



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 28, 2026 – 05:14 PM UTC

PDB ID : 2VQI / pdb_00002vqi
Title : Structure of the P pilus usher (PapC) translocation pore
Authors : Remaut, H.; Tang, C.; Henderson, N.S.; Pinkner, J.S.; Wang, T.; Hultgren, S.J.; Thanassi, D.G.; Li, H.; Waksman, G.
Deposited on : 2008-03-16
Resolution : 3.20 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
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
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

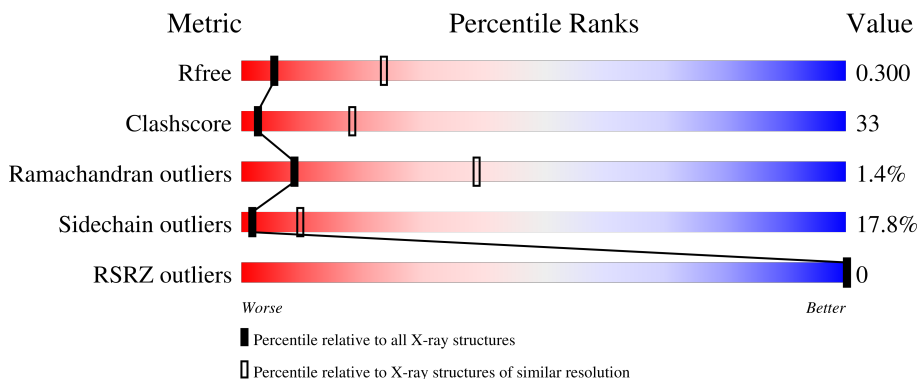
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.20 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	1466 (3.20-3.20)
Clashscore	190562	1573 (3.20-3.20)
Ramachandran outliers	187476	1548 (3.20-3.20)
Sidechain outliers	187428	1547 (3.20-3.20)
RSRZ outliers	180081	1466 (3.20-3.20)

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	515	
1	B	515	

2 Entry composition [i](#)

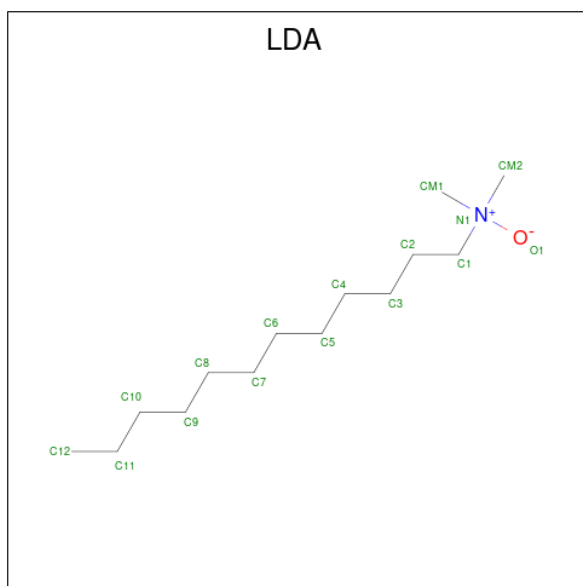
There are 4 unique types of molecules in this entry. The entry contains 7625 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 OUTER MEMBRANE USHER PROTEIN PAPC.

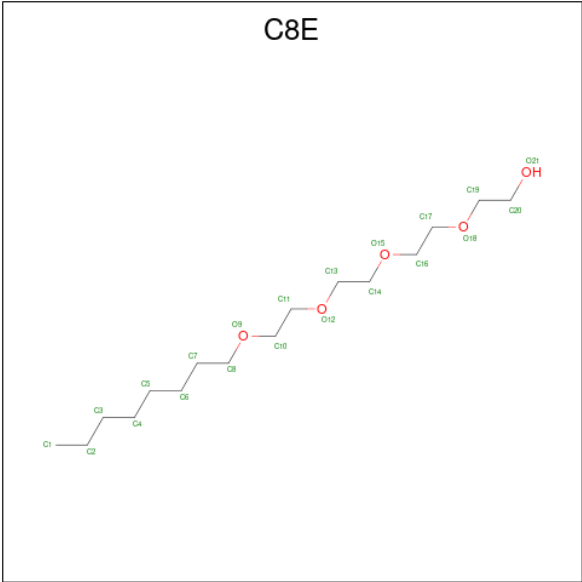
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	477	Total	C	N	O	Se	0	0	0
			3767	2353	675	731	8			
1	B	477	Total	C	N	O	Se	0	0	0
			3750	2342	674	726	8			

- Molecule 2 is LAURYL DIMETHYLAMINE-N-OXIDE (CCD ID: LDA) (formula: $C_{14}H_{31}NO$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			16	14	1	1		
2	B	1	Total	C	N	O	0	0
			16	14	1	1		

- Molecule 3 is (HYDROXYETHYLOXY)TRI(ETHYLOXY)OCTANE (CCD ID: C8E) (formula: $C_{16}H_{34}O_5$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	B	1	Total	C	O	0	0
			21	16	5		
3	B	1	Total	C	O	0	0
			21	16	5		

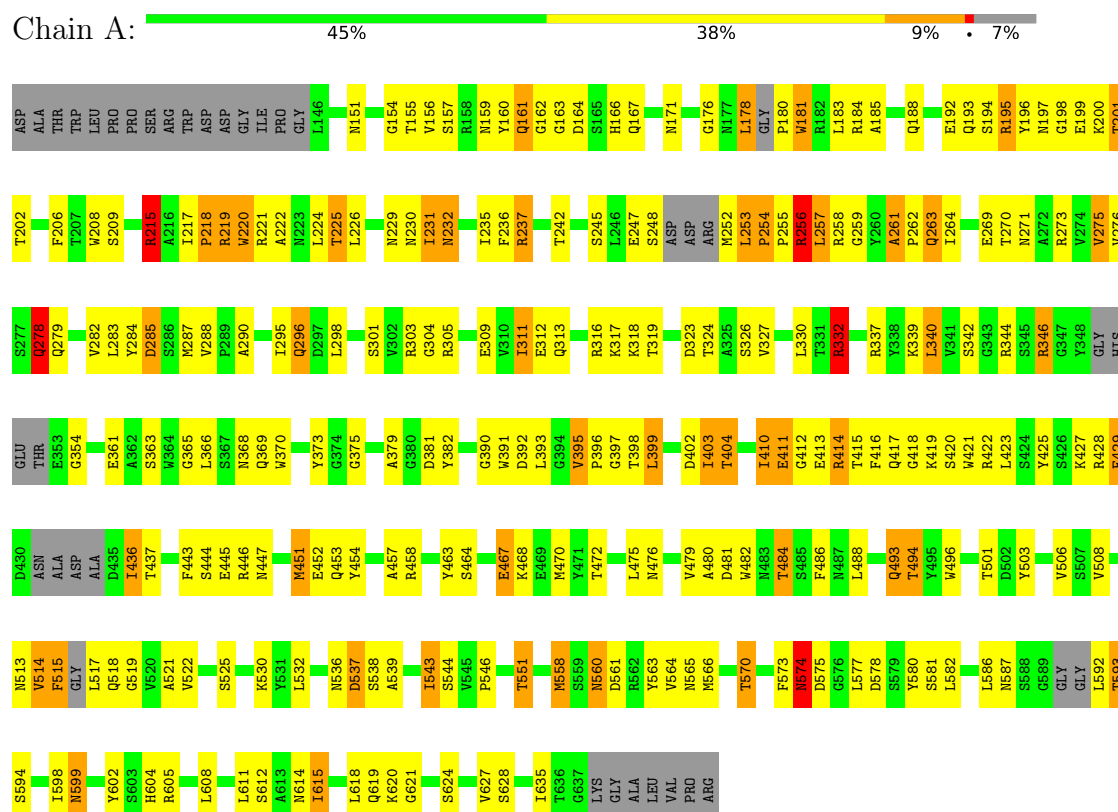
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	15	Total	O	0	0
			15	15		
4	B	19	Total	O	0	0
			19	19		

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 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: OUTER MEMBRANE USHER PROTEIN PAPC



• Molecule 1: OUTER MEMBRANE USHER PROTEIN PAPC



F357	F358	E361	W364	S367	N368	Q369	W370	S371	L372	A376	G380	D381	Y382	N383	A384	L385	A386	A387	G388	A389	G390	W391	D392	L393	G394	Y395	P396	G397	T398	L399	D402	I403	T404	R409	I410	E411	G412	E413	R414	S420	Y425	R428	F429	ASP	ASN	ALA	ASP	A434	D435	I436	
T437	F438	S444	Y448	M449	T450	M451	E452	Q453	Y454	L455	R458	Y459	R460	N461	M462	Y463	S464	S465	R466	E467	K468	E469	M470	T474	L475	N476	D481	W482	S485	F486	N487	L488	Q489	Y490	S491	R492	Q493	T494	D497	I498	R499	K500	T501	D502	Y503	Y504	T505	V506	S507	R510	Y511
F512	N513	V514	F515	GLY	LEU	GLN	G519	V520	L524	R528	Y531	L532	G533	R534	D535	N536	D537	S538	A539	Y540	I543	S544	V545	T549	G550	T551	S555	N560	Y563	M566	T570	D571	N574	D575	G576	L577	D578	S579	Y580	N583	A584	G585	L586	R587	S588	G591					
L592	T593	S594	Q595	R596	Q597	T598	N599	Y602	S603	H604	R605	N614	I615	A616	S617	L618	Q619	R620	G621	Y622	T623	S624	F625	G626	V627	S628	G632	A633	T634	I635	T636	GLY	LYS	GLY	ALA	LEU	VAL	PRO	ARG												

4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	166.50Å 101.90Å 113.70Å 90.00° 128.20° 90.00°	Depositor
Resolution (Å)	15.00 – 3.20 15.00 – 3.20	Depositor EDS
% Data completeness (in resolution range)	99.9 (15.00-3.20) 99.9 (15.00-3.20)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.69 (at 3.19Å)	Xtriage
Refinement program	CNS 1.2	Depositor
R, R_{free}	0.259 , 0.296 0.264 , 0.300	Depositor DCC
R_{free} test set	2410 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	53.4	Xtriage
Anisotropy	0.154	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.24 , 31.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	7625	wwPDB-VP
Average B, all atoms (Å ²)	50.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.22% of the height of the origin peak. No significant pseudotranslation is detected.*

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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: C8E, LDA

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	0.51	0/3840	0.95	16/5184 (0.3%)
1	B	0.63	2/3825 (0.1%)	1.02	20/5167 (0.4%)
All	All	0.57	2/7665 (0.0%)	0.99	36/10351 (0.3%)

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	5
1	B	0	8
All	All	0	13

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	147	MSE	CG-SE	15.35	2.41	1.95
1	B	147	MSE	SE-CE	13.72	2.36	1.95

The worst 5 of 36 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	254	PRO	CA-C-N	8.81	128.45	118.85
1	B	254	PRO	C-N-CA	8.81	128.45	118.85
1	B	436	ILE	N-CA-C	8.24	120.45	108.58
1	B	238	SER	N-CA-C	8.23	120.53	110.41
1	B	549	THR	N-CA-C	-7.36	104.15	113.72

There are no chirality outliers.

5 of 13 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	162	GLY	Peptide
1	A	199	GLU	Peptide
1	A	215	ARG	Sidechain
1	A	218	PRO	Peptide
1	A	278	GLN	Peptide

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	3767	0	3590	255	0
1	B	3750	0	3576	229	0
2	A	16	0	31	6	0
2	B	16	0	31	3	0
3	B	42	0	68	6	0
4	A	15	0	0	4	0
4	B	19	0	0	2	0
All	All	7625	0	7296	478	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 33.

The worst 5 of 478 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:B:395:VAL:HB	1:B:429:PHE:CE1	1.67	1.28
1:B:181:TRP:CZ3	1:B:215:ARG:HB3	1.70	1.27
1:B:147:MSE:SE	1:B:147:MSE:CE	2.36	1.23
1:A:180:PRO:O	1:A:215:ARG:HB2	1.40	1.20
1:A:316:ARG:HH21	1:A:318:LYS:NZ	1.41	1.19

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	463/515 (90%)	416 (90%)	40 (9%)	7 (2%)	8	37
1	B	467/515 (91%)	424 (91%)	37 (8%)	6 (1%)	9	40
All	All	930/1030 (90%)	840 (90%)	77 (8%)	13 (1%)	9	39

5 of 13 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	414	ARG
1	B	395	VAL
1	B	414	ARG
1	B	575	ASP
1	A	480	ALA

5.3.2 Protein sidechains

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	396/414 (96%)	323 (82%)	73 (18%)	1	9
1	B	392/414 (95%)	325 (83%)	67 (17%)	2	11
All	All	788/828 (95%)	648 (82%)	140 (18%)	2	10

5 of 140 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	449	MSE

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Mol	Chain	Res	Type
1	B	498	ILE
1	B	575	ASP
1	A	494	THR
1	A	493	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 26 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	599	ASN
1	B	197	ASN
1	B	493	GLN
1	B	171	ASN
1	B	205	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

4 ligands 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
3	C8E	B	1637	-	20,20,20	0.38	0	19,19,19	0.39	0
3	C8E	B	1638	-	20,20,20	0.38	0	19,19,19	0.39	0
2	LDA	A	1638	-	13,15,15	2.49	2 (15%)	14,17,17	0.52	0
2	LDA	B	1639	-	13,15,15	2.49	2 (15%)	14,17,17	0.52	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
3	C8E	B	1637	-	-	9/18/18/18	-
3	C8E	B	1638	-	-	10/18/18/18	-
2	LDA	A	1638	-	-	10/13/13/13	-
2	LDA	B	1639	-	-	4/13/13/13	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1638	LDA	O1-N1	-6.85	1.25	1.42
2	B	1639	LDA	O1-N1	-6.84	1.25	1.42
2	A	1638	LDA	C1-N1	-5.76	1.45	1.51
2	B	1639	LDA	C1-N1	-5.75	1.45	1.51

There are no bond angle outliers.

There are no chirality outliers.

5 of 33 torsion outliers are listed below:

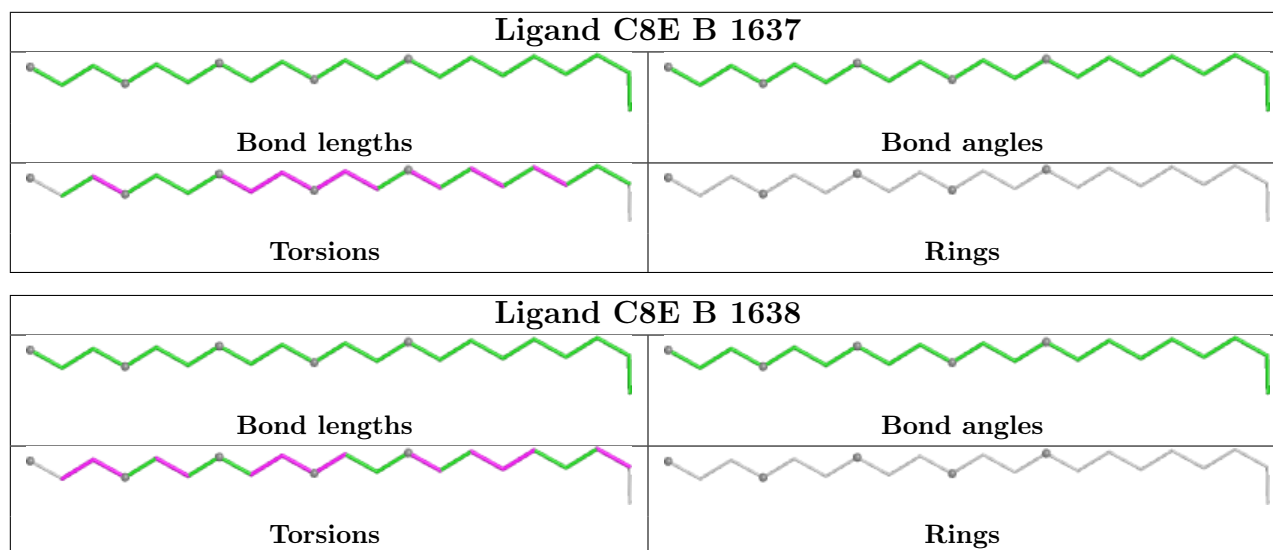
Mol	Chain	Res	Type	Atoms
2	A	1638	LDA	C2-C1-N1-O1
2	A	1638	LDA	C2-C1-N1-CM1
2	A	1638	LDA	C2-C1-N1-CM2
3	B	1638	C8E	C4-C5-C6-C7
3	B	1637	C8E	C10-C11-O12-C13

There are no ring outliers.

3 monomers are involved in 15 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	1637	C8E	6	0
2	A	1638	LDA	6	0
2	B	1639	LDA	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 all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



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	469/515 (91%)	-1.60	0 100 100	18, 46, 75, 87	33 (7%)
1	B	469/515 (91%)	-1.59	0 100 100	18, 46, 75, 91	32 (6%)
All	All	938/1030 (91%)	-1.59	0 100 100	18, 46, 75, 91	65 (6%)

There are no RSRZ outliers to report.

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 oligosaccharides in this entry.

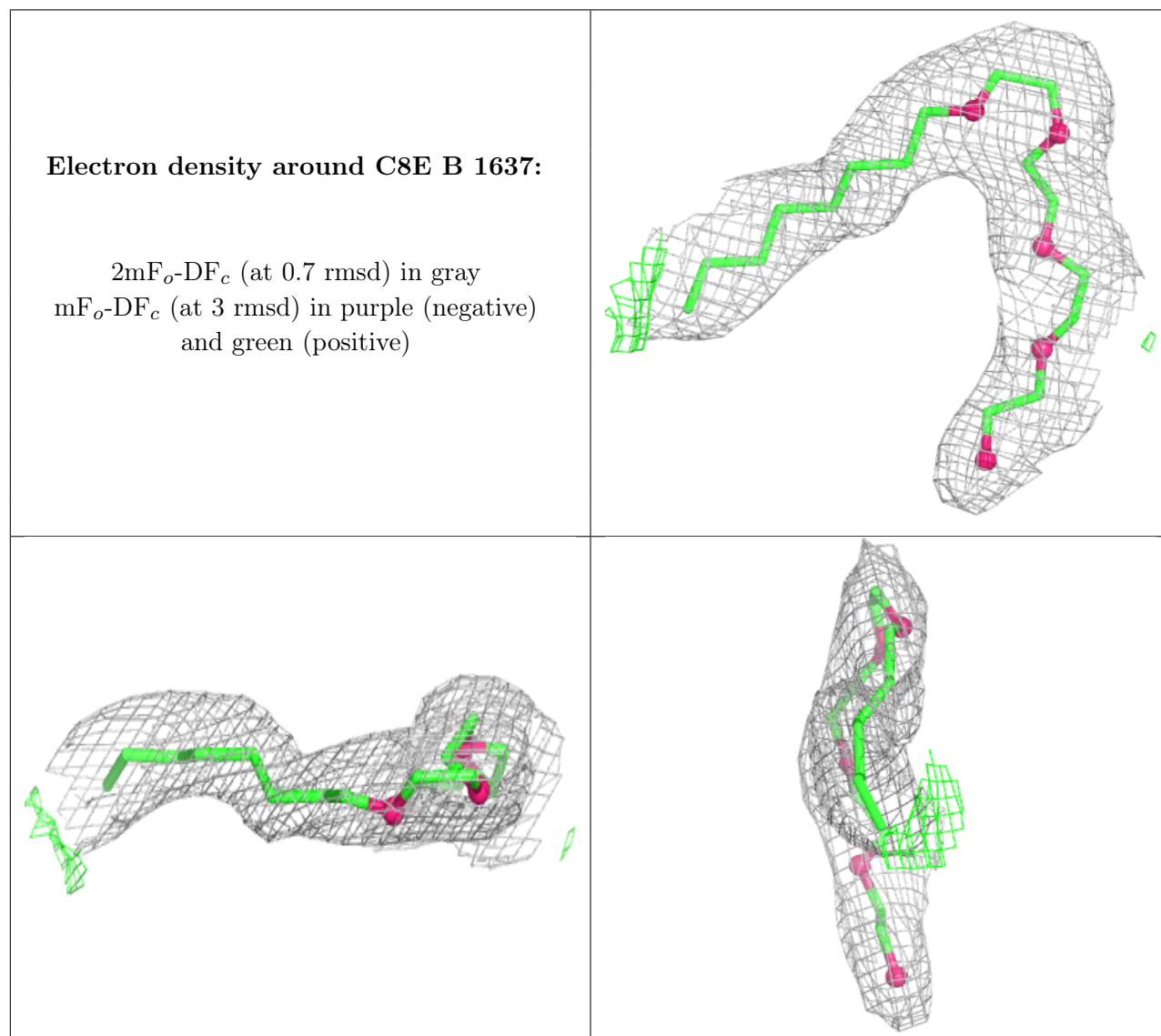
6.4 Ligands [i](#)

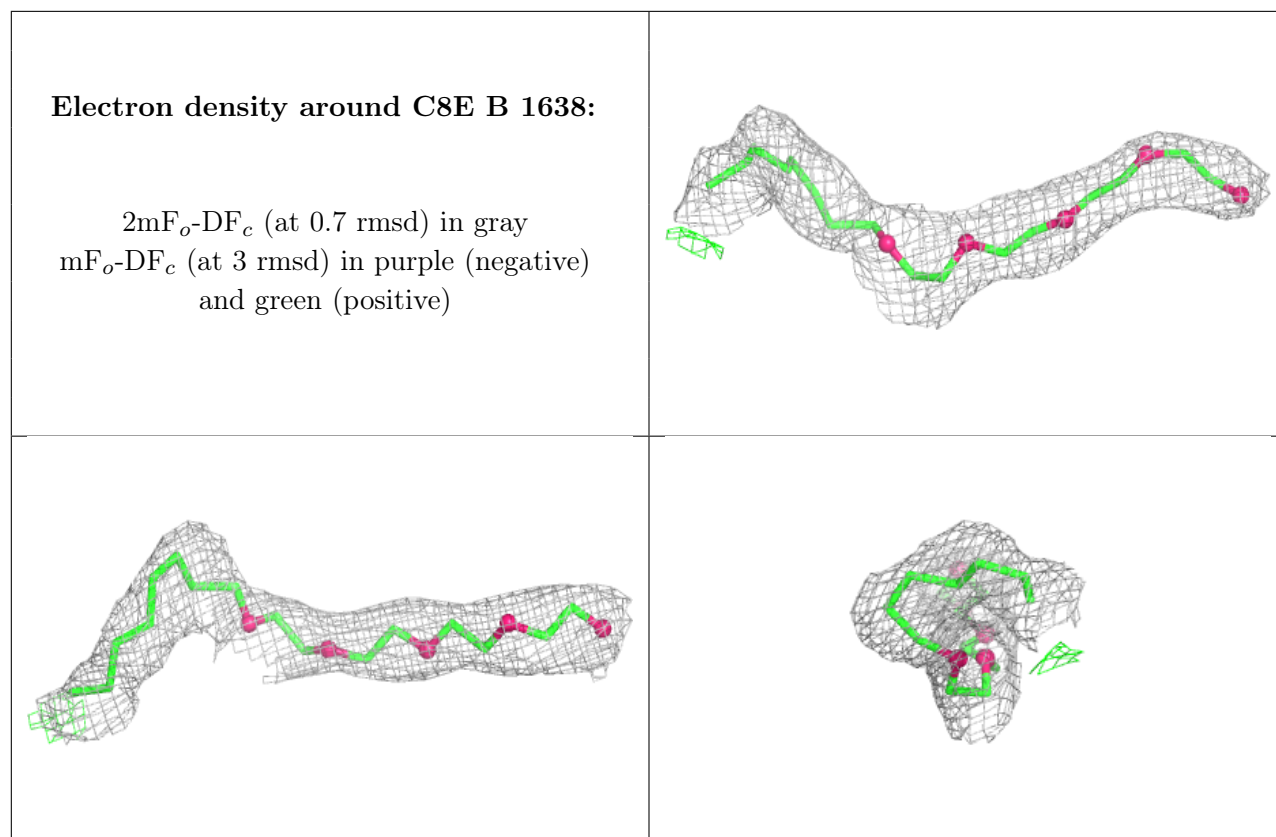
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled ‘Q< 0.9’ lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
3	C8E	B	1637	21/21	0.98	0.04	77,83,86,86	0
2	LDA	A	1638	16/16	0.99	0.04	78,83,89,90	0
3	C8E	B	1638	21/21	0.99	0.04	81,90,93,94	0
2	LDA	B	1639	16/16	1.00	0.04	54,57,70,70	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers

as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.





6.5 Other polymers [i](#)

There are no such residues in this entry.