Snake Aperture Measurement for EIC Beam Screen Planning

APEX Planning Meeting

5/5/2023

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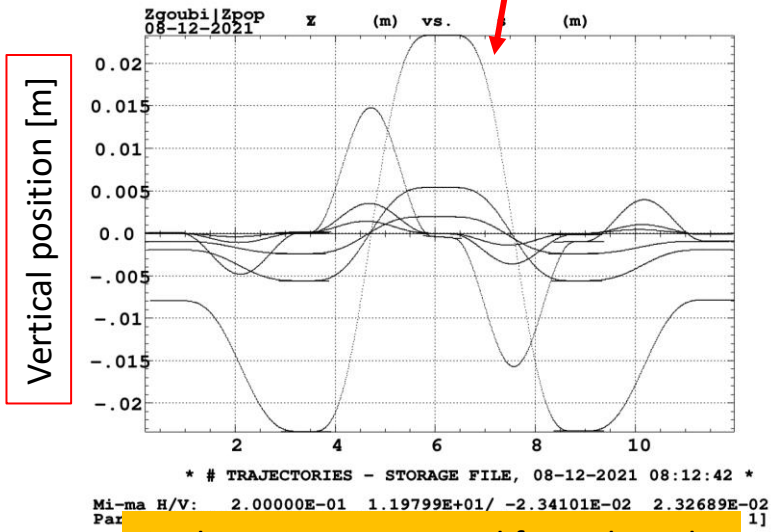
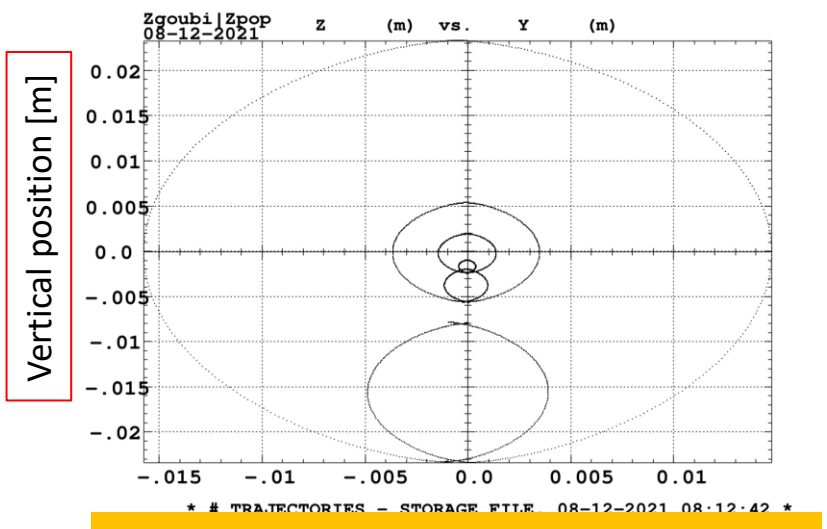
The problem

- Largest vertical excursion in RHIC (in any configuration) is trajectory inside helical dipole snakes at injection energy
  - ~22 mm vertical excursion in the helical orbit
- Perturbed trajectory extends outside of snake body into the arcs
- The vertical aperture (in the arc) will be restricted by the beam screen insertion (round → racetrack)
  - Snake aperture remains the same
- We need to know if the beam still fits
- This is only a problem at injection and therefore not for the rotators
- EIC wants to know by JULY whether the screen near the snakes need modification

Large vertical excursion

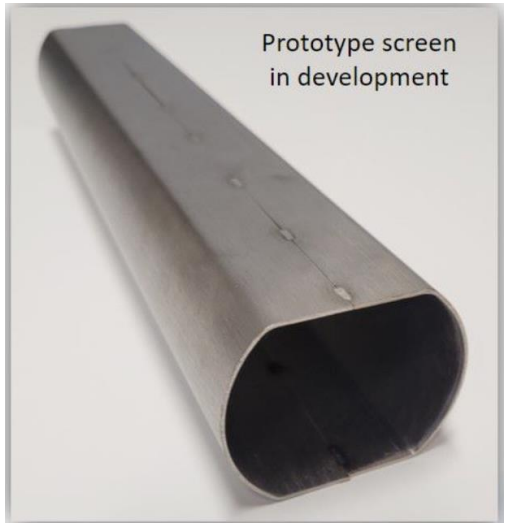


Snake trajectory viewed from the side



Snake trajectory viewed down the beam pipe

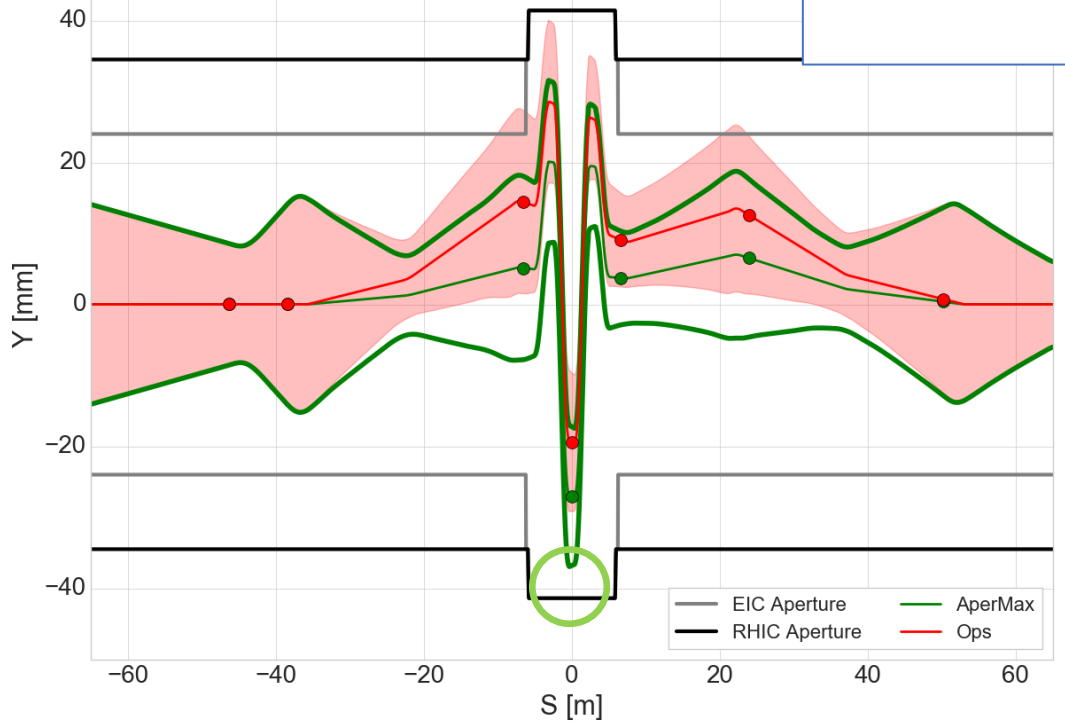
”Racetrack” screen insert



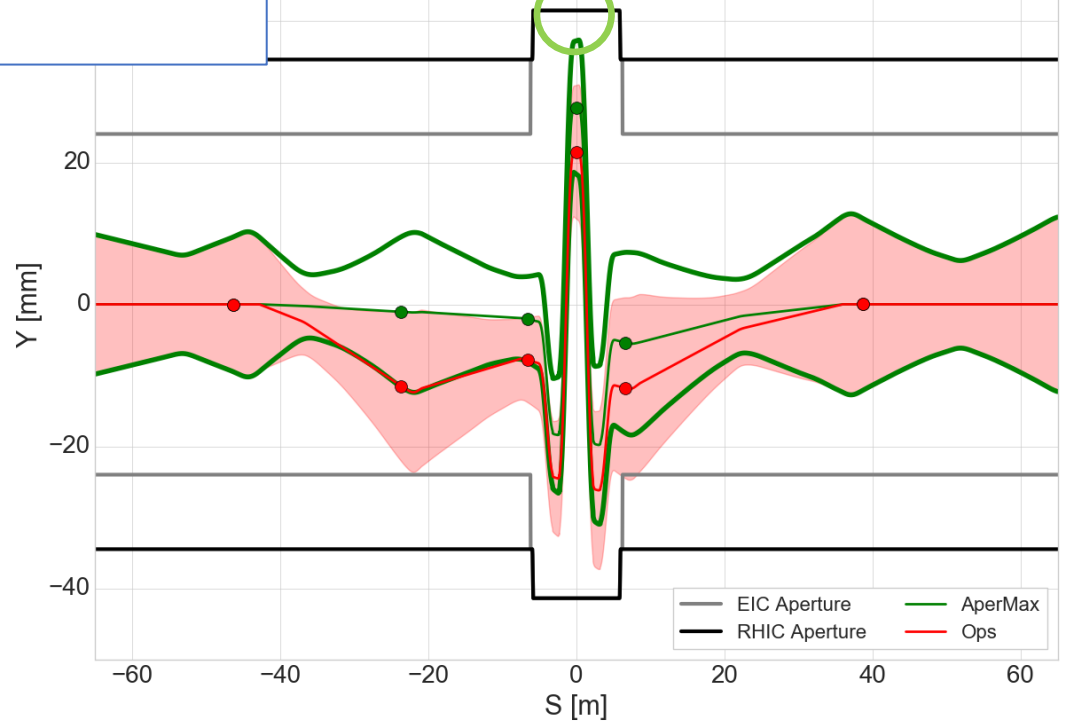
Comparison of trajectory used in operations with proposed trajectory

RED = Operational trajectory
GREEN = Proposed trajectory

B3/Y9 snake



Y3/B9 snake



Fit 4-bump currents specifically to maximize aperture in EIC: available aperture ~8.5 sigma
(slightly better than calculated 'operational' apertures in sigma).
Limiting aperture is in the center of the snake in both cases.

These are new solutions, differ substantially from operations and design: should be tested with proton beam
The operational positions have been adjusted to their current values over years under increasingly restrictive conditions. They may well be optimal under real conditions.

APEX Proposal

- Establish circulating proton beam:
  - Yellow only
  - Both snakes in normal configuration
  - Start with ‘normal’ operational orbits
  - Measure aperture*
- Use orbit feedback to move orbit to proposed orbit
  - Observe change in losses
  - Measure aperture*
- Have to repeat at each snake (trajectory/optics are different): total of 4 aperture measurements, 2 snakes x 2 trajectory options

- * Measure aperture means:
  - Move trajectory by small amount (orbit FB), single bunch, ~0.5e11 intensity
  - Observe steady state loss
  - Inject, observe injection loss
  - Repeat moves until injection loss is ~200 counts on a loss monitor (threshold typically ~300 counts on the snake)
  - Injection losses are ‘acute’, easier to see. Steady state losses (BLM, DCCT) can also be examined, but tend to be slow and small…a lagging indicator.

- Scheduling
  - Total time is 5-6 hours (Travis suggested maybe 8). Most efficient if this is all finished in one session.
  - Dominated by setup time : proton beam being established in RHIC for this experiment
  - Protons need to be captured in 28 MHz system (not new, but not typical)
  - Requires protons, not necessarily polarized at AGS extraction
  - Time sensitive, EIC wants to make a decision by July.