



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 10, 2026 – 05:15 PM UTC

PDB ID : 3AZT / pdb_00003azt
Title : Diverse Substrates Recognition Mechanism Revealed by Thermotoga maritima Cel5A Structures in Complex with Cellotetraose
Authors : Wu, T.H.; Huang, C.H.; Ko, T.P.; Lai, H.L.; Ma, Y.; Chen, C.C.; Cheng, Y.S.; Liu, J.R.; Guo, R.T.
Deposited on : 2011-05-30
Resolution : 1.80 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

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) : 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

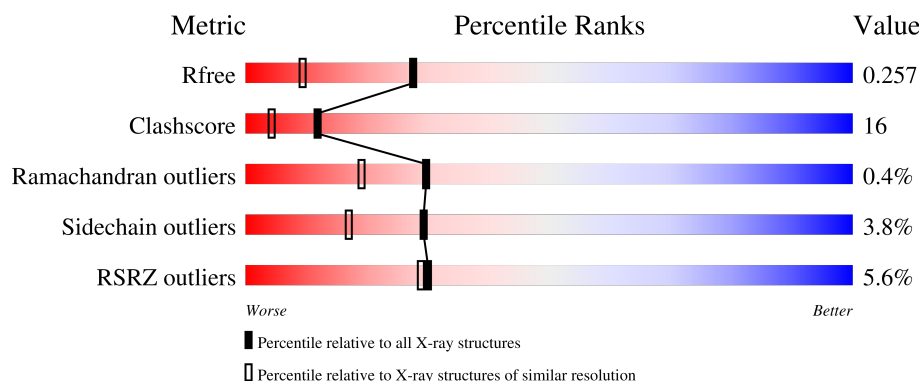
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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 ≥ 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	317	
1	B	317	
1	C	317	
1	D	317	
2	E	4	

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Mol	Chain	Length	Quality of chain
2	F	4	 A horizontal bar chart showing the quality of chain F. The bar is divided into three segments: a green segment on the left labeled '50%', a yellow segment in the middle labeled '25%', and an orange segment on the right labeled '25%'. The segments are separated by thin black lines.

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 11405 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 Endoglucanase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	311	Total	C	N	O	S	0	0	0
			2610	1699	445	461	5			
1	B	308	Total	C	N	O	S	0	0	0
			2591	1687	442	458	4			
1	C	308	Total	C	N	O	S	0	0	0
			2591	1687	442	458	4			
1	D	311	Total	C	N	O	S	0	0	0
			2610	1699	445	461	5			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	253	ALA	GLU	engineered mutation	UNP Q9X273
B	253	ALA	GLU	engineered mutation	UNP Q9X273
C	253	ALA	GLU	engineered mutation	UNP Q9X273
D	253	ALA	GLU	engineered mutation	UNP Q9X273

- Molecule 2 is an oligosaccharide called beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-alpha-D-glucopyranose.



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
2	E	4	Total	C	O	0	0	0
			45	24	21			
2	F	4	Total	C	O	0	0	0
			45	24	21			

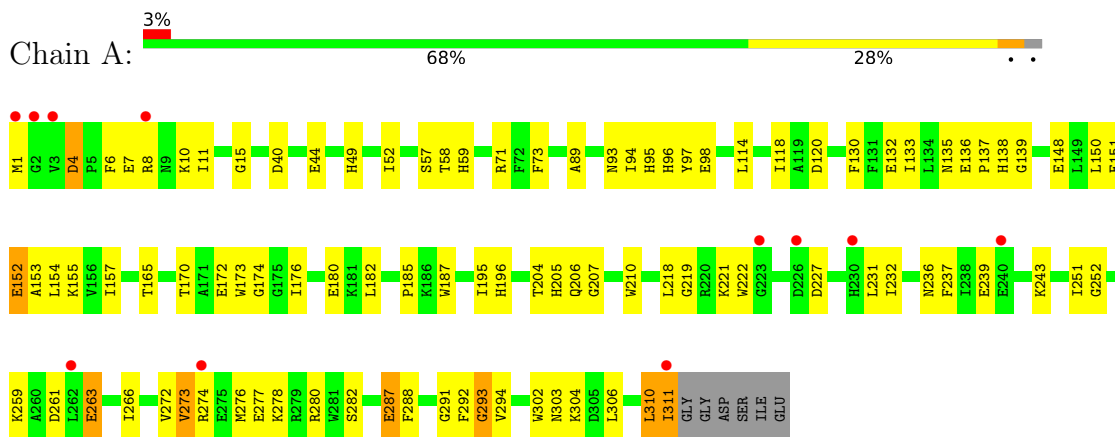
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	240	Total 240	O 240	0	0
3	B	239	Total 239	O 239	0	0
3	C	211	Total 211	O 211	0	0
3	D	223	Total 223	O 223	0	0

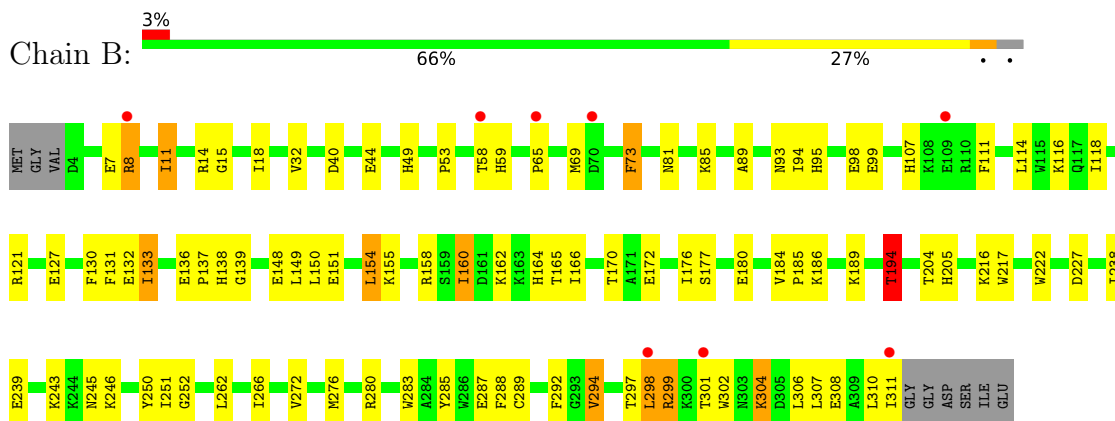
3 Residue-property plots [i](#)

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.

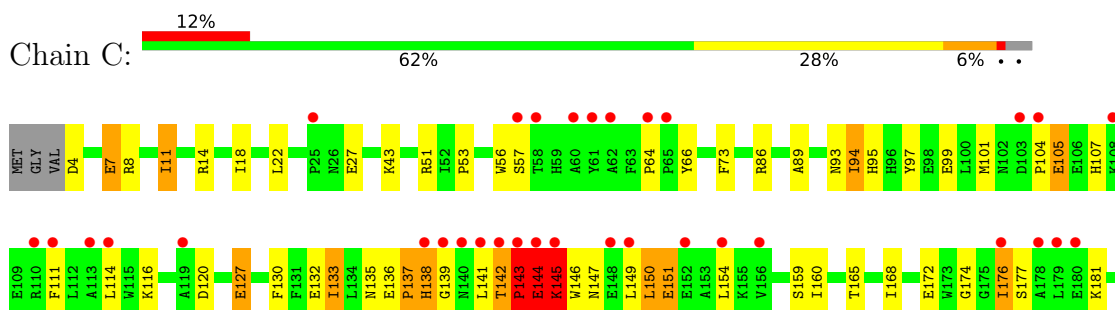
• Molecule 1: Endoglucanase

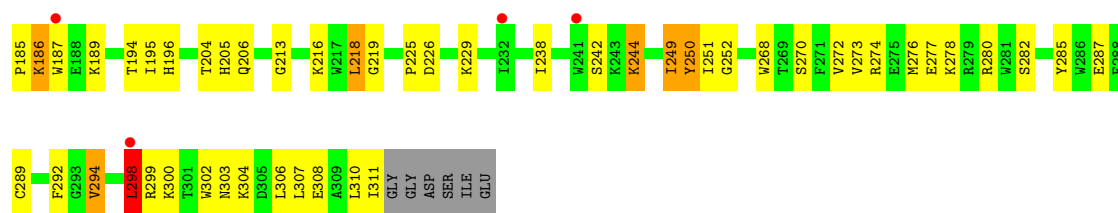


• Molecule 1: Endoglucanase

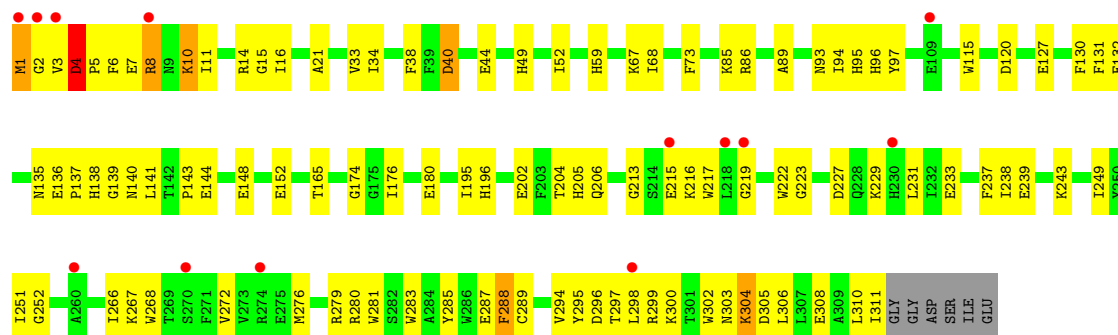


• Molecule 1: Endoglucanase





● Molecule 1: Endoglucanase



● Molecule 2: beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-alpha-D-glucopyranose



● Molecule 2: beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-beta-D-glucopyranose-(1-4)-alpha-D-glucopyranose



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	82.38Å 76.16Å 94.28Å 90.00° 90.54° 90.00°	Depositor
Resolution (Å)	25.00 – 1.80 25.00 – 1.80	Depositor EDS
% Data completeness (in resolution range)	(Not available) (25.00-1.80) 92.8 (25.00-1.80)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.42 (at 1.80Å)	Xtriage
Refinement program	CNS 1.2	Depositor
R, R_{free}	0.221 , 0.262 0.216 , 0.257	Depositor DCC
R_{free} test set	5067 reflections (5.05%)	wwPDB-VP
Wilson B-factor (Å ²)	22.6	Xtriage
Anisotropy	0.710	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 42.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.022 for h,-k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	11405	wwPDB-VP
Average B, all atoms (Å ²)	30.0	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 85.54 % 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 1.2220e-07. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹Intensities estimated from amplitudes.

²Theoretical 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: GLC, BGC

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	1.18	13/2691 (0.5%)	1.21	21/3640 (0.6%)
1	B	0.92	4/2672 (0.1%)	1.15	20/3615 (0.6%)
1	C	0.87	2/2672 (0.1%)	1.21	34/3615 (0.9%)
1	D	1.21	19/2691 (0.7%)	1.19	17/3640 (0.5%)
All	All	1.06	38/10726 (0.4%)	1.19	92/14510 (0.6%)

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	C	0	1

The worst 5 of 38 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	139	GLY	C-O	-17.47	1.01	1.24
1	A	96	HIS	C-O	-15.41	1.04	1.23
1	D	94	ILE	C-O	-14.95	1.07	1.24
1	A	138	HIS	C-O	-14.88	1.07	1.23
1	B	138	HIS	C-O	-14.29	1.07	1.23

The worst 5 of 92 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	293	GLY	N-CA-C	11.79	125.48	111.93
1	C	144	GLU	N-CA-C	11.70	135.72	110.80
1	C	145	LYS	N-CA-C	-10.54	88.36	110.80
1	B	288	PHE	N-CA-C	10.10	121.98	110.97

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	204	THR	N-CA-C	9.14	121.25	111.28

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	C	250	TYR	Sidechain

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	2610	0	2551	46	0
1	B	2591	0	2527	84	0
1	C	2591	0	2527	119	0
1	D	2610	0	2551	87	0
2	E	45	0	39	1	0
2	F	45	0	39	1	0
3	A	240	0	0	2	0
3	B	239	0	0	8	0
3	C	211	0	0	10	0
3	D	223	0	0	6	0
All	All	11405	0	10234	327	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 16.

The worst 5 of 327 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:C:144:GLU:HG2	1:C:146:TRP:HB3	1.24	1.16
1:D:1:MET:HE1	1:D:3:VAL:HG23	1.20	1.11
1:D:251:ILE:HD11	1:D:281:TRP:CE3	1.87	1.10
1:B:186:LYS:HE3	1:D:280:ARG:HH21	1.16	1.08
1:C:142:THR:O	1:C:144:GLU:N	1.90	1.03

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	309/317 (98%)	296 (96%)	13 (4%)	0	100	100
1	B	306/317 (96%)	295 (96%)	10 (3%)	1 (0%)	36	25
1	C	306/317 (96%)	286 (94%)	17 (6%)	3 (1%)	12	4
1	D	309/317 (98%)	296 (96%)	12 (4%)	1 (0%)	36	25
All	All	1230/1268 (97%)	1173 (95%)	52 (4%)	5 (0%)	30	19

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	299	ARG
1	C	143	PRO
1	C	144	GLU
1	C	298	LEU
1	D	4	ASP

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	272/276 (99%)	262 (96%)	10 (4%)	30	18
1	B	270/276 (98%)	260 (96%)	10 (4%)	30	18
1	C	270/276 (98%)	254 (94%)	16 (6%)	18	7

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	D	272/276 (99%)	267 (98%)	5 (2%)	51 43
All	All	1084/1104 (98%)	1043 (96%)	41 (4%)	29 17

5 of 41 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	151	GLU
1	C	298	LEU
1	C	176	ILE
1	C	226	ASP
1	D	8	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	206	GLN
1	D	59	HIS
1	C	245	ASN
1	D	81	ASN
1	B	102	ASN

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 ⓘ

8 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	E	1	2	12,12,12	0.52	0	17,17,17	0.93	1 (5%)
2	BGC	E	2	2	11,11,12	0.36	0	15,15,17	0.43	0
2	BGC	E	3	2	11,11,12	0.37	0	15,15,17	1.05	1 (6%)
2	BGC	E	4	2	11,11,12	0.36	0	15,15,17	0.77	0
2	GLC	F	1	2	12,12,12	0.50	0	17,17,17	1.07	2 (11%)
2	BGC	F	2	2	11,11,12	0.40	0	15,15,17	0.82	0
2	BGC	F	3	2	11,11,12	0.38	0	15,15,17	0.77	1 (6%)
2	BGC	F	4	2	11,11,12	0.36	0	15,15,17	0.89	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	E	1	2	-	0/2/22/22	0/1/1/1
2	BGC	E	2	2	-	1/2/19/22	0/1/1/1
2	BGC	E	3	2	-	0/2/19/22	0/1/1/1
2	BGC	E	4	2	-	0/2/19/22	0/1/1/1
2	GLC	F	1	2	-	0/2/22/22	0/1/1/1
2	BGC	F	2	2	-	0/2/19/22	0/1/1/1
2	BGC	F	3	2	-	0/2/19/22	0/1/1/1
2	BGC	F	4	2	-	0/2/19/22	0/1/1/1

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	F	1	GLC	C3-C4-C5	-2.75	105.24	110.23
2	E	3	BGC	C6-C5-C4	-2.67	106.47	113.02
2	F	3	BGC	C6-C5-C4	-2.32	107.32	113.02
2	F	1	GLC	C4-C3-C2	-2.17	107.03	110.83
2	E	1	GLC	C4-C3-C2	-2.14	107.07	110.83

There are no chirality outliers.

All (1) torsion outliers are listed below:

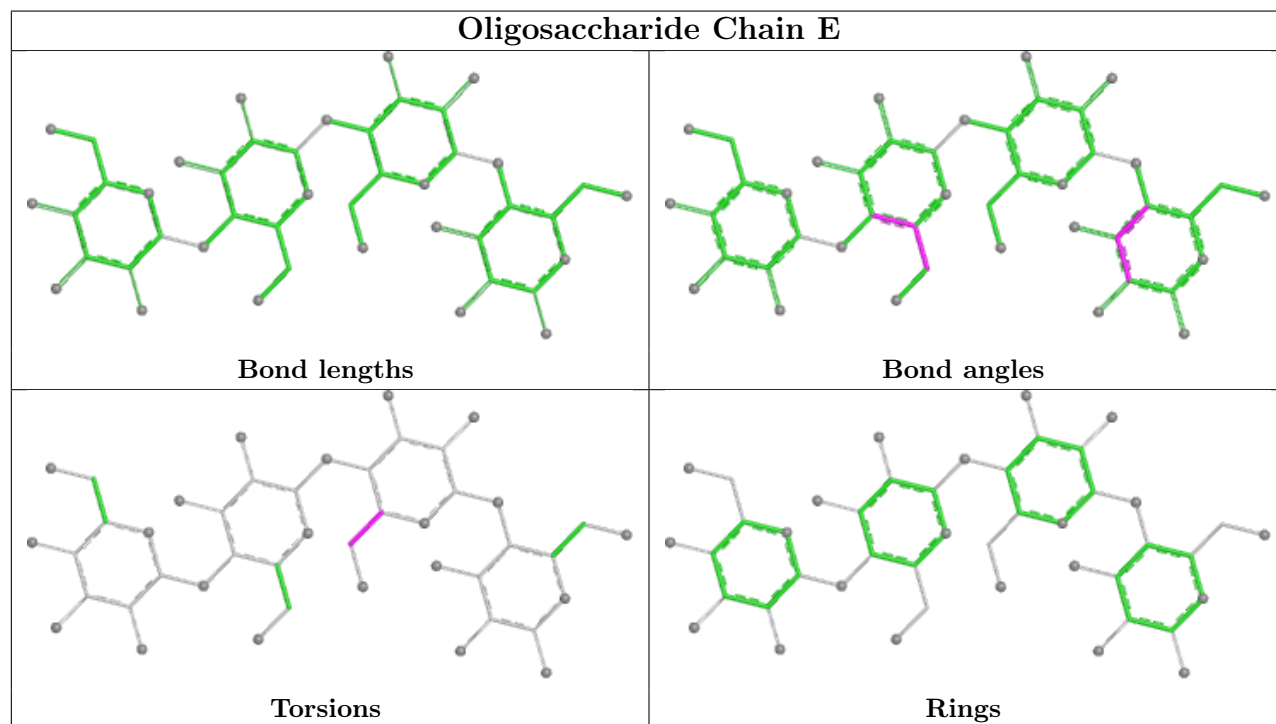
Mol	Chain	Res	Type	Atoms
2	E	2	BGC	O5-C5-C6-O6

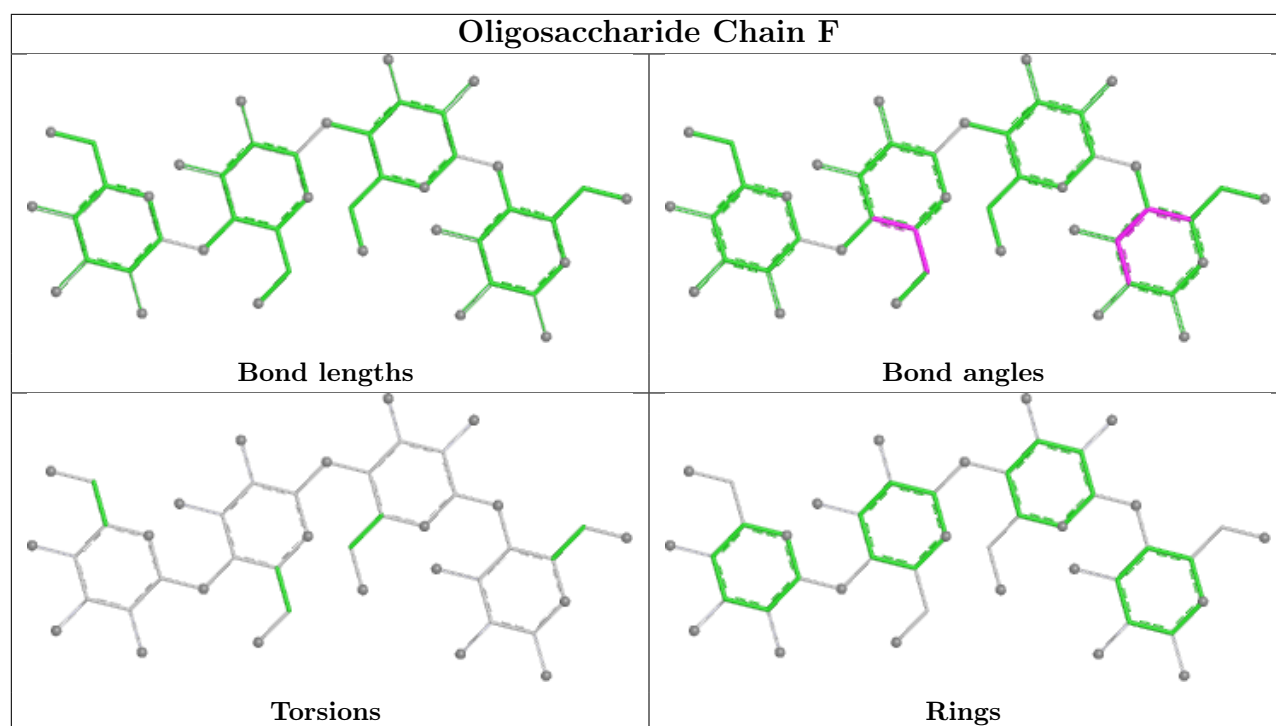
There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	E	1	GLC	1	0
2	F	1	GLC	1	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 [i](#)

There are no ligands in this entry.

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, 95th 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 ²)	Q<0.9
1	A	311/317 (98%)	0.32	11 (3%) 47 47	17, 26, 40, 54	0
1	B	308/317 (97%)	0.22	8 (2%) 57 57	17, 28, 40, 57	0
1	C	308/317 (97%)	0.74	37 (12%) 9 7	19, 32, 45, 58	0
1	D	311/317 (98%)	0.37	13 (4%) 40 40	17, 27, 42, 68	0
All	All	1238/1268 (97%)	0.41	69 (5%) 30 29	17, 28, 42, 68	0

The worst 5 of 69 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1	MET	4.8
1	C	143	PRO	4.8
1	C	141	LEU	4.1
1	D	2	GLY	4.1
1	C	144	GLU	3.8

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](#)

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, 95th 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.

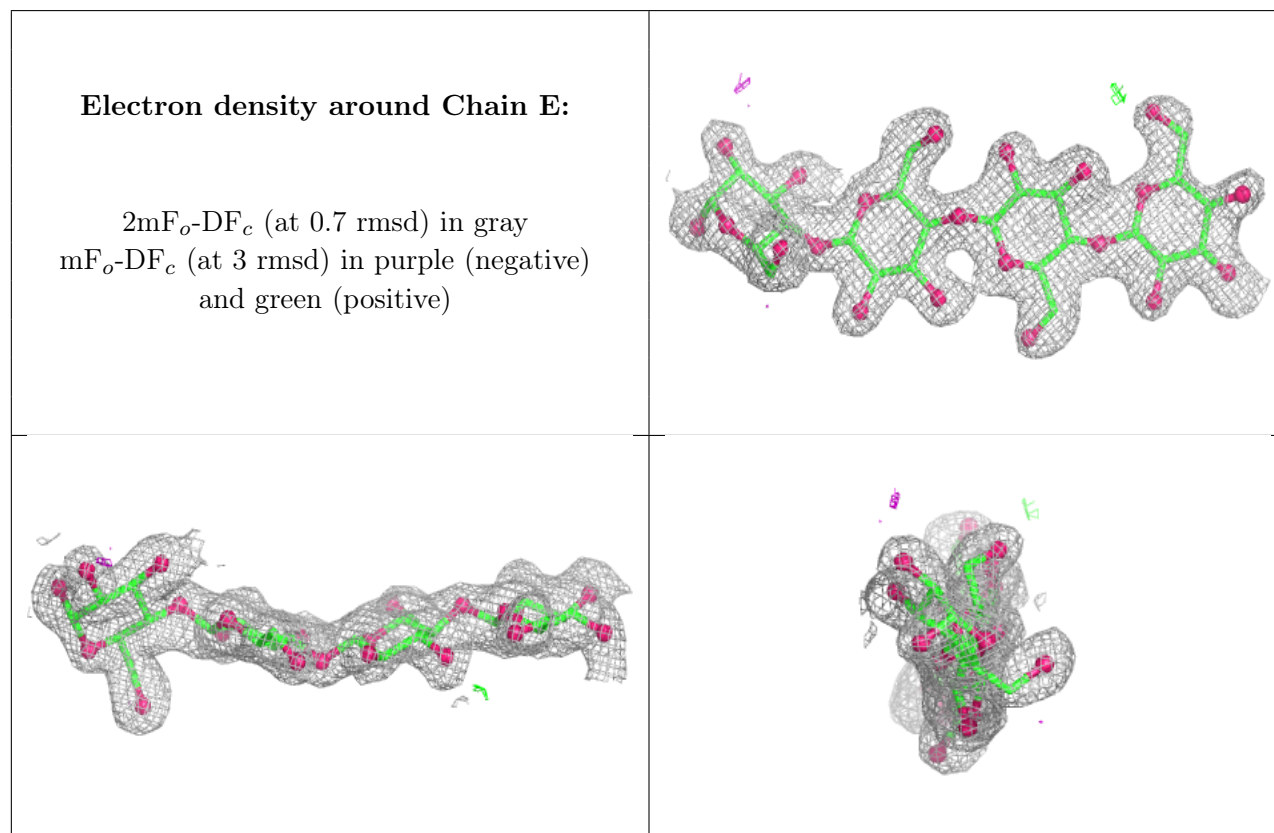
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	BGC	F	4	11/12	0.63	0.17	55,58,61,61	0
2	BGC	E	4	11/12	0.82	0.10	43,45,46,47	0

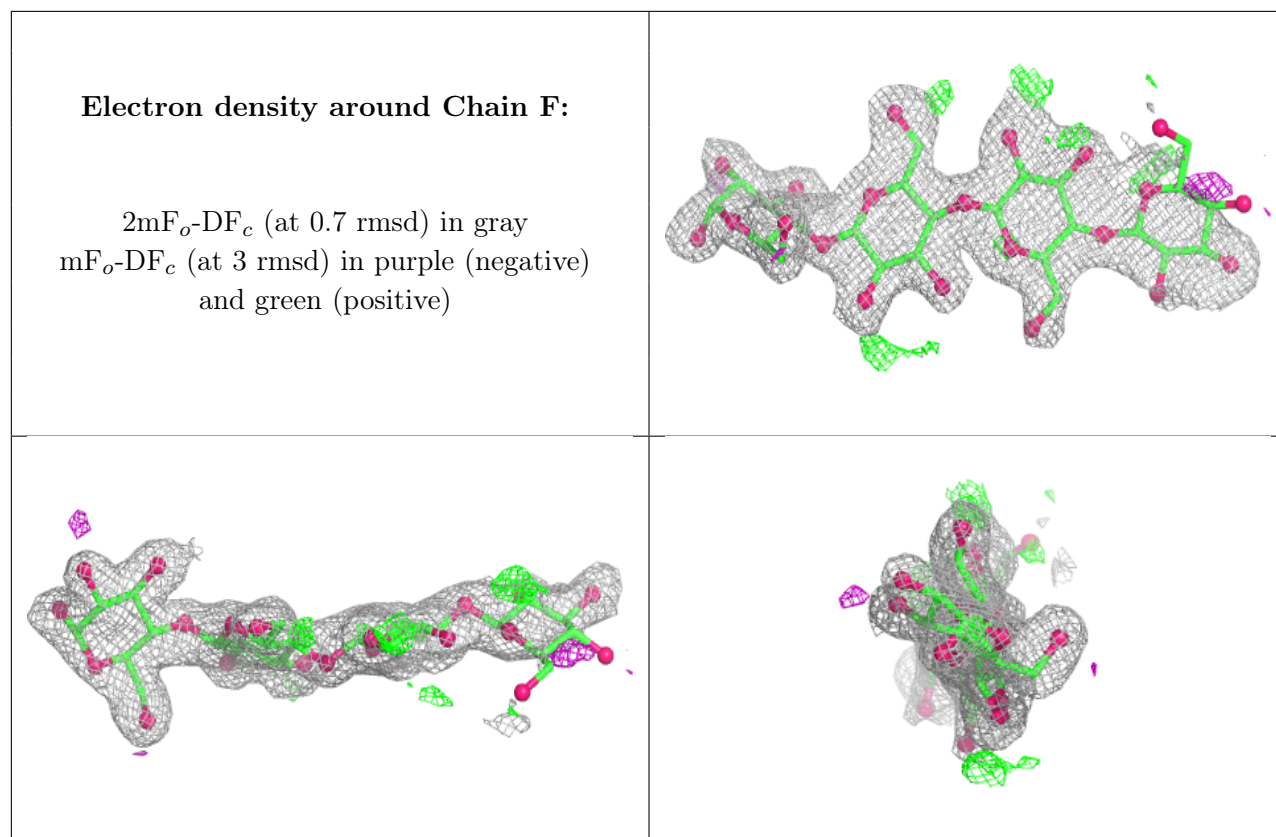
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	BGC	F	3	11/12	0.89	0.10	40,42,48,50	0
2	BGC	E	3	11/12	0.89	0.09	34,38,39,40	0
2	GLC	E	1	12/12	0.90	0.09	25,26,30,31	0
2	BGC	F	2	11/12	0.90	0.09	33,36,39,43	0
2	GLC	F	1	12/12	0.91	0.09	25,29,31,33	0
2	BGC	E	2	11/12	0.91	0.08	23,29,32,32	0

The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.





6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.