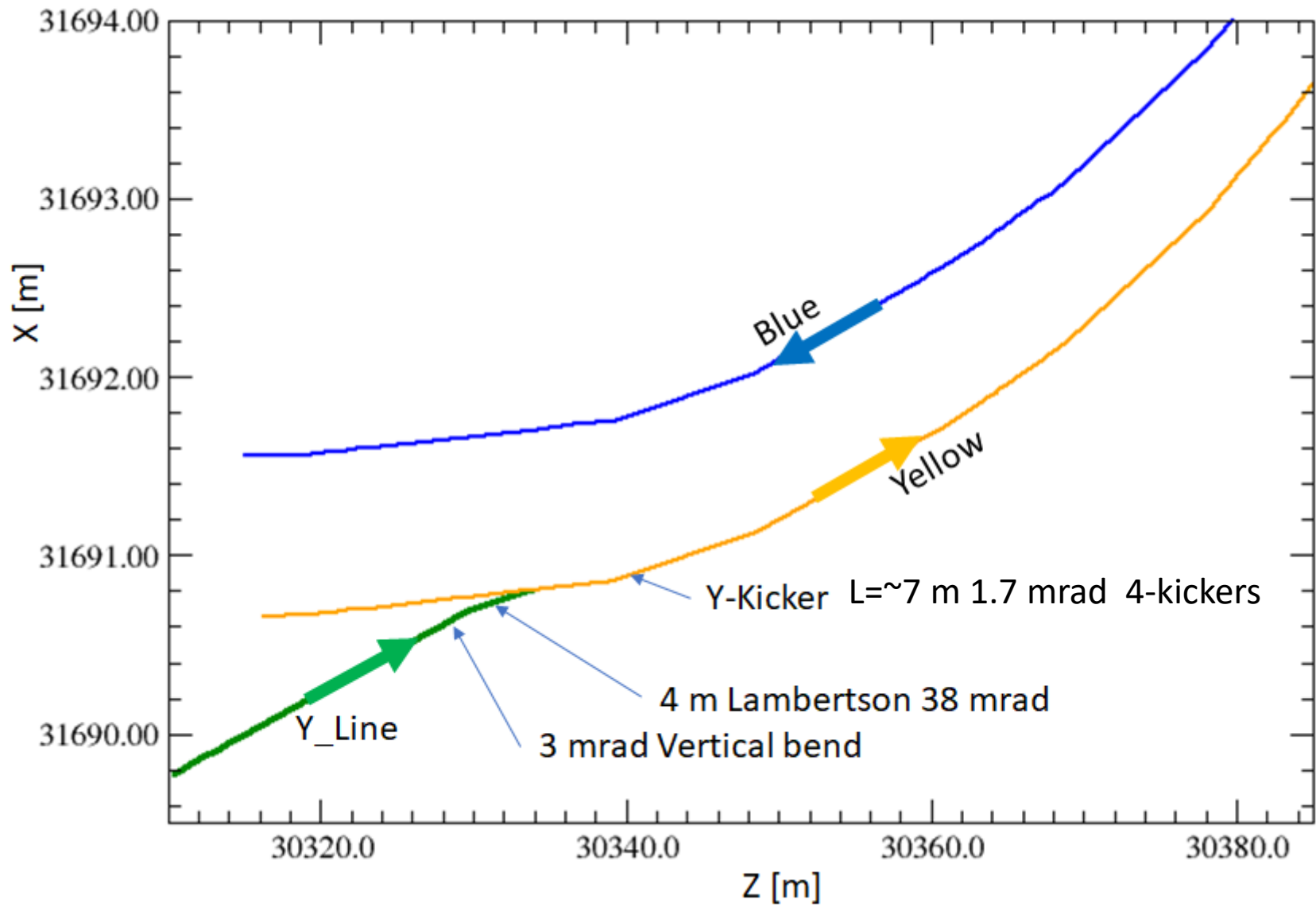


AtR to Yellow Injection of 330 hadron bunches for eRHIC

N. Tsoupas, M. Blaskiewicz, Y. Luo, F. Meot, C. Montag, V. Ptitsyn,
S. Tepikian, others..



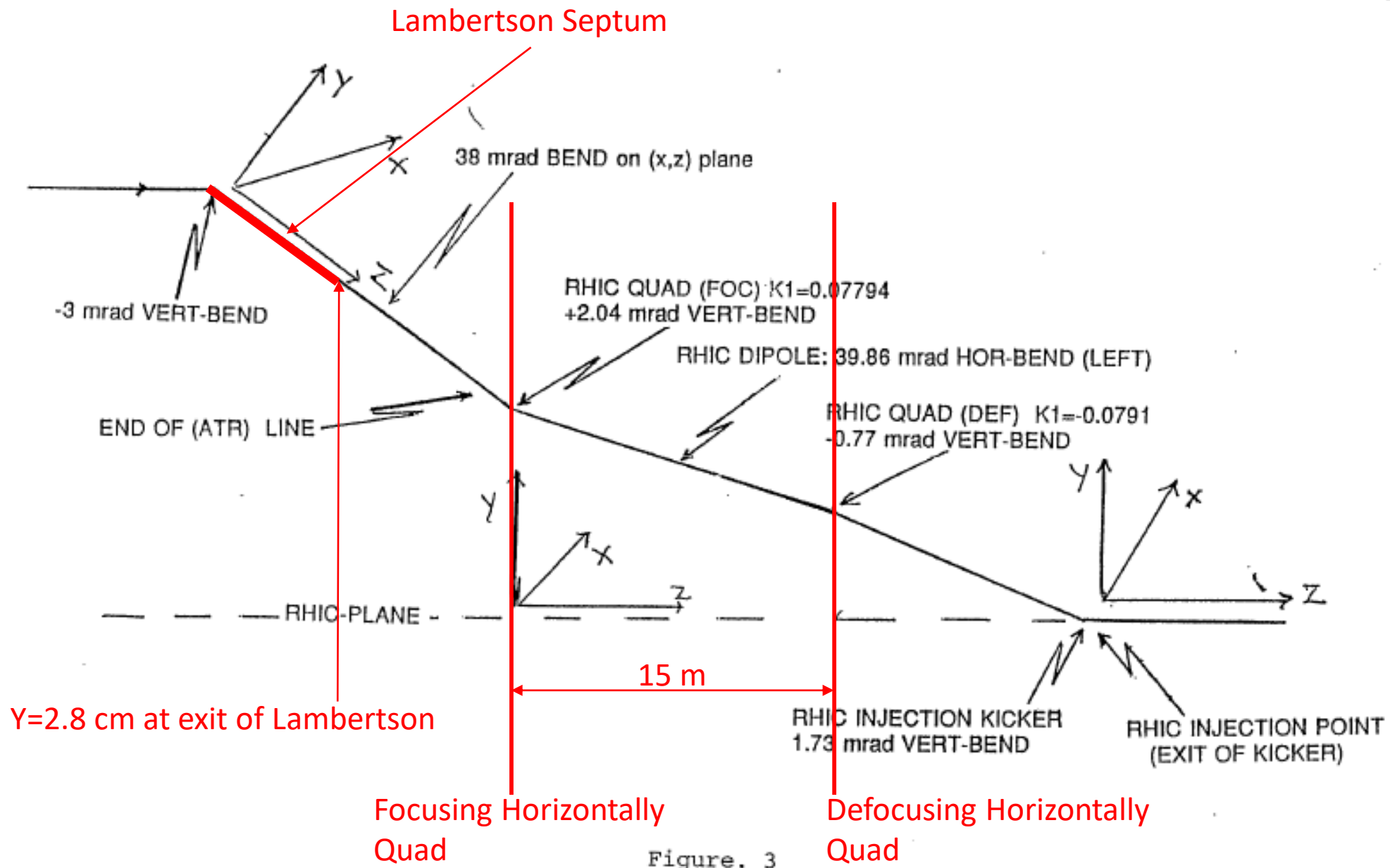
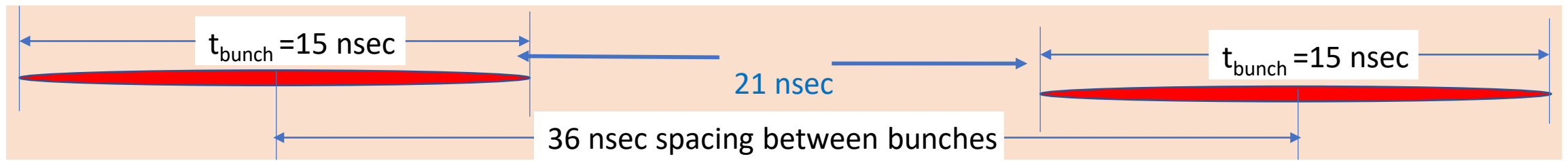


Figure. 3

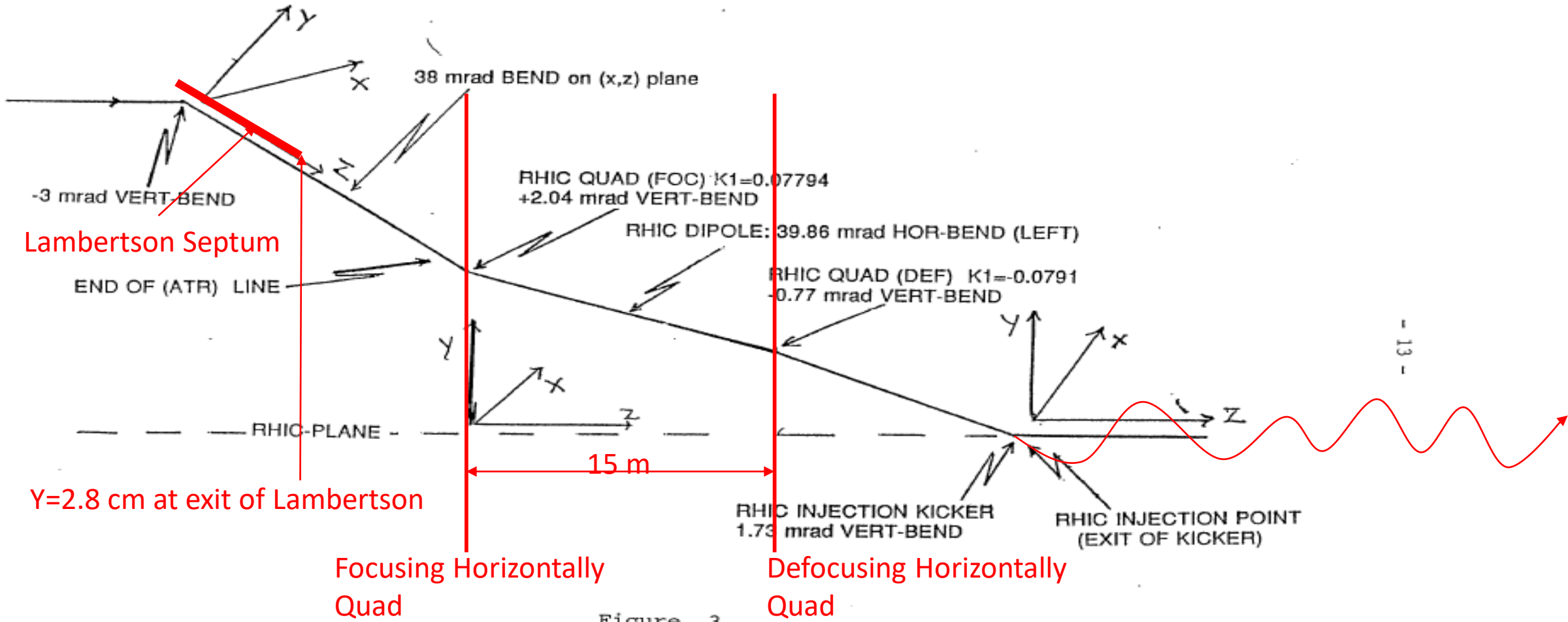


- There will be 330 bunches circulating in the Yellow ring of the eRHIC collider.
- The spacing of 330 bunches circulating in the Yellow ring is $\sim 36 \text{ nsec}$
- The present “RHIC Injection Kicker System” has a rise time of $\sim 85 \text{ nsec}$ therefore it prohibits the injection of 330 bunches.
- A new “RHIC Injection Kicker System” should be based on transmission-line (strip line) design. But there is not enough space ($\sim 7 \text{ m}$) to accommodate many kickers in the location of the present kickers.
- We are investigating the possibility of an alternative Injection scheme which is almost the same to the present hadron injection scheme with some modification.

What is proposed:

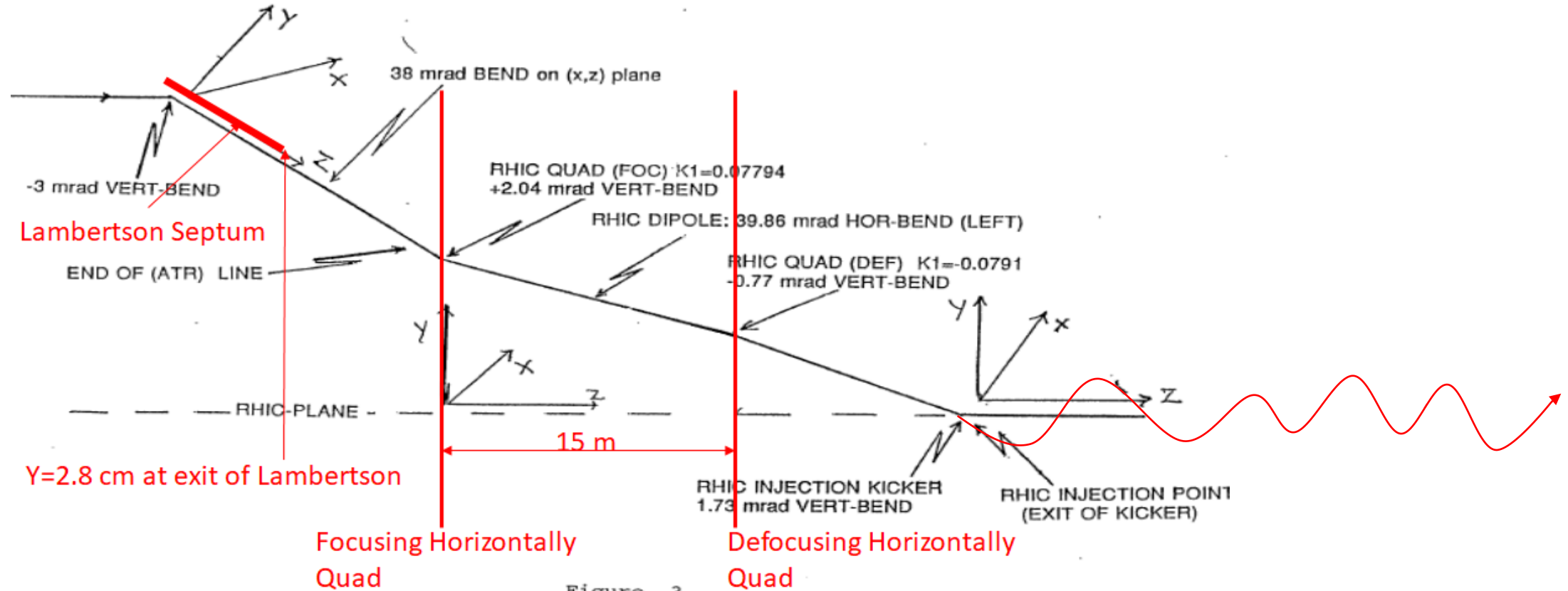
- a) Provide a partial Ykick to the bunch to reduce the 1.73 mrad incident angle of the injected bunch
- b) Allow the beam to be transported from the Ykicker to IP4 with betatron oscillations.
- c) Provide the final kick to the bunch at IP4 with fast kickers

Fig. 3



What do we want to find from this APEX study?

To determine the maximum betatron oscillations the beam bunch can exhibit without losses as it is transported for the Ykicker to IP4



Further theoretical studies:

- Is there a beam optics which will reduce the betatron oscillation?
- Can the 1.73 mrad be reduced by adjusting the strength of QFB6 and QDA6?

Some ways to reduce the 1.7 mrad final kick

Fig. 3

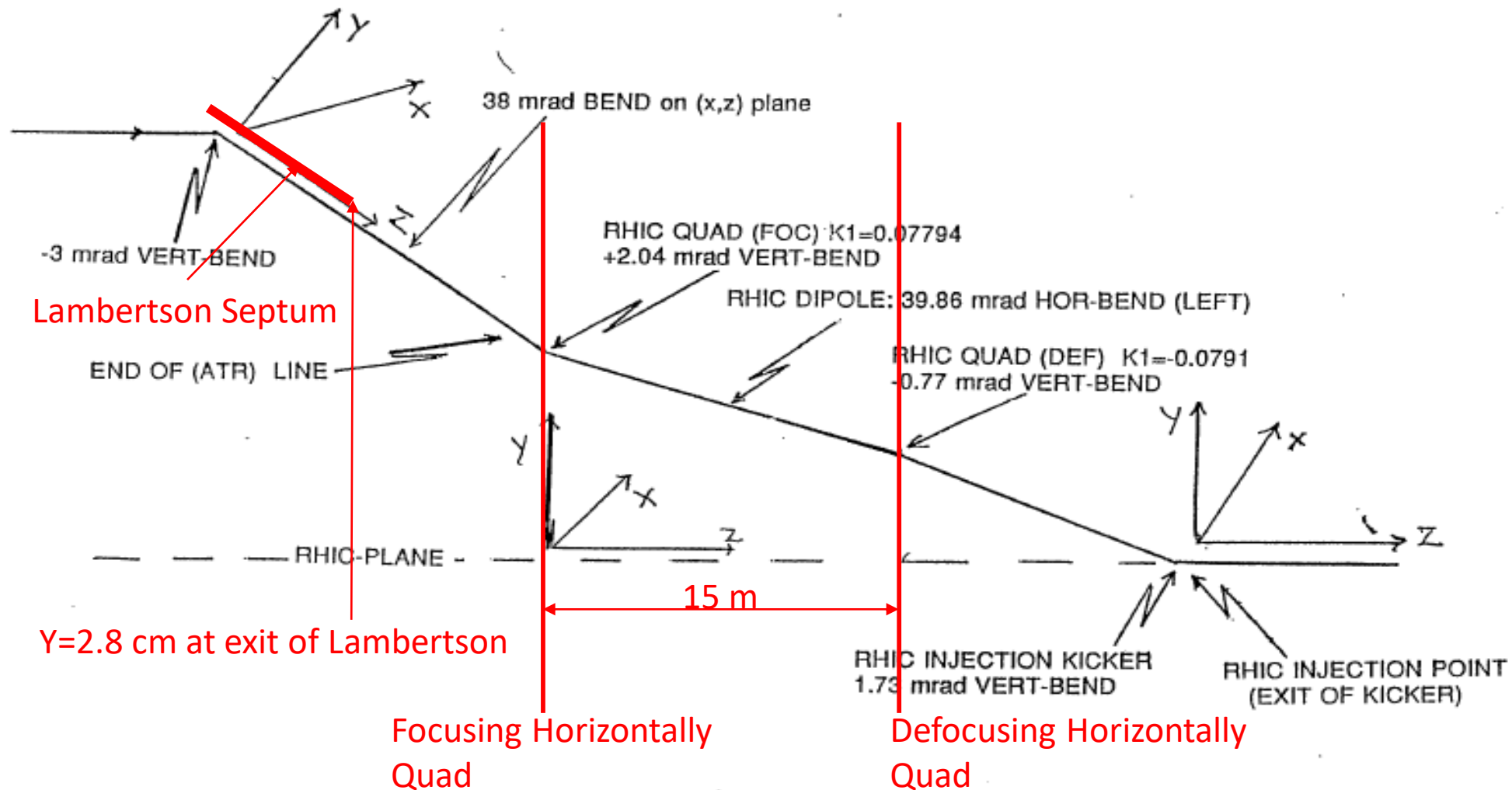


Figure. 3

Geometry and optics at present Injection

$$Y_{\text{inj-exit-of Lamb}} = 31.5 \text{ mm}, \text{ Angle} = 1.7 \text{ mrad}$$

Fig. 3

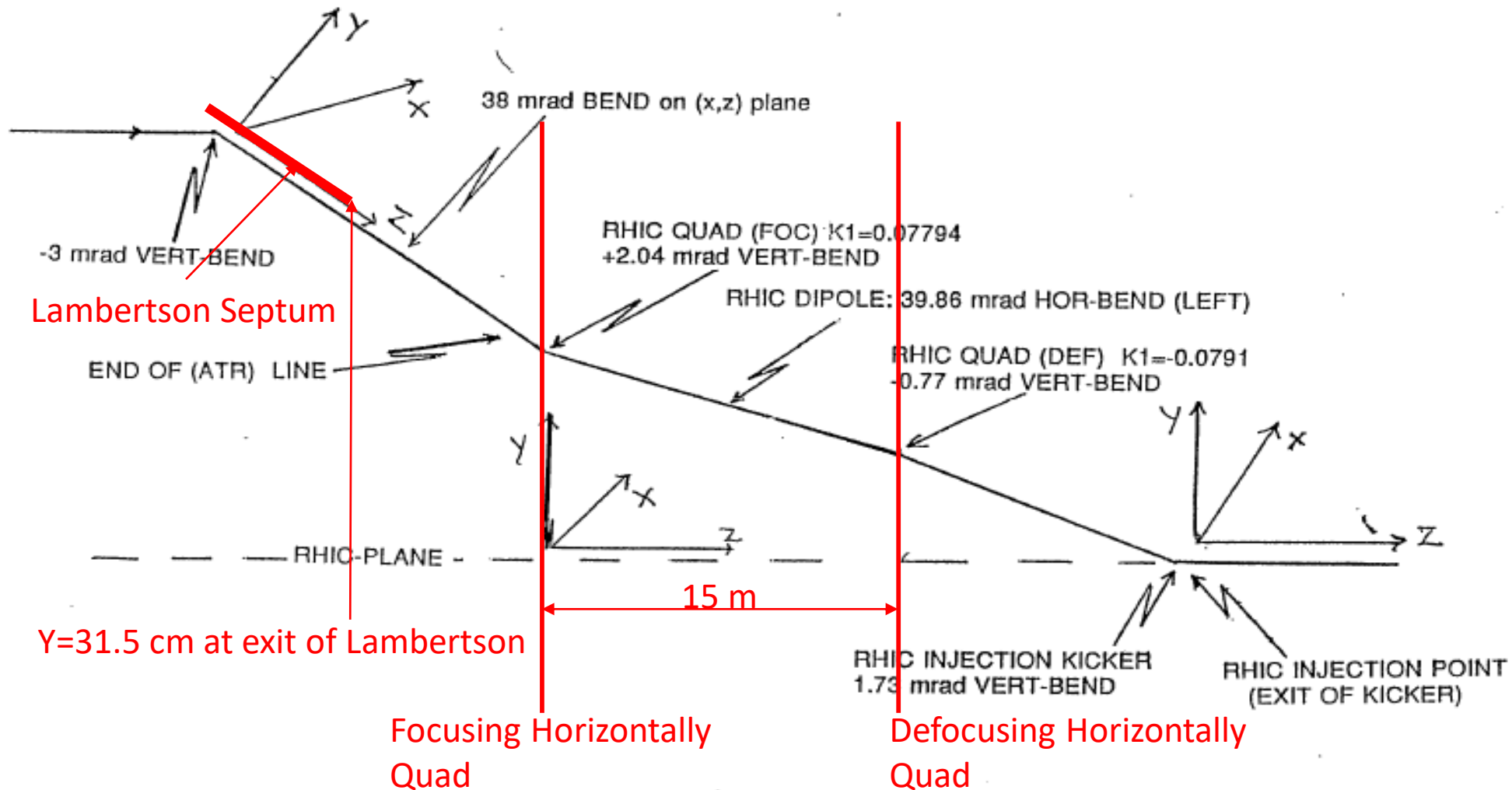
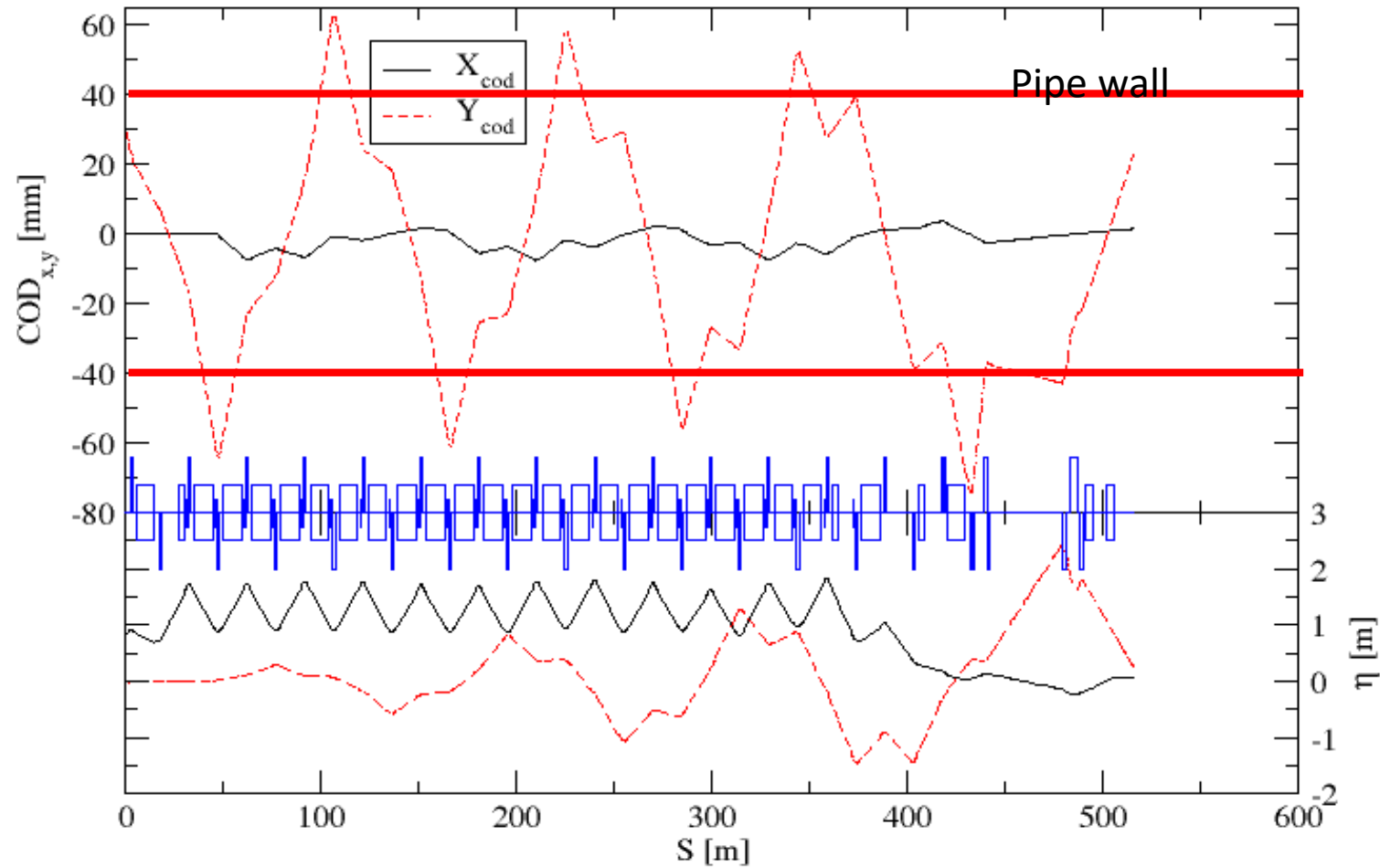


Figure. 3

How does the Injected trajectory look like with no kick

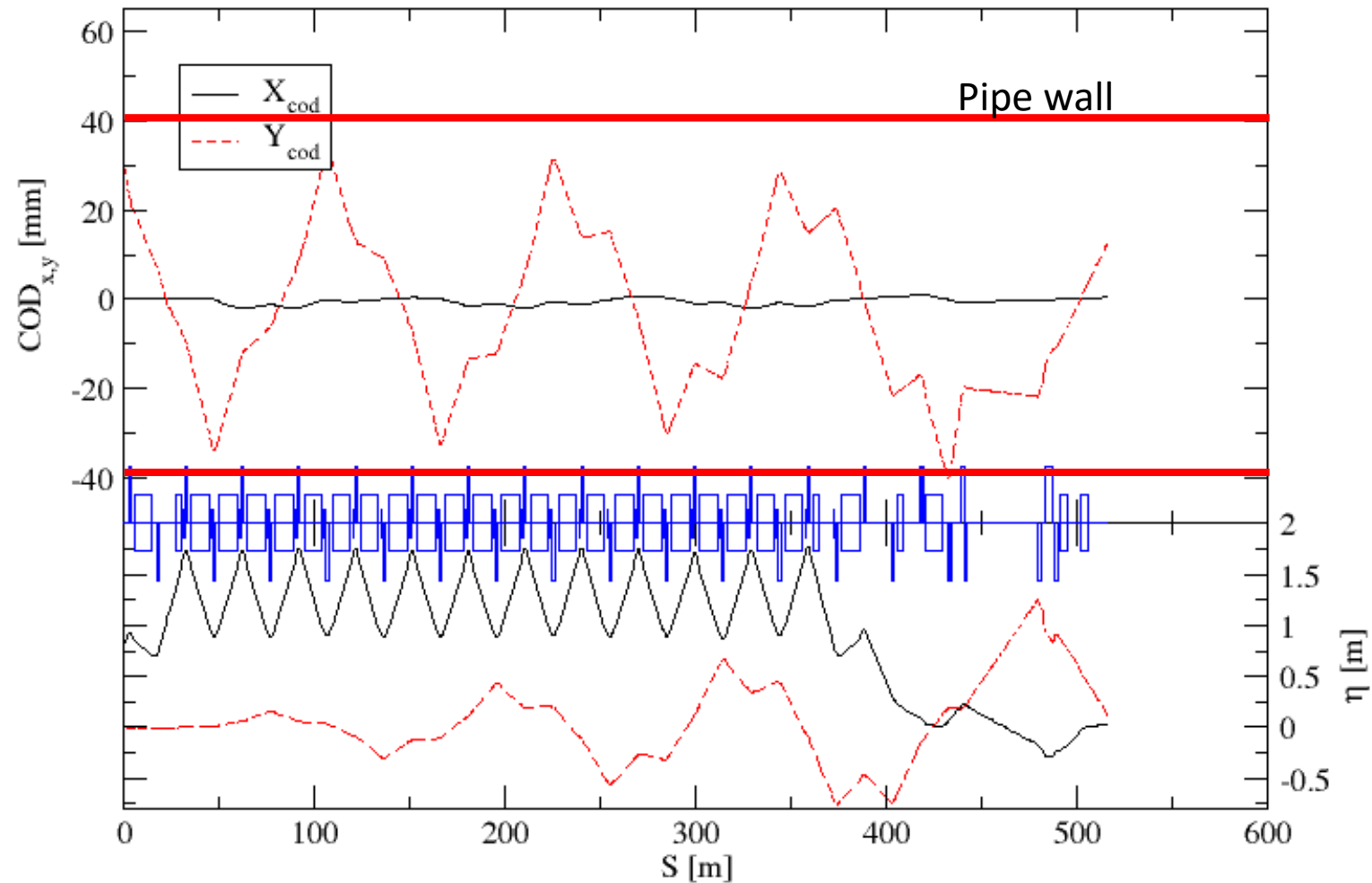
LAMB to IP4 Yellow No Bump No Ykick



How does the Injected trajectory look like with partial kick

InjLAMB to IP4 Yellow with Bump and kick $4 \times 0.15 \text{ mrad} = 0.6 \text{ mrad}$


Additional Kick needed $= 4 \times (0.425 - 0.15) = 1.1 \text{ mrad}$




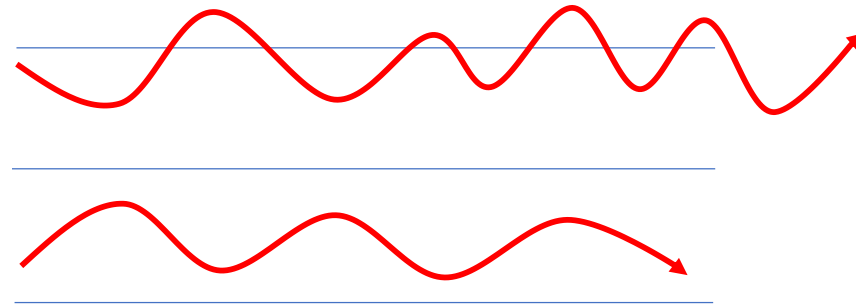
Summary

- Under the present beam Optics of the IP6 to IP4 Yellow arc...
- What is the maximum/minimum Ykick which will transport the bunch to IP4 with NO-losses?

$Ykick_{nominal}(1.7 \text{ mrad})$ 

- $Ykick_{max} = Ykick_{nominal}(1.7 \text{ mrad}) + Ykick_{transport}$ 

- $Ykick_{min} = Ykick_{nominal}(1.7 \text{ mrad}) - Ykick_{transport}$ 

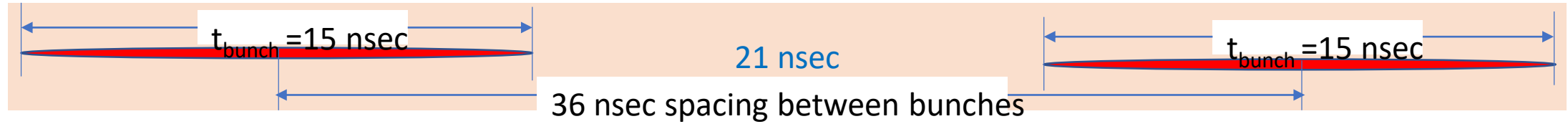


- $Ykick_{transport} = (Ykick_{max} - Ykick_{min})/2$ Ykick to provide for the beam to be transported to IP4 with No Losses

- Thus we should reduce the nominal $Ykick_{nominal}$ of 1.7 mrad by:

- $Ykick_{reduction} = Ykick_{nominal}(1.7 \text{ mrad}) - Ykick_{transport}$

Are there ways to make this nominal Injection work for 330 bunches?



- Use of transmission line kickers:
 - Can these kickers provide the required kick in the 7 mm available space?
 - We cannot pack strip-Line kickers: Their Length and spacing is determined by the 21 nsec spacing.
- Use short RL kickers with $P_{\text{pulse}} \text{FormomingNetwork-PS}$ next to them?
 - Rise time???
- The 1.7 mrad angle of incidence of the bunch can be reduced.
 - Can the beam optics be modified to allow the beam transport and circulation of the beam?

Next 2 slides: Vary Injection Quads to reduce value of Ykick

Fig. 3

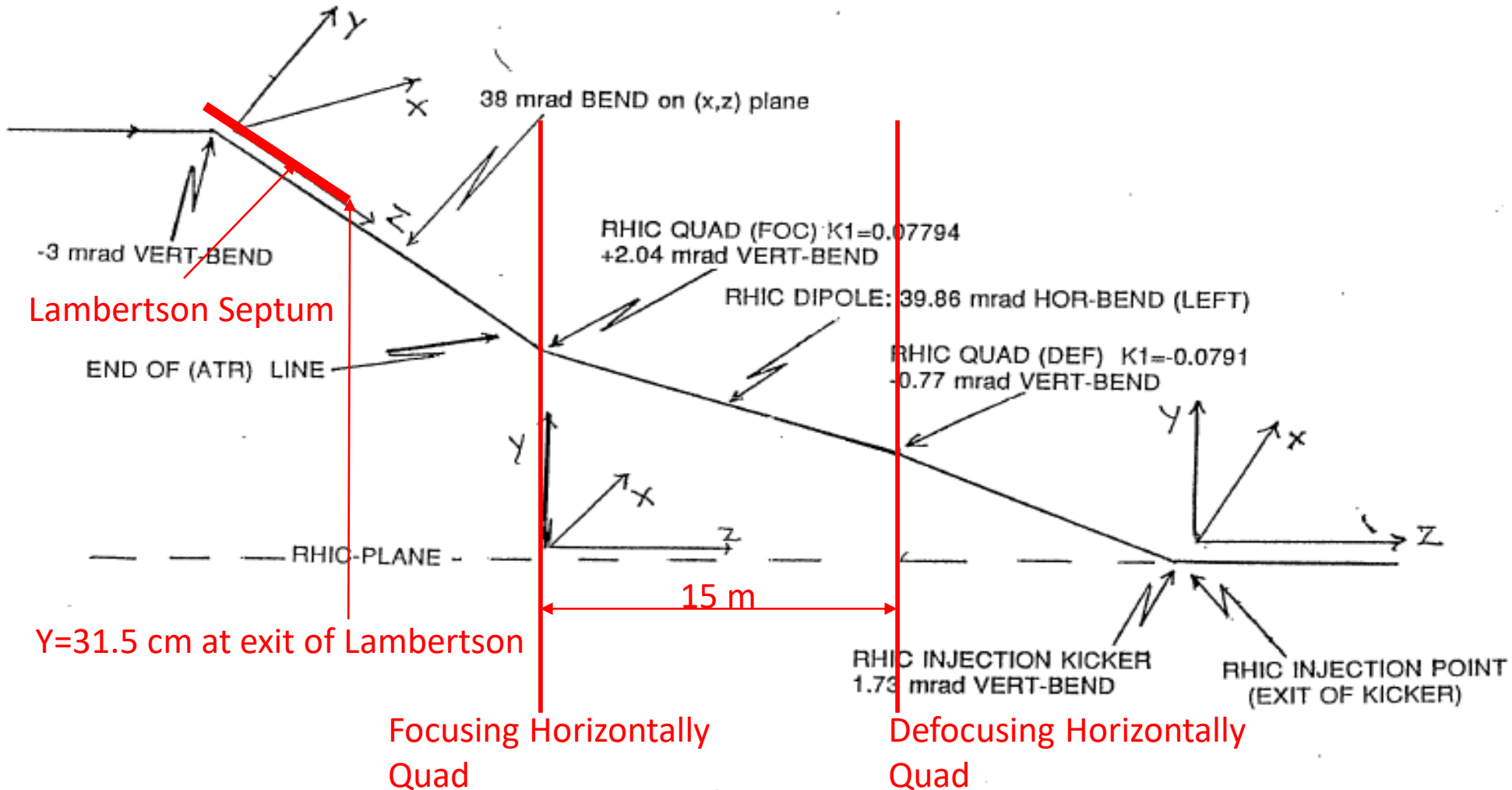


Figure. 3

Geometry and optics at present Injection

$Y_{inj-exit-of\ Lamb} = 29\text{ mm}$, Angle(reduced) = 1.4 mrad

Fig. 3

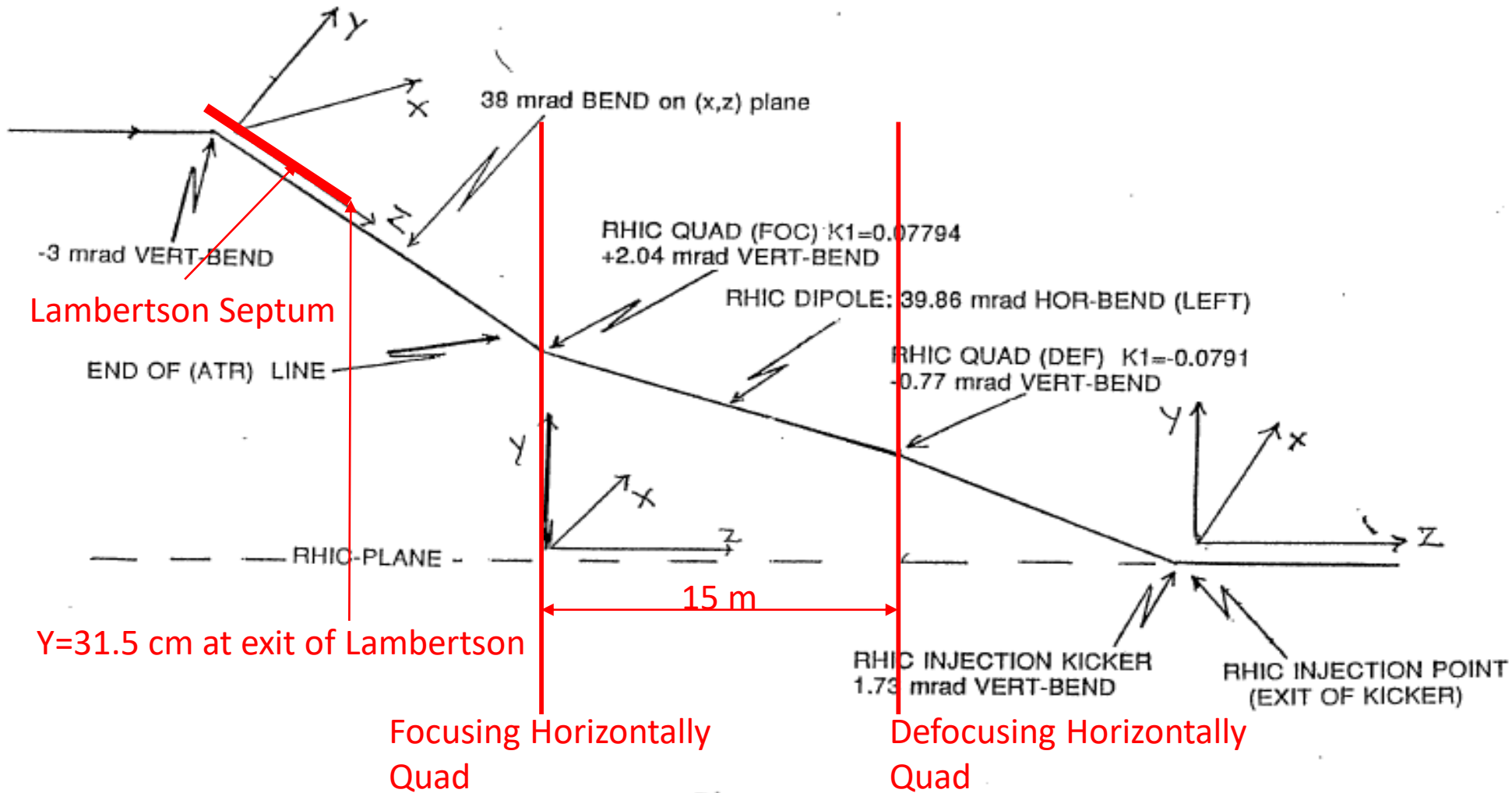


Figure. 3

Geometry and optics at present Injection

$Y_{inj-exit-of\ Lamb} = 26\text{ mm}$, Angle(reduced) = 1.2 mrad

Fig. 3

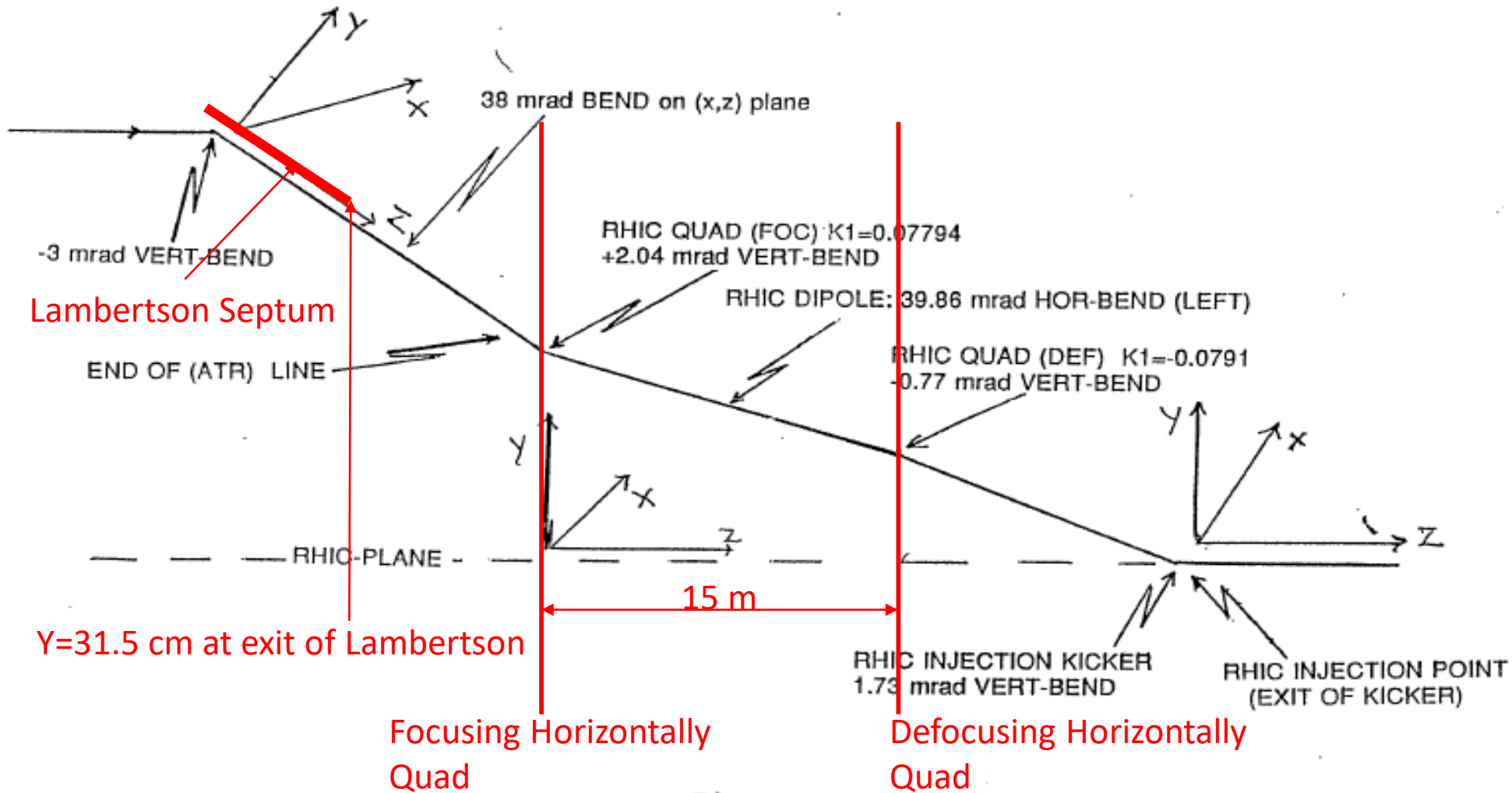


Figure. 3

The End

Below ... Under Study

- Replace the present kickers with five 0.9 m long and 0.06 mrad each stripline kickers. of total kick ~ 0.3 mrad
- Let the beam exhibit vertical betatron oscillations as it approaches the IP4.
- Use γ_t quads to make the phase advance between the present kicker location and the IP4 $\Delta\phi = n\pi$
- Placement of a number of stripline kickers at the IP4 straight section will kick the bunches along the reference orbit.

APEX Experiment

- Generate a local beam bump to test the reduction in strength of the present kickers.
- Kick the vertically the circulating beam bunch at the location of the Lamberton magnet and using the γ_t quads adjust the phase advance in the section between Lamberton and IP4 to $\Delta\phi=n\pi$
- Using a vertical corrector at IP4 remove the vertical betatron oscillations of the beam.