The EPICS Interface to Libera

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A Lightning Introduction to EPICS

- "Client-Server" model: devices (called *IOC*s or "IO Controllers") publish *process variables* (*PV*s) by name.
- "Publish-Subscribe" model: each IOC makes a set of PVs available, any client can connect to any PV for writing or reading a single value, or for monitoring for updates.
- No central database: all clients send out broadcasts when connecting to a new PV, all IOCs providing the PV respond (there should be at most one IOC per PV).
- Each PV (generally) provides a single value: integer, floating point number, or a fixed length waveform.
- In general all PVs are active in an IOC even when there are no subscriptions (subscriptions are concealed from IOC code), and multiple subscriptions have surprisingly little performance impact.
- Every PV can be delivered with a timestamp specifying precisely when the data it refers to was processed.

Typical Libera EPICS PVs

All Libera EPICS process variables names are of the form

`$(device):$(group):$(part)`

`$(device)`
: is the IOC name (the configured `hostname` is used)

`$(group)`
: is a two letter code

Example PVs:

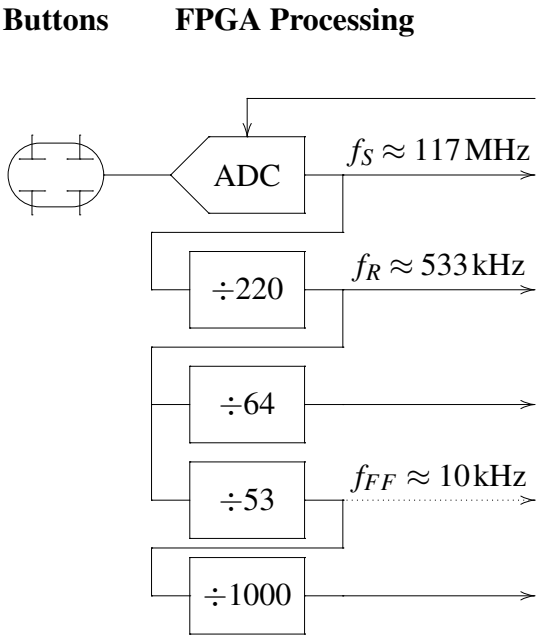
`TS-DI-EBPM-01:FR:WFX`
: 2048 point waveform of turn by turn X positions in nm, updating on every trigger.

`TS-DI-EBPM-01:SA:X`
: Single floating point number: X position in mm updated every 100ms.

`TS-DI-EBPM-01:CF:AUTOSW_S`
: Controls state of rotating multiplexer switches: can be set to *Manual* or *Automatic*.

The current development Libera EPICS driver publishes 378 PVs!

Libera EPICS System Overview



CK	Clock control
FT	1024 pt Waveform + Scalar @trigger (5 Hz)
FR	2048 pt Waveform @trigger (5 Hz)
TT	524,288 pt Waveform on demand
PM	16,384 pt Waveform on postmortem trigger
SC	Signal Conditioning
BN	3,000 pt Waveform @trigger (5 Hz)
FF	Fast feedback status and control
IL	Interlock control
SA	Scalar @10 Hz
CF	Configuration
SE	Sensors: system monitoring

Note: SC not yet released; FF requires Diamond FPGA.

Position Readout

The following groups of PVs are used to read positions.

`FT`	Single point reduced from selected window into ADC sample rate buffer (1024 points at approximately 117MHz), captured on trigger. Used for "first turn" analysis and transfer paths.
`FR, PM`	Fixed length waveforms (2048 and 16,384 points respectively) with one point per turn ("turn by turn"), updated on trigger or postmortem event respectively.
`TT`	Variable length turn by turn waveforms armed and captured on trigger. Sliding window used to read out up to half a million points.
`BN`	Fixed length waveforms with one point per 64 turns, and per 1024 turns, updated on trigger.
`SA`	One point per update, updates at 10Hz.

All points are available as raw A, B, C, D button readings (with I&Q quadrature, except for SA) as well as X, Y, Q and S.

Control and Status

The following PV groups are used to manage and monitor the state of Libera.

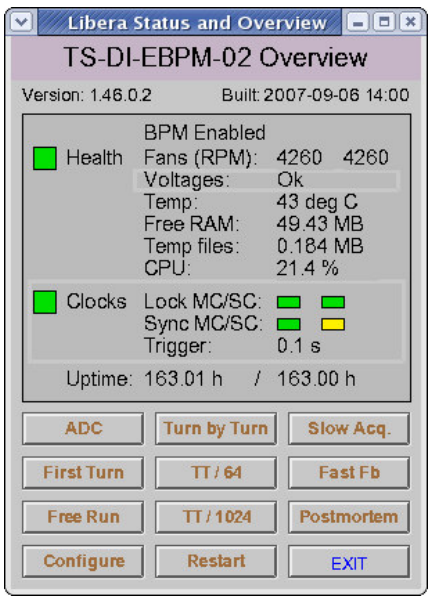
`CF` General configuration control, principally button geometry, beam offsets and attenuation control.

`IL` Interlock management configuration and control including control of interlock window and interlock enable, as well as interlock status reports.

`SE` System status monitoring, also aggregated into a single `HEALTH` PV. Monitors fans, temperature, voltages, and memory and cpu usage.

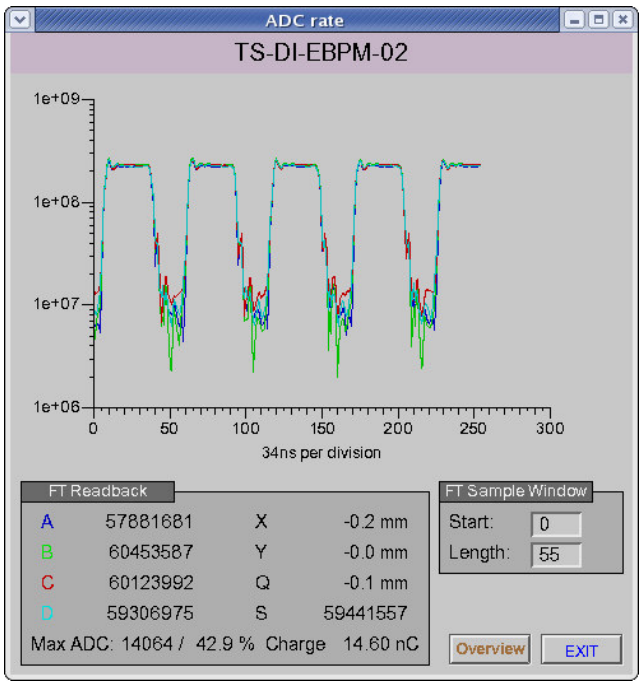
`CK` Clock control including triggered synchronisation, status monitoring and timestamp management.

Libera Status and Overview



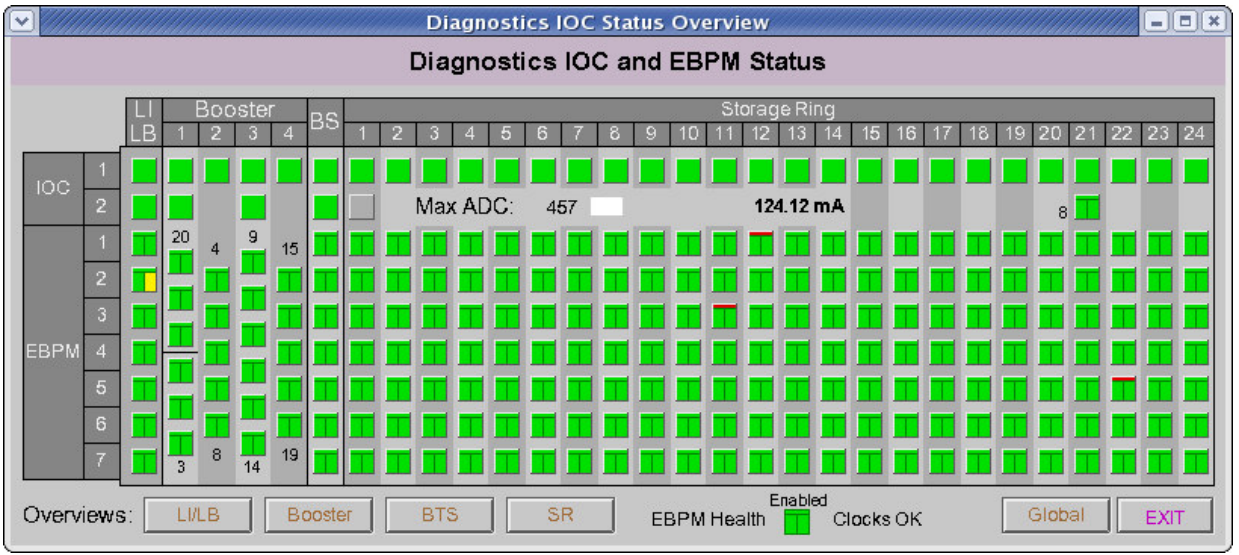
- BPM enabled flag: used to mark BPM as not currently in use and disables MPS interlock if disabled.
- Overall system health report.
- Clock status report.
- System and EPICS driver uptime.
- Links to screens providing all other Libera functionality.

ADC Rate Data (“First Turn”)



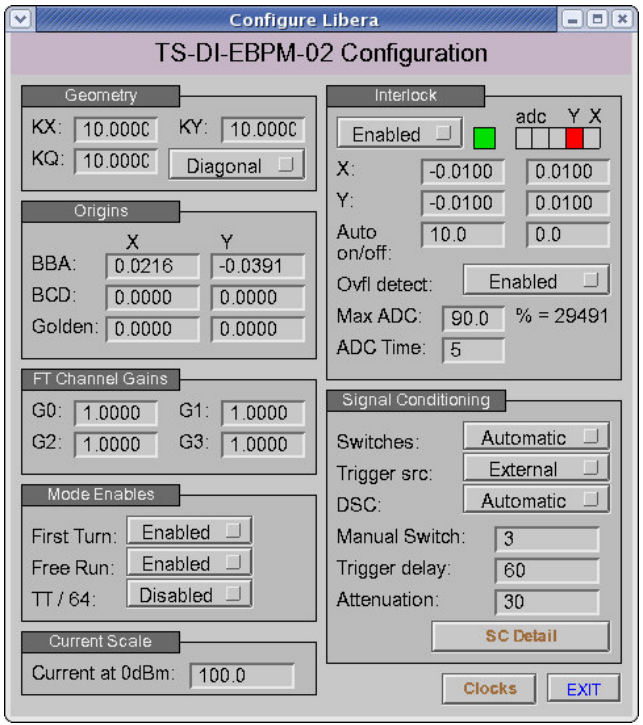
- Raw 1024 point ADC buffers (reduced to 256 point magnitudes). The fill pattern is clearly visible.
- Selectable sample window: selecting first train in the window.
- Measured button intensities within the window together with calculated beam position and estimated charge.
- Maximum ADC reading over the entire sample.

Diamond System Status Overview



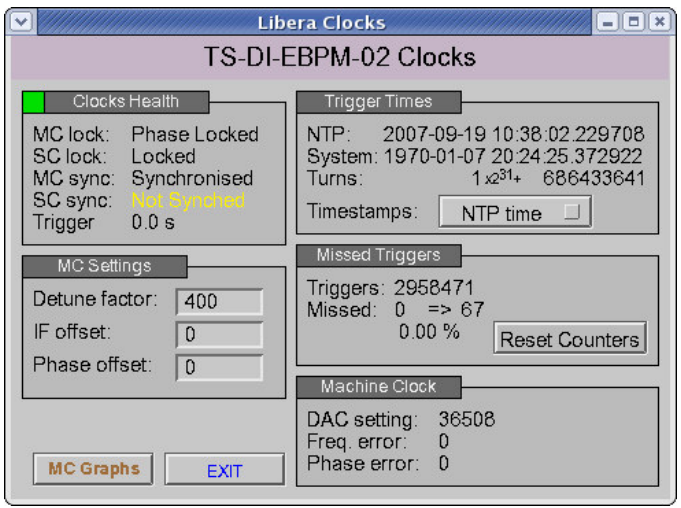
- Shows all Diagnostics IOCs at Diamond.
- For each Libera EBPM shows machine health, clock status and whether the BPM is enabled.

Configuration



- EBPM geometry and orientation configuration.
- Beam origin control: “Beam Based Alignment” and “Beam Current Dependent” offsets separated into distinct components.
- Interlock status and configuration: note auto on/off feature.
- Attenuators, signal conditioning and detailed sampling control.

Clock Control



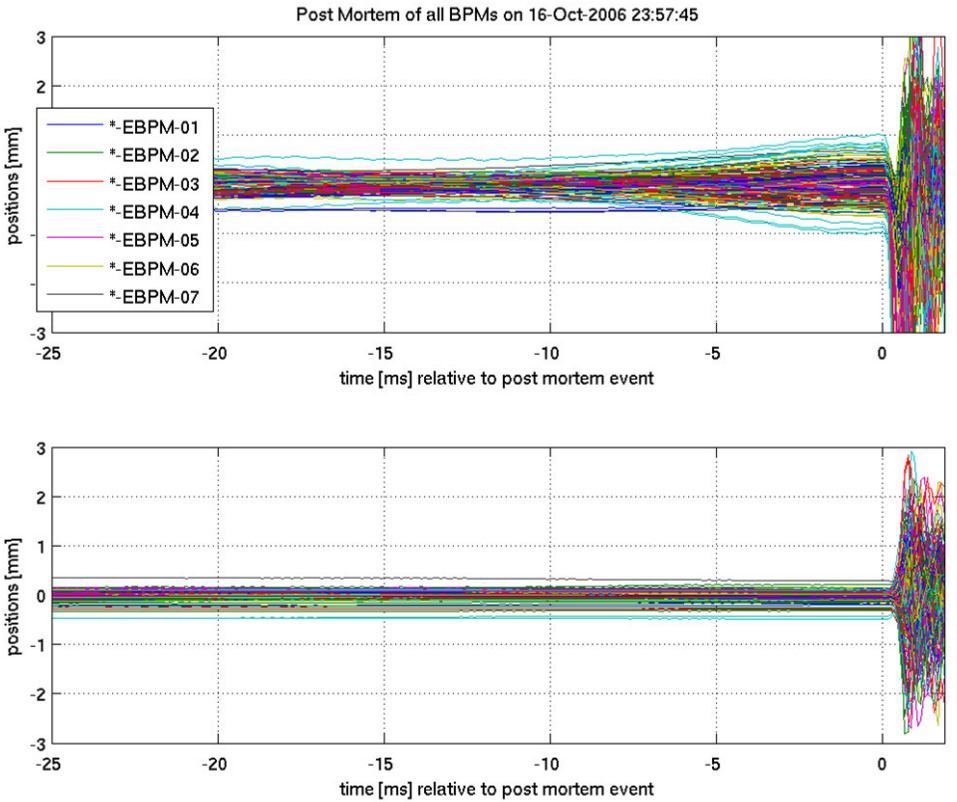
- Clock lock and synchronisation status.
- Machine clock detuning and phase adjustment.
- Timestamps: can choose system clock or NTP clock for time-stamps.
- Trigger monitoring: if no trigger received recently, reports fault.

Future Directions

The currently published Libera EPICS release (1.40.2) is compatible with Libera drivers and FPGA version 1.42. Future changes include:

- Support for Libera drivers and FPGA version 1.46 — we're currently using this version at Diamond, our version 1.40.2.1.
- Support for Linux 2.6, Libera drivers 1.60 and later. Driver currently doesn't work (known signal handling issue).
- New Signal Conditioning processing — implemented, but still slightly broken...
- *You tell me!*

Storage Ring Beam Dump Postmortem



Booster Ramp Data