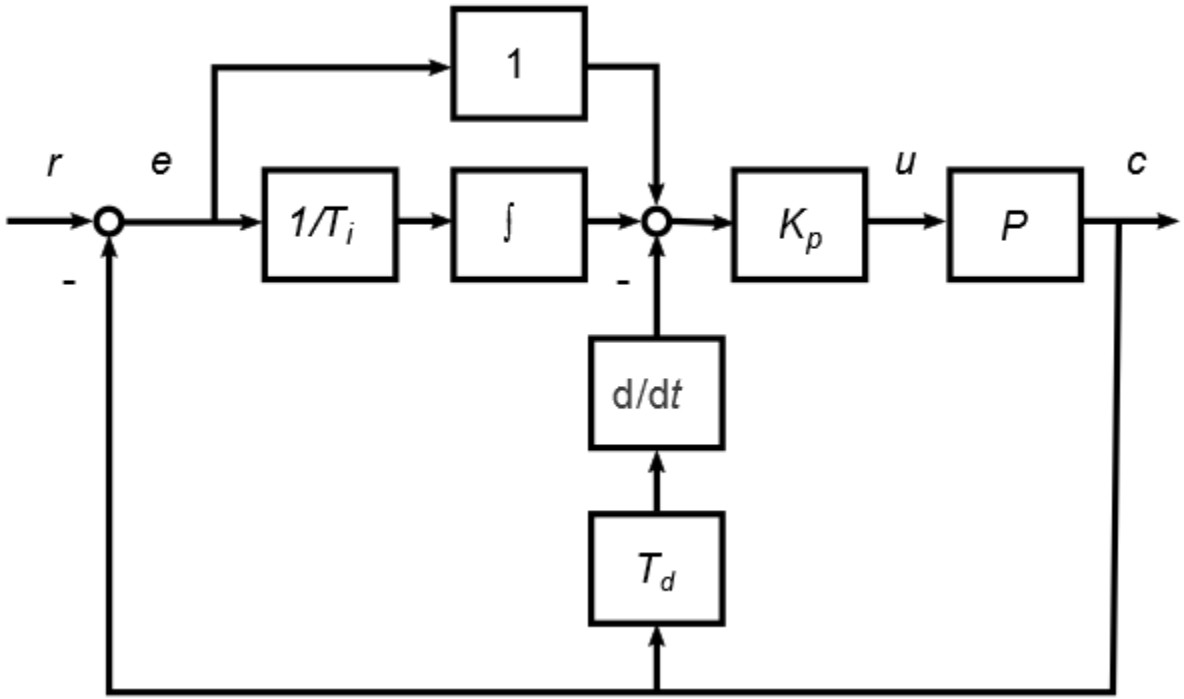
Case study: ECC16 tuning of a cart-ball balancer

Jan Jantzen

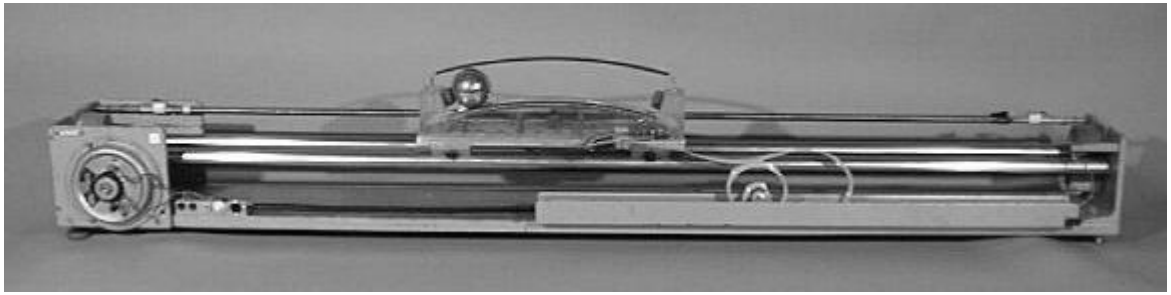
jj@inference.dk

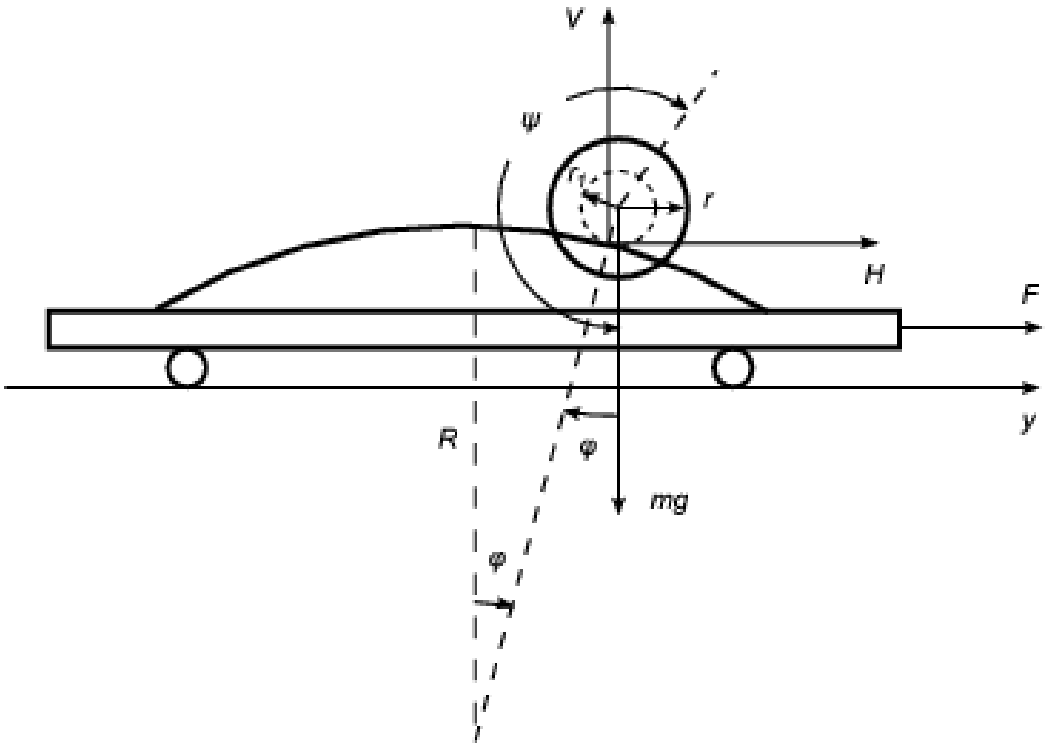
Summary

- Unstable process, two P-D controlllers
- Choose a desired settling time Ts, increase Kp as much as possible
- Use PD controller configuration below (with Ti = inf)

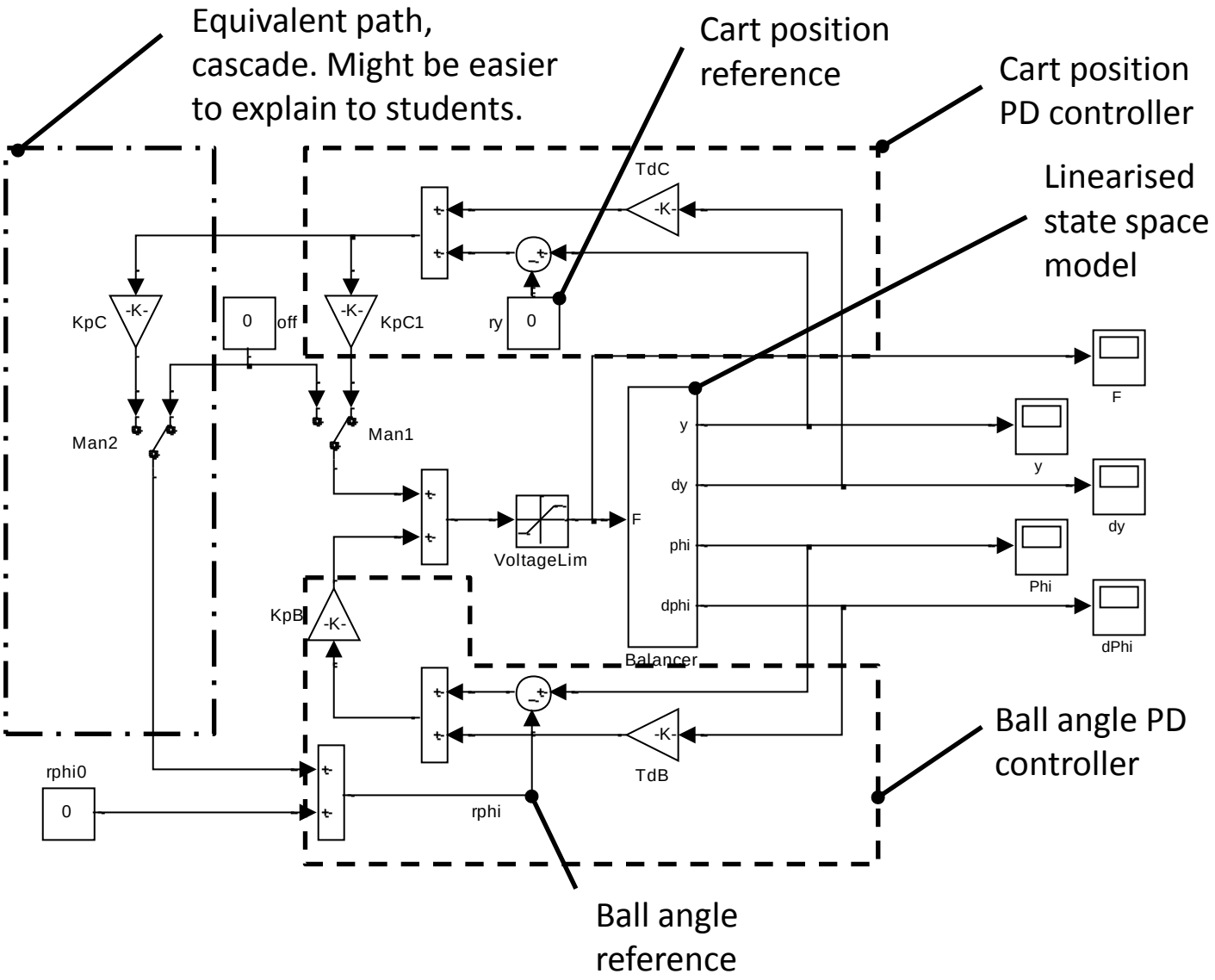


Cart-ball lab rig and symbols

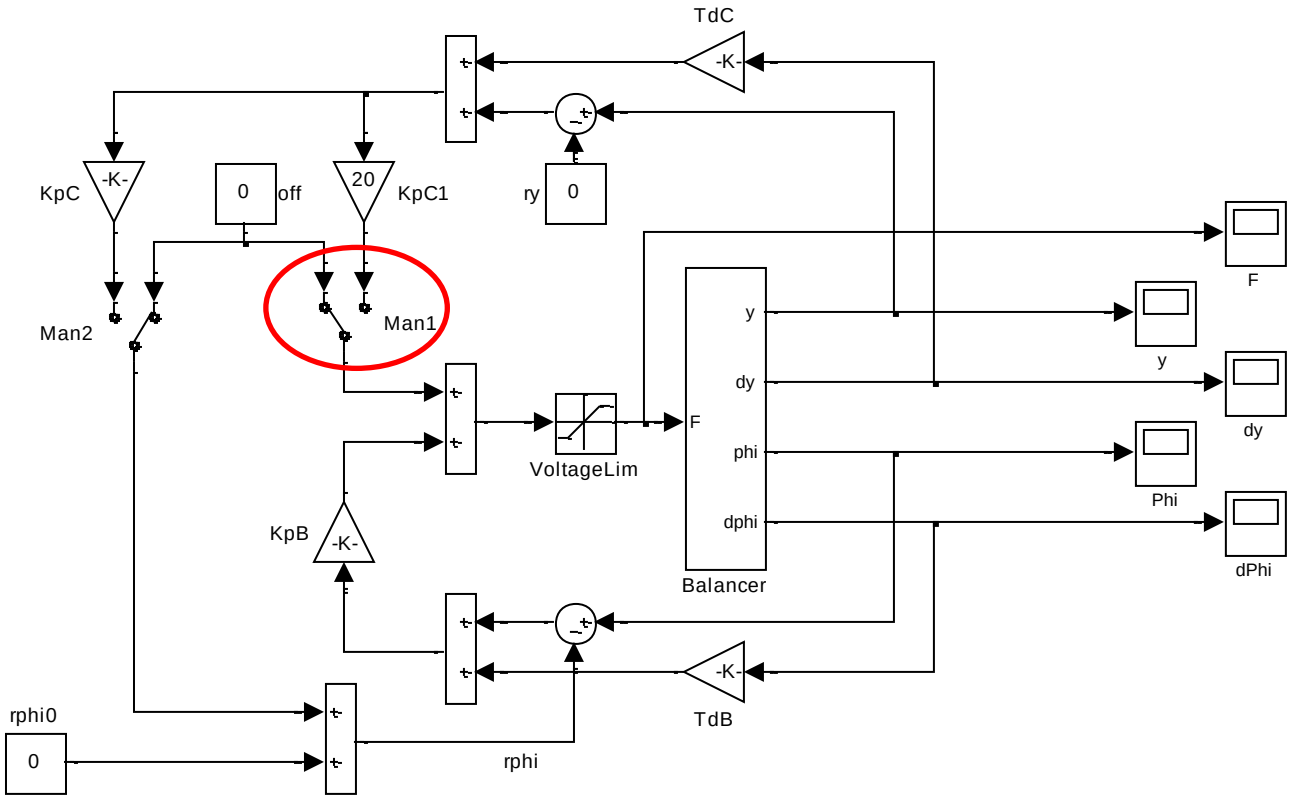




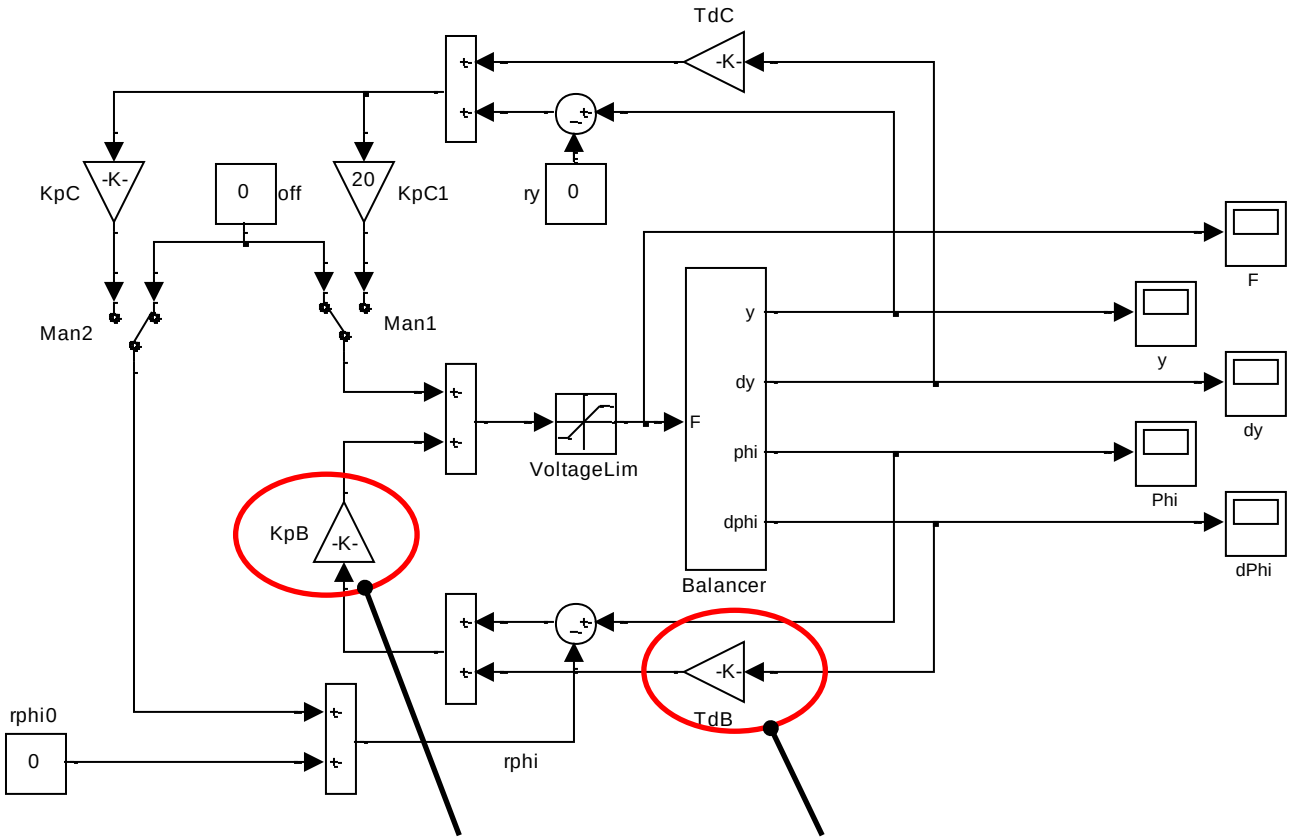
Simulink model



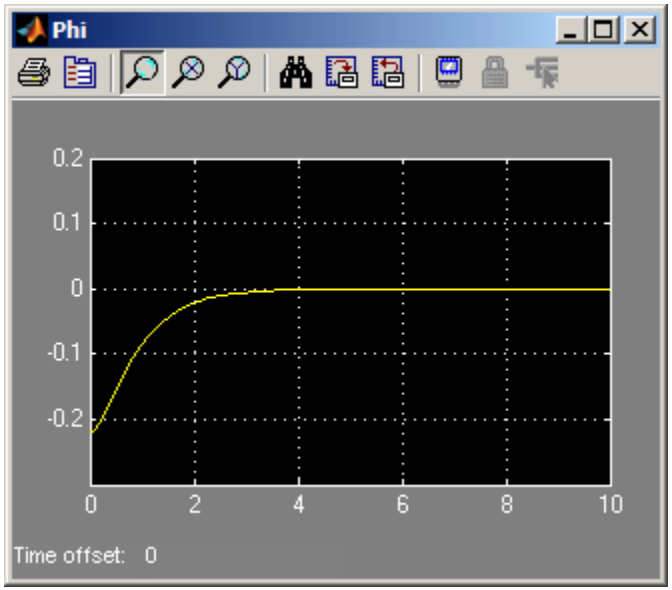
Tune ball angle controller first, disable cart controller



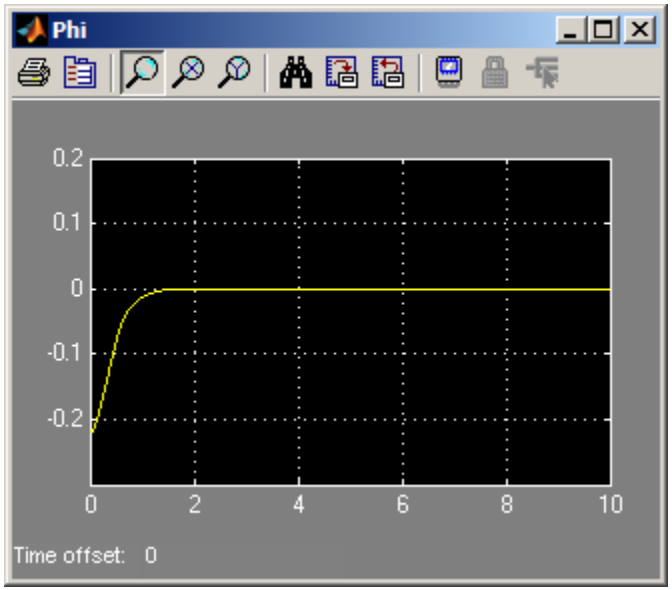
Choose desired settling time TsB = 1 second



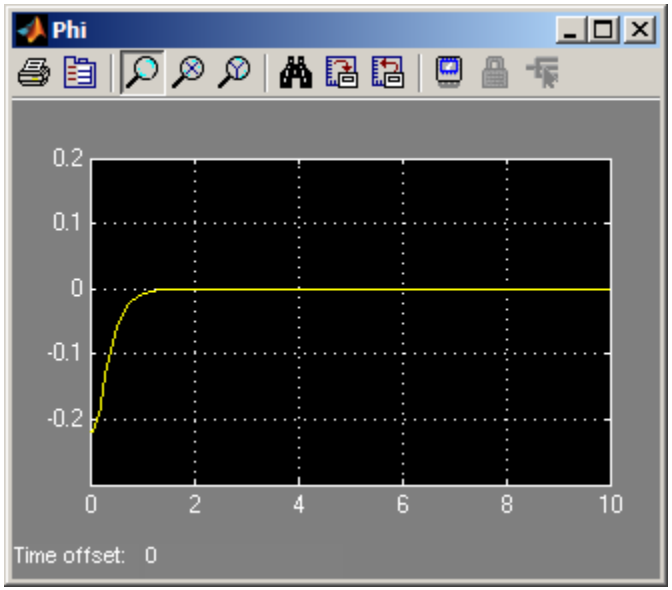
KpB = 50



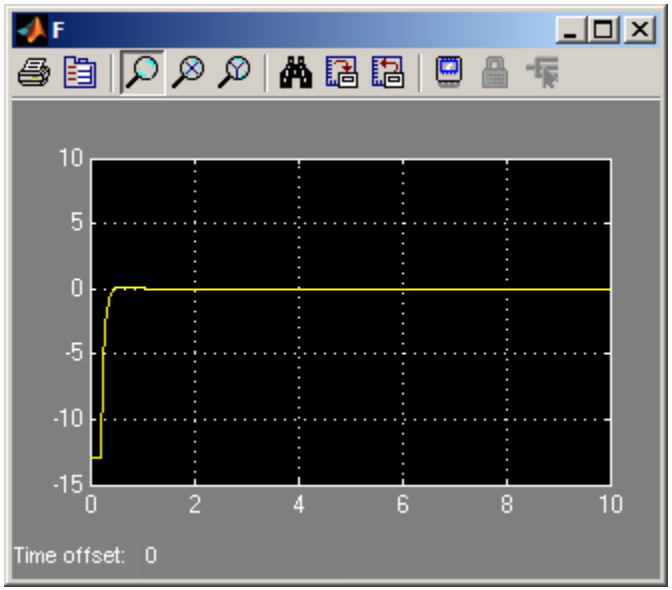
KpB = 100



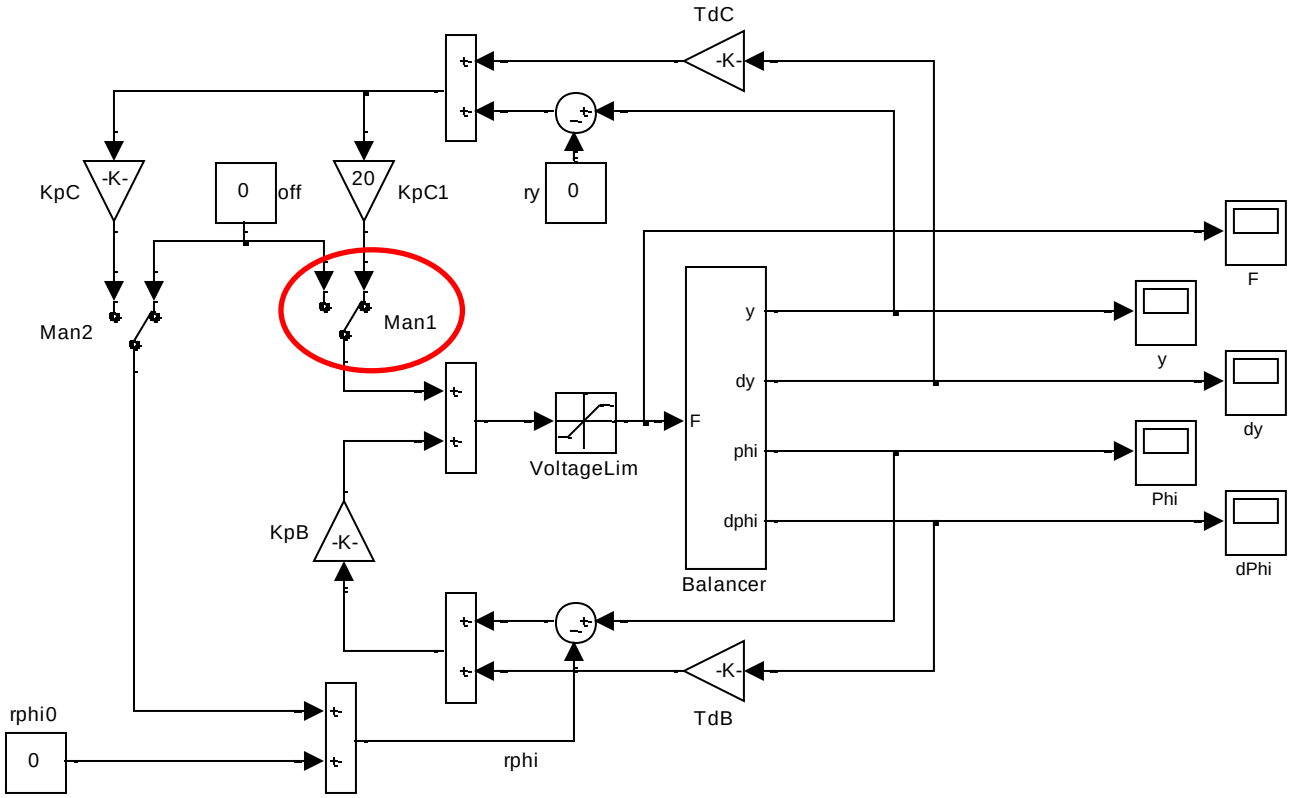
KpB = 200



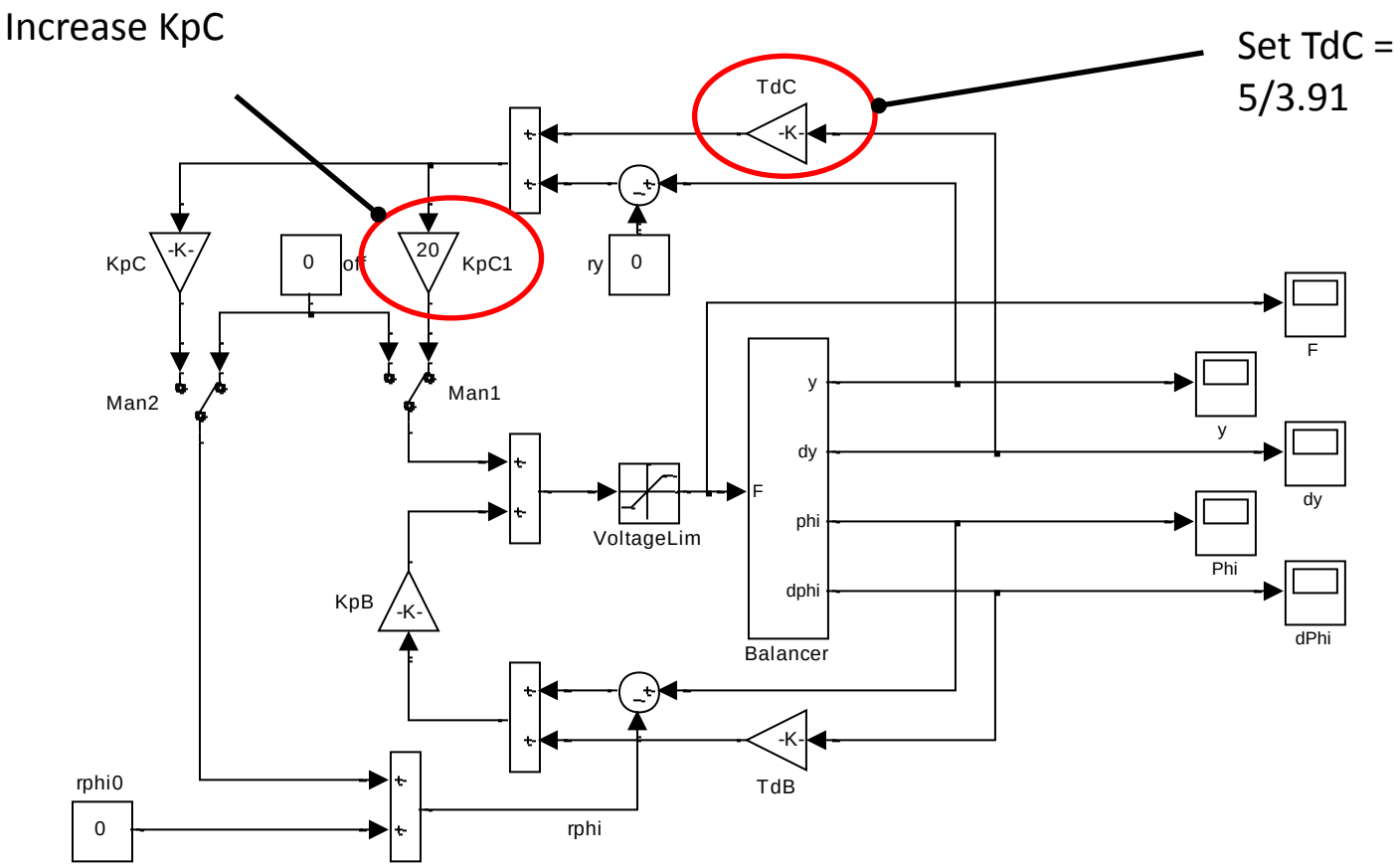
Control signal *F* saturates in [-13, 13] volts; no further improvement in the response



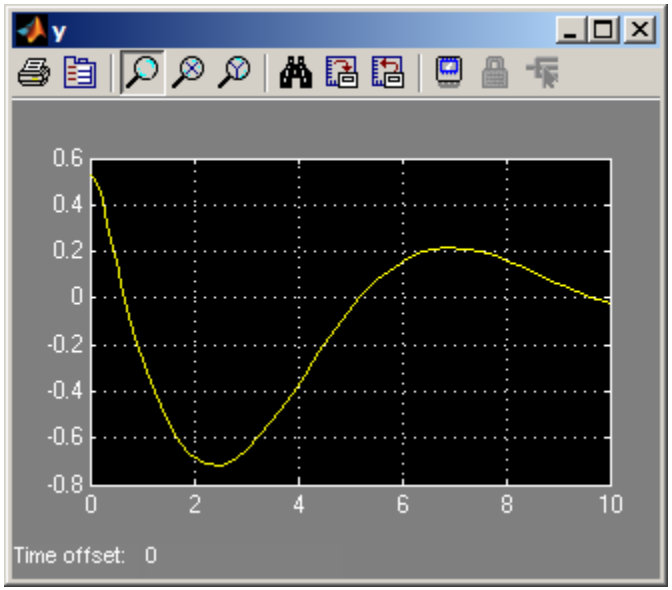
Enable cart controller



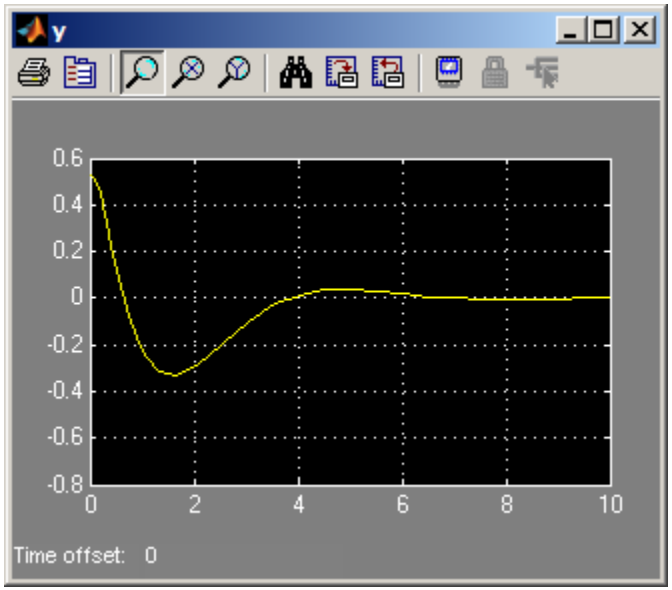
Choose desired cart settling time TsC = 5 seconds



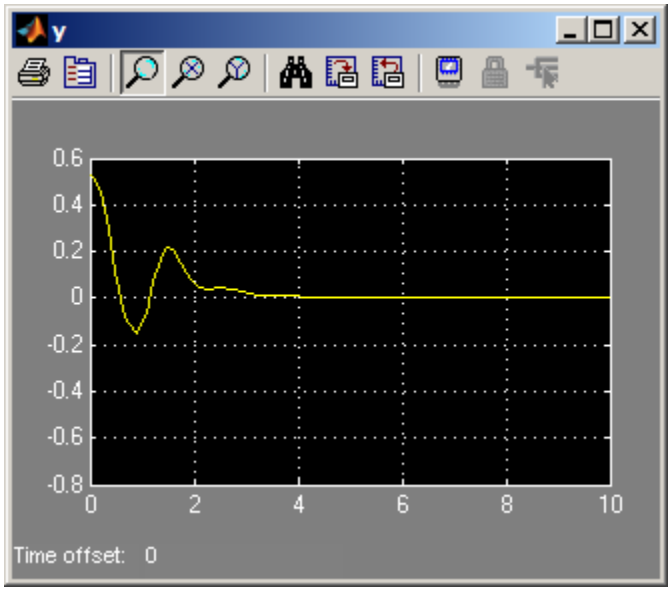
KpC = 7.5



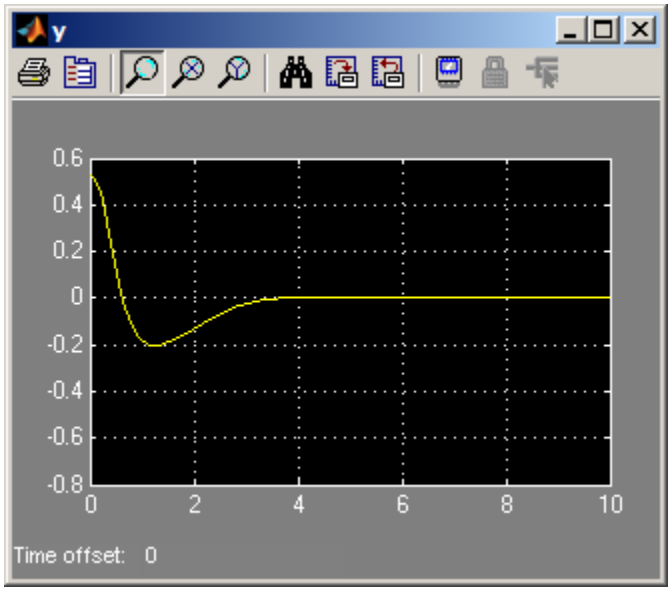
KpC = 15



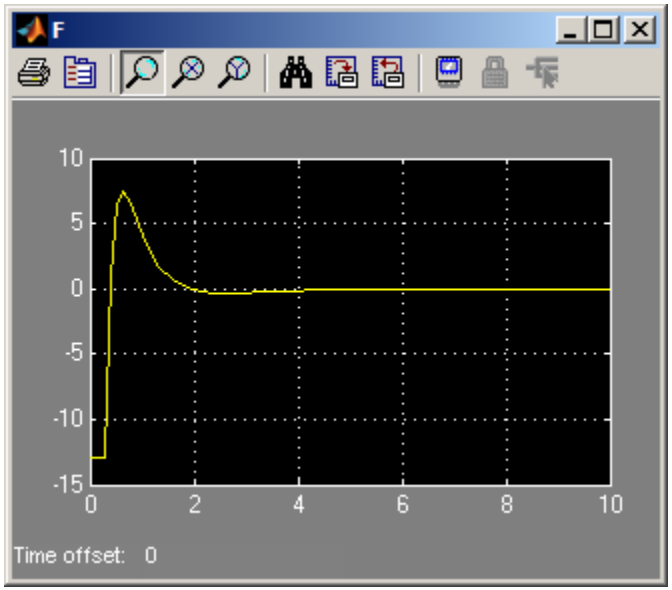
KpC = 30
Too oscillatory



Reduce to KpC = 20



Control signal F



References

- J Jantzen 2013 *Fundamentals of Fuzzy Control: A Practical Approach*. Wiley.
- J Jantzen and C Jakobsen 2016 Turning PID Controller Tuning Into a Simple Consideration of Settling Time. *Proc European Control Conference 2016, ECC16, Aalborg Denmark*, 370-375