

ARCE – Augmented Reality for Concurrent Engineering Activities

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Lusospace numbers

From Lisbon, Portugal





Introduction

To the ARCE (Augmented Reality for Concurrent Engineering) project

- Objectives:
 - 1. Development of a collaborative AR application, for multidisciplinary and distributed design teams, to enable visualization and editing of design models;
 - 2. Test the developed application in a concurrent engineering design exercise, at ESA CDF (ESTEC);
 - 3. Reach TRL 4
- Two phases:
 - Phase 1 2020 to mid-2022
 - Phase2 mid-2022 to mid-2023
- **Consortium:** Lusospace (prime) and Critical Software (subco for Phase 1)

BEYOND THE CHALLENGE



Requirements Definition

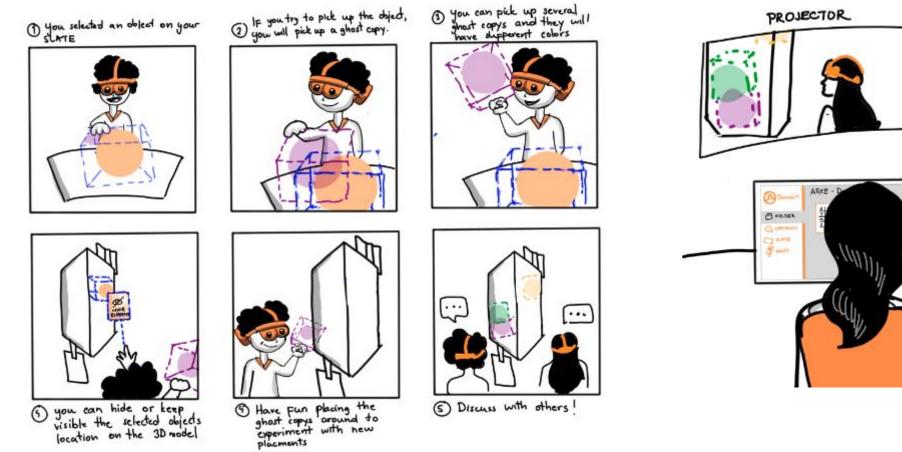


- Target: Concurrent Design Facility of ESTEC
- Integration with OCDT/COMET Engineering Databases





Requirements Definition

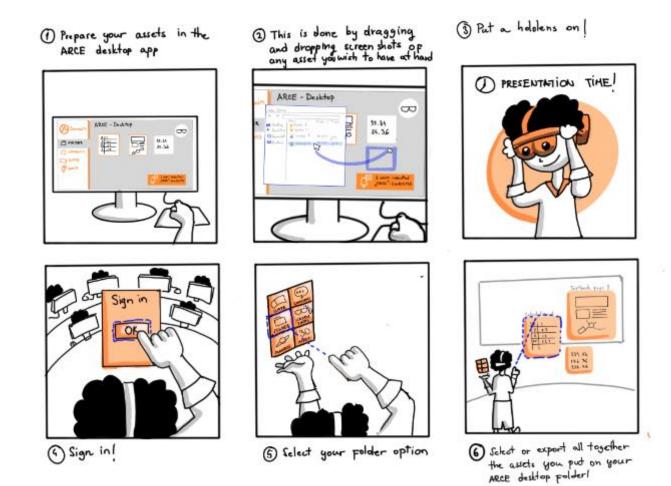








Requirements Definition

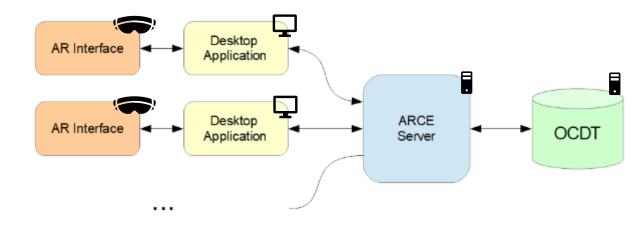




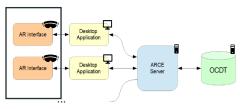
Application Definition

Three main applications were defined as part of the ARCE system:

- Server Application: generates and manages the ARCE Design
 Session, synchronizing the connected Desktop Applications on the
 'System's distributed features.
- **Desktop Application**: keeps the user logged in the session; video stream client on features like Presentation Mode.
- AR Interface: main means of interaction with the system. The user makes changes to the Concurrent Engineering (CE) Model, CAD Model and other Session data through the AR Interface



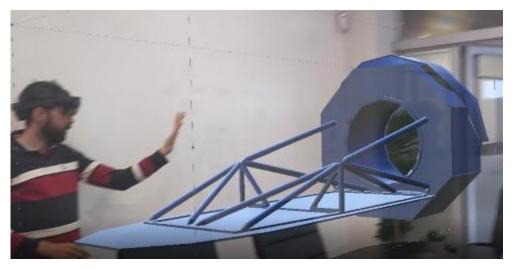




To comply with the established requirements, the UX/GUI design of the ARCE AR application was designed with two sets of main feature groups:

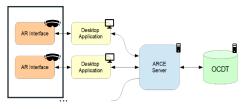


2D Information



3D Information





Main features: exploring the product tree, exploring/editing parameters, element definitions and design options, exploring budget and iterations, all in accordance to user profile/permissions

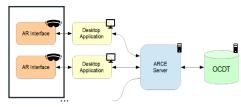


Inspect paramenter



Budget feature

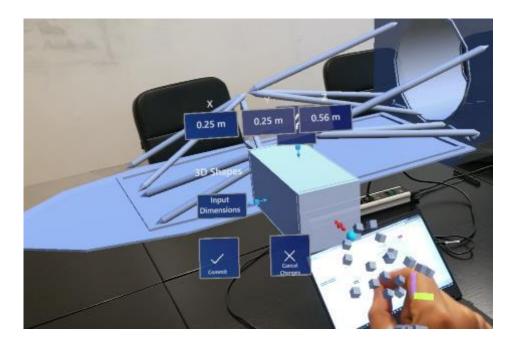


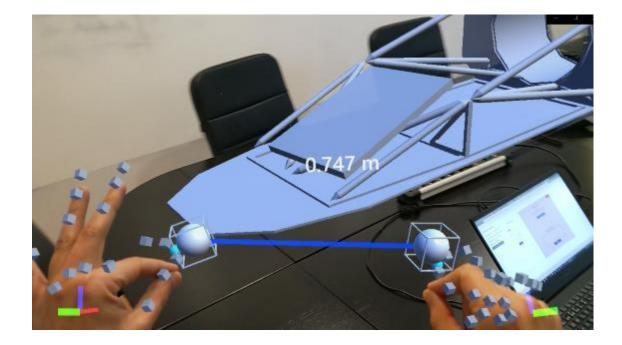


AR Interface

The interaction with the 3D model designed includes moving/hiding components on the Working Model, adding shapes, ruler

feature

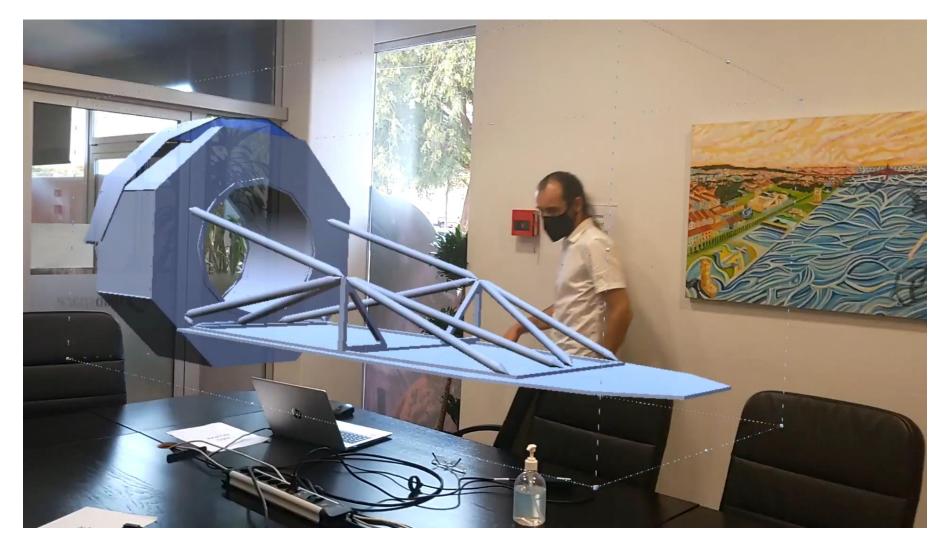




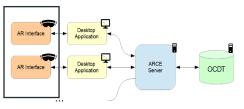
Ruler feature

Adding shapes

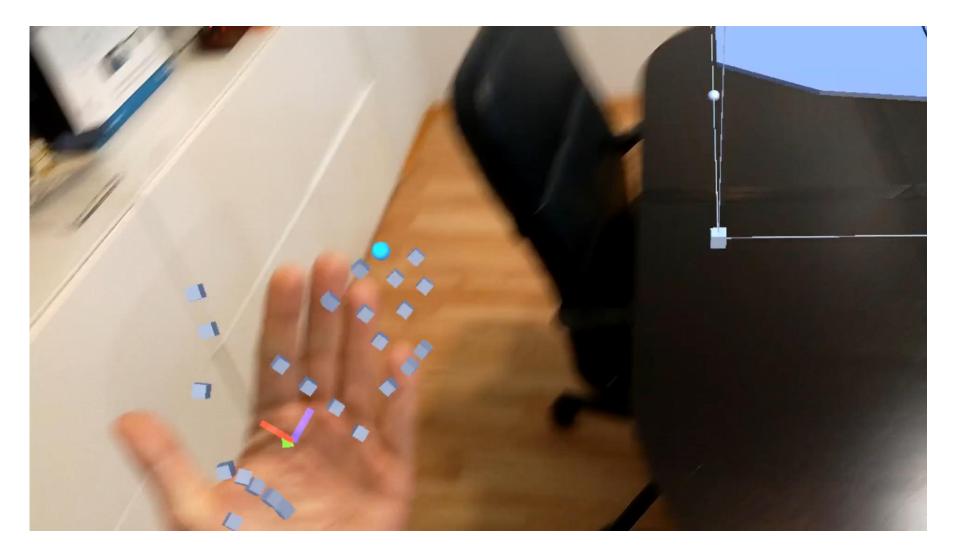
AR Interface – Multi player view



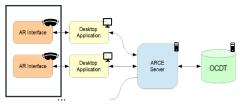




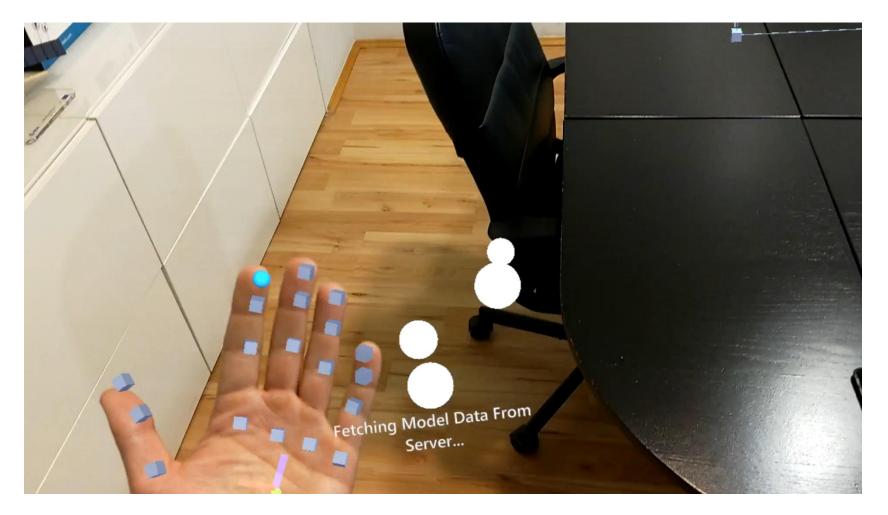
AR Interface - Product Tree



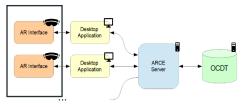




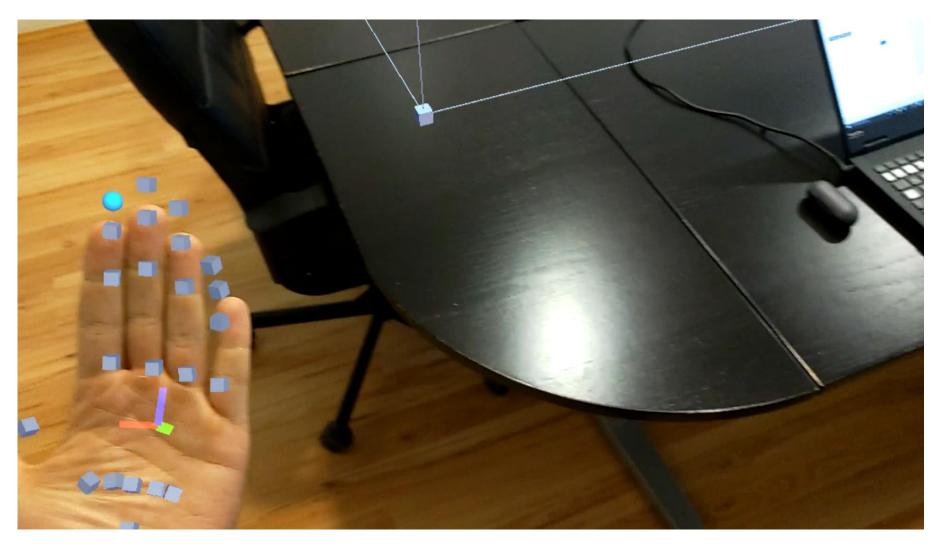
AR Interface - Budget feature



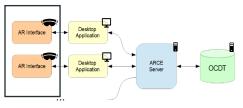


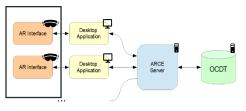


AR Interface - Ruler









UX/UI Design

Desktop Interface

UI designed as to allow for login, viewing presentations and user point of view

ARCE Server	AR Interface	\mathbf{P}
Logon Active Donair: <u>System Engineering</u>	Welcome! Please turn on your HoloLens and start the ARCE AR application in your HoloLens, please input either the Desktop Address (192.168.1.128) or use your HoloLens to scan the QR code! Image: Comparison of the Compar	

Main desktop menu

Baselet Tale Nodel Ad 0 07 Product 30 Shapes Made) 800 5 **Ongoing Presentations** Host admin Attendes: admin Leave

Presentation mode

www.lusospace.com



AR Interface

Application Development

UX/UI Design

Server Interface

A frontend for the server was designed to allow for starting the session, selecting the model and mapping CAD to CE elements

ARCE Server	Arce Server - session starter			
	CAD Path			
	C:\CADFiles GO UP			
	0000_XIPE-Spacecraft.arce_1.stp			_
	0000_XIPE-Spacecraft.stp			
	000_XIPE_SVM_alternate.arce_1.stp	CAD Model	OCDT Model	Link
admin	000_XIPE_SVM_alternate.arce_2.stp	XIPE SVM STR 11944F Adapter	X band Transponder Redundant	XIPE_SVM_PWR_Batteries - Battery_general1
	000_XIPE_SVM_alternate.arce_3.stp	XIPE SVM STR Central-Cylinder	X band Transponder	XIPE_SVM_PWR_Batteries - Battery_general2
		XIPE_SVM_STR_IF-Ring-PLM	FPA Mounting Structure	XIPE_SVM_PWR_PCDU - Power Conditioning & Distribution Unit
Password	000_XIPE_SVM_extractedFrom_0000_XIPE-Spacecraft.arce_1.stp	XIPE_SVM_STR_Bottom_Panel	Heater_Propulsion	XIPE_SVM_COMM_X-LGA-LHCP - X band Low Gain Antenna LHCP
	000_XIPE_SVM_extractedFrom_0000_XIPE-Spacecraft.arce_2.stp	XIPE_SVM_STR_Shear-Panel	Detector Set Mounting Interface	XIPE_SVM_COMM_X-LGA-RHCP - X band Low Gain Antenna RHCP
	output.stp	XIPE_SVM_STR_Shear-Panel	X band Low Gain Antenna LHCP	XIPE_SVM_COMM_X-EPC - X Band Electronic Power Conditioning
	XIPE_all_v1.arce_1.stp	XIPE_SVM_STR_Shear-Panel	X band Low Gain Antenna RHCP	XIPE_SVM_AOCS_Gyro-Astrix-1090 - Redundant GYRO Airbus Astrix 1090
	XIPE_all_v1.stp	XIPE_SVM_STR_Shear-Panel	A6 launcher	XIPE_SVM_AOCS_Gyro-Astrix-1090 - Nominal GYRO Airbus Astrix 1090
	· ··· = _ ··· = +	XIPE_SVM_STR_Shear-Panel	Telescope Tube	XIPE_SVM_AOCS_MagneTorquer - MTQ Zarm MT110-2
	CE model location	XIPE_SVM_STR_Shear-Panel	Mechanisms Subsystem	XIPE_SVM_COMM_X-TWT - X Band Traveling Wave Tube
		XIPE_SVM_STR_Shear-Panel	X Band Electronic Power Conditioning	XIPE_SVM_AOCS_RW - Nominal RW Rockwell Collins RSI 12
	http://10.1.1.20	XIPE_SVM_STR_Shear-Panel	X Band Electronic Power Conditioning Redudant	XIPE_SVM_Radiation_RADMON - Radiation Monitor
		XIPE_SVM_STR_Top_Panel	Electronic Power Conditioning	XIPE_SVM_STR_Shear-Panel - Service Module Shear Panel
		XIPE_SVM_STR_Closure-Panel-A	Service Module Central Cylinder	XIPE_SVM_PROP_ATK_PSI_80342-1_Propellant_Tank - Equipment XIPE_Tank
	Engineering model selection Engineering model iteration	VIDE QVAX QTD Observe Danel A	Dedetor QUAL	VIDE Q\84 AOPQ_QTTD E11 Darkinstant QTD Qorlam Liketra Elactronice I Init (
CE model location: http://10.1.1.20	X-ray Imaging Polarimetry Explorer OCI Second Iteration Load	Back Link Remove Br	okan Remove All Brokan	

Selecting necessary elements

OCDT/CAD element mapping interface

Server login menu



Validation

Design Exercise



Two users running a design exercise and moving pieces of the 3D model while the presentation mode is active and visible on the projector canvas



One user manipulating the Product tree and properties of an object while the presentation mode is active



Conclusions

Validation

- At the end of the exercise, feedback was gathered though a survey with both quantitative and qualitative questions
- "I found that the ARCE application could add value to a concurrent engineering session" got a 4.5 out of 5
- Most useful features noted were the interaction with the 3D model shared by all users, presentation mode and budget feature
- Key improvements desired: undo/reset function, budget improvement, connectivity issues



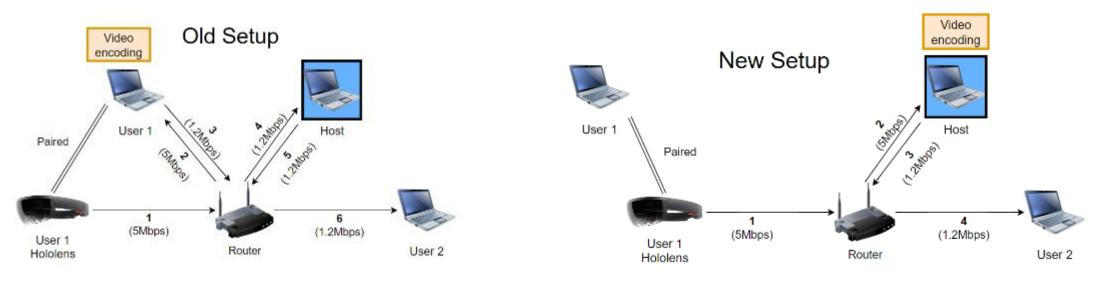
Second phase of ARCE

Objectives

- Implementation of network connectivity resilience improvement
- Implementation of UX/UI improvements

Network Connectivity Improvement

- 1. Implemented multiple communication channels between applications
- 2. Streamlined communication paths:





Network Hops: 4

Latency reduction: -33%



Desktop Application

Desktop Application

AR Interface

AR Interface



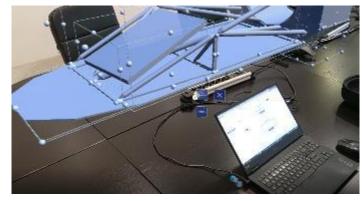
3D interaction, menus

Improvements implemented

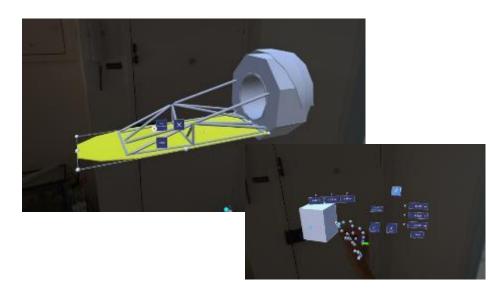
3D model interaction improved, with the following changes:

- Used raycasting (no bounding boxes) combined with hovering highlight much easier to select specific components in the 3D model
- Improved the position/interaction with the dedicated menu
 (Hide/Parameters) optimized size, interaction now enabled through direct clicking as well
- Optimized the current loading/instantiating of the objects every time a "Fetching data" is happening

Before



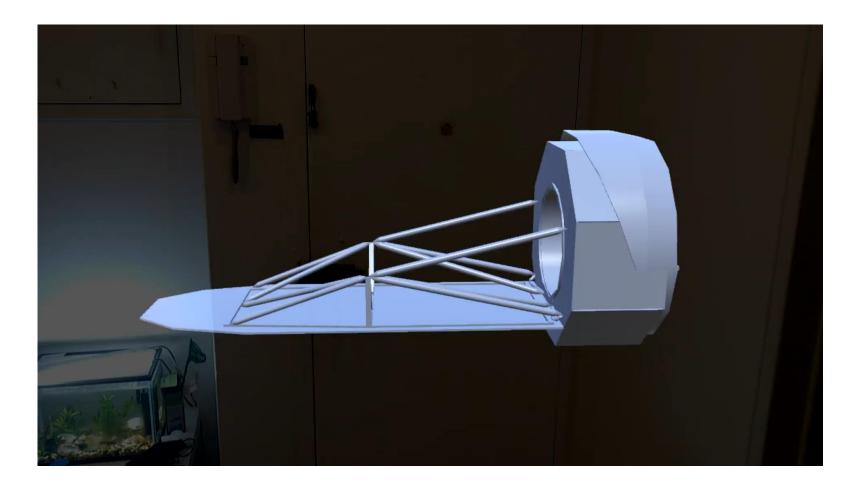
After





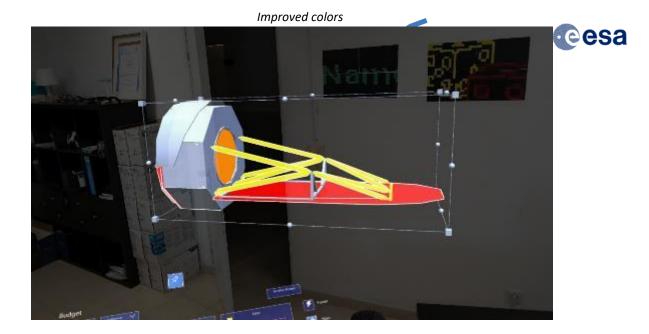
Features undo / redo

Modifications implemented



Budget What was done

- Budget heat map betterment:
- Budgets visualization improved. Colors for the High, Medium and Low parts are now more linear and less ambiguous/confusing when Budget menu is open.
- In terms of calculations:
 - Mass budget was reviewed
 - Power budget: display P_on instead of P_mean
 - Fringe cases (e.g. all equal) fixed







Conclusions

Objectives met

- Successfully implemented a software suite that allows for interacting with satellite 3D models (modifying absolute/relative positions and orientation of the model/components, evaluating dimensions) and engineering data (consulting and altering parameters, design options, budgets and issues, amongst others) in an AR environment.
- 3D model's position and orientation is shared amongst all users in the session, engineering data is synchronized between all **AR users and OCDT**, and a **presentation mode** is available for those users not wearing AR headsets.
- Several users from different disciplines can participate in the session (dully authorized and with corresponding permissions), and visualisation and editing of design models was proven at the CDF during the final design exercise.



Next steps

Roadmap

- Overall raise of the TRL, from TRL 4 to TRL5/6 and further, based on user feedback
- Integration and harmonization with third-party ESA developments, e.g. to allow for automatic links between CAD model and Engineering Model in OCDT/COMET
- Final deployment at the ESTEC CDF



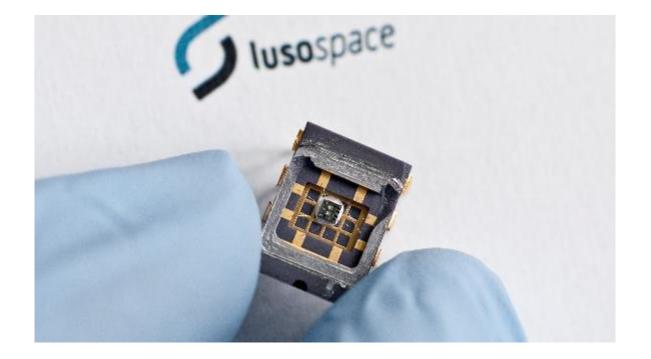
Check out our demos outside!

Questions?



Get In Touch

We will be pleased to help you.



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