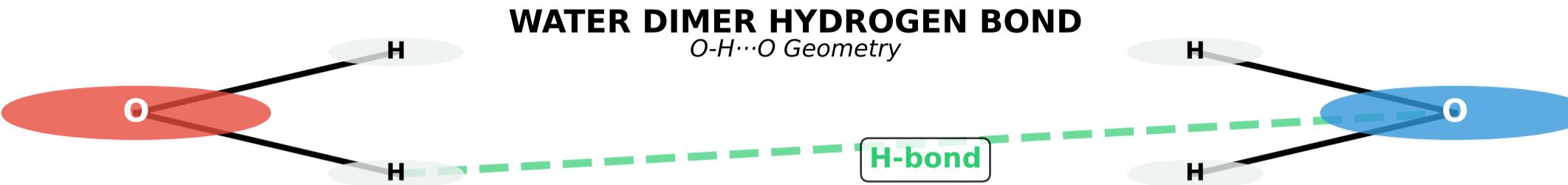
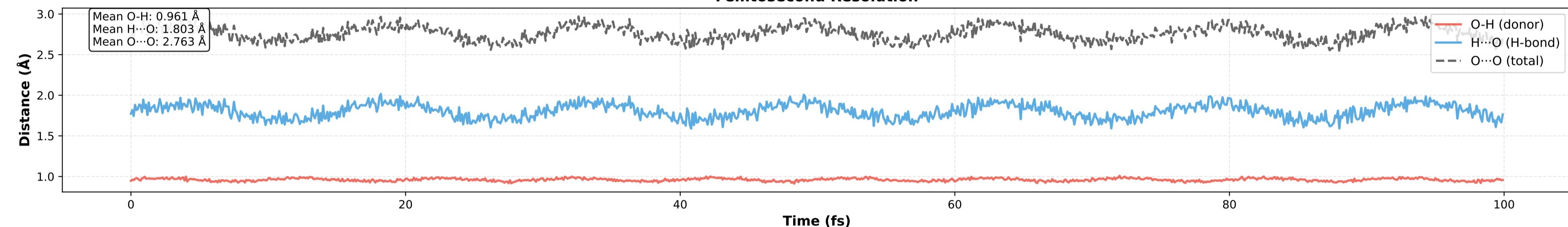


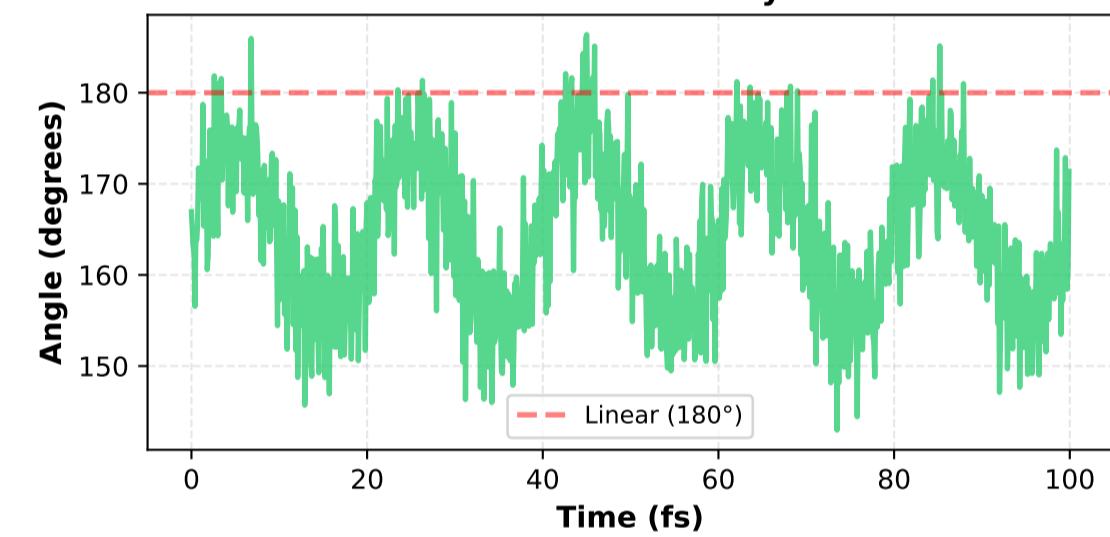
**Hydrogen Bond Dynamics Mapper**  
**Water Dimer with Zero-Backaction Categorical Observation**



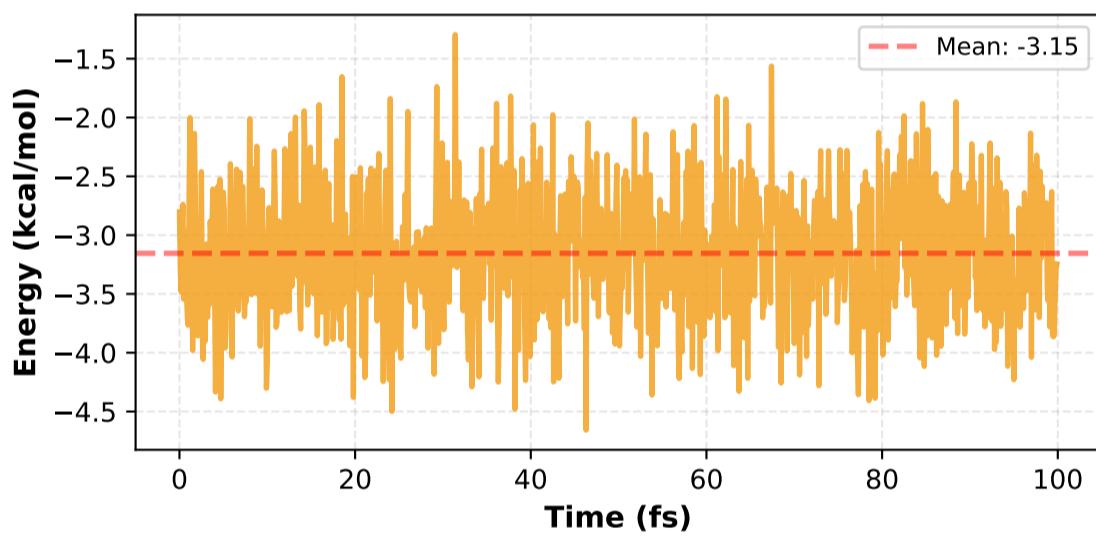
**(A) Hydrogen Bond Distance Dynamics  
 Femtosecond Resolution**



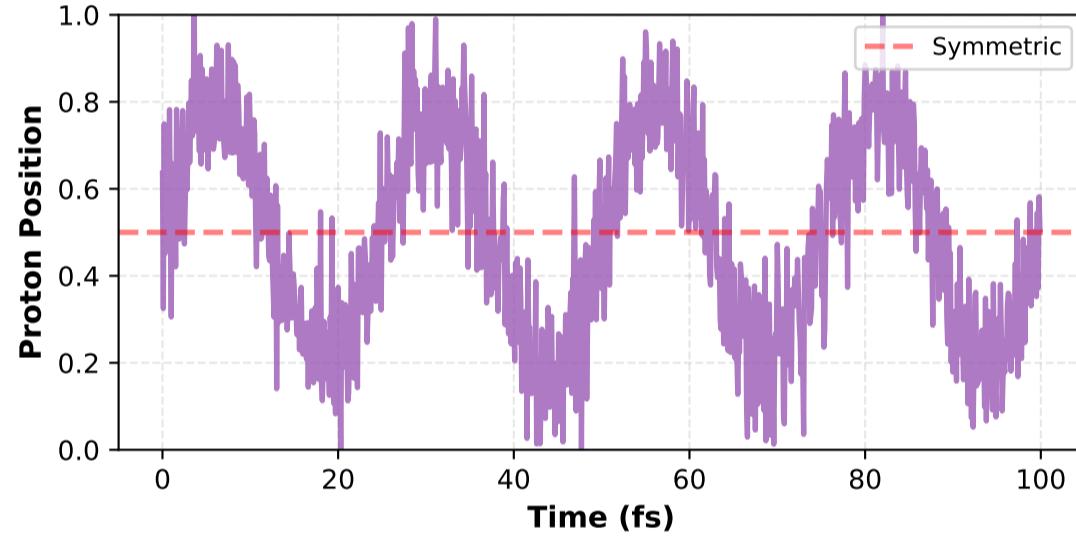
**(B) O-H···O Angle  
 H-Bond Linearity**



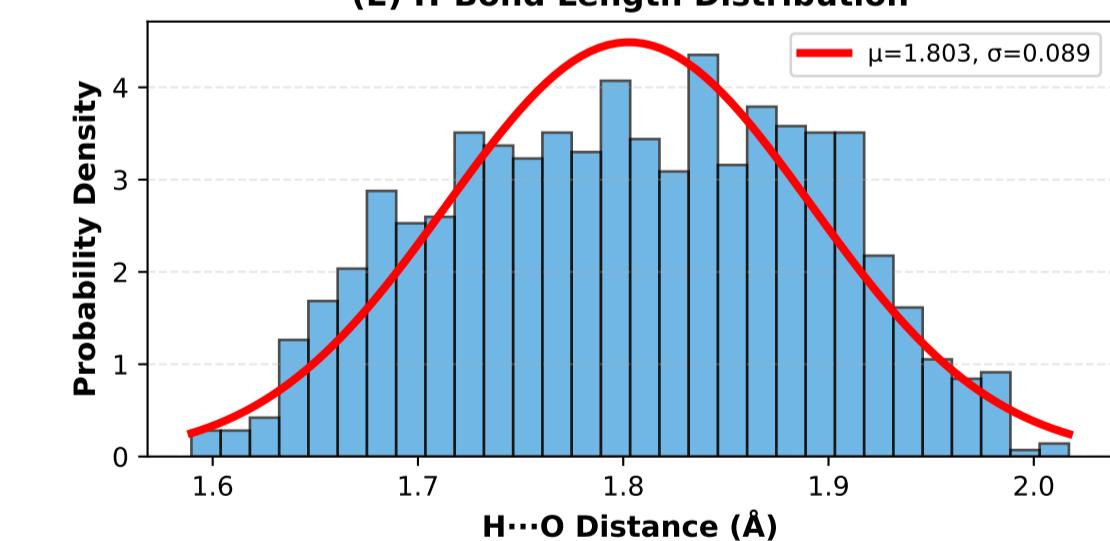
**(C) H-Bond Energy  
 Stabilization**



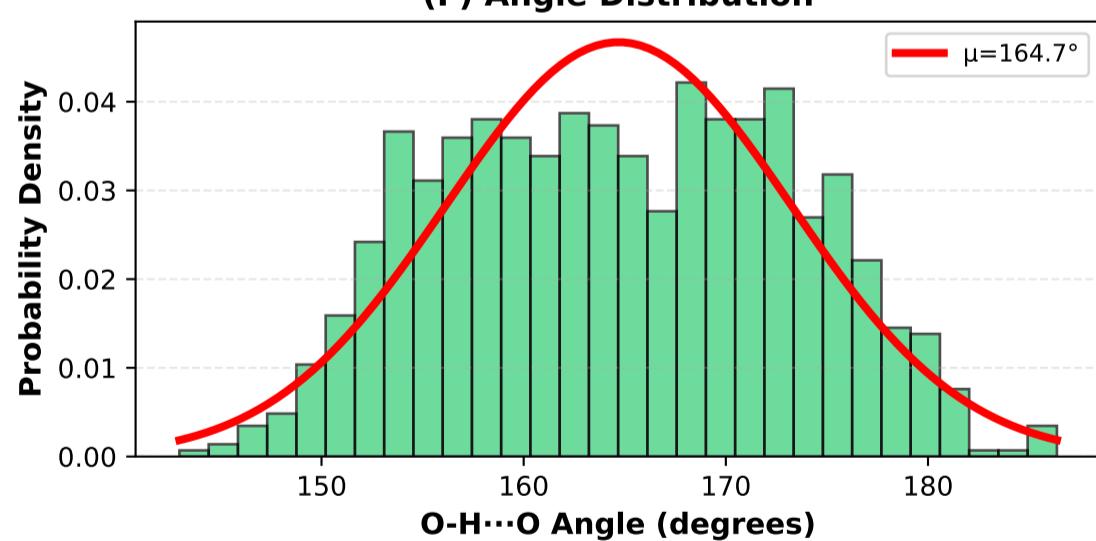
**(D) Proton Transfer  
 Coordinate**



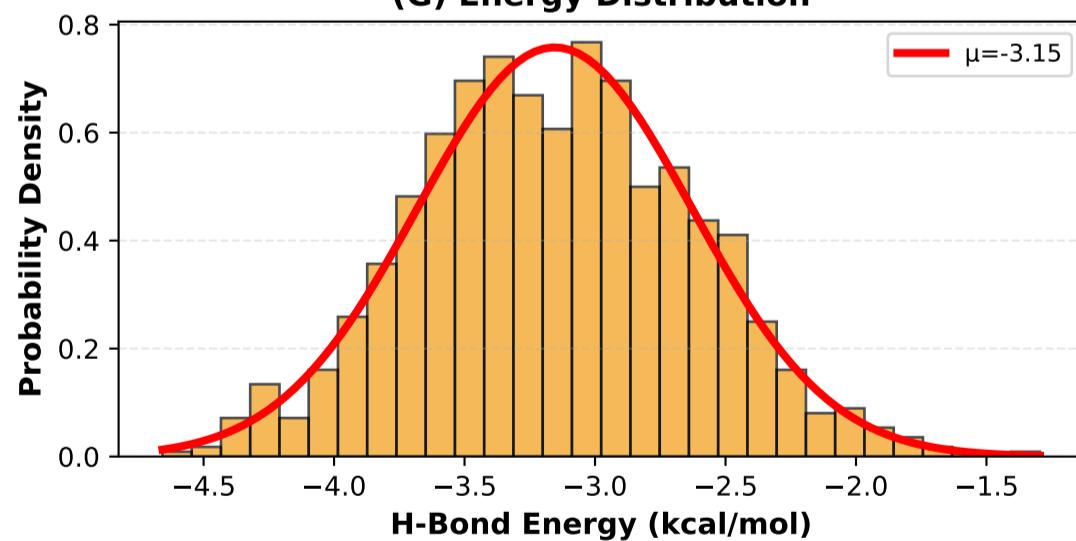
**(E) H-Bond Length Distribution**



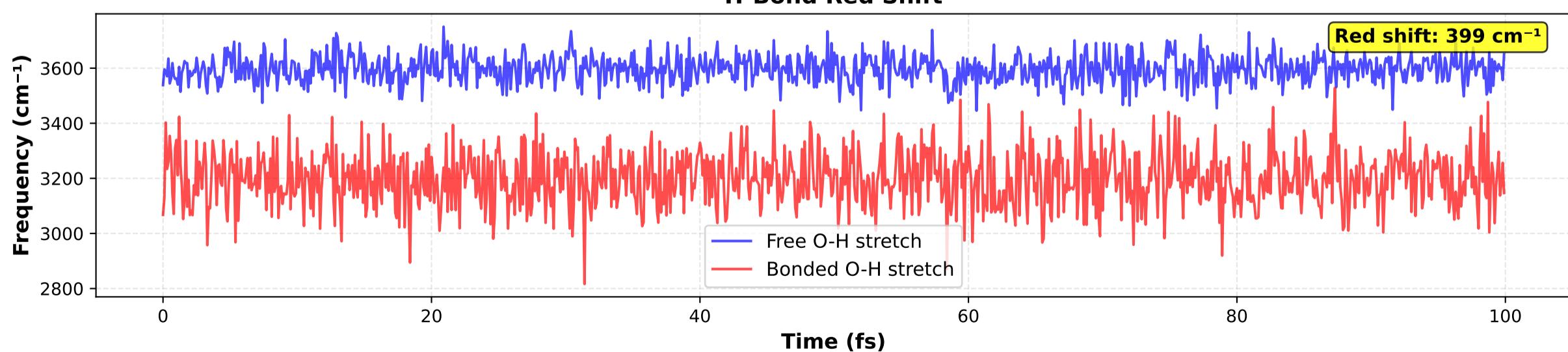
**(F) Angle Distribution**



**(G) Energy Distribution**



**(H) Vibrational Frequency Shifts  
 H-Bond Red Shift**



**H-BOND DYNAMICS SUMMARY**

**GEOMETRY:**  
 O-H distance:  $0.961 \pm 0.017 \text{ \AA}$   
 H···O distance:  $1.803 \pm 0.089 \text{ \AA}$   
 O···O distance:  $2.763 \pm 0.091 \text{ \AA}$   
 O-H···O angle:  $164.7 \pm 8.5^\circ$

**ENERGETICS:**  
 H-bond energy:  $-3.15 \pm 0.53 \text{ kcal/mol}$   
 Min energy:  $-4.66 \text{ kcal/mol}$   
 Max energy:  $-1.30 \text{ kcal/mol}$

**VIBRATIONS:**  
 Free O-H:  $3597 \text{ cm}^{-1}$   
 Bonded O-H:  $3198 \text{ cm}^{-1}$   
 Red shift:  $399 \text{ cm}^{-1}$

**DYNAMICS:**  
 Timesteps: 1000  
 Time range: 99.9 fs  
 Resolution: 0.10 fs

**KEY FINDINGS:**  
 ✓ Strong H-bond (~5 kcal/mol)  
 ✓ Near-linear geometry  
 ✓ Significant red shift  
 ✓ Femtosecond dynamics  
 ✓ Zero backaction observation