Design for Recycler BPM Calibration Acnet Page

Marc W. Mengel

Abstract

This paper describes the current design for the Acnet Console application which will manage BPM Calibration for the Recycler Ring at Fermilab. This document provides a initial description of the intended usage of the software, and an overview of how the software is broken into modules. It should assist other people in understanding the software. It will be updated as design work completes, and as implementation progresses.

Intended Usage

Functionality

The BPM Calibration Application will allow users to:

- initiate calibration tests on one, several, or all BPMs on one, several, or all control "houses" in the Recycler Ring.
- select from one or several intensity levels and waveforms of calibration signal.
- abort such tests if they feel it is taking too long
- view test results in a fasion which lets them quickly identify problem BPMs.
- review history of, and adjust value of, calibration parameters for BPMs.

Screens

Currently, the application is envisioned as proceeding through 4 screens:

1. A **setup** screen that lets the user select:
    - Houses, (and BPMS within those houses??) to calibrate [default all in all]
    - Calibration Intensity Levels [default all]
    - Calibration Waveforms to use [default all]

   and lets them start the calibration
2. A **progress** screen, which shows the progress of calibration on the various houses as we step through the various intensities and waveforms
3. A **results** screen which shows a graph of average and RMS positions read back from various BPMs, and lets the user select a BPM for the **adjustment** screen; and has a "Adjust All Outliers" button (with an R U sure popup) to adjust all out of tolerance BPMs to a recommended calibration value.
4. The **adjustment** screen, which shows a history of past calibration values for this BPM as a time plot and histogram, provides recommended new values for calibration parameters (which may be "ignore this BPM"), and allows the user to pick values (default the recommended ones) and set the calibration

parameters for the BPM to those values.

The normal usage would start at the **setup** screen, pause at the **progress** screen as calibration sets are made, and then move on to the **results** screen, where various trips to the **adjustment** screen and back would be made. The thorough user would then go back to the Setup screen, re-run the calibration, and review how the new values worked on the **results** screen.

Initial setup for a given housefull of BPMs could be made by the "Adjust All Outliers" button on the **results** page.

Architecture of the software

The code will be organized into a few small modules of one source file each:

- a **hardware** module which will do all of the ACNET communication with the BPM house ACNET nodes. This module will initialy be stubbed out with routines that provide fake data for testing.
- a **state** module which will keep track of what screen the user is on, and how far through the calibration process we are.
- a module for each of the 4 screens (**setup, progress, results, adjustment**), which will draw that screen on the users display console.
- a **history** module which will track the calibration history of the various BPMs in a database
- a **main** module, which will house the main Console application event loop, and update the **state** module as events come in, which will in turn aks the appropriate screen module to update the console display.

The subroutine call interfaces for these modules will be described in more detail in the following sections.

The hardware module

The **hardware** module will be in file "hw.c", and have interface subroutines:

int hw_init();
    Initialize hardware interfaces (i.e dio init/lock routines)
int hw_trm();
    shutdown hardware interfaces (i.e dio close/unlock routines)
int start_signal_generator(int house, int beam_type, int ratio);
    turn on the calibration signal generator in a given house generating a given beam type, and with A:B ratio given (currently only 1:1 or 2:1)
int stop_signal_generator(int house, int beam_type);
    turn off calibration signal generator (must *always* be called before leaving application!)
int start_data_collection(int house, int beam_type);
    tell the front end to begin collecting closed-orbit data for the given beam_type.
int check_data_ready(int house, int beam_type);
    see if started data collection has finished.
int collect_data(int house, int raw, int *pn_bpms, float *pos, float *rms);
    retrieve collected data into arrays. This actually sums the values into the array; they will be divided by the number of sampling runs at the end of the data collection before graphing.

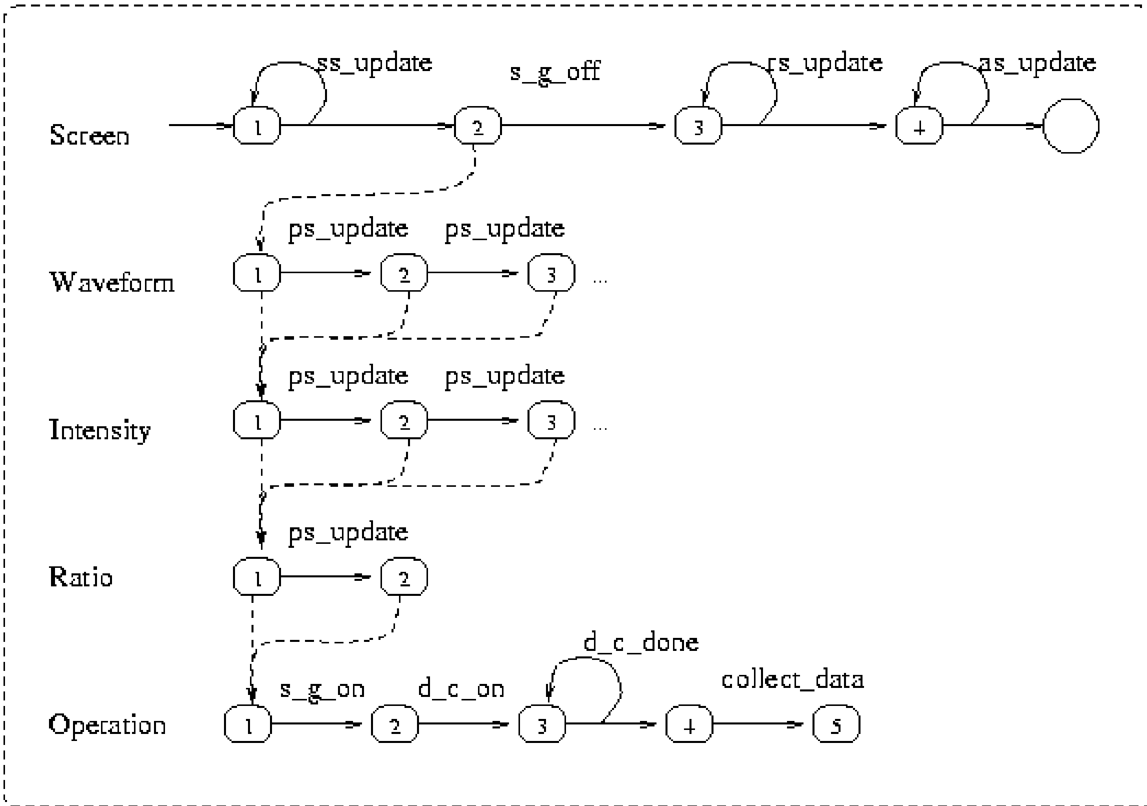
The state module

In order to allow calibration to be done in bite-sized bits, while polling for user requests to abort, etc; main flow of control of the application will be buried in a state machine, with each event from the event loop allowing us to tick forward a state at a time.

This module will receive event notifications from the **main** module, and will refer the appropriate event to the current **screen** module's update() call, or other internal subroutine calls, as indicated on the state transfer edges in the diagram below. Each such subroutine will return a result of either:

- 0 == stay in this state
- 1 == move to "next" state
- -1 == revert to setup screen
- -3 == revert to adjust screen

The state diagram (with nested sub-state diagrams indicated with dashed lines) looks like:



int st_update(int wid,int type,int row,int col,int info)
: update appropriate screen with new event.

s_g_on()
: Turn on signal generator for current waveform, intensity, etc. in all selected houses.

d_c_on()
: Turn on data collection in all selected houses.

d_c_done()
: Check if data collection is done in all selected houses, or if we have timed out.

collect_data()
: collect raw and adjusted data for all selected houses

s_g_off()
: turn off signal generator in all houses

The state module will also hold the data read back from the calibration data collection in arrays:

```
float st_pos[]; float st_rms[], st_pos_raw[], st_rms_raw[];
int n_samples;
```

The setup screen module

This module will deal with the setup screen, which should look something like:

```
                             BPM Calibration Setup

 +-Coverage==========+    +-Intensities=======+    +-Beam Simulation==+
 |[x] All BPMs       |    |[x] Low (0.1V)     |    |[x] un-bunched    |
 |[ ] Houses:___-___ |    |[x] Med (0.5V)     |    |[x] 2.5MHz        |
```

```
 |[ ] BPMs:____-____ |   |[x] High(0.9V)     |   |[x] 7.0MHz        |
 +===================+   +===================+   +==================+

                          [Start Calibration]

 +-Messages=========================================================+
 |                                                                  |
 |                                                                  |
 |                                                                  |
 |                                                                  |
 +==================================================================+
```

ss_draw();

draw the setup screen

ss_update(int type,int row,int col,int info)

handle an event from the main loop. This will consist of one of:

- accepting specific house/bpm ranges (or "all")
- accepting specific intensity ranges (or "all")
- accepting specific beam type ranges (or "all")
- moving to the progress screen

The progress screen module

```
                         BPM Calibration Progress

        +-Progress==============================================+
        |XXXXXXXXXX                                             |
        +=======================================================+

                              [ Abort ]

                        Intensity: 0.3v
                            Ratio: 2
                         Waveform: unbunched

 +-Messages=========================================================+
 |                                                                  |
 |                                                                  |
 |                                                                  |
 |                                                                  |
 +==================================================================+
```

ps_draw();

draw the progress screen

ps_update(int type,int row,int col,int info)

handle an event from the main loop. This will consist of:

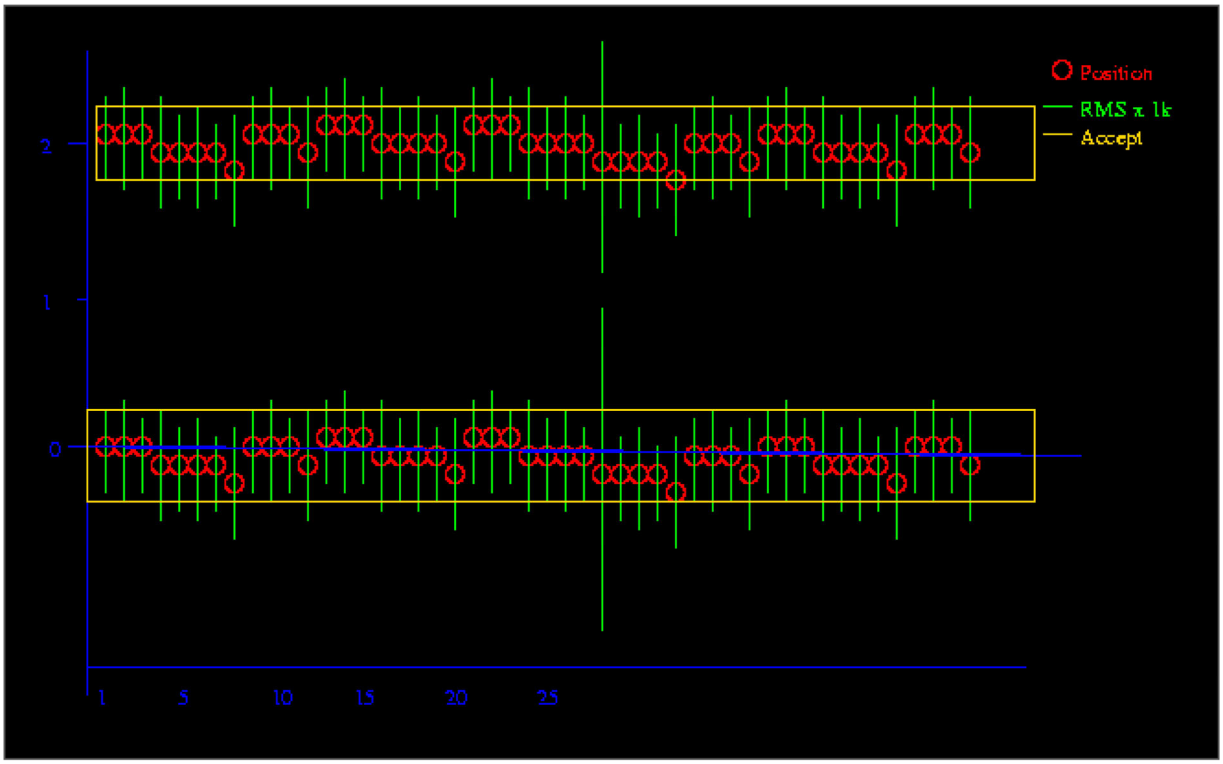
updating progress bar, and current waveform, ratio, and intensity

- aborting if the user has requested it.

The results screen module

```
                     BPM Calibration Results
      [Return to Setup]                          [Adjust All Outliers]

 +-Display====+============+                 +-Selected-+===============+
 |[ ] Raw     |[x] Position |                |BPM: 37    |  R    Pos RMS    |
 |[X] Adjusted|[ ] Intensity|                |           | 1:1   0.3 0.003 |
 +============+=============+                | [Adjust]  | 2:1   2.3 0.002 |
                                             +==========+================+
```




```
 +-Messages==================================================================+
 |                                                                           |
 |                                                                           |
 |                                                                           |
 |                                                                           |
 +===========================================================================+
```

rs_draw();

draw the results screen

rs_update(int type,int row,int col,int info)

handle an event from the main loop. This will consist of either

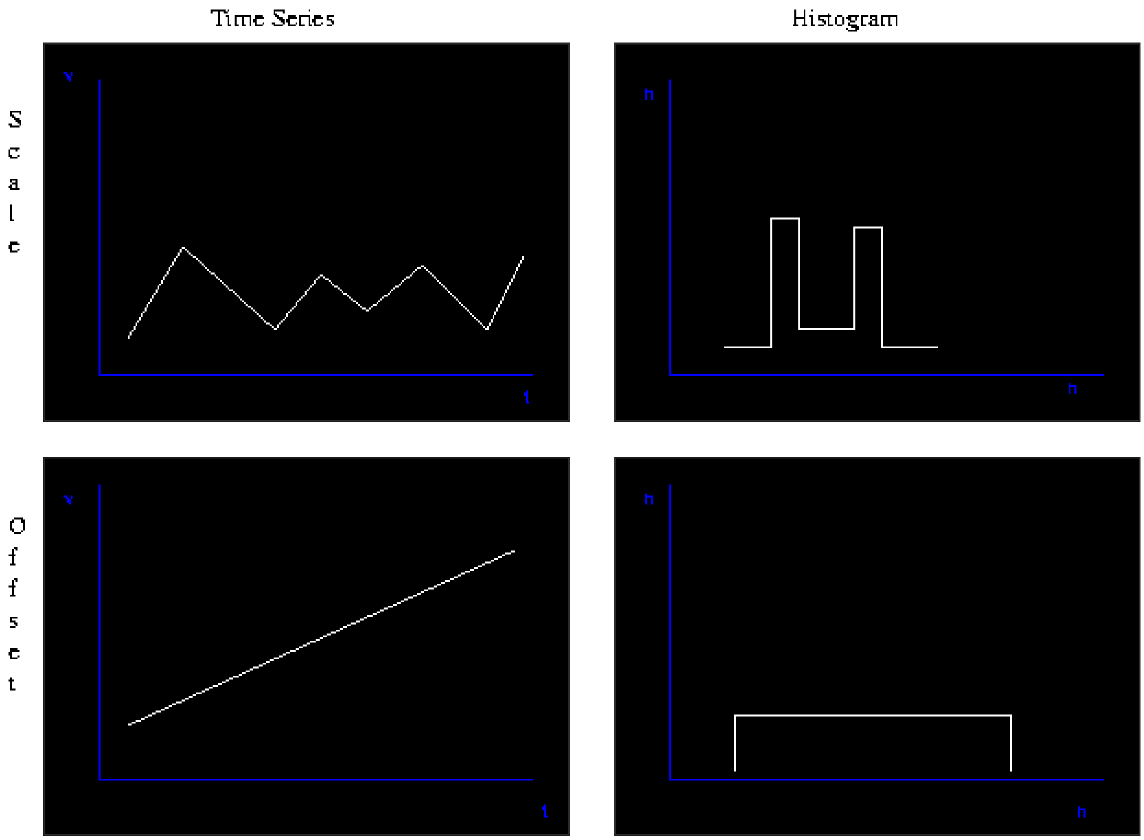
- selecting a BPM as current, and updating the text parameters box.
- transferring to the adjustment screen for the current BPM
- adjusting all BPMs with the "Adjust All" button
- hopping back to the setup screen at user request ("Setup") button.

The adjustment screen module

This module should present a screen like:

```
                     BPM Calibration Adjustment

      [Return to Setup]                     [Return to Results]
```




```
                       Scale    Offset
     [ ] Historical Average    0.0025   0.0020
     [ ] Latest Reccomendation 0.0030   0.0020
     [ ] Custom Value          ______   _______

                  [Adjust Calibration]

  +-Messages==========================================================+
  |                                                                   |
  |                                                                   |
  |                                                                   |
  |                                                                   |
  +===================================================================+
```

as_draw();

draw the adjustment screen

as_update(int type,int row,int col,int info)

handle an event from the main loop. This will consist of either

- accepting a new parameter value

- adjusting this BPM by calling the history module
- hopping back to the result screen at user request.

The history module

This module will help us track history of calibration of BPMs.

hs_fetch(int maxbpms; int &nbpms, float *shifts, float *scales);
    Get current calibration params for BPMs
hs_history(int bpm, int max, int &n, float *shifts, float *scales, long *dates);
    Get historical calibration params for a given BPM.
hs_adjust(int bpm, float shift, float scale);
    Set new shift and scale value for the given BPM.
hs_forget_before(int bpm, long date);
    Remove entries older than `date` from history for a given BPM.

The main module

This consists pretty much of the main() subroutine, which will call the routines to initialize the hardware, call the state machine repeatedly, then clean up.>