# Integrative Structure Validation Report ?

## October 09, 2025 - 04:40 PM PDT

*The following software was used in the production of this report:*

*IHMValidation Version 3.0*
*Python-IHM Version 2.5*
*EMDB validation analysis Version 0.0.1.dev127*
*ChimeraX Version 1.9*
*Chimera Version 1.19*
*MapQ Version 1.8.1*

| | |
|---|---|
| PDB ID | 9A1P \| pdb_00009a1p |
| PDB-Dev ID | PDBDEV_00000097 |
| Structure Title | Comprehensive structure and functional adaptations of the yeast nuclear pore complex |
| Structure Authors | Akey CW; Singh D; Ouch C; Echeverria I; Nudelman I; Varberg JM; Yu Z; Fang F; Shi Y; Wang J; Salzberg D; Song K; Xu C; Gumbart JC; Suslov S; Unruh J; Jaspersen SL; Chait BT; Sali A; Fernandez-Martinez J; Ludtke SJ; Villa E; Rout MP |
| Deposited on | 2021-11-19 |

*This is a PDB-IHM Structure Validation Report.*

*We welcome your comments at helpdesk@pdb-ihm.org*

*A user guide is available at https://pdb-ihm.org/validation_help.html with specific help available everywhere you see the ? symbol.*

*List of references used to build this report is available here.*

## 1. Overview ?

### 1.1. Summary ?

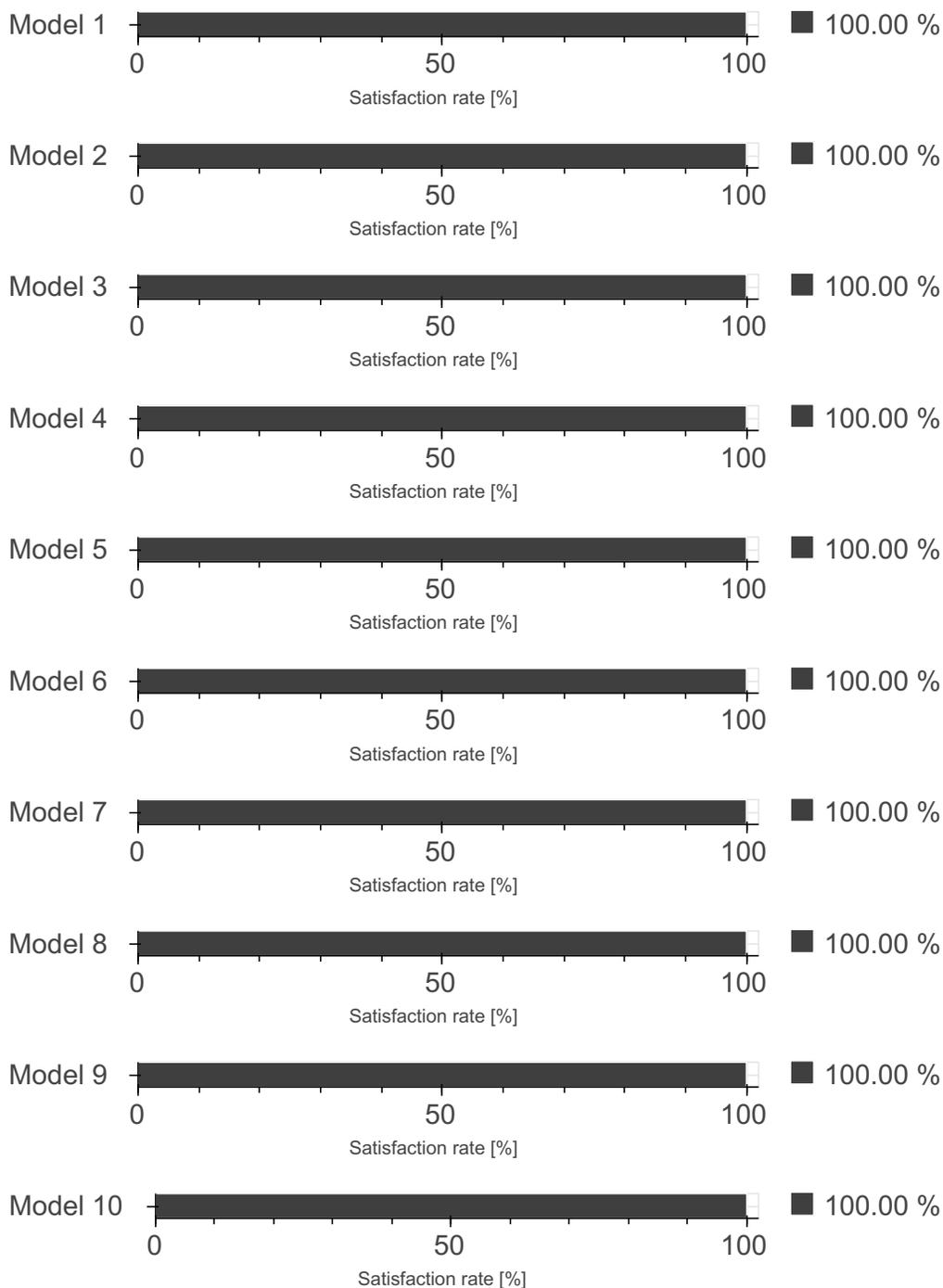This entry consists of 10 model(s). A total of 3 dataset(s) were used to build this entry.

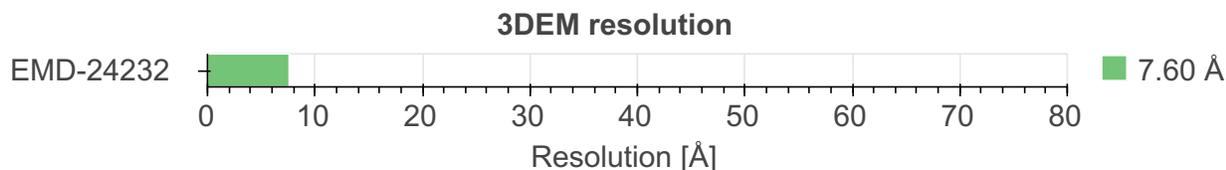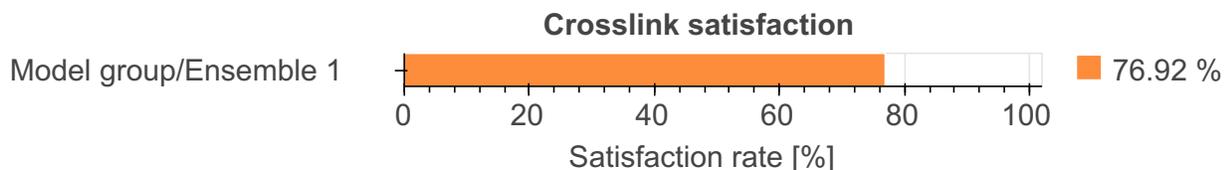| Name | Type | Count |
|---|---|---|
| 3DEM volume | Experimental data | 1 |

| Name | Type | Count |
|---|---|---|
| Crosslinking-MS data | Experimental data | 1 |
| Experimental model | Starting model | 1 |

## 1.2. Overall quality ?

*This validation report contains model quality assessments for all structures, data quality and fit to model assessments for SAS and crosslinking-MS datasets. Data quality and fit to model assessments for other datasets and model uncertainty are under development. Number of plots is limited to 256.*

### Model Quality: Excluded Volume Analysis ?

Model 1 — 100.00 %
Satisfaction rate [%]

Model 2 — 100.00 %
Satisfaction rate [%]

Model 3 — 100.00 %
Satisfaction rate [%]

Model 4 — 100.00 %
Satisfaction rate [%]

Model 5 — 100.00 %
Satisfaction rate [%]

Model 6 — 100.00 %
Satisfaction rate [%]

Model 7 — 100.00 %
Satisfaction rate [%]

Model 8 — 100.00 %
Satisfaction rate [%]

Model 9 — 100.00 %
Satisfaction rate [%]

Model 10 — 100.00 %
Satisfaction rate [%]

**Data Quality** ?

**3DEM resolution**

EMD-24232 [bar] ■ 7.60 Å

0  10  20  30  40  50  60  70  80
Resolution [Å]

**Fit to Data Used for Modeling** ?

**Crosslink satisfaction**

Model group/Ensemble 1 [bar] ■ 76.92 %

0  20  40  60  80  100
Satisfaction rate [%]

# 2. Model Details ?

## 2.1. Ensemble information ?

*This entry consists of 1 distinct ensemble(s).*

## 2.2. Representation ?

*This entry has 1 representation(s).*

| ID | Model(s) | Entity ID | Molecule name | Chain(s) [auth] | Total residues | Rigid segments | Flexible segments | Model coverage/ Starting model coverage (%) | Scale |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-10 | 2 | Nup170 | 0 | 1502 | 1-1502 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | Y | | | | | |
| | | 1 | Nup157 | 1 | 1391 | 1-1391 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | Z | | | | | |
| | | 5 | Nsp1 | A | 823 | 1-823 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | D | | | | | |
| | | | | G | | | | | |
| | | | | J | | | | | |
| | | 6 | Nup57 | B | 541 | 1-541 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | E | | | | | |
| | | | | H | | | | | |
| | | | | K | | | | | |
| | | 7 | Nup49 | C | 472 | 1-472 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | F | | | | | |

| ID | Model(s) | Entity ID | Molecule name | Chain(s) [auth] | Total residues | Rigid segments | Flexible segments | Model coverage/ Starting model coverage (%) | Scale |
|---|---|---|---|---|---|---|---|---|---|
| | | | | I | | | | | |
| | | | | L | | | | | |
| | | 9 | Nup192 | M | 1683 | 1-1683 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | O | | | | | |
| | | 8 | Nup188 | N | 1655 | 1-1655 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | P | | | | | |
| | | 10 | Nic96 | Q | 839 | 1-839 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | R | | | | | |
| | | | | S | | | | | |
| | | | | T | | | | | |
| | | 3 | Nup53 | U | 475 | 1-475 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | W | | | | | |
| | | 4 | Nup59 | V | 528 | 1-528 | - | 100.00 / 100.00 | Coarse-grained: 1 residue(s) per bead |
| | | | | X | | | | | |

## 2.3. Datasets used for modeling ⍰

*There are 3 unique datasets used to build the models in this entry.*

| ID | Dataset type | Database name | Data access code |
|---|---|---|---|
| 1 | Crosslinking-MS data | Zenodo | 10.5281/zenodo.5662389 |
| 2 | 3DEM volume | EMDB | EMD-24232 |
| 3 | Experimental model | PDB | pdb_00007n85 |

## 2.4. Methodology and software ⍰

*This entry is a result of 1 distinct protocol(s).*

| Step number | Protocol ID | Method name | Method type | Method description | Number of computed models | Multi state modeling | Multi scale modeling |
|---|---|---|---|---|---|---|---|
| 1 | 1 | Production sampling | Enumeration | Not available | 1200 | False | True |

*There are 2 software packages reported in this entry.*

| ID | Software name | Software version | Software classification | Software location |
|---|---|---|---|---|
| 1 | PSIPRED | 4.00 | secondary structure prediction | http://bioinf.cs.ucl.ac.uk/psipred/ |
| 2 | Integrative Modeling Platform (IMP) | 2.20 | integrative model building | https://integrativemodeling.org |

# 3. Data quality ?

## 3.2. Crosslinking-MS

*At the moment, data validation is only available for crosslinking-MS data deposited as a fully compliant dataset in the PRIDE Crosslinking database. Correspondence between crosslinking-MS and entry entities is established using pyHMMER. Only residue pairs that passed the reported threshold are used for the analysis. The values in the report have to be interpreted in the context of the experiment (i.e. only a minor fraction of in-situ or in-vivo dataset can be used for modeling).*

Crosslinking-MS dataset is not available in the PRIDE Crosslinking database.

## 3.3. 3DEM ?

*This section describes quality of the 3DEM datasets*

### EMD-24232

#### 3.3.1. Experimental information ?

| | |
|---|---|
| EM reconstruction method: | SINGLE PARTICLE |
| Resolution: | 7.60 Å |
| Recommended level: | 0.595 |
| Estimated volume: | 20886.90 nm³ |
| Specimen preparation: | Preparation ID    1    Vitrification |
| Map-only validation report: | wwPDB validation report |

#### 3.3.2. Map visualisation ?

This section contains visualisations of the EMDB entry EMD-24232. These allow visual inspection of the internal detail of the map and identification of artifacts. Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.
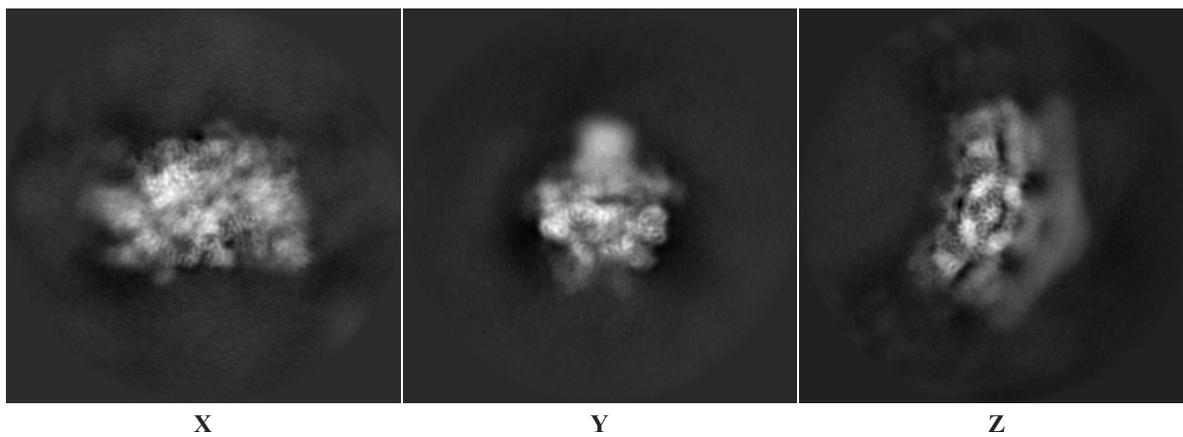
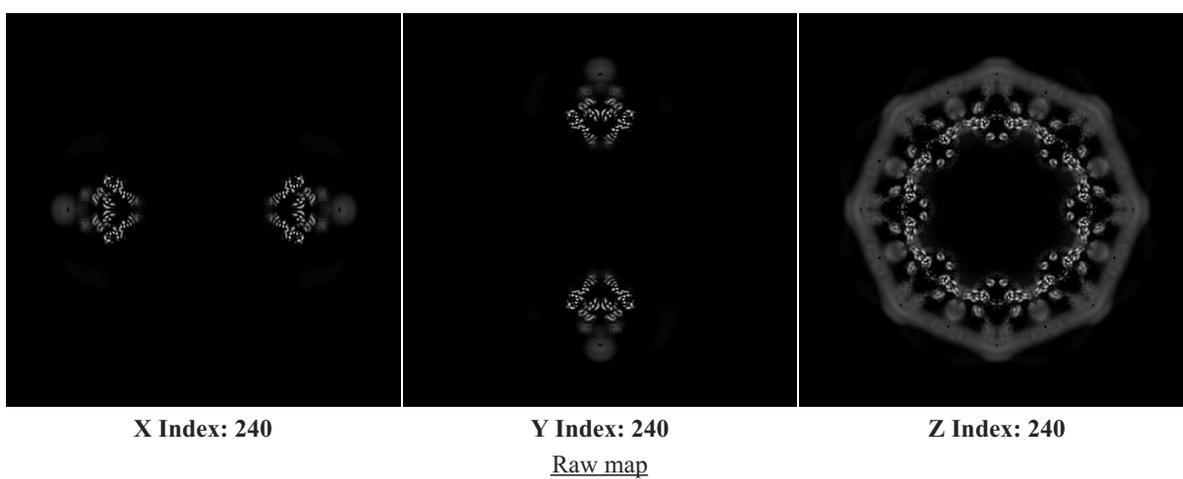##### 3.3.2.1. Orthogonal projections ?

Primary map



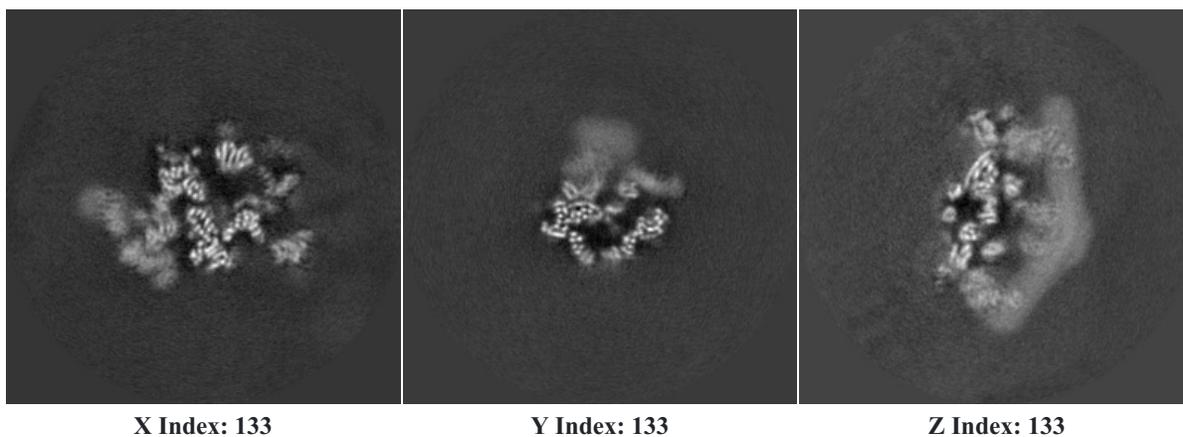| X | Y | Z |
|---|---|---|

Raw map

| X | Y | Z |
|---|---|---|
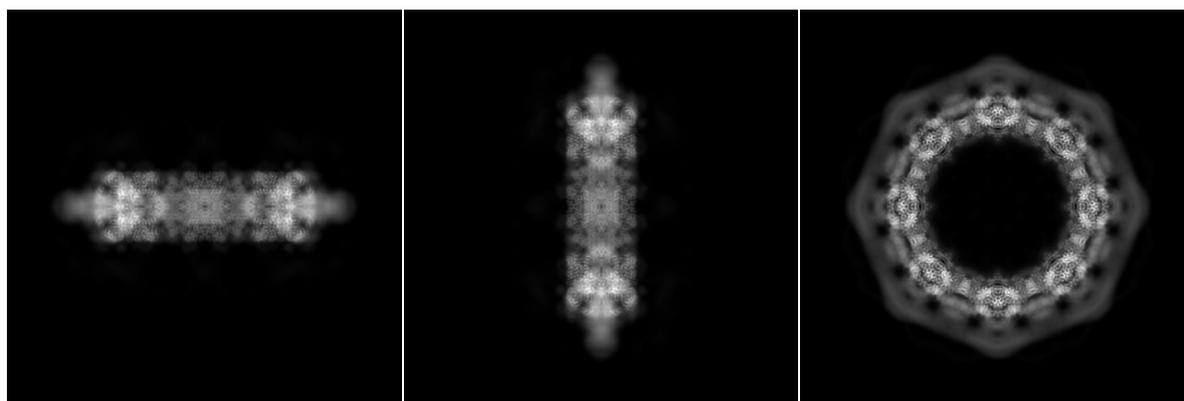
The images above show the map projected in three orthogonal directions.

### 3.3.2.2. Central slices ?

Primary map



| X Index: 240 | Y Index: 240 | Z Index: 240 |
|---|---|---|

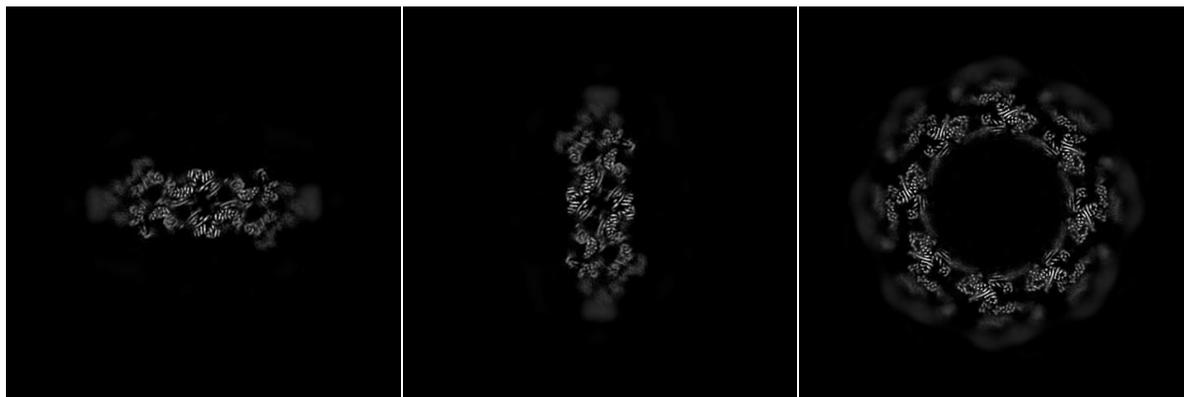Raw map



| X Index: 133 | Y Index: 133 | Z Index: 133 |
|---|---|---|

The images above show central slices of the map in three orthogonal directions.
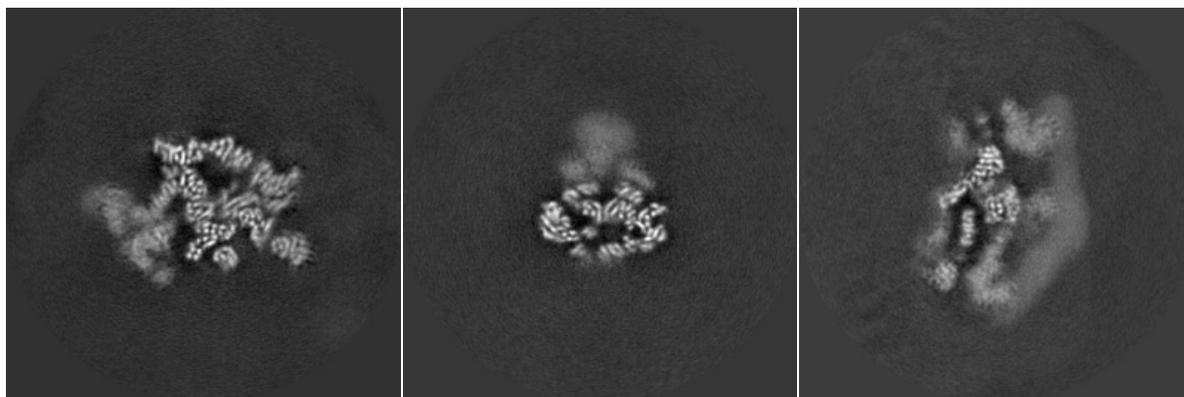
### 3.3.2.3. Largest variance slices ?

Primary map

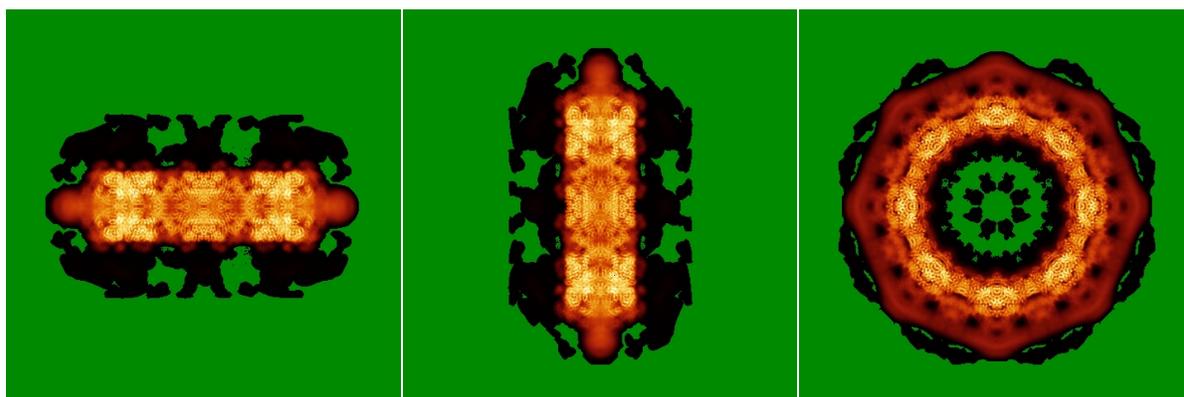| X Index: 340 | Y Index: 140 | Z Index: 257 |

Raw map



| X Index: 129 | Y Index: 126 | Z Index: 125 |

The images above show the largest variance slices of the map in three orthogonal directions.

### 3.3.2.4 Orthogonal standard-deviation projections (false-color) ⓘ
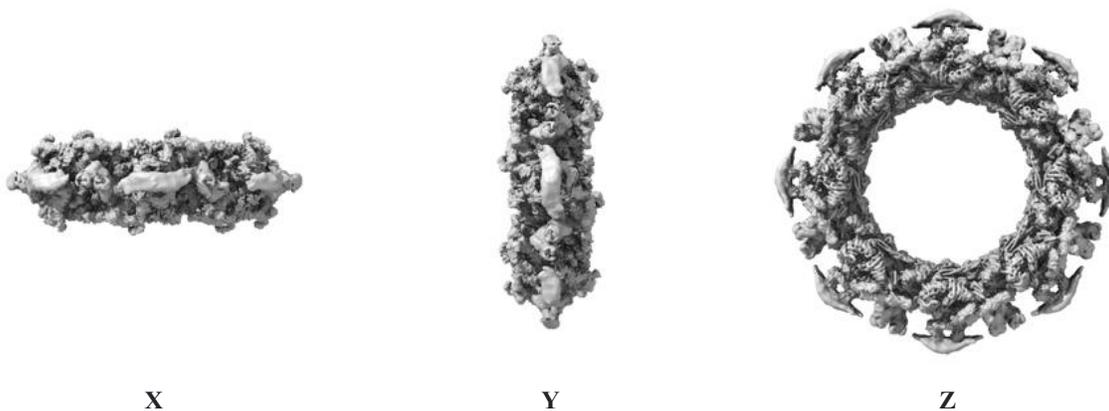
Primary map



| X | Y | Z |

Raw map

| X | Y | Z |
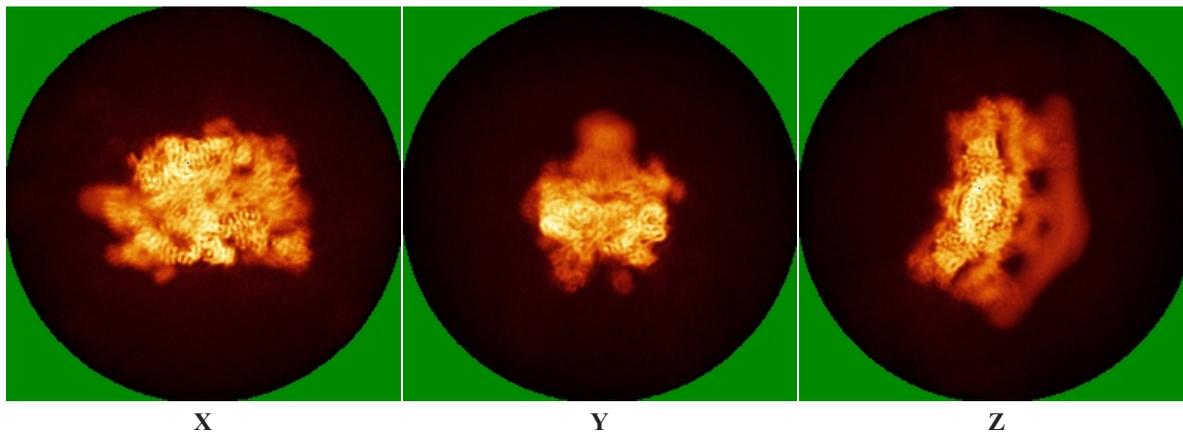
The images above show the map standard deviation projections with false color in three orthogonal directions. Minimum values are shown in green, max in blue, and dark to light orange shades represent small to large values respectively.
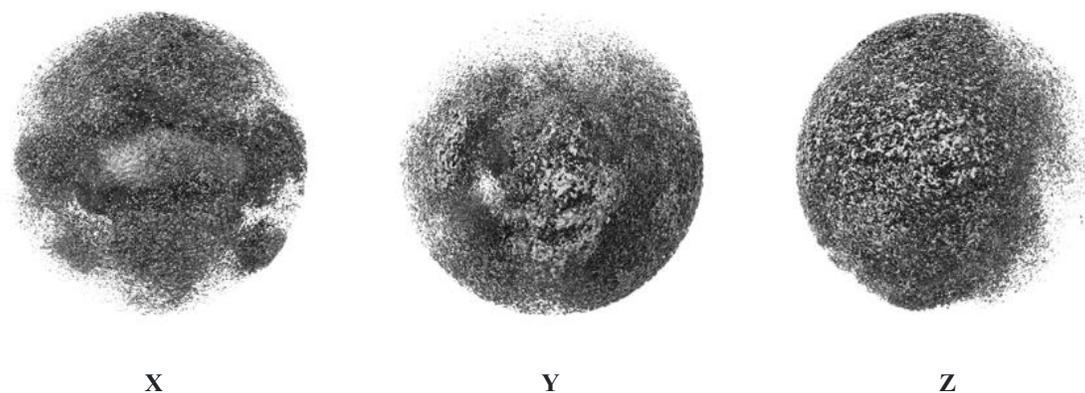
### 3.3.2.5. Orthogonal surface views ?

Primary map



| X | Y | Z |

The images above show the 3D surface view of the map at the recommended contour level 0.595 . These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

Raw map



| X | Y | Z |

These images show the 3D surface of the raw map. The raw map's contour level 0.090 was selected so that its surface encloses the same volume as the primary map does at its recommended contour level.

### 3.3.2.6. Mask visualisation ?

This section shows the 3D surface view of the primary map at 50% transparency overlaid with the specified mask at 0% transparency. A mask typically either:

- Encompasses the whole structure;
- Separates out a domain, a functional unit, a monomer or an area of interest from a larger structure.
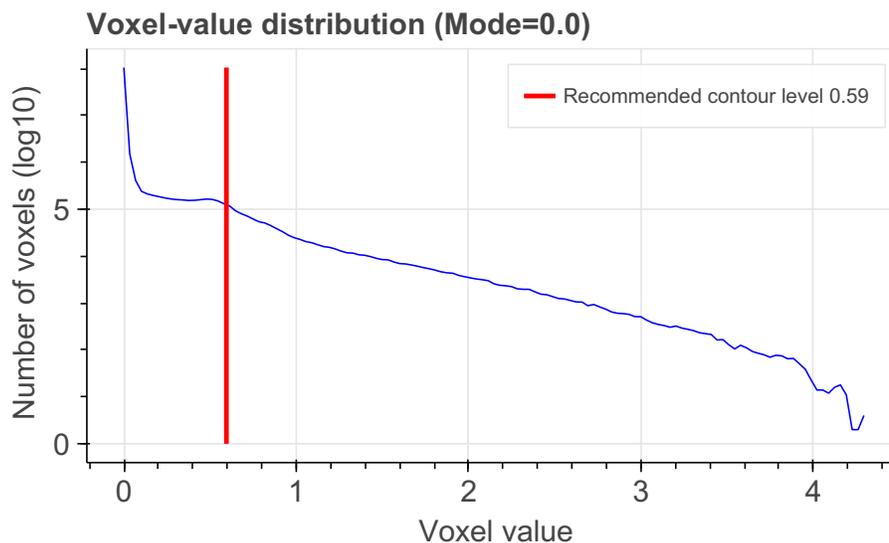
emd_24232_msk_1.map ?



| X | Y | Z |
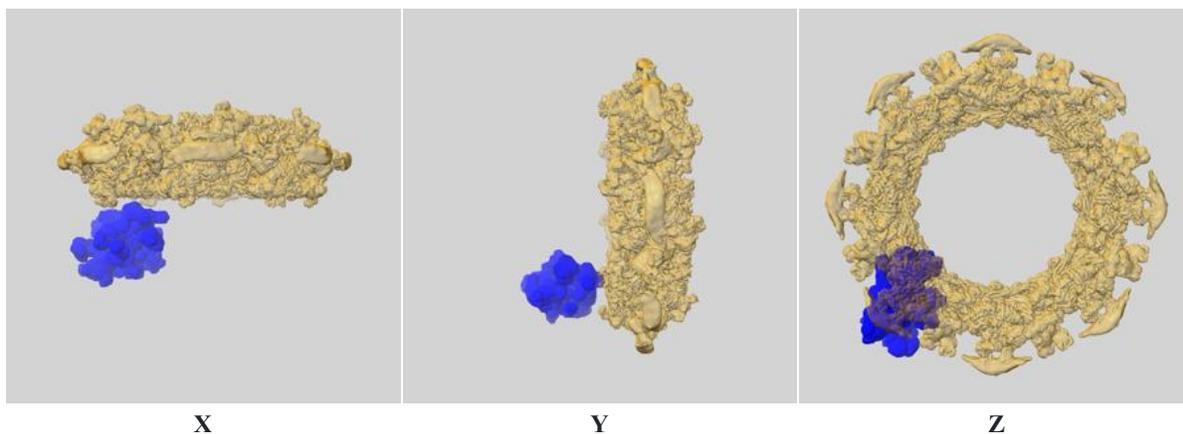
### 3.3.3. Map analysis ?

*This section contains the results of statistical analysis of the map.*

### 3.3.3.1. Map-value distribution ?



**Voxel-value distribution (Mode=0.0)**

Recommended contour level 0.59

The map-value distribution is plotted in 128 intervals along the x-axis. The y-axis is logarithmic. A spike in this graph at zero usually indicates that the volume has been masked.

### 3.3.3.2. Volume estimate ?

## Volume estimate (Estimated volume=20886.90 nm³)
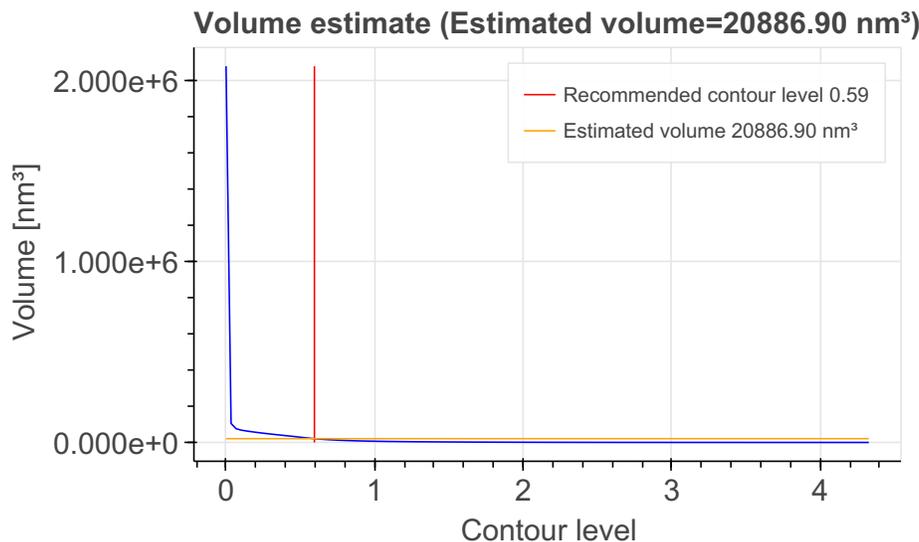


The volume at the recommended contour level is 20886.90 nm³.

The volume estimate graph shows how the enclosed volume varies with the contour level. The recommended contour level is shown as a vertical line and the intersection between the line and the curve gives the volume of the enclosed surface at the given level.

### 3.3.3.3. Rotationally averaged power spectrum ?

## Rotationally averaged power spectrum
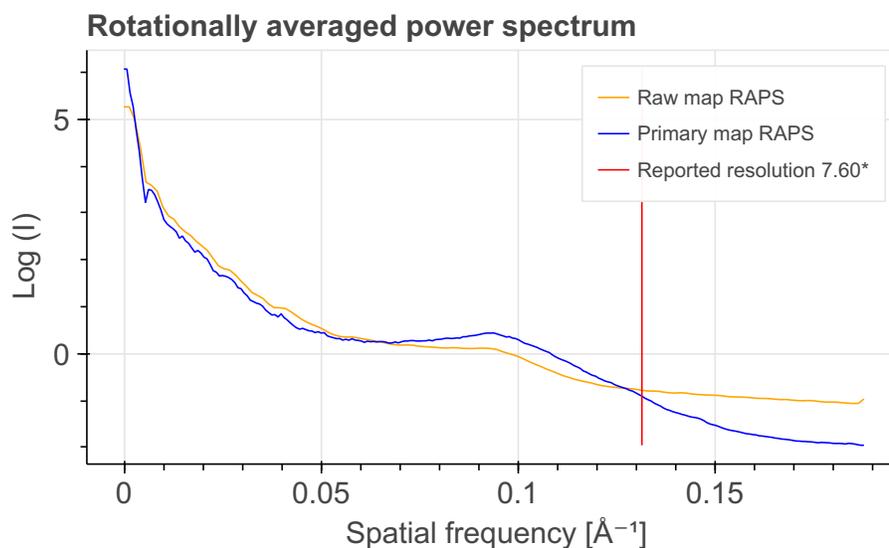


*Reported resolution corresponds to spatial frequency of $0.132 \ \text{Å}^{-1}$

### 3.3.4. Fourier-Shell correlation ?

### 3.3.4.1. FSC ?

Fourier-Shell Correlation (FSC) is the most commonly used method to estimate the resolution of single-particle and subtomogram-averaged maps. The shape of the curve depends on the imposed symmetry, mask and whether or not the two 3D reconstructions used were processed from a common reference. The reported resolution is shown as a black line. A curve is displayed for the half-bit criterion in addition to lines showing the 0.143 gold standard cut-off and 0.5 cut-off.

**FSC**
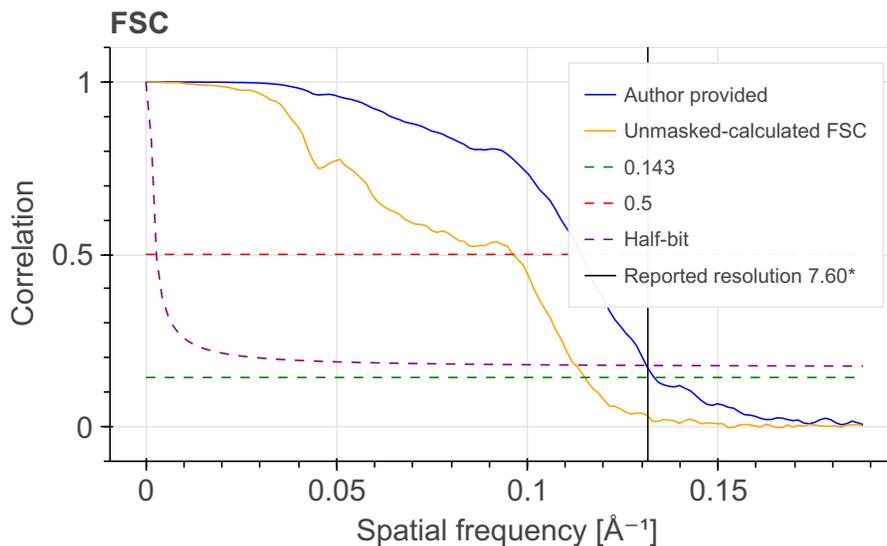


*Reported resolution corresponds to spatial frequency of 0.132 Å⁻¹

### 3.3.4.2. Resolution estimates ?

| Resolution estimate (Å) | Estimation criterion (FSC cut-off) | | |
|---|---|---|---|
| | **0.143** | **0.5** | **Half-bit** |
| Reported by author | 7.60 | - | - |
| Author-provided FSC curve | 7.51 | 8.76 | 7.62 |
| Unmasked-calculated* | 8.69 | 10.40 | 8.88 |

*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps. The value from deposited half-maps intersecting FSC 0.143 CUT-OFF 8.69 differs from the reported value 7.60 by more than 10%.

# 4. Model quality ?

For models with atomic structures, MolProbity analysis is performed. For models with coarse-grained or multi-scale structures, excluded volume analysis is performed.

## 4.1a. Excluded Volume Analysis ?

*Excluded volume satisfaction for the models in the entry are listed below. The Analysed column shows the number of particle-partice or particle-atom pairs for which excluded volume was analysed.*

| Model ID | Analysed | Number of violations | Excluded Volume Satisfaction (%) |
|---|---|---|---|
| 1 | 7541209455 | 124879 | 100.00 |
| 2 | 7541209455 | 124879 | 100.00 |
| 3 | 7541209455 | 124879 | 100.00 |
| 4 | 7541209455 | 124879 | 100.00 |
| 5 | 7541209455 | 124879 | 100.00 |
| 6 | 7541209455 | 124879 | 100.00 |
| 7 | 7541209455 | 124879 | 100.00 |

| Model ID | Analysed | Number of violations | Excluded Volume Satisfaction (%) |
|---|---|---|---|
| 8 | 7541209455 | 124879 | 100.00 |
| 9 | 7541209455 | 124879 | 100.00 |
| 10 | 7541209455 | 124879 | 100.00 |

# 5. Fit to Data Used for Modeling Assessment ?
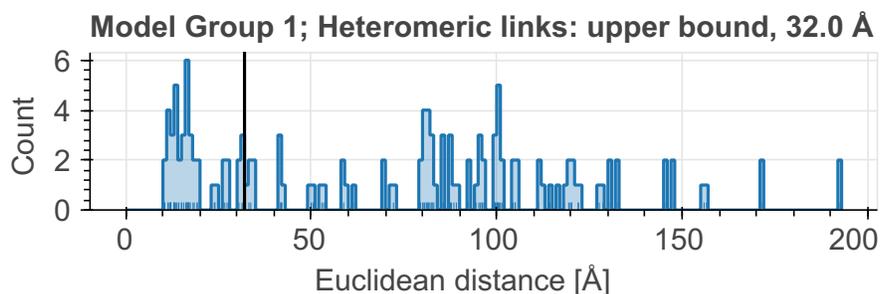
## 5.2. Crosslinking-MS ?

### 5.2.1. Restraint types ?

*This table summarizes information about crosslinker(s) used for data generation, and how crosslinking information was translated into actual modeling restraints. Restraints assigned "by-residue" are interpreted as between CA atoms. Restraints between coarse-grained beads are indicated as "coarse-grained". Restraint group represents a set of crosslinking restraints applied collectively in the modeling.*

There are 1284 crosslinking restraints combined in 114 restraint groups.

| Linker | Residue 1 | Atom 1 | Residue 2 | Atom 2 | Restraint type | Distance, Å | Count |
|---|---|---|---|---|---|---|---|
| DSS | ALA | CA | LYS | CA | upper bound | 32.00 | 692 |
| DSS | LYS | CA | LYS | CA | upper bound | 32.00 | 512 |
| DSS | ALA | CA | ALA | CA | upper bound | 32.00 | 80 |

Distograms of individual restraints

Distograms (i.e., histogram plots of distances) provide an overview of distributions of distances between residues for which chemical crosslinks were identified. The shift of the distogram relative to the threshold value may indicate a poor model. Restraints with identical thresholds are grouped into one plot. Only the best distance per restraint per model group/ensemble is plotted. Inter- and intramolecular (including self-links) restraints are also grouped into one plot. Distance for a restraint between coarse-grained beads is calculated as a minimal distance between shells; if beads intersect, the distance will be reported as 0.0. A bead with the highest available resolution for a given residue is used for the assessment.



Model Group 1; Heteromeric links: upper bound, 32.0 Å

Model Group 1; Self-links: upper bound, 32.0 Å
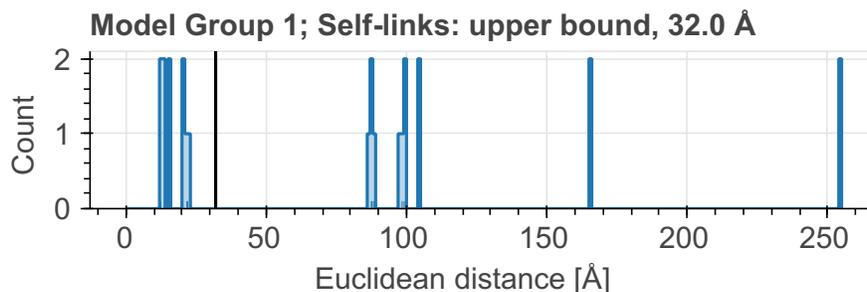
## 5.2.2. Satisfaction of restraints ?

*Satisfaction of restraints is calculated on a restraint group (a set of crosslinking restraints applied collectively in the modeling) level. Satisfaction of a restraint group depends on satisfaction of individual restraints in the group and the conditionality (all/any). A restraint group is considered satisfied, if the condition was met in at least one model of the model group/ensemble. The number of measured restraints can be smaller than the total number of restraint groups if crosslinks involve non-modeled residues. Only deposited models are used for validation right now.*

| State group | State | Model group | # of Deposited models/Total | Restraint group type | Satisfied (%) | Violated (%) | Count (Total=114) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 10/10 | All | 76.92 | 23.08 | 13 |
| | | | | Heteromeric links/ Intermolecular | 72.73 | 27.27 | 11 |
| | | | | Self-links/ Ambiguous | 100.00 | 0.00 | 2 |

Per-model satisfaction rates in ensembles

*Every point represents one model in a model group/ensemble. Where possible, boxplots with quartile marks are also plotted.*


Satisfaction rates in Model Group 1
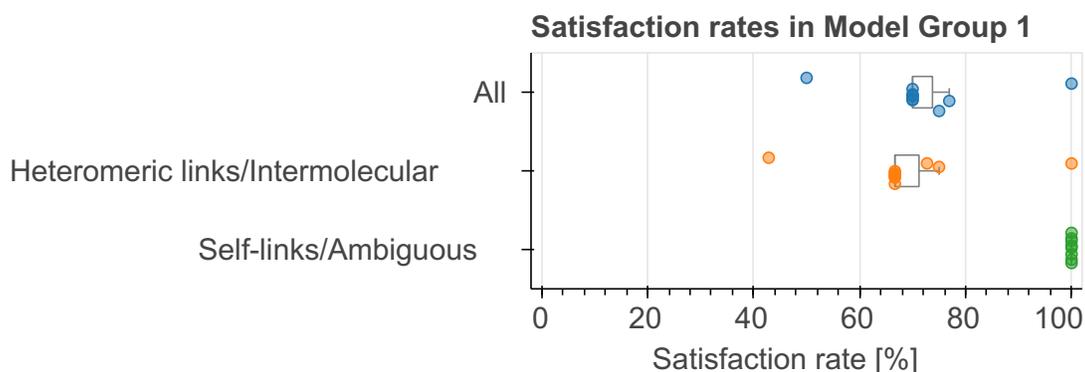
## 5.3. 3DEM

*This section describes fit of models to the 3DEM data. Only results for the representative model, selected as a first model with the largest number of asymmetric units.*

3DEM validation for coarse-grained structures is under development.

# 6. Fit to Data Used for Validation Assessment ?

Validation for this section is under development.