



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 10:54 AM UTC

PDB ID : 6CH2 / pdb\_00006ch2  
Title : Crystal structure of the cytoplasmic domain of FlhA and FliT-FliD complex  
Authors : Xing, Q.; Shi, K.; Kalodimos, C.G.  
Deposited on : 2018-02-21  
Resolution : 2.70 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)

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<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  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtrriage (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

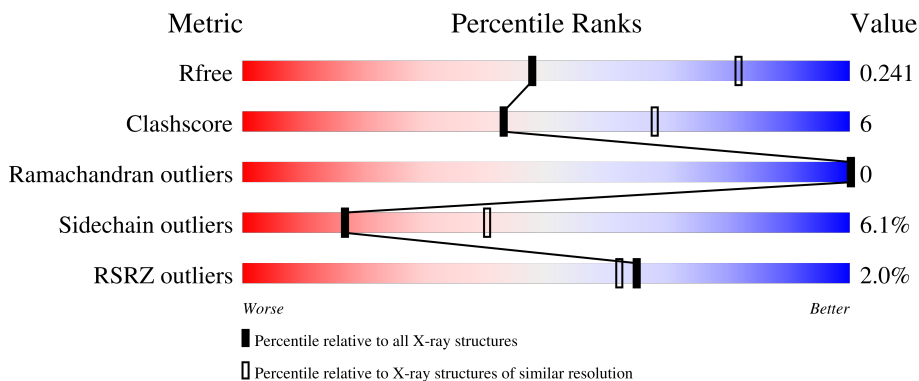
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.70 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.



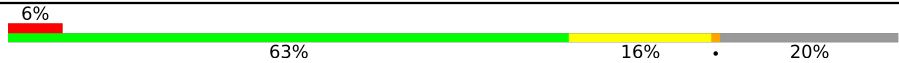
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	180053	3538 (2.70-2.70)
Clashscore	190562	3843 (2.70-2.70)
Ramachandran outliers	187476	3778 (2.70-2.70)
Sidechain outliers	187428	3778 (2.70-2.70)
RSRZ outliers	180081	3538 (2.70-2.70)

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	334	82% 15% ..
1	B	334	78% 19% ..
1	C	334	79% 17% ..
2	D	179	66% 14% • 20%
2	E	179	69% 12% • 18%

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Mol	Chain	Length	Quality of chain
2	F	179	 <p>A horizontal bar chart representing the quality of chain. The bar is divided into four segments: a small red segment at the beginning labeled '6%', followed by a large green segment labeled '63%', a yellow segment labeled '16%', and a grey segment at the end labeled '16%'. There is a small black dot on the grey segment.</p>

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 11214 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 Flagellar biosynthesis protein FlhA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	331	Total	C	N	O	S	0	0	0
			2562	1621	458	474	9			
1	B	332	Total	C	N	O	S	0	0	0
			2568	1625	459	475	9			
1	C	329	Total	C	N	O	S	0	0	0
			2552	1617	455	471	9			

There are 3 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	359	GLY	-	expression tag	UNP P40729
B	359	GLY	-	expression tag	UNP P40729
C	359	GLY	-	expression tag	UNP P40729

- Molecule 2 is a protein called Flagellar hook-associated protein 2,Flagellar protein FlhT.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	D	144	Total	C	N	O	S	0	0	0
			1154	720	198	231	5			
2	E	147	Total	C	N	O	S	0	0	0
			1178	734	204	234	6			
2	F	143	Total	C	N	O	S	0	0	0
			1147	719	198	225	5			

There are 51 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	1	GLY	-	expression tag	UNP P16328
D	2	ALA	-	expression tag	UNP P16328
D	3	HIS	-	expression tag	UNP P16328
D	4	MET	-	expression tag	UNP P16328
D	45	GLY	-	linker	UNP P16328

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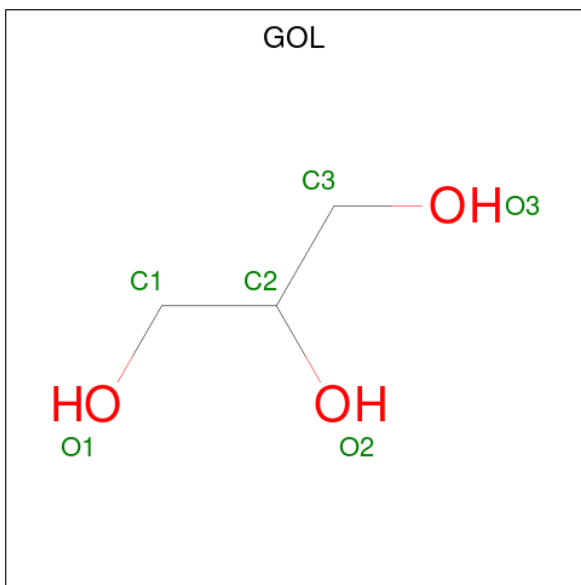
Chain	Residue	Modelled	Actual	Comment	Reference
D	46	GLY	-	linker	UNP P16328
D	47	SER	-	linker	UNP P16328
D	48	GLY	-	linker	UNP P16328
D	49	GLY	-	linker	UNP P16328
D	50	SER	-	linker	UNP P16328
D	51	GLY	-	linker	UNP P16328
D	52	SER	-	linker	UNP P16328
D	53	GLY	-	linker	UNP P16328
D	54	GLY	-	linker	UNP P16328
D	55	SER	-	linker	UNP P16328
D	56	GLY	-	linker	UNP P16328
D	57	GLY	-	linker	UNP P16328
E	1	GLY	-	expression tag	UNP P16328
E	2	ALA	-	expression tag	UNP P16328
E	3	HIS	-	expression tag	UNP P16328
E	4	MET	-	expression tag	UNP P16328
E	45	GLY	-	linker	UNP P16328
E	46	GLY	-	linker	UNP P16328
E	47	SER	-	linker	UNP P16328
E	48	GLY	-	linker	UNP P16328
E	49	GLY	-	linker	UNP P16328
E	50	SER	-	linker	UNP P16328
E	51	GLY	-	linker	UNP P16328
E	52	SER	-	linker	UNP P16328
E	53	GLY	-	linker	UNP P16328
E	54	GLY	-	linker	UNP P16328
E	55	SER	-	linker	UNP P16328
E	56	GLY	-	linker	UNP P16328
E	57	GLY	-	linker	UNP P16328
F	1	GLY	-	expression tag	UNP P16328
F	2	ALA	-	expression tag	UNP P16328
F	3	HIS	-	expression tag	UNP P16328
F	4	MET	-	expression tag	UNP P16328
F	45	GLY	-	linker	UNP P16328
F	46	GLY	-	linker	UNP P16328
F	47	SER	-	linker	UNP P16328
F	48	GLY	-	linker	UNP P16328
F	49	GLY	-	linker	UNP P16328
F	50	SER	-	linker	UNP P16328
F	51	GLY	-	linker	UNP P16328
F	52	SER	-	linker	UNP P16328
F	53	GLY	-	linker	UNP P16328

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Chain	Residue	Modelled	Actual	Comment	Reference
F	54	GLY	-	linker	UNP P16328
F	55	SER	-	linker	UNP P16328
F	56	GLY	-	linker	UNP P16328
F	57	GLY	-	linker	UNP P16328

- Molecule 3 is GLYCEROL (CCD ID: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			6	3	3		
3	B	1	Total	C	O	0	0
			6	3	3		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	10	Total	O	0	0
			10	10		
4	B	8	Total	O	0	0
			8	8		
4	C	10	Total	O	0	0
			10	10		
4	D	6	Total	O	0	0
			6	6		
4	E	5	Total	O	0	0
			5	5		

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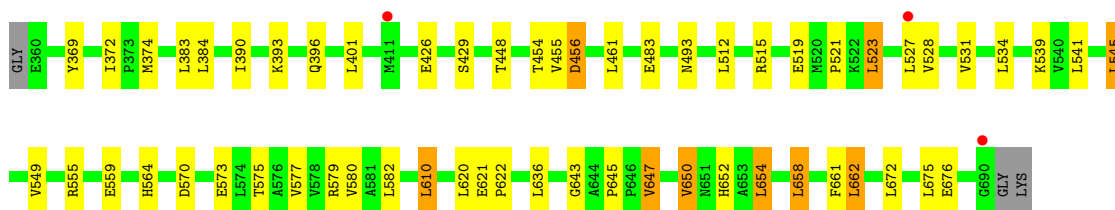
<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
4	F	2	Total	O	0	0
			2	2		

### 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.

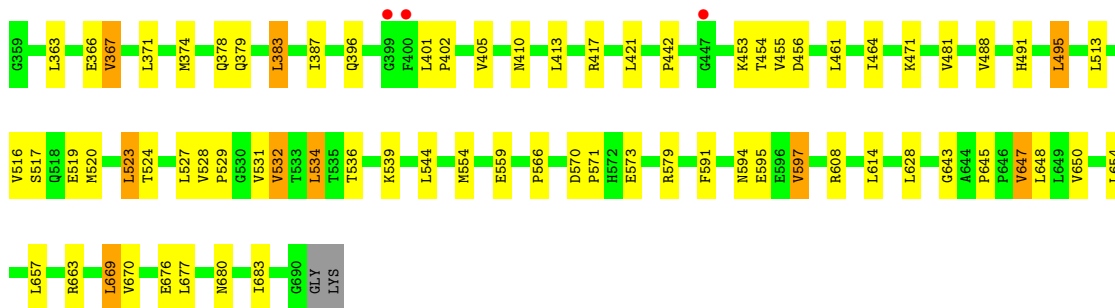
- Molecule 1: Flagellar biosynthesis protein FlhA

Chain A: 




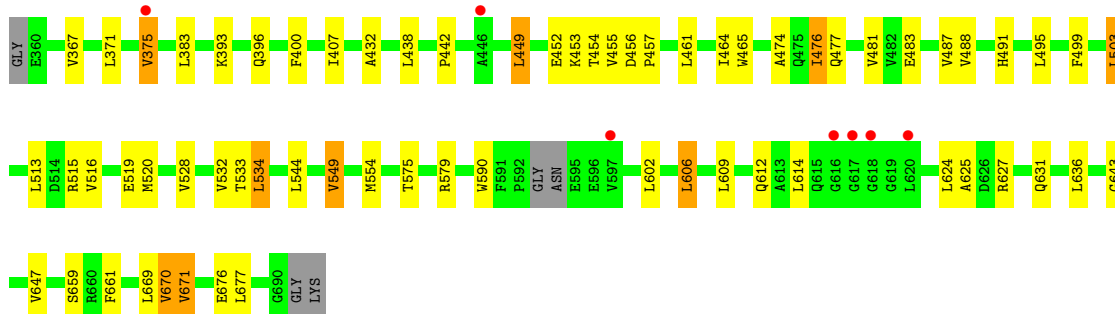
- Molecule 1: Flagellar biosynthesis protein FlhA

Chain B: 

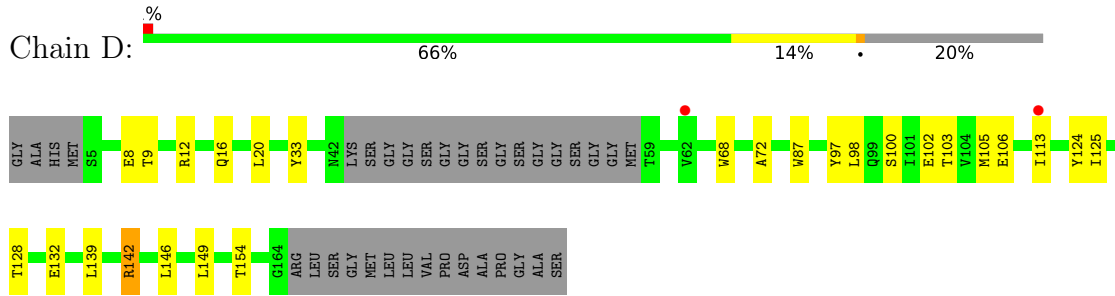


- Molecule 1: Flagellar biosynthesis protein FlhA

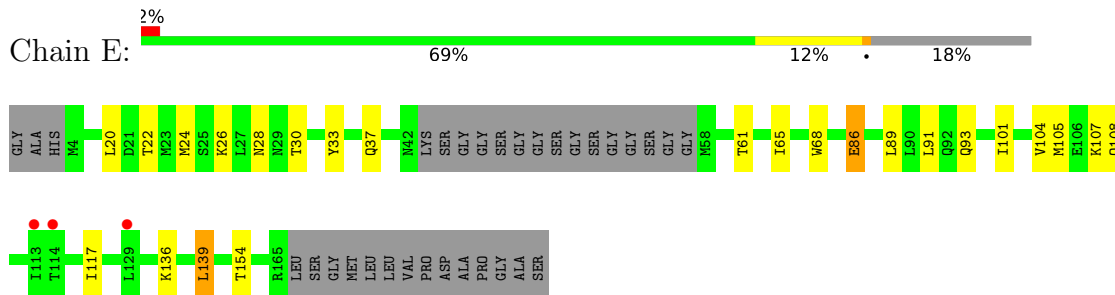
Chain C: 



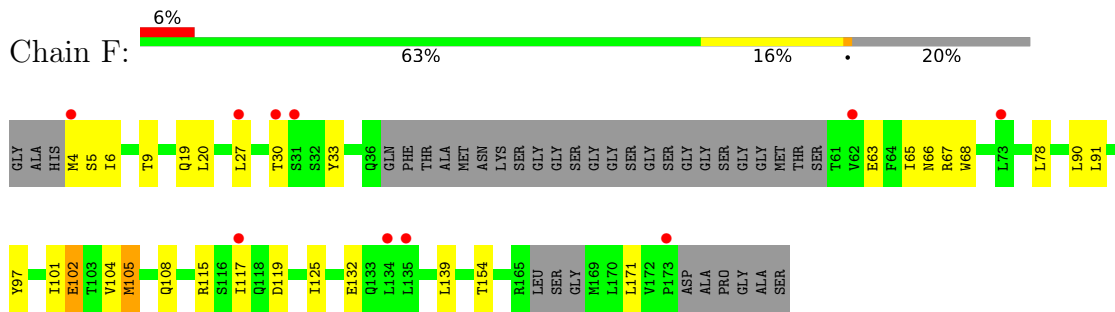
- Molecule 2: Flagellar hook-associated protein 2,Flagellar protein FliT



- Molecule 2: Flagellar hook-associated protein 2,Flagellar protein FliT



- Molecule 2: Flagellar hook-associated protein 2,Flagellar protein FliT



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	49.11Å 77.59Å 119.27Å 86.88° 89.00° 84.27°	Depositor
Resolution (Å)	39.70 – 2.70 39.70 – 2.70	Depositor EDS
% Data completeness (in resolution range)	93.0 (39.70-2.70) 93.0 (39.70-2.70)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	0.05	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.21 (at 2.51Å)	Xtrriage
Refinement program	PHENIX (dev_2747: ???)	Depositor
R, $R_{free}$	0.233 , 0.266 0.233 , 0.241	Depositor DCC
$R_{free}$ test set	2722 reflections (4.87%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	61.2	Xtrriage
Anisotropy	0.257	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 63.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	11214	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	99.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.41% 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: GOL

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	0.12	0/2606	0.33	0/3538
1	B	0.13	0/2612	0.33	0/3546
1	C	0.12	0/2595	0.31	0/3522
2	D	0.11	0/1166	0.27	0/1573
2	E	0.11	0/1190	0.28	0/1604
2	F	0.11	0/1158	0.32	0/1561
All	All	0.12	0/11327	0.31	0/15344

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	2562	0	2622	28	0
1	B	2568	0	2632	41	0
1	C	2552	0	2619	31	0
2	D	1154	0	1160	15	0
2	E	1178	0	1184	13	0
2	F	1147	0	1165	21	0
3	A	6	0	8	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	6	0	8	0	0
4	A	10	0	0	0	0
4	B	8	0	0	1	0
4	C	10	0	0	0	0
4	D	6	0	0	0	0
4	E	5	0	0	0	0
4	F	2	0	0	0	0
All	All	11214	0	11398	139	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 6.

The worst 5 of 139 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:C:400:PHE:HA	1:C:515:ARG:HH12	1.54	0.72
1:A:523:LEU:HD11	1:A:559:GLU:HG3	1.72	0.72
2:D:16:GLN:OE1	2:D:142:ARG:NH1	2.23	0.71
2:F:63:GLU:OE1	2:F:66:ASN:ND2	2.28	0.67
1:B:579:ARG:NH1	1:B:676:GLU:OE2	2.29	0.66

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	329/334 (98%)	317 (96%)	12 (4%)	0	100	100
1	B	330/334 (99%)	319 (97%)	11 (3%)	0	100	100
1	C	325/334 (97%)	314 (97%)	11 (3%)	0	100	100
2	D	140/179 (78%)	138 (99%)	2 (1%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	E	143/179 (80%)	140 (98%)	3 (2%)	0	100	100
2	F	137/179 (76%)	134 (98%)	3 (2%)	0	100	100
All	All	1404/1539 (91%)	1362 (97%)	42 (3%)	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	275/277 (99%)	254 (92%)	21 (8%)	12	30
1	B	276/277 (100%)	257 (93%)	19 (7%)	14	34
1	C	275/277 (99%)	254 (92%)	21 (8%)	12	30
2	D	131/151 (87%)	129 (98%)	2 (2%)	57	81
2	E	133/151 (88%)	127 (96%)	6 (4%)	24	52
2	F	130/151 (86%)	125 (96%)	5 (4%)	29	58
All	All	1220/1284 (95%)	1146 (94%)	74 (6%)	17	40

5 of 74 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	647	VAL
2	F	102	GLU
1	C	671	VAL
2	E	93	GLN
1	B	396	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
2	F	66	ASN
2	F	156	GLN

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Mol	Chain	Res	Type
1	C	568	GLN
1	C	589	GLN
1	C	680	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](#)

2 ligands are modelled in this entry.

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	$\# Z  > 2$
3	GOL	A	701	-	5,5,5	0.95	0	5,5,5	1.07	0
3	GOL	B	701	-	5,5,5	1.00	0	5,5,5	1.04	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. '2' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	GOL	A	701	-	-	0/4/4/4	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	GOL	B	701	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	701	GOL	O1-C1-C2-C3
3	B	701	GOL	O1-C1-C2-O2

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 [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	331/334 (99%)	0.01	3 (0%) 81 80	48, 79, 117, 170	0
1	B	332/334 (99%)	0.10	3 (0%) 81 80	42, 77, 147, 201	0
1	C	329/334 (98%)	0.19	7 (2%) 63 61	43, 86, 144, 217	0
2	D	144/179 (80%)	0.35	2 (1%) 73 72	51, 101, 159, 194	0
2	E	147/179 (82%)	0.29	3 (2%) 65 62	58, 108, 189, 252	0
2	F	143/179 (79%)	0.68	10 (6%) 22 19	73, 167, 243, 267	0
All	All	1426/1539 (92%)	0.20	28 (1%) 65 62	42, 90, 183, 267	0

The worst 5 of 28 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	D	113	ILE	3.4
2	F	27	LEU	3.1
2	F	117	ILE	3.1
1	B	399	GLY	3.0
1	C	616	GLY	3.0

### 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](#)

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(Å <sup>2</sup> )	Q<0.9
3	GOL	B	701	6/6	0.80	0.15	92,93,95,96	0
3	GOL	A	701	6/6	0.83	0.11	132,138,139,139	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.