wwPDB NMR Structure Validation Summary Report (i)

Apr 27, 2016 – 05:32 AM BST

PDB ID	:	2RU4
Title	:	Designed Armadillo Repeat Protein Self-ASsembled Complex (YIIM2-MAII)
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Deposited on	:	2013-11-22

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:

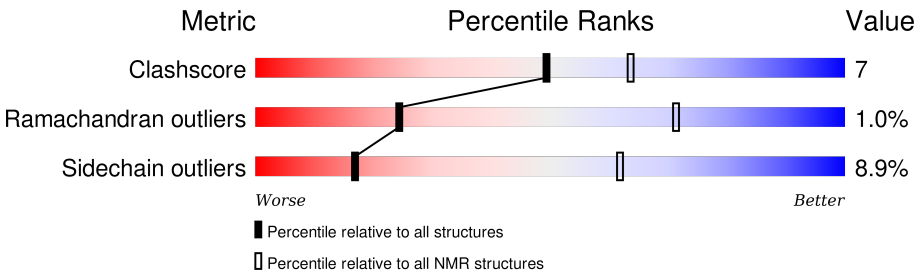
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal 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 is 86%.

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	115	51% 10% • 37%
2	B	84	80% 18% •

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 5 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *closest to the average*.

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:44-A:115, B:116-B:197 (154)	0.54	5

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 3 clusters and 2 single-model clusters were found.

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

3 Entry composition (i)

There are 2 unique types of molecules in this entry. The entry contains 2984 atoms, of which 1490 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Armadillo Repeat Protein, N-terminal fragment, YIIM2.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	115	1706	531	851	144	178	2	0

- Molecule 2 is a protein called Armadillo Repeat Protein, C-terminal fragment, MAII.

Mol	Chain	Residues	Atoms					Trace
			Total	C	H	N	O	
2	B	84	1278	394	639	112	133	0

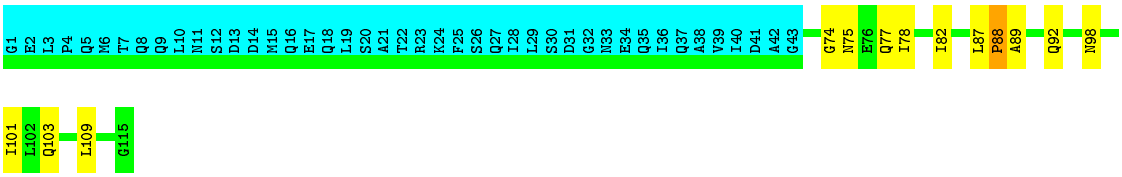
4 Residue-property plots (i)

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: Armadillo Repeat Protein, N-terminal fragment, YIIM2

Chain A: 51% 10% • 37%



- Molecule 2: Armadillo Repeat Protein, C-terminal fragment, MAII

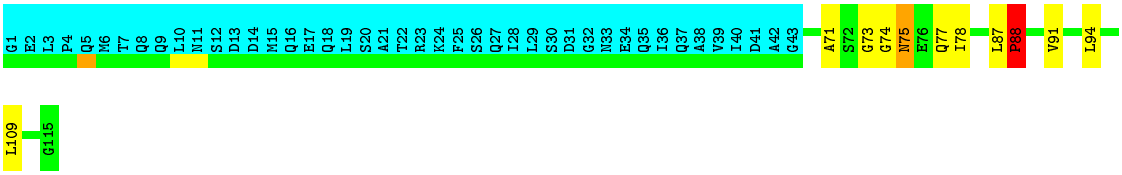
Chain B: 80% 18% •

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

The representative model is number 5. Colouring as in section 4.1 above.

- Molecule 1: Armadillo Repeat Protein, N-terminal fragment, YIIM2

Chain A: 53% 8% •• 37%



- Molecule 2: Armadillo Repeat Protein, C-terminal fragment, MAII

Chain B: 74% 23% ••

G116
Q134
L135
L136
E141
Q145
L148
N159
A170
L171
E172
K173
L174
E175
Q176
L177
Q178
E181
N182
E183
K184
I185
Q186
K187
E188
S198
H199

5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *torsion angle dynamics, 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
UNIO	structure solution	2.0.2
CYANA	geometry optimization	3.96a
CYANA	structure solution	3.96a
X-PLOR NIH	refinement	2.32
CYANA	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)	2ru4_cs.str
Number of chemical shift lists	2
Total number of shifts	1899
Number of shifts mapped to atoms	1899
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	86%

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	0.79±0.03	0±0/533 (0.0±0.0%)	0.69±0.03	0±0/731 (0.1±0.1%)
2	B	0.79±0.03	0±0/628 (0.0±0.0%)	0.70±0.02	0±0/848 (0.0±0.0%)
All	All	0.79	1/23220 (0.0%)	0.70	9/31580 (0.0%)

All unique bond outliers are listed below.

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)	Models	
								Worst	Total
1	A	98	ASN	N-CA	-5.35	1.35	1.46	19	1

All unique angle outliers are listed below.

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})	Models	
								Worst	Total
1	A	88	PRO	N-CA-CB	-6.49	95.46	102.60	10	9

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	526	535	535	10±3
2	B	623	626	624	8±3
All	All	22980	23220	23180	342

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 7.

5 of 137 unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
2:B:142:GLN:HA	2:B:142:GLN:HE21	0.69	1.46	15	1
2:B:170:ALA:O	2:B:174:LEU:HG	0.62	1.95	15	20
2:B:142:GLN:CA	2:B:142:GLN:HE21	0.60	2.08	1	2
2:B:142:GLN:HE21	2:B:142:GLN:CA	0.60	2.08	14	1
1:A:100:GLN:O	1:A:103:GLN:HG2	0.60	1.96	14	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	71/115 (62%)	67±1 (95±1%)	3±1 (5±2%)	0±0 (0±1%)	50	83
2	B	81/84 (96%)	76±2 (94±2%)	4±1 (5±2%)	1±1 (2±1%)	16	59
All	All	3040/3980 (76%)	2867 (94%)	142 (5%)	31 (1%)	24	71

5 of 11 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
2	B	181	GLU	6
2	B	118	GLU	5
2	B	157	GLY	5
2	B	117	ASN	4
2	B	127	GLY	4

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	56/93 (60%)	53±1 (94±2%)	4±1 (6±2%)	27	72
2	B	65/67 (97%)	58±2 (89±3%)	7±2 (11±3%)	12	55
All	All	2420/3200 (76%)	2204 (91%)	216 (9%)	17	62

5 of 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)
2	B	134	GLN	20
2	B	171	LEU	19
2	B	173	LYS	18
2	B	136	LEU	13
1	A	88	PRO	13

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)

The completeness of assignment taking into account all chemical shift lists is 86% for the well-defined parts and 72% for the entire structure.

7.1 Chemical shift list 1

File name: 2ru4_cs.str

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	956
Number of shifts mapped to atoms	956
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	0

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	84	-0.54 ± 0.10	Should be applied
$^{13}C_{\beta}$	79	0.28 ± 0.11	None needed (< 0.5 ppm)
$^{13}C'$	76	-0.33 ± 0.09	None needed (< 0.5 ppm)
^{15}N	81	1.11 ± 0.22	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 40%, i.e. 716 atoms were assigned a chemical shift out of a possible 1799. 0 out of 32 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	343/758 (45%)	139/302 (46%)	137/308 (44%)	67/148 (45%)
Sidechain	369/997 (37%)	221/577 (38%)	136/384 (35%)	12/36 (33%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	4/44 (9%)	2/22 (9%)	0/17 (0%)	2/5 (40%)
Overall	716/1799 (40%)	362/901 (40%)	273/709 (39%)	81/189 (43%)

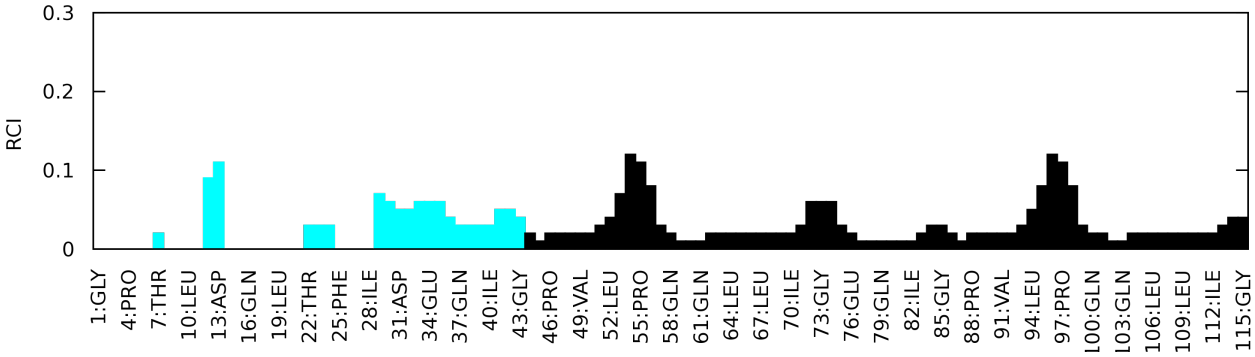
7.1.4 Statistically unusual chemical shifts (i)

There are no statistically unusual chemical shifts.

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:



7.2 Chemical shift list 2

File name: 2ru4_cs.str

Chemical shift list name: *assigned_chem_shift_list_2*

7.2.1 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	943
Number of shifts mapped to atoms	943
Number of unparsed shifts	0

Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	3

7.2.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	79	-0.62 ± 0.22	Should be applied
$^{13}C_{\beta}$	75	0.25 ± 0.09	None needed (< 0.5 ppm)
$^{13}C'$	60	-0.34 ± 0.10	None needed (< 0.5 ppm)
^{15}N	76	1.18 ± 0.19	Should be applied

7.2.3 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 46%, i.e. 832 atoms were assigned a chemical shift out of a possible 1799. 0 out of 32 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	364/758 (48%)	152/302 (50%)	137/308 (44%)	75/148 (51%)
Sidechain	466/997 (47%)	287/577 (50%)	168/384 (44%)	11/36 (31%)
Aromatic	2/44 (5%)	1/22 (5%)	0/17 (0%)	1/5 (20%)
Overall	832/1799 (46%)	440/901 (49%)	305/709 (43%)	87/189 (46%)

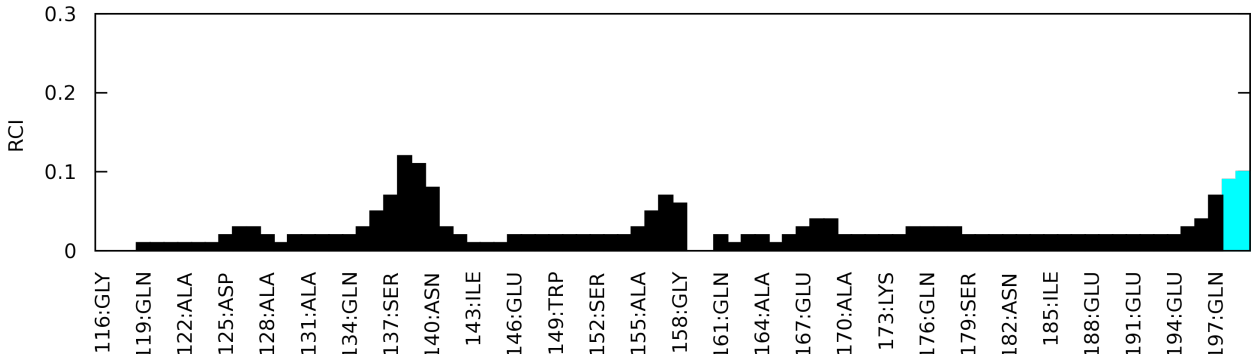
7.2.4 Statistically unusual chemical shifts (i)

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
2	B	184	LYS	HD3	2.95	2.75 – 0.45	5.9
2	B	184	LYS	HD2	2.95	2.76 – 0.46	5.8
2	B	182	ASN	H	11.49	11.45 – 5.25	5.1

7.2.5 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 B: