



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 05:40 PM UTC

PDB ID : 1XII / pdb_00001xii
Title : MODES OF BINDING SUBSTRATES AND THEIR ANALOGUES TO THE
ENZYME D-XYLOSE ISOMERASE
Authors : Carrell, H.L.; Glusker, J.P.
Deposited on : 1994-03-07
Resolution : 1.70 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

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>.

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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

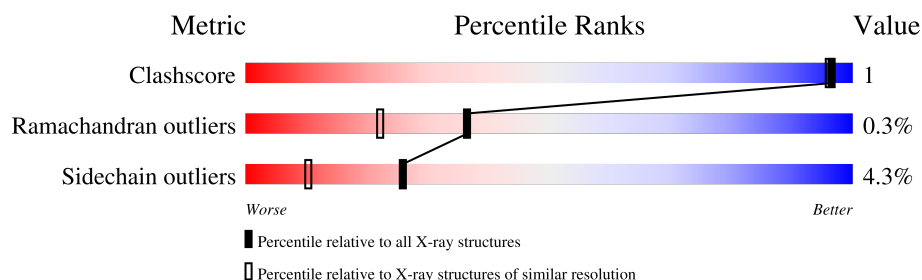
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.70 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))
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)

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 ≥ 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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	388	 72% 24% . .

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 3343 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.

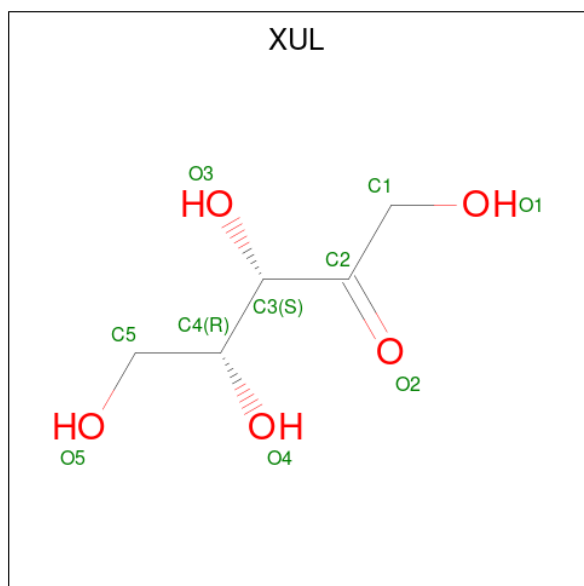
- Molecule 1 is a protein called D-XYLOSE ISOMERASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	385	3031	1906	545	572	8	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	41	GLN	ARG	conflict	UNP P24300

- Molecule 2 is D-XYLULOSE (CCD ID: XUL) (formula: C₅H₁₀O₅).



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

- Molecule 3 is MANGANESE (II) ION (CCD ID: MN) (formula: Mn).

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

- Molecule 4 is water.

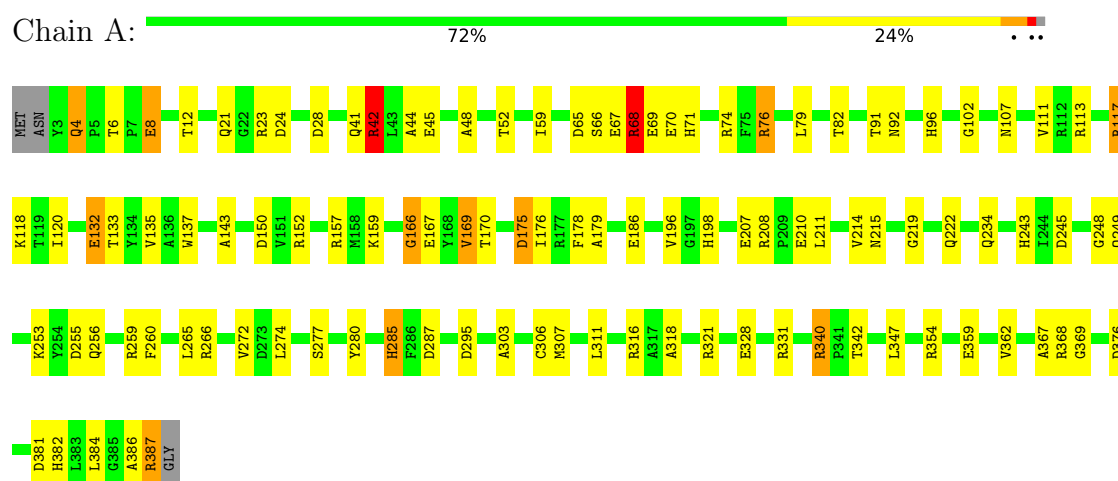
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	300	Total 300	O 300	0	0

3 Residue-property plots

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. 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. 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.

Note EDS was not executed.

• Molecule 1: D-XYLOSE ISOMERASE



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α , β , γ	93.78Å 99.54Å 102.90Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	12.00 – 1.70	Depositor
% Data completeness (in resolution range)	(Not available) (12.00-1.70)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.147 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	3343	wwPDB-VP
Average B, all atoms (Å ²)	13.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: MN, 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	1.73	28/3103 (0.9%)	2.24	108/4201 (2.6%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	3

All (28) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	196	VAL	CA-CB	9.09	1.64	1.54
1	A	248	GLY	CA-C	7.80	1.59	1.52
1	A	253	LYS	C-O	7.64	1.31	1.24
1	A	82	THR	CA-CB	6.92	1.64	1.54
1	A	249	GLN	N-CA	6.19	1.53	1.46
1	A	307	MET	N-CA	6.08	1.53	1.46
1	A	234	GLN	C-O	6.00	1.31	1.24
1	A	6	THR	CA-CB	5.94	1.61	1.54
1	A	159	LYS	N-CA	5.81	1.53	1.46
1	A	274	LEU	C-O	5.81	1.30	1.24
1	A	68	ARG	CD-NE	5.73	1.54	1.46
1	A	340	ARG	CD-NE	-5.72	1.38	1.46
1	A	135	VAL	N-CA	5.67	1.52	1.46
1	A	175	ASP	C-O	5.60	1.31	1.23
1	A	219	GLY	N-CA	5.50	1.53	1.45
1	A	340	ARG	CZ-NH2	5.50	1.40	1.33
1	A	137	TRP	CA-C	5.46	1.59	1.52
1	A	214	VAL	N-CA	5.37	1.52	1.46

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	111	VAL	N-CA	5.33	1.52	1.46
1	A	311	LEU	N-CA	5.32	1.52	1.46
1	A	179	ALA	N-CA	5.31	1.52	1.46
1	A	120	ILE	CA-CB	5.25	1.61	1.54
1	A	295	ASP	N-CA	5.16	1.51	1.45
1	A	102	GLY	N-CA	5.15	1.49	1.45
1	A	215	ASN	CA-C	5.12	1.58	1.52
1	A	44	ALA	N-CA	5.12	1.52	1.46
1	A	222	GLN	N-CA	5.04	1.52	1.46
1	A	272	VAL	N-CA	5.03	1.52	1.46

All (108) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	386	ALA	CA-C-N	23.54	164.07	121.70
1	A	386	ALA	C-N-CA	23.54	164.07	121.70
1	A	340	ARG	CD-NE-CZ	23.38	157.14	124.40
1	A	68	ARG	NE-CZ-NH2	15.12	132.81	119.20
1	A	175	ASP	CA-CB-CG	-12.22	100.38	112.60
1	A	340	ARG	NE-CZ-NH2	-11.44	108.91	119.20
1	A	340	ARG	NE-CZ-NH1	11.21	132.71	121.50
1	A	74	ARG	NE-CZ-NH2	-10.87	109.42	119.20
1	A	68	ARG	NH1-CZ-NH2	-10.59	105.53	119.30
1	A	68	ARG	CA-CB-CG	9.25	132.60	114.10
1	A	266	ARG	NE-CZ-NH2	-8.94	111.16	119.20
1	A	76	ARG	NE-CZ-NH2	-8.65	111.42	119.20
1	A	23	ARG	CD-NE-CZ	8.46	136.24	124.40
1	A	196	VAL	CA-CB-CG2	-8.41	96.10	110.40
1	A	137	TRP	CA-C-O	-8.35	111.52	120.46
1	A	169	VAL	CA-CB-CG1	8.35	124.59	110.40
1	A	362	VAL	O-C-N	8.31	130.39	121.83
1	A	113	ARG	NE-CZ-NH2	-8.15	111.86	119.20
1	A	24	ASP	CB-CA-C	8.09	126.11	110.17
1	A	4	GLN	CB-CG-CD	8.05	126.29	112.60
1	A	132	GLU	N-CA-CB	-7.89	98.78	110.53
1	A	306	CYS	O-C-N	7.85	130.25	122.09
1	A	196	VAL	CA-C-O	-7.79	113.17	121.27
1	A	369	GLY	O-C-N	-7.73	112.94	122.76
1	A	362	VAL	CA-C-O	-7.71	112.68	120.85
1	A	331	ARG	NH1-CZ-NH2	7.69	129.30	119.30
1	A	69	GLU	CB-CG-CD	7.57	125.46	112.60
1	A	68	ARG	CB-CG-CD	7.54	128.63	111.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	376	ASP	CA-CB-CG	-7.45	105.15	112.60
1	A	253	LYS	CA-C-O	-7.43	113.21	120.94
1	A	387	ARG	N-CA-CB	7.36	123.02	110.50
1	A	210	GLU	CB-CG-CD	7.34	125.08	112.60
1	A	68	ARG	CD-NE-CZ	-7.32	114.15	124.40
1	A	382	HIS	CA-CB-CG	-7.30	106.50	113.80
1	A	12	THR	O-C-N	7.24	132.56	123.15
1	A	150	ASP	CA-CB-CG	-7.21	105.39	112.60
1	A	42	ARG	CD-NE-CZ	6.91	134.07	124.40
1	A	143	ALA	O-C-N	6.88	130.27	123.46
1	A	152	ARG	NE-CZ-NH2	-6.80	113.08	119.20
1	A	303	ALA	O-C-N	-6.66	115.21	122.07
1	A	316	ARG	CD-NE-CZ	-6.59	115.17	124.40
1	A	41	GLN	OE1-CD-NE2	-6.47	116.13	122.60
1	A	76	ARG	NH1-CZ-NH2	6.45	127.69	119.30
1	A	331	ARG	NE-CZ-NH2	-6.43	113.42	119.20
1	A	21	GLN	OE1-CD-NE2	6.38	128.98	122.60
1	A	248	GLY	O-C-N	6.37	129.50	123.57
1	A	133	THR	CA-C-N	-6.35	114.05	123.00
1	A	133	THR	C-N-CA	-6.35	114.05	123.00
1	A	96	HIS	CA-CB-CG	-6.29	107.51	113.80
1	A	107	ASN	CA-C-O	-6.24	113.93	120.55
1	A	166	GLY	N-CA-C	-6.24	104.79	112.77
1	A	4	GLN	OE1-CD-NE2	-6.16	116.44	122.60
1	A	176	ILE	N-CA-C	-6.05	100.36	108.35
1	A	265	LEU	CA-C-O	-6.01	114.04	120.42
1	A	368	ARG	NE-CZ-NH2	-6.01	113.79	119.20
1	A	285	HIS	O-C-N	6.01	130.22	123.19
1	A	102	GLY	N-CA-C	-5.99	106.03	112.08
1	A	208	ARG	O-C-N	5.94	126.71	121.37
1	A	285	HIS	CA-C-O	-5.91	114.24	120.80
1	A	277	SER	CB-CA-C	5.89	122.40	110.38
1	A	234	GLN	CA-C-O	-5.89	114.18	120.42
1	A	287	ASP	CA-CB-CG	-5.81	106.79	112.60
1	A	48	ALA	N-CA-CB	-5.79	102.45	110.38
1	A	342	THR	O-C-N	5.68	129.26	122.27
1	A	198	HIS	CA-C-O	-5.66	114.84	120.90
1	A	196	VAL	CB-CA-C	-5.65	104.65	111.88
1	A	67	GLU	CG-CD-OE2	-5.64	105.43	118.40
1	A	260	PHE	CA-CB-CG	-5.61	108.19	113.80
1	A	167	GLU	O-C-N	-5.55	116.24	122.12
1	A	152	ARG	CA-C-O	-5.52	115.02	120.82

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	207	GLU	CB-CG-CD	5.52	121.98	112.60
1	A	71	HIS	CA-CB-CG	-5.50	108.30	113.80
1	A	44	ALA	N-CA-C	-5.46	105.41	111.36
1	A	118	LYS	CA-C-N	5.38	127.43	120.44
1	A	118	LYS	C-N-CA	5.38	127.43	120.44
1	A	45	GLU	N-CA-C	5.36	117.87	111.71
1	A	79	LEU	O-C-N	5.33	128.23	122.15
1	A	176	ILE	CA-C-O	-5.30	115.22	120.90
1	A	8	GLU	CA-CB-CG	5.30	124.69	114.10
1	A	65	ASP	CB-CA-C	5.30	120.73	110.46
1	A	117	ARG	NE-CZ-NH1	5.29	126.78	121.50
1	A	243	HIS	CA-C-N	-5.29	114.62	122.23
1	A	243	HIS	C-N-CA	-5.29	114.62	122.23
1	A	255	ASP	N-CA-CB	-5.28	102.58	110.24
1	A	280	TYR	CA-C-N	-5.25	114.28	122.37
1	A	280	TYR	C-N-CA	-5.25	114.28	122.37
1	A	367	ALA	N-CA-C	-5.25	106.83	113.18
1	A	211	LEU	CA-C-N	-5.23	114.25	122.73
1	A	211	LEU	C-N-CA	-5.23	114.25	122.73
1	A	92	ASN	CA-C-O	-5.22	115.34	120.98
1	A	259	ARG	CA-C-O	5.21	127.07	121.55
1	A	82	THR	CA-CB-OG1	-5.19	101.81	109.60
1	A	137	TRP	O-C-N	5.18	129.65	123.13
1	A	328	GLU	CA-CB-CG	5.18	124.45	114.10
1	A	207	GLU	CG-CD-OE2	5.17	130.29	118.40
1	A	157	ARG	NE-CZ-NH1	5.14	126.64	121.50
1	A	318	ALA	CA-C-O	-5.13	114.98	120.42
1	A	52	THR	CA-CB-OG1	-5.12	101.92	109.60
1	A	362	VAL	N-CA-CB	5.10	118.23	110.58
1	A	256	GLN	CA-C-O	-5.09	114.59	120.24
1	A	243	HIS	O-C-N	5.08	128.59	123.26
1	A	132	GLU	CB-CA-C	-5.08	100.82	109.65
1	A	384	LEU	CA-C-O	-5.06	112.63	119.11
1	A	59	ILE	O-C-N	5.06	126.87	121.10
1	A	178	PHE	O-C-N	5.05	128.90	123.10
1	A	316	ARG	NE-CZ-NH2	-5.04	114.66	119.20
1	A	68	ARG	N-CA-CB	5.04	117.45	109.94
1	A	243	HIS	CA-C-O	-5.03	116.05	121.38

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	117	ARG	Sidechain
1	A	321	ARG	Sidechain
1	A	42	ARG	Sidechain

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	3031	0	2899	6	1
2	A	10	0	9	0	0
3	A	2	0	0	0	0
4	A	300	0	0	1	1
All	All	3343	0	2908	6	1

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 (6) 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:354:ARG:HB3	1:A:359:GLU:HG3	1.75	0.67
1:A:387:ARG:NH1	4:A:684:HOH:O	2.31	0.63
1:A:381:ASP:HB3	1:A:387:ARG:HG3	1.83	0.59
1:A:245:ASP:OD1	1:A:285:HIS:HD2	1.96	0.49
1:A:68:ARG:HH11	1:A:68:ARG:HD3	1.58	0.43
1:A:166:GLY:O	1:A:170:THR:HG23	2.20	0.42

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:28:ASP:OD2	4:A:599:HOH:O[3_656]	2.15	0.05

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	383/388 (99%)	372 (97%)	10 (3%)	1 (0%)	36	22

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	186	GLU

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	302/304 (99%)	289 (96%)	13 (4%)	26	10

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	GLN
1	A	8	GLU
1	A	42	ARG
1	A	66	SER
1	A	68	ARG
1	A	70	GLU
1	A	76	ARG
1	A	91	THR
1	A	132	GLU
1	A	169	VAL

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Mol	Chain	Res	Type
1	A	175	ASP
1	A	340	ARG
1	A	347	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	41	GLN
1	A	285	HIS
1	A	348	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 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	$\# Z > 2$
2	XUL	A	389	3	9,9,9	1.87	2 (22%)	6,11,11	2.10	3 (50%)

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	XUL	A	389	3	-	1/12/12/12	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	389	XUL	C1-C2	4.15	1.61	1.50
2	A	389	XUL	O2-C2	2.88	1.26	1.21

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	389	XUL	O1-C1-C2	-2.94	104.94	112.73
2	A	389	XUL	O4-C4-C3	2.70	113.60	109.67
2	A	389	XUL	O4-C4-C5	-2.57	103.18	109.03

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	389	XUL	O2-C2-C3-O3

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

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.