Application and Controls Software Project List for ATF2 EXT and FFS Tuning Goals

Glen White
ATF2 Software Workshop
LAL, June 2008

- EXT tuning and feedback

- FFS tuning and feedback

- Online optics manipulations

- EPICS IOC development

- FS software development

- New hardware controls in FS

Some General Comments

- Two main categories of project

    - Lower-level controls software (hardware drivers, EPICS DB, EPICS-level interfaces).

    - Higher-level apps (through FS) (tuning algorithms)

- Project list slides shown here just brief overview for discussion

    - Responsible person should be found for each project and first task should be construction of a more detailed task list.

    - Only EXT/FFS related projects shown here

    - Priorities shown are a subjective view on the urgency of the tasks as relates to the primary goal of ATF2.

- For simulation development- need agreed centrally maintained list of error sources for comparison purposes.

- Need to agree procedure to sign-off on projects to declare them as production versions (agree chosen techniques to be used, quality of code etc...)

- Overlap between many tasks listed here and those for the EXT emittance study group- this is not duplicate work, just consolidating all task descriptions here.

Generic Project Deliverables

- For all software application projects:

  - Test algorithms and make choice based on simulation performance

  - Migrate code to control environment (FS&|ATF2 computer).

  - Make graphical interface to run on main control system

    - this is the "manual" interface to run this one tuning task in isolation.

  - Also have easy to use functional interface to be called by other apps with well defined input/outputs etc

    - This can form part of a larger automated tuning system

  - Documentation

    - Main functions should contain instructions for use

    - Graphical interfaces should contain step-by-step detailed useage instructions

    - Also put full documentation for application, together with project information, work still to do etc on wiki

- EPICS – control software projects:

  - EPICS DB's written and tested including simulation mode

  - Documentation in wiki (including project details, work to do and a detailed description of all PV's)

  - Test graphical interfaces

  - Archiving + restore list

Coupling Measurement and Correction in EXT

- Priority: V. High

- Work Done:

  - MW / GW / CR / JB / MA

  - Experience at ATF with wirescanner system

  - Developed strategy for ATF2 with simulations (including integrated)

  - Study of startup conditions (only 2 skew Quad's)

- Methods

  - Iterative scanning of wirescanners

  - Faster, single step 4-d calculation and correction?

- Simulation work required

  - Performance estimation with realistic errors

  - Ability to correct expected coupling sources- from ring (from ring simulation inputs), and from QM7...

- FS/controls integration

  - Need wirescanner interface to automate procedure

  - Writing and testing of FS code

Dispersion Measurement and Correction in EXT

- Priority: V. High

- Work Done:

  - MW / GW / CR / JB / MA

  - Experience at ATF

  - Developed strategy for ATF2 with simulations (including integrated)

- Methods

  - DR energy scan, QF1X+QF6X eta-x / QS1X+QS2X sum knob for eta-y

- Simulation work required

  - Study case with QM7 error source (eta-y' not corrected by above...)

  - Study possibility of correction without DR E ramp measurement.

- FS/controls integration

  - Need interface to DR E ramp to automate procedure.

  - Write and test FS code.

EXT Beta-Matching

- Priority: V. High.

- Work done:

  - MW / RA

  - Experience at ATF matching extraction line for emittance measurement program

- Methods

  - Beta-matching for changing conditions out of the ring

  - Ensuring optimal conditions for Coupling and Dispersion measurements and corrections.

  - Automated procedures

- Simulation work required

  - Coping with expected misaligments and simulated ring extraction parameters

  - Coping with QM7

- FS/controls integration

  - Tools required exist.

  - Write and test FS code.

Beamline Modeling Tools

- Priority: V. High.

- Work done:
  - Some tools associated with other tasks (R measurement for steering etc...)

- Methods
  - Set of tools to check validity of current latices periodically.

- Simulation work required
  - Code needed and developed by commissioning team, probably mostly directly in the accelerator environment first.

- FS/controls integration
  - Migrate tools used in commissioning into FS environment to use during tuning.

EXT Orbit Steering / Feedback

- Priority: V. high

- Work done:

  - A. Scarfe /GW/YR

  - Simulations performed with applied errors etc

  - Basic steering tests carried out in FS at ATF

- Methods

  - 1-1 steering

  - Feedback 1-1 steering with gain

  - More complex feedback- state-feedback, filter + optimal gain etc... ?

- Simulation work required

  - Find optimal method (simpler better if minimal difference)

  - Tune gain for feedback with expected noise spectra

  - Provide mechanism for online tuning of feedback parameters

  - Simulation of initial h/w setup expected (missing cavity bpms etc...)

  - Optimisation of performance together with FFS feedback.

- FS/controls integration

  - Have all tools required (when EPICS DB for Cav BPMs in place...)

  - Write and test FS code.

EXT Bunch-by-Bunch Feedback

- Priority: low/med – most probably need for goal 2 (IP stability)?

- Work done

    - JRL (+ FONT group)

    - Design of feedback, and identification of location in lattice

    - Some preliminary simulation studies of performance

- Methods

    - 2-phase intra-train vertical trajectory correction in EXT coupling-correction section

    - Classical PI digital hardware-based feedback.

    - More complex state-space system?

- Simulation work required

    - Expected jitter coming out of feedback section with respect to:

        - Pulse-pulse jitter from ring extraction system

        - Incoming intra-train bunch-bunch noise

        - Expected levels of coupling (and associated correction)

    - Operation of this bunch-bunch FB with EXT & FFS trajectory feedbacks (& IP FB)

    - Optimal feedback coefficients for ranges of jitter levels.

    - Interface for online tuning of feedback constants.

- FS/controls integration

    - EPICS interface for Feeback controls.

    - Write and test FS code. Extend FS code to properly deal with multi-bunch?

FFS Orbit Steering / Feedback

- Priority: V. High

- Work done

    - A. Scarfe/YR/GW

    - Simulation studies done with applied errors etc.

- Methods

    - Orbit steering using magnet movers (special case of 1-1 steering).

    - Feedback using 2 pairs of correctors/bpms: orthoganal 2-phase x and y correction at IP pos + ang phases

    - Matrix inversion + simple gain feedback

    - More complex state-space FB needed?

- Simulation work required

    - Find optimal magnet-mover steering method.

    - Find optimal FB method (simpler better if minimal difference)

    - Tune gain for feedback with expected noise spectra

    - Provide mechanism for online tuning of feedback parameters

    - Optimisation of performance together with other feedbacks.

- FS/controls integration

    - Special BPM for IP-phase feedback BPM, with it's own mover etc...

    - Write and test FS code.

IP Feedback

- Priority: low (IP BPM FB) + high (BSM FB)

- Work done

  - YR

  - Design of Feedback parameters, and IP stability simulation

- Methods

  - Feedback based on Shintake BSM phase signal to keep beam in measurement dynamic range of device.

  - Feedback based on IP BPM system (goal 2).

- Simulation work required

  - Design of feedback systems

  - Integration with other FB's

  - Performance based on expected noise spectra etc...

- FS/controls integration

  - EPICS + FS interface required for Shintake Monitor and IP BPM

  - Write and test FS code.

Feedback Integration

- Priority: high

- Work done

  - Individual feedback system study only

- Methods

  - Common interface to feedbacks

    - Gains

    - set-points

- Simulation work required

  - Study best initial parameters etc with standard error parameters

  - Write common interface for online monitoring and optimisation of feedbacks

- FS/controls integration

  - Separate control panel for integrated control of feedbacks

  - Individual feedback system control software needs to be in place first...

IP Waist and Beta Adjustment

- Priority: high, needed for Nov.

- Work done

    - Sha.B

    - Optics solutions for different IP waist positions and beta sizes using MAD

- Methods

    - Waist scans in presence of errors.

    - Variable IP beta for tuning (orthogonality with other knobs, fine tuning...).

    - IP Waist shift for 3 different IP z-locations.

- Simulation work required

    - Clearly define procedures and devices used.

    - Check performance with realistic errors.

    - Inclusion into integrated tuning simulations.

    - Check phase at FFS IP-phase Feebback location.

- FS/controls integration

    - All required tools exist.

    - Write and test FS code.

EXT Beam-Based Alignment

- Priority: High

- Work done

  - GW

  - Integrated simulations include only expected misalignments

- Methods

  - Quad Shunting (not studied)

  - Ballistic alignment (not studied)

- Simulation work required

  - Find optimal method.

  - Check performance with realistic errors.

  - Inclusion into integrated tuning simulations.

- FS/controls integration

  - All required tools exist.

  - Write and test FS code.

FFS Beam-Based Alignment

- Priority: High

- Work done

    - GW

    - Simulations as part of int. sim studies of quad-shunting and sext alignment

- Methods

    - Mover-based Quad shunting (studied)

    - Ballistic alignment (not studied)

    - Sextupole-BPM alignment by parabolic BPM response to magnet motion through beam. (studied)

- Simulation work required

    - Find optimal methods.

    - Check performance with realistic errors.

    - Inclusion into integrated tuning simulations.

- FS/controls integration

    - All required tools exist.

    - First-draft FS code and GUI exist.

Final IP Spot Size Tuning

- Priority: med/high, needed for early 2009?

- Work done

    - YR/JJ/RTG/GW

    - Various studies of sext + quad multi-knobs

    - Int. tuning simulations with error conditions (with one implementation of knobs)

- Methods

    - Sextupole mover-based multi-knobs.

    - Tuning of waist with final doublet strength changes.

    - Correction of some IP coupling terms with EXT Skew Quads.

    - Study for lowest achievable beam size with reduced IP beta

- Simulation work required

    - Find good orthogonal knobs.

    - Optimise correction procedure (faster) with full error source consideration.

    - Inclusion into integrated simulations.

    - Study if existing methods still work with reduced IP beta-function and detail how to achieve

- FS/controls integration

    - Need Shintake Monitor (+ other IP size monitors?) readout in EPICS + FS.

    - Write and test FS code.

Integrated Automated Tuning

- Priority: low

- Work done

  - GW/SM

  - Integrated tuning studies, with many error conditions, checks for magnet mover range deviations etc...

- Methods

  - Combine all tuning steps with rigorous automated checking to generate an automated tuning program

  - Ability to test effect w.r.t. probabilistic beam size achievable / tuning time of changes to tuning procedures

- Simulation work required

  - Extend integrated simulation work to include many simulated error conditions and as much "reality" as possible to design automated system.

- FS/controls integration

  - No additional requirements over those for individual tuning steps

  - Final implementation depends upon successful automation of individual tasks outlined earlier.

Bunch-Bunch IP Feedback

- Priority: Med

- Work done

  - If Shintake BSM needs ~<30nm stability w.r.t. IP vertical beam waist, simulations suggest not possible without further IP stabilisation?

  - Some feasibility studies by Honda-san...

- Methods

  - Beam-based feedback with IP cavity BPM and fast corrector close to IP

- Work required

  - Detailed h/w design and simulation

- FS/controls integration

  -

Magnet Mover IOC Development

- Priority: med/high

- Work done

  - JN/GW

  - Drivers and EPICS DB + test EDM interface tested at SLAC, now in place at ATF2

- Aims

  - Produce a good simulation at the IOC driver level of the response of the magnet movers to a move command.

- Work required

  - Need something rudimentary initially- just have mover IOC report requested move in sim mode.

  - With more data, can have better simulation:

    - Simulate time to move based on requested move

    - Simulate available move phase-space

    - Simulate trimming behaviour.

Power Supply IOC Development

- Priority: low

- Work done

  - GW

  - h/w drivers and EPICS DB written, Matlab-based graphical interface for testing exists, tested at SLAC, now in operation at ATF2

- Aims

  - Produce a good simulation at the IOC driver level of the response of the power supplies.

- Work required

  - Simulation within the High-Availability PS IOC (for FFS magnets) already present- the power supplies report being set to the value required.

  - HAPS very accurate- 20bit, not an important source of error for ATF2 tuning.

  - Other magnets have lower resolution PS's – maybe better to simulate this behaviour at FS software level though?

C & S - band Cavity BPM IOC Development

- Priority: High

- Work done

  - SB et. al.

  - Drivers and analysis code exist for BPM system (turning waveforms into position readings) at a low-level.

- Aims

  - Create an EPICS IOC for cavity BPMs

  - Software integration with mover system for calibration

  - FFS IP phase BPM mover system

- Work required

  - EPICS DB required with simulation mode for use away from ATF (not try to read hardware and allows FS to set position values and read them back (FS does all "BPM simulation" with tracking tools)).

  - Decide at what level to implement calibration stuff with links to mover code etc.

EPICS Readout of Fiber-PLIC beam loss monitor

- Priority: low

- Work done

  - DM

  - Analogue interface at ATF (look at scope waveforms)

- Aims

  - Digitise beam loss signal and write to EPICS database

- Work required

  - ?

Flight Simulator Core Software Development

- Priority: med (ongoing...)

- Work done

  - GW/YR

  - Software developed and tested in simulation and in production at ATF

- Wish list

  - Improve speed and reliability of software (socket code development).

    - Handle additional transfer protocols other than just ascii.

    - Error handling and reporting

  - Additional functionality

    - Handle multiple clients

    - Parallel processing

    - Additional interfaces (SAD, MAD, LOCO, AT......)

  - More documentation

  - Software repository management (migration to KEK)

EPICS Interface for Wirescanners

- Priority: med/high

- Work done

  –

- Aims

  – Write an EPICS database which interfaces with the driver code for the wirescanner software.

  – Be able to automate the wirescanner beamsize taking process from the FS.

- Work required

  – Understand existing wirescanner interface and write a software-based EPICS driver based on this.

  – Write the EPICS database once driver developed.

  – Interface this in FS.

EPICS Interface for IP BSM (Shintake Monitor)

- Priority: med/high

- Work done

  –

- Aims

  – Write an EPICS database which interfaces with the driver code for the BSM software (readout IP beamsize into EPICS record when it is taken).

- Work required

  – Provide a mechanism where BSM can automatically write beam size data to an EPICS record when it is processed.

    - Preferably access to the 90 raw intensity data points per scan so different analysis techniques can be tried.

  – Simulation of BSM for FS.

  – Import this data into the FS.

EPICS Infrastructure Development

- Priority: med (ongoing...)

- Work done

    - SB, GW

    - Installation of db archiving software on atfsad

    - ATF <-> EPICS IOC

- Aims

    - Db archiving/restore functionality

    - Timestamping / synchronising with V-system issues etc...

    - Alarm handling etc etc- what needs doing in EPICS, what can be left to ATF control system through VSYSTEM?

    - Developing ATF (VSYSTEM) <-> EPICS 'soft' IOC

- Work needed

    - Testing of systems with full IOC load

    - Synchronous acquisition across systems? Only 1.56 Hz- accurate timestamps enough? Utilise local ntpd...

    - Change ATF IOC to deal with ATF2 systems