SpaceTech GmbH

Company Presentation

2/2018

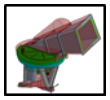
Company Profile

Systems


- Mission Design
- Small Satellites
- Constellations
- End-to-End Systems

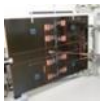
Instruments

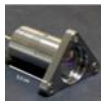




- Optical Instruments
- Ultra-Stable Instrument Structures & Mechanisms

Equipment

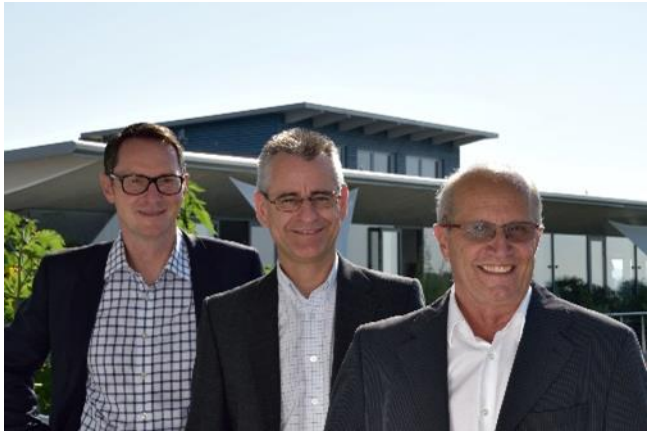




- Solar Generators
- Structures & Mechanisms
- Electronics
- Instrument Equipment

SpaceTech GmbH

Seelbachstrasse 9-11-13
88090 Immenstaad
Germany
www.spacetech-i.com



Executive Board: Wolfgang Pitz (CEO), Frank Gilles, Bernhard Doll (Founder)

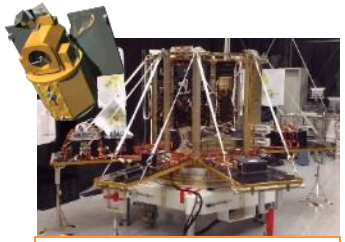
Facts & Figures

- Foundation: 2004
- Staff: 100 (avg. age 39)
- Yearly Turnover: 20 M€
- Annual Growth: ~10%
- Substantial Expansion in Progress

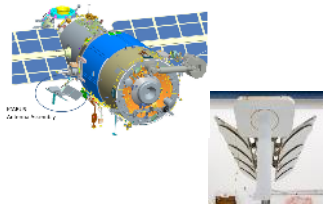
Company Heritage – onboard of 14 missions

Systems

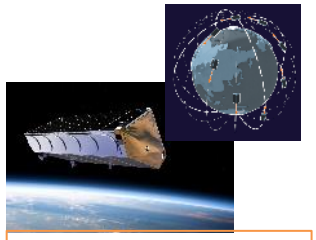
- Mission Design
- Small Satellites
- Constellations
- End-to-End Systems



Formosat-5



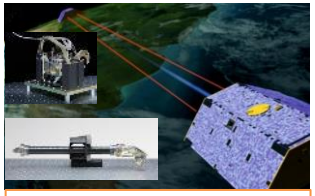
ICARUS



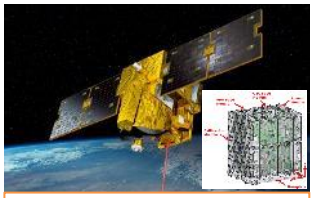
M2Space

Instruments

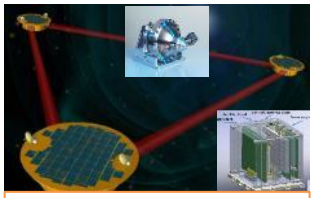
- Optical Instruments
- Ultra-Stable Instrument Structures & Mechanisms



GRACE FO LRI

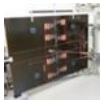


MERLIN FRU

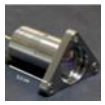


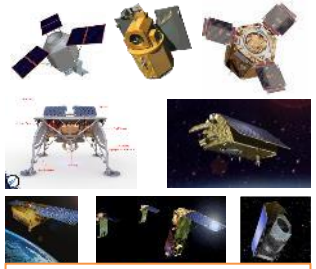
LISA/NGGM Laser

Equipment



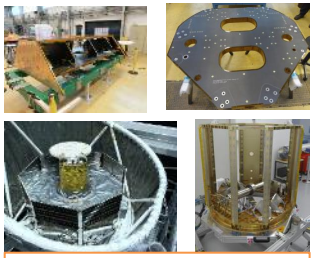
- Solar Generators
- Structures & Mechanisms
- Electronics
- Instrument Equipment





Solar Generators

GT2, FS5, S5P, Space IL, NGSAR,EUCLID,…



Structures

GRACE FO, Formosat-5 BepiColombo,…

Mechanisms

JUICE, Sentinel 6, GFO,GT2, FS5, S5P,…

Company Profile - Facilities

Clean Rooms

- ISO 8 / class 100,000
- ISO 7 / class 10,000
- ISO 5 / class 100

Manufacturing Capabilities

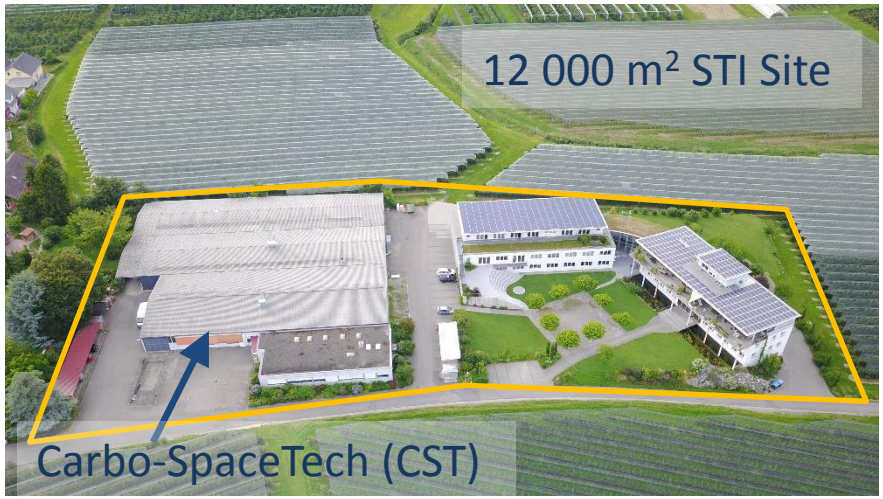
- Electronic labs
- Mechanical workshops
- Laser-optics lab
- Mechanical integration hall
- Carbon Fibre production facility

Test Facilities

- Several thermal vacuum chambers
- Temperature cabinets
- Shakers and shock tables

STI Site Extension Plan

2017: Present



2018: new building G4

for Solar Generator Factory, STI and CST Offices

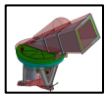
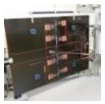
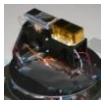
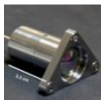
2020+: new buildings G5 and G6

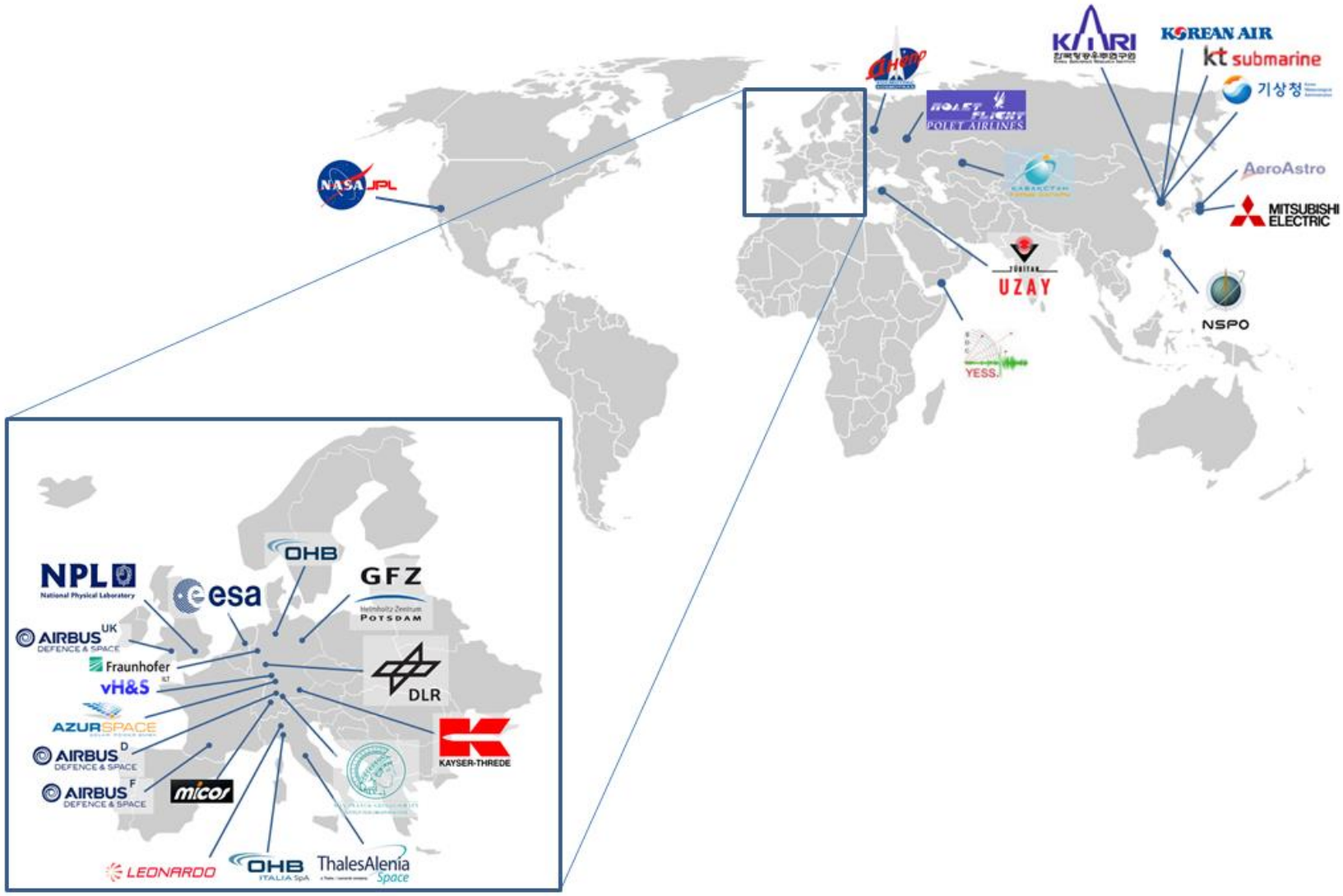
EV Tests and Cleanroom, STI and CST offices

SpaceTech Customers & Partners





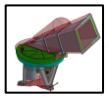
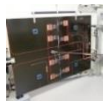
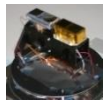
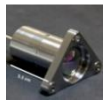







Company Organization





Executive Board
W. Pitz (CEO), B. Doll, F. Gilles, T. Franck

Finance, Administr. & IT
F. Gilles

Business Development
K. Nicklaus

Systems
W. Pitz

Solar Arrays & Mechanical Products
T. Franck

Electrical Products
J. Krieger

Payloads
K. Voss

Carbo-SpaceTech (CST)
66% STI Share

Product Assurance

System, Electrical & SW Engineering

Mechanical & Thermal Engineering

AIT & Facilities

Senior Experts

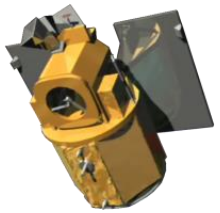
Small Satellites & Missions

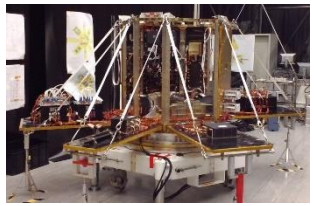
Missions & Satellites

SpaceTech develops small satellites, providing low cost solutions for a wide range of applications.

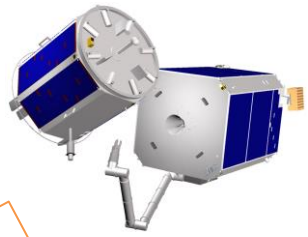
- Formosat 5
  - "Satellite Kit"
  - Sys. Eng. Support, Procurement
  - Structure, solar generator, propulsion, sun sensor
  - Launched in 08/2017

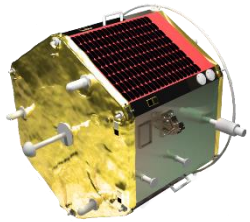
In Orbit





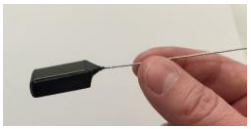
- DEOS
  - Phase A prime, Phase B Client prime
  - Mission/satellite design
  - Design of the docking/berthing mechanism
  - Mission stopped by DLR after Phase B





- ICARUS
  - Tracking of animals from space
  - ISS payload, attached to Russian Module
  - Launch scheduled for October 2017

FM delivered
Launch 3/2018



M2Space - Initiative

Missions & Satellites

Making M2M Communication Global

- The IoT market is large and growing fast from 20 B$ today to 75 B$ in 2025 (IHS Forecast).
- Applications with demand for global connectivity are currently restricted by the reach of terrestrial networks, covering only 90% of the IoT market.

SpaceTech has started an initiative for the implementation of a satellite-based IoT Service:

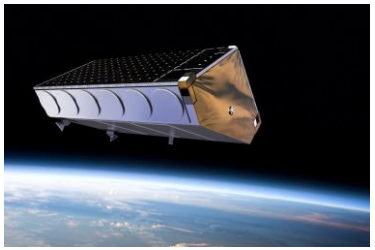
- M2Space Constellation Gen 1 / Tranche 1 until 2021: 4 Satellites - latency ~3 h (< 7h)
- M2Space Constellation Gen 1 / Tranche 2 until 2023: 12 Satellites - latency ~ 1h (<2h)
- M2Space Constellation Gen 2: 48 Satellites – communication in quasi-real-time

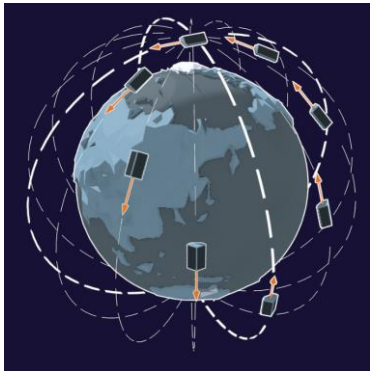
M2Space Unique Characteristics

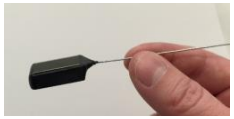
- Smallest Sensors with direct link to space
- Interoperability with existing terrestrial IoT- Systems and Smartphones
- Selectable channels for different Frequencies/Encoding
- SpaceTech leading edge payload technology with heritage

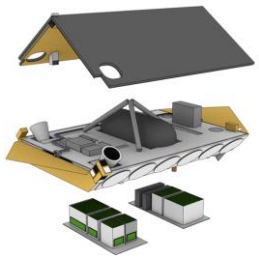
Status

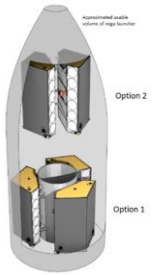
- Consolidation Phase started with venture capital funding
- Open for Anchor Customers/Channel Partners/Strategic Investors





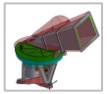






Optical Instrument activities - overview

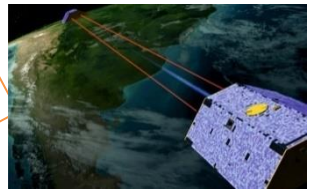
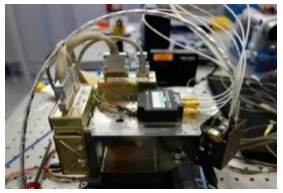


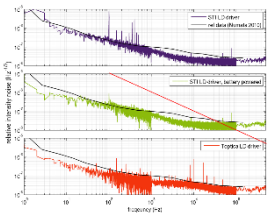


SpaceTech develops laser-optical systems with a focus on earth observation and science missions.

- GRACE Follow-On
  - Prime for German Laser Ranging Interferometer part
  - Cooperation with JPL/NASA
  - Ranging noise 80 nm/√Hz
  - Launch scheduled for March 2018

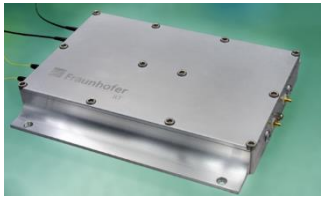
2 FMs delivered
Launch 3/2018

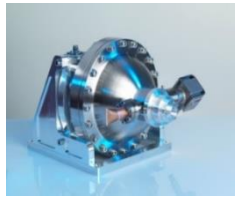





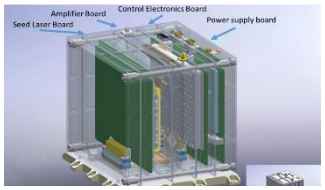
- MERLIN Frequency Reference Unit (FRU)
  - German-French mission on methane gas measurement
  - Subsystem for absolute frequency reference
  - FM delivery in 2018

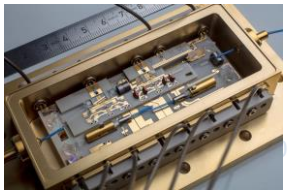
- High Stability Laser (HSL)
  - Laser system for NGGM, GRACE 2, LISA…
  - Fiber amplifier, reference cavity, control electronics
  - > 500 mW, frequency noise 40 Hz/√Hz < 1 Hz
  - EBB completed, component qualification running





- GWO Metrology Laser (BB, EM)
  - Laser system for LISA, 2 W output power



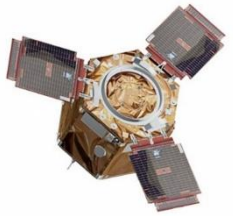


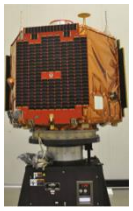
Solar Generators

SpaceTech develops deployable solar generators, with focus on dedicated solutions for Earth observation and science missions.

- GökTürk 2
  - Deployable solar array
  - Delivered in 2010
  - Launched in 2012

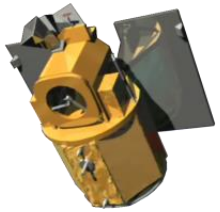
In orbit

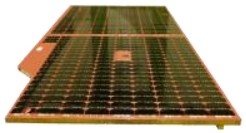




- Formosat-5
  - Deployable mounted solar array
  - Delivered in 2012
  - Launched in August 2017

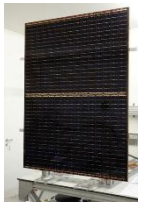
In orbit



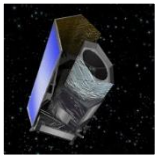


- Sentinel-5 Precursor
  - Deployable solar array
  - Delivered in 2014
  - Launch scheduled for 2017

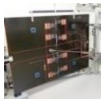
In orbit

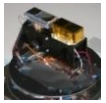


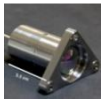
- In development (C/D contract)
  - Space IL, delivery in 2017
  - NGSAR, delivery in 2017
  - C-Sat, delivery in 2017
  - EUCLID, delivery in 2018
  - JASON CS, delivery in 2019



Satellite Equipment



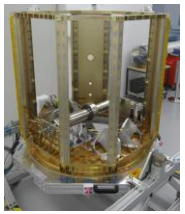
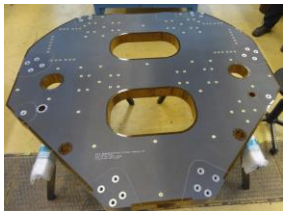




Structures, Mechanisms & MGSE

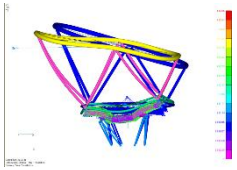
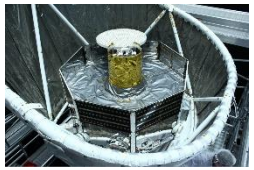
- Formosat-5
  - Primary structure, top panel, MGSE
  - Delivered in 2012/2013
  - Launched in August 2017

In orbit

- Bepi Colombo
  - STM of MOSIF Sun Shield
  - Delivered in 2009
  - Launch scheduled for 2018

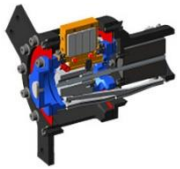
STM delivered

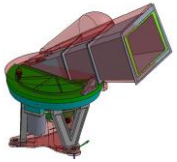
- GRACE Follow-On
  - Primary and secondary structure, MGSE
  - Deployable S-Band antenna boom
  - Delivered in 2015/2016
  - Launch scheduled for 2018

FM delivered

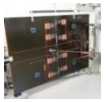
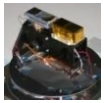
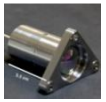

- Refocus Mechanisms (BB tests completed)
  - Motor driven (0.5 µm accuracy, 300 µm travel)
  - Heater driven (0.5 µm accuracy, 10 µm travel)




- In development (C/D contract)
  - JUICE RIME antenna
  - Sentinel-5 Calibration Subsystem (CAS)

Satellite Equipment

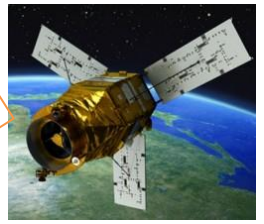




Deployment Mechanisms

STI develops reliable and robust deployment mechanisms, mainly as part of solar generator or antenna contracts.

- Kompsat-3: Solar Array
  - Spring driven cam system with high torque margin
  - CFRP strut with metal C-springs, low latching shock

In orbit



- GökTürk-2: Solar Array
  - Spring driven cam system with high torque margin
  - No strut, low deployed stiffness, low latching shock

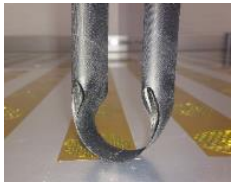
In orbit

- Sentinel-5 Precursor: Solar Array
  - Spring driven cam system with high torque margin
  - CFRP strut with metal C-springs, low latching shock

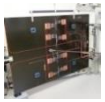
In orbit

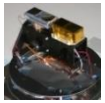
- GRACE FO: Antenna Boom
  - Spring driven cam system with high torque margin
  - Aluminum boom

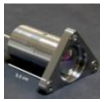
- Current developments (C/D contracts)
  - JUICE RIME antenna (slotted CFRP, multi-hinge). Boom is covered by silver strip to act as antenna.
  - Improved, adapted mechanisms for Jason-CS and C-Sat



Satellite Equipment



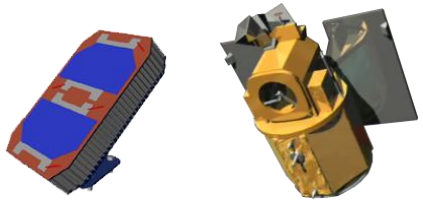




AOCS Sensors

- OSS on Formosat-5
  - Omnidirectional Sun Sensor (OSS)
  - Based on 6 orthogonally oriented solar cells
  - < 15° peak error

In orbit

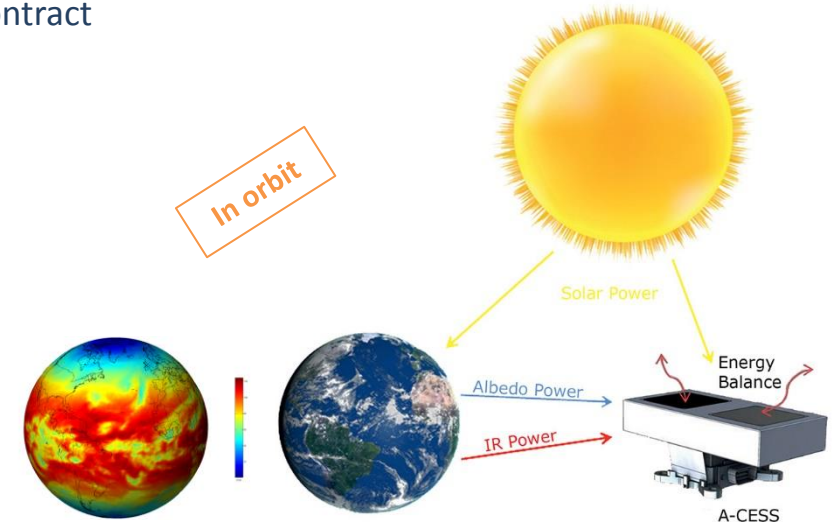


- CESS
  - Omnidirectional Coarse Earth and Sun Sensor
  - Based on 6 orthogonal oriented CESS heads
  - < 12° peak error on Earth vector
  - < 5° peak error on Sun vector
  - Supports spin rates up to 10°/s
  - 2 FM sets delivered by STI, 7 FM sets under contract

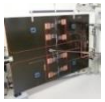
2 FM sets delivered

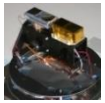
- Background/Heritage
  - Flight heritage on over 15 LEO satellites
  - Patented by B. Doll & W. Pitz (when at Airbus)
  - STI has Airbus exclusive license

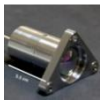
In orbit



Satellite Equipment







Electronics

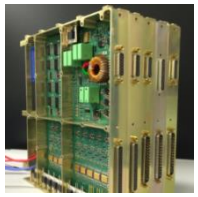
SpaceTech develops electronics with focus on:

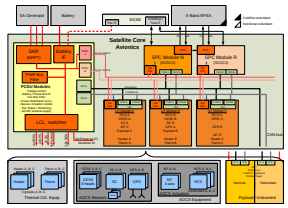
- Power control and distribution units
- Instrument control units
- Ultra low noise current sources

- **GökTürk 2**
  - Pyrodrive Module
  - Launched in 2012

In orbit

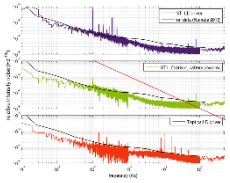
- **Satellite Core Avionics (EM completed)**
  - Combination of OBC and PCDU for small satellites
  - Prototype demonstrated in 2015



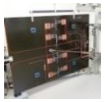


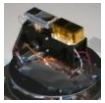
- **MERLIN Frequency Reference Unit**
  - FRU control electronics, FPGA based
  - FM delivery scheduled for 2018

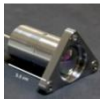
- **Laser diode drivers**
  - Ultra low noise current sources
  - For use with e.g. DFB & ECDL Lasers
  - BB ready, FM delivery scheduled for 2018



Satellite Equipment







Small Satellites

Optical Instruments

Satellite Equipment

Thank you very much for your attention.