

# Inventory of Facilities in Norway for the Analysis of Cultural Heritage Materials, based on a Survey of the SciCult Partnership

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## **At present, the infrastructure comprises:**

- University of Oslo (UiO)  
Museum of Cultural Heritage (MCH) as coordinator
- Natural History Museum (NHM),
- Department of Geosciences, The Faculty of Mathematics and Natural Sciences
- Department of Physics, The Faculty of Mathematics and Natural Sciences
- Applied Research, Technology and Innovation (SINTEF)
- University Museum of Bergen (UiB)
- Department of Cultural History
- Norwegian Institute for Cultural Heritage Research (NIKU)
- Norwegian Maritime Museum (NMM)
- Norwegian University of Science and Technology (NTNU)
- The Department of Marine Technology (IVT), Department of Archaeology and Cultural History (University Museum VM), Department of biology (Faculty of Natural Sciences NV)
- The Norwegian Colour and Visual Computing Laboratory (Colourlab), Department of Computer Science (IDI), NTNU Gjøvik
- The Norwegian Centre for Transmission Electron Microscopy (NORTEM)

The following is categorised according to E-RIHS way of categorizing their infrastructure:

### **ARCHLAB (archives)**

E-RIHS defines Archlab as ‘Access to specialised knowledge and organized scientific information – including technical images, analytical data and conservation documentation – in datasets largely unpublished from archives of prestigious European museums, galleries and research institutions.’

### **FIXLAB (fixed facilities)**

E-rihs defines Fixlab as ‘Access to large-scale and medium-scale facilities (particle accelerators and synchrotrons, neutron sources; non-transportable analytical instruments) offering a unique expertise to users in the heritage field, for sophisticated scientific investigations on samples or whole objects, revealing their micro structure and chemical composition, giving essential and invaluable insights into historical technologies, materials, alteration and degradation phenomena or authenticity.’

### **MOLAB (mobile facilities)**

E-rihs defines Molab as ‘Advanced mobile analytical instrumentation for non-invasive measurements on valuable or immovable objects, archaeological sites and historical monuments. The MOBILE LABORATORY allows its users to implement complex multi-technique diagnostic projects, permitting the most effective in situ investigations.’

### **DIGILAB (Virtual facilities)**

The table below contains data on the participants, the equipment they have access to, and the competence offered. This table will form the basis for a common web platform. The aim is to form a national network to make the equipment available for researchers in the field. The web platform can contain short general start page with enough information to enable the visitor to link to other individual pages with more information on the individual lab facilities, the facilities available there

together with the competence of the personnel working there can offer and contact and reservation information.

The local page should contain type of analyses that can be performed, on what type of equipment (brand, type, age and other relevant information), remarks on the type of probes that are relevant for sampling (restriction and challenges such as size etc.).

## Overview of equipment divided into categories of analyses

Equipment	Owners	Location		Remarks
FIXLAB				
Transmission Electron Microscopy (TEM)	NORTEM, owned together with SINTEF	Forskningsparken, Gaustadalleen 21. Placed in several different rooms	Øystein Prytz	<a href="https://nortem.no/about/">https://nortem.no/about/</a> Access to top modern TEM infra structure.
2 x Transmission Electron Microscopy (TEM) and upgrades including ion-etching for preparing TEM samples	Department of Physics, UiO	Forskningsparken, Gaustadalleen 21.	Øystein Prytz	External users without their own specialists are normally referred to SINTEF for the purchase of research services. UiO's use as of today is mainly through dedicated users (PhD and PD). It is considered to create internal schemes for UiO's user environments through the employment of a researcher with user support as his main task. (infrastructure for studies of inorganic materials)
Variable Pressure Scanning Electron Microscopy (VP SEM) and Energy Dispersive X-ray (EDX)	NMH, UiO Department of technical and scientific conservation v. Nélia Castro	Kabelgata 40, 0580, Økern, room U562	Henrik Friis	<a href="https://www.nhm.uio.no/english/research/infrastructure/geo-lab/">https://www.nhm.uio.no/english/research/infrastructure/geo-lab/</a> The Geo Laboratory at the Natural History Museum (Økern) specializes in imaging, chemical and structural characterization of geological materials.
Elektron MicroProbe Analysis (EMPA) <sup>i</sup>	Department of Geosciences, UiO	Elektronmikro-sonde laboratoriet Sem Sælandsvei 1, rom 0019 + 0018 Adm Leder Institutt: Anne Cathrine Modahl Adm. Lab-	Muriel Erambert	<a href="https://www.mn.uio.no/geo/english/research/about/infrastucture/facilities/material-characterisation/structure-composition/electron-microprobe-laboratory/">https://www.mn.uio.no/geo/english/research/about/infrastucture/facilities/material-characterisation/structure-composition/electron-microprobe-laboratory/</a> In-situ x-ray micro analysis of main and spore elements in solid materials. Access for everyone at UiO and other external users from academia (other universities, research centers, museums), and commercial companies.

Equipment	Owners	Location		Remarks
		coordinator: Thor Thorsen		
<p>LVSFESEM, Zeiss Supra, 55 VP  FESEM, Zeiss ultra 55 Limited edition  Field Emission- Scanning Electron Microscopy (FESEM) (Hitachi SU-6600)  Low Vacuum-SEM (LVSEM) (Hitachi S-3400N)  TEM (JEM-2010)  Hitachi IM3000 ION MILL  JSM840, Online EBSD  K6154 YSL-OIM + Quantax Esprit, offline F-380  K6838 TSL-OIM + Quantax Esprit, offline F-380  K7345 TEAM/OIM + Quantax Esprit, offline F-380  Jeol6010</p>	<p>NTNU,  Faculty of Natural Sciences and Technology,  Department of Materials Science and Engineering</p>	<p>Electron Microscope Laboratories  Alfred Getzvei 2,  Building F-3 Floor  Sem Sælandsvei 12,  Building K2-036</p>	<p>Jarle Hjelen:  JarleHjelen@ntnu.no</p>	<p><a href="https://www.material.ntnu.no/lab/material/about_us.html">https://www.material.ntnu.no/lab/material/about_us.html</a>  Booking via  <a href="https://www.material.ntnu.no/lab/material/booking.php">https://www.material.ntnu.no/lab/material/booking.php</a>  I SEM-lab inngår også et dedikert prepareringslaboratorium. På 80-tallet bestod denne i hovedsak av en vakuum carbonpådampner og en sputtercoater for å belegge ikke-elektrisk ledende prøver med et ledende sjikt. I de senere år er denne laben utvidet med en plasmarensner og to ionemøller.  I 2007 ble det kjøpt inn en ny FESEM, en Zeiss ULTRA 55 Limited Edition, og i 2010 anskaffet SEM lab en ny LVFESEM, Hitachi SU-6600. Disse ble finansiert ved et bidrag/avslag på kr. 600.000 fra Zeiss og salg av SEMene som ble innkjøpt i 2002. Begge disse FESEMene ble utstyrt med EDS og EBSD. Hitachi-SEMene ble utstyrt med doble EDS-detektorer som var et bidrag fra Bruker AXS i forbindelse med et samarbeid mellom Bruker, IGB og IMT (Mineral Liberation Analysis). Siden Hitachi-SEMene har doble EDSdetektorer, prøvebord med mulighet til store forflytninger og høy strålestrøm (200nA), er denne SEMen svært godt egnet til analyser av geologiske prøver. Zeiss-instrumentene har stort prøvekompartiment som muliggjør montering av in-situ utstyr som delvis er utviklet i egen lab. Dette in-situ utstyret er kompatibelt med EBSD utstyret, slik at man kan studere utvikling av lokal kornmorfologi, -orientering, -tekstur, korgrenser etc. under termo-mekanisk behandling. Mange PhD- og masterstudenter har benyttet dette spesielle utstyret under sitt eksperimentelle arbeid de siste 10 årene.</p>

Equipment	Owners	Location		Remarks
				SEM-lab benyttes i en rekke kurs ved IMT, bl.a. TMT4300 Lys- og elektronmikroskopi, MT8207 Elektronmikroskopi, TMT4166 Eksperimentell material- og elektrokjemi, TMT 4905 Materialteknologi, masteroppgave, TMT 4500 Materialteknologi, fordypningsprosjekt hvor både demonstrasjoner og praktiske øvelser inngår. Et meget stort antall av masterstudentene ved både IMT og andre institutter benytter laboratoriet i forbindelse med prosjektoppgaven og hovedoppgaven. Tilsvarende er der svært mange Ph.D-studenter og Post docs som benytter SEM-lab i sin forskning. Sannsynligvis er SEM-lab det laboratoriet ved IMT som har vært mest brukt av studenter og forskere i løpet av laboratoriets 40-årige historie.
Quadrupol Inductively Coupled Plasma Mass Spectrometry (ICPMS) with laser micro probe and system for analyses of solutions	Department of Geosciences, UiO	Electron microprobe laboratory	Professor Tom Andersen <a href="https://www.mn.uio.no/ibv/personer/vit/tomand/index.html">https://www.mn.uio.no/ibv/personer/vit/tomand/index.html</a>	Multi collector ICPMS with laser micro probe for analysis of solids and desolvating nebulizer for solutions (analysis of isotope relations). Quadrupol ICPMS with laser micro probe and system for analysis of solutions (for analysis of trace element concentrations).
Quadrupole Time-of-Flight Mass Spectrometry (QTOF-MS) and Prospec-MS, (Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS)		Kjemibygningen QTOF-MS og Prospec-MS room V 252 Tel no. 22 85 73 89 FT-ICR MS: rom V 244 Tel no. 22 85 75 88	Professor Einar Uggerud Instrument-responsible Principal engineer Osamu Sekiguchi	<a href="https://www.mn.uio.no/kjemi/forskning/om/infrastruktur/ms/om/">https://www.mn.uio.no/kjemi/forskning/om/infrastruktur/ms/om/</a> Laboratory of Mass spectrometry Works with methods ranging from analytical to theoretical chemistry. Mass spectrometry is a very central method of analysis in modern chemistry, and our goal is to be a leader in the country. Candidates who have this as a special field can get relevant work after complete education, due to the amount of at least 50 laboratories with mass spectrometers only in Norway. There has recently been great growth in

Equipment	Owners	Location		Remarks
				Norwegian mass spectrometry – both in chemical analysis and biochemistry.
Scanning Electron microscopy-Energy Dispersive Spectroscopy (SEM-EDS)	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
High performance liquid chromatography (HPLC)	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
Raman spectroscopy	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
UV-Vis spectroscopy	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
Gas Chromatography-Mass Spectrometry (GC-MS)	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
Fourier Transform InfraRed (FTIR) spectroscopy	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
Single crystal X-Ray Diffraction (SXRD)	NHM, UiO		Henrik Friis	
Micro X-ray Computed Tomography (micro-CT) Scanning	NMH, UiO		Øyvind Hammer	
Freeze drier. 6 meter long	SNF, Norwegian Maritime Museum (NMM)		Pål Thome pal.thome@marmuseum.no	<a href="https://marmuseum.no/konservering">https://marmuseum.no/konservering</a> At the moment booked for several years ahead. Please contact conservator directly.
<b>MOLAB</b>				
X-Ray Fluorescence (XRF)	Department of Cultural History,		Hanah Lukesova	

Equipment	Owners	Location		Remarks
	University Museum of Bergen, UiB			
pXRD: Tracer-IIISD v/ Emyrean	UiO, Saving Oseberg	Økern MCH lab	Researcher Calin Steindal	
Powder PXRD	NHM, UiO Seksjon for konservering og forsknings-teknikk v/ Nélia Castro	Kabelgata 40, 0580, Økern, rom U562	Øivind Hammer	<a href="https://www.nhm.uio.no/english/research/infrastructure/geo-lab/">https://www.nhm.uio.no/english/research/infrastructure/geo-lab/</a>
pXRF: Makrotank v/ Müller Bruker	UiO: Saving Oseberg	Økern KHM lab	Researcher Calin Steindal	
pXRF	National museum	Conservation studio/ laboratory, Vestbanen		
pXRF	NIKU	Conservation facilities, Storgata 2, 6. og 7. etg	Conservator Susanne Kaun	<a href="https://www.niku.no/analyser-og-dokumentasjon/">https://www.niku.no/analyser-og-dokumentasjon/</a>
pFTIR		Conservation studio/ laboratory, Vestbanen		
Micro fading	The National Museum	Conservation studio/ laboratory, Vestbanen		
Digital X-ray	UiO	Økern KHM konserveringslab		

Equipment	Owners	Location		Remarks
Digital X-Ray	The National Museum	Conservation studio/ laboratory, Vestbanen		Predominantly set up for paintings and works of art on paper.
X-ray	NIKU	Storgata 2, 6. og 7. etg.	Christina Spaarschuh, Barbro Wedvik	
Fully digital UV, IR	The National Museum	Conservation studio/ laboratory, Vestbanen		Predominantly set for paintings and works of art on paper.
For measuring/ georeferencing: GPS TPS Drone with camera: Phantom 4 multispectral – camera and drone with ordinary camera Programmer: Agisoft Metashape (x2 lisenser) Adobe Creative Cloud Suite (x1 lisens) CaptureOne (x1 lisens)	KHM-UiO	DigDok	Espen Uleberg	
Magnetic measurements: Bartington Grad 601 Dual; Sensys MX V3 16 channel; Bartington MS2 with lab and field sensors. Electromagnetic: GSSI Sir 3000 single channel GPR system with antennas; 3d-radar towed multi-frequency GPR system; CMD Mini explorer electromagnetic	Department of Archaeology and Cultural History (University Museum VM),	NTNU VM	Ole Risbøl, Arne Stamnes	Access to equipment and instruments for geophysics and airborne remote sensing of archaeological sites and landscapes.

Equipment	Owners	Location		Remarks
induction meter. Electric measurements: Tigre 65 Earth Resistivity System. Other: UTV Yamaha Wolverine vehicle + trailer; Cart system for Electrical resistivity tomography (ERT) and magnetometer; DJI MATRICE 600 pro with Light Detection and Ranging (LiDAR)				
Visible and Near Infrared (VNIR), Short Wave Infrared (SWIR) hyperspectral camera	NTNU-Colourlab	Colourlab, NTNU Gjøvik	Sony George	The hyperspectral imaging systems (HySpex VNIR 1800 and SWIR 384) can be used in multiple settings- lab rack, rotational stage, art scanner.
Art scanner	NTNU-Colourlab	Colourlab, NTNU Gjøvik	Sony George	This is configured to use with the spectral imaging systems to scan art objects
Multispectral imaging systems	NTNU-Colourlab	Colourlab, NTNU Gjøvik	Sony George	Multispectral camera – filter wheel and snapshot
<b>DIGILAB</b>				
2D high-resolution microscopy HIROX	The National Museum	Conservation studio/ laboratory, Vestbanen		From 2021 the National museum will be operating from new and modern conservation facilities. It will be able to offer a range of imaging techniques for 2D artworks and has some portable non-invasive analytical tools.
Photographic documentation IR, UV, RTI, fotogrammetry, Panorama- og 360-grader opptak.	NIKU	Storgata 2, 6. og 7. etg.	Christina Spaarschuh, Barbro Wedvik	Since a number of NIKU's missions are field based, they focus on mobile analytics methods that provide great flexibility and broad scope.

Equipment	Owners	Location		Remarks
3D scanning: (Structured Light Scanning (SLS): 1 stk. Atos Core MV 45 1 stk. Atos Core MV 135 1 stk. Atos Core MV 300 1 stk. Atos Compact Scan MV 1200, MV 300, MV 150. Eks. Atos Core MV 45 has 5 mill points within the area 45x45mm. Programvare: 1 stk. Atos Professional 2019 (scannerprogramvare) 1 stk. GOM Inspect Professional 2019 stk. Atos STL. Scan (scannerprogramvare without TRITOP) - 2 stk. Rhino 6  Til fotogrammetri Utstyr: Olympus OM-D E-M1 Mark II M. Zuiko 60mm macro M. Zuiko 12-24mm wide Sony Alpha 7R IV 50mm macro 24mm wide Carbon fiber stand Novoflex Focus-stacking System Matterport 3D kamera	MCH, UiO	The Viking Ship Museum	Over engineer Bjarte Aarseth <a href="mailto:b.e.aarseth@khm.uio.no">b.e.aarseth@khm.uio.no</a>	<a href="https://www.khm.uio.no/om/organisasjon/seksjon-for-samlingsforvaltning/ansatte/aarseth/index.html">https://www.khm.uio.no/om/organisasjon/seksjon-for-samlingsforvaltning/ansatte/aarseth/index.html</a> The scanner system uses "blue light" to aid the scanning of reflecting surfaces.  Small coordinates of 3D objects can be measured quick and precise with the portable TRITOP-systemet. Measurements that traditionally would be performed by 3D coordinate machines are performed with the aid of this TRITOP-system. Example: ytterpunkter og seksjoner, holes and edges, diameter, length and angles. The system is used to measure points of reference before the 3D scanning of large object (such as the Oseberg and Gokstad Viking ships) and the scanning of small objects.  3D Software that Aarseth works with on a daily basis: GOM Inspect GOM Inspect Professional ATOS Professional TRITOP Professional Rhinoceros Autodesk Inventor Illustrator/Photoshop Z-brush

Equipment	Owners	Location		Remarks
Large light tent and two LED daylight lamps.				
Other competences				
Dendro dating	NTNU	Gamle fysikk, 163, Gløshaugen, Sem Sælands vei 5	Terje Tun <a href="https://www.ntnu.no/ansatte/terje.thun">https://www.ntnu.no/ansatte/terje.thun</a>	<a href="https://www.ntnu.no/museum/dendrokronologisk-datering">https://www.ntnu.no/museum/dendrokronologisk-datering</a> .
<sup>14</sup> C dating	NTNU National laboratories for carbon dating	Sem Sælands vei 5, Gløshaugen, Trondheim <ul style="list-style-type: none"> <li>Postal adresse: 7491 Trondheim</li> </ul>	E-mail: datlab@vm.ntnu.no Telephone lab: +47 918 97 525 Contact: Associate professor Marie-Josée Nadeau Associate professor Terje Thun	<a href="https://www.ntnu.no/museum/nasjonallaboratoriene-for-datering">https://www.ntnu.no/museum/nasjonallaboratoriene-for-datering</a>

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<sup>i</sup> Finansiert NFR (2001), oppgradert i 2010 for 1.2 MNOK (UiO) – Ny søknad for innkjøp av ny EMPA som del av en Nasjonal Infrastruktur innfridd i 2019.