# AC dipole experiments

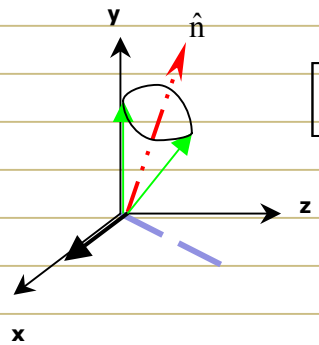
- 5 applications have been proposed for the next RHIC run
  - high-precision linear optics measurements
  - fast global decoupling
  - measurement of nonlinear & linear driving term
  - nonlinear phase space distortion measurement
  - spin flipping and other spin diagnostics

- The purposes of each application along with a short description have been documented in the AC Dipole Applications in Beam and Spin Dynamics memo

- a loose collaboration has been formed between us and LHC

# The advantage of using ac dipole

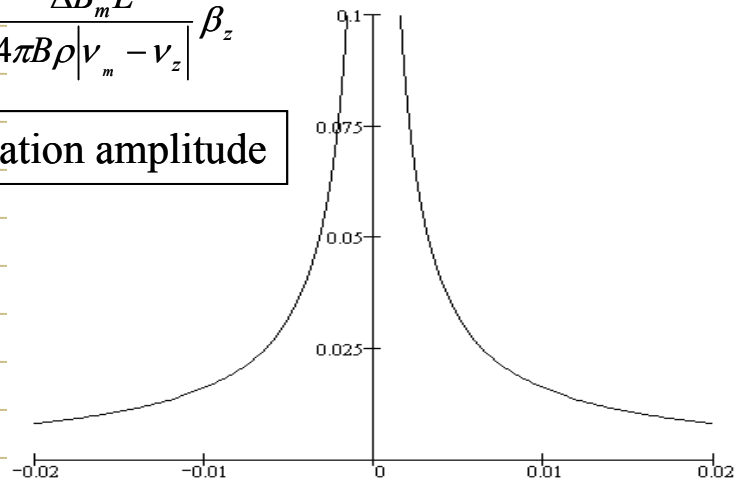
- the adiabatic excited coherence preserves the beam emittance
- can launch the beam to a large amplitude to explore the nonlinear beam dynamics
- the vertical ac dipole can also resonate around the spin precession frequency can be used to manipulate the spin motion



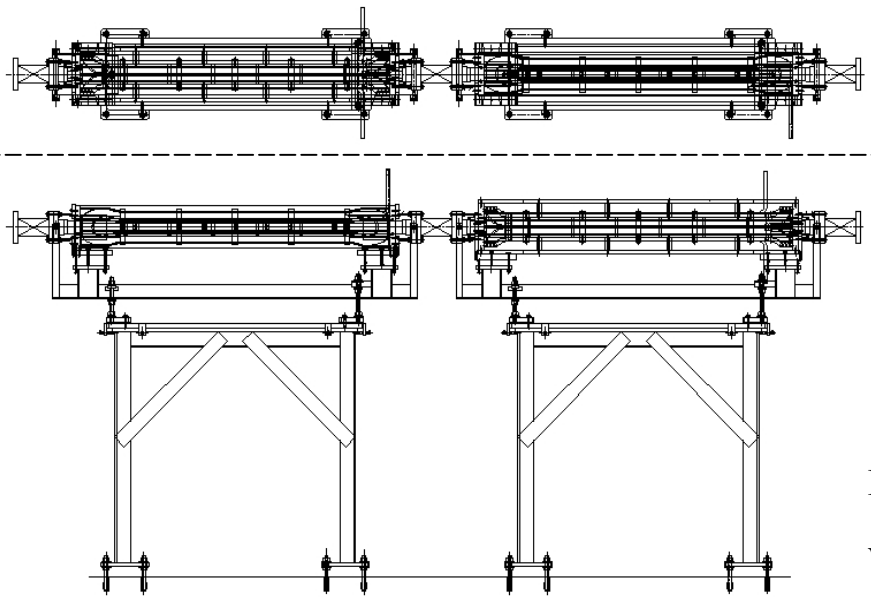

$$\varepsilon = \frac{1}{4\pi}(1+G\gamma)\frac{B_m L}{B\rho}$$

$$z_{coh} = \frac{\Delta B_m L}{4\pi B\rho\left|\nu_m - \nu_z\right|}\beta_z$$

Coherent oscillation amplitude



# AC dipole location



Vertical ac dipole  Horizontal ac dipole




| | max B [G-m] | resonant frequency | frequency range[kHz] |
|---|---|---|---|
| Horizontal | 100 | 64.0kHz | +-1 |
| vertical | 100 | 64.0kHz | +-1 |
| | 100 | 37.5kHz | +-1 |

# High-precision linear optics measurements

- objective

  Measure beta function and phase advance around the ring

- observable(s)
  - 1k turn-by-turn bpm data.
  - about 1σ coherence amplitude

- Data analysis
  - an online application is under construction
  - input: TBT bpm data around the ring

    ac dipole parameter
  - output: beta function

    phase advance

- Team: Bai, Todd, ...

# Fast global decoupling

- objective

  online decoupling

- observable(s)
  - 1k turn-by-turn bpm data from both planes
  - about 1σ coherence amplitude
- Data analysis
  - an online application is under construction
  - input: TBT bpm data around the ring

    ac dipole parameter
  - output: coupling strength
- Team: Bai, Tomas, Schemidt, Todd, ...

# Measurement of nonlinear and linear driving term

- objective

  measure nonlinear resonance driving term from the Fourier spectrum

- observable(s)
  - > 1k turn-by-turn bpm data from both planes
  - prefers large oscillation amplitude
- Data analysis
  - SUSSIX
  - input: TBT bpm data around the ring
  - output: driving terms
- Team: Schemidt, Tomas, ...

# Nonlinear phase space distortion

- objective

  test the idea of assessing the nonlinearity by using SUSSIX

- observable(s)
  - 1million turn-by-turn bpm data from both planes
  - prefers large amplitude oscillation
- Data analysis
  - reconstruct phase space
  - input: TBT bpm data around the ring
  - output: distortion of the phase space
- Team: Todd, ...

# Spin flipping and diagnostics

- objective

  achieve 99.9% spin flip

  measure spin tune to calibrate the snake settings

- observable(s)
  - asymmetry of the beam
- Data analysis
  - input: beam asymmetry before and after the spin flipping
  - output: spin flipping efficiency
- Team: Bai, MacKay, Ranjbar, …

| application | |
|---|---|
| linear optics measurement | parasitic |
| global decoupling | needs dedicated time to commission |
| spin flipping & other manipulation | needs dedicated time to commission |
| nonlinear driving terms | dedicated |
| nonlinear phase space distortion | dedicated |