



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 03:33 PM UTC

PDB ID : 5UJW / pdb\_00005ujw  
Title : Crystal structure of triosephosphate isomerase from *Francisella tularensis* subsp. *tularensis* SCHU S4  
Authors : Chang, C.; Maltseva, N.; Kim, Y.; Shatsman, S.; Joachimiak, A.; Anderson, W.F.; Center for Structural Genomics of Infectious Diseases (CSGID)  
Deposited on : 2017-01-19  
Resolution : 2.65 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 : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
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

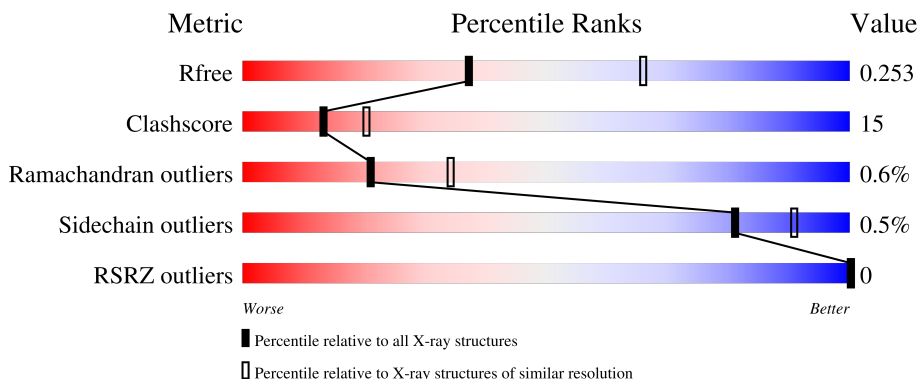
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.65 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	1110 (2.66-2.66)
Clashscore	190562	1141 (2.66-2.66)
Ramachandran outliers	187476	1126 (2.66-2.66)
Sidechain outliers	187428	1126 (2.66-2.66)
RSRZ outliers	180081	1110 (2.66-2.66)

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	253	
1	B	253	
1	C	253	
1	D	253	
1	E	253	

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Mol	Chain	Length	Quality of chain
1	F	253	 57% 40%

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 11331 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.

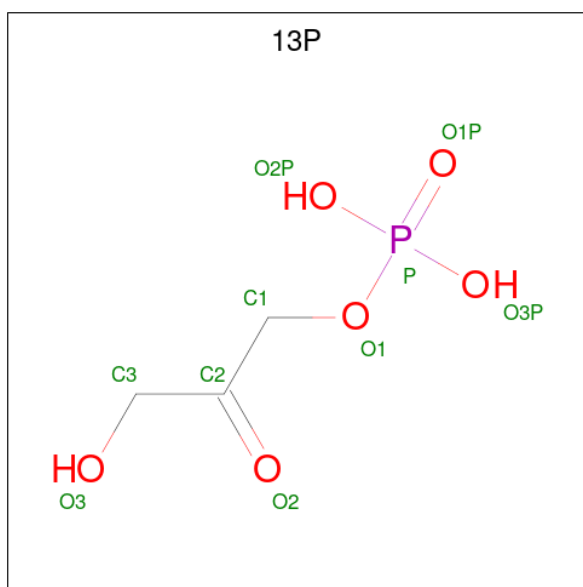
- Molecule 1 is a protein called Triosephosphate isomerase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	N	O	S	Se			
1	A	247	1876	1188	314	368	3	3	0	0	0
1	B	243	1846	1168	307	364	3	4	0	0	0
1	C	248	1879	1191	314	368	3	3	0	0	0
1	D	250	1883	1194	317	366	3	3	0	0	0
1	E	248	1850	1166	312	366	3	3	0	0	0
1	F	246	1810	1135	305	363	4	3	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

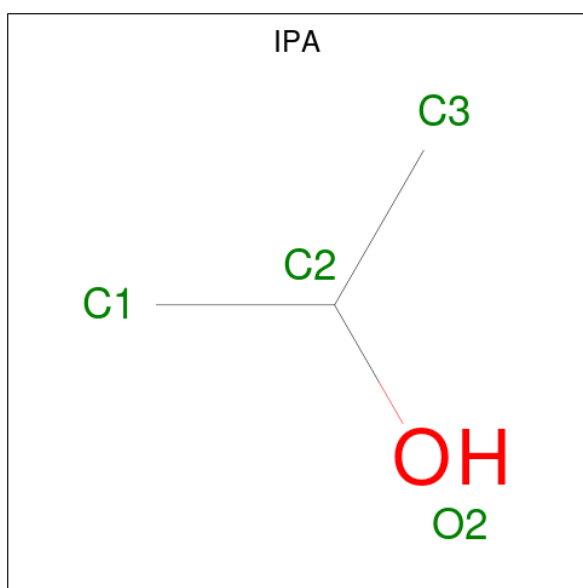
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MSE	-	initiating methionine	UNP Q5NII7
B	1	MSE	-	initiating methionine	UNP Q5NII7
C	1	MSE	-	initiating methionine	UNP Q5NII7
D	1	MSE	-	initiating methionine	UNP Q5NII7
E	1	MSE	-	initiating methionine	UNP Q5NII7
F	1	MSE	-	initiating methionine	UNP Q5NII7

- Molecule 2 is 1,3-DIHYDROXYACETONEPHOSPHATE (CCD ID: 13P) (formula: C<sub>3</sub>H<sub>7</sub>O<sub>6</sub>P).



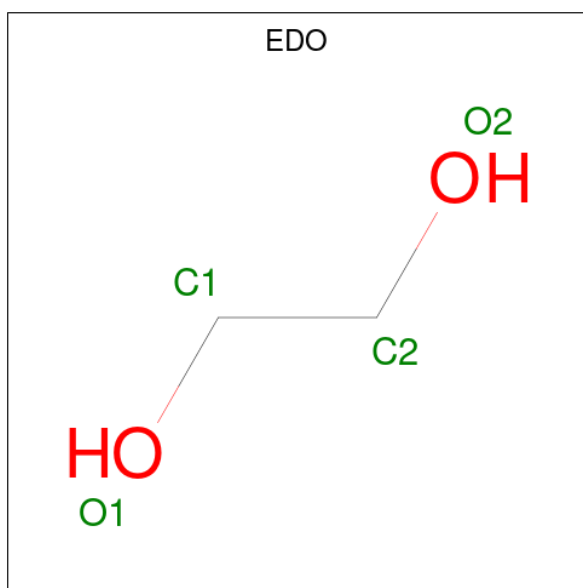
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	O	P	0	0
			10	3	6	1		
2	C	1	Total	C	O	P	0	0
			10	3	6	1		

- Molecule 3 is ISOPROPYL ALCOHOL (CCD ID: IPA) (formula:  $C_3H_8O$ ).



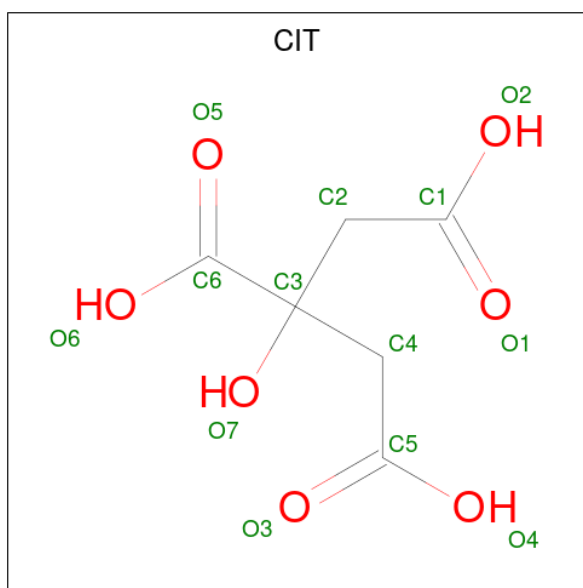
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			4	3	1		
3	C	1	Total	C	O	0	0
			4	3	1		

- Molecule 4 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula:  $C_2H_6O_2$ ).



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

- Molecule 5 is CITRIC ACID (CCD ID: CIT) (formula:  $C_6H_8O_7$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	D	1	Total	C	O	0	0
			13	6	7		

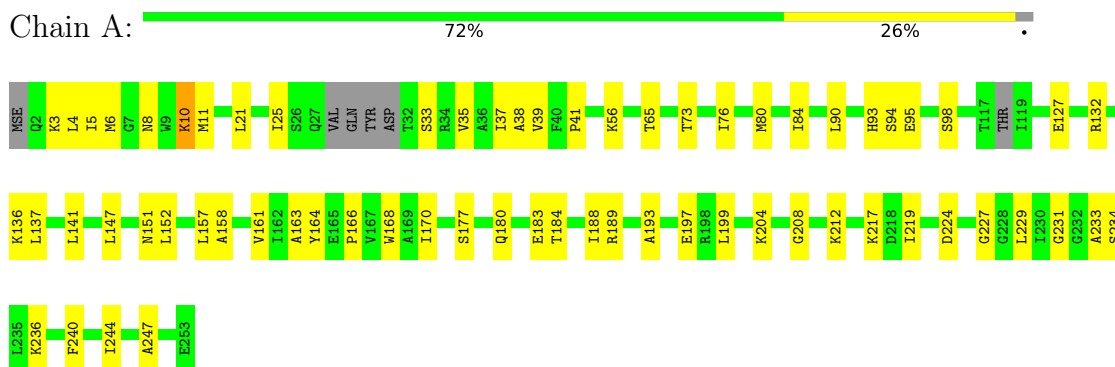
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	26	Total 26	O 26	0	0
6	B	32	Total 32	O 32	0	0
6	C	36	Total 36	O 36	0	0
6	D	22	Total 22	O 22	0	0
6	E	12	Total 12	O 12	0	0
6	F	14	Total 14	O 14	0	0

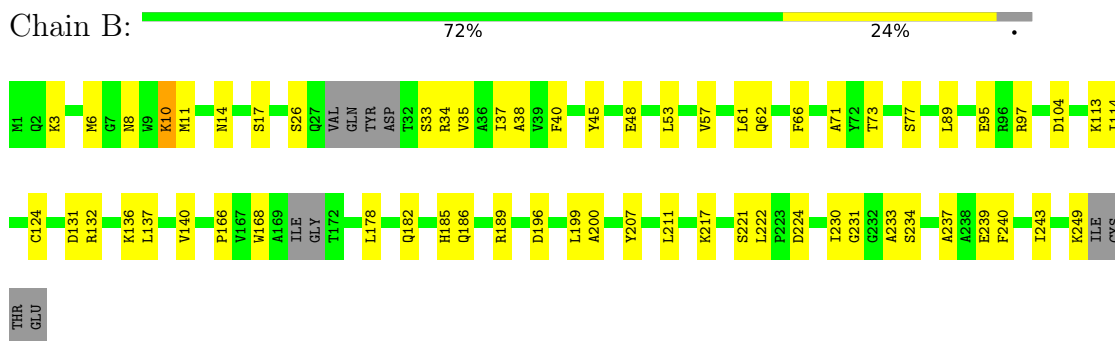
### 3 Residue-property plots [i](#)

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.

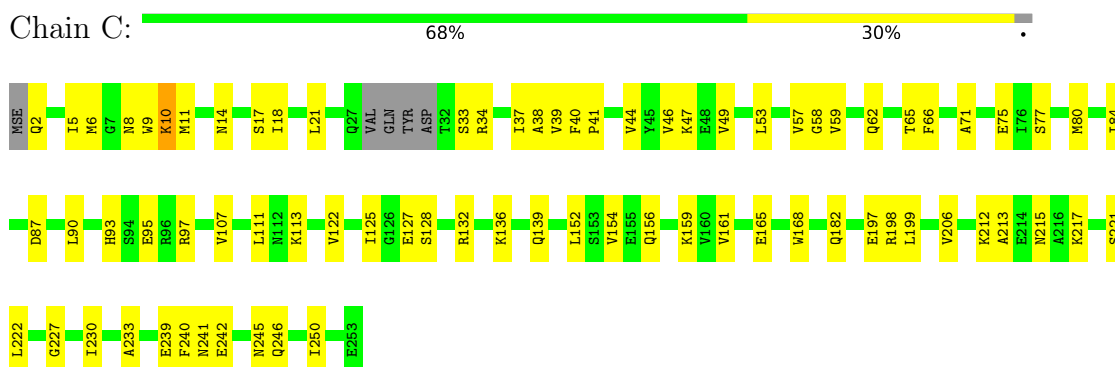
- Molecule 1: Triosephosphate isomerase



- Molecule 1: Triosephosphate isomerase

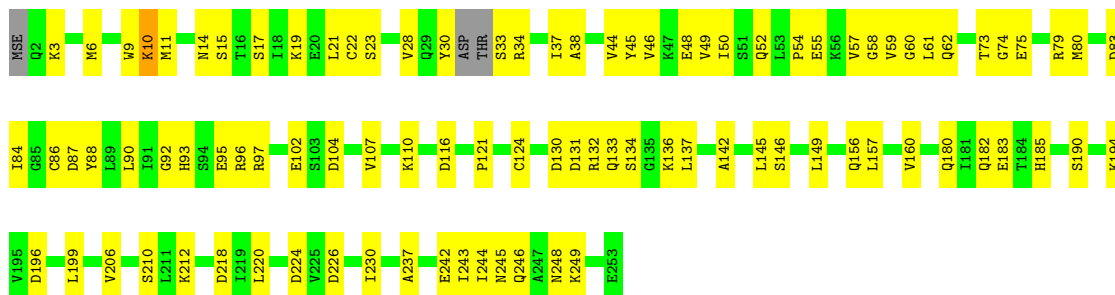


- Molecule 1: Triosephosphate isomerase



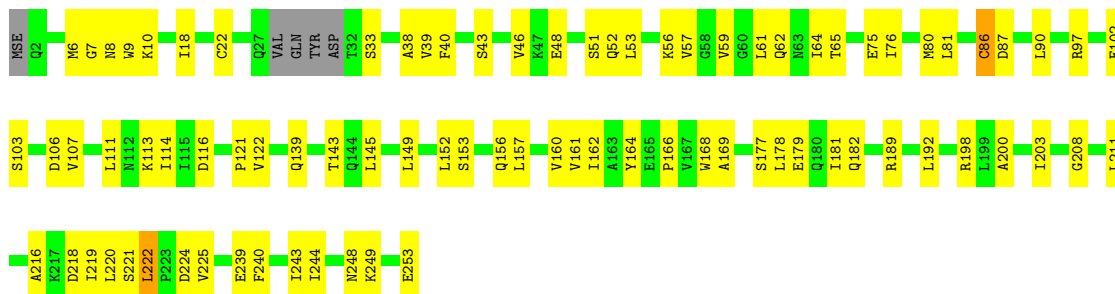
- Molecule 1: Triosephosphate isomerase

Chain D:  62% 37%



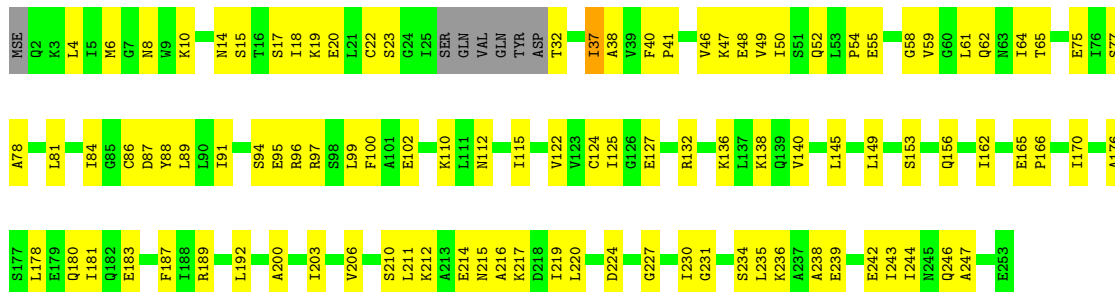
- Molecule 1: Triosephosphate isomerase

Chain E:  65% 32%



- Molecule 1: Triosephosphate isomerase

Chain F:  57% 40%



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	76.72Å 136.97Å 84.60Å 90.00° 89.98° 90.00°	Depositor
Resolution (Å)	32.58 – 2.65 32.58 – 2.65	Depositor EDS
% Data completeness (in resolution range)	97.0 (32.58-2.65) 96.9 (32.58-2.65)	Depositor EDS
$R_{merge}$	0.11	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.01 (at 2.64Å)	Xtriage
Refinement program	PHENIX dev_2650	Depositor
R, $R_{free}$	0.216 , 0.252 0.217 , 0.253	Depositor DCC
$R_{free}$ test set	2425 reflections (4.78%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	41.1	Xtriage
Anisotropy	0.120	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.26 , 12.4	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.437 for h,-k,-l	Xtriage
Reported twinning fraction	0.500 for h,-k,-l	Depositor
Outliers	0 of 49161 reflections	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	11331	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.98% 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: EDO, IPA, 13P, CIT

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	0.14	0/1893	0.31	0/2550
1	B	0.14	0/1863	0.34	0/2512
1	C	0.12	0/1897	0.29	0/2558
1	D	0.11	0/1901	0.30	0/2564
1	E	0.16	0/1868	0.38	0/2521
1	F	0.16	0/1826	0.37	0/2466
All	All	0.14	0/11248	0.33	0/15171

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	1876	0	1907	45	0
1	B	1846	0	1874	41	0
1	C	1879	0	1911	55	0
1	D	1883	0	1902	67	0
1	E	1850	0	1828	64	0
1	F	1810	0	1766	75	0
2	A	10	0	5	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	C	10	0	5	0	0
3	A	4	0	8	0	0
3	C	4	0	8	0	0
4	C	4	0	6	1	0
5	D	13	0	5	3	0
6	A	26	0	0	0	0
6	B	32	0	0	0	0
6	C	36	0	0	1	0
6	D	22	0	0	1	0
6	E	12	0	0	3	0
6	F	14	0	0	0	0
All	All	11331	0	11225	331	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 15.

The worst 5 of 331 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:F:65:THR:HG22	1:F:75:GLU:CD	1.88	0.98
1:A:11:MSE:HE3	1:B:77:SER:HB3	1.59	0.83
1:F:211:LEU:HD21	1:F:219:ILE:HD11	1.62	0.80
1:C:75:GLU:HG2	1:D:96:ARG:HH22	1.50	0.75
1:E:114:ILE:HD11	1:E:121:PRO:HB3	1.68	0.75

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	241/253 (95%)	227 (94%)	13 (5%)	1 (0%)	30 45

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	237/253 (94%)	216 (91%)	19 (8%)	2 (1%)	16	27
1	C	244/253 (96%)	229 (94%)	14 (6%)	1 (0%)	30	45
1	D	246/253 (97%)	228 (93%)	17 (7%)	1 (0%)	30	45
1	E	244/253 (96%)	216 (88%)	25 (10%)	3 (1%)	10	17
1	F	242/253 (96%)	212 (88%)	30 (12%)	0	100	100
All	All	1454/1518 (96%)	1328 (91%)	118 (8%)	8 (1%)	21	34

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	10	LYS
1	E	10	LYS
1	B	26	SER
1	E	86	CYS
1	C	10	LYS

### 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	205/212 (97%)	205 (100%)	0	100	100
1	B	203/212 (96%)	202 (100%)	1 (0%)	81	91
1	C	205/212 (97%)	204 (100%)	1 (0%)	81	91
1	D	202/212 (95%)	201 (100%)	1 (0%)	81	91
1	E	195/212 (92%)	193 (99%)	2 (1%)	68	81
1	F	189/212 (89%)	188 (100%)	1 (0%)	81	91
All	All	1199/1272 (94%)	1193 (100%)	6 (0%)	81	91

5 of 6 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	39	VAL

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Mol	Chain	Res	Type
1	E	51	SER
1	F	37	ILE
1	C	39	VAL
1	B	53	LEU

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

Mol	Chain	Res	Type
1	E	215	ASN
1	F	245	ASN
1	C	93	HIS
1	C	182	GLN
1	C	185	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 oligosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

6 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
4	EDO	C	303	-	3,3,3	0.42	0	2,2,2	0.39	0
3	IPA	C	302	-	3,3,3	0.52	0	3,3,3	0.21	0
3	IPA	A	302	-	3,3,3	0.52	0	3,3,3	0.22	0
2	13P	A	301	-	9,9,9	0.54	0	10,12,12	0.99	0
2	13P	C	301	-	9,9,9	0.54	0	10,12,12	1.02	0
5	CIT	D	301	-	12,12,12	1.20	1 (8%)	17,17,17	1.24	1 (5%)

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	13P	A	301	-	-	2/8/8/8	-
2	13P	C	301	-	-	0/8/8/8	-
4	EDO	C	303	-	-	0/1/1/1	-
5	CIT	D	301	-	-	6/16/16/16	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	D	301	CIT	C3-C6	-2.15	1.51	1.53

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	D	301	CIT	O6-C6-C3	2.78	118.47	113.14

There are no chirality outliers.

5 of 8 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	301	13P	C1-C2-C3-O3
5	D	301	CIT	O7-C3-C4-C5
5	D	301	CIT	C6-C3-C4-C5
5	D	301	CIT	C2-C3-C4-C5
5	D	301	CIT	C1-C2-C3-O7

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	C	303	EDO	1	0
5	D	301	CIT	3	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	244/253 (96%)	-1.86	0 100 100	18, 32, 53, 82	0
1	B	239/253 (94%)	-1.82	0 100 100	19, 36, 57, 74	0
1	C	245/253 (96%)	-1.85	0 100 100	18, 31, 55, 97	0
1	D	247/253 (97%)	-1.78	0 100 100	19, 37, 62, 104	0
1	E	245/253 (96%)	-1.66	0 100 100	34, 56, 85, 128	0
1	F	243/253 (96%)	-1.67	0 100 100	31, 57, 90, 147	0
All	All	1463/1518 (96%)	-1.77	0 100 100	18, 40, 77, 147	0

There are no RSRZ outliers to report.

### 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	IPA	A	302	4/4	0.98	0.06	17,24,27,34	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
3	IPA	C	302	4/4	0.98	0.07	36,41,43,43	0
2	13P	A	301	10/10	0.99	0.02	17,30,56,57	0
2	13P	C	301	10/10	0.99	0.03	28,59,71,74	0
4	EDO	C	303	4/4	0.99	0.03	8,14,16,23	0
5	CIT	D	301	13/13	1.00	0.02	17,30,45,47	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.