Compression Studies
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Preliminary report

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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.
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
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=zet1*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
Z1 contour Plot, Acc39 vs Acc1 Phase

- Plot of Acc1 vs Acc39 phases the give constant contour lines of Z1 going from 1 to 0 in steps of 0.2
- 1 no compression top
- 0 full compression bottom
Tuning trajectories from no to full compression, data points

- 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
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
Same Z1 plot vs Acc39
Arrival time on Crest Tool C Schmidt
Acc1 & Acc39
On crest & initial development of head destruction  BC2
Further Destruction

Final BC2 compression
Z1 vs Acc23 phase
Choice of Acc23 phase dictates the value of Z1 for full compression, Z=0, bottom curve

- Z1 vs Acc23 phase
- Bottom curve Z=0
- R562 = 0.0709
- Lines with Z=0, 0.05, 0.1
- Z=0 at bottom
- Region of operation ~15 to 30 deg?
Z vs Acc23 phase, Z1 parameter just different way of looking

- Z1 from
- 0.1 to 0.4
- Steps 0.05
- (bottom to top)
With measurement data

- Measurements
- Acc1 4.3
- Acc39 167.1 (-12.9)
- Z1 from
- 0.1 to 0.4
- Steps 0.05
Compression in BC3  
Measurement & predicted

- Measurements
  With lines of

- $Z_1 = 0.22$
  prediction

- $Z_1 = 0.26$
  measured
Linearization correction for Acc2/3 possible

- Acc39 additional gradient for Acc2/3 linearization
- Gets large as Z1 > 0.3
- Can re-compute Acc1/39 contour plot for linF = 1.1 (or other values)

3 dV3 vs Z1, nonlin correction v1
Final compression with BC3
SASE & spectrometer, pyros

• Achieved SASE ~140 microJ
  – By standard tuning of gun and beamline components
  – But with only small changes to Acc1, 39, 2/3

• Recorded pyro and antenna signals, to be analyzed

• S Wesch got good spectrometer data
Conclusions & outlook

- Still need to do real analysis of LOLA data (here only took data from log shot)
- The model seems to work well and helps one understand operating point selection
- It should be able to guide one to other points to explore
  - Different linerization amounts (linF)
  - Different BC2/BC3 compression (Z1)
  - Different Phase combinations (Acc1/39)
  - Different beam charge effects (eg Z1 choice vs Q, Space charge)
  - Should be able to extend to 3 compressors (XFEL) and guide in condition selection there.
- Pyro and spectrometer data to look at
- Knowing on crest phases critical, a history would be nice
End

• Thanks to Flash Team