

Supplementary Table S1. Metadata and microbiological data of various spacesuit samples examined during this study

Set #	Suit type ^a	Tube ID	25 cm ² d Locations	Canister assembly ID	Canister assembly ID	Swab area/ cm ²	Collection date	No. PMA_16S rDNA copies/25 cm ²	PMA_16S rDNA copies/25 cm ²	No. PMA_17S rDNA copies/25 cm ²	PMA_17S rDNA copies/25 cm ²	Bacteria (RZA)	Pathogenic Bacteria (BA)	Fungi (PDA/rza)	Bacterial ID_pure culture	Fungal ID_pure culture	
Set-1	EMU	JC-001	Left wrist joint	129	EE129_IM	70-87	12/16/16	2.21E+05	1.19E+05	1.51E+02	4.74E+01	1.50E+02		5.00E+01		<i>Bacillus velezensis</i> (2), <i>Arthrobacter psychrochitiniphilus</i> (1) and <i>Arthrobacter enclensis</i> (1)	
	EMU	JC-013	Left inner glove gauntlet	128	EE128_IM	190-240	12/16/16	6.95E+05	1.27E+05	1.39E+03	1.34E+03	1.50E+02		5.00E+01		<i>Arthrobacter psychrochitiniphilus</i> (1)	<i>Penicillium fagi</i> (1), <i>Epicoccum nigrum</i> (1)
	EMU	JC-018	Left outer glove gauntlet	127	EE127_IM	250-360	12/16/16	7.28E+05	2.36E+05	2.60E+03	1.01E+03	9.00E+02	5.00E+01			<i>Bacillus zhongzhouensis</i> (1)	
	EMU	JC-023	Right wrist joint	132	EE132_IM	70-87	12/16/16	5.08E+05	2.55E+05	5.78E+02	1.72E+03	7.00E+02				<i>Pseudarthrobacter scleromae</i> (1), <i>Kocuria indica</i> (2), <i>Arthrobacter enclensis</i> (1)	
	EMU	JC-034	Right inner glove gauntlet	131	EE131_IM	144	12/16/16	7.71E+05	1.63E+05	2.39E+03	2.42E+03	1.00E+02		5.00E+01		<i>Massilia norwichensis</i> (1)	<i>Nenetria sp</i> (1)
	EMU	JC-038	Right outer glove gauntlet	130	EE130_IM	220-280	12/16/16	6.87E+05	2.89E+05	5.27E+03	3.83E+03	5.00E+01					
	EMU	JC-044	Control - Do not remove from canister	125	EE125_IM		12/16/16	1.21E+03	8.11E+02	2.11E+03	7.41E+03						
Set-2	EMU	JC-002	Left wrist joint	136	EE136_IM	43	12/16/16	2.33E+05	3.74E+03	3.03E+03	7.08E+02		5.10E+01			<i>Bacillus zhongzhouensis</i>	
	EMU	JC-019	Left outer glove gauntlet	135	EE135_IM	180-220	12/16/16	5.28E+05	1.44E+05	4.65E+03	4.43E+03		5.10E+01			<i>Bacillus manliponensis</i> (1)	
	EMU	JC-024	Right wrist joint	139	EE139_IM	61	12/16/16	4.00E+05	4.44E+05	3.95E+02	5.39E+02	5.20E+01	1.02E+02			<i>Staphylococcus capitis subs. urealyticus</i> (1), <i>Staphylococcus pasteurii</i> (1), <i>Agromyces humatus</i> (1)	<i>Alternaria sp</i> (2), <i>Aureobasidium pullulans</i> (1)
	EMU	JC-039	Right outer glove gauntlet	138	EE138_IM	25	12/16/16	1.17E+06	1.58E+05	1.76E+03	2.53E+03		2.04E+02	1.53E+02			
	EMU	JC-045	Control - Do not remove from canister	134	EE134_IM		12/16/16	7.75E+02	2.58E+02	8.46E+02	3.22E+03						
Set-3	EMU	JC-003	Left wrist joint	144	EE144_IM	65	2/6/17	1.15E+05	7.47E+05	8.51E+02	2.61E+03						
	EMU	JC-014	Left inner glove gauntlet	145	EE145_IM	25	2/6/17	7.39E+05	5.77E+05	1.13E+04	5.84E+02		5.00E+01				
	EMU	JC-020	Left outer glove gauntlet	143	EE143_IM	25	2/6/17	1.49E+05	4.99E+05	1.37E+04	4.92E+02		5.00E+01			<i>Kocuria arsenatis</i> (1)	
	EMU	JC-025	Right wrist joint	146	EE146_IM	65	2/6/17	1.84E+06	5.93E+05	2.47E+03	2.61E+03						
	EMU	JC-046	Control - Do not remove from canister	147	EE147_IM		2/6/17	4.09E+03	1.55E+03	2.44E+03	2.08E+03						
Set-4	EMU	JC-004	Left wrist joint	153	EE153_IM	43	3/15/17	1.60E+06	1.33E+06	3.14E+04	1.81E+03		3.50E+02			<i>Bacillus zhongzhouensis</i> (5)	
	EMU	JC-015	Left inner glove gauntlet	152	EE152_IM	25	3/15/17	2.21E+06	1.30E+06	9.32E+03	1.44E+03						
	EMU	JC-021	Left outer glove gauntlet	151	EE151_IM	25	3/15/17	1.30E+06	1.25E+06	4.68E+03	5.35E+02						
	EMU	JC-026	Right wrist joint	156	EE156_IM	43	3/15/17	8.34E+04	1.50E+06	7.77E+03	2.07E+03						
	EMU	JC-035	Right inner glove gauntlet	155	EE155_IM	25	3/15/16	3.74E+05	3.04E+05	4.14E+03	2.06E+03						
	EMU	JC-040	Right outer glove gauntlet	154	EE154_IM	25	3/15/17	1.83E+06	1.09E+06	4.69E+03	1.50E+03	5.00E+01	5.00E+01				
	EMU	JC-047	Control - Do not remove from canister	141	EE141_IM		3/15/17	2.55E+03	4.76E+03	1.28E+02	1.85E+03						
Set-5	OCCS	JC-005	Left wrist joint	158	EE158_IM	43	3/16/17	2.57E+05	2.42E+05	7.55E+02	4.50E+02						
	OCCS	JC-006	Left wrist joint	161	EE161_IM	43	3/16/17	2.51E+05	2.63E+05	6.76E+03	5.16E+02						
	OCCS	JC-027	Right wrist joint	159	EE159_IM	43	3/16/17	2.64E+05	3.73E+05	1.06E+05	1.17E+04			5.00E+01			<i>Naganisha adeliensis</i> (1)
	OCCS	JC-028	Right wrist joint	162	EE162_IM	43	3/16/17	8.38E+05	2.72E+05	4.08E+03	6.81E+02						
	MACES/OCCS	JC-048	Control - Do not remove from canister	157	EE157_IM		3/16/17	1.06E+03	2.99E+02	9.59E+02	7.02E+02						
Set-6	EMU	JC-007	Left wrist joint	168	EE168_IM	43	5/30/17	2.00E+07	3.12E+05	2.22E+03	1.92E+03						
	MACES	JC-008	Left wrist joint	174	EE174_IM	43	6/8/17	7.46E+06	4.23E+05	4.08E+02	2.62E+02						
	MACES	JC-009	Left wrist joint	177	EE177_IM	43	6/8/17	7.11E+06	4.45E+05	6.46E+03	1.37E+03						
	OCCS	JC-010	Left wrist joint	180	EE180_IM	43	6/12/17	5.13E+06	1.65E+06	3.91E+03	3.56E+03		5.00E+01			<i>Bacillus velezensis</i> (1)	
	MACES	JC-011	Left wrist joint	183	EE183_IM	43	6/12/17	3.38E+06	1.11E+06	8.84E+03	5.35E+03	5.00E+01	5.00E+01				
	EMU	JC-022	Left outer glove gauntlet	166	EE166_IM	25	5/30/17	8.16E+06	5.29E+05	1.50E+03	5.29E+03						
	EMU	JC-016	Left inner glove gauntlet	167	EE167_IM	25	5/30/17	4.74E+06	2.09E+05	1.26E+04	3.40E+03	5.00E+01					
	EMU	JC-029	Right wrist joint	171	EE171_IM	25	5/30/17	3.59E+06	7.39E+05	1.64E+04	1.24E+03						
	MACES	JC-030	Right wrist joint	175	EE175_IM	43	6/8/17	8.13E+06	5.31E+05	2.33E+03	1.66E+03						
	OCCS	JC-031	Right wrist joint	181	EE181_IM	43	6/12/17	7.79E+06	3.97E+06	5.85E+03	3.88E+03	5.00E+01				<i>Pseudokineococcus lusitania</i> (1)	
	MACES	JC-032	Right wrist joint	184	EE184_IM	43	6/12/17	4.16E+06	3.10E+05	2.24E+04	1.46E+04						
	EMU	JC-036	Right inner glove gauntlet	170	EE170_IM	25	5/30/17	1.10E+07	7.19E+05	2.55E+03	3.24E+03						
	EMU	JC-041	Right outer glove gauntlet	169	EE169_IM	43	5/30/17	1.51E+07	7.53E+05	4.43E+02	2.41E+04						
	EMU	JC-042	Right outer glove gauntlet	173	EE173_IM	25	6/14/17	5.62E+06	3.44E+05	3.26E+03	7.05E+03						
Set-7	EMU	JC-012	Left wrist joint	239	EE239_IM	43	6/26/17	1.91E+06	7.29E+05	4.11E+02	2.05E+03						
	EMU	JC-017	Left inner glove gauntlet	238	EE238_IM	25	6/26/17	1.61E+06	4.58E+05	2.35E+01	5.08E+01						
	EMU	JC-033	Right wrist joint	236	EE236_IM	43	6/26/17	2.03E+06	4.84E+05	7.54E+02	7.49E+01						
	EMU	JC-037	Right inner glove gauntlet	235	EE235_IM	25	6/26/17	1.04E+07	5.97E+05	2.22E+04	4.24E+03						
	EMU	JC-043	Right outer glove gauntlet	234	EE234_IM	25	5/16/17	6.52E+06	1.08E+06	3.62E+04	6.13E+03						

- a. The ACES, MACES, and OCCS suits use the same fabric.
- b. "The ACES is comprised of three layers of fabric. The innermost layer, or bladder layer, is the actual pressure vessel. It is comprised of seam sealed GoreTex fabric. The second layer of ACES, the restraint layer, is a net-type material, dubbed "Linknet" by DCCI. Linknet provides shape to the bladder layer in the torso and arm regions while allowing for moderate mobility at full pressure. The outermost layer, or cover layer, is made of high-visibility. The cover layer serves the purposes of abrasion protection, momentary fire protection, and high visibility for rescue scenarios in the event of an orbiter bailout. The cover layer also serves as the restraint for the legs"
- [Watson, R. D. \(2014\). Modified Advanced Crew Escape Suit Intravehicular Activity Suit for Extravehicular Activity Mobility Evaluations. 44th International Conference on Environmental Systems, July 2014. 9 |](#)
- c. The EMU is more complicated, but for the purposes of this paper we are focusing on the gloves. The gloves, and most of the EMU are covered with a TMG (Thermal Micrometeoroid Garment): "The finger and thumbs of the TMG are formed of front and back halves, with the back halves being comprised of multi-layer insulation consisting of an outer layer of Teflon fabric over multiple layers of unreinforced aluminized Mylar, in between which is a non-woven Dacron spacer material to prevent thermal shorting of the aluminized layers. The innermost layer of the fingers is a nylon chiffon which acts as a protective buffer between the restraint and aluminized Mylar." The palm of the glove is Vectran coated with silicon and RTV 3145
- Vectran is an aromatic polyester fiber of 4-hydroxybenzoic acid and 6-hydroxynaphthalene-2-carboxylic acid
 - Mylar is a polyester film made from Polyethylene terephthalate
 - Dacron is also Polyethylene terephthalate
 - RTV 3145 is a PDMS (polydimethylsiloxane) silicon sealant
 - Nomex is a meta-aramid
- d. On the rest of the suit the outer layer is orthofabric instead of teflon and the inner layer is neoprene coated ripstop instead of nylon chiffon.
- [Hamilton Sundstrand Corporation. \(2017\). NASA Extravehicular Mobility Unit \(EMU\) ISS/SSA Data Book \(rev. 4\). Screenshot: 588. \[https://www.jsc.nasa.gov/images/content/000000main_nasa_emu_data_book_jsc-e-daa-tms5224.pdf\]\(https://www.jsc.nasa.gov/images/content/000000main_nasa_emu_data_book_jsc-e-daa-tms5224.pdf\)](#)
- e. "The Shuttle EMU has 14 layers to protect astronauts on EVA's. The inner layers comprise the liquid-cooling and ventilation garment. First comes a liner of Nylon tricot over which is a layer of spandex fabric laced with plastic tubing. Next comes the pressure bladder layer of urethane-coated nylon and fabric layer of pressure-restraining Dacron®. Above the bladder and restraint layer is a liner of Neoprene coated Nylon Ripstop. This is followed by a seven-layer thermal micrometeoroid garment of aluminized Mylar®, laminated with Dacron® scrim. The outer layer of the suit is made of Ortho-Fabric which consists of a blend of Gortex®, Kevlar®, and Nomex® materials"
- NASA. Sited for Spacewalking an Activity Guide for Technology Education, Mathematics, and Science.