Bunch filling pattern
with harmonic number 315

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Assumptions

1) proton beam circulate counter-clockwise, electron clockwise;

2) Base harmonic numbers:

    proton ring: 1260

    electron ring: 1260 * 6 = 7560

3) Bunch numbers:

               1260 per ring (best)

4) abort gap not into consideration this time.

DCR

System	RF System Name	h	H	Frequency (MHz)
hR	Capture/Accel	315	1	24.623
hR	Bunch Split 1	630	2	49.265
hR	Bunch Split 2	1260	4	98.529
hR	Store 1	2520	8	197.059
hR	Store 2	7560	24	591.177
eSR	Store 1	7560	24	591.177
eSR	Store 2	22680	72	1773.531
hR	hCrab	5040	16	394.118
eSR	eCrab	5040	16	394.118
SHC	SHC ERL	7560	24	591.177

Proposed Filling Pattern

- Proton:

  uniform filling 1260 bunches along the ring

- Electron:

  (**210*6 + 2 + 209*6 +4) * 3**

  3 batches whole ring ; Each batch consists of two trains:

  210 bunch and 209 bunches separated by 2 electron buckets

- PHENIX:

  shifted south by 1 electron bucket: 0.507meter

Collisions per turn
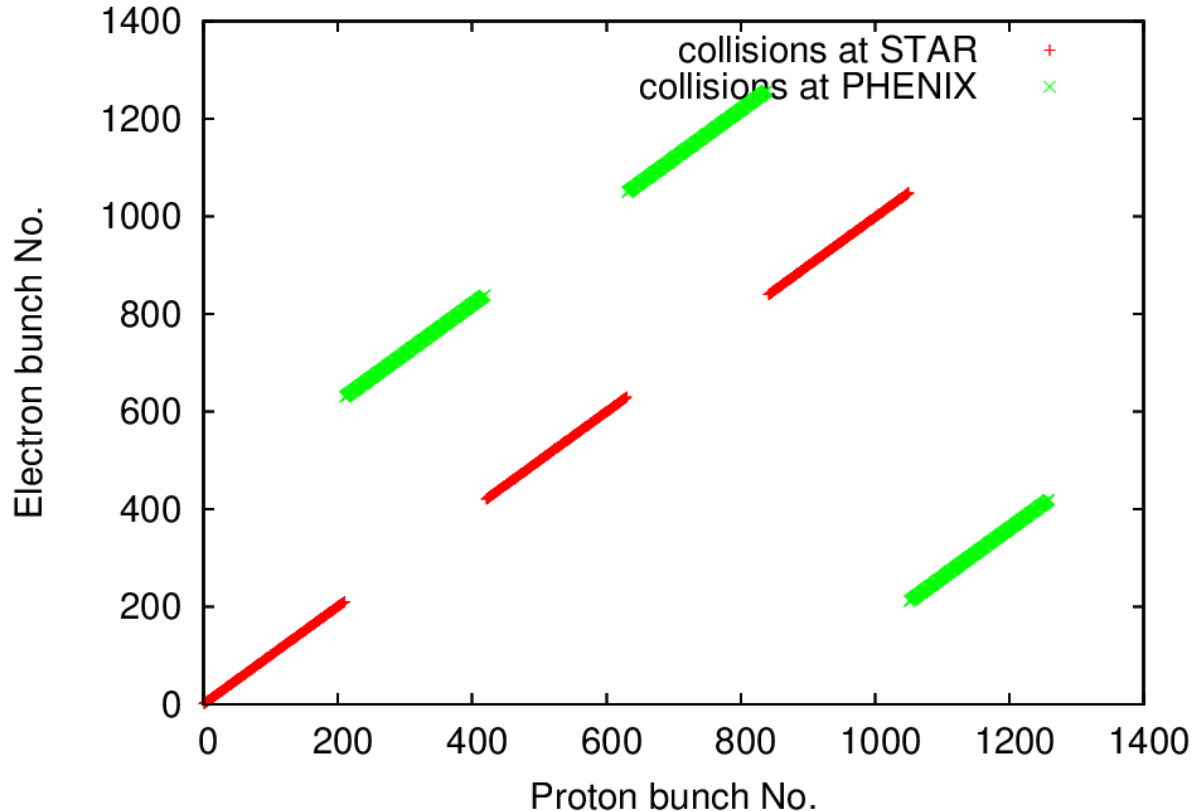
1) 1260 p bunches, 1257 e bunches.

2) Each turn, 630 collisions at STAR, 627 collisions at PHENIX.

3) Each bunch only collide once per turn!

Crab cavity frequencies

1) Proton bunch uniformly filled.

2) Electron bunches not uniformly filled but they are separated by 2 * M, M integer electron buckets.

   2 electron bucket corresponds to

$$(591.177 \text{MHz} \ / \ 3) = 197.059 \text{ MHz}$$

3) Therefore, both 197.059MHz and 197.059*2 = 394.118MHz can be used to crab all bunches at IP6 and IP8.

Conclusion

1) Checked the bunch filling pattern and collision patterns with proposed h=315, instead of tranditional 360.

2) There is no issue to collide beams at STAR and PHENIX simultaneously. The luminosity will be almost equally shared by both detectors. And each bunch only collide once per turn. No gear-changing beam-beam collision.

3) Both 197MHz and 394MHz can be chosen for crab cavity frequency in the electron ring.