Libera Software Developments

A summary of recent software
developments on Libera at Diamond.

Michael Abbott
Diamond Light Source
22nd June 2009

Overview

Operational Experience

    RF board faults – helpful to have DSC coeffs.

    long duration ADC overflow – FPGA changes

New DLS EPICS 2.0 features

    Support 2.0 FPGA features

    Many other small improvements

New DLS Libera system distribution

    Designed as smaller more maintainable system upgrade
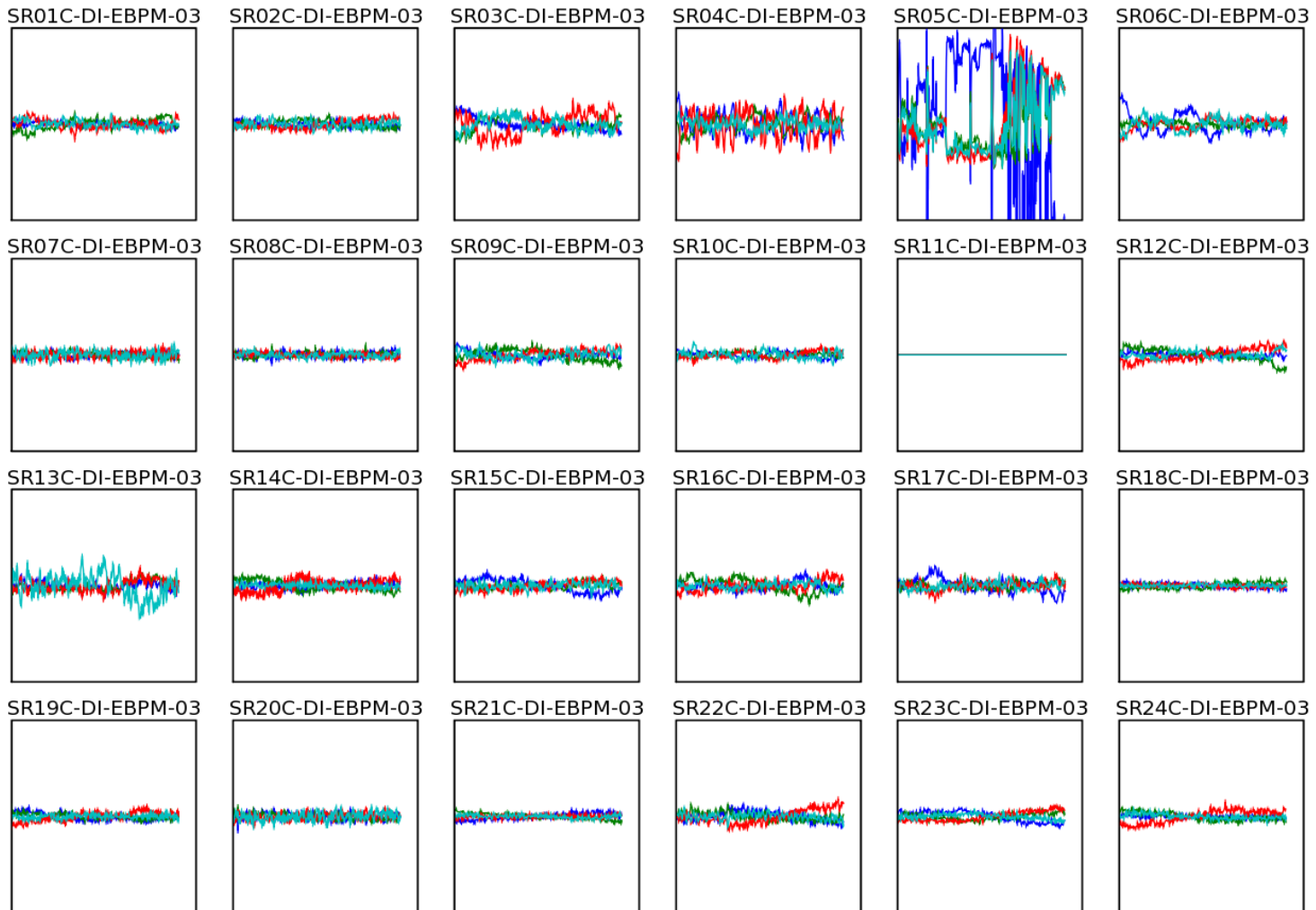
Operational Experience

- RF channel instabilities, already reported last year

- Long spurious ADC overflow events on high current running

- Two spontaneous SBC failures

- Continuing very rare crashes (one every 2 months in a population of 205)

Michael Abbott, Diamond Light Source, 22nd June 2009

RF instabilities

- Originally noticed sudden small jumps in positions when running fast feedback

- Detailing monitoring of Signal Conditioning parameters identified some Liberas as troublesome

- Turning switching off reveals one faulty channel

- Unable to identify faulty component on RF board, so bought replacement boards.

- Around half a dozen boards affected.

Signal Conditioning

Evolution of channel gains over one hour (vertical range +-0.002)

SR01C-DI-EBPM-03	SR02C-DI-EBPM-03	SR03C-DI-EBPM-03	SR04C-DI-EBPM-03	SR05C-DI-EBPM-03	SR06C-DI-EBPM-03
SR07C-DI-EBPM-03	SR08C-DI-EBPM-03	SR09C-DI-EBPM-03	SR10C-DI-EBPM-03	SR11C-DI-EBPM-03	SR12C-DI-EBPM-03
SR13C-DI-EBPM-03	SR14C-DI-EBPM-03	SR15C-DI-EBPM-03	SR16C-DI-EBPM-03	SR17C-DI-EBPM-03	SR18C-DI-EBPM-03
SR19C-DI-EBPM-03	SR20C-DI-EBPM-03	SR21C-DI-EBPM-03	SR22C-DI-EBPM-03	SR23C-DI-EBPM-03	SR24C-DI-EBPM-03

One button unstable

ADC Overflow

- ADC overflow interlocks observed on high current runs (started at around 250 mA, impossible to run at 300mA).

- ADC overflow events lasting 100s of turns observed!

- Unable to filter with existing FPGA support

- New ADC interlock mechanism implemented, patch sent to i-Tech for consideration.

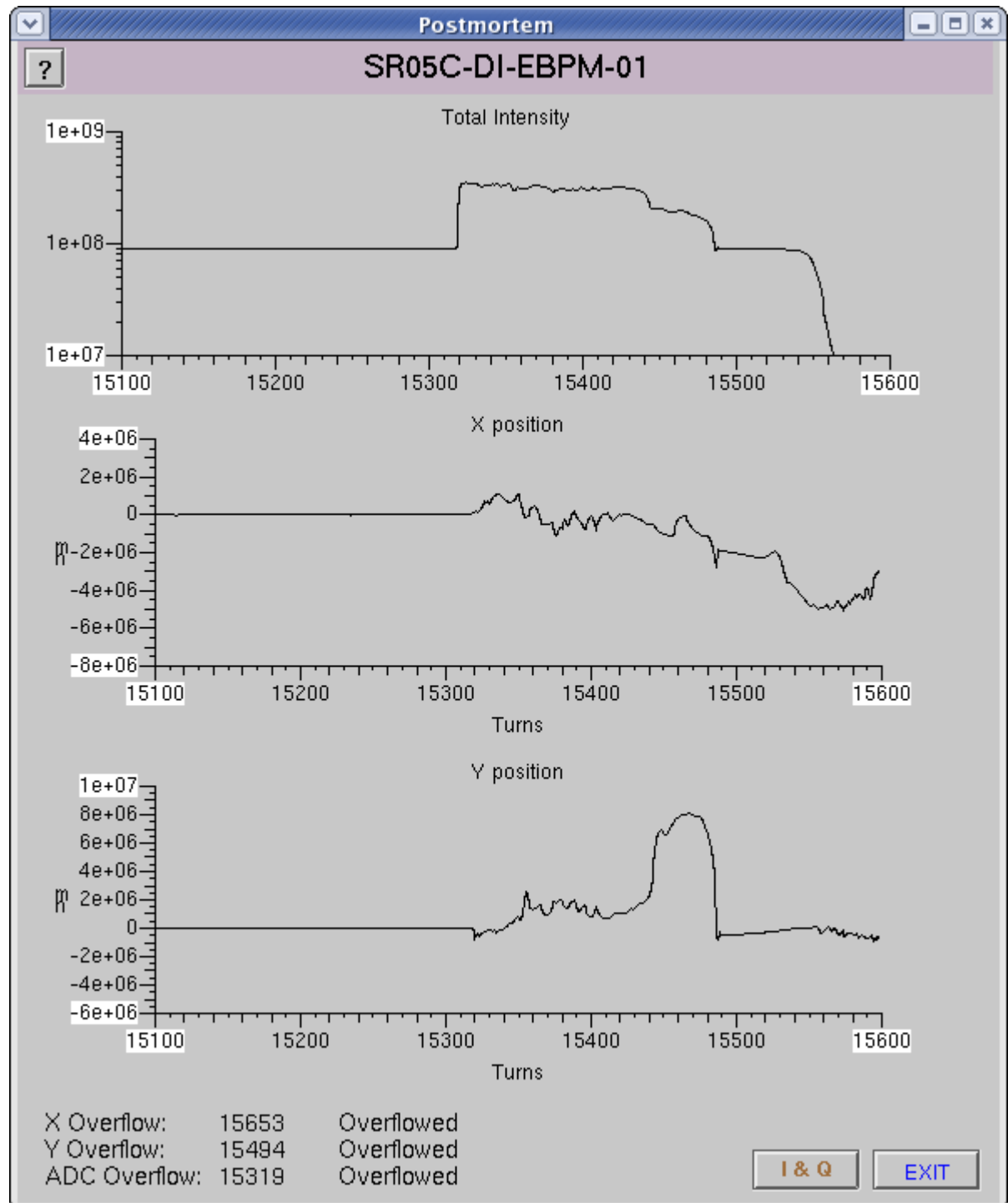- Don't know if Brilliance affected by this issue.

Interlock caused by ADC overflow

Note intensity elevated by at least four-fold for 160 turns.

Beam tripped shortly after.

Was able to pin overflow down down to a single channel.

Occurs randomly among many Liberas on the machine.

Original ADC Overflow Interlock

- Detects continuous ADC overflow for a set number of **samples**

- Can filter (with an IIR) to smooth over glitches

- Cannot set sample count to more than one turn: the gap in the fill will reset the detection logic!

Diamond ADC Overflow Interlock

- On each **turn** detect *any* overflow event, marking that turn as overflowed

- Only trigger ADC overflow if N successive **turns** seen marked as overflowed

- At Diamond we run with N=500 (1 ms)!

We believe this addresses the practical case of ADC overflow caused by invalid attenuator settings, without adding extra risk, and avoids spurious interlocks.

Non Booting SBC

- Two Liberas failed to boot with corrupt flash.

- First time we reflashed the kernel (from u-boot) and could return the machine to service.

- Second time the u-boot also failed to boot
  - Unable to reflash without u-boot at Diamond
  - Sent to i-Tech, but u-boot had recovered!
  - Will buy replacement SBC from i-Tech

Spontaneous SBC Crashes

- Perhaps once a month or two a Libera crashes completely – no Linux system running anymore!

- Statistically perhaps once in 20 years of running, so effectively unreproducible.

- Often occurs within days of being booted.

- Inclined to blame faulty multithreading support on older ARM Linux distributions (we are still running release 1.46) – maybe gone away with i-Tech 2.0 release?

Libera SBC System Software

- i-Tech 1.6 and 1.8 releases introduced upgrade to 2.6 Linux kernel.

- Serious bug in threading library not addressed in 1.6 or 1.8 release.

- I *think* 2.0 addresses threading library bug (and improves floating point support), but still using very old glibc (2.3.6, same as 1.6 and 1.8).

- Started work on Diamond SBC Linux over a year ago, only remaining task is automated installation and distribution.

Diamond Linux Distribution

Goals:

- Multiple targets: aim to target Power Supply controller and PowerPC VME boards with this distribution as well as Libera.

- Simple and small: current version comprises around 80 files (and many symbolic links!) and occupies around 5MB.

- Reproducible build: 2MB of scripts and patches to rebuild complete toolchain and file system – easier to maintain and distribute.

Boot and Distribution Options

Updated u-boot and distribution offers some interesting boot option:

- Try out without installing (tftp boot + init ramfs or nfs rootfs)

- Can easily switch between alternative Libera installations

- Just need a tftp server on the network

Michael Abbott, Diamond Light Source, 22nd June 2009

Our difficulties with i-Tech distribution

- Source updates from i-Tech are *enormous,* for example, latest kernel update delivered as 140MB .tgz file – actual content described in 250KB patch file! Hard to manage.

- Very complex build tools required for build process, seems intimately entangled with Debian build – very difficult to rebuild system without using Debian.

- Don't see how to upgrade compiler or library, i-Tech distribution still using glibc 2.3.6. Current release is 2.9, Diamond distribution currently using 2.7, can easily upgrade.

- i-Tech distribution rather larger and more complex: over 1,500 separate files and 22MB. The i-Tech `/etc` directory is almost ten times the size of the Diamond `/etc` directory. Makes configuration management much harder to understand.

Michael Abbott, Diamond Light Source, 22nd June 2009

EPICS Driver Update

2.00 EPICS driver to be released very soon:

- Works seamlessly on any Libera from 1.46 to 2.0

- Correctly recognises FPGA version (not so easy!)

- Supports new version 2 FPGA features:

    - Spike removal control (recent patch sent to iTech)

    - Mean sum between triggers

    - Internal PM trigger control (not yet done)

    - Control of MAF parameters (not yet done)

- A number of extra functions.

New EPICS driver functions

- Attenuator offsets: allows mixing Brilliance and Electron with global attenuator control

- More detailed system identification and diagnostics

- NTP status monitoring integrated into clock status

- Health daemon integration (now available on 1.46)

- Decimated long triggered turn by turn data (not previously supported)
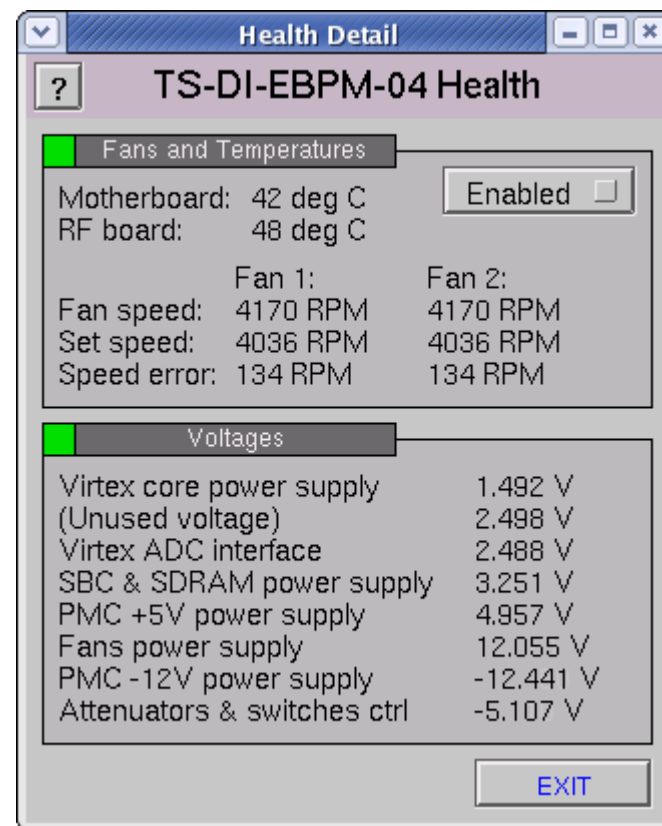
Spike Removal Diagnostics
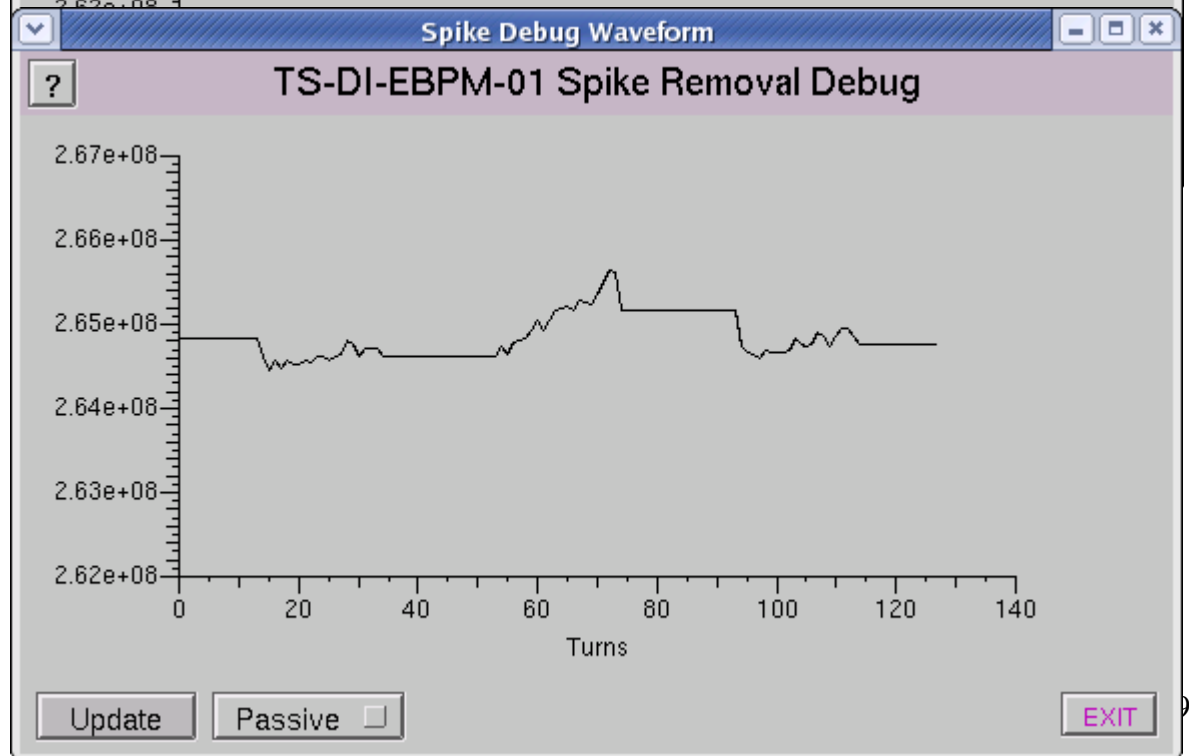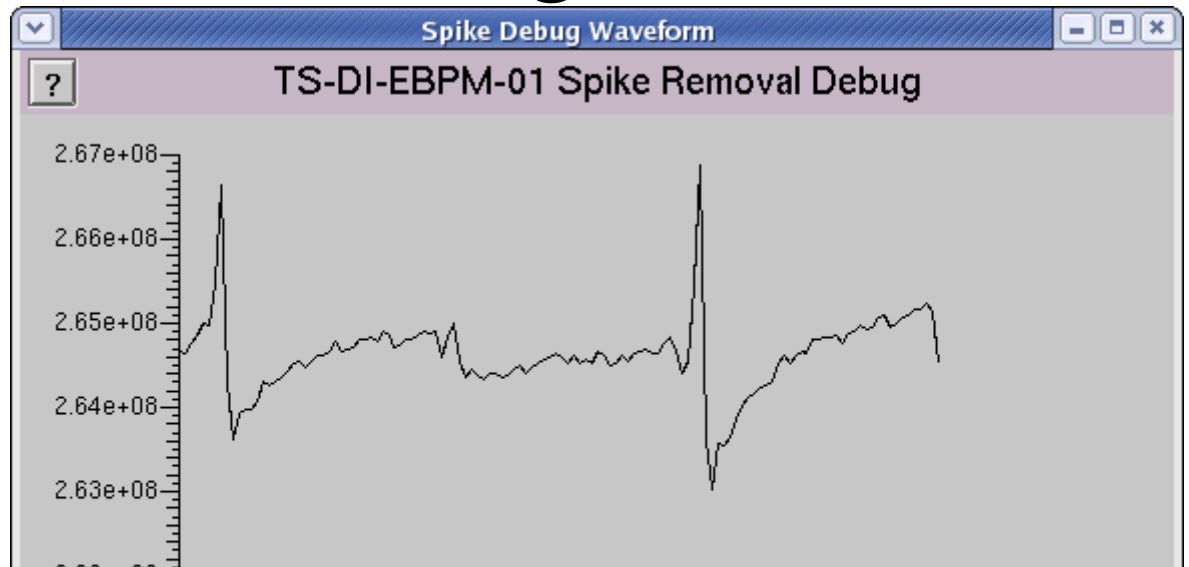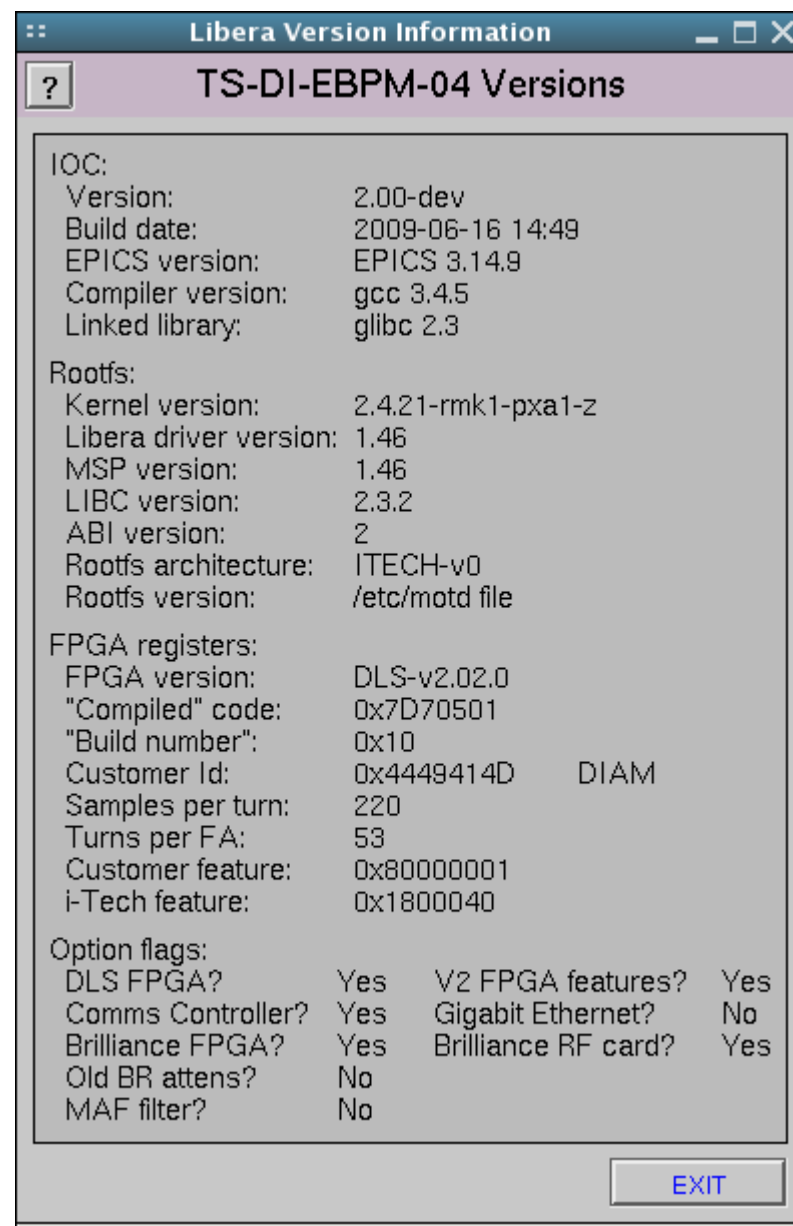
FPGA and System Identification

- Not as easy as it should be. Have i-Tech configuration register – but not always used when it needs to be.

- Fortunately can probe various registers and can distinguish:

    - 1.6/1.8 from 1.46 FPGA (slight risk of error here)

    - 2.0 from 1.8: requires recognising new MAXADC register!

- Allows same software to operate correctly with all versions of driver and firmware.

- Can use 2.0 FPGA on 1.46 Libera!

Libera Version Information

TS-DI-EBPM-04 Versions

```
IOC:
  Version:              2.00-dev
  Build date:           2009-06-16 14:49
  EPICS version:        EPICS 3.14.9
  Compiler version:     gcc 3.4.5
  Linked library:       glibc 2.3

Rootfs:
  Kernel version:       2.4.21-rmk1-pxa1-z
  Libera driver version: 1.46
  MSP version:          1.46
  LIBC version:         2.3.2
  ABI version:          2
  Rootfs architecture:  ITECH-v0
  Rootfs version:       /etc/motd file

FPGA registers:
  FPGA version:         DLS-v2.02.0
  "Compiled" code:      0x7D70501
  "Build number":       0x10
  Customer Id:          0x4449414D    DIAM
  Samples per turn:     220
  Turns per FA:         53
  Customer feature:     0x80000001
  i-Tech feature:       0x1800040

Option flags:
  DLS FPGA?        Yes    V2 FPGA features?   Yes
  Comms Controller? Yes   Gigabit Ethernet?   No
  Brilliance FPGA?  Yes   Brilliance RF card?  Yes
  Old BR attens?   No
  MAF filter?      No
```

EXIT

Conclusions

- Hardware working well

- Minor changes to software ongoing

- Some FPGA changes, patches to i-Tech:

  - MAX ADC, included in i-Tech 2.0 FPGA

  - ADC overflow, submitted

  - Diamond Communication Controller now available from i-Tech as FPGA option

- Major system upgrade imminent at Diamond

- EPICS 2.0 beta available now, release soon.

Michael Abbott, Diamond Light Source, 22nd June 2009