

OPPOSED FLAME SPREADING ALONG A STRUCTURED PMMA-SAMPLE IN EXPLORATION ATMOSPHERE UNDER MICROGRAVITY

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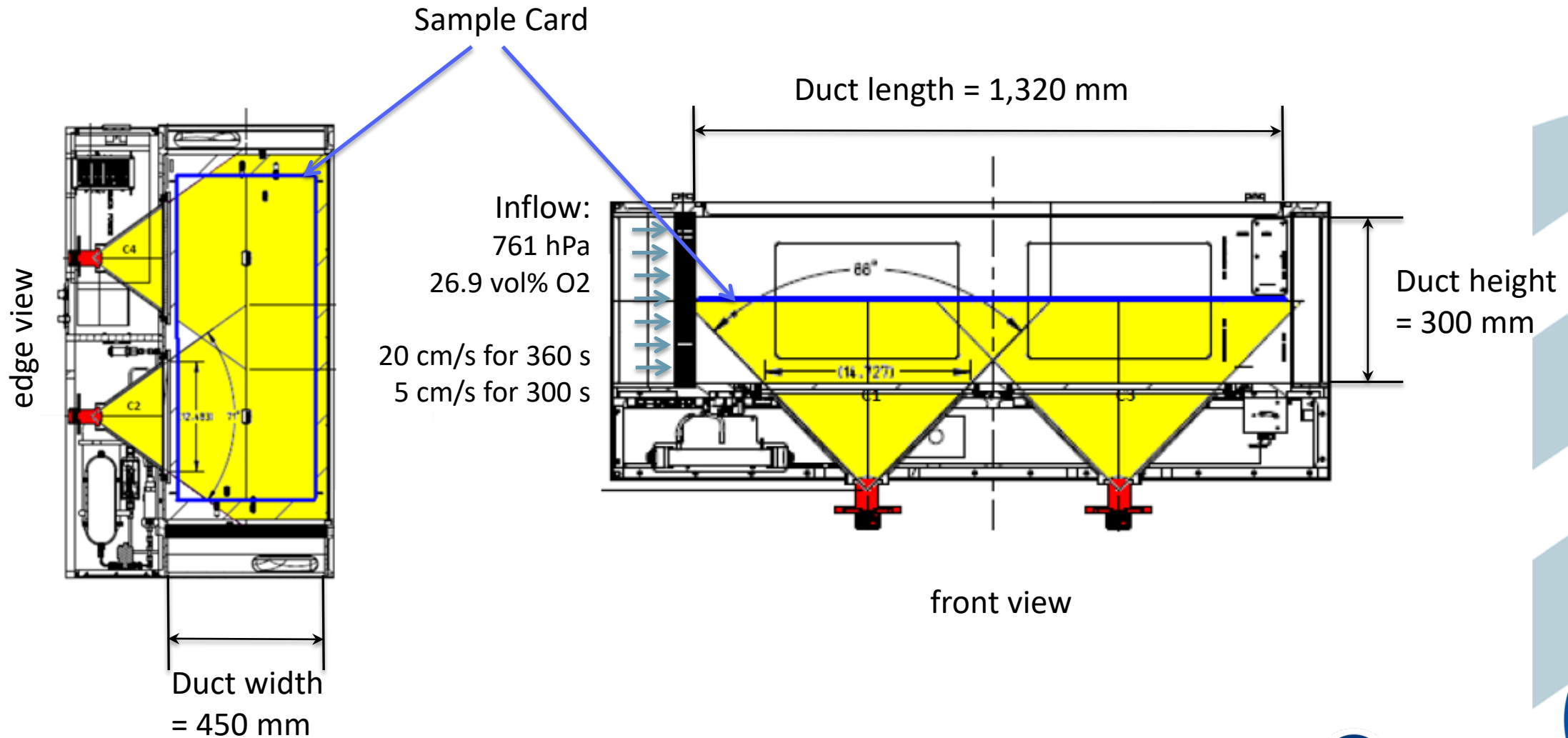
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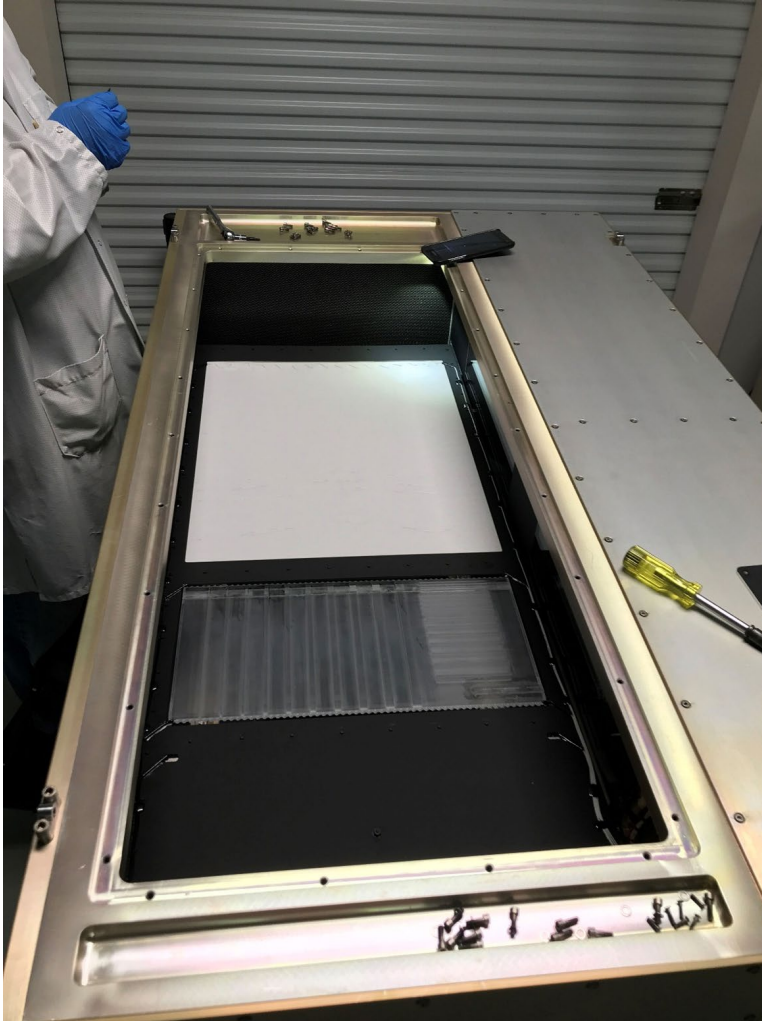


How do surface-structures support opposed flame spreading compared to a flat surface as requested by the NASA-STD 6001 ?

In real life, potentially flammable materials, such as PMMA, cannot always be installed flat and remain unstructured, and not all edges can always be protected against ignition.

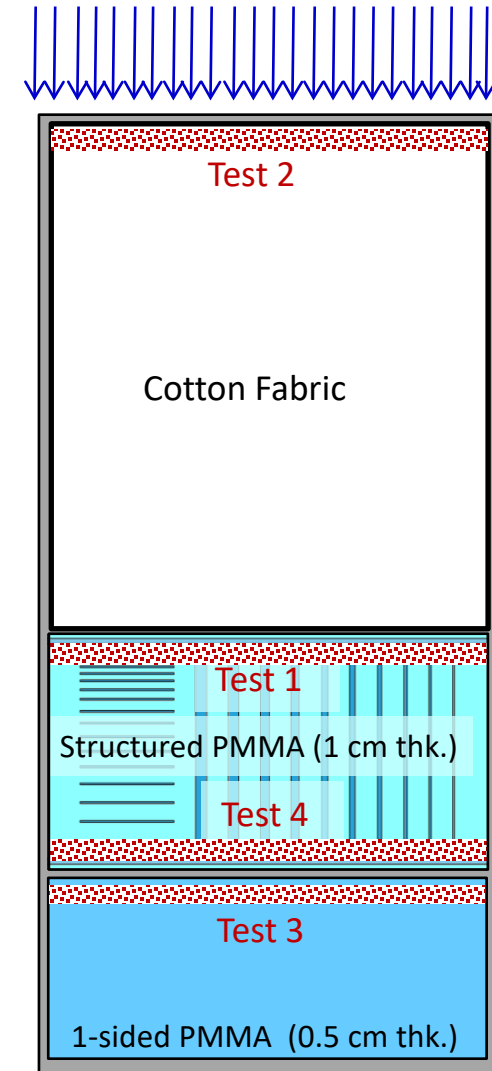
The conditions of NASA-STD 6001 (Test 1), which investigates upward burning under 1g (propagation in the direction of natural convection), are more like the conditions of propagation against a forced oxidizer flow in microgravity, as will be shown.





Mounting sample card
at ZIN Technology, Inc.

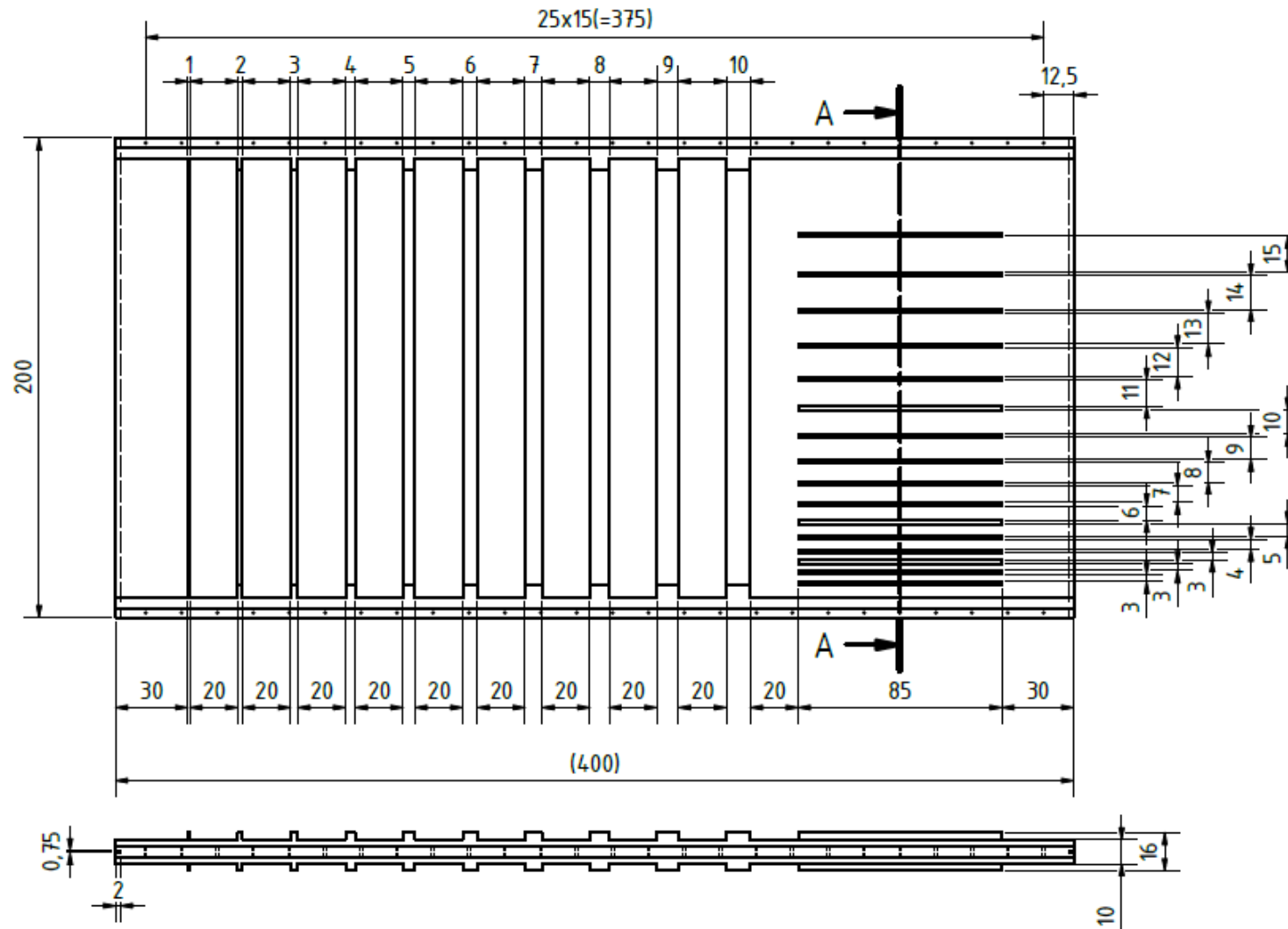
Planned test logic



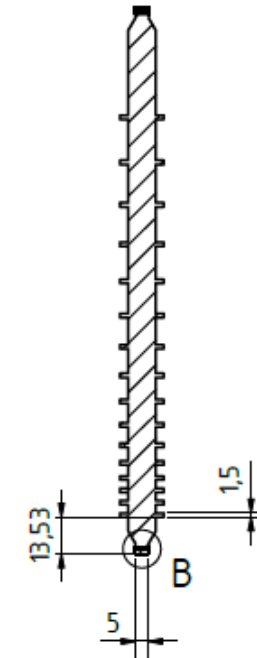


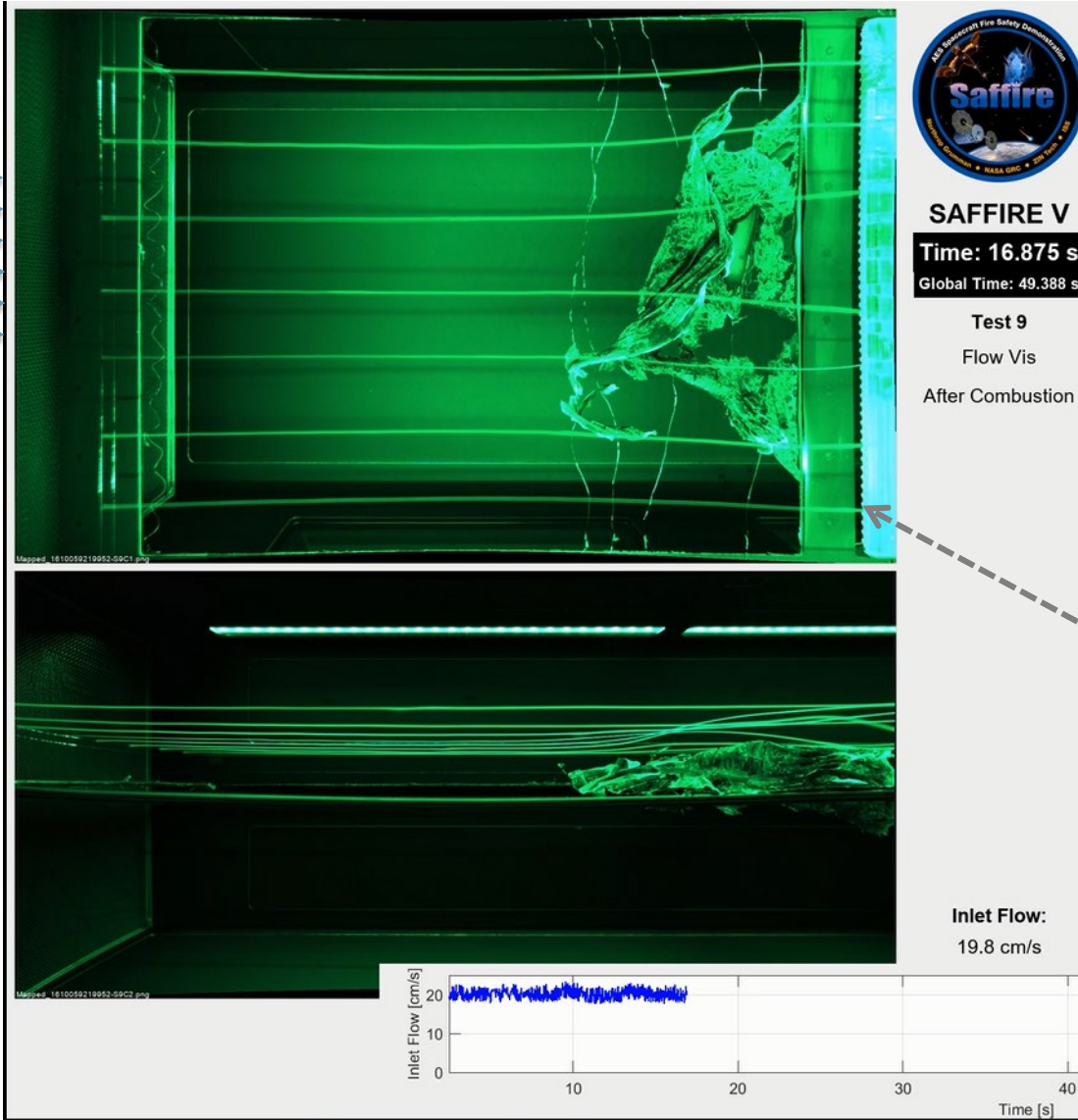
Experimental Setup

CYGNUS-Spacecraft, Flight NG 14, January 2021



A-A (1 : 2)



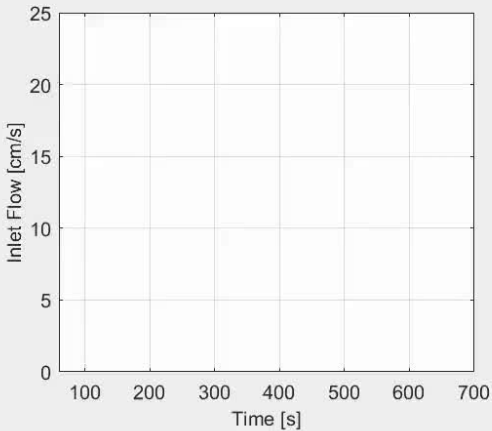
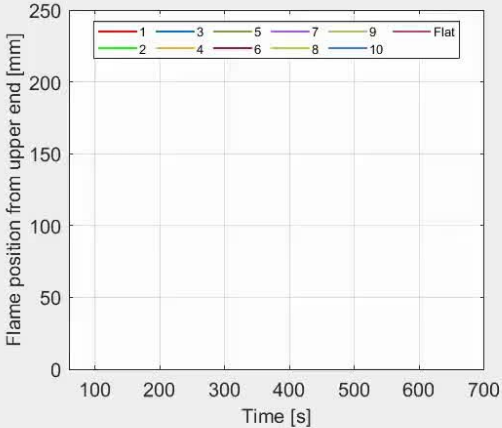
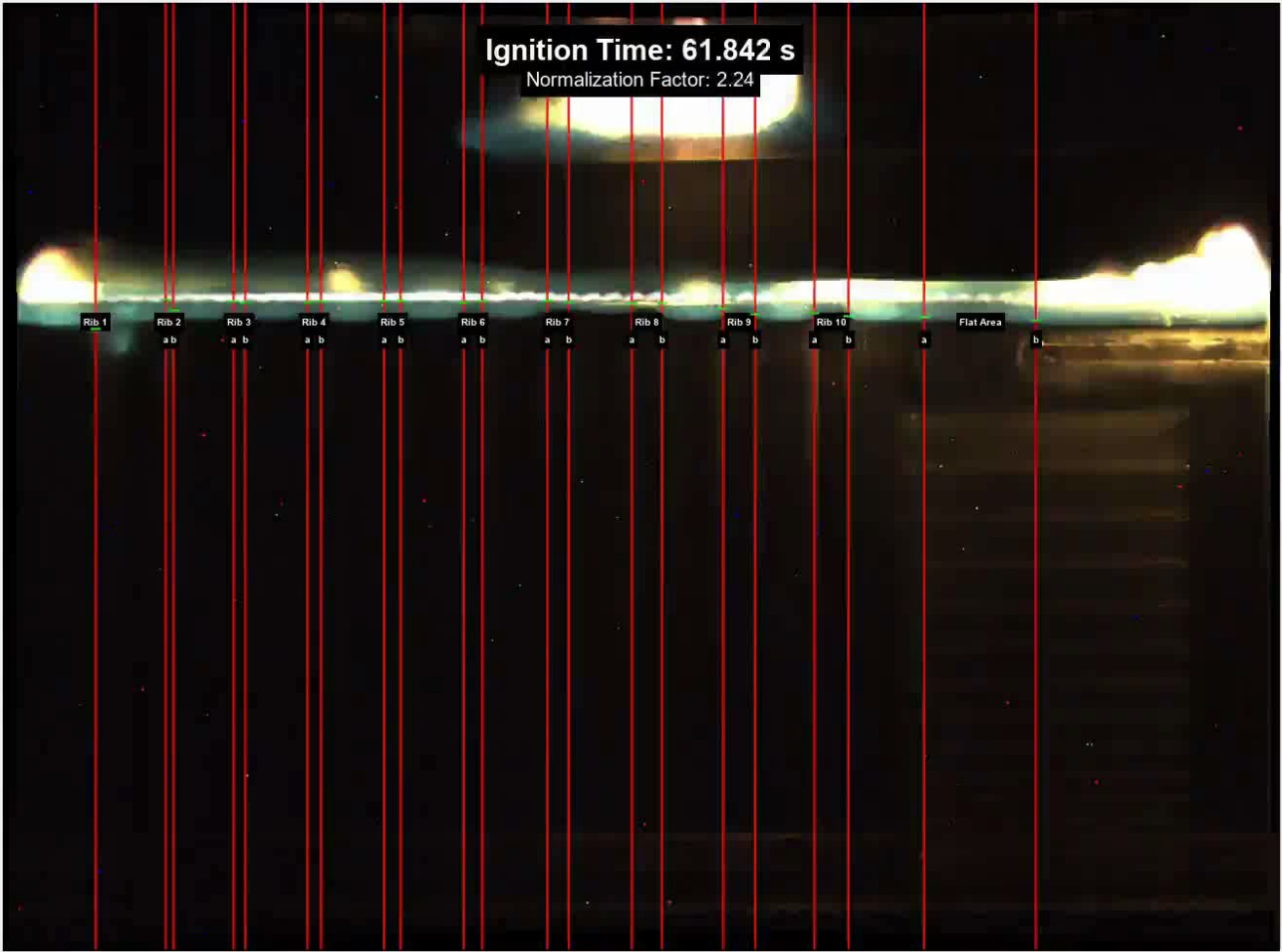


Flow visualization:

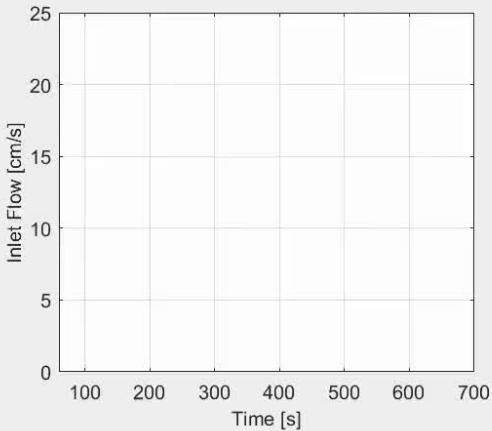
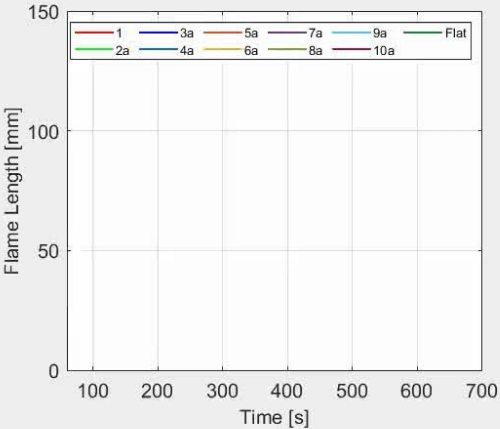
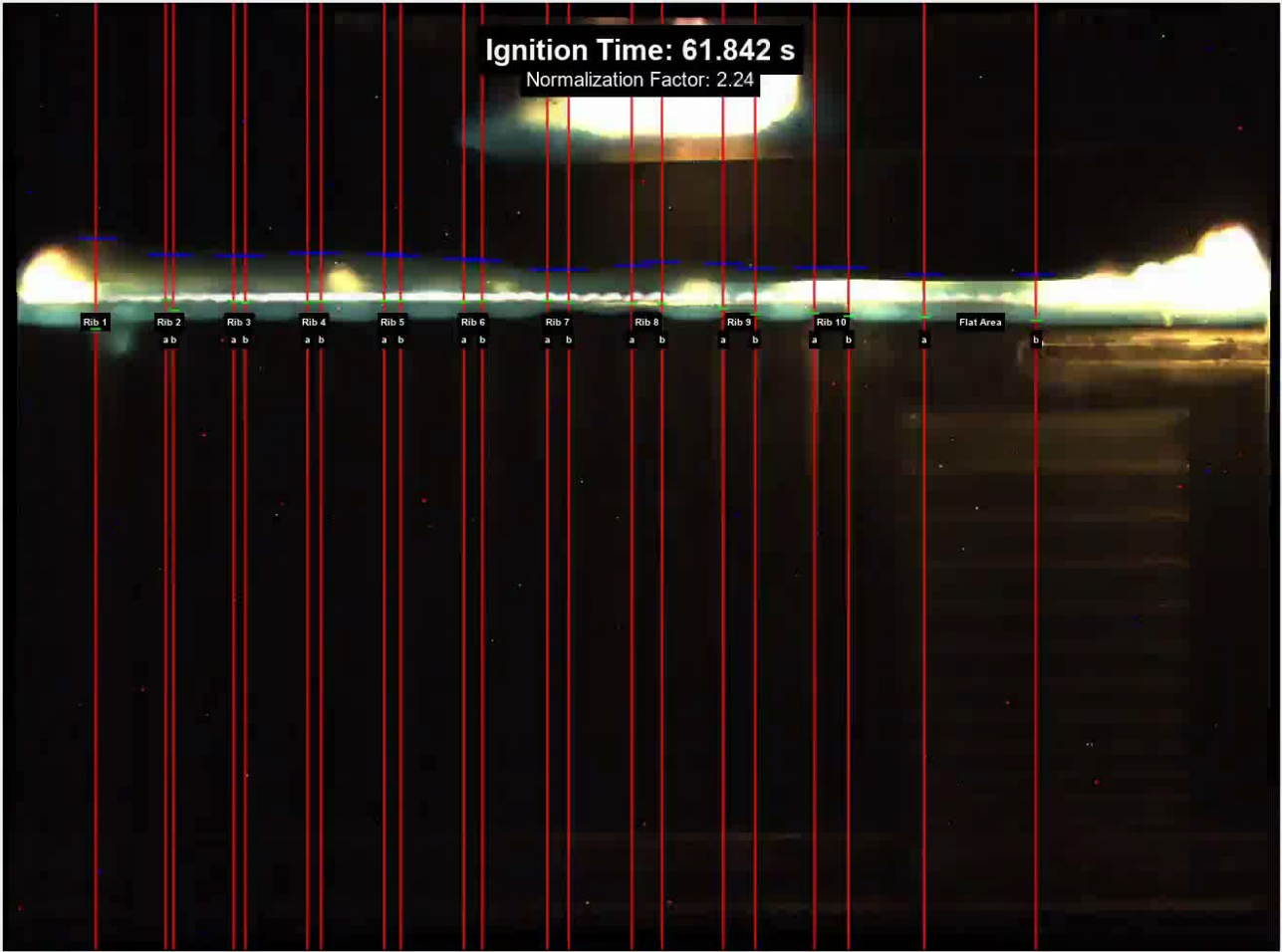
The incident flow is slightly disturbed by incompletely burned remnants of the cotton sample.



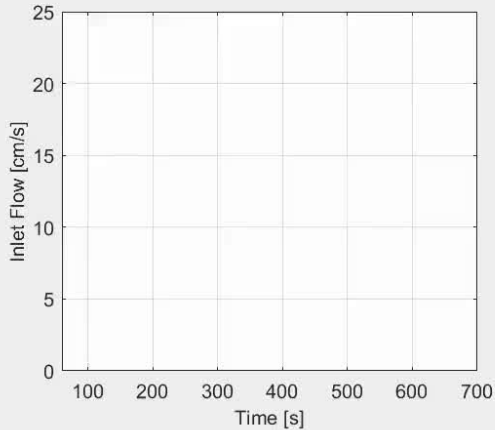
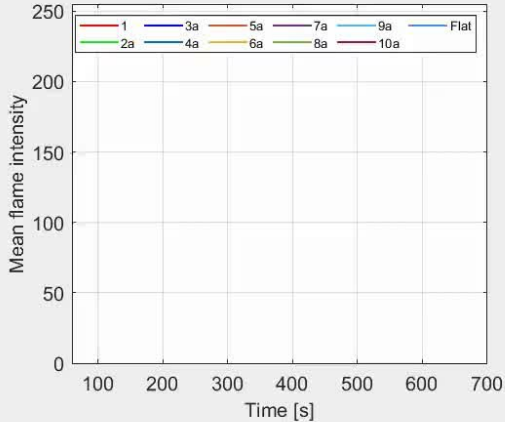
Flame front tracking

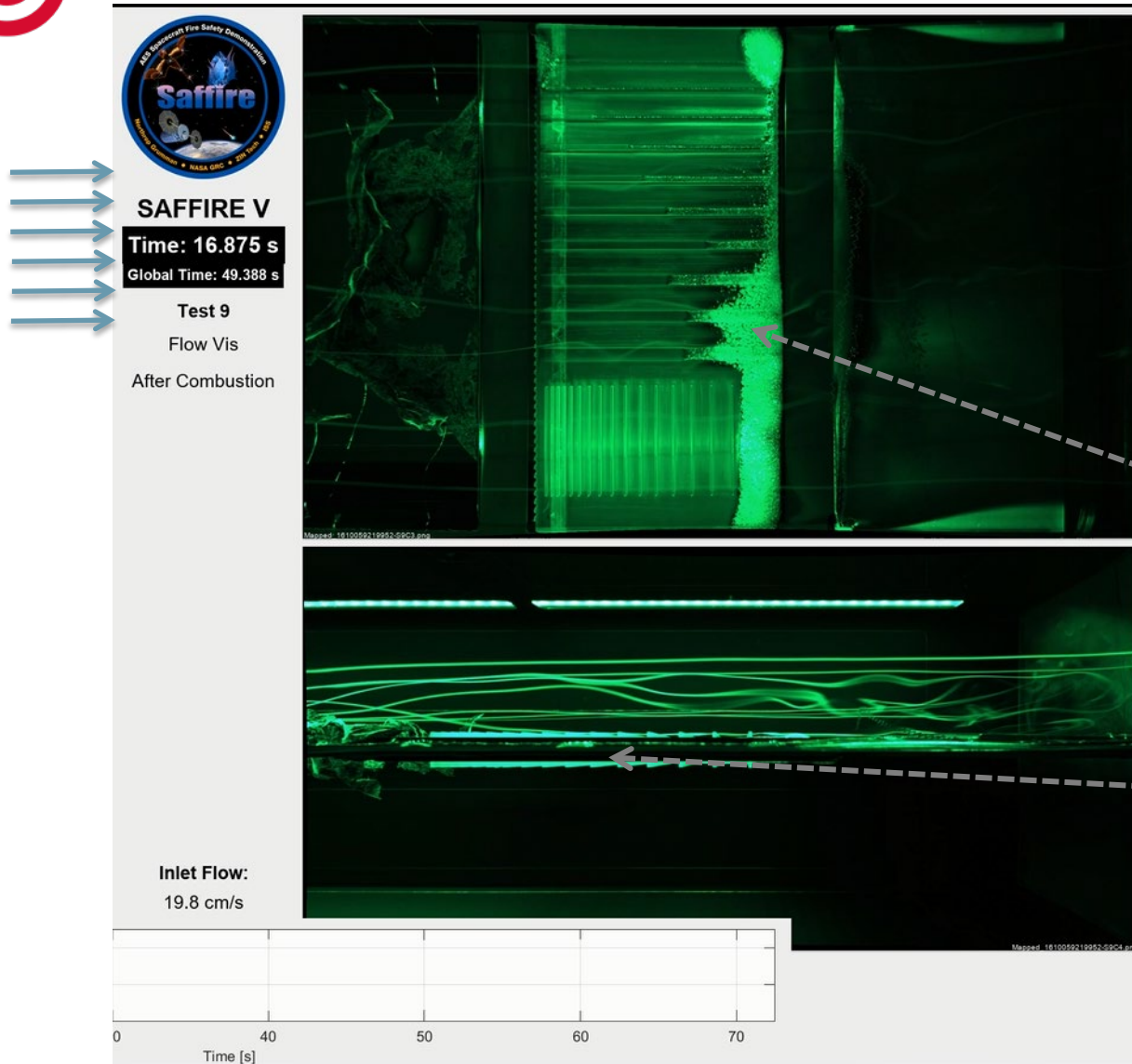


Flame length tracking



Flame flickering





Flow visualization:

The incident flow is slightly disturbed by incompletely burned remnants of the cotton sample.

Deviating combustion progress
in the area of ribs 8, 9 and 10.

Clearly perturbed flow
field.



- Ribs significantly accelerate the opposed spread rate of flames.
- The narrower the rib, the more.
- Wider ribs show more and more independently propagating edge flames.
- The propagation speed along the 10 mm wide rib is only slightly faster than that of a flat plate.
- Flame lengths are finite because material pyrolyzing under the flame is protected by it from oxygen ingress – “shadowing effect”.
- A flame that has reached the leading edge of the specimen dwells there and propagates only across the width of the edge.
- Flames in the shadow of other flames extinguish due to the "shadowing effect".
- The experiment shows that concurrent flame propagation is unlikely.
- Even small perturbations of the stratification lead to considerably increased propagation velocity.
- In the case of active fire tackling, it can be deduced that an accompanying disturbance of the stratification can quickly lead to dangerous backdraft.
- This is all the more so because microgravity combustion produces much larger quantities of combustible flue gases than fires on the ground.
- The small disturbance of the inflow also delayed ignition and led to ignition of the deflagration type.



Thank you for your attention!

The authors are very grateful to NASA and the performing companies and institutions for the opportunity to conduct these unique and enlightening experiments on large and comparably much less contained fires in space.

We thank all members of the International Science Team for the extremely fruitful collaboration.

We also gratefully acknowledge the support of the European- and German Space Agencies ESA and DLR.

We deeply hope for this kind of research to be continued for the sake of safer future journeys to the Moon, Mars and beyond.

