4DN–BINA–OME Advanced & Confocal Extension Microscope HARDWARE Specifications

Instrument

ManufacturerSpecs (extension base)

TIRFHardwareModule
- ID
- Method
- Ring
- Motorized
- PrismRef
- AnnotationRef

ConfocalScanner–APE
- ID
- Name
- NrOfScanPoint
- MaxFrameRate
- PointsConfiguration
- AnnotationRef

AcoustoOptical Device–APE
- ID (AcoustoOpticalDeviceID)
- Name
- ContrastRatio
- Coating
- AttenuationMethod
- AttenuationCoefficient
- TuningAccuracy
- Polarization
- Bragg
- TuningResolution
- TuningRate
- AngleOfIncidence
- AngularAperture
- Material
- Design
- Geometry
- OperatingTemperature
- AnnotationRef

ElectroOpticalDevice–APE
- ID (ElectroOpticalDeviceID)
- Name
- ModulationMode
- ContrastRatio
- Coating
- AttenuationMethod
- AttenuationCoefficient
- TuningAccuracy
- TuningResolution
- TuningRate
- AngleOfIncidence
- AngularAperture
- OperatingTemperature
- OperatingHumidity
- WarmUpTime
- AnnotationRef

MicrolensArray
- ID
- Name
- LensletDiameter
- LensletPitch
- LensletArrangement
- LensletShape
- LensletType
- Coating
- Reflectance
- SubstrateMaterial
- FrontFocalLength
- BackFocalLenght
- AnnotationRef

OpticalAperture–APE
- ID
- Name
- OuterDiameter
- OpticsHolderPosition
- AnnotationRef

Detector–APE

Camera–APE

Children Entities (choose one)

RasterScanner
- Type
- HorizontalScanningSpeed
- VerticalScanningSpeed

SpinninkDisk
- SingleDisk
- DiskSpeed

Children Entities (choose one)

AcoustoOptical BeamSplitter

AcoustoOptical Deflector

AcoustoOptical Modulator
- Type

AcoustoOptical TuneableFilter

Children Entities (choose one)

DeformableMirror
- Type
- Actuators
- ActuatorPitch
- ActuatorStroke
- ResponseTime

ElectroOptical Modulator
- ID
- Method

LiquidCrystal TuneableFilter
- SelectableBandwidth
- MaximumPower

SpatialLightModulator
- Type
- ModulationMode
- ArrayWidth
- ArrayHeight
- FrameRate

Children Entities (choose one)

DiffractionGrating
- Period
- SpatialFrequency
- Transmittive
- ModulationMode
- Ronchi

MaskingPlate
- Function
- Excitation
- ApertureSize
- ApertureNr.
- ApertureShape
- Material

PinHole
- MaxDiameter
- Shape

Children Entities (choose one)

WavefrontSensor
- Type
- Accuracy
- Sensitivity

WavelengthRange
- PeakWavelength
- CutOn
- CutOff
- WavelenghtProfileFile

WavelengthRange
- PeakWavelength
- CutOn
- CutOff
- WavelenghtProfileFile

PockelsCell
- HalfWaveVoltage
- Material

WavelengthRange
- PeakWavelength
- CutOn
- CutOff
- WavelenghtProfileFile

IS–A (labels throughout)

4DN–BINA–OME Advanced & Confocal Extension Image ACQUISITION Settings

LightSourceSettings

TO BE MERGED

Image

Microbeam Manipulation
- ID
- Type
- ExperimenterRef
- ROIRef
- Description [Sub-element]
- ——
- AnnotationRef

Ref

Pixels

Experiment

Channel / **Channel** / **Channel**

LightPath

ConfocalScanner Settings
- ID (ConfocalScannerID)
- PresetPinholeSize
- ScanMode
- IntegrationMode
- IntegrationMethod
- IntegrationNumber
- EffectiveZoom
- ZoomAreaWidth
- ZoomAreaHeight
- Descanned
- ScanFormat
- MultiChannelMode
- ScanTime
- ConfocalFieldNumber
- Rotation
- ScanningFrequency

AcoustoOptical DeviceSettings–APE
- ID (AcoustoOpticalDeviceID)
- DiffractionEfficiency
- AcousticFrequency
- TransmittanceProfileFie [Sub-Element]
- ReflectanceProfileFie [Sub-Element]

ElectroOptical DeviceSettings–APE
- ID (ElectroOpticalDeviceID)
- TransmittanceProfileFie [Sub-Element]
- ReflectanceProfileFie [Sub-Element]

TIRFSettings
- ID
- HILO
- TIRFAngle
- TIRFHardwareModuleRef
- TIRFLigthPath [Sub-element]
- Description [Sub-element]

OpticalAperture Settings–APE
- ID (OpticalApertureID)
- TransmittanceProfileFie [Sub-Element]
- ReflectanceProfileFie [Sub-Element]

ChildrenEntity (choose one)

AcoustoOptical TuneableFilterSettings

AcoustoOptical BeamSplitterSettings

AcoustoOptical DeflectorSettings

AcoustoOptical ModulatorSettings

ChildrenEntity (choose one)

DeformableMirror Settings

ElectroOptical ModulatorSettings

LiquidCrystal TuneableFilterSettings

SpatialLightModulator Settings

ChildrenEntity (choose one)

DiffractionGrating Settings
- DiffractionEfficiency

MaskingPlateSettings

PinHoleSettings
- Aperture

TransmissionWavelength RangeSettings
- CutOn
- CutOff
- Transmittance

ReflectionWavelength RangeSettings
- CutOn
- CutOff
- Reflectance

TransmissionWavelength RangeSettings
- CutOn
- CutOff
- Transmittance

ReflectionWavelength RangeSettings
- CutOn
- CutOff
- Reflectance

TransmissionWavelength RangeSettings
- CutOn
- CutOff
- Transmittance

ReflectionWavelength RangeSettings
- CutOn
- CutOff
- Reflectance

Notes

Blue edges, blue edges represent RELATIONSHIPs between entities. SOLID EDGES are used to connect an Element with a REQUIRED Sub–Element. DASHED EDGED are used to connect an Element with an OPTIONAL Sub–Element. In addition, different CARDINALITIES can be represented as follow:

Element 1	1 to 1 … ∞	Element 2
Element 1	1 to 0 … ∞	Element 2
Element 1	1 to 0 … 1	Element 2
Element 1	1 to 1	Element 2

Black dashed arrows, these arrows simbolize an inheritance relationship similar to what would connect a hypothetical "Feline" parent element with a "Cat" child element. In this example, while the "Cat" element represents a "concrete" entity that exist in the real–world, the "Feline" element represents an "abstract" category that is only useful for categorization pruposes. In a similar manner, these arrows connect concrete elements that represents actual microscope hardware components with their Abstract Parent Elements (APE), which are utilized for making the model less repetitive and more efficient to read by software tools. These arrows should be read as follows, a "Laser" IS–A "LightSource".

Dashed grey edges, these edges signify "Extends" and they should be read as follows: "Objective" extends "ManufacturerSpecs". In this example, the concept of extension indicates that Objective is of type "ManufacturerSpecs" but it has additional attributes that are unique to it and distinguishes from other elements.
––––
–AnnotationRef, This element always refers to a Comment/Annotation element as described for Channel. However for simplicity most Comment/Annotation elements have been omitted and the AnnotationRef has been inserted in the referring element as an attribute.
–[Sub–Element], For simplicity and when indicated Sub–Elements are listed whithin the referring element as attributes.
–References, For simplicity and when indicated, Reference elements (e.g., ImageRef) are listed whithin the referring element as attributes.
–Units were omitted from this diagram for simplicity. However, they are essential for reproducibility and they are included in the model and in all its formal representations.
–Attributes listed after the ––– separator have been added to the OME Core as part of the proposed revision.
–Attributes listed in parenthesis and after the .... separator have been removed as part of the proposed extension.
–APE, Abstract Parent Entity (see explanation above).

Legend

This is a Entity–Relationship diagrammatic representation of a proposed REVISION of the OME Core data model (blue/red boxes) along side a proposed OME BASIC EXTENSION (grey boxes) developed by members of the Imaging Working Group of the 4D Nucleome network (https://www.4dnucleome.org) and by members of the BINA Quality Control and Data Management Working Group (https://www.bioimagingna.org/qc–dm–wg).

The Entity–Relationship formalism is utilized to model information about a real–world situation or an actual object (in this case a Microscope INSTRUMENT and an IMAGE acquired using that Instrument) by using three types of model elements:
1) ENTITIES, represented by Boxes;
2) RELATIONSHIPS, represented by blue lines connecting boxes; and
3) ATTRIBUTES, represented by fields within boxes

When describing a real–life situation or object:
1) ENTITIES correspond to NOUNS = the items we want to collect information about.
2) RELATIONSHIPS correspond to VERBS = actions/states/occurrences that connect Entities with each other
3) ATTRIBUTES correspond to ADJECTIVES = they describe the actual information (in our case metadata) that we want to record about each Entity.

In order to interpret the schema please start either from the <INSTRUMENT> element for the Microscope Hardware Specifications section of the diagram or from the <IMAGE> element of the Image Acquisition Settings sections.Then follow the blue lines to the connected boxes and think something like:
1) An Instrument has a Microscope Body, might rest on a Microscope Table, utilizes a Light Source and magnifies the sample using an Objective.
2) Alternatively, an Image was produced as part of a specific Experiment, was collected in a specific Imaging Environment and using specific Microscope Settings and has four Channels.

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