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Astro-
und Feinwerktechnik
Adlershof GmbH

4th IAA Conference on University Satellite Missions and Cubesat Workshop

Changing of the Requirements and Astrofein‘s Business Models for Cubesat Deployer

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Astro- und Feinwerktechnik Adlershof GmbH

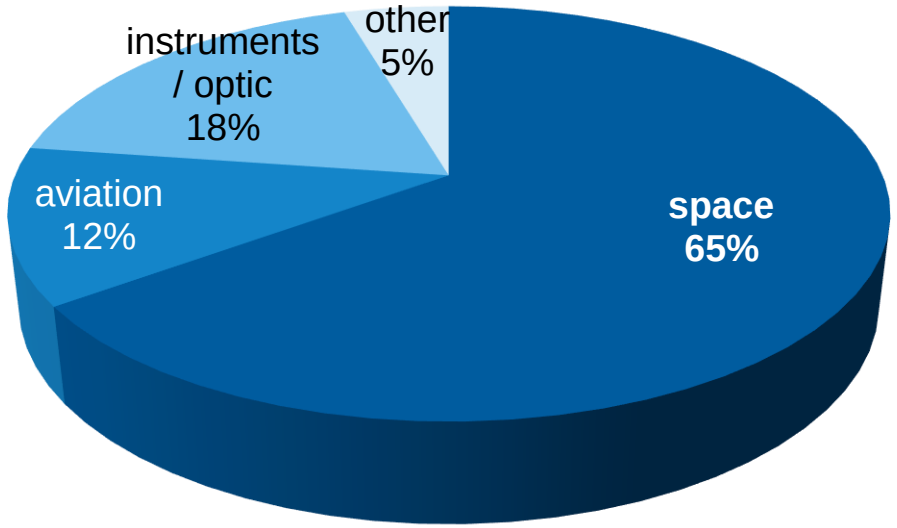
Established October 1993

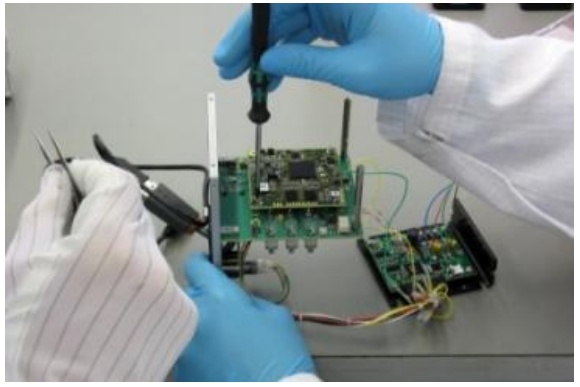
spin off from the Institute for Space Sensor Technology of the German Aerospace Center (DLR), Berlin-Adlershof

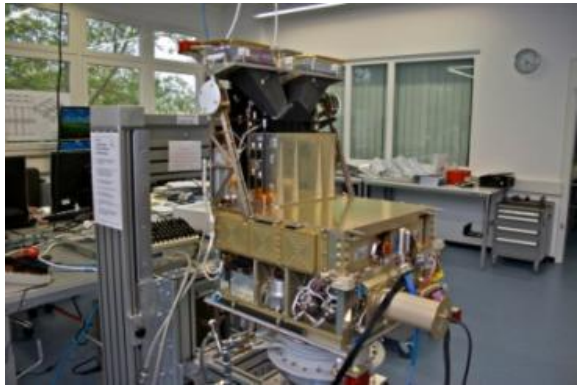
Supplier of components ➔ **Systems for space /**

Small System Integrator

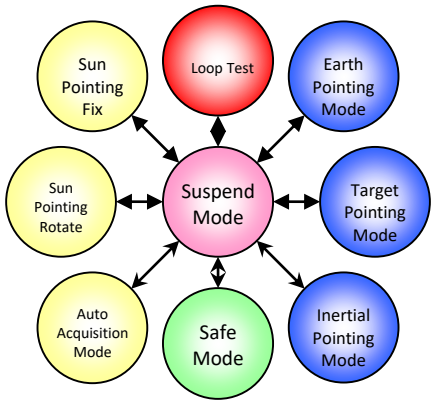
Markets



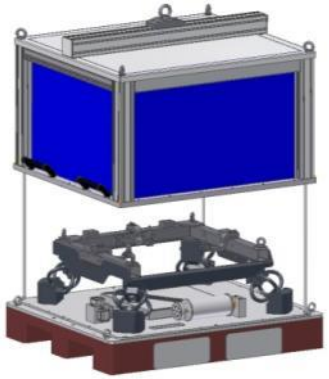




Astro- und Feinwerktechnik Adlershof GmbH - Products



Attitude control systems

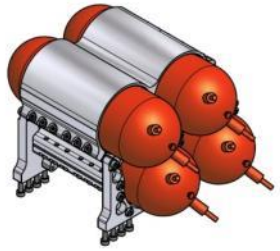


MGSE (e.g. transport containers)

Structures and Mechanisms

Test- and Verification facilities

EGSE



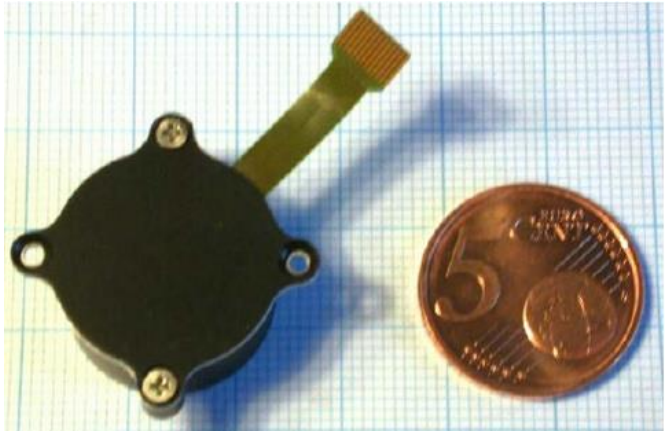
Power subsystems

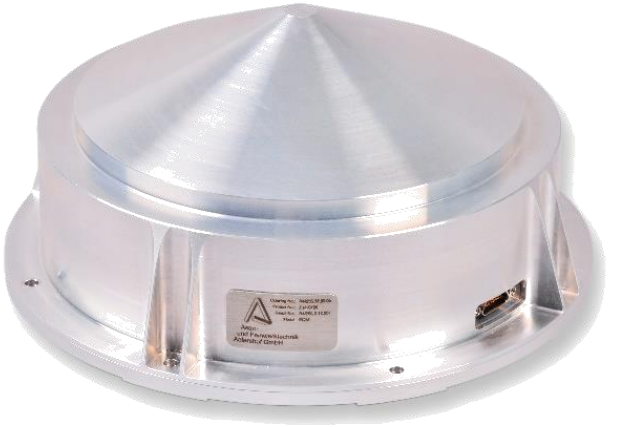
Thermal subsystems

AOCS-Components

Products - Reaction Wheels

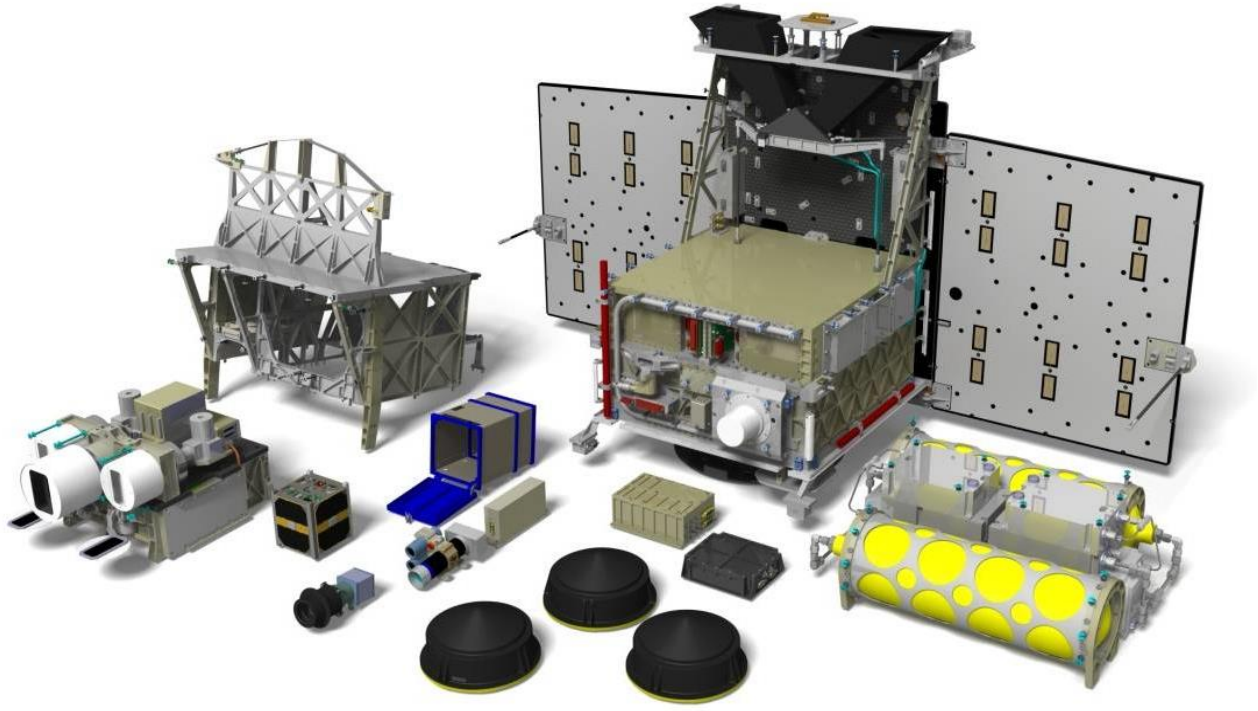
- RW 1 for **Cubesats** (10^{-4} Nms) (FKZ 50JR0552)
- RW 35 for **Nano- and Microsatellites** (0,1 Nms)
- RW 90 for **Small- and Microsatellites** (0,34 Nms)
- RW 150 for **Small Satellites** (1 Nms)
- RW 250 for **Small Satellites** (4 Nms)

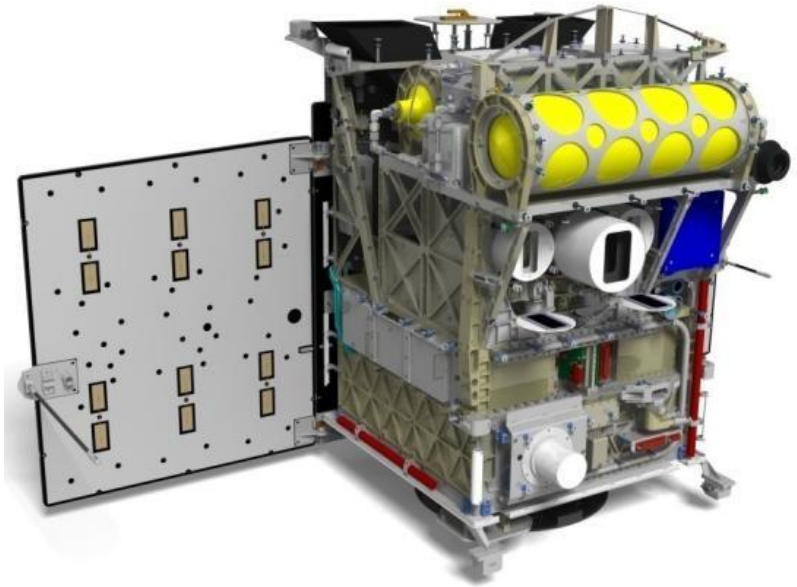




Recent satellite - BIROS

- Integration of BIROS Infrared Satellite, based on TET platform
- AFW as subcontractor for satellite bus (Prime is DLR-OS)
- Flying with TET-1 as FIREBIRD constellation
- Successfully launched on 22th June 2016





Changing of the Requirements and Astrofein‘s Business Models for Cubesat Deployer

The Beginning (1999-2005)

- In 1999 the cubesat standard was defined at Stanford University by Prof. Robert J. Twiggs as 10 x 10 x 10 cm cube with 1 kg mass.
  - Cubesat quality assurance approach required special deployer
- During the following years first 1U cubesats were developed primary in US and Japan and launched with the P-POD or T-POD deployer system.
- No launch service provider at this time. Each payload was cooperating directly with the launcher or via it‘s own space agency.
- Lot of mission losses (some by problems in the design of cubesat deployer), but concept of cubesat was established and spread out to Europe.
- At this point (2005/2006) the success of the cubesat idea, at this time still focusing on in-orbit demonstration and educational missions, become interesting for industry

The Year 2006

- Astro- und Feinwerktechnik Adlershof GmbH had the idea to go into the cubesat business as component deliverer to spin out it‘s classical space knowledge to improve the quality of cubesat components
  - Based on the Attitude control components – The RW-1 reaction wheel
    - Later used in multiple European and Asian cubesat plattforms (e.g. BEESAT, GOM-X)
  - Based of the heritage in structure and mechanism – The SPL cubesat deployer
- At same time ISIS was founded as launch service provider to launch cubesats (especially for Europe)
- Teaming with ISIS for the launch of BeeSat, UWE-2, ITUpSat-1 and SwissCube.

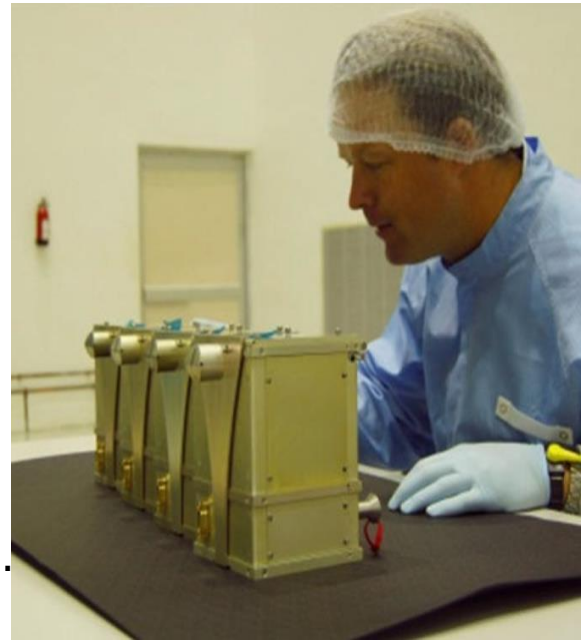


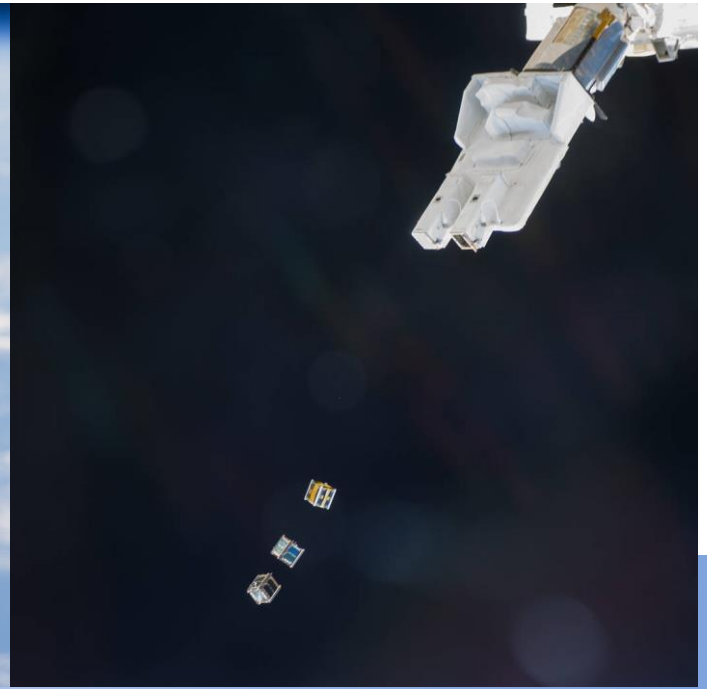
Image Credit: ISIS

Learning from failures of others for your own design

- Satellites were hitting the door of the deployer
    - Decouple the movement into a staged deployment (Door opening and locking, then release of cubesat)
- Satellites were destroyed due to rattling inside the deployer which results in massive vibration loads
    - Design a damping and clamping mechanism
- Satellites were not deployed, but no one knows
    - Integrate a „release completed“ sensor
- All this ideas resulting in the design of the light-weight SPL with the named features.

Next Steps – Design of the PSL- Family

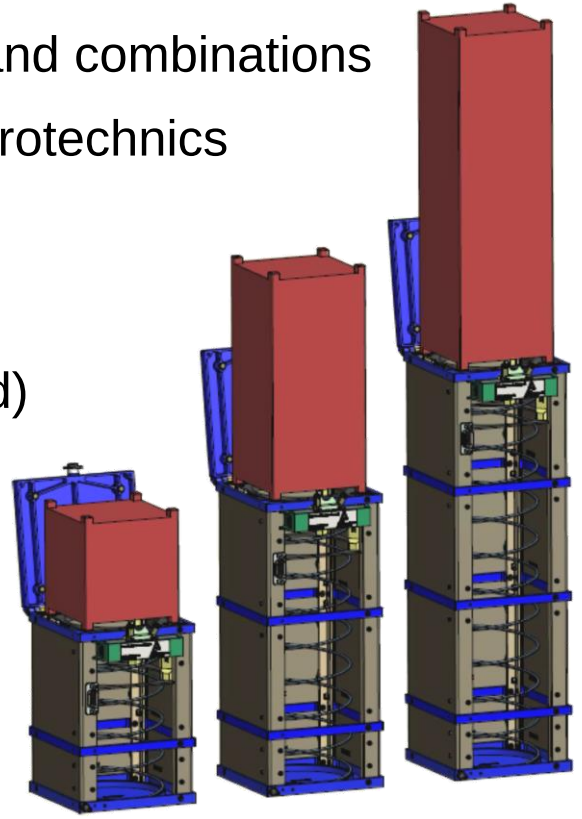
- During the following years the cubesats were going to become 2U and 3U and become heavier.
- ISIS developed there own deployer system
  - Need for Astrofein to interact more directly with customer and launchers during this years
- Lot of problems were seen with the attitude control subsystems of cubesats, which often uses B-Dot algorithm for the attitude control
  - Reason was mostly a very high rotation speed after the deployment of the satellite, which could not be compensated



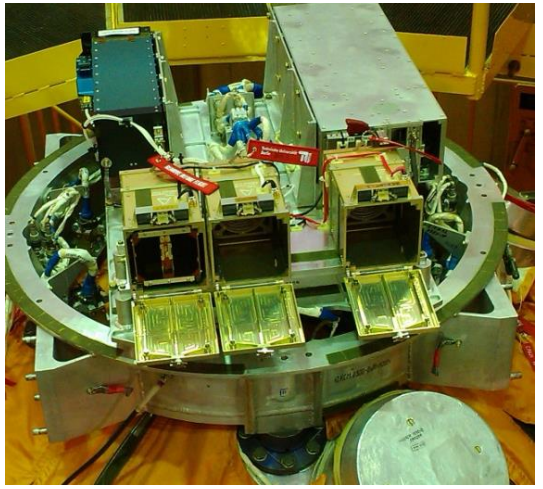
PicoSatelliteLauncher Family

The family of PSL is a flight proven deployment mechanism for CubeSats

- Deployer for 1U, 2U and 3U CubeSats and combinations
- Flight proven unlock principle without pyrotechnics
- Redundancy in actuation and telemetry
- Deployment is initiated if the door is completely opened and locked (patented)
- Patented fixation of the CubeSat in X,Y and Z
- Roller bearing guided deployment wagon and strict guidance of the cubesat until deployment



1U, 2U an d 3U Satellite Deployer (PSL – Product)

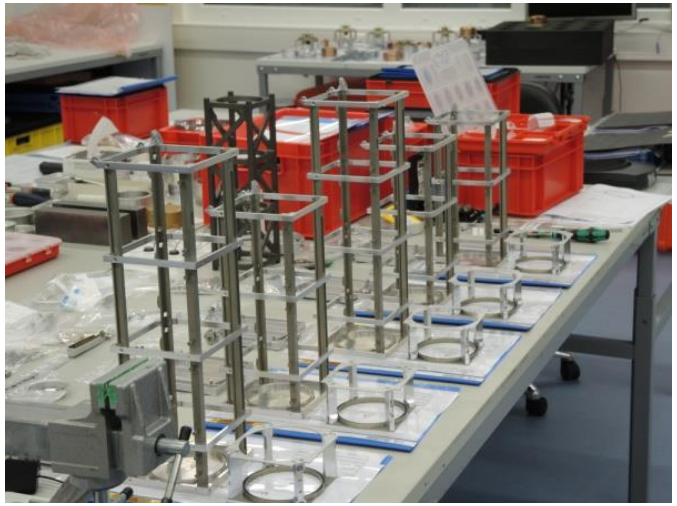


Three 1U SPL on the BION Spacecraft

=> **100% success rate of all flown deployer**

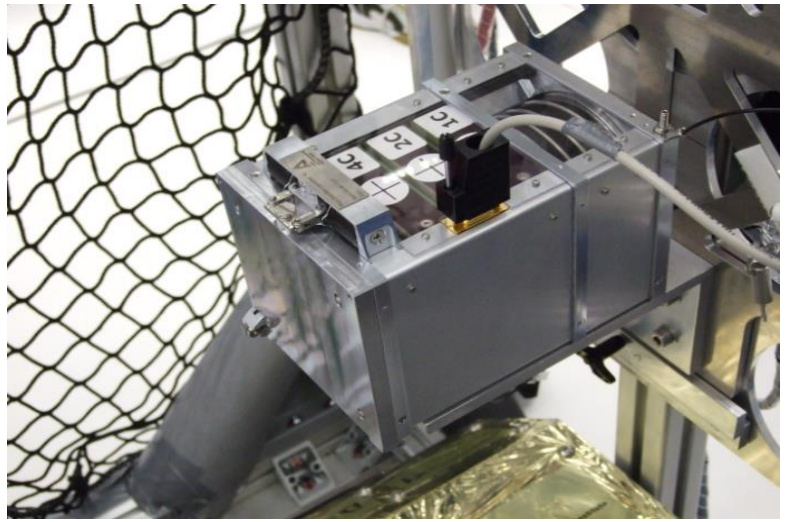
PSL-Family 100% Success rate

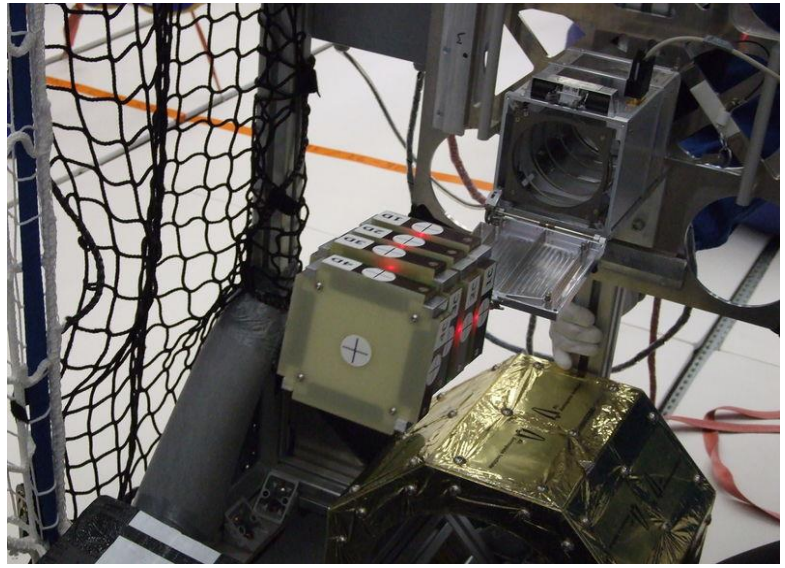
- **Examples for Flight Heritage of the familiy:**
  - Start of Chángzhēng 6 (Maiden Flight) on September 19th 2015; on Board 3 x **DPL** und 2 x **TPL**
  - Parabolic Flight of an **SPL** within the Experiment TUPEX-5 in May 2015



Production of CubeSat Deployer

Chángzhēng – 6 (Long March)
Maiden Flight: 19th Sept. 2015

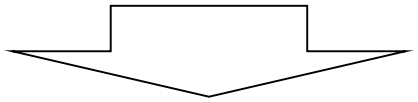




Development of the last three years (until now)

- Cubesats become bigger and heavier – now 6U and 12U cubesats are most used standard for planned commercial missions (first 16U satellites in development) and 12U means now often up to 20 or 28 kg
- Requirements for more room on the sides for bigger solar panels and other add-ons

- Astrofein has decided:
  - Not to go into the market as launch service provider by itself
  - To increase it activities on the market by cooperation with the most successful launch service provider (mostly US) as well as new rocket providers (e.g. Falcon 9, Launcher One, China's LM and KZ)



- Need of a cost effective light-weight 12U system which can be also used for other form factors (1U/2U/3U/6U)

- System which can be used and integrated also by untrained people

- And it needs design features and GSE which allows the launch service provider to answer all needs (e.g. testing or integration) of the cubesat manufacturers as well as the rocket integrators

What does Design for „Launch Service Provider“ means?

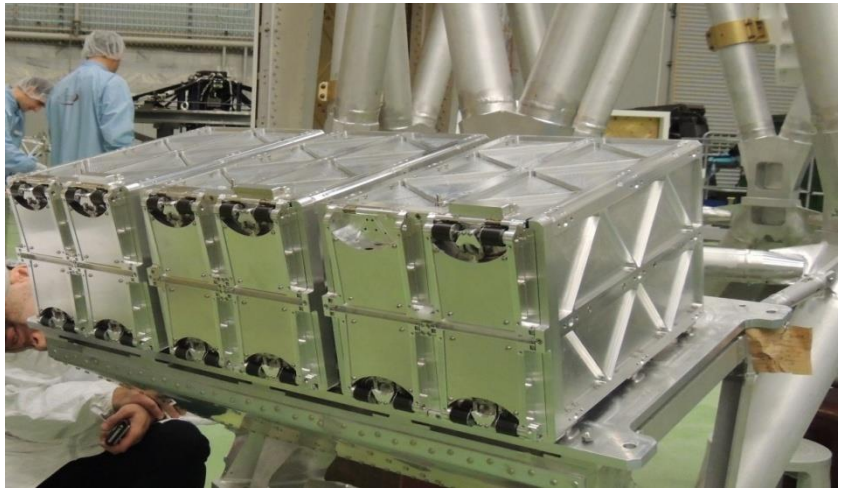
For cubesat customer:

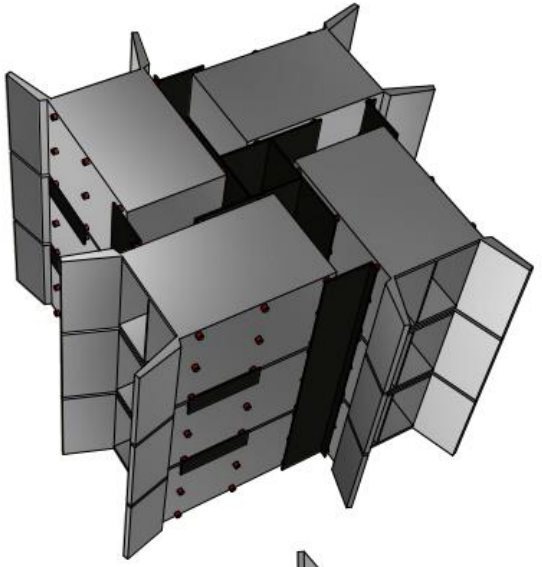
- FM can be used as vibration testbed for the cubesat to allow a „real life“ testing
- Multiple access windows with design which allows operation after launcher integration

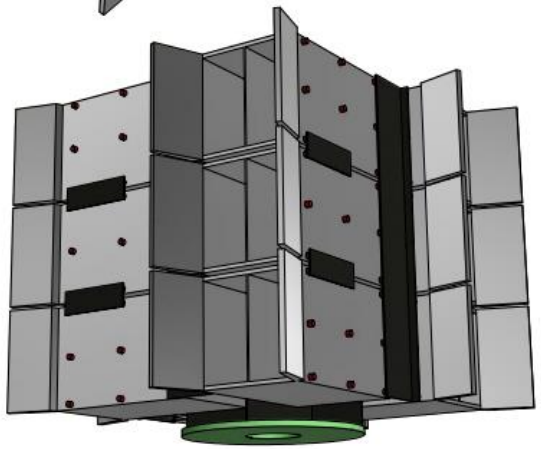
For launcher integrator:

- FM can be tested multiple times without the need of replacing parts
  - Based on our unique redundant magnetic opening mechanism
  - Contains the possibility also to test everything after integration of the satellite and deployer on the rocket
- Easy handling and resetting of the system without any specific tools - can be made by hand
- Redundant activation and sensor system
- Simulators which simulates the envelope and electrical system for fit checks and electrical check of the whole rocket
- Simplified Simulators for preparing the assembly harness and testing the launch sequencers of the launch service provider
- Easy stacking in horizontal and vertical direction with minimal space for each system for multiple launches

SIM and sSIM for PSL-P and example of stacking options





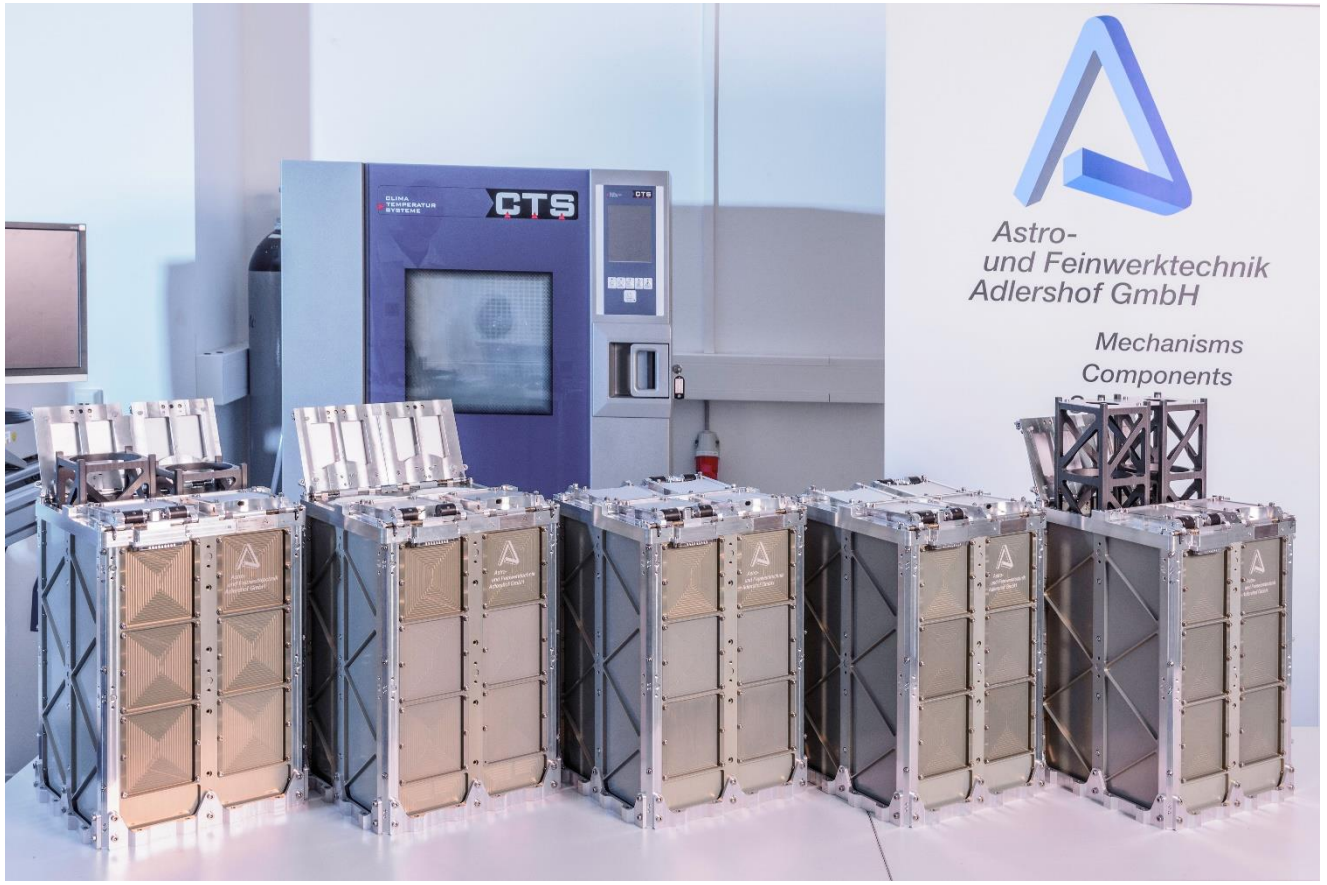


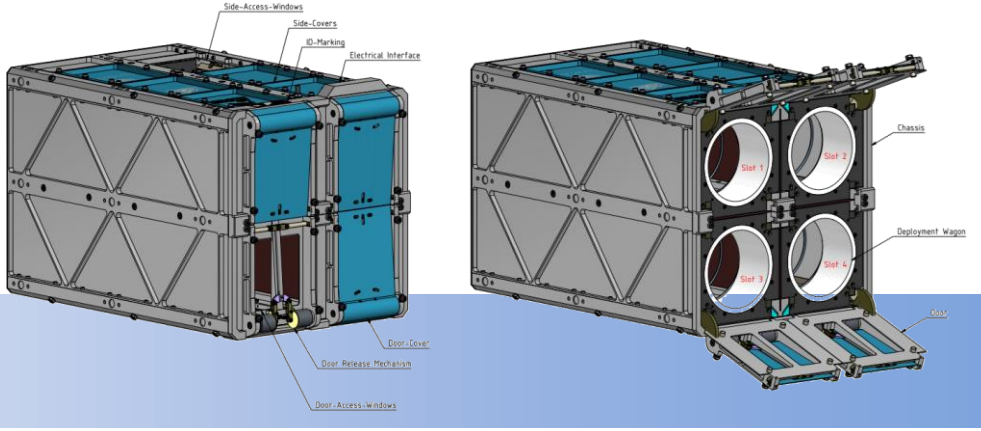
CubeSat Deployer – PSL-Packs

- For 1/2/3U, 6U and 12U Systems
- Relies on the Principles of PSL
- Modular Approach / construction kid
  - e.g. access windows on all sides possible
  - vertical or horizontal assembly
- Lower mass compared to competitors
- Clamping mechanism and deployer wagon on roller bearings
- Redundant opening mechanism and release sensor

Current Status:

- Multiple items produced and qualified
- **11** Flight Models Delivered
- **Launch** is scheduled for **Q1/18**





=> Next step: 6U and 16U deployer

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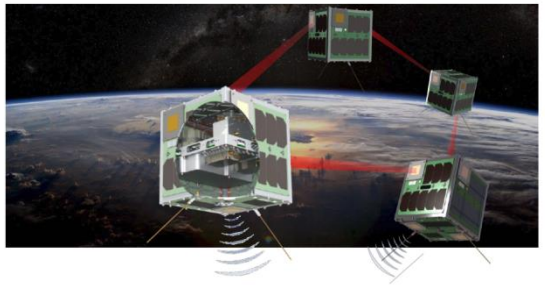
Customization for Swarm/Formation Flying

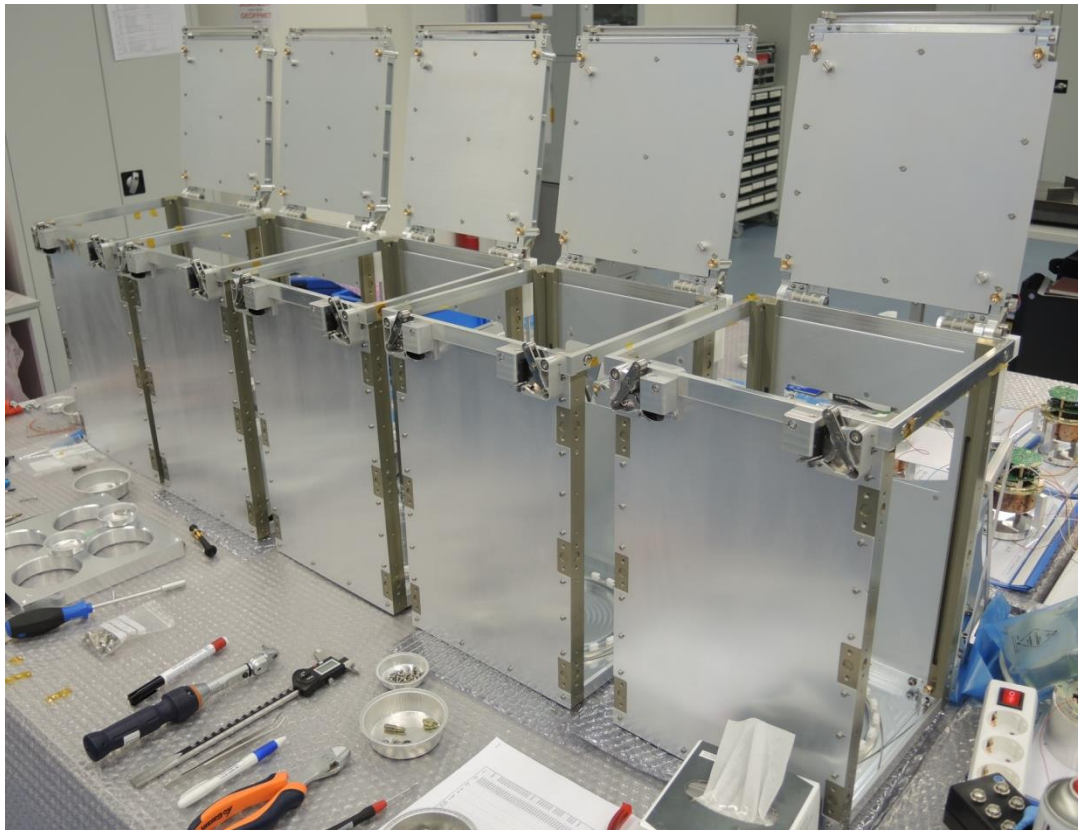
- More and more Swarm and Formation flying missions were designed and build
- Typically launched with the same flight in one or multiple deployer systems (depending from size and numbers)
- The mission mostly requires low distances (e.g. <100 km) for the RF-Communication between the satellites (Satellite Interlink)
- Some are not equipped with propulsion and all need a LEOP time after deploying of the satellite

- This means the delta Velocity should be nearly zero between the different cubesat's, to avoid fast growing of the distances between the satellites
- Results in the design of the customized SNL deployer for the S-NET Project of the TU-Berlin

SNL – Nano Satellite Launcher for S-NET of TU-Berlin

- 5x FM Container for the S-NET program of TU-Berlin
  - 4x Flight Model
  - 1x Flight Spare
  - + 1x Qualification Model
- Based on PSL Know-How
- Concept:
  - Eject satellites in sequential order
  - Satellite velocity delivered of all 5x SNL should be similar
  - Required: ± 4.5 cm/s
  - Achieved: ± 2.0 cm/s
- **Delivered Dec 2016**
- **Launch 22. Dec 2017**





5x FMs in final assembly stage, October 2016

Questions?

Contact

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