

# Ramp Optics measurement and correction

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APEX workshop 2013

# Outline

Present status

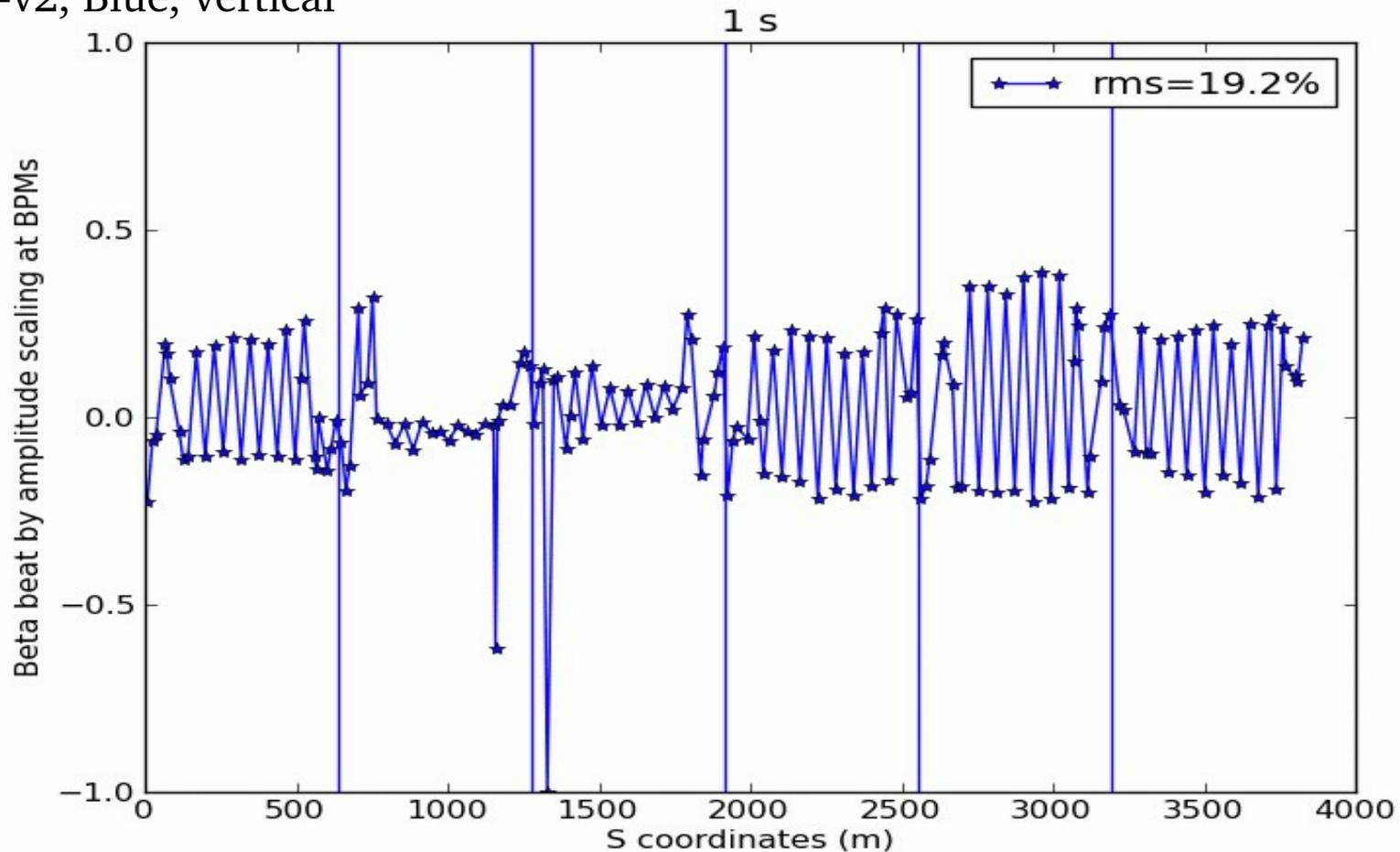
Plans

# Status

- By kicking one bunch with the Artus tune meter, turn-by-turn orbits are obtained on the ramp
- Information extracted from the turn-by-turn orbits: beta beat, phase beat, beta functions at devices
- These ramp optics measurements have been used to:
  - a. find abnormality of the ramp (for example, vertical emittance shrinking in Yellow ring during beta squeeze of e-lens lattice, beta function at YV IPM found decreasing opposite to design)
  - b. determine gradient errors and correction
  - c. allow interpolation of the measured optical functions to intermediate locations (e.g. at IPs, IPMs, polarimeters, Schottky....)

# Beta beat on the ramp

pp13b-v2, Blue, vertical



The global beta beat decreases towards the middle of the ramp, then it increases as beta stars get squeezed;  
This movie wasn't shown successfully in RHIC retreat 2013

# History of ramp optics correction attempts

- Rotator ramp optics correction is operational in Yellow ring in 2013:

## Observations from the 12 by 12 test ramp:

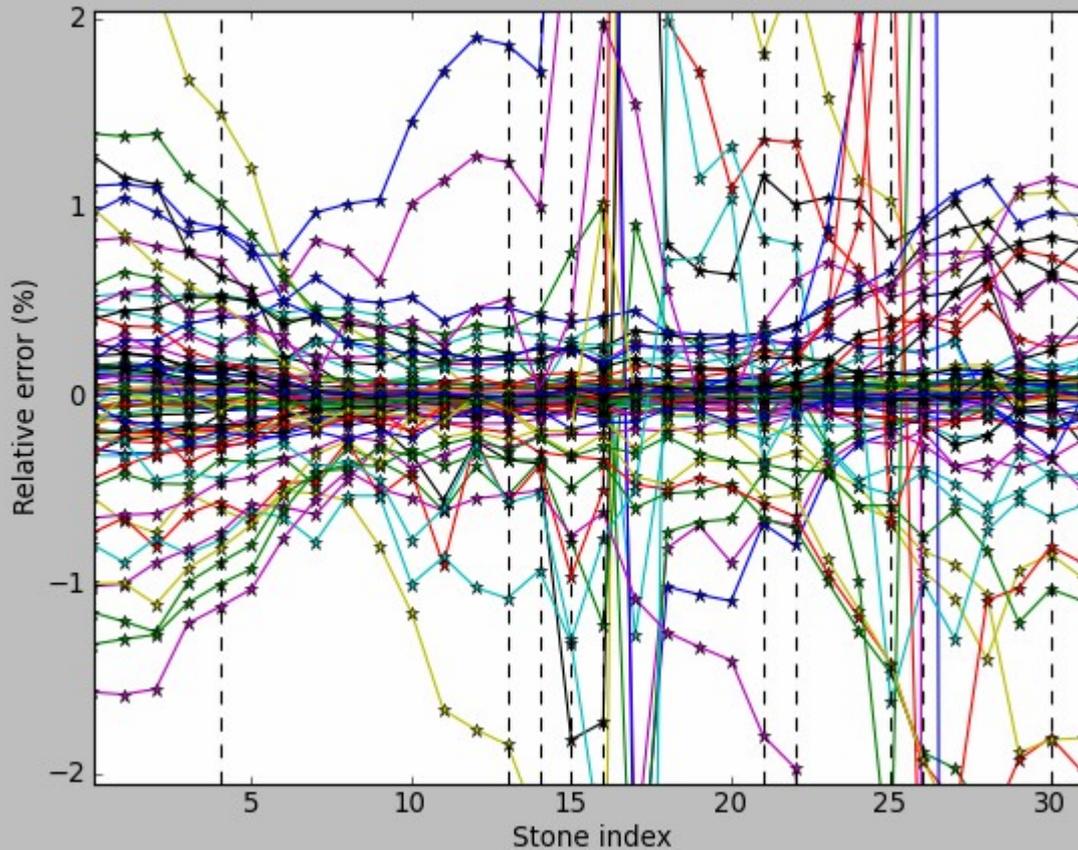
1. Back-propagated optics corrections at store into the rotator ramp
  2. Beam loss is same as a physics ramp
  3. IPM emittance is the same as a physics ramp
  4. Calculated emittance (by StoreAnalysis) is as good as a good physics store
  5. In the test (corrections implemented for both rings), ZDC scaled rate reached 1070 kHz for STAR,  $\sim 15\%$  increase of Luminosity
- Energy ramp correction encountered problems of excursion with anchoring stones

# Questions

- Is relative gradient error  $\Delta G/G_0 = (G-G_0)/G_0$  a constant on the ramp in principle?
- Is  $\Delta G/G$  close to a constant from the ramp optics correction calculation?
- If the statements above are true, then ramp optics correction can be implemented as rescaling of magnet currents; for instance, relative error  $\Delta G/G_0 = 1\%$  for one magnet, then the current needs to be scaled by  $1/(1+\Delta G/G_0) \sim 99\%$

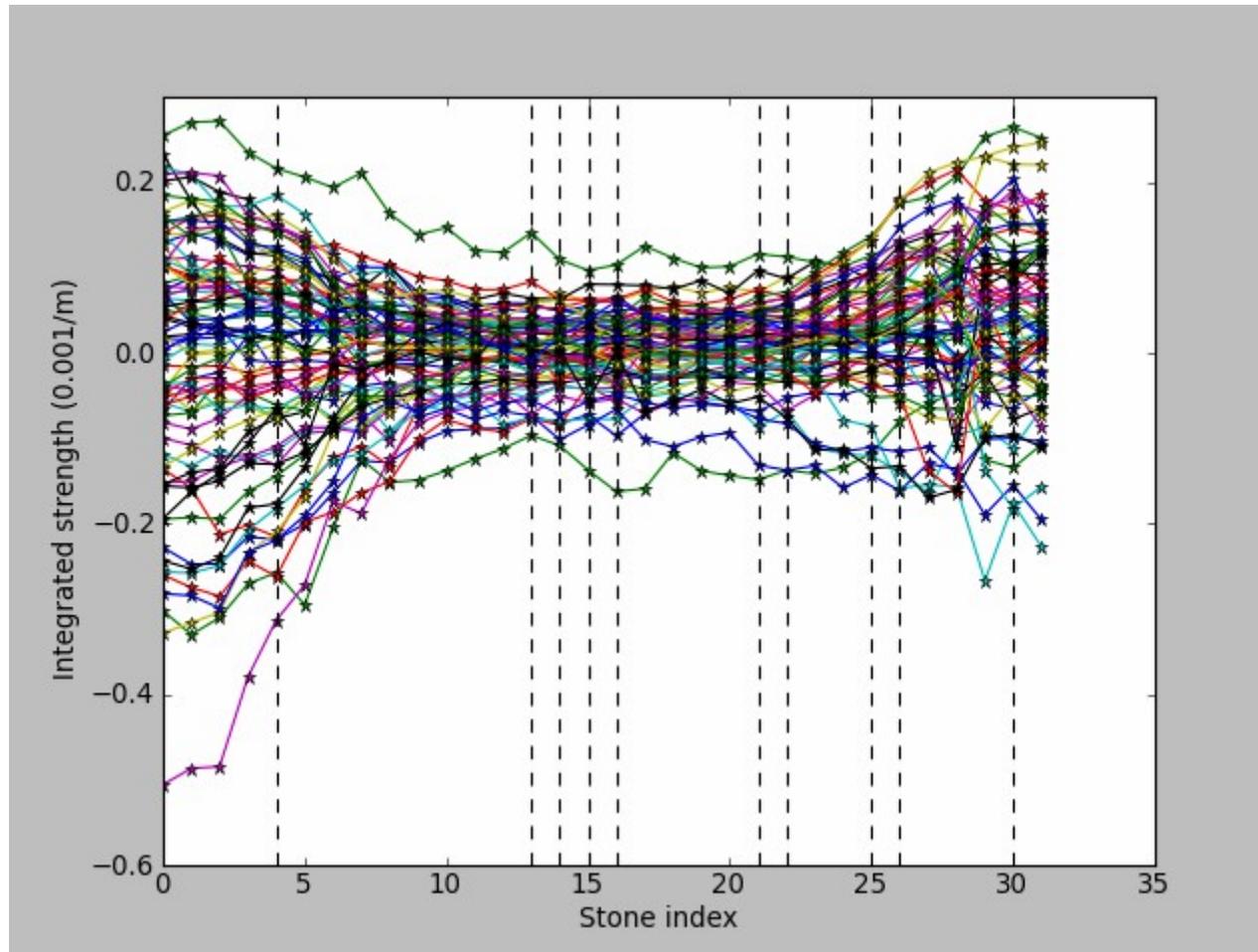
# Relative error evolution

pp13b-v2, Yellow, fill#: 17354



Calculated relative gradient errors from ramp optics measurements do not stay as constant

# Strength evolution



Dashed lines are at the stones where quadrupole magnets are anchored or partially anchored; In-between the anchored stones, strengths change more or less linear

# Plans

1. Priority for measurement and implementation of ramp optics correction will be driven by experimental need; measurements and confirmation (correction?) of beam optics during ATS or during step-wise and/or continuous beta-squeeze seem likely warranted
2. Concerning implementation of corrections during the "ramp", two options are being considered:
  - a). Implement corrections at the anchored stones, plus the store stone
  - b). Copy a ramp file, implement all the corrections, re-fit the magnet currents

Happy Holiday!