Investigations of bunch compression, linearization, and bunch current profiles

(ongoing investigation)

H Edwards

with

C Behrens, M Dohlus, (E Schneidmiller)

Purpose- A study of kinematics

- Try to understand:
  - The compression operating point (s) and choices of conditions (phases, gradients, …)
  - The role of Acc39 vs Acc1
  - The relative compression in BC2 vs BC3
- Trace evolution from no to full compression and how well does it match simple kinematic model
- The model is then an easy tool to aid in selection of operating point.
- How well can one control current profile, connect to resulting SASE

Measurement & Analysis based on LOLA And C Behrens help & data analysis tools

Model - based on Igor's work

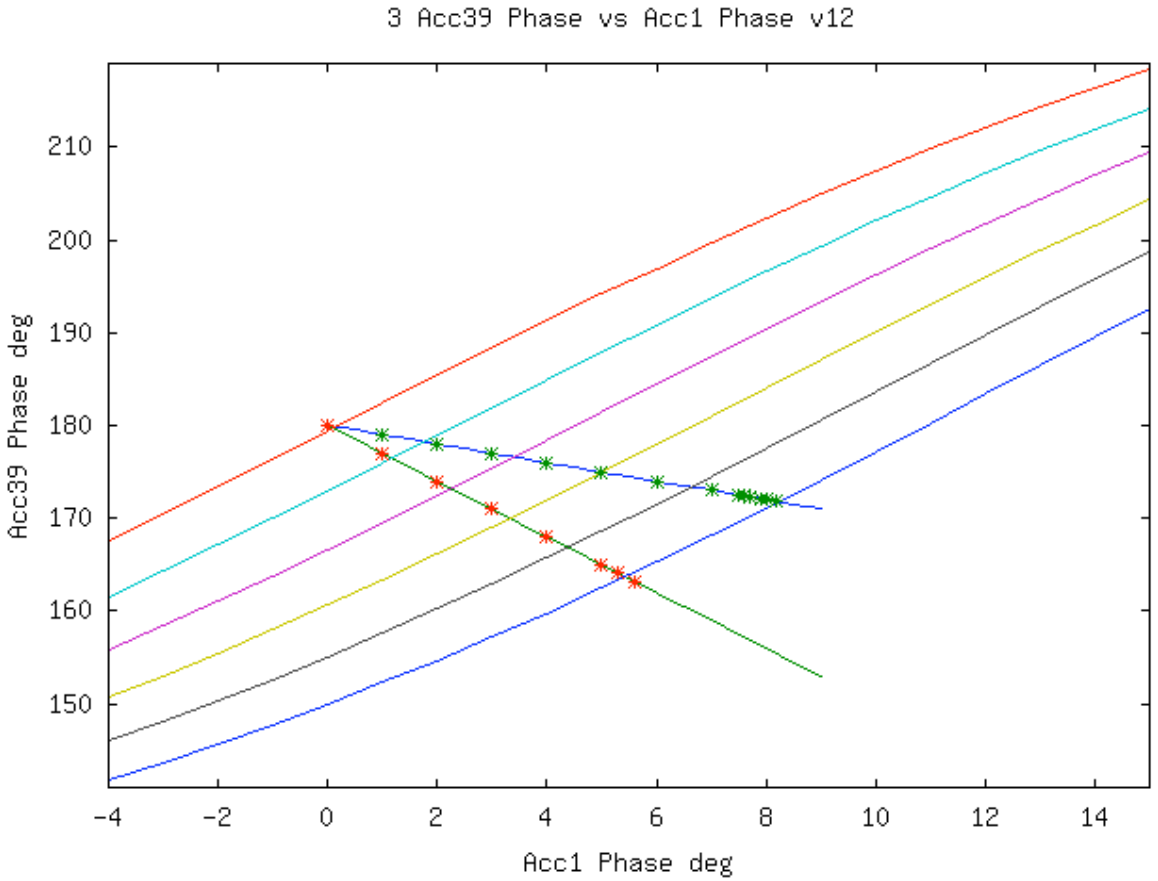
- Based on Igor's RF Tweak
  - Used his eqns as starting point
  - Purely kinematics- no beam dynamics
  - Should work (till collective effects take over)

Tuning trajectories from no to full compression, data points

(Z1 is “inverse compression”, 0=full compression, after BC2)

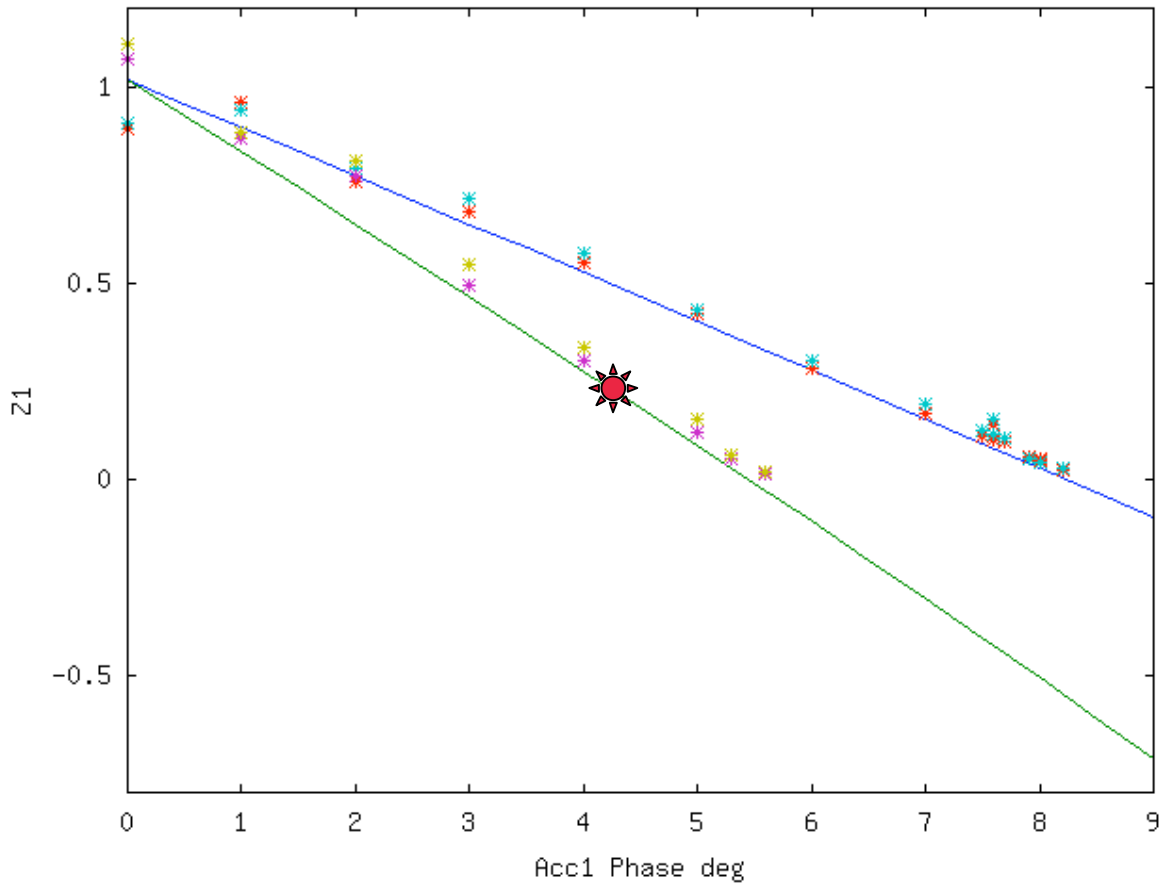
- Two trajectories across Z1 contours
- With measurement points
- Acc1:ACC39 ratios of 1:-1 and 1:-3
- 1:-3 is nice because energy stays constant

Lines of constant Z1 from 1 (top) to 0 in steps of 0.2 (Acc1 Phase vs Acc39 Phase)



Measured and calculated Z1 vs Acc1 phase, two ratios

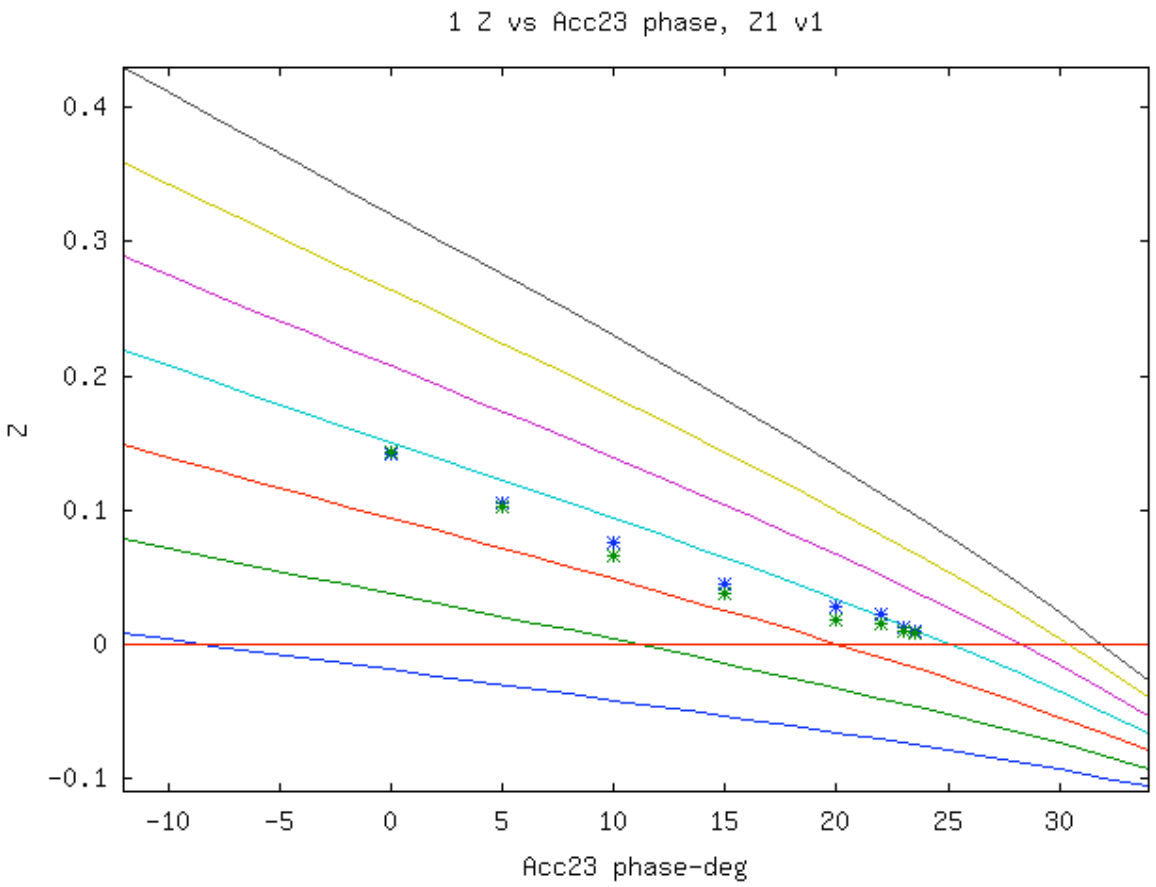
- Measurements of BC2 Z1 compression
- Acc1/Acc39 phase 1:1 and 1:3
- Point for Acc23 compression
- Acc1:Acc39
- 4.3:-12.9 deg



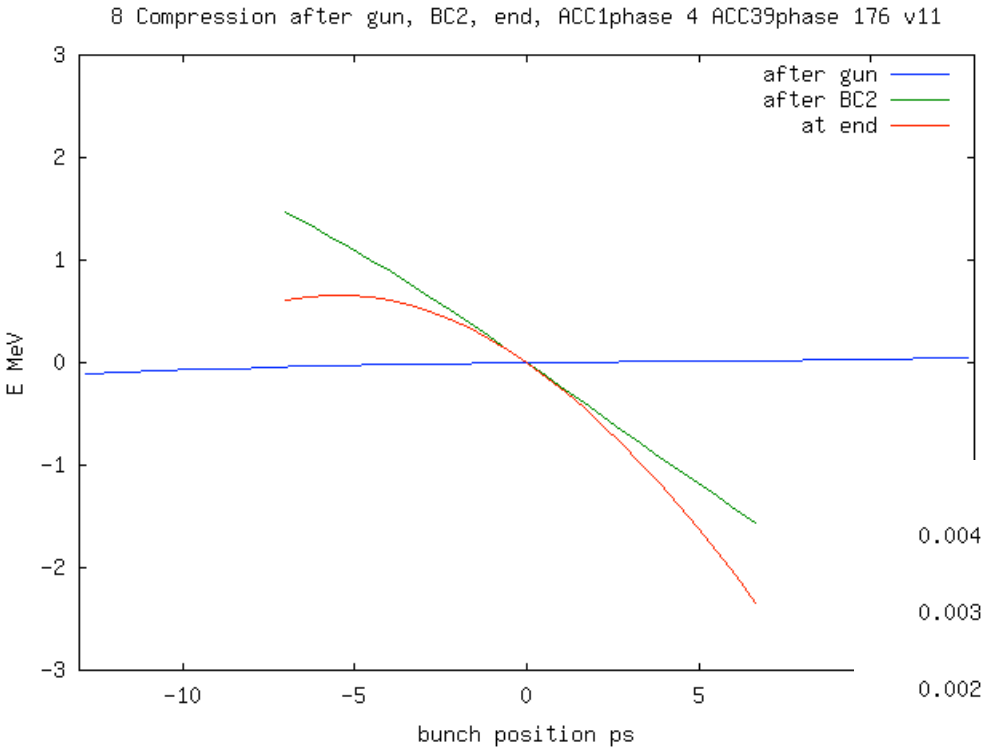
Inverse compression "Z" after BC3, with measurement data, Z vs Acc23 phase for different Z1's, & data

- Measurements
- Acc1 4.3
- Acc39 167.1 (-12.9)
- Z1 from
- 0.1 to 0.4
- Steps 0.05

- Data fits within
- Z1 predicted 0.22
- Z1 measured 0.26

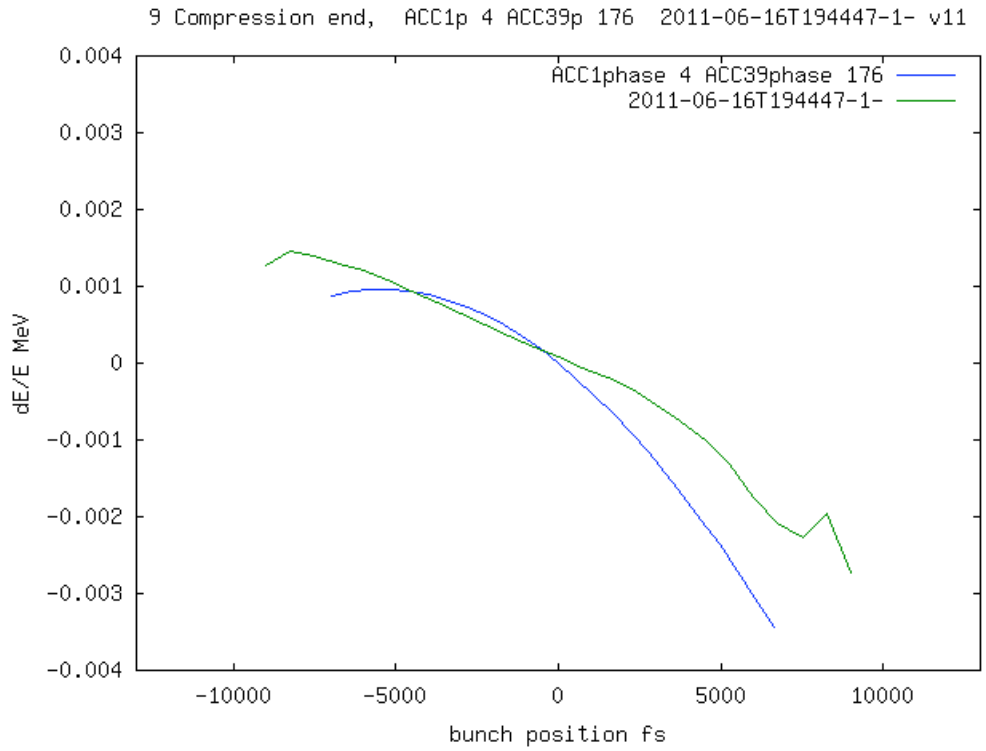


Compare Mean Slice Energy



(Example BC3 off,
weak compression)

Measurement (green)
and calculation (blue)



Calculation
After gun (blue) E 5 MeV
After BC2 (green) E150
After Acc23,4567 (red) E 680 MeV

Summary

- Investigations of bunch compression, linearization, and bunch current profiles
- H Edwards, C Behrens, M Dohlus, (E Schneidmiller when compare with SASE), (S Wesch, others, possible diagnostics comparisons)
- Hardware changes-no (other than planned improvements)
- Shutdown-no
- Beam time- ~ 2 shifts/study period
- When - continuing study, evolving through years if useful
- (people are just my best guess, need to confirm, and others interested?)

The Equations

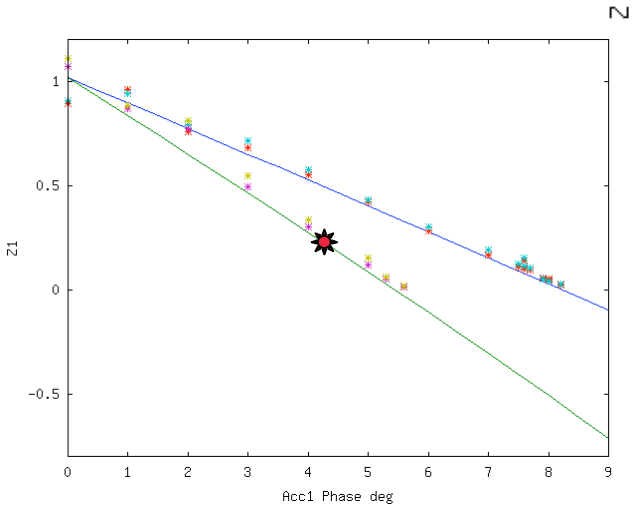
- Acc1 (1), Acc39 (3), Acc2/3 (2)
- Z1 BC2 inverse compression, (Z1=1/C1)
- Z final inverse compression after BC3 (1/C)

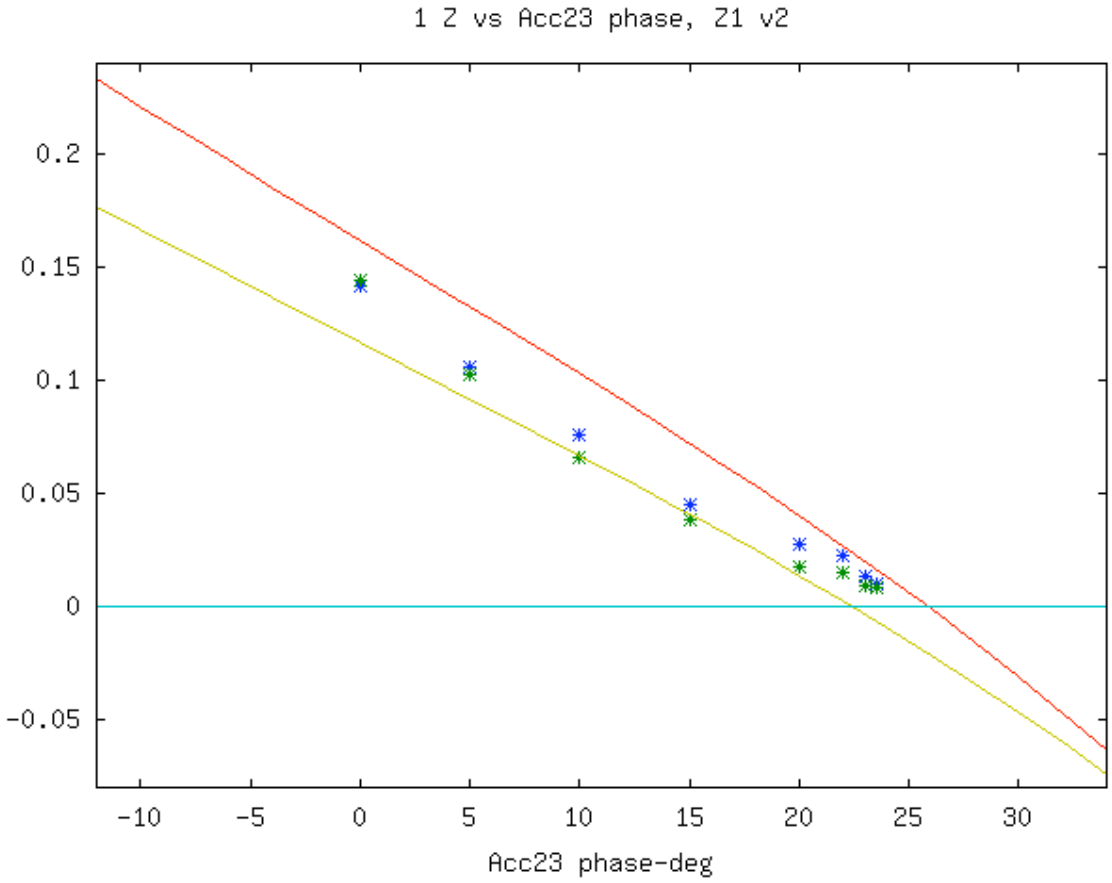
- E1=E0 + V1*cos(f1) + V3*cos(f3);
- E2=E1 + V2*cos(f2);
- dE1=zeta1*E0 - k*V1*sin(f1) - 3*k*V3*sin(f3);
- Z1=1 - (dE1*r56)/E1;
- dE2=dE1 - k*V2*Z1*sin(f2);
- Z=Z1 - r562*dE2/E2;
- Parameters (can be selected)
- linF=-9*V3*cos(f3)/V1*cos(f1) =1 full linearization
- Z=0 look for solutions for full compression
- k=2pi*f/c

Compression in BC3
Measurement & predicted

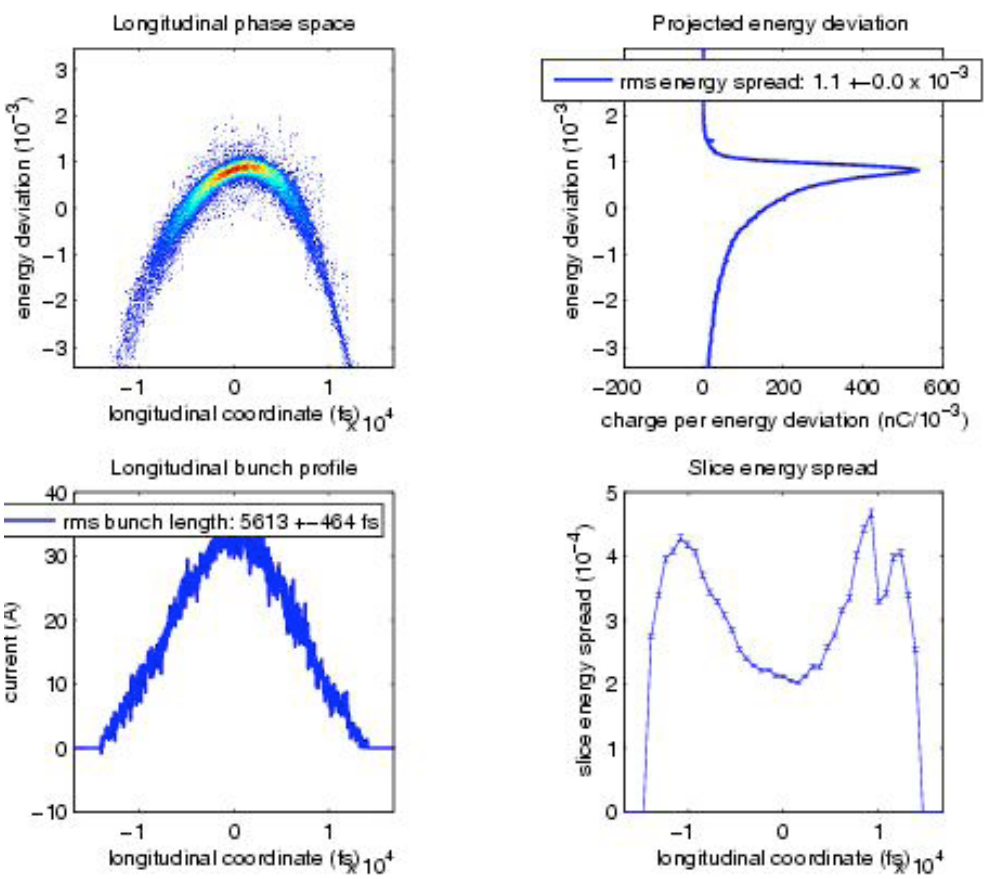
- Measurements
  With lines of

- Z1=0.22
  prediction
- Z1=0.26
  measured





On crest & initial development of head destruction BC2



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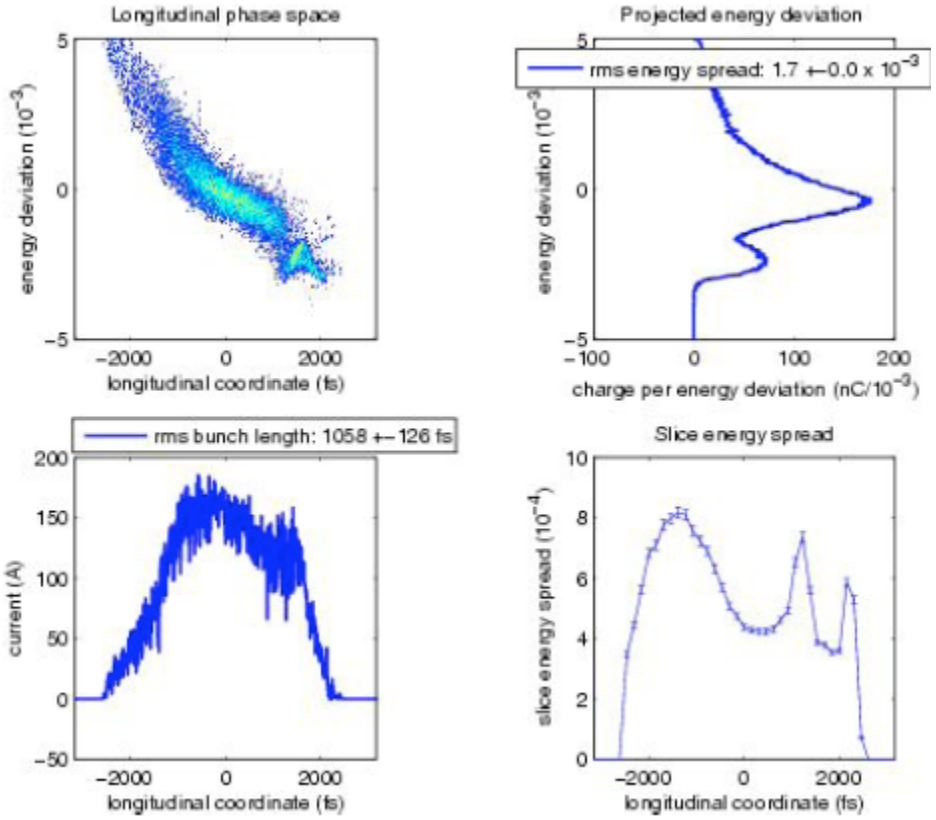

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