



AQUAPAD PROJECT

New tools for water microbial monitoring during long duration manned spaceflights

Christine ROZAND and Cécile THEVENOT



1. Introduction and Context

From Earth application to PROXIMA mission

Liquid Microbiological testings



2015 - Cholera Endemic in Haïti



Test of Paper-based devices to detect *Vibrio cholerae* in water samples collected in Haïti ^[1]

[1] Romain Briquaire, et Al., Application of a paper based device containing a new culture medium to detect *Vibrio cholerae* in water samples collected in Haïti, *Journal of Microbiological Methods*, Volume 133, February 2017, Pages 23-31

Journal of Microbiological Methods 133 (2017) 23–31



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Review

Application of a paper based device containing a new culture medium to detect *Vibrio cholerae* in water samples collected in Haiti



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^d Laboratoire National de Santé Publique, Rue Chardonner #2 and Delmas 33, Port-au-Prince, Haiti

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PAD technology Vs. Petri dishes



Petri dishes = traditional device for microbial culture
Contain agar based culture media (with water)



PAD = proposed alternative
Dry-impregnated culture medium (no water)



Equivalent to 600 Petri dishes !



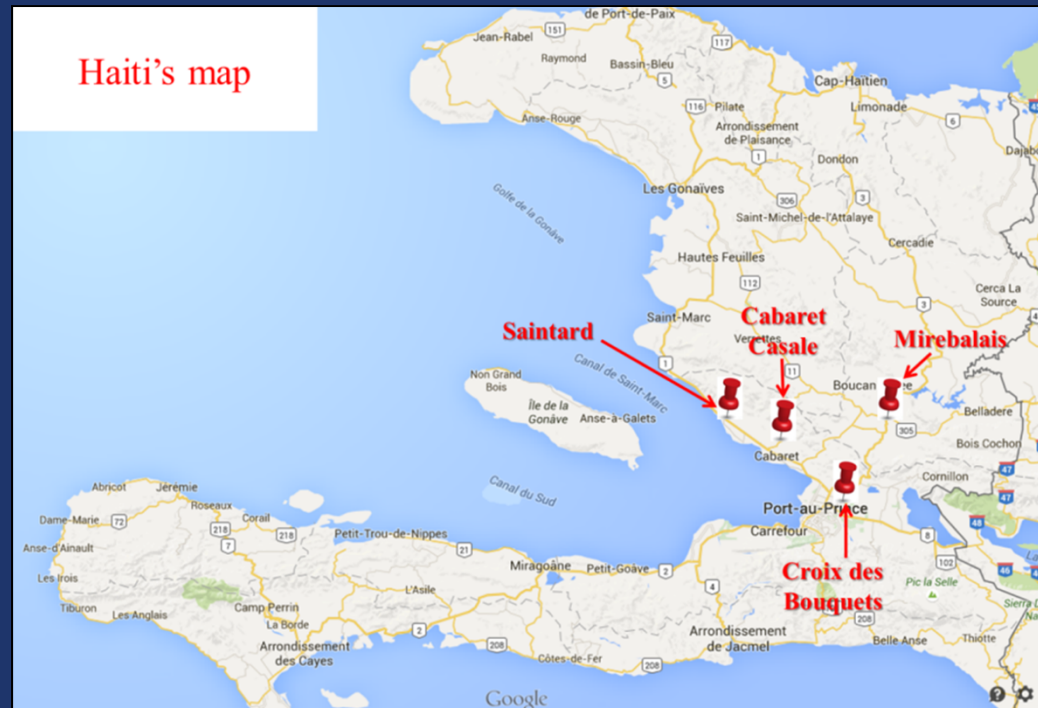
	Petri dishes	PAD
Logistic	Inside a lab	No lab required
Skills in microbiology	Required	Not necessary
Shelf life	Several months at Temperature <8°C	Several years at Ambient Temperature
Weight	20/25g per plate	< 10g per device (≈ 2 Petri dishes)

Sampling zones



180 water samples

5 different categories of water: spring, river, canal, sea, hand pump water



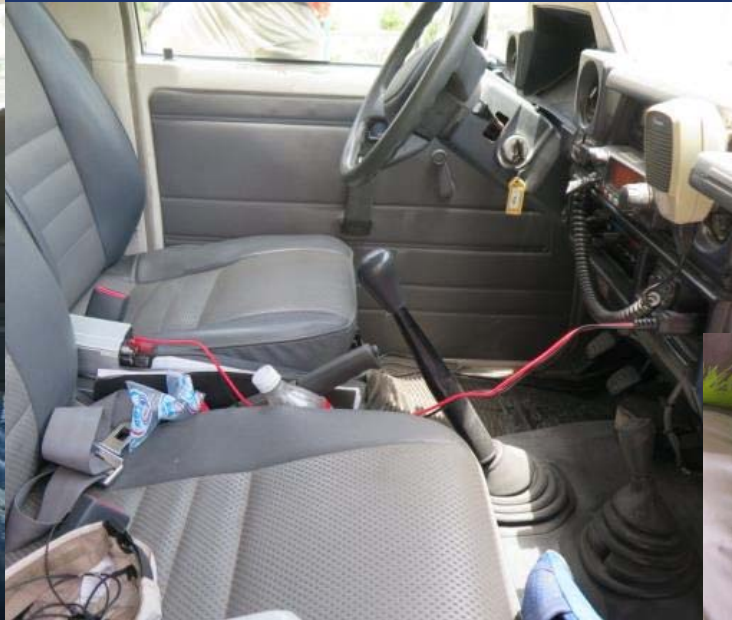
No lab infrastructure



Workflow (2): It's very easy...!



Workflow (2): Incubation



Results

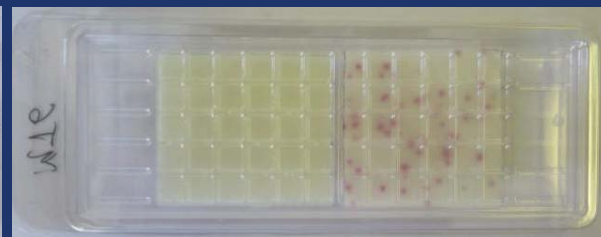


Green colony = *Vibrio cholerae*



Other examples of results:

Red colony = *Escherichia coli*





2016-2017 - PROXIMA Mission

6 months stay onboard International Space Station

7 payloads sponsored by French Space Agency



Paper based device for Space Applications



Microbial contamination in a confined environment can induce:

- ▷ Risk for the crew health
- ▷ Risk of biodegradation of the equipment
- ▷ Risk of contamination of ECLSS





2. Aquapad for ISS

In-flight analysis of 1mL water sample

Aquapad for PROXIMA



Sample analysed:
1mL of ISS water

Parameter analysed:
Total Bacteria Count

Growth medium:
R3A

Chromogenic substrate:
TTC (red)



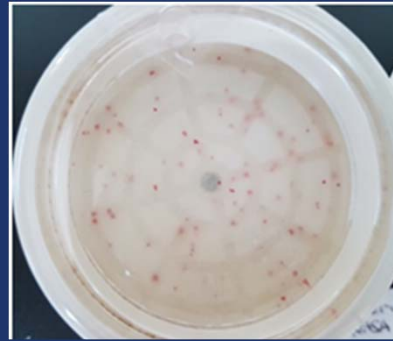
Aquapad 1mL for Total Bacteria Count



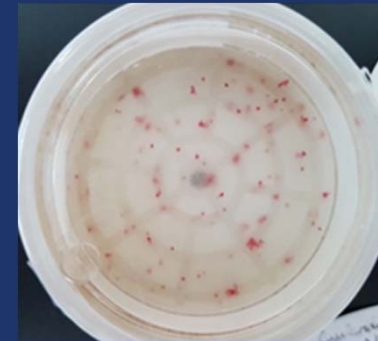
E. coli
ATCC 25922



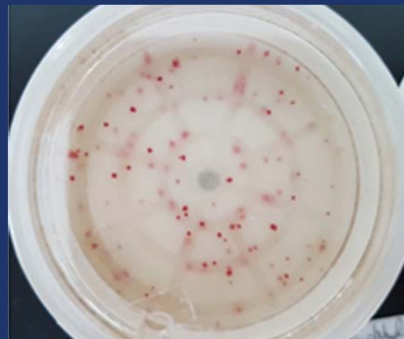
B. cepacia
NASA strain



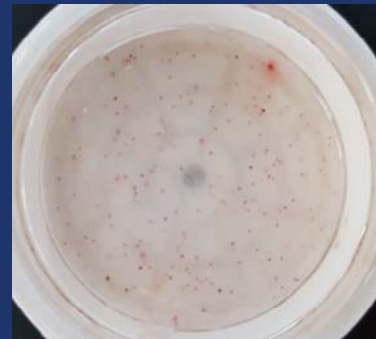
C. metallidurans
NASA strain



B. multivorans
NASA strain



R. picketti
NASA strain



Water Analysis in ISS



Water Parameter	Requirements	Units
Total Bacteria Count	< 50	CFU/mL

ISS MORD

	MCD (NASA)	Aquapad
Crew Time	~ 40 min/session	< 20 min/session
Operations	Numerous steps, tedious	Easy
Nb items /Trash	7 items (syringes, filters...)	2 items
Shelf Life	22 months	> 5 years



Microbial Capture Device (NASA)



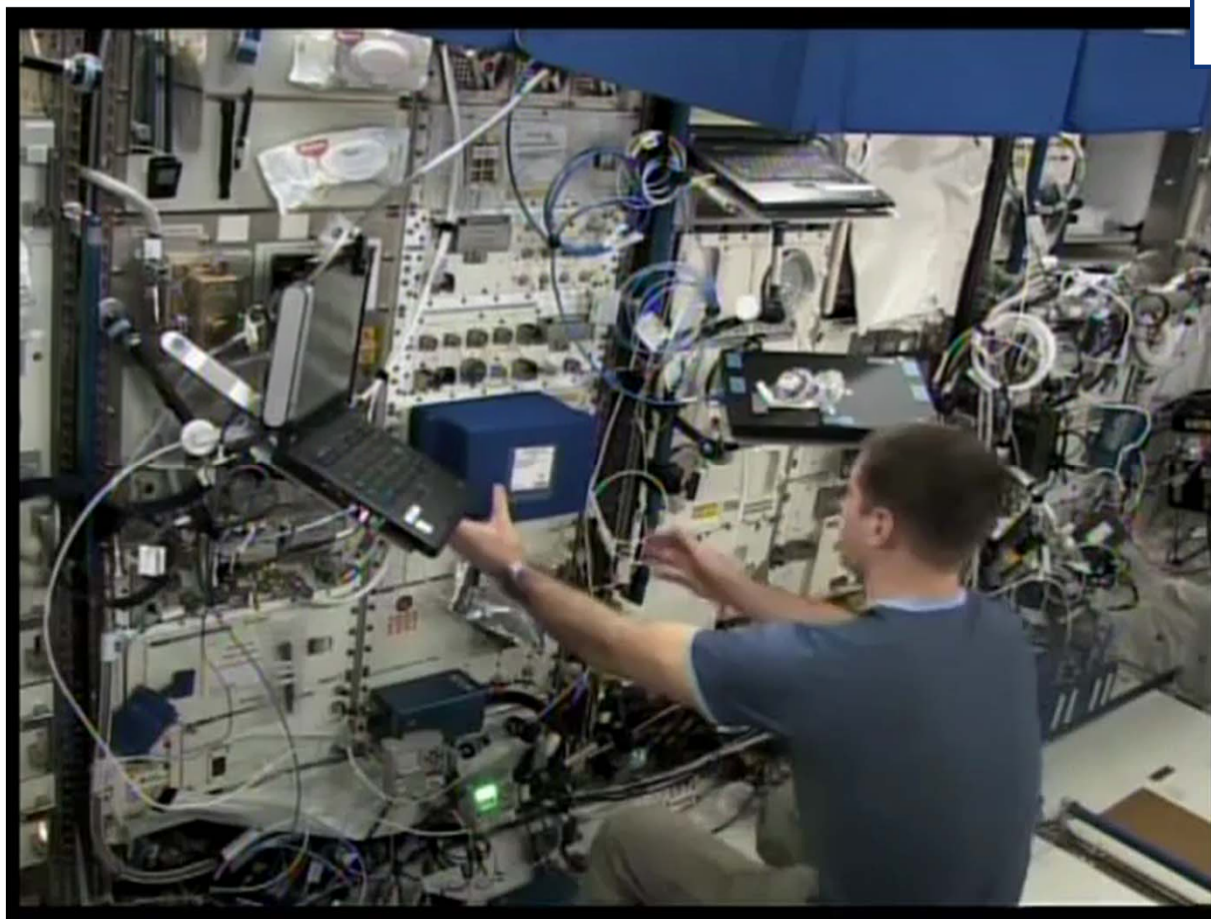
Aquapad



3. Aquapad for PROXIMA

On Orbit Operations

Video Thomas Pesquet



Packaging and Launch

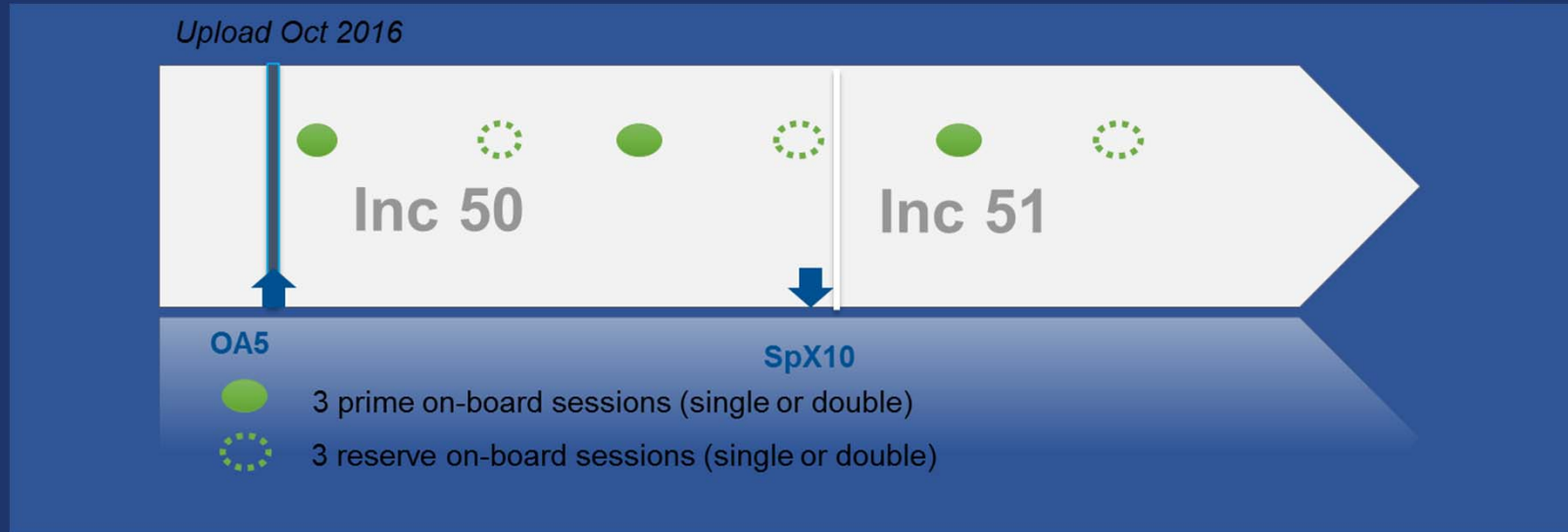


Upload – 17 October 2016

- 1 Aquapad Kit
- 20 Aquapads
- 20 Syringes
- 2 Tools



Aquapad Operations



The same day
Piggy back from Water Bag

44hr +/- 4 hrs after
ambient Incubation (26°C - 78 °F)

EHS-MCD/CFM-PROCESS
NASA microbial analysis

NASA Activity

AQUAPAD-SAMPLING
20 min

Sampling of water from water bag temp-stowed after EHS-MDC/CFM-PROCESS and injection in Aquapad device

AQUAPAD-ANALYSIS
15 min

Pictures of contamination through Aquapad Holder using EVERYWEAR and trash

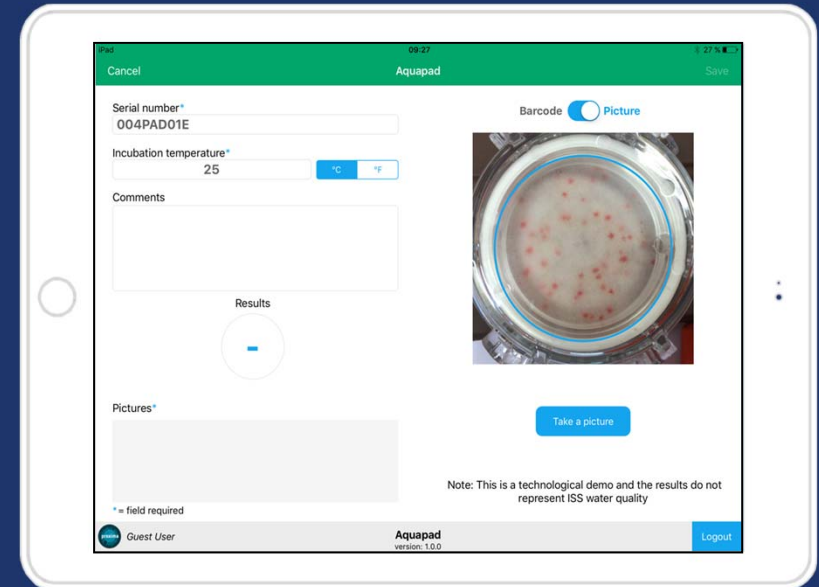


Aquapad Analysis « EveryWear » iPad Application



« EveryWear » is a suite of iPad applications:

- ▶ Nutritional Assessment
- ▶ Bluetooth sensors
- ▶ Medical monitoring
- ▶ Support to science

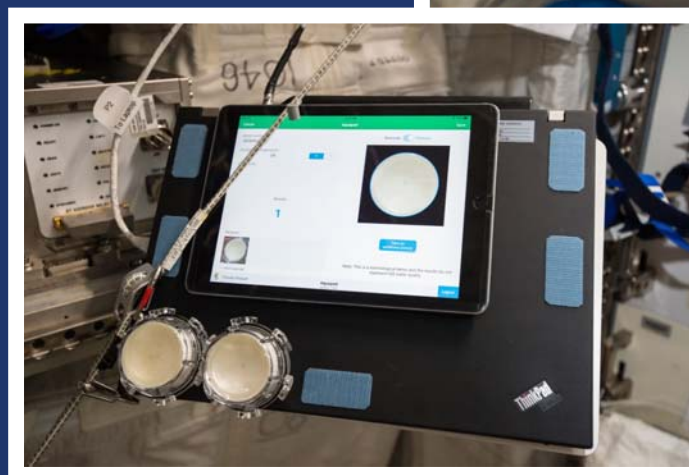


Automated Data encryption
& download via LS1 server

Aquapad in-flight results



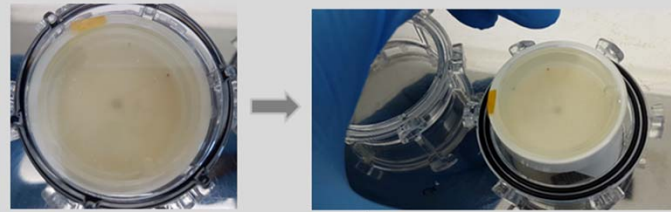
	Nb of Aquapads	Incubation duration	T°	Count
Session 1 (22-25 Nov 2016)	2	69h 15min	26 °C	12 - 12
Session 2 (14-17 Dec 2016)	2	69h 15min	26 °C	3 - 4
Session 3 (17-19 Jan 2017)	2	50h	26 °C	0 - 0
Session 4 (14-16 Mar 2017)	2	40h40min	30°C	0 - 0



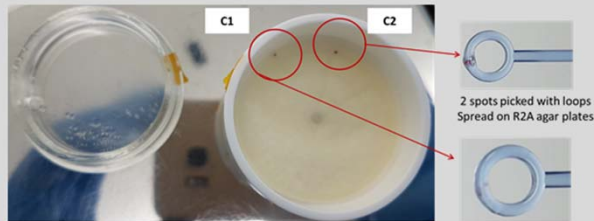
Download of Aquapad - bacterial strains identification



Aquapad S/N 07



2 spot recovered

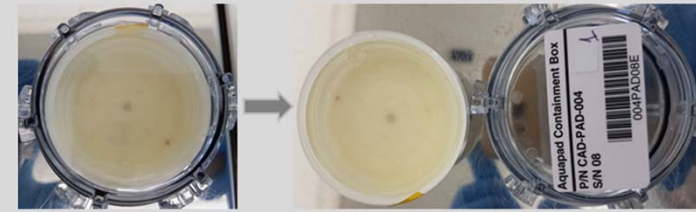


Deposit on agar plate
+ 24hrs at 35°C
incubation



VITEK® MS Results To Review	
Patient ID	
Patient Name	
Accession ID	C1-1
Specimen Type	
Organism Name	St <i>Staphylococcus hominis</i>
Pathogenicity	
Claimed / Non-validated ID	Non-validated
Organism Type	Protocol Bacteria
Confidence Value	99.9
Confidence Level	High
User Consolidated	No
Computation Engine	MS-CE CLI_3.0.0

Aquapad S/N 08



1 spot recovered



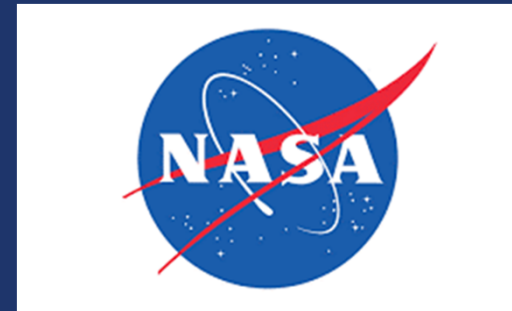
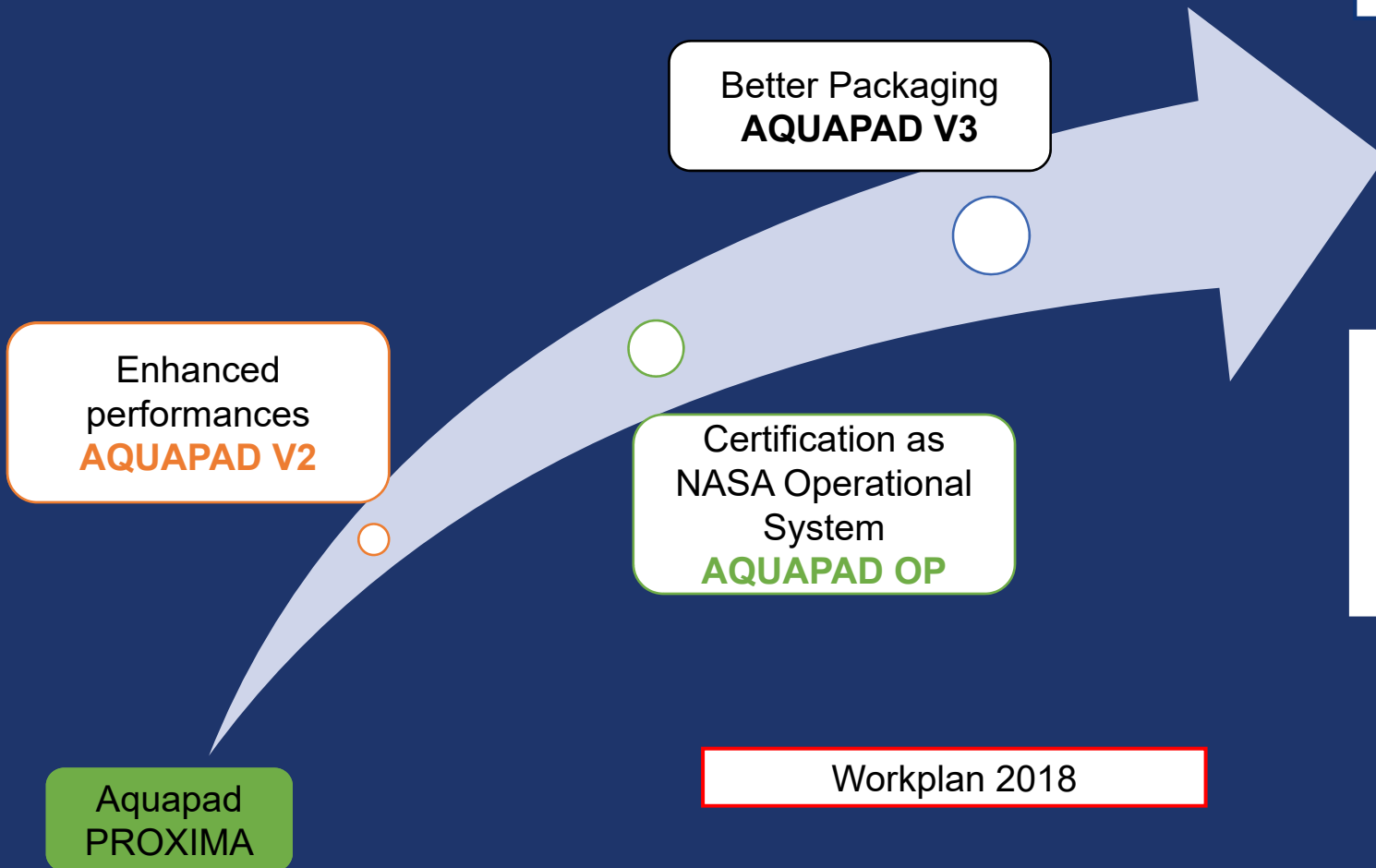
Deposit on agar plate
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incubation



VITEK® MS Results To Review	
Patient ID	
Patient Name	
Accession ID	C3-1
Specimen Type	
Organism Name	St <i>Staphylococcus haemolyticus</i>
Pathogenicity	
Claimed / Non-validated ID	Claimed
Organism Type	Protocol Bacteria
Confidence Value	99.9
Confidence Level	High
User Consolidated	No
Computation Engine	MS-CE CLI_3.0.0



Aquapad 1mL Activities



4. Aquapad for future missions

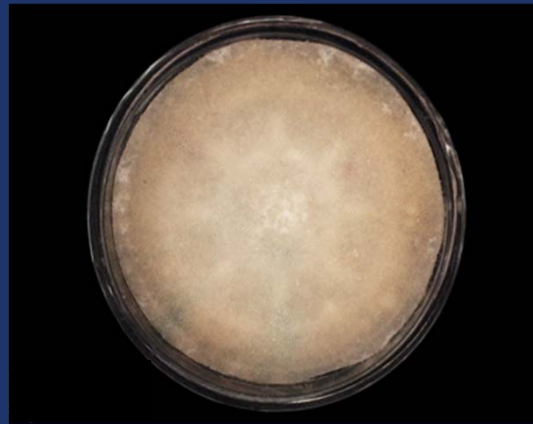
A versatile Petri Dish



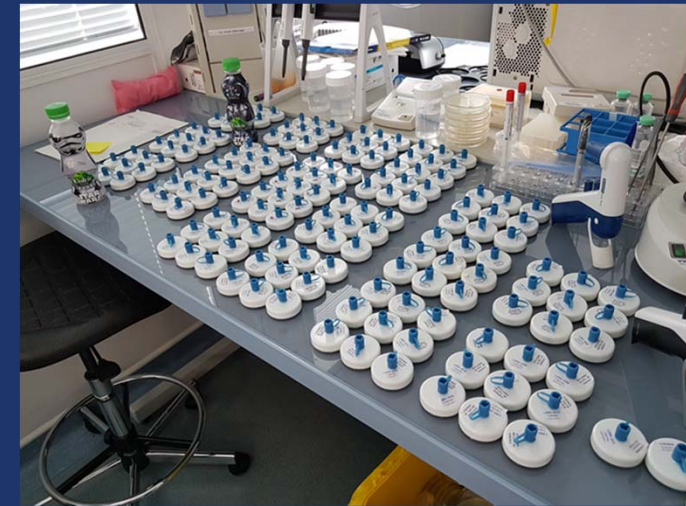
Aquapad for future missions



- ▷ Operational system for routine Use in ISS
- ▷ Testing Antarctica base with IPEV
- ▷ Next step : chromogenic culture media and increased sample volume (100mL)



1mL water sample spiked with *E. coli* and *E. faecalis* strains



Aquapad for future missions



- ▷ Currently evaluated in the Antarctica base Concordia



Aquapad for future missions



- ▷ **Currently evaluated in the Antarctica base Concordia**





Acknowledgment



Lucie Campagnolo

Aknowledgment



Thanks for your attention

Any questions ?

You can find us at :

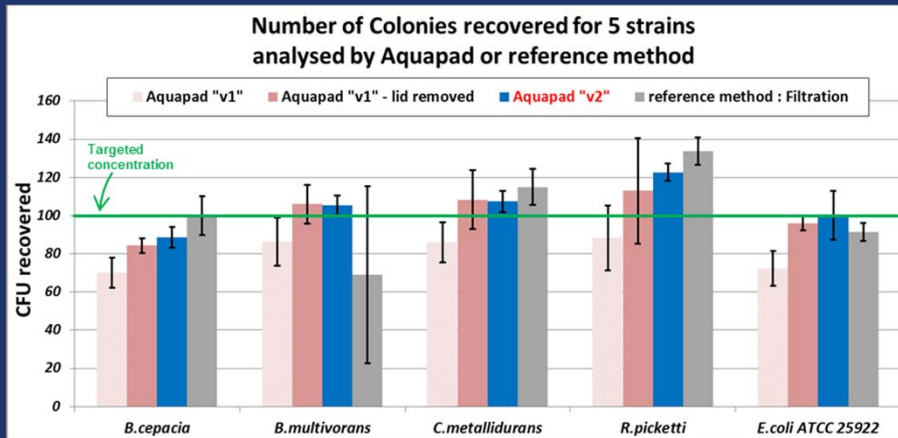
Christine.rozand@biomerieux.com

[Cecile .Thevenot@cnes.fr](mailto:Cecile.Thevenot@cnes.fr)

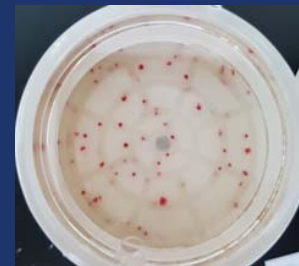


Back-up slides

Aquapad 1mL for Total Bacteria Count



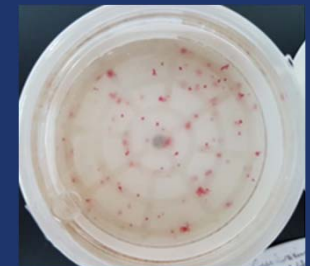
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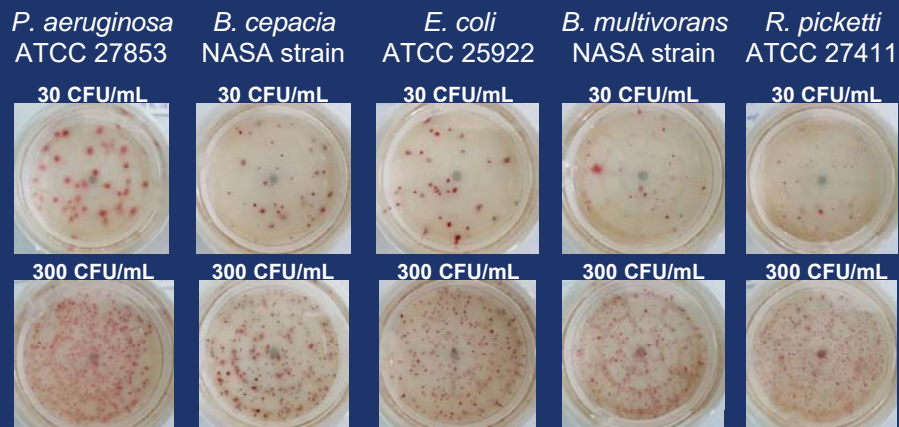


C. metallidurans
NASA strain

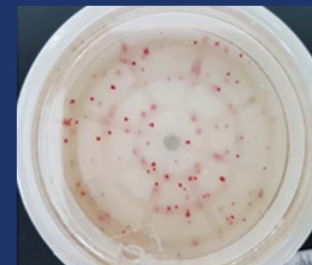


Other tests at different concentrations

Examples of results :



B. multivorans
NASA strain



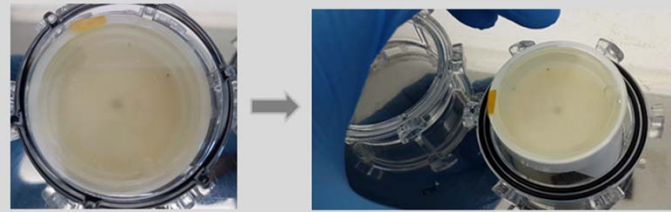
R. picketti
NASA strain



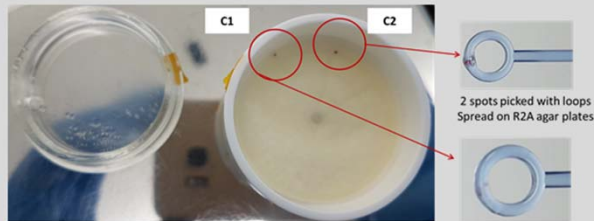
Download of Aquapad - bacterial strains identification



Aquapad S/N 07



2 spot recovered

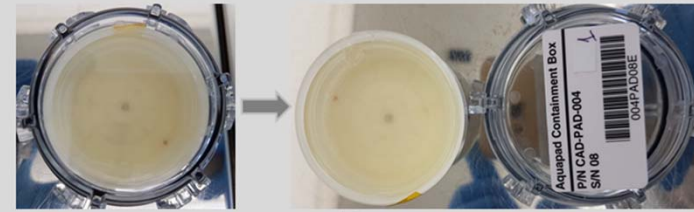


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Aquapad S/N 08



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Patient Name	
Accession ID	C3-1
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Organism Name	Staphylococcus haemolyticus
Pathogenicity	St
Claimed / Non-validated ID	Claimed
Organism Type	Protocol Bacteria
Confidence Value	99.9
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User Consolidated	No
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