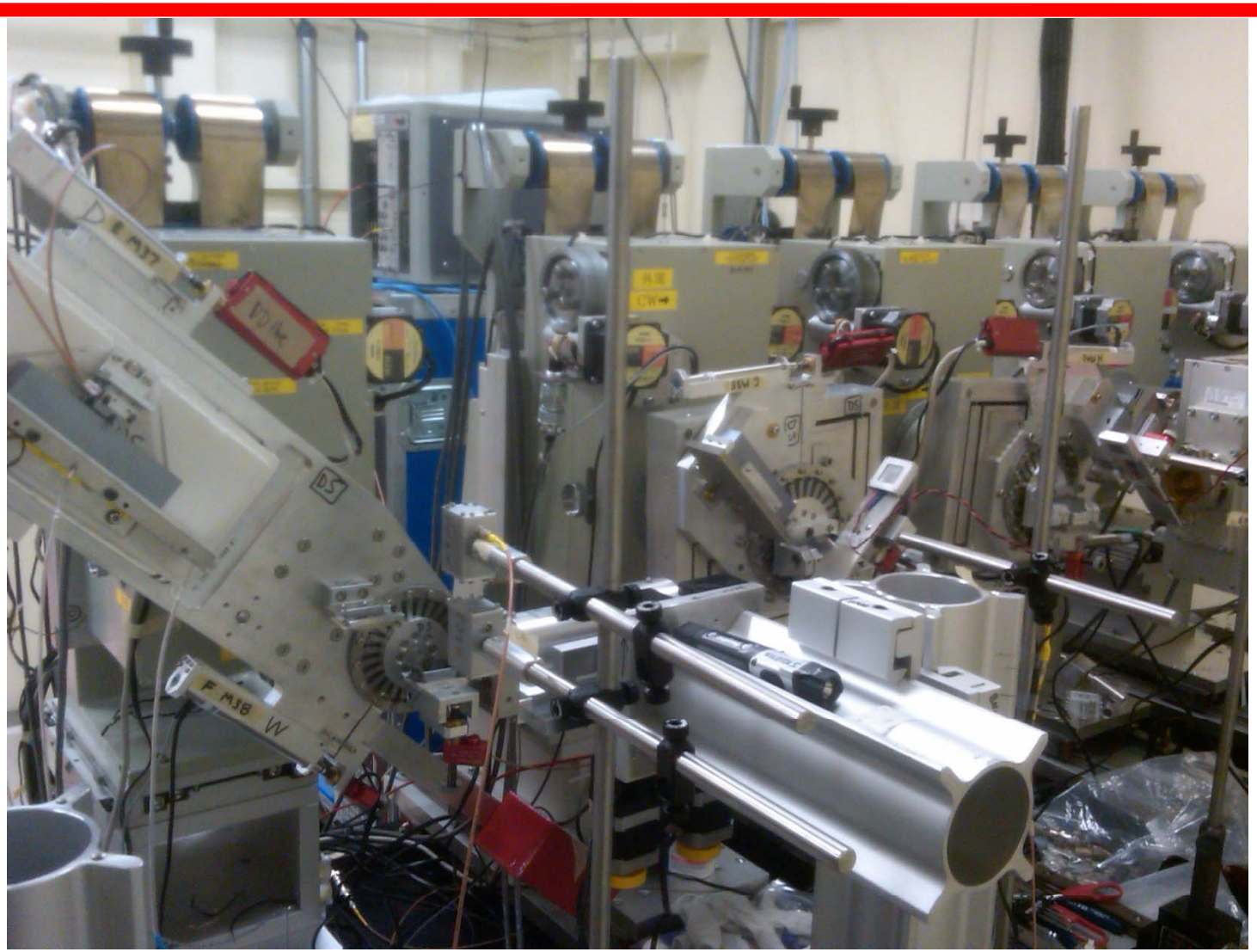
IXS R&D @ SPring-8 Jan 2012



debrief 2012.02.02

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U.S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES

A work with many contributions

- Yong Cai – NSLS-II IXS group POC
- Scott Coburn, Stephen Antonelli – 4B flexure characterization, temperature controls and testing
- Alexey Suvorov – 4B crystal design, imaging and diffractometry methods
- Nalaka Kodituwakku – crystal processing and metrology
- Alessandro Cunsolo – experimental design
- Jeff Keister – system integration, detectors, controls, methods, logistics
- Leo Reffi – designer (all parts)
- David Levy – fabrication (all parts)
- Michelle Scaduto – shipping and travel support
- Kaz Gofron, Daron Chabot, Wayne Lewis – epics controls support
- Chiharu Takami – logistics and badging support at SPring-8 BL12XU
- Nozomu Hiraoka – beamline support at SPring-8 BL12XU
- Ku-Ding Tsuei – BL12XU POC
- Yoshiki Kohmura – beamline support at SPring-8 BL29XUL, coordination of darkroom facility access
- Yasuko Matsumoto –badging support at SPring-8 BL29XUL
- Tetsuya Ishikawa – access support at SPring-8 BL29XUL (RIKEN Coherent X-ray Optics Laboratory)

Run Timeline

- Jan 18-19 Setup (no beam)
- Jan 20 x-ray beam start. CDW aligned.
- Jan 21 aligned CS 4B crystals, observed azimuth miscut
- Jan 22 measured mediocre results for CS 4B. Exchanged 4B crystals for BNL ones, restored good result
- Jan 23 Measured motion for trapezoid actuators & Kohzu goniometers; collected D crystal lattice uniformity data
- Jan 24 Increased D crystal temperature by 1 & 2 degrees
- Jan 25 Measured final 4B & CDW scans at 2 degrees above RT; packed up mobile system
- Jan 26 Topography of 4B crystals at BL29XUL

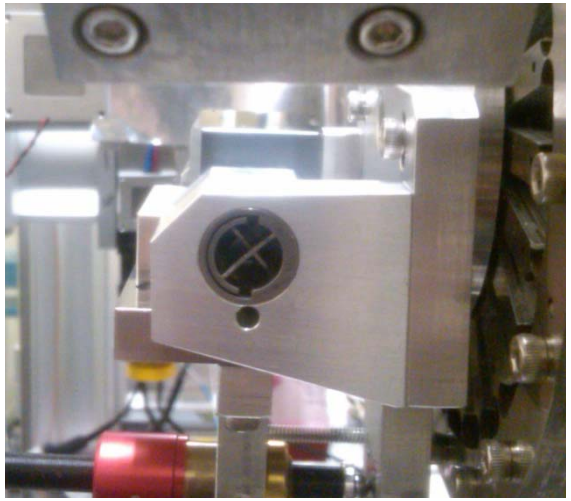
Run Goals

- Check CS A/B crystals
- Check 4B trapezoids at ~10 nrad level with x-rays (since interferometer not sensitive enough)
- Accumulate additional D lattice uniformity data
- Check D crystal temperature control
- Collect topography data
- Confirm Petra-III result for 4B-CDW resolution, efficiency, lineshape
- Improve understanding of implementation details, individual crystals along the way

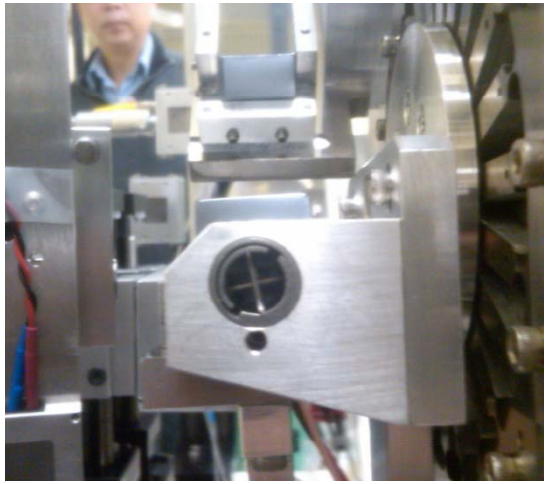
Run result: CS Crystals

- Resolution ~1.5x that seen at Petra-3 using BNL crystals (0.87 µm vs 0.6 µm)
- Efficiency: ~ 15% (was ~18%) (*neglecting air*)
- Obvious chi offset

➔ NOT SO GOOD!



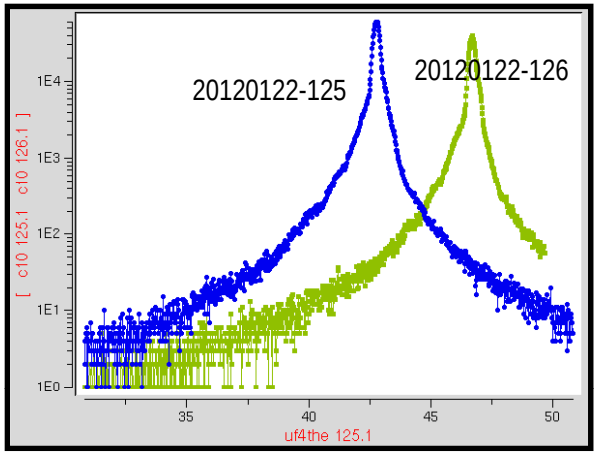
A1 (upstream)



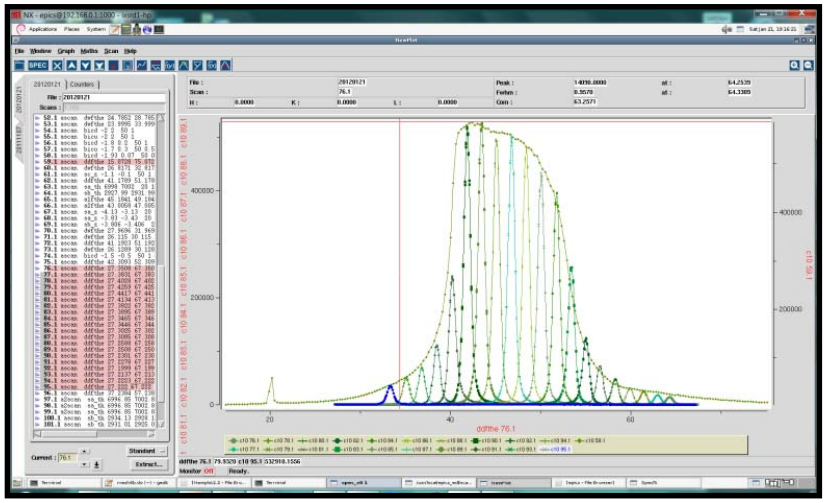
A2 (downstream)

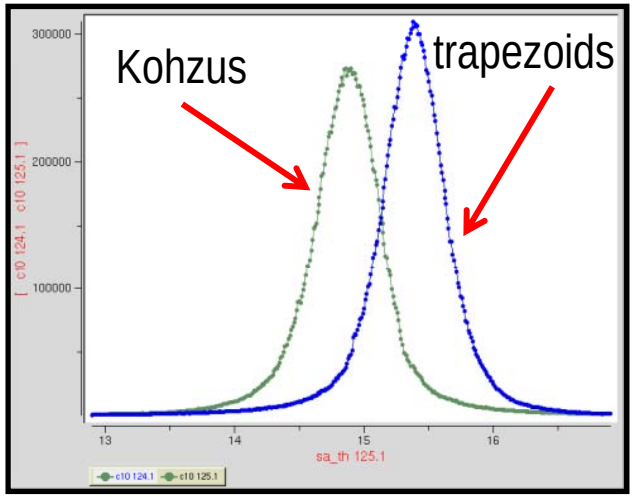
Run result: 4B trapezoid

- Lost motion in + direction
- Too much load?



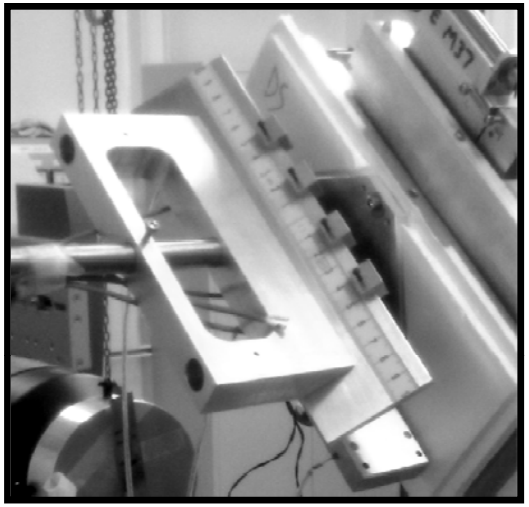
- Kohzu result seems pretty good!

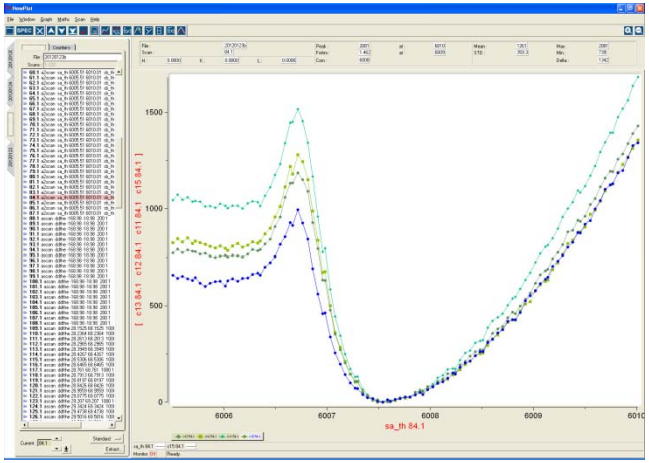


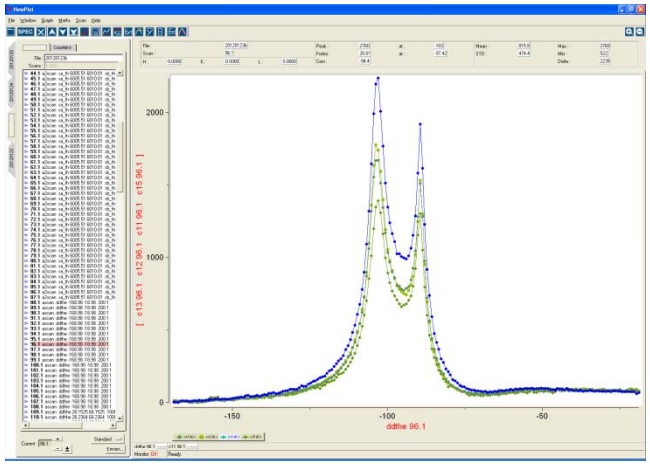


Run result: Uniformity Test

- 4 diodes spaced 30 mm apart
- Energy / Angle and Angle / Energy grids collected (to be analyzed)
- Utilized Keithley / V2F signal chain

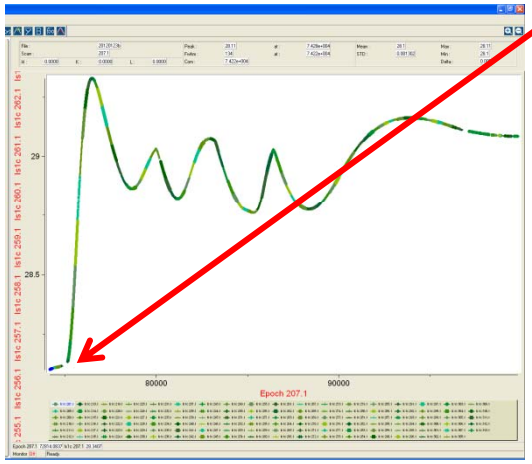




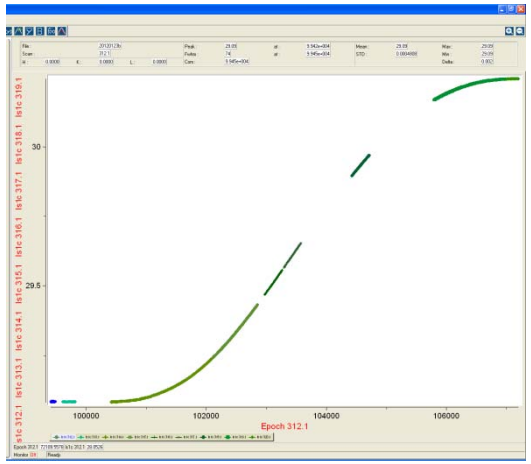


Run result: Temperature control

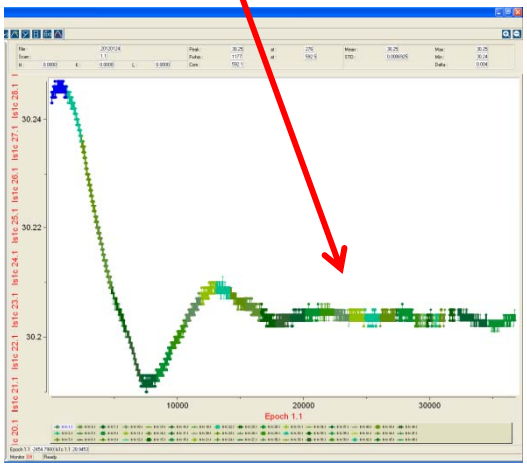
- Oscillations observed; crystals add significant thermal mass?
- Ultimate performance seen: < 1 meV combined at ~ 1 mK/h stability over 4 hours (room temp ~ 10-100 mK/h)



Original PID settings (40,5,10)
Oscillation for ~ 5 hours

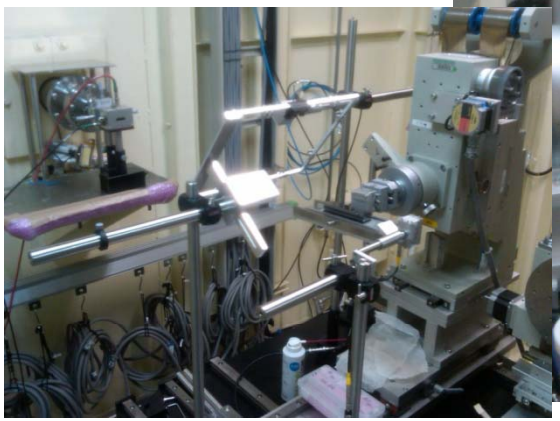


PID settings manually optimized (5,3,0) for 1 A range (8.1%)
~ 1 degree in >1.5 hours

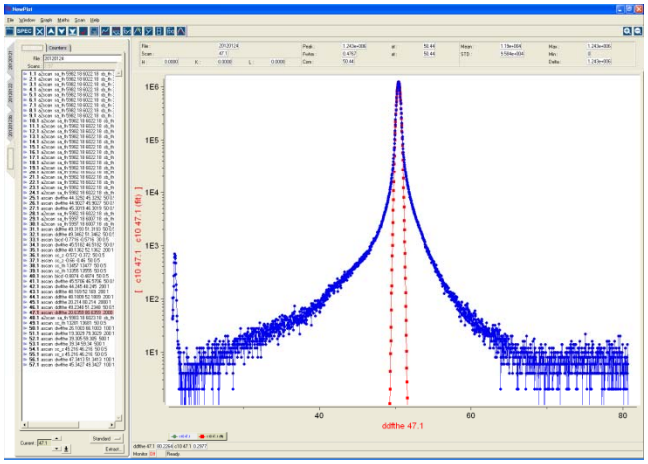


Run result: Topography

- All A & B crystals imaged in 1 8-hour shift, including setup/alignment at BL29XUL, chemical prep/cleanup, and development.
- Limited control of exposure time (< 2 seconds).
- Crystal and beam quality looks v. good, CS crystals may have measureable skew.

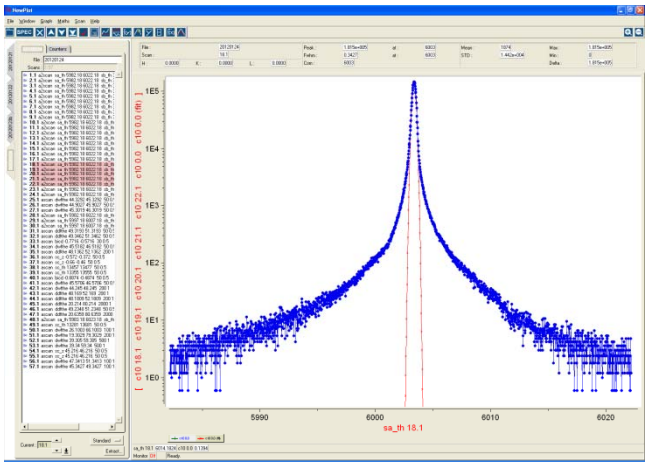


Run result: 4B-CDW confirmation



D rocking curve: 0.509 µm
(4.45 µrad): 1.06 meV TOTAL
(**assuming 8.75 µrad/µm per interferometer calibration)
Efficiency: 24% neglecting air

Compared to
0.63 µm (1.3 meV)
Efficiency 18% neglecting air



4B rocking curve: 0.348 µrad
~1.16 meV TOTAL**
(**assuming 0.300 µrad/ meV??)

COULD NOT DO THIS LAST TIME
(Kohzus better here)

Steps along the way

Energy setting

Phase 1: 4Bounce alignment and test

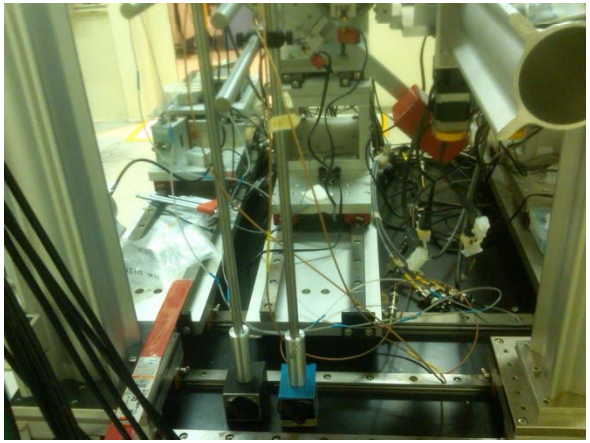
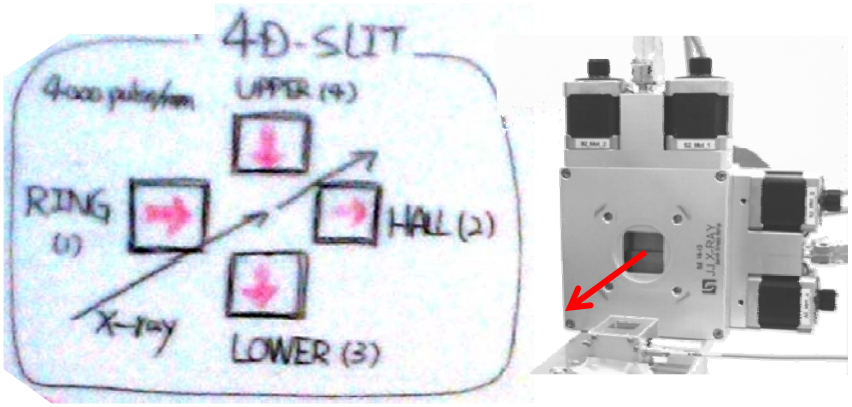


Table arrangment (detectors and motor cables)

Ready for next user!

Notes on the implementation at SPring-8

- Slit convention (CCW ring)
  - H hall (outboard, what we would call -x)
  - R ring (inboard, what we would call +x)
  - T top ➔ U upper
  - B bottom ➔ L lower or D down

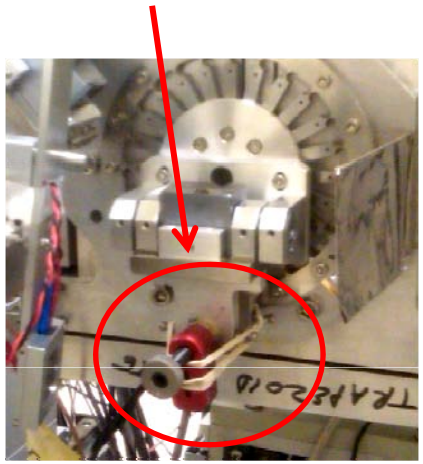


+ motion is *AWAY FROM MOTOR*

Control system at BL12XU=EM
Control system at BL29XUL=homebrew

Issues

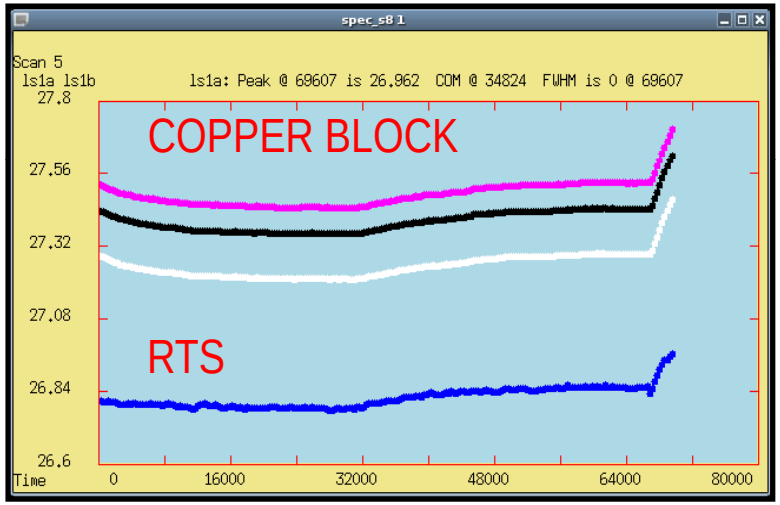
- 1 instance of CL pico jamming at + limit
- 1 pico 4-wire coupler found NG
- CDW has D offset from C?
- Shims don't match BNL A crystals
- Power trip(s) at BL12XU
- One mini diode channel noisier than others
- APD pulse tripling when teed to beamline
- Some PI drivers still not working
- A chi return springs much weaker than flex pivot (rubber band used)



the SPring-8 Environment

Super strong doors and hutches
(pneumatic or AC motor)

Temperature controlled environment of the hutch and experimental Hall: data available.
(need quantification, comparison with PETRA-III)



(Estimate 10-100 mK/h over 4 h)

BL12XU Hutch underpowered?

Power trips occurred when Keithleys were added 1/23 (don't draw much)

“Power” tools used

- “super paper” (gafchromic XR-QA2) (ours!)
- Cross line laser level (*ours!*)
- Xray Imaging camera from Princeton Inst.
- Digital level (~0.05 degree accuracy), unfortunately somewhat bulky
- NSLS-built APD

- “MINI” Diode Boxes

NOT USED THIS RUN (could be useful later)

Remote visible cameras

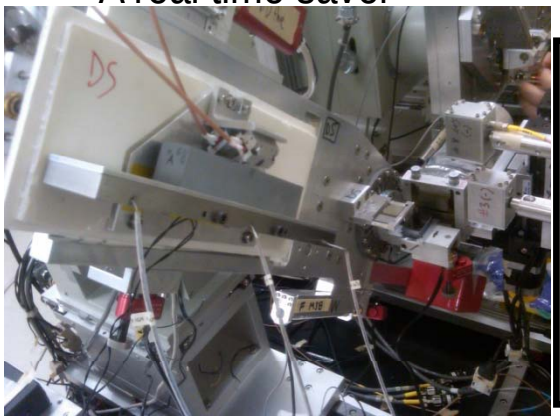
New “mini” diodeboxes

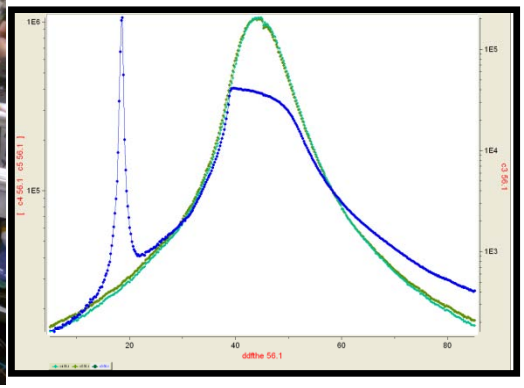
The newest and smallest member of the diodebox family

5 boxes for 10x10 diodes made just for this trip

Dual arrangement for D phi setting:

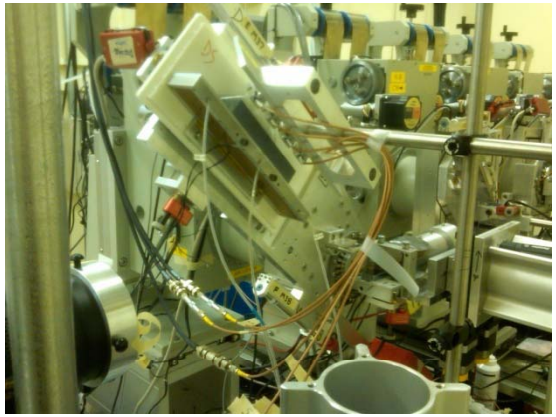
- A real time saver





440 same position AND intensity

Slide arrangement for uniformity test



Controls performance (EPICS etc)

- New Keithley 428 implementation worked like a champ
- New i404 over-range alarm worked like a champ
- NX gave NO issues using updated client configuration (directdraw disabled). Observed slowdowns on server side (2-3x) due to Newplot
- PI E621 controller still gives a few wrinkles
  - Resolution and deadband used how? We set to 0.001 µm
  - Retries used how? We set to 0
  - Upon powercycle, disable/enable sequence required, in addition to re-assertion of last actuator setting (reverts to 0)
- Lakeshore application difficult to use, some readbacks apparently missing
- CSS channelarchiverviewer not reporting data older than 3-4 hours, LS temperatures not archived?

Shipping improvements

- Palettes and straps
- Laser level with shipping documentation

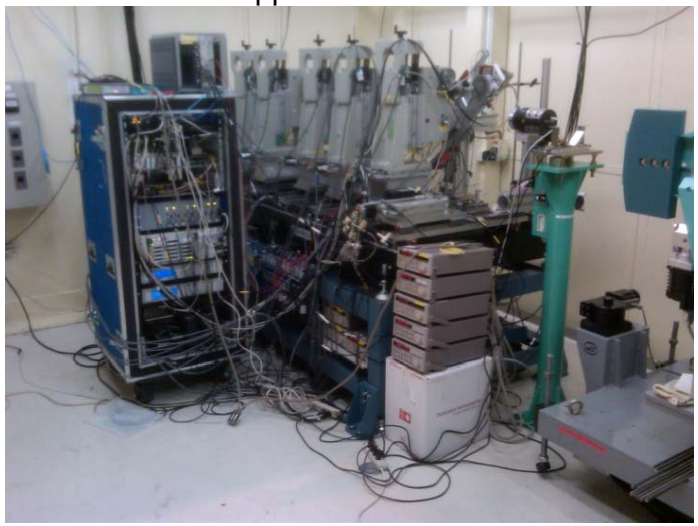
Ready for pickup at BNL bldg 703 East.

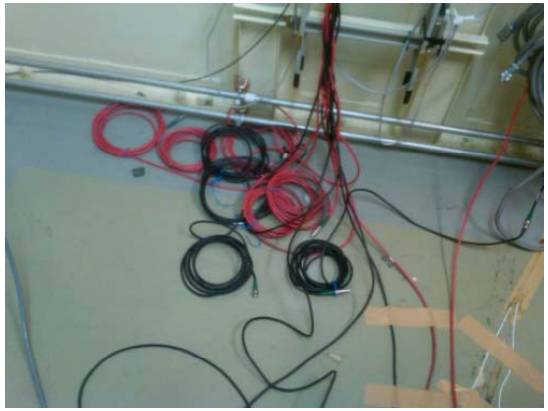
As delivered to SPring-8 BL12XU
Note BNL shipping added the saran wrap

Latest on return ➔ to be picked up at SPring-8 Feb 2

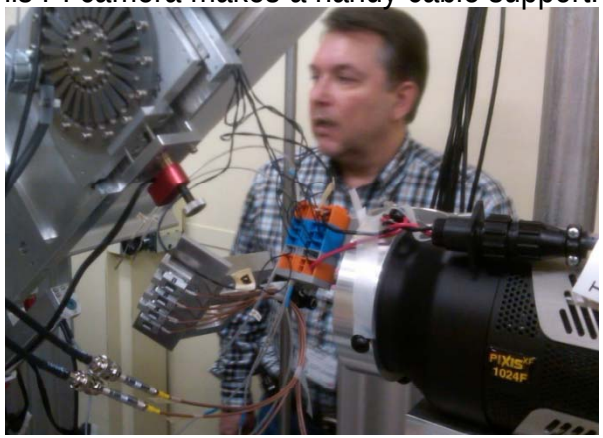
Cable management… Can we do better?

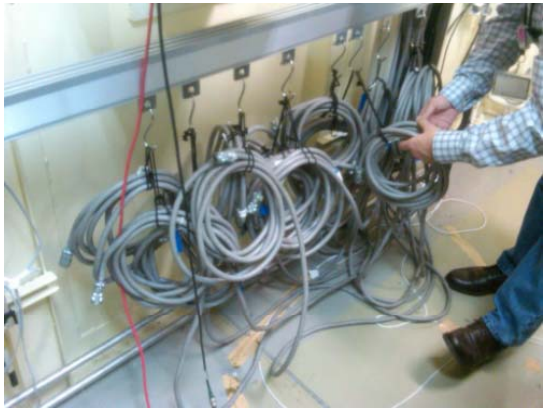
Is this what it's supposed to look like?





This PI camera makes a handy cable support.

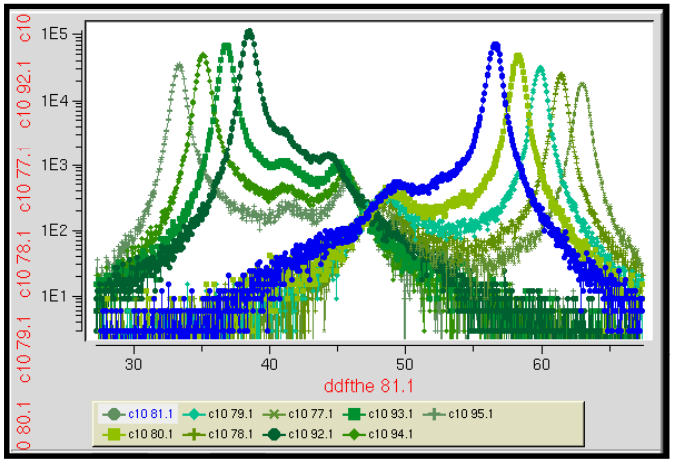




"Typical" beamline hutch cable management at SPring-8

Mysteries

- Additional (weak) peak seen in CDW scan after 4B
  - Was seen at Petra-III also
- Kohzu goniometers at SPring-8 better than the ones at Petra-III?
  - Drivers?
  - Mechanics?
- Why can't CS get it right? What is the key?
  - Substrate?
  - Surface finishing?
  - ?



More to come

- Detailed analysis of resolution, lineshape, and efficiency
- Individual crystal reflectivities summary (see paper log book)
- Topography analysis (scan films)
- Uniformity data preparation and analysis
- Temperature data analysis