Cornell University
Laboratory for Elementary-Particle Physics

CesrTA Simulation and Beam measurement Program CTA09

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Critical R&D Issues

- The principal goal of the CTA09 workshop is to review and refine the plans for the CesrTA R&D program over the course of the next year.
- In this talk, I will focus on issues related to electron cloud simulations, and to measurements made using the beam as a probe of the cloud.
- I will outline what I understand to be the tasks needed to address these issues, and illustrate one of them with examples.
- In the general discussions today and tomorrow morning, we should
  - clarify, and add to (or remove from), the list of tasks
  - establish priorities for the tasks, and interested people
  - identify the time scale and resources needed (experimental equipment, experimental time, computing time, etc.) for the tasks.
  - document this information in the session "Notes template".
- This information will be summarized tomorrow during the summary session, and will form part of the outline for the CesrTA R&D program over the course of the next year.

Electron Cloud Simulations for CesrTA: Tasks-1

- All simulations:
  - scattered radiation
    - As input to any of our simulations, estimate of the scattered radiation around the CESR ring. This will need X-ray scattering and absorption data for guidance.
    - Modify the simulation codes to be able to input a non-uniform distribution and different PE energy/angular spectrum for the scattered radiation.
  - photoelectron model
    - Develop an improved photoelectron model (quantum efficiency, photoelectron energy, angular spectra, effect of fluorescence) based on existing data, with measurements if needed.
    - incorporate into simulation programs.
  - determining the model parameters
    - Design a set of experiments (RFA, TE wave, tune shift) which can be done at CesrTA that can independently determine the key electron cloud physics paramters.
- RFA 2D and 3D simulations (more on this from Joe Calvey)
  - include the details of the RFA structure itself into the cloud simulation programs.
  - develop a procedure for automating the (2D) simulation of a given data set.
  - run simulations for the existing data sets for a range of cloud physics parameters, to establish the best fit ranges of these parameters for different surfaces and mitigation techniques.
  - develop capability to simulate cloud and RFA in quadrupole

Electron Cloud Simulations for CesrTA: Tasks-2

- RFA 3D wiggler simulations (more on this from Christine Celata)
  - resolve discrepancies between simulation codes regarding the structure of the cloud in the By=0 regions
  - compare the simulations (including the RFA structure) with RFA measurements in the non-zero By regions
  - identify experimentally accessible signatures of the structure of the cloud in the By=0 regions.
- TE Wave measurements
  - Simulate cloud densities sampled by TE wave measurements
- Coherent tune shifts
  - automate the calculation of tune shifts from drifts and dipoles performed with and without coherent motion of the whole train.
  - estimate contributions to tune shifts from wigglers and quadrupoles.
  - run simulations for the existing data sets for a range of cloud physics parameters, to establish the best fit ranges of these parameters. (Examples at the end!)
  - correlate with the parameters found from the RFA simulations and in-situ SEY.
  - develop estimates of cloud-induced betatron phase advances over sections of the ring.

Electron Cloud Simulations for CesrTA: Tasks-2

- Coherent instabilities (more on this tomorrow from Mauro Pivi and Ohmi-san).
  - Using as guidance the cloud densities derived from the tune shift measurements, estimate the threshold, growth time and mode spectrum for multibunch instabilities at CesrTA.
  - Using as guidance the cloud densities derived from the tune shift measurements, estimate the threshold for the head-tail instability at CesrTA.
- Sub-threshold emittance growth (more on this from Mauro Pivi and Ohmi-san).
  - At cloud densites below the instability thresholds, estimate the expected level of incoherent emittance growth at CesrTA for positrons and electrons.
- Other topics….?

Beam-cloud interaction experiments for CesrTA Tasks-1

- Coherent tune shifts
  - Complete reprocessing of older tune shift data from Nov 08 and Jan 09 runs.
  - Develop techniques and software to process tune shift data from Dimtel feedback system; process data from June 09 run.
  - Develop software to process tune shift data and multibunch mode spectra from new BPM system.
  - Make witness bunch and train current dependence measurements with 4, 8, 12, 16 ns using Dimtel system. Choose train length, witness timing, particle species and energy to distinguish primaries (short trains, low bunch current, electrons) from secondaries (long trains, high bunch current, positrons).
  - Make witness bunch and train current dependence measurements, with 4, 8, 12, 16 ns using the new BPM system, with existing (full train) pingers.
  - Make witness bunch and train current dependence measurements, using the new BPM system to make betatron phase advance meaurements as a function of bunch number.

Beam-cloud interaction experiments for CesrTA Tasks-2

- Coherent multi-bunch instabilities
  - Use new BPM system to observe threshold and modes of coherent multi-bunch instabilities at 4, 8, 12, 16 ns as a function of cloud configuration and feedback settings.
- Coherent single-bunch instabilities
  - Assuming that we can exceed threshold, establish appropriate cloud conditions and measure threshold (via synchrobetatron sideband enhancement?).
- Incoherent emittance growth
  - Use X-ray beam size monitor to measure growth of vertical emittance vs. bunch number in trains of positrons and electrons at 2 and 5 GeV, at various bunch spacings and currents.
- Other topics….?

1.9 GeV positrons 10 tr 15 wit

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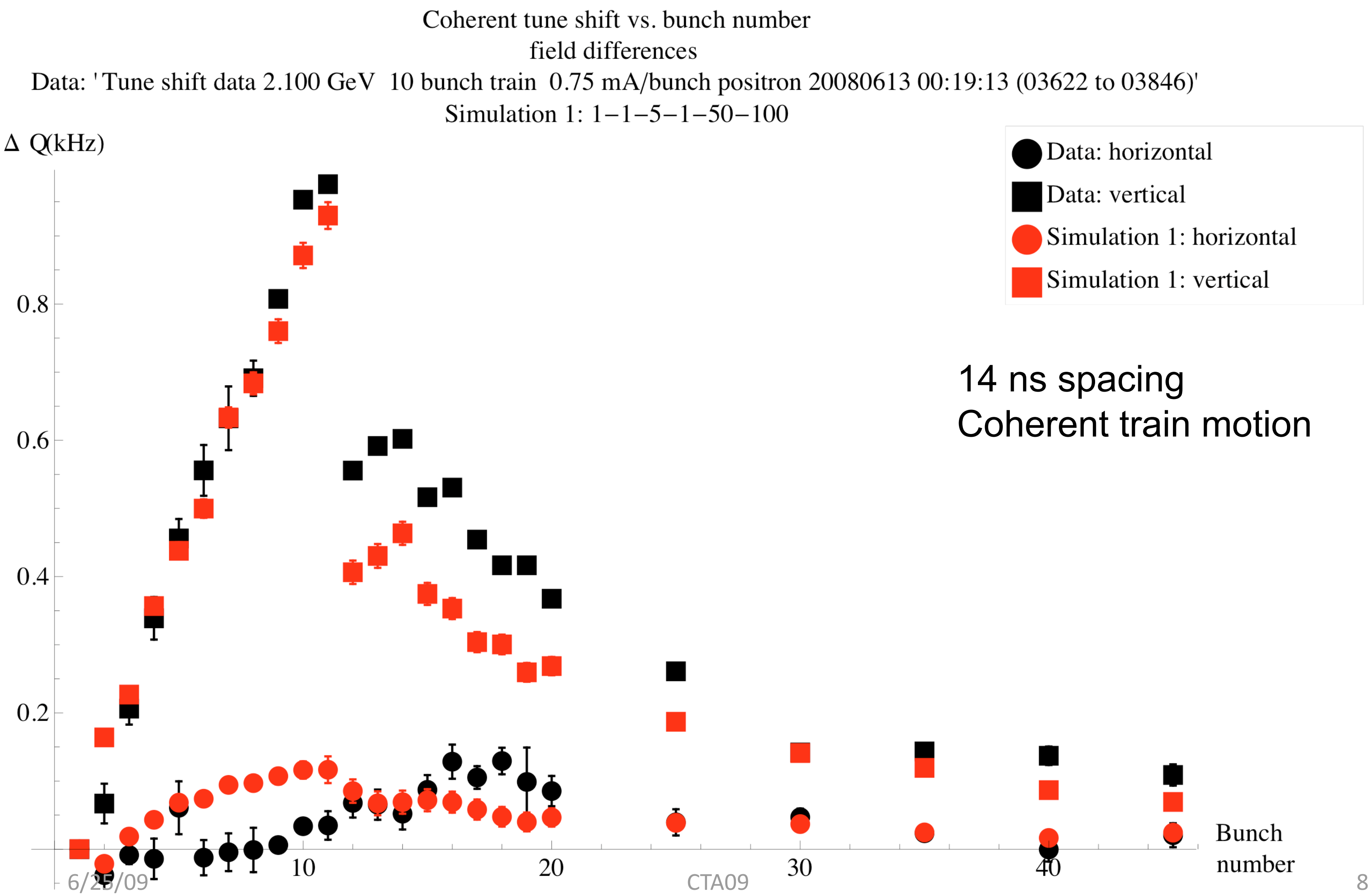
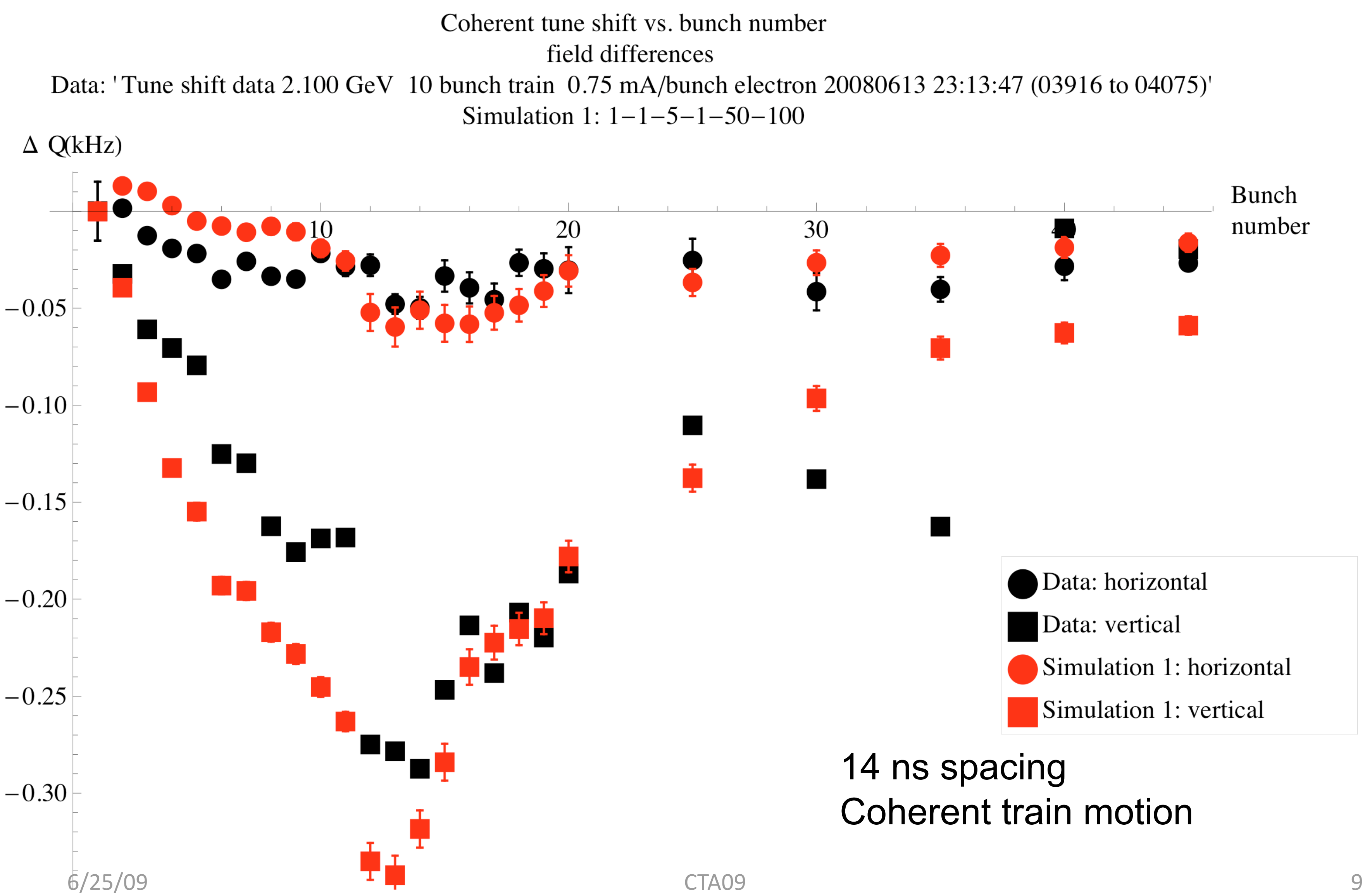


14 ns spacing
Coherent train motion

1.9 GeV electrons 10 tr 15 wit



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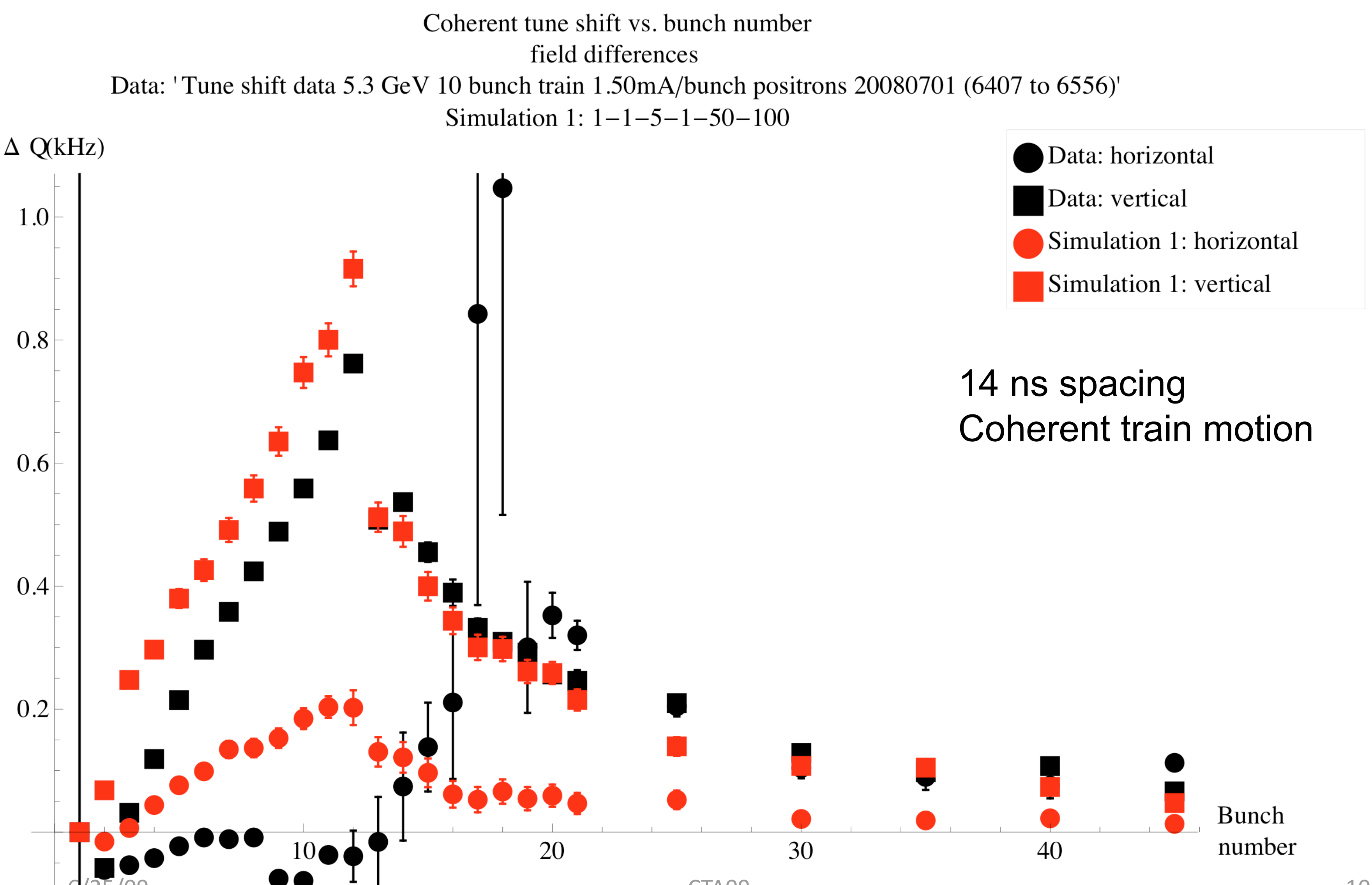
Coherent train motion

5.3 GeV positrons 10 tr 16 wit



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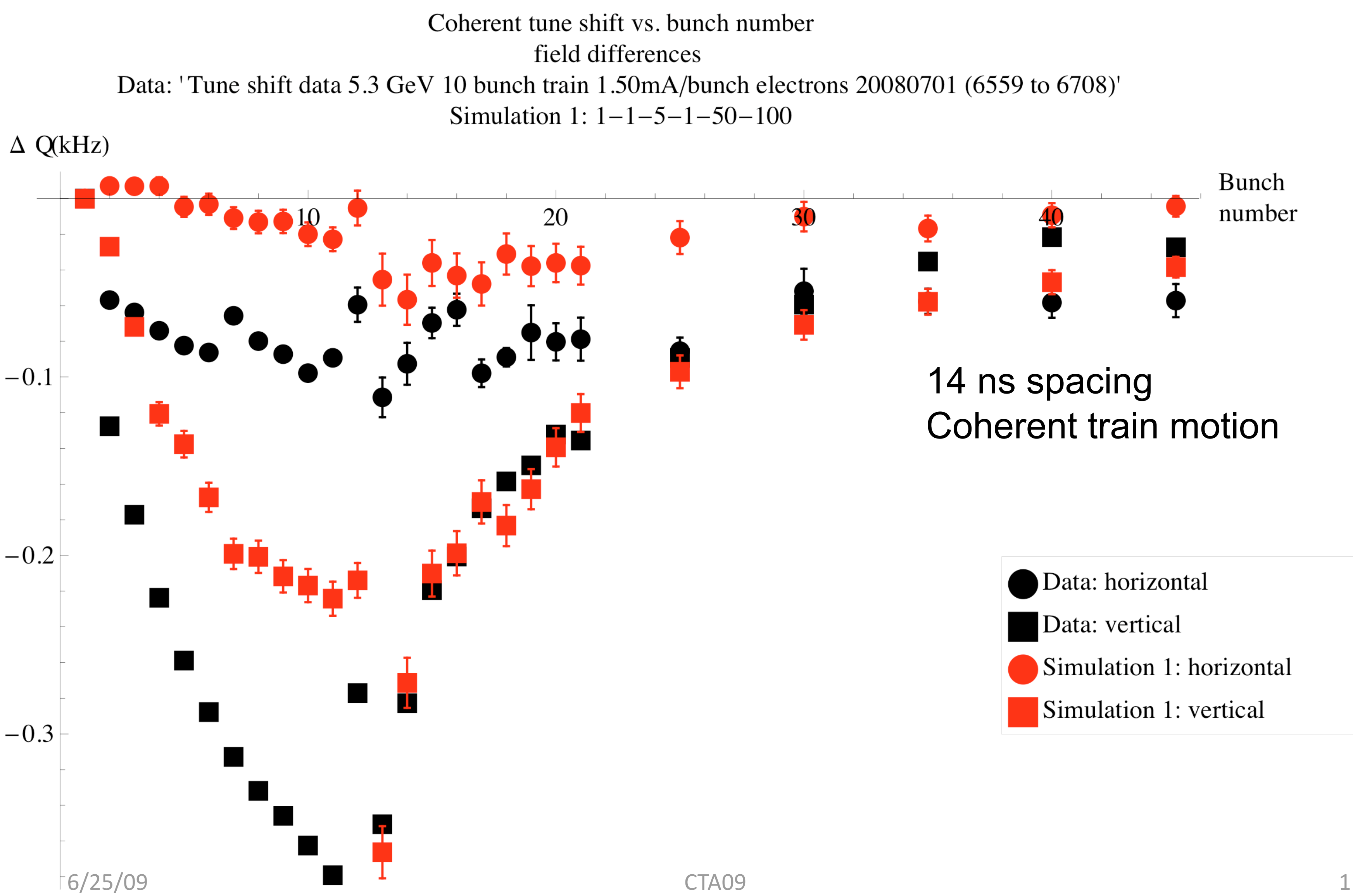
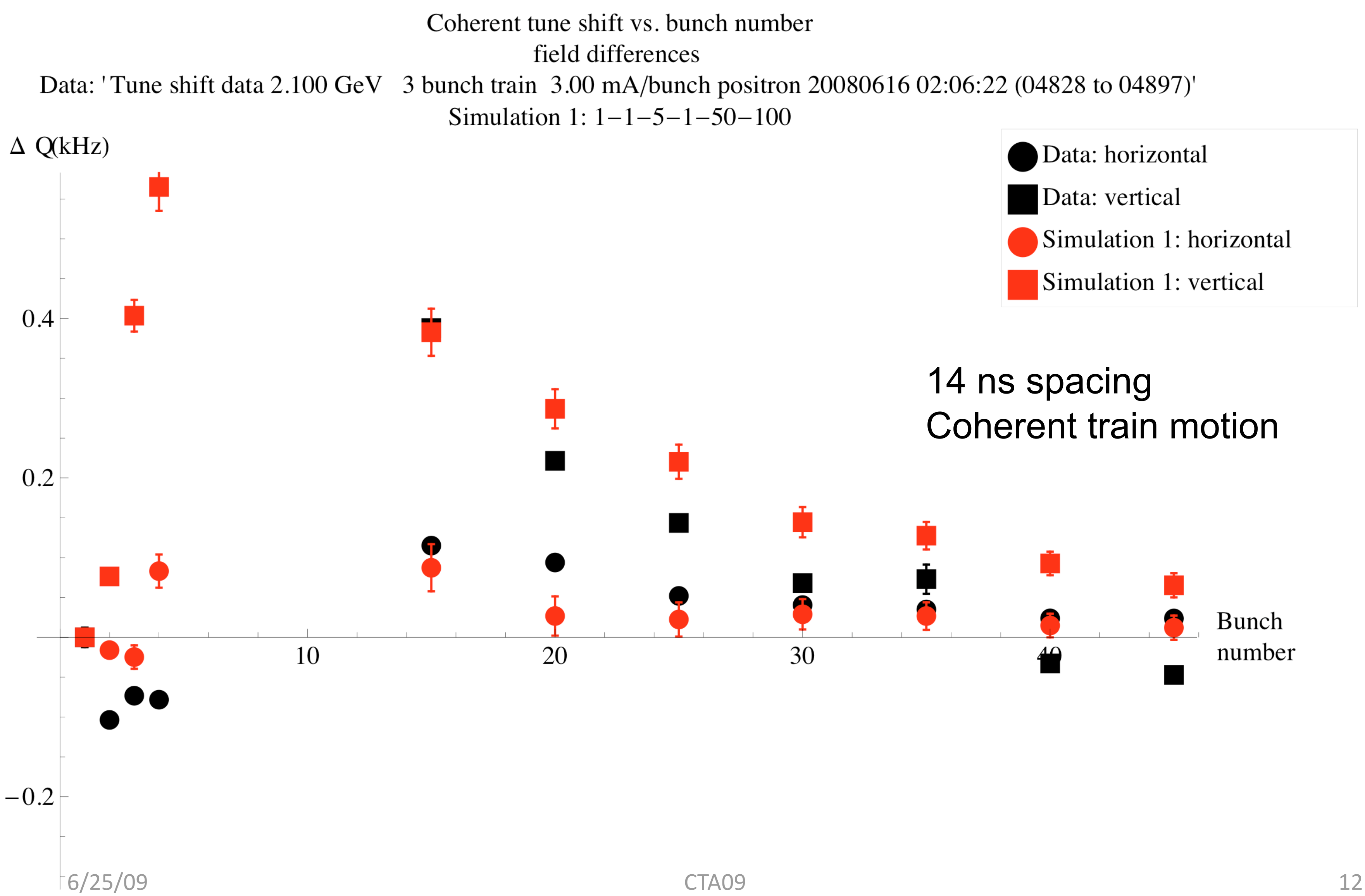


14 ns spacing
Coherent train motion

2.1 GeV positrons 3 tr 7 wit



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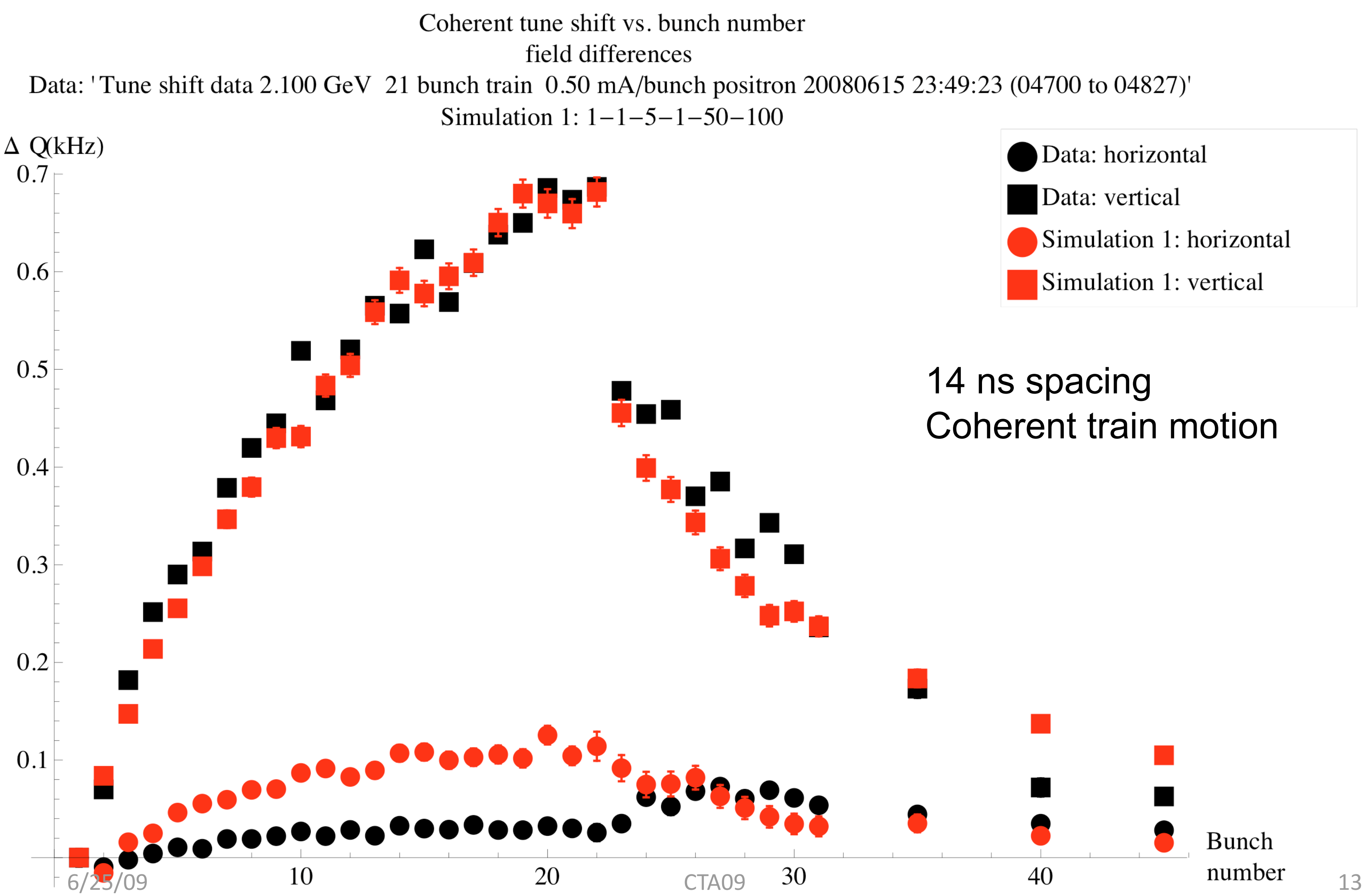
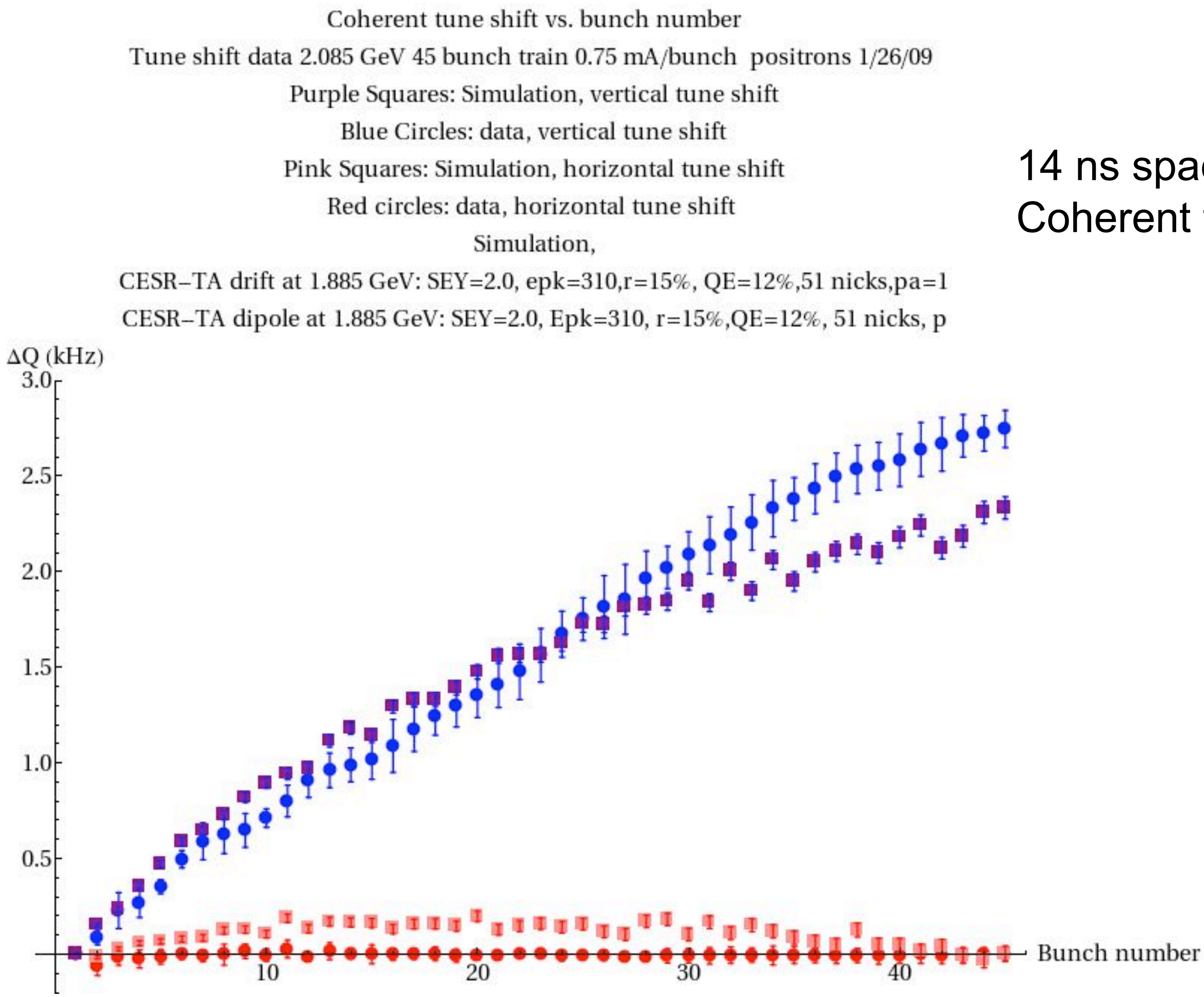


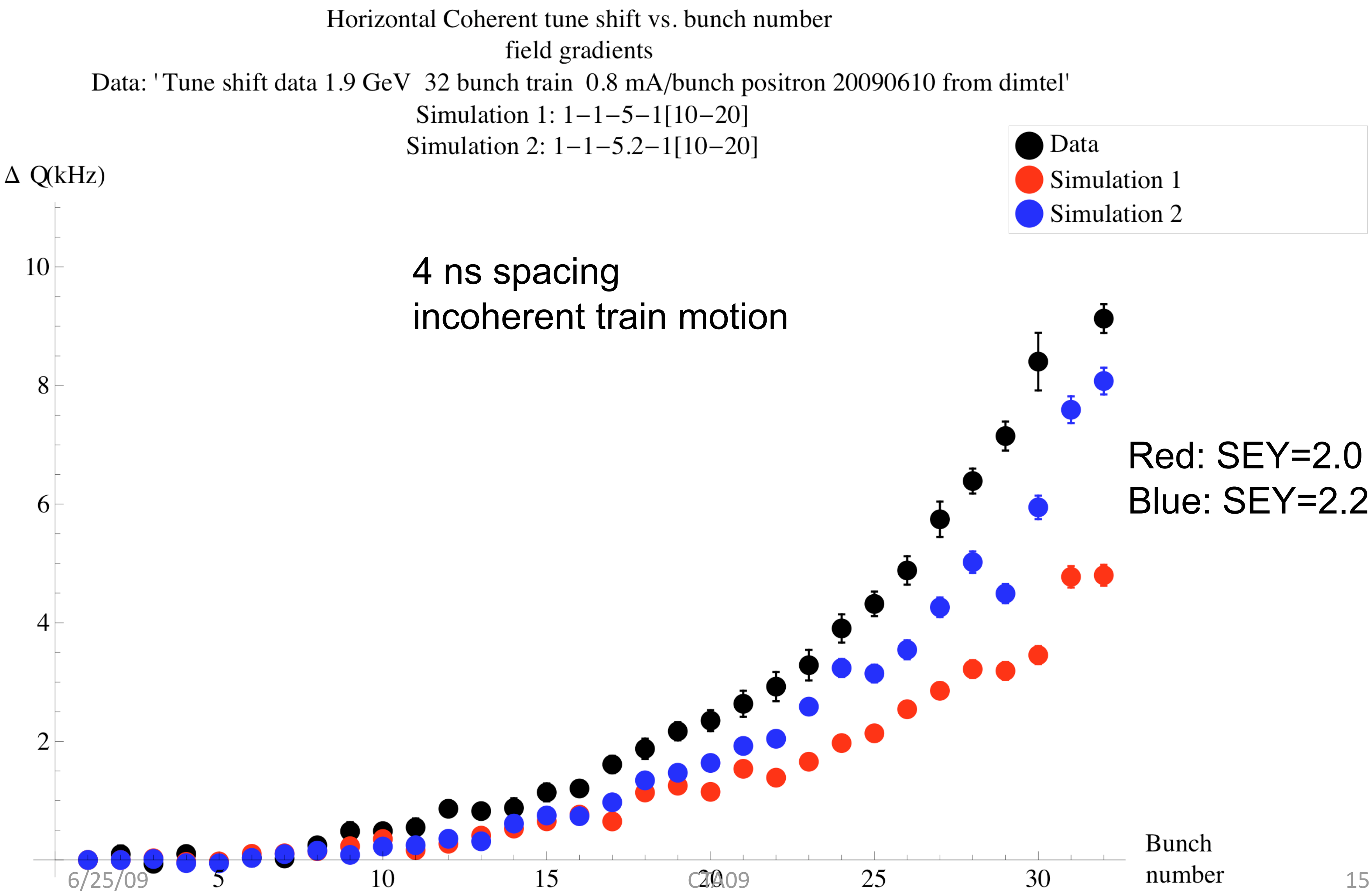
14 ns spacing
Coherent train motion

2.1 GeV positrons 45 bunch train



14 ns spacing
Coherent train motion

2.1 GeV positrons 32 bunch train



2.1 GeV positrons 32 bunch train