Full wwPDB EM Validation Report ⓘ

Jan 6, 2025 – 02:23 PM JST

PDB ID	:	8IU2
EMDB ID	:	EMD-35714
Title	:	Cryo-EM structure of Long-wave-sensitive opsin 1
Authors	:	Peng, Q.; Cheng, X.Y.; Li, J.; Lu, Q.Y.; Li, Y.Y.; Zhang, J.
Deposited on	:	2023-03-23
Resolution	:	3.35 Å(reported)

This is a Full wwPDB EM 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/EMValidationReportHelp
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:

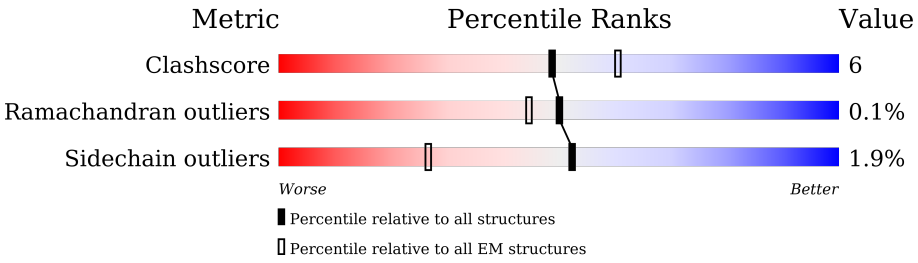
EMDB validation analysis	:	FAILED
Mogul	:	1.8.5 (274361), CSD as541be (2020)
MolProbity	:	4.02b-467
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ	:	FAILED
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.40

1 Overall quality at a glance

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 3.35 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)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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 <=5%

Mol	Chain	Length	Quality of chain
1	R	364	70% 12% • 18%
2	A	354	53% 6% • 41%
3	B	340	87% 12%
4	G	71	79% •• 18%
5	S	259	80% 10% • 10%

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
6	RET	R	401	-	-	X	-

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 8728 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Long-wave-sensitive opsin 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	R	298	2338	1558	375	384	21	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
R	129	GLN	GLU	engineered mutation	UNP P04000

- Molecule 2 is a protein called Guanine nucleotide-binding protein G(i) subunit alpha-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	A	209	1589	1020	267	290	12	0	0

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	47	CYS	SER	engineered mutation	UNP P63096
A	202	THR	GLY	engineered mutation	UNP P63096
A	203	ALA	GLY	engineered mutation	UNP P63096
A	245	ALA	GLU	engineered mutation	UNP P63096
A	326	SER	ALA	engineered mutation	UNP P63096

- Molecule 3 is a protein called Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	B	339	2599	1603	468	507	21	0	0

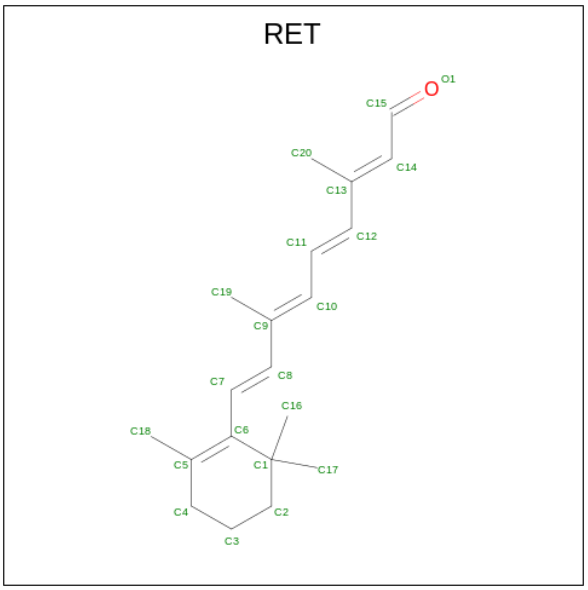
- Molecule 4 is a protein called Guanine nucleotide-binding protein G(I)/G(S)/G(O) subunit gamma-2.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	G	58	Total	C	N	O	S	0	0
			438	274	76	85	3		

- Molecule 5 is a protein called scFv Recombinant Human Monoclonal Antibody (scFv16).

Mol	Chain	Residues	Atoms					AltConf	Trace
5	S	233	Total	C	N	O	S	0	0
			1744	1110	295	329	10		

- Molecule 6 is RETINAL (three-letter code: RET) (formula: $C_{20}H_{28}O$) (labeled as "Ligand of Interest" by depositor).



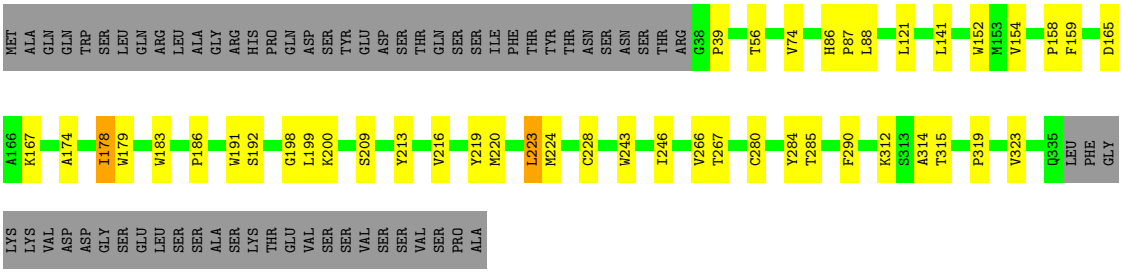
Mol	Chain	Residues	Atoms		AltConf
6	R	1	Total	C	0
			20	20	

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. 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.

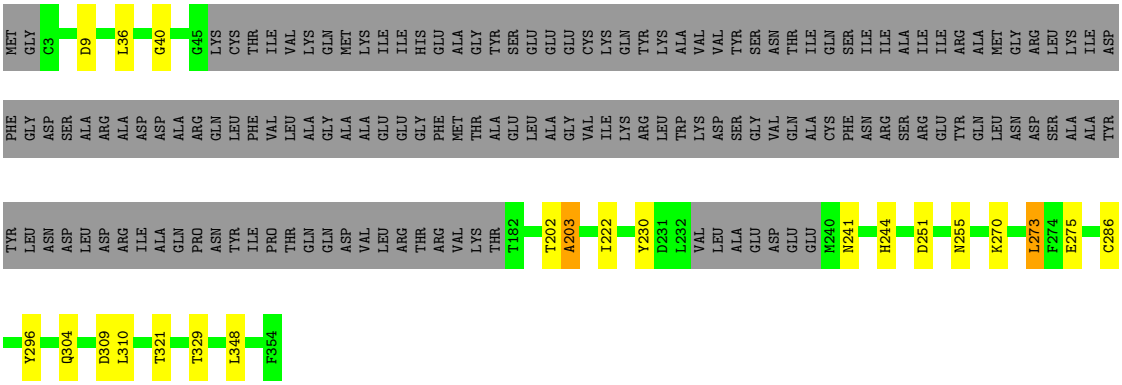
• Molecule 1: Long-wave-sensitive opsin 1

Chain R:



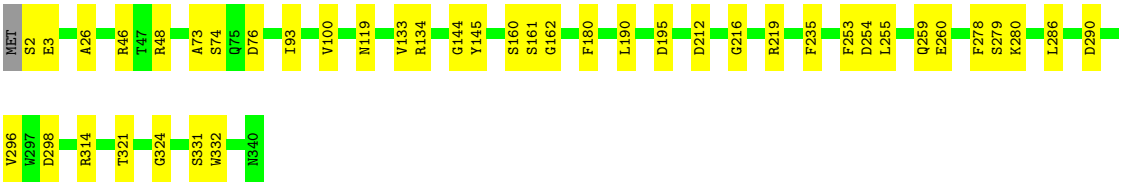
• Molecule 2: Guanine nucleotide-binding protein G(i) subunit alpha-1

Chain A:



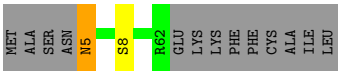
• Molecule 3: Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta-1

Chain B:



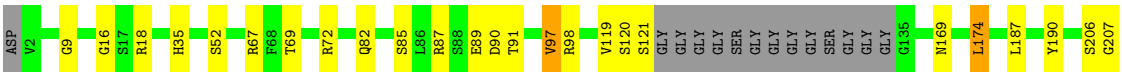
• Molecule 4: Guanine nucleotide-binding protein G(I)/G(S)/G(O) subunit gamma-2

Chain G:



• Molecule 5: scFv Recombinant Human Monoclonal Antibody (scFv16)

Chain S:



4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	240610	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TALOS ARCTICA	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	41	Depositor
Minimum defocus (nm)	1800	Depositor
Maximum defocus (nm)	2200	Depositor
Magnification	Not provided	
Image detector	GATAN K3 (6k x 4k)	Depositor

5 Model quality

5.1 Standard geometry

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

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	R	0.58	0/2418	0.62	0/3314
2	A	0.53	0/1618	0.59	0/2186
3	B	0.65	0/2646	0.68	0/3587
4	G	0.36	0/444	0.51	0/601
5	S	0.59	0/1787	0.65	1/2427 (0.0%)
All	All	0.59	0/8913	0.64	1/12115 (0.0%)

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
3	B	0	1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	S	174	LEU	CA-CB-CG	-5.07	103.65	115.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
3	B	195	ASP	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	R	2338	0	2329	44	0
2	A	1589	0	1511	14	0
3	B	2599	0	2502	22	0
4	G	438	0	443	1	0
5	S	1744	0	1666	14	0
6	R	20	0	27	19	0
All	All	8728	0	8478	97	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 6.

All (97) 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:R:174:ALA:O	1:R:178:ILE:HG23	1.58	1.03
1:R:285:THR:HG22	6:R:401:RET:H162	1.57	0.87
1:R:219:TYR:CZ	1:R:223:LEU:HD12	2.11	0.85
2:A:40:GLY:O	2:A:202:THR:HG21	1.76	0.84
1:R:228:CYS:HB2	6:R:401:RET:H173	1.60	0.84
1:R:243:TRP:HE1	1:R:267:THR:HG1	1.25	0.83
1:R:228:CYS:CB	6:R:401:RET:H173	2.14	0.78
1:R:280:CYS:HB2	1:R:314:ALA:HB2	1.71	0.73
2:A:202:THR:O	2:A:203:ALA:CB	2.37	0.73
1:R:86:HIS:ND1	1:R:87:PRO:HD2	2.04	0.72
2:A:202:THR:O	2:A:203:ALA:HB2	1.89	0.70
1:R:219:TYR:CE2	1:R:223:LEU:HD12	2.27	0.70
1:R:219:TYR:CZ	1:R:223:LEU:CD1	2.75	0.69
5:S:87:ARG:HG3	5:S:89:GLU:H	1.56	0.69
1:R:224:MET:HA	6:R:401:RET:H172	1.75	0.68
6:R:401:RET:H181	6:R:401:RET:C8	2.24	0.68
1:R:285:THR:HG22	6:R:401:RET:C16	2.26	0.65
5:S:69:THR:HB	5:S:82:GLN:HB3	1.79	0.65
1:R:224:MET:HB2	6:R:401:RET:H32	1.78	0.64
1:R:224:MET:HB2	6:R:401:RET:C3	2.27	0.64
1:R:224:MET:HG3	6:R:401:RET:H22	1.80	0.63

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:R:86:HIS:CE1	1:R:87:PRO:HD2	2.34	0.62
1:R:213:TYR:HB2	1:R:216:VAL:HG23	1.81	0.62
1:R:312:LYS:O	1:R:315:THR:HG23	2.02	0.60
3:B:93:ILE:HG12	3:B:133:VAL:HG21	1.84	0.59
3:B:26:ALA:HB2	3:B:259:GLN:HE22	1.68	0.59
5:S:35:HIS:HB2	5:S:97:VAL:HG13	1.84	0.59
1:R:192:SER:HB2	1:R:216:VAL:HA	1.84	0.59
3:B:161:SER:OG	3:B:162:GLY:N	2.35	0.58
2:A:40:GLY:O	2:A:202:THR:CG2	2.49	0.58
1:R:228:CYS:HB2	6:R:401:RET:C17	2.31	0.57
2:A:251:ASP:OD1	2:A:255:ASN:ND2	2.38	0.56
3:B:180:PHE:HE1	3:B:216:GLY:HA2	1.71	0.56
3:B:76:ASP:N	3:B:76:ASP:OD1	2.38	0.56
1:R:246:ILE:HD13	1:R:266:VAL:HG21	1.89	0.55
1:R:224:MET:HA	6:R:401:RET:C17	2.36	0.55
3:B:298:ASP:N	3:B:298:ASP:OD1	2.39	0.55
3:B:212:ASP:OD2	3:B:219:ARG:NH2	2.39	0.54
3:B:331:SER:OG	3:B:332:TRP:N	2.40	0.54
5:S:67:ARG:NH2	5:S:90:ASP:OD2	2.40	0.54
1:R:224:MET:CB	6:R:401:RET:H32	2.37	0.54
1:R:228:CYS:HB3	6:R:401:RET:H173	1.90	0.53
1:R:39:PRO:HB3	1:R:200:LYS:HB3	1.91	0.53
5:S:187:LEU:HD21	5:S:190:TYR:HB3	1.90	0.53
3:B:119:ASN:ND2	3:B:144:GLY:O	2.42	0.52
1:R:246:ILE:HG12	2:A:348:LEU:HD11	1.92	0.52
5:S:91:THR:HB	5:S:119:VAL:HG22	1.92	0.52
1:R:174:ALA:O	1:R:178:ILE:CG2	2.45	0.51
1:R:224:MET:CA	6:R:401:RET:H32	2.41	0.50
3:B:279:SER:OG	3:B:280:LYS:N	2.45	0.50
1:R:86:HIS:ND1	1:R:87:PRO:CD	2.74	0.50
3:B:73:ALA:HB1	3:B:100:VAL:HG21	1.94	0.50
1:R:88:LEU:HD11	1:R:154:VAL:HG21	1.94	0.49
6:R:401:RET:H181	6:R:401:RET:H8	1.95	0.49
3:B:74:SER:OG	3:B:76:ASP:OD1	2.30	0.49
2:A:270:LYS:HB3	2:A:273:LEU:HD11	1.95	0.48
5:S:174:LEU:HD22	5:S:212:PHE:CG	2.49	0.48
3:B:290:ASP:OD1	3:B:314:ARG:NE	2.47	0.47
3:B:160:SER:HB3	3:B:190:LEU:HD23	1.95	0.47
3:B:286:LEU:HD13	3:B:296:VAL:HG22	1.96	0.47
1:R:183:TRP:O	1:R:186:PRO:HD2	2.15	0.47
1:R:219:TYR:OH	1:R:223:LEU:HD11	2.16	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:R:165:ASP:HB2	1:R:167:LYS:HG2	1.98	0.46
2:A:36:LEU:HD13	2:A:222:ILE:HD11	1.97	0.46
1:R:224:MET:HB2	6:R:401:RET:H31	1.98	0.45
1:R:152:TRP:CZ2	1:R:158:PRO:HB3	2.51	0.45
6:R:401:RET:C8	6:R:401:RET:C18	2.92	0.45
3:B:145:TYR:O	3:B:162:GLY:N	2.50	0.44
1:R:280:CYS:CB	1:R:314:ALA:HB2	2.44	0.44
3:B:2:SER:OG	3:B:3:GLU:N	2.50	0.44
5:S:206:SER:OG	5:S:207:GLY:N	2.51	0.44
1:R:86:HIS:CG	1:R:87:PRO:HD2	2.52	0.44
5:S:9:GLY:O	5:S:18:ARG:NH1	2.50	0.44
2:A:275:GLU:HB2	2:A:296:TYR:CE1	2.53	0.44
5:S:120:SER:OG	5:S:121:SER:N	2.49	0.44
3:B:321:THR:HG23	3:B:324:GLY:H	1.83	0.43
5:S:67:ARG:HH12	5:S:87:ARG:HE	1.65	0.43
6:R:401:RET:H8	6:R:401:RET:C18	2.49	0.43
3:B:46:ARG:HB2	3:B:48:ARG:HH12	1.84	0.43
2:A:9:ASP:OD2	5:S:169:ASN:ND2	2.51	0.43
2:A:309:ASP:O	2:A:310:LEU:HB2	2.19	0.43
3:B:254:ASP:OD1	3:B:255:LEU:N	2.52	0.42
2:A:241:ASN:OD1	2:A:244:HIS:ND1	2.43	0.42
3:B:235:PHE:HD1	3:B:278:PHE:HE2	1.67	0.42
1:R:141:LEU:HD12	1:R:141:LEU:HA	1.84	0.42
1:R:315:THR:O	1:R:319:PRO:HD2	2.20	0.41
1:R:74:VAL:HG22	1:R:323:VAL:HG11	2.01	0.41
5:S:52:SER:O	5:S:72:ARG:NH1	2.53	0.41
1:R:56:THR:HG21	1:R:199:LEU:HD11	2.02	0.41
3:B:253:PHE:HA	3:B:260:GLU:HA	2.01	0.41
2:A:304:GLN:HG3	2:A:321:THR:HG21	2.02	0.41
4:G:5:ASN:HB3	4:G:8:SER:HB3	2.03	0.41
1:R:198:GLY:O	1:R:200:LYS:HG3	2.20	0.41
5:S:16:GLY:O	5:S:85:SER:N	2.54	0.41
1:R:198:GLY:C	1:R:200:LYS:N	2.73	0.41
2:A:230:TYR:HB2	2:A:286:CYS:HB2	2.03	0.40
1:R:224:MET:CB	6:R:401:RET:C3	2.98	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 PDB entries followed by that with respect to all EM entries.

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	R	296/364 (81%)	286 (97%)	10 (3%)	0	100 100
2	A	203/354 (57%)	193 (95%)	9 (4%)	1 (0%)	25 53
3	B	337/340 (99%)	302 (90%)	35 (10%)	0	100 100
4	G	56/71 (79%)	51 (91%)	5 (9%)	0	100 100
5	S	229/259 (88%)	213 (93%)	16 (7%)	0	100 100
All	All	1121/1388 (81%)	1045 (93%)	75 (7%)	1 (0%)	50 77

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	A	203	ALA

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 PDB entries followed by that with respect to all EM entries.

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	R	246/309 (80%)	236 (96%)	10 (4%)	26 52
2	A	160/306 (52%)	158 (99%)	2 (1%)	65 79
3	B	280/283 (99%)	279 (100%)	1 (0%)	89 94
4	G	46/58 (79%)	45 (98%)	1 (2%)	47 68
5	S	184/208 (88%)	181 (98%)	3 (2%)	58 75
All	All	916/1164 (79%)	899 (98%)	17 (2%)	52 72

All (17) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	R	121	LEU
1	R	159	PHE
1	R	178	ILE
1	R	179	TRP
1	R	191	TRP
1	R	209	SER
1	R	220	MET
1	R	223	LEU
1	R	284	TYR
1	R	290	PHE
2	A	273	LEU
2	A	329	THR
3	B	134	ARG
4	G	5	ASN
5	S	97	VAL
5	S	98	ARG
5	S	218	ARG

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

Mol	Chain	Res	Type
1	R	129	GLN
1	R	294	ASN
1	R	331	ASN
3	B	91	HIS
3	B	110	ASN
3	B	259	GLN
3	B	266	HIS
4	G	5	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)

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	$\#\|Z\| > 2$
6	RET	R	401	1	20,20,21	2.35	3 (15%)	27,27,28	0.85	1 (3%)

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
6	RET	R	401	1	-	3/13/30/31	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	R	401	RET	C14-C13	9.07	1.40	1.33
6	R	401	RET	C10-C9	2.94	1.39	1.35
6	R	401	RET	C15-C14	-2.33	1.40	1.49

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
6	R	401	RET	C11-C10-C9	-2.30	124.03	127.31

There are no chirality outliers.

All (3) torsion outliers are listed below:

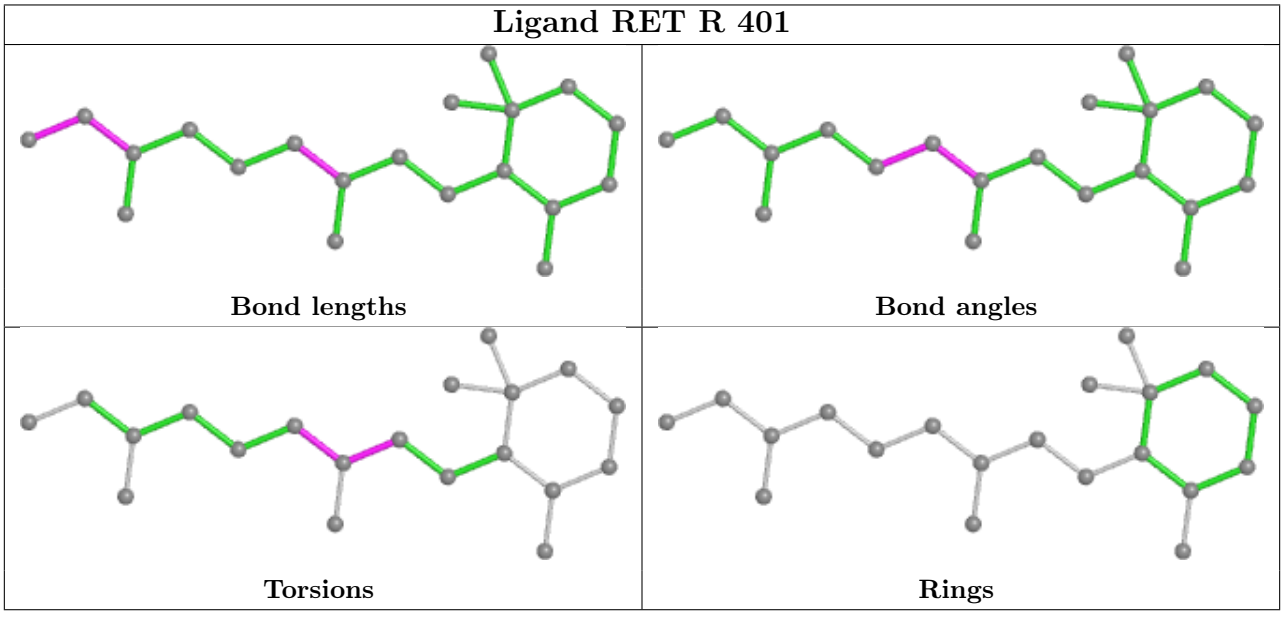
Mol	Chain	Res	Type	Atoms
6	R	401	RET	C11-C10-C9-C8
6	R	401	RET	C11-C10-C9-C19
6	R	401	RET	C7-C8-C9-C10

There are no ring outliers.

1 monomer is involved in 19 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	R	401	RET	19	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 then 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

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.