



wwPDB NMR Structure Validation Summary Report ⓘ

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PDB ID : 2MHK
BMRB ID : 18853
Title : E. coli LpoA N-terminal domain
Authors : Jean, N.L.; Bougault, C.; Lodge, A.; Derouaux, A.; Callens, G.; Egan, A.;
Lewis, R.J.; Vollmer, W.; Simorre, J.
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This is a wwPDB NMR Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

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<https://www.wwpdb.org/validation/2017/NMRValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)
wwPDB-RCI : v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV : Wang et al. (2010)
wwPDB-ShiftChecker : v1.2
BMRB Restraints Analysis : v1.2
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.40

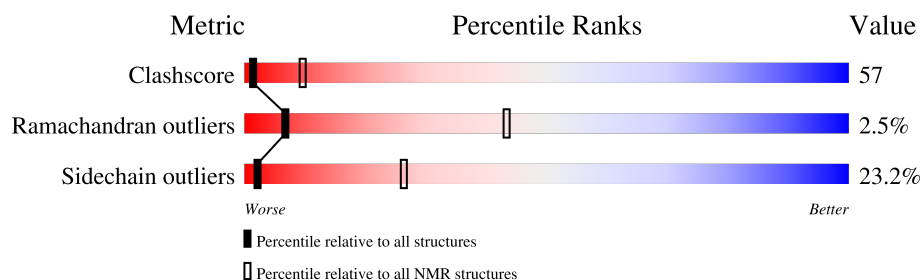
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 90%.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	NMR archive (#Entries)
Clashscore	210492	14027
Ramachandran outliers	207382	12486
Sidechain outliers	206894	12463

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and a grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	250	<div> <div></div> <div>25%</div> <div>47%</div> <div>14%</div> <div>14%</div> </div>

2 Ensemble composition and analysis

This entry contains 20 models. Model 10 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *lowest energy*.

The following residues are included in the computation of the global validation metrics.

Well-defined (core) protein residues			
Well-defined core	Residue range (total)	Backbone RMSD (Å)	Medoid model
1	A:28-A:188, A:192-A:246 (216)	0.27	10

Ill-defined regions of proteins are excluded from the global statistics.

Ligands and non-protein polymers are included in the analysis.

The models can be grouped into 2 clusters and 3 single-model clusters were found.

Cluster number	Models
1	1, 2, 4, 5, 7, 8, 9, 10, 12, 14, 15, 16, 17, 19, 20
2	6, 13
Single-model clusters	3; 11; 18

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 3916 atoms, of which 1945 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Penicillin-binding protein activator LpoA.

Mol	Chain	Residues	Atoms						Trace
1	A	250	Total	C	H	N	O	S	0
			3916	1224	1945	362	377	8	

There are 21 discrepancies between the modelled and reference sequences:

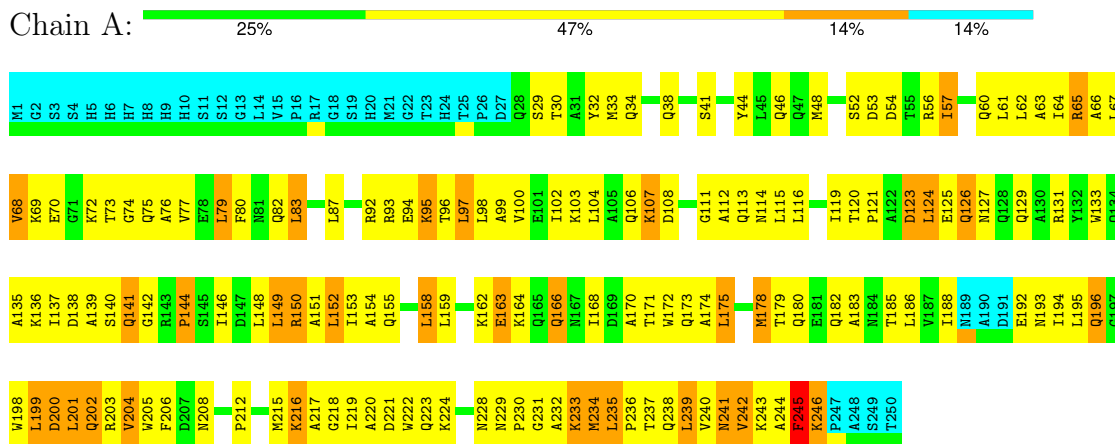
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	expression tag	UNP P45464
A	2	GLY	-	expression tag	UNP P45464
A	3	SER	-	expression tag	UNP P45464
A	4	SER	-	expression tag	UNP P45464
A	5	HIS	-	expression tag	UNP P45464
A	6	HIS	-	expression tag	UNP P45464
A	7	HIS	-	expression tag	UNP P45464
A	8	HIS	-	expression tag	UNP P45464
A	9	HIS	-	expression tag	UNP P45464
A	10	HIS	-	expression tag	UNP P45464
A	11	SER	-	expression tag	UNP P45464
A	12	SER	-	expression tag	UNP P45464
A	13	GLY	-	expression tag	UNP P45464
A	14	LEU	-	expression tag	UNP P45464
A	15	VAL	-	expression tag	UNP P45464
A	16	PRO	-	expression tag	UNP P45464
A	17	ARG	-	expression tag	UNP P45464
A	18	GLY	-	expression tag	UNP P45464
A	19	SER	-	expression tag	UNP P45464
A	20	HIS	-	expression tag	UNP P45464
A	21	MET	-	expression tag	UNP P45464

4 Residue-property plots [i](#)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

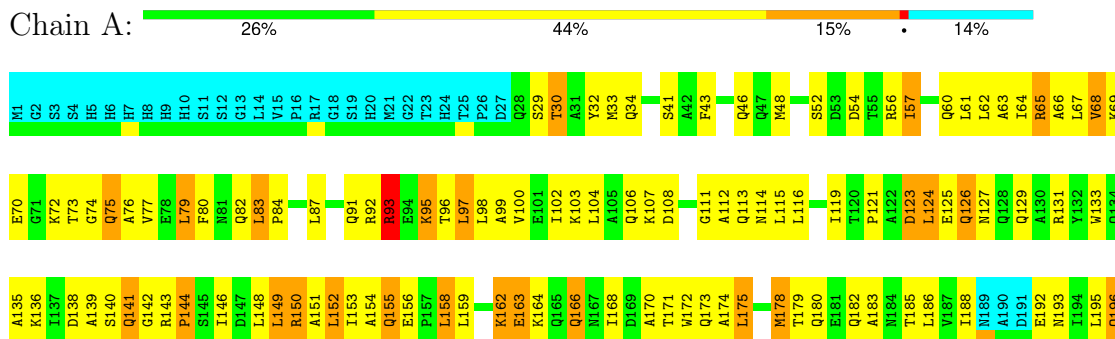
- Molecule 1: Penicillin-binding protein activator LpoA



4.2 Residue scores for the representative (medoid) model from the NMR ensemble

The representative model is number 10. Colouring as in section 4.1 above.

- Molecule 1: Penicillin-binding protein activator LpoA



G197	W198	L199	D200	L201	Q202	R203	V204	W205	F206	D207	N208	P212	M215	K216	A217	G218	I219	A220	D221	W222	Q223	K224	N228	N229	P230	G231	A232	K233	N234	L235	P236	T237	Q238	I239	V240	N241	V242	K243	A244	F245	K246	P247	A248	S249	T250
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

5 Refinement protocol and experimental data overview

The models were refined using the following method: *simulated annealing*.

Of the 700 calculated structures, 20 were deposited, based on the following criterion: *structures with the lowest energy*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
CNS	structure solution	1.2
CNS	refinement	1.2

The following table shows chemical shift validation statistics as aggregates over all chemical shift files. Detailed validation can be found in section 7 of this report.

Chemical shift file(s)	working_cs.cif
Number of chemical shift lists	1
Total number of shifts	2922
Number of shifts mapped to atoms	2922
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	90%

6 Model quality i

6.1 Standard geometry i

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the (average) root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	#Z>5	RMSZ	#Z>5
1	A	0.60±0.03	1±1/1749 (0.1± 0.1%)	0.76±0.01	0±0/2370 (0.0± 0.0%)
All	All	0.60	29/34980 (0.1%)	0.76	1/47400 (0.0%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	Chirality	Planarity
1	A	0.0±0.0	0.1±0.2
All	All	0	1

5 of 8 unique bond outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)	Models	
								Worst	Total
1	A	44	TYR	CE1-CZ	9.02	1.50	1.38	18	5
1	A	44	TYR	CE2-CZ	-8.81	1.27	1.38	18	5
1	A	80	PHE	CE2-CZ	8.23	1.52	1.37	6	4
1	A	245	PHE	CE2-CZ	7.26	1.51	1.37	16	4
1	A	206	PHE	CE1-CZ	6.64	1.50	1.37	9	5

All unique angle outliers are listed below.

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	93	ARG	NE-CZ-NH1	6.28	123.44	120.30	10	1

There are no chirality outliers.

All unique planar outliers are listed below.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	245	PHE	Sidechain	1

6.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in each chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	1720	1720	1720	196±7
All	All	34400	34400	34400	3930

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 57.

5 of 409 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:61:LEU:HA	1:A:98:LEU:HD21	0.98	1.29	16	20
1:A:32:TYR:HB2	1:A:62:LEU:HD21	0.96	1.36	8	20
1:A:172:TRP:CD1	1:A:238:GLN:HB2	0.90	2.02	11	20
1:A:231:GLY:O	1:A:235:LEU:HG	0.84	1.71	13	20
1:A:164:LYS:O	1:A:168:ILE:HG12	0.82	1.74	13	20

6.3 Torsion angles [i](#)

6.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all NMR entries. The Analysed column shows the number of residues for which the backbone conformation was analysed and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	216/250 (86%)	189±2 (88±1%)	22±2 (10±1%)	5±1 (2±0%)	7	43
All	All	4320/5000 (86%)	3781 (88%)	432 (10%)	107 (2%)	7	43

5 of 9 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	124	LEU	20
1	A	141	GLN	20
1	A	246	LYS	20
1	A	144	PRO	19
1	A	53	ASP	16

6.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all NMR entries. The Analysed column shows the number of residues for which the sidechain conformation was analysed and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	180/208 (87%)	138±3 (77±2%)	42±3 (23±2%)	2	26
All	All	3600/4160 (87%)	2763 (77%)	837 (23%)	2	26

5 of 85 unique residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	57	ILE	20
1	A	68	VAL	20
1	A	75	GLN	20
1	A	79	LEU	20
1	A	83	LEU	20

6.3.3 RNA [i](#)

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

6.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.6 Ligand geometry [i](#)

There are no ligands in this entry.

6.7 Other polymers [i](#)

There are no such molecules in this entry.

6.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

7 Chemical shift validation [i](#)

The completeness of assignment taking into account all chemical shift lists is 90% for the well-defined parts and 86% for the entire structure.

7.1 Chemical shift list 1

File name: working_cs.cif

Chemical shift list name: *assigned_chem_shift_list*

7.1.1 Bookkeeping [i](#)

The following table shows the results of parsing the chemical shift list and reports the number of nuclei with statistically unusual chemical shifts.

Total number of shifts	2922
Number of shifts mapped to atoms	2922
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	15

7.1.2 Chemical shift referencing [i](#)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	239	-1.32 ± 0.10	Should be checked
$^{13}\text{C}_\beta$	225	-0.82 ± 0.05	Should be checked
$^{13}\text{C}'$	226	-0.20 ± 0.08	None needed (< 0.5 ppm)
^{15}N	224	0.35 ± 0.15	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments [i](#)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 90%, i.e. 2700 atoms were assigned a chemical shift out of a possible 3007. 0 out of 32 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	1058/1073 (99%)	431/433 (100%)	421/432 (97%)	206/208 (99%)
Sidechain	1510/1776 (85%)	1002/1146 (87%)	475/544 (87%)	33/86 (38%)

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	Total	¹ H	¹³ C	¹⁵ N
Aromatic	132/158 (84%)	66/77 (86%)	60/75 (80%)	6/6 (100%)
Overall	2700/3007 (90%)	1499/1656 (91%)	956/1051 (91%)	245/300 (82%)

7.1.4 Statistically unusual chemical shifts ⓘ

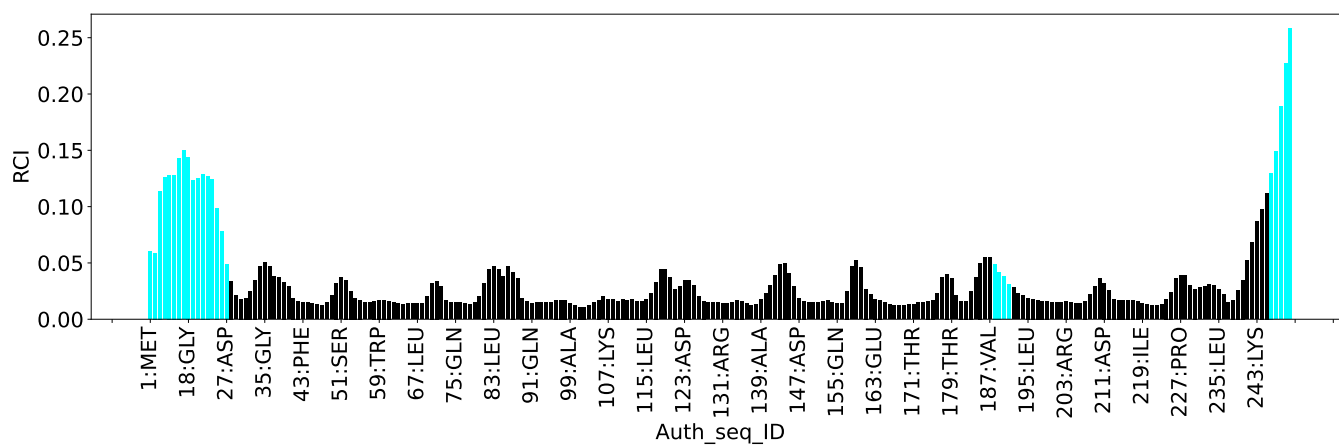
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

List Id	Chain	Res	Type	Atom	Shift, ppm	Expected range, ppm	Z-score
1	A	47	GLN	HG2	-0.11	1.01 – 3.62	-9.3
1	A	47	GLN	HB3	-0.38	0.71 – 3.33	-9.1
1	A	176	SER	HB2	1.80	2.61 – 5.13	-8.2
1	A	47	GLN	HB2	0.26	0.80 – 3.29	-7.2
1	A	171	THR	HG21	-0.33	0.08 – 2.19	-7.0
1	A	171	THR	HG22	-0.33	0.08 – 2.19	-7.0
1	A	171	THR	HG23	-0.33	0.08 – 2.19	-7.0
1	A	201	LEU	HB2	-0.74	-0.07 – 3.30	-7.0
1	A	209	ARG	HD2	1.67	1.97 – 4.26	-6.3
1	A	172	TRP	HZ2	5.57	5.71 – 8.86	-5.5
1	A	154	ALA	HB1	0.03	0.14 – 2.58	-5.5
1	A	154	ALA	HB2	0.03	0.14 – 2.58	-5.5
1	A	154	ALA	HB3	0.03	0.14 – 2.58	-5.5
1	A	47	GLN	HG3	0.80	0.91 – 3.68	-5.4
1	A	29	SER	HB2	2.57	2.61 – 5.13	-5.2

7.1.5 Random Coil Index (RCI) plots ⓘ

The image below reports *random coil index* values for the protein chains in the structure. The height of each bar gives a probability of a given residue to be disordered, as predicted from the available chemical shifts and the amino acid sequence. A value above 0.2 is an indication of significant predicted disorder. The colour of the bar shows whether the residue is in the well-defined core (black) or in the ill-defined residue ranges (cyan), as described in section 2 on ensemble composition. If well-defined core and ill-defined regions are not identified then it is shown as gray bars.

Random coil index (RCI) for chain A:



8 NMR restraints analysis

8.1 Conformationally restricting restraints

The following table provides the summary of experimentally observed NMR restraints in different categories. Restraints are classified into different categories based on the sequence separation of the atoms involved.

Description	Value
Total distance restraints	6086
Intra-residue ($ i-j =0$)	2113
Sequential ($ i-j =1$)	1223
Medium range ($ i-j >1$ and $ i-j <5$)	1296
Long range ($ i-j \geq 5$)	1454
Inter-chain	0
Hydrogen bond restraints	0
Disulfide bond restraints	0
Total dihedral-angle restraints	426
Number of unmapped restraints	0
Number of restraints per residue	26.0
Number of long range restraints per residue ¹	5.8

¹Long range hydrogen bonds and disulfide bonds are counted as long range restraints while calculating the number of long range restraints per residue

8.2 Residual restraint violations

This section provides the overview of the restraint violations analysis. The violations are binned as small, medium and large violations based on its absolute value. Average number of violations per model is calculated by dividing the total number of violations in each bin by the size of the ensemble.

8.2.1 Average number of distance violations per model

Distance violations less than 0.1 Å are not included in the calculation.

Bins (Å)	Average number of violations per model	Max (Å)
0.1-0.2 (Small)	354.0	0.2
0.2-0.5 (Medium)	668.0	0.5
>0.5 (Large)	514.0	2.98

8.2.2 Average number of dihedral-angle violations per model [i](#)

Dihedral-angle violations less than 1° are not included in the calculation.

Bins (°)	Average number of violations per model	Max (°)
1.0-10.0 (Small)	27.8	9.91
10.0-20.0 (Medium)	0.5	12.13
>20.0 (Large)	None	None

9 Distance violation analysis ⓘ

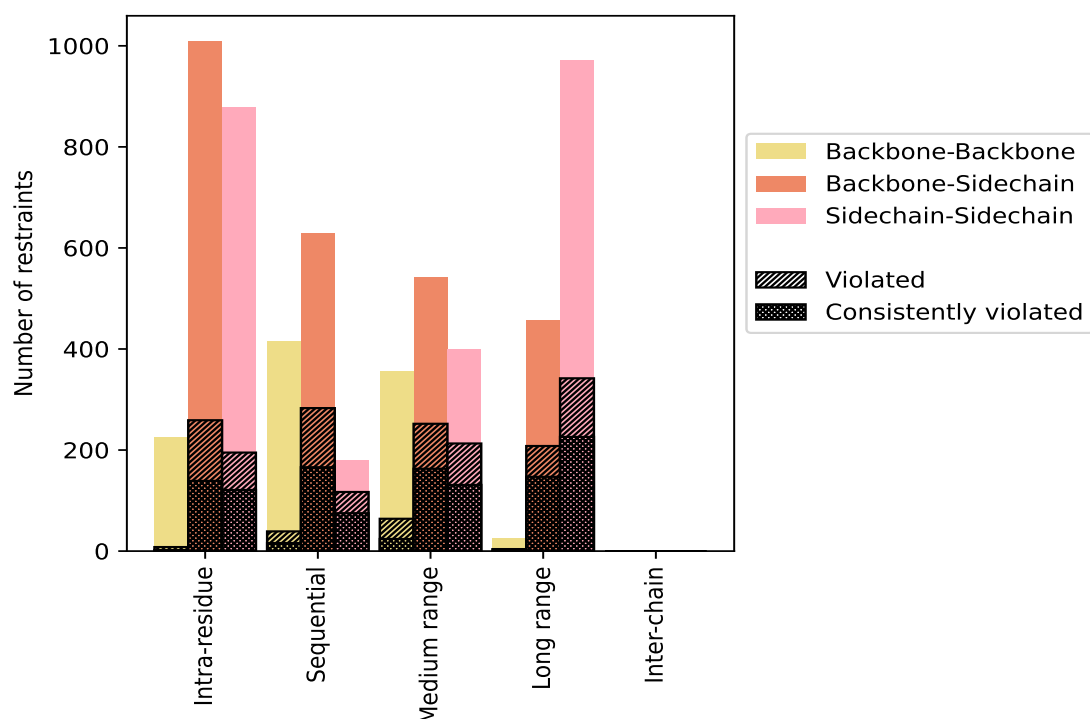
9.1 Summary of distance violations ⓘ

The following table shows the summary of distance violations in different restraint categories based on the sequence separation of the atoms involved. Each category is further sub-divided into three sub-categories based on the atoms involved. Violations less than 0.1 Å are not included in the statistics.

Restrains type	Count	% ¹	Violated ³			Consistently Violated ⁴		
			Count	% ²	% ¹	Count	% ²	% ¹
Intra-residue ($i-j =0$)	2113	34.7	462	21.9	7.6	262	12.4	4.3
Backbone-Backbone	226	3.7	8	3.5	0.1	2	0.9	0.0
Backbone-Sidechain	1009	16.6	259	25.7	4.3	139	13.8	2.3
Sidechain-Sidechain	878	14.4	195	22.2	3.2	121	13.8	2.0
Sequential ($i-j =1$)	1223	20.1	439	35.9	7.2	257	21.0	4.2
Backbone-Backbone	415	6.8	39	9.4	0.6	16	3.9	0.3
Backbone-Sidechain	629	10.3	283	45.0	4.7	166	26.4	2.7
Sidechain-Sidechain	179	2.9	117	65.4	1.9	75	41.9	1.2
Medium range ($i-j >1$ & $i-j <5$)	1296	21.3	529	40.8	8.7	318	24.5	5.2
Backbone-Backbone	355	5.8	64	18.0	1.1	24	6.8	0.4
Backbone-Sidechain	541	8.9	252	46.6	4.1	163	30.1	2.7
Sidechain-Sidechain	400	6.6	213	53.2	3.5	131	32.8	2.2
Long range ($i-j \geq 5$)	1454	23.9	554	38.1	9.1	374	25.7	6.1
Backbone-Backbone	26	0.4	4	15.4	0.1	1	3.8	0.0
Backbone-Sidechain	456	7.5	208	45.6	3.4	147	32.2	2.4
Sidechain-Sidechain	972	16.0	342	35.2	5.6	226	23.3	3.7
Inter-chain	0	0.0	0	0.0	0.0	0	0.0	0.0
Backbone-Backbone	0	0.0	0	0.0	0.0	0	0.0	0.0
Backbone-Sidechain	0	0.0	0	0.0	0.0	0	0.0	0.0
Sidechain-Sidechain	0	0.0	0	0.0	0.0	0	0.0	0.0
Hydrogen bond	0	0.0	0	0.0	0.0	0	0.0	0.0
Disulfide bond	0	0.0	0	0.0	0.0	0	0.0	0.0
Total	6086	100.0	1984	32.6	32.6	1211	19.9	19.9
Backbone-Backbone	1022	16.8	115	11.3	1.9	43	4.2	0.7
Backbone-Sidechain	2635	43.3	1002	38.0	16.5	615	23.3	10.1
Sidechain-Sidechain	2429	39.9	867	35.7	14.2	553	22.8	9.1

¹ percentage calculated with respect to the total number of distance restraints, ² percentage calculated with respect to the number of restraints in a particular restraint category, ³ violated in at least one model, ⁴ violated in all the models

9.1.1 Bar chart : Distribution of distance restraints and violations [i](#)



Violated and consistently violated restraints are shown using different hatch patterns in their respective categories. The hydrogen bonds and disulfied bonds are counted in their appropriate category on the x-axis

9.2 Distance violation statistics for each model [i](#)

The following table provides the distance violation statistics for each model in the ensemble. Violations less than 0.1 Å are not included in the statistics.

Model ID	Number of violations						Mean (Å)	Max (Å)	SD ⁶ (Å)	Median (Å)
	IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵	Total				
1	349	342	409	468	0	1568	0.48	2.61	0.39	0.36
2	352	339	407	461	0	1559	0.48	2.54	0.39	0.36
3	355	341	401	465	0	1562	0.48	2.6	0.4	0.36
4	345	346	410	467	0	1568	0.48	2.6	0.39	0.35
5	354	349	403	455	0	1561	0.47	2.98	0.39	0.35
6	339	342	408	469	0	1558	0.48	2.59	0.38	0.36
7	345	333	404	457	0	1539	0.49	2.72	0.39	0.37
8	353	341	398	465	0	1557	0.48	2.95	0.39	0.36
9	350	340	399	463	0	1552	0.48	2.62	0.38	0.36
10	352	338	401	459	0	1550	0.48	2.59	0.39	0.36

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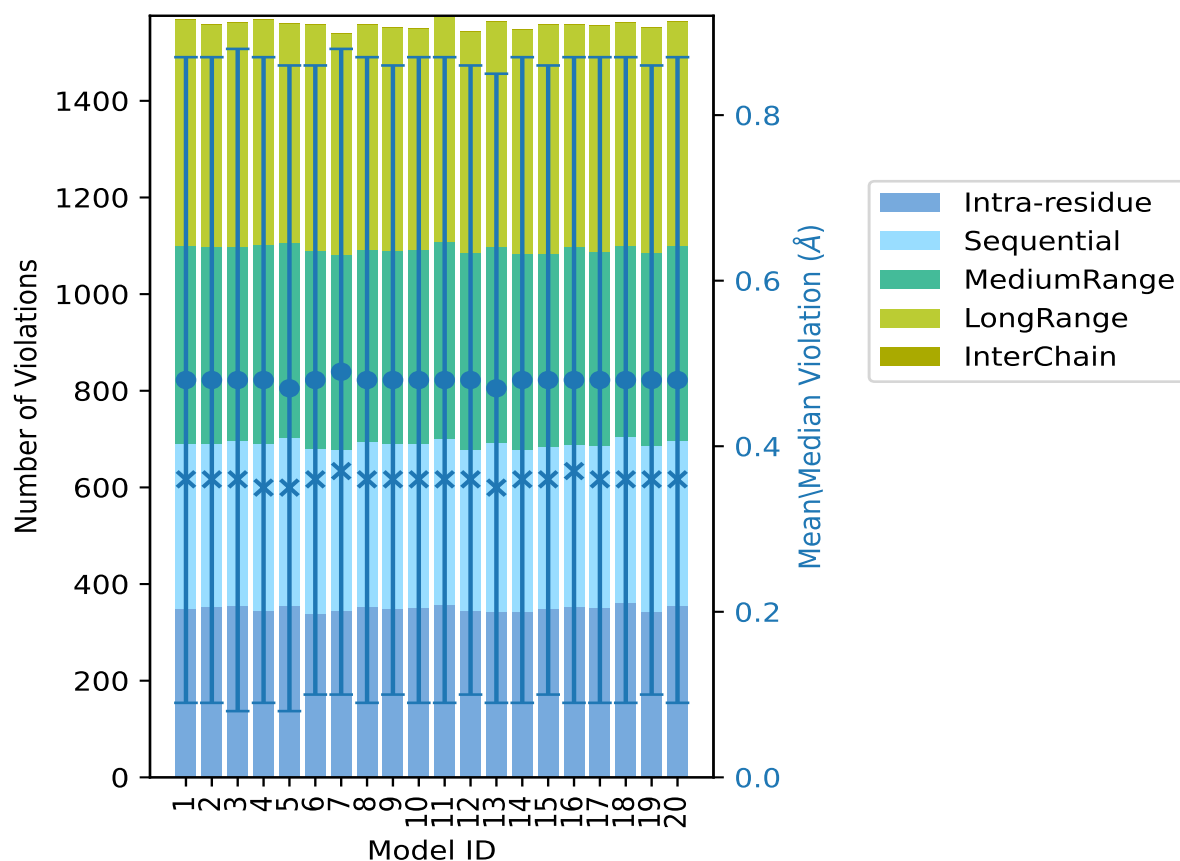
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Model ID	Number of violations						Mean (Å)	Max (Å)	SD ⁶ (Å)	Median (Å)
	IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵	Total				
11	357	344	407	468	0	1576	0.48	2.98	0.39	0.36
12	345	334	406	459	0	1544	0.48	2.5	0.38	0.36
13	342	351	404	467	0	1564	0.47	2.51	0.38	0.35
14	342	337	404	464	0	1547	0.48	2.64	0.39	0.36
15	349	336	398	474	0	1557	0.48	2.57	0.38	0.36
16	353	336	409	461	0	1559	0.48	2.64	0.39	0.37
17	351	334	403	467	0	1555	0.48	2.6	0.39	0.36
18	362	343	395	462	0	1562	0.48	2.56	0.39	0.36
19	342	343	401	466	0	1552	0.48	2.55	0.38	0.36
20	354	343	404	464	0	1565	0.48	2.58	0.39	0.36

¹Intra-residue restraints, ²Sequential restraints, ³Medium range restraints, ⁴Long range restraints,

⁵Inter-chain restraints, ⁶Standard deviation

9.2.1 Bar graph : Distance Violation statistics for each model ⓘ



The mean(dot),median(x) and the standard deviation are shown in blue with respect to the y axis on the right

9.3 Distance violation statistics for the ensemble

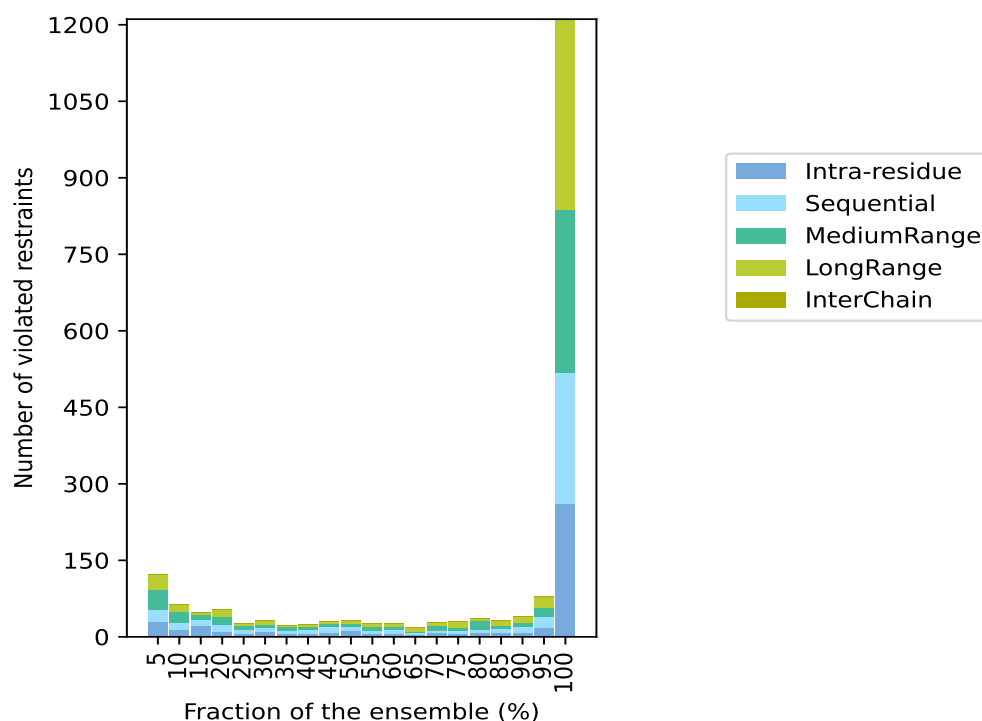
Violation analysis may find that some restraints are violated in few models and some are violated in most of models. The following table provides this information as number of violated restraints for a given fraction of the ensemble. In total, 4102(IR:1651, SQ:784, MR:767, LR:900, IC:0) restraints are not violated in the ensemble.

Number of violated restraints						Fraction of the ensemble	
IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵	Total	Count ⁶	%
30	24	38	30	0	122	1	5.0
14	14	21	15	0	64	2	10.0
22	11	11	4	0	48	3	15.0
10	14	16	13	0	53	4	20.0
6	8	7	5	0	26	5	25.0
10	8	6	8	0	32	6	30.0
7	4	9	2	0	22	7	35.0
6	7	7	5	0	25	8	40.0
8	12	7	4	0	31	9	45.0
12	8	6	6	0	32	10	50.0
6	7	8	6	0	27	11	55.0
7	6	7	6	0	26	12	60.0
5	3	2	9	0	19	13	65.0
7	5	10	6	0	28	14	70.0
6	6	7	12	0	31	15	75.0
8	7	16	5	0	36	16	80.0
9	6	7	10	0	32	17	85.0
9	10	9	12	0	40	18	90.0
18	22	17	22	0	79	19	95.0
262	257	318	374	0	1211	20	100.0

¹Intra-residue restraints, ²Sequential restraints, ³Medium range restraints, ⁴Long range restraints,

⁵Inter-chain restraints, ⁶ Number of models with violations

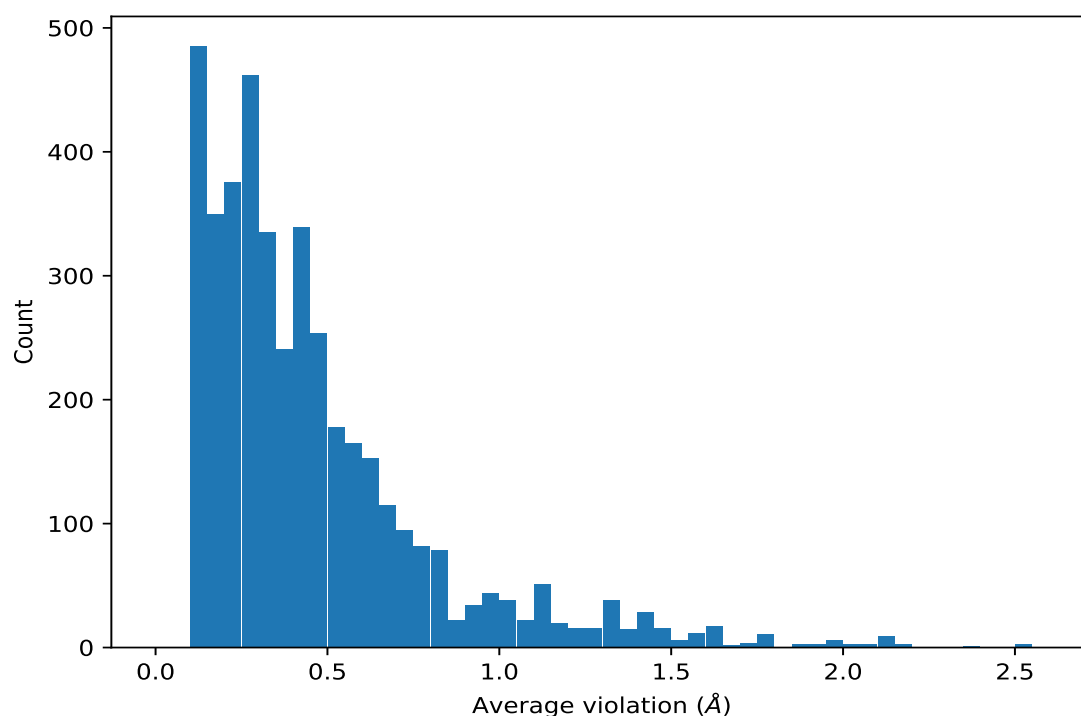
9.3.1 Bar graph : Distance violation statistics for the ensemble [i](#)



9.4 Most violated distance restraints in the ensemble [i](#)

9.4.1 Histogram : Distribution of mean distance violations [i](#)

The following histogram shows the distribution of the average value of the violation. The average is calculated for each restraint that is violated in more than one model over all the violated models in the ensemble



9.4.2 Table: Most violated distance restraints [i](#)

The following table provides the mean and the standard deviation of the violations for the 10 worst performing restraints, sorted by number of violated models and the mean violation value. The Key (restraint list ID, restraint ID) is the unique identifier for a given restraint. Rows with same key represent combinatorial or ambiguous restraints and are counted as a single restraint.

Key	Atom-1	Atom-2	Models ¹	Mean (Å)	SD ¹ (Å)	Median (Å)
(1,3607)	1:136:A:LYS:HG2	1:154:A:ALA:HB1	20	2.54	0.03	2.53
(1,3607)	1:136:A:LYS:HG2	1:154:A:ALA:HB3	20	2.54	0.03	2.53
(1,3607)	1:136:A:LYS:HG2	1:154:A:ALA:HB2	20	2.54	0.03	2.53
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	20	2.37	0.37	2.59
(1,3332)	1:199:A:LEU:HD12	1:203:A:ARG:HD2	20	2.15	0.05	2.14
(1,3332)	1:199:A:LEU:HD11	1:203:A:ARG:HD2	20	2.15	0.05	2.14
(1,3332)	1:199:A:LEU:HD13	1:203:A:ARG:HD2	20	2.15	0.05	2.14
(1,3059)	1:122:A:ALA:HB3	1:121:A:PRO:HG3	20	2.14	0.02	2.14
(1,3059)	1:122:A:ALA:HB2	1:121:A:PRO:HG3	20	2.14	0.02	2.14
(1,3059)	1:122:A:ALA:HB1	1:121:A:PRO:HG3	20	2.14	0.02	2.14
(1,3665)	1:115:A:LEU:HD22	1:114:A:ASN:HB2	20	2.12	0.02	2.11
(1,3665)	1:115:A:LEU:HD23	1:114:A:ASN:HB2	20	2.12	0.02	2.11
(1,3665)	1:115:A:LEU:HD21	1:114:A:ASN:HB2	20	2.12	0.02	2.11
(1,1622)	1:37:A:ALA:HB2	1:28:A:GLN:HB2	20	2.1	0.11	2.12
(1,1622)	1:37:A:ALA:HB3	1:28:A:GLN:HB2	20	2.1	0.11	2.12
(1,1622)	1:37:A:ALA:HB1	1:28:A:GLN:HB2	20	2.1	0.11	2.12

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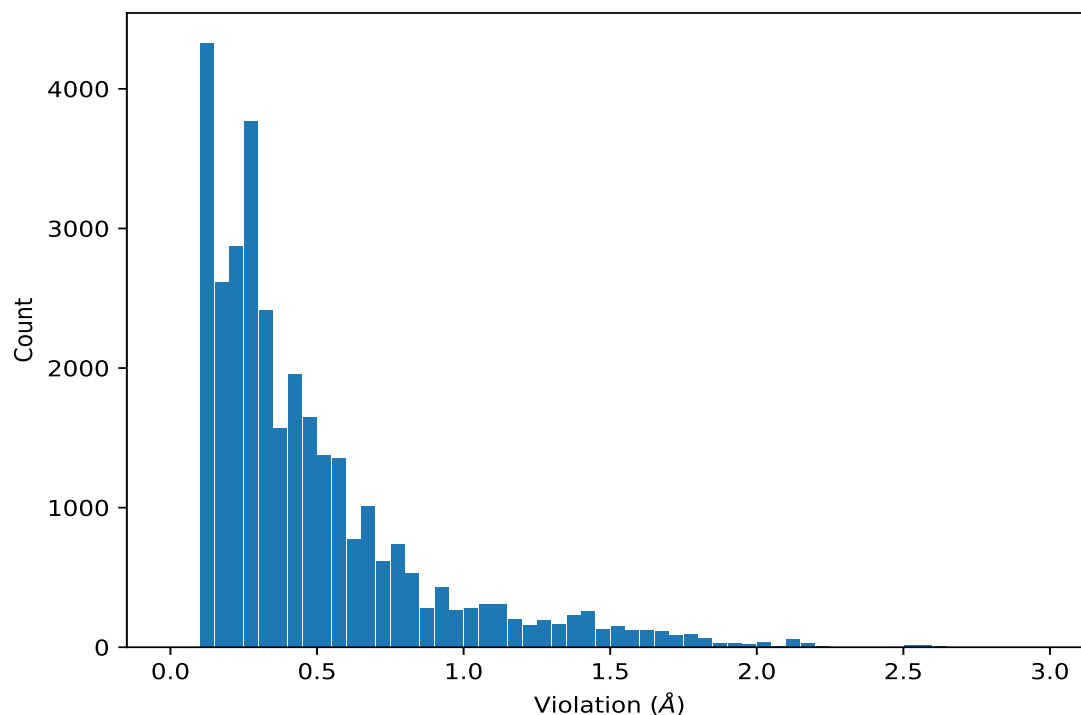
Key	Atom-1	Atom-2	Models ¹	Mean (Å)	SD ¹ (Å)	Median (Å)
(1,2661)	1:183:A:ALA:HB3	1:182:A:GLN:HB2	20	2.06	0.11	2.11
(1,2661)	1:183:A:ALA:HB1	1:182:A:GLN:HB2	20	2.06	0.11	2.11
(1,2661)	1:183:A:ALA:HB2	1:182:A:GLN:HB2	20	2.06	0.11	2.11
(1,2876)	1:136:A:LYS:HG3	1:100:A:VAL:HG13	20	2.04	0.02	2.04
(1,2876)	1:136:A:LYS:HG3	1:100:A:VAL:HG12	20	2.04	0.02	2.04
(1,2876)	1:136:A:LYS:HG3	1:100:A:VAL:HG11	20	2.04	0.02	2.04
(1,2448)	1:175:A:LEU:HD21	1:202:A:GLN:HE22	20	1.98	0.03	1.98
(1,2448)	1:175:A:LEU:HD22	1:202:A:GLN:HE22	20	1.98	0.03	1.98
(1,2448)	1:175:A:LEU:HD23	1:202:A:GLN:HE22	20	1.98	0.03	1.98
(1,436)	1:199:A:LEU:HD13	1:198:A:TRP:HB2	20	1.97	0.07	1.96

¹Number of violated models, ²Standard deviation

9.5 All violated distance restraints [i](#)

9.5.1 Histogram : Distribution of distance violations [i](#)

The following histogram shows the distribution of the absolute value of the violation for all violated restraints in the ensemble.



9.5.2 Table : All distance violations

The following table provides the 10 worst performing restraints, sorted by the violation value. The Key (restraint list ID, restraint ID) is the unique identifier for a given restraint. Rows with same key represent combinatorial or ambiguous restraints and are counted as a single restraint.

Key	Atom-1	Atom-2	Model ID	Violation (Å)
(1,3057)	1:233:A:LYS:HD3	1:230:A:PRO:HB2	5	2.98
(1,3057)	1:233:A:LYS:HD3	1:230:A:PRO:HB2	11	2.98
(1,3057)	1:233:A:LYS:HD3	1:230:A:PRO:HB2	8	2.95
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	7	2.72
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	14	2.64
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	16	2.64
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	8	2.62
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	9	2.62
(1,2171)	1:227:A:PRO:HD3	1:228:A:ASN:HD22	1	2.61
(1,3607)	1:136:A:LYS:HG2	1:154:A:ALA:HB3	3	2.6

10 Dihedral-angle violation analysis [i](#)

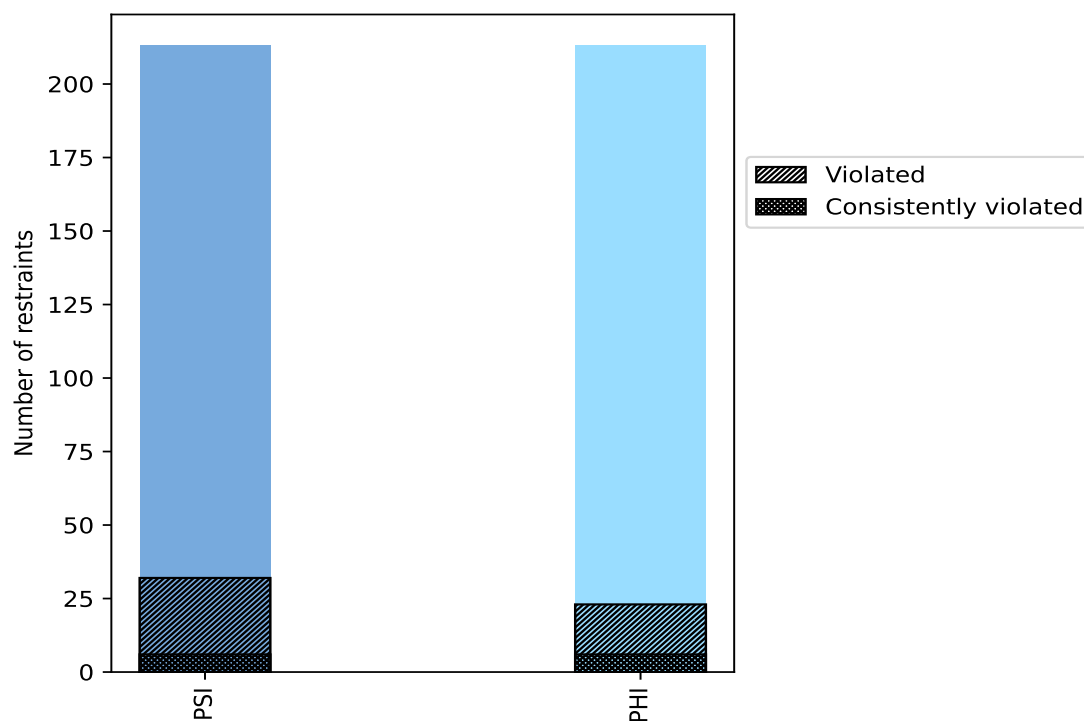
10.1 Summary of dihedral-angle violations [i](#)

The following table provides the summary of dihedral-angle violations in different dihedral-angle types. Violations less than 1° are not included in the calculation.

Angle type	Count	% ¹	Violated ³			Consistently Violated ⁴		
			Count	% ²	% ¹	Count	% ²	% ¹
PSI	213	50.0	32	15.0	7.5	6	2.8	1.4
PHI	213	50.0	23	10.8	5.4	6	2.8	1.4
Total	426	100.0	55	12.9	12.9	12	2.8	2.8

¹ percentage calculated with respect to total number of dihedral-angle restraints, ² percentage calculated with respect to number of restraints in a particular dihedral-angle type, ³ violated in at least one model, ⁴ violated in all the models

10.1.1 Bar chart : Distribution of dihedral-angles and violations [i](#)



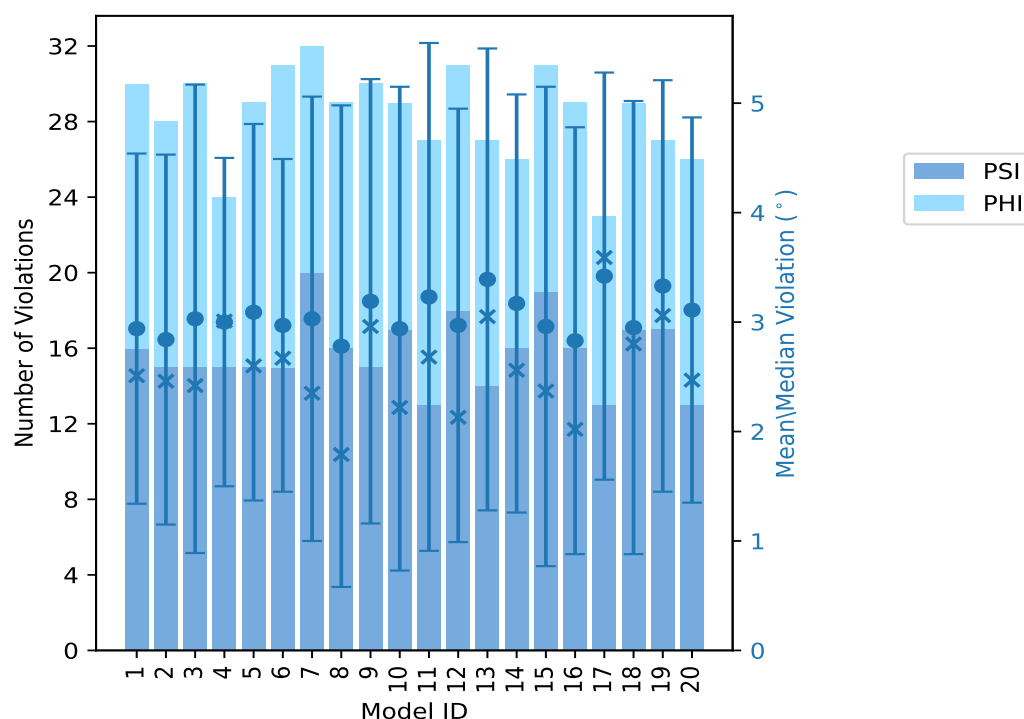
Violated and consistently violated restraints are shown using different hatch patterns in their respective categories

10.2 Dihedral-angle violation statistics for each model

The following table provides the dihedral-angle violation statistics for each model in the ensemble. Violations less than 1° are not included in the statistics.

Model ID	Number of violations			Mean (°)	Max (°)	SD (°)	Median (°)
	PSI	PHI	Total				
1	16	14	30	2.94	7.12	1.6	2.51
2	15	13	28	2.84	7.34	1.69	2.46
3	15	15	30	3.03	11.65	2.14	2.42
4	15	9	24	3.0	6.96	1.5	3.01
5	15	14	29	3.09	8.12	1.72	2.6
6	15	16	31	2.97	6.84	1.52	2.67
7	20	12	32	3.03	10.94	2.03	2.35
8	16	13	29	2.78	11.15	2.2	1.79
9	15	15	30	3.19	10.94	2.03	2.96
10	17	12	29	2.94	11.7	2.21	2.22
11	13	14	27	3.23	11.73	2.32	2.68
12	18	13	31	2.97	10.21	1.98	2.13
13	14	13	27	3.39	10.82	2.11	3.05
14	16	10	26	3.17	9.91	1.91	2.56
15	19	12	31	2.96	12.13	2.19	2.37
16	16	13	29	2.83	9.75	1.95	2.02
17	13	10	23	3.42	7.64	1.86	3.59
18	17	12	29	2.95	11.59	2.07	2.8
19	17	10	27	3.33	9.03	1.88	3.06
20	13	13	26	3.11	8.34	1.76	2.47

10.2.1 Bar graph : Dihedral violation statistics for each model [i](#)



The mean(dot),median(x) and the standard deviation are shown in blue with respect to the y axis on the right

10.3 Dihedral-angle violation statistics for the ensemble [i](#)

Violation analysis may find that some restraints are violated in very few models and some are violated in most of models. The following table provides this information as number of violated restraints for a given fraction of ensemble.

Number of violated restraints			Fraction of the ensemble	
PSI	PHI	Total	Count ¹	%
6	6	12	1	5.0
2	1	3	2	10.0
2	1	3	3	15.0
3	0	3	4	20.0
0	1	1	5	25.0
2	0	2	6	30.0
0	0	0	7	35.0
1	0	1	8	40.0
0	1	1	9	45.0
4	0	4	10	50.0
0	0	0	11	55.0

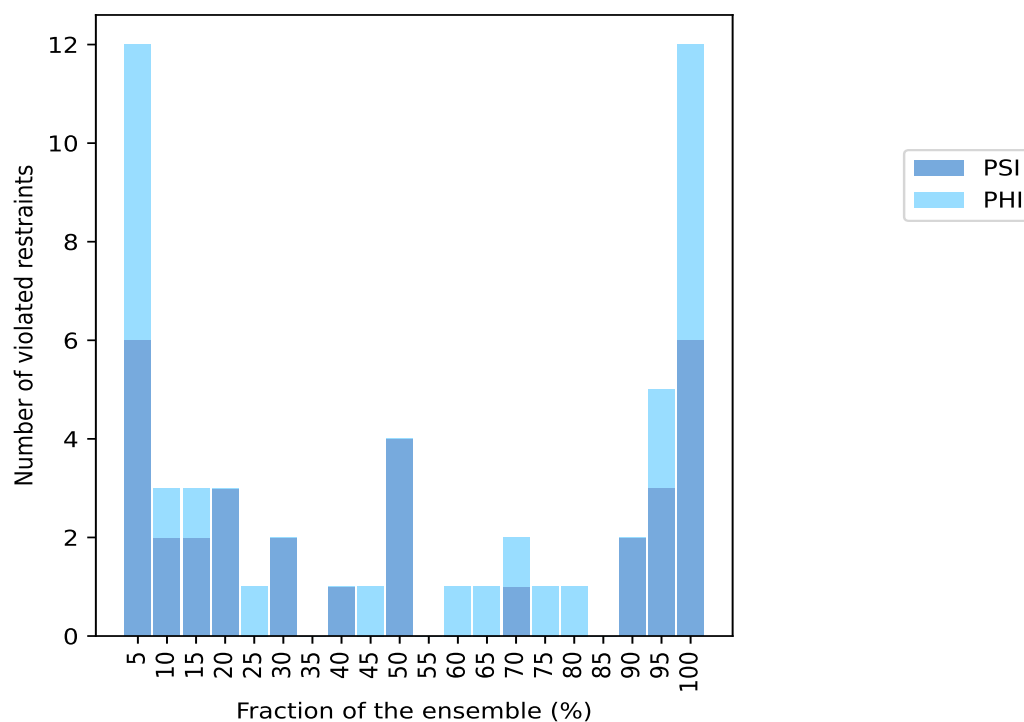
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Number of violated restraints			Fraction of the ensemble	
PSI	PHI	Total	Count ¹	%
0	1	1	12	60.0
0	1	1	13	65.0
1	1	2	14	70.0
0	1	1	15	75.0
0	1	1	16	80.0
0	0	0	17	85.0
2	0	2	18	90.0
3	2	5	19	95.0
6	6	12	20	100.0

¹ Number of models with violations

10.3.1 Bar graph : Dihedral-angle Violation statistics for the ensemble [i](#)

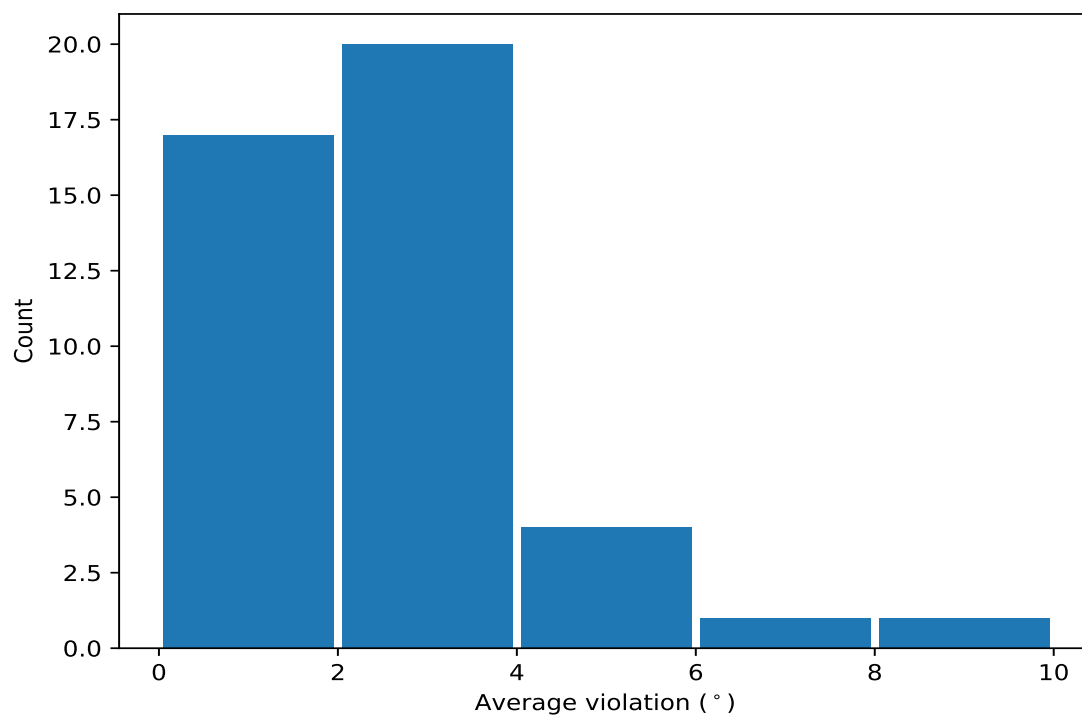


10.4 Most violated dihedral-angle restraints in the ensemble [i](#)

10.4.1 Histogram : Distribution of mean dihedral-angle violations [i](#)

The following histogram shows the distribution of the average value of the violation. The average is calculated for each restraint that is violated in more than one model over all the violated models

in the ensemble



10.4.2 Table: Most violated dihedral-angle restraints [i](#)

The following table provides the mean and the standard deviation of the violations for the 10 worst performing restraints, sorted by number of violated models and the mean violation value. The Key (restraint list ID, restraint ID) is the unique identifier for a given restraint.

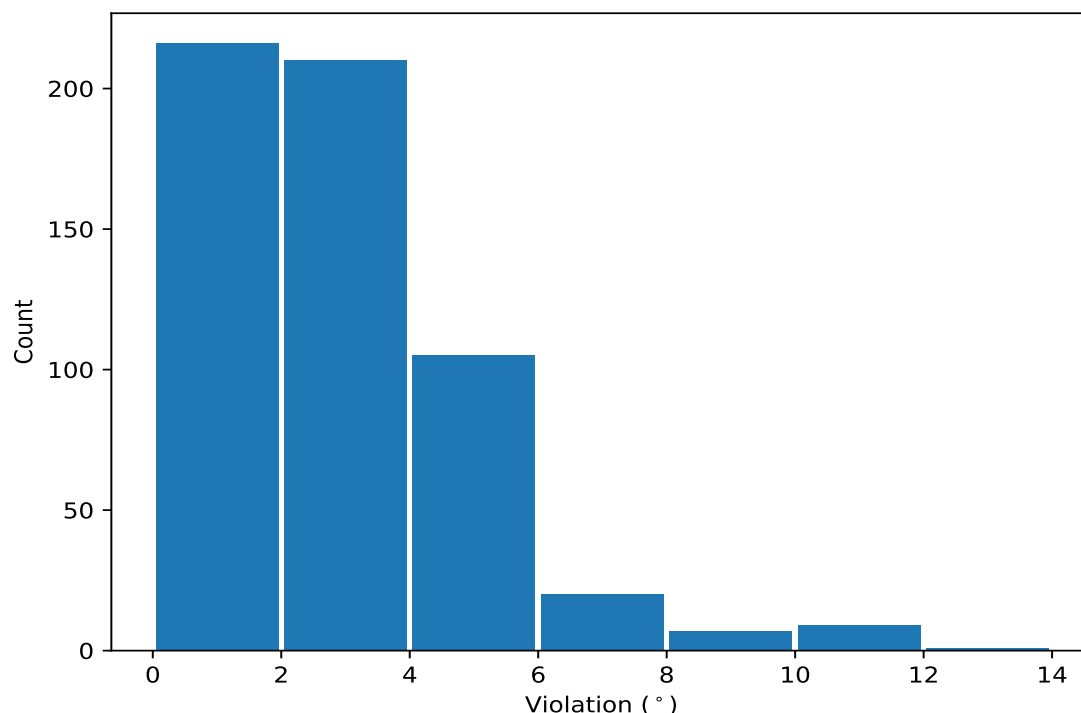
Key	Atom-1	Atom-2	Atom-3	Atom-4	Models ¹	Mean	SD ²	Median
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	20	9.41	2.14	10.06
(1,104)	1:72:A:LYS:N	1:72:A:LYS:CA	1:72:A:LYS:C	1:73:A:THR:N	20	7.38	0.67	7.38
(1,233)	1:141:A:GLN:C	1:142:A:GLY:N	1:142:A:GLY:CA	1:142:A:GLY:C	20	4.6	0.56	4.6
(1,408)	1:236:A:PRO:N	1:236:A:PRO:CA	1:236:A:PRO:C	1:237:A:THR:N	20	4.44	0.5	4.44
(1,132)	1:87:A:LEU:N	1:87:A:LEU:CA	1:87:A:LEU:C	1:88:A:ASN:N	20	4.38	0.55	4.33
(1,17)	1:26:A:PRO:C	1:27:A:ASP:N	1:27:A:ASP:CA	1:27:A:ASP:C	20	4.26	0.6	4.22
(1,247)	1:150:A:ARG:C	1:151:A:ALA:N	1:151:A:ALA:CA	1:151:A:ALA:C	20	3.87	0.51	3.79
(1,105)	1:72:A:LYS:C	1:73:A:THR:N	1:73:A:THR:CA	1:73:A:THR:C	20	3.73	0.42	3.62
(1,66)	1:53:A:ASP:N	1:53:A:ASP:CA	1:53:A:ASP:C	1:54:A:ASP:N	20	3.3	0.73	3.32
(1,256)	1:155:A:GLN:N	1:155:A:GLN:CA	1:155:A:GLN:C	1:156:A:GLU:N	20	2.84	0.82	2.82

¹ Number of violated models, ²Standard deviation, All angle values are in degree (°)

10.5 All violated dihedral-angle restraints [i](#)

10.5.1 Histogram : Distribution of violations [i](#)

The following histogram shows the distribution of the absolute value of the violation for all violated restraints in the ensemble.



10.5.2 Table: All violated dihedral-angle restraints [i](#)

The following table provides the list of violations for the 10 worst performing restraints, sorted by the violation value. The Key (restraint list ID, restraint ID) is the unique identifier for a given restraint.

Key	Atom-1	Atom-2	Atom-3	Atom-4	Model ID	Violation (°)
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	15	12.13
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	11	11.73
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	10	11.7
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	3	11.65
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	18	11.59
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	8	11.15
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	7	10.94
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	9	10.94
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	13	10.82
(1,321)	1:192:A:GLU:C	1:193:A:ASN:N	1:193:A:ASN:CA	1:193:A:ASN:C	12	10.21