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## **First mechanical study on a lightweight microconcentrator design for space applications**

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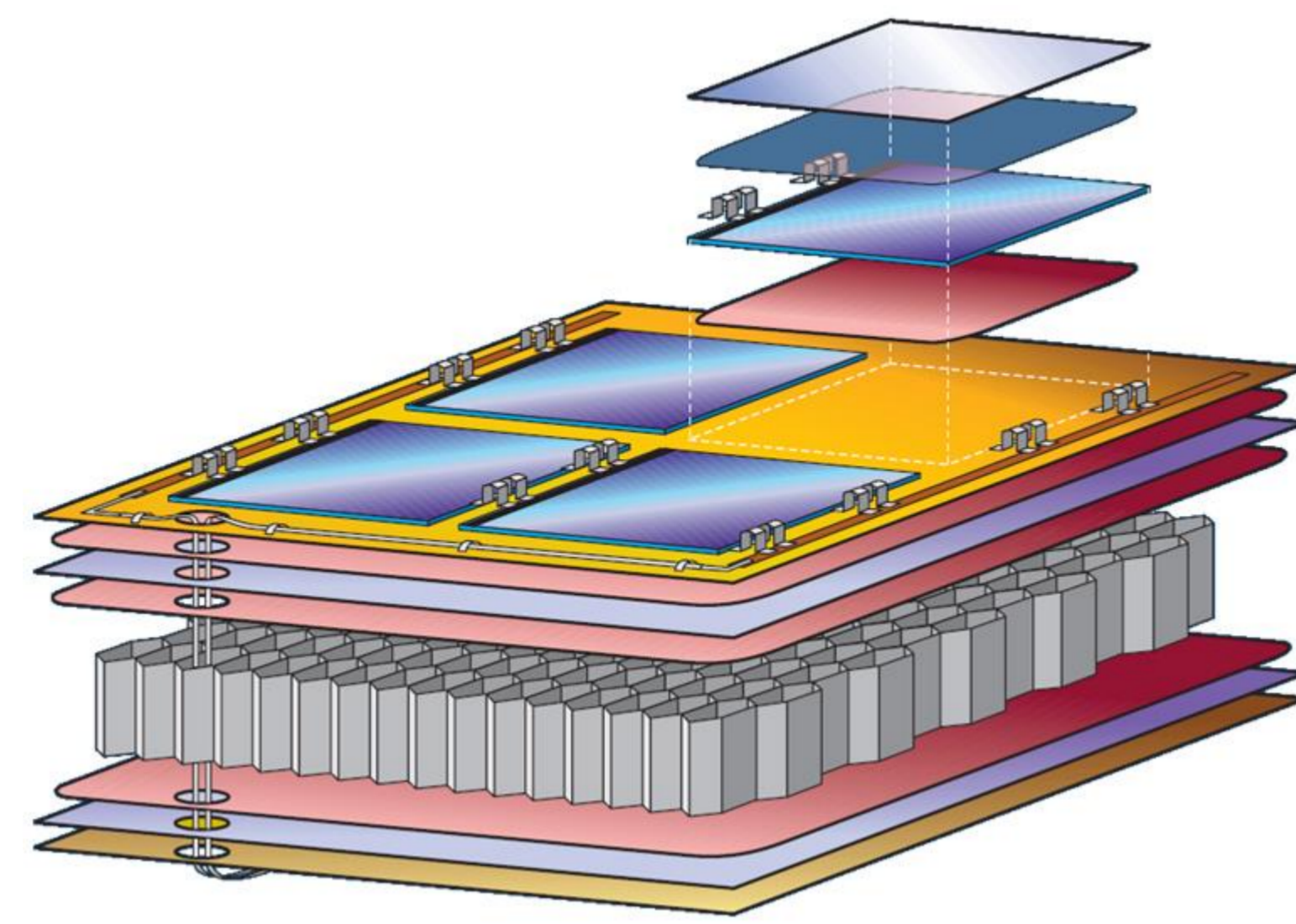
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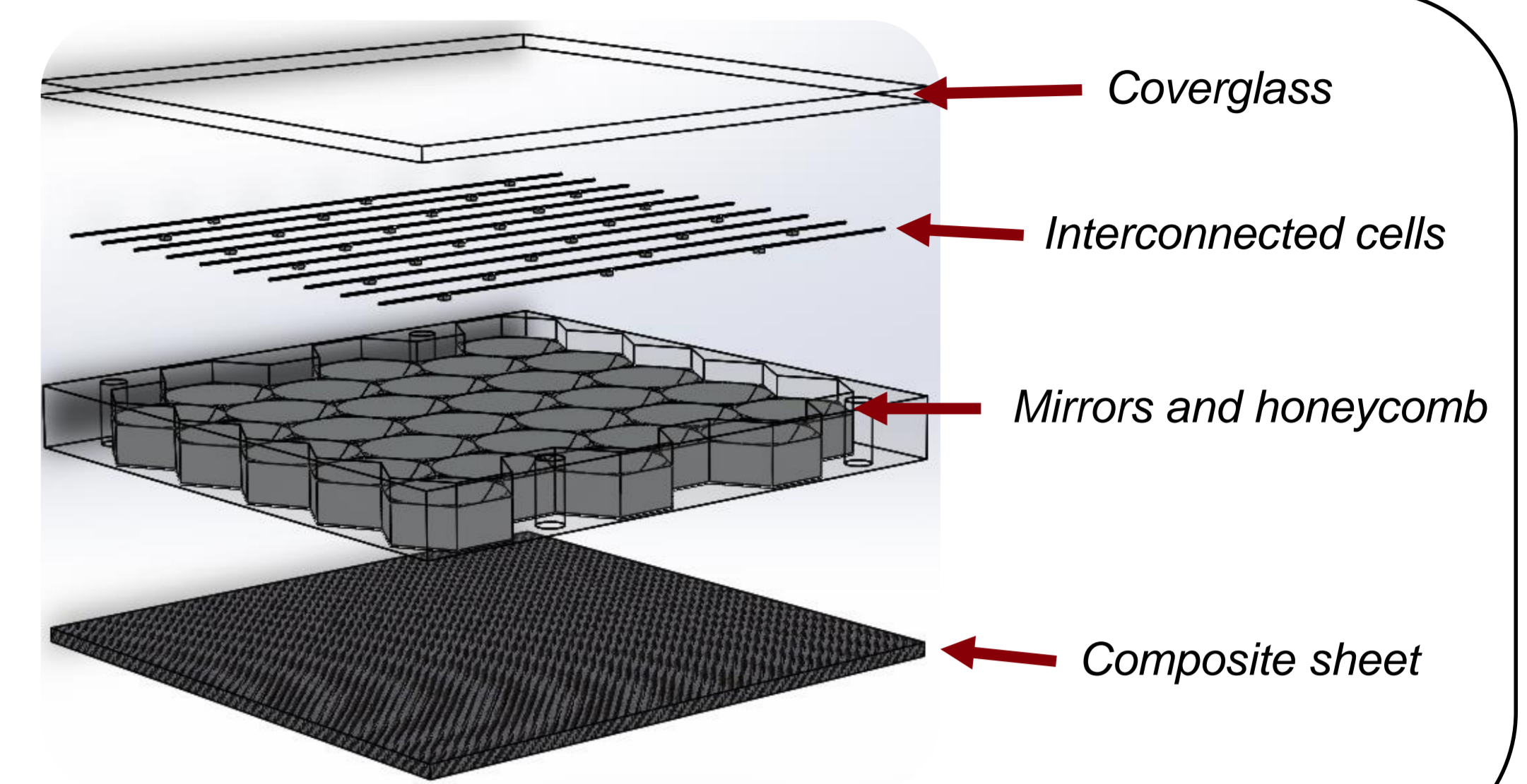
## Context & objectives

Low cost trends in Space:

- Concentration to reduce cell cost
- Lightweight to reduce launch cost
- Innovative design proposal
- **Need to study the mechanical behaviour of the design**

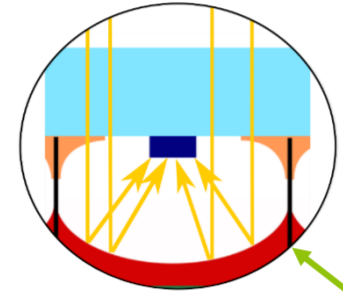


Standard rigid panel [1]



Exploded view of our concentrator design [2]

## Methodology

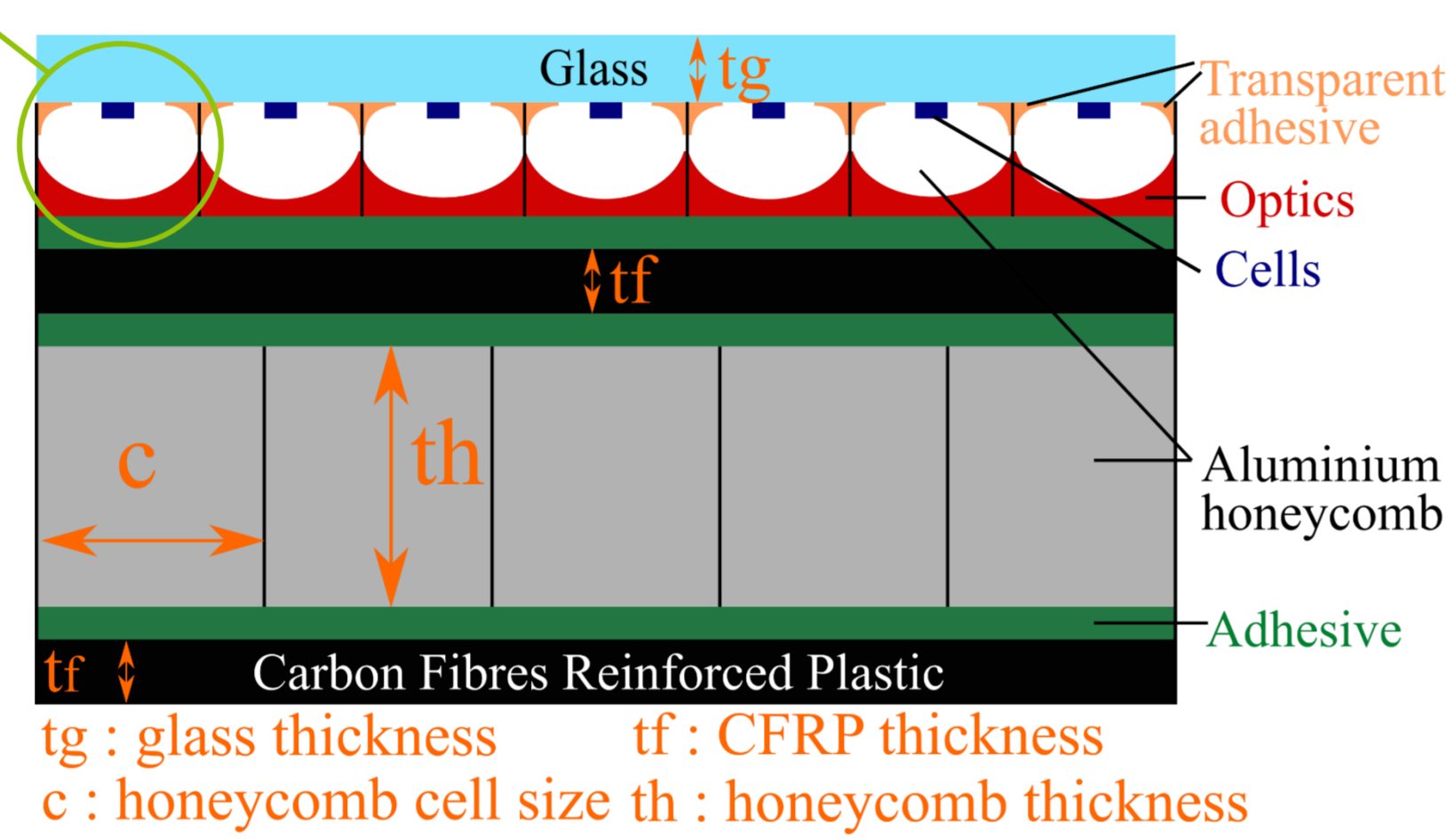


### Parametric study

- CFRP thickness ( $t_f$ )
- Glass thickness ( $t_g$ )
- Honeycomb thickness and cell size ( $th$ ,  $c$ )

### Design of experiments

- Get the main effects
- Limit the number of experiments



$t_g$ : glass thickness     $t_f$ : CFRP thickness  
 $c$ : honeycomb cell size     $th$ : honeycomb thickness

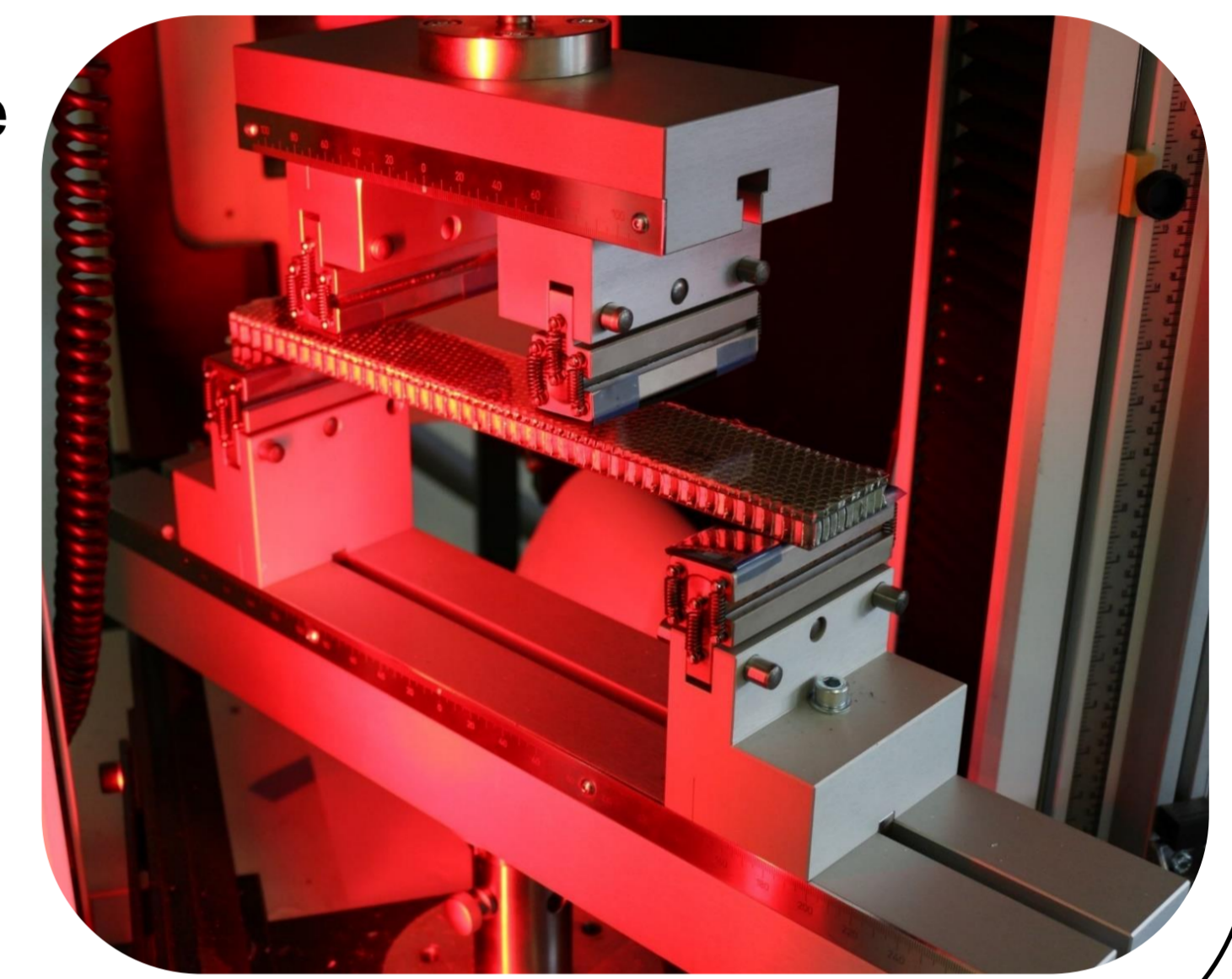
## Materials

### 4 - point bending tests

- ASTM D7250 [3] conforming machine
- Video extensometer
- 5 samples for each configuration



Sample configuration #8



4-point bending setup

## Results: bending stiffness

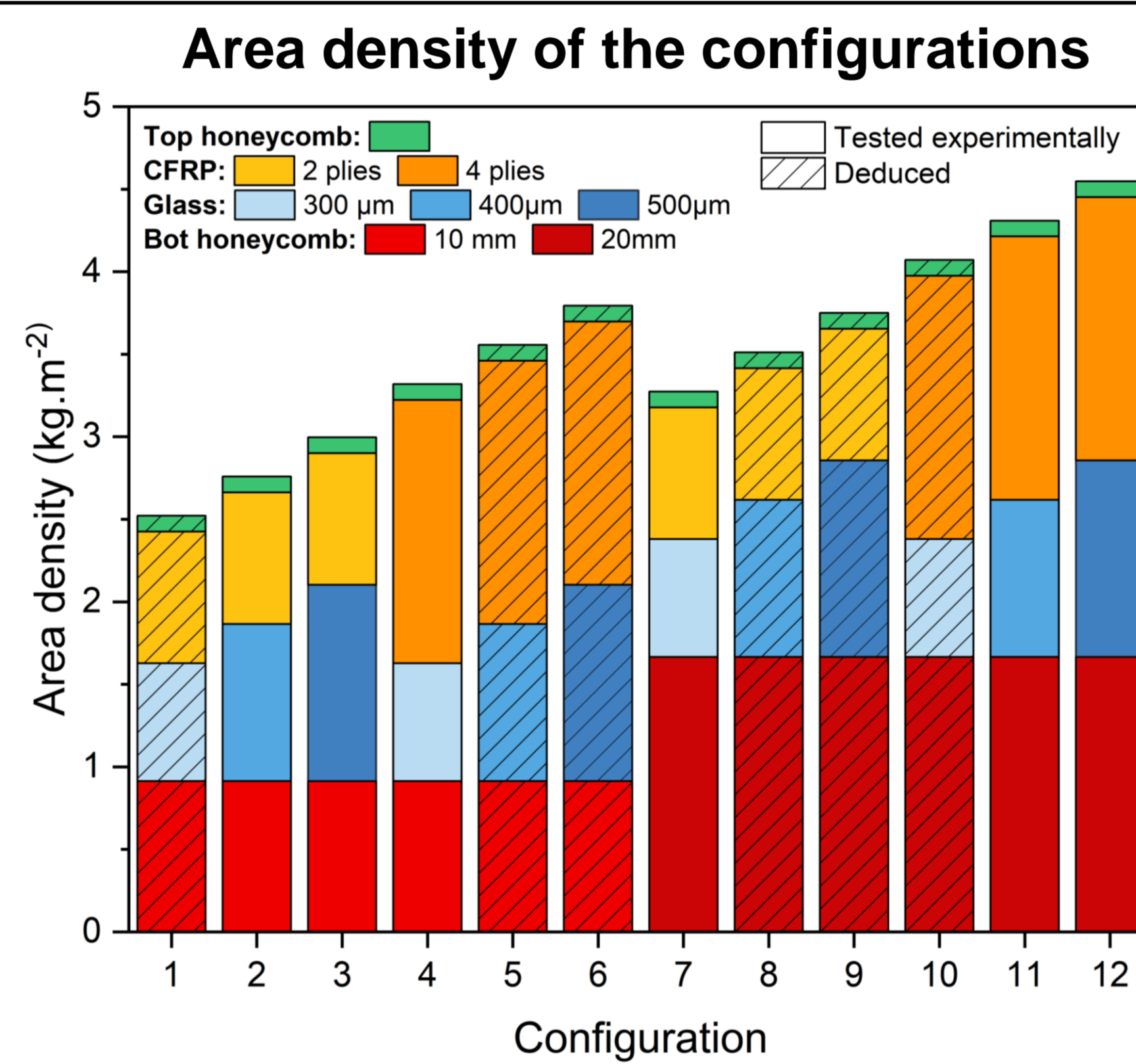
High density honeycombs were used and proved to be quite heavy

Higher specific stiffness with a thicker honeycomb

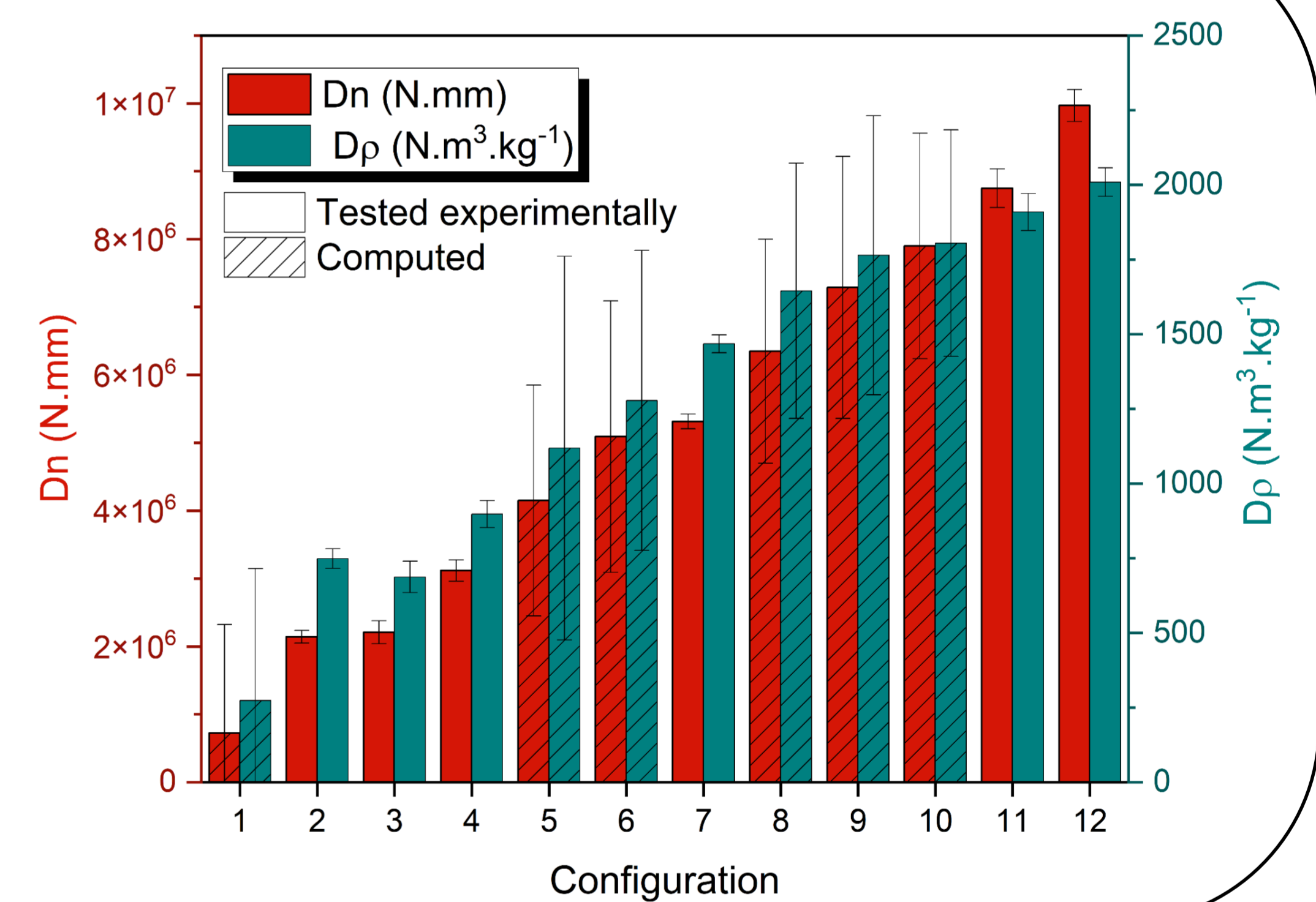
- Possibility to decrease its density without changing the mechanical behaviour a lot

Glass thickness has a lower influence than the other two parameters

- Possible way to decrease the mass of the structure



## Bending stiffness for each configuration

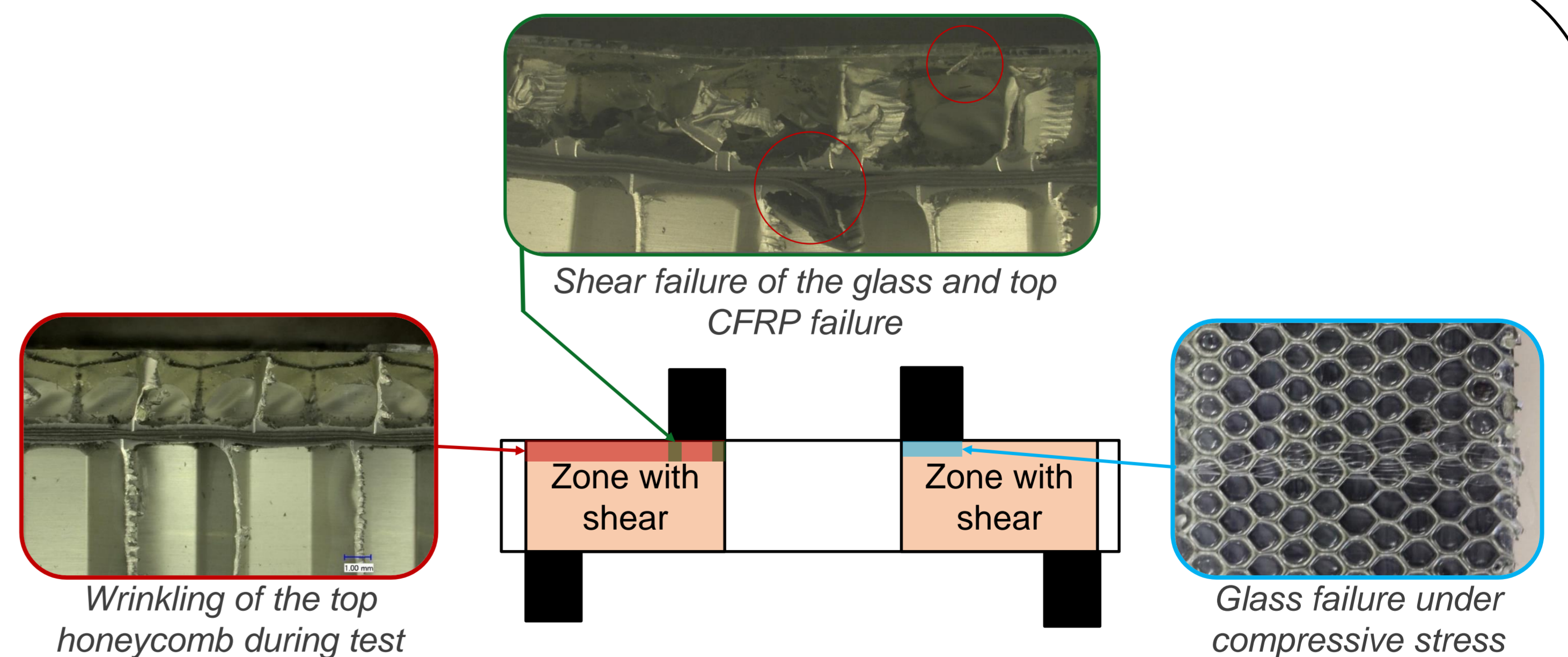


## Results: failure modes

### Different phenomena were observed:

- Glass failure below the loading areas: local compressive stress
- Glass failure on the edges of the loading areas: local shear stress
- Crushing of the top honeycomb
- Failure of the top CFRP → compressive stress
- Failure of the bottom CFRP → tensile stress

For some samples with thicker glass and thinner CFRP, the glass did not break during the test



## Conclusion & Perspectives

- The bending stiffness and area density of different  $\mu$ -concentrator designs was determined with 4-point bending tests
- Thicker glass (400, 500  $\mu$ m) and thinner CFRP (2 plies) is useful to prevent glass failure
- A thicker honeycomb (20 mm) and a thinner glass (300  $\mu$ m) help decreasing the mass
- Compromise to be determined: configurations 8 and 11 seem to be the most promising ones
- Prospect: Finite Element Method simulations in progress

## References:

- [1] R. W. Francis, C. Sve, and T. S. Wall, "Thermal Cycling Techniques for Solar Panels", Crosslink Fall, Vol. 6, No. 3, 2005
- [2] A. Bermudez-Garcia, P. Voarino, O. Racourt, patent pending, Concentrateur optique à structure alvéolaire, FR2013856, 21/12/2020.
- [3] ASTM D7250/D7250M standards: Standard Practice for Determining Sandwich Beam Flexural and Shear Stiffness, 2020

## Acknowledgments:

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