



# 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:

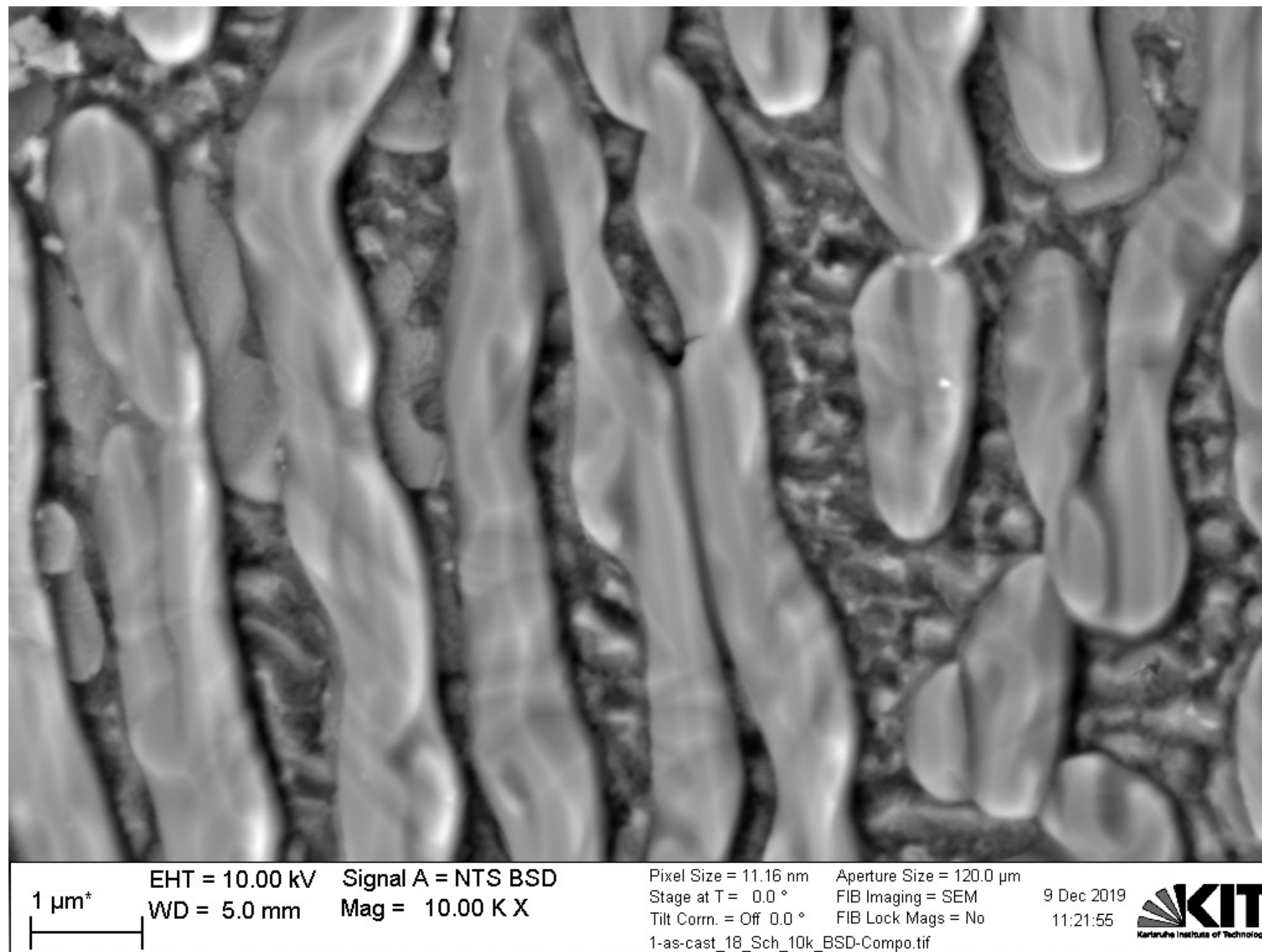
```

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

# SEM Image: TIFF file from ZEISS

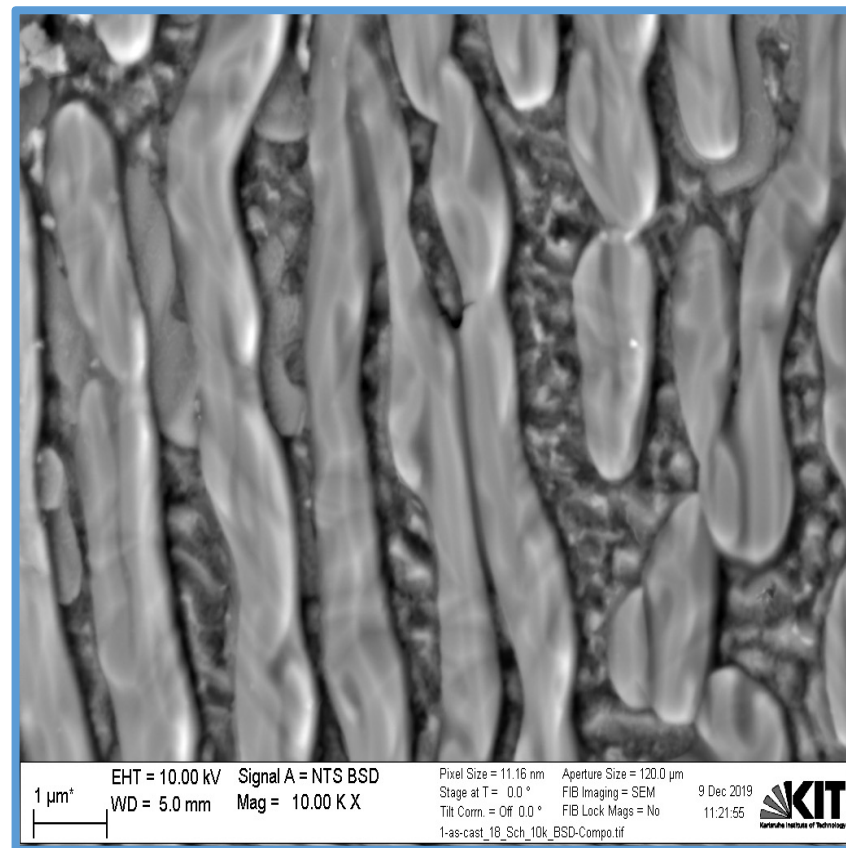


Courtesy of: Sabine Schlabach

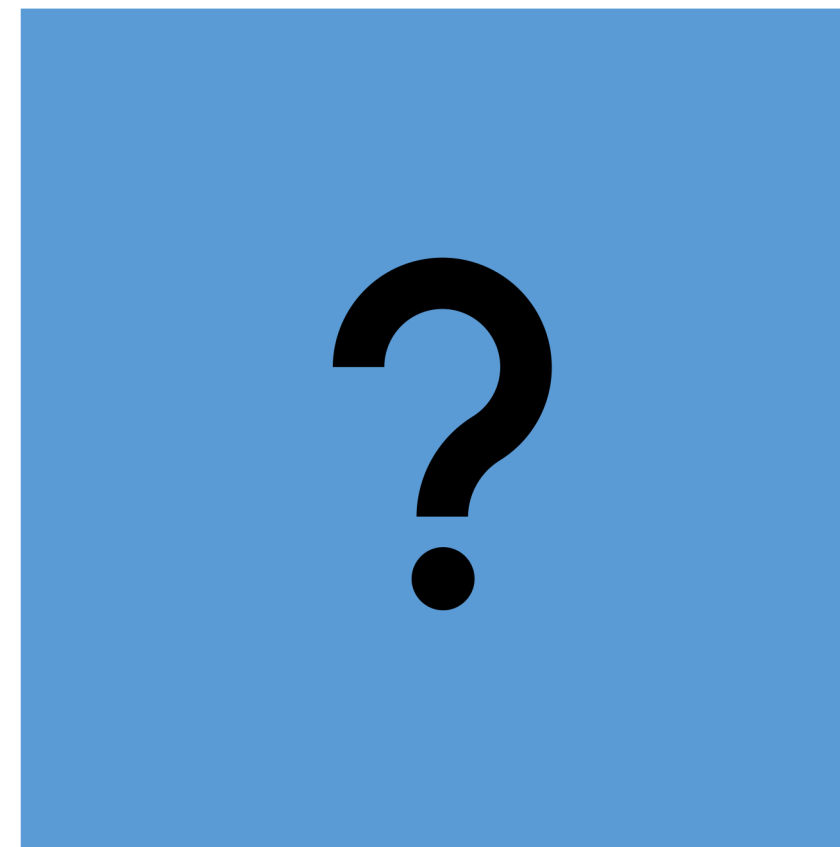
```
1455 AP_FIB_STIGMATOR_X
1456 FIB Stig X = -3.0 %
1457 AP_STAGE_AT_M
1458 Stage at M = 0.100 mm
1459 AP_STAGE_AT_Z
1460 Stage at Z = 36.853 mm
1461 AP_STAGE_AT_Y
1462 Stage at Y = 93.5093 mm
1463 AP_ACTUALCURRENT
1464 Fil I = 2.290 A
1465 AP_STAGE_AT_X
1466 Stage at X = 74.9182 mm
1467 AP_ACTUALKV
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 °
```



# 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"
}
```

# Mapping service

 **Mapping Service**  
Extract metadata and map it to a JSON schema.

Not logged in

Login

The Mapping Service is a tool designed to extract metadata from different kinds of data produced by instruments, and map this metadata to published metadata schemas. [Show More](#)

Choose a suitable mapping from available options

## SEM/FIB Tomography Acquisition to TXT

Creates a summary of all metadata extracted from images in a comma delimited txt file. Last updated: 23.08.2023

Select

## Thermo Fisher SEM TIFF to JSON

This plugin is able to handle a variety of SEM images generated by ThermoFisher/FEI instruments and extract and map their metadata to the SEM schema. A resulting metadata document in JSON format is then created. Last updated: 30.11.2023

Select

## Zeiss SEM to JSON

This plugin is able to handle a variety of Zeiss SEM images and processes them using the Hyperspy library. A resulting metadata document in JSON format is then created. Last updated: 15.02.2024

Select

## SEM to TXT

This python based tool extracts metadata from machine generated scanning microscopy images in the TIFF format and generates a TXT file containing a summary of the mapped metadata. Last updated: 19.12.2023

Select


Drag & Drop your files or [Browse](#)

Map document

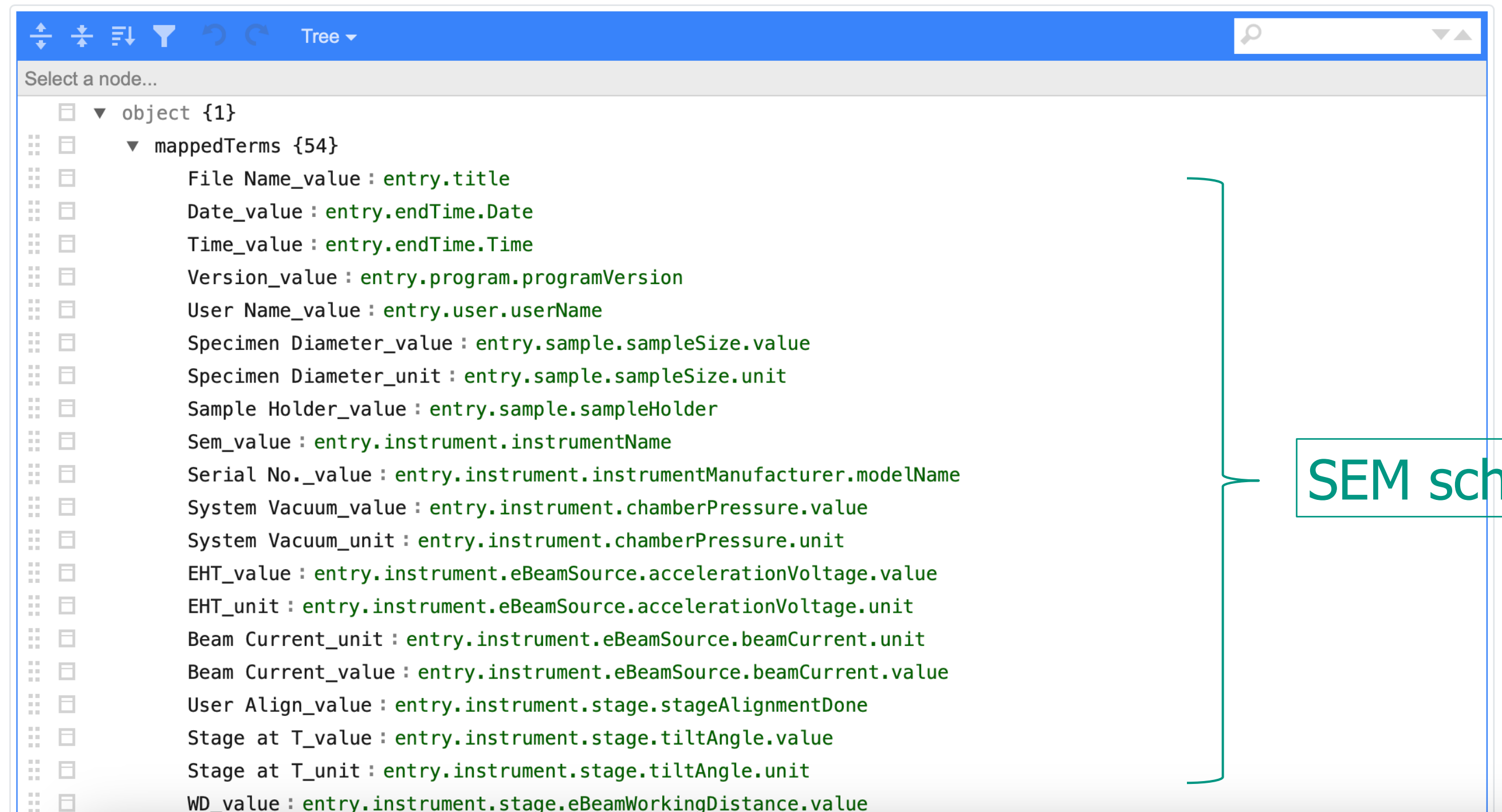
<https://metarepo.nffa.eu/frontend/mapping-service-ui.html>

# Metadata mapping: zeiss\_to\_json

Schema Document

Choose File  map.json

Select the schema of your document.



The screenshot shows a tree view of a JSON document. The root node is 'object {1}', which contains a 'mappedTerms {54}' object. This object lists 54 mappings between ZEISS terms (left) and SEM schema terms (right). The mappings are as follows:

- File Name\_value : entry.title
- Date\_value : entry.endTime.Date
- Time\_value : entry.endTime.Time
- Version\_value : entry.program.programVersion
- User Name\_value : entry.user.userName
- Specimen Diameter\_value : entry.sample.sampleSize.value
- Specimen Diameter\_unit : entry.sample.sampleSize.unit
- Sample Holder\_value : entry.sample.sampleHolder
- Sem\_value : entry.instrument.instrumentName
- Serial No.\_value : entry.instrument.instrumentManufacturer.modelName
- System Vacuum\_value : entry.instrument.chamberPressure.value
- System Vacuum\_unit : entry.instrument.chamberPressure.unit
- EHT\_value : entry.instrument.eBeamSource.accelerationVoltage.value
- EHT\_unit : entry.instrument.eBeamSource.accelerationVoltage.unit
- Beam Current\_unit : entry.instrument.eBeamSource.beamCurrent.unit
- Beam Current\_value : entry.instrument.eBeamSource.beamCurrent.value
- User Align\_value : entry.instrument.stage.stageAlignmentDone
- Stage at T\_value : entry.instrument.stage.tiltAngle.value
- Stage at T\_unit : entry.instrument.stage.tiltAngle.unit
- WD\_value : entry.instrument.stage.eBeamWorkingDistance.value

ZEISS terms

SEM schema terms



# 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
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 0
1471 AP_SAMPLE_AT_Y
1472 Sample at Y = 0.0000
1473 AP_STAGE_AT_R
1474 Stage at R = 15.0 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**

# Metadata Editor



Metadata editor

Label: raw data    Schema ID: sem    Version: 18

LOAD SCHEMA

LOAD JSON DOCUMENT

MERGE JSON DOCUMENT



Entry

Technique\*

High Resolution Field Emission Scanning Electron Microscopy

Measurement Purpose

Measurement Description

Secondary Electron (SE) mode

Equipment

Through-Lens Detector (TLD)



Metadata editor

Upload to MetaStore

Upload metadata documents to MetaStore (NFFA login required)



Export

Save

BACK

HOME



# MetaRepo

nffa.eu **MetaRepo**  
Repository for Management of Metadata Schemas and Metadata Documents

Schema Management | Metadata Management | Search | Show/Hide Filters | Logged in as rossella.aversa@kit.edu | Logout

Schema Documents

Identifier	Version	Type	Label	Date Updated	
nep_proposal	3	JSON	proposal	2023-09-22 08:57	
▼ precursor_schema (1) (1 item)					
precursor_schema	1	JSON	precursor	2023-09-12 10:20	
▼ raw_data_schema (2) (1 item)					
raw_data_schema	2	JSON	raw data	2023-12-13 11:29	
▼ sample_schema (1) (1 item)					
sample_schema	1	JSON	sample	2023-09-12 10:21	
▼ sem (18) (1 item)					
sem	18	JSON	raw data	2024-03-21 17:40	
▼ sem_fib_tomography_acquisition (5) (1 item)					
sem_fib_tomography_acq...	5	JSON	raw data	2024-03-05 22:02	
▼ sem_fib_tomography_dataset (5) (1 item)					
sem_fib_tomography_dat...	5	JSON	raw data	2024-03-05 22:03	
▼ sem_fib_tomography_image (5) (1 item)					
sem_fib_tomography_ima...	5	JSON	raw data	2024-03-05 22:04	
▼ tem (2) (1 item)					
tem	2	JSON	raw data	2024-03-06 10:10	

[Register new Metadata Schema](#)

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

nffa.eu **MetaRepo**  
Repository for Management of Metadata Schemas and Metadata Documents

Schema Management | Metadata Management | Search | Show/Hide Filters | Logged in as rossella.aversa@kit.edu | Logout

Metadata Documents

<b>Identifier</b>	
<b>Related Resource</b>	<a href="https://b2share.eudat.eu/api/files/5fc88ad5-2f13-483c-8b80-a5862c91dbbb/Biological.tar">https://b2share.eudat.eu/api/files/5fc88ad5-2f13-483c-8b80-a5862c91dbbb/Biological.tar</a>
<b>Schema Identifier</b>	<a href="#">mldata_basic_schema (version=2)</a>
<b>Date Updated</b>	2023-03-19 15:51
	a3704a48-729f-45fb-802c-14e25432c5ca
<b>Related Resource</b>	<a href="https://zenodo.org/record/7442919/files/rawStudyDataSet0.zip?download=1">https://zenodo.org/record/7442919/files/rawStudyDataSet0.zip?download=1</a>
<b>Schema Identifier</b>	<a href="#">mldata_basic_schema (version=2)</a>
<b>Date Updated</b>	2023-03-19 15:47
▼ sem (version=18) (1 item)	
	98a79b77-f55a-47a3-85bf-209df39cbb0e
<b>Related Resource</b>	<a href="https://doi.org/10.5281/zenodo.10850111">https://doi.org/10.5281/zenodo.10850111</a>
<b>Schema Identifier</b>	<a href="#">sem (version=18)</a>
<b>Date Updated</b>	2024-03-26 17:07
▼ datacite (version=1) (1 item)	
	p298_1_nep_proposal_m1_1_datacite
<b>Related Resource</b>	<a href="https://doi.org/10.5281/zenodo.6107721">https://doi.org/10.5281/zenodo.6107721</a>
<b>Schema Identifier</b>	<a href="#">datacite (version=1)</a>
<b>Date Updated</b>	2022-05-03 12:47
▼ mri_ml (version=1) (1 item)	
	p298_1_nep_proposal_m1_1_mri_ml
<b>Related Resource</b>	<a href="https://doi.org/10.5281/zenodo.6107721">https://doi.org/10.5281/zenodo.6107721</a>
<b>Schema Identifier</b>	<a href="#">mri_ml (version=1)</a>

[Register new Metadata Document](#)

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

# MetaRepo

▼ sem (version=18) (1 item)

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

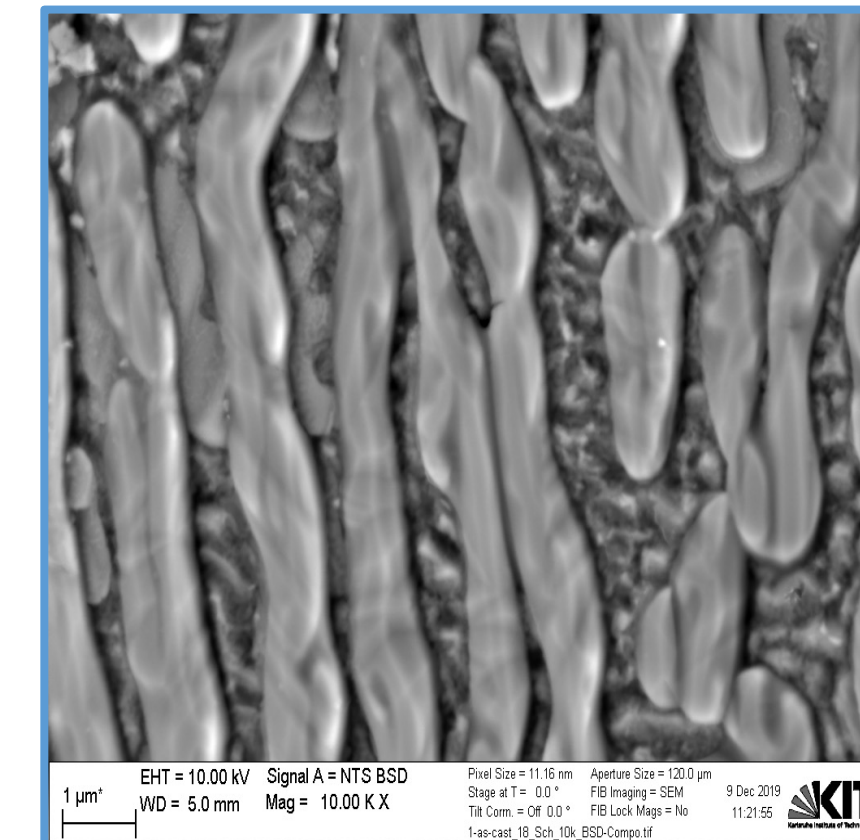
Related Resource <https://doi.org/10.5281/zenodo.10850111>

Schema Identifier [sem \(version=18\)](#)

Date Updated 2024-03-26 17:07

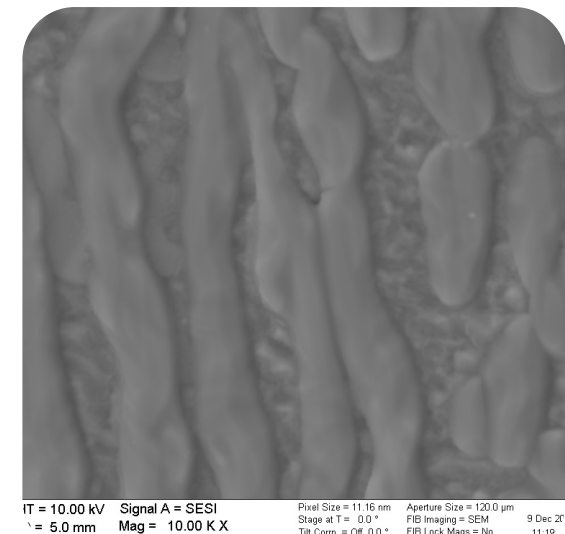
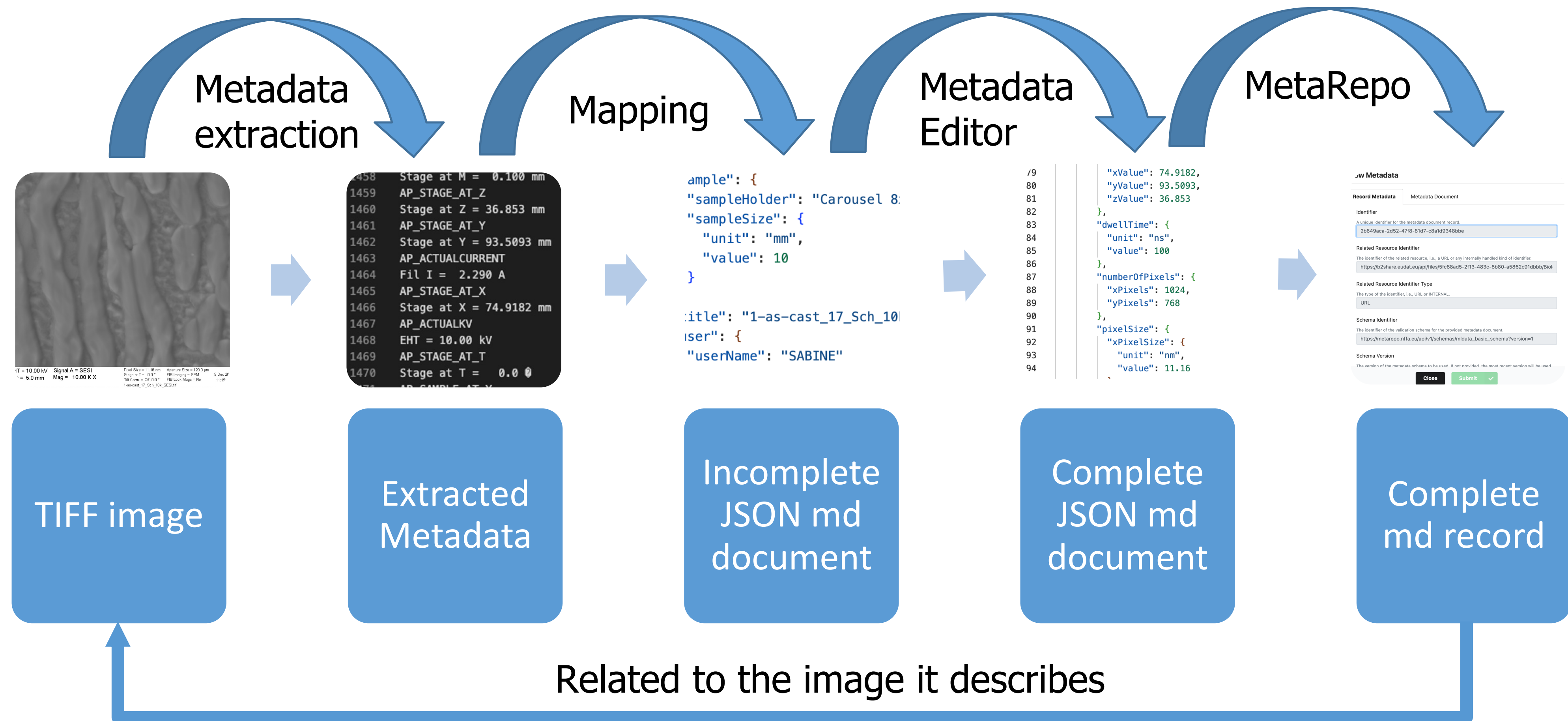
```
"gunPressure": {
  "value": 0.0000000373,
  "unit": "mbar"
},
"angleToEBeam": {
  "value": 54,
  "unit": "degree"
}
```

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





# SEM metadata management Workflow



```

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
  
```

```

"ample": {
  "sampleHolder": "Carousel 8:
  "sampleSize": {
    "unit": "mm",
    "value": 10
  }
}
:title": "1-as-cast_17_Sch_10
:iser": {
  "userName": "SABINE"
}
  
```

```

/9
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
"xValue": 74.9182,
"yValue": 93.5093,
"zValue": 36.853
},
"dwellTime": {
  "unit": "ns",
  "value": 100
},
"numberOfPixels": {
  "xPixels": 1024,
  "yPixels": 768
},
"pixelSize": {
  "xPixelSize": {
    "unit": "nm",
    "value": 11.16
  }
}
  
```

**MetaRepo**

Record Metadata Metadata Document

Identifier  
A unique identifier for the metadata document record.

Related Resource Identifier  
The identifier of the related resource, i.e., a URL or any internally handled kind of identifier.

Related Resource Identifier Type  
The type of the identifier, i.e., URL or INTERNAL.

Schema Identifier  
The identifier of the validation schema for the provided metadata document.

Schema Version  
The version of the metadata schema to be used. If not provided, the most recent version will be used.



# Application to a NEP publication

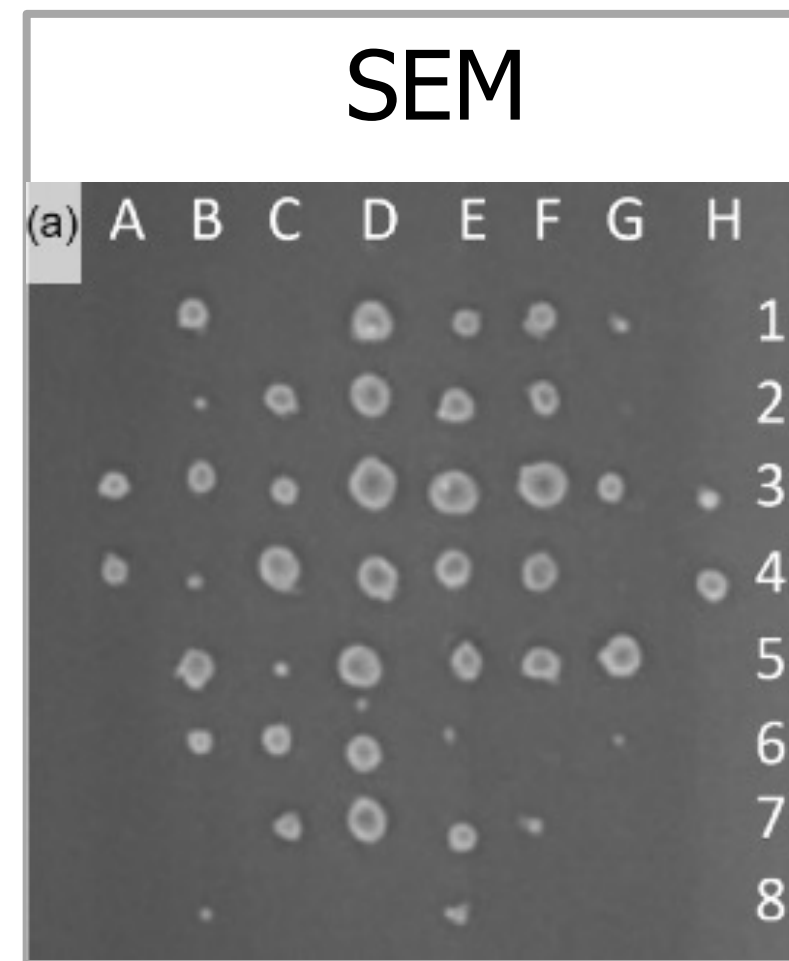
## Paper

### Coherent x-ray diffraction of a semiregular Pt nanodot array

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

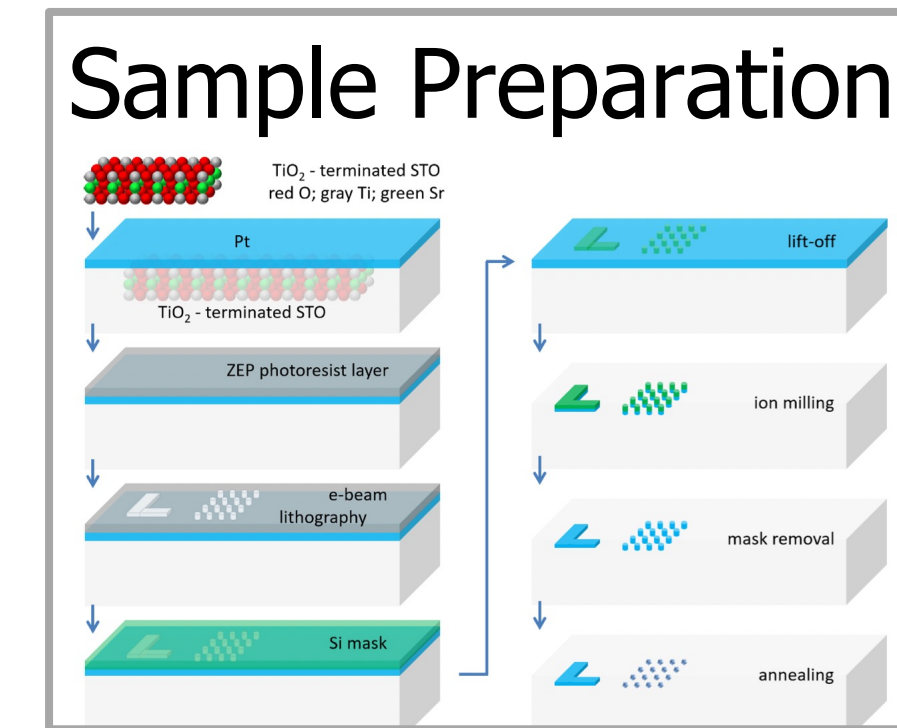
<sup>1</sup>Centre for X-ray and Nano Science (CXNS), Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany  
<sup>2</sup>University of Hamburg, Department of Physics, Hamburg, Germany  
<sup>3</sup>European XFEL GmbH, Schenefeld, Germany  
<sup>4</sup>Center for Free-Electron Laser Science (CFEL),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

## SEM



## Zenodo

## Sample Preparation



## SEM Metadata Document

```

"measurementPurpose": {
  "measurementPurposeOptions": [
    "correlative characterization",
    "high quality measurement (pre
  ]
}
{
  "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"
  ]
}

```

# Slides and material

- <https://tinyurl.com/nepsummerschool>





# Contact us

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- 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