

Beam-beam simulations for SuperKEKB Phase-3

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Acknowledgements:

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Outline

- **Introduction**
- **Simulation using BBWS and BBSS**
- **Summary**

1. Introduction

➤ Phase-3 machine parameters (Road map)

- Ref. A. Morita, Talk at SuperKEKB commissioning meeting, Oct. 12, 2018

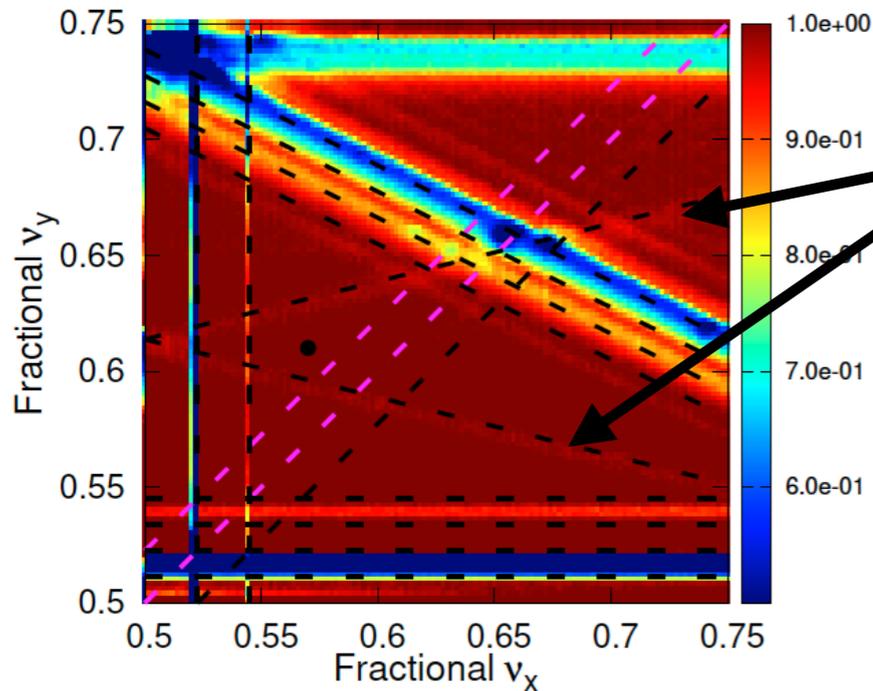
	1		1ex		2		2ex		3		3'		3ex	
	HER	LER												
I_b (A)	1.0	1.2	1.0	1.4	1.0	1.4	1.2	1.7	1.3	1.8	1.15	1.6	1.4	2.0
# bunch	1576		1576		1576		1576		1576		1576		1576	
ϵ_x (nm)	4.6	2.0	4.6	2.0	4.6	2.0	4.6	2.0	4.6	2.0	4.6	2.0	4.6	2.0
ϵ_y (pm)	368	160	230	150	138	140	128.8	130	138	140	101.2	100	101.2	100
β_x (mm)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
β_y (mm)	3	3	3	3	2	2	2	2	1.4	1.4	1.25	1.25	1.2	1.2
σ_z (mm)	6	6	6	6	6	6	6	6	6	6	6	6	6	6
v_x	45.57	44.57	45.57	44.57	45.57	44.57	45.57	44.57	45.57	44.57	45.57	44.57	45.57	44.57
v_y	43.61	46.61	43.61	46.61	43.61	46.61	43.61	46.61	43.61	46.61	43.61	46.61	43.61	46.61
v_s	0.0258	0.0225	0.0258	0.0225	0.0258	0.0225	0.0258	0.0225	0.0258	0.0225	0.0258	0.0225	0.0258	0.0225
ξ_y (Geom.)	0.0272	0.0262	0.0328	0.0331	0.0278	0.0351	0.0351	0.0436	0.0302	0.0387	0.0301	0.0397	0.0369	0.0453
\mathcal{L} (Geom.)	1.06E+34		1.46E+34		2.08E+34		3.14E+34		4.11E+34		4.00E+34		6.20E+34	
\mathcal{L} (BBSS)	1.00E+34		1.30E+34		1.74E+34		2.16E+34		2.52E+34		2.55E+34		3.21E+34	

2. BBWS simulation: Tune scan

Talk on Dec.13, 2018

➤ Parameter set (1)

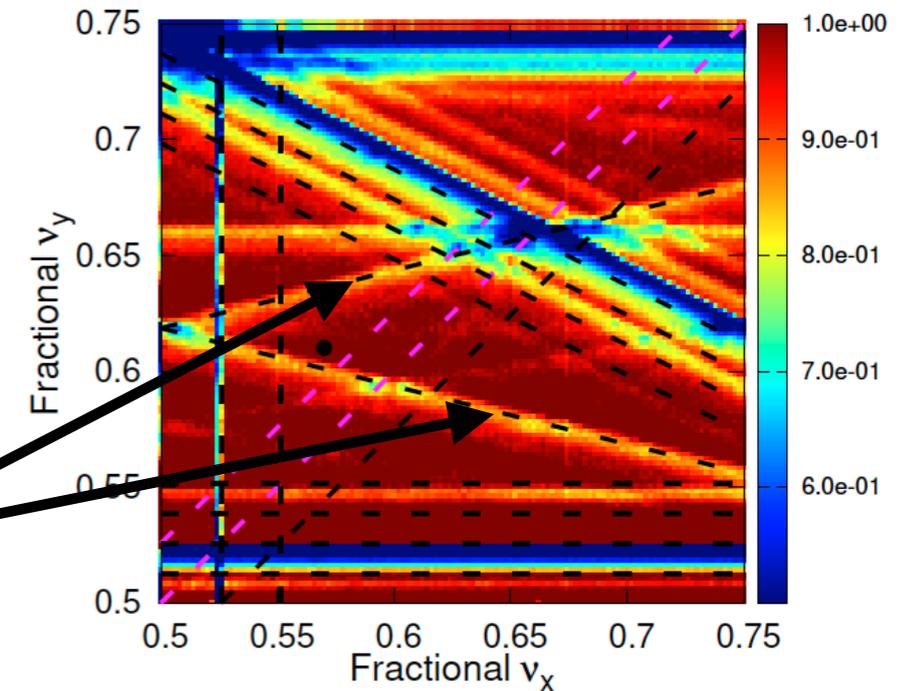
$e+(W)e-(S)$
Lum. (L/L_0)



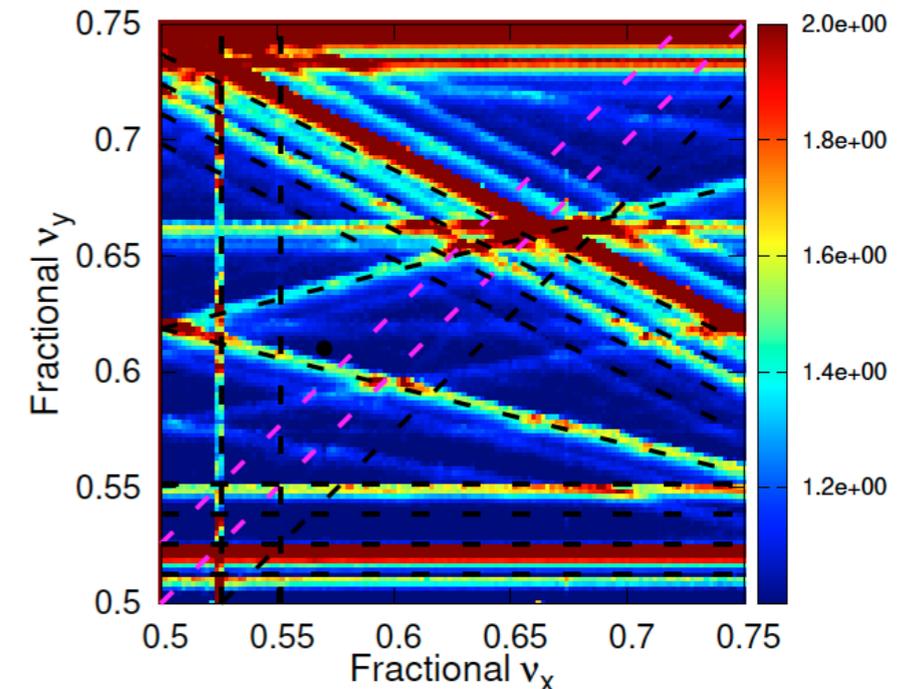
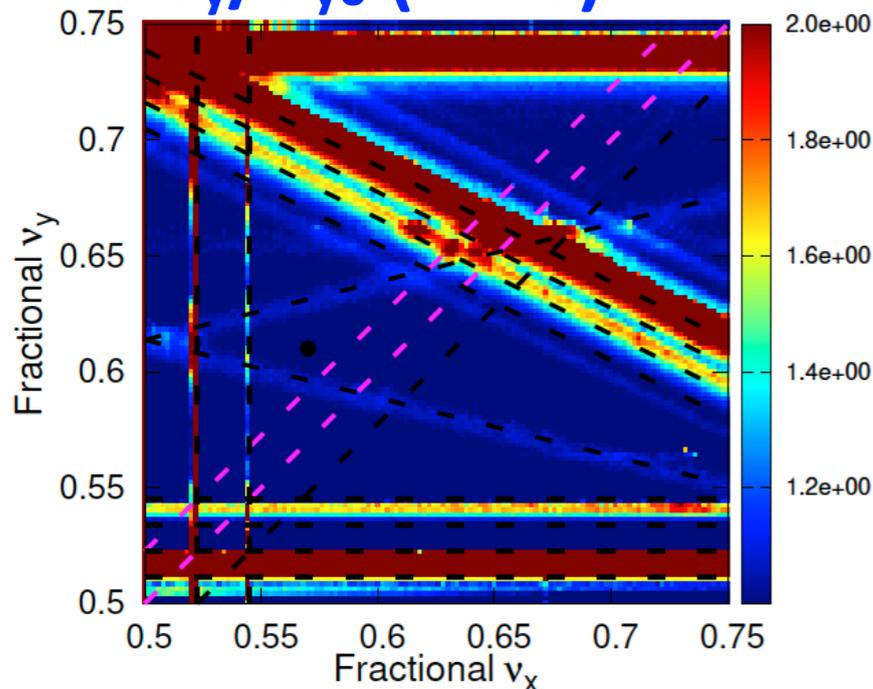
$$\pm v_x + 4v_y + 2v_s = N$$

$$\pm v_x + 4v_y + v_s = N$$

$e+(S)e-(W)$



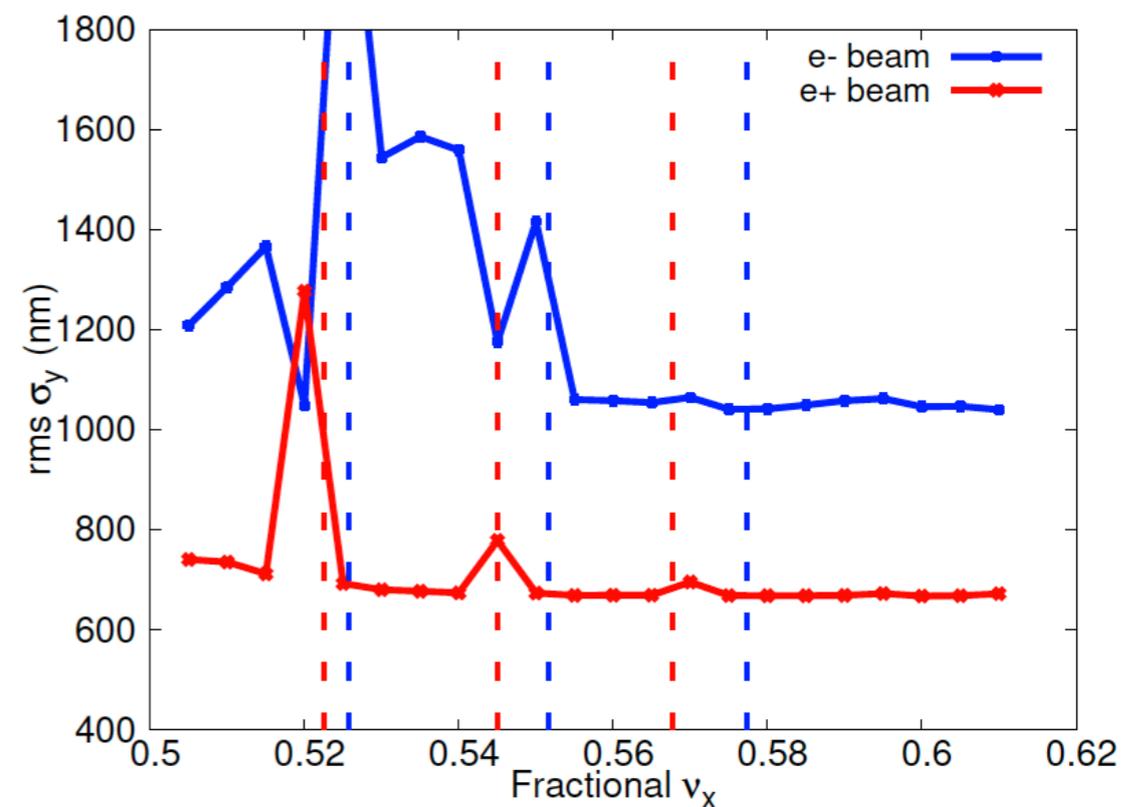
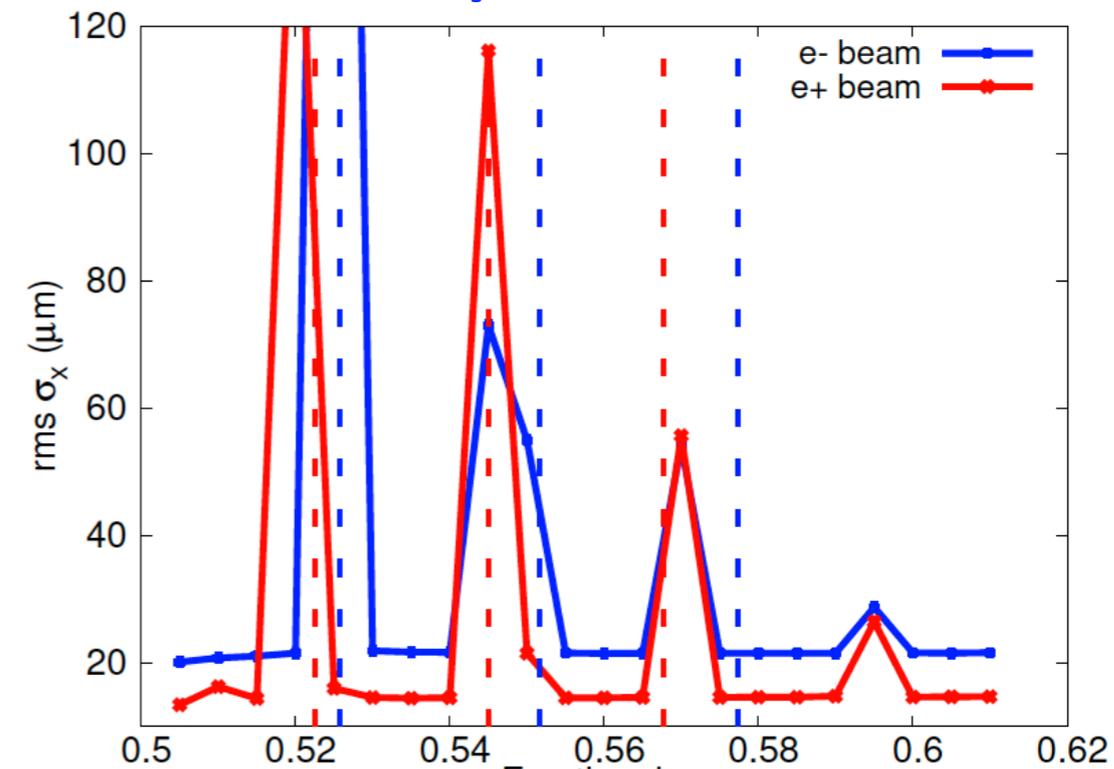
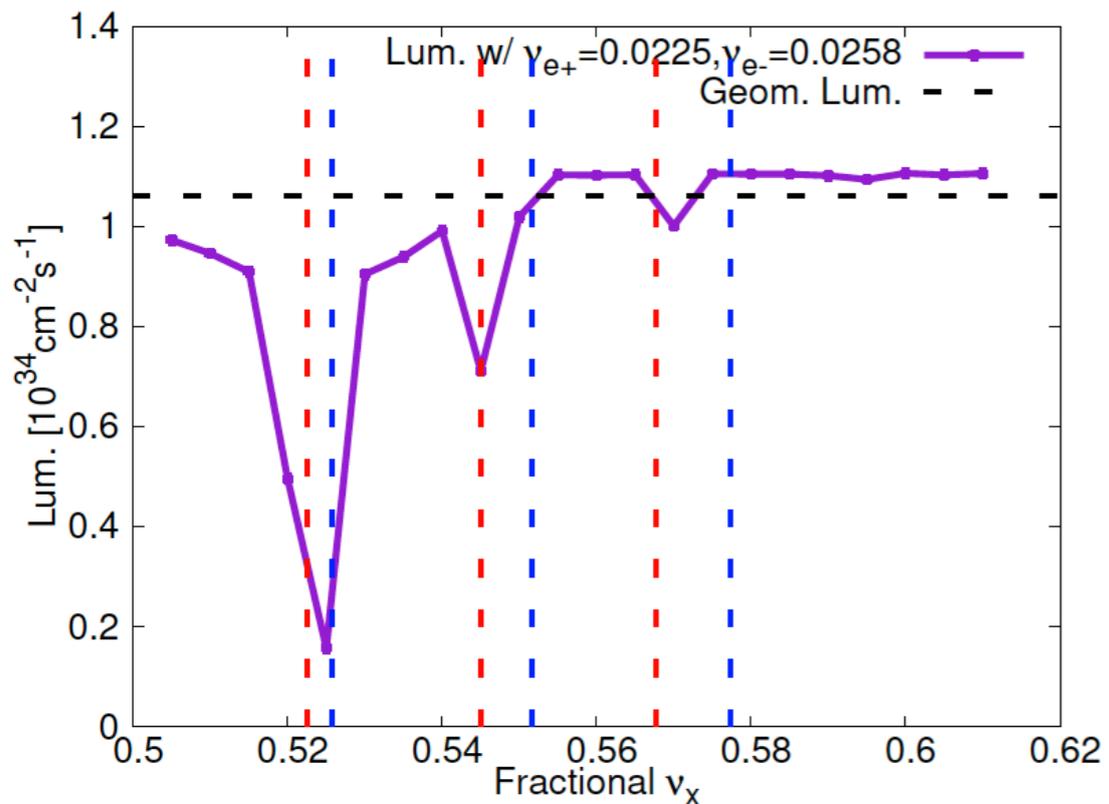
σ_y/σ_{y0} (RMS)



2. BBSS simulation

➤ All parameter set (1): $v_y = *.61$

● Scan of v_x (same fractional part for LER and HER)

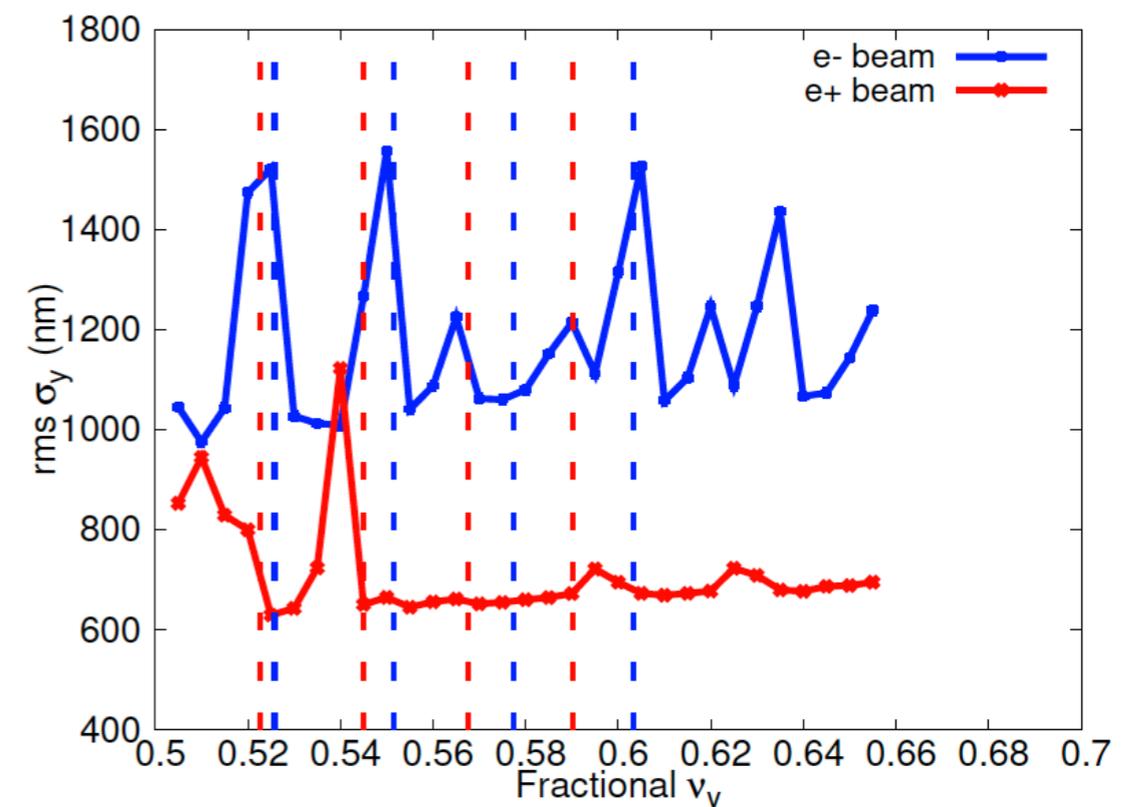
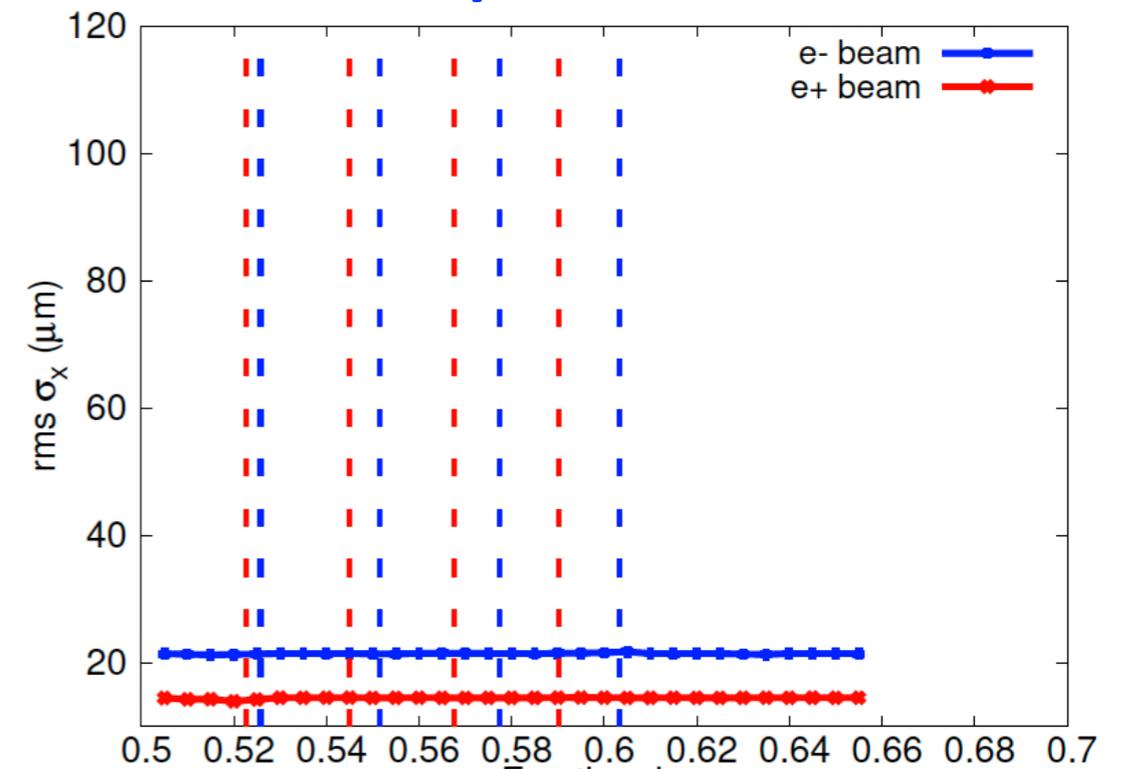
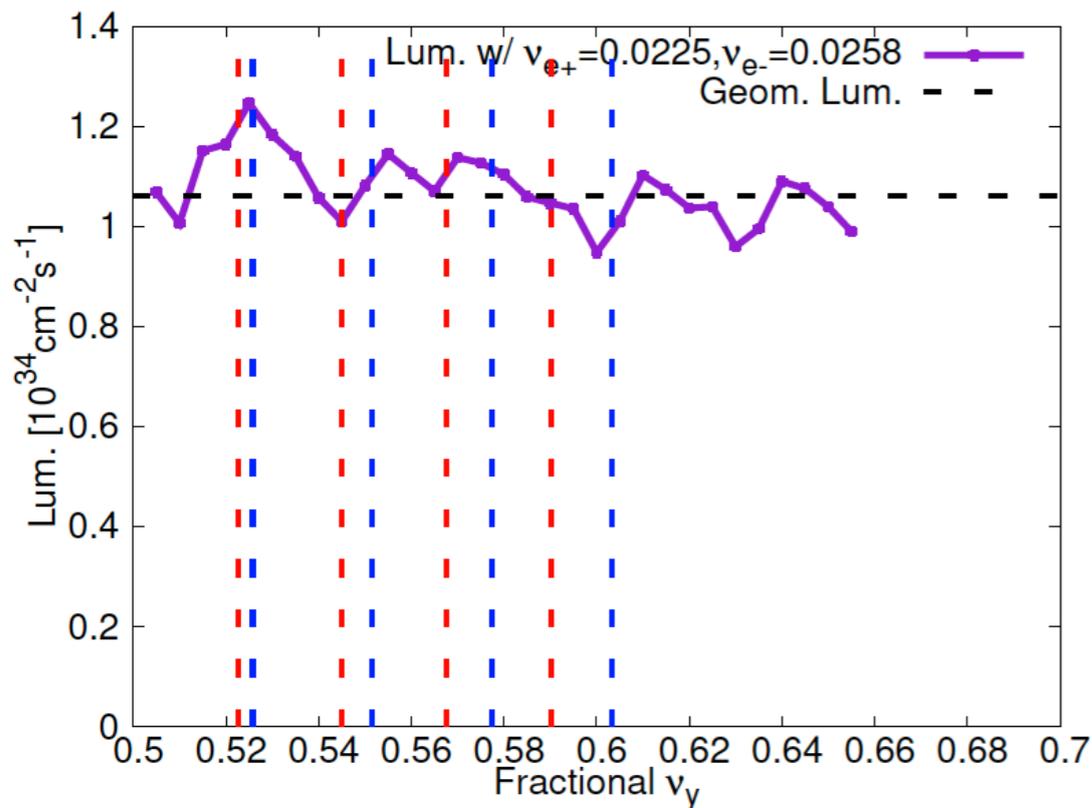


Beam sizes for $v_{s+} = .0225, v_{s-} = .0258$

2. BBSS simulation

➤ All parameter set (1): $v_x = *.56$

- Scan of v_y (same fractional part for LER and HER)
- Beam very unstable for $v_y < *.53$

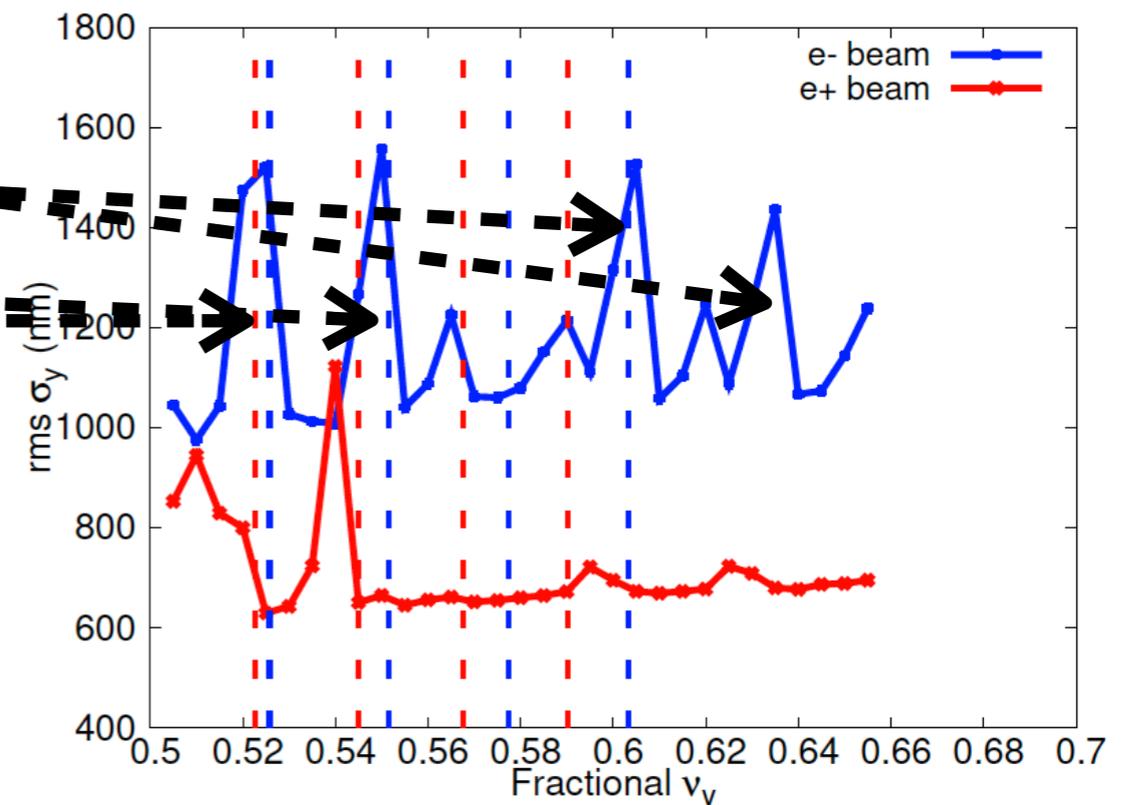
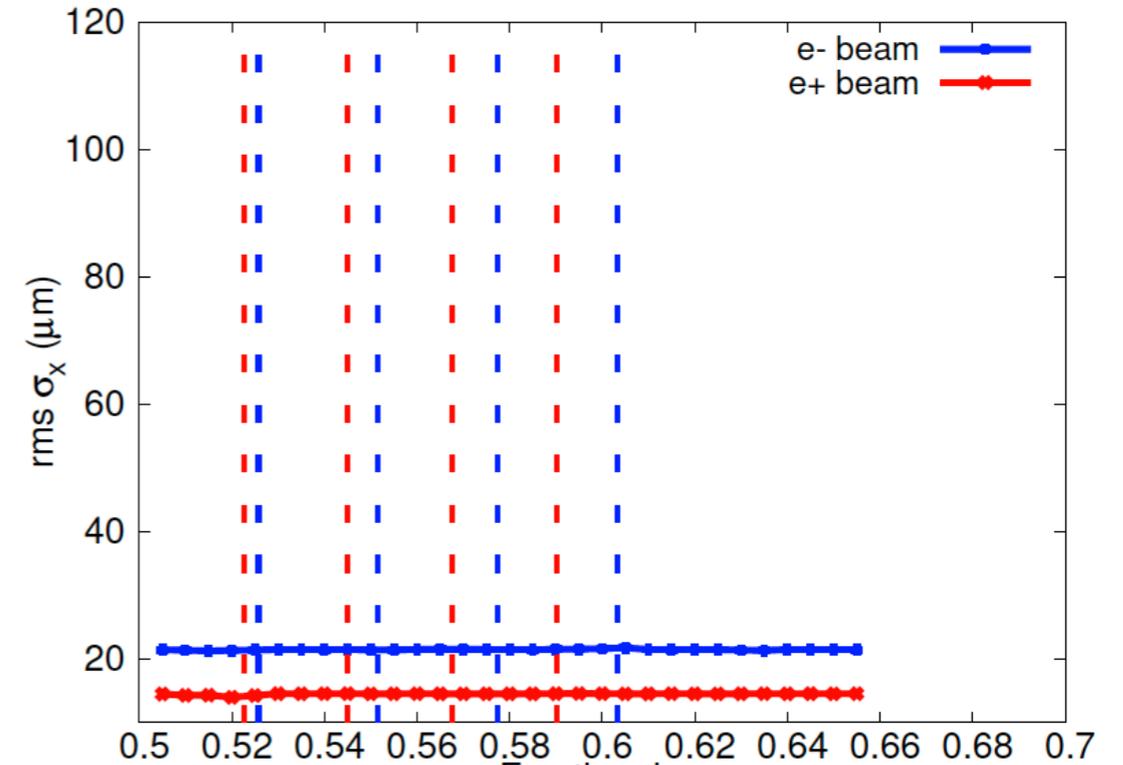
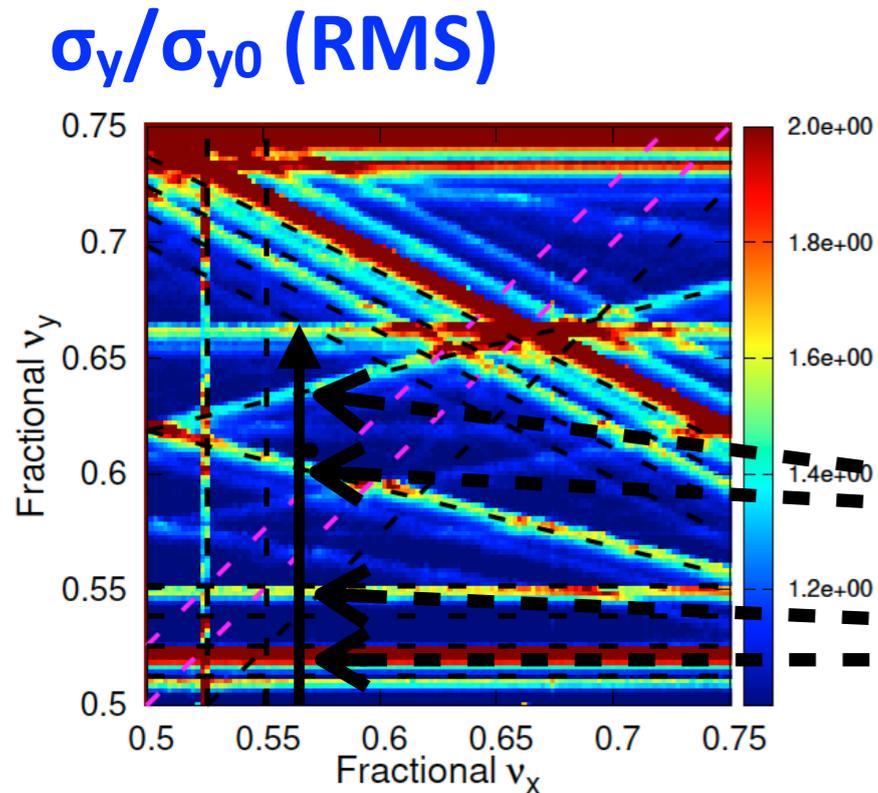


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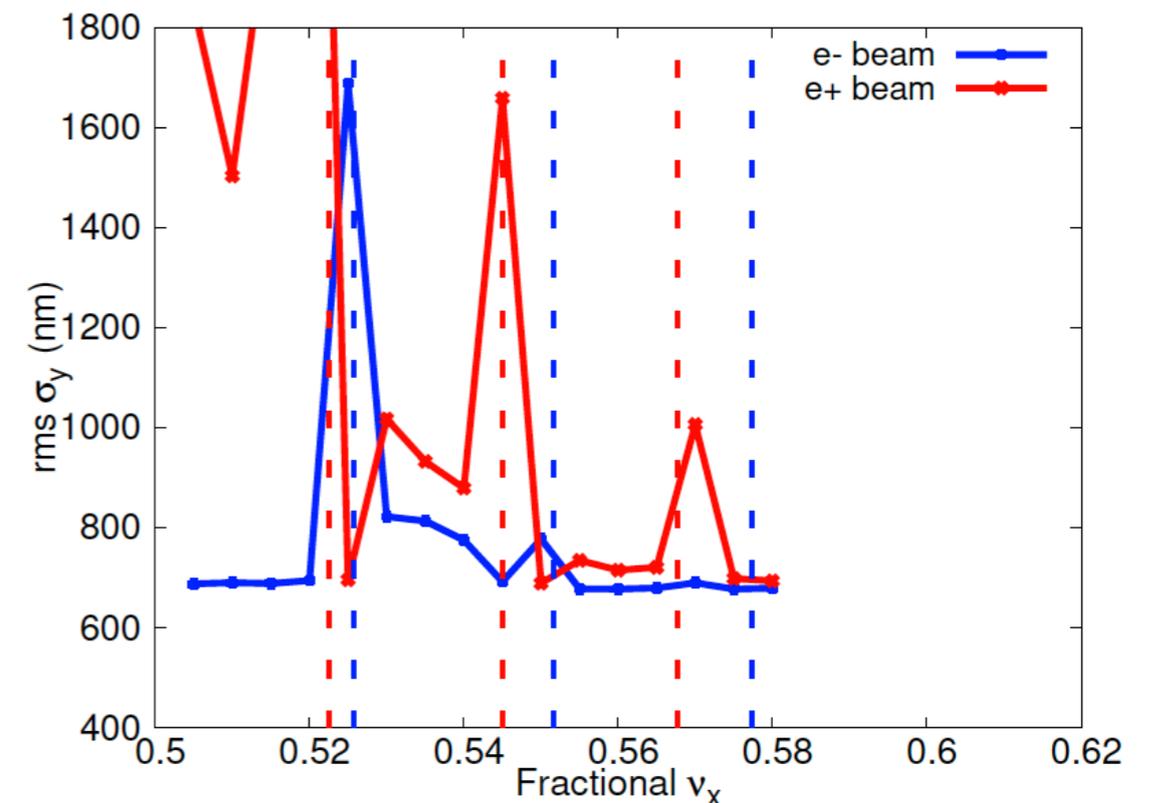
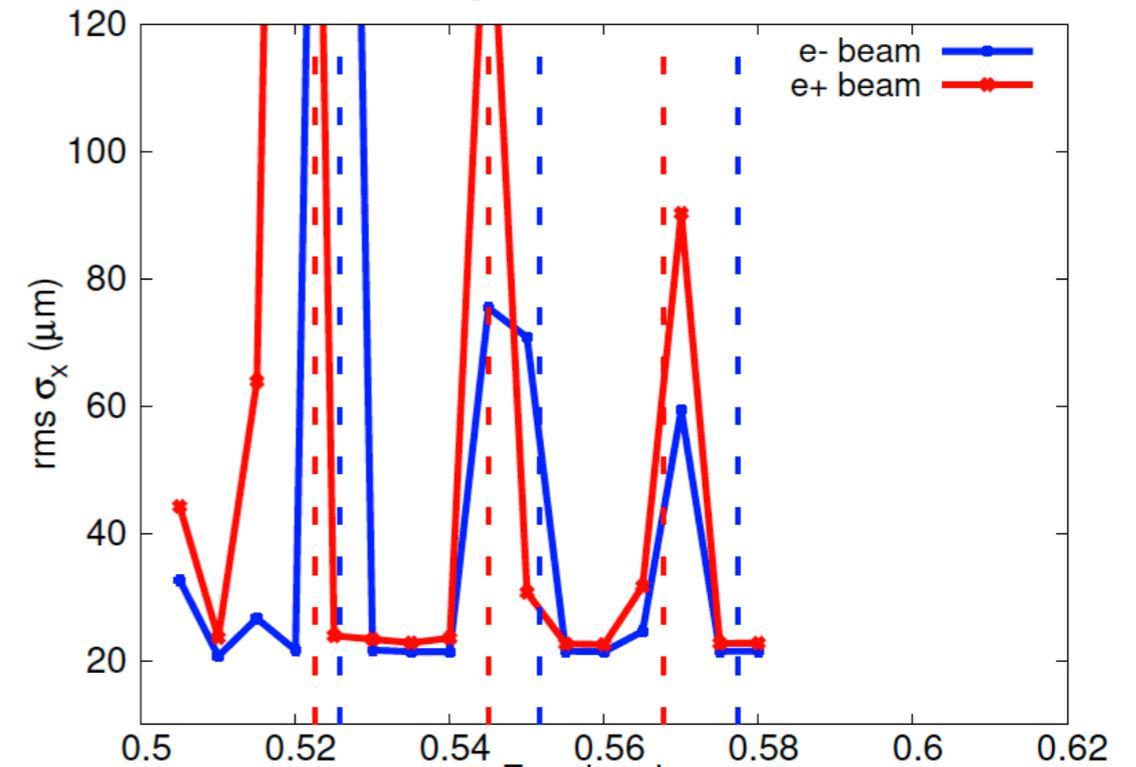
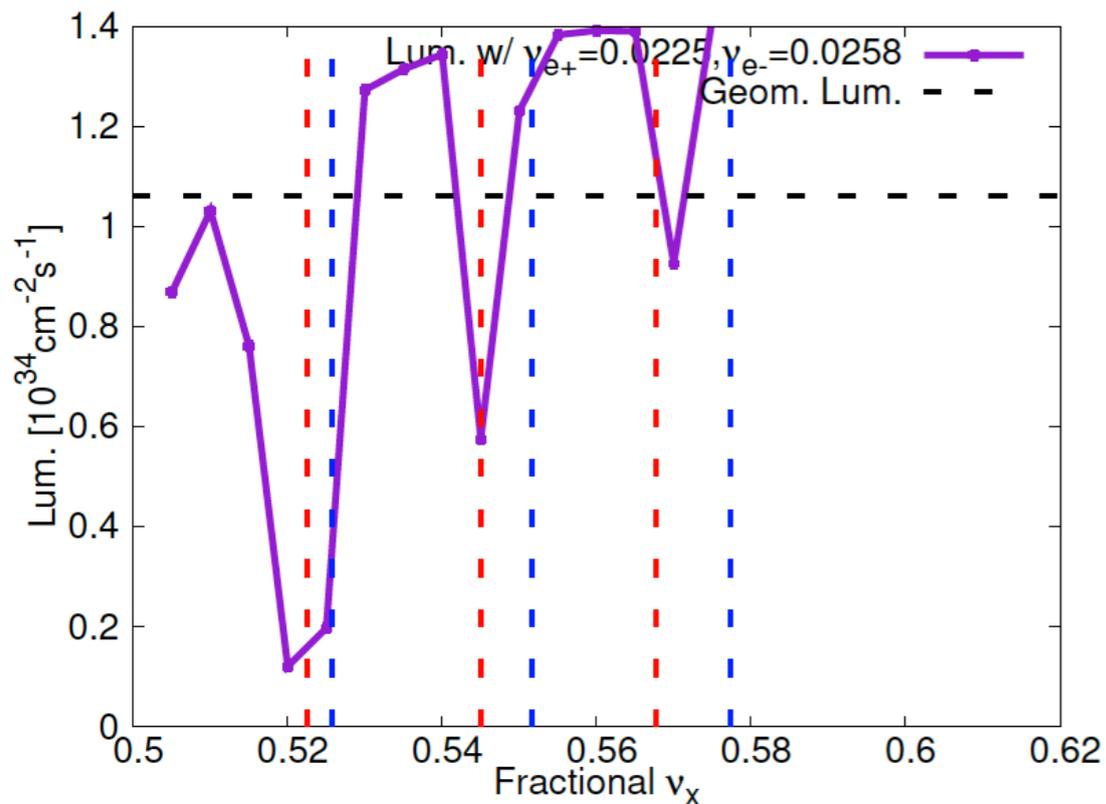
➤ All parameter set (1): $v_y = *.61$

● Scan of v_x (same fractional part for LER and HER)

Change parameters:

$\beta_{x+}^* = 0.1 \text{ m} \rightarrow 0.23 \text{ m}$ (equalize σ_y^*)

$\varepsilon_{y-} = 0.368 \text{ nm} \rightarrow 0.16 \text{ m}$ (equalize σ_x^*)



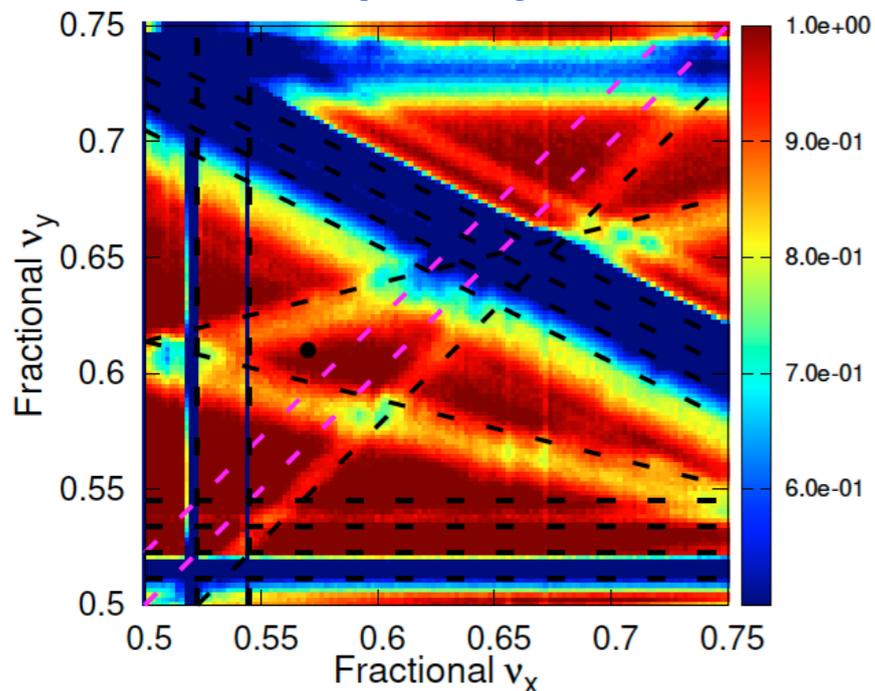
Beam sizes for $v_{s+} = .0225, v_{s-} = .0258$

2. BBWS simulation: Tune scan

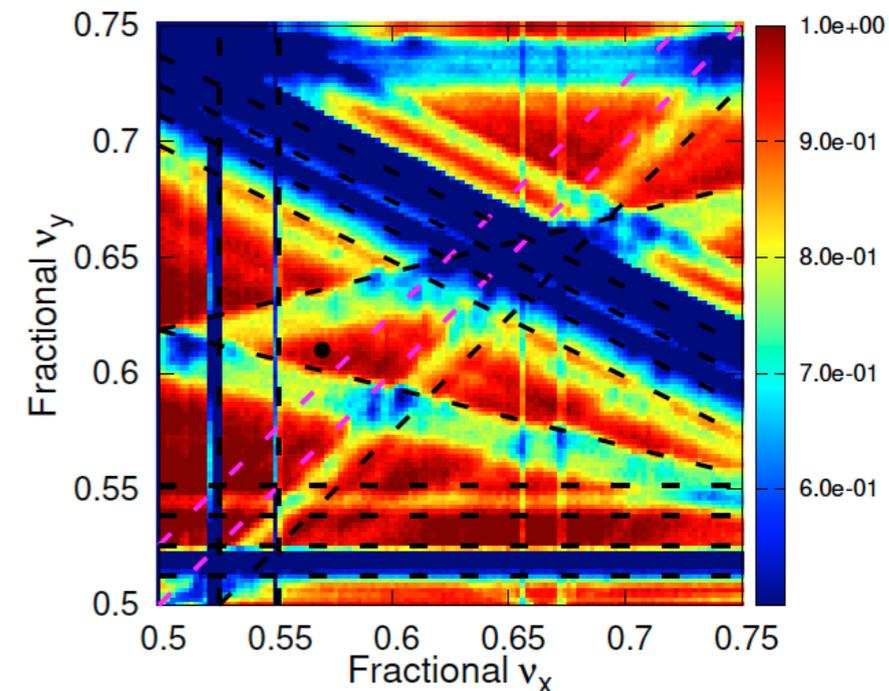
Talk on Dec.13, 2018

➤ Parameter set (3ex)

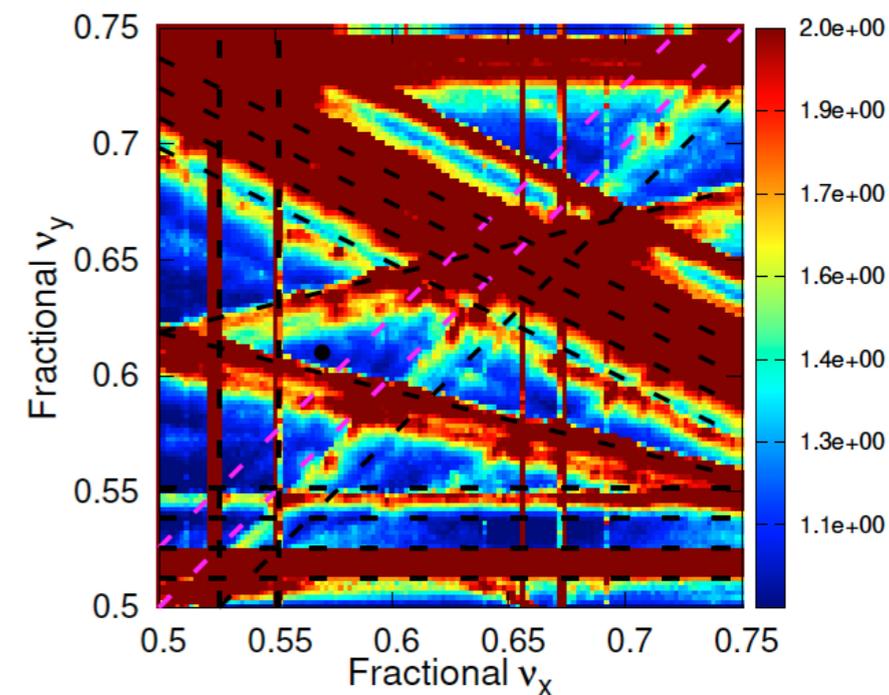
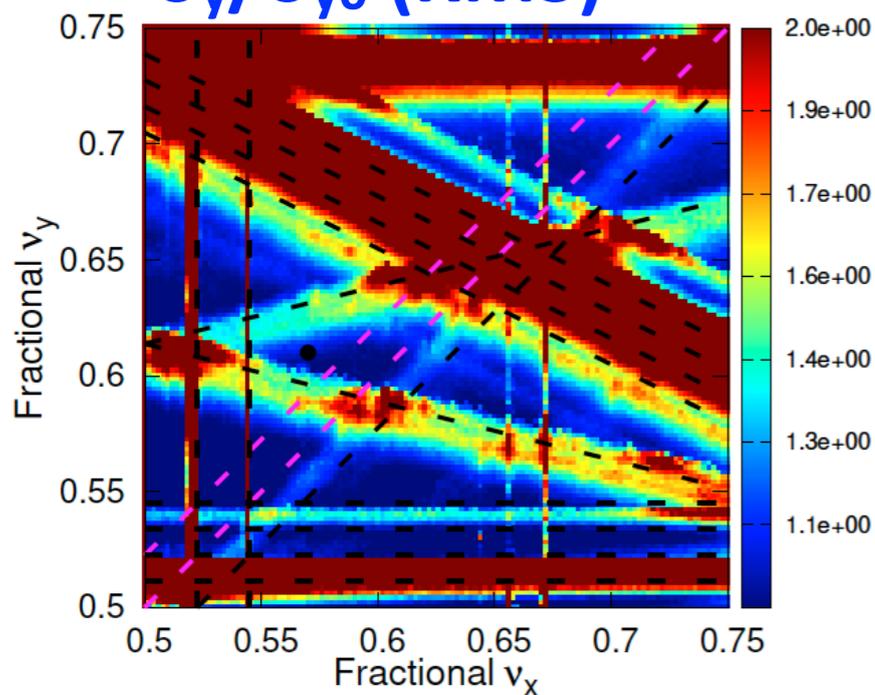
$e+(W)e-(S)$
Lum. (L/L_0)



$e+(S)e-(W)$



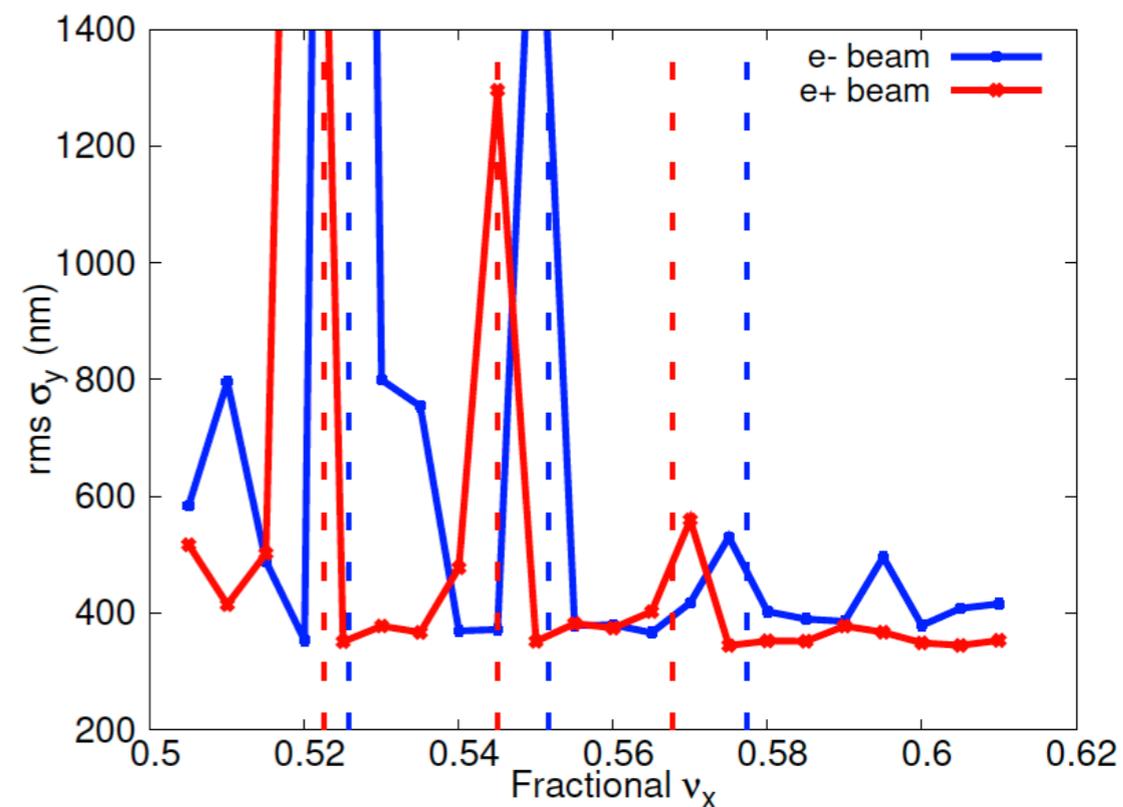
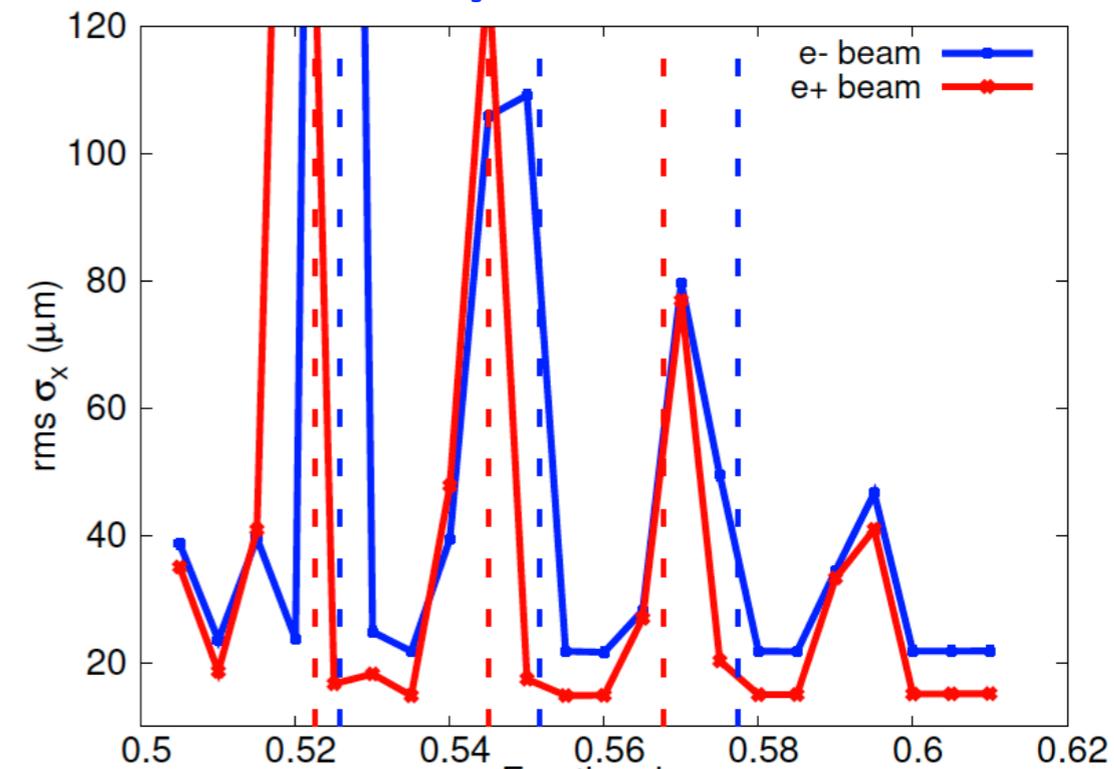
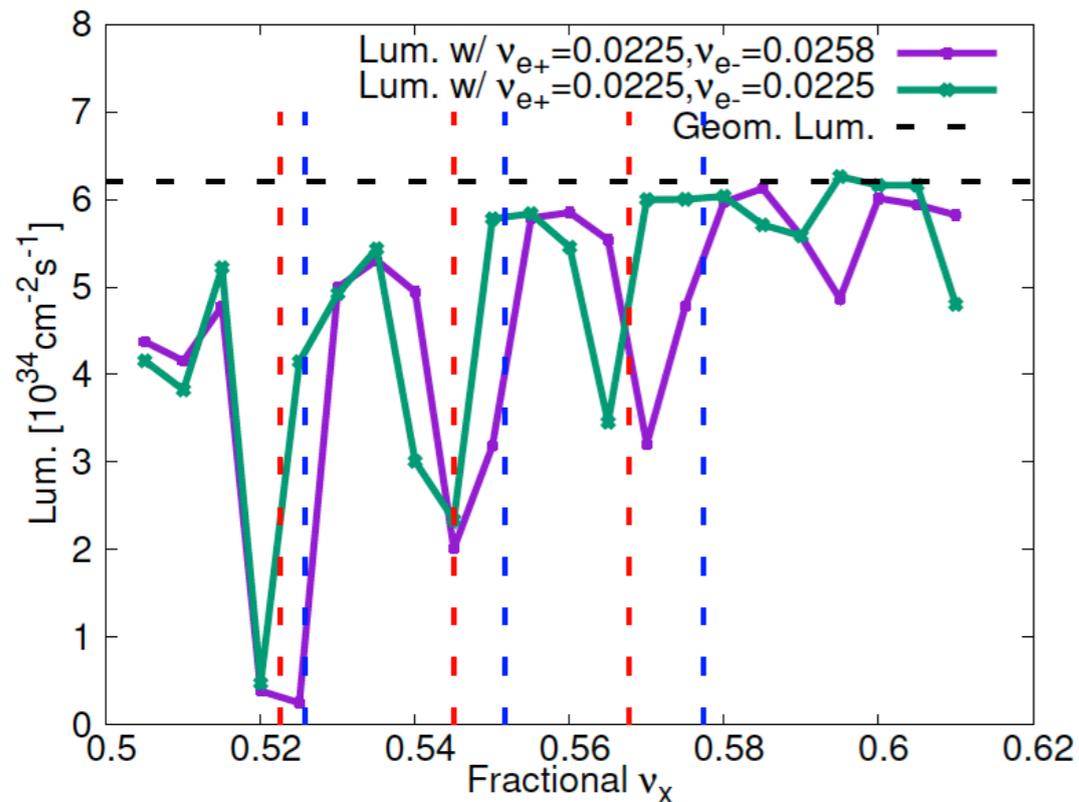
σ_y/σ_{y0} (RMS)



2. BBSS simulation

➤ All parameter set (3ex): $v_y = *.61$

● Scan of v_x (same fractional part for LER and HER)

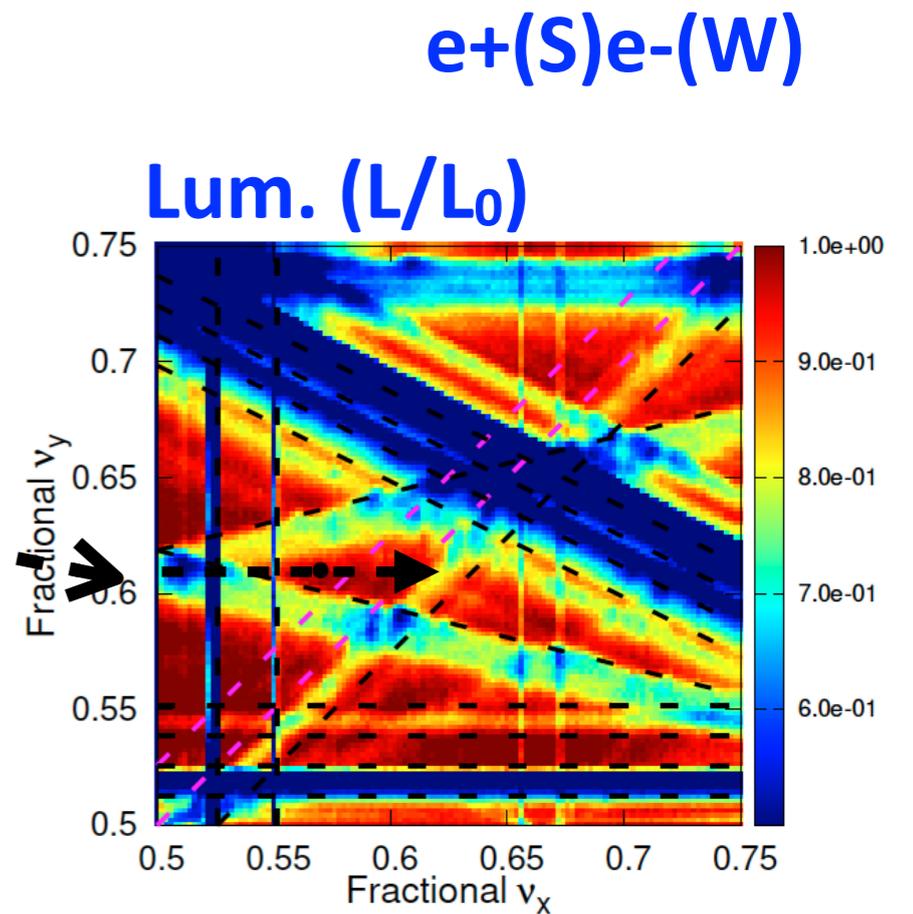
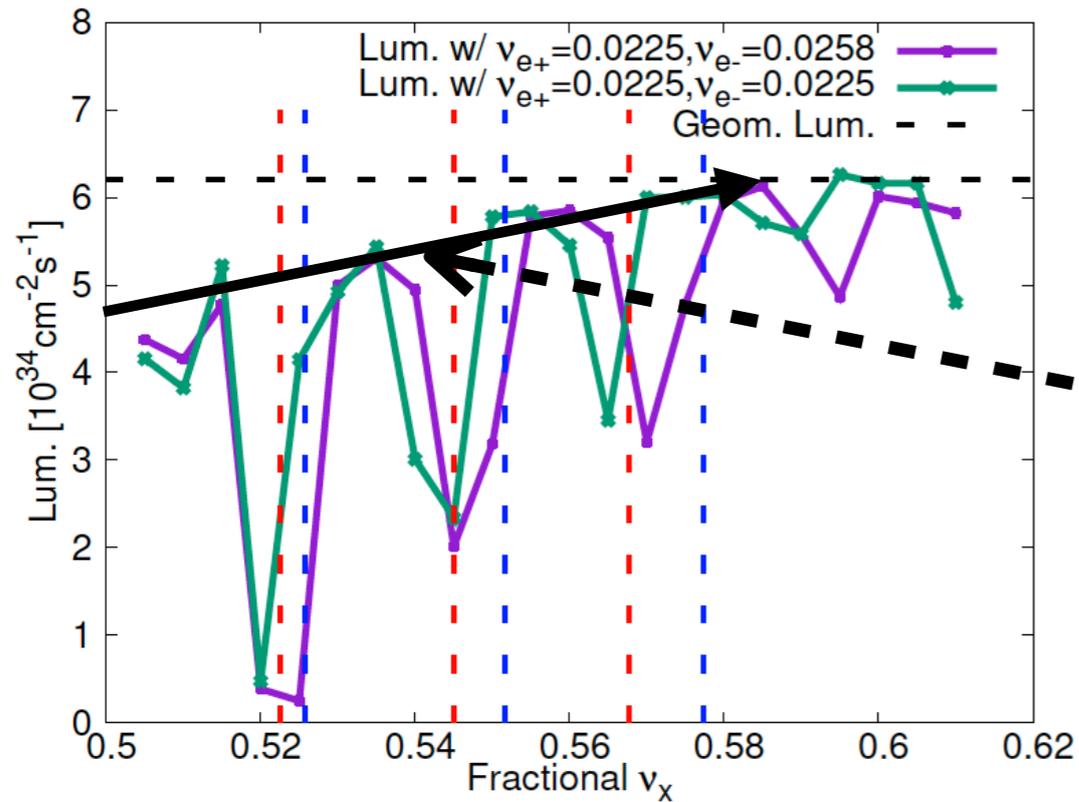


Beam sizes for $v_{s+}=.0225, v_{s-}=.0258$

2. BBSS simulation

➤ All parameter set (3ex): $v_y = *.61$

- Synchro-beta resonances are wider in BBSS simulation than in those in BBWS?
- The luminosity slope (black arrow) can be explained in BBWS sim.



Beam sizes for $v_{s+}=.0225, v_{s-}=.0258$

3. Summary

➤ On parameter set (1)

- e- beam is weaker than e+ beam
- Beam-beam instabilities seen in BBWS simulations are always seen in BBSS simulations (It should be true)
- Beam-beam instabilities only seen in BBSS simulations can be questionable (numerical noise or true physics?):
 - * $\nu_x - 3\nu_s = N/2, \nu_x - 4\nu_s = N/2$
 - * Need to be benchmarked (using another code), or to be checked through beam experiments

➤ On parameter set (3ex)

- Agreement found in BBWS and BBSS simulations
- Resonances of $\nu_x - 3\nu_s = N/2, \nu_x - 4\nu_s = N/2$ to be understood (through benchmark simulation or experiments)