

# **New Space Solar Generator – An Integrated Design and Manufacturing Approach**

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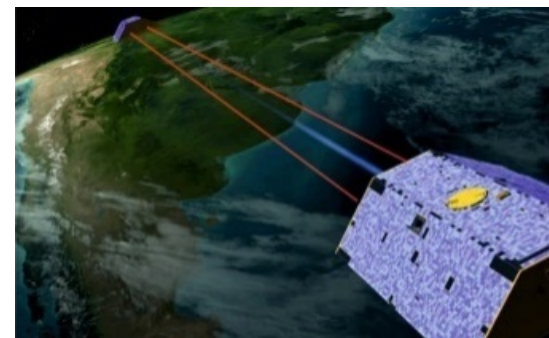
## Agenda:

- Introduction SpaceTech Immenstaad (STI)
- STI New Space Solar Generator Approach
- CFRP Sandwich Substrate
- Photovoltaic Assembly & Laydown
- Deployment Mechanism
- Qualification Status
- Flight Model Design Example

Foundation: 2004 - Staff: ~90 - Yearly Turnover: ~ 20 M€ - Annual Growth: ~10%

## GRACE Follow-On

- Prime for German Laser Ranging Interferometer part
- Ranging noise  $80 \text{ nm}/\sqrt{\text{Hz}}$
- In orbit since 2018
- LISA technology demonstrator



## ICARUS

- Tracking of Animals from Space
- ISS Payload, attached to Russian Module
- In orbit since 2017



## OneWeb

- Solar Array Deployment System
- 6 Pilots launched in 2019





Having extensive heritage in solar generator system engineering since our foundation in 2004, SpaceTech GmbH (STI) has recently focused on the development of our own in-house solar generator manufacturing capabilities with the following objectives:

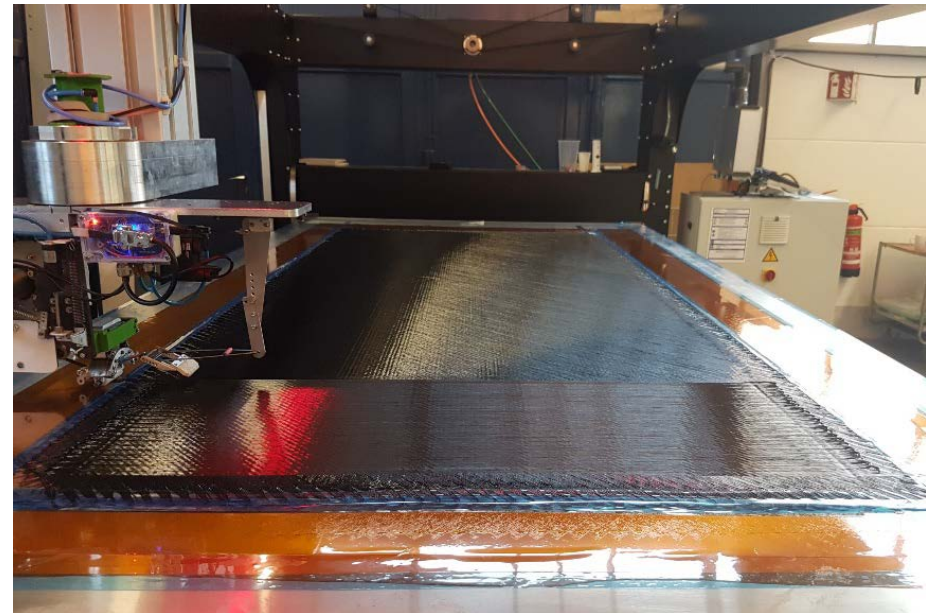
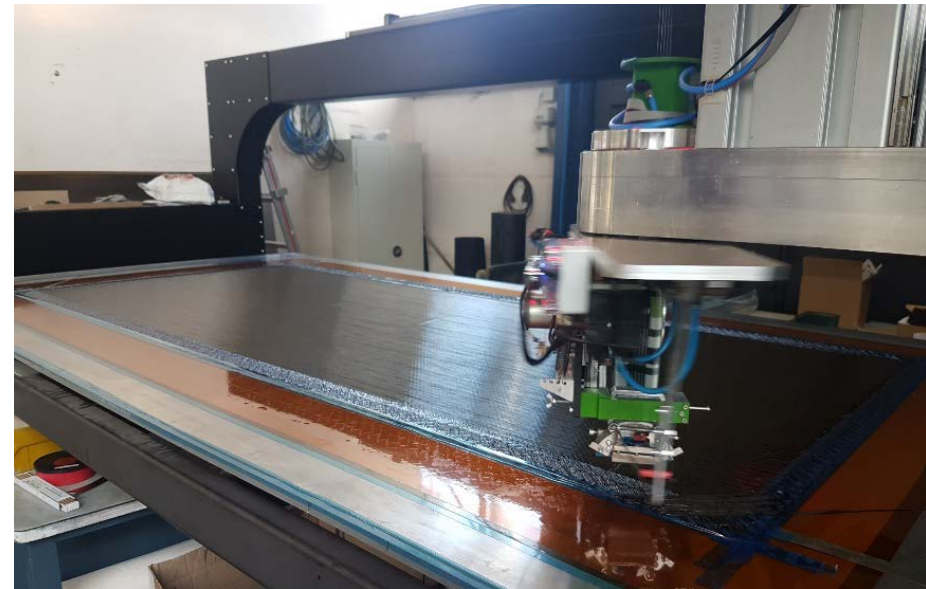
- Manufacturing of all main components apart from CICs
- Highest possible degree of automation
- Autonomous in-line process control and monitoring
- High throughput, low cost
- Full qualification of all subsystems by Q2 2019





# CFRP Sandwich Substrate

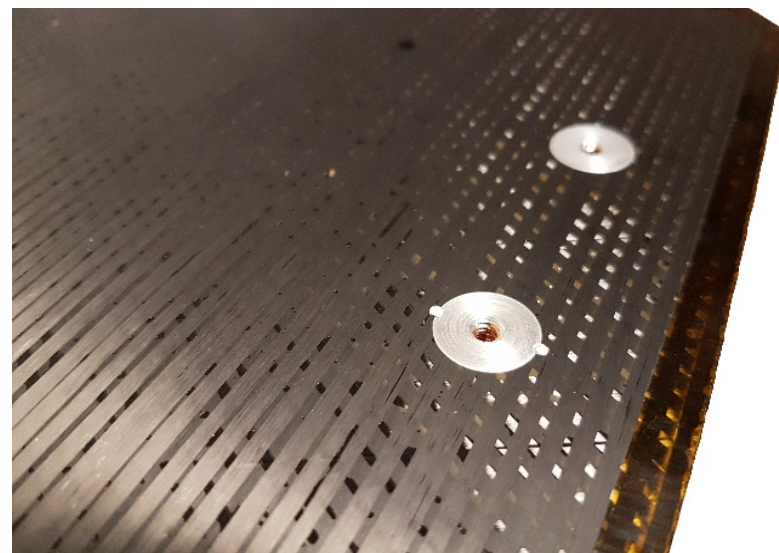
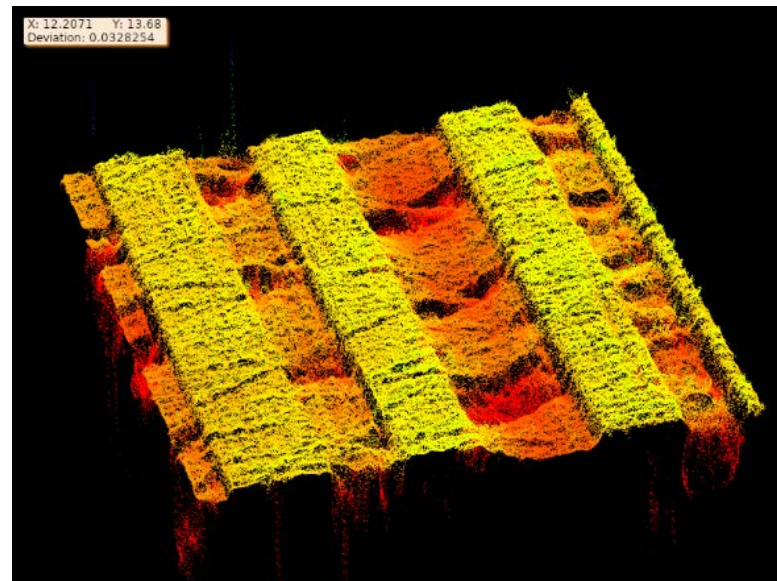
- In-house (STI & CST) developed wet filament placement process
- Using dry fiber from spool
- Freedom of choice to combine any resin and fiber system
- Optional integrated bonding process with polyimide foils
- Free choice of layer angles 0 – 360°
- Optional open fiber grid for extremely thin and lightweight face sheets



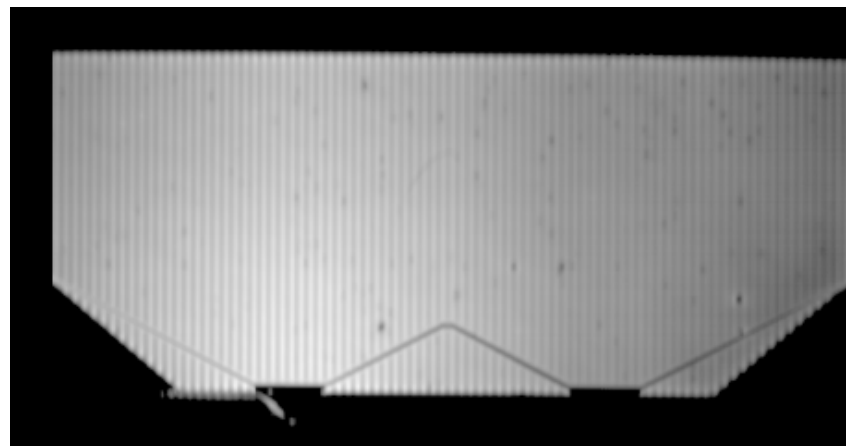
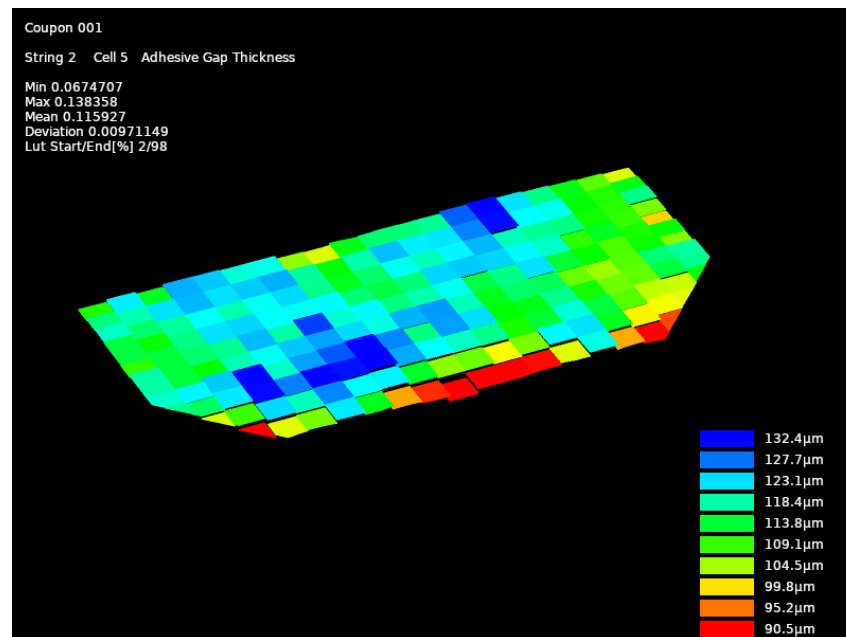


# CFRP Sandwich Substrate

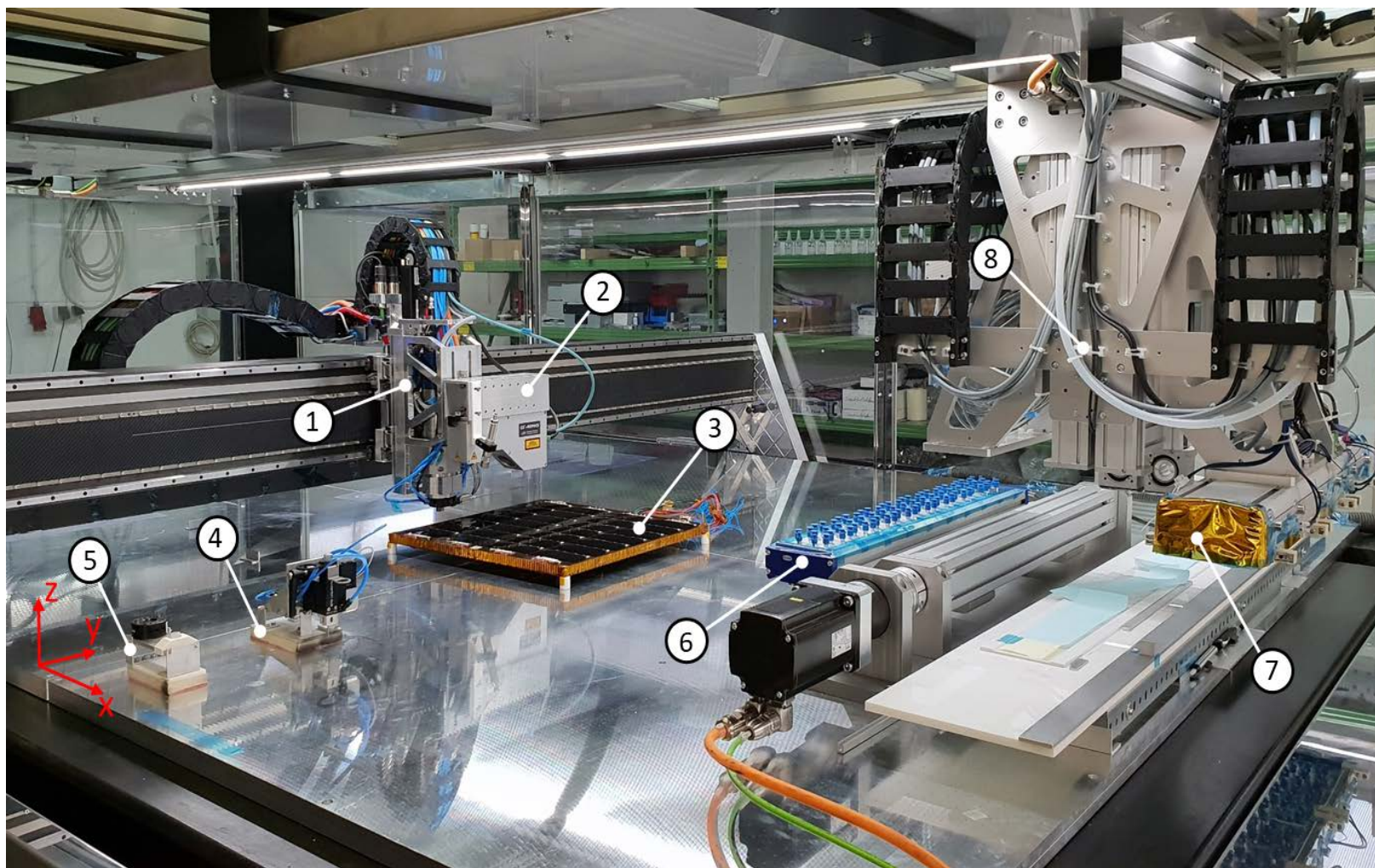
- In-situ hot press sandwich curing
- No pre-curing of face sheets required, complete sandwich is cured in one single step
- No autoclave required, thus significantly reducing time, cost and resources
- Fully automated insert potting, fixed by core splice adhesive allowing to place solar cells over rear side inserts without the risk of cell damage



- Fully automated PVA laydown process:
  - Primer application
  - RTV adhesive dot dispensing
  - CIC (SCA) Pick & Place
- In-line process control and monitoring:
  - High resolution visual inspection
  - 3D topology
  - Electroluminescence
  - Photoluminescence
- Deep learning based analysis:
  - Real time process evaluation
  - Process self-optimization







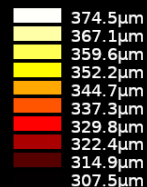
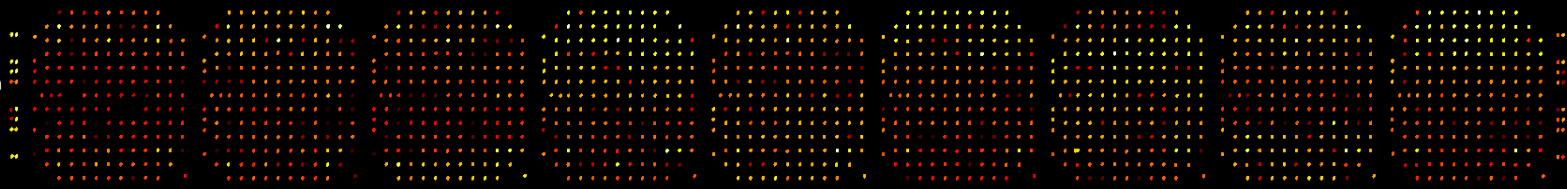
1) Portal machine's X-Y-Z-axis, 2) Inspection Head, 3) Substrate, 4) RTV dispensing tool, 5) Primer tool, 6) Flipper unit, 7) Heating & Handling tool, 8) Pick & Place unit



# RTV Dot Application In-Line Process Control

Dot Heights  
String 3

Mean: 343.8 $\mu$ m  
St.Dev.: 4.5%

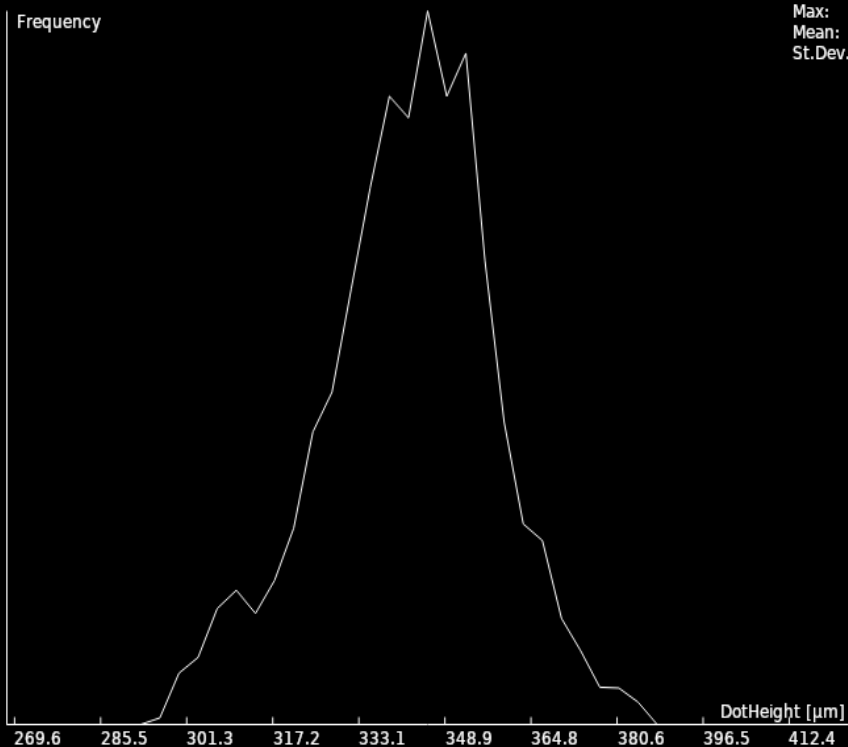


## Full Panel Dot Height Histogram

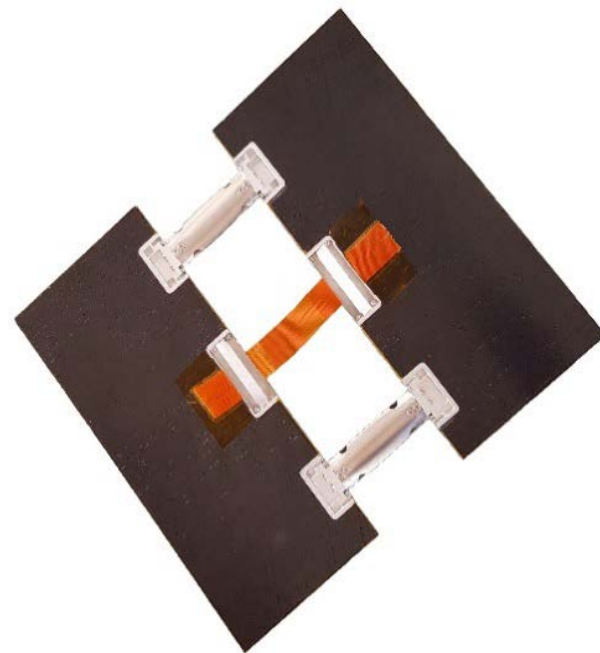
Frequency

Dot Heights

Min: 298.5 $\mu$ m  
Max: 387.5 $\mu$ m  
Mean: 343.8 $\mu$ m  
St.Dev.: 4.6%

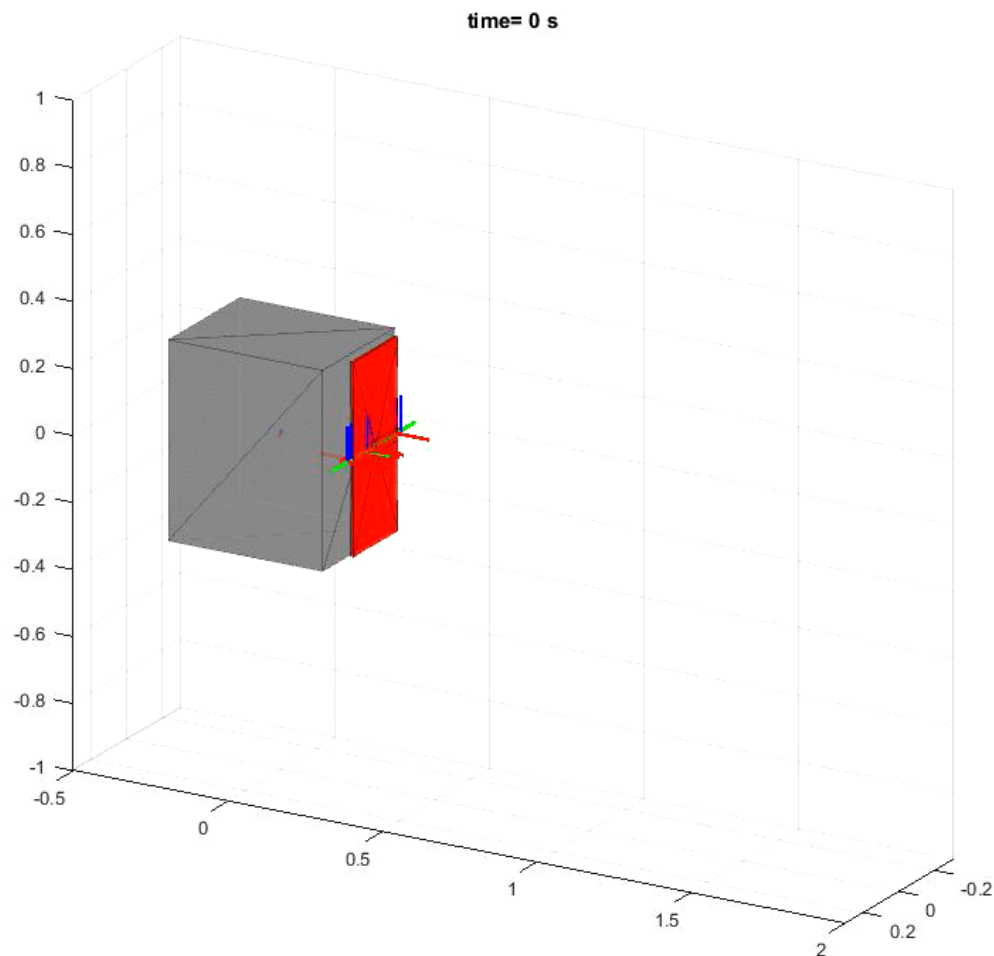


- Smart C-hinges with soft latch
- Significant cost and weight advantage compared to synchronized concepts
- Kick springs avoid chaotic deployment and guarantee a narrow and specified deployment corridor
- Extensive Monte Carlo multi-body simulation (MBS) variations analyzed
- Almost no non recurring cost for new missions

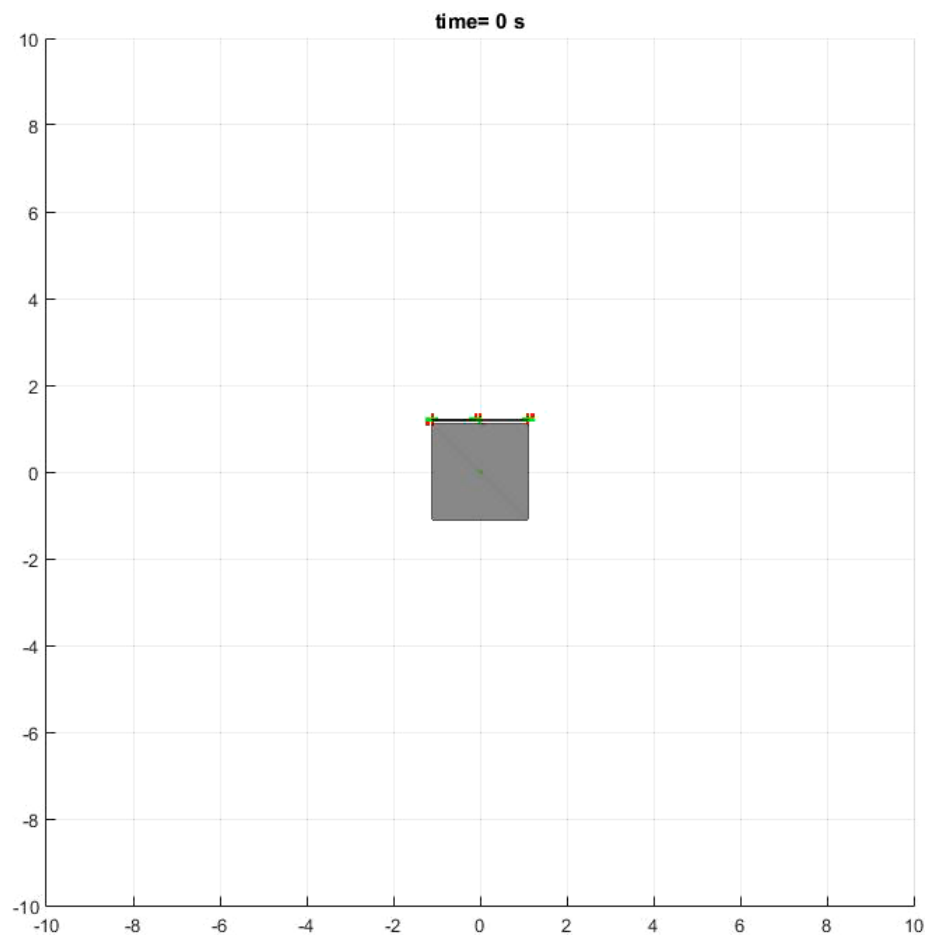




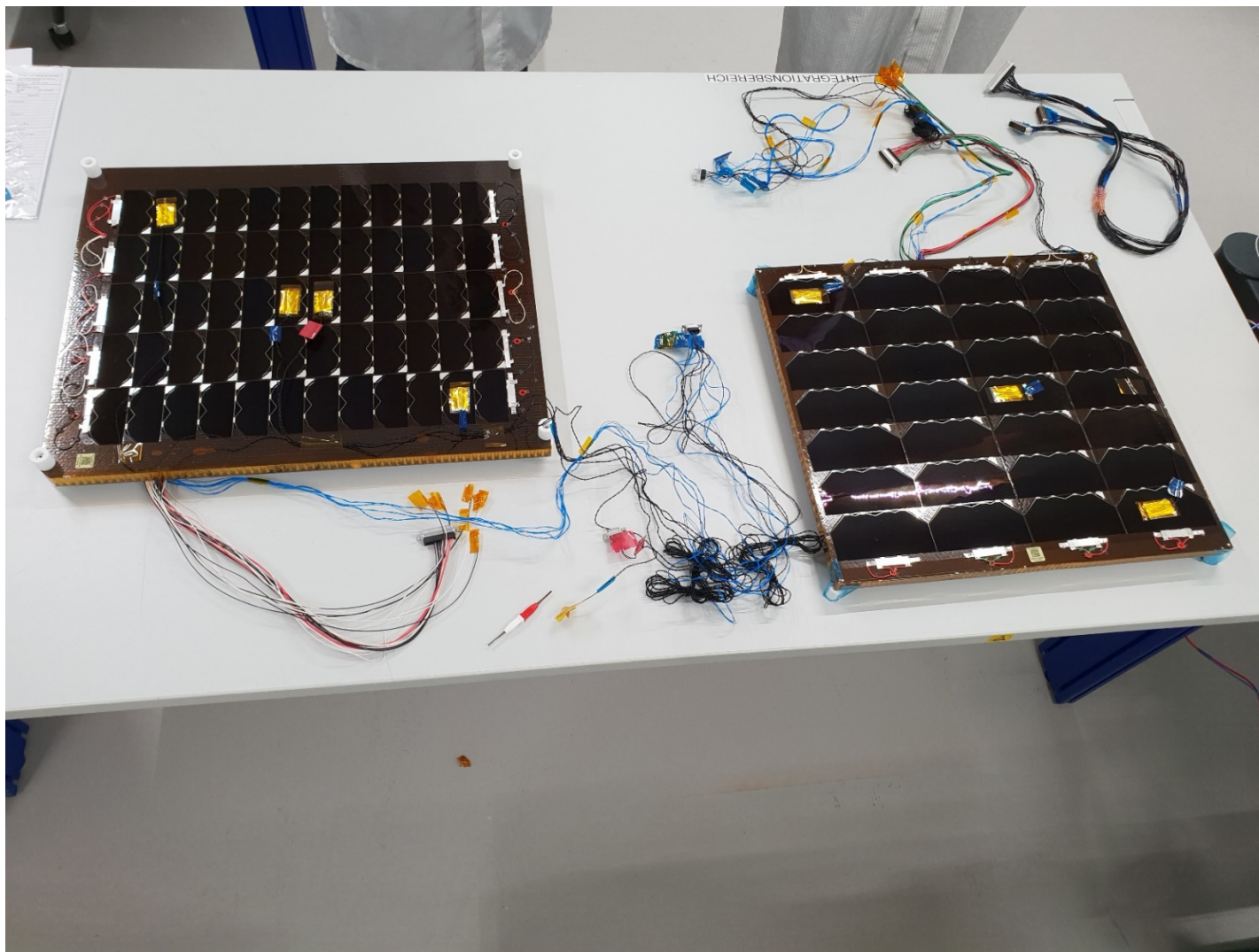
- 4 small panels, e.g. LEO SmallSat
- Simultaneous release of 5 hinges, no synchronization
- High deployment speed



- 3 large panels, e.g. GEO
- Simultaneous release of 4 hinges, no synchronization
- Slow deployment speed,  $3^\circ/\text{s}$



## New Space Solar Generator Coupon 01 & 02 Post-TVAC Inspection



- CFRP Sandwich Substrate:
  - Full qualification completed
  - Flight heritage in several missions
  - SpaceIL moon rover landing on 11<sup>th</sup> of April 2019
- Photovoltaic Assembly:
  - Qualification ongoing
  - All tests until APTC completed
  - 8x -170°C, + 150°C TVAC cycles passed successfully
  - More than 15,000 APTC cycles without any major issues
- Deployment Mechanism:
  - Established highly advanced multi body simulation
  - OneWeb production and flight heritage
  - Correlation and verification with 0-g test stand





# 0-g Test Stand Deployment Verification





# STI New Space Solar Generator Design Example

Smart C-Hinges, In-Situ CFRP Panels, 480W EOL, FM Delivery Q1 2020







Launch your visions

Thank you very much for your attention.