

Flame Propagation Between Flat Roofing and Photovoltaic Installations



By Farah Binte Mohd Faudzi
Supervised by Prof. Grunde Jomaas
Special thanks to Jens Steemann Kristensen





Elon Musk  @elonmusk · Aug 18, 2019

Tesla Solar just relaunched. Lmk what you think ... [Tesla.com/solar](https://tesla.com/solar)



Elon Musk  @elonmusk

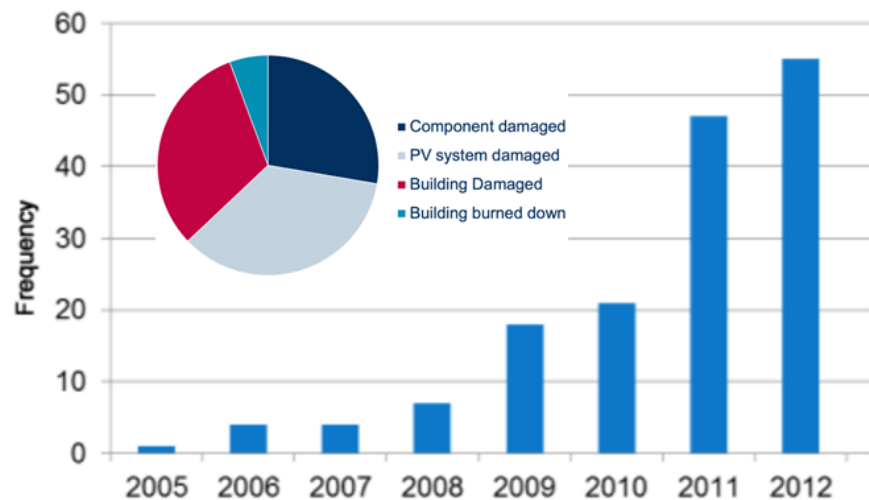
With the new lower Tesla pricing, it's like having a money printer on your roof if you live a state with high electricity costs. Still better to buy, but the rental option makes the economics obvious.

10:51 AM · Aug 18, 2019



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Fire Incidents caused by PV in Germany



New Jersey, USA (2012)



Nordeney, Germany (2013)



Goch, Germany (2012)



TECH

Walmart sues Tesla over solar panel fires at seven stores

PUBLISHED TUE, AUG 20 2019 4:33 PM EDT | UPDATED WED, AUG 21 2019 12:36 PM EDT

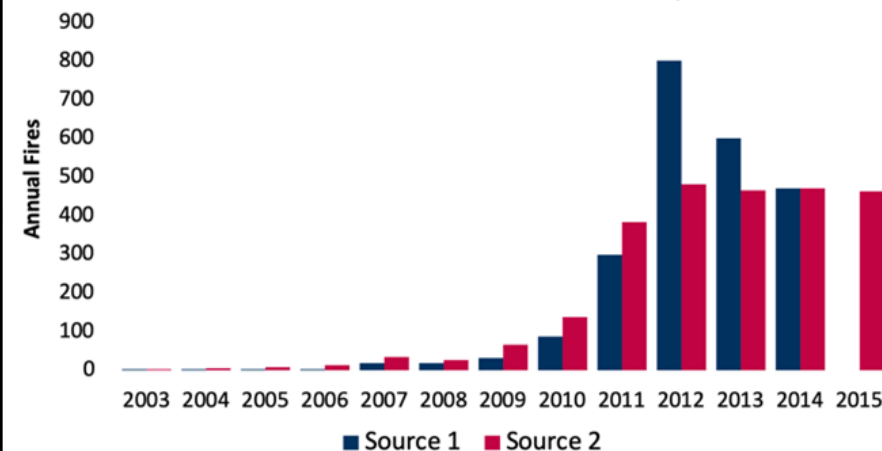


Lora Kolodny
@LORAKOLODNY

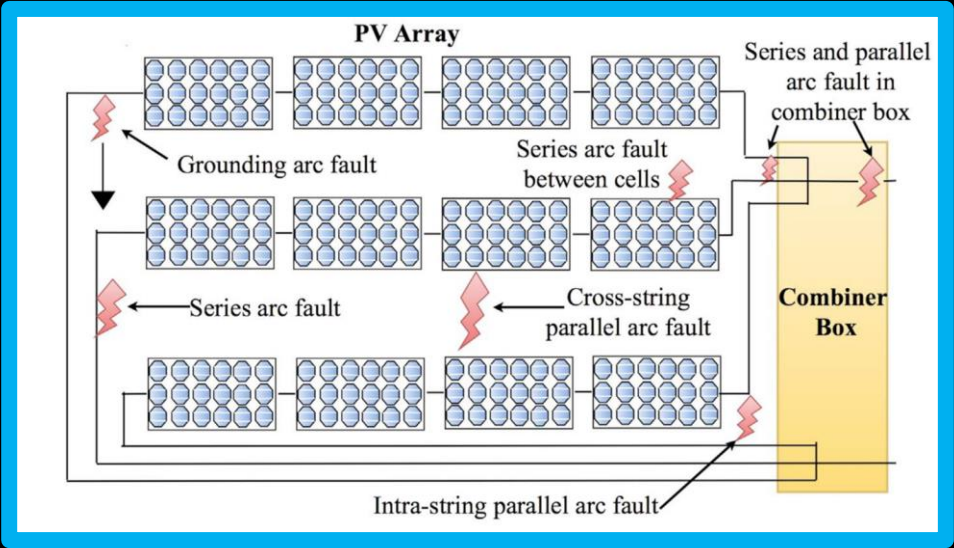
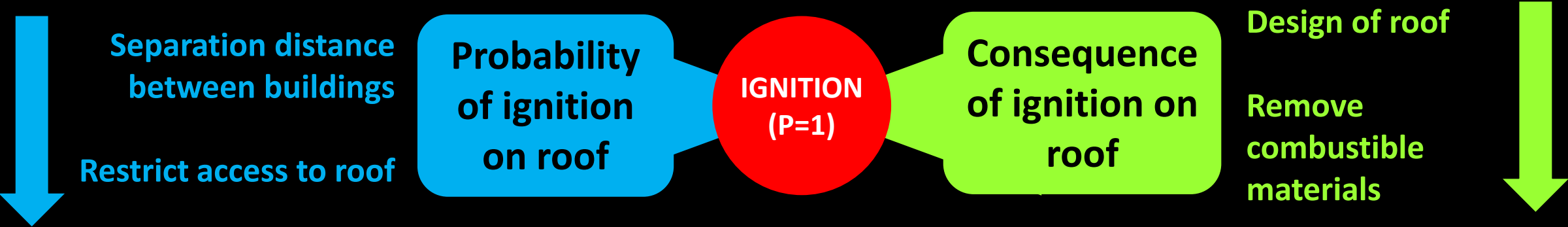
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FIRES INVOLVING PV INSTALLATIONS, ITALY



FIRE-RELATED RISK FLAT ROOF CONSTRUCTION + PV INSTALLATIONS



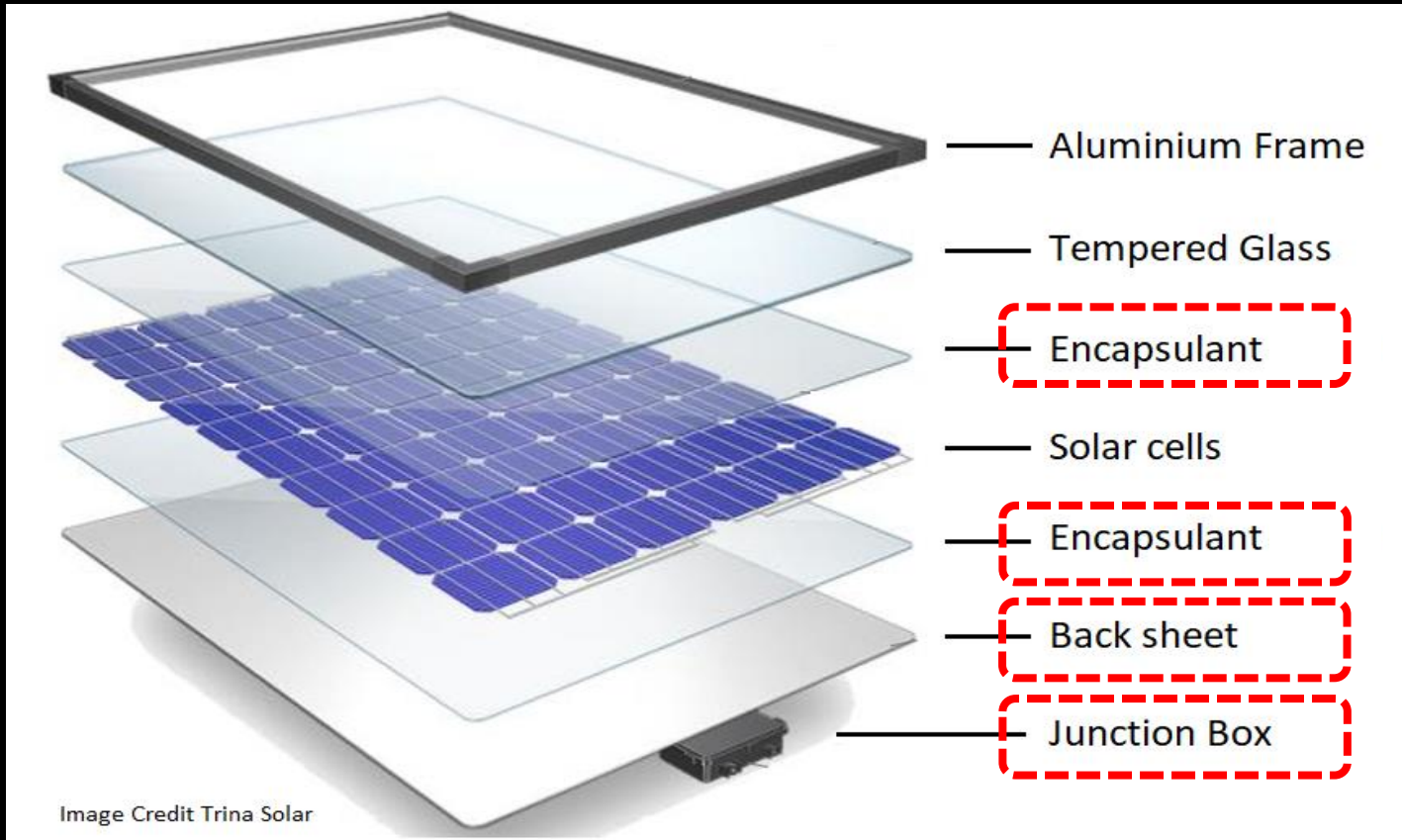
A roof construction should not be designed for IF, but WHEN.

So why do extensive fire on roofs with PV installations still occur?

[1] SLu S., Phung BT., and Zhang D. (2018), <https://doi.org/10.1016/j.rser.2018.03.010>

Adapted from Jens' workshop "Solar Panel and Fire Safety" (<https://www.youtube.com/watch?v=D9ygbo2XpFU&t=2406s>)

INCREASED FIRE LOAD?



**Combustible
components of the PV
module is less than 10%
by mass.**

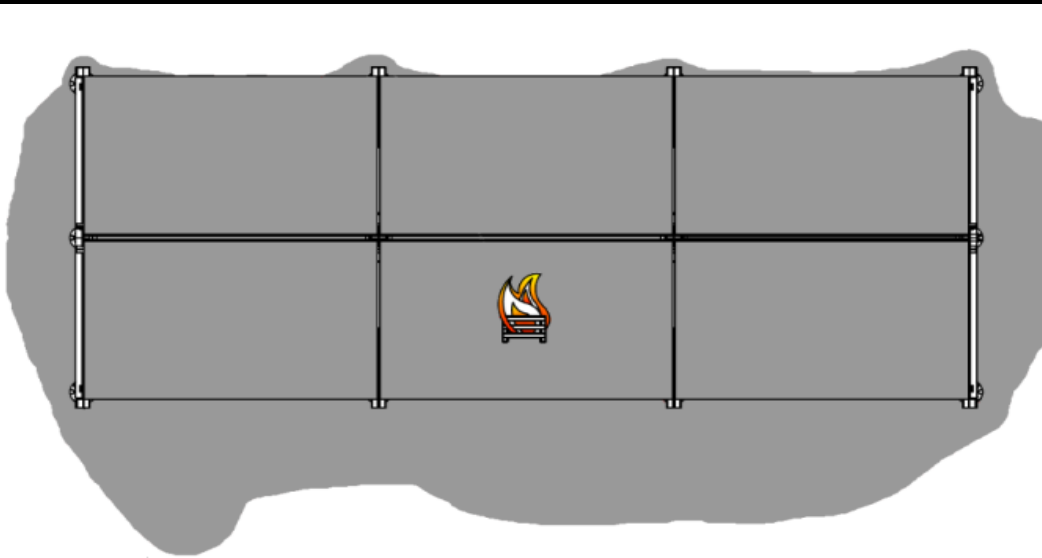
+ Cables and Mounting system

CHANGED FIRE DYNAMICS



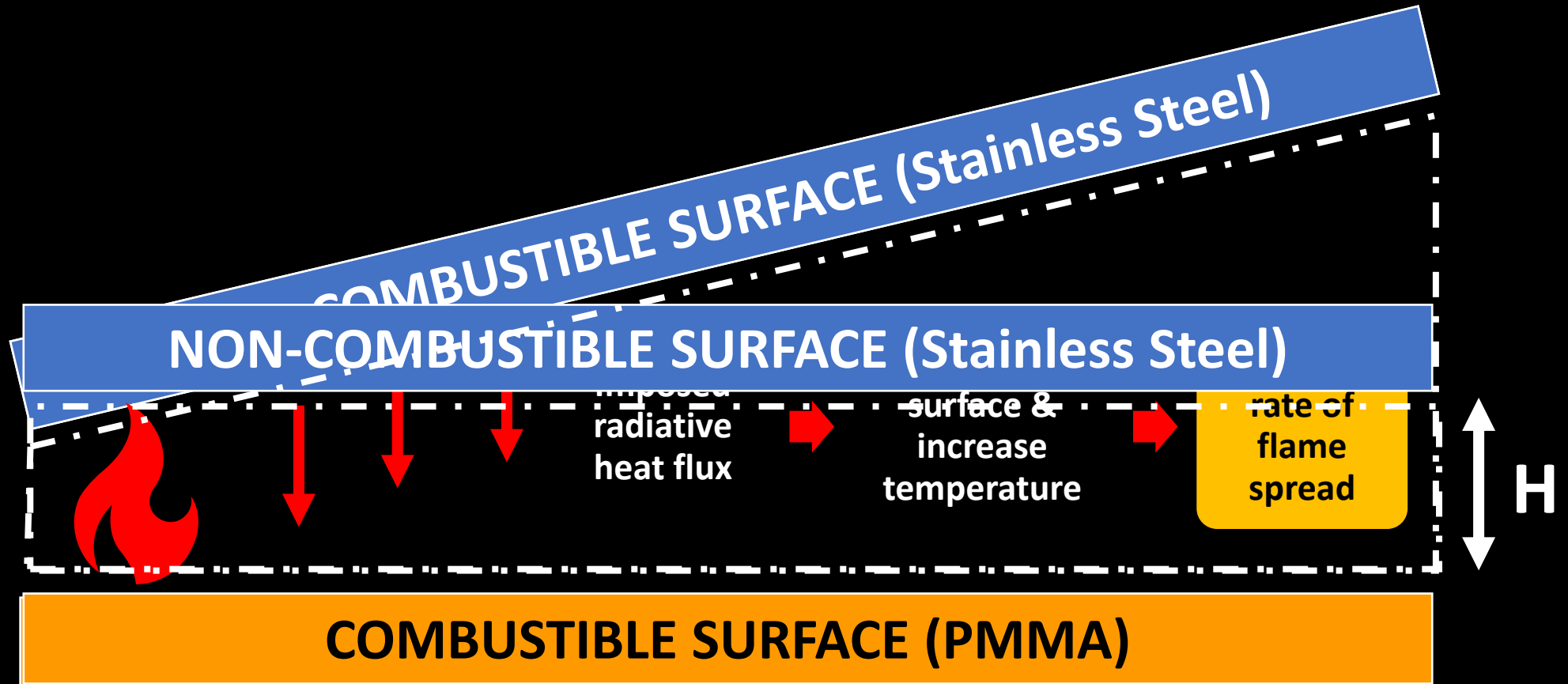
Fire spread mainly confined to the gap between PV installations and flat roofs.

Does the gap height matter?



Full scale experiments by Kristensen, J.S. (2016)

METHODOLOGY

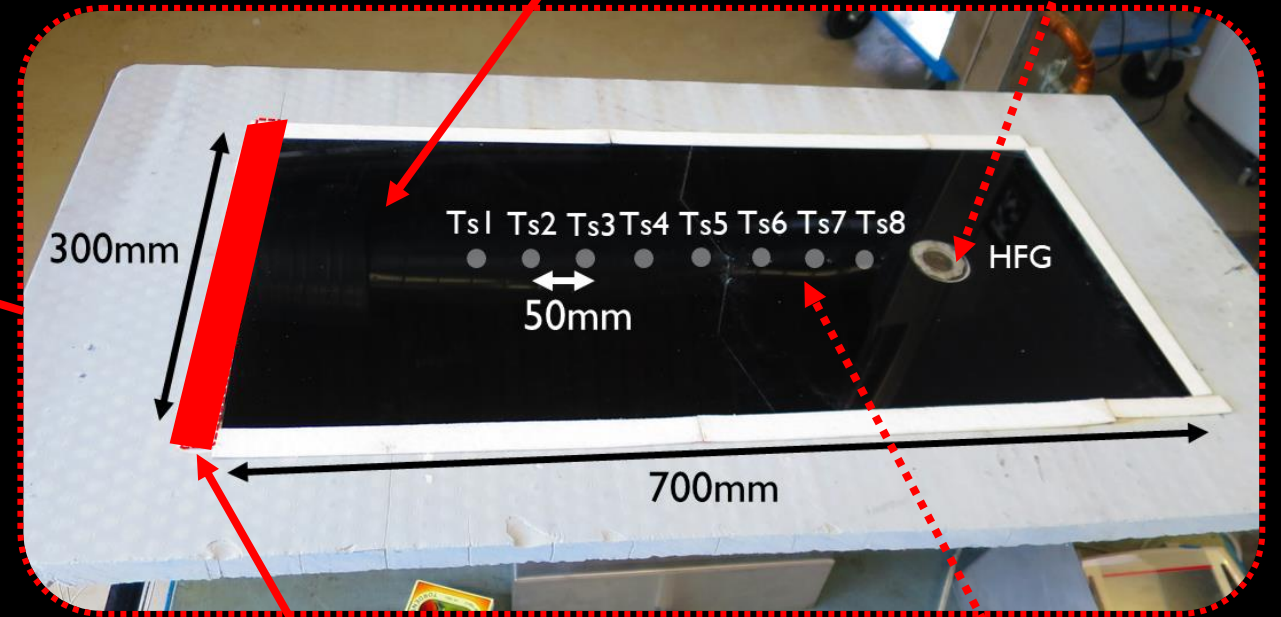
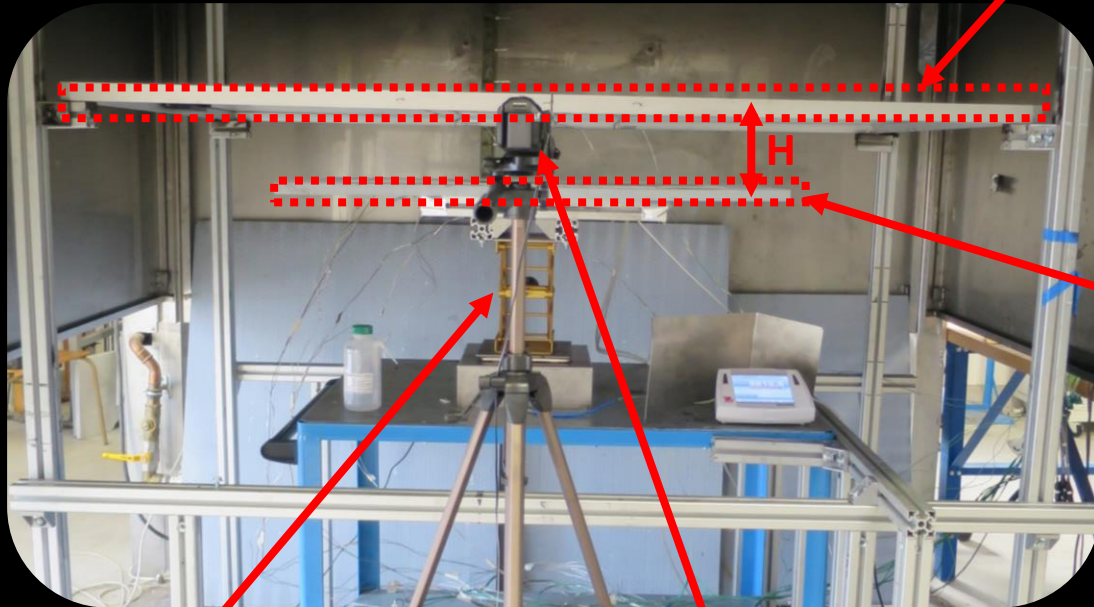


EXPERIMENTAL SET-UP

Stainless Steel
Surrogate Panel
(PV panels)

Heat Flux
Gauge

PMMA Sample



Laboratory
Jack

Video
Camera

IGNITION!!!

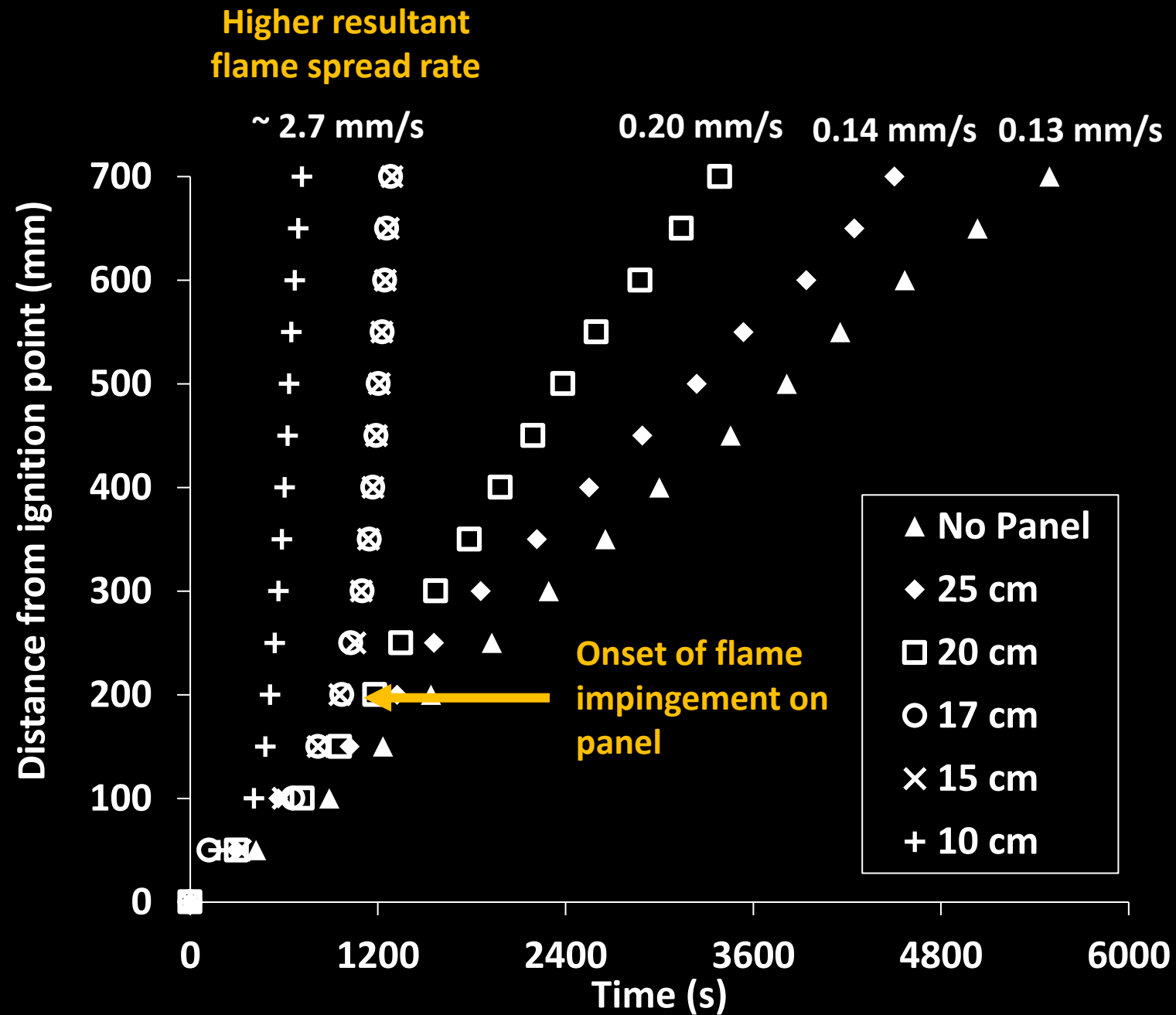
Thermocouple
embedded in the
sample

VISUAL OBSERVATIONS

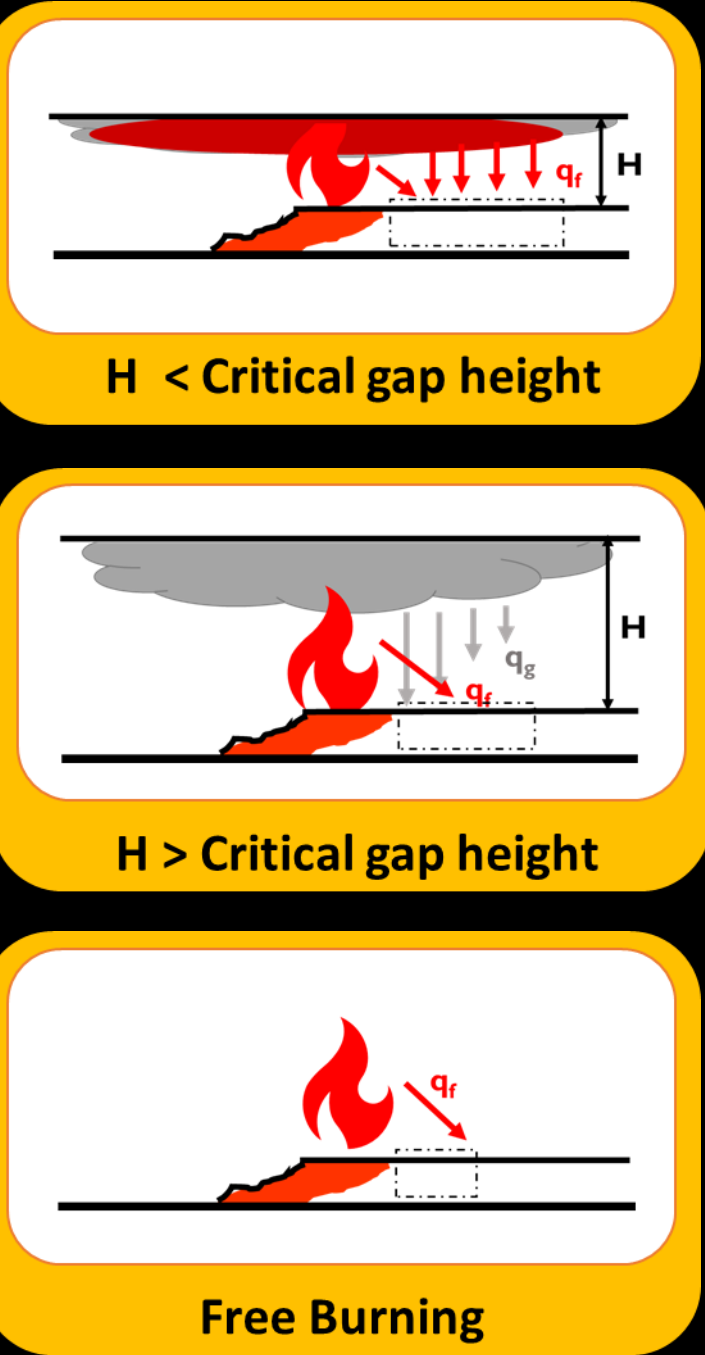
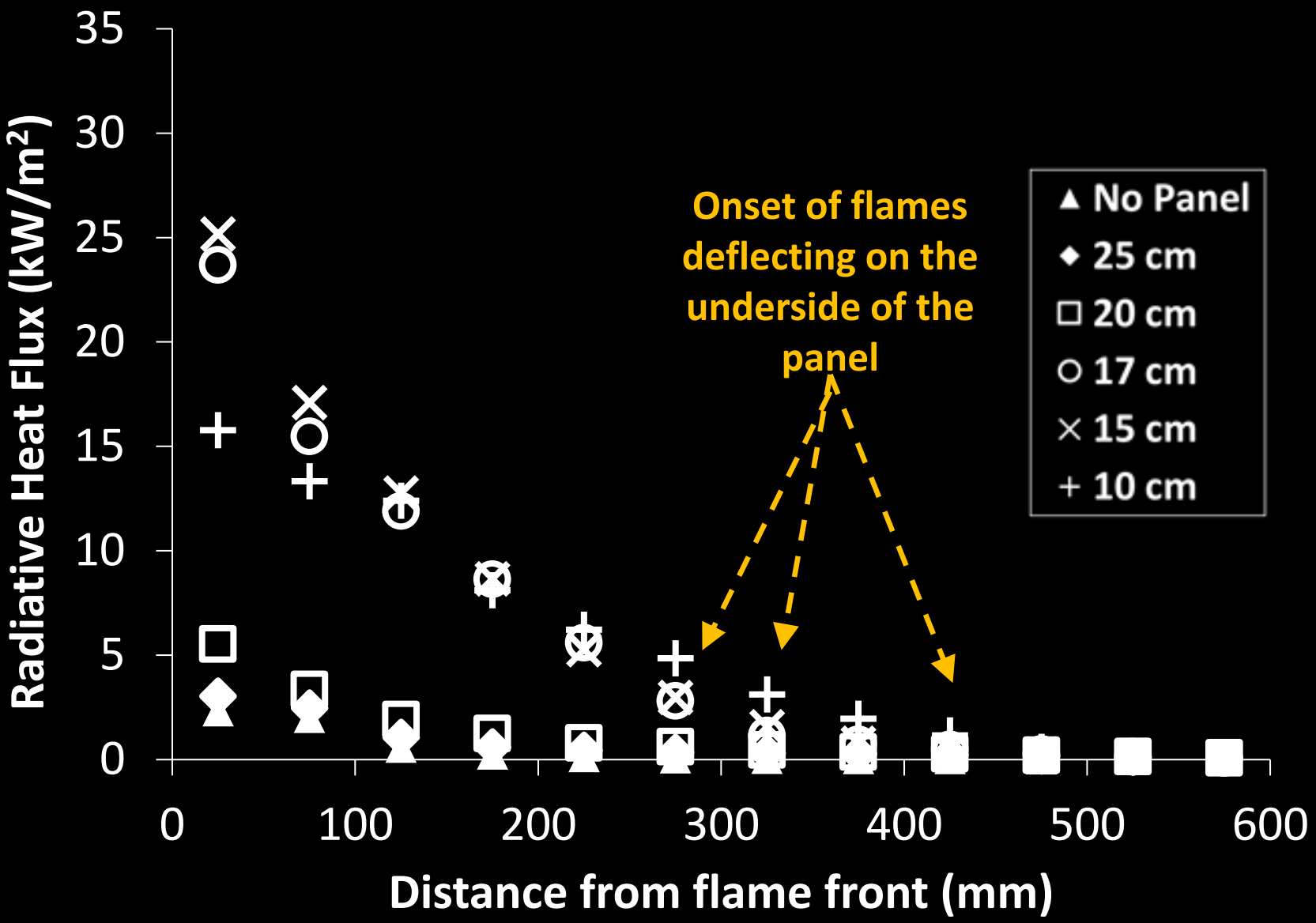


NOTE:
All 3 videos are at x 64 speed

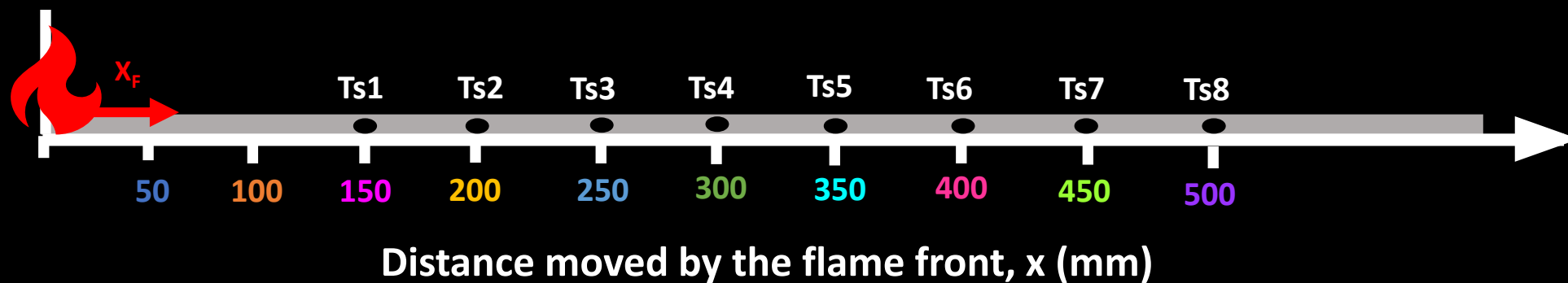
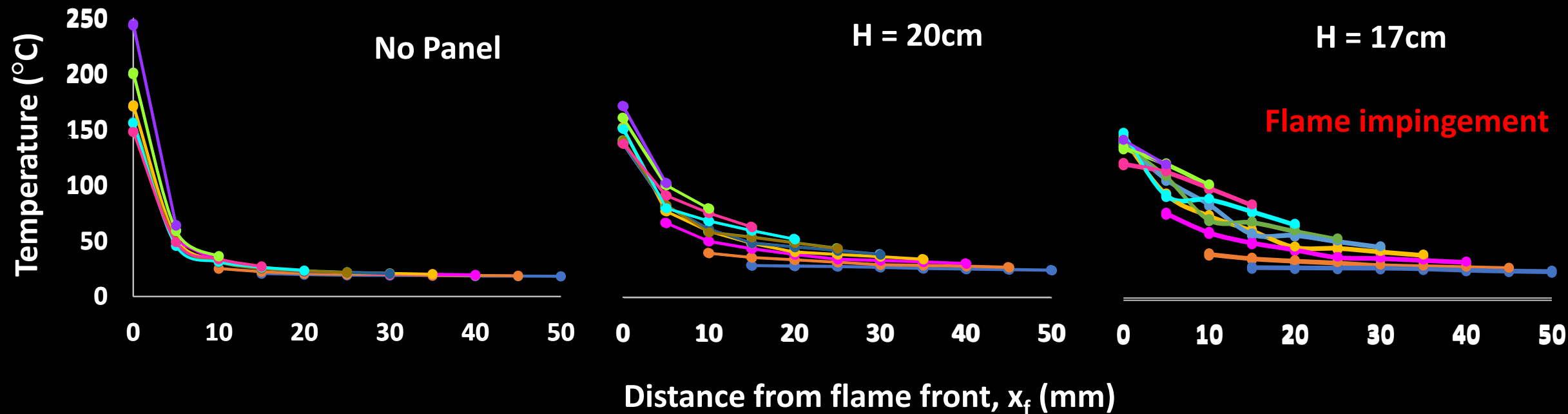
FLAME SPREAD RATE



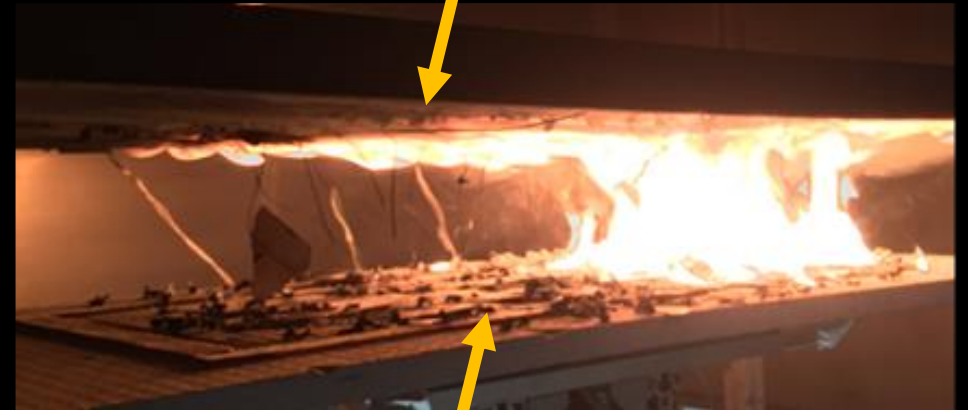
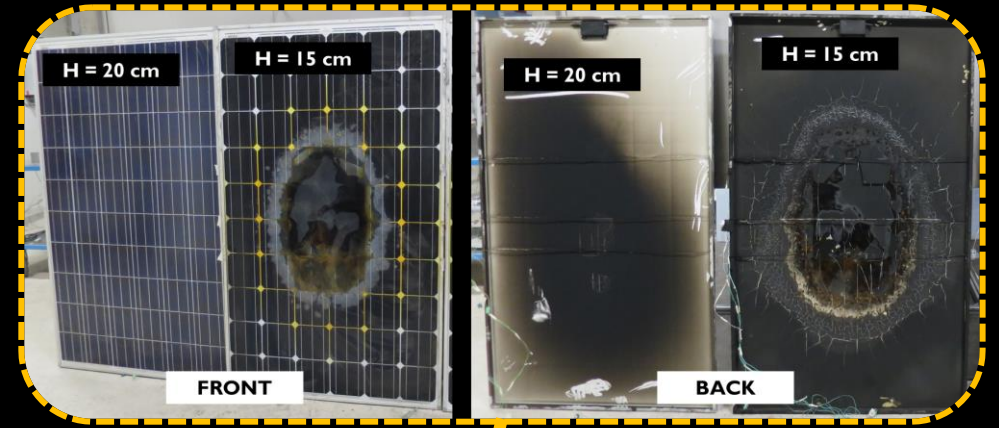
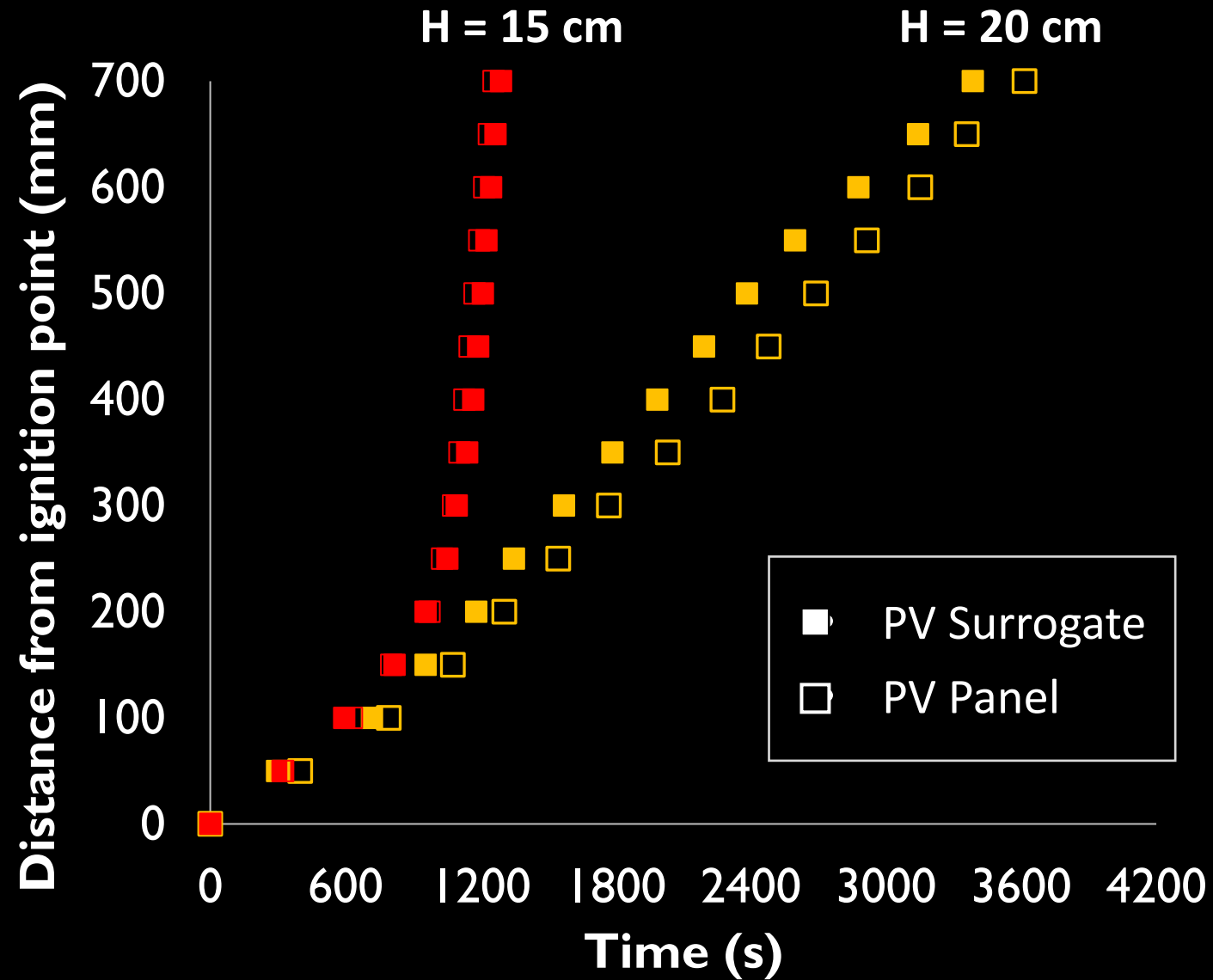
RADIATIVE HEAT FLUX



SURFACE TEMPERATURE



ACTUAL PV PANELS



CONCLUSION



**Presence of the critical distance
to limit fire spread**

**Potential mitigation measure to
reduce the effect of fire**

**Optimised PV installation design
against other considerations**

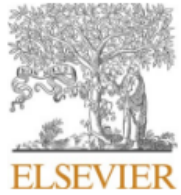


What's next...

Limitation of current test procedures

Further studies on applicability to actual installation parameters

Further work



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Fire Safety Journal

journal homepage: <http://www.elsevier.com/locate/firesaf>



Experimental study of flame spread underneath photovoltaic (PV) modules

Jens Steemann Kristensen^{a,*}, Farah Binte Mohd Faudzi^b, Grunde Jomaas^a

^a School of Engineering, BRE Centre for Fire Safety Engineering, University of Edinburgh, Edinburgh, EH9 3JL, UK

^b International Master of Science in Fire Safety Engineering (IMSFE), Ghent University, B-9000, Ghent, Belgium

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Fire growth

ABSTRACT

The horizontal flame spread underneath a photovoltaic (PV) module (or a plate) was studied for various gap heights to understand the fundamental fire dynamics between it and a flat roof construction. In a number of experiments, an opaque black polymethyl methacrylate (PMMA) and a black stainless-steel plate were used as surrogate fuel and module, respectively. Additional experiments were conducted with actual PV modules to analyse the reproducibility of the surrogate results and to study the potential effect of the small fuel contribution from the PV modules. PMMA samples (70 cm long) of varying widths (20 cm, 30 cm and 40 cm) were ignited at one end, and flame spread rate, mass loss, radiative heat flux and temperatures were recorded. For the 30 cm wide samples, a reduction in gap height from 20 cm to 17 cm resulted in a significant increase in the flame spread rate (from 0.37 mm/s to 2.41 mm/s). A similar critical gap height (transition into a much faster flame spread rate) was identified for all widths. Thus, introducing gap height requirements into PV installation standards could offer an inexpensive and elegant design that could reduce the fire risk associated with PV modules on flat roofs significantly.

IAFSS 2021 presentation:

Go to [youtube.com](https://www.youtube.com) -> Edinburgh Fire ->

Experimental study of Flame Spread
Underneath Photovoltaic (PV) Modules

<https://www.youtube.com/watch?v=PwmzZ26vEYU&list=PL0-kcF7cwWfdKMLN6qo--FBtXDghDukji&index=3>