Summary of integrative structure determination of Integrative structure of the human nuclear pore complex nuclear basket (PDB ID: 9AAV | pdb_00009aav)

1. Model Composition	
1.1. Entry composition	- E3 SUMO-protein ligase RanBP2: chain(s) A1, A2, A3, A4, A5, A6, A7, A8, B1, B2, B3, B4, B5, B6, B7, B8, C1, C2, C3, C4, C5, C6, C7, C8, D1, D2, D3, D4, D5, D6, D7, D8, E1, E2, E3, E4, E5, E6, E7, E8 (3224 residues) - Nuclear pore complex protein Nup93: chain(s) AA1, AA2, AA3, AA4, AA5, AA6, AA7, AA8, BA1, BA2, BA3, BA4, BA5, BA6, BA7, BA8, CA1, CA2, CA3, CA4, CA5, CA6, CA7, CA8, DA1, DA2, DA3, DA4, DA5, DA6, DA7, DA8, EA1, EA2, EA3, EA4, EA5, EA6, EA7, EA8, FA1, FA2, FA3, FA4, FA5, FA6, FA7, FA8, GA1, GA2, GA3, GA4, GA5, GA6, GA7, GA8 (819 residues) - Sphingomyelin phosphodiesterase 4: chain(s) AB1, AB2, AB3, AB4, AB5, AB6, AB7, AB8, BB1, BB2, BB3, BB4, BB5, BB6, BB7, BB8 (866 residues) - Nuclear pore complex protein Nup153: chain(s) AC1, AC2, AC3, AC4, AC5, AC6, AC7, AC8, BC1, BC2, BC3, BC4, BC5, BC6, BC7, BC8, CC1, CC2, CC3, CC4, CC5, CC6, CC7, CC8 (1475 residues) - Nuclear pore complex protein Nup98: chain(s) AD1, AD2, AD3, AD4, AD5, AD6, AD7, AD8, BD1, BD2, BD3, BD4, BD5, BD6, BD7, BD8, CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8, ZC1, ZC2, ZC3, ZC4, ZC5, ZC6, ZC7, ZC8 (880 residues) - Nuclear pore complex protein Nup43: chain(s) AE1, AE2, AE3, AE4, AE5, AE6, AE7, AE8, BE1, BE2, BE3, BE4, BE5, BE6, BE7, BE8, CE1, CE2, CE3, CE4, CE5, CE6, CE7, CE8, ZD1, ZD2, ZD3, ZD4, ZD5, ZD6, ZD7, ZD8 (380 residues) - Nuclear pore complex protein Nup133: chain(s) CB1, CB2, CB3, CB4, CB5, CB6, CB7, CB8, DB1, DB2, DB3, DB4, DB5, DB6, DB7, DB8, EB1, EB2, EB3, EB4, EB5, EB6, EB7, EB8, FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8 (1156 residues) - Centrin-2: chain(s) DC1, DC2, DC3, DC4, DC5, DC6, DC7, DC8 (172 residues) - Nuclear pore complex protein Nup214: chain(s) DD1, DD2, DD3, DD4, DD5, DD6, DD7, DD8, ED1, ED2, ED3, ED4, ED5, ED6, ED7, ED8 (2090 residues) - Nuclear pore complex protein ELYS: chain(s) DE1, DE2, DE3, DE4, DE5, DE6, DE7, DE8, EE1, EE2, EE3, EE4, EE5, EE6, EE7, EE8 (2266 residues) - Transcription/export complex protein 2 homolog: chain(s) EC1, EC2, EC3, EC4, EC5, EC6, EC7, EC8, FC1, FC2, FC3, FC4, FC5, FC6, FC7, FC8, GC1, GC2, GC3, GC4, GC5, GC6, GC7, GC8, HC1, HC2, HC3, HC4, HC5, HC6, HC7, HC8 (101 residues) - Nuclear pore membrane glycoprotein 210: chain(s) F1, F2, F3, F4, F5, F6, F7, F8, G1, G2, G3, G4, G5, G6, G7, G8, H1, H2, H3, H4, H5, H6, H7, H8, I1, I2, I3, I4, I5, I6, I7, I8, J1, J2, J3, J4, J5, J6, J7, J8, K1, K2, K3, K4, K5, K6, K7, K8, L1, L2, L3, L4, L5, L6, L7, L8, M1, M2, M3, M4, M5, M6, M7, M8 (1887 residues) - Nuclear envelope pore membrane protein POM 121: chain(s) FD1, FD2, FD3, FD4, FD5, FD6, FD7, FD8, GD1, GD2, GD3, GD4, GD5, GD6, GD7, GD8 (1249

residues)
- Nuclear pore complex protein Nup107: chain(s) GB1, GB2, GB3, GB4, GB5, GB6, GB7, GB8, HB1, HB2, HB3, HB4, HB5, HB6, HB7, HB8, IB1, IB2, IB3, IB4, IB5, IB6, IB7, IB8, JB1, JB2, JB3, JB4, JB5, JB6, JB7, JB8 (925 residues)
- Nuclear pore complex protein Nup188: chain(s) HA1, HA2, HA3, HA4, HA5, HA6, HA7, HA8, IA1, IA2, IA3, IA4, IA5, IA6, IA7, IA8 (1749 residues)
- Nuclear pore complex protein Nup62: chain(s) HD1, HD2, HD3, HD4, HD5, HD6, HD7, HD8, ID1, ID2, ID3, ID4, ID5, ID6, ID7, ID8, JD1, JD2, JD3, JD4, JD5, JD6, JD7, JD8, KD1, KD2, KD3, KD4, KD5, KD6, KD7, KD8, LD1, LD2, LD3, LD4, LD5, LD6, LD7, LD8, MD1, MD2, MD3, MD4, MD5, MD6, MD7, MD8 (522 residues)
- PCI domain-containing protein 2: chain(s) IC1, IC2, IC3, IC4, IC5, IC6, IC7, IC8 (399 residues)
- Nuclear pore complex protein Nup205: chain(s) JA1, JA2, JA3, JA4, JA5, JA6, JA7, JA8, KA1, KA2, KA3, KA4, KA5, KA6, KA7, KA8, LA1, LA2, LA3, LA4, LA5, LA6, LA7, LA8, MA1, MA2, MA3, MA4, MA5, MA6, MA7, MA8, NA1, NA2, NA3, NA4, NA5, NA6, NA7, NA8 (2012 residues)
- 26S proteasome complex subunit SEM1: chain(s) JC1, JC2, JC3, JC4, JC5, JC6, JC7, JC8 (70 residues)
- Nuclear pore complex protein Nup96 (NUP96 part of NUP98-NUP96 precursor, P52948): chain(s) KB1, KB2, KB3, KB4, KB5, KB6, KB7, KB8, LB1, LB2, LB3, LB4, LB5, LB6, LB7, LB8, MB1, MB2, MB3, MB4, MB5, MB6, MB7, MB8, NB1, NB2, NB3, NB4, NB5, NB6, NB7, NB8 (937 residues)
- Spliceosome RNA helicase DDX39B: chain(s) KC1, KC2, KC3, KC4, KC5, KC6, KC7, KC8 (428 residues)
- ATP-dependent RNA helicase DDX19B: chain(s) LC1, LC2, LC3, LC4, LC5, LC6, LC7, LC8, OC1, OC2, OC3, OC4, OC5, OC6, OC7, OC8 (479 residues)
- Nuclear pore complex protein GLE1: chain(s) MC1, MC2, MC3, MC4, MC5, MC6, MC7, MC8, PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8 (698 residues)
- Nuclear pore complex protein TPR: chain(s) N1, N2, N3, N4, N5, N6, N7, N8, O1, O2, O3, O4, O5, O6, O7, O8, R1, R2, R3, R4, R5, R6, R7, R8, S1, S2, S3, S4, S5, S6, S7, S8 (2363 residues)
- Nuclear pore complex protein Nup42: chain(s) NC1, NC2, NC3, NC4, NC5, NC6, NC7, NC8, QC1, QC2, QC3, QC4, QC5, QC6, QC7, QC8 (423 residues)
- Protein SEC13 homolog: chain(s) ND1, ND2, ND3, ND4, ND5, ND6, ND7, ND8, OD1, OD2, OD3, OD4, OD5, OD6, OD7, OD8, PD1, PD2, PD3, PD4, PD5, PD6, PD7, PD8, QD1, QD2, QD3, QD4, QD5, QD6, QD7, QD8 (322 residues)
- Nuclear pore complex protein Nup155: chain(s) OA1, OA2, OA3, OA4, OA5, OA6, OA7, OA8, PA1, PA2, PA3, PA4, PA5, PA6, PA7, PA8, QA1, QA2, QA3, QA4, QA5, QA6, QA7, QA8, RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, SA1, SA2, SA3, SA4, SA5, SA6, SA7, SA8, TA1, TA2, TA3, TA4, TA5, TA6, TA7, TA8 (1391 residues)
- Nuclear pore complex protein Nup160: chain(s) OB1, OB2, OB3, OB4, OB5, OB6, OB7, OB8, PB1, PB2, PB3, PB4, PB5, PB6, PB7, PB8, QB1, QB2, QB3, QB4, QB5, QB6, QB7, QB8, RB1, RB2, RB3, RB4, RB5, RB6, RB7, RB8 (1436 residues)
- ALADIN: chain(s) P1, P2, P3, P4, P5, P6, P7, P8, Q1,

	Q2, Q3, Q4, Q5, Q6, Q7, Q8 (546 residues) - Nuclear pore complex protein Nup54: chain(s) RC1, RC2, RC3, RC4, RC5, RC6, RC7, RC8, SC1, SC2, SC3, SC4, SC5, SC6, SC7, SC8, TC1, TC2, TC3, TC4, TC5, TC6, TC7, TC8, UC1, UC2, UC3, UC4, UC5, UC6, UC7, UC8 (507 residues) - Nucleoporin Seh1: chain(s) RD1, RD2, RD3, RD4, RD5, RD6, RD7, RD8, SD1, SD2, SD3, SD4, SD5, SD6, SD7, SD8, TD1, TD2, TD3, TD4, TD5, TD6, TD7, TD8, UD1, UD2, UD3, UD4, UD5, UD6, UD7, UD8 (360 residues) - Nuclear pore complex protein Nup37: chain(s) SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, UB1, UB2, UB3, UB4, UB5, UB6, UB7, UB8, VB1, VB2, VB3, VB4, VB5, VB6, VB7, VB8 (326 residues) - Germinal-center associated nuclear protein: chain(s) T1, T2, T3, T4, T5, T6, T7, T8 (1980 residues) - Nuclear pore complex protein Nup50: chain(s) U1, U2, U3, U4, U5, U6, U7, U8, V1, V2, V3, V4, V5, V6, V7, V8, W1, W2, W3, W4, W5, W6, W7, W8, X1, X2, X3, X4, X5, X6, X7, X8, Y1, Y2, Y3, Y4, Y5, Y6, Y7, Y8, Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8 (468 residues) - Nuclear envelope protein NDC1: chain(s) UA1, UA2, UA3, UA4, UA5, UA6, UA7, UA8, VA1, VA2, VA3, VA4, VA5, VA6, VA7, VA8 (674 residues) - Nuclear pore complex protein Nup58: chain(s) VC1, VC2, VC3, VC4, VC5, VC6, VC7, VC8, WC1, WC2, WC3, WC4, WC5, WC6, WC7, WC8, XC1, XC2, XC3, XC4, XC5, XC6, XC7, XC8, YC1, YC2, YC3, YC4, YC5, YC6, YC7, YC8 (599 residues) - Nuclear pore complex protein Nup85: chain(s) VD1, VD2, VD3, VD4, VD5, VD6, VD7, VD8, WD1, WD2, WD3, WD4, WD5, WD6, WD7, WD8, XD1, XD2, XD3, XD4, XD5, XD6, XD7, XD8, YD1, YD2, YD3, YD4, YD5, YD6, YD7, YD8 (656 residues) - Nuclear pore complex protein Nup35: chain(s) WA1, WA2, WA3, WA4, WA5, WA6, WA7, WA8, XA1, XA2, XA3, XA4, XA5, XA6, XA7, XA8, YA1, YA2, YA3, YA4, YA5, YA6, YA7, YA8, ZA1, ZA2, ZA3, ZA4, ZA5, ZA6, ZA7, ZA8 (326 residues) - Nuclear pore complex protein Nup88: chain(s) WB1, WB2, WB3, WB4, WB5, WB6, WB7, WB8, XB1, XB2, XB3, XB4, XB5, XB6, XB7, XB8 (741 residues) - Transmembrane protein 209: chain(s) YB1, YB2, YB3, YB4, YB5, YB6, YB7, YB8, ZB1, ZB2, ZB3, ZB4, ZB5, ZB6, ZB7, ZB8 (561 residues)
1.2. Datasets used for modeling	- 3DEM volume, EMDB: EMD-58804 - Crosslinking-MS data, PRIDE: PXD080872 - Crosslinking-MS data, PRIDE: PXD081158 - 3DEM volume, EMDB: EMD-14322 - Crosslinking-MS data, PRIDE: PXD081113 - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available - De Novo model, Not available

	- De Novo model, Not available - De Novo model, Not available
2. Representation	
2.1. Number of representations	1
2.2. Scale	Atomic
2.3. Number of rigid and flexible segments	0, 1080
3. Restraints	
3.1. Physical principles	Information about physical principles was not provided
3.2. Experimental data	- Crosslinking-MS (16 groups, 320 restraints) - 3DEM (1 restraint)
4. Validation	
4.1. Sampling validation	Not available
4.2. Number of ensembles	0
4.3. Number of models in ensembles	Not applicable
4.4. Number of deposited models	1
4.5. Model precision	Not available

4.6. Data quality	- EMD-58804: resolution is 28.00 Å - EMD-14322: resolution is 12.00 Å - PXD081113: 16 crosslinks (16 Other)
4.7. Model quality: assessment of atomic segments	- Clashscore: 31.59 - Ramachandran outliers: 36642 - Sidechain outliers: 15026
4.8. Fit to data used for modeling	- Satisfaction of crosslinks: 87.50% - 3DEM q-score(s): 0.00-0.02 - 3DEM atom inclusion score(s): 0.10-0.60
4.9. Fit to data used for validation	Fit of model to information not used to compute it has not been determined
5. Methodology and Software	
5.1. Method name (step 1)	Starting model generation
5.2. Method type	AlphaFold prediction
5.3. Method description	Subcomplex and nucleoporin structures were predicted with AlphaFold 3 (server and standalone). TPR homodimers were modeled with AF3x guided by XL-MS cross-links, and the TPR tetramer (residues 1-320 and 660-1460) with ColabFold using the top homodimer models as custom templates. The highest-ranked models (USalign, pLDDT, PAE and agreement with XL-MS data) were selected as starting models.
5.4. Number of computed models	1
5.1. Method name (step 2)	Systematic fitting
5.2. Method type	Superposition and systematic rigid-body fitting
5.3. Method description	The scaffold was assembled ring by ring, using the previously published human NPC models (Mosalaganti et al.) and the cryo-ET map of the human macrophage NPC. Inner ring (IR): an initial IR model was built from the published constricted-state NPC model; AF3 models of the previously assigned NUPs and their subcomplexes were superposed onto their counterparts in that structure, and the newly identified subcomplexes (NUP155-SMPD4, TMEM209 CTD-(NUP98-NUP93-NUP62-NUP58-NUP54)x2, NUP93-NUP35x2) were positioned by systematic rigid-body fitting with Assembline; the resulting IR model was then fitted as a rigid body into the dilated-state macrophage cryo-ET map. Nuclear ring (NR) and nuclear basket: modeled using the macrophage cryo-ET map and the published model; AF3 models of the previously assigned NUPs and their subcomplexes were superposed onto the corresponding components in the published structure fitted into the map, and the newly identified subcomplexes (NUP85-SEH1-NUP43-GANP-NUP153, NUP205-NUP93-GANP, NUP96-NUP107-TPRx2-NUP153-GANP) were positioned by systematic fitting with Assembline; the NUP85-SEH1-NUP43-GANP-NUP153-Centrin-2-ENY2x2 subcomplex was placed by superposition onto the NUP85-SEH1-NUP43-

	GANP-NUP153 model and used as a reference to position GANP-ENY2x4; the inner TPR insertion region (TPRx2-NUP153-GANP) and the TPR tetramer were placed manually and locally refined in ChimeraX. Cytoplasmic ring (CR): generated with the same approach as the NR; the second copy of the NUP214 subcomplex was positioned by systematic fitting with Assembline. Luminal ring (LR): initial coordinates were taken directly from the previously published dilated-state NPC model. Systematic-fitting runs used 100,000 random placements requiring at least 30% map overlap, scored by cross-correlation about the mean (cam score) and assessed via Fisher-transformed z-scores and Benjamini-Hochberg-adjusted p-values.
5.4. Number of computed models	1
5.1. Method name (step 3)	Integrative refinement
5.2. Method type	Assembline/IMP refinement
5.3. Method description	The assembled NPC model was refined with Assembline built on the Integrative Modeling Platform (IMP v2.15) and the Python Modeling Interface (PMI). Models were divided into rigid-body segments in a C-alpha-only representation; the scoring function combined EM-fit restraints, steric-clash penalties (SoftSpherePairScore), connectivity restraints between sequentially adjacent domains, and elastic-network restraints derived from AF3 subcomplex models. Refined C-alpha representations were back-mapped to the atomic AF3 models.
5.4. Number of computed models	1
5.1. Method name (step 4)	Flexible and disordered region building
5.2. Method type	MODELLER/ISOLDE
5.3. Method description	AF3 models of flexible domains and all disordered regions were placed in arbitrary positions and connected within chains using MODELLER and ISOLDE; remaining clashes were removed with MODELLER.
5.4. Number of computed models	1
5.5. Software	- AlphaFold 3 (version Not available) - Assembline (version Not available) - Integrative Modeling Platform (IMP) (version 2.15) - MODELLER (version Not available) - AF3x (version Not available) - ColabFold (version Not available) - Python Modeling Interface (PMI) (version Not available) - UCSF Chimera (version Not available) - ISOLDE (version Not available) - UCSF ChimeraX (version 1.10/v10)