My own LLRF list for the ILC 9mA test and some very raw analysis

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- Cavity tuning.
  - Is the current methodology of flattening gradients with no beam OK?
  - Can it be saved and restored?
  - Beam based 3-stub tuner calibration. ±5° accuracy, time consuming.
  - Drift?

- Minimize transient in power and gradient waveforms generated by klystron phase rotation with large drive swings.
  - Apply smoothing or other phase correction algorithm.
- Study the impact of klystron saturation when RF unit is operated at high gradient and heavy beam loading (probably most severe for ACC456)
  - Apply a klystron linearization algorithm.
  - We run ACC456 almost to the power limit with CLG=60. Data analysis is due.

- Gradient and Powers:
  - Fix crosstalk in RF chain (probably in the Vector Modulator)
  - Minimize 250 KHz noise. Or eliminate it by using higher IF downconverter. One algorithm in place works but needs no be calibrated for every CLG, (also every gradient step?)
  - Study other measurement noises and delays that limit the closed loop gain.
  - Understand (or calibrate) power probes.
  - Understand forward to reverse power coupling.
  - Measure Lorentz force detuning (compare to simulation models). Are the LFD parameters wide spread? How about the ringing cavities? Will these cavities compromise the ΔE/E goal <0.1%
  - Understand if ringing cavities will be a bigger problem at high gradient and under heavy beam loading.

- Closed loop measurements
  - Study gain limits, instabilities, and oscillations (Ampl. And Freq.)
  - Study close loop gain (CLG) vs $\Delta E/E$. Look at the influence of oscillations in $\Delta E/E$.
  - Look at A and ϕ gradient flatness vs. CLG

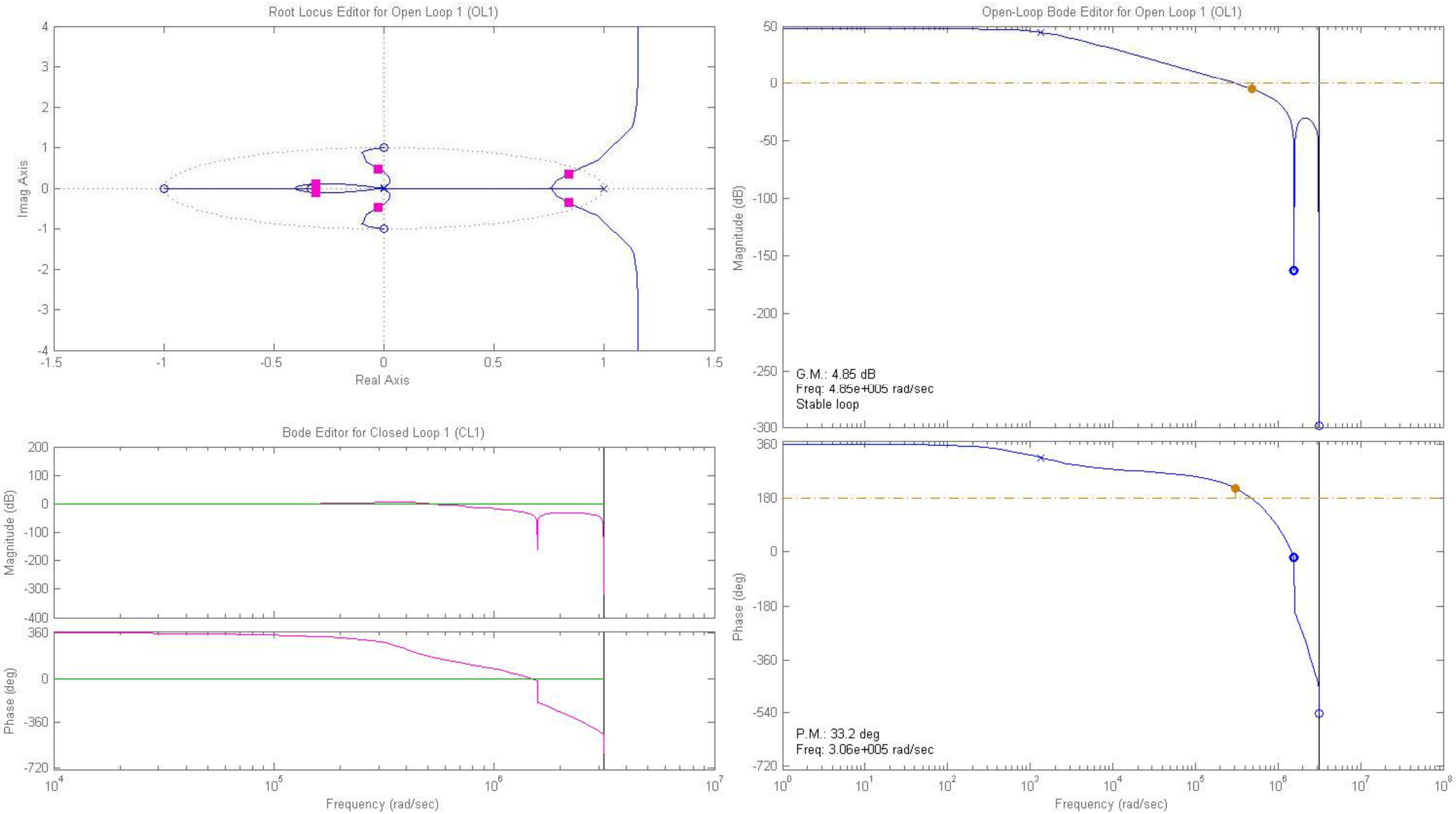
- Beam loading
  - From Sept. 08 data, understand how beam fluctuations will impact the LLRF gradient. (May be they don’t)
  - Beam charge jitter (oscillations) must be damped by the LLRF.
  - Are we going to run BC on crest or off crest?
  - Use simulations to extrapolate results. Can simulations provide accurate estimations committing a reasonable effort.

- Beam loses:
  - Correlate gradient performance and beam with beam loses.
- It would be interesting to understand how gradient flatness, ΔE/E and beam loses are affected by:
  - CLG
  - Gradient levels
  - Beam loading (up to 9 mA)

ACC456 stability model

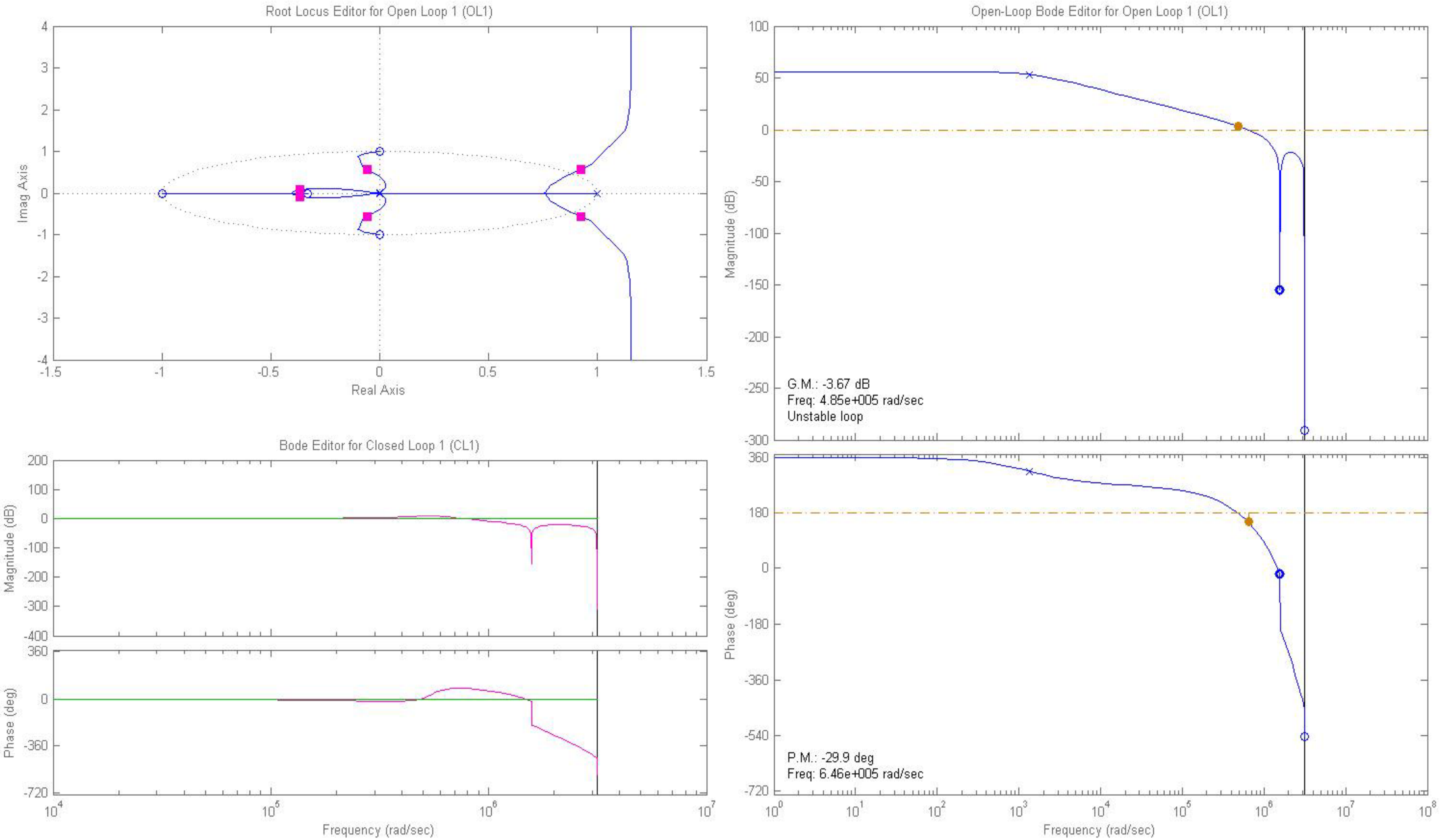
- Matlab model of ACC456 operating at variable gain from 40 to 160.
- Loop delay of about 8us.
- Filtering method: moving average window of 2 to 4 samples.

ACC456 control Kp=60, 4TAP FIR

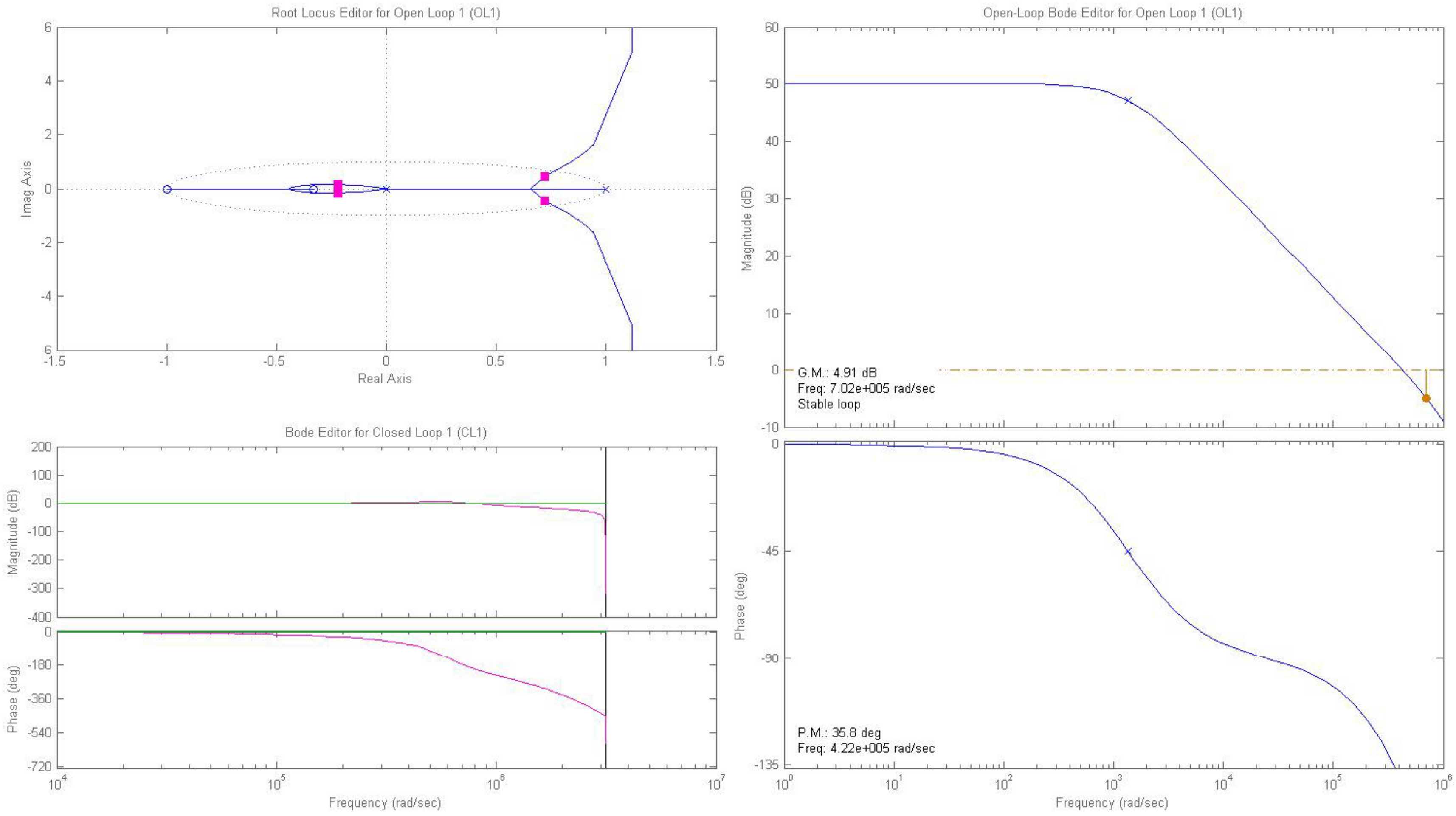


Stable, GM~5dB

ACC456 control Kp=160, 4TAP FIR



ACC456 control Kp=160, 2TAP FIR



Preparation for long-pulse 9mA experiment

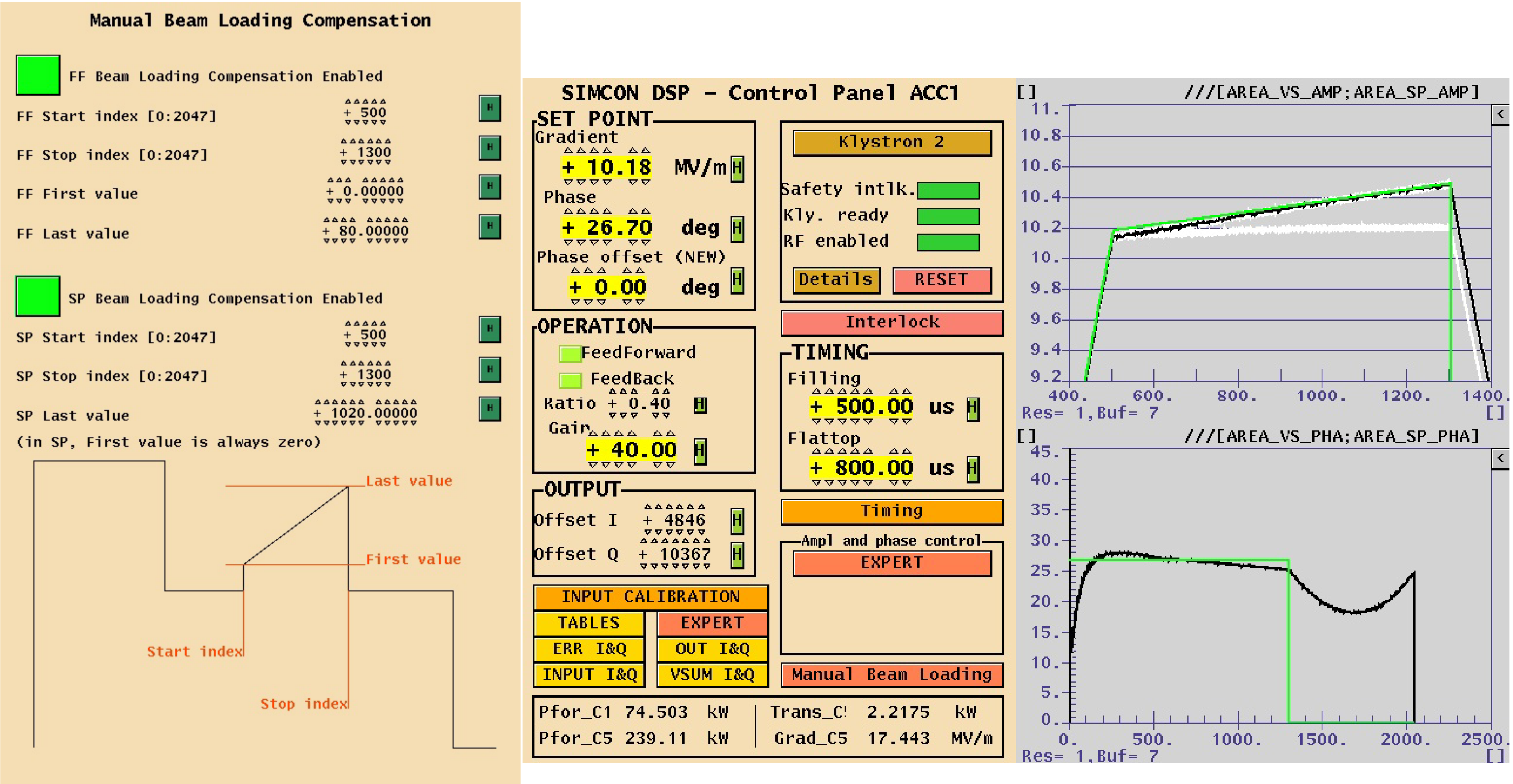
- Achievements
  - Feedforward smoothing compensation tested. The smoothing using gain tables performed OK and managed to lower the transients in cavity powers.Smoothing using FF tables did not worked OK, Valeri will test this again on Friday.
  - 250kHz ripple compensation works well in ACC2/3
  - Manual beam loading compensation tested with good performance in all modules. Energy profile flattened out.
  - Test of gains on ACC456. Closed loop gain was increased from 40 to 120 in steps of 10 to study gradient and energy performance.
  - At the end of the shift we set ACC23 CLG at 100 and ACC456 CLG at 50 and flattened energies again.

Partial list of accomplishments during this week's shifts

- We pushed the gradients up in ACC23 and ACC4/6.
- We measured cavity quenches.
- Non DESY collaborators acquired good experience with FLASH operation.
- We saw that when repeat motor tuner positions most cavities recover the original detuning. Cavity #3 in ACC2 did not come back to the same detuning (400Hz far).
- We spotted and think that we understand an oscillation in the klystron forward power that is sent to all cavities. It may be a crosstalk in the RF Vector Modulator.

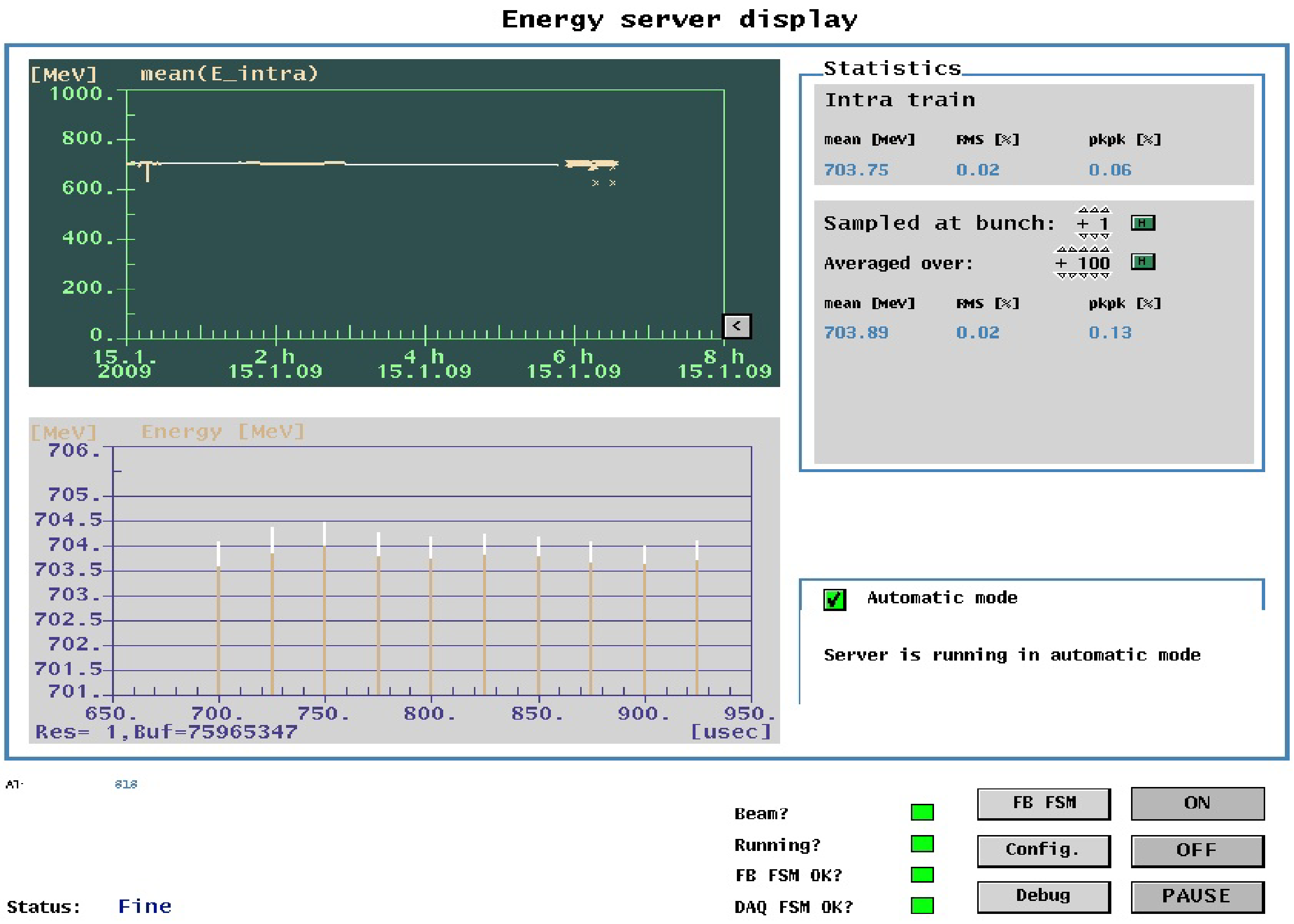
Beam loading compensation

- Algorithm acts on SP and FF tables trying to flatten the energy.

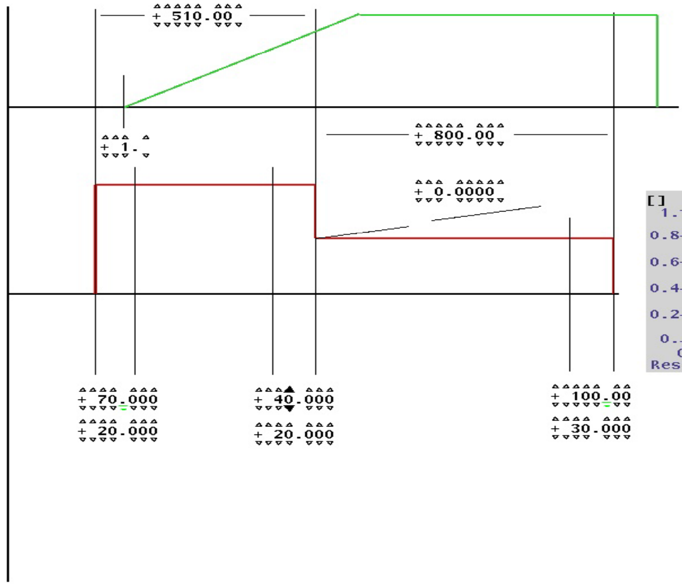


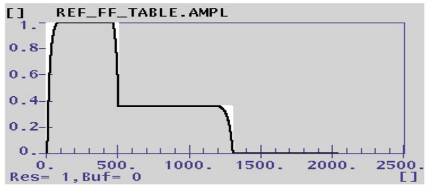
Energy at the dump

- ΔE/E flattened to about 0.5 MeV o better

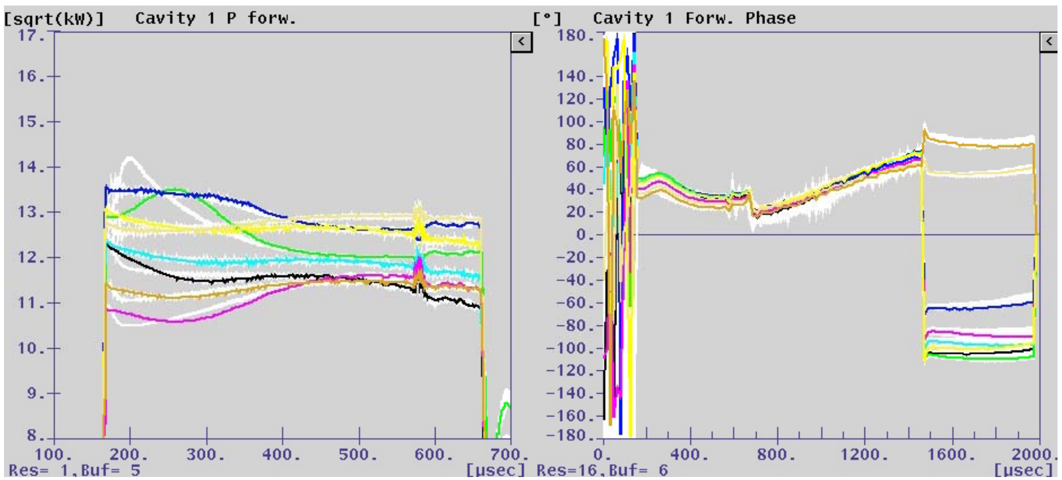


Smoothing of forward power overshoots



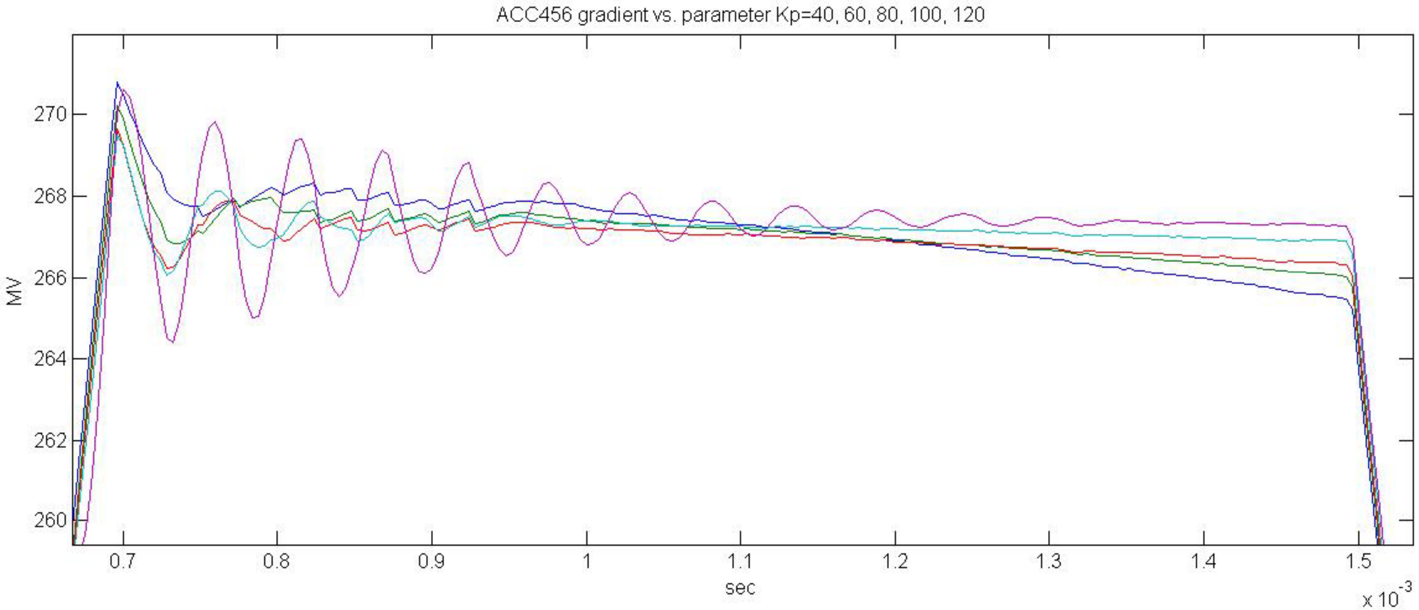


Forward power is smoothed adjusting gain values in several portions of the table.



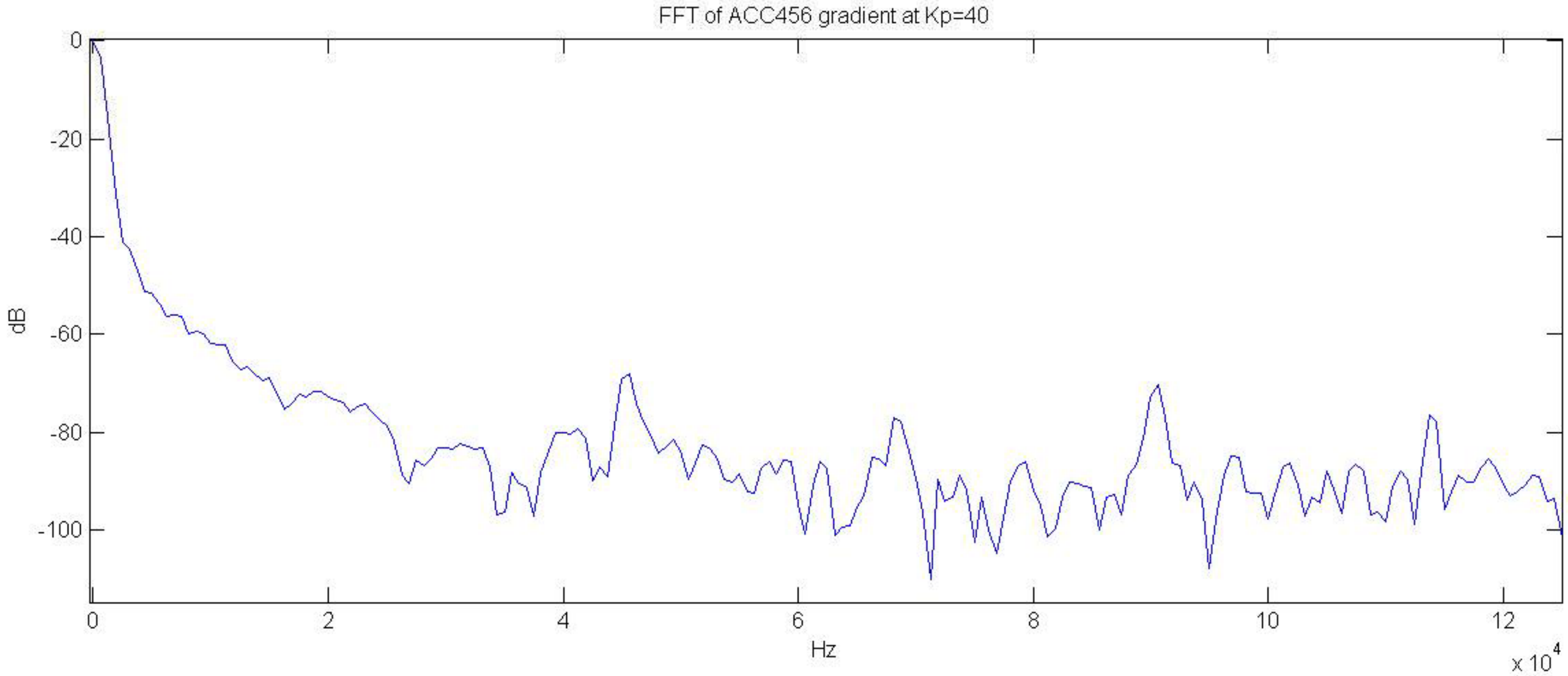
Smoothed forward power in ACC456 cavities.
White traces show powers before smoothing.

Mean gradient vs. parameter Kp

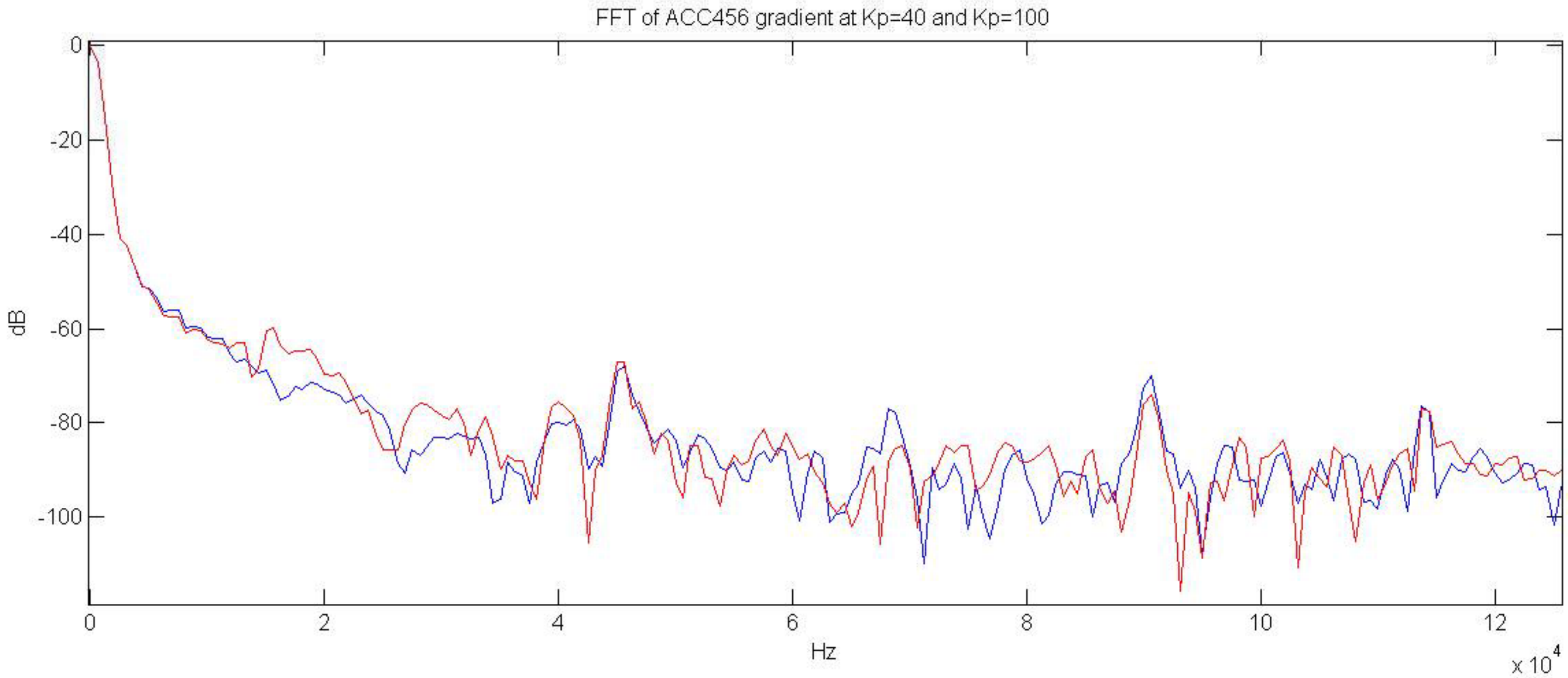


- Kp = 40, 60, 80, 100, 120

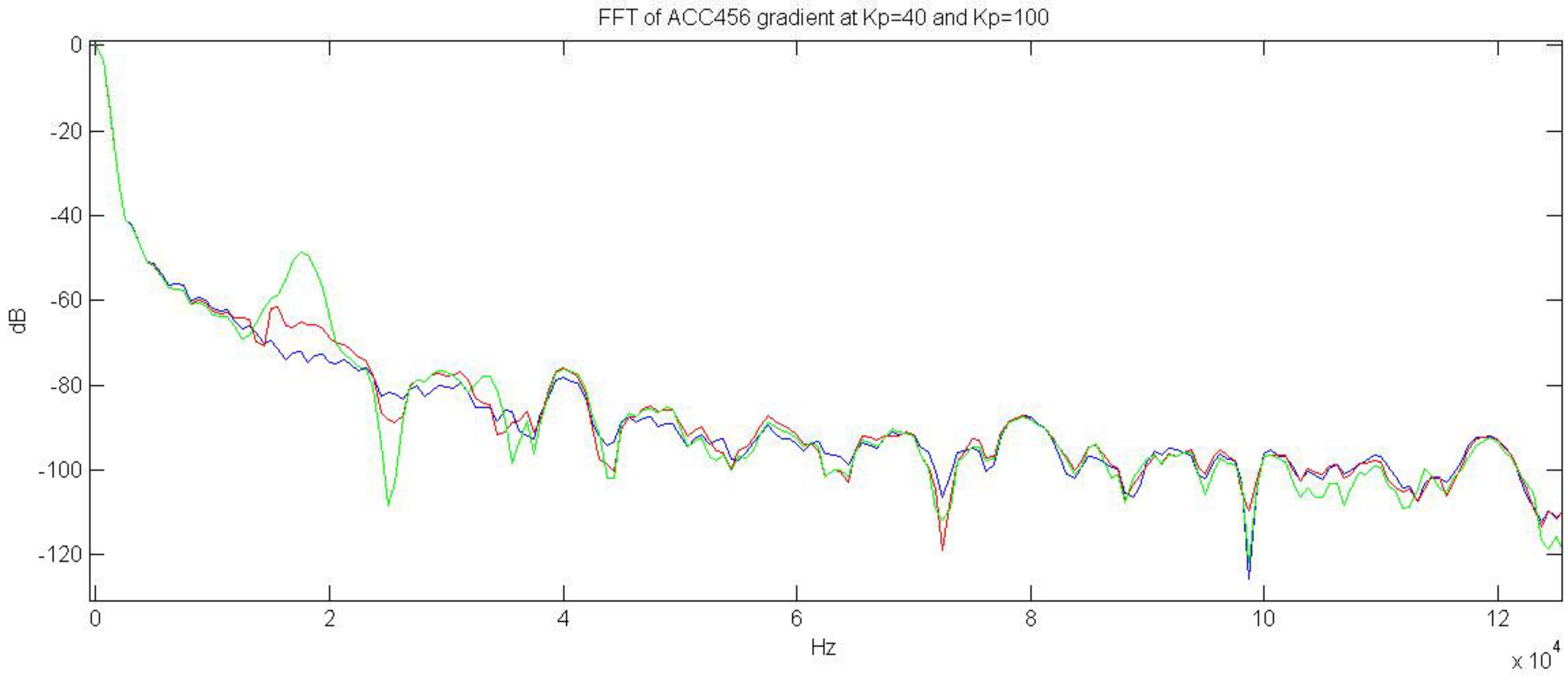
FFT of ACC6 gradient, Kp=40



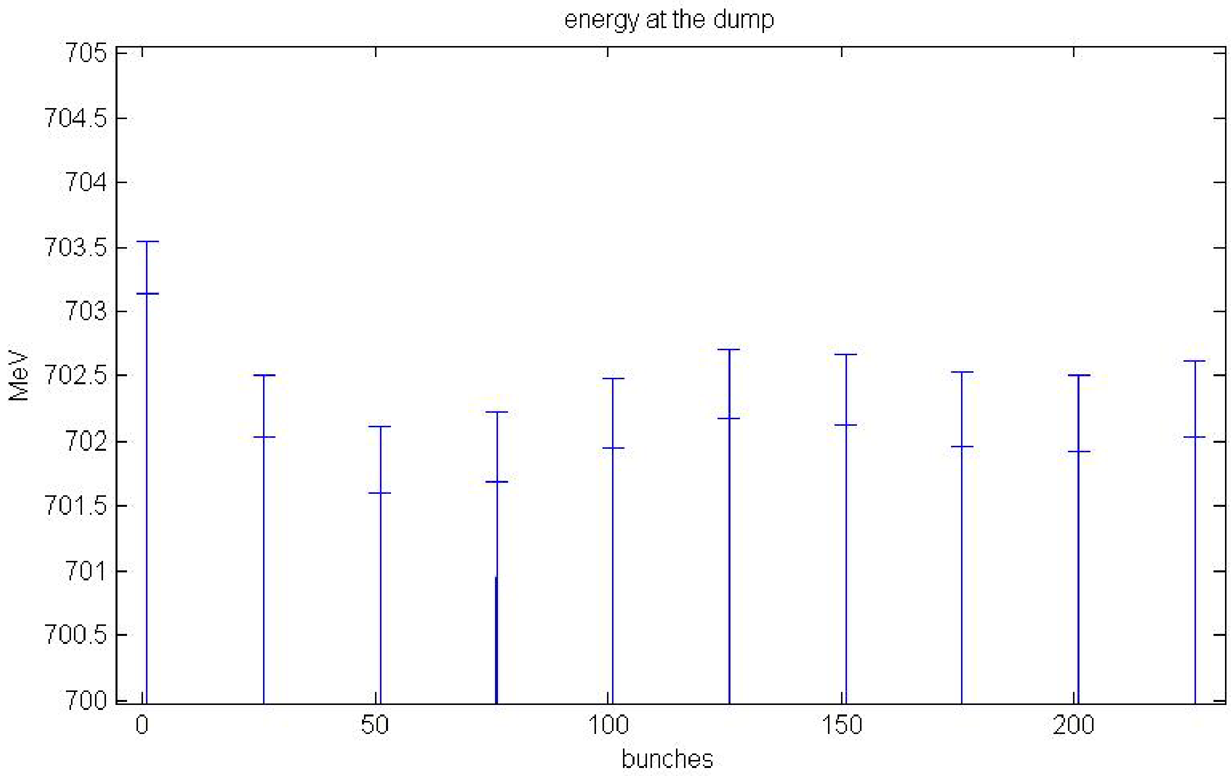
FFT of ACC6 gradient, Kp=40, 100, 120



FFT of ACC6 gradient, Kp=40, 100, 120



Energy at the dump



Does this oscillation match any of the VS noise frequencies?
Maybe a subharmonic created by undersampling a faster oscillation.