



Status and new Developements in Motion Control at BESSY II

Overview

Beam Positionion Control

Heydemann Correction

Energy Materials In-Situ Laboratory (EMIL)

New Control Scheme for Continuous Mode

Issues with Absolute Encoders

Monochromator Control Program (MCCP) Overview

Undulator

Switching
Mirror

Grating
Chamber

High Order
Suppressor

Filter

Apertures

PSD

Exit Slit

ue491sgm1.adl (auf cree)

About Light on Grating UE49-SGM1

STOP ClearError ZeroOrder Settings Slits/Filt. Continuous Experts Id On

Set Energy(eV) 459.700 Hold OFF ON Linear_Horizontal.idt

Exit slit(um) 200 Track OFF ON Track Off Normal

Photon Energy 459.698 eV

Bandwidth Slit 513.3 meV

Angle Corr. off

SGM PGM

FluxM Filter out out out less

slit(um)@mm	LineDens	Order	cff	Emin(eV)	Emax(eV)	Polaris.	Harm	slope/offset
200 @ 500	410.0	-1	0.550	151.8	548.0	Horizontal	1	1.000 0.000

current 299.2 hor. 0.203 -0.632 0.0203 0.0026 ver. 0.003 -1.087 -0.0293 -0.0057

FE-Apertures upper 0.7000 lower -0.7000 wall 0.3000 ring -0.3000

put 0.1000 in in 0.1000 put put 0.1000 in in 0.1000 put

0.700 -0.700 0.300 -0.300

gap shift(p) shift(a) hor vert

40.628 -0.000 0.000 -6.400 4.000

current xBPM1 xBPM2 eBPMup eBPMdwn Aerotech Undulator remote SMU1

299.2 hor. 0.203 -0.632 0.0203 0.0026 -0.491694 START STOP

ver. 0.003 -1.087 -0.0293 -0.0057 HOMED -0.4917 TrioBoards gap-dest. EMEC More Displays

FE-Apertures ready 125 85 101 84 158 connected 40.628 parallel FE-Pinhole

upper lower wall ring

0.7000 -0.7000 0.3000 -0.3000

put 0.1000 in in 0.1000 put put 0.1000 in in 0.1000 put

0.700 -0.700 0.300 -0.300

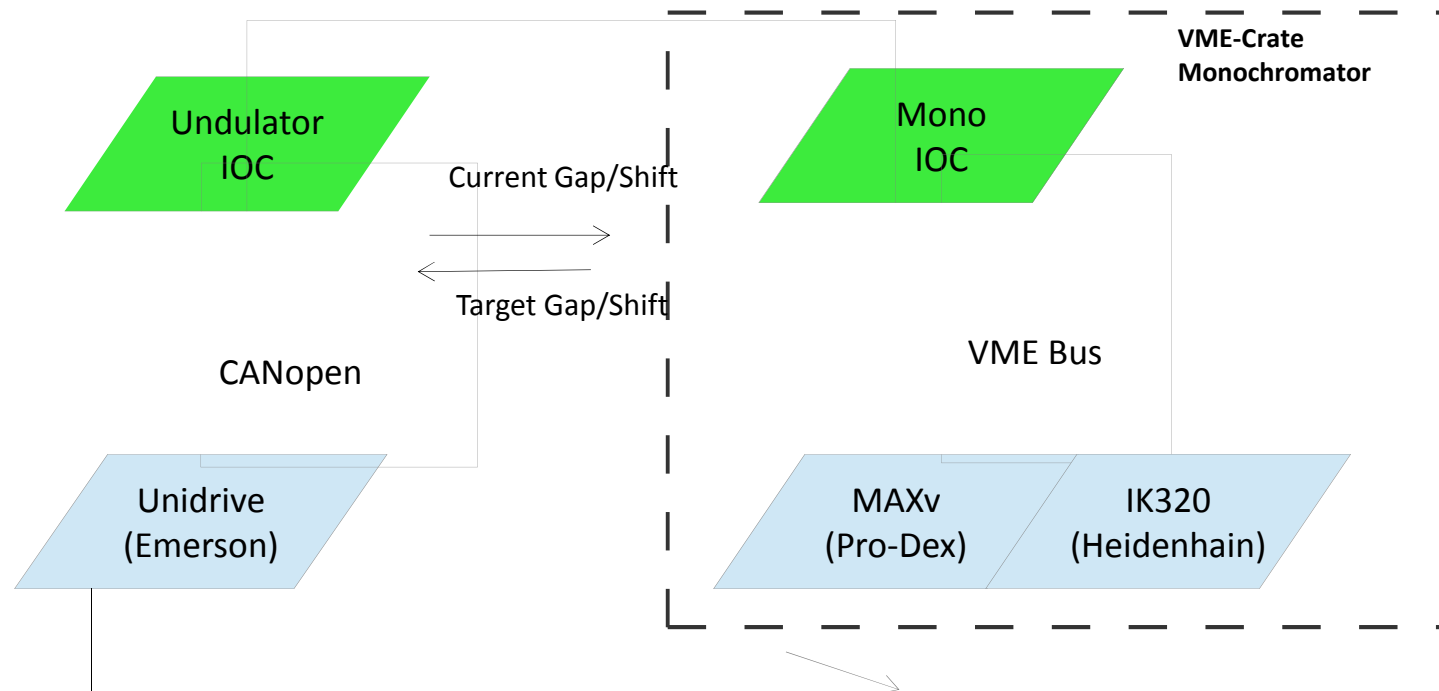
gap shift(p) shift(a) hor vert

40.628 -0.000 0.000 -6.400 4.000

Monochromator Control Program (MCCP) Overview



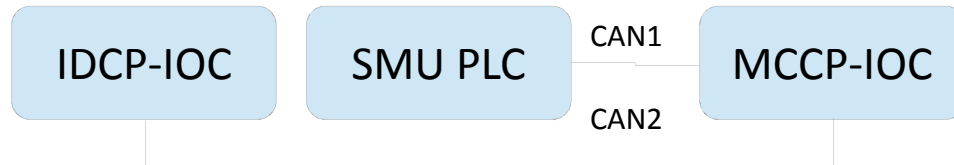
Beamline Control Scheme



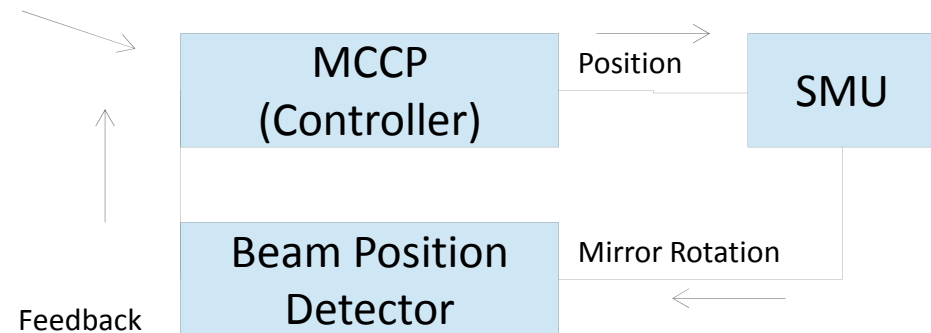
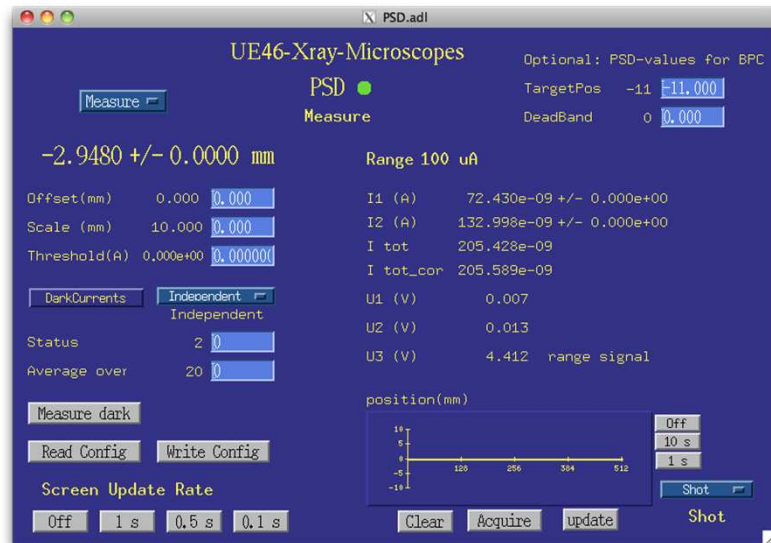
EnDat 2.2

- Position Feedback via CANopen
- Monochromator IOC: MVME162 (Motorola)
VME6/OMS58/MAXv (Pro-Dex)
IK320 (Heidenhain)
- Undulator IOC: MVME 2100 (Motorola)
Unidrive SP (Emerson)

Beam Position Control



- Full LoCuM Support:
- Configuration via RS232 Interface
- DAQ of 4 Channels up to 4kHz
- Drift of beam position
- due to temperature changes.
- Compensation by moving M1



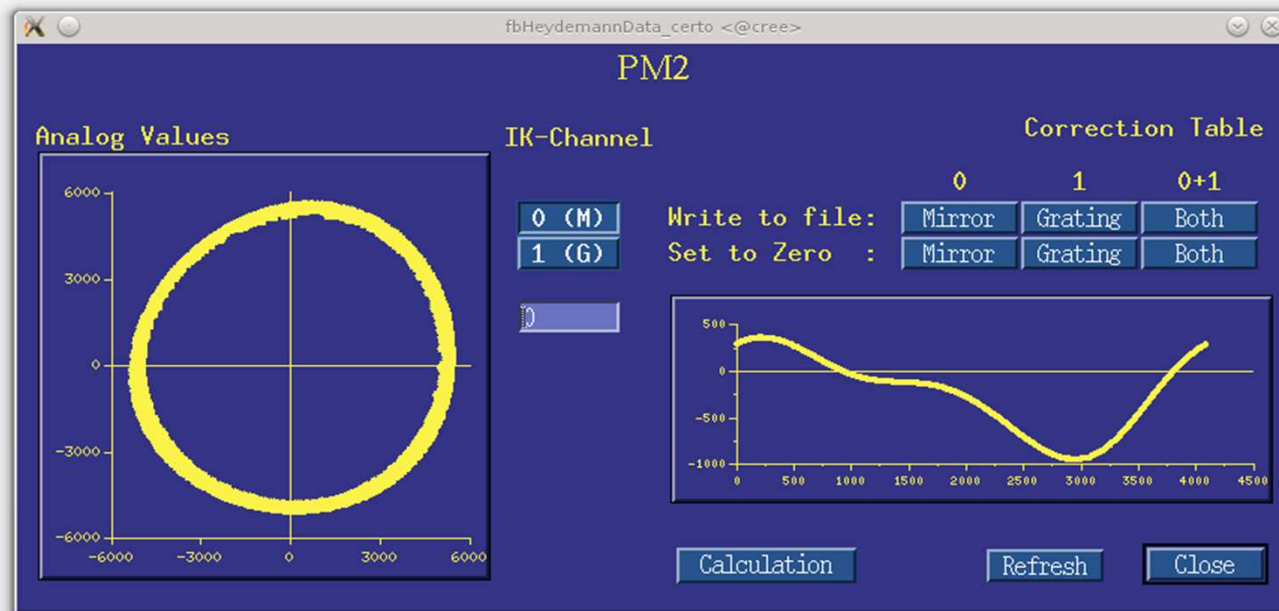
Feedback Support Modules

Feedback Support Modules are being created for specific hardware (Encoder Cards, Laser Inter

Used for beamline diagnostic, closed loop systems (feedback), optimisation (e.g. Heydamann (

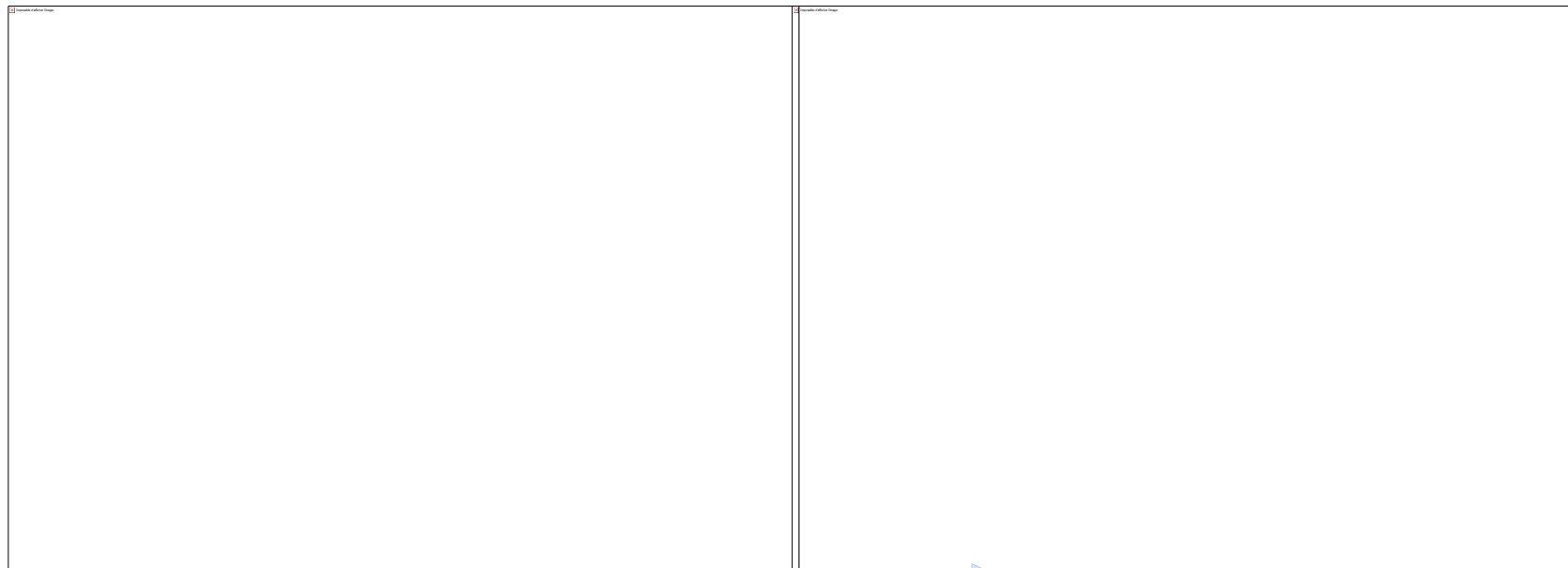
DAQ up to 4kHz

Can be triggered on special events or continuous.



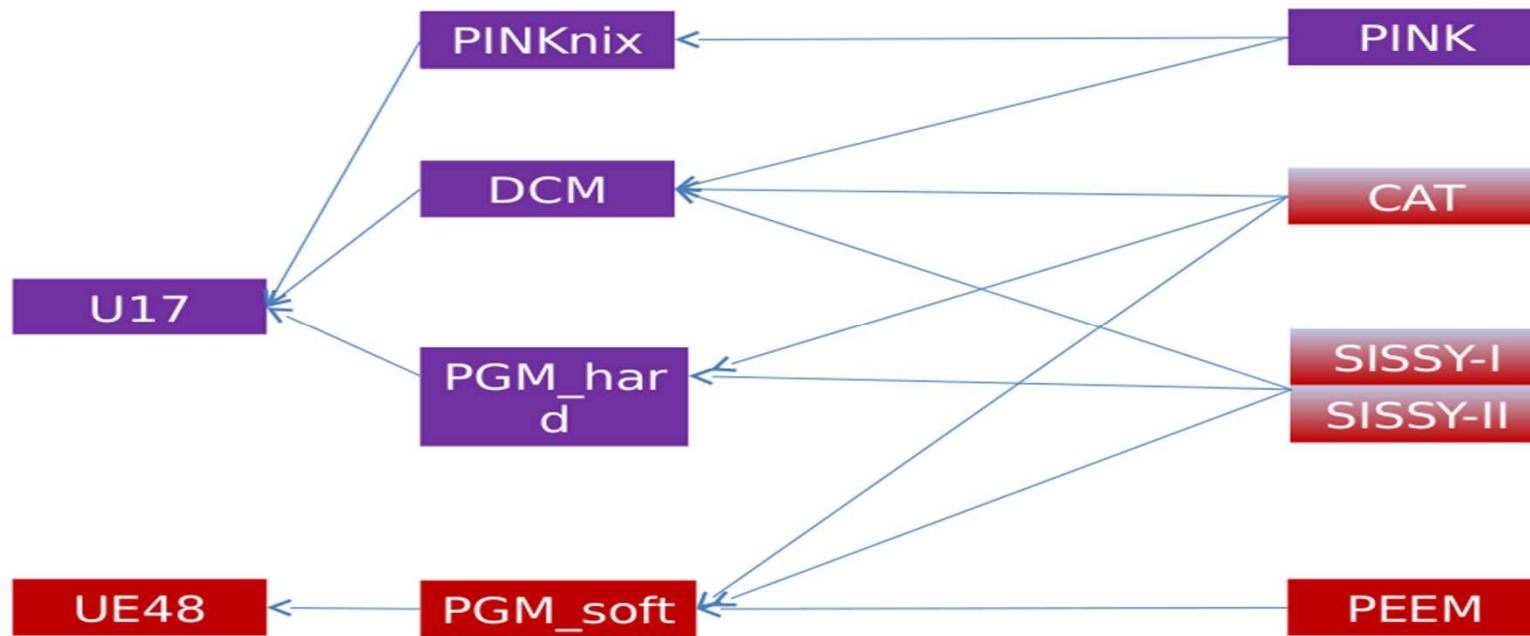
Heydemann Correction

The Heydemann Correction is the determination and correction of quadrature errors of th
This has to be done if anything is changed on the encoder system (cable, interpolator card



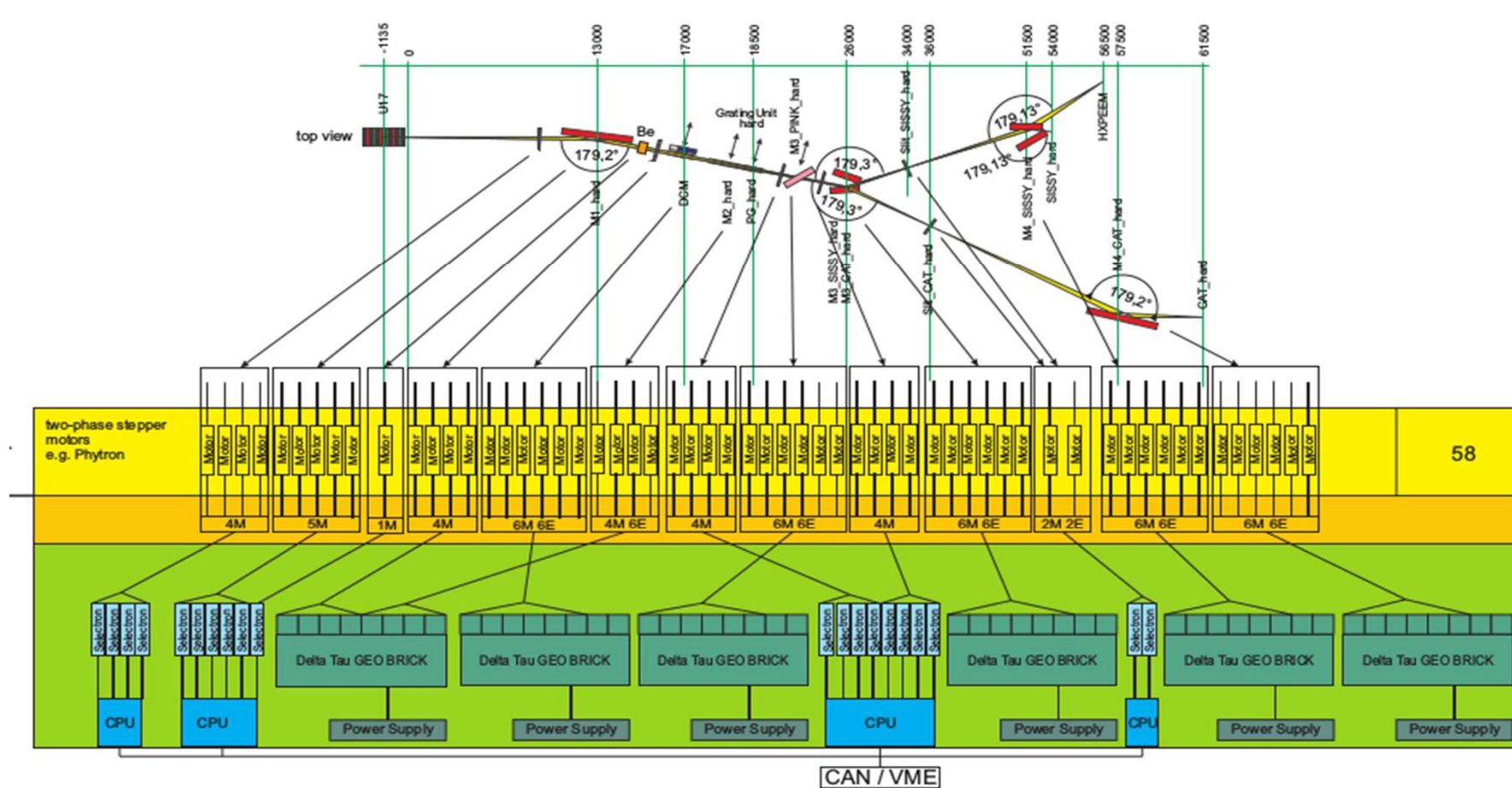
Correction of all 4 RON905 signals.

EMIL Beamline Layout



- ~ 150 Axes
- PGM, Hexapods and DCM with absolute encoder Renishaw Resolute REXA
- ES with incremental encoder Renishaw Tonic
- Aperture without encoder

EMIL Hardware Overview

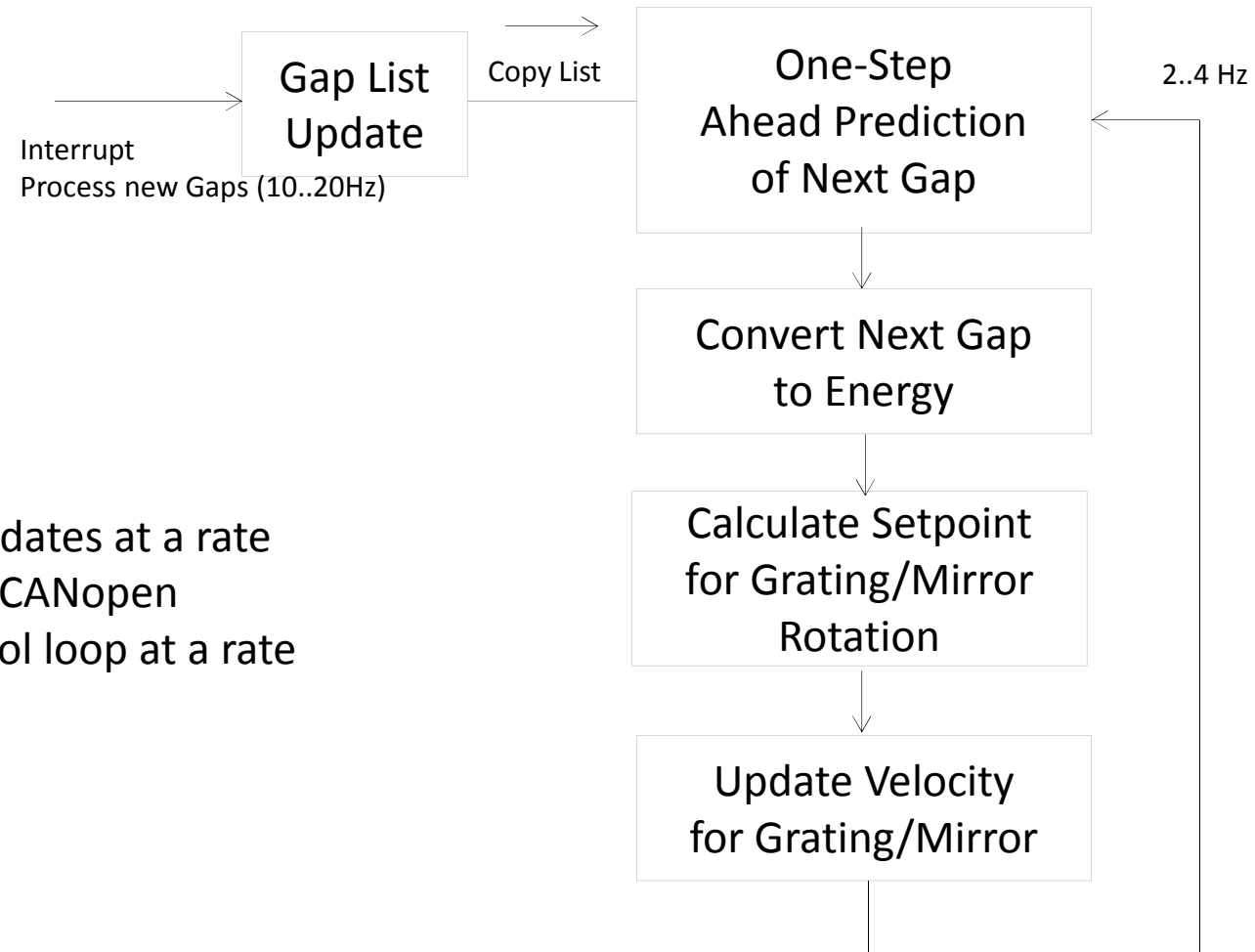


- Geobrick LV IMS II
- Selectron PLC with Motion Module
- VME Crate as slow control IOC
- Unidrive SP Emerson

Geobrick LV IMS II

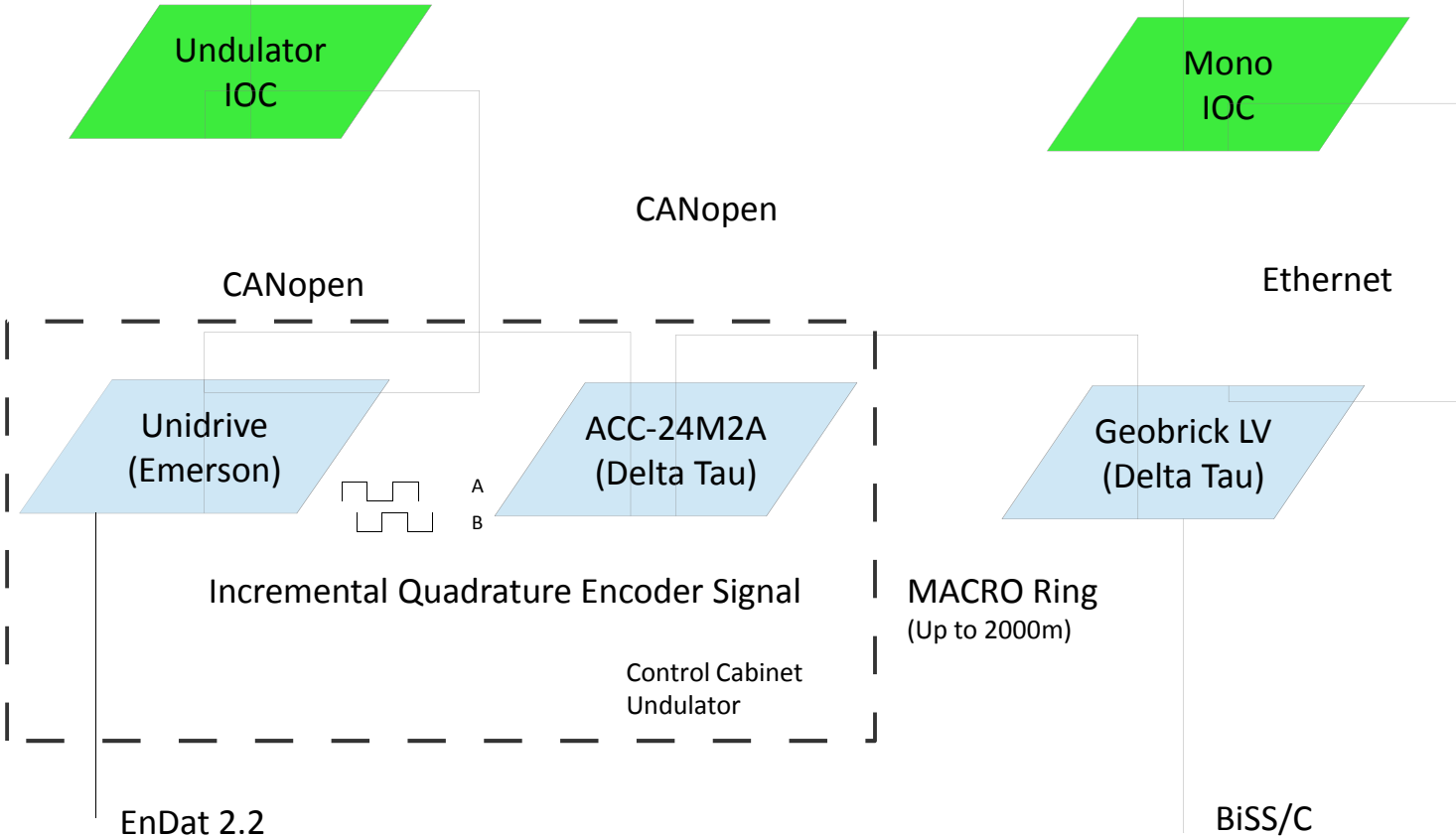
- 240 Mhz DSP
 - * Stepper in Open-loop
 - * Non-Linear Control Scheme
 - * Complex Fwd/Inverse Kinematics
 - * Encoder Filtering, Collision Check, Watch Dog
 - * Following Error, Motor Current
 - * Undulator Look-up Tables
- BiSS/C Absolute Encoder
 - * No Reference Procedure
 - * No Signal Correction
 - * Delay Compensation (up to 80m@4MHz)
- MACRO Bus
 - * Undulator Gap/Position ACC-24M
 - * DAQ for PSD and BI Diagnostics ACC-52M

Continuous Mode – Data Flow and Processing



- Gap position updates at a rate of 10..20 Hz via CANopen
- Predictive control loop at a rate of 2..4 Hz

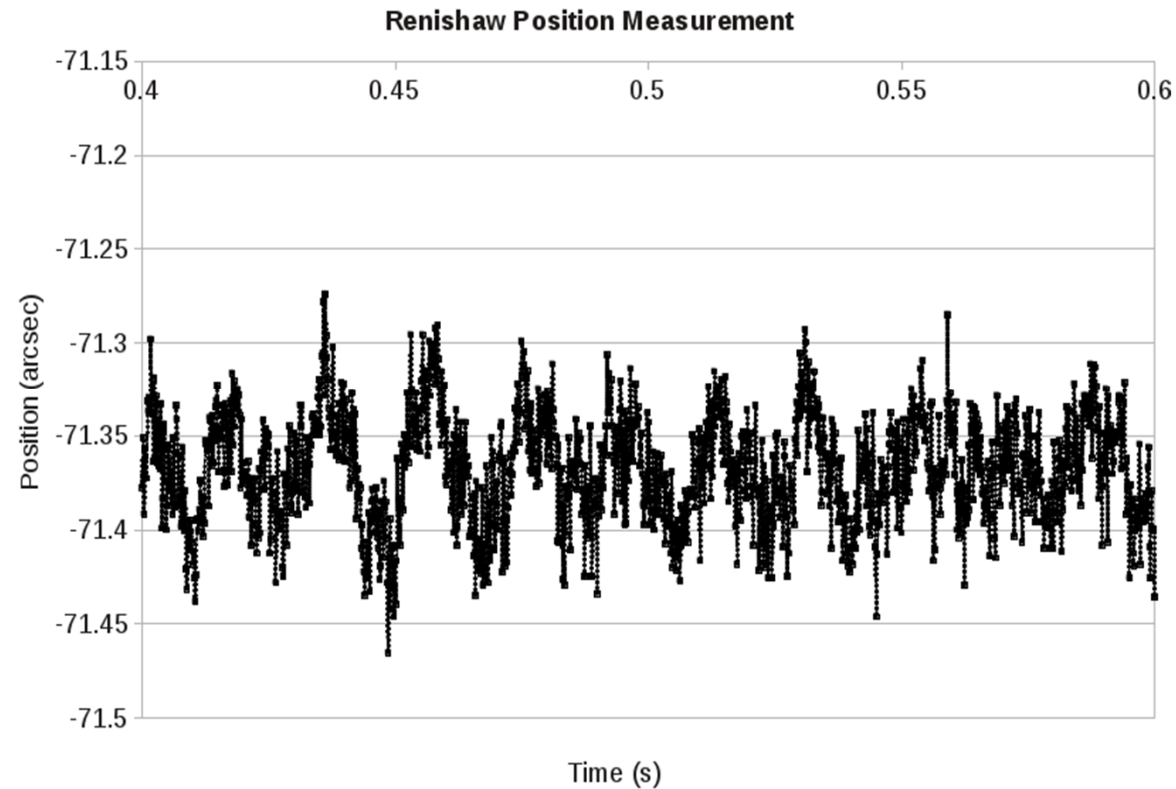
Continuous Mode – New Implementation for EMIL



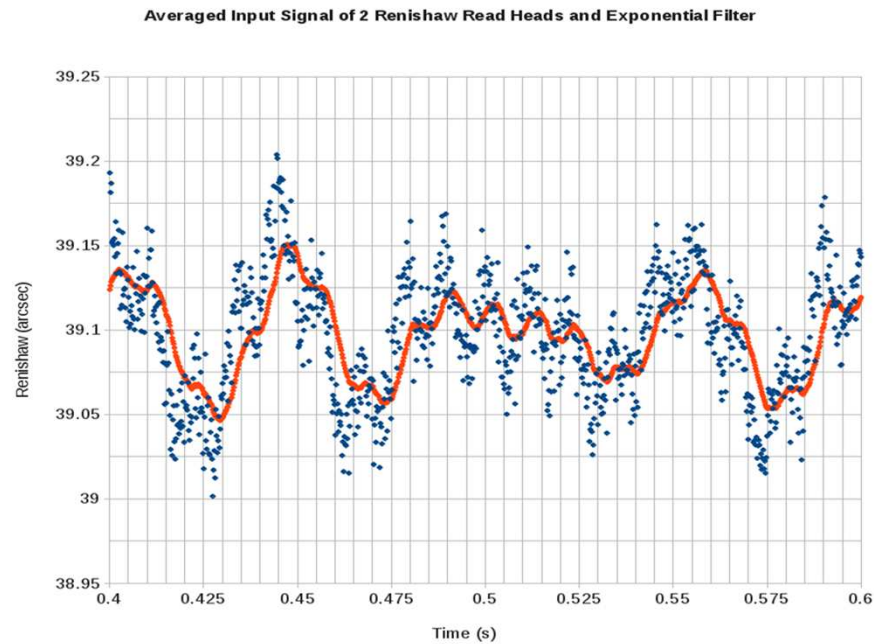
- Motion controller connected via non deterministic Ethernet to IOC.
- Hard real time position feedback via encoder signal from undulator to the motion controller of monochromator.
- Slow control providing lookup tables from monochromator IOC.
- Generated smooth output to monochromator stepper drives using splined moves on motion controller.

Renishaw Resolute 32Bit BiSS/C

- Cable Length 20m
- Digital Resolution: $360^\circ / 2^{32} = 0.301748514$ marcsec
- Tested Sample Rate 4..10 kHz at 1MHz Serial Clock
- Disturbance: standard deviation $\sigma=0.028$ arcsec
- Voltage drop on long cable length

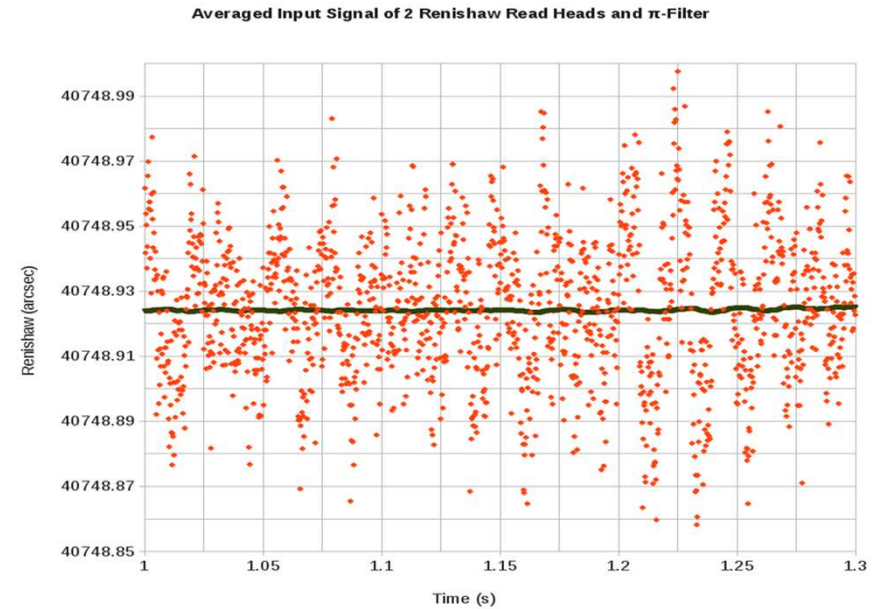


Position Measurement (BiSS/C) and Position Filtering

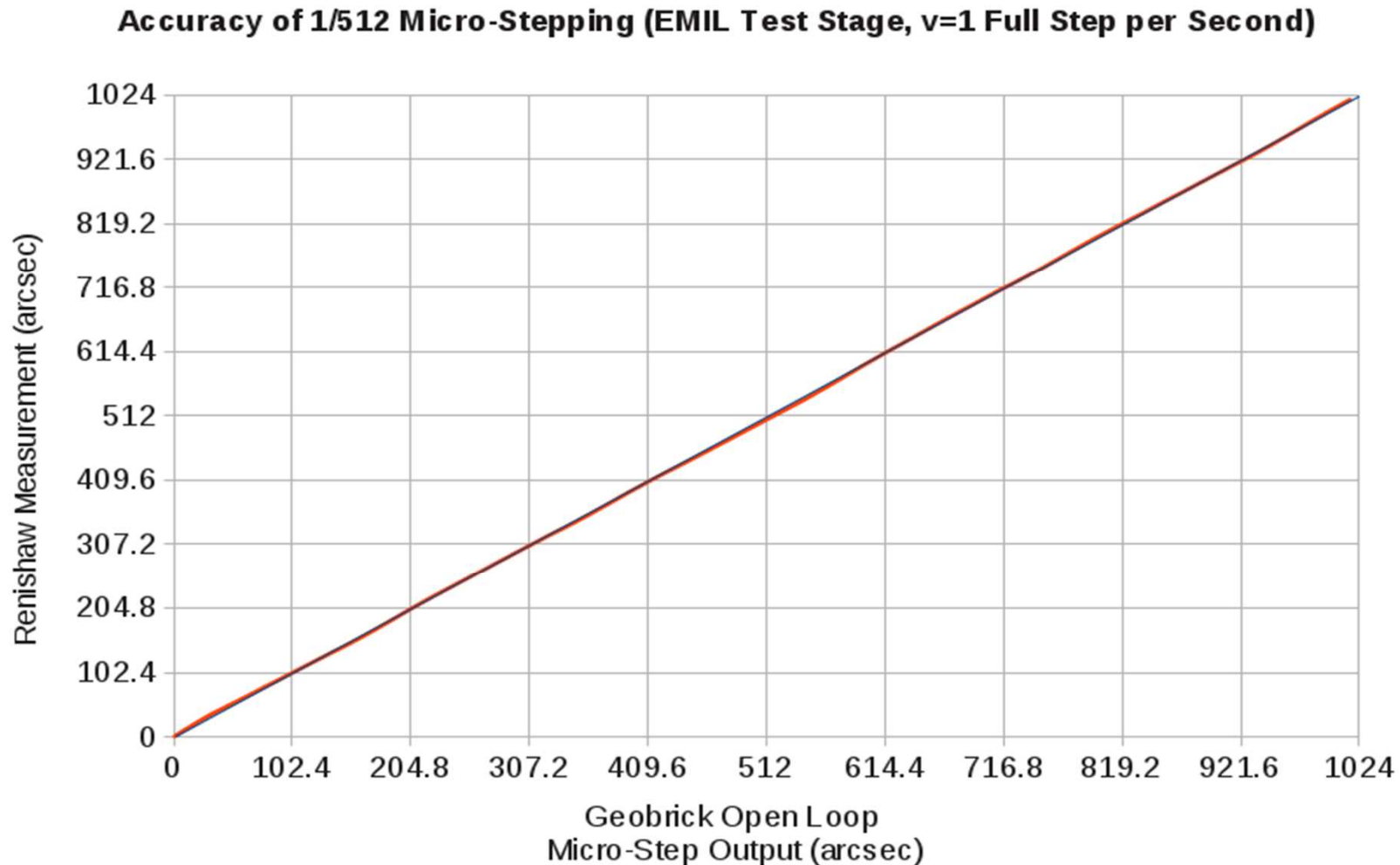


Exponential Filter used for
Closed Loop Positioning

Moving Average Filter for
Monochromator Position



Accuracy of Micro-Stepping on Test Sage

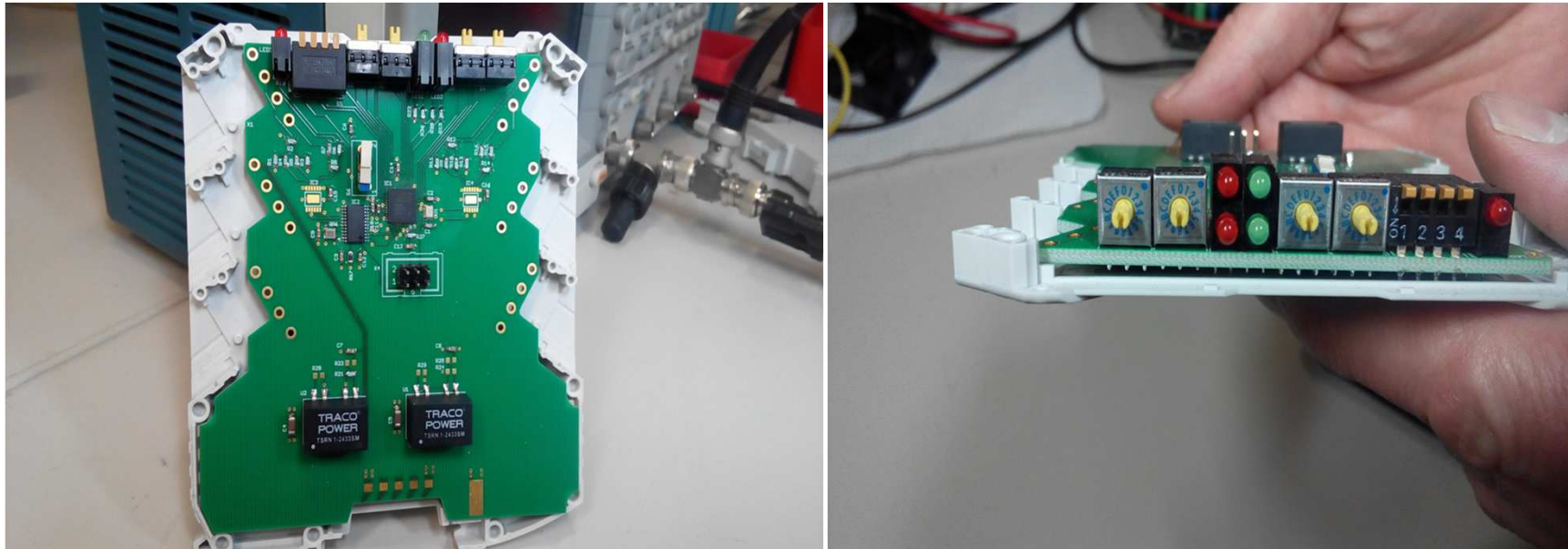


Accuracy of open loop micro-stepping better than 1/10 full step.

1 Micro Step ≈ 0.19 arcsec

1 Step $\approx 0.19 * 512$ arcsec ≈ 100 arcsec

BiSS/C to SSI Converter



- SSI as Industrial Protocol for Absolute Encoder
- Different Clock Speed
- BiSS/C 32 Bit \leftrightarrow SSI 27 Bit
- Delay Compensation
- Up to 2.5 kHz sample Rate on SSI side
- Further questions to roland.fleschhauer@helmholtz-berlin.de