

Integrative Structure Validation Report

October 09, 2025 - 04:51 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

PDB ID	9A9S pdb_00009a9s
Structure Title	Human elongation factor 1 complex
Structure Authors	Gong, Z.; Zhang, B.; Liang, Z.; Zhang, Y.; Zhang, L.; Liu, M.; Zhao, Q.
Deposited on	2025-04-08

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

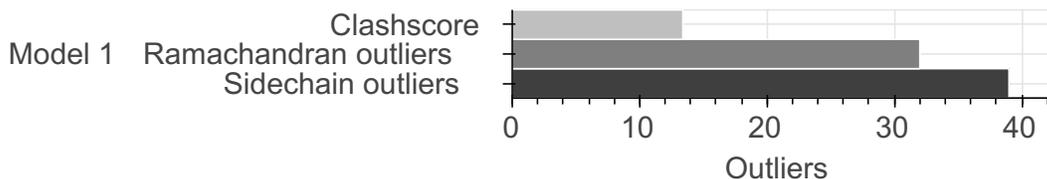
This entry consists of 1 model(s). A total of 5 dataset(s) were used to build this entry.

Name	Type	Count
Crosslinking-MS data	Experimental data	1
De Novo model	Starting model	4

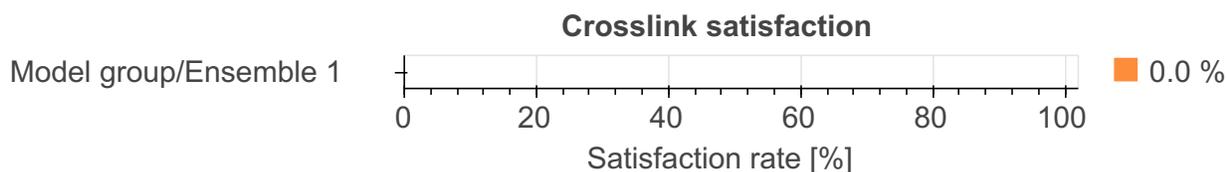
1.2. Overall quality

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 [?](#)



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	Elongation factor 1-gamma	A	437	-	1-437	100.00 / 100.00	Atomic
		2	Elongation factor 1-alpha 1	B	462	-	1-462	100.00 / 100.00	Atomic
		3	Elongation factor 1-beta	C	97	-	1-97	100.00 / 100.00	Atomic
		4	Elongation factor 1-delta	D	93	-	1-93	100.00 / 100.00	Atomic

2.3. Datasets used for modeling [?](#)

There are 5 unique datasets used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	Crosslinking-MS data	PRIDE	PXD047554

ID	Dataset type	Database name	Data access code
2	De Novo model	AlphaFoldDB	AF-P26641-F1
3	De Novo model	AlphaFoldDB	AF-P68104-F1
4	De Novo model	AlphaFoldDB	AF-P24534-F1
5	De Novo model	AlphaFoldDB	AF-P29692-F1

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	Monte Carlo simulated annealing	The structure of the complex consisting of four protein subunits was modeled using the four protein monomer structures generated by AlphaFold2 as the initial structures, with intracellular crosslinking mass spectrometry data as constraints, and employing a rigid body refinement structural strategy.	Not available	False	False

There is 1 software package reported in this entry.

ID	Software name	Software version	Software classification	Software location
1	Xplor-NIH	2.53	model building	https://nmr.cit.nih.gov/xplor-nih/

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

Standard geometry: bond outliers ?

There are 2 bond length outliers in this entry (0.02% of 8740 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	156	ARG	NE-CZ	4.64	1.27	1.33	1	1
A	189	ARG	CZ-NH2	4.50	1.27	1.33	1	1

Standard geometry: angle outliers ?

There are 64 bond angle outliers in this entry (0.54% of 11829 assessed bonds). A summary is provided below.

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
B	118	ALA	C-CA-CB	7.92	122.38	110.50	1	1
A	156	ARG	NE-CZ-NH2	7.73	112.25	119.20	1	1
B	296	HIS	CA-CB-CG	7.66	121.46	113.80	1	1
A	143	ASP	CA-CB-CG	7.56	105.04	112.60	1	1
D	56	GLN	OE1-CD-NE2	7.34	115.26	122.60	1	1
A	156	ARG	CD-NE-CZ	6.08	132.91	124.40	1	1
A	156	ARG	N-CA-CB	6.05	120.79	110.50	1	1
B	7	HIS	CB-CG-CD2	5.82	123.63	131.20	1	1
B	124	GLU	N-CA-CB	5.79	120.34	110.50	1	1
B	124	GLU	CA-CB-CG	5.65	125.40	114.10	1	1
B	153	ASN	OD1-CG-ND2	5.54	117.06	122.60	1	1
D	63	ASP	CA-CB-CG	5.39	117.99	112.60	1	1
A	378	ARG	NH1-CZ-NH2	5.36	112.33	119.30	1	1
B	352	GLN	OE1-CD-NE2	5.34	117.26	122.60	1	1
A	174	GLN	OE1-CD-NE2	5.30	117.30	122.60	1	1
B	71	ILE	C-N-CA	5.23	131.11	121.70	1	1
C	60	GLN	OE1-CD-NE2	5.13	117.47	122.60	1	1
B	95	HIS	CB-CG-CD2	5.08	124.60	131.20	1	1
A	161	ASP	C-CA-CB	5.06	119.72	110.10	1	1
A	225	GLN	OE1-CD-NE2	5.06	117.54	122.60	1	1
B	124	GLU	CB-CG-CD	5.02	121.14	112.60	1	1
A	299	ASN	C-CA-CB	4.93	100.74	110.10	1	1
B	108	GLN	OE1-CD-NE2	4.90	117.70	122.60	1	1
A	39	HIS	CB-CG-CD2	4.79	124.98	131.20	1	1
A	94	GLN	OE1-CD-NE2	4.78	117.82	122.60	1	1
B	159	GLU	CB-CG-CD	4.76	104.50	112.60	1	1
A	88	THR	CA-CB-CG2	4.76	118.60	110.50	1	1
A	189	ARG	NH1-CZ-NH2	4.71	113.18	119.30	1	1

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
B	319	ASP	CA-CB-CG	4.55	117.15	112.60	1	1
B	114	LEU	C-N-CA	4.48	129.76	121.70	1	1
A	189	ARG	NE-CZ-NH2	4.46	123.22	119.20	1	1
B	324	ASN	OD1-CG-ND2	4.45	118.15	122.60	1	1
B	125	ALA	C-N-CA	4.44	129.70	121.70	1	1
B	96	ARG	NE-CZ-NH2	4.39	123.16	119.20	1	1
A	122	HIS	CB-CG-CD2	4.39	125.49	131.20	1	1
D	11	LEU	C-CA-CB	4.37	118.40	110.10	1	1
A	280	PHE	CA-CB-CG	4.36	109.44	113.80	1	1
B	164	GLN	OE1-CD-NE2	4.35	118.25	122.60	1	1
A	424	GLN	OE1-CD-NE2	4.35	118.25	122.60	1	1
C	78	GLN	OE1-CD-NE2	4.34	118.26	122.60	1	1
C	38	GLN	OE1-CD-NE2	4.30	118.30	122.60	1	1
A	203	VAL	CA-CB-CG2	4.29	103.11	110.40	1	1
A	21	ALA	C-CA-CB	4.29	116.93	110.50	1	1
B	197	ASN	OD1-CG-ND2	4.28	118.32	122.60	1	1
B	175	SER	N-CA-CB	4.27	117.76	110.50	1	1
A	348	ARG	CD-NE-CZ	4.26	130.36	124.40	1	1
C	62	GLN	OE1-CD-NE2	4.26	118.34	122.60	1	1
A	353	ARG	CD-NE-CZ	4.22	130.31	124.40	1	1
A	288	PHE	CA-CB-CG	4.21	109.59	113.80	1	1
A	215	GLN	OE1-CD-NE2	4.21	118.39	122.60	1	1
D	34	GLN	OE1-CD-NE2	4.21	118.39	122.60	1	1
A	282	HIS	CA-CB-CG	4.21	109.59	113.80	1	1
D	25	GLN	OE1-CD-NE2	4.17	118.43	122.60	1	1
B	296	HIS	C-CA-CB	4.16	118.01	110.10	1	1
A	97	GLN	OE1-CD-NE2	4.14	118.46	122.60	1	1
B	161	PRO	C-N-CA	4.14	129.15	121.70	1	1
B	364	HIS	CB-CG-CD2	4.14	125.82	131.20	1	1
B	295	HIS	C-N-CA	4.12	129.11	121.70	1	1
A	160	ALA	C-N-CA	4.10	129.08	121.70	1	1
B	380	ASP	CA-CB-CG	4.10	108.50	112.60	1	1
A	28	GLN	OE1-CD-NE2	4.08	118.52	122.60	1	1
B	158	THR	CA-CB-OG1	4.06	115.70	109.60	1	1
B	349	HIS	CA-CB-CG	4.04	109.76	113.80	1	1

Chain	Res	Type	Atoms	Z	Observed (Å)	Ideal (Å)	Model ID (Worst)	Models (Total)
A	95	VAL	CA-CB-CG1	4.00	117.20	110.40	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	13.39	229

There are 229 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)
D:11:LEU:HD21	D:56:GLN:HE21	1.02	1	1
B:103:ILE:HD13	B:425:ALA:HB2	0.96	1	1
A:288:PHE:O	A:289:VAL:HG13	0.95	1	1
A:366:ASN:ND2	D:45:LEU:H	0.92	1	1
A:157:VAL:HG11	A:200:PHE:CE1	0.87	1	1
D:5:VAL:O	D:6:ALA:HB3	0.78	1	1
B:177:TYR:CE2	B:181:ILE:HD11	0.78	1	1
A:366:ASN:HD22	D:45:LEU:HB3	0.78	1	1
A:288:PHE:C	A:289:VAL:HG22	0.77	1	1
C:9:VAL:O	C:10:ALA:HB3	0.77	1	1
A:95:VAL:HA	A:160:ALA:HB2	0.77	1	1
C:6:PRO:O	C:7:ALA:HB2	0.76	1	1
A:366:ASN:ND2	D:45:LEU:N	0.75	1	1
B:99:ILE:HG21	B:432:THR:HG21	0.72	1	1
A:378:ARG:HH21	C:35:ARG:NH2	0.72	1	1
A:238:ARG:CG	A:238:ARG:HH11	0.69	1	1
C:7:ALA:HB3	C:11:LYS:NZ	0.69	1	1
D:4:LEU:O	D:5:VAL:HG22	0.69	1	1
A:280:PHE:O	A:281:ALA:HB2	0.69	1	1
A:366:ASN:ND2	D:45:LEU:O	0.68	1	1
A:99:VAL:HG13	A:163:THR:HG21	0.68	1	1
A:281:ALA:C	A:282:HIS:CG	0.64	1	1
A:299:ASN:HD21	B:296:HIS:HB3	0.64	1	1
B:103:ILE:HD13	B:425:ALA:CB	0.64	1	1
C:7:ALA:O	C:11:LYS:NZ	0.63	1	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:245:GLN:O	A:246:ALA:HB2	0.63	1	1
A:258:ALA:HB1	A:259:PRO:HD2	0.62	1	1
D:5:VAL:O	D:6:ALA:CB	0.62	1	1
A:161:ASP:HA	A:190:TRP:CZ2	0.62	1	1
A:256:ALA:HB1	A:257:PRO:HD2	0.62	1	1
A:152:LEU:HG	A:190:TRP:CE2	0.62	1	1
D:11:LEU:HD21	D:56:GLN:NE2	0.62	1	1
A:299:ASN:HD21	B:296:HIS:CB	0.61	1	1
B:171:VAL:HG22	B:190:PHE:CD2	0.61	1	1
A:288:PHE:O	A:289:VAL:CG1	0.60	1	1
A:24:TYR:CE1	A:199:GLN:HB2	0.60	1	1
A:84:LEU:HD13	A:162:ILE:CD1	0.60	1	1
C:6:PRO:O	C:7:ALA:CB	0.60	1	1
D:4:LEU:O	D:5:VAL:O	0.60	1	1
B:28:ILE:HD13	B:78:TRP:CE3	0.59	1	1
A:99:VAL:HG22	A:163:THR:HB	0.59	1	1
A:366:ASN:HD22	D:45:LEU:CB	0.59	1	1
D:5:VAL:HG12	D:64:ASP:OD1	0.59	1	1
C:4:LYS:O	C:5:LYS:C	0.59	1	1
A:238:ARG:CG	A:238:ARG:NH1	0.59	1	1
A:170:TRP:CD1	A:170:TRP:H	0.58	1	1
A:151:PHE:HA	A:190:TRP:CD1	0.58	1	1
A:228:LYS:C	A:229:ASP:CG	0.58	1	1
A:228:LYS:O	A:229:ASP:CG	0.58	1	1
A:228:LYS:O	A:229:ASP:CB	0.58	1	1
B:63:LEU:HD13	B:78:TRP:CH2	0.58	1	1
B:167:TYR:O	B:171:VAL:HG23	0.58	1	1
A:152:LEU:HD12	A:190:TRP:CZ2	0.58	1	1
A:21:ALA:HB1	A:80:SER:HB3	0.58	1	1
A:157:VAL:HG11	A:200:PHE:CZ	0.57	1	1
D:4:LEU:O	D:5:VAL:CG2	0.57	1	1
A:227:LYS:O	A:229:ASP:OD1	0.57	1	1
D:11:LEU:CD2	D:88:ALA:HB3	0.57	1	1
A:269:ALA:O	A:270:LEU:O	0.57	1	1
D:11:LEU:CD2	D:56:GLN:HE21	0.57	1	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:161:ASP:CG	A:190:TRP:HE1	0.56	1	1
C:7:ALA:O	C:8:LEU:C	0.56	1	1
C:9:VAL:O	C:10:ALA:CB	0.56	1	1
A:146:LEU:HD13	A:187:THR:HA	0.56	1	1
B:99:ILE:CG2	B:432:THR:HG21	0.56	1	1
A:146:LEU:CD1	A:187:THR:HA	0.56	1	1
C:7:ALA:O	C:11:LYS:CE	0.56	1	1
B:73:ILE:HA	B:100:LYS:HE2	0.55	1	1
C:7:ALA:O	C:8:LEU:O	0.55	1	1
A:146:LEU:HD21	A:152:LEU:HA	0.55	1	1
A:269:ALA:O	A:270:LEU:C	0.55	1	1
A:20:ILE:HD11	A:204:LEU:CG	0.54	1	1
C:48:LYS:HE3	C:60:GLN:OE1	0.54	1	1
B:73:ILE:HG23	B:100:LYS:HG2	0.54	1	1
A:13:TRP:CE2	A:170:TRP:CZ2	0.54	1	1
A:20:ILE:HD11	A:204:LEU:HG	0.54	1	1
B:58:TRP:CZ2	B:62:LYS:HE3	0.53	1	1
A:351:LYS:HZ3	B:66:GLU:CD	0.53	1	1
A:18:ALA:HA	A:76:ALA:HA	0.53	1	1
C:16:LEU:HD22	C:89:MET:CE	0.53	1	1
B:73:ILE:HG12	B:100:LYS:HE2	0.53	1	1
D:11:LEU:HD23	D:88:ALA:HB3	0.53	1	1
A:91:ALA:HB1	A:153:VAL:CG1	0.53	1	1
A:366:ASN:HD22	D:45:LEU:CA	0.53	1	1
A:151:PHE:CZ	A:156:ARG:HA	0.52	1	1
A:238:ARG:HG3	A:238:ARG:NH1	0.52	1	1
A:281:ALA:H	A:282:HIS:CE1	0.52	1	1
B:177:TYR:CZ	B:181:ILE:HD11	0.52	1	1
B:60:LEU:HA	B:78:TRP:CZ2	0.52	1	1
A:13:TRP:CZ2	A:170:TRP:CH2	0.52	1	1
A:170:TRP:CD1	A:170:TRP:N	0.52	1	1
A:287:THR:O	A:289:VAL:HG22	0.52	1	1
A:152:LEU:CD1	A:190:TRP:CZ2	0.52	1	1
A:24:TYR:HB2	A:84:LEU:HD11	0.51	1	1
A:95:VAL:O	A:99:VAL:HG23	0.51	1	1

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
B:139:LEU:CD2	B:435:VAL:HG21	0.51	1	1
B:55:LYS:HE2	B:56:TYR:CE1	0.51	1	1
A:21:ALA:HB1	A:80:SER:CA	0.51	1	1
A:299:ASN:HA	B:297:GLU:HG3	0.51	1	1
C:7:ALA:C	C:11:LYS:HZ1	0.51	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	1081	975	74	32

There are 32 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	71	GLU	1
A	161	ASP	1
A	227	LYS	1
A	229	ASP	1
A	231	PRO	1
A	238	ARG	1
A	241	LYS	1
A	242	GLN	1
A	246	ALA	1
A	254	ALA	1
A	264	ASP	1
A	265	GLU	1
A	266	CYS	1
A	267	GLU	1
A	270	LEU	1
A	271	ALA	1
A	276	ALA	1
A	279	PRO	1
A	281	ALA	1
A	283	LEU	1
A	285	LYS	1
A	286	SER	1

Chain	Res	Type	Models (Total)
A	289	VAL	1
B	66	GLU	1
B	72	THR	1
B	212	LYS	1
B	448	ALA	1
C	7	ALA	1
C	8	LEU	1
D	2	PRO	1
D	5	VAL	1
D	6	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	918	847	32	39

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

Chain	Res	Type	Models (Total)
A	88	THR	1
A	170	TRP	1
A	229	ASP	1
A	230	THR	1
A	234	GLU	1
A	238	ARG	1
A	240	GLU	1
A	241	LYS	1
A	242	GLN	1
A	247	GLU	1
A	250	GLU	1
A	263	MET	1
A	266	CYS	1
A	268	GLN	1
A	270	LEU	1
A	273	GLU	1
A	277	LYS	1

Chain	Res	Type	Models (Total)
A	282	HIS	1
A	283	LEU	1
A	285	LYS	1
A	286	SER	1
A	287	THR	1
A	289	VAL	1
B	17	ASP	1
B	39	ILE	1
B	60	LEU	1
B	63	LEU	1
B	72	THR	1
B	75	ILE	1
B	76	SER	1
B	107	SER	1
B	124	GLU	1
B	157	SER	1
B	239	THR	1
B	389	ASP	1
B	454	SER	1
C	1	LYS	1
C	2	LYS	1
C	4	LYS	1

5. Fit to Data Used for Modeling Assessment

5.2. Crosslinking-MS

5.2.1. Restraint types

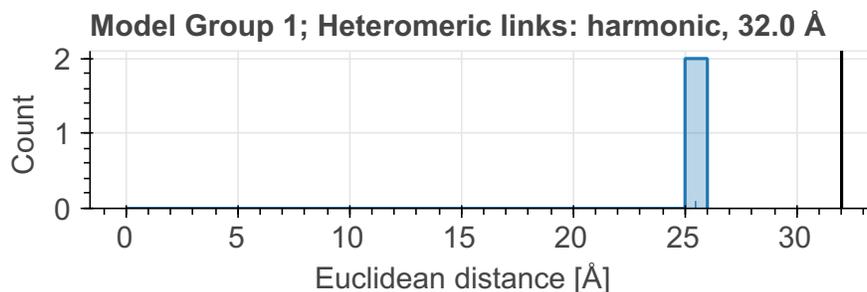
This table summarizes information about crosslinker(s) used for data generation, and how crosslinking information was translated into actual modeling restraints. Restraints assigned "by-residue" are interpreted as between CA atoms. Restraints between coarse-grained beads are indicated as "coarse-grained".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

There are 2 crosslinking restraints combined in 1 restraint groups.

Linker	Residue 1	Atom 1	Residue 2	Atom 2	Restraint type	Distance, Å	Count
TDS	LYS	CA	LYS	CA	harmonic	32.00	2

[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.



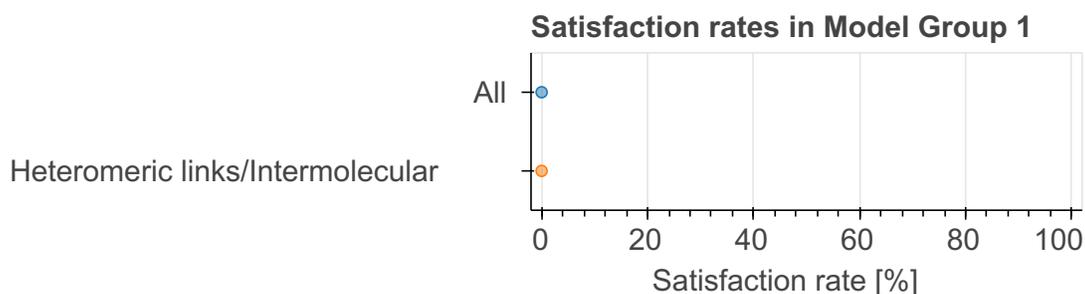
5.2.2. Satisfaction of restraints ?

*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

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.