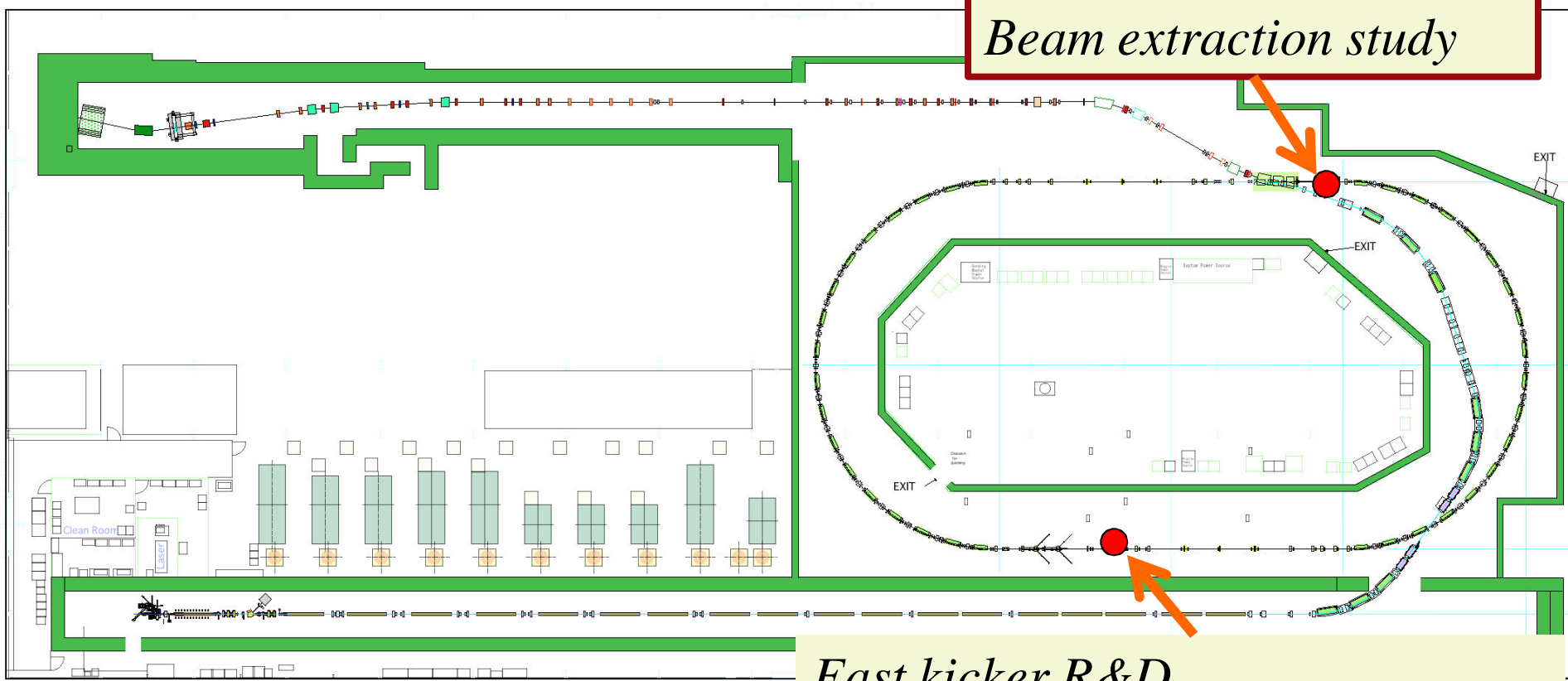


**PRELIMINARY RESULTS OF FAST KICKER STUDY  
AT KEK-ATF IN MAR/2010\***

T. Naito<sup>#</sup>, S. Araki, H. Hayano, K. Kubo, S. Kuroda, N. Terunuma, T. Okugi, J. Urakawa,  
KEK, Tsukuba, Japan

*N. Terunuma (KEK)  
ILC2010, Beijing, March 29<sup>th</sup>, 2010*

*Fast kicker R&D  
Beam extraction study*



*Fast kicker R&D  
Initial test of Pulser performance*

2010/3/27

# *Fast kicker Experiments JFY2009*

- Dedicated beam time

- swap the kicker in DR (pulse magnet <--> fast kicker)
- lack of the knowledge of ATF2 beam tuning under the fast kicker

- 2009. Jan. (1 week)

Two pulsers were broken by the **radiation damage** during only a few hours.

- 2009. June (1 week)

The beam did not come out to the extraction line for lack of the kick angle.  
**Kicker electrode deformation.**

- 2009. Oct. (2 week)

**The first beam extraction by the Fast Kicker.**

The beam extraction have succeeded up to 17 bunches.

- 2010. Mar. (2 week)

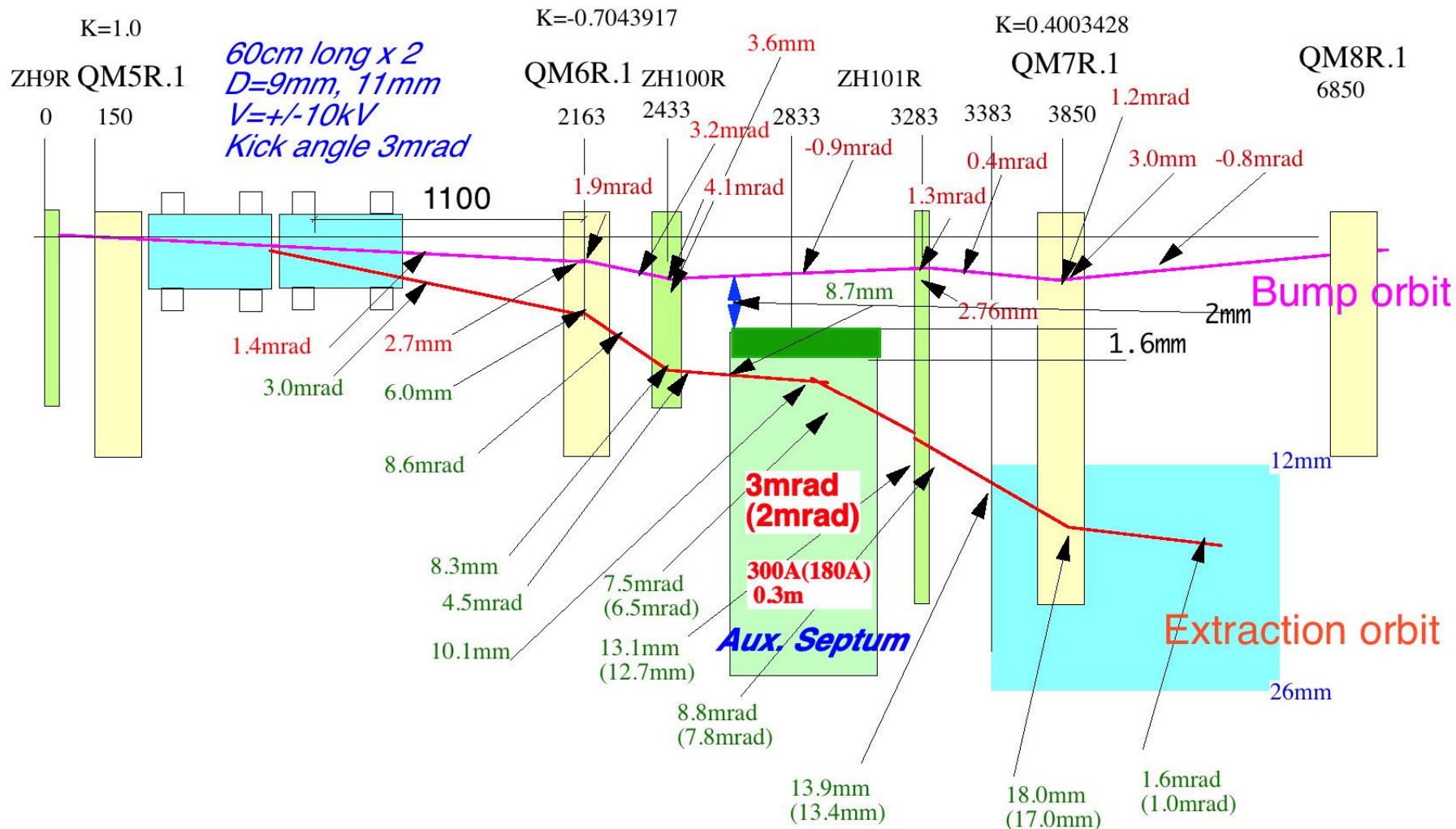
**Stability measurements**

**The beam extraction have succeeded up to 27 bunches.**

# Beam Extraction Orbit using Strip-line Kicker, Aux. septum & Pulse bump



3mrad kick angle





# Timing chart of 30 bunches beam extraction

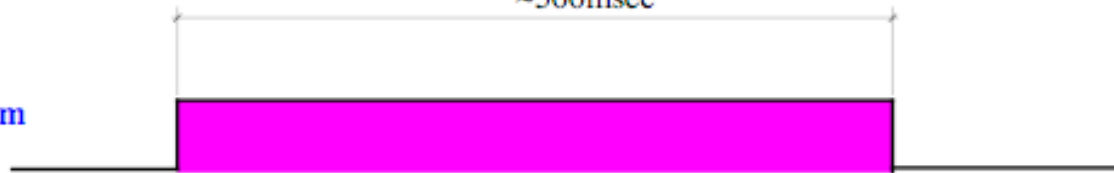
The bump orbit is gradually changed after all of the bunches have been damped. The strip-line kicker kicks out the beams at the timing of the flat-top of the bump orbit. The beams are extracted as one long bunch train, which is 10micro-sec long with 154ns (or 308 ns) bunch spacing.

Injection beam  
1st Train    2nd Train    3rd Train

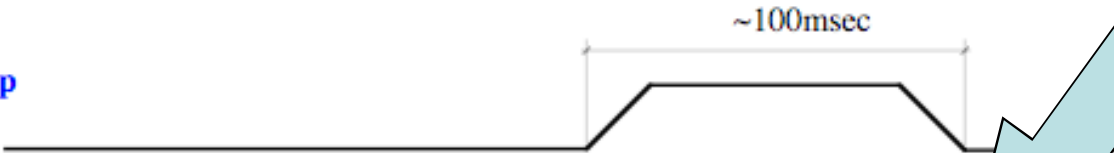


~500msec

Stored beam

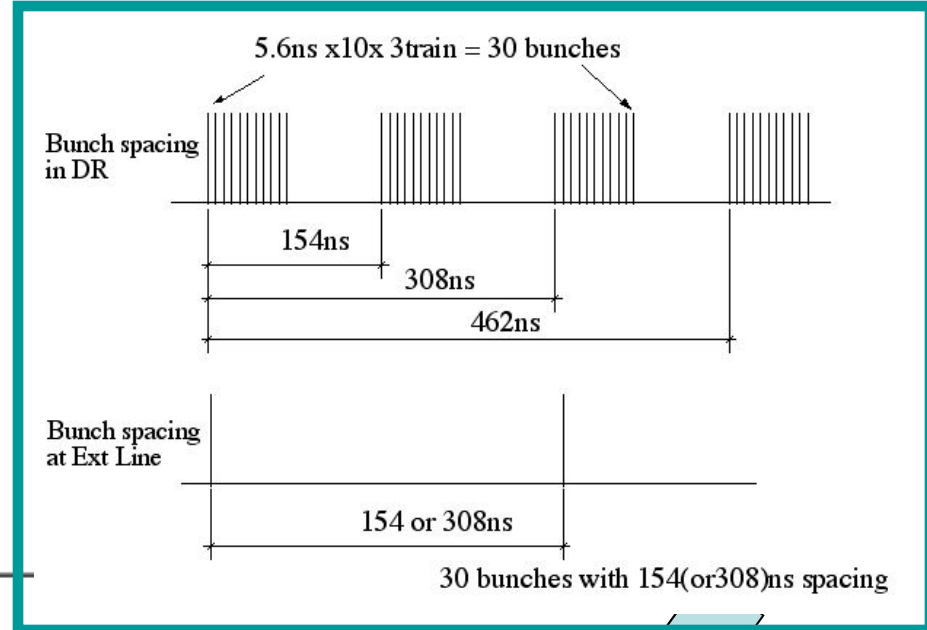


Local bump height



~100msec

Extracted beam



$5.6\text{ns} \times 10 \times 3\text{train} = 30 \text{ bunches}$

Bunch spacing in DR

154ns

308ns

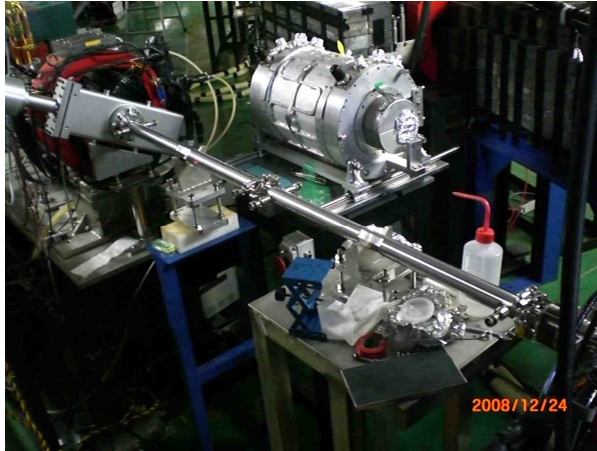
462ns

Bunch spacing at Ext Line

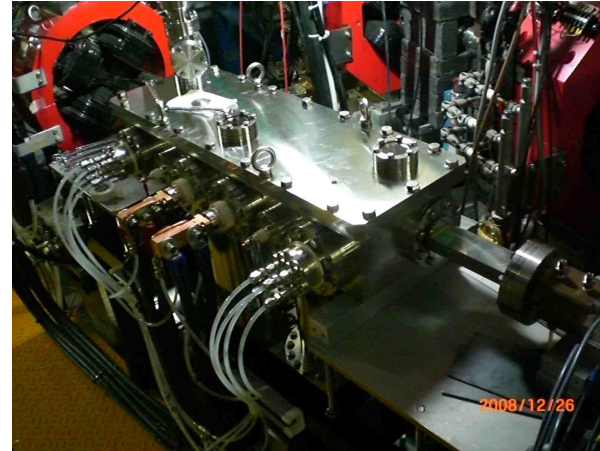
154 or 308ns

30 bunches with 154(or308)ns spacing

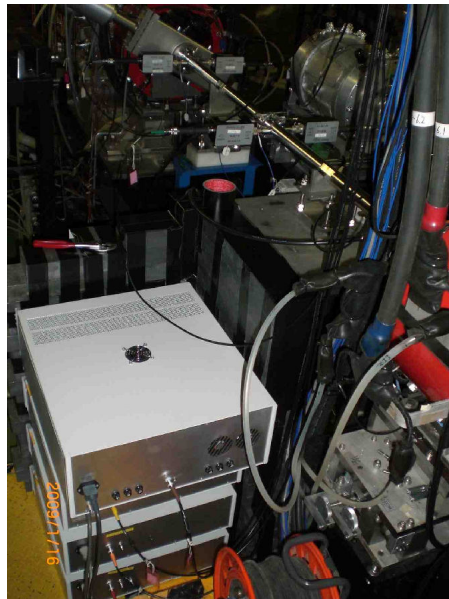
# Pictures of the installed components(2009Jan)



*Strip-line electrodes*



*Aux. Septum*



2010/3/27 *FDI pulsers*

The radiation level at the location was  
>10msv/h(gamma) and  
100u sv/h(neutron).



*Bump PS and Septum PS*

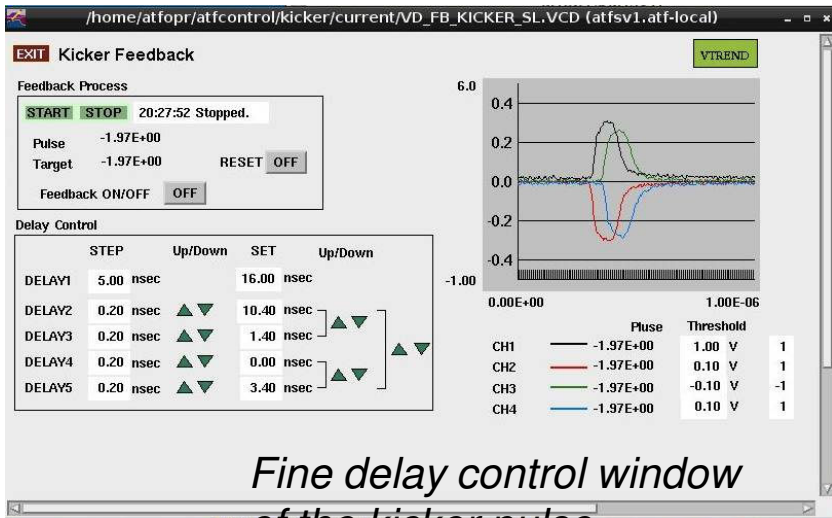
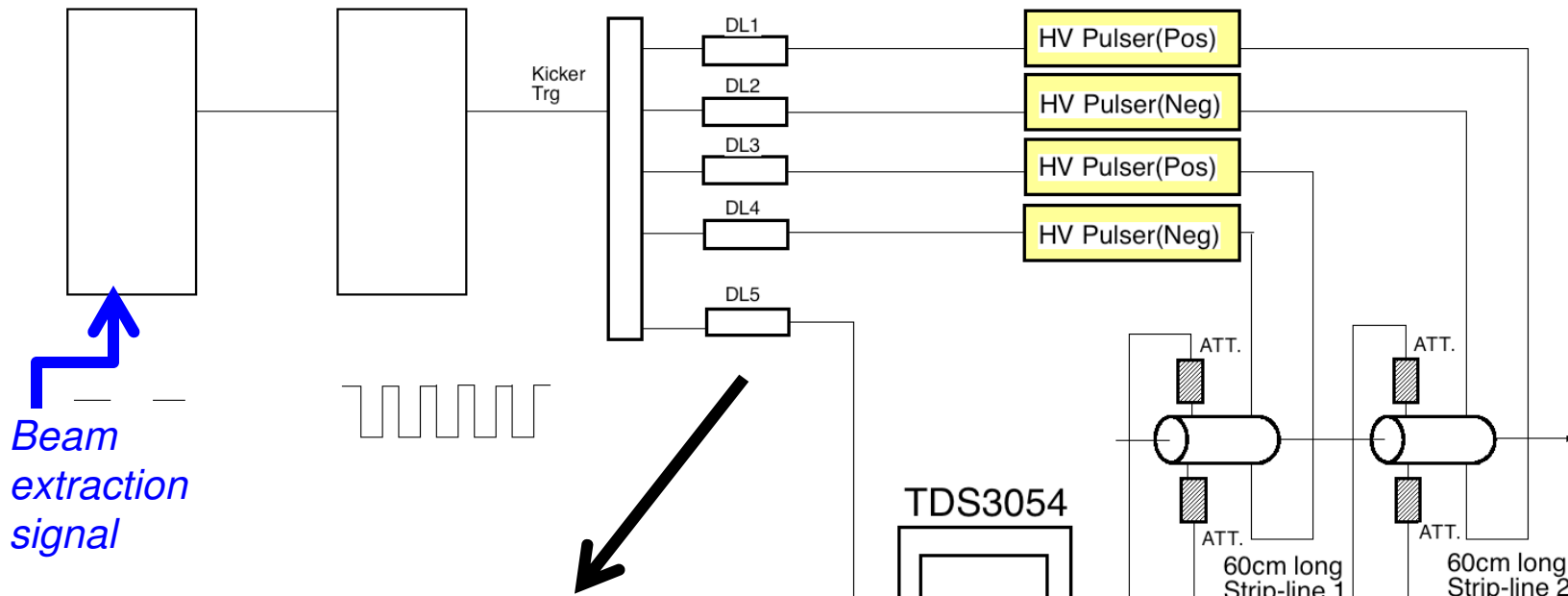
# Trigger system for fast kicker

Programmable Delay counter TD-4

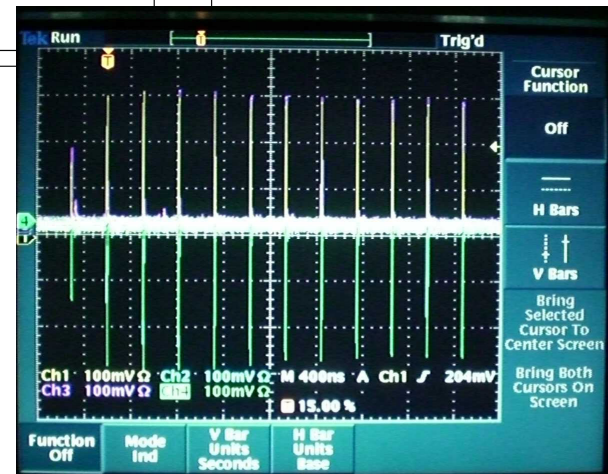
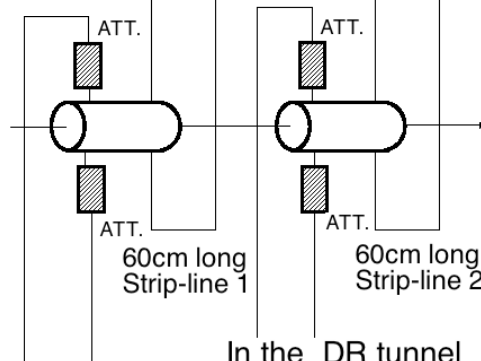
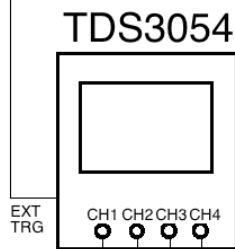
Pulse train generator

fine delays  
30ps step  
32ns max

FID pulsers



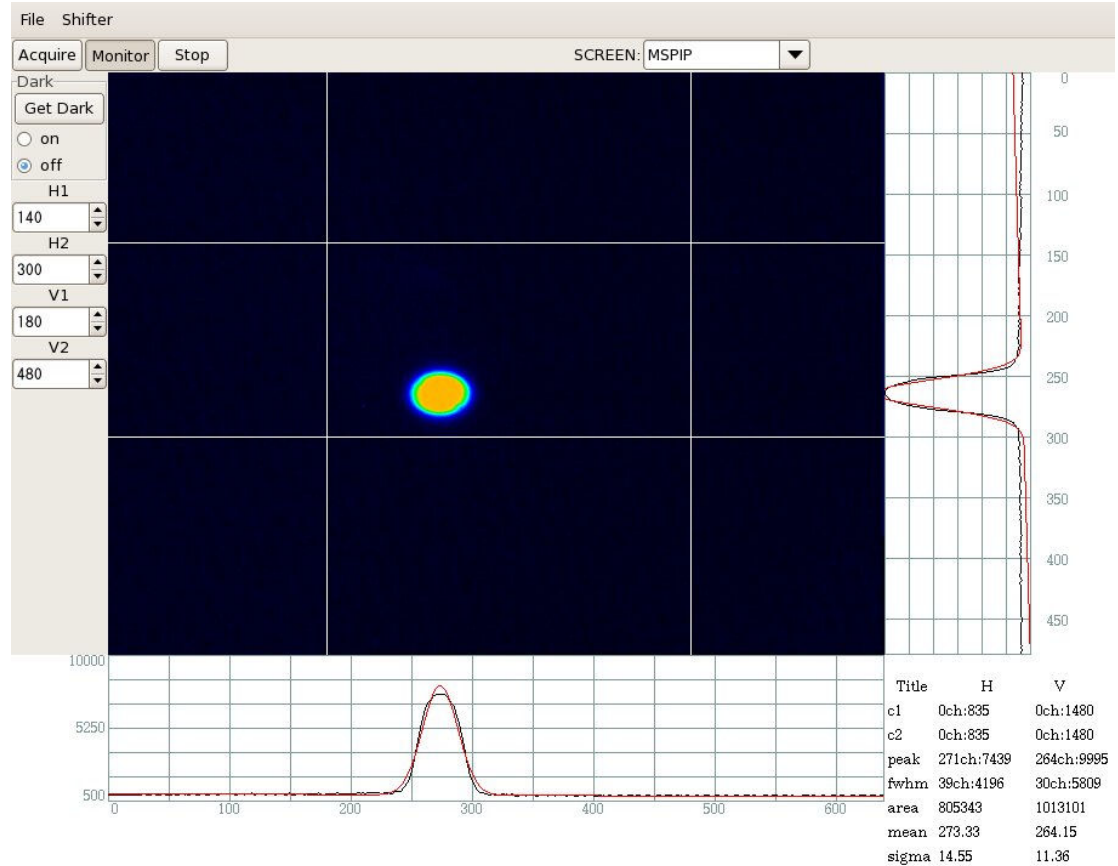
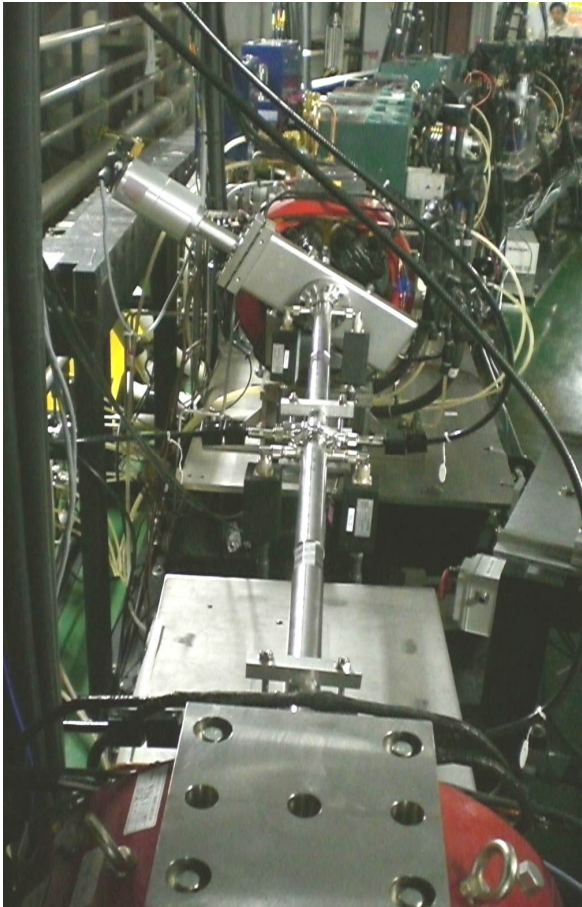
*Fine delay control window of the kicker pulse*



# Single bunch extraction

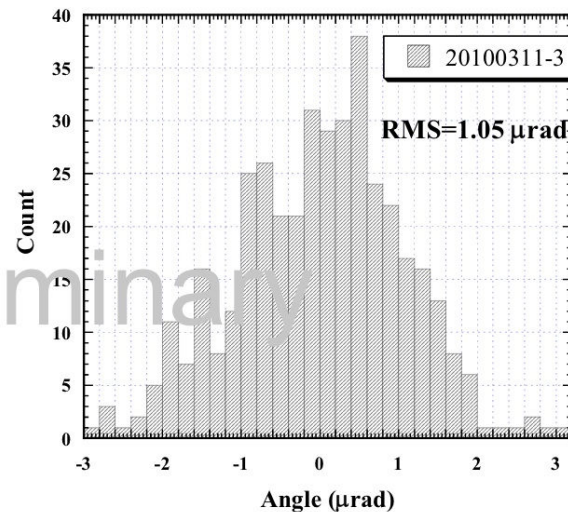
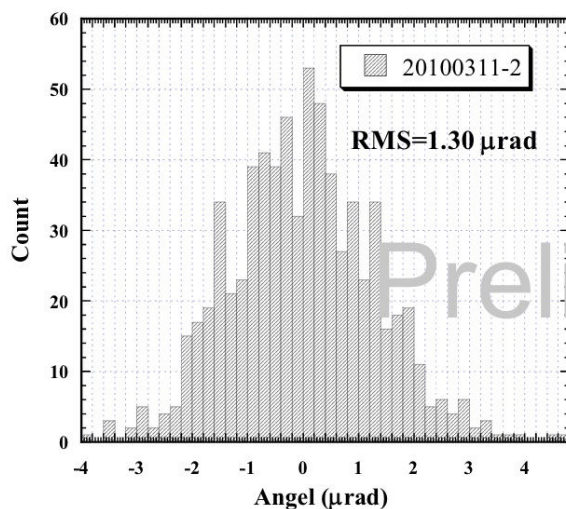


# Beam Extraction succeeded from DR to ATF2 2009.Oct. 22.



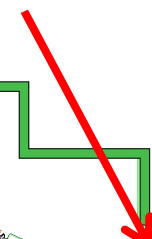
*Beam profile at MS1X screen monitor,  
which is located at the downstream of  
the septum magnets.*

# Kick angle jitter measurement



Preliminary

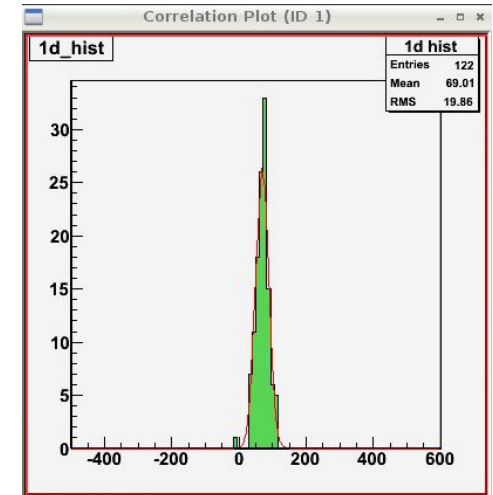
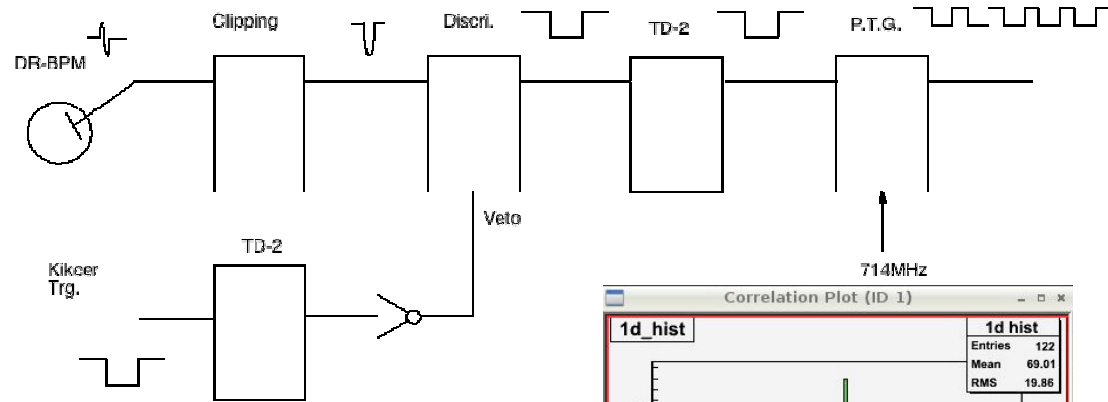
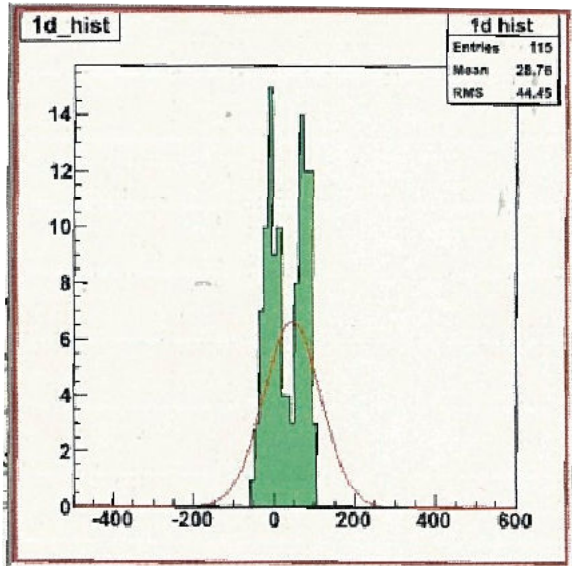
*Fast Kicker*



*ATF2 Cavity BPMs*

The kick angle jitter was estimated from the BPM measurement of the ATF2 beamline. The fit from the measured positions and the R12 of each location shows the angle distribution of the kicker. Figure shows the result of two set of the data. Each data used 700 shots and 400 shot, respectively. The measured angle jitters were 1.3micro-rad and 1.05micro-rad, respectively (preliminary). **The angle jitters of the kicker were  $4.3 \times 10^{-4}$  and  $3.5 \times 10^{-4}$ , respectively.**

# Timing system improvements for the Fast Kicker: re-synchronization for the beam timing



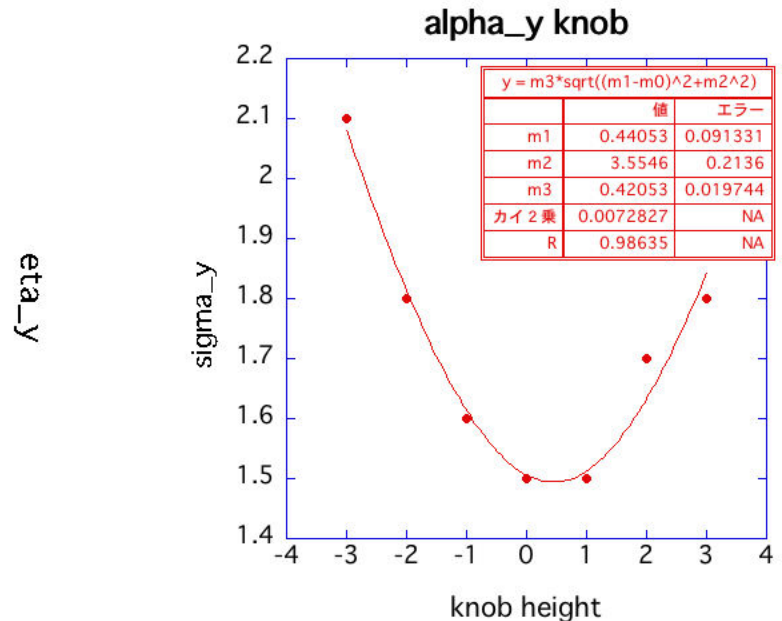
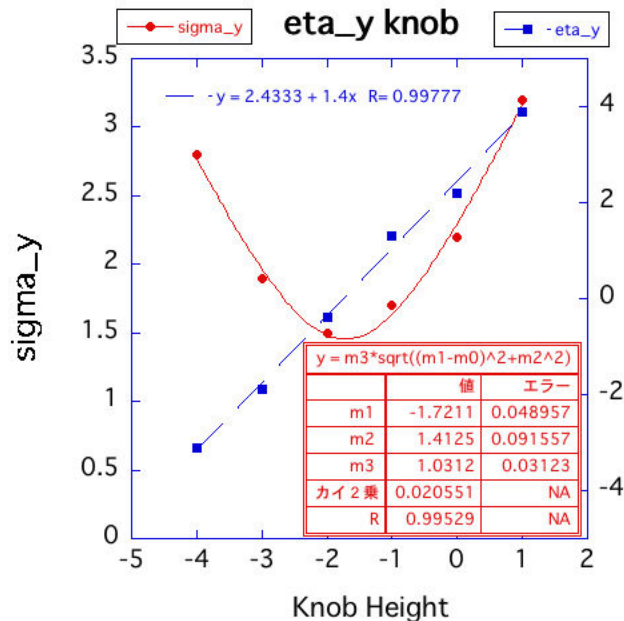
*Bi-stable beam position under the DR-RF frequency ramp for the dispersion measurement was found.*

*It was caused by the clock differences in the trigger system.*

*Fast kicker used 357 and 178.5 MHz.*

*Re-synchronization by a DR beam signal fixed the miscounting of the timing system for the extraction kicker.*

# Beam size measurement under the Fast Kicker operation



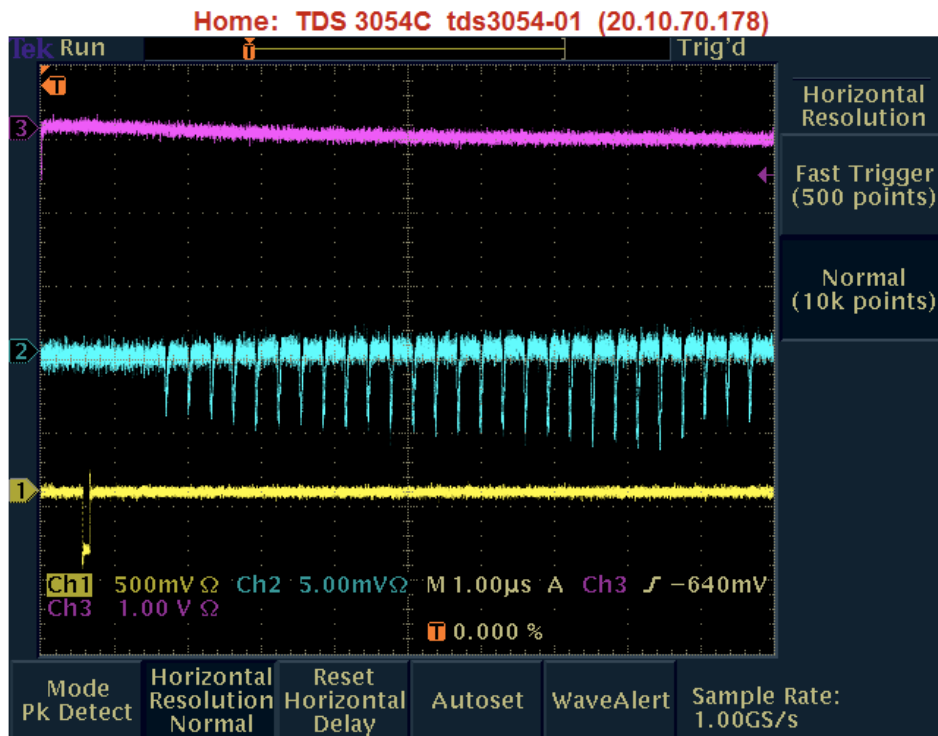
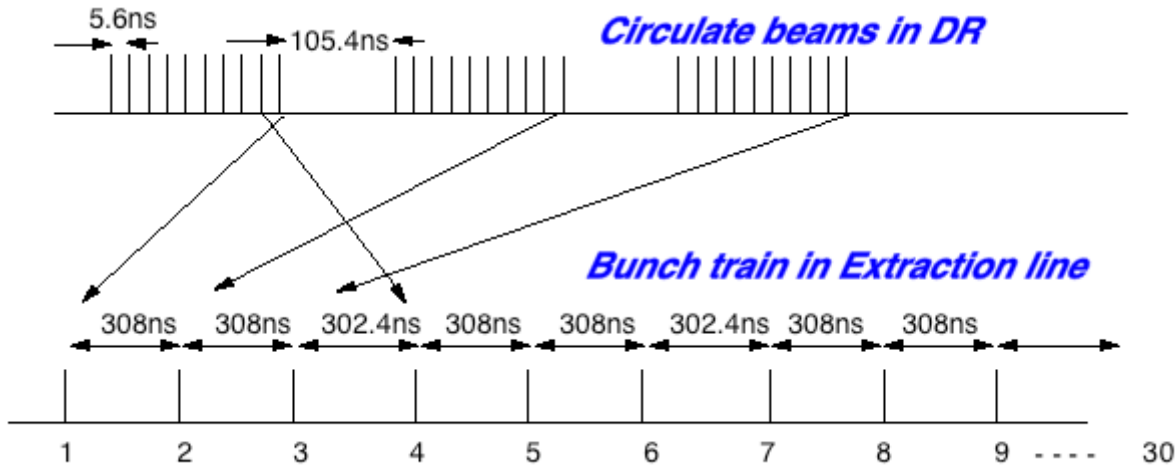
*We could minimize the beam size to 1.5um at MW1IP (post-IP Carbon WS) by KEK multi-knob. It reached the measurement limit of this WS.*

**2010 / 3 / 19 Owl Shift**

**T. Okugi (KEK)**

# Multi-bunch extraction

# Multi-bunch beam extraction by the Fast kicker



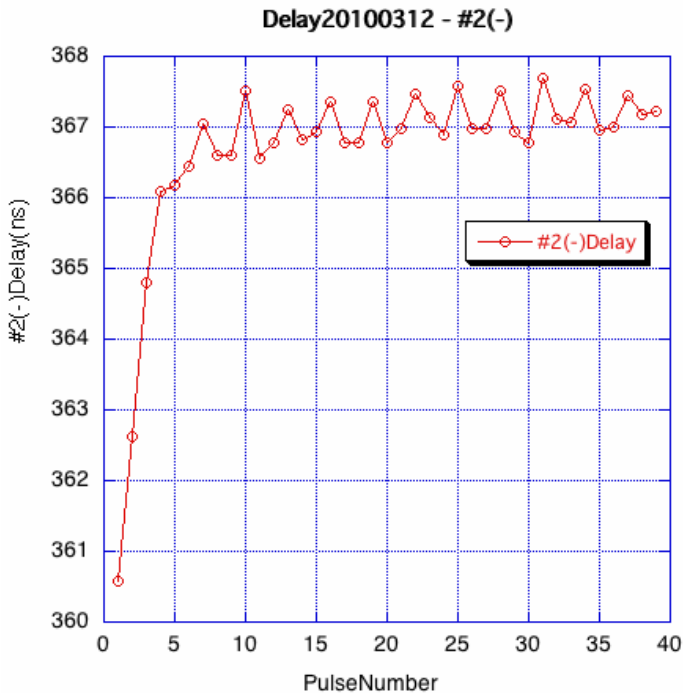
in DR:

- 3 Trains,
- 9(max 10) bunches/train with 5.6 nsec spacing

Extracted:

- 27(max 30) bunches with 308 ns spacing
- bunch-by-bunch profile follows that in the DR.
- bunches were extracted from the last bunch to the first bunch.

# To the next step



The kick angle and the angle jitter were different for each pulse of the pulser. Figure 9 shows the time delay from input to output for the number of the pulse of the FID pulser. The delay is different for each pulse, which means all pulses can't adjust to the optimum timing. The characteristics are different for each pulser. We should solve this problem.

To measure the beam characteristics of the extracted beam of the multi-bunch, we need to develop following items,

- multi-bunch monitor system at the extraction line,
- stable laser system to generate 5.6ns spacing multi-bunch,
- stable multi-bunch storage in the DR,
- etc.

# Summary

- *Significant progress was done in March 2010.*
- *Four 10kV/3Mhz pulsers were used with a bump orbit for the ATF beam extraction.*
- *Kick angle was stable as  $4 \times 10^{-4} < \text{ILC requirement}$ .*
- *Multi-bunch extraction was demonstrated with 308 nsec spacing.*
- *We had about a week continuous operation with no significant failures.*
- *Further improvements of the HV pulser should be done for multi-bunch extraction.*