



NFDI4  
BIOIMAGE

# Recommended Metadata for Biological Images

and how we use REMBI at CAi

Vanessa Fuchs and Tom Boissonnet

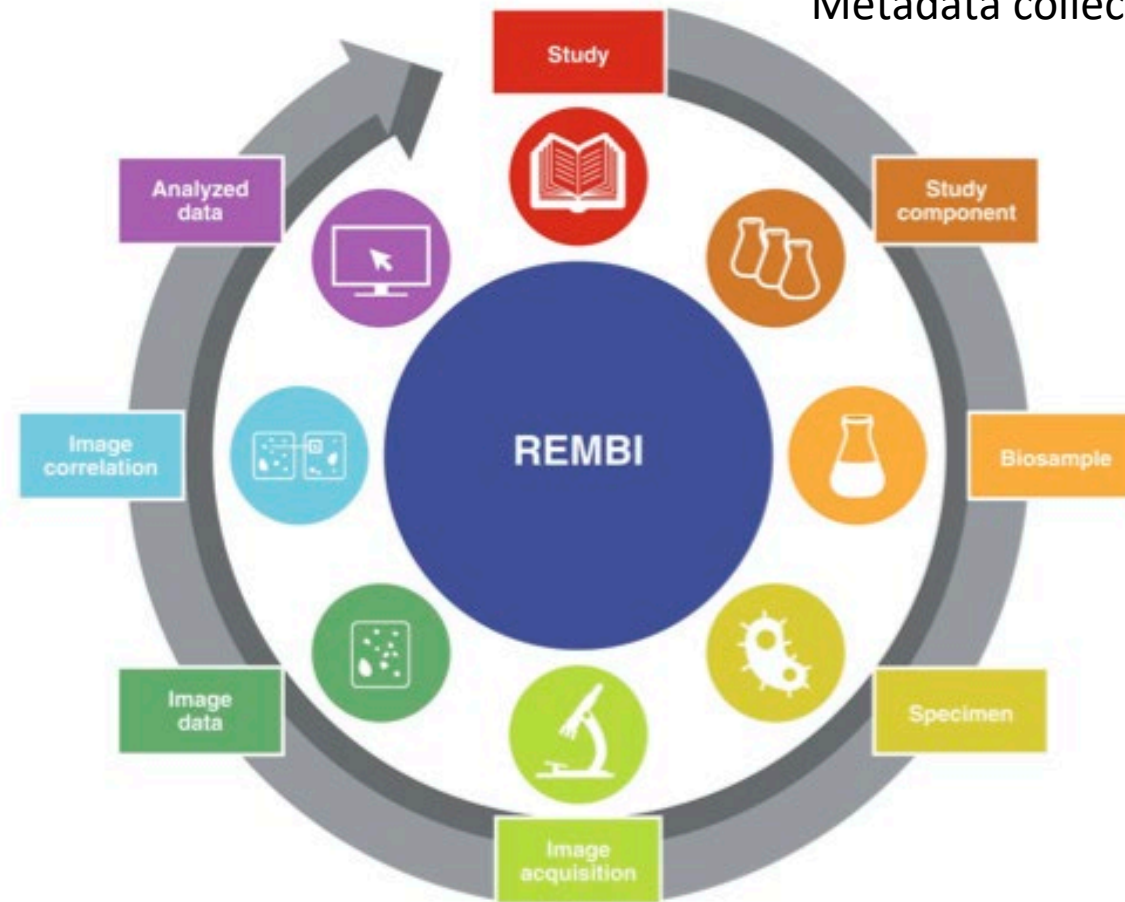
Center for Advanced Imaging (CAi) at HHU Düsseldorf



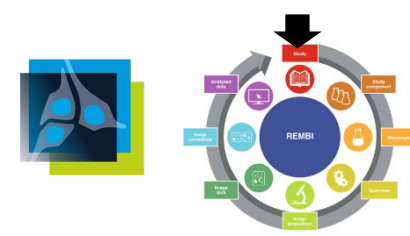
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# REMBI provides guidelines for metadata for biological images

Metadata collected in 8 containers/modules



# REMBI module 1: Study



“Study is the highest level metadata, describing your project, including funding and publications.”

Study			
(contains 1 or more)	Study type	Type of the overall study, which may include	text, ontology
	Study description	Study description, e.g., title of published paper	text
	General dataset info	Authors, publications, licenses etc	misc.

Recommendation by I3D:bio:



Key-Value pairs in OMERO at the “Project”-level:

The screenshot shows the OMERO web interface. On the left, a tree view lists images under the project 'nanodomains at RHID'. The main panel displays the 'General' tab for this project, showing details like Project ID (5363), Owner (Vanessa Fuchs), and a list of Key-Value pairs. The 'REMBI Annotations' section is also visible, showing the study type and description.

Data acquired in the lab of Prof. Grossmann  
<https://www.icib.hhu.de/>

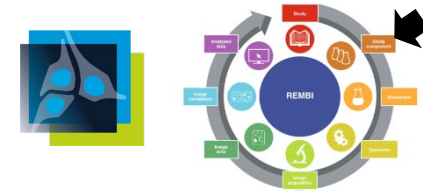
I3D:bio project: <https://www.i3dbio.de/>

Original publication: <https://doi.org/10.1038/s41592-021-01166-8>

<https://www.ebi.ac.uk/bioimage-archive/rembi-help-overview/>



# REMBI module 2: Study component



**Study Component** acts as a container that helps you organise your data, based on experiment types or samples etc. A Study Component contains one or more of the following components: biosample, specimen, image acquisition, image correlation, image analysis (latter two are only required if relevant).

## Study component

(contains Image data	Imaging method	Technique used to acquire image data	ontology
	Study component description	Description specific to this image dataset	text

Recommendation by I3D:bio:



One per Dataset (Key-Value Pairs in OMERO at the Dataset-level)

I3D:bio project: <https://www.i3dbio.de/>

Original publication: <https://doi.org/10.1038/s41592-021-01166-8>

<https://www.ebi.ac.uk/bioimage-archive/rembi-help-overview/>





# REMBI module 3: Biosample

**Biosample** is about what it is you have imaged, for example, the species of the organism that you're imaging, if you're using a particular cell line, genetic background etc.

## Biosample

Identity	Internal unique ID	
Biological entity	What is being imaged	text and/or ontology entry (multiple possible)
Organism	Species (multiple possible)	taxonomy
Intrinsic variable	Intrinsic (e.g. genetic) alteration if applicable	text and/or ontology entry (multiple possible)
Extrinsic variable	External biosample treatment (e.g. reagent) if applicable	text and/or ontology entry (multiple possible) or associated file
Experimental variables	What is intentionally varied (e.g. time) between multiple entries in this study component	text and/or ontology entry (multiple possible)

Recommendation by I3D:bio:



I3D:bio

One per Dataset (Key-Value Pairs in OMERO at the Dataset-level)

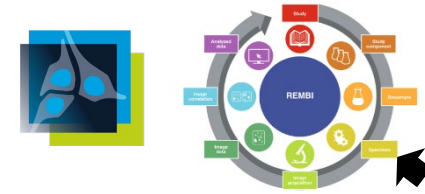
I3D:bio project: <https://www.i3dbio.de/>

Original publication: <https://doi.org/10.1038/s41592-021-01166-8>

<https://www.ebi.ac.uk/bioimage-archive/rembi-help-overview/>



# REMBI module 4: Specimen



**Specimen** metadata describes how your sample was prepared for imaging.

<b>Specimen</b> (linked to Biosample)			
Experimental status	Test/ control		
Location within Biosample	Plate/dish coordinate or tissue location		text or associated file
Preparation method	Sample preparation protocol		text, file, ontology, or widget for specific method types
Signal/contrast mechanism	How is the signal generated by this sample		text, ontology
Channel - content	Specific specimen staining (e.g. IEM, DAB)		text
Channel - biological entity	What molecule is stained		text, ontology entries



Recommendation by I3D:bio:

One per Dataset (Key-Value Pairs in OMERO at the Dataset-level)

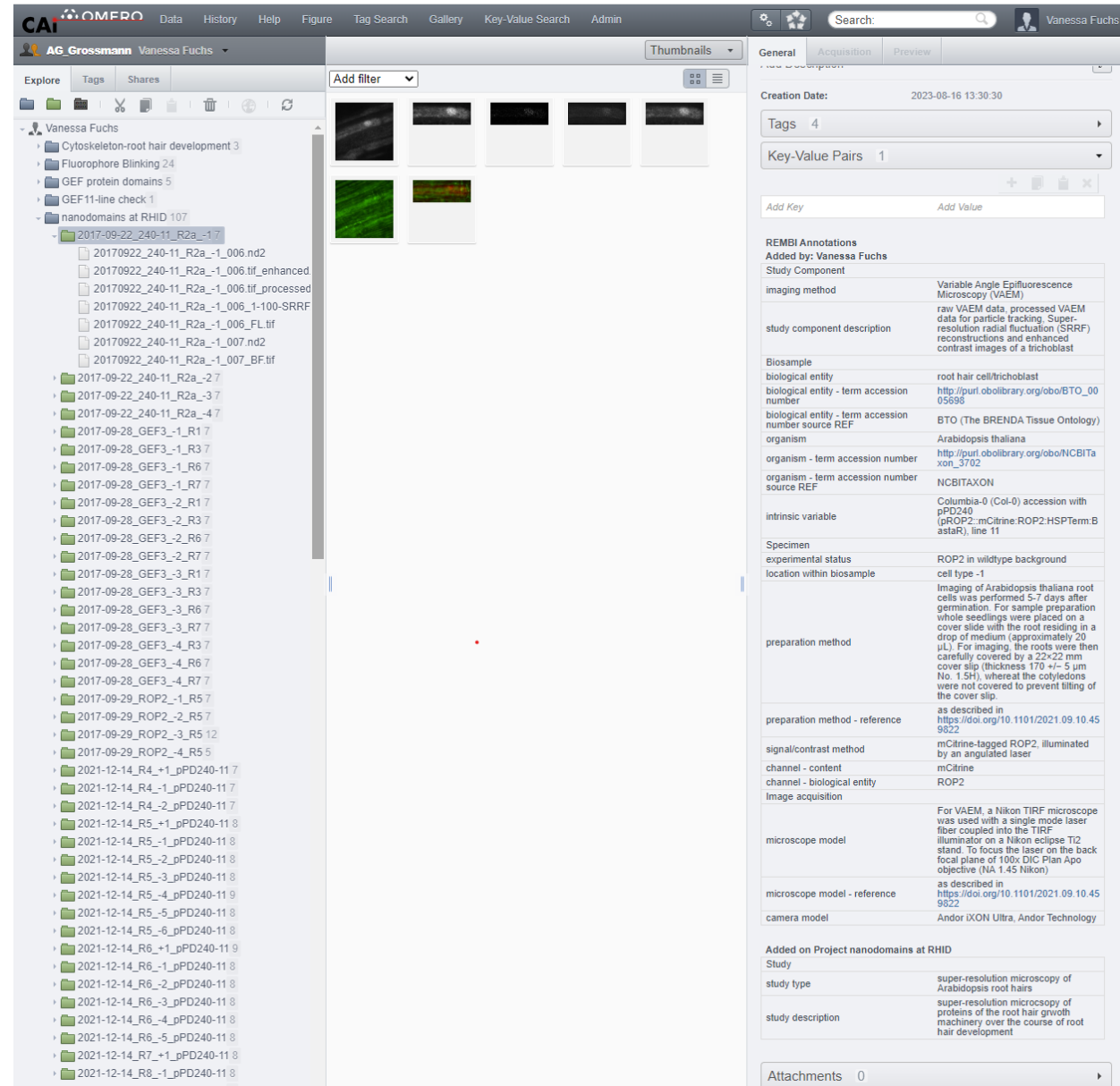
I3D:bio project: <https://www.i3dbio.de/>

Original publication: <https://doi.org/10.1038/s41592-021-01166-8>

<https://www.ebi.ac.uk/bioimage-archive/rembi-help-overview/>



# REMBI at CAi



The screenshot displays the CAi OMERO web interface. On the left, a file explorer shows a hierarchical structure of datasets under 'Vanessa Fuchs', including folders like 'Cytoskeleton-root hair development 3' and 'nanodomains at RHID 107'. The central area shows a grid of image thumbnails. The right panel provides detailed metadata for a selected dataset, including creation date, tags, key-value pairs, and REMBI annotations.

**REMBI Annotations**  
Added by: Vanessa Fuchs

Study Component	Variable Angle Epifluorescence Microscopy (VAEM)
imaging method	raw VAEM data, processed VAEM data for particle tracking, Super-resolution radial fluctuation (SRRF) reconstructions and enhanced contrast images of a trichoblast
study component description	
Biosample	
biological entity	root hair cell/trichoblast
biological entity - term accession number	<a href="http://purl.obolibrary.org/obo/BTO_0005695">http://purl.obolibrary.org/obo/BTO_0005695</a>
biological entity - term accession number source REF	BTO (The BRENDA Tissue Ontology)
organism	Arabidopsis thaliana
organism - term accession number	<a href="http://purl.obolibrary.org/obo/NCBITaxon_3702">http://purl.obolibrary.org/obo/NCBITaxon_3702</a>
organism - term accession number source REF	NCBITAXON
intrinsic variable	Columbia-0 (Col-0) accession with pPD240 (pROP2::mCitrine:ROP2:HSPTerm:BastaR), line 11
Specimen	
experimental status	ROP2 in wildtype background
location within biosample	cell type -1
preparation method	Imaging of Arabidopsis thaliana root cells was performed 5-7 days after germination. For sample preparation whole seedlings were placed on a cover slide with the root residing in a drop of medium (approximately 20 µL). For imaging, the roots were then carefully covered by a 22x22 mm cover slip (thickness 170 µm ± 5 µm No. 1.5H), whereas the cotyledons were not covered to prevent tilting of the cover slip.
preparation method - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
signal/contrast method	mCitrine-tagged ROP2, illuminated by an angulated laser
channel - content	mCitrine
channel - biological entity	ROP2
Image acquisition	
microscope model	For VAEM, a Nikon TIRF microscope was used with a single mode laser fiber coupled into the TIRF illuminator on a Nikon eclipse Ti2 stand. To focus the laser on the back focal plane of 100x DIC Plan Apo objective (NA 1.45 Nikon)
microscope model - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
camera model	Andor IXON Ultra, Andor Technology

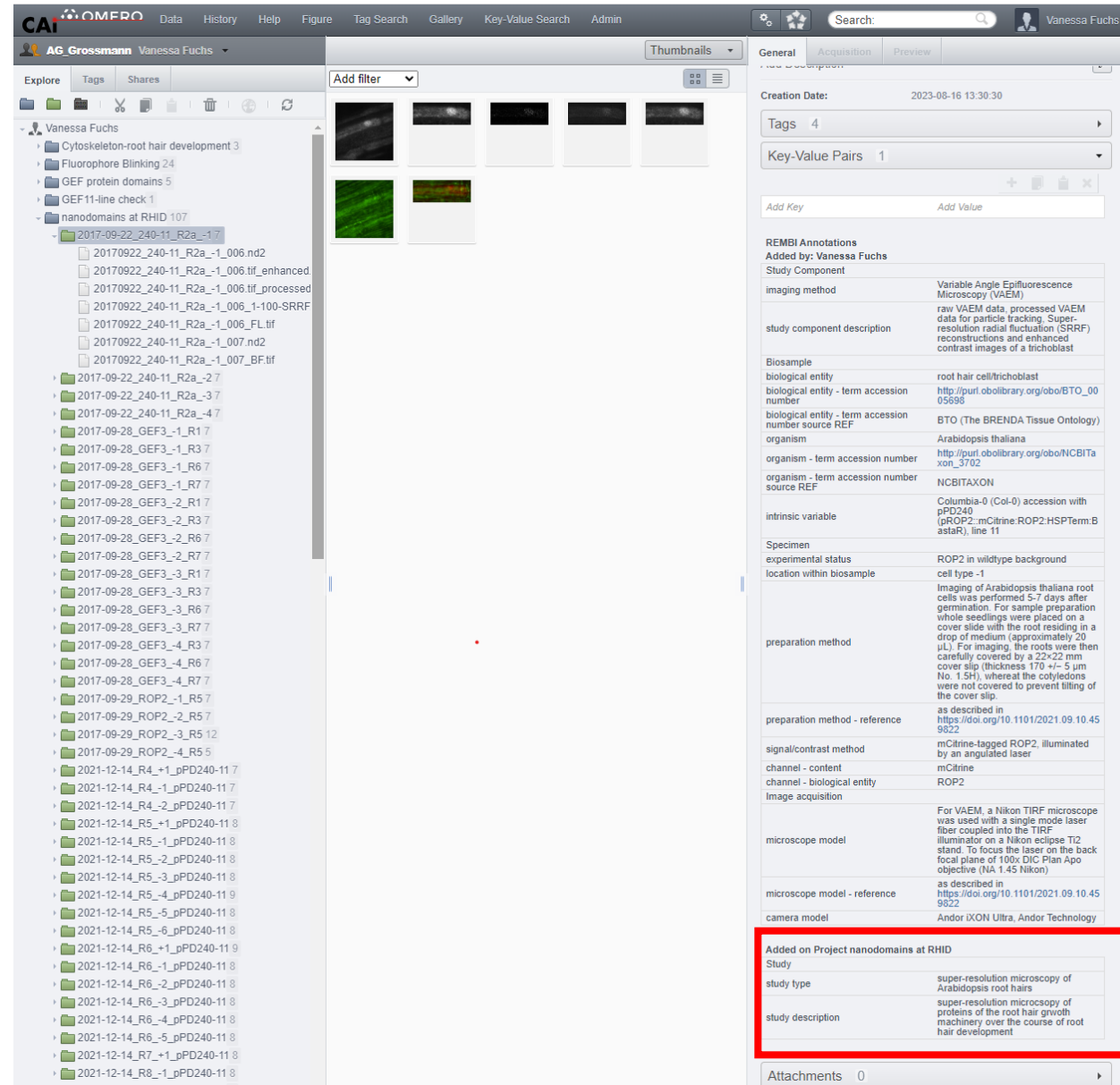
Added on Project nanodomains at RHID

Study	
study type	super-resolution microscopy of Arabidopsis root hairs
study description	super-resolution microscopy of proteins of the root hair growth machinery over the course of root hair development

Attachments 0



# REMBI at CAi



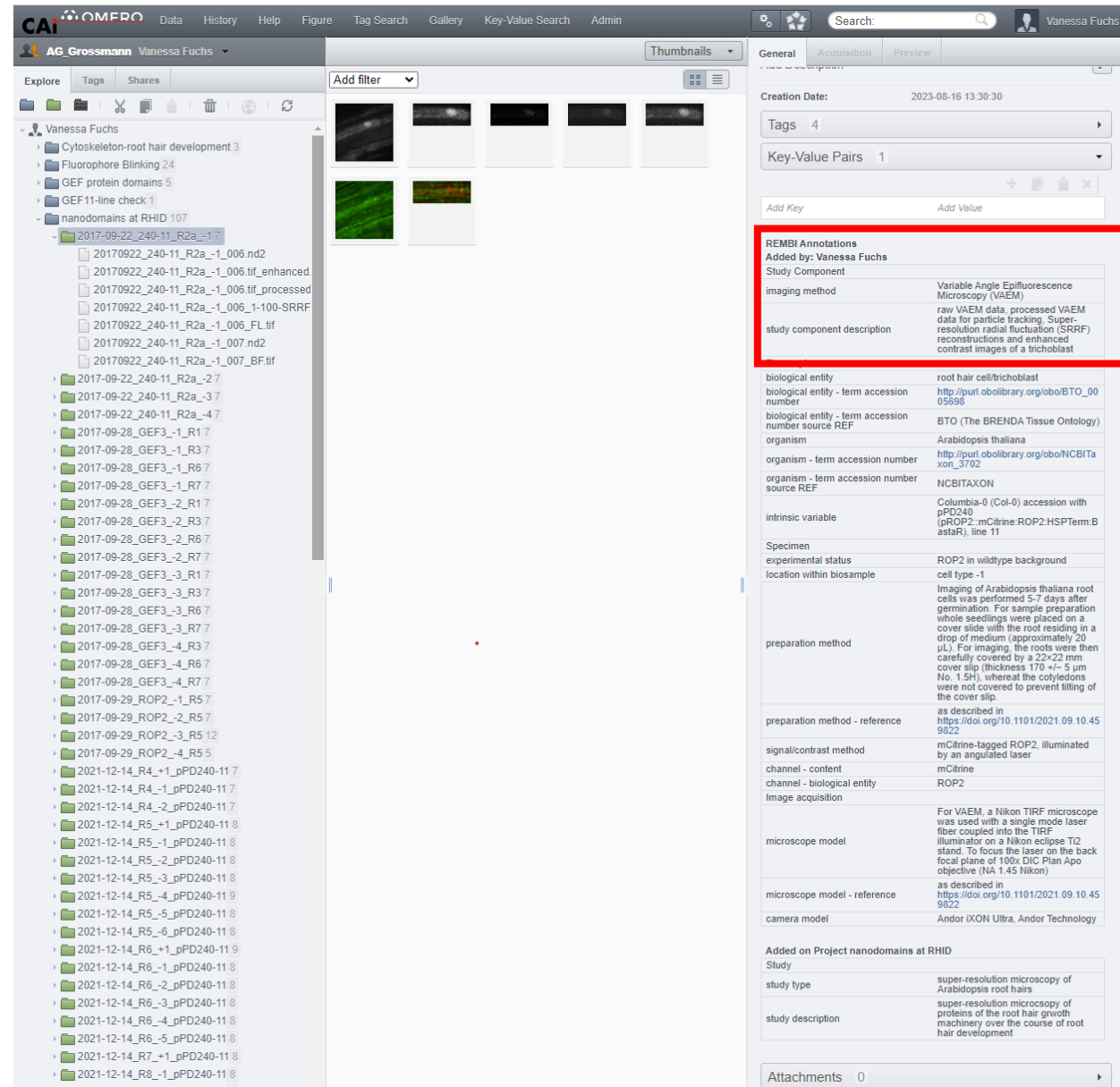
The screenshot displays the CAi OMERO web interface. On the left, a file explorer shows a project structure under 'Vanessa Fuchs' with various folders and files related to nanodomains at RHID. The central area shows a grid of image thumbnails. The right-hand panel contains metadata and REMBI annotations. The REMBI annotations section is highlighted with a red box and contains the following information:

Added on Project nanodomains at RHID	
Study	
study type	super-resolution microscopy of Arabidopsis root hairs
study description	super-resolution microscopy of proteins of the root hair growth machinery over the course of root hair development

Module1: Study –  
project level



# REMBI at CAi

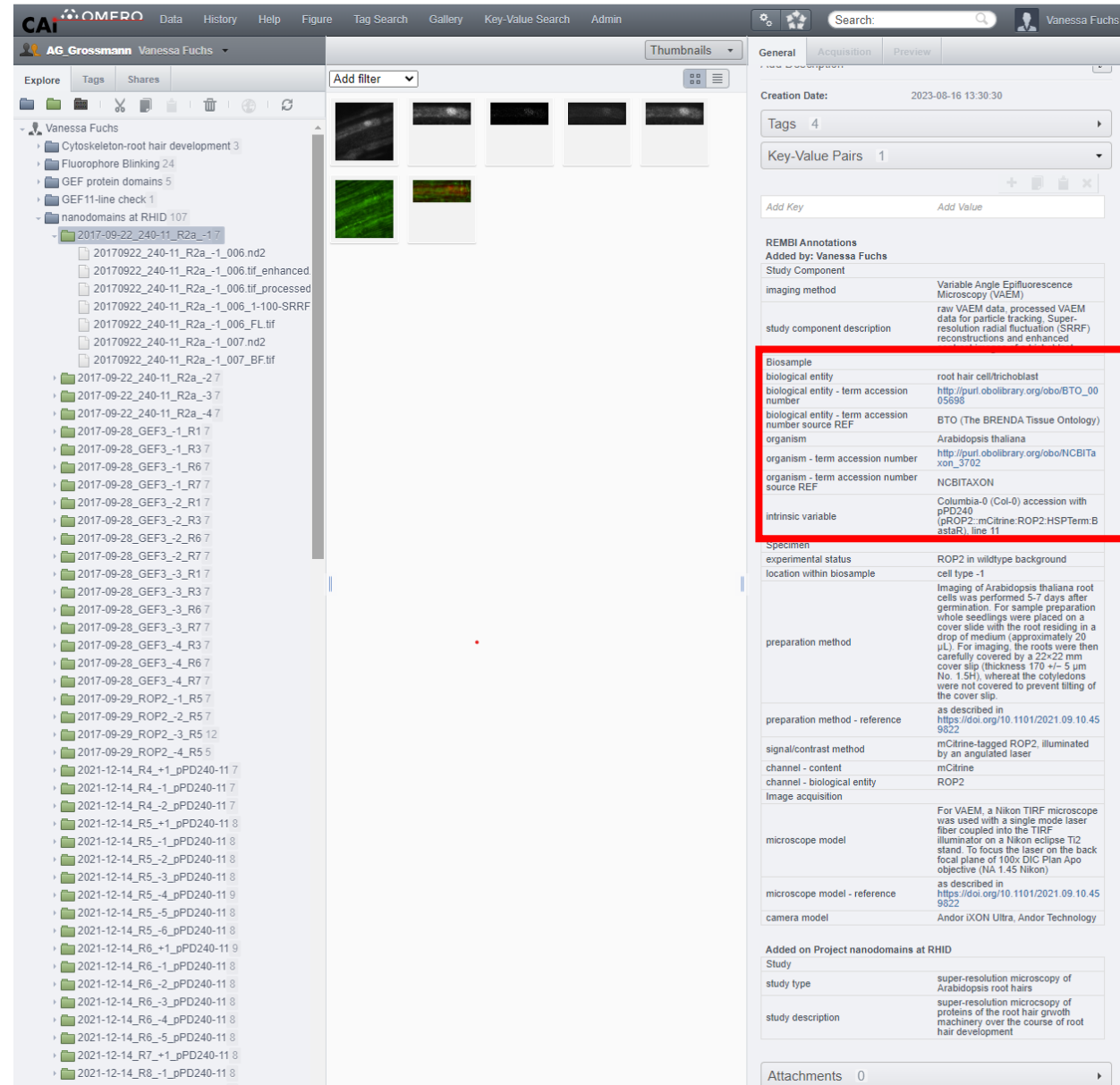


The screenshot displays the CAi OMERO web interface. On the left, a file explorer shows a directory structure for 'Vanessa Fuchs' containing various microscopy datasets. The main panel shows a grid of image thumbnails. On the right, the 'REMBI Annotations' section is highlighted with a red box, showing a table of metadata for a specific dataset.

REMBI Annotations	
Added by: Vanessa Fuchs	
Study Component	Variable Angle Epifluorescence Microscopy (VAEM)
imaging method	raw VAEM data, processed VAEM data for particle tracking, Super-resolution radial fluctuation (SRRF) reconstructions and enhanced contrast images of a trichoblast
biological entity	root hair cell/trichoblast
biological entity - term accession number	<a href="http://purl.obolibrary.org/obo/BTO_0005695">http://purl.obolibrary.org/obo/BTO_0005695</a>
biological entity - term accession number source REF	BTO (The BRENDA Tissue Ontology)
organism	Arabidopsis thaliana
organism - term accession number	<a href="http://purl.obolibrary.org/obo/NCBITaxon_3702">http://purl.obolibrary.org/obo/NCBITaxon_3702</a>
organism - term accession number source REF	NCBITAXON
intrinsic variable	Columbia-0 (Col-0) accession with pPD240 (pROP2::mCitrine:ROP2:HSPTerm:BastaR), line 11
Specimen	
experimental status	ROP2 in wildtype background
location within biosample	cell type -1
preparation method	Imaging of Arabidopsis thaliana root cells was performed 5-7 days after germination. For sample preparation whole seedlings were placed on a cover slide with the root residing in a drop of medium (approximately 20 µL). For imaging, the roots were then carefully covered by a 22x22 mm cover slip (thickness 170 µm ± 5 µm No. 1.5H), whereas the cotyledons were not covered to prevent tilting of the cover slip.
preparation method - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
signal/contrast method	mCitrine-tagged ROP2, illuminated by an angulated laser
channel - content	mCitrine
channel - biological entity	ROP2
Image acquisition	
microscope model	For VAEM, a Nikon TIRF microscope was used with a single mode laser fiber coupled into the TIRF illuminator on a Nikon eclipse Ti2 stand. To focus the laser on the back focal plane of 100x DIC Plan Apo objective (NA 1.45 Nikon)
microscope model - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
camera model	Andor iXON Ultra, Andor Technology
Added on Project nanodomains at RHID	
Study	
study type	super-resolution microscopy of Arabidopsis root hairs
study description	super-resolution microscopy of proteins of the root hair growth machinery over the course of root hair development
Attachments	0

Module2: Study component – dataset level

# REMBI at CAi



CAi OMERO Data History Help Figure Tag Search Gallery Key-Value Search Admin

Vanessa Fuchs

Explore Tags Shares

Vanessa Fuchs

- Cytoskeleton-root hair development 3
- Fluorophore Blinking 24
- GEF protein domains 5
- GEF11-line check 1
- nanodomains at RHID 107
  - 2017-09-22\_240-11\_R2a\_1-7
    - 20170922\_240-11\_R2a\_1\_006.nd2
    - 20170922\_240-11\_R2a\_1\_006.tif\_enhanced
    - 20170922\_240-11\_R2a\_1\_006.tif\_processed
    - 20170922\_240-11\_R2a\_1\_006\_1-100-SRRF
    - 20170922\_240-11\_R2a\_1\_006\_FL.tif
    - 20170922\_240-11\_R2a\_1\_007.nd2
    - 20170922\_240-11\_R2a\_1\_007\_BF.tif
  - 2017-09-22\_240-11\_R2a\_2-7
  - 2017-09-22\_240-11\_R2a\_3-7
  - 2017-09-22\_240-11\_R2a\_4-7
  - 2017-09-28\_GEF3\_1-R1 7
  - 2017-09-28\_GEF3\_1-R3 7
  - 2017-09-28\_GEF3\_1-R6 7
  - 2017-09-28\_GEF3\_1-R7 7
  - 2017-09-28\_GEF3\_2-R1 7
  - 2017-09-28\_GEF3\_2-R3 7
  - 2017-09-28\_GEF3\_2-R6 7
  - 2017-09-28\_GEF3\_2-R7 7
  - 2017-09-28\_GEF3\_3-R1 7
  - 2017-09-28\_GEF3\_3-R3 7
  - 2017-09-28\_GEF3\_3-R6 7
  - 2017-09-28\_GEF3\_3-R7 7
  - 2017-09-28\_GEF3\_4-R3 7
  - 2017-09-28\_GEF3\_4-R6 7
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  - 2017-09-29\_ROP2\_4-R5 5
  - 2021-12-14\_R4\_+1\_pPD240-11 7
  - 2021-12-14\_R4\_1\_pPD240-11 7
  - 2021-12-14\_R4\_2\_pPD240-11 7
  - 2021-12-14\_R5\_+1\_pPD240-11 8
  - 2021-12-14\_R5\_1\_pPD240-11 8
  - 2021-12-14\_R5\_2\_pPD240-11 8
  - 2021-12-14\_R5\_3\_pPD240-11 8
  - 2021-12-14\_R5\_4\_pPD240-11 9
  - 2021-12-14\_R5\_5\_pPD240-11 8
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  - 2021-12-14\_R6\_+1\_pPD240-11 9
  - 2021-12-14\_R6\_1\_pPD240-11 8
  - 2021-12-14\_R6\_2\_pPD240-11 8
  - 2021-12-14\_R6\_3\_pPD240-11 8
  - 2021-12-14\_R6\_4\_pPD240-11 8
  - 2021-12-14\_R6\_5\_pPD240-11 8
  - 2021-12-14\_R7\_+1\_pPD240-11 8
  - 2021-12-14\_R8\_1\_pPD240-11 8

2023-08-16 13:30:30

Tags 4

Key-Value Pairs 1

Add Key Add Value

REMBI Annotations

Added by: Vanessa Fuchs

Study Component	Variable Angle Epifluorescence Microscopy (VAEM)
imaging method	raw VAEM data, processed VAEM data for particle tracking, Super-resolution radial fluctuation (SRRF) reconstructions and enhanced
study component description	

Biosample

biological entity	root hair cell/trichoblast
biological entity - term accession number	<a href="http://purl.obolibrary.org/obo/BTO_0005695">http://purl.obolibrary.org/obo/BTO_0005695</a>
biological entity - term accession number source REF	BTO (The BRENDA Tissue Ontology)
organism	Arabidopsis thaliana
organism - term accession number	<a href="http://purl.obolibrary.org/obo/NCBITaxon_3702">http://purl.obolibrary.org/obo/NCBITaxon_3702</a>
organism - term accession number source REF	NCBITAXON
intrinsic variable	Columbia-0 (Col-0) accession with pPD240 (pROP2::mCitrine:ROP2:HSPTerm:BastaR), line 11

Specimen

experimental status	ROP2 in wildtype background
location within biosample	cell type -1
preparation method	Imaging of Arabidopsis thaliana root cells was performed 5-7 days after germination. For sample preparation whole seedlings were placed on a cover slide with the root residing in a drop of medium (approximately 20 µL). For imaging, the roots were then carefully covered by a 22x22 mm cover slip (thickness 170 µm ± 5 µm No. 1.5H), whereat the cotyledons were not covered to prevent tilting of the cover slip.
preparation method - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
signal/contrast method	mCitrine-tagged ROP2, illuminated by an angulated laser
channel - content	mCitrine
channel - biological entity	ROP2
Image acquisition	For VAEM, a Nikon TIRF microscope was used with a single mode laser fiber coupled into the TIRF illuminator on a Nikon eclipse Ti2 stand. To focus the laser on the back focal plane of 100x DIC Plan Apo objective (NA 1.45 Nikon)
microscope model	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
microscope model - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
camera model	Andor iXON Ultra, Andor Technology

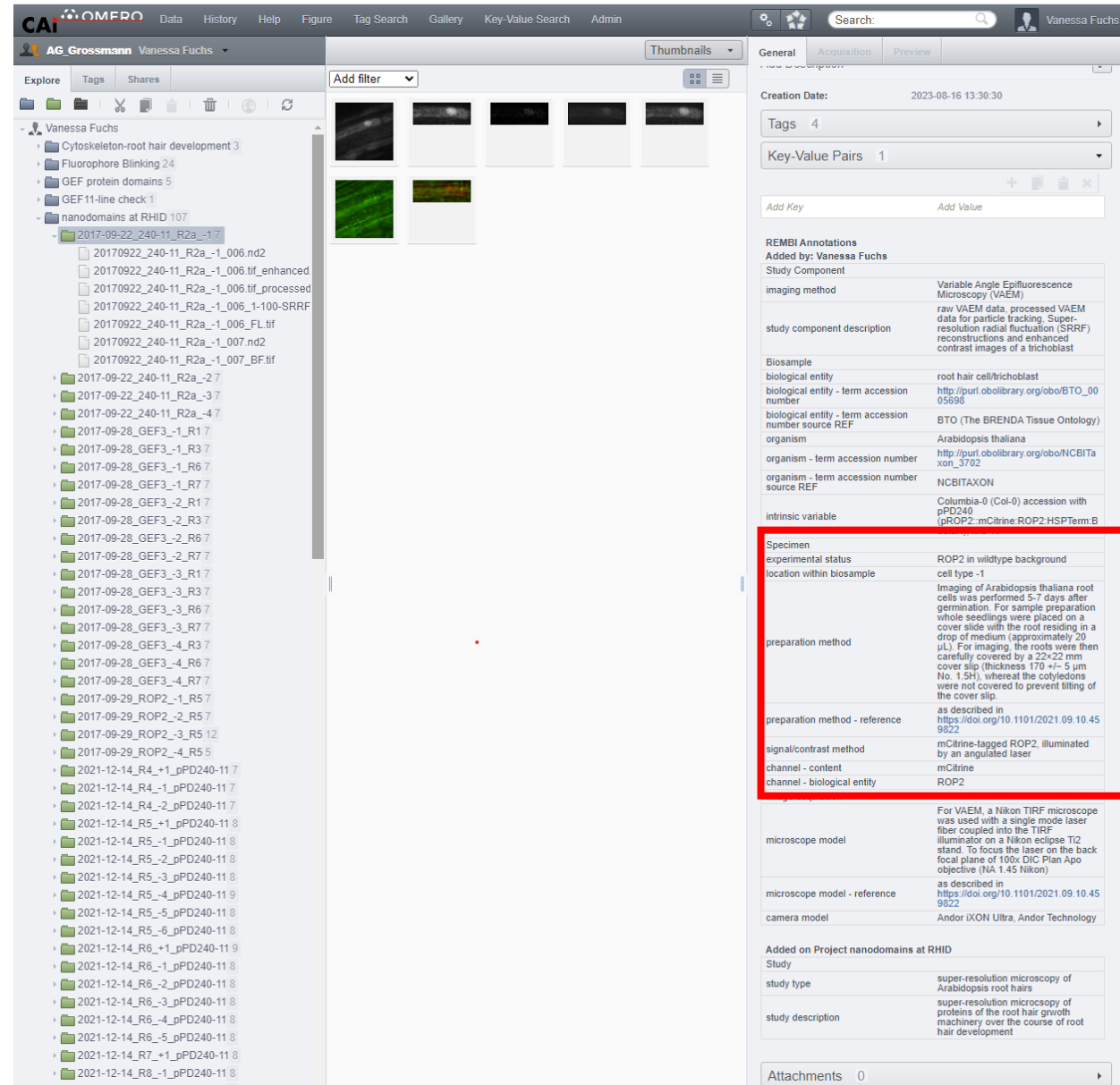
Added on Project nanodomains at RHID

Study	
study type	super-resolution microscopy of Arabidopsis root hairs
study description	super-resolution microscopy of proteins of the root hair growth machinery over the course of root hair development

Attachments 0

## Module 3: Biosample – dataset level

# REMBI at CAi



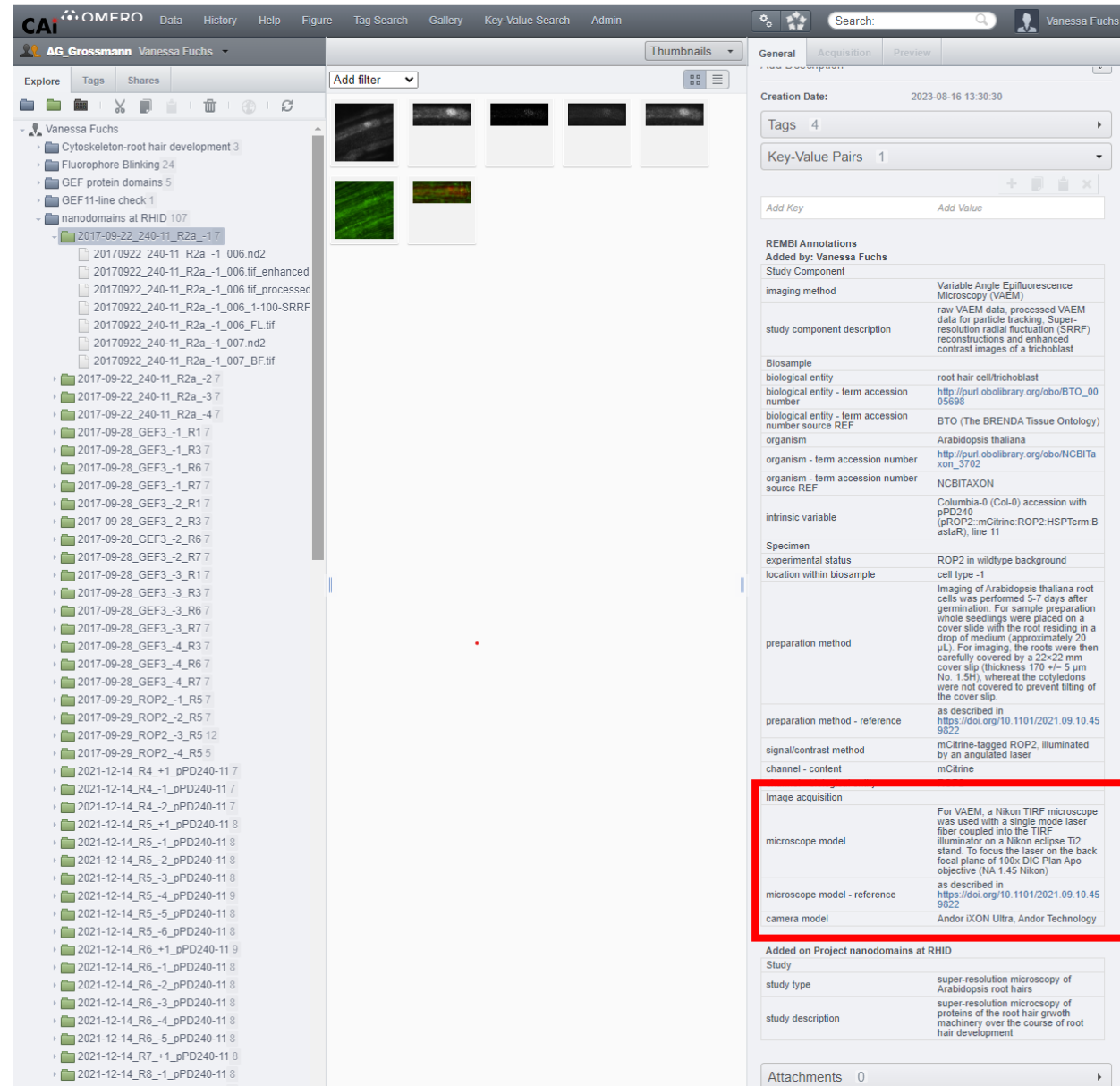
The screenshot displays the CAi OMERO web interface. On the left, a file explorer shows a directory structure for 'Vanessa Fuchs' containing various microscopy datasets. The main panel shows a grid of image thumbnails. On the right, the 'REMBI Annotations' section is visible, detailing the dataset's metadata.

**REMBI Annotations**  
Added by: Vanessa Fuchs

Study Component	Variable Angle Epifluorescence Microscopy (VAEM)
imaging method	raw VAEM data, processed VAEM data for particle tracking, Super-resolution radial fluctuation (SRRF) reconstructions and enhanced contrast images of a trichoblast
study component description	
Biosample	
biological entity	root hair cell/trichoblast
biological entity - term accession number	<a href="http://purl.obolibrary.org/obo/BTO_0005695">http://purl.obolibrary.org/obo/BTO_0005695</a>
biological entity - term accession number source REF	BTO (The BRENDA Tissue Ontology)
organism	Arabidopsis thaliana
organism - term accession number	<a href="http://purl.obolibrary.org/obo/NCBITaxon_3702">http://purl.obolibrary.org/obo/NCBITaxon_3702</a>
organism - term accession number source REF	NCBITAXON
intrinsic variable	Columbia-0 (Col-0) accession with pPD240
Specimen	
experimental status	ROP2 in wildtype background
location within biosample	cell type -1
preparation method	Imaging of Arabidopsis thaliana root cells was performed 5-7 days after germination. For sample preparation whole seedlings were placed on a cover slide with the root residing in a drop of medium (approximately 20 µL). For imaging, the roots were then carefully covered by a 22x22 mm cover slip (thickness 170 +/- 5 µm No. 1.5H), whereat the cotyledons were not covered to prevent tilting of the cover slip.
preparation method - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
signal/contrast method	mCitrine-tagged ROP2, illuminated by an angulated laser
channel - content	mCitrine
channel - biological entity	ROP2
microscope model	For VAEM, a Nikon TIRF microscope was used with a single mode laser fiber coupled into the TIRF illuminator on a Nikon eclipse Ti2 stand. To focus the laser on the back focal plane of 100x DIC Plan Apo objective (NA 1.45 Nikon)
microscope model - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
camera model	Andor iXON Ultra, Andor Technology
Added on Project nanodomains at RHID	
Study	
study type	super-resolution microscopy of Arabidopsis root hairs
study description	super-resolution microscopy of proteins of the root hair growth machinery over the course of root hair development
Attachments	0

## Module 4: Specimen – dataset level

# REMBI at CAi



The screenshot displays the CAi OMERO web interface. On the left, a file explorer shows a directory structure for 'Vanessa Fuchs' containing various microscopy datasets. The main panel shows a grid of image thumbnails. On the right, the 'REMBI Annotations' section is visible, detailing the acquisition and processing of the images. A red box highlights the 'Image acquisition' section, which includes the following information:

Field	Value
microscope model	For VAEEM, a Nikon TIRF microscope was used with a single mode laser fiber coupled into the TIRF illuminator on a Nikon eclipse Ti2 stand. To focus the laser on the back focal plane of 100x DIC Plan Apo objective (NA 1.45 Nikon)
microscope model - reference	as described in <a href="https://doi.org/10.1101/2021.09.10.459822">https://doi.org/10.1101/2021.09.10.459822</a>
camera model	Andor iXON Ultra, Andor Technology

Below the highlighted section, the 'Added on Project nanodomains at RHID' section is visible, showing details about the study type and description.

Module 5: Image acquisition – dataset level

# Acknowledgments

In cooperation with

Information Infrastructure for BioImage Data (I3D:bio)



<https://www.i3dbio.de/>

Center for **A**dvanced **i**maging (CAi) at Heinrich-Heine University  
Düsseldorf

<https://www.cai.hhu.de/>