SW OSC Lattice with Nonlinearities

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Overview

- Start with SW 500MeV OSC lattice, based on present-day layout
  - Technically two lattices– one without CCUs, and one with 2 CCUs
  - With-CCU lattice has local optics modifications to account for distortion from undulators
- Check two sextupole distributions:
  - Start with basic 2-family sextupole distribution (chromaticities approx. unity)
  - Optimize from 2-family using RDTs only (new Tao implementation of Bengtsson)
- For each scenario, check frequency map analysis (FMA)
  - See next slide for overview of method

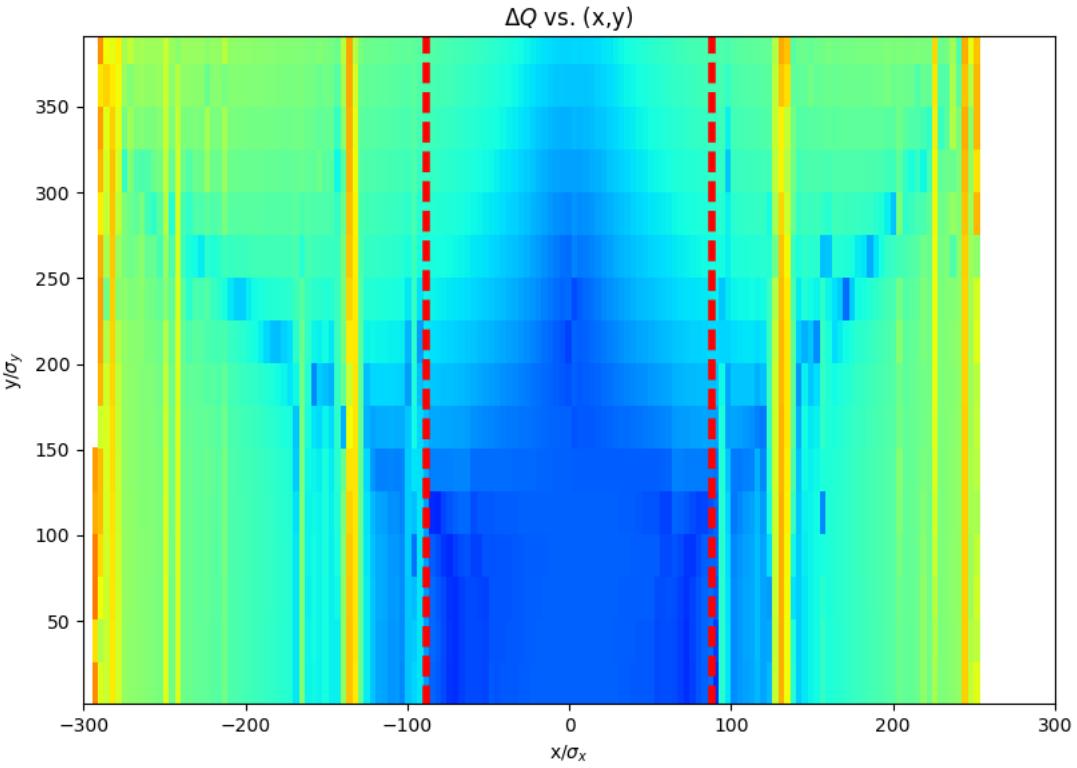
Frequency Map Analysis

- Method:
  - Scan starting amplitude through x/y plane or x/δ plane
  - Track for 2048 turns
  - FFT first and last 1024 turns; compute tunes
  - Plot tune shift as color scale: $dQ = \log_{10}\sqrt{\Delta Q_x^2 + \Delta Q_y^2}$
- Multiple representations of data:
  1. Plot tune shift vs. x/y → **dynamic aperture (DA)**
  2. Plot tune shift vs. x/δ → **momentum aperture (MA)**
  3. Plot tune shift vs. tunes from first 1024 turns → **tune footprint**
- Primary questions:
  - Are the DA and MA sufficiently large?
  - Is the tune footprint reasonable?

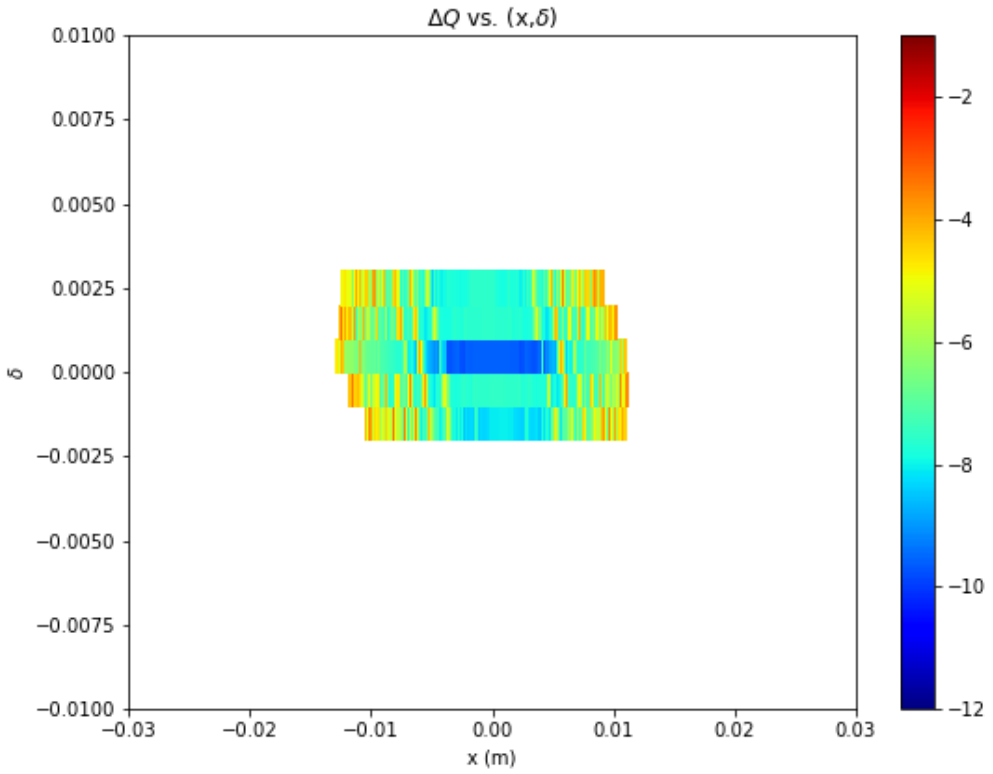
  → **For today, focus mostly on DA, and in particular, horizontal DA**

2-fam, no multipoles or CCUs

dQ vs. x,y

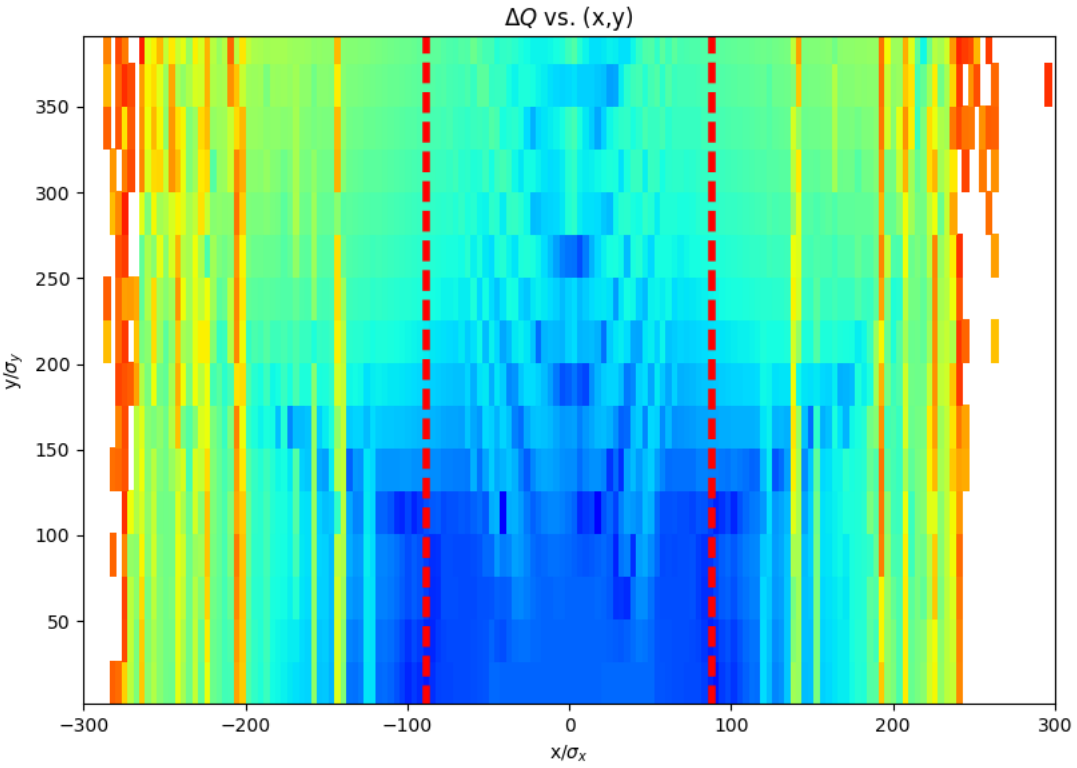


dQ vs. x,δ

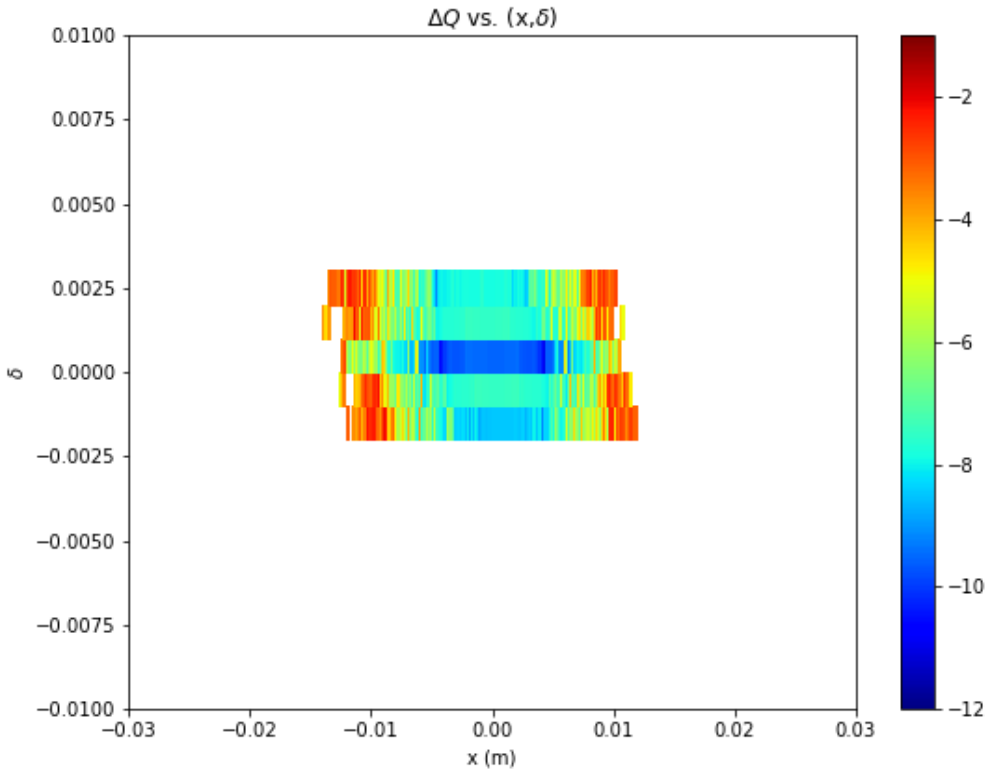


2-fam, with multipoles, no CCUs

dQ vs. x,y



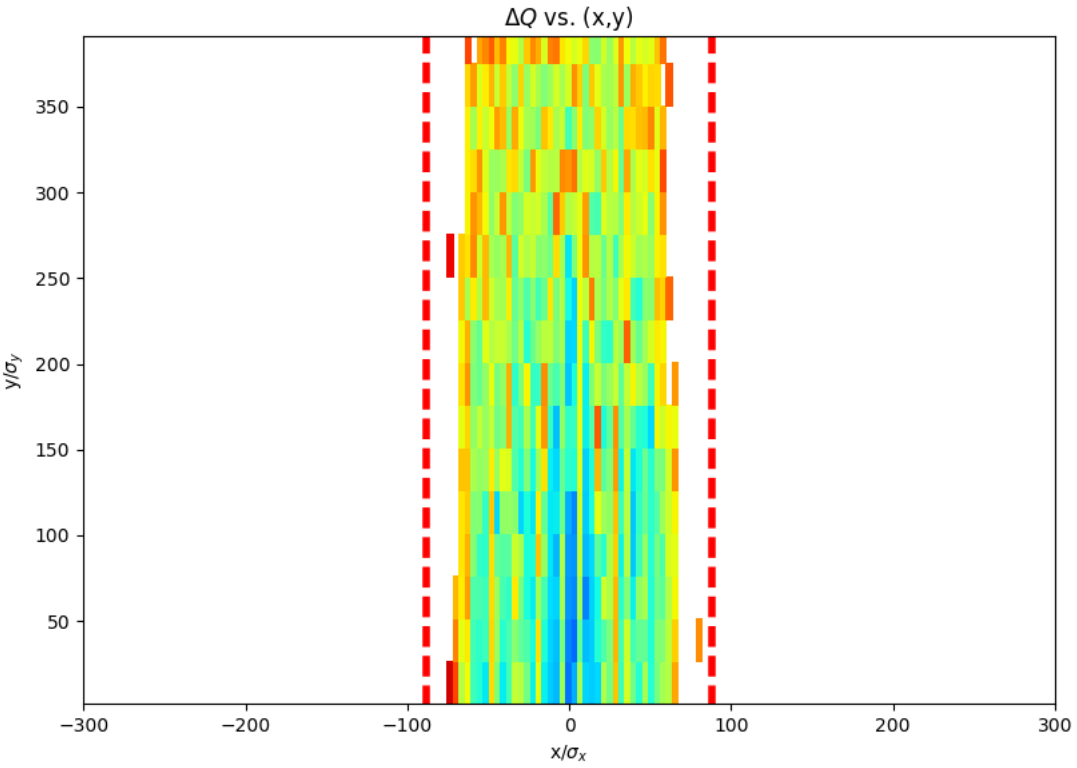
dQ vs. x,δ



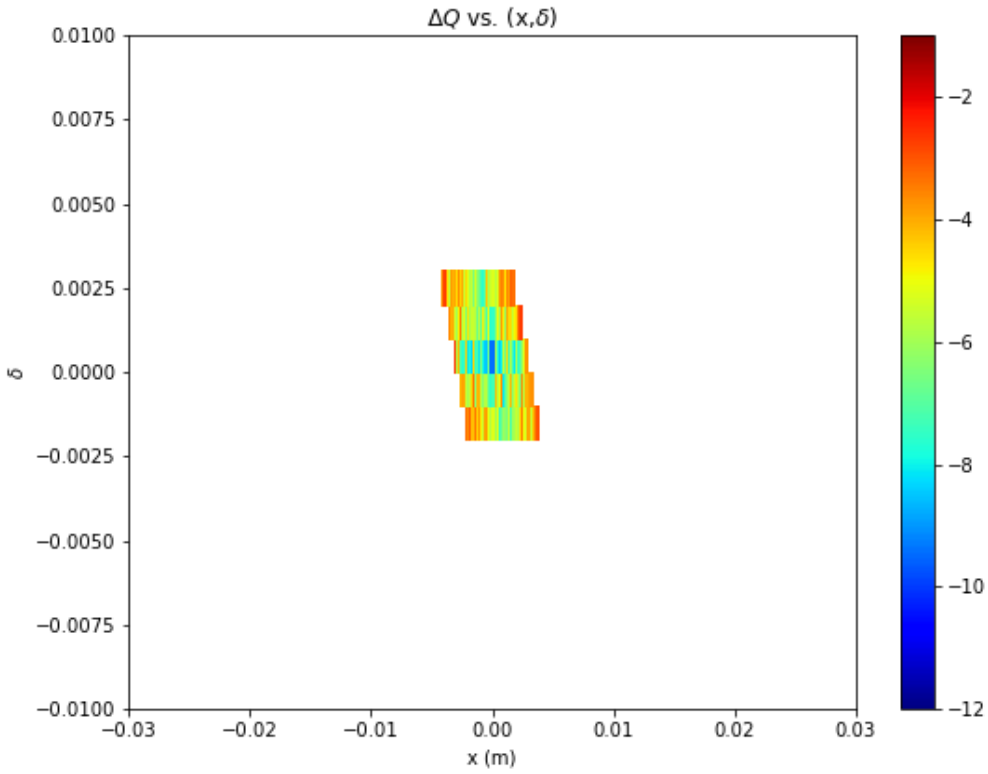
NOTE: North Arc (10w-10e) multipoles only

2-fam, with multipoles, 2 CCUs

dQ vs. x,y



dQ vs. x,δ

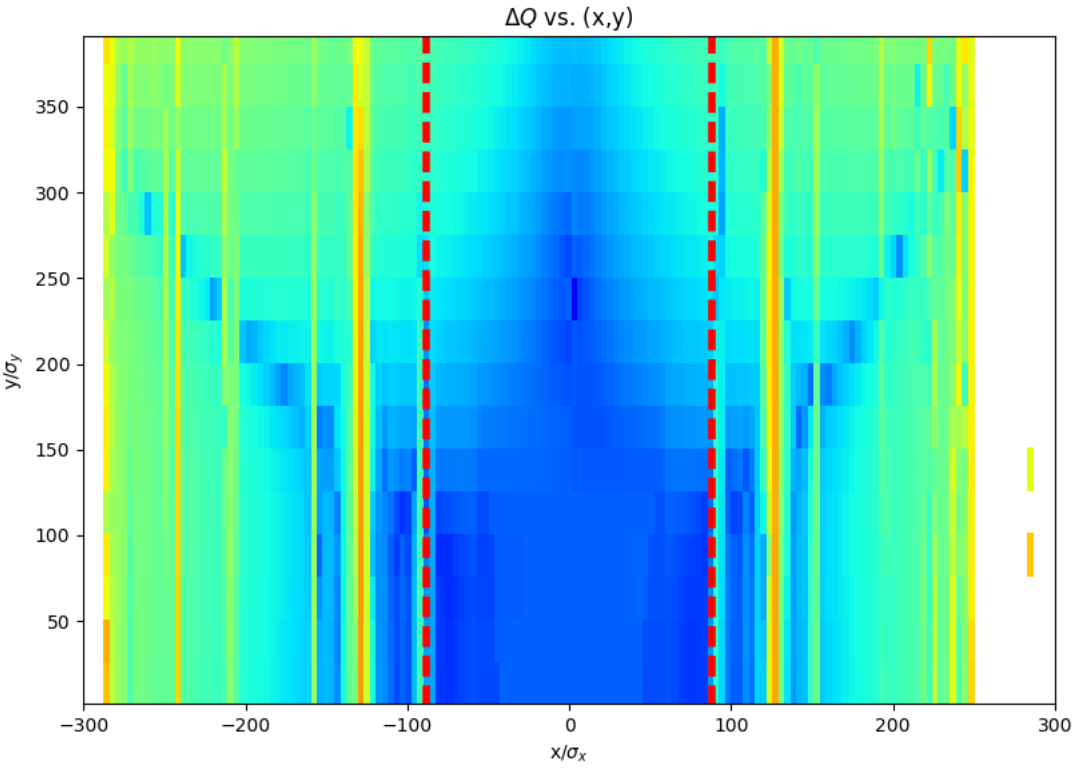


Comments

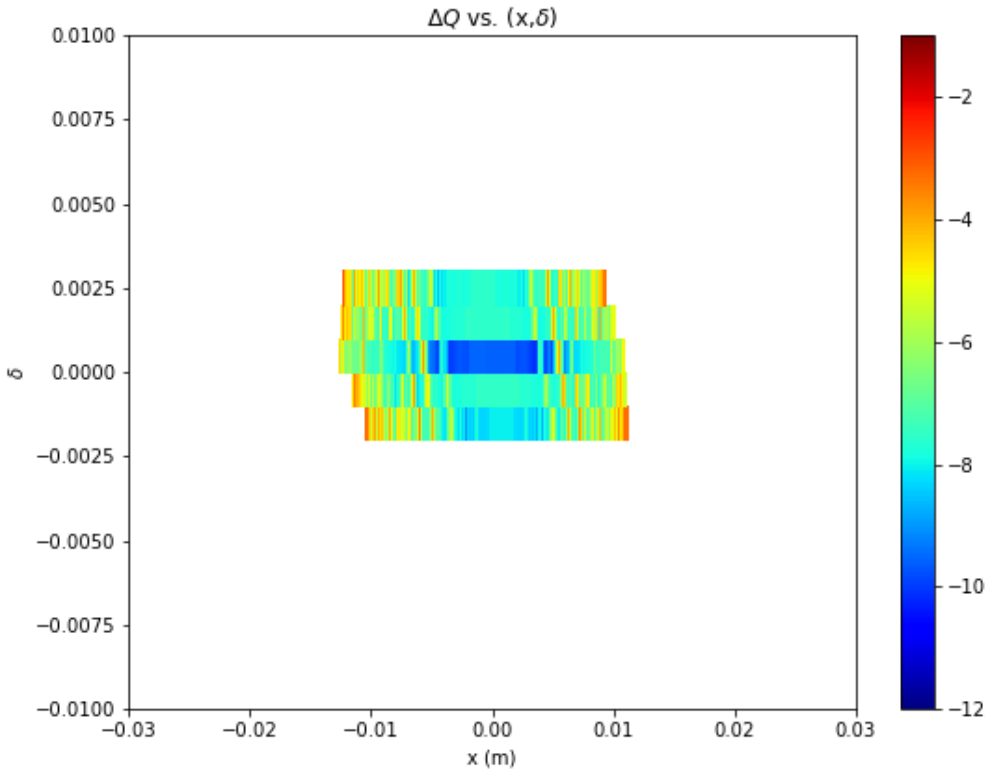
- For 2-family sextupoles, DA looks fine up to including multipoles*
  - *note: only 10w:10e multipoles were included in this test, due to a typo in the input file. However, I do not believe the remaining 1/6 of the ring will significantly affect the results.
- Including the 2 CCUs at 7-8W drastically impacts DA
  - A better sextupole distribution may improve matters
- Next step: optimize from 2-family distribution, using new Tao-based RDTs (Bengtsson)
  - **Note:** Because Bengtsson is analytic, only elements with a true b2 or b3 multipole are included– there is no method presently implemented in Tao which would account for the undulators' contributions directly!

RDT-optimized; no multipoles or CCUs

dQ vs. x,y



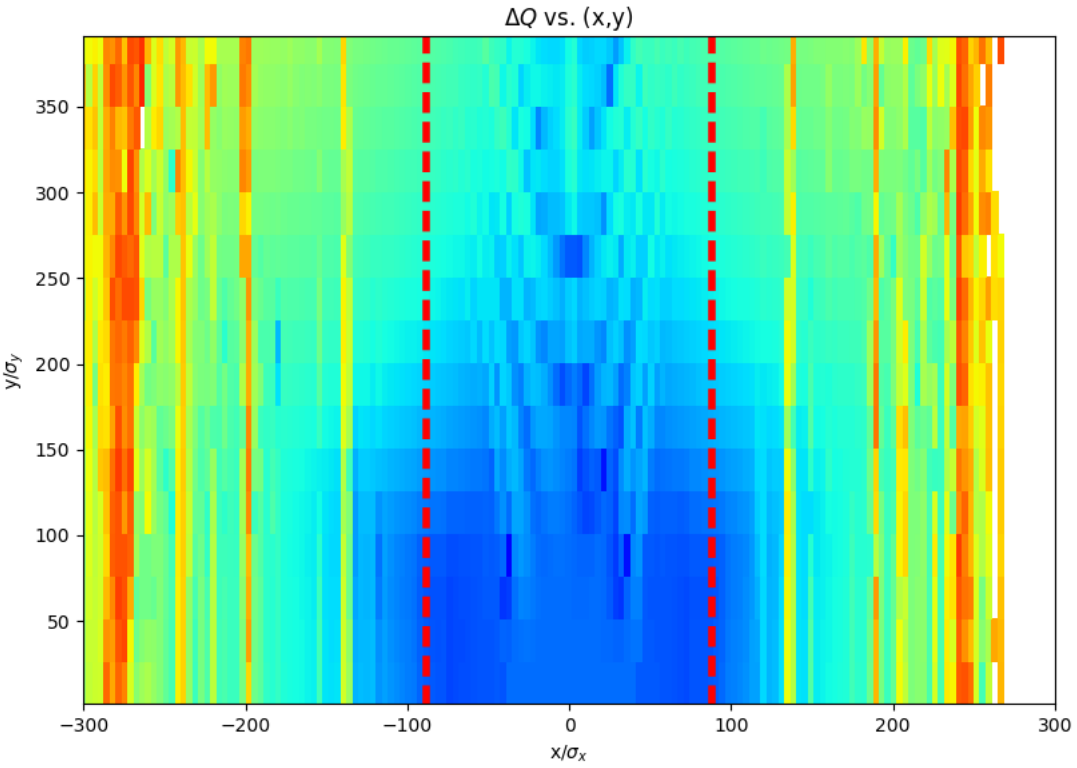
dQ vs. x,δ



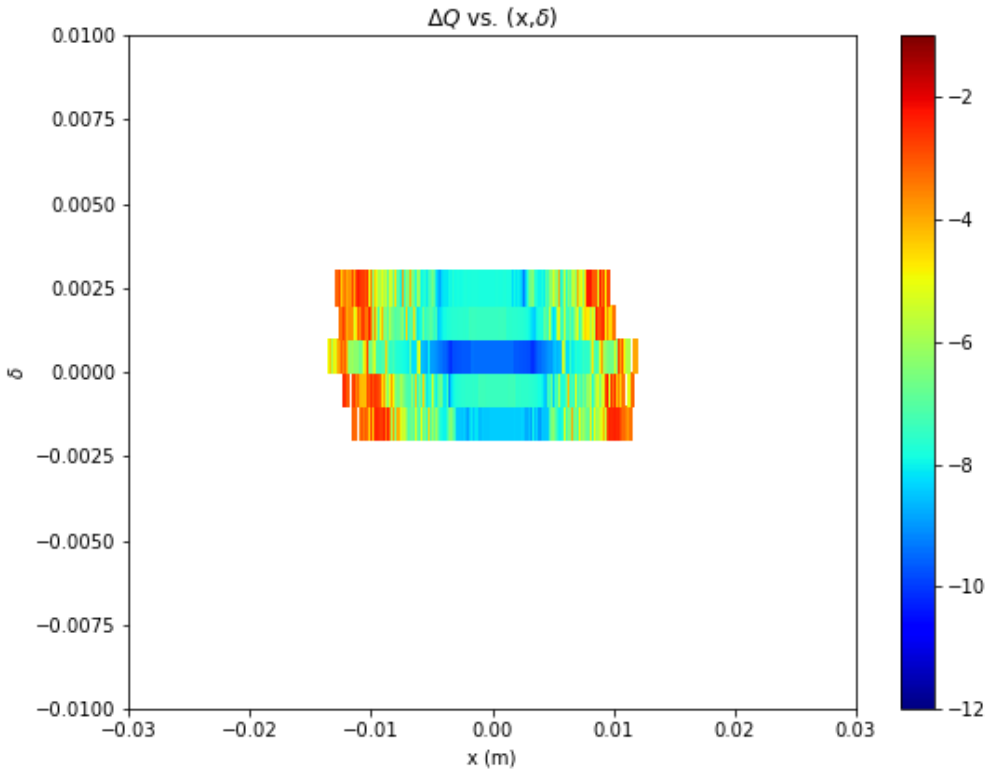
- Compare to slide 4 (2-family, no multipoles or CCUs)
- Almost no difference in DA or MA
- Somewhat expected result– DA/MA already looked good with 2-family

RDT-optimized; with multipoles, no CCUs

dQ vs. x,y



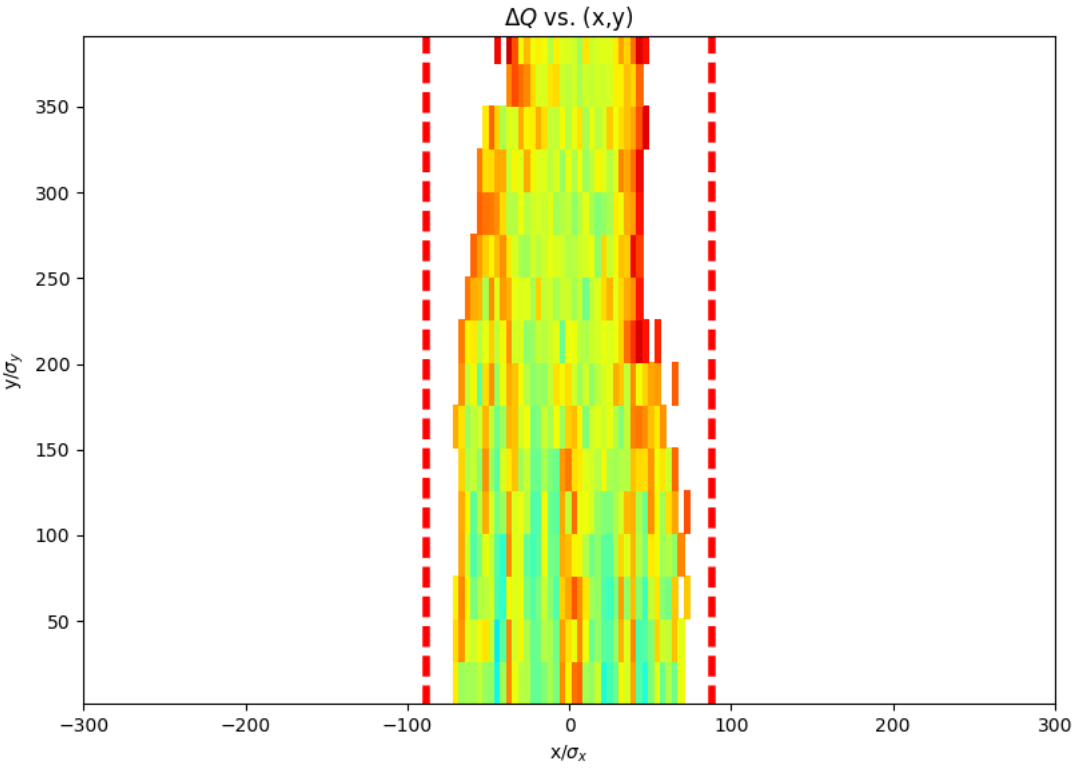
dQ vs. x,δ



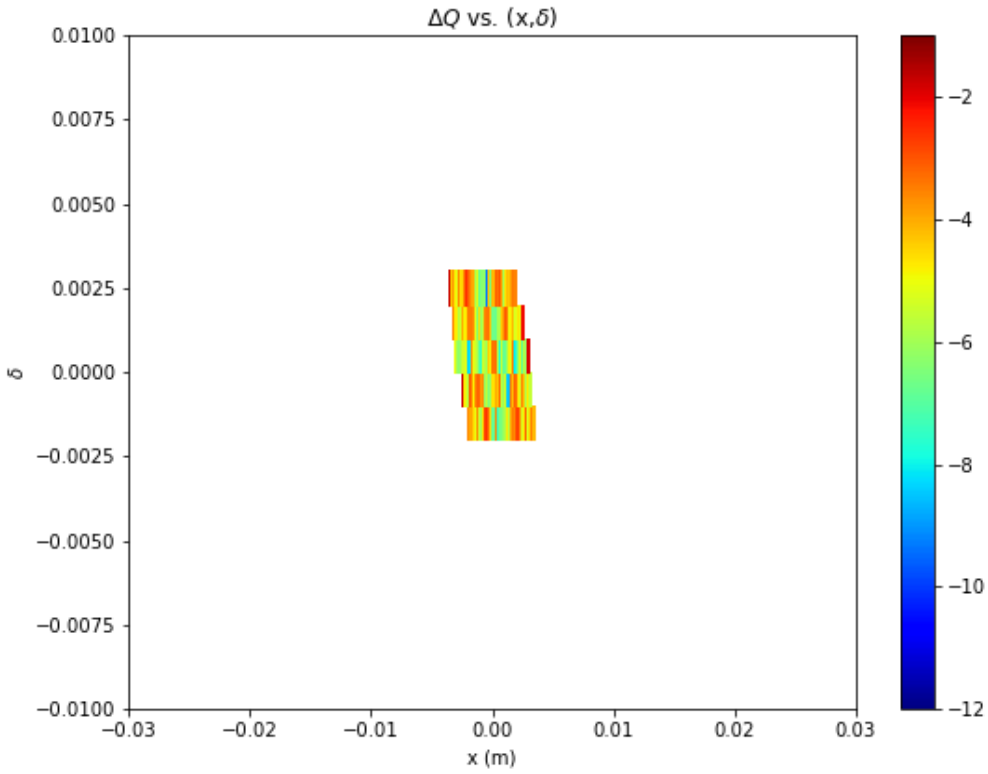
- 10w:10e multipoles only
- Compare to slide 5 (2-family, with multipoles, no CCUs)
- Almost no difference in DA or MA
- Somewhat expected result– DA/MA already looked good with 2-family

RDT-optimized; with multipoles, 2 CCUs

dQ vs. x,y



dQ vs. x,δ



- 10w:10e multipoles only
- Compare to slide 6 (2-family, with multipoles, 2 CCUs)
- Almost no difference in DA or MA
- Somewhat expected result– DA/MA already looked good with 2-family

Comments

- New sextupole distribution doesn't really change matters
  - Not terribly surprising. The starting point for 2-family without IDs already looks pretty good; the only way we'll make an improvement is to incorporate IDs into the optimization
- Including IDs in optimization will require PTC
  - MPE has started looking at RDTs in PTC; still needs some work to get this implemented in Tao. Perhaps before end of 2017?