

Integrative Structure Validation Report

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

IHMValidation Version 3.0

Python-IHM Version 2.5


MolProbity Version 4.5.2

pyHMMER Version 0.11.1

PDB ID	9A69 pdb_00009a69
PDB-Dev ID	PDBDEV_00000302
Structure Title	Integrative model of MCPB-MCPC by crosslinking MS and deep learning
Structure Authors	Stahl, K.; Brock, O.; Rappsilber, J.
Deposited on	2024-01-23

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

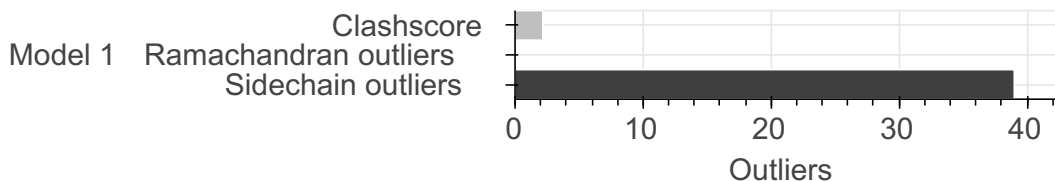
This entry consists of 1 model(s). A total of 1 dataset(s) were used to build this entry.

Name	Type	Count
Crosslinking-MS data	Experimental data	1

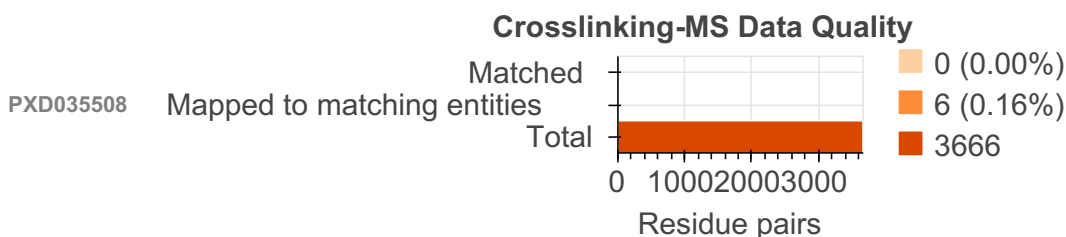
1.2. Overall quality

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.

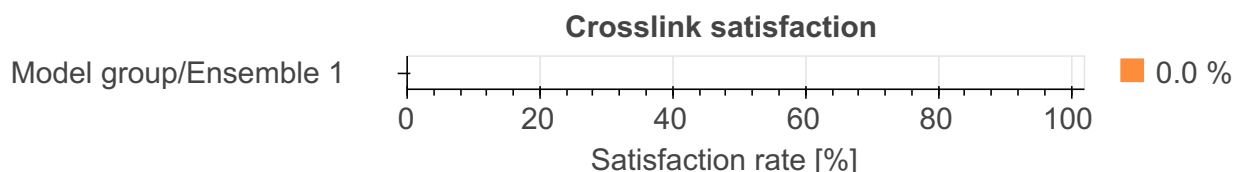
Model Quality: MolProbity Analysis ?



Data Quality ?



Fit to Data Used for Modeling ?



2. Model Details ?

2.1. Ensemble information ?

This entry consists of 0 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	MCPB_BACSU	A	662	-	1-662	100.00 / 0.00	Atomic
		2	MCPC_BACSU	B	655	-	1-655	100.00 / 0.00	Atomic

2.3. Datasets used for modeling ?

There is 1 unique dataset used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	Crosslinking-MS data	PRIDE	PXD035508

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	AlphaLink2	AlphaLink2	Not available	1	False	False

There is 1 software package reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	AlphaLink2	1.00	model building	https://github.com/Rappsilber-Laboratory/AlphaLink2

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).

[PXD035508](#)

Number of entities in the crosslinking-MS dataset: 810

Number of entities in the entry: 2

Matching entities:

Entity ID	Molecule name	Crosslinking-MS Entity ID	E-value	Exact match
1	MCPB_BACSU	dbseq_P39215_target	0.00	True
2	MCPC_BACSU	dbseq_P54576_target	0.00	True

Residue pairs stats:

Source	Total	In matched entities	Total matched
9A69	1	1 (100.00%)	0 (0.00%)
PXD035508	3666	6 (0.16%)	0 (0.00%)

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.

4.1b. MolProbity Analysis ?

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

Standard geometry: bond outliers ?

There are no bond length outliers.

Standard geometry: angle outliers ?

There are 70 bond angle outliers in this entry (0.51% of 13750 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	410	GLN	OE1-CD-NE2	5.59	117.01	122.60	1	1
A	99	PHE	CA-CB-CG	5.57	119.37	113.80	1	1
A	420	GLN	OE1-CD-NE2	5.18	117.42	122.60	1	1
A	556	GLN	OE1-CD-NE2	5.15	117.45	122.60	1	1
B	218	GLN	OE1-CD-NE2	5.14	117.46	122.60	1	1
B	96	GLN	OE1-CD-NE2	5.05	117.55	122.60	1	1
A	461	GLN	OE1-CD-NE2	5.03	117.57	122.60	1	1
A	601	GLN	OE1-CD-NE2	4.99	117.61	122.60	1	1
A	622	GLN	OE1-CD-NE2	4.94	117.66	122.60	1	1
B	609	GLN	OE1-CD-NE2	4.94	117.66	122.60	1	1
B	266	GLN	OE1-CD-NE2	4.90	117.70	122.60	1	1
B	249	GLN	OE1-CD-NE2	4.88	117.72	122.60	1	1
B	172	GLN	OE1-CD-NE2	4.84	117.76	122.60	1	1
A	538	GLN	OE1-CD-NE2	4.82	117.78	122.60	1	1
B	602	GLN	OE1-CD-NE2	4.80	117.80	122.60	1	1
B	588	GLN	OE1-CD-NE2	4.79	117.81	122.60	1	1
A	142	GLN	OE1-CD-NE2	4.77	117.83	122.60	1	1
A	587	GLN	OE1-CD-NE2	4.77	117.83	122.60	1	1
A	400	GLN	OE1-CD-NE2	4.77	117.83	122.60	1	1
A	458	GLN	OE1-CD-NE2	4.77	117.83	122.60	1	1
B	379	GLN	OE1-CD-NE2	4.76	117.84	122.60	1	1
B	92	ASP	CA-CB-CG	4.70	117.30	112.60	1	1
B	53	GLN	OE1-CD-NE2	4.70	117.90	122.60	1	1
A	419	GLN	OE1-CD-NE2	4.69	117.91	122.60	1	1
A	332	HIS	CB-CG-CD2	4.69	125.11	131.20	1	1

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	91	ASN	OD1-CG-ND2	4.65	117.95	122.60	1	1
A	315	GLN	OE1-CD-NE2	4.59	118.01	122.60	1	1
A	490	GLN	OE1-CD-NE2	4.54	118.06	122.60	1	1
B	45	GLN	OE1-CD-NE2	4.53	118.07	122.60	1	1
B	306	GLN	OE1-CD-NE2	4.52	118.08	122.60	1	1
B	578	GLN	OE1-CD-NE2	4.52	118.08	122.60	1	1
A	86	PHE	CA-CB-CG	4.47	109.33	113.80	1	1
A	107	GLN	OE1-CD-NE2	4.47	118.13	122.60	1	1
B	261	GLN	OE1-CD-NE2	4.45	118.15	122.60	1	1
A	559	GLN	OE1-CD-NE2	4.45	118.15	122.60	1	1
A	452	GLN	OE1-CD-NE2	4.44	118.16	122.60	1	1
A	249	ASP	CA-CB-CG	4.42	117.02	112.60	1	1
B	76	HIS	CB-CG-CD2	4.40	125.47	131.20	1	1
A	447	GLN	OE1-CD-NE2	4.39	118.21	122.60	1	1
A	118	ASN	OD1-CG-ND2	4.38	118.22	122.60	1	1
A	525	GLN	OE1-CD-NE2	4.38	118.22	122.60	1	1
B	644	GLN	OE1-CD-NE2	4.37	118.23	122.60	1	1
A	434	GLN	OE1-CD-NE2	4.35	118.25	122.60	1	1
B	226	GLN	OE1-CD-NE2	4.34	118.26	122.60	1	1
B	351	GLN	OE1-CD-NE2	4.32	118.28	122.60	1	1
A	462	GLN	OE1-CD-NE2	4.31	118.29	122.60	1	1
A	410	GLN	CB-CG-CD	4.30	119.90	112.60	1	1
A	195	GLN	OE1-CD-NE2	4.29	118.31	122.60	1	1
A	242	GLN	OE1-CD-NE2	4.29	118.31	122.60	1	1
B	365	GLN	OE1-CD-NE2	4.28	118.32	122.60	1	1
A	349	GLN	OE1-CD-NE2	4.27	118.33	122.60	1	1
B	484	GLN	OE1-CD-NE2	4.27	118.33	122.60	1	1
B	625	GLN	OE1-CD-NE2	4.23	118.37	122.60	1	1
A	171	GLN	OE1-CD-NE2	4.22	118.38	122.60	1	1
B	467	GLN	OE1-CD-NE2	4.21	118.39	122.60	1	1
A	595	GLN	OE1-CD-NE2	4.14	118.46	122.60	1	1
A	192	GLN	OE1-CD-NE2	4.12	118.48	122.60	1	1
A	448	GLN	OE1-CD-NE2	4.12	118.48	122.60	1	1
B	93	ASP	CA-CB-CG	4.12	116.72	112.60	1	1
A	631	GLN	OE1-CD-NE2	4.12	118.48	122.60	1	1

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	359	GLN	OE1-CD-NE2	4.11	118.49	122.60	1	1
B	344	ASN	OD1-CG-ND2	4.11	118.49	122.60	1	1
A	492	ASN	OD1-CG-ND2	4.09	118.51	122.60	1	1
B	339	ASN	OD1-CG-ND2	4.07	118.53	122.60	1	1
A	46	GLN	OE1-CD-NE2	4.06	118.54	122.60	1	1
B	519	GLN	OE1-CD-NE2	4.06	118.54	122.60	1	1
B	555	GLN	OE1-CD-NE2	4.05	118.55	122.60	1	1
A	92	GLN	OE1-CD-NE2	4.04	118.56	122.60	1	1
A	647	GLN	OE1-CD-NE2	4.03	118.57	122.60	1	1
B	188	GLN	OE1-CD-NE2	4.00	118.60	122.60	1	1

Too-close contacts

The following all-atom clashscore is based on a MolProbity analysis. All-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The table below contains clashscores for all atomic models in this entry.

Model ID	Clash score	Number of clashes
1	2.17	44

There are 44 clashes. The table below contains the detailed list of all clashes based on a MolProbity analysis. Bad clashes are ≥ 0.4 Angstrom.

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:428:ILE:HG23	B:576:LEU:HD22	0.89	1	1
A:428:ILE:HG22	A:586:LEU:HD11	0.74	1	1
A:455:SER:HB2	B:551:MET:HE1	0.69	1	1
A:102:TYR:CD1	A:112:ILE:HD11	0.67	1	1
A:393:PHE:CD1	A:621:ILE:HD11	0.66	1	1
A:470:LEU:HD22	B:534:ILE:HG23	0.65	1	1
A:393:PHE:HD1	A:621:ILE:HD11	0.63	1	1
A:165:MET:HE2	A:186:ILE:HD12	0.58	1	1
A:250:LYS:HE2	A:269:TYR:CE1	0.57	1	1
A:400:GLN:HE21	B:604:ILE:HG23	0.57	1	1
B:440:LEU:HD12	B:566:LEU:HD12	0.57	1	1
A:428:ILE:HG23	B:576:LEU:CD2	0.56	1	1
A:347:MET:SD	B:341:MET:HE1	0.55	1	1
B:468:THR:HG21	B:534:ILE:CG2	0.54	1	1
A:85:ALA:HB1	A:95:ILE:HD11	0.53	1	1
B:94:ILE:HA	B:97:ILE:HD12	0.53	1	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:404:VAL:HG11	A:611:ALA:HB2	0.51	1	1
A:418:LEU:HD21	A:596:LEU:HD23	0.51	1	1
B:90:PHE:CZ	B:109:ILE:HD12	0.51	1	1
A:319:THR:HG22	A:324:ASP:HB3	0.50	1	1
A:225:LEU:HD23	A:229:TRP:CH2	0.50	1	1
A:550:MET:HE3	B:457:VAL:HG22	0.49	1	1
A:156:PRO:HB3	A:165:MET:HE1	0.49	1	1
A:390:ILE:HG23	A:621:ILE:HG23	0.48	1	1
A:7:TRP:CZ2	A:15:LYS:HE2	0.48	1	1
B:415:ILE:HG22	B:587:ILE:HD11	0.47	1	1
B:148:TRP:CZ3	B:164:ALA:HB2	0.47	1	1
A:557:GLU:HA	A:557:GLU:OE1	0.46	1	1
A:455:SER:CB	B:551:MET:HE1	0.45	1	1
A:393:PHE:CZ	B:387:VAL:HG13	0.45	1	1
A:586:LEU:HD23	A:589:MET:CE	0.45	1	1
A:453:MET:HE1	A:561:GLY:HA3	0.45	1	1
B:468:THR:HG21	B:534:ILE:HG22	0.45	1	1
B:468:THR:HG21	B:534:ILE:HG21	0.44	1	1
B:132:SER:HA	B:137:LYS:HE3	0.43	1	1
A:481:LEU:HD11	A:533:ILE:HG22	0.43	1	1
B:108:TYR:CE1	B:179:SER:HB2	0.43	1	1
A:156:PRO:HB3	A:165:MET:CE	0.43	1	1
A:165:MET:HE3	A:166:VAL:N	0.41	1	1
A:7:TRP:CE2	A:15:LYS:HE2	0.41	1	1
B:384:ILE:HA	B:384:ILE:HD13	0.41	1	1
A:71:ALA:HB1	A:151:ILE:HD13	0.40	1	1
B:440:LEU:HD11	B:562:THR:HG22	0.40	1	1
A:659:PHE:CE2	B:348:MET:CE	0.40	1	1

Torsion angles: Protein backbone ?

In the following table, Ramachandran outliers are listed. The Analysed column shows the number of residues for which the backbone conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	1313	1303	10	0

Torsion angles : Protein sidechains ?

In the following table, sidechain rotameric outliers are listed. The Analysed column shows the number of residues for which the

sidechain conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	1119	1037	43	39

There are 39 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	3	THR	1
A	8	LEU	1
A	25	LEU	1
A	39	SER	1
A	241	LEU	1
A	288	LEU	1
A	301	PHE	1
A	310	LEU	1
A	313	LEU	1
A	327	GLU	1
A	354	LEU	1
A	385	HIS	1
A	410	GLN	1
A	543	GLU	1
A	565	THR	1
A	614	SER	1
B	1	MET	1
B	26	LEU	1
B	28	SER	1
B	227	THR	1
B	230	THR	1
B	271	SER	1
B	279	LEU	1
B	283	LEU	1
B	307	LEU	1
B	350	GLU	1
B	363	SER	1
B	384	ILE	1
B	408	LEU	1
B	444	LEU	1

Chain	Res	Type	Models (Total)
B	464	LEU	1
B	488	LEU	1
B	501	GLU	1
B	526	HIS	1
B	533	LEU	1
B	536	LEU	1
B	557	SER	1
B	647	MET	1
B	650	ILE	1

5. Fit to Data Used for Modeling Assessment ?

5.2. Crosslinking-MS ?

5.2.1. Restraint types ?

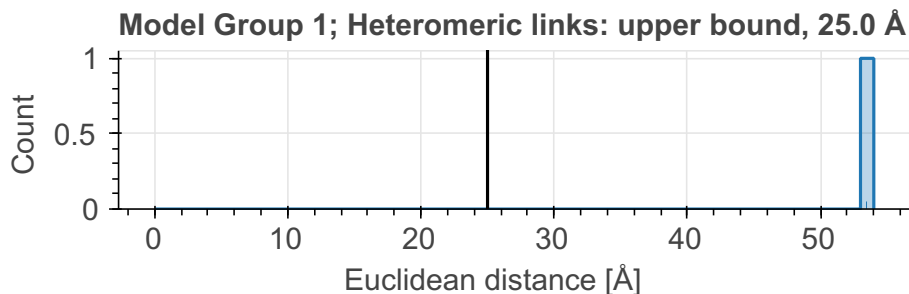
This table summarizes information about crosslinker(s) used for data generation, and how crosslinking information was translated into actual modeling restraints. Restraints assigned "by-residue" are interpreted as between CA atoms. Restraints between coarse-grained beads are indicated as "coarse-grained".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

There are 1 crosslinking restraints combined in 1 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
SDA	LYS	CA	LYS	CA	upper bound	25.00	1

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.



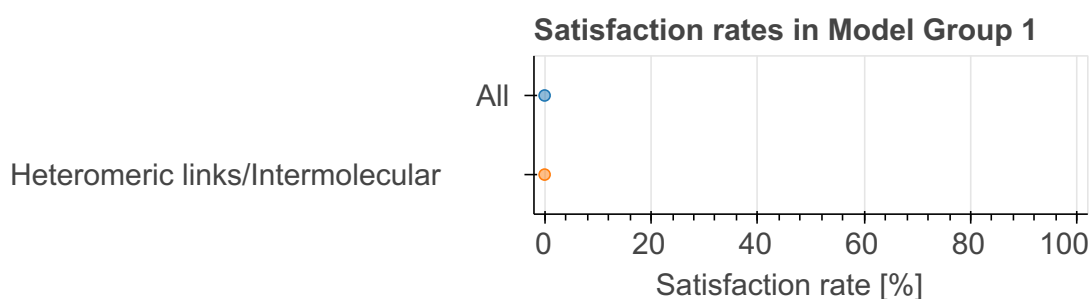
5.2.2. Satisfaction of restraints ?

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=1)
1	1	1	1/1	All	0.00	100.00	1
				Heteromeric links/Intermolecular	0.00	100.00	1

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.



6. Fit to Data Used for Validation Assessment

Validation for this section is under development.

Acknowledgments

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