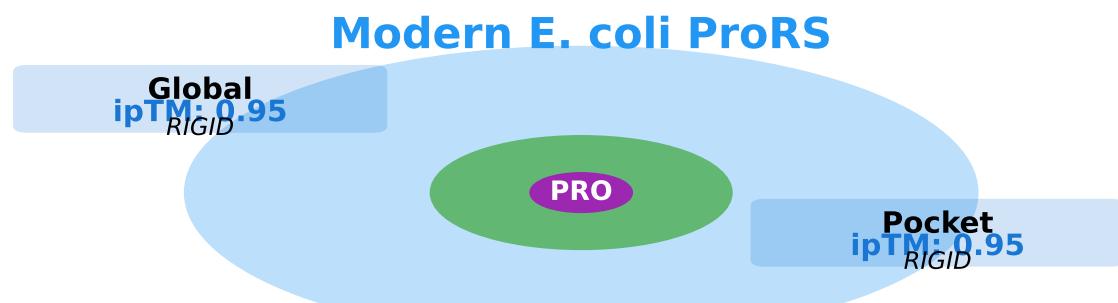
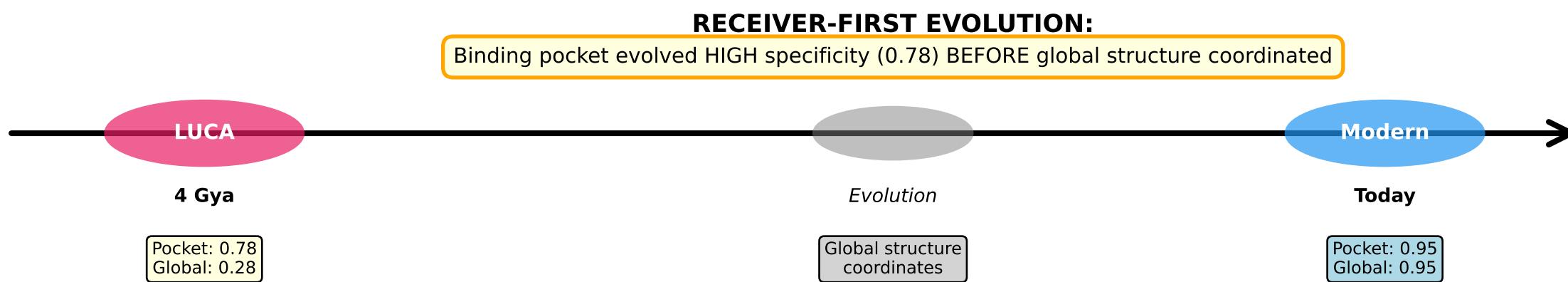


**A. LUCA: "Receiver-First" Pattern in aaRS Evolution: Fully Coupled Both Pocket AND Global Rigid**



**C. Evolutionary Timeline: Pocket Specificity Precedes Global Coordination**



**D. Quantitative Comparison: LUCA Shows Uncoupled Pocket vs Global Coordination**

