



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 12:12 AM UTC

PDB ID : 4MMR / pdb_00004mmr
Title : Crystal Structure of Prefusion-stabilized RSV F Variant Cav1 at pH 9.5
Authors : Stewart-Jones, G.B.E.; McLellan, J.S.; Joyce, M.G.; Sastry, M.; Yang, Y.;
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Deposited on : 2013-09-09
Resolution : 3.10 Å(reported)

This is a Full wwPDB X-ray 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/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

MolProbity : 4-5-2 with Phenix2.0
Xtriage (Phenix) : 2.0
EDS : 3.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4 : 9.0.010 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

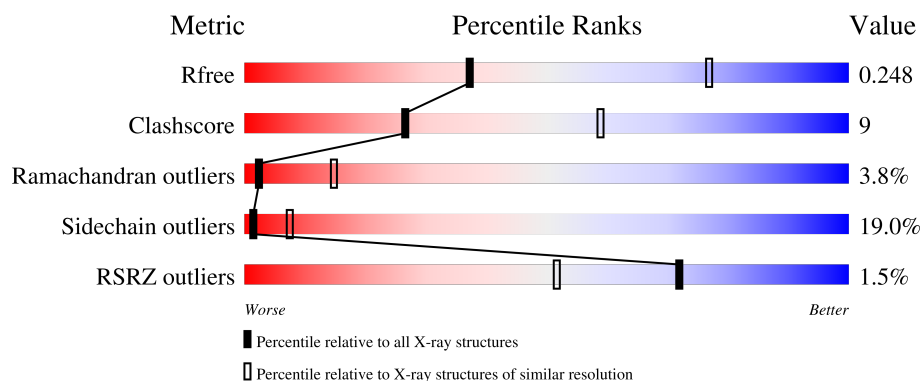
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.10 Å.

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)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	1456 (3.10-3.10)
Clashscore	190562	1539 (3.10-3.10)
Ramachandran outliers	187476	1467 (3.10-3.10)
Sidechain outliers	187428	1467 (3.10-3.10)
RSRZ outliers	180081	1456 (3.10-3.10)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. 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 $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	82	7% 59% 22% 12% • 5%
2	B	414	62% 23% 6% • 9%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 3523 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Fusion glycoprotein F2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	78	Total	C	N	O	S	0	0	0
			612	385	100	124	3			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	102	ALA	PRO	engineered mutation	UNP P03420

- Molecule 2 is a protein called Fusion glycoprotein F1 fused with Fibrin trimerization domain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	377	Total	C	N	O	S	0	0	0
			2911	1841	480	572	18			

There are 15 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	190	PHE	SER	engineered mutation	UNP P03420
B	207	LEU	VAL	engineered mutation	UNP P03420
B	379	VAL	ILE	engineered mutation	UNP P03420
B	447	VAL	MET	engineered mutation	UNP P03420
B	514	SER	-	linker	UNP P03420
B	515	ALA	-	linker	UNP P03420
B	516	ILE	-	linker	UNP P03420
B	517	GLY	-	linker	UNP P03420
B	539	LEU	PHE	variant	UNP P10104
B	545	GLY	-	expression tag	UNP P10104
B	546	GLY	-	expression tag	UNP P10104
B	547	LEU	-	expression tag	UNP P10104
B	548	VAL	-	expression tag	UNP P10104
B	549	PRO	-	expression tag	UNP P10104

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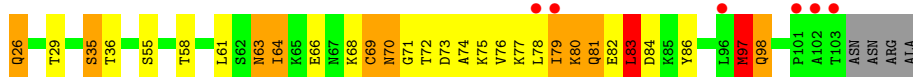
Chain	Residue	Modelled	Actual	Comment	Reference
B	550	ARG	-	expression tag	UNP P10104

3 Residue-property plots

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-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. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

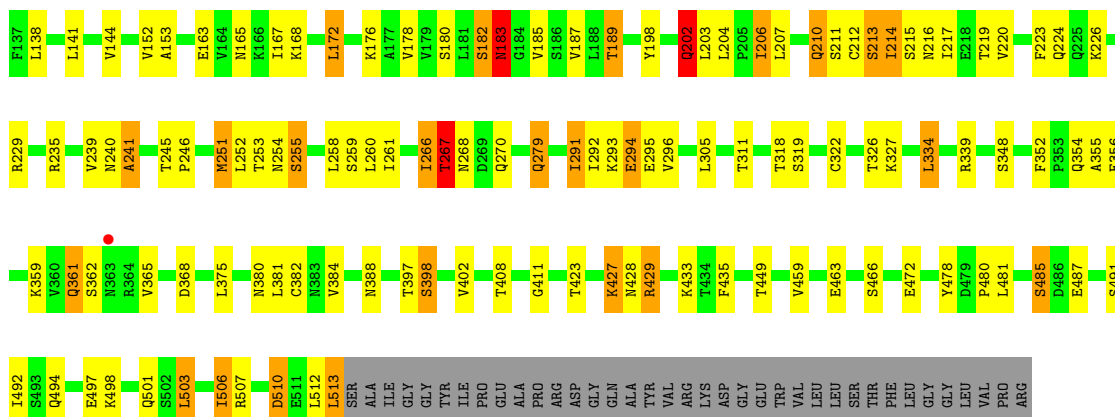
- Molecule 1: Fusion glycoprotein F2

Chain A: 



- Molecule 2: Fusion glycoprotein F1 fused with Fibrin trimerization domain

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 3 2	Depositor
Cell constants a, b, c, α , β , γ	170.85Å 170.85Å 170.85Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	45.66 – 3.10 45.66 – 3.10	Depositor EDS
% Data completeness (in resolution range)	99.1 (45.66-3.10) 99.1 (45.66-3.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.62 (at 3.12Å)	Xtriage
Refinement program	REFMAC 5.7.0032	Depositor
R, R_{free}	0.219 , 0.264 0.209 , 0.248	Depositor DCC
R_{free} test set	796 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å ²)	98.4	Xtriage
Anisotropy	0.000	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 95.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3523	wwPDB-VP
Average B, all atoms (Å ²)	124.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.46% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

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 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	0.82	1/619 (0.2%)	0.98	1/836 (0.1%)
2	B	0.81	0/2955	1.10	10/4007 (0.2%)
All	All	0.81	1/3574 (0.0%)	1.08	11/4843 (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 outliers	#Planarity outliers
2	B	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	70	ASN	CA-C	6.16	1.56	1.52

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	375	LEU	CA-C-N	8.75	128.81	119.89
2	B	375	LEU	C-N-CA	8.75	128.81	119.89
2	B	326	THR	N-CA-C	7.78	119.84	111.36
2	B	291	ILE	CB-CA-C	-7.66	100.00	111.80
2	B	183	ASN	N-CA-C	-6.49	105.00	113.12
2	B	388	ASN	N-CA-C	5.88	116.36	109.60
2	B	352	PHE	CA-C-N	5.70	125.07	118.85
2	B	352	PHE	C-N-CA	5.70	125.07	118.85
2	B	291	ILE	N-CA-C	5.58	115.20	108.06
2	B	266	ILE	CB-CA-C	-5.47	103.69	111.40
1	A	84	ASP	N-CA-C	-5.06	105.45	110.97

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	B	182	SER	Peptide

5.2 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 the 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 within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	612	0	620	18	0
2	B	2911	0	2947	55	1
All	All	3523	0	3567	66	1

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 9.

All (66) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:361:GLN:O	2:B:362:SER:OG	2.10	0.69
1:A:70:ASN:N	2:B:212:CYS:SG	2.68	0.66
2:B:397:THR:OG1	2:B:487:GLU:HB2	1.94	0.66
1:A:97:MET:SD	1:A:98:GLN:HG3	2.36	0.66
2:B:506:ILE:HG22	2:B:507:ARG:N	2.09	0.65
1:A:63:ASN:OD1	1:A:63:ASN:N	2.31	0.62
2:B:229:ARG:HH21	2:B:253:THR:HG23	1.67	0.59
2:B:245:THR:HA	2:B:246:PRO:C	2.28	0.59
2:B:279:GLN:N	2:B:279:GLN:OE1	2.35	0.58
2:B:429:ARG:HB2	2:B:429:ARG:CZ	2.34	0.58
2:B:167:ILE:HG23	2:B:189:THR:HG21	1.85	0.58
2:B:178:VAL:HG12	2:B:178:VAL:O	2.02	0.58
2:B:267:THR:OG1	2:B:268:ASN:N	2.36	0.57
2:B:334:LEU:C	2:B:334:LEU:HD23	2.29	0.57
2:B:427:LYS:HD3	2:B:428:ASN:N	2.21	0.55
1:A:78:LEU:CD2	2:B:220:VAL:HG11	2.37	0.55
1:A:97:MET:HB3	1:A:98:GLN:HE21	1.72	0.53
2:B:433:LYS:HE3	2:B:435:PHE:CE1	2.44	0.53
2:B:478:TYR:O	2:B:480:PRO:HD3	2.08	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:368:ASP:OD1	2:B:368:ASP:C	2.52	0.52
1:A:26:GLN:O	1:A:26:GLN:OE1	2.26	0.52
2:B:163:GLU:CD	2:B:182:SER:H	2.18	0.52
2:B:240:ASN:O	2:B:241:ALA:C	2.53	0.51
2:B:293:LYS:O	2:B:294:GLU:C	2.53	0.51
1:A:69:CYS:SG	1:A:70:ASN:N	2.83	0.51
2:B:198:TYR:C	2:B:198:TYR:CD1	2.89	0.50
2:B:202:GLN:HE21	2:B:202:GLN:C	2.19	0.50
2:B:506:ILE:CG2	2:B:507:ARG:N	2.75	0.50
2:B:202:GLN:O	2:B:202:GLN:NE2	2.45	0.49
1:A:82:GLU:HG2	2:B:224:GLN:HA	1.94	0.49
2:B:258:LEU:HA	2:B:261:ILE:HD12	1.95	0.49
1:A:35:SER:HB2	1:A:36:THR:HG23	1.94	0.49
2:B:293:LYS:O	2:B:296:VAL:HG12	2.14	0.48
1:A:80:LYS:HD3	1:A:81:GLN:N	2.28	0.48
1:A:86:TYR:C	1:A:86:TYR:CD1	2.92	0.48
1:A:63:ASN:C	1:A:64:ILE:HG12	2.40	0.47
1:A:76:VAL:HA	1:A:79:ILE:HG22	1.95	0.47
2:B:211:SER:OG	2:B:212:CYS:SG	2.65	0.47
2:B:267:THR:HG23	2:B:270:GLN:HG3	1.97	0.47
1:A:78:LEU:HD22	2:B:220:VAL:HG11	1.96	0.46
2:B:138:LEU:HB3	2:B:141:LEU:HD12	1.98	0.46
2:B:223:PHE:HA	2:B:226:LYS:HB2	1.97	0.46
2:B:408:THR:OG1	2:B:411:GLY:N	2.49	0.46
2:B:398:SER:HA	2:B:485:SER:O	2.16	0.46
2:B:254:ASN:O	2:B:255:SER:C	2.58	0.45
2:B:428:ASN:HB2	2:B:429:ARG:NH1	2.31	0.45
1:A:71:GLY:N	2:B:212:CYS:SG	2.90	0.45
2:B:152:VAL:O	2:B:153:ALA:C	2.59	0.45
1:A:83:LEU:HA	1:A:86:TYR:HB3	1.99	0.45
2:B:293:LYS:O	2:B:295:GLU:N	2.50	0.45
2:B:318:THR:O	2:B:339:ARG:NH1	2.51	0.44
2:B:254:ASN:ND2	2:B:254:ASN:H	2.16	0.43
2:B:210:GLN:HA	2:B:212:CYS:HA	2.01	0.43
2:B:503:LEU:O	2:B:507:ARG:HG3	2.19	0.43
2:B:491:SER:OG	2:B:494:GLN:HB2	2.18	0.42
2:B:223:PHE:O	2:B:224:GLN:C	2.62	0.42
2:B:497:GLU:HG2	2:B:498:LYS:N	2.34	0.42
2:B:183:ASN:OD1	2:B:185:VAL:HG22	2.20	0.42
1:A:73:ASP:HB3	2:B:214:ILE:HB	2.00	0.42
2:B:251:MET:HE2	2:B:251:MET:HB2	1.97	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:507:ARG:CZ	2:B:507:ARG:HB2	2.49	0.42
1:A:61:LEU:O	2:B:295:GLU:CB	2.68	0.42
2:B:254:ASN:O	2:B:258:LEU:HD12	2.20	0.42
2:B:361:GLN:C	2:B:362:SER:HG	2.16	0.42
2:B:183:ASN:HD21	2:B:185:VAL:HG13	1.85	0.40
2:B:512:LEU:HD23	2:B:513:LEU:HD22	2.03	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:213:SER:OG	2:B:215:SER:O[14_444]	2.19	0.01

5.3 Torsion angles [i](#)

5.3.1 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 X-ray entries followed by that with respect to entries of similar resolution.

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	76/82 (93%)	56 (74%)	15 (20%)	5 (7%)	1	6
2	B	375/414 (91%)	306 (82%)	57 (15%)	12 (3%)	3	18
All	All	451/496 (91%)	362 (80%)	72 (16%)	17 (4%)	2	15

All (17) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	64	ILE
2	B	202	GLN
2	B	294	GLU
1	A	74	ALA
1	A	83	LEU
2	B	206	ILE
2	B	213	SER

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Mol	Chain	Res	Type
2	B	267	THR
2	B	510	ASP
1	A	97	MET
2	B	172	LEU
2	B	255	SER
2	B	382	CYS
2	B	241	ALA
1	A	55	SER
2	B	355	ALA
2	B	217	ILE

5.3.2 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 X-ray entries followed by that with respect to entries of similar resolution.

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	70/73 (96%)	53 (76%)	17 (24%)	1	3
2	B	345/373 (92%)	283 (82%)	62 (18%)	2	8
All	All	415/446 (93%)	336 (81%)	79 (19%)	1	7

All (79) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	26	GLN
1	A	29	THR
1	A	35	SER
1	A	58	THR
1	A	63	ASN
1	A	66	GLU
1	A	68	LYS
1	A	69	CYS
1	A	72	THR
1	A	75	LYS
1	A	77	LYS
1	A	79	ILE
1	A	80	LYS

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Mol	Chain	Res	Type
1	A	81	GLN
1	A	83	LEU
1	A	97	MET
1	A	98	GLN
2	B	144	VAL
2	B	165	ASN
2	B	168	LYS
2	B	172	LEU
2	B	176	LYS
2	B	180	SER
2	B	183	ASN
2	B	187	VAL
2	B	189	THR
2	B	202	GLN
2	B	203	LEU
2	B	204	LEU
2	B	206	ILE
2	B	207	LEU
2	B	210	GLN
2	B	214	ILE
2	B	216	ASN
2	B	219	THR
2	B	235	ARG
2	B	239	VAL
2	B	251	MET
2	B	252	LEU
2	B	259	SER
2	B	260	LEU
2	B	266	ILE
2	B	267	THR
2	B	279	GLN
2	B	291	ILE
2	B	292	ILE
2	B	305	LEU
2	B	311	THR
2	B	319	SER
2	B	322	CYS
2	B	327	LYS
2	B	334	LEU
2	B	348	SER
2	B	354	GLN
2	B	356	GLU

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Mol	Chain	Res	Type
2	B	359	LYS
2	B	361	GLN
2	B	365	VAL
2	B	380	ASN
2	B	381	LEU
2	B	384	VAL
2	B	398	SER
2	B	402	VAL
2	B	423	THR
2	B	427	LYS
2	B	429	ARG
2	B	449	THR
2	B	459	VAL
2	B	463	GLU
2	B	466	SER
2	B	472	GLU
2	B	481	LEU
2	B	485	SER
2	B	492	ILE
2	B	501	GLN
2	B	503	LEU
2	B	506	ILE
2	B	510	ASP
2	B	513	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	70	ASN
1	A	81	GLN
1	A	98	GLN
2	B	202	GLN
2	B	216	ASN
2	B	254	ASN
2	B	276	ASN
2	B	277	ASN
2	B	354	GLN
2	B	380	ASN
2	B	501	GLN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

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

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	78/82 (95%)	0.13	6 (7%) 19 10	82, 134, 237, 245	0
2	B	377/414 (91%)	-0.21	1 (0%) 90 80	68, 105, 185, 306	0
All	All	455/496 (91%)	-0.15	7 (1%) 72 52	68, 107, 203, 306	0

All (7) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	102	ALA	5.7
1	A	96	LEU	3.2
1	A	101	PRO	2.7
1	A	78	LEU	2.5
2	B	363	ASN	2.3
1	A	103	THR	2.3
1	A	79	ILE	2.2

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

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

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.