AC Dipole

Participants:

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Principle:

- Excite the beam with a sine-wave who's frequency is different from the betatron-tune.
- Theory predicts that one can achieve large beam oscillation amplitudes WITHOUT blowing up the emittance, if the excitation amplitude is ramped up and down adiabatically
- Tested at the BNL AGS. Used to induce spin-flip during the crossing of depolarising resonances.

Possible applications:

- Dynamic aperture studies.
- Measurement of resonant driving terms.
- Beta and phase-advance measurements.

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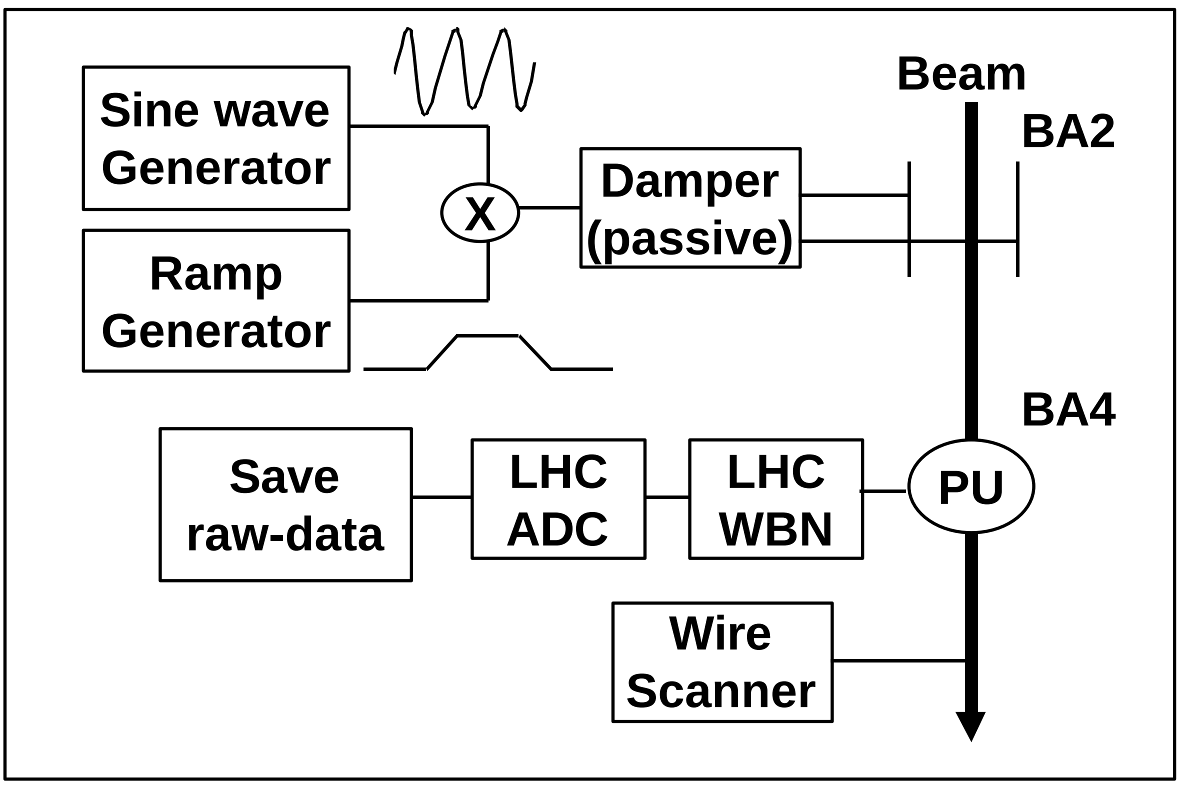
- **SPS MD on P2 (03/11/2000):**
  - **MDRF beam - 72 bunches, 25ns spacing.**
  - **Total intensity of 1.0 - 1.3 x 10^{12} protons.**
  - **Measurement set up for vertical plane.**

beam injected:	17285 ms
wire scan IN scan:	17320 ms
excitation ramp start:	17460 ms or 17360
excitation ramp down end:	17460 ms , 17660 ms or 17760
wire scan OUT scan:	17800 ms (on next supercycle)
tune measurement	17885 ms (injection + 600ms)



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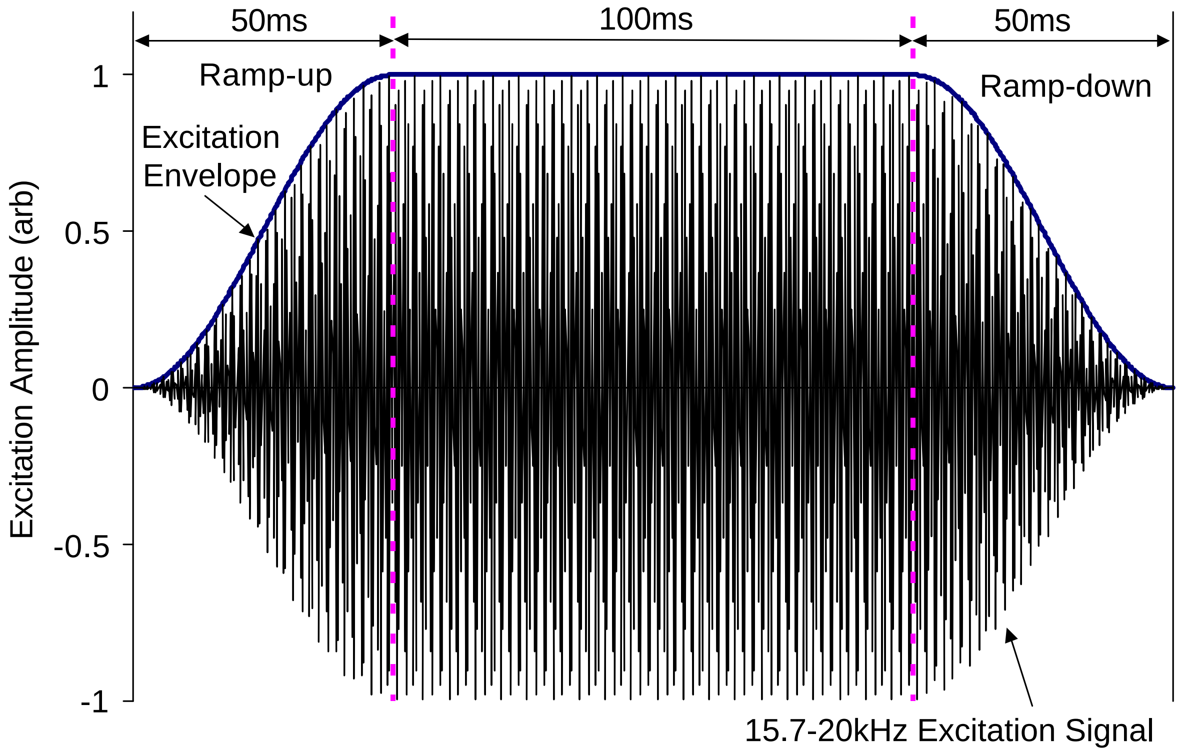
- **Excitation settings:**



$$Z_{coh\_pick-up} = \frac{\theta}{4\pi\delta}\sqrt{\beta_{pick-up} \times \beta_{damper}}$$

$$\Rightarrow \quad Z_{coh\_pick-up} = \frac{4.2\mu rad}{4\pi\delta}\sqrt{102m \times 39m} = \frac{21}{\delta}\mu m$$

q = Max. angular deflection by damper
d = Difference between tune and excitation freq.

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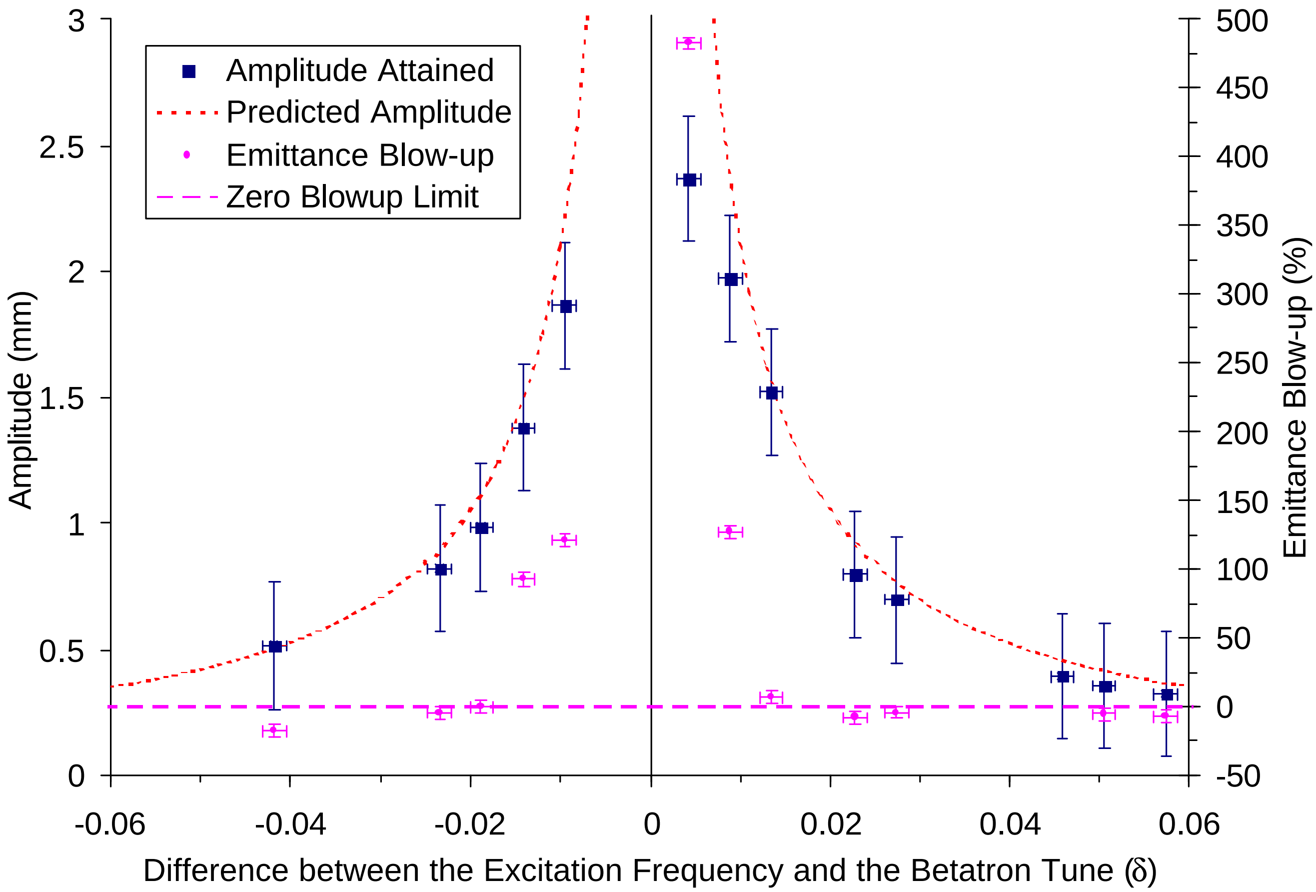
Results - Frequency Sweep:

- **Oscillation amplitude and emittance blow-up measured as a function of d.**



- **Tune spread (3s) ~ 0.012**
- **No measurable blow-up seen when exciting outside the tune spread**

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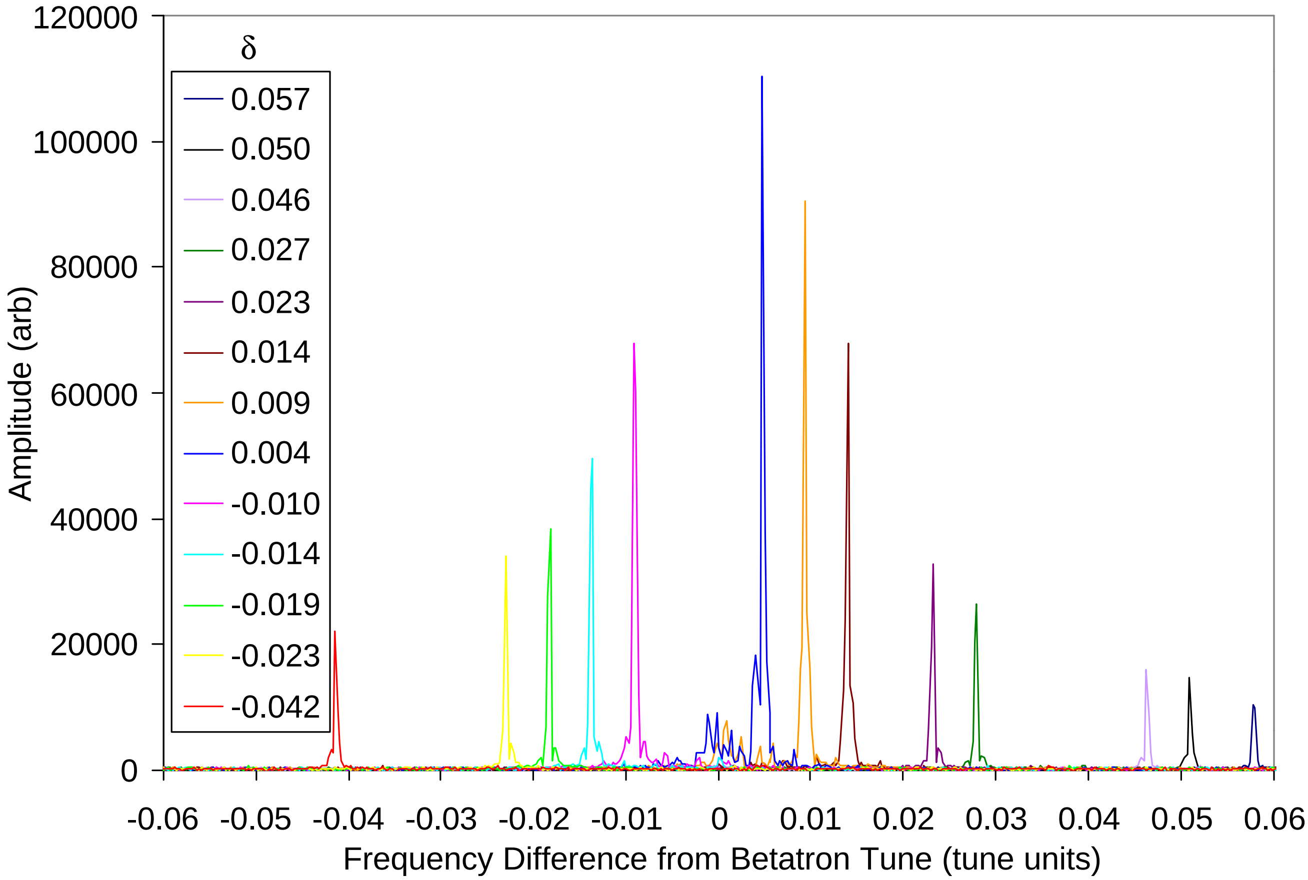
Results - Frequency Sweep (cont):

- FFT of the beam response for various excitation frequencies.



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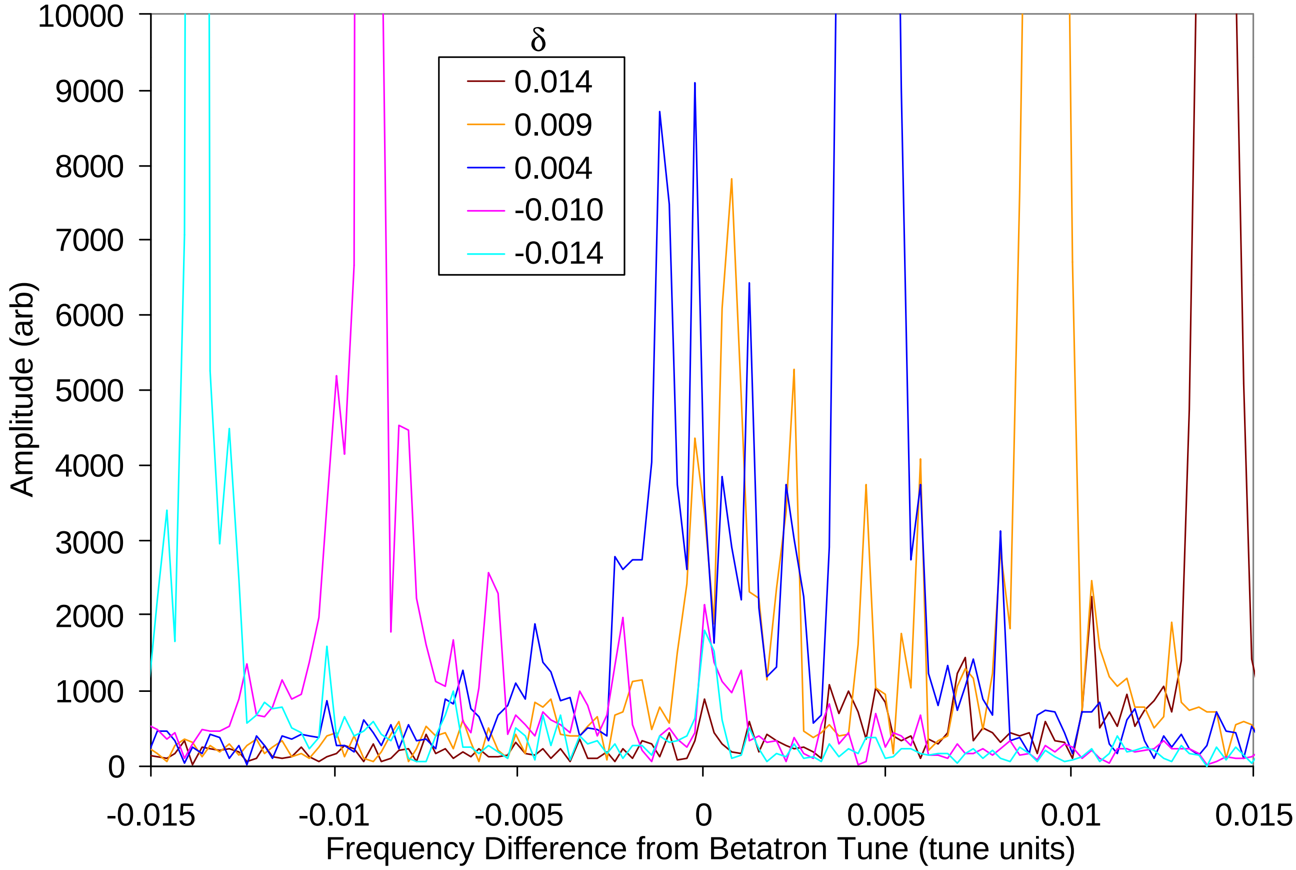
- **Results - Frequency Sweep (cont):**



- **Resonances can be seen to be excited when the driving frequency is within the tune spread.**

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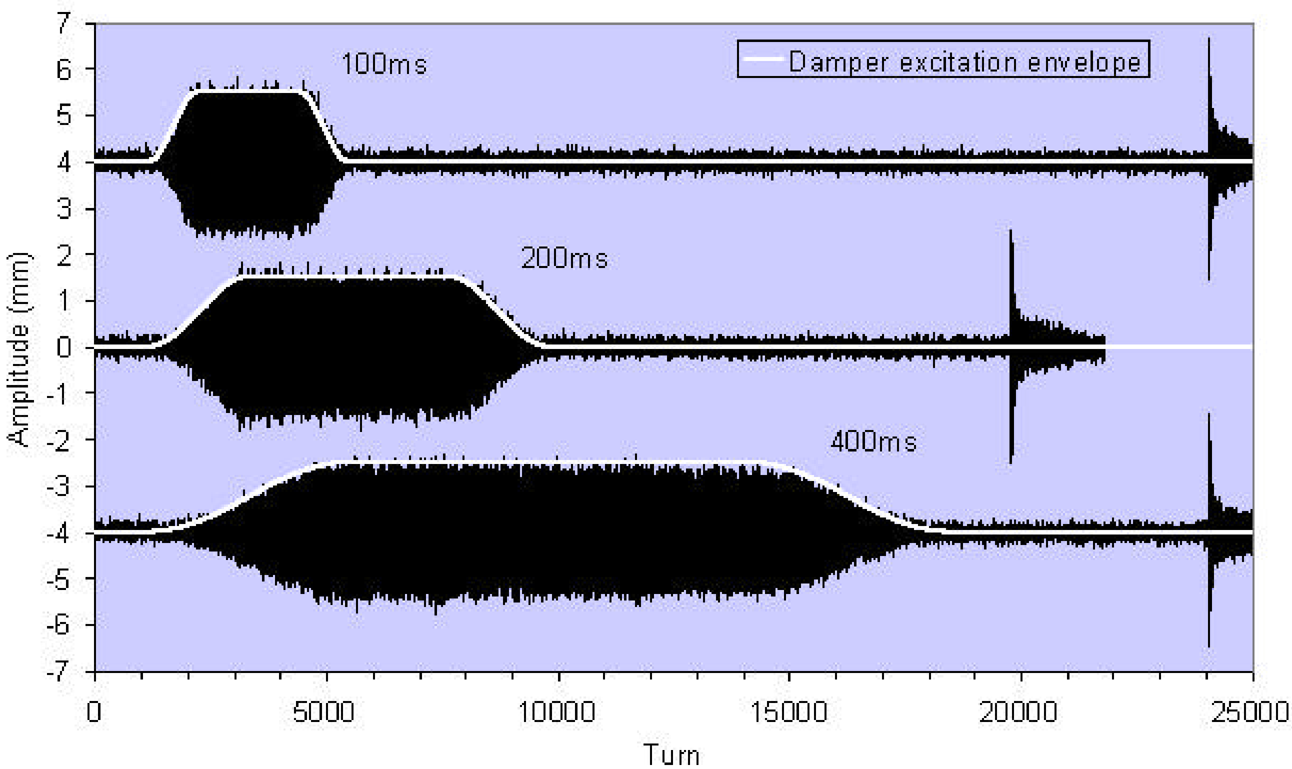
- **Results - Excitation Length:**
  - **Beam response to excitation lengths of 100ms, 200ms and 400ms. Ramp-up/ramp-down of 25ms, 50ms and 100ms.**



  - **Emittance blow-up of 17%, 21% and 64% measured**
  - **No increase in emittance for fast ramp rates**
  - **Excitation was probably still adiabatic, but choice of freq (δ = 0.014) not optimum.**

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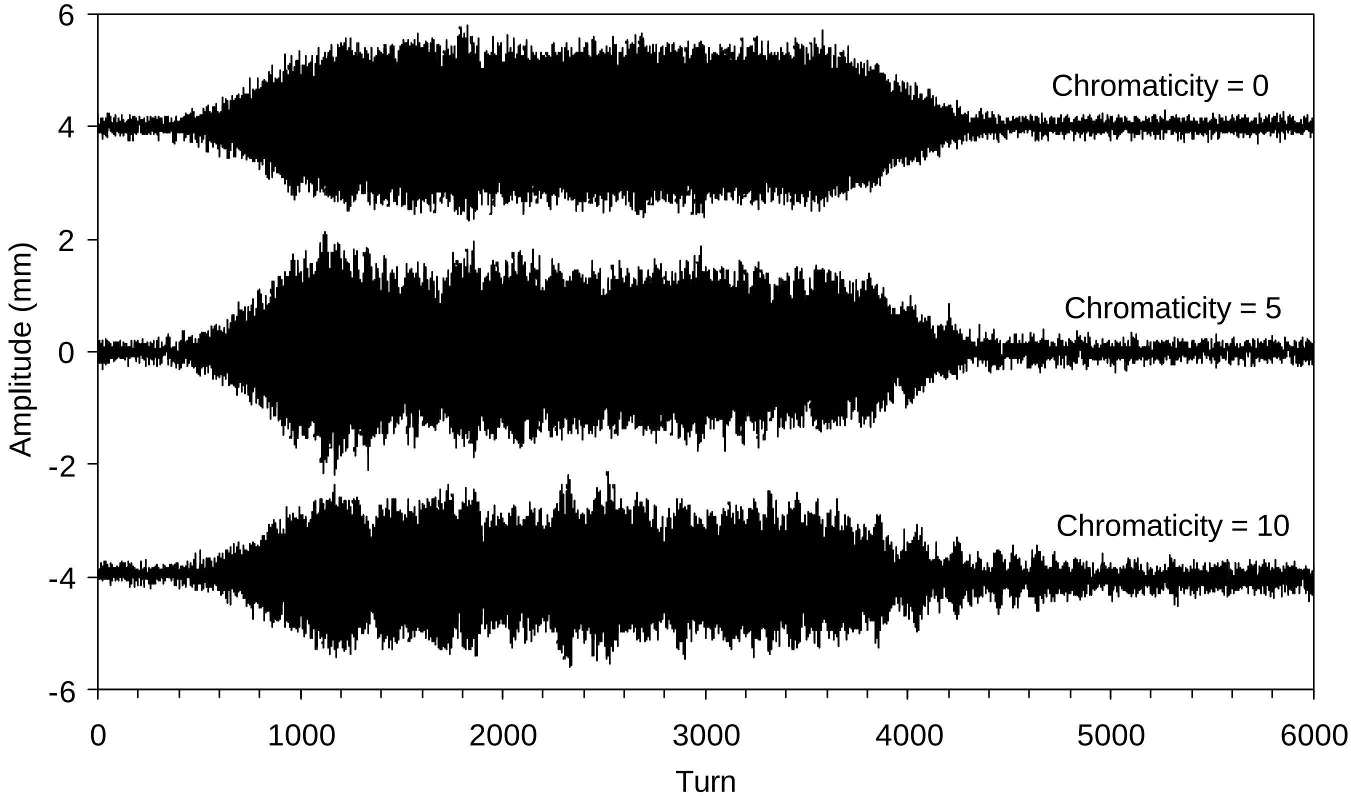
Results - Chromaticity:

- Beam response for various settings of the chromaticity



- Emittance blow up measured as 20% (Q' = 0), 200% (Q' = 0.2), 500% (Q' = 0.4).
- Again d not optimum as blow-up is non-zero even for Q'=0.

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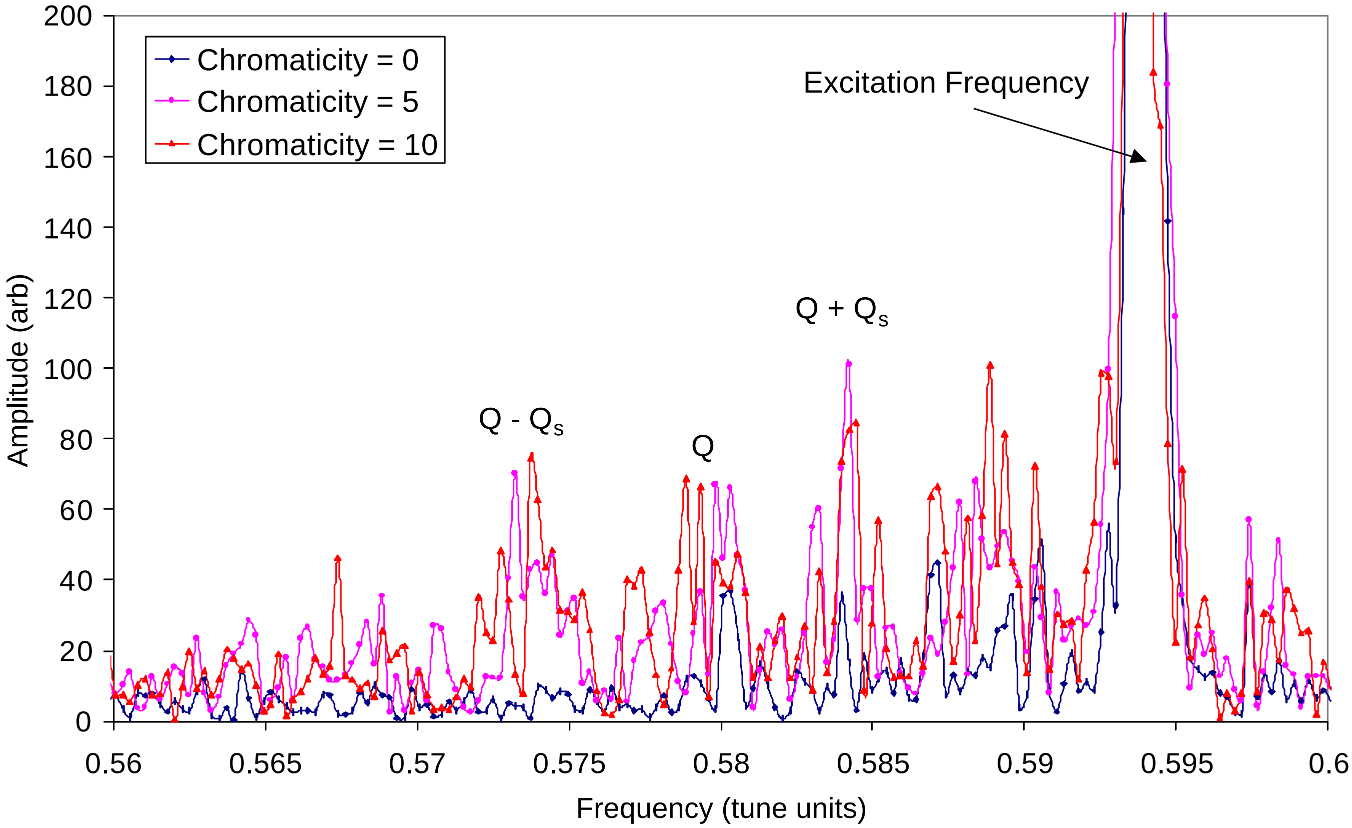
- **Results - Chromaticity (cont):**
  - **FFT of the beam response for various settings of the chromaticity**



  - **As expected more resonances are excited with increasing chromaticity.**

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- **Summary:**
  - **Emittance conserving excitation demonstrated using the transverse damper.**
  - **Due to large tune spread at low energy, the maximum amplitude possible for zero blow-up is limited (large $\delta \Rightarrow$ low amplitude).**
  - **Varying the octupole strength had no measurable effect.**
    (This was done very quickly and will have to be repeated - should manifest itself in a skew of the amplitude v δ plot)
  - **No non-adiabatic effects were seen for fast ramp-up rates. This should be repeated for an optimised δ.**
  - **Blow-up was seen to depend on Q'. Again this should be repeated for an optimised δ.**