STATUS OF THE CONTINUOUS MODE SCAN FOR UNDULATOR BEAMLINES AT BESSY II

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Continuous Mode – Energy Scans

- Mono and ID move separately to intermediate target positions.
- Stable flux for long measurements.
- Dwell and settling time for each move.
- Communication software overhead.

- Mono and ID cover the whole range of a scan in a non-stop coupled motion.
- Depending on application ~5 times faster than step mode.
- Reduced radiation exposure time.
Continuous mode software first employed 2006.
17 beamlines support continuous mode 2015.
3 new beamlines under construction requesting continuous mode.
Continuous Mode – Current Implementation

- Position Feedback via CANopen
- Monochromator IOC: MVME162 (Motorola)
  VME6/OMS58/MAXv (Pro-Dex)
  IK320 (Heidenhain)
- Undulator IOC: MVME 2100 (Motorola)
  Unidrive SP (Emerson)
• Monochromator follows motion of undulator gap position.
• Undulator energy calculated from lookup table using up to 3rd order polynomial interpolation or cubic splines.
• Trajectory needed for grating and mirror calculated using grating equation and conditions (fix focus, fix beta, fix theta).
• IK320 counter card and angle encoder RON905 ensure high encoder resolution.
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 – (Soft) Limits on Following Error (FE)

- Intensity modulations < 2% limiting tolerable difference between monochromator energy and undulator energy (FE).
- Undulator bandwidth decreases with higher harmonics.
- Inaccurate undulator lookup tables would have great impact on this limit of the FE.
Continuous Mode – Feedback Module

- EPICS based library designed for RT DAQ
- CM diagnostics plugin
- Interrupt triggered processing
- Two datasets consisting of four data arrays
- Phi, Psi, monochromator energy, undulator energy
- Data alternately copied to EPICS record layer
- Continuously filled by feedback task
- camonitor for user feedback
- Evaluation of the data after the scan
Continuous Mode – RT Position Data Acquisition and Scheduling

- Data acquisition rate up to ~ 4 kHz.
- Depending on data processing by the feedback plugin.
- Hardware triggered after data processing.

VxWorks auxClock Interrupts

IK320 DAQ delay time after trigger.

Feedback Read Data and Processing
Other Tasks

Highest Priority
• CAN Jitter has big impact on stability.
• Needed for further diagnostics, tuning, and optimization procedures.
• Correction of energy scale by correlating feedback data with experimental data.
• Complex filters on feedback data to remove disturbances.
Continuous Mode – Experimental Validation

- Molecular Nitrogen absorption spectra taken.
- Step mode vs. continuous mode at a velocity of 0.1 eV/s.
- Monochromator energy feedback data had been taken at a rate of 800 Hz.
Continuous Mode – Limitations

- The undulator moves gap with constant velocity.
- Fixed shift.
- Shift is at optimum for elliptical polatisation.
- Direction reversal prevented by monochromator software.
Continuous Mode – Possible 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.
● A stable and robust control scheme running on 17 beamlines.
● Following error within the limits imposed by higher undulator harmonics ensuring flux modulation < 2%.
● Energy scans possible over the whole energy range of ID-Harmonic
● Monochromator Modi are preserved (e.g fixed focus, fixed beta, fixed theta)
● Diagnostic tools essential for further development.
● Data acquisition at a rate up to 1 kHz for monochromator energy and axes positions offered to users.
● Deterministic communication between monochromator and undulator needed for current implementation.
● New control scheme needed for new beamlines with hardware connected via non deterministic Ethernet.