

Fast kicker study



Machine Time

2011/10/18~10/29(2 weeks)

TB meeting

2011/01/14 T.Naito



ILC kicker

Bunch spacing

154(308)ns



Injector



154(308)ns

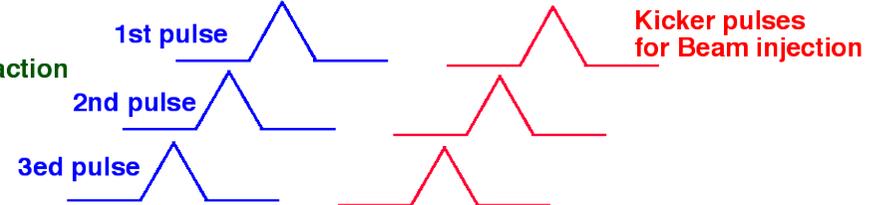
3.08(6.15)ns



To main linac

C = 6km
Frev. = 50kHz
(20micro-sec)

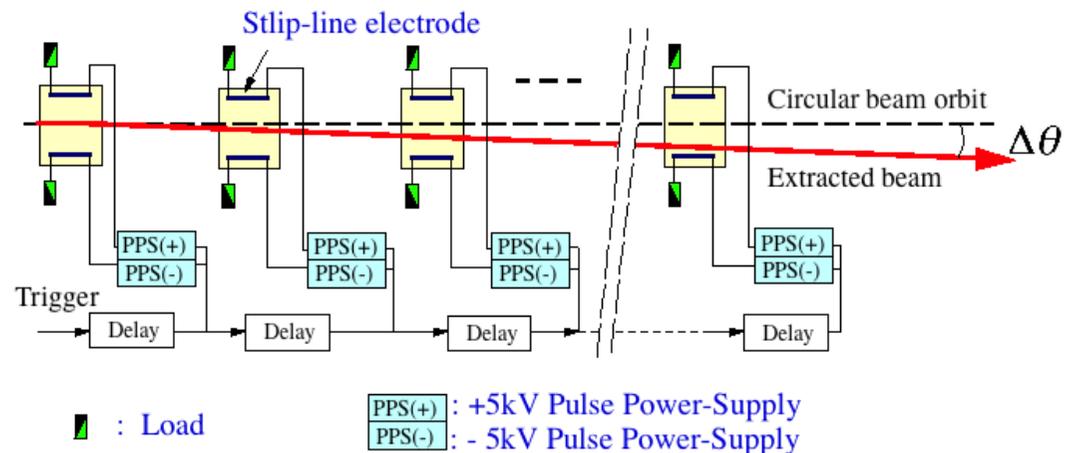
Kicker pulses
for Beam extraction



| | |
|------------------------------------|---------------------|
| Kick angle | 0.6 mrad |
| b_x at kicker | 50 m |
| Repetition rate of the burst | 6 - 2MHz |
| Number of macro-pulse | 1320/2625/5120 |
| Repetition rate of the macro-pulse | 5 Hz |
| Rise and fall time | < 3 - 9 ns |
| Peak kick stability | 0.07 % |
| Residual kick | < 0.42 μ radian |

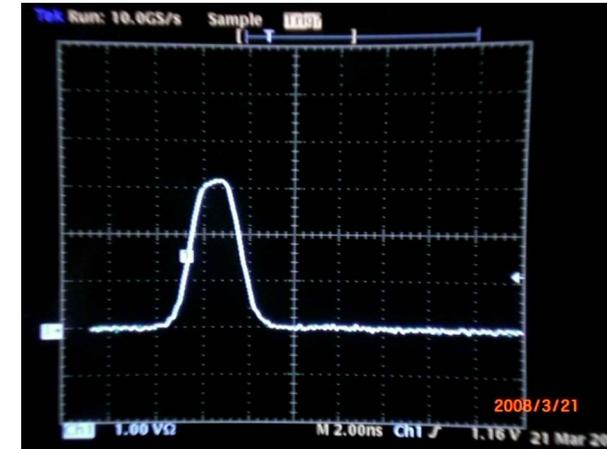
ILC kicker parameters

Multi-units of strip-line kicker



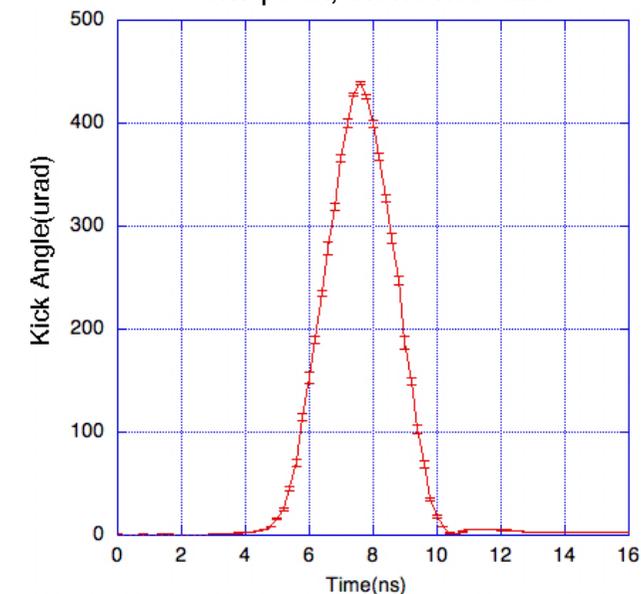
Single unit test(30cm long strip-line)

(To confirm 3ns of the rise time of the strip-line kicker)



Waveform of FID puls
5kv peak, 1.5ns rise time

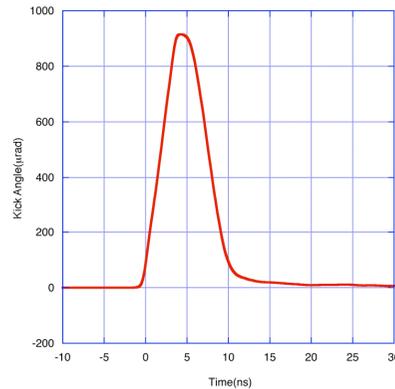
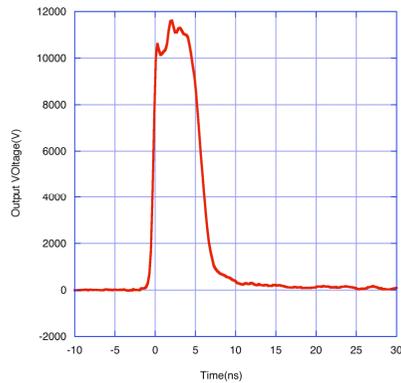
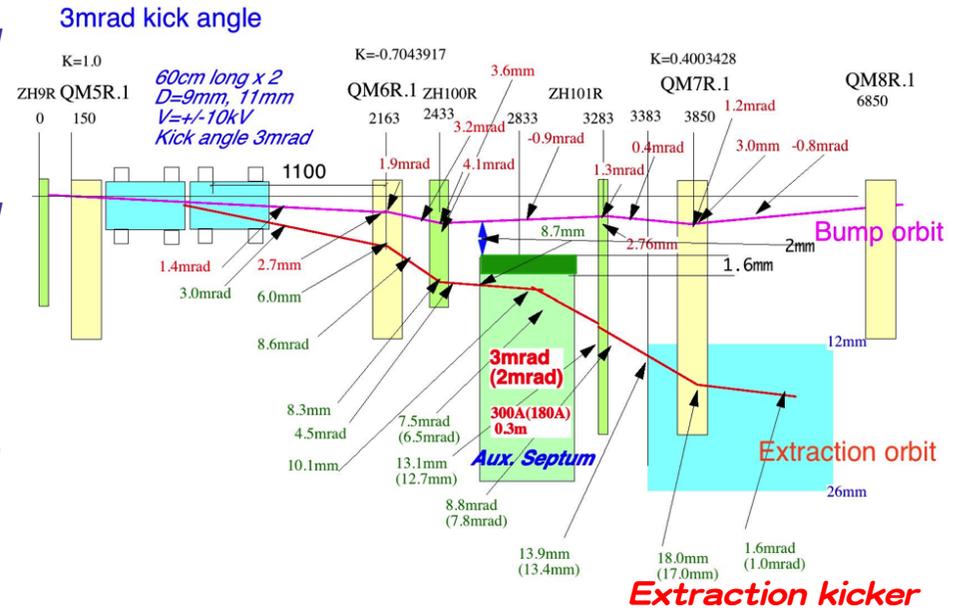
- *Time response measurement using 30cm long strip-line electrode.*
- *The drive pulser(FID Co. Ltd) have 1.5ns rise time, 5kV peak voltage, 3MHz and 3000 burst pulse.*
- *The measured rise time was 3ns, which meets the ILC requirement.*



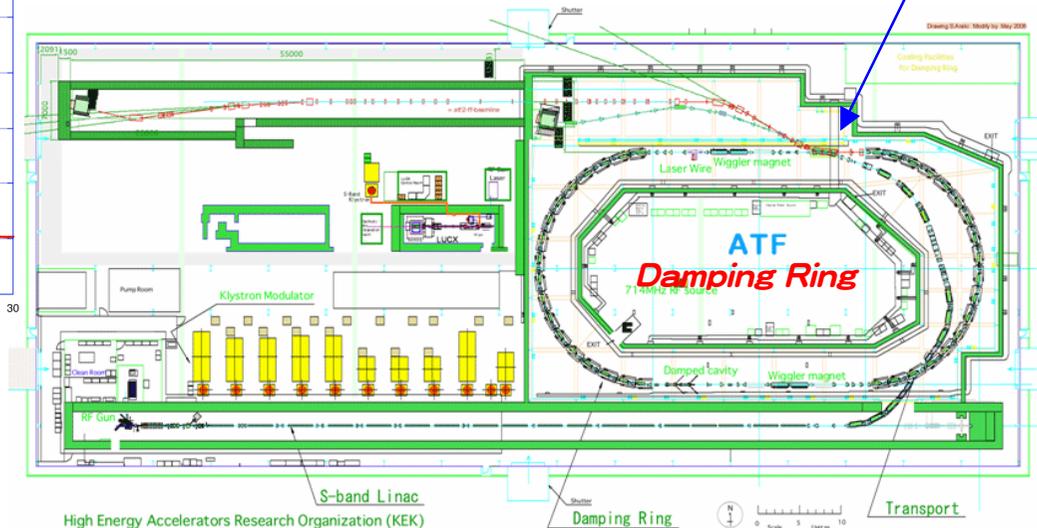


Beam extraction test(1)

- The beam extraction test was carried out to confirm the performance of the strip-line kicker.
- The pulsed magnet kicker was replaced to two units of 60cm long strip-line kicker.
- To help the lack of the kick angle, a local bump orbit and an auxiliary septum is used.



ATF2 Extraction line

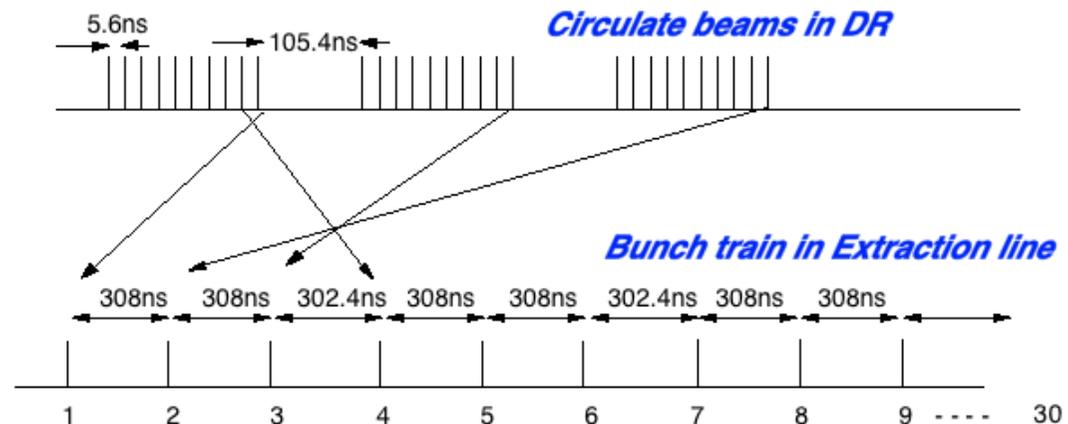
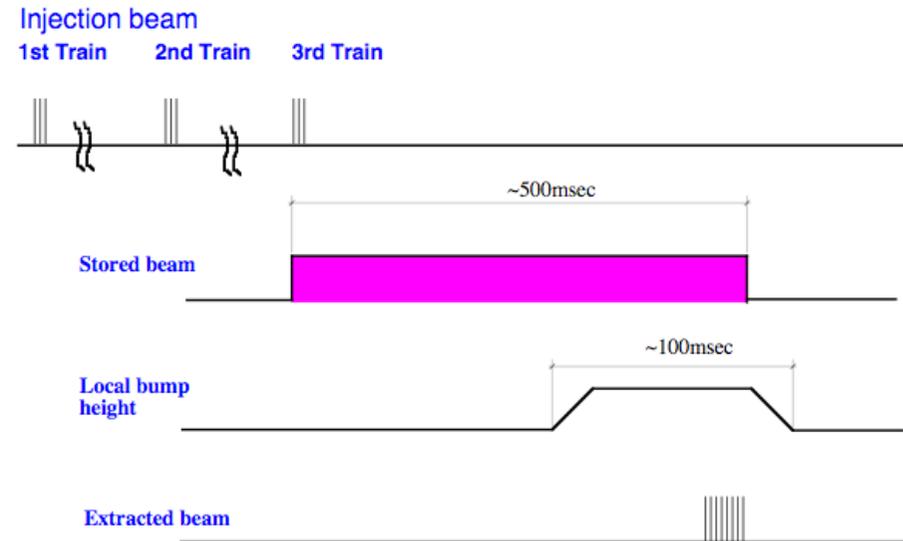




Beam extraction test(2)

The time sequence is that ,

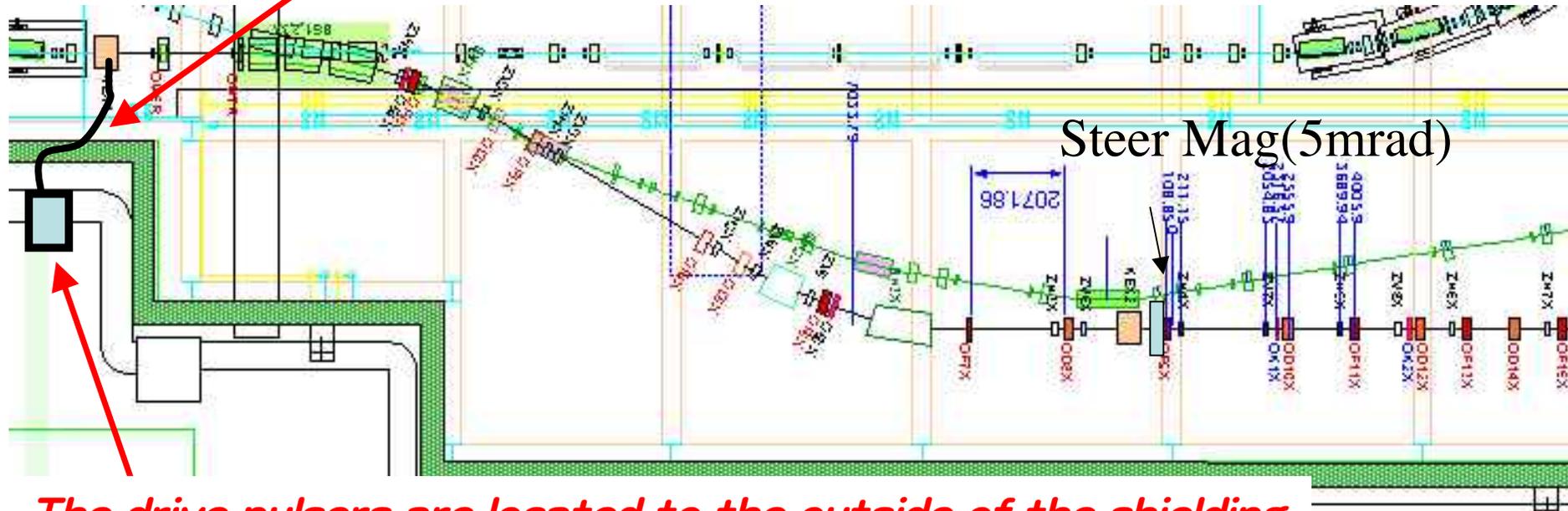
1. 10 bunches with 5.6ns bunch spacing beam is injected to the DR three times, 30 bunches total.
2. The local bump orbit is excited gradually after all of beam is damped.
3. The beam is kicked out bunch-by-bunch by the strip-line kicker.
4. The local bump orbit is return to zero.



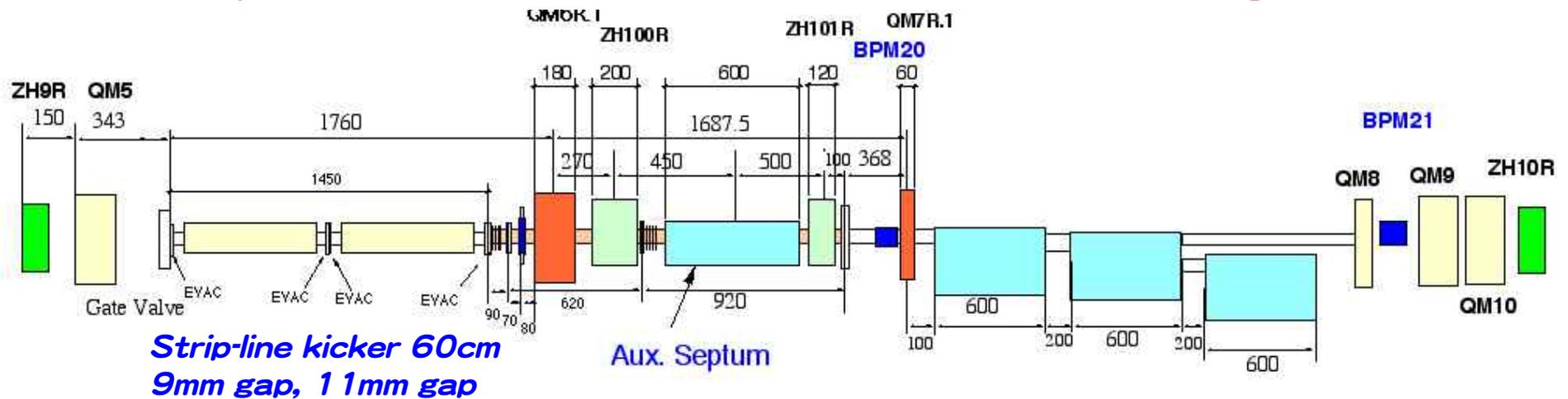
Kicker and PS location



6m cables



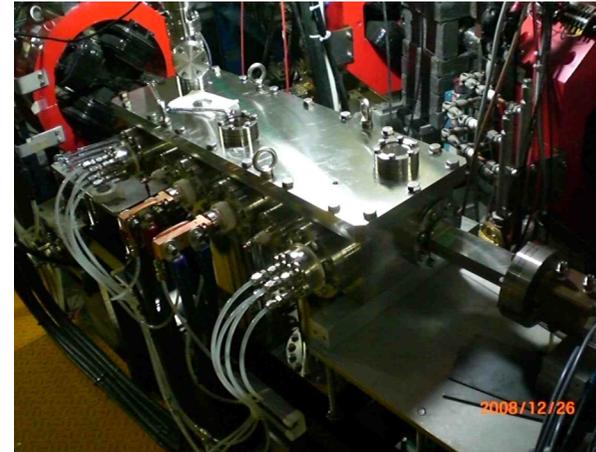
The drive pulsers are located to the outside of the shielding.



Pictures of the installed components



Strip-line electrodes



Aux. Septum



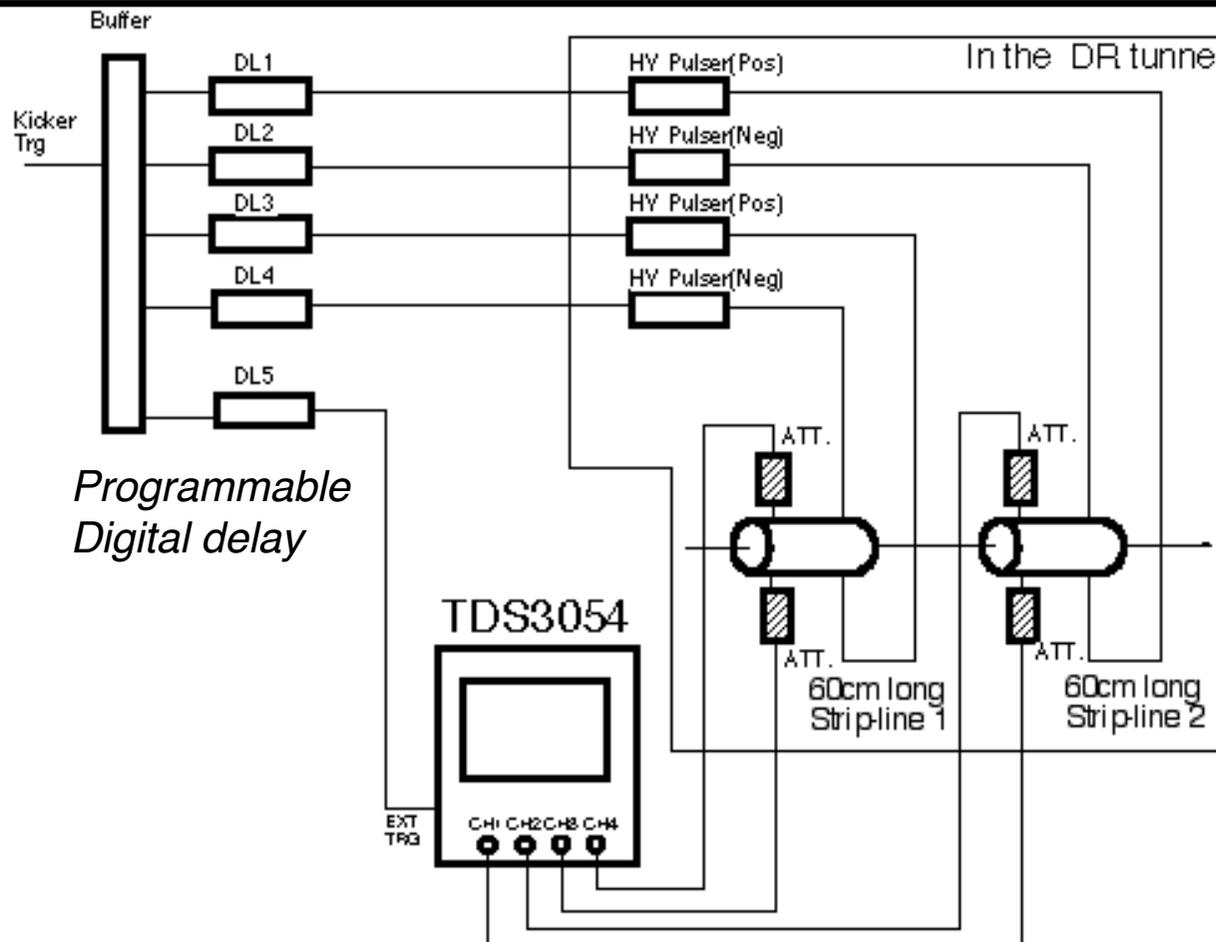
FDI pulsers



Bump PS and Septum PS

Trigger timing FB for Strip-line kicker

20080115 T. Naito



Precise triggers for each pulser and the timing control is required. The pulse measurement by the scope and the timing control by digital delays consist the trigger timing feedback. The step of the digital delay is 60ps. The trigger system could keep the pulse timing in the range of 200ps.

Improvements for multi-bunch extraction



- ***Stable beam storage to the DR***

Previous experiment could not realize stable beam extraction, which come from unstable beam storage to the DR

|

Stable 5.6ns laser system for RF gun and other effort could cure the beam blow up at the inection.

- ***Timing adjustment circuit is newly installed***

We already understood FID pulser has timing shift at the burst mode, when changing the interval.

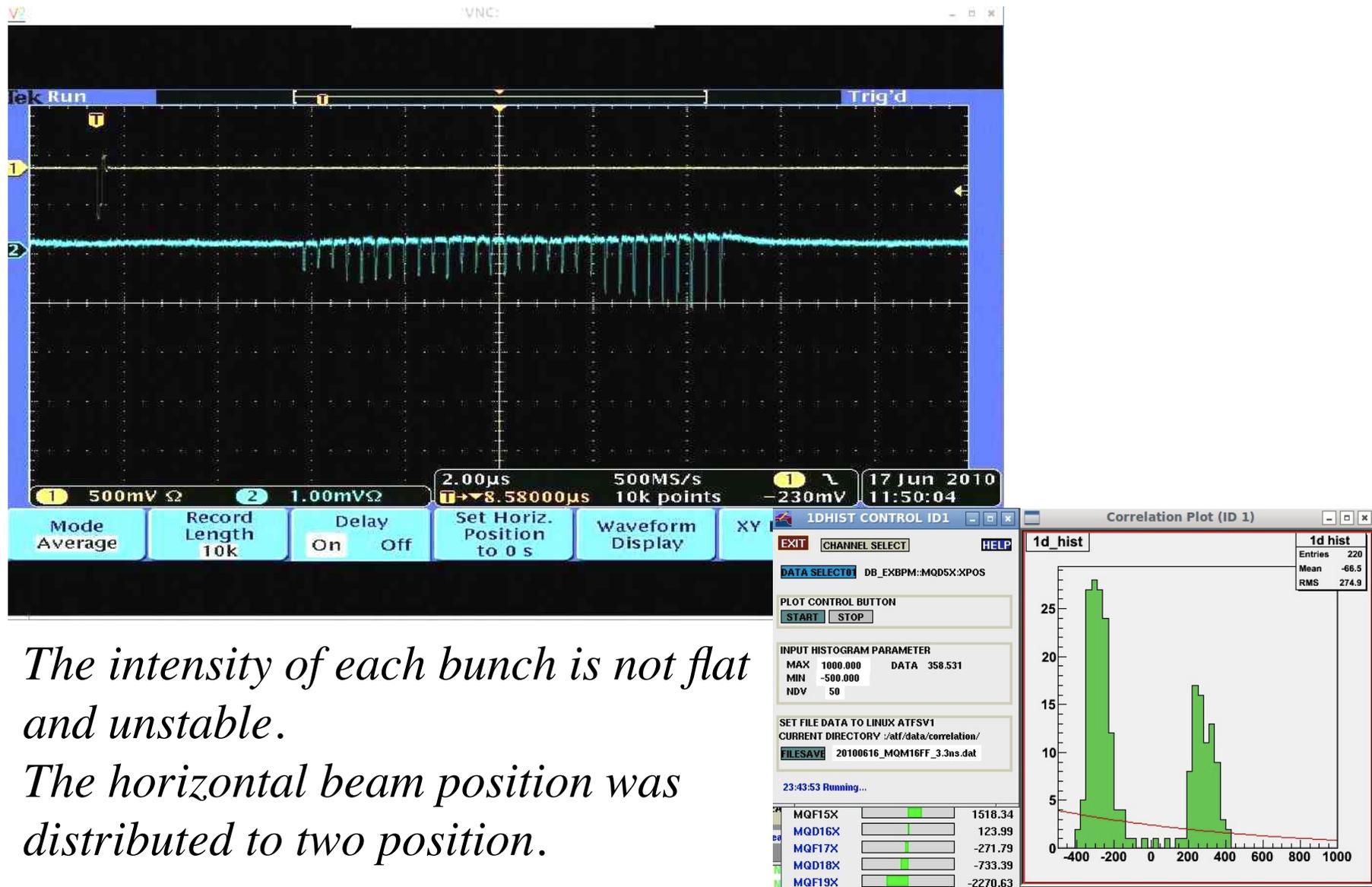
|

Timing adjustment circuit is used to make stable stable kicker pulse timing.



Multi-bunch extraction (30 bunches) with 308ns bunch spacing

2010/06/17

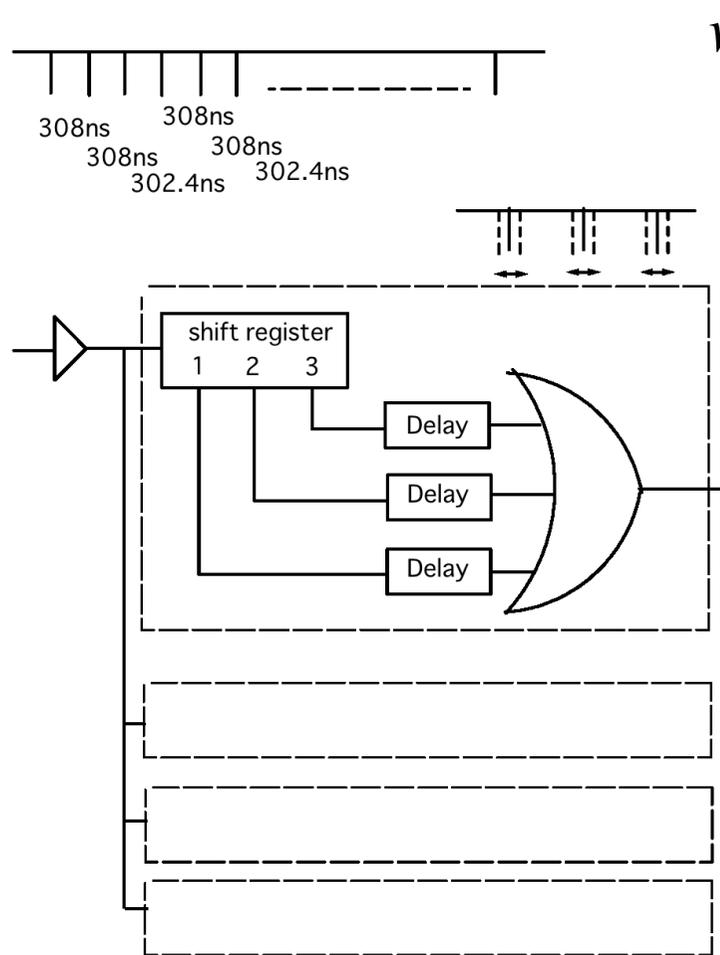


The intensity of each bunch is not flat and unstable.

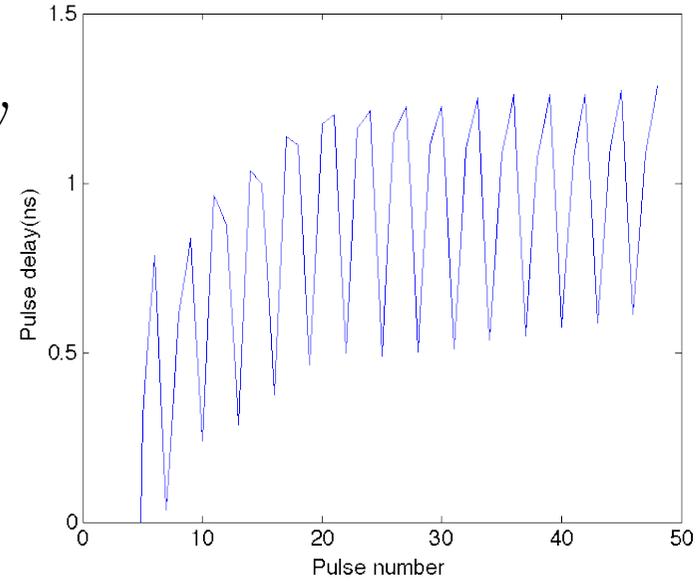
The horizontal beam position was distributed to two position.



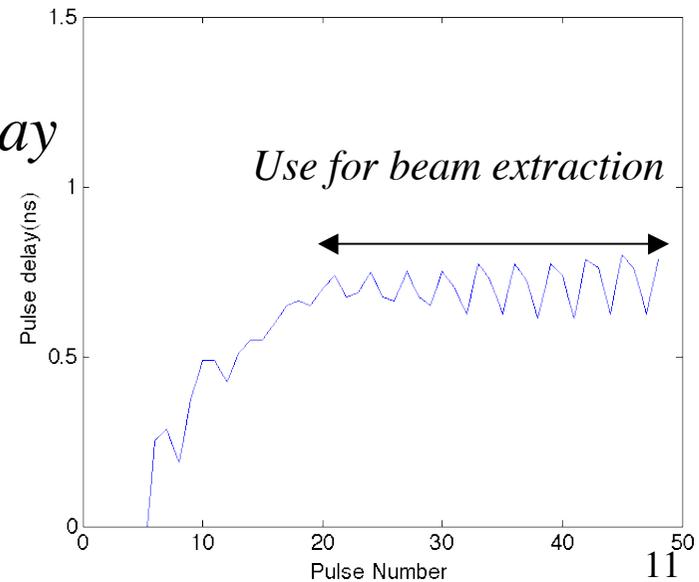
Pulse train delay adjustment circuit



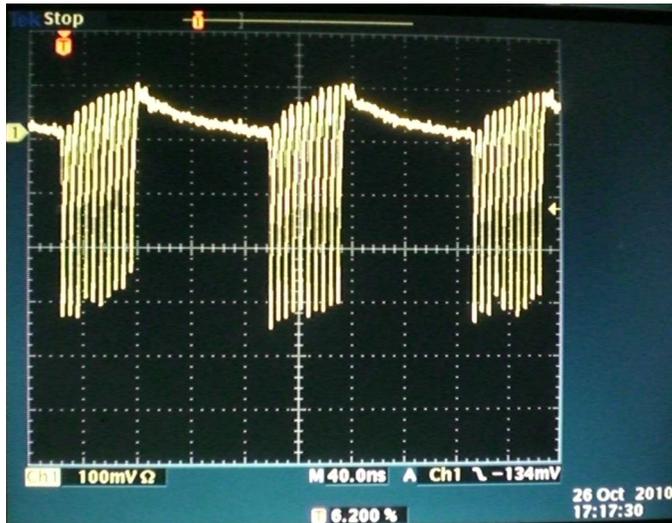
w/o delay



with delay

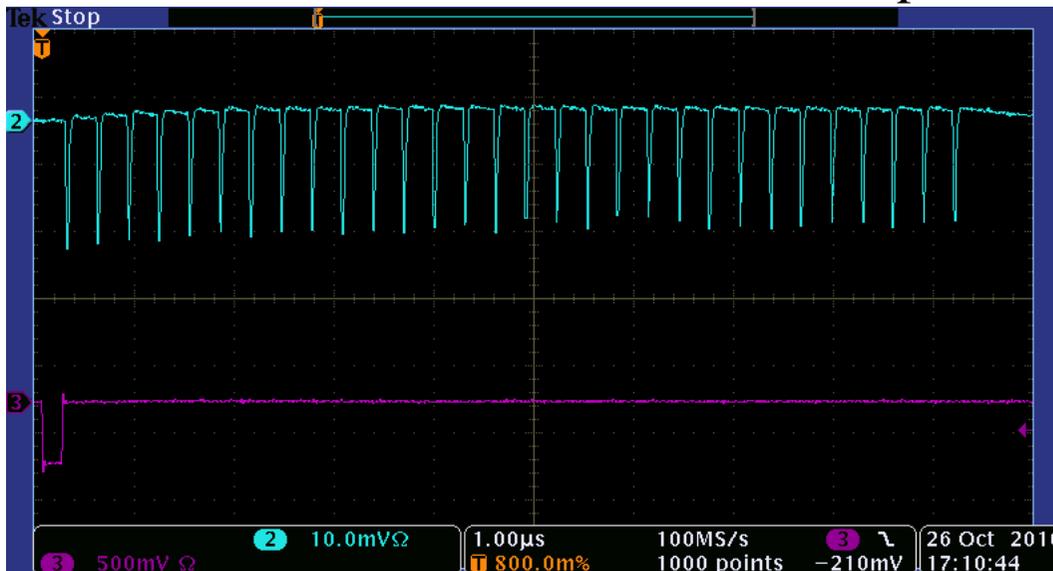


Multi-bunch Beam in the DR and the extraction line



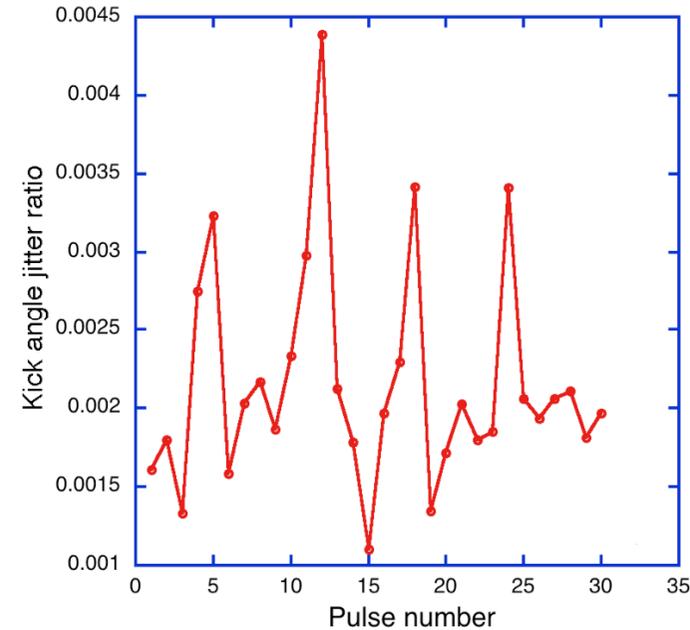
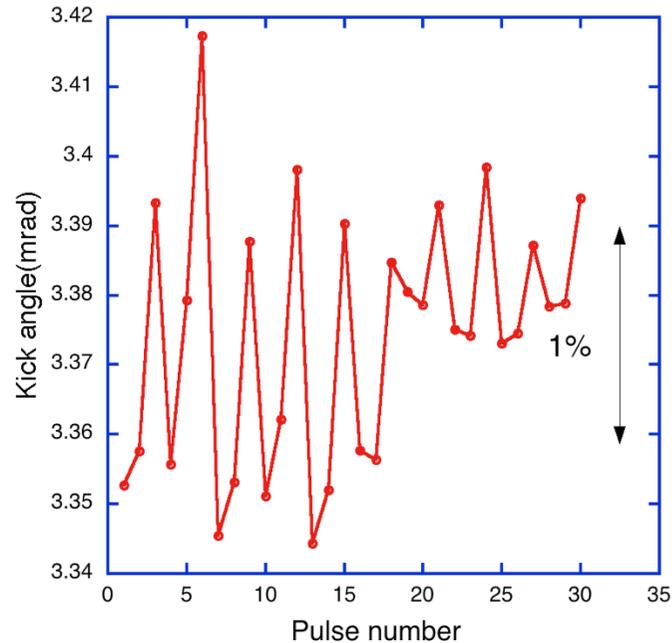
30 bunches of the beam are stored to the DR, stably.

Stable beam extraction was confirmed at the extraction line. The beam reach to the beam dump without any beam loss.





Orbit and jitter measurement



Left figure shows the kick angle as a function of the pulse number. The kick angle of the multi-bunch distributes around 1%. It shows the difference of the kick field for each pulse.

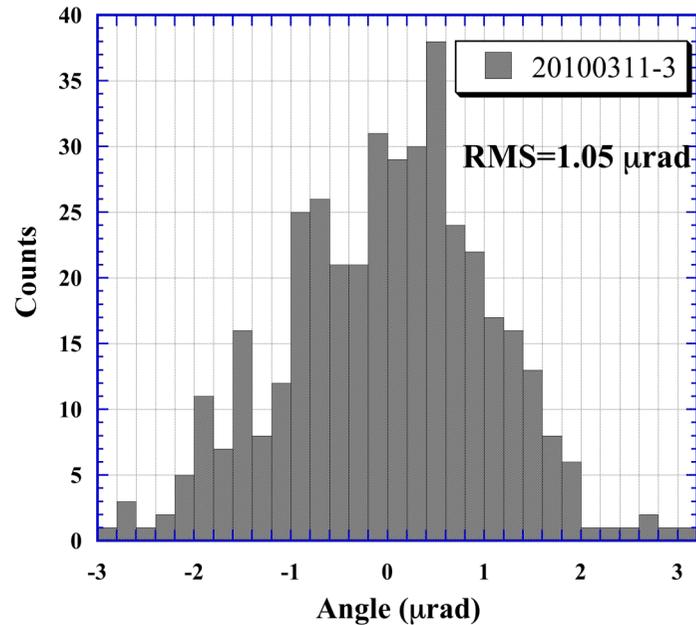
Right figure shows the kick angle jitter ratio for the kick angle as a function of the pulse number. The jitter ratio for the kick angle was distributed from 1×10^{-3} to 4×10^{-3} for each pulse. This value is larger than the single bunch jitter.

The timing adjustment was not enough at this time.

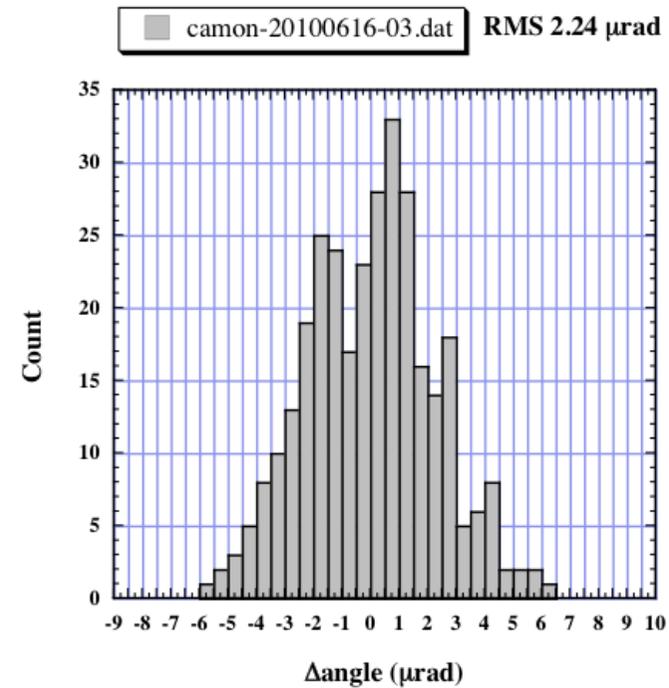


Single bunch jitter

Jitter $1.05e-6/3e-3=3.5e-4$

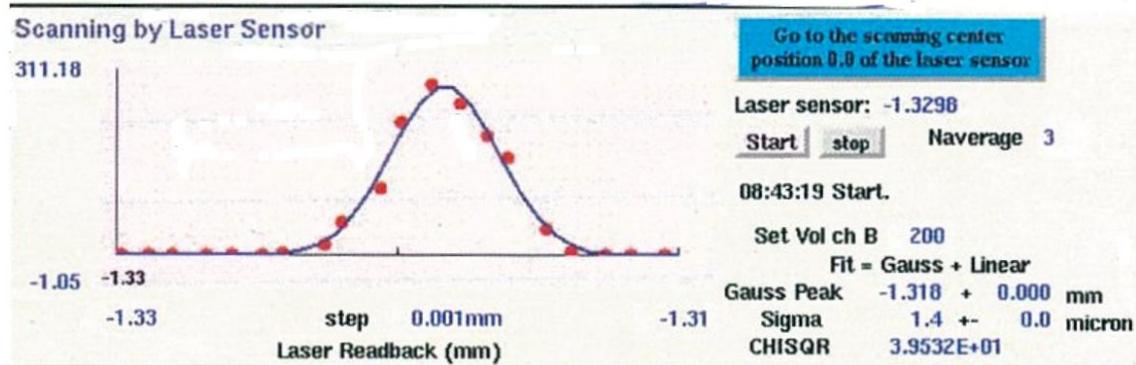


Jitter $2.24e-6/3e-3=7.4e-4$





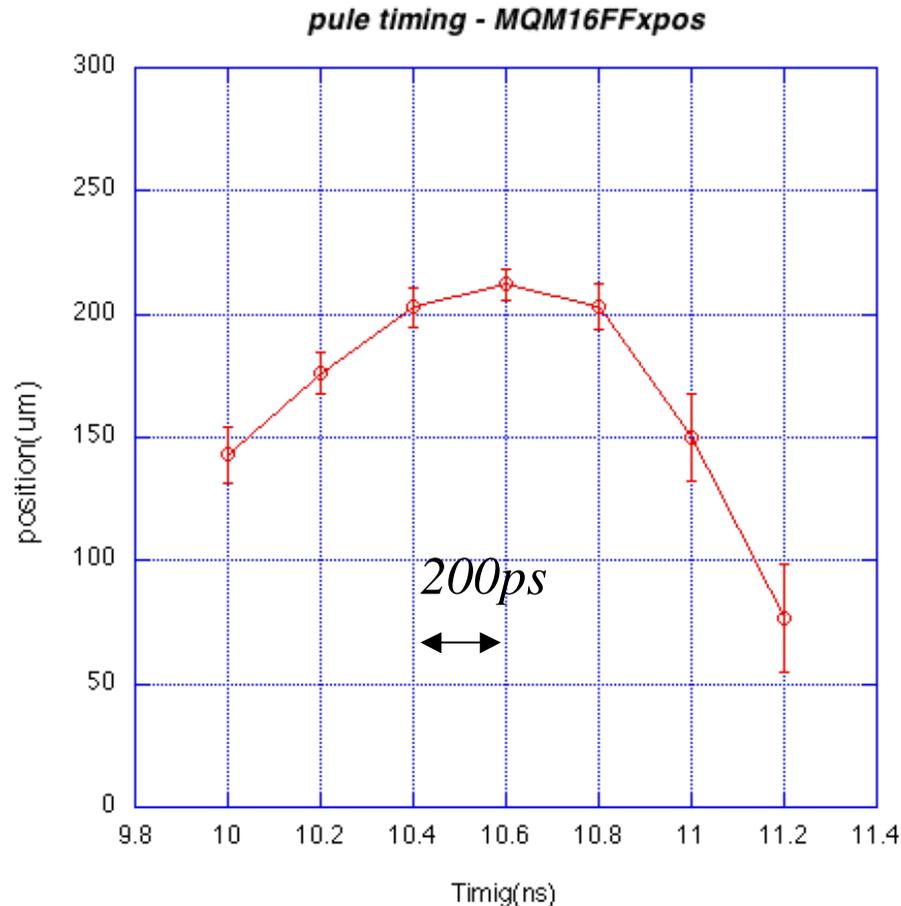
Use for ATF2 beam



We could confirmed the dispersion correction of the ATF2 beam line by the beam profile change of the MS1IP wire scanner. The measured size was limited to 1.4um due to the wire size.



Profile of the kick field and the jitter

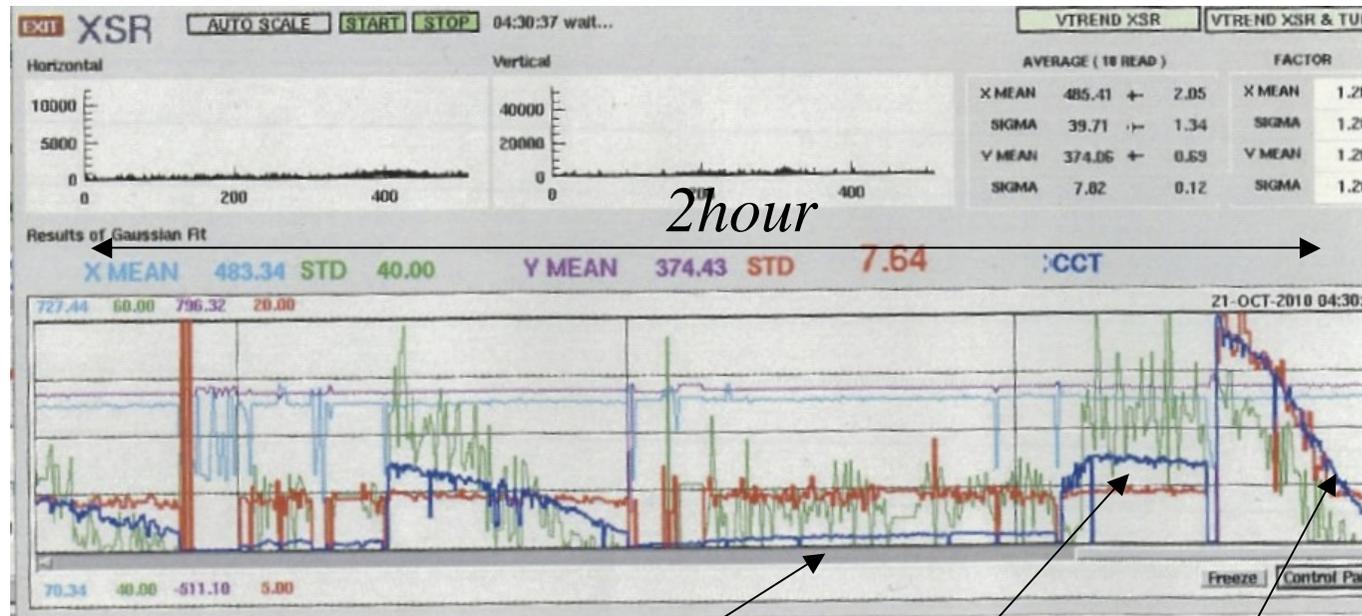


Plot shows the beam position at MQM16FF BPM, when scanned the kicker pulse timing. There is no flattop of the kick field and the jitter increased at the both side of the peak.

To make stable beam kick, careful timing adjustment of four pulses is needed.



Problem



Blue line: current
Red line: v size

single bunch
1 train

9 bunch
1 train
 $I_{tot}=2 \times 10^{10}$

9 bunch
3 train
 $I_{tot}=6 \times 10^{10}$

The stored current decreased gradually when the multi-bunch operation. The current decrease depends on the stored current. Several minutes after the beam stop, the situation recovered.

We suspect the heating of the strip-line electrode made such a happening.



Summary and Next step

Fast kicker performance was confirmed by the multi-bunch beam extraction from the ATF-DR to the ATF2 extraction line.

The kick angle stability 3.5×10^{-4} was measured for the single bunch beam. The multi-bunch kick angle and the stability were measured.

For the next step, we have to clear following problems,

- 1. High current beam storage is limited by the horizontal aperture of the strip-line(9mm).***
- 2. The stored current reduction have to cure.***