Integrative Structure Validation Report

October 09, 2025 - 04:50 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
PrISM Version dbe5a41
PyMOL Version 2.5.0

PDB ID	9A9C | pdb_00009a9c
Structure Title	PTEN-4A model. Model restrained with crosslinking-MS data from "strained" conformation and CTT. RoseTTAFold-generated initial structure
Structure Authors	Dawson, J.E.; Eng, C.
Deposited on	2025-01-08

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

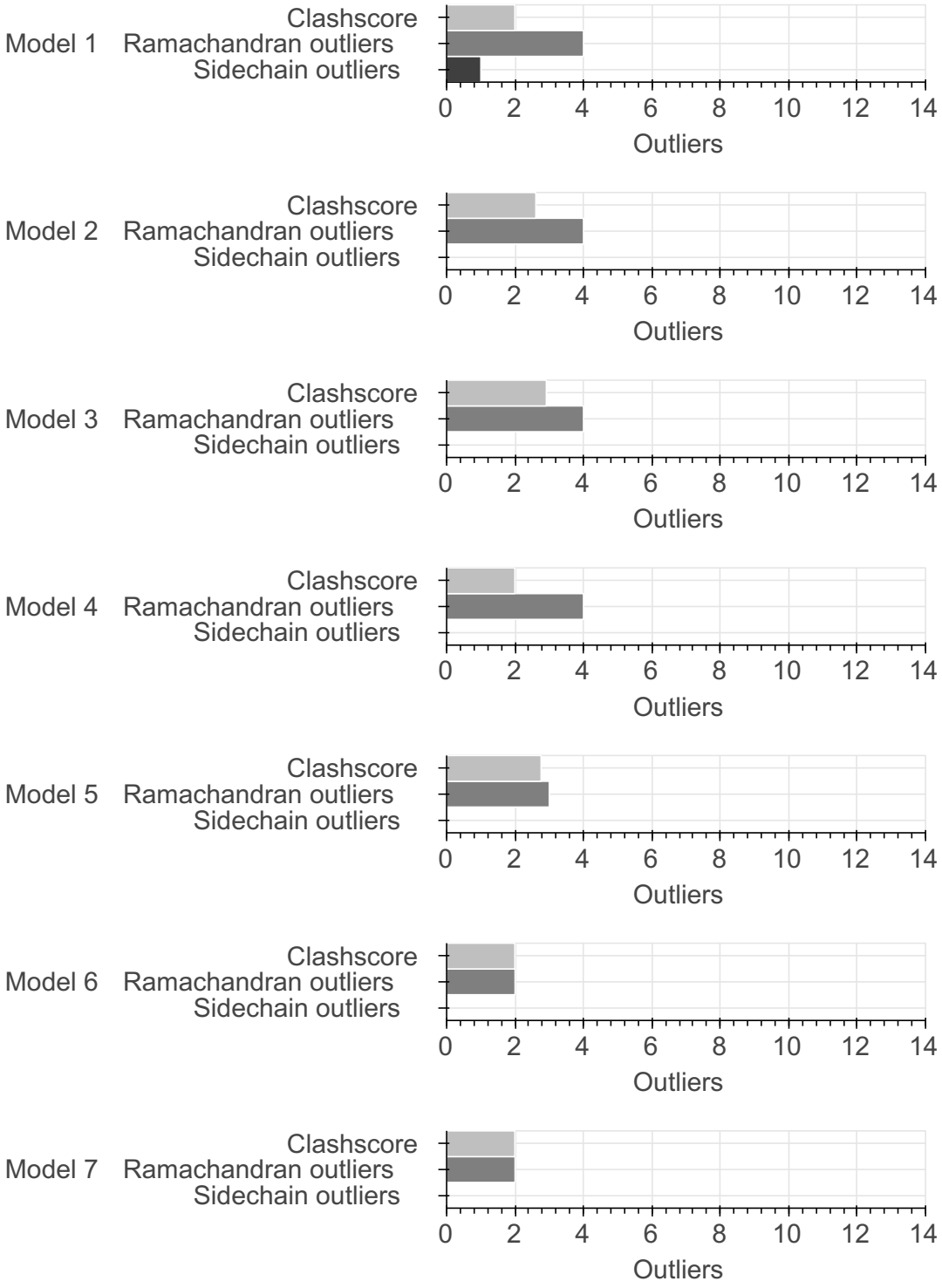
This entry consists of 17 model(s). A total of 2 dataset(s) were used to build this entry.

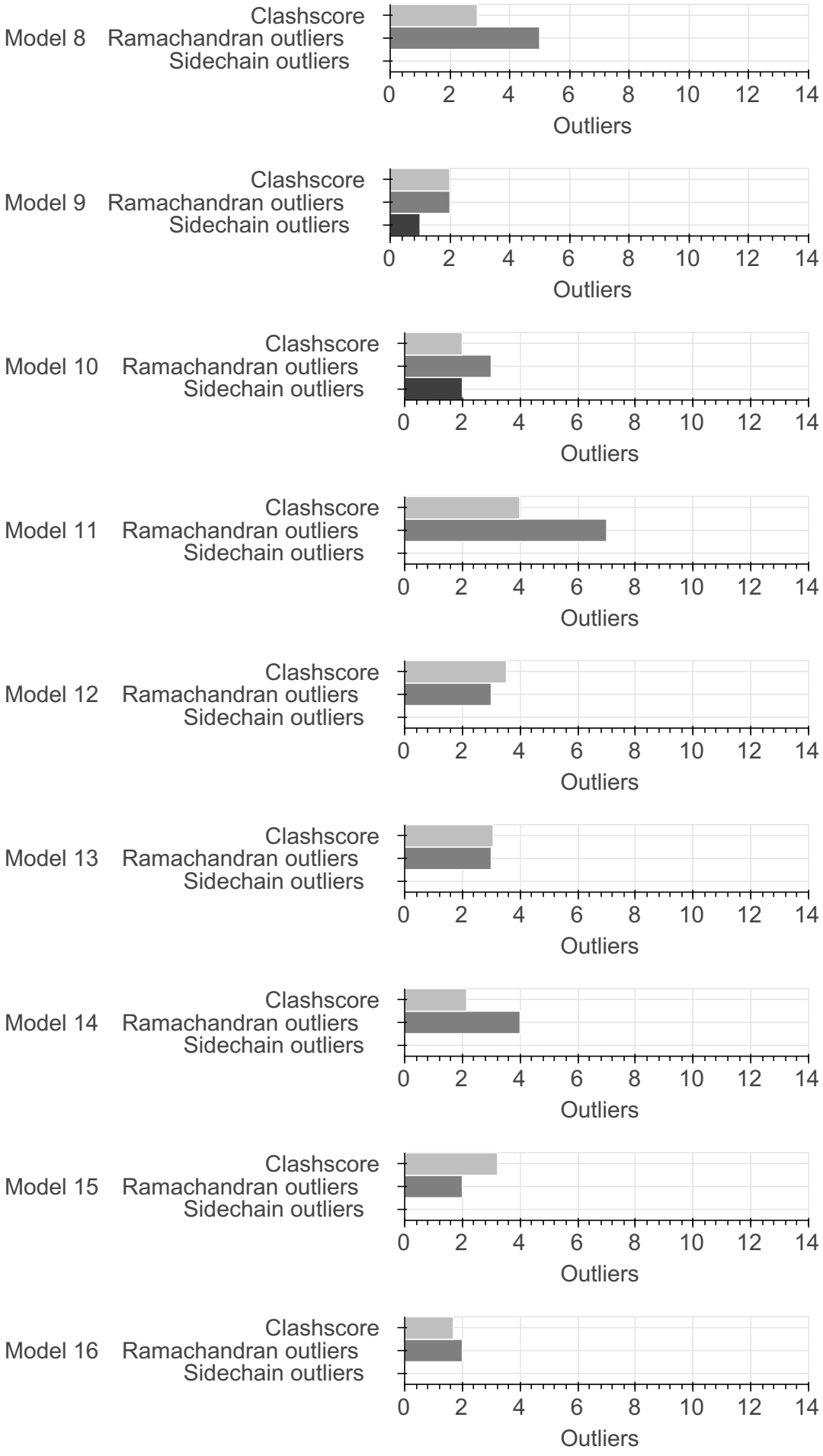
Name	Type	Count
Crosslinking-MS data	Experimental data	1
De Novo model	Starting model	1

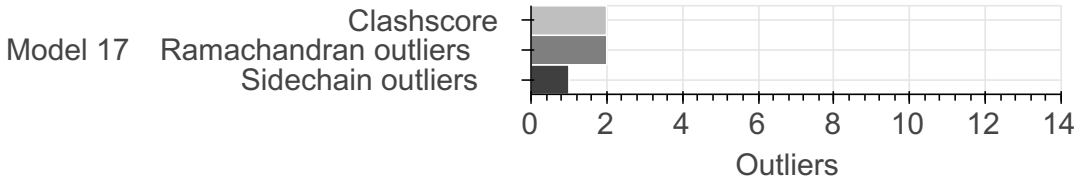
1.2. Overall quality

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.

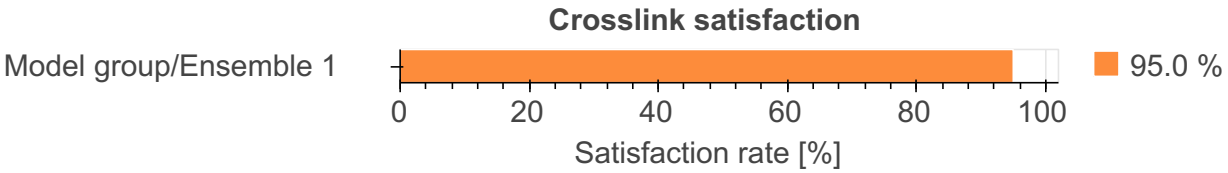
Model Quality: MolProbity Analysis




Model 8
Model 9
Model 10
Model 11
Model 12
Model 13
Model 14
Model 15
Model 16
Clashscore
Ramachandran outliers
Sidechain outliers
0 2 4 6 8 10 12 14
Outliers



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	1-17	1	Phosphatidylinositol 3,4,5-trisphosphate 3-phosphatase and dual-specificity protein phosphatase PTEN, PTEN-4A variant	A	403	-	1-403	100.00 / 100.00	Atomic

2.3. Datasets used for modeling

There are 2 unique datasets used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	De Novo model	Not available	Not available
2	Crosslinking-MS data	PRIDE	PXD060469

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	Protein structure prediction and 4A mutation (S380A/T382A/T383A/S385A)	RoseTTAFold, PyMOL	Not available	1	False	False
2	1	Rosetta pre-relaxation	Rosetta relax protocol. Unrestrained. Lowest energy model of 200 used in next step	Not available	200	False	False
3	1	Restrained modeling	Rosetta, crosslinking-MS distance restraints	The individual models were restrained with subsets of experimental crosslink data in order to parse out specific restraints that correspond to a particular model. The crosslink list table provides the full set of experimental data obtained and the crosslink restraint table identifies the subset of crosslink restraints used in the modeling.	2000	False	False

There are 3 software packages reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	RoseTTAFold	Not available	Protein Structure Prediction	https://github.com/RosettaCommons/RoseTTAFold
2	Rosetta	2020.08	Model building and refinement	https://rosettacommons.org/software/
3	Rosetta	3.12	Model building and refinement	https://rosettacommons.org/software/

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.

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 56 bond length outliers in this entry (0.10% of 57868 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	125	LYS	C-N	9.65	1.19	1.33	3	17
A	380	ALA	C-N	4.99	1.40	1.33	2	17
A	74	ARG	C-O	4.95	1.13	1.23	1	17
A	134	MET	SD-CE	4.51	1.68	1.79	5	1
A	200	PHE	CB-CG	4.44	1.40	1.50	13	2
A	48	ASN	CB-CG	4.30	1.41	1.52	8	2

Standard geometry: angle outliers

There are 229 bond angle outliers in this entry (0.29% of 78251 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	385	ALA	CA-C-N	7.30	130.80	116.20	9	17
A	386	ASP	CA-C-N	6.53	126.70	116.90	9	17
A	292	ASN	CA-CB-CG	6.49	119.09	112.60	5	4
A	347	PHE	CA-CB-CG	5.55	119.35	113.80	15	16
A	268	ASP	CA-CB-CG	5.53	118.13	112.60	17	11
A	385	ALA	CA-C-O	5.20	111.96	120.80	9	17
A	389	ASN	CA-C-O	4.99	112.31	120.80	2	17
A	386	ASP	CA-C-O	4.94	112.39	120.80	5	17
A	200	PHE	CA-CB-CG	4.80	109.00	113.80	14	2
A	384	ASP	CA-C-N	4.49	125.18	116.20	12	17
A	341	PHE	CA-CB-CG	4.40	118.20	113.80	3	11
A	312	ASP	CA-CB-CG	4.36	116.96	112.60	16	8
A	241	PHE	CA-CB-CG	4.30	118.10	113.80	12	10
A	380	ALA	C-CA-CB	4.14	116.71	110.50	7	17
A	148	ALA	C-CA-CB	4.13	104.31	110.50	16	17
A	124	CYS	C-N-CA	4.12	114.28	121.70	11	17

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	74	ARG	CA-C-O	4.06	127.71	120.80	2	14

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	1.99	13
2	2.61	17
3	2.91	19
4	1.99	13
5	2.76	18
6	1.99	13
7	1.99	13
8	2.91	19
9	1.99	13
10	1.99	13
11	3.99	26
12	3.53	23
13	3.07	20
14	2.15	14
15	3.22	21
16	1.69	11
17	1.99	13

There are 279 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:60:LYS:HA	A:60:LYS:HE2	0.71	2	9
A:122:ILE:H	A:122:ILE:HD12	0.65	15	1
A:188:TYR:CD2	A:188:TYR:O	0.65	11	10
A:162:ASP:OD2	A:332:LYS:NZ	0.62	5	5
A:267:LYS:NZ	A:381:ASP:OD2	0.61	3	2
A:403:VAL:OXT	A:403:VAL:HG12	0.61	16	17
A:72:ALA:N	A:90:PHE:O	0.60	7	9
A:159:ARG:HD2	A:159:ARG:O	0.59	5	2
A:43:GLU:HG3	A:43:GLU:O	0.58	13	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:80:LYS:NZ	A:386:ASP:OD1	0.56	13	1
A:66:LYS:NZ	A:107:ASP:OD2	0.56	12	7
A:23:LEU:N	A:23:LEU:HD23	0.54	3	2
A:78:THR:O	A:78:THR:HG22	0.54	11	2
A:221:LYS:HB2	A:221:LYS:NZ	0.54	13	3
A:134:MET:HA	A:134:MET:HE2	0.54	2	1
A:300:ILE:C	A:300:ILE:HD12	0.54	17	15
A:92:ASP:OD2	A:269:LYS:NZ	0.53	3	1
A:147:LYS:NZ	A:299:GLU:OE1	0.53	10	1
A:43:GLU:OE1	A:47:ARG:NH1	0.52	11	3
A:312:ASP:C	A:312:ASP:OD1	0.51	15	8
A:295:LEU:C	A:295:LEU:HD12	0.51	13	8
A:58:ASP:O	A:62:LYS:N	0.50	16	1
A:76:TYR:CG	A:77:ASP:N	0.49	5	5
A:18:GLU:OE1	A:60:LYS:NZ	0.49	15	2
A:284:GLU:CD	A:284:GLU:H	0.49	8	5
A:316:LEU:C	A:316:LEU:HD23	0.49	16	1
A:199:MET:C	A:199:MET:SD	0.47	12	10
A:292:ASN:CG	A:293:GLY:H	0.47	5	4
A:56:PHE:O	A:60:LYS:N	0.47	7	1
A:125:LYS:NZ	A:386:ASP:OD1	0.47	1	2
A:91:GLU:OE1	A:254:LYS:NZ	0.47	16	1
A:322:LYS:N	A:341:PHE:O	0.47	14	14
A:76:TYR:O	A:77:ASP:C	0.46	4	1
A:268:ASP:O	A:269:LYS:C	0.46	13	8
A:322:LYS:NZ	A:334:ASN:OD1	0.46	11	6
A:70:LEU:O	A:130:ARG:NH1	0.46	1	3
A:125:LYS:NZ	A:384:ASP:OD2	0.46	12	1
A:354:PRO:O	A:355:SER:C	0.46	13	8
A:326:ASP:O	A:330:LYS:NZ	0.46	5	1
A:81:PHE:O	A:82:ASN:C	0.46	17	1
A:188:TYR:CG	A:188:TYR:O	0.46	11	2
A:129:GLY:O	A:132:GLY:N	0.46	11	7
A:95:PRO:HA	A:96:PRO:HD3	0.46	9	2
A:102:LYS:HB3	A:103:PRO:CD	0.45	1	14

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:48:ASN:O	A:49:ASN:C	0.45	6	3
A:19:ASP:OD2	A:60:LYS:NZ	0.45	5	1
A:80:LYS:NZ	A:386:ASP:OD2	0.45	5	1
A:123:HIS:HA	A:131:THR:HG1	0.45	12	1
A:23:LEU:H	A:23:LEU:HD23	0.44	15	2
A:77:ASP:O	A:79:ALA:N	0.44	8	1
A:221:LYS:HB2	A:221:LYS:HZ2	0.44	13	2
A:286:THR:O	A:286:THR:HG22	0.44	10	1
A:367:PRO:O	A:369:VAL:N	0.44	15	1
A:292:ASN:OD1	A:293:GLY:N	0.44	17	1
A:82:ASN:O	A:84:ARG:N	0.44	5	1
A:133:VAL:CG2	A:171:GLN:HB3	0.44	1	5
A:69:ASN:C	A:69:ASN:OD1	0.44	2	2
A:166:VAL:O	A:172:ARG:NE	0.43	8	1
A:168:ILE:HB	A:171:GLN:CD	0.43	13	1
A:56:PHE:C	A:56:PHE:CD1	0.43	10	1
A:266:LYS:NZ	A:381:ASP:OD2	0.43	12	1
A:199:MET:HB2	A:199:MET:HE2	0.43	8	2
A:92:ASP:O	A:130:ARG:NH1	0.43	2	1
A:88:TYR:N	A:89:PRO:HD3	0.43	16	3
A:129:GLY:CA	A:171:GLN:OE1	0.43	11	1
A:5:ILE:HG21	A:46:TYR:H	0.42	8	1
A:122:ILE:N	A:122:ILE:HD12	0.42	15	1
A:189:ARG:O	A:278:PHE:CD1	0.42	14	1
A:164:LYS:O	A:172:ARG:NH2	0.42	15	1
A:169:PRO:HD2	A:326:ASP:HA	0.42	12	4
A:92:ASP:O	A:130:ARG:NH2	0.42	12	1
A:46:TYR:O	A:47:ARG:HB2	0.42	11	1
A:223:LYS:NZ	A:381:ASP:OD1	0.42	2	1
A:61:HIS:O	A:62:LYS:C	0.42	4	1
A:91:GLU:O	A:130:ARG:NH1	0.42	9	3
A:38:PRO:HA	A:48:ASN:O	0.42	12	1
A:290:VAL:O	A:291:GLU:HB2	0.41	5	3
A:330:LYS:NZ	A:393:ASP:OD2	0.41	3	1
A:83:CYS:O	A:83:CYS:SG	0.41	11	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:368:ASP:C	A:368:ASP:OD1	0.41	8	1
A:91:GLU:HB2	A:94:ASN:HD22	0.41	9	2
A:168:ILE:O	A:171:GLN:HB2	0.41	13	1
A:123:HIS:N	A:123:HIS:ND1	0.41	1	1
A:180:TYR:CD1	A:180:TYR:N	0.41	1	1
A:90:PHE:O	A:130:ARG:NH1	0.40	11	1
A:220:LEU:O	A:221:LYS:HB2	0.40	13	1
A:29:TYR:HH	A:145:PHE:HE2	0.40	1	1
A:37:PHE:HA	A:38:PRO:HD3	0.40	11	1
A:25:LEU:C	A:25:LEU:HD23	0.40	17	1
A:402:LYS:O	A:403:VAL:HB	0.40	2	1
A:23:LEU:N	A:23:LEU:HD22	0.40	11	1
A:82:ASN:ND2	A:123:HIS:NE2	0.40	12	1
A:310:ASP:O	A:313:LYS:NZ	0.40	14	1
A:123:HIS:CD2	A:123:HIS:N	0.40	8	1
A:255:VAL:HB	A:273:PHE:CE2	0.40	11	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	401	365	32	4
2	401	373	24	4
3	401	372	25	4
4	401	369	28	4
5	401	372	26	3
6	401	368	31	2
7	401	370	29	2
8	401	368	28	5
9	401	372	27	2
10	401	366	32	3
11	401	366	28	7
12	401	370	28	3
13	401	371	27	3
14	401	372	25	4
15	401	363	36	2

Model ID	Analysed	Favored	Allowed	Outliers
16	401	362	37	2
17	401	373	26	2

There are 9 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	46	TYR	17
A	210	THR	17
A	326	ASP	8
A	392	PHE	4
A	47	ARG	3
A	83	CYS	3
A	78	THR	2
A	381	ASP	1
A	382	ALA	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	367	361	5	1
2	367	359	8	0
3	367	360	7	0
4	367	362	5	0
5	367	363	4	0
6	367	361	6	0
7	367	360	7	0
8	367	359	8	0
9	367	361	5	1
10	367	361	4	2
11	367	360	7	0
12	367	359	8	0
13	367	362	5	0
14	367	359	8	0
15	367	359	8	0
16	367	362	5	0
17	367	359	7	1

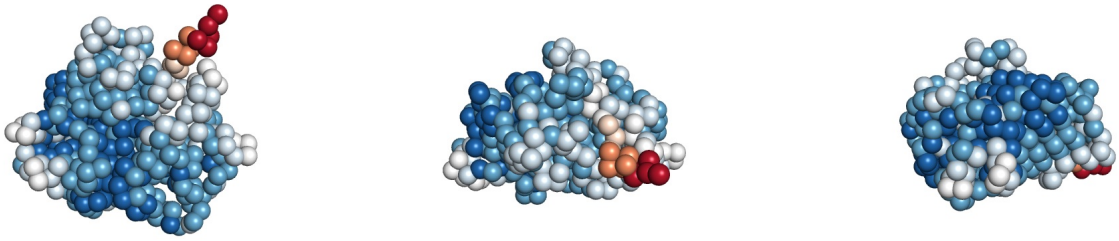
There are 4 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	303	ILE	2
A	76	TYR	1
A	80	LYS	1
A	308	ARG	1

4.2. PrISM Precision Analysis

*Regions of **low** **high** precision, defined as the variability among the models that satisfy the input data and calculated as the density-weighted root mean-square fluctuation (RMSF) from the bead/atom center of density, annotated and visualized using PrISM. The per-bead precision is computed from the deposited ensemble of superposed integrative models. High- and low-precision regions are then determined by clustering beads of similar precision based on their proximity in the structure. Only coarse-grained beads (or CA atoms for atomic models) of deposited models are used for assessment and visualization, and three projections for each representative model are generated.*

PrISM analysis for Ensemble 1 (models deposited/total: 17/17).



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.

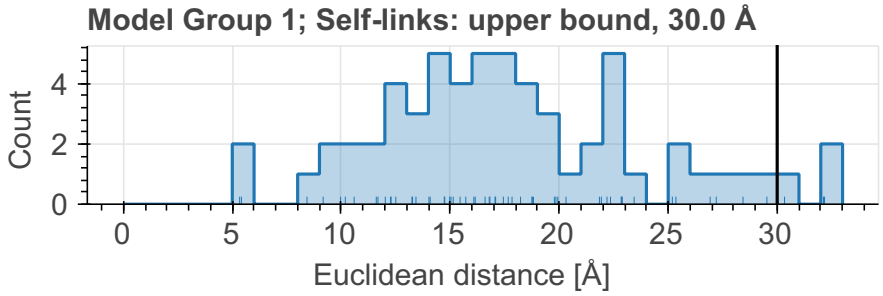
There are 60 crosslinking restraints combined in 60 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
DSSO	LYS	CA	LYS	CA	upper bound	30.00	50
DHSO	ASP	CA	ASP	CA	upper bound	30.00	1
DHSO	ASP	CA	GLU	CA	upper bound	30.00	5
DHSO	GLU	CA	GLU	CA	upper bound	30.00	4

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.



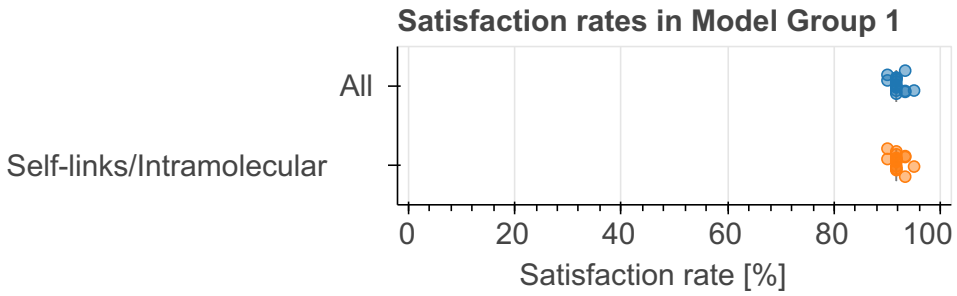
5.2.2. Satisfaction of restraints

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=60)
1	1	1	17/17	All	95.00	5.00	60
				Self-links/ Intramolecular	95.00	5.00	60

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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