UK Heat Transfer Conference 2017

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A MODULAR TEST-RIG FOR SHARED THERMO-FLUID DYNAMICS EXPERIMENTS IN REDUCED GRAVITY ENVIRONMENT

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L.Pietrasanta[a*], L.Pietrasanta@brighton.ac.uk
D. Fioriti[b], davide.fioriti@ing.unipi.it
M.Bernagozzi, M.Bernagozzi@brighton.ac.uk
N. Miche[a], N.D.D.Miche@brighton.ac.uk
L. Araneo[c], lucio.araneo@polimi.it
M. Mameli[ab], mauro.mameli@unibg.it
M. Marengo[a], M.Marengo@brighton.ac.uk

University of Brighton
Advanced Engineering Centre

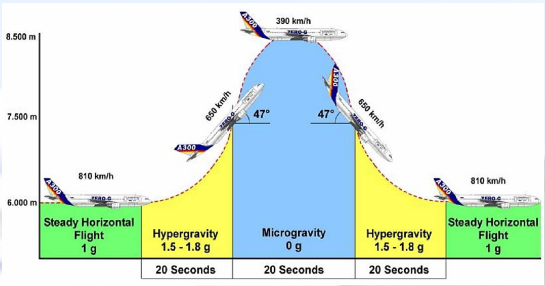
Novel Hybrid Heat Pipe for Space and Ground Applications

[a] School of Computing, Engineering and Mathematics, University of Brighton, BN2 4GJ, Brighton,,UK
[b] Università di Pisa, DESTEC, Largo Lazzarino 2, 56122 Pisa, Italy
[c] Politecnico di Milano, Dipartimento di Energia, Via Lambruschini 4A, 20158 Milano, Italy

European Space Agency

1. INTRODUCTION

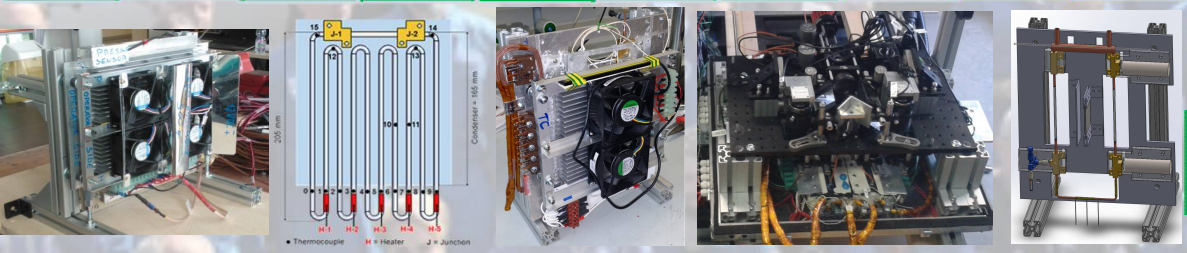
Parabolic flights represent an important tool for short space-related experiments under reduced gravity conditions. During the ballistic flight manoeuvres, the investigators have the possibility to operate their experiments, in a laboratory-like environment, where the level of gravity decreases for approximately 20s. A parabolic flight rack able to host up to two thermo-fluid dynamics experiments has been designed, realized and qualified during the ESA 66th Parabolic Flight Campaign. This microgravity research platform, is the first UK facility available for such investigations, providing a data acquisition system, cooling system and heating system compliant with Novespace requirements.



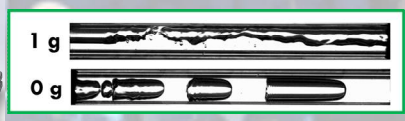
2. EXPERIENCES IN PARABOLIC FLIGHT CAMPAIGNS

MAY 2013	MAY 2014	OCT 2014	MAR 2015	OCT 2015	NOV 2016	MAY 2017 A	MAY 2017 B	NOV 2017 A	NOV 2017 B
ESA PF 58th Copper Tube Pulsating Heat Pipe D=1.1 mm FC-72 UniBg UniPi Polimi	ESA PF 59th Copper Tube Pulsating Heat Pipe D=1.1 mm FC-72 UniBg UniPi Polimi	ESA PF 60th Copper Plate Flat Pulsating Heat Pipe D=1.7 mm FC-72 PPrime Polimi UniBg UniPi	ESA PF 61st Aluminium Tube Pulsating Heat Pipe D=3 mm FC-72 UniBg UniPi Polimi	ESA PF 63rd Aluminium Tube Pulsating Heat Pipe D=3 mm FC-72 UniBg UniPi Polimi	ESA PF 65th Copper Flat Plate Pulsating Heat Pipe D=2.5 mm Self reweting PPrime UniNa UoB	ESA PF 66th Copper Tube Pulsating Heat Pipe D=2 mm Ethanol, FC-72 UniBg Polimi UoB	ESA PF 66th Fluid vein stability in Copper Groove D=2 mm. Self rewetting UoB ULB	ESA PF 67th Aluminium Tube Pulsating Heat Pipe D=3 mm. IR, FC-72 UniPi Polimi UoB	ESA PF 67th Aluminium Tube Pulsating Heat Pipe D=3 mm. IR, Ethanol, FC-72 UniPi Polimi UoB

- Due to the complexity of the parabolic flight investigation, a re-flight has to be take into account during the planning of the activities.



Images from thermo-fluid dynamic experiments previously tested aboard of Zero-G ESA Parabolic Flights

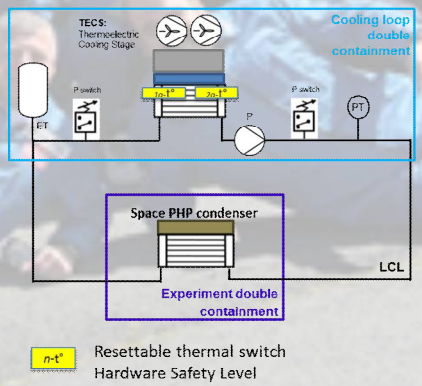


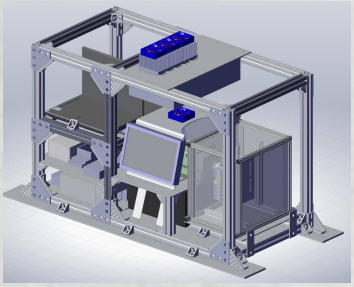
Activation of slug/plug flow in Pulsating Heat Pipe under microgravity condition

3. THE EXPERIMENTAL RACK

Sub-syst.	Description	Type	Function
1	Test cell	Thermal	Tested device, electric heating and temperature control
2	Liquid Cooling Loop	Thermal	Heat Sink (300W max, -5°C to +60°C)
3	Liquid Heating Loop	Thermal	Heat Source (180W max, up to 80°C)
4	High Speed Camera	Diagnostics	Visualization of transparent sections
5	ESA MW-IR High Speed Camera	Diagnostics	Visualization and temperature measurement of IR transparent sections
6	Power, DAQ, PC	Power and Signal acq.	Power supply, Data acquisition system and safety control
7	Rack Structure	Structural	Primary structure
8	Exp. box	Structural	Double containment and vibration damping

Experimental box dimensions: 800x600x800mm - Max experiment weight:60Kg





Rack during the 66th ESA PFC and rendering of the modification for the 67th and 68th ESA PFC

3. CONCLUSIONS

A modular parabolic flight rack has been designed and realised with the aim of hosting thermo-fluid dynamic experiments from different research teams. The first campaign has highlighted the high adaptability of the system to third part payloads and suggested improvements for the future flights. A tool for microgravity thermo-fluid dynamic related experiments is available for the UK science community and interested companies.