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PERFORMANCE EVALUATION OF ERL MAIN LINAC TUNER *

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Abstract

We evaluated a slidejack tuner adopted as compact ERL Main Linac tuner. The frequency of cavity is disturbed by not only its Lorenz detuning but also michrophinics come from the outer disturbance. KEK tuner compensates the frequency by extending a cavity. Tuning is driven by two system, piezo and slidejack system. Slide-jack mechanism with long stroke drives coarsely piezo adjust precisely and fast. We tested performance of the tuners on operation.

CERL PROJECT

Now compact ERL (cERL) is running to obtain elemental technology for 3Gev Energy Recovery Linac (ERL) project (Fig. 1). We have been carrying on R&D for production of cryomodule consists of 1.3GHz superconductive RF cavity (Fig. 2)

Figure 1: Compact ERL.

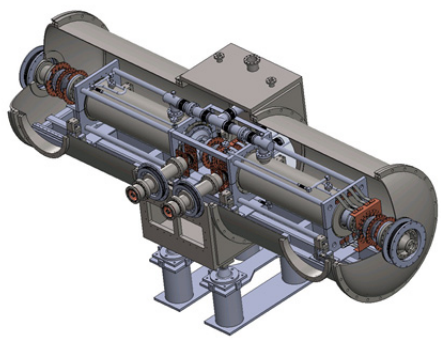

Figure 2: cERL main linac cryomodule.

CERL MAIN LINAC TUNER

We adopted improved slidejack tuner as a frequency tuner in ERL main RF cavities. Figures 3 and 4 show tuning system. This tuner has 2 tuning system. Slidejack system tunes roughly and piezo system tunes precisely and quickly. The high stiffness is the main specification of this tuner. This slidejack tuner was applied in STF module [1].

Figure 5 shows improved cERL tuner. We improved slidejack tuner for ERL Main Linac in several ways. First, we improvement alignment system. Tuner has some shafts and gears. It is important to align these parts. The old tuner must be aligned when it is attached to the module and it is difficult to align precisely. New tuner is improved to be aligned before attachment. This improved alignment accuracy and reduce shaft rotating torque. Secondly, new tuner has 2 piezo actuators whereas old tuner has 1 actuator. This improvement enhances robustness and tuning stroke.

Frequency of compact ERL Main Linac cavity changes in proportion to cavity extension and the proportion factor is 300kHz/mm. Mechanical slidejack tuner has 2.5 mm dynamic range. Piezo stroke at normal temperature is 80um. Piezo stroke at low temperature is estimated 10% of normal temperature. Cavity stroke is a half of piezo stroke because the piezo drives only half side.

The estimated cavity extension stroke is 4um. Thus, mechanical adjustment should be in 4um.

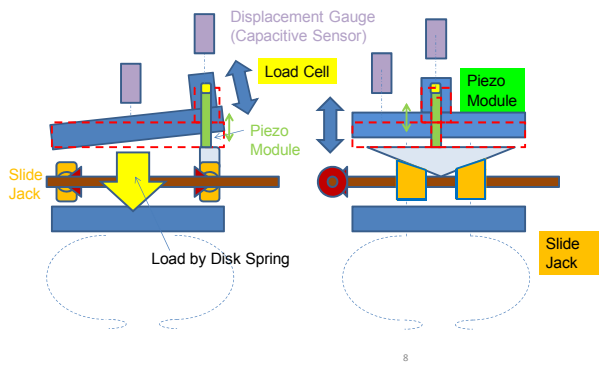

Figure 3: Piezo tuning system.

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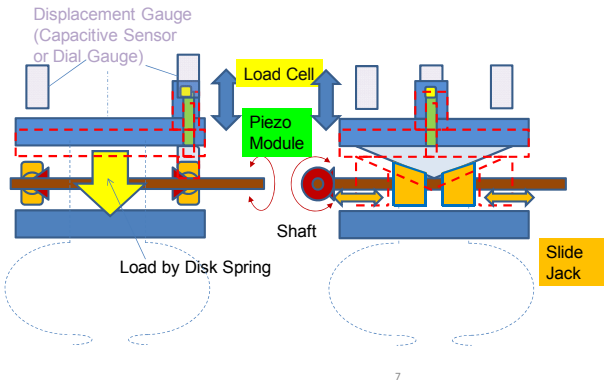

Figure 4: Slide jack tuning system.

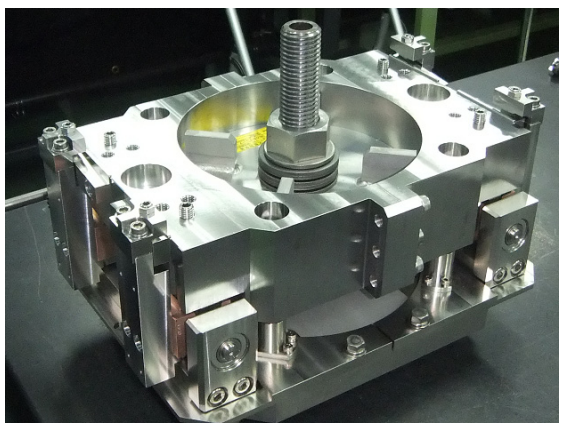

Figure 5: cERL main linac tuner.

PERFORMED BASIC TEST

We have performed basic experiment using model tuner and confirmed that backlash and torque are of no matter.

We tested the tuner installed in a module and confirmed that the tuner is capable of tune frequency approximately 1300MHz [2].

PREPERATION FOR OPERATION

We connected the control driver to the tuner directly and manipulate manually in past experiment. cERL operation requires feedback control and remote control.

For this purpose, at first we carried out measurement of transition of tuner remote command pulse. Secondary, we connected and tested safety devices.

Figure 6 shows the resonance frequency of the cavity of "F0" and command pulse to the motor and the piezo driver. The motor is able to adjust tuner in piezo tuneable range by remote control.

Tuner is controlled by monitoring phase in operation. To avoid false operation, potentiometers monitor tuner displacement roughly and directly. Figure 7 shows Potentiometer output vs tuner displacement.

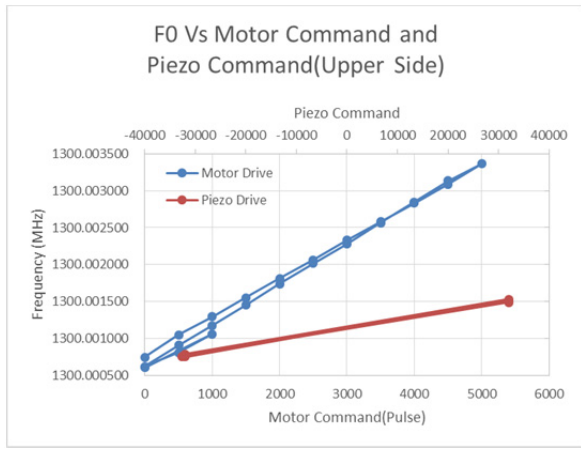

Figure 6: F0 vs motor command and piezo command.

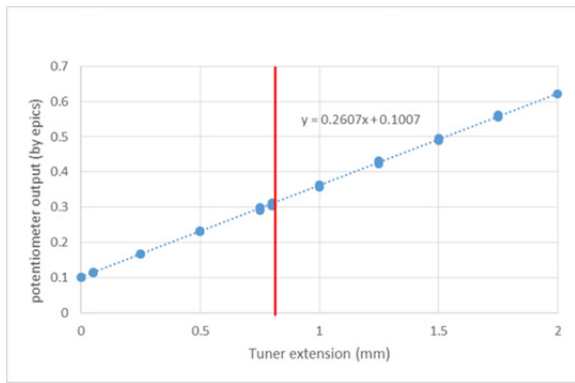

Figure 7: Amplitude vs potentiometer.

CERL BEAM OPERATION TEST

We carried out the operation test of cERL main linac cryomodule using beam with energy recovery. Figure 8 shows phase shift between input power to the cavity (Pin) the transmitted power from the cavity (Pt) and piezo voltage. Phase shift is restrained to 0.2 degree by physical cavity control with digital feedback control board. This is equal to frequency shift of 9Hz by taking into account of the high loaded Q of $1x10^7$ and 30nm cavity extension. Finally, phase shift is under 0.02degree by electrical control [3]. Piezo voltage drifts from 200V to 300V in 12 hours operation and now we are investigating about the reason of this drift. We note that this drift is smaller than our piezo tuning range of 500V and tuner feedback system was stably controlled by the digital feedback during cERL beam operation.

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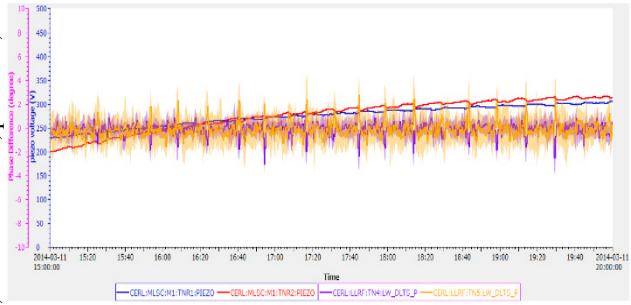

Figure 8: Phase stability and piezo driving voltage. Red and blue lines show the piezo voltages of ML1 and ML2 main linac cavity, respectively. Purple and orange lines show the phase shifts of ML1 and ML2 main linac cavity, respectively.

CONCLUSION

We improved slidejack tuner for cERL main linac tuner.

We confirmed that cERL tuner is capable of tuning cavity frequency at 1300MHz±9Hz only by physical tuning. By using this improved tuner, we could stably operate cERL main linac under high loaded Q condition with LLRF system at present [4].

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