



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 05:55 PM UTC

PDB ID : 1UDE / pdb_00001ude
Title : Crystal structure of the Inorganic pyrophosphatase from the hyperthermophilic archaeon *Pyrococcus horikoshii* OT3
Authors : Liu, B.; Gao, R.; Zhou, W.; Bartlam, M.; Rao, Z.
Deposited on : 2003-04-29
Resolution : 2.66 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
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

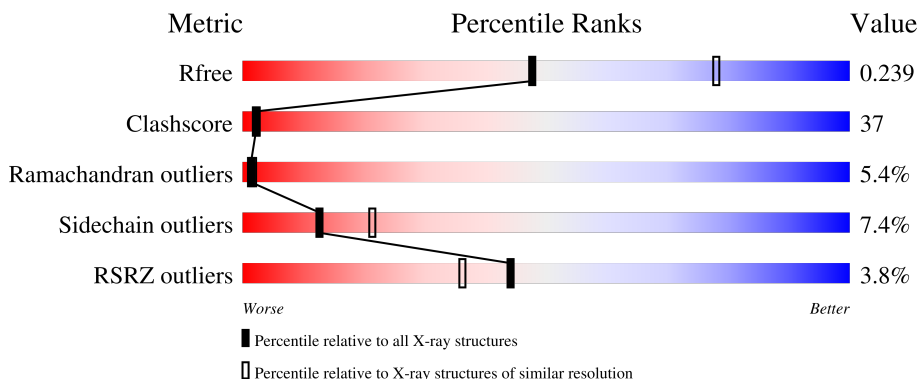
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.66 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	1110 (2.66-2.66)
Clashscore	190562	1141 (2.66-2.66)
Ramachandran outliers	187476	1126 (2.66-2.66)
Sidechain outliers	187428	1126 (2.66-2.66)
RSRZ outliers	180081	1110 (2.66-2.66)

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	195	 3% 36% 41% 9% 14%
1	B	195	 3% 36% 41% 8% 14%
1	C	195	 5% 26% 46% 10% 14%

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 4238 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 Inorganic pyrophosphatase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	168	Total	C	N	O	S	0	0	0
			1390	913	218	255	4			
1	B	167	Total	C	N	O	S	0	0	0
			1381	907	216	254	4			
1	C	167	Total	C	N	O	S	0	0	0
			1374	901	216	253	4			

There are 51 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-16	HIS	-	expression tag	UNP O59570
A	-15	HIS	-	expression tag	UNP O59570
A	-14	HIS	-	expression tag	UNP O59570
A	-13	HIS	-	expression tag	UNP O59570
A	-12	HIS	-	expression tag	UNP O59570
A	-11	HIS	-	expression tag	UNP O59570
A	-10	SER	-	expression tag	UNP O59570
A	-9	SER	-	expression tag	UNP O59570
A	-8	GLY	-	expression tag	UNP O59570
A	-7	LEU	-	expression tag	UNP O59570
A	-6	VAL	-	expression tag	UNP O59570
A	-5	PRO	-	expression tag	UNP O59570
A	-4	ARG	-	expression tag	UNP O59570
A	-3	GLY	-	expression tag	UNP O59570
A	-2	SER	-	expression tag	UNP O59570
A	-1	HIS	-	expression tag	UNP O59570
A	0	MET	-	expression tag	UNP O59570
B	-16	HIS	-	expression tag	UNP O59570
B	-15	HIS	-	expression tag	UNP O59570
B	-14	HIS	-	expression tag	UNP O59570
B	-13	HIS	-	expression tag	UNP O59570
B	-12	HIS	-	expression tag	UNP O59570
B	-11	HIS	-	expression tag	UNP O59570

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Chain	Residue	Modelled	Actual	Comment	Reference
B	-10	SER	-	expression tag	UNP O59570
B	-9	SER	-	expression tag	UNP O59570
B	-8	GLY	-	expression tag	UNP O59570
B	-7	LEU	-	expression tag	UNP O59570
B	-6	VAL	-	expression tag	UNP O59570
B	-5	PRO	-	expression tag	UNP O59570
B	-4	ARG	-	expression tag	UNP O59570
B	-3	GLY	-	expression tag	UNP O59570
B	-2	SER	-	expression tag	UNP O59570
B	-1	HIS	-	expression tag	UNP O59570
B	0	MET	-	expression tag	UNP O59570
C	-16	HIS	-	expression tag	UNP O59570
C	-15	HIS	-	expression tag	UNP O59570
C	-14	HIS	-	expression tag	UNP O59570
C	-13	HIS	-	expression tag	UNP O59570
C	-12	HIS	-	expression tag	UNP O59570
C	-11	HIS	-	expression tag	UNP O59570
C	-10	SER	-	expression tag	UNP O59570
C	-9	SER	-	expression tag	UNP O59570
C	-8	GLY	-	expression tag	UNP O59570
C	-7	LEU	-	expression tag	UNP O59570
C	-6	VAL	-	expression tag	UNP O59570
C	-5	PRO	-	expression tag	UNP O59570
C	-4	ARG	-	expression tag	UNP O59570
C	-3	GLY	-	expression tag	UNP O59570
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C	-1	HIS	-	expression tag	UNP O59570
C	0	MET	-	expression tag	UNP O59570

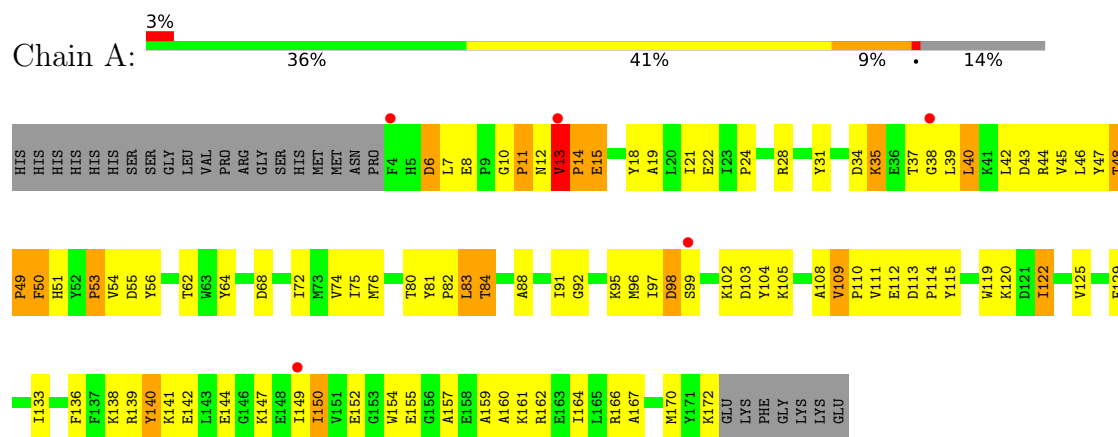
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	42	Total O 42 42	0	0
2	B	33	Total O 33 33	0	0
2	C	18	Total O 18 18	0	0

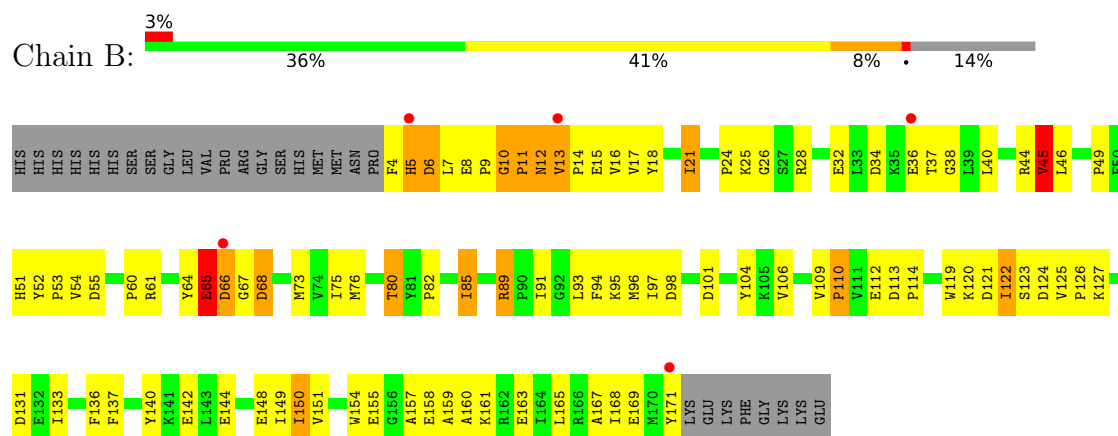
3 Residue-property plots

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.

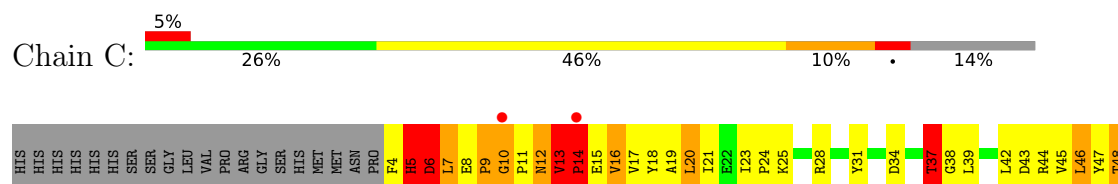
• Molecule 1: Inorganic pyrophosphatase

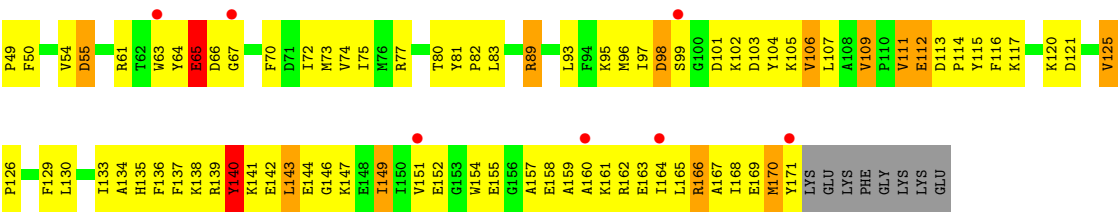


• Molecule 1: Inorganic pyrophosphatase



• Molecule 1: Inorganic pyrophosphatase





4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α , β , γ	71.83Å 86.69Å 92.82Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.00 – 2.66 50.00 – 2.67	Depositor EDS
% Data completeness (in resolution range)	98.5 (50.00-2.66) 98.6 (50.00-2.67)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.25 (at 2.65Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.232 , 0.277 0.234 , 0.239	Depositor DCC
R_{free} test set	1684 reflections (9.90%)	wwPDB-VP
Wilson B-factor (Å ²)	45.3	Xtriage
Anisotropy	0.011	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 67.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.43$, $\langle L^2 \rangle = 0.25$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	4238	wwPDB-VP
Average B, all atoms (Å ²)	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.23% 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	1.04	3/1431 (0.2%)	1.22	12/1941 (0.6%)
1	B	1.04	4/1422 (0.3%)	1.41	21/1930 (1.1%)
1	C	0.94	1/1414 (0.1%)	1.45	17/1919 (0.9%)
All	All	1.01	8/4267 (0.2%)	1.36	50/5790 (0.9%)

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	1	0

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	98	ASP	C-N	-11.99	1.17	1.33
1	B	66	ASP	N-CA	-7.54	1.36	1.46
1	B	65	GLU	CA-C	-7.37	1.42	1.52
1	A	76	MET	SD-CE	-7.36	1.61	1.79
1	B	45	VAL	CA-CB	6.50	1.61	1.54

The worst 5 of 50 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	14	PRO	CA-N-CD	-18.82	85.65	112.00
1	C	5	HIS	CB-CA-C	-16.00	78.58	110.42
1	C	10	GLY	CA-C-N	15.65	137.50	120.12
1	C	10	GLY	C-N-CA	15.65	137.50	120.12
1	B	65	GLU	CA-C-N	-13.92	99.95	121.66

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	C	6	ASP	CA

There are no planarity outliers.

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	1390	0	1376	83	0
1	B	1381	0	1364	101	0
1	C	1374	0	1357	130	2
2	A	42	0	0	1	0
2	B	33	0	0	1	0
2	C	18	0	0	1	0
All	All	4238	0	4097	303	2

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 37.

The worst 5 of 303 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:48:THR:HG22	1:C:49:PRO:HD2	1.32	1.03
1:C:138:LYS:HE3	1:C:139:ARG:NH1	1.73	1.03
1:C:93:LEU:HD22	1:C:160:ALA:HA	1.47	0.97
1:C:138:LYS:HE3	1:C:139:ARG:HH11	1.27	0.97
1:C:138:LYS:O	1:C:139:ARG:HD2	1.67	0.93

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:13:VAL:CG2	1:C:13:VAL:CG2[2_655]	1.78	0.42
1:C:139:ARG:NH2	1:C:139:ARG:NH2[2_755]	1.88	0.32

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	166/195 (85%)	143 (86%)	17 (10%)	6 (4%)	2	4
1	B	165/195 (85%)	139 (84%)	18 (11%)	8 (5%)	2	2
1	C	165/195 (85%)	119 (72%)	33 (20%)	13 (8%)	1	0
All	All	496/585 (85%)	401 (81%)	68 (14%)	27 (5%)	1	2

5 of 27 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	11	PRO
1	B	6	ASP
1	B	11	PRO
1	B	65	GLU
1	C	5	HIS

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	149/173 (86%)	139 (93%)	10 (7%)	15	25
1	B	148/173 (86%)	140 (95%)	8 (5%)	20	35
1	C	147/173 (85%)	132 (90%)	15 (10%)	7	10
All	All	444/519 (86%)	411 (93%)	33 (7%)	13	21

5 of 33 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	121	ASP
1	C	140	TYR
1	C	166	ARG
1	B	45	VAL
1	B	32	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	A	29	ASN
1	A	51	HIS
1	A	135	HIS
1	B	51	HIS
1	C	51	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 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	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	98:ASP	C	99:SER	N	1.16

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	168/195 (86%)	0.01	5 (2%)	52	45	13, 32, 61, 72	0
1	B	167/195 (85%)	0.07	5 (2%)	52	45	15, 35, 59, 78	0
1	C	167/195 (85%)	0.72	9 (5%)	31	25	21, 50, 71, 77	0
All	All	502/585 (85%)	0.27	19 (3%)	44	36	13, 38, 67, 78	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	171	TYR	5.4
1	A	13	VAL	4.0
1	A	4	PHE	3.5
1	C	63	TRP	3.3
1	C	151	VAL	2.9

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.