

## Hip Bend Subroutines

Smooth bend from 0 to A, risetime  $\Delta t$ , start decrease at time  $T_1$ , finish decrease at  $T_1 + \Delta t$ .

$$\phi_{fl}(t, \Delta T, A) := 3 \cdot A \cdot \left[ \left( \frac{t}{\Delta T} \right)^2 - \frac{2}{3} \cdot \left( \frac{t}{\Delta T} \right)^3 \right]$$

$$\phi_{tfl}(t, \Delta T, A) := 6 \cdot A \cdot \left[ \frac{t}{\Delta T^2} - \frac{(t)^2}{\Delta T^3} \right]$$

$$\phi_{ttf}(t, \Delta T, A) := 6 \cdot A \cdot \left( \frac{1}{\Delta T^2} - 2 \cdot \frac{t}{\Delta T^3} \right)$$

Starting from  $A_s$ , go to  $A_m$ , decrease to  $A_e$

$$\phi_{1f}(t, A_s, A_m, A_e) := \text{if} \left[ t < \Delta T, A_s + \phi_{fl}(t, \Delta T, A_m - A_s), \text{if} \left[ t < T_1, A_m, \text{if} \left[ t < T_1 + \Delta T, (A_m + \phi_{fl}(t - T_1, \Delta T, A_e - A_m)), A_e \right] \right] \right]$$

$$\phi_{1tf}(t, A_s, A_m, A_e) := \text{if} \left( t < \Delta T, \phi_{tfl}(t, \Delta T, A_m - A_s), \text{if} \left( t < T_1, 0, \text{if} \left( t < T_1 + \Delta T, \phi_{tfl}(t - T_1, \Delta T, A_e - A_m), 0 \right) \right) \right)$$

$$\phi_{1ttf}(t, A_s, A_m, A_e) := \text{if} \left( t < \Delta T, \phi_{ttf}(t, \Delta T, A_m - A_s), \text{if} \left( t < T_1, 0, \text{if} \left( t < T_1 + \Delta T, \phi_{ttf}(t - T_1, \Delta T, A_e - A_m), 0 \right) \right) \right)$$

Start from 0, go to  $A_1$ , stay at  $A_2$ , go to  $A_3$  at  $T_2$ , and end at 0

$$\phi_f(t) := \text{if} \left( t < T_2, \phi_{1f}(t, 0, A_1, A_2), \phi_{1f}(t - T_2, A_2, A_3, 0) \right)$$

$$\phi_{tf}(t) := \text{if} \left( t < T_2, \phi_{1tf}(t, 0, A_1, A_2), \phi_{1tf}(t - T_2, A_2, A_3, 0) \right)$$

$$\phi_{ttf}(t) := \text{if} \left( t < T_2, \phi_{1ttf}(t, 0, A_1, A_2), \phi_{1ttf}(t - T_2, A_2, A_3, 0) \right)$$