LOCALIZATION OF TRANSVERSE IMPEDANCE SOURCES IN THE SPS USING HEADTAIL MACROPARTICLE SIMULATIONS

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Introduction

Transverse Mode Coupling Instability driven by machine **impedance** is one of the major single bunch intensity limitations in the SPS. **Possible cures** include an increase of the slippage factor [1] or the **identification and elimination of the major sources of impedance** of the machine. The transverse effective impedance can be inferred either **locally** or **globally** using respectively **phase advance beating with intensity** between BPMs and **coherent tune shift with intensity** at one BPM location [2,3].

Localization

When a beam circulates in an accelerator, it interacts with the e.m. field excited during its passage [4]. The phase advance observables can be obtained Fourier-nalyzing the tracked data collected at BPMs, either during MDs or using a macroparticle code as HEADTAIL (HDTL) [5] for development studies.

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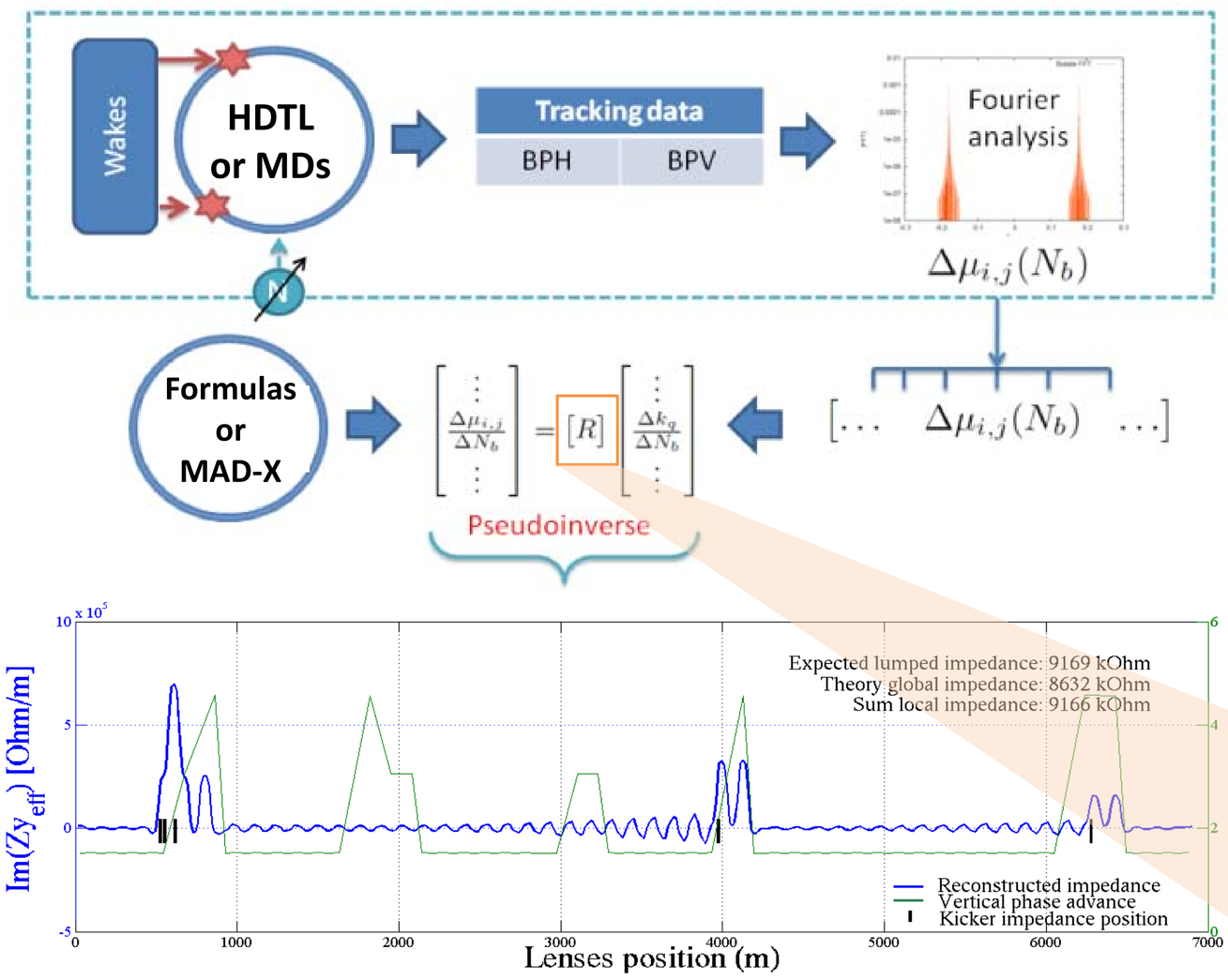
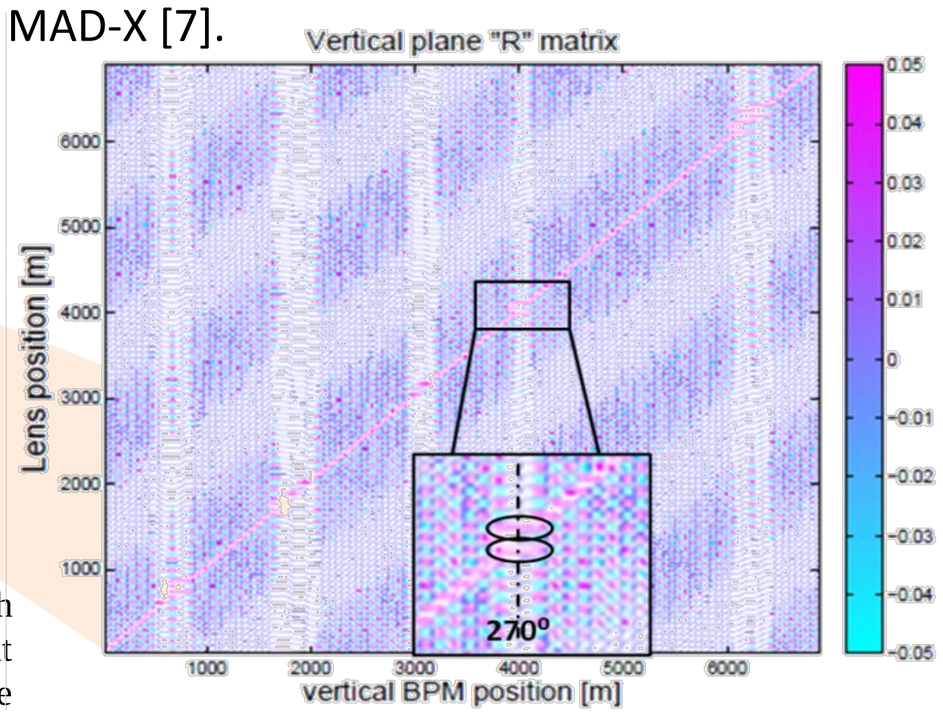


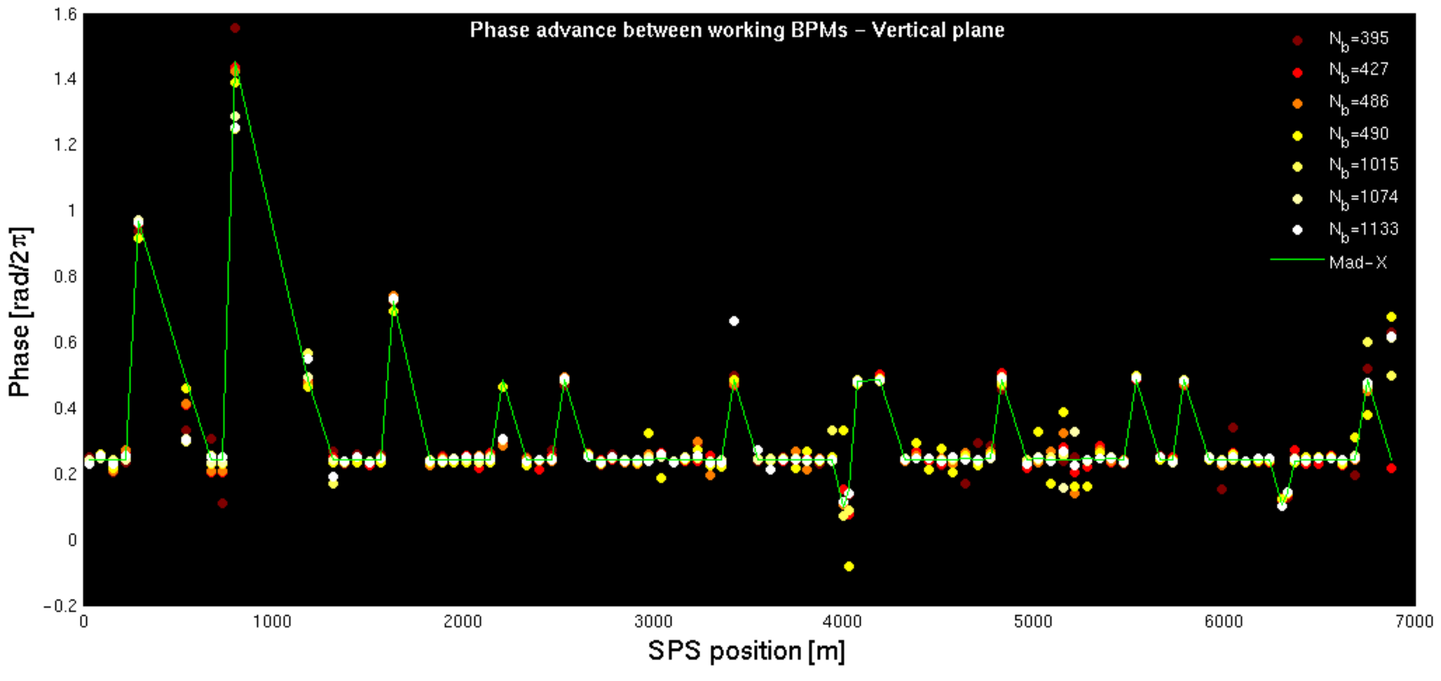
In the limit in which **the impedance detuning can be associated with a thin quadrupole detuning**, a series of thin lenses can be used to reconstruct the effect of an impedance. Varying the strength of the equivalent lens with intensity we get a quantity proportional to the effective impedance in the place of the lens. A **response matrix** (to the lens kick) can be constructed either with analytical formulas [6] for the phase advance beating between BPMs or with MAD-X [7].



The scheme on the right shows the procedure used to test the localization algorithm with HEADTAIL. It can be observed that the impedance can be localized near the black bars, but doubled peaks appear. These are due to the response matrix degeneration in the long phase advance section (as 270° ones).

Limits and outlook

- We found limits in response matrix degeneracy due to the periodicity of phase advance beating. A solution to this problem could be to increase the phase sampling between BPMs, i.e. using lower tunes.
- Another limit is linked to the accuracy in phase measurement we can achieve with real data. As shown in the figure below, not all the BPMs are usually working and the noise limit could bury the difference in phase advance with intensity.



References

[1] *"Experimental studies with low transition energy optics in the SPS"* H.Bartosik et.al IPAC'11, these proceedings.
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[3] *"Transverse Impedance Localization Using dependent Optics"* R.Calaga et al., PAC'09.
[4] *"Physics of Collective Beam Instabilities in high energy Accelerators",* A.W.Chao, John Wiley & Sons, 1993.
[5] *"Recent developments for the HEADTAIL code: updating and benchmarks"*, D.Quatraro, G.Rumolo, B.Salvant, PAC'09.
[6] *"Localization of transverse impedance sources in the SPS using HEADTAIL macroparticle simulations"*, N.Biancacci, CERN-Thesis-2010-166.
[7] *"MAD-X User Guide",* http://mad.web.cern.ch/mad.

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