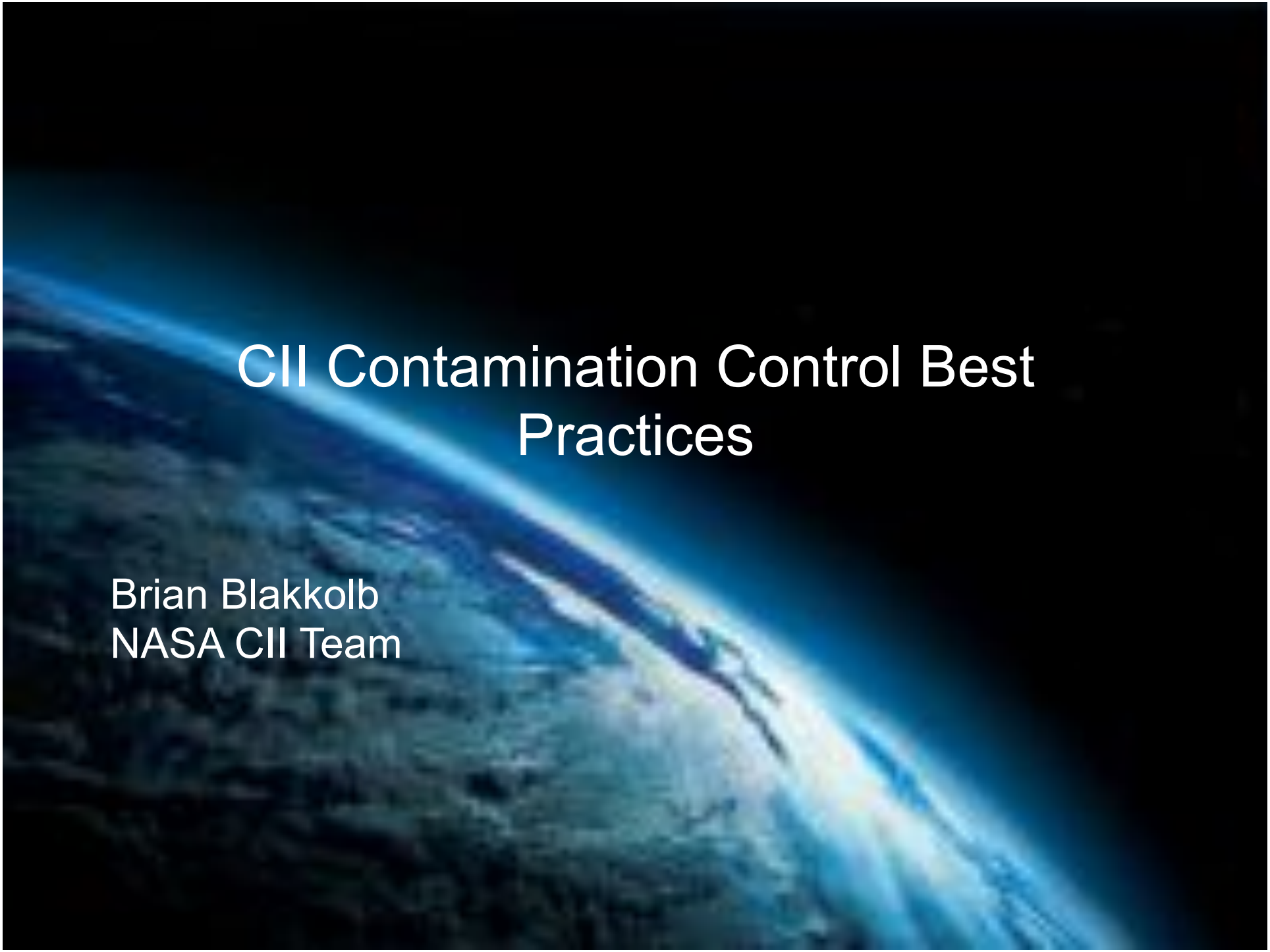

CII Contamination Control Best Practices

Brian Blakkolb
NASA CII Team

Scope

- Contamination Control can be thought of as a sub-system with interfaces to most other hardware subsystems
  - CC protocols enable instrument and system performance by limiting performance degradation from self- and cross-contamination environments
- For Hosted Payloads, Contamination Control “Best Practices” fall into the following categories:
  - ”*Do no harm*”: Instrument-generated contamination as is affects compatibility of the Instrument with the Host Spacecraft, i.e., cross contamination
  - Spacecraft-to-Instrument integration and integrated assembly and test operations
  - Spacecraft- and launch vehicle-induced contamination environments
  - Instrument purge

Interface Assumptions

- Key Assumptions
  - The Host Spacecraft Owner/Integrator and the Instrument Developer will negotiate detailed parameters regarding contamination control. Documented in a Contamination Interface Control Document (CICD).
  - The Host Spacecraft Provider/Systems Integrator will attach the Instrument to the Host Spacecraft such that the contamination products from the vents of the Instrument do not directly impinge on the contamination-sensitive surfaces nor directly enter the aperture of another component of the Spacecraft system.
  - The Instrument Provider will ensure that any GSE accompanying the Instrument is cleanroom and vacuum compatible in accordance with the CICD.
  - Instrument Provider will provide for measures to protect sensitive instrument surfaces during system I&T, transportation, and launch site processing. Documented in the CICD.
  - The Launch Vehicle Provider defines the upper limit for the induced contamination environment.

Instrument-Generated Contamination

ID	Function	Guidelines	Rationale/Comment
9.7.2	**Limit Instrument-Generated Contamination**		Prevent instrument-to-spacecraft and instrument-to instrument-cross contamination
9.7.2.1	**Cleanliness Verification**	Verify the cleanliness of instrument exterior surfaces by test	Instrument cleanliness consistent with the Host Spacecraft

Instrument-Generated Contamination

ID	Function	Guidelines	Rationale/ Comment
9.7.2.2	**Sources of Contamination**	Document all sources of contamination emitted from the Instrument	Document in CICD Mitigate cross contamination
9.7.2.3	**Instrument Venting**	Number, location, size, vent path, and operation time	Mitigate cross contamination
9.7.2.4	**Outgassing flux**	Document the flux of outgassing products issuing from the primary Instrument vents	Mitigate cross contamination

Instrument-Generated Contamination

ID	Function	Guidelines	Rationale/ Comment
9.7.2.5	**Sealed Hardware**	Prevent the escape of actuating materials from electro-explosive devices, hot-wax switches, and other similar devices	Mitigate cross contamination

Instrument-Generated Contamination

ID	Function	Guidelines	Rationale/ Comment
9.7.2.6	**Materials selection**	Non-metallic materials meet the nominal criteria for thermal-vacuum stability* *[Total Mass Loss (TML) ≤ 1.0 %, Collected Volatile Condensable Material (CVCM) ≤ 0.1 %, per ASTM E595 test method.]	Mitigate instrument-to-spacecraft and instrument-to instrument-cross contamination
9.7.2.7	**Instrument component level thermal-vacuum bakeout**	Wiring harnesses and thermal blankets should be compatible with thermal-vacuum bakeout	Bakeout may be necessary to meet Spacecraft contamination requirements

Instrument-Generated Contamination

ID	Function	Guidelines	Rationale/ Comment
9.7.2.8	**Particulate debris generation**	Avoid the use of materials that are prone to produce particulate debris	Host Spacecraft Providers generally prohibit materials prone to produce particulate debris from incidental contact, friction, wear during operation, *etc.*
9.7.2.9	**Compatibility w/ Spacecraft I&T Environments**	Compatibility with ISO-6 to ISO-8 controlled environments	

Contamination Control during Spacecraft I&T

ID	Function	Guidelines	Rationale/ Comment
9.7.3	**Accommodation of externally generated contamination**		
9.7.3.1	**Protective covers**	Provide covers for sensitive surfaces	Preserve Instrument cleanliness during Spacecraft I&T
9.7.3.2	Documentation	Requirements and procedures for the use of protective covers (such as bags, draping materials, or hard covers, *etc*)	
9.7.3.3	**Cleanliness requirements**	Document the cleanliness goals for all contamination-sensitive instrument surfaces that will be exposed while in the I&T Environment	
Instrument should mitigate the risk posed by externally generated contamination			

Instrument Purge 1/2

ID	Function	Guidelines	Rationale/ Comment
9.7.4 Purge	The Spacecraft Provider generally can provide access to a gas supply of the desired type, purity, and flow rate. Instrument provider provides the necessary purge interface ground support equipment (GSE)		
9.7.4.1	**Purge GSE**	Instrument Provider responsible for GSE incorporating all necessary filtration, gas conditioning, pressure regulation, *etc*	Instrument provider is responsible for control of the purge gas input to the instrument during Spacecraft I&T

Instrument Purge 2/2

ID	Function	Guidelines	Rationale/ Comment
9.7.4.2	**Spacecraft to Instrument Purge Interface**	MICD should document any required mechanical interface of the purge between the Instrument and Spacecraft	The Spacecraft Provider will negotiate with the Launch Vehicle Provider any resultant required purge interface between the Spacecraft and Launch Vehicle

The Instrument Provider is generally responsible for the specifying the quality and control of purge gases supplied to the instrument

Instrument cleaning and inspection

ID	Function	Guidelines	Rationale/ Comment
9.7.4.3	**Inspection and Cleaning During I&T**	Instrument Provider responsible for Instrument cleaning process	A member of the Spacecraft I&T team may be designated to perform function
9.7.4.4	Documentation	CICD will document any required inspection or cleaning of the Instrument while in the I&T Environment	Inspections and cleaning consume schedule resources; must be conducted in coordination with other Spacecraft I&T activities

The Instrument Provider is responsible for inspection/cleaning procedures

Spacecraft and Launch Vehicle Analyses

ID	Function	Guidelines	Rationale/ Comment
9.7.4.5	**Spacecraft Contamination Analysis**	Spacecraft Contractor may perform analyses or make estimates of the expected spacecraft-induced contamination environment, which will be documented in CICD	
9.7.4.6	**Launch Vehicle Contamination Analysis**	Spacecraft and Instrument Providers should use this information in developing mitigations against the risk of contamination during integrated operations with the Launch Vehicle	
Definition of the external contamination environment			

Summary of Contamination Control Best Practices

- **9.7.2 Instrument Generated Contamination**
- 9.7.2.1 Verification of Cleanliness
- 9.7.2.2 Instrument Sources of Contamination
- 9.7.2.3 Instrument Venting Documentation
- 9.7.2.4 Flux of outgassing products
- 9.7.2.5 Sealed Hardware
- 9.7.2.6 Nonmetallic Materials Selection
- 9.7.2.7 Wiring and MLI Cleanliness Guidelines
- 9.7.2.8 Particulate Debris Generation
- 9.7.2.9 Spacecraft Integration Environments

- **9.7.3 Accommodation of Externally Generated Contamination**
- 9.7.3.1 Protective Covers: Responsibility
- 9.7.3.2 Protective Covers: Documentation
- 9.7.3.3 Instrument Cleanliness Requirements

- **9.7.4 Instrument Purge**
- 9.7.4.1 Instrument Purge Ground Support Equipment (GSE)
- 9.7.4.2 Spacecraft to Instrument Purge Interface
- 9.7.4.3 Instrument Inspection and Cleaning During I&T: Responsibility
- 9.7.4.4 Instrument Inspection and Cleaning During I&T: Documentation
- 9.7.4.5 Spacecraft Contractor Supplied Analysis Inputs
- 9.7.4.6 Launch Vehicle Contractor Supplied Analysis Inputs