Integrative Structure Validation Report

October 09, 2025 - 04:41 PM PDT

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	9A2U | pdb_00009a2u
PDB-Dev ID	PDBDEV_00000179
Structure Title	Model of E. coli RplN by in-cell photo-crosslinking MS and deep learning
Structure Authors	Stahl, K.; Graziadei, A.; Dau, T.; Brock, O.; Rappsilber, J.
Deposited on	2023-02-03

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

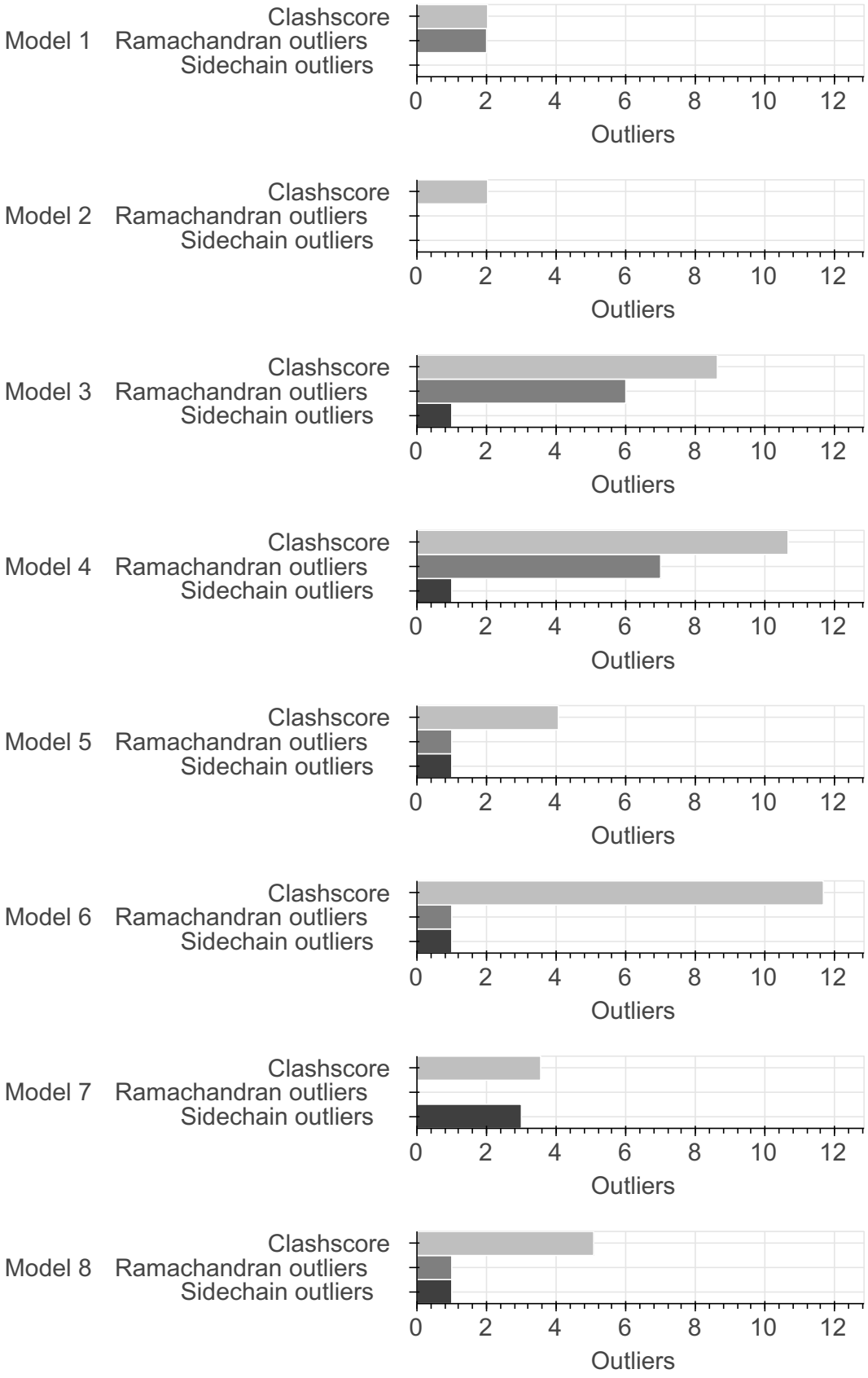
This entry consists of 10 model(s). A total of 1 dataset(s) were used to build this entry.

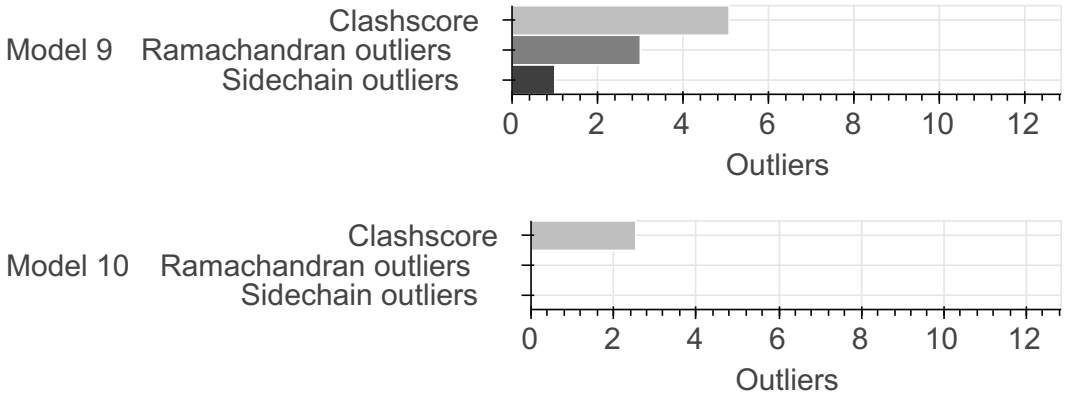
Name	Type	Count
Crosslinking-MS data	Experimental data	1

1.2. Overall quality

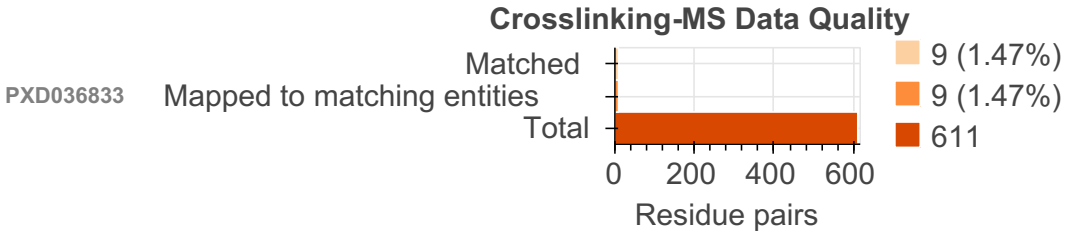
This validation report contains model quality assessments for all structures, data quality and fit to model assessments for SAS and crosslinking-MS datasets. Data quality and fit to model assessments for other datasets and model uncertainty are under development. Number of plots is limited to 256.

Model Quality: MolProbity Analysis

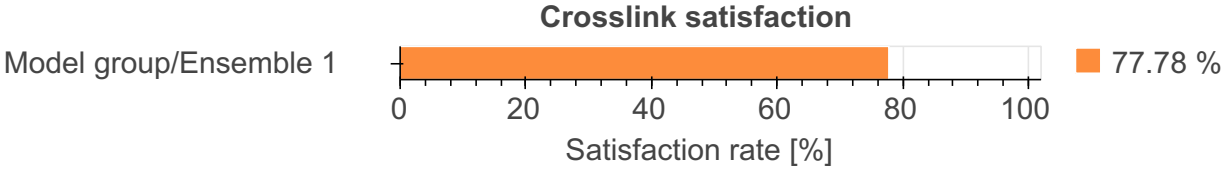




Data Quality



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	1-10	1	P0ADY3	A	123	-	1-123	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	jPOSTrepo	JPST001851

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	AlphaLink	AlphaLink with 10 msa subsamples	Not available	10	False	False

There is 1 software package reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	AlphaLink	1.00	model building	https://github.com/lhatsk/AlphaLink

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).

PXD036833

Number of entities in the crosslinking-MS dataset: 1102

Number of entities in the entry: 1

Matching entities:

Entity ID	Molecule name	Crosslinking-MS Entity ID	E-value	Exact match
1	P0ADY3	dbseq_P0ADY3_target	0.00	True

Residue pairs stats:

Source	Total	In matched entities	Total matched
9A2U	9	9 (100.00%)	9 (100.00%)
PXD036833	611	9 (1.47%)	9 (1.47%)

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-partice or particle-atom pairs for which excluded volume was analysed.

Standard geometry: bond outliers

There are 3 bond length outliers in this entry (0.03% of 9560 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	97	THR	N-CA	4.98	1.55	1.46	4	1
A	96	GLY	N-CA	4.80	1.53	1.45	4	1
A	96	GLY	CA-C	4.32	1.59	1.52	4	1

Standard geometry: angle outliers

There are 41 bond angle outliers in this entry (0.32% of 12810 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	96	GLY	C-N-CA	8.60	137.18	121.70	4	1
A	81	GLY	N-CA-C	8.23	137.17	113.30	4	1
A	95	ILE	C-N-CA	7.65	135.47	121.70	4	1
A	97	THR	C-N-CA	7.44	135.08	121.70	3	2
A	91	SER	C-N-CA	7.20	134.67	121.70	4	1
A	81	GLY	C-N-CA	7.04	134.37	121.70	4	2
A	97	THR	N-CA-CB	6.98	123.36	111.50	4	1
A	115	ILE	C-N-CA	5.88	132.28	121.70	6	1
A	12	ASP	CA-CB-CG	5.79	118.39	112.60	3	1
A	96	GLY	N-CA-C	5.07	128.00	113.30	4	1
A	122	VAL	C-N-CA	5.04	130.77	121.70	8	1
A	104	THR	CA-CB-OG1	4.96	117.03	109.60	2	1
A	80	ASP	CA-C-O	4.88	112.51	120.80	4	1
A	11	ALA	C-CA-CB	4.82	117.73	110.50	6	1
A	97	THR	N-CA-C	4.66	124.06	111.00	4	1
A	117	SER	C-N-CA	4.57	129.93	121.70	6	1
A	5	GLN	OE1-CD-NE2	4.45	118.15	122.60	3	5
A	90	ASN	C-N-CA	4.44	129.69	121.70	3	1
A	104	THR	N-CA-CB	4.43	103.98	111.50	2	1
A	3	GLN	OE1-CD-NE2	4.30	118.30	122.60	1	5

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	13	ASN	OD1-CG-ND2	4.25	118.35	122.60	6	1
A	96	GLY	CA-C-N	4.23	124.66	116.20	4	1
A	97	THR	CA-CB-CG2	4.15	117.56	110.50	4	1
A	41	ILE	CA-CB-CG1	4.13	117.42	110.40	2	3
A	92	GLU	C-N-CA	4.11	129.09	121.70	3	1
A	82	ASN	OD1-CG-ND2	4.06	118.54	122.60	7	1
A	93	GLN	OE1-CD-NE2	4.05	118.55	122.60	5	2
A	84	CYS	C-N-CA	4.03	128.96	121.70	4	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	2.03	4
2	2.03	4
3	8.63	17
4	10.66	21
5	4.06	8
6	11.68	23
7	3.55	7
8	5.08	10
9	5.08	10
10	2.54	5

There are 109 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:66:LYS:CE	A:95:ILE:HG21	0.86	6	1
A:66:LYS:HE2	A:95:ILE:HG21	0.84	6	1
A:71:ARG:HE	A:77:ILE:HD11	0.76	4	1
A:66:LYS:HE3	A:95:ILE:HG21	0.70	6	1
A:41:ILE:HD11	A:86:LEU:HD21	0.69	3	1
A:80:ASP:HA	A:96:GLY:H	0.68	4	1
A:81:GLY:HA3	A:97:THR:HB	0.68	4	1
A:99:ILE:HD12	A:115:ILE:HG22	0.66	3	1
A:87:LEU:HD13	A:94:PRO:HB3	0.65	9	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:20:MET:HE3	A:44:LYS:HE2	0.65	6	1
A:83:ALA:HB3	A:118:LEU:HD11	0.64	3	1
A:11:ALA:HB3	A:118:LEU:H	0.63	6	1
A:99:ILE:HD11	A:116:ILE:C	0.62	3	1
A:1:MET:HE3	A:32:TYR:CE1	0.62	7	1
A:81:GLY:CA	A:96:GLY:C	0.62	4	1
A:79:PHE:CG	A:97:THR:HG21	0.60	6	1
A:80:ASP:HA	A:96:GLY:N	0.59	4	1
A:77:ILE:HG21	A:79:PHE:CZ	0.59	3	1
A:94:PRO:CG	A:118:LEU:HD11	0.59	10	1
A:108:ARG:HG2	A:116:ILE:HD13	0.59	8	1
A:71:ARG:NE	A:77:ILE:HD11	0.58	4	1
A:11:ALA:HB1	A:103:VAL:HG21	0.58	5	1
A:41:ILE:HD11	A:86:LEU:CD2	0.58	3	1
A:81:GLY:HA2	A:96:GLY:C	0.57	4	1
A:99:ILE:HD11	A:115:ILE:CG2	0.56	1	1
A:9:ASN:HB3	A:87:LEU:HD12	0.56	9	1
A:58:LEU:HD13	A:118:LEU:HD22	0.56	4	1
A:11:ALA:HB3	A:118:LEU:N	0.56	6	1
A:35:VAL:HG11	A:104:THR:HG21	0.56	2	2
A:99:ILE:HD11	A:115:ILE:HG22	0.55	1	1
A:69:VAL:HG11	A:100:PHE:CG	0.55	5	1
A:81:GLY:HA3	A:97:THR:CB	0.55	4	1
A:79:PHE:O	A:95:ILE:HG23	0.55	4	1
A:10:VAL:HG13	A:115:ILE:HG23	0.54	6	1
A:43:ILE:HD11	A:60:ALA:HB2	0.54	9	1
A:20:MET:HE3	A:44:LYS:CE	0.54	6	1
A:99:ILE:CD1	A:115:ILE:HG22	0.54	3	1
A:81:GLY:HA3	A:96:GLY:C	0.53	4	1
A:94:PRO:HG2	A:118:LEU:HD11	0.53	10	1
A:40:LYS:HE2	A:57:VAL:CG1	0.52	6	3
A:66:LYS:HE2	A:80:ASP:O	0.52	1	1
A:20:MET:HE2	A:42:THR:CG2	0.51	3	1
A:35:VAL:CG1	A:104:THR:HG21	0.50	2	2
A:40:LYS:HE2	A:57:VAL:HG11	0.50	4	3

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:77:ILE:HD11	A:103:VAL:HG21	0.50	6	1
A:85:VAL:HG13	A:96:GLY:HA3	0.49	9	1
A:40:LYS:HE3	A:57:VAL:HG12	0.49	8	2
A:71:ARG:CZ	A:77:ILE:HD12	0.49	5	1
A:80:ASP:O	A:97:THR:HB	0.48	4	1
A:51:LYS:NZ	A:97:THR:HG23	0.48	5	1
A:71:ARG:CZ	A:77:ILE:HD11	0.48	7	1
A:64:ARG:HH22	A:106:GLU:CD	0.48	7	1
A:7:MET:HB3	A:87:LEU:HD12	0.48	4	1
A:12:ASP:HB3	A:116:ILE:CD1	0.48	3	1
A:12:ASP:HB3	A:116:ILE:H	0.47	6	1
A:32:TYR:O	A:35:VAL:HG13	0.47	6	1
A:35:VAL:HG22	A:64:ARG:HA	0.47	4	2
A:81:GLY:CA	A:97:THR:HB	0.47	4	1
A:12:ASP:HB3	A:116:ILE:HD11	0.47	3	1
A:1:MET:O	A:25:LEU:HD12	0.46	3	1
A:52:VAL:CG1	A:113:MET:HE1	0.46	6	1
A:40:LYS:HE3	A:59:LYS:HE2	0.46	9	1
A:40:LYS:HE3	A:59:LYS:CD	0.46	9	1
A:10:VAL:HG22	A:84:CYS:SG	0.46	4	1
A:1:MET:HE3	A:32:TYR:CD1	0.46	7	1
A:99:ILE:HD12	A:115:ILE:CG2	0.45	3	1
A:8:LEU:HA	A:85:VAL:O	0.45	4	1
A:77:ILE:CD1	A:103:VAL:HG21	0.45	6	1
A:8:LEU:HD23	A:86:LEU:HA	0.44	4	2
A:11:ALA:HB3	A:117:SER:HA	0.44	6	1
A:66:LYS:HA	A:80:ASP:OD1	0.44	5	1
A:51:LYS:HZ1	A:97:THR:HG23	0.44	5	1
A:61:VAL:HG11	A:115:ILE:CD1	0.44	8	1
A:64:ARG:NH1	A:79:PHE:CD1	0.43	3	1
A:99:ILE:CD1	A:115:ILE:HG23	0.43	8	1
A:58:LEU:HD13	A:113:MET:CE	0.43	6	1
A:99:ILE:HG22	A:100:PHE:N	0.43	3	1
A:98:ARG:HD3	A:122:VAL:HG11	0.43	5	1
A:8:LEU:HD23	A:82:ASN:HB3	0.43	8	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:64:ARG:HE	A:83:ALA:HB3	0.42	8	1
A:61:VAL:HG21	A:112:PHE:CE1	0.42	3	1
A:87:LEU:HD13	A:94:PRO:CB	0.42	9	1
A:40:LYS:HE3	A:59:LYS:HG2	0.42	9	1
A:105:ARG:HG3	A:122:VAL:HG12	0.41	2	1
A:2:ILE:HB	A:33:ALA:HB3	0.41	5	1
A:77:ILE:CG2	A:79:PHE:CZ	0.41	3	1
A:108:ARG:HH21	A:122:VAL:HG11	0.41	8	1
A:81:GLY:CA	A:96:GLY:O	0.41	4	1
A:52:VAL:HG12	A:113:MET:HE1	0.41	6	1
A:65:THR:O	A:97:THR:HG22	0.41	6	1
A:114:LYS:HE2	A:116:ILE:HD11	0.41	6	1
A:35:VAL:HG11	A:104:THR:CG2	0.41	8	1
A:2:ILE:HG23	A:22:ILE:HG23	0.41	9	1
A:80:ASP:O	A:97:THR:CB	0.41	4	1
A:43:ILE:HD11	A:60:ALA:CB	0.41	9	1
A:103:VAL:HG11	A:112:PHE:CE1	0.41	7	1
A:94:PRO:CB	A:118:LEU:HD11	0.41	10	1
A:7:MET:HE3	A:18:ARG:HG2	0.41	2	1
A:103:VAL:HG11	A:112:PHE:CD1	0.40	7	1
A:69:VAL:HG23	A:79:PHE:HE2	0.40	6	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	121	115	4	2
2	121	116	5	0
3	121	106	9	6
4	121	100	14	7
5	121	116	4	1
6	121	112	8	1
7	121	116	5	0
8	121	115	5	1
9	121	102	16	3

Model ID	Analysed	Favored	Allowed	Outliers
10	121	114	7	0

There are 18 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	82	ASN	2
A	91	SER	2
A	116	ILE	2
A	6	THR	1
A	26	GLY	1
A	27	GLY	1
A	30	ARG	1
A	80	ASP	1
A	89	ASN	1
A	92	GLU	1
A	93	GLN	1
A	96	GLY	1
A	98	ARG	1
A	100	PHE	1
A	114	LYS	1
A	115	ILE	1
A	117	SER	1
A	122	VAL	1

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	104	99	5	0
2	104	100	4	0
3	104	101	2	1
4	104	102	1	1
5	104	102	1	1
6	104	99	4	1
7	104	101	0	3
8	104	98	5	1
9	104	98	5	1

Model ID	Analysed	Favored	Allowed	Outliers
10	104	103	1	0

There are 8 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	97	THR	2
A	1	MET	1
A	6	THR	1
A	41	ILE	1
A	63	VAL	1
A	86	LEU	1
A	108	ARG	1
A	112	PHE	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.

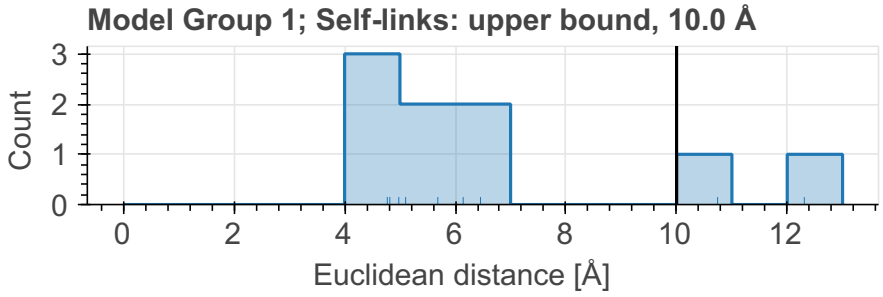
There are 9 crosslinking restraints combined in 9 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
L-Photo-Leucine	ASN	CA	LEU	CA	upper bound	10.00	2
L-Photo-Leucine	LEU	CA	VAL	CA	upper bound	10.00	1
L-Photo-Leucine	LEU	CA	LEU	CA	upper bound	10.00	2
L-Photo-Leucine	CYS	CA	LEU	CA	upper bound	10.00	1
L-Photo-Leucine	LEU	CA	MET	CA	upper bound	10.00	1
L-Photo-Leucine	LEU	CA	THR	CA	upper bound	10.00	1
L-Photo-Leucine	LEU	CA	SER	CA	upper bound	10.00	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.



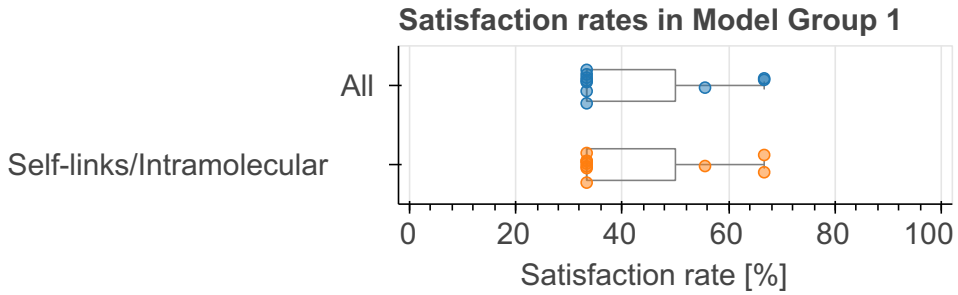
5.2.2. Satisfaction of restraints

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=9)
1	1	1	10/10	All	77.78	22.22	9
				Self-links/ Intramolecular	77.78	22.22	9

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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