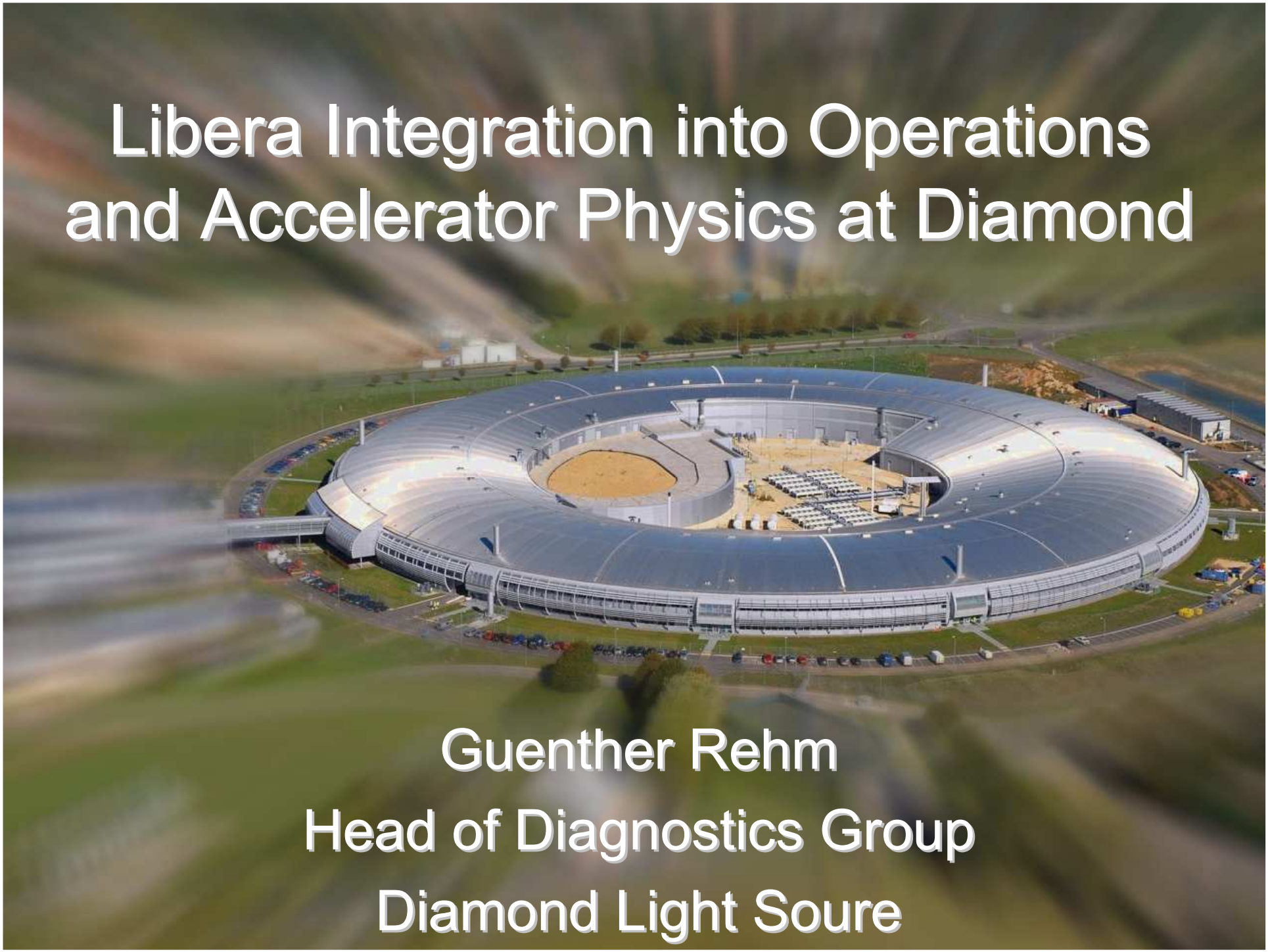
Libera Integration into Operations and Accelerator Physics at Diamond



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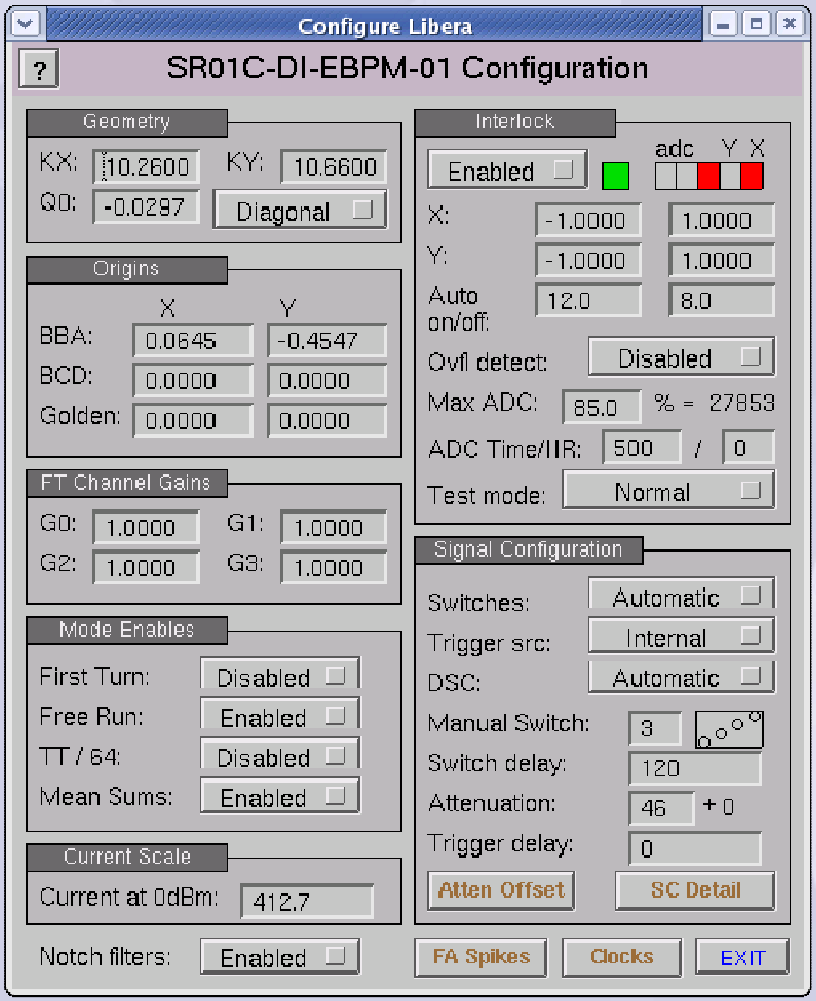
Outline

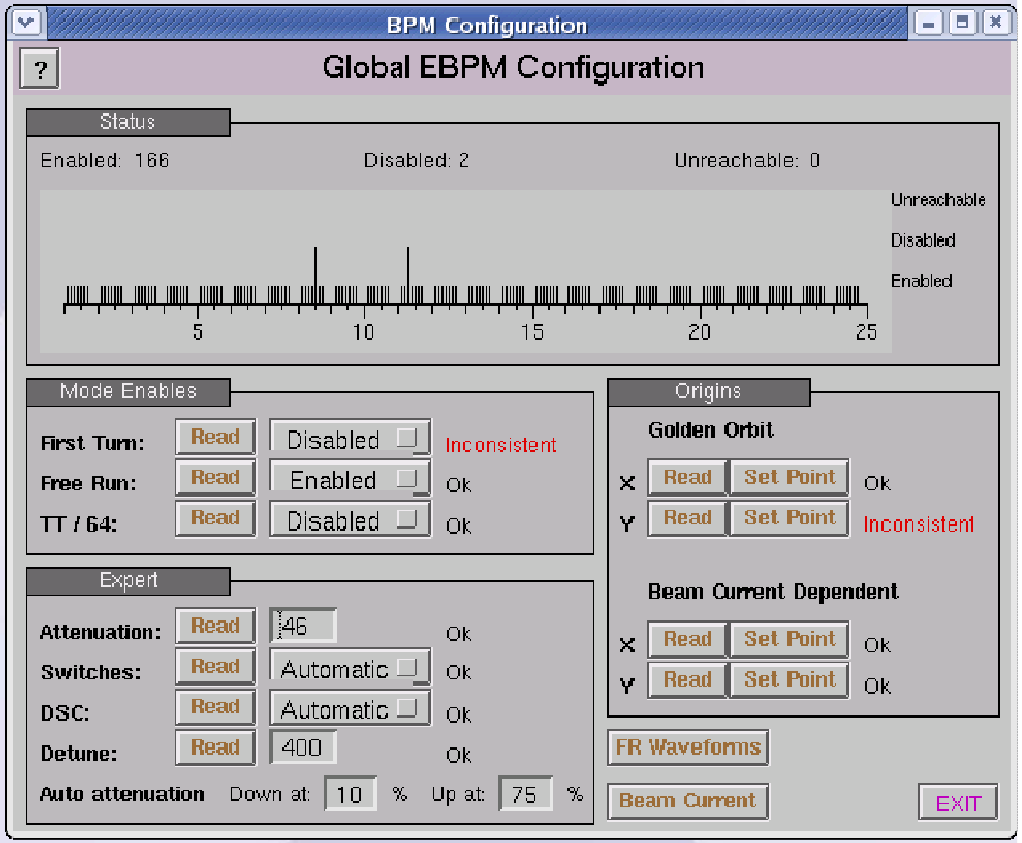
- The BPM Concentrator
- Beam current and lifetime measurement with Libera
- Phase advance measurement from T-b-T data and CW excitation

The BPM Concentrator

- Manage configuration of 168 BPMs together
- Collect individual data into waveforms, e.g. beam position into orbit
- Determine and set attenuator level
- Keep track of BPM status : enabled/disabled/unreachable
- Stop FOFB if status changes
- Calculate and distribute beam current calibration factors

Configuration of one / many BPMs

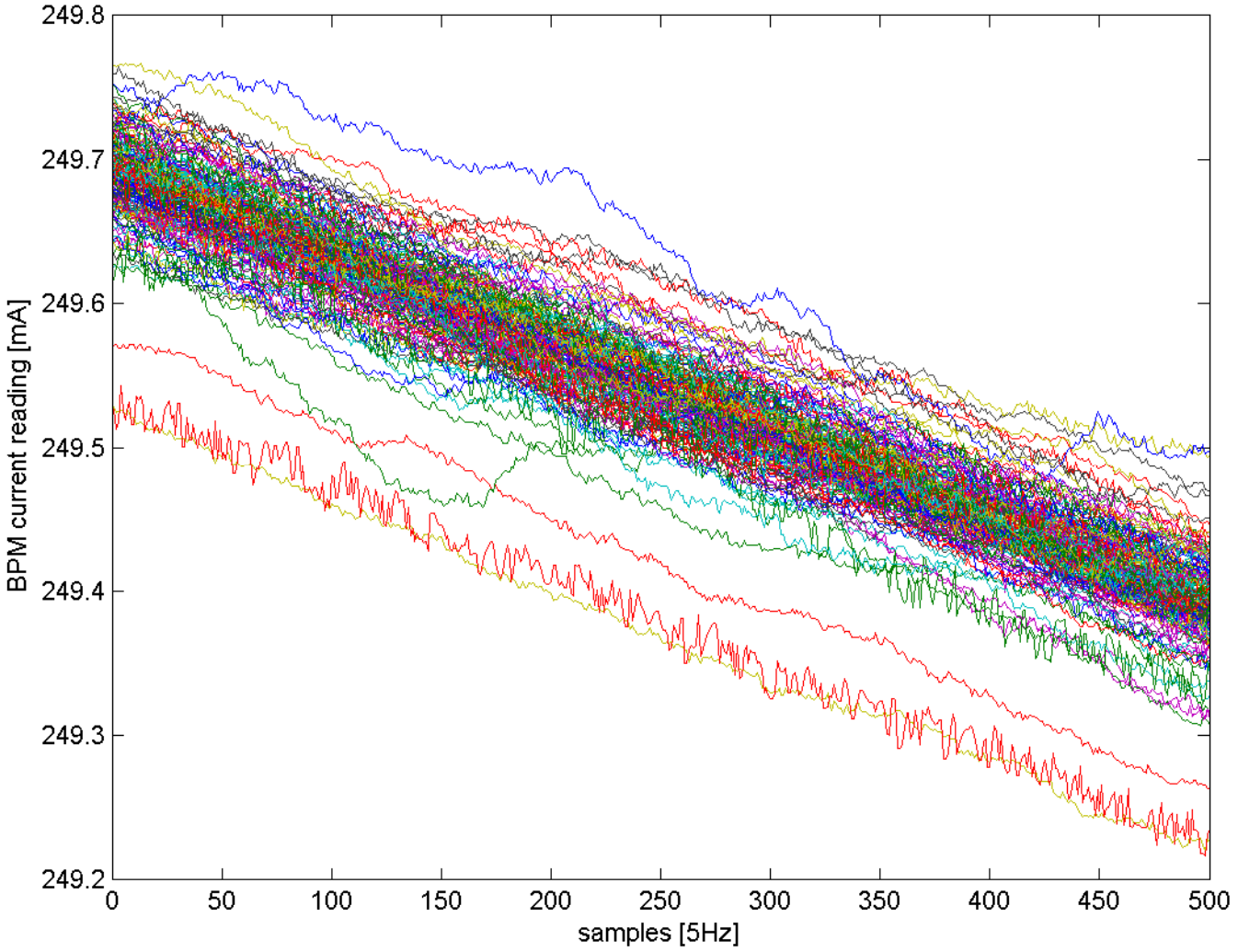




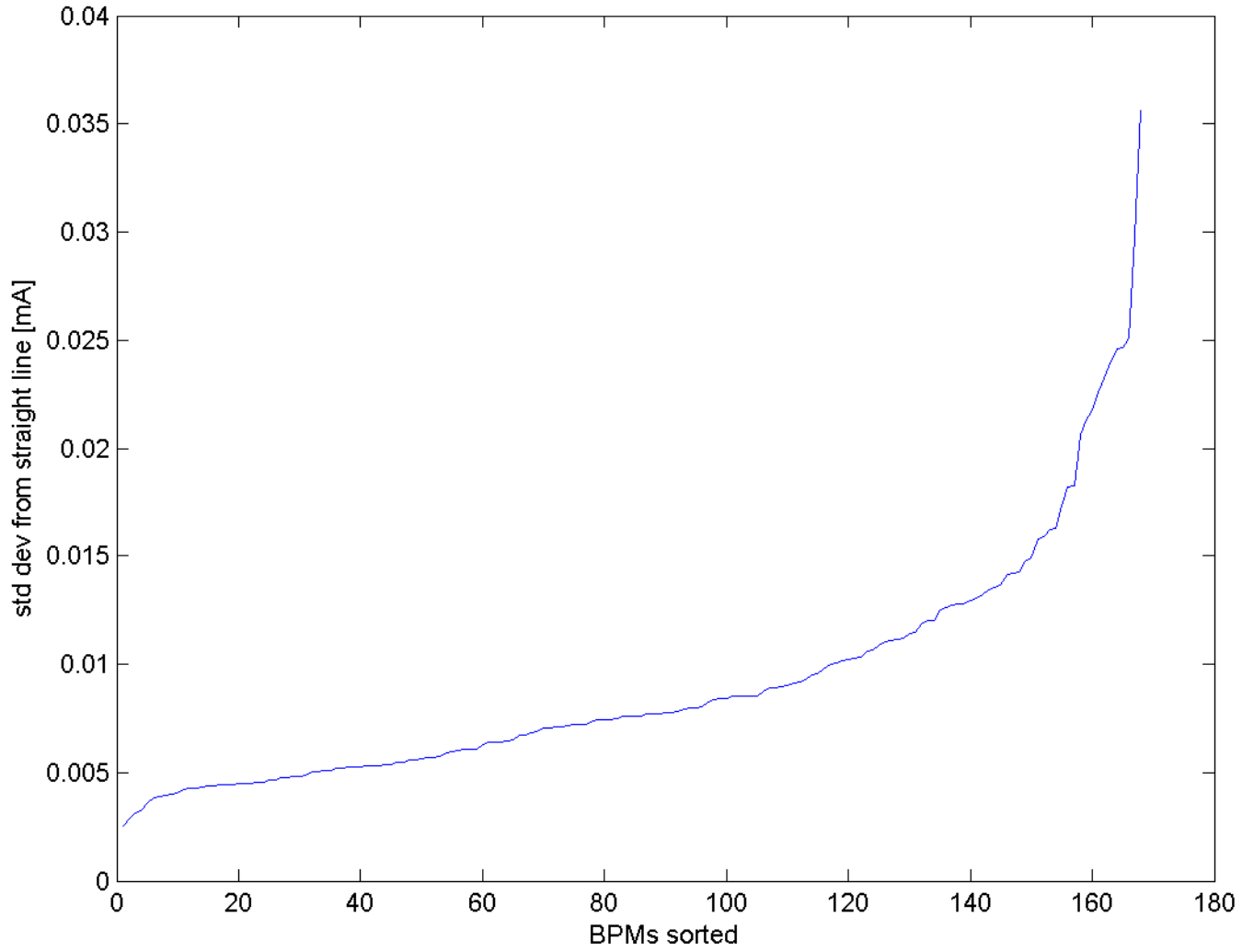
Beam Current from Libera

- Calculate input power from SA sum signal and attenuator setting
- Take into account systematic errors on attenuators
- Then single calibration factor will convert from input power to beam current, needs to be determined from know beam current (DCCT) once.
- All is fine, but then the total gain drifts and a recalibration is required.
- This is now done frequently (every 10s)

Beam Current from 168 BPMs

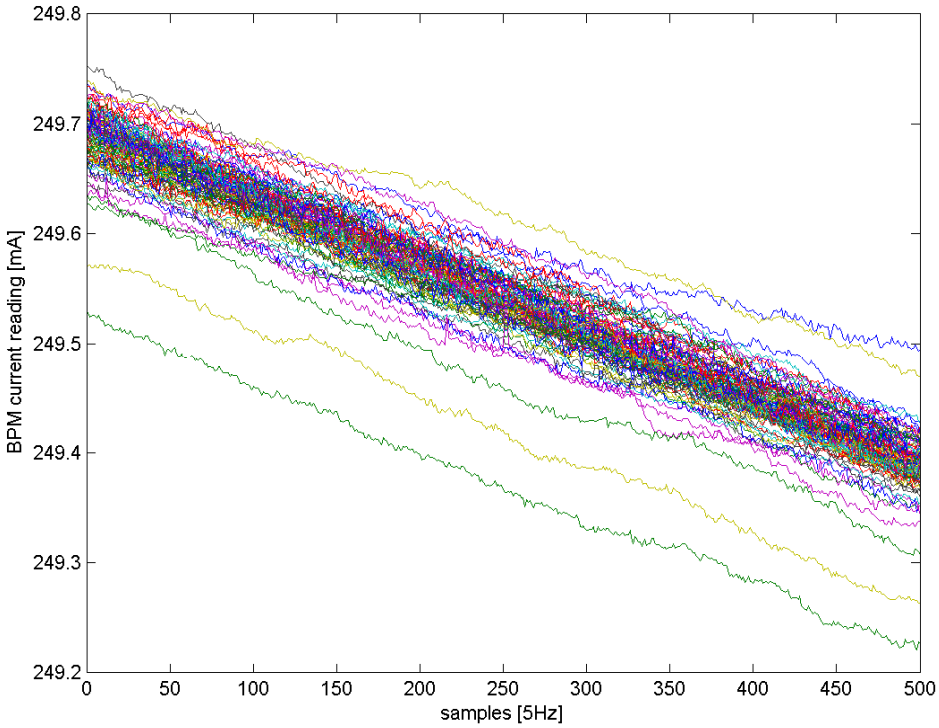


Noise Variations from BPM to BPM

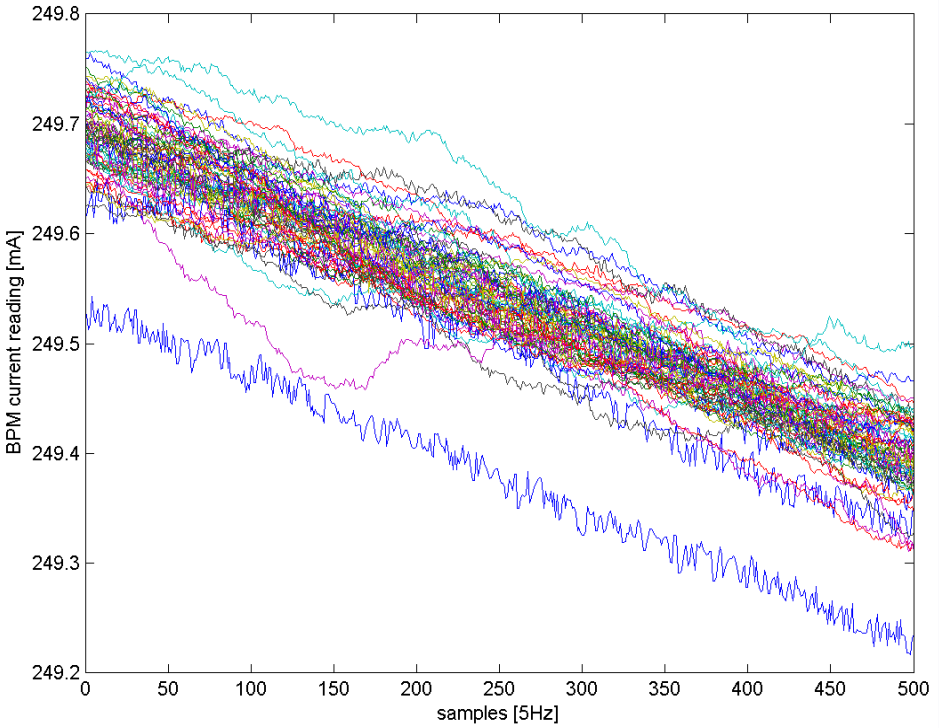


The good ones and the bad ones

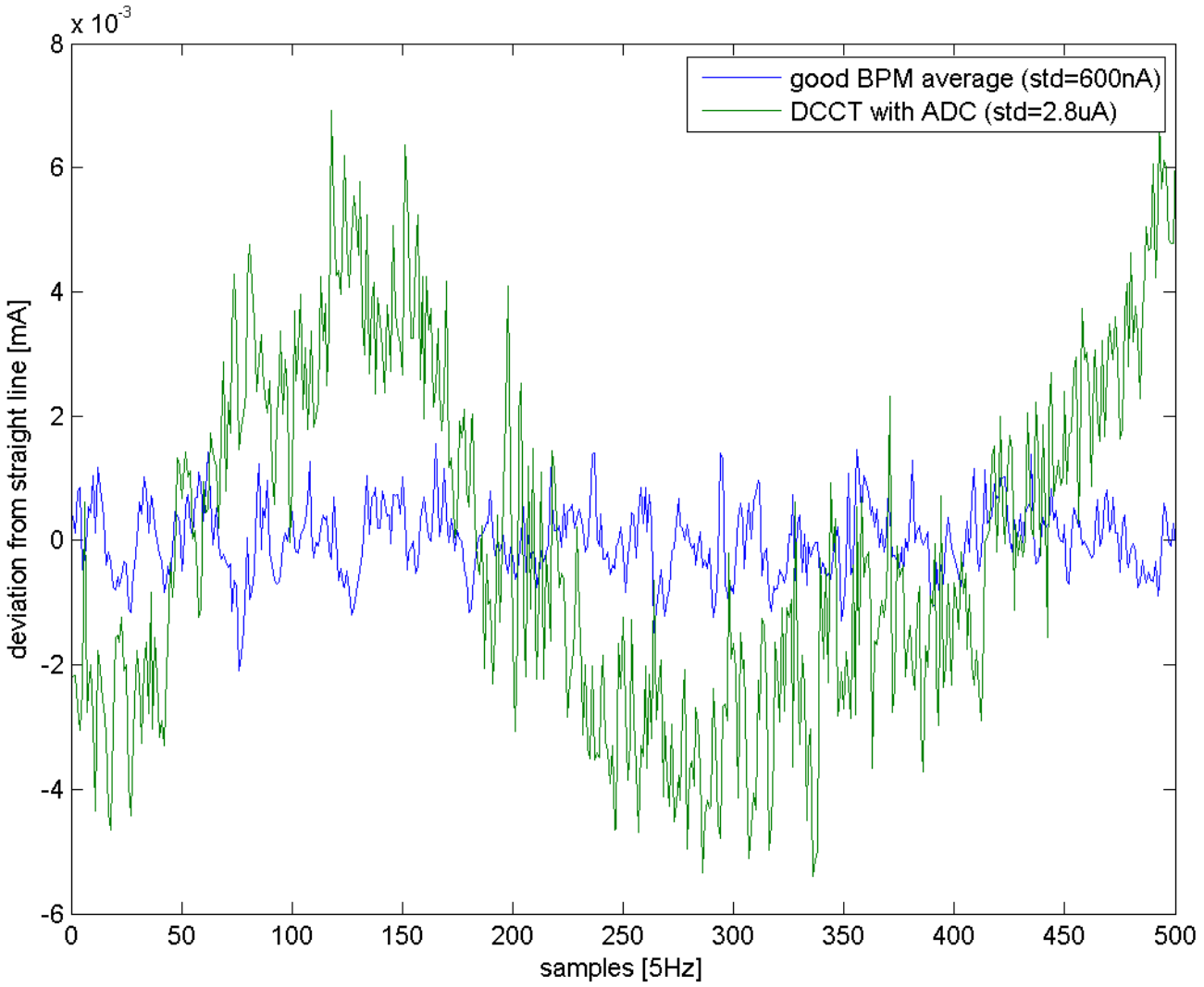
100 best



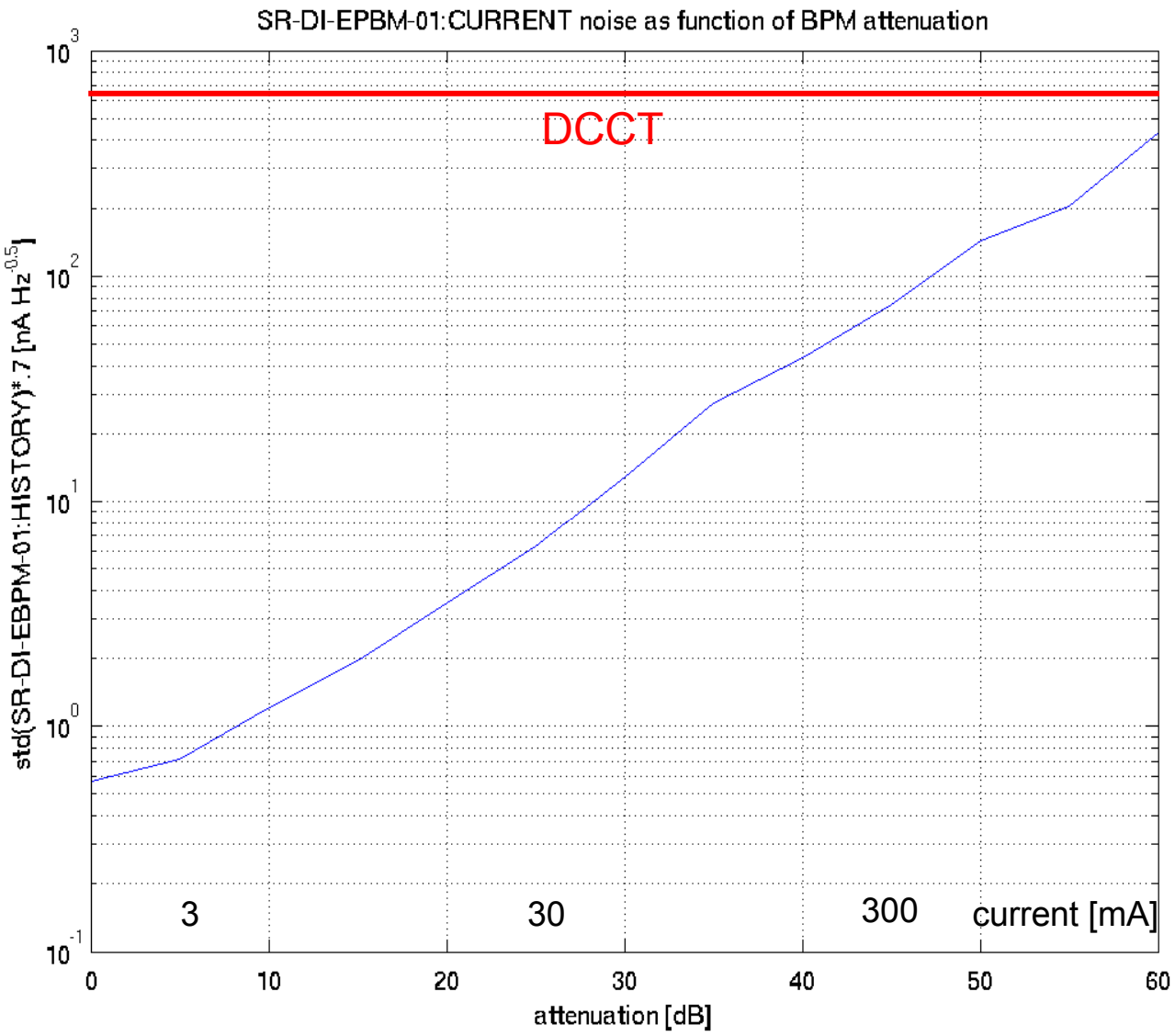
68 worst



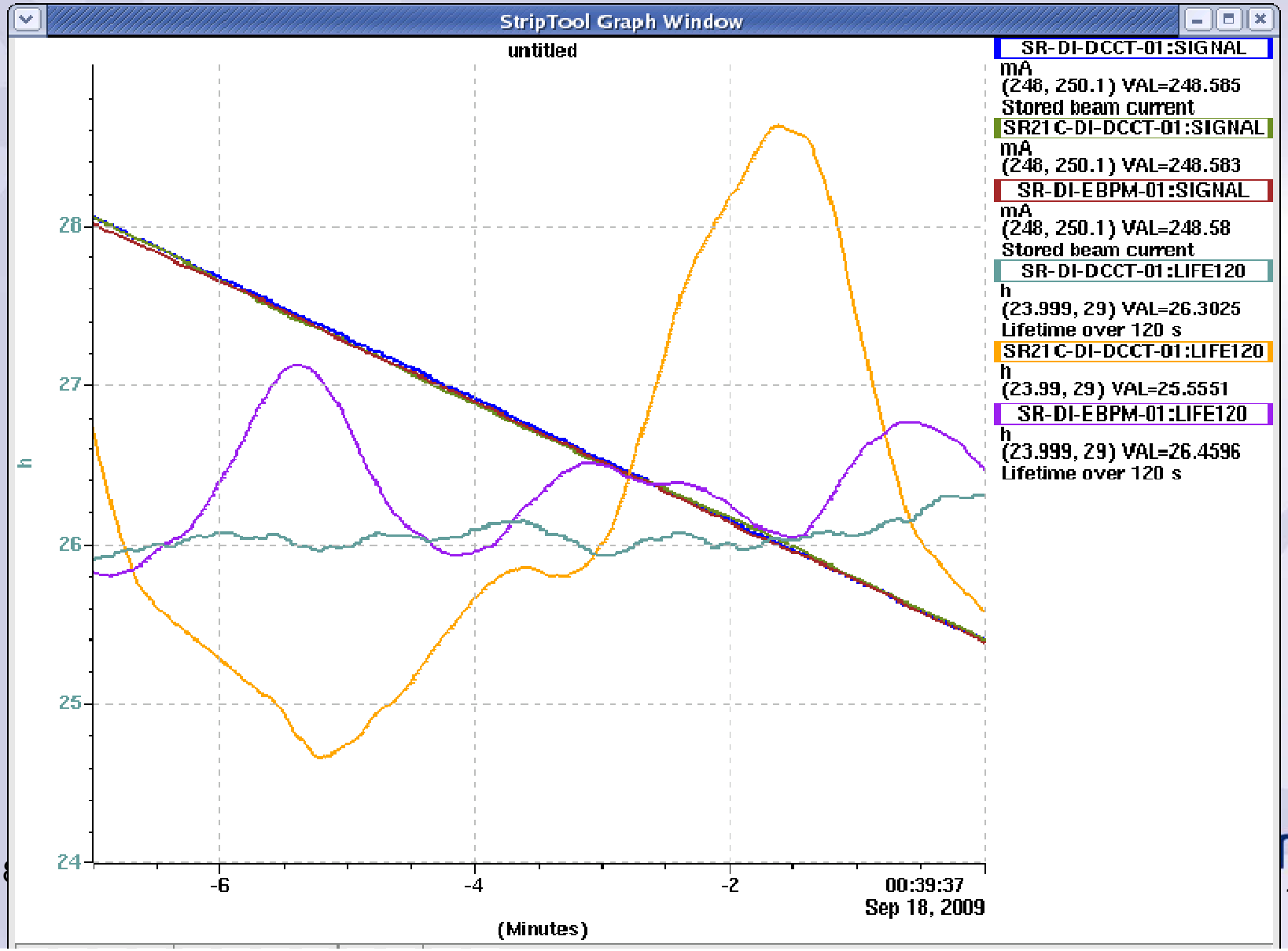
Good BPM average and DCCT



Noise on DCCT and BPM average



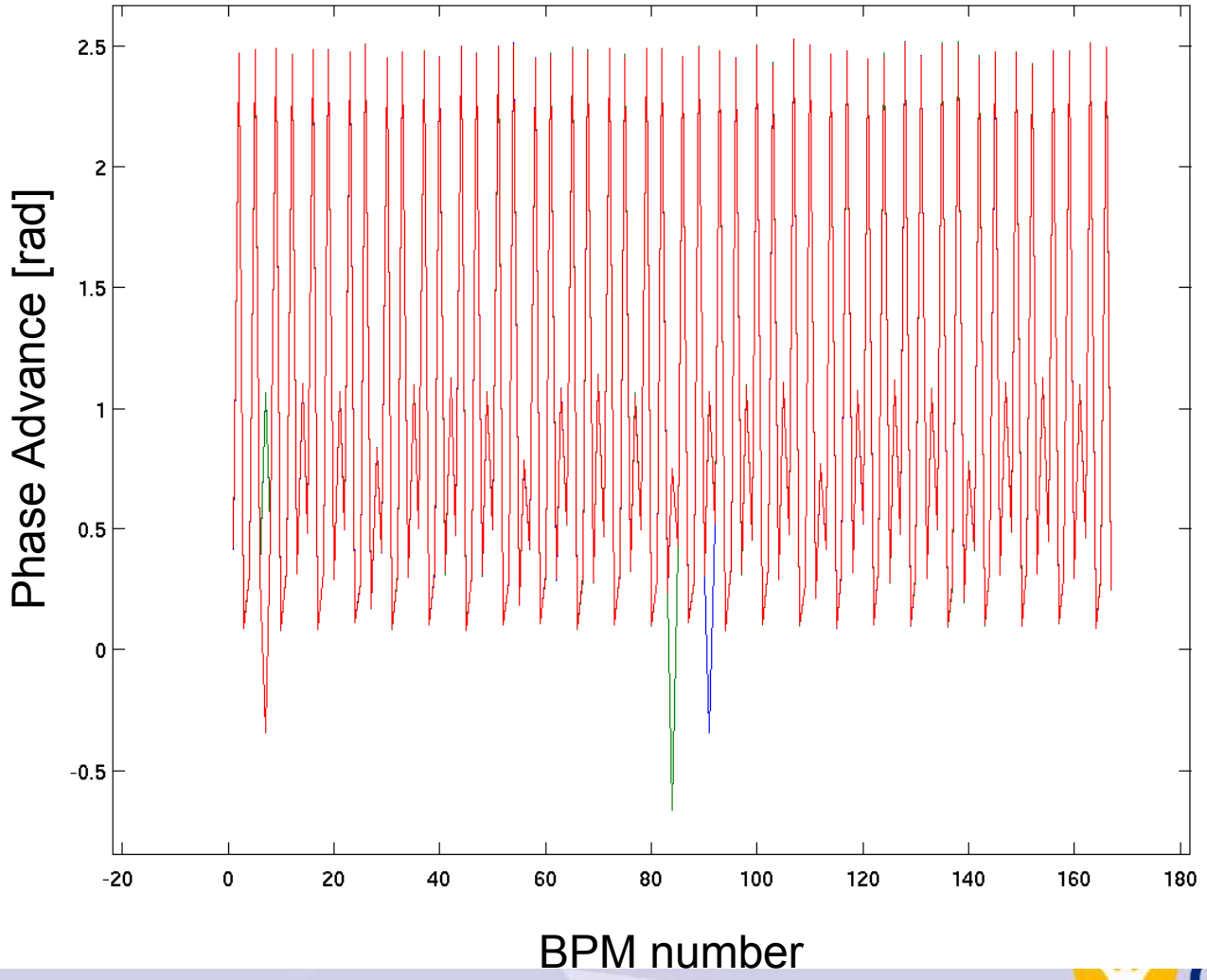
Lifetime from Average Current



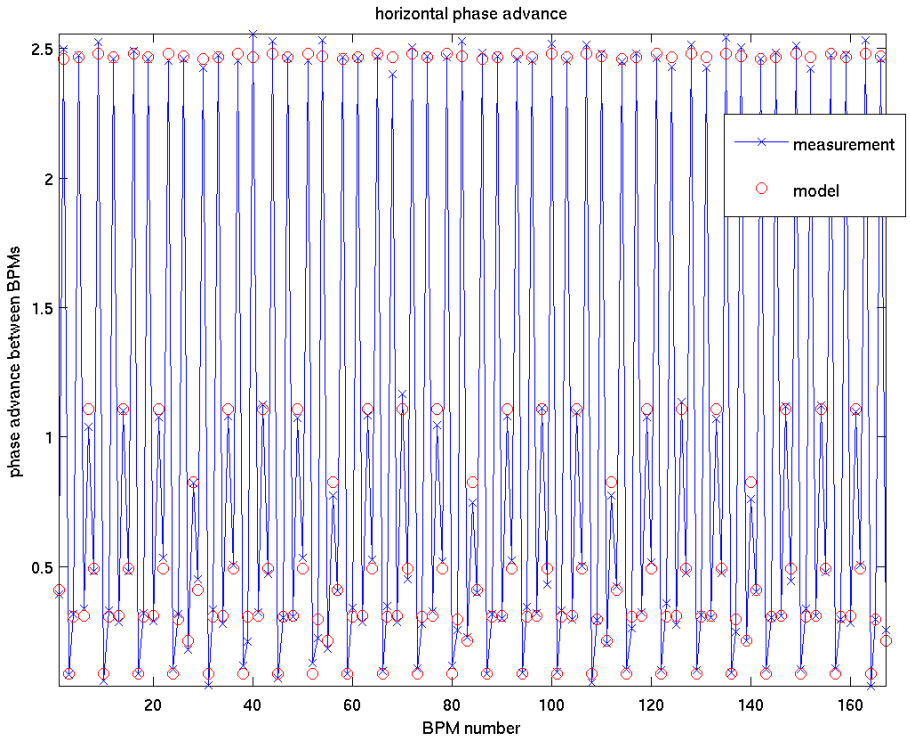
Betatron Phase Advance Measurement

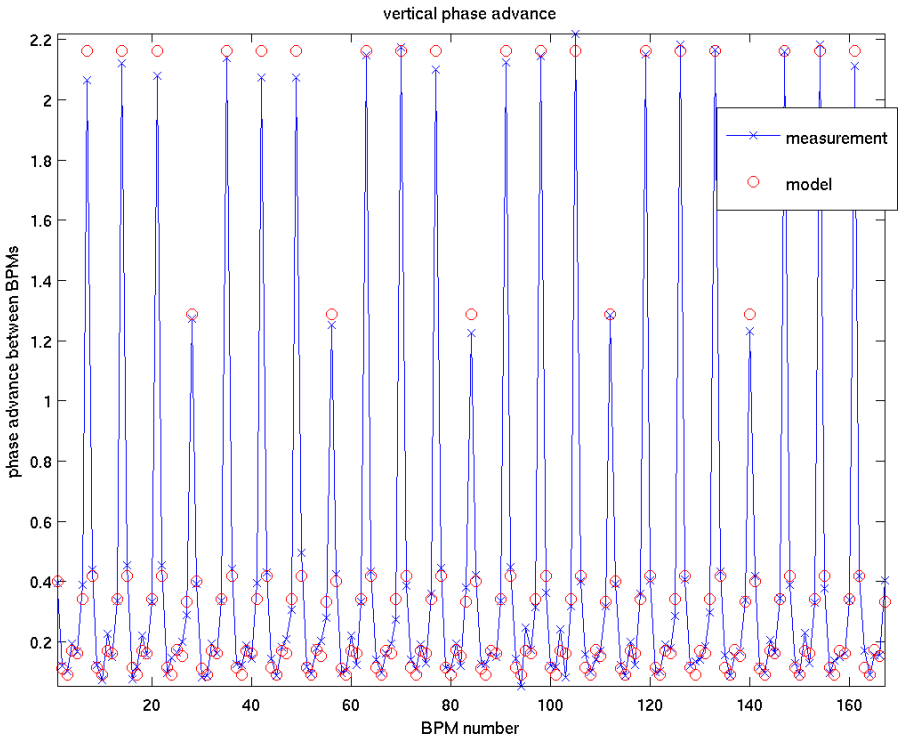
- Excite oscillation with CW on tune in one plane using stripline (only a few um amplitude required)
- Trigger T-b-T acquisition on all BPMs at once
- Read T-b-T data and analyse (using FFT or I/Q detector) for tune line, look at phase angle of tune line, then unwrap and calculate difference (phase advance between BPMs)
- Repeat three times to get unique result (one BPM will always be wrong in any one measurement)

Three Measurements



Measurement and Model





An Idea:

- Analysis of T-b-T data is often searching for magnitude and phase at a single frequency (e.g. excitation or harmonic of)
- This could be done inside Libera
  - Reduce amount of data to transfer by 10^6
  - Distribute computation to 168 processors
- First simple implementation in software
- Then build detector into FPGA, allow averaging for long periods to further improve sensitivity

Acknowledgements

- Controls: Michael Abbott, Isa Uzun, James Rowland, Mark Heron
- Accelerator Physics: Ian Martin, Riccardo Bartolini

Thank you for your attention!