On–the–Fly Scanning at the SLS Material Science Beamline

by

David Maden

Beam Group, SLS
CH–5232 PSI–Villigen

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Captions and Notes

Slide–A: Title page.

Slide–B: This page.

Slide–C: Captions and Notes (continued).

Slide–D: Schematic diagram of Powder Diffractometer (PD) on the Material Science Beamline (X04SA) at SLS.

Notes:

a) Analyser arm with 5 analyser crystals.
b) Multistrip detector possibility.

Slide–E: Detailed diagram of the Analyser Arm showing the 5 analyser crystals.

Slide–F: On–the–Fly Data Flow Diagram

Notes:

a) "OTF Reader" is spawned by "on–the–fly" at start–of–run. It reads encoder and scaler values from the hardware, synchronised to the ioc ticks, and pipes them to "on–the–fly".
b) on–the–fly receives piped data from "OTF Reader" and writes it via NFS to disk.
c) The vxWorks pipe is used as a buffer so that tick synchronisation is not lost when data is written to the NFS file server.
d) The data is written to file in SDDS ASCII format. The file header contains information such at encoder resolution, etc.
e) The scalers free–run during the scan. Data is read directly from the VME modules, not from the EPICS records. Max scan rate is 60 Hz.
f) The EPICS Soft PVs are used to control the scan from the host. For this, there is an medm interface as shown in the next slide.

Slide–G: medm Interface for On–the–Fly Scans.

Notes:

a) The Start/Stop button is a Shell Command object. This launches a Python script on the host, which performs the scan. The motor is moved to the start position at normal speed; the speed is then set to obtain the required scan duration; the motor is started and the ioc instructed to start data acquisition via an EPICS channel.
b) The run ends when the motor stops moving. A scan can therefore be interrupted at any time by simply stopping the motor.
c) The scan rate is set via the "Ticks per Point" field on the "Setup" related display.

Captions and Notes (continued)

Slide–H: Extract from Data Read–out Code.

Notes:

a) Data is read as fast as possible to obtain maximum resolution whilst the motor is moving.

b) If the motor has an associated encoder, the hardware encoder register is read out from VME. If the motor does not have an encoder, the step count register of the motor controlling card is read out from VME.

Slide–I: Example data from a calibration On–the–Fly Scan.
The data from the 5 scalers have been rebinned and merged.

Scan Duration	= 1 hour
Number of Raw Data Points	= 21745
Measurement frequency	= 60 Hz
Effective bin width	= 1.16 arcsec

Slide–J: Same as Slide–I showing data from the individual scalers.

Slide–K: Raw Data for 1 Peak of 1 Scaler of Scan shown in Slide–I.
The raw data of the beam monitor is also shown.
Number of points in plot = 619 (i.e. ~ 10 secs).

Slide–L: Early normalised data from a 1 MHz pulser.

The "OTF Reader" is running at the vxWorks default priority of 100 and there is no pipe to buffer data before it is written to disk. Note:

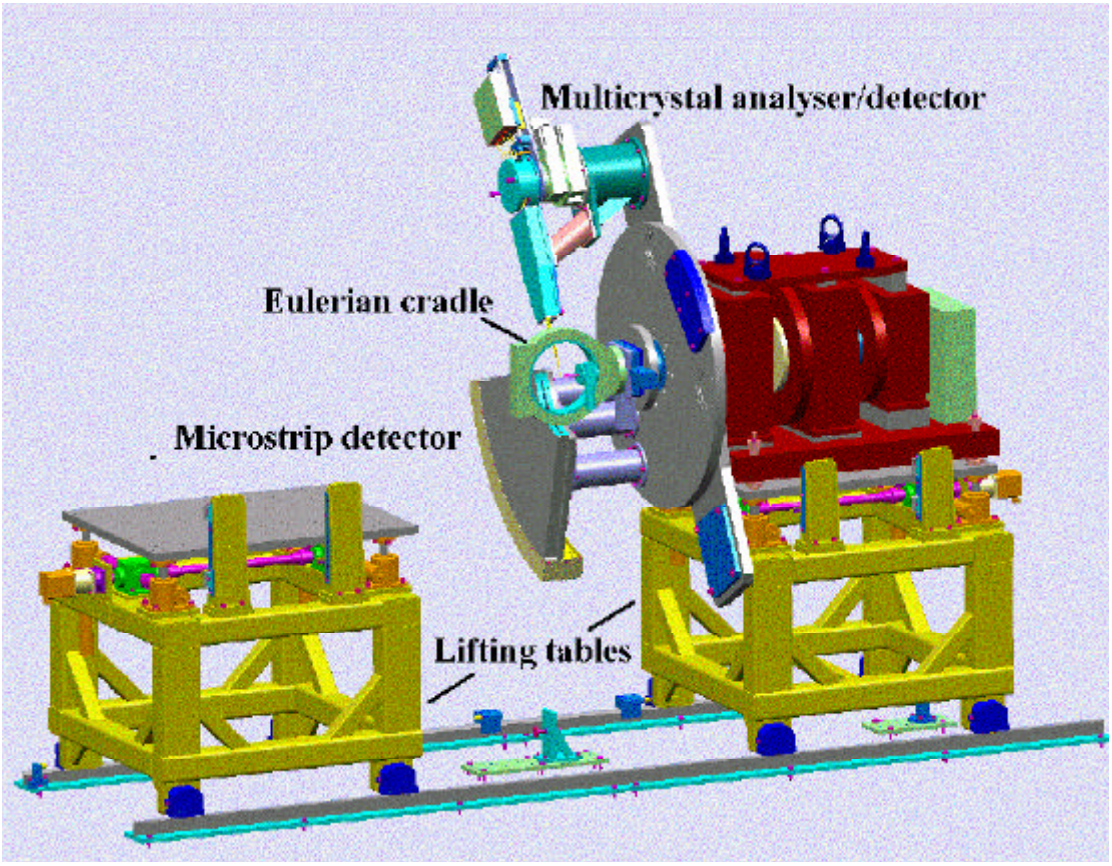
a) When the data is written, a clock tick is missed causing a double width bin.

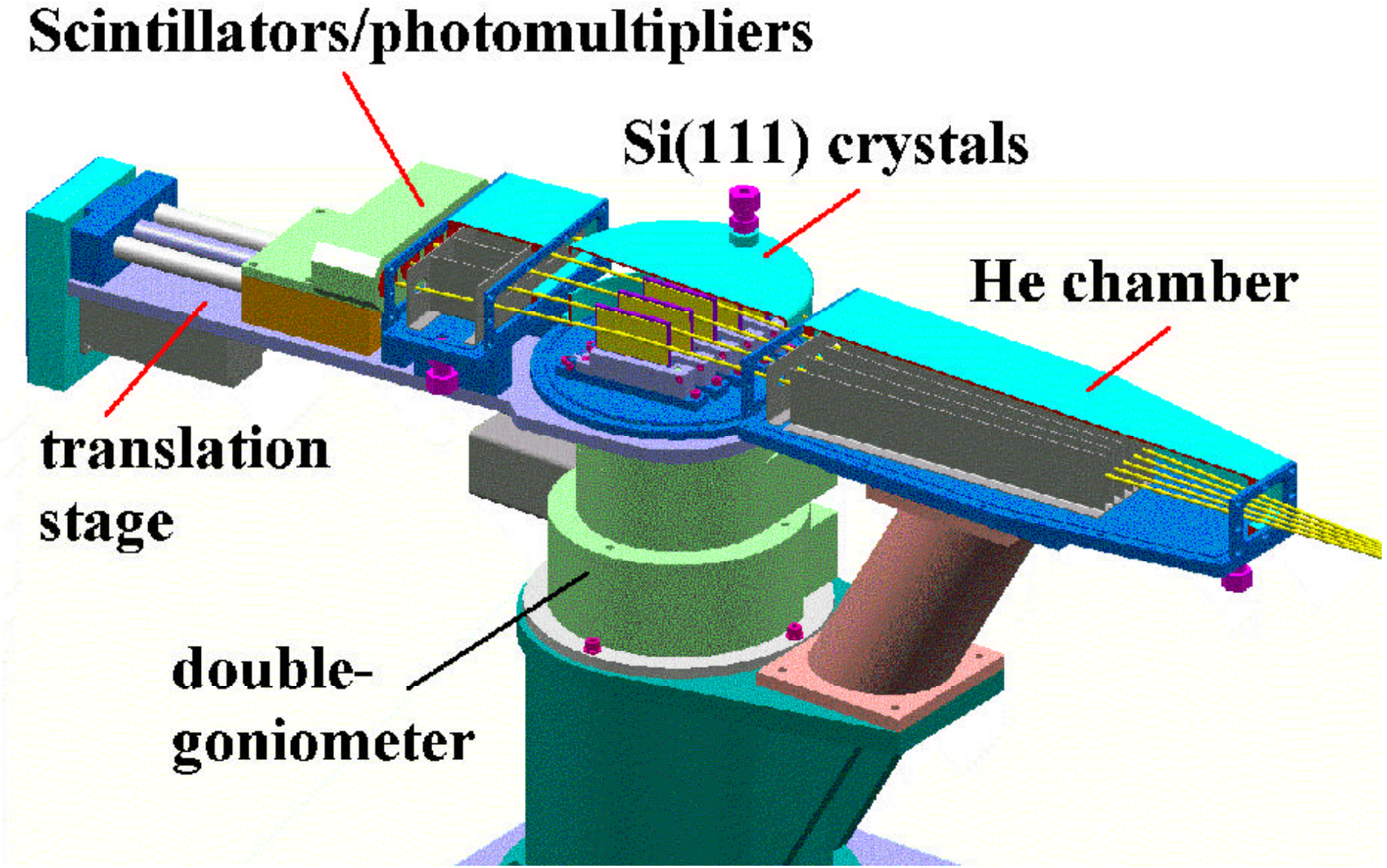
b) There is a significant ripple in the bin width of 3 to 4% caused by the EPICS record scanning tasks, which run at a higher priority.

Slide–M: Later normalised data from a 1 MHz pulser.

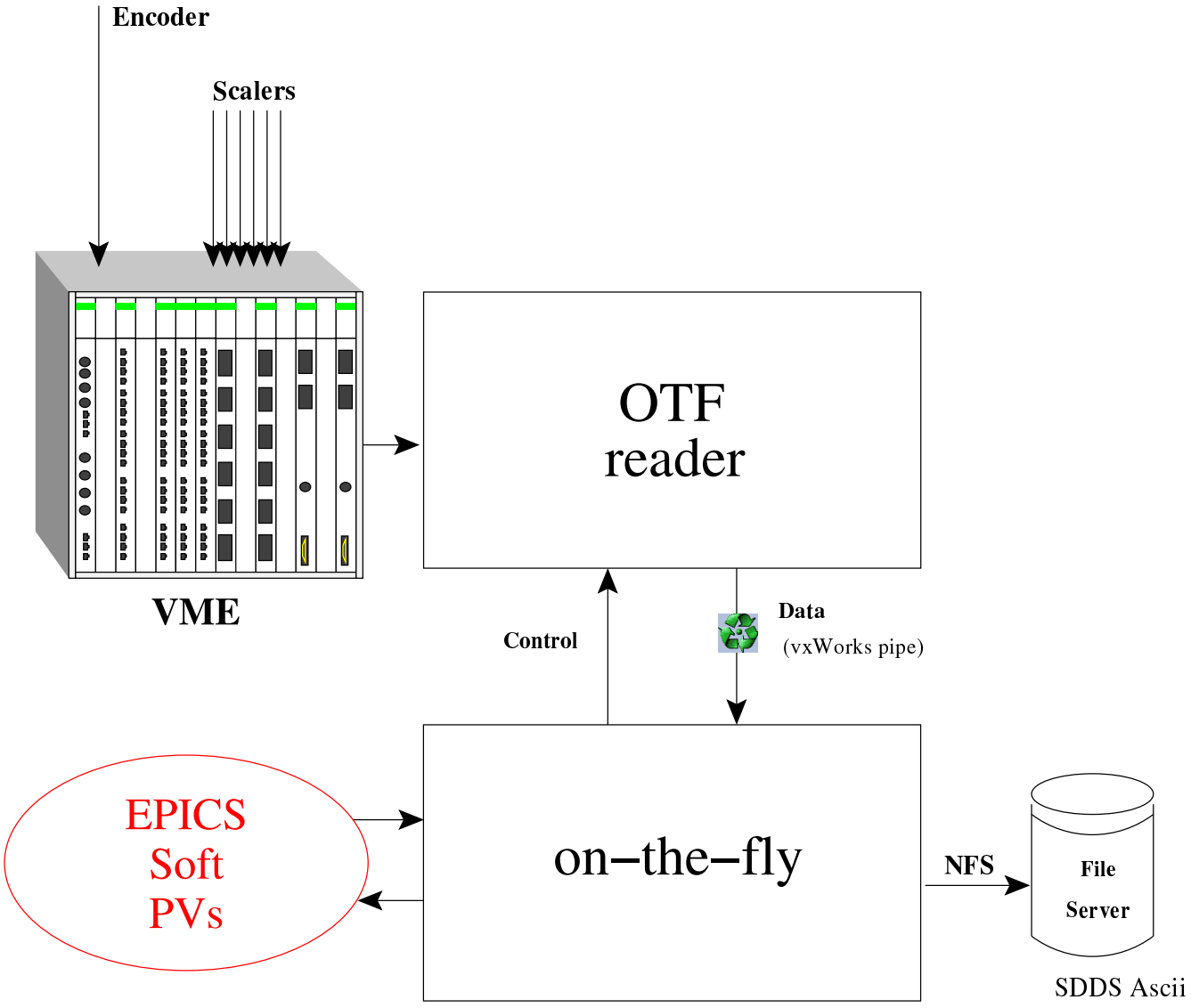
The "OTF Reader" is running at a vxWorks priority of 60, which is above the EPICS record scanning tasks, and there is a pipe to buffer data on its way to disk. Note that there are no longer any double width bins and the bin width ripple is now better than 1%.

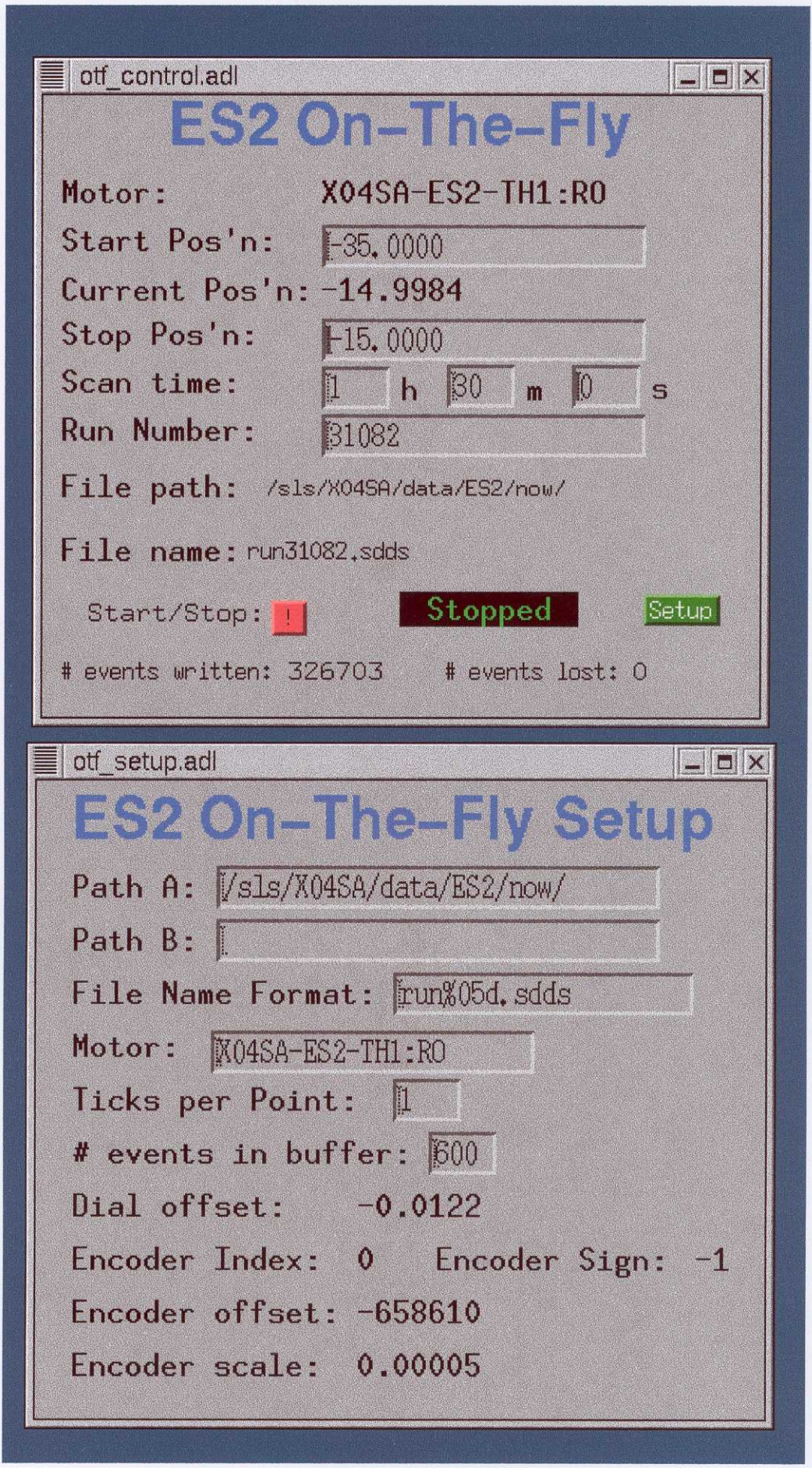
Slide–N: An update notice for users of the SPEC program.


Multicrystal analyser/detector
Eulerian cradle
Microstrip detector
Lifting tables


Scintillators/photomultipliers
Si(111) crystals
He chamber
translation stage
double-goniometer

On–the–Fly Data Flow



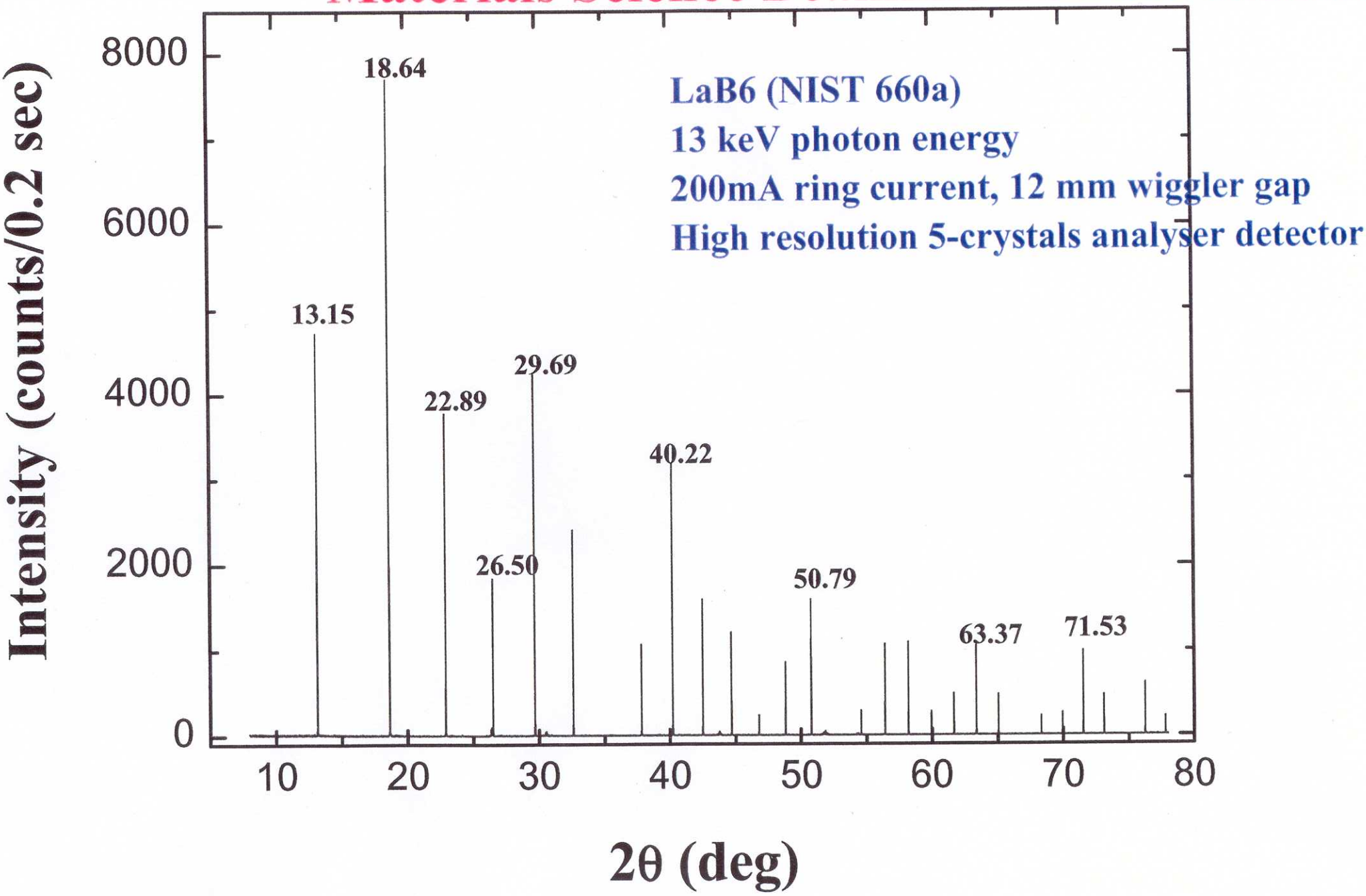

otf_control.adl
ES2 On-The-Fly
Motor: X04SA-ES2-TH1:RO
Start Pos'n: -35.0000
Current Pos'n: -14.9984
Stop Pos'n: -15.0000
Scan time: 1 h 30 m 0 s
Run Number: 31082
File path: /sls/X04SA/data/ES2/now/
File name: run31082.sdds
Start/Stop:
Stopped
Setup
events written: 326703
events lost: 0
otf_setup.adl
ES2 On-The-Fly Setup
Path A: /sls/X04SA/data/ES2/now/
Path B:
File Name Format: run%05d.sdds
Motor: X04SA-ES2-TH1:RO
Ticks per Point: 1
events in buffer: 600
Dial offset: -0.0122
Encoder Index: 0 Encoder Sign: -1
Encoder offset: -658610
Encoder scale: 0.00005

Read Data as fast as possible ...

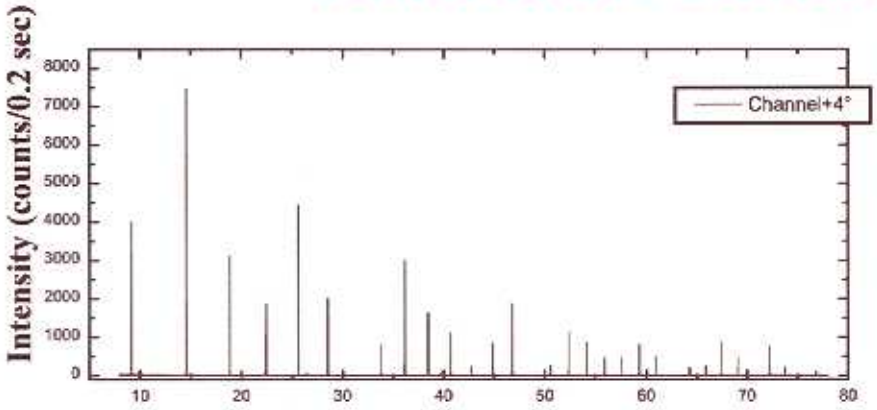
```
volatile struct io_DCR_mem   *pDcrMem
volatile struct io_SSI_mem   *pSsiMem
volatile struct io_VME58_mem *pVme58Mem
     ...
     ...
     ...
               */
               ** Read the data as fast as possible.
               ** Then massage it.
               */
  if (type == 0) {
    OTF_this_ev[0] = pSsiMem->enc[chan];   /* Read encoder */
  }else {
    ui2a = pVme58Mem[card]->motors[chan].pos[0]; /* Read motor */
    ui2b = pVme58Mem[card]->motors[chan].pos[1];
  }
  OTF_this_ev[1] = pDcrMem->cntr0;        /* Read counters */
  OTF_this_ev[2] = pDcrMem->cntr1;
  OTF_this_ev[3] = pDcrMem->cntr2;
  OTF_this_ev[4] = pDcrMem->cntr3;
  OTF_this_ev[5] = pDcrMem->cntr4;
  OTF_this_ev[6] = pDcrMem->opto;
     ...
     ...
```

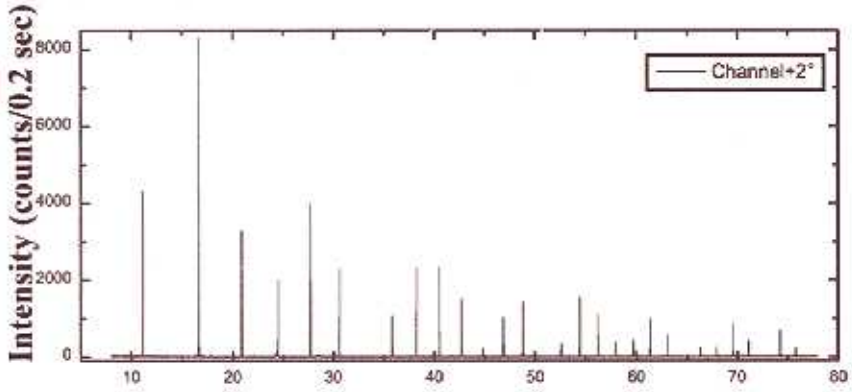
~9 µsec

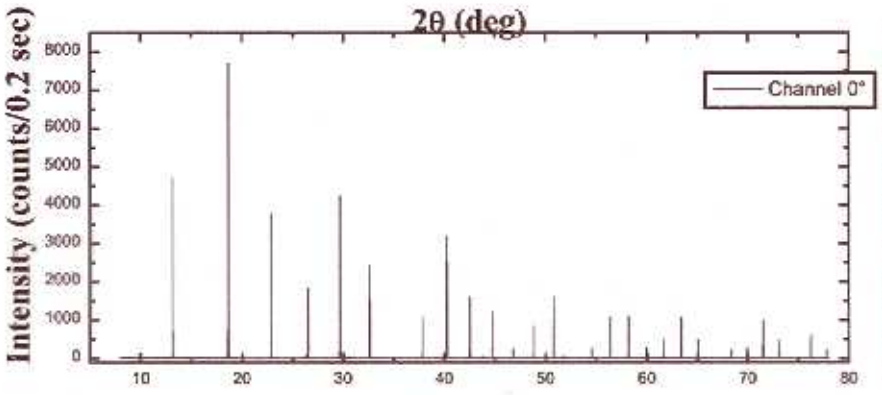
Materials Science Beamline-Powder endstati

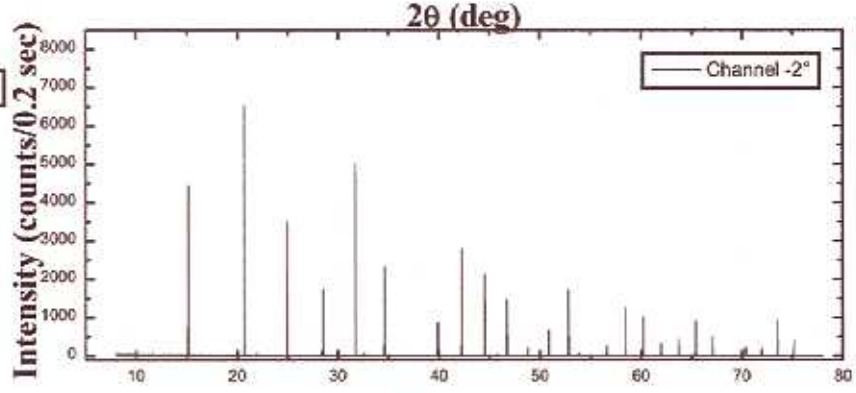


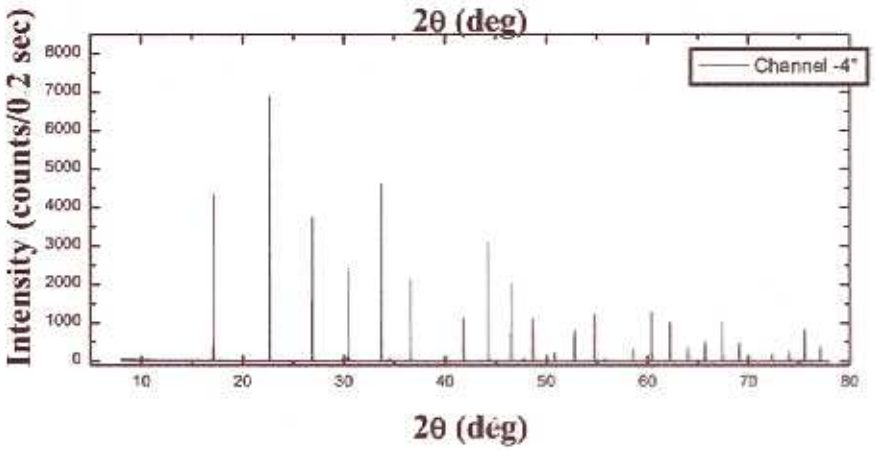
Materials Science beamline-Powder station











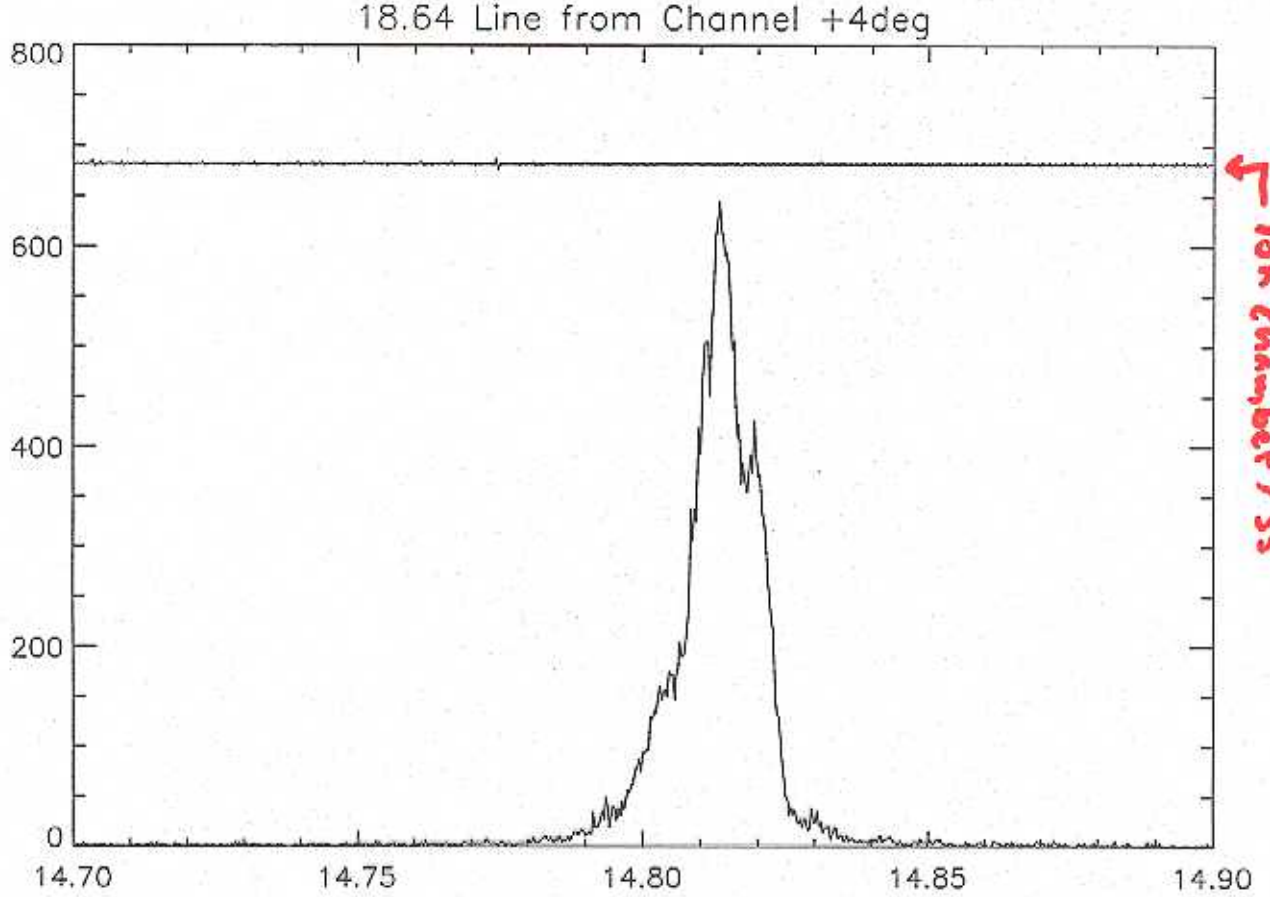
LaB6 (NIST 660a)

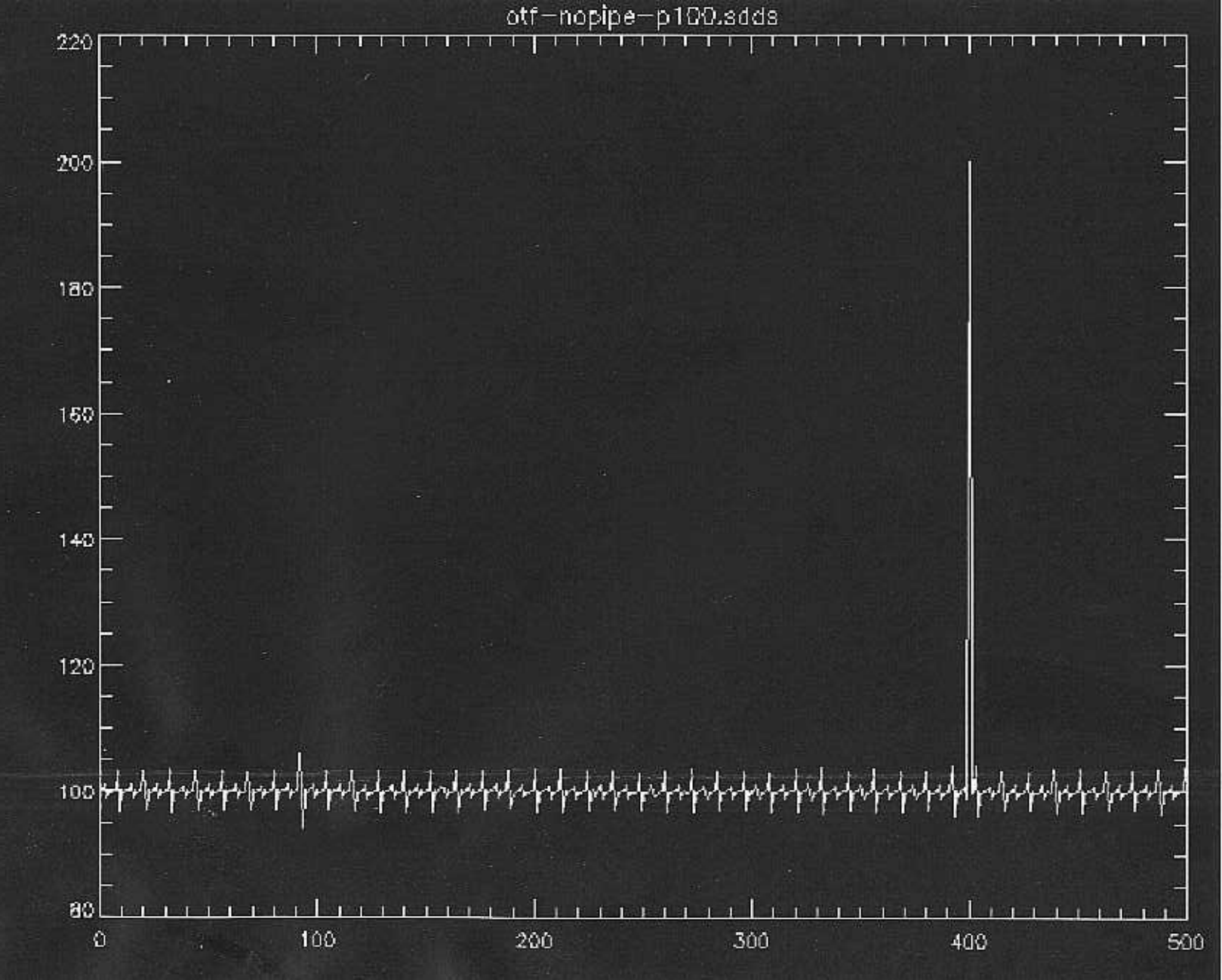
13 keV

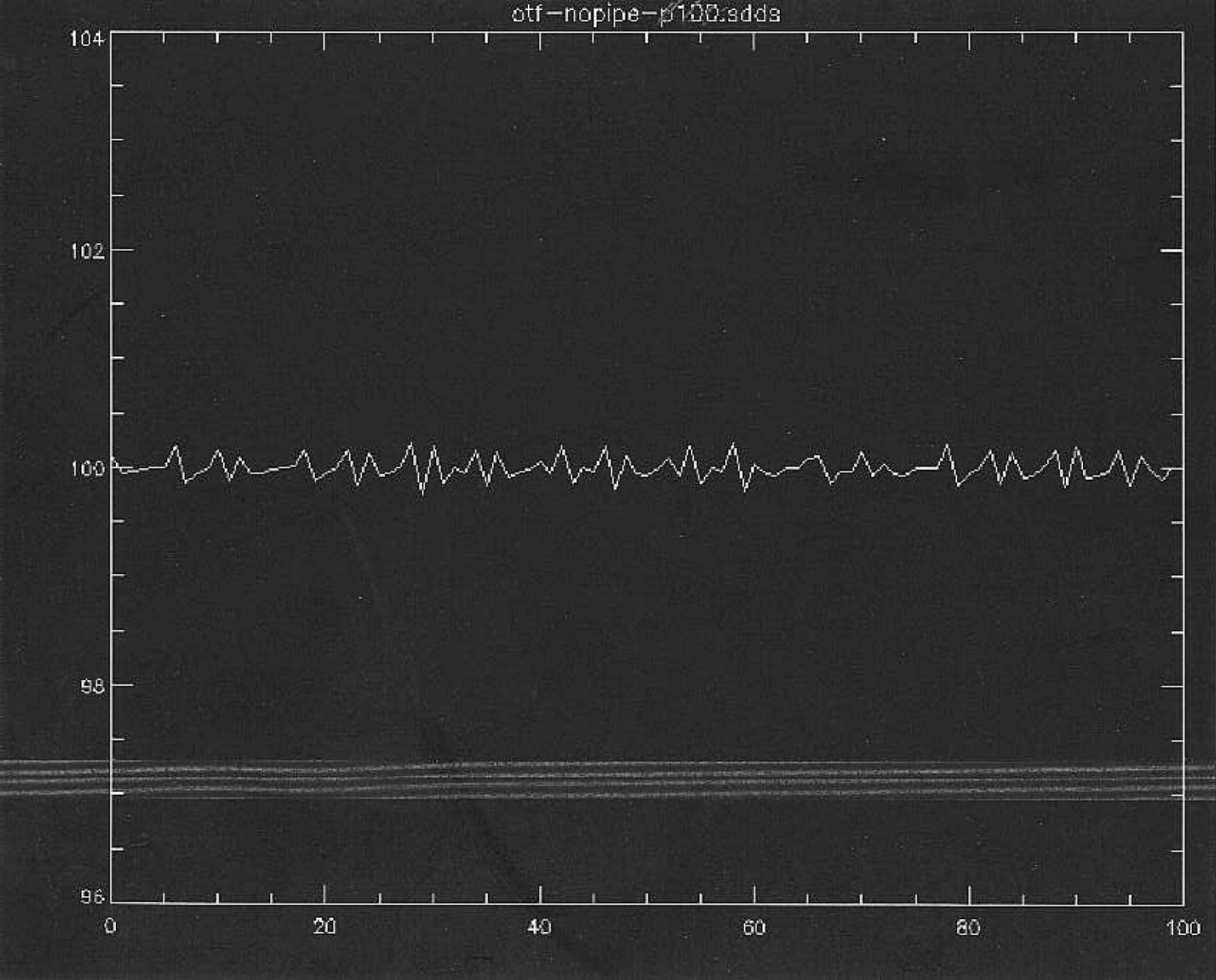
200mA, 12mm wiggler gap

5-crystal analyzer detector system

Total acquisition time: 1 hour


18.64 Line from Channel +4deg
800
600
400
200
0
14.70
14.75
14.80
14.85
14.90
↑ ion chamber/35


otf-nopipe-p100.sdds
220
200
180
160
140
120
100
80
0
100
200
300
400
500


otf-nopipe-p100.sdds
104
102
100
98
96
0
20
40
60
80
100

SPEC Update

a) More liberal motor names:

{Prefix}{Suffix}

e.g. X04SA–SD:ALPHA
X04SA–EH2–SH1:TR2

b) EPICS knows best!

i.e. SPEC will not modify EPICS motor parameters