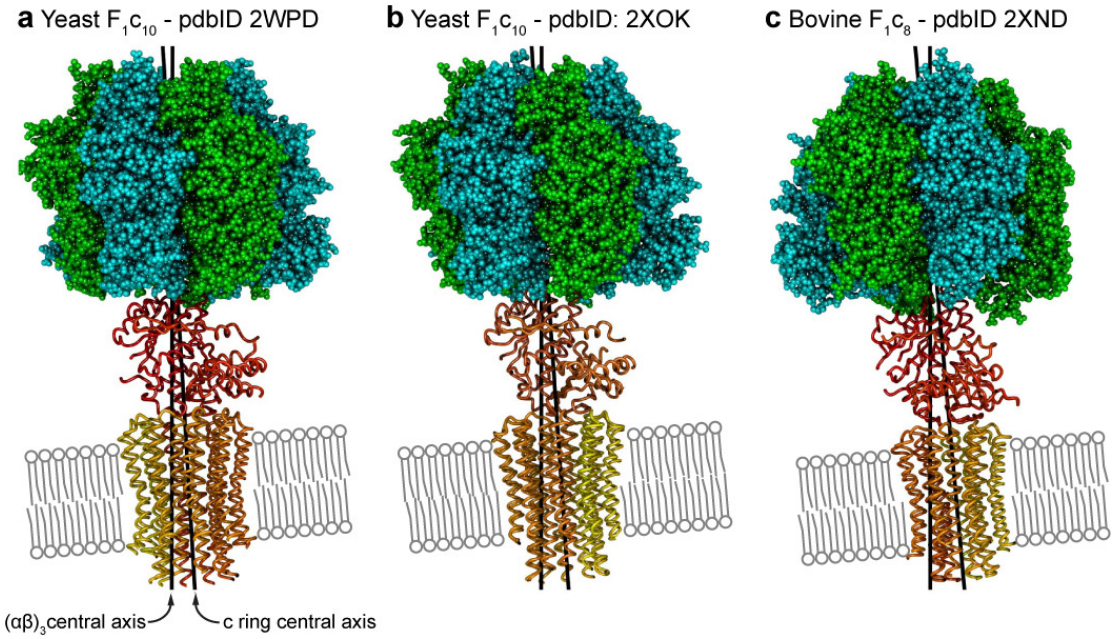
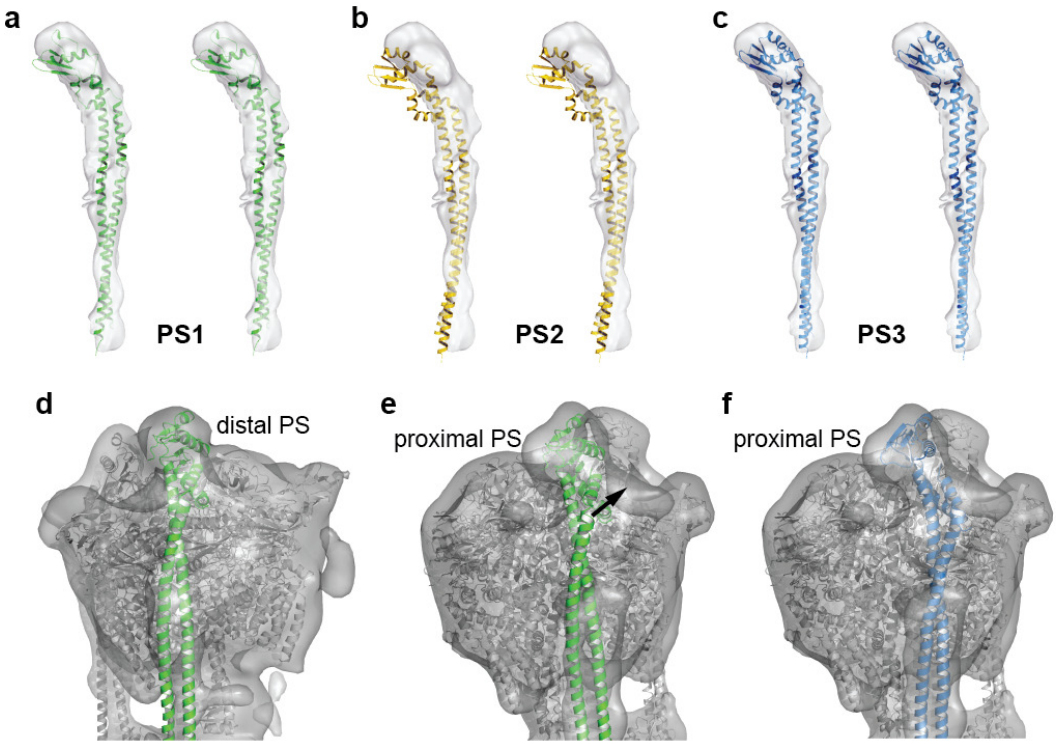
Supplementary Figure S1: F-type rotation axes are off-center from $(\alpha\beta)_3$ axes



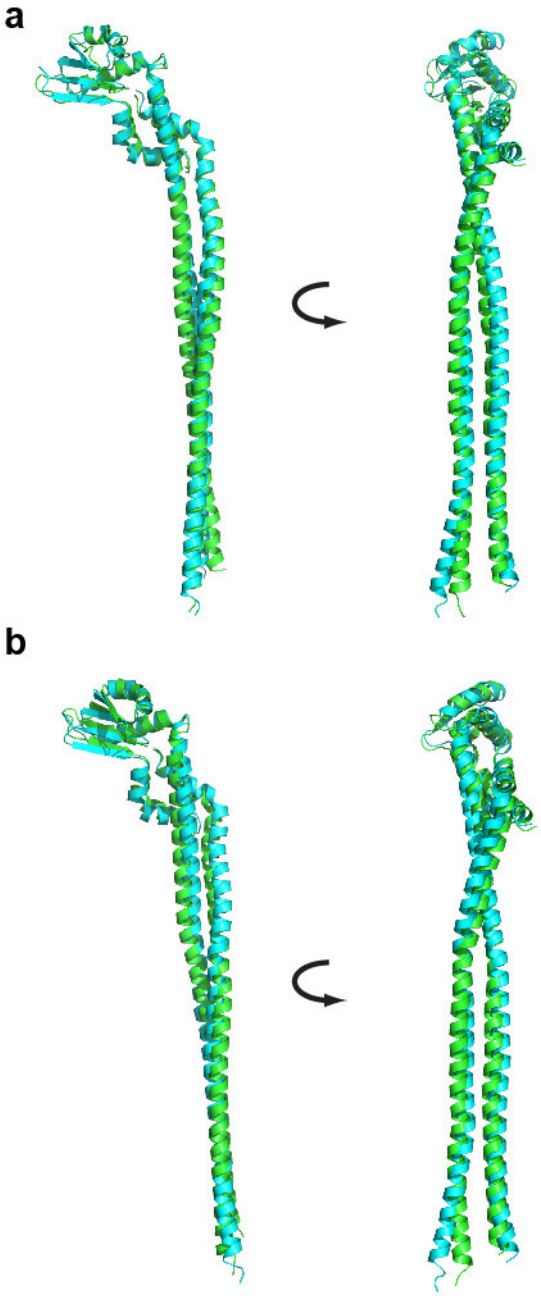
F-type rotation axes off-center from $(\alpha\beta)_3$ axes (see Table 1 for values of inclination). Crystal structures of yeast and bovine F_1c_n complexes, with the central axis through the catalytic $(\alpha\beta)_3$ head and the axis through the center of the c-ring labelled. (**a**) F_1c_{10} (2WPD)[28], (**b**) F_1c_{10} (2XOK)[27] and (**c**) F_1c_8 (2XND)[29].

Supplementary Figure S2: PS1, PS2 and PS3 fitted to the EM density of the proximal peripheral stalk



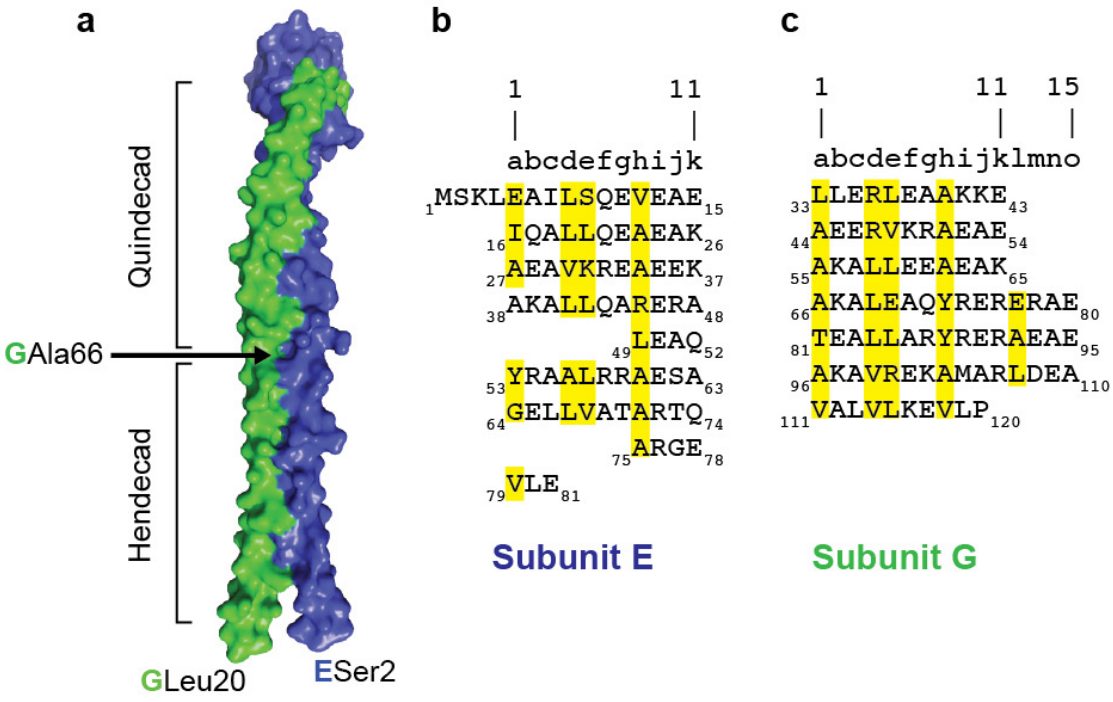
PS1 (**a**), PS2 (**b**) and PS3 (**c**) fitted into the EM density of the proximal peripheral stalk[10]. Correlation coefficients for the fit calculated by Chimera[35] are 0.86, 0.83 and 0.92 respectively. (**d**) EM density of intact *Tt*_A-ATPase, with composite model showing good fit of the PS1 structure into distal peripheral stalk EM density. (**e**) EM density of intact *Tt*_A-ATPase, with composite model showing the inferior fit of PS1 into proximal peripheral stalk EM density. (**f**) EM density of intact *Tt*_A-ATPase, with composite model showing improved fit of the PS3 model into proximal peripheral stalk EM density.

Supplementary Figure S3: Normal Mode Analysis of PS2



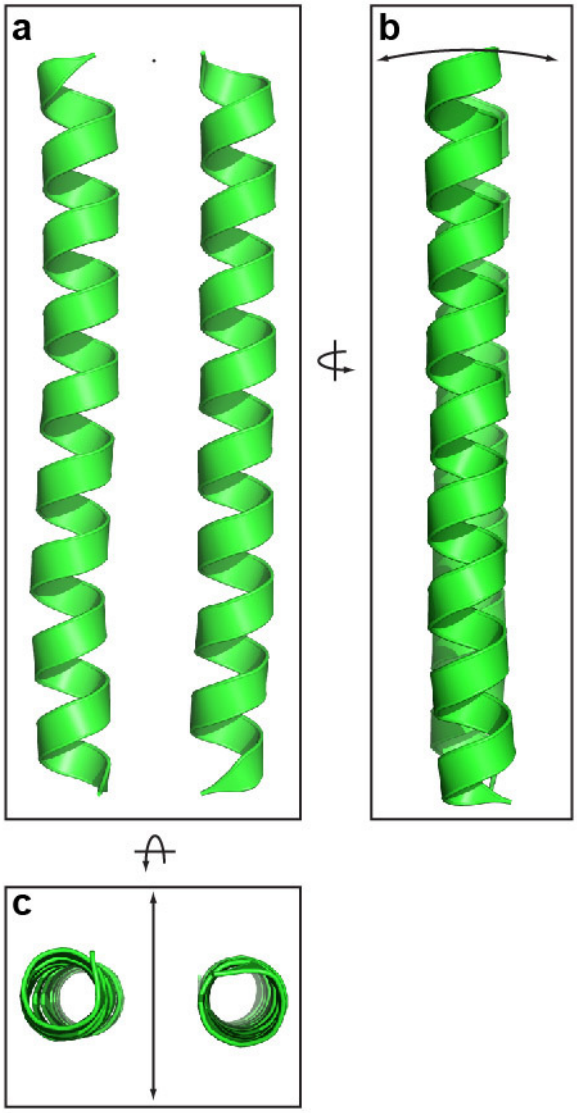
Normal Mode Analysis of PS2. Comparison of crystal and EM models with their simulated NMA counterparts using modes 7 (ω = 15.9 cm^{-1}) and 8 (ω = 31.2 cm^{-1}) applied to PS2. (**a**) PS1 crystal structure in green and PS2->PS1 NMA model (A = -124 and 82) in cyan. (**b**) PS3 EM model in green and PS2->PS3 NMA model (A = -282 and 86) in cyan.

Supplementary Figure S4: Right-handed coiled-coil domain architecture of the peripheral stalk complex



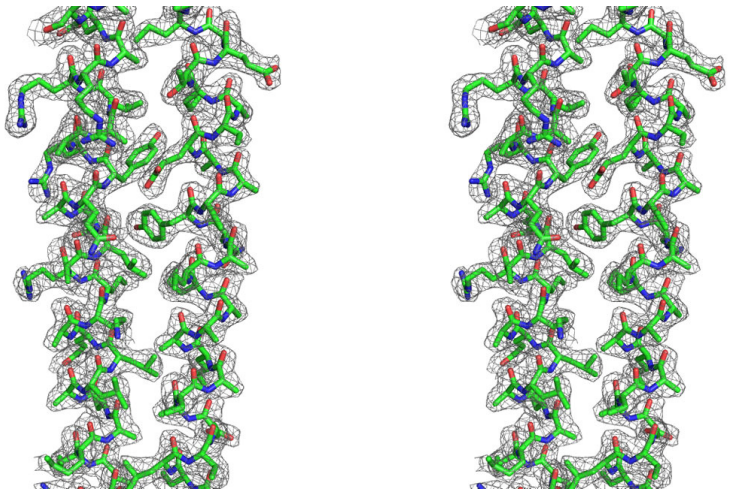
Right-handed coiled-coil domain architecture of the peripheral stalk complex (**a**) as encoded in hendecad (11-mer) and quindecad (15-mer) sequence repeats in subunits E (**b**) and G (**c**) – adapted from reference (26).

Supplementary Figure S5: Flexibility of a right-handed coiled-coil



Example of right-handed coiled-coil consisting of pure hendecad repeats leading to parallel helices (pdb entry 1fe6[61]) with arrow indicating the direction of greatest flexibility according to NMA. Parallel coils are flexible in a plane perpendicular to the broad face of the coil (which has the least cross-sectional area), similar to the mechanical properties of a rectangular beam or that of a ruler.

Supplementary Figure S6: Example electron density



Stereo view of the 2Fo-Fc electron density map of the peripheral stalk from *Tt*_ATPase to 2.25 Å resolution. Region shown corresponds to residues 37-61 of subunit E and 58-84 of subunit G, with σ cut-off set to 1.0.

Supplementary References:

61. Stetefeld, J. et al. Crystal structure of a naturally occurring parallel right-handed coiled coil tetramer. *Nature structural biology* **7**, 772-6 (2000).
62. Drory, O., Frolow, F. & Nelson, N. Crystal structure of yeast V-ATPase subunit C reveals its stator function. *EMBO reports* **5**, 1148-52 (2004).