Injection tuning of ATF

ATF2 Technical Review
2013/04/03 T.Naito

To supply stable beams to ATF2, the injector needs to fine tunings for E, dE/E, timing, orbit, optics matching, etc..

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    1. *Pulse power supplies*
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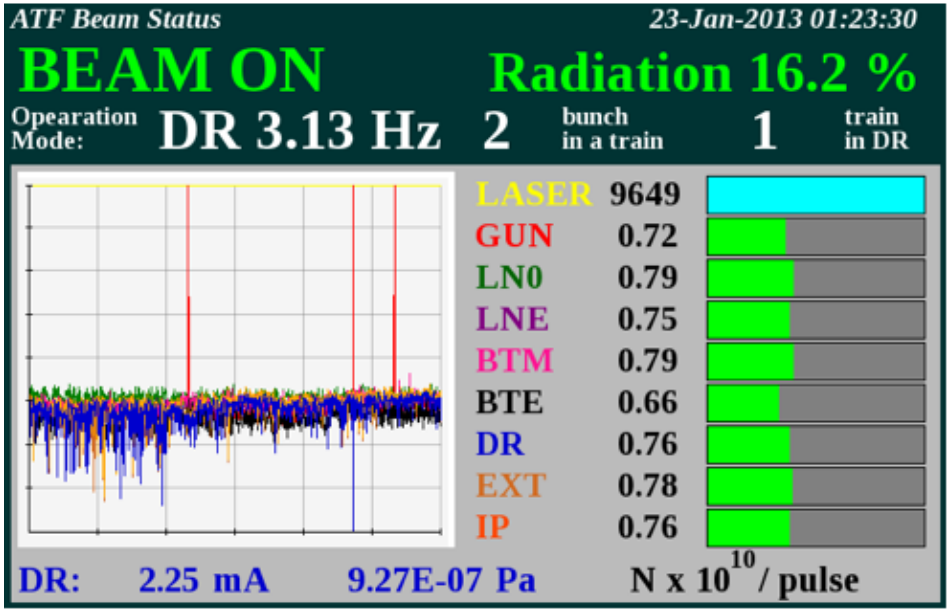
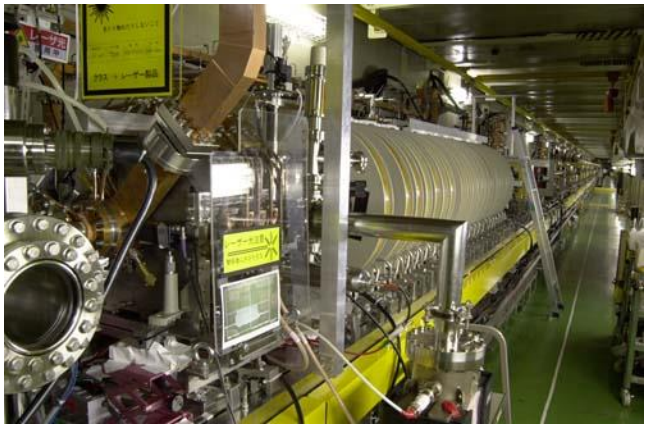
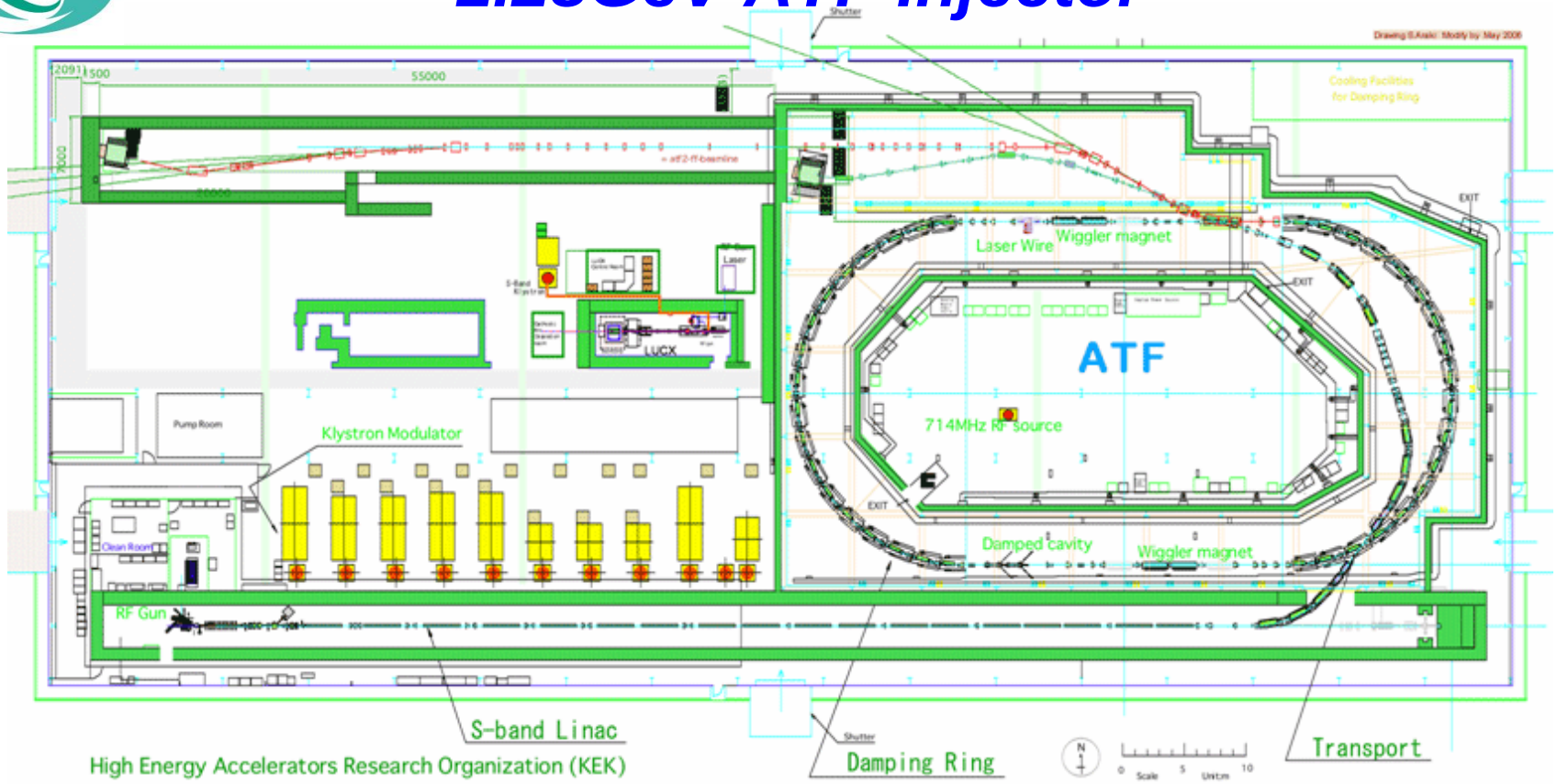




Design acceptance of the ATF-DR

Emittance(x,y)	*3×10^{-3}m*
Timing	*+/−350ps*
dE/E	*+/−1.5%*

1.28GeV ATF Injector

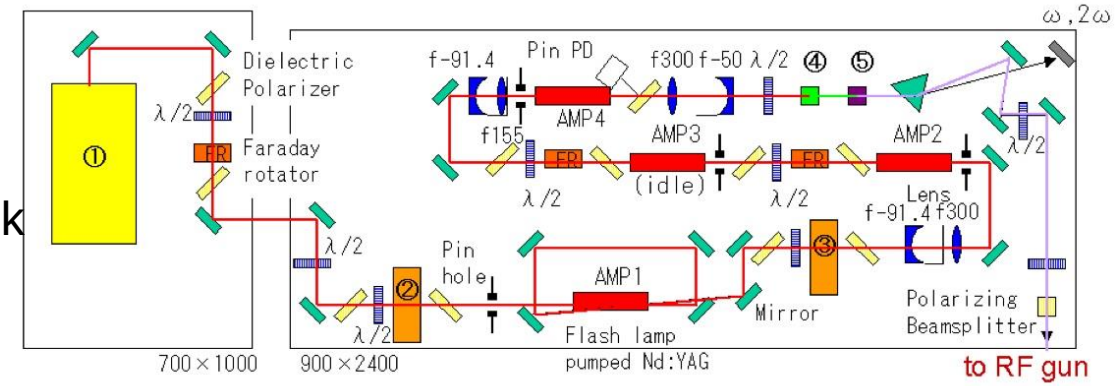


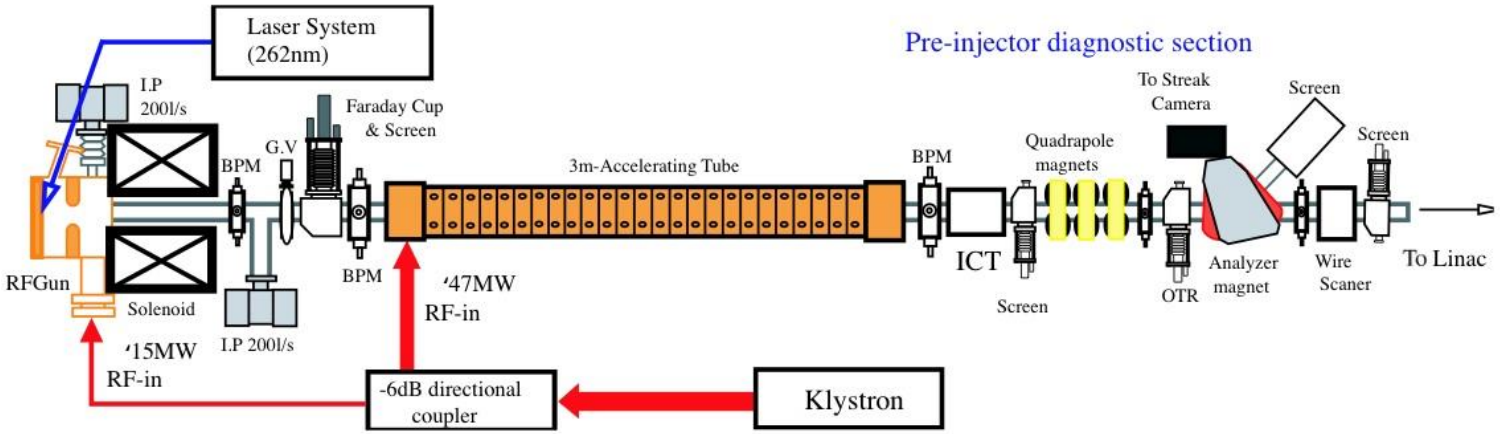
1. S-band linac
1)Laser triggered RF Gun(CsTe cathode)
2)Pre-injector 3m long Acc. Structure x1
3)3m long Acc. Structure x 18
2. Beam Trans port
3. DC septum, Injection kicker(on axis injection)

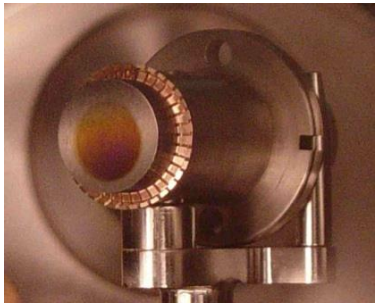
E=1.28GeV
Ne=1x10^{10} e-/bunch
Bunch#/shot 1 ~ 20 bunches
Bunch spacing 2.8~5.6ns
Rep=3.12Hz(12.5Hz max)
Normalize Emittance=3x10^{-5} m

Gun and Pre-injector

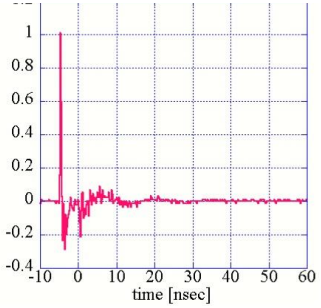
Mode lock Laser

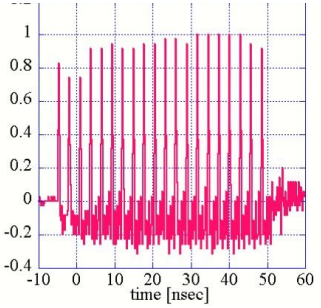






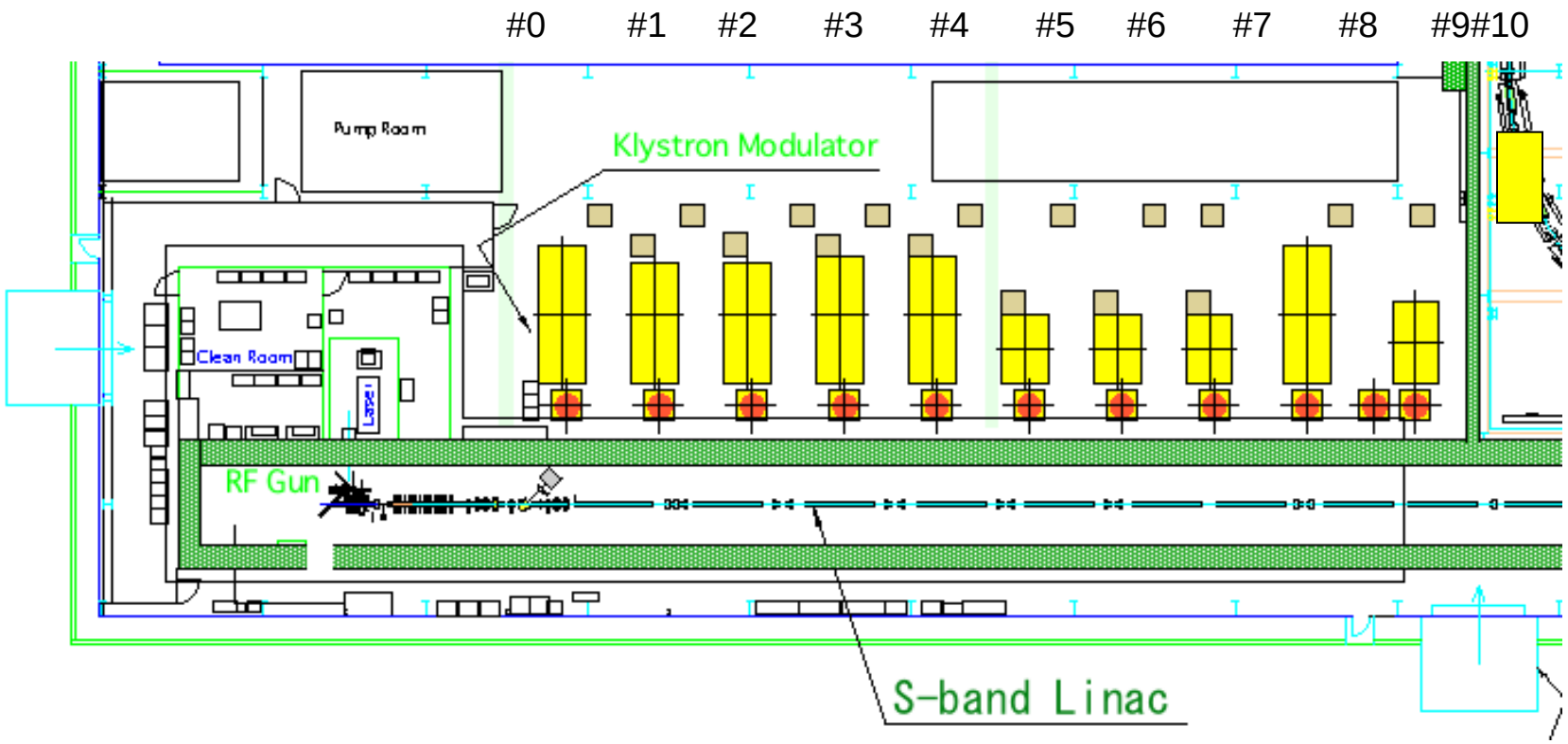
Cathode - Load lock system is used to replace new one.





Bunch Current

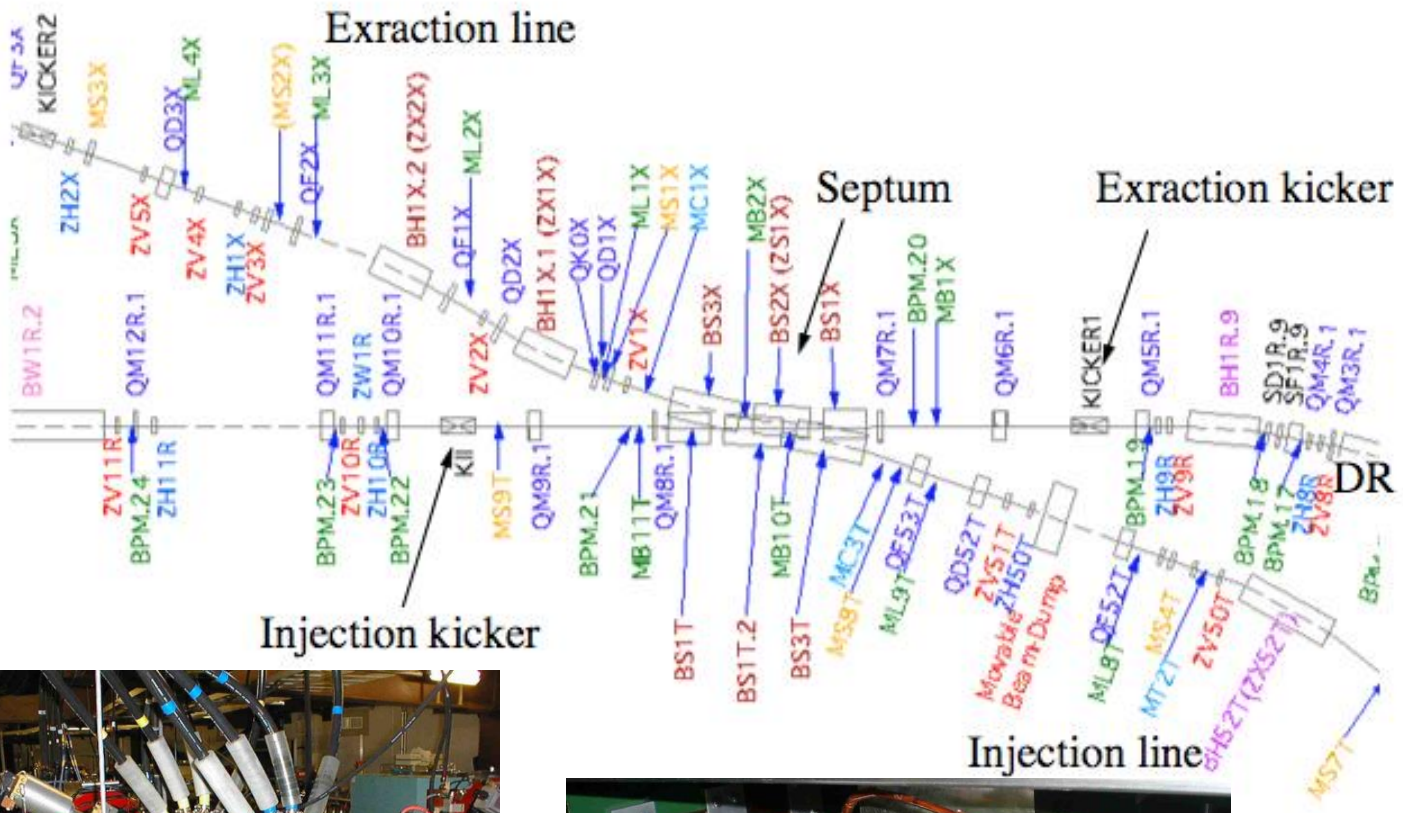
Linac

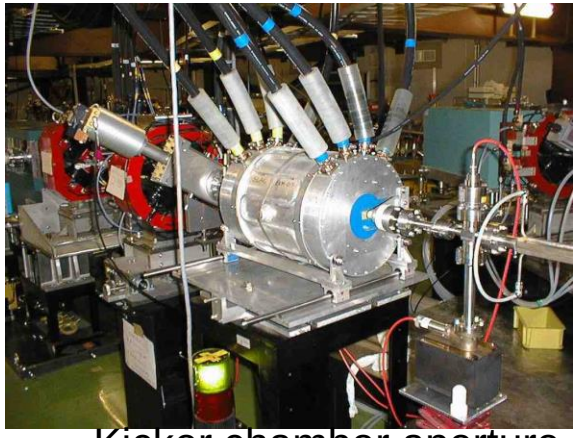


The high power pulse RF is produced by 11 klystrons.

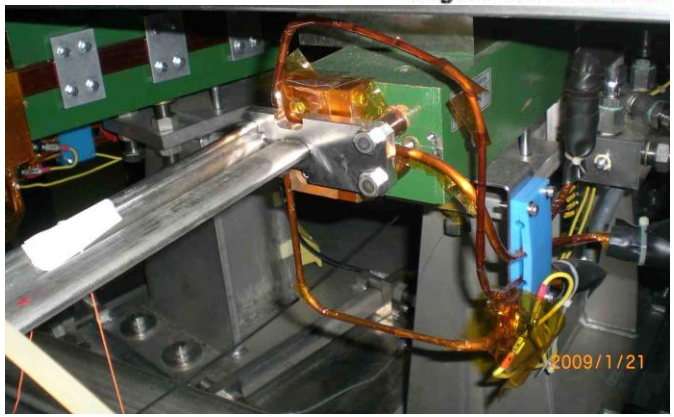
#0 RF gun + 1st Accelerator structure
#1~#8 Two Accelerator structures using SLED
#9, #10 Single Accelerator structure for the Energy compensation of muti-bunch beam acceleration
(#9, #10 are not used for the single bunch acceleration.)

Septum and kicker region



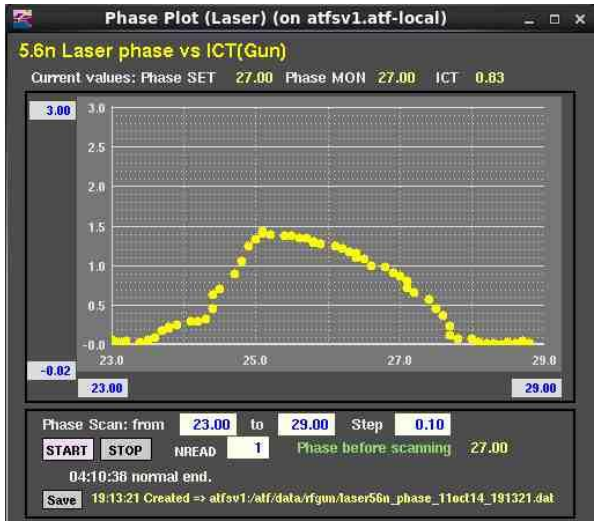


Kicker chamber aperture
16mm diameter



Septum chamber aperture
7 x 22 mm for injection beam

Injection tuning(1)

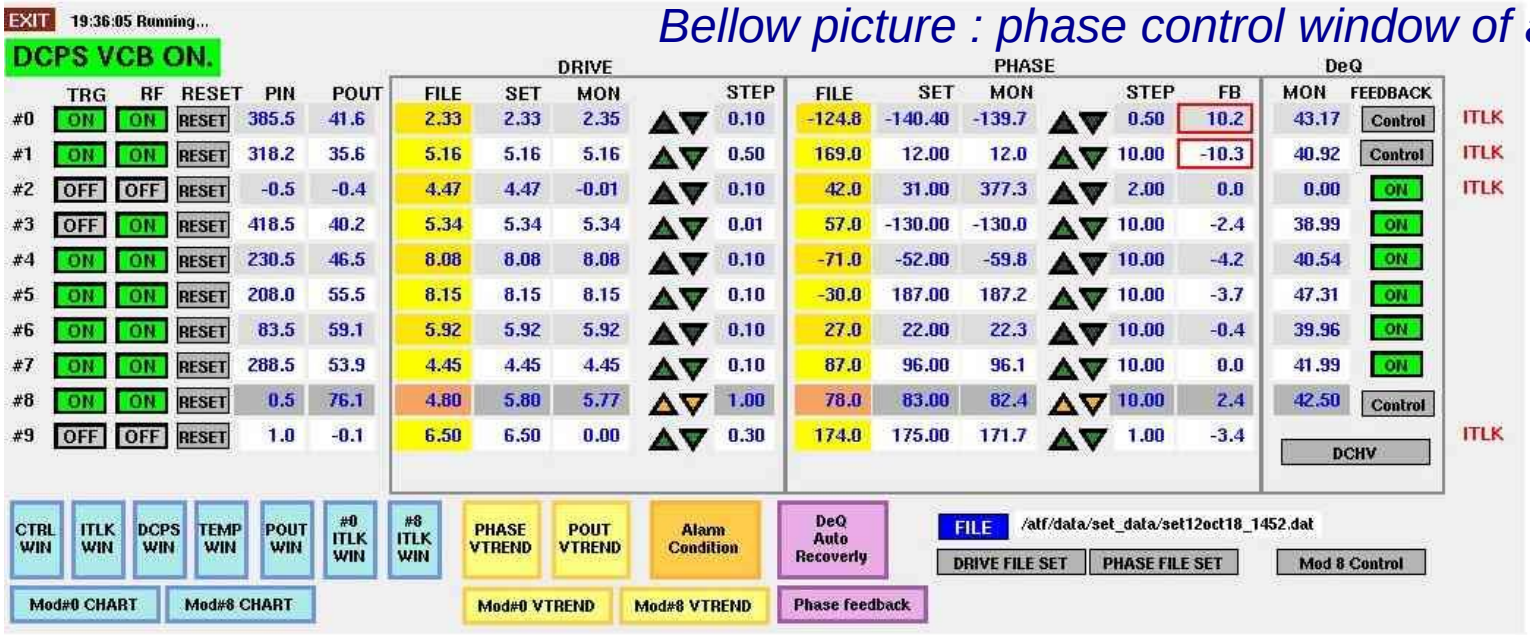


Gun and linac tuning

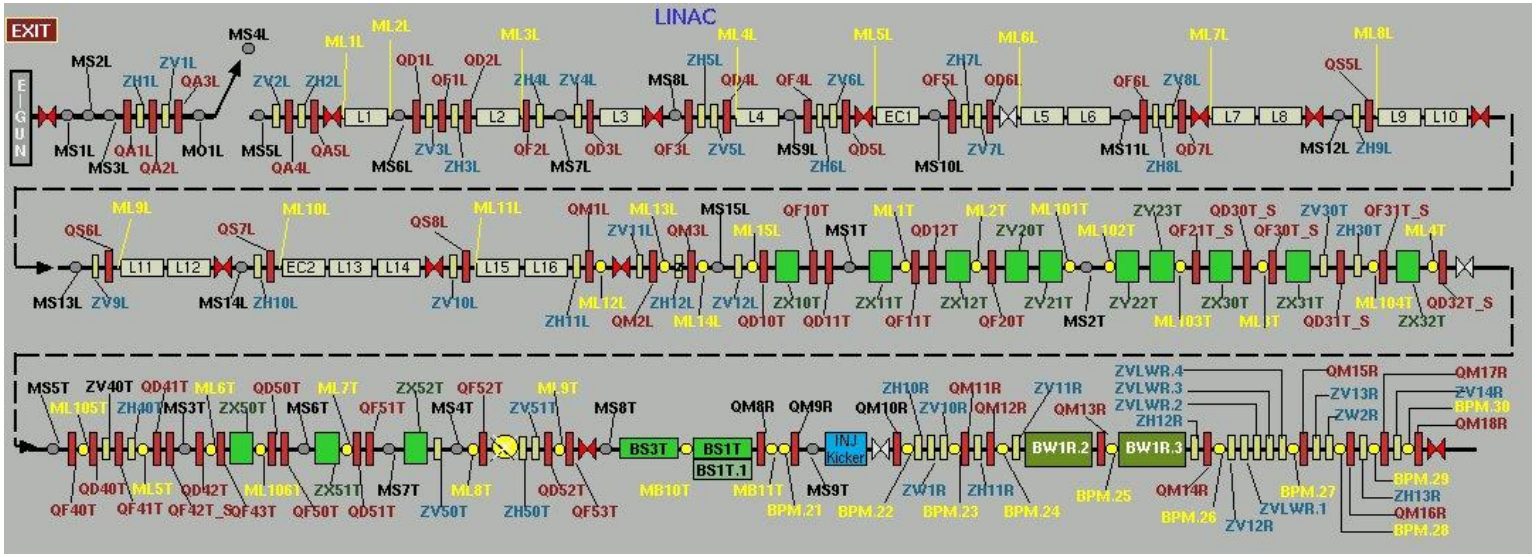
The beam emission is controlled by the laser power and the phase. Especially, the beam quality is very sensitive with the phase between the laser and the RF cavity. The beam energy is adjusted by the phase control of all klystrons. E and dE/E is confirmed by a screen monitor at the end of the linac.

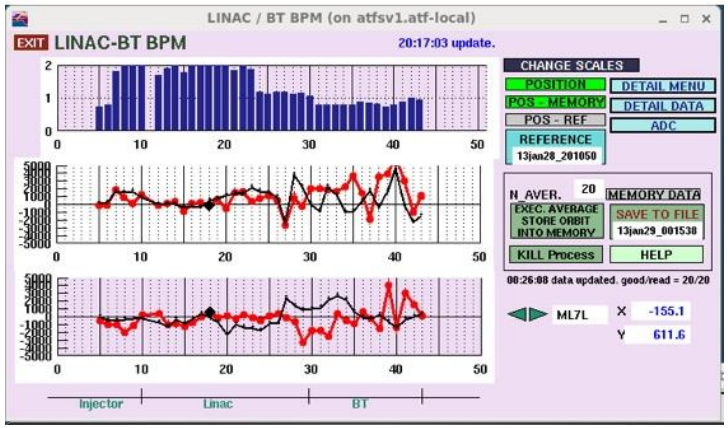
Left picture : the beam emission characteristics for the laser phase.

Bellow picture : phase control window of all klystrons.



Injection tuning(2)



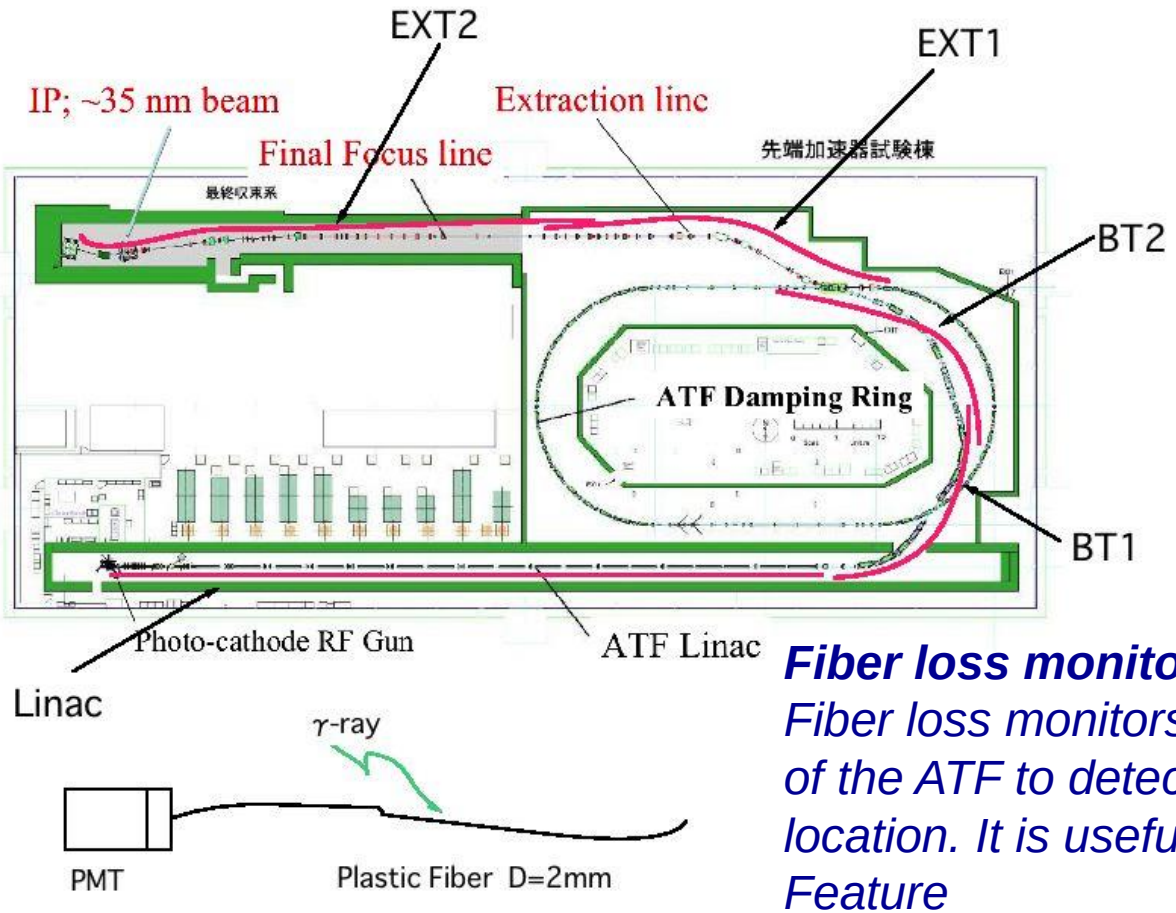


Orbit and Matching tuning

The orbit and matching control is done by the popup window for each device. We are using many monitors, BPMs, Current monitors, Screen monitors, loss monitors, etc., by looking these monitors, the beam is steered to the end of BT. The difficulty is that the beam conditions are strongly depend on the linac condition.

Left picture : BPM measurement, the red line shows present orbit and the black line shows previous orbit, which means the orbit change is happen so often.

Injection tuning(3) Fiber loss monitor



Fiber loss monitor

Fiber loss monitors were installed for all area of the ATF to detect the beam loss at each location. It is useful tool for the beam tuning.

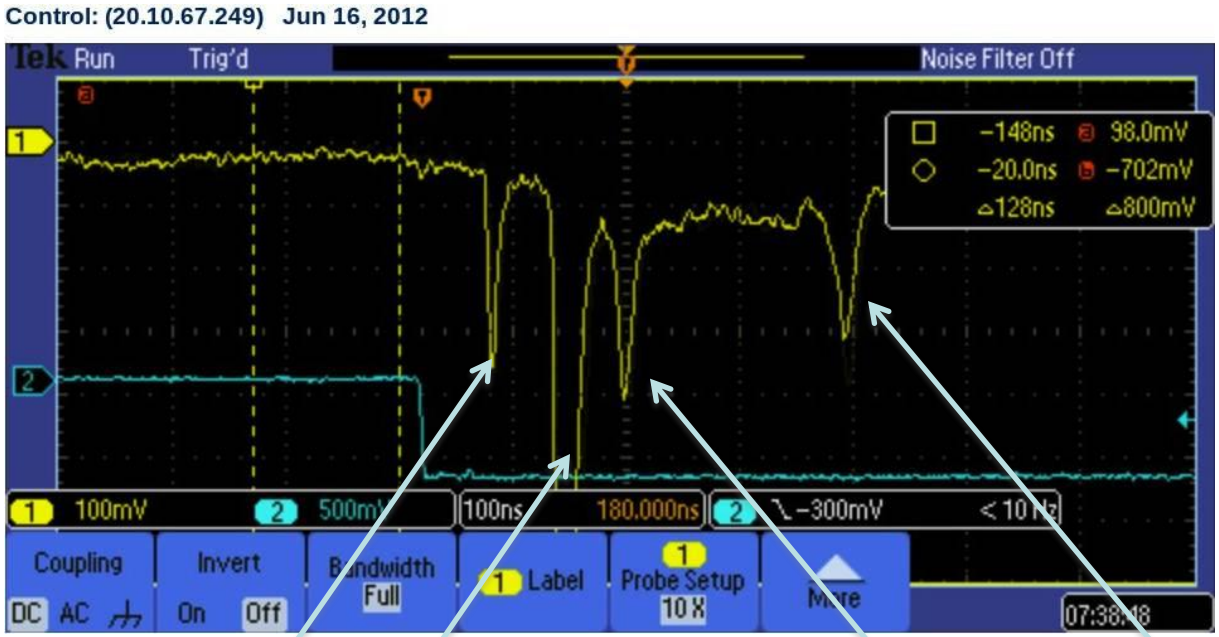
Feature

1)It is easy to find out the beam loss location.

2)High sensitivity

3)Need to check the radiation damage

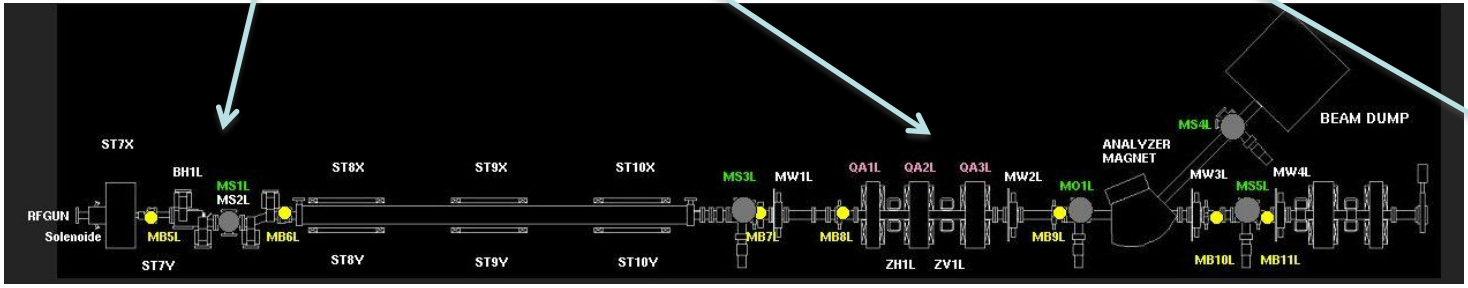
Injection tuning(3) Fiber loss monitor



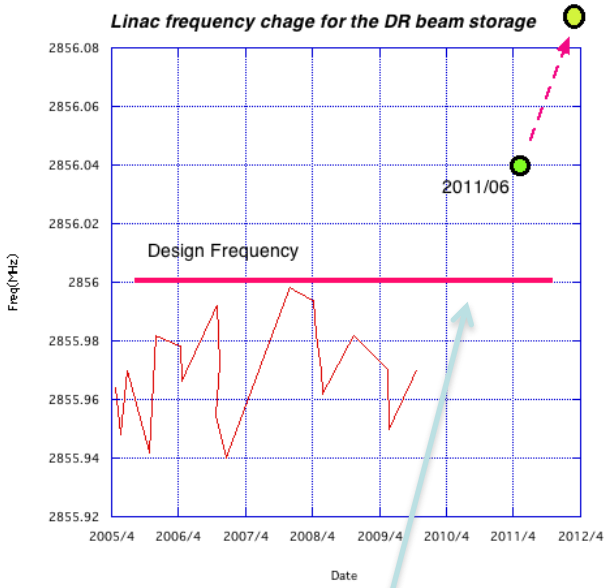
Example of beam loss

The beam loss location can be found for each location. The tuning try to minimize the beam loss.

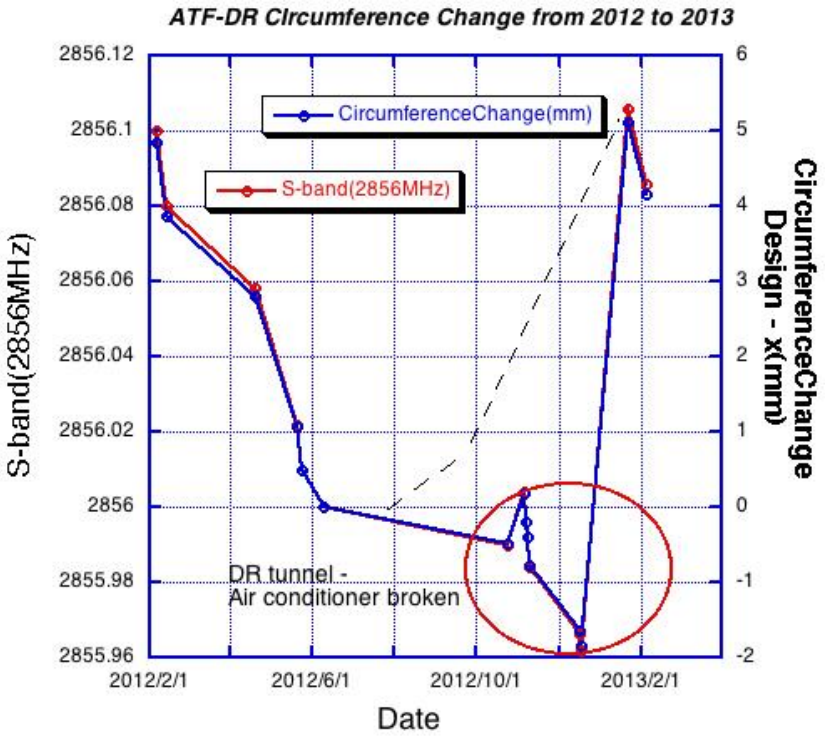
1) Chicane or L0 2) Between MS3L to MS5L 3) L1 input 4) L3 input



Injection tuning(4)

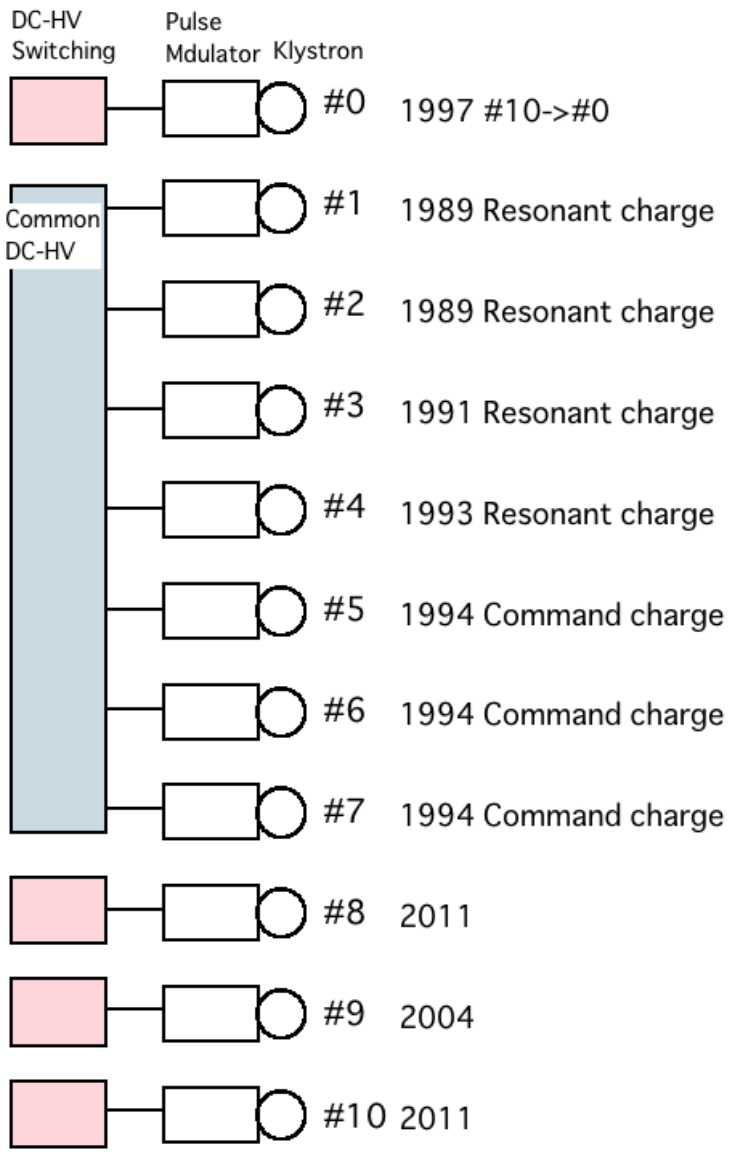


11Mar2011



According to the environment temperature, the circumference of the DR changes. The RF frequency of the DR RF cavity(714MHz) is changed to adjust the center orbit of the DR. The linac frequency is synchronized with the DR RF frequency. Consequently, to adjust the center orbit of the DR, the linac frequency(2856MHz) is often changed. According to the frequency change, the temperature of the cooling water of the SLED has to be changed. The graphs show the history of the changing frequency and the estimated circumference change. The circumference changed after Mar11.

Renewal of the klystron PS(1)

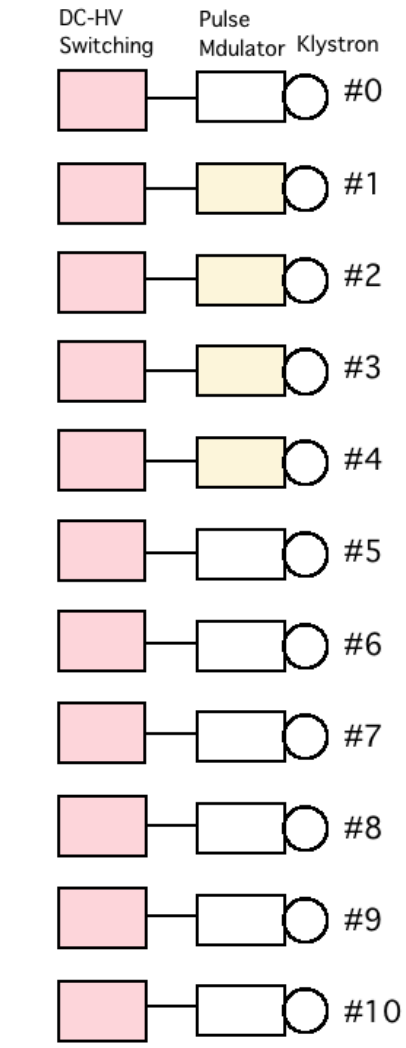


Stabilization of the klystron power supply is key issue for the stable beam.
Each klystron power supply has different history and different hardware.
Especially, the common DC High Voltage power supply(common DC HV PS) is located outside of the building, which made many troubles.
The replacement of the power supplies from the common DC HV PS to the switching HV PS is now in progress.

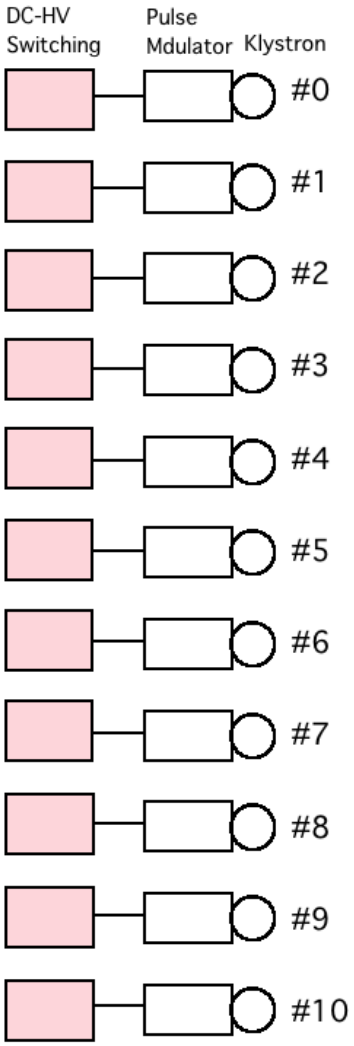
ATF Building *DC HV PS*

Renewal of the klystron PS(2)

Apr/2013
All switching PS

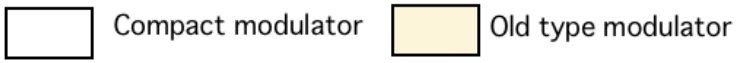


Oct/2013
All compact modulator



Old type modulator

Compact modulator



Renewal of the cooling water system

The linac cooling water system was fabricated in 1990, which supplies the cooling water for the accelerator structures. It is very old and the cooling power reduced year by year. At the every spring run, especially high temperature day time, the system was often down for the over heating.

The low repetition rate operation of the linac is effective to avoid the system down.

The replacement to a new cooling water system is scheduled in this summer shutdown.

Summary

The effort of the injection tuning was improved by using many monitors, especially, the fiber loss monitor is effective(thanks to D. McCormick SLAC), which is used not only linac and BT, but ATF2 beam line. The tuning time was reduced from 1 shift to half shift to store the ordinary current.

The hardware renewal is scheduled to improve the stability.

1.Common HV-PS is replaced to switching PS. (2013/04)

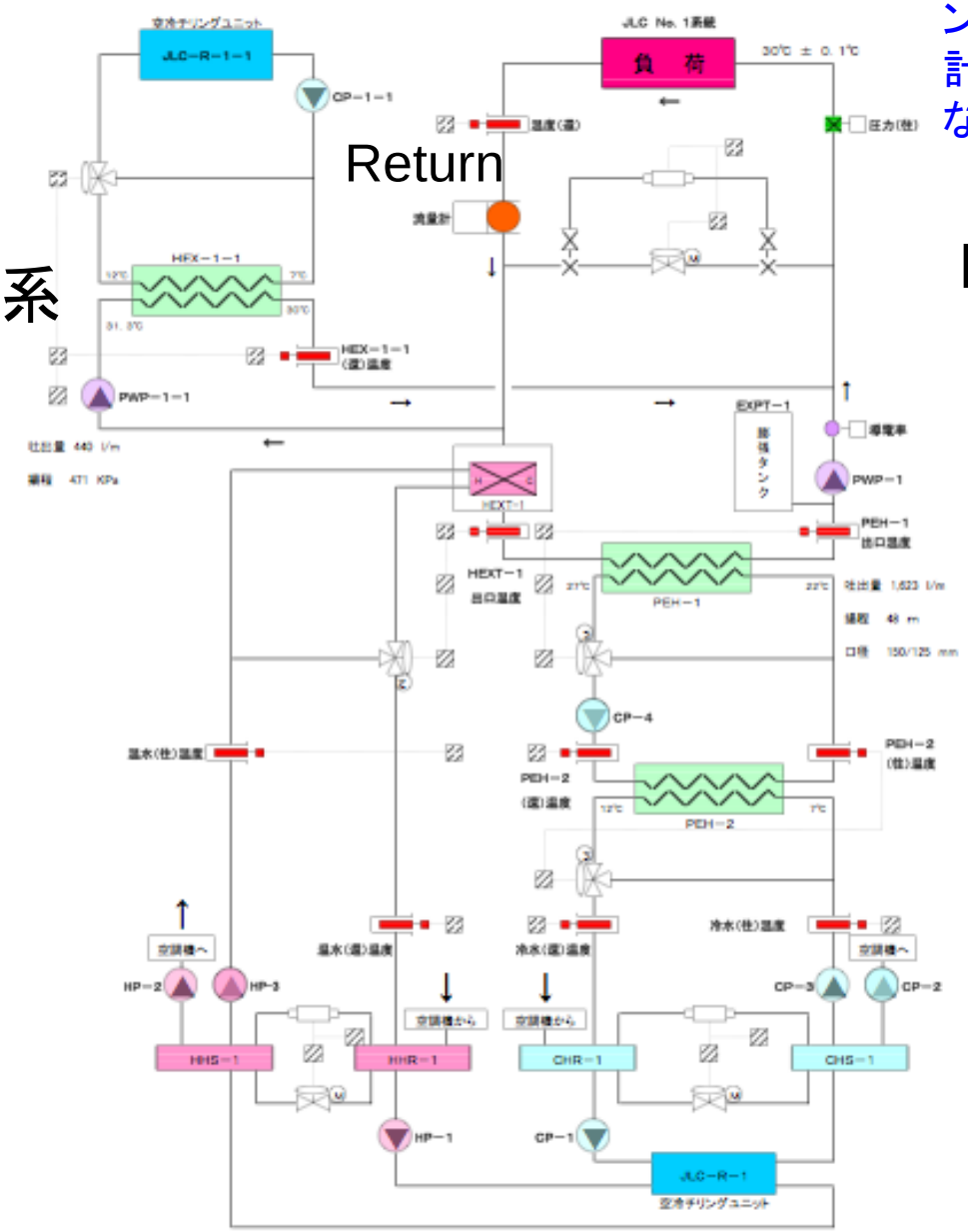
2.Pulse modulator is replaced to compact type. (2013/summer)

3.Cooling water system of the linac is replaced to new one. (2013/summer)

Backup

ライナック冷却水システム

JLC-PWP-1系統 （No.1系統）



Return

Sub
(4)30℃系

Main

(3)30℃系

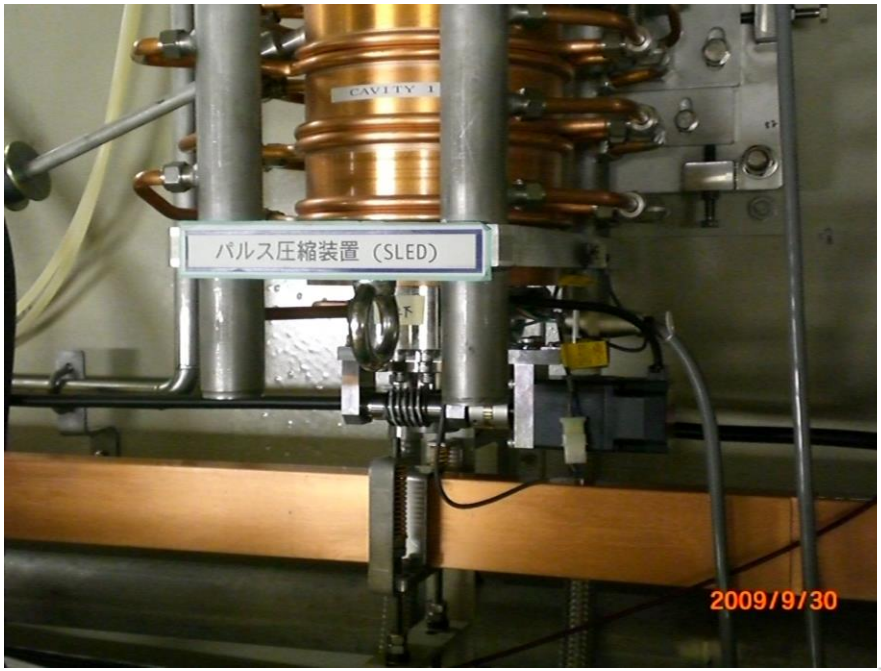
(2)22℃系

(1)7℃系

冷却水システムは、1600L/minのメインに400L/minのサブを足すという設計で安定性から見るといい設計ではない。

SLED

The Q-value,10^5, is very high, so the tuning frequency is very sensitive with the temperature.



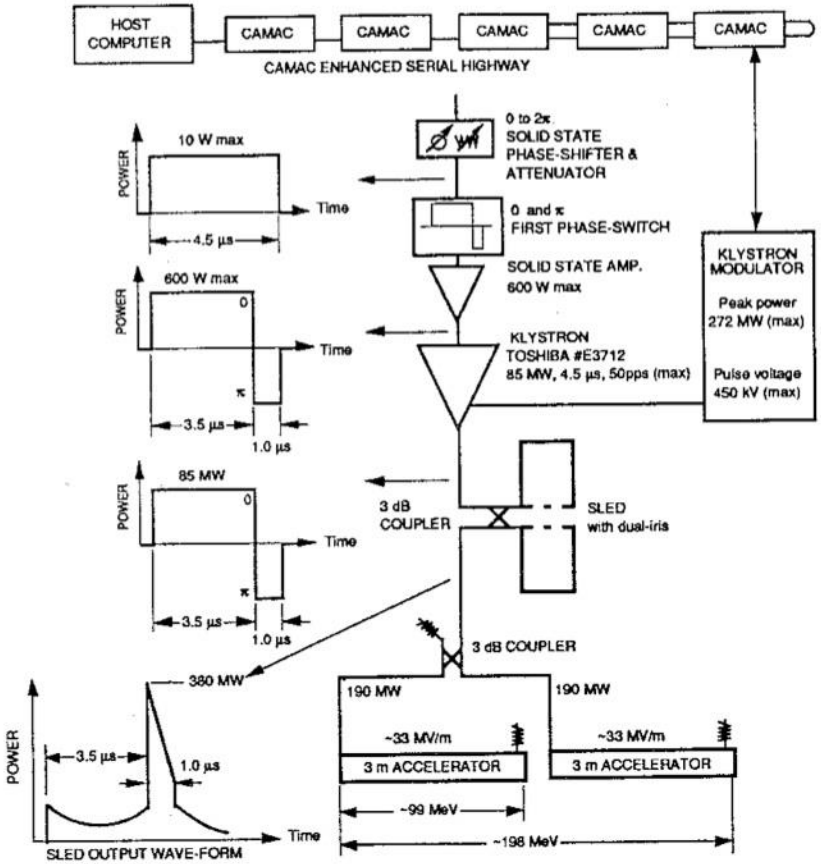


Fig. 1 A schematic diagram of an accelerating unit of the ATF injector linac.

#8 SLED tuning(20091008)

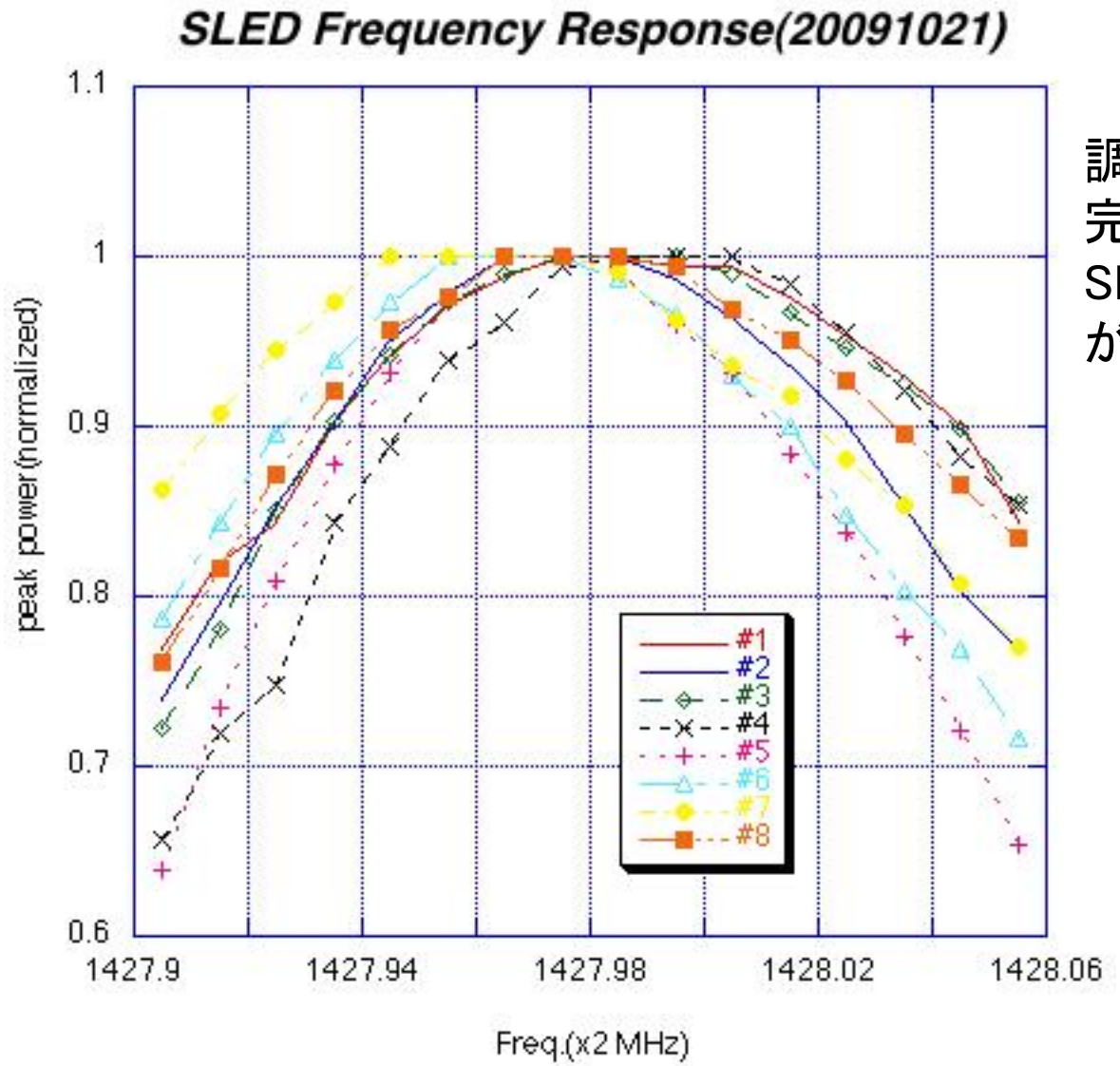
SLED 波形

Tuning 前

片側のみtuning

De-tunerを入れる。

Tuning 後



調整後、
完全にではないが8台全てのSLEDに対して周波数の調整が出来た。