



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 11:01 PM UTC

PDB ID : 9EP3 / pdb\_00009ep3  
Title : Structure of the SA2/SCC1/WAPL complex  
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Deposited on : 2024-03-16  
Resolution : 3.08 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
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

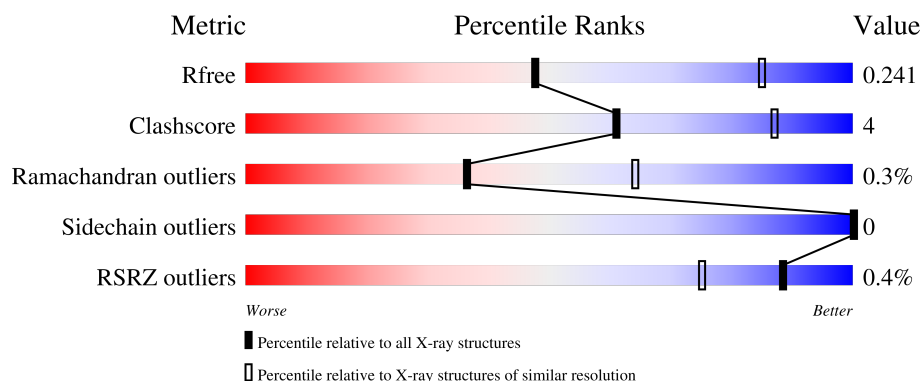
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.08 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	2010 (3.10-3.06)
Clashscore	190562	2102 (3.10-3.06)
Ramachandran outliers	187476	1982 (3.10-3.06)
Sidechain outliers	187428	1981 (3.10-3.06)
RSRZ outliers	180081	2010 (3.10-3.06)

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	981	 85% 10% 5%
2	B	140	 46% 6% 47%
3	C	22	 50% 5% 5% 41%

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 16716 atoms, of which 8334 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 Cohesin subunit SA-2.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	935	Total	C	H	N	O	S	0	1	0
			15208	4848	7595	1268	1441	56			

- Molecule 2 is a protein called Double-strand-break repair protein rad21 homolog.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
2	B	74	Total	C	H	N	O	S	0	0	0
			1235	385	639	101	107	3			

- Molecule 3 is a protein called Wings apart-like protein homolog.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
3	C	13	Total	C	H	N	O		0	0	0
			214	72	100	24	18				

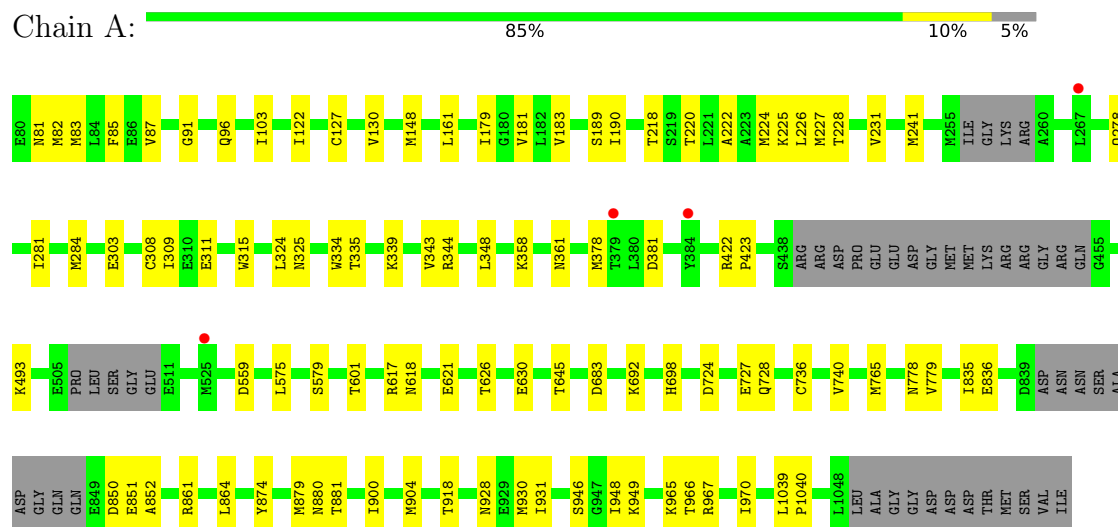
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	49	Total	O	0	0
			49	49		
4	B	10	Total	O	0	0
			10	10		

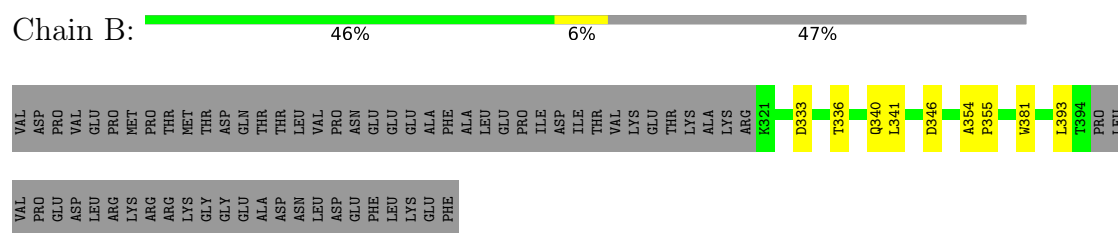
### 3 Residue-property plots

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: Cohesin subunit SA-2



#### • Molecule 2: Double-strand-break repair protein rad21 homolog



#### • Molecule 3: Wings apart-like protein homolog



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	78.43Å 107.44Å 181.91Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.97 – 3.08 47.97 – 3.08	Depositor EDS
% Data completeness (in resolution range)	97.9 (47.97-3.08) 98.1 (47.97-3.08)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.30 (at 3.07Å)	Xtriage
Refinement program	PHENIX (1.19.2_4158: ???)	Depositor
R, $R_{free}$	0.224 , 0.268 (Not available) , 0.241	Depositor DCC
$R_{free}$ test set	1394 reflections (4.76%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	98.2	Xtriage
Anisotropy	0.332	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.42 , 106.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	16716	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	133.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.67% 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](#)

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	0.14	0/7750	0.30	0/10448
2	B	0.14	0/606	0.33	0/818
3	C	0.16	0/119	0.37	0/162
All	All	0.14	0/8475	0.30	0/11428

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 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	A	7613	7595	7595	65	0
2	B	596	639	639	8	0
3	C	114	100	100	1	0
4	A	49	0	0	9	0
4	B	10	0	0	1	0
All	All	8382	8334	8334	70	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 4.

All (70) 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:621:GLU:N	4:A:1301:HOH:O	1.91	1.03
1:A:617:ARG:O	4:A:1301:HOH:O	1.84	0.95
1:A:218:THR:OG1	4:A:1302:HOH:O	2.05	0.73
1:A:303:GLU:OE1	4:A:1303:HOH:O	2.07	0.71
1:A:224:MET:HE2	1:A:308:CYS:HA	1.75	0.66
1:A:683:ASP:OD2	4:A:1304:HOH:O	2.13	0.66
1:A:835:ILE:HG22	1:A:836:GLU:H	1.63	0.64
1:A:698:HIS:NE2	1:A:740:VAL:HG22	2.15	0.61
1:A:344:ARG:NE	1:A:381:ASP:OD2	2.32	0.60
1:A:861:ARG:HA	1:A:864:LEU:HD12	1.84	0.60
1:A:130:VAL:N	1:A:148:MET:HE1	2.17	0.58
1:A:618:ASN:C	4:A:1301:HOH:O	2.48	0.57
1:A:161:LEU:N	4:A:1306:HOH:O	2.30	0.56
2:B:333:ASP:OD1	2:B:336:THR:HG23	2.06	0.56
1:A:281:ILE:HD13	1:A:284:MET:CE	2.36	0.56
1:A:81:ASN:O	1:A:81:ASN:ND2	2.40	0.54
1:A:967:ARG:O	1:A:970:ILE:HG22	2.07	0.54
1:A:493:LYS:NZ	1:A:559:ASP:OD2	2.36	0.54
1:A:309:ILE:HG13	1:A:335:THR:HG21	1.91	0.52
1:A:227:MET:O	1:A:231:VAL:HG23	2.09	0.52
1:A:930:MET:HE3	1:A:948:ILE:HD12	1.92	0.52
1:A:334:TRP:HA	2:B:341:LEU:HD21	1.93	0.50
1:A:325:ASN:N	1:A:325:ASN:OD1	2.44	0.50
1:A:778:ASN:OD1	1:A:779:VAL:N	2.45	0.50
1:A:358:LYS:HG3	1:A:358:LYS:O	2.14	0.48
2:B:333:ASP:CG	2:B:336:THR:HG23	2.39	0.47
1:A:1039:LEU:N	1:A:1040:PRO:CD	2.77	0.47
1:A:626:THR:HG22	1:A:692:LYS:CE	2.45	0.47
1:A:736:CYS:O	1:A:740:VAL:HG23	2.14	0.47
1:A:727:GLU:HG3	1:A:728:GLN:N	2.30	0.47
1:A:692:LYS:NZ	4:A:1310:HOH:O	2.47	0.46
1:A:241:MET:HE1	1:A:278:GLN:OE1	2.15	0.46
1:A:880:ASN:OD1	1:A:881:THR:N	2.49	0.46
1:A:220:THR:O	1:A:224:MET:HG2	2.15	0.46
2:B:340:GLN:NE2	4:B:701:HOH:O	2.29	0.46
1:A:227:MET:HG2	1:A:315:TRP:CZ2	2.52	0.44
1:A:946:SER:HA	1:A:949:LYS:HD2	1.99	0.44
1:A:900:ILE:O	1:A:904:MET:HG3	2.17	0.44
1:A:928:ASN:HA	1:A:931:ILE:HG12	2.00	0.44
1:A:575:LEU:O	1:A:579:SER:N	2.51	0.44
1:A:618:ASN:O	4:A:1301:HOH:O	2.19	0.44
1:A:96:GLN:HA	1:A:181:VAL:HG11	2.00	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:87:VAL:O	1:A:91:GLY:N	2.51	0.44
1:A:630:GLU:HG3	2:B:381:TRP:CH2	2.52	0.43
1:A:83:MET:O	1:A:87:VAL:HG23	2.19	0.43
1:A:324:LEU:HD13	1:A:361:ASN:HD22	1.82	0.43
1:A:879:MET:HG2	1:A:918:THR:HG21	2.00	0.43
1:A:225:LYS:HA	1:A:228:THR:HG22	1.99	0.43
1:A:601:THR:HG21	1:A:645:THR:OG1	2.18	0.43
1:A:82:MET:HE2	1:A:85:PHE:CE1	2.54	0.43
1:A:183:VAL:HG21	1:A:226:LEU:HD12	2.01	0.43
1:A:339:LYS:NZ	2:B:346:ASP:OD1	2.48	0.43
1:A:224:MET:HE3	1:A:311:GLU:HB2	2.01	0.42
1:A:626:THR:HG22	1:A:692:LYS:HE2	2.02	0.42
1:A:930:MET:CE	1:A:948:ILE:HD12	2.49	0.42
2:B:354:ALA:O	2:B:355:PRO:C	2.60	0.42
1:A:422:ARG:O	1:A:423:PRO:C	2.63	0.42
1:A:179:ILE:HD13	1:A:222:ALA:HA	2.00	0.42
3:C:31:HIS:O	3:C:32:PRO:O	2.37	0.42
1:A:348:LEU:HD11	1:A:378:MET:HE2	2.01	0.41
1:A:103:ILE:HG23	1:A:190:ILE:CD1	2.50	0.41
1:A:851:GLU:HG3	1:A:852:ALA:N	2.36	0.41
1:A:335:THR:HG22	1:A:343:VAL:HG12	2.03	0.41
1:A:965:LYS:O	1:A:966:THR:C	2.64	0.41
1:A:122:ILE:HG22	1:A:127:CYS:HB3	2.02	0.41
1:A:765:MET:HE3	1:A:765:MET:HB3	2.00	0.41
1:A:724:ASP:O	1:A:724:ASP:CG	2.64	0.41
1:A:874:TYR:CZ	2:B:393:LEU:HD22	2.56	0.40
1:A:228:THR:HB	1:A:315:TRP:HE1	1.86	0.40
1:A:966:THR:O	1:A:967:ARG:C	2.63	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	926/981 (94%)	882 (95%)	42 (4%)	2 (0%)	43	71
2	B	72/140 (51%)	70 (97%)	2 (3%)	0	100	100
3	C	11/22 (50%)	10 (91%)	0	1 (9%)	0	3
All	All	1009/1143 (88%)	962 (95%)	44 (4%)	3 (0%)	36	64

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	C	32	PRO
1	A	189	SER
1	A	850	ASP

### 5.3.2 Protein sidechains ⓘ

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	846/882 (96%)	846 (100%)	0	100	100
2	B	69/129 (54%)	69 (100%)	0	100	100
3	C	11/20 (55%)	11 (100%)	0	100	100
All	All	926/1031 (90%)	926 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	123	GLN
1	A	590	GLN
1	A	593	GLN
1	A	786	GLN
1	A	1046	ASN
2	B	378	GLN
3	C	25	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](#)

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	935/981 (95%)	-0.16	4 (0%) 88 75	71, 132, 199, 261	1 (0%)
2	B	74/140 (52%)	-0.21	0 100 100	76, 109, 141, 157	0
3	C	13/22 (59%)	0.34	0 100 100	107, 143, 179, 193	0
All	All	1022/1143 (89%)	-0.16	4 (0%) 88 75	71, 130, 196, 261	1 (0%)

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	267	LEU	2.5
1	A	384[A]	TYR	2.4
1	A	379	THR	2.2
1	A	525	MET	2.1

### 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.