NSLS-II Motion Controls

BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

U.S. DEPARTMENT OF ENERGY | Office of Science

NSLS-II Motion Controls

- Overview
- Controllers
- Instrumentation
- Applications and software
- Experiment integration
- Successes and failures

NSLS-II Overview

- 7 operational beamlines, 15 in development
- Approaching 1000 motors in service
- Mostly steppers, a few brushless servos, many piezos of different types
- Most axes encoded, typically with incremental encoders.

Motion controllers

- Stepper and servo motor controller – Delta Tau GeoBrick-LV
- Brick Controller and PowerPMAC for specific applications
- Vendor-supplied controllers – Delta Tau and Newport
- Piezo controllers – SmarAct, Attocube, PI, PiezoJena, nPoint etc.

Standard NSLS-II motor controller

- Standardized on Delta Tau GeoBrick-LV
- Used for most stepper and servo motors
- Custom interfacing to NSLS-II standards
- Standard and low current versions
- Variants for absolute encoders and MACRO

Other motor controllers at NSLS-II

- Mostly Delta Tau, except for piezos
- Delta Tau Brick Controllers on insertion devices
- Vendor supplied Delta Tau solutions for some beamline components
- Newport, Galil and Aerotech controllers being delivered with new beamline components

Piezo motor controllers

- Wide range of piezo motors used, particularly in endstations
- Application specific requirements drive selection
- Attocube, PI, PiezoJena, SmarAct, nPoint etc.

Motor types

- Most motors are two-phase steppers
- Some brushless servos
- No standard manufacturer
- Most fall in the current range supported by standard GeoBrick-LV (0.25 A – 5.0 A)

Encoders

- Most axes have encoders
- Most encoders are incremental
- Renishaw TONiC is preferred incremental encoder, but not mandatory
- Some axes have absolute encoders, where homing is difficult
- Standard absolute protocol is BiSS-C
- Renishaw Resolute is preferred absolute encoder

Other instrumentation

- Limit switches
  - dry contact, normally closed is standard
  - active limits supported, but not preferred
- Very few home switches
- Critical axes have overtravel limit switches to directly kill power to drives

Interface software

- EPICS is standard control system
- Using GMCA/Diamond-developed EPICS support for Delta Tau
- Motion commands implemented through EPICS motor record
- Additional detailed status obtained from Delta Tau

Interface software

- Growing number of controllers requires additional software modules to support

Motion controller software

- Delta Tau programming standards adopted from Diamond
- Standard configuration as starting point
- In-house developed controllers adhere well to this standard
- Using standard Delta Tau features, including PLCs for protection and homing, coordinate systems for virtual axes.

Non-Delta Tau controller software

- Most non-Delta Tau controllers have minimal configuration or custom software
- Piezos have none

Upcoming applications

- Monochromator energy
- Dual monochromator synchronization
- Monochromator – undulator energy synchronization across MACRO interface
- Insertion device control

Experiment integration

- Current experiments run using step-scanning
- Most will migrate to fly-scanning
- Options for fly-scanning
  - Delta Tau generated position triggers
  - Delta Tau capturing positions based on external trigger
  - External box (e.g., Zebra) reading encoder and generating position triggers

Successes

- Standardization of controller, instrumentation, interface definitions
- Close collaboration with a number of vendors, assisting them with development using NSLS-II standard controller

Failures

- Vendor-supplied insertion device control software complex and unreliable
  - Failure on our part to work with them closely enough
- Encroachment of other stepper motor controller types
- Didn’t standardize on encoder vendor pinout for custom controller

Questions?