Full wwPDB NMR Structure Validation Report (i)

May 29, 2020 – 07:38 am BST

PDB ID	:	5M0A
Title	:	Solution structure of isolated 15th Fibronectin III domain from human fibronectin
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Deposited on	:	2016-10-04

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 (1)) were used in the production of this report:

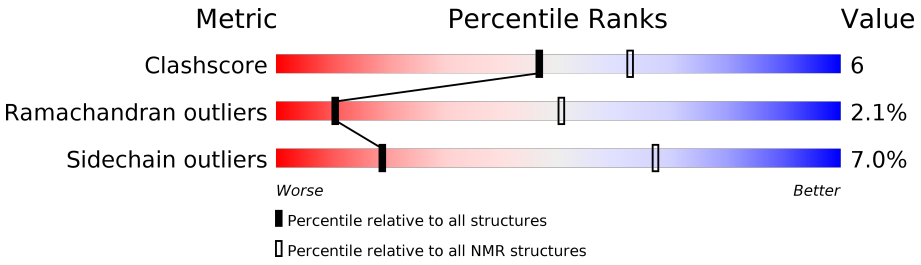
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	2.11
Ideal geometry (proteins)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

1 Overall quality at a glance

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

The overall completeness of chemical shifts assignment is 81%.

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	86	67% 17% • 14%

2 Ensemble composition and analysis

This entry contains 20 models. Model 2 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:404-A:477 (74)	0.18	2

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

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 1297 atoms, of which 640 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Fibronectin.

Mol	Chain	Residues	Atoms						Trace
1	A	86	Total	C	H	N	O	S	0
			1297	404	640	114	138	1	

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	457	ILE	VAL	variant	UNP P02751

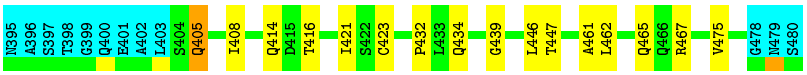
4 Residue-property plots

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: Fibronectin

Chain A:



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

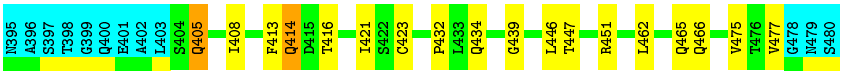
- Molecule 1: Fibronectin

Chain A:

4.2.2 Score per residue for model 2 (medoid)

- Molecule 1: Fibronectin

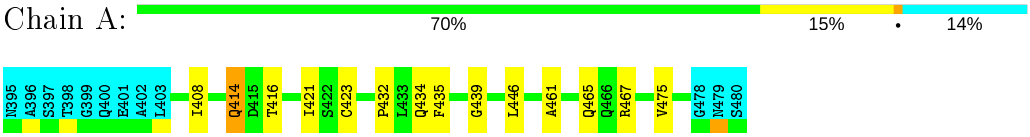
Chain A:



4.2.3 Score per residue for model 3

• Molecule 1: Fibronectin

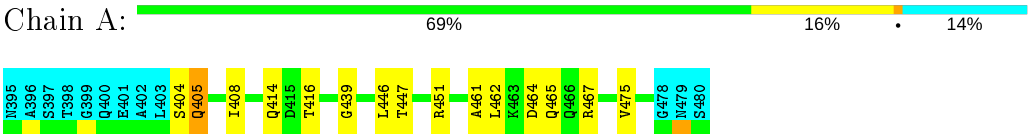
Chain A:



4.2.4 Score per residue for model 4

• Molecule 1: Fibronectin

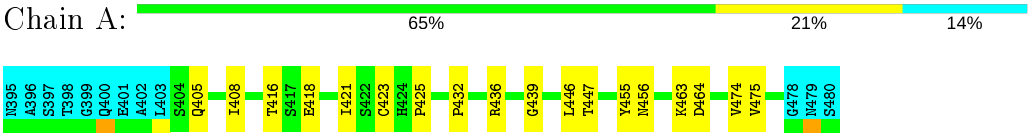
Chain A:



4.2.5 Score per residue for model 5

• Molecule 1: Fibronectin

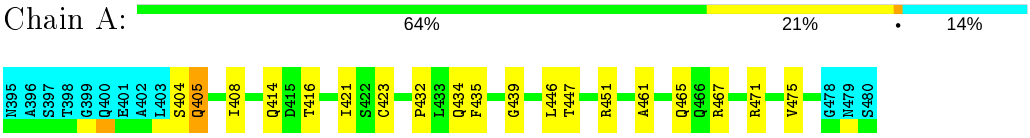
Chain A:



4.2.6 Score per residue for model 6

• Molecule 1: Fibronectin

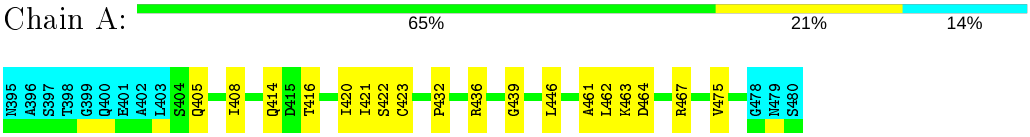
Chain A:



4.2.7 Score per residue for model 7

• Molecule 1: Fibronectin

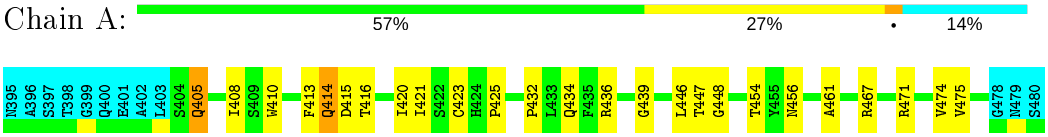
Chain A:



4.2.8 Score per residue for model 8

- Molecule 1: Fibronectin

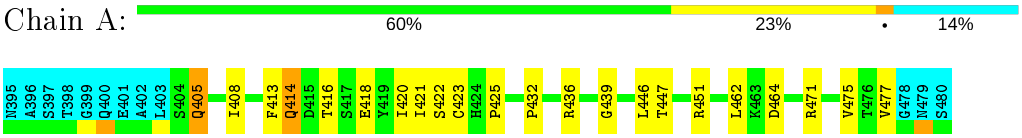
Chain A:



4.2.9 Score per residue for model 9

- Molecule 1: Fibronectin

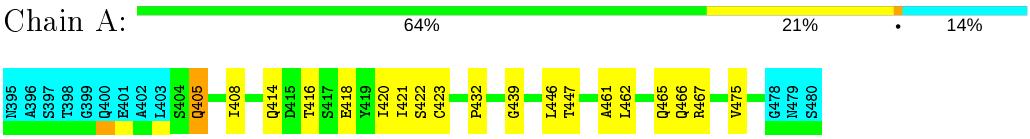
Chain A:



4.2.10 Score per residue for model 10

- Molecule 1: Fibronectin

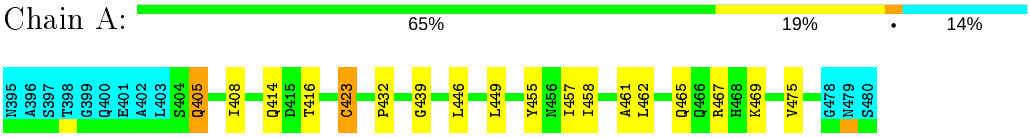
Chain A:



4.2.11 Score per residue for model 11

- Molecule 1: Fibronectin

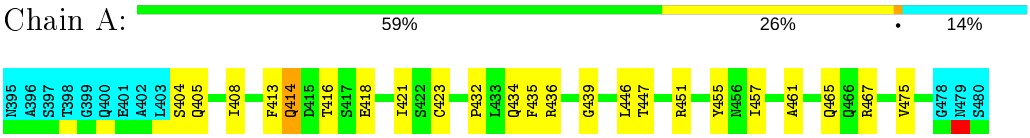
Chain A:



4.2.12 Score per residue for model 12

- Molecule 1: Fibronectin

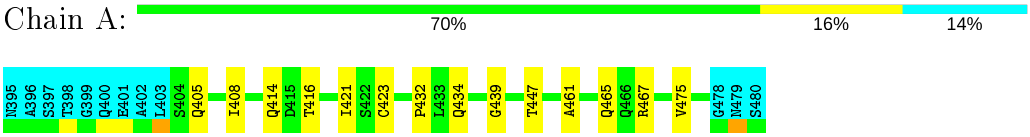
Chain A:



4.2.13 Score per residue for model 13

• Molecule 1: Fibronectin

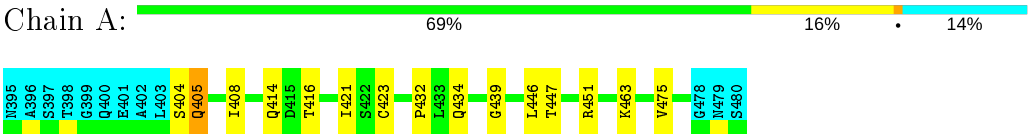
Chain A:



4.2.14 Score per residue for model 14

• Molecule 1: Fibronectin

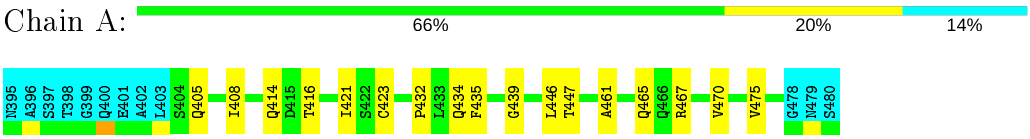
Chain A:



4.2.15 Score per residue for model 15

• Molecule 1: Fibronectin

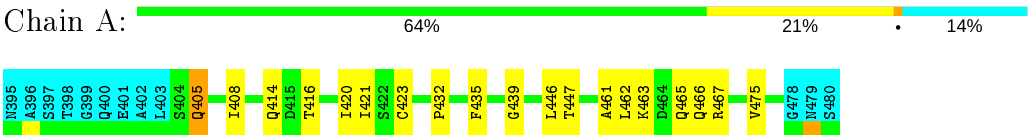
Chain A:



4.2.16 Score per residue for model 16

• Molecule 1: Fibronectin

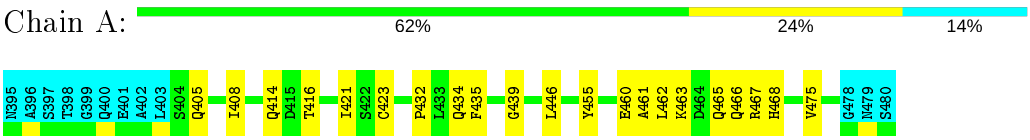
Chain A:



4.2.17 Score per residue for model 17

• Molecule 1: Fibronectin

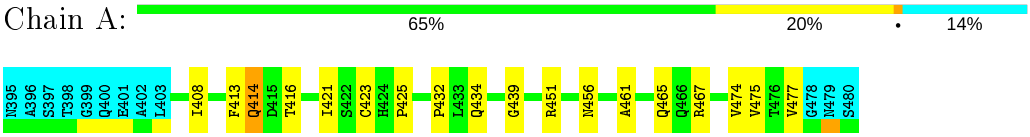
Chain A:



4.2.18 Score per residue for model 18

- Molecule 1: Fibronectin

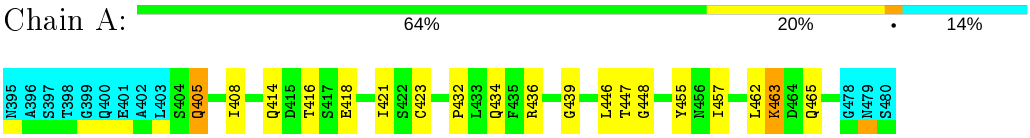
Chain A:



4.2.19 Score per residue for model 19

- Molecule 1: Fibronectin

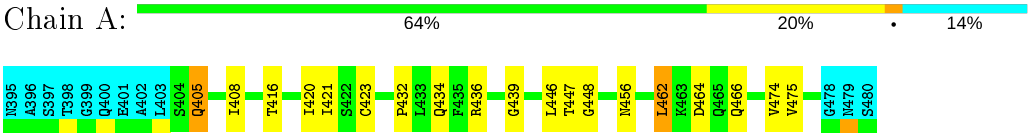
Chain A:



4.2.20 Score per residue for model 20

- Molecule 1: Fibronectin

Chain A:



5 Refinement protocol and experimental data overview

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

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
ARIA	structure calculation	2.3

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	954
Number of shifts mapped to atoms	954
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	81%

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

6 Model quality

6.1 Standard geometry

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

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	577	568	566	7±2
All	All	11540	11360	11320	148

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 6.

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

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:423:CYS:SG	1:A:455:TYR:HB3	0.75	2.22	19	5
1:A:416:THR:O	1:A:439:GLY:HA3	0.73	1.84	6	20
1:A:422:SER:OG	1:A:458:ILE:HB	0.63	1.93	1	1
1:A:423:CYS:O	1:A:432:PRO:HA	0.62	1.95	5	18
1:A:463:LYS:HB2	1:A:463:LYS:NZ	0.61	2.10	19	1
1:A:421:ILE:HG21	1:A:446:LEU:HD11	0.58	1.74	16	1
1:A:461:ALA:O	1:A:467:ARG:HA	0.58	1.98	8	14
1:A:463:LYS:HB2	1:A:463:LYS:HZ2	0.57	1.59	19	1
1:A:404:SER:OG	1:A:451:ARG:HB3	0.57	2.00	4	3
1:A:413:PHE:O	1:A:414:GLN:HB3	0.55	2.01	1	4
1:A:421:ILE:HG21	1:A:446:LEU:HD21	0.55	1.79	5	5
1:A:435:PHE:CD1	1:A:446:LEU:HG	0.54	2.37	17	5
1:A:421:ILE:O	1:A:434:GLN:HA	0.53	2.04	12	12
1:A:418:GLU:OE1	1:A:436:ARG:HD2	0.52	2.05	5	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:405:GLN:HA	1:A:446:LEU:O	0.52	2.04	9	12
1:A:463:LYS:O	1:A:464:ASP:HB2	0.52	2.05	7	2
1:A:418:GLU:OE2	1:A:436:ARG:HD2	0.52	2.04	19	1
1:A:423:CYS:SG	1:A:457:ILE:HG12	0.51	2.46	11	3
1:A:418:GLU:OE1	1:A:436:ARG:HD3	0.49	2.08	9	1
1:A:420:ILE:HD11	1:A:462:LEU:HD12	0.49	1.84	9	2
1:A:456:ASN:HA	1:A:474:VAL:HA	0.48	1.85	8	4
1:A:420:ILE:HG12	1:A:436:ARG:HG2	0.48	1.83	20	3
1:A:451:ARG:HA	1:A:477:VAL:HG12	0.48	1.83	2	3
1:A:413:PHE:O	1:A:414:GLN:HB2	0.48	2.09	8	2
1:A:420:ILE:CG1	1:A:436:ARG:HG2	0.47	2.40	20	1
1:A:456:ASN:HA	1:A:474:VAL:HB	0.47	1.87	8	4
1:A:423:CYS:SG	1:A:449:LEU:HD21	0.46	2.50	11	1
1:A:410:TRP:HA	1:A:471:ARG:NE	0.46	2.26	8	1
1:A:462:LEU:HA	1:A:466:GLN:O	0.45	2.11	2	3
1:A:420:ILE:HA	1:A:435:PHE:O	0.43	2.13	16	1
1:A:414:GLN:O	1:A:463:LYS:HE3	0.43	2.13	19	1
1:A:418:GLU:HB2	1:A:462:LEU:HB3	0.43	1.90	9	2
1:A:423:CYS:O	1:A:425:PRO:HD3	0.42	2.14	9	3
1:A:458:ILE:HG23	1:A:469:LYS:HD2	0.42	1.91	11	1
1:A:425:PRO:HA	1:A:454:THR:O	0.42	2.15	8	1
1:A:404:SER:OG	1:A:451:ARG:HD2	0.41	2.16	6	1
1:A:418:GLU:OE2	1:A:436:ARG:HB3	0.41	2.16	12	1
1:A:463:LYS:O	1:A:466:GLN:HG2	0.41	2.15	16	1
1:A:460:GLU:HA	1:A:468:HIS:O	0.40	2.17	17	1
1:A:418:GLU:OE1	1:A:462:LEU:HD13	0.40	2.17	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	74/86 (86%)	70±2 (95±2%)	2±1 (3±2%)	2±1 (2±1%)	10	50
All	All	1480/1720 (86%)	1400 (95%)	49 (3%)	31 (2%)	10	50

All 3 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	414	GLN	16
1	A	465	GLN	14
1	A	415	ASP	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	66/74 (89%)	61±1 (93±2%)	5±1 (7±2%)	19	67
All	All	1320/1480 (89%)	1227 (93%)	93 (7%)	19	67

All 13 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	408	ILE	19
1	A	475	VAL	19
1	A	405	GLN	18
1	A	447	THR	15
1	A	462	LEU	5
1	A	414	GLN	3
1	A	463	LYS	3
1	A	464	ASP	3
1	A	422	SER	3
1	A	471	ARG	2
1	A	466	GLN	1
1	A	423	CYS	1
1	A	470	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

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

6.5 Carbohydrates

There are no carbohydrates in this entry.

6.6 Ligand geometry

There are no ligands in this entry.

6.7 Other polymers

There are no such molecules in this entry.

6.8 Polymer linkage issues

There are no chain breaks in this entry.

7 Chemical shift validation

The completeness of assignment taking into account all chemical shift lists is 81% for the well-defined parts and 81% for the entire structure.

7.1 Chemical shift list 1

File name: input_cs.cif

Chemical shift list name: *chemical_shift_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	954
Number of shifts mapped to atoms	954
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	5

7.1.2 Chemical shift referencing

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	86	-0.10 ± 0.11	None needed (< 0.5 ppm)
$^{13}C_{\beta}$	80	0.06 ± 0.12	None needed (< 0.5 ppm)
$^{13}C'$	0	—	None (insufficient data)
^{15}N	82	-0.50 ± 0.31	None needed (< 0.5 ppm)

7.1.3 Completeness of resonance assignments

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 81%, i.e. 717 atoms were assigned a chemical shift out of a possible 886. 11 out of 11 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	288/362 (80%)	144/144 (100%)	74/148 (50%)	70/70 (100%)
Sidechain	381/462 (82%)	233/268 (87%)	144/174 (83%)	4/20 (20%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	48/62 (77%)	26/32 (81%)	21/25 (84%)	1/5 (20%)
Overall	717/886 (81%)	403/444 (91%)	239/347 (69%)	75/95 (79%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 81%, i.e. 812 atoms were assigned a chemical shift out of a possible 1000. 12 out of 12 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	335/422 (79%)	167/168 (99%)	86/172 (50%)	82/82 (100%)
Sidechain	429/516 (83%)	263/299 (88%)	159/194 (82%)	7/23 (30%)
Aromatic	48/62 (77%)	26/32 (81%)	21/25 (84%)	1/5 (20%)
Overall	812/1000 (81%)	456/499 (91%)	266/391 (68%)	90/110 (82%)

7.1.4 Statistically unusual chemical shifts (i)

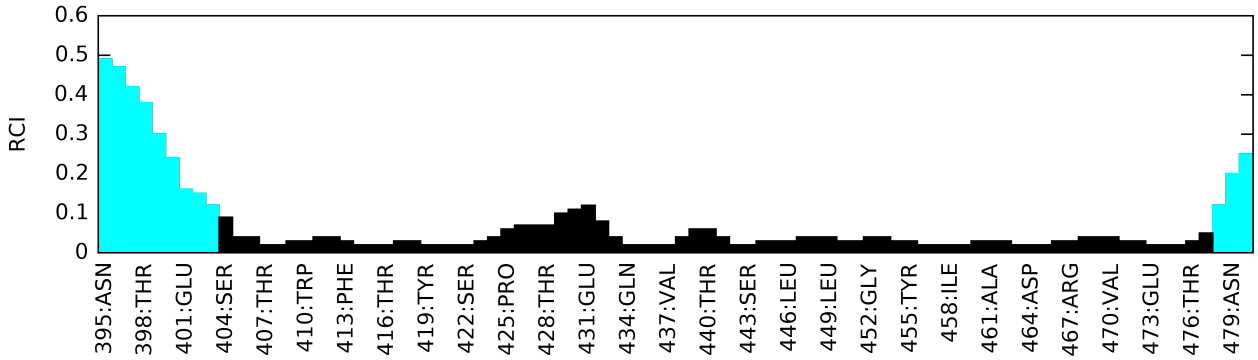
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	419	TYR	HH	-0.40	16.26 – 2.26	-6.9
1	A	410	TRP	HE1	6.53	12.85 – 7.35	-6.5
1	A	459	VAL	HG11	-0.64	2.13 – -0.47	-5.7
1	A	459	VAL	HG12	-0.64	2.13 – -0.47	-5.7
1	A	459	VAL	HG13	-0.64	2.13 – -0.47	-5.7

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
0.6
0.5
0.4
0.3
0.2
0.1
0
395:ASN
398:THR
401:GLU
404:SER
407:THR
410:TRP
413:PHE
416:THR
419:TYR
422:SER
425:PRO
428:THR
431:GLU
434:GLN
437:VAL
440:THR
443:SER
446:LEU
449:LEU
452:GLY
455:TYR
458:ILE
461:ALA
464:ASP
467:ARG
470:VAL
473:GLU
476:THR
479:ASN