



# Full wwPDB X-ray Structure Validation Report ⓘ

Apr 4, 2026 – 10:22 PM UTC

PDB ID : 9ULP / pdb\_00009ulp  
Title : Crystal structure of FtsB from Streptococcus pyogenes in complex with Nb1 nanobody  
Authors : Fernandez-Perez, J.; Caaveiro, J.M.M.; Tsumoto, K.  
Deposited on : 2025-04-20  
Resolution : 2.55 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](mailto: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>.

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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

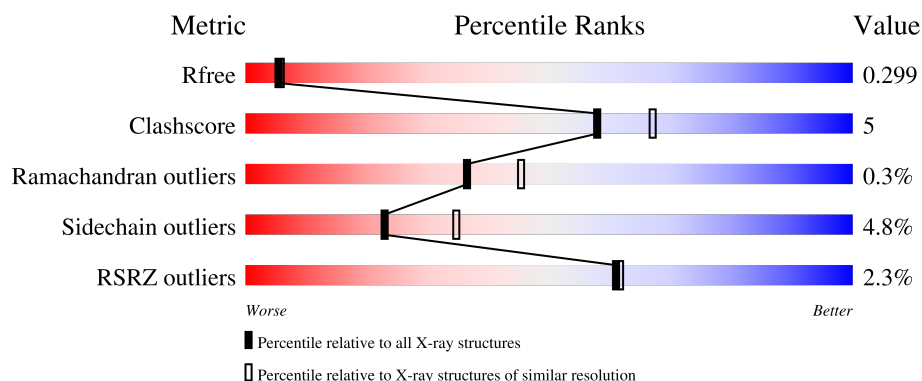
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.55 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	1091 (2.54-2.54)
Clashscore	190562	1120 (2.54-2.54)
Ramachandran outliers	187476	1106 (2.54-2.54)
Sidechain outliers	187428	1106 (2.54-2.54)
RSRZ outliers	180081	1091 (2.54-2.54)

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  $\geq 3$ , 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	283	
1	B	283	
2	C	124	
2	D	124	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 6236 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 Iron-hydroxamate ABC transporter substrate-binding protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	0	1	0
			2194	1424	355	412	3			
1	B	274	Total	C	N	O	S	0	0	0
			2183	1417	353	410	3			

- Molecule 2 is a protein called VHH.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	119	Total	C	N	O	S	0	0	0
			902	560	167	172	3			
2	D	116	Total	C	N	O	S	0	0	0
			876	545	160	168	3			

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	27	Total	O	0	0
			27	27		
3	C	11	Total	O	0	0
			11	11		
3	B	29	Total	O	0	0
			29	29		
3	D	14	Total	O	0	0
			14	14		



- Molecule 1: Iron-hydroxamate ABC transporter substrate-binding protein



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	38.36Å 60.46Å 318.08Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.18 – 2.55 48.18 – 2.55	Depositor EDS
% Data completeness (in resolution range)	95.7 (48.18-2.55) 95.7 (48.18-2.55)	Depositor EDS
$R_{merge}$	0.12	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.28 (at 2.54Å)	Xtriage
Refinement program	REFMAC 5.8.0430	Depositor
R, $R_{free}$	0.253 , 0.307 0.252 , 0.299	Depositor DCC
$R_{free}$ test set	1208 reflections (4.78%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	39.2	Xtriage
Anisotropy	0.229	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.30 , 30.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.41$ , $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.90	EDS
Total number of atoms	6236	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.34% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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	0.49	0/2241	0.93	1/3032 (0.0%)
1	B	0.49	0/2230	0.93	1/3018 (0.0%)
2	C	0.50	0/921	0.87	0/1252
2	D	0.49	0/893	0.84	0/1214
All	All	0.49	0/6285	0.91	2/8516 (0.0%)

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	C	0	1
2	D	0	2
All	All	0	3

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	B	289	THR	CA-CB-OG1	-6.09	100.46	109.60
1	A	289	THR	CA-CB-OG1	-5.45	101.42	109.60

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	C	66	ARG	Sidechain
2	D	116	VAL	Peptide
2	D	66	ARG	Sidechain

## 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	2194	0	2245	21	0
1	B	2183	0	2234	15	0
2	C	902	0	881	11	1
2	D	876	0	862	10	1
3	A	27	0	0	1	0
3	B	29	0	0	1	0
3	C	11	0	0	0	0
3	D	14	0	0	1	0
All	All	6236	0	6222	56	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 5.

All (56) 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:69:LYS:HE2	1:B:91:THR:HB	1.77	0.65
1:A:262:TYR:HA	1:A:267:TRP:CD1	2.36	0.60
2:C:110:GLN:OE1	2:C:110:GLN:N	2.32	0.60
1:A:238:GLU:HA	1:A:266:LEU:HD21	1.84	0.58
2:C:28:ILE:HD13	2:C:97:VAL:HG21	1.84	0.58
2:C:2:VAL:HG22	2:C:3:GLN:N	2.18	0.58
1:A:121:GLU:CD	2:C:2:VAL:HG21	2.30	0.57
1:A:238:GLU:HA	1:A:266:LEU:CD2	2.36	0.55
2:D:2:VAL:HG12	2:D:26:ARG:HB3	1.89	0.54
2:C:75:GLN:O	2:C:76:ASN:C	2.49	0.54
1:A:237:GLN:HB2	1:A:261:LEU:HD11	1.89	0.54
1:A:68:LEU:HD11	1:A:115:VAL:HG21	1.90	0.53
1:B:187:PHE:HB3	1:B:211:ILE:CD1	2.40	0.52
2:C:31:ILE:HA	2:C:53:THR:HG21	1.92	0.51
1:B:187:PHE:CB	1:B:211:ILE:HD12	2.41	0.50
2:D:26:ARG:HH12	2:D:29:ILE:HD13	1.76	0.50
1:B:259:SER:O	1:B:260:ALA:HB3	2.11	0.50
1:A:87:ILE:HD12	1:A:87:ILE:N	2.27	0.49
2:D:29:ILE:N	2:D:29:ILE:HD12	2.27	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:244:ILE:HD12	1:A:270:ILE:HD13	1.94	0.48
1:B:70:LYS:HE2	1:B:162:TRP:CD1	2.49	0.48
2:D:2:VAL:CG1	2:D:26:ARG:HB3	2.44	0.47
1:A:258:GLY:O	1:A:259:SER:C	2.57	0.47
1:B:211:ILE:HG13	1:B:212:HIS:N	2.29	0.46
1:A:158:LYS:HD3	3:A:412:HOH:O	2.16	0.46
1:A:269:SER:HA	1:A:274:LYS:HE2	1.97	0.46
1:B:230:GLN:HG3	1:B:232:TYR:O	2.15	0.45
2:C:29:ILE:HD12	2:C:29:ILE:N	2.32	0.45
1:B:190:MET:HE3	1:B:197:VAL:HG13	1.98	0.45
1:A:240:LEU:N	1:A:241:PRO:CD	2.80	0.44
2:D:33:VAL:HG13	2:D:98:ARG:HG2	2.00	0.44
1:A:261:LEU:O	1:A:267:TRP:HB3	2.18	0.44
2:D:26:ARG:HG2	2:D:27:SER:N	2.32	0.44
1:B:64:TYR:O	1:B:65:THR:C	2.61	0.43
1:A:35:LEU:HD13	1:A:49:ASP:HB3	2.00	0.43
1:A:64:TYR:O	1:A:65:THR:C	2.61	0.43
1:B:72:ASP:OD2	1:B:158:LYS:NZ	2.40	0.43
1:B:187:PHE:HB3	1:B:211:ILE:HD12	1.98	0.43
1:B:209:GLU:O	1:B:213:GLN:HB2	2.19	0.42
1:B:240:LEU:N	1:B:241:PRO:CD	2.82	0.42
2:D:20:LEU:HG	2:D:82:MET:HE2	2.01	0.42
2:C:13:GLN:CD	2:C:13:GLN:H	2.27	0.42
2:C:29:ILE:N	2:C:29:ILE:CD1	2.83	0.42
1:A:250:ILE:HD11	1:A:267:TRP:CH2	2.54	0.42
1:A:157:GLY:O	1:A:161:LYS:HG3	2.19	0.42
2:D:110:GLN:H	2:D:110:GLN:CD	2.27	0.42
2:D:86:LYS:HG3	2:D:88:SER:OG	2.20	0.41
2:D:45:ARG:NH1	3:D:201:HOH:O	2.53	0.41
1:A:160:LYS:O	1:A:164:LYS:HG2	2.20	0.41
1:A:209:GLU:O	1:A:213:GLN:HB2	2.20	0.41
2:C:55:GLY:O	2:C:56:SER:C	2.64	0.41
1:A:197:VAL:HG11	1:A:240:LEU:HD11	2.02	0.41
1:A:60:LEU:HD13	1:A:100:ALA:HA	2.01	0.40
2:C:31:ILE:HG23	2:C:53:THR:CG2	2.51	0.40
1:B:84:LYS:HD3	3:B:411:HOH:O	2.20	0.40
1:B:110:LYS:N	1:B:111:PRO:HD3	2.37	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:C:17:SER:OG	2:D:73:ASN:ND2[1_455]	2.16	0.04

## 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	274/283 (97%)	257 (94%)	15 (6%)	2 (1%)	18	25
1	B	272/283 (96%)	259 (95%)	13 (5%)	0	100	100
2	C	117/124 (94%)	114 (97%)	3 (3%)	0	100	100
2	D	114/124 (92%)	111 (97%)	3 (3%)	0	100	100
All	All	777/814 (96%)	741 (95%)	34 (4%)	2 (0%)	36	45

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	258	GLY
1	A	259	SER

### 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	237/244 (97%)	231 (98%)	6 (2%)	42	60
1	B	236/244 (97%)	228 (97%)	8 (3%)	32	48
2	C	96/101 (95%)	86 (90%)	10 (10%)	7	8

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	D	93/101 (92%)	84 (90%)	9 (10%)	8	9
All	All	662/690 (96%)	629 (95%)	33 (5%)	23	33

All (33) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	41	ILE
1	A	55[A]	LYS
1	A	55[B]	LYS
1	A	72	ASP
1	A	229	LYS
1	A	256	LYS
2	C	2	VAL
2	C	11	LEU
2	C	12	VAL
2	C	13	GLN
2	C	33	VAL
2	C	44	GLN
2	C	50	VAL
2	C	53	THR
2	C	97	VAL
2	C	113	ARG
1	B	35	LEU
1	B	96	LYS
1	B	125	GLN
1	B	175	LYS
1	B	221	GLU
1	B	237	GLN
1	B	256	LYS
1	B	266	LEU
2	D	2	VAL
2	D	11	LEU
2	D	12	VAL
2	D	33	VAL
2	D	39	GLN
2	D	50	VAL
2	D	53	THR
2	D	98	ARG
2	D	110	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
2	C	58	ASN
2	C	75	GLN
1	B	125	GLN
1	B	230	GLN
1	B	268	GLN
2	D	76	ASN
2	D	83	ASN
2	D	96	ASN

### 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	275/283 (97%)	0.65	14 (5%) 33 33	23, 43, 69, 84	1 (0%)
1	B	274/283 (96%)	0.22	2 (0%) 84 86	25, 34, 49, 60	0
2	C	119/124 (95%)	0.37	1 (0%) 82 84	27, 36, 51, 78	0
2	D	116/124 (93%)	0.53	1 (0%) 81 83	31, 39, 58, 72	0
All	All	784/814 (96%)	0.44	18 (2%) 61 62	23, 38, 59, 84	1 (0%)

All (18) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	C	2	VAL	4.0
1	A	261	LEU	3.6
2	D	2	VAL	3.3
1	B	260	ALA	3.1
1	A	207	GLY	2.9
1	A	40	GLN	2.8
1	A	266	LEU	2.7
1	A	268	GLN	2.7
1	A	185	ALA	2.6
1	A	168	THR	2.4
1	A	308	SER	2.3
1	A	94	LYS	2.3
1	B	35	LEU	2.3
1	A	153	PHE	2.3
1	A	265	LYS	2.3
1	A	122	ASN	2.2
1	A	272	ALA	2.2
1	A	237	GLN	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 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.