

Supporting Material, File S1 Text

An amplified derepression controller with multisite inhibition and positive feedback

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Controller performance towards step-wise changes in k_1 and linearly increasing k_1 values

As shown in the schematic diagram by Fig 7 and Eqs 9 and 10 in the main text, a positive feedback can be implemented by first-order or second-order autocatalysis in C , which increase controller performance in terms of its life-time.

Here, results with step-wise changes and with linear increase in k_1 are shown when C is produced by first-order and second-order autocatalysis.

First-order autocatalysis in C

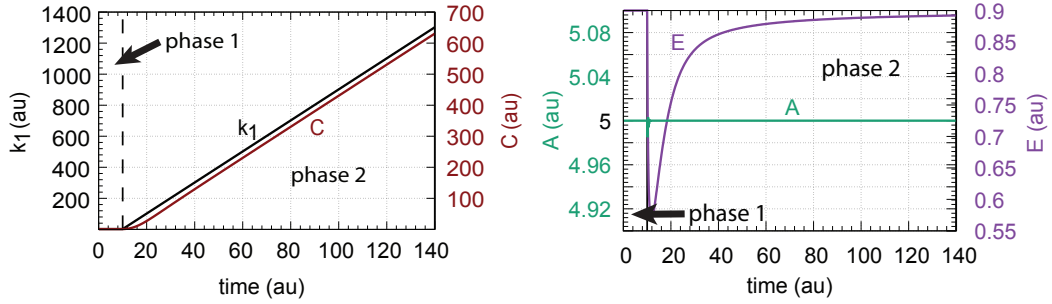


Figure S1: Controller performance with first-order autocatalysis in C (Eq. 9 in the main text) and linear increase of k_1 ($\dot{k}_1=10.0$). Phase 1: the controller is at steady state at its set-point $A_{set}=5.0$ with constant $k_1=2.0$. Initial concentrations: $A_0=5.0$, $E_0=0.9$, $C_0=1.0$. Phase 2: k_1 increases linearly, $k_2=1 \times 10^5$, $k_3=5 \times 10^2$, $k_4=1 \times 10^2$, $k_5=10.0$, and $k_6=1.0$. $K_M=1 \times 10^{-6}$, $K_I=0.1$, $n = 4$ (Eq 6 in the main text). Left panel: k_1 and C as a function of time; right panel: A and E as a function of time.

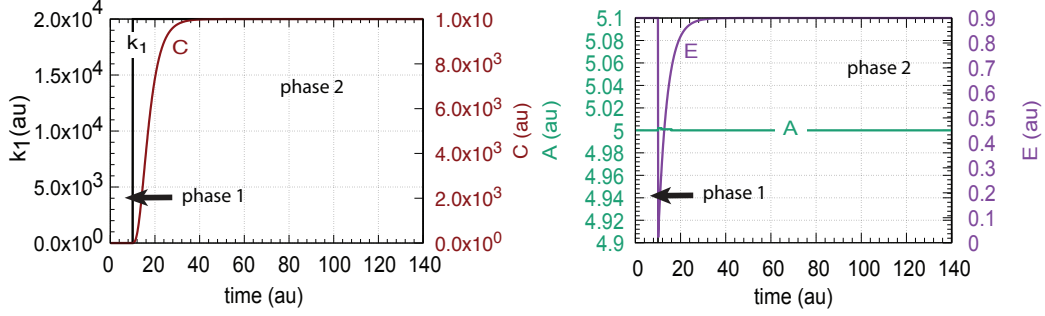


Figure S2: Controller performance with first-order autocatalysis in C (Eq. 9 in the main text) and step-wise increase of k_1 . Phase 1: the controller is at steady state at its set-point $A_{set}=5.0$ with constant $k_1=2.0$. Initial concentrations: $A_0=5.0$, $E_0=0.9$, $C_0=1.0$. Phase 2: $k_1=2 \times 10^4$, $k_2=1 \times 10^5$, $k_3=5 \times 10^2$, $k_4=1 \times 10^2$, $k_5=10.0$, and $k_6=1.0$. $K_M=1 \times 10^{-6}$, $K_I=0.1$, $n = 4$ (Eq 6 in the main text). Left panel: k_1 and C as a function of time; right panel: A and E as a function of time.

Second-order autocatalysis in C

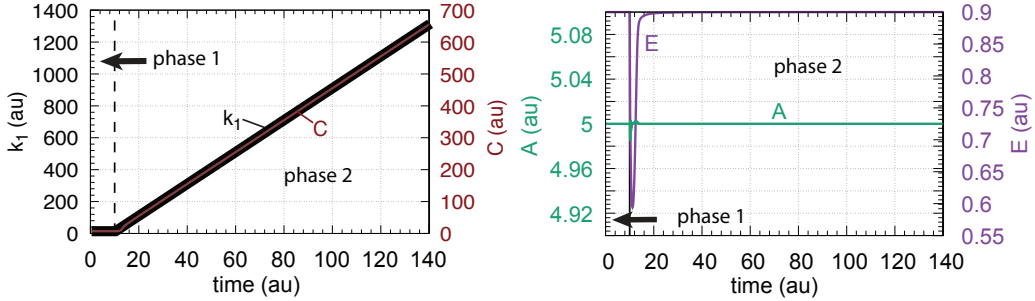


Figure S3: Controller performance with second-order autocatalysis in C (Eq. 10 in the main text) and linear increase of k_1 ($\dot{k}_1=10.0$). Phase 1: the controller is at steady state at its set-point $A_{set}=5.0$ with constant $k_1=2.0$. Initial concentrations: $A_0=5.0$, $E_0=0.9$, $C_0=1.0$. Phase 2: k_1 increases linearly, $k_2=1 \times 10^5$, $k_3=5 \times 10^2$, $k_4=1 \times 10^2$, $k_5=10.0$, and $k_6=1.0$. $K_M=1 \times 10^{-6}$, $K_I=0.1$, $n = 4$ (Eq 6 in the main text). Left panel: k_1 and C as a function of time; right panel: A and E as a function of time.

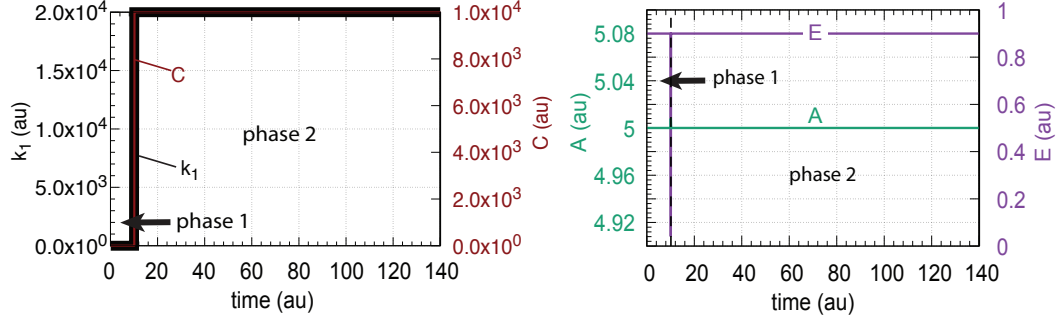


Figure S4: Controller performance with second-order autocatalysis in C (Eq. 10 in the main text) and step-wise increase of k_1 . Phase 1: the controller is at steady state at its set-point $A_{set}=5.0$ with constant $k_1=2.0$. Initial concentrations: $A_0=5.0$, $E_0=0.9$, $C_0=1.0$. Phase 2: $k_1=2 \times 10^4$, $k_2=1 \times 10^5$, $k_3=5 \times 10^2$, $k_4=1 \times 10^2$, $k_5=10.0$, and $k_6=1.0$. $K_M=1 \times 10^{-6}$, $K_I=0.1$, $n = 4$ (Eq 6 in the main text). Left panel: k_1 and C as a function of time; right panel: A and E as a function of time.