



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 01:53 PM UTC

PDB ID : 2GOP / pdb_00002gop
Title : The beta-propeller domain of the Trilobed protease from *Pyrococcus furiosus* reveals an open velcro topology
Authors : Bosch, J.; Tamura, T.; Tamura, N.; Baumeister, W.; Essen, L.-O.
Deposited on : 2006-04-13
Resolution : 2.00 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
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

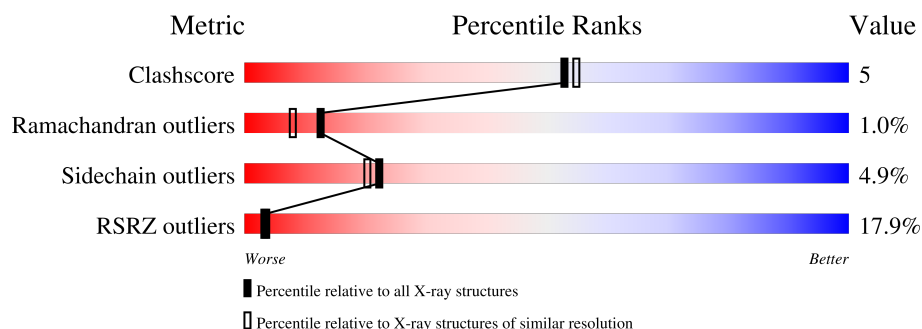
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 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	11152 (2.00-2.00)
Ramachandran outliers	187476	11031 (2.00-2.00)
Sidechain outliers	187428	11029 (2.00-2.00)
RSRZ outliers	180081	10067 (2.00-2.00)

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	347	8% 81% 9% • 8%
1	B	347	24% 73% 13% • 12%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 5479 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 Trilobed Protease.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	320	Total	C	N	O	S	0	6	0
			2708	1757	444	500	7			
1	B	304	Total	C	N	O	S	8	1	0
			2529	1635	414	474	6			

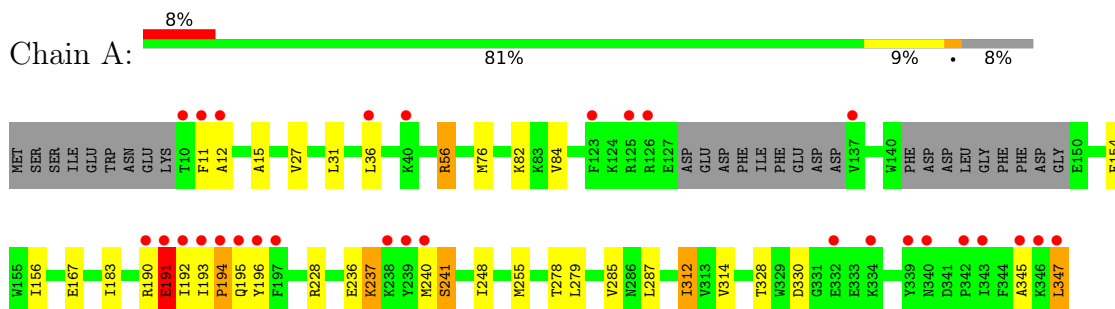
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	156	Total	O	0	0
			156	156		
2	B	86	Total	O	0	0
			86	86		

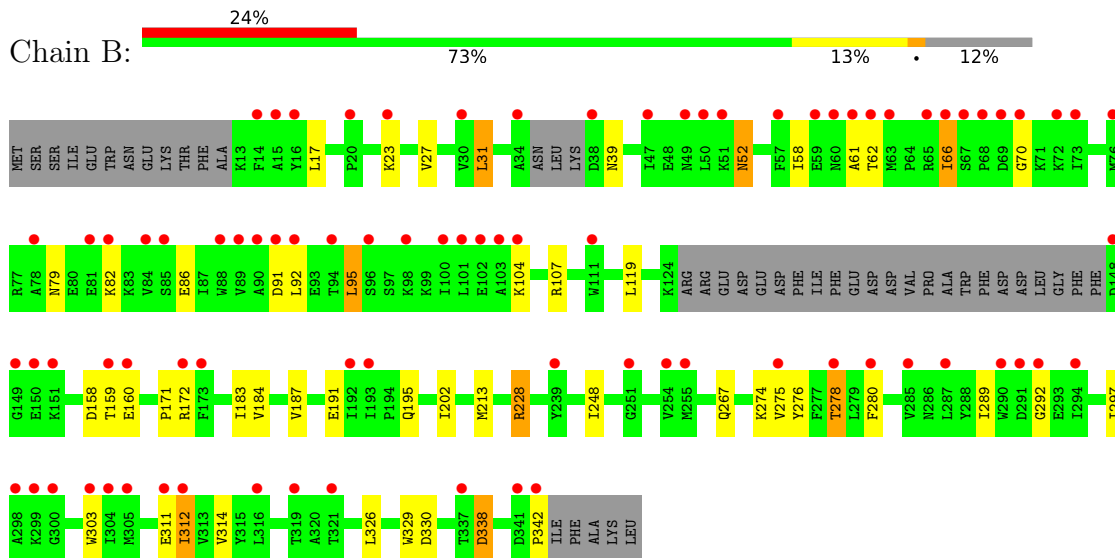
3 Residue-property plots [i](#)

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: Trilobed Protease



• Molecule 1: Trilobed Protease



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	54.75Å 88.50Å 153.97Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	18.72 – 2.00 18.72 – 2.00	Depositor EDS
% Data completeness (in resolution range)	100.0 (18.72-2.00) 80.0 (18.72-2.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.45 (at 2.00Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.209 , 0.258 0.223 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	39.7	Xtriage
Anisotropy	0.045	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 67.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	5479	wwPDB-VP
Average B, all atoms (Å ²)	55.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.03% 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

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	0.52	0/2789	0.70	2/3755 (0.1%)
1	B	0.91	4/2589 (0.2%)	0.71	6/3484 (0.2%)
All	All	0.74	4/5378 (0.1%)	0.71	8/7239 (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	2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	338	ASP	CA-CB	-24.63	1.28	1.53
1	B	171	PRO	C-N	-24.13	1.00	1.33
1	B	326	LEU	CA-CB	-17.85	1.26	1.53
1	B	172	ARG	C-N	12.77	1.50	1.33

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	338	ASP	N-CA-CB	8.34	123.45	111.19
1	B	171	PRO	CA-C-N	7.93	132.48	120.82
1	B	171	PRO	C-N-CA	7.93	132.48	120.82
1	B	342	PRO	N-CA-CB	7.13	110.84	103.00
1	B	338	ASP	CA-CB-CG	-6.37	106.23	112.60
1	A	241	SER	N-CA-C	5.65	122.83	110.80
1	B	292	GLY	N-CA-C	-5.60	107.59	113.58
1	A	191	GLU	N-CA-C	5.33	122.16	110.80

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	196	TYR	Peptide
1	A	240	MET	Peptide

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	2708	0	2704	29	0
1	B	2529	0	2489	25	0
2	A	156	0	0	1	0
2	B	86	0	0	0	0
All	All	5479	0	5193	52	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 (52) 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:156:ILE:HD11	1:A:183:ILE:HD11	1.53	0.89
1:A:314[B]:VAL:HG22	1:A:328:THR:HG22	1.57	0.87
1:B:267:GLN:H	1:B:278:THR:HG22	1.51	0.76
1:A:193:ILE:HG22	1:A:193:ILE:O	1.85	0.75
1:A:15:ALA:HB1	1:A:31:LEU:HD11	1.74	0.69
1:B:276:TYR:CE2	1:B:289:ILE:HD13	2.30	0.67
1:A:156:ILE:HD11	1:A:183:ILE:CD1	2.24	0.65
1:B:23:LYS:HB2	1:B:66:ILE:HD11	1.81	0.64
1:A:56:ARG:HH11	1:A:56:ARG:HG3	1.62	0.63
1:B:184:VAL:HG13	1:B:213:MET:HE1	1.82	0.61
1:A:312:ILE:HD11	1:A:330:ASP:HB3	1.81	0.61
1:B:17:LEU:HD21	1:B:31:LEU:HD22	1.84	0.60
1:B:27:VAL:HG21	1:B:314:VAL:HG21	1.85	0.58
1:B:202:ILE:HG22	1:B:213:MET:HE3	1.86	0.58
1:B:274:LYS:HB3	1:B:289:ILE:HD11	1.85	0.57
1:A:236:GLU:O	1:A:237:LYS:HG2	2.05	0.56

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:119:LEU:HD22	1:B:183:ILE:HD12	1.88	0.55
1:A:241:SER:HB3	1:B:280:PHE:CE1	2.40	0.55
1:A:15:ALA:HB1	1:A:31:LEU:CD1	2.36	0.55
1:A:278[B]:THR:HG23	1:A:285:VAL:HG13	1.91	0.53
1:B:17:LEU:CD2	1:B:31:LEU:HD22	2.39	0.53
1:B:70:GLY:O	1:B:92:LEU:HD12	2.10	0.52
1:A:36:LEU:HD23	1:A:36:LEU:H	1.76	0.51
1:A:278[B]:THR:HG23	1:A:285:VAL:CG1	2.40	0.51
1:A:278[B]:THR:CG2	1:A:285:VAL:CG1	2.89	0.51
1:A:345:ALA:O	1:A:347:LEU:HD22	2.11	0.50
1:A:278[B]:THR:CG2	1:A:285:VAL:HG13	2.43	0.48
1:B:79:ASN:HD22	1:B:86:GLU:CD	2.20	0.48
1:B:91:ASP:O	1:B:95:LEU:HA	2.13	0.48
1:A:193:ILE:O	1:A:194:PRO:O	2.32	0.48
1:A:241:SER:HB3	1:B:280:PHE:CD1	2.48	0.48
1:B:27:VAL:CG2	1:B:314:VAL:HG21	2.45	0.47
1:A:156:ILE:CD1	1:A:183:ILE:HD11	2.36	0.46
1:B:276:TYR:CD2	1:B:289:ILE:HD13	2.50	0.46
1:B:158:ASP:OD1	1:B:160:GLU:N	2.48	0.45
1:A:193:ILE:O	1:A:193:ILE:CG2	2.57	0.45
1:B:23:LYS:HB2	1:B:66:ILE:CD1	2.47	0.44
1:B:184:VAL:HG13	1:B:213:MET:CE	2.48	0.44
1:A:190:ARG:O	1:A:191:GLU:O	2.35	0.44
1:A:56:ARG:HH11	1:A:56:ARG:CG	2.28	0.43
1:B:267:GLN:N	1:B:278:THR:HG22	2.28	0.43
1:B:58:ILE:HG22	1:B:61:ALA:HB2	2.01	0.43
1:B:297:ILE:HG23	1:B:329:TRP:CD2	2.54	0.43
1:B:228:ARG:HB3	1:B:248:ILE:HG23	2.00	0.43
1:A:27:VAL:HG12	1:A:314[B]:VAL:HG21	2.01	0.42
1:A:191:GLU:CD	1:A:193:ILE:HD12	2.44	0.42
1:A:154:PHE:O	1:A:167:GLU:HA	2.18	0.42
1:B:312:ILE:HD11	1:B:330:ASP:HB3	2.03	0.41
1:A:82:LYS:HB3	1:A:84:VAL:HG22	2.03	0.40
1:A:76:MET:HE2	2:A:423:HOH:O	2.21	0.40
1:A:192:ILE:O	1:A:192:ILE:HG22	2.22	0.40
1:A:228[A]:ARG:HD3	1:A:248:ILE:HG21	2.03	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	320/347 (92%)	298 (93%)	18 (6%)	4 (1%)	9	5
1	B	299/347 (86%)	281 (94%)	16 (5%)	2 (1%)	18	14
All	All	619/694 (89%)	579 (94%)	34 (6%)	6 (1%)	12	8

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	191	GLU
1	A	194	PRO
1	A	12	ALA
1	B	52	ASN
1	A	11	PHE
1	B	39	ASN

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	293/312 (94%)	284 (97%)	9 (3%)	35	37
1	B	270/312 (86%)	250 (93%)	20 (7%)	13	9
All	All	563/624 (90%)	534 (95%)	29 (5%)	22	18

All (29) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	56	ARG
1	A	195	GLN
1	A	237	LYS
1	A	255[A]	MET
1	A	255[B]	MET
1	A	279	LEU
1	A	287	LEU
1	A	312	ILE
1	A	347	LEU
1	B	31	LEU
1	B	52	ASN
1	B	62	THR
1	B	66	ILE
1	B	82	LYS
1	B	95	LEU
1	B	104	LYS
1	B	107	ARG
1	B	159	THR
1	B	187	VAL
1	B	191	GLU
1	B	195	GLN
1	B	228	ARG
1	B	275	VAL
1	B	278	THR
1	B	303	TRP
1	B	311[A]	GLU
1	B	311[B]	GLU
1	B	312	ILE
1	B	338	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	267	GLN
1	B	244	ASN

5.3.3 RNA ⓘ

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](#)

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](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	B	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	B	171:PRO	C	172:ARG	N	1.00

6 Fit of model and data

6.1 Protein, DNA and RNA chains

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	320/347 (92%)	0.71	29 (9%) 15 13	21, 44, 71, 101	6 (1%)
1	B	304/347 (87%)	1.45	83 (27%) 1 1	20, 62, 86, 97	3 (0%)
All	All	624/694 (89%)	1.07	112 (17%) 3 3	20, 50, 83, 101	9 (1%)

All (112) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	103	ALA	6.2
1	A	193	ILE	5.4
1	B	92	LEU	5.0
1	A	192	ILE	5.0
1	B	101	LEU	5.0
1	A	11	PHE	4.8
1	B	68	PRO	4.6
1	B	50	LEU	4.5
1	A	197	PHE	4.5
1	A	239	TYR	4.3
1	B	15	ALA	4.2
1	B	90	ALA	4.2
1	A	339	TYR	4.2
1	B	88	TRP	4.1
1	B	34	ALA	4.1
1	A	346	LYS	4.1
1	B	66	ILE	4.1
1	B	303	TRP	4.0
1	B	70	GLY	3.9
1	A	340	ASN	3.8
1	B	89	VAL	3.8
1	B	342	PRO	3.7
1	A	194	PRO	3.7
1	B	62	THR	3.7

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Mol	Chain	Res	Type	RSRZ
1	A	196	TYR	3.6
1	A	10	THR	3.5
1	B	14	PHE	3.4
1	B	251	GLY	3.4
1	B	38	ASP	3.3
1	A	342	PRO	3.3
1	B	67	SER	3.3
1	B	91	ASP	3.3
1	B	47	ILE	3.3
1	B	111	TRP	3.2
1	B	61	ALA	3.1
1	B	312	ILE	3.1
1	B	57	PHE	3.1
1	A	190	ARG	3.1
1	B	78	ALA	3.1
1	B	172	ARG	3.1
1	B	51	LYS	3.0
1	B	285	VAL	2.9
1	A	347	LEU	2.9
1	B	290	TRP	2.9
1	B	292	GLY	2.8
1	B	275	VAL	2.8
1	B	94	THR	2.8
1	A	345	ALA	2.7
1	B	254	VAL	2.7
1	B	192	ILE	2.7
1	A	240	MET	2.7
1	A	191	GLU	2.7
1	B	150	GLU	2.7
1	B	100	ILE	2.7
1	B	69	ASP	2.7
1	A	343	ILE	2.7
1	B	149	GLY	2.6
1	A	12	ALA	2.6
1	A	125	ARG	2.6
1	B	255	MET	2.6
1	B	82	LYS	2.6
1	B	85	SER	2.6
1	A	137	VAL	2.5
1	B	73	ILE	2.5
1	B	60	ASN	2.5
1	B	16	TYR	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	81	GLU	2.5
1	B	72	LYS	2.5
1	B	239	TYR	2.4
1	B	337	THR	2.4
1	B	20	PRO	2.4
1	B	173	PHE	2.4
1	B	341	ASP	2.4
1	B	59	GLU	2.4
1	B	65	ARG	2.4
1	B	63	MET	2.3
1	B	104	LYS	2.3
1	A	36	LEU	2.3
1	A	332	GLU	2.3
1	B	159	THR	2.3
1	A	40	LYS	2.3
1	B	98	LYS	2.3
1	B	287	LEU	2.3
1	B	160	GLU	2.2
1	B	304	ILE	2.2
1	B	321	THR	2.2
1	B	84	VAL	2.2
1	B	299	LYS	2.2
1	A	126	ARG	2.2
1	B	49	ASN	2.2
1	B	280	PHE	2.2
1	B	151	LYS	2.2
1	B	76	MET	2.2
1	B	319	THR	2.2
1	B	311[A]	GLU	2.1
1	B	148	ASP	2.1
1	B	294	ILE	2.1
1	A	238	LYS	2.1
1	B	298	ALA	2.1
1	B	291	ASP	2.1
1	B	278	THR	2.1
1	B	300	GLY	2.1
1	B	193	ILE	2.1
1	B	305	MET	2.0
1	A	334	LYS	2.0
1	A	123	PHE	2.0
1	B	30	VAL	2.0
1	B	102	GLU	2.0

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Mol	Chain	Res	Type	RSRZ
1	B	96	SER	2.0
1	A	195	GLN	2.0
1	B	316	LEU	2.0
1	B	23	LYS	2.0

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.