



# wwPDB X-ray Structure Validation Summary Report ⓘ

Jun 12, 2024 – 06:46 PM EDT

PDB ID : 3QDK  
Title : Structural insight on mechanism and diverse substrate selection strategy of ribulokinase  
Authors : Agarwal, R.; Burley, S.K.; Swaminathan, S.; New York SGX Research Center for Structural Genomics (NYSGXRC)  
Deposited on : 2011-01-18  
Resolution : 2.31 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 : 4.02b-467  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtriage (Phenix) : 1.20.1  
EDS : 2.36.2  
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) : 2.36.2

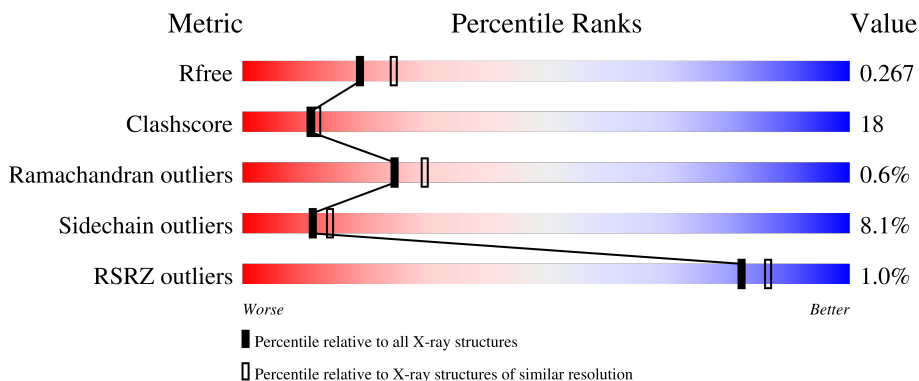
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

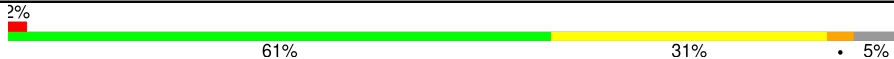



The reported resolution of this entry is 2.31 Å.

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	5974 (2.34-2.30)
Clashscore	141614	6604 (2.34-2.30)
Ramachandran outliers	138981	6523 (2.34-2.30)
Sidechain outliers	138945	6523 (2.34-2.30)
RSRZ outliers	127900	5855 (2.34-2.30)

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	572	
1	B	572	
1	C	572	
1	D	572	

## 2 Entry composition i

There are 3 unique types of molecules in this entry. The entry contains 17164 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 Ribulokinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	546	4163	2646	709	786	22	0	0	0
1	B	543	4155	2642	705	786	22	0	0	0
1	C	549	4202	2670	717	793	22	0	0	0
1	D	554	4239	2690	724	803	22	0	0	0

There are 44 discrepancies between the modelled and reference sequences:

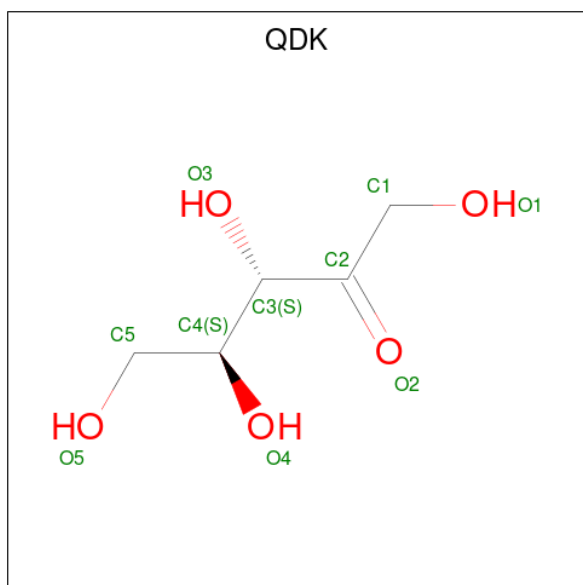
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	expression tag	UNP Q9KBQ3
A	2	SER	-	expression tag	UNP Q9KBQ3
A	3	LEU	-	expression tag	UNP Q9KBQ3
A	565	GLU	-	expression tag	UNP Q9KBQ3
A	566	GLY	-	expression tag	UNP Q9KBQ3
A	567	HIS	-	expression tag	UNP Q9KBQ3
A	568	HIS	-	expression tag	UNP Q9KBQ3
A	569	HIS	-	expression tag	UNP Q9KBQ3
A	570	HIS	-	expression tag	UNP Q9KBQ3
A	571	HIS	-	expression tag	UNP Q9KBQ3
A	572	HIS	-	expression tag	UNP Q9KBQ3
B	1	MET	-	expression tag	UNP Q9KBQ3
B	2	SER	-	expression tag	UNP Q9KBQ3
B	3	LEU	-	expression tag	UNP Q9KBQ3
B	565	GLU	-	expression tag	UNP Q9KBQ3
B	566	GLY	-	expression tag	UNP Q9KBQ3
B	567	HIS	-	expression tag	UNP Q9KBQ3
B	568	HIS	-	expression tag	UNP Q9KBQ3
B	569	HIS	-	expression tag	UNP Q9KBQ3
B	570	HIS	-	expression tag	UNP Q9KBQ3
B	571	HIS	-	expression tag	UNP Q9KBQ3

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Chain	Residue	Modelled	Actual	Comment	Reference
B	572	HIS	-	expression tag	UNP Q9KBQ3
C	1	MET	-	expression tag	UNP Q9KBQ3
C	2	SER	-	expression tag	UNP Q9KBQ3
C	3	LEU	-	expression tag	UNP Q9KBQ3
C	565	GLU	-	expression tag	UNP Q9KBQ3
C	566	GLY	-	expression tag	UNP Q9KBQ3
C	567	HIS	-	expression tag	UNP Q9KBQ3
C	568	HIS	-	expression tag	UNP Q9KBQ3
C	569	HIS	-	expression tag	UNP Q9KBQ3
C	570	HIS	-	expression tag	UNP Q9KBQ3
C	571	HIS	-	expression tag	UNP Q9KBQ3
C	572	HIS	-	expression tag	UNP Q9KBQ3
D	1	MET	-	expression tag	UNP Q9KBQ3
D	2	SER	-	expression tag	UNP Q9KBQ3
D	3	LEU	-	expression tag	UNP Q9KBQ3
D	565	GLU	-	expression tag	UNP Q9KBQ3
D	566	GLY	-	expression tag	UNP Q9KBQ3
D	567	HIS	-	expression tag	UNP Q9KBQ3
D	568	HIS	-	expression tag	UNP Q9KBQ3
D	569	HIS	-	expression tag	UNP Q9KBQ3
D	570	HIS	-	expression tag	UNP Q9KBQ3
D	571	HIS	-	expression tag	UNP Q9KBQ3
D	572	HIS	-	expression tag	UNP Q9KBQ3

- Molecule 2 is L-ribulose (three-letter code: QDK) (formula:  $C_5H_{10}O_5$ ).



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

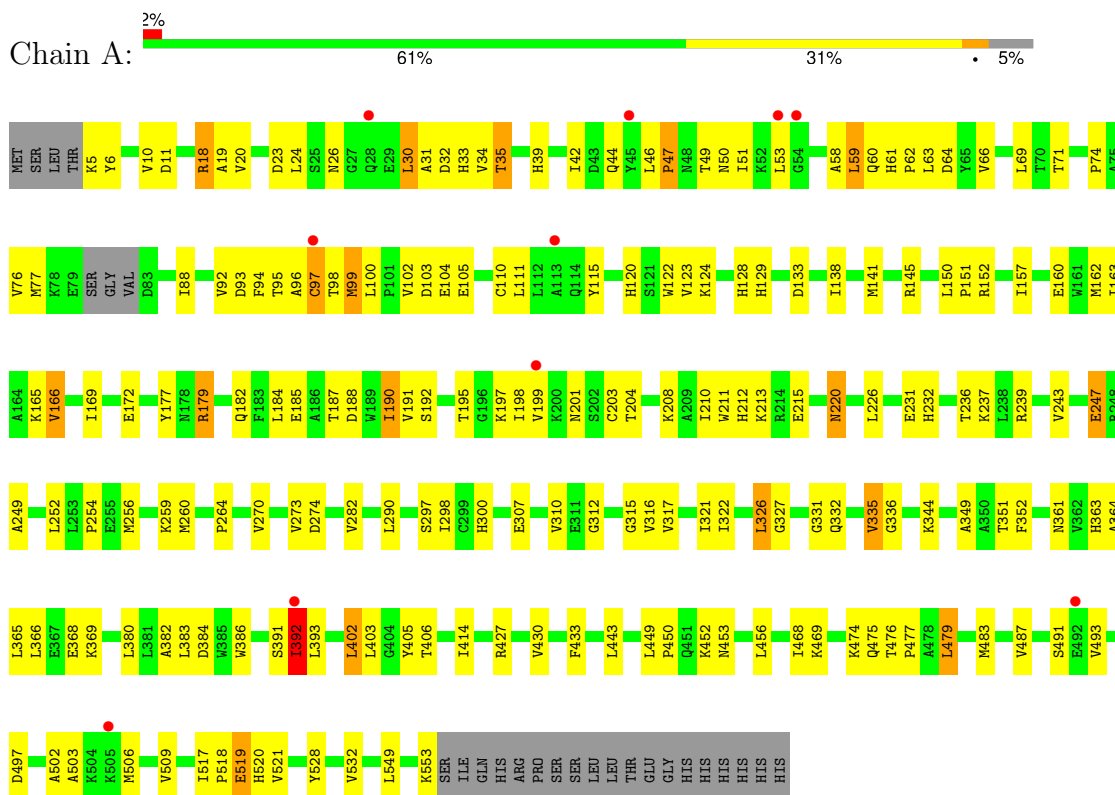
- Molecule 3 is water.

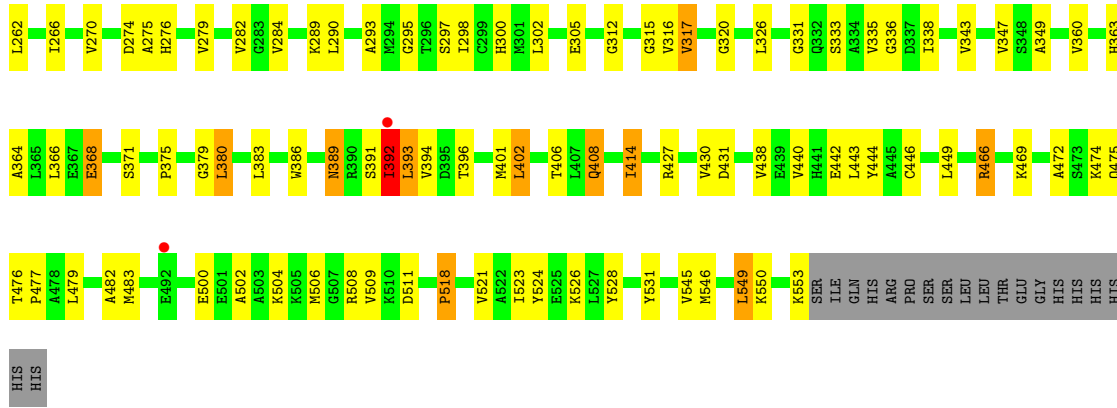
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	76	Total	O	0	0
			76	76		
3	B	77	Total	O	0	0
			77	77		
3	C	100	Total	O	0	0
			100	100		
3	D	142	Total	O	0	0
			142	142		

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

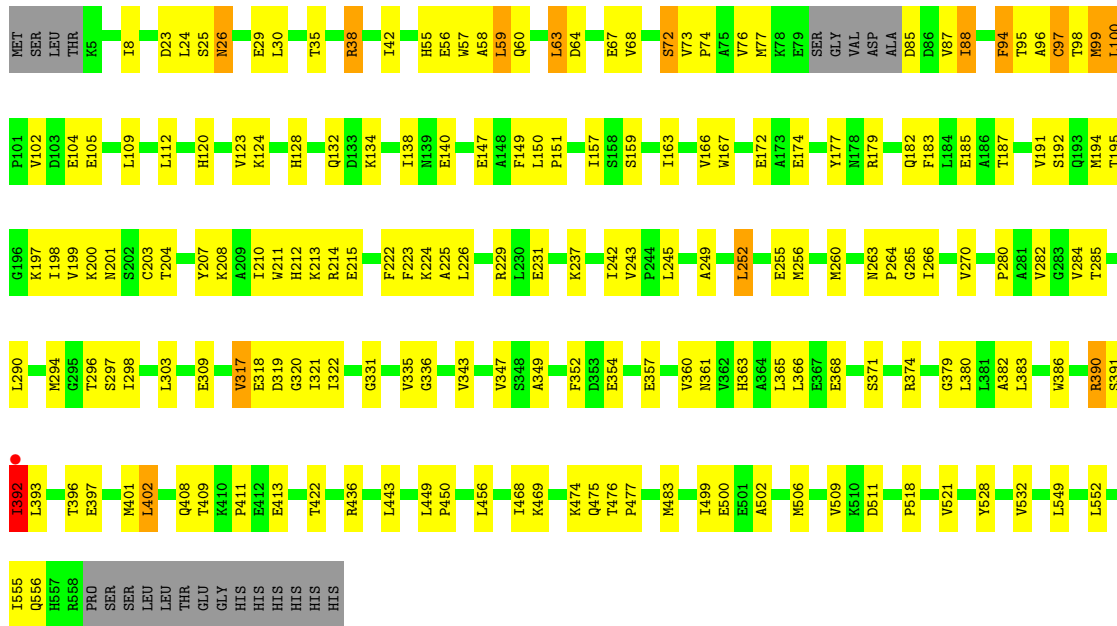
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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: Ribulokinase

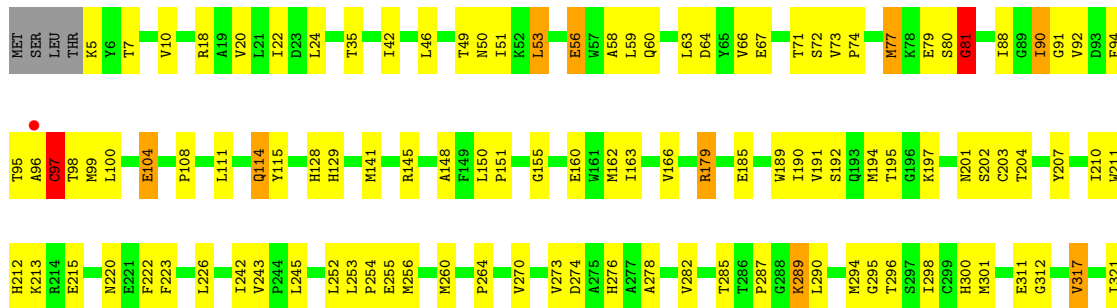


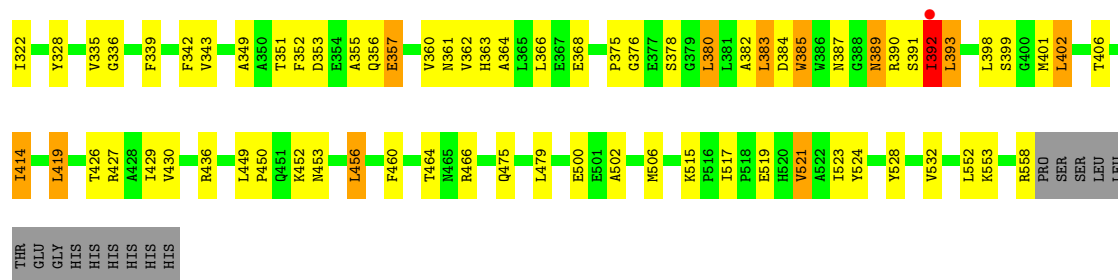


• Molecule 1: Ribulokinase



• Molecule 1: Ribulokinase







## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	56.68Å 88.84Å 230.53Å 90.00° 92.75° 90.00°	Depositor
Resolution (Å)	48.31 – 2.31 48.31 – 2.31	Depositor EDS
% Data completeness (in resolution range)	96.6 (48.31-2.31) 96.3 (48.31-2.31)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.92 (at 2.32Å)	Xtrriage
Refinement program	CNS 1.1, CCP4	Depositor
R, $R_{free}$	0.224 , 0.274 0.218 , 0.267	Depositor DCC
$R_{free}$ test set	2940 reflections (2.97%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	33.4	Xtrriage
Anisotropy	0.306	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 46.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.46$ , $\langle L^2 \rangle = 0.29$	Xtrriage
Estimated twinning fraction	0.037 for h,-k,-l	Xtrriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	17164	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	35.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.13% 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: QDK

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	0.42	0/4255	0.67	2/5776 (0.0%)
1	B	0.42	0/4246	0.66	1/5762 (0.0%)
1	C	0.42	0/4295	0.65	1/5826 (0.0%)
1	D	0.46	0/4333	0.71	4/5880 (0.1%)
All	All	0.43	0/17129	0.67	8/23244 (0.0%)

There are no bond length outliers.

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	97	CYS	CA-CB-SG	-9.99	96.02	114.00
1	A	97	CYS	CA-CB-SG	-6.70	101.93	114.00
1	A	98	THR	N-CA-C	-6.47	93.53	111.00
1	B	98	THR	N-CA-C	-6.07	94.62	111.00
1	C	98	THR	N-CA-C	-5.89	95.10	111.00

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	4163	0	4066	161	0
1	B	4155	0	4069	155	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	4202	0	4107	141	0
1	D	4239	0	4140	153	0
2	A	10	0	10	3	0
3	A	76	0	0	4	0
3	B	77	0	0	6	0
3	C	100	0	0	5	0
3	D	142	0	0	4	0
All	All	17164	0	16392	594	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 18.

The worst 5 of 594 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:D:195:THR:HG23	1:D:197:LYS:H	1.30	0.96
1:A:69:LEU:HD11	1:A:190:ILE:HD11	1.45	0.96
1:B:389:ASN:HD21	1:B:393:LEU:HB3	1.31	0.94
1:C:195:THR:HG23	1:C:197:LYS:H	1.37	0.87
1:B:61:HIS:HD1	1:B:122:TRP:HZ3	1.22	0.86

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	542/572 (95%)	508 (94%)	31 (6%)	3 (1%)	25 30
1	B	539/572 (94%)	499 (93%)	36 (7%)	4 (1%)	22 26
1	C	545/572 (95%)	509 (93%)	34 (6%)	2 (0%)	34 41
1	D	552/572 (96%)	523 (95%)	24 (4%)	5 (1%)	17 19

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
All	All	2178/2288 (95%)	2039 (94%)	125 (6%)	14 (1%)	25 30

5 of 14 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	384	ASP
1	B	55	HIS
1	D	357	GLU
1	D	392	ILE
1	B	48	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	425/461 (92%)	391 (92%)	34 (8%)	12 15
1	B	426/461 (92%)	399 (94%)	27 (6%)	18 24
1	C	430/461 (93%)	387 (90%)	43 (10%)	7 8
1	D	434/461 (94%)	399 (92%)	35 (8%)	11 14
All	All	1715/1844 (93%)	1576 (92%)	139 (8%)	11 14

5 of 139 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	190	ILE
1	D	317	VAL
1	D	393	LEU
1	B	368	GLU
1	B	366	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 66 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	212	HIS
1	D	276	HIS
1	D	556	GLN
1	B	168	GLN
1	B	132	GLN

### 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](#)

1 ligand is 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	$\# Z  > 2$
2	QDK	A	573	-	9,9,9	1.95	2 (22%)	6,11,11	1.32	1 (16%)

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	QDK	A	573	-	-	4/12/12/12	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	573	QDK	C4-C3	4.04	1.58	1.53
2	A	573	QDK	O1-C1	2.51	1.49	1.41

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	573	QDK	O5-C5-C4	-2.06	106.83	111.16

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	573	QDK	O1-C1-C2-C3
2	A	573	QDK	C1-C2-C3-C4
2	A	573	QDK	O2-C2-C3-C4
2	A	573	QDK	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	573	QDK	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	546/572 (95%)	0.09	10 (1%) 68 75	25, 39, 49, 54	0
1	B	543/572 (94%)	-0.03	8 (1%) 73 79	21, 38, 48, 55	0
1	C	549/572 (95%)	-0.14	1 (0%) 95 97	20, 36, 47, 53	0
1	D	554/572 (96%)	-0.09	2 (0%) 92 95	20, 30, 42, 50	0
All	All	2192/2288 (95%)	-0.04	21 (0%) 82 86	20, 36, 48, 55	0

The worst 5 of 21 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	45	TYR	4.6
1	C	392	ILE	3.9
1	A	97	CYS	2.7
1	A	505	LYS	2.7
1	B	96	ALA	2.5

### 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
2	QDK	A	573	10/10	0.79	0.21	22,23,26,26	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.