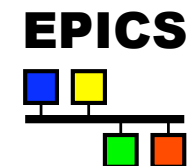


BEPCII Libera Control System

**Beam Instrument Group
Accelerator Research Center
IHEP
Huizhou Ma
2010.3**

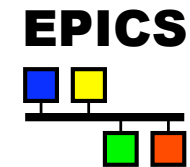


Outline

- Introduction of Libera
- Libera EPICS PVs
- Libera System Overview
- Soft IOC of Libera



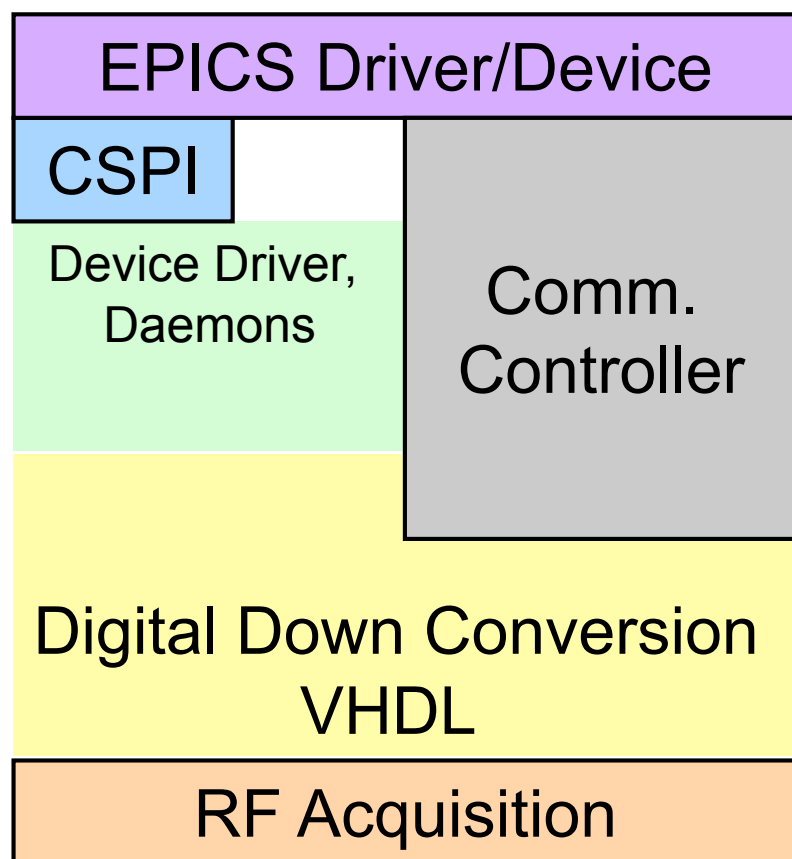
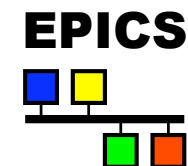
What is Libera



Libera is an all-in-one product of Instrument Technologies company that enables accurate beam position monitoring, trouble-free commissioning, and local and global feedback building in accelerator facilities.



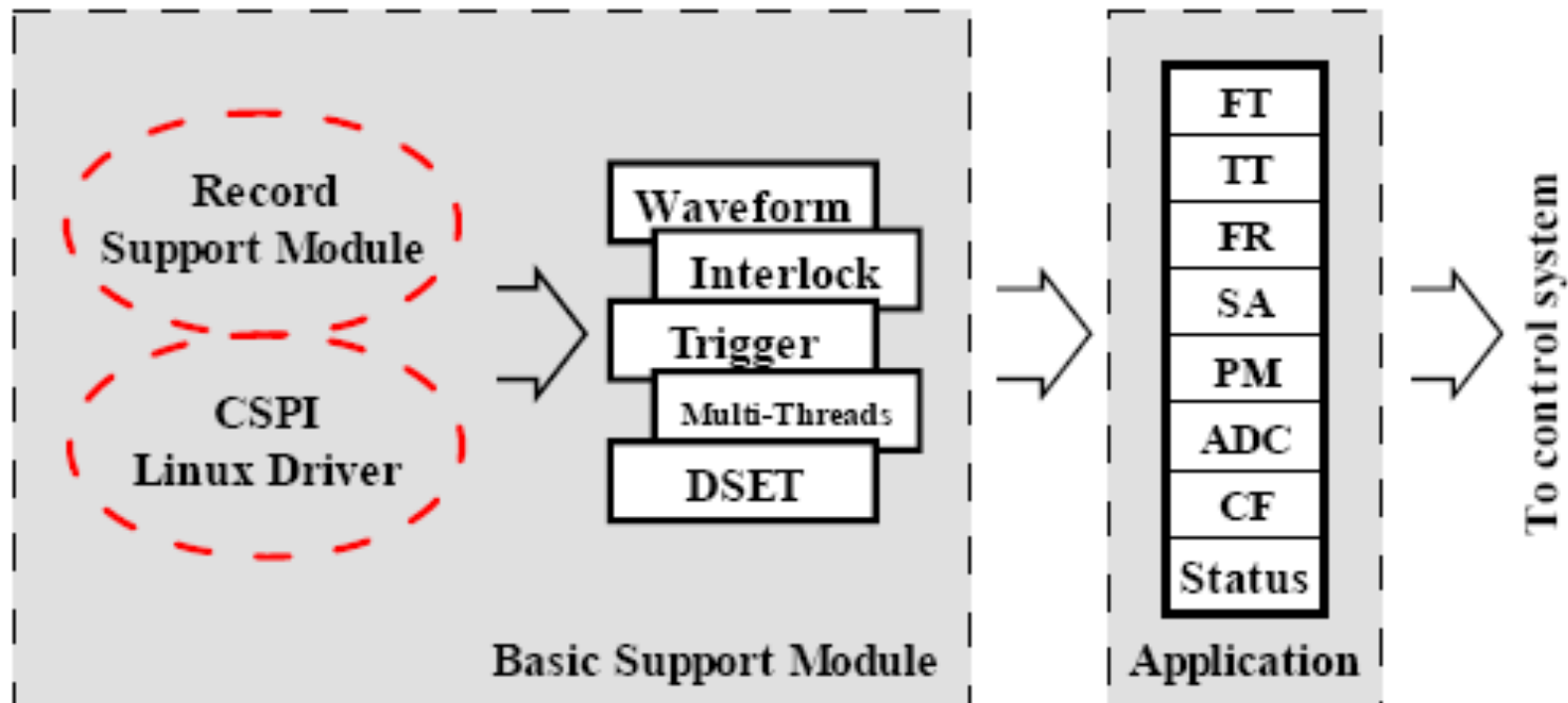
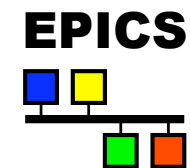
Libera System Architecture



- EPICS(R3.14.8.2) Driver Device first developed by Diamond and then modified for BEPCII Control System by BI group of IHEP
- CSPI, LinuxDriver, Daemon, DDC developed by I-Tech.

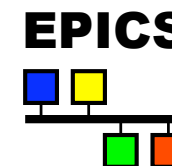


Scheme of Libera EPICS Driver





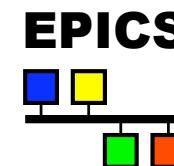
Libera PV record Types



Record Nme	Record Type	Description	Record Nme	Record Type	Description
ai	Analog Input	Obtain an analog value from hardware and then convert it to engineering units	histogram	histogram	Store frequency counts of a signal into an array of arbitrary length.
ao	Analog Output	Output values to digital-analog converters.	longin	Long Input.	Retrieve a long integer value of up to 32 bits.
bi	Binary Input	Obtain a binary value of 0 or 1.	longout	Long Output	Store long integer values of up to 32 bits and write them to hardware devices
bo	Binary Output	Store a simple bit (0 or 1) value to be sent to a Digital Output module.	mbbi	Multi-Bit Binary Input	Read multiple bit inputs from hardware
calc	Calculation	perform algebraic, relational, and logical operations on values retrieved from other records	mbbo	Multi-Bit Binary Output	Send a binary value (representing one of up to 16 states) to a Digital Output module
calcout	Calculation Output Record	Similar to the Calc record with the added feature of having outputs (an "output link" and an "output event") which are conditionally executed based on the result of the calculation.	stringin	String Input	retrieves an arbitrary ASCII string of up to 40 characters
compress	compress	Collect and compress data from arrays	stringout	String Output	write an arbitrary ASCII string of up to 40 characters to other records or software variables
fanout	fanout	Uses several forward processing links to force multiple passive records to scan.	subroutine	subroutine	call a C initialization routine and a recurring scan routine
			waveform	waveform	interface waveform digitizers



How does a Libera record find its device support

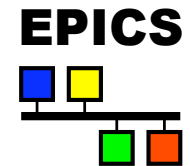


libera.dbd 'device' statements:

- device(longin, CONSTANT, longinLibera, "Libera")
- device(longout, CONSTANT, longoutLibera, "Libera")
- device(ai, CONSTANT, aiLibera, "Libera")
- device(ao, CONSTANT, aoLibera, "Libera")
- device(bi, CONSTANT, biLibera, "Libera")
- device(bo, CONSTANT, boLibera, "Libera")
- device(stringin, CONSTANT, stringinLibera, "Libera")
- device(stringout, CONSTANT, stringoutLibera, "Libera")
- device(waveform, CONSTANT, waveformLibera, "Libera")
- device(mbbi, CONSTANT, mbbiLibera, "Libera")
- device(mbbo, CONSTANT, mbboLibera, "Libera")



PVs from Libera



All Libera EPICS process variables names are of the form

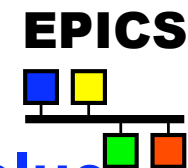
- $\$(\text{device}):\$(\text{group}):\$(\text{part})$
 - $\$(\text{device})$ is the IOC name (the configured hostname is used)
 - $\$(\text{group})$ is a two letter code

Example PVs:

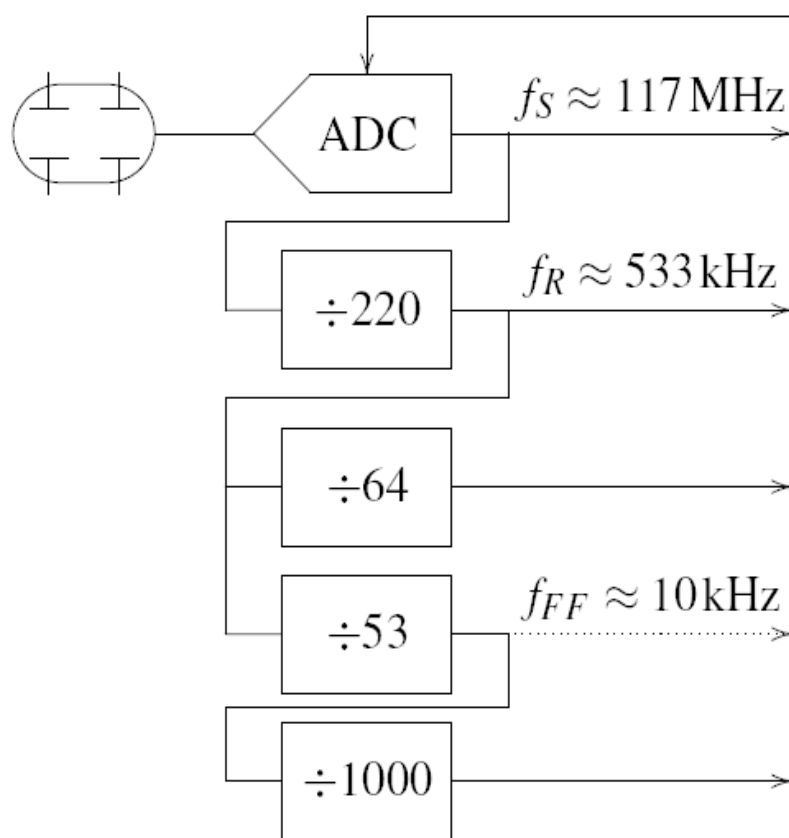
- LIBERA1:FR:WFX
 - 2048 point waveform of turn by turn X positions in nm, updating on every trigger.
- LIBERA1:SA:X
 - Single floating point number: X position in mm updated every 100ms.
- LIBERA1:CF:AUTOSWS
 - Controls state of rotating multiplexer switches: can be set to *Manual* or *Automatic*.
- The current development Libera EPICS driver publishes more than 300 PVs!



Data streams to PVs

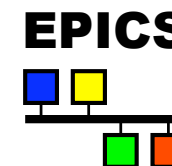


Group name Code blue



Configuration and control

- **CK** Clock control
- **FT** 1024 pt Waveform + Scalar @trigger
- **FR** 2048 pt Waveform @trigger
- **TT** 524,288 pt Waveform on demand
- **PM** 16,384 pt Waveform on postmortem trigger
- **SC** Signal Conditioning
- **BN** 3000pt Waveform Trigger
- **FF** Fast feedback status and control
- **IL** Interlock control
- **SA** Scalar @10 Hz
- **CF** Configuration and control
- **SE** Sensors: system monitoring



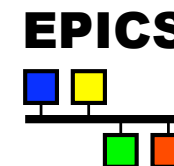
Position Readout

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

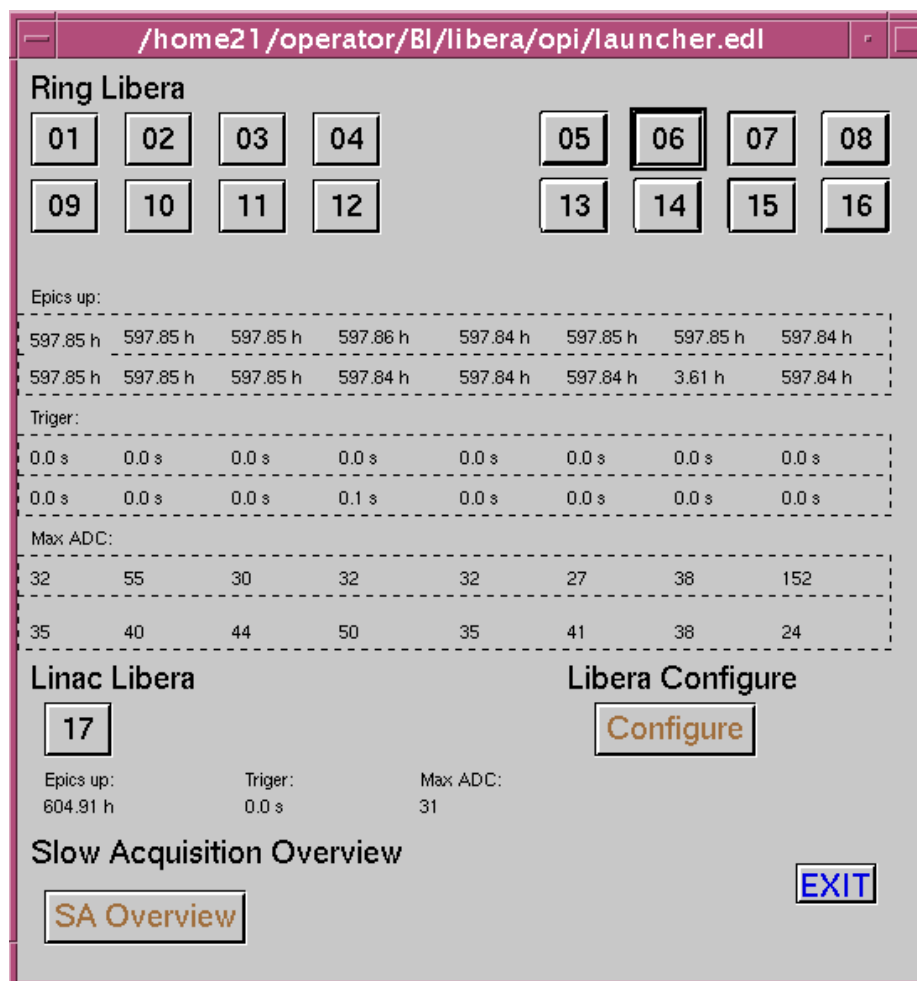
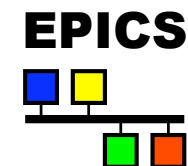


The following PV groups are used to manage and monitor the state of Libera.

- **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 System Overview

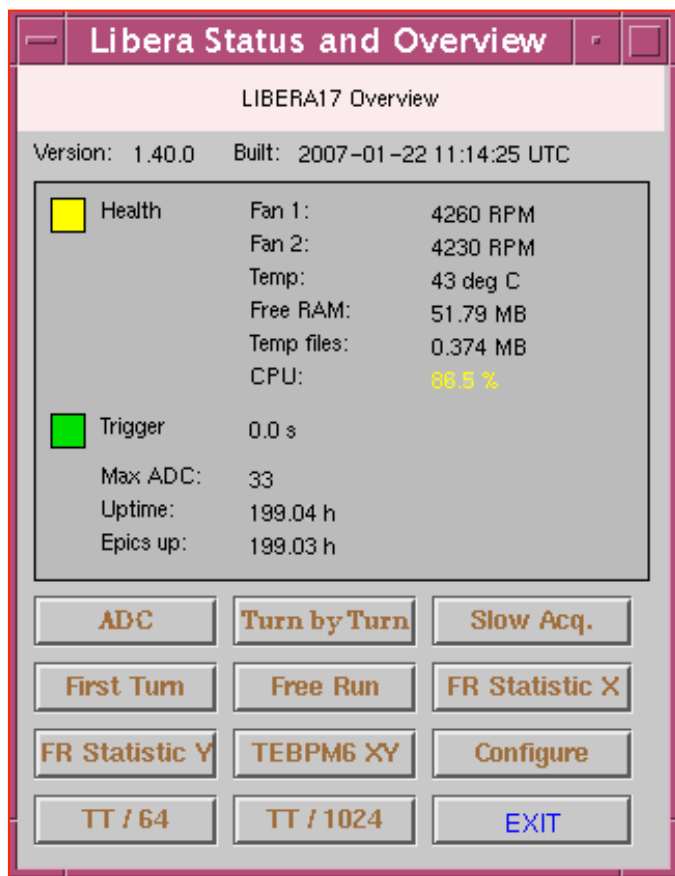
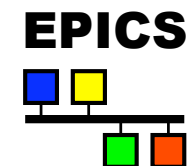


Developed with EDM

- Shows all Libera IOC's at IHEP.
- For each Libera EBPM shows EPICS up time, trigger status and Max ADC counts.



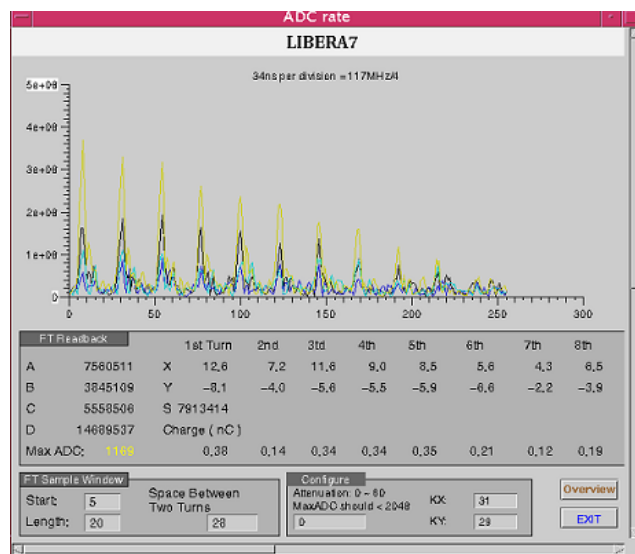
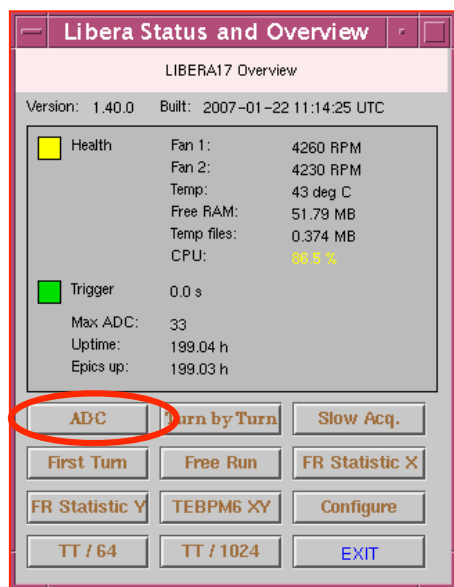
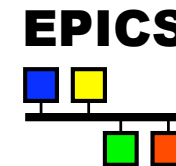
Single Libera Status and Overview



- Overall system health report.
- Clock status report.
- System and EPICS driver uptime.
- Links to screens providing all other Libera functionality.



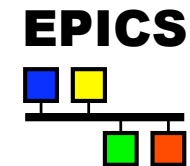
ADC Rate Data (First Turn)



- Raw 1024 point ADC buffers (reduced to 256 point magnitudes).
- 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.



Configuration



Configure Libera

LIBERA4 Configuration

Geometry	
KX:	14.5000
KY:	14.5000
KQ:	10.0000
X0:	0.0000
Y0:	0.0000
DIAGONAL <input type="checkbox"/>	

Channel Gains	
G0:	1.0000
G1:	1.0000
G2:	1.0000
G3:	1.0000

Mode Enables	
First Turn:	Enabled <input type="checkbox"/>
Free Run:	Enabled <input type="checkbox"/>
TT / 64:	Enabled <input type="checkbox"/>

LMTD Tuning	
Detuned <input type="checkbox"/>	
Detune factor:	400

Interlock	
Disabled <input type="checkbox"/> ■	
Clear	
Ready	
X:	-5.0000 5.0000
Y:	-5.0000 5.0000
Min Signal:	200.0
Disabled <input type="checkbox"/>	
Max ADC:	1900
ADC Time:	5

Switches	
Switches:	Fixed <input type="checkbox"/>
Switch:	3
Attenuation:	46
AGC:	Disabled <input type="checkbox"/>

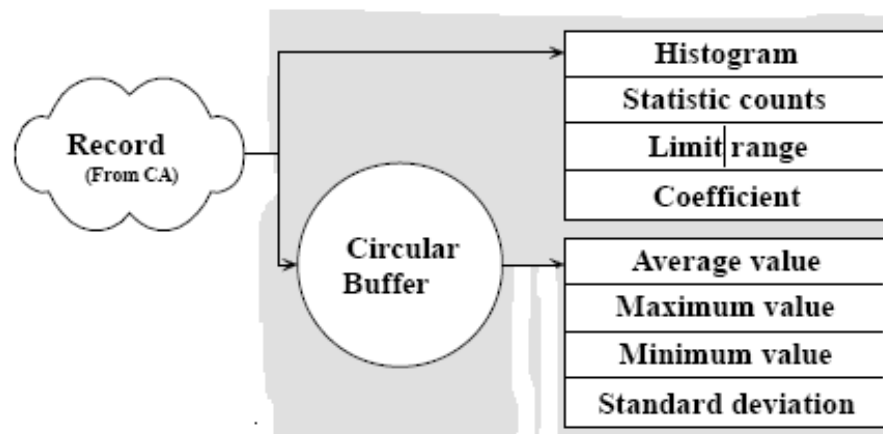
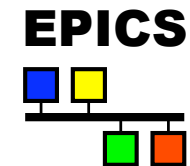
Current Scale	
Current at 0dBm:	1000.0

EXIT

- BPM geometry and orientation configuration.
- Interlock status and configuration: note auto on/off feature.
- Attenuators, signal conditioning and detailed sampling control.



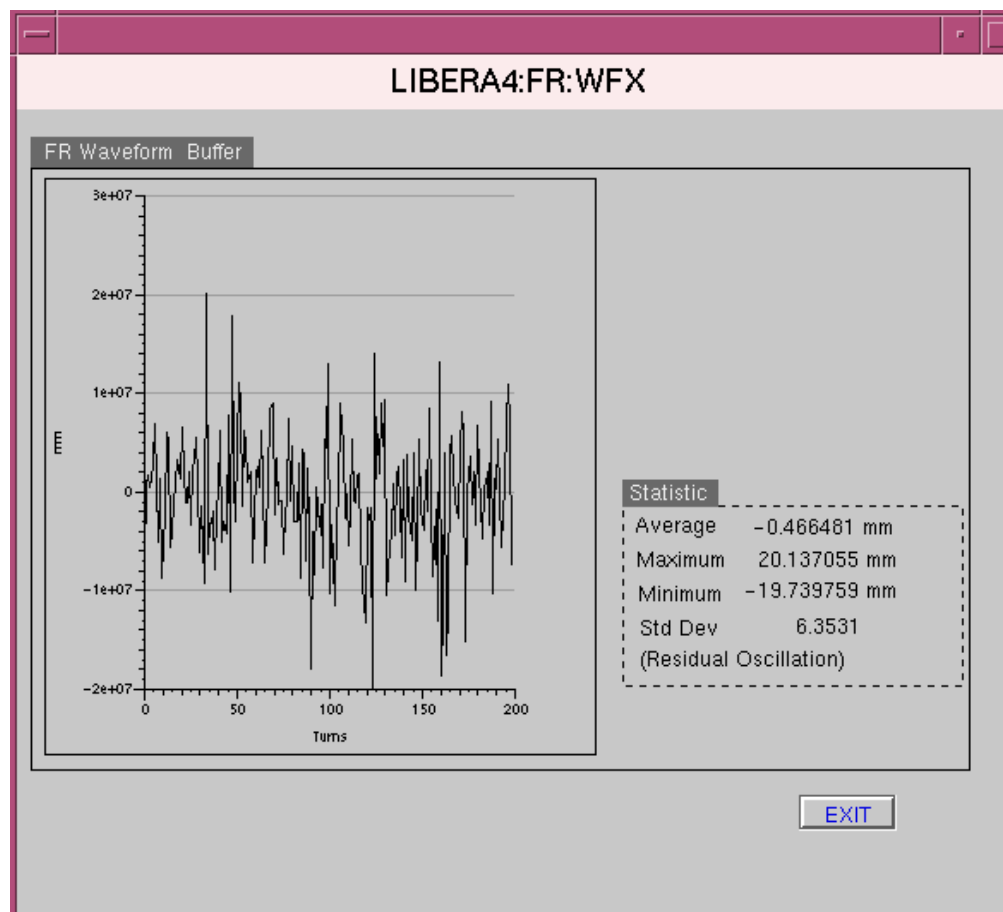
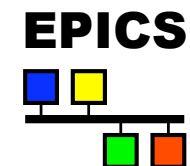
Soft IOC of Libera



```
=====
#!../bin/linux-x86/Libera
cd ../..
dbLoadDatabase("dbd/libera.dbd")
Libera_registerRecordDeviceDriver(pdbbase)
dbLoadRecords ("db/RingBpm.db")
dbLoadRecords ("db/
    StatisticD.db", "device=LIBERA1:SA:X, record=LIBERA1:SA:X, count=100, cycle=.1
    second")
dbLoadRecords ("db/
    StatisticWL.db", "device=LIBERA1:FR:WFX, record=LIBERA1:FR:WFX, count=1024, cyc
    le=.1 second")
.....
cd ./iocBoot/ioc
iocInit()
```



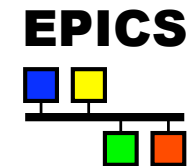

Soft IOC of Libera



Display for the statistic of Libera Waveform data



Soft IOC of Libera



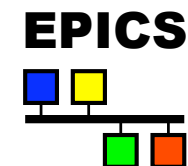
A example of record in "RingBpm.db":

```
record(LiberaBpmPos, "LIBERA2:R4OBPM12:SA:POS")
```

```
{  
    field(DESC, "libera BPM XY calculator")  
    field(SCAN, ".1 second")  
    field(EGU, "mm")  
    field(PREC, "8")  
    field(DTYP, "LiberaBPM")  
    field(INA0, "LIBERA2:SA:A")  
    field(INB0, "LIBERA2:SA:B")  
    field(INC0, "LIBERA2:SA:C")  
    field(IND0, "LIBERA2:SA:D")  
    field(IN05, "LIBERA2:SA:CURRENET")  
    field(IN06, " R4O:BI:DCCT:current ")  
    field(IN07, "0.999062")  
    field(IN08, "0.993602")  
    field(L0A, "0.040238")  
    field(L0B, "-0.014050")  
    field(L0C, "-0.147896")  
    field(L0D, "2.100644")  
    ...  
}
```



Soft IOC of Libera



/home21/operator/BI/libera/opi/SA_Details.edi

LIBERA2

Slow Acquisition Details

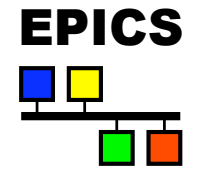
Cable Equalize Set

U	-0.00505723 mm	PCO	0.00000000
V	-0.03160675 mm	PED	2787.00000000
ABCD_X	-2.44310789 mm	ABCD_Y	-2.54463147 mm
ABC_X	-2.14227263 mm	ABC_Y	-2.80766493 mm
BCD_X	-2.71425856 mm	BCD_Y	-2.79954823 mm
CDA_X	-2.70773800 mm	CDA_Y	-2.29402076 mm
DAB_X	-2.13978744 mm	DAB_Y	-2.27227314 mm
PDX	0.30332045	PDY	0.27235833
Mea Count	319920.00000000	Error Rate	0.00871155

1

EXIT

Shows the calculated position data and the error rate of measurement for Beam Position



Thanks for your attention!