

HOW THALES ALENIA SPACE COOPERATES WITH ACADEMIA



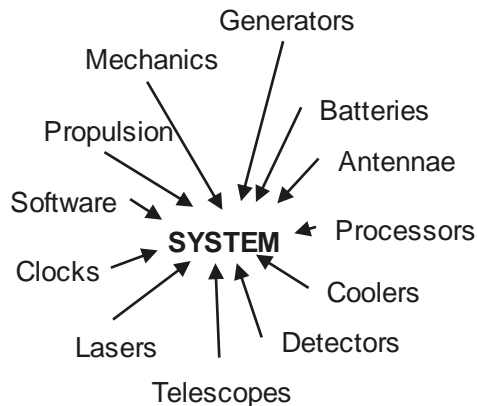
R&D AT THALES ALENIA SPACE

/// Thales Alenia Space is a Large System Integrator that builds space infrastructures in many domains

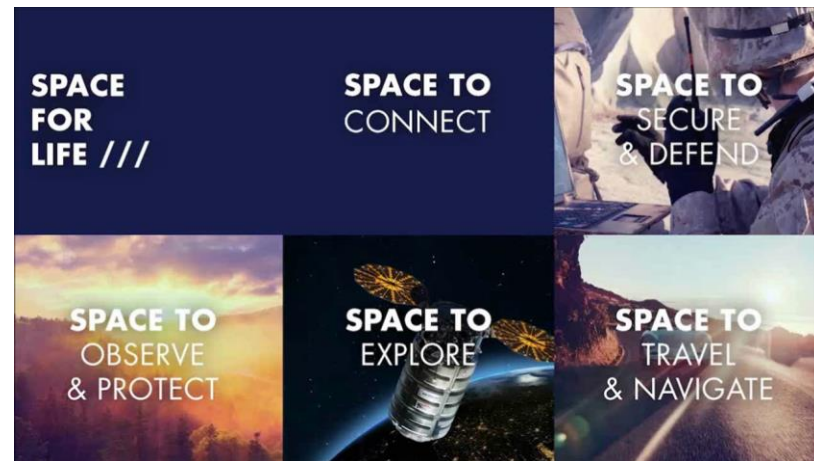
/ FROM EARTH TO DEEP SPACE

/ FOR VARIOUS APPLICATIONS

/// Our infrastructures integrate a wide range of technologies that need to be prepared upstream.

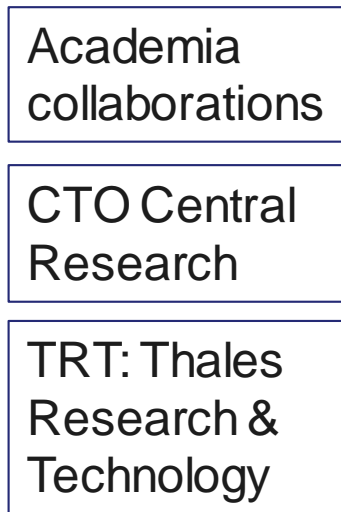


/// We are organized to mature all the necessary elements



THE R&D LIFE CYCLE

Early technologies



TRL 1-4

Explore, learn, remove fundamental roadblocks
Doc = 'RTI challenge'

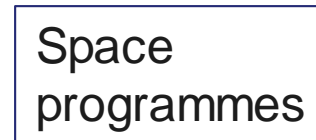
Maturation into products



TRL 5-7...

Remove implementation roadblocks, reduce user skill
Doc = 'Product plan'

Operational systems



TRL ...8-9

Make it work 24/7 for 15 years lifetime
Doc = 'FFP Contract' !

STRUCTURING RESEARCH & TECHNOLOGY WITH ACADEMIA

/// A wide range of enabling and disruptive technologies to be explored and matured

/ **NEEDED FOR PREPARING THE FUTURE OF TELECOMMUNICATION, NAVIGATION AND EARTH OBSERVATION MISSIONS**

/ **LISTED AS RESEARCH, TECHNOLOGY AND INNOVATION CHALLENGES**

/// Collaborations with academic partners increase the perimeter of the covered actions, and allow a faster progress for the evaluation of an emergent technology

/// Complementarity contributions and a win-win scheme

/ **INDUSTRIAL APPLICATIVE VISION VS THE ACADEMIC SCIENTIFIC APPROACH**

/ **CROSS-FERTILIZATION, FRUITFUL EXCHANGES AROUND REAL SCIENTIFIC CHALLENGES**

/ **AN INCREASED VISIBILITY AND AN ENHANCED IMPACT IN THE SCIENTIFIC COMMUNITY**

/// Train R&D young European Engineers with strong industrial flavor and academic excellence

/ **ATTRACTIVE CONTEXT FOR STUDENTS**

/ **PREPARE THE TECHNOLOGICAL LEADERS OF THE SPACE INDUSTRY**

STRUCTURING RESEARCH & TECHNOLOGY WITH ACADEMIA

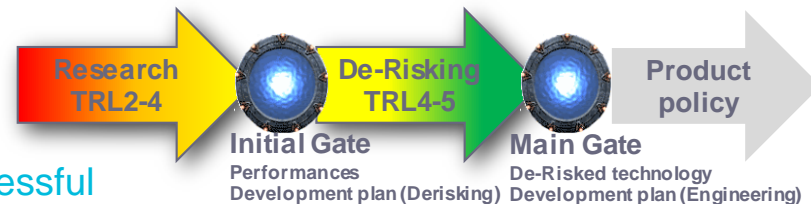
/// Focus on Early stages of TRL

- / EXPLORATION OF NEW TECHNOLOGIES
- / INVESTIGATION OF SPACE APPLICATIONS
- / DEMONSTRATE FEASIBILITY WITH PROTOTYPES
- / INITIATE TRANSFER TO DOMAINS AND COMPETENCE CENTERS



/// Objective to reach a milestone called “Initial Gate”

- / THE APPLICATION OF THE TECHNOLOGY TO SOLVE THE IDENTIFIED CHALLENGE IS REVIEWED
- / THE TECHNOLOGY IS DISSEMINATED FOR ASSESSING ITS POSSIBLE APPLICATION FOR OTHER NEEDS
- / THE APPLICATION IS DEFINED AND THE DERISKING PHASE STARTS OR THE ACTIVITY IS STOPPED OR POSTPONED



/// Target long term collaborations when first steps are successful

- / BUILD A COLLABORATION SPIRIT IN CONFIDENCE
- / CAPITALIZE THE RESULTS IN A COMMON ROAD MAP ON THE TECHNOLOGY
- / PREPARE THE NEXT ACTIONS IN RELATIONSHIP WITH AGENCIES, EUROPEAN INSTITUTIONS...

VARIOUS LEVELS OF PARTNERSHIPS

/// Collaborations in the frame of PhD projects co-funded by Thales Alenia Space France

/ 45 PHD PROJECTS SUPPORTED AND RENEWED BY 1/3 EVERY YEAR.

/ SUBJECTS PROPOSED BY R&D ENGINEERS

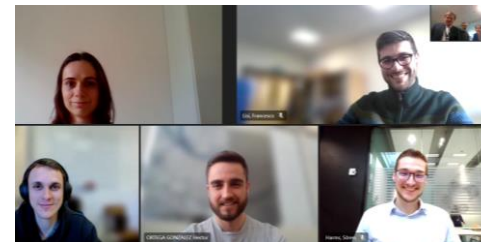
- Presents the proposed innovation, the current state of the art, the expected impacts
- Suggests and motivates a possible collaboration scheme

/ SELECTION BY A PHD COMMITTEE

- includes R&D leaders of competence centers and Telecom, EO and Navigation domains

/ CO-FUNDING FROM AGENCIES OR INSTITUTIONS IS REQUESTED

- ESA OSIP program is a nice instrument



/// Collaborations in the frame of Doctoral Networks of Horizon Europe

/ ATTRACTIVE AND COMPETITIVE PROJECTS THAT FUND A COHORT OF PHD STUDENTS (TYP 5-15) ON A GIVEN THEMATIC

/ CONSORTIUM OF ACADEMIC AND INDUSTRIAL PARTNERS

/ MOBILITY OF THE PHD STUDENTS AMONG THE ACADEMIC AND INDUSTRIAL PARTNERS

/ THALES ALENIA SPACE HAS STRONG EXPERIENCES ON SUCH NETWORKS



VARIOUS LEVELS OF PARTNERSHIPS

/// Long term agreement with privileged partners : An intention to work together and a contractual framework valid for all activities

/ TÉSA / TLC-NAV – SIGNAL PROCESSING

/ ISAE-CIMI – ELECTRONIC - CMOS DETECTORS

/ HERIOT WATT UNIVERSITY – SYSTEM TOOLS FOR ACTIVE ANTENNA PAYLOADS

/// The joint Laboratory : A pluri-annual planification of the common research

/ “AXIS” / RF FRONT ENDS WITH XLIM (LIMOGES, FRANCE)

/ “MERLIN” / SPACE ANTENNAS WITH IETR (RENNES, FRANCE)

/ “SOIE” / INSTRUMENTS WITH LAM (MARSEILLE, FRANCE)

/ “LOSCA” / ASTRONOMY WITH OCA (NICE, FRANCE)

/ “IRCIT” / IONOSPHERIC RESEARCH WITH IRAP (TOULOUSE, FRANCE)



Signature of the MERLIN joint laboratory

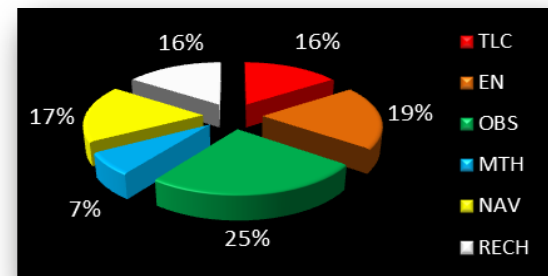


EXAMPLES OF PHD PROJECTS



PhD

- / DESIGN OF NANOSTRUCTURED BLAZED GRATINGS FOR COMPACT AND EFFICIENT SPECTRO-IMAGERS IN SPACE
- / EXPERIMENTAL STUDY OF THE ADDITIVE MANUFACTURING OF SILICON NITRIDE
- / RADIATION EFFECTS ON INGAAS INFRARED DETECTORS FOR SPACE APPLICATIONS
- / HIGH PERFORMANCE BACKSIDE PIXELS IN CHARGE DOMAIN
- / SHAPE OPTIMIZATION FOR REFLEXIVE OPTICS
- / PRAGMATIC DESIGN AND MONITORING OF ARRAY-FED REFLECTORS
- / WIDEBAND WIDE-SCANNING ARRAYS WITH IMPROVED POLARIZATION PURITY
- / QUASI-OPTICAL BEAMFORMER IN SUBSTRATE INTEGRATED WAVEGUIDE TECHNOLOGIES
- / INTEGRATED HPA-ANTENNA CO-DESIGN AT L/S-BAND
- / DESIGN OF ULTRA-COMPACT CIRCULATORS AND ISOLATORS IN W-BAND FOR VERY HIGH THROUGHPUT COMMUNICATION SYSTEMS
- / DIGITAL TWIN OF ACTIVE PHASED ARRAYS
- / ENHANCING FLEXIBILITY AND THROUGHPUT FOR SPACE ACTIVE PHASED ARRAYS WITH ADVANCED SIGNAL PROCESSING AND RESOURCE ALLOCATION STRATEGIES
- / EXPLOITATION OF AI FOR NETWORK CHARACTERIZATION AND RESOURCE
- / ORCHESTRATION OF SPACE EDGE COMPUTING (SEC) IN CONSTELLATIONS
- / NAVIGATION USING 6G NON-TERRESTRIAL NETWORK (NTN) COMMUNICATION SYSTEMS
- / THE FLUX OF METEOROID IN NEAR EARTH SPACE AS MEASURED BY THEIR LUNAR IMPACT FLASHES
- / NOVEL TIME-MINIMIZATION ALGORITHMS FOR COLLISION AVOIDANCE OPTIMIZATION
- / ON BOARD ANOMALY DETECTION FOR HYPERSPECTRAL SATELLITE MISSIONS
- / MANAGEMENT SUPERVISION SYSTEM TO FACILITATE DECISIONMAKING IN THE INDUSTRIAL CONTEXT



SUCCESS STORIES



/// Our first joint laboratory on emerging RF Technologies for satellites

/// CREATED IN 2006 WITH XLIM (LIMOGES)

/// New architectures of RF subsystems

/// GAN AMPLIFIERS, SIP

/// Novel characterization methods

/// HIGH POWER DEVICES, MODELLING
OF NON LINEAR DEVICES

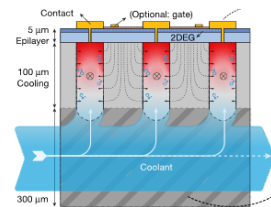
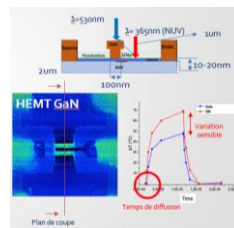
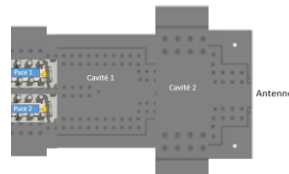
/// Integration and miniaturisation

/// SYSTEM-IN-PACKAGE, MICRO FLUIDIC,

/// NEW FILTERING SOLUTIONS,

/// MICRO ADDITIVE MANUFACTURING,
3D PRINTING, PHASE CHANGING COMPONENTS

/// More than 50 PhD awarded !



Home / XLIM Technology in orbit

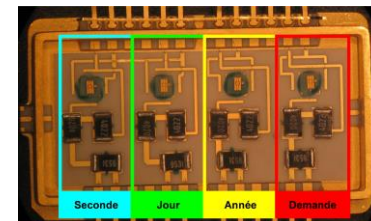
XLIM TECHNOLOGY IN ORBIT

Submitted on Friday 07 February 09:51



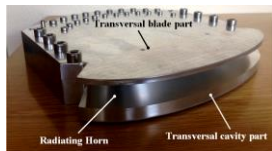
XLIM RF-MEMS switches took off from Kuru on thursday Feb. 6th, onboard of satellite Athena Fidus, as part of the MEMO project, supported by the french space agency CNES and managed by Thales Alenia Space

Highlight on a major achievement

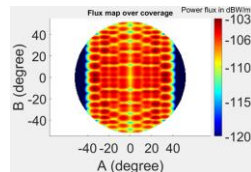
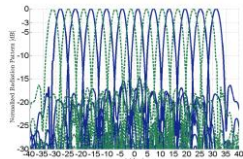


SUCCESS STORIES

/ EXAMPLE OF SUCCESSIVE TECHNOLOGICAL DEVELOPMENTS IN THE JOINT MERLIN LABORATORY ON MULTIPLE BEAM WIDE ANGLE SCANNING ANTENNAS FOR CONSTELLATION



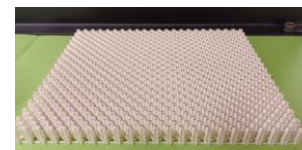
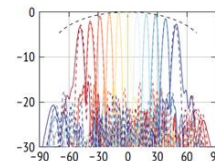
Ka Rx/Tx, $\pm 35^\circ$



96 beam Payload with QO Radiators



Steerable QO Radiator, Ka band,
Groove Gap WG Feed, $\pm 60^\circ$



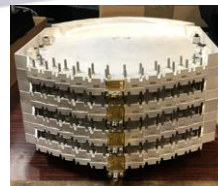
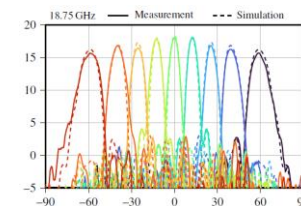
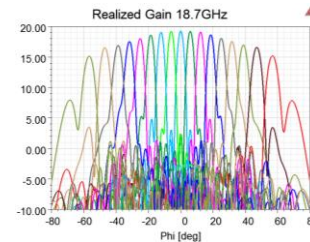
Full Metal Polariser, Ka band
Rx/Tx



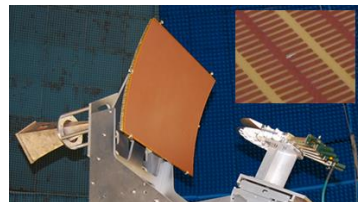
Injected Molded dielectric QO
Radiators, Ka band, $\pm 60^\circ$



PCB QO Radiators, Ka band,
 $\pm 60^\circ$



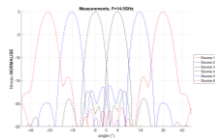
Injected Molded QO Radiators,
Ka band



QO Radiator + Polarising Reflector,
Ku band



Ku Rx/Tx, $\pm 25^\circ$



/// GOOD : Ground Optical Orbit Determination

- / GROUND BASED TELESCOPE TO MEASURE OPTICALLY THE POSITION OF SATELLITES
- / TELESCOPE DIAMETER 250 MM, CUPOLA DIMENSION 2,3 M

/// Developed in the LOSCA joint laboratory

- / WITH : OBSERVATOIRE DE LA COTE D'AZUR (OCA), UNIVERSITE DE NICE COTE D'AZUR, CENTRE NATIONAL DE LA RECHERCHÉ SCIENTIFIQUE
- / MISSIONS AND TECHNOLOGIES FOR :
 - Space surveillance : satellites, débris, astéroïdes,...
 - Observation of earth and universe

/// Main features

- / AN INDEPENDENT WAY TO MEASURE OUR SATELLITE POSITIONING
- / MEASUREMENT ACCURACY IMPROVED BY A FACTOR OF 10
- / ALLOWS DETECTION OF DEBRIS THAT CAN HIT OUR SATELLITE
- / OPTIMIZE THE MOTION TO AVOID DEBRIS (ENERGY OPTIMIZATION)
- / DETECT SPY SATELLITE THAT APPROACHES OUR SATELLITE



Les débris spatiaux suivis depuis Caussols

Un diamètre de 25 cm, une coupole de 2,3 m... Ses mensurations ne sont pas extravagantes, mais son utilisation pourrait bien, à l'avenir, prévenir bon nombre de catastrophes. Sur le plateau de Calern, à Caussols, dans l'arrière-pays grassois, le fabricant de satellites **Thales Alenia Space** et l'Observatoire de la Côte d'Azur inaugure ce mercredi un télescope pour le suivi des débris spatiaux. À terme, *Good*, c'est son nom, pourra être utilisé de façon autonome pour « la surveillance [de leurs] trajectoires » afin « de prévenir des collisions ». Photo: **Thales Alenia Space**

SUCCESS STORIES



/// REVOLVE: Radio Technologies for Broadband Connectivity in a Rapidly Evolving Space Ecosystem

/ [HTTP://REVOLVE.EPS.HW.AC.UK/](http://revolve.eps.hw.ac.uk/)

/ DISRUPTIVE ANTENNAS BASED ON EMERGING TECHNOLOGIES ENABLING NOVEL SATELLITE TELECOMMUNICATION SYSTEMS

/ THALES ALENIA SPACE AT DRIVING SEAT

/// A fruitful scientific project

/ 4 PATENTS

/ 38 PUBLICATIONS

/ THALES PHD PRIZE IN 2022

/ 2 DEMOS SHOWCASED AT PARIS AIRSHOW 2023






Context

The space sector is rapidly evolving and disruptive solutions are now called for

Mission specific technology

- ✓ UHTS
- ✓ LEO/MEO
- ✓ HAPS
- ✓ Small GEO
- ✓ Flexible payload
- ✓ SOTM

Bottom-up

- ✓ Payload & system architecture
- ✓ Quasi-optical techniques
- ✓ Mixed analog-digital solutions
- ✓ Additive manufacturing
- ✓ Mechanical reconfiguration
- ✓ Membranes and deployment

Research agenda

WP4: Agile RF system integration






WP1: Innovative systems

WP2: Mech & RF co-design

WP3: Materials & Manufacturing

Project info

Partners

- ✓ Heriot-Watt University
- ✓ Thales Alenia Space
- ✓ CNRS – IETR
- ✓ Prodintec
- ✓ LSS

Resources

- ✓ 7 PhD Fellows
- ✓ 21 Technical experts
- ✓ 4 year project (2017-2020)
- ✓ Expert advisory board
- ✓ Budget of €1.8M

/// 7 PhD Students all hired in the space industrial sector

/ 2 TASF, 1 AIRBUS, 3 SME, 1 ESA



P. Caine (CEO Thales) presents innovations among which 2 new technologies developed in Revolve



Prix THALES 2022 - Charalampos STOUMPOS: High efficiency feed in additive manufacturing

THALES ALENIA SPACE OPEN



SOME REASONS OF SUCCESS

/// Thales Alenia Space appoints Experts in all strategic emerging technologies

/// **STRONG CONNECTION WITH THE ACADEMIC COMMUNITY**

/// **CONNECTION WITH BUSINESS DEVELOPERS AND PRODUCT LINE MANAGERS IN TELECOMMUNICATION, EARTH OBSERVATION, NAVIGATION**

/// **CONNECTION WITH THE COMMUNITY OF R&D EXPERTS**

/// **FAVORABLE CONDITIONS FOR IDENTIFYING THE BEST USE CASES FOR DEVELOPING NEW TECHNOLOGIES, AND FOR DEVISING DISRUPTIVE SUBSYSTEMS TAKING ADVANTAGES OF MULTIDISCIPLINARY TECHNOLOGIES**

/// Experience in the Integration of academics in our industrial environment

/// **HOST PHD STUDENTS IN THE FIRST MONTHS OF THEIR RESEARCH**

- Team building approach
- Organize Cohort of PhD students for collectively building skills on space engineering

/// **HOST SUPERVISORS FOR KICK-OFF MEETINGS AND COMMON EVENTS WITH OTHER RESEARCH PROJECTS**

/// **PROVIDE TRAINING SESSIONS WITH BUSINESS AND TECHNOLOGY LEADERS ON THE MAIN RESEARCH CHALLENGES RELATED TO THE TOPIC**



Industrial Training session



Team Building of the REVOLVE project : Booth at « Toulouse Capitale Europeene de la Science »

	Title	Speaker
8h00 - 8h30		
8h30 - 9h00		
9h00 - 9h30	Welcome	C. Valorge (TAS-F)
9h30 - 10h30	ANTERRA : Antenna Systems Experts for 6G Non-Terrestrial Networks	Ulf Johannsen (Eindhoven University of Technology)
10h00 - 10h30	HARMONY : Harmonised Federated And Fractionated Systems for Satellite Services	Thomas Delamotte (University of the Bundeswehr Munich)
10h30 - 11h00	REVOLVE : An inspiring former MSCA Project	George Goussetis (Heriot Watt University)
11h00 - 11h30	Pause	
11h30 - 12h00	Vision and Challenges for a Multi-orbit satellite broadband Operator	Daniele Finocchiaro or Laurent Roux (Eutelsat, TBC)
12h00 - 12h30	Research Directions of Space and Satellite Telecommunication Systems: The SatNEx V perspective	Nader Alagha, ESA
12h30 - 13h00	Lunch break Cafeteria amph	
13h00 - 13h30		
13h30 - 14h00	Software Defined Satellites and Very High Throughput Satellites	P. Voisin, TAS-F
14h00 - 14h30	Constellations for Telecommunications	J.F. Boutillon, TAS-F
14h30 - 15h00	Constellations for Advanced Navigation Services	T. Calmettes, TAS-F
15h30 - 16h00	Pause	
16h00 - 16h30	The promises and challenges of Satcom for 6G	M. Nadarassin, TAS-F
16h30 - 17h00	Ground Segment for VHTS and Constellations	JL Almeida, TAS-F
17h00 - 17h30		
17h30 - 18h00	Wrap-Up	
18h00 - 18h30		
18h30 - 19h00		
19h00 - 19h30	Social Dinner/event at "La Cité de l'Espace"	

Agenda of a Training event with key experts proposed to our academic partners

/// Foster technology transfer for a fast transition to the products

- /// Internal dissemination channels that may widen the application scope

-

[illegible]

THALES ALENIA SPACE OPEN



ThalesAlenia
a Thales / Leonardo company Space

SOME REASONS OF SUCCESS

/// Targeting high impact through publications and patents

/ SCIENTIFIC PUBLICATIONS : TARGET 5 PUBLICATIONS PER PHD STUDENTS

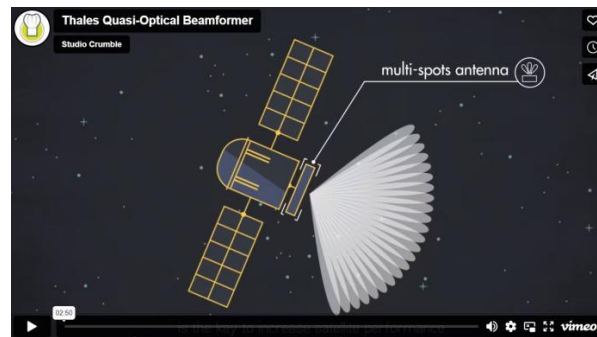
/ MIGHT BE ANTICIPATED BY PATENTS

/ PUBLICATIONS AND PATENTS PROCESSES WITH EXTERNAL PARTNERS ARE FULLY MASTERED
PROCESSES WITHIN THALES ALENIA SPACE

/// Disseminate for a larger audience

/ NEWS-LETTERS, WEB SITE FOR SOME PROJECTS

/ VIDEOS FOR EXPLAINING SIMPLY CONCEPTS
AND APPLICATIONS



Example of a motion presented at Thales Innovdays



Dear colleagues, partners, and satellite innovation enthusiasts,
Welcome to the first edition of our HARMONY project newsletter. Since our official launch in October 2022, we have embarked on an exciting journey. During this summer, most HARMONY PhD students were able to meet and work together at Thales Alenia Space in Toulouse. HARMONY PhDs are now progressively joining their host institutions or companies all around Europe.

[Visit our website to know more about the HARMONY PhDs!](#)

Retrospective



Our first significant event as part of the HARMONY project took place at the European Conference on Antennas and Propagation 2023, held in Florence, Italy, in March. Here, international experts came together to discuss innovative antenna solutions for broadband satellite systems. A dedicated session, organized by HARMONY partners CNRS and Heriot-Watt University, saw riveting talks and exchanges on this topic with engineers and researchers from Thales Alenia Space, Viasat, NASA/DPL, UCSD, and WaveUp. The shift from relying predominantly on large geostationary platforms to embracing the emergence of LEO and MEO constellations has created an engaging research sphere for the antenna community, and particularly our HARMONY researchers.

PERSPECTIVES FOR HUNGARIAN ACADEMIA



/// Thales Alenia Space is a space industry with European footprint and is implementing new industrial partnerships in additional countries

/// In the frame of the cooperation agreement set up with Hungary, proposition to enlarge the cooperation to Research & Technology with Hungarian academics

/// First step is to identify technological domains of excellence where research is needed

/// Possible paths to explore :

/ CONNECT WITH OUR R&D TECHNOLOGICAL LEADERS

/ DEFINE COLLABORATIONS

- Context : ESA OSIP Project, or Cooperation Agreement between Hungary and Thales Alenia Space

/ DURING THIS COLLABORATION, ORGANISE TRAINING AND BRAINSTORMING SESSIONS

- Industrial training sessions on current challenges for space, possibly in common with other projects
- Presentation of scientific topics from Hungarian academics terminated by brainstorming sessions
- Presentation from Industry could be also organised at Hungarian universities

/ ENLARGE THE COOPERATION WITH OTHER PARTNERS

- Possibility to team up with our privileged academic partners and to define a tri-partite project that could also overlap with EURASMUS program and include a joint Master Degree (HU/FR) and an internship at Thales Alenia Space.





Thank you for your attention!