



Full wwPDB NMR Structure Validation Report ⓘ

Mar 5, 2026 – 01:28 PM UTC

PDB ID : 2KDK / pdb_00002kdk
Title : Structure of human circadian clock protein BMAL2 C-terminal PAS domain
Authors : Wasielewski, E.; Correia, C.; Prendergast, F.G.; Mer, G.
Deposited on : 2009-01-10

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

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

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

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

MolProbity : 4-5-2 with Phenix2.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
wwPDB-RCI : v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV : Wang et al. (2010)
wwPDB-ShiftChecker : v1.2
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

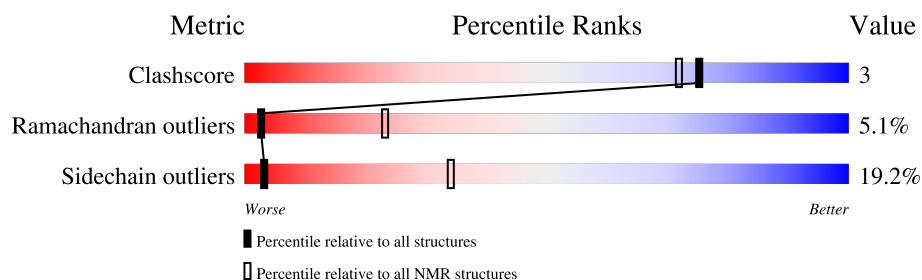
1 Overall quality at a glance

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	229148	14424
Ramachandran outliers	224038	12848
Sidechain outliers	223484	12823

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	121	

2 Ensemble composition and analysis

This entry contains 10 models. Model 7 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *lowest energy*.

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

Well-defined (core) protein residues			
Well-defined core	Residue range (total)	Backbone RMSD (Å)	Medoid model
1	A:317-A:420 (104)	0.70	7

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 1 clusters and 1 single-model cluster was found.

Cluster number	Models
1	1, 2, 3, 4, 5, 6, 7, 9, 10
Single-model clusters	8

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 1890 atoms, of which 932 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Aryl hydrocarbon receptor nuclear translocator-like protein 2.

Mol	Chain	Residues	Atoms							Trace
1	A	118	Total	C	H	N	O	S		0
			1890	613	932	158	186	1		

There are 4 discrepancies between the modelled and reference sequences:

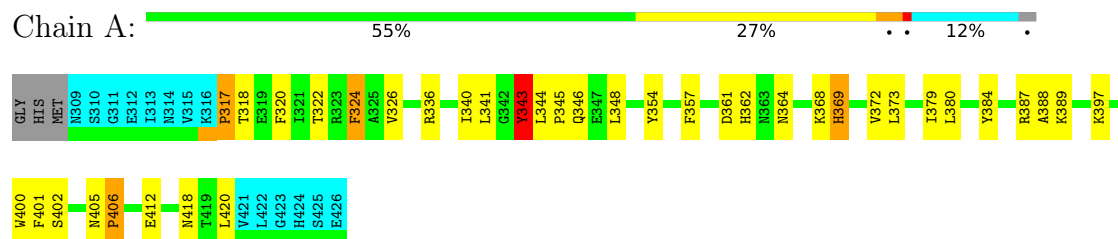
Chain	Residue	Modelled	Actual	Comment	Reference
A	306	GLY	-	expression tag	UNP Q8WYA1
A	307	HIS	-	expression tag	UNP Q8WYA1
A	308	MET	-	expression tag	UNP Q8WYA1
A	407	ASP	TRP	engineered mutation	UNP Q8WYA1

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: Aryl hydrocarbon receptor nuclear translocator-like protein 2

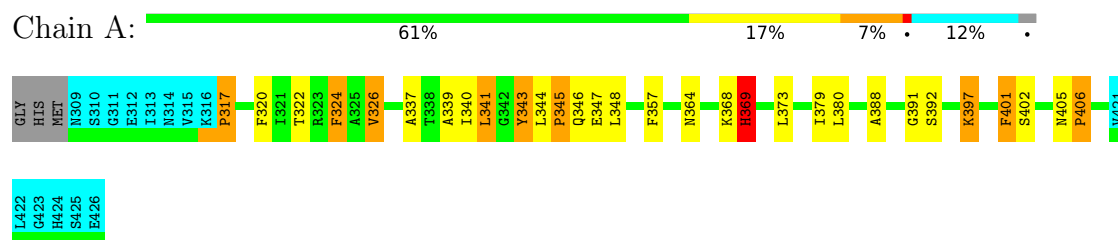


4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

4.2.1 Score per residue for model 1

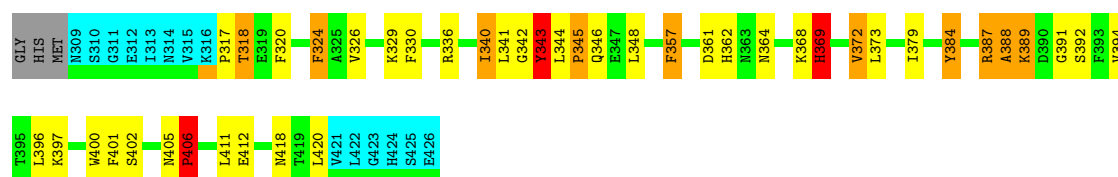
- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2



4.2.2 Score per residue for model 2

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2

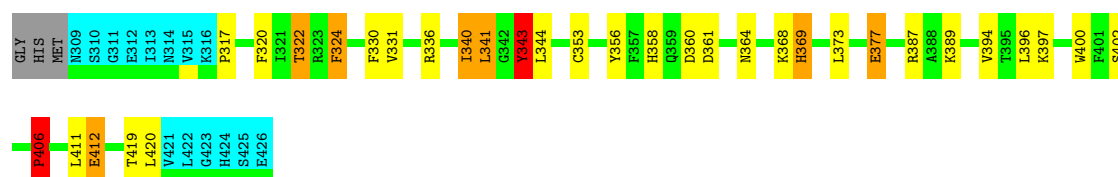




4.2.3 Score per residue for model 3

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2

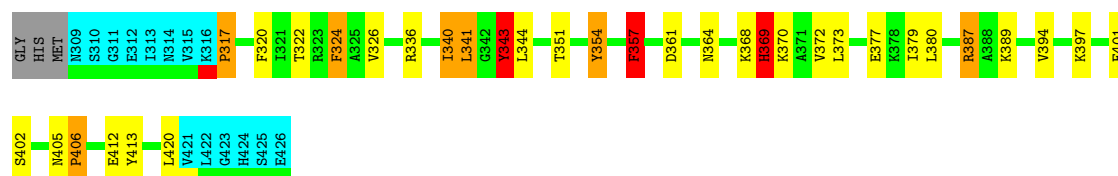
Chain A:



4.2.4 Score per residue for model 4

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2

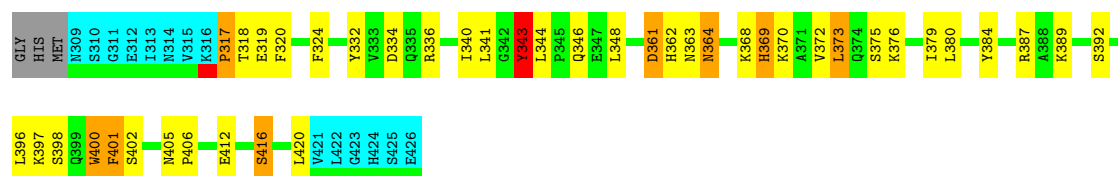
Chain A:



4.2.5 Score per residue for model 5

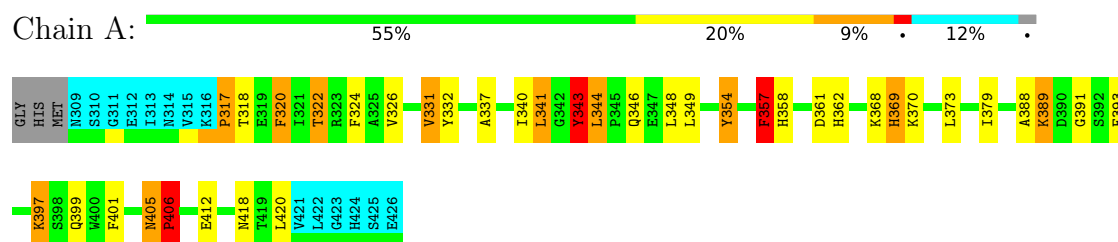
- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2

Chain A:



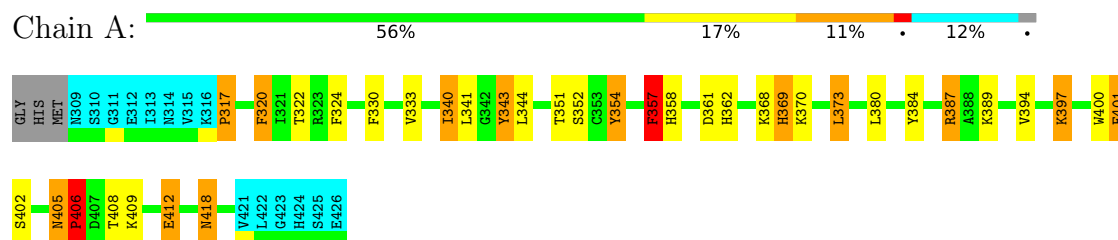
4.2.6 Score per residue for model 6

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2



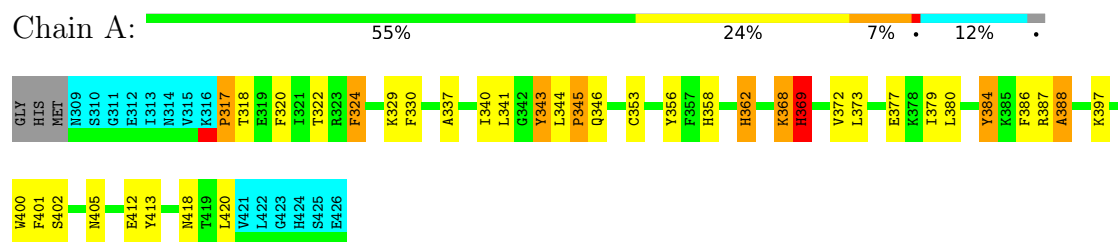
4.2.7 Score per residue for model 7 (medoid)

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2



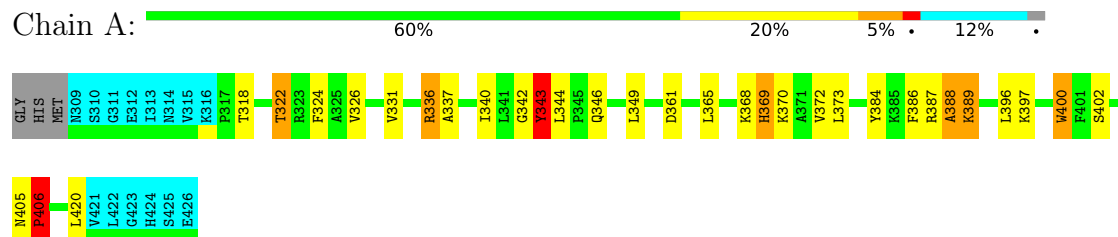
4.2.8 Score per residue for model 8

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2



4.2.9 Score per residue for model 9

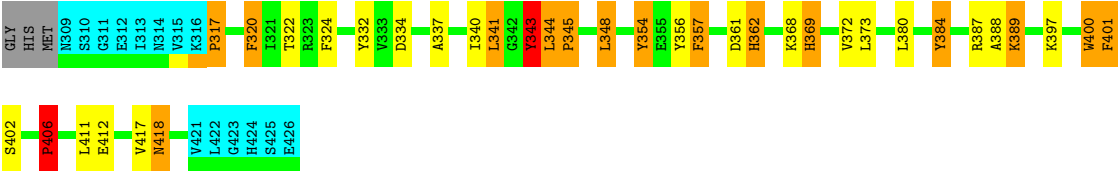
- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2



4.2.10 Score per residue for model 10

- Molecule 1: Aryl hydrocarbon receptor nuclear translocator-like protein 2

Chain A: 56% 16% 12% 12%



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
CYANA	structure solution	
Amber	refinement	8.0

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	0.76±0.01	0±0/876 (0.0± 0.0%)	1.70±0.04	16±4/1187 (1.3± 0.4%)
All	All	0.76	0/8760 (0.0%)	1.70	160/11870 (1.3%)

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	6.5±1.4
All	All	0	65

There are no bond-length outliers.

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	324	PHE	CA-CB-CG	11.13	124.93	113.80	2	10
1	A	357	PHE	CA-CB-CG	10.58	124.38	113.80	2	6
1	A	401	PHE	CA-CB-CG	9.36	123.16	113.80	10	8
1	A	369	HIS	CB-CG-CD2	-9.12	119.34	131.20	3	4
1	A	387	ARG	CB-CA-C	8.76	127.85	110.42	5	4
1	A	320	PHE	CA-CB-CG	8.43	122.23	113.80	7	9
1	A	343	TYR	CA-CB-CG	8.24	128.74	113.90	7	9
1	A	369	HIS	CA-CB-CG	-8.01	105.79	113.80	3	1
1	A	387	ARG	CA-C-N	7.99	136.80	121.54	8	4
1	A	387	ARG	C-N-CA	7.99	136.80	121.54	8	4
1	A	331	VAL	CB-CA-C	7.31	118.52	110.62	6	2
1	A	317	PRO	CA-N-CD	-7.22	101.90	112.00	1	5
1	A	418	ASN	CA-CB-CG	7.12	119.72	112.60	10	5
1	A	334	ASP	CA-CB-CG	7.11	119.71	112.60	10	1
1	A	386	PHE	CA-CB-CG	7.01	120.81	113.80	9	2

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	370	LYS	N-CA-CB	6.81	120.13	110.12	9	5
1	A	405	ASN	N-CA-C	-6.74	100.78	110.08	7	3
1	A	362	HIS	CB-CG-CD2	-6.71	122.48	131.20	5	3
1	A	372	VAL	CB-CA-C	6.55	122.80	110.94	2	1
1	A	397	LYS	N-CA-C	-6.42	97.34	107.93	7	9
1	A	361	ASP	CA-CB-CG	-6.38	106.22	112.60	5	1
1	A	361	ASP	N-CA-C	-6.11	104.03	112.03	9	1
1	A	330	PHE	CA-CB-CG	6.07	119.87	113.80	3	4
1	A	322	THR	CA-CB-CG2	6.06	120.81	110.50	3	3
1	A	358	HIS	CA-CB-CG	6.04	119.84	113.80	7	2
1	A	318	THR	CA-C-N	5.89	131.93	121.75	5	2
1	A	318	THR	C-N-CA	5.89	131.93	121.75	5	2
1	A	362	HIS	CA-CB-CG	5.83	119.63	113.80	10	2
1	A	394	VAL	N-CA-CB	-5.72	106.05	112.45	2	1
1	A	354	TYR	CB-CA-C	5.67	118.19	111.22	7	4
1	A	412	GLU	CB-CA-C	5.65	118.09	109.34	2	3
1	A	408	THR	CA-C-N	5.54	132.12	121.54	7	1
1	A	408	THR	C-N-CA	5.54	132.12	121.54	7	1
1	A	393	PHE	CA-CB-CG	5.52	119.32	113.80	6	1
1	A	364	ASN	CA-C-N	5.52	127.99	120.54	1	4
1	A	364	ASN	C-N-CA	5.52	127.99	120.54	1	4
1	A	322	THR	N-CA-CB	-5.49	103.06	111.56	6	1
1	A	358	HIS	CB-CG-CD2	-5.43	124.15	131.20	8	2
1	A	388	ALA	CA-C-N	5.41	131.87	121.54	9	3
1	A	388	ALA	C-N-CA	5.41	131.87	121.54	9	3
1	A	373	LEU	CA-C-N	5.40	128.06	120.28	7	2
1	A	373	LEU	C-N-CA	5.40	128.06	120.28	7	2
1	A	400	TRP	CA-CB-CG	5.38	123.82	113.60	5	1
1	A	369	HIS	N-CA-C	-5.35	105.52	111.36	2	1
1	A	372	VAL	CA-CB-CG1	5.34	119.49	110.40	2	1
1	A	394	VAL	CB-CA-C	5.24	118.68	111.34	7	1
1	A	318	THR	N-CA-C	-5.23	104.39	111.55	9	1
1	A	339	ALA	CA-C-N	5.13	127.03	120.56	1	1
1	A	339	ALA	C-N-CA	5.13	127.03	120.56	1	1
1	A	375	SER	CA-C-N	5.12	131.33	121.54	5	1
1	A	375	SER	C-N-CA	5.12	131.33	121.54	5	1
1	A	360	ASP	CA-C-N	5.12	131.32	121.54	3	1
1	A	360	ASP	C-N-CA	5.12	131.32	121.54	3	1
1	A	340	ILE	CA-CB-CG2	5.05	119.08	110.50	7	2
1	A	406	PRO	CA-N-CD	-5.04	104.95	112.00	9	1
1	A	363	ASN	N-CA-CB	5.01	117.58	110.16	5	1

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)	Models	
								Worst	Total
1	A	397	LYS	CB-CA-C	5.00	117.93	110.62	8	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	344	LEU	Peptide,Mainchain	10
1	A	369	HIS	Sidechain	10
1	A	406	PRO	Peptide	9
1	A	405	ASN	Peptide	7
1	A	343	TYR	Sidechain	5
1	A	384	TYR	Sidechain	5
1	A	332	TYR	Sidechain	3
1	A	317	PRO	Peptide	2
1	A	320	PHE	Sidechain	2
1	A	387	ARG	Sidechain	1
1	A	356	TYR	Sidechain	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	854	832	832	5±2
All	All	8540	8320	8320	53

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 3.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:340:ILE:HG23	1:A:341:LEU:H	0.66	1.50	3	2
1:A:341:LEU:HD11	1:A:343:TYR:CE1	0.57	2.34	1	1
1:A:341:LEU:HD22	1:A:388:ALA:HB2	0.56	1.76	10	2
1:A:336:ARG:O	1:A:340:ILE:HG22	0.53	2.04	3	5

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:337:ALA:HA	1:A:340:ILE:HG22	0.52	1.79	10	5
1:A:379:ILE:C	1:A:380:LEU:HD12	0.52	2.30	4	4
1:A:344:LEU:HD13	1:A:346:GLN:HE22	0.49	1.68	6	1
1:A:340:ILE:HG23	1:A:341:LEU:HG	0.48	1.85	7	4
1:A:379:ILE:HD12	1:A:400:TRP:O	0.48	2.08	2	3
1:A:372:VAL:HG21	1:A:400:TRP:HB2	0.48	1.85	5	3
1:A:343:TYR:CE1	1:A:348:LEU:HD21	0.46	2.46	5	1
1:A:343:TYR:CE1	1:A:348:LEU:HG	0.45	2.47	2	3
1:A:369:HIS:HA	1:A:372:VAL:HG12	0.44	1.89	2	1
1:A:344:LEU:HD12	1:A:344:LEU:N	0.44	2.27	6	2
1:A:369:HIS:ND1	1:A:369:HIS:C	0.44	2.75	8	1
1:A:340:ILE:HG23	1:A:341:LEU:HD12	0.44	1.90	3	1
1:A:372:VAL:HA	1:A:380:LEU:HD13	0.42	1.91	5	3
1:A:343:TYR:CD2	1:A:388:ALA:HA	0.42	2.49	1	1
1:A:400:TRP:CE3	1:A:416:SER:HB2	0.42	2.49	5	1
1:A:353:CYS:HA	1:A:356:TYR:CE1	0.42	2.49	3	2
1:A:379:ILE:HD11	1:A:399:GLN:HB2	0.42	1.91	6	1
1:A:341:LEU:HB2	1:A:343:TYR:CE1	0.41	2.51	2	1
1:A:368:LYS:HA	1:A:368:LYS:HE3	0.41	1.93	8	1
1:A:341:LEU:CD1	1:A:343:TYR:CE1	0.41	3.03	1	1
1:A:337:ALA:HB1	1:A:348:LEU:CD1	0.41	2.46	6	1
1:A:341:LEU:HD11	1:A:343:TYR:CZ	0.40	2.51	1	1
1:A:319:GLU:CA	1:A:340:ILE:HD12	0.40	2.46	5	1

6.3 Torsion angles ⓘ

6.3.1 Protein backbone ⓘ

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	104/121 (86%)	88±1 (85±1%)	11±2 (10±2%)	5±1 (5±1%)	3	23
All	All	1040/1210 (86%)	879 (85%)	108 (10%)	53 (5%)	3	23

All 17 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	317	PRO	7
1	A	361	ASP	7
1	A	406	PRO	7
1	A	346	GLN	5
1	A	345	PRO	4
1	A	389	LYS	4
1	A	391	GLY	3
1	A	388	ALA	3
1	A	357	PHE	3
1	A	342	GLY	2
1	A	340	ILE	2
1	A	326	VAL	1
1	A	377	GLU	1
1	A	376	LYS	1
1	A	392	SER	1
1	A	352	SER	1
1	A	409	LYS	1

6.3.2 Protein sidechains

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	95/109 (87%)	77±3 (81±3%)	18±3 (19±3%)	3	34
All	All	950/1090 (87%)	768 (81%)	182 (19%)	3	34

All 48 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	343	TYR	10
1	A	368	LYS	10
1	A	373	LEU	10
1	A	369	HIS	9
1	A	402	SER	9
1	A	322	THR	8
1	A	389	LYS	8
1	A	420	LEU	7
1	A	412	GLU	7

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Mol	Chain	Res	Type	Models (Total)
1	A	406	PRO	6
1	A	324	PHE	5
1	A	326	VAL	5
1	A	341	LEU	5
1	A	357	PHE	5
1	A	345	PRO	4
1	A	397	LYS	4
1	A	401	PHE	4
1	A	362	HIS	4
1	A	384	TYR	4
1	A	396	LEU	4
1	A	400	TRP	4
1	A	354	TYR	4
1	A	318	THR	3
1	A	411	LEU	3
1	A	377	GLU	3
1	A	387	ARG	3
1	A	348	LEU	2
1	A	392	SER	2
1	A	329	LYS	2
1	A	364	ASN	2
1	A	394	VAL	2
1	A	317	PRO	2
1	A	351	THR	2
1	A	413	TYR	2
1	A	331	VAL	2
1	A	349	LEU	2
1	A	380	LEU	2
1	A	418	ASN	2
1	A	347	GLU	1
1	A	419	THR	1
1	A	334	ASP	1
1	A	398	SER	1
1	A	416	SER	1
1	A	320	PHE	1
1	A	333	VAL	1
1	A	336	ARG	1
1	A	365	LEU	1
1	A	417	VAL	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 oligosaccharides in this entry.

6.6 Ligand geometry [i](#)

There are no ligands in this entry.

6.7 Other polymers [i](#)

There are no such molecules in this entry.

6.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

7 Chemical shift validation

No chemical shift data were provided