Cleanroom Contamination Identification Method Development

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1. Introduction

During fabrication, assembly, and testing of spacecraft and flight hardware it is key to avoid contaminants that can cause degradation that could result in failure or loss of performance. Sensitive equipment such as sensors and optics (Figure 1) are assembled following stringent contamination control procedures. Use of the forced air sampling method for identification and sizing of airborne particles before they can deposit on flight hardware will help to prevent damage to spacecraft, avoid schedule delays, and allow for mission success.

Figure 1. James Webb Space Telescope Mirror inside cleanroom facility at NASA Goddard Space Flight Center. (Credit: NASA)

2. Objective

To further develop the forced air sampling method into an established laboratory capability that can be provided as requested for a facility or costumer. This method will allow for fast sampling and routine identification of unknown contamination sources within the cleanroom (Figure 2).

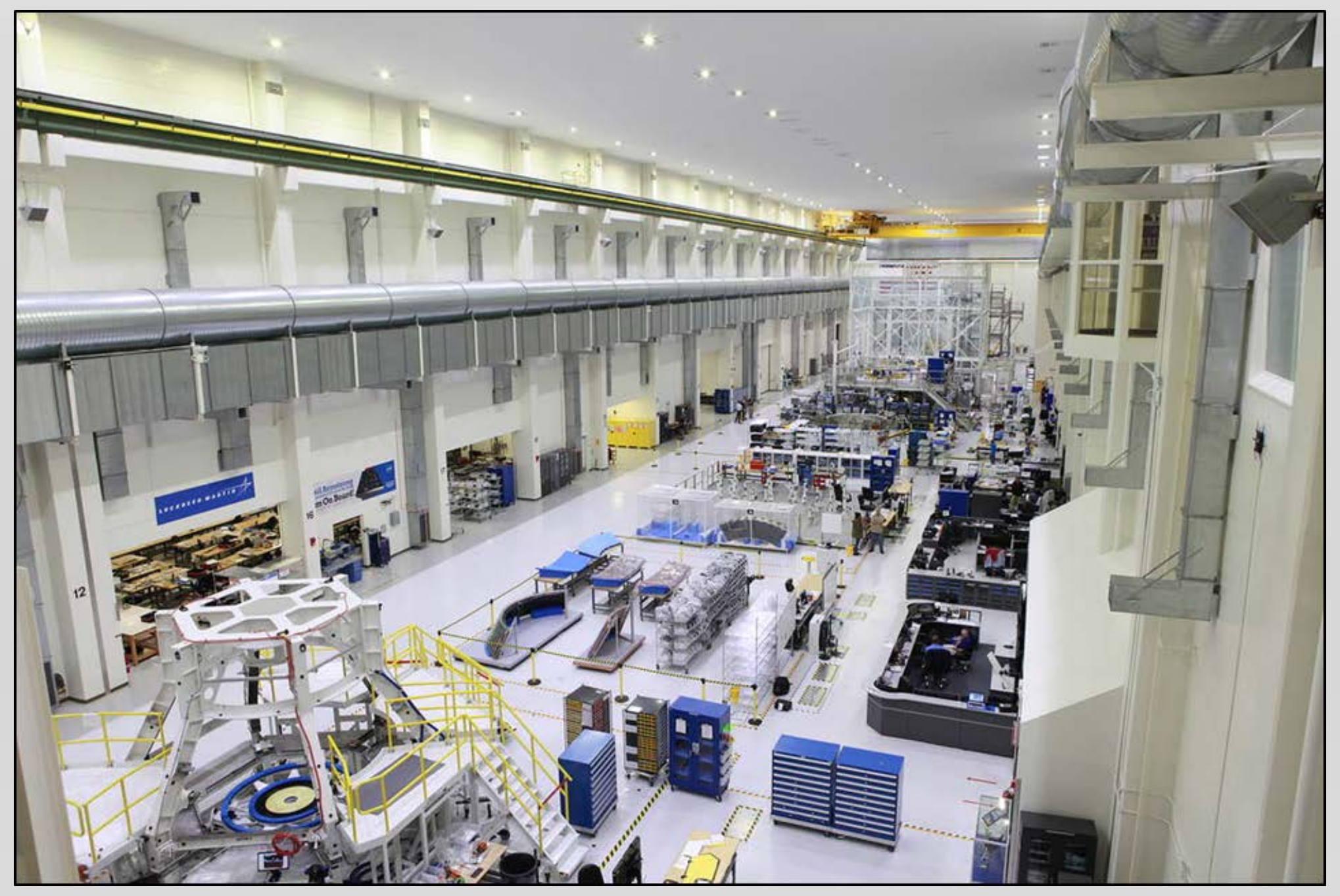

Figure 2. Neil Armstrong Operations and Checkout (O&C) building cleanroom. (Credit: NASA / Ben Smegelsky)

3. Contamination Control

Current contamination monitoring methods include airborne particle counters (APCs), and visual inspection. Counts from APCs are the primary metric used to define a cleanroom class and therefore its level of cleanliness, and visual inspection is used to verify the surface cleanliness of the instruments. No method currently provides the identity of a contaminant particle. Figures 3 and 4 show an SEM image and EDS chemical analysis for a fiberglass contaminant. The proposed technology that will be developed aspires to improve the contamination detection process by accurately identifying the contaminant therefore allowing the engineers and scientists to determine the contamination source.

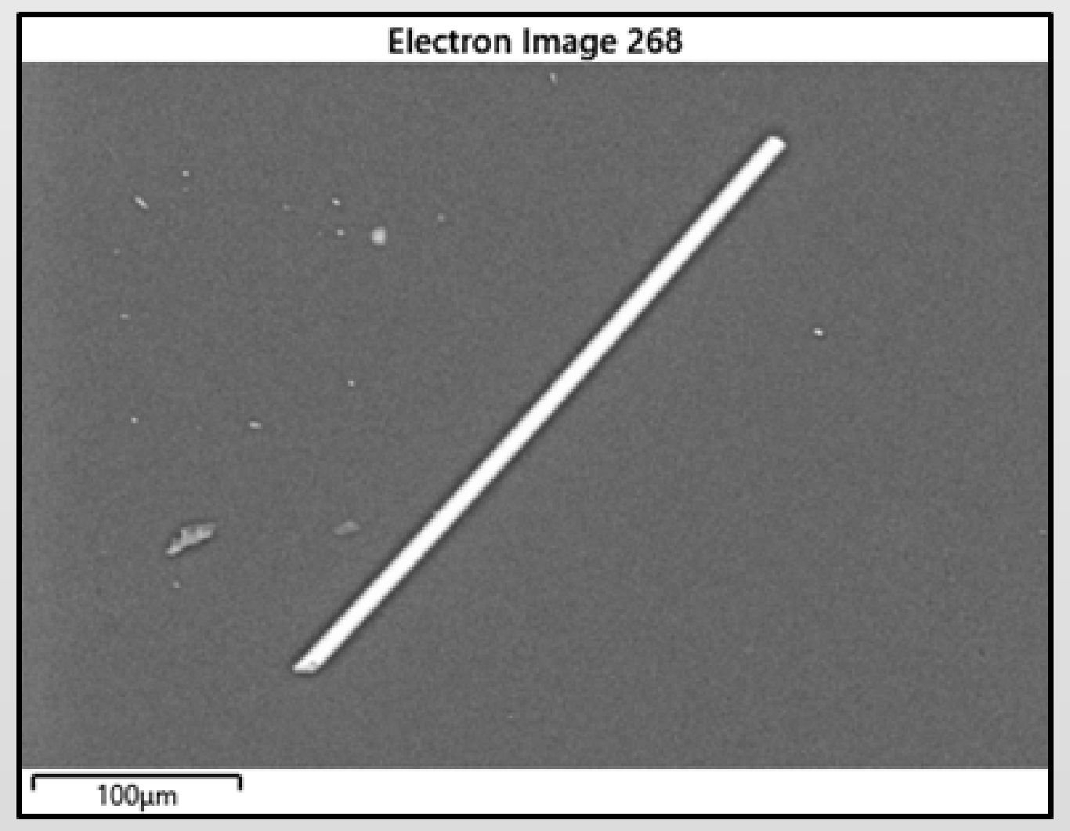

Figure 3. Fiberglass contaminant SEM image. (Credit: NASA / Athela Frandsen)

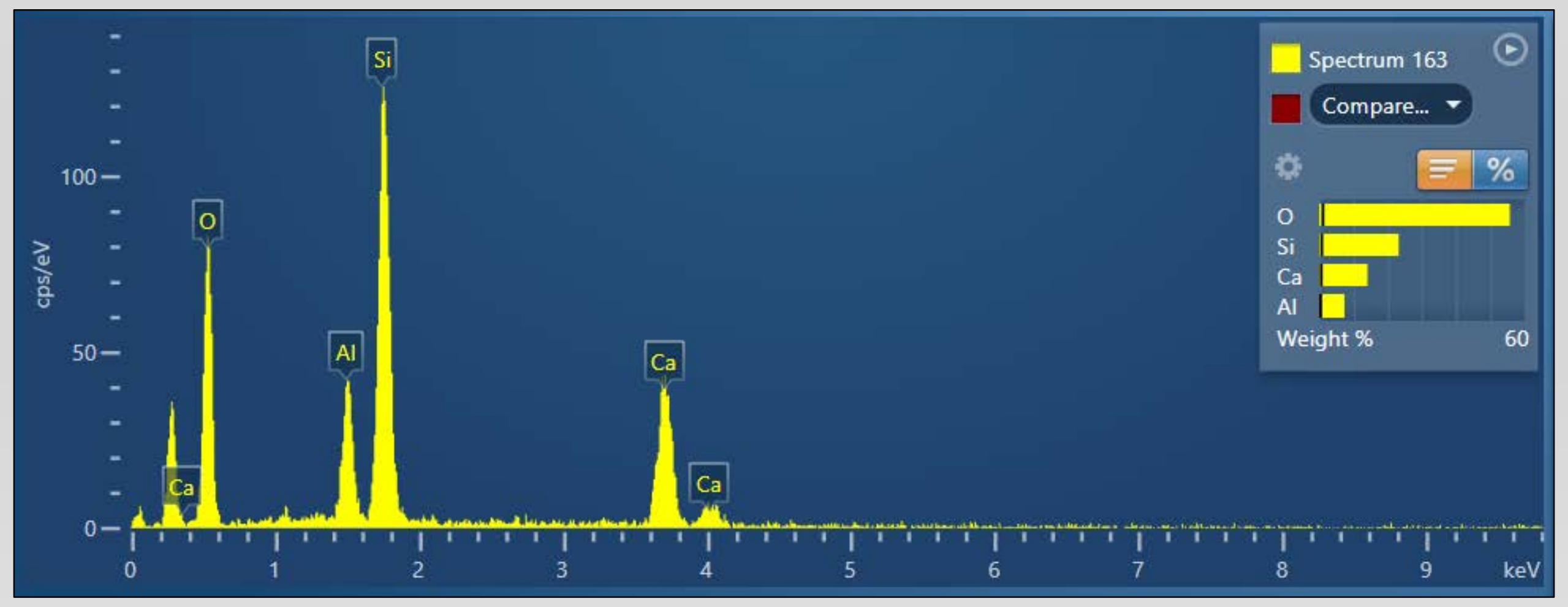

Figure 4. Fiberglass contaminant EDS chemical analysis. (Credit: NASA / Athela Frandsen)

4. Technical Approach

The airborne particles are sampled using cassettes (Figure 5) which contain an internal filter which captures the particles. The test method development required extensive research to identify an air sampling cassette that increases sample collection efficiency and a filter that has low enough background contamination to allow differentiation between a blank (control) and the collected sample.

5. Research Results

Market research was conducted to determine the most suitable options for cassette and filters for the forced air sampling method. There are various cassettes and filters available for purchase for a wide range of applications. It was determined that a conductive black cassette and a polycarbonate filter were the best options to improve the sample collection method.

Conductive black cassettes, in comparison to the standard styrene, are manufactured using polypropylene filled with carbon. This makes the cassette conductive and minimizes the tendency of particles to stick to the wall of the cassette due to electrostatic force. In previous trials a mixed cellulose ester (MCE) filter was used to capture the contaminants, however the rougher surface of the filter contributed to entrapment of the particles within the filter structure and made it harder to identify the particles. In comparison, track etched polycarbonate filters have random cylindrical pores and a smooth surface which contributes to uniform sample distribution on the surface of the filter.

Once fully developed, use of the forced air sampling method will help to detect contamination events that could cause damage to spacecraft, avoid schedule delays, and allow for mission success.

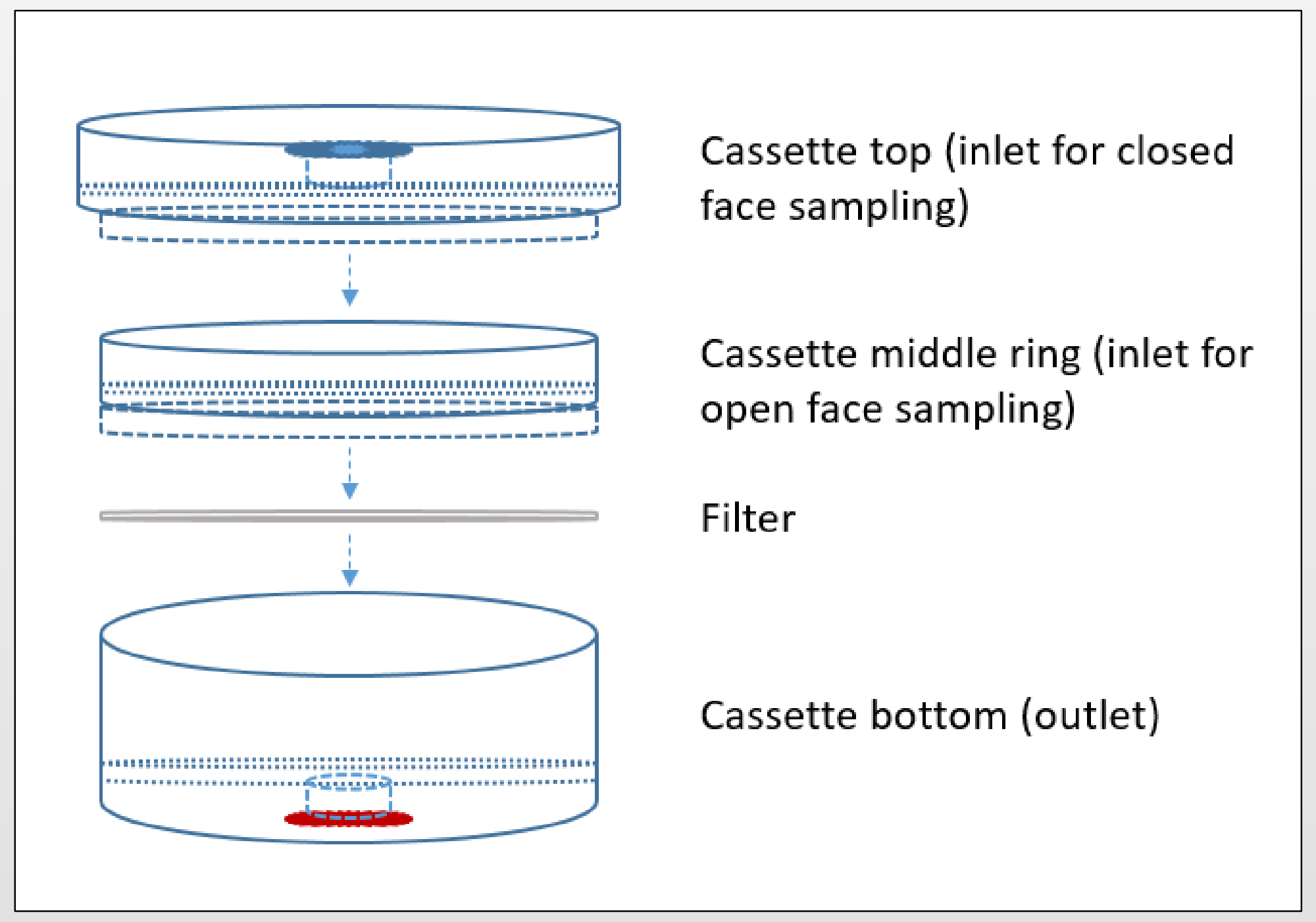

Figure 5. Cassette and filter configuration. (Credit: Jailyn Hernandez)

5. Future Work

1. Testing, pre-cleaning, and assembling blank (control) cassettes and filters to determine medium efficiency and suitability.
2. Perform sample collection in different environments such as offices and cleanrooms to establish ideal operating parameters.
3. Analyze and characterize particles using a scanning electron microscope with energy dispersive x-ray spectroscopy (SEM/EDS). Assistant characterization techniques may include: optical microscopy (OM), Fourier transform infrared spectroscopy (FTIR) and polarized light microscopy (PLM).

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