



# wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 29, 2023 – 03:19 PM EDT

PDB ID : 3LX4  
Title : Stepwise [FeFe]-hydrogenase H-cluster assembly revealed in the structure of HydA(deltaEFG)  
Authors : Mulder, D.W.; Boyd, E.S.; Sarma, R.; Lange, R.K.; Endrizzi, J.A.; Broderick, J.B.; Peters, J.W.  
Deposited on : 2010-02-24  
Resolution : 1.97 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.35  
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) : 2.35

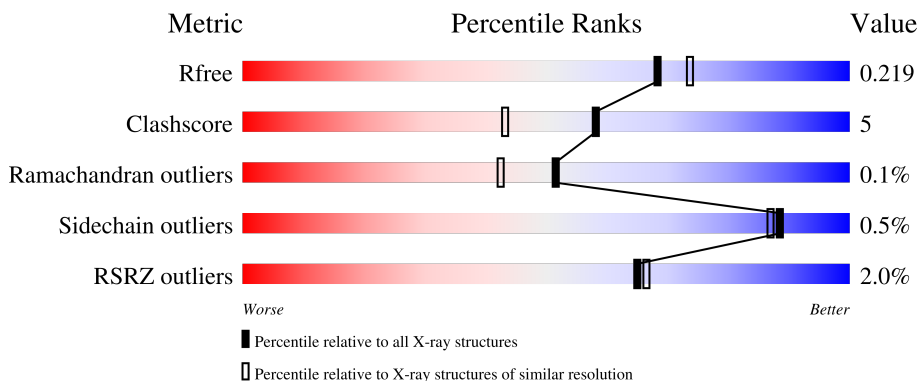
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.97 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	11647 (2.00-1.96)
Clashscore	141614	1014 (1.98-1.98)
Ramachandran outliers	138981	1006 (1.98-1.98)
Sidechain outliers	138945	1006 (1.98-1.98)
RSRZ outliers	127900	11410 (2.00-1.96)

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	457	 2% 81% 8% 11%
1	B	457	 2% 81% 8% 11%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	ACT	A	460	-	-	X	-
4	ACT	B	460	-	-	X	-

## 2 Entry composition i

There are 5 unique types of molecules in this entry. The entry contains 7005 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 Fe-hydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	407	3102	1954	538	585	25	7	3	0
1	B	407	3102	1954	538	585	25	7	3	0

There are 32 discrepancies between the modelled and reference sequences:

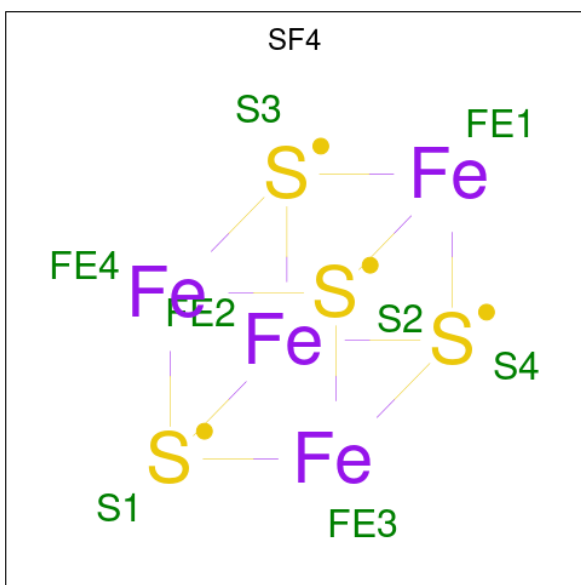
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	expression tag	UNP Q9FYU1
A	2	GLY	-	expression tag	UNP Q9FYU1
A	3	SER	-	expression tag	UNP Q9FYU1
A	4	SER	-	expression tag	UNP Q9FYU1
A	5	HIS	-	expression tag	UNP Q9FYU1
A	6	HIS	-	expression tag	UNP Q9FYU1
A	7	HIS	-	expression tag	UNP Q9FYU1
A	8	HIS	-	expression tag	UNP Q9FYU1
A	9	HIS	-	expression tag	UNP Q9FYU1
A	10	HIS	-	expression tag	UNP Q9FYU1
A	11	SER	-	expression tag	UNP Q9FYU1
A	12	GLN	-	expression tag	UNP Q9FYU1
A	13	ASP	-	expression tag	UNP Q9FYU1
A	14	PRO	-	expression tag	UNP Q9FYU1
A	15	ASN	-	expression tag	UNP Q9FYU1
A	16	SER	-	expression tag	UNP Q9FYU1
B	1	MET	-	expression tag	UNP Q9FYU1
B	2	GLY	-	expression tag	UNP Q9FYU1
B	3	SER	-	expression tag	UNP Q9FYU1
B	4	SER	-	expression tag	UNP Q9FYU1
B	5	HIS	-	expression tag	UNP Q9FYU1
B	6	HIS	-	expression tag	UNP Q9FYU1
B	7	HIS	-	expression tag	UNP Q9FYU1
B	8	HIS	-	expression tag	UNP Q9FYU1
B	9	HIS	-	expression tag	UNP Q9FYU1

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Chain	Residue	Modelled	Actual	Comment	Reference
B	10	HIS	-	expression tag	UNP Q9FYU1
B	11	SER	-	expression tag	UNP Q9FYU1
B	12	GLN	-	expression tag	UNP Q9FYU1
B	13	ASP	-	expression tag	UNP Q9FYU1
B	14	PRO	-	expression tag	UNP Q9FYU1
B	15	ASN	-	expression tag	UNP Q9FYU1
B	16	SER	-	expression tag	UNP Q9FYU1

- Molecule 2 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe<sub>4</sub>S<sub>4</sub>).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Fe S	0	0
			8	4 4		
2	B	1	Total	Fe S	0	0
			8	4 4		

- Molecule 3 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Cl	0	0
			1	1		
3	B	1	Total	Cl	0	0
			1	1		

- Molecule 4 is ACETATE ION (three-letter code: ACT) (formula: C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>).



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

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	364	Total O 364 364	0	0
5	B	411	Total O 411 411	0	0



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 32	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	70.89Å 70.89Å 155.43Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 1.97 19.92 – 1.97	Depositor EDS
% Data completeness (in resolution range)	97.8 (20.00-1.97) 97.8 (19.92-1.97)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.87 (at 1.96Å)	Xtrriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.170 , 0.216 0.171 , 0.219	Depositor DCC
$R_{free}$ test set	3074 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	22.8	Xtrriage
Anisotropy	0.088	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 39.3	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.51$ , $\langle L^2 \rangle = 0.35$	Xtrriage
Estimated twinning fraction	0.006 for -h,-k,l 0.479 for h,-h-k,-l 0.008 for -k,-h,-l	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	7005	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	26.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.36% 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 [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: ACT, CL, SF4

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	0.32	0/3173	0.47	0/4289
1	B	0.32	0/3173	0.48	1/4289 (0.0%)
All	All	0.32	0/6346	0.48	1/8578 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	137	LEU	CA-CB-CG	5.34	127.59	115.30

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	3102	0	3114	31	0
1	B	3102	0	3114	27	0
2	A	8	0	0	1	0
2	B	8	0	0	1	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	4	0	3	4	0
4	B	4	0	3	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	A	364	0	0	5	1
5	B	411	0	0	3	1
All	All	7005	0	6234	60	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.

The worst 5 of 60 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:458:SF4:S3	4:B:460:ACT:H1	2.26	0.74
1:B:169:LYS:HE2	1:B:242:VAL:HG13	1.70	0.73
1:A:114:GLU:HA	1:A:309:ARG:HD2	1.73	0.71
1:A:406:LEU:H	1:A:406:LEU:HD22	1.56	0.71
1:B:138:GLU:OE1	1:B:194:ARG:NH2	2.24	0.70

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)
5:A:853:HOH:O	5:B:939:HOH:O[3_665]	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	403/457 (88%)	396 (98%)	7 (2%)	0	100	100
1	B	403/457 (88%)	398 (99%)	4 (1%)	1 (0%)	47	38
All	All	806/914 (88%)	794 (98%)	11 (1%)	1 (0%)	51	42

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	328	ASP

### 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	330/363 (91%)	330 (100%)	0	100	100
1	B	330/363 (91%)	327 (99%)	3 (1%)	78	77
All	All	660/726 (91%)	657 (100%)	3 (0%)	88	87

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

Mol	Chain	Res	Type
1	B	137	LEU
1	B	177	MET
1	B	217	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	155	GLN
1	A	416	HIS
1	B	155	GLN
1	B	416	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](#)

Of 6 ligands modelled in this entry, 2 are monoatomic - leaving 4 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	SF4	A	458	1	0,12,12	-	-	-		
2	SF4	B	458	1	0,12,12	-	-	-		
4	ACT	B	460	-	3,3,3	0.78	0	3,3,3	1.14	0
4	ACT	A	460	-	3,3,3	0.71	0	3,3,3	1.20	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	SF4	A	458	1	-	-	0/6/5/5
2	SF4	B	458	1	-	-	0/6/5/5

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.

4 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	458	SF4	1	0
2	B	458	SF4	1	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	460	ACT	4	0
4	A	460	ACT	4	0

## 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, 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	407/457 (89%)	-0.36	9 (2%) 62 63	12, 22, 47, 88	1 (0%)
1	B	407/457 (89%)	-0.37	7 (1%) 70 71	12, 22, 46, 88	1 (0%)
All	All	814/914 (89%)	-0.36	16 (1%) 65 66	12, 22, 47, 88	2 (0%)

The worst 5 of 16 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	311	ALA	4.6
1	A	406	LEU	4.2
1	A	311	ALA	3.9
1	A	323	GLY	3.7
1	A	308	HIS	3.6

### 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](#)

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<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
4	ACT	A	460	4/4	0.74	0.15	39,45,45,49	0
4	ACT	B	460	4/4	0.75	0.17	33,46,51,51	0
2	SF4	A	458	8/8	0.99	0.05	18,20,21,24	0
2	SF4	B	458	8/8	0.99	0.06	19,20,21,24	0
3	CL	A	459	1/1	1.00	0.04	16,16,16,16	0
3	CL	B	459	1/1	1.00	0.04	16,16,16,16	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.