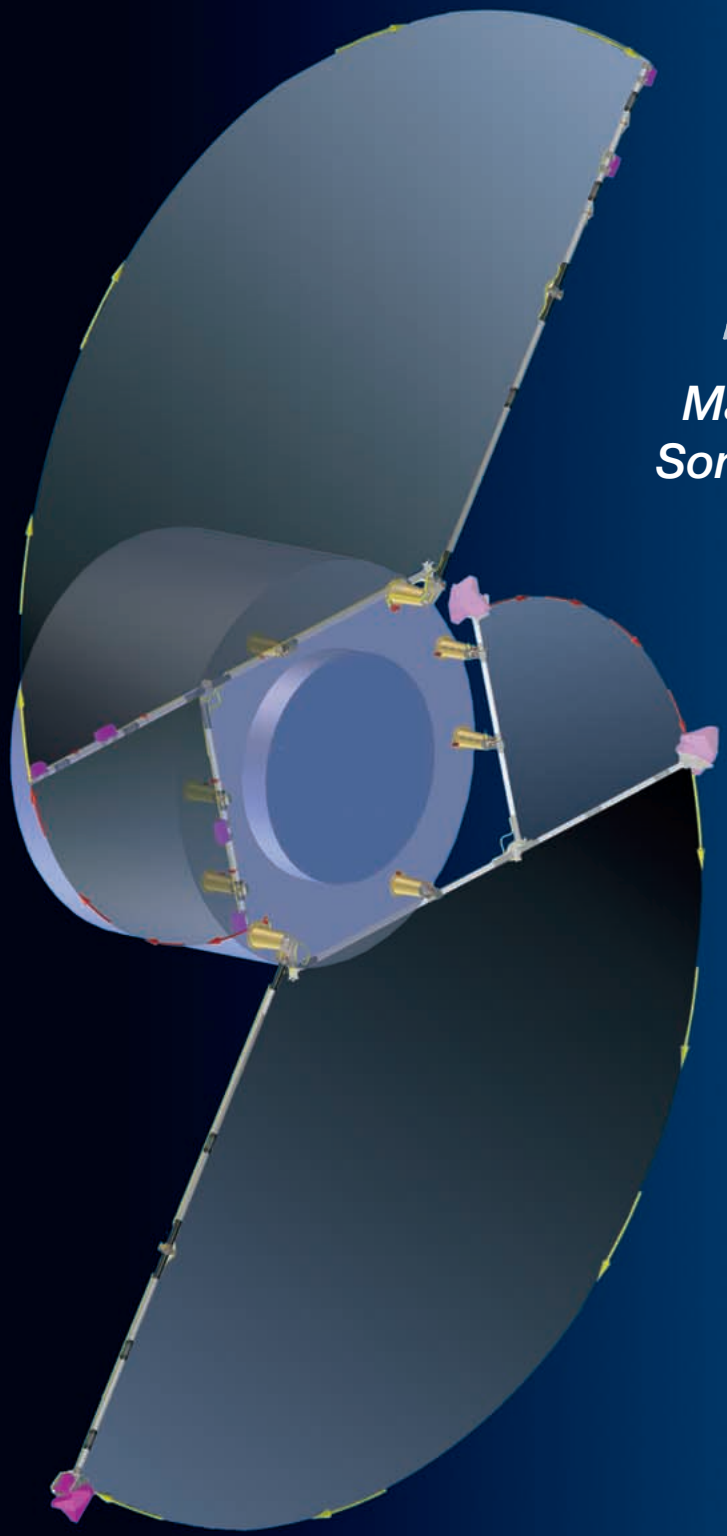
Deployable Booms

Astro-
und Feinwerktechnik
Adlershof GmbH



Ingenieurbüro
Markus Thiel

Simulation, Analysis,
Mechanical Engineering.

Magson
GmbH

Magnetische
Sondierungsgeräte

Space-proven deployment mechanisms

High-reliable deployment mechanisms are essential for the success of space projects. Antennas have to be deployed and oriented to establish communication links, sensitive scientific sensors like magnetometers require an accurate alignment at an outer position where noise from the spacecraft is lower.

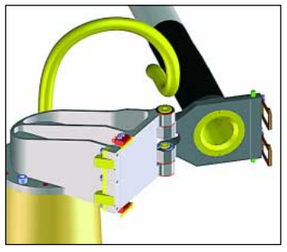
Three companies, Astro- und Feinwerktechnik Adlershof GmbH, Magson GmbH and Ingenieurbüro Thiel have decided to combine their heritage and enthusiasm for space engineering to form a center of competence for deployment mechanisms and, in particular, deployable booms.

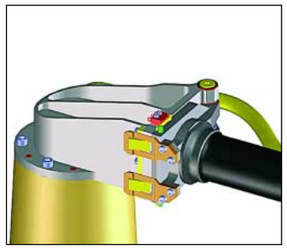
From ideas to qualified systems

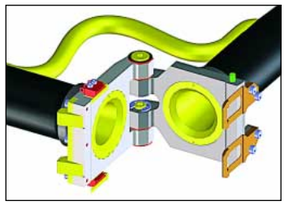
Significant contributions to missions like Equator-S, ROSETTA and Double Star are an evidence of our skills in simulation and analysis, mechanical and electrical engineering, manufacturing and assembly, integration and verification. Our approach is to procure complete sub-systems, including mechanisms and the associated control electronics. Our standards in engineering, manufacturing, verification and documentation are in compliance with the demanding rules postulated by the European Space Agency ESA.

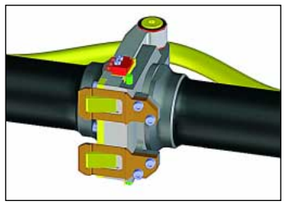
From conceptual design to excellent products - A deployable boom for Double Star

In 2003 and 2004, the consortium has delivered deployable booms for Double Star, the first joint mission of ESA and the Chinese Space Agency. Within this mission, two scientific satellites have been launched to explore the magnetosphere, one in a near equatorial, the other in a polar orbit.

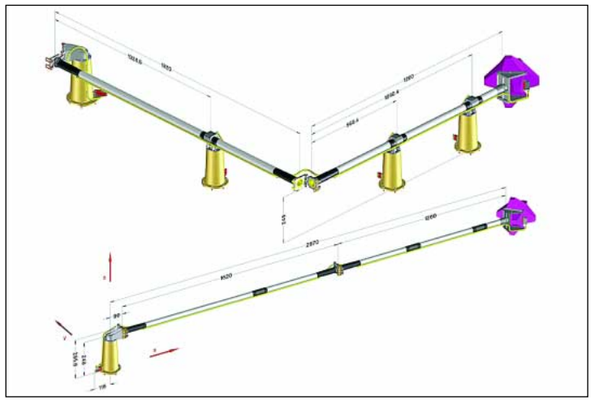






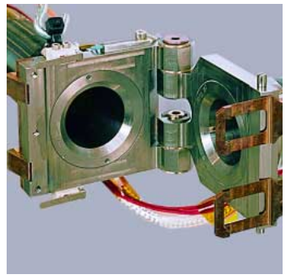


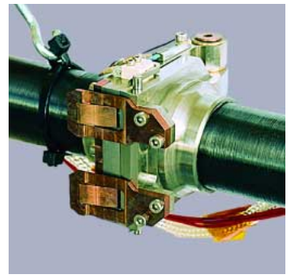
The satellites are equipped each with two 3m-booms to deploy magnetometer sensors. A single boom consists of two CFRP (carbon-fiber reinforced plastic) segments, interconnected by titanium hinges.
The mechanical interface to the spacecraft structure is a rigid aluminium socket with a titanium hinge on top.
The status of the systems is monitored by micro - switches and temperature sensors at all clamps and hinges.

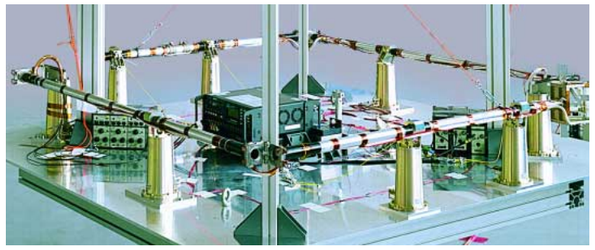


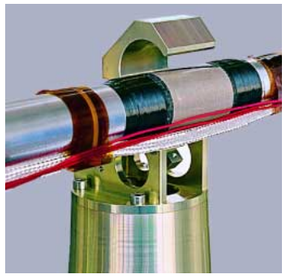
Deployment strategy

Up to the deployment, the boom segments are secured by spring loaded clamps, which can be opened by firing a pyrotechnical rod cutter. The deployment is driven by centrifugal forces only. The boom hinges are equipped with a redundant self-locking mechanism, which is designed to guarantee a play-free and accurate positioning of the boom after deployment.
The deployment is performed in two steps: The outer segments of both booms are released first. After successful locking of the outer hinges, the clamps of the inner segments are opened to release the complete booms.



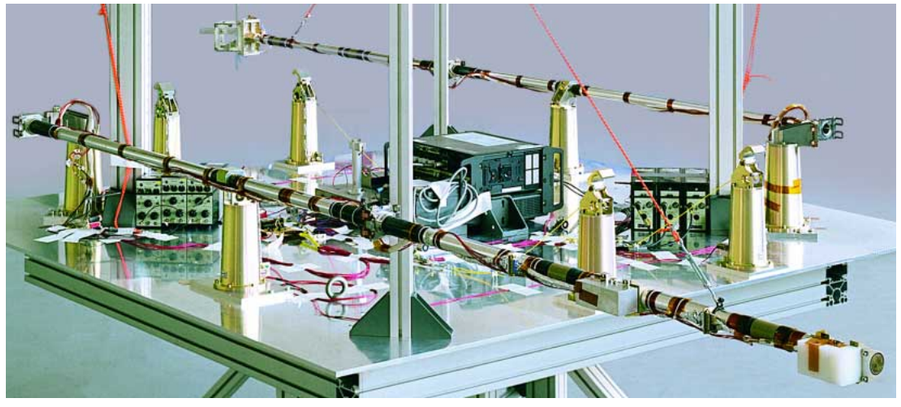






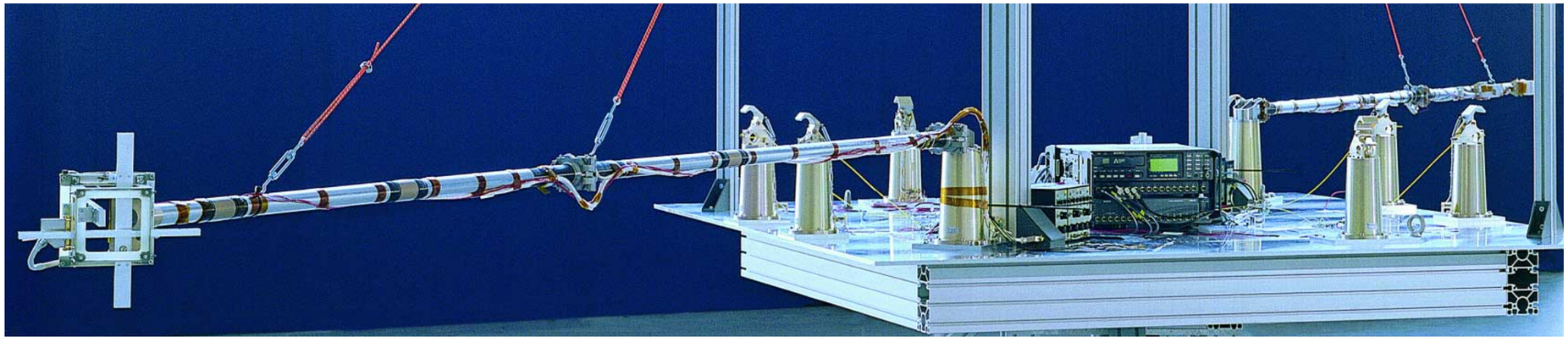
Qualification and verification

Like all S/C systems, the booms for Double Star had to pass a specific qualification and verification programme. All required facilities and equipment for alignment verification, thermal vacuum, vibration and deployment testing are available within the consortium.
The deployment test with the Double Star boom was carried out on a spin table with controlled speed and gravity compensation. To compare the dynamic behaviour with results from the deployment simulation, the mechanism was equipped with accelerometers and the signals recorded on a mobile data acquisition system.



Scalable solutions for a variety of applications

The design principle of the Double Star boom can be adapted to a variety of spin-stabilized satellites, with spin rates from 5 ... 50 rpm.
A concept for an active, spring-driven deployment, using redundant deployment springs at the hinges is available for non-spinning satellites.
Both versions can be realized either with one or two boom segments. The length of the deployed boom can be extended to more than four meters, depending on the dimensions of the spacecraft and on the mass to be deployed.
A design concept for a multi-segment boom with a deployed length of up to ten meters is under investigation.



From ideas to systems - **teamwork**

Magson GmbH

Magnetische Sondierungsgeräte

Carl-Scheele-Straße 14
D-12489 Berlin
phone.: +49 30-6392 3932
fax: +49 30-6392 3944
Internet: www.magson.de
email: office@magson.de

MAGSON GMBH develops, produces, and qualifies electronic systems for space and aeronautics applications.

During the last ten years, Magson GmbH has taken the opportunity to prove its skills and efficiency by hardware contributions to several space projects. Focus of the development are magnetometers for scientific and attitude control applications.
On behalf of leading research institutes, instruments for the German small satellites Equator- S and Bird, the MIR space station, the ESA missions Mars Express, Venus Express and Rosetta, the Chinese Double Star mission as well as the NASA mission Themis have been developed and manufactured. In close cooperation with competent partners we deliver instruments with full space qualification including thermal- vacuum, vibration and EMC tests. Due to the ongoing miniaturization of instruments for space missions the use of field programmable gate arrays - FPGA's is be comming more and more importand. In order to implement complex digital systems in FPGA's, IP cores for telemetry interfaces, scalable RISC processors and motor controller are avialable.

Ingenieurbüro Markus Thiel

Simulation, Analysis, Mechanical Engineering

Gartenstraße 3
D 86655 Harburg
phone.: +49(0) 9080-922054
fax: +49 (0) 9080-922057

email: ib-thiel@t-online.de

In 2001, Markus Thiel has established a design and engineering office, inspired by the idea of developing high-reliable mechanisms for scientific space projects.
Markus Thiel has been working as a mechanical engineer in the space segment since 1993, participating in projects such as EQUATOR-S, Stardust CIDA, and the ESA comet-mission ROSETTA.
The preferred approach of Ingenieurbüro Thiel is to implement simple and straight-forward working principles and to reduce the complexity of space systems wherever possible in order to achieve a maximum in functional reliability at an affordable technological effort.
As a partner of leading aero-space companies, we are participating in the development of mechanisms, instruments and subsystems for scientific satellites, using cutting-edge 3D design and analysis tools.
Our key competences include
- computer-based simulation, analysis and visualization of dynamic processes,
- reliable technical solutions for space tribology problems,
- elaboration and implementation of redundancy concepts for space systems.

We are prepared to meet the most demanding requirements.

Astro- und Feinwerktechnik Adlershof GmbH

Albert-Einstein-Str.12
D-12489 Berlin
phone.: +49 30 - 6392 1000
fax: +49 30 - 6392 1002
Internet: www.astrofein.com
email: info@astrofein.com

Astro- und Feinwerktechnik Adlershof GmbH
was established in 1993, with an expert staff derived primarily from members of the Institute for Space Research at the former German Academy of Sciences and its successor institute, the Berlin- Adlershof center of the German Aerospace Research Establishment (DLR).

Our field of operations includes:

- Development and design work
- Design and prototype construction
- Mechanical processing
- Environment simulations

In space technology hardware, we have specialized in the scientific payload area and especially optoelectronic equipment.

Our expertise also extends to (electro-) mechanical hardware for small - scale satellites, such as reaction wheels and solar panels including operational mechanisms.

We have additional extensive experience in OGSE and MGSE, such as developing and producing transport containers and handling devices.

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