Research data usecase: Scanning Electron Microscopy

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Metadata

- From FAIR Principles: "*Metadata should richly describe the data with a plurality of accurate and relevant attributes*"

How the SEM schema looks like:

```
499         "pressureDetails":{
500            "type":"object",
501            "description":"(Required) - Descri
502            "additionalProperties":false,
503            "properties":{
504               "value":{
505                  "type":"number",
506                  "default":-9999,
507                  "description":"(Required) -
508               },
509               "unit":{
510                  "type":"string",
511                  "default":"Pa",
```

https://ceur-ws.org/Vol-3036/paper21.pdf

How a SEM md document looks like:

```
113         "gunPressure": {
114           "value": 0.0000000373,
115           "unit": "mbar"
116         },
117         "angleToEBeam": {
118           "value": 54,
119           "unit": "degree"
120         }
```

… Automate some steps,
to reduce the manual work

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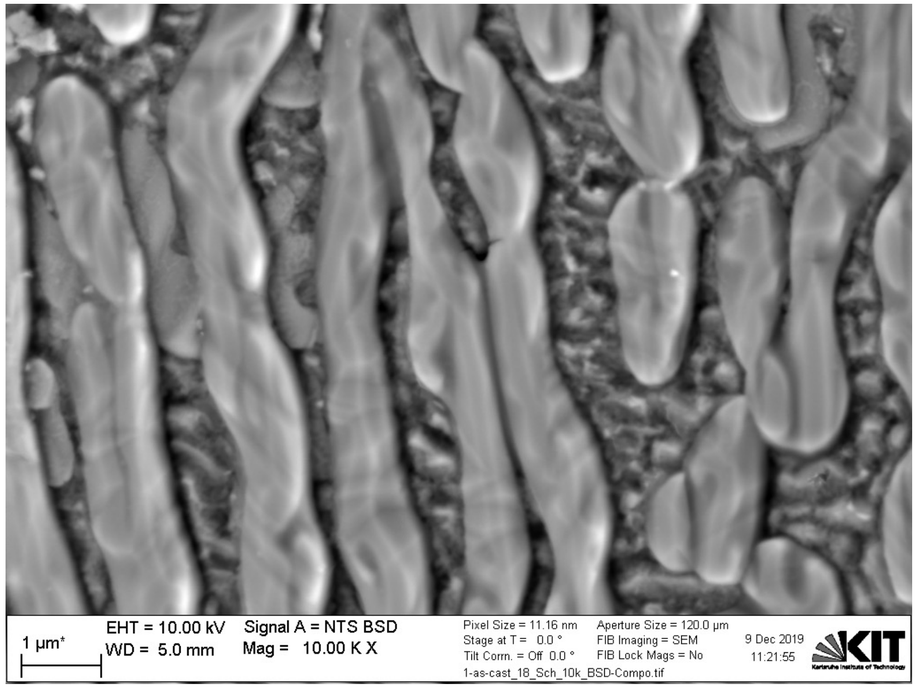
SEM Image: TIFF file from ZEISS



Courtesy of: Sabine Schlabach

```
1455    AP_FIB_STIGMATOR_X
1456    FIB Stig X =  -3.0 %
1457    AP_STAGE_AT_M
1458    Stage at M =  0.100 mm
1459    AP_STAGE_AT_Z
1460    Stage at Z = 36.853 mm
1461    AP_STAGE_AT_Y
1462    Stage at Y = 93.5093 mm
1463    AP_ACTUALCURRENT
1464    Fil I =  2.290 A
1465    AP_STAGE_AT_X
1466    Stage at X = 74.9182 mm
1467    AP_ACTUALKV
1468    EHT = 10.00 kV
1469    AP_STAGE_AT_T
1470    Stage at T =   0.0 °
1471    AP_SAMPLE_AT_Y
1472    Sample at Y = 0.0000
1473    AP_STAGE_AT_R
1474    Stage at R =  15.0 °
```

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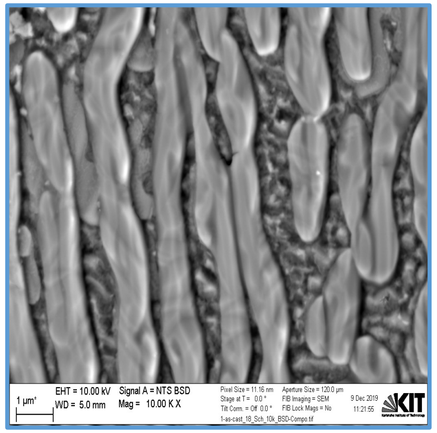
SEM Image: TIFF file from ZEISS




```
1464   Fil I =  2.290 A
1465   AP_STAGE_AT_X
1466   Stage at X = 74.9182 mm
1467   AP_ACTUALKV
1468   EHT = 10.00 kV
1469   AP_STAGE_AT_T
1470   Stage at T =   0.0 
1471   AP_SAMPLE_AT_Y
1472   Sample at Y = 0.0000
1473   AP_STAGE_AT_R
1474   Stage at R =  15.0 
```

?

```
"pressureDetails":{
   "type":"object",
   "description":"(Required) – Descri
   "additionalProperties":false,
   "properties":{
      "value":{
         "type":"number",
         "default":-9999,
         "description":"(Required) –
      },
      "unit":{
         "type":"string",
         "default":"Pa",
```

```
"gunPressure": {
  "value": 0.0000000373,
  "unit": "mbar"
},
"angleToEBeam": {
  "value": 54,
  "unit": "degree"
}
```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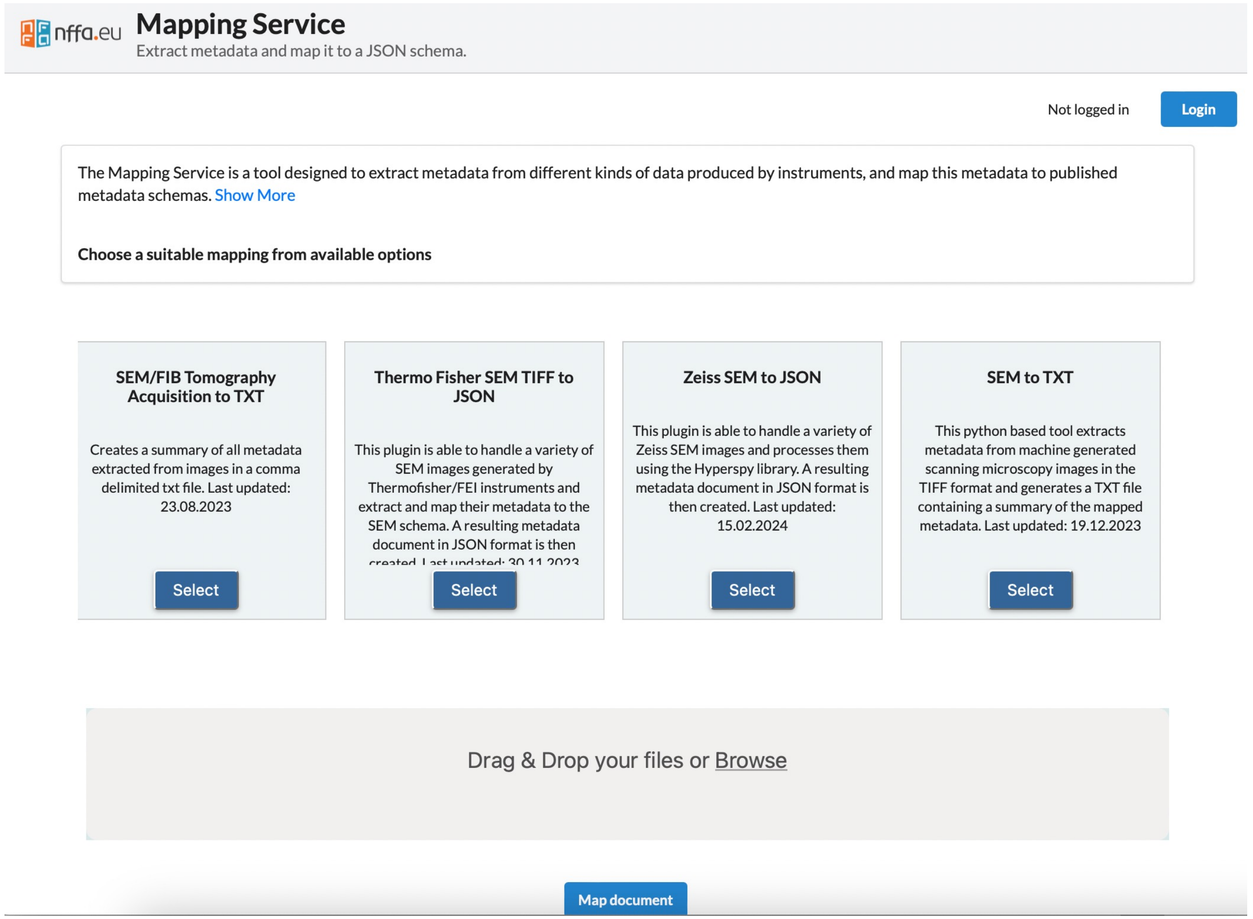
Mapping service



https://metarepo.nffa.eu/frontend/mapping-service-ui.html

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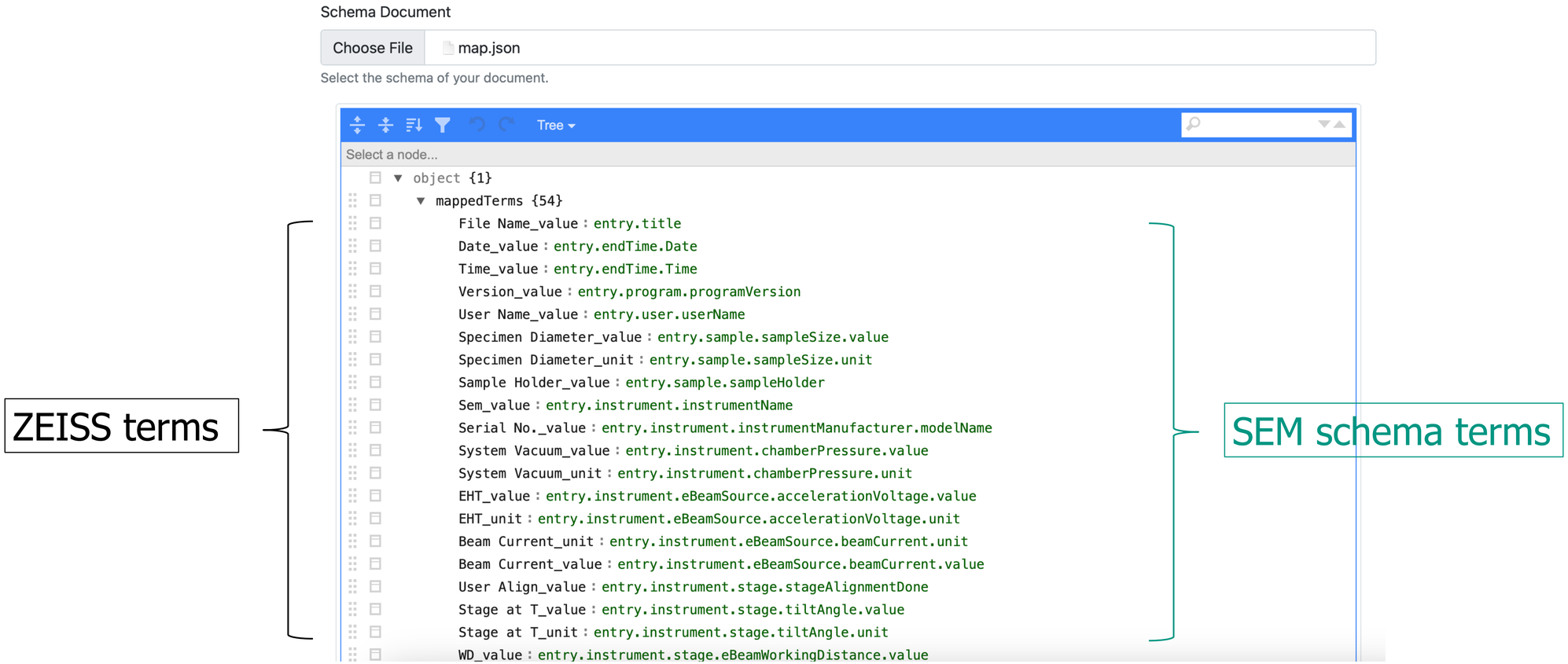
Metadata mapping: zeiss_to_json



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Extract metadata and map them to SEM schema

```
1455    AP_FIB_STIGMATOR_X
1456    FIB Stig X =  -3.0 %
1457    AP_STAGE_AT_M
1458    Stage at M =  0.100 mm
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1474    Stage at R =  15.0 
```

```
113         "gunPressure": {
114           "value": 0.0000000373,
115           "unit": "mbar"
116         },
117         "angleToEBeam": {
118           "value": 54,
119           "unit": "degree"
120         }
```

From md embedded in the TIFF file to **JSON md document**

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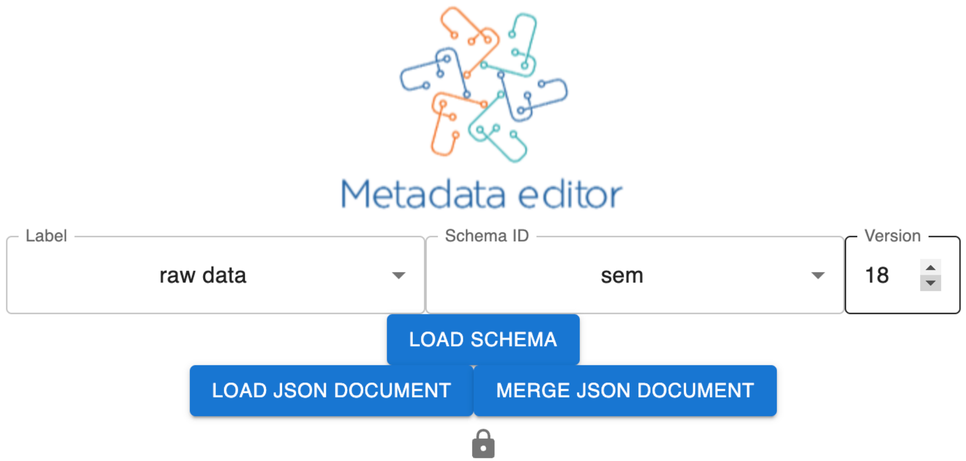
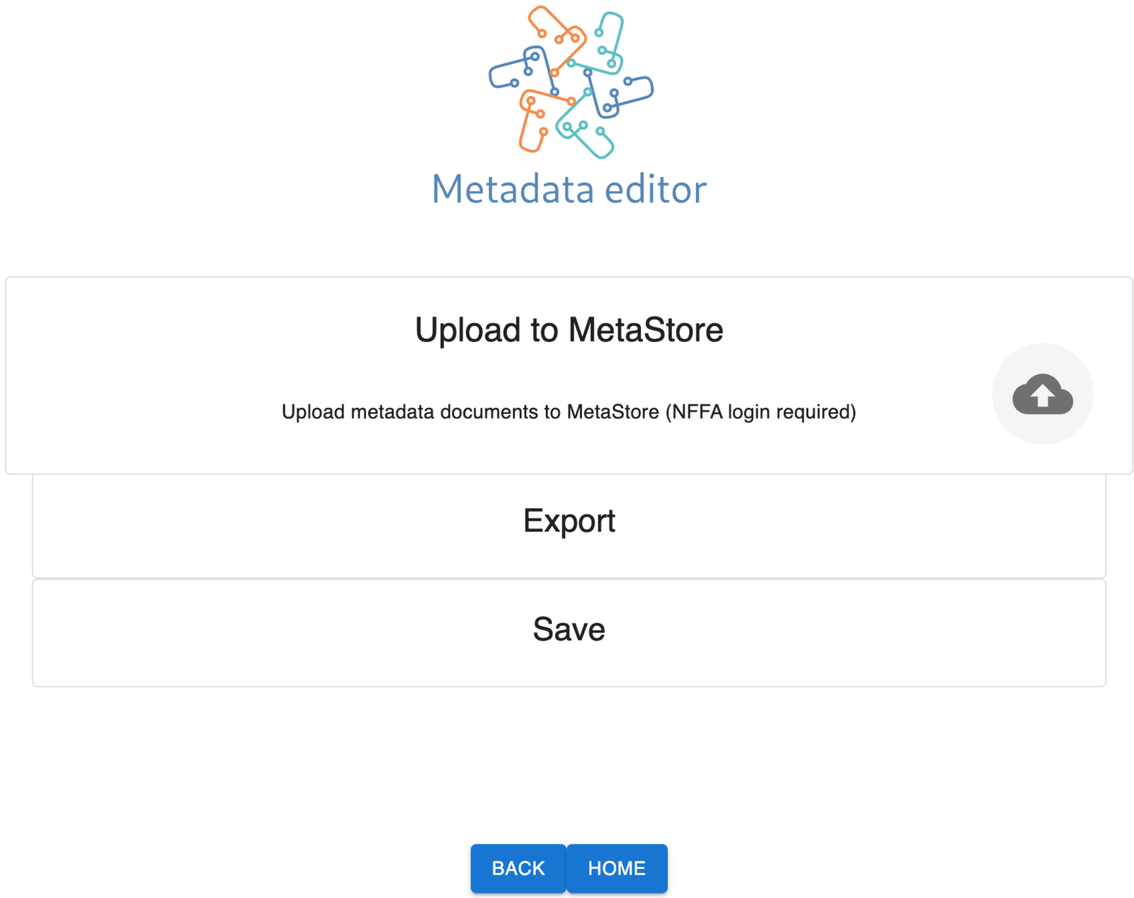
Metadata Editor





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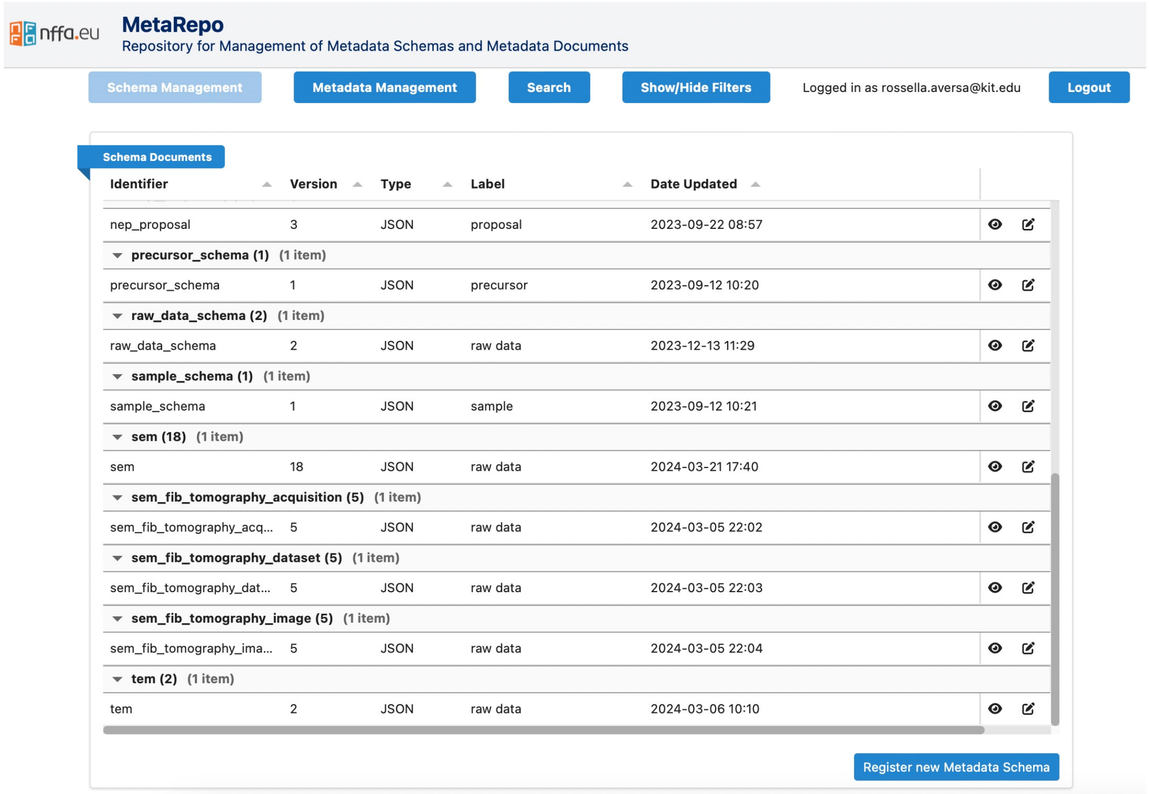
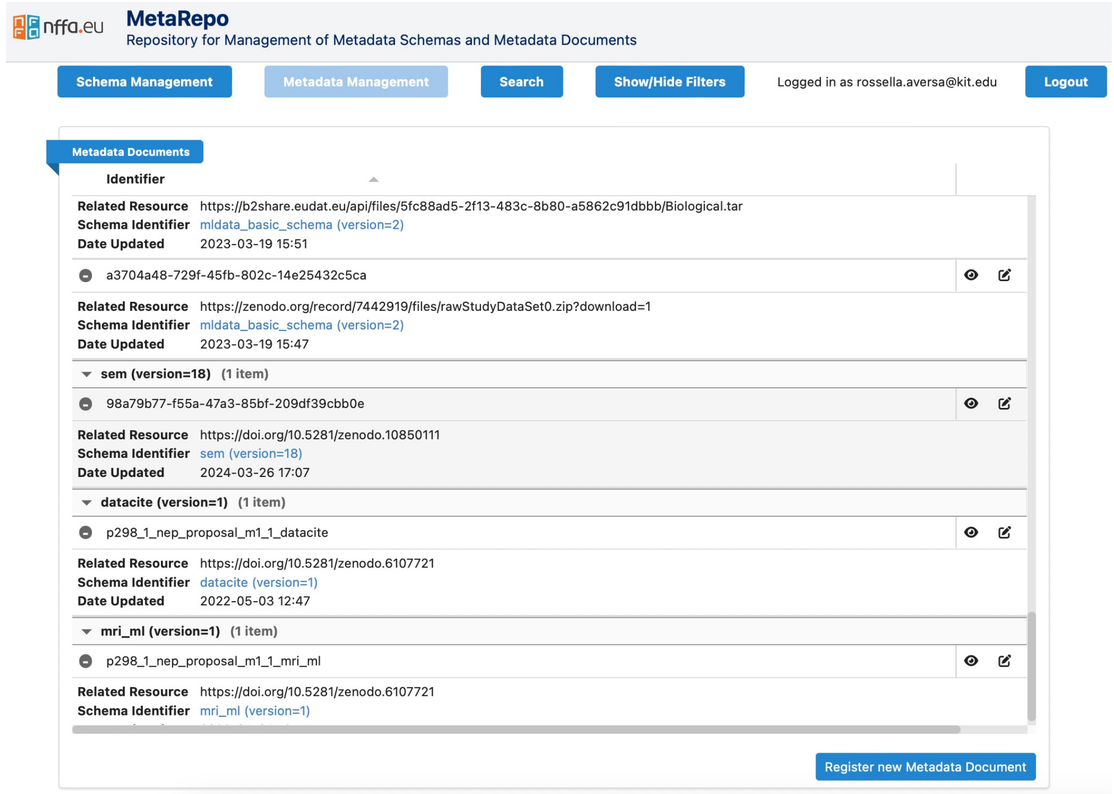
MetaRepo



https://metarepo.nffa.eu/frontend/schema-management.html



https://metarepo.nffa.eu/frontend/metadata-management.html

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MetaRepo

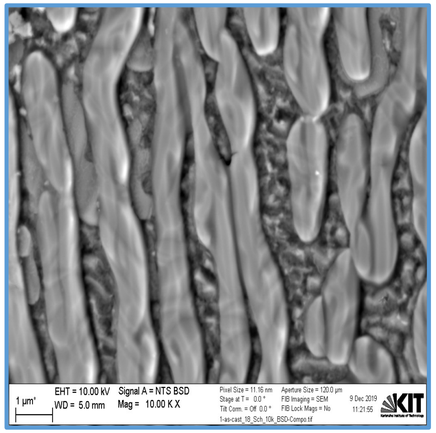
sem (version=18) (1 item)

98a79b77-f55a-47a3-85bf-209df39cbb0e

Related Resource	https://doi.org/10.5281/zenodo.10850111
Schema Identifier	sem (version=18)
Date Updated	2024-03-26 17:07


```
"gunPressure": {
  "value": 0.0000000373,
  "unit": "mbar"
},
"angleToEBeam": {
  "value": 54,
  "unit": "degree"
}
```

```
"pressureDetails":{
   "type":"object",
   "description":"(Required) - Descri
   "additionalProperties":false,
   "properties":{
      "value":{
         "type":"number",
         "default":-9999,
         "description":"(Required) -
      },
      "unit":{
         "type":"string",
         "default":"Pa",
```

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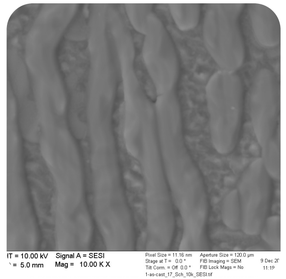
SEM metadata management Workflow

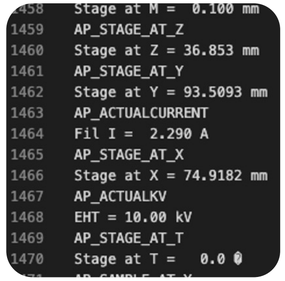
Metadata extraction

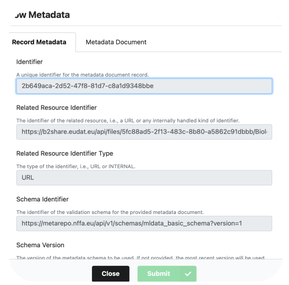
Mapping

Metadata Editor

MetaRepo







TIFF image

Extracted Metadata

Incomplete JSON md document

Complete JSON md document

Complete md record

Related to the image it describes

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Application to a NEP publication

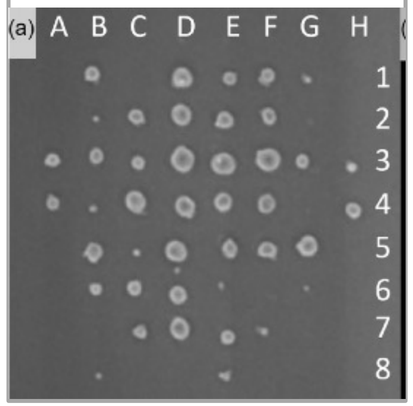
Paper

Coherent x-ray diffraction of a semiregular Pt nanodot array

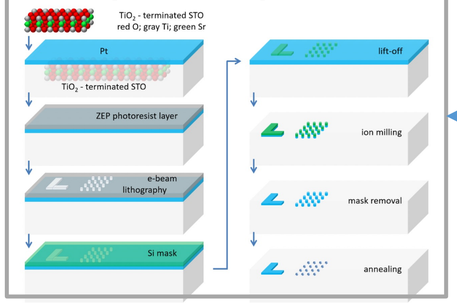
Thomas F. Keller,[1,2,*,†] Roman Shayduk,[3,†] Chan Kim,[3] Nastasia Mukharamova,[1] Arti Dangwal Pandey,[1] Manuel Abuin,[1] Vedran Vonk,[1] Irene Fernandez-Cuesta,[2] Miriam Barthelmess,[4] Robert Frömter,[2,5] Alexey Zozulya,[3] Artur Erbe,[6] and Andreas Stierle[1,2]

[1]*Centre for X-ray and Nano Science (CXNS), Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany*
[2]*University of Hamburg, Department of Physics, Hamburg, Germany*
[3]*European XFEL GmbH, Schenefeld, Germany*
[4]*Center for Free-Electron Laser Science (CFEL), Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany*
[5]*Institute of Physics, Johannes Gutenberg-Universität Mainz, Mainz, Germany*
[6]*Helmholtz Zentrum Dresden Rossendorf, Dresden, Germany*

SEM



Sample Preparation



Zenodo

SEM Metadata Document

```
"measurementPurpose": {
   "measurementPurposeOptions": [
      "correlative characterization
      "high quality measurement (pr
   ]
   {
      "parentType": "sample",
      "parentReferenceType": "MetaStore URI",
      "parentReference": "https://metarepo.nffa.eu/api/
   }
],
```

Sample Metadata Document

```
"samplePurpose": {
   "samplePurposeOptions": [
      "correlative characterization
      "high quality measurement (pre
   ]
"preparationAction": "mechanicalAndSurface",
"mechanicalAndSurface": {
   "mechanicalAndSurfaceMethod": "lithography",
   "comments": "creation of pattern and markers",
   "consumables": [
      "ZEP photoresist"
   ]
```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secretariat@nffa.eu

Slides and material

- https://tinyurl.com/nepsummerschool

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Contact us

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- The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under the National Research Data Infrastructure – NFDI 38/1 – project number 460247524
- The Joint Laboratory Model and Data driven Materials Characterization (JL MDMC), a cross-centre platform of the Helmholtz Association
- NFFA-Europe-Pilot (EU H2020 – n. 101007417)
- The research program “Engineering Digital Futures” of the Helmholtz Association of German Research Centers
- The Helmholtz Metadata Collaboration Platform

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