



wwPDB NMR Structure Validation Summary Report ⓘ

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PDB ID : 9MEM / pdb_00009mem
BMRB ID : 25290
Title : Anabaena Sensory Rhodopsin Structure Determination from Paramagnetic Relaxation Enhancement and NMR Restraints
Authors : Vaz, R.F.; Brown, L.; Ladizhansky, V.
Deposited on : 2024-12-06

This is a wwPDB NMR Structure Validation Summary Report for a publicly released PDB entry.

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

A user guide is available at

<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
Mogul : 2022.3.0, CSD as543be (2022)
buster-report : 1.1.7 (2018)
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) : 2.42

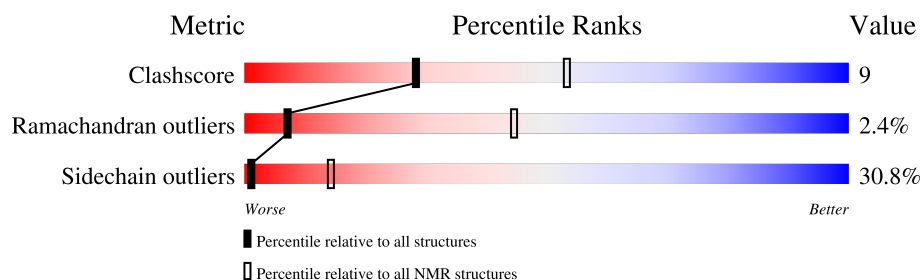
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLID-STATE NMR

The overall completeness of chemical shifts assignment is 35%.

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	235	

2 Ensemble composition and analysis

This entry contains 10 models. Model 1 is the overall representative, medoid model (most similar to other models).

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:6-A:91, A:103-A:222 (206)	1.42	1

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, 6, 7, 9
2	5, 10
Single-model clusters	3; 4; 8

3 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 3788 atoms, of which 1900 are hydrogens and 0 are deuteriums.

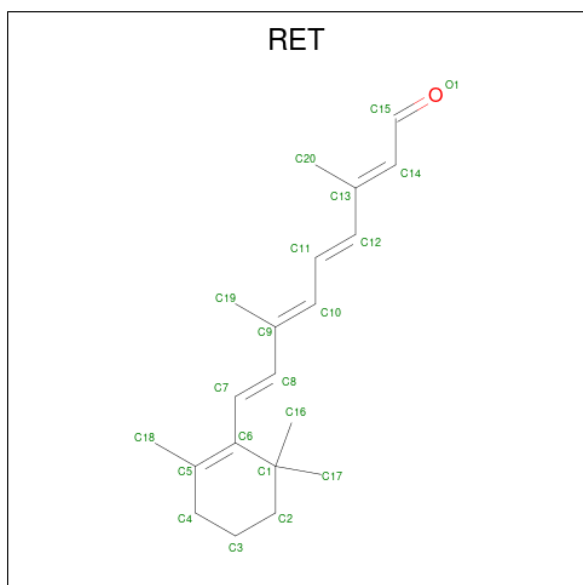
- Molecule 1 is a protein called Bacteriorhodopsin.

Mol	Chain	Residues	Atoms						Trace
1	A	229	Total	C	H	N	O	S	0
			3740	1248	1872	298	311	11	

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	230	HIS	-	expression tag	UNP Q8YSC4
A	231	HIS	-	expression tag	UNP Q8YSC4
A	232	HIS	-	expression tag	UNP Q8YSC4
A	233	HIS	-	expression tag	UNP Q8YSC4
A	234	HIS	-	expression tag	UNP Q8YSC4
A	235	HIS	-	expression tag	UNP Q8YSC4

- Molecule 2 is RETINAL (CCD ID: RET) (formula: $C_{20}H_{28}O$).



Mol	Chain	Residues	Atoms		
2	A	1	Total	C	H
			48	20	28

5 Refinement protocol and experimental data overview

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

Of the 100 calculated structures, 10 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
X-PLOR NIH	structure calculation	
X-PLOR NIH	refinement	

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	2
Total number of shifts	1185
Number of shifts mapped to atoms	1185
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	35%

Note: This is a solid-state NMR structure, where hydrogen atoms are typically not assigned a chemical shift value, which may lead to lower completeness of assignment measure.

6 Model quality [i](#)

6.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: RET

There are no covalent bond-length or bond-angle outliers.

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no planarity outliers.

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	1672	1674	1674	29±5
2	A	20	28	27	2±0
All	All	16920	17020	17017	315

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 9.

5 of 156 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:40:ALA:O	1:A:44:PRO:CD	0.89	2.20	5	10
1:A:176:TRP:O	1:A:180:PRO:CD	0.88	2.21	5	10
1:A:202:PHE:O	1:A:206:PRO:CD	0.88	2.22	2	10
1:A:77:MET:O	1:A:81:PRO:CD	0.84	2.26	7	10
1:A:77:MET:O	1:A:81:PRO:HD2	0.81	1.75	7	10

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	206/235 (88%)	178±3 (87±2%)	23±3 (11±1%)	5±2 (2±1%)	7	44
All	All	2060/2350 (88%)	1784 (87%)	227 (11%)	49 (2%)	7	44

5 of 19 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	29	PRO	6
1	A	151	ARG	6
1	A	192	TRP	6
1	A	190	PHE	5
1	A	59	GLY	4

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	175/204 (86%)	121±2 (69±1%)	54±2 (31±1%)	1	14
All	All	1750/2040 (86%)	1211 (69%)	539 (31%)	1	14

5 of 140 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	210	LYS	10
1	A	213	PHE	10
1	A	172	PHE	9
1	A	127	VAL	8
1	A	218	LEU	8

6.3.3 RNA ⓘ

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

6.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.6 Ligand geometry ⓘ

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds for which Mogul statistics could be retrieved, the number of bonds that are observed in the model and the number of bonds that are defined in the chemical component dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length is the number of standard deviations the observed value is removed from the expected value. A bond length with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the average root-mean-square of all Z scores of the bond lengths.

Mol	Type	Chain	Res	Link	Bond lengths		
					Counts	RMSZ	#Z>2
2	RET	A	301	1	20,20,21	2.78±0.02	4±0 (20±0%)

In the following table, the Counts columns list the number of angles for which Mogul statistics could be retrieved, the number of angles that are observed in the model and the number of angles that are defined in the chemical component dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond angle is the number of standard deviations the observed value is removed from the expected value. A bond angle with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the average root-mean-square of all Z scores of the bond angles.

Mol	Type	Chain	Res	Link	Bond angles		
					Counts	RMSZ	#Z>2
2	RET	A	301	1	27,27,28	1.66±0.00	6±0 (22±0%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the chemical component dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means

no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	RET	A	301	1	-	0±0,13,30,31	0±0,1,1,1

All 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
2	A	301	RET	C14-C13	10.71	1.41	1.33	8	10
2	A	301	RET	C1-C6	3.78	1.58	1.53	10	10
2	A	301	RET	C15-C14	3.17	1.37	1.49	6	10
2	A	301	RET	C12-C13	2.29	1.41	1.46	5	10

5 of 6 unique angle outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

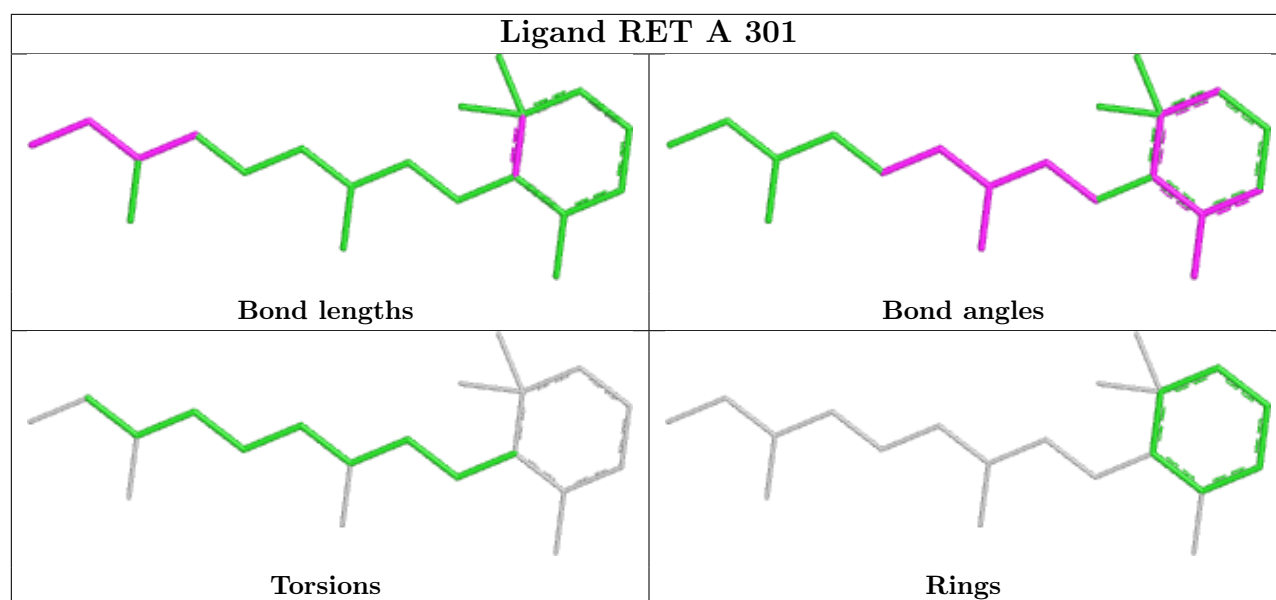
Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
2	A	301	RET	C18-C5-C6	4.24	119.86	124.48	2	10
2	A	301	RET	C11-C10-C9	3.46	122.43	127.28	1	10
2	A	301	RET	C7-C8-C9	2.72	122.21	126.23	7	10
2	A	301	RET	C19-C9-C10	2.36	119.00	122.82	3	10
2	A	301	RET	C18-C5-C4	2.26	118.41	113.60	5	10

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



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

The completeness of assignment taking into account all chemical shift lists is 35% for the well-defined parts and 33% for the entire structure.

7.1 Chemical shift list 1

File name: working_cs.cif

Chemical shift list name: *assigned_chem_shift_list_1*

7.1.1 Bookkeeping

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	1142
Number of shifts mapped to atoms	1142
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	4

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	205	-1.33 ± 0.20	Should be checked
$^{13}\text{C}_\beta$	176	0.53 ± 0.10	Should be checked
$^{13}\text{C}'$	203	-0.40 ± 0.24	None needed (< 0.5 ppm)
^{15}N	205	1.40 ± 0.35	Should be applied

7.1.3 Completeness of resonance assignments

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 35%, i.e. 1041 atoms were assigned a chemical shift out of a possible 2948. 0 out of 41 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	581/1030 (56%)	0/420 (0%)	392/412 (95%)	189/198 (95%)
Sidechain	392/1523 (26%)	0/1018 (0%)	386/467 (83%)	6/38 (16%)

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	Total	¹ H	¹³ C	¹⁵ N
Aromatic	68/395 (17%)	0/192 (0%)	64/183 (35%)	4/20 (20%)
Overall	1041/2948 (35%)	0/1630 (0%)	842/1062 (79%)	199/256 (78%)

Note: This is a solid-state NMR structure, where hydrogen atoms are typically not assigned a chemical shift value, which may lead to lower completeness of assignment measure.

7.1.4 Statistically unusual chemical shifts ⓘ

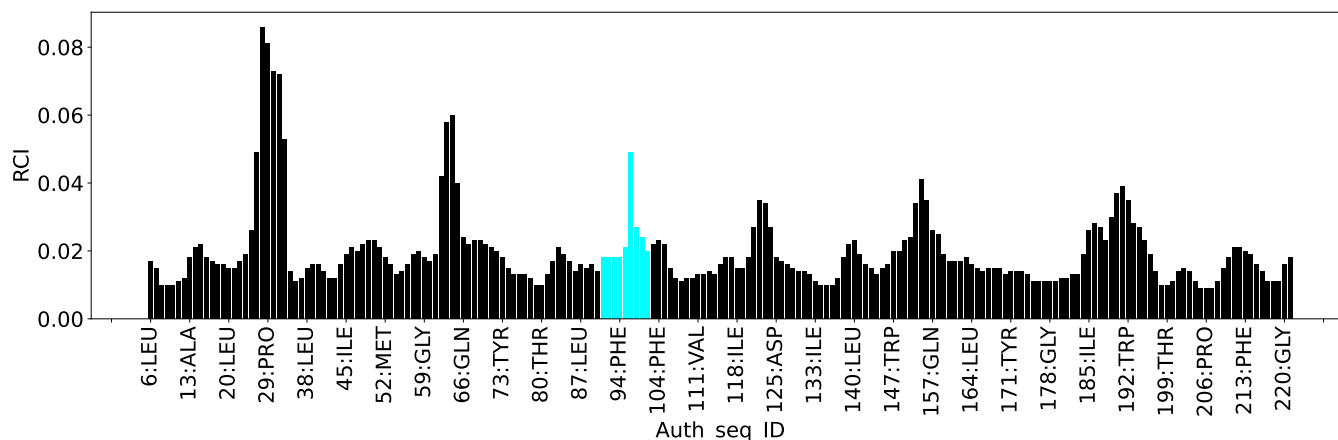
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

List Id	Chain	Res	Type	Atom	Shift, ppm	Expected range, ppm	Z-score
1	A	210	LYS	NZ	177.20	19.79 – 46.09	54.9
1	A	210	LYS	CE	55.67	37.57 – 46.21	15.9
1	A	109	GLN	NE2	98.30	103.38 – 120.35	-8.0
1	A	128	ARG	CD	37.40	38.57 – 47.75	-6.3

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:



7.2 Chemical shift list 2

File name: working_cs.cif

Chemical shift list name: *assigned_chem_shift_list_1_dup*

7.2.1 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	43
Number of shifts mapped to atoms	43
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	0

7.2.2 Chemical shift referencing [i](#)

No chemical shift referencing corrections were calculated (not enough data).

7.2.3 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 1%, i.e. 28 atoms were assigned a chemical shift out of a possible 2948. 0 out of 41 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹ H	¹³ C	¹⁵ N
Backbone	18/1030 (2%)	0/420 (0%)	12/412 (3%)	6/198 (3%)
Sidechain	6/1523 (0%)	0/1018 (0%)	6/467 (1%)	0/38 (0%)
Aromatic	4/395 (1%)	0/192 (0%)	4/183 (2%)	0/20 (0%)
Overall	28/2948 (1%)	0/1630 (0%)	22/1062 (2%)	6/256 (2%)

Note: This is a solid-state NMR structure, where hydrogen atoms are typically not assigned a chemical shift value, which may lead to lower completeness of assignment measure.

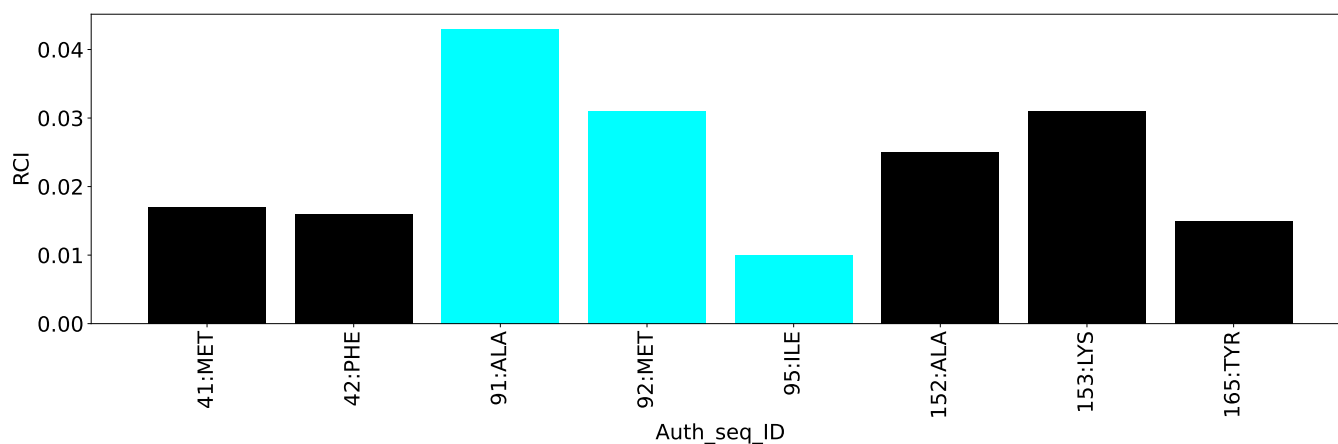
7.2.4 Statistically unusual chemical shifts [i](#)

There are no statistically unusual chemical shifts.

7.2.5 Random Coil Index (RCI) plots [i](#)

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	4093
Intra-residue ($ i-j =0$)	1702
Sequential ($ i-j =1$)	737
Medium range ($ i-j >1$ and $ i-j <5$)	725
Long range ($ i-j \geq 5$)	785
Inter-chain	0
Hydrogen bond restraints	144
Disulfide bond restraints	0
Total dihedral-angle restraints	372
Number of unmapped restraints	0
Number of restraints per residue	18.9
Number of long range restraints per residue ¹	3.3

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)	24.0	0.19
0.2-0.5 (Medium)	34.6	0.5
>0.5 (Large)	144.0	31.32

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)	0.1	1.08
10.0-20.0 (Medium)	None	None
>20.0 (Large)	None	None

9 Distance violation analysis ⓘ

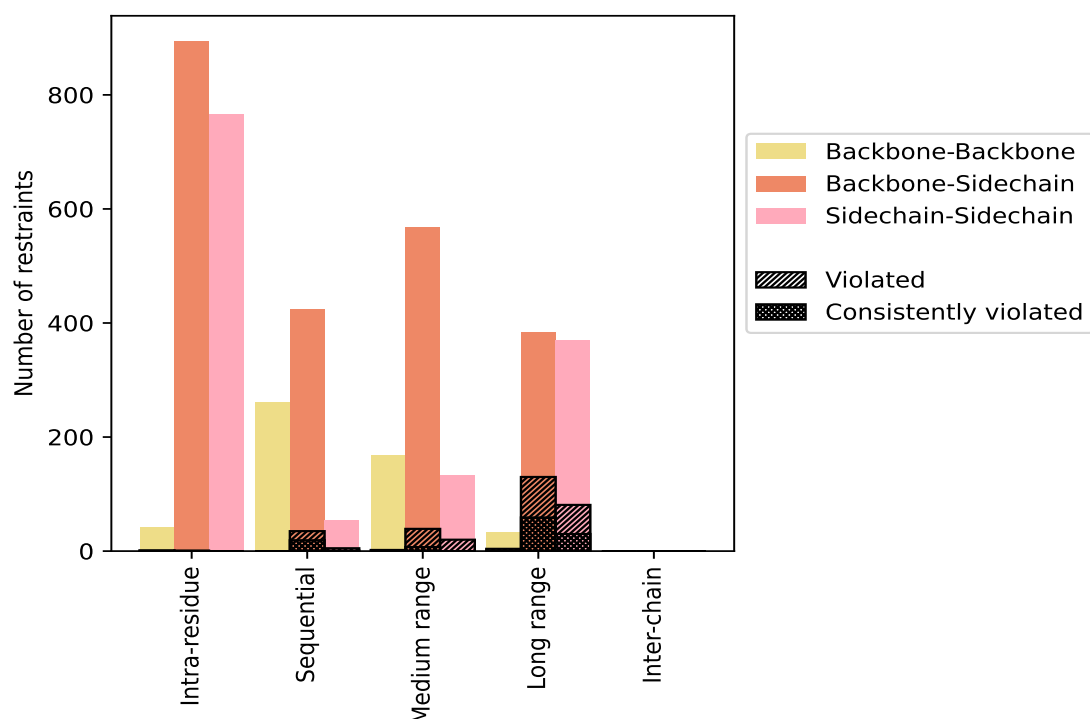
9.1 Summary of distance violations ⓘ

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)	1702	41.6	2	0.1	0.0	1	0.1	0.0
Backbone-Backbone	42	1.0	1	2.4	0.0	1	2.4	0.0
Backbone-Sidechain	894	21.8	1	0.1	0.0	0	0.0	0.0
Sidechain-Sidechain	766	18.7	0	0.0	0.0	0	0.0	0.0
Sequential (i-j =1)	737	18.0	40	5.4	1.0	20	2.7	0.5
Backbone-Backbone	260	6.4	0	0.0	0.0	0	0.0	0.0
Backbone-Sidechain	423	10.3	35	8.3	0.9	19	4.5	0.5
Sidechain-Sidechain	54	1.3	5	9.3	0.1	1	1.9	0.0
Medium range (i-j >1 & i-j <5)	725	17.7	54	7.4	1.3	3	0.4	0.1
Backbone-Backbone	168	4.1	2	1.2	0.0	0	0.0	0.0
Backbone-Sidechain	424	10.4	32	7.5	0.8	3	0.7	0.1
Sidechain-Sidechain	133	3.2	20	15.0	0.5	0	0.0	0.0
Long range (i-j ≥5)	785	19.2	215	27.4	5.3	90	11.5	2.2
Backbone-Backbone	32	0.8	4	12.5	0.1	1	3.1	0.0
Backbone-Sidechain	384	9.4	130	33.9	3.2	59	15.4	1.4
Sidechain-Sidechain	369	9.0	81	22.0	2.0	30	8.1	0.7
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	144	3.5	7	4.9	0.2	4	2.8	0.1
Disulfide bond	0	0.0	0	0.0	0.0	0	0.0	0.0
Total	4093	100.0	318	7.8	7.8	118	2.9	2.9
Backbone-Backbone	502	12.3	7	1.4	0.2	2	0.4	0.0
Backbone-Sidechain	2269	55.4	205	9.0	5.0	85	3.7	2.1
Sidechain-Sidechain	1322	32.3	106	8.0	2.6	31	2.3	0.8

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

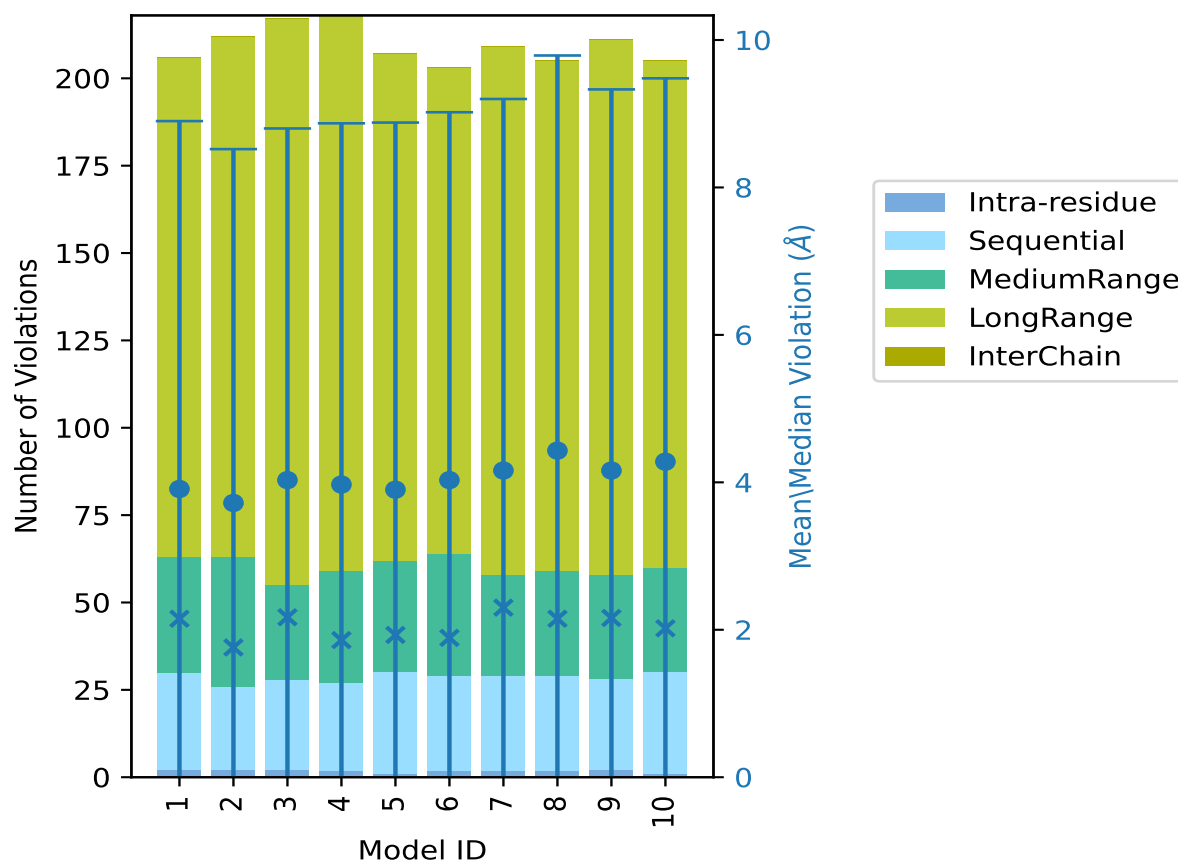
9.2 Distance violation statistics for each model [i](#)

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	2	28	33	143	0	206	3.91	27.26	4.99	2.15
2	2	24	37	149	0	212	3.72	27.17	4.8	1.76
3	2	26	27	162	0	217	4.03	28.64	4.77	2.17
4	2	25	32	159	0	218	3.97	27.15	4.9	1.86
5	1	29	32	145	0	207	3.9	31.32	4.98	1.93
6	2	27	35	139	0	203	4.03	26.54	4.99	1.89
7	2	27	29	151	0	209	4.16	29.26	5.04	2.3
8	2	27	30	146	0	205	4.43	27.72	5.36	2.15
9	2	26	30	153	0	211	4.16	28.9	5.17	2.16
10	1	29	30	145	0	205	4.28	29.0	5.2	2.02

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 [i](#)



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 [i](#)

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, 3638(IR:1700, SQ:697, MR:671, LR:570, 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	%
0	7	10	38	0	55	1	10.0
0	3	6	9	0	18	2	20.0
0	3	8	9	0	20	3	30.0

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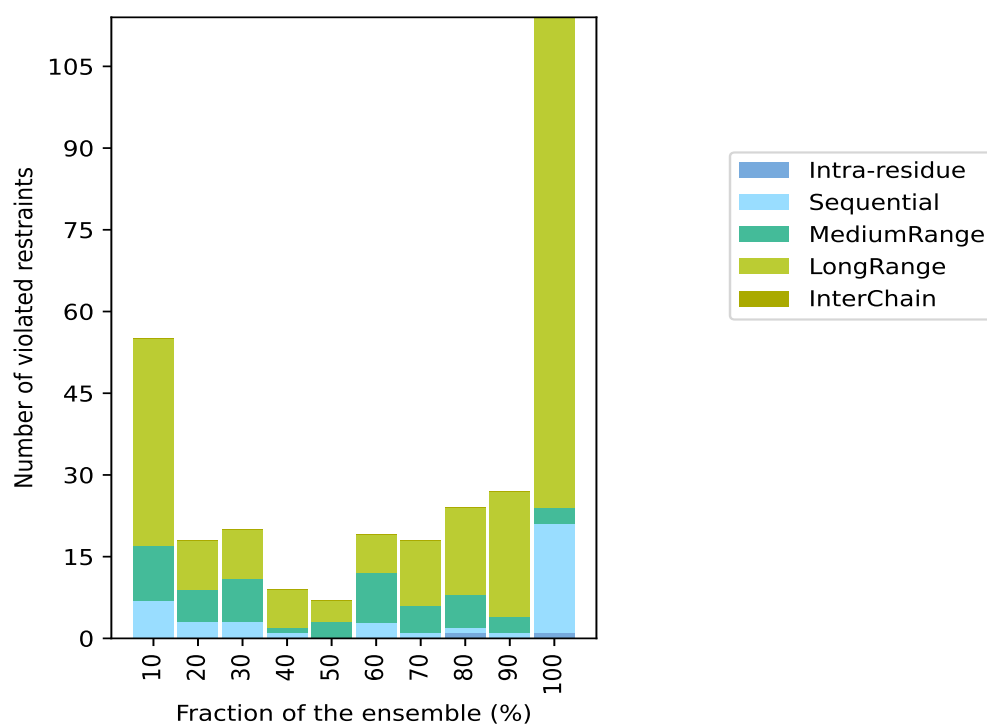
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Number of violated restraints						Fraction of the ensemble	
IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵	Total	Count ⁶	%
0	1	1	7	0	9	4	40.0
0	0	3	4	0	7	5	50.0
0	3	9	7	0	19	6	60.0
0	1	5	12	0	18	7	70.0
1	1	6	16	0	24	8	80.0
0	1	3	23	0	27	9	90.0
1	20	3	90	0	114	10	100.0

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](#)

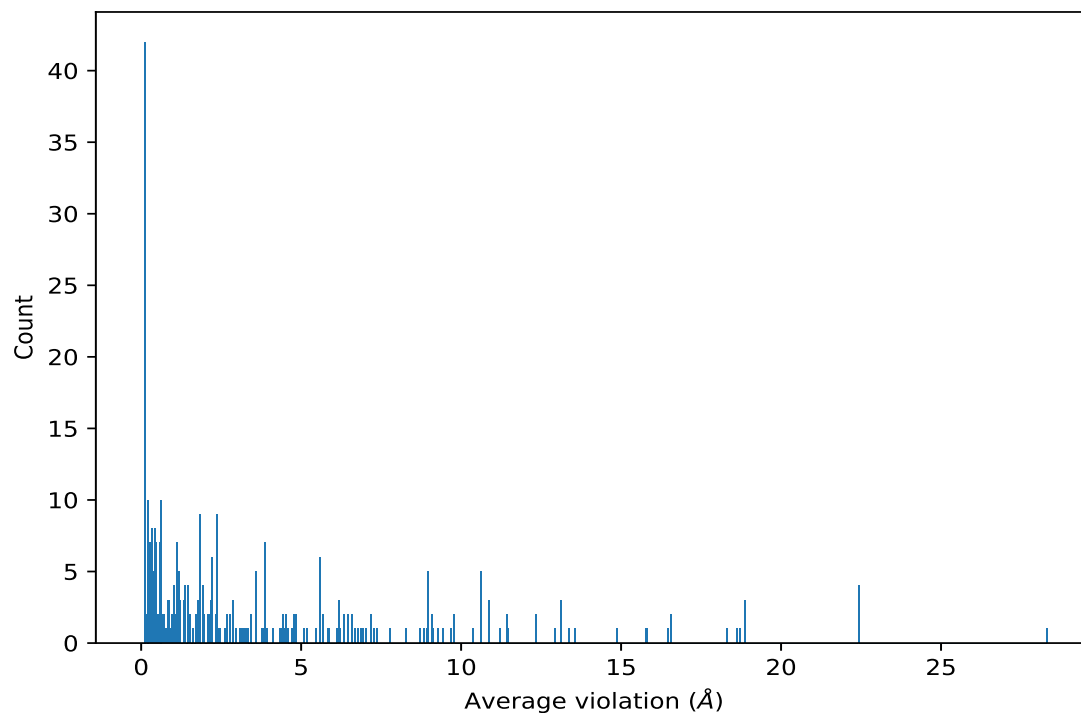


9.4 Most violated distance restraints in the ensemble [i](#)

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.

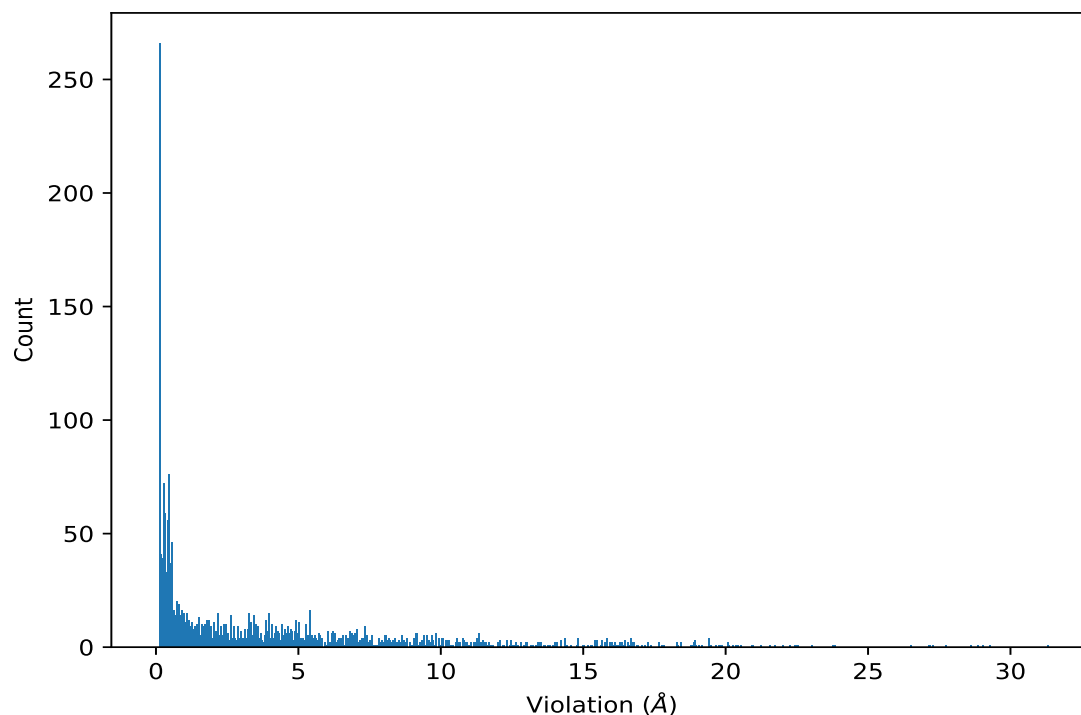
Key	Atom-1	Atom-2	Models ¹	Mean (Å)	SD ¹ (Å)	Median (Å)
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	10	28.3	1.35	28.18
(5,79)	1:122:A:SER:OG	1:32:A:VAL:HG11	10	22.44	0.83	22.38
(5,79)	1:122:A:SER:OG	1:32:A:VAL:HG13	10	22.44	0.83	22.38
(5,79)	1:122:A:SER:OG	1:32:A:VAL:HG12	10	22.44	0.83	22.38
(5,79)	1:122:A:SER:OG	1:32:A:VAL:HG21	10	22.44	0.83	22.38
(5,58)	1:97:A:LYS:O	1:181:A:ILE:HD12	10	18.85	2.07	19.62
(5,58)	1:97:A:LYS:O	1:181:A:ILE:HD13	10	18.85	2.07	19.62
(5,58)	1:97:A:LYS:O	1:181:A:ILE:HD11	10	18.85	2.07	19.62
(4,145)	1:122:A:SER:OG	1:148:A:ASN:HA	10	18.73	0.67	18.92
(4,63)	1:92:A:MET:O	1:184:A:ILE:HA	10	18.6	2.14	18.94
(4,9)	1:5:A:SER:OG	1:126:A:TRP:HA	10	18.32	2.67	18.9
(4,8)	1:5:A:SER:OG	1:124:A:ARG:HA	10	16.58	2.42	16.82
(4,39)	1:58:A:GLN:NE2	1:130:A:LEU:HA	10	16.56	0.71	16.68
(4,40)	1:58:A:GLN:NE2	1:134:A:CYS:HA	10	16.46	0.33	16.44
(4,127)	1:122:A:SER:OG	1:15:A:MET:HA	10	15.8	0.38	15.83

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 [i](#)

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)
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	5	31.32
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	7	29.26
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	10	29.0
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	9	28.9
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	3	28.64
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	8	27.72
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	1	27.26
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	2	27.17

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Key	Atom-1	Atom-2	Model ID	Violation (Å)
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	4	27.15
(4,93)	1:97:A:LYS:O	1:125:A:ASP:H	6	26.54

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

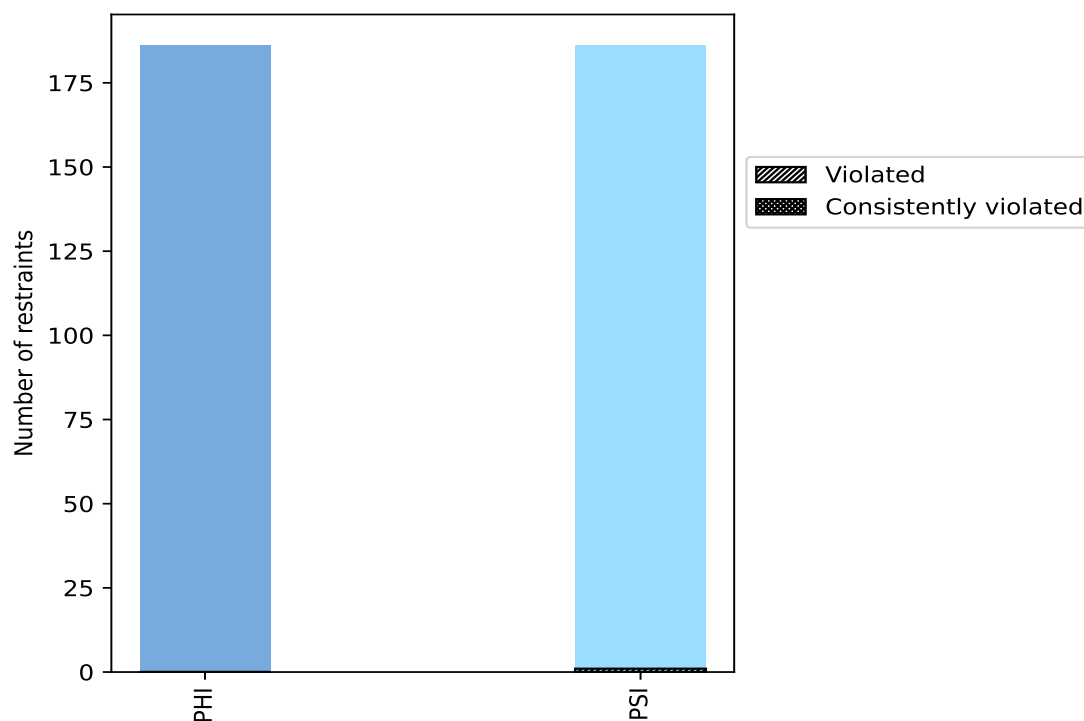
10.1 Summary of dihedral-angle violations [i](#)

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
PHI	186	50.0	0	0.0	0.0	0	0.0	0.0
PSI	186	50.0	1	0.5	0.3	0	0.0	0.0
Total	372	100.0	1	0.3	0.3	0	0.0	0.0

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](#)



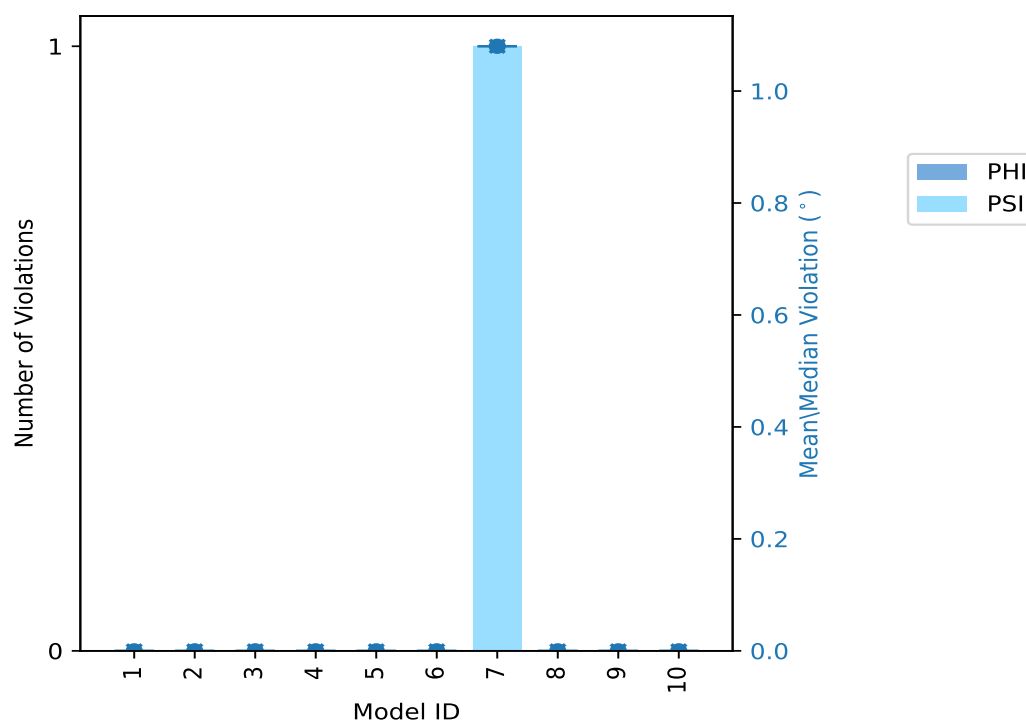
Violated and consistently violated restraints are shown using different hatch patterns in their respective categories

10.2 Dihedral-angle violation statistics for each model [i](#)

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 (°)
	PHI	PSI	Total				
1	0	0	0	0.0	0.0	0.0	0.0
2	0	0	0	0.0	0.0	0.0	0.0
3	0	0	0	0.0	0.0	0.0	0.0
4	0	0	0	0.0	0.0	0.0	0.0
5	0	0	0	0.0	0.0	0.0	0.0
6	0	0	0	0.0	0.0	0.0	0.0
7	0	1	1	1.08	1.08	0.0	1.08
8	0	0	0	0.0	0.0	0.0	0.0
9	0	0	0	0.0	0.0	0.0	0.0
10	0	0	0	0.0	0.0	0.0	0.0

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

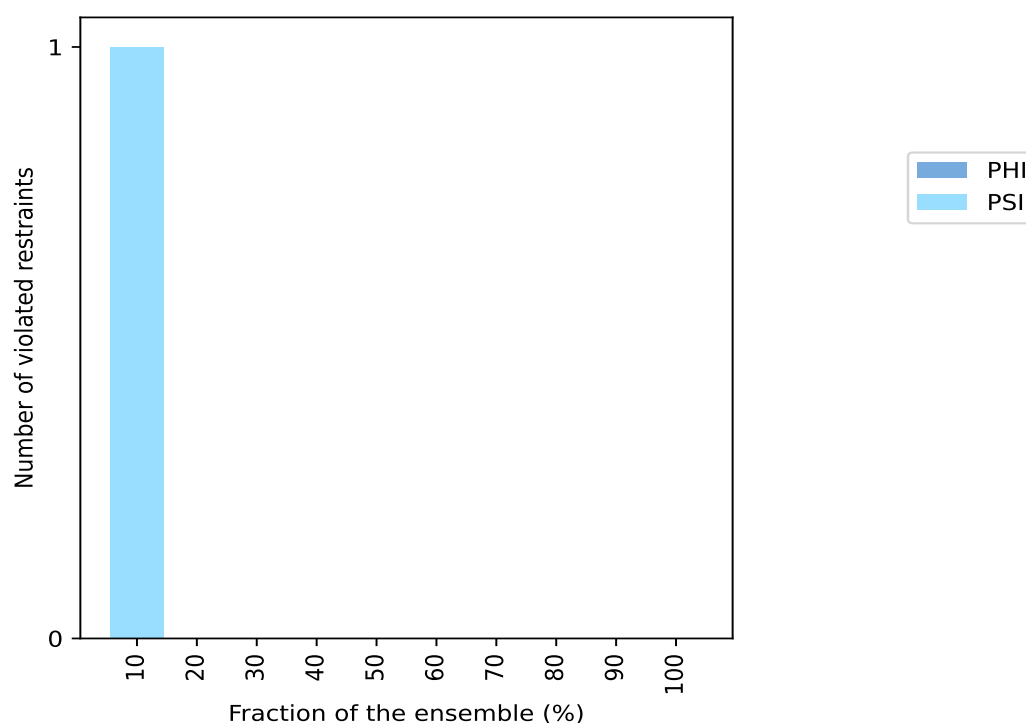
10.3 Dihedral-angle violation statistics for the ensemble [i](#)

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	
PHI	PSI	Total	Count ¹	%
0	1	1	1	10.0
0	0	0	2	20.0
0	0	0	3	30.0
0	0	0	4	40.0
0	0	0	5	50.0
0	0	0	6	60.0
0	0	0	7	70.0
0	0	0	8	80.0
0	0	0	9	90.0
0	0	0	10	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](#)

No violations found

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.

Data insufficient to plot histogram

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

The following table lists the absolute value of the violation for each restraint in the ensemble sorted by its 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 (°)
(1,342)	1:205:A:LEU:N	1:205:A:LEU:CA	1:205:A:LEU:C	1:206:A:PRO:N	7	1.08