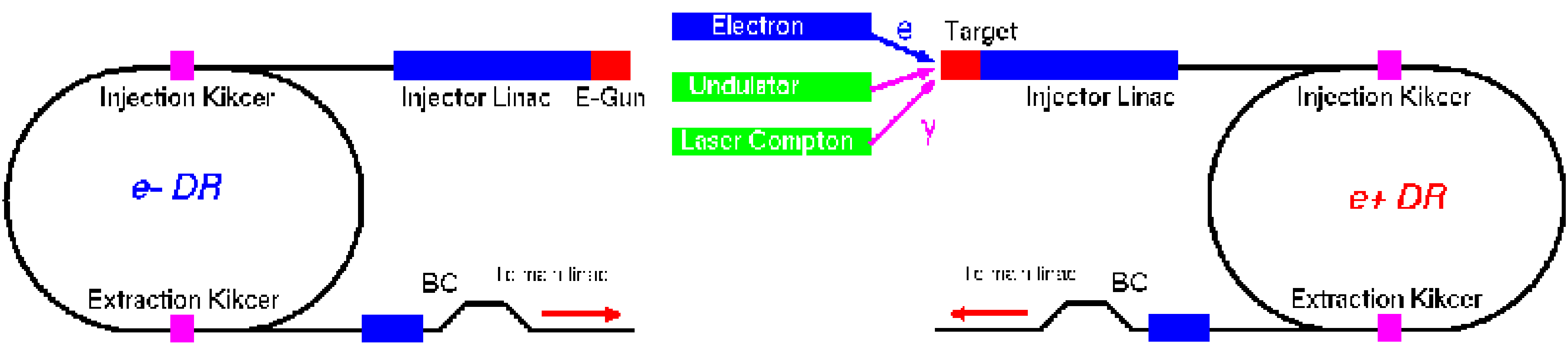
Injector and DR Design Status and Issue

KURIKI Masao
ILC Asian WG3(a) convener

- Introduction
- WG3a task and effort
- WG3b task and effort
- Summary

Introduction
-ILC Injector-

- Because the damping takes full inter-pulse period (200ms), all 2800 bunches have to be stored in DR simultaneously.
  - 3nC x 2800 bunches with 330ns spacing



Introduction
-WG3 Structure-

- WG3 is reformed to a) and b).
- WG3a (M. Kuriki, J. Sheppard, J. Clark)
  - Electron and positron sources.
  - Injector linacs.
- WG3b (J. Gao, A. Wolski, S. Guiducci)
  - Electron DR
  - Positron DR
  - Subsystems
  - BC and BT belong to WG1.

WG3a Tasks
-Electron Injector-

- Electron source : No other choice than DC photo-cathode gun at this moment.
  - R&D to improve the performance, e.g. cathode life time, DC high voltage, etc.
- Choice on the injector linac.
  - Warm linac make the laser and the injection kicker easy, but need a shorter damping time of DR.
  - Cold linac has opposite properties.

WG3a Task
-Positron Injector-

- Positron production schemes can be categorized
  - a) Planar and b) Helical undulators.
  - c) Electron beam driven Conventional.
  - d) Compton.
- Technical investigation is on going.
- Results will be documented. Based on the document and the discussion in Snowmass, the technical assessment will be taken.

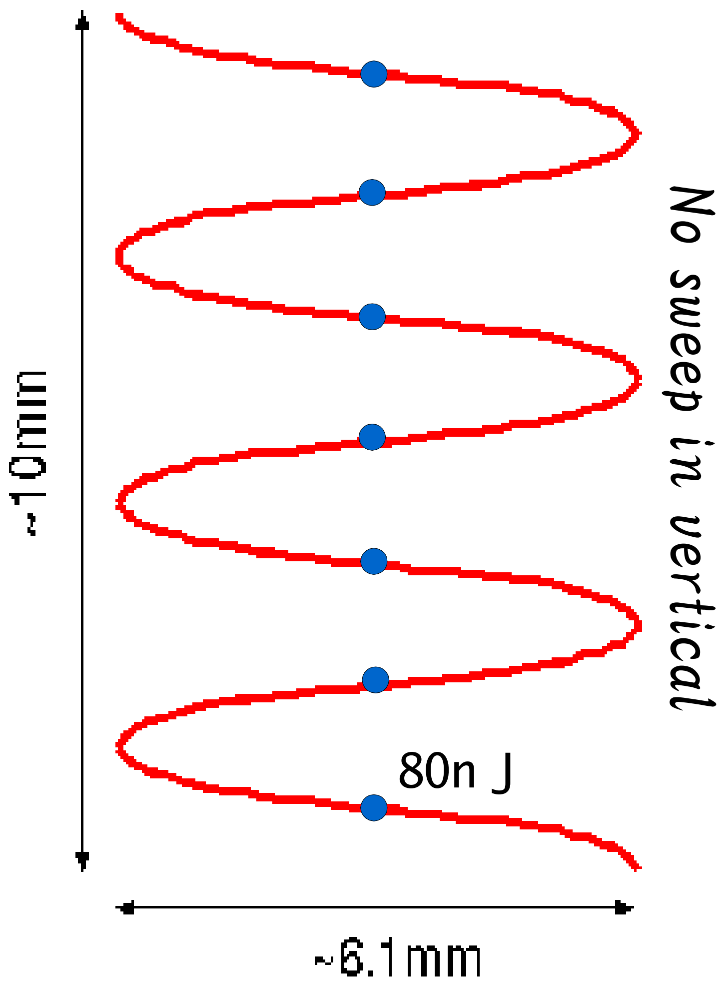
WG3a: Asian Contribution

- Polarized electron source development at Nagoya.
  - ILC-PES(Polarized Electron Source) group will be formed. Nagoya will be the Asian regional center.
- IPPAK (ILC Positron Project At KEKB).
  - Provide an important information of the target damage threshold to the assessment.
- Conceptual design of Compton based e+ source.
- Demonstration of proof of principle of Compton scheme.

IPPAK
ILC Positron Project At KEKB

- IPPAK will demonstrate the target hardness against the electron beam.
- Test target : W(74)-Re(26) alloy
- Drive beam : KEKB HER stored beam.

Experimental Mode



- KEKB mode
  - Use the normal KEKB dump beam.
  - Duration to make the energy deposit is much shorter. Reproduce only the energy density.
- ILC mode
  - Turning off the vertical kicker.
  - Bunches at the zero-cross hit a same spot every 1430ns.
  - Reproduce energy density and flux.

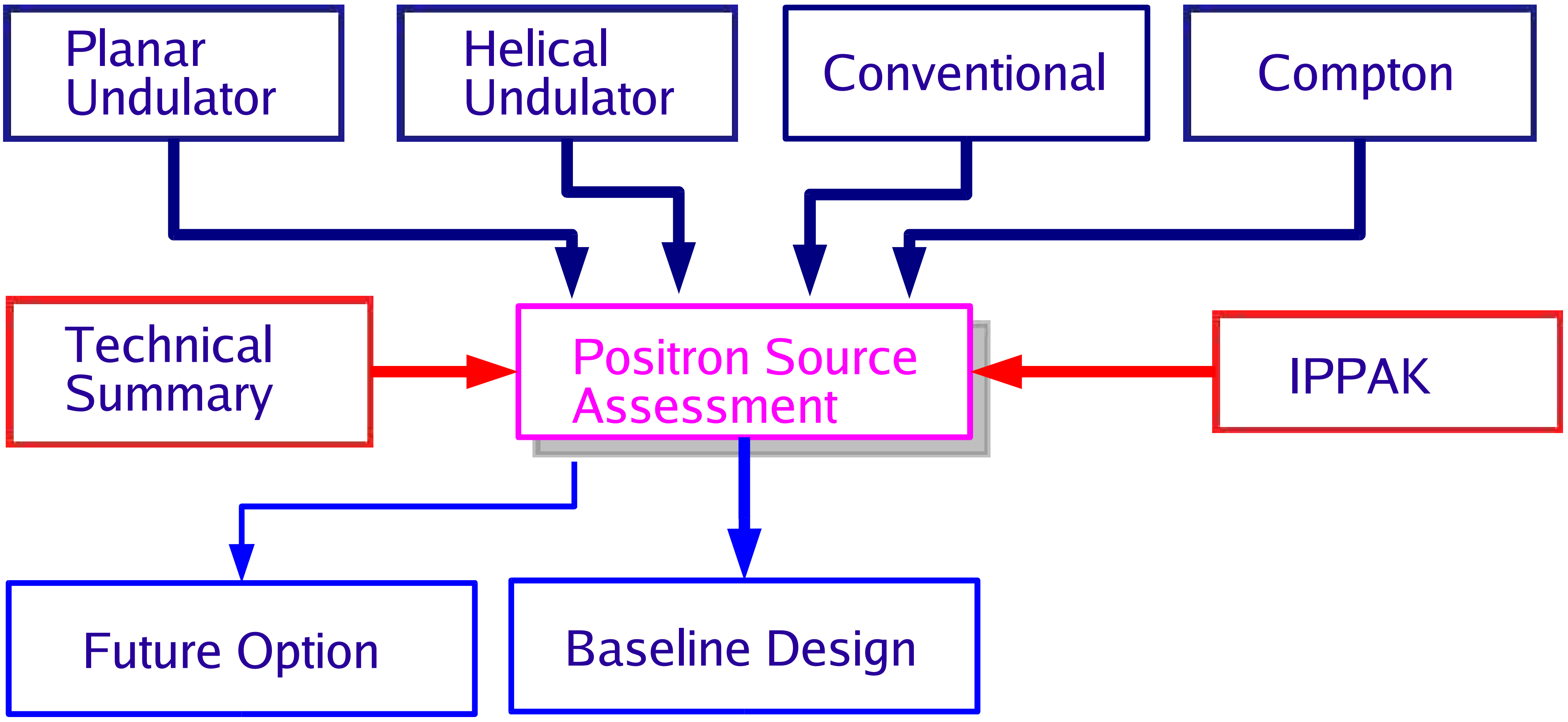
Results

- Investigation with an optical scope .
- Significant damage(many cracks) was observed in KEKB mode.
- Nothing but a colored area was observed in ILC2(significant), ILC1(not clear) modes.
- Nothing was observed in ILC0.7 mode.

IPPAK Summary

- The Significant damage was observed in KEKB mode, but not in ILC2, 1, 0.7.
- Because energy density of both modes is in a same range, it might show some temporal effect easing the damage.
- By considering only this sudden effect, the target load corresponding to those in ILC1 and 0.7 is acceptable.
  - ILC1 : 50m/s rotation and 2ms pulse, or 100m/s rotation and 1ms pulse.
  - ILC07 : 50m/s rotation and 3ms pulse, or 150 m/s rotation and 1ms pulse.

WG3a Flow Chart



WG3a: Asian Strategy

- Propose the warm linac as the electron injector.
- Recommend the conventional e+ production as the base line because of the simplicity.
- Consider Compton scheme as an advanced option for the polarized e+ at this moment.

WG3b task

- Decide the DR system.
  - Circumference and layout.
  - Bunch fill pattern.
  - Beam injection and extraction schemes.
- Since it is hard to select one design scientifically, we assess the proposals: DR assessment task.

DR Assessment Task

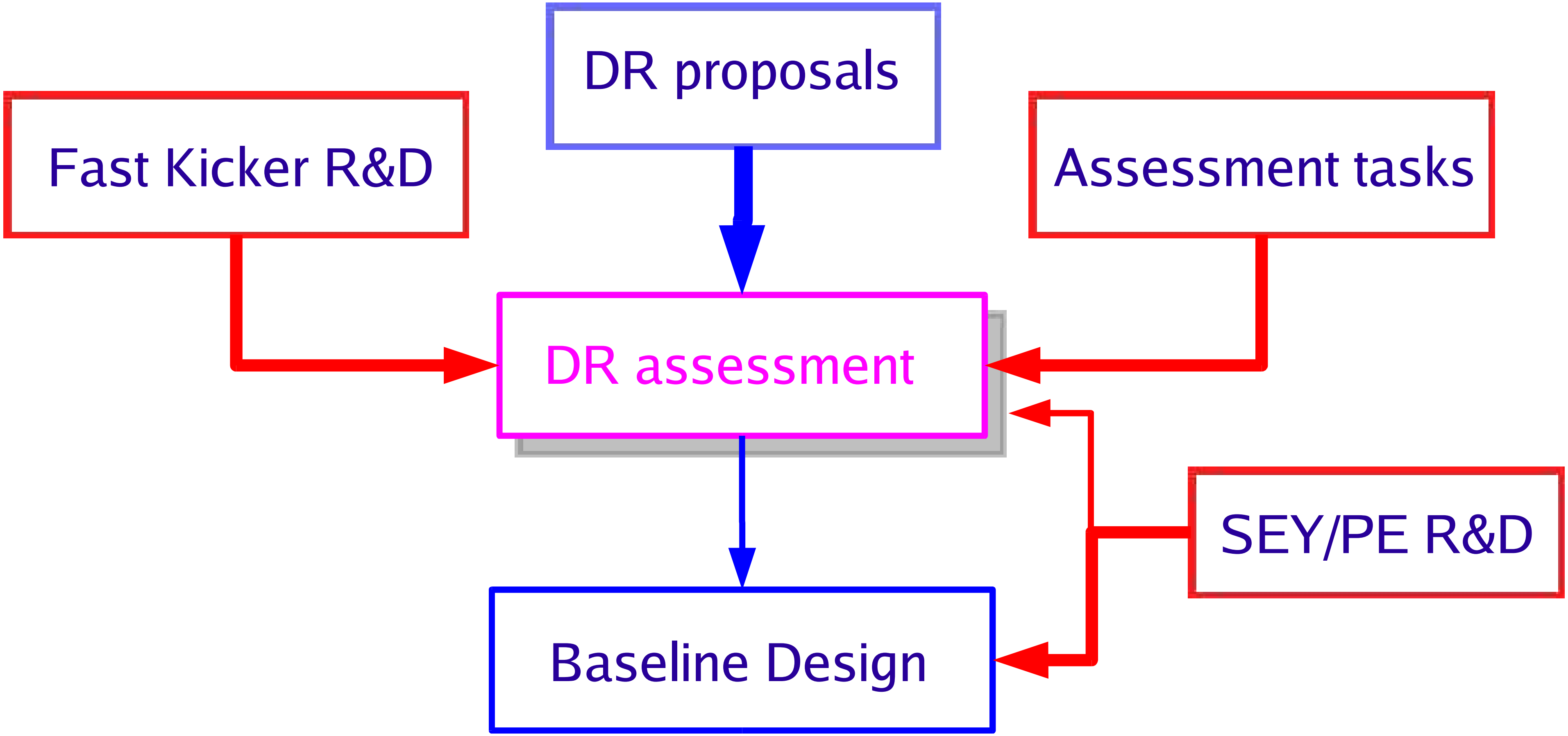
- Obligation : Provide information of the issue.

Task #	Description	Leaders
1	Dynamic aperture	Y. Cai (SLAC), Y. Ohnishi (KEK)
2	Vertical emittance tuning and tolerance	J. Jones (Darebury), K. Kubo (KEK)
3	Classical instabilities	A. Wolski (LBNL), TBA
4	Characterize space-charge effects.	M. Venurini (LBNL), K. Oide(KEK)
5	Kickers	M. Ross (SLAC), T. Naito (KEK)
6	Electron cloud effects	F. Zimmerman (CERN) or R. Wanzenberg (DESY), K. Ohmi(KEK)
7	Fast-ion effects	M. Pivi (SLAC), Eun-san Kim (Pohang)
8	Make cost estimates.	J. Nunan (ANL), S. Guiducci (INFN), J. Urakawa (KEK)
9	Beam losses	S. Guiducci (INFN)
10	Estimate de-polarization	D. Barber (DESY)
11	Pre-damping ring evaluations	M. Kuriki (KEK)

Asian Contribution

- Fast kicker study at ATF (KEK, SLAC, DESY).
- SEY/Photo-emission study at KEKB.
- DR Assessment tasks;
  - Dynamic Aperture.
  - Space charge.
  - Electron cloud effect.
  - Fast Ion Instability.
  - Pre-DR study.

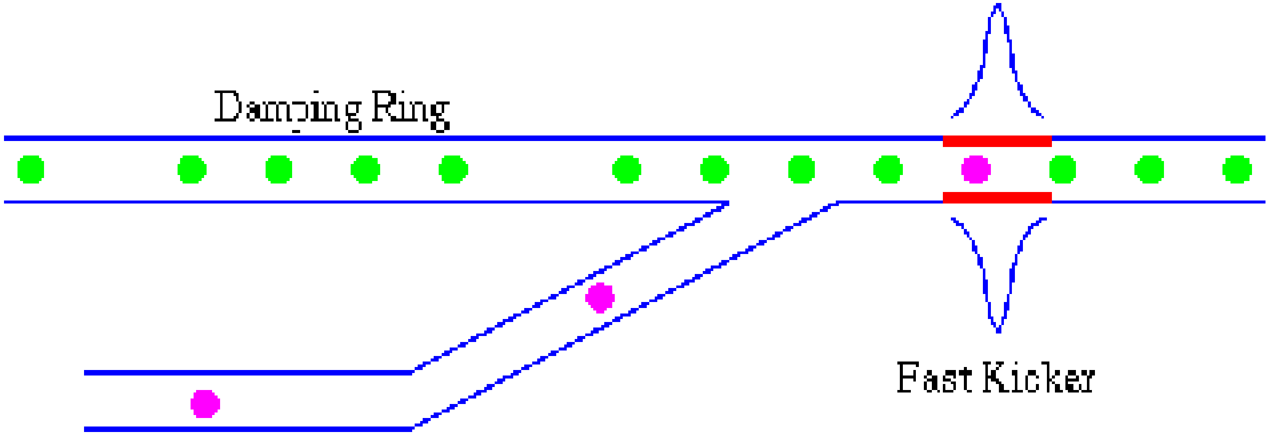
WG3b Flow Chart



Fast Kicker Study

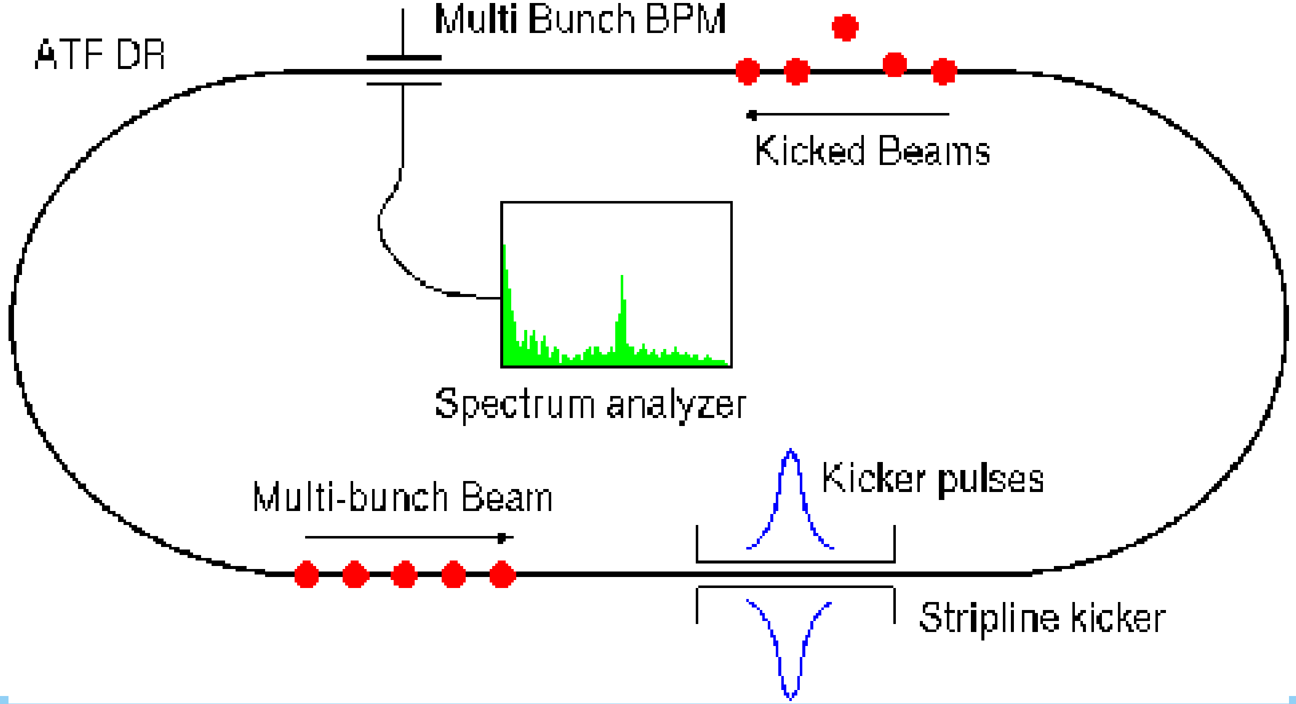
ILC DR Beam Injection/Extraction

- A compressed storage in DR is essential.
- The kicker pulse width decide the shortest bunch spacing in DR for the individual beam handling.

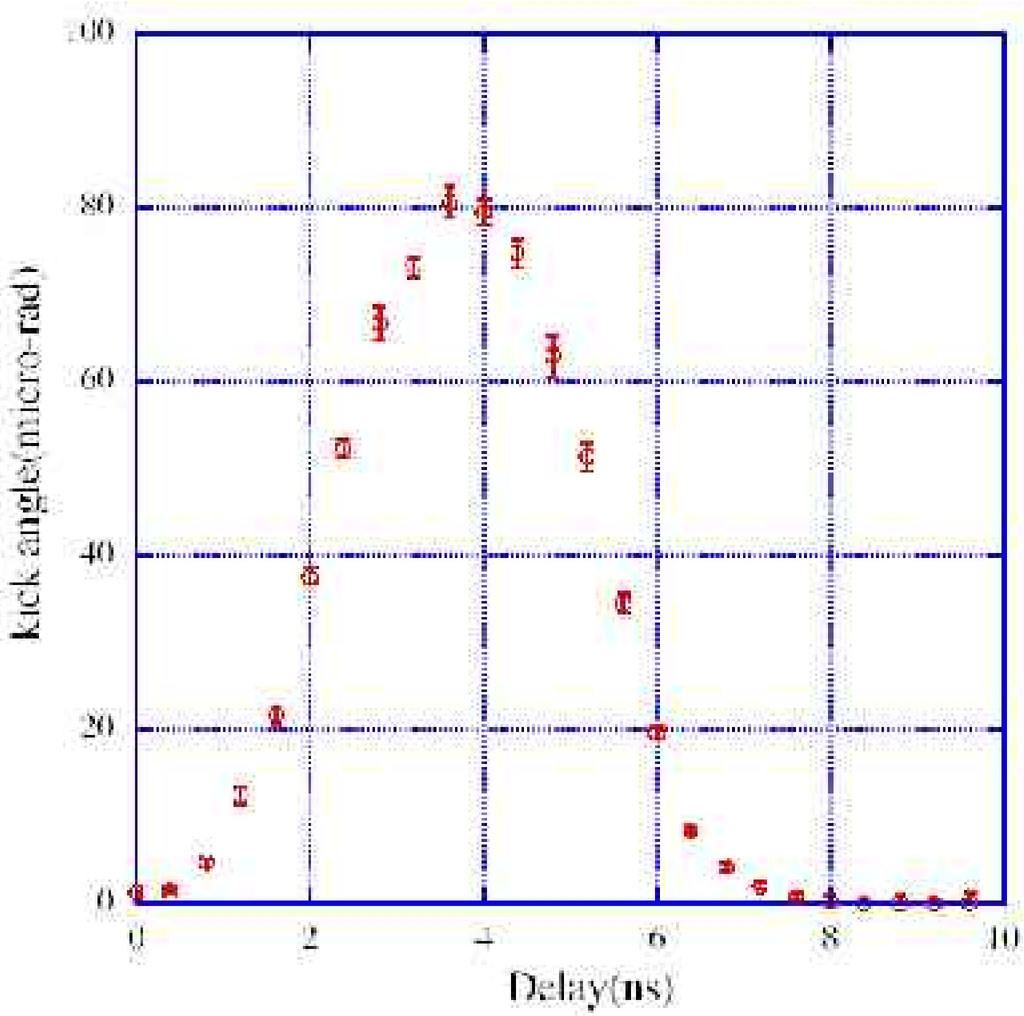


Demonstration in ATF

- A strip line kicker driven by a fast pulser, deflects the beam stored in ATF-DR.
- The kick is observed by a multi-bunch BPM as a betatron motion .

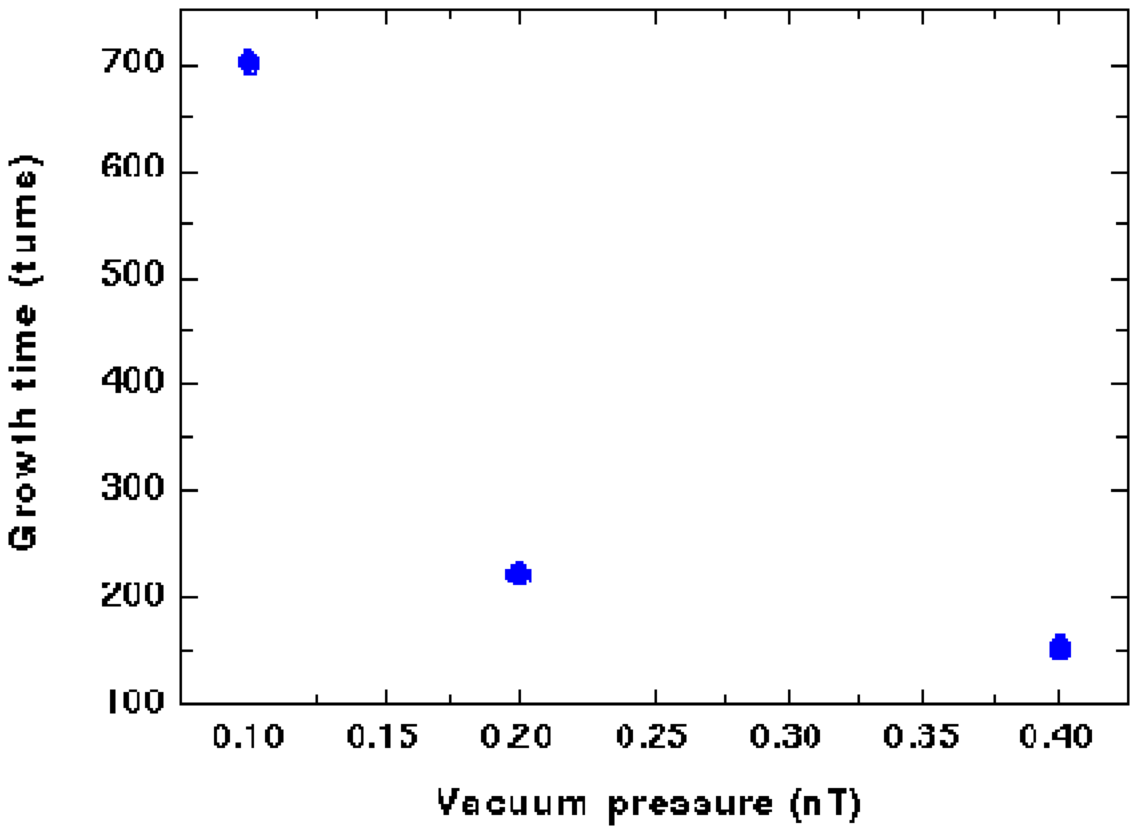


Fast Kicker Summary



- Pulser : 5 kV, 1-1,2 ns rise time, < 100 ps jitter, 3 Mhz reputation.
- Scan the kick angle with the pulse trigger timing.
- Rise and fall time ~3.6ns which makes a short DR possible.
- Kick angle ~80urad (calc. 93urad)

Exponential growth time of fast-ion instability at LBNL 3 km damping ring



E.S. Kim (ACFA LCWS05)

Preliminary simulation results show necessity of bunch by bunch feedback system to suppress the beam instability in the vacuum pressure of 0.1 nT.

SEY/PE Studies

- Electron yield determines the maximum current density in DR to prevent the electron cloud effect.
- Demonstration of electron cloud suppression with ante-chamber coated with TiN which has lower SEY (Secondary Electron Yield) at KEKB.
- In-situ measurement of SEY of the graphitized Cu surface which could be a replacement of the expensive TiN coated surface at KEKB.
- A large impact to the technical design rather than a conceptual design.

2pm Emittance Beam Stabilization

- These items are important as more perfect demonstrations of ILC beam at ATF.
- This is also an unique contribution of KEK/Japan to ILC development.
- The results, however, do not have a big impact on the injector scheme discussion in Snowmass.
- The result is actually essential for ATF2 (Final Focus) rather than ILC injector design itself.

WG3b: Asian Strategy

- Range of Nb(2820-5840) is suggested by WG1.
- DR should be designed in order to store 2820 bunchs with a safe tb (7.2ns) and 5640 bunches with an achieved (3.6ns) tb.
- Assuming this short tb demonstrated by Kicker experiment, DR with an independent tunnel is possible.

WG3b Asian Strategy (cont)

- Because of the operation-ability, the independent tunnel is favored.
  - 6km Dogbone (7.2ns) has less space charge, less damping time, and less wigglers. It can be built in a 4km independent tunnel.
  - Doubble decker of two 3km DRs with an independent tunnel is possible.
  - 6km circular ring is built in 6km independent tunnel.

Summary

- WG3 is now split into a) and b) for more efficient work.
- In both WG, assessment tasks will be taken for the critical decision: Positron production and DR layout.
- Asian Group provide the important and critical information to the assessment tasks.
- Based on the results of our efforts, we insist our own strategy.