Full wwPDB X-ray Structure Validation Report (i)

Feb 12, 2024 – 08:10 PM EST

PDB ID	:	3I4H
Title	:	Crystal structure of Cas6 in Pyrococcus furiosus
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Deposited on	:	2009-07-01
Resolution	:	2.25 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 (i) 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 (1)) were used in the production of this report:

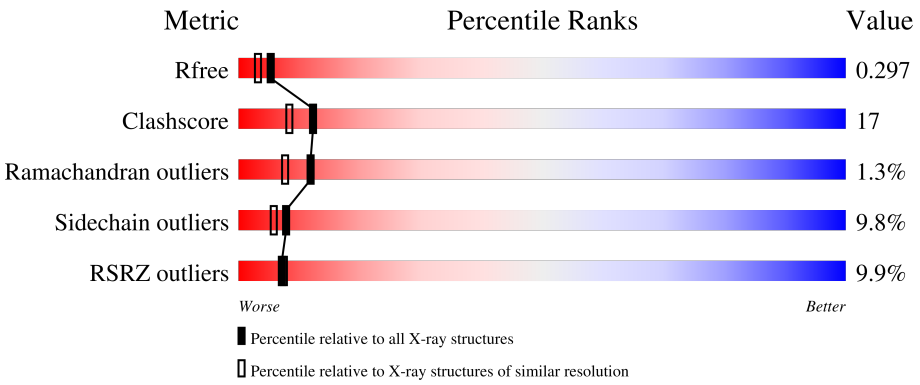
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.25 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}	130704	1377 (2.26-2.26)
Clashscore	141614	1487 (2.26-2.26)
Ramachandran outliers	138981	1449 (2.26-2.26)
Sidechain outliers	138945	1450 (2.26-2.26)
RSRZ outliers	127900	1356 (2.26-2.26)

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 <=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	X	273	8% 51% 26% 7% • 15%

2 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 1913 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 endoribonuclease.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	X	232	1913	1259	314	333	7	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

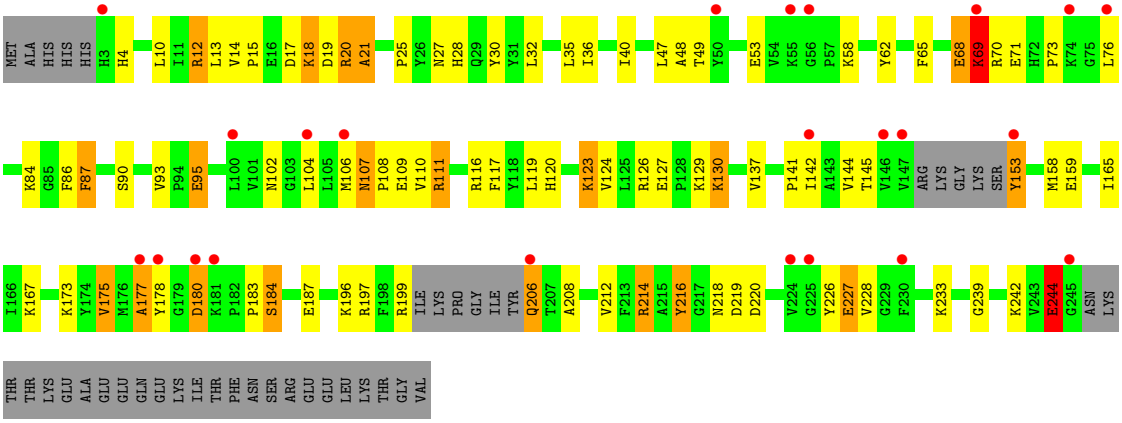
Chain	Residue	Modelled	Actual	Comment	Reference
X	-2	MET	-	expression tag	UNP Q8U1S4
X	-1	ALA	-	expression tag	UNP Q8U1S4
X	0	HIS	-	expression tag	UNP Q8U1S4
X	1	HIS	-	expression tag	UNP Q8U1S4
X	2	HIS	-	expression tag	UNP Q8U1S4
X	3	HIS	-	expression tag	UNP Q8U1S4
X	4	HIS	-	expression tag	UNP Q8U1S4
X	5	HIS	-	expression tag	UNP Q8U1S4
X	6	GLY	-	expression tag	UNP Q8U1S4
X	7	SER	-	expression tag	UNP Q8U1S4

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: endoribonuclease

Chain X:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α, β, γ	84.75Å 84.75Å 81.68Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.50 – 2.25 20.51 – 2.24	Depositor EDS
% Data completeness (in resolution range)	100.0 (20.50-2.25) 96.3 (20.51-2.24)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$< I/\sigma(I) >$ [1]	11.62 (at 2.23Å)	Xtriage
Refinement program	REFMAC 5.2.0005, CNS	Depositor
R, R_{free}	0.226 , 0.289 0.240 , 0.297	Depositor DCC
R_{free} test set	832 reflections (5.16%)	wwPDB-VP
Wilson B-factor (Å^2)	55.9	Xtriage
Anisotropy	0.044	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 47.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.040 for -h,-k,l	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	1913	wwPDB-VP
Average B, all atoms (Å^2)	63.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.51% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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)

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	X	1.54	15/1970 (0.8%)	1.31	13/2658 (0.5%)

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	X	0	1

All (15) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	X	95	GLU	CG-CD	10.90	1.68	1.51
1	X	212	VAL	CB-CG2	7.90	1.69	1.52
1	X	90	SER	CA-CB	6.92	1.63	1.52
1	X	123	LYS	CE-NZ	6.69	1.65	1.49
1	X	226	TYR	CD1-CE1	-6.57	1.29	1.39
1	X	109	GLU	CG-CD	6.56	1.61	1.51
1	X	187	GLU	CD-OE1	6.38	1.32	1.25
1	X	227	GLU	CB-CG	5.79	1.63	1.52
1	X	216	TYR	CE1-CZ	-5.79	1.31	1.38
1	X	93	VAL	CB-CG2	5.49	1.64	1.52
1	X	87	PHE	CE1-CZ	5.45	1.47	1.37
1	X	244	GLU	CG-CD	5.39	1.60	1.51
1	X	62	TYR	CB-CG	5.34	1.59	1.51
1	X	62	TYR	CD1-CE1	-5.31	1.31	1.39
1	X	30	TYR	CE2-CZ	5.31	1.45	1.38

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	177	ALA	CB-CA-C	-24.51	73.33	110.10

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	177	ALA	N-CA-C	9.90	137.73	111.00
1	X	180	ASP	N-CA-C	9.55	136.78	111.00
1	X	219	ASP	CB-CG-OD1	7.63	125.17	118.30
1	X	12	ARG	NE-CZ-NH1	7.61	124.10	120.30
1	X	220	ASP	CB-CG-OD2	6.57	124.21	118.30
1	X	220	ASP	CB-CG-OD1	-6.46	112.49	118.30
1	X	102	ASN	CB-CA-C	-5.60	99.19	110.40
1	X	226	TYR	CZ-CE2-CD2	-5.51	114.84	119.80
1	X	58	LYS	CD-CE-NZ	-5.35	99.39	111.70
1	X	21	ALA	N-CA-CB	5.27	117.48	110.10
1	X	21	ALA	N-CA-C	-5.22	96.91	111.00
1	X	111	ARG	NE-CZ-NH2	-5.02	117.79	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	X	68	GLU	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	X	1913	0	1903	65	0
All	All	1913	0	1903	65	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 17.

All (65) 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:X:175:VAL:CG2	1:X:180:ASP:O	1.82	1.26
1:X:175:VAL:HG23	1:X:180:ASP:O	1.06	1.22
1:X:84:LYS:HE2	1:X:120:HIS:CE1	1.90	1.05

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:X:17:ASP:OD2	1:X:17:ASP:O	1.80	0.97
1:X:84:LYS:HE2	1:X:120:HIS:ND1	1.92	0.85
1:X:104:LEU:O	1:X:107:ASN:O	1.94	0.83
1:X:130:LYS:H	1:X:130:LYS:HE3	1.45	0.80
1:X:4:HIS:CD2	1:X:177:ALA:O	2.39	0.76
1:X:107:ASN:ND2	1:X:107:ASN:N	2.33	0.75
1:X:84:LYS:CE	1:X:120:HIS:CE1	2.70	0.73
1:X:167:LYS:NZ	1:X:184:SER:O	2.24	0.71
1:X:107:ASN:N	1:X:107:ASN:HD22	1.88	0.70
1:X:12:ARG:NH2	1:X:123:LYS:HD3	2.09	0.68
1:X:49:THR:O	1:X:53:GLU:HG2	1.95	0.67
1:X:10:LEU:HD11	1:X:86:PHE:CD1	2.38	0.58
1:X:28:HIS:CE1	1:X:65:PHE:H	2.24	0.56
1:X:4:HIS:HD2	1:X:177:ALA:O	1.88	0.55
1:X:12:ARG:HH22	1:X:123:LYS:CD	2.20	0.55
1:X:68:GLU:C	1:X:69:LYS:O	2.46	0.54
1:X:73:PRO:CB	1:X:76:LEU:HD22	2.38	0.54
1:X:127:GLU:OE1	1:X:227:GLU:OE2	2.26	0.54
1:X:14:VAL:HG23	1:X:15:PRO:HD2	1.90	0.53
1:X:12:ARG:HH22	1:X:123:LYS:HD3	1.73	0.53
1:X:183:PRO:HB3	1:X:218:ASN:ND2	2.24	0.53
1:X:144:VAL:HG13	1:X:165:ILE:HG21	1.90	0.53
1:X:19:ASP:O	1:X:20:ARG:HB2	2.10	0.52
1:X:47:LEU:HD22	1:X:95:GLU:HG2	1.91	0.51
1:X:141:PRO:HB2	1:X:208:ALA:HB1	1.92	0.51
1:X:130:LYS:HD2	1:X:130:LYS:C	2.33	0.50
1:X:25:PRO:O	1:X:28:HIS:HD2	1.96	0.49
1:X:36:ILE:HD11	1:X:87:PHE:CE2	2.48	0.49
1:X:173:LYS:HD3	1:X:228:VAL:CG2	2.42	0.48
1:X:28:HIS:HE1	1:X:65:PHE:H	1.61	0.48
1:X:144:VAL:CG1	1:X:165:ILE:HG21	2.43	0.47
1:X:142:ILE:HG13	1:X:239:GLY:HA2	1.97	0.47
1:X:84:LYS:HE2	1:X:120:HIS:HE1	1.68	0.47
1:X:104:LEU:O	1:X:119:LEU:HD22	2.14	0.47
1:X:214:ARG:HG2	1:X:216:TYR:OH	2.15	0.47
1:X:18:LYS:NZ	1:X:18:LYS:HB2	2.29	0.47
1:X:144:VAL:HG13	1:X:165:ILE:CG2	2.44	0.47
1:X:199:ARG:C	1:X:206:GLN:N	2.68	0.47
1:X:130:LYS:HE3	1:X:130:LYS:N	2.21	0.46
1:X:111:ARG:CZ	1:X:116:ARG:HG2	2.45	0.46
1:X:73:PRO:HB2	1:X:76:LEU:HD22	1.97	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:X:84:LYS:CE	1:X:120:HIS:HE1	2.23	0.44
1:X:110:VAL:HG22	1:X:117:PHE:HB2	1.99	0.44
1:X:10:LEU:HD11	1:X:86:PHE:HD1	1.82	0.44
1:X:214:ARG:HG2	1:X:216:TYR:CZ	2.53	0.44
1:X:129:LYS:HA	1:X:129:LYS:HD3	1.85	0.43
1:X:124:VAL:H	1:X:124:VAL:HG23	1.31	0.43
1:X:84:LYS:NZ	1:X:120:HIS:HE1	2.16	0.43
1:X:14:VAL:CG2	1:X:15:PRO:HD2	2.48	0.43
1:X:68:GLU:O	1:X:69:LYS:O	2.37	0.43
1:X:137:VAL:HG23	1:X:244:GLU:HB2	2.01	0.43
1:X:242:LYS:HE3	1:X:242:LYS:HB3	1.43	0.43
1:X:40:ILE:HG22	1:X:48:ALA:HB2	2.01	0.43
1:X:107:ASN:HD22	1:X:107:ASN:H	1.65	0.42
1:X:84:LYS:NZ	1:X:120:HIS:CE1	2.88	0.41
1:X:32:LEU:HD12	1:X:32:LEU:HA	1.86	0.41
1:X:106:MET:C	1:X:107:ASN:ND2	2.74	0.41
1:X:20:ARG:HG2	1:X:21:ALA:H	1.86	0.41
1:X:145:THR:HA	1:X:153:TYR:O	2.21	0.41
1:X:206:GLN:OE1	1:X:233:LYS:HE2	2.21	0.41
1:X:4:HIS:HB2	1:X:178:TYR:CE2	2.56	0.40
1:X:141:PRO:HB2	1:X:208:ALA:CB	2.51	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	X	226/273 (83%)	203 (90%)	20 (9%)	3 (1%)	12 8

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	X	69	LYS
1	X	20	ARG
1	X	108	PRO

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	X	205/241 (85%)	185 (90%)	20 (10%)	8 6

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	X	13	LEU
1	X	18	LYS
1	X	27	ASN
1	X	35	LEU
1	X	69	LYS
1	X	70	ARG
1	X	71	GLU
1	X	107	ASN
1	X	126	ARG
1	X	130	LYS
1	X	153	TYR
1	X	158	MET
1	X	159	GLU
1	X	175	VAL
1	X	184	SER
1	X	196	LYS
1	X	197	ARG
1	X	206	GLN
1	X	214	ARG
1	X	244	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	X	4	HIS
1	X	28	HIS
1	X	33	GLN
1	X	107	ASN
1	X	120	HIS

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 monosaccharides 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)

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	X	232/273 (84%)	0.65	23 (9%) 7 7	31, 58, 99, 108	0

All (23) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	X	147	VAL	7.3
1	X	153	TYR	6.0
1	X	146	VAL	5.9
1	X	178	TYR	4.8
1	X	69	LYS	4.5
1	X	245	GLY	4.2
1	X	177	ALA	3.6
1	X	3	HIS	3.5
1	X	55	LYS	3.4
1	X	180	ASP	3.2
1	X	56	GLY	3.1
1	X	76	LEU	2.9
1	X	181	LYS	2.7
1	X	224	VAL	2.7
1	X	225	GLY	2.5
1	X	74	LYS	2.5
1	X	142	ILE	2.5
1	X	104	LEU	2.2
1	X	106	MET	2.2
1	X	206	GLN	2.2
1	X	100	LEU	2.2
1	X	50	TYR	2.0
1	X	230	PHE	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 monosaccharides 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.