



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 12:34 PM UTC

PDB ID : 4BPC / pdb\_00004bpc  
Title : Structure of the Catalytic Domain of Protein Tyrosine Phosphatase Sigma in the Sulfenic Acid Form  
Authors : Jeon, T.J.; Chien, P.N.; Chun, H.J.; Ryu, S.E.  
Deposited on : 2013-05-24  
Resolution : 2.10 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](mailto: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>.

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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  
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

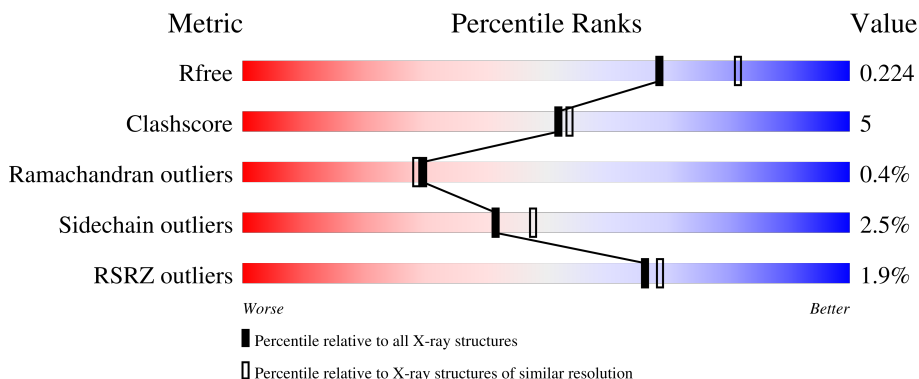
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

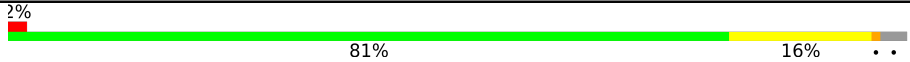
The reported resolution of this entry is 2.10 Å.

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	6658 (2.10-2.10)
Clashscore	190562	7164 (2.10-2.10)
Ramachandran outliers	187476	7099 (2.10-2.10)
Sidechain outliers	187428	7100 (2.10-2.10)
RSRZ outliers	180081	6662 (2.10-2.10)

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  $\geq 3$ , 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	582	

## 2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 4768 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 RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE S.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	567	4587	2913	798	854	22	0	0	0

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1457	ARG	CYS	variant	UNP Q13332
A	1530	ALA	CYS	engineered mutation	UNP Q13332
A	1577	ALA	CYS	engineered mutation	UNP Q13332
A	1598	ALA	CYS	engineered mutation	UNP Q13332
A	1651	ALA	CYS	engineered mutation	UNP Q13332
A	1704	ALA	CYS	engineered mutation	UNP Q13332
A	1723	ALA	CYS	engineered mutation	UNP Q13332
A	1932	ALA	CYS	engineered mutation	UNP Q13332

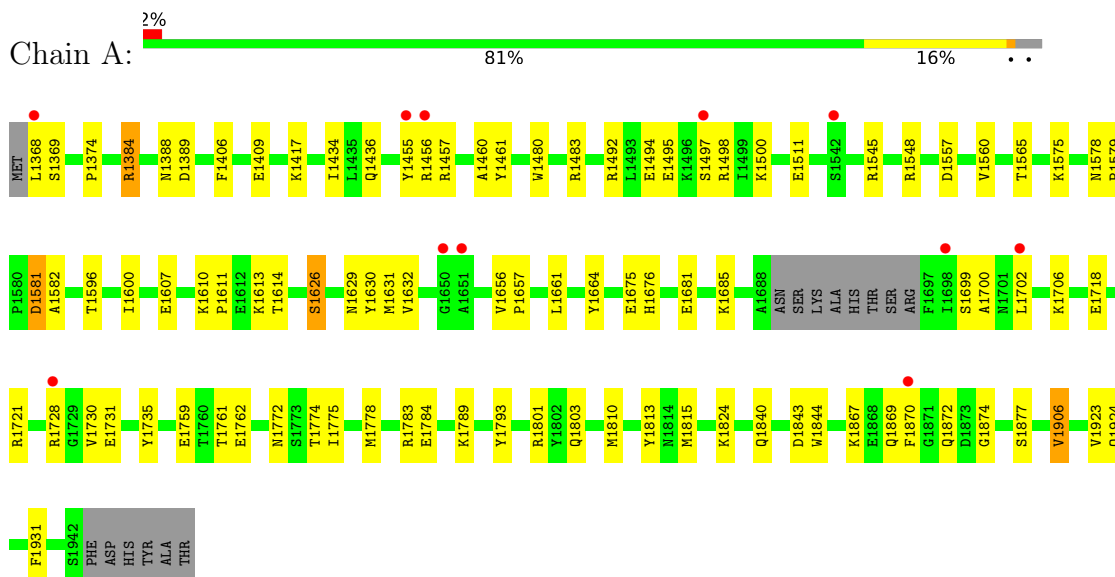
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	181	Total 181	O 181	0	0

### 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: RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE S



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 61	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	94.67Å 94.67Å 123.42Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	37.56 – 2.10 37.56 – 2.10	Depositor EDS
% Data completeness (in resolution range)	98.2 (37.56-2.10) 98.2 (37.56-2.10)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.61 (at 2.10Å)	Xtrriage
Refinement program	REFMAC 5.7.0029	Depositor
R, $R_{free}$	0.178 , 0.222 0.181 , 0.224	Depositor DCC
$R_{free}$ test set	1822 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	38.5	Xtrriage
Anisotropy	0.010	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 37.4	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	0.051 for h,-h-k,-l	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	4768	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	51.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.83% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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 [i](#)

### 5.1 Standard geometry [i](#)

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

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	1.18	9/4693 (0.2%)	1.11	8/6361 (0.1%)

All (9) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	1417	LYS	C-O	-8.38	1.16	1.24
1	A	1560	VAL	C-O	-7.02	1.17	1.24
1	A	1906	VAL	C-O	-6.78	1.17	1.24
1	A	1436	GLN	CA-C	-6.49	1.46	1.53
1	A	1877	SER	CA-C	5.53	1.60	1.52
1	A	1483	ARG	CA-C	-5.20	1.46	1.53
1	A	1578	ASN	C-O	-5.16	1.17	1.24
1	A	1581	ASP	N-CA	5.14	1.52	1.46
1	A	1931	PHE	CA-C	5.04	1.59	1.52

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	1924	GLN	N-CA-C	7.15	119.93	111.71
1	A	1626	SER	N-CA-C	-6.58	105.26	113.28
1	A	1565	THR	CA-C-N	-6.57	112.14	118.97
1	A	1565	THR	C-N-CA	-6.57	112.14	118.97
1	A	1844	TRP	N-CA-C	-5.55	102.78	109.72
1	A	1596	THR	N-CA-C	-5.24	105.47	111.07
1	A	1560	VAL	N-CA-CB	-5.20	108.24	111.83
1	A	1613	LYS	N-CA-C	5.09	118.62	111.90

There are no chirality outliers.

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	4587	0	4463	46	5
2	A	181	0	0	6	0
All	All	4768	0	4463	46	5

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 (46) 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:1409:GLU:CG	2:A:2015:HOH:O	2.21	0.86
1:A:1409:GLU:HG2	2:A:2015:HOH:O	1.83	0.73
1:A:1494:GLU:OE2	1:A:1497:SER:HA	2.04	0.58
1:A:1457:ARG:HB3	1:A:1460:ALA:HB2	1.86	0.57
1:A:1374:PRO:HA	1:A:1614:THR:HG22	1.88	0.56
1:A:1492:ARG:HD3	2:A:2067:HOH:O	2.06	0.56
1:A:1409:GLU:HG3	2:A:2015:HOH:O	1.98	0.55
1:A:1813:TYR:HB3	1:A:1815:MET:HE2	1.89	0.55
1:A:1869:GLN:HG2	1:A:1870:PHE:CD1	2.42	0.55
1:A:1456:ARG:O	1:A:1457:ARG:HD2	2.08	0.54
1:A:1801:ARG:NH1	1:A:1803:GLN:O	2.38	0.54
1:A:1869:GLN:HG2	1:A:1870:PHE:CE1	2.43	0.54
1:A:1810:MET:HE2	1:A:1810:MET:HA	1.90	0.53
1:A:1480:TRP:O	1:A:1545:ARG:NH1	2.42	0.53
1:A:1778:MET:HG2	1:A:1840:GLN:HG3	1.92	0.52
1:A:1579:PRO:HG2	1:A:1582:ALA:HB2	1.91	0.52
1:A:1784:GLU:HG3	1:A:1789:LYS:HG3	1.92	0.51
1:A:1656:VAL:HG21	1:A:1664:TYR:CG	2.46	0.50
1:A:1783:ARG:NH2	2:A:2145:HOH:O	2.44	0.50
1:A:1762:GLU:HG3	2:A:2133:HOH:O	2.12	0.49
1:A:1581:ASP:N	1:A:1581:ASP:OD1	2.46	0.48
1:A:1810:MET:HG3	1:A:1824:LYS:HG2	1.96	0.48
1:A:1700:ALA:HA	1:A:1735:TYR:CE1	2.49	0.47
1:A:1718:GLU:O	1:A:1721:ARG:HG2	2.15	0.46
1:A:1681:GLU:O	1:A:1685:LYS:HG2	2.15	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:1457:ARG:HH12	1:A:1607:GLU:HB3	1.81	0.46
1:A:1406:PHE:CZ	1:A:1626:SER:HA	2.52	0.45
1:A:1610:LYS:HB2	1:A:1611:PRO:HD3	1.99	0.44
1:A:1575:LYS:HD2	1:A:1575:LYS:HA	1.79	0.44
1:A:1759:GLU:H	1:A:1759:GLU:CD	2.23	0.44
1:A:1656:VAL:HG11	1:A:1661:LEU:HA	1.99	0.44
1:A:1761:THR:HG23	1:A:1793:TYR:HB2	1.99	0.44
1:A:1495:GLU:HB3	1:A:1557:ASP:OD1	2.18	0.44
1:A:1548:ARG:HH11	1:A:1548:ARG:HG3	1.83	0.43
1:A:1774:THR:OG1	1:A:1872:GLN:HG3	2.19	0.42
1:A:1772:ASN:O	1:A:1874:GLY:HA3	2.20	0.42
1:A:1656:VAL:HA	1:A:1657:PRO:HD3	1.86	0.42
1:A:1455:TYR:O	1:A:1457:ARG:HD3	2.20	0.42
1:A:1368:LEU:O	1:A:1369:SER:CB	2.68	0.41
1:A:1870:PHE:HB2	1:A:1872:GLN:HE22	1.84	0.41
1:A:1775:ILE:HD11	1:A:1867:LYS:HA	2.03	0.41
1:A:1498:ARG:HE	1:A:1500:LYS:HE2	1.86	0.41
1:A:1699:SER:HA	1:A:1702:LEU:HG	2.03	0.41
1:A:1706:LYS:HE3	1:A:1706:LYS:HB3	1.78	0.41
1:A:1461:TYR:CE2	1:A:1600:ILE:HG23	2.56	0.40
1:A:1630:TYR:O	1:A:1631:MET:C	2.62	0.40

All (5) 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:A:1384:ARG:NH1	1:A:1728:ARG:NH2[2_665]	1.01	1.19
1:A:1384:ARG:CZ	1:A:1728:ARG:NH2[2_665]	1.58	0.62
1:A:1384:ARG:NH1	1:A:1728:ARG:CZ[2_665]	1.74	0.46
1:A:1384:ARG:NH2	1:A:1728:ARG:NH2[2_665]	2.01	0.19
1:A:1384:ARG:NH1	1:A:1728:ARG:NH1[2_665]	2.16	0.04

## 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	562/582 (97%)	531 (94%)	29 (5%)	2 (0%)	30 28

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	1632	VAL
1	A	1923	VAL

### 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	488/502 (97%)	476 (98%)	12 (2%)	42 48

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1384	ARG
1	A	1388	ASN
1	A	1389	ASP
1	A	1434	ILE
1	A	1511	GLU
1	A	1629	ASN
1	A	1675	GLU
1	A	1676	HIS
1	A	1730	VAL
1	A	1731	GLU
1	A	1843	ASP
1	A	1906	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	1381	HIS
1	A	1578	ASN
1	A	1620	HIS
1	A	1772	ASN
1	A	1872	GLN
1	A	1934	GLN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

1 non-standard protein/DNA/RNA residue 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	$\# Z  > 2$
1	CSO	A	1589	1	3,6,7	0.58	0	1,6,8	0.32	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
1	CSO	A	1589	1	-	1/1/5/7	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	1589	CSO	N-CA-CB-SG

There are no ring outliers.

No monomer is involved in short contacts.

## 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](#)

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	566/582 (97%)	0.05	11 (1%) 66 69	24, 48, 87, 117	1 (0%)

All (11) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1651	ALA	6.5
1	A	1368	LEU	4.5
1	A	1456	ARG	3.3
1	A	1698	ILE	3.0
1	A	1870	PHE	2.9
1	A	1702	LEU	2.8
1	A	1455	TYR	2.7
1	A	1650	GLY	2.6
1	A	1728	ARG	2.3
1	A	1542	SER	2.1
1	A	1497	SER	2.1

### 6.2 Non-standard residues in protein, DNA, RNA chains [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	CSO	A	1589	7/8	0.96	0.06	23,27,41,46	0

### 6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

## 6.4 Ligands

There are no ligands in this entry.

## 6.5 Other polymers

There are no such residues in this entry.