DRFS LLRF system configuration

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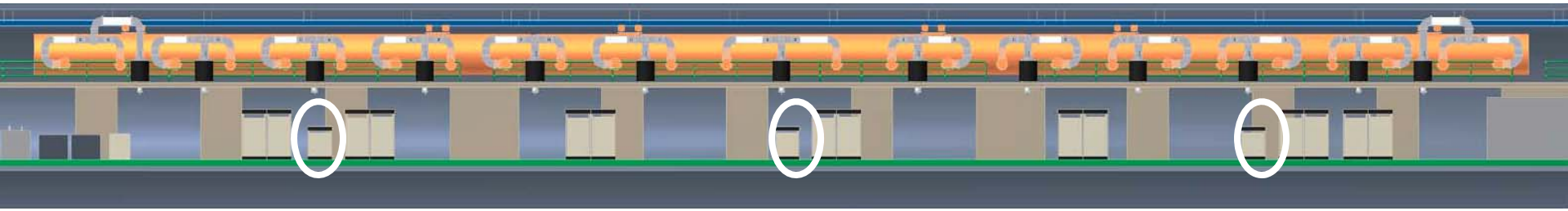
- LLRF lack layout for DRFS
- DRFS cavity grouping
- HLRF requirements
- Cavity filling pattern

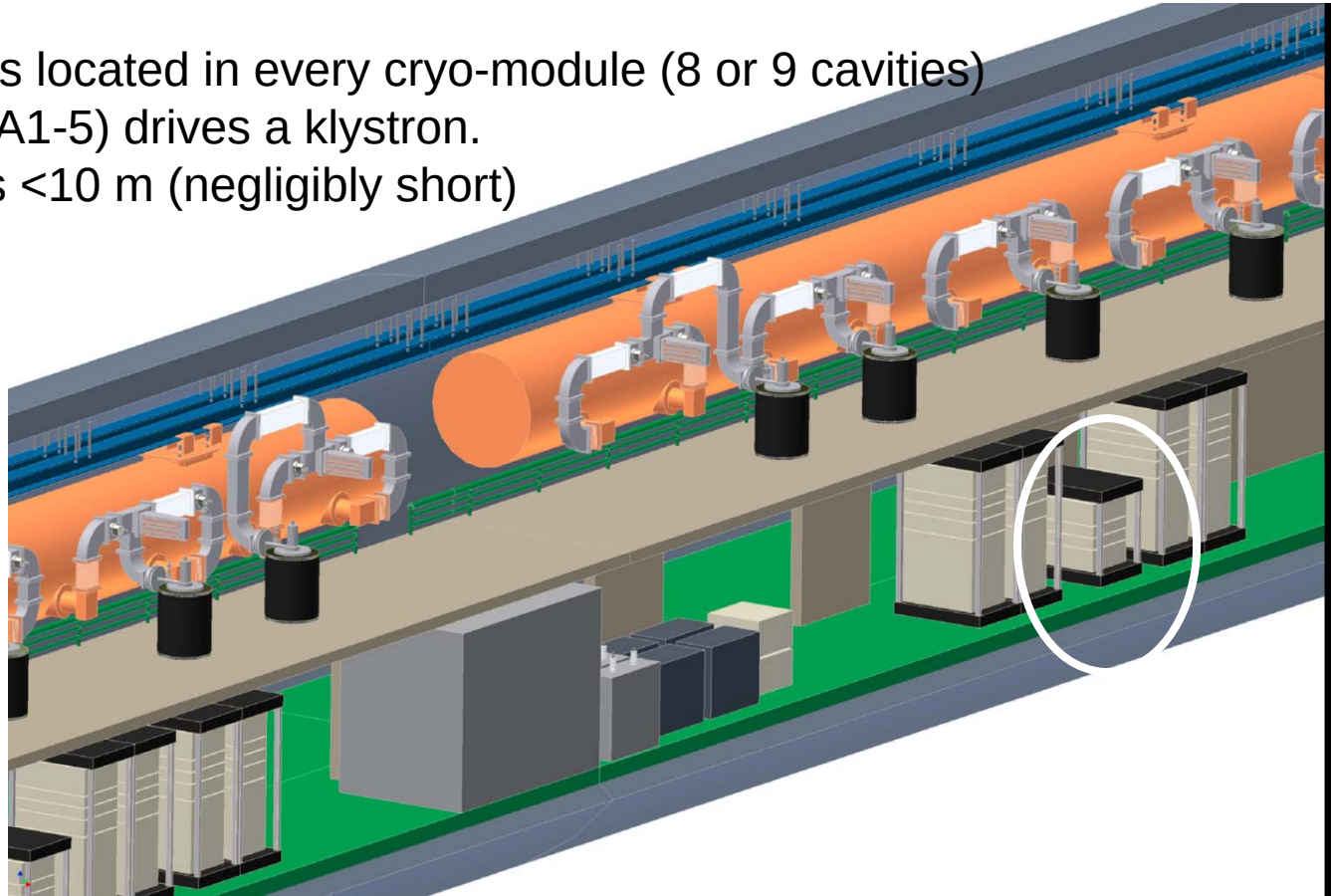
GDE meeting Beijing (Mar.27, 2010)

LLRF lack layout for DRFS

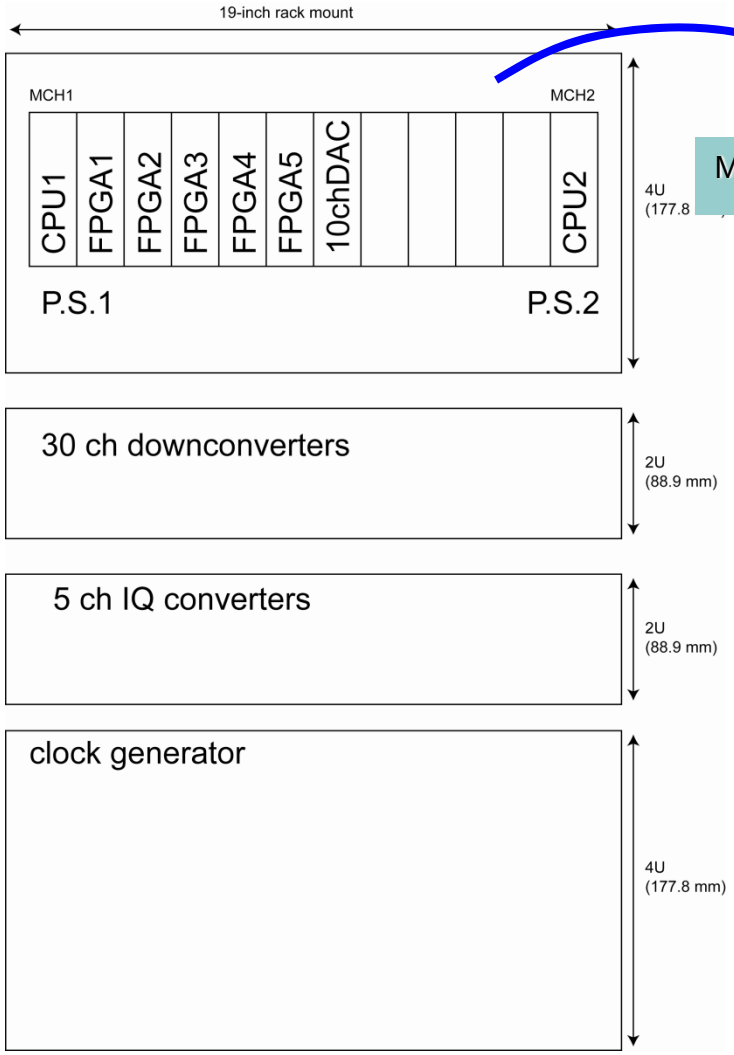


1 baseline unit (26 cavities, 3 cryomodules)

- 19 inch rack (total 16U) is located in every cryo-module (8 or 9 cavities)
- Each FPGA board (FPGA1-5) drives a klystron.
- Maximum cable length is <10 m (negligibly short)



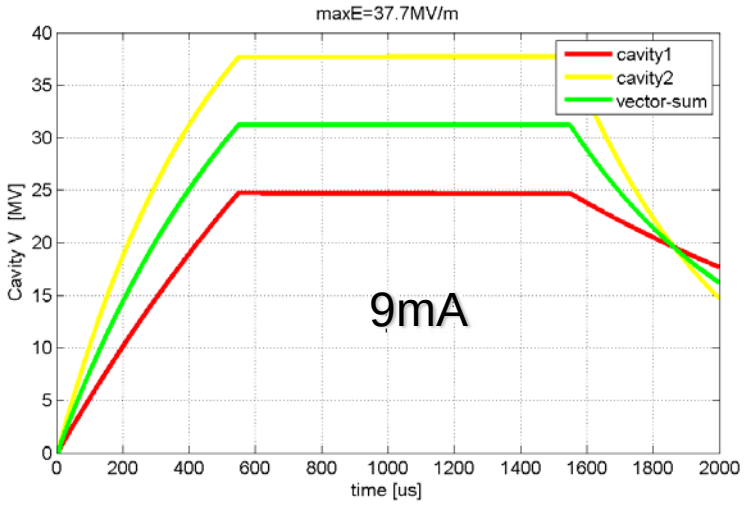
LLRF lack layout for DRFS (2)

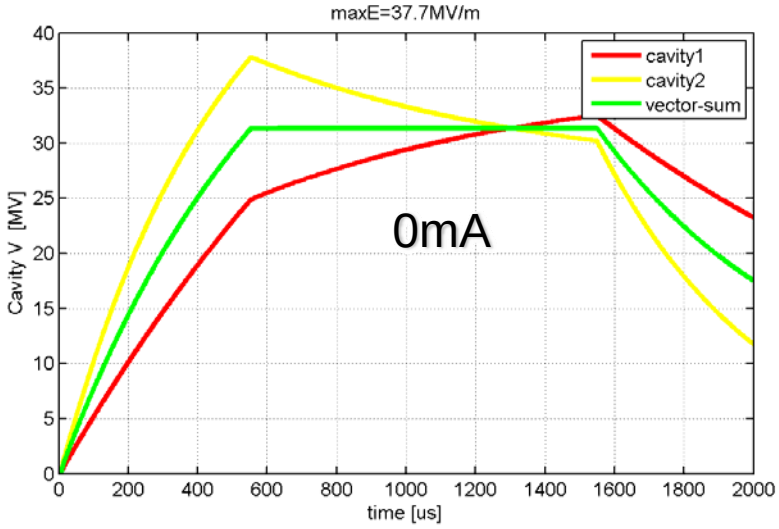


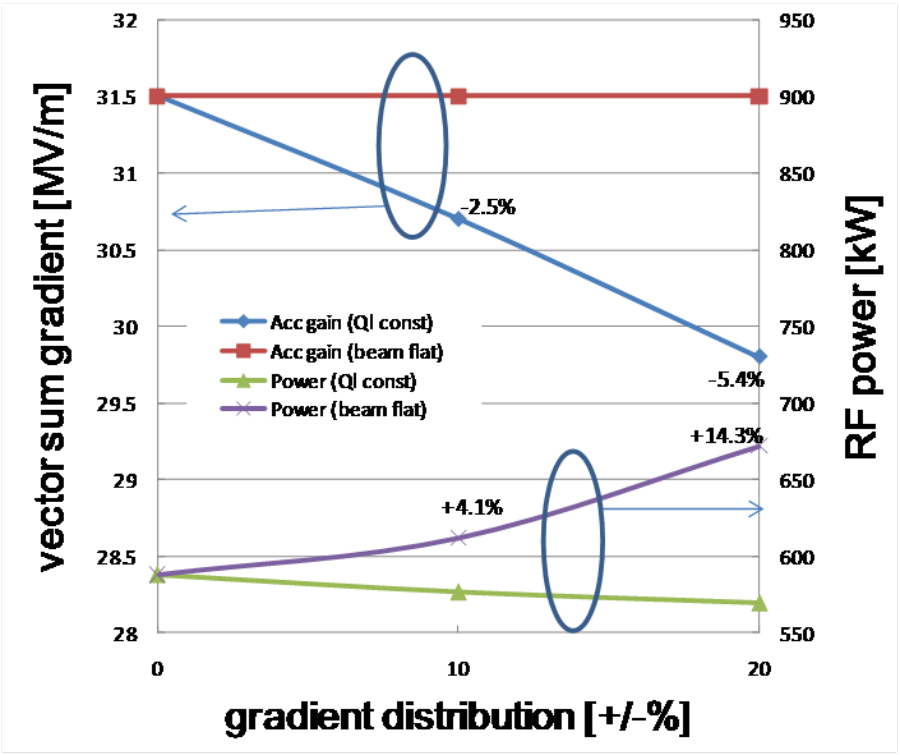
Micro-TCA

- Each FPGA board (FPGA1-5) drives a klystron.
- 10ch DACs are used for piezo drivers.
- 30 ch downconverters receive rf signals (cavity , forward and reflection power of each cavity)
- Clock generator creates clock and timing signals synchronized with master oscillator.

DRFS cavity grouping



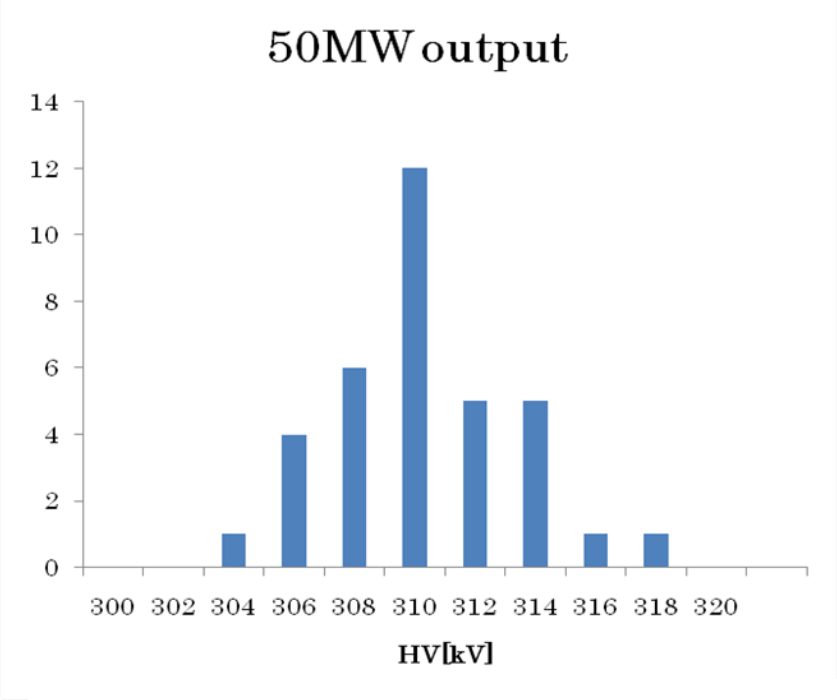




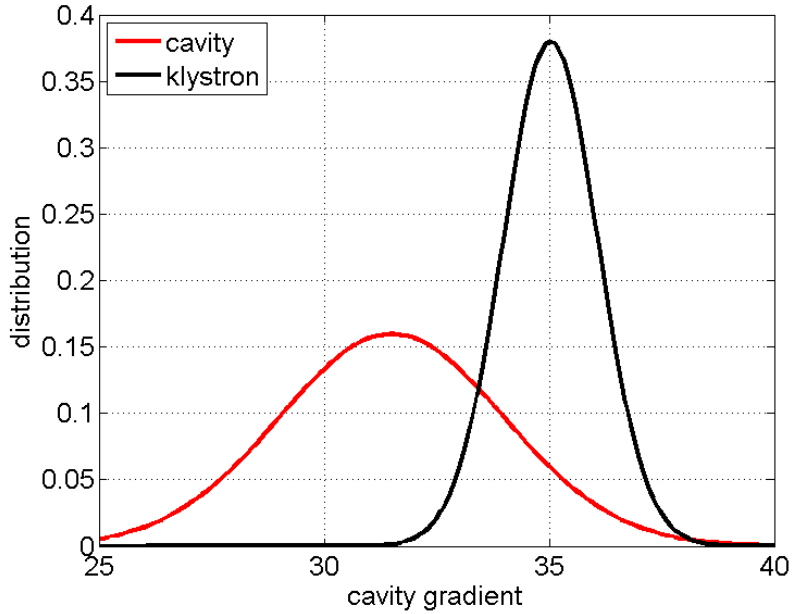
- If different gradient cavities are driven by a klystron, we need more power to operate them (~14% if operate 25&38MV/m cav.)
- In addition, flatness is only guaranteed when operated the certain beam current.

-> In DRFS, we will make cavity grouping and operate at same gradient.

HLRF requirements



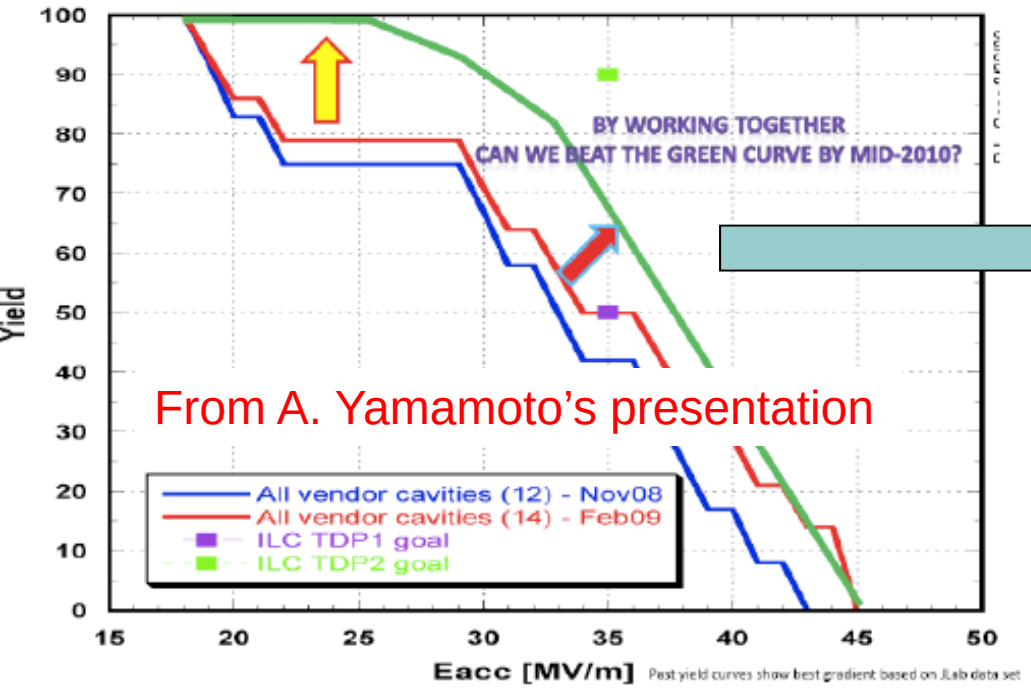
- KEKB injector klystrons (40 MW and 50 MW) are statistically analysed.
- Klystrons have 1.2% (40 MW) and 1% (50 MW) rms HV distribution to reach 40 or 50 MW.
- These correspond to ~3% power distribution with same HV. (P~V^2.5)



- Suppose the cavity distribution is 2.5 MV/m rms, 770kW klystrons can drive 38 MV/m cavities with 15% rf overhead.

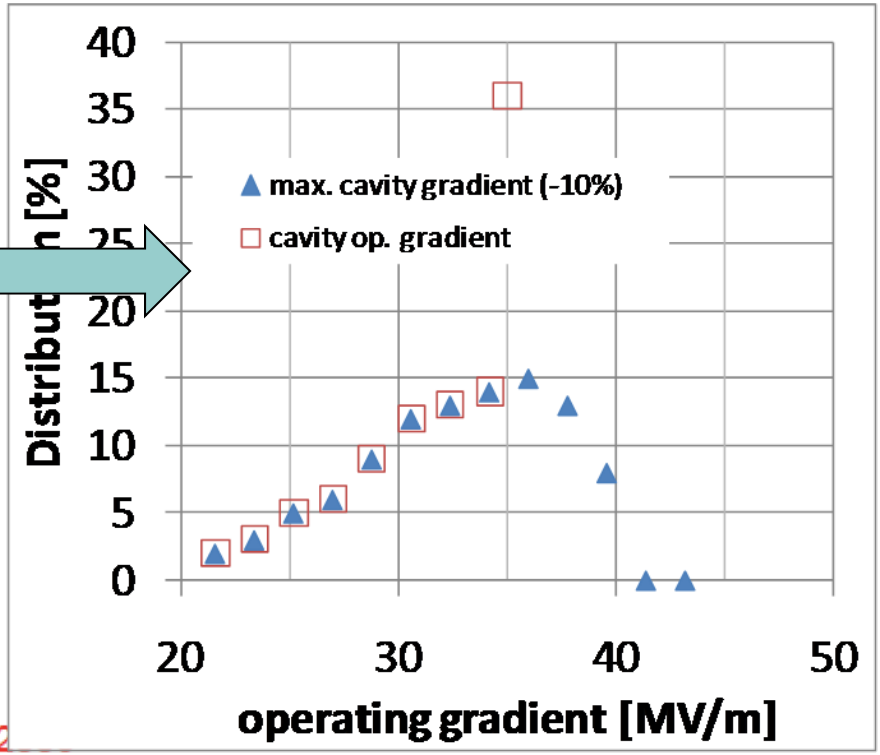
HLRF requirements (2)

From the different point of view….



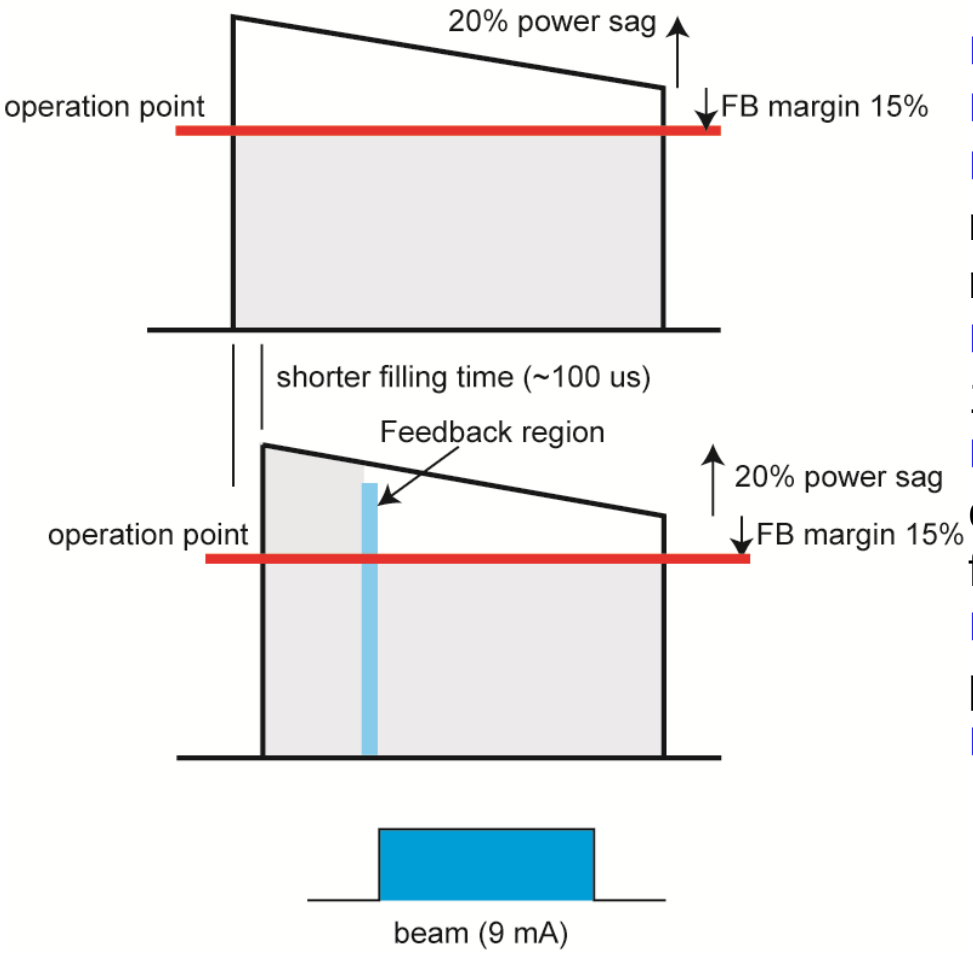
From A. Yamamoto's presentation

First presented at cavity vendor meeting at FNAL, March 6, 2



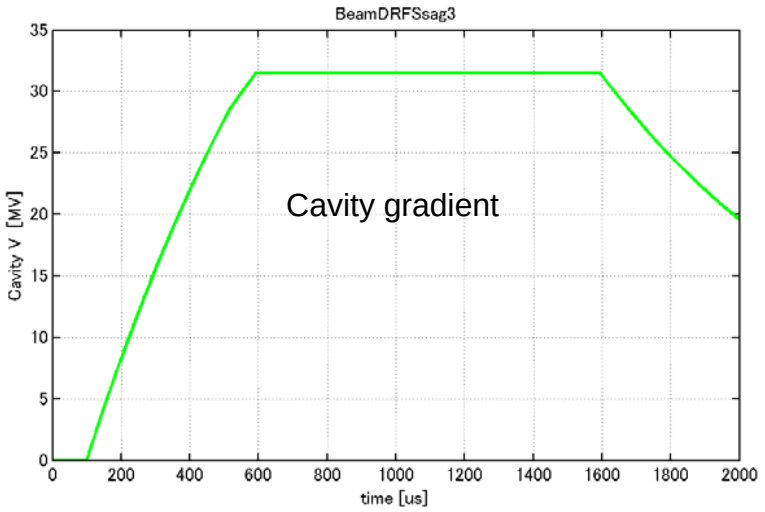
- Suppose the cavity max. gradient improve, the operational gradient (-10% of max. quench limit) and 770kW klystron yield 31.9MV/m (even if we limit the operational gradient to be 35 MV/m)
- We propose 770 kW klystron for DRFS with cavity pairing.

Cavity filling pattern (1)



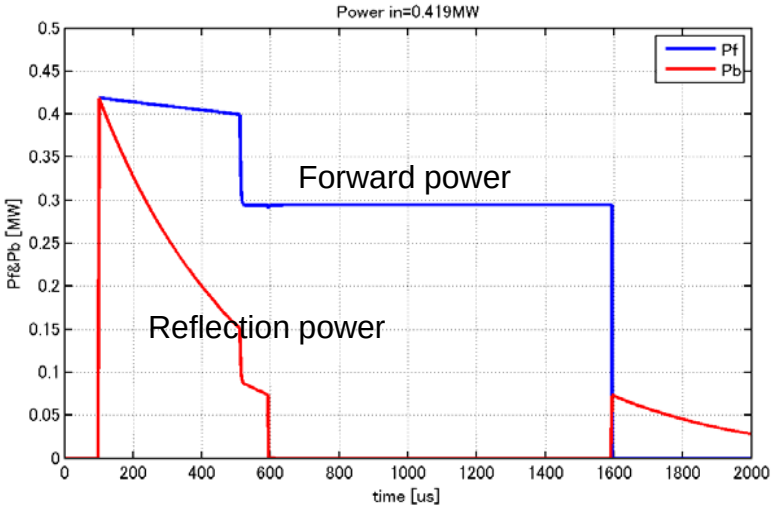
- DRFS modulators with sag
- 8 deg./% HV
- If sag ~10%, 80deg. Rotation during rf pulse -> phase compensation will be required.
- Output will be 20% more in case of 10% sag.
- In order to use the rf power efficiently, we propose “Full power filling” scheme.
- This is effective to shorten the rf pulse.
- Filling is made only phase control.

Cavity filling pattern (2)



- Shorter rf pulse width is confirmed by simulation.
- 15% rf power overhead is assumed.

HV sag	Power sag	Average power increase	RF pulse saving
10%	20%	10%	6.2%
5%	10%	5%	5%



- Full-power filling can compensate the rf power increase by 5% HV sag.

Summary

- uTCA based llrf system is planed for DRFS.
- Cavity grouping will be adopted for higher cavity efficiency.
- Nominal 770 kW klystrons can drive 35 MV/m pair and the good-performance klystrons can drive 38 MV/m pair.
- Full-power filling scheme is proposed and will be studied at S1-grobal.