Advanced Photon Source High-Level Orbit Correction Software

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Development Philosophy

- Divide the work in several single-function GUI applications and IOC software.
  - Each part of system can be debugged more easily.
- Usually each application started out simply, then increased in complexity, as needed.
- Applications share information (data and confguration) through files in SDDS format.

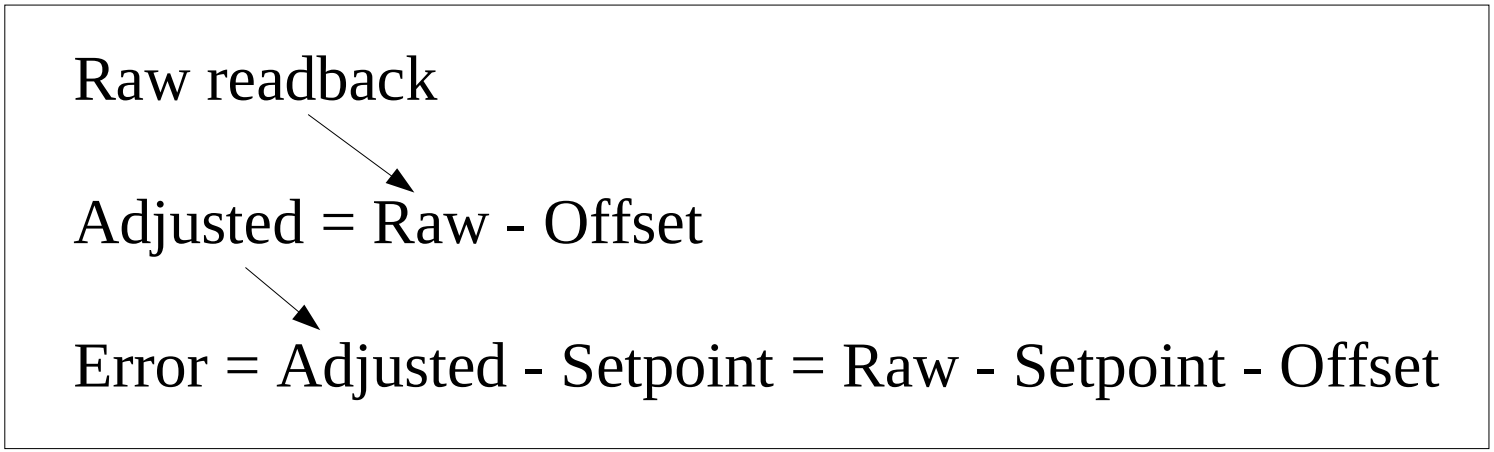
Development Philosophy

- GUI written in tcl/tk using widget libraries with consistent look and feel.
- Need to make software structure general to prevent extensive rewrites when a complication arises.
- This talk emphasizes the software components needed for orbit control rather than the particular implementations of the software.

Application Types

- Management of data related to orbit.
- Configuration management, i.e. to easily handle frequent changes in device availability.
- Actions:
  - Execution of orbit correction
  - Testing and control of other control system quantities

Orbit Data Processing in IOC

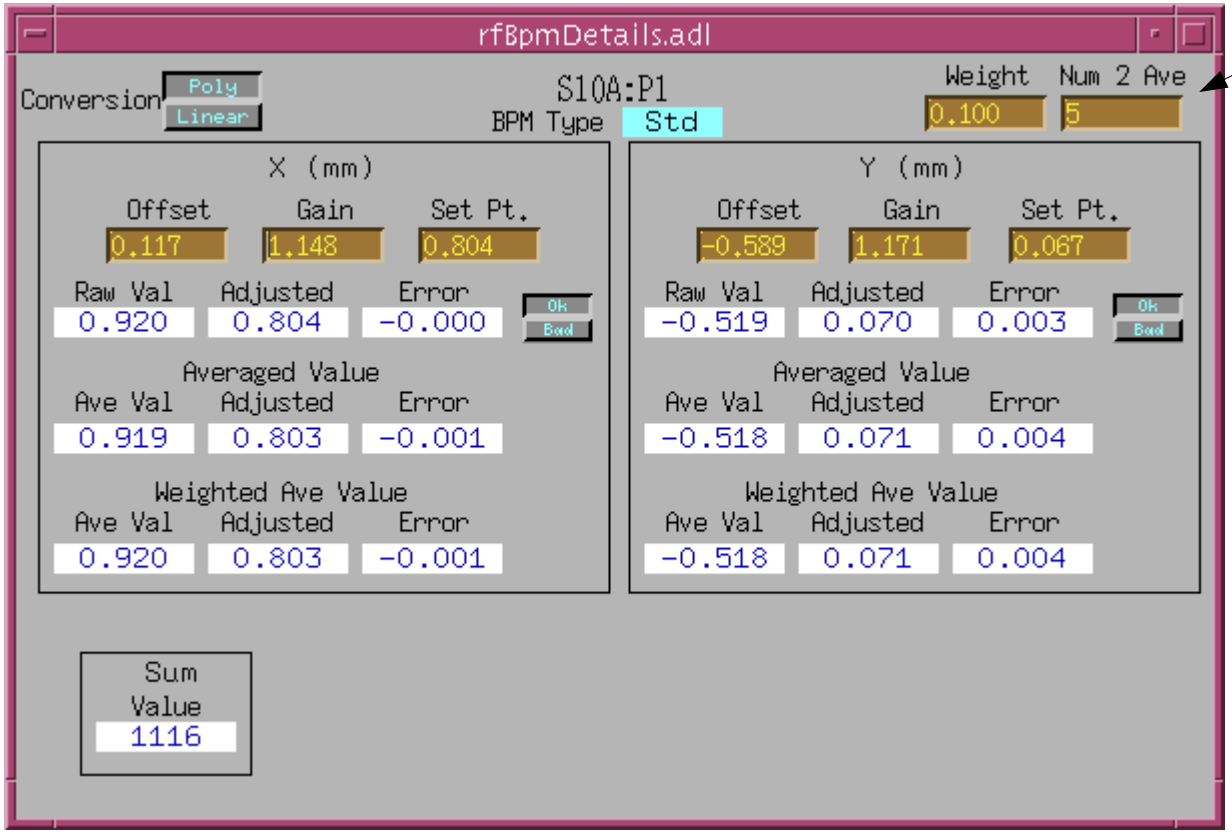


- Offset: beam-based measurement.
- Setpoint: where Users' want the beam.
- Offset and setpoint interchangeable for error, but good to maintain accurate database to keep correct physical interpretation.

Orbit Data Processing

- Available averaging of bpm data in bpm iocs:
  - None (i.e. output of 7 ms averaging)
  - Software boxcar averaging of above (0.1 sec to 12.8 sec)
  - Low-pass filter
- 9 readback quantities available for each bpm.
- Boxcar used in orbit correction.
- Others used in data logging.

Orbit Data Processing



Averaging parameters

Low-level display illustrating many of the readback data related to one bpm.

Other Orbit Data Processing

- Polynomials for raw data
  - Allow several types of bi-variate polynomials.
  - Application to update setpoint and offset when converting.
  - Use one polynomial type all the time, really.
- Gains
  - Same application to update setpoint and offset.
  - Values measured with lattice model.

Save/Compare/Restore

- General application, which we use for saving setpoint, offsets (with other SR control names).
- Required for different lattices (setpoints) and for different bunche pattern (offsets)
- Ability to restore part of save-set
- Use named links as "Preferred" files for current operations.

Data Logger

- Log low-passed bpm readbacks, offsets, setpoints at specified intervals (1 minute).
- Log average bpms at faster rate for a short time when orbit glitch occurs.
- Log turn-by-turn bpm history data when a beam loss occurs.

Beam-Based Measurements

- Measure offsets with orbit and quadrupole scan. Others are measured by "straight line" interpolation method.
- Measure Xray bpms gains with mechanical mover.
- BPM gains calculated by lattice optics fitting.
- Archive all measurements.

Orbit Display

- General application for display array of similar control names (Array Display Tool - ADT, part of Epics distribution).
- Configuration for any of the 11 bpm data possible.
- Tcl/tk wrapper for general substitution and wildcard matching.

Run Control Pvs

- General method of registering with the control system a workstation process to ensure that only one instance of that process is running at a time across the network.
- A run control PV must be pinged continuously by the associated application to ensure application is still running.
- If pinging stops, then an alarm condition on run control PV is created. Useful for detecting problems.

Offset Intensity Dependence Compensation

- Applies offset changes continuously when beam decays according to preset table.
- Separate application to make measurement of intensity dependence. Also used to find bad bpms.

Device Status Management

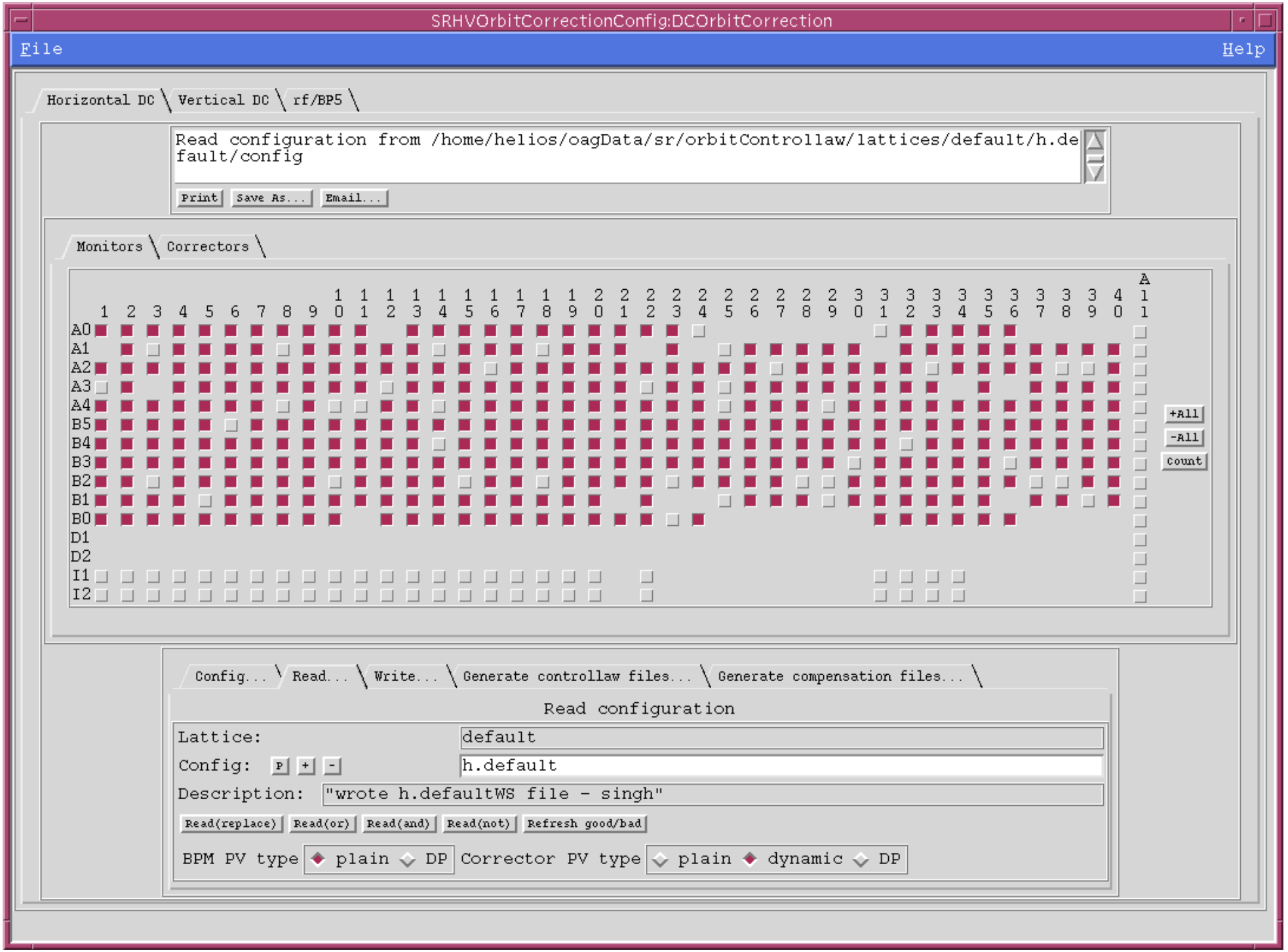
- Each device (bpm or corrector) have various qualities, which affect their use. Permitted uses is saved as data.
- BPM fields: "non-existing", "ok for logging", "ok for DC OC", "ok for RTFS", "OK for steering", "Type", "Electronics type", etc
- Corrector fields: "non-existing", "ok for DC OC", "ok for RTFS".
- Data accessed by many applications for configuration of widgets and actions.

Orbit Correction Configuration

- Selection of bpms and correctors.
- Automatically hides which bpms and correctors that are bad.
- Creates configuration and correction matrix written to a named or dated directory, i.e. 2002-1205.00
- Selection of reference response matrix.

Orbit Correction Configuration

- Selection of system of bpms and correctors, i.e. regular channel access or reflective memory.
- Frequency band overlap FF matrix calculated.
- Same application for both RTFS and DC OC.


SRHVOrbitCorrectionConfig:DCOrbitCorrection
File
Help
Horizontal DC
Vertical DC
rf/BP5
Read configuration from /home/helios/oagData/sr/orbitControllaw/lattices/default/h.default/config
Print
Save As...
Email...
Monitors
Correctors
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 A11
A0
A1
A2
A3
A4
B5
B4
B3
B2
B1
B0
D1
D2
I1
I2
+All
-All
Count
Config...
Read...
Write...
Generate controllaw files...
Generate compensation files...
Read configuration
Lattice:
default
Config:
P
+
-
h.default
Description:
"wrote h.defaultWS file - singh"
Read(replace)
Read(or)
Read(and)
Read(not)
Refresh good/bad
BPM PV type
plain
DP
Corrector PV type
plain
dynamic
DP

Lattice Optics Selection

- Application to re-link several database directories that depend on lattice optics.
- Orbit correction and local steering files are (obviously) optics dependent.
- Other links are for knob files and other optics correction files.

Orbit Correction

- Selection of configuration from a list.
- Selection of parameters for test files and command line arguments, i.e. interval, gain, overlap compensation, despiking parameters.
- Start and abort orbit correction
- Sets up other bpm and corrector PVs as indicators useful for operations and alarm configuration.

Orbit Correction (cont'd)

- Run PV tests as separate process to reduce work by orbit correction process.
- Bpm, corrector and stored current limits for correction validity.
- Corrector range error, i.e. current changes relative to a reference file. Alarm used to prevent large orbit drifts.

Local Steering

- Procedure Execution Manager (PEM), general tcl/tk application that allows automation of complex sequence of actions.
- Local bump steering uses a PEM to setup the orbit readback for steering (i.e. sets the error everywhere to zero), do the local steering with special orbit correction, then restore the orbit readback.
- Steering setpoints changes can be entered as delta positions and angles.

Orbit Correction in Epics

- Orbit correction software ported to VxWorks (Epics).
- Waveforms created for bpms and correctors in RTFS ioc to rapidly connect to bpms and correctors through reflective memory and RTFS DSPs.
- Though setup is completely different from workstation based OC and extremely complicated, the GUIs for orbit correction are essentially unchanged.

Orbit Recovery Application

- Restore orbit at light source points for a new focusing optics or for a return to an old one.
- Series of alternating orbit correction with multiple local bumps (for dipole sources and ID sources in h and v planes) and partial recovery of savesets of bpm setpoints.

Summary of Databases

- BPM status
- Corrector status
- BPM septoints, DC offsets (i.e. general save/compare/restore application)
- History of BPM setpoint/offset restore actions
- DC Offset measurements
- Offset intensity dependence
- Gain measurements (xray bpms, rf bpms)

Summary of Databases

- Orbit correction configurations for both DC OC and RTFS.
- History of local steering actions
- Logged data:
  - Continual readbacks of relevant BPMs and correctors on long time scale (e.g. 60 seconds),
  - same as above but with much shorter time scale (1 seconds) at an orbit glitch or beam dump, and
  - Turn-by-turn bpm history before beam dump.

Summary of Databases

- Lattice optics and dependent files.
- Feedforward waveforms for circularly polarized undulator.

Summary

- This represents an important effort to organize the data, to make the configurations easy to modify when necessary, and to make improvements to beam stability.