Integrative Structure Validation Report

October 09, 2025 - 04:49 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	9A8N | pdb_00009a8n
PDB-Dev ID	PDBDEV_00000387
Structure Title	Modeling of Yeast NPC basket
Structure Authors	Singh, D.; Soni, N.; Hutchings, J.; Echeverria, I.; Shaikh, F.; Duquette, M.; Suslov, S.; Li, Z.; van Eeuwen, T.; Molloy, K.; Shi, Y.; Wang, J.; Guo, Q.; Chait, B.T.; Fernandez-Martinez, J.; Rout, M.P.; Sali, A.; Villa, E.
Deposited on	2024-07-07

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 1 model(s). A total of 11 dataset(s) were used to build this entry.

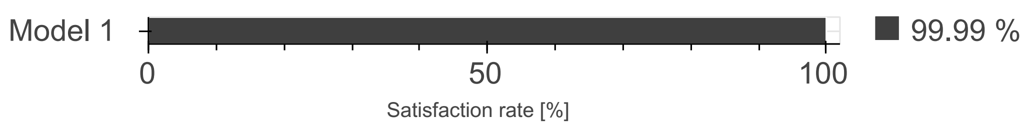
Name	Type	Count
3DEM volume	Experimental data	3

Name	Type	Count
Crosslinking-MS data	Experimental data	2
De Novo model	Starting model	4
Experimental model	Starting model	2

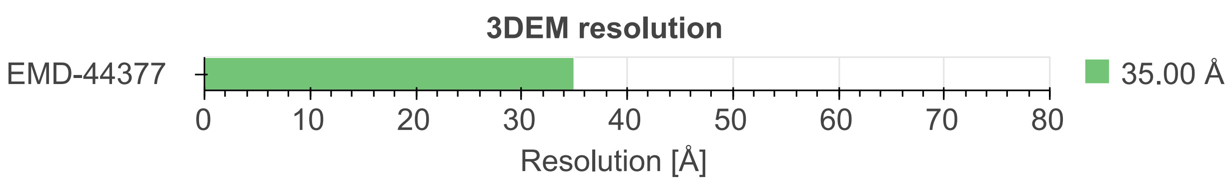
1.2. Overall quality ?

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.

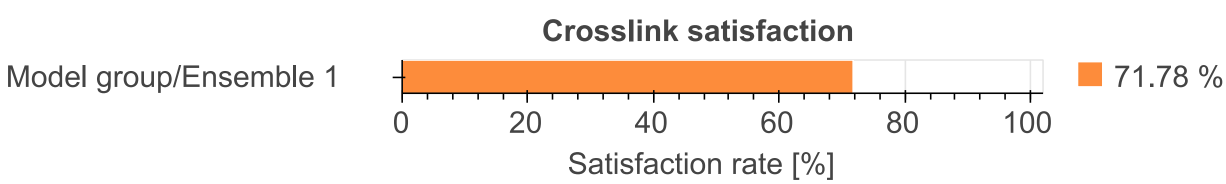
Model Quality: Excluded Volume Analysis ?



Data Quality ?



Fit to Data Used for Modeling ?



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	1	Unknown MLP Protein	A	1875	71-183, 197-221, 239-281, 285-324, 340-371, 435-463, 535-570, 575-617, 622-668, 689-717, 745-773, 791-840, 844-893, 930-986, 990-1088, 1092-1127, 1143-1199, 1212-1251, 1254-1286, 1290-1339, 1343-1385, 1408-1457	1-70, 184-196, 222-238, 282-284, 325-339, 372-434, 464-534, 571-574, 618-621, 669-688, 718-744, 774-790, 841-843, 894-929, 987-989, 1089-1091, 1128-1142, 1200-1211, 1252-1253, 1287-1289, 1340-1342, 1386-1407, 1458-1875	100.00 / 54.99	Multiscale: Coarse-grained: 1 - 50 residue(s) per bead
				B					
				C					
				D					
				E					
				F					
				G					
				H					
				I					
				J					
				K					
				L					
				M					
				N					
				O					
				P					
		2	Nucleoporin NUP1	Q	1076	1-32, 85-104, 106-123	33-84, 105, 124-335	31.13 / 20.90	Multiscale: Coarse-grained: 1 - 30 residue(s) per bead
				R					
				S					
				T					
				U					
				V					
				W					
				X					
		3	Nucleoporin NUP2	Y	720	83-136, 602-720	1-82, 137-601	100.00 / 24.03	Multiscale: Coarse-grained: 1 - 30 residue(s) per bead
				Z					
				AA					
				AB					
				AC					
				AD					
				AE					
				AF					

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
				AG					
				AH					
				AI					
				AJ					
				AK					
				AL					
				AM					
				AN					
		4	Nucleoporin NUP60	AO	539	27-47, 91-104, 106-119, 121-140, 142-162	1-26, 48-90, 105, 120, 141, 163-398, 505-539	80.33 / 20.79	Multiscale: Coarse-grained: 1 - 30 residue(s) per bead
				AP					
				AQ					
				AR					
				AS					
				AT					
				AU					
				AV					
				AW					
				AX					
				AY					
				AZ					
				BA					
				BB					
				BC					
				BD					
		5	Nucleoporin NUP120	BE	1037	1-29, 53-305, 311-711, 714-1036	30-52, 306-310, 712-713, 1037	100.00 / 97.01	Multiscale: Coarse-grained: 1 - 23 residue(s) per bead
				BF					
				BG					
				BH					
				BI					
				BJ					
				BK					
				BL					

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
				BM					
				BN					
				BO					
				BP					
				BQ					
				BR					
				BS					
				BT					
		6	Nucleoporin NUP85	BU	744	47-126, 132-230, 235-436, 451-744	1-46, 127-131, 231-234, 437-450	100.00 / 90.73	Multiscale: Coarse-grained: 1 - 46 residue(s) per bead
				BW					
				BY					
				CA					
				CC					
				CE					
				CG					
				CI					
		6	Nucleoporin NUP85	BV	744	47-126, 132-230, 235-436, 451-739	1-46, 127-131, 231-234, 437-450, 740-744	100.00 / 90.05	Multiscale: Coarse-grained: 1 - 46 residue(s) per bead
				BX					
				BZ					
				CB					
				CD					
				CF					
				CH					
				CJ					
		7	Nucleoporin NUP145C	CK	712	119-712	1-118	100.00 / 83.43	Multiscale: Coarse-grained: 1 - 50 residue(s) per bead
				CL					
				CM					
				CN					
				CO					
				CP					
				CQ					
				CR					

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
				CS					
				CT					
				CU					
				CV					
				CW					
				CX					
				CY					
				CZ					
		8	Protein transport protein SEC13	DA	297	8-157, 170-293	1-7, 158-169, 294-297	100.00 / 92.26	Multiscale: Coarse-grained: 1 - 12 residue(s) per bead
				DB					
				DC					
				DD					
				DE					
				DF					
				DG					
				DH					
				DI					
				DJ					
				DK					
				DL					
				DM					
				DN					
				DO					
				DP					
		9	Nucleoporin SEH1	DQ	349	1-248, 288-346	249-287, 347-349	100.00 / 87.97	Multiscale: Coarse-grained: 1 - 39 residue(s) per bead
				DR					
				DS					
				DT					
				DU					
				DV					
				DW					
				DX					

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
				DY					
				DZ					
				EA					
				EB					
				EC					
				ED					
				EE					
				EF					
		10	Nucleoporin NUP84	EG	726	7-20, 27-80, 96-126, 136-364, 372-483, 506-562, 575-726	1-6, 21-26, 81-95, 127-135, 365-371, 484-505, 563-574	100.00 / 89.39	Multiscale: Coarse-grained: 1 - 22 residue(s) per bead
				EH					
				EI					
				EJ					
				EK					
				EL					
				EM					
				EN					
				EO					
				EP					
				EQ					
				ER					
				ES					
				ET					
				EU					
				EV					
		11	Nucleoporin NUP133	EW	1157	63-183, 198-480, 490-763, 772-1155	1-62, 184-197, 481-489, 764-771, 1156-1157	100.00 / 91.79	Multiscale: Coarse-grained: 1 - 50 residue(s) per bead
				EY					
				FA					
				FC					
				FE					
				FG					
				FI					
				FK					

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
		11	Nucleoporin NUP133	EX	1157	56-77, 86-125, 133-144, 162-184, 193-200, 206-249, 258-480, 490-763, 772-1155	1-55, 78-85, 126-132, 145-161, 185-192, 201-205, 250-257, 481-489, 764-771, 1156-1157	100.00 / 89.02	Multiscale: Coarse-grained: 1 - 50 residue(s) per bead
				EZ					
				FB					
				FD					
				FF					
				FH					
				FJ					
				FL					

2.3. Datasets used for modeling

There are 11 unique datasets used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	De Novo model	Zenodo	10.5281/zenodo.13131753
2	De Novo model	Zenodo	10.5281/zenodo.13131753
3	De Novo model	Zenodo	10.5281/zenodo.13131753
4	De Novo model	Zenodo	10.5281/zenodo.13131753
5	Experimental model	PDB	pdb_00007n84
6	Experimental model	Zenodo	10.5281/zenodo.13131753
7	Crosslinking-MS data	Zenodo	10.5281/zenodo.13131753
8	Crosslinking-MS data	Zenodo	10.5281/zenodo.13131753
9	3DEM volume	EMDB	EMD-44377
10	3DEM volume	Zenodo	10.5281/zenodo.13131753
11	3DEM volume	Zenodo	10.5281/zenodo.13131753

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	Sampling	Replica exchange monte carlo	Not available	1000	False	True
2	1	Sampling	Replica exchange monte carlo	Not available	15467933	False	True

There are 3 software packages reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	IMP PMI module	2.19.0	integrative model building	https://integrativemodeling.org
3	COCONUT	1.0.0	Coiled-coil model building	https://github.com/neeleshsoni21/COCONUT
2	Integrative Modeling Platform (IMP)	2.19.0	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-44377

3.3.1. Experimental information

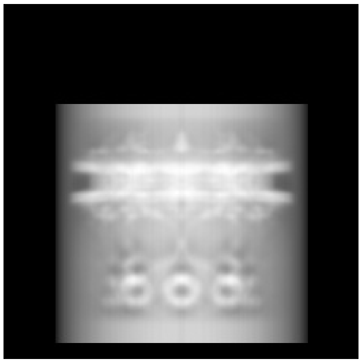
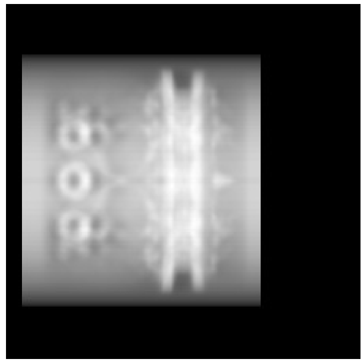
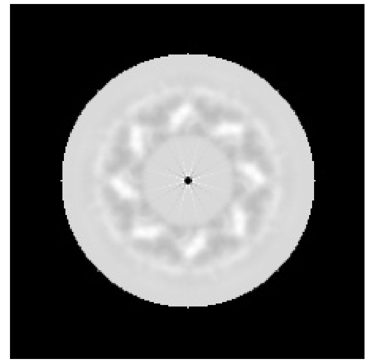
EM reconstruction method:	SUBTOMOGRAM AVERAGING
Resolution:	35.00 Å
Recommended level:	0.246
Estimated volume:	299100.00 nm³
Specimen preparation:	Preparation ID 1 Vitrification
Map-only validation report:	wwPDB validation report

3.3.2. Map visualisation

This section contains visualisations of the EMDB entry EMD-44377. 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

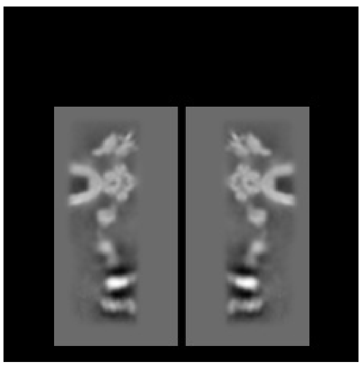
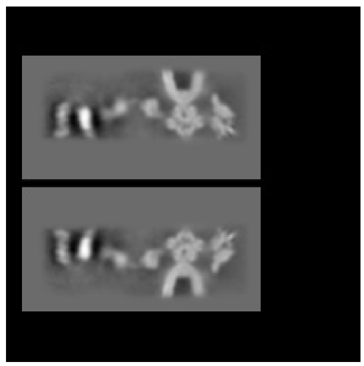
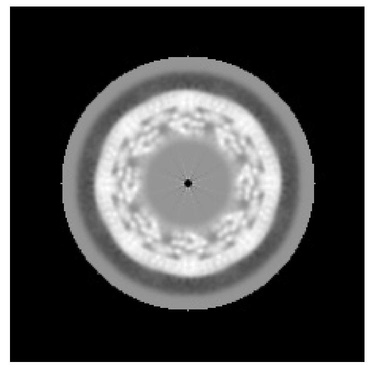




X **Y** **Z**

The images above show the map projected in three orthogonal directions.

3.3.2.2. Central slices

Primary map

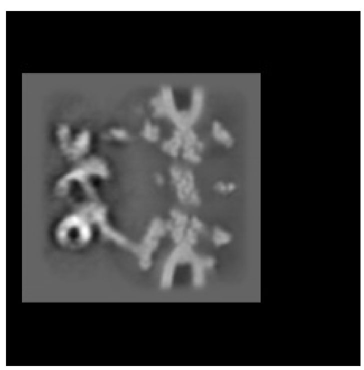
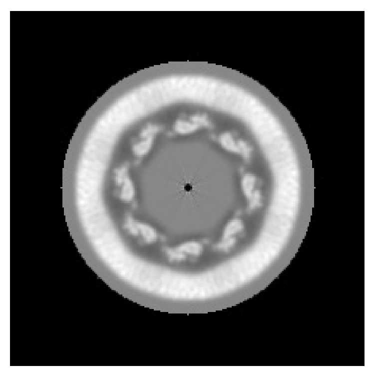




X Index: 112 **Y Index: 112** **Z Index: 112**

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

3.3.2.3. Largest variance slices

Primary map

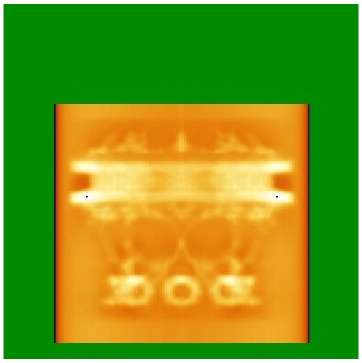
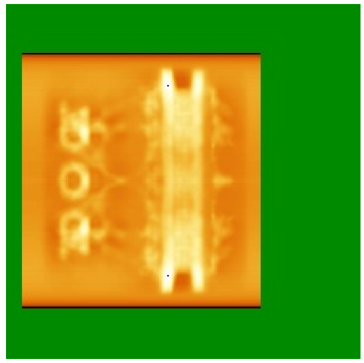
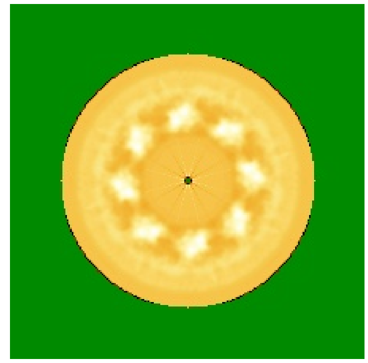




X Index: 79 **Y Index: 79** **Z Index: 103**

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

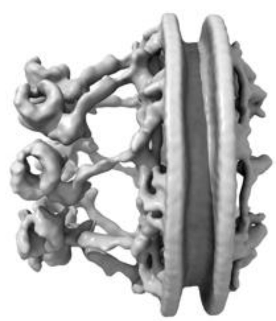
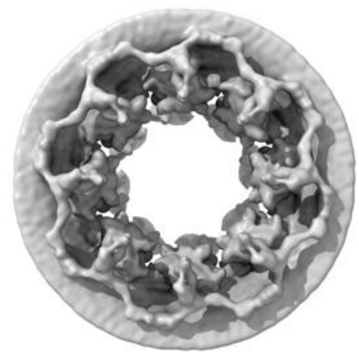
  

X **Y** **Z**

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

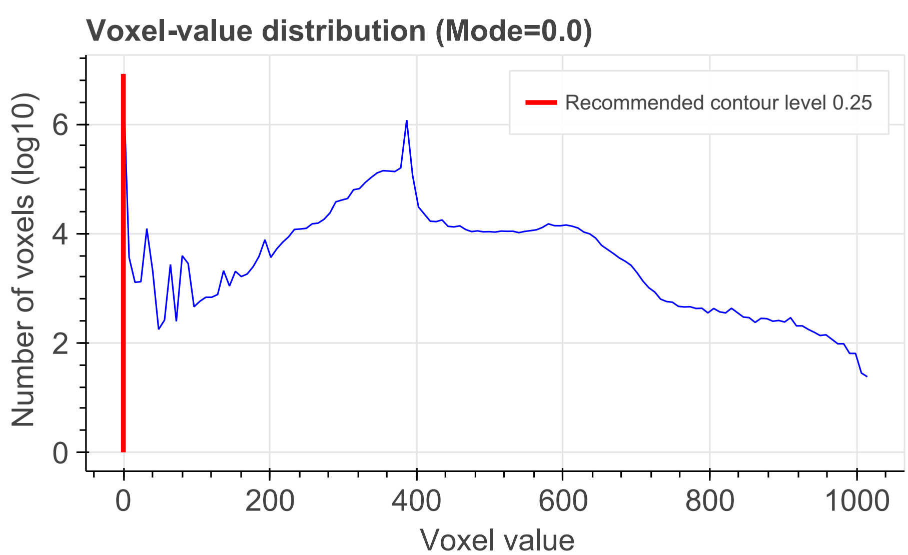
X **Y** **Z**

The images above show the 3D surface view of the map at the recommended contour level 0.246 . These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

3.3.3. Map analysis

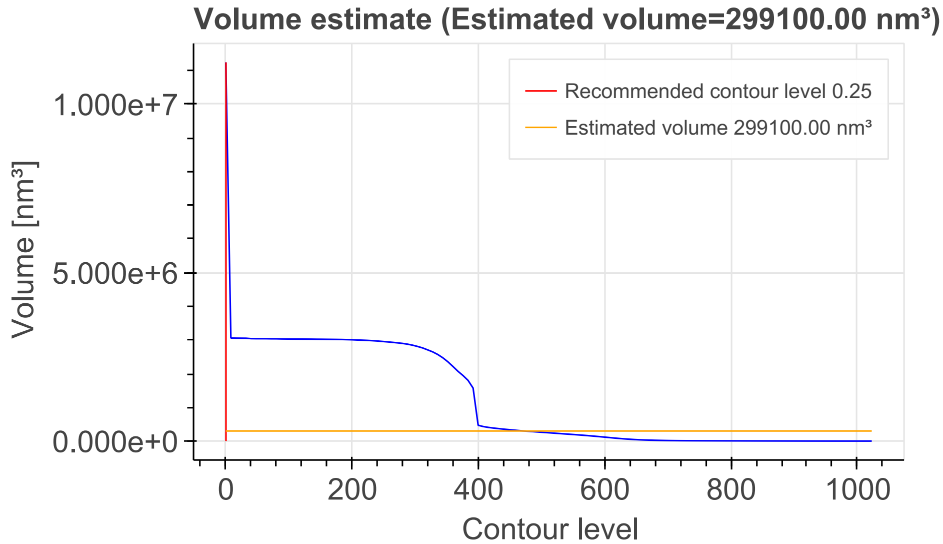
This section contains the results of statistical analysis of the map.

3.3.3.1. Map-value distribution



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.

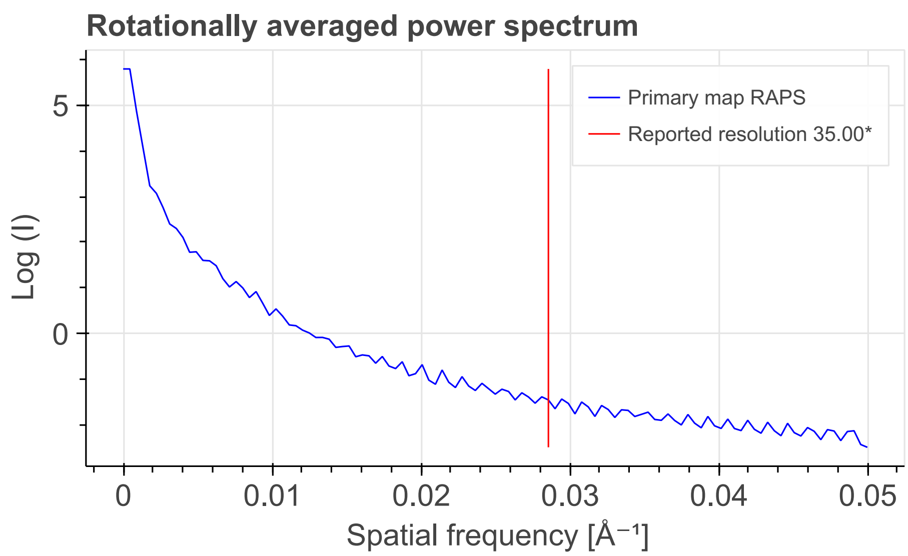
3.3.3.2. Volume estimate ?



The volume at the recommended contour level is 299100.00 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 ?



*Reported resolution corresponds to spatial frequency of 0.029 $Å^{-1}$

3.3.4. Fourier-Shell correlation ?

3.3.4.2. Resolution estimates ?

Resolution estimate (Å)	**Estimation criterion (FSC cut-off)**		
	0.143	**0.5**	**Half-bit**
Reported by author	35.00	-	-

Author-provided FSC curve is not available.

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	4672689456	234504	99.99

5. Fit to Data Used for Modeling Assessment ?

5.2. Crosslinking-MS ?

5.2.1. Restraint types ?

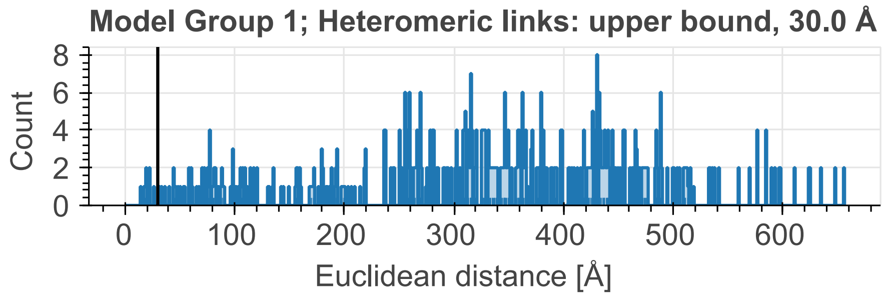
This table summarizes information about crosslinker(s) used for data generation, and how crosslinking information was translated into actual modeling restraints. Restraints assigned "by-residue" are interpreted as between CA atoms. Restraints between coarse-grained beads are indicated as "coarse-grained".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

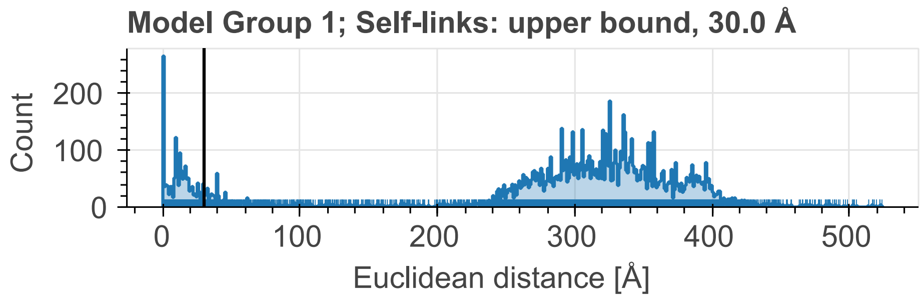
There are 12843 crosslinking restraints combined in 652 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
DSS	UNK	CA	UNK	CA	upper bound	30.00	4858
DSS	UNK	coarse-grained	UNK	coarse-grained	upper bound	30.00	6232
DSS	LYS	coarse-grained	UNK	coarse-grained	upper bound	30.00	190
DSS	LYS	CA	UNK	CA	upper bound	30.00	80
DSS	LYS	coarse-grained	LYS	coarse-grained	upper bound	30.00	1185
DSS	LYS	CA	LYS	CA	upper bound	30.00	198
DSS	HIS	coarse-grained	LYS	coarse-grained	upper bound	30.00	20
DSS	THR	coarse-grained	UNK	coarse-grained	upper bound	30.00	40
DSS	LYS	coarse-grained	THR	coarse-grained	upper bound	30.00	20
DSS	LYS	coarse-grained	MET	coarse-grained	upper bound	30.00	20

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.





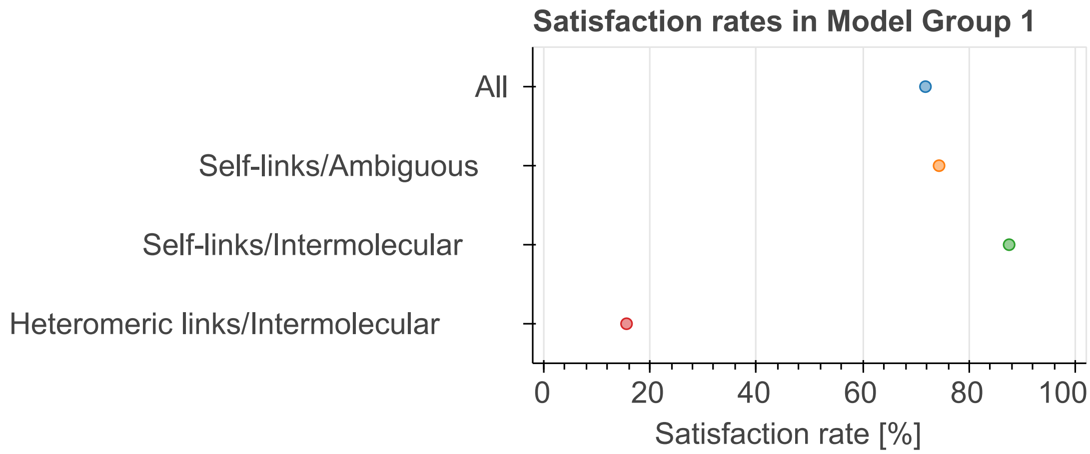
5.2.2. Satisfaction of restraints

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=652)
1	1	1	1/1	All	71.78	28.22	652
				Self-links/ Ambiguous	74.34	25.66	604
				Self-links/ Intermolecular	87.50	12.50	16
				Heteromeric links/ Intermolecular	15.62	84.38	32

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.



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.

Acknowledgments

The development of integrative model validation metrics, implementation of a model validation pipeline, and creation of a validation report for integrative structures are funded by NSF awards to the PDB-IHM team (DBI-1756248, DBI-2112966, DBI-2112967, DBI-2112968, and DBI-1756250) and awards from NSF, NIH, and DOE to the RCSB PDB (DBI-2321666, R01GM157729, and DE-SC0019749). The PDB-IHM team and members of the Sali lab contributed model validation metrics and software packages.

Dr. Jill Trewhella, Dr. Dina Schneidman, and members of the SASBDB repository are acknowledged for their advice and support in implementing SAS validation methods. Team members from the labs of Dr. Juri Rappsilber, Dr. Alexander Leitner, Dr. Andrea Graziadei, and members of PRIDE database are acknowledged for their advice and support in implementing crosslinking-MS validation methods. We are grateful to Dr. Shruthi Viswanath for discussions about uncertainty assessment of integrative structural models.

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