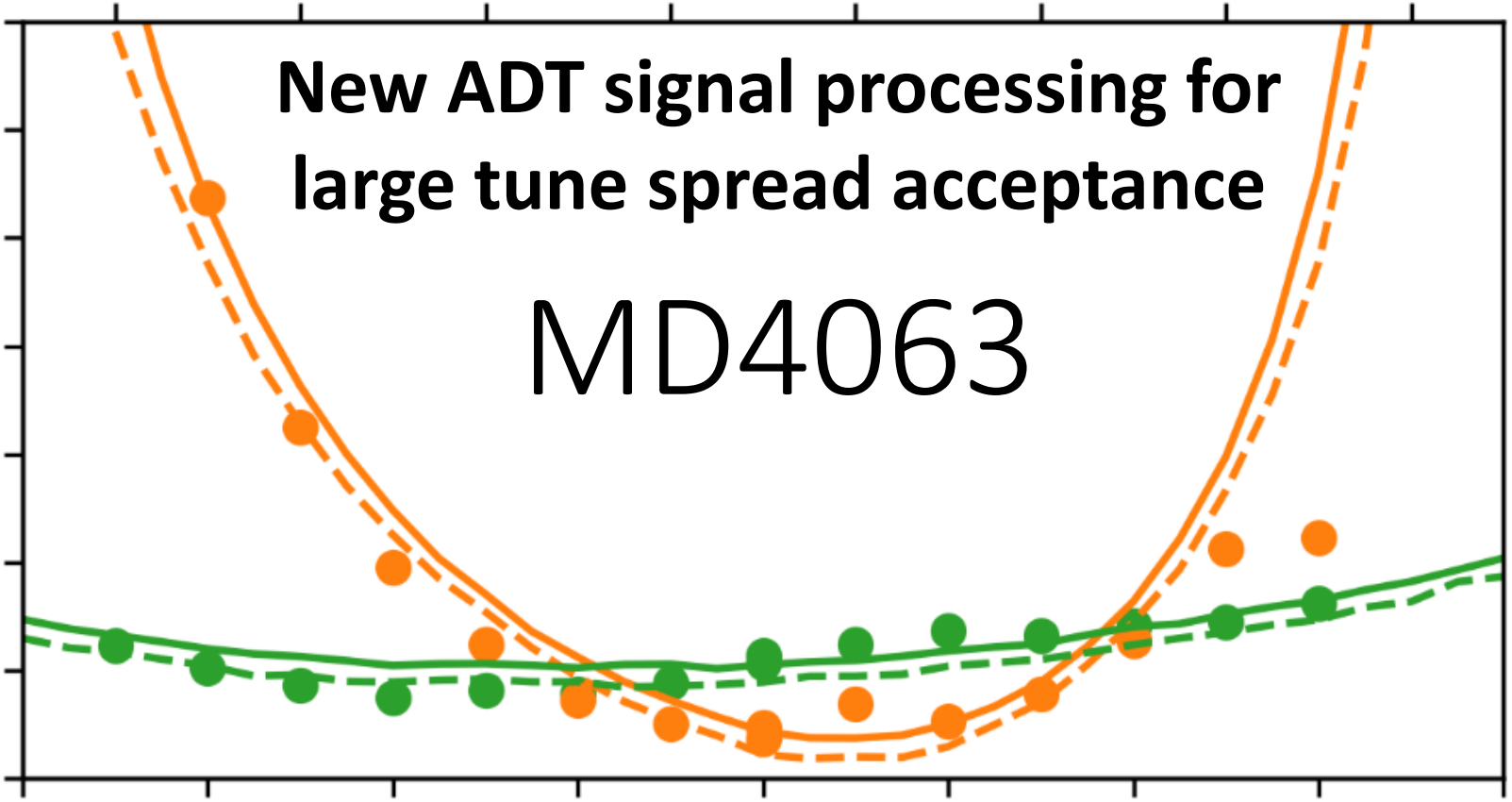
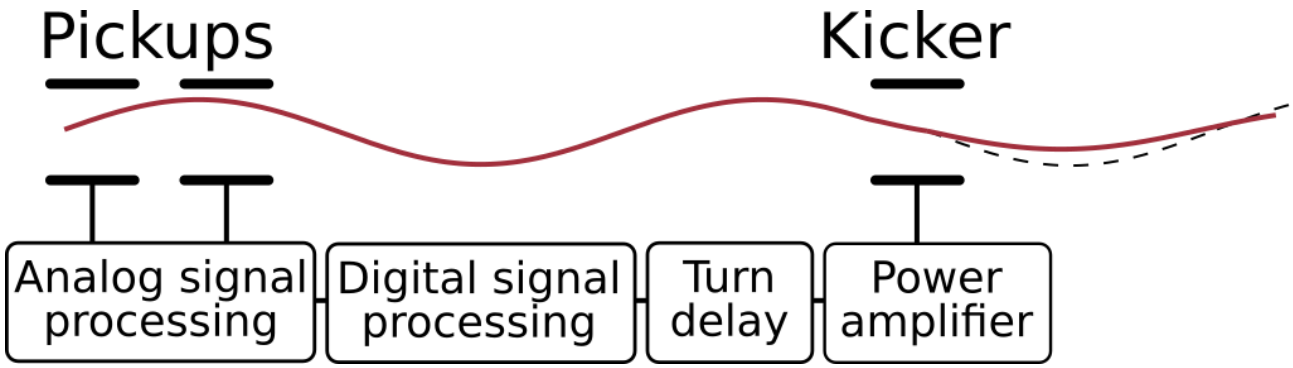


X. Buffat, **J. Komppula**, G. Kotzian, D. Valuch

LHC ADT



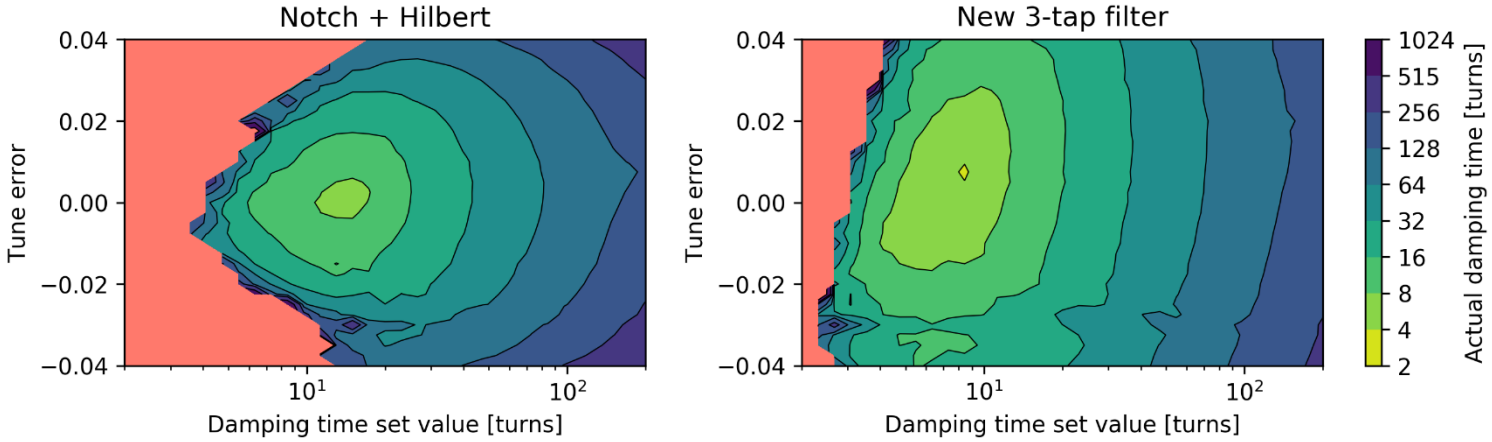
Two families of digital filters

MD for new turn by turn filters

- **Bunch by bunch filters**
  - Phase and gain linearization for the power amplifiers and kickers
  - E.g. “standard bandwidth”, “enhanced bandwidth”

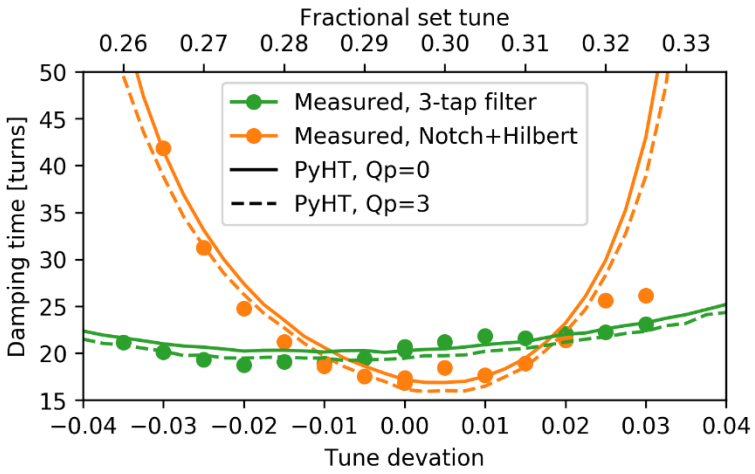
- **Turn by turn filters**
  - Closed orbit suppression
  - Pickup to kicker betatron phase advance correction

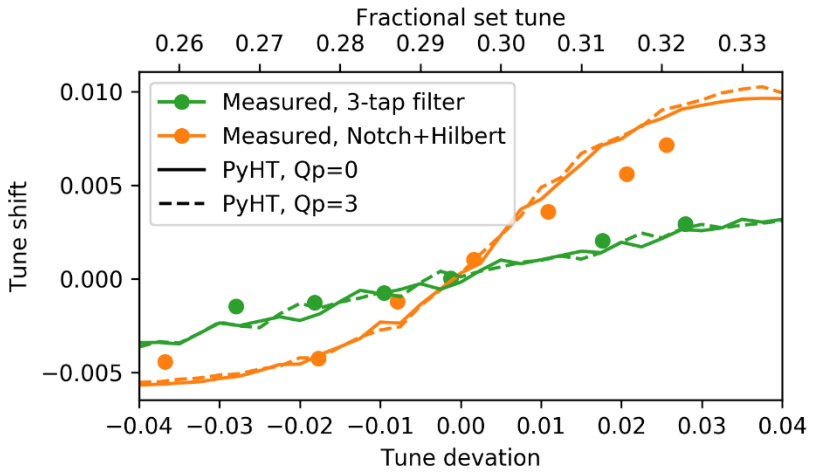
New turn by turn filters



- Currently used ADT filter scheme (Notch+Hilbert) is 8 taps long
- 3-tap filters allow larger tune acceptance and gain margins
- Test for 16-tap filter (possible noise reduction)
- MD procedure
  - Single pickup (BPMCS.9R4.B1) and kicker in vertical plane
  - Damping time measured as a function of tune
    - Injection machine settings, low chromaticity (2-4 units) and no octupoles
    - Fractional tune varied between 0.25 and 0.33
    - Beam kicked with the ADT
    - Data from ObsBoxB.LHC.ADT.B1V.Q9.Tune2k buffer
    - Reference tune for tune shifts from the kicks with >200 turns damping time

Tune acceptance comparison

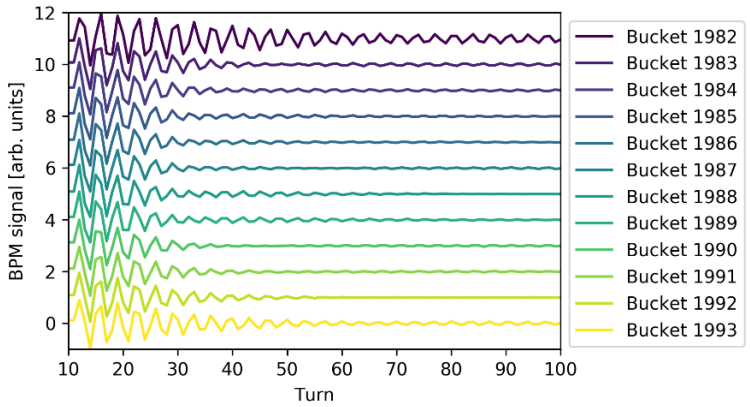


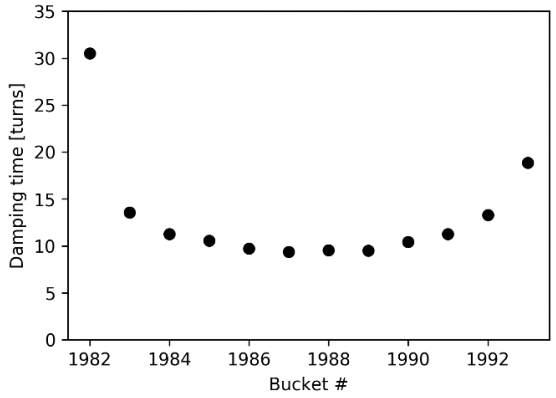


- Observations
  - 3-tap filter provides flat response in the studied tune range
  - 3-tap filter induces less tune shift
    - In general, ADT amplifies tune shifts
    - Amplification depends on ADT gain (damping time) and filter
  - Good agreement between the PyHEADTAIL simulations and the measurements

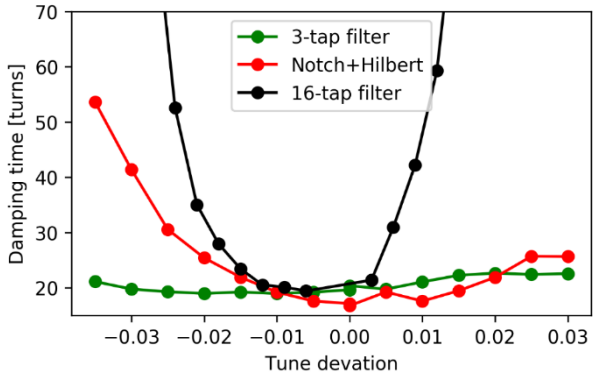
Additional tests

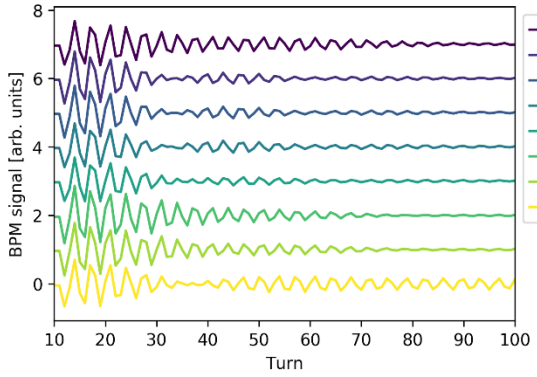
- Bunch train injection with the 3-tap filter
  - 10 turns damping time demonstrated with the nominal injection settings





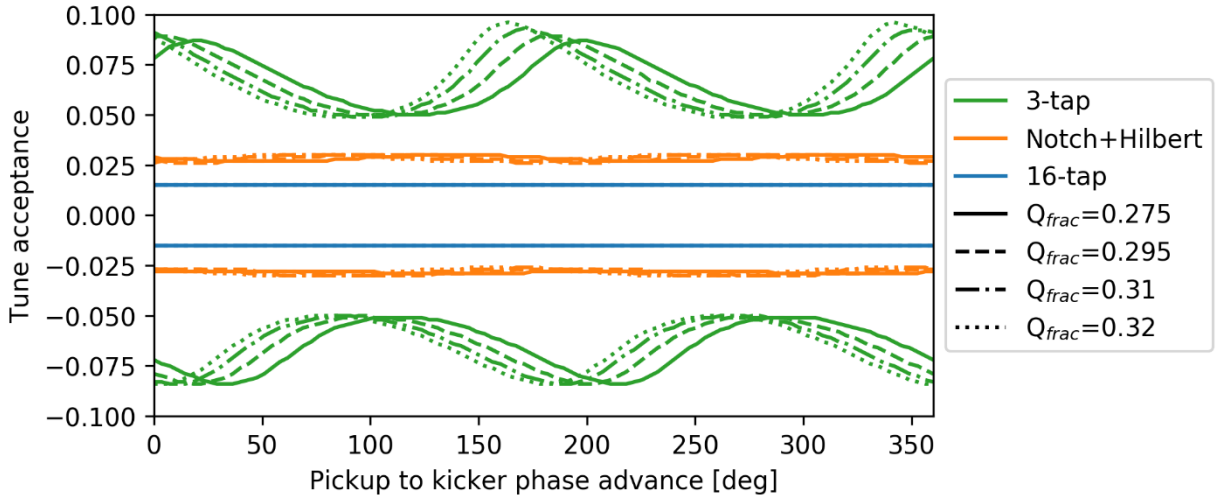
- 16 tap filter
  - Tune acceptance measured
  - <15 turns damping times demonstrated for single bunch injections





Note: Gain varied between the indiv injections

Ready for operational use?

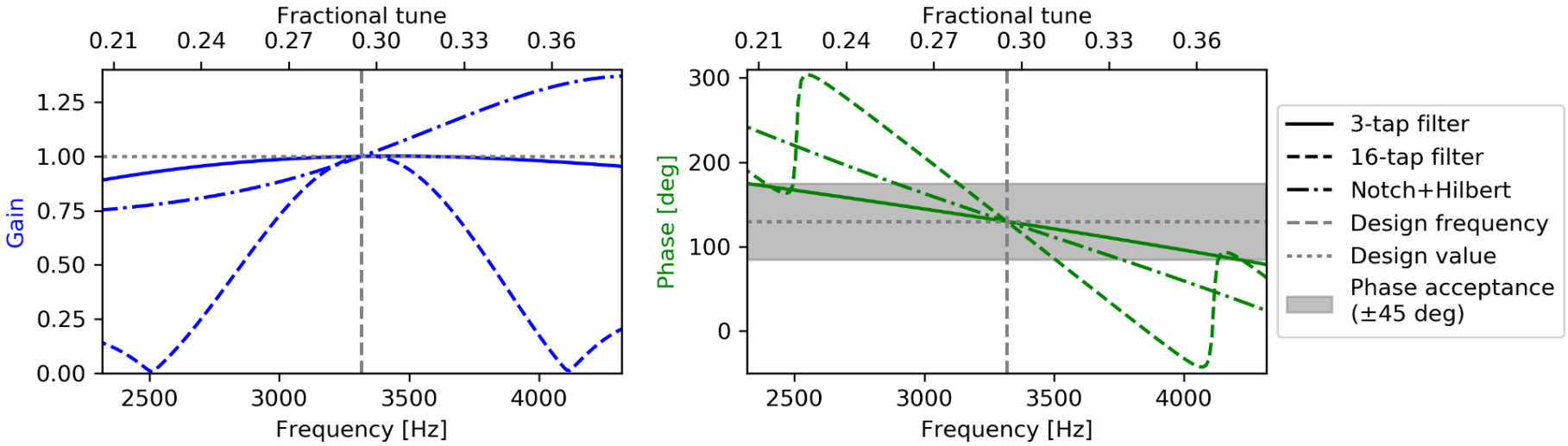


- 3-tap filter: no drawbacks found so far
  - **Tune acceptance:** Better for all the tunes and pickup locations
  - **Noise performance:** Similar to the currently used scheme
  - **Flexibility:** Analytical equation for all the operational schemes

- 16-tap filter?
  - MD demonstrated technical feasibility for operational testing after the LS2
  - Better noise performance is not obvious
    - Fundamental challenges to suppress beam noise at the betatron frequency (error propagation)
    - Noise and damping can be modified around the betatron frequency
      - Open question: any effects when operated with chromaticity and octupoles?

Thank you!

Filter frequency responses



Pickup BPMCS.7R4.B1 → Kicker ADTKV.A5R4.B1

3-tap filter coefficients