

Implementation of the EPICS Software Feedback Loop at BioCARS

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- Needed feedback systems for BM and ID double crystal monochromators
 - Beam stability during experiment
 - Speed up energy scans
- Relative humidity experiments

Options?

- Hardware solutions
 - Commercial PID controllers
 - MOSTAB
- Software
 - Enhanced PID record (EPICS, Mark Rivers)
 - Analogic DVX 2503 (ADC)
 - Acromag 9210 (DAC)

EPID could do everything we needed without the need to buy additional equipment!!!

Save money, time, and provided a more flexible system.

pid_control.adl

BMD_feedback_loop

Readback PV: 14BMD:mono_pid1 incalc.

Control PV: 14BMD:DAC1 6 PP NMS

Setpoint: 1.11840

Feedback:

More

pid_parameters.adl

PID feedback parameters

KP: -0.80000 P: -0.00112

KI: 8.00000 I: 5.52916

KD: 0.00000 D: 0.00000

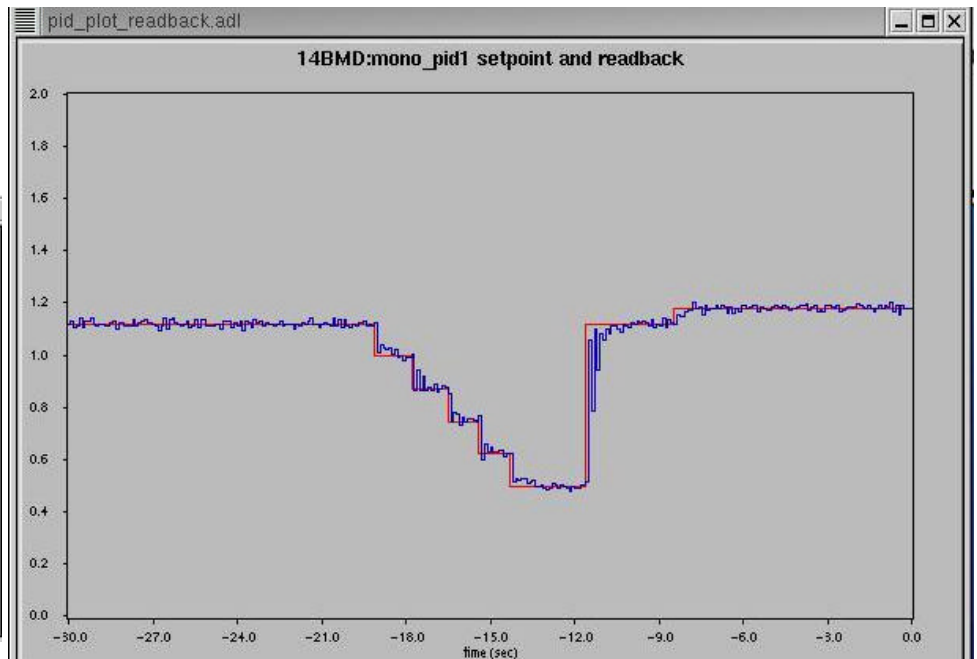
Delta time: 0.10000

Error: 0.00140

Output: 5.52804

Low limit: 0.00000

High limit: 10.00000



userTransform_full.adl

PID input calculation

4BMD:mono_pid1_incald

PROC: 5 2=Less

ENABLE ALL

CONTENT	INPUT PARAMETER	EXPRESSION	VALUE	OUTPUT PARAMETER
A	Goal Post	14BMD:DVX 6.VAL NPP	1.12047	
B	Ring current	S:SRcurrentAI NPP NMS	102.12395	
C	Ops @ PV		101.06090	
D	Peak Voltage		1.24254	
E	Set Point	0.9*D/C*B	1.12118	14BMD:mono_pid1.VAL I
F			0.00000	
G			0.00000	
H			0.00000	
I			0.00000	
J			0.00000	
K			0.00000	
L			0.00000	
M			0.00000	
N			0.00000	
O			0.00000	
P			0.00000	

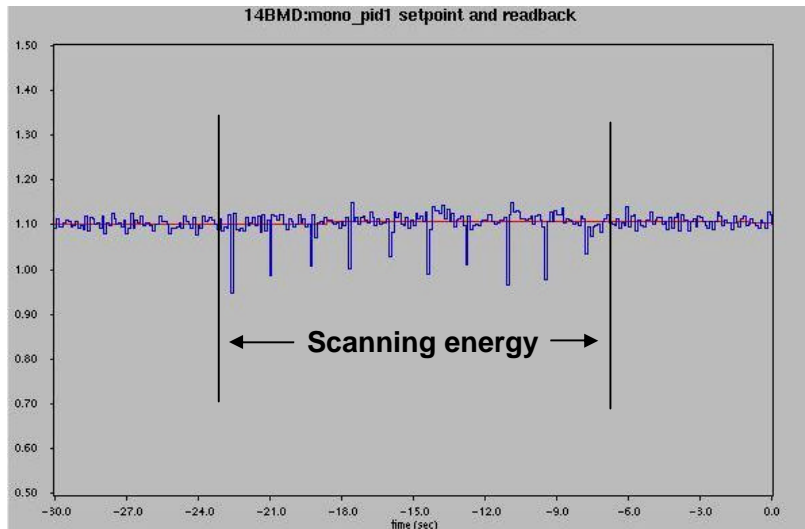
maximum: 2.00000

minimum: 0.00000

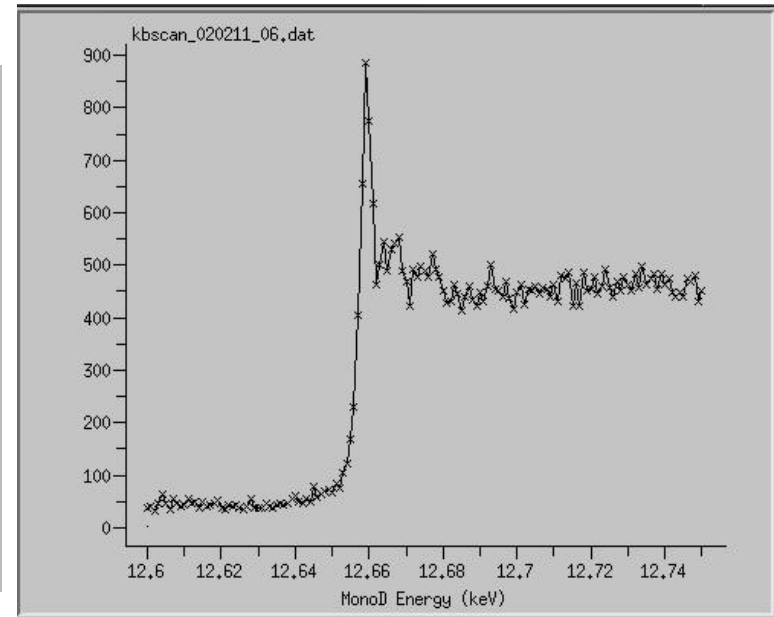
Replot

- Monitor intensity at a diode downstream of the monochromator
- Normally lock onto 85-90% of the maximum peak intensity
- UserTransform record is used to deal with changes in the ring current (decay)

Results....Great!



Plot of peak intensity over time



Selenium edge scan

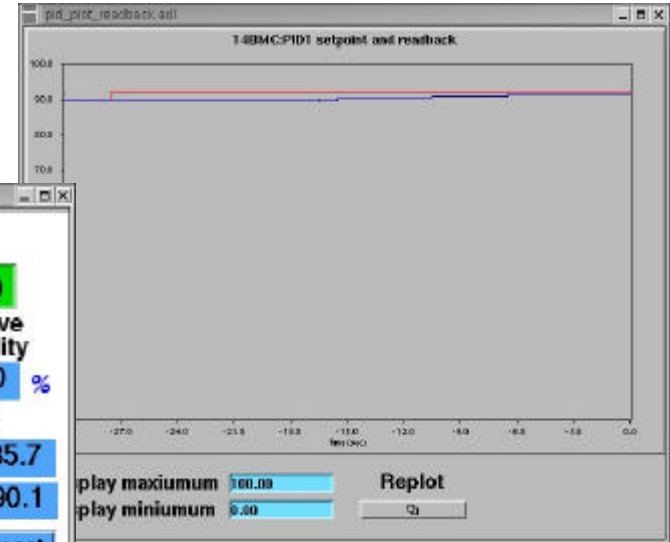
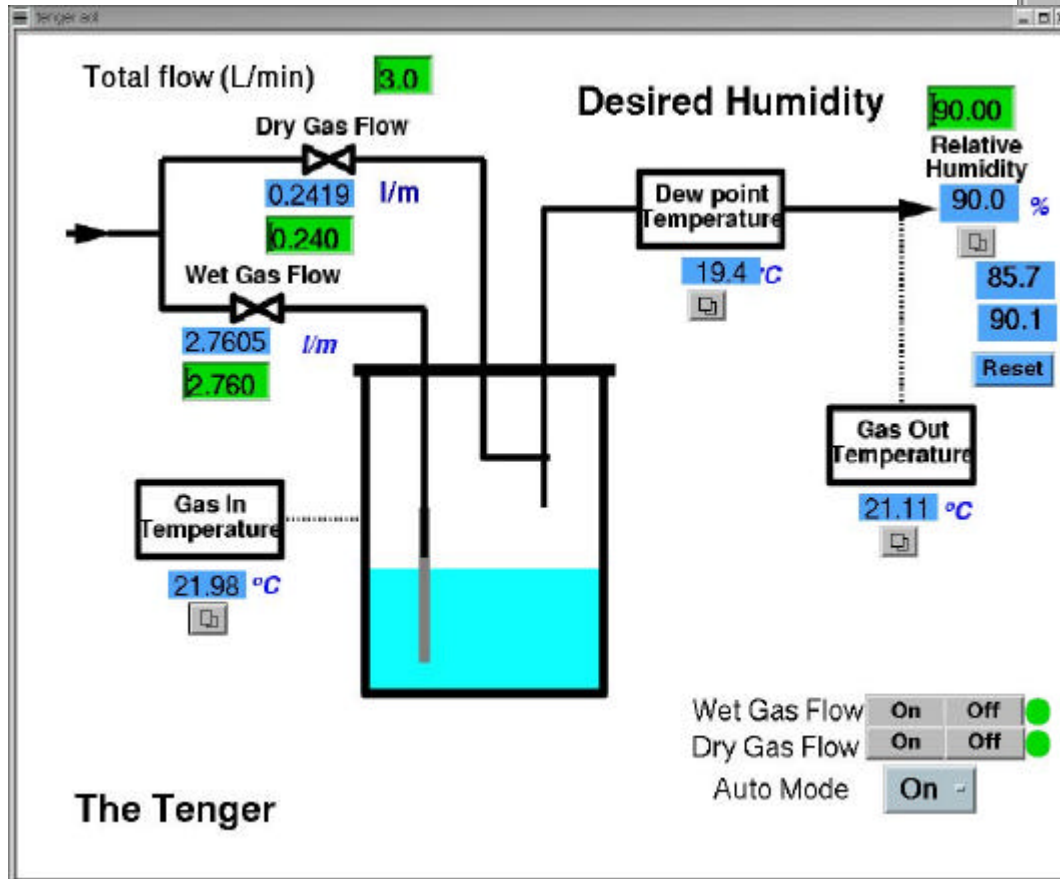
- No more drift in beam intensity
- Reduced time to do an edge scan from ~20 min. down to ~3 min.
- Currently using "Slow" feedback
 - Limited response time of 10 Hz
- Could implement "Fast" feedback
 - Up to 10 kHz

Relative Humidity Experiments

- Wanted to improve crystal quality
- Needed to control the humidity around a sample during a data collection
- Wanted to have everything under computer control

Relative Humidity Experiments

MEDM interface

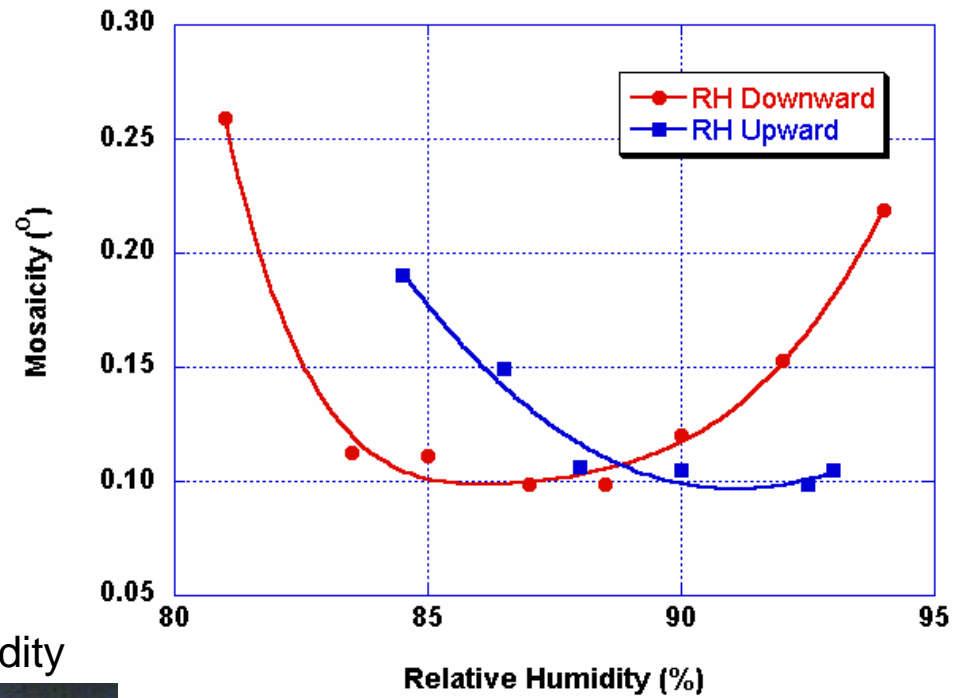
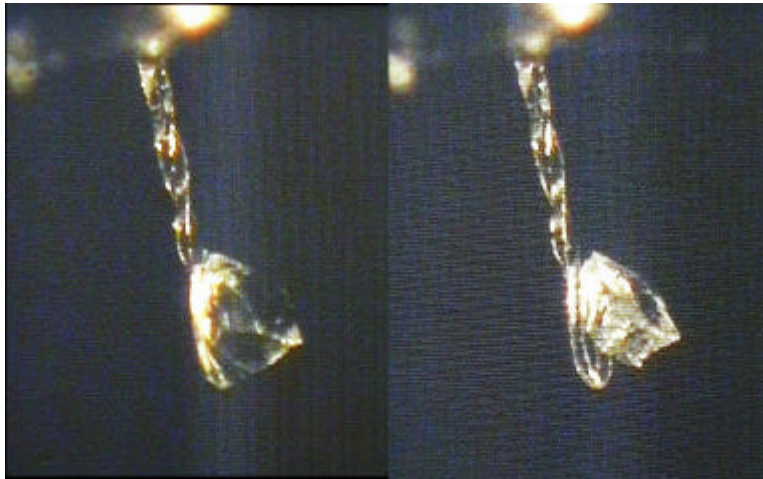


- MKS Instruments MASS-FLO controller (RS232)
- NesLab water bath RTE-221 (RS232)
- EdgeTech dew point meter (DAC/ADC)
- LakeShore temperature controller (GPIB)

Lysozyme Crystal

High humidity

Low humidity



- Hysteresis
- Higher mosaicity at high and low relative humidity's

Work done by T.-Y. Teng, CARS

GSECARS Applications of EPID record

- Monochromator second crystal feedback:
 - Feedback on beam position on 13-ID, using photo-diodes in-vacuum slits, measuring scattered radiation from in-vacuum slits
 - Feedback on beam intensity on 13-BM, using table-top ion chamber.
 - Recovers gracefully from beam dumps. PV available to indicate “feedback locked”, which data acquisition programs can wait for.
- Furnace temperature control in the large-volume press in 13-BM-D and 13-ID-D. Safety checks to limit voltage, current, and power.
- Pressure control in the large-volume press, via hydraulic pump, in 13-BM-D. Can ramp pressure up and down using scan record to control setpoint
- Temperature stabilization via laser power control in the laser-heated diamond-anvil cell in 13-ID-D.