Invest in

A Launchpad to Space Success

INVEST IN AALBORG

Welcome to Aalborg
A 20-minute city in North Denmark

Through the years, Aalborg has been a driving force in the Danish space industry, emerging as a prominent hub for space innovation and satellite technology.

In the 1990's, Aalborg played a significant role in the early evolution of the mobile communication systems. This laid the foundation for Aalborg's strong position in various fields, including space and satellite technology.

Today, Aalborg is home to some of the world's leading space and satellite companies, and Aalborg technology is on board some of the most important space missions in the world - with ESA, NASA and SpaceX.

In this white paper, we explore five chapters and five reasons for the space success in Aalborg.

1. THE RESEARCH

The commercial space success in Aalborg is driven by exceptional scientific research at the highest-ranked engineering university in Europe, Aalborg University.

Aalborg University's research and achievements are globally acknowledged, and its problem-based research approach, known as the Aalborg-model, draws students, researchers, and partnerships from around the globe.

2. THE TEST SITES

North Denmark is known as a living lab for Renewables, Connectivity and Space Technology.

Turning ideas and concepts into reality can take years of planning and testing. However, the availability of small and large test sites in Aalborg has accelerated the innovation process for many companies.

3. THE COMPANIES

Aalborg is home to an influential ecosystem of companies that are driving innovation in European space technology. Their contributions to the space economy is growing every year - providing essential services on Earth, such as maritime communication, environmental monitoring and 5G integration.

4. THE TECHNOLOGIES

The city's innovative companies are at the forefront of developing sophisticated microsatellites, advanced communication systems, and sustainable power solutions. These technologies not only enhance space missions but also provide critical applications on Earth.

Some of the more detailed space focus areas in Aalborg include:

- Robotics in Space
- Communication (5G/6G – Antennas)
- Orbit Prediction
- Swarms (CubeSat)
- Drones
- International CubeSat Communication

5. THE PEOPLE

It's the people and their skills that set Aalborg apart. The city features a highly skilled and educated talent pool, with a total workforce of +270,000 within commuting distance.

North Danes are known for their dedication, flexibility, and high-level qualifications. **Welcome to Aalborg!**

Did you know?

In the 1990s and up to the turn of the millennium, Aalborg played an important role in the global mobile industry, which helped transform Aalborg's identity. From *"the city with the smoking chimneys"* to the knowledge and cultural city we know today.

Although much has changed since the 1990s, *"Mobilicom Valley"* laid the foundation for Aalborg's leading position in various fields, including space and satellite technology.

Chapter 1

THE RESEARCH

THE RESEARCH @Aalborg University

It is hard to overestimate the importance of Aalborg University(AAU) for NorthDenmark - also in the field of space exploration.

For more than 20 years, AAU has played a central role in research and development within the European space technology.

Since the late 2000s, a high-tech stronghold in space technology has developed around Aalborg University. This growth is built on the foundation of the robust research environment at the Department of Electronic Systems.

Space technology emerged as a research area at AAU in the 1990s when the university participated in the development of Denmark's first satellite, the Ørsted Satellite. This sparked significant interest in space technology, and the Department of Electronic Systems established a space education program.

At the same time, researchers and students became aware of a development in the USA involving nanosatellites (cubesats), which cost much less to build than traditional satellites. The department initiated a program where students built nanosatellites themselves. The students were divided into groups, each responsible for different parts of a satellite. AAU's first nanosatellite was launched in 2003 and successfully demonstrated that the small satellites could take images of the Earth using an integrated camera.

In 2007, three students decided to test the commercial potential. They founded the company GomSpace and quickly generated sales to universities around the world.

Since then, GomSpace has successfully developed satellites for monitoring and radio communication in the maritime and aviation sectors.

Space Research Projects
Aalborg University is engaged in a diverse range of space research projects. These projects include developing advanced lunar and Mars exploration technologies, such as autonomous rovers and robotic systems.

Researchers are also focusing on innovative satellite communication solutions, including high-bandwidth systems and precise orbit determination.

The university's work extends to improving global hydrological models and drought monitoring systems, leveraging satellite data for enhanced water resource management.

Additionally, Aalborg University is contributing to large-scale missions aimed at detecting gravitational waves and studying extreme states of matter in space.

Scan for more information about AAU Space

Space researchers at Aalborg University include:

- Jens Dalsgaard
- Petar Popovski
- Simon Bøgh
- Israel Leyva Mayorga
- Preben Mogensen
- Gert Frølund Pedersen

Space Research Projects

by AAU Space

3D-Twin will design a distributed digital twin architecture for 3D networks based on the O-RAN framework.

SURE is to develop onboard functions within the GNC system that enable a progressive transition from precomputed robustness to embedded autonomy in the execution of a launch mission.

SATNEX V - SCS will investigate and design mechanisms to achieve semantic communication in Earth observation applications.

In **PLANSPACE**, a lunar multi-microgrid system based on solar power and energy storage systems is to be developed.

In **DeCoSAT**, coordinated control design and energy management of microgrid-based SmallSat will be proposed.

ModSPACE presents a comprehensive review of different PV-models and studies dedicated to the radiation-induced degradation and shielding of the PV cells.

The enhanced X-ray Timing and Polarimetry **(eXTP)** mission is a future satellite designed to study extreme states of matter density, gravity, and magnetism in space.

LISA will be a large-scale space mission designed to detect one of the most elusive phenomena in astronomy - gravitational waves.

Robot Grasp Learning On The Moon looks into the use of Deep Reinforcement Learning for vision-based robotic grasping of objects on the Moon.

Autonomous Space Rover Navigation With RL demonstrates autonomous navigation capabilities in unknown areas (mapless) on Mars with a reinforcement learning-based robot behavior learning approach.

The overall purpose of **SPACOM** is to further support the communication, behavioral health, and performance in human space exploration.

This **SatNEx V** project focuses on using the intelligence at the satellites to train models for routing in large non-geostationary orbit (NGSO) satellite **constellations.**

About AAU Space

AAU Space is the direct entry to all space-related activities within research and education at Aalborg University. It brings interdisciplinary learnings and resources together with the aim of creating new knowledge and strong collaborations.

Research and education focused on space have existed for more than 20 years at Aalborg University. The development of the Ørsted Satellite in the 1990s and the first student-built CubeSat in 2003, in particular, helped accelerate the interest.

Scan for more research projects

www.investinaalborg.dk

Chapter 2

THE TEST SITES

The North Danish region is a living lab

THE TEST SITES

The North Danish region contains several small- and large-scale test sites across the entire area where new technologies and solutions are tested and demonstrated. Large offshore and onshore territories enable further development in the region and the construction of new sites and facilities.

The larger facilities are predominantly utilized in the energy and renewables sectors, yet they also have significant intersections within the field of space technology.

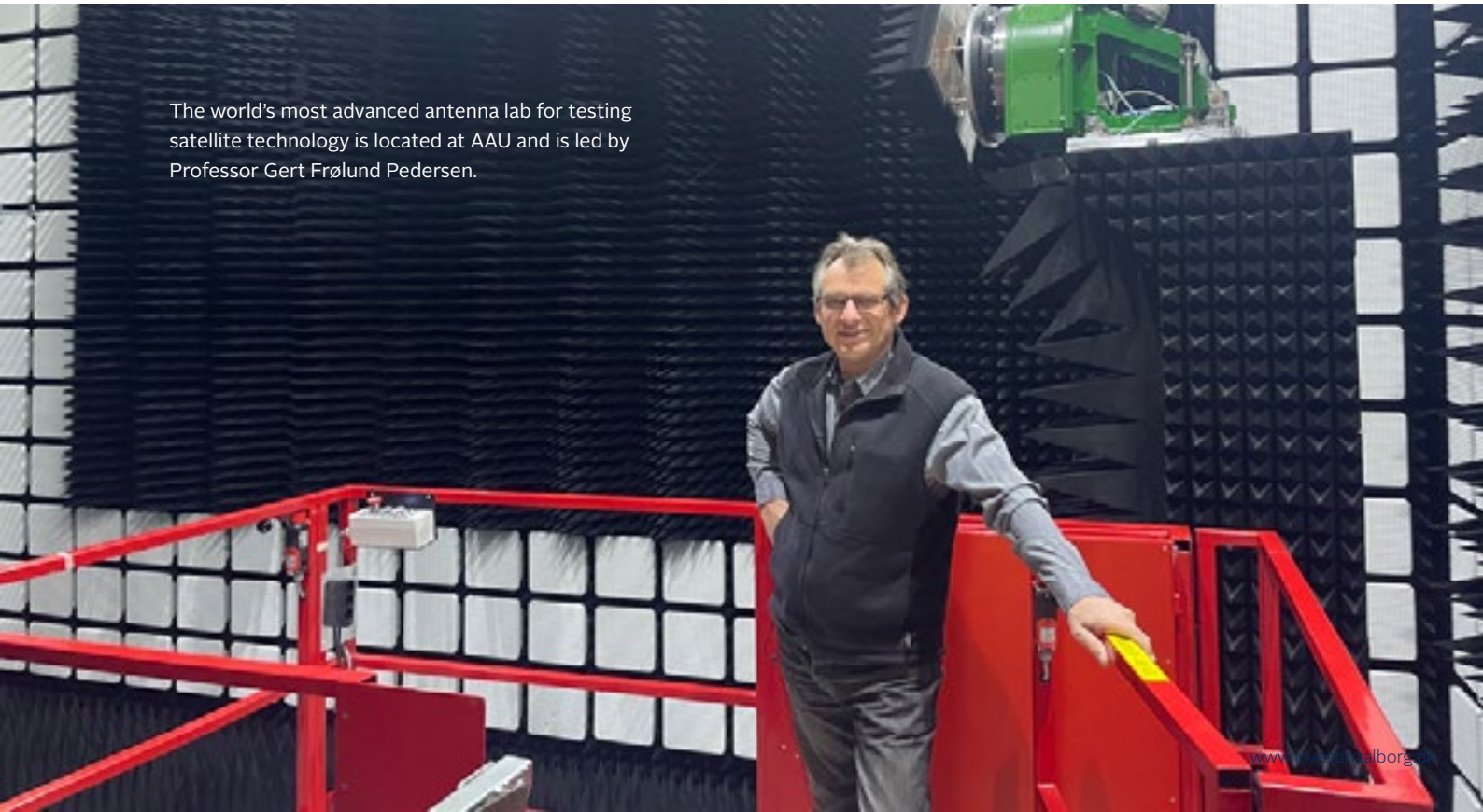
The most advanced antenna laboratory in the world
The antenna laboratory at Aalborg University in Denmark stands as a premier facility within AAU's Department of Electronic Systems, renowned for its decades-long leadership in antenna research. This expansive laboratory, one of the largest globally, features innovative design elements like a removable roof and wall, combining the benefits of an enclosed anechoic chamber with the capabilities of an outdoor measurement station.

In practice, the lab simulates an infinitely large space that is shielded and radio-anechoic - offering a unique environment for advanced research.

The lab is designed to facilitate precise measurements of large objects and signals over vast distances without the typical interference caused by ground reflections and other outdoor factors.

Equipped with an elevator and a measurement platform, the lab can lift and rotate large objects, such as cars and satellites weighing up to 3,500 kg. The removable roof allows even larger items, like wind turbine blades or fighter planes, to be partially or completely lowered into the lab.

The facility also caters to industries focused on smaller antennas and mobile devices, with two standard antenna measurement chambers that enable a wide range of research applications. This flexible environment supports the experimental research essential to AAU's innovation goals, spanning technologies from small antennas to integrated communication systems in vehicles, clothing, household appliances, and future, yet-to-be-imagined technologies.



The world's most advanced antenna lab for testing satellite technology is located at AAU and is led by Professor Gert Frølund Pedersen.

The region of North Denmark is a living lab

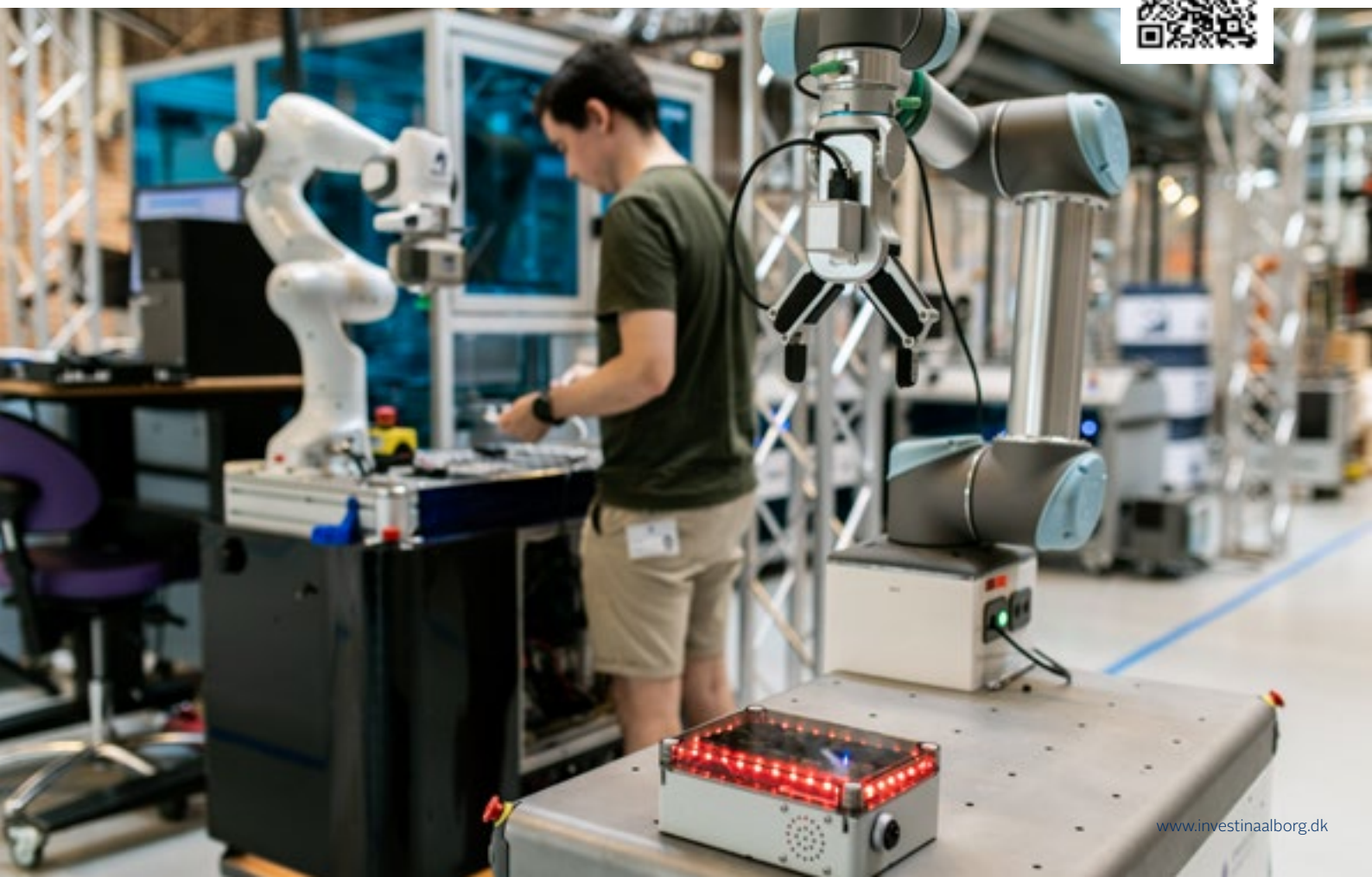
THE TEST SITES

5G Smart Production Lab
Aalborg University has created a testing and production environment available to relevant companies. The purpose is to spread the knowledge and business opportunities within 5G and IoT in the business world. Production equipment includes line modules, robotic arms, AMRs, etc.

The lab is equipped with the most modern wireless technologies such as 4G, 5G, Wi-Fi6 and LoRa which makes it possible for AAU researchers and industrial partners to work together in the integration and testing of advanced Industrial IoT systems for the factories of the future.

Aalborg University is the highest ranking university in Denmark within computer science research, and the 5G Smart Production Lab give the companies the opportunity to get research-based advice and help to test new business models and technological solutions.

Scan for virtual tour of 5G Smart Production Lab



Chapter 3

THE TECHNOLOGIES

THE TECHNOLOGIES

A lot of the expertise within space in Aalborg revolves around technologies for nanosatellites and as well as hardware and software to receive and utilize satellite data in various products.

One way to divide space technologies in Aalborg is in Up- and Downstream technologies.

Upstream: Exploiting non-space technology in the space domain.

Downstream: Exploiting space technology or utilize space systems in a non-space domain.

Upstream: From Earth to Space
Aalborg's contribution within upstream applications includes the city's expertise in satellite, robotics and drone technology which has been applied to space exploration.

Aalborg's upstream applications have paved the way for more efficient and cost-effective space exploration.

- Space Domain Awareness

Technologies for real-time tracking, detection, and characterization of space objects to ensure collision avoidance and safeguard critical assets.

- Geostationary Microsatellites

Small geostationary communications satellites designed for launch into Low Earth Orbit (LEO) or Geostationary Transfer Orbit (GTO) and customizable satellite solutions crafted from modular subsystems for diverse missions in both Low Earth Orbit (LEO) and Geostationary Orbit (GEO).

- Astronomical Observation Satellites

Microsatellites equipped with advanced telescopes for astronomical observations.

- Advanced Communication systems and Non-Terrestrial Networks (NTN)

High-frequency radio payloads, antennas, and software-defined radios for space missions.

- Power and Propulsion Systems for Satellites

Advanced power supply systems, battery packs, and propulsion modules for nanosatellites.

- On-board Computers and Software Systems

Miniaturized, feature-rich on-board computers and integrated software for satellite operations.

- Attitude Determination Control Systems (ADCS)

Subsystems for precise attitude and orbit control in nanosatellites.

Aalborg has evolved into a key destination for space technology, especially renowned for its expertise within:

Nanosatellites: Development and production

Satellite data usage in different products

Equipment to receive satellite data.

THE TECHNOLOGIES

Downstream: From Space to Earth
In terms of downstream applications, Aalborg's expertise in space technology has been utilized in various non-space domains. For instance, the city's expertise in communication technology is applied to the development of 5G/6G antennas that can be used on Earth.

The city's contribution to downstream applications has opened opportunities for innovation in various industries, from telecommunications, real-time tracking and disaster response.

- Maritime Communication Systems

Satellite-based communication and messaging systems for maritime applications, enhancing connectivity and data exchange.

- Integration of 5G/6G Non-Terrestrial Networks (NTN) and Terrestrial Networks

Integration of satellite technology with 5G/6G networks to extend coverage and enhance connectivity.

- Broadband Global Area Network (BGAN)

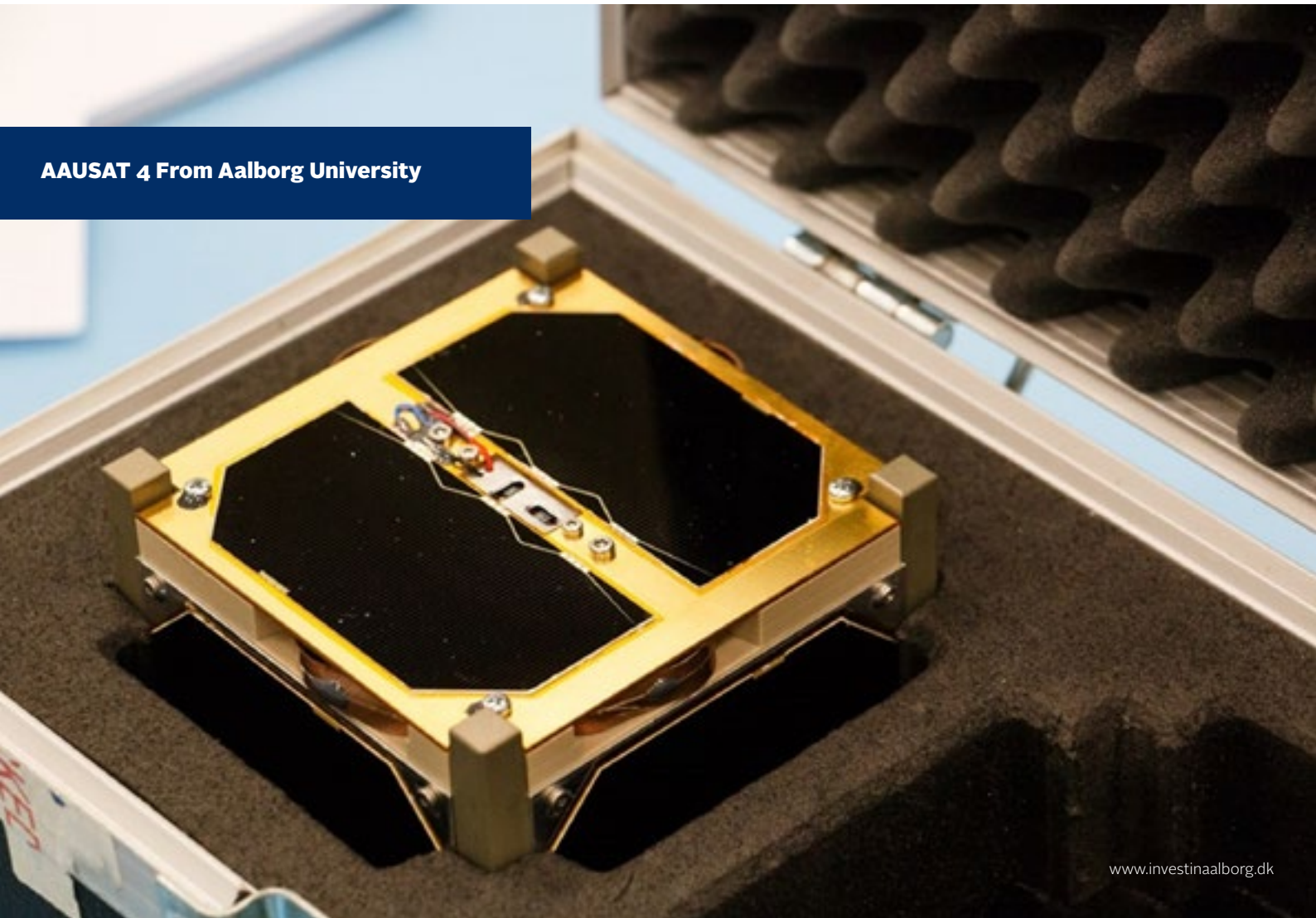
Satellite-based broadband communication network offering global coverage for internet, video, and voice services.

- Demand Assigned Multiple Access & Integrated Waveform (DAMA/IW)

Protocols for efficient satellite communications, predominantly used in defense and military sectors.

- Monitoring Services Using VDES Satellites

Satellite-based services for measuring global radiation on VHF frequencies and developing algorithms to detect changes in specific regions.



AAUSAT 4 From Aalborg University

Chapter 4

THE COMPANIES

Companies in Aalborg and North Denmark related to the space industry

Aalborg has played a crucial role in the foundation of the Danish space economy.
Today, Aalborg and North Denmark is home to a wide selection of companies in the space and satellite industry.

2Operate A/S
Operational and power efficiency of radio access networks

AnyBody Technology A/S
CAE software for musculoskeletal biomechanics

ClearSky Vision ApS
AI optical imagery and radar imagery

Cobham SatCom A/S
Radio and satellite communication technology

Danphone A/S
Maritime Communication and Safety Systems

GomSpace A/S
Nanosatellites and cubesats

HYTEK Aalborg
technological training courses

Gatehouse Satcom A/S
Satellite communication software

Keysight Technologies Denmark ApS
Electronics test and measurement equipment and software

Necas A/S
High-tech electronic products

Polaris Electronics A/S
Maritime communication and navigation systems

NOKIA Denmark A/S
Wireless network development and edge clouds

Robotto ApS
AI-powered drones and drone software

Rohde & Schwarz Danmark A/S
Test-, measurement- and communications equipment

Satlab A/S
Advanced radio systems

SpaceCom A/S
Advanced communication solutions

Space Inventor A/S
Manufacturing microsatellites

Steinwurf ApS
Software and hardware to power real time solutions

Sternula A/S
Connecting the oceans with satellites

Trackunit A/S
SaaS-based IoT solution for the construction industry

Space Connect Denmark - National hub for digital technologies in space

Aalborg University and several of the above mentioned companies have come together to create ‘Space Connect Denmark (SCD)’ to capitalise on the innovation in the region and position Denmark on the international space scene.

The overall goal of SCD is to act as a neutral facilitator, bridging businesses, universities, and research institutions to promote innovation, research, and economic progress in digital space technologies.

ESA BIC Startups

by AAU Space

The European Space Agency Business Incubation Center Denmark (ESA BIC Denmark) is an incubator which aims to support entrepreneurs in transforming their space-based business ideas into commercial startups.

STEPUP HORSE
Real-time monitoring and analysis of racehorses' health.

ALUMNI START-UP

ROBOTTO
Autonomous systems with computer vision, AI, high-precision GNSS and drones for e.g. recognition of forest fires.

BE MARS
Battery management system for commercial satellite applications.

ALUMNI START-UP

CLEARSKY VISION
Artificial intelligence and radar imagery to remove clouds, shadows and image artifacts from optical images.

VIXOS AVIATION
A highly reliable and flexible system using satellite link for flight termination.

Chapter 5

THE PEOPLE

It's all about finding the right people

THE PEOPLE

Aalborg is a leading European business destination whose citizens several times have been ranked as the happiest people in Europe and as those who feel the safest. Home to world-class companies, major R&D facilities, innovative entrepreneurs, a renowned university and university hospital, Aalborg and North Denmark is a dynamic, thriving and business-focused region.

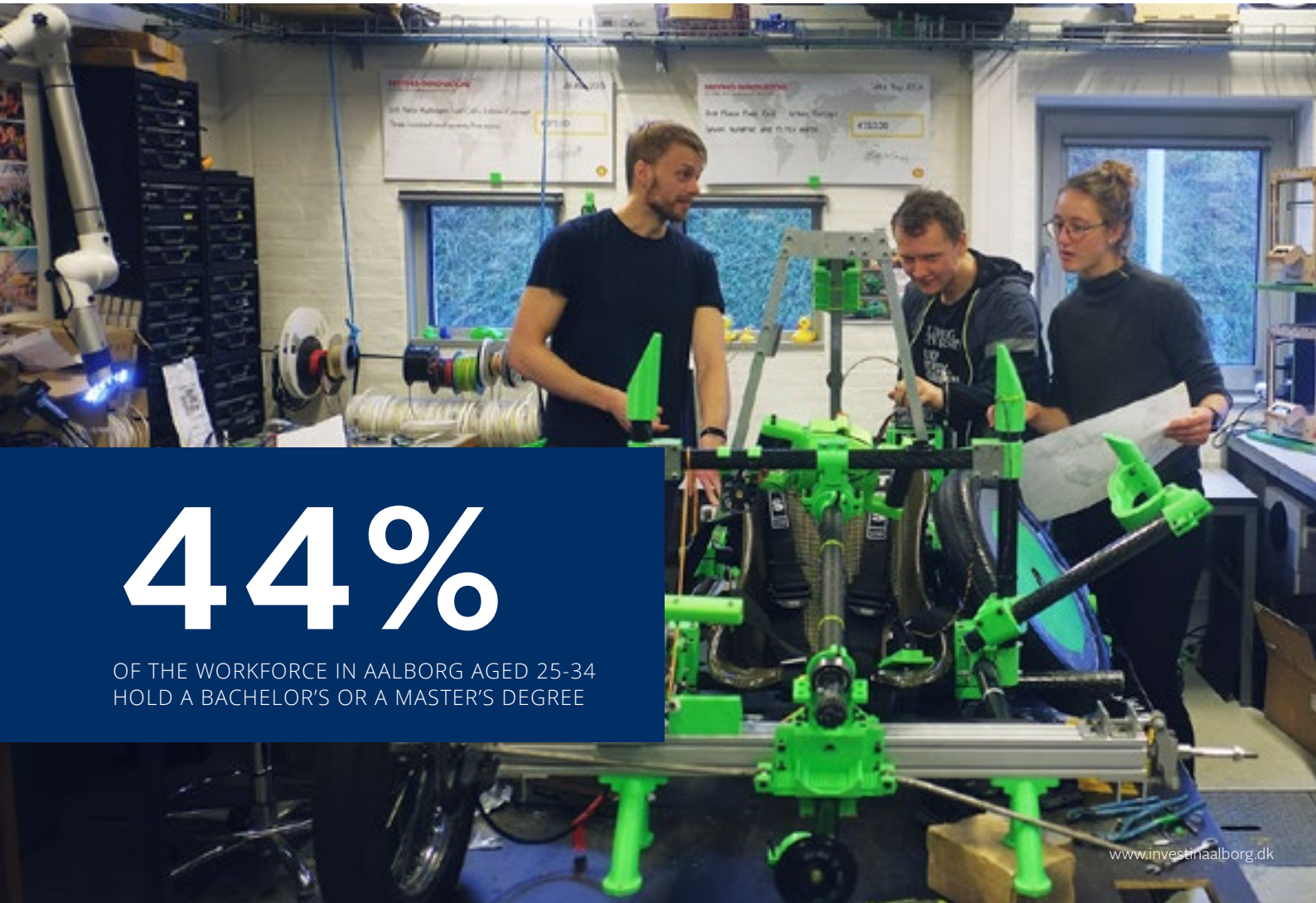
It is the people and their skills that make the difference.

When setting up your business in Aalborg, you gain access to a highly skilled talent pool. The total workforce amounts to 270.000 people within commuting distance. North Danes are characterised by their dedication, flexibility and high-level qualifications.

Young and growing population
Aalborg is Denmark's third-largest municipality with over +220,000 inhabitants. The population grows every year, and most newcomers are young people about to begin their studies at Aalborg University or University College of Northern Denmark. In total, Aalborg has approximately 45,000 students.

However, Aalborg is not just a place for academics. The city continues to cultivate its proud industrial roots, with a focus also on a strong vocational workforce.

Global city
There are about 12,000 international employees in Aalborg, and 4,800 international students at University College North Denmark and Aalborg University. Aalborg's diverse talent pool is providing both greater multilingual capabilities and new global opportunities.



44%

OF THE WORKFORCE IN AALBORG AGED 25-34 HOLD A BACHELOR'S OR A MASTER'S DEGREE

THE PEOPLE

Europe's Best University for Engineering
Aalborg University (AAU) has approximately 20,000 students, and University College of Northern Denmark (UCN) has around 8,000. Aalborg University is internationally recognized for its PBL (Problem-Based Learning) methods, which forms an essential foundation for skilled, innovative, and independent graduates for the future job market and entrepreneurs in new businesses.

Aalborg University ranks as the best engineering university in Europe and the 8th best in the world according to US News World Ranking.

Additionally, Aalborg University holds the top spot in Denmark for collaboration with the business sector according to the Confederation of Danish Industry.

Aalborg University is ranked 4th in the world within sustainability.

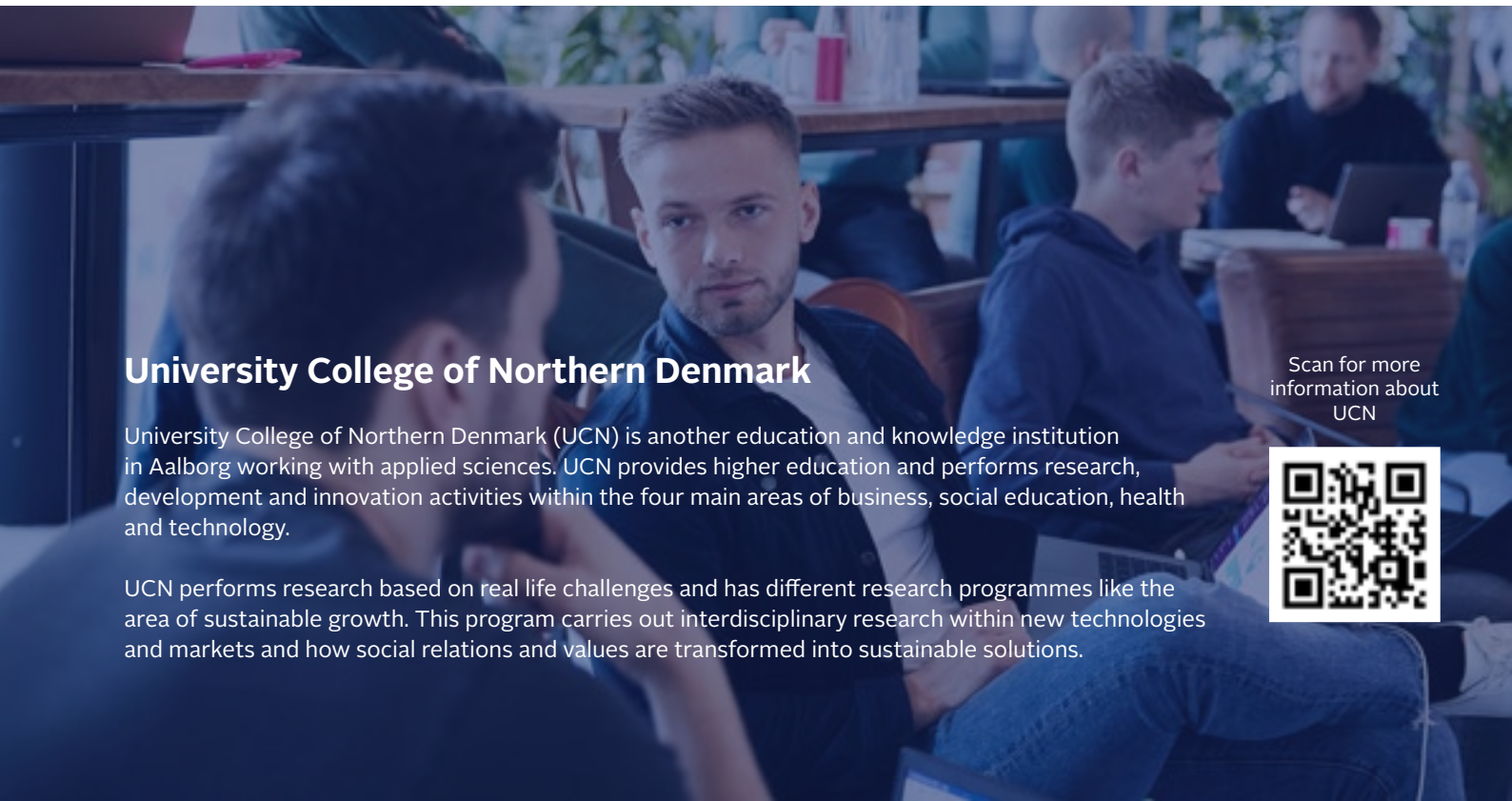
Educational Programs related to Space
Aalborg University offers a range of space-related educational programs across various departments and faculties (the Technical Faculty of IT and Design, the Faculty of Engineering and Science, and the Faculty of Medicine).

Space and space-related subjects are integrated into various programs at both bachelor's and master's levels. This enables students from different backgrounds and departments to collaborate on projects that are highly significant for their education.
Examples of AAU Courses related to Space Technology skills:

- Security in IoT and Cloud Architectures
- Traffic Analysis and Network Security
- Network Security
- Antennas and Propagation
- Distributed Real Time Systems
- Multi Variable Control
- Software and Automation Frameworks
- Robot Navigation
- Machine Learning
- System of Systems/Complex Systems
- Non-linear Control Systems
- Design of Embedded SW
- Digital Design

Creating Space Jobs
Since 2003, AAU has launched five entirely student-constructed cubesats and contributed subsystems and ground stations to a German scientific microsatellite (AISAT-1) and a student satellite, Baumanetz, from Moscow University. Additionally, AAU is the largest contributor to ESA Education's SSETI EXPRESS, a 50 kg student satellite.

This has led to the creation of approximately 400 space-related jobs in Aalborg and North Denmark in companies founded by former cubesat students.



University College of Northern Denmark

University College of Northern Denmark (UCN) is another education and knowledge institution in Aalborg working with applied sciences. UCN provides higher education and performs research, development and innovation activities within the four main areas of business, social education, health and technology.

UCN performs research based on real life challenges and has different research programmes like the area of sustainable growth. This program carries out interdisciplinary research within new technologies and markets and how social relations and values are transformed into sustainable solutions.

Scan for more information about UCN

5 Good reasons to invest in Aalborg

1
Aalborg is a Talent Factory
Aalborg offers a supreme technical workforce and world-class educational programs at the highest ranked engineering university in Europe. But Aalborg is not just a place for academics. The city is also home to a skilled and experienced vocational workforce.

2
Gateway with Global Accessibility
Located in the heart of Europe, Aalborg connects Scandinavia with the continent. And with an international airport, a leading inland port, and an effective infrastructure, you have the world at your doorstep.

3
Leading Green Business Destination
Aalborg is home to some of the world's leading energy companies, researchers and test facilities. Wind power, fuel cells, smart energy, power-to-x, carbon capture and power electronics are some of the areas within the green ecosystem in Aalborg.

4
Best Quality of Life
The citizens of Aalborg rank among the happiest people in Europe and those who feel the safest. Aalborg is a UNICEF Child-Friendly City and here you'll find a unique work-life balance that makes Aalborg an exceptional place to live.

5
Connectivity and Digital Excellence
Aalborg is among the most digital municipalities in the Nordics. Known in the 1990s as 'Mobilicom Valley,' Aalborg laid the foundation for becoming the connectivity hotspot it is today.

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Top 25 Reasons Magazine

INVEST IN AALBORG

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About Invest in Aalborg

Invest in Aalborg is the result of an increasingly globalised city that joins forces to ensure you one-point-of-contact when you are looking to expand or relocate your company to Aalborg.

We offer easy access to prime location options and local authorities as well as contact to world class researchers and an extensive business network.

Invest in Aalborg is a part of the City of Aalborg.

Feel free to contact us and let us help you build your business case.

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How can we help you?

Our point of departure is your needs and enquiries

Child Friendly Cities Initiative | unicef for alle verdens børn

City of Aalborg