Feasibility Study for a Fast Shutter and Slit System

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Content by Anders Sandström

ESS Motion Control and Automation Group

www.europeanspallationsource.se

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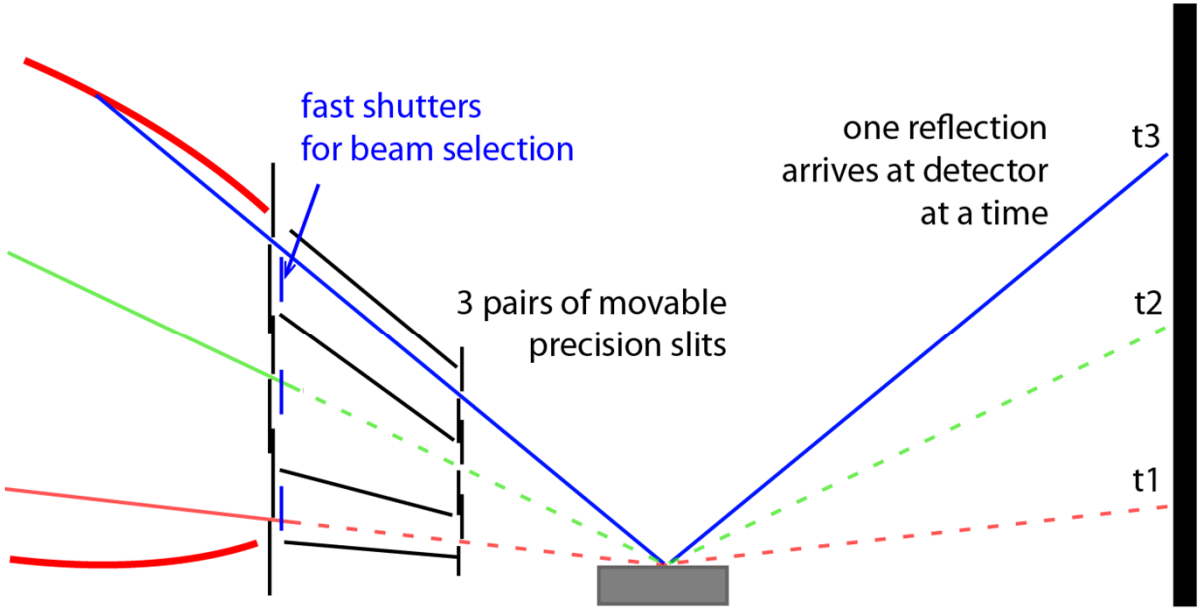
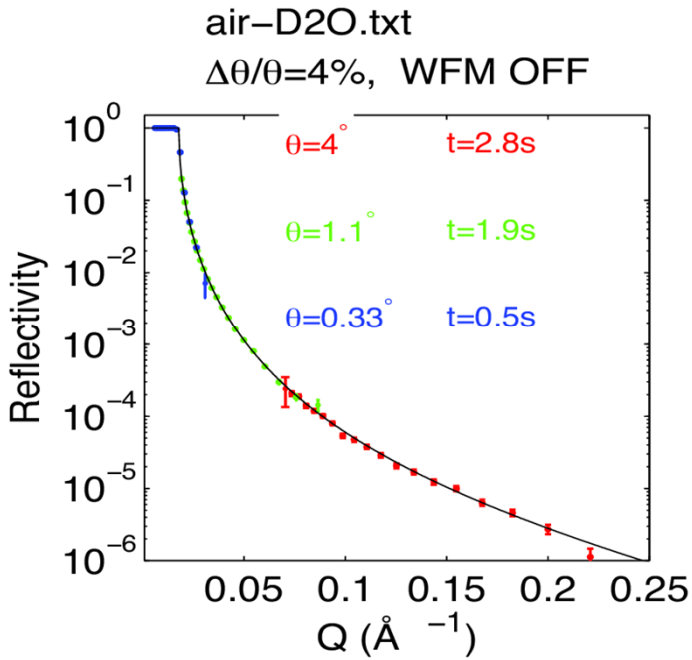
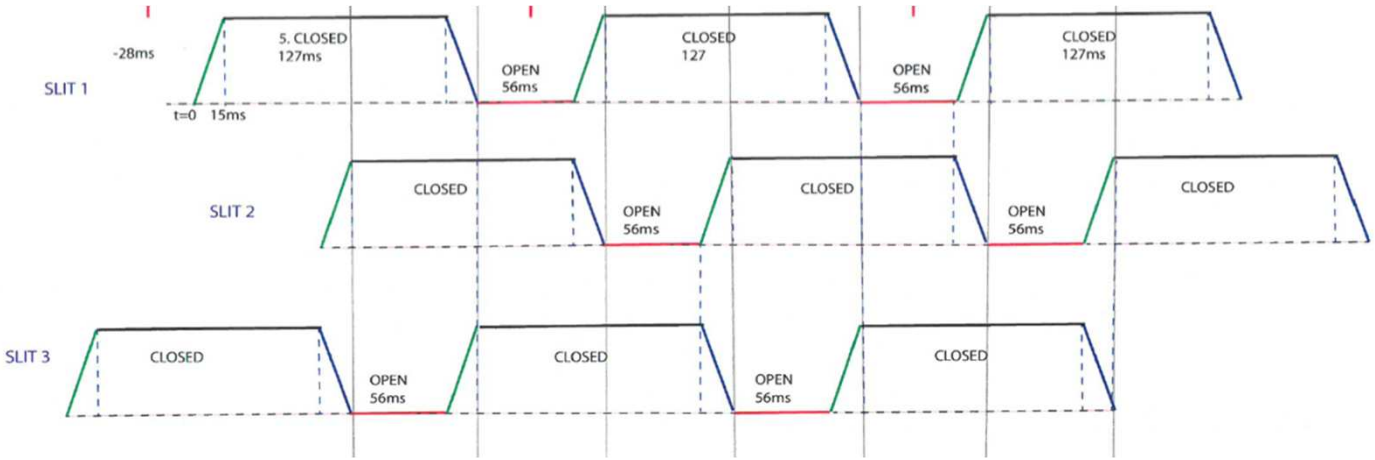
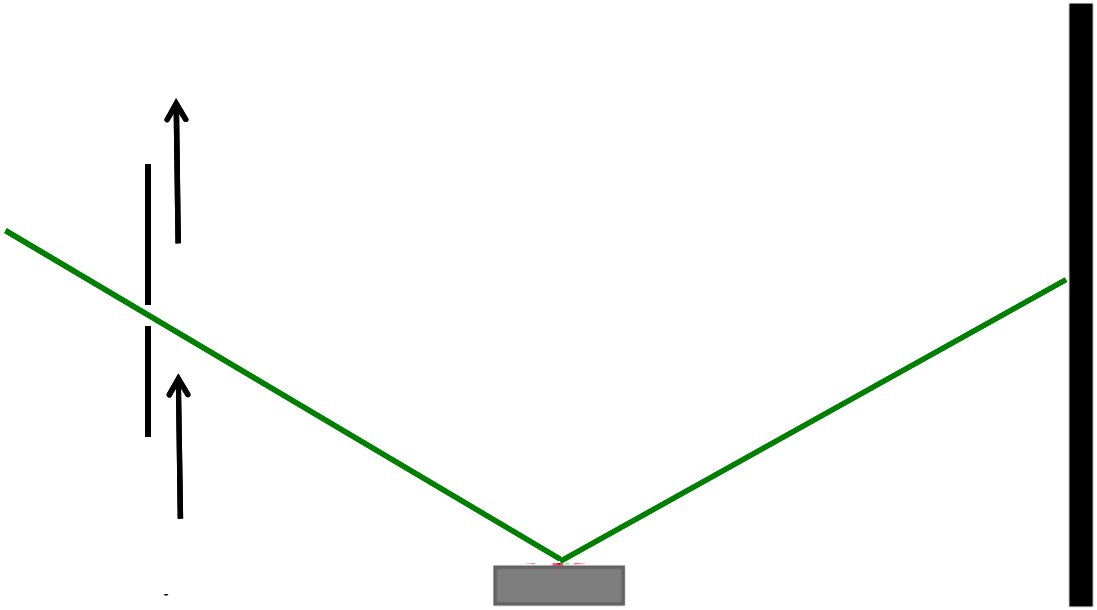
Application 1

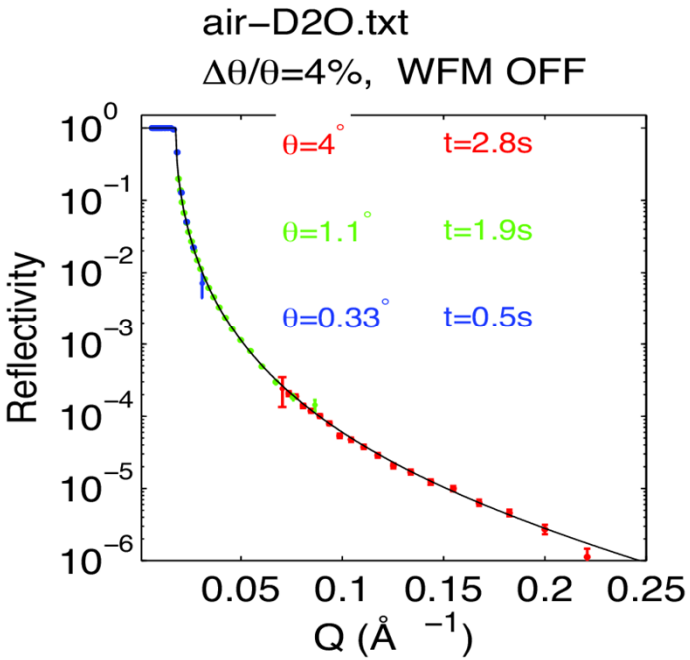


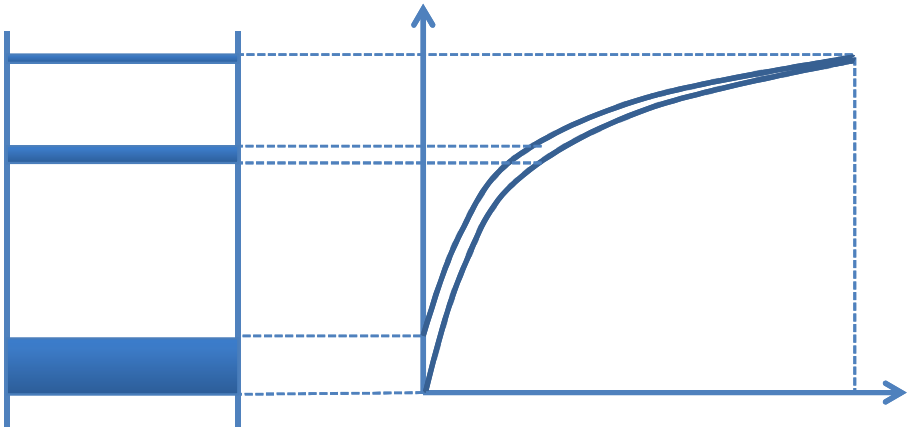




Application 2



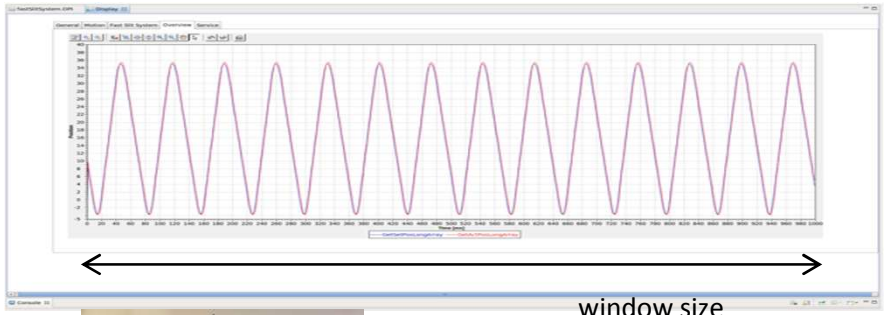




Requirements

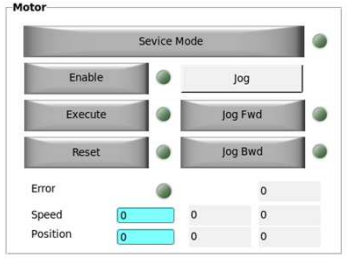
- Movements need to be **synchronized** to 14Hz pulse of the accelerator
- Several axes need to be **synchronized** to each other
- Accuracy range between ±1 to ±10µm
- Travel range of slits 60mm in 10ms
- Configurable trajectories
- Operate in vacuum
- Movements are quite fast and the 5mm of B4C absorbing material creates high inertia

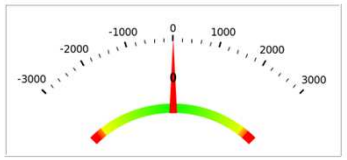
Experimental setup



window size
1000 ms (14 cycles)

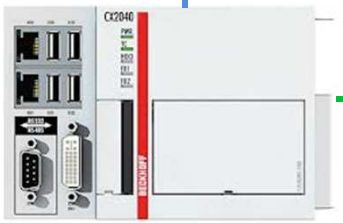
GUI in CSS
(Control System Studio)





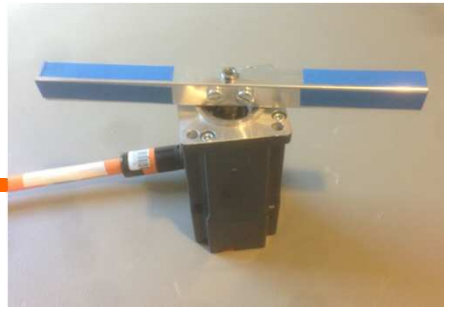
EPICS IOC
Linux

14 Hz pulse (proton pulse sync)



EtherCAT

EtherCAT



Beckhoff
CX2040

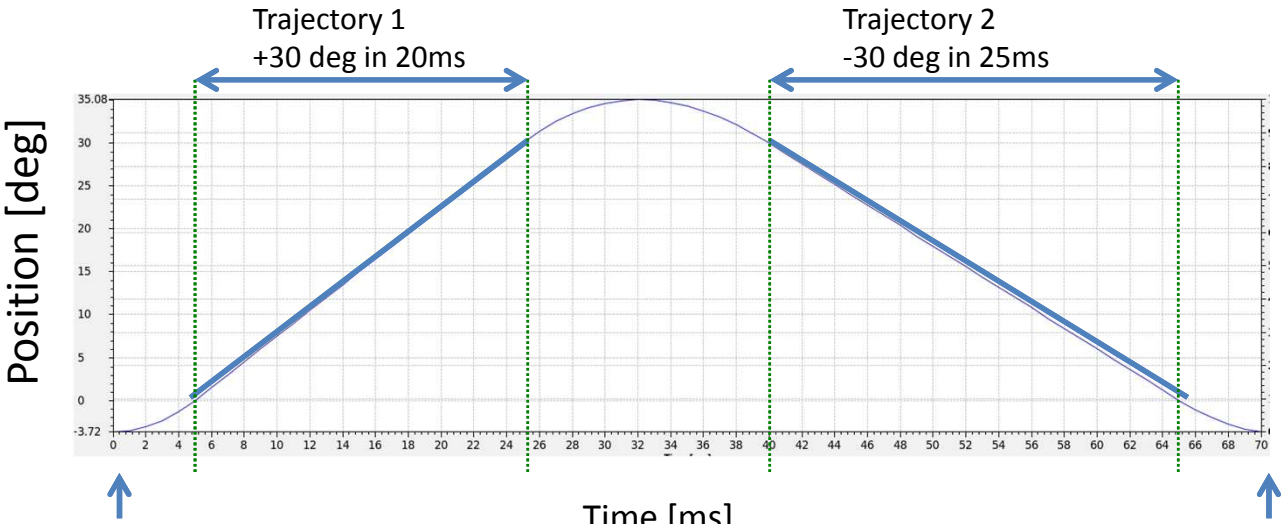
Beckhoff
EL1252-0050

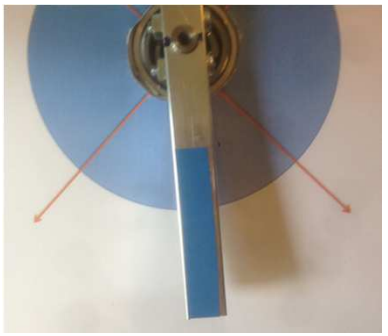
Beckhoff
EL7201

BLDC 48V, 2.8A
(low inertia load)

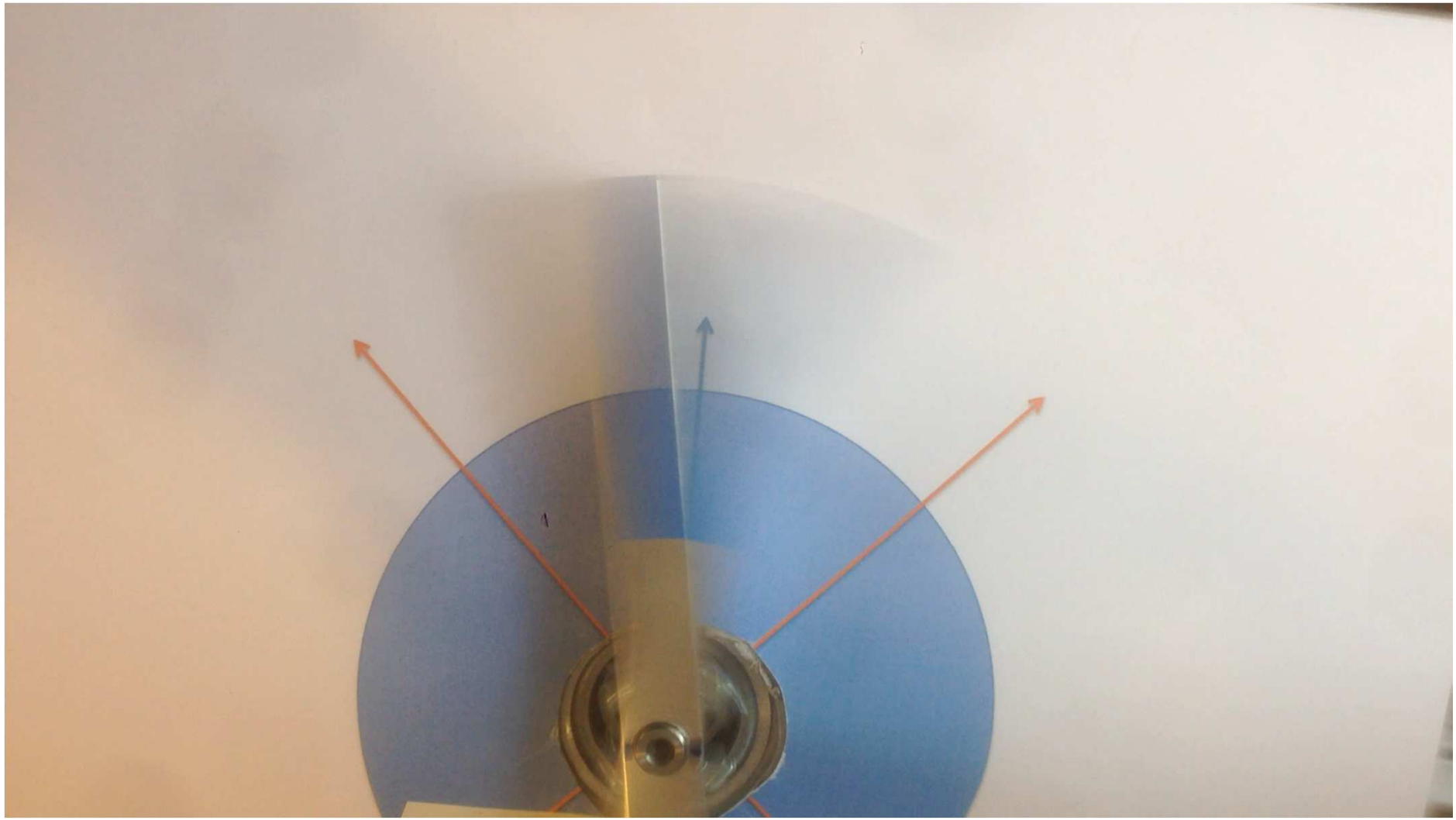
Experimental setup

Control of a 60° movement in a 14 Hz period



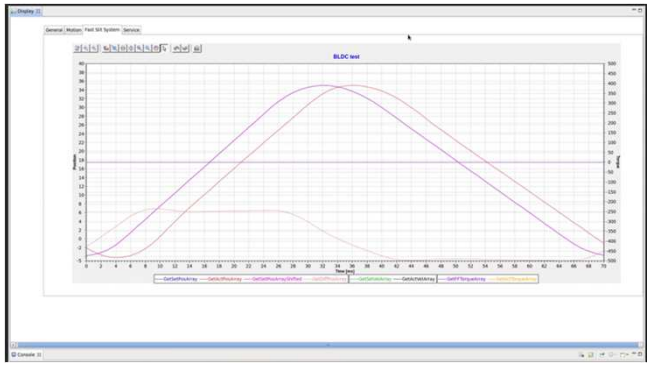


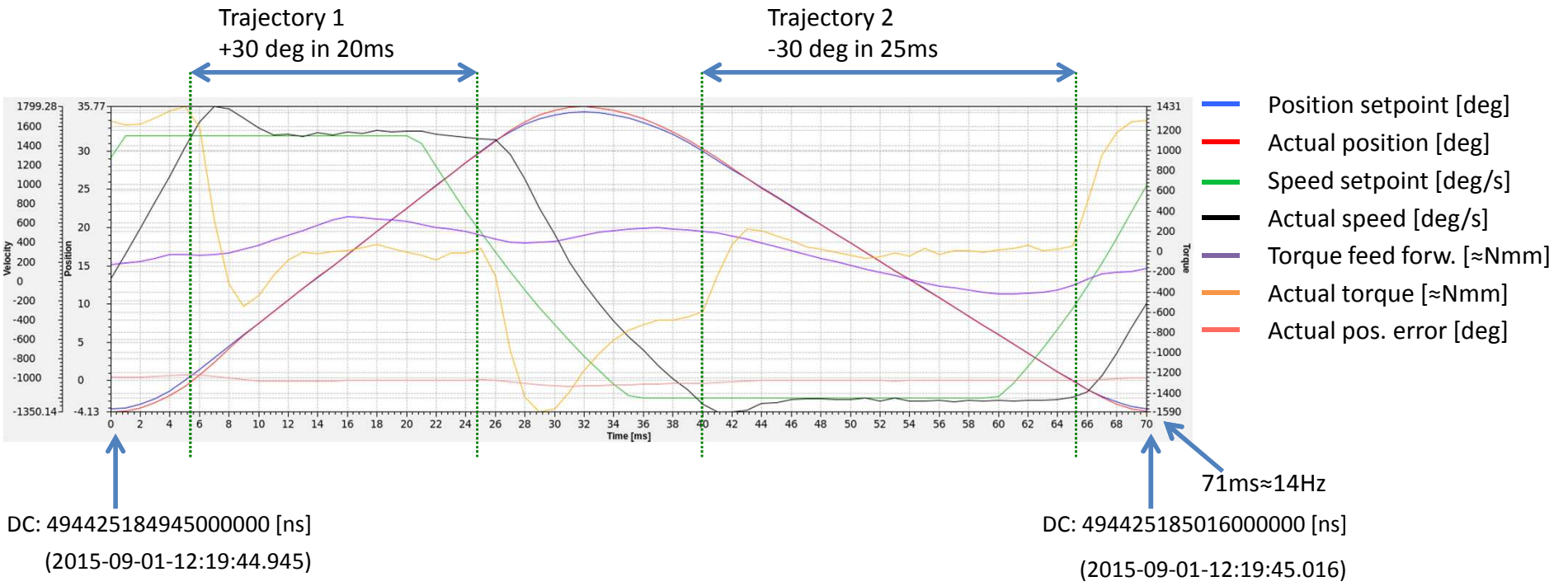
Experimental setup



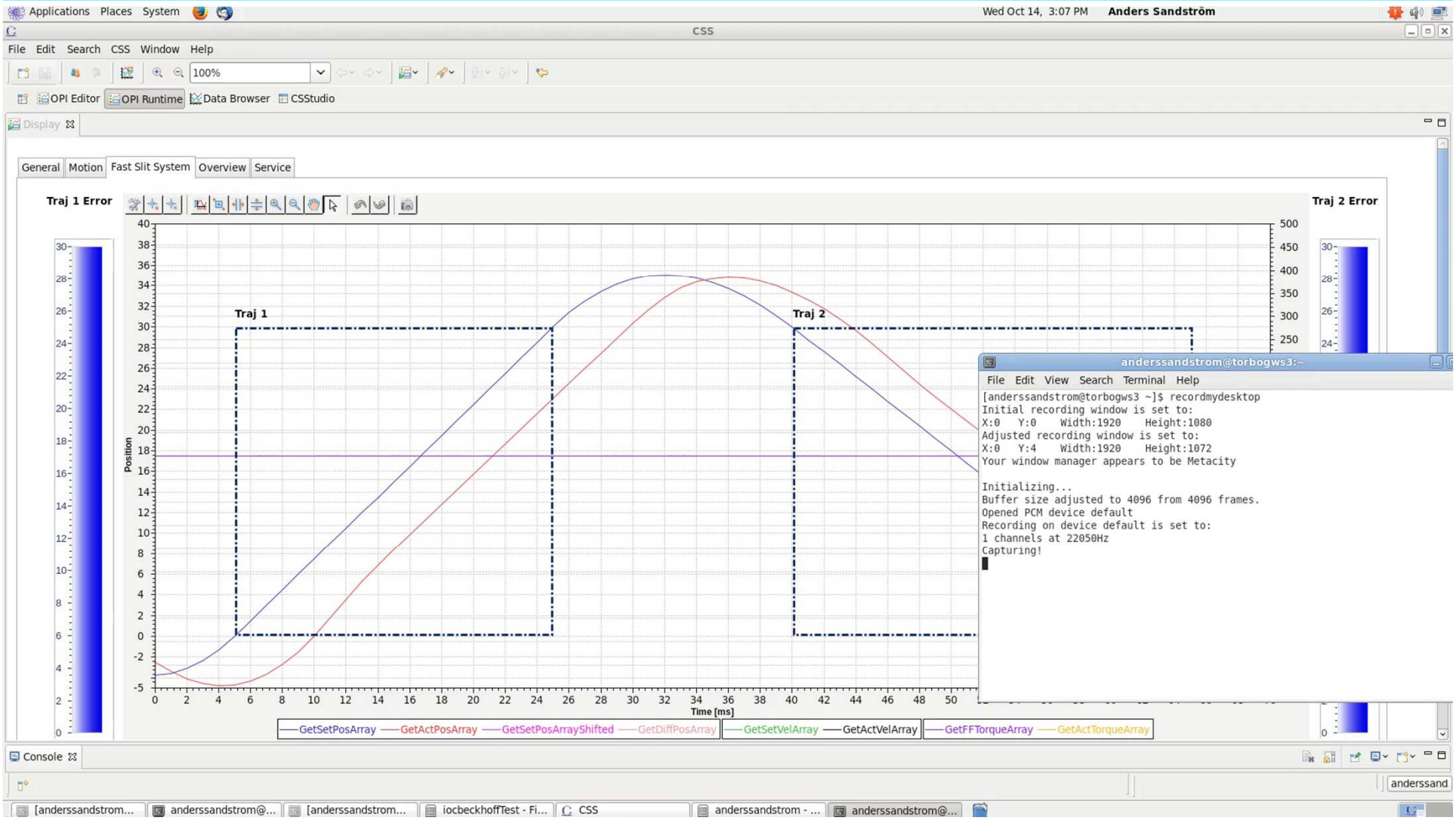
Results

Concepts used:
- Adaptive phase shift compensation
- Adaptive torque feed forward





Results


Applications Places System
Wed Oct 14, 3:07 PM Anders Sandström
CSS
File Edit Search CSS Window Help
OPI Editor OPI Runtime Data Browser CSStudio
Display
General Motion Fast Slit System Overview Service
Traj 1 Error
Traj 2 Error
Traj 1
Traj 2
Position
Time [ms]
GetSetPosArray GetActPosArray GetSetPosArrayShifted GetDiffPosArray GetSetVelArray GetActVelArray GetFFTorqueArray GetActTorqueArray
anderssandstrom@torbogws3:~
File Edit View Search Terminal Help
[anderssandstrom@torbogws3 ~]$ recordmydesktop
Initial recording window is set to:
X:0 Y:0 Width:1920 Height:1080
Adjusted recording window is set to:
X:0 Y:4 Width:1920 Height:1072
Your window manager appears to be Metacity
Initializing...
Buffer size adjusted to 4096 from 4096 frames.
Opened PCM device default
Recording on device default is set to:
1 channels at 22050Hz
Capturing!
Console
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iocbeckhoffTest - Fi...
CSS
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Conclusions / Summary

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- The feed forward control concept was successfully applied to repetitive movements
- It can compensate position errors in high dynamic processes
- The phase shift compensation is useful for the linear parts of trajectories and the feed forward torque compensates for the high dynamic regions
- This type of adaptive control has the potential to compensate for changing conditions during lifetime
- Beckhoff system has the flexibility to enable us to write and implement this ourselves

Acknowledgements

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- Beckhoff Sweden:
  - Krister Danielsson, Nicklas Bergh