Instructions how to set up and run Response Matrix fit

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1 Set up GUI for new machine

GUI parameters are defined in file *locoDefaultSettingsAndLists*. A new section for the new machine will need to be created in this file. GUI is set up in such a way that all elements of the fit – quads, correctors, BPMs – can be included/removed from the fit by clicking a button on corresponding widget. For that, all elements are represented in a 2D table. To make elements representable in a 2D table, all names have to consist of sector name (columns of the table) and element name (rows of the table). For example, BPM S13A:P3 – S13 is sector name, A:P3 is element name. The table assumes that there is A:P3 BPM is all sectors (cells). If not all sectors have A:P3 element, use *missingElements* lists to define lists of missing elements. File *locoDefaultSettingsAndLists* contains sector list, element name lists, and other inputs.

If the naming convention of the new machine does not allow for sector-element names, write conversion procedures from actual element names of the new machine to something that can be made in sector-element form. See example in APS_U section of the *locoDefaultSettingsAndLists* file. In APS_U file, there are only 2 sectors S01 and S02 which are repeated 20 times. The conversion procedures convert two sectors with element occurence into 40 sectors and backwards.

These instructions will describe how to run response matrix fit using simulated response matrices. Measured response matrix fit is done similarly, but requires a section for new machine handling in program *locoTransformMeasuredFiles*. Simulated response matrices are not machine specific. For the first test, it is recommended to use small number of elements for faster calculations and debugging.

The GUI is only used to generate commands to run separate programs in a separate window. The commands and the their output are shown in that separate window.

2 Start *SRLOCOFitting* GUI

The following environment variables are needed to be defined: LOCO_BINDIR, LOCO_CONFIGDIR, ELEGANT_BINDIR. LOCO_BINDIR should contain program codes, LOCO_CONFIGDIR is used to save/restore run configurations, ELEGANT_BINDIR should point to the `elegant` executable.

Create a working directory and copy file '*initialDefinitions.tcl* into that directory. Examples of this file can be found in the Examples/CONFIG directory. Edit this file for new machine. Most of the variables in this file are self-explanatory. Pay special attention to the section "Submitting Jobs related variables." There are two types of submittion: long – for calculation of the derivative matrix, and short – for calculating response matrix during iterations. Long submission can be performed to another computer that is decribed in variable *remotePath*. If this variable is empty, the calculation will be done on the local computer. Short submission is done on the local computer.

- Go to the working directory

- Start *SRLOCOFitting* by typing "SRLOCOFitting -machineName <new-machine>"

- In lower part tab "Files/Files for Calculations" enter lattice file (.lte file). Optionally, enter parameter file names.

- In the middle part of the GUI, go to "Response Matrix Elements" tab. Choose correctors and BPMs that will be included in the measured response matrix. Horizontal and vertical BPM lists have to be the same presently. Use small number of elements for the first test.

- Switch to "Fit Variables" tab and choose the elements that will be used for fitting. You can use "Read RM config" button to copy the elements from the "Response Matrix Elements".

- Switch to "Noise Elements" tab and choose quadrupoles and quadrupole tilts for noise generation. No sextupoles or orbit correction correctors needed.

- In the lower part, switch to "Generate Test Files" tab

- Enter "Output rootname" and some errors. Quad, corrector, and BPM errors are fractional, tilt and sextupole displacement errors are absolute

- Enter response masurement kick in rads

- Press "Make test files". It will start a new execution window where you can see output of the running program *locoGenerateResponseWithErrors*.

- When *locoGenerateResponseWithErrors* run is complete, it will populate "Files/Measurement Files" entry boxes with just calculated files.

3   Run Response Matrix Fit

- In "Options" tab choose element types that will be used in the fitting.

- Switch to "Calculate" tab

- Check "Calculate response derivative?"

- Press small "Refresh" button next to "RMD size (MB)". It will calculate the size fo the derivative matrix and the number of variables in the fit. It will also set "Number of singular values" to a suggested number.

- Press "Fit" button. It will start the fit in the window that was started before for the response matrix generation. During the run, you can plot progress.

- After the fit is completed, you can plot various parameters using buttons in the "Plot results" tab.

- Save the fit results and configuration in the "Save/Restore" tab. Enter comment starting with the date of the measurement/fit in format YYYY/MM/DD for consistent sorting later.

Example of the command to run fitting:

```
/usr/local/oag/apps/bin/linux-x86_64/locoFitting -machineName APS \
-acceleratorCode elegant\
-latticeInputFile /home/oxygen/SR/LOCO/CONFIG/082/match5.new \
-paramFileList "" -beamlineName RING \
-hrmMeasuredInput /home/oxygen/SR/LOCO/workdir/measuredhResponse.flhrm.traMe \
-vrmMeasuredInput /home/oxygen/SR/LOCO/workdir/measuredvResponse.flvrm.traMe \
-workDir /home/oxygen/SR/LOCO/workdir \
-nux 36.189 -nuy 19.272 \
-usePreviousSolution 0 -previousResultsFile "" \
-recalculateDerivative 1 -filterDerivative 0 -recalculateInverse 1 -recombineDerivative 1 \
-useBpmWeight 0 -SVnumber 2544 -corFraction 0.5 -iterations 100 -bigIterNumber 3 \
-averLevel 0 -nonlinLevel 0.002 -badPointsLevel 0.001 \
-resultsFile /home/oxygen/SR/LOCO/workdir/results.loco \
-analMode 2 -definitionFile /home/oxygen/SR/LOCO/workdir/initialDefinitions.tcl \
-elementListRMFile /home/oxygen/SR/LOCO/workdir/listRM.sdds \
-elementListVarFile /home/oxygen/SR/LOCO/workdir/listVar.sdds \
-optionsList "useTune 1 useQuads 1 useSpecElem 0 useAverGains 0 useEnergy 0 fitDispersion 1  \
useCorrsTilt 1 useBPMsTilt 1 useBPMsCoef 1 useCorrs 1 useBPMs 1 useSkew 1" \
-prepareMatricesOnly 0 -abortFile /home/oxygen/SR/LOCO/workdir/run.abort -outputStatusDevice stdout
```

4   Fit measured response matrix

Add a section for the new machine to the file *locoTransformMeasuredFiles* which will transform the measured response matrix from the measured format to the calculation format. See the code for examples. The transformation command is run by the *SRLOCOFitting* GUI before starting the fit. The example of the command:

```
/usr/local/oag/apps/bin/linux-x86_64/locoTransformMeasuredFiles  \
-workDir /home/oxygen/SR/LOCO/workdir  \
-machineName APS  \
-xRawResponse "/home/oxygen/SR/LOCO/CONFIG/082/hResponse02.hrm"  \
-xyRawResponse "/home/oxygen/SR/LOCO/CONFIG/082/hResponse02.vrm"  \
-yRawResponse "/home/oxygen/SR/LOCO/CONFIG/082/vResponse02.vrm"  \
-yxRawResponse "/home/oxygen/SR/LOCO/CONFIG/082/vResponse02.hrm"  \
-dispRawFile "/home/oxygen/SR/LOCO/CONFIG/082/Response02.disp"  \
-useKickFiles 0 -kickFileX "" -kickFileY ""
```