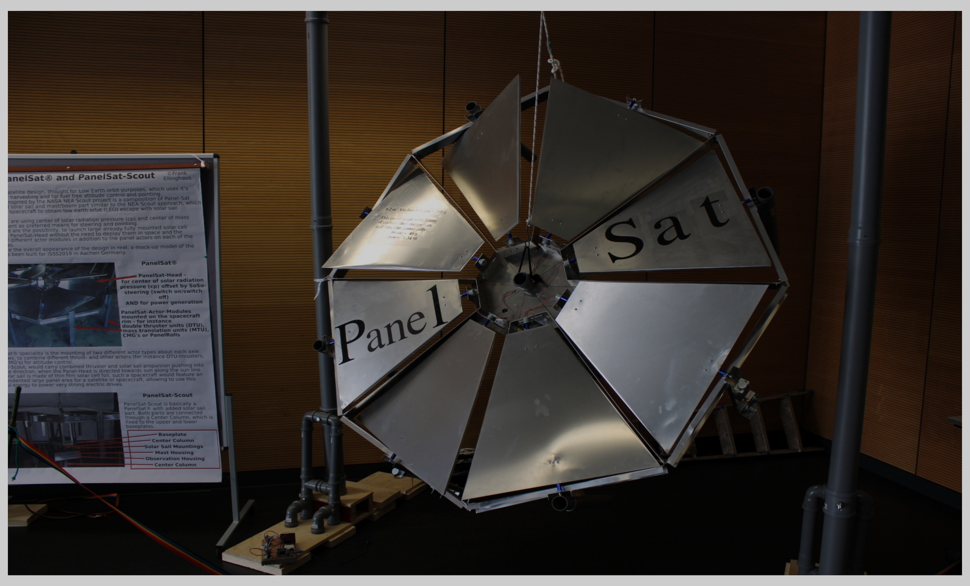
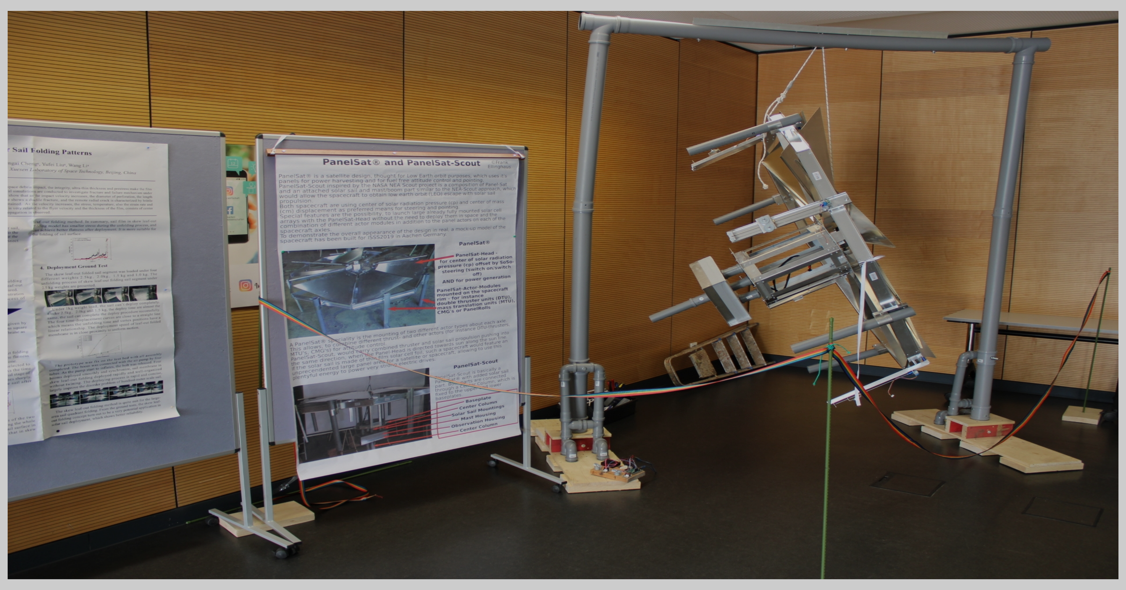
PanelSat GmbH
author and CEO Frank Ellinghaus
info@panelsat.info
https://panelsat.info

The Beginning - ISSS 2019





bulky, manually constructed 1.8 m model.
It couldn't orient itself, and the motors weren't strong enough to move the panels, when pointing towards earth center.

First 3-D-printed Mini.-Model
(about 50 cm diameter)

-- A milestone
It helped us grasp the physical symmetry needed und what was missing: - - dynamic balance

First 3-D Mass-centered Test Model,
yet no panels

Suspending the PanelSat® model from a thread revealed an important behavior. it did self-align.

One of the octagonal edges consistently pointed toward Earth's center, forming a stable orientation.
This passive alignment occurred without any sensors, motors, or software — purely through gravity and internal balance.
We identified two distinct rotation centers:
– the geometric center of the panel ring structure,
– and the true center of mass between the two structural rings — close to the point where the actual thread is attached to the connecting tube between both ring structures.

This inspired the idea of a "virtual thread axis" — an imagined axis that a well-balanced satellite might naturally align with, even in orbit, without any external force.
While I can't yet prove this behavior in space, it aligns with known tether experiments — and with my own earlier tests, where the 5-V-stepper-motors could no longer rotate panels once they pointed directly toward Earth's center.
In short: gravity became not just a constraint, but a partner. The real thread on Earth could become a sensitive measurement tool — one that physicists and materials experts might use to predict the future behavior of a satellite in space.
Gravity, which we initially saw as an obstacle in our lab, had now become a tool for exploration.

Video Clip 1 Demonstrating Attitude Shift Through Mass Displacement
https://panelsat.info/Downloads/MassDisplacementShifting.mp4

In this first clip, I demonstrate two core motion modes of PanelSat's MSU-based (MSU=Mass Shifting Unit) control:
First, both MSU-masses shift into the same direction — this causes the satellite to tilt.
Why? Because the center of mass moves to one side, and the entire system leans toward it.
This behavior was verified by attaching a single weight to one side of the model – it tilts immediately.
Then, I mimique the reversal of two masses, creating opposing motion by pushing it with both hands.
This doesn't shift the overall center of mass, but it does generate angular momentum – the model rotates.
What you see here is the core principle of MSU-based control:

- Tilting through net mass displacement
- Rotation through differential acceleration

Video Clip 2 Rotational Reversal:
https://panelsat.info/Downloads/RotationalReversal.mp4
The model has slowed down after six full rotations.
It decelerates, stops, and reverses direction — all due to tension in the thread. Some of the deceleration may also be caused by air resistance — but the dominant effect clearly comes from thread tension.
Key Insight:
Although only 2 mm thick, a suspension thread exerts enough elastic counter-force to stop and reverse the rotation of a 4.5 kg, 1 m-wide satellite model — repeatedly, and without any electronics.
This oscillation happens multiple times.
It illustrates a key principle:
A tiny force — applied through the thinnest thread at the very center of the system — is able to reverse the rotation of a structure over one meter in diameter.
Not because of leverage — but despite the model's massive lever arms, compared to the tiny 1mm radius of the thread.
And that's the deeper point:
Gravity only acts along the thread axis.
So whether on Earth or in space, as long as the satellite rotates perpendicularly to that axis, gravity has no direct effect on the motion.
That's why what we observe here — rotation, slowing, reversal — tells us something real about how a satellite like PanelSat could behave in orbit.
And isn't that, in itself, reason enough to adopt this very axis as the reference frame for a gravity-guided attitude control system?