



# Full wwPDB NMR Structure Validation Report ⓘ

Feb 23, 2022 – 02:25 PM EST

PDB ID : 1Y6D  
Title : Solution structure and dynamics of LuxU from *Vibrio harveyi*, a phosphotransferase protein involved in bacterial quorum sensing  
Authors : Ulrich, D.L.; Kojetin, D.; Bassler, B.L.; Cavanagh, J.; Loria, J.P.  
Deposited on : 2004-12-06

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

We welcome your comments at [validation@mail.wwpdb.org](mailto: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.

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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)  
RCI : v\_1n\_11\_5\_13\_A (Berjanski et al., 2005)  
PANAV : Wang et al. (2010)  
ShiftChecker : 2.26  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.26

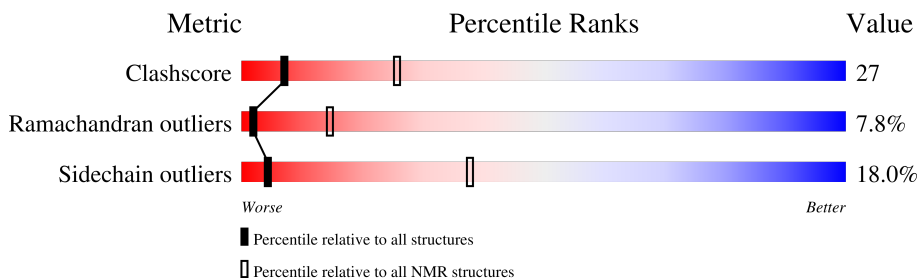
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*SOLUTION NMR*

The overall completeness of chemical shifts assignment was not calculated.

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  $\geq 3$ , 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	120	

## 2 Ensemble composition and analysis

This entry contains 19 models. The atoms present in the NMR models are not consistent. Some calculations may have failed as a result. All residues are included in the validation scores. Model 5 is the overall representative, medoid model (most similar to other models). The authors have identified model 17 as representative.

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:2-A:114 (113)	0.53	5

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 1 single-model cluster was found.

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

### 3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 1771 atoms, of which 883 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Phosphorelay protein luxU.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	114	1771	552	883	149	182	5	0

There are 6 discrepancies between the modelled and reference sequences:

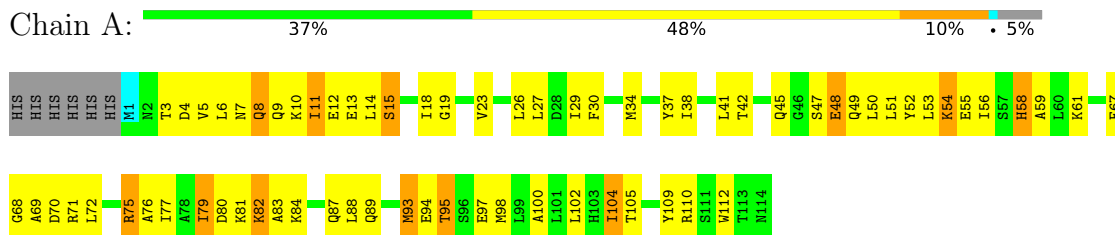
Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	HIS	-	expression tag	UNP Q9ZBB6
A	-4	HIS	-	expression tag	UNP Q9ZBB6
A	-3	HIS	-	expression tag	UNP Q9ZBB6
A	-2	HIS	-	expression tag	UNP Q9ZBB6
A	-1	HIS	-	expression tag	UNP Q9ZBB6
A	0	HIS	-	expression tag	UNP Q9ZBB6

## 4 Residue-property plots

### 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: Phosphorelay protein luxU

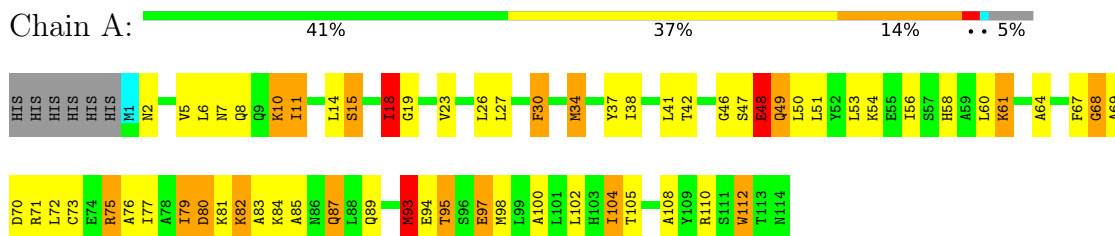


### 4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

#### 4.2.1 Score per residue for model 1

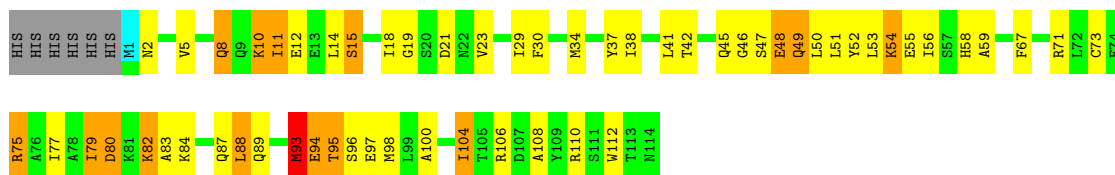
- Molecule 1: Phosphorelay protein luxU



#### 4.2.2 Score per residue for model 2

- Molecule 1: Phosphorelay protein luxU

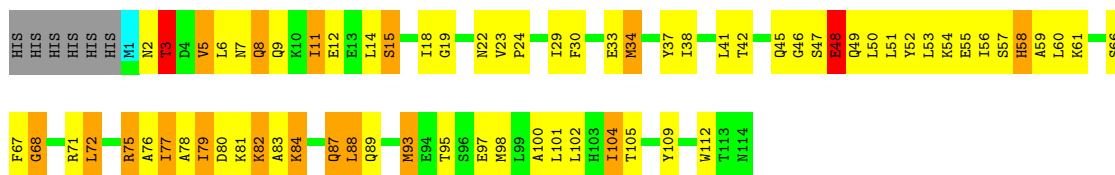




### 4.2.3 Score per residue for model 3

- Molecule 1: Phosphorelay protein luxU

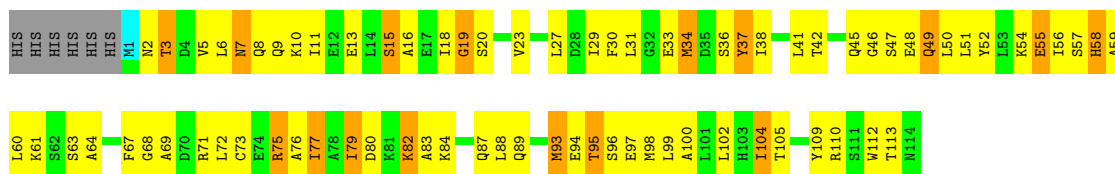
Chain A: 36% 42% 14% 5%



### 4.2.4 Score per residue for model 4

- Molecule 1: Phosphorelay protein luxU

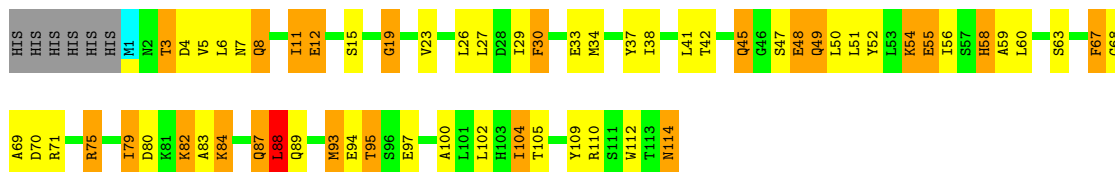
Chain A: 30% 51% 13% 5%



### 4.2.5 Score per residue for model 5 (medoid)

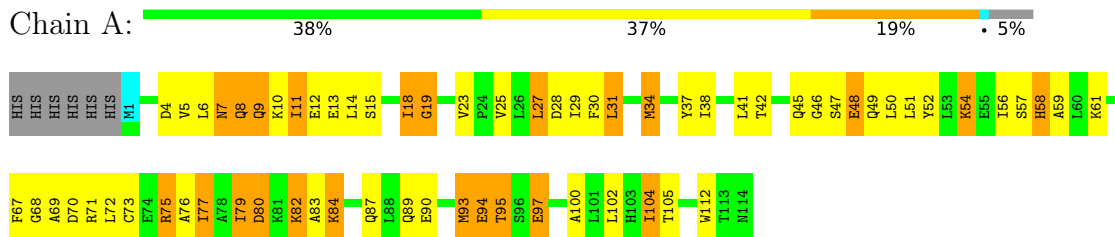
- Molecule 1: Phosphorelay protein luxU

Chain A: 43% 32% 18% 5%



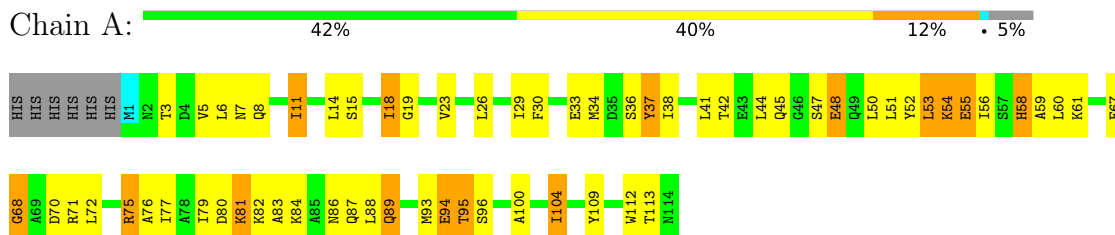
### 4.2.6 Score per residue for model 6

- Molecule 1: Phosphorelay protein luxU



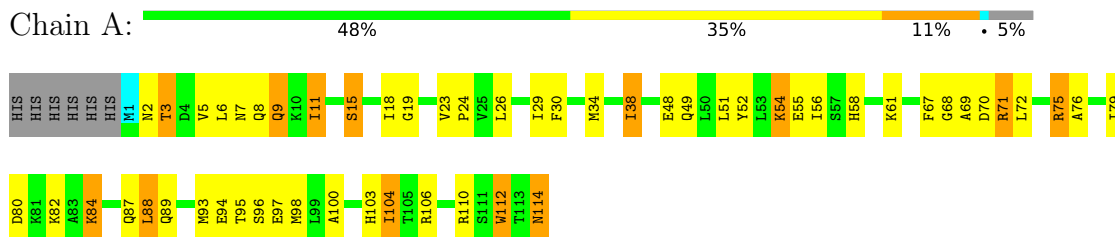
#### 4.2.7 Score per residue for model 7

- Molecule 1: Phosphorelay protein luxU



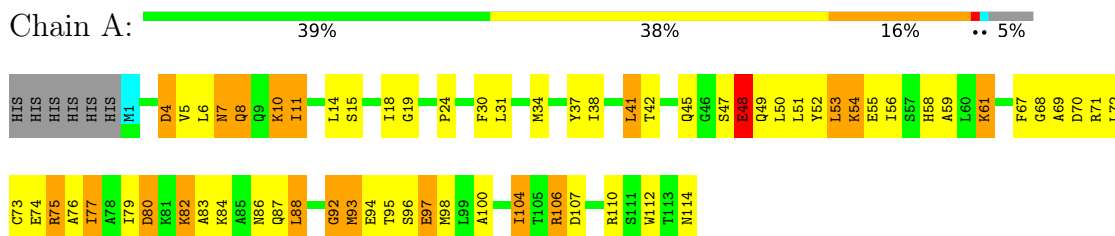
#### 4.2.8 Score per residue for model 8

- Molecule 1: Phosphorelay protein luxU



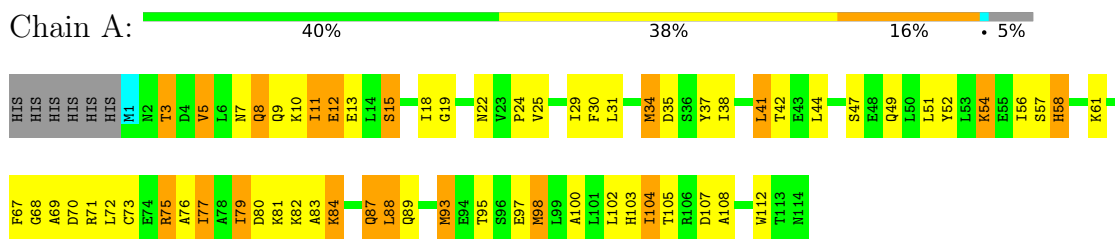
#### 4.2.9 Score per residue for model 9

- Molecule 1: Phosphorelay protein luxU



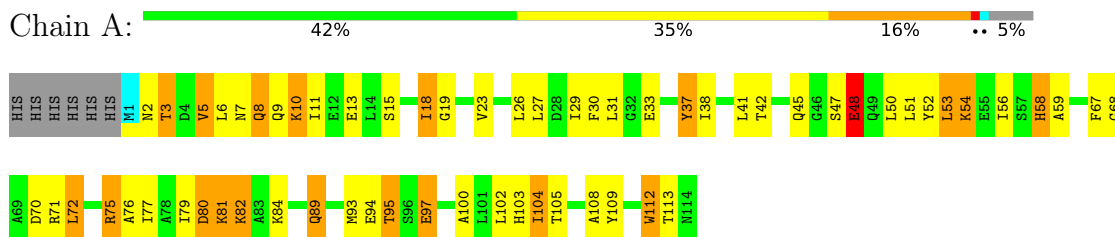
### 4.2.10 Score per residue for model 10

- Molecule 1: Phosphorelay protein luxU



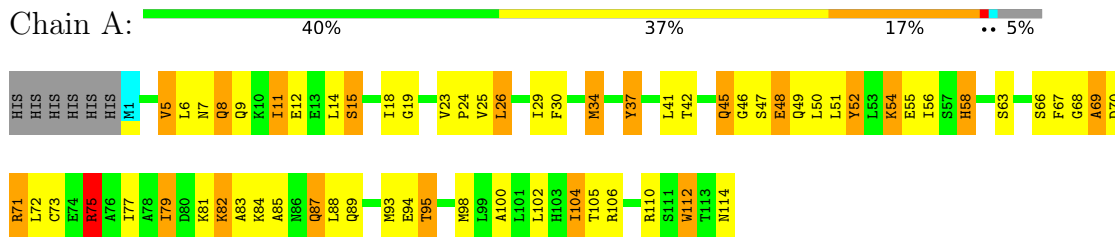
### 4.2.11 Score per residue for model 11

- Molecule 1: Phosphorelay protein luxU



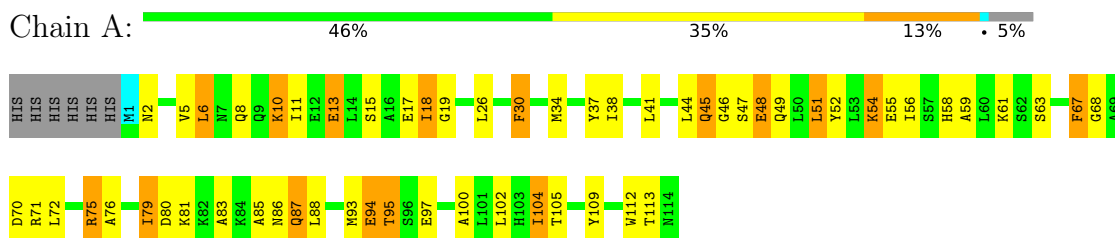
### 4.2.12 Score per residue for model 12

- Molecule 1: Phosphorelay protein luxU



### 4.2.13 Score per residue for model 13

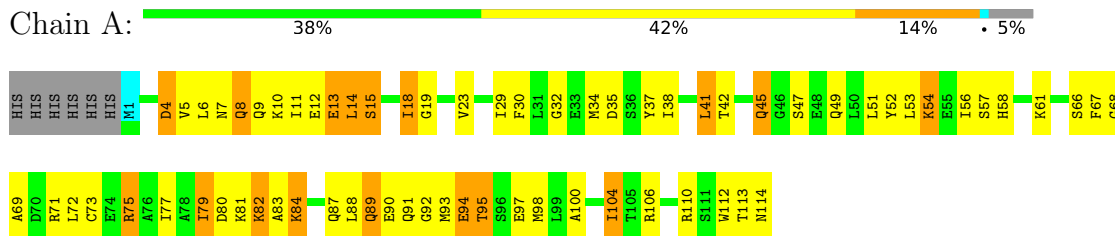
- Molecule 1: Phosphorelay protein luxU





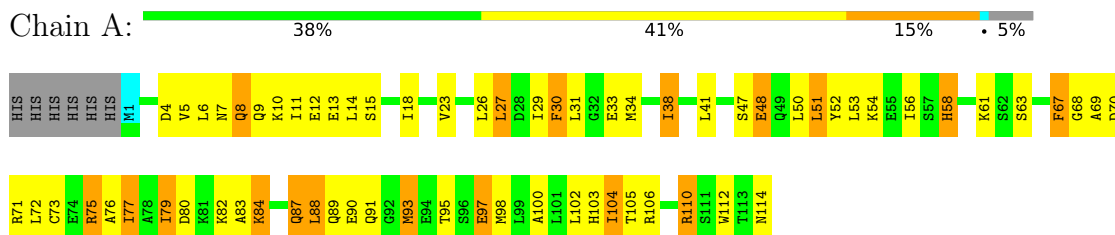
## 4.2.14 Score per residue for model 14

- Molecule 1: Phosphorelay protein luxU



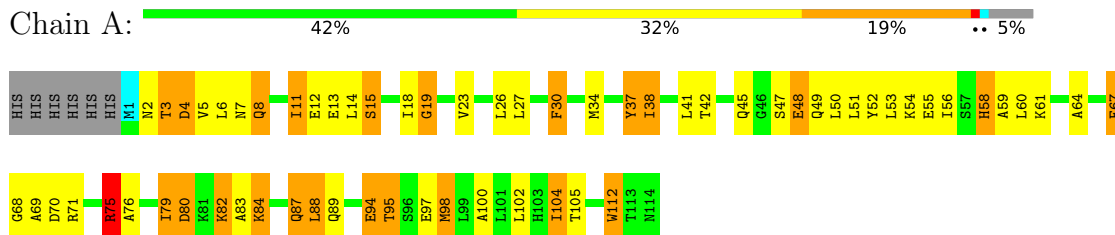
## 4.2.15 Score per residue for model 15

- Molecule 1: Phosphorelay protein luxU



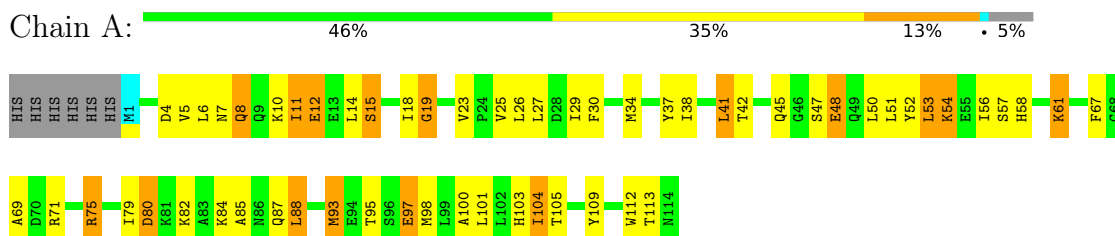
## 4.2.16 Score per residue for model 16

- Molecule 1: Phosphorelay protein luxU



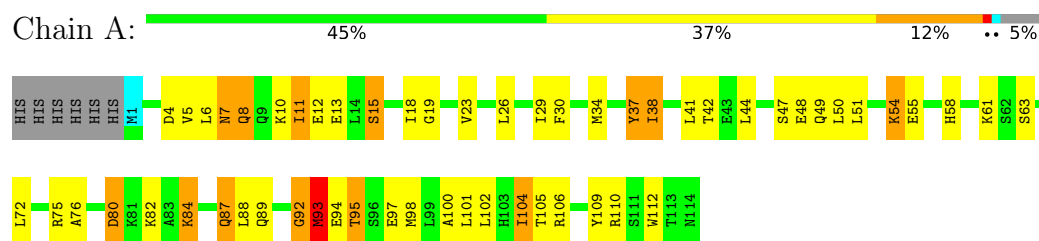
## 4.2.17 Score per residue for model 17

- Molecule 1: Phosphorelay protein luxU



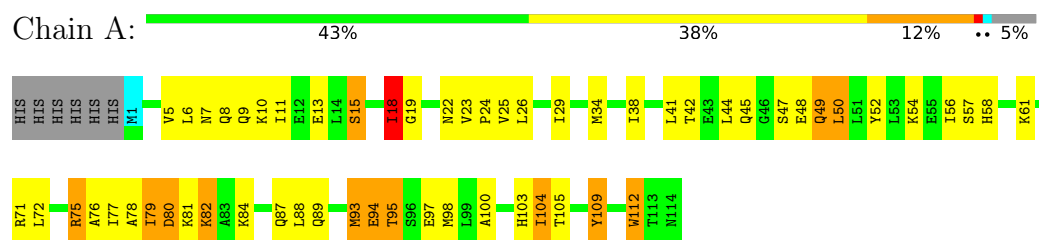
### 4.2.18 Score per residue for model 18

- Molecule 1: Phosphorelay protein luxU



### 4.2.19 Score per residue for model 19

- Molecule 1: Phosphorelay protein luxU



## 5 Refinement protocol and experimental data overview

Of the 19 calculated structures, 19 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	1.0
DYANA	structure solution	CYANA
XPLOR-NIH	refinement	

No chemical shift data was provided.

## 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	0.96±0.03	0±1/889 ( 0.0± 0.1%)	1.07±0.04	1±1/1197 ( 0.1± 0.1%)
All	All	0.96	7/16891 ( 0.0%)	1.07	12/22743 ( 0.1%)

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	1.1±1.1
All	All	0	21

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
1	A	19	GLY	N-CA	-6.15	1.36	1.46	4	1
1	A	80	ASP	CA-C	-5.76	1.38	1.52	16	4
1	A	37	TYR	N-CA	-5.41	1.35	1.46	4	1
1	A	37	TYR	CB-CG	-5.10	1.44	1.51	2	1

All 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
1	A	37	TYR	CB-CG-CD2	-6.94	116.83	121.00	11	4
1	A	37	TYR	CB-CG-CD1	-6.81	116.91	121.00	7	3
1	A	37	TYR	CA-CB-CG	-6.02	101.96	113.40	2	2
1	A	79	ILE	CA-C-N	-5.90	104.23	117.20	13	2
1	A	93	MET	N-CA-CB	5.32	120.18	110.60	18	1

There are no chirality outliers.

All unique planar outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	79	ILE	Mainchain	12
1	A	81	LYS	Mainchain	3
1	A	110	ARG	Sidechain	3
1	A	75	ARG	Sidechain	2
1	A	82	LYS	Mainchain	1

## 6.2 Too-close contacts

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	880	874	874	47±5
All	All	16720	16606	16606	892

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 27.

All unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:75:ARG:O	1:A:79:ILE:HB	0.83	1.73	6	16
1:A:4:ASP:HA	1:A:8:GLN:NE2	0.80	1.92	6	8
1:A:8:GLN:NE2	1:A:8:GLN:H	0.77	1.77	5	5
1:A:80:ASP:HA	1:A:84:LYS:HB2	0.76	1.58	1	5
1:A:95:THR:HA	1:A:98:MET:HE2	0.75	1.57	1	2
1:A:48:GLU:HA	1:A:51:LEU:CD2	0.74	2.12	3	2
1:A:30:PHE:O	1:A:34:MET:HB2	0.74	1.82	17	7
1:A:89:GLN:NE2	1:A:93:MET:HA	0.70	2.02	4	7
1:A:8:GLN:H	1:A:8:GLN:HE21	0.70	1.26	5	1
1:A:88:LEU:HB3	1:A:93:MET:SD	0.70	2.27	14	1
1:A:54:LYS:O	1:A:58:HIS:HB3	0.69	1.87	8	16
1:A:37:TYR:CD2	1:A:41:LEU:HG	0.69	2.22	14	2
1:A:80:ASP:HA	1:A:84:LYS:HB3	0.69	1.64	18	3
1:A:38:ILE:O	1:A:42:THR:HB	0.69	1.88	6	11
1:A:50:LEU:O	1:A:54:LYS:HG2	0.68	1.88	16	7

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:48:GLU:O	1:A:51:LEU:HB3	0.68	1.89	9	5
1:A:79:ILE:O	1:A:84:LYS:HG2	0.67	1.88	11	1
1:A:100:ALA:O	1:A:104:ILE:HG22	0.67	1.90	5	19
1:A:49:GLN:HA	1:A:98:MET:SD	0.67	2.29	8	5
1:A:41:LEU:HB3	1:A:47:SER:CB	0.65	2.21	18	9
1:A:38:ILE:HG12	1:A:51:LEU:HB2	0.65	1.66	11	2
1:A:37:TYR:O	1:A:41:LEU:HB2	0.65	1.91	17	12
1:A:11:ILE:O	1:A:15:SER:HB2	0.65	1.92	2	11
1:A:50:LEU:O	1:A:54:LYS:HG3	0.64	1.92	7	4
1:A:37:TYR:O	1:A:41:LEU:HG	0.64	1.92	9	1
1:A:41:LEU:HB3	1:A:47:SER:HB2	0.64	1.68	19	4
1:A:42:THR:HA	1:A:45:GLN:O	0.64	1.92	19	7
1:A:48:GLU:HA	1:A:51:LEU:HD23	0.64	1.70	3	1
1:A:8:GLN:O	1:A:12:GLU:HB2	0.63	1.93	16	9
1:A:38:ILE:HG13	1:A:51:LEU:HD22	0.63	1.70	17	2
1:A:89:GLN:CB	1:A:93:MET:H	0.63	2.06	7	2
1:A:11:ILE:HG12	1:A:67:PHE:HB2	0.63	1.69	16	3
1:A:106:ARG:O	1:A:110:ARG:HG2	0.63	1.92	8	4
1:A:46:GLY:O	1:A:49:GLN:HB3	0.62	1.95	12	7
1:A:47:SER:O	1:A:50:LEU:HB3	0.62	1.95	2	8
1:A:30:PHE:HB2	1:A:59:ALA:HB1	0.62	1.71	5	2
1:A:110:ARG:HD3	1:A:114:ASN:O	0.62	1.95	5	1
1:A:25:VAL:O	1:A:29:ILE:HG13	0.62	1.93	6	1
1:A:84:LYS:O	1:A:88:LEU:HG	0.62	1.94	10	6
1:A:52:TYR:O	1:A:56:ILE:HG12	0.62	1.94	14	17
1:A:71:ARG:O	1:A:75:ARG:HB3	0.62	1.95	18	19
1:A:38:ILE:HG12	1:A:51:LEU:HD22	0.62	1.71	16	5
1:A:37:TYR:CG	1:A:41:LEU:HG	0.61	2.30	10	2
1:A:11:ILE:CG1	1:A:67:PHE:HB3	0.61	2.25	3	7
1:A:11:ILE:CG1	1:A:67:PHE:HB2	0.61	2.26	16	5
1:A:7:ASN:O	1:A:11:ILE:HB	0.61	1.94	11	3
1:A:15:SER:HA	1:A:67:PHE:CZ	0.61	2.31	10	1
1:A:34:MET:HG2	1:A:55:GLU:HB3	0.61	1.72	12	1
1:A:41:LEU:HB3	1:A:47:SER:HB3	0.60	1.72	11	4
1:A:6:LEU:HD12	1:A:7:ASN:N	0.60	2.11	19	15
1:A:4:ASP:HA	1:A:8:GLN:HE22	0.60	1.54	5	2
1:A:86:ASN:HA	1:A:92:GLY:CA	0.60	2.26	9	1
1:A:45:GLN:HG3	1:A:47:SER:H	0.60	1.56	12	5
1:A:93:MET:HA	1:A:97:GLU:OE1	0.59	1.97	6	5
1:A:38:ILE:HA	1:A:41:LEU:HB2	0.59	1.74	19	2
1:A:8:GLN:HE21	1:A:8:GLN:N	0.59	1.95	5	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:27:LEU:HA	1:A:30:PHE:CE2	0.59	2.33	16	2
1:A:60:LEU:O	1:A:64:ALA:HB3	0.58	1.97	4	2
1:A:34:MET:HB3	1:A:51:LEU:HD11	0.58	1.75	5	2
1:A:19:GLY:HA3	1:A:23:VAL:HG13	0.58	1.74	12	2
1:A:2:ASN:OD1	1:A:108:ALA:HB1	0.58	1.99	1	1
1:A:80:ASP:HA	1:A:84:LYS:CB	0.58	2.27	1	6
1:A:11:ILE:HG13	1:A:67:PHE:HB3	0.58	1.74	2	5
1:A:105:THR:HA	1:A:109:TYR:CD1	0.58	2.34	18	5
1:A:11:ILE:HG13	1:A:67:PHE:HB2	0.58	1.76	18	4
1:A:27:LEU:O	1:A:31:LEU:HD13	0.58	1.99	15	4
1:A:76:ALA:O	1:A:80:ASP:HB2	0.58	1.99	15	9
1:A:79:ILE:O	1:A:84:LYS:HB3	0.58	1.98	12	1
1:A:19:GLY:HA2	1:A:22:ASN:OD1	0.58	1.98	19	1
1:A:9:GLN:O	1:A:13:GLU:HG3	0.57	1.99	11	1
1:A:2:ASN:OD1	1:A:72:LEU:HD22	0.57	1.98	13	1
1:A:54:LYS:HE3	1:A:54:LYS:C	0.57	2.19	18	1
1:A:110:ARG:HD3	1:A:114:ASN:OXT	0.57	1.98	8	1
1:A:7:ASN:O	1:A:11:ILE:HG22	0.57	2.00	12	10
1:A:80:ASP:CG	1:A:84:LYS:HG2	0.56	2.19	5	2
1:A:56:ILE:O	1:A:61:LYS:HB2	0.56	2.01	7	4
1:A:85:ALA:HB1	1:A:93:MET:HB3	0.56	1.76	12	1
1:A:81:LYS:O	1:A:85:ALA:HB3	0.56	2.01	13	1
1:A:63:SER:HB3	1:A:67:PHE:CE2	0.56	2.36	5	4
1:A:82:LYS:HD3	1:A:83:ALA:N	0.55	2.16	5	4
1:A:68:GLY:HA3	1:A:72:LEU:HD21	0.55	1.78	9	2
1:A:84:LYS:O	1:A:88:LEU:HB2	0.55	2.01	17	2
1:A:51:LEU:O	1:A:54:LYS:HE2	0.55	2.00	6	1
1:A:95:THR:O	1:A:98:MET:HG2	0.55	2.01	2	2
1:A:100:ALA:HA	1:A:103:HIS:NE2	0.55	2.16	8	5
1:A:50:LEU:HG	1:A:54:LYS:CD	0.55	2.31	4	1
1:A:38:ILE:CG1	1:A:51:LEU:HD22	0.54	2.32	17	3
1:A:96:SER:O	1:A:100:ALA:HB2	0.54	2.03	8	3
1:A:80:ASP:O	1:A:84:LYS:HB3	0.54	2.02	18	1
1:A:8:GLN:H	1:A:8:GLN:CD	0.54	2.05	16	4
1:A:6:LEU:HD22	1:A:70:ASP:OD2	0.54	2.03	16	1
1:A:10:LYS:N	1:A:10:LYS:HE2	0.54	2.17	1	1
1:A:75:ARG:C	1:A:75:ARG:HD3	0.54	2.22	19	13
1:A:19:GLY:O	1:A:24:PRO:HD3	0.54	2.02	10	4
1:A:85:ALA:CB	1:A:97:GLU:HG3	0.54	2.32	17	1
1:A:10:LYS:HA	1:A:13:GLU:CG	0.54	2.33	19	4
1:A:82:LYS:HD2	1:A:83:ALA:N	0.53	2.19	1	3

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:97:GLU:OE2	1:A:98:MET:HG3	0.53	2.03	17	1
1:A:10:LYS:N	1:A:10:LYS:HE3	0.53	2.18	11	1
1:A:38:ILE:HD11	1:A:51:LEU:HB3	0.53	1.81	13	2
1:A:83:ALA:O	1:A:87:GLN:HB2	0.53	2.03	10	4
1:A:51:LEU:HA	1:A:54:LYS:HG2	0.53	1.80	12	1
1:A:80:ASP:HA	1:A:84:LYS:CG	0.53	2.34	16	11
1:A:10:LYS:HA	1:A:13:GLU:HG2	0.53	1.80	19	4
1:A:30:PHE:HB3	1:A:59:ALA:HB1	0.53	1.80	6	3
1:A:6:LEU:O	1:A:10:LYS:HB3	0.53	2.02	15	1
1:A:83:ALA:O	1:A:87:GLN:HB3	0.53	2.04	2	4
1:A:38:ILE:CD1	1:A:51:LEU:HD22	0.53	2.34	6	4
1:A:76:ALA:O	1:A:80:ASP:HB3	0.53	2.04	11	1
1:A:75:ARG:O	1:A:79:ILE:HG12	0.53	2.02	13	1
1:A:52:TYR:OH	1:A:81:LYS:HA	0.53	2.03	7	1
1:A:51:LEU:HA	1:A:54:LYS:CG	0.52	2.34	12	2
1:A:85:ALA:HA	1:A:88:LEU:CD2	0.52	2.35	13	1
1:A:78:ALA:O	1:A:82:LYS:HG3	0.52	2.03	3	1
1:A:70:ASP:OD1	1:A:71:ARG:HG3	0.52	2.03	12	1
1:A:89:GLN:HE22	1:A:91:GLN:HB2	0.52	1.64	14	1
1:A:55:GLU:HA	1:A:58:HIS:ND1	0.52	2.19	4	1
1:A:80:ASP:HA	1:A:84:LYS:HG3	0.52	1.80	15	2
1:A:51:LEU:HD12	1:A:54:LYS:HZ3	0.52	1.64	18	1
1:A:11:ILE:HG12	1:A:67:PHE:HB3	0.52	1.82	7	2
1:A:38:ILE:CD1	1:A:51:LEU:HD13	0.52	2.35	1	3
1:A:38:ILE:HD11	1:A:51:LEU:HD22	0.52	1.81	3	2
1:A:34:MET:HG3	1:A:51:LEU:HD11	0.52	1.82	10	1
1:A:14:LEU:HG	1:A:66:SER:O	0.52	2.04	12	2
1:A:51:LEU:O	1:A:55:GLU:HB3	0.52	2.04	7	2
1:A:50:LEU:HG	1:A:54:LYS:HD2	0.52	1.82	4	2
1:A:80:ASP:O	1:A:84:LYS:HB2	0.52	2.05	19	1
1:A:72:LEU:O	1:A:76:ALA:HB3	0.52	2.05	7	11
1:A:105:THR:O	1:A:109:TYR:HB2	0.52	2.04	19	4
1:A:29:ILE:O	1:A:33:GLU:HG2	0.52	2.05	11	3
1:A:73:CYS:O	1:A:77:ILE:HG12	0.52	2.04	2	4
1:A:19:GLY:CA	1:A:23:VAL:HG13	0.52	2.35	18	2
1:A:47:SER:O	1:A:51:LEU:HD23	0.52	2.04	14	1
1:A:27:LEU:HA	1:A:30:PHE:CD2	0.51	2.40	15	4
1:A:19:GLY:O	1:A:23:VAL:HG22	0.51	2.05	4	3
1:A:48:GLU:HB3	1:A:98:MET:CE	0.51	2.35	16	1
1:A:51:LEU:HD12	1:A:54:LYS:NZ	0.51	2.19	18	1
1:A:51:LEU:HA	1:A:54:LYS:CE	0.51	2.35	6	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:94:GLU:OE2	1:A:95:THR:HG22	0.51	2.06	19	1
1:A:19:GLY:O	1:A:23:VAL:HG12	0.51	2.05	7	10
1:A:48:GLU:CA	1:A:51:LEU:HG	0.51	2.35	6	1
1:A:51:LEU:HA	1:A:54:LYS:HE2	0.51	1.81	6	1
1:A:97:GLU:H	1:A:97:GLU:CD	0.51	2.08	11	3
1:A:86:ASN:ND2	1:A:92:GLY:HA3	0.51	2.21	9	1
1:A:38:ILE:HG12	1:A:51:LEU:HD13	0.51	1.82	18	4
1:A:38:ILE:HG12	1:A:51:LEU:HD12	0.51	1.83	2	1
1:A:81:LYS:HB3	1:A:81:LYS:NZ	0.51	2.21	11	1
1:A:48:GLU:HA	1:A:51:LEU:HG	0.51	1.82	6	1
1:A:5:VAL:O	1:A:9:GLN:HB2	0.50	2.06	10	3
1:A:9:GLN:HA	1:A:9:GLN:HE21	0.50	1.66	8	1
1:A:30:PHE:HB3	1:A:59:ALA:CB	0.50	2.37	6	5
1:A:30:PHE:O	1:A:34:MET:HG2	0.50	2.07	8	3
1:A:88:LEU:HD21	1:A:97:GLU:HA	0.50	1.82	13	1
1:A:84:LYS:NZ	1:A:84:LYS:HB3	0.50	2.21	19	1
1:A:30:PHE:HB3	1:A:59:ALA:HB2	0.50	1.84	11	2
1:A:33:GLU:HA	1:A:36:SER:OG	0.50	2.06	7	2
1:A:97:GLU:OE1	1:A:98:MET:HG3	0.50	2.07	8	2
1:A:94:GLU:O	1:A:95:THR:HB	0.49	2.06	18	13
1:A:34:MET:HE1	1:A:54:LYS:HE3	0.49	1.84	8	1
1:A:104:ILE:O	1:A:108:ALA:HB3	0.49	2.07	10	3
1:A:48:GLU:O	1:A:51:LEU:HG	0.49	2.07	17	1
1:A:37:TYR:HB3	1:A:51:LEU:HD13	0.49	1.84	12	1
1:A:2:ASN:HB2	1:A:6:LEU:HD11	0.49	1.85	1	1
1:A:68:GLY:C	1:A:70:ASP:H	0.49	2.10	11	11
1:A:72:LEU:H	1:A:72:LEU:HD23	0.49	1.68	7	5
1:A:77:ILE:O	1:A:81:LYS:HE2	0.49	2.08	11	1
1:A:85:ALA:HA	1:A:88:LEU:CG	0.49	2.37	13	1
1:A:72:LEU:HA	1:A:76:ALA:CB	0.49	2.38	13	1
1:A:70:ASP:OD2	1:A:71:ARG:HG3	0.48	2.07	8	1
1:A:63:SER:HB2	1:A:67:PHE:CE2	0.48	2.42	12	1
1:A:2:ASN:HB3	1:A:6:LEU:HD11	0.48	1.84	16	1
1:A:9:GLN:HE21	1:A:9:GLN:N	0.48	2.05	6	1
1:A:14:LEU:O	1:A:18:ILE:HG23	0.48	2.08	7	5
1:A:8:GLN:NE2	1:A:9:GLN:H	0.48	2.06	12	2
1:A:6:LEU:HD12	1:A:7:ASN:H	0.48	1.68	11	1
1:A:6:LEU:HA	1:A:10:LYS:HB2	0.48	1.83	13	1
1:A:92:GLY:C	1:A:94:GLU:H	0.48	2.11	14	1
1:A:102:LEU:HA	1:A:105:THR:HG22	0.48	1.86	1	10
1:A:6:LEU:HD13	1:A:72:LEU:HD22	0.48	1.84	7	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:89:GLN:OE1	1:A:94:GLU:HG3	0.48	2.08	16	1
1:A:85:ALA:HB1	1:A:97:GLU:HG3	0.48	1.84	17	1
1:A:80:ASP:CA	1:A:84:LYS:HB2	0.48	2.37	19	3
1:A:48:GLU:HA	1:A:51:LEU:CG	0.48	2.39	6	2
1:A:19:GLY:C	1:A:21:ASP:H	0.47	2.12	2	1
1:A:29:ILE:HG13	1:A:30:PHE:N	0.47	2.24	2	8
1:A:50:LEU:O	1:A:53:LEU:HG	0.47	2.08	2	1
1:A:103:HIS:O	1:A:107:ASP:HB2	0.47	2.08	10	1
1:A:41:LEU:HD12	1:A:47:SER:OG	0.47	2.09	12	1
1:A:45:GLN:HG3	1:A:47:SER:HB2	0.47	1.85	9	1
1:A:106:ARG:O	1:A:110:ARG:HB2	0.47	2.08	18	2
1:A:64:ALA:HA	1:A:67:PHE:CD1	0.47	2.44	16	1
1:A:23:VAL:O	1:A:27:LEU:HB3	0.47	2.09	17	1
1:A:38:ILE:HG13	1:A:51:LEU:CD2	0.47	2.39	17	1
1:A:34:MET:HA	1:A:34:MET:CE	0.47	2.38	3	2
1:A:2:ASN:OD1	1:A:7:ASN:HB2	0.47	2.08	8	1
1:A:70:ASP:OD2	1:A:71:ARG:HD3	0.47	2.10	11	1
1:A:63:SER:HB2	1:A:67:PHE:CZ	0.47	2.45	12	1
1:A:76:ALA:HA	1:A:80:ASP:OD1	0.47	2.10	1	1
1:A:8:GLN:O	1:A:12:GLU:HB3	0.47	2.10	6	2
1:A:84:LYS:O	1:A:87:GLN:HG3	0.47	2.10	18	1
1:A:87:GLN:NE2	1:A:87:GLN:HA	0.47	2.24	6	1
1:A:97:GLU:OE2	1:A:98:MET:HG2	0.47	2.10	9	1
1:A:63:SER:HB3	1:A:67:PHE:CZ	0.47	2.45	18	1
1:A:86:ASN:HA	1:A:92:GLY:HA2	0.46	1.87	9	1
1:A:51:LEU:HB3	1:A:98:MET:SD	0.46	2.51	10	1
1:A:50:LEU:O	1:A:53:LEU:HD13	0.46	2.10	9	1
1:A:97:GLU:O	1:A:100:ALA:HB3	0.46	2.10	3	9
1:A:57:SER:O	1:A:61:LYS:HB3	0.46	2.09	4	6
1:A:61:LYS:HA	1:A:61:LYS:HE2	0.46	1.86	1	2
1:A:80:ASP:CA	1:A:84:LYS:HB3	0.46	2.40	18	1
1:A:84:LYS:C	1:A:84:LYS:HD3	0.46	2.30	10	1
1:A:34:MET:CG	1:A:55:GLU:HB3	0.46	2.39	12	1
1:A:61:LYS:HE3	1:A:61:LYS:HA	0.46	1.88	15	1
1:A:48:GLU:HB2	1:A:98:MET:CE	0.46	2.41	1	1
1:A:93:MET:HG3	1:A:97:GLU:HB3	0.46	1.87	14	1
1:A:10:LYS:O	1:A:14:LEU:HB2	0.46	2.11	17	4
1:A:109:TYR:HA	1:A:113:THR:CB	0.46	2.40	4	1
1:A:55:GLU:OE1	1:A:60:LEU:HB2	0.46	2.11	5	3
1:A:95:THR:O	1:A:98:MET:HG3	0.46	2.11	16	1
1:A:89:GLN:HE22	1:A:97:GLU:N	0.46	2.09	1	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:41:LEU:HB2	1:A:47:SER:OG	0.46	2.11	6	2
1:A:85:ALA:HA	1:A:88:LEU:HG	0.46	1.88	13	1
1:A:50:LEU:O	1:A:53:LEU:HD12	0.46	2.11	17	1
1:A:9:GLN:O	1:A:13:GLU:HG2	0.46	2.10	19	1
1:A:80:ASP:HA	1:A:84:LYS:HG2	0.45	1.87	8	2
1:A:85:ALA:HA	1:A:88:LEU:HD23	0.45	1.86	13	1
1:A:68:GLY:O	1:A:73:CYS:HB2	0.45	2.12	14	1
1:A:101:LEU:HA	1:A:104:ILE:CG2	0.45	2.41	3	3
1:A:13:GLU:HG3	1:A:14:LEU:N	0.45	2.27	15	3
1:A:38:ILE:HD11	1:A:51:LEU:HD13	0.45	1.87	9	1
1:A:110:ARG:O	1:A:110:ARG:HD3	0.45	2.12	9	1
1:A:23:VAL:HG12	1:A:67:PHE:CD1	0.45	2.46	18	1
1:A:29:ILE:O	1:A:33:GLU:HG3	0.45	2.12	3	1
1:A:32:GLY:O	1:A:35:ASP:HB3	0.45	2.11	14	1
1:A:7:ASN:OD1	1:A:112:TRP:HB2	0.45	2.12	19	6
1:A:109:TYR:HA	1:A:113:THR:OG1	0.45	2.12	13	2
1:A:71:ARG:HA	1:A:75:ARG:CB	0.45	2.41	8	1
1:A:6:LEU:O	1:A:10:LYS:HB2	0.45	2.11	11	1
1:A:25:VAL:O	1:A:29:ILE:HG12	0.45	2.10	19	3
1:A:80:ASP:HA	1:A:84:LYS:HD2	0.45	1.87	10	1
1:A:38:ILE:CG1	1:A:51:LEU:HD13	0.45	2.42	18	2
1:A:38:ILE:CG1	1:A:51:LEU:HD12	0.45	2.41	2	1
1:A:98:MET:SD	1:A:99:LEU:HG	0.45	2.51	4	1
1:A:77:ILE:HD13	1:A:77:ILE:N	0.45	2.26	4	4
1:A:97:GLU:CD	1:A:98:MET:HG3	0.45	2.32	8	1
1:A:7:ASN:HA	1:A:11:ILE:HB	0.45	1.87	12	1
1:A:92:GLY:O	1:A:93:MET:HG2	0.45	2.12	18	1
1:A:79:ILE:HA	1:A:82:LYS:HD3	0.45	1.88	19	1
1:A:78:ALA:O	1:A:82:LYS:HD3	0.45	2.12	19	1
1:A:34:MET:CB	1:A:51:LEU:HD11	0.45	2.42	5	1
1:A:73:CYS:O	1:A:77:ILE:HD13	0.44	2.12	6	3
1:A:89:GLN:CD	1:A:93:MET:HA	0.44	2.32	1	2
1:A:89:GLN:NE2	1:A:97:GLU:HB2	0.44	2.27	2	1
1:A:2:ASN:O	1:A:3:THR:HG22	0.44	2.12	4	1
1:A:102:LEU:O	1:A:105:THR:HG22	0.44	2.11	13	2
1:A:84:LYS:O	1:A:87:GLN:HG2	0.44	2.11	2	2
1:A:37:TYR:HD1	1:A:41:LEU:HG	0.44	1.73	5	3
1:A:37:TYR:HB3	1:A:41:LEU:CD2	0.44	2.41	9	1
1:A:51:LEU:O	1:A:55:GLU:HG2	0.44	2.12	18	1
1:A:42:THR:OG1	1:A:48:GLU:HG3	0.44	2.12	19	1
1:A:38:ILE:HD13	1:A:51:LEU:HD13	0.44	1.88	1	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:31:LEU:O	1:A:34:MET:HB3	0.44	2.13	9	1
1:A:34:MET:O	1:A:38:ILE:HD13	0.44	2.12	2	1
1:A:87:GLN:HG3	1:A:88:LEU:N	0.44	2.27	5	2
1:A:3:THR:HG23	1:A:5:VAL:HG12	0.44	1.89	10	2
1:A:31:LEU:O	1:A:35:ASP:HB2	0.44	2.12	10	1
1:A:107:ASP:O	1:A:110:ARG:HB3	0.44	2.13	9	1
1:A:105:THR:HA	1:A:109:TYR:CE1	0.44	2.48	17	3
1:A:95:THR:HA	1:A:98:MET:CE	0.44	2.43	12	1
1:A:97:GLU:O	1:A:101:LEU:HD23	0.44	2.12	18	1
1:A:85:ALA:HB1	1:A:93:MET:SD	0.44	2.52	1	1
1:A:38:ILE:HG12	1:A:51:LEU:CD1	0.44	2.42	2	1
1:A:109:TYR:O	1:A:113:THR:HG22	0.44	2.13	17	1
1:A:11:ILE:HG12	1:A:15:SER:HB2	0.44	1.90	4	1
1:A:77:ILE:HA	1:A:80:ASP:CB	0.44	2.43	7	1
1:A:2:ASN:O	1:A:3:THR:HB	0.43	2.12	3	2
1:A:10:LYS:HE2	1:A:69:ALA:HB3	0.43	1.90	14	1
1:A:18:ILE:HG12	1:A:19:GLY:N	0.43	2.28	19	4
1:A:113:THR:HG22	1:A:114:ASN:ND2	0.43	2.28	14	1
1:A:49:GLN:HE21	1:A:50:LEU:N	0.43	2.10	4	1
1:A:48:GLU:HA	1:A:51:LEU:HD21	0.43	1.90	17	1
1:A:11:ILE:O	1:A:15:SER:HB3	0.43	2.14	4	1
1:A:77:ILE:HA	1:A:80:ASP:HB2	0.43	1.88	7	1
1:A:50:LEU:O	1:A:53:LEU:HD23	0.43	2.13	1	1
1:A:14:LEU:HD23	1:A:66:SER:O	0.43	2.14	3	1
1:A:80:ASP:OD2	1:A:84:LYS:HG2	0.43	2.14	14	1
1:A:2:ASN:ND2	1:A:72:LEU:HD21	0.43	2.29	8	1
1:A:77:ILE:HD12	1:A:77:ILE:N	0.42	2.29	12	2
1:A:56:ILE:HB	1:A:77:ILE:HD12	0.42	1.90	14	2
1:A:5:VAL:H	1:A:8:GLN:NE2	0.42	2.10	12	1
1:A:77:ILE:N	1:A:77:ILE:HD13	0.42	2.28	2	1
1:A:41:LEU:O	1:A:45:GLN:HG2	0.42	2.14	3	1
1:A:38:ILE:HG12	1:A:51:LEU:CG	0.42	2.43	2	1
1:A:53:LEU:O	1:A:57:SER:HB2	0.42	2.14	3	1
1:A:48:GLU:HB3	1:A:98:MET:SD	0.42	2.54	15	1
1:A:16:ALA:O	1:A:20:SER:HB3	0.42	2.15	4	1
1:A:8:GLN:HE22	1:A:9:GLN:HG3	0.42	1.74	11	1
1:A:89:GLN:HB2	1:A:91:GLN:OE1	0.42	2.13	15	1
1:A:50:LEU:HA	1:A:53:LEU:CD1	0.42	2.44	7	1
1:A:53:LEU:HB2	1:A:54:LYS:HE3	0.42	1.91	11	1
1:A:48:GLU:HB2	1:A:98:MET:HE3	0.42	1.91	1	1
1:A:34:MET:SD	1:A:54:LYS:HB2	0.42	2.54	3	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:83:ALA:O	1:A:87:GLN:N	0.42	2.53	12	1
1:A:83:ALA:HA	1:A:86:ASN:CB	0.42	2.45	13	1
1:A:67:PHE:CZ	1:A:109:TYR:HE2	0.42	2.32	5	1
1:A:38:ILE:HG13	1:A:48:GLU:HA	0.42	1.91	8	2
1:A:51:LEU:HD12	1:A:54:LYS:HE2	0.42	1.90	5	1
1:A:109:TYR:O	1:A:113:THR:HB	0.42	2.14	7	1
1:A:37:TYR:HB3	1:A:47:SER:OG	0.42	2.15	10	1
1:A:84:LYS:HA	1:A:87:GLN:HG2	0.42	1.91	12	1
1:A:53:LEU:HD22	1:A:54:LYS:CE	0.42	2.44	15	1
1:A:41:LEU:HD13	1:A:47:SER:HB3	0.42	1.92	2	3
1:A:41:LEU:HB3	1:A:48:GLU:N	0.42	2.29	13	1
1:A:106:ARG:O	1:A:110:ARG:HD2	0.41	2.15	12	1
1:A:19:GLY:O	1:A:24:PRO:HD2	0.41	2.14	9	1
1:A:87:GLN:HE21	1:A:87:GLN:C	0.41	2.18	10	1
1:A:42:THR:HG23	1:A:48:GLU:OE1	0.41	2.15	1	1
1:A:38:ILE:HG13	1:A:48:GLU:CD	0.41	2.35	5	1
1:A:51:LEU:HA	1:A:54:LYS:HD3	0.41	1.91	5	1
1:A:89:GLN:HE22	1:A:97:GLU:CD	0.41	2.18	8	1
1:A:38:ILE:HG12	1:A:51:LEU:CB	0.41	2.44	4	1
1:A:49:GLN:O	1:A:52:TYR:HB3	0.41	2.16	5	1
1:A:11:ILE:HG12	1:A:67:PHE:O	0.41	2.15	12	1
1:A:26:LEU:HD12	1:A:63:SER:HB3	0.41	1.93	12	1
1:A:8:GLN:O	1:A:12:GLU:CB	0.41	2.68	15	1
1:A:8:GLN:NE2	1:A:9:GLN:N	0.41	2.68	14	1
1:A:68:GLY:CA	1:A:72:LEU:HD11	0.41	2.46	3	1
1:A:75:ARG:HD3	1:A:75:ARG:O	0.41	2.15	7	1
1:A:69:ALA:HA	1:A:73:CYS:SG	0.41	2.55	12	1
1:A:29:ILE:HD12	1:A:30:PHE:CD1	0.41	2.51	8	1
1:A:8:GLN:NE2	1:A:8:GLN:N	0.41	2.57	5	1
1:A:11:ILE:HG12	1:A:67:PHE:CD2	0.41	2.51	10	1
1:A:79:ILE:HA	1:A:82:LYS:HD2	0.41	1.93	11	1
1:A:38:ILE:O	1:A:42:THR:HG22	0.41	2.16	2	1
1:A:89:GLN:HG2	1:A:96:SER:HB2	0.41	1.93	2	1
1:A:82:LYS:HG2	1:A:83:ALA:N	0.41	2.31	4	1
1:A:50:LEU:O	1:A:54:LYS:HD3	0.41	2.16	5	1
1:A:45:GLN:HG3	1:A:47:SER:N	0.41	2.30	6	2
1:A:37:TYR:HB3	1:A:41:LEU:HD23	0.41	1.93	9	1
1:A:11:ILE:HG12	1:A:67:PHE:CB	0.41	2.43	16	1
1:A:109:TYR:C	1:A:113:THR:HG22	0.41	2.36	17	1
1:A:55:GLU:O	1:A:60:LEU:N	0.41	2.51	3	1
1:A:22:ASN:O	1:A:25:VAL:HB	0.40	2.16	10	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:23:VAL:N	1:A:24:PRO:HD2	0.40	2.31	8	1
1:A:30:PHE:CD1	1:A:59:ALA:HB3	0.40	2.51	13	1
1:A:102:LEU:HD11	1:A:106:ARG:CZ	0.40	2.46	15	1
1:A:37:TYR:O	1:A:41:LEU:N	0.40	2.53	9	1
1:A:97:GLU:CD	1:A:97:GLU:H	0.40	2.19	9	1
1:A:7:ASN:OD1	1:A:11:ILE:HG21	0.40	2.17	12	1
1:A:44:LEU:O	1:A:45:GLN:HB3	0.40	2.16	13	1
1:A:45:GLN:CG	1:A:47:SER:HB2	0.40	2.47	14	1
1:A:11:ILE:HD13	1:A:15:SER:HB2	0.40	1.93	16	1
1:A:51:LEU:HA	1:A:54:LYS:NZ	0.40	2.32	18	1
1:A:11:ILE:HG13	1:A:67:PHE:CB	0.40	2.47	19	1

## 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	112/120 (93%)	84±2 (75±2%)	19±3 (17±2%)	9±2 (8±1%)	2	14
All	All	2128/2280 (93%)	1592 (75%)	370 (17%)	166 (8%)	2	14

All 22 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	5	VAL	19
1	A	95	THR	19
1	A	15	SER	17
1	A	48	GLU	15
1	A	93	MET	13
1	A	69	ALA	11
1	A	18	ILE	10
1	A	3	THR	8
1	A	88	LEU	7
1	A	68	GLY	6
1	A	77	ILE	6

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Mol	Chain	Res	Type	Models (Total)
1	A	45	GLN	5
1	A	82	LYS	5
1	A	58	HIS	4
1	A	19	GLY	4
1	A	94	GLU	4
1	A	89	GLN	3
1	A	71	ARG	3
1	A	4	ASP	3
1	A	92	GLY	2
1	A	81	LYS	1
1	A	90	GLU	1

### 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	96/103 (93%)	79±2 (82±2%)	17±2 (18±2%)	4	38
All	All	1824/1957 (93%)	1495 (82%)	329 (18%)	4	38

All 59 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	8	GLN	19
1	A	104	ILE	19
1	A	112	TRP	19
1	A	75	ARG	18
1	A	54	LYS	14
1	A	87	GLN	14
1	A	11	ILE	13
1	A	82	LYS	13
1	A	26	LEU	12
1	A	84	LYS	11
1	A	34	MET	10
1	A	18	ILE	9
1	A	49	GLN	8
1	A	97	GLU	8

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Mol	Chain	Res	Type	Models (Total)
1	A	58	HIS	8
1	A	61	LYS	7
1	A	88	LEU	7
1	A	10	LYS	6
1	A	55	GLU	6
1	A	67	PHE	6
1	A	53	LEU	6
1	A	80	ASP	6
1	A	30	PHE	5
1	A	48	GLU	5
1	A	94	GLU	5
1	A	114	ASN	5
1	A	3	THR	4
1	A	72	LEU	4
1	A	81	LYS	4
1	A	7	ASN	4
1	A	9	GLN	4
1	A	44	LEU	4
1	A	38	ILE	4
1	A	41	LEU	4
1	A	93	MET	3
1	A	12	GLU	3
1	A	89	GLN	3
1	A	23	VAL	3
1	A	27	LEU	2
1	A	90	GLU	2
1	A	98	MET	2
1	A	13	GLU	2
1	A	51	LEU	2
1	A	2	ASN	1
1	A	22	ASN	1
1	A	77	ILE	1
1	A	28	ASP	1
1	A	31	LEU	1
1	A	86	ASN	1
1	A	96	SER	1
1	A	74	GLU	1
1	A	106	ARG	1
1	A	113	THR	1
1	A	52	TYR	1
1	A	6	LEU	1
1	A	17	GLU	1

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Mol	Chain	Res	Type	Models (Total)
1	A	14	LEU	1
1	A	50	LEU	1
1	A	109	TYR	1

### 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

No chemical shift data were provided