

# Space Charge Results

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Electron Column Modeling Meeting  
January 22, 2019

# Simulation Parameters

- All cases:
  - 32x32x32 grid
  - 327,680 macroparticles
    - 10 macroparticles per cell
  - RF on – 4<sup>th</sup> harmonic, 0 lag, 500 V, 5 cm long, 2.18 MHz
  - 72 steps per turn

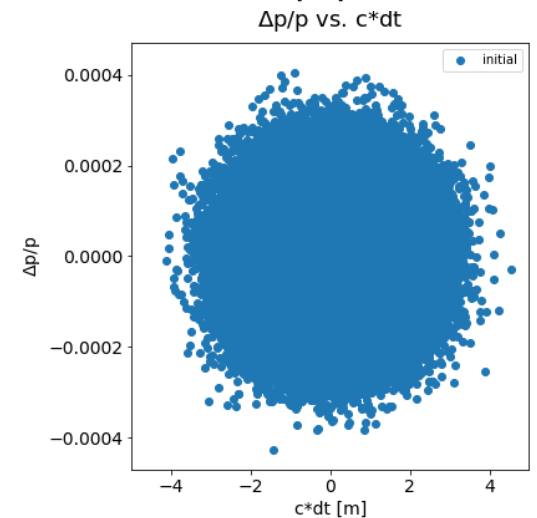
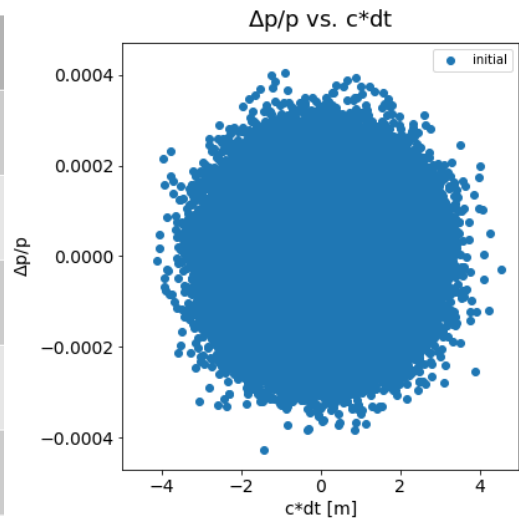
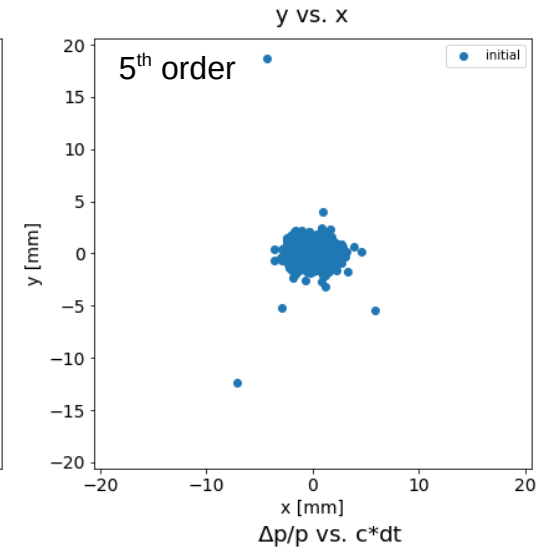
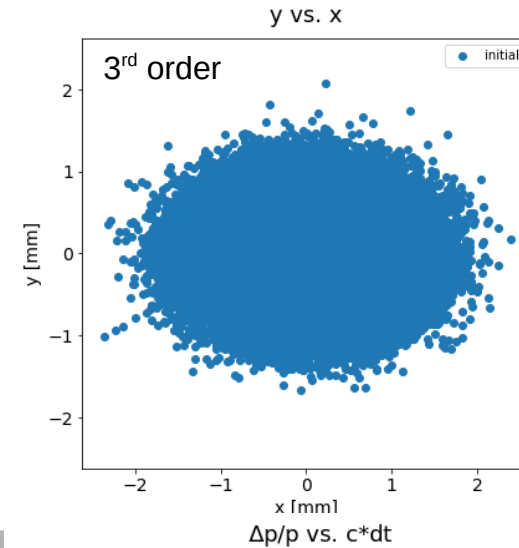
# General Synergia Update

- It was discovered (by Eric) that the Anaconda build of Synergia does not play well with space charge
- After rebuilding without Anaconda, things seem to be working better

# Stepper Order Sanity Check

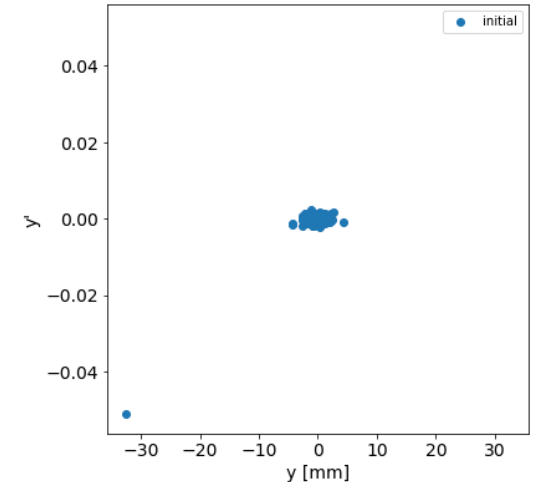
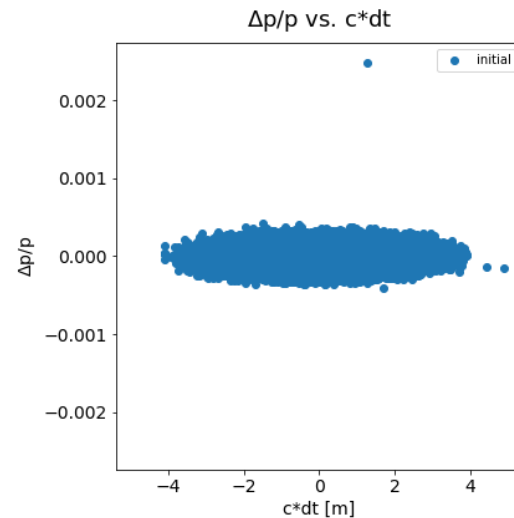
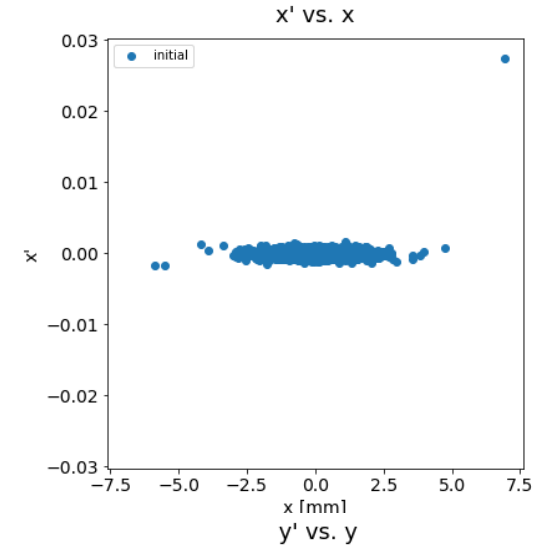
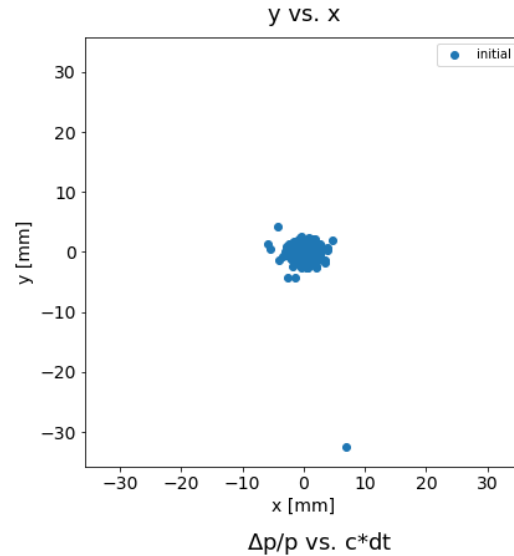
- Initial distributions of 3<sup>rd</sup> vs. 5<sup>th</sup> order steppers should be very similar
- chef maps turned off
- Particles still lost at larger beam sizes for 5<sup>th</sup> order

	3 <sup>rd</sup> Order	5 <sup>th</sup> Order
$x_{\text{RMS}}$ (mm)	0.511	0.516
$y_{\text{RMS}}$ (mm)	0.372	0.3778
$z_{\text{RMS}}$ (cm)	7.003360	7.003362
$\epsilon_{x, \text{RMS}}$ (mm-mrad)	0.101	0.103
$\epsilon_{y, \text{RMS}}$ (mm-mrad)	0.101	0.103



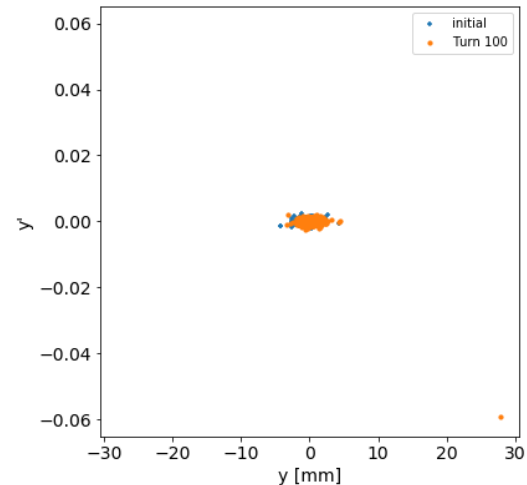
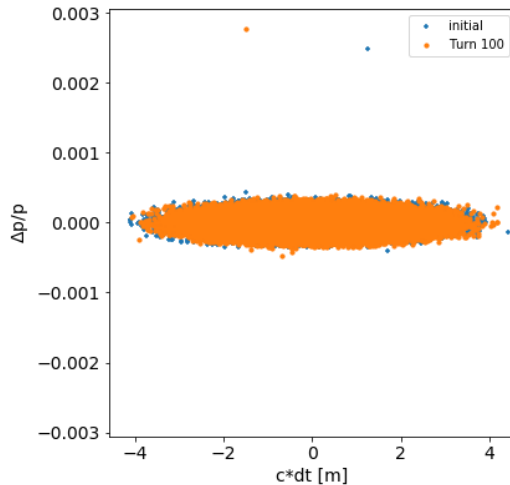
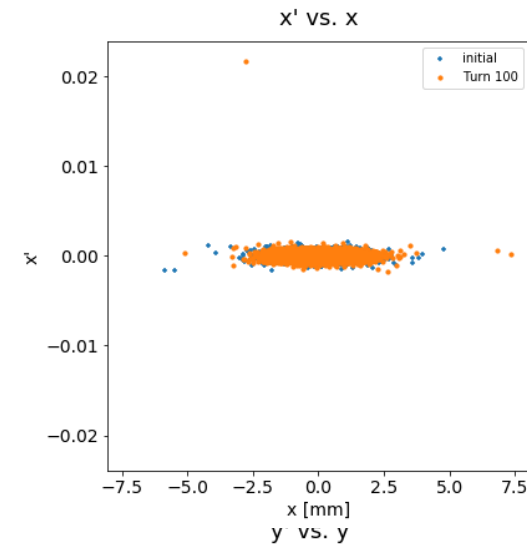
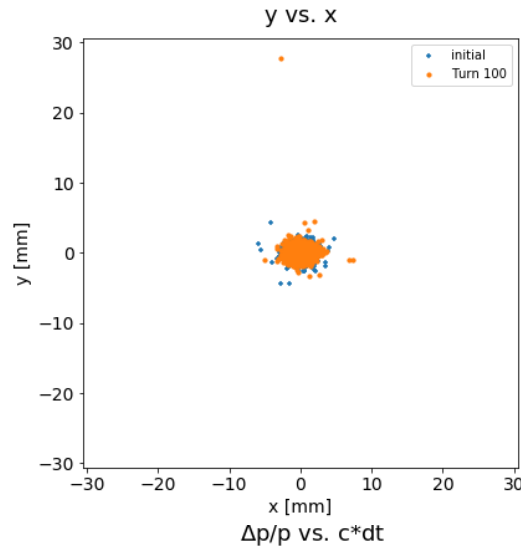
# No SC – Initial Distribution

- $X_{\text{RMS}} = 0.5158 \text{ mm}$
- $y_{\text{RMS}} = 0.3800 \text{ mm}$
- $Z_{\text{RMS}} = 6.992 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 1.05968\text{e-}7$
- $\epsilon_{y,\text{RMS}} = 1.08266\text{e-}7$

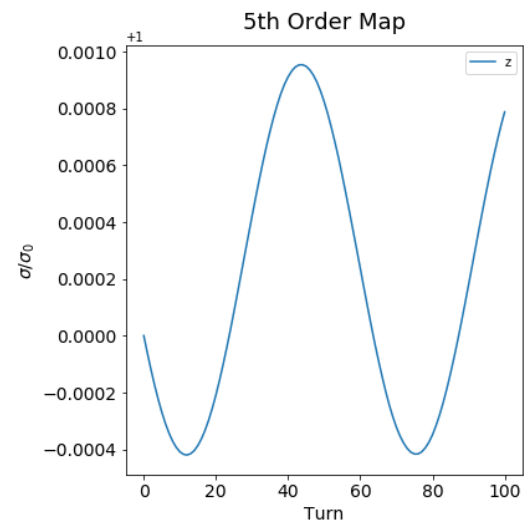
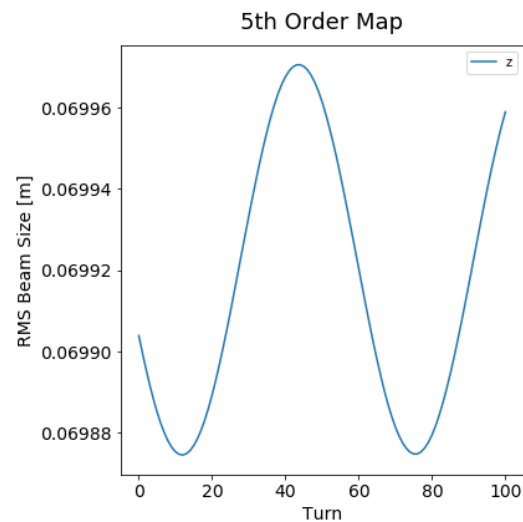
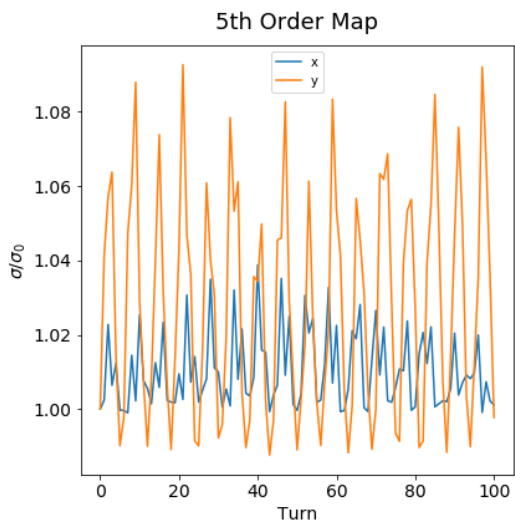
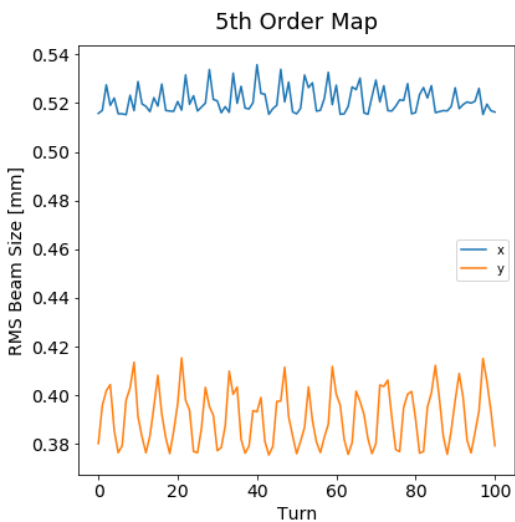


# No SC – 100<sup>th</sup> Turn Distribution

- $X_{\text{RMS}} = 0.5163 \text{ mm}$
- $y_{\text{RMS}} = 0.3792 \text{ mm}$
- $Z_{\text{RMS}} = 6.990 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 1.04854\text{e-}7$
- $\epsilon_{y,\text{RMS}} = 1.11120\text{e-}7$

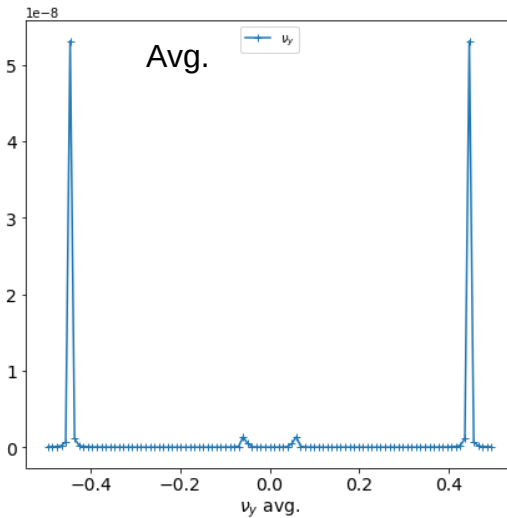
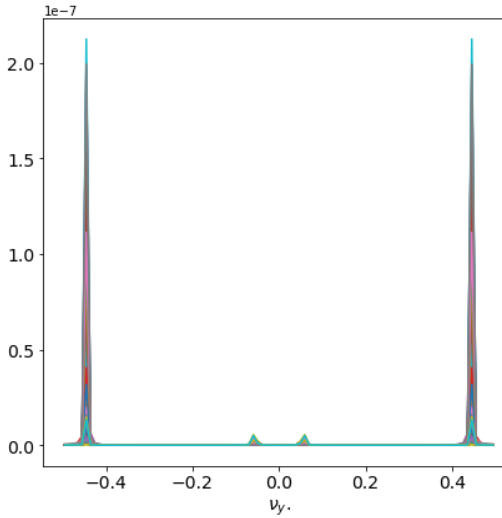
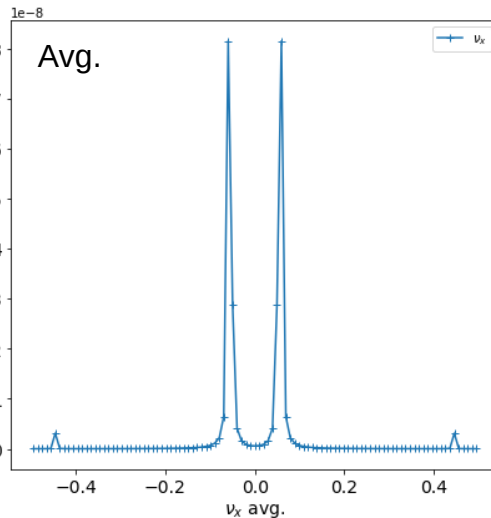
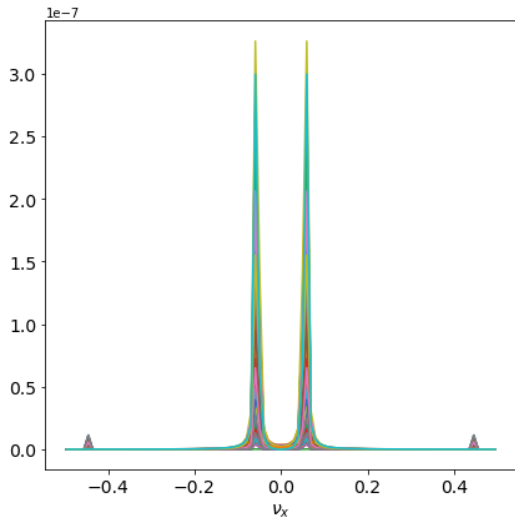


# No SC – Beam Size Growth



# No SC – Tunes

- From Synergia:
  - $Q_x = 0.05572113613579235$
  - $Q_y = 0.5557115743991281$
- From 100 turn FFT
  - $Q_x = 0.0594$
  - $Q_y = 0.4455$



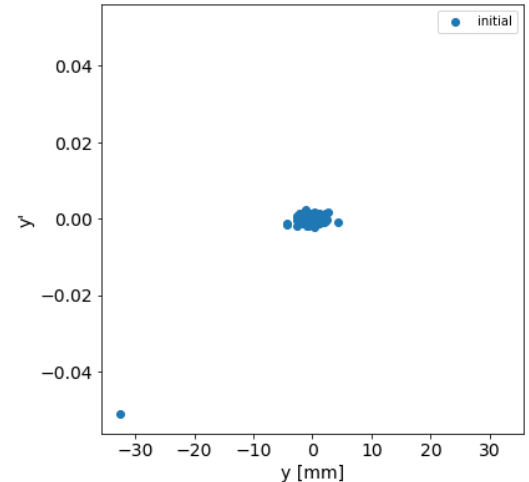
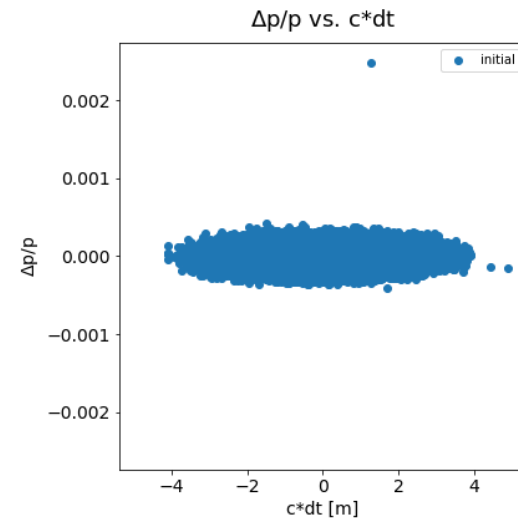
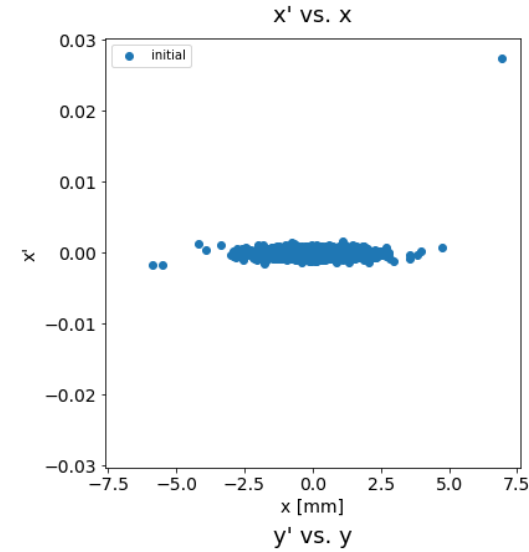
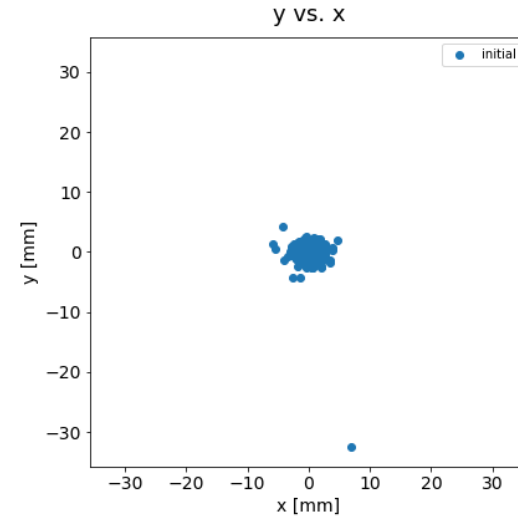


# Space Charge Parameters

- 5<sup>th</sup> order stepper
- 3dopen-hockney solver used

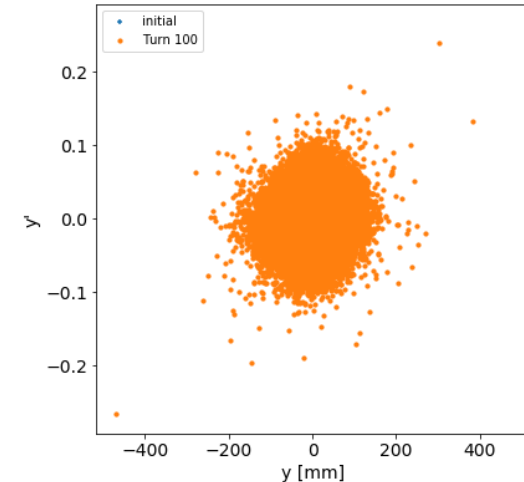
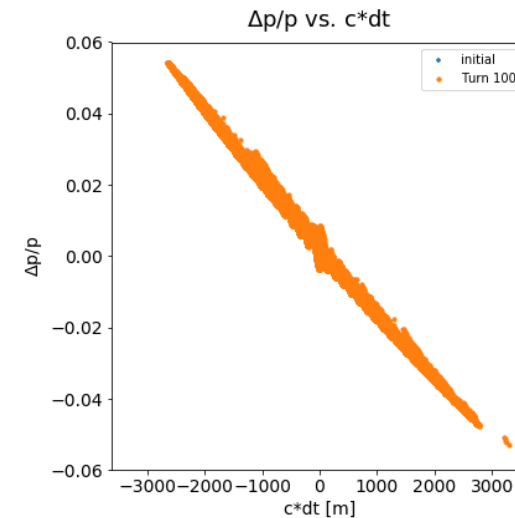
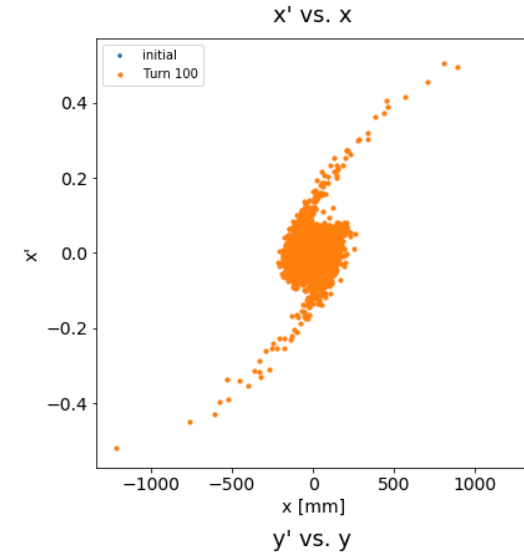
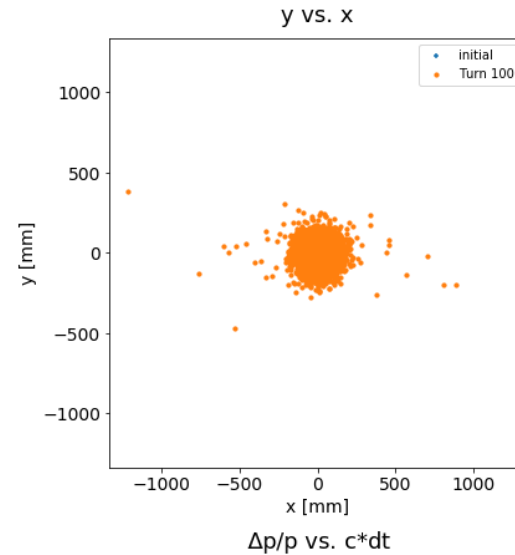
# 8 mA – Initial Distribution

- $X_{\text{RMS}} = 0.5158 \text{ mm}$
- $Y_{\text{RMS}} = 0.3800 \text{ mm}$
- $Z_{\text{RMS}} = 6.990 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 1.05968\text{e-}7$
- $\epsilon_{y,\text{RMS}} = 1.08266\text{e-}7$

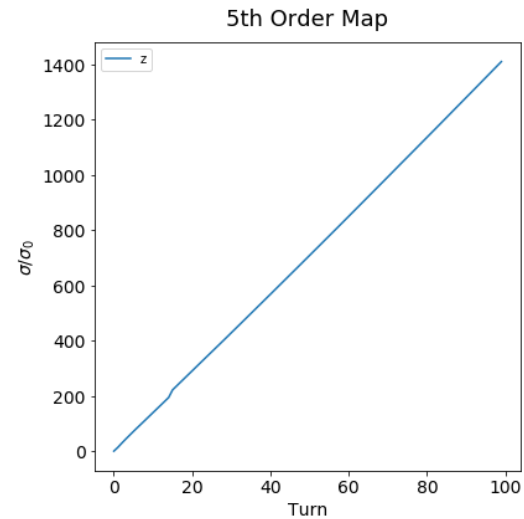
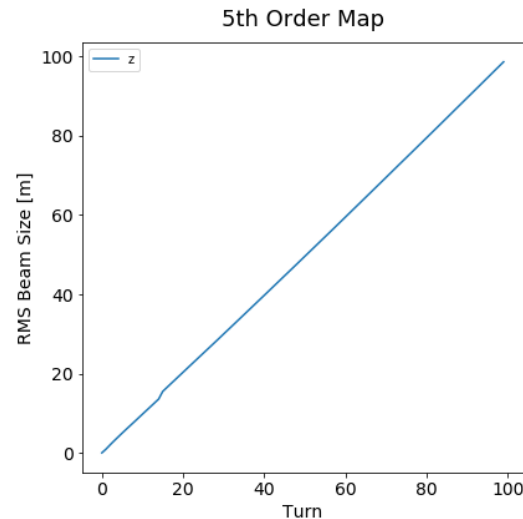
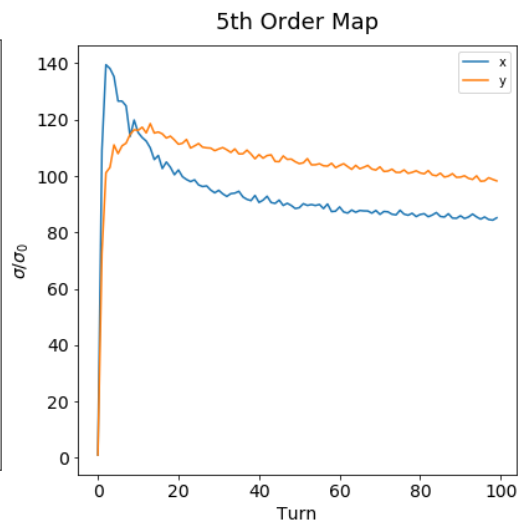
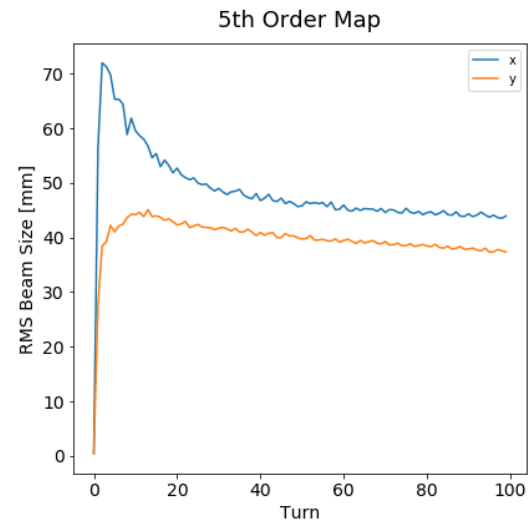


# 8 mA – 100<sup>th</sup> Turn Distribution

- $X_{\text{RMS}} = 43.93 \text{ mm}$
- $Y_{\text{RMS}} = 37.34 \text{ mm}$
- $Z_{\text{RMS}} = 9859 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 8.533\text{e-}4$
- $\epsilon_{y,\text{RMS}} = 9.429\text{e-}4$
- 177,238 particles



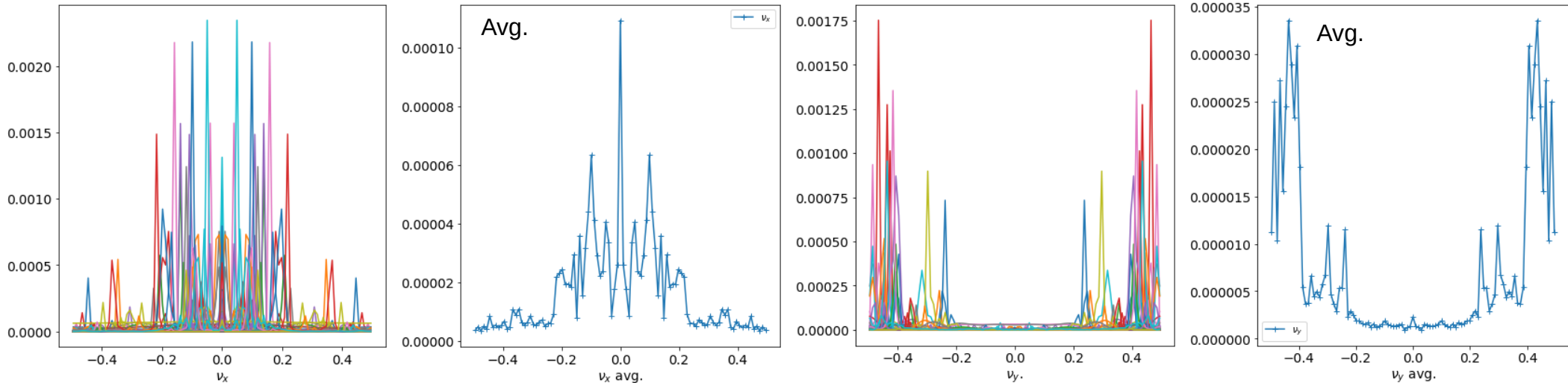
# 8 mA – Beam Size Growth



# 8 mA – Tunes

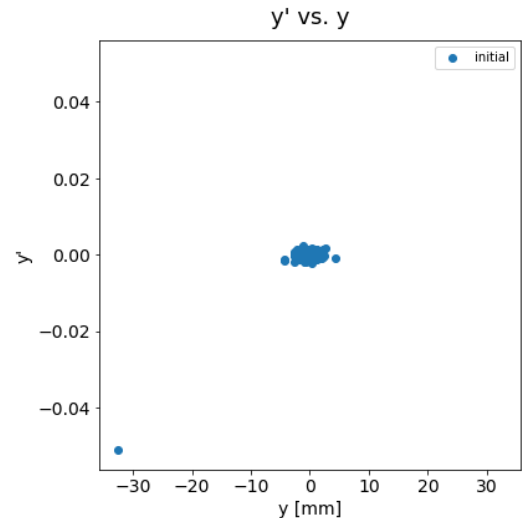
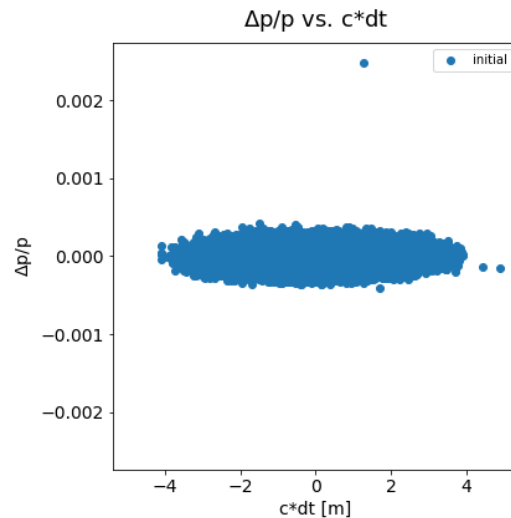
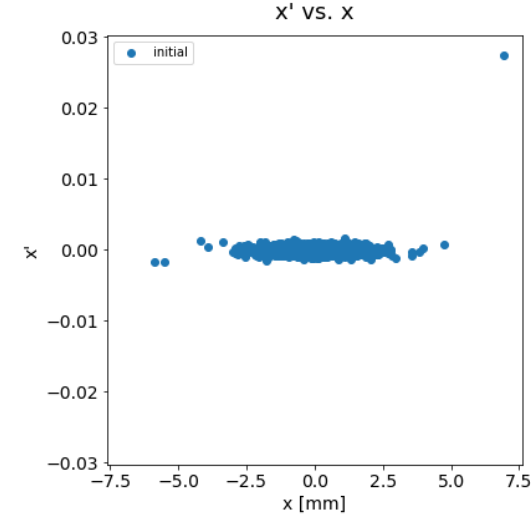
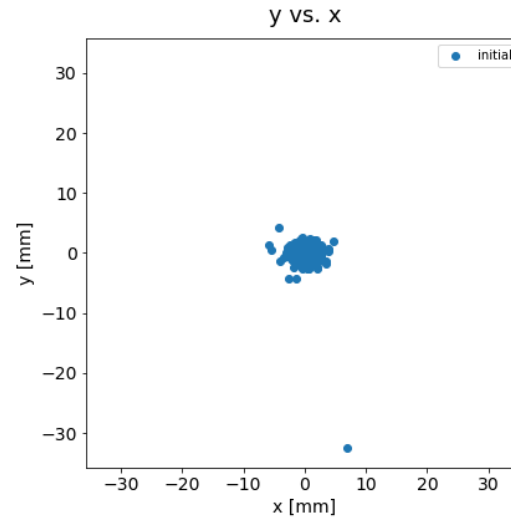
- Undepressed tunes:
- $Q_x = 0.05572113613579235$
- $Q_y = 0.5557115743991281$

- $DQ = -1.622$



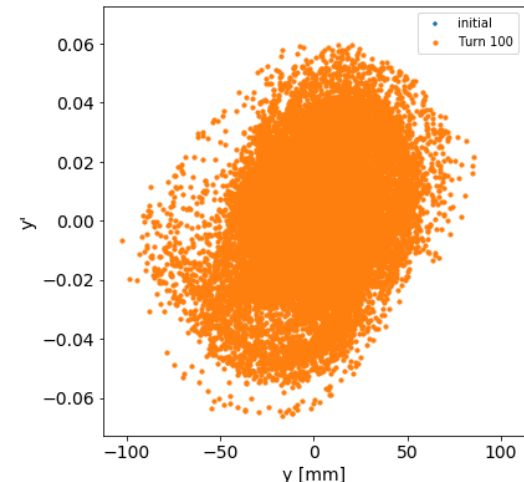
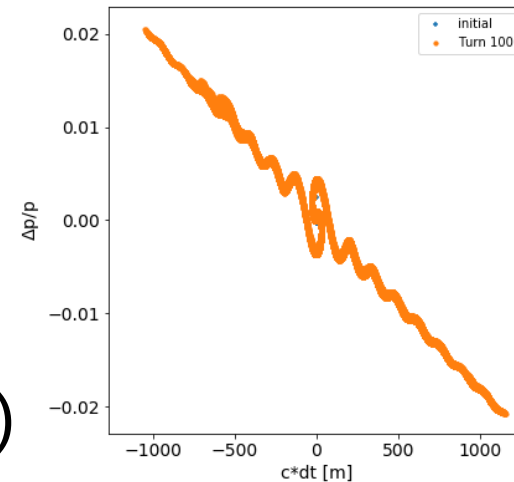
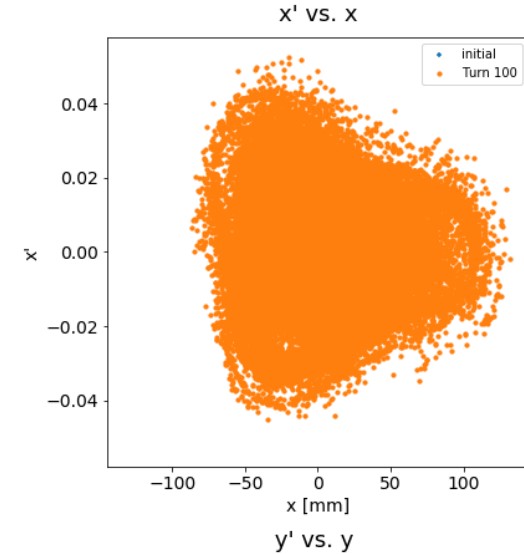
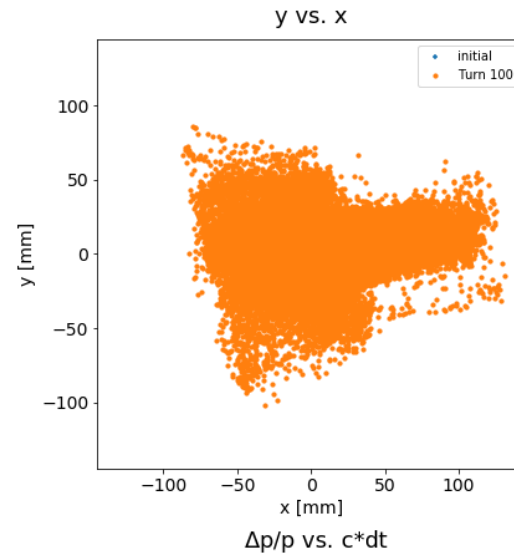
# 0.8 mA – Initial Distribution

- $X_{\text{RMS}} = 0.5158 \text{ mm}$
- $Y_{\text{RMS}} = 0.3800 \text{ mm}$
- $Z_{\text{RMS}} = 6.990 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 1.05968\text{e-}7$
- $\epsilon_{y,\text{RMS}} = 1.08266\text{e-}7$

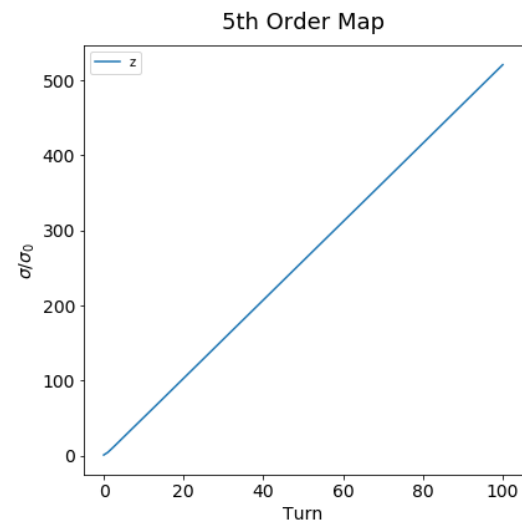
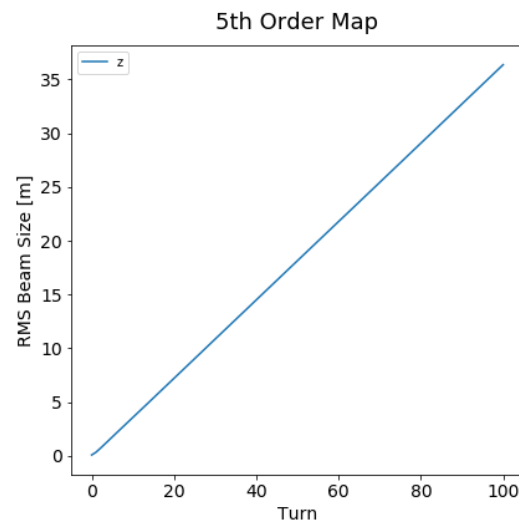
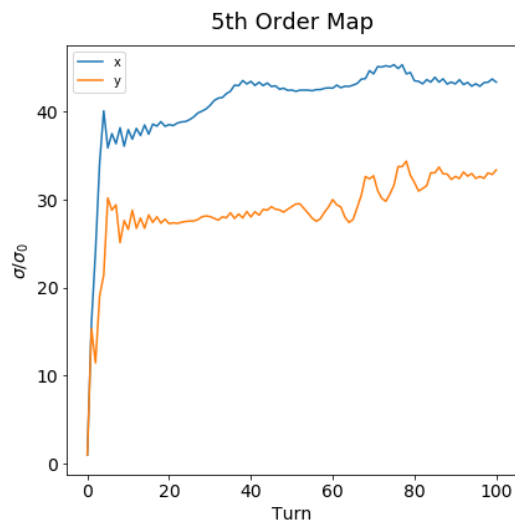
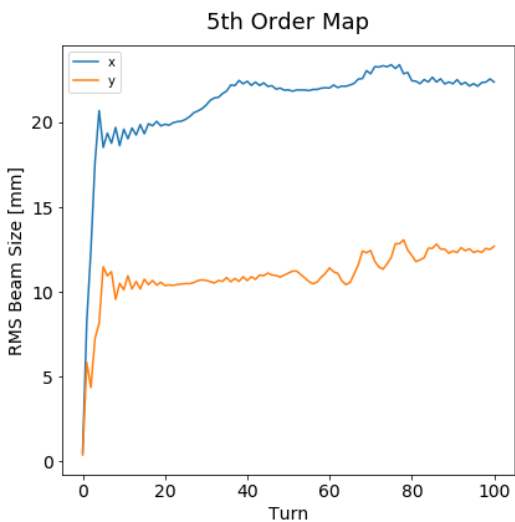


# 0.8 mA – 100<sup>th</sup> Turn Distribution

- $X_{\text{RMS}} = 22.36$  mm
- $Y_{\text{RMS}} = 12.68$  mm
- $Z_{\text{RMS}} = 3637$  cm
- $\epsilon_{x,\text{RMS}} = 2.042\text{e-}4$
- $\epsilon_{y,\text{RMS}} = 1.192\text{e-}4$
- 327,680 particles (none lost)



# 0.8 mA – Beam Size Growth

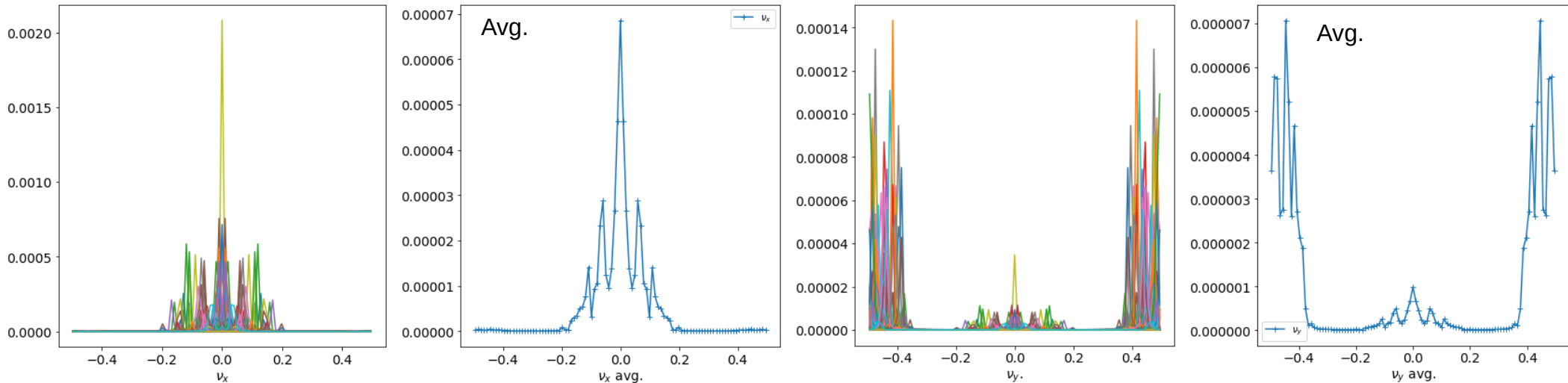




# 0.8 mA – Tunes

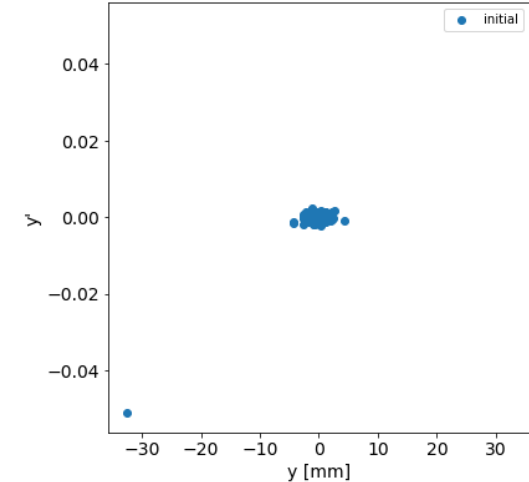
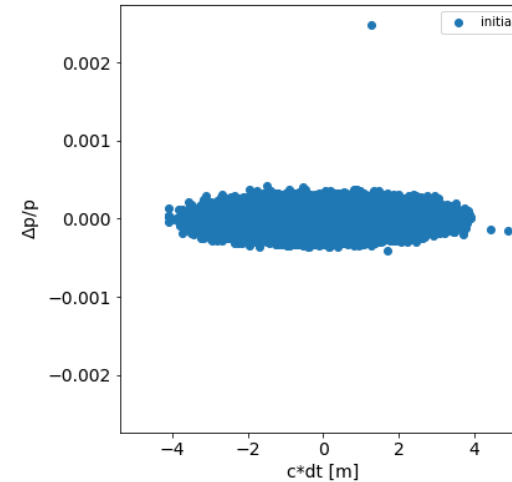
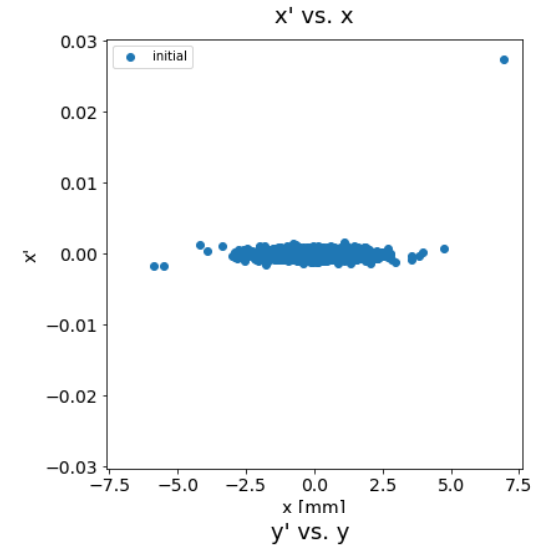
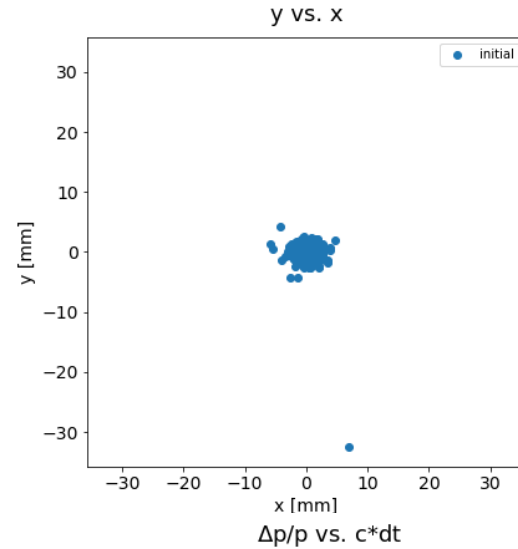
- Undepressed tunes:
- $Q_x = 0.05572113613579235$
- $Q_y = 0.5557115743991281$

- $dQ = -0.1622$



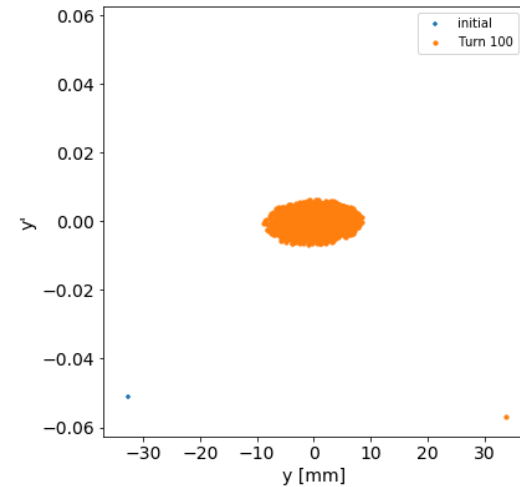
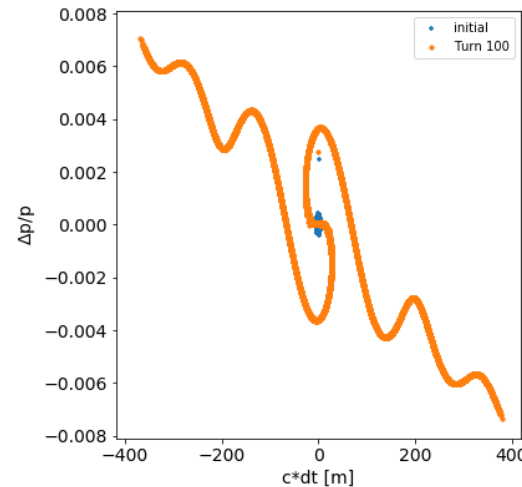
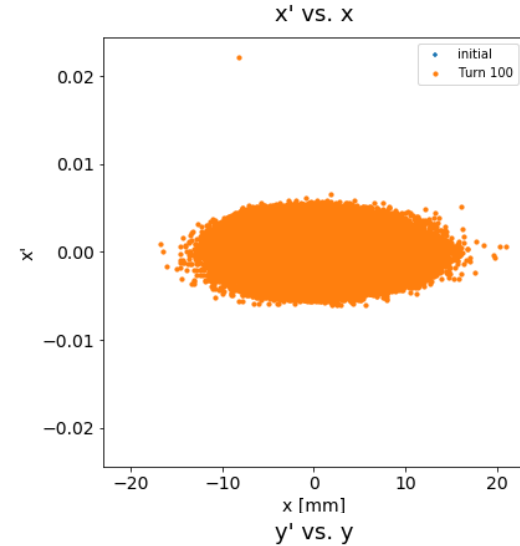
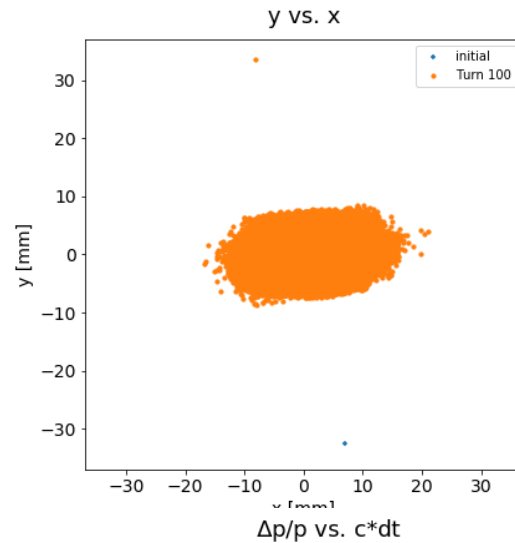
# 0.08 mA – Initial Distribution

- $X_{\text{RMS}} = 0.5158 \text{ mm}$
- $Y_{\text{RMS}} = 0.3800 \text{ mm}$
- $Z_{\text{RMS}} = 6.990 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 1.05968\text{e-}7$
- $\epsilon_{y,\text{RMS}} = 1.08266\text{e-}7$

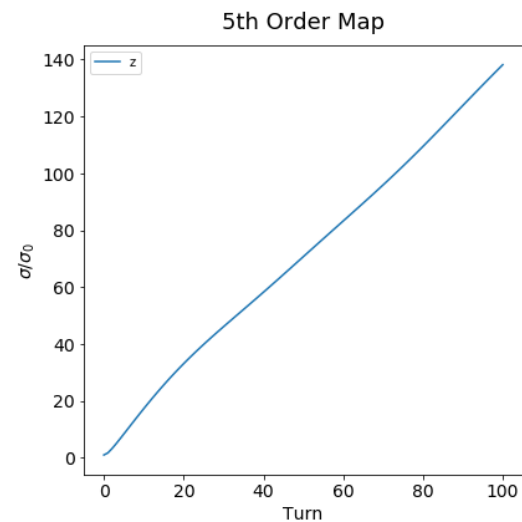
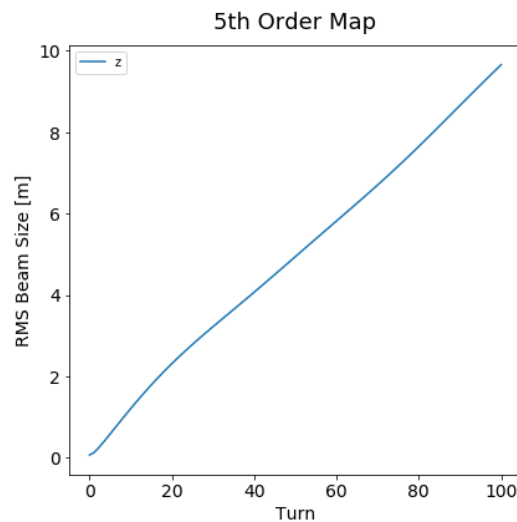
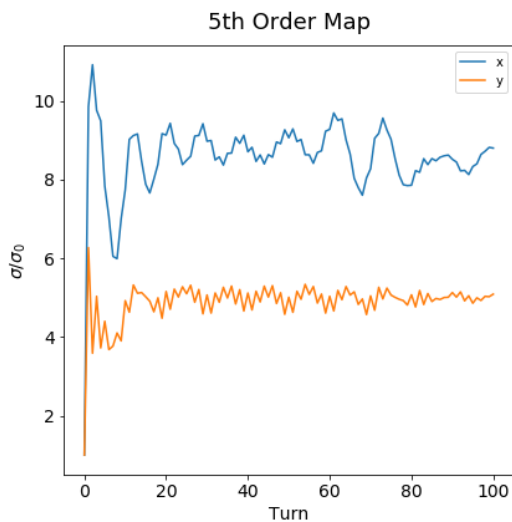
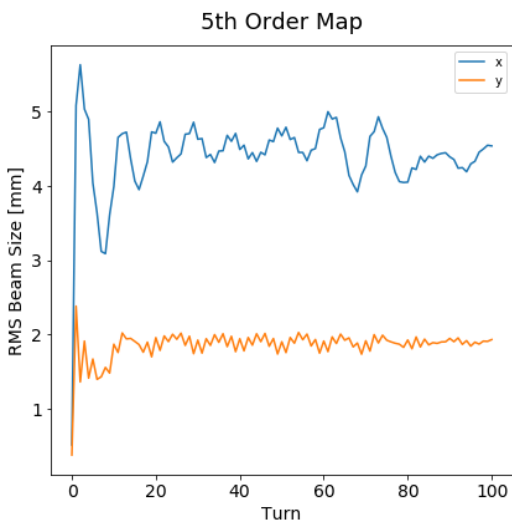


# 0.08 mA – 100<sup>th</sup> Turn Distribution

- $X_{\text{RMS}} = 4.538 \text{ mm}$
- $Y_{\text{RMS}} = 1.933 \text{ mm}$
- $Z_{\text{RMS}} = 965.9 \text{ cm}$
- $\epsilon_{x,\text{RMS}} = 7.3684\text{e-}6$
- $\epsilon_{y,\text{RMS}} = 2.6975\text{e-}6$
- 327,680 particles (none lost)



# 0.08 mA – Beam Size Growth



# 0.08 mA – Tunes

- Undepressed tunes:
- $Q_x = 0.05572113613579235$
- $Q_y = 0.5557115743991281$

- $dQ = -0.01622$
- $Q_x = 0.04950$
- $Q_y = 0.4455$

