AC Dipole Beam Experiments

RHIC Beam Experiment Workshop 2003

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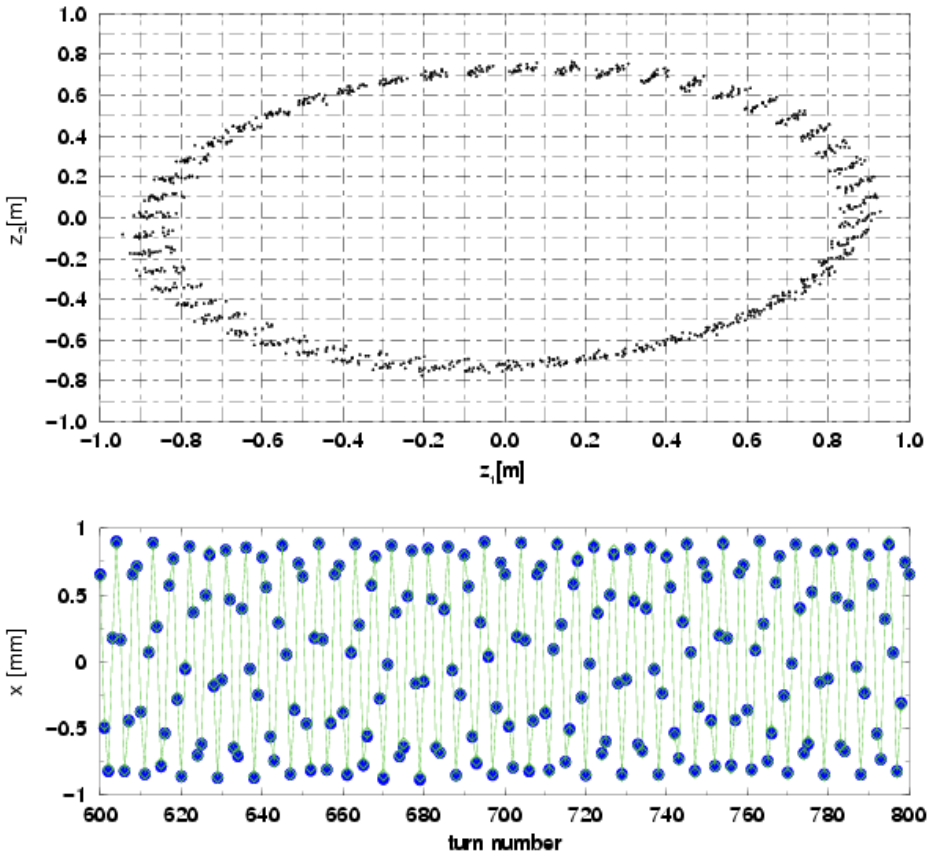
Outline

- Review the ac dipole experiments in FY 2003
  - Linear optics measurements
  - Linear coupling measurements
  - Spin flipping
- experiments for FY2004
- Conclusions

Linear Optics Measurements

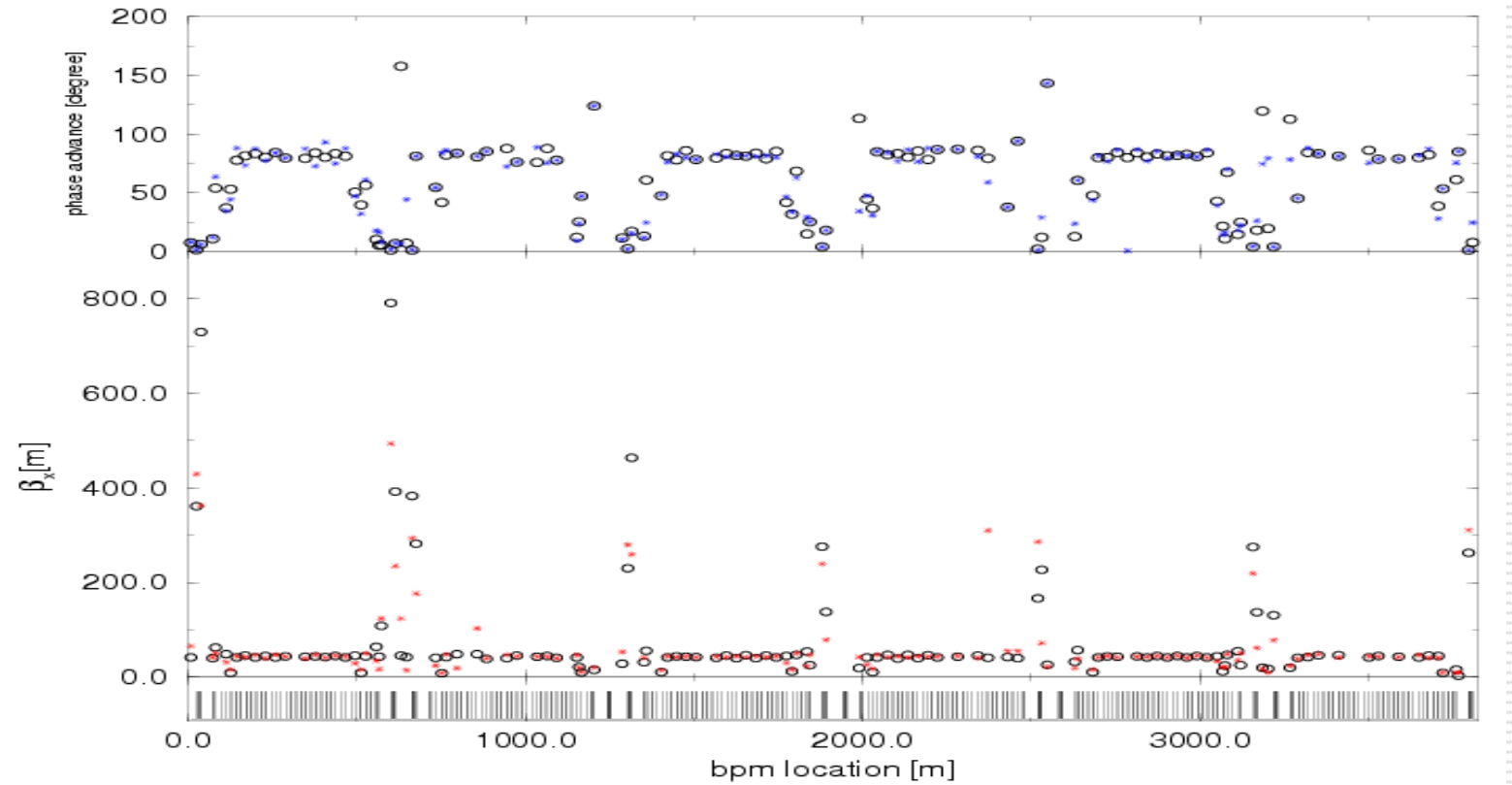
$$\beta_1 \frac{m_{11}^{1,2}}{m_{12}^{1,2}} - \cot\phi_{12} = \beta_1 \frac{m_{11}^{1,3}}{m_{12}^{1,3}} - \cot\phi_{13}$$

$$\beta_1 = \beta_1^m \sqrt{\frac{\beta_2/\beta_1}{\beta_2^m/\beta_1^m}} \frac{\sin\phi_{12}^m}{\sin\phi_{12}}$$



An example of Linear Optics Measurements

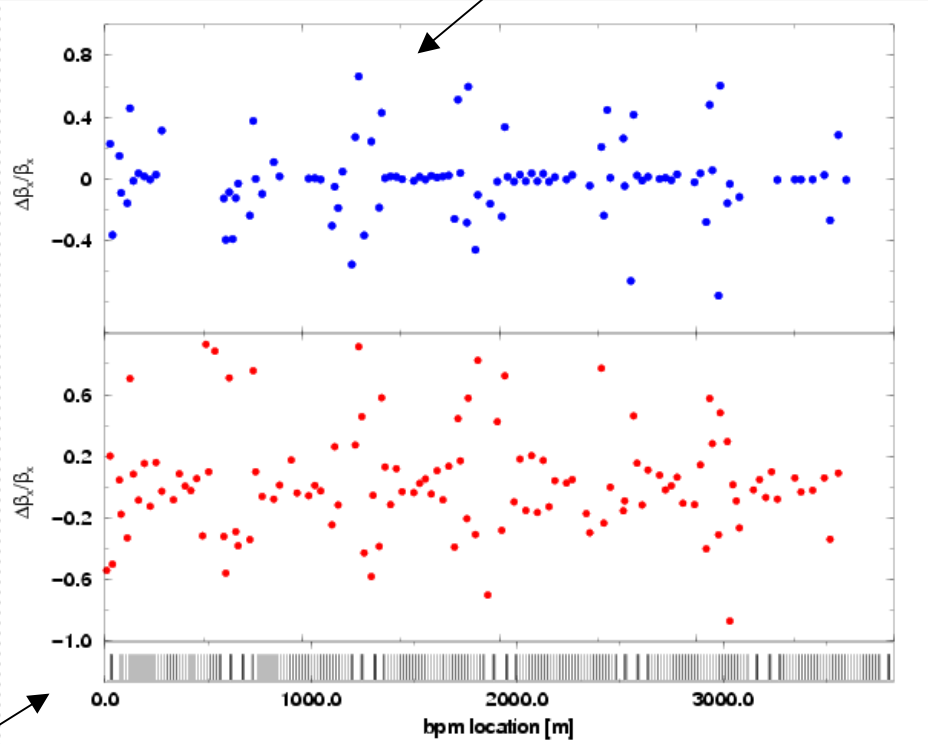
- Optics measurement in Yellow at Au store



What did we learn from the Linear Optics Measurements?

- Measurements
  - Optics measurements in both rings at injection and at store during dAu run as well as pp run
  - Clearly see the effects of β* on the beta wave. The smaller β*, the bigger beta wave. This is an indication that the gradient error in the triplets could be the source.

Yellow at injection



Yellow at store

Linear Coupling measurements

$$\begin{pmatrix} x \\ x' \\ y \\ y' \end{pmatrix} = R \begin{pmatrix} u \\ u' \\ v \\ v' \end{pmatrix}$$

$$R = \begin{pmatrix} \gamma I & C \\ -C^{+} & \gamma I \end{pmatrix}$$

$$\bar{C} = \begin{pmatrix} \frac{1}{\sqrt{\beta_u}} & 0 \\ \frac{\alpha_u}{\beta_u} & \sqrt{\beta_u} \end{pmatrix} C \begin{pmatrix} \sqrt{\beta_u} & 0 \\ \frac{\alpha_u}{\beta_u} & \frac{1}{\sqrt{\beta_u}} \end{pmatrix}$$

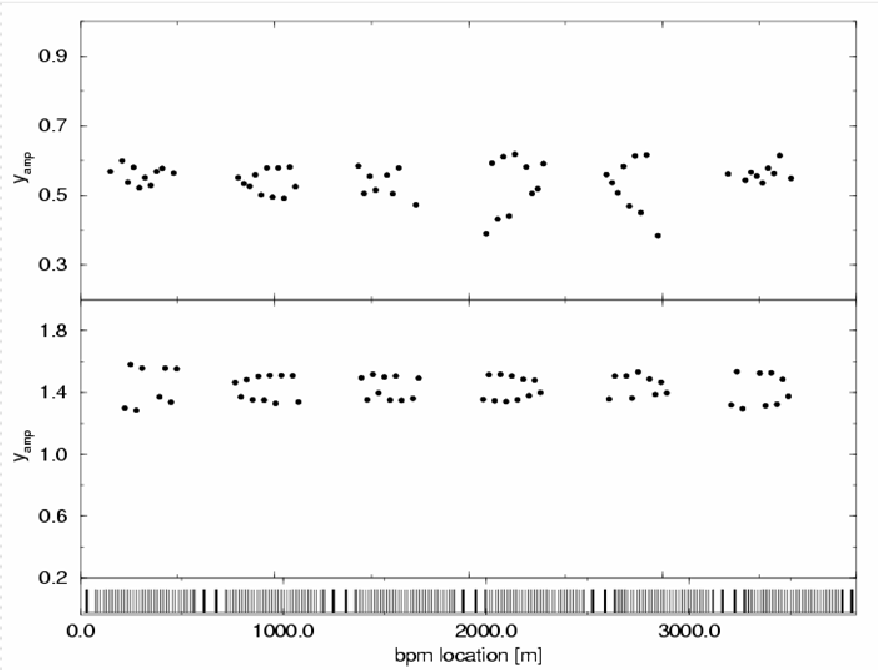
$$x = \gamma \frac{\sqrt{\beta_x}}{4\pi B\rho\delta_x}(\gamma\delta x')\cos(Q_m\theta + \chi)$$

$$y = \frac{\sqrt{\beta_y}}{4\pi B\rho\delta_x}(\gamma\delta x')[\bar{c}_{22}\cos(Q_m\theta + \chi) + \bar{c}_{12}\sin(Q_m\theta + \chi)]$$

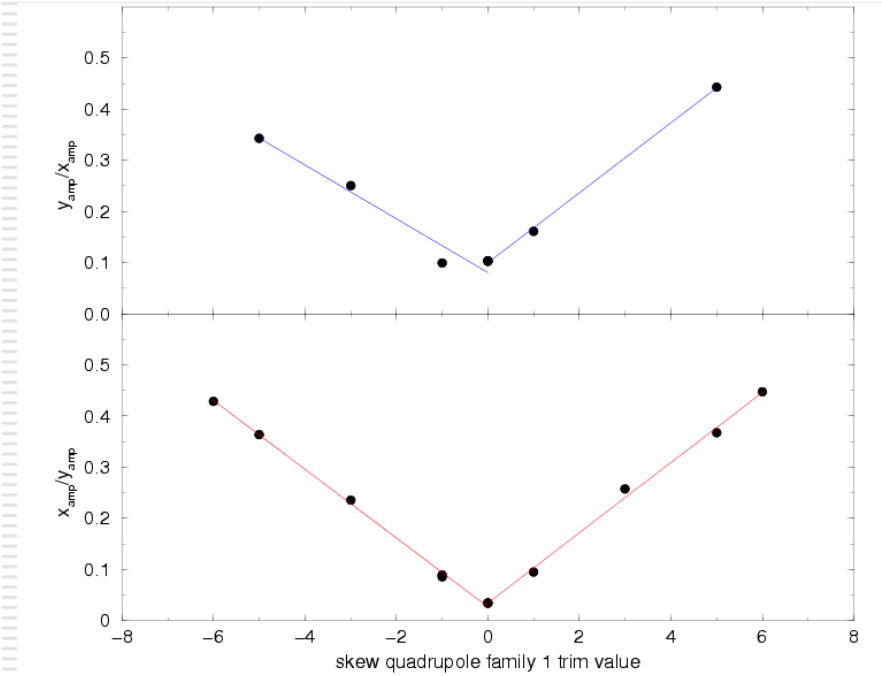
$$\sqrt{\frac{\beta_y}{\beta_x}}\frac{1}{\gamma}\sqrt{\bar{c}_{22}^2 + \bar{c}_{12}^2} = \frac{y_{amp}}{x_{amp}}$$

$$\sqrt{\frac{\beta_x}{\beta_y}}\frac{1}{\gamma}\sqrt{\bar{c}_{11}^2 + \bar{c}_{12}^2} = \frac{x_{amp}}{y_{amp}}$$

Linear Coupling measurements



The top plot shows amplitude of the H coherence excited by a V AC Dipole with skew quad family 1 trim value set to 0.005. The amplitude of the corresponding vertical coherence amplitude at each bpm is shown in the middle plot.



The measured ratio of amplitudes for hotizontal (top) and vertical (bottom) AC Dipole excitation with different skew quadrapole settings.

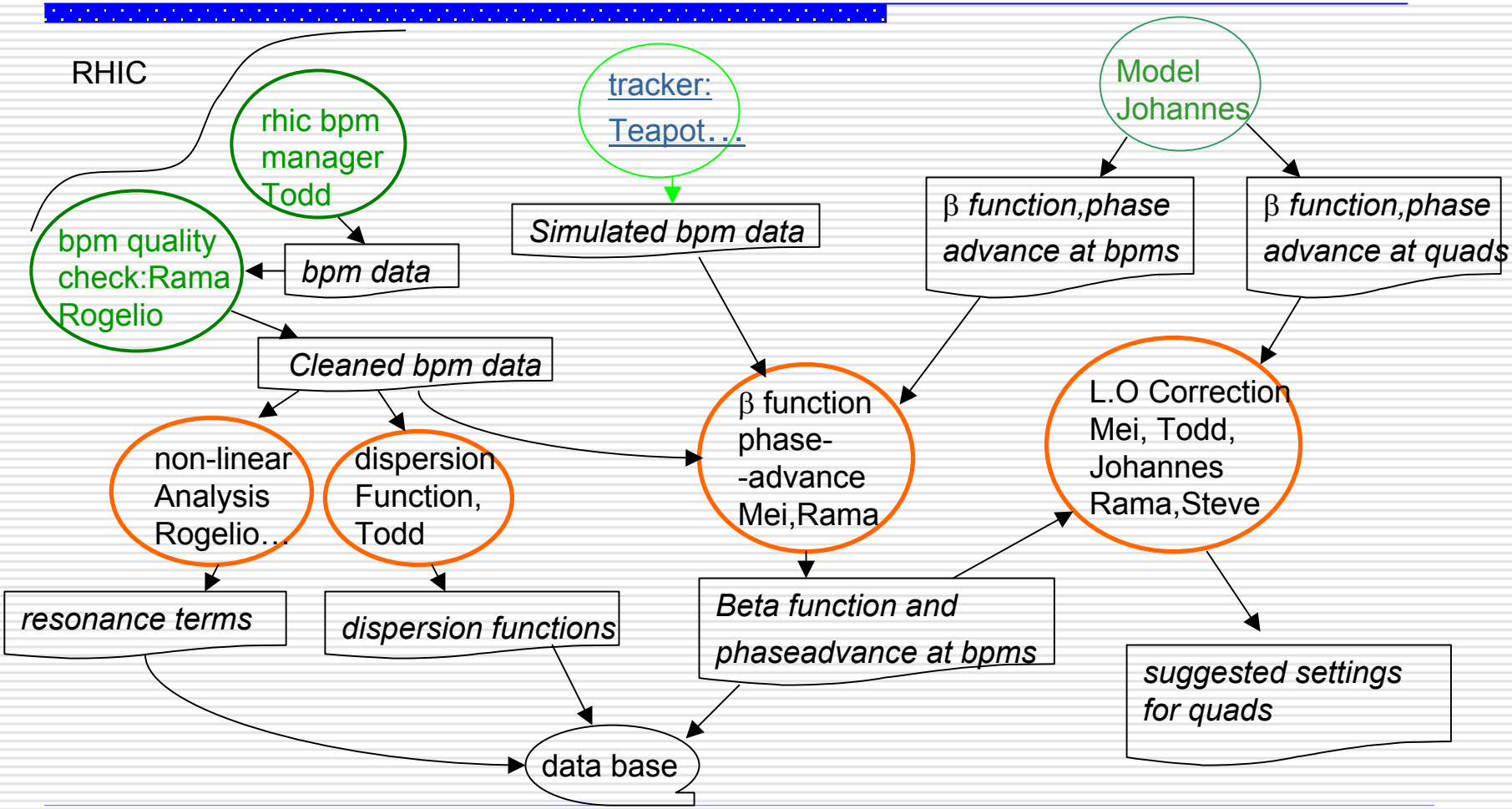
What did we learn from FY 2003

- The method works
- The quality of the measurement relies on the quality of the bpms. The method is vulnerable on missing bpms as well as the wrong timing.
- The bpm tbt multiple triggering problem also makes the measurement more difficult.
- Needs to know the tunes before measurement
- The fact that both ac dipoles common to both beams makes it difficult to share beam time with other experiments

Plan for FY 2004

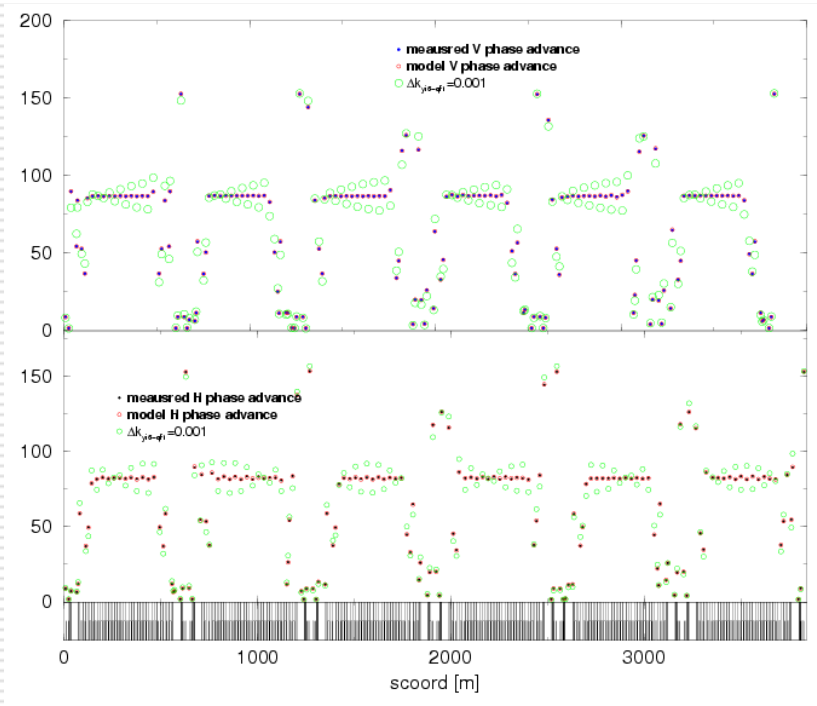
- Linear optics corrections
  - Optics measurements
  - Dispersion measurements
- Linear coupling measurments
- Non-linear resonance term measurements
- Action-angle method

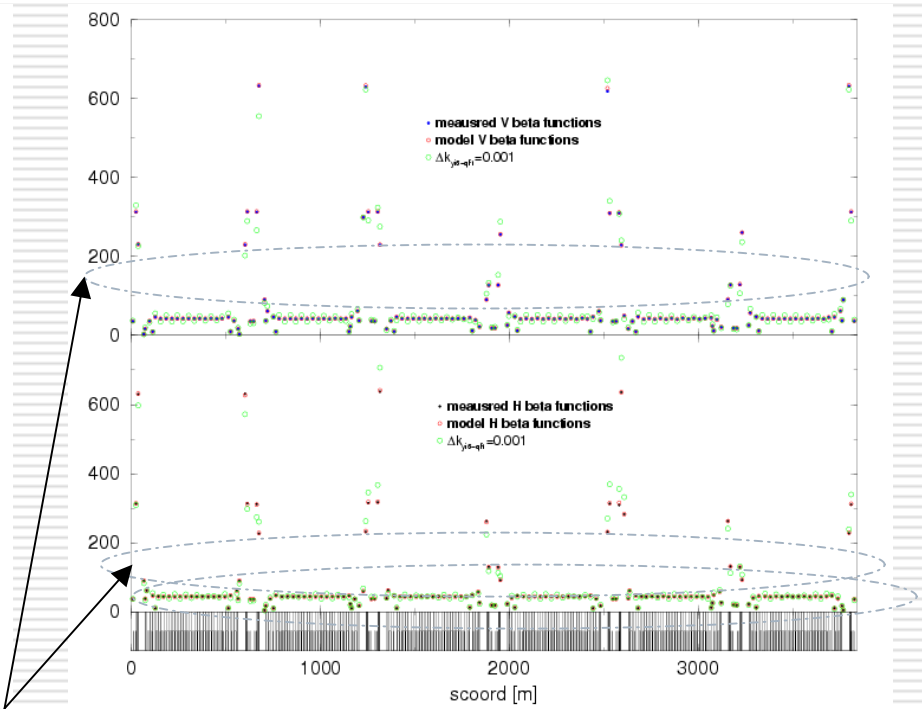
Ac dipole experiment bubble chart



simulation

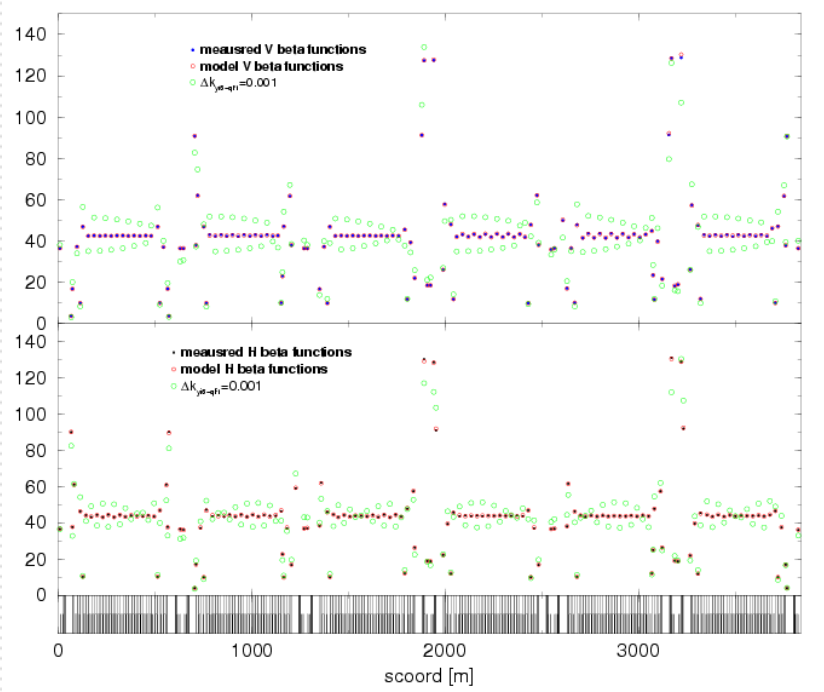
Lattice: Yellow-dAu-top-ideal.sxf --- Fulvia
Tracker: MIA_BPM --- Nikolay, Rama

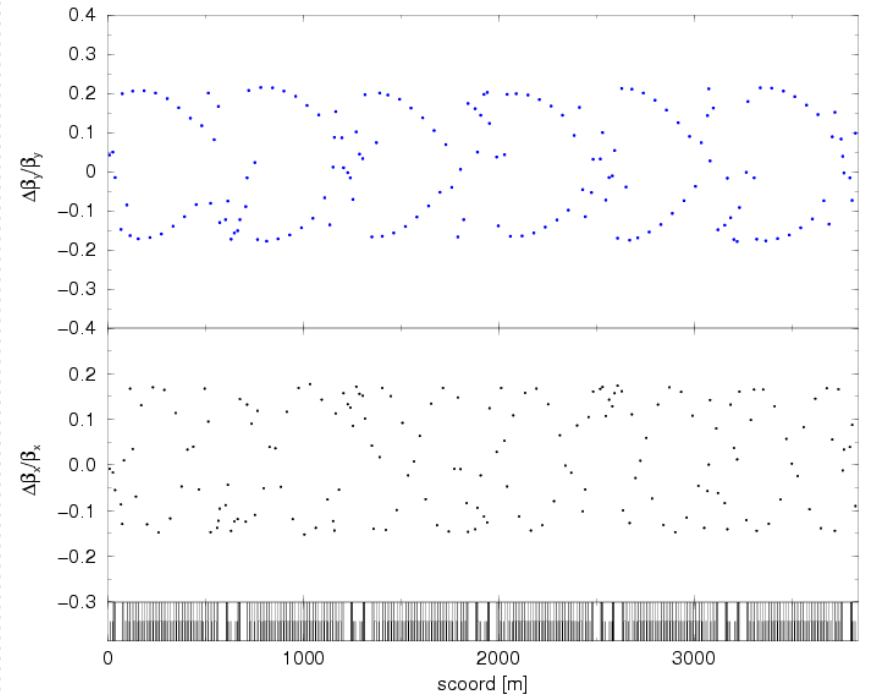




zoom

Beta function -- zoom





Linear optics correction

- goal:
  - Routine optics measurements, beta function, phase advance and dispersion functions
  - Test the various algorithms of gradient error correction
    - Johannes fitting routine
    - Qlorb
    - Others…
- people who are involved:
  - Mei, Todd, Johannes, Steve, Rama

Linear coupling

- goal
  - measure the coupling strength vs. different skew quad setting. Also need to use the traditional method to measure the ΔQmin under the same conditions.
- Prefer to perform the experiment at injection
- people who are involved:
  - Mei, Todd, Rama, Fulvia…

Non-linearity measurements

- goal
  - measure the resonant driving terms
  - measure the multipole strength
- method
  - Sussix
  - Action angle analysis
- people who are involved:
  - Rogelio, Wolfram, Andrea(GSI), Giovanni(GSI), Mei, Todd, Rama

MIA analysis

- goal:
  - Bpm quality check
  - Obtain the linear optics
  - Obtain the coupling information
- parasitic to the other ac dipole experiments
- people who are involved:
  - Rama

What do we need for experiments?

- Ac dipole H & V
- Tune meter
- IPM
- Reliable bpms,bpms,bpms and bpms
- Ac dipole control software and data analysis application: Loptics

conclusion

- linear optics correction: 8hrs
- Linear coupling measurement: 8hrs
- Non-linear measurements
  - Resonance term using Sussix
  - Action-angle
- MIA: parasitic to the linear optics correction experiment as well as others