



Power overhead for Ilrf feedback

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- Study report at FLASH
- STF-0.5 result

Study condition at FLASH

- The data are obtained by Simcon FPGA board.
 - Clock frequency of ADC is 40 MHz.
 - IF frequency is 250 kHz.
 - DAC clock is 1 MHz.
-
- at FB gain of 100, feedback drives additional 13%rf power.

LLRF Control System for SC cavity based on parameters identification

Experimental results for ACC1 module
driven with the SIMCON board

Tomasz Czarski

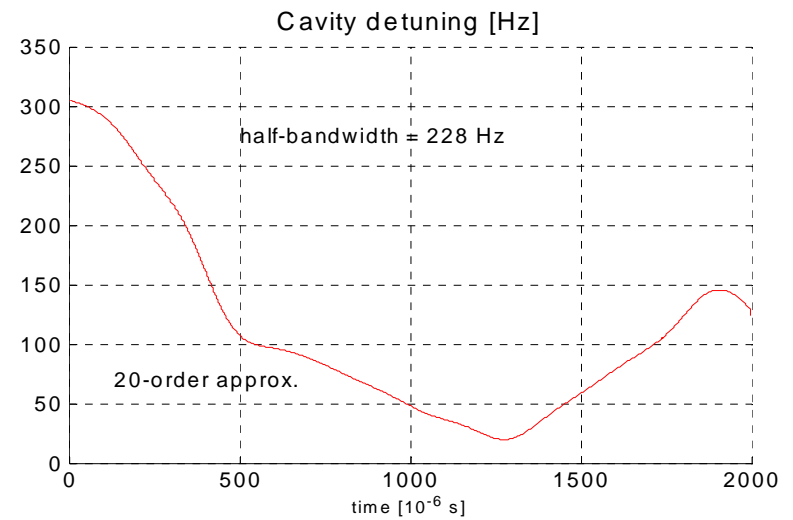
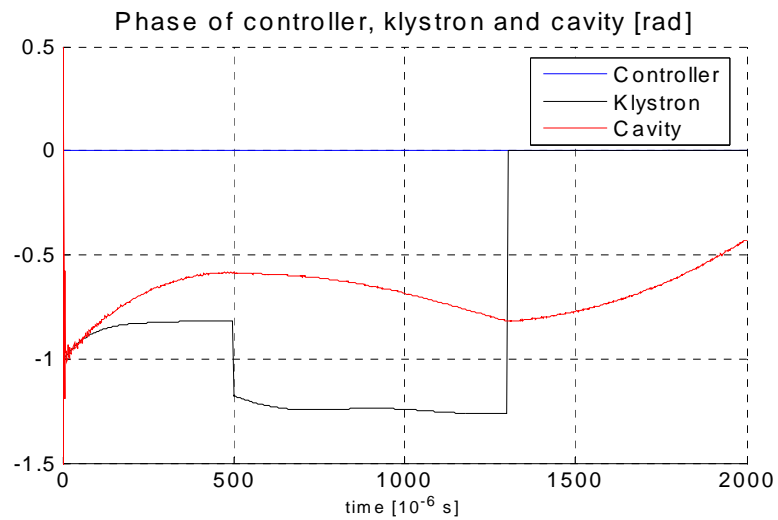
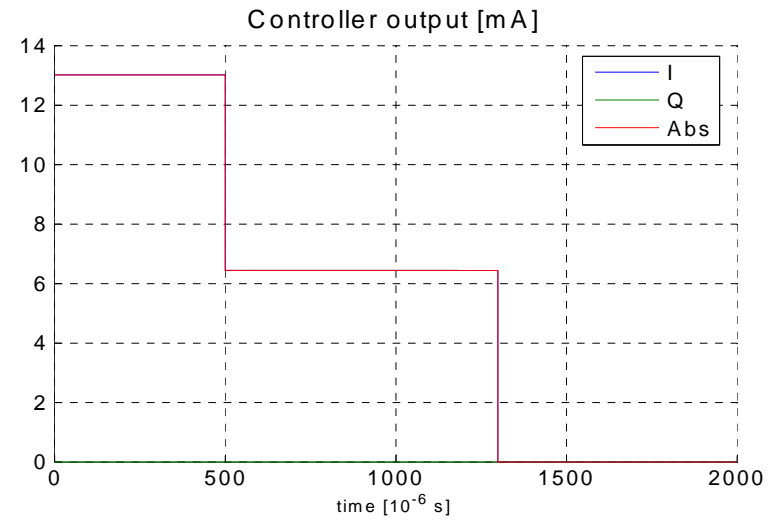
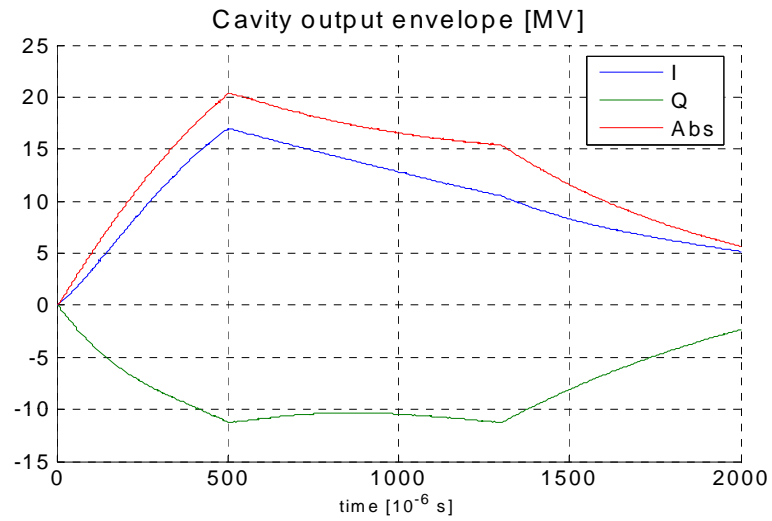
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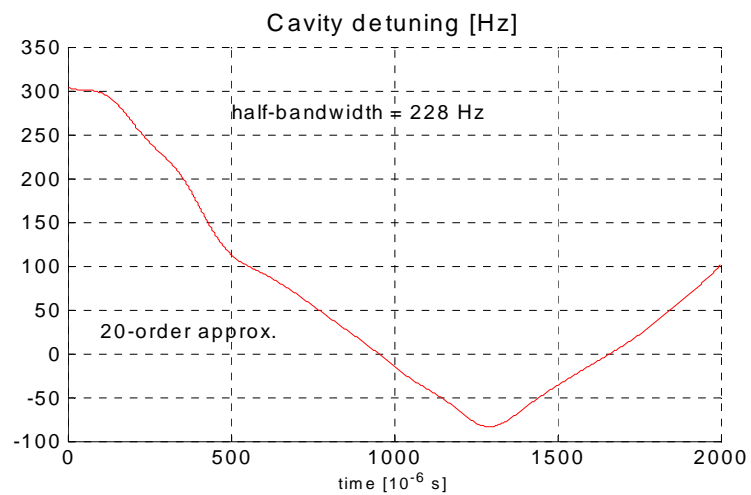
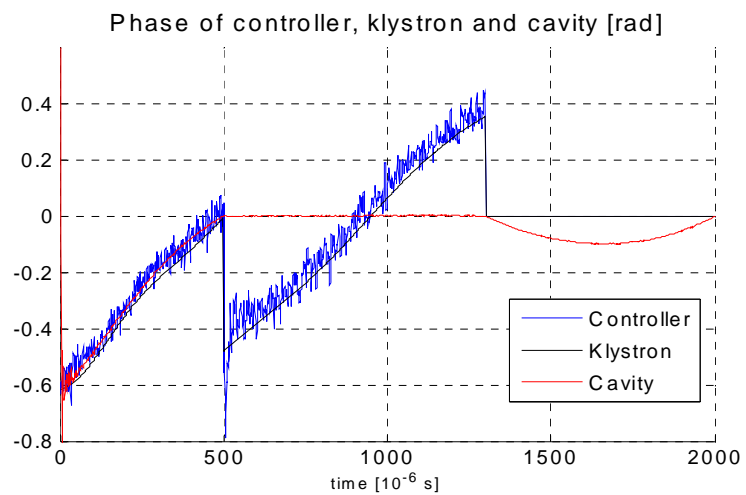
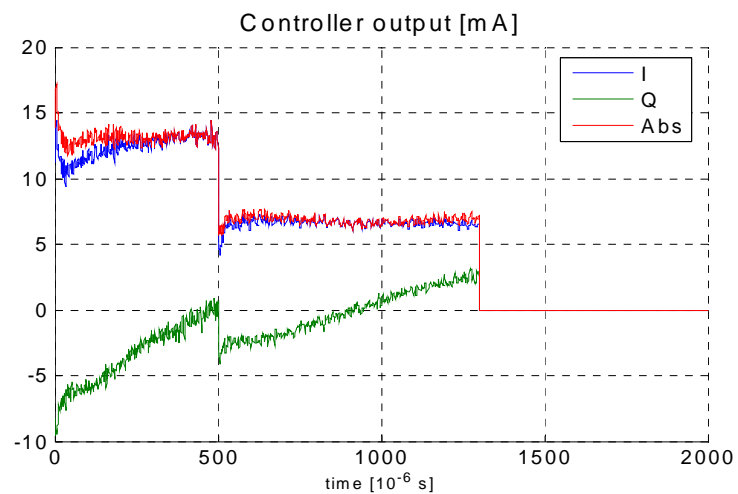
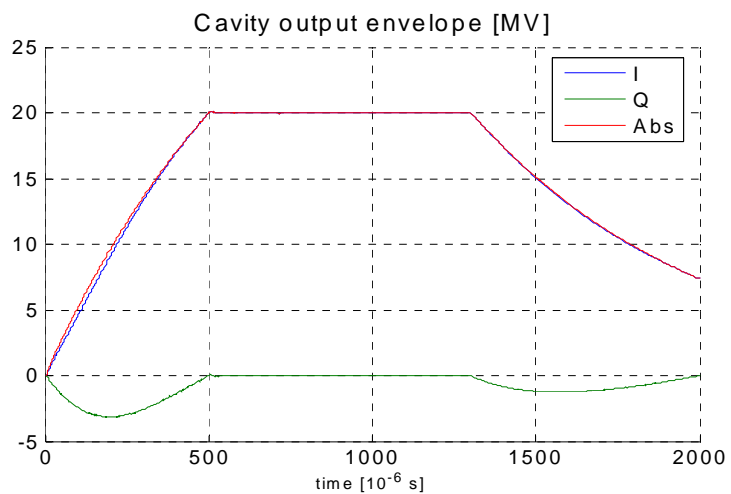
ELHEP-DESY Group



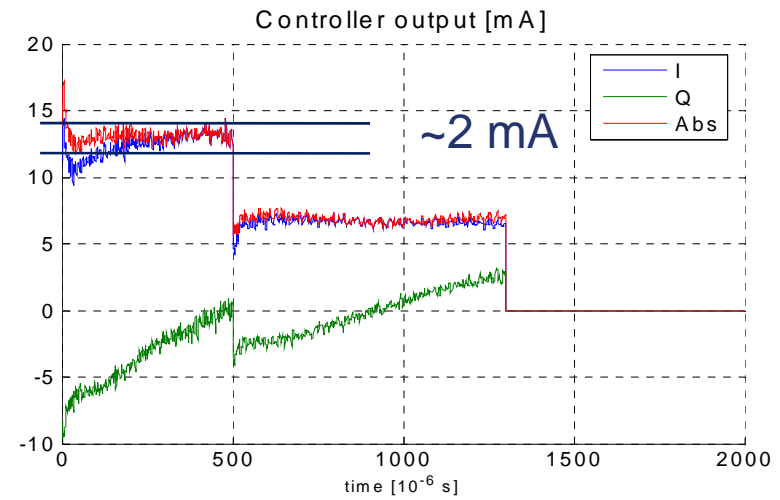
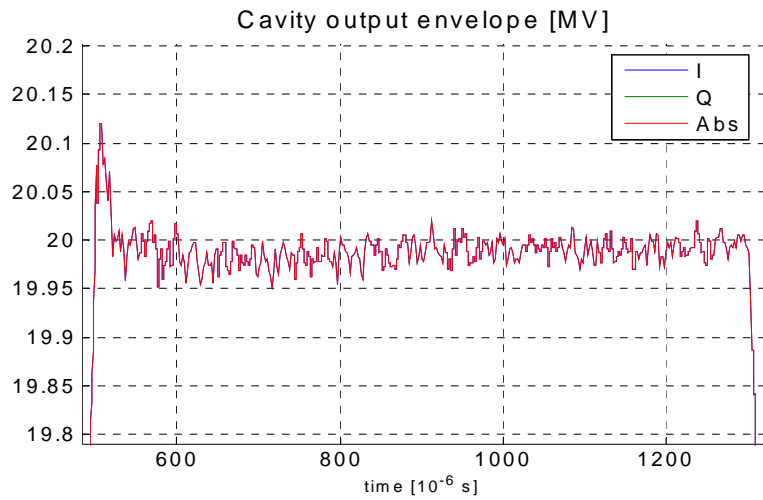
Adaptive Feed Forward – 1_{st} step



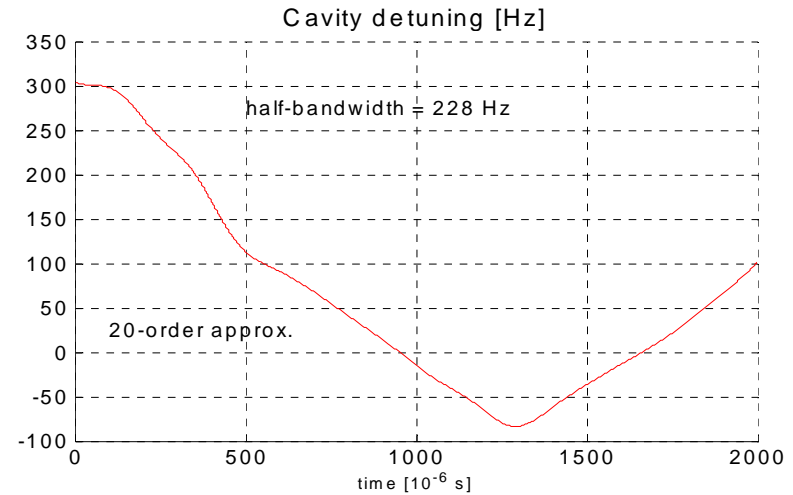
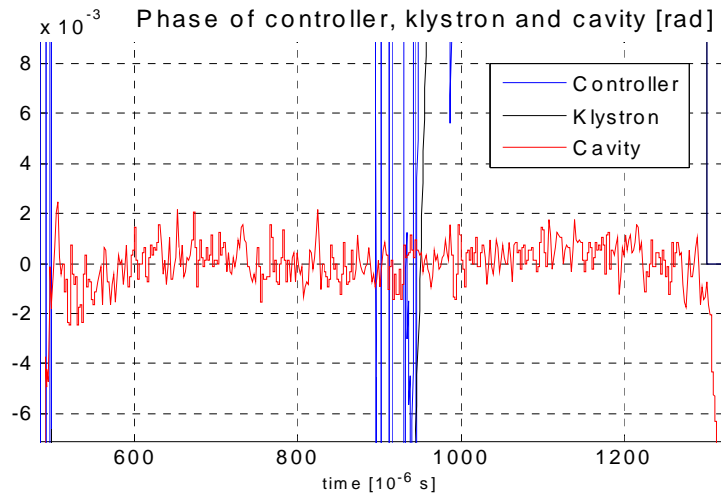
Single cavity driving: Feed Forward and Feedback mode (gain=100)



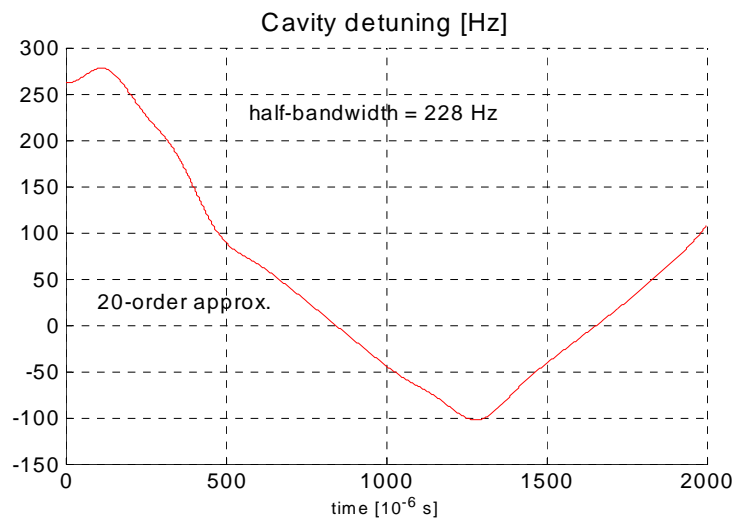
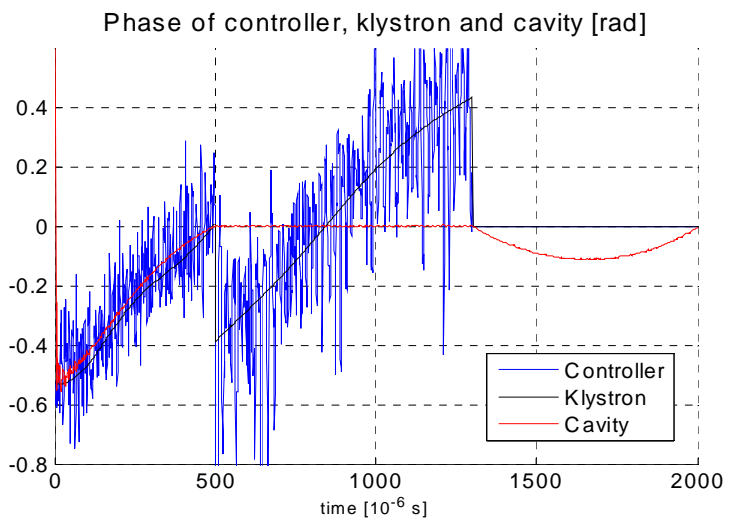
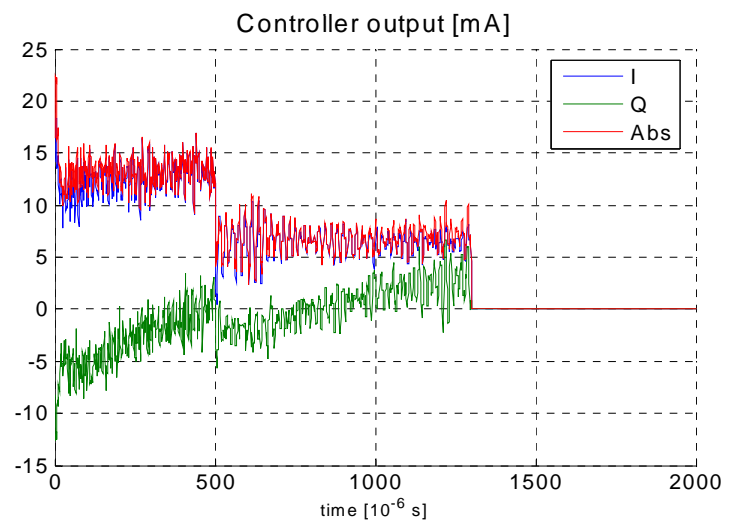
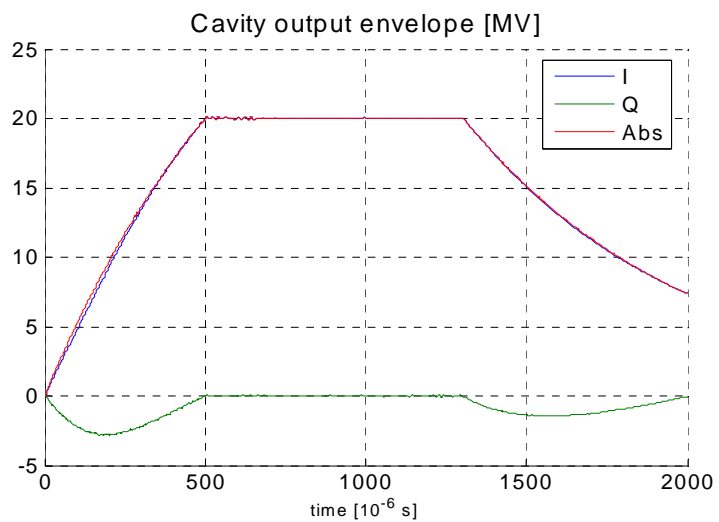
Feed Forward and Feedback mode (gain=100) zoomed flattop area



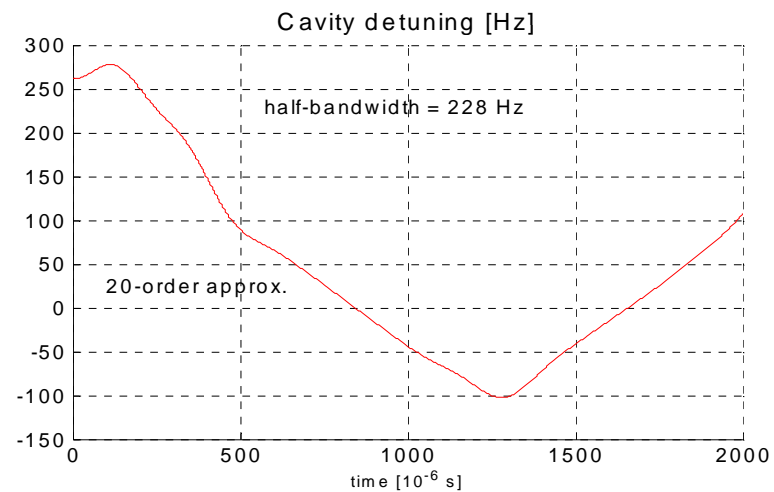
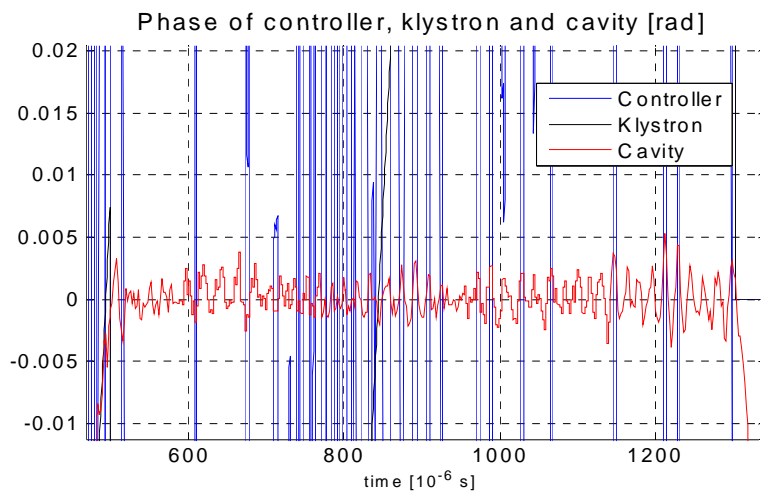
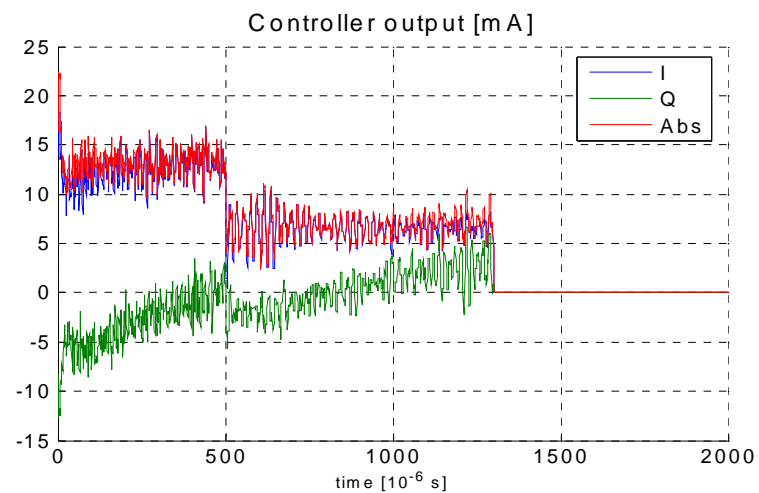
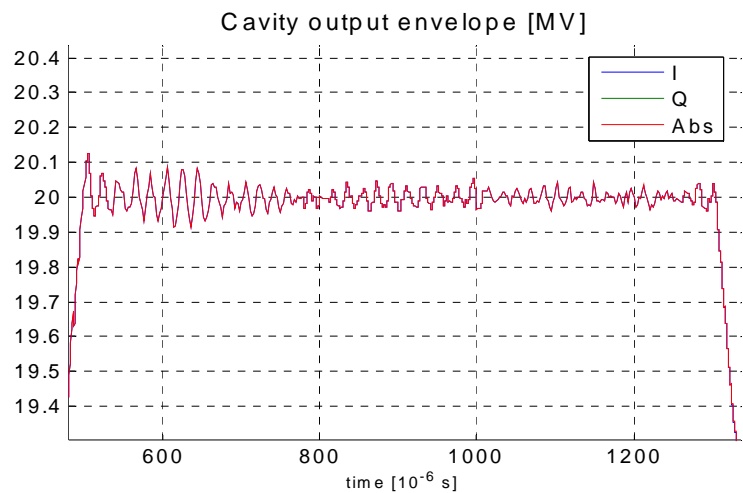
Driver current is 13~15mA, which corresponds to $(15^2 - 14^2) / 15^2 * 100 = 12.8\%$



Feed Forward and Feedback mode (gain=200)

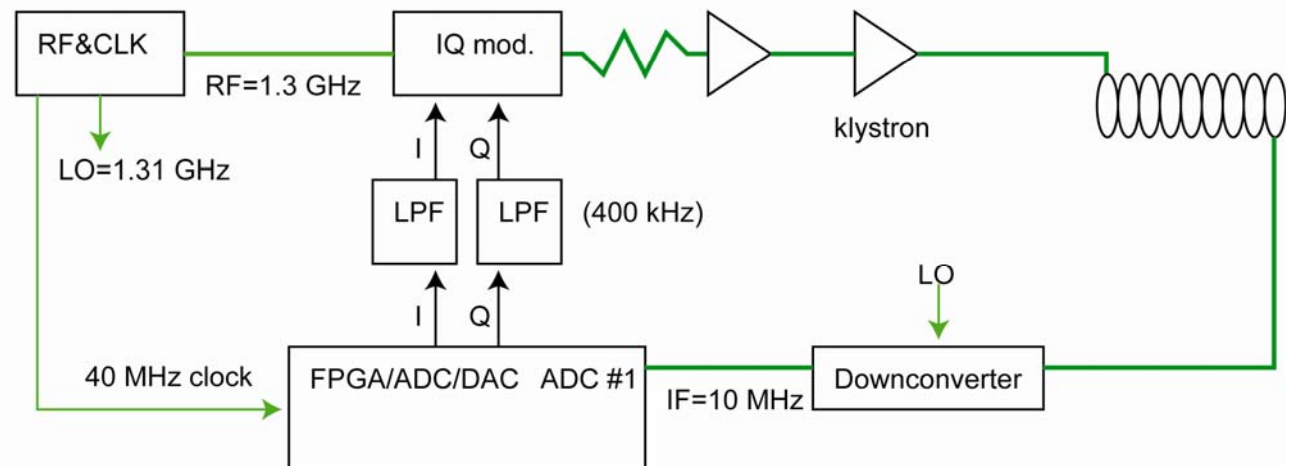


Feed Forward and Feedback mode (gain=200) zoomed flattop area

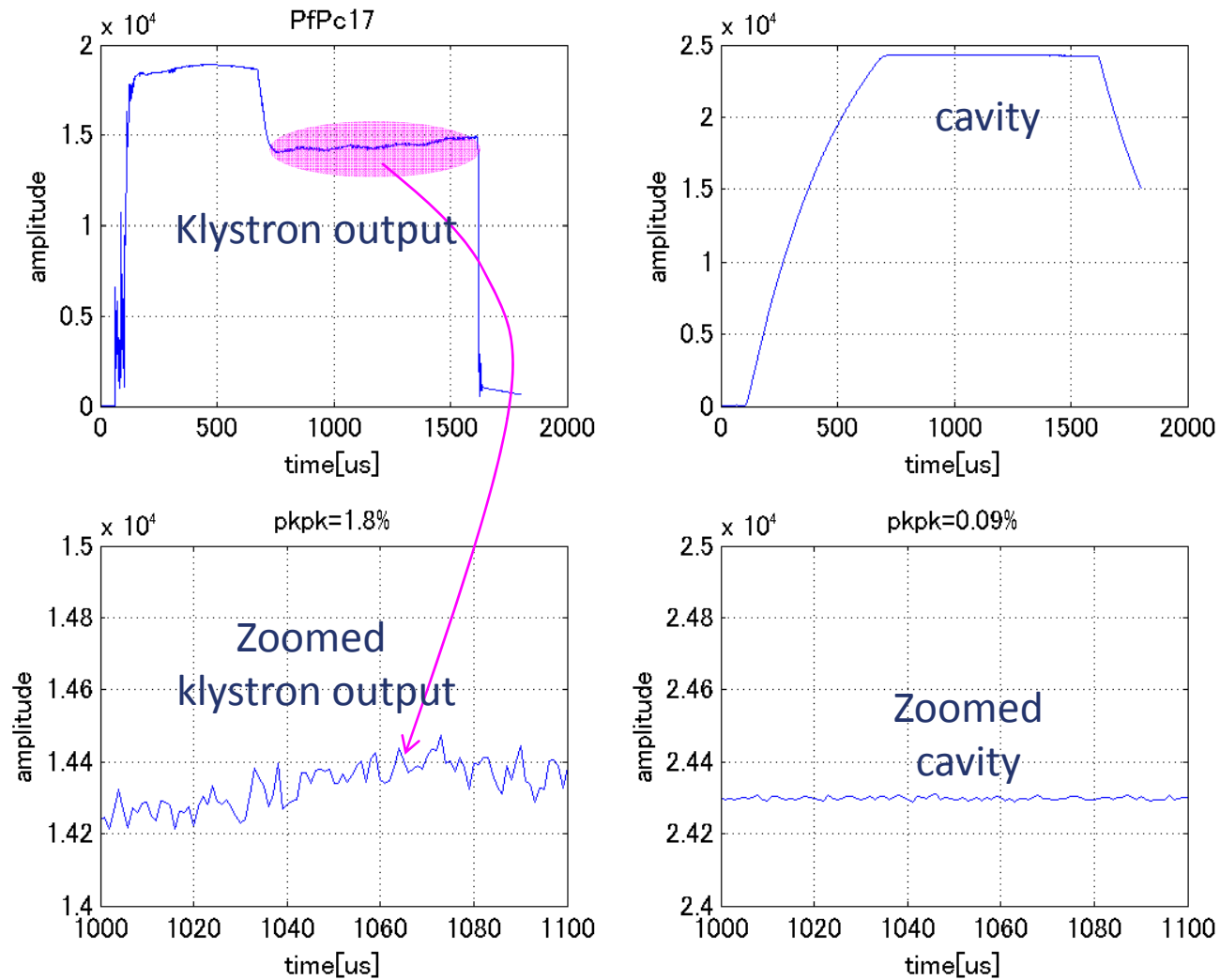


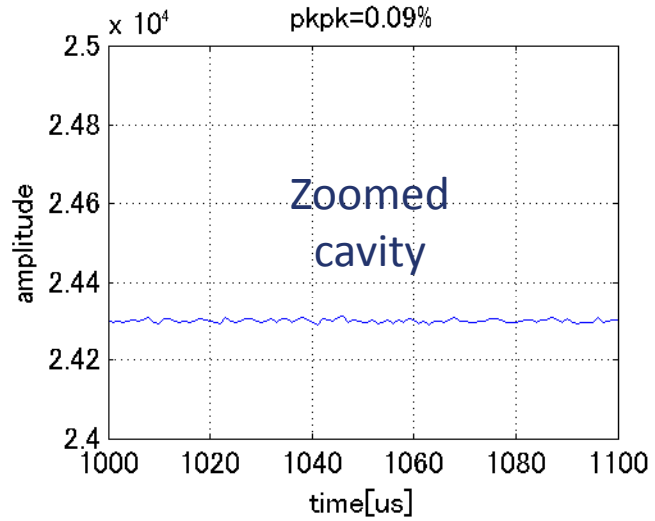
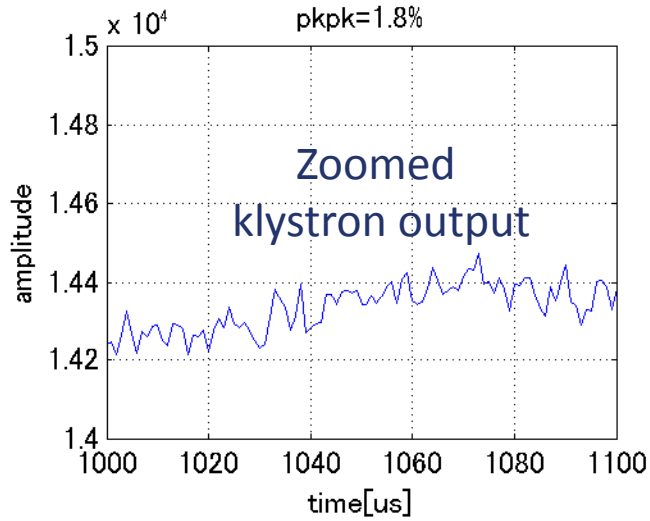
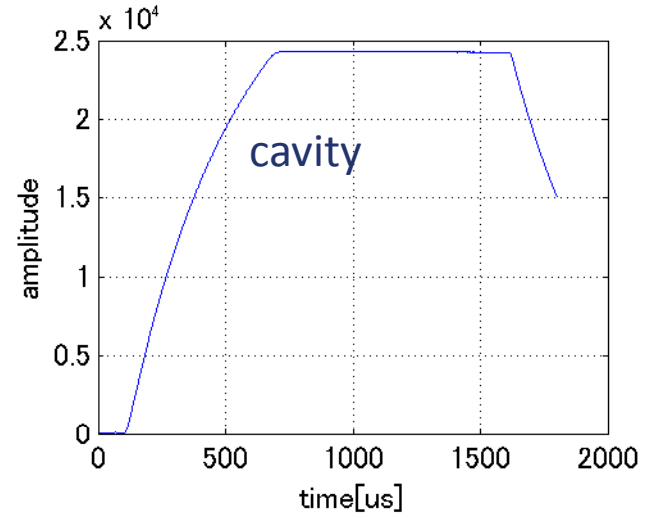
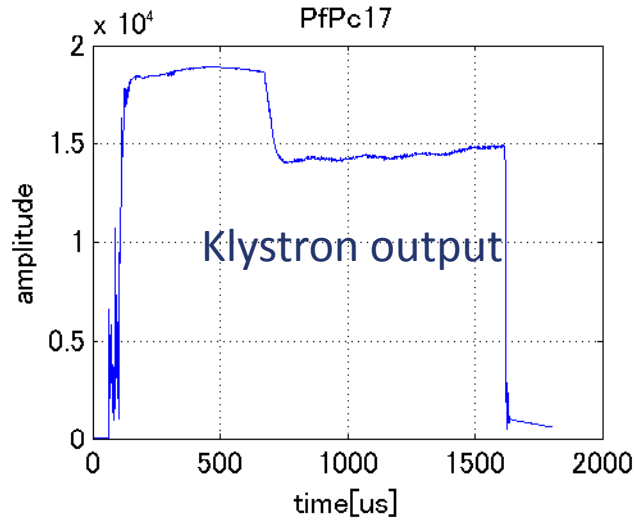
STF-0.5 operational experience

- Operation condition
 - $V_{acc}=18$ MV/m
 - with feedback (Proportional gain~35)
 - $QI\sim 1.7e6$ ($x\sim 2$ overcoupling) (-> lower detuning effect)
 - 40 MHz ADC, DAC
 - 90 pulses (18 sec.) data
 - without beam
- Both klystron output and cavity gradient were monitored in digital system.
- Cavity gradient is quite stable ($<0.1\%$ rms)



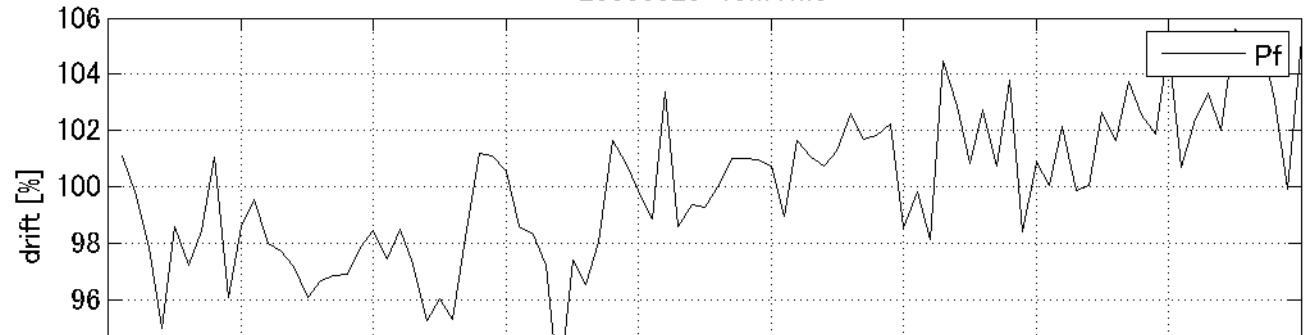
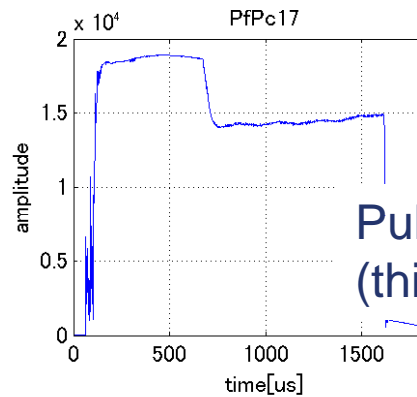
Operational condition





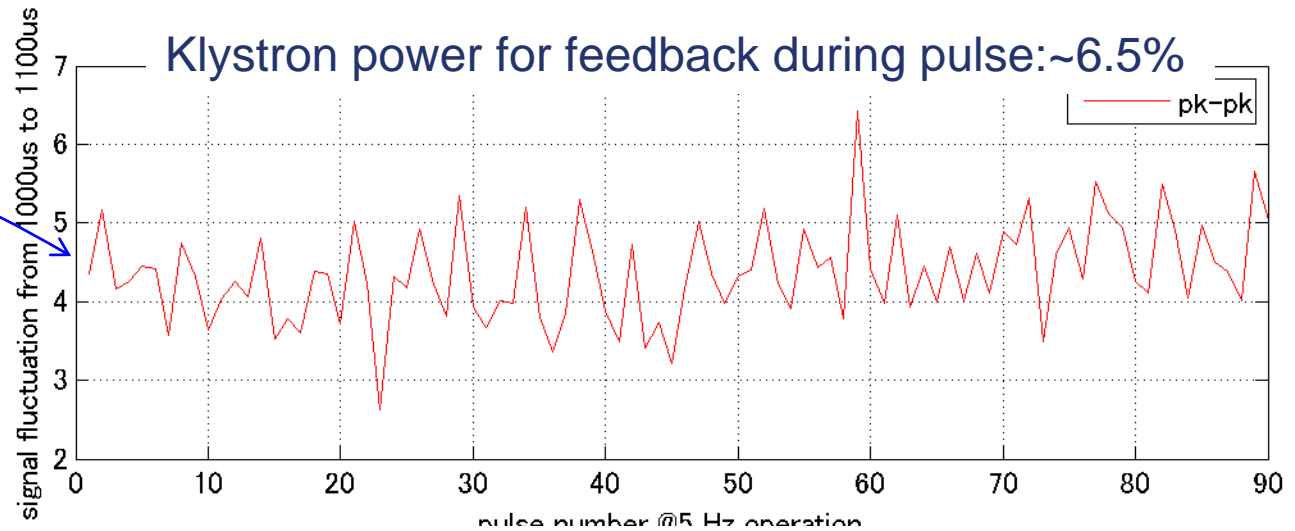
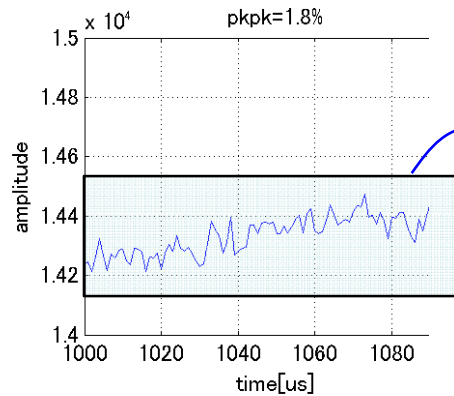
Klystron power fluctuation for FB (for short period)

20080328-18MVm3



Pulse-to-pulse additional klystron power for feedback: $\sim \pm 5\%$
(this partly includes microphonics and modulator ripple compensation.)

pulse number @ 5 Hz operation



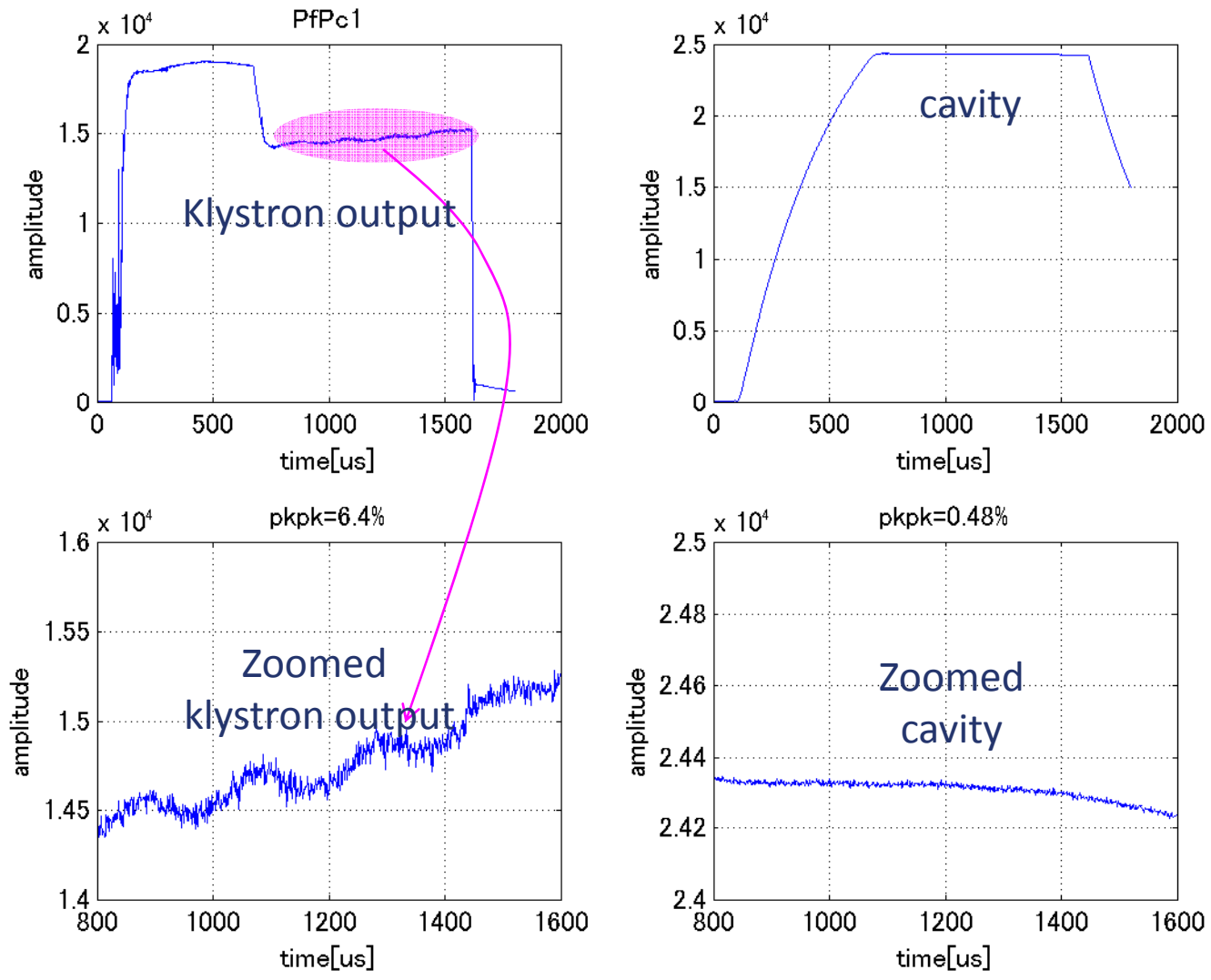
Klystron power for feedback during pulse: $\sim 6.5\%$

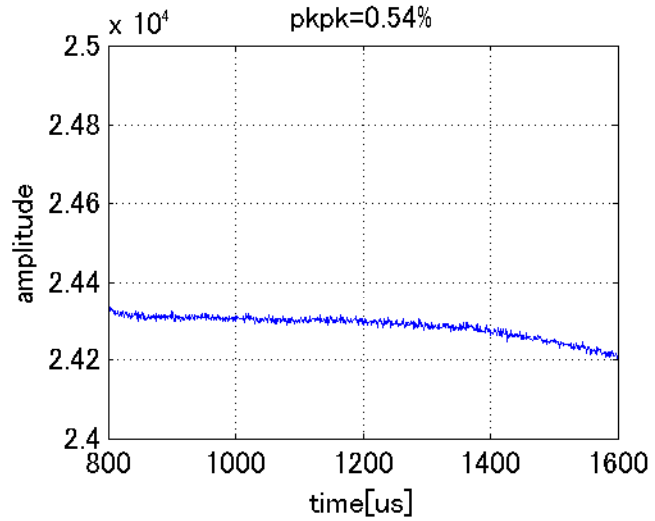
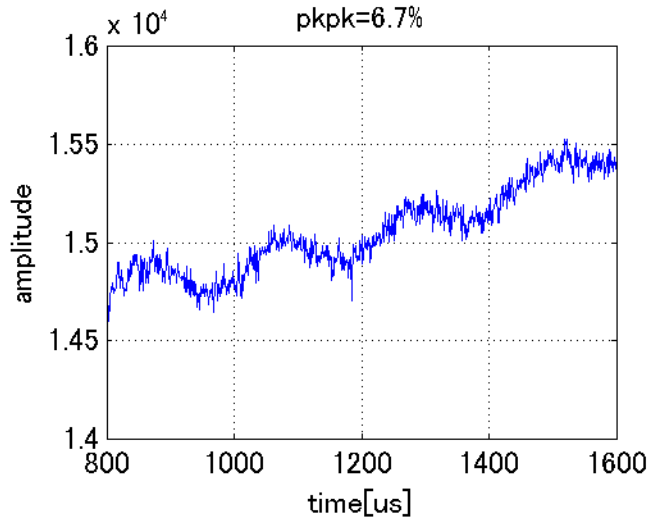
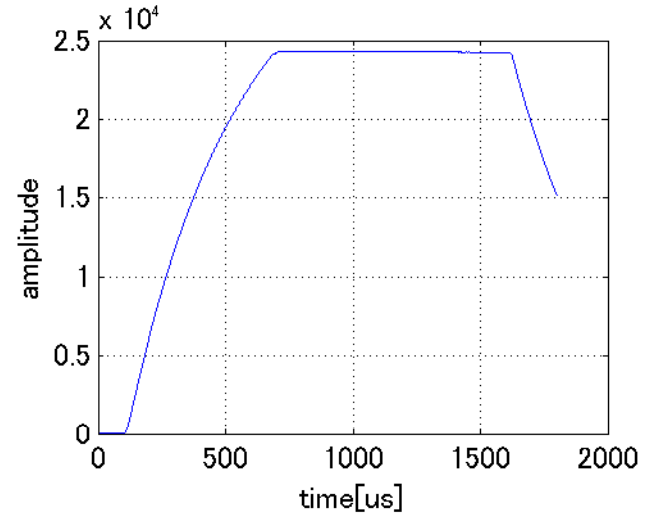
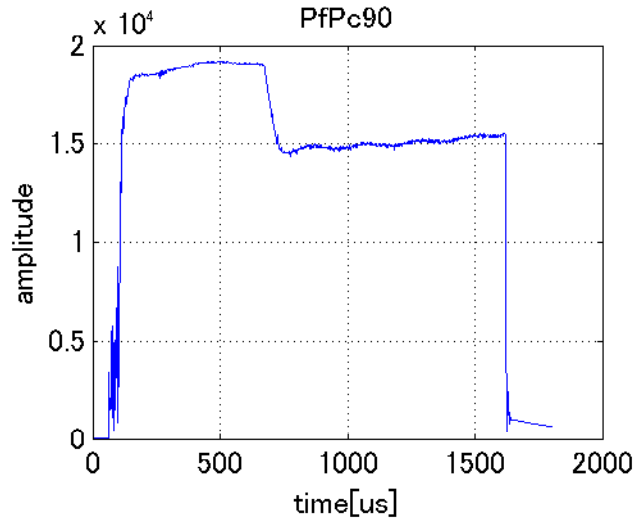
Around 12% of overhead (only for LLRF feedback) will be necessary.

Summary

- FLASH and STF-0.5 study (without beam) indicate that **10%-15% actual llrf overhead** will be necessary.
- This does **not** include the rf losses due to
 - reflection from waveguide system (additional ~1%)
 - performance change of klystron due to reflection (~?%)
 - coupler (over-coupled) (additional ~2%)
 - beam compensation (additional ~1%)
 - Lorentz force detuning (additional ~2%)
 - *any other items to be discovered...*
- Total overhead (llrf feedback + additional fluctuation) should be 17%~22%. (**overhead after ML KO meeting is 14%.**)
- Increase in total overhead could be the cost-driver but this is the “trade-offs” (cost v.s. field stability, high availability).

Operational condition

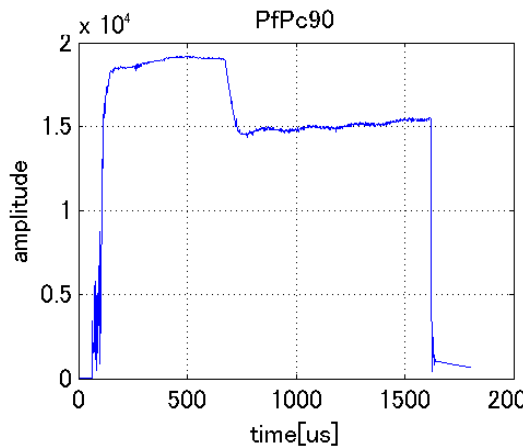




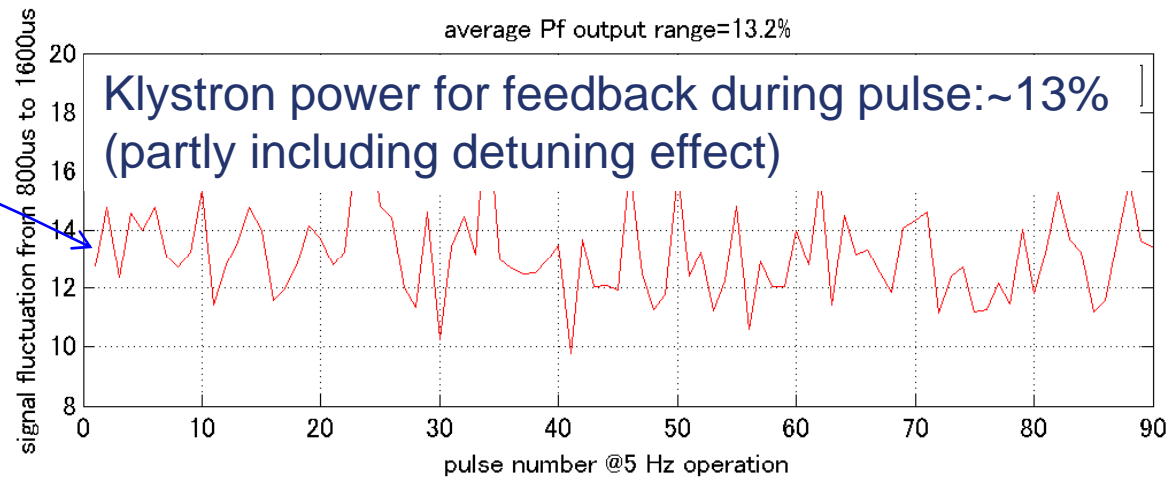
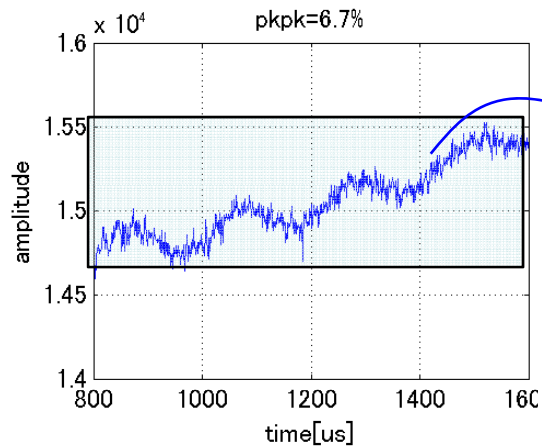
Klystron power fluctuation for FB

Drift of klystron power for feedback: $\sim \pm 5\%$

(this partly includes microphonics and modulator ripple compensation.)



average Pf output range=13.2%



Klystron power for feedback during pulse: $\sim 13\%$
(partly including detuning effect)