# *Status of ATF Fast Kicker Experiment*

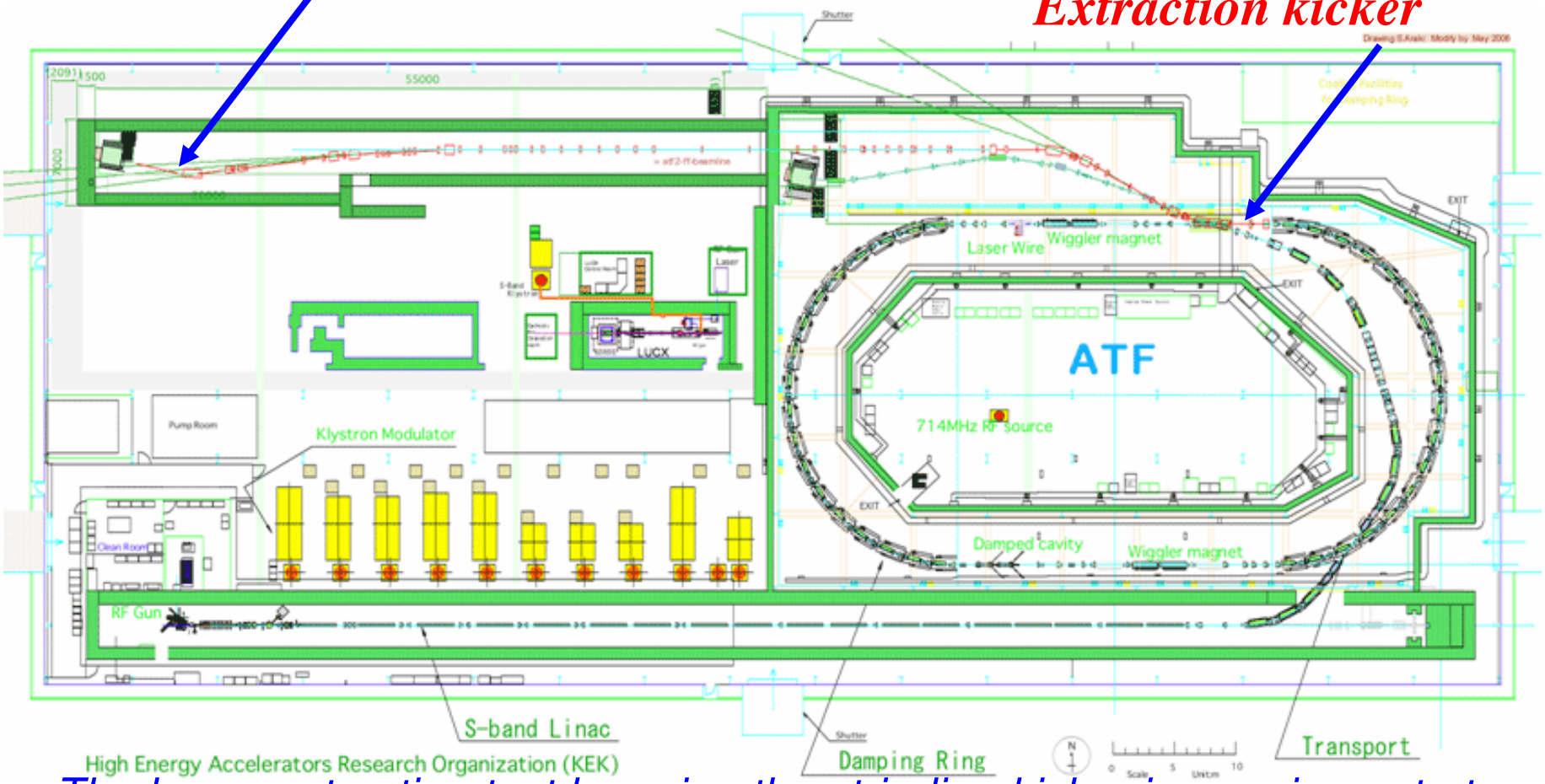
**Presented by Junji Urakawa on behalf of Takashi Naito.**

**Contents;**
**Outline of our experiment,**
**Status of fast pulser power supply,**
**Plan**

***2009 Linear Collider Workshop of the Americas from 28 September***

# Fast kicker Experiment at ATF

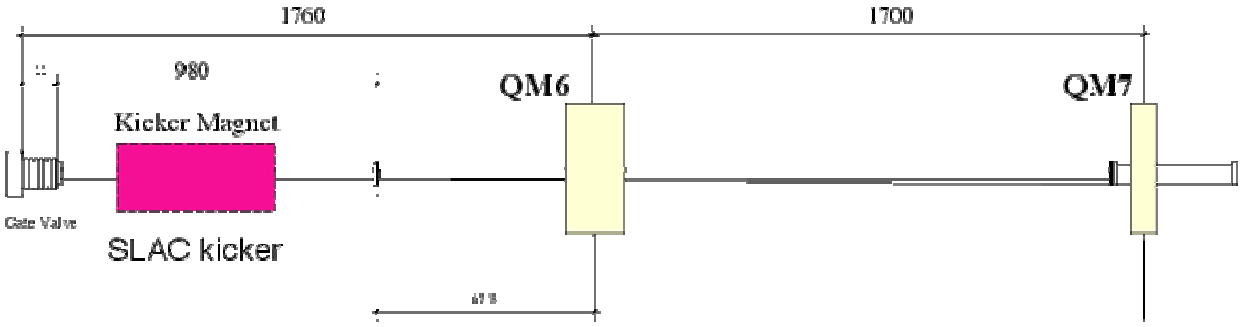
*ATF2 - 35nm beam production, measurement*

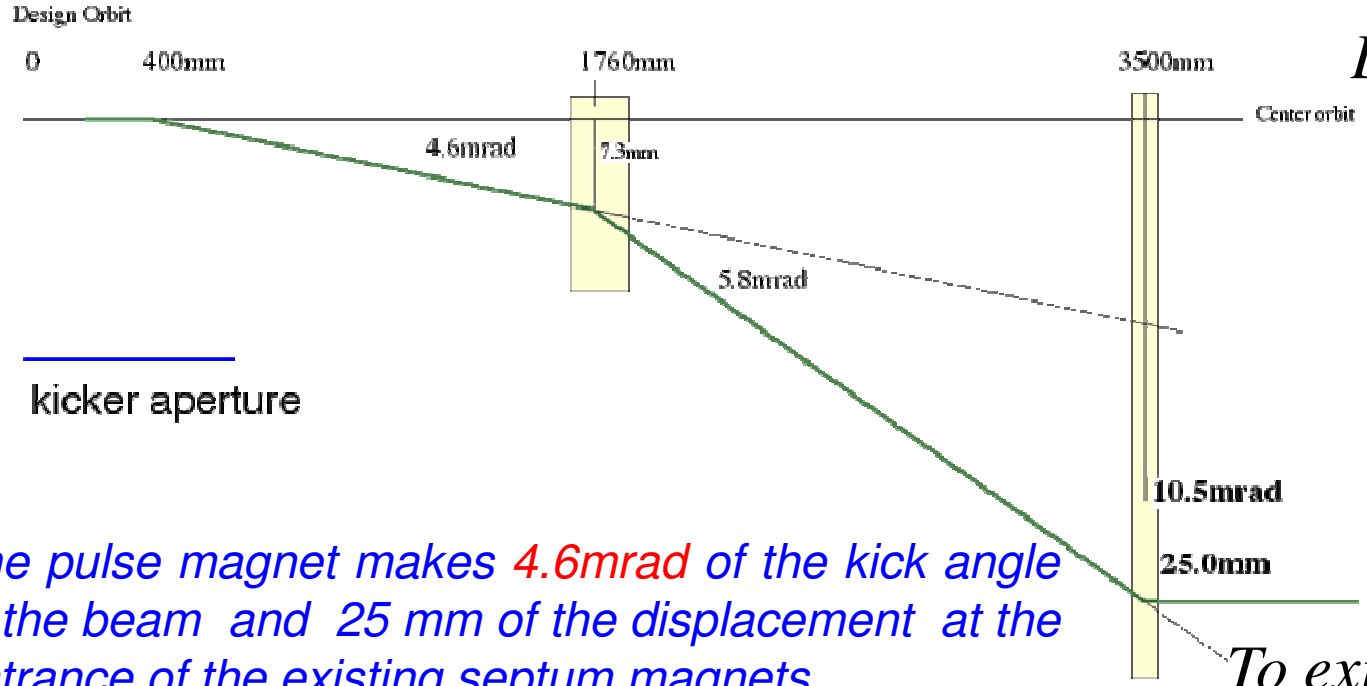



*The beam extraction test by using the strip-line kicker is carrying out at KEK-ATF. The main problem is that the kick angle of strip-line kicker is not enough compared to the kick angle of the existing pulse magnet in order to make necessary extraction orbit.*

# Present layout





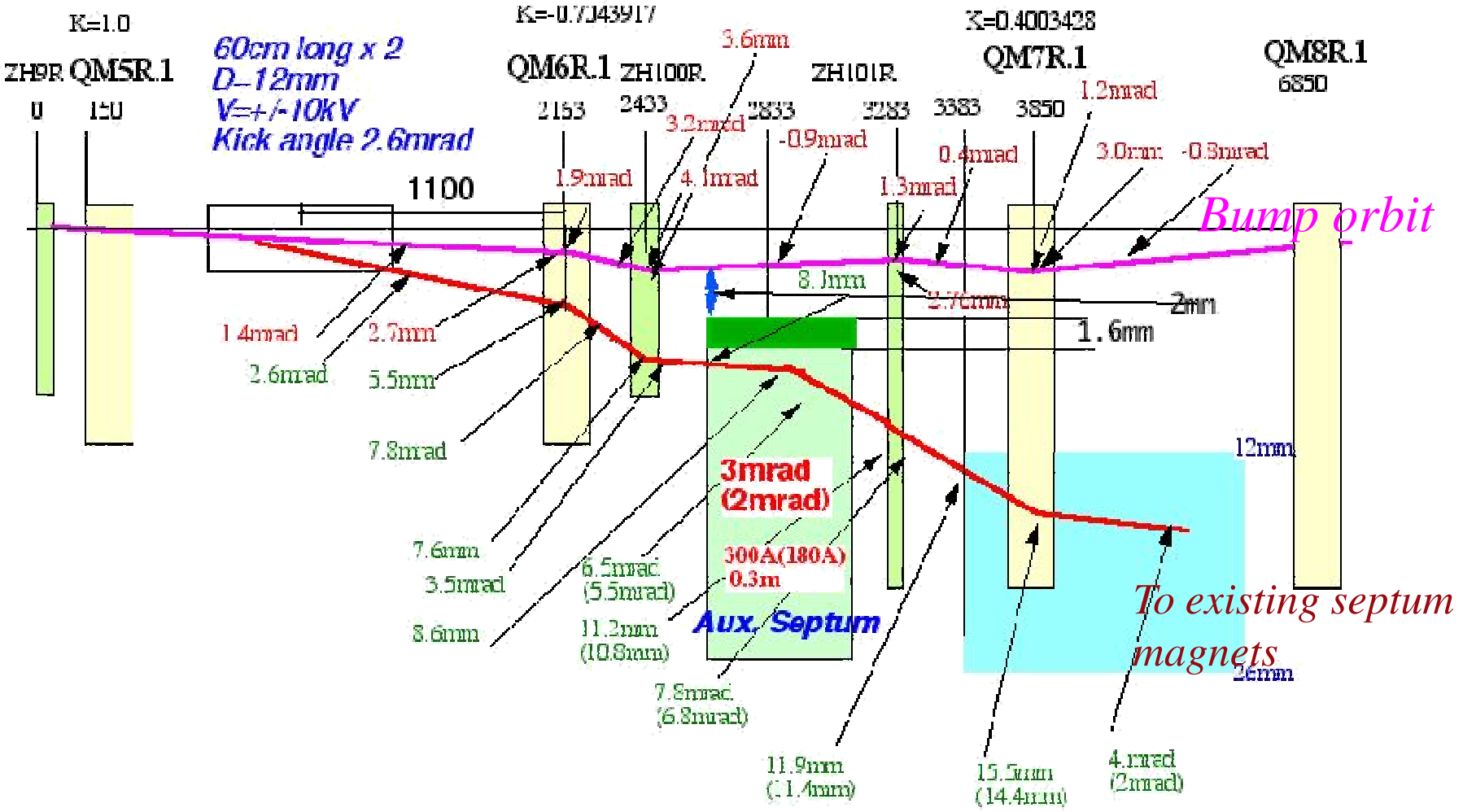

*DR orbit*

*The pulse magnet makes 4.6mrad of the kick angle to the beam and 25 mm of the displacement at the entrance of the existing septum magnets.*

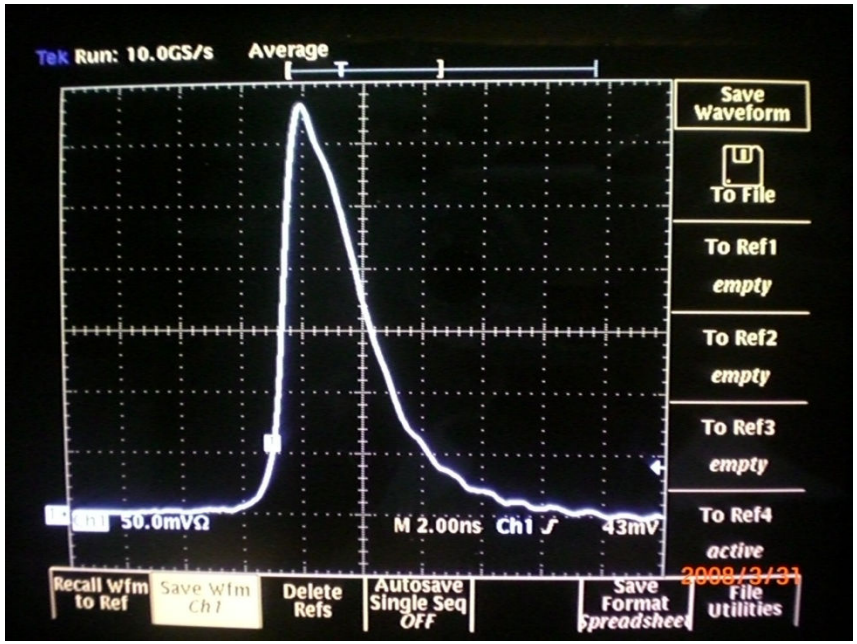
*To existing septum magnets*

# Beam Extraction Orbit by using Strip-line Kicker & pulse bump

2.6mrad kick angle



# Pulse source(FID FPG 10-6000KN )




***Specification***

Maximum output voltage + 10 kV

- 10 kV

Rise time @ 10-90% level - < 1 ns

Rise time @ 5-95% level - < 1.2 ns

Pulse duration @ 90% - 0.2-0.3 ns

Pulse duration @ 50% - 1.5-2 ns

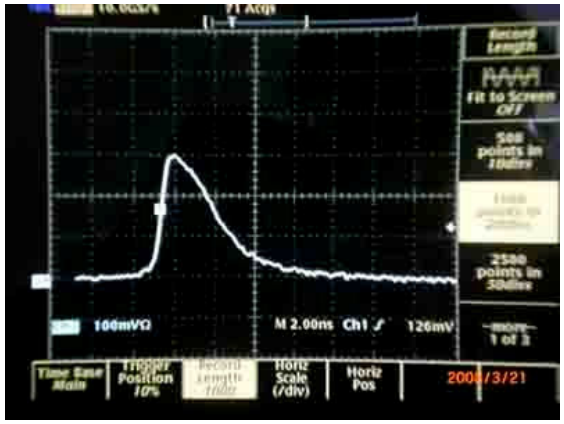
Output pulse amplitude stability – 0.5-0.7%

Maximum PRF in burst – 6.5 MHz

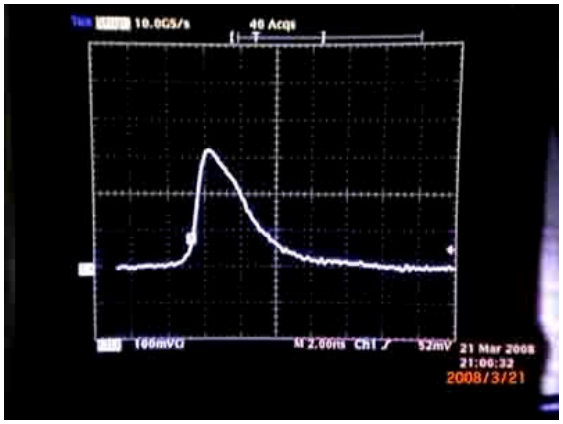
Number of pulses in burst - up to 110

PRF of bursts - up to 5 Hz

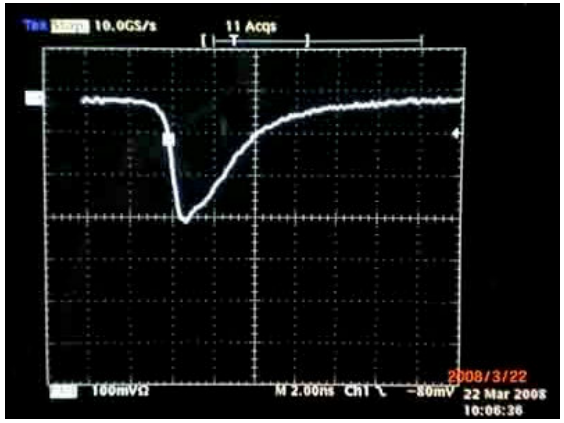
# 10kV pulse apply to the strip-line



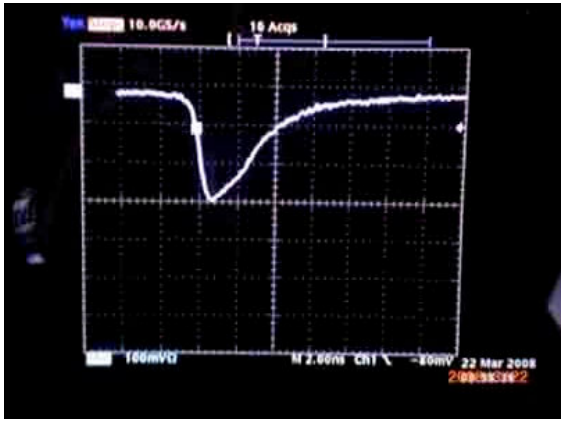

Pulser output(pos) 9.7kV peak




Strip-line output(pos)



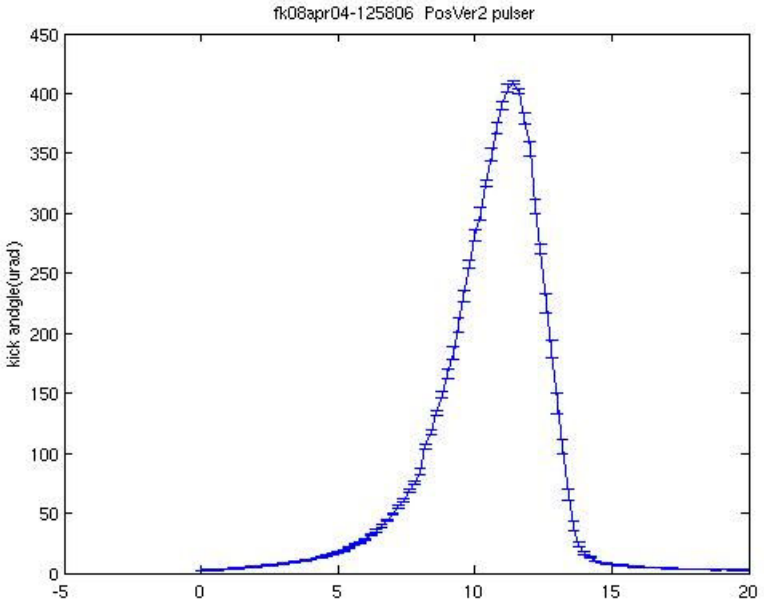

Pulser output(neg) 8.5kV peak

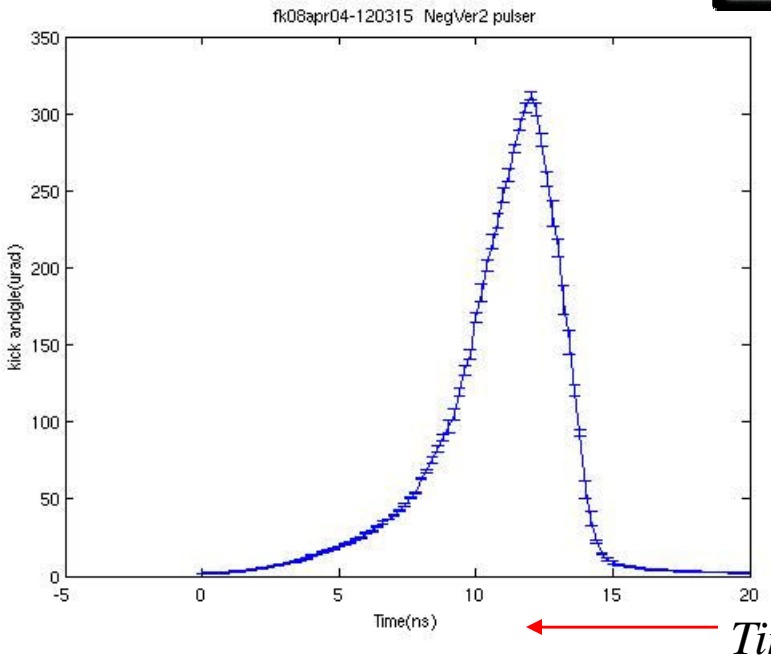


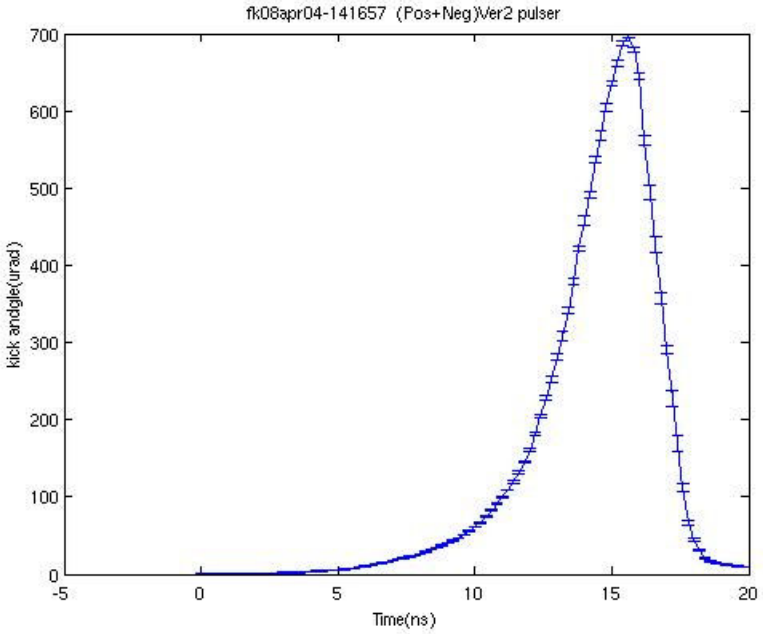

Strip-line output(neg)

A 10kV pulse could be applied for each electrode without any deterioration to the waveform of the pulser, which means no-discharge at the connectors and the electrodes.

# Beam kick profile from the beam oscillation amplitude

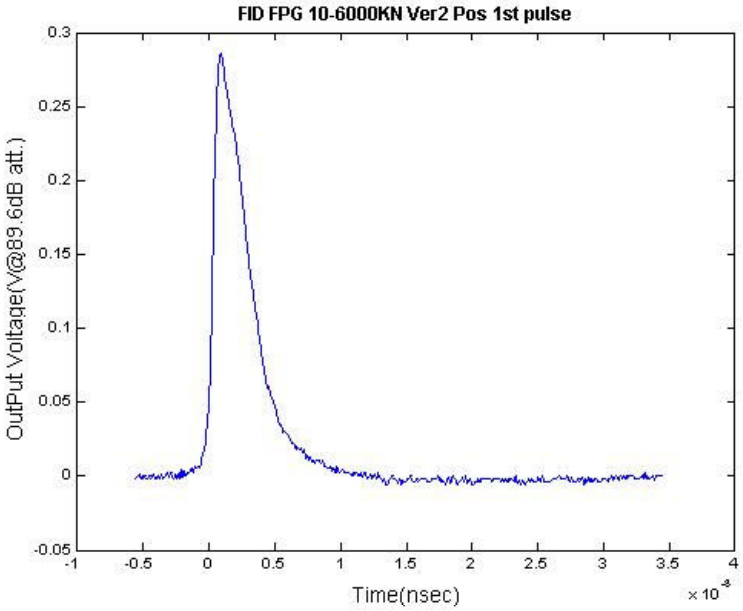


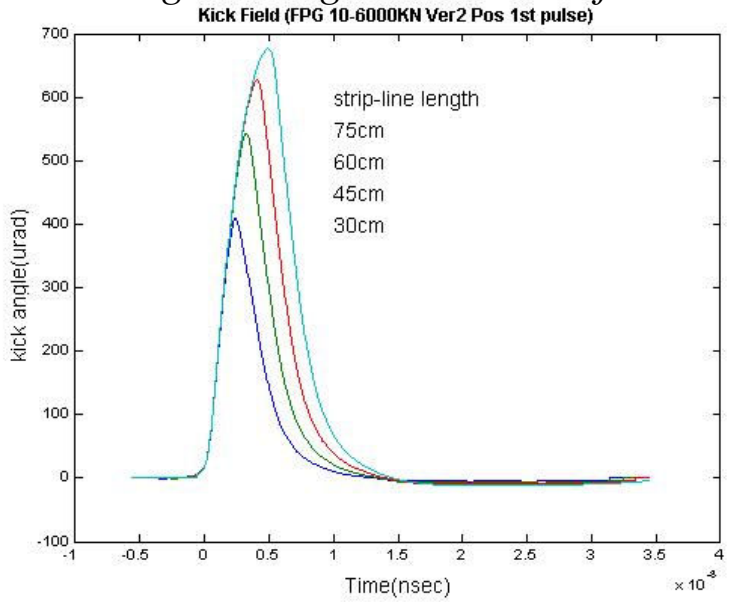




Beam kick test in the DR was carried out. The pictures show the timing scan of the kick pulses for the beam timing in the cases of the Positive, Negative and Pos+Neg pulses. The peak kick angles are 0.4, 0.3 and 0.7mrad, respectively, which agreeds with the estimation from the kick voltage and the strip-line dimensions.

# Estimation of kick angle




*High Voltage Pulse Waveform*

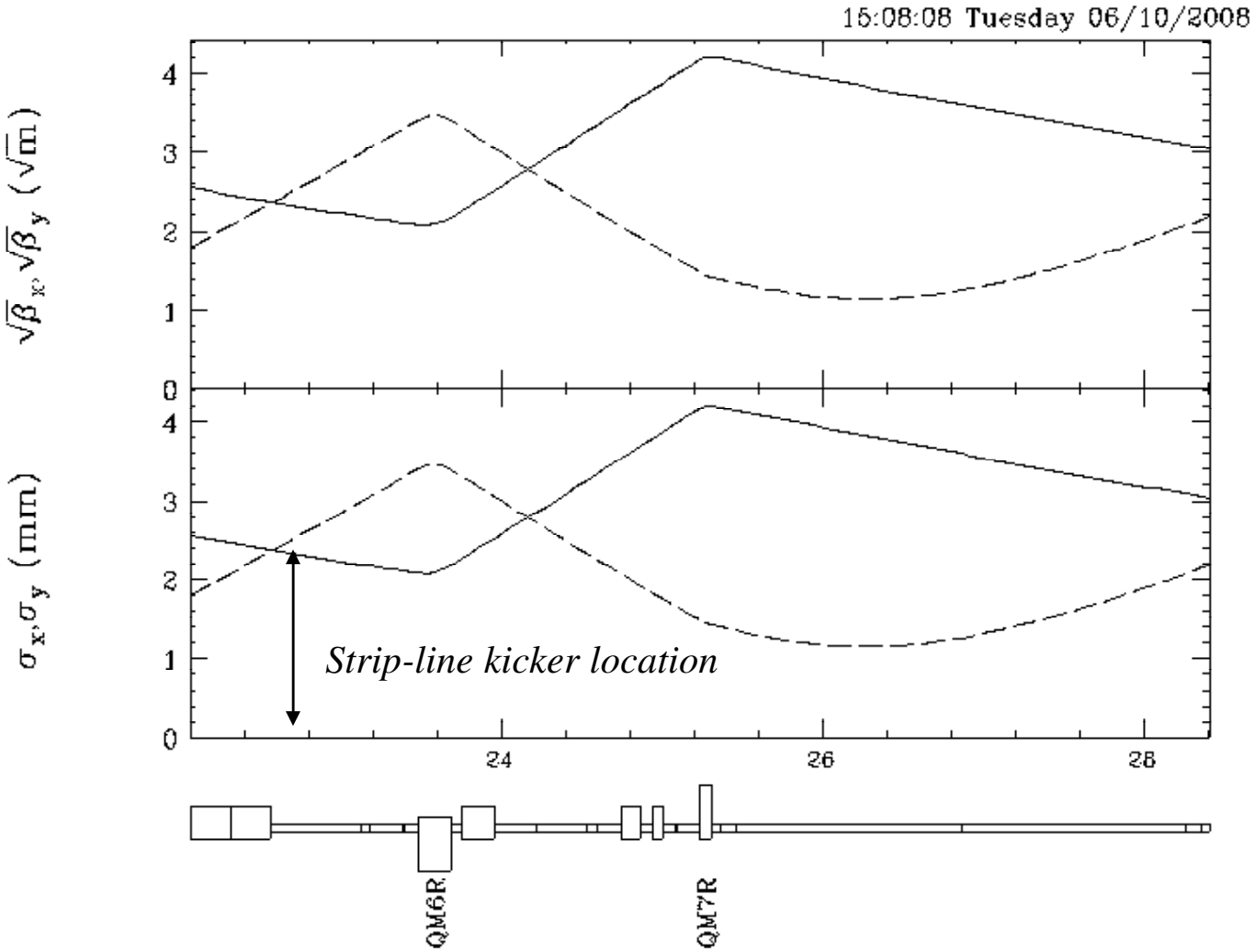



*Calculation of the kick field*

*When a high voltage pulse(upper picture) is applied to the different length of the strip-line, the waveform of the kick field and the kick angle are calculated. The kick angle is calibrated from the result of the beam kick test in DR.*

*In the case of a 60cm long strip-line, the kick angle is 0.6mrad and the rise time is less than 5ns. When a pair of pulsers(positive/negative) for each strip-line and two unit of 60cm long strip-lines are used, the total kick angle will be 2.4mrad.*

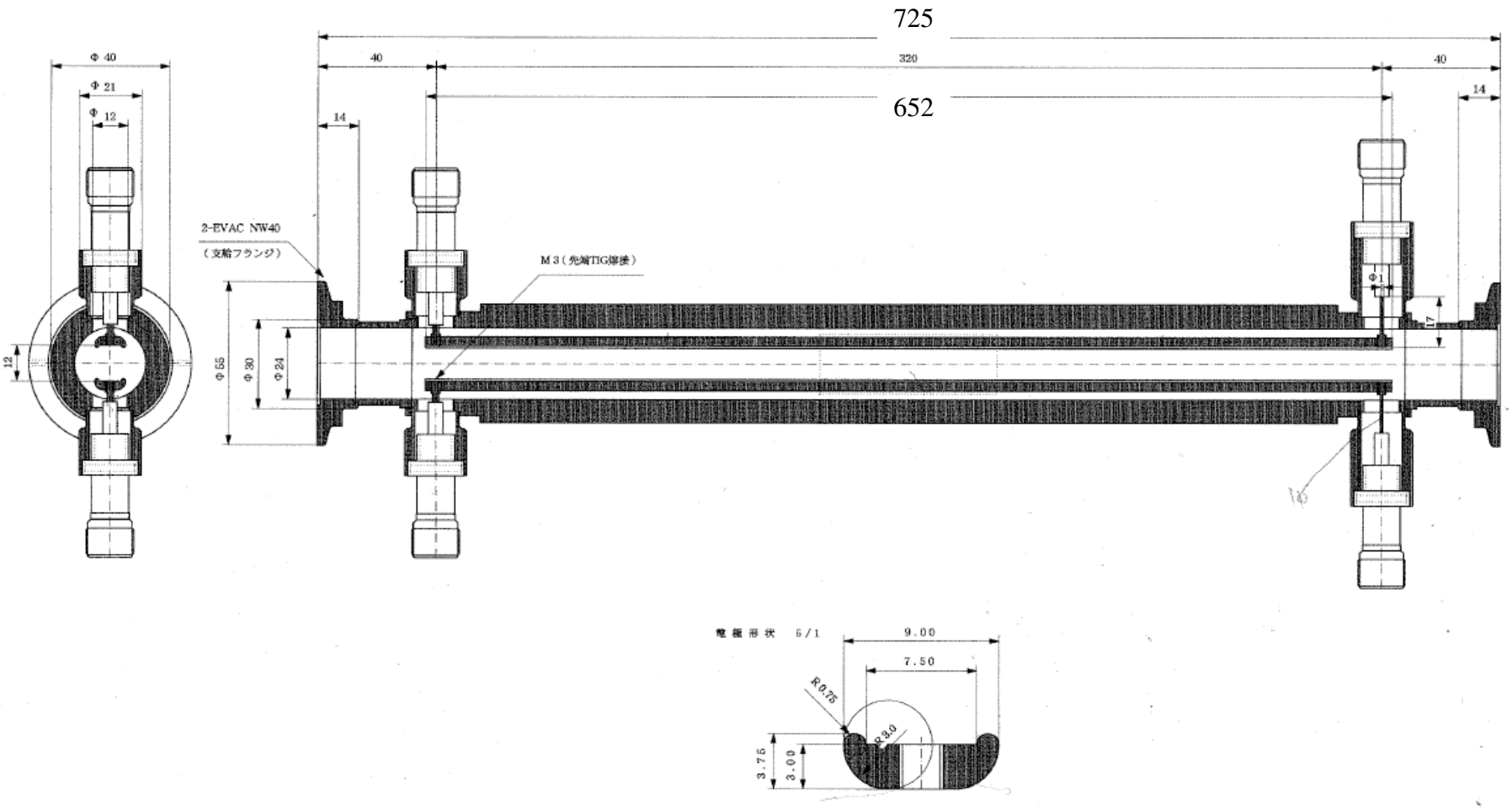
# Aperture




***Emittance(inj.) =$10^{-6}$, Energy spread (inj.)=1%***

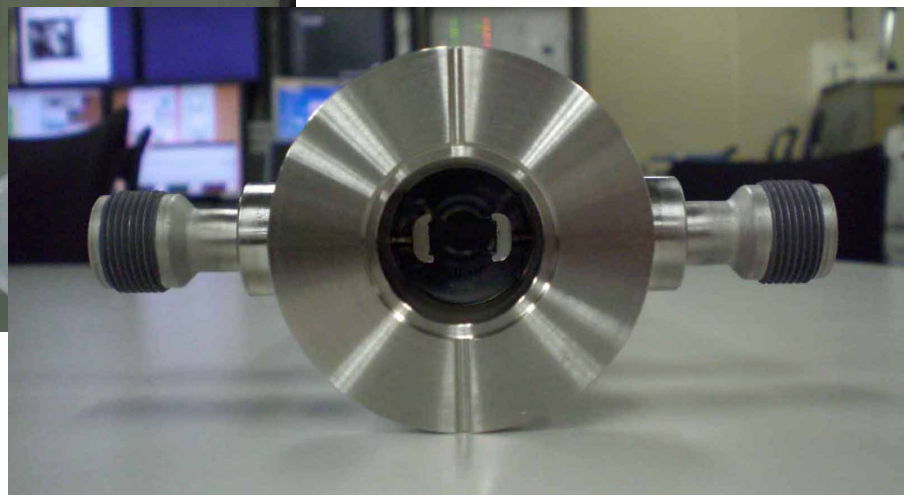
**Horizontal aperture is limited by the strip-line electrode. 3σ of the injection beam can pass through a 12mm gap of the strip-line kicker section.**

# Proto type strip-line kicker(60cm long)



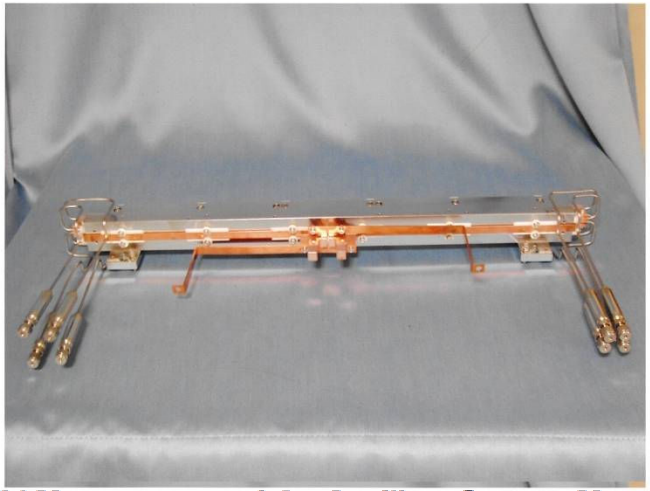

**KEK fabricated a prototype 60cm long strip-line kicker, which has 12mm electrode gap. The input/output connectors are HN-type commercial available feed-through.**

# Photo of the fabricated strip-line kicker

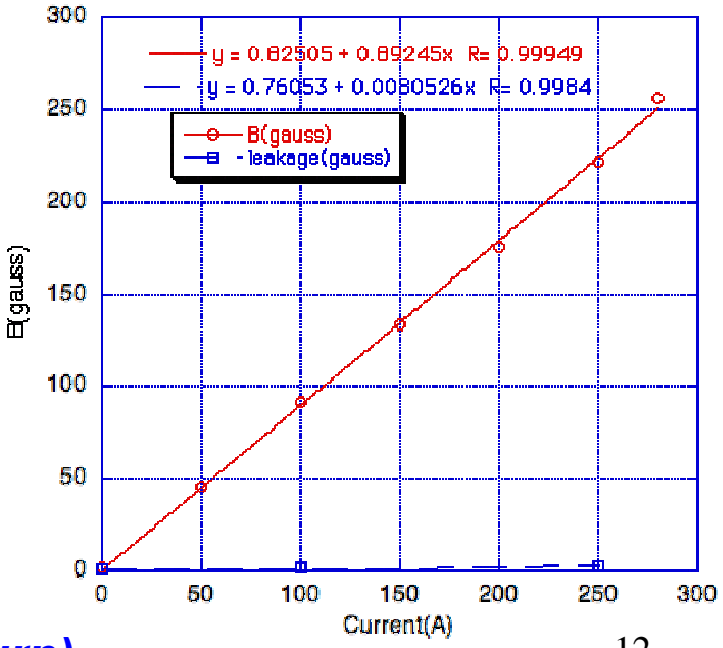


# Auxiliary septum magnet

***The current test up to 300A was done without any temperature problem. The leakage flax is less than 1%, which can be compensated by the auxiliary coil.***



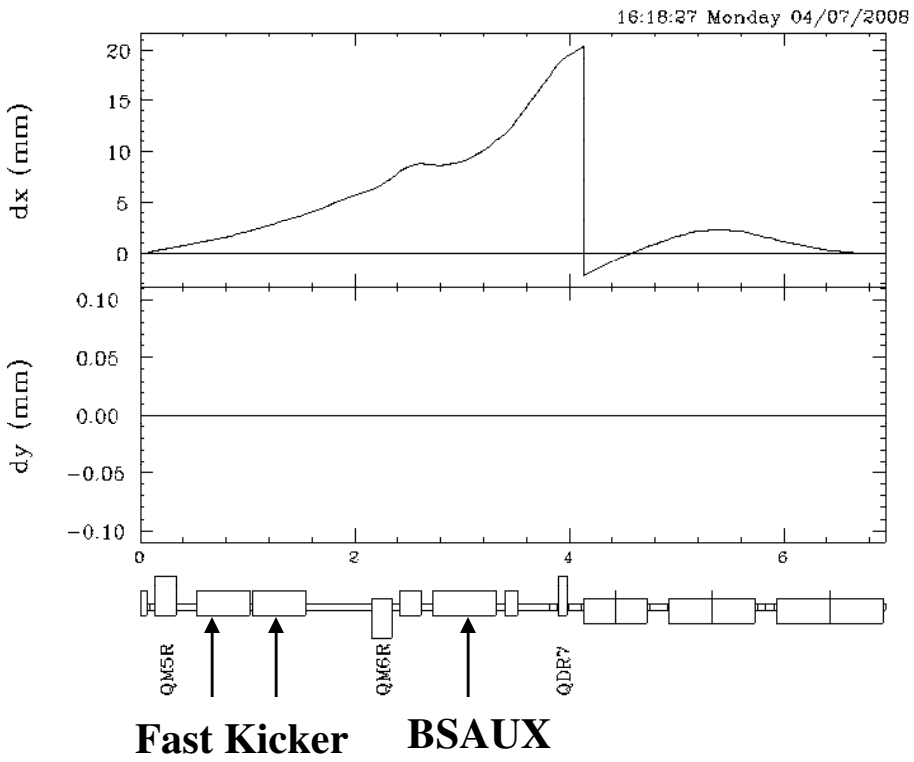
***Feild Measurement of the Auxiliary Septum Magnet***


***Aux. coil(1turn)*** ***Main coil(1turn)***

# EXT Orbit with Fast Kicker

***By S.Kuroda***




Fast Kicker Strength: 1mrad x 2 = 2mrad

**Correctors K0**: ZH9R -0.002320433716
ZH100R 0.009876184722
ZH101R -0.005210348744

Free parameters; K0 of BSAUX, BS1-3X

Imposed Condition;

Abs[dx]< 3 mm in BS1-3X region

dx=dpx=0 at the end of BS3X

Results;

BSAUX K0=-.010280163677

BS1X K0 =.0011826626821

BS2X K0 =.0031361169236

BS3X K0 =-.0013134448462

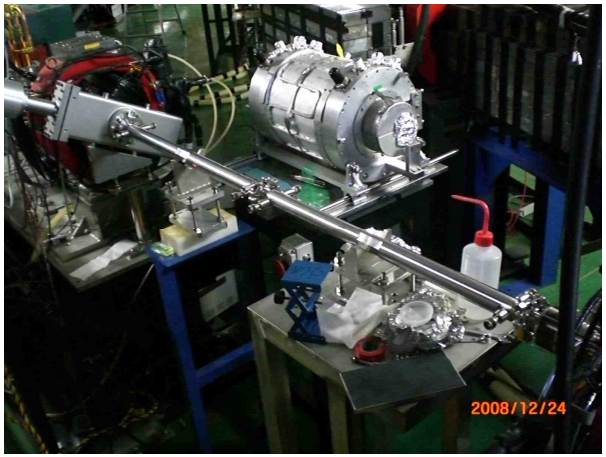
**BS1&2X is weaker by 8.4%, BS3X is stronger by 1.1%.**

Orbit is measured from DR design orbit
+ toward EXT

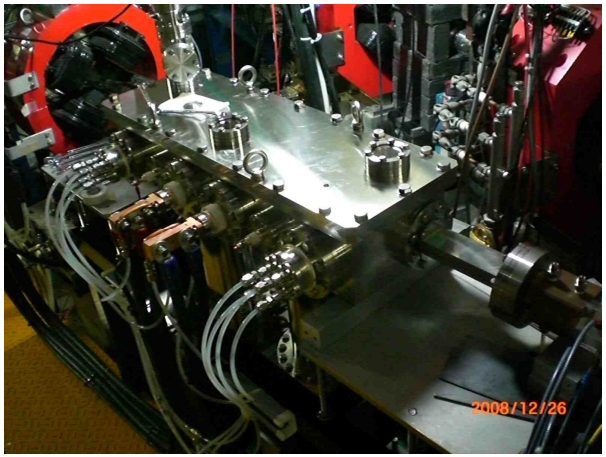
Orbit is measured from EXT design orbit
- toward DR

**Physical aperture in septum region must be larger than 3mm+orbit distortion(+beam size)**

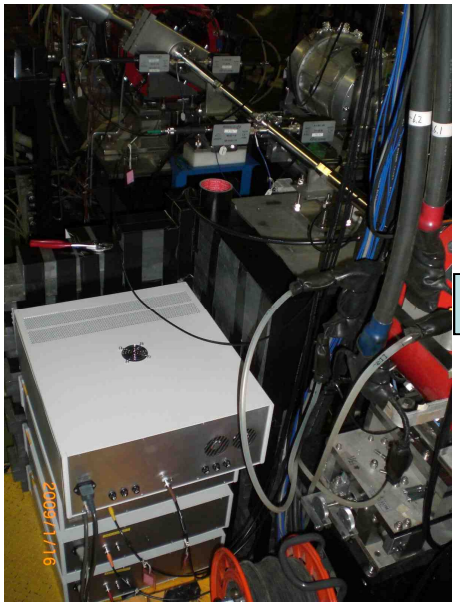
# Pictures of installed components




Strip-line electrodes




Aux. Septum



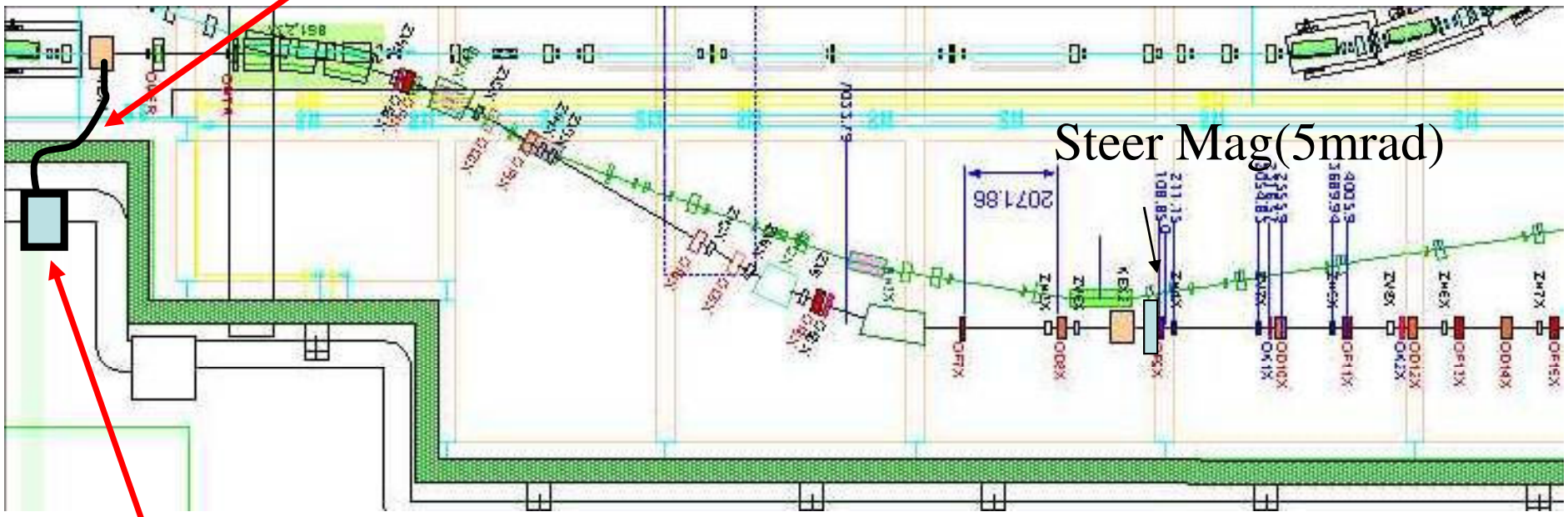

*FDI pulsers in Jan.*

FDI pulsers in June

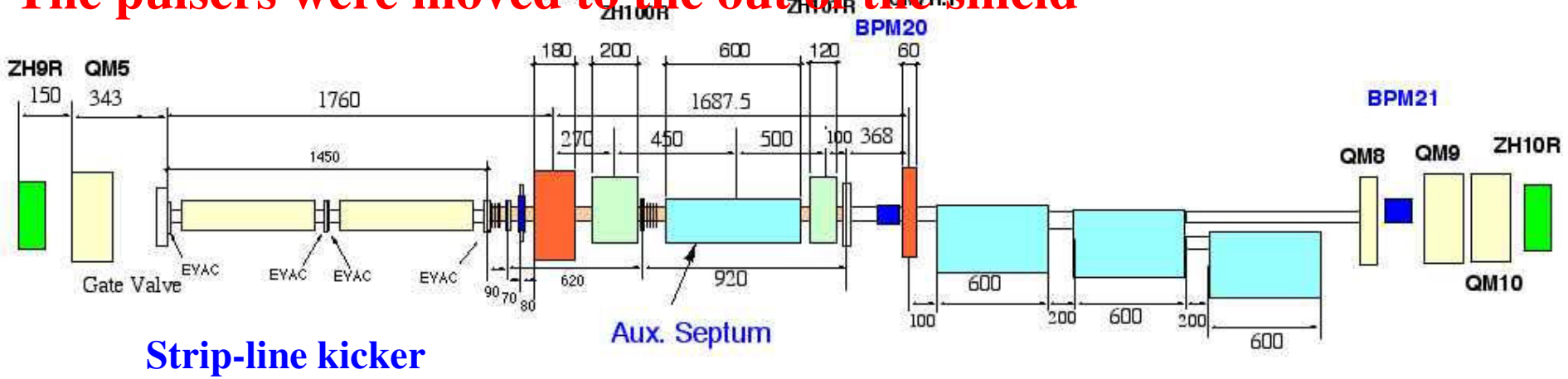

Bump PS and Septum PS

# The location of the pulsers

6m cables




The pulsers were moved to the out of the shield




Strip-line kicker

# *Trouble of the pulsers*

The beam test in January was stopped due to the pulser trouble. Two of four pulsers broke down just after one hour from turned on the pulsers under the beam storage condition. We suspect that the trouble comes from the high radiation environment and the high current condition in the semiconductors due to followning reasons,

•LLNL pulser was also tested at the same location, it was also broken after one hour from turned on the pulser.

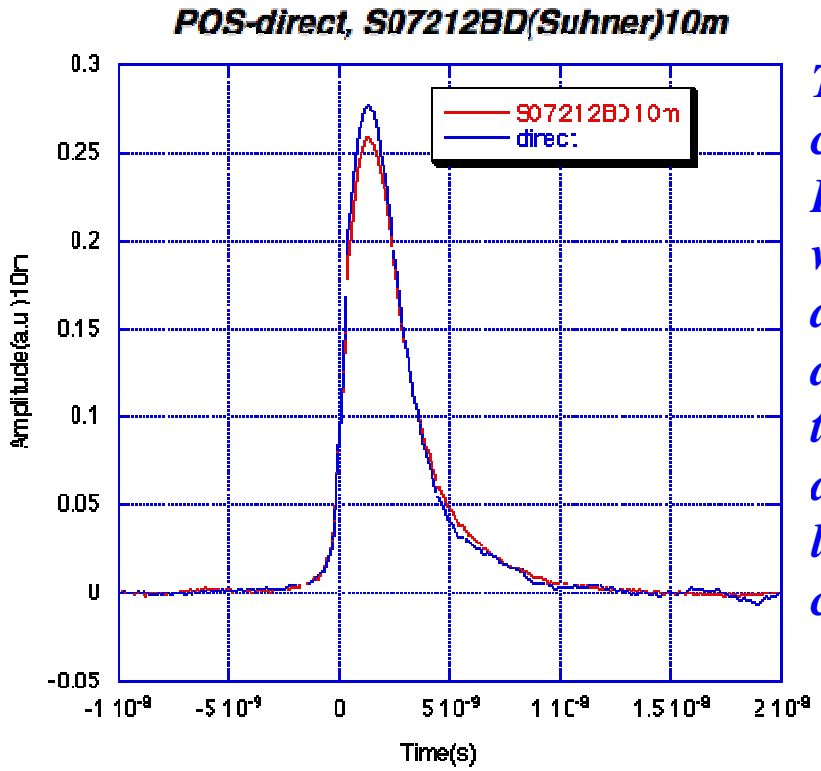
•The radiation level at the location of the pulser was very high, over10msv/h(gamma) and 100micro sv/h(neutron).

•There was no trouble at the experiment of the south straight section, where was low radiation area. The FID pulser was operated over one week and the location was just below the beam line.

The troubled pulsers were sent back to FID Co., they reported that the FET of the drive circuit was broken, it not the DSRD device. It agree with the expectation of the radiation damage of ON device, which means high current flow of the semiconductor.

From the result, we decided to locate the pulser outside of the shielding.

# Waveform with 10m long cable




*The pulse transmission characteristics was checked to locate the pulser out of the shielding. Picture shows the comparison of the waveform with and w/o 10m long cable. There is no deterioration for the rise time of the pulse, the amplitude loss was several %, which came from the voltage drop in the cable. The minimum distance of the cable is 6m long, the amplitude loss can be reduced to half when use a 6m long cable.*

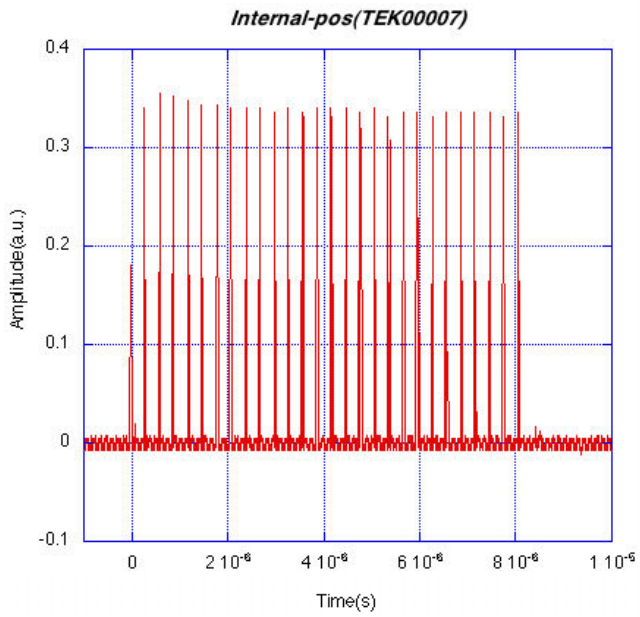
# Results of Fast kicker Exp. in June

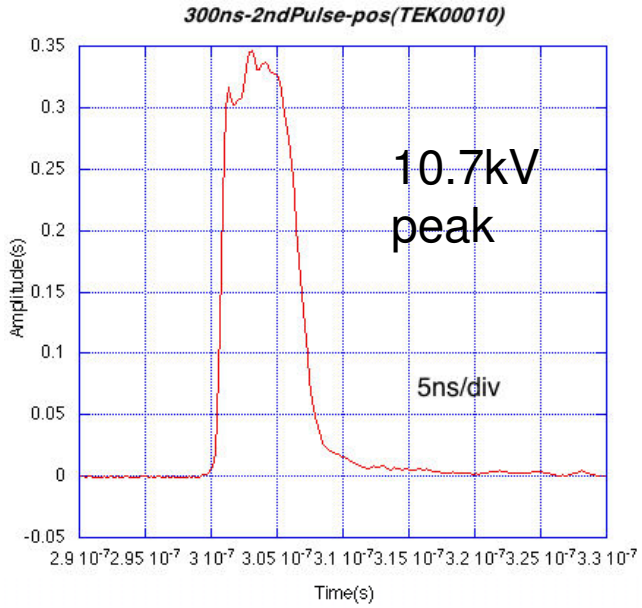
- The good beam injection to DR was confirmed without any beam loss.
- The pulse bump orbit and the function of the auxiliary septum was confirmed.
- The FID pulser worked in a week without any trouble.
- Unfortunately, the extracted beam could not be confirmed. The kicked beam was disappeared at the wall of the aux. septum.

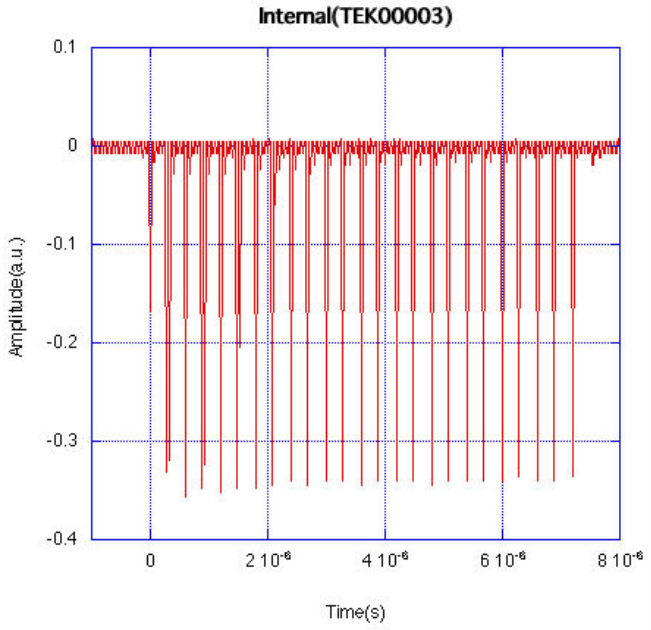
The reasons are,

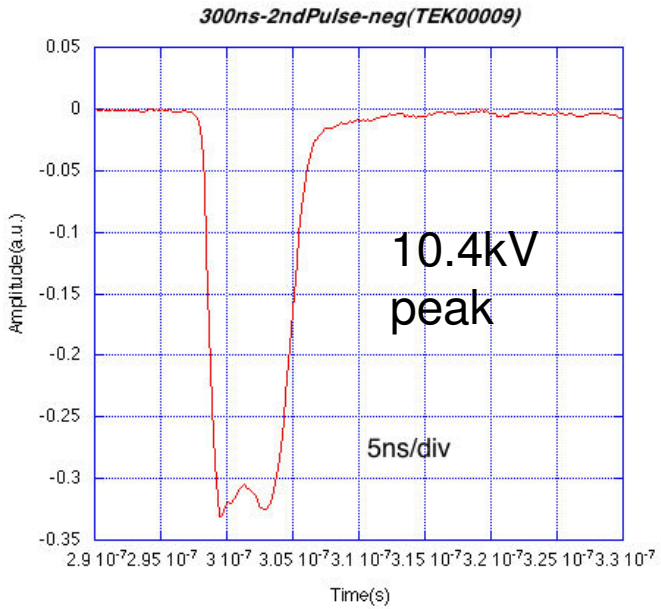
1) The pulse bump orbit could not make the large orbit displacement, which means that the stored beam could not approach necessary orbit near the wall.
2) The kick angle of the strip-line was lower than the design(~2mrad), which comes from the fabrication error of the strip-line electrode.

# 10kV, 4ns pulser



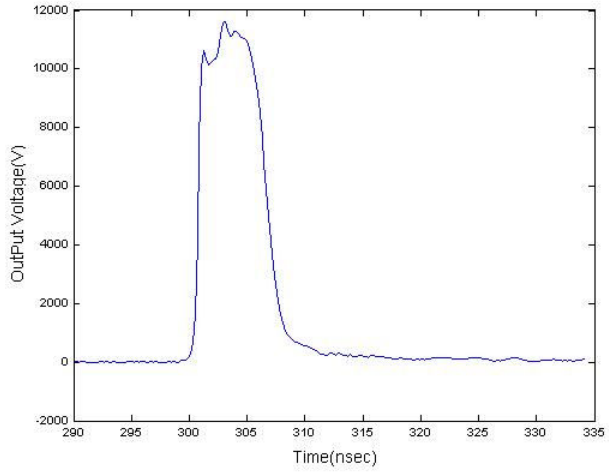



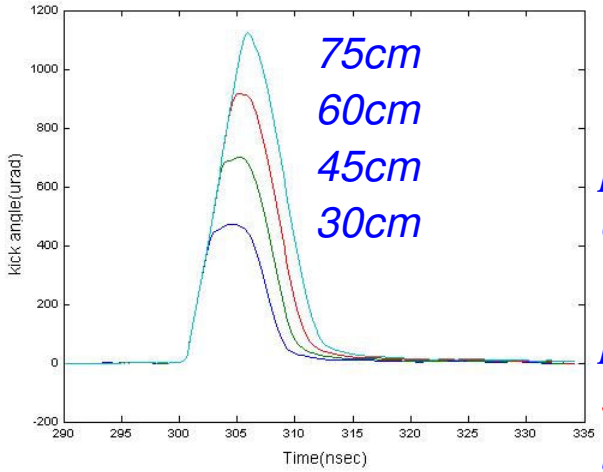

To increase the kick angle, we ordered 4ns pulse width pulsers (FPG10-3000N2G) to FID. The kick angle increases by 50%.

Until mid. of Oct., four fast pulse power supplies are ready.

# *Kick angle estimation of the 4ns pulser*

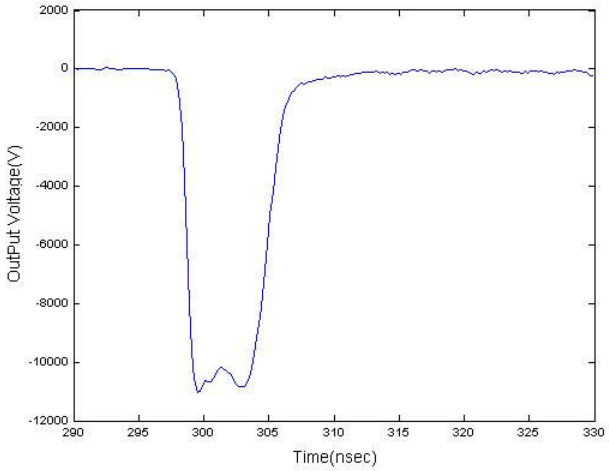


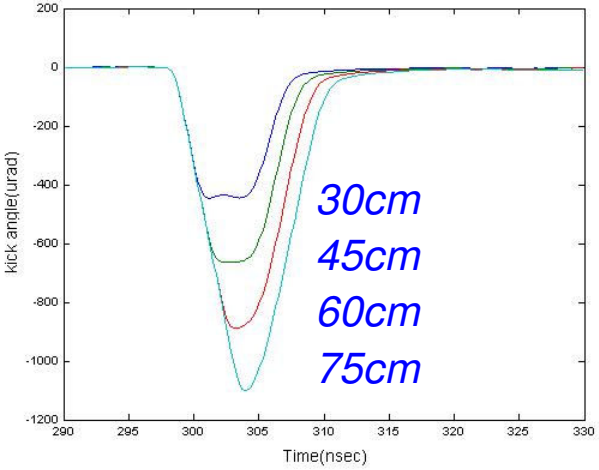

*Pulse waveforms*




*Estimated kick angles*

***The kick angle of the 4ns pulser will be 0.9mrad in the case of 60cm long strip-line. The total kick angle of two pairs of the strip-line is 3.6mrad, which will be able to extract the beam without the auxiliary septum magnet.***



# Next Beam Test

**Next beam test is scheduled,**

**2009 Oct. 2weeks(10/19~, 10/26~)**

**Buck-up schedule for the beam test**

**2010 Jan. 1week(1/18~).**

**Improvements for next beam test,**

**1)Re-fabricate the strip-line electrode( 20% kick angle up ?**

**We guess that the kick angle was 1.9 mrad in June, maybe.)**

**2)Using 4ns pulser x 4 (50% up)**

***We hope we will establish the kick angle***

***of 3.6 mrad in Oct..***