Full wwPDB NMR Structure Validation Report (i)

Jun 14, 2020 – 11:49 am BST

PDB ID	:	2L12
Title	:	Solution NMR structure of the chromobox protein 7 with H3K9me3
Authors	:	Kaustov, L.; Lemak, A.; Gutmanas, A.; Fares, C.; Quang, H.; Loppnau, P.; Min, J.; Edwards, A.; Arrowsmith, C.; Structural Genomics Consortium (SGC)
Deposited on	:	2010-07-22

This is a Full wwPDB NMR Structure Validation 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 (i) symbol.

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

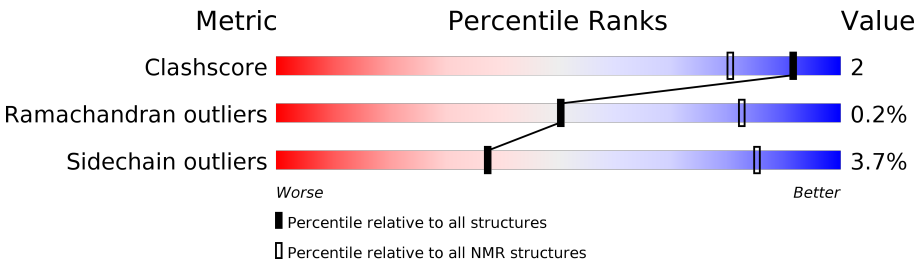
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	2.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment is 79%.

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 <=5%

Mol	Chain	Length	Quality of chain
1	A	56	88% • 11%
2	B	15	27% 73%

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 9 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:3-A:52, B:5-B:8 (54)	0.39	9

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. No single-model clusters were found.

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

3 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 1208 atoms, of which 614 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Chromobox homolog 7.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	56	968	313	486	82	86	1	0

- Molecule 2 is a protein called Histone H3.

Mol	Chain	Residues	Atoms					Trace
			Total	C	H	N	O	
2	B	15	240	66	128	25	21	0

4 Residue-property plots (i)

4.1 Average score per residue in the NMR ensemble

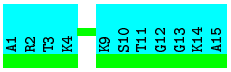
These plots are provided for all protein, RNA and DNA chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-coded according to the number of geometric quality criteria for which they contain 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: Chromobox homolog 7

Chain A:

- Molecule 2: Histone H3

Chain B:



4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

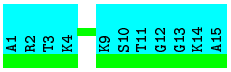
4.2.1 Score per residue for model 1

- Molecule 1: Chromobox homolog 7

Chain A:

- Molecule 2: Histone H3

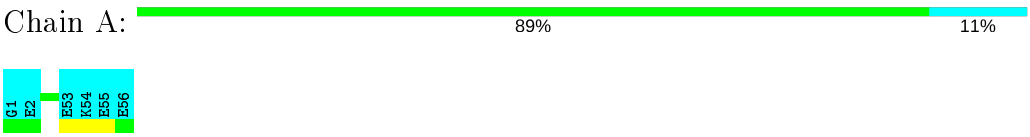
Chain B:



4.2.2 Score per residue for model 2

- Molecule 1: Chromobox homolog 7

Chain A:



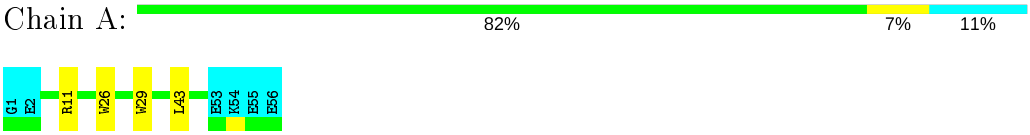
- Molecule 2: Histone H3

Chain B:

4.2.3 Score per residue for model 3

- Molecule 1: Chromobox homolog 7

Chain A:



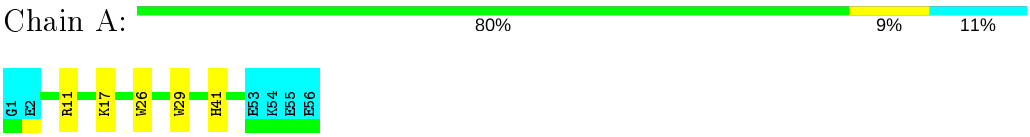
- Molecule 2: Histone H3

Chain B:

4.2.4 Score per residue for model 4

- Molecule 1: Chromobox homolog 7

Chain A:



- Molecule 2: Histone H3

Chain B:

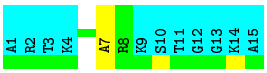
4.2.5 Score per residue for model 5

- Molecule 1: Chromobox homolog 7

Chain A:

- Molecule 2: Histone H3

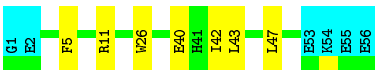
Chain B:



4.2.6 Score per residue for model 6

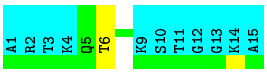
- Molecule 1: Chromobox homolog 7

Chain A:



- Molecule 2: Histone H3

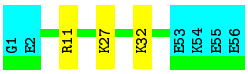
Chain B:



4.2.7 Score per residue for model 7

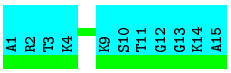
- Molecule 1: Chromobox homolog 7

Chain A:



- Molecule 2: Histone H3

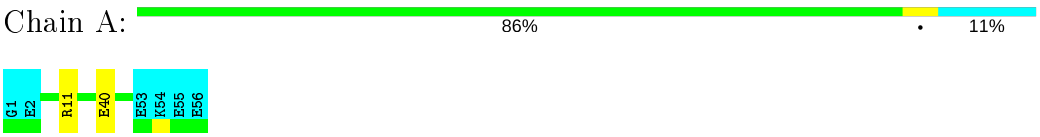
Chain B:



4.2.8 Score per residue for model 8

- Molecule 1: Chromobox homolog 7

Chain A:



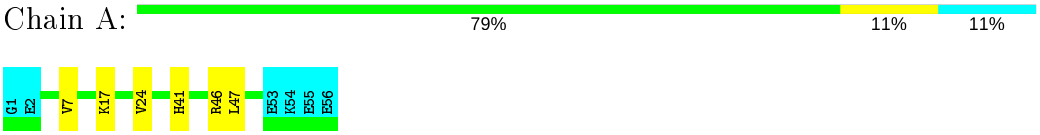
- Molecule 2: Histone H3

Chain B:

4.2.9 Score per residue for model 9 (medoid)

- Molecule 1: Chromobox homolog 7

Chain A:



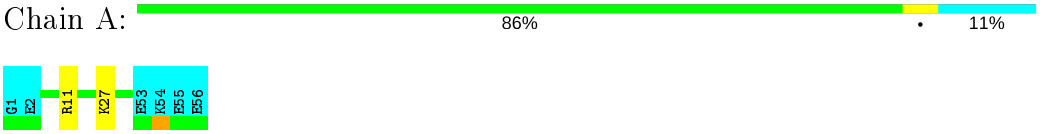
- Molecule 2: Histone H3

Chain B:

4.2.10 Score per residue for model 10

- Molecule 1: Chromobox homolog 7

Chain A:



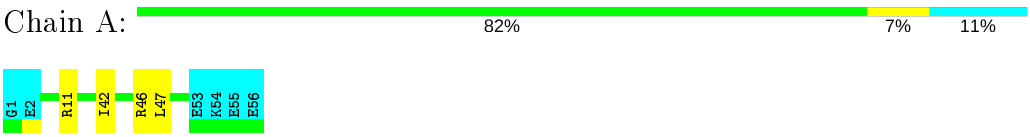
- Molecule 2: Histone H3

Chain B:

4.2.11 Score per residue for model 11

- Molecule 1: Chromobox homolog 7

Chain A:



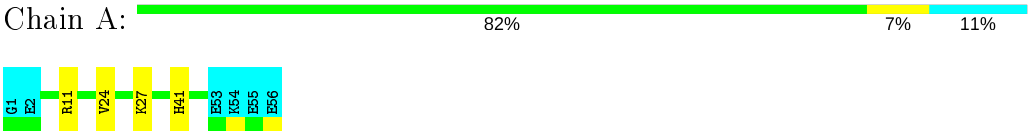
- Molecule 2: Histone H3

Chain B:

4.2.12 Score per residue for model 12

- Molecule 1: Chromobox homolog 7

Chain A:



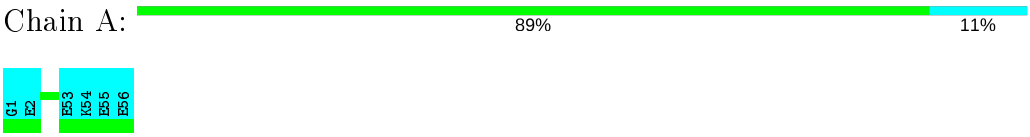
- Molecule 2: Histone H3

Chain B:

4.2.13 Score per residue for model 13

- Molecule 1: Chromobox homolog 7

Chain A:



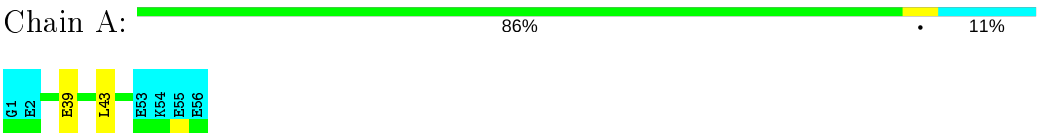
- Molecule 2: Histone H3

Chain B:

4.2.14 Score per residue for model 14

- Molecule 1: Chromobox homolog 7

Chain A:



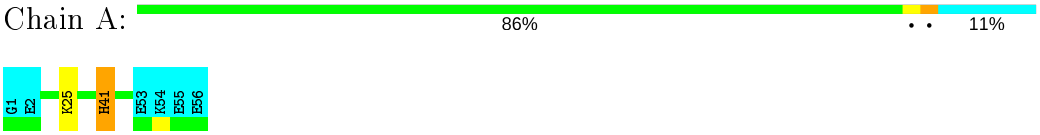
- Molecule 2: Histone H3

Chain B:

4.2.15 Score per residue for model 15

- Molecule 1: Chromobox homolog 7

Chain A:



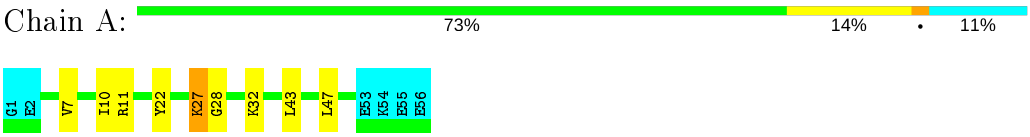
- Molecule 2: Histone H3

Chain B:

4.2.16 Score per residue for model 16

- Molecule 1: Chromobox homolog 7

Chain A:



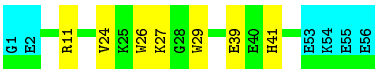
- Molecule 2: Histone H3

Chain B:

4.2.17 Score per residue for model 17

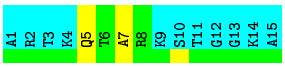
- Molecule 1: Chromobox homolog 7

Chain A: 77% 13% 11%



- Molecule 2: Histone H3

Chain B: 13% 13% 73%



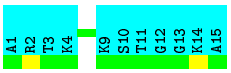
4.2.18 Score per residue for model 18

- Molecule 1: Chromobox homolog 7

Chain A: 84% 5% 11%

- Molecule 2: Histone H3

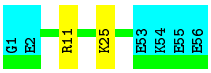
Chain B: 27% 73%



4.2.19 Score per residue for model 19

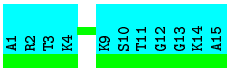
- Molecule 1: Chromobox homolog 7

Chain A: 86% • 11%



- Molecule 2: Histone H3

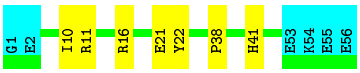
Chain B: 27% 73%



4.2.20 Score per residue for model 20

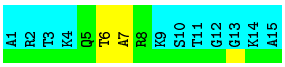
- Molecule 1: Chromobox homolog 7

Chain A:



- Molecule 2: Histone H3

Chain B:



5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *molecular dynamics*.

Of the 100 calculated structures, 20 were deposited, based on the following criterion: *structures with the lowest energy*.

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

Software name	Classification	Version
CYANA	structure solution	
CNS	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)	input_cs.cif
Number of chemical shift lists	1
Total number of shifts	736
Number of shifts mapped to atoms	702
Number of unparsed shifts	0
Number of shifts with mapping errors	34
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	79%

No validations of the models with respect to experimental NMR restraints is performed at this time.

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: M3L

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	432	444	443	1±1
2	B	32	33	33	1±1
All	All	9280	9540	9520	29

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 2.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:10:ILE:HD12	1:A:22:TYR:HB3	0.56	1.76	16	2
1:A:40:GLU:HG2	2:B:8:ARG:HH22	0.49	1.67	8	1
1:A:26:TRP:HB2	1:A:29:TRP:HB2	0.49	1.84	4	3
1:A:41:HIS:CD2	2:B:7:ALA:HB1	0.48	2.43	17	4
1:A:21:GLU:HA	1:A:38:PRO:HA	0.44	1.88	1	2
1:A:24:VAL:HG21	1:A:41:HIS:NE2	0.44	2.26	17	3
1:A:42:ILE:HG23	1:A:47:LEU:HD23	0.44	1.90	1	3
1:A:41:HIS:ND1	2:B:7:ALA:HB1	0.44	2.28	15	1
1:A:7:VAL:HG21	1:A:47:LEU:HD13	0.43	1.90	9	2
1:A:41:HIS:HD2	2:B:7:ALA:HB1	0.42	1.73	20	1
1:A:43:LEU:HD12	2:B:6:THR:HB	0.42	1.92	6	2

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:43:LEU:HD11	2:B:8:ARG:HG3	0.41	1.91	14	1
1:A:5:PHE:HB2	1:A:26:TRP:CE3	0.41	2.51	6	1
1:A:43:LEU:HD11	2:B:6:THR:HB	0.41	1.92	16	1
1:A:46:ARG:HB2	2:B:5:GLN:HE21	0.41	1.75	9	1
1:A:27:LYS:HD3	1:A:28:GLY:N	0.40	2.31	16	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	50/56 (89%)	47±1 (94±3%)	3±1 (6±2%)	0±0 (0±0%)	54	85
2	B	4/15 (27%)	4±0 (90±12%)	0±0 (9±12%)	0±0 (1±5%)	16	63
All	All	1080/1420 (76%)	1015 (94%)	63 (6%)	2 (0%)	50	82

All 2 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	27	LYS	1
2	B	6	THR	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	46/51 (90%)	44±1 (96±2%)	2±1 (4±2%)	38	86
2	B	3/9 (33%)	3±0 (95±12%)	0±0 (5±12%)	28	77
All	All	980/1200 (82%)	944 (96%)	36 (4%)	37	85

All 12 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	11	ARG	14
1	A	39	GLU	4
1	A	27	LYS	4
1	A	32	LYS	3
2	B	5	GLN	2
1	A	25	LYS	2
1	A	17	LYS	2
1	A	40	GLU	1
1	A	41	HIS	1
1	A	43	LEU	1
2	B	6	THR	1
1	A	16	ARG	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)

1 non-standard protein/DNA/RNA residue 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	M3L	B	9	2	10,11,12	1.02±0.09	0±0 (0±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	M3L	B	9	2	9,14,16	0.23±0.04	0±0 (0±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	M3L	B	9	2	-	0±0,9,10,12	-

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

6.5 Carbohydrates (i)

There are no carbohydrates in this entry.

6.6 Ligand geometry (i)

There are no ligands in this entry.

6.7 Other polymers (i)

There are no such molecules in this entry.

6.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

7 Chemical shift validation (i)

The completeness of assignment taking into account all chemical shift lists is 79% for the well-defined parts and 69% for the entire structure.

7.1 Chemical shift list 1

File name: input_cs.cif

Chemical shift list name: *assigned_chem_shift_list_1*

7.1.1 Bookkeeping (i)

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

Total number of shifts	736
Number of shifts mapped to atoms	702
Number of unparsed shifts	0
Number of shifts with mapping errors	34
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	4

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

- Chain not found in structure. All 34 occurences are reported below.

Chain	Res	Type	Atom	Shift Data		
				Value	Uncertainty	Ambiguity
UNMAPPED	6	THR	HA	4.07	0.03	1
UNMAPPED	7	ALA	HB1	1.35	0.03	1
UNMAPPED	7	ALA	HA	3.89	0.03	1
UNMAPPED	9	M3L	HA	4.22	0.03	1
UNMAPPED	6	THR	HB	4.18	0.03	1
UNMAPPED	3	THR	HG21	1.2	0.03	1
UNMAPPED	8	ARG	HD3	3.09	0.03	2
UNMAPPED	9	M3L	HD3	1.56	0.03	2
UNMAPPED	9	M3L	HD2	1.56	0.03	2
UNMAPPED	7	ALA	HB3	1.35	0.03	1
UNMAPPED	9	M3L	HE2	2.87	0.03	2
UNMAPPED	5	GLN	HG3	1.97	0.03	2
UNMAPPED	8	ARG	HD2	3.09	0.03	2
UNMAPPED	7	ALA	HB2	1.35	0.03	1

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Chain	Res	Type	Atom	Shift Data		
				Value	Uncertainty	Ambiguity
UNMAPPED	6	THR	HG23	1.08	0.03	1
UNMAPPED	8	ARG	HG2	1.54	0.03	2
UNMAPPED	3	THR	HG22	1.2	0.03	1
UNMAPPED	3	THR	HG23	1.2	0.03	1
UNMAPPED	10	SER	HA	4.43	0.03	1
UNMAPPED	5	GLN	HB3	1.86	0.03	2
UNMAPPED	5	GLN	HA	4.28	0.03	1
UNMAPPED	10	SER	HB3	3.79	0.03	2
UNMAPPED	10	SER	HB2	3.77	0.03	2
UNMAPPED	3	THR	HA	3.99	0.03	1
UNMAPPED	8	ARG	HG3	1.54	0.03	2
UNMAPPED	5	GLN	HG2	2.27	0.03	2
UNMAPPED	8	ARG	HB3	1.67	0.03	2
UNMAPPED	5	GLN	HB2	1.88	0.03	2
UNMAPPED	6	THR	HG21	1.08	0.03	1
UNMAPPED	8	ARG	HA	4.3	0.03	1
UNMAPPED	8	ARG	HB2	1.75	0.03	2
UNMAPPED	6	THR	HG22	1.08	0.03	1
UNMAPPED	5	GLN	HE21	6.74	0.03	2
UNMAPPED	9	M3L	HE3	2.87	0.03	2

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	54	0.10 ± 0.21	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	52	0.09 ± 0.30	None needed (< 0.5 ppm)
$^{13}C'$	42	0.37 ± 0.19	None needed (< 0.5 ppm)
^{15}N	42	0.13 ± 0.37	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments (i)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 79%, i.e. 598 atoms were assigned a chemical shift out of a possible 755. 9 out of 9 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	215/262 (82%)	88/104 (85%)	89/108 (82%)	38/50 (76%)

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	Total	^{1}H	^{13}C	^{15}N
Sidechain	324/416 (78%)	204/248 (82%)	120/144 (83%)	0/24 (0%)
Aromatic	59/77 (77%)	34/39 (87%)	23/33 (70%)	2/5 (40%)
Overall	598/755 (79%)	326/391 (83%)	232/285 (81%)	40/79 (51%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 69%, i.e. 647 atoms were assigned a chemical shift out of a possible 935. 9 out of 9 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	234/342 (68%)	96/136 (71%)	96/140 (69%)	42/66 (64%)
Sidechain	354/516 (69%)	224/307 (73%)	130/179 (73%)	0/30 (0%)
Aromatic	59/77 (77%)	34/39 (87%)	23/33 (70%)	2/5 (40%)
Overall	647/935 (69%)	354/482 (73%)	249/352 (71%)	44/101 (44%)

7.1.4 Statistically unusual chemical shifts (i)

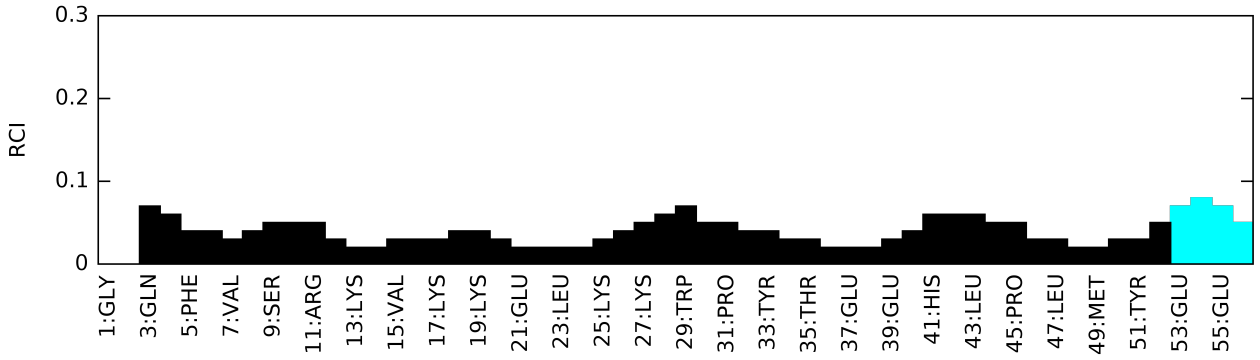
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	23	LEU	HB3	-1.51	3.34 – -0.26	-8.5
1	A	24	VAL	HG21	-0.91	2.20 – -0.60	-6.1
1	A	24	VAL	HG22	-0.91	2.20 – -0.60	-6.1
1	A	24	VAL	HG23	-0.91	2.20 – -0.60	-6.1

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.

Random coil index (RCI) for chain A:


RCI
0.3
0.2
0.1
0
1:GLY
3:GLN
5:PHE
7:VAL
9:SER
11:ARG
13:LYS
15:VAL
17:LYS
19:LYS
21:GLU
23:LEU
25:LYS
27:LYS
29:TRP
31:PRO
33:TYR
35:THR
37:GLU
39:GLU
41:HIS
43:LEU
45:PRO
47:LEU
49:MET
51:TYR
53:GLU
55:GLU