# Full wwPDB NMR Structure Validation Report (i)

Dec 13, 2023 – 11:54 PM EST

| | | |
|---|---|---|
| PDB ID | : | 2JOX |
| BMRB ID | : | 15208 |
| Title | : | Embryonic Neural Inducing Factor Churchill is not a DNA-Binding Zinc Finger Protein: Solution Structure Reveals a Solvent-Exposed beta-Sheet and Zinc Binuclear Cluster |
| Authors | : | Lee, B.M.; Buck-Koehntop, B.A.; Martinez-Yamout, M.A.; Gottesfeld, J.M.; Dyson, H.; Wright, P.E. |
| Deposited on | : | 2007-04-07 |

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
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The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

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

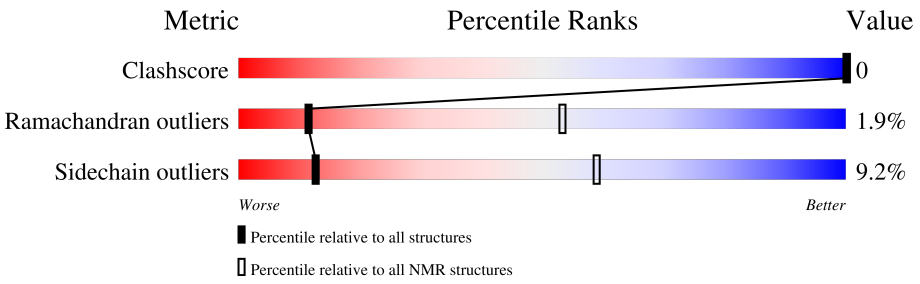
| | | |
|---|---|---|
| Cyrange | : | Kirchner and Güntert (2011) |
| NmrClust | : | Kelley et al. (1996) |
| MolProbity | : | 4.02b-467 |
| Percentile statistics | : | 20191225.v01 (using entries in the PDB archive December 25th 2019) |
| wwPDB-RCI | : | v_1n_11_5_13_A (Berjanski et al., 2005) |
| PANAV | : | Wang et al. (2010) |
| wwPDB-ShiftChecker | : | v1.2 |
| Ideal geometry (proteins) | : | Engh & Huber (2001) |
| Ideal geometry (DNA, RNA) | : | Parkinson et al. (1996) |
| Validation Pipeline (wwPDB-VP) | : | 2.36 |

# 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 93%.

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 | 106 | 79% 12% • 8% |

# 2 Ensemble composition and analysis (i)

This entry contains 20 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:2-A:99 (98) | 0.12 | 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 2 clusters and 1 single-model cluster was found.

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

# 3 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 1640 atoms, of which 794 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Churchill protein.

| Mol | Chain | Residues | Atoms | | | | | | Trace |
|---|---|---|---|---|---|---|---|---|---|
| | | | Total | C | H | N | O | S | |
| 1 | A | 106 | 1637 | 523 | 794 | 140 | 168 | 12 | 0 |

- Molecule 2 is ZINC ION (three-letter code: ZN) (formula: Zn).

| Mol | Chain | Residues | Atoms | |
|---|---|---|---|---|
| | | | Total | Zn |
| 2 | A | 3 | 3 | 3 |

# 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: Churchill protein

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: Churchill protein

Chain A:

### 4.2.2 Score per residue for model 2

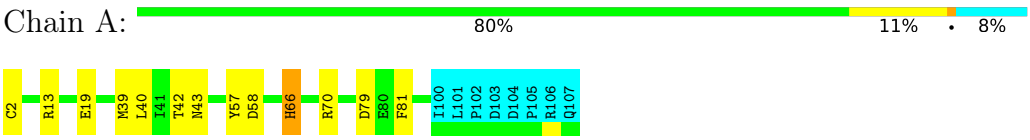
• Molecule 1: Churchill protein

Chain A:

### 4.2.3 Score per residue for model 3

- Molecule 1: Churchill protein

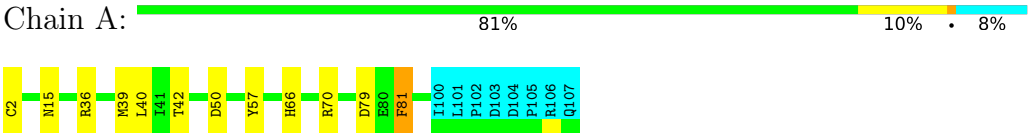
Chain A:




### 4.2.4 Score per residue for model 4

- Molecule 1: Churchill protein

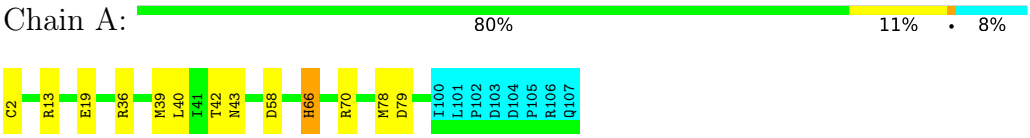
Chain A:




### 4.2.5 Score per residue for model 5

- Molecule 1: Churchill protein

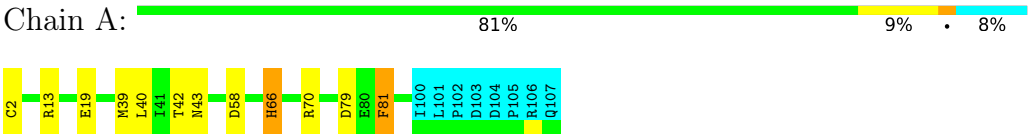
Chain A:




### 4.2.6 Score per residue for model 6

- Molecule 1: Churchill protein

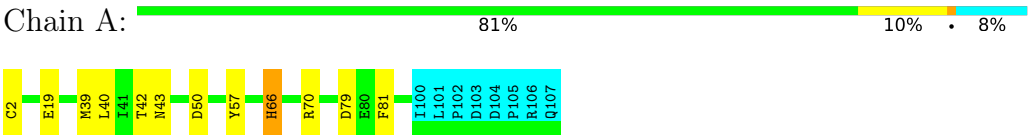
Chain A:




### 4.2.7 Score per residue for model 7 (medoid)

- Molecule 1: Churchill protein

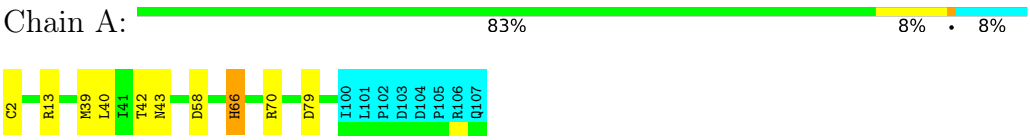
Chain A:



### 4.2.8 Score per residue for model 8

- Molecule 1: Churchill protein

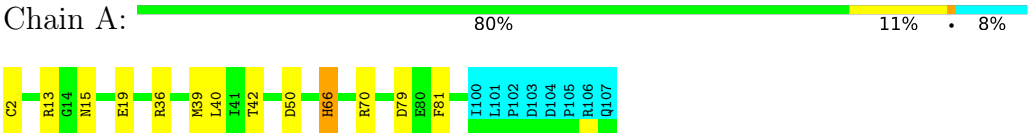
Chain A:




### 4.2.9 Score per residue for model 9

- Molecule 1: Churchill protein

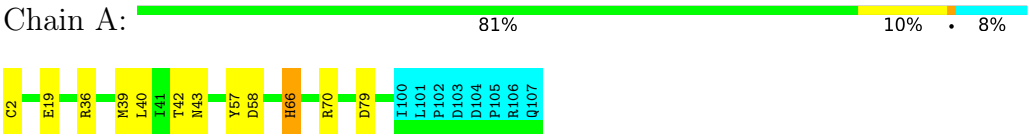
Chain A:




### 4.2.10 Score per residue for model 10

- Molecule 1: Churchill protein

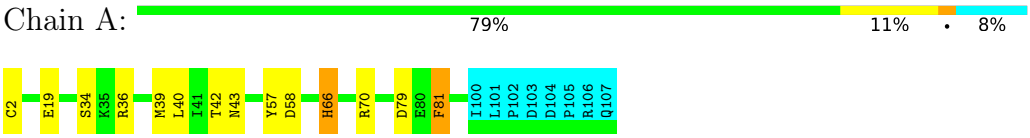
Chain A:




### 4.2.11 Score per residue for model 11

- Molecule 1: Churchill protein

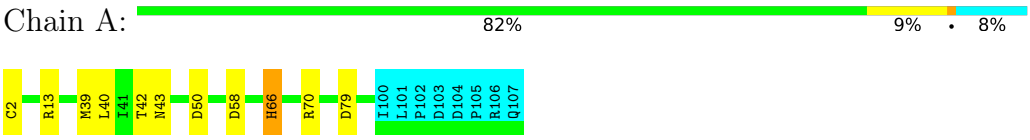
Chain A:




### 4.2.12 Score per residue for model 12

- Molecule 1: Churchill protein

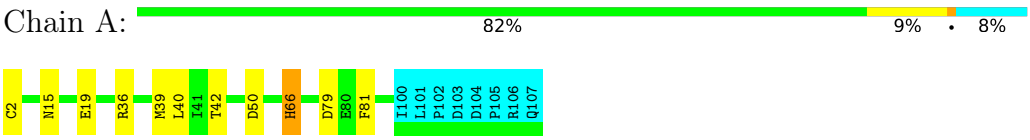
Chain A:



### 4.2.13 Score per residue for model 13

- Molecule 1: Churchill protein

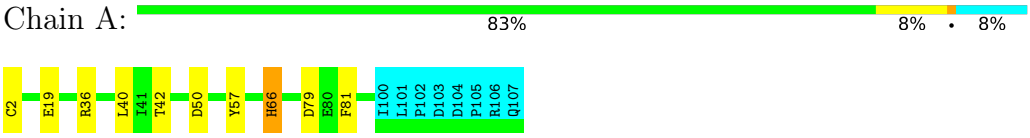
Chain A:




### 4.2.14 Score per residue for model 14

- Molecule 1: Churchill protein

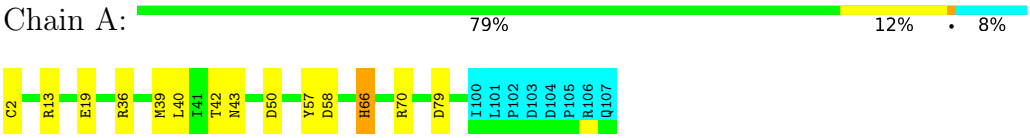
Chain A:




### 4.2.15 Score per residue for model 15

- Molecule 1: Churchill protein

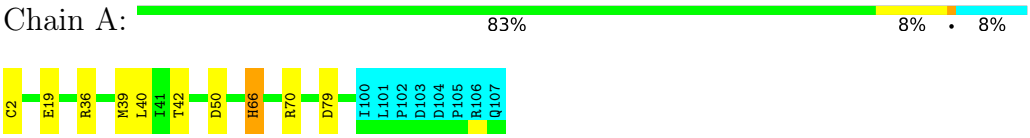
Chain A:




### 4.2.16 Score per residue for model 16

- Molecule 1: Churchill protein

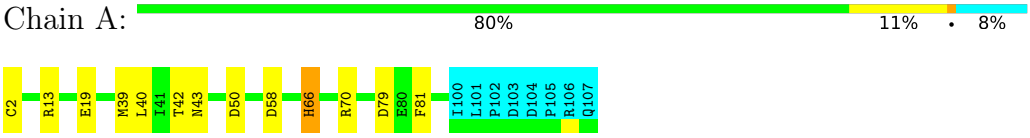
Chain A:




### 4.2.17 Score per residue for model 17

- Molecule 1: Churchill protein

Chain A:



### 4.2.18 Score per residue for model 18

- Molecule 1: Churchill protein

Chain A:

### 4.2.19 Score per residue for model 19

- Molecule 1: Churchill protein

Chain A:

### 4.2.20 Score per residue for model 20

- Molecule 1: Churchill protein

Chain A:

# 5 Refinement protocol and experimental data overview (i)

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

Of the 200 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** |
|---|---|---|
| Amber | refinement | 8 |
| CYANA | structure solution | 2.1 |
| CYANA | refinement | 2.1 |

The following table shows chemical shift validation statistics as aggregates over all chemical shift files. Detailed validation can be found in section 7 of this report.

| Chemical shift file(s) | working_cs.cif |
|---|---|
| Number of chemical shift lists | 1 |
| Total number of shifts | 1301 |
| Number of shifts mapped to atoms | 1301 |
| Number of unparsed shifts | 0 |
| Number of shifts with mapping errors | 0 |
| Number of shifts with mapping warnings | 0 |
| Assignment completeness (well-defined parts) | 93% |

# 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: ZN

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 | 0.72±0.00 | 0±0/791 ( 0.0± 0.0%) | 1.06±0.01 | 2±1/1065 ( 0.2± 0.1%) |
| All | All | 0.72 | 0/15820 ( 0.0%) | 1.06 | 40/21300 ( 0.2%) |

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 | 1.5±0.5 |
| All | All | 0 | 30 |

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($^o$) | Ideal($^o$) | Models | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Worst | Total |
| 1 | A | 70 | ARG | NE-CZ-NH1 | 6.04 | 123.32 | 120.30 | 19 | 15 |
| 1 | A | 13 | ARG | NE-CZ-NH1 | 5.83 | 123.21 | 120.30 | 2 | 12 |
| 1 | A | 36 | ARG | NE-CZ-NH1 | 5.81 | 123.21 | 120.30 | 5 | 9 |
| 1 | A | 81 | PHE | CB-CG-CD2 | -5.30 | 117.09 | 120.80 | 6 | 4 |

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 | 66 | HIS | Sidechain | 19 |
| 1 | A | 57 | TYR | Sidechain | 11 |

## 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 |
|---|---|---|---|---|---|
| All | All | 15600 | 14580 | 14540 | - |

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 -.

There are no clashes.

## 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 | 97/106 (92%) | 87±1 (90±1%) | 8±1 (8±1%) | 2±1 (2±1%) | 11 53 |
| All | All | 1940/2120 (92%) | 1747 (90%) | 156 (8%) | 37 (2%) | 11 53 |

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 | 79 | ASP | 20 |
| 1 | A | 50 | ASP | 11 |
| 1 | A | 15 | ASN | 6 |

### 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 | 89/97 (92%) | 81±1 (91±1%) | 8±1 (9±1%) | 13 59 |
| All | All | 1780/1940 (92%) | 1617 (91%) | 163 (9%) | 13 59 |

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 | 2 | CYS | 20 |
| 1 | A | 40 | LEU | 20 |
| 1 | A | 42 | THR | 20 |
| 1 | A | 66 | HIS | 20 |
| 1 | A | 39 | MET | 19 |
| 1 | A | 19 | GLU | 17 |
| 1 | A | 43 | ASN | 14 |
| 1 | A | 58 | ASP | 13 |
| 1 | A | 81 | PHE | 11 |
| 1 | A | 70 | ARG | 4 |
| 1 | A | 78 | MET | 2 |
| 1 | A | 34 | SER | 2 |
| 1 | A | 8 | LYS | 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)

Of 3 ligands modelled in this entry, 3 are monoatomic - leaving 0 for Mogul analysis.

## 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 93% for the well-defined parts and 93% for the entire structure.

## 7.1 Chemical shift list 1

File name: working_cs.cif

Chemical shift list name: *assigned_chem_shift_list_1*

### 7.1.1 Bookkeeping (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 | 1301 |
| Number of shifts mapped to atoms | 1301 |
| Number of unparsed shifts | 0 |
| Number of shifts with mapping errors | 0 |
| Number of shifts with mapping warnings | 0 |
| Number of shift outliers (ShiftChecker) | 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 |
|---|---|---|---|
| $^{13}C_{\alpha}$ | 106 | -0.25 ± 0.18 | None needed (< 0.5 ppm) |
| $^{13}C_{\beta}$ | 100 | -0.05 ± 0.17 | None needed (< 0.5 ppm) |
| $^{13}C'$ | 105 | 0.39 ± 0.17 | None needed (< 0.5 ppm) |
| $^{15}N$ | 101 | -1.28 ± 0.43 | Should be applied |

### 7.1.3 Completeness of resonance assignments (i)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 93%, i.e. 1195 atoms were assigned a chemical shift out of a possible 1290. 0 out of 13 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

| | Total | $^{1}H$ | $^{13}C$ | $^{15}N$ |
|---|---|---|---|---|
| Backbone | 489/494 (99%) | 199/201 (99%) | 195/196 (99%) | 95/97 (98%) |
| Sidechain | 630/681 (93%) | 427/439 (97%) | 193/220 (88%) | 10/22 (45%) |

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| | Total | $^{1}$H | $^{13}$C | $^{15}$N |
|---|---|---|---|---|
| Aromatic | 76/115 (66%) | 47/57 (82%) | 29/53 (55%) | 0/5 (0%) |
| Overall | 1195/1290 (93%) | 673/697 (97%) | 417/469 (89%) | 105/124 (85%) |

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 93%, i.e. 1301 atoms were assigned a chemical shift out of a possible 1406. 0 out of 14 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

| | Total | $^{1}$H | $^{13}$C | $^{15}$N |
|---|---|---|---|---|
| Backbone | 525/530 (99%) | 213/215 (99%) | 211/212 (100%) | 101/103 (98%) |
| Sidechain | 700/761 (92%) | 474/490 (97%) | 214/245 (87%) | 12/26 (46%) |
| Aromatic | 76/115 (66%) | 47/57 (82%) | 29/53 (55%) | 0/5 (0%) |
| Overall | 1301/1406 (93%) | 734/762 (96%) | 454/510 (89%) | 113/134 (84%) |

### 7.1.4 Statistically unusual chemical shifts (i)

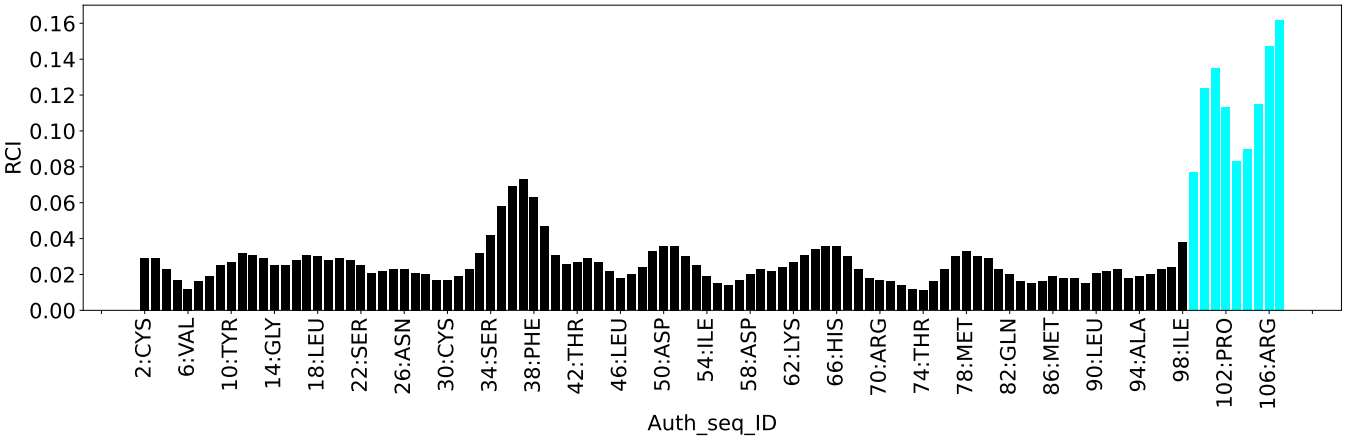
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

| List Id | Chain | Res | Type | Atom | Shift, *ppm* | Expected range, *ppm* | Z-score |
|---|---|---|---|---|---|---|---|
| 1 | A | 53 | GLU | CG | 54.83 | 30.20 – 42.01 | 15.8 |
| 1 | A | 19 | GLU | HB3 | 0.55 | 0.95 – 3.05 | -6.9 |

### 7.1.5 Random Coil Index (RCI) plots (i)

The image below reports *random coil index* values for the protein chains in the structure. The height of each bar gives a probability of a given residue to be disordered, as predicted from the available chemical shifts and the amino acid sequence. A value above 0.2 is an indication of significant predicted disorder. The colour of the bar shows whether the residue is in the well-defined core (black) or in the ill-defined residue ranges (cyan), as described in section 2 on ensemble composition.If well-defined core and ill-defined regions are not identified then it is shown as gray bars.

Random coil index (RCI) for chain A:


RCI
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
2:CYS
6:VAL
10:TYR
14:GLY
18:LEU
22:SER
26:ASN
30:CYS
34:SER
38:PHE
42:THR
46:LEU
50:ASP
54:ILE
58:ASP
62:LYS
66:HIS
70:ARG
74:THR
78:MET
82:GLN
86:MET
90:LEU
94:ALA
98:ILE
102:PRO
106:ARG
Auth_seq_ID