EXCISCOPE
POLARIS

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Next generation x-ray microimaging

PHASE CONTRAST MADE EASY

Complete solution

The Exciscope Polaris is a phase-contrast tomography system that provides a unique combination of contrast, resolution and speed. Thanks to high-performance components, accurate scan algorithms and carefully tailored image reconstruction, it is now possible to make fast high-resolution scans of low-contrast samples within a compact design.

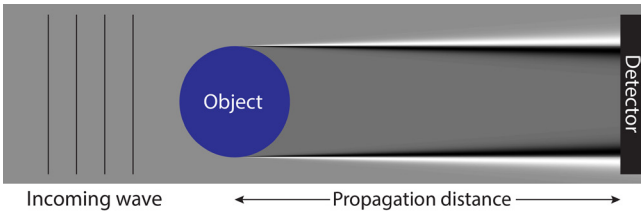
- World's brightest lab source (up to 160 kV and 250 W!)
- Down to 1 µm observable 3D resolution
- Multiple detector options for scanning flexibility
- Fast and scalable data processing with cloud reconstruction software
- Proprietary software including multiple artefact reduction techniques
- Phase retrieval algorithm to allow easily tunable sample-specific phase retrieval

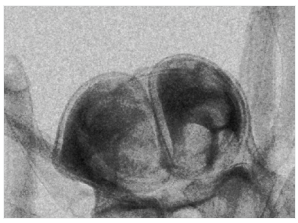
Exciscope Polaris at the 3D Imaging Center, DTU, Copenhagen, DK

What is phase-contrast imaging?

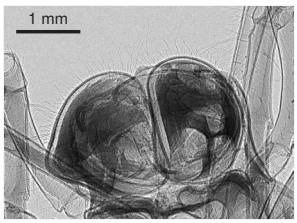
X-ray phase-contrast imaging utilizes that x-ray photons are slightly refracted when passing through an object. This enables superior image contrast in materials with low atomic number, such as biological tissues, food and plastics.

In order to to make phase-contrast tomography with high quality, phase retrieval and specialized artifact handling is necessary. Multiple types of artifacts will arise if this is not treated correctly.





Absorption contrast



Phase contrast

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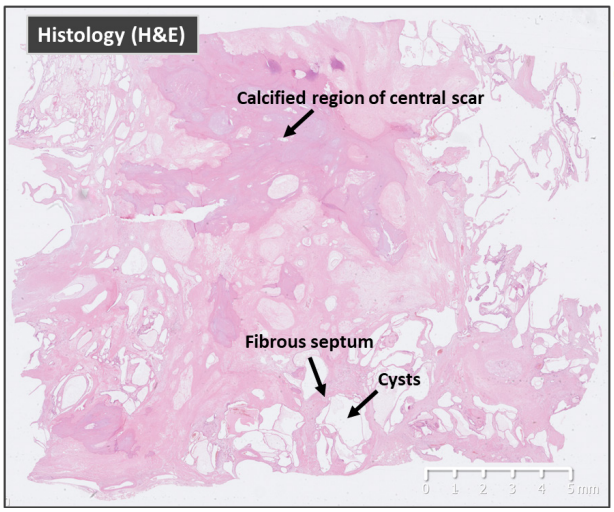
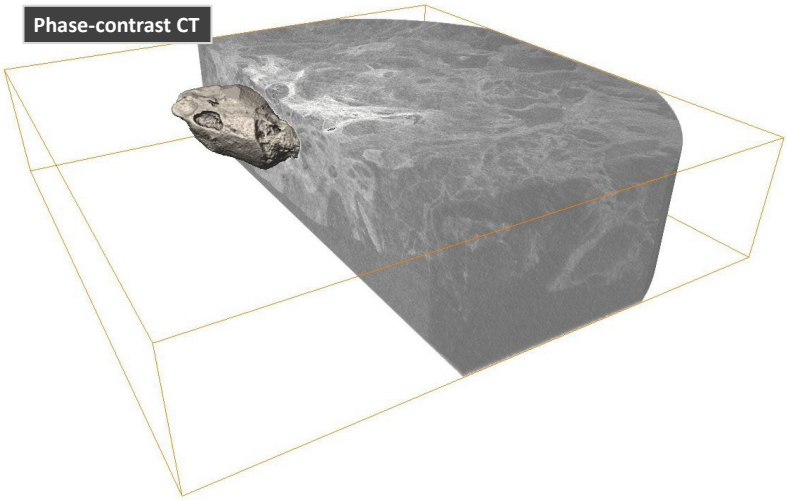
Application examples

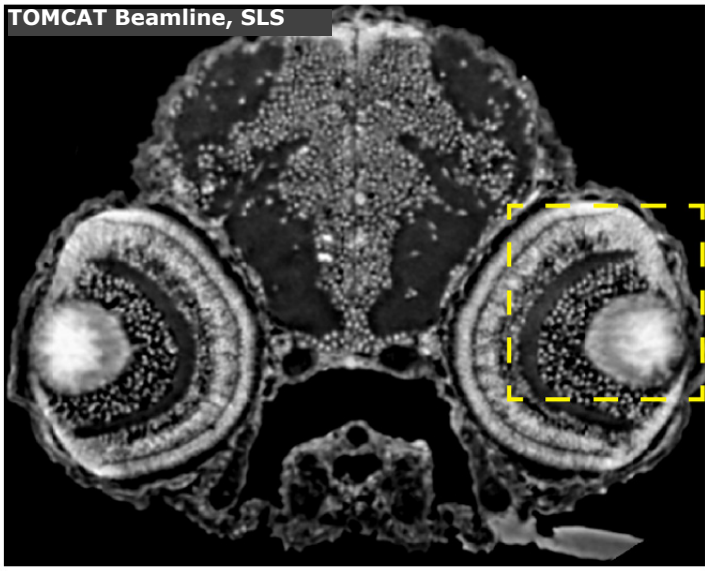


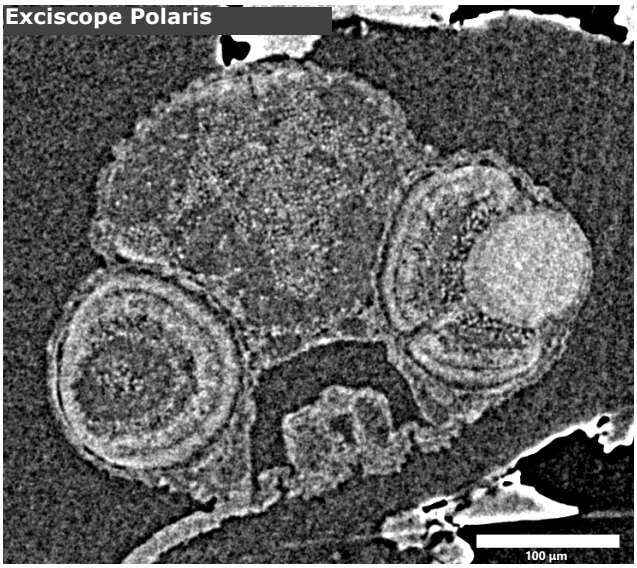


3D virtual x-ray histology

In contrast to classical histology, the sectioning can be done virtually in the computer, in any direction. In addition, 3D information can identify features that are not present in certain 2D slices as well as their morphology.

Images: Virtual x-ray histology and classical histology of a pancreas with serous cystic neoplasm and calcified scar.





Biomedical imaging

Detailed 3D imaging of soft-tissue samples provides a non-destructive complement to classical histology for biomedical and medical research.

Images: Virtual slices through the eyes of a zebrafish, imaged at a synchrotron beamline (left) and with the Exciscope Polaris (right) displaying 1 µm observable resolution.

Reprinted from: A. Migga et al., Proc. SPIE 118400T (2021)

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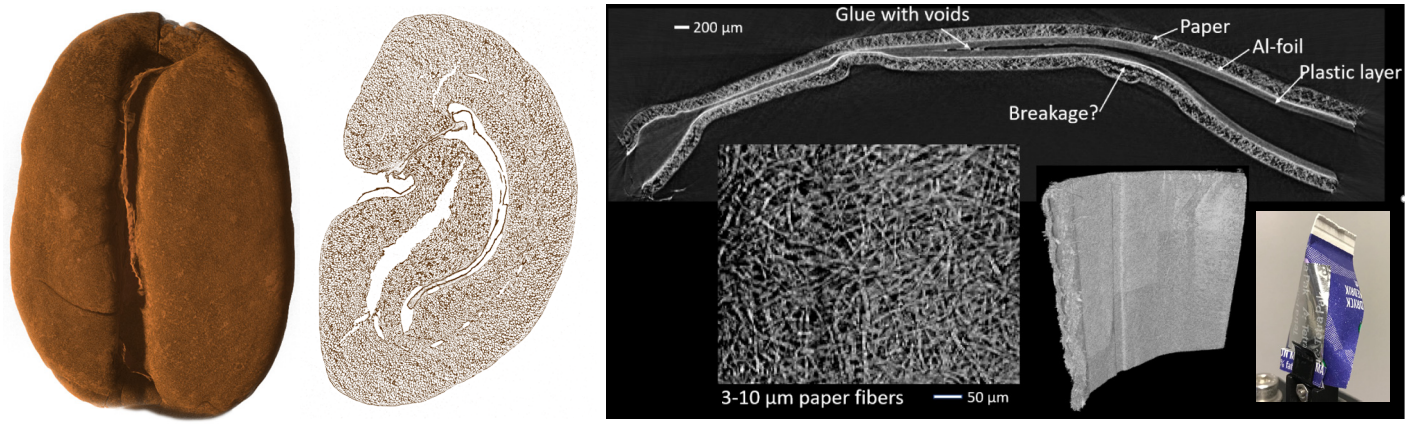
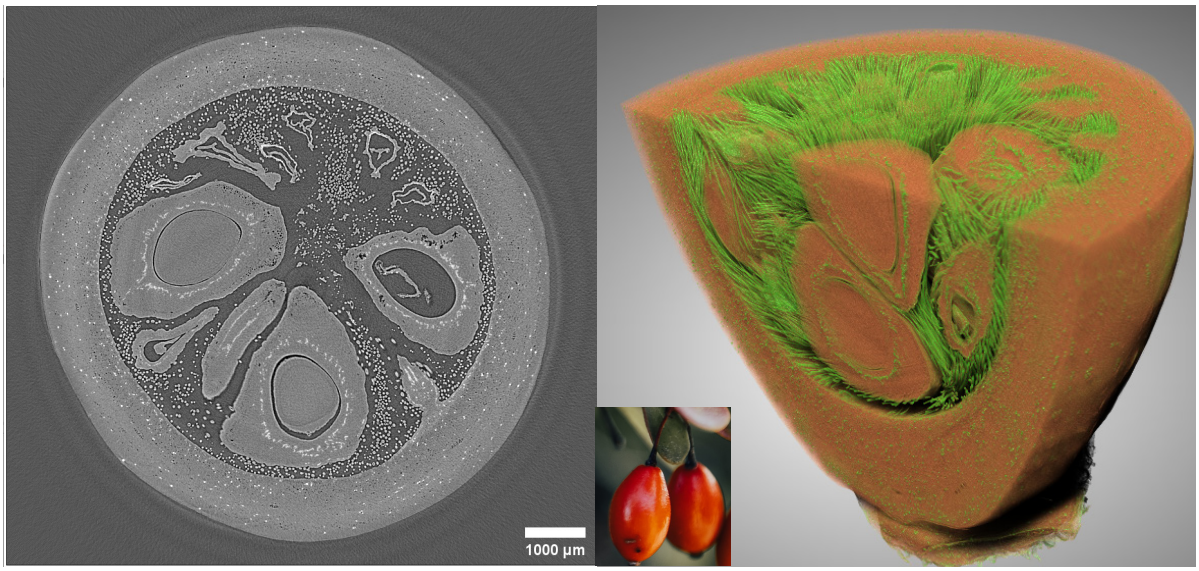
Application examples (cont.)



Food and Packaging

State-of-the art equipment makes it possible to do fast 3D imaging of low absorption food as well as imaging complex products made from multiple material types.

Image: (left) 3D rendering and virtual slice of a roasted coffee beam. (right) Virtual slices and 3D rendering of the joint of a milk package container.



Agriculture

Identify defects and diseases in plantlife non-destructively with high contrast.

Image: Virtual slice slice (left) and 3D rendering (right) of edible rosehip

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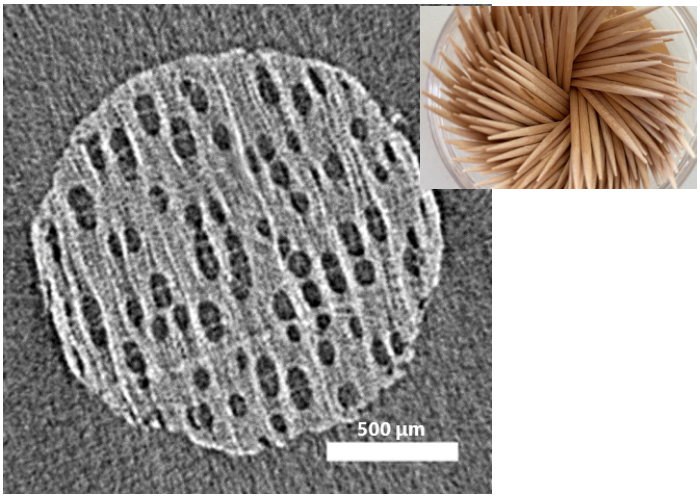
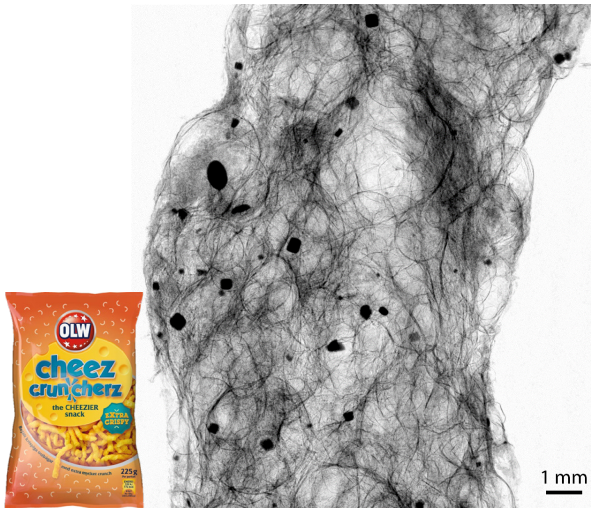
Application examples (cont.)

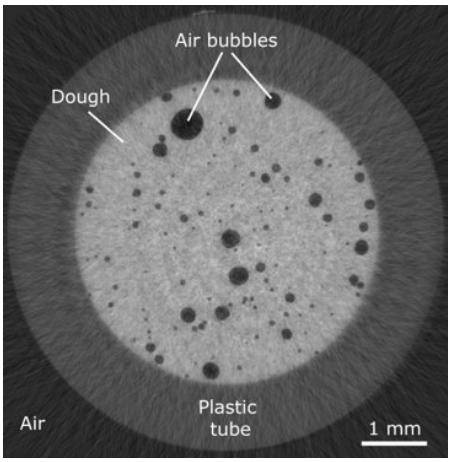


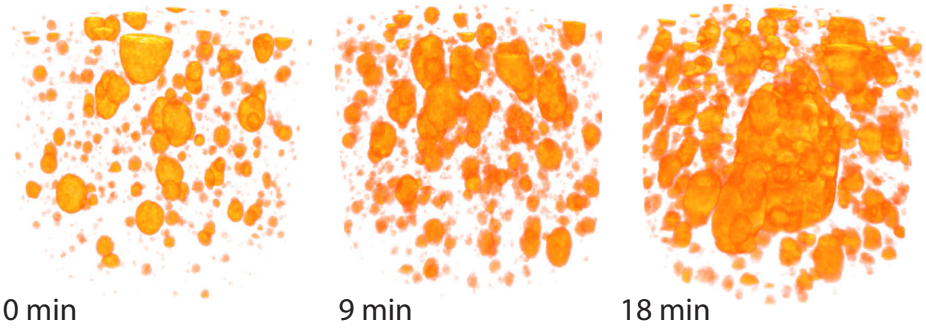


Fast scans

Our high flux from the liquid-metal-jet x-ray sources allow for CT measurements to be completed in a matter of seconds.

Images: (left) Virtual slice of a toothpick with TOTAL scan time of 10 sec. and resolution of ~20-30 µm. (right) Projection of cheese doodle, 75 ms exposure time.





4D Imaging of ongoing processes

The high flux and short scan times also allow for in-house 3D imaging of ongoing proceses over time (4D), bringing us even closer to live imaging.

Image: Growing air pockets within a section of proofing bread dough, 7 reconstructions over 18 minutes.

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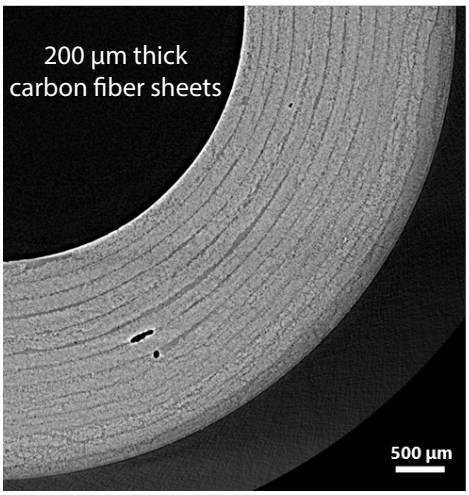
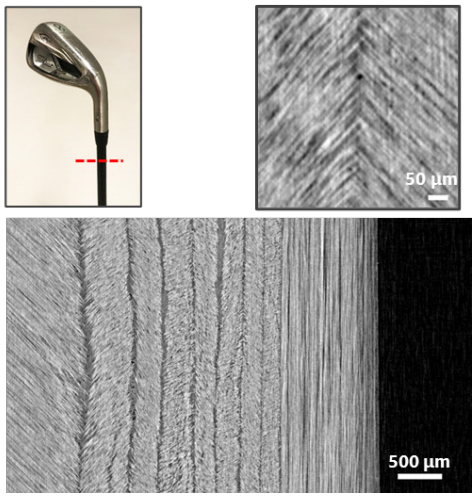
Application examples (cont.)

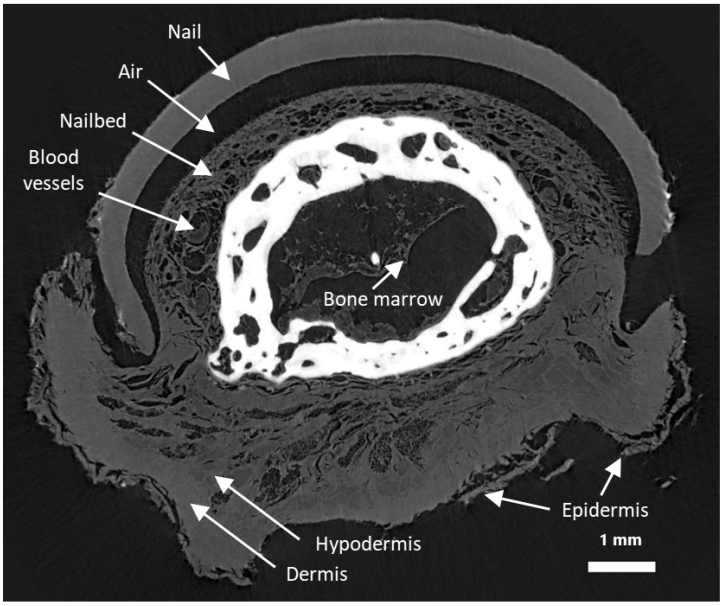




Composite materials

The high contrast and resolution allows for inspection of fiber orientation and voids down to a few micrometers.

Images: Virtual slices of a golf club shaft.



Archaeology

The non-destructive nature of the method allows for high-resolution 3D imaging of sensitive samples.

Image: Virtual slice of the fingertip of a human mummy.

Read more: J. Romell et al., Radiology 289, 670 (2018)

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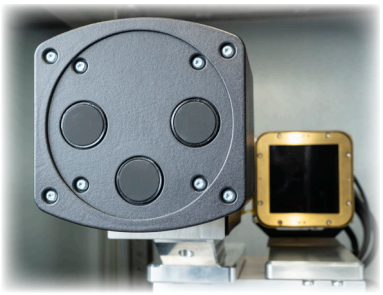
TECHNICAL DETAILS

Polaris overview specs	
Max sample size [mm]	210 Ø x 550 h
Max. sample weight [kg]	6
Footprint [m] (w, d, h)	1.05 x 2.16 x 1.88
Instrument weight [kg]	~1700

Detector: Tailor your system

The detector choice depends on your application and how you want to balance resolution, field-of-view and speed. The standard setup includes one detector for large field-of-view and one multi-turret detector for high resolution. Multiple regions can be combined to reconstruct volumes far larger than the field-of-view.



Detector	**Multi-objective high resolution**			**Large field-of-view**
Pixels	2048 × 2048			4096 × 4096
Objective	10×	4×	2×	
Pixel size [µm]	0.65	1.6	3.3	16
Field-of-view [mm]	1.3	3.3	6.7	66
Resolution [µm]*	1.0	2.5	5.0	6.0
Voxel size [µm]*	0.50	1.3	2.5	3.0
Min. source-sample distance [mm]		150		150
Max. source-detector distance [mm]		1250		1580

**for typical scan parameters*

Add-on: in-situ package

Exciscope offers an in-situ package that enables measurements with advanced sample environments and in-situ equipment. It provides both electrical and liquid/gas connectors that allow for continuous rotation.

X-ray source: MetalJet from Excillum

The brightest x-ray source you can get in a tabletop format provides outstanding performance and the gallium-rich target (I1) provides the best contrast for organic samples. This source reaches a max power of up to 250 W, which can lead to similar quality while shortening scan times by a factor of 10 compared to standard x-ray sources.

Model	**D2+**	
Jet material (target)	I1	
9.2 keV peak brightness [ph/s/mm^2/mrad^2]	2.6×10^{10}	
24.1 keV peak brightness [ph/s/mm^2/mrad^2]	1.7×10^{9}	
Voltage [kVp]*	21 - 70	30 - 160
Min. spot size (FWHM) [µm]	~10	
Power at min. spot size, 50 kV [W]	133.9	
Max. Power [W]	250	

**D2+ source comes in 70 kV max and 160 kV max models*

Customized designs and special extra features

Exciscope is happy to accommodate customer needs in form of custom parts or systems, e.g., incorporating your own specialized detector. This can include implementing a photon counting detector, or upgrading the source to a E1+ model (Indium-rich I2 jet material, Max. Power increased to 1000 W!).* Contact us to discuss your ideas today!

**These implemenations may extend delivery time*

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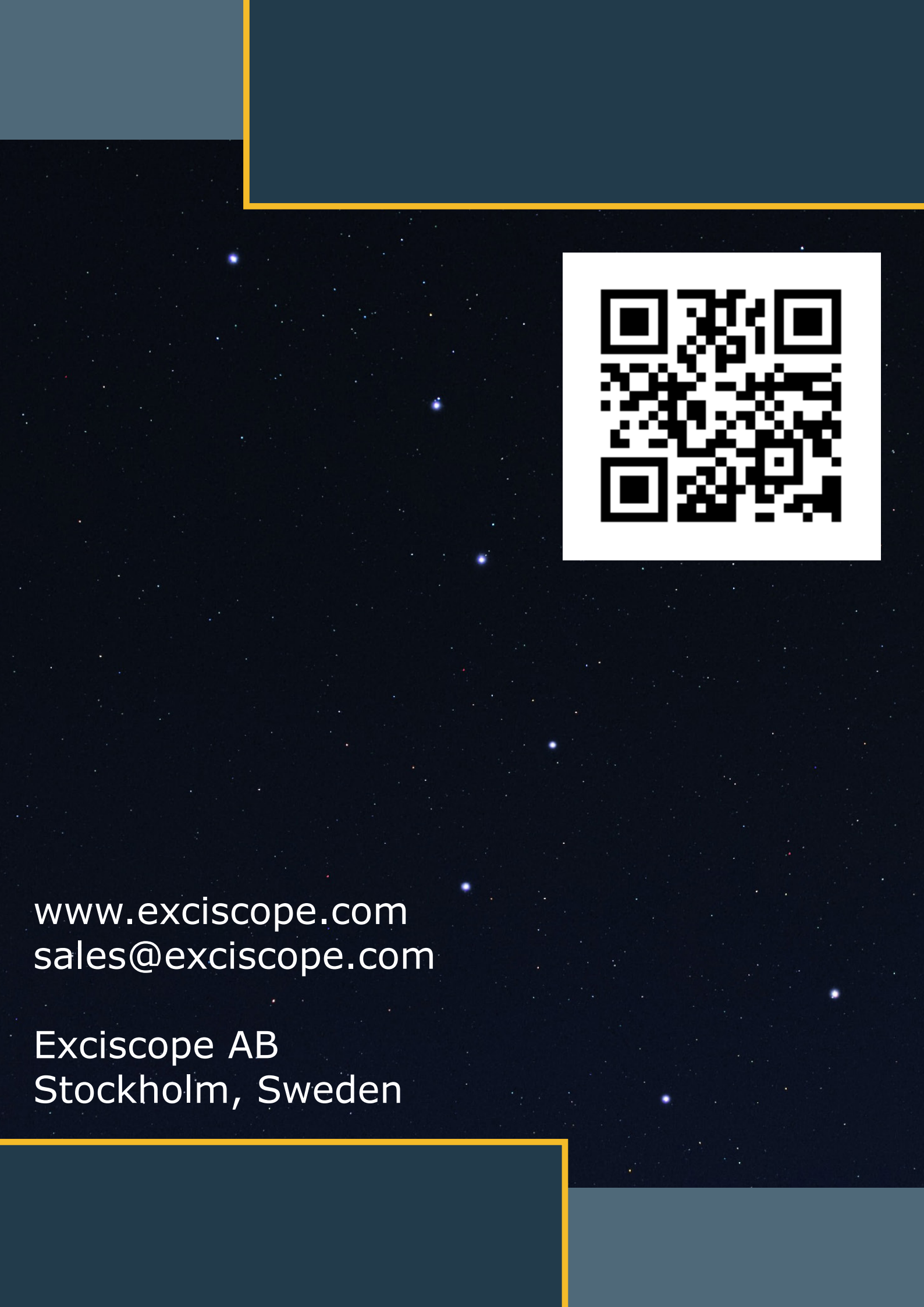

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