



Talos 12 TEM

Multidisciplinary 120 kV
transmission electron microscopy
built to fit your needs

Transmission electron microscopy for biology, pathology, and drug development

With electron microscopy, we can see breakthroughs everywhere, whether it's improving the food we grow, understanding what keeps us healthy, or developing new therapeutics that help us when things go wrong. The Thermo Scientific™ Talos™ 12 Transmission Electron Microscope (TEM) is the next step in our 120 kV instrumentation, designed to fit your needs.

The user-friendly Talos 12 TEM offers exceptional performance for a diverse range of scientific imaging and experimentation needs. It features a reduced footprint with a robust enclosure, along with systems that improve accessibility, bringing trusted performance and automation to more researchers and their labs.

It can be configured as a conventional system for routine TEM imaging of cells and tissues, as an advanced system for sample characterization with different scanning transmission electron microscopy (STEM) and energy-dispersive X-ray spectroscopy (EDS) detectors, or even as an entry-level cryo-electron microscopy (cryo-EM) platform. Its modular design allows it to meet the diverse needs of both research labs and core facilities.



Large-area cell and tissue imaging for the life sciences and pathology with streamlined workflows for automated multi-scale imaging of multiple regions of interest



Enabling structural biology research from negative stain imaging to biochemical optimization and data collection for cryo-EM single particle analysis



Cryo-EM imaging with minimal ice growth and transmission loss thanks to a digitally controlled, retractable cryo-box; longer data collection sessions for single particle analysis help shorten time to structure



Accelerated nanoparticle characterization for drug delivery vectors, optimized by high-throughput cryogenic acquisition strategies, AI-powered segmentation, and critical quality attribute (CQA) analysis with Thermo Scientific™ Amira™ Software



Advanced life sciences imaging with tomography for 3D visualization, correlative light and electron microscopy (CLEM), along with elemental analysis and mapping through optional energy-dispersive X-ray spectroscopy

Built for you Talos 12 Transmission Electron Microscope

The next step in 120 kV TEM, designed to fit your needs

Transmission electron microscopy (TEM) continues to fundamentally impact our ability to study biological structures at the nanoscale, enabling profound insights into the mechanisms of diseases, the interactions of biomolecules, and the structural basis of cellular functions. These capabilities are fostering significant advancements in biological research and the development of innovative therapeutic approaches. By improving the accessibility of TEM instruments, more labs can accommodate these advanced tools, enhancing scientific productivity and innovation with high-resolution imaging.

Proven performance, designed to fit your needs

Exceptional imaging quality delivered by an optically stable lens system combined with integrated detectors. A robust enclosure delivers high stability, with a widened sample loading area and transfer deck to support tools and holder loading stations during user interactions with the TEM.

Improved accessibility

Color LEDs convey system status and provide a working light for sample exchanges in dark rooms. Light animations direct users to insert holders properly and provide alerts for low liquid nitrogen levels or other system issues.

Reduced footprint

With a reduced physical footprint (compared to previous Talos generations), the Talos 12 TEM is now suitable for a wider range of core labs and imaging facilities.



Effortless remote operation and powerful system management for flexible collaboration

Workflow software supports collaboration regardless of location with digitally controlled hardware components and integrated cameras.



ACT Ecolabel

Unambiguous documentation of the instrument's environmental footprint is provided by the ACT Ecolabel, as assessed by My Green Lab, an independent non-profit organization.

A fully integrated TEM solution for easy and automated high-resolution imaging

Proven 120 kV TEM performance

Exceptional imaging quality delivered by an optically stable, constant-power objective lens system, combined with integrated, high-sensitivity, and large-field-of-view detectors with fast electronics.

The Ceta family of CMOS cameras

Delivering a large dynamic range and fast camera speeds

Fully integrated and embedded into the design of the Talos 12 TEM, Thermo Scientific Ceta™ Cameras provide stability alongside optimized detector performance. These cameras offer a sensitive and robust fiber-optic-coupled scintillator as well as a large field of view and high speed. This provides you the speed and high-contrast visualization necessary to quickly scan and find regions of interest.

Talos 12 TEM detector options include:

- Ceta-S and Ceta-F Cameras, designed for low-dose applications, such as the analysis of beam-sensitive samples
- Ceta-D Camera, specially configured for low-dose diffraction imaging
- The Thermo Scientific Falcon C Direct Electron Detector, a dedicated detector for cryo-EM



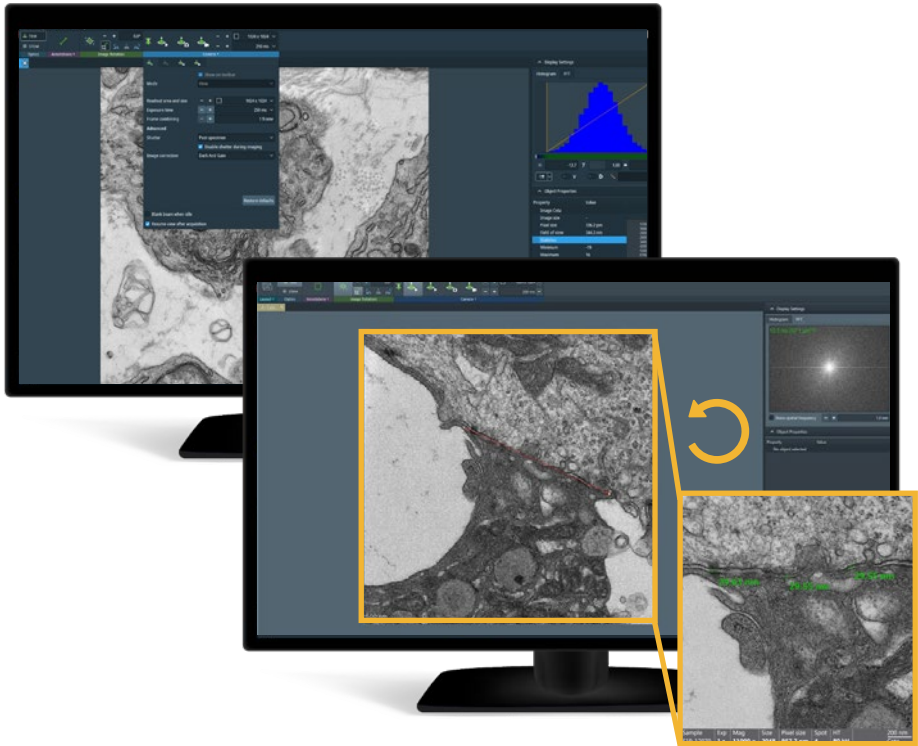
Ceta CMOS Camera



Velox Software

An accessible imaging UI with scripting functionality

The Talos 12 TEM is equipped with Thermo Scientific Velox™ Software, a workflow-based user interface ideal for both novice and expert TEM and STEM users alike. Velox Software combines comprehensive access to microscope optics and detectors, providing superior experimental control for high reproducibility. Automatic tuning functions ease the learning curve for novice operators and improve time-to-data for experienced users.



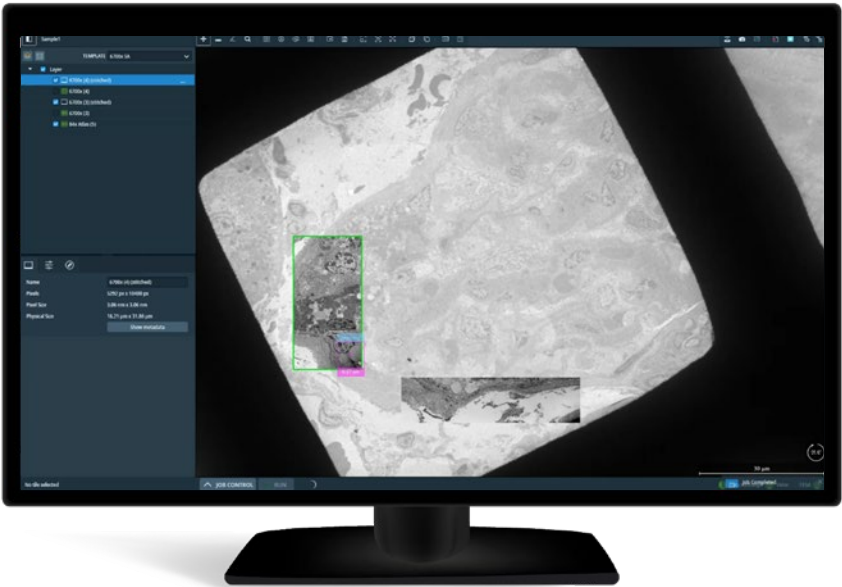
Live TEM rotation adjustment: Velox Software allows better visualization of the sample without removing it from the microscope by easy rotation of the sample image with the mouse. The software also enables automatic stage direction adjustments while keeping all raw data.



Maps 3 Software

Large-area, multi-scale 2D imaging

Thermo Scientific Maps 3 Software is an add-on for the Talos 12 TEM that facilitates automated data collection for large area imaging. Easily navigate large tissue sections, find your regions of interest, and set up batch acquisition of multiple tile sets to acquire high-resolution data in context. Navigation and data collection of the sample is easy and intuitive, even for new users.



Transmission electron microscopy for high-resolution cellular details

The Talos 12 TEM can visualize the internal structures of cells, organelles, and macromolecules, providing insights into their organization and function. It is a key technology for researchers across the life sciences who are interested in ultrastructural analyses and morphological studies, as well as pathologists looking for disease-related changes in cell and tissue structures.

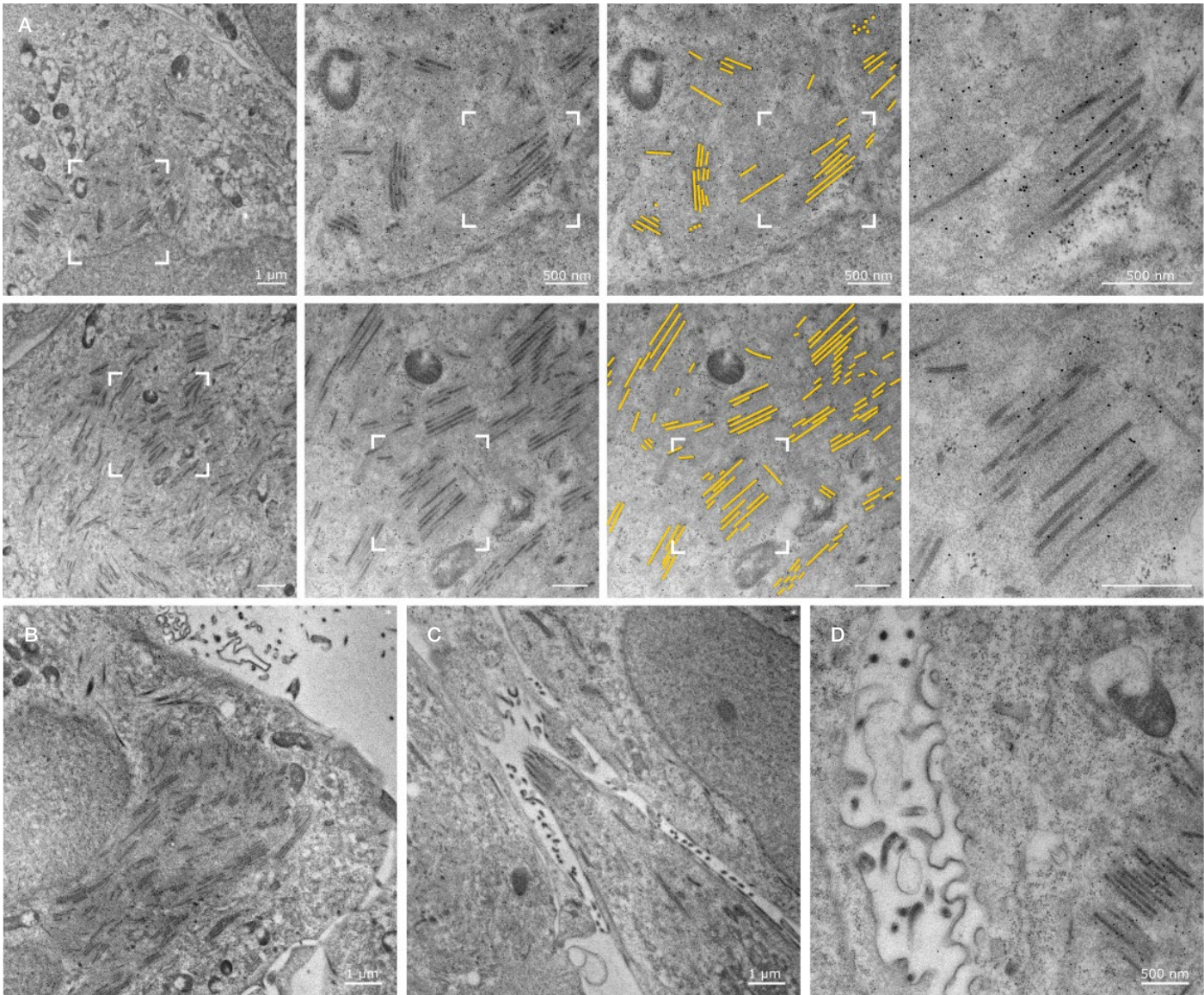


Dr. Melina Vallbracht is a Group Leader and Head of Microscopy at the Paul-Ehrlich-Institute, Germany.

Dr. Vallbracht's team works to understand how the Ebola virus and other negative-strand RNA viruses remodel the host cell to replicate and create new virions.

In M. Vallbracht *et al.*, she explored how the Ebola virus replicates in membraneless organelles termed viral factories (VFs).

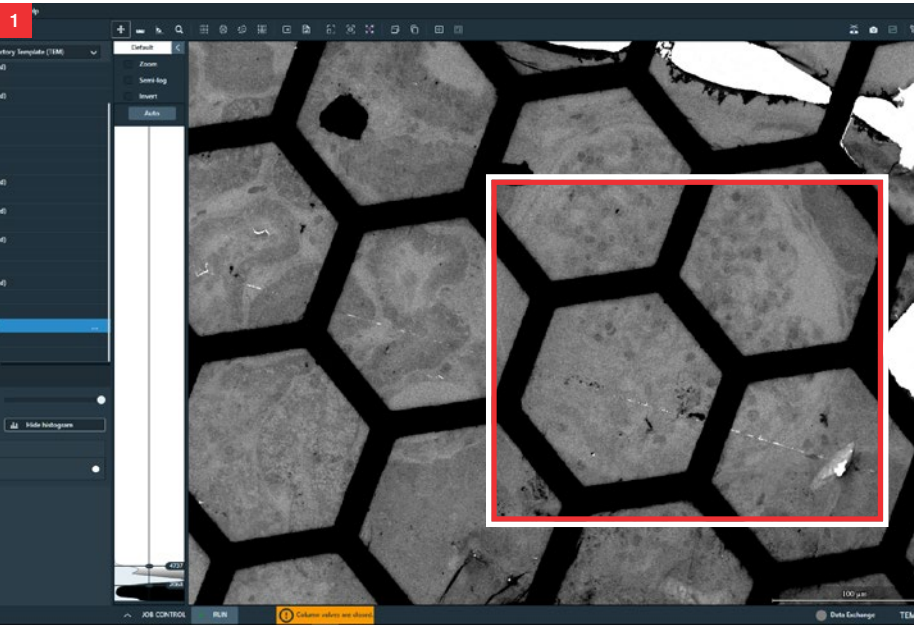
In this example, the Talos TEM was used to examine thin sections of cells infected with Ebola and revealed virus nucleocapsid formation over time. The full study illustrates a more complete picture of Ebola nucleocapsid assembly, which drives viral factory maturation.



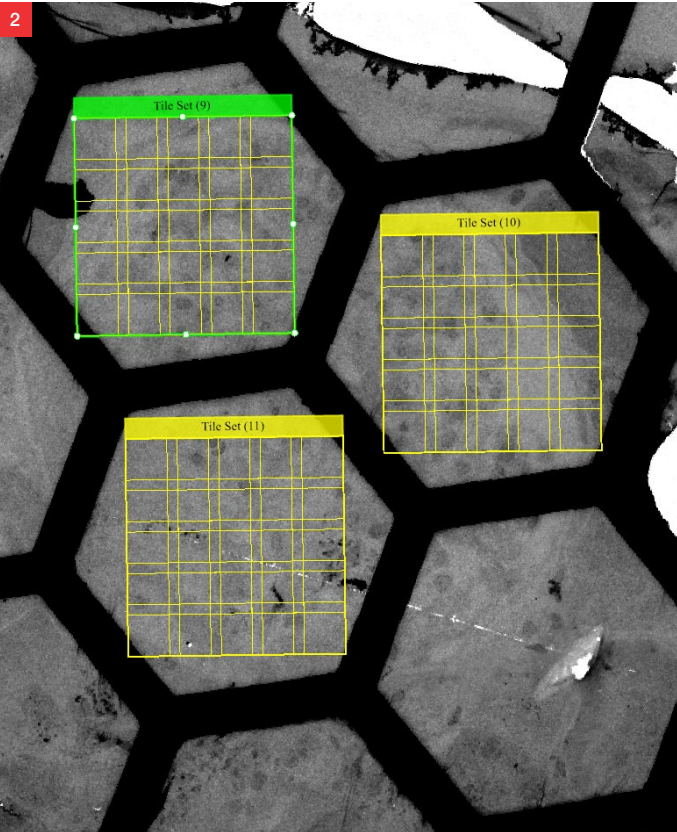
Thin-section transmission electron microscopy of Ebola viral factories. At 22 hours post-infection, the assembled nucleocapsids appear in parallel bundles (A, B), dispersed throughout the cytoplasm, later separating on the way to the budding sites at the plasma membrane (C). Plasma membrane ruffling (D) is also observed during later stages of infection. Section thickness: 100 nm. Labelled with 10 nm immunogold against EBOV nucleoprotein. Learn more in the full article: Vallbracht M, *et al.* Nucleocapsid assembly drives Ebola viral factory maturation and dispersion. *Cell* 188(3) (2025). [doi: 10.1016/j.cell.2024.11.024](https://doi.org/10.1016/j.cell.2024.11.024)

Explore cellular ultrastructure

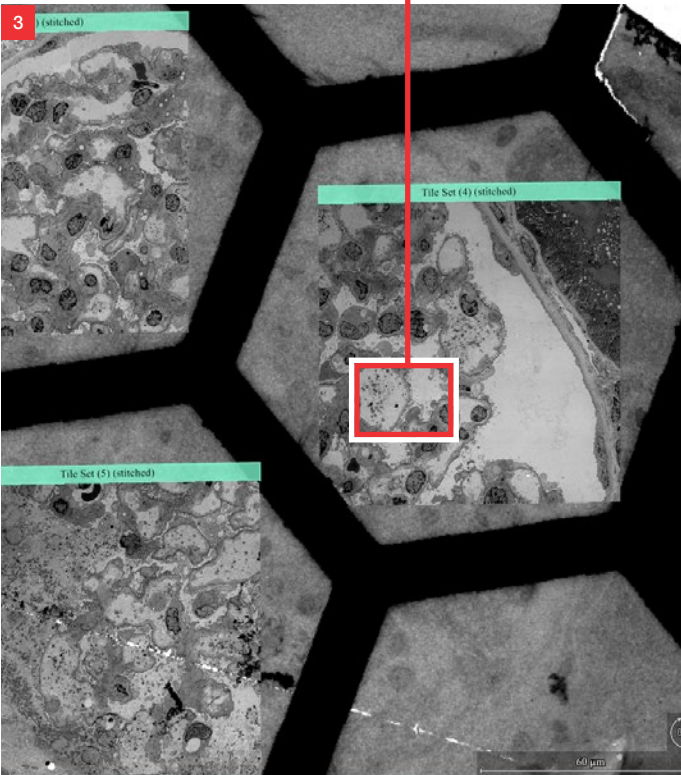
Visualize resin-embedded cells and tissues down to sub-nanometer resolution



Identify area to be imaged in high resolution.



Set up batch acquisition of tiles that encompasses the target area.



Data is automatically collected and stitched into seamless images.

Images courtesy of Department of Renal Pathology, Brigham and Women's Hospital, USA.

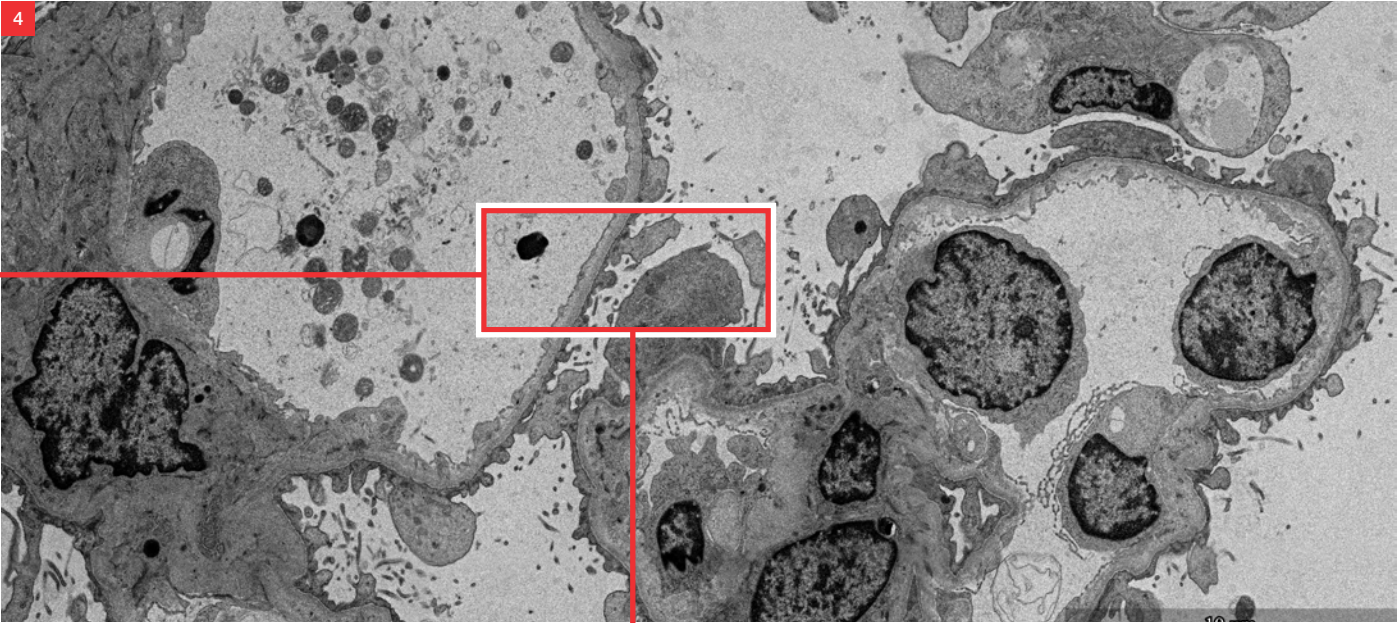
Pathology imaging

Understand cell and tissue abnormalities, infections, and dysfunctions

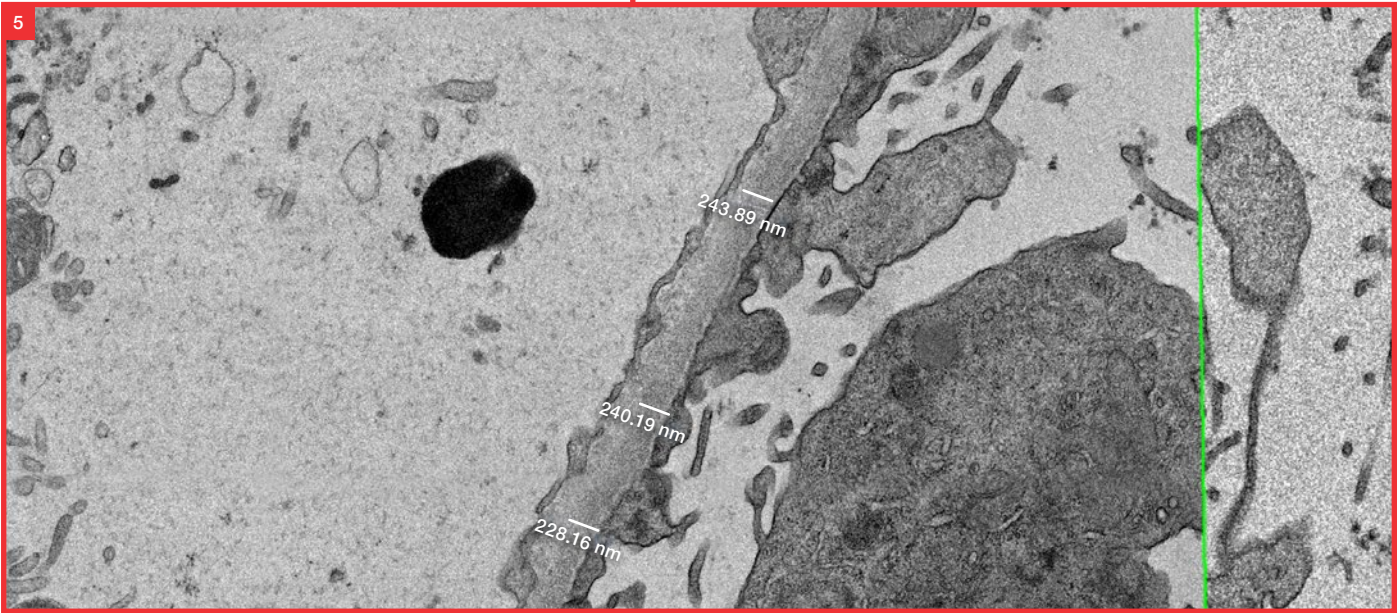
The Talos 12 TEM provides crisp, high-contrast images for the accurate analysis of membranes, cellular organelles, and pathogens. This information is often critical for understanding the tissue pathology resulting from cell and organ dysfunctions, viral or microorganism infections, and cancer.

Experience reduced time to results with streamlined pathology workflows, adaptable to a multi-user environment, providing options for newer users to easily collect data as well as for advanced users who utilize more sophisticated controls.

Offline data viewing and collaboration, available for Maps 3 Software, allows for the integration of data annotation and storage so that multiple team members can work together to collaborate and analyze data simultaneously.



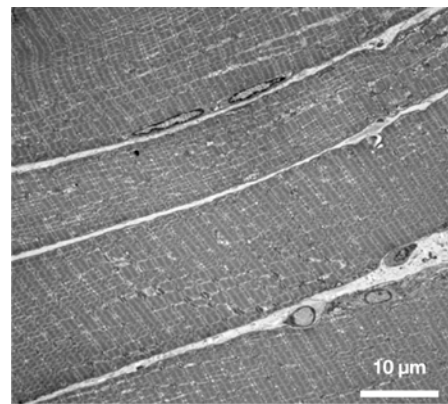
Digital zoom into area of interest.



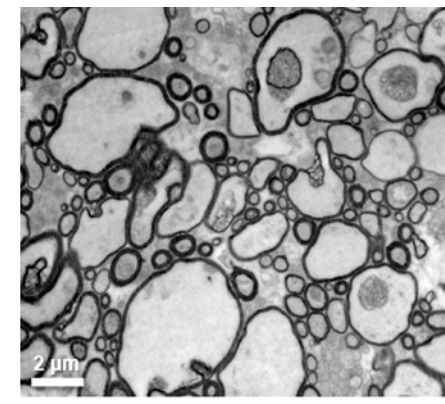
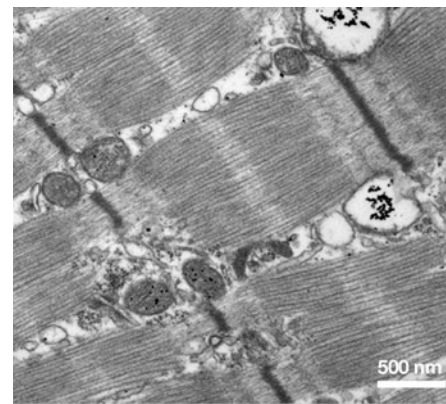
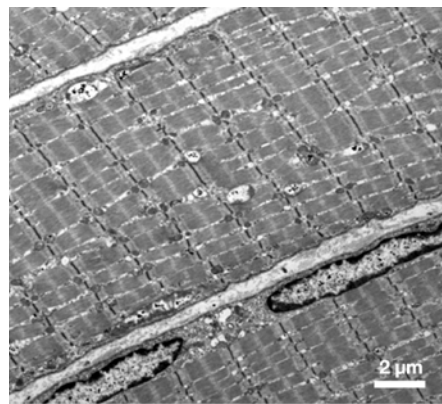
Add measurements and annotations. Collaborate with remote team members and analyze data simultaneously.

What will you find at the nanoscale?

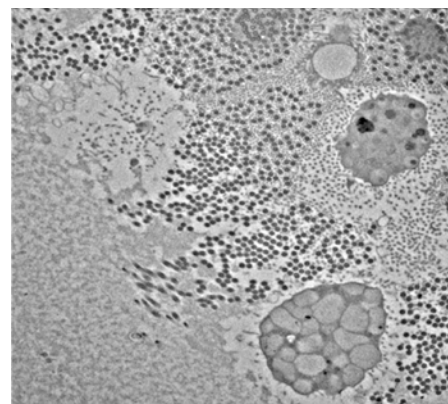
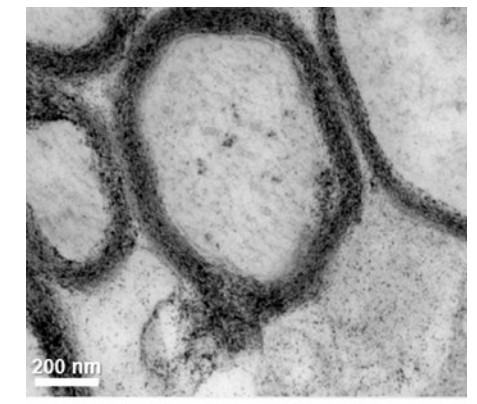
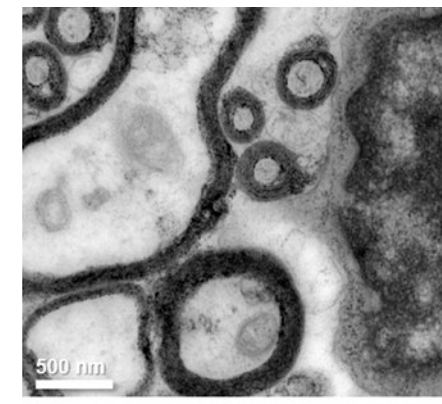
From muscles to macrophages – high-resolution imaging of resin-embedded tissues enables ultrastructural observation for all fields of biology



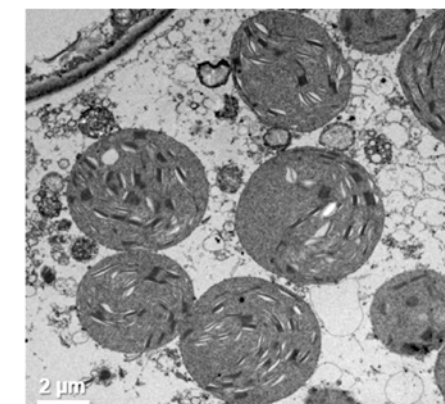
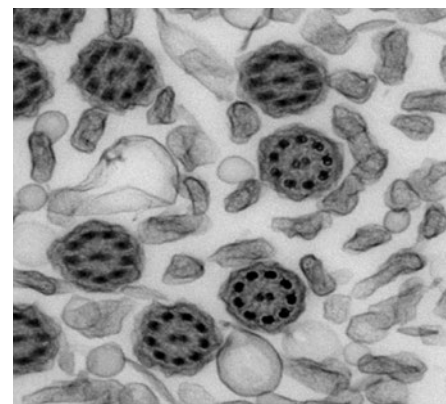
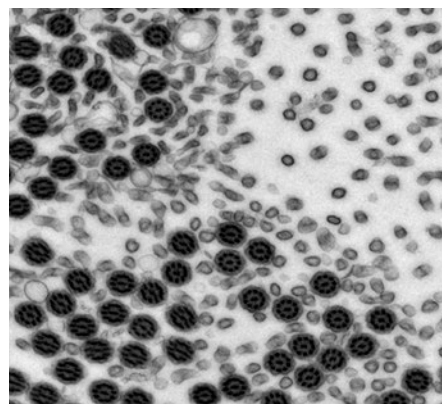
Muscle



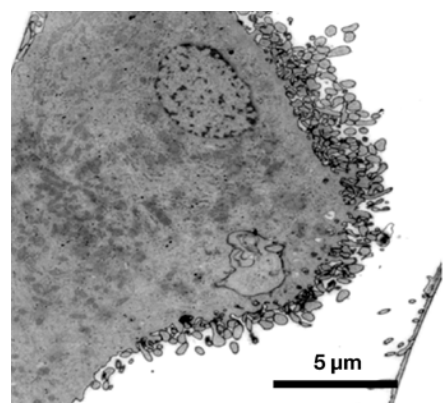
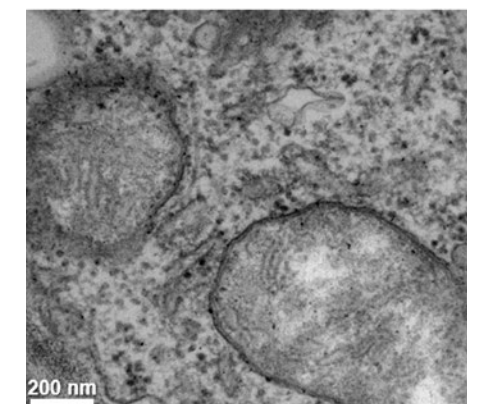
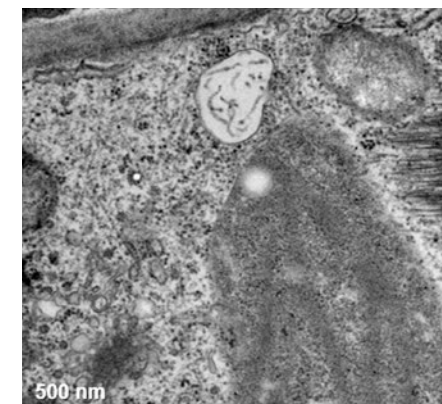
Brain



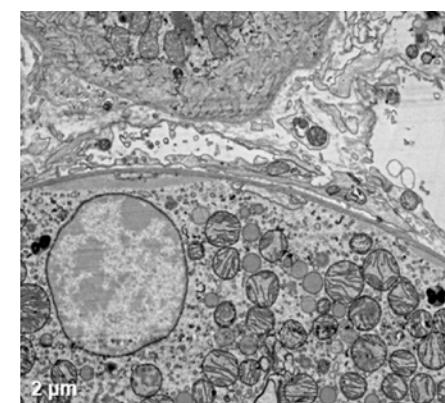
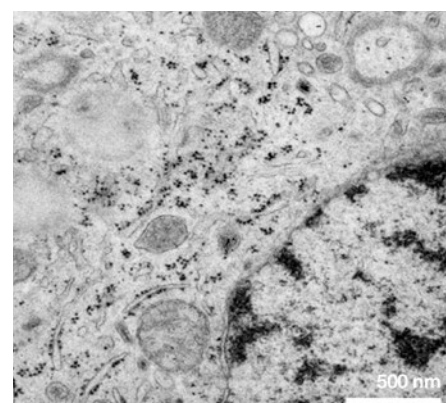
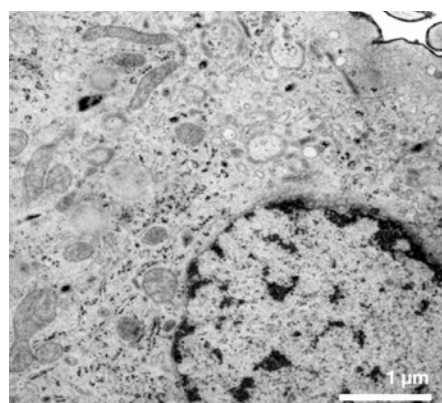
Lung cilia



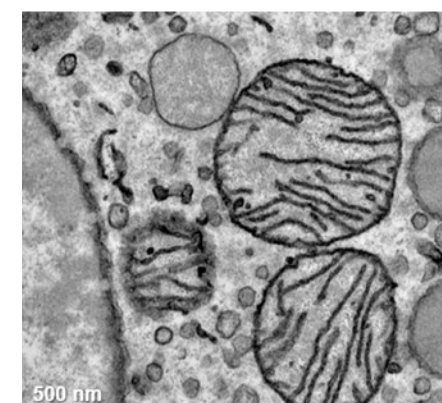
Tobacco leaf



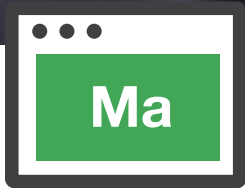
Macrophage



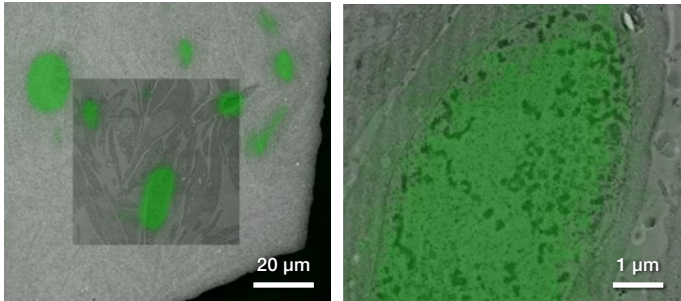
Liver



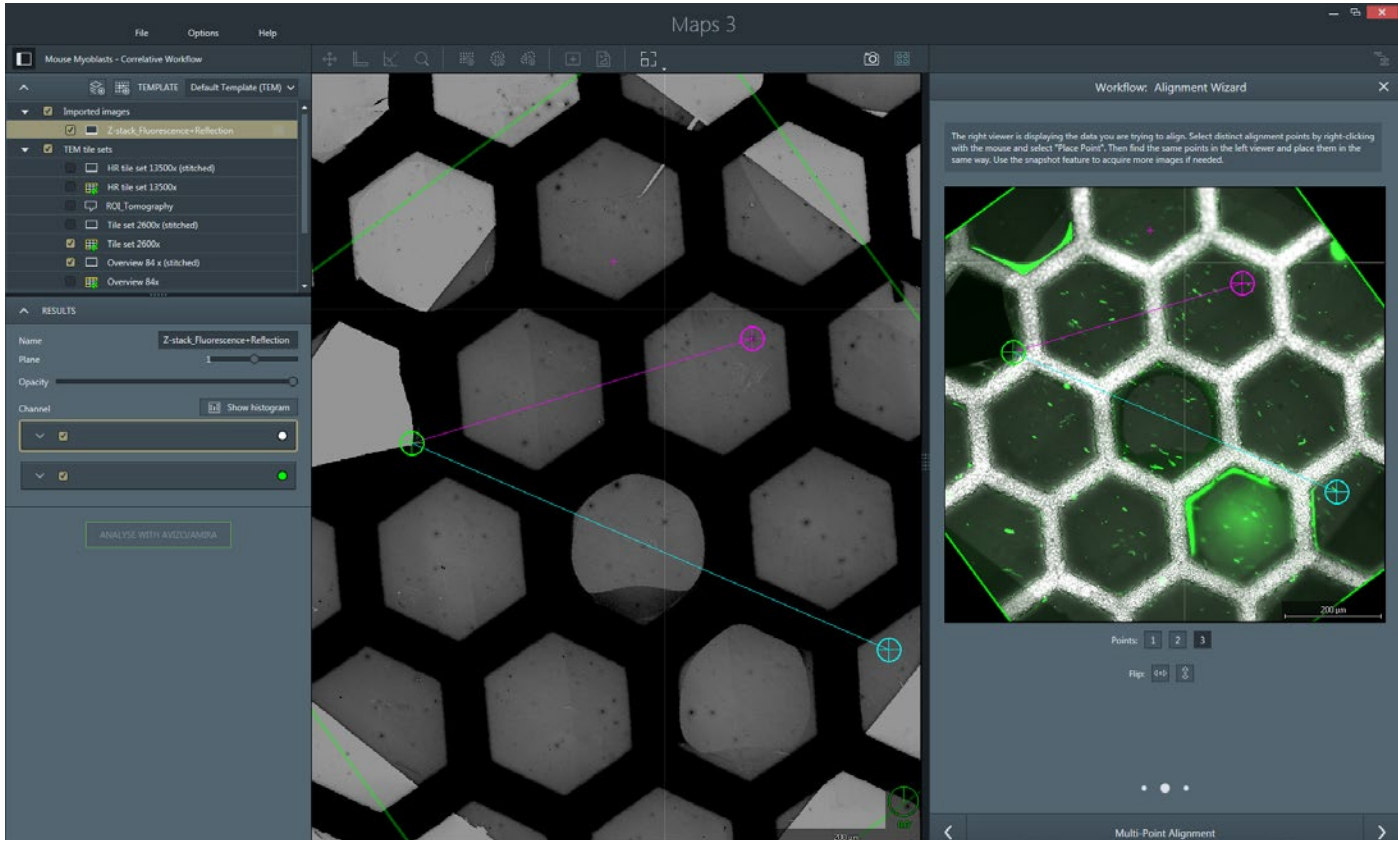
Expand cell and tissue analyses with advanced applications



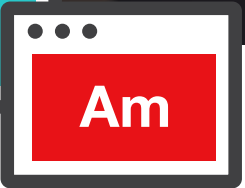
Correlative light and electron microscopy
Gain more insights through a combination of imaging technologies
Correlative light and electron microscopy (CLEM) combines the strengths of both techniques; light microscopy offers the ability to use fluorescent markers to label specific proteins or structures, whereas electron microscopy provides high-resolution, detailed images of cellular ultrastructure, down to the nanometer scale. CLEM with the Talos 12 TEM is streamlined with Maps 3 Software, yielding a more comprehensive understanding of biological samples.



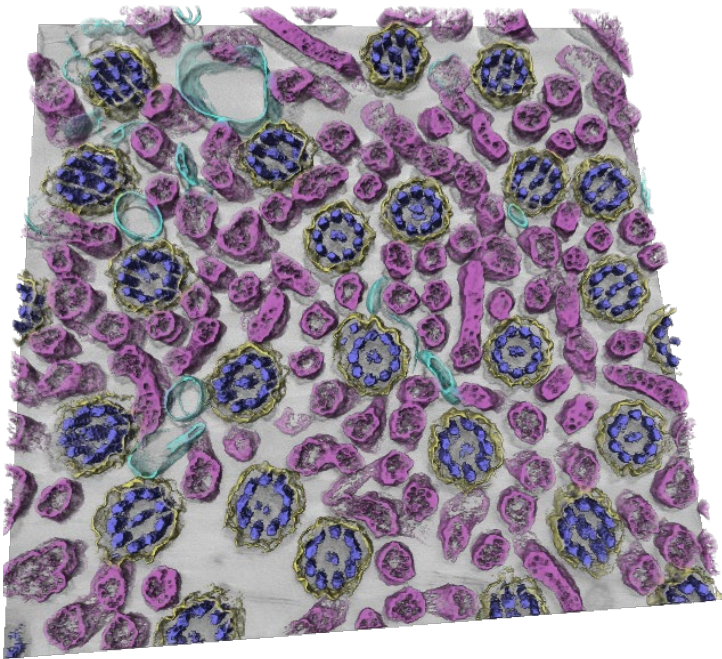
Identification and imaging of regions of interest at different magnifications and image resolution using Maps 3 Software.



Maps 3 Software uses the Bio-Formats library to import over 100 proprietary file formats including those from 3rd party light microscopes. Images are scaled according to their metadata and a multi-point routine is used to align them with the TEM. Sample: mouse myoblast sections on a TEM grid labeled with Invitrogen™ Alexa Fluor™ 488 Dye.

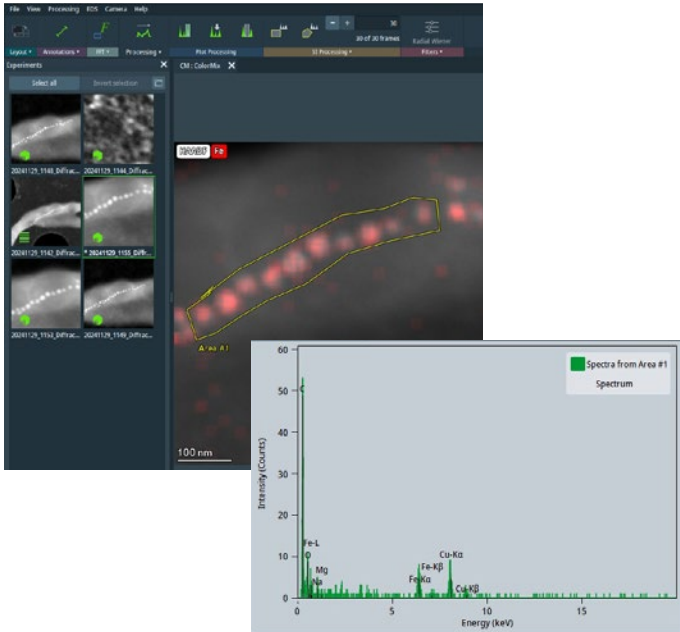


Tomography
Understand three-dimensional spatial relationships
3D visualization with tomography provides detailed insights into the organization of cellular structures and macromolecular complexes at nanometer resolution. Gain detailed structural information into spatial relationships of cellular components, such as organelles, virus particles, and protein complexes. Tomography with the Talos 12 TEM is powered by Thermo Scientific Tomography 5 Software along with AI deep-learning-based segmentation in Amira Software.



3D reconstruction of resin-embedded section of lung cilia.

EDS elemental analysis
Identify and quantify the elemental composition in TEM samples
Analyze the distribution of elements in cellular structures, tissues, and biominerals with the addition of energy-dispersive X-ray spectroscopy. Powered by Velox Software, EDS elemental analysis can be leveraged from quick surface scans down to the analysis of individual atoms. As EDS is heavily used by materials science and geoscience researchers, it is a key addition to Talos 12 TEMs in multi-user facilities that are shared across multiple departments. Expand EDS analysis to large-area tile sets with Maps 3 Software or in 3D with Tomography 5 Software.



Compositional analysis of *Magnetospirillum gryphiswaldense*, unstained dehydrated cells on TEM grid. Sample courtesy of Prof. Dr. Dirk Schüler, University of Bayreuth, Germany.

Transmission electron microscopy for structural biology research

Structural biology examines the architecture of biological macromolecules to better understand how they function.

TEM is a key technology for researchers in this field.

- Negative stain imaging is a simple and efficient TEM technique used to examine proteins in 2D.
- Cryo-EM is a form of electron microscopy in which samples are rapidly frozen to preserve their natural structure without the need for fixation or staining.
- Single particle analysis (SPA) is a cryo-EM technique used to determine the 3D structure of macromolecules, such as proteins and complexes, at high resolution. The development of SPA has enabled the 3D analysis of complexes that do not crystallize (and therefore are inaccessible to X-ray crystallography) such as ribosomes and proteasomes, as well as membrane proteins, viruses, and nanoparticles.

Applications in structural biology range from the analysis of pathogens and disease to vaccine and drug design.

The Talos 12 TEM provides scientists with a lower point of entry for visualizing protein complexes and cellular structures, either with negative stain imaging or under cryogenic conditions. Additionally, the Talos 12 TEM can be used to optimize sample preparation for single particle analysis to reduce time to results for high-resolution 3D protein structure determination.

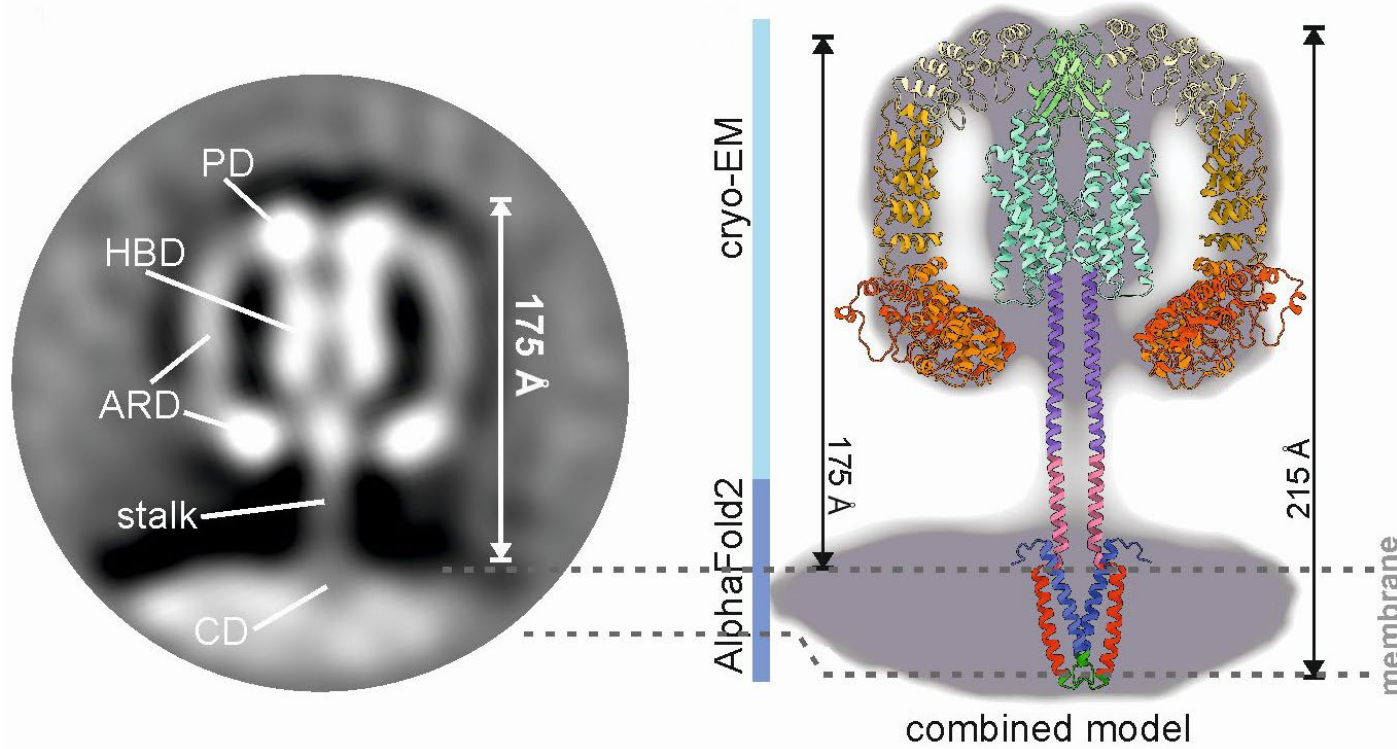
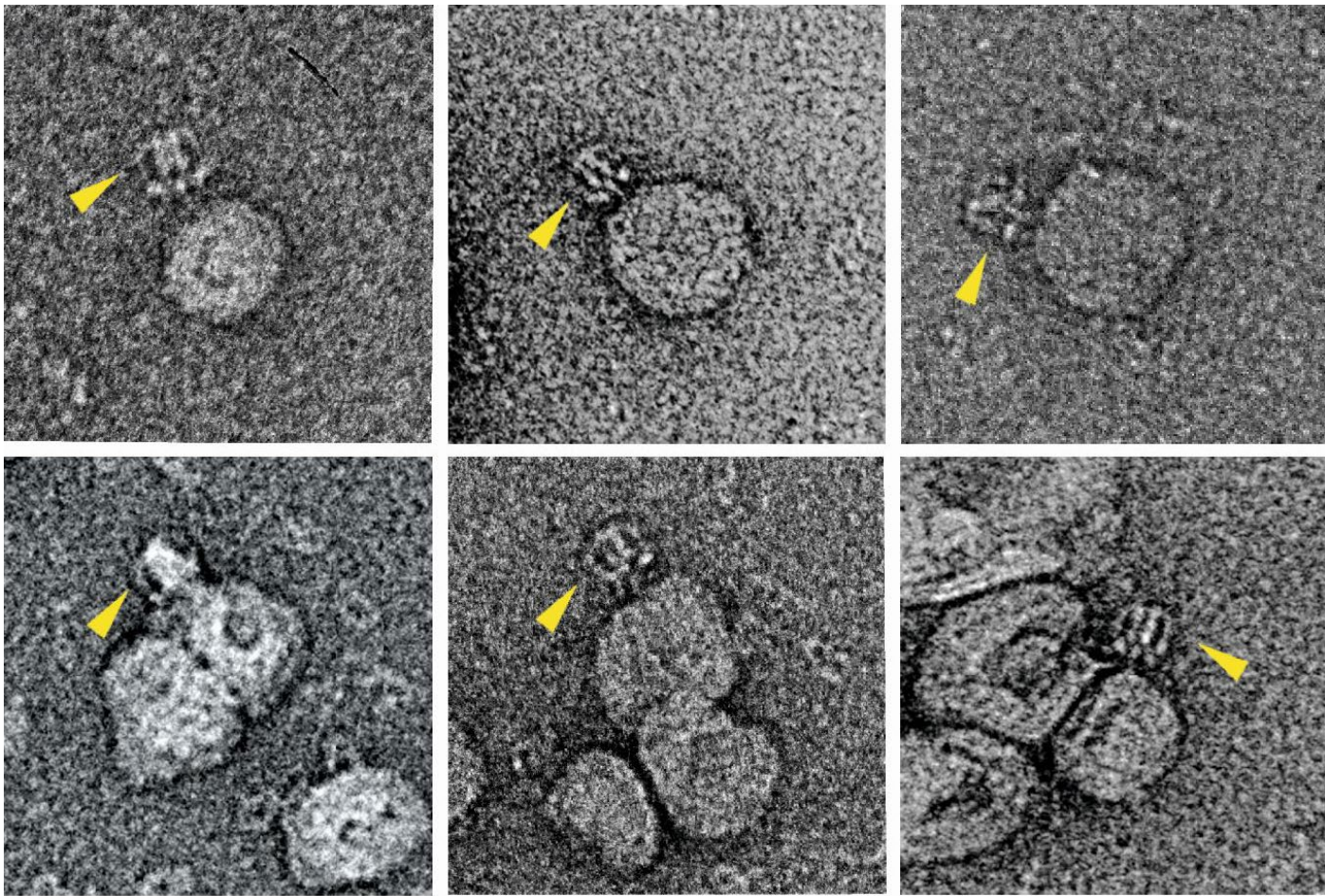


Prof. Dr. Christos Gatsogiannis is a Principal Investigator at the University of Muenster, Germany.

His team elucidates the architecture of complex nanomachines using structural biology techniques. One of their research areas examines the molecular mechanisms of pore-forming neurotoxins.

In B.U. Klink, *et al.*, his team uses cryo-EM to uncover the structural mechanism for how the α -LTX toxin in black widow spider venom inserts itself into presynaptic nerve terminals and triggers a massive release of neurotransmitters.

In this work, negative stain imaging with the Talos TEM was used to optimize sample preparation and investigate the membrane incorporation of the α -LTX toxin into liposomes.



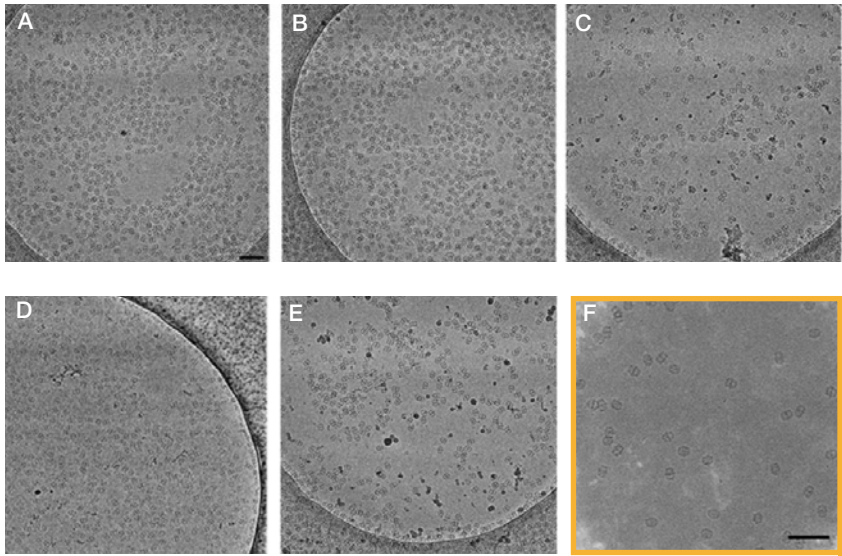
Structural characterization of black widow spider venom. (A) Negative stain imaging of latrotoxin tetramer pores on liposomes, shown across six representative fields. (B) From 988 micrographs, a total of 108 similar particles were used to create a 2D class average. The individual domains of the toxin are highlighted (CD - connector domain, HBD helical bundle domain, PD beta-sheet plug domain, ARD - ankyrin repeat domain). (C) Molecular model of the complete α -LTX pore obtained by combining data from cryo-EM and the AlphaFold2 prediction (not shown) overlaid in the negative stain average of the α -LTX pore on liposomes.

Learn more in the full article: Klink BU, *et al.* Structural basis of α -latrotoxin transition to a cation-selective pore. *Nat Commun* 15:8551 (2024). [doi: 10.1038/s41467-024-52635-5](https://doi.org/10.1038/s41467-024-52635-5)

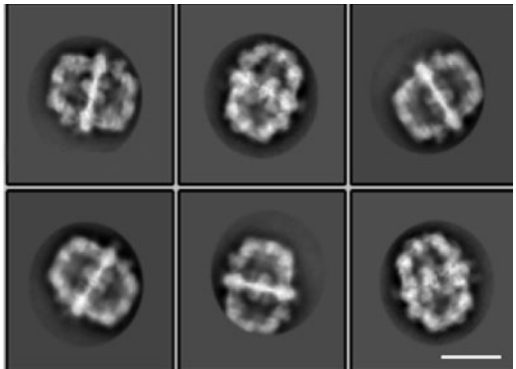
Cryo-EM single particle analysis

Proper sample preparation is crucial for obtaining optimal single particle analysis data. Well-prepared samples ensure the preservation of native structures, minimal artifacts, and provide a homogeneous, well-distributed sample with diverse orientations, all of which are essential for accurate and high-resolution 3D reconstruction.

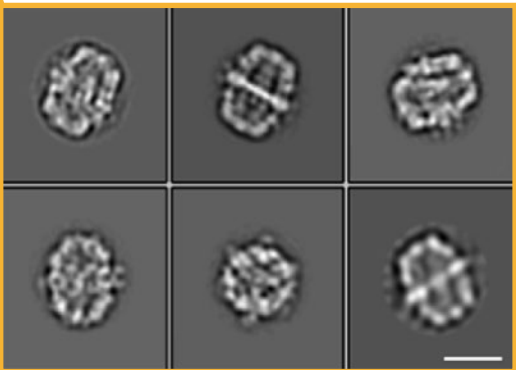
Optimizing sample preparation for single particle analysis
Faster time to results and higher resolution data
The Talos 12 TEM is designed to quickly assess the stability, homogeneity, and concentration of purified samples, either with negative stain imaging or under cryo-EM conditions. Ice thickness, particle density, air-water interface artifacts, and the preferred orientation of particles can be adjusted. Optimized sample conditions will lead to improved results and shorter time to structure from the subsequent single particle analysis data collection, performed with either the Talos 12 TEM itself or using a higher-kV cryo-TEM.



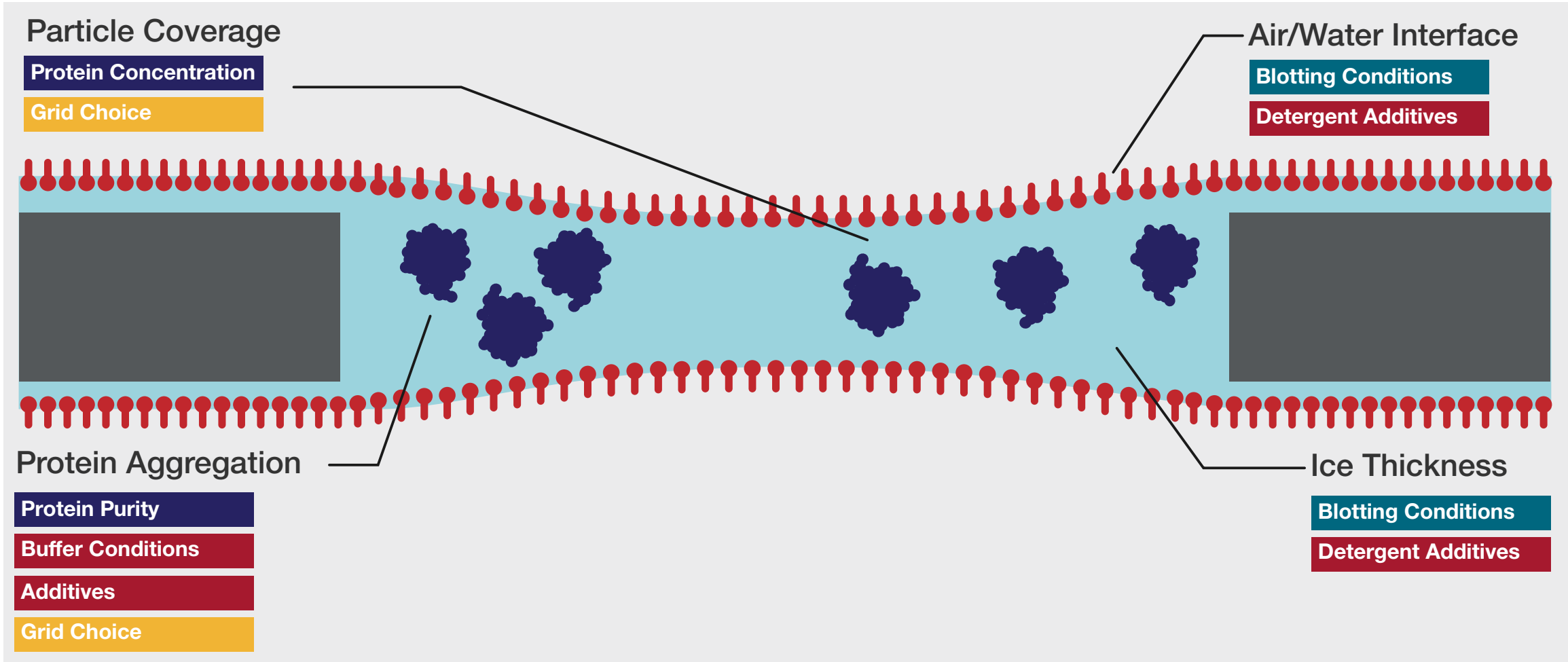
Screening samples prepared in different detergents (A) FOM, (B) DM, (C) Tween 20, (D) CTAB, (E) OG and (F) CHAPS. (F) yields the best conditions for single particle analysis data collection.



Before buffer optimization



After buffer optimization



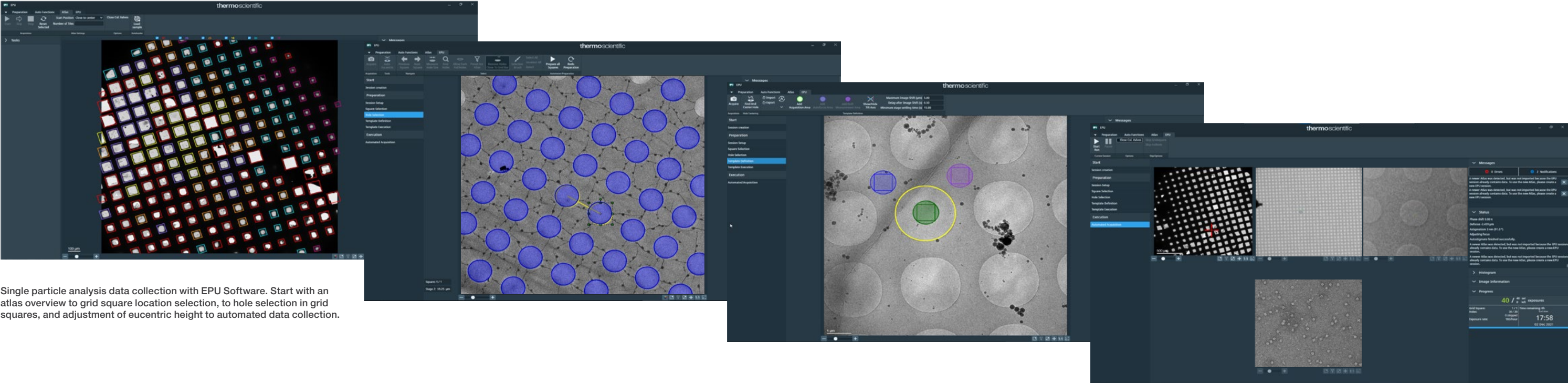
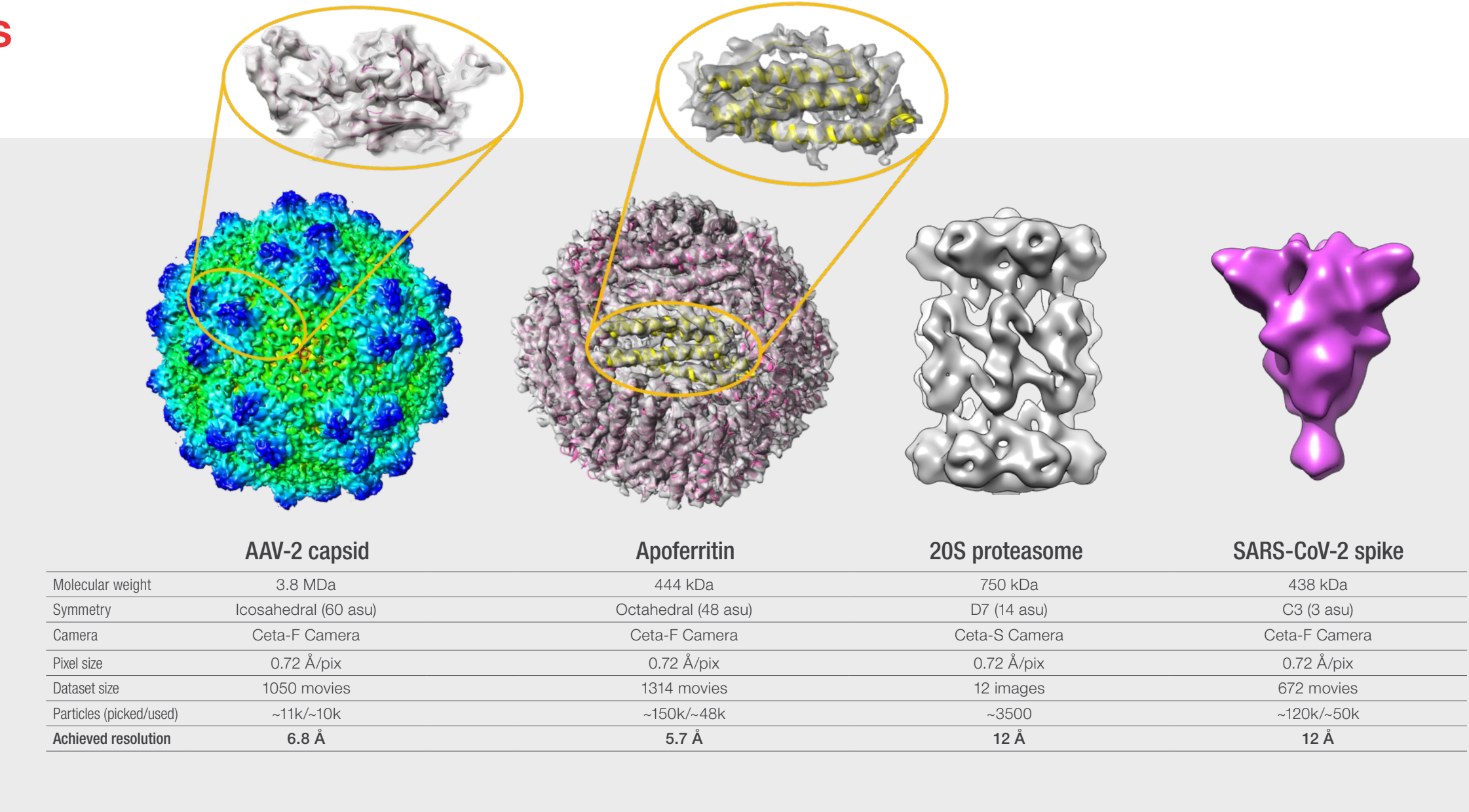
Sample considerations for improving single particle analysis results.

Single particle analysis data collection

Visualize macromolecules and proteins with cryo-EM

The Talos 12 TEM features automated single particle analysis data collection powered by Thermo Scientific EPU Software. The instrument's integrated Ceta Camera is also optimized for the low doses used in single particle analysis, meaning that the Talos 12 TEM can easily resolve 3D structures of protein complexes at up to ~6 Å. At this resolution, individual protein subunits can be determined along with their arrangement and interactions. Combined with the optional Falcon C Direct Electron Detector, it can expand these capabilities, providing a standalone single particle analysis solution for a range of target proteins.

EPU Software enables the Talos 12 TEM with automated single particle analysis data collection. Experience independent optics and camera settings for all used imaging modes. All settings can be saved and reloaded for collection of a new single particle analysis dataset.



3D imaging of cellular structures and nanoparticles

Tomography for visualization of 3D structures

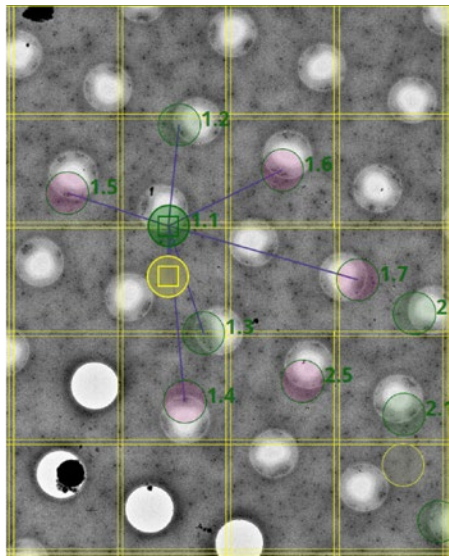
The Talos 12 TEM can be powered by Tomography 5 Software for automated tilt-series acquisition using integrated workflows. Search map acquisition enables the mapping of entire grid squares using medium magnification, offering increased data-collection throughput and improved navigational accuracy. Several regions of interest can then be identified for automatic multi-site batch acquisition of 3D data for tomography.

Off-axis multi-shot acquisition significantly enhances throughput. This feature allows several tomogram positions to be recorded with only one focus and tracking area, thereby streamlining the data acquisition process and increasing efficiency. The dose-symmetric acquisition scheme ensures optimal electron dose distribution for high resolution sub-tomogram averaging.

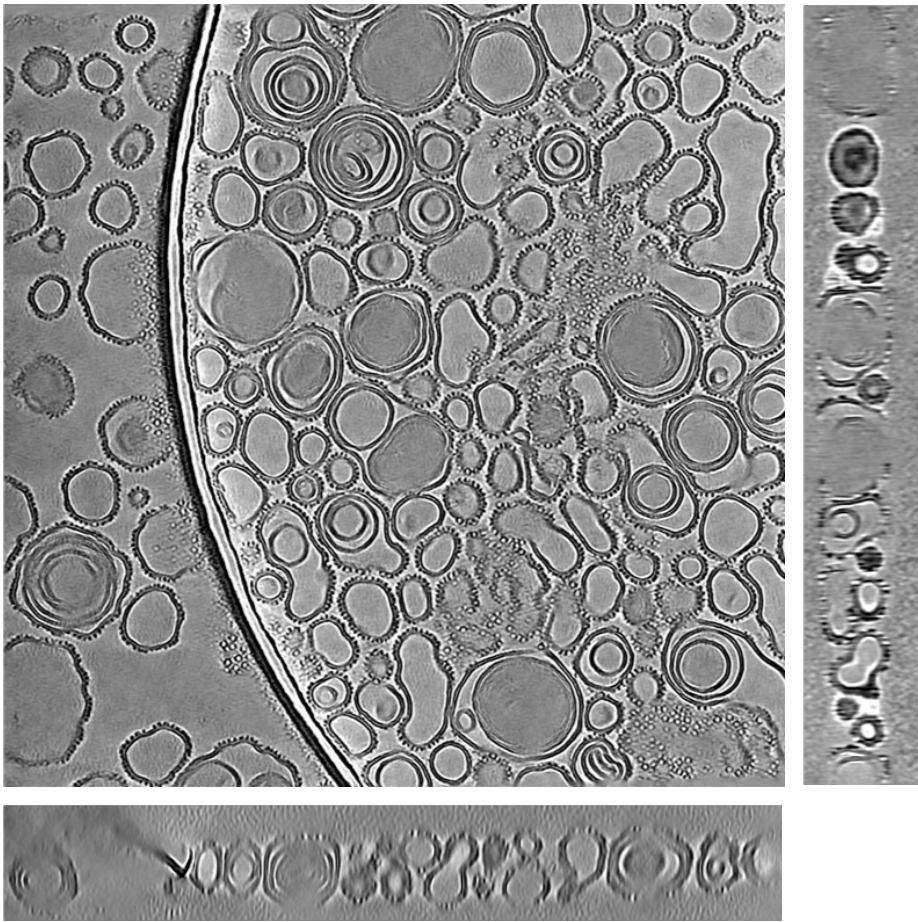
Example – proteoliposome architecture

Tomography imaging of FraC proteoliposomes shows how 3D cryogenic analysis with the Talos 12 TEM, powered by Tomography 5 Software, can reveal fine details of actinoporins within the membrane environment of large unilamellar vesicles (LUVs).

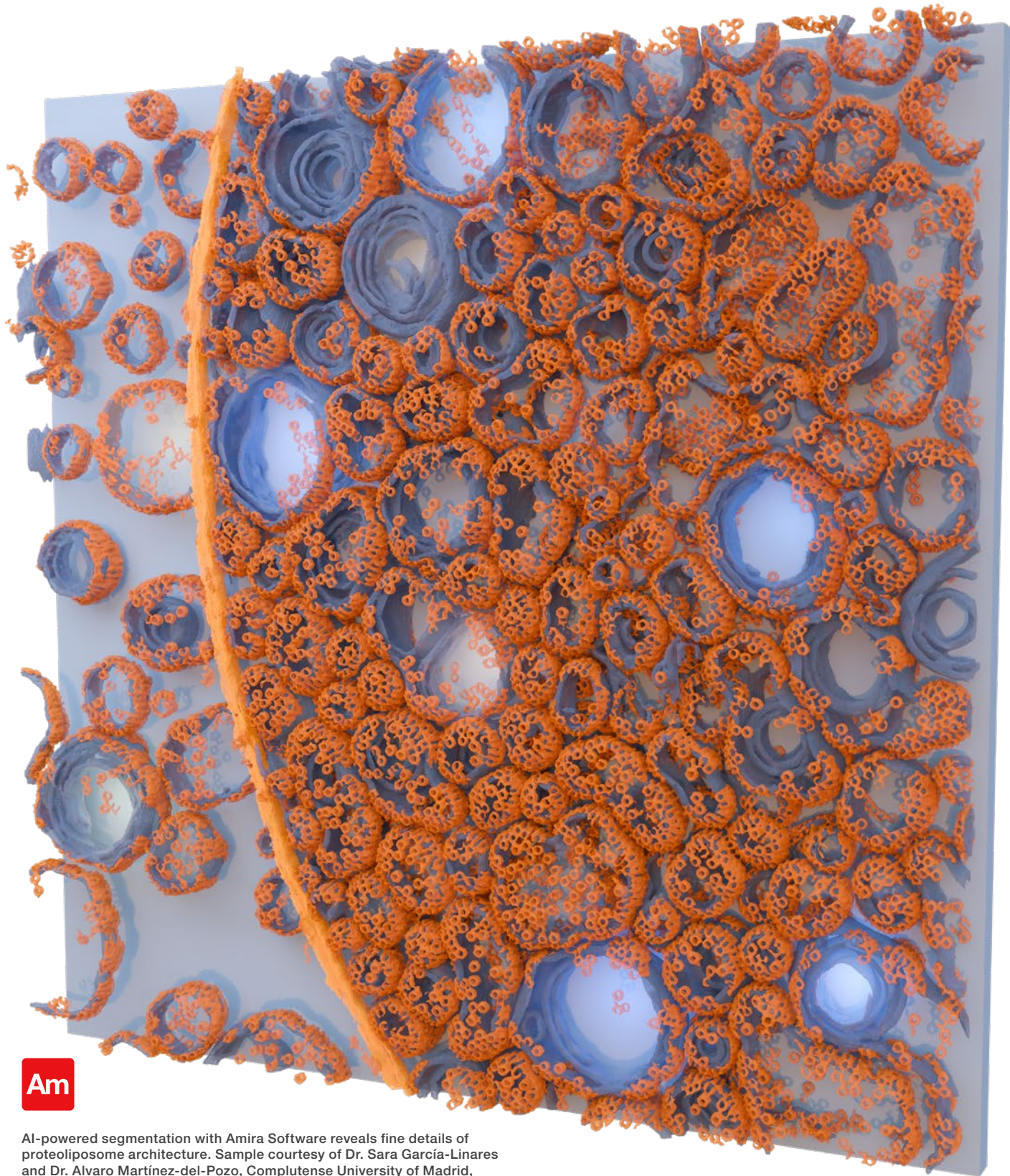
To



Multiple exposure areas can be collected during a single tilt series. This speeds up the collection of tomographic data significantly.



Reconstruction (IMOD, SIRT-like weighted back projection), denoised with CryoCare after reconstruction.



Am

AI-powered segmentation with Amira Software reveals fine details of proteoliposome architecture. Sample courtesy of Dr. Sara García-Linares and Dr. Alvaro Martínez-del-Pozo, Complutense University of Madrid, Spain, and Dr. Jaime Martín-Benito Romero, CNB-CSIC, Spain.

Nanoparticle characterization

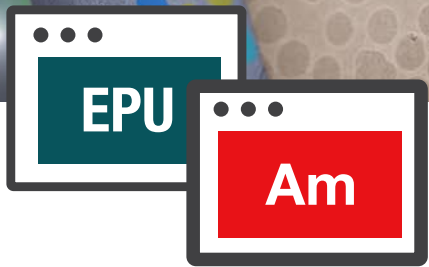
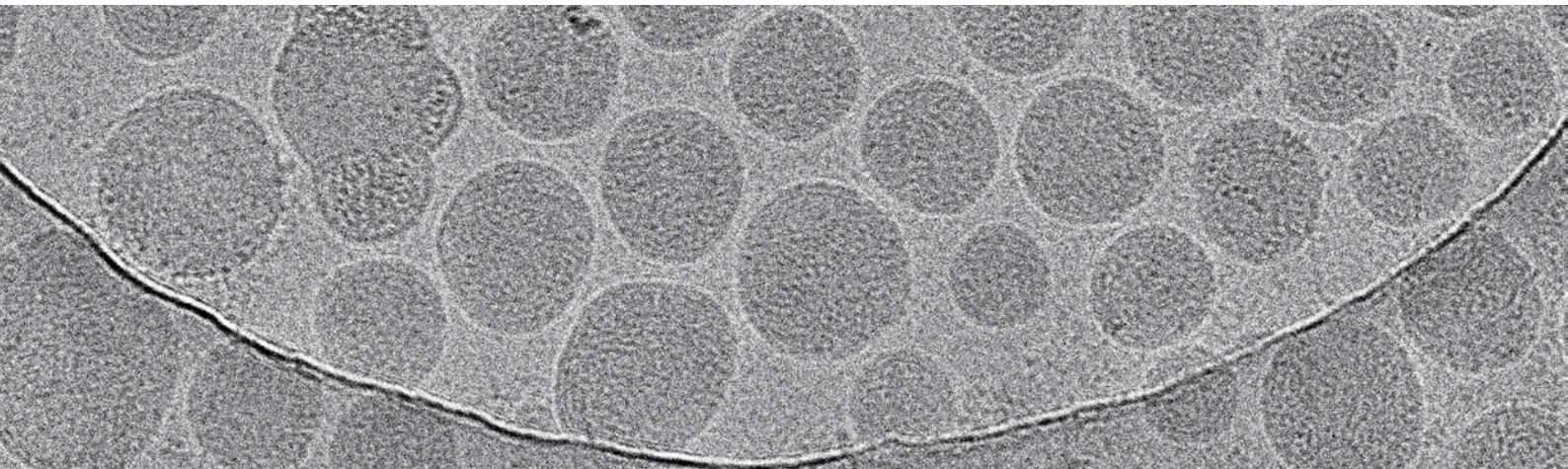
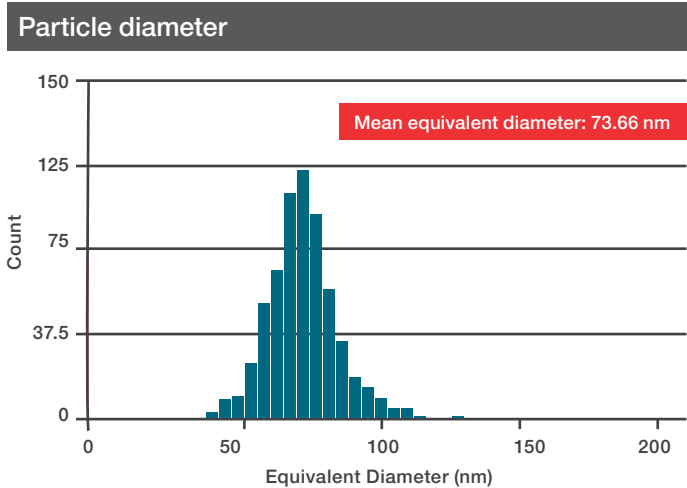
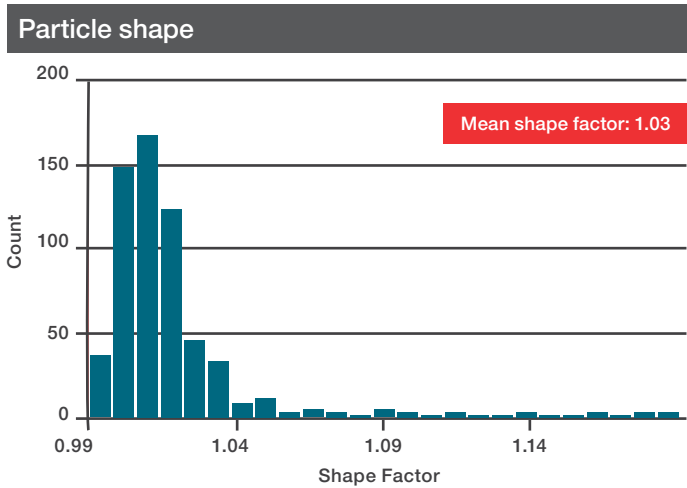
Utilizing cryo-EM to optimize novel drug delivery systems

Nanoparticle-based drug delivery systems have emerged as a powerful tool in drug development. Among these, lipid nanoparticles (LNPs) stand out due to their unique properties, including high surface area, tunable size, and the ability to encapsulate and deliver therapeutic agents. Regulatory authorities, including the US FDA and the European Medicines Agency, emphasize the analysis of key morphological features to ensure the efficacy and quality of nanoparticle- and viral-vector-based therapeutics.

Cryo-EM is the most widely used method for LNP analysis, having advantages in accuracy, direct visualization of size, shape, lamellarity, and 2D/3D morphology, as well as the ability to determine surface properties at high resolution and at near-native conditions, regardless of cargo/formulation.

The Talos 12 TEM delivers the data for the analysis of critical quality attributes (CQAs), including accurate size and shape, encapsulation efficiency assessment of RNA loading and distribution, batch-to-batch consistency, as well as nano-structural insights and process optimizations.

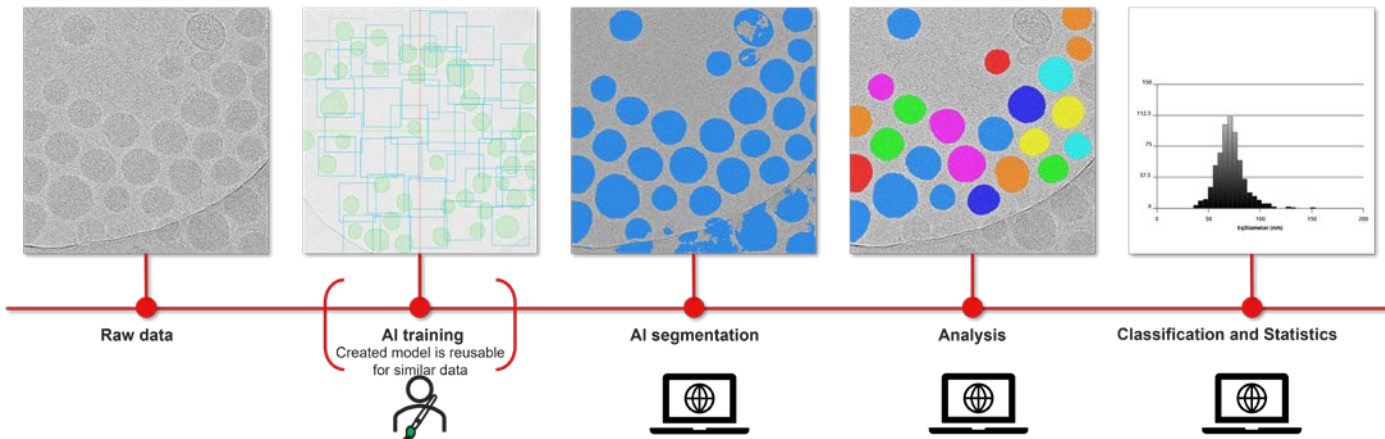
Achieving statistical significance in CQA assessment requires the analysis of large datasets with numerous particles. The Talos 12 TEM, optimized for high-throughput nanoparticle imaging, paired with AI-enabled Amira 3D Software for semi-automated image processing, delivers a streamlined workflow for fast, accurate, and reproducible LNP characterization.



Semi-automated nanoparticle characterization

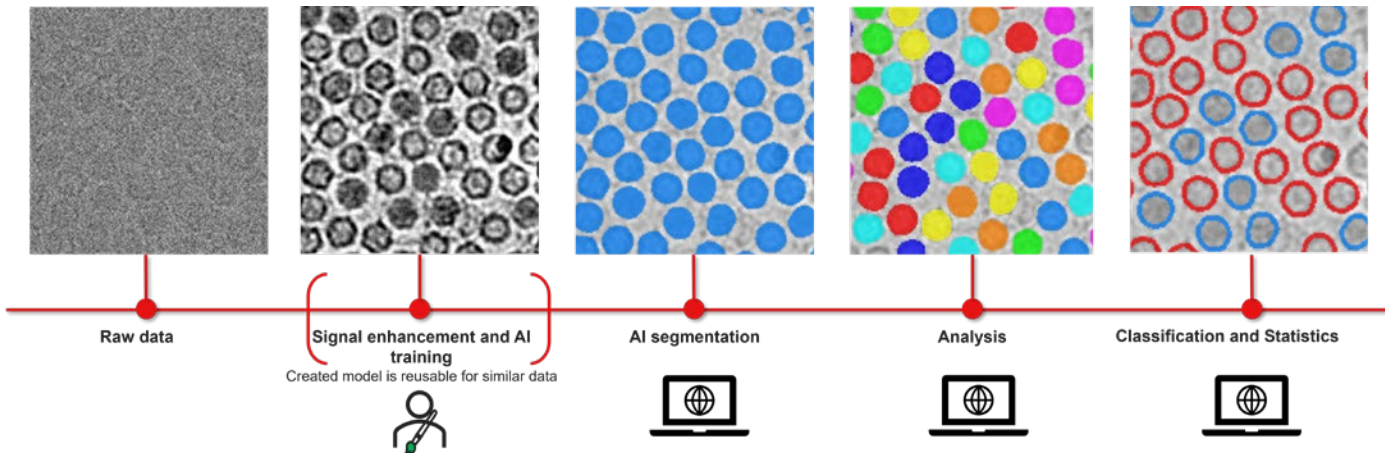
High-throughput data acquisition with the Talos 12 TEM, equipped with EPU Software and combined with AI-based image analysis in Amira 3D Software, can automate image analysis workflows and enhance the precision and efficiency of nanoparticle characterization. Tailored workflows for both LNP and AAV analysis provide detailed insights and reduce the time and human error associated with traditional methods.

Beyond basic metrics such as shape, size, and morphology, Amira 3D Software enables a wide range of CQA analyses through customizable scripts. Tailor investigations to specific research needs, ensuring comprehensive and precise evaluations of LNPs. Whether it's assessing particle distribution, surface characteristics, or internal architecture, Amira 3D Software stands out as a powerful and versatile tool in the field of nanoparticle research.



LNP characterization workflow

Based on cryo-EM images, particle shape (elongation), surface area, and diameter were calculated for more than 600 LNPs. The overall analysis, including the generation of the AI-based segmentation model, was performed in approximately 1 hour.

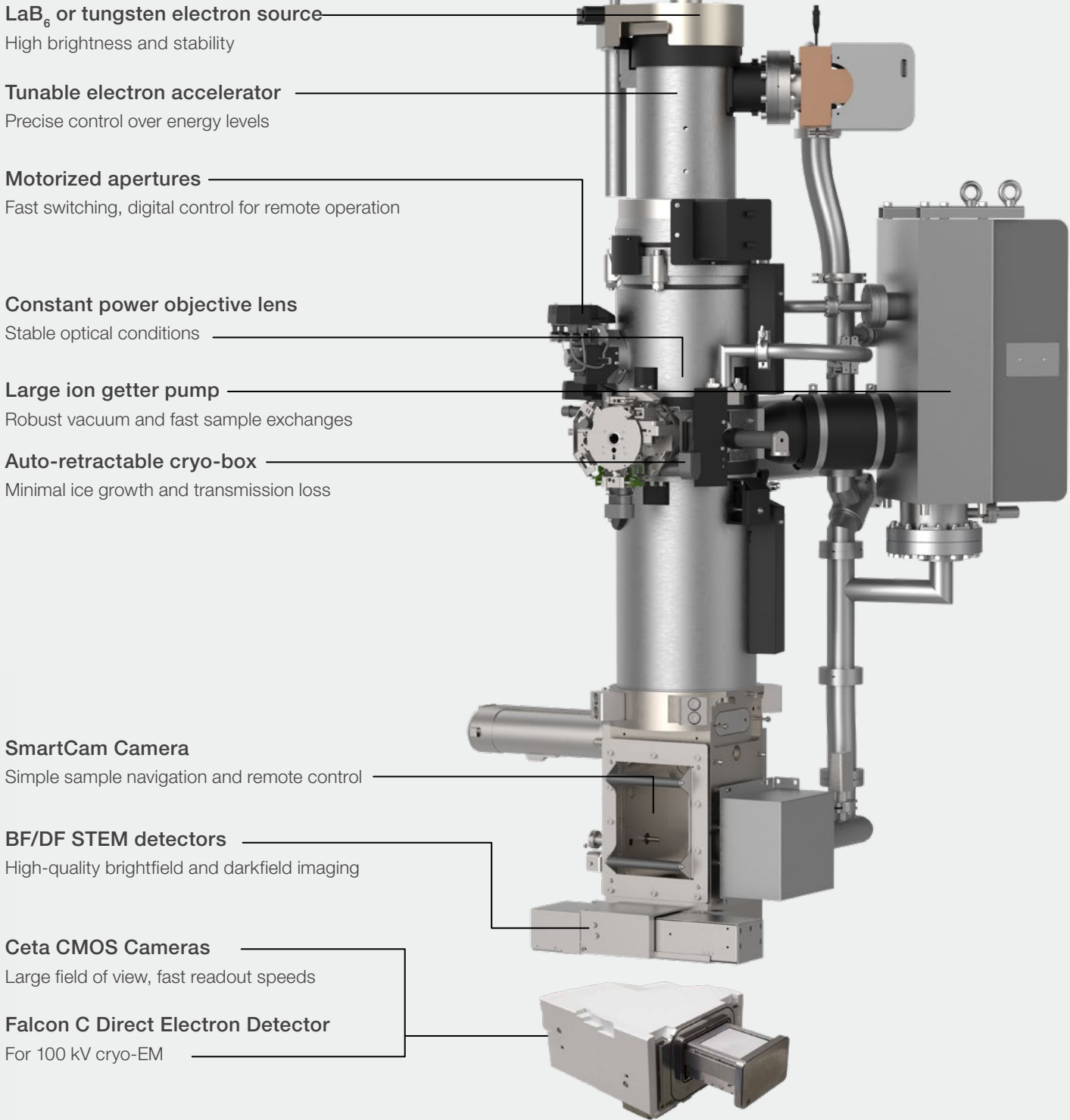
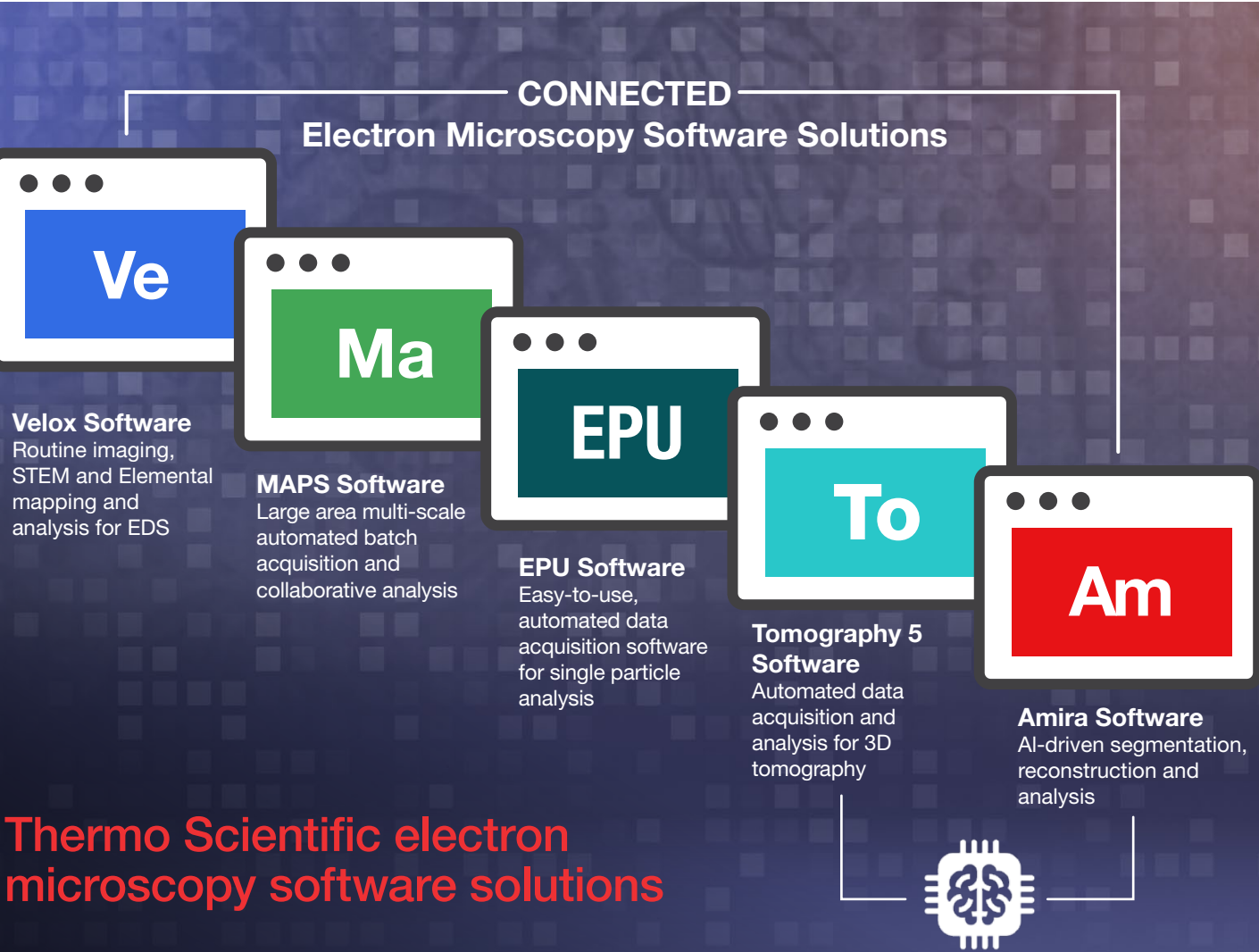


AAV characterization workflow

Cryo-EM images of more than 300 AAVs were used to determine particle shape (elongation) and diameter. The number of filled and empty particles was also calculated for the population. The overall analysis, including the generation of the AI segmentation model, was performed in approximately 12 hours.

Talos 12 TEM technical highlights

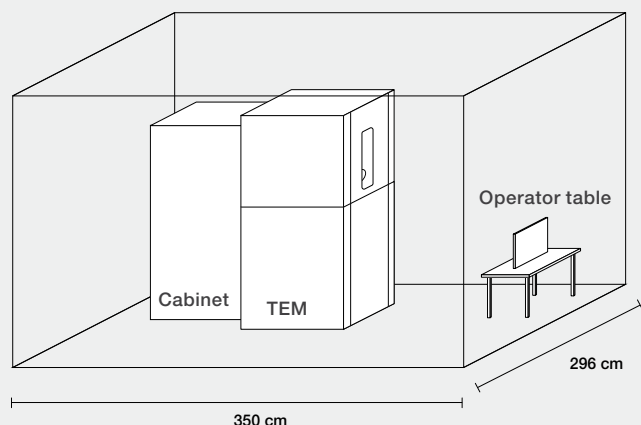
- Thermionic electron source (LaB₆ or tungsten filament)
- Continuously adjustable acceleration voltage within 20–120 kV
- Constant-power objective C-Twin lens for superior beam stability and rapid magnification changes
- Robust system enclosure for high system stability
 - Reduced system footprint
 - LED lighting for operational guidance
 - Transfer deck to support holders and tools
- Digital search-and-view camera for interactive examination of samples in ambient lighting
- Motorized, automatically retractable cryo-box for minimum transmission loss
- Motorized apertures for fast and easy switching and remote operation
- Optional long-duration dewar for long data-acquisition sessions without user intervention
- Full integration of 16-megapixel Ceta CMOS Camera into the Talos 12 TEM for seamless and enhanced automation, providing a large field of view and high read-out speed.
- Camera options include:
 - Ceta-S or Ceta-F Cameras, optimized for low-dose applications, such as the analysis of beam-sensitive samples
 - Ceta-D Camera, a scintillator-based camera optimized for low-dose diffraction data collection
 - Thermo Scientific Falcon C Direct Electron Detector, a dedicated detector for cryo-EM
- Optional STEM detectors with high sensitivity and increased speed
- Optional side-entry and retractable EDS detector for chemical analysis
- Operates via a Microsoft Windows 11 workstation



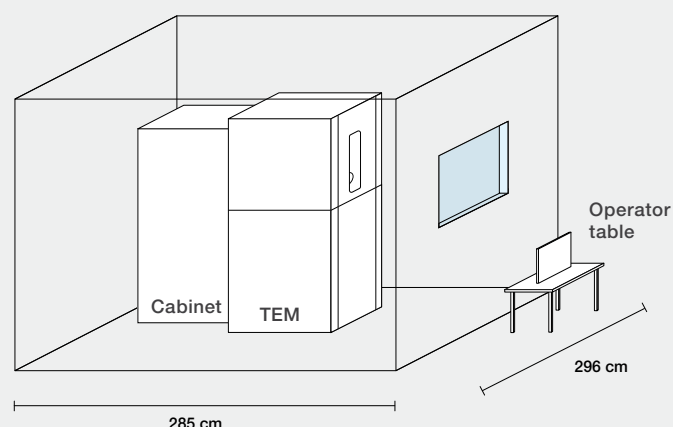
Talos 12 TEM specifications

- TEM line resolution: 0.204 nm
- TEM point resolution: <0.37 nm
- STEM HAADF resolution: <1.0 nm (with LaB₆)
- STEM magnification range: 205x-140Mx
- Maximum tilt angle (stage): ±90°
- TEM magnification range
 - 25–650kx (standard)
 - 35–910kx (enhanced)

Talos 12 TEM room requirements



Room configuration option A
 $10.4 \text{ m}^2 = 3.5 \times 2.96 \text{ m}$



Room configuration option B
 $8.4 \text{ m}^2 = 2.85 \times 2.96 \text{ m}$

Installation requirements

- Environmental temperature: 18–23°C
- Temperature stability: 1°C per 24 hours
- Relative humidity: <80%
- Room dimensions (see illustration to the left):
 - Room configuration option A: 3.5 x 2.96 m (11.48 x 9.71 ft)
 - Room configuration option B: 2.85 x 2.96 m (9.35 x 9.71 ft)
- Room height: 2.6 m (8.53 ft)

See the pre-installation manual for detailed information and possible room layouts.

Learn more at thermofisher.com/talos12

thermoscientific