



wwPDB NMR Structure Validation Summary Report ⓘ

Jun 6, 2023 – 05:57 pm BST

PDB ID : 2XKU
BMRB ID : 17166
Title : Prion-like conversion during amyloid formation at atomic resolution
Authors : Eichner, T.; Kalverda, A.P.; Thompson, G.S.; Homans, S.W.; Radford, S.E.
Deposited on : 2010-07-12

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
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
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) : 2.33

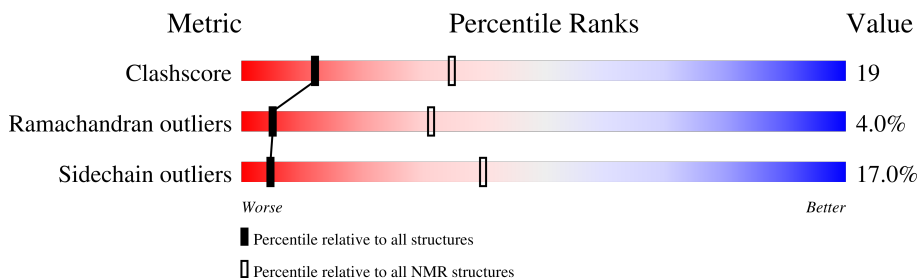
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 91%.

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	158937	12864
Ramachandran outliers	154571	11451
Sidechain outliers	154315	11428

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	94	

2 Ensemble composition and analysis

This entry contains 30 models. Model 15 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:7-A:50, A:64-A:99 (80)	0.36	15

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 5 clusters and 4 single-model clusters were found.

Cluster number	Models
1	1, 2, 11, 12, 13, 14, 26, 27, 28
2	5, 15, 17, 19, 20, 21, 22, 23
3	8, 16, 25, 29, 30
4	10, 18
5	7, 24
Single-model clusters	3; 4; 6; 9

3 Entry composition [i](#)

There is only 1 type of molecule in this entry. The entry contains 1524 atoms, of which 740 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called BETA-2-MICROGLOBULIN.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	94	1524	501	740	130	149	4	0

There is a discrepancy between the modelled and reference sequences:

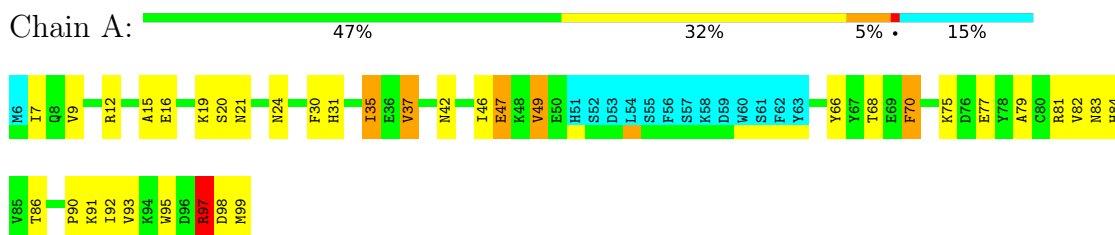
Chain	Residue	Modelled	Actual	Comment	Reference
A	6	MET	-	expression tag	UNP P61769

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.

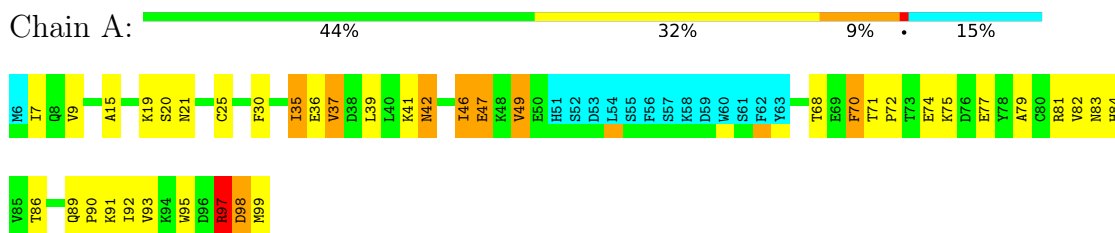
- Molecule 1: BETA-2-MICROGLOBULIN



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

The representative model is number 15. Colouring as in section 4.1 above.

- Molecule 1: BETA-2-MICROGLOBULIN



5 Refinement protocol and experimental data overview

The models were refined using the following method: *NONE*.

Of the 30 calculated structures, 30 were deposited, based on the following criterion: *LOWEST ENERGY*.

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

Software name	Classification	Version
CcpNmr Analysis	refinement	1.0
CcpNmr Analysis	structure solution	2.1
Xplor-NIH	structure solution	2.17
NMRPipe	structure solution	2.5
ARIA	structure solution	2.1
NMRView	structure solution	5.22
PASD ALGORITHM	structure solution	1.0
VNMR	structure solution	6.1C

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	1170
Number of shifts mapped to atoms	1169
Number of unparsed shifts	0
Number of shifts with mapping errors	1
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	91%

6 Model quality [i](#)

6.1 Standard geometry [i](#)

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

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	2

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

All unique planar outliers are listed below.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	28	SER	Peptide	2

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	661	636	637	25±3
All	All	19830	19080	19110	747

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 19.

5 of 131 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:49:VAL:HG23	1:A:68:THR:HB	0.92	1.38	26	30
1:A:21:ASN:HB2	1:A:70:PHE:CZ	0.87	2.05	4	26

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:20:SER:HA	1:A:70:PHE:O	0.85	1.71	17	30
1:A:39:LEU:HG	1:A:80:CYS:SG	0.84	2.11	17	1
1:A:21:ASN:HB3	1:A:70:PHE:CZ	0.83	2.07	9	3

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	79/94 (84%)	68±2 (86±2%)	8±2 (10±2%)	3±1 (4±1%)	5	31
All	All	2370/2820 (84%)	2050 (86%)	226 (10%)	94 (4%)	5	31

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	97	ARG	30
1	A	47	GLU	29
1	A	98	ASP	14
1	A	46	ILE	8
1	A	17	ASN	7

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	75/89 (84%)	62±2 (83±3%)	13±2 (17±3%)	5	40
All	All	2250/2670 (84%)	1867 (83%)	383 (17%)	5	40

5 of 36 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	37	VAL	30
1	A	49	VAL	30
1	A	70	PHE	30
1	A	92	ILE	30
1	A	35	ILE	29

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 monosaccharides 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

The completeness of assignment taking into account all chemical shift lists is 91% for the well-defined parts and 89% 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	1170
Number of shifts mapped to atoms	1169
Number of unparsed shifts	0
Number of shifts with mapping errors	1
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	6

The following assigned chemical shifts were not mapped to the molecules present in the coordinate file.

- No matching atom found in the structure. All 1 occurrences are reported below.

List ID	Chain	Res	Type	Atom	Shift Data		
					Value	Uncertainty	Ambiguity
1	A	99	MET	H	7.617	0.013	1

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	94	0.22 ± 0.17	None needed (< 0.5 ppm)
$^{13}\text{C}_\beta$	88	-0.42 ± 0.18	None needed (< 0.5 ppm)
$^{13}\text{C}'$	87	0.57 ± 0.16	Should be applied
^{15}N	90	-1.11 ± 0.33	Should be applied

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 91%, i.e. 1018 atoms were assigned a chemical shift out of a possible 1119. 0 out of 13 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹ H	¹³ C	¹⁵ N
Backbone	390/395 (99%)	157/159 (99%)	159/160 (99%)	74/76 (97%)
Sidechain	544/616 (88%)	369/396 (93%)	170/195 (87%)	5/25 (20%)
Aromatic	84/108 (78%)	44/53 (83%)	39/51 (76%)	1/4 (25%)
Overall	1018/1119 (91%)	570/608 (94%)	368/406 (91%)	80/105 (76%)

7.1.4 Statistically unusual chemical shifts [i](#)

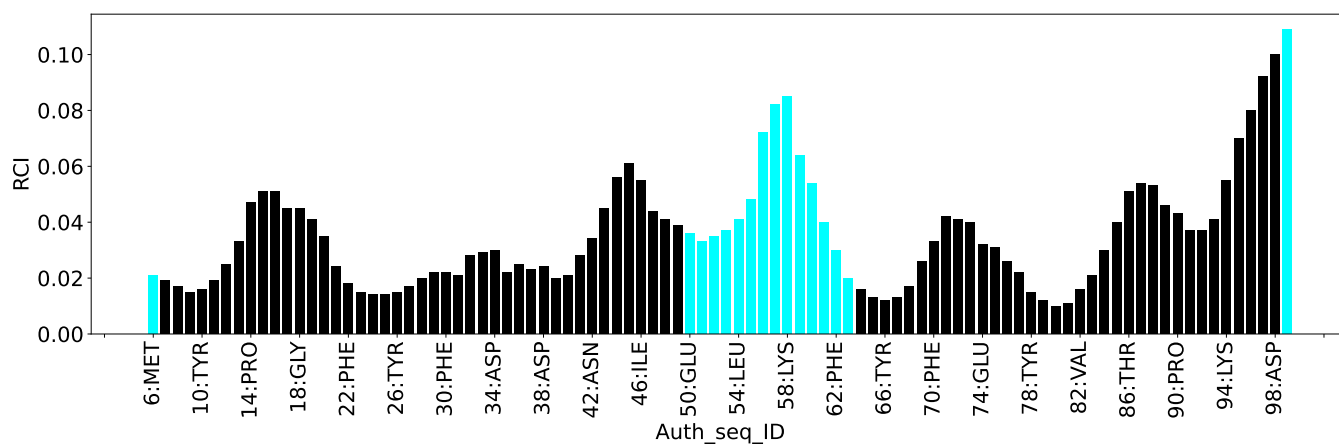
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

List Id	Chain	Res	Type	Atom	Shift, ppm	Expected range, ppm	Z-score
1	A	50	GLU	HB2	0.46	1.00 – 3.05	-7.6
1	A	90	PRO	N	101.07	108.67 – 162.11	-6.4
1	A	23	LEU	HB3	-0.74	-0.26 – 3.31	-6.4
1	A	32	PRO	N	103.91	108.67 – 162.11	-5.9
1	A	72	PRO	N	107.30	108.67 – 162.11	-5.3
1	A	14	PRO	N	108.52	108.67 – 162.11	-5.0

7.1.5 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	551
Intra-residue ($ i-j =0$)	90
Sequential ($ i-j =1$)	104
Medium range ($ i-j >1$ and $ i-j <5$)	84
Long range ($ i-j \geq 5$)	273
Inter-chain	0
Hydrogen bond restraints	0
Disulfide bond restraints	0
Total dihedral-angle restraints	1076
Number of unmapped restraints	14
Number of restraints per residue	17.3
Number of long range restraints per residue ¹	2.9

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)	36.7	0.2
0.2-0.5 (Medium)	43.4	0.5
>0.5 (Large)	49.2	1.68

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)	52.0	10.0
10.0-20.0 (Medium)	54.8	20.0
>20.0 (Large)	740.9	168.8

9 Distance violation analysis i

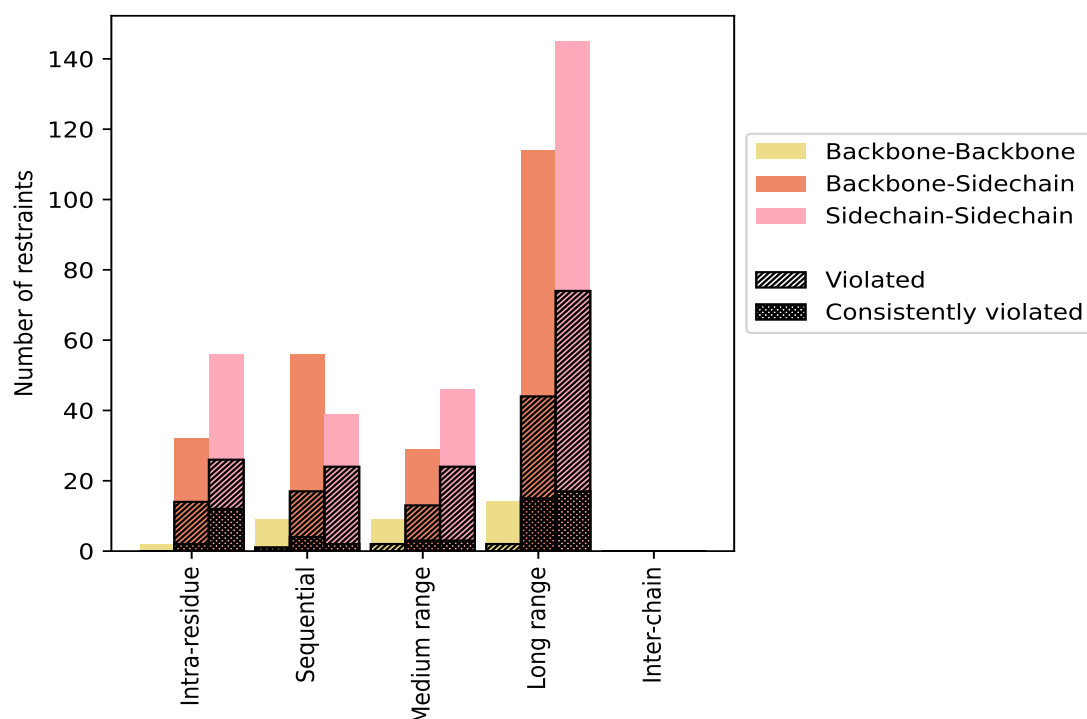
9.1 Summary of distance violations i

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 ($i-j =0$)	90	16.3	40	44.4	7.3	14	15.6	2.5
Backbone-Backbone	2	0.4	0	0.0	0.0	0	0.0	0.0
Backbone-Sidechain	32	5.8	14	43.8	2.5	2	6.2	0.4
Sidechain-Sidechain	56	10.2	26	46.4	4.7	12	21.4	2.2
Sequential ($i-j =1$)	104	18.9	42	40.4	7.6	7	6.7	1.3
Backbone-Backbone	9	1.6	1	11.1	0.2	1	11.1	0.2
Backbone-Sidechain	56	10.2	17	30.4	3.1	4	7.1	0.7
Sidechain-Sidechain	39	7.1	24	61.5	4.4	2	5.1	0.4
Medium range ($i-j >1$ & $i-j <5$)	84	15.2	39	46.4	7.1	6	7.1	1.1
Backbone-Backbone	9	1.6	2	22.2	0.4	0	0.0	0.0
Backbone-Sidechain	29	5.3	13	44.8	2.4	3	10.3	0.5
Sidechain-Sidechain	46	8.3	24	52.2	4.4	3	6.5	0.5
Long range ($i-j \geq 5$)	273	49.5	120	44.0	21.8	32	11.7	5.8
Backbone-Backbone	14	2.5	2	14.3	0.4	0	0.0	0.0
Backbone-Sidechain	114	20.7	44	38.6	8.0	15	13.2	2.7
Sidechain-Sidechain	145	26.3	74	51.0	13.4	17	11.7	3.1
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	551	100.0	241	43.7	43.7	59	10.7	10.7
Backbone-Backbone	34	6.2	5	14.7	0.9	1	2.9	0.2
Backbone-Sidechain	231	41.9	88	38.1	16.0	24	10.4	4.4
Sidechain-Sidechain	286	51.9	148	51.7	26.9	34	11.9	6.2

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 disulfid 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					Total	Mean (Å)	Max (Å)	SD ⁶ (Å)	Median (Å)
	IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵					
1	23	19	20	72	0	134	0.5	1.61	0.37	0.38
2	21	29	15	69	0	134	0.44	1.5	0.31	0.32
3	25	24	21	67	0	137	0.46	1.6	0.35	0.34
4	24	22	20	63	0	129	0.49	1.59	0.37	0.35
5	21	21	20	62	0	124	0.5	1.68	0.36	0.39
6	27	18	18	67	0	130	0.45	1.55	0.34	0.34
7	25	20	20	61	0	126	0.49	1.56	0.34	0.34
8	26	23	17	79	0	145	0.45	1.63	0.34	0.33
9	27	20	17	64	0	128	0.49	1.5	0.36	0.37
10	23	21	17	67	0	128	0.46	1.57	0.32	0.35
11	26	25	22	60	0	133	0.48	1.61	0.36	0.35

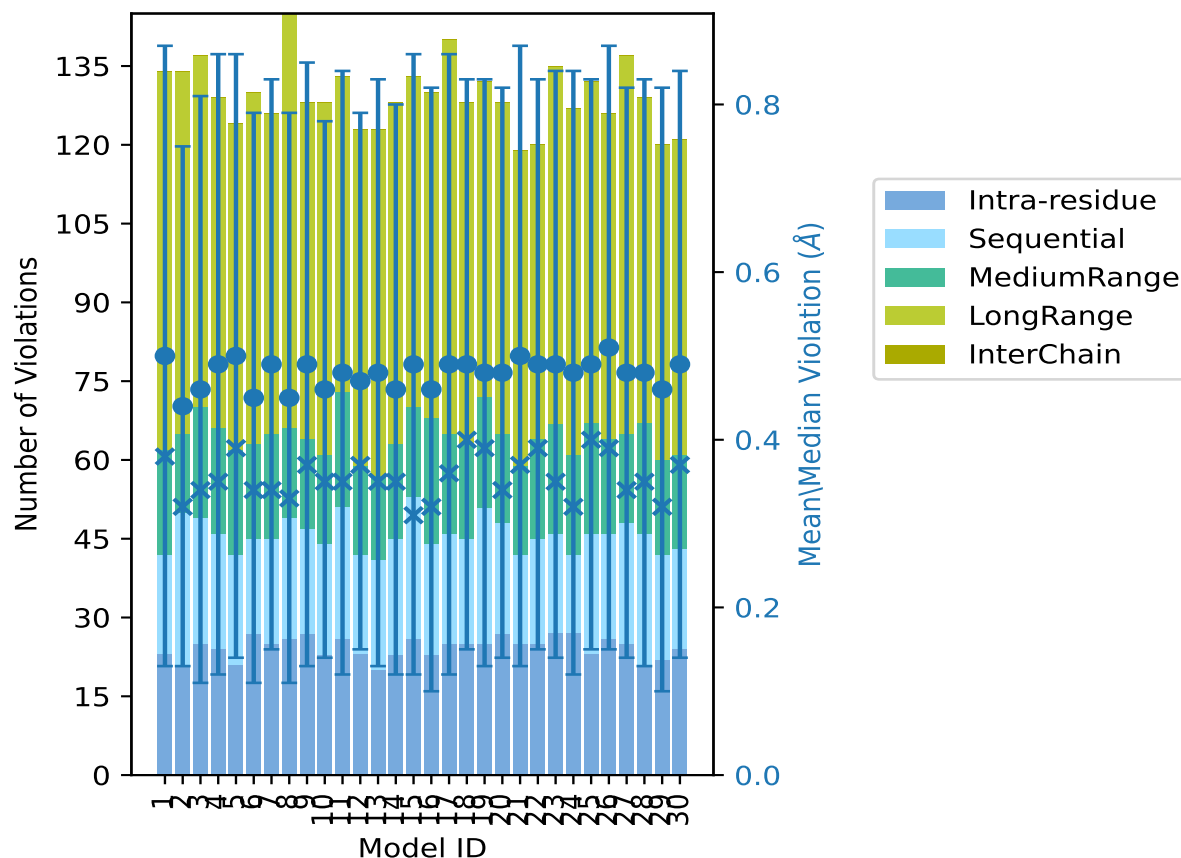
Continued on next page...

Continued from previous page...

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				
12	23	19	17	64	0	123	0.47	1.44	0.32	0.37
13	20	21	16	66	0	123	0.48	1.6	0.35	0.35
14	23	22	18	65	0	128	0.46	1.61	0.34	0.35
15	26	27	17	63	0	133	0.49	1.51	0.37	0.31
16	23	21	24	62	0	130	0.46	1.55	0.36	0.32
17	25	21	19	75	0	140	0.49	1.6	0.37	0.36
18	25	20	18	65	0	128	0.49	1.47	0.34	0.4
19	25	26	21	60	0	132	0.48	1.6	0.35	0.39
20	27	21	17	63	0	128	0.48	1.5	0.34	0.34
21	25	17	17	60	0	119	0.5	1.65	0.37	0.37
22	25	20	19	56	0	120	0.49	1.43	0.34	0.39
23	27	19	21	68	0	135	0.49	1.47	0.35	0.35
24	27	15	19	66	0	127	0.48	1.49	0.36	0.32
25	23	23	21	65	0	132	0.49	1.58	0.34	0.4
26	26	20	18	62	0	126	0.51	1.54	0.36	0.39
27	25	23	17	72	0	137	0.48	1.51	0.34	0.34
28	21	25	21	62	0	129	0.48	1.5	0.35	0.35
29	22	20	18	60	0	120	0.46	1.54	0.36	0.32
30	24	19	18	60	0	121	0.49	1.51	0.35	0.37

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, 310(IR:50, SQ:62, MR:45, LR:153, 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	%
2	2	5	7	0	16	1	3.3
6	3	2	10	0	21	2	6.7
1	3	2	8	0	14	3	10.0
0	2	1	7	0	10	4	13.3
1	2	2	2	0	7	5	16.7
0	1	2	7	0	10	6	20.0

Continued on next page...

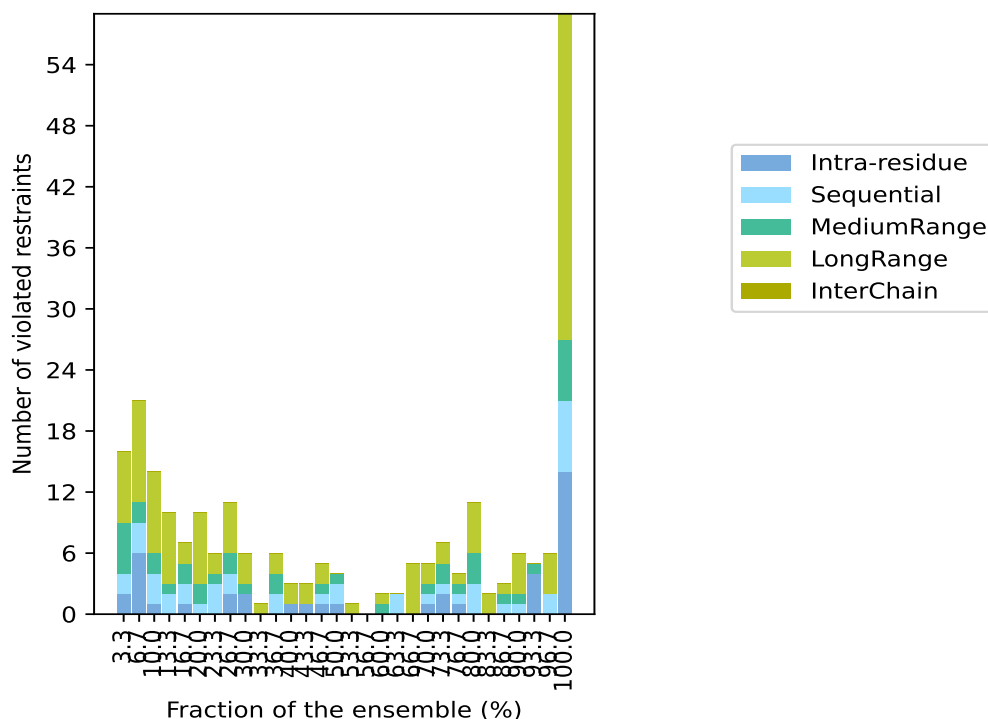
Continued from previous page...

Number of violated restraints						Fraction of the ensemble	
IR ¹	SQ ²	MR ³	LR ⁴	IC ⁵	Total	Count ⁶	%
0	3	1	2	0	6	7	23.3
2	2	2	5	0	11	8	26.7
2	0	1	3	0	6	9	30.0
0	0	0	1	0	1	10	33.3
0	2	2	2	0	6	11	36.7
1	0	0	2	0	3	12	40.0
1	0	0	2	0	3	13	43.3
1	1	1	2	0	5	14	46.7
1	2	1	0	0	4	15	50.0
0	0	0	1	0	1	16	53.3
0	0	0	0	0	0	17	56.7
0	0	1	1	0	2	18	60.0
0	2	0	0	0	2	19	63.3
0	0	0	5	0	5	20	66.7
1	1	1	2	0	5	21	70.0
2	1	2	2	0	7	22	73.3
1	1	1	1	0	4	23	76.7
0	3	3	5	0	11	24	80.0
0	0	0	2	0	2	25	83.3
0	1	1	1	0	3	26	86.7
0	1	1	4	0	6	27	90.0
4	0	1	0	0	5	28	93.3
0	2	0	4	0	6	29	96.7
14	7	6	32	0	59	30	100.0

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

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

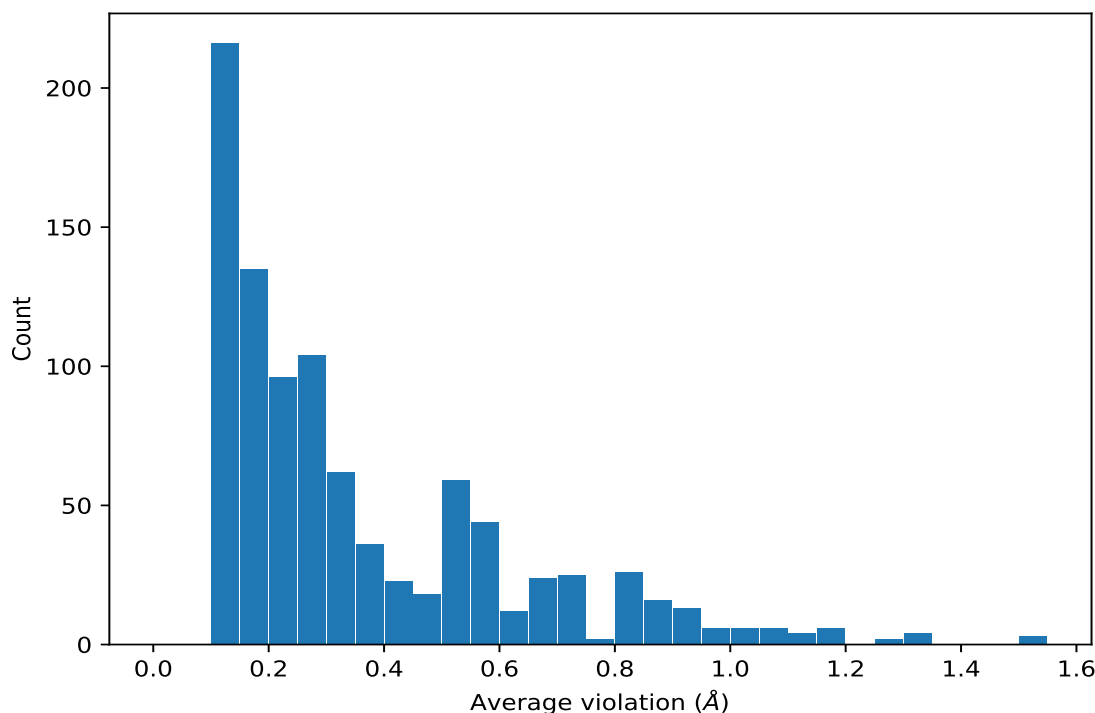
9.3.1 Bar graph : Distance violation statistics for the ensemble [i](#)



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)
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	30	1.5	0.09	1.5
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	30	1.5	0.09	1.5
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	30	1.5	0.09	1.5
(1,338)	1:A:64:LEU:HG	1:A:30:PHE:HB3	30	1.31	0.09	1.31
(1,338)	1:A:32:PRO:HG2	1:A:30:PHE:HB3	30	1.31	0.09	1.31
(1,408)	1:A:11:SER:HB2	1:A:70:PHE:HZ	30	1.18	0.03	1.18
(1,408)	1:A:11:SER:HB3	1:A:70:PHE:HZ	30	1.18	0.03	1.18
(1,408)	1:A:23:LEU:HA	1:A:70:PHE:HZ	30	1.18	0.03	1.18
(1,342)	1:A:90:PRO:HA	1:A:83:ASN:HB2	30	1.16	0.09	1.18
(1,342)	1:A:72:PRO:HA	1:A:70:PHE:HB3	30	1.16	0.09	1.18
(1,342)	1:A:72:PRO:HA	1:A:17:ASN:HB3	30	1.16	0.09	1.18
(1,296)	1:A:41:LYS:HD2	1:A:46:ILE:HG12	30	1.09	0.07	1.1
(1,296)	1:A:46:ILE:HG12	1:A:41:LYS:HB3	30	1.09	0.07	1.1
(1,355)	1:A:81:ARG:HB2	1:A:81:ARG:HD2	30	1.05	0.1	1.02
(1,355)	1:A:81:ARG:HB2	1:A:81:ARG:HD3	30	1.05	0.1	1.02
(1,355)	1:A:81:ARG:HD2	1:A:40:LEU:HG	30	1.05	0.1	1.02

Continued on next page...

Continued from previous page...

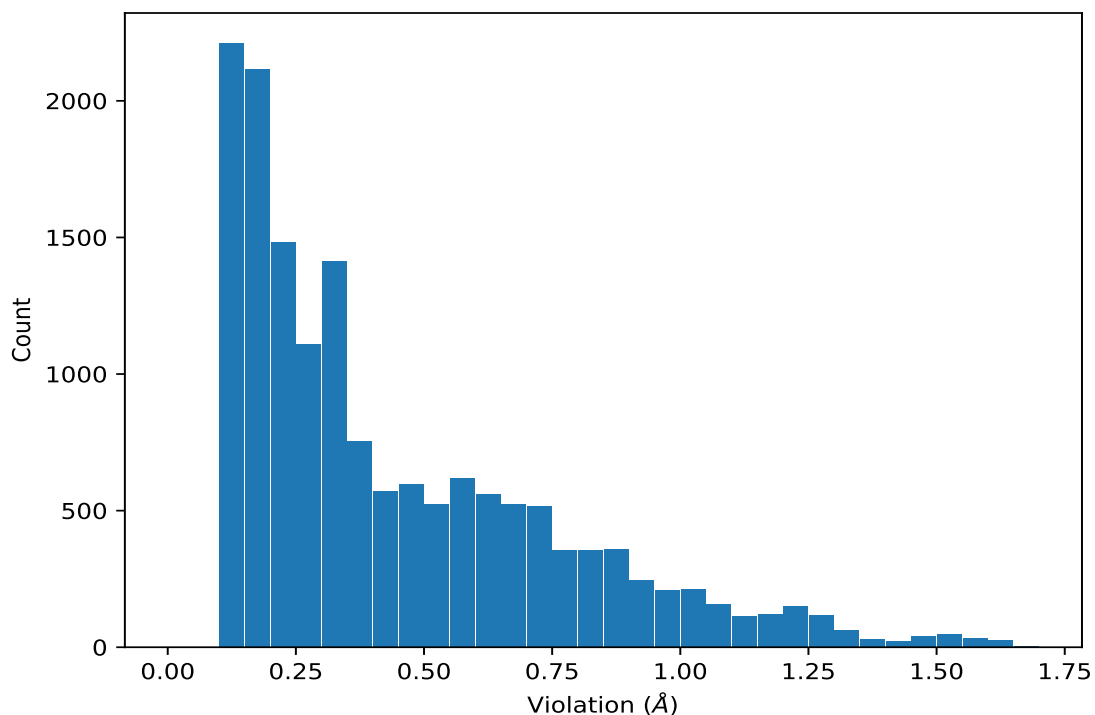
Key	Atom-1	Atom-2	Models ¹	Mean (Å)	SD ¹ (Å)	Median (Å)
(1,355)	1:A:81:ARG:HD3	1:A:40:LEU:HG	30	1.05	0.1	1.02
(1,142)	1:A:94:LYS:HG3	1:A:94:LYS:HE2	30	1.0	0.11	1.03
(1,142)	1:A:94:LYS:HG3	1:A:94:LYS:HE3	30	1.0	0.11	1.03
(1,365)	1:A:78:TYR:HA	1:A:40:LEU:HD11	30	0.99	0.06	0.99
(1,365)	1:A:78:TYR:HA	1:A:40:LEU:HD12	30	0.99	0.06	0.99
(1,365)	1:A:78:TYR:HA	1:A:40:LEU:HD13	30	0.99	0.06	0.99
(1,365)	1:A:78:TYR:HA	1:A:41:LYS:HG2	30	0.99	0.06	0.99
(1,141)	1:A:94:LYS:HE2	1:A:94:LYS:HG2	30	0.89	0.05	0.86
(1,141)	1:A:94:LYS:HE3	1:A:94:LYS:HG2	30	0.89	0.05	0.86
(1,392)	1:A:32:PRO:HG3	1:A:64:LEU:HG	30	0.87	0.09	0.87

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)
(1,199)	1:A:98:ASP:HB2	1:A:99:MET:HB2	5	1.68
(1,199)	1:A:98:ASP:HB2	1:A:77:GLU:HB3	5	1.68
(1,61)	1:A:38:ASP:HB3	1:A:45:ARG:HD2	21	1.65
(1,61)	1:A:38:ASP:HB3	1:A:80:CYS:HB2	21	1.65
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	8	1.63
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	8	1.63
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	8	1.63
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	1	1.61
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	1	1.61
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	1	1.61
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	14	1.61
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	14	1.61
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	14	1.61
(1,61)	1:A:38:ASP:HB3	1:A:45:ARG:HD2	11	1.61
(1,61)	1:A:38:ASP:HB3	1:A:80:CYS:HB2	11	1.61
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	3	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	3	1.6
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	3	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	13	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	13	1.6
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	13	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	17	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG3	17	1.6
(1,64)	1:A:38:ASP:HB3	1:A:81:ARG:HG2	17	1.6
(1,64)	1:A:38:ASP:HB3	1:A:45:ARG:HG2	19	1.6

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

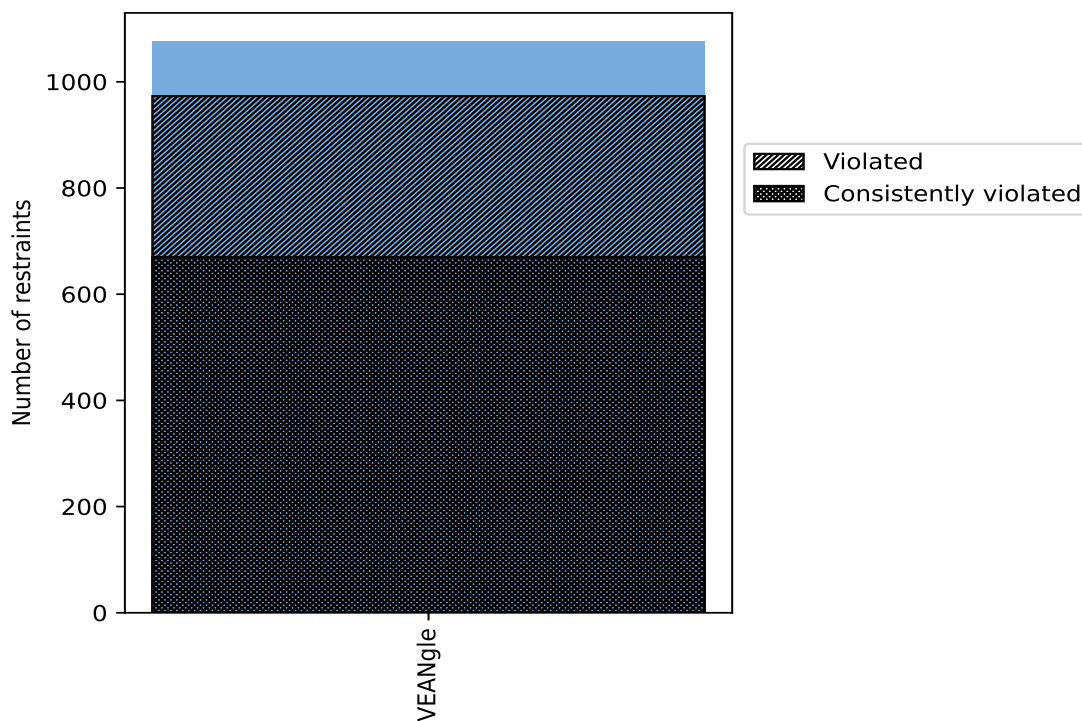
10.1 Summary of dihedral-angle violations [i](#)

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
VEAngle	1076	100.0	973	90.4	90.4	670	62.3	62.3
Total	1076	100.0	973	90.4	90.4	670	62.3	62.3

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](#)



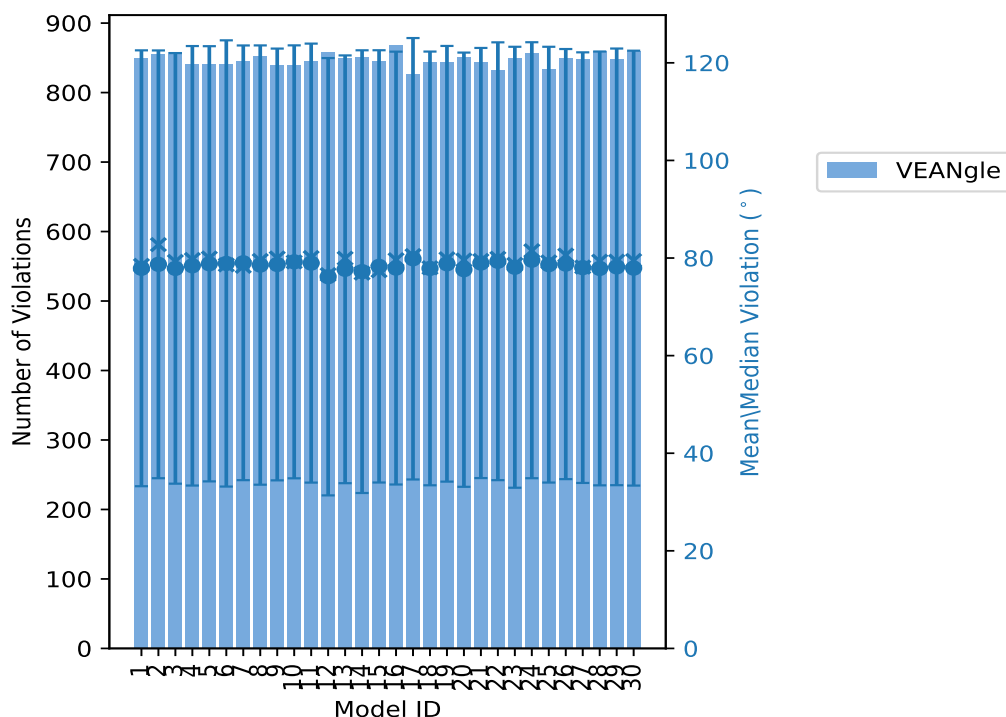
Violated and consistently violated restraints are shown using different hatch patterns in their respective categories

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 (°)
	VEANgle	Total				
1	850	850	77.9	168.0	44.66	78.5
2	856	856	78.71	163.2	43.83	82.75
3	859	859	77.88	162.4	44.12	79.3
4	841	841	78.41	167.9	45.03	79.7
5	841	841	78.82	167.6	44.59	80.0
6	841	841	78.89	165.0	45.72	78.6
7	846	846	79.02	163.6	44.54	78.3
8	852	852	78.56	162.3	45.01	79.5
9	839	839	78.68	163.7	44.24	80.0
10	839	839	79.22	165.7	44.36	79.2
11	845	845	78.96	168.6	44.98	80.1
12	859	859	76.17	159.6	44.81	76.6
13	850	850	77.69	162.0	43.83	79.95
14	851	851	77.21	164.4	45.36	76.9
15	846	846	78.29	163.0	44.29	77.4
16	868	868	77.94	162.7	44.35	79.65
17	826	826	79.85	161.1	45.23	80.5
18	844	844	77.87	165.9	44.44	78.0
19	844	844	78.82	168.8	44.64	79.85
20	851	851	77.61	161.6	44.49	79.6
21	844	844	78.98	161.3	44.07	79.5
22	832	832	79.34	160.6	44.86	79.95
23	849	849	78.11	165.1	45.18	78.7
24	857	857	79.55	163.8	44.67	81.5
25	834	834	78.64	162.7	44.65	79.2
26	850	850	78.76	160.6	44.07	80.6
27	848	848	78.03	167.1	44.12	78.15
28	860	860	77.87	160.1	44.45	79.35
29	848	848	78.19	161.4	44.74	79.35
30	860	860	77.93	168.5	44.56	79.5

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		
	VEANgle	Total	Count ¹
31	31	1	3.3
14	14	2	6.7
8	8	3	10.0
5	5	4	13.3
2	2	5	16.7
9	9	6	20.0
6	6	7	23.3
1	1	8	26.7
7	7	9	30.0
6	6	10	33.3
2	2	11	36.7

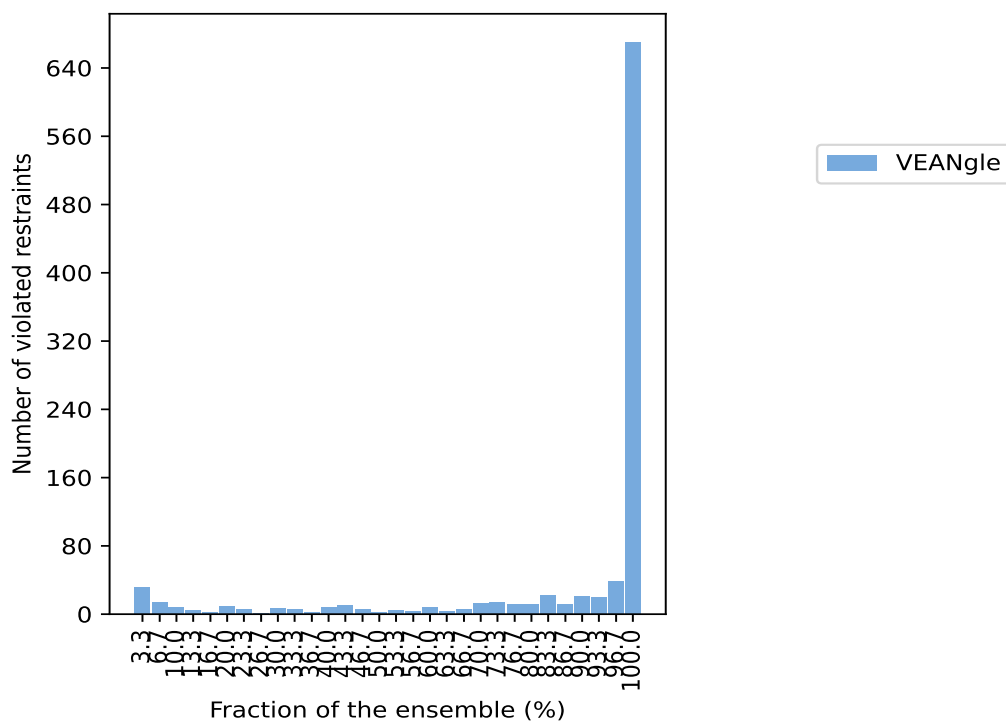
Continued on next page...

Continued from previous page...

Number of violated restraints		Fraction of the ensemble	
VEANgle	Total	Count ¹	%
8	8	12	40.0
10	10	13	43.3
6	6	14	46.7
2	2	15	50.0
4	4	16	53.3
3	3	17	56.7
8	8	18	60.0
3	3	19	63.3
6	6	20	66.7
13	13	21	70.0
14	14	22	73.3
11	11	23	76.7
11	11	24	80.0
22	22	25	83.3
11	11	26	86.7
21	21	27	90.0
20	20	28	93.3
39	39	29	96.7
670	670	30	100.0

¹ Number of models with violations

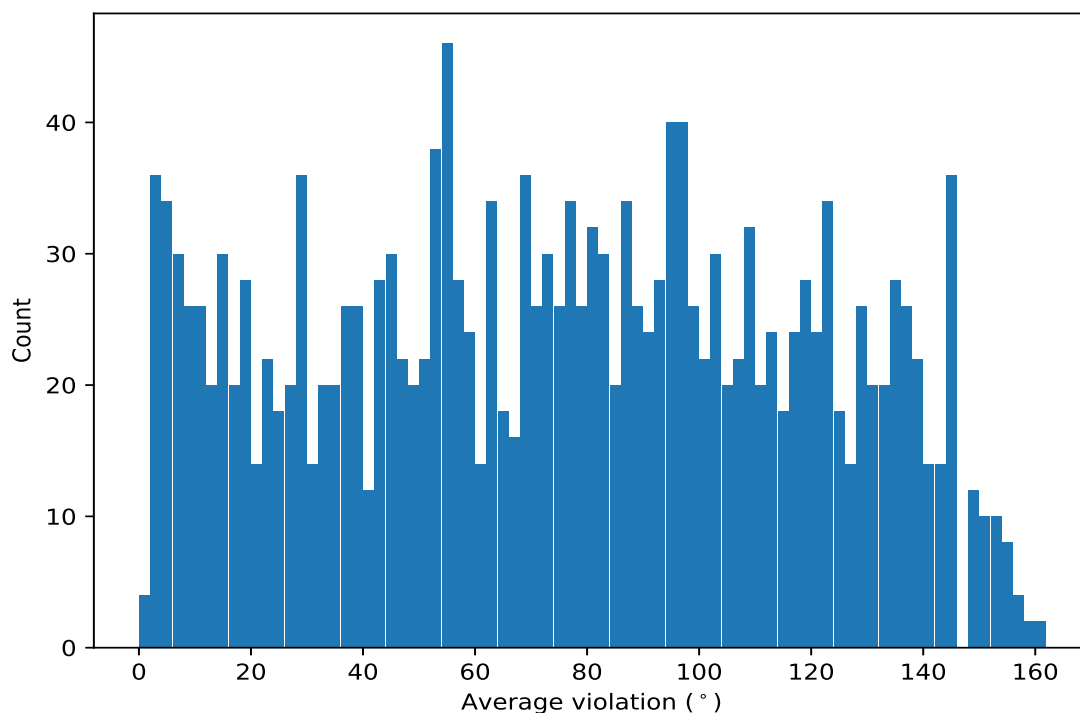
10.3.1 Bar graph : Dihedral-angle Violation statistics for the ensemble [i](#)



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.

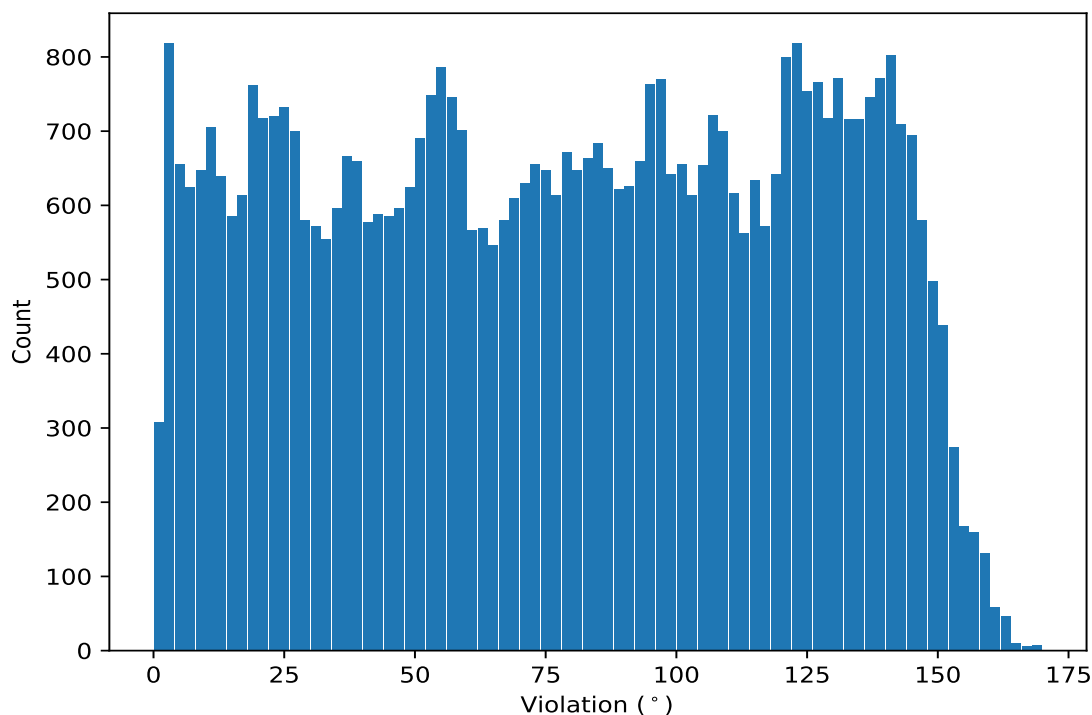
Key	Atom-1	Atom-2	Atom-3	Atom-4	Models ¹	Mean	SD ²	Median
(1,3)	1:A:20:SER:N	1:A:20:SER:H	1:A:50:GLU:N	1:A:50:GLU:H	30	160.14	4.01	160.9
(1,3)	1:A:20:SER:N	1:A:20:SER:H	1:A:50:GLU:N	1:A:50:GLU:H	30	160.14	4.01	160.9
(1,28)	1:A:24:ASN:N	1:A:24:ASN:H	1:A:75:LYS:N	1:A:75:LYS:H	30	158.64	2.94	159.45
(1,28)	1:A:24:ASN:N	1:A:24:ASN:H	1:A:75:LYS:N	1:A:75:LYS:H	30	158.64	2.94	159.45
(1,74)	1:A:44:GLU:N	1:A:44:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	157.71	1.18	158.1
(1,74)	1:A:44:GLU:N	1:A:44:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	157.71	1.18	158.1
(1,19)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:69:GLU:N	1:A:69:GLU:H	30	156.29	10.68	160.1
(1,19)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:69:GLU:N	1:A:69:GLU:H	30	156.29	10.68	160.1
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	155.48	13.63	157.8
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	155.48	13.63	157.8
(1,45)	1:A:35:ILE:N	1:A:35:ILE:H	1:A:49:VAL:N	1:A:49:VAL:H	30	155.39	3.84	155.45
(1,45)	1:A:35:ILE:N	1:A:35:ILE:H	1:A:49:VAL:N	1:A:49:VAL:H	30	155.39	3.84	155.45
(1,90)	1:A:75:LYS:N	1:A:75:LYS:H	1:A:78:TYR:N	1:A:78:TYR:H	30	155.27	2.61	156.1
(1,90)	1:A:75:LYS:N	1:A:75:LYS:H	1:A:78:TYR:N	1:A:78:TYR:H	30	155.27	2.61	156.1
(1,49)	1:A:35:ILE:N	1:A:35:ILE:H	1:A:41:LYS:N	1:A:41:LYS:H	30	154.1	3.79	155.1
(1,49)	1:A:35:ILE:N	1:A:35:ILE:H	1:A:41:LYS:N	1:A:41:LYS:H	30	154.1	3.79	155.1
(1,26)	1:A:20:SER:N	1:A:20:SER:H	1:A:24:ASN:N	1:A:24:ASN:H	30	153.99	9.77	156.05
(1,26)	1:A:20:SER:N	1:A:20:SER:H	1:A:24:ASN:N	1:A:24:ASN:H	30	153.99	9.77	156.05
(1,137)	1:A:68:THR:N	1:A:68:THR:H	1:A:75:LYS:N	1:A:75:LYS:H	30	153.88	2.01	153.9

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 (°)
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	19	168.8
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	19	168.8
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	11	168.6
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	11	168.6
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	168.5
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	30	168.5
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	1	168.0
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	1	168.0
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	4	167.9
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	4	167.9
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	5	167.6
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	5	167.6
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	27	167.1
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	27	167.1

Continued on next page...

Continued from previous page...

Key	Atom-1	Atom-2	Atom-3	Atom-4	Model ID	Violation (°)
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	18	165.9
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	18	165.9
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	10	165.7
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	10	165.7
(1,1)	1:A:50:GLU:N	1:A:50:GLU:H	1:A:92:ILE:N	1:A:92:ILE:H	23	165.1