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In this note we summarize the calculated 10^6 turn dynamic apertures with the proposed head-on beam-beam compensation in the Relativistic Heavy Ion Collider (RHIC). To compensate the head-on beam-beam effect in the RHIC 250 GeV polarized proton run, we are planning to introduce a DC electron beam with the same transverse profile as the proton beam to collide with the proton beam [1, 2]. Such a device to provide the electron beam is called an electron lens (e-lens). In this note we first present the optics and beam parameters and the tracking setup. Then we compare the calculated dynamic apertures without and with head-on beam-beam compensation. The effects of adjusted phase advances between IP8 and the center of e-lens and second order chromaticity correction are checked. In the end we will scan the proton and electron beam parameters with head-on beam-beam compensation.

1 Optics and Beam Parameters

In the following simulation we adopt the Blue ring lattice for 250 GeV RHIC polarized proton run. Table 1 gives the optics and beam parameters for the proton beam for this study. The proton beams collide at IP6 and IP8 where β^*s are about 0.5 m. β^*s at all other non-colliding IPs are about 10 m. The normalized rms transverse emittance ϵ_n is 2.5 mm.mrad. The longitudinal beam area is 0.17 eV.s, which gives rms beam momentum spread 0.14×10^{-3} and the rms bunch length 0.44 m.

So far we haven't demonstrated 250 GeV polarized proton run with $\beta^* = 0.5$ m in the RHIC. In the 2009 250 GeV RHIC polarized proton run, the β^*s at IP6 and IP8 were about 0.7 m. Figure 2 shows the β function and horizontal dispersion along the ring with the $\beta^* = 0.5$m lattice. The β^* at IP6 and IP8 from the lattice model are actually about 0.53 m for this lattice. From Figure 2, there are about ± 1.0 m horizontal dispersion in the IR6 and IR8 which is different from the larger β^* lattices we have used in the previous proton run. Therefore the lattice with $\beta^* = 0.5$ m in this study may need further optimization.

As we know, low β^* lattice will increase the strengths of chromatic sextupoles to correct the increased natural linear chromaticity. The second order chromaticities will increase too. The second order chromaticity for the lattice are about (2400, 2700). For off-momentum particles with relative momentum deviation, the chromatic tune shift from the linear and the second order chromaticity are comparable. In this article we will investigate the effect of second order chromaticity correction with head-on beam-beam compensation.

From Table 1, with any beam-beam interaction, the horizontal and vertical betatron phase advances between IP6 and IP8 are (10.6π, 9.7π). The phase advances between IP8 and the center of e-lens are (8.5π, 11.1π). The phase advances between IP6 and the center of e-lens are (19.1π,19.6π). To better compensate the nonlinearity from proton-proton collision at IP8 with the e-lens, we will adjust the betatron phase advances between IP8 and the center of e-lens to multipoles of π in both the horizontal and vertical planes. After phase adjustment, the phase advances between IP8 and the center of e-lens will be (9.0π, 11.0π).

2 Beam-beam and compensation parameters

The total linear beam-beam tune shift, or the total beam-beam parameter from proton-proton collisions at IP6 and IP8 is

$$\xi_{pp} = -\frac{N_p r_p}{4\pi\epsilon_n} \times N_{IP}. \tag{1}$$

Here r_p is the classic radius of proton. The number of proton-proton colliding points $N_{IP} = 2$. In the fallowing dynamic aperture calculation we will focus on three bunch intensities $N_p = 2.0 \times 10^{11}$, 2.5×10^{11} and 3.0×10^{11}. From Eq. (1), the total proton-proton beam-beam parameters with 2 colliding points are

Table 1: Parameters for the proton beams

quantity	unit	value
lattice		
ring circumference	m	3833.8451
energy	GeV	250
relativistic γ	-	266
proton-proton colliding points	-	IP6, IP8
location of e-lens	-	around IP10
$\beta^*_{x,y}$ at IP6 and IP8	m	0.53
$\beta^e_{x,y}$ at e-lens	m	10.0
$\beta^*_{x,y}$ at all other IPs	m	10.0
betatron phases between IP6 and IP8	(10.6π, 9.7π)	
betatron phases between IP6 and e-lens center	(8.5π, 11.1π)	
betatron phases between IP6 and e-lens center	(19.1π,19.6π)	
transverse parameters		
normalized transverse rms emittance $\epsilon_{x,y}$	mm·mrad	2.5
transverse rms beam size at IP6 and IP8 $\sigma^*_{x,y}$	mm	0.068
transverse rms beam size at e-lens $\sigma^e_{x,y}$	mm	0.31
transverse tunes	$(28.67, 29.68)$	
linear chromaticities	$(1, 1)$	
second order chromaticities without correction	(2400, 2700)	
proton-proton beam-beam parameter per IP	-0.01 * ($N_p/1.0 \times 10^{11}$)	
longitudinal parameters		
harmonic number	-	360
rf cavity voltage	kV	300
rms longitudinal bunch area	eV·s	0.17
rms momentum spread	-	0.14×10^{-3}
rms bunch length	m	0.44

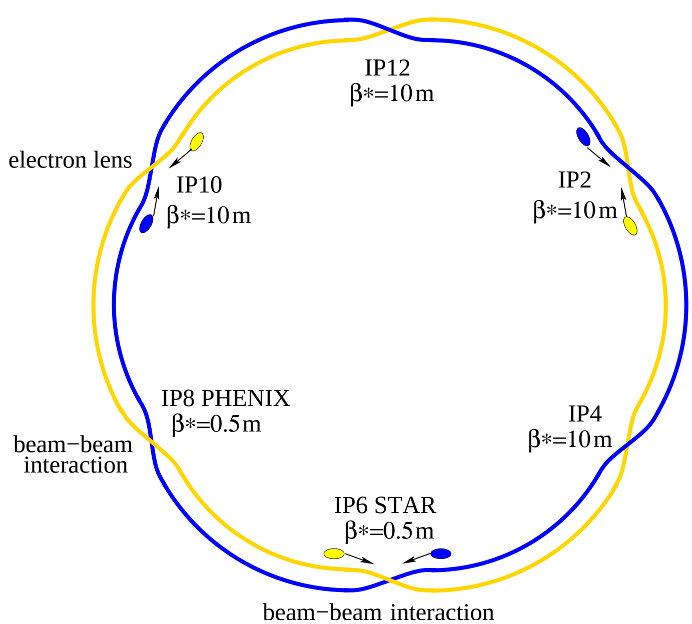

Figure 1: Layout of RHIC head-on beam-beam compensation.

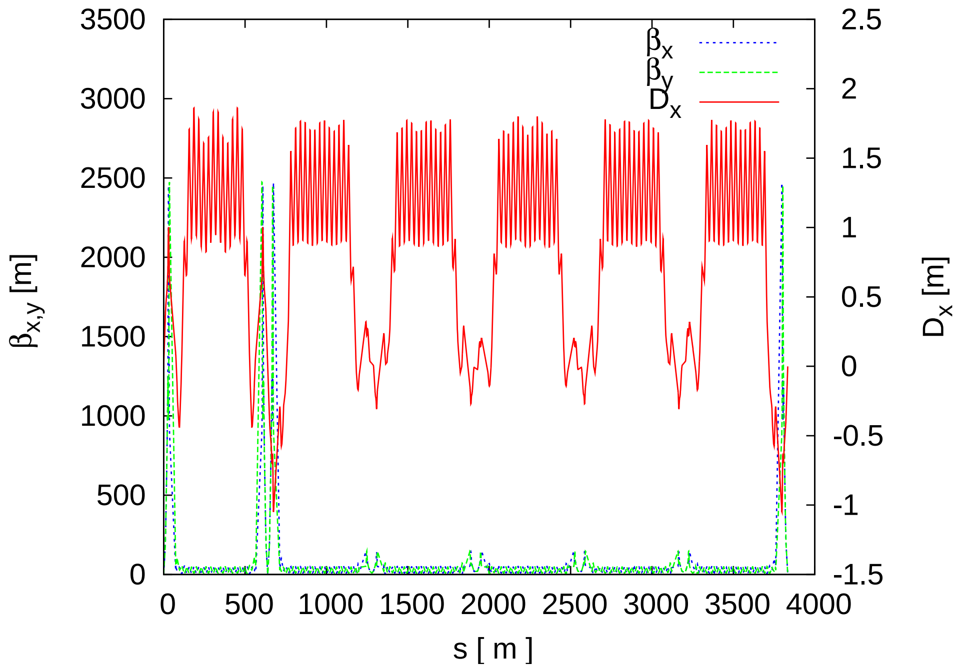

Figure 2: Layout of RHIC head-on beam-beam compensation.

about -0.020, -0.024, and -0.030 for bunch intensities 2.0×10^{11}, 2.5×10^{11} and 3.0×10^{11} respectively. Clearly there is not enough room in the current RHIC polarized proton tune space (2/3, 7/10) to hold all the beam-beam tune shift and tune spread generated by the proton-proton collisions with bunch intensity above 2.0×10^{11}.

In the current design, the e-lenses are to be placed 1 m north in the Blue ring and 1 m south in the Yellow ring around IP10. The effective electron-proton interaction length is 2 m long. We define full and half head-on beam-beam compensations to compensate full or half total proton-proton beam-beam parameter. In the following study, we will mainly focus on the half beam-beam compensation. The full head-on beam-beam compensation introduces too much nonlinearities into the proton beam dynamic and therefore deteriorates the proton particle's dynamic aperture. Figure 1 is the schematic plot of the head-on beam-beam compensation in the RHIC.

3 Tracking Setup

We will numerically calculate the dynamic apertures and compare them under different beam-beam conditions. Dynamic aperture is defined as the maximum transverse amplitude below which the particles will survive in a long-term tracking. It is oan important indicator to predict the beam lifetime imposed by the nonlinear beam dynamics. Of course, due to the fact that dynamic aperture is calculated for certain particles and a limited tracking turns, it doesn't reflect the survival map of all particles in the bunch. And the dynamic aperture doesn't hint emittance growth.

In this note we will track particles in 5 phase angles in the first quadrant in the x-y plane. The initial transverse momenta and the initial time delay of test particles are set to zero. The initial relative momentum deviation will be $dp/p = 0$ (on-momentum) or 0.0005. The starting point of tracking is IP6. The particles are to be tracked up to 10^6 turns. The dynamic apertures are measured in units of rms transverse beam size $\sigma = \sqrt{\epsilon_n \beta^* / \gamma}$. Since there are some differences in the dynamic apertures searched in different phase angles, we will focus on comparison of the minimum dynamic aperture among these 5 phase angles.

Considering β^* is comparable to the bunch length at IP6 and IP8, the 6-D weak-strong synchro-beam map a la Hirata [3] is used to calculate the proton-proton beam-beam interactions. The e-lens will be split into 8 slices and for each slice, considering the electron beam is a DC beam, a drift–(4D weak-strong beam-beam kick)–drift model is used to calculate the forces the proton test particles get from the electron beam. The 4D weak-strong beam-beam kick is based on the equation by Bassetti-Erskine [4]. The strong proton beam in another ring and the electron beam are considered rigid and will not be affected by the test particles

Table 2: Calculated dynamic aperture with one and two proton-proton collisions.

Bunch intensity	p-p interaction points	dp/p_0	Dynamic aperture 15°	30°	45°	60°	75°	Minimum
2.0e11	IP6	0.0	9.4	7.7	7.1	6.1	8.3	6.1
2.5e11	IP6	0.0	9.4	8.1	7.7	6.9	8.6	6.9
3.0e11	IP6	0.0	9.4	8.3	7.9	7.5	9.4	7.5
2.0e11	IP6, IP8	0.0	9.4	7.7	7.9	7.9	8.3	7.7
2.5e11	IP6, IP8	0.0	9.6	8.3	7.7	7.7	9.0	7.7
3.0e11	IP6, IP8	0.0	9.4	7.1	7.5	7.7	8.1	7.1
2.0e11	IP6	0.0005	7.5	7.1	6.7	5.9	5.3	5.3
2.5e11	IP6	0.0005	7.5	7.3	6.9	5.9	5.1	5.1
3.0e11	IP6	0.0005	6.9	7.1	6.5	6.3	5.7	5.7
2.0e11	IP6, IP8	0.0005	6.7	7.1	5.9	5.1	5.1	5.1
2.5e11	IP6, IP8	0.0005	5.3	5.5	4.7	3.6	4.5	3.6
3.0e11	IP6, IP8	0.0005	4.3	4.0	3.2	3.4	3.4	3.2

Table 3: Calculated dynamic apertures with half head-on beam-beam compensation

Bunch intensity	dp/p_0	Dynamic aperture 15°	30°	45°	60°	75°	Minimum
2.0e11	0.0	7.3	7.3	6.9	6.1	6.1	6.1
2.5e11	0.0	7.1	6.5	6.3	5.7	7.1	5.7
3.0e11	0.0	6.7	6.5	5.9	6.1	7.1	5.9
2.0e11	0.0005	6.3	6.1	5.7	4.7	4.7	4.7
2.5e11	0.0005	7.1	5.7	4.5	4.7	4.1	4.1
3.0e11	0.0005	5.7	6.3	4.9	4.9	4.3	4.3

in the simulation.

The particle motion in the magnetic elements is tracked with the 4th order symplectic integration by R. Ruth [5]. To save the time involved in the numeric tracking, we treat the multipoles as thin lenses. That is, the non-zero length multipoles will be replaced by drift–(multipole kick)–drift. Of course, the tunes and chromaticities will be re-matched to original ones before the dynamic aperture tracking. In the study the tunes are always set to (28.67, 29.68) and the linear chromaticities are set to (+1, +1) with beam-beam and/or beam-beam compensation before tracking.

4 Tracking results

4.1 Without beam-beam compensation

First we calculate the dynamic aperture without head-on beam-beam compensation. For comparison, we calculate the dynamic apertures with one collision at IP6 and with two collisions at IP6 and IP8. Table 2 and Figure 3 show the calculated dynamic apertures in the 5 phase angles.

From Figure 3, for all three bunch intensities $Np = 2.0 \times 10^{11}$, 2.5×10^{11} and 3.0×10^{11}, for the off-momentum particles with $dp/p = 0.0005$, the dynamic apertures with two collisions are smaller than that with one collision. From Table 2, from one to two collisions, the minimum dynamic apertures drop about 1.5σ and 2.5σ for bunch intensities 2.5×10^{11} and 3.0×10^{11} respectively. The minimum dynamic apertures with two collisions are below 4σ for bunch intensities 2.5×10^{11} and 3.0×10^{11} respectively.

From Figure 2, the calculated dynamic apertures are very unbalanced in the 5 phase angles. The minimum dynamic aperture always happens in the phase angle of 75°. This may be due to the fact that the linear lattice is not optimized and the the magnetic resonance driving terms are not compensated.

4.2 With half beam-beam compensation

In the following study the proton beams always collide at IP6 and IP8. Here we investigate the effect of half head-on beam-beam compensation on the dynamic aperture. As mentioned above, half head-on beam-beam

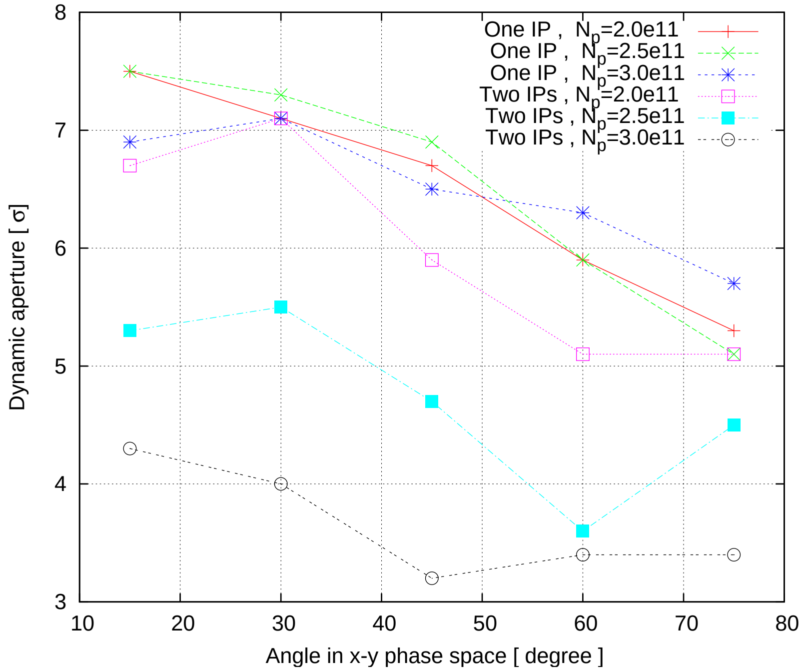

Figure 3: Calculated dynamic apertures with one or two proton-proton collisions.

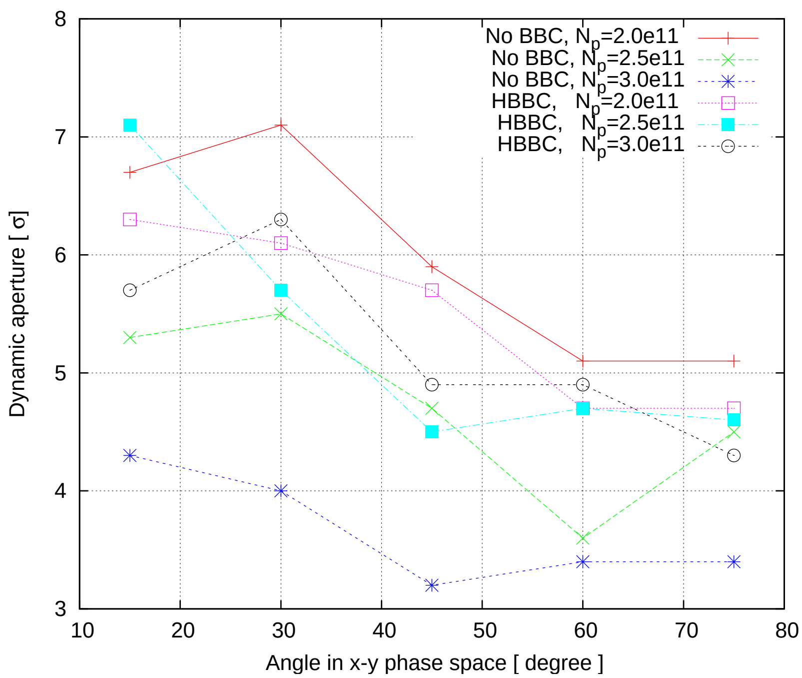

Figure 4: Calculated dynamic apertures with half head-on beam-beam compensation.

Table 4: Calculated dynamic apertures with phase advances of $k\pi$ between IP8 and the center of the e-lens

Bunch intensity	dp/p_0	Dynamic aperture					
		15°	30°	45°	60°	75°	Minimum
2.0e11	0.0	6.7	6.9	6.5	6.9	6.1	6.1
2.5e11	0.0	6.5	6.9	6.5	6.7	6.5	6.5
3.0e11	0.0	6.1	5.9	6.1	5.9	6.7	5.9
2.0e11	0.0005	6.9	6.9	6.3	5.3	5.5	5.3
2.5e11	0.0005	6.7	6.5	6.1	5.3	4.9	4.9
3.0e11	0.0005	6.1	6.1	4.7	5.1	3.8	3.8

compensation compensates half linear proton-proton beam-beam tune shift. Table 3 and Figure 4 show the calculated dynamic apertures for the three bunch intensities.

Comparing Table 3 to Table 2, for the off-momentum particles with $dp/p_0 = 0.0005$, half head-on beam-beam compensation increases the minimum dynamic apertures by 0.5σ and 1.1σ for proton bunch intensities 2.5×10^{11} and 3.0×10^{11}. However, for bunch intensities 2.0×10^{11}, the minimum dynamic aperture drops by 0.4σ with half head-on beam-beam compensation.

4.3 With adjusted phase advances

For half head-on beam-beam compensation, to better compensate the nonlinearities from the proton-proton beam-beam interaction at IP8 with the e-lens around IP10, we will adjust the betatron phase advances between IP8 and the center of e-lens to be multiples of π. Without any beam-beam interaction and phase adjustment, the betatron phase advances between IP8 and the center of the e-lens are (8.5π, 11.1π). In this study, we will adjust the betatron phase advances between IP8 and the center of the e-lens to be $(7\pi, 9\pi)$.

To adjust the phase advances between IP8 and the e-lens, we insert two artificial betatron phase shift matrices before and after the e-lens in the lattice model. The phase shift matrices don't change the overall ring tunes and Twiss parameters. However, the exact $(7\pi, 9\pi)$ betatron phase advances are only true for on-momentum particles because of chromatic tune shift.

Table 4 shows the calculated dynamic apertures with half head-on beam-beam compensation and with phase advances of $k\pi$ between IP8 and the center of the e-lens. Figure 5 shows these dynamic apertures for the particles with $dp/p_0 = 0.0005$. In Figure 5, for comparison, the dynamic apertures without phase adjustment from Table 3 are also shown.

Comparing Table 4 to Table 3, the phase advances of $k\pi$ between IP8 and the center of the e-lens improve the minimum dynamic apertures by 0.8σ for the on-momentum particles with bunch intensity 2.5×10^{11}. For bunch intensities 2.0×10^{11} and 3.0×10^{11}, there is no improvement in the dynamic apertures of on-momentum particles.

For the off-momentum particles with $dp/p_0 = 0.0005$, the phase advances of $k\pi$ increase the minimum dynamic apertures by 0.6σ and 0.3σ for proton bunch intensities 2.0×10^{11} and 2.5×10^{11} respectively, but decrease the minimum dynamic aperture by 0.5σ for bunch intensity 3.0×10^{11}.

4.4 Scan of relative momentum deviation

Here we scan the relative momentum deviation dp/p_0 with half head-on beam-beam compensation and phase advances of $k\pi$ between IP8 and e-lens. As we mentioned, the phase advances of $(7\pi, 9\pi)$ are only true for the on-momentum particles.

Figure 6 shows the minimum dynamic apertures in the scan of relative momentum deviation dp/p_0. From Figure 6, the on-momentum particles do have larger minimum dynamic apertures than the off-momentum particles. For proton bunch intensities of 2.5×10^{11} and 3.0×10^{11}, the minimum dynamic apertures drop 1.5 - 2 σ from on-momentum particles to off-momentum particles with $dp/p_0 = \pm 0.0005$.

4.5 Scan of first order chromaticity

Here we continue to scan the first order chromaticity Q' with half head-on beam-beam compensation and phase advances of $k\pi$ between IP8 and the e-lens. By adjusting first order chromaticities with chromatic sextupoles in the arcs, the off-momentum phase advances between IP8 and e-lens will be adjusted too.

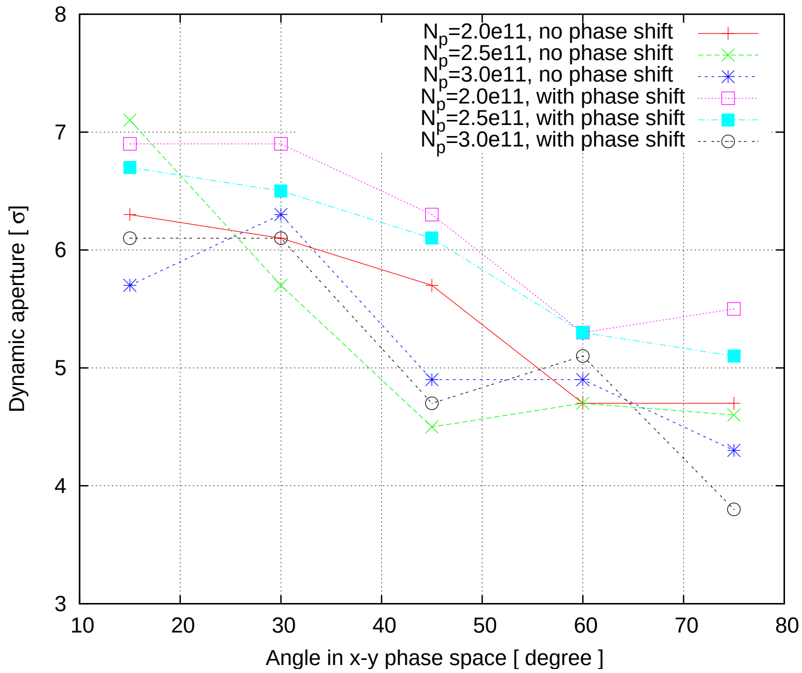

Figure 5: Calculated dynamic apertures withphase advances of $k\pi$ between IP8 and the center of the e-lens.

Table 5: Calculated dynamic apertures with second order chromaticity correction.

Bunch intensity	dp/p_0	Dynamic aperture					
		15°	30°	45°	60°	75°	Minimum
2.0e11	0.0	8.3	6.9	6.7	6.9	6.1	6.1
2.5e11	0.0	6.9	6.7	6.3	7.1	7.5	6.3
3.0e11	0.0	6.1	5.9	5.9	6.1	6.9	5.9
2.0e11	0.0005	6.7	6.7	6.1	5.7	5.5	5.5
2.5e11	0.0005	6.5	6.5	6.3	5.3	4.5	4.5
3.0e11	0.0005	6.5	6.3	6.1	4.5	3.8	3.8

Figure 7 shows the minimum dynamic apertures of off-momentum particles with $dp/p_0 = 0.0005$ in the scan of linear chromaticities from -2 to +4. From Figure 7, for the bunch intensity 2.0×10^{11} and 2.5×10^{11}, the peak minimum dynamic apertures happen at zero linear chromaticity. For bunch intensities 3.0×10^{11}, it is hard to conclude where the peak minimum dynamic aperture is.

4.6 With second order chromaticity correction

Here we investigate the effect of the second order chromaticity Q'' on the dynamic aperture with half head-on beam-beam compensation and multipole phase advances of $k\pi$ between IP8 and e-lens. In the simulation, we used the convenient 4 knobs suggested in Ref. [6] to minimize the second order chromaticities. After correction, the second order chromaticities in both the horizontal and vertical planes are below 500. In this study, the sextupole resonance driving terms are not minimized.

Table 5 shows the calculated dynamic apertures with Q'' corrections for particles. Figure 8 shows the calculated dynamic aperture with Q'' corrections for particles with $dp/p_0 = 0.0005$. Comparing Table 5 to Table 4, for the off-momentum particles with $dp/p_0 = 0.0005$, there are clear dynamic aperture increase for the proton bunch intensity 3.0×10^{11} in three angles of 15°, 30° and 45°. For proton bunch intensities 2.0×10^{11}, second order chromaticity correction improves the minimum dynamic aperture by 0.2σ. For proton bunch intensities 2.5×10^{11}, second order chromaticity correction decreases the minimum dynamic aperture by 0.4σ.

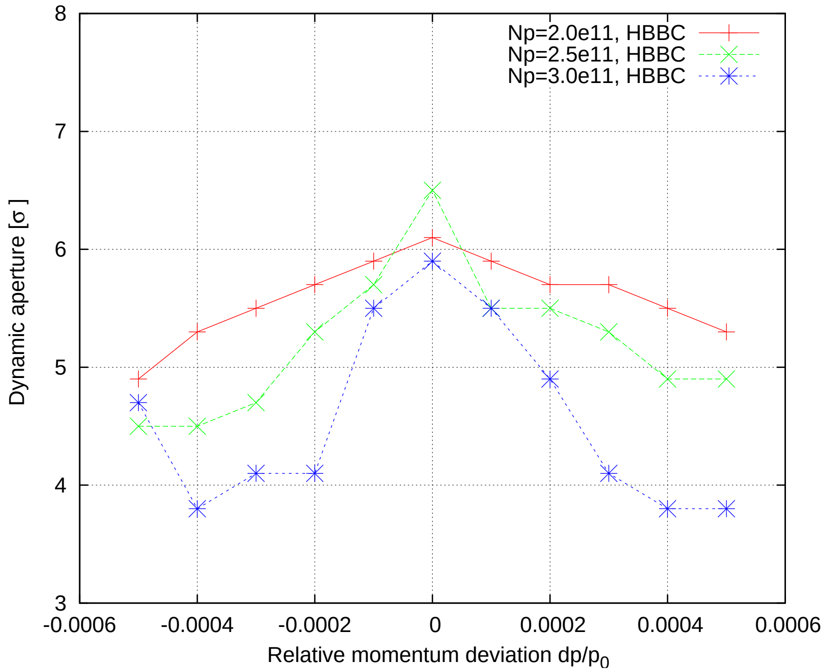

Figure 6: Calculated minimum dynamic apertures in the scan of relative momentum deviation dp/p_0.

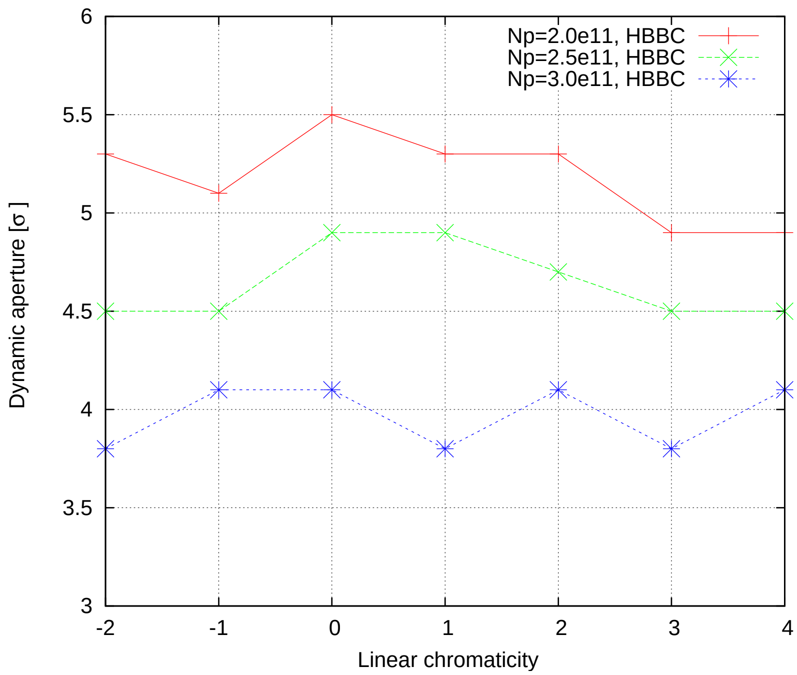

Figure 7: Calculated minimum dynamic aperture in the scan of linear chromaticity.

Table 6: Calculated minimum dynamic apertures in the proton tune scan

proton tunes	$N_p = 2.0 \times 10^{11}$	$N_p = 2.5 \times 10^{11}$	$N_p = 3.0 \times 10^{11}$
(28.670, 29.675)	5.3	4.9	5.5
(28.675, 29.680)	5.7	4.7	3.8
(28.680, 29.685)	4.3	4.7	3.8
(28.675, 29.670)	5.3	5.7	5.5
(28.680, 29.675)	5.9	5.5	5.1
(28.685, 29.680)	4.3	4.3	3.8

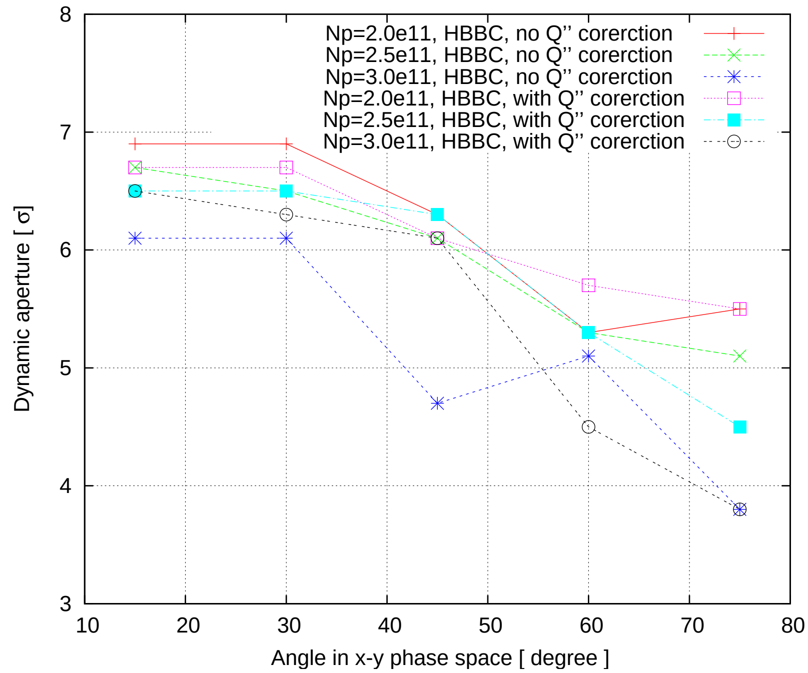

Figure 8: Calculated dynamic aperture with second order chromaticity correction.

4.7 Scan of the proton beam working point

In the above simulation we calculate the dynamic aperture with fixed collisional tunes (28.67, 29.68). Here we scan the proton tunes along the diagonal in the tune space. Due to the limited tune space between 2/3 and 7/10, actually we only can scan several working points along the diagonal. In this study the difference of the transverse tunes is 0.005.

Table 6 shows the calculated dynamic aperture in the proton tune scan for the three proton bunch intensities. The shown tunes in Table 6 are the tunes including beam-beam and half beam-beam compensation. Phase advances of $k\pi$ between IP8 and the center of the e-lens and the second order chromaticity correction are included. From Table 6, in most cases the minimum dynamic apertures of tunes below diagonal are larger than those with swapped above diagonal tunes. And lower working points give larger minimum dynamic apertures.

4.8 Scan of the proton bunch intensity

Here we scan of the proton bunch intensity with different bam-beam compensation conditions: without beam-beam compensation, with half beam-beam compensation, with phase advances of $k\pi$ between IP8 and the center of the e-lens, and with the second order chromaticity correction.

Figure 9 shows the minimum dynamic apertures in the scan of proton bunch intensities from 1.2×10^{11} to 3.0×10^{11}. From Figure 9, below a proton bunch intensity of 2.0×10^{11}, half beam-beam compensation doesn't help improve the dynamic aperture. Also from Figure 9, for proton bunch intensity from 2.0×10^{11} to 2.5×10^{11}, phase advances of $k\pi$ between IP8 and the center of the e-lens increase the minimum dynamic apertures. And the second order chromaticity correction increases the minimum dynamic apertures with bunch intensity from 2.0×10^{11} up to 2.8×10^{11}.

4.9 Scan of the head-on beam-beam compensation strength

Here we scan the beam-beam compensation strength, that is, the electron beam intensity in the e-lens. We define the compensation strength as the electron beam intensity divided by twice the proton bunch intensity. For half and full head-on beam-beam compensations, the compensation strength are 0.5 and 1.0 respectively.

Figure 10 shows the minimum dynamic aperture in the scan of the compensation strength. In this study, phase advances of $k\pi$ between IP8 and the center of the e-lens and the second order chromaticity correction are included. From Figure 10, compensation with compensation strength above 0.7 reduces the dynamic

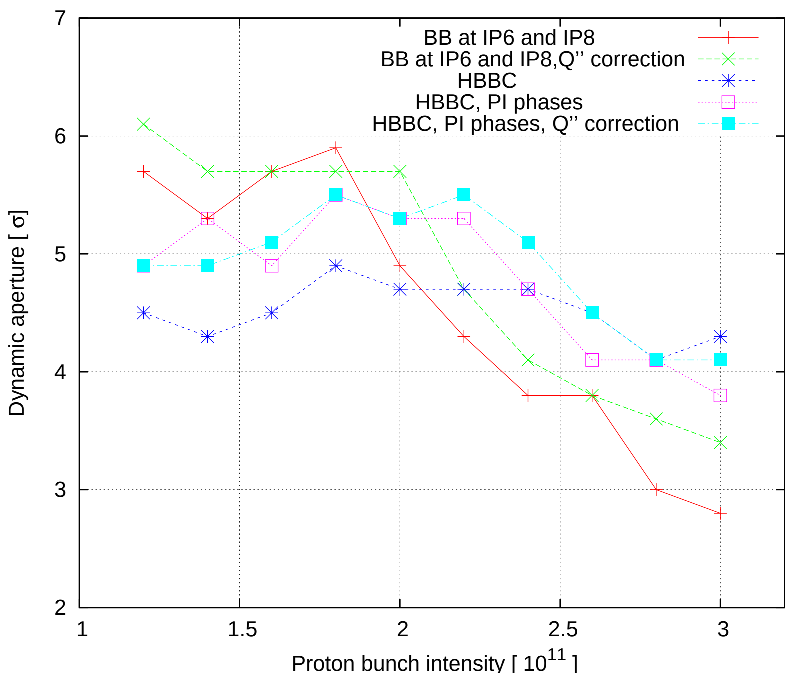

Figure 9: Calculated minimum dynamic aperture with half head-on beam-beam compensation in the scan of proton bunch intensity

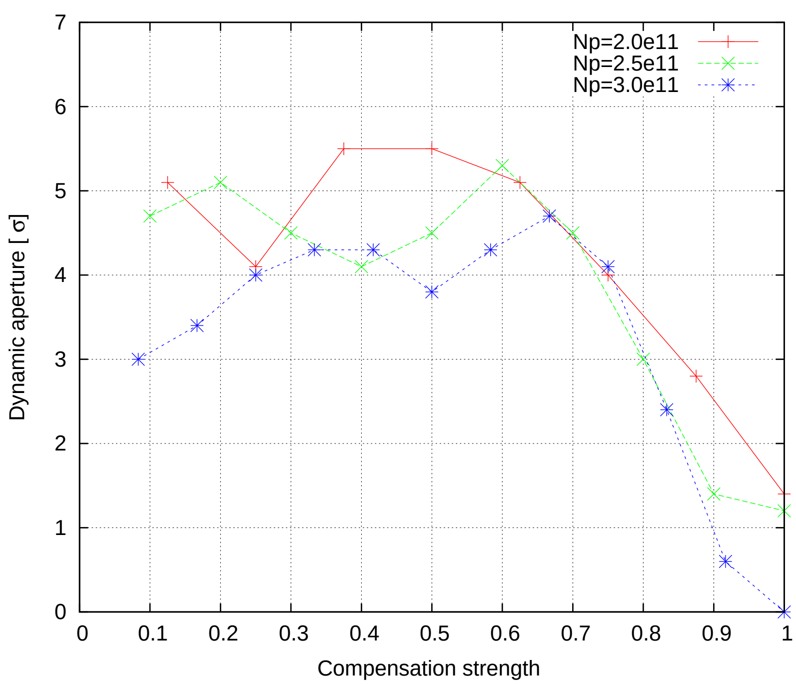

Figure 10: Calculated minimum dynamic aperture versus the compensation strength.

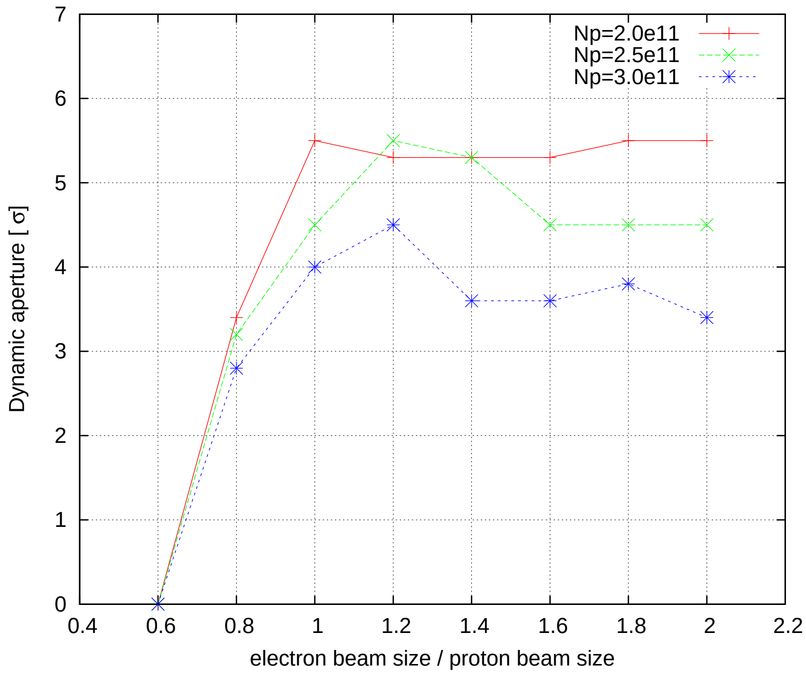

Figure 11: Calculated minimum dynamic aperture versus electron beam size.

aperture for all the three bunch intensities. For bunch intensity 2.0×10^{11}, the peak minimum dynamic aperture occurs at compensation strength 0.4 0.5, while for bunch intensities 2.5×10^{11} and 3.0×10^{11}, the peak minimum dynamic aperture occur at compensation strength 0.6 0.65.

4.10 Scan of the electron beam size

Here we scan the electron beam size with half head-on beam-beam compensation. Figure 11 shows the calculated minimum dynamic aperture versus the electron beam size divided by the proton beam size. Phase advances of $k\pi$ between IP8 and the center of the e-lens and the second order chromaticity correction are included.

From Figure 11, the dynamic aperture quickly drops when the electron beam size is smaller than that of proton bunch. The peak minimum dynamic aperture happen when the electron beam size is 20$\tilde{4}$0% bigger than the proton bunch's.

5 Summary

In this note we calculated and compared the dynamic apertures with head-on beam-beam compensation with the Blue ring 250 GeV proton run lattice. The β^*s are IP6 and IP8 are nominally 0.5 m. For off-momentum particles with relative momentum deviation $dp/p_0 = 0.0005$, the half head-on beam-beam compensation improves the minimum dynamic aperture with proton bunch intensities above 2.0×10^{11}. Phase advances of multiples of π between IP8 and the e-lens and the second order chromaticity correction also increase the minimum dynamic apertures with bunch intensity from 2.0×10^{11} up to 2.8×10^{11}. The proton tune scan shows that working points below the diagonal give higher dynamic apertures than the working points above the diagonal. A slightly larger electron beam size than the proton's yields larger proton dynamic aperture. The scan of the compensation strength hints that around half beam-beam compensation is the optimum to apply the head-on beam-beam compensation.

In this note we used the dynamic aperture as the observable to judge the effect of head-on beam-beam compensation. And most of the time we were only using the dynamic apertures of the off-momentum particles with relative momentum deviation $dp/p_0 = 0.0005$. Therefore, the conclusion based these particles may not reflect to the behaviors of the whole proton beam. Also, the dynamic aperture doesn't provide any information about the action dilution of particles and emittance growth of the bunch. To confirm the observations from dynamic aperture calculation, multi-particle tracking is necessary.

All the simulations in the note were done with SimTrack [7]. SimTrack is a c++ library for optical calculation and particle tracking in high energy circular accelerators.

References

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6 Appendix I: DAs with 6-D beam-beam treatment

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Subject:   Evaluation of dynamic aperture in presence of  head-on beam-beam compensation in RHIC
BB at IP6 and IP8:  6-D weak-strong
E-lens :    4-D weak-strong with 6-8 integrations

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JobID   NP       BB      DELTA     Q     Q'        DA( 15 / 30 / 45 / 60/ 75 / minimum )

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Only BB at IP6:

  39     2.0e11  6D       0.0       .67/.68  1/1    9.4    7.7    7.1    6.1    8.3    6.1
  40     2.5e11  6D       0.0       .67/.68  1/1    9.4    8.1    7.7    6.9    8.6    6.9
  41     3.0e11  6D       0.0       .67/.68  1/1    9.4    8.3    7.9    7.5    9.4    7.5

  42     2.0e11  6D       0.0005    .67/.68  1/1    7.5    7.1    6.7    5.9    5.3    5.3
  43     2.5e11  6D       0.0005    .67/.68  1/1    7.5    7.3    6.9    5.9    5.1    5.1
  44     3.0e11  6D       0.0005    .67/.68  1/1    6.9    7.1    6.5    6.3    5.7    5.7

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Only BB at IP6 and IP8:

  45     2.0e11  6D       0.0       .67/.68  1/1    9.4    7.7    7.9    7.9    8.3    7.7
  46     2.5e11  6D       0.0       .67/.68  1/1    9.6    8.3    7.7    7.7    9.0    7.7
  47     3.0e11  6D       0.0       .67/.68  1/1    9.4    7.1    7.5    7.7    8.1    7.1

  48     2.0e11  6D       0.0005    .67/.68  1/1    6.7    7.1    5.9    5.1    5.1    5.1
  49     2.5e11  6D       0.0005    .67/.68  1/1    5.3    5.5    4.7    3.6   <6.3>   3.6
  50     3.0e11  6D       0.0005    .67/.68  1/1    4.3    4.0    3.2    3.4    3.4    3.2

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HBBC No phasers:

  1      2.0e11  6D       0.0       .67/.68  1/1    7.3    7.3    6.9    6.1    6.1    6.1
  2      2.5e11  6D       0.0       .67/.68  1/1    7.1    6.5    6.3    5.7    7.1    5.7
  3      3.0e11  6D       0.0       .67/.68  1/1    6.7    6.5    5.9    6.1    7.1    5.9

  4      2.0e11  6D       0.0005    .67/.68  1/1    6.3    6.1    5.7    4.7    4.7    4.7
  5      2.5e11  6D       0.0005    .67/.68  1/1    7.1    5.7    4.5    4.7    4.1    4.1
  6      3.0e11  6D       0.0005    .67/.68  1/1    5.7    6.3    4.9    4.9    4.3    4.3

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HBBC with PI phasers:

  7      2.0e11  6D       0.0       .67/.68  1/1    6.7    6.9    6.5    6.9    6.1    6.1
  8      2.5e11  6D       0.0       .67/.68  1/1    6.5    6.9    6.5    6.7    6.5    6.5
  9      3.0e11  6D       0.0       .67/.68  1/1    6.1    5.9    6.1    5.9    6.7    5.9

  10     2.0e11  6D       0.0005    .67/.68  1/1    6.9    6.9    6.3    5.3    5.5    5.3
  11     2.5e11  6D       0.0005    .67/.68  1/1    6.7    6.5    6.1    5.3    4.9    4.9
  12     3.0e11  6D       0.0005    .67/.68  1/1    6.1    6.1    4.7    5.1    3.8    3.8

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Scan dp/p0  on top of PI phasers:  Np=2.0e11
```

400	2.0e11	6D	-0.0005	.67/.68	1/1	6.1	6.1	6.3	5.5	4.9	4.9
401	2.0e11	6D	-0.0004	.67/.68	1/1	6.5	6.5	6.1	5.3	5.5	5.3
402	2.0e11	6D	-0.0003	.67/.68	1/1	6.5	6.3	6.3	5.5	5.7	5.5
403	2.0e11	6D	-0.0002	.67/.68	1/1	6.5	6.7	6.5	5.7	5.7	5.7
404	2.0e11	6D	-0.0001	.67/.68	1/1	6.7	6.5	6.5	5.9	5.9	5.9
405	2.0e11	6D	0.000	.67/.68	1/1	6.7	6.9	6.5	6.9	6.1	6.1
406	2.0e11	6D	0.0001	.67/.68	1/1	6.7	6.9	6.5	5.9	5.9	5.9
407	2.0e11	6D	0.0002	.67/.68	1/1	6.9	7.1	6.7	6.1	5.7	5.7
408	2.0e11	6D	0.0003	.67/.68	1/1	6.9	6.7	6.5	5.7	5.7	5.7
409	2.0e11	6D	0.0004	.67/.68	1/1	7.1	7.1	6.7	5.5	5.5	5.5
410	2.0e11	6D	0.0005	.67/.68	1/1	6.9	6.9	6.3	5.3	5.5	5.3

Scan dp/p0 on top of PI phasers: Np=2.5e11

13	2.5e11	6D	-0.0005	.67/.68	1/1	6.1	5.7	6.3	4.7	4.5	4.5
14	2.5e11	6D	-0.0004	.67/.68	1/1	6.1	5.9	5.7	5.7	4.5	4.5
15	2.5e11	6D	-0.0003	.67/.68	1/1	6.7	6.1	6.1	5.5	4.7	4.7
16	2.5e11	6D	-0.0002	.67/.68	1/1	6.3	6.7	5.9	5.3	5.9	5.3
17	2.5e11	6D	-0.0001	.67/.68	1/1	6.5	6.5	6.3	5.7	6.3	5.7
18	2.5e11	6D	0.000	.67/.68	1/1	6.5	6.9	6.5	6.7	6.5	6.5
19	2.5e11	6D	0.0001	.67/.68	1/1	6.7	6.7	6.5	5.5	6.3	5.5
20	2.5e11	6D	0.0002	.67/.68	1/1	6.7	6.7	6.3	5.5	5.9	5.5
21	2.5e11	6D	0.0003	.67/.68	1/1	6.7	6.7	6.1	5.5	5.3	5.3
22	2.5e11	6D	0.0004	.67/.68	1/1	6.7	6.5	6.1	5.5	4.9	4.9
23	2.5e11	6D	0.0005	.67/.68	1/1	6.7	6.5	6.1	5.3	4.9	4.9

Scan dp/p0 on top of PI phasers: Np=3.0e11

411	3.0e11	6D	-0.0005	.67/.68	1/1	5.5	5.3	4.9	4.7	4.7	4.7
412	3.0e11	6D	-0.0004	.67/.68	1/1	5.9	5.7	5.1	4.5	3.8	3.8
413	3.0e11	6D	-0.0003	.67/.68	1/1	5.7	6.1	6.3	4.9	4.1	4.1
414	3.0e11	6D	-0.0002	.67/.68	1/1	5.7	5.9	5.7	4.9	4.1	4.1
415	3.0e11	6D	-0.0001	.67/.68	1/1	6.3	5.9	5.7	5.5	6.3	5.5
416	3.0e11	6D	0.000	.67/.68	1/1	6.1	5.9	6.1	5.9	6.7	5.9
417	3.0e11	6D	0.0001	.67/.68	1/1	5.9	6.1	5.9	5.5	5.7	5.5
418	3.0e11	6D	0.0002	.67/.68	1/1	5.9	6.5	5.3	5.1	4.9	4.9
419	3.0e11	6D	0.0003	.67/.68	1/1	6.5	5.9	5.7	4.3	4.1	4.1
420	3.0e11	6D	0.0004	.67/.68	1/1	6.1	6.3	5.5	5.1	3.8	3.8
421	3.0e11	6D	0.0005	.67/.68	1/1	6.1	6.1	4.7	5.1	3.8	3.8

Scan Q' on top of PI phasers Np=2.0e11

422	2.0e11	6D	0.0005	67/.68	-4/-4	6.5	6.7	5.9	5.1	5.3	5.1
423	2.0e11	6D	0.0005	.67/.68	-3/-3	6.7	6.7	6.3	5.3	5.5	5.3
424	2.0e11	6D	0.0005	.67/.68	-2/-2	6.9	6.3	6.1	5.3	5.9	5.3
425	2.0e11	6D	0.0005	.67/.68	-1/-1	6.7	6.5	6.1	5.1	5.5	5.1
426	2.0e11	6D	0.0005	.67/.68	0/ 0	6.7	6.7	5.9	5.5	5.7	5.5
427	2.0e11	6D	0.0005	.67/.68	1/ 1	6.9	6.9	6.3	5.3	5.5	5.3
428	2.0e11	6D	0.0005	.67/.68	2/ 2	7.1	6.7	6.3	5.5	5.3	5.3
429	2.0e11	6D	0.0005	67/.68	3/ 3	6.5	6.5	6.1	5.5	4.9	4.9
430	2.0e11	6D	0.0005	67/.68	4/ 4	6.5	6.3	5.7	5.1	4.9	4.9

Scan Q' on top of PI phasers Np=2.5e11

24	2.5e11	6D	0.0005	67/.68	-4/-4	6.7	6.5	5.9	5.5	4.7	4.7
25	2.5e11	6D	0.0005	.67/.68	-3/-3	6.7	6.7	6.3	4.9	4.5	4.5
26	2.5e11	6D	0.0005	.67/.68	-2/-2	6.3	6.7	6.3	5.7	4.5	4.5
27	2.5e11	6D	0.0005	.67/.68	-1/-1	6.5	6.9	6.3	5.3	4.5	4.5
28	2.5e11	6D	0.0005	.67/.68	0/ 0	6.7	6.5	6.3	5.3	4.9	4.9

29	2.5e11	6D	0.0005	.67/.68	1/ 1	6.7	6.5	6.1	5.3	4.9	4.9
30	2.5e11	6D	0.0005	.67/.68	2/ 2	6.1	5.9	5.7	4.9	4.7	4.7
31	2.5e11	6D	0.0005	67/.68	3/ 3	6.7	6.5	6.3	4.9	4.5	4.5
32	2.5e11	6D	0.0003	67/.68	4/ 4	6.1	6.1	5.7	5.1	4.5	4.5

Scan Q' on top of PI phasers Np=3.0e11

431	3.0e11	6D	0.0005	67/.68	-4/-4	5.9	6.3	5.7	4.7	4.1	4.1
432	3.0e11	6D	0.0005	.67/.68	-3/-3	5.9	5.3	5.5	4.5	3.8	3.8
433	3.0e11	6D	0.0005	.67/.68	-2/-2	5.9	5.9	5.3	4.7	3.8	3.8
434	3.0e11	6D	0.0005	.67/.68	-1/-1	5.9	6.3	5.3	4.5	4.1	4.1
435	3.0e11	6D	0.0005	.67/.68	0/ 0	5.9	6.7	6.1	4.1	4.7	4.1
436	3.0e11	6D	0.0005	.67/.68	1/ 1	6.1	6.1	4.7	5.1	3.8	3.8
437	3.0e11	6D	0.0005	.67/.68	2/ 2	5.9	5.7	4.9	4.7	4.1	4.1
438	3.0e11	6D	0.0005	67/.68	3/ 3	5.7	5.3	5.3	4.3	3.8	3.8
439	3.0e11	6D	0.0003	67/.68	4/ 4	5.3	6.3	5.3	4.9	4.1	4.1

Q'' correction on top of PI phasers

33	2.0e11	6D	0.000	67/.68	1 / 1	8.3	6.9	6.7	6.9	6.1	6.1
34	2.5e11	6D	0.000	.67/.68	1 / 1	6.9	6.7	6.3	7.1	7.5	6.3
35	3.0e11	6D	0.000	.67/.68	1 / 1	6.1	5.9	5.9	6.1	6.9	5.9
36	2.0e11	6D	0.0005	67/.68	1 / 1	6.7	6.7	6.1	5.7	5.5	5.5
37	2.5e11	6D	0.0005	.67/.68	1 / 1	6.5	6.5	6.3	5.3	4.5	4.5
38	3.0e11	6D	0.0005	.67/.68	1 / 1	6.5	6.3	6.1	4.5	3.8	3.8

Scan of phase shift away from PI phasers, Np=2.5e11

						Mfront (degree)						
101	2.5e11	6D	0.0005	67/.68	1 / 1	20+	6.1	6.3	6.1	5.1	4.7	4.7
102	2.5e11	6D	0.0005	.67/.68	1 / 1	15+	6.5	6.5	6.3	5.3	4.5	4.5
103	2.5e11	6D	0.0005	.67/.68	1 / 1	10+	6.3	6.7	6.1	6.3	4.7	4.7
104	2.5e11	6D	0.0005	67/.68	1 / 1	5+	6.3	6.7	6.1	5.5	4.5	4.5
105	2.5e11	6D	0.0005	.67/.68	1 / 1	2.5+	6.5	6.5	6.3	5.5	4.7	4.7
106	2.5e11	6D	0.0005	.67/.68	1 / 1	0	7.1	6.3	6.7	5.3	4.7	4.7
107	2.5e11	6D	0.0005	67/.68	1 / 1	-2.5	6.3	6.1	6.3	5.5	4.7	4.7
108	2.5e11	6D	0.0005	.67/.68	1 / 1	-5	7.1	6.5	6.1	6.3	4.7	4.7
109	2.5e11	6D	0.0005	.67/.68	1 / 1	-10	6.7	6.3	6.3	5.5	4.7	4.7
110	2.5e11	6D	0.0005	67/.68	1 / 1	-15	6.7	6.5	5.7	5.7	5.7	5.7
111	2.5e11	6D	0.0005	.67/.68	1 / 1	-20	6.7	6.3	5.9	5.9	5.7	5.7

Scan of phase shift away from PI phasers, Np=2.0e11

440	2.0e11	6D	0.0005	67/.68	1 / 1	15.0+	6.7	6.5	6.1	5.1	5.1	5.1
441	2.0e11	6D	0.0005	.67/.68	1 / 1	10.0+	6.9	6.9	6.3	5.5	5.3	5.3
442	2.0e11	6D	0.0005	.67/.68	1 / 1	5.0+	6.9	7.1	6.3	5.7	5.3	5.3
443	2.0e11	6D	0.0005	67/.68	1 / 1	2.5+	7.1	6.7	6.3	6.1	5.3	5.3
444	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0+	6.7	6.7	6.3	5.7	5.3	5.3
445	2.0e11	6D	0.0005	.67/.68	1 / 1	1.5+	7.1	6.7	6.3	5.9	5.5	5.5
446	2.0e11	6D	0.0005	67/.68	1 / 1	1.0	6.9	7.1	6.1	5.9	5.3	5.3
447	2.0e11	6D	0.0005	.67/.68	1 / 1	.5+	6.7	6.9	6.5	5.3	5.5	5.3
448	2.0e11	6D	0.0005	.67/.68	1 / 1	0	6.5	6.5	6.3	5.5	5.5	5.5
449	2.0e11	6D	0.0005	67/.68	1 / 1	-0.5	6.5	6.5	6.3	5.9	5.7	5.7
450	2.0e11	6D	0.0005	.67/.68	1 / 1	-1.0	6.7	6.5	6.5	5.3	5.3	5.3
451	2.0e11	6D	0.0005	.67/.68	1 / 1	-1.5	6.7	6.5	6.3	5.7	5.1	5.1
452	2.0e11	6D	0.0005	67/.68	1 / 1	-2.0	6.7	6.5	6.5	5.9	5.3	5.3
453	2.0e11	6D	0.0005	.67/.68	1 / 1	-2.5	6.9	7.1	6.1	5.7	5.5	5.5

454	2.0e11	6D	0.0005	.67/.68	1 / 1	-5.0	6.5	6.1	6.1	5.5	5.5	5.5
455	2.0e11	6D	0.0005	.67/.68	1 / 1	-10.0	6.5	6.5	5.9	5.3	5.3	5.3
456	2.0e11	6D	0.0005	.67/.68	1 / 1	-15.0	6.3	6.3	5.7	5.3	5.3	5.3

Scan of phase shift away from PI phasers, Np=2.5e11

102	2.5e11	6D	0.0005	.67/.68	1 / 1	15+	6.5	6.5	6.3	5.3	4.5	4.5
103	2.5e11	6D	0.0005	.67/.68	1 / 1	10+	6.3	6.7	6.1	6.3	4.7	4.7
104	2.5e11	6D	0.0005	67/.68	1 / 1	5+	6.3	6.7	6.1	5.5	4.5	4.5
153	2.5e11	6D	0.0005	67/.68	1 / 1	2.5+	6.5	6.5	6.3	5.5	4.7	4.7
154	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0+	6.5	6.5	6.1	5.5	4.5	4.5
155	2.5e11	6D	0.0005	.67/.68	1 / 1	1.5+	6.5	6.5	6.1	5.9	4.7	4.7
156	2.5e11	6D	0.0005	67/.68	1 / 1	1.0	6.5	6.5	6.1	5.3	4.7	4.7
157	2.5e11	6D	0.0005	.67/.68	1 / 1	.5+	6.5	6.5	6.3	5.5	4.7	4.7
158	2.5e11	6D	0.0005	.67/.68	1 / 1	0	7.1	6.3	6.7	5.3	4.7	4.7
159	2.5e11	6D	0.0005	67/.68	1 / 1	-0.5	6.5	6.3	5.9	5.3	4.7	4.7
160	2.5e11	6D	0.0005	.67/.68	1 / 1	-1.0	6.5	6.3	5.7	4.9	4.9	4.9
161	2.5e11	6D	0.0005	.67/.68	1 / 1	-1.5	6.5	6.5	6.3	5.3	4.7	4.7
162	2.5e11	6D	0.0005	67/.68	1 / 1	-2.0	6.7	6.5	6.3	4.9	4.5	4.5
163	2.5e11	6D	0.0005	.67/.68	1 / 1	-2.5	6.3	6.1	6.3	5.5	4.7	4.7
108	2.5e11	6D	0.0005	.67/.68	1 / 1	-5	7.1	6.5	6.1	6.3	4.7	4.7
109	2.5e11	6D	0.0005	.67/.68	1 / 1	-10	6.7	6.3	6.3	5.5	4.7	4.7
110	2.5e11	6D	0.0005	67/.68	1 / 1	-15	6.7	6.5	5.7	5.7	5.7	5.7

Scan of phase shift away from PI phasers, Np=3.0e11

457	3.0e11	6D	0.0005	67/.68	1 / 1	15.0+	5.9	5.9	5.7	5.3	4.9	4.9
458	3.0e11	6D	0.0005	.67/.68	1 / 1	10.0+	6.1	5.9	5.3	5.5	4.3	4.3
459	3.0e11	6D	0.0005	.67/.68	1 / 1	5.0+	5.7	6.1	5.9	4.3	4.0	4.0
460	3.0e11	6D	0.0005	67/.68	1 / 1	3.0+	5.7	6.3	5.7	4.5	4.0	4.0
461	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0+	6.3	6.5	5.3	4.3	3.8	3.8
462	3.0e11	6D	0.0005	.67/.68	1 / 1	1.5+	6.3	6.1	5.9	4.5	3.8	3.8
463	3.0e11	6D	0.0005	67/.68	1 / 1	1.0	6.3	5.9	5.5	4.3	4.0	4.0
464	3.0e11	6D	0.0005	.67/.68	1 / 1	.5+	6.3	5.7	5.9	4.5	3.8	3.8
465	3.0e11	6D	0.0005	.67/.68	1 / 1	0	6.3	6.5	6.1	4.5	3.8	3.8
466	3.0e11	6D	0.0005	67/.68	1 / 1	-0.5	5.7	6.3	5.9	4.5	3.8	3.8
467	3.0e11	6D	0.0005	.67/.68	1 / 1	-1.0	6.3	5.7	5.7	4.7	4.0	4.0
468	3.0e11	6D	0.0005	.67/.68	1 / 1	-1.5	6.1	6.3	5.5	4.7	5.5	4.7
469	3.0e11	6D	0.0005	67/.68	1 / 1	-2.0	6.5	5.7	5.7	5.1	4.0	4.0
470	3.0e11	6D	0.0005	.67/.68	1 / 1	-2.5	6.1	5.7	5.9	4.5	4.0	4.0
471	3.0e11	6D	0.0005	.67/.68	1 / 1	-5.0	5.7	5.9	5.3	5.1	4.7	4.7
472	3.0e11	6D	0.0005	.67/.68	1 / 1	-10.0	6.3	6.3	5.3	5.1	3.8	3.8
473	3.0e11	6D	0.0005	.67/.68	1 / 1	-15.0	5.9	5.9	5.5	5.1	5.9	5.1

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scan Ne (compensation strength), with Q'' correction , Q'=1, PI phasers

123	2.0e11	0.5e11	6D	0.0005	67/.68	1 / 1	7.1	6.7	5.9	5.3	5.1	5.1
124	2.0e11	1.0e11	6D	0.0005	67/.68	1 / 1	6.9	6.5	5.9	6.1	4.1	4.1
125	2.0e11	1.5e11	6D	0.0005	67/.68	1 / 1	7.1	7.1	7.1	5.9	5.5	5.5
126	2.0e11	2.0e11	6D	0.0005	67/.68	1 / 1	6.7	6.7	6.1	5.7	5.5	5.5
127	2.0e11	2.5e11	6D	0.0005	67/.68	1 / 1	6.1	6.3	5.5	5.7	5.1	5.1
128	2.0e11	3.0e11	6D	0.0005	67/.68	1 / 1	5.5	5.1	4.3	4.0	5.3	4.0
129	2.0e11	3.5e11	6D	0.0005	67/.68	1 / 1	4.1	3.4	3.0	2.8	5.1	2.8
130	2.0e11	4.0e11	6D	0.0005	67/.68	1 / 1	1.4	1.4	1.6	2.4	3.8	1.4

131	2.5e11	0.5e11	6D	0.0005	67/.68	1 / 1	5.5	6.3	4.9	4.7	4.9	4.7
132	2.5e11	1.0e11	6D	0.0005	67/.68	1 / 1	6.3	5.7	5.1	5.5	5.5	5.1
133	2.5e11	1.5e11	6D	0.0005	67/.68	1 / 1	5.3	5.9	5.3	5.5	4.5	4.5
134	2.5e11	2.0e11	6D	0.0005	67/.68	1 / 1	6.5	6.3	6.1	4.5	4.1	4.1
135	2.5e11	2.5e11	6D	0.0005	67/.68	1 / 1	6.5	6.5	6.3	5.3	4.5	4.5

136	2.5e11	3.0e11	6D	0.0005	67/.68	1 / 1	6.3	6.1	6.3	5.7	5.3	5.3
137	2.5e11	3.5e11	6D	0.0005	67/.68	1 / 1	5.9	5.3	4.9	4.9	4.5	4.5
138	2.5e11	4.0e11	6D	0.0005	67/.68	1 / 1	4.9	4.7	4.0	3.0	3.0	3.0
139	2.5e11	4.5e11	6D	0.0005	67/.68	1 / 1	2.2	2.0	1.6	1.4	4.7	1.4
140	2.5e11	5.0e11	6D	0.0005	67/.68	1 / 1	1.2	1.2	1.4	2.0	3.2	1.2
141	3.0e11	0.5e11	6D	0.0005	67/.68	1 / 1	6.3	4.9	3.8	3.0	3.8	3.0
142	3.0e11	1.0e11	6D	0.0005	67/.68	1 / 1	4.5	4.5	4.0	4.3	3.4	3.4
143	3.0e11	1.5e11	6D	0.0005	67/.68	1 / 1	5.3	4.9	4.1	4.0	4.0	4.0
144	3.0e11	2.0e11	6D	0.0005	67/.68	1 / 1	5.3	5.5	4.7	4.3	4.5	4.3
145	3.0e11	2.5e11	6D	0.0005	67/.68	1 / 1	5.7	6.3	5.5	4.7	4.3	4.3
146	3.0e11	3.0e11	6D	0.0005	67/.68	1 / 1	6.5	6.3	6.1	4.5	3.8	3.8
147	3.0e11	3.5e11	6D	0.0005	67/.68	1 / 1	6.1	6.1	5.9	5.5	4.3	4.3
148	3.0e11	4.0e11	6D	0.0005	67/.68	1 / 1	5.7	5.9	5.5	4.7	5.1	4.7
149	3.0e11	4.5e11	6D	0.0005	67/.68	1 / 1	5.3	4.7	4.7	4.1	4.1	4.1
150	3.0e11	5.0e11	6D	0.0005	67/.68	1 / 1	3.8	3.8	3.4	2.8	2.4	2.4
151	3.0e11	5.5e11	6D	0.0005	67/.68	1 / 1	1.4	1.2	0.8	0.6	3.8	0.6
152	3.0e11	6.0e11	6D	0.0005	67/.68	1 / 1	0.0	0.0	0.0	0.2	0.2	0.0

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scan electron beam size: (copy from workshop126) with Q'' correction, with PI phaser,

						factor (sigma_e= factor * sigma_p)						
175	2.0e11	6D	0.0005	.67/.68	1 / 1	0.6	0.0	0.0	0.0	0.0	0.0	0.0
176	2.0e11	6D	0.0005	.67/.68	1 / 1	0.8	4.7	4.7	3.4	4.1	5.1	3.4
177	2.0e11	6D	0.0005	.67/.68	1 / 1	1.0	6.7	6.7	6.1	5.7	5.5	5.5
178	2.0e11	6D	0.0005	.67/.68	1 / 1	1.2	7.1	7.1	6.9	5.7	5.3	5.3
179	2.0e11	6D	0.0005	.67/.68	1 / 1	1.4	7.9	7.1	6.1	6.5	5.3	5.3
180	2.0e11	6D	0.0005	.67/.68	1 / 1	1.6	7.3	6.9	6.1	5.9	5.3	5.3
181	2.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.9	6.7	6.7	6.3	5.5	5.5
182	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0	7.3	7.1	6.9	5.5	5.7	5.5
183	2.5e11	6D	0.0005	.67/.68	1 / 1	0.6	0.0	0.0	0.0	0.0	0.0	0.0
184	2.5e11	6D	0.0005	.67/.68	1 / 1	0.8	4.7	4.0	3.4	3.2	5.1	3.2
185	2.5e11	6D	0.0005	.67/.68	1 / 1	1.0	6.5	6.5	6.3	5.3	4.5	4.5
186	2.5e11	6D	0.0005	.67/.68	1 / 1	1.2	6.5	6.5	5.9	5.7	5.5	5.5
187	2.5e11	6D	0.0005	.67/.68	1 / 1	1.4	6.3	6.7	6.3	5.3	5.5	5.3
188	2.5e11	6D	0.0005	.67/.68	1 / 1	1.6	6.5	6.7	5.3	4.5	4.7	4.5
189	2.5e11	6D	0.0005	.67/.68	1 / 1	1.8	5.9	5.5	5.3	4.5	5.9	4.5
190	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0	5.9	6.3	4.5	4.7	5.7	4.5
191	3.0e11	6D	0.0005	.67/.68	1 / 1	0.6	0.0	0.0	0.0	0.0	0.0	0.0
192	3.0e11	6D	0.0005	.67/.68	1 / 1	0.8	4.7	4.1	3.8	2.8	4.5	2.8
193	3.0e11	6D	0.0005	.67/.68	1 / 1	1.0	5.5	6.3	5.3	4.5	4.0	4.0
194	3.0e11	6D	0.0005	.67/.68	1 / 1	1.2	5.9	5.7	4.9	4.7	4.5	4.5
195	3.0e11	6D	0.0005	.67/.68	1 / 1	1.4	5.5	5.5	4.7	4.5	3.6	3.6
196	3.0e11	6D	0.0005	.67/.68	1 / 1	1.6	4.5	4.5	4.0	3.6	3.6	3.6
197	3.0e11	6D	0.0005	.67/.68	1 / 1	1.8	5.7	4.9	3.8	4.1	6.3	3.8
198	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.3	5.5	3.4	3.8	6.3	3.4

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scan proton-electron X/Y offset: (from 0 to SEPMAX), with Q'' correction, with PI phaser

						offset[sigma]						
199	2.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.5	6.7	6.3	5.9	5.3	5.3
200	2.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.9	6.5	6.3	5.3	5.1	5.1
201	2.0e11	6D	0.0005	.67/.68	1 / 1	0.6	6.7	6.5	6.3	5.5	5.3	5.3
202	2.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.5	6.7	6.1	5.9	5.3	5.3
203	2.0e11	6D	0.0005	.67/.68	1 / 1	1.0	6.9	6.5	6.1	5.7	5.5	5.5
204	2.0e11	6D	0.0005	.67/.68	1 / 1	1.2	7.1	6.7	6.1	5.7	5.5	5.5

205	2.0e11	6D	0.0005	.67/.68	1 / 1	1.4	6.5	6.5	6.1	5.5	5.3	5.3
206	2.0e11	6D	0.0005	.67/.68	1 / 1	1.6	6.5	6.7	6.1	5.5	5.1	5.1
207	2.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.5	6.5	6.2	6.0	5.0	5.0
208	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.7	6.5	6.3	5.7	5.1	5.1
209	2.5e11	6D	0.0005	.67/.68	1 / 1	0.2	6.7	6.7	5.9	5.5	4.5	4.5
210	2.5e11	6D	0.0005	.67/.68	1 / 1	0.4	6.3	6.3	6.1	5.1	4.5	4.5
211	2.5e11	6D	0.0005	.67/.68	1 / 1	0.6	6.7	6.3	5.7	5.5	4.5	4.5
212	2.5e11	6D	0.0005	.67/.68	1 / 1	0.8	6.5	6.1	5.9	5.1	4.5	4.5
213	2.5e11	6D	0.0005	.67/.68	1 / 1	1.0	6.1	6.7	6.3	5.3	4.5	4.5
214	2.5e11	6D	0.0005	.67/.68	1 / 1	1.2	6.3	6.1	6.3	5.5	4.5	4.5
215	2.5e11	6D	0.0005	.67/.68	1 / 1	1.4	6.5	6.3	6.1	5.3	4.7	4.7
216	2.5e11	6D	0.0005	.67/.68	1 / 1	1.6	6.5	6.3	5.9	5.3	4.5	4.5
217	2.5e11	6D	0.0005	.67/.68	1 / 1	1.8	6.2	6.2	6.0	5.2	4.6	4.6
218	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0	6.3	6.5	6.3	5.7	4.7	4.7
219	3.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.3	6.1	5.7	4.7	4.3	4.3
220	3.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.3	6.1	6.1	4.0	4.7	4.0
221	3.0e11	6D	0.0005	.67/.68	1 / 1	0.6	6.3	5.7	5.9	4.5	4.0	4.0
222	3.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.0	6.0	5.4	4.0	5.0	4.0
223	3.0e11	6D	0.0005	.67/.68	1 / 1	1.0	5.7	6.5	5.3	4.5	4.7	4.5
224	3.0e11	6D	0.0005	.67/.68	1 / 1	1.2	6.3	5.7	5.5	4.5	4.1	4.1
225	3.0e11	6D	0.0005	.67/.68	1 / 1	1.4	5.5	5.7	5.7	5.1	4.0	4.0
226	3.0e11	6D	0.0005	.67/.68	1 / 1	1.6	5.7	6.1	5.9	4.7	4.0	4.0
227	3.0e11	6D	0.0005	.67/.68	1 / 1	1.8	5.9	6.3	5.3	5.5	3.8	3.8
228	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.5	6.1	5.3	4.9	4.0	4.0

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scan proton-electron crossing angle: (from 0-MAX in 8 slices), with Q'' correction, with PI phaser

						mrad						
229	2.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.5	6.9	6.5	5.7	5.5	5.5
230	2.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.5	6.7	6.3	5.9	5.3	5.3
231	2.0e11	6D	0.0005	.67/.68	1 / 1	0.6	6.5	6.9	6.5	5.7	5.3	5.3
232	2.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.7	6.7	6.3	5.5	5.3	5.3
233	2.0e11	6D	0.0005	.67/.68	1 / 1	1.0	6.7	6.7	6.1	5.5	5.3	5.3
234	2.0e11	6D	0.0005	.67/.68	1 / 1	1.2	6.5	6.5	6.1	5.5	5.1	5.1
235	2.0e11	6D	0.0005	.67/.68	1 / 1	1.4	6.7	6.7	6.1	5.7	5.1	5.1
236	2.0e11	6D	0.0005	.67/.68	1 / 1	1.6	6.5	6.9	6.3	5.3	6.3	5.3
237	2.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.7	6.9	6.3	5.9	5.3	5.3
238	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.9	6.7	6.1	5.3	6.3	5.3
239	2.5e11	6D	0.0005	.67/.68	1 / 1	0.2	6.3	6.1	5.9	5.3	4.5	4.5
240	2.5e11	6D	0.0005	.67/.68	1 / 1	0.4	6.5	6.5	6.1	5.9	4.5	4.5
241	2.5e11	6D	0.0005	.67/.68	1 / 1	0.6	6.9	7.1	6.7	5.5	5.1	5.1
242	2.5e11	6D	0.0005	.67/.68	1 / 1	0.8	6.5	6.5	6.1	5.5	4.9	4.9
243	2.5e11	6D	0.0005	.67/.68	1 / 1	1.0	6.7	6.5	6.5	5.7	4.9	4.9
244	2.5e11	6D	0.0005	.67/.68	1 / 1	1.2	7.1	6.9	6.1	5.9	4.9	4.9
245	2.5e11	6D	0.0005	.67/.68	1 / 1	1.4	6.3	6.9	6.3	5.9	5.1	5.1
246	2.5e11	6D	0.0005	.67/.68	1 / 1	1.6	6.7	6.5	6.1	5.7	5.3	5.3
247	2.5e11	6D	0.0005	.67/.68	1 / 1	1.8	6.7	6.9	6.3	5.7	5.5	5.5
248	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0	6.7	7.1	6.1	5.7	5.3	5.3
249	3.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.3	6.3	5.7	4.5	4.0	4.0
250	3.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.3	6.1	5.9	5.1	4.1	4.1
251	3.0e11	6D	0.0005	.67/.68	1 / 1	0.6	6.5	6.5	6.1	5.3	4.7	4.7
252	3.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.7	6.1	6.1	4.9	4.3	4.3
253	3.0e11	6D	0.0005	.67/.68	1 / 1	1.0	6.7	6.5	6.1	5.9	4.5	4.5
254	3.0e11	6D	0.0005	.67/.68	1 / 1	1.2	6.2	6.5	6.2	5.6	4.4	4.4
255	3.0e11	6D	0.0005	.67/.68	1 / 1	1.4	6.5	6.9	6.5	5.3	4.7	4.7
256	3.0e11	6D	0.0005	.67/.68	1 / 1	1.6	6.7	6.9	6.5	5.5	4.3	4.3
257	3.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.7	6.9	6.3	5.3	4.7	4.7
258	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.7	6.5	6.5	5.7	4.5	4.5

<< Repeat 199-258, but with 1.2 larger electron beam, sigma_e = 1.2 * sigma_p >>

scan proton-electron X/Y offset: (from 0 to SEPMAX), with Q'' correction, with PI phasers

						offset[sigma]						
259	2.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.9	7.1	6.5	5.5	5.1	5.1
260	2.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.9	6.9	6.7	5.7	4.5	4.5
261	2.0e11	6D	0.0005	.67/.68	1 / 1	0.6	7.3	7.1	6.7	6.3	6.3	6.3
262	2.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.7	7.9	6.5	5.1	4.9	4.9
263	2.0e11	6D	0.0005	.67/.68	1 / 1	1.0	7.3	6.9	6.7	6.1	5.3	5.3
264	2.0e11	6D	0.0005	.67/.68	1 / 1	1.2	7.0	6.2	6.2	6.2		
265	2.0e11	6D	0.0005	.67/.68	1 / 1	1.4	7.5	7.3	7.1	5.9	4.5	4.5
266	2.0e11	6D	0.0005	.67/.68	1 / 1	1.6	7.1	7.5	7.1	5.5	5.5	5.5
267	2.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.9	6.1	7.3	6.3	5.3	5.3
268	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.9	7.5	6.7	6.1	5.3	5.3
269	2.5e11	6D	0.0005	.67/.68	1 / 1	0.2	6.3	6.5	5.9	5.3	4.9	4.9
270	2.5e11	6D	0.0005	.67/.68	1 / 1	0.4	6.2	6.9	6.0	6.0	5.0	5.0
271	2.5e11	6D	0.0005	.67/.68	1 / 1	0.6	6.1	6.7	6.3	5.5	5.5	5.5
272	2.5e11	6D	0.0005	.67/.68	1 / 1	0.8	7.1	6.7	6.1	5.3	5.3	5.3
273	2.5e11	6D	0.0005	.67/.68	1 / 1	1.0	6.5	6.5	5.9	5.9	4.9	4.9
274	2.5e11	6D	0.0005	.67/.68	1 / 1	1.2	6.2	6.5	6.2	5.4	5.0	5.0
275	2.5e11	6D	0.0005	.67/.68	1 / 1	1.4	6.2	6.5	6.2	5.6	5.4	5.4
276	2.5e11	6D	0.0005	.67/.68	1 / 1	1.6	6.3	7.1	6.1	5.7	4.7	4.7
277	2.5e11	6D	0.0005	.67/.68	1 / 1	1.8	6.5	6.7	6.1	6.3	5.3	5.3
278	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0	6.5	6.5	6.3	5.7	5.3	5.3
279	3.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.0	5.6	5.4	4.8	4.4	4.4
280	3.0e11	6D	0.0005	.67/.68	1 / 1	0.4	5.6	5.6	5.0	4.6	4.4	4.4
281	3.0e11	6D	0.0005	.67/.68	1 / 1	0.6	5.7	5.7	5.5	4.7	4.7	4.7
282	3.0e11	6D	0.0005	.67/.68	1 / 1	0.8	5.8	6.2	5.0	5.4	4.4	4.4
283	3.0e11	6D	0.0005	.67/.68	1 / 1	1.0	5.7	5.5	6.3	4.7	4.7	4.7
284	3.0e11	6D	0.0005	.67/.68	1 / 1	1.2	5.9	5.5	5.1	4.7	4.5	4.5
285	3.0e11	6D	0.0005	.67/.68	1 / 1	1.4	6.7	5.9	6.3	4.1	4.1	4.1
286	3.0e11	6D	0.0005	.67/.68	1 / 1	1.6	6.0	6.2	5.3	5.6	4.4	4.4
287	3.0e11	6D	0.0005	.67/.68	1 / 1	1.8	5.2	6.0	6.0	4.6	4.4	4.4
288	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.7	6.3	5.5	4.5	5.1	4.5

scan proton-electron crossing angle: (from 0-MAX in 8 slices),with Q'' correction, with PI phasers

						mrad						
289	2.0e11	6D	0.0005	.67/.68	1 / 1	0.2	7.1	7.3	6.7	5.9	5.1	5.1
290	2.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.9	7.9	6.7	5.3	5.5	5.3
291	2.0e11	6D	0.0005	.67/.68	1 / 1	0.6	7.1	7.1	6.7	6.3	5.5	5.5
292	2.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.9	7.3	6.2	6.2	5.4	5.4
293	2.0e11	6D	0.0005	.67/.68	1 / 1	1.0	7.3	7.3	6.9	6.3	5.1	5.1
294	2.0e11	6D	0.0005	.67/.68	1 / 1	1.2	7.1	7.5	7.1	6.1	4.9	4.9
295	2.0e11	6D	0.0005	.67/.68	1 / 1	1.4	7.1	7.5	7.3	5.7	5.3	5.3
296	2.0e11	6D	0.0005	.67/.68	1 / 1	1.6	7.5	7.3	7.1	6.3	4.9	4.9
297	2.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.9	7.3	6.5	6.1	5.5	5.5
298	2.0e11	6D	0.0005	.67/.68	1 / 1	2.0	7.3	6.9	7.1	5.7	5.9	5.7
299	2.5e11	6D	0.0005	.67/.68	1 / 1	0.2	6.5	7.1	5.9	5.5	5.1	5.1
300	2.5e11	6D	0.0005	.67/.68	1 / 1	0.4	6.7	6.7	5.9	5.9	5.1	5.1
301	2.5e11	6D	0.0005	.67/.68	1 / 1	0.6	6.9	6.5	6.3	5.9	5.5	5.5
302	2.5e11	6D	0.0005	.67/.68	1 / 1	0.8	6.9	7.3	7.1	5.3	4.9	4.9
303	2.5e11	6D	0.0005	.67/.68	1 / 1	1.0	6.7	6.5	7.1	5.3	5.3	5.3
304	2.5e11	6D	0.0005	.67/.68	1 / 1	1.2	7.1	6.9	6.7	6.3	5.1	5.1
305	2.5e11	6D	0.0005	.67/.68	1 / 1	1.4	6.9	6.7	6.5	6.3	4.9	4.9
306	2.5e11	6D	0.0005	.67/.68	1 / 1	1.6	6.5	6.9	6.7	5.9	5.5	5.5
307	2.5e11	6D	0.0005	.67/.68	1 / 1	1.8	6.7	7.9	7.1	5.9	5.1	5.1

308	2.5e11	6D	0.0005	.67/.68	1 / 1	2.0	7.1	6.9	6.7	5.7	5.7	5.7

309	3.0e11	6D	0.0005	.67/.68	1 / 1	0.2	6.3	5.3	5.9	5.1	4.9	4.9
310	3.0e11	6D	0.0005	.67/.68	1 / 1	0.4	6.1	6.3	5.3	5.1	4.7	4.7
311	3.0e11	6D	0.0005	.67/.68	1 / 1	0.6	6.3	5.3	4.5	4.9	4.3	4.3
312	3.0e11	6D	0.0005	.67/.68	1 / 1	0.8	6.3	6.3	5.7	5.1	5.1	5.1
313	3.0e11	6D	0.0005	.67/.68	1 / 1	1.0	6.9	5.9	6.3	4.5	4.3	4.3
314	3.0e11	6D	0.0005	.67/.68	1 / 1	1.2	6.7	6.1	6.3	4.7	5.1	4.7
315	3.0e11	6D	0.0005	.67/.68	1 / 1	1.4	6.5	6.3	5.5	4.9	5.1	4.9
316	3.0e11	6D	0.0005	.67/.68	1 / 1	1.6	6.7	6.7	5.3	4.9	5.5	4.9
317	3.0e11	6D	0.0005	.67/.68	1 / 1	1.8	6.9	5.9	7.1	5.5	4.5	4.5
318	3.0e11	6D	0.0005	.67/.68	1 / 1	2.0	6.7	5.7	5.9	4.7	5.1	4.7

Scan proton beam working points, with Q’’ correction, with PI phasers

baseline copied from workshop126

474	2.0e11	6D	0.0005	0.67 / 0.675	1 / 1	6.3	6.1	6.7	5.9	5.3	5.3
475	2.0e11	6D	0.0005	0.675 / 0.680	1 / 1	7.9	6.5	6.7	5.7	5.7	5.7
476	2.0e11	6D	0.0005	0.680 / 0.685	1 / 1	5.3	5.5	5.7	4.5	4.3	4.3
477	2.0e11	6D	0.0005	0.685 / 0.68	1 / 1	5.9	4.3	5.7	5.9	5.7	4.3
478	2.0e11	6D	0.0005	0.68 / 0.675	1 / 1	6.5	5.9	6.5	6.9	6.3	5.9
479	2.0e11	6D	0.0005	0.675 / 0.67	1 / 1	5.3	5.7	6.3	6.3	6.1	5.3

baseline copied from workshop135

480	2.5e11	6D	0.0005	0.67 / 0.675	1 / 1	6.1	6.7	6.1	5.9	4.9	4.9
481	2.5e11	6D	0.0005	0.675 / 0.680	1 / 1	5.7	5.7	5.5	5.3	4.7	4.7
482	2.5e11	6D	0.0005	0.680 / 0.685	1 / 1	5.3	5.7	5.1	4.7	5.1	4.7
483	2.5e11	6D	0.0005	0.685 / 0.68	1 / 1	6.3	4.3	5.1	5.1	4.5	4.3
484	2.5e11	6D	0.0005	0.68 / 0.675	1 / 1	5.9	5.5	6.1	5.9	7.1	5.5
485	2.5e11	6D	0.0005	0.675 / 0.67	1 / 1	5.9	5.7	6.5	6.7	6.5	5.7

baseline copied from workshop146

486	3.0e11	6D	0.0005	0.67 / 0.675	1 / 1	6.5	6.1	6.1	5.5	5.5	5.5
487	3.0e11	6D	0.0005	0.675 / 0.680	1 / 1	6.1	4.7	5.9	4.0	3.8	3.8
488	3.0e11	6D	0.0005	0.680 / 0.685	1 / 1	4.1	3.8	3.8	4.1	4.1	3.8
489	3.0e11	6D	0.0005	0.685 / 0.68	1 / 1	5.9	4.9	4.0	4.7	3.8	3.8
490	3.0e11	6D	0.0005	0.68 / 0.675	1 / 1	6.3	5.1	5.7	5.7	5.3	5.1
491	3.0e11	6D	0.0005	0.675 / 0.67	1 / 1	5.5	5.7	6.3	6.9	6.5	5.5

Summary of DA calculation with HBBC, PI phasers, Q’’ correction.

scan proton bunch intensity, baseline copied from workshop135

(workshop259-302 DA_binary1.cpp destoryed unfortunately and DA_binary_search1 reproduced)

< BB at IP6 and IP8, no Q’’ correct. >

492	1.2e11	6D	0.0003	0.67 / 0.68	1 / 1	7.7	7.5	6.9	6.1	6.5	6.1
493	1.4e11	6D	0.0003	0.67 / 0.68	1 / 1	7.9	7.5	7.5	6.1	5.9	5.9
494	1.6e11	6D	0.0003	0.67 / 0.68	1 / 1	7.9	7.7	7.9	6.7	6.1	6.1
495	1.8e11	6D	0.0003	0.67 / 0.68	1 / 1	7.7	7.7	7.1	6.7	5.9	5.9
496	2.0e11	6D	0.0003	0.67 / 0.68	1 / 1	7.1	7.9	7.3	6.5	5.7	5.7
497	2.2e11	6D	0.0003	0.67 / 0.68	1 / 1	8.4	6.9	6.5	6.1	6.9	6.1
498	2.4e11	6D	0.0003	0.67 / 0.68	1 / 1	8.1	6.1	6.7	6.3	5.7	5.7
499	2.6e11	6D	0.0003	0.67 / 0.68	1 / 1	7.3	6.7	5.9	4.7	6.3	4.7
500	2.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.5	5.7	5.3	5.7	5.3
501	3.0e11	6D	0.0003	0.67 / 0.68	1 / 1	5.7	4.7	4.5	4.3	6.7	4.3

502	1.2e11	6D	0.0005	0.67 / 0.68	1 / 1	7.7	7.9	6.7	5.7	5.7	5.7
503	1.4e11	6D	0.0005	0.67 / 0.68	1 / 1	7.5	7.3	7.1	6.1	5.3	5.3
504	1.6e11	6D	0.0005	0.67 / 0.68	1 / 1	7.7	7.5	6.9	6.1	5.7	5.7
505	1.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.9	7.5	6.9	5.9	5.9	5.9
506	2.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.9	6.7	6.3	5.5	4.9	4.9
507	2.2e11	6D	0.0005	0.67 / 0.68	1 / 1	5.5	5.5	6.3	4.3	4.3	4.3
508	2.4e11	6D	0.0005	0.67 / 0.68	1 / 1	7.1	4.9	5.1	3.8	5.1	3.8
509	2.6e11	6D	0.0005	0.67 / 0.68	1 / 1	5.9	5.3	4.0	4.0	3.8	3.8
510	2.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	5.1	3.6	3.0	4.7	3.0
511	3.0e11	6D	0.0005	0.67 / 0.68	1 / 1	4.7	4.0	3.2	2.8	4.1	2.8

< BB at IP6 and IP8, with Q'' correct. >

580	1.2e11	6D	0.0003	0.67 / 0.68	1 / 1	7.7	7.3	6.9	6.7	6.5	6.5
581	1.4e11	6D	0.0003	0.67 / 0.68	1 / 1	7.7	7.7	7.7	6.3	6.7	6.3
582	1.6e11	6D	0.0003	0.67 / 0.68	1 / 1	8.4	8.1	7.7	6.7	7.3	6.7
583	1.8e11	6D	0.0003	0.67 / 0.68	1 / 1	7.7	7.5	7.5	6.7	6.7	6.7
584	2.0e11	6D	0.0003	0.67 / 0.68	1 / 1	7.9	8.1	7.5	6.1	5.9	5.9
585	2.2e11	6D	0.0003	0.67 / 0.68	1 / 1	8.4	8.1	6.5	7.1	6.9	6.5
586	2.4e11	6D	0.0003	0.67 / 0.68	1 / 1	8.1	8.1	6.1	6.5	5.9	5.9
587	2.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	7.5	5.3	4.9	6.7	4.9
588	2.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.7	5.5	5.9	6.1	5.5
589	3.0e11	6D	0.0003	0.67 / 0.68	1 / 1	5.3	4.7	4.5	4.3	6.9	4.3

590	1.2e11	6D	0.0005	0.67 / 0.68	1 / 1	7.3	7.3	6.7	6.1	6.3	6.1
591	1.4e11	6D	0.0005	0.67 / 0.68	1 / 1	7.3	7.9	6.9	5.9	5.7	5.7
592	1.6e11	6D	0.0005	0.67 / 0.68	1 / 1	7.9	7.9	6.9	7.1	5.7	5.7
593	1.8e11	6D	0.0005	0.67 / 0.68	1 / 1	7.9	7.5	6.9	6.3	5.7	5.7
594	2.0e11	6D	0.0005	0.67 / 0.68	1 / 1	7.1	6.9	5.9	6.3	5.7	5.7
595	2.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	6.3	5.9	4.7	5.9	4.7
596	2.4e11	6D	0.0005	0.67 / 0.68	1 / 1	5.7	5.3	4.7	4.5	4.1	4.1
597	2.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	6.5	4.1	3.8	4.3	3.8
598	2.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	5.9	3.6	5.1	6.3	3.6
599	3.0e11	6D	0.0005	0.67 / 0.68	1 / 1	4.7	3.6	3.4	4.0	4.3	3.4

< With HBBC, no Q'' correct. >

512	1.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	5.7	4.9	5.3	4.7	4.7
513	1.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	5.7	5.3	4.5	4.9	4.5
514	1.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.3	5.3	4.7	4.9	4.7
515	1.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.9	6.3	5.9	4.7	4.9	4.7
516	2.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.7	5.7	5.1	4.7	4.7
517	2.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.9	5.3	5.3	4.9	4.9
518	2.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.9	5.7	5.5	5.3	5.3
519	2.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	5.9	5.9	5.5	4.9	4.9
520	2.8e11	6D	0.0003	0.67 / 0.68	1 / 1	5.9	5.9	5.9	4.9	4.9	4.9
521	3.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.1	5.7	5.9	4.5	4.3	4.3

522	1.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	5.5	4.7	4.5	4.9	4.5
523	1.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	5.7	4.3	4.3	4.3	4.3
524	1.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	5.5	4.9	4.5	4.7	4.5
525	1.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	5.9	5.9	4.9	4.9	4.9
526	2.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	6.1	5.7	4.7	4.7	4.7
527	2.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	5.9	5.9	4.9	4.7	4.7
528	2.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.3	5.5	5.1	4.7	4.7
529	2.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.3	4.9	5.5	4.5	4.5
530	2.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	5.7	4.9	4.5	4.1	4.1
531	3.0e11	6D	0.0005	0.67 / 0.68	1 / 1	5.7	6.3	4.9	4.9	4.3	4.3

< With BBC, with PI phasers, no Q'' correct. >

532	1.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.3	5.7	5.7	5.1	5.1
533	1.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.7	5.9	5.9	5.3	5.3
534	1.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.5	6.1	6.3	5.3	5.3
535	1.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.9	6.9	6.3	5.7	5.1	5.1
536	2.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.9	6.7	6.5	5.7	5.7	5.7
537	2.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.9	6.3	5.7	5.3	5.3
538	2.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.7	6.1	5.5	5.3	5.3
539	2.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.3	6.3	5.7	4.9	5.1	4.9
540	2.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.5	6.5	5.9	4.3	4.3
541	3.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	5.9	5.7	4.3	4.1	4.1

542	1.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.3	5.3	5.7	4.9	4.9
543	1.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.7	5.7	5.7	5.3	5.3
544	1.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.9	6.5	5.9	5.1	4.9	4.9
545	1.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.7	6.1	5.5	5.5	5.5
546	2.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.9	6.9	6.3	5.3	5.5	5.3
547	2.2e11	6D	0.0005	0.67 / 0.68	1 / 1	7.1	6.7	6.3	5.5	5.3	5.3
548	2.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.7	6.1	5.3	4.7	4.7
549	2.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.7	5.9	4.9	4.1	4.1
550	2.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	6.1	5.5	4.5	4.1	4.1
551	3.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.1	6.1	4.7	5.1	3.8	3.8

< With BBC, PI phasers, Q'' correction >

552	1.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.1	5.3	5.7	6.1	5.3
553	1.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.3	5.9	5.9	6.3	5.9
554	1.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.9	6.5	5.9	6.1	6.3	5.9
555	1.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.7	6.3	5.9	5.5	5.5
556	2.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.9	6.3	5.9	5.9	5.9
557	2.2e11	6D	0.0003	0.67 / 0.68	1 / 1	6.7	6.5	6.3	5.9	5.9	5.9
558	2.4e11	6D	0.0003	0.67 / 0.68	1 / 1	6.5	6.7	6.3	5.7	5.3	5.3
559	2.6e11	6D	0.0003	0.67 / 0.68	1 / 1	6.3	6.5	6.3	5.9	5.7	5.7
560	2.8e11	6D	0.0003	0.67 / 0.68	1 / 1	6.3	6.5	5.9	5.3	6.3	5.3
561	3.0e11	6D	0.0003	0.67 / 0.68	1 / 1	6.1	6.3	5.9	4.7	4.1	4.1

562	1.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.1	5.3	5.1	4.9	4.9
563	1.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.3	5.7	5.5	4.9	4.9
564	1.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.5	5.9	5.5	5.1	5.1
565	1.8e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.7	6.1	5.9	5.5	5.5
566	2.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.3	5.9	5.5	5.3	5.3
567	2.2e11	6D	0.0005	0.67 / 0.68	1 / 1	6.5	6.9	6.3	5.7	5.5	5.5
568	2.4e11	6D	0.0005	0.67 / 0.68	1 / 1	6.7	6.7	6.1	5.7	5.1	5.1
569	2.6e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	6.5	5.9	6.3	4.5	4.5
570	2.8e11	6D	0.0005	0.67 / 0.68	1 / 1	5.9	7.1	6.3	4.7	4.1	4.1
571	3.0e11	6D	0.0005	0.67 / 0.68	1 / 1	6.3	5.9	5.9	4.7	4.1	4.1

copy workshop508 to 572 , redo Np=2.5e11 BB only to check DA in 75 degree

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7 Appendix II: DAs with 4-D beam-beam treatment

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Subject:   Evaluation of dynamic aperture in presence of  head-on beam-beam compensation in RHIC
BB at IP6 and IP8:  4-D weak-strong
E-lens :    4-D weak-strong with zero length

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JobID   NP       BB      DELTA     Q     Q'        DA( 15 / 30 / 45 / 60/ 75 / minimum )

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Only BB at IP6:

  89     2.0e11  4D       0.0       .67/.68  1/1      6.9    7.5    7.1    5.9    7.5    5.9
  90     2.5e11  4D       0.0       .67/.68  1/1      6.7    6.5    6.5    6.3    7.1    6.3
  91     3.0e11  4D       0.0       .67/.68  1/1      6.7    6.3    6.5    6.1    7.7    6.1

  92     2.0e11  4D       0.0005    .67/.68  1/1      6.7    6.7    6.1    5.5    5.1    5.1
  93     2.5e11  4D       0.0005    .67/.68  1/1      6.7    6.1    5.7    5.1    4.7    4.7
  94     3.0e11  4D       0.0005    .67/.68  1/1      5.7    5.1    4.5    3.8    4.7    3.8


Only BB at IP6 and IP8:

  95     2.0e11  4D       0.0       .67/.68  1/1      6.1    5.7    6.3    6.3    7.9    5.7
  96     2.5e11  4D       0.0       .67/.68  1/1      7.9    6.3    6.3    6.9    7.3    6.3
  97     3.0e11  4D       0.0       .67/.68  1/1      8.4    6.7    5.5    7.1    7.3    5.5

  98     2.0e11  4D       0.0005    .67/.68  1/1      5.5    4.3    3.8    3.6    4.1    3.6
  99     2.5e11  4D       0.0005    .67/.68  1/1      4.1    3.8    3.6    3.2    3.2    3.2
 100     3.0e11  4D       0.0005    .67/.68  1/1      4.1    3.4    2.8    2.6    2.4    2.4


HBBC No phasers:

 51      2.0e11  4D       0.0       .67/.68  1/1     6.7    6.7    6.7    6.5    5.9    5.9
 52      2.5e11  4D       0.0       .67/.68  1/1     6.5    6.5    5.7    4.9    6.3    4.9
 53      3.0e11  4D       0.0       .67/.68  1/1     6.3    5.7    5.3    5.9    5.9    5.3

 54      2.0e11  4D       0.0005    .67/.68  1/1     6.5    6.1    4.9    4.5    4.3    4.3
 55      2.5e11  4D       0.0005    .67/.68  1/1     6.1    5.3    4.5    4.0    4.0    4.0
 56      3.0e11  4D       0.0005    .67/.68  1/1     4.1    4.3    4.0    3.4    3.2    3.2

HBBC Added Phasers:

 57      2.0e11  4D       0.0       .67/.68  1/1    6.5    6.7    6.3    6.5    6.5    6.3
 58      2.5e11  4D       0.0       .67/.68  1/1    6.1    6.1    6.3    5.7    6.5    5.7
 59      3.0e11  4D       0.0       .67/.68  1/1    5.9    5.7    5.5    5.5    6.5    5.5

 60      2.0e11  4D       0.0005    .67/.68  1/1    6.5    6.5    5.9    5.3    4.1    4.1
 61      2.5e11  4D       0.0005    .67/.68  1/1    6.1    6.1    5.7    4.5    4.1    4.1
 62      3.0e11  4D       0.0005    .67/.68  1/1    5.3    4.9    4.7    3.8    3.4    3.4

Scan deltap  on top of phasers PI

  63     2.5e11  4D       -0.0005  .67/.68  1/1     5.9    5.5    5.5    4.3    4.0    4.0
  64     2.5e11  4D       -0.0004  .67/.68  1/1     5.9    5.3    6.3    4.9    4.3    4.3
  65     2.5e11  4D       -0.0003  .67/.68  1/1     5.9    6.1    5.9    4.7    4.3    4.3
  66     2.5e11  4D       -0.0002  .67/.68  1/1     5.9    5.7    5.9    4.3    4.5    4.3
  67     2.5e11  4D       -0.0001  .67/.68  1/1     6.1    6.3    5.9    4.9    5.5    4.9
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68	2.5e11	4D	0.000	.67/.68	1/1	6.1	6.1	6.3	5.7	6.5	5.7
69	2.5e11	4D	0.0001	.67/.68	1/1	6.3	6.5	5.3	5.1	5.5	5.1
70	2.5e11	4D	0.0002	.67/.68	1/1	6.3	6.3	5.9	4.9	4.9	4.9
71	2.5e11	4D	0.0003	.67/.68	1/1	6.1	6.3	5.7	4.5	4.5	4.5
72	2.5e11	4D	0.0004	.67/.68	1/1	6.1	6.5	5.3	4.5	4.3	4.3
73	2.5e11	4D	0.0005	.67/.68	1/1	6.1	6.1	5.7	4.5	4.1	4.1

Scan Q' on top of phaser PI

74	2.5e11	4D	0.0005	67/.68	-4/-4	5.9	5.5	5.7	4.3	4.1	4.1
75	2.5e11	4D	0.0005	.67/.68	-3/-3	6.5	6.3	5.3	4.9	4.3	4.3
76	2.5e11	4D	0.0005	.67/.68	-2/-2	5.9	6.3	5.5	4.7	4.3	4.3
77	2.5e11	4D	0.0005	.67/.68	-1/-1	6.3	6.3	6.1	4.3	4.1	4.1
78	2.5e11	4D	0.0005	.67/.68	0/ 0	6.1	5.9	5.5	4.7	4.1	4.1
79	2.5e11	4D	0.0005	.67/.68	1/ 1	6.1	6.1	5.7	4.5	4.1	4.1
80	2.5e11	4D	0.0005	.67/.68	2/ 2	5.9	5.9	5.1	4.7	4.0	4.0
81	2.5e11	4D	0.0005	67/.68	3/ 3	5.7	5.5	4.9	4.5	3.8	3.8
82	2.5e11	4D	0.0005	67/.68	4/ 4	5.5	5.3	5.1	4.5	3.6	3.6

With Q'' correction , Q'=1, phasers PI etc.

83	2.0e11	4D	0.000	67/.68	1 / 1	8.1	6.7	6.3	6.7	5.9	5.9
84	2.5e11	4D	0.000	.67/.68	1 / 1	6.1	6.5	5.9	5.7	6.3	5.7
85	3.0e11	4D	0.000	.67/.68	1 / 1	5.9	5.9	5.9	5.5	6.5	5.5
86	2.0e11	4D	0.0005	67/.68	1 / 1	6.5	6.5	6.1	5.3	4.7	4.7
87	2.5e11	4D	0.0005	.67/.68	1 / 1	6.3	5.9	5.3	4.9	4.3	4.3
88	3.0e11	4D	0.0005	.67/.68	1 / 1	5.3	5.3	4.5	4.0	3.8	3.8

on top of above, scan phasers away from PI

						Mfront [degree]						
112	2.5e11	4D	0.0005	67/.68	1 / 1	20+	6.1	5.3	4.7	4.5	4.3	4.3
113	2.5e11	4D	0.0005	.67/.68	1 / 1	15+	5.9	5.3	4.9	4.5	4.3	4.3
114	2.5e11	4D	0.0005	.67/.68	1 / 1	10+	5.7	6.1	5.5	4.7	4.1	4.1
115	2.5e11	4D	0.0005	67/.68	1 / 1	5+	6.3	6.3	5.3	4.9	4.1	4.1
116	2.5e11	4D	0.0005	.67/.68	1 / 1	2.5+	6.1	6.1	5.7	4.7	4.1	4.1
117	2.5e11	4D	0.0005	.67/.68	1 / 1	0	6.1	6.1	5.5	4.9	4.1	4.1
118	2.5e11	4D	0.0005	67/.68	1 / 1	-2.5	6.1	6.3	5.5	4.7	4.3	4.3
119	2.5e11	4D	0.0005	.67/.68	1 / 1	-5	6.1	6.3	5.9	4.7	4.5	4.5
120	2.5e11	4D	0.0005	.67/.68	1 / 1	-10	6.1	5.7	5.3	4.5	4.5	4.5
121	2.5e11	4D	0.0005	67/.68	1 / 1	-15	6.3	6.3	5.3	4.5	4.5	4.5
122	2.5e11	4D	0.0005	.67/.68	1 / 1	-20	6.1	6.3	5.3	4.5	4.5	4.5
164	2.5e11	4D	0.0005	67/.68	1 / 1	2.5+	6.1	6.1	5.7	4.7	4.1	4.1
165	2.5e11	4D	0.0005	.67/.68	1 / 1	2.0+	6.3	5.7	5.7	4.5	4.5	4.5
166	2.5e11	4D	0.0005	.67/.68	1 / 1	1.5+	5.9	5.9	5.9	4.9	4.1	4.1
167	2.5e11	4D	0.0005	67/.68	1 / 1	1.0	5.7	5.9	5.5	4.5	4.1	4.1
168	2.5e11	4D	0.0005	.67/.68	1 / 1	.5+	6.1	6.1	6.1	4.5	4.3	4.3
169	2.5e11	4D	0.0005	.67/.68	1 / 1	0	6.1	6.1	5.5	4.9	4.1	4.1
170	2.5e11	4D	0.0005	67/.68	1 / 1	-0.5	6.5	6.3	5.7	4.9	4.9	4.9
171	2.5e11	4D	0.0005	.67/.68	1 / 1	-1.0	6.1	6.5	5.7	4.5	4.3	4.3
172	2.5e11	4D	0.0005	.67/.68	1 / 1	-1.5	5.9	6.1	5.5	4.7	4.3	4.3
173	2.5e11	4D	0.0005	67/.68	1 / 1	-2.0	6.3	5.9	5.3	5.1	4.3	4.3
174	2.5e11	4D	0.0005	.67/.68	1 / 1	-2.5	6.1	6.3	5.5	4.7	4.3	4.3