



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 08:15 PM UTC

PDB ID : 2BXY / pdb_00002bxy
Title : Is radiation damage dependent on the dose-rate used during macromolecular crystallography data collection
Authors : Leiros, H.-K.S.; Timmins, J.; Ravelli, R.B.G.; McSweeney, S.M.
Deposited on : 2005-07-28
Resolution : 1.75 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

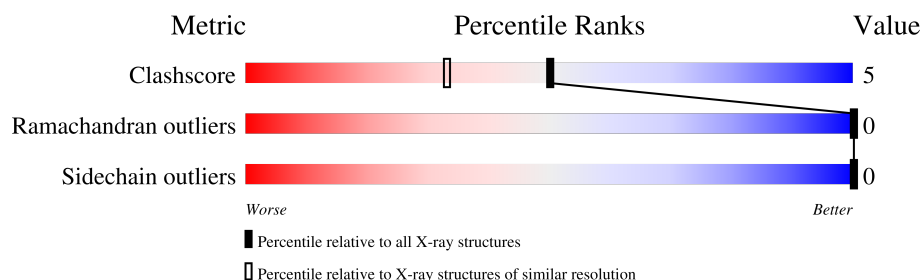
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.75 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	3299 (1.76-1.76)
Ramachandran outliers	187476	3274 (1.76-1.76)
Sidechain outliers	187428	3274 (1.76-1.76)

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	602	
2	B	2	
2	C	2	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	GLC	A	702	X	-	-	-

2 Entry composition [i](#)

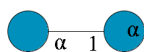
There are 7 unique types of molecules in this entry. The entry contains 5804 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 MALTOOLIGOSYLTREHALOSE TREHALOHYDROLASE.

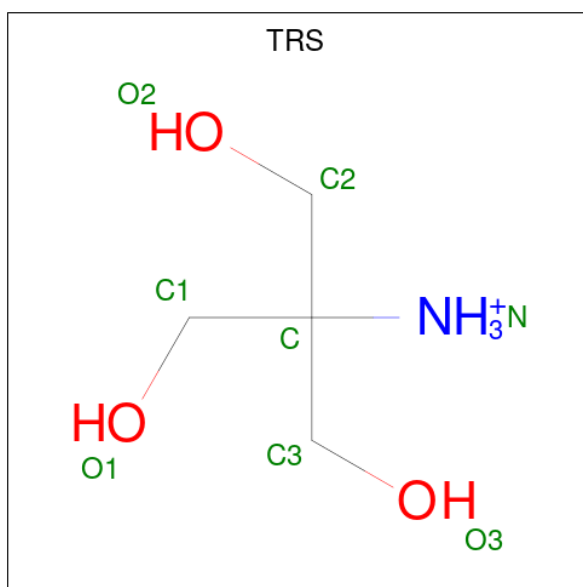
Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	580	Total	C	N	O	S	Se	31	29	0
			4865	3076	868	909	2	10			

- Molecule 2 is an oligosaccharide called alpha-D-glucopyranose-(1-1)-alpha-D-glucopyranose.



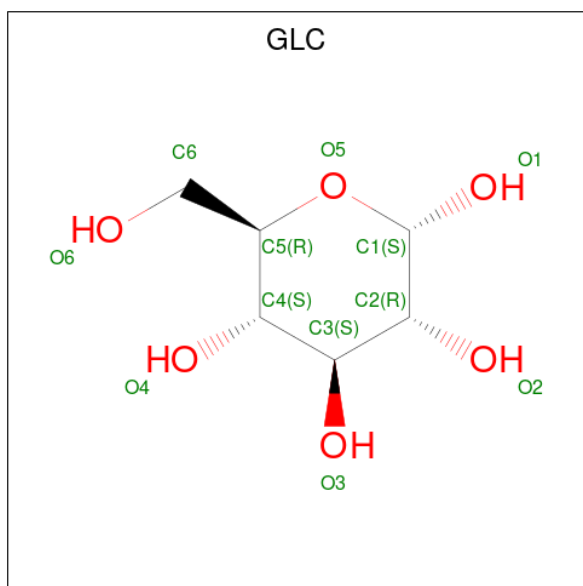
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
2	B	2	Total	C	O	0	0	0
			23	12	11			
2	C	2	Total	C	O	0	0	0
			23	12	11			

- Molecule 3 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (CCD ID: TRS) (formula: C₄H₁₂NO₃).



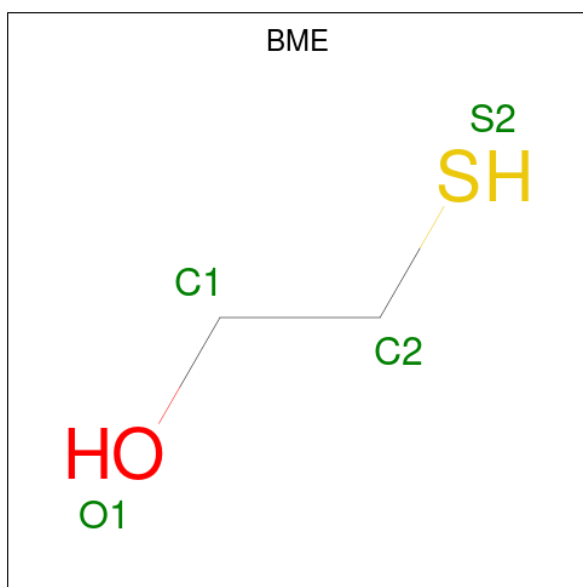
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	N	O	0	0
			8	4	1	3		

- Molecule 4 is alpha-D-glucopyranose (CCD ID: GLC) (formula: $C_6H_{12}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			12	6	6		
4	A	1	Total	C	O	0	0
			12	6	6		

- Molecule 5 is BETA-MERCAPTOETHANOL (CCD ID: BME) (formula: C_2H_6OS).



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

- Molecule 6 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1	Total	Mg	0	0
			1	1		

- Molecule 7 is water.

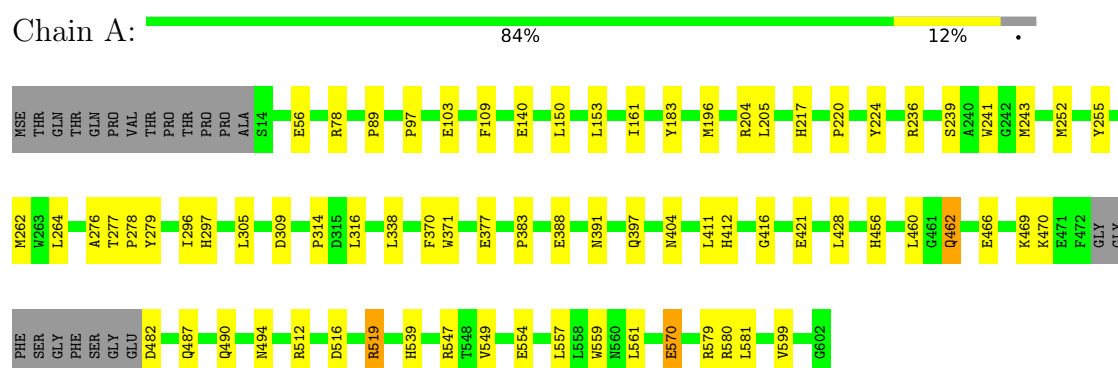
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	856	Total	O	0	27
			856	856		

3 Residue-property plots

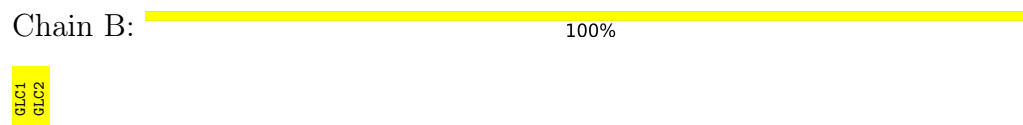
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded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



• Molecule 2: alpha-D-glucopyranose-(1-1)-alpha-D-glucopyranose



• Molecule 2: alpha-D-glucopyranose-(1-1)-alpha-D-glucopyranose



4 Data and refinement statistics

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

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	59.42Å 66.53Å 152.52Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 1.75	Depositor
% Data completeness (in resolution range)	99.5 (20.00-1.75)	Depositor
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	REFMAC 5.2.0003	Depositor
R, R_{free}	0.147 , 0.188	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	5804	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: MG, TRS, GLC, BME

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	1.05	7/4992 (0.1%)	0.94	9/6780 (0.1%)

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 (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	580	ARG	CZ-NH1	-29.85	0.91	1.32
1	A	470	LYS	CG-CD	16.56	2.02	1.52
1	A	469	LYS	CD-CE	12.61	1.90	1.52
1	A	466	GLU	CG-CD	-9.20	1.29	1.52
1	A	579	ARG	CD-NE	7.91	1.57	1.46
1	A	519	ARG	CZ-NH1	6.21	1.41	1.32
1	A	243	MSE	SE-CE	-5.20	1.79	1.95

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	570	GLU	OE1-CD-OE2	-15.57	85.53	122.90
1	A	482	ASP	CA-CB-CG	-14.38	98.22	112.60
1	A	462	GLN	OE1-CD-NE2	-13.79	108.81	122.60
1	A	470	LYS	CB-CG-CD	-11.09	85.80	111.30
1	A	579	ARG	CG-CD-NE	6.87	127.12	112.00
1	A	519	ARG	NE-CZ-NH1	-6.55	114.95	121.50

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	469	LYS	CG-CD-CE	-6.21	97.01	111.30
1	A	466	GLU	CB-CG-CD	5.72	122.32	112.60
1	A	570	GLU	CG-CD-OE2	5.50	131.06	118.40

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	462	GLN	Sidechain
1	A	512[A]	ARG	Sidechain
1	A	570	GLU	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	4865	0	4598	51	0
2	B	23	0	21	0	0
2	C	23	0	21	3	0
3	A	8	0	12	3	0
4	A	24	0	24	0	0
5	A	4	0	5	0	0
6	A	1	0	0	0	0
7	A	856	0	0	12	0
All	All	5804	0	4681	51	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 (51) 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:239:SER:HB2	7:A:828:HOH:O	1.24	1.34
1:A:204:ARG:HG2	7:A:997:HOH:O	1.46	1.15
1:A:404[A]:ASN:OD1	7:A:803[A]:HOH:O	1.73	1.03

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:296[B]:ILE:HD13	1:A:305:LEU:HD21	1.39	1.01
1:A:416[A]:GLY:O	3:A:701:TRS:O2	1.95	0.82
1:A:388:GLU:H	1:A:391:ASN:HD22	1.26	0.80
1:A:56[A]:GLU:OE2	7:A:804[A]:HOH:O	2.03	0.77
1:A:456:HIS:H	1:A:487:GLN:HE22	1.36	0.72
1:A:296[B]:ILE:CD1	1:A:305:LEU:HD21	2.21	0.68
1:A:388:GLU:H	1:A:391:ASN:ND2	1.93	0.66
1:A:103:GLU:OE1	7:A:805[A]:HOH:O	2.13	0.66
1:A:314:PRO:HG2	2:C:2:GLC:H2	1.78	0.66
1:A:338:LEU:O	3:A:701:TRS:H21	2.02	0.58
1:A:217:HIS:CD2	1:A:241:TRP:HD1	2.22	0.57
1:A:547:ARG:HE	1:A:554[B]:GLU:CD	2.14	0.56
1:A:183:TYR:CD1	1:A:262[B]:MSE:HE3	2.42	0.55
1:A:239:SER:CB	7:A:828:HOH:O	2.07	0.54
1:A:397:GLN:NE2	1:A:411:LEU:H	2.05	0.54
1:A:236:ARG:NH1	7:A:814:HOH:O	2.43	0.52
1:A:314:PRO:HG2	2:C:2:GLC:C2	2.39	0.51
1:A:78:ARG:CZ	1:A:97:PRO:HG2	2.42	0.50
1:A:516:ASP:OD1	1:A:519:ARG:NH2	2.43	0.50
1:A:183:TYR:HD1	1:A:262[B]:MSE:HE3	1.75	0.49
1:A:370:PHE:CZ	1:A:377:GLU:HB3	2.48	0.48
1:A:264:LEU:HD12	1:A:296[B]:ILE:HG12	1.96	0.48
1:A:428:LEU:HA	1:A:557:LEU:HD22	1.95	0.48
1:A:383:PRO:HG2	2:C:2:GLC:H61	1.97	0.46
1:A:89:PRO:HG2	1:A:224:TYR:CE2	2.50	0.46
1:A:140:GLU:OE2	7:A:807:HOH:O	2.21	0.46
1:A:404[A]:ASN:ND2	7:A:824:HOH:O	2.48	0.45
1:A:109:PHE:HD1	1:A:196[A]:MSE:HE1	1.82	0.45
1:A:388:GLU:N	1:A:391:ASN:HD22	2.04	0.45
1:A:397:GLN:HE22	1:A:411:LEU:H	1.65	0.45
1:A:539:HIS:HD2	7:A:1295:HOH:O	2.00	0.45
1:A:412:HIS:H	1:A:412:HIS:CD2	2.35	0.44
1:A:371:TRP:O	1:A:377:GLU:HA	2.17	0.43
1:A:236:ARG:NH2	7:A:809:HOH:O	2.35	0.43
1:A:150:LEU:HB3	1:A:205:LEU:HD12	2.01	0.43
1:A:153:LEU:HD13	1:A:161[B]:ILE:HD12	2.01	0.43
1:A:296[B]:ILE:HD12	1:A:305:LEU:HD11	2.01	0.43
1:A:581[B]:LEU:HD23	1:A:599:VAL:CG2	2.49	0.42
1:A:421:GLU:OE2	3:A:701:TRS:H22	2.20	0.42
1:A:252:MSE:HE3	1:A:255:TYR:HB3	2.02	0.41
1:A:297[A]:HIS:HE1	7:A:1137:HOH:O	2.03	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:309:ASP:CG	1:A:316:LEU:HD11	2.46	0.41
1:A:490:GLN:NE2	1:A:494[A]:ASN:OD1	2.46	0.41
1:A:549:VAL:HG22	1:A:554[B]:GLU:HG3	2.03	0.41
1:A:277:THR:N	1:A:278:PRO:CD	2.84	0.40
1:A:276:ALA:HB1	1:A:279:TYR:HD2	1.86	0.40
1:A:559:TRP:CD2	1:A:561[A]:LEU:HD21	2.56	0.40
1:A:220:PRO:HG2	1:A:460:LEU:HD21	2.02	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	607/602 (101%)	601 (99%)	6 (1%)	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	497/475 (105%)	497 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such

sidechains are listed below:

Mol	Chain	Res	Type
1	A	342	GLN
1	A	382	HIS
1	A	391	ASN
1	A	397	GLN
1	A	412	HIS
1	A	487	GLN
1	A	539	HIS
1	A	563	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

4 monosaccharides 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	$\# Z > 2$
2	GLC	B	1	2	11,11,12	1.30	1 (9%)	15,15,17	1.18	1 (6%)
2	GLC	B	2	2	12,12,12	0.95	1 (8%)	17,17,17	0.76	0
2	GLC	C	1	2	11,11,12	0.86	0	15,15,17	0.72	1 (6%)
2	GLC	C	2	2	12,12,12	0.89	0	17,17,17	0.90	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
2	GLC	B	1	2	-	0/2/19/22	0/1/1/1
2	GLC	B	2	2	-	0/2/22/22	0/1/1/1
2	GLC	C	1	2	-	2/2/19/22	0/1/1/1
2	GLC	C	2	2	-	2/2/22/22	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1	GLC	C2-C3	3.31	1.57	1.52
2	B	2	GLC	O1-C1	2.25	1.46	1.39

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	1	GLC	C1-O5-C5	3.43	116.78	112.19
2	C	1	GLC	O5-C5-C6	2.03	111.62	107.66

There are no chirality outliers.

All (4) torsion outliers are listed below:

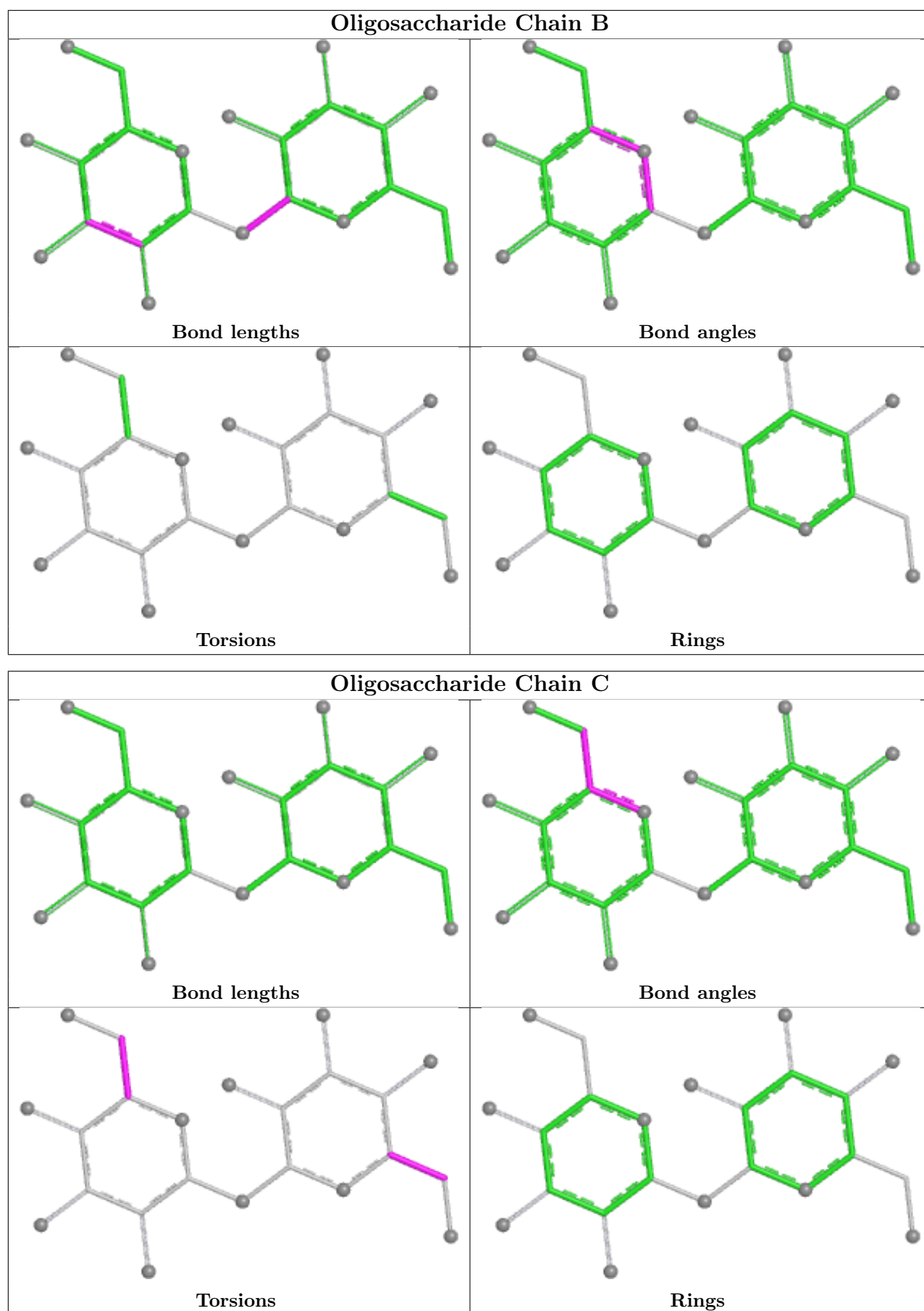
Mol	Chain	Res	Type	Atoms
2	C	2	GLC	O5-C5-C6-O6
2	C	2	GLC	C4-C5-C6-O6
2	C	1	GLC	C4-C5-C6-O6
2	C	1	GLC	O5-C5-C6-O6

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	2	GLC	3	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.



5.6 Ligand geometry

Of 5 ligands modelled in this entry, 1 is monoatomic - leaving 4 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	GLC	A	703	-	12,12,12	0.67	0	17,17,17	1.41	4 (23%)
5	BME	A	704	-	3,3,3	0.38	0	2,2,2	0.98	0
4	GLC	A	702	-	12,12,12	0.59	0	17,17,17	1.42	3 (17%)
3	TRS	A	701	-	7,7,7	0.58	0	9,9,9	1.26	1 (11%)

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	GLC	A	703	-	-	0/2/22/22	0/1/1/1
5	BME	A	704	-	-	0/1/1/1	-
4	GLC	A	702	-	1/1/5/5	0/2/22/22	0/1/1/1
3	TRS	A	701	-	-	4/9/9/9	-

There are no bond length outliers.

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	702	GLC	O5-C1-C2	-3.02	104.99	110.30
4	A	703	GLC	C1-C2-C3	-2.65	104.95	110.36
4	A	702	GLC	C1-O5-C5	-2.65	108.53	113.65
4	A	703	GLC	C4-C3-C2	2.57	115.35	110.83
4	A	702	GLC	C1-C2-C3	-2.49	105.28	110.36
4	A	703	GLC	O4-C4-C5	2.35	115.10	109.32
4	A	703	GLC	O1-C1-C2	-2.26	102.41	108.98
3	A	701	TRS	C3-C-C2	-2.03	105.25	110.66

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
4	A	702	GLC	C1

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	701	TRS	C1-C-C3-O3
3	A	701	TRS	C2-C-C3-O3
3	A	701	TRS	N-C-C3-O3
3	A	701	TRS	N-C-C2-O2

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	701	TRS	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

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.