Full wwPDB X-ray Structure Validation Report ⓘ

May 18, 2020 – 05:51 pm BST

PDB ID	:	5BWJ
Title	:	Structural characterization and modeling of the Borrelia burgdorferi hybrid histidine kinase Hk1 periplasmic sensor
Authors	:	Bauer, W.J.; Luthra, A.; Zhu, G.; Radolf, J.D.; Malkowski, M.G.; Caimano, M.J.
Deposited on	:	2015-06-08
Resolution	:	2.05 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 following versions of software and data (see references ⓘ) were used in the production of this report:

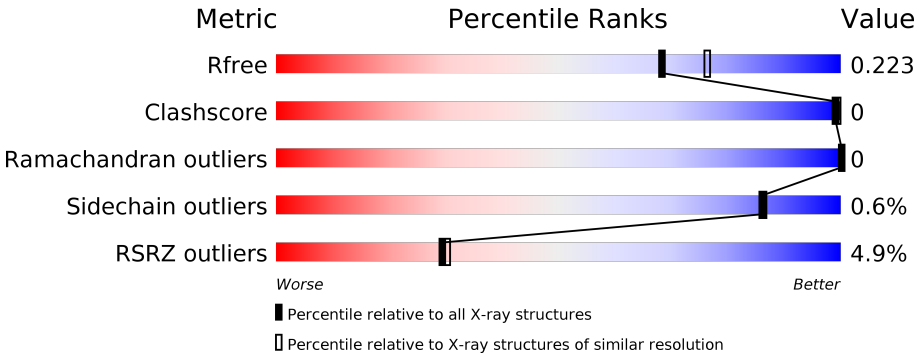
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.05 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	2684 (2.08-2.04)
Clashscore	141614	2801 (2.08-2.04)
Ramachandran outliers	138981	2768 (2.08-2.04)
Sidechain outliers	138945	2768 (2.08-2.04)
RSRZ outliers	127900	2646 (2.08-2.04)

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 on 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 <=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	227	5% 85% • 14%
1	B	227	4% 84% • 14%
1	C	227	5% 89% 11%
1	D	227	3% 88% • 11%

2 Entry composition

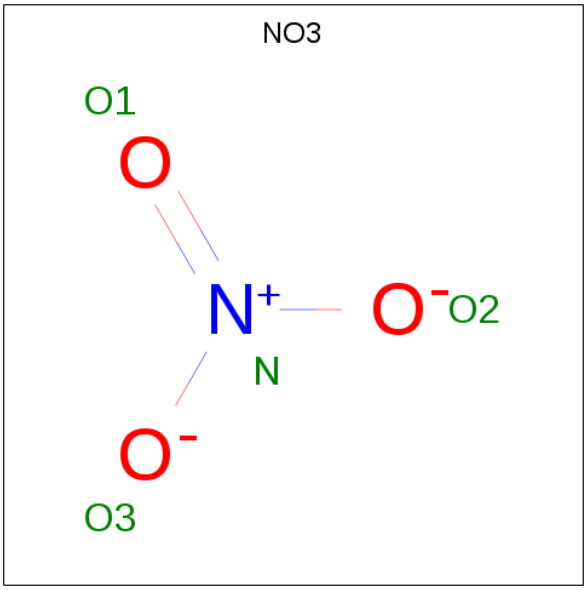
There are 4 unique types of molecules in this entry. The entry contains 12734 atoms, of which 6090 are hydrogens and 0 are deuteriums.

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 Sensory transduction histidine kinase, putative.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	195	Total	C	H	N	O	S	0	1	0
			3118	1037	1533	251	294	3			
1	B	196	Total	C	H	N	O	S	0	0	0
			2995	1008	1458	244	283	2			
1	C	202	Total	C	H	N	O	S	0	0	0
			3111	1039	1515	252	302	3			
1	D	203	Total	C	H	N	O	S	0	1	0
			3220	1074	1584	258	300	4			

- Molecule 2 is NITRATE ION (three-letter code: NO3) (formula: NO_3).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	N	O		0	0
			4	1	3			
2	A	1	Total	N	O		0	0
			4	1	3			

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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total N O 4 1 3	0	0
2	B	1	Total N O 4 1 3	0	0
2	C	1	Total N O 4 1 3	0	0
2	C	1	Total N O 4 1 3	0	0
2	D	1	Total N O 4 1 3	0	0
2	D	1	Total N O 4 1 3	0	0

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Mg 1 1	0	0

- Molecule 4 is water.

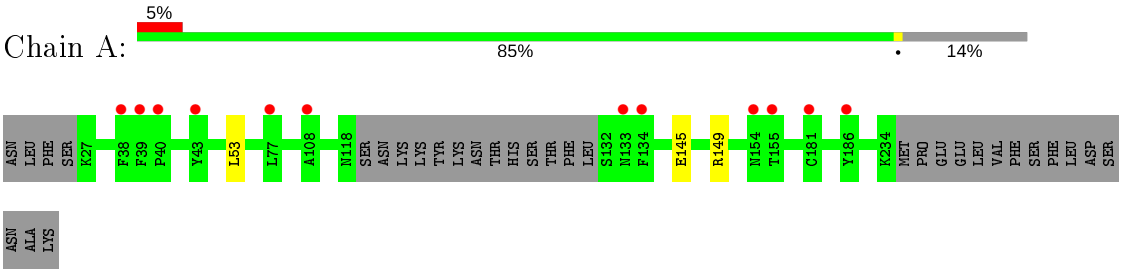
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	75	Total O 75 75	0	0
4	B	59	Total O 59 59	0	0
4	C	49	Total O 49 49	0	0
4	D	74	Total O 74 74	0	0

3 Residue-property plots

These plots are drawn for all protein, RNA and DNA 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.

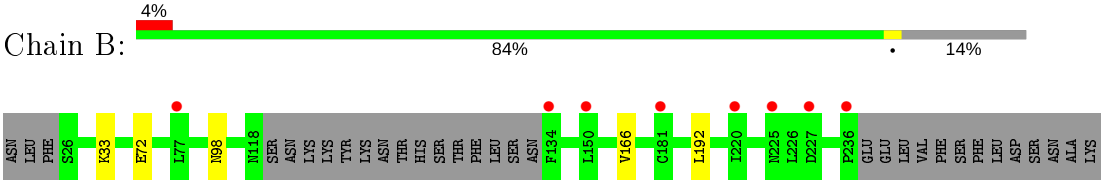
- Molecule 1: Sensory transduction histidine kinase, putative

Chain A:



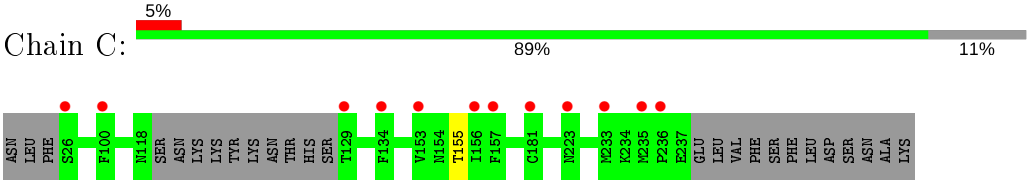
- Molecule 1: Sensory transduction histidine kinase, putative

Chain B:



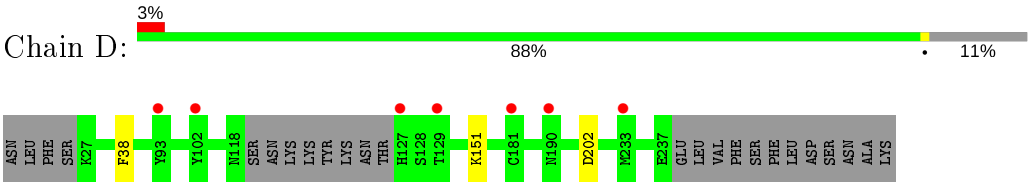
- Molecule 1: Sensory transduction histidine kinase, putative

Chain C:



- Molecule 1: Sensory transduction histidine kinase, putative

Chain D:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	58.30Å 62.85Å 111.81Å 90.00° 101.32° 90.00°	Depositor
Resolution (Å)	37.66 – 2.05 37.66 – 2.05	Depositor EDS
% Data completeness (in resolution range)	99.5 (37.66-2.05) 99.5 (37.66-2.05)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$< I/\sigma(I) >$ [1]	1.29 (at 2.05Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.9_1692)	Depositor
R, R_{free}	0.193 , 0.221 0.197 , 0.223	Depositor DCC
R_{free} test set	1997 reflections (4.03%)	wwPDB-VP
Wilson B-factor (Å^2)	38.6	Xtriage
Anisotropy	0.149	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.40 , 52.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	12734	wwPDB-VP
Average B, all atoms (Å^2)	54.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.79% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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

Bond lengths and bond angles in the following residue types are not validated in this section: MG, NO3

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	0.24	0/1620	0.40	0/2194
1	B	0.22	0/1567	0.37	0/2127
1	C	0.22	0/1627	0.37	0/2206
1	D	0.23	0/1673	0.37	0/2265
All	All	0.23	0/6487	0.38	0/8792

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

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	1585	1533	1533	1	0
1	B	1537	1458	1458	2	0
1	C	1596	1515	1514	0	0
1	D	1636	1584	1584	1	0
2	A	12	0	0	0	0
2	B	4	0	0	0	0
2	C	8	0	0	0	0
2	D	8	0	0	0	0
3	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	A	75	0	0	0	0
4	B	59	0	0	0	0
4	C	49	0	0	0	0
4	D	74	0	0	0	0
All	All	6644	6090	6089	4	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 0.

All (4) 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:D:151:LYS:NZ	1:D:202:ASP:O	2.19	0.76
1:A:145:GLU:OE2	1:A:149[B]:ARG:NH2	2.43	0.52
1:B:33:LYS:NZ	1:B:72:GLU:OE1	2.48	0.47
1:B:166:VAL:HG12	1:B:192:LEU:HD12	1.99	0.43

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	192/227 (85%)	187 (97%)	5 (3%)	0	100	100
1	B	192/227 (85%)	184 (96%)	8 (4%)	0	100	100
1	C	198/227 (87%)	188 (95%)	10 (5%)	0	100	100
1	D	200/227 (88%)	190 (95%)	10 (5%)	0	100	100
All	All	782/908 (86%)	749 (96%)	33 (4%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains

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	169/211 (80%)	168 (99%)	1 (1%)	86	86
1	B	156/211 (74%)	155 (99%)	1 (1%)	86	86
1	C	167/211 (79%)	166 (99%)	1 (1%)	86	86
1	D	173/211 (82%)	172 (99%)	1 (1%)	86	86
All	All	665/844 (79%)	661 (99%)	4 (1%)	86	86

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	53	LEU
1	B	98	ASN
1	C	155	THR
1	D	38	PHE

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

5.3.3 RNA

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains

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

5.5 Carbohydrates

There are no carbohydrates in this entry.

5.6 Ligand geometry (i)

Of 9 ligands modelled in this entry, 1 is monoatomic - leaving 8 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	NO3	D	302	-	1,3,3	0.62	0	0,3,3	0.00	-
2	NO3	A	301	-	1,3,3	0.66	0	0,3,3	0.00	-
2	NO3	C	301	-	1,3,3	0.64	0	0,3,3	0.00	-
2	NO3	B	301	-	1,3,3	0.62	0	0,3,3	0.00	-
2	NO3	A	303	-	1,3,3	0.61	0	0,3,3	0.00	-
2	NO3	D	301	-	1,3,3	0.63	0	0,3,3	0.00	-
2	NO3	C	302	-	1,3,3	0.64	0	0,3,3	0.00	-
2	NO3	A	302	-	1,3,3	0.63	0	0,3,3	0.00	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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^{th} 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	195/227 (85%)	0.38	12 (6%) 20 21	26, 41, 71, 109	0
1	B	196/227 (86%)	0.36	8 (4%) 37 39	31, 51, 84, 107	0
1	C	202/227 (88%)	0.44	12 (5%) 22 23	26, 54, 88, 110	0
1	D	203/227 (89%)	0.24	7 (3%) 45 47	27, 45, 85, 122	0
All	All	796/908 (87%)	0.35	39 (4%) 29 30	26, 47, 84, 122	0

All (39) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	134	PHE	6.6
1	C	134	PHE	4.3
1	A	134	PHE	4.1
1	C	236	PRO	4.1
1	D	129	THR	3.9
1	A	154	ASN	3.4
1	B	150	LEU	3.2
1	A	39	PHE	3.2
1	C	129	THR	3.2
1	D	127	HIS	3.2
1	C	26	SER	3.1
1	C	100	PHE	3.1
1	A	181	CYS	3.1
1	C	157	PHE	3.1
1	C	153	VAL	2.9
1	B	77	LEU	2.8
1	B	236	PRO	2.8
1	A	38	PHE	2.8
1	B	225	ASN	2.7
1	C	223	ASN	2.7
1	A	77	LEU	2.7

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Mol	Chain	Res	Type	RSRZ
1	C	235	MET	2.6
1	D	181	CYS	2.5
1	C	156	ILE	2.5
1	D	233	MET	2.5
1	A	186	TYR	2.5
1	D	102	TYR	2.3
1	A	40	PRO	2.3
1	C	233	MET	2.3
1	A	133	ASN	2.2
1	D	190	ASN	2.2
1	A	43	TYR	2.2
1	D	93	TYR	2.2
1	B	220	ILE	2.1
1	B	181	CYS	2.1
1	A	155	THR	2.1
1	A	108	ALA	2.1
1	B	227	ASP	2.1
1	C	181	CYS	2.1

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 carbohydrates in this entry.

6.4 Ligands (i)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	NO3	B	301	4/4	0.60	0.31	168,169,169,169	0
2	NO3	C	302	4/4	0.79	0.19	102,102,102,103	0
2	NO3	D	302	4/4	0.84	0.34	84,87,87,89	0
2	NO3	A	302	4/4	0.86	0.50	84,84,84,85	0
2	NO3	A	303	4/4	0.87	0.35	125,126,126,126	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	MG	A	304	1/1	0.88	0.13	55,55,55,55	0
2	NO3	C	301	4/4	0.93	0.26	80,81,81,82	0
2	NO3	D	301	4/4	0.94	0.19	93,93,93,94	0
2	NO3	A	301	4/4	0.98	0.14	52,52,52,53	0

6.5 Other polymers (i)

There are no such residues in this entry.