wwPDB NMR Structure Validation Summary Report (i)

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PDB ID	:	2NR2
Title	:	The MUMO (minimal under-restraining minimal over-restraining) method for the determination of native states ensembles of proteins
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This is a wwPDB NMR Structure Validation Summary Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
http://wwpdb.org/validation/2016/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:

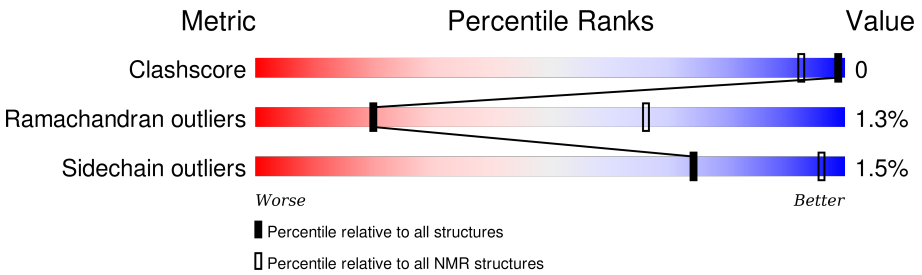
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	rb-20027457

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 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	114402	11133
Ramachandran outliers	111179	9975
Sidechain outliers	111093	9958

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	76	88% 5% 7%

2 Ensemble composition and analysis (i)

This entry contains 144 models. Model 100 is the overall representative, medoid model (most similar to other models).

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:1-A:71 (71)	0.36	100

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 18 clusters and 14 single-model clusters were found.

Cluster number	Models
1	1, 2, 6, 11, 13, 18, 22, 26, 27, 33, 37, 39, 41, 43, 45, 47, 56, 57, 58, 61, 87, 90, 102, 108, 110, 112, 115, 120, 125, 128, 133, 139, 140, 143
2	3, 7, 9, 10, 20, 25, 29, 31, 46, 49, 53, 60, 64, 71, 82, 83, 89, 114, 117, 118, 122, 134, 135, 136, 137, 141
3	8, 16, 35, 36, 54, 65, 66, 72, 84, 86, 103, 104, 105, 106, 124
4	23, 24, 42, 55, 91, 101, 107, 109, 119, 132
5	5, 30, 67, 69, 85, 88, 113, 131
6	4, 19, 21, 77, 111, 129
7	28, 32, 48, 70, 100, 130
8	50, 93, 98
9	15, 51, 127
10	17, 76, 78
11	14, 138
12	40, 44
13	73, 80
14	81, 96
15	68, 121
16	34, 94
17	52, 92
18	59, 142
Single-model clusters	12; 38; 62; 63; 74; 75; 79; 95; 97; 99; 116; 123; 126; 144

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 1231 atoms, of which 629 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Ubiquitin.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	76	1231	378	629	105	118	1	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: Ubiquitin

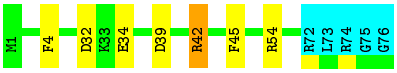
Chain A:

4.2 Residue scores for the representative (medoid) model from the NMR ensemble

The representative model is number 100. Colouring as in section 4.1 above.

- Molecule 1: Ubiquitin

Chain A:



5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *MUMO (minimal under-restraining minimal over-restraining) refinement using previously published NOE distance restraints and order parameter restraints as inputs to ensemble-averaged simulated annealing..*

Of the 144 calculated structures, 144 were deposited, based on the following criterion: *all calculated structures submitted.*

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

Software name	Classification	Version
CHARMM	refinement	c30

No chemical shift data was provided. 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)

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±0.00	0±0/570 (0.0±0.0%)	1.85±0.07	10±3/770 (1.3±0.4%)
All	All	0.96	0/82080 (0.0%)	1.86	1464/110880 (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	0.9±0.9
All	All	0	134

There are no bond-length outliers.

5 of 268 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	54	ARG	NE-CZ-NH1	22.06	131.33	120.30	104	76
1	A	59	TYR	CB-CG-CD1	-16.54	111.07	121.00	62	46
1	A	54	ARG	NE-CZ-NH2	-15.56	112.52	120.30	17	65
1	A	42	ARG	NE-CZ-NH1	15.41	128.01	120.30	101	60
1	A	42	ARG	NE-CZ-NH2	-14.16	113.22	120.30	136	61

There are no chirality outliers.

5 of 11 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	42	ARG	Sidechain	40
1	A	54	ARG	Sidechain	39
1	A	59	TYR	Sidechain	36

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Mol	Chain	Res	Type	Group	Models (Total)
1	A	45	PHE	Sidechain	7
1	A	4	PHE	Sidechain	6

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	563	586	586	0±0
All	All	81072	84384	84384	22

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 0.

5 of 21 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:23:ILE:HD13	1:A:50:LEU:HB3	0.67	1.66	77	1
1:A:22:THR:O	1:A:26:VAL:HG23	0.54	2.02	125	1
1:A:61:ILE:HD13	1:A:67:LEU:HD21	0.54	1.80	140	1
1:A:45:PHE:HB2	1:A:50:LEU:HD21	0.51	1.83	81	1
1:A:7:THR:HG22	1:A:69:LEU:HD23	0.47	1.85	96	2

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	70/76 (92%)	65±2 (93±3%)	4±2 (5±3%)	1±1 (1±1%)	20 66
All	All	10080/10944 (92%)	9407 (93%)	546 (5%)	127 (1%)	20 66

5 of 10 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	10	GLY	48
1	A	46	ALA	32
1	A	47	GLY	27
1	A	60	ASN	5
1	A	63	LYS	5

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	65/68 (96%)	64±1 (98±2%)	1±1 (2±2%)	74 96
All	All	9360/9792 (96%)	9215 (98%)	145 (2%)	74 96

5 of 43 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	1	MET	16
1	A	52	ASP	11
1	A	2	GLN	9
1	A	38	PRO	8
1	A	13	ILE	8

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 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)

No chemical shift data were provided