Towards Harmonic Cavity Simulations
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INTRODUCTION

- **Active NC harmonic cavity project in development for implementation into the EBS (see talks by J. Jacob and V. Serriere).**

- **Some beam dynamics questions are still outstanding:**
  - Is the harmonic cavity system intrinsically stable?
  - How to properly model the feedback of the harmonic cavity?
  - How are other filling modes affected by the harmonic cavity?

- **Significant development of simulation tools has occurred, multi-bunch parallelised collective effects tracking now possible in PyAT.**
  - Parallelisation not dependent on Nbunches, so simulations of uniform filling at ESRF are possible.

- **A beam loading pass method that iteratively computes the beam voltage and updates the cavity voltage and phase has been written and is under test.**
  - Uses either the longitudinal wake function or the phasor model to compute the beam voltage.
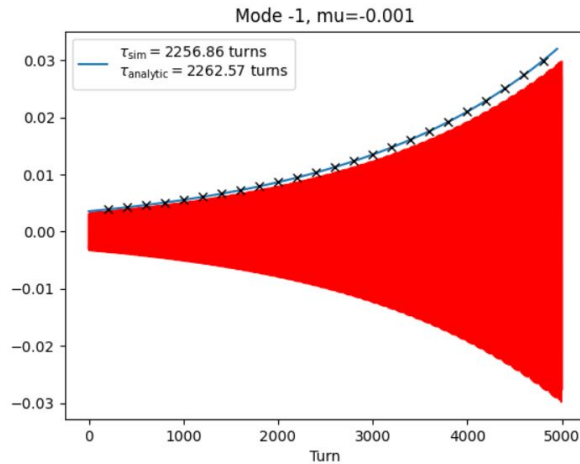
The code can be found on: https://github.com/atcollab/at
Multibunch parallel collective effects has been merged with the master.
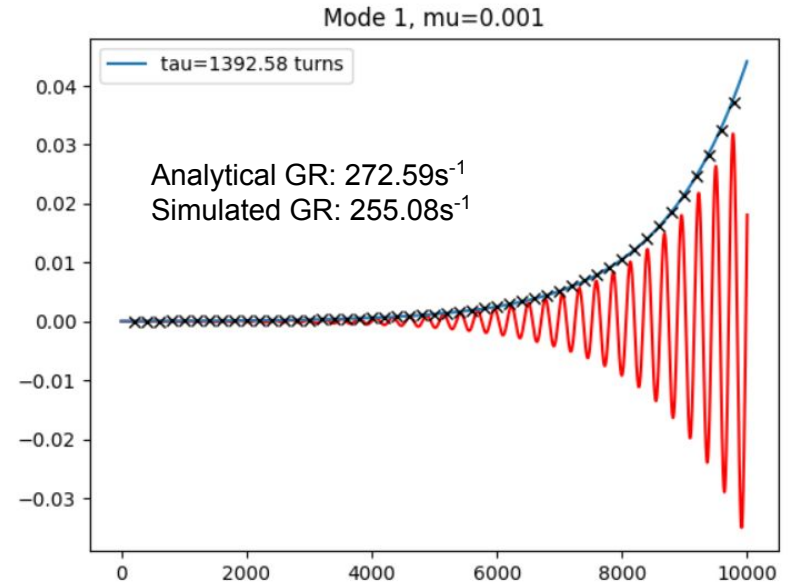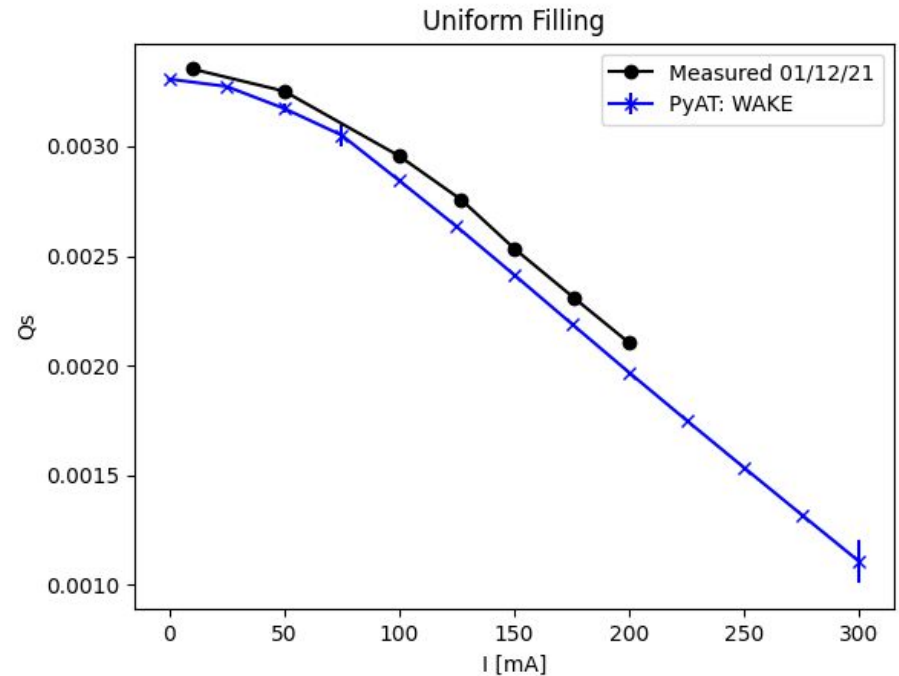Beam loading module to be merged soon

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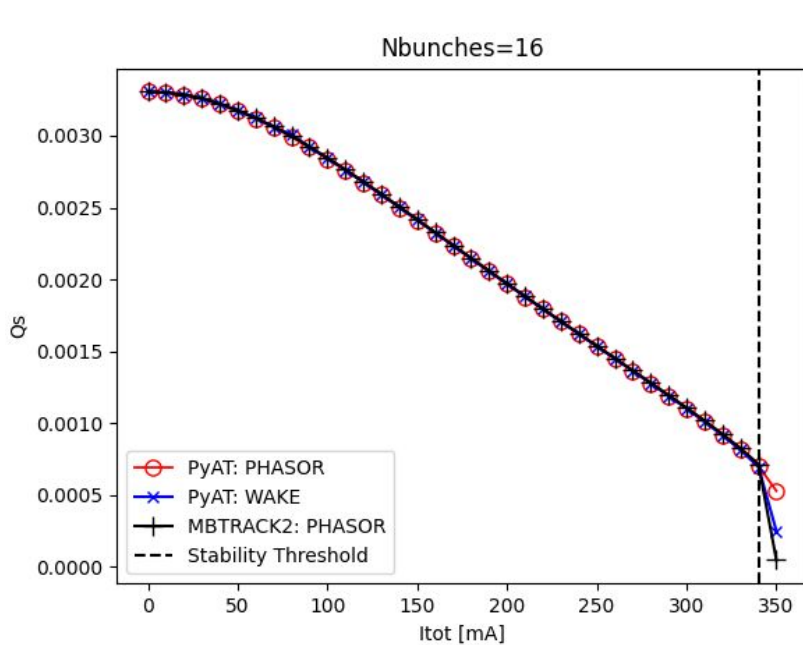## AC Robinson Instability - SB
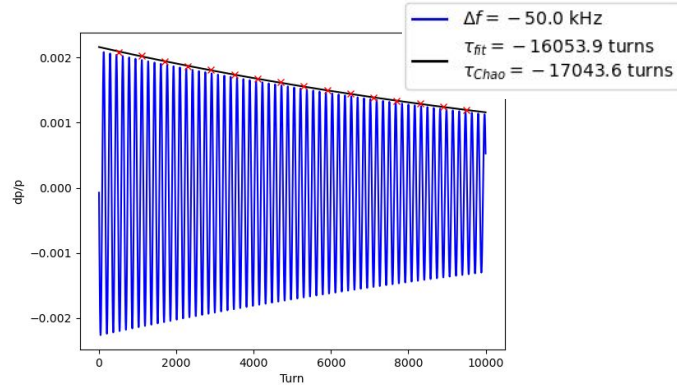
Transverse Resistive Wall - MB

Longitudinal Coupled Bunch Instability - MB

Analytical GR: $272.59 s^{-1}$
Simulated GR: $255.08 s^{-1}$

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BEAM LOADING BENCHMARKING

- **Psi and Vgen are computed from formula.**
- **Vbeam is computed using either the wake method (good for low Q) or the phasor model (better for high Q).**

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ROAD MAP FOR HARMONIC CAVITY SIMULATIONS

- **We have an almost benchmarked multi-bunch model in PyAT. We are now starting to get to the interesting harmonic cavity simulations.**

- **We have already some harmonic cavity simulations without beam loading (main or harmonic). E.g. Implementation of simple phase loops to recover optimal bunch lengthening.**
    - Nothing new or interesting to show yet.
    - Has highlighted the question of how this will be implemented in real life i.e. what are our observables / diagnostics? The simulations should reflect reality. Is the flat potential really achievable or do we just go for maximum bunch lengthening?

- **Next steps:**
    - Bunch lengthening with beam loading (first main only, then main and harmonic)
    - Check stability of harmonic cavity system
    - Parameterise and test different types of HC feedback

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