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

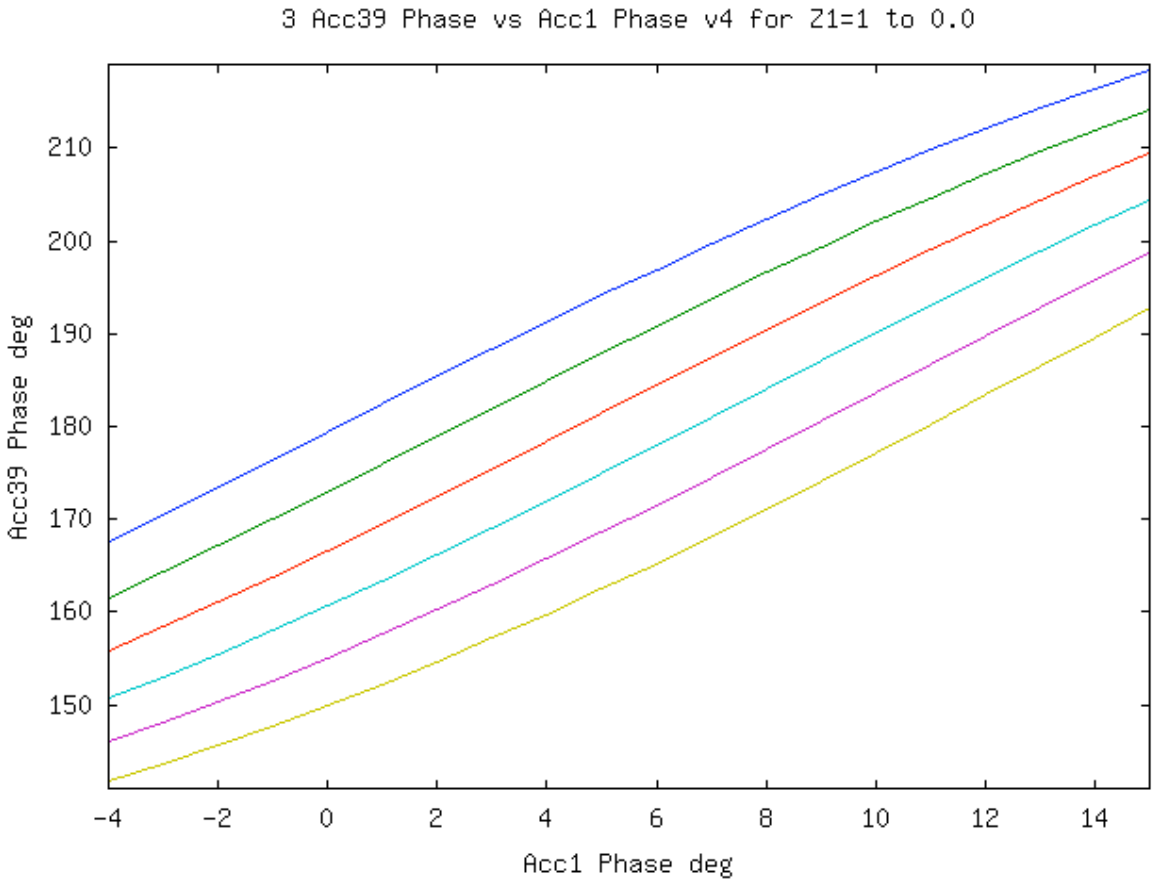
The Equations

- 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=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

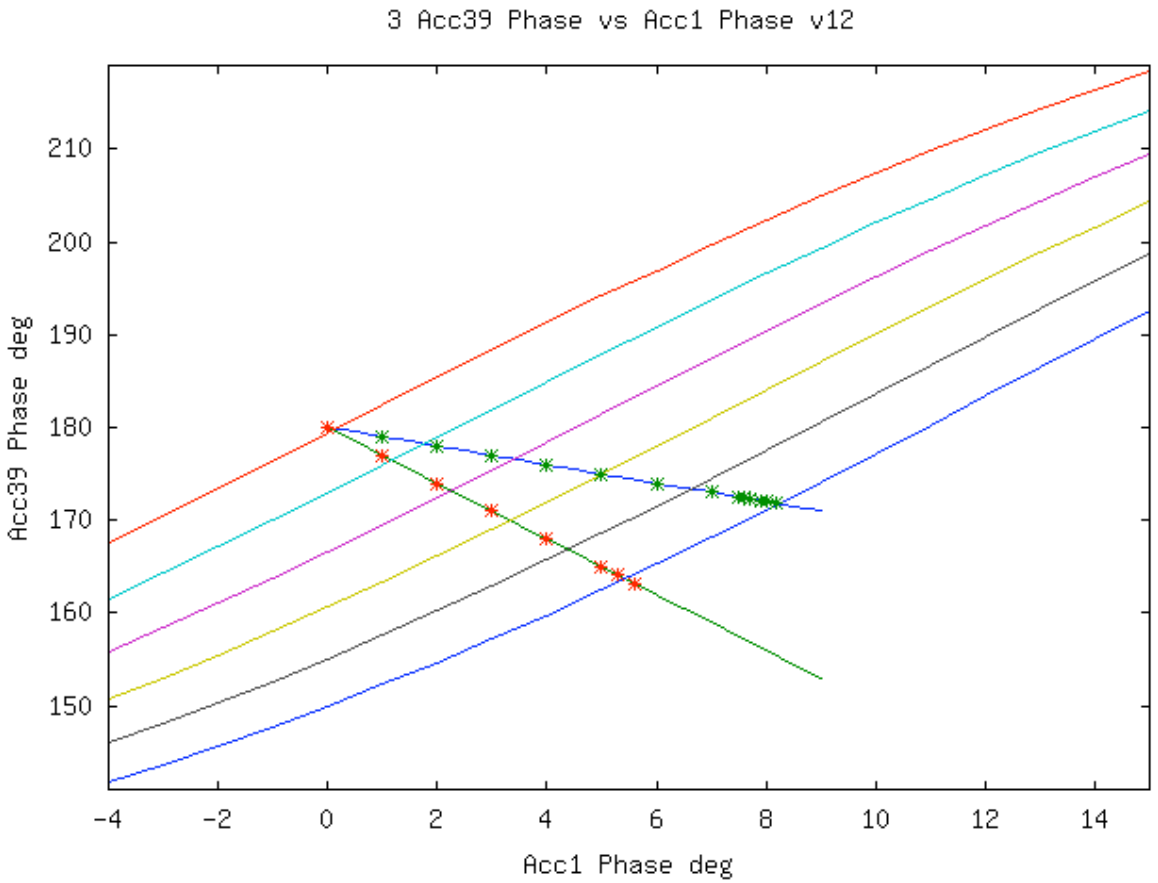
Z1 contour Plot, Acc39 vs Acc1 Phase

- 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



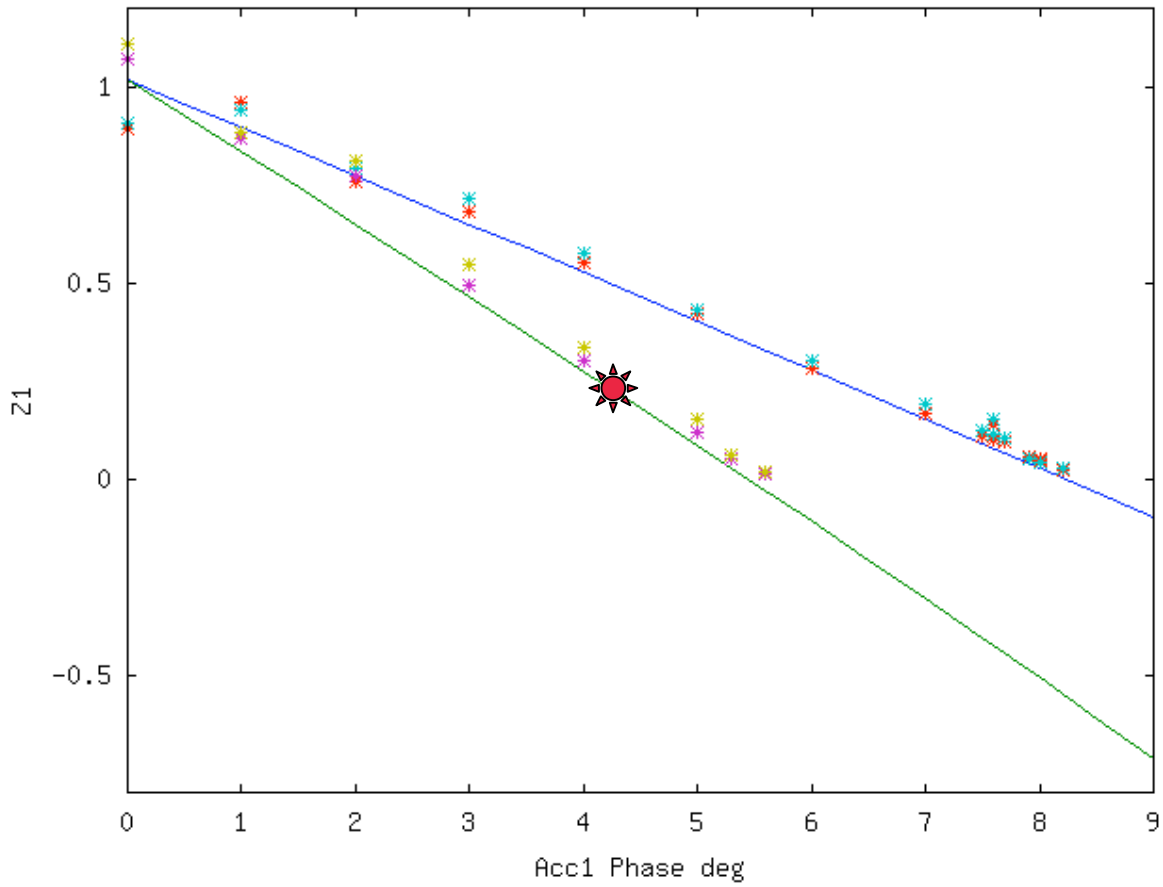
Tuning trajectories from no to full compression, data points

- 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

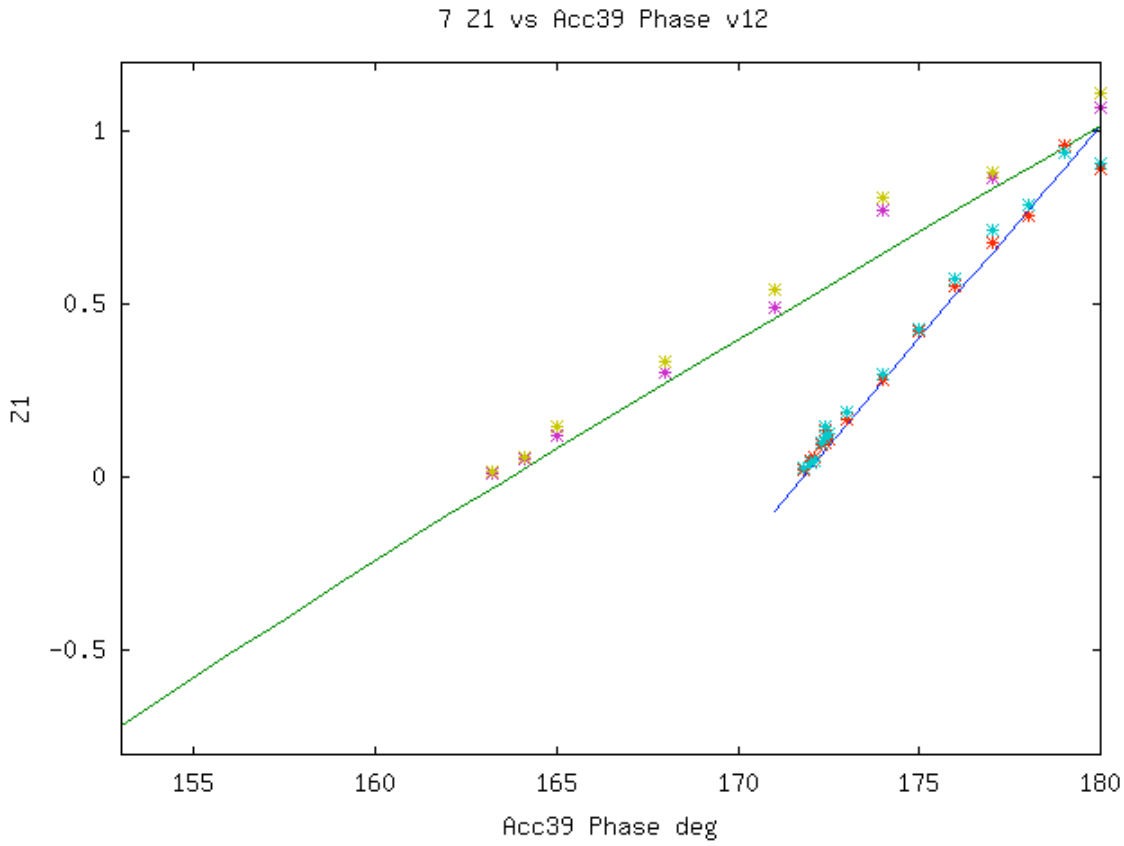


Measured and calculated Z1 vs Acc1 phase, two ratios

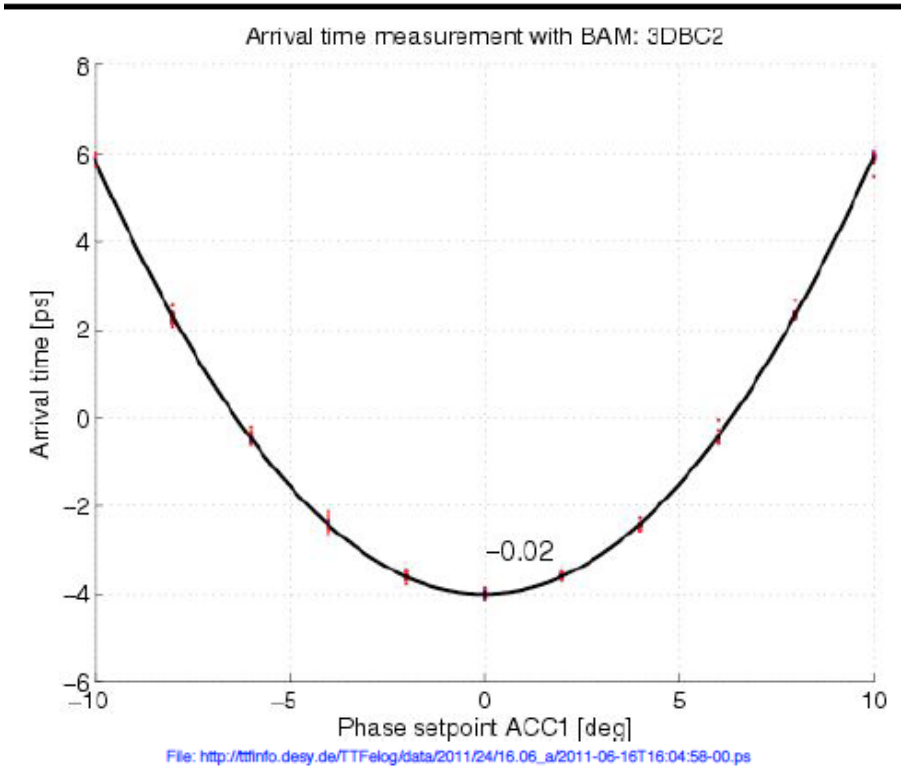
- Measurements of BC2 Z1 compression
- Acc1/Acc39 phase 1:1 and 1:3
- Point for Acc23 compression
- Acc1:Acc39
- 4.3:-12.9 deg

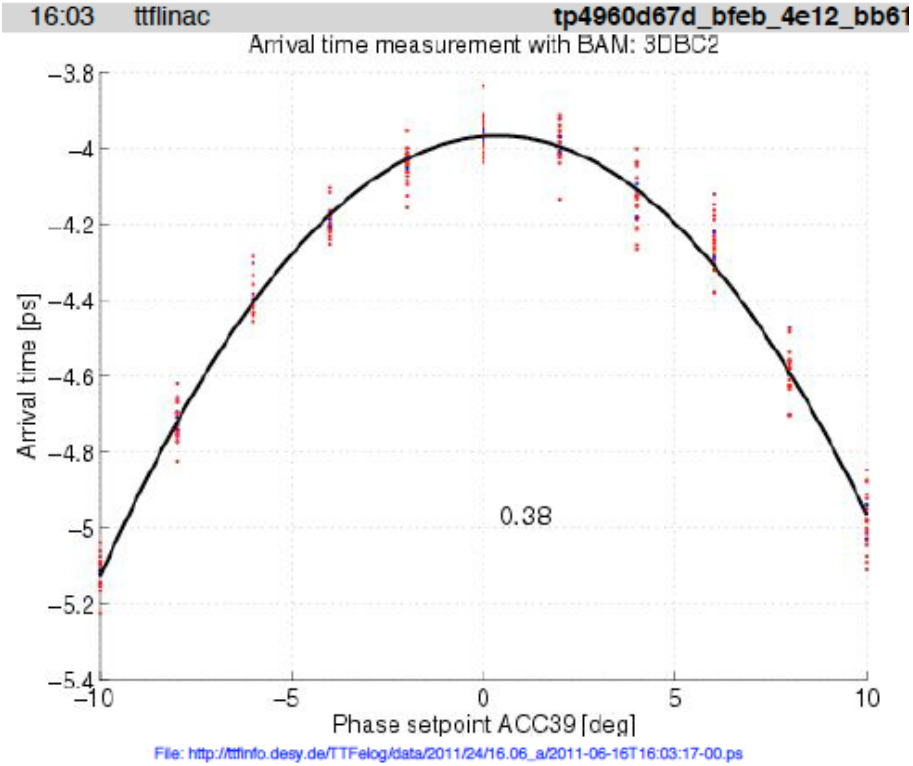


Same Z1 plot vs Acc39

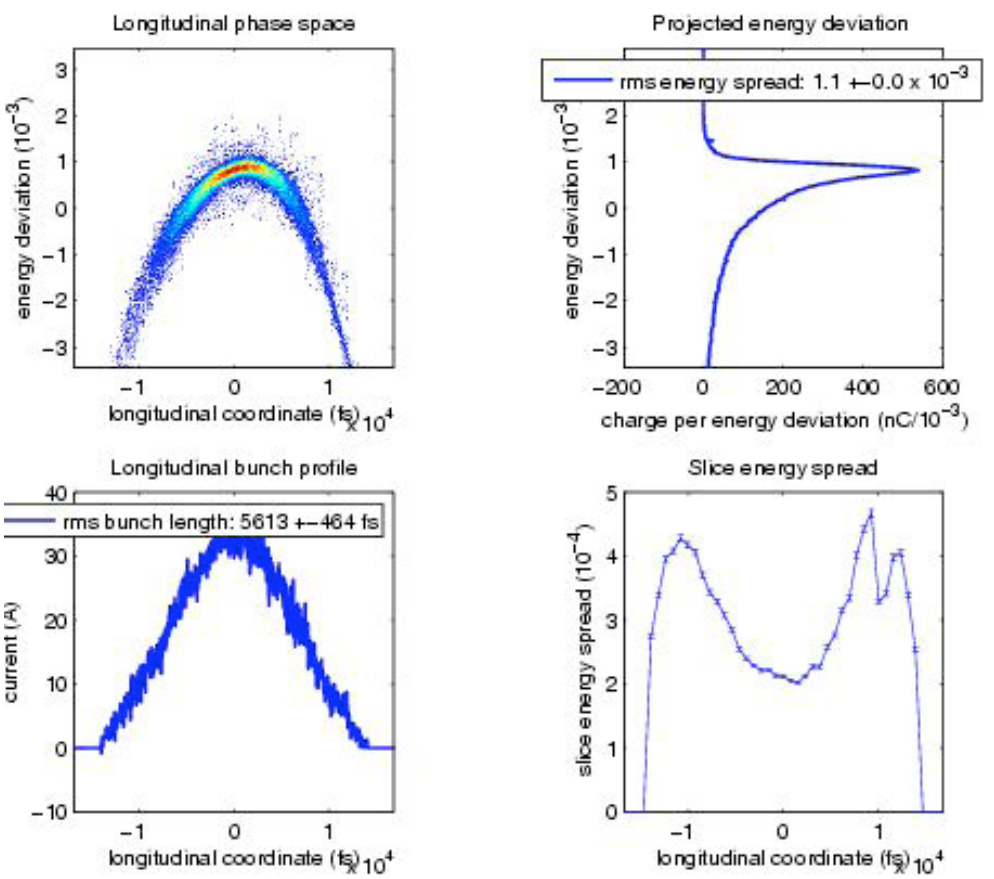


Arrival time on Crest Tool C Schmidt
Acc1 & Acc39





On crest & initial development of head destruction BC2



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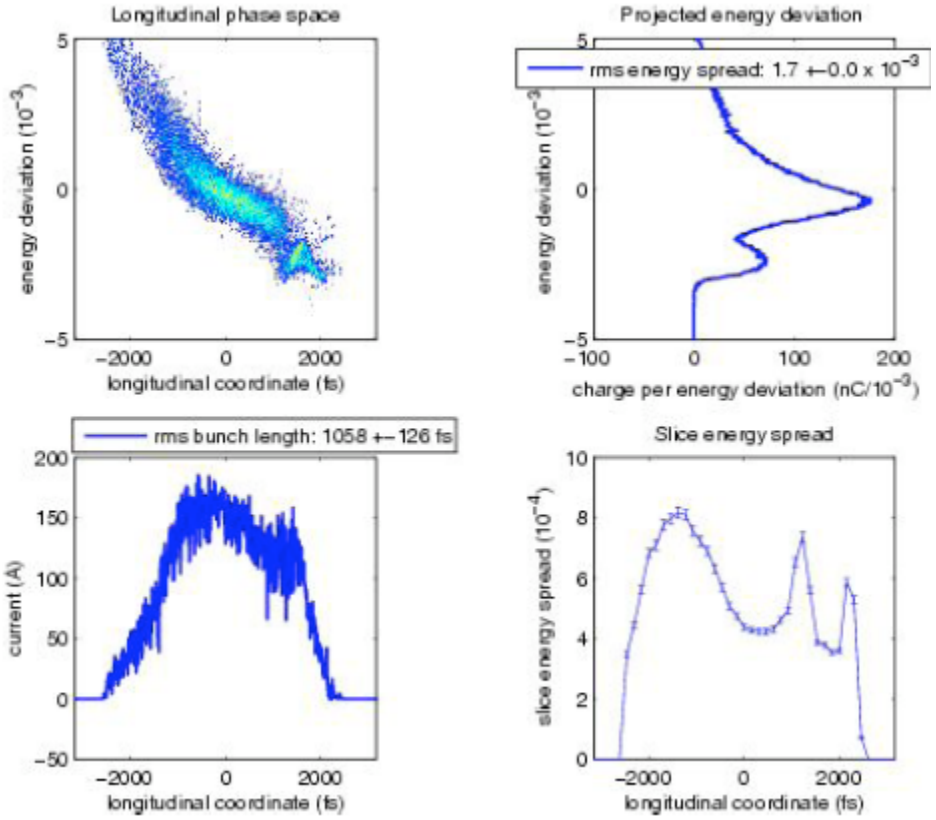

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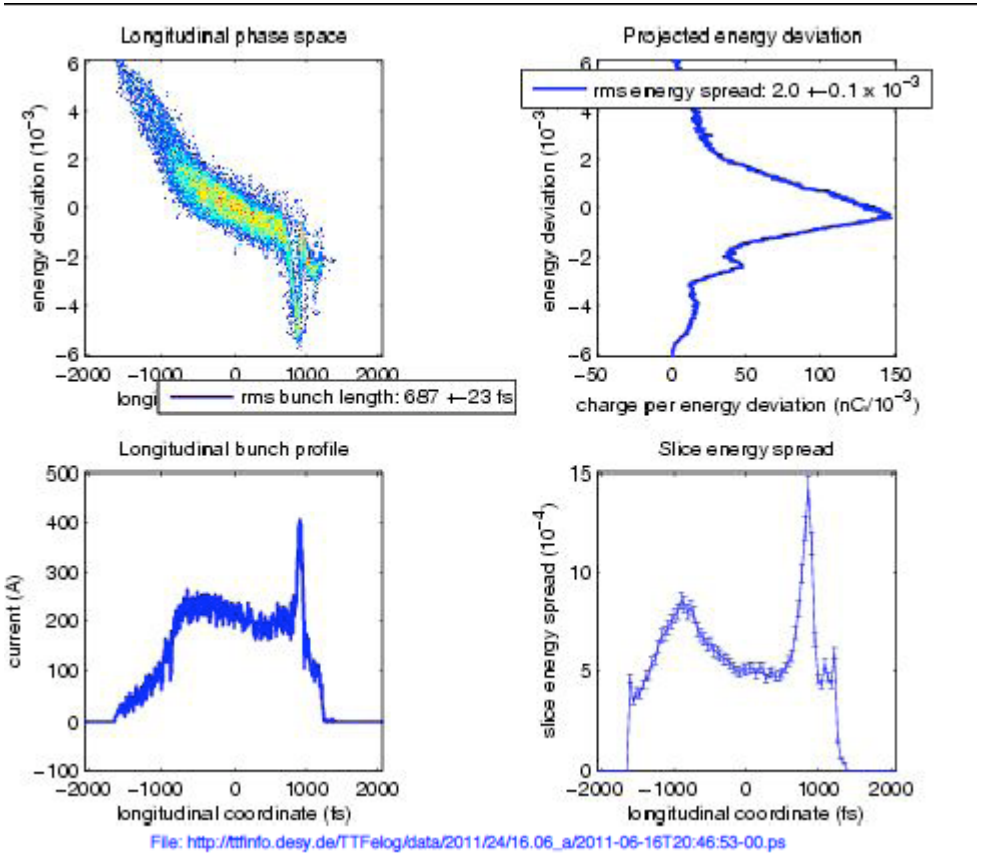
Further Destruction



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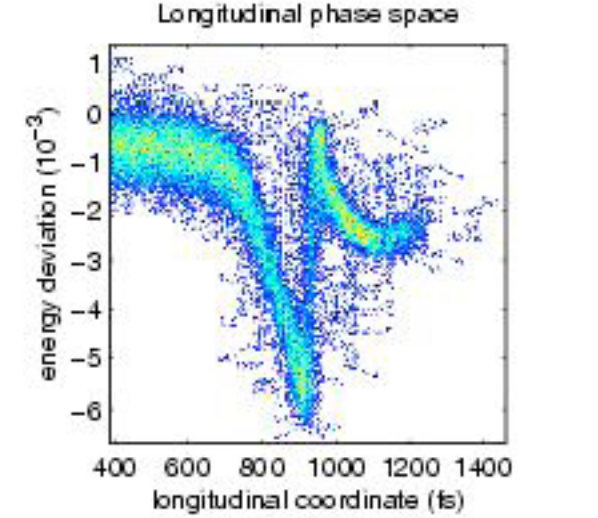
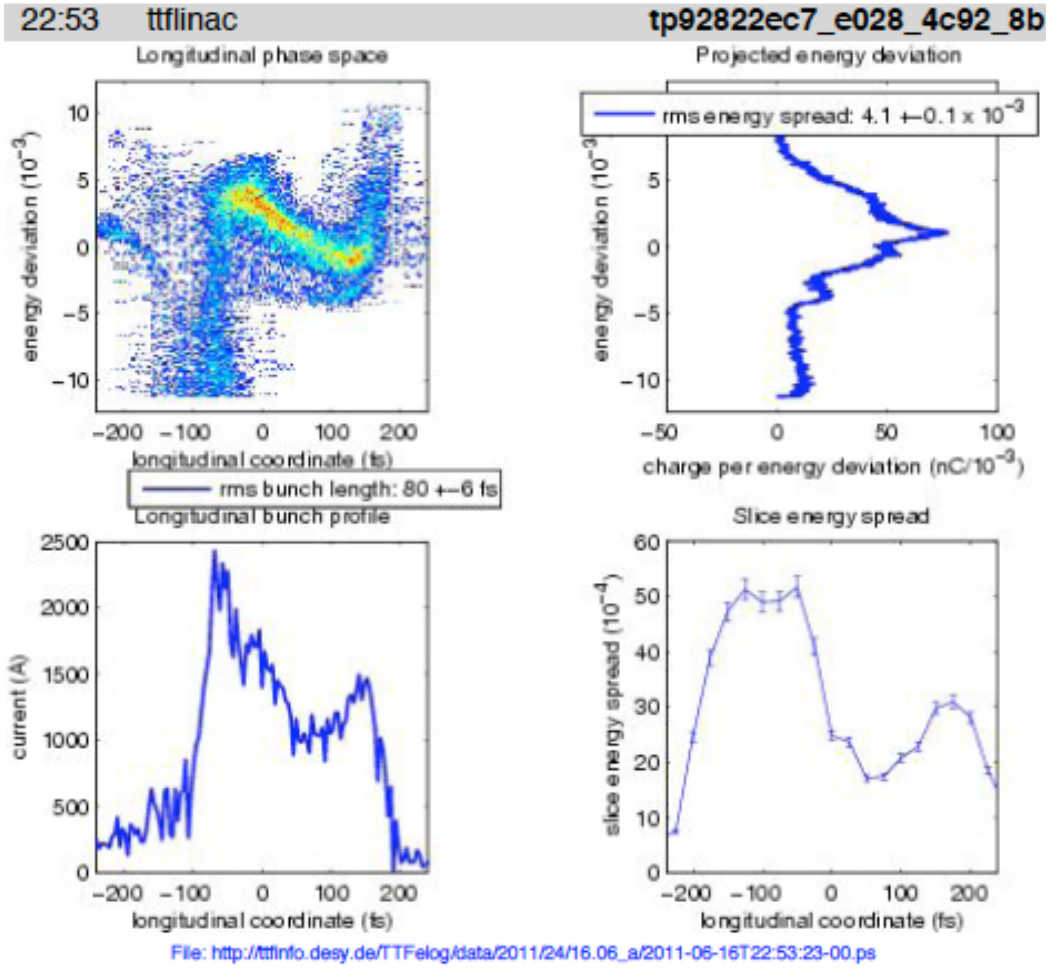
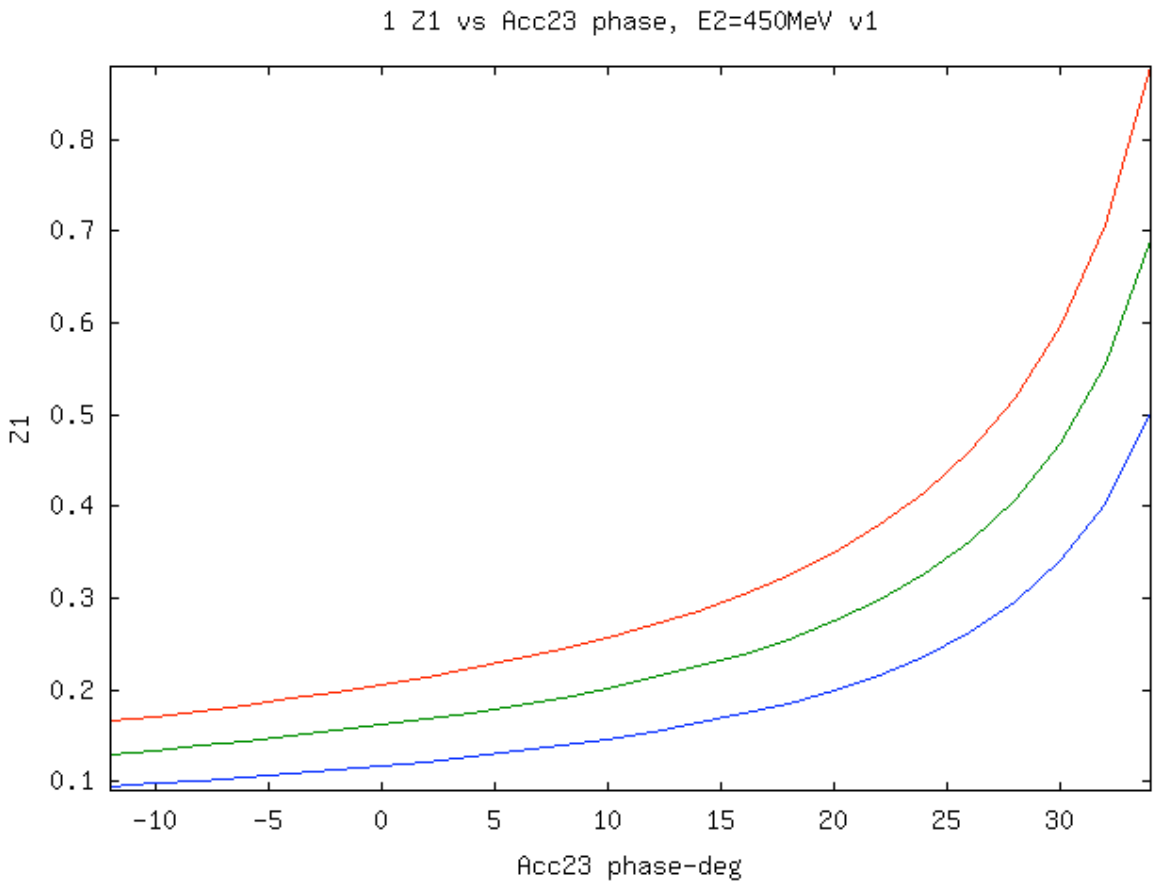


Final BC2 compression



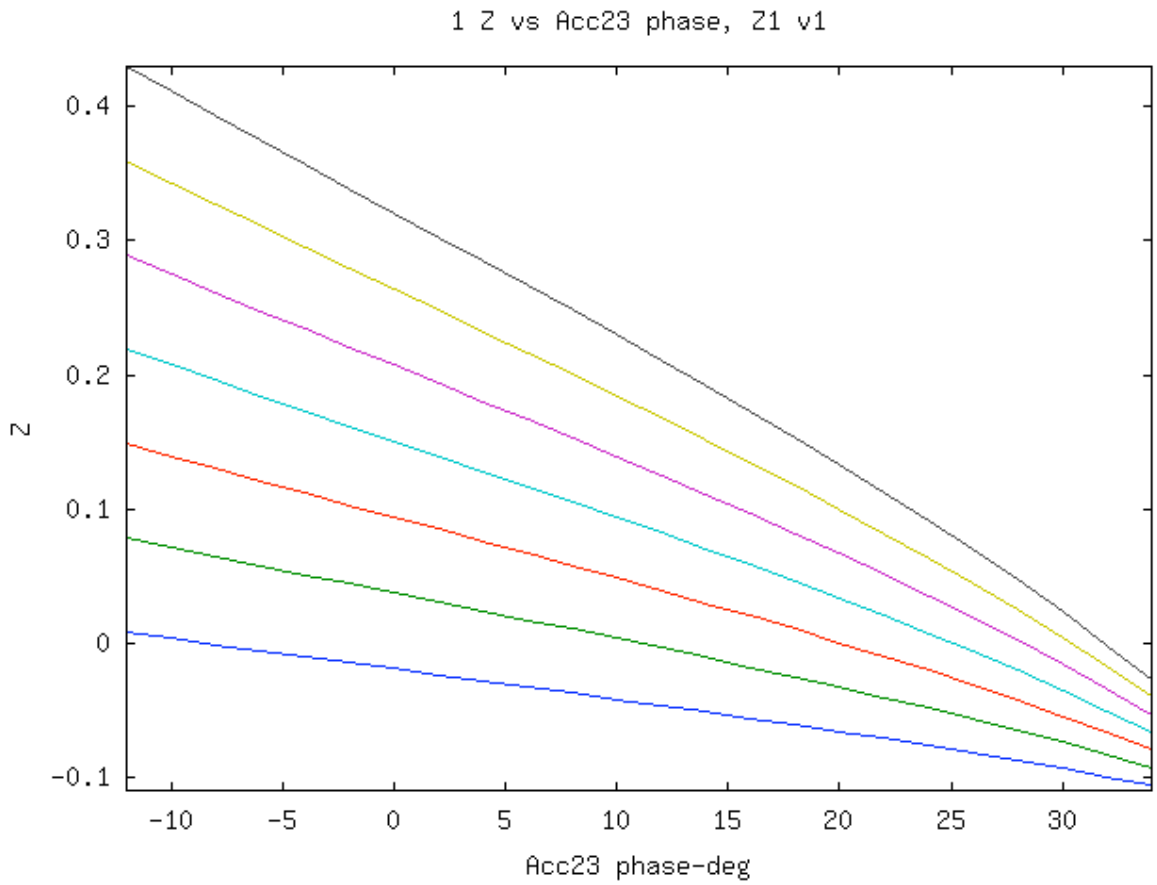
Z1 vs Acc23 phase
Choice of Acc23 phase dictates the value of Z1 for full compression, Z=0, bottom curve

- Z1 vs Acc23 phase
- Botton curve Z=0
- R562 = 0.0709
- Lines with Z=0, 0.05, 0.1
- Z=0 at botton
- Region of operation ~15 to 30 deg?



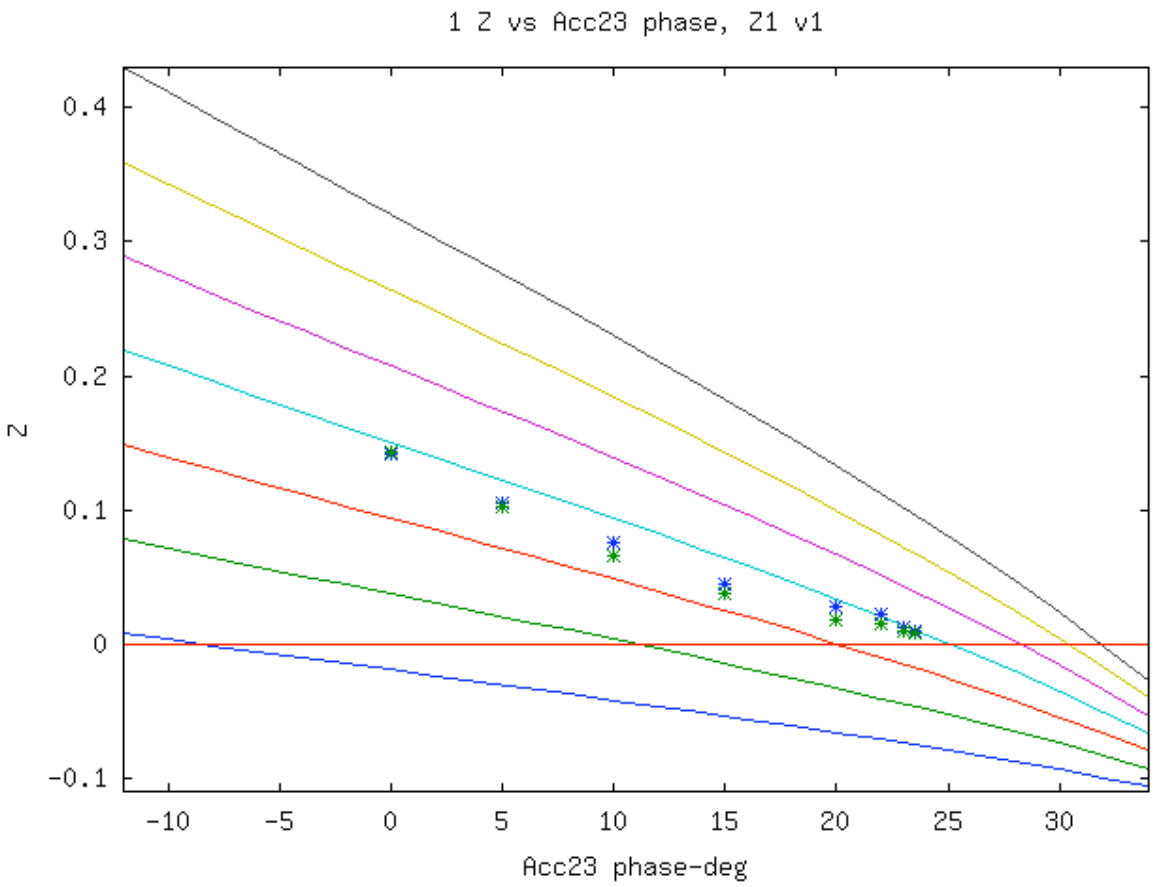
Z vs Acc23 phase, Z1 parameter just different way of looking

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



With measurement data

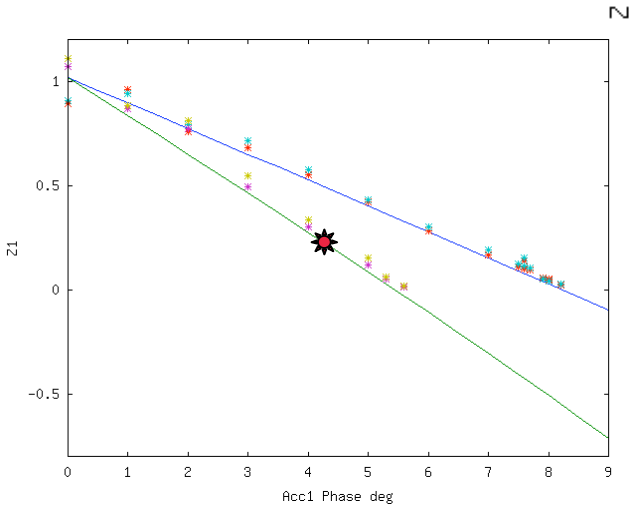
- Measurements
- Acc1 4.3
- Acc39 167.1 (-12.9)
- Z1 from
- 0.1 to 0.4
- Steps 0.05

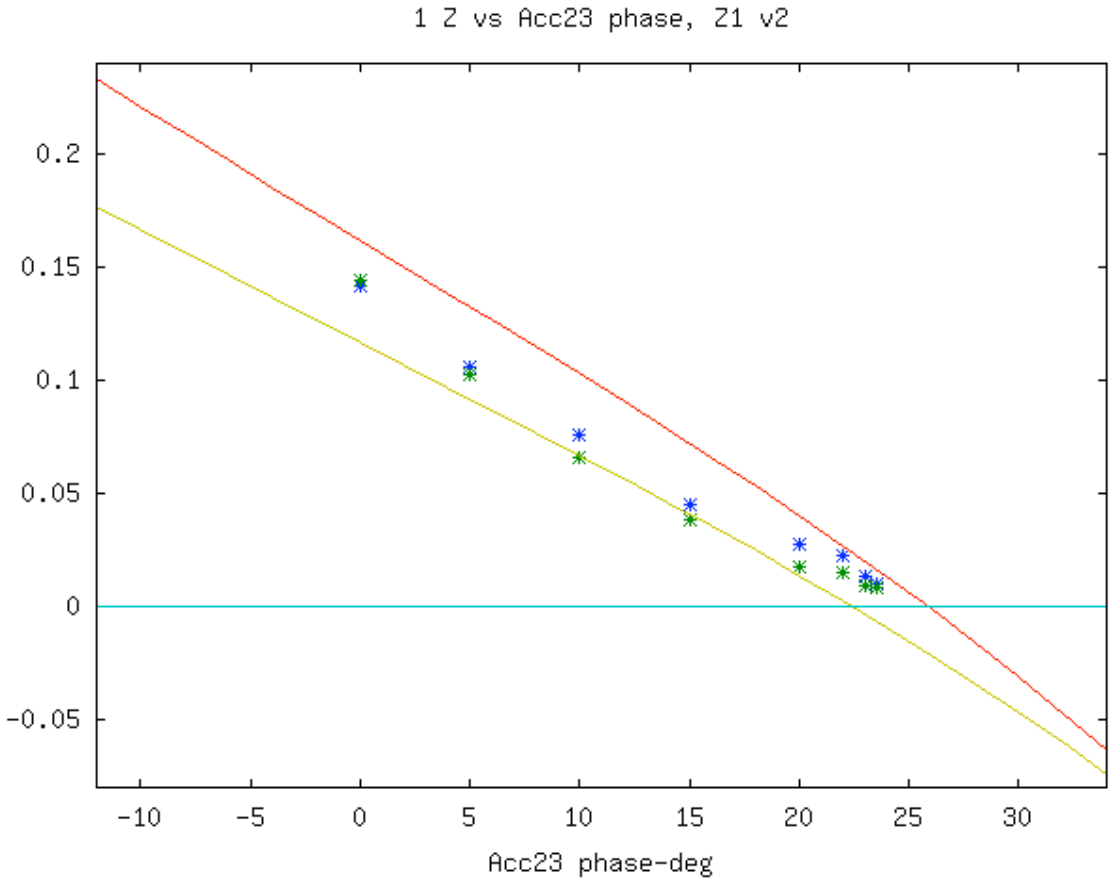


Compression in BC3
Measurement & predicted

- Measurements
  With lines of

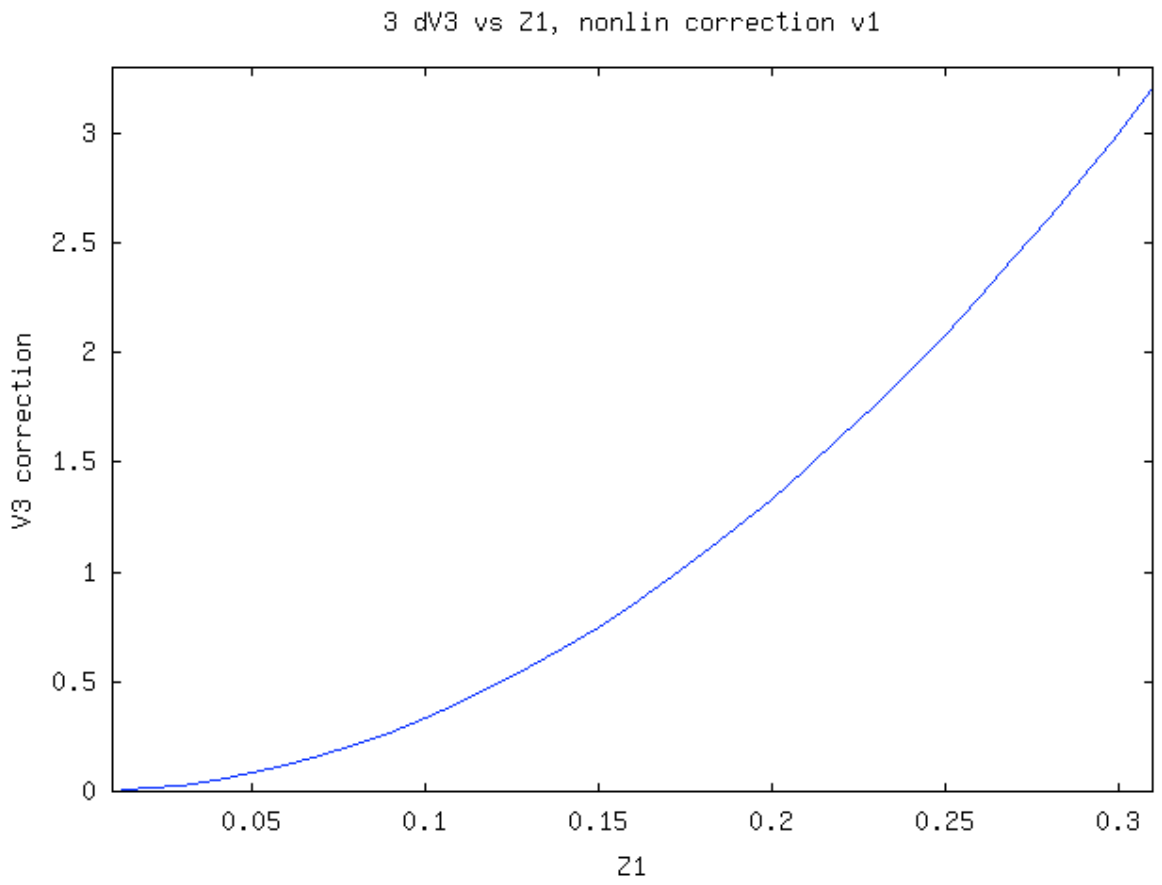
- Z1=0.22
  prediction
- Z1=0.26
  measured



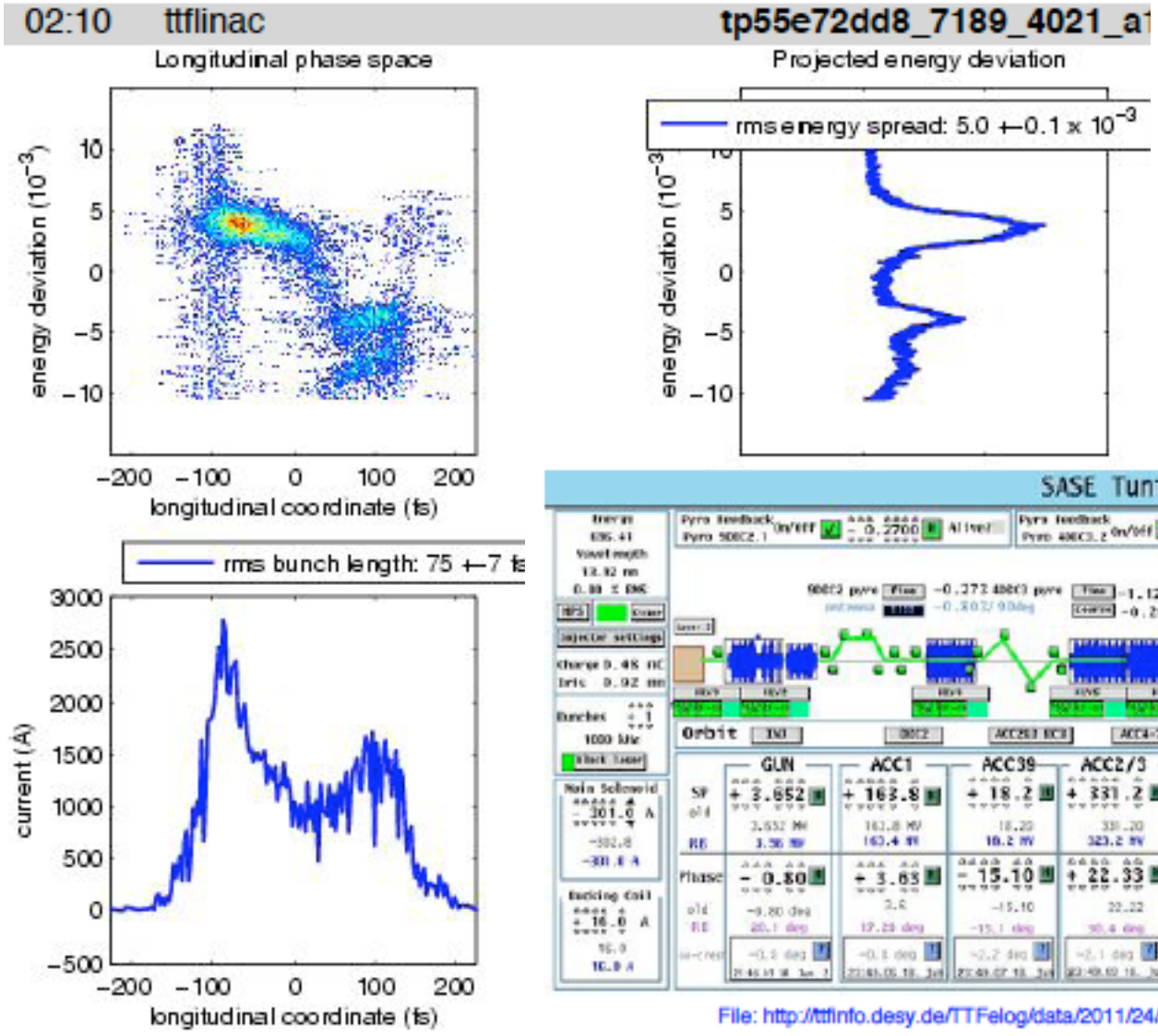


Linearization correction for Acc2/3 possible

- 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)
-



Final compression with BC3



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File: http://ttfinfo.desy.de/TTFelog/data/2011/24/18.06_n/2011-06-19T02:10:52-00.ps

SASE & spectrometer, pyros

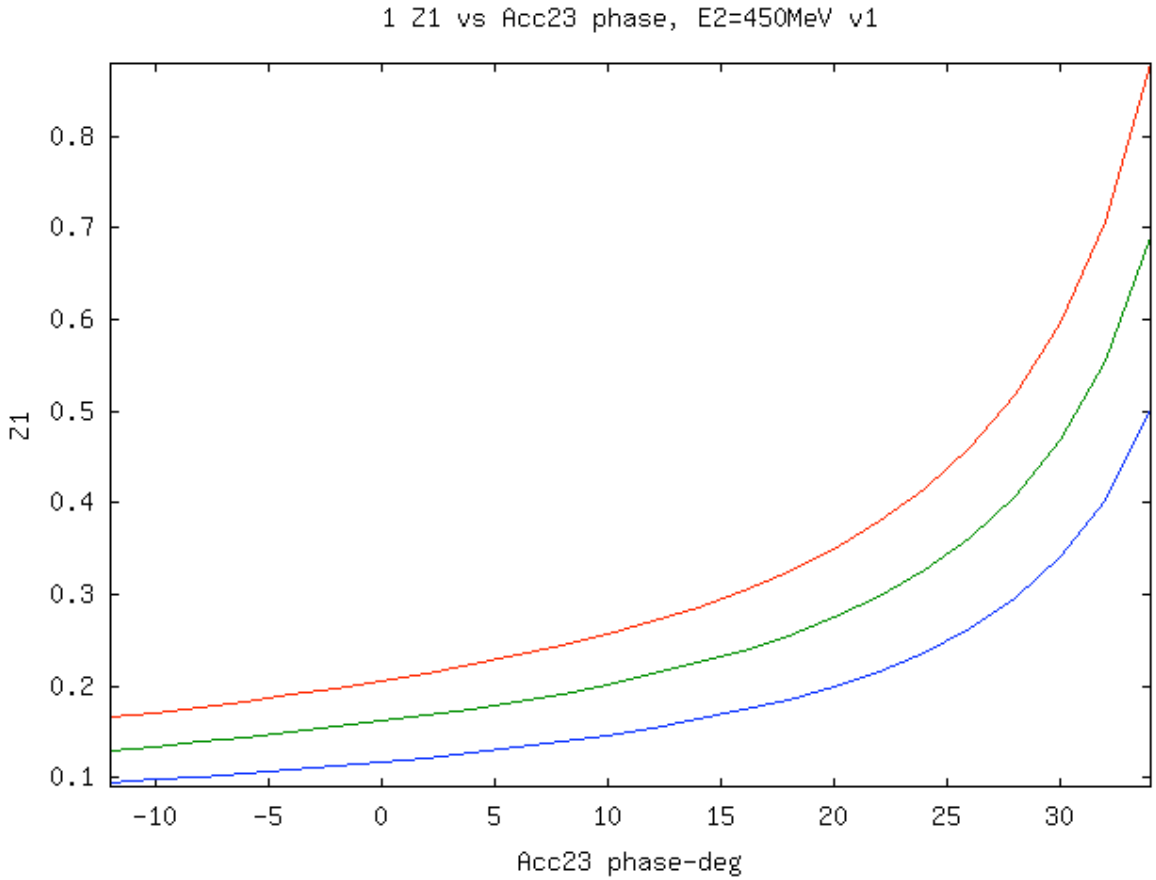
- Achieved SASE ~140 microJ
  - By standard tuning of gun and beamline components
  - But with only small changes to Acc1, 39, 2/3
- Recorded pyro and antenna signals, to be analyzed
- S Wesch got good spectrometer data

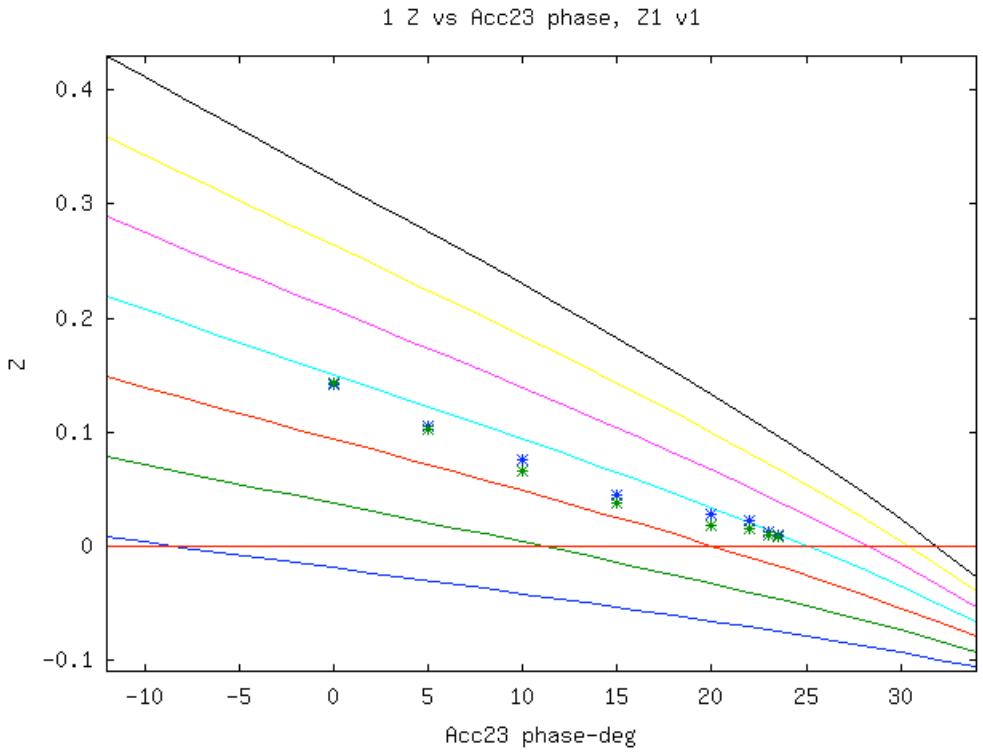
Conclusions & outlook

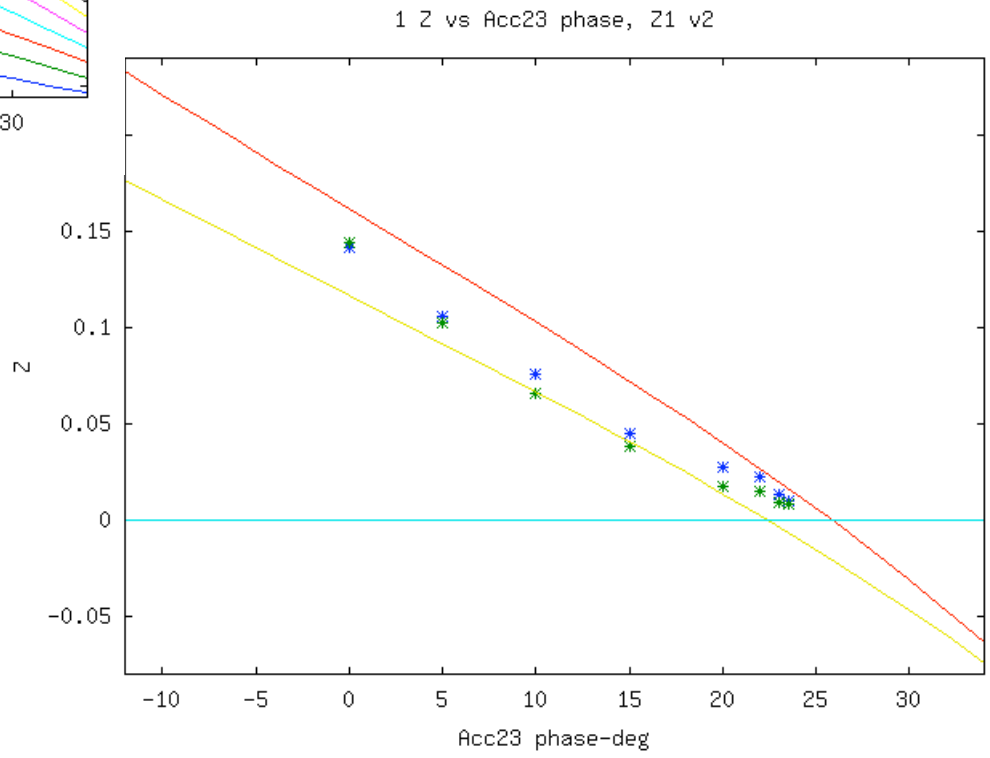
- Still need to do real analysis of LOLA data (here only took data from log shot)
- The model seems to work well and helps one understand operating point selection
- It should be able to guide one to other points to explore
  - Different linerizatiion amounts (linF)
  - Different BC2/BC3 compression (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


1 Z1 vs Acc23 phase, E2=450MeV v1
Z1
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-10
-5
0
5
10
15
20
25
30
Acc23 phase-deg


1 Z vs Acc23 phase, Z1 v1
Z
Acc23 phase-deg
0.4
0.3
0.2
0.1
0
-0.1
-10
-5
0
5
10
15
20
25
30


1 Z vs Acc23 phase, Z1 v2
Z
Acc23 phase-deg
0.15
0.1
0.05
0
-0.05
-10
-5
0
5
10
15
20
25
30