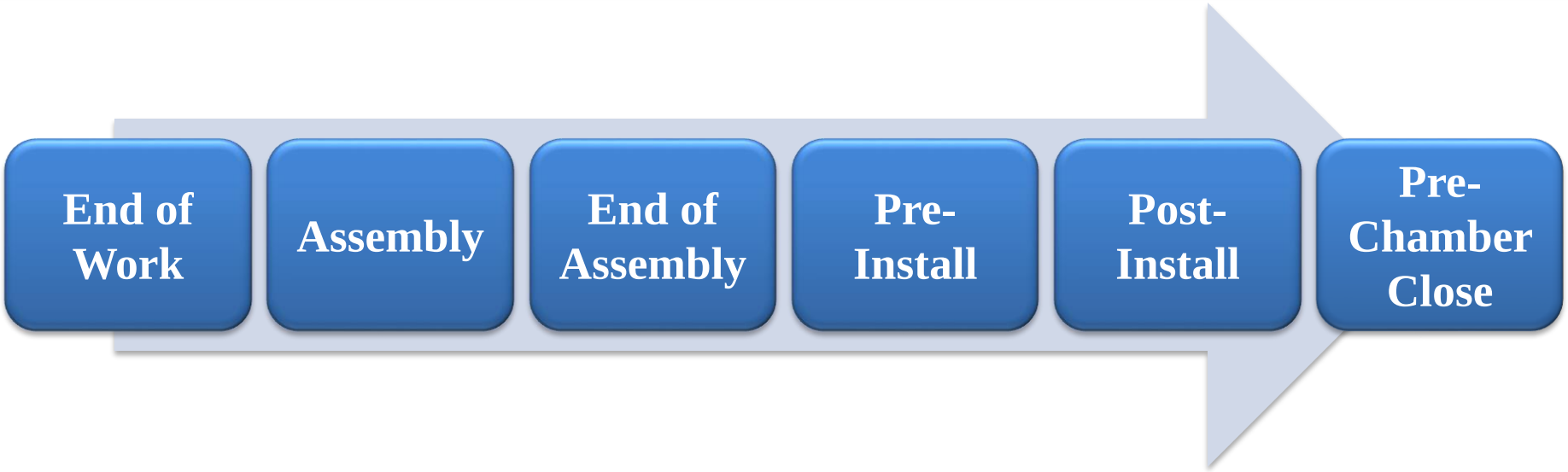
- Glove testing
  - ➢*Finding: IPA wash reduces contamination.*

•How to wash gloves
  - •Think peanut butter hands

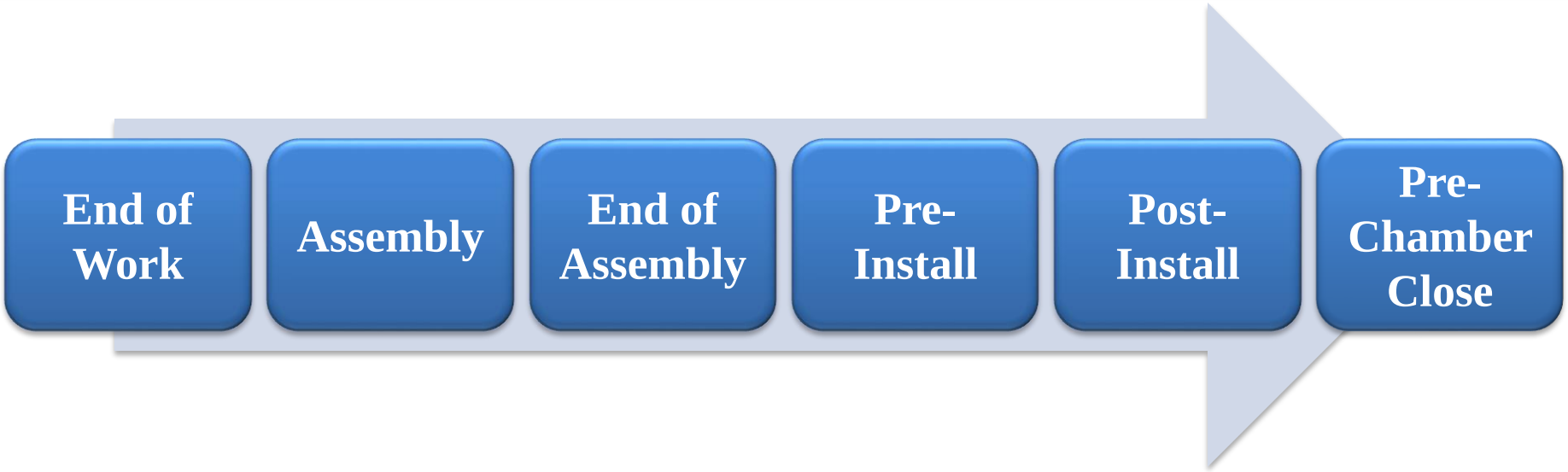
“Clean-as-you-go”

End of Work

“Clean-as-you-go”



“Clean-as-you-go”



- *Applies to EVERYONE.*

“Clean-as-you-go”

End of Work → Assembly → End of Assembly → Pre-Install → Post-Install → Pre-Chamber Close

- Wipes
  - Chamber & gloves : Vectra Alpha10
  - Gross cleaning: Valutek pre-saturated

“Clean-as-you-go”

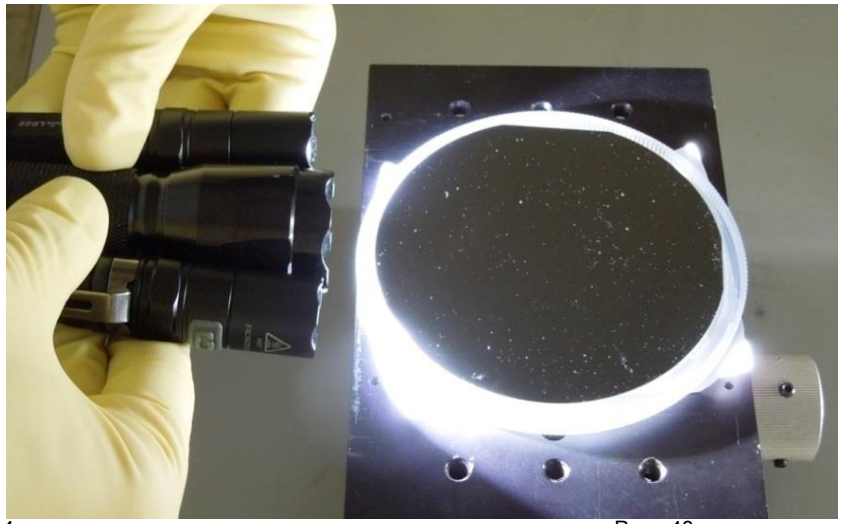
End of Work → Assembly → End of Assembly → Pre-Install → Post-Install → Pre-Chamber Close

- Wipes
  - Chamber & gloves : Vectra Alpha10
  - Gross cleaning: Valutek pre-saturated
- ANY high purity IPA
  - Hand & surfaces

“Clean-as-you-go”

End of Work → Assembly → End of Assembly → Pre-Install → Post-Install → Pre-Chamber Close

- Wipes
  - Chamber & gloves : Vectra Alpha10
  - Gross cleaning: Valutek pre-saturated
- ANY high purity IPA
  - Hand & surfaces
- Flashlight arrays



“Clean-as-you-go”

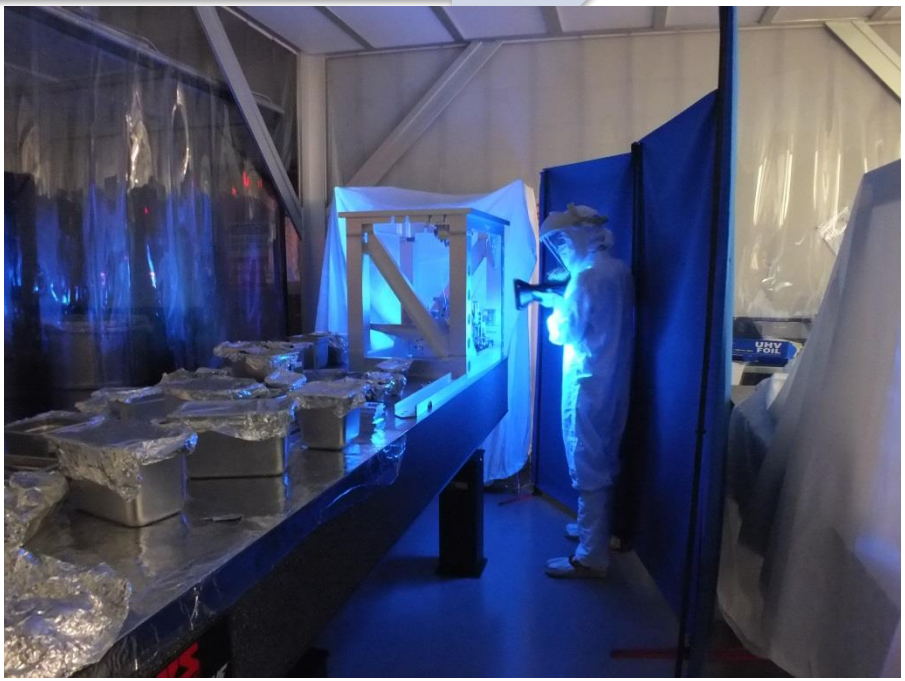
End of Work → Assembly → End of Assembly → Pre-Install → Post-Install → Pre-Chamber Close

- Wipes
  - Chamber & gloves : Vectra Alpha10
  - Gross cleaning: Valutek pre-saturated
- ANY high purity IPA
  - Hand & surfaces
- Flashlight arrays
- Tiger vacuum cleaners

“Clean-as-you-go”

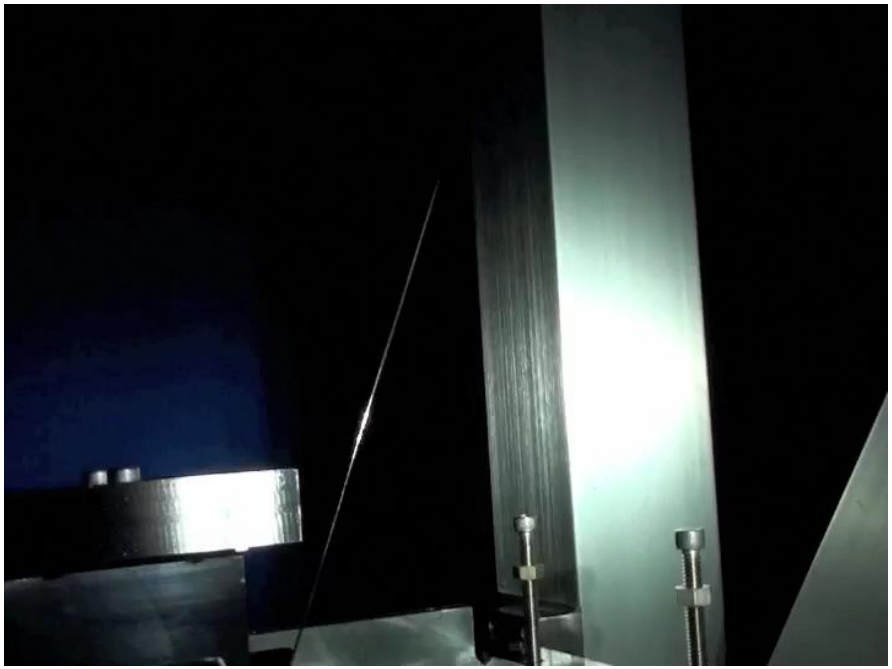
End of Work | **Assembly** | **End of Assembly** | Pre-Install | Post-Install | Pre-Chamber Close

- UV-A inspection light
  - NOT around optics

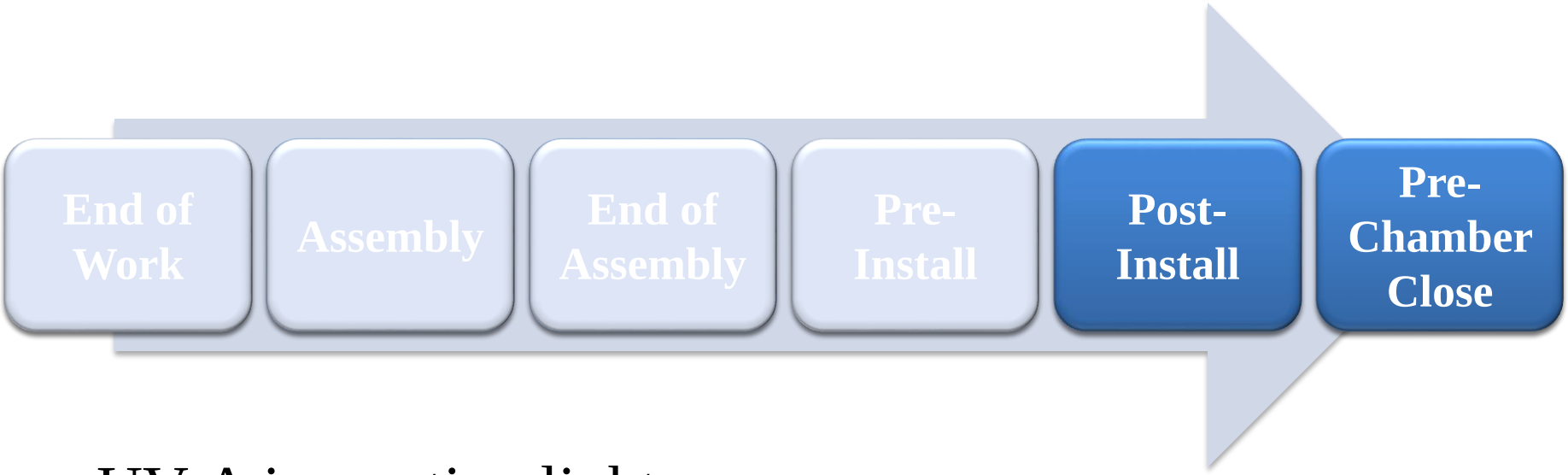


“Clean-as-you-go”

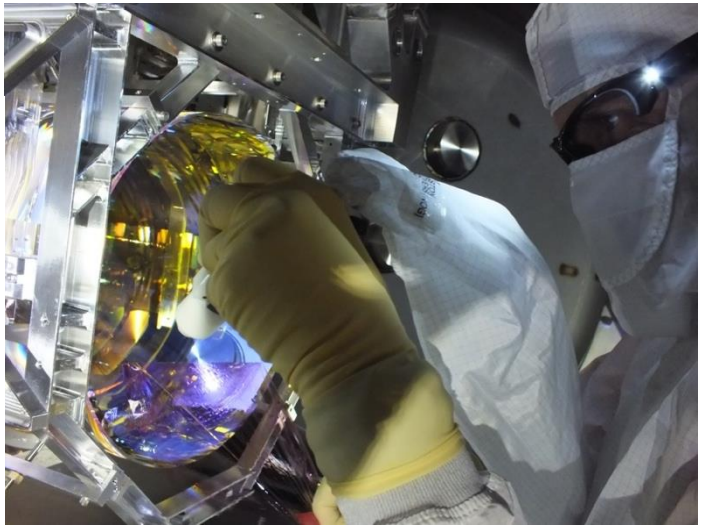
End of Work | **Assembly** | **End of Assembly** | Pre-Install | Post-Install | Pre-Chamber Close



“Clean-as-you-go”



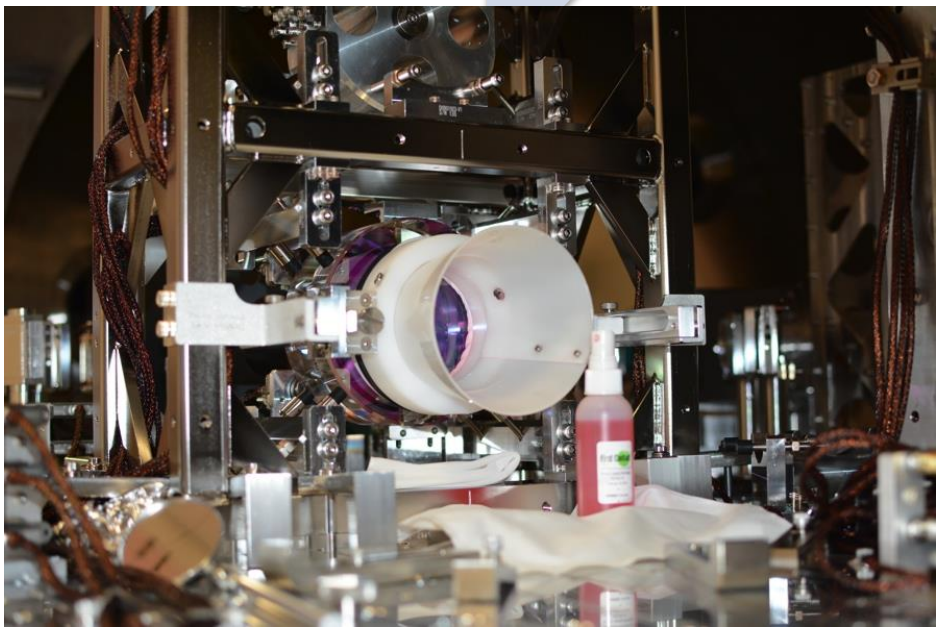
- UV-A inspection light
  - NOT around optics
- Top Gun ionizer
  - Static charge on optic
  - Dust on metal surfaces



“Clean-as-you-go”

End of Work → Assembly → End of Assembly → Pre-Install → **Post-Install** → Pre-Chamber Close

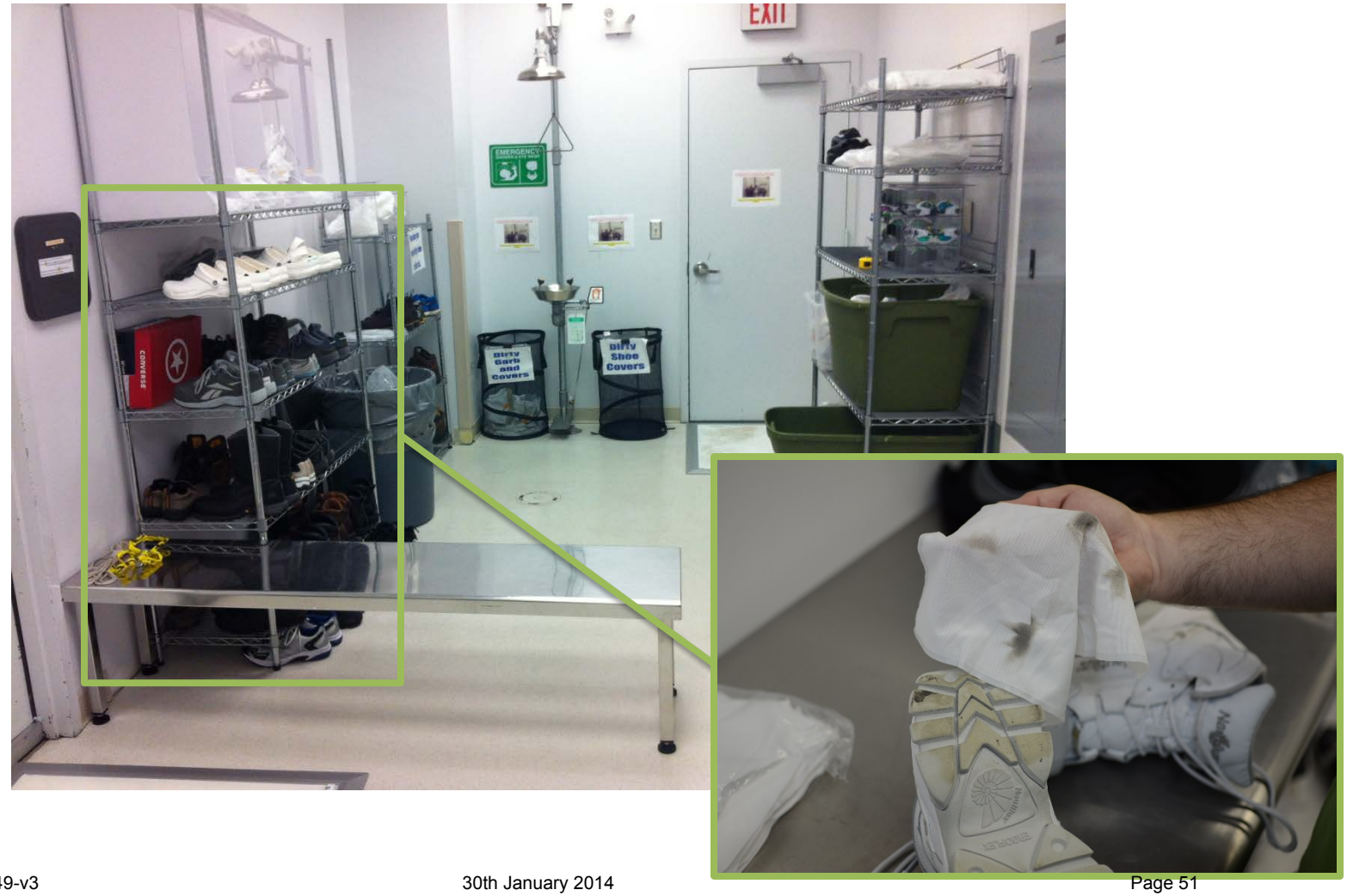
- UV-A inspection light
  - NOT around optics
- Top Gun ionizer
  - Static charge on optic
  - Dust on metal surfaces
- First Contact



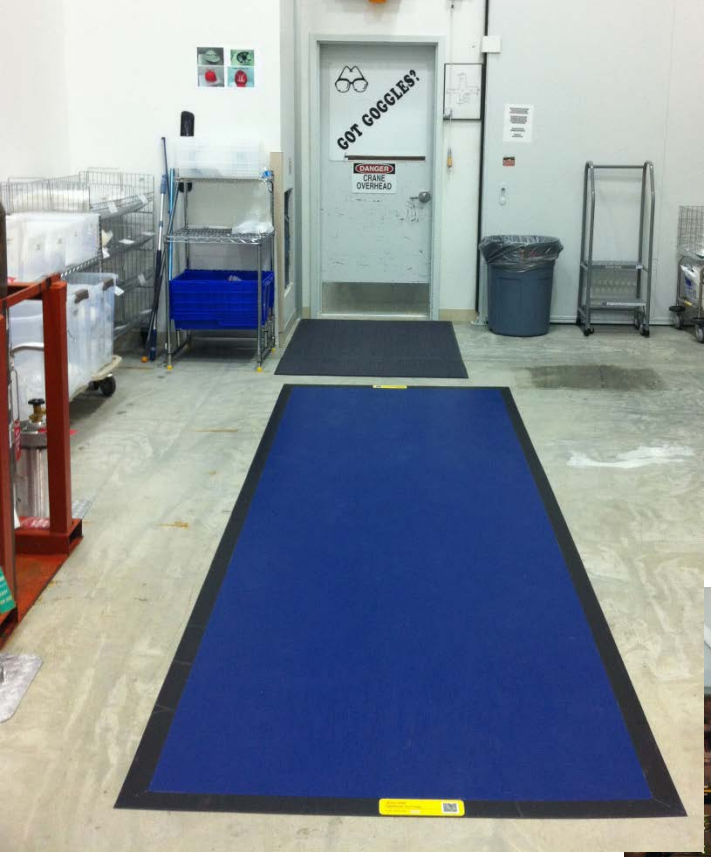
LHO Optimized Transition Area

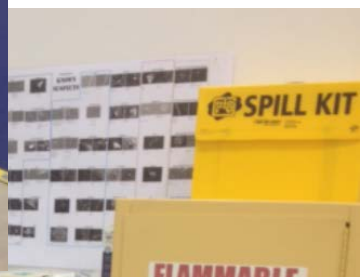
LHO Optimized Transition Area

LHO Optimized Transition Area



LLO Optimized Transition Area





CC tools available from cleaning area for your use

Are you part of the _____ effort at LHO?

Assembly

Install

Commissioning

Operations

What you should do next…

- Set yourself up with basic tools:

What you should do next…

- Set yourself up with basic tools:


- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist

What you should do next…

- Set yourself up with basic tools:


- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist
- Talk to local the CC reps:

Bryan Smith	Gary Traylor
Matt Heintze	Danny Sellars
Stuart Aston	

What you should do next…

- Set yourself up with basic tools:


- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist
- Talk to local the CC reps:

  Bryan Smith
  Matt Heintze
  Stuart Aston
  Gary Traylor
  Danny Sellars

- Contact Calum Torrie, Margot Phelps, or Kate Gushwa at Caltech if you have further questions:

  Office: 626 395 4629
  Cell: 626 394 8116 (also on Voxer)
  Email: ctorrie@ligo.caltech.edu
  Skype: calumiantorrie@skype.com

Are you part of the _____ effort at LLO?

Assembly

Install

Commissioning

Operations

What you should do next…

- Set yourself up with basic tools:

What you should do next…

- Set yourself up with basic tools:

- Check out the new “cleaning area”

What you should do next…

- Set yourself up with basic tools:


- Check out the new “cleaning area”
- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist

What you should do next…

- Set yourself up with basic tools:


- Check out the new “cleaning area”
- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist
- Talk to local the CC reps: Betsy Weaver, Travis Sadecki & Jodi Fauver

What you should do next…

- Set yourself up with basic tools:


- Check out the new “cleaning area”
- Read LIGO-E1201035, Chamber Entry & Exit Guidelines
  - Useful checklist
- Talk to local the CC reps: Betsy Weaver, Travis Sadecki & Jodi Fauver
- Contact Calum Torrie, Margot Phelps, or Kate Gushwa at Caltech if you have further questions:
  - Office: 626 395 4629
  - Cell: 626 394 8116 (also on Voxer)
  - Email: ctorrie@ligo.caltech.edu
  - Skype: calumiantorrie@skype.com

Reminder

- **LIGO-T1300511 Some thoughts regarding Particulate Contamination Requirements**
- LIGO-E1201035 Chamber Entry & Exit Guidelines
- LIGO-T1300665 The LIGO Particulate Evaluation Tool (PET)
- LIGO-T080067 Protecting Installed Optics from Particulates
- LIGO-E0900047 aLIGO Contamination Control Plan
- LIGO-T1300093 Prudential Body Box Results
- LIGO-G1300777 Contamination Control Requirements – Gloves, Cleaning on the Go and The Plan (past, present, and future)
- LIGO-G1300427 Slides for Contamination Control
- LIGO-T1300493 "Known" Particulate Sample Poster
- LIGO-E1201096 Contamination Sample Handling – How to receive, use, send, buy and store samples.
- Contamination Control wiki