



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 2, 2025 – 02:34 PM EST

PDB ID : 9BNX
Title : Crystal Structure of L50F SARS-CoV-2 Main Protease
Authors : Papini, C.; Kenneson, J.; Anderson, K.S.
Deposited on : 2024-05-03
Resolution : 2.48 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
Xtrriage (Phenix) : 1.21
EDS : 3.0
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4 : 9.0.004 (Gargrove)
Density-Fitness : 1.0.11
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.40

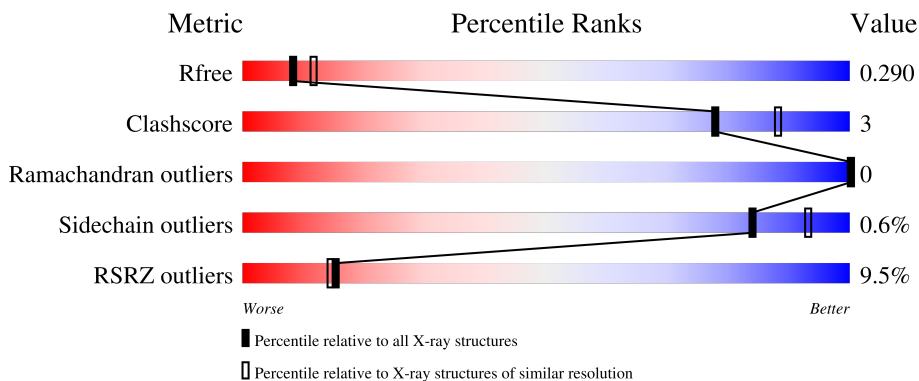
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.48 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}	164625	7106 (2.50-2.46)
Clashscore	180529	7991 (2.50-2.46)
Ramachandran outliers	177936	7888 (2.50-2.46)
Sidechain outliers	177891	7890 (2.50-2.46)
RSRZ outliers	164620	7106 (2.50-2.46)

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	 13% 92% 8%
1	B	306	 6% 93% 7%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4555 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	305	2231	1413	373	425	20	0	0	0
1	B	306	2303	1464	385	432	22	0	0	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	50	PHE	LEU	conflict	UNP P0DTD1
B	50	PHE	LEU	conflict	UNP P0DTD1

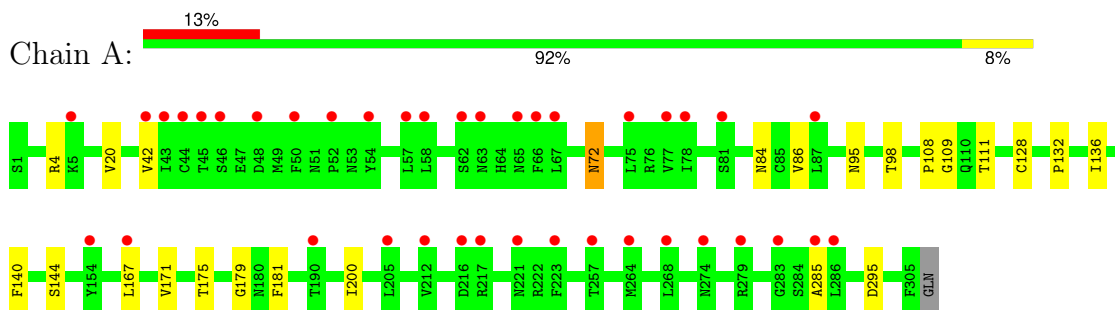
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	5	Total	O	0	0
			5	5		
2	B	16	Total	O	0	0
			16	16		

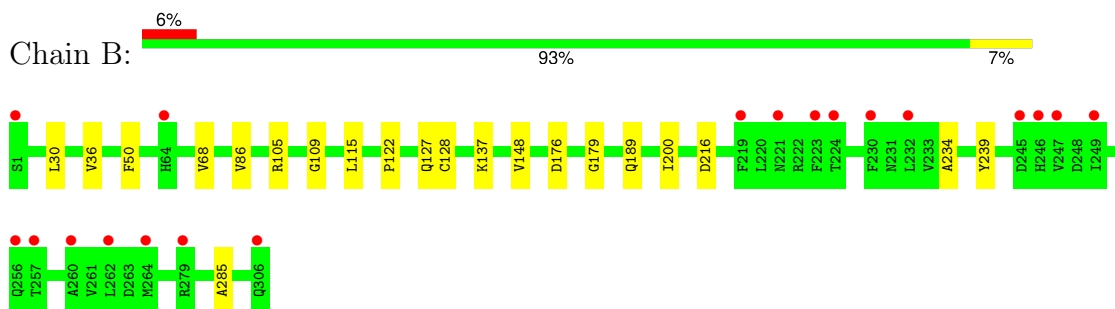
3 Residue-property plots [i](#)

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	122.86Å 81.05Å 63.83Å 90.00° 90.33° 90.00°	Depositor
Resolution (Å)	33.83 – 2.48 33.83 – 2.48	Depositor EDS
% Data completeness (in resolution range)	99.8 (33.83-2.48) 99.8 (33.83-2.48)	Depositor EDS
R_{merge}	0.18	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.07 (at 2.48Å)	Xtrriage
Refinement program	PHENIX 1.19.2_4158	Depositor
R, R_{free}	0.253 , 0.290 0.251 , 0.290	Depositor DCC
R_{free} test set	1182 reflections (5.29%)	wwPDB-VP
Wilson B-factor (Å ²)	64.0	Xtrriage
Anisotropy	0.124	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 39.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.53$, $\langle L^2 \rangle = 0.36$	Xtrriage
Estimated twinning fraction	0.006 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	4555	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 5.85% 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	0.25	0/2280	0.45	0/3115
1	B	0.26	0/2354	0.47	0/3206
All	All	0.25	0/4634	0.46	0/6321

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	2231	0	2089	16	0
1	B	2303	0	2211	12	0
2	A	5	0	0	0	0
2	B	16	0	0	0	0
All	All	4555	0	4300	24	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 3.

All (24) 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:B:234:ALA:HB1	1:B:239:TYR:HB2	1.75	0.69

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:109:GLY:HA2	1:A:200:ILE:HD13	1.76	0.67
1:B:105:ARG:NH1	1:B:176:ASP:OD2	2.34	0.59
1:A:4:ARG:NH2	1:B:127:GLN:O	2.39	0.56
1:A:111:THR:OG1	1:A:295:ASP:OD2	2.24	0.52
1:A:167:LEU:HD12	1:A:171:VAL:HG23	1.93	0.49
1:A:95:ASN:HB3	1:A:98:THR:OG1	2.13	0.49
1:A:175:THR:HG22	1:A:181:PHE:HA	1.94	0.48
1:B:115:LEU:HD11	1:B:122:PRO:HB3	1.94	0.48
1:A:4:ARG:NH1	1:B:137:LYS:O	2.48	0.47
1:A:128:CYS:SG	1:A:136:ILE:HB	2.56	0.45
1:B:109:GLY:HA2	1:B:200:ILE:HD13	1.99	0.45
1:B:30:LEU:HD22	1:B:148:VAL:HG11	1.99	0.44
1:B:50:PHE:HA	1:B:189:GLN:HB3	2.00	0.43
1:A:72:ASN:N	1:A:72:ASN:OD1	2.52	0.43
1:A:285:ALA:HB3	1:B:285:ALA:HB3	1.99	0.42
1:B:86:VAL:HG23	1:B:179:GLY:HA2	2.01	0.42
1:A:140:PHE:HB3	1:A:144:SER:OG	2.19	0.42
1:B:36:VAL:HG21	1:B:68:VAL:HG11	2.02	0.42
1:A:86:VAL:HG23	1:A:179:GLY:HA2	2.02	0.42
1:A:84:ASN:HB2	1:A:179:GLY:HA3	2.02	0.41
1:A:20:VAL:HG12	1:A:42:VAL:HG21	2.03	0.41
1:A:4:ARG:HD3	1:B:137:LYS:O	2.21	0.41
1:A:108:PRO:HB3	1:A:132:PRO:HA	2.03	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	303/306 (99%)	288 (95%)	15 (5%)	0	100	100
1	B	304/306 (99%)	288 (95%)	16 (5%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
All	All	607/612 (99%)	576 (95%)	31 (5%)	0	100	100

There are no Ramachandran outliers to report.

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	232/263 (88%)	231 (100%)	1 (0%)	89	95
1	B	247/263 (94%)	245 (99%)	2 (1%)	79	90
All	All	479/526 (91%)	476 (99%)	3 (1%)	84	93

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	72	ASN
1	B	128	CYS
1	B	216	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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

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	305/306 (99%)	0.91	39 (12%) 9 8	36, 79, 114, 125	0
1	B	306/306 (100%)	0.54	19 (6%) 28 26	34, 62, 104, 118	0
All	All	611/612 (99%)	0.72	58 (9%) 15 14	34, 68, 112, 125	0

All (58) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	223	PHE	3.9
1	A	65	ASN	3.7
1	A	75	LEU	3.2
1	A	216	ASP	3.2
1	B	245	ASP	3.2
1	B	262	LEU	3.1
1	B	230	PHE	3.1
1	A	221	ASN	3.1
1	B	260	ALA	3.1
1	B	221	ASN	3.1
1	A	50	PHE	3.0
1	B	249	ILE	2.9
1	B	223	PHE	2.9
1	A	285	ALA	2.9
1	A	45	THR	2.9
1	A	57	LEU	2.9
1	A	63	ASN	2.9
1	A	43	ILE	2.8
1	A	54	TYR	2.8
1	A	78	ILE	2.8
1	A	44	CYS	2.8
1	A	87	LEU	2.7
1	A	264	MET	2.7
1	A	52	PRO	2.7

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Mol	Chain	Res	Type	RSRZ
1	A	67	LEU	2.7
1	A	257	THR	2.6
1	A	81	SER	2.6
1	A	42	VAL	2.5
1	A	190	THR	2.5
1	A	5	LYS	2.5
1	B	1	SER	2.5
1	A	154	TYR	2.5
1	A	286	LEU	2.5
1	B	224	THR	2.4
1	A	283	GLY	2.4
1	A	217	ARG	2.4
1	B	279	ARG	2.4
1	B	257	THR	2.4
1	B	246	HIS	2.3
1	A	62	SER	2.3
1	A	77	VAL	2.3
1	A	58	LEU	2.2
1	A	205	LEU	2.2
1	A	66	PHE	2.2
1	B	219	PHE	2.2
1	B	64	HIS	2.1
1	A	279	ARG	2.1
1	A	212	VAL	2.1
1	B	247	VAL	2.1
1	B	232	LEU	2.1
1	B	256	GLN	2.1
1	A	274	ASN	2.1
1	A	167	LEU	2.1
1	A	268	LEU	2.1
1	A	46	SER	2.1
1	A	48	ASP	2.0
1	B	306	GLN	2.0
1	B	264	MET	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.