Integrative Structure Validation Report

October 09, 2025 - 04:42 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	9A36 | pdb_00009a36
PDB-Dev ID	PDBDEV_00000191
Structure Title	Model of E. coli CirA 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

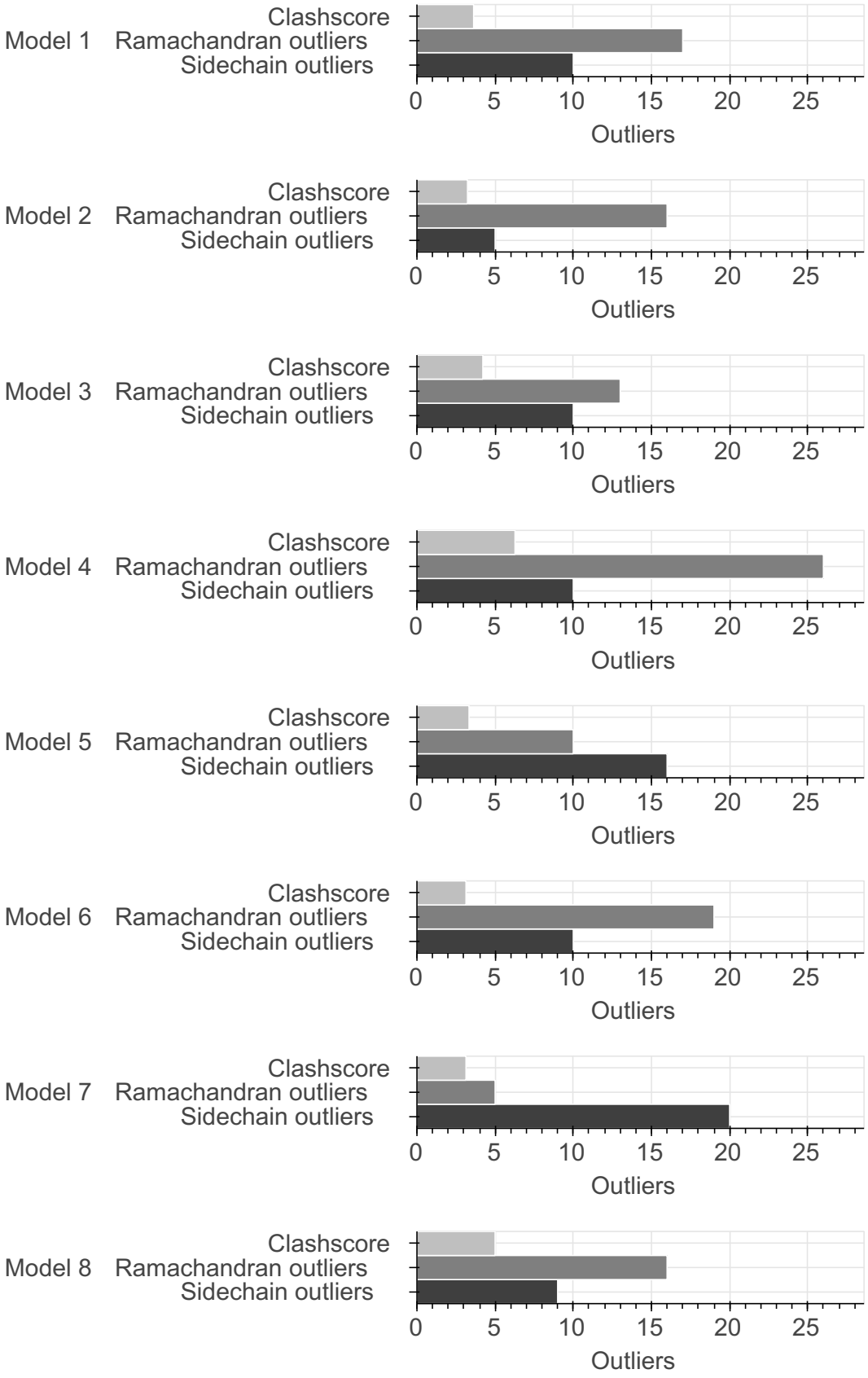
This entry consists of 10 model(s). A total of 1 dataset(s) were used to build this entry.

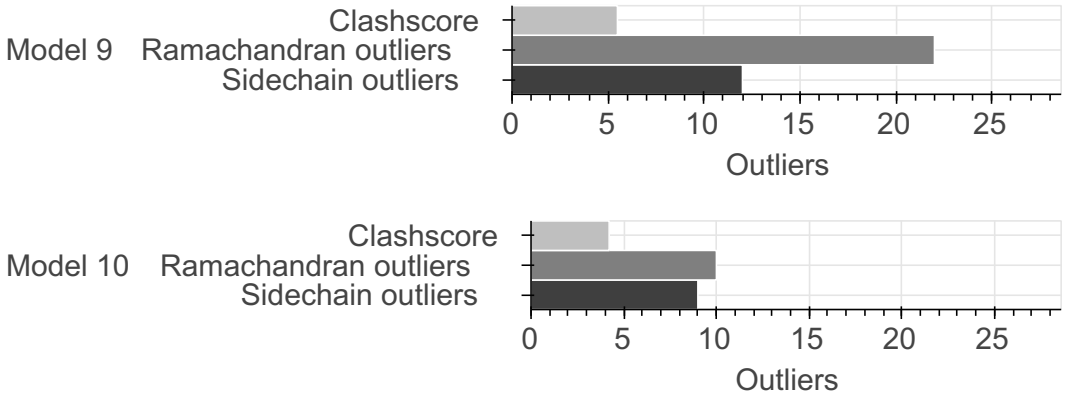
Name	Type	Count
Crosslinking-MS data	Experimental data	1

1.2. Overall quality

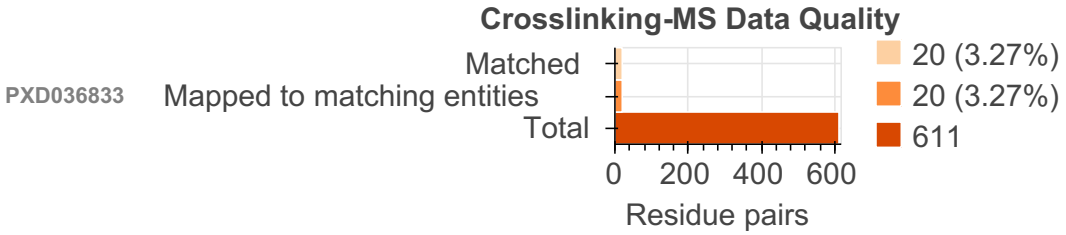
This validation report contains model quality assessments for all structures, data quality and fit to model assessments for SAS and crosslinking-MS datasets. Data quality and fit to model assessments for other datasets and model uncertainty are under development. Number of plots is limited to 256.

Model Quality: MolProbity Analysis

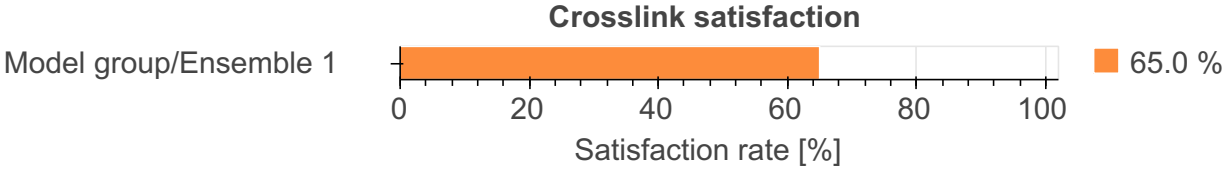




Data Quality



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	P17315	A	663	-	1-663	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	P17315	dbseq_P17315_target	0.00	True

Residue pairs stats:

Source	Total	In matched entities	Total matched
9A36	20	20 (100.00%)	20 (100.00%)
PXD036833	611	20 (3.27%)	20 (3.27%)

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 14 bond length outliers in this entry (0.03% of 53387 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	37	ALA	N-CA	74.52	2.87	1.46	7	1
A	23	VAL	CB-CG2	55.90	3.37	1.52	5	1
A	22	PRO	N-CD	36.91	1.99	1.47	7	1
A	22	PRO	N-CA	35.56	2.00	1.47	7	1
A	21	TRP	NE1-CE2	34.26	1.75	1.37	5	1
A	22	PRO	CA-CB	29.76	2.13	1.53	7	1
A	21	TRP	CG-CD2	25.62	1.89	1.43	5	1
A	21	TRP	CD2-CE2	21.35	1.77	1.41	5	1
A	22	PRO	CG-CD	18.75	2.14	1.50	7	1
A	21	TRP	CD1-NE1	18.34	1.76	1.37	5	1
A	22	PRO	CB-CG	12.77	2.13	1.49	7	1
A	21	TRP	CG-CD1	10.83	1.64	1.36	5	1
A	111	ARG	CZ-NH2	4.78	1.27	1.33	2	1
A	37	ALA	CA-C	4.74	1.62	1.52	7	1

Standard geometry: angle outliers

There are 368 bond angle outliers in this entry (0.51% of 72554 assessed bonds). A summary is provided below. The output is limited to 100 rows.

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	36	THR	C-N-CA	13.54	146.08	121.70	7	1
A	37	ALA	N-CA-CB	13.11	130.06	110.40	7	1
A	37	ALA	C-CA-CB	12.12	92.31	110.50	7	1
A	586	ASP	CA-CB-CG	9.08	121.68	112.60	5	1
A	23	VAL	CA-CB-CG2	8.58	124.99	110.40	5	1
A	2	PHE	C-N-CA	8.17	136.41	121.70	2	1
A	1	MET	C-N-CA	8.10	136.28	121.70	9	3
A	102	LEU	C-N-CA	7.45	135.11	121.70	8	1

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	25	ALA	C-CA-CB	7.37	121.55	110.50	5	2
A	85	ASN	OD1-CG-ND2	7.22	115.38	122.60	4	1
A	251	PHE	CA-CB-CG	6.92	120.72	113.80	9	1
A	27	ASP	C-N-CA	6.84	134.01	121.70	4	1
A	108	VAL	C-N-CA	6.80	133.93	121.70	4	1
A	23	VAL	CG1-CB-CG2	6.55	125.20	110.80	5	1
A	214	ASP	CA-CB-CG	6.53	119.13	112.60	7	1
A	553	ASP	CA-CB-CG	6.39	118.99	112.60	6	1
A	275	GLN	OE1-CD-NE2	6.30	116.30	122.60	8	5
A	56	GLN	OE1-CD-NE2	6.29	116.31	122.60	6	6
A	37	ALA	N-CA-C	6.22	128.40	111.00	7	1
A	260	GLN	OE1-CD-NE2	6.14	116.46	122.60	10	5
A	20	ALA	C-N-CA	6.14	132.75	121.70	5	2
A	397	ARG	NE-CZ-NH2	6.10	124.69	119.20	2	2
A	642	SER	C-N-CA	6.09	132.66	121.70	1	2
A	113	ALA	C-CA-CB	6.05	119.58	110.50	1	1
A	483	LYS	C-N-CA	5.98	132.47	121.70	9	1
A	264	SER	C-N-CA	5.98	132.46	121.70	9	1
A	25	ALA	C-N-CA	5.96	132.42	121.70	5	2
A	37	ALA	C-N-CA	5.91	132.35	121.70	7	1
A	393	HIS	CB-CG-CD2	5.86	123.58	131.20	8	3
A	622	GLN	OE1-CD-NE2	5.84	116.76	122.60	9	10
A	21	TRP	CG-CD2-CE3	5.80	139.70	133.90	5	1
A	601	ALA	C-N-CA	5.79	132.13	121.70	9	2
A	111	ARG	C-N-CA	5.77	132.08	121.70	4	1
A	95	ASP	CA-CB-CG	5.74	118.34	112.60	4	1
A	43	ASN	OD1-CG-ND2	5.67	116.93	122.60	10	3
A	589	PHE	CA-CB-CG	5.67	119.47	113.80	9	1
A	118	ASN	CA-CB-CG	5.66	118.26	112.60	7	1
A	46	ASP	CA-CB-CG	5.66	118.26	112.60	5	1
A	361	GLN	OE1-CD-NE2	5.61	116.99	122.60	2	9
A	592	SER	C-N-CA	5.54	131.68	121.70	1	1
A	339	ARG	NE-CZ-NH2	5.50	124.15	119.20	8	2
A	540	ASN	OD1-CG-ND2	5.44	117.16	122.60	8	3

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	491	THR	C-N-CA	5.44	131.50	121.70	4	1
A	103	VAL	N-CA-CB	5.44	120.74	111.50	8	1
A	81	ASN	CA-CB-CG	5.43	118.03	112.60	5	1
A	539	PHE	CA-CB-CG	5.42	119.22	113.80	5	1
A	22	PRO	C-N-CA	5.42	131.46	121.70	5	1
A	110	SER	C-N-CA	5.41	131.44	121.70	4	2
A	643	ARG	C-N-CA	5.40	131.42	121.70	6	1
A	265	ASP	CA-CB-CG	5.35	117.95	112.60	10	1
A	17	ILE	C-N-CA	5.33	131.30	121.70	4	2
A	216	GLN	OE1-CD-NE2	5.33	117.27	122.60	10	9
A	552	ASN	OD1-CG-ND2	5.29	117.31	122.60	2	4
A	177	HIS	C-N-CA	5.28	131.21	121.70	9	2
A	60	GLN	OE1-CD-NE2	5.28	117.32	122.60	4	9
A	348	ASN	CA-CB-CG	5.27	117.87	112.60	6	2
A	37	ALA	O-C-N	5.27	114.57	123.00	7	1
A	270	ASN	OD1-CG-ND2	5.25	117.35	122.60	1	3
A	522	ASN	OD1-CG-ND2	5.24	117.36	122.60	9	1
A	23	VAL	CA-CB-CG1	5.24	101.50	110.40	5	1
A	446	ASP	CA-CB-CG	5.23	117.83	112.60	9	1
A	268	ASP	CA-CB-CG	5.22	117.82	112.60	4	1
A	660	ASP	CA-CB-CG	5.21	117.81	112.60	10	2
A	114	VAL	C-N-CA	5.21	131.07	121.70	4	2
A	42	GLN	OE1-CD-NE2	5.21	117.39	122.60	1	6
A	352	GLY	C-N-CA	5.20	131.07	121.70	6	3
A	425	GLN	OE1-CD-NE2	5.18	117.42	122.60	4	4
A	250	ASP	C-N-CA	5.17	131.01	121.70	9	1
A	112	ASN	OD1-CG-ND2	5.16	117.44	122.60	8	3
A	330	GLN	OE1-CD-NE2	5.15	117.45	122.60	10	8
A	599	LYS	C-N-CA	5.10	130.88	121.70	10	1
A	116	ARG	C-N-CA	5.09	130.87	121.70	1	1
A	210	ARG	NE-CZ-NH2	5.06	123.76	119.20	10	1
A	529	GLN	OE1-CD-NE2	5.06	117.54	122.60	9	3
A	238	ASN	OD1-CG-ND2	5.05	117.55	122.60	3	1
A	387	HIS	CB-CG-CD2	5.05	124.64	131.20	7	1
A	598	GLN	OE1-CD-NE2	5.04	117.56	122.60	3	7

Chain	Res	Type	Atoms	|Z|	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	490	ARG	C-N-CA	5.03	130.75	121.70	4	1
A	574	ASN	OD1-CG-ND2	5.03	117.57	122.60	9	1
A	598	GLN	C-N-CA	5.02	130.74	121.70	10	1
A	92	ARG	CD-NE-CZ	4.98	131.38	124.40	5	1
A	213	ASP	C-N-CA	4.98	130.67	121.70	9	1
A	467	TRP	C-N-CA	4.98	130.67	121.70	5	1
A	479	ARG	CD-NE-CZ	4.93	131.30	124.40	7	1
A	22	PRO	N-CA-CB	4.92	108.42	103.00	7	1
A	109	ASN	OD1-CG-ND2	4.92	117.68	122.60	8	1
A	84	ASP	CA-CB-CG	4.92	117.52	112.60	2	1
A	121	ASP	C-CA-CB	4.92	119.44	110.10	9	1
A	23	VAL	C-CA-CB	4.91	120.74	111.40	5	1
A	524	ASN	OD1-CG-ND2	4.91	117.69	122.60	9	6
A	65	GLN	OE1-CD-NE2	4.91	117.69	122.60	5	4
A	327	ALA	C-N-CA	4.90	130.51	121.70	7	1
A	649	ASN	OD1-CG-ND2	4.88	117.72	122.60	9	3
A	23	VAL	C-N-CA	4.88	130.48	121.70	9	1
A	175	GLN	OE1-CD-NE2	4.87	117.73	122.60	10	8
A	1	MET	CA-C-N	4.86	125.91	116.20	9	1
A	247	GLN	OE1-CD-NE2	4.84	117.76	122.60	1	4
A	282	ASN	OD1-CG-ND2	4.84	117.76	122.60	8	1
A	16	ALA	C-N-CA	4.82	130.38	121.70	4	3
A	115	PHE	CA-CB-CG	4.81	118.61	113.80	10	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	3.63	37
2	3.23	33
3	4.21	43
4	6.27	64
5	3.33	34
6	3.14	32
7	3.14	32
8	5.00	51

Model ID	Clash score	Number of clashes
9	5.49	56
10	4.21	43

There are 425 clashes. The table below contains the detailed list of all clashes based on a MolProbity analysis. Bad clashes are >= 0.4 Angstrom. The output is limited to 100 rows.

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:21:TRP:CD2	A:21:TRP:CE2	1.60	5	1
A:21:TRP:CD2	A:21:TRP:CG	1.55	5	1
A:21:TRP:CE2	A:21:TRP:NE1	1.54	5	1
A:21:TRP:CD1	A:21:TRP:NE1	1.47	5	1
A:22:PRO:CG	A:37:ALA:HA	1.42	7	1
A:21:TRP:CG	A:23:VAL:HB	1.38	5	1
A:22:PRO:CB	A:22:PRO:CG	1.26	7	1
A:22:PRO:CD	A:22:PRO:N	1.26	7	1
A:22:PRO:CD	A:22:PRO:CG	1.25	7	1
A:22:PRO:CA	A:22:PRO:CB	1.25	7	1
A:22:PRO:CA	A:22:PRO:N	1.24	7	1
A:21:TRP:CD2	A:23:VAL:CB	1.21	5	1
A:21:TRP:CD2	A:23:VAL:CG2	1.21	5	1
A:21:TRP:CE2	A:23:VAL:CG2	1.20	5	1
A:21:TRP:CG	A:23:VAL:CG2	1.19	5	1
A:21:TRP:CD1	A:23:VAL:CG2	1.19	5	1
A:21:TRP:CE2	A:23:VAL:CB	1.18	5	1
A:22:PRO:CD	A:37:ALA:HA	1.18	7	1
A:21:TRP:CD1	A:23:VAL:CB	1.17	5	1
A:21:TRP:CG	A:23:VAL:CB	1.17	5	1
A:22:PRO:CD	A:37:ALA:CA	1.09	7	1
A:22:PRO:CA	A:37:ALA:CA	1.09	7	1
A:22:PRO:CB	A:37:ALA:CA	1.08	7	1
A:22:PRO:CG	A:37:ALA:CA	1.08	7	1
A:21:TRP:CD2	A:23:VAL:HB	1.02	5	1
A:22:PRO:CB	A:37:ALA:N	1.00	7	1
A:21:TRP:NE1	A:23:VAL:CG2	0.99	5	1
A:22:PRO:CA	A:37:ALA:N	0.99	7	1
A:22:PRO:CD	A:37:ALA:N	0.98	7	1
A:21:TRP:NE1	A:23:VAL:CB	0.98	5	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:22:PRO:CG	A:37:ALA:N	0.97	7	1
A:22:PRO:N	A:37:ALA:CA	0.94	7	1
A:195:ILE:HD12	A:244:THR:HG21	0.92	8	1
A:491:THR:HG23	A:504:VAL:HG21	0.89	10	1
A:21:TRP:CD2	A:23:VAL:HG21	0.87	5	1
A:22:PRO:N	A:37:ALA:N	0.85	7	1
A:22:PRO:HG3	A:37:ALA:HA	0.81	7	1
A:78:GLN:HE22	A:572:THR:HG21	0.81	6	1
A:22:PRO:HB3	A:37:ALA:CB	0.79	7	1
A:22:PRO:CB	A:37:ALA:CB	0.78	7	1
A:160:ILE:CG2	A:195:ILE:HD11	0.78	8	1
A:21:TRP:CG	A:23:VAL:HG23	0.77	5	1
A:21:TRP:CE2	A:23:VAL:CG1	0.76	5	1
A:160:ILE:HG21	A:198:VAL:HG11	0.76	1	1
A:21:TRP:CD1	A:23:VAL:HG23	0.76	5	1
A:21:TRP:CD1	A:23:VAL:CA	0.75	5	1
A:103:VAL:HG21	A:125:ILE:HD11	0.74	8	1
A:160:ILE:HD12	A:242:ALA:HB3	0.74	3	2
A:140:MET:HE1	A:399:TYR:CE1	0.74	6	1
A:22:PRO:N	A:37:ALA:H	0.73	7	1
A:33:MET:HE1	A:55:THR:HG22	0.73	9	1
A:93:GLY:CA	A:552:ASN:HD21	0.70	10	2
A:143:LEU:HD13	A:397:ARG:NH2	0.70	10	3
A:21:TRP:CD1	A:23:VAL:HA	0.70	5	1
A:349:LEU:HD13	A:431:THR:H	0.69	10	1
A:105:GLY:HA2	A:150:GLY:HA3	0.68	4	1
A:496:ALA:HA	A:500:TYR:CE2	0.67	9	1
A:78:GLN:NE2	A:572:THR:HG21	0.67	6	1
A:64:VAL:HG23	A:127:VAL:HG11	0.67	9	1
A:54:ILE:HD13	A:70:VAL:HG12	0.67	2	2
A:115:PHE:CE1	A:272:LEU:HD22	0.67	9	1
A:115:PHE:CD1	A:430:TRP:CH2	0.66	3	1
A:430:TRP:CH2	A:432:SER:HB3	0.66	2	1
A:70:VAL:HG11	A:133:ILE:CD1	0.66	4	1
A:22:PRO:HB3	A:37:ALA:HB2	0.66	7	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:37:ALA:HB3	A:143:LEU:HD23	0.66	8	3
A:144:TYR:CD2	A:152:VAL:HG21	0.66	4	3
A:64:VAL:HG21	A:70:VAL:HG22	0.65	3	2
A:22:PRO:N	A:37:ALA:C	0.65	7	1
A:160:ILE:HG23	A:195:ILE:HD11	0.65	8	1
A:418:PHE:CE1	A:449:PRO:CB	0.64	9	1
A:63:PRO:HB2	A:656:PHE:CZ	0.64	3	1
A:84:ASP:CG	A:113:ALA:HB2	0.64	4	1
A:84:ASP:OD1	A:113:ALA:HB2	0.64	4	1
A:21:TRP:NE1	A:23:VAL:HG22	0.64	5	1
A:21:TRP:CD1	A:21:TRP:CE2	0.64	5	1
A:160:ILE:HG22	A:195:ILE:HD11	0.64	8	1
A:54:ILE:HD11	A:74:VAL:CG2	0.63	2	3
A:614:ILE:HD12	A:646:TYR:CZ	0.63	10	1
A:21:TRP:CD1	A:21:TRP:CD2	0.63	5	1
A:393:HIS:CG	A:418:PHE:CE1	0.63	9	1
A:243:TRP:CH2	A:251:PHE:CG	0.63	9	1
A:68:LYS:HB3	A:122:LEU:HD13	0.63	2	1
A:143:LEU:HD22	A:397:ARG:HH22	0.62	3	1
A:44:LEU:HD22	A:53:VAL:HG11	0.62	4	1
A:71:LEU:HD12	A:122:LEU:HD22	0.61	9	1
A:424:LEU:HD13	A:430:TRP:HE3	0.61	3	1
A:285:TRP:CZ3	A:292:LEU:HD21	0.61	6	1
A:63:PRO:HG3	A:590:TYR:CE1	0.61	9	1
A:426:LEU:HD23	A:441:ILE:HG23	0.61	9	1
A:21:TRP:CD2	A:23:VAL:CG1	0.60	5	1
A:243:TRP:CE3	A:251:PHE:HA	0.60	9	1
A:105:GLY:CA	A:150:GLY:HA3	0.60	4	1
A:393:HIS:CD2	A:418:PHE:CZ	0.60	9	1
A:521:TYR:CE2	A:523:VAL:HG22	0.59	6	2
A:243:TRP:CH2	A:251:PHE:CD2	0.59	9	1
A:26:VAL:HG13	A:30:GLY:C	0.59	10	1
A:63:PRO:CB	A:656:PHE:CE1	0.59	1	1
A:614:ILE:HD11	A:641:LEU:CD1	0.59	10	1
A:24:LEU:HD11	A:132:ARG:NH1	0.59	8	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	661	591	53	17
2	661	616	29	16
3	661	611	37	13
4	661	589	46	26
5	661	580	71	10
6	661	588	54	19
7	661	603	53	5
8	661	601	44	16
9	661	580	59	22
10	661	606	45	10

There are 96 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	23	VAL	6
A	24	LEU	4
A	31	GLU	4
A	220	THR	4
A	222	ASP	4
A	354	SER	4
A	433	ASN	4
A	11	GLY	3
A	15	SER	3
A	17	ILE	3
A	26	VAL	3
A	219	THR	3
A	265	ASP	3
A	353	THR	3
A	6	PRO	2
A	16	ALA	2
A	18	SER	2
A	21	TRP	2
A	29	ASP	2
A	109	ASN	2

Chain	Res	Type	Models (Total)
A	111	ARG	2
A	115	PHE	2
A	116	ARG	2
A	117	HIS	2
A	118	ASN	2
A	122	LEU	2
A	178	ARG	2
A	351	GLY	2
A	435	CYS	2
A	493	ASP	2
A	541	ASP	2
A	645	ASP	2
A	646	TYR	2
A	650	GLU	2
A	651	ASP	2
A	2	PHE	1
A	3	ARG	1
A	7	PHE	1
A	10	VAL	1
A	20	ALA	1
A	22	PRO	1
A	27	ASP	1
A	30	GLY	1
A	38	SER	1
A	39	SER	1
A	78	GLN	1
A	80	THR	1
A	84	ASP	1
A	85	ASN	1
A	93	GLY	1
A	112	ASN	1
A	119	ASP	1
A	161	GLY	1
A	162	GLN	1
A	196	ASP	1

Chain	Res	Type	Models (Total)
A	213	ASP	1
A	223	THR	1
A	225	GLU	1
A	229	ILE	1
A	234	SER	1
A	247	GLN	1
A	266	SER	1
A	288	GLY	1
A	290	SER	1
A	303	ASN	1
A	307	SER	1
A	324	PRO	1
A	327	ALA	1
A	348	ASN	1
A	428	PRO	1
A	429	ASP	1
A	436	ARG	1
A	437	GLY	1
A	438	ALA	1
A	443	GLY	1
A	468	LEU	1
A	469	GLU	1
A	484	ASP	1
A	489	SER	1
A	491	THR	1
A	500	TYR	1
A	501	GLN	1
A	503	PHE	1
A	505	GLY	1
A	524	ASN	1
A	589	PHE	1
A	600	ARG	1
A	602	ASP	1
A	603	SER	1
A	604	ALA	1

Chain	Res	Type	Models (Total)
A	607	LYS	1
A	608	THR	1
A	643	ARG	1
A	644	ASP	1
A	647	SER	1
A	652	GLY	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	568	536	22	10
2	568	548	15	5
3	568	548	10	10
4	568	538	20	10
5	568	517	35	16
6	568	544	14	10
7	568	513	35	20
8	568	540	19	9
9	568	540	16	12
10	568	546	13	9

There are 70 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	12	LEU	7
A	226	THR	6
A	608	THR	6
A	24	LEU	5
A	491	THR	5
A	14	LEU	4
A	494	VAL	3
A	54	ILE	2
A	68	LYS	2
A	164	TRP	2
A	173	THR	2
A	220	THR	2

Chain	Res	Type	Models (Total)
A	221	THR	2
A	326	THR	2
A	430	TRP	2
A	434	SER	2
A	523	VAL	2
A	644	ASP	2
A	660	ASP	2
A	1	MET	1
A	21	TRP	1
A	23	VAL	1
A	27	ASP	1
A	28	ASP	1
A	29	ASP	1
A	38	SER	1
A	57	GLU	1
A	77	VAL	1
A	80	THR	1
A	95	ASP	1
A	103	VAL	1
A	104	ASP	1
A	115	PHE	1
A	117	HIS	1
A	118	ASN	1
A	119	ASP	1
A	121	ASP	1
A	142	SER	1
A	149	LEU	1
A	183	THR	1
A	195	ILE	1
A	212	LYS	1
A	217	ASN	1
A	219	THR	1
A	234	SER	1
A	243	TRP	1
A	250	ASP	1

Chain	Res	Type	Models (Total)
A	251	PHE	1
A	258	ASP	1
A	260	GLN	1
A	325	LEU	1
A	345	ASP	1
A	347	VAL	1
A	389	THR	1
A	424	LEU	1
A	429	ASP	1
A	431	THR	1
A	439	CYS	1
A	446	ASP	1
A	481	ASP	1
A	495	ASN	1
A	517	VAL	1
A	524	ASN	1
A	540	ASN	1
A	567	ASP	1
A	576	THR	1
A	589	PHE	1
A	605	THR	1
A	642	SER	1
A	649	ASN	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.

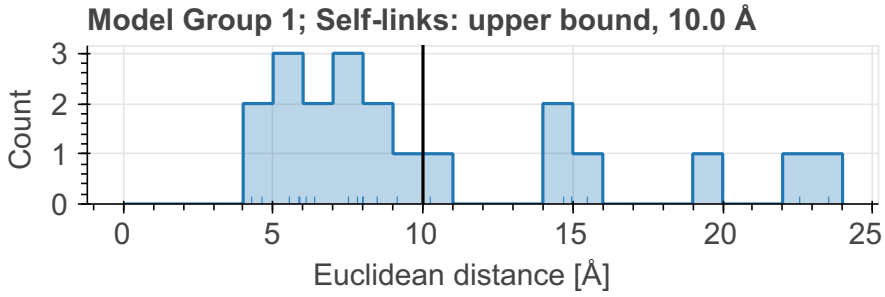
There are 20 crosslinking restraints combined in 20 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
L-Photo-Leucine	LEU	CA	TYR	CA	upper bound	10.00	3

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
L-Photo-Leucine	ASP	CA	LEU	CA	upper bound	10.00	4
L-Photo-Leucine	LEU	CA	PRO	CA	upper bound	10.00	1
L-Photo-Leucine	LEU	CA	VAL	CA	upper bound	10.00	1
L-Photo-Leucine	ASN	CA	LEU	CA	upper bound	10.00	3
L-Photo-Leucine	LEU	CA	LEU	CA	upper bound	10.00	2
L-Photo-Leucine	GLU	CA	LEU	CA	upper bound	10.00	3
L-Photo-Leucine	HIS	CA	LEU	CA	upper bound	10.00	1
L-Photo-Leucine	CYS	CA	LEU	CA	upper bound	10.00	1
L-Photo-Leucine	ALA	CA	LEU	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.



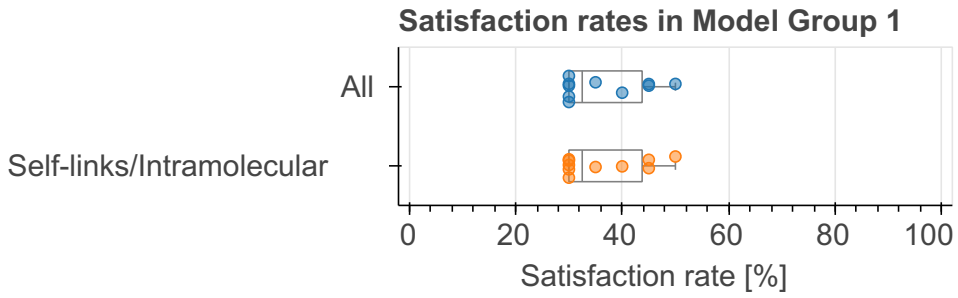
5.2.2. Satisfaction of restraints

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=20)
1	1	1	10/10	All	65.00	35.00	20
				Self-links/ Intramolecular	65.00	35.00	20

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

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.

Members of the wwPDB Integrative/Hybrid Methods Task Force provided recommendations and community support for the project.