Optics measurement in the LHC close to the half integer tune resonance

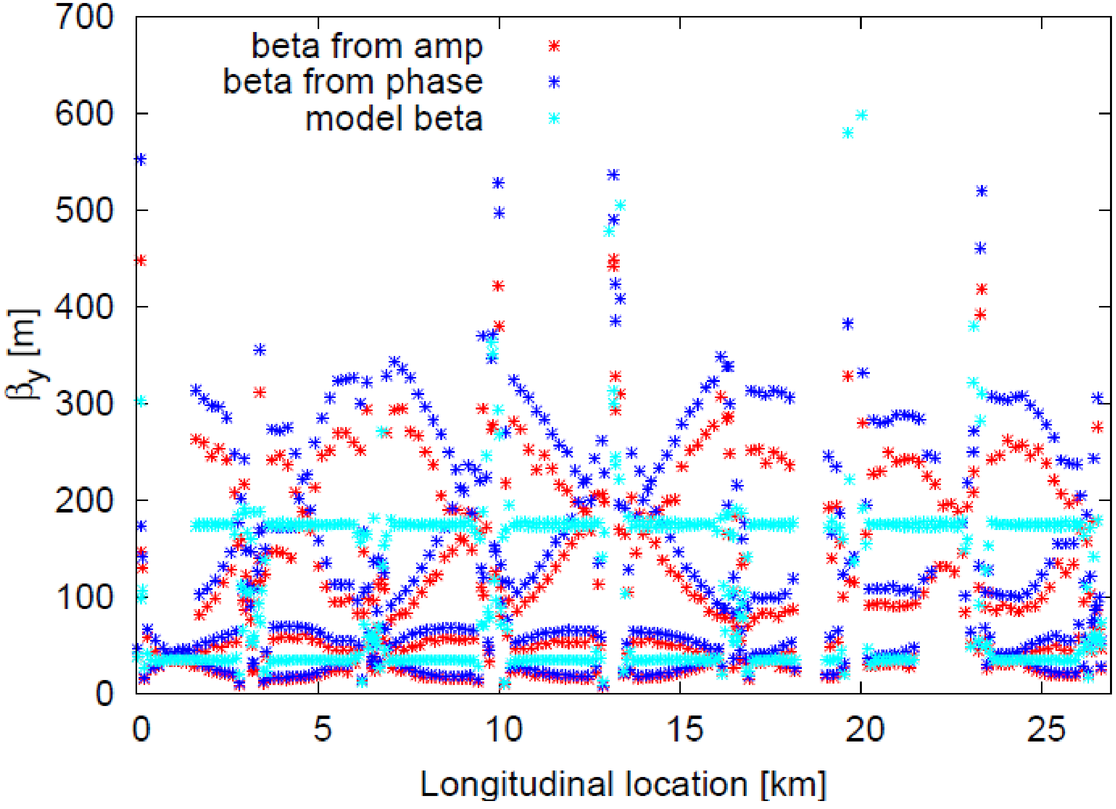
Andy Langner

Motivation

- Measurements close to the half integer resonance have been performed

→ Large beta-beat

- Discrepancy between two methods for obtaining the beta function

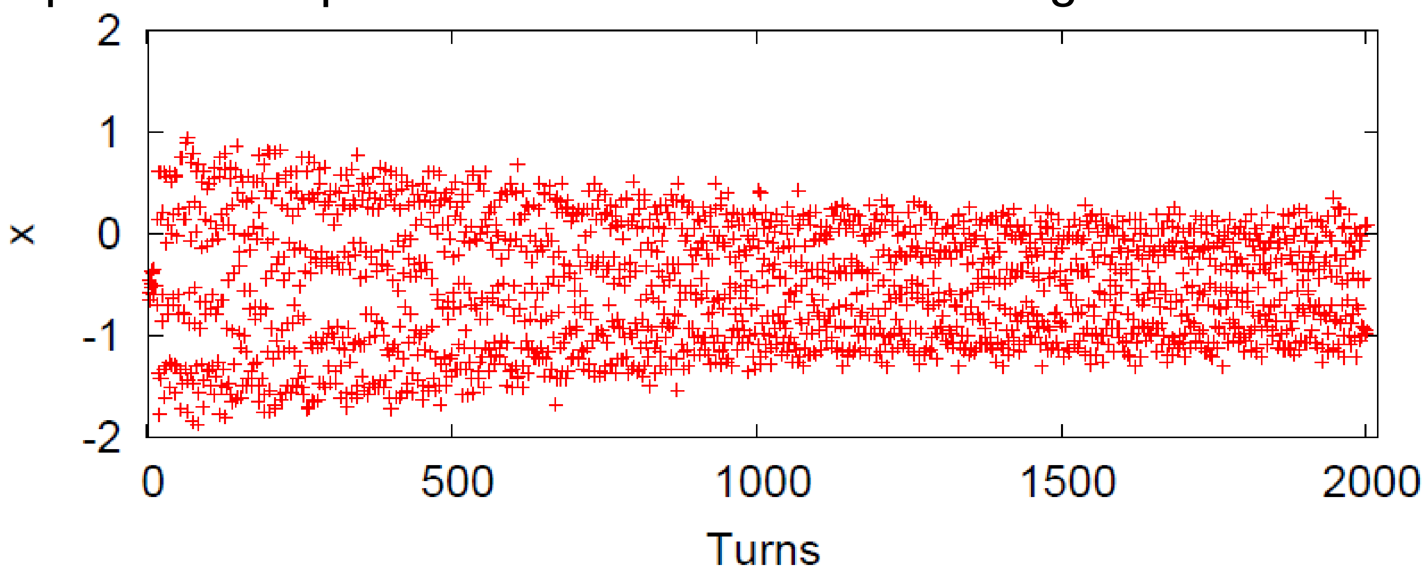


Obtaining the beta function

- Exciting oscillations of the beam (kick / AC Dipole)

- Turn by turn data at one BPM is of the form:
  $x_m = A \cos(2\,\pi\, Q_x m + \varphi_0)$

- Amplitude and phase can be used for obtaining the beta function



Introducing used errors

Distributed Errors

Using a table of known dipole errors and its corrections.

Local Errors

Applying an error of $2 \cdot 10^{-4}\ m^{-2}$ at four trim quadrupoles of the triplet: ktqx2.l8, ktqx2.r2, ktqx2.r1, ktqx2.r5;

Noise

A gaussian noise of 0.2mm RMS is added to the recorded positions by the BPMs → Signal to noise ratio of 25-30%.

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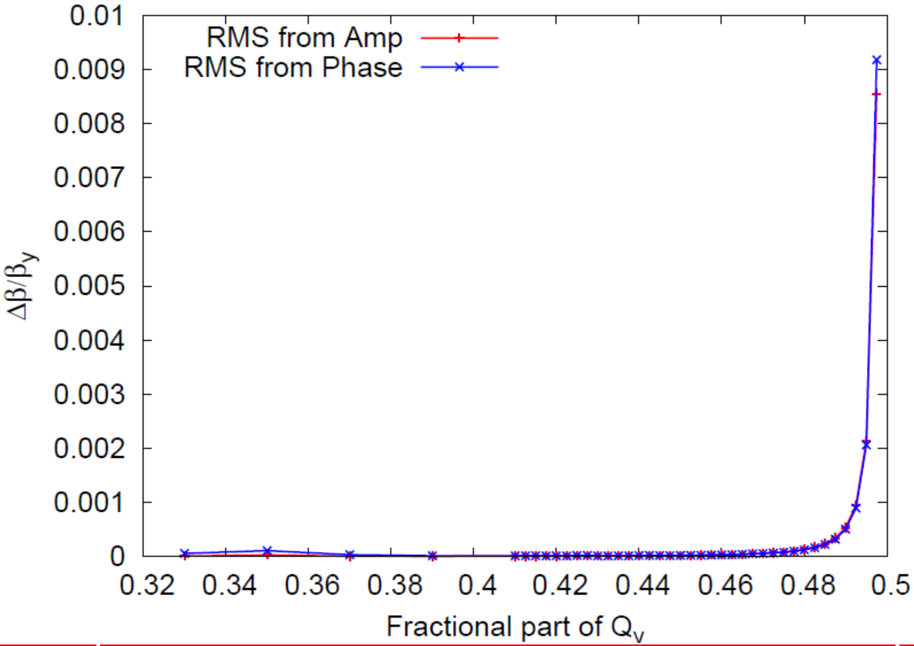
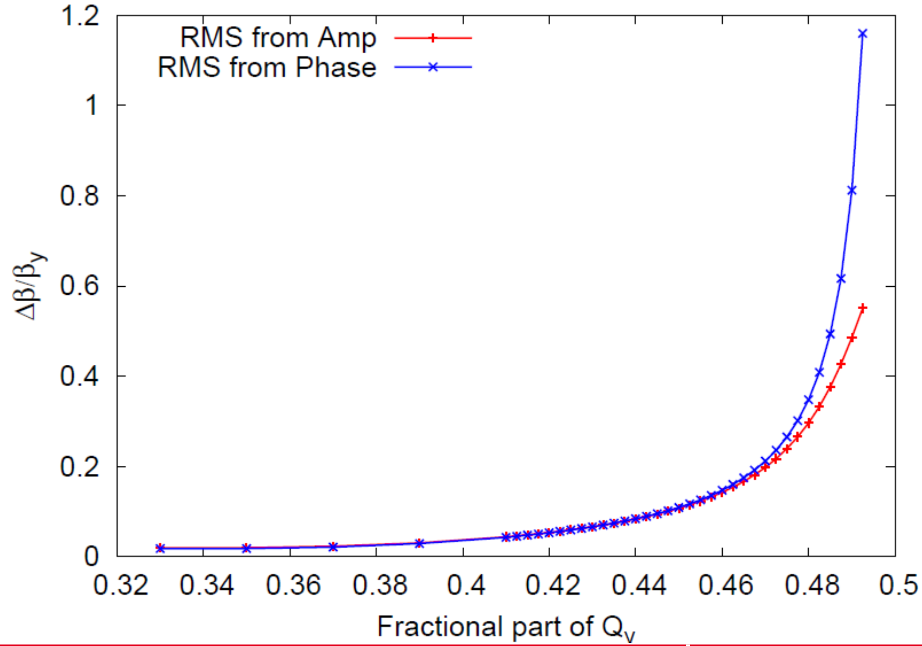
Simulations

- Using MADX for tracking particles for 1000 turns
- Obtain beta function with 'GetLLM' using amplitude and phase method
- Beta Beat is computed and the RMS value for all BPMs derived

Ideal system



Distributed errors



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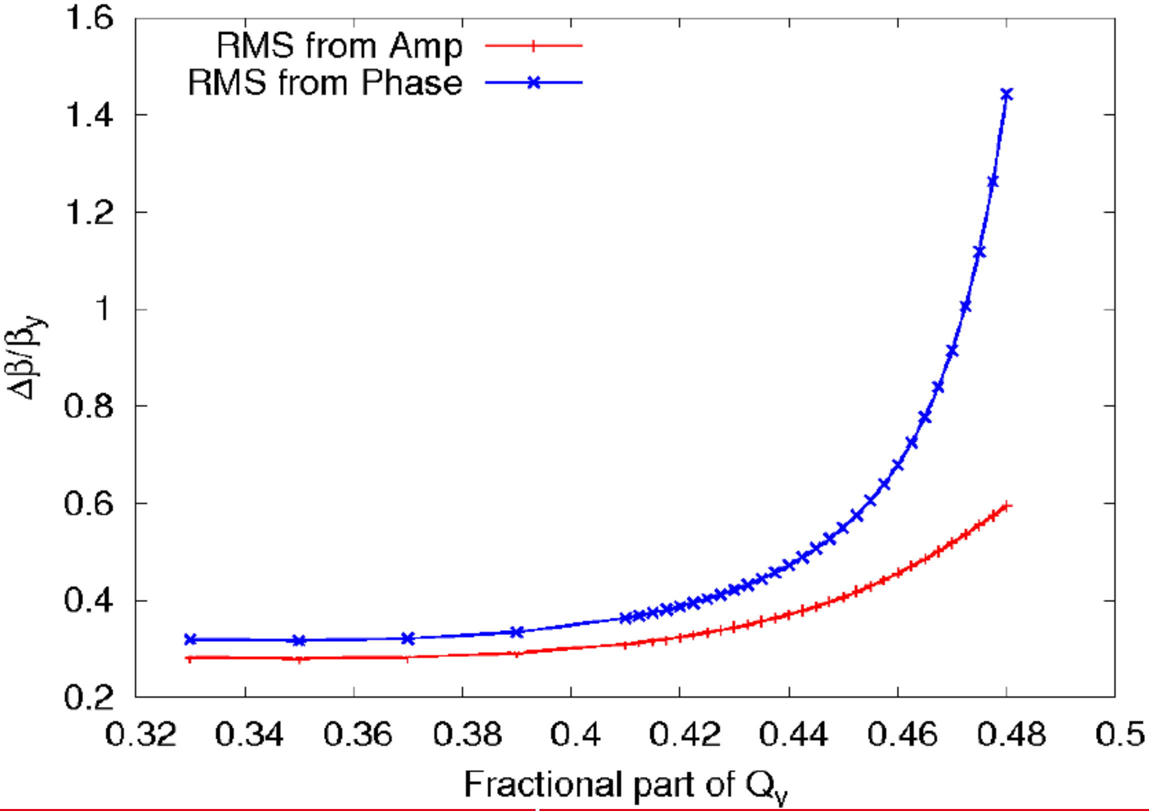
Simulations with Local Errors

- Applying local errors at the trim quadrupoles of the triplet.

→ Large discrepancy between both methods

→ Which is the more accurate one?



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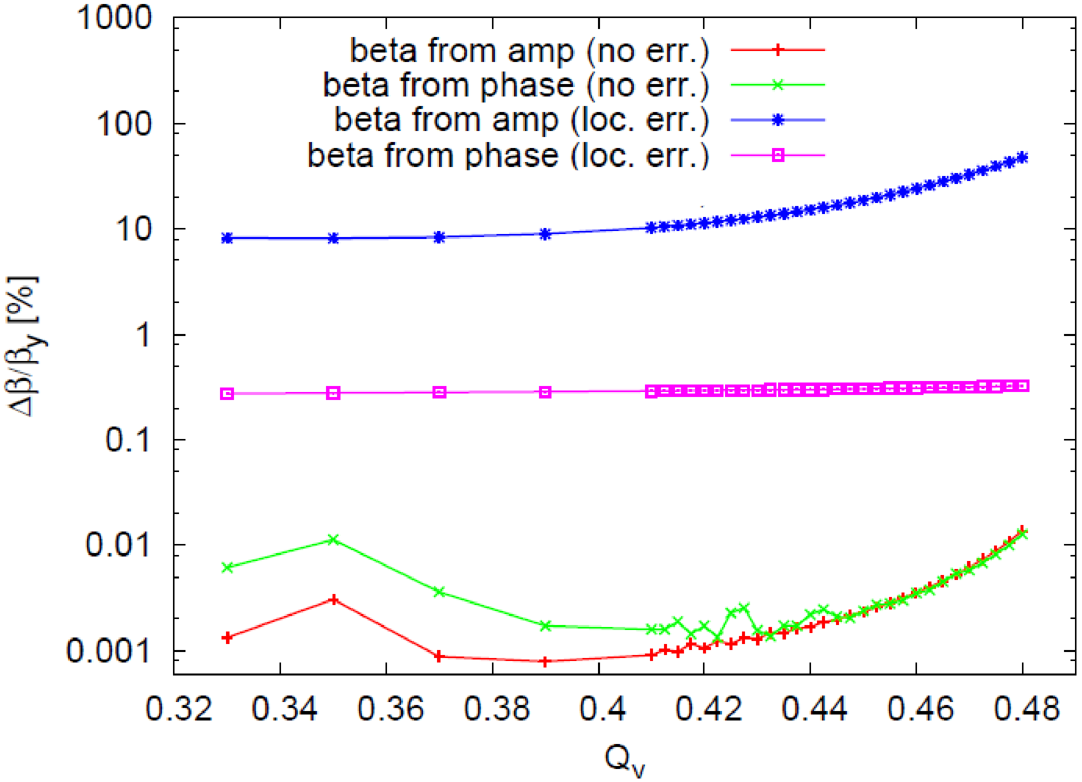
Accuracy

- A relative beta beat between the twiss model and the beta functions obtained with ‘GetLLM’ was derived

→ Phase method is more accurate in the presence of local errors



Rescaling algorithm

- Motivation: Using phase data to improve amplitude method

→ Use the most accurate BPM to find a global rescaling factor

- Filter BPM
  - non-arc BPMs
  - with large errors
  - with negative beta function

- Calculate the ratios between beta functions from phase and amplitude method

→ Derive the mean ratio

→ Rescale output of amplitude method with this ratio

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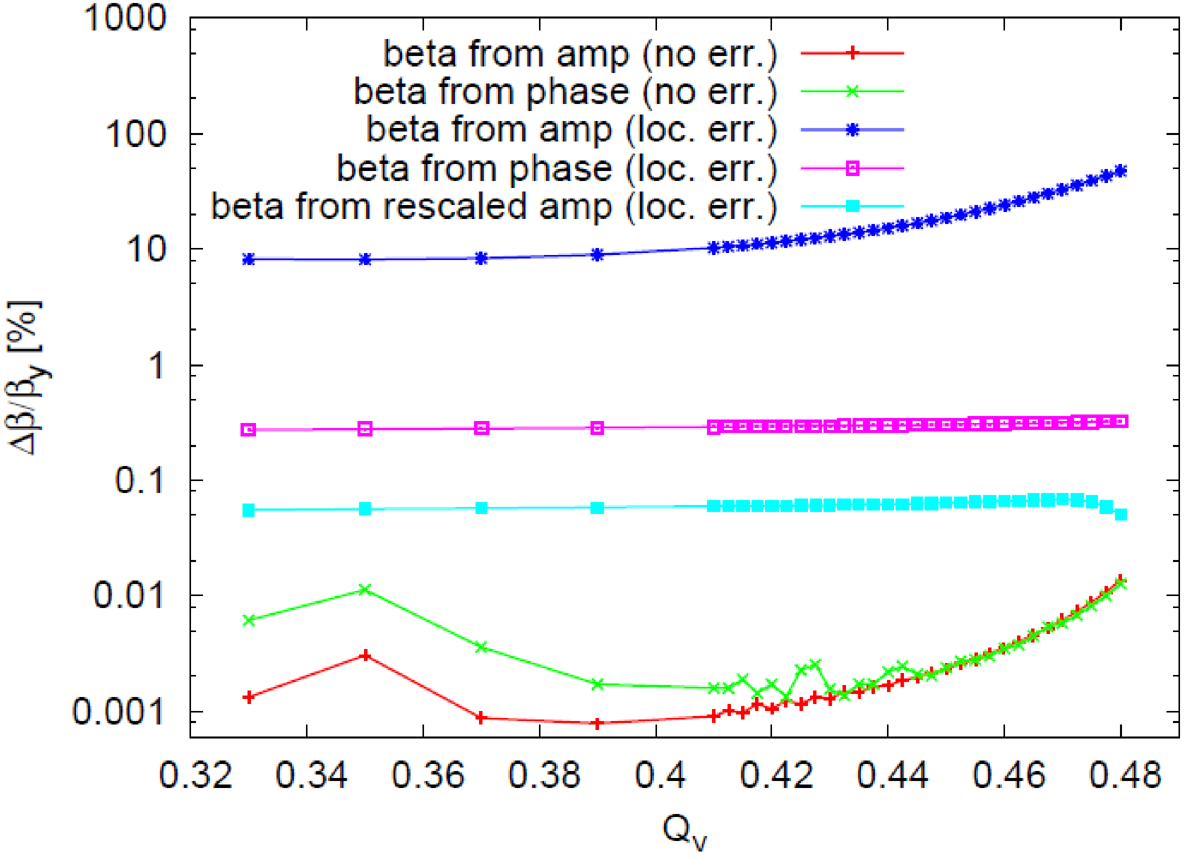
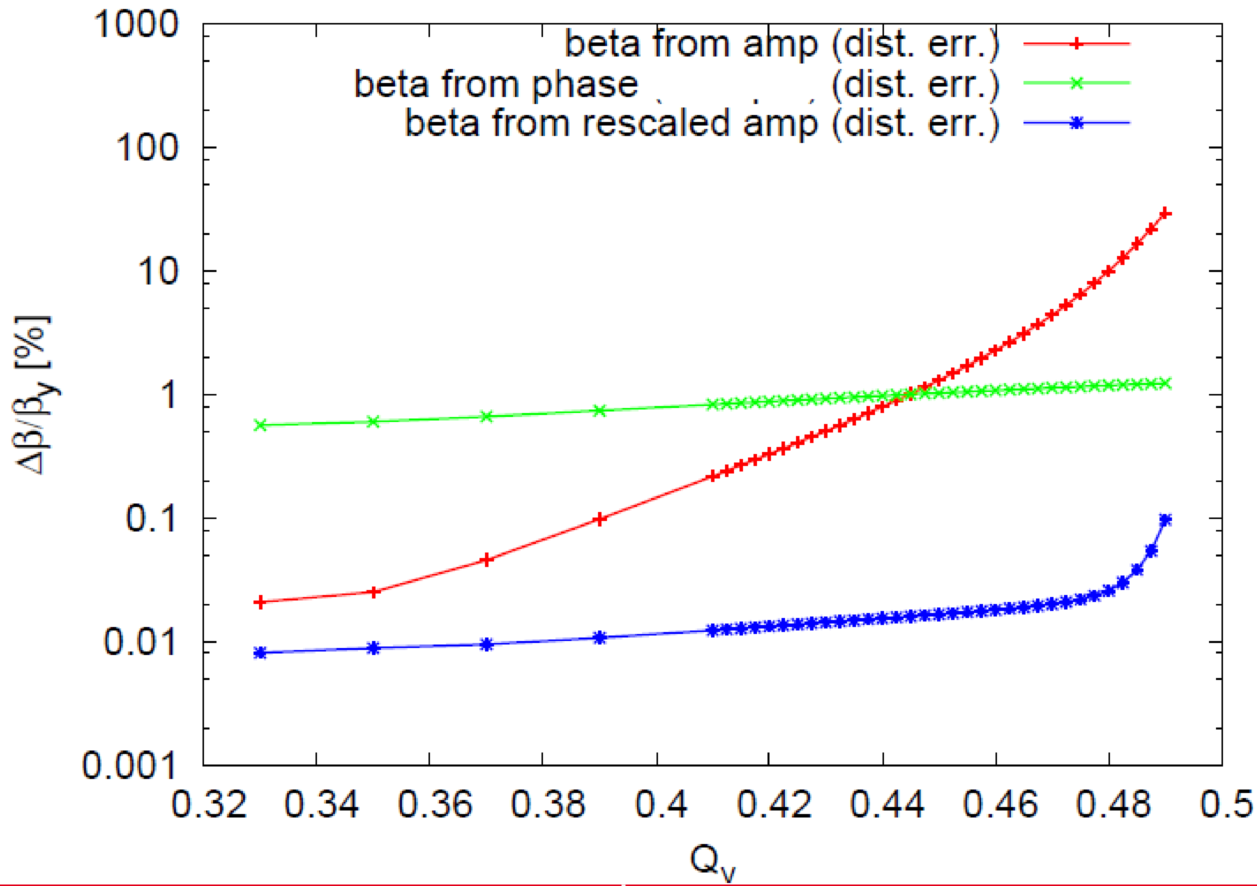
Accuracy

- After rescaling the accuracy of the amplitude method improved significantly



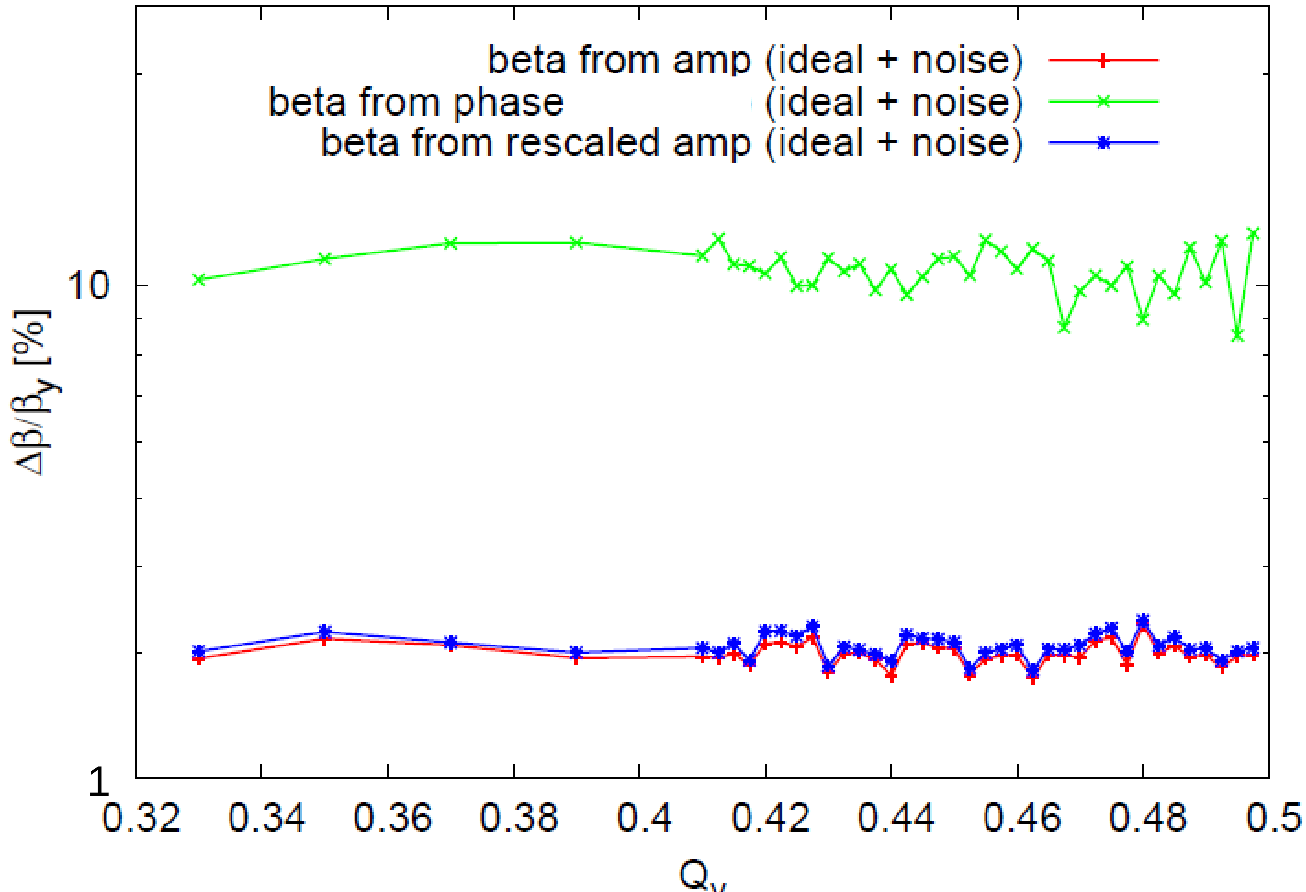
Distributed errors

- In the case of distributed errors, the amplitude method gets worse when approaching the half integer



Ideal system with noise

- Phase method is a lot more sensitive to noise than the amplitude method



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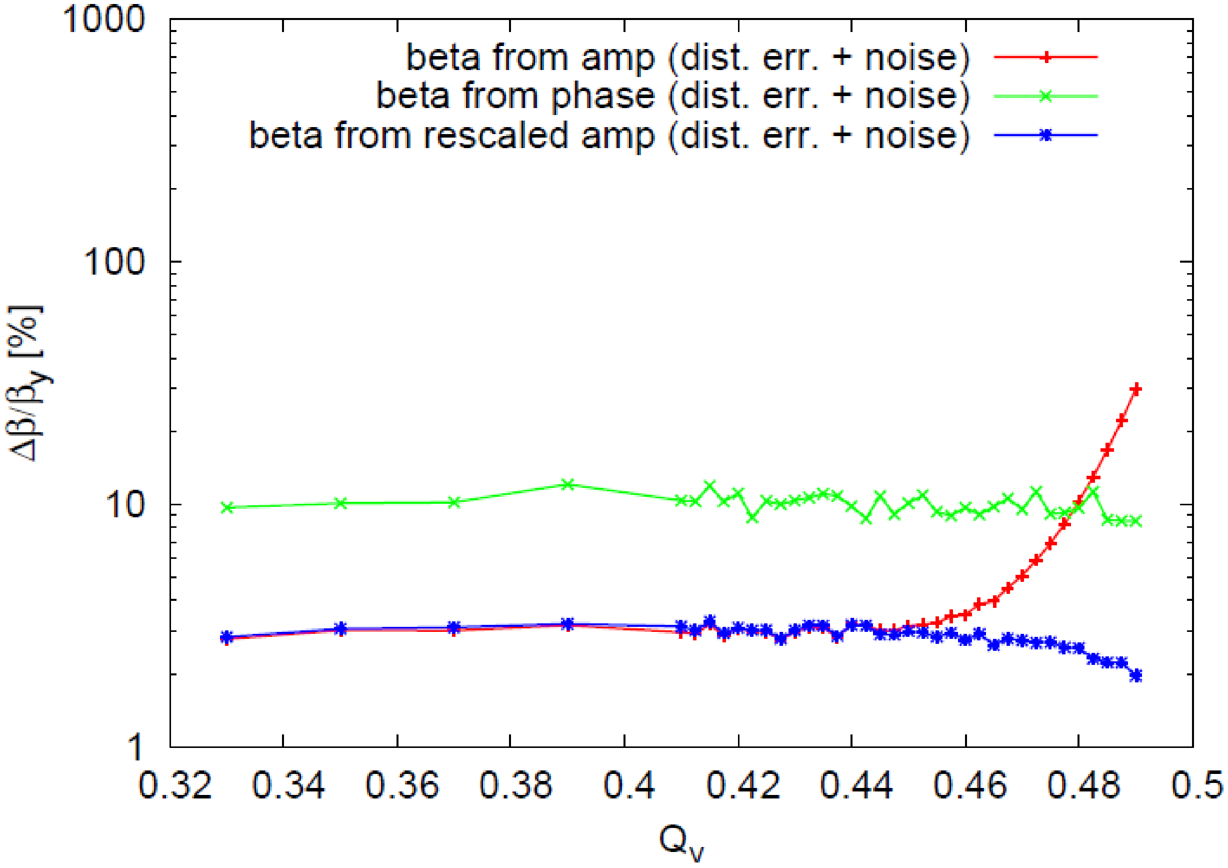
Distributed errors and noise

- Amplitude method is more accurate because of the noise, but gets worse when approaching half integer due to the errors.



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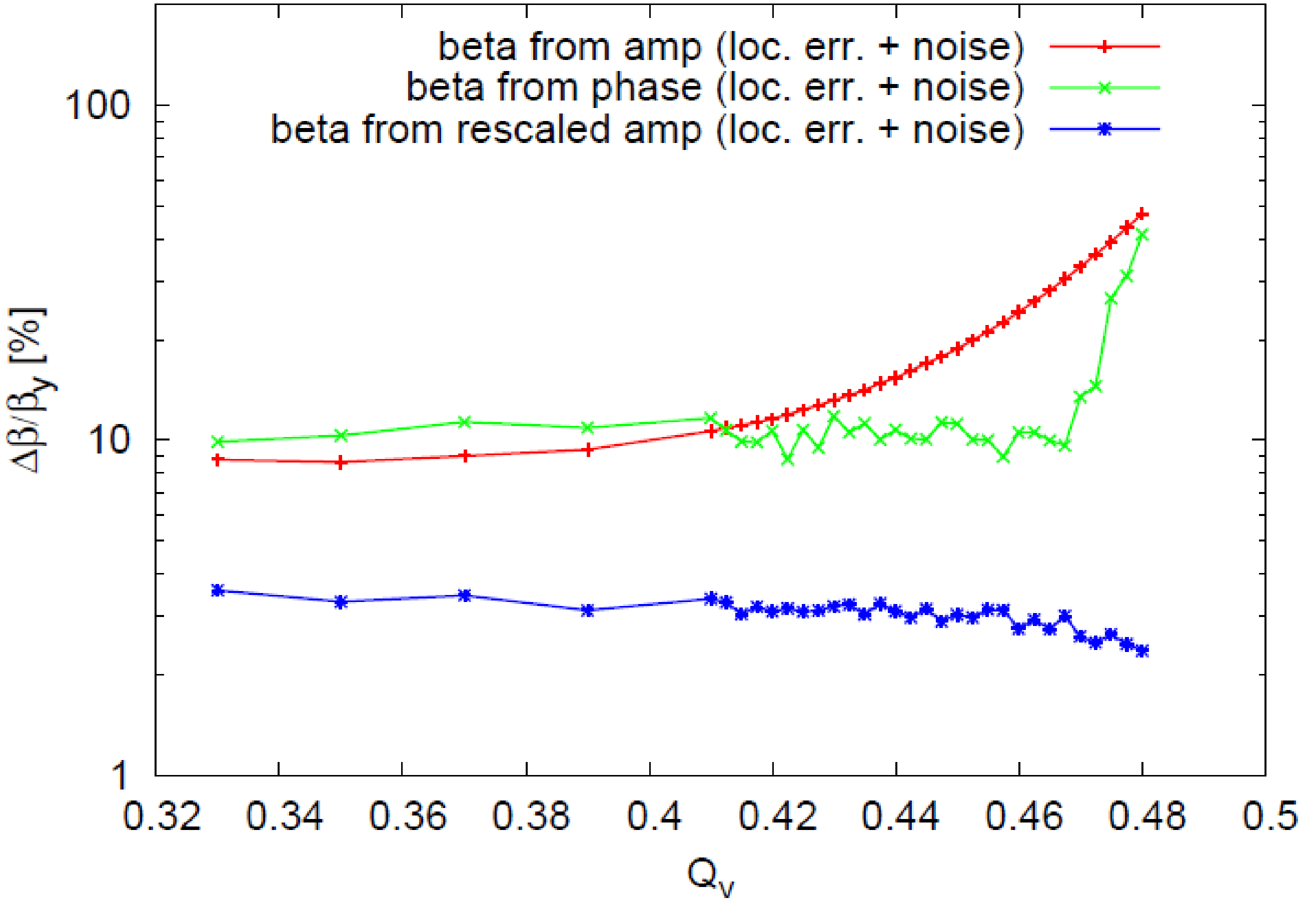
Local errors and noise

- Amplitude method can be improved in case of local errors with noise



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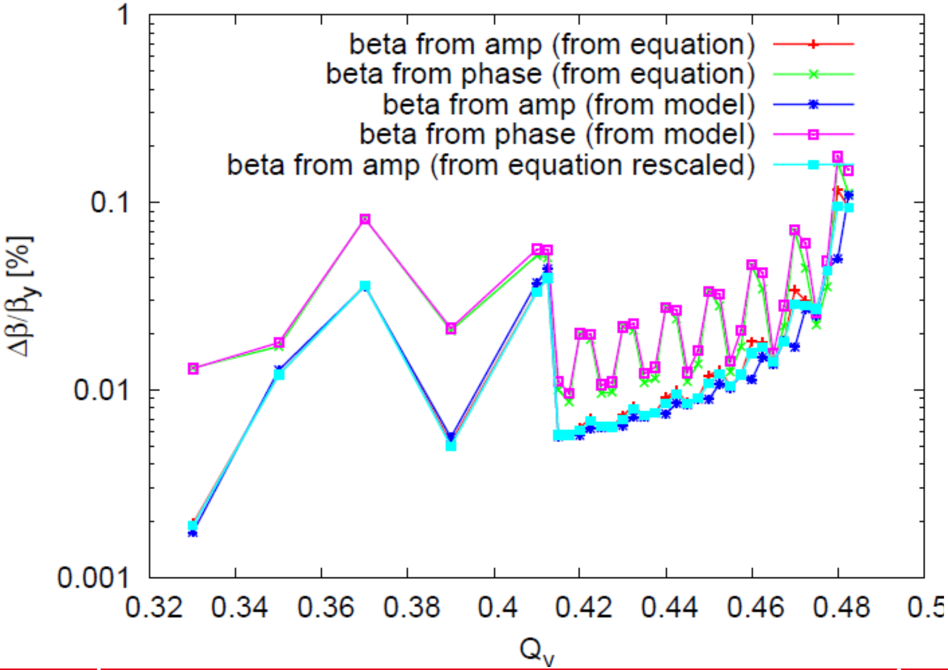
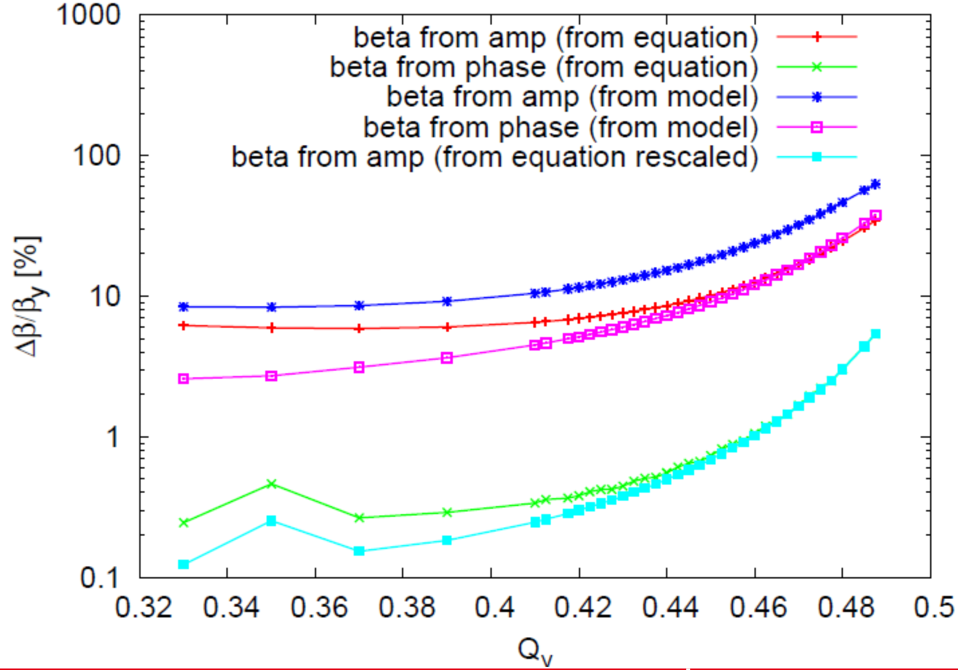
AC Dipole

- The rescaling algorithm was also implemented for the case of using AC Dipole for exciting the beam
- Accuracy of the results from using model is worse than the results from equation

Ideal system



Local errors



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Conclusions

- Discrepancy between amplitude and phase method was studied
- Phase method was identified to be more accurate in the presence of local errors
- A rescaling algorithm was implemented into ‘GetLLM’ to improve the results of the amplitude method
- The rescaling algorithm works for free oscillations as well as for the AC Dipole

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