



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 11:18 PM UTC

PDB ID : 4BC4 / pdb\_00004bc4  
Title : Crystal structure of human D-xylulokinase in complex with D-xylulose  
Authors : Bunker, R.D.; Loomes, K.M.; Baker, E.N.  
Deposited on : 2012-10-01  
Resolution : 1.79 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  
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

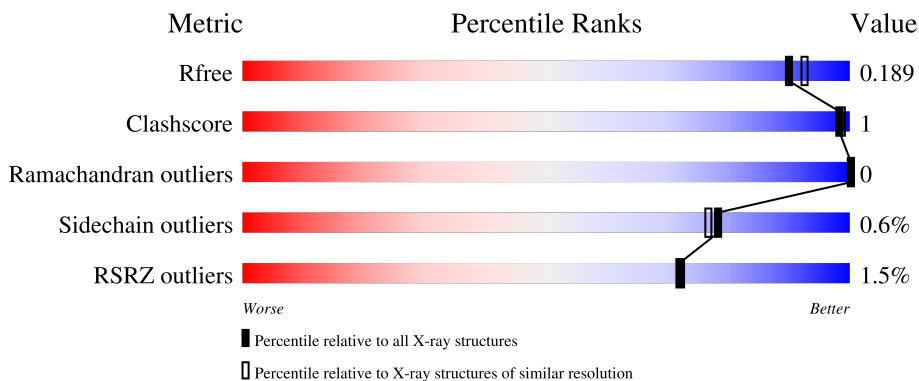
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.79 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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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	538	 94%
1	B	538	 94%
1	C	538	 95%

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 24235 atoms, of which 11501 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.

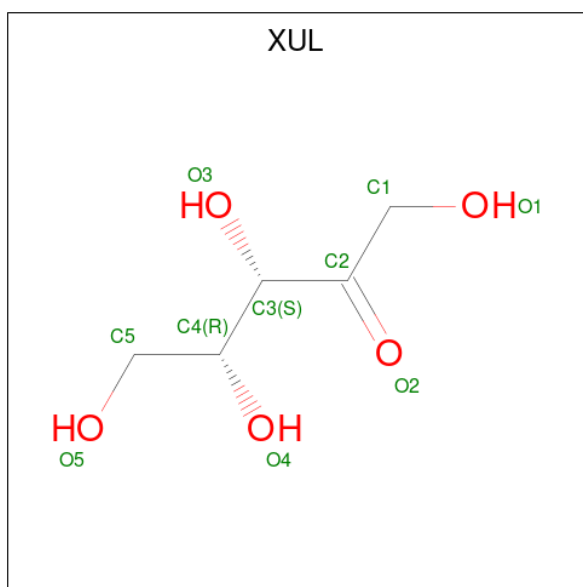
- Molecule 1 is a protein called XYLULOSE KINASE.

Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S	Se			
1	A	525	7784	2521	3795	685	758	13	12	0	0	0
1	B	525	7827	2521	3836	684	760	14	12	0	1	0
1	C	524	7795	2513	3822	682	752	14	12	0	1	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	GLY	-	expression tag	UNP O75191
A	0	ALA	-	expression tag	UNP O75191
B	-1	GLY	-	expression tag	UNP O75191
B	0	ALA	-	expression tag	UNP O75191
C	-1	GLY	-	expression tag	UNP O75191
C	0	ALA	-	expression tag	UNP O75191

- Molecule 2 is D-XYLULOSE (CCD ID: XUL) (formula: C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
2	A	1	Total	C	H	O	0	0
			20	5	10	5		
2	B	1	Total	C	H	O	0	0
			20	5	10	5		
2	C	1	Total	C	H	O	0	0
			20	5	10	5		

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C<sub>2</sub>H<sub>6</sub>O<sub>2</sub>).



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

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	B	1	Total	C	H	O	0	0
			10	2	6	2		
3	C	1	Total	C	H	O	0	0
			10	2	6	2		

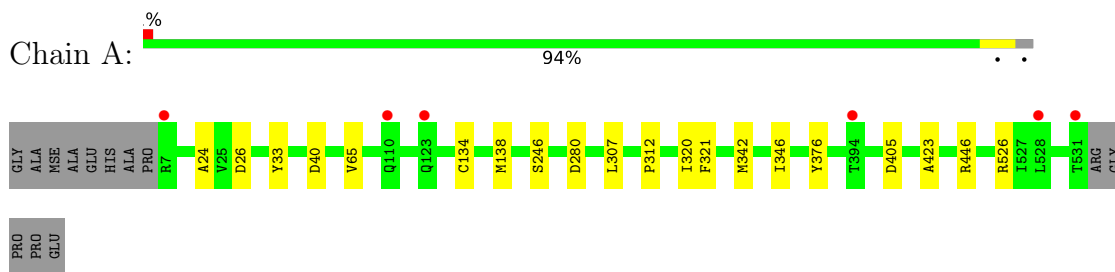
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	266	Total	O	0	0
			266	266		
4	B	246	Total	O	0	0
			246	246		
4	C	227	Total	O	0	0
			227	227		

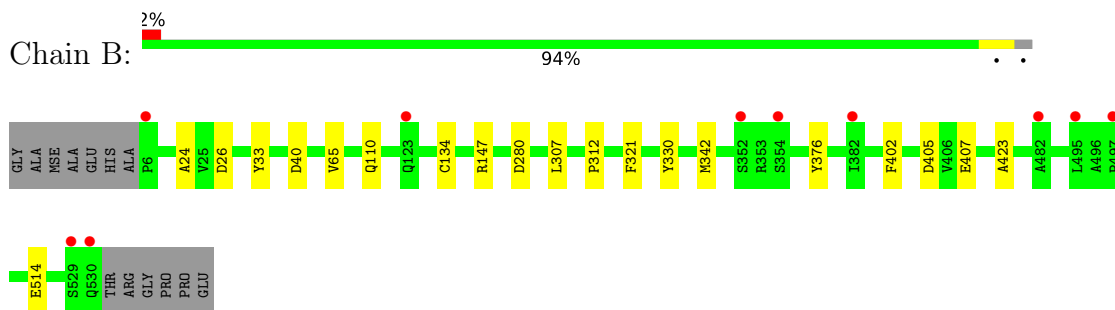
### 3 Residue-property plots [i](#)

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.

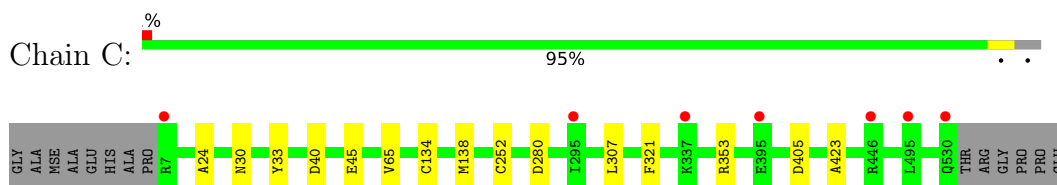
- Molecule 1: XYLULOSE KINASE



- Molecule 1: XYLULOSE KINASE



- Molecule 1: XYLULOSE KINASE



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 32	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	102.80Å 102.80Å 159.35Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	59.37 – 1.79 59.37 – 1.79	Depositor EDS
% Data completeness (in resolution range)	97.6 (59.37-1.79) 97.6 (59.37-1.79)	Depositor EDS
$R_{merge}$	0.22	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.46 (at 1.79Å)	Xtriage
Refinement program	BUSTER 2.11.1	Depositor
R, $R_{free}$	0.167 , 0.186 0.170 , 0.189	Depositor DCC
$R_{free}$ test set	8724 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	27.4	Xtriage
Anisotropy	0.167	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.44 , 44.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.002 for -h,-k,l 0.028 for h,-h-k,-l 0.017 for -k,-h,-l	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	24235	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 20.79 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 8.0470e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

<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, XUL

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	0.83	1/4070 (0.0%)	1.05	6/5512 (0.1%)
1	B	0.81	0/4073	1.04	6/5518 (0.1%)
1	C	0.81	1/4057 (0.0%)	1.05	5/5495 (0.1%)
All	All	0.82	2/12200 (0.0%)	1.04	17/16525 (0.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	138	MSE	SE-CE	-5.41	1.79	1.95
1	A	138	MSE	SE-CE	-5.23	1.79	1.95

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	405	ASP	CA-CB-CG	7.28	119.88	112.60
1	C	280	ASP	CA-CB-CG	6.69	119.29	112.60
1	C	405	ASP	CA-CB-CG	6.62	119.22	112.60
1	A	405	ASP	CA-CB-CG	6.50	119.10	112.60
1	B	402	PHE	CA-CB-CG	6.46	120.26	113.80
1	C	40	ASP	CA-CB-CG	6.39	118.99	112.60
1	C	30	ASN	CA-CB-CG	6.33	118.93	112.60
1	B	280	ASP	CA-CB-CG	6.25	118.85	112.60
1	B	40	ASP	CA-CB-CG	6.09	118.69	112.60
1	A	280	ASP	CA-CB-CG	6.00	118.60	112.60
1	A	40	ASP	CA-CB-CG	5.79	118.39	112.60
1	B	26	ASP	CA-CB-CG	5.73	118.33	112.60
1	B	321	PHE	CA-CB-CG	5.59	119.39	113.80
1	C	321	PHE	CA-CB-CG	5.53	119.33	113.80
1	A	526	ARG	CB-CG-CD	5.51	123.97	111.30
1	A	321	PHE	CA-CB-CG	5.51	119.31	113.80

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	26	ASP	CA-CB-CG	5.37	117.97	112.60

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	3989	3795	3858	6	0
1	B	3991	3836	3845	5	0
1	C	3973	3822	3840	5	0
2	A	10	10	10	0	0
2	B	10	10	10	0	0
2	C	10	10	10	0	0
3	A	4	6	6	0	0
3	B	4	6	6	0	0
3	C	4	6	6	0	0
4	A	266	0	0	0	0
4	B	246	0	0	0	0
4	C	227	0	0	1	0
All	All	12734	11501	11591	15	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 1.

All (15) 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:342:MSE:HE2	1:B:376:TYR:HB3	1.89	0.54
1:A:342:MSE:HE2	1:A:376:TYR:HB3	1.91	0.52
1:C:252:CYS:SG	4:C:2116:HOH:O	2.58	0.47
1:C:65:VAL:HB	1:C:134:CYS:SG	2.55	0.46
1:A:312:PRO:HB3	1:A:320:ILE:HG21	1.96	0.46
1:C:24:ALA:HB3	1:C:33:TYR:HB3	1.98	0.46
1:B:65:VAL:HB	1:B:134:CYS:SG	2.56	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:24:ALA:HB3	1:A:33:TYR:HB3	1.99	0.45
1:A:65:VAL:HB	1:A:134:CYS:SG	2.58	0.44
1:B:24:ALA:HB3	1:B:33:TYR:HB3	1.99	0.44
1:C:307:LEU:HD21	1:C:423:ALA:HA	2.00	0.43
1:B:307:LEU:HD21	1:B:423:ALA:HA	2.01	0.42
1:A:307:LEU:HD21	1:A:423:ALA:HA	2.01	0.41
1:A:446:ARG:HB2	1:C:45:GLU:O	2.21	0.41
1:B:312:PRO:HD3	1:B:330:TYR:CD1	2.57	0.40

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	523/538 (97%)	515 (98%)	8 (2%)	0	100	100
1	B	524/538 (97%)	514 (98%)	10 (2%)	0	100	100
1	C	523/538 (97%)	517 (99%)	6 (1%)	0	100	100
All	All	1570/1614 (97%)	1546 (98%)	24 (2%)	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	424/427 (99%)	422 (100%)	2 (0%)	81	80
1	B	424/427 (99%)	420 (99%)	4 (1%)	70	67
1	C	421/427 (99%)	420 (100%)	1 (0%)	87	87
All	All	1269/1281 (99%)	1262 (99%)	7 (1%)	78	77

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	246	SER
1	A	346	ILE
1	B	110	GLN
1	B	147	ARG
1	B	407	GLU
1	B	514	GLU
1	C	353	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (15) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	70	GLN
1	A	123	GLN
1	A	157	GLN
1	A	174	ASN
1	A	182	GLN
1	A	396	ASN
1	B	110	GLN
1	B	182	GLN
1	B	396	ASN
1	C	97	GLN
1	C	123	GLN
1	C	157	GLN
1	C	174	ASN
1	C	328	GLN
1	C	396	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](#)

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
3	EDO	A	1533	-	3,3,3	0.59	0	2,2,2	0.37	0
2	XUL	B	1531	-	9,9,9	0.66	0	6,11,11	1.04	1 (16%)
3	EDO	C	1532	-	3,3,3	0.57	0	2,2,2	0.59	0
2	XUL	A	1532	-	9,9,9	0.60	0	6,11,11	1.37	1 (16%)
2	XUL	C	1531	-	9,9,9	0.48	0	6,11,11	1.62	2 (33%)
3	EDO	B	1532	-	3,3,3	0.51	0	2,2,2	0.54	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
3	EDO	A	1533	-	-	0/1/1/1	-
2	XUL	B	1531	-	-	0/12/12/12	-
3	EDO	C	1532	-	-	0/1/1/1	-
2	XUL	A	1532	-	-	0/12/12/12	-
2	XUL	C	1531	-	-	0/12/12/12	-
3	EDO	B	1532	-	-	1/1/1/1	-

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	1532	XUL	O2-C2-C1	3.07	125.38	120.16
2	C	1531	XUL	O4-C4-C3	2.94	113.95	109.67
2	C	1531	XUL	O2-C2-C1	2.56	124.52	120.16
2	B	1531	XUL	O2-C2-C1	2.28	124.03	120.16

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	1532	EDO	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

### 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	513/538 (95%)	-0.18	6 (1%) 76 77	20, 32, 51, 86	0
1	B	513/538 (95%)	-0.08	10 (1%) 66 66	16, 33, 54, 85	1 (0%)
1	C	512/538 (95%)	-0.18	7 (1%) 73 73	18, 33, 51, 91	1 (0%)
All	All	1538/1614 (95%)	-0.15	23 (1%) 72 72	16, 33, 52, 91	2 (0%)

All (23) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	531	THR	4.9
1	C	530	GLN	4.7
1	B	530	GLN	4.5
1	B	352	SER	4.1
1	C	7	ARG	3.0
1	A	7	ARG	2.9
1	B	382	ILE	2.9
1	B	6	PRO	2.8
1	A	528	LEU	2.7
1	A	394	THR	2.7
1	B	529	SER	2.7
1	C	295	ILE	2.7
1	B	354	SER	2.4
1	B	495	LEU	2.4
1	C	495	LEU	2.4
1	C	337	LYS	2.4
1	A	123	GLN	2.3
1	C	395	GLU	2.2
1	A	110	GLN	2.1
1	B	123	GLN	2.1
1	C	446	ARG	2.1
1	B	497	PRO	2.0
1	B	482	ALA	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](#)

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
3	EDO	B	1532	4/4	0.91	0.14	46,54,60,60	0
3	EDO	A	1533	4/4	0.97	0.06	32,33,34,35	0
2	XUL	A	1532	10/10	0.97	0.05	21,24,26,28	0
3	EDO	C	1532	4/4	0.97	0.07	36,37,39,39	0
2	XUL	C	1531	10/10	0.98	0.05	22,24,26,28	0
2	XUL	B	1531	10/10	0.98	0.04	22,24,26,26	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.