



Full wwPDB X-ray Structure Validation Report ⓘ

Jul 29, 2024 – 02:39 PM EDT

PDB ID : 9AUN
Title : Structure of SARS-CoV-2 Mpro mutant (T21I,T304I)
Authors : Gajiwala, K.S.; Greasley, S.E.; Ferre, R.A.; Liu, W.; Stewart, A.E.
Deposited on : 2024-02-29
Resolution : 2.29 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 : 4.02b-467
Xtriage (Phenix) : 1.13
EDS : 2.37.1
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.37.1

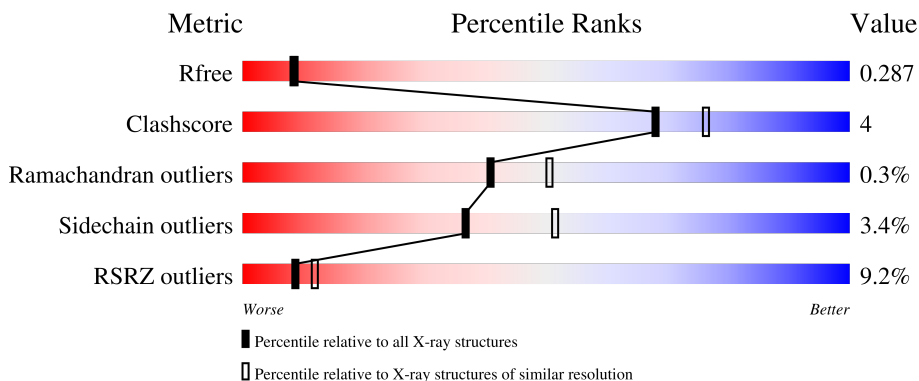
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.29 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}	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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	306	 3% 89% 11%
1	B	306	 15% 85% 13% ..

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4708 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 3C-like proteinase nsp5.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	306	2369	1503	402	442	22	0	0	0
1	B	301	2330	1476	396	436	22	0	0	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	21	ILE	THR	engineered mutation	UNP P0DTD1
A	304	ILE	THR	engineered mutation	UNP P0DTD1
B	21	ILE	THR	engineered mutation	UNP P0DTD1
B	304	ILE	THR	engineered mutation	UNP P0DTD1

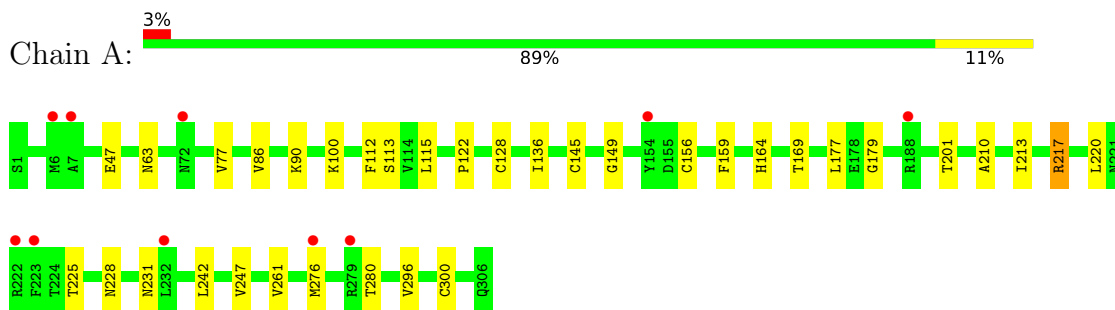
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	8	Total	O	0	0
			8	8		
2	B	1	Total	O	0	0
			1	1		

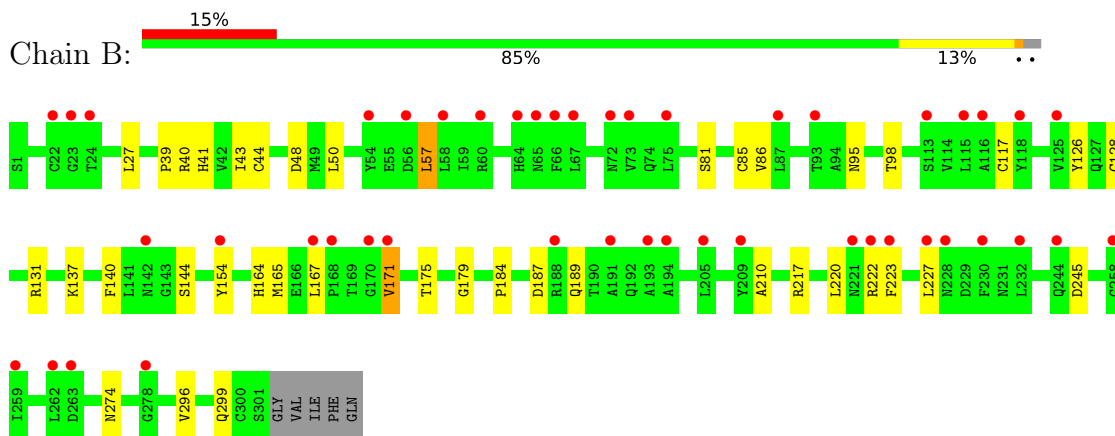
3 Residue-property plots [i](#)

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: 3C-like proteinase nsp5



- Molecule 1: 3C-like proteinase nsp5



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	123.27Å 82.08Å 64.37Å 90.00° 90.33° 90.00°	Depositor
Resolution (Å)	32.19 – 2.29 32.19 – 2.29	Depositor EDS
% Data completeness (in resolution range)	72.0 (32.19-2.29) 72.0 (32.19-2.29)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.69 (at 2.29Å)	Xtrriage
Refinement program	BUSTER 2.11.8 (8-JUN-2022)	Depositor
R, R_{free}	0.242 , 0.291 0.235 , 0.287	Depositor DCC
R_{free} test set	1052 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	64.5	Xtrriage
Anisotropy	0.011	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 38.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtrriage
Estimated twinning fraction	0.022 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	4708	wwPDB-VP
Average B, all atoms (Å ²)	71.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.43% 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 [i](#)

5.1 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 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	0.39	0/2422	0.60	0/3291
1	B	0.35	0/2382	0.55	0/3237
All	All	0.37	0/4804	0.57	0/6528

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 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 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	2369	0	2322	17	0
1	B	2330	0	2282	18	0
2	A	8	0	0	0	0
2	B	1	0	0	0	0
All	All	4708	0	4604	35	0

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 4.

All (35) 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)
1:A:100:LYS:NZ	1:A:156:CYS:HB2	1.83	0.93

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:100:LYS:HZ2	1:A:156:CYS:HB2	1.41	0.83
1:A:86:VAL:HG13	1:A:179:GLY:HA2	1.77	0.67
1:A:100:LYS:HZ3	1:A:156:CYS:HB2	1.59	0.65
1:B:43:ILE:HD12	1:B:57:LEU:HB3	1.83	0.61
1:B:86:VAL:HG13	1:B:179:GLY:HA2	1.86	0.58
1:B:167:LEU:HD12	1:B:171:VAL:HG23	1.87	0.57
1:A:231:ASN:HD21	1:A:242:LEU:H	1.51	0.57
1:A:213:ILE:HG21	1:A:300:CYS:HB3	1.88	0.56
1:B:164:HIS:CE1	1:B:175:THR:HG23	2.40	0.55
1:A:115:LEU:HD11	1:A:122:PRO:HB3	1.88	0.55
1:A:231:ASN:ND2	1:A:242:LEU:H	2.05	0.55
1:A:145:CYS:SG	1:A:164:HIS:O	2.66	0.53
1:A:159:PHE:HB3	1:A:177:LEU:HD13	1.91	0.53
1:B:210:ALA:HB2	1:B:296:VAL:HG13	1.94	0.50
1:B:44:CYS:HB3	1:B:48:ASP:HB2	1.94	0.50
1:A:63:ASN:HB3	1:A:77:VAL:O	2.12	0.49
1:B:40:ARG:HD3	1:B:85:CYS:HA	1.95	0.49
1:B:126:TYR:HE2	1:B:128:CYS:SG	2.37	0.48
1:B:164:HIS:CE1	1:B:175:THR:CG2	2.97	0.47
1:B:222:ARG:NH2	1:B:223:PHE:CE1	2.83	0.47
1:A:247:VAL:HG13	1:A:261:VAL:HG11	1.96	0.46
1:B:217:ARG:HB2	1:B:220:LEU:HD12	1.97	0.46
1:B:41:HIS:ND1	1:B:165:MET:CE	2.79	0.45
1:A:217:ARG:HB3	1:A:220:LEU:HD12	1.99	0.44
1:B:95:ASN:HB3	1:B:98:THR:OG1	2.18	0.44
1:B:117:CYS:O	1:B:144:SER:HA	2.18	0.43
1:B:140:PHE:HB3	1:B:144:SER:OG	2.18	0.43
1:A:210:ALA:HB2	1:A:296:VAL:HG13	2.02	0.42
1:B:131:ARG:HD3	1:B:137:LYS:HE2	2.02	0.42
1:A:113:SER:O	1:A:149:GLY:HA2	2.19	0.42
1:A:276:MET:HE2	1:A:280:THR:HA	2.02	0.41
1:A:112:PHE:HZ	1:A:136:ILE:HG21	1.85	0.41
1:B:126:TYR:HE2	1:B:128:CYS:HG	1.63	0.41
1:B:27:LEU:HD13	1:B:39:PRO:HD2	2.04	0.40

There are no symmetry-related clashes.

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	304/306 (99%)	294 (97%)	10 (3%)	0	100	100
1	B	299/306 (98%)	279 (93%)	18 (6%)	2 (1%)	22	26
All	All	603/612 (98%)	573 (95%)	28 (5%)	2 (0%)	41	50

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	154	TYR
1	B	184	PRO

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	263/263 (100%)	255 (97%)	8 (3%)	41	57
1	B	259/263 (98%)	249 (96%)	10 (4%)	32	46
All	All	522/526 (99%)	504 (97%)	18 (3%)	37	51

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	47	GLU
1	A	90	LYS
1	A	128	CYS
1	A	169	THR

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Mol	Chain	Res	Type
1	A	201	THR
1	A	217	ARG
1	A	225	THR
1	A	228	ASN
1	B	50	LEU
1	B	57	LEU
1	B	81	SER
1	B	171	VAL
1	B	187	ASP
1	B	189	GLN
1	B	227	LEU
1	B	245	ASP
1	B	274	ASN
1	B	299	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	231	ASN
1	B	19	GLN
1	B	164	HIS

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 monosaccharides 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

6.1 Protein, DNA and RNA chains

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	306/306 (100%)	0.31	10 (3%) 46 53	37, 59, 81, 99	0
1	B	301/306 (98%)	0.93	46 (15%) 2 3	43, 80, 112, 120	0
All	All	607/612 (99%)	0.62	56 (9%) 9 12	37, 68, 108, 120	0

All (56) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	64	HIS	6.3
1	B	60	ARG	6.1
1	B	154	TYR	5.1
1	B	223	PHE	5.1
1	B	66	PHE	4.5
1	B	167	LEU	4.4
1	B	191	ALA	4.2
1	B	227	LEU	3.9
1	A	154	TYR	3.8
1	B	205	LEU	3.8
1	B	228	ASN	3.6
1	B	22	CYS	3.5
1	A	223	PHE	3.5
1	B	230	PHE	3.5
1	B	72	ASN	3.3
1	B	142	ASN	3.3
1	B	222	ARG	3.3
1	B	258	GLY	3.2
1	B	263	ASP	3.2
1	B	65	ASN	3.2
1	B	193	ALA	3.2
1	B	75	LEU	3.1
1	A	222	ARG	3.1
1	B	67	LEU	2.8

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Mol	Chain	Res	Type	RSRZ
1	B	58	LEU	2.8
1	B	262	LEU	2.7
1	A	276	MET	2.7
1	B	24	THR	2.7
1	B	54	TYR	2.7
1	B	93	THR	2.6
1	B	168	PRO	2.6
1	B	244	GLN	2.5
1	B	87	LEU	2.5
1	B	232	LEU	2.5
1	B	23	GLY	2.5
1	B	278	GLY	2.5
1	A	7	ALA	2.5
1	B	170	GLY	2.4
1	B	125	VAL	2.4
1	B	116	ALA	2.4
1	B	171	VAL	2.4
1	B	209	TYR	2.4
1	B	221	ASN	2.4
1	B	118	TYR	2.3
1	B	188	ARG	2.2
1	B	115	LEU	2.2
1	B	73	VAL	2.2
1	B	194	ALA	2.2
1	B	56	ASP	2.2
1	A	232	LEU	2.2
1	A	6	MET	2.2
1	A	279	ARG	2.1
1	A	72	ASN	2.1
1	A	188	ARG	2.1
1	B	113	SER	2.1
1	B	259	ILE	2.0

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 monosaccharides 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.