



in cooperation with



Ultra-Stable Arm in the European Large Deployable Reflector Subsystem LEA

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Main Partners:



End Customers:



ESA Living Planet Symposium – May 24th, 2022

⁽¹⁾ HPS GmbH, ⁽²⁾ LSS GmbH, ⁽³⁾ Beyond Gravity Germany GmbH, ⁽⁴⁾ INEGI

WeLEA Consortium

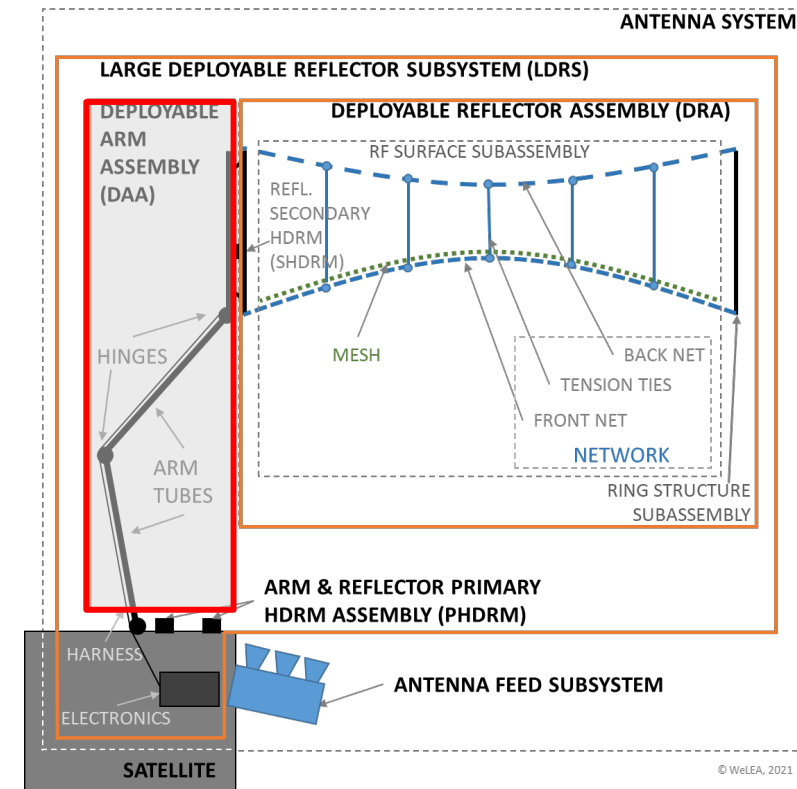
The European LDRS-Solution „LEA“ (**L**arge **E**uropean **A**ntenna) is supplied by an integrated project team called „WeLEA“ under the lead of HPS as Prime Contractor to the Customer, with LSS as major partner.

- › The WeLEA consortium comprises around 15 companies (mainly SME) out of 7 European countries.
- › Each of the WeLEA consortium members is contributing to the LDRS with their corresponding and specialized experience
- › This combination forms a team providing the comprehensive and complete capabilities required for the overall Large Deployable Reflector Subsystem (LDRS)
- › Key partners in this WeLEA consortium are:
 - HPS GmbH, Munich/Germany
(LDRS prime, system engineering, accommodation, arm)
 - LSS GmbH, Munich/Germany
(Design, integration and testing of reflector assembly).



Large Deployable Reflector Subsystem (LDRS) Elements

- › LDRS is a scalable deployable reflector subsystem architecture for a wide range of capabilities.
- › The architecture can be adapted to reflector sizes and arm lengths between 5 m and 25 m.
- › LEA product family is capable for frequency applications from L-, S-, C-, X- to Ka-Band suitable for earth observation, telecom or science domains.
- › The standard delivery of the LDRS comprises:
 - Deployable Arm Assembly (DAA) with Hinges
 - Deployable Reflector Assembly (DRA) incl. RF reflective mesh
 - Hold-Down-and-Release Mechanisms (HDRMs)
 - Harness
 - Electronics for deployment control of Arm and Reflector
 - Thermal Hardware
 - Ground Support Equipment (MGSE, EGSE) for test activities
 - Qualification and execution of test campaigns (functional, mechanical, RF, vibration, thermal-vacuum)
 - Satellite integration support.

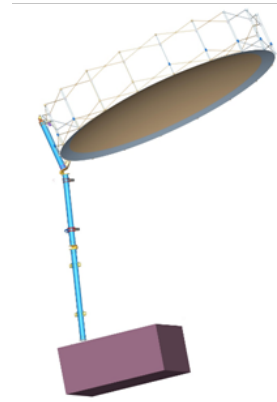


The LEA Family – Past and Present



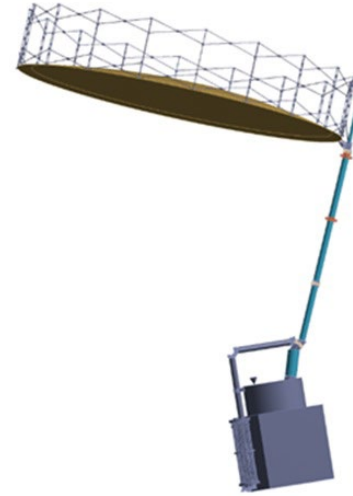
LEA-C4

LEA-C4 EM (SCALABLE, ESA)



LEA-X5

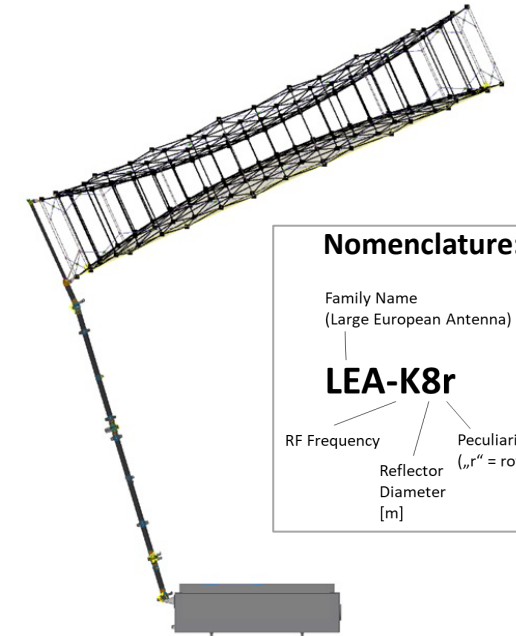
LEA-X5 PFM (LEA, EC H2020)



LEA-K8r

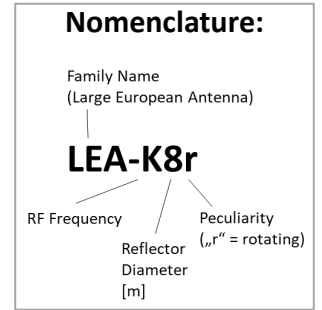
LEA-K8r EQM/PFM (CIMR, ESA/TAS)
 LEA-K8r EM Arm (LADEA, ESA)
 LEA-K8r EM Reflector (LEOB, ESA)

CIMR-Mission (Copernicus Program)



LEA-L12

FM Preliminary Design (LEOB, ESA + ROSE-L Phase A)

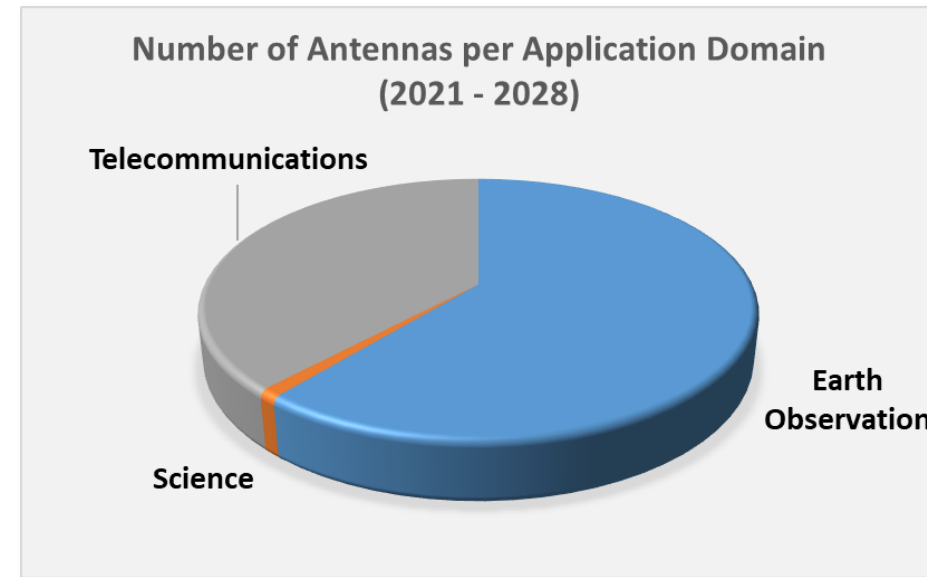
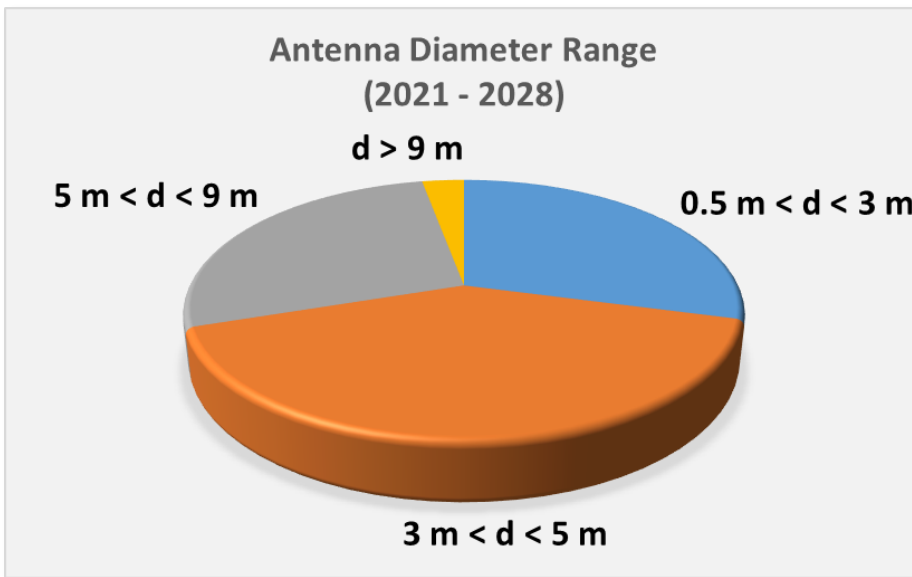


Examples of Future LDRS Mission Opportunities

- › ESA Earth Explorer Missions (from L- to Ka-Band), e.g. Cryorad
- › Institutional & Governmental EO
› Broadband Telecom, 4-5m, Ka (Telecom)
- › Export Customers

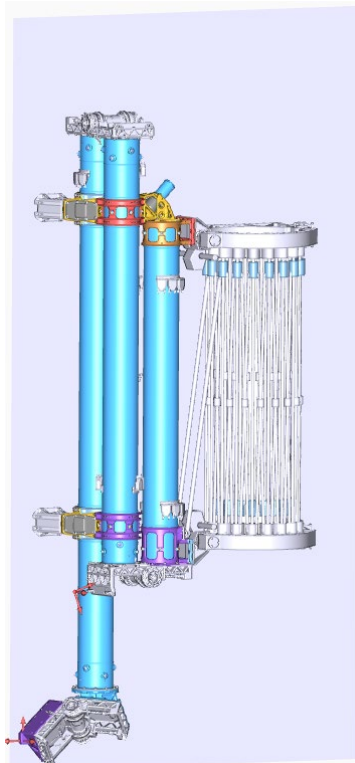
Market Outlook (2021 – 2028) for Large Deployable Antennas*

- › Large unfurlable reflectors are commercially available US – however, these have a very high price tag and are currently subject to USA export regulations
 - ⇒ European solution for competitive product to support European non-dependence.
- › Earth Observation is currently driving the market for Large Deployable Antennas.



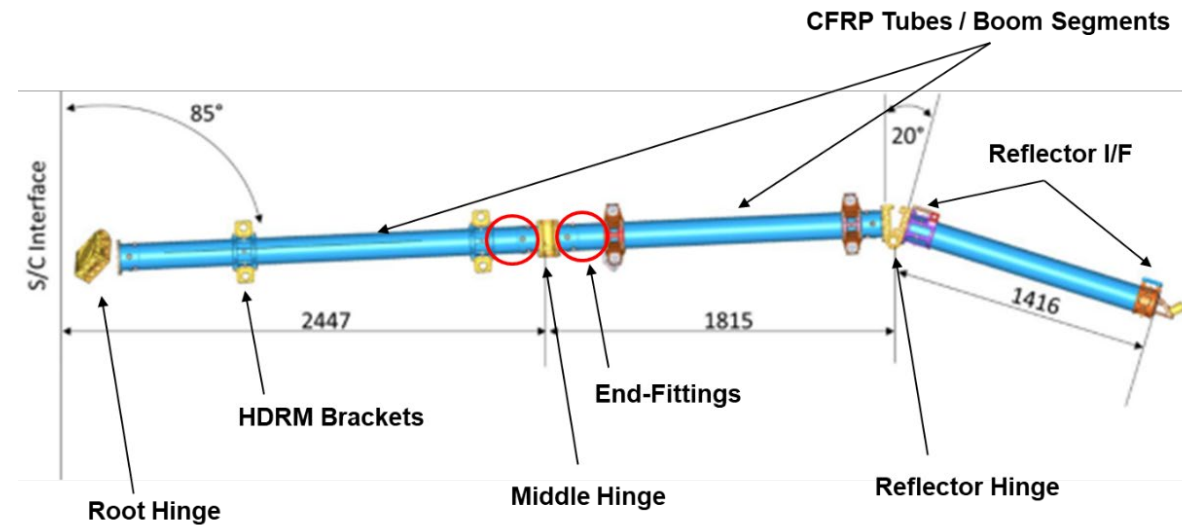
* Source: ESA internal Market Analysis 2021

LEA-X5 PFM – Arm Design



Graph: HPS

LEA-X5 Arm Characteristic	Dimension
Arm Length:	5.7 m
Number of Hinges:	3
Arm Mass (incl. Hinges, HDRM, Harness):	54.4 kg

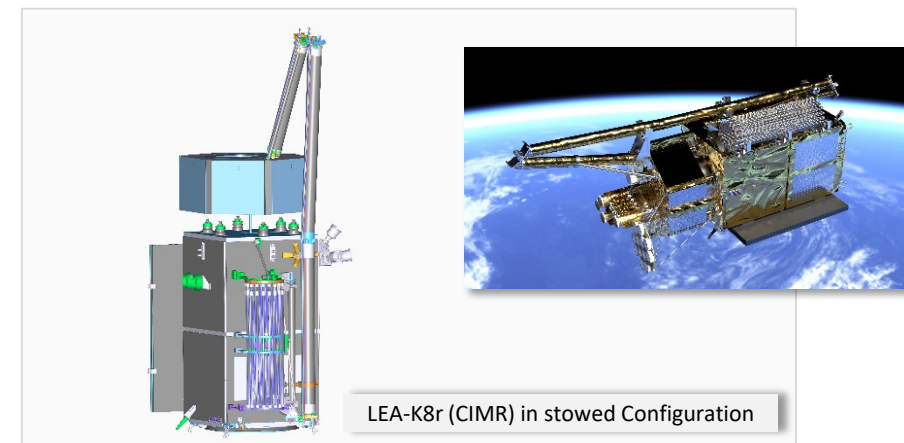
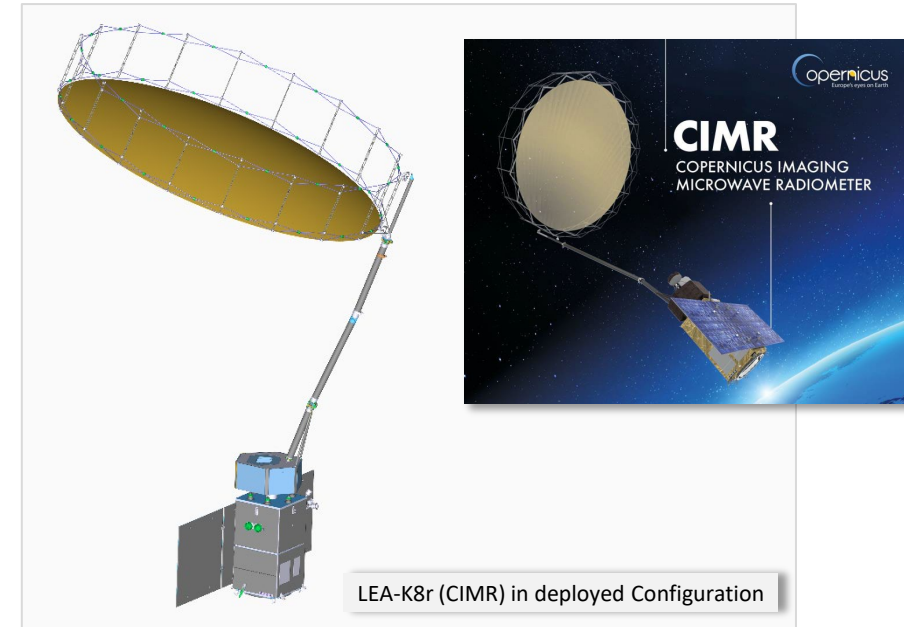


▶ Final Review with European Commission on 15.06.2021: LEA-X5 PFM Project concluded successfully

LEA-K8r: CIMR Radiometer Mission

- › EU/ESA Copernicus High Priority Mission with large rotating arm & reflector (length & diameter: 8 m)
- › CIMR Phase B2/C/D & FM2:
 - Satellite Prime: Thales Alenia Space Italy (TAS-I)
 - LDRS Prime: HPS (leads consortium of 15 companies)
 - Main Partner: LSS (responsible for the reflector)

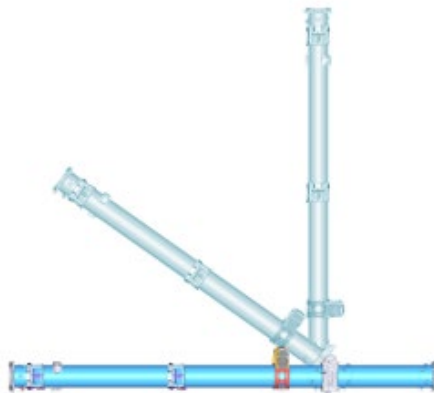
Milestone	Date
LDRS KO	21.12.2020
LDRS TRL-5 Datapack Delivery Satellite/LDRS SRR Datapack Delivery	31.05.2021
Satellite/LDRS SRR Co-Location	30.06. - 02.07.2021
Satellite SRR Close-out (LDRS TRL 5 Declaration Approval)	16.07.2021
LDRS PDR Close-Out	01.11.2022
LDRS CDR Close-Out	June 2024
LDRS EQM DRB	July 2024
LDRS PFM DRB1 (first Flight Model)	March 2026
LDRS PFM DRB2	April 2027
Launch	2028



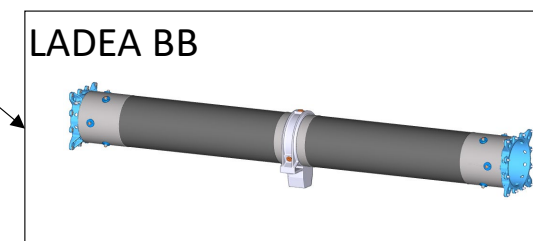
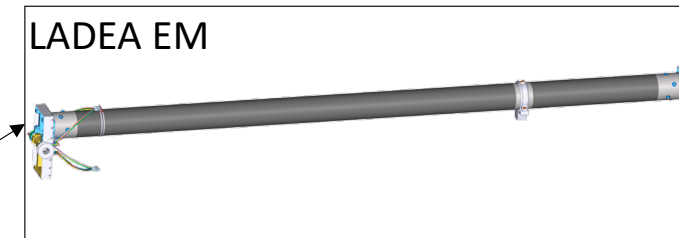
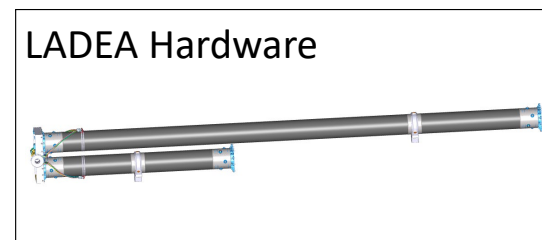
LEA-K8r – Arm BB/EM

- › Prime contractor of LADEA contract: HPS GmbH
- › Customer: ESA
- › Key contributors:
 - Beyond Gravity GmbH (Hinge mechanism)
 - Invent GmbH (CFRP tubes with end fittings)
- › Overall LADEA Hardware is composed of:
 - LADEA EM (Long CFRP Arm Segment incl. Hinge, 4.0 m)
 - LADEA BB (Short CFRP Arm Segment, 1.5 m)
- › Based on technology developed in ESA contract ABDS (Articulated Booms – Large Ultrastable Deployment Structures)

LADEA Milestones	Date
Kick-off	09.01.2020
Requirement Review	04.03.2020
Manufacturing Readiness Review	04.06.2020
BB Test Readiness Review	12.03.2021
EM Test Readiness Review	16.04.2021
Test Review Board	16.06.2021
Final Review	14.07.2021



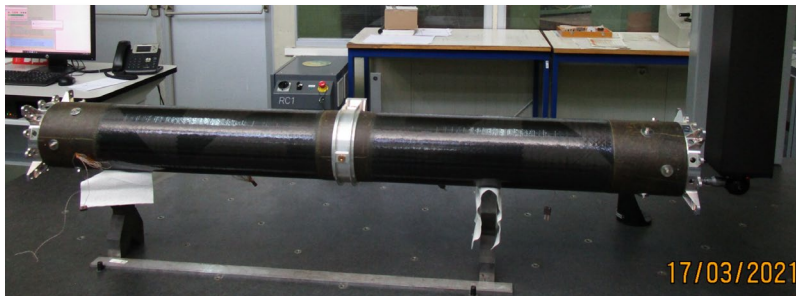
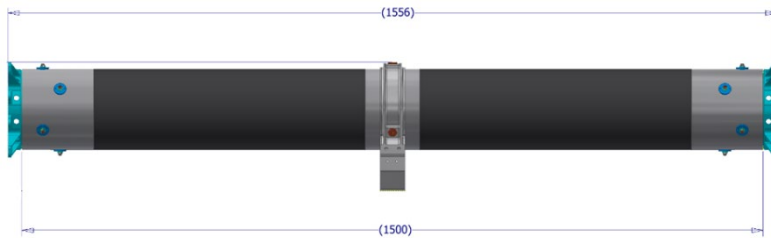
ULTRA-STABLE ARM IN THE EUROPEAN LARGE DEPLOYABLE REFLECTOR SUBSYSTEM LEA



LEA-K8r – Arm BB/EM

LEA-K8r BB (Length: 1.5 m):

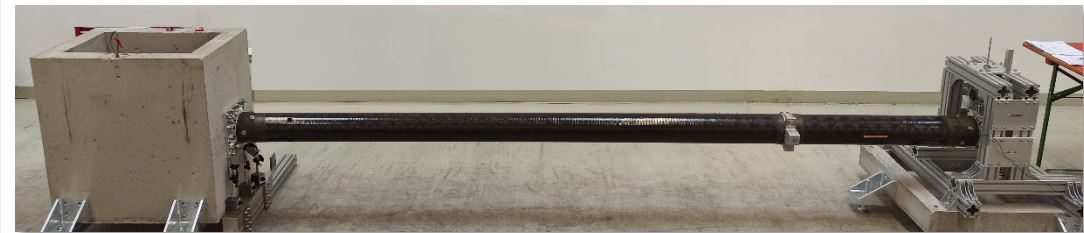
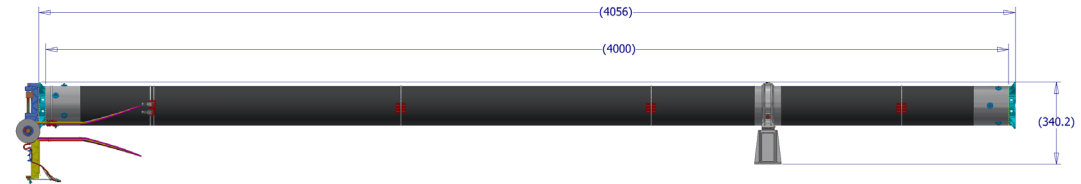
- CFRP Tube (L = 1500 mm) with GFRP Doublers
- 2 x Aluminum End Fitting and Rivets
- HDRM Ring
- Rivets and Washers.



17/03/2021

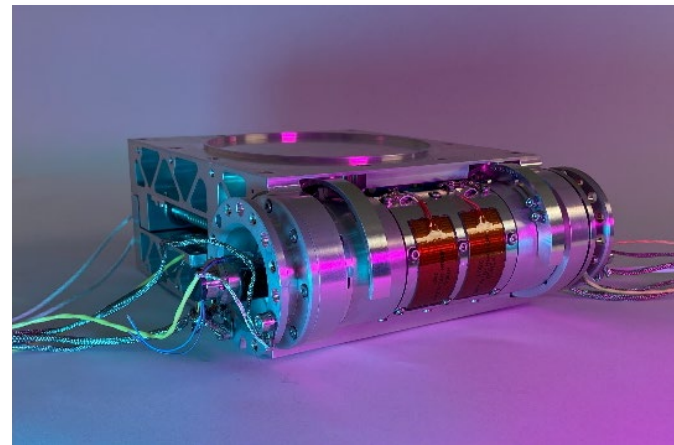
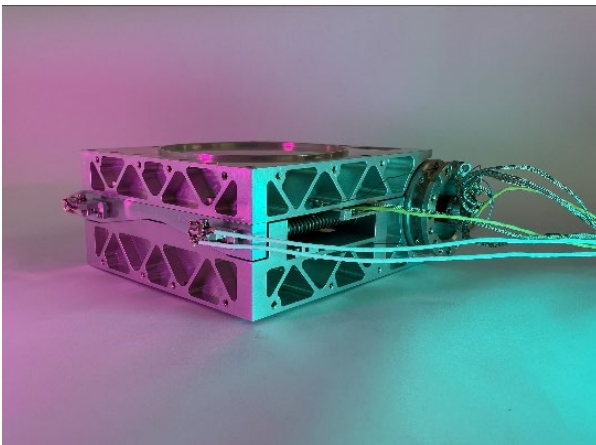
LEA-K8r EM (Length: 4.0 m):

- CFRP Tube (L = 4000 mm) with GFRP Doublers
- 2 x Aluminum End Fitting and rivets
- Aluminum HDRM Ring
- Aluminum HDRM Tower
- Rivets and Washers
- Hinge mechanism
- Dummy Harness Lines and Brackets
- Thermal Hardware around Hinge (MLI plus Support Structure).



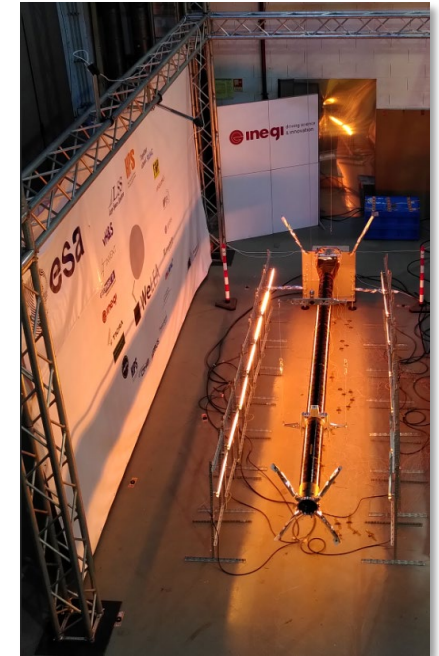
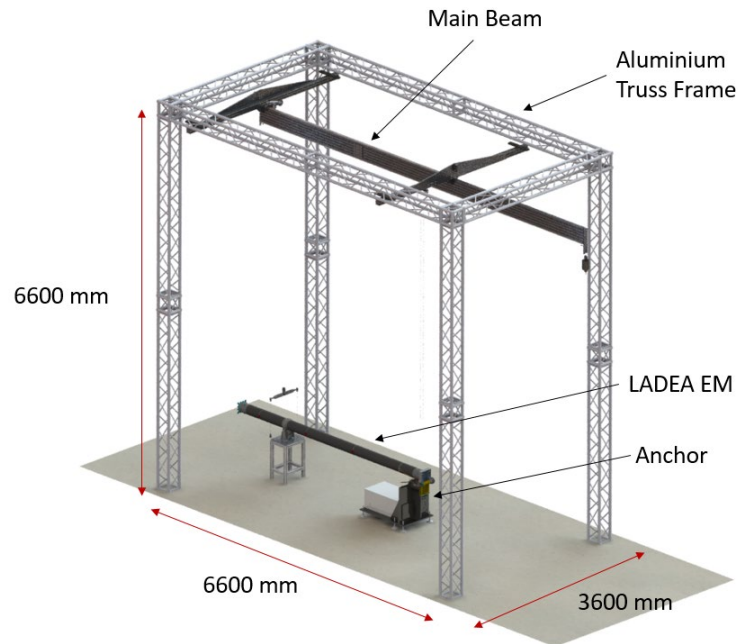
LEA-K8r – Hinge of Arm EM

- › LDRS hinge development started in 2016 by Beyond Gravity GmbH (formerly RUAG Space GmbH) as ESA ARTES project, with follow-on developments in EU (LEA / H2020) and ESA (ABDS, LADEA) contracts.
- › Electrically motorized, low mass, ITAR-free single-axis hinge mechanism
 - Designed to deploy large space structures like antenna booms with high accuracy and repeatability.
- › Controlled and defined deployment.
- › Actuated by space qualified brushed DC motor with connected harmonic drive gear.
- › Adjustable deployment angles between 0° and 185° with minimum emitted shock.
- › Designed to establish a maximum of stiffness in latched end configuration with high latching force.
- › Redundancy implemented for increased reliability and failure tolerance.



LEA-K8r: MGSE for Arm EM Deployment & TED Testing

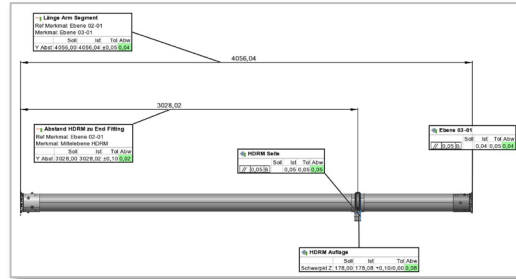
- › 0-g MGSE for LADEA Arm Assembly developed, manufactured and installed by INEGI, with main elements:
 - Structural frame (aluminum truss structure)
 - Main Beam with bottom track of 7 m length, guiding several low friction pulleys for offloading system
 - Anchor (stable root for connecting the arm hinge)
- › Test setup for TED testing (configuration with emitters on one or both sides of arm hardware)



LEA-K8r: Arm EM – Test Program

› Extensive Test Program on Arm EM executed:

- Properties,
- Functional,
- Mechanical,
- Thermal,
- Electrical.



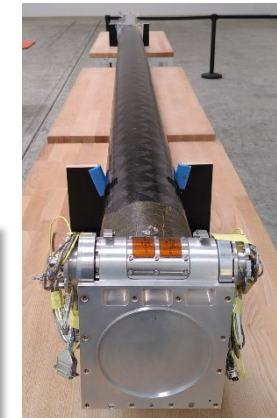
LEA-K8r Arm EM (LADEA) Deployment Test at INEGI, Portugal (April 2021)



LEA-K8r Arm EM (LADEA) TED Test at INEGI, Portugal



LEA-K8r Arm EM (LADEA) Mechanical Stiffness and Electrical Test at HPS, Germany



Key Achievements of LADEA Project

- › Critical manufacturing processes (e.g. CFRP tubes of more than 4 m length) have been verified on Hardware elements of CIMR-like dimensions.
- › Consolidated hinge design for integration in LDRS CIMR mission.
- › LADEA design has proved very good correlation with predicted performances in extensive test campaigns.
- › LADEA arm design concept allows the combination with different deployable LDRS dimensions from approximately 3 m – 20 m aperture.
- › Outcome of LADEA project activity is providing scalable boom technology for large Deployable Arm Assemblies (DAA) for a wide range of different LEA applications (Earth Observation, Telecom or Science) of Large Deployable Reflector Subsystems (LDRS).
- › LADEA development activities (design, manufacturing, testing) increased technological readiness to TRL-6 for arm development of CIMR Mission (EU Copernicus Program).





Videos auf YT: <https://www.youtube.com/channel/UCsrzsAsZvT2i0Tu-WRUit7w>

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