ILC injector R&D plan
(ATF Related Projects I)

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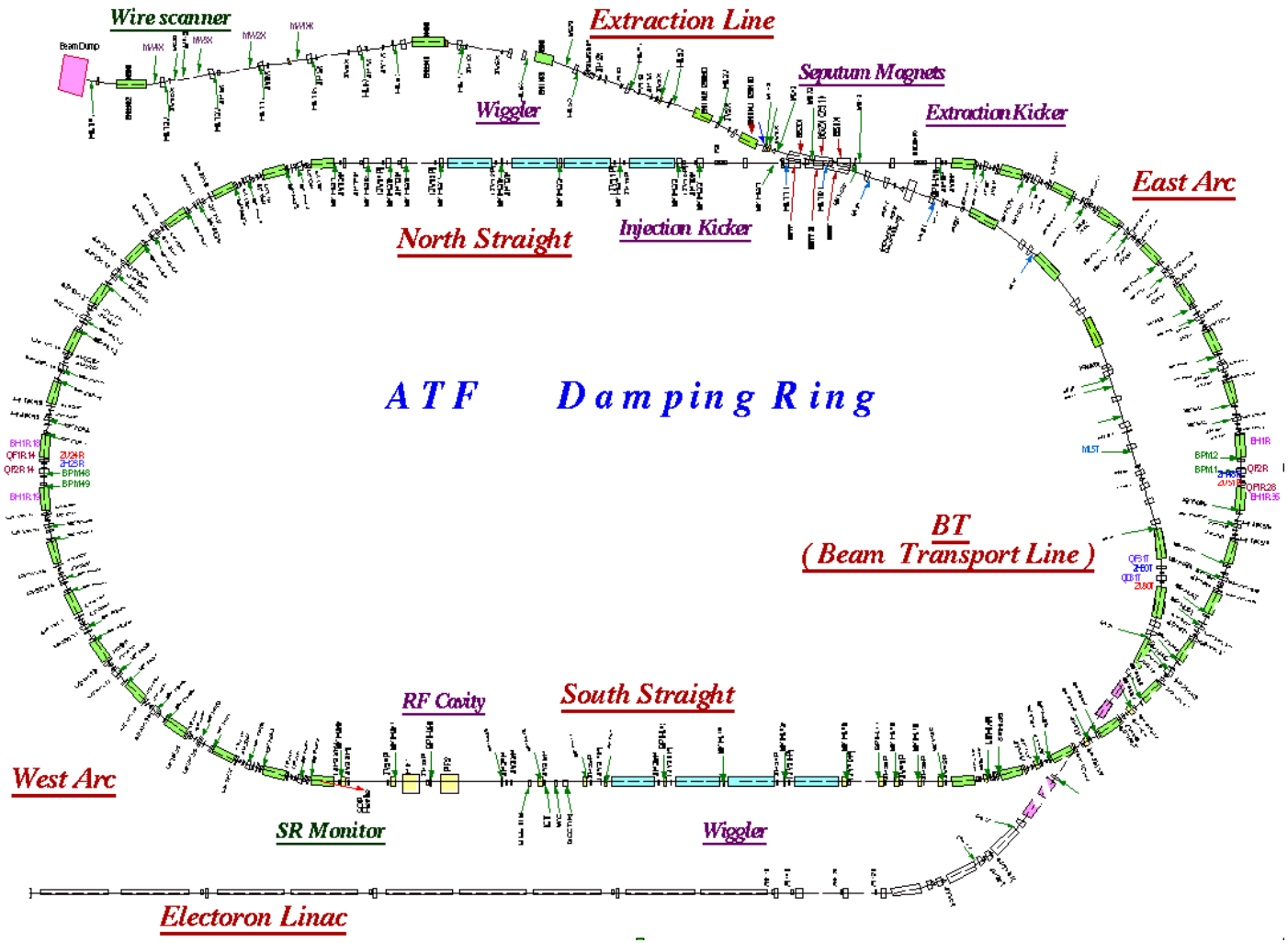
Contents

ATF Overview

- E = 1.28GeV
- N = 2x10^{10} e/bunch
- 1 ~ 20 bunches
- $\varepsilon_{x/y}$ - 1.5nm/4pm
- 20 weeks/year
- 2 weeks/month



Demonstration of Proof of Principle for the Fast Kicker - Motivation -

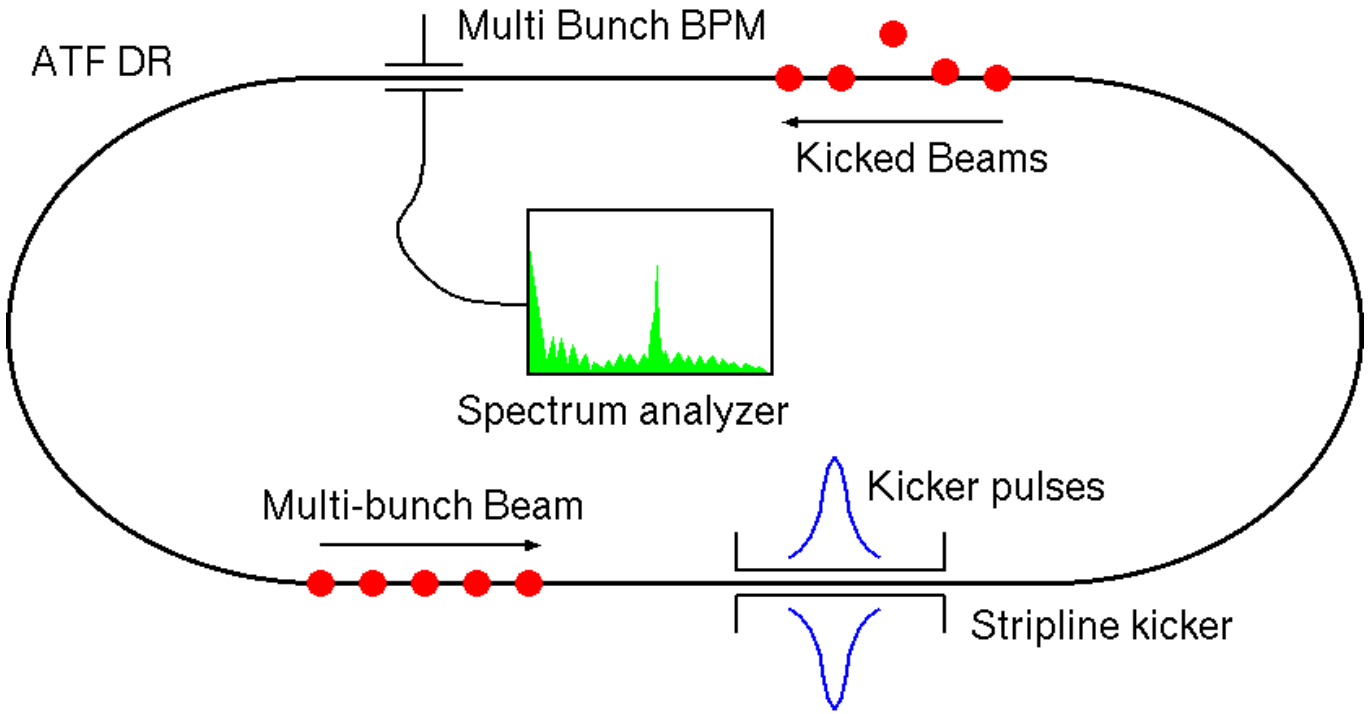
- A fast kicker is a key component to determine the DR layout that will be determined in Snowmass 05.
- Any reasonably enough demonstration has been never carried out for the fast kicker.

Motivation (2)

- If the short bunch spacing in ILC DR was proved, a smaller DR which has many merits, was realistic.
- This is an only experiment which can be carried out quickly.
- The experiment is one of the most urgent and important project.
- The project is already started as a collaboration among KEK, SLAC, and DESY.

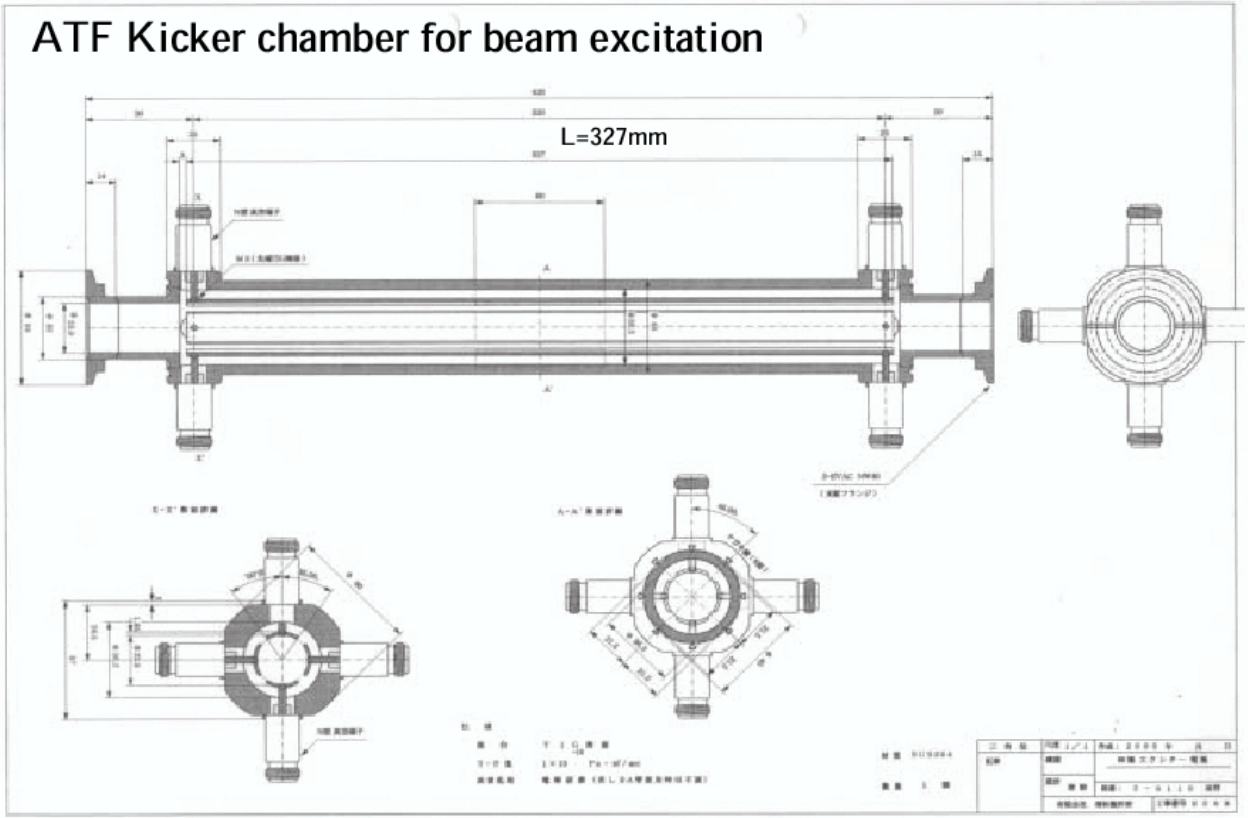
The Experiment

- A strip line kicker deflects Multi-bunch beam to qualify the shortest bunch spacing for the individual beam handling.
- The kick is observed by a multi-bunch BPM as a betatron enhancement .



ATF Strip-line kicker

- 2.2ns rise/fall time (determined by the propagation time).
- 327mm length.
- 10 kV (+-5kV).
- Kick angle ~ 60 urad makes more than 200um displacement.

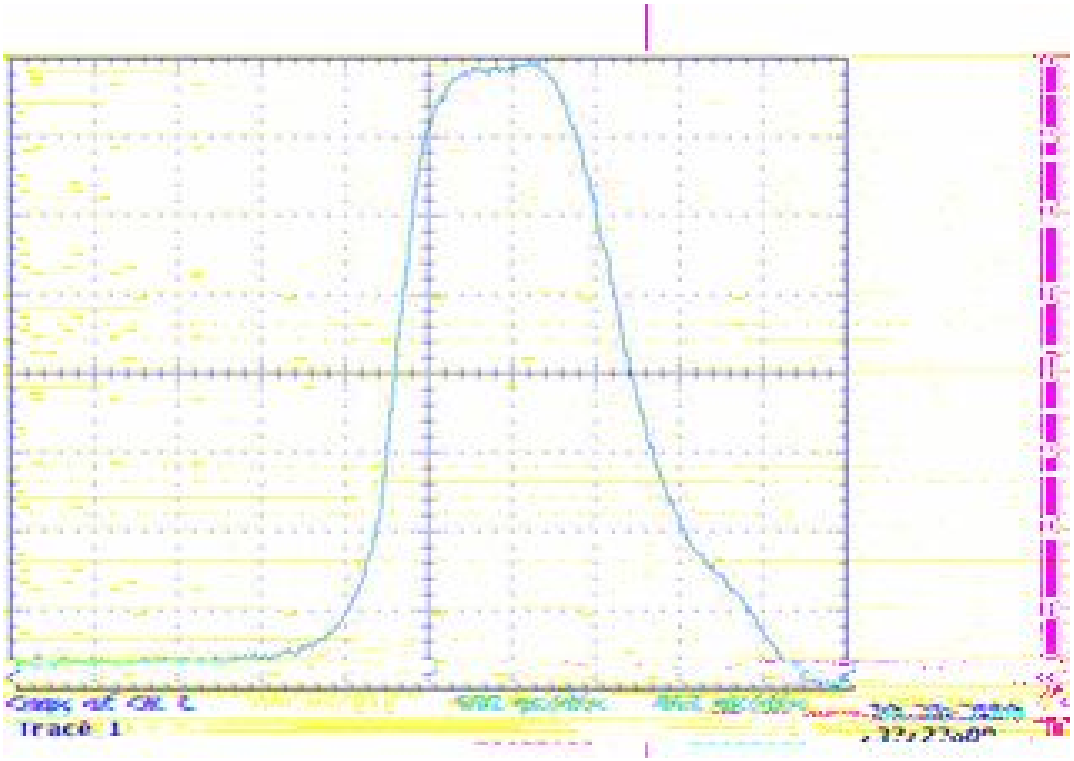


Fast Pulser

FID GmbH pulse power supply
FPG 5-3000M

Maximum amplitude at 50 Ohm - 5 kV
Rise time - 1-1,2 ns
Pulse width at 50% of amplitude - 2-3 ns
Jitter - not more than 100 ps
Maximum PRF in burst mode - 3 MHz
Delivery - 5-6 months
Warranty - 12 months
Price - 1 pc EUR 53000

2 pcs EUR 99000 (From Naito)

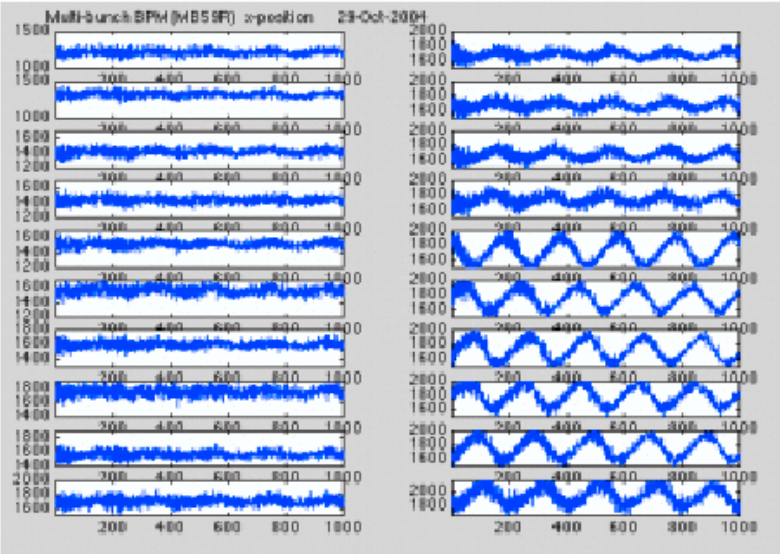


Compatible to ILC requirement!

Multi-bunch BPM

- A button type BPM with FADC turn by turn processing.
- Individual turn by turn position measurement for each bunch.
- By analyzing the data, the betatron oscillation amplitude is obtained with a high accuracy (~several tens um) which is enough to observe the enhancement.

An example of MB oscillation measurement



Schedule

- The strip-line kicker is almost ready.
- MB BPM will be implemented in January 05.
- The pulser will be manufactured until March 05.
- The experiment is carried out on May and June 05.

Experiment on Positron Target at KEKB - Motivation -

- Positron production scheme has a couple of candidates:
  - 1) Conventional + CS
  - 2) Undulator
- Conventional is more reliable, more simple, and more cost-effective.
- Undulator is a new scheme, more complex, and more expensive.

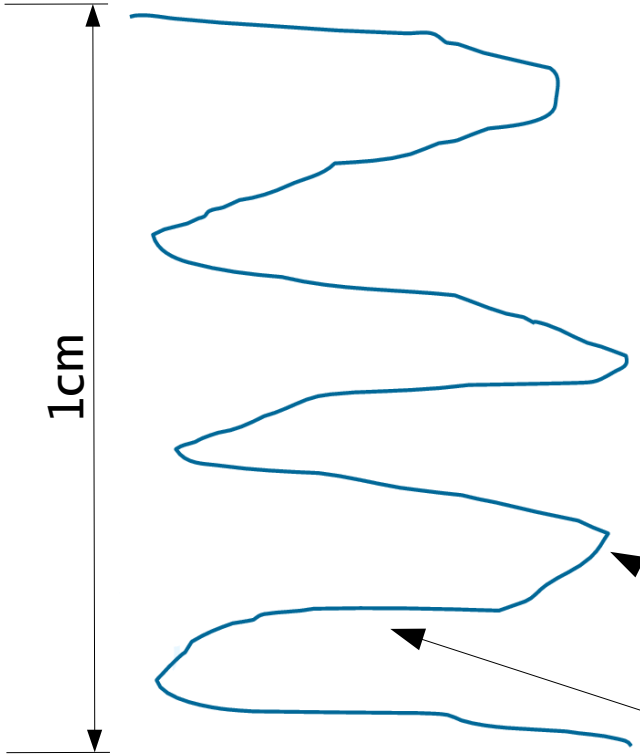
Motivation (2)

- In the view of the system simplicity, the conventional scheme is desirable.
- The biggest issue for the conventional scheme is radiation damage including the target break and the environmental contamination.
- The choice will make in Snowmass 05. To establish the reliability, this is an only experiment which can be carried out quickly.
- The experiment is urgent and important.

The Experiment

- ILC : 6GeV, 3nC, 2850 bunches.
  - 18 J for one bunch.
  - 51300 J for one pulse.
- KEKB: 8GeV, 10nC, 1300 bunches.
  - 80 J for one bunch.
  - 104000 J for one pulse (stored beam).
- By injecting the KEKB stored beam into a test target set on the beam dump, the target damage in ILC could be reproduced.

KEKB Beam Dump

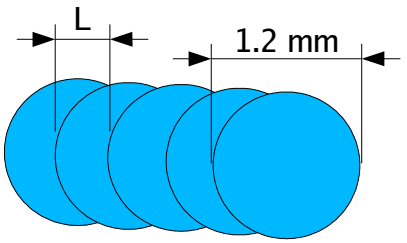


- HER: 8GeV, 10nC, 1300 bunches.
- Bunch spacing 6-8 ns.
- The beam is deflected as shown when it is dumped.
- The step size for next bunch depends on the position:
  - The smallest step is 0.007mm.
  - The largest step is 0.053mm.

Bunch Overlap

- Assume 0.6mm radius giving 1mm^2 spot size. KEKB beam size is much small, but the size means EM shower distribution in the target.
- Taking beam energy E(GeV), intensity N(nC), and step size L(mm), the energy deposit Q (J/mm^2) .

$$Q = \frac{2 \times 0.6}{L} E \times N$$



Energy Deposit

- ILC : 6GeV, 3nC, 340ns spacing, 0.017mm shift for next bunch (50 m/s rotation).
  - 18 J/mm^2(*) for one bunch.
  - 70.6 bunches overlap giving 1270 J/mm^2.
- KEKB: 8GeV, 10nC, 7ns spacing, 0.007 – 0.053mm shift for next bunch.
  - 80 J/mm^2 (*)for one bunch.
  - 23-172 bunches overlap giving 1810 – 13700 J/mm^2.

* Assume 1mm^2 spot size.

Comparison

- KEKB energy deposit is more than that in ILC. The ILC energy deposit can be reproduced by adjusting the intensity.
- Both energy deposits are well above the single bunch threshold established in SLC operation.
- The damage on the ILC positron production target can be qualified with this experiment with assistance of simulations.

	SLC	ILC	KEKB
Bunch energy (J)	320	18	80
Energy deposit (J/mm^2)	320	1270	1810 – 13700

Schedule

- Design the target load system : until January 05.
- Writing a proposal to LCPAC until February 05.
- The experiment is carried out until July 05.

Other Projects (1)

- Fast kicker development to extract the beam in ILC format. The priority is next of the express items.
  - Several fast pulser R&Ds are in progress as collaborations with SLAC, DESY, etc.
  - When any reliable device is established for ATF operation, the kicker is manufactured and installed.
- Epoxy magnet kicker making a very long pulse to extract all bunches in DR for the fast feedback experiment.
  - SLAC will manufacture it.
  - The technology is well established.

Other Projects (2)

- Fourier series kicker as a future option.
  - Array of RF deflectors with different frequencies make a sharp peak which allows a shorter bunch spacing.
  - The kick may be transverse or longitudinal with a dispersive section.
  - Stability will be excellent due to the CW operation, but the technology is still premature.
  - It is going to be a good option for shorter bunch spacing operation with less bunch intensity at the energy upgrade.

Other Projects (3)

- Improve ATF performance: A large impact on ATF II.
  - 1pm emittance by a super high-resolution BPM.
  - Extracted beam stabilization with a feed-forward beam control.
  - Improve the extracted beam emittance by reducing XY coupling in the extraction line.
- These projects are natural extensions of the current activities of the collaborations (FONT, NanoBPM, and ATF II).

Summary

- ILC injector has tons of issues to be settled.
- Kicker Demonstration at ATF and Positron Target Test at KEKB are the express items to be done and can be done until Snowmass 05.
- ATF improvements are very important to make full use of ATF and ATF II.
- The kicker stability will be a final issue to determine the ILC performance. It has to be examined at some period with a real beam.