



Full wwPDB NMR Structure Validation Report ⓘ

May 28, 2020 – 10:59 pm BST

PDB ID : 2LC5
Title : Calmodulin-like Protein from Entamoeba histolytica: Solution Structure and Calcium-Binding Properties of a Partially Folded Protein
Authors : Rout, A.K.; Padhan, N.; Barnwal, R.P.; Bhattacharya, A.; Chary, K.V.
Deposited on : 2011-04-23

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 ⓘ symbol.

The following versions of software and data (see [references ⓘ](#)) 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

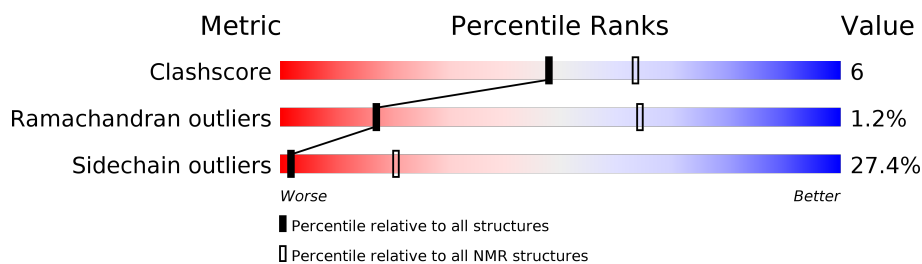
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment is 77%.

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 $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	151	 34% 13% • 8% 44%

2 Ensemble composition and analysis i

This entry contains 20 models. Model 8 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:8-A:80 (73)	0.51	8

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 4 single-model clusters were found.

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

3 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 1350 atoms, of which 663 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Calmodulin, putative.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	85	1348	426	663	109	147	3	0

- Molecule 2 is CALCIUM ION (three-letter code: CA) (formula: Ca).

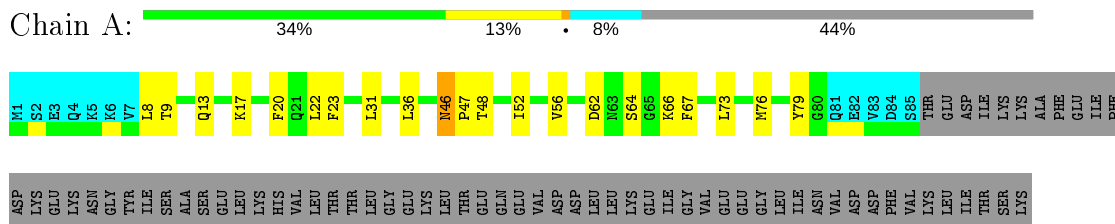
Mol	Chain	Residues	Atoms	
2	A	2	Total	Ca
			2	2

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: Calmodulin, putative

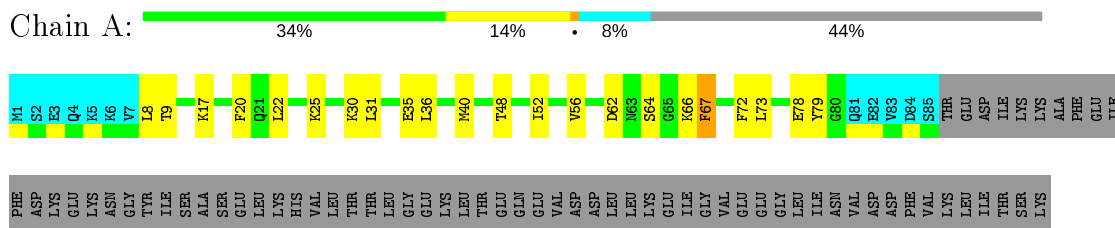


4.2 Scores per residue for each member of the ensemble

Colouring as in section [4.1](#) above.

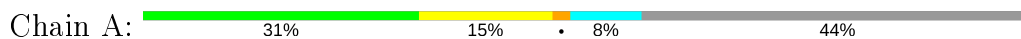
4.2.1 Score per residue for model 1

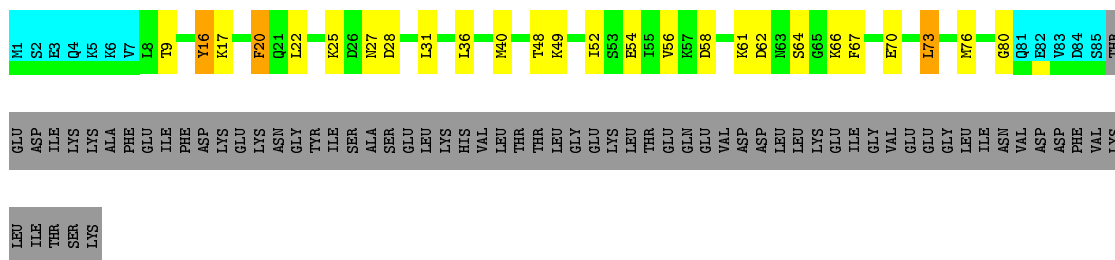
- Molecule 1: Calmodulin, putative



4.2.2 Score per residue for model 2

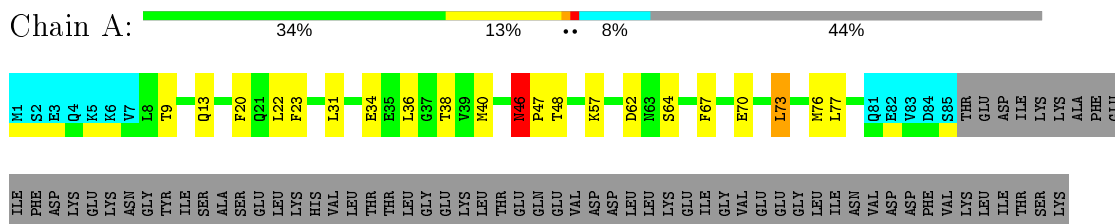
- Molecule 1: Calmodulin, putative





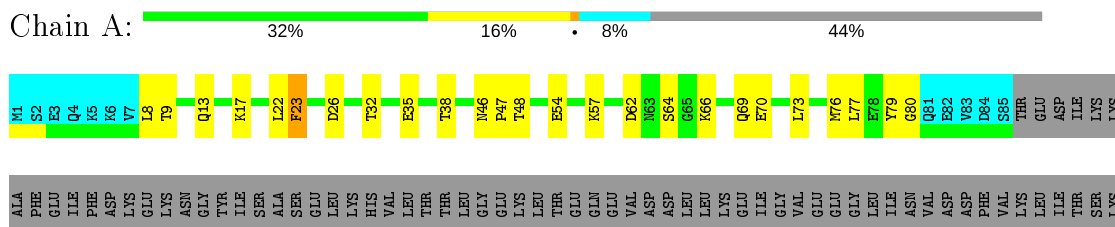
4.2.3 Score per residue for model 3

- Molecule 1: Calmodulin, putative



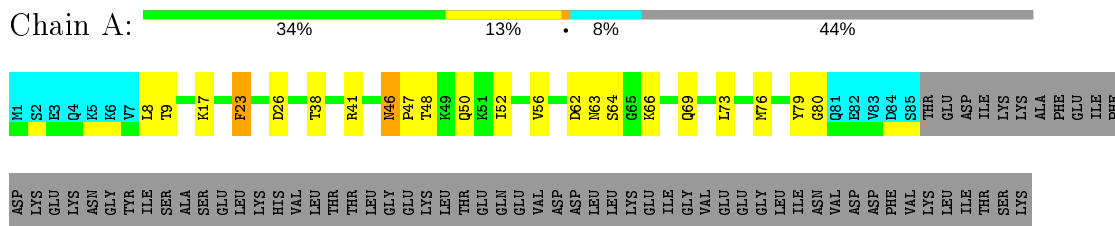
4.2.4 Score per residue for model 4

- Molecule 1: Calmodulin, putative



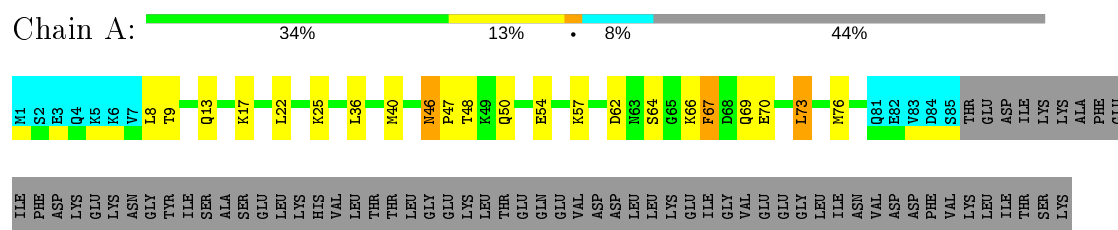
4.2.5 Score per residue for model 5

- Molecule 1: Calmodulin, putative



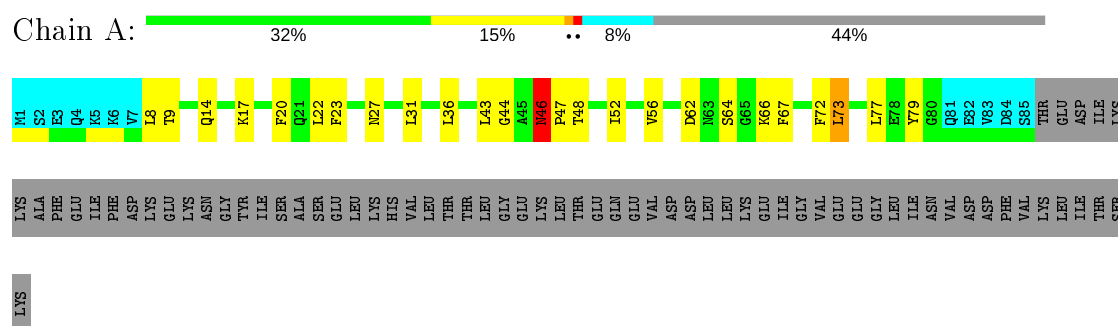
4.2.6 Score per residue for model 6

- Molecule 1: Calmodulin, putative



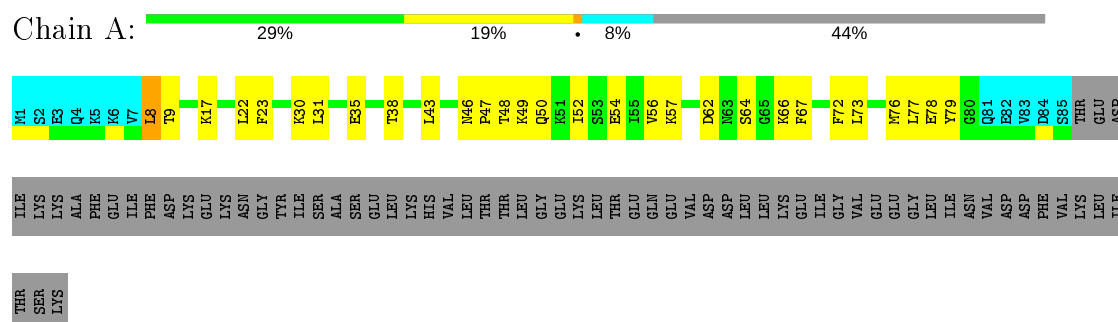
4.2.7 Score per residue for model 7

- Molecule 1: Calmodulin, putative



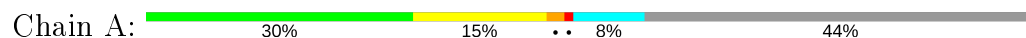
4.2.8 Score per residue for model 8 (medoid)

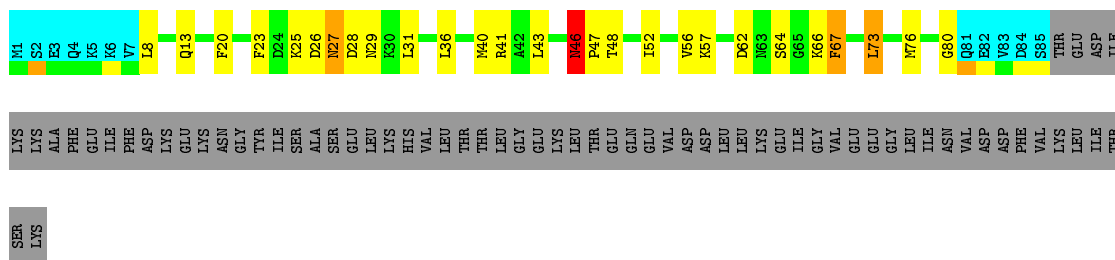
- Molecule 1: Calmodulin, putative



4.2.9 Score per residue for model 9

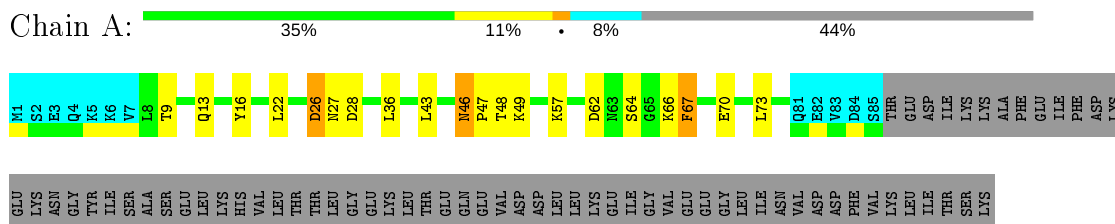
- Molecule 1: Calmodulin, putative





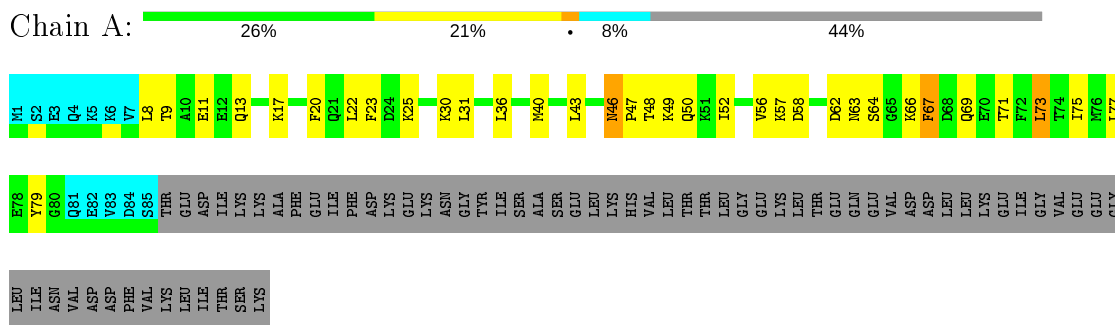
4.2.10 Score per residue for model 10

- Molecule 1: Calmodulin, putative



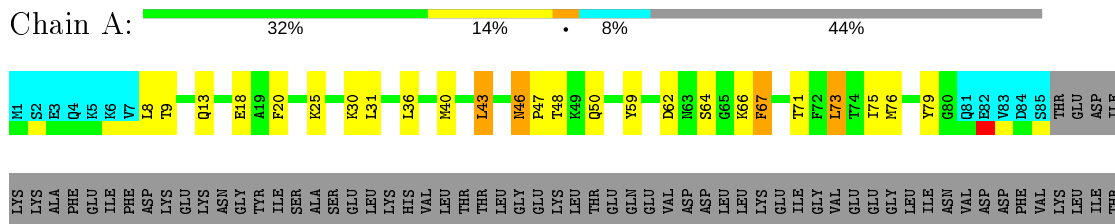
4.2.11 Score per residue for model 11

- Molecule 1: Calmodulin, putative



4.2.12 Score per residue for model 12

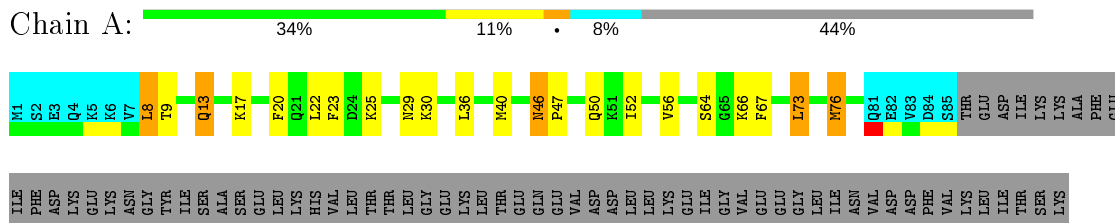
- Molecule 1: Calmodulin, putative



SER
LYS

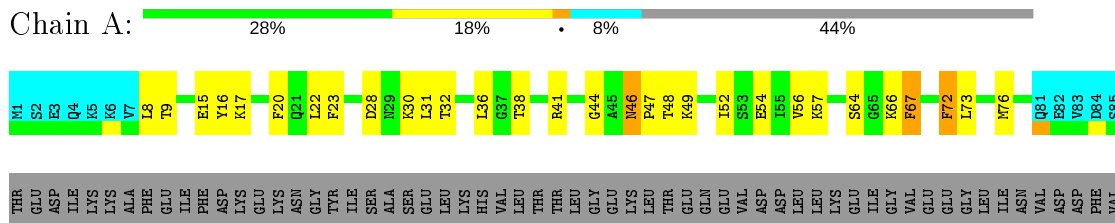
4.2.13 Score per residue for model 13

- Molecule 1: Calmodulin, putative



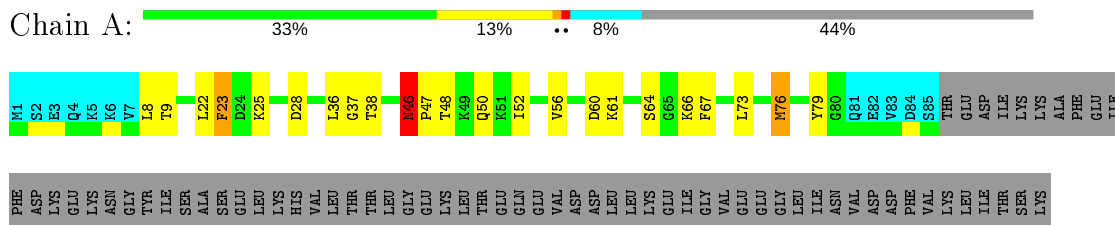
4.2.14 Score per residue for model 14

- Molecule 1: Calmodulin, putative

LYS
LEU
ILE
THR
SER
LYS

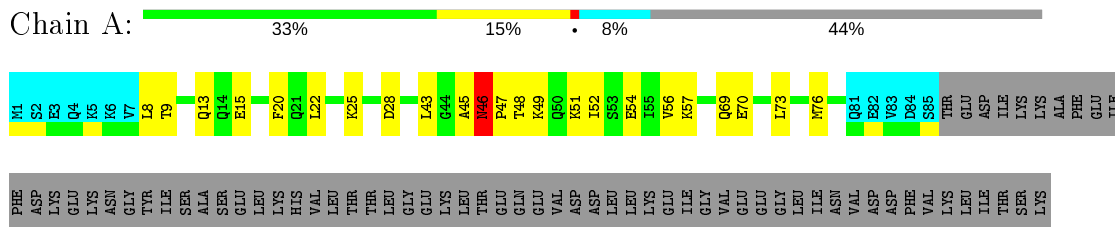
4.2.15 Score per residue for model 15

- Molecule 1: Calmodulin, putative



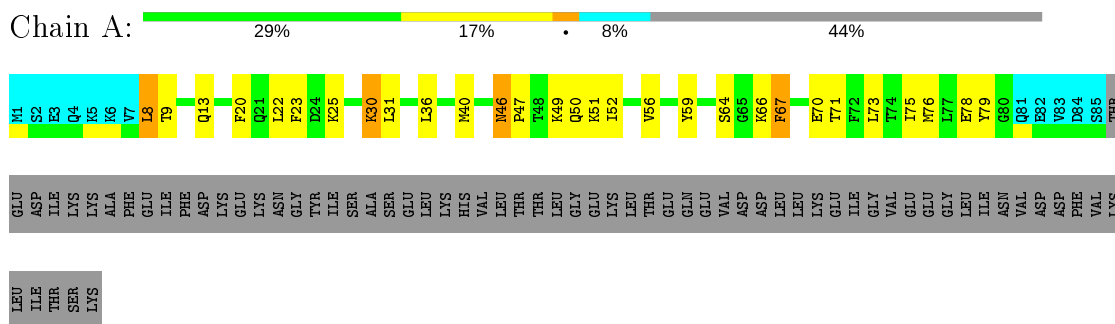
4.2.16 Score per residue for model 16

- Molecule 1: Calmodulin, putative



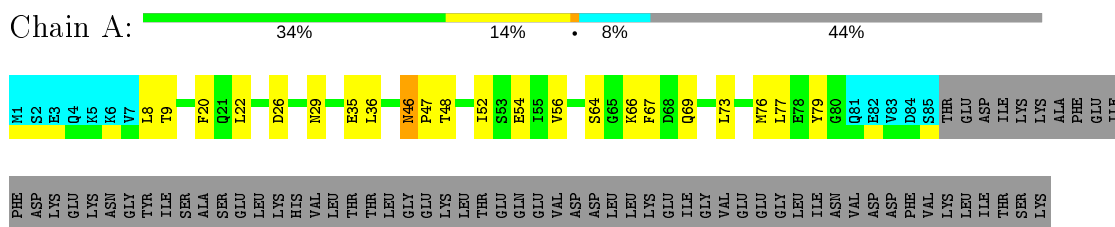
4.2.17 Score per residue for model 17

- Molecule 1: Calmodulin, putative



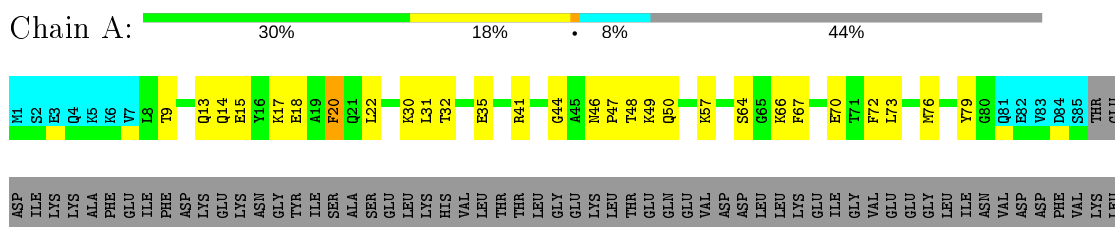
4.2.18 Score per residue for model 18

- Molecule 1: Calmodulin, putative



4.2.19 Score per residue for model 19


- Molecule 1: Calmodulin, putative

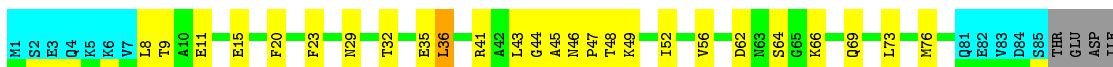


ILE
THR
SER
LYS

4.2.20 Score per residue for model 20

- Molecule 1: Calmodulin, putative

Chain A:  31% 17% 8% 44%



LYS
LYS
ALA
PHE
GLU
ILE
PHE
ASP
LYS
GLU
LYS
ASN
GLY
TYR
ILE
SER
ALA
SER
GLU
LEU
LYS
HIS
VAL
LEU
THR
THR
LEU
GLY
L43
GLU
LYS
LYS
LEU
THR
GLU
GLN
GLU
VAL
ASP
ASP
LEU
LEU
LYS
GLU
ILE
GLY
VAL
GLU
GLU
GLY
LEU
ILE
ASN
VAL
ASP
ASP
PHE
VAL
LYS
LEU
ILE
THR

SER
LYS

5 Refinement protocol and experimental data overview

The models were refined using the following method: *DGSA-distance geometry simulated annealing, DISTANCE GEOMETRY, SIMULATED ANNEALING*.

Of the 100 calculated structures, 20 were deposited, based on the following criterion: *STRUCTURES WITH THE LOWEST ENER*.

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

Software name	Classification	Version
TALOS	structure solution	
CYANA 3.0	refinement	Beta

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	1386
Number of shifts mapped to atoms	1386
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	77%

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:
CA

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	589	568	568	7±2
All	All	11820	11360	11360	147

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:36:LEU:HD13	1:A:67:PHE:CG	0.65	2.27	12	4
1:A:20:PHE:CD2	1:A:31:LEU:HD13	0.65	2.27	2	2
1:A:8:LEU:HD11	1:A:77:LEU:HD23	0.63	1.70	8	2
1:A:8:LEU:HD13	1:A:80:GLY:C	0.62	2.14	9	1
1:A:52:ILE:O	1:A:56:VAL:HG23	0.61	1.95	2	12
1:A:23:PHE:CZ	1:A:38:THR:HG21	0.61	2.30	4	6
1:A:32:THR:HG22	1:A:35:GLU:OE2	0.60	1.95	4	1
1:A:13:GLN:CD	1:A:73:LEU:HD21	0.60	2.16	9	3
1:A:8:LEU:HD21	1:A:76:MET:O	0.59	1.97	13	1
1:A:16:TYR:CE2	1:A:73:LEU:HD12	0.59	2.32	2	1
1:A:20:PHE:HB2	1:A:31:LEU:HD21	0.58	1.76	19	2
1:A:20:PHE:CD2	1:A:31:LEU:HD22	0.58	2.33	11	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:31:LEU:HD12	1:A:35:GLU:HB3	0.58	1.75	1	2
1:A:36:LEU:HD22	1:A:67:PHE:CE1	0.57	2.34	2	7
1:A:30:LYS:O	1:A:31:LEU:HD12	0.57	2.00	11	2
1:A:30:LYS:C	1:A:31:LEU:HD22	0.56	2.20	8	2
1:A:17:LYS:HD3	1:A:73:LEU:HD11	0.56	1.78	11	3
1:A:32:THR:HG22	1:A:66:LYS:CE	0.55	2.31	14	1
1:A:20:PHE:O	1:A:31:LEU:HD11	0.54	2.02	3	2
1:A:36:LEU:CD2	1:A:56:VAL:HG21	0.54	2.33	15	2
1:A:36:LEU:HD23	1:A:56:VAL:HG11	0.53	1.81	17	1
1:A:36:LEU:HD13	1:A:67:PHE:CD2	0.52	2.39	7	4
1:A:71:THR:HG22	1:A:75:ILE:HD11	0.49	1.84	11	2
1:A:43:LEU:HD13	1:A:43:LEU:O	0.49	2.08	12	1
1:A:36:LEU:O	1:A:36:LEU:HD13	0.49	2.07	20	1
1:A:36:LEU:HD22	1:A:67:PHE:CZ	0.49	2.43	7	2
1:A:31:LEU:HD12	1:A:35:GLU:CB	0.49	2.37	1	2
1:A:71:THR:HG22	1:A:75:ILE:CD1	0.49	2.38	11	2
1:A:36:LEU:HD22	1:A:67:PHE:CD1	0.48	2.43	12	2
1:A:32:THR:HG23	1:A:35:GLU:OE1	0.47	2.09	19	1
1:A:46:ASN:CB	1:A:47:PRO:CD	0.47	2.93	3	18
1:A:32:THR:HG23	1:A:35:GLU:OE2	0.47	2.10	20	1
1:A:36:LEU:HD21	1:A:56:VAL:HG21	0.47	1.86	15	1
1:A:52:ILE:O	1:A:56:VAL:HG13	0.46	2.10	17	1
1:A:41:ARG:O	1:A:45:ALA:HB2	0.46	2.11	20	1
1:A:32:THR:HG22	1:A:66:LYS:HE2	0.45	1.89	14	1
1:A:36:LEU:HD23	1:A:56:VAL:HG21	0.45	1.88	18	1
1:A:16:TYR:CZ	1:A:73:LEU:HD12	0.45	2.47	2	1
1:A:8:LEU:O	1:A:8:LEU:HD23	0.45	2.12	6	1
1:A:13:GLN:CG	1:A:73:LEU:HD11	0.45	2.41	13	1
1:A:23:PHE:CE2	1:A:38:THR:HG21	0.44	2.47	5	1
1:A:13:GLN:HG3	1:A:73:LEU:HD21	0.44	1.88	3	1
1:A:30:LYS:O	1:A:31:LEU:HD13	0.44	2.13	14	2
1:A:31:LEU:HD12	1:A:35:GLU:CD	0.43	2.33	8	2
1:A:46:ASN:N	1:A:47:PRO:HD2	0.43	2.28	18	18
1:A:69:GLN:O	1:A:73:LEU:HD12	0.43	2.13	6	3
1:A:8:LEU:HD11	1:A:77:LEU:CD2	0.43	2.43	4	1
1:A:36:LEU:HD13	1:A:67:PHE:CE2	0.43	2.49	2	1
1:A:20:PHE:HD2	1:A:31:LEU:HD13	0.42	1.73	3	1
1:A:13:GLN:HG3	1:A:73:LEU:HD11	0.42	1.91	13	1
1:A:20:PHE:HB2	1:A:31:LEU:HD13	0.42	1.90	9	2
1:A:8:LEU:HD13	1:A:76:MET:CE	0.42	2.44	15	1
1:A:77:LEU:HD13	1:A:77:LEU:C	0.42	2.35	7	1

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Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:32:THR:HG22	1:A:66:LYS:NZ	0.42	2.29	14	1
1:A:52:ILE:O	1:A:56:VAL:HG22	0.42	2.15	17	1
1:A:8:LEU:HD13	1:A:80:GLY:O	0.41	2.14	9	1
1:A:8:LEU:HD11	1:A:76:MET:CE	0.41	2.46	6	1
1:A:20:PHE:CG	1:A:31:LEU:HD13	0.41	2.50	2	1
1:A:36:LEU:CD2	1:A:56:VAL:HG11	0.41	2.45	17	1
1:A:16:TYR:HH	1:A:72:PHE:HD2	0.41	1.56	14	1
1:A:37:GLY:HA2	1:A:52:ILE:HD12	0.41	1.93	15	1
1:A:20:PHE:HB3	1:A:31:LEU:HD13	0.41	1.93	7	1
1:A:36:LEU:HD13	1:A:67:PHE:CZ	0.40	2.50	2	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	73/151 (48%)	66±1 (90±2%)	6±1 (8±2%)	1±1 (1±1%)	17	64
All	All	1460/3020 (48%)	1321 (90%)	121 (8%)	18 (1%)	17	64

All 7 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	46	ASN	6
1	A	44	GLY	4
1	A	80	GLY	3
1	A	26	ASP	2
1	A	45	ALA	1
1	A	27	ASN	1
1	A	8	LEU	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	64/136 (47%)	46±2 (73±3%)	18±2 (27±3%)	2	21
All	All	1280/2720 (47%)	929 (73%)	351 (27%)	2	21

All 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)
1	A	73	LEU	19
1	A	64	SER	19
1	A	9	THR	19
1	A	48	THR	18
1	A	66	LYS	17
1	A	22	LEU	16
1	A	76	MET	15
1	A	46	ASN	13
1	A	62	ASP	13
1	A	67	PHE	13
1	A	8	LEU	11
1	A	79	TYR	11
1	A	25	LYS	10
1	A	57	LYS	10
1	A	40	MET	9
1	A	23	PHE	9
1	A	50	GLN	9
1	A	49	LYS	9
1	A	70	GLU	8
1	A	17	LYS	8
1	A	20	PHE	8
1	A	13	GLN	8
1	A	54	GLU	7
1	A	28	ASP	6
1	A	43	LEU	6
1	A	72	PHE	5
1	A	26	ASP	4
1	A	15	GLU	4
1	A	41	ARG	4
1	A	27	ASN	4
1	A	69	GLN	4
1	A	29	ASN	4
1	A	77	LEU	3

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Mol	Chain	Res	Type	Models (Total)
1	A	78	GLU	3
1	A	30	LYS	3
1	A	59	TYR	2
1	A	16	TYR	2
1	A	63	ASN	2
1	A	14	GLN	2
1	A	18	GLU	2
1	A	51	LYS	2
1	A	61	LYS	2
1	A	11	GLU	2
1	A	58	ASP	2
1	A	60	ASP	1
1	A	35	GLU	1
1	A	36	LEU	1
1	A	34	GLU	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 carbohydrates in this entry.

6.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 2 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 77% for the well-defined parts and 76% 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	1386
Number of shifts mapped to atoms	1386
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	1

7.1.2 Chemical shift referencing [i](#)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction \pm precision, ppm	Suggested action
$^{13}\text{C}_\alpha$	144	-1.09 ± 0.19	Should be applied
$^{13}\text{C}_\beta$	136	-0.54 ± 0.09	Should be applied
$^{13}\text{C}'$	144	2.51 ± 0.11	Should be applied
^{15}N	135	0.46 ± 0.35	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 77%, i.e. 695 atoms were assigned a chemical shift out of a possible 902. 8 out of 9 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^1H	^{13}C	^{15}N
Backbone	363/363 (100%)	145/145 (100%)	146/146 (100%)	72/72 (100%)
Sidechain	332/479 (69%)	186/278 (67%)	146/181 (81%)	0/20 (0%)

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	Total	¹ H	¹³ C	¹⁵ N
Aromatic	0/60 (0%)	0/32 (0%)	0/28 (0%)	0/0 (—%)
Overall	695/902 (77%)	331/455 (73%)	292/355 (82%)	72/92 (78%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 76%, i.e. 796 atoms were assigned a chemical shift out of a possible 1052. 10 out of 11 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	¹ H	¹³ C	¹⁵ N
Backbone	411/423 (97%)	164/169 (97%)	166/170 (98%)	81/84 (96%)
Sidechain	385/569 (68%)	215/331 (65%)	170/214 (79%)	0/24 (0%)
Aromatic	0/60 (0%)	0/32 (0%)	0/28 (0%)	0/0 (—%)
Overall	796/1052 (76%)	379/532 (71%)	336/412 (82%)	81/108 (75%)

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	127	ASP	HB3	0.78	4.07 – 1.27	-6.7

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:

