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Beam experiments in January 2023

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KURNS beam stacking

January experiment

- (horizontal) tune measurement with different initial amplitude [1~2 days]
- First try of step 1 experiment [~3 days]
- Test of step 2 and 3 experiments [~1 days]

- Total ~ a week if allowed

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(horizontal) tune measurement

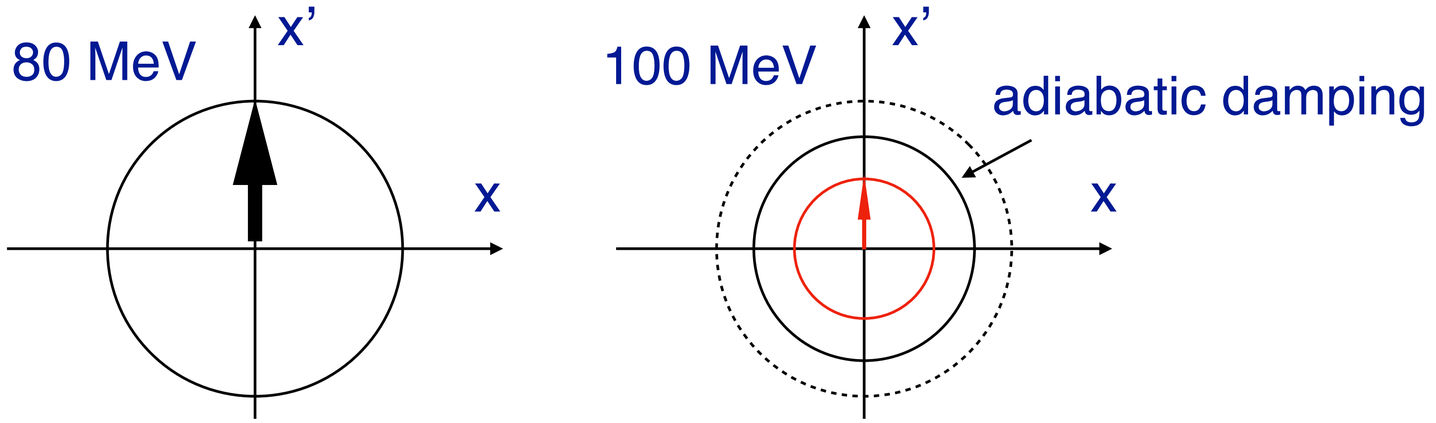
purpose and idea

- Measure amplitude dependent tune shift.
- Tune measurement by turn-by-turn BPM.
- Difficult part is to control initial betatron amplitude.
  - Small amplitude tune should be measured by small oscillations excited with a shaker.
  - Can the extraction kicker be excited with different strength?
  - Kick angle is inversely proportional to the beam momentum with the same kicker strength.
- Combined of two (at different beam momentum with different kicker strength) should give us results which can be scaled.

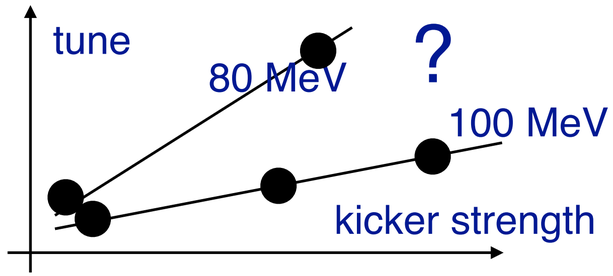
(horizontal) tune measurement

methods

- Accelerate the beams up to 2 different energy, e.g. 80 MeV and 100 MeV.
- Using the extraction kicker, excite a coherent oscillations.
  - Measure horizontal tune with several different kicker strength at 80 MeV and 100 MeV.
  - Obtain amplitude dependent tune shift results at 80 MeV and 100 MeV.
  - The same strength of the kicker magnet gives 90% of coherent oscillations at 100 MeV compared with 80 MeV (black and red arrows below).



- How the gradient of amplitude dependent tune shift scales at 80 MeV and 100 MeV with known kicker strength.
  - If the geometrical dynamic aperture is independent of momentum, …



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(horizontal) tune measurement

days necessary for data taking

- Is there any installation of equipment necessary?
  - BPM, extraction kicker, power supply, etc.
  - Vacuum breaking is involved?

- Measurement takes a day or two.
  - Do data taking in the early stage of two weeks period.
  - Offline analysis takes a few days.
  - If the results do not look convincing, do data taking again in the second week.

- Total 1~2 days (excluding offline analysis) depending on hardware preparation.

First try of step 1 measurement

- Basically, measurement of momentum spread before and after debunching (and rebunching) process.

- Test several RF patterns including acceleration up to a certain energy (~50 MeV).
- Test dp/p measurement methods, one or some of below.
    - Schottky measurement
    - Tomography
    - Transverse beam size
    - Phase displacement
    - Perturbation by an empty bucket

- Roughly ~3 days (excluding offline analysis)?

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Step 1: One bunch only

Subject	Preparation	Measurements
Debunch adiabatically the 1st bunch	• Determine RF profile (frequency and voltage) to minimise dp/p after debunch • Fix energy for debunching (two or three).	• dp/p measurement • Feasibility and accuracy
Rebunch the coasting beam	• Determine RF profile (frequency and voltage) to minimise longitudinal emittance	• Beam intensity measurement • Longitudinal tomography measurement
Repeat debunch and rebunch process	• Same above	• **Beam intensity**, **dp/p** increase at debunch, **longitudinal emittance** increase at rebunch vs. the number of process

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What would be the AWG requirements?

Test of step 2 and 3 measurements

- Acceleration of h=2 RF frequency.
    - How high energy h=2 RF can be used for acceleration.

- Accelerate the beams up to ~ 50 MeV and debunch.
- Acceleration of h=2 empty buckets.

- Roughly ~1 days (excluding offline analysis)?

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Step 2: One coasting beam and an empty bucket

Subject	Preparation	Measurements
After debunching at E1, increase RF voltage with frequency at several points between injection and E1.	• Simulation to see how the coasting beam is affected. • When E1 is increased and RF frequency ratio approach 2, how quickly interference grows?	• dp/p measurement vs time (time scale should be determined by simulation)
Increase the energy of an empty bucket and adiabatically decrease voltage as if the beam is accelerated and debunched.	• Simulation to see how the coasting beam is affected.	• dp/p measurement
(optionally) rebunch the coasting beam	• Same with one bunch	• Beam intensity measurement • Longitudinal tomography measurement

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Step 3: One coasting beam and another accelerating beam

Subject	Preparation	Measurements
Increase the energy of the 2nd beam and adiabatically decrease voltage.	• Simulation to see how the coasting beam is affected and the 2nd beam is added.	• dp/p measurement
Rebunch the coasting beam from two acceleration.	• Determine RF profile (frequency and voltage) to minimise longitudinal emittance	• Beam intensity measurement • Longitudinal tomography measurement
Repeat debunch and rebunch process (similar to measurement with one bunch but different dp/p)		• **Beam intensity**, **dp/p** increase at debunch, **longitudinal emittance** increase at rebunch vs. the number of process

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Backups

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