



# Full wwPDB X-ray Structure Validation Report ⓘ

Jun 15, 2024 – 07:43 PM EDT

PDB ID : 4NWX  
Title : Crystal structure of phosphoglycerate mutase from *Staphylococcus aureus* in 2-phosphoglyceric acid bound form  
Authors : Roychowdhury, A.; Kundu, A.; Bose, M.; Gujar, A.; Das, A.K.  
Deposited on : 2013-12-07  
Resolution : 2.01 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 : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.37.1  
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) : 2.37.1

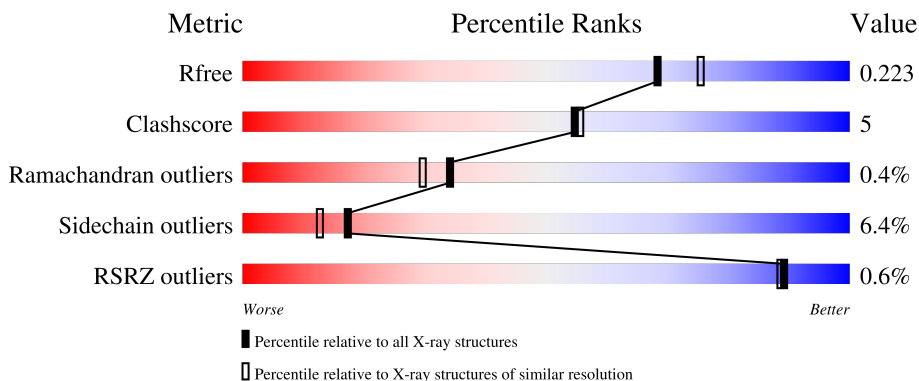
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

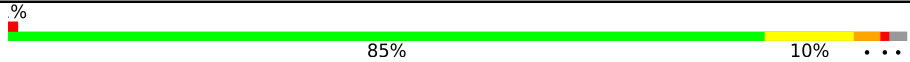
The reported resolution of this entry is 2.01 Å.

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	8085 (2.00-2.00)
Clashscore	141614	9178 (2.00-2.00)
Ramachandran outliers	138981	9054 (2.00-2.00)
Sidechain outliers	138945	9053 (2.00-2.00)
RSRZ outliers	127900	7900 (2.00-2.00)

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	513	

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 4295 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.

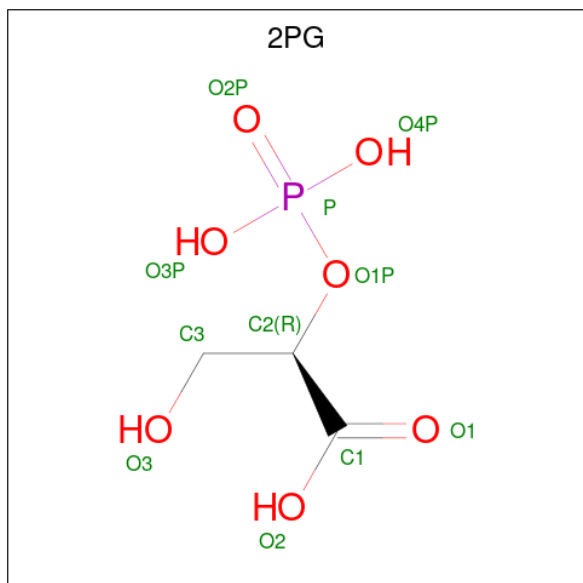
- Molecule 1 is a protein called 2,3-bisphosphoglycerate-independent phosphoglycerate mutase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	503	3970	2497	673	789	11	0	2	0

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-7	HIS	-	expression tag	UNP Q2G029
A	-6	HIS	-	expression tag	UNP Q2G029
A	-5	HIS	-	expression tag	UNP Q2G029
A	-4	HIS	-	expression tag	UNP Q2G029
A	-3	HIS	-	expression tag	UNP Q2G029
A	-2	HIS	-	expression tag	UNP Q2G029
A	-1	GLY	-	expression tag	UNP Q2G029
A	0	SER	-	expression tag	UNP Q2G029

- Molecule 2 is 2-PHOSPHOGLYCERIC ACID (three-letter code: 2PG) (formula: C<sub>3</sub>H<sub>7</sub>O<sub>7</sub>P).

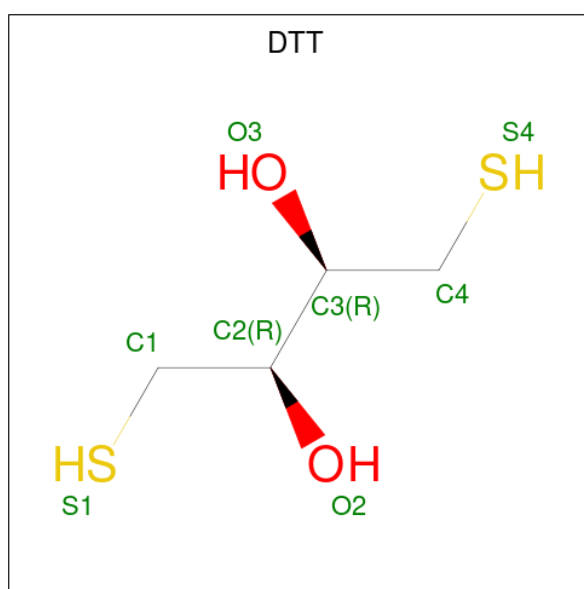


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	O	P	0	0
			11	3	7	1		

- Molecule 3 is MANGANESE (II) ION (three-letter code: MN) (formula: Mn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	2	Total	Mn	0	0
			2	2		

- Molecule 4 is 2,3-DIHYDROXY-1,4-DITHIOBUTANE (three-letter code: DTT) (formula: C<sub>4</sub>H<sub>10</sub>O<sub>2</sub>S<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	O	S	0	0
			8	4	2	2		

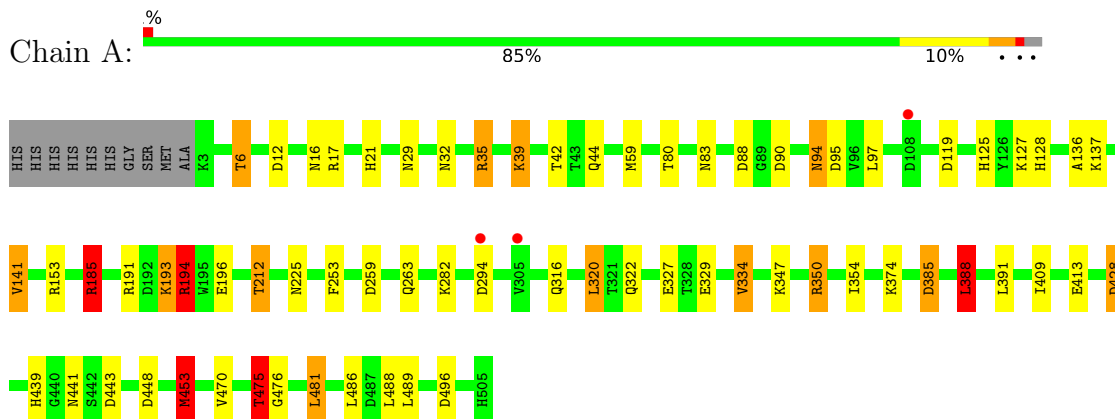
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	304	Total	O	0	0
			304	304		

### 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: 2,3-bisphosphoglycerate-independent phosphoglycerate mutase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	73.64Å 83.21Å 89.07Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.64 – 2.01 19.63 – 2.01	Depositor EDS
% Data completeness (in resolution range)	99.0 (19.64-2.01) 99.1 (19.63-2.01)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.10	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.12 (at 2.01Å)	Xtrriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.168 , 0.216 0.177 , 0.223	Depositor DCC
$R_{free}$ test set	1848 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	18.3	Xtrriage
Anisotropy	0.361	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.38 , 44.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	4295	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	19.0	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: DTT, 2PG, MN

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	0.96	3/4048 (0.1%)	1.16	30/5481 (0.5%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	329	GLU	CD-OE2	-7.48	1.17	1.25
1	A	428	ASP	CB-CG	-5.24	1.40	1.51
1	A	185	ARG	CD-NE	-5.18	1.37	1.46

All (30) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	194	ARG	NE-CZ-NH2	-17.20	111.70	120.30
1	A	185	ARG	NE-CZ-NH2	-17.05	111.78	120.30
1	A	185	ARG	NE-CZ-NH1	16.52	128.56	120.30
1	A	194	ARG	NE-CZ-NH1	15.03	127.81	120.30
1	A	17	ARG	NE-CZ-NH2	-10.57	115.01	120.30
1	A	35	ARG	NE-CZ-NH1	-10.48	115.06	120.30
1	A	17	ARG	NE-CZ-NH1	9.82	125.21	120.30
1	A	350	ARG	NE-CZ-NH1	9.73	125.17	120.30
1	A	191	ARG	NE-CZ-NH2	8.85	124.72	120.30
1	A	350	ARG	NE-CZ-NH2	-8.82	115.89	120.30
1	A	259	ASP	CB-CG-OD1	8.81	126.23	118.30
1	A	334	VAL	CG1-CB-CG2	8.12	123.89	110.90
1	A	119	ASP	CB-CG-OD1	7.48	125.03	118.30
1	A	35	ARG	NE-CZ-NH2	7.18	123.89	120.30
1	A	481	LEU	CB-CG-CD1	6.66	122.32	111.00
1	A	481	LEU	CB-CG-CD2	6.20	121.54	111.00
1	A	496	ASP	CB-CG-OD1	6.10	123.79	118.30
1	A	191	ARG	NE-CZ-NH1	-6.03	117.28	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	448	ASP	CB-CG-OD2	5.99	123.69	118.30
1	A	95	ASP	CB-CG-OD2	-5.96	112.94	118.30
1	A	194	ARG	CD-NE-CZ	5.85	131.79	123.60
1	A	385	ASP	CB-CG-OD2	5.78	123.50	118.30
1	A	95	ASP	CB-CG-OD1	5.58	123.32	118.30
1	A	194	ARG	CG-CD-NE	-5.53	100.19	111.80
1	A	453	MET	CG-SD-CE	-5.49	91.42	100.20
1	A	185	ARG	CD-NE-CZ	5.45	131.24	123.60
1	A	475	THR	CB-CA-C	-5.42	96.98	111.60
1	A	12	ASP	CB-CG-OD2	-5.41	113.43	118.30
1	A	388	LEU	CB-CG-CD2	5.20	119.84	111.00
1	A	320	LEU	CB-CG-CD1	5.11	119.69	111.00

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	3970	0	3835	39	0
2	A	11	0	4	1	0
3	A	2	0	0	0	0
4	A	8	0	10	2	0
5	A	304	0	0	17	0
All	All	4295	0	3849	41	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 5.

All (41) 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:A:80:THR:HG21	5:A:879:HOH:O	1.63	0.96
1:A:193:LYS:H	1:A:263:GLN:HE22	1.11	0.93
1:A:185:ARG:HD3	5:A:739:HOH:O	1.75	0.84

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:453:MET:CE	5:A:945:HOH:O	2.32	0.78
1:A:453:MET:HE2	5:A:945:HOH:O	1.86	0.75
1:A:16:ASN:HD22	1:A:44:GLN:HE21	1.34	0.75
1:A:125:HIS:HD2	1:A:127:LYS:H	1.34	0.75
1:A:29:ASN:HB3	5:A:829:HOH:O	1.90	0.71
1:A:316:GLN:HE21	1:A:347:LYS:H	1.39	0.70
1:A:212:THR:CG2	5:A:837:HOH:O	2.42	0.68
1:A:193:LYS:H	1:A:263:GLN:NE2	1.91	0.67
4:A:604:DTT:H11	4:A:604:DTT:S4	2.36	0.65
1:A:94:ASN:HD22	1:A:97:LEU:H	1.45	0.63
1:A:350:ARG:NH2	1:A:385:ASP:OD1	2.33	0.62
1:A:21:HIS:HD2	5:A:869:HOH:O	1.83	0.59
1:A:16:ASN:HD22	1:A:44:GLN:NE2	2.03	0.56
1:A:350:ARG:HH22	1:A:385:ASP:CG	2.09	0.56
1:A:212:THR:HG23	5:A:837:HOH:O	2.05	0.55
1:A:125:HIS:HE1	5:A:908:HOH:O	1.90	0.54
1:A:475:THR:HG22	1:A:476:GLY:H	1.73	0.54
1:A:194:ARG:HD3	1:A:196:GLU:OE1	2.08	0.53
1:A:212:THR:HG21	5:A:969:HOH:O	2.09	0.53
1:A:59:MET:CE	5:A:706:HOH:O	2.57	0.53
1:A:39:LYS:O	1:A:39:LYS:HG3	2.08	0.52
1:A:185:ARG:CD	5:A:739:HOH:O	2.44	0.50
1:A:475:THR:HG23	5:A:947:HOH:O	2.10	0.50
1:A:6:THR:HG23	1:A:489:LEU:CD2	2.43	0.49
1:A:59:MET:HE3	5:A:706:HOH:O	2.13	0.48
1:A:322:GLN:HA	1:A:388:LEU:O	2.14	0.47
4:A:604:DTT:S4	4:A:604:DTT:C1	3.00	0.46
1:A:128:HIS:HD2	5:A:722:HOH:O	1.98	0.46
1:A:347:LYS:NZ	5:A:890:HOH:O	2.33	0.46
1:A:475:THR:CG2	5:A:947:HOH:O	2.64	0.45
1:A:83:ASN:OD1	1:A:128:HIS:HE1	2.00	0.45
1:A:153:ARG:HD3	2:A:601:2PG:H32	1.99	0.44
1:A:327:GLU:HA	1:A:354:ILE:O	2.17	0.43
1:A:6:THR:HG23	1:A:489:LEU:HD21	2.01	0.43
1:A:88:ASP:OD2	1:A:90:ASP:OD2	2.36	0.43
1:A:136:ALA:O	1:A:141:VAL:HG13	2.20	0.42
1:A:32:ASN:HD22	1:A:35:ARG:HH21	1.68	0.42
1:A:409:ILE:O	1:A:413:GLU:HG3	2.20	0.41

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	503/513 (98%)	491 (98%)	10 (2%)	2 (0%)	34 30

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	439	HIS
1	A	441	ASN

### 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	425/433 (98%)	398 (94%)	27 (6%)	17 13

All (27) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	6	THR
1	A	39	LYS
1	A	42	THR
1	A	94	ASN
1	A	137	LYS
1	A	141	VAL
1	A	185	ARG
1	A	193	LYS
1	A	194	ARG

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<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>
1	A	212	THR
1	A	225	ASN
1	A	253	PHE
1	A	282	LYS
1	A	294	ASP
1	A	320	LEU
1	A	334	VAL
1	A	374	LYS
1	A	388	LEU
1	A	391	LEU
1	A	428	ASP
1	A	443	ASP
1	A	453	MET
1	A	470	VAL
1	A	475	THR
1	A	481	LEU
1	A	486	LEU
1	A	488	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (16) such sidechains are listed below:

<b>Mol</b>	<b>Chain</b>	<b>Res</b>	<b>Type</b>
1	A	21	HIS
1	A	29	ASN
1	A	32	ASN
1	A	44	GLN
1	A	94	ASN
1	A	103	HIS
1	A	107	HIS
1	A	125	HIS
1	A	128	HIS
1	A	207	ASN
1	A	263	GLN
1	A	270	ASN
1	A	308	ASN
1	A	316	GLN
1	A	319	ASN
1	A	459	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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 4 ligands modelled in this entry, 2 are monoatomic - leaving 2 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
4	DTT	A	604	-	7,7,7	0.74	0	4,8,8	0.90	0
2	2PG	A	601	-	9,10,10	2.22	1 (11%)	11,14,14	1.66	3 (27%)

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
4	DTT	A	604	-	-	4/8/8/8	-
2	2PG	A	601	-	-	1/11/11/11	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	601	2PG	C2-C1	-5.69	1.47	1.52

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	601	2PG	O1-C1-C2	-2.85	115.84	122.57
2	A	601	2PG	O2-C1-C2	2.51	120.18	113.03
2	A	601	2PG	P-O1P-C2	-2.28	117.80	123.04

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	604	DTT	C2-C3-C4-S4
4	A	604	DTT	O3-C3-C4-S4
4	A	604	DTT	C1-C2-C3-C4
4	A	604	DTT	C1-C2-C3-O3
2	A	601	2PG	C3-C2-O1P-P

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	604	DTT	2	0
2	A	601	2PG	1	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	503/513 (98%)	-0.55	3 (0%) 89 88	11, 17, 32, 44	0

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	108	ASP	2.2
1	A	305	VAL	2.2
1	A	294	ASP	2.2

### 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(Å <sup>2</sup> )	Q<0.9
4	DTT	A	604	8/8	0.80	0.18	38,51,60,68	0
2	2PG	A	601	11/11	0.98	0.10	15,20,24,24	0
3	MN	A	603	1/1	1.00	0.03	13,13,13,13	0
3	MN	A	602	1/1	1.00	0.04	8,8,8,8	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.