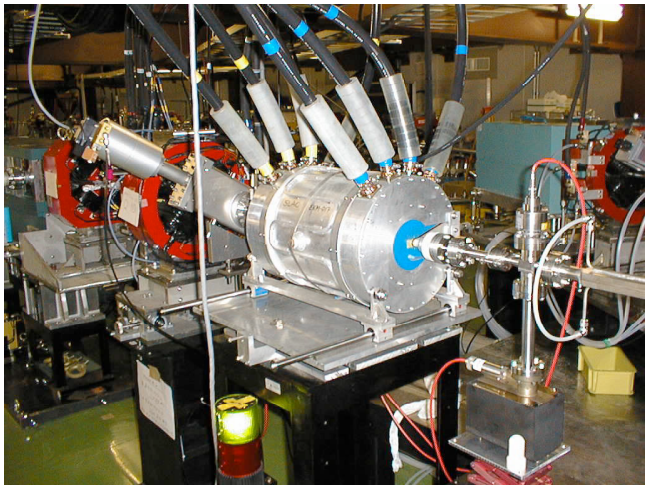
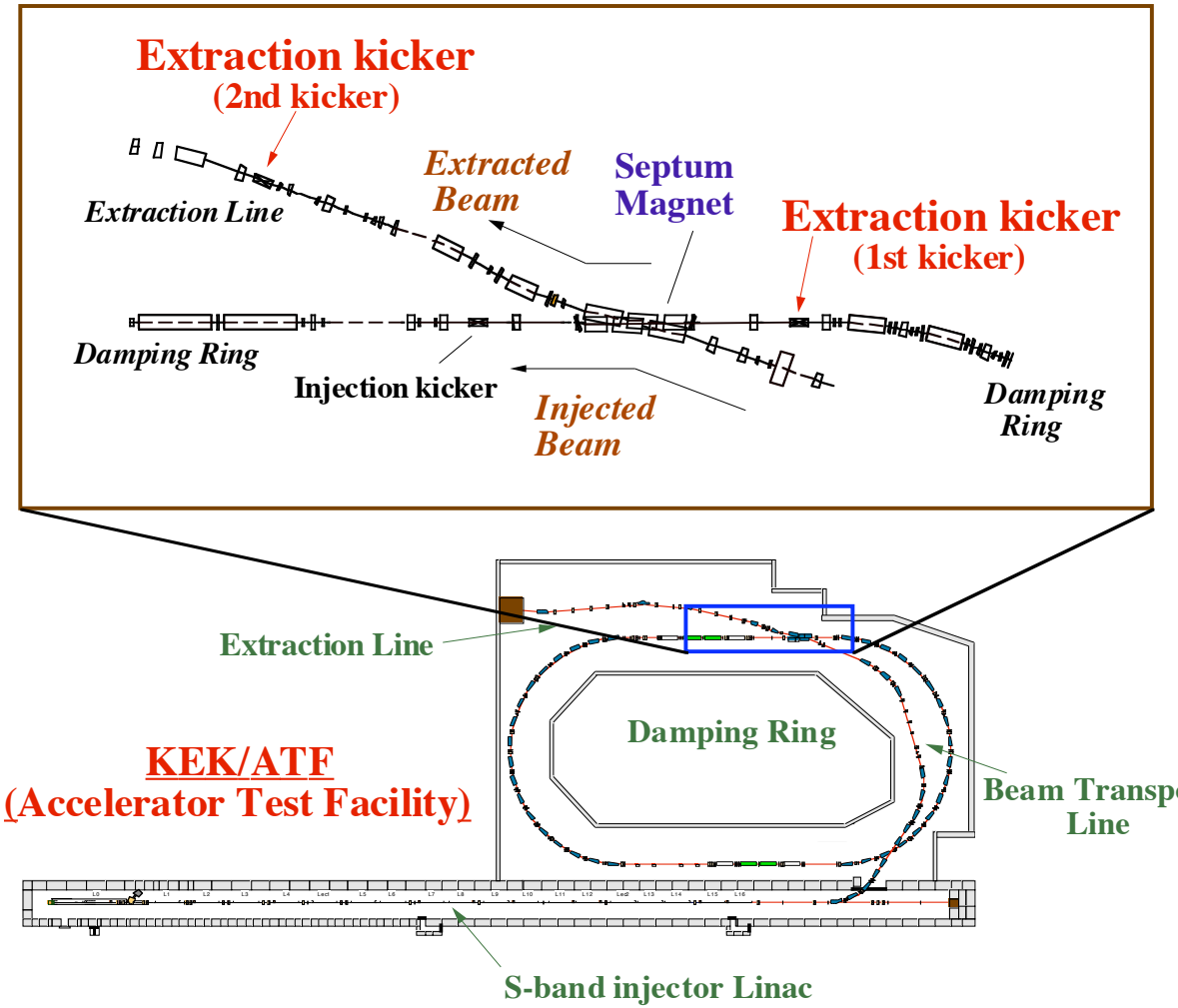
Fast Kicker R&D at ATF

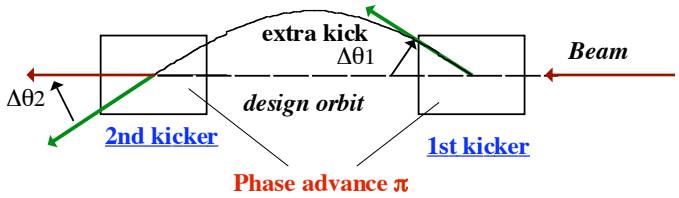
20060703 T.Naito

- Present kicker system
- Test result from the Beam Oscillation in the DR
- Preliminary Test and Multi-bunch Extraction design
- Future plan

Pulse Magnet Double kicker system

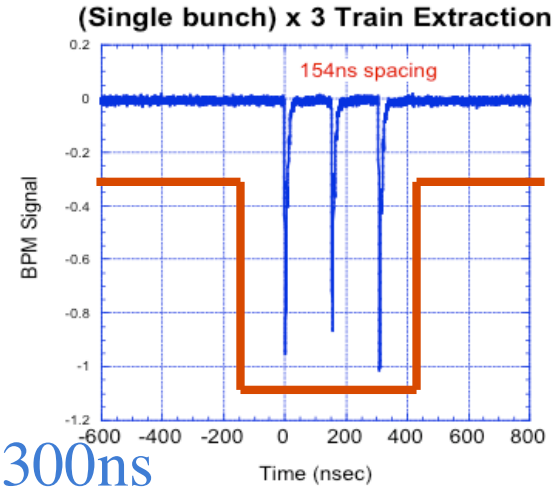






Kick angle Stability

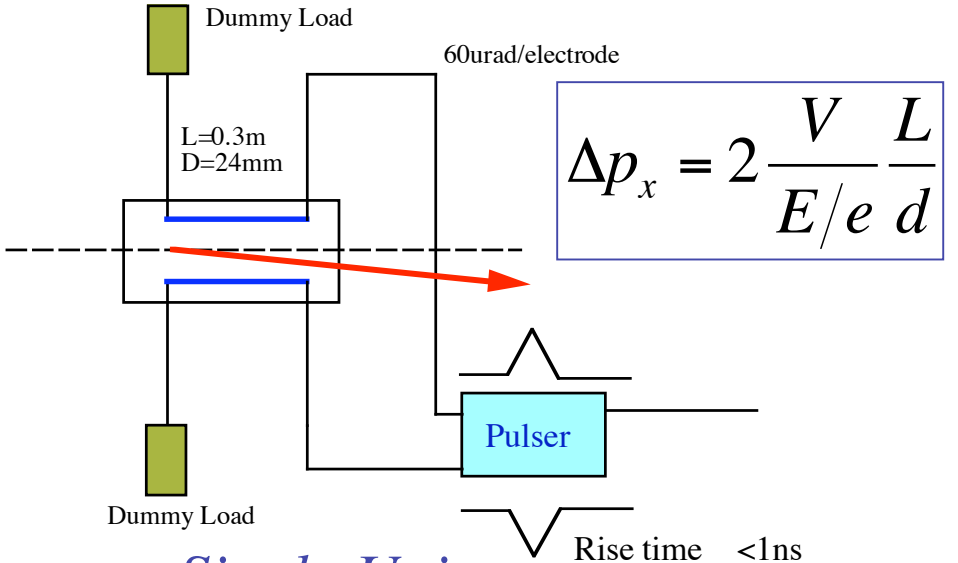
1×10^{-3} -> 2.8×10^{-4}



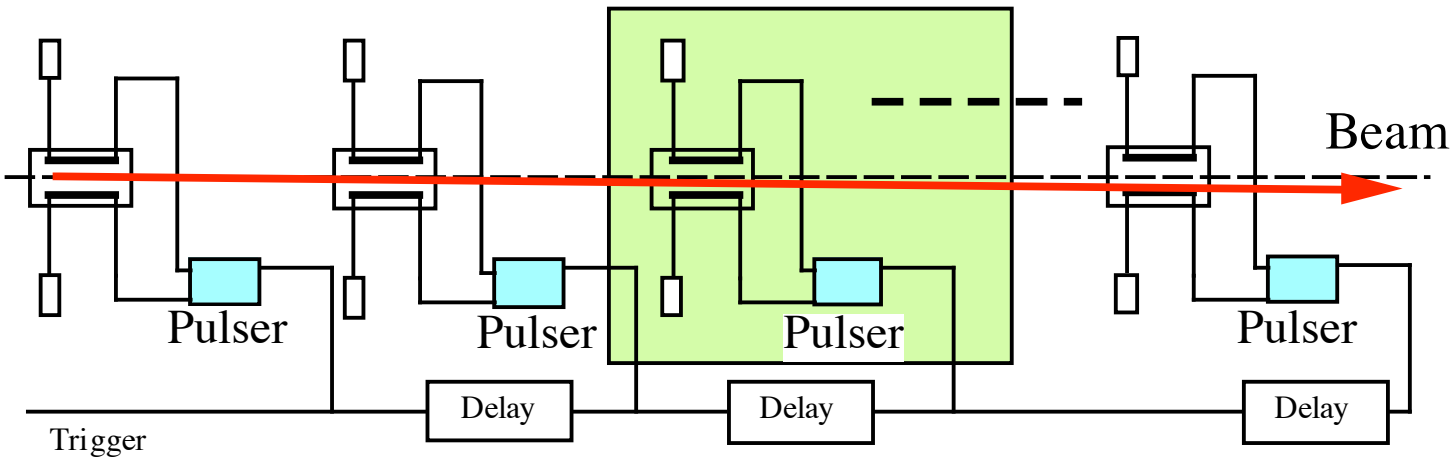
Thyratron Switch <120Hz, 40kV, 300ns

ILC kicker design

The kicker unit, which consist of the strip-line electrode and the fast high voltage pulse power supply, makes the very fast kick field, ~3ns rise/fall time. 20~40 units will be used to get the total kick angle(0.6mrad) at 5GeV, β=50m.

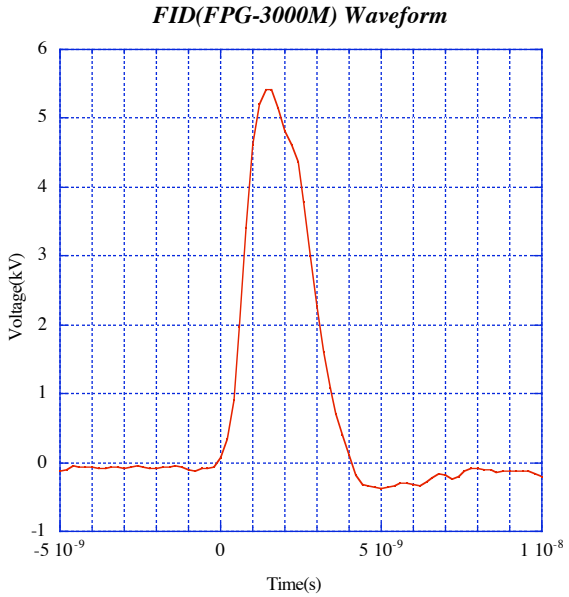


Single Unit



Pulse generator

We tested some of pulse generators, FID, Behlke, LLNL. FID Technology has very fast and high repetition rate pulse generators. The specification meets our requirement for the high voltage pulse source. We tested the kicker performance by using the pulser.

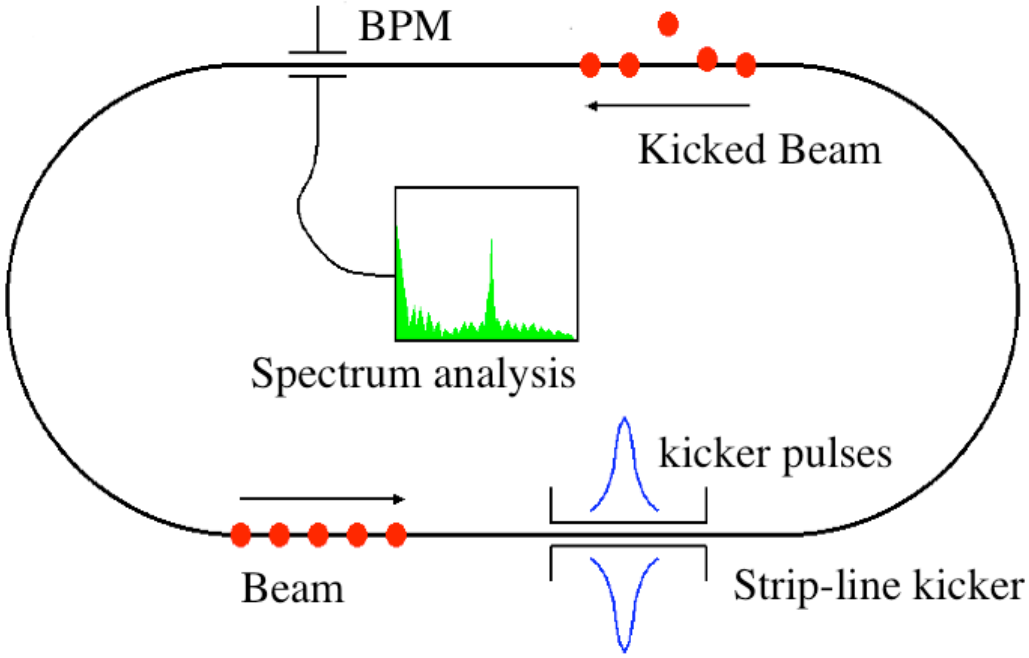


Specifications

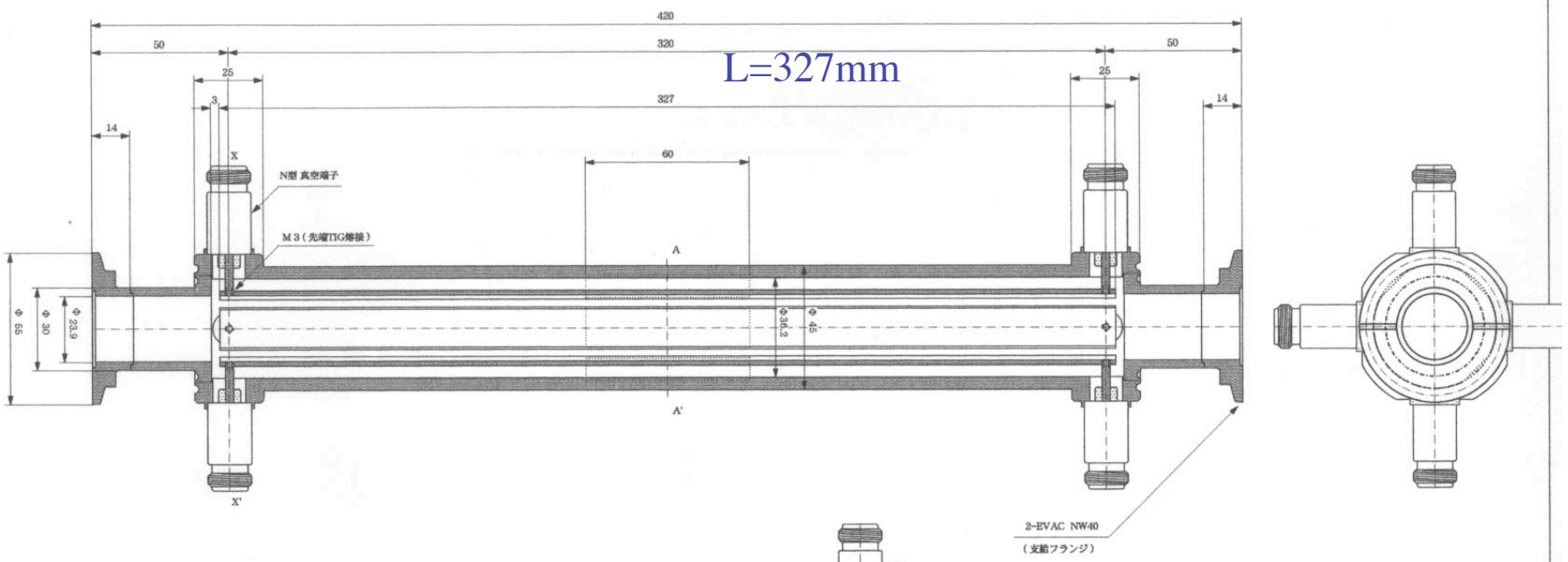
Amplitude at 50 ohm : 5 kV
Rise time : 1-1,2 ns
Pulse width at 50% of amplitude : 2-3 ns
Maximum PRF in burst mode - 3 MHz

Beam kick test in ATF DR

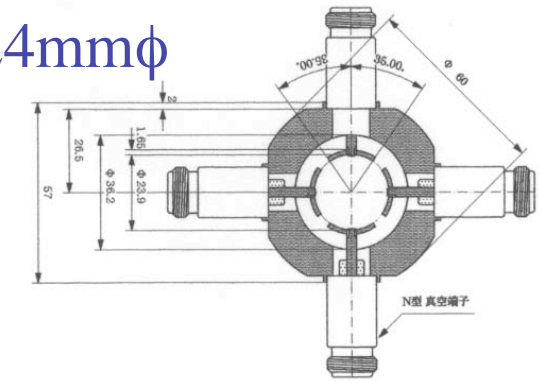
We fabricated the single unit of the strip-line kicker.
The kicker pulse is applied to the strip-line electrode at just the time of the beam goes through the electrode.
The beam kick is observed by a turn-by-turn BPM as the amplitude of the oscillation of the betatron frequency component.
The kick effect is measured by scanning the pulse timing.



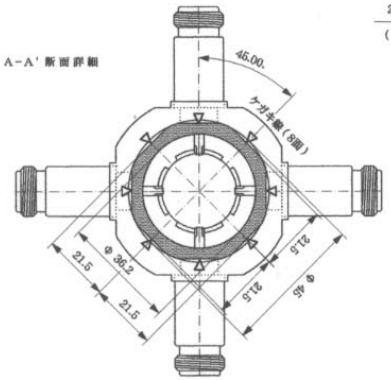
ATF Kicker chamber for beam excitation



X－X' 断面詳細



A－A' 断面詳細



仕　様

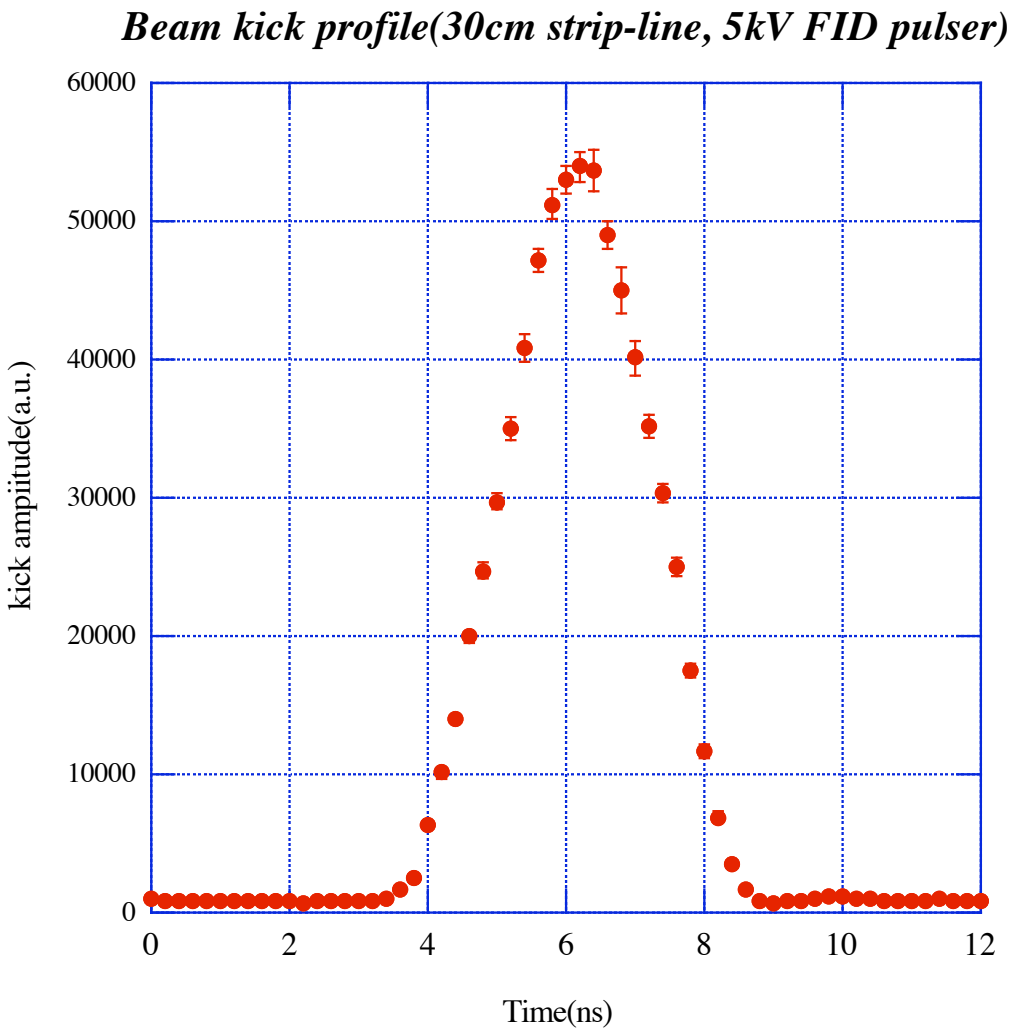
接　合	T I G 溶 接
リーク量	1×10^{-10} Pa・m³/sec
表面処理	電解研磨（但し BA管使用時は不要）

材質　SUS304

数量　1　個

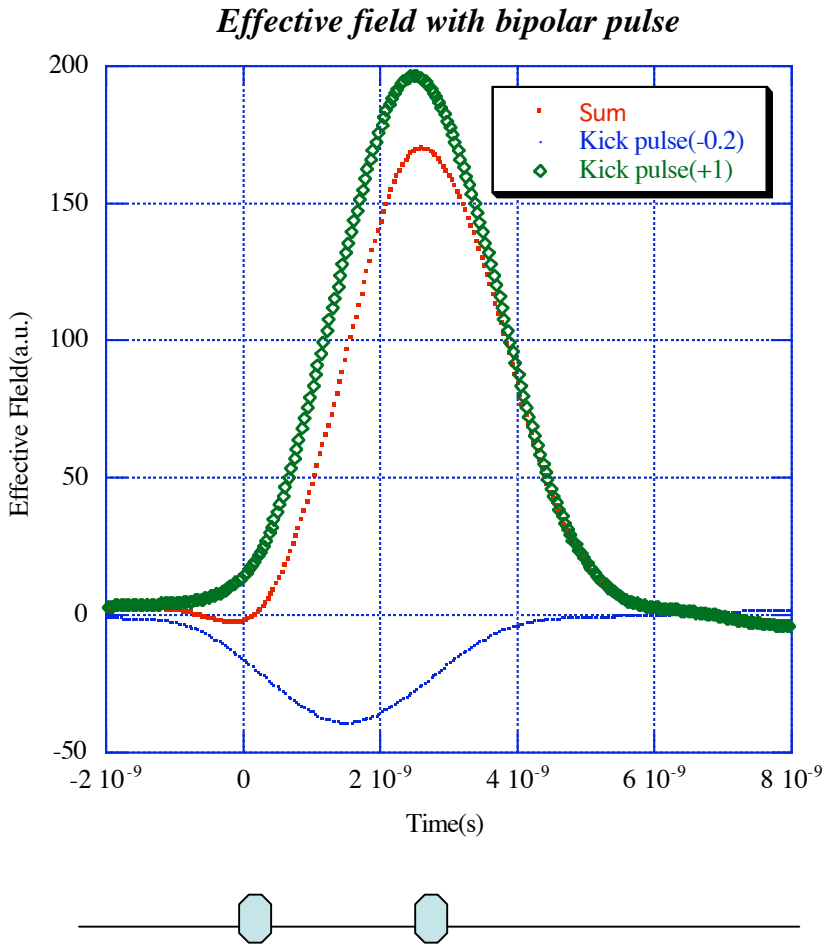
三角法	尺度 1／1	作成：2000年　月　日	
記事	確認	四極エクシター電極	
	設計 清野	図番：2－0110　改符	
	有限会社　清和製作所	工事番号 9068	

Measurement result of FPG5-3000M



Rise time~3.2ns
Kick angle ~85μrad
(calc.　94.7μrad)

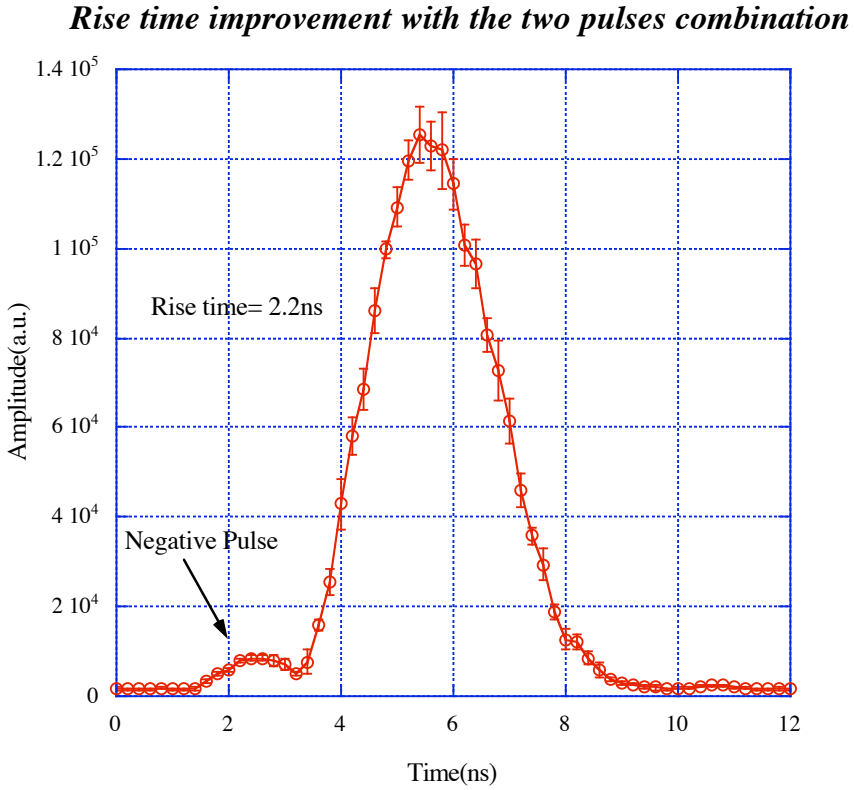
Rise Time improvement by using bipolar pulse



beam

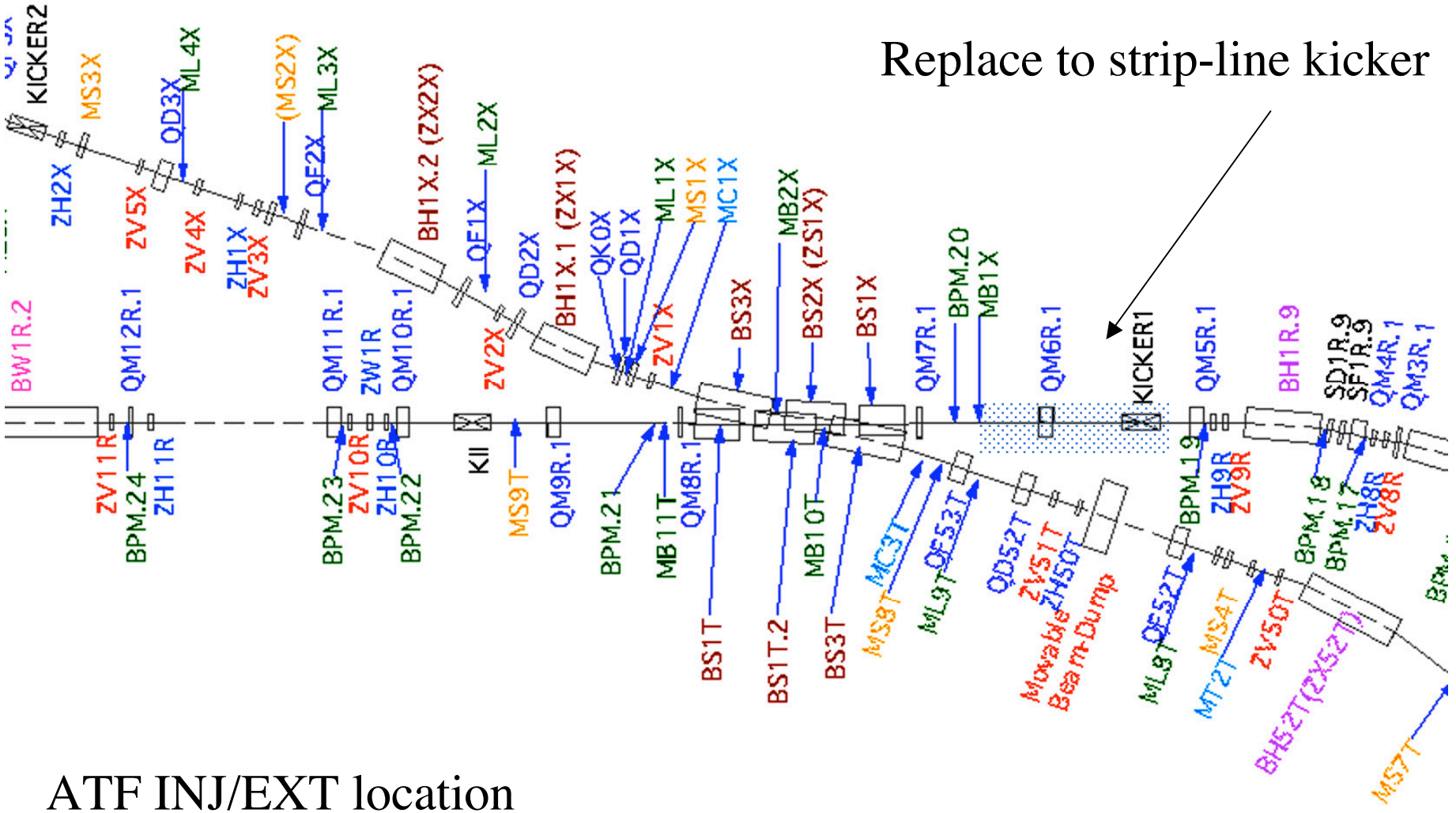
The rise time improvement was tested by applying the two pulses which has opposite polarity, different amplitude and shifted timing. The figure shows the calculation of the positive pulse(+1), the negative pulse(-0.2) and the sum of the pulses. The rise time of the sum signal is improved compare to the positive pulse. The most significant result of this idea is that the method will be able to make the zero cross field at any timing, for example, the previous beam timing or the next beam timing.

Rise time improvement test



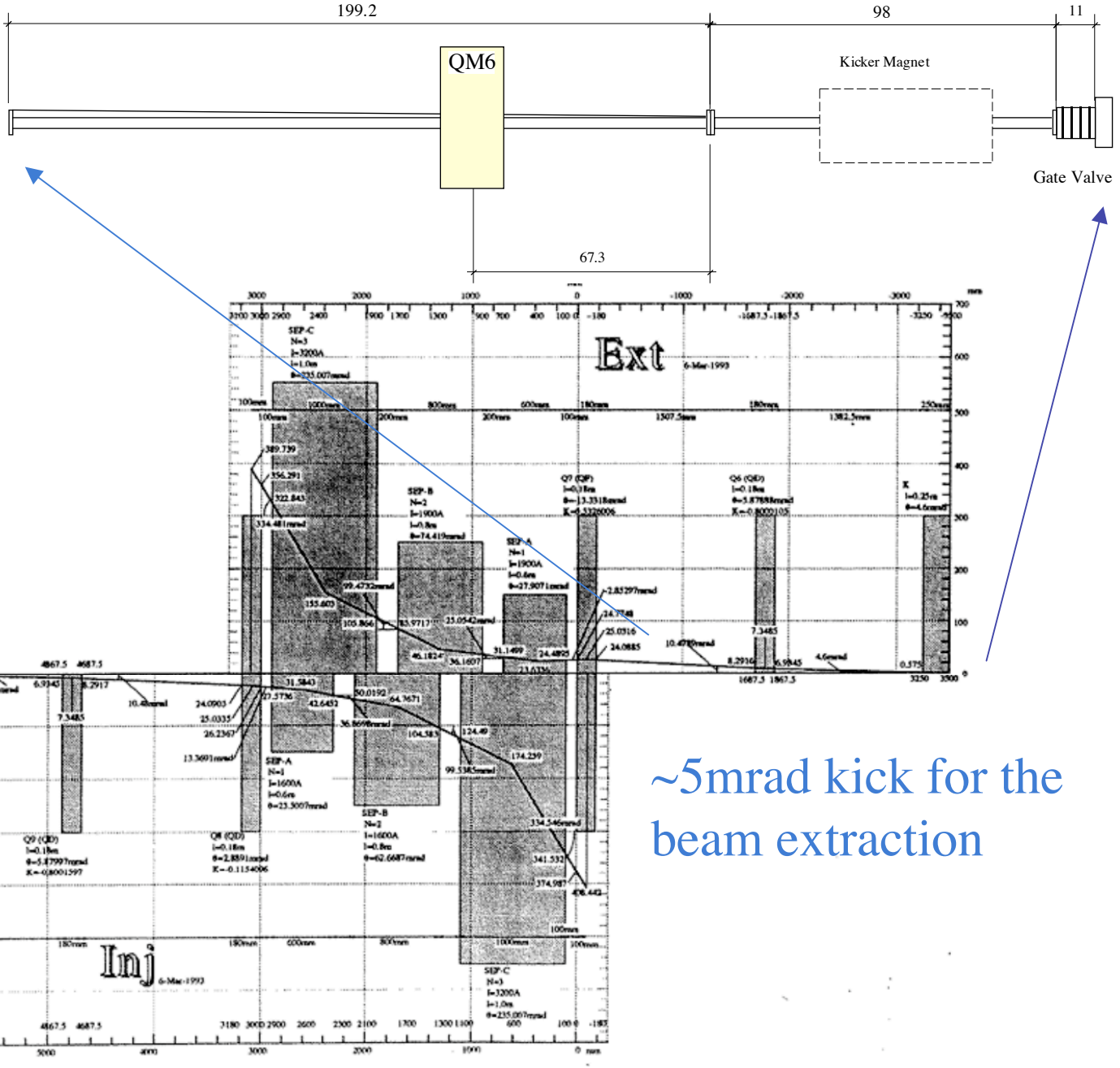
This graph shows the timing scan result at the combination of the 100% positive pulse and the 8% of negative pulse. The rise time, at the left side slope, improved from 3.2ns to 2.2ns. The small amplitude at left side of the main pulse is the negative kick pulse.

Beam Extraction Test

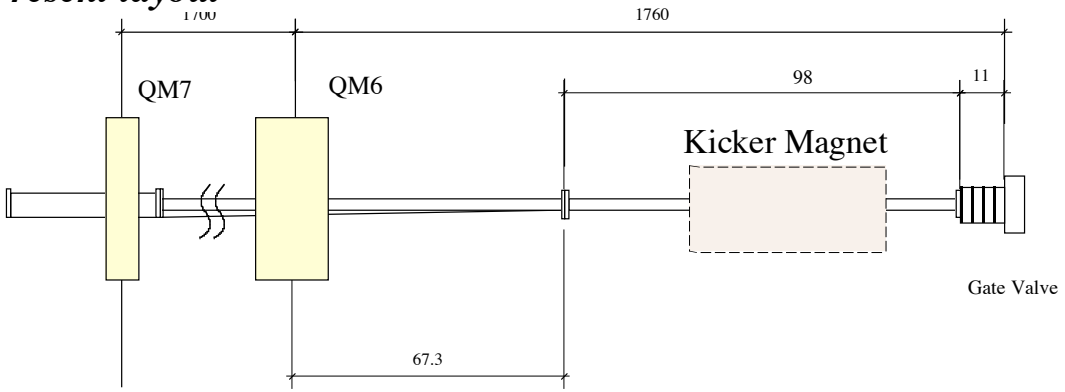


ATF INJ/EXT location

Present layout and design orbit

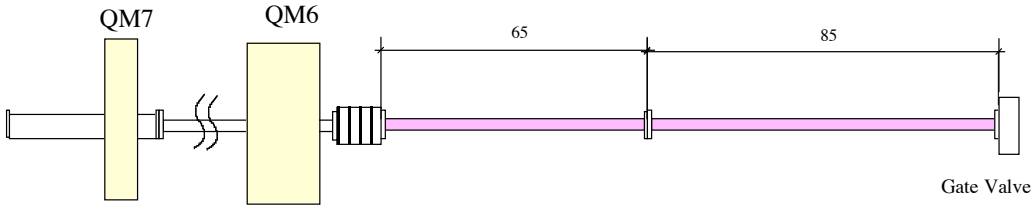


Present layout



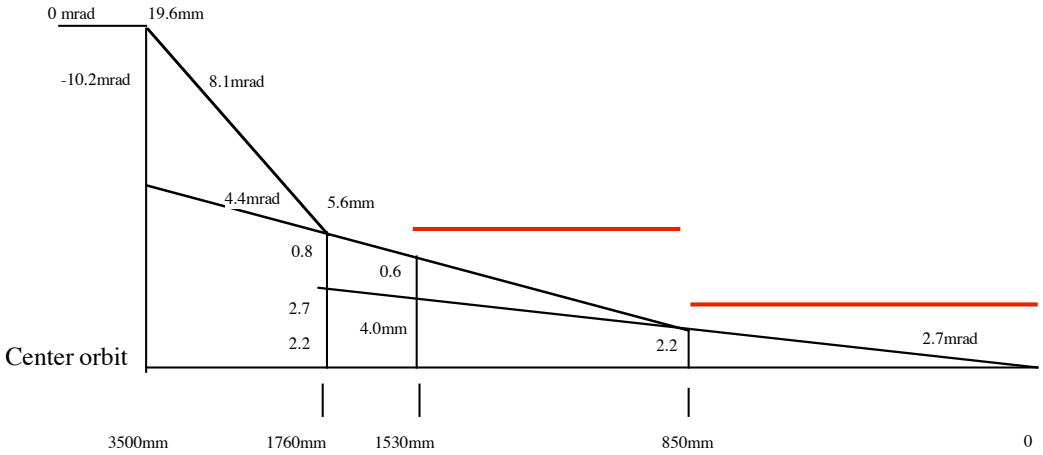
Single pulser +
2 strip-lines(1m long)

Location of Strip-lines



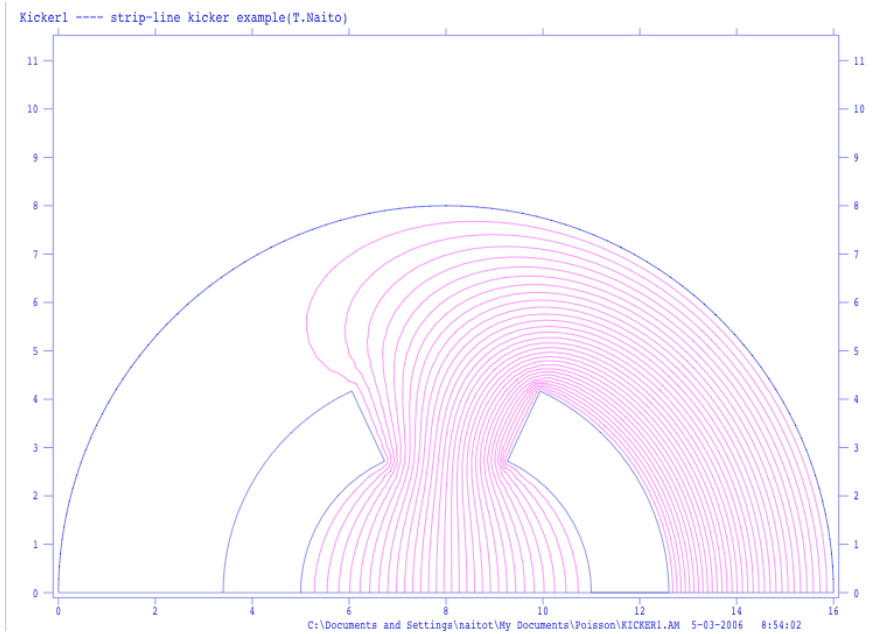
Strip-Line1 Strip-Line2

Design Orbit

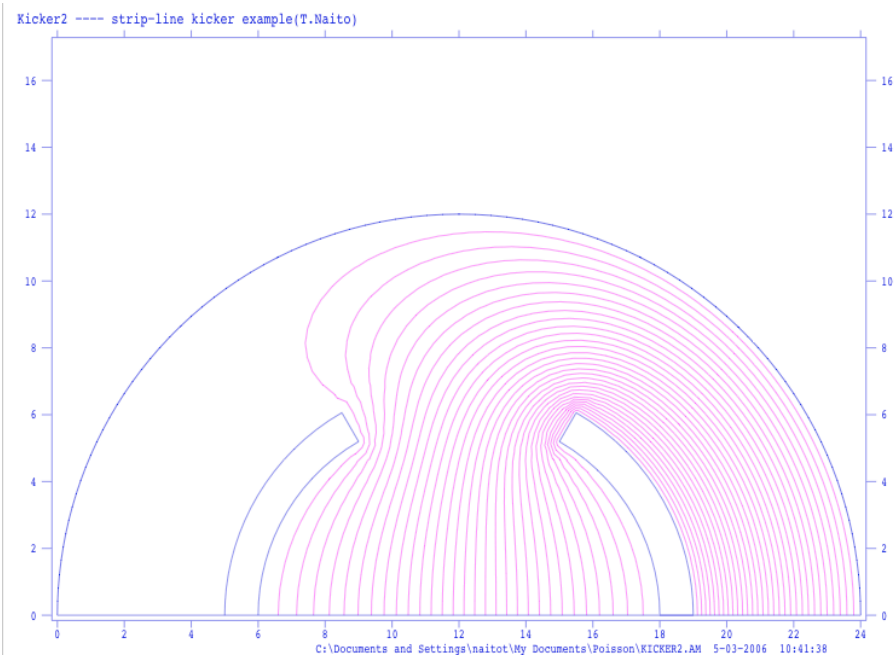


Electrode distance

Strip-line Electrode Design



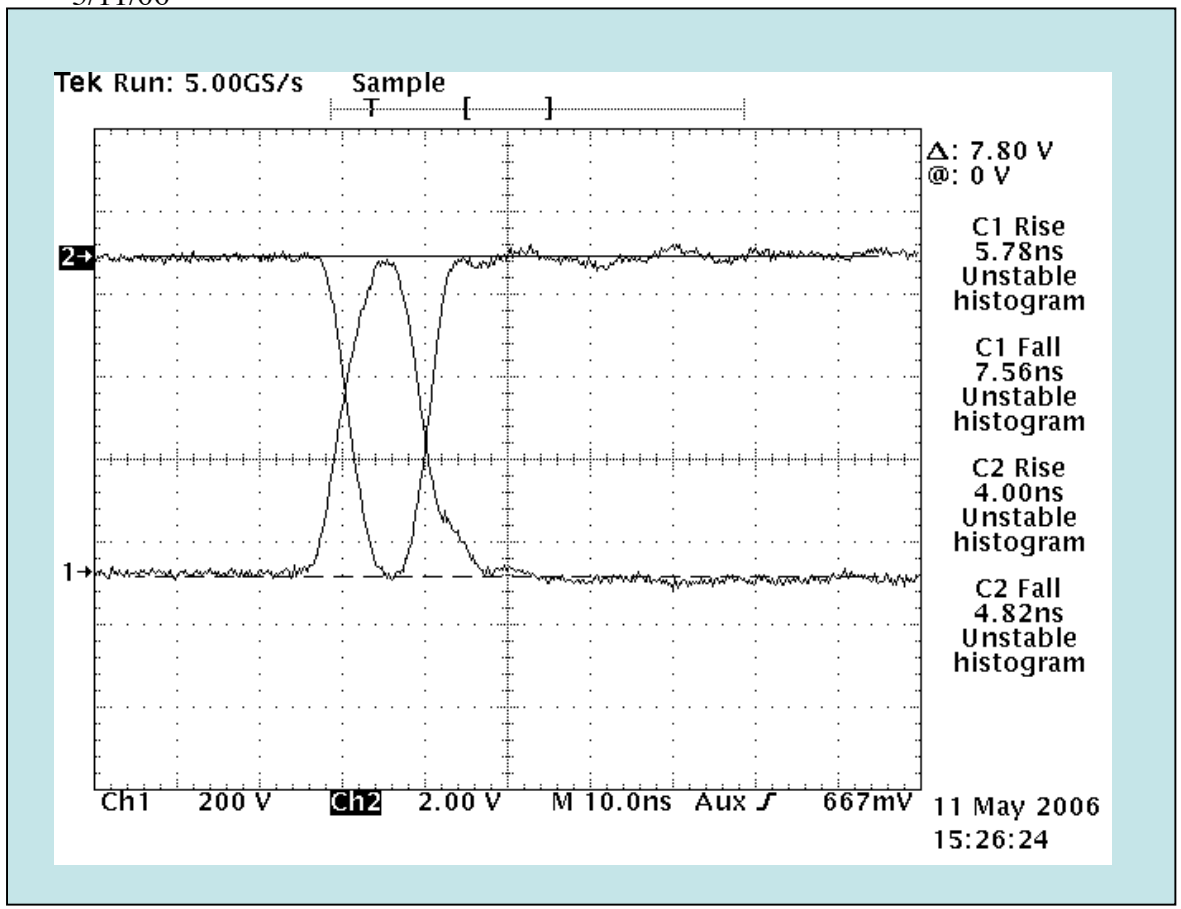
6mm ϕ



12mm ϕ

Data Taken By:
Ed Cook
5/11/06

LLNL pulser

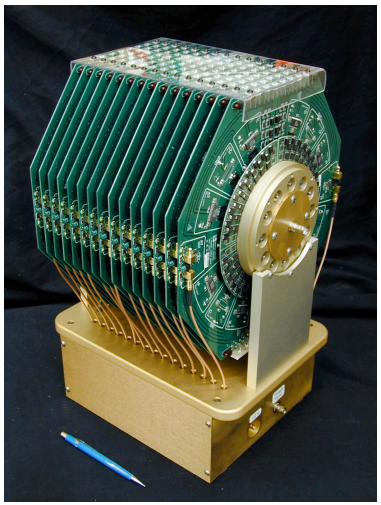


Inductive Adder pulser manufactured by Ed Cook(LLNL)

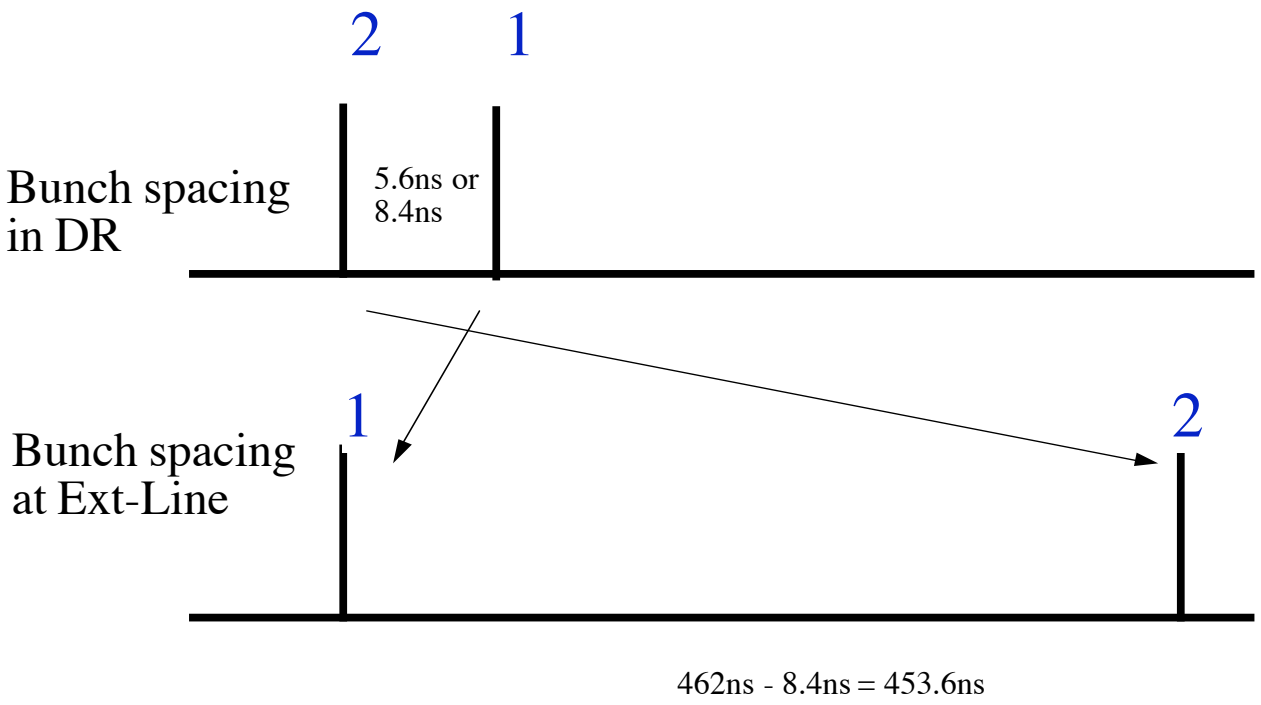
The stacked FET boards makes the high speed and high voltage pulse.

Rise time ~5.7ns

Vp ~ +/-8kV

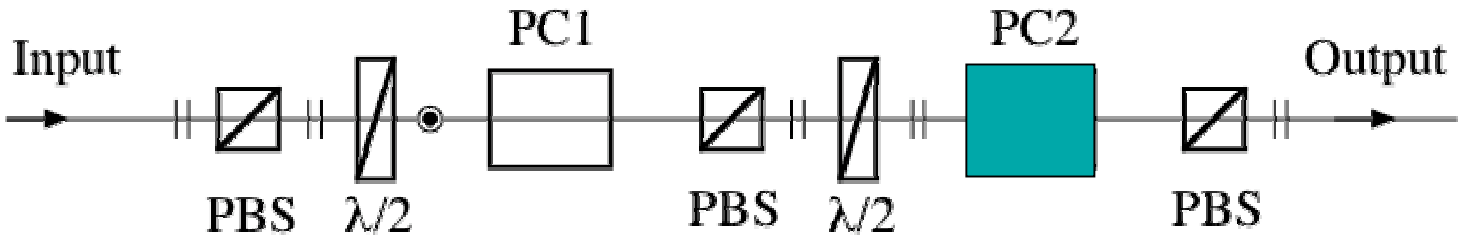


Inj/Ext Beam

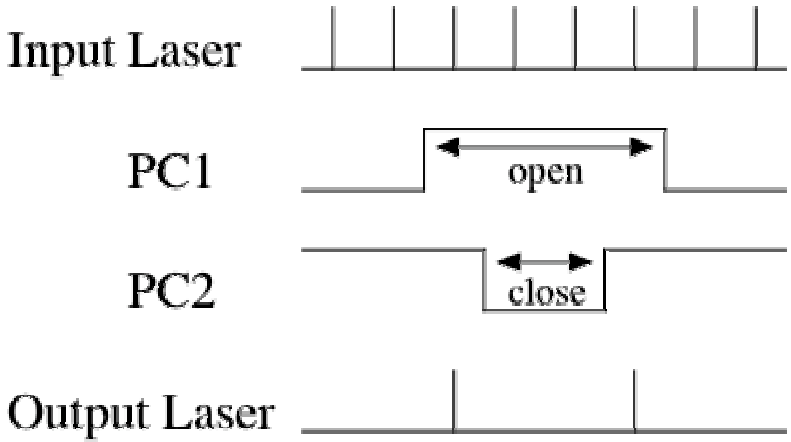


The two bunches are injected to DR at one injection cycle and the damped beams are extracted to the extraction line using two individual pulses of the strip-line kicker.

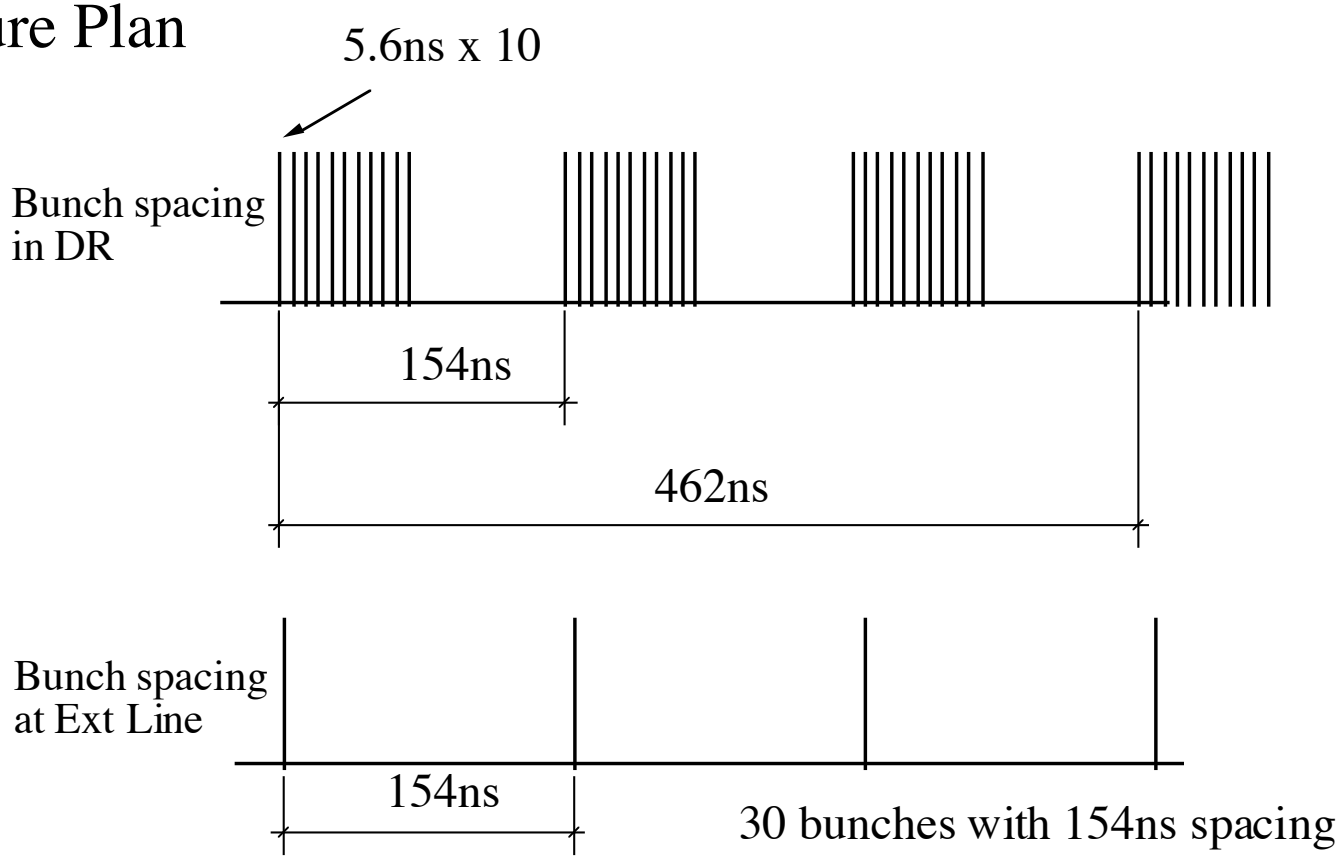
Laser modification of the RF GUN for two bunches beam generation with arbitrary bunch spacing



PC: Pockels Cell
PBS: Polarizing beam splitter



Future Plan



3 train of the bunch train will be injected in one machine cycle, the single train has 10 bunches with 5.6ns spacing and each bunch has 1x10^10 electron. The damped beam will be extracted as 30 bunches of the beam train which has 154ns spacing.

Summary

- The strip-line kicker development is caring out in ATF-DR. The fast rise/fall time profiles were measured by using FID pulser. The measured rise/fall time is about 3ns which is meet with ILC specification.
- The design and the preparation of the beam extraction test from the DR to the Extraction-Line is ongoing.
- Multi-bunch beam extraction scheme for the future plan of ATF2 is proposed.