Status of the LHC on-line model

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Functionality

- General purpose: provide optics and simulations on the fly to humans and control system
- Use-cases (routine operation)
    - Evaluate and create knobs, trims and others settings
    - Plot aperture restrictions
- Use-cases (commissioning)
    - To be defined

Design

- Graphical interface to MADX (in java)
- Import of MADX input files directly from the control system
- Repository of scripts and optics input files
- Client/server mode for processing requests
- Analysis tools

LOMO v0.0 - /afs/cern.ch/eng/sl/online/om/repository/sps/repo.xml

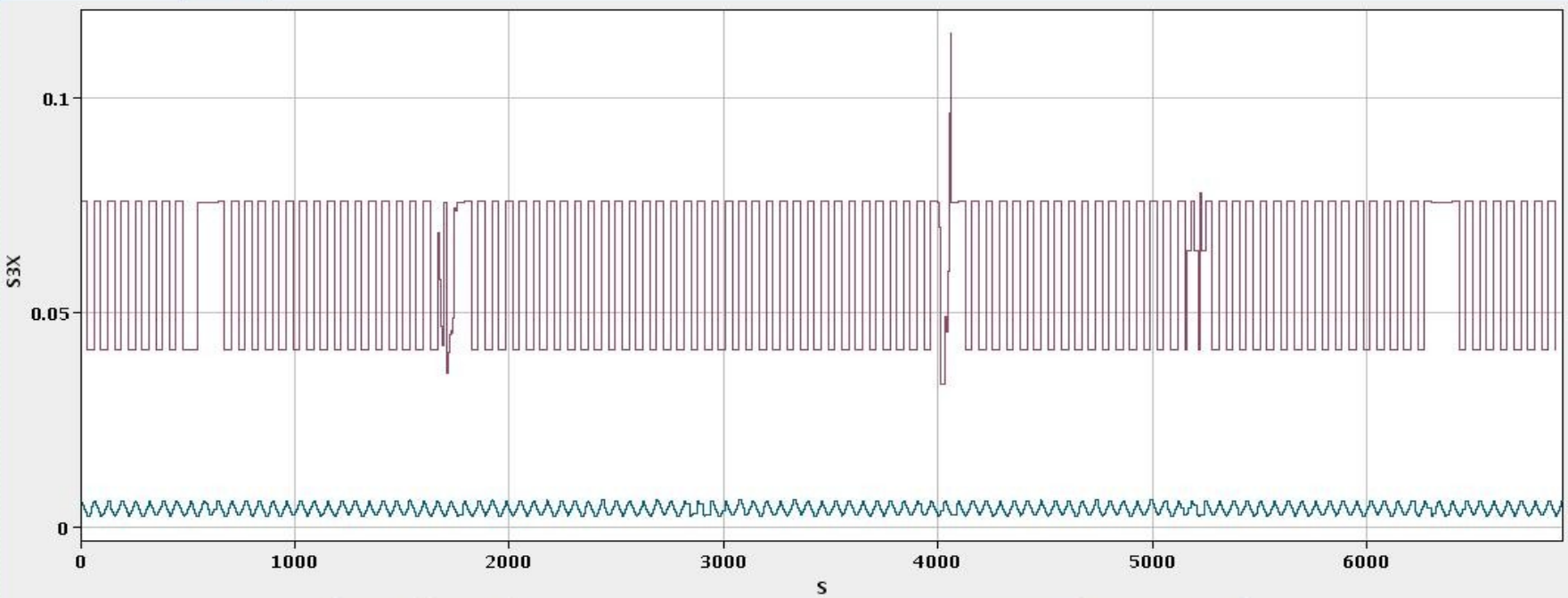
File Edit Tools Repository (SVN) Help

run Update

Repository Data

- Root
  - MADX tfs
    - tune.tfs
    - LSS4-extrbmp.tfs
    - table.tfs
    - twiss.tfs
    - aperture.tfs
  - Knobs
  - BPM data

twiss_ideal.madx Plot 0



S S3X x aperture y aperture stairs

Output Server

```
>
running twiss_idealin/afs/cern.ch/eng/sl/online/om/repository/sps/scripts/twiss_ideal.madx format : madx
madx engine
your system is Linux
Executining /afs/cern.ch/eng/sl/online/om/dev/util/madx.py /afs/cern.ch/eng/sl/online/om/repository/sps/scripts/twiss_ideal.madx
MADX ERR>In: `optics/decks': File exists
MADX>
MADX>  ++++++++++++++++++++++++++++++++++++++++++++
MADX>  +           MAD-X 3.04.02           +
MADX>  + Code Modification Date: 12.07.2007     +
MADX>  + Execution Time Stamp: 06.09.07 20.04.44 +
MADX>  ++++++++++++++++++++++++++++++++++++++++++++
ExitValue: 0
MADX>!-------------------------------------------------------------------------------
MADX>
MADX>! sps - nominal optics
MADX>
updating data tree
MADX>!-------------------------------------------------------------------------------
MADX>
MADX>
MADX>
MADX>! link the optics repository
MADX>
```

Deployment

- CVS (repository acc-co/accsoft/om/)
- /afs/cern.ch/eng/sl/online/om

Machine model

- Developing an analysis toolkit within the online model
- More or less available – several driving term analysis tools based on sussix (Matlab , python)
- bpm analysis (fft etc.) based on root – under construction
- Fitting routines for multipole errors
- Statistical learning approach

Optics fits

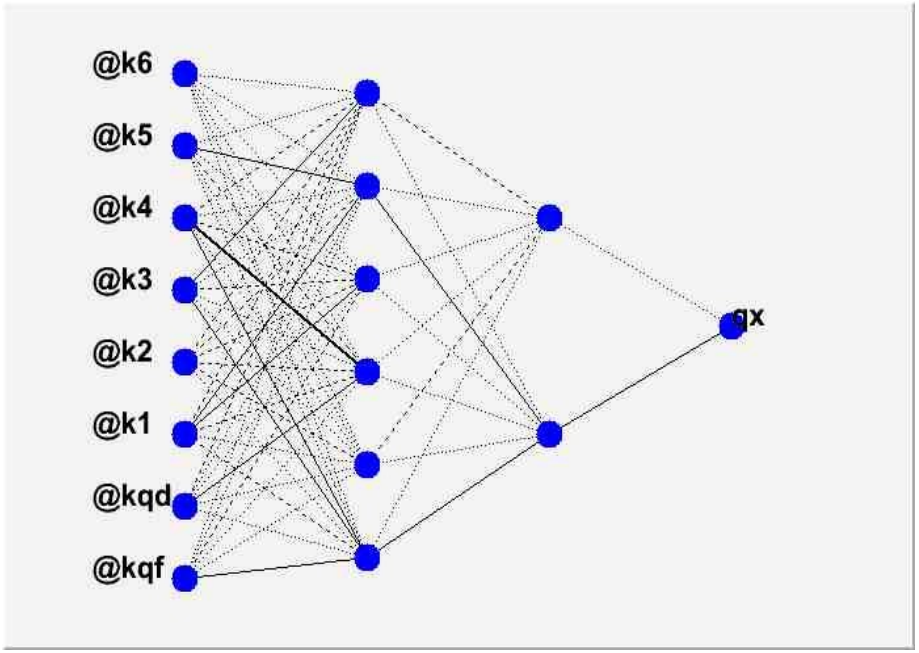
- K-values in the control system need be adjusted to make sensible results
- Use bpm data -> extract tunes etc -> fit thin multipole corrections with MADX
- FiDel data expected to be used as an initial guess
- Space charge tune shifts etc. - by postprocessing

Statistical fits

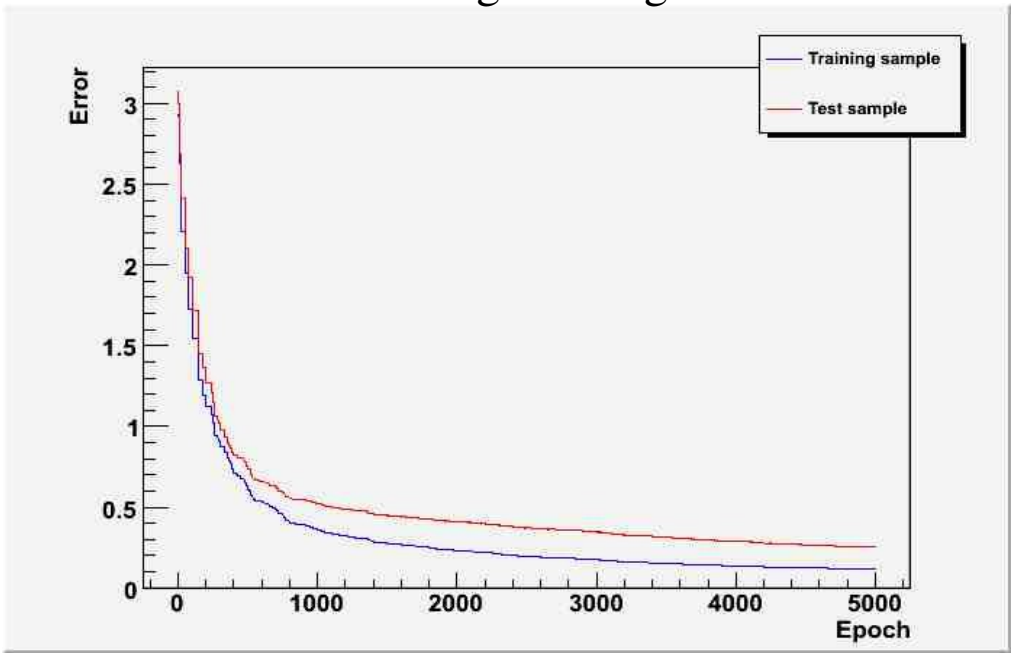
- Simulations can be used to construct a statistical model of the machine
- Statistical model can be used to speed-up calculations or include effects beyond MADX capabilities
- One possible approach – neural network training with simulated data

Neural network fits

Network structure



Training convergence



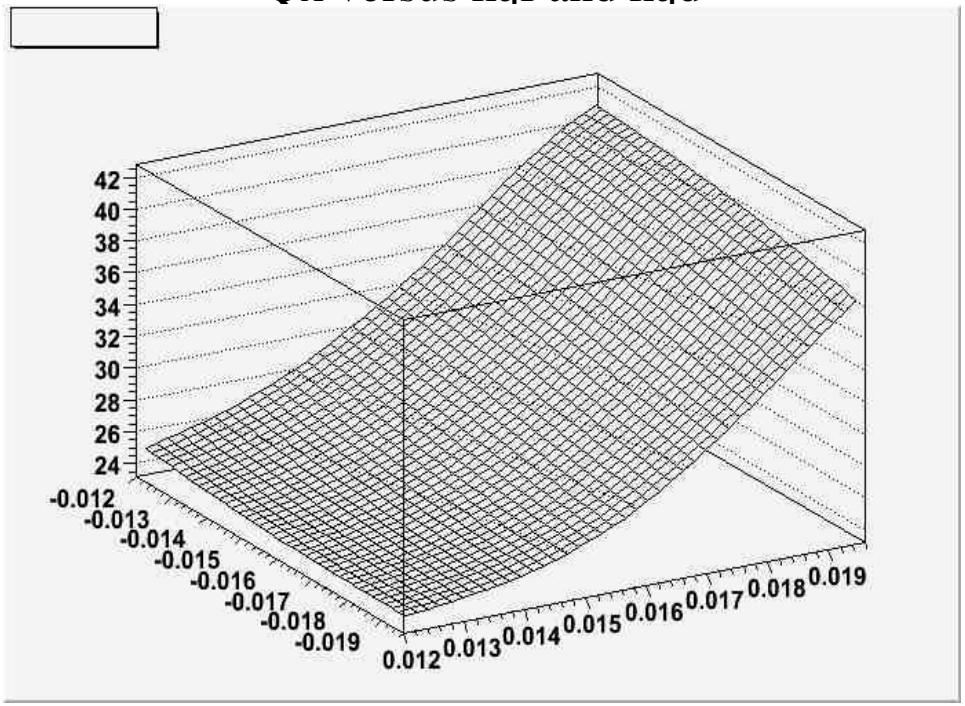
An example of a neural network fit of the tune for SPS lattice.

Main quadrupole and 6 corrector strengths used as input values.

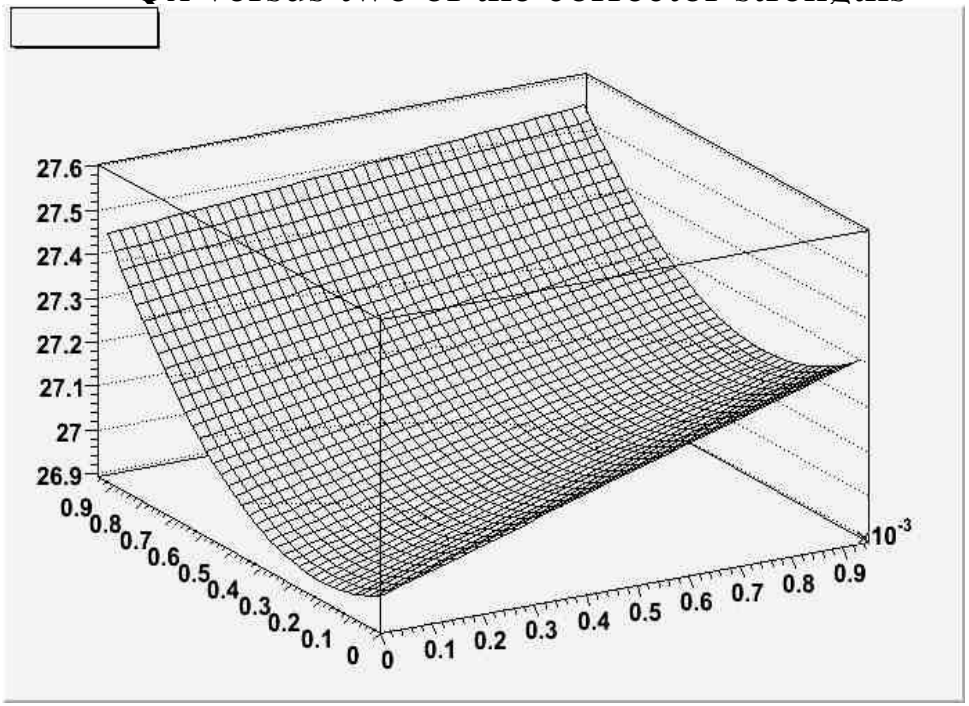
Training data produced with MADX

Neural network fits

Qx versus kqf and kqd



Qx versus two of the corrector strengths



Neural network fits

- Hard to attain high precision
- Useful when qualitative analysis of multidimensional data needed
- Network tells about statistical weights of input parameters
- Other statistical methods can be used for enhancement (SM etc.)
- For baseline OM functionality statistical methods are just an additional option
- Statistical methods for hidden parameter analysis (EM algorithm) can be considered
- Developing a more general statistical package can be considered (e.g. vacuum-background correlation analysis etc.)

Conclusion

- Beta version of the online model developed
- Need to put more effort into physics? - more use-cases needed (especially commissioning)
- Maintenance – concern ?
- Next steps to be defines