

Description of Additional Supplementary Files

File Name: Supplementary Movie 1

Description: Movie showing a typical simulated trajectory of a 100-kb long gene (white monomers) along with two 100-kb long flanking regions (dark blue monomers). The red monomers represent RNA Pol II bound loci within the genes. The average Pol II density is 0.5, $E = -3kT$ and no restriction on interaction valency. The left panel shows the 3D organization of all the monomers while the right panel only shows the arrangement of Pol II-bound monomers. The lower panel provides a 1D representation of the location of Pol II-bound monomers within the gene. The movie depicts the condensation of Pol II-bound monomers, which subsequently facilitates the compaction of the full gene.

File Name: Supplementary Movie 2

Description: As in Supplementary Movie 1 but for a valency number 2. The movie illustrates how a smaller valency number destabilizes Pol II-mediated condensation, leading to a reduction in intragene compaction.

File Name: Supplementary Movie 3

Description: Movie demonstrating how bursty gene activity impacts on the structural dynamics of the gene. In the left panel, a typical simulated trajectory for a 200-kb long gene (Cyan monomers) with flanking regions (dark blue monomers). Monomers of different colors represent Pol II-bound regions belonging to different transcriptional trains. The right panel visualizes the spatial arrangement of Pol II-bound monomers from different trains, providing insights into their interplay. The lower panel shows the 1D arrangement of Pol II-bound monomers within the gene, highlighting their positioning. This movie illustrates how gene conformation is influenced and shaped by the dynamic intra- and intertrain interactions.

File Name: Supplementary Movie 4

Description: Movie illustrating inter-gene interactions. In the left panel, a simulated trajectory showing the behavior of two distinct genes (white and light blue monomers) with their surrounding genomic regions (dark blue monomers). Pol II-bound loci for each gene are represented by red and orange monomers respectively. The left panel provides insight into the spatial arrangement of Pol II-bound monomers belonging to different genes. The lower panel shows the 1D representation of the location of Pol II-bound monomers within these genes. This movie illustrates how intra- and inter-gene interactions are driven by dynamic Pol II-mediated interactions, ultimately leading to the formation of transcriptionally-active subcompartments.