Proposal of further study for ILC final focus system

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2014/ 3/ 18

ATF2 topical meeting, LAPP

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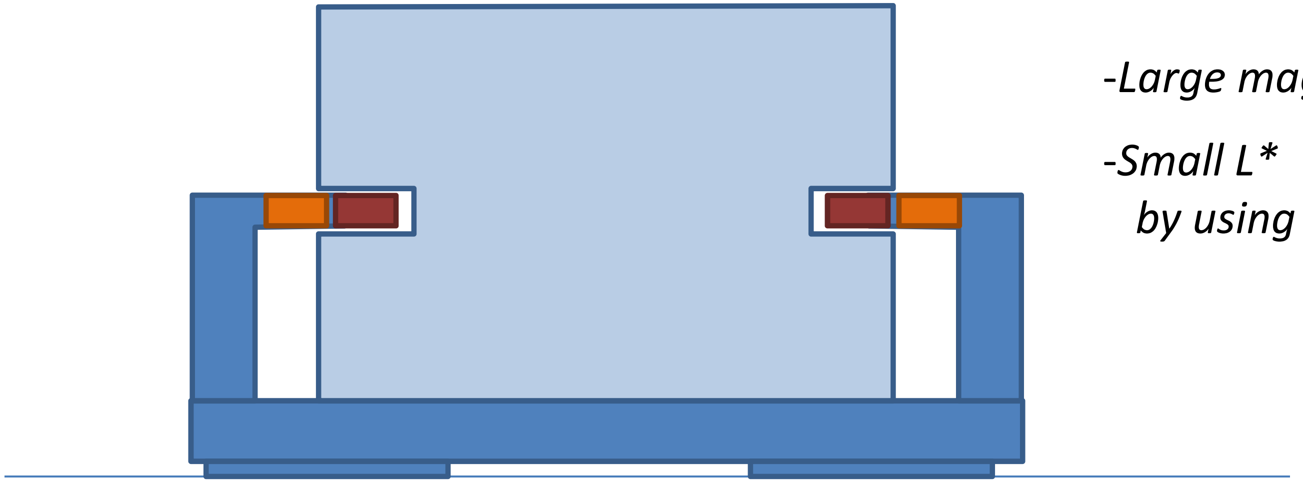
QD0 configuration for ILC

ILC Baseline Design



-Large magnet vibration (50nm)

*-Small L**
by using SC magnet

Large L* option

-Small magnet vibration
Hybrid magnet
Separate to detector

-Same magnet for all detector

- easy for anti-solenoid correction

- reduce luminosity ?
- increase the tuning difficulty ?

QD0 vibration tolerance and Intra-train Feedback

-QD0 vibration requirement for ILC is 50nm.

-It generates roughly 100nm beam jitter at IP (5.6nm vertical beam size at IP)

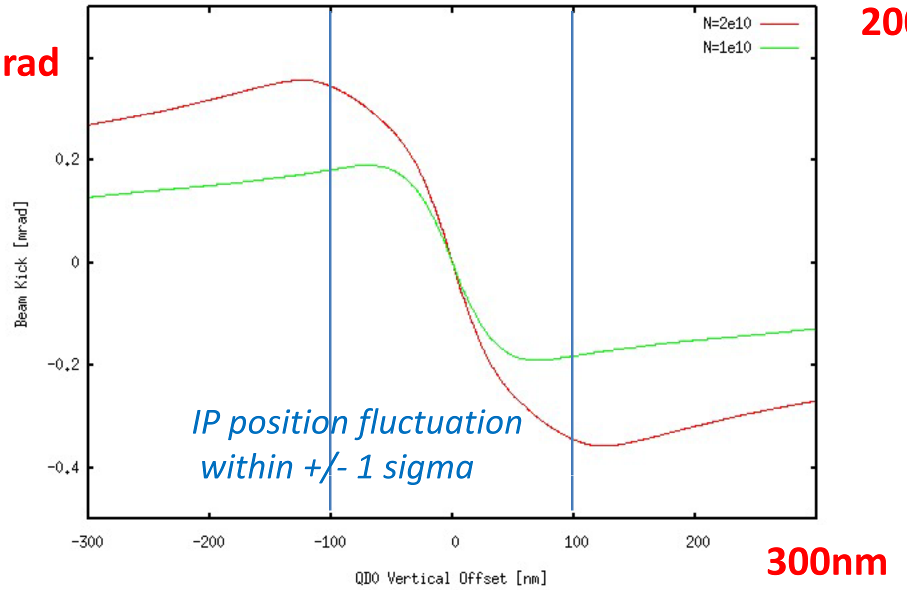
-In ILC, we will correct the IP beam position by intra-train feedback.

-In order to apply the intra-train feedback, we must prepare high current multi-bunch beam.

-We cannot collide the electron and positron beams at IP by using single bunch beams for ILC TDR design (50nm vibration in between QD0s).

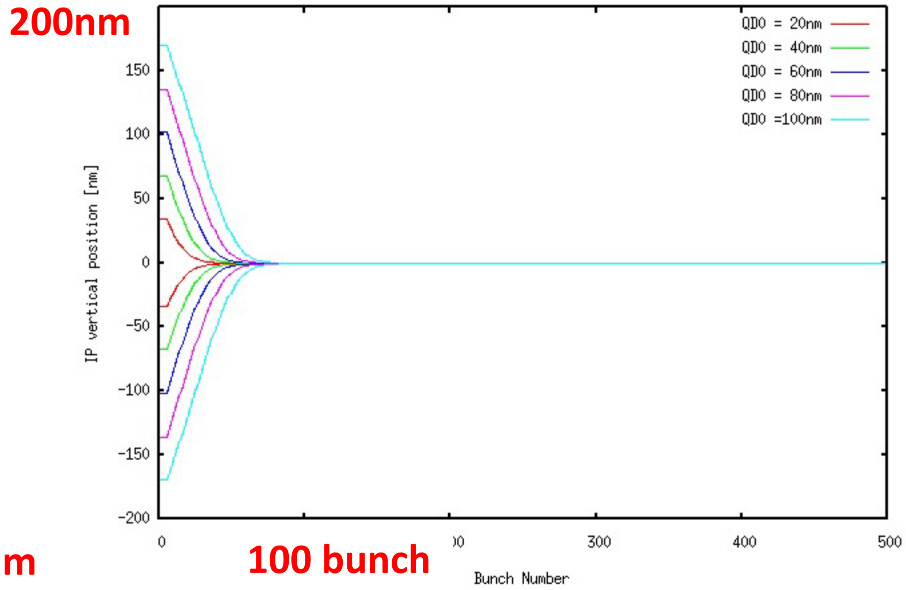
Example of Intra-train feedback

Beam-beam kick for ILC IP Parameter



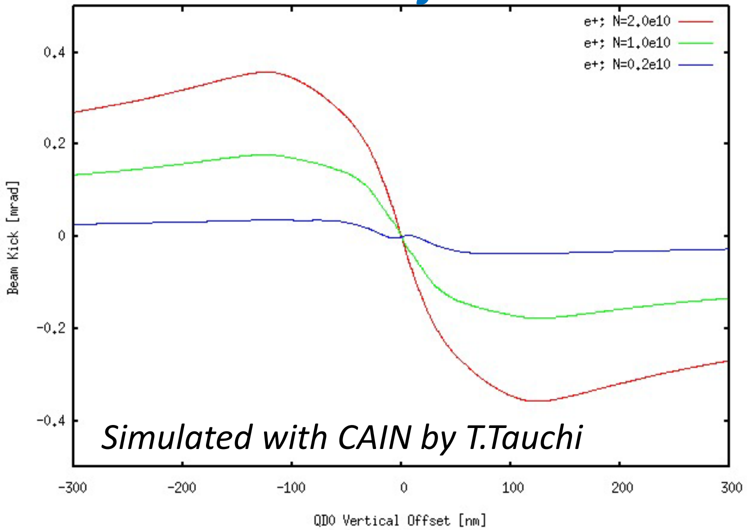
Simulated with CAIN by T.Tauchi

Example of the intra-train feedback

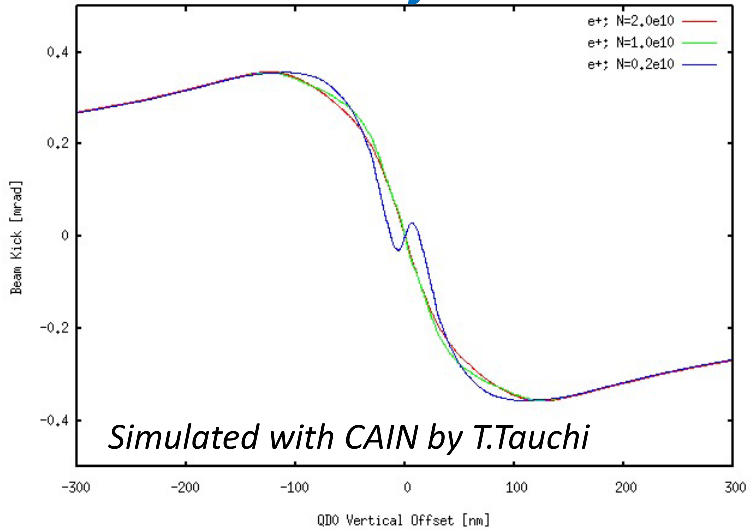


Intra-train feedback
for different beam intensity of two beams

Beam Kick for Electron



Beam Kick for Positron

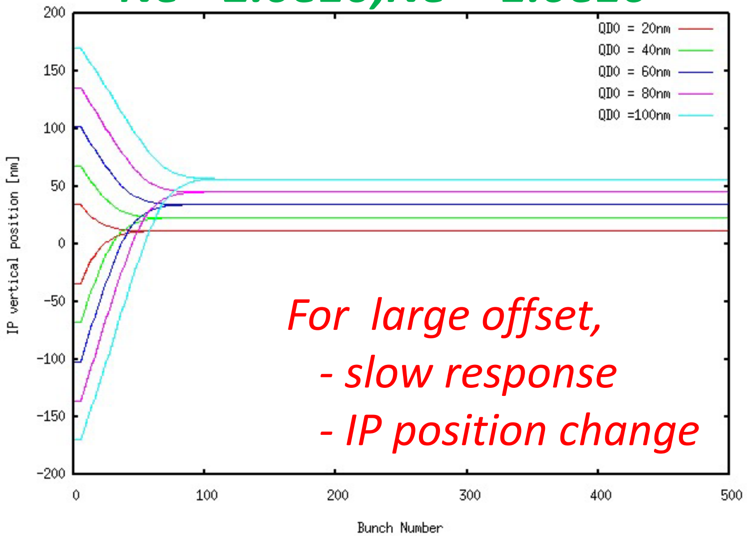


Ne-=2.0e10,
Ne+=2.0e10

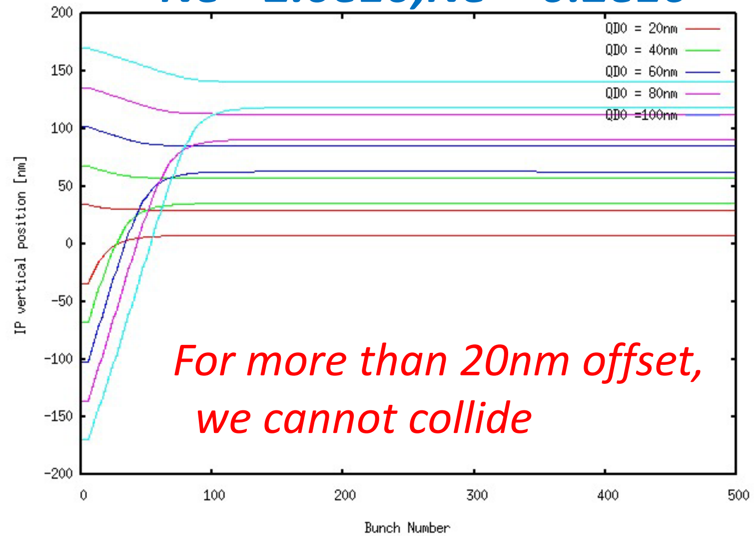
Ne-=2.0e10,
Ne+=1.0e10

Ne-=2.0e10,
Ne+=0.2e10

Ne-=2.0e10,Ne+=1.0e10



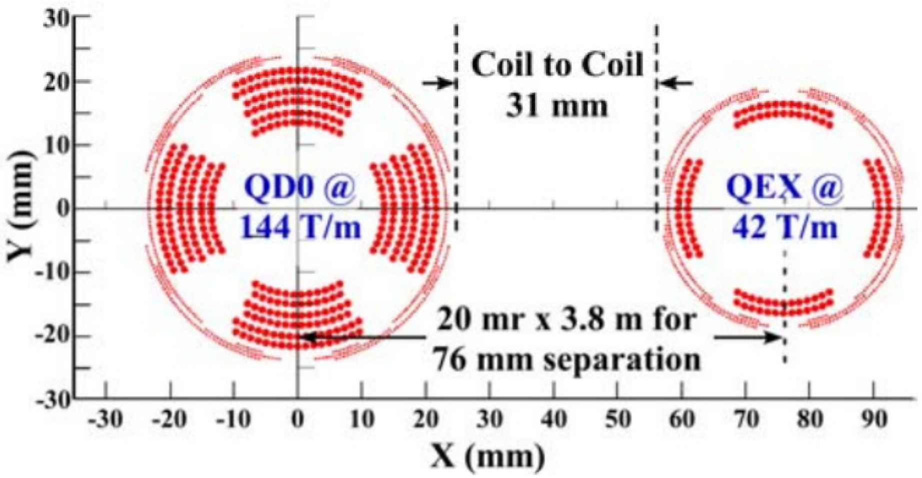
Ne-=2.0e10,Ne+=0.2e10



Final Focus Magnet for ILC

TDR baseline design

Superconducting Magnet (BNL)



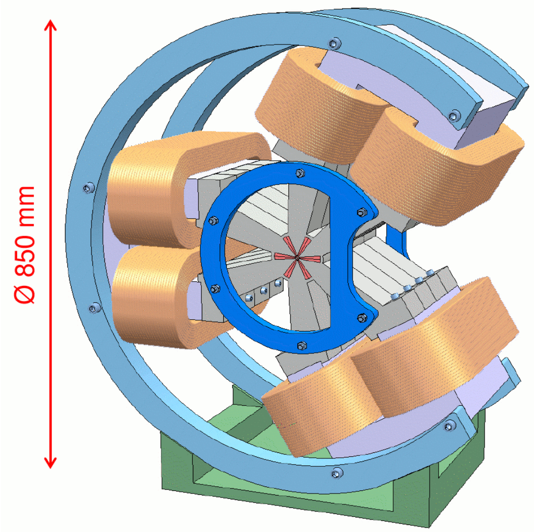
We can install in the detector.

Compact(ϕ 50mm)

No so stable (< 50nm)

CERN proposed at LCWS2013

Hybrid Magnet (CERN for CLIC)



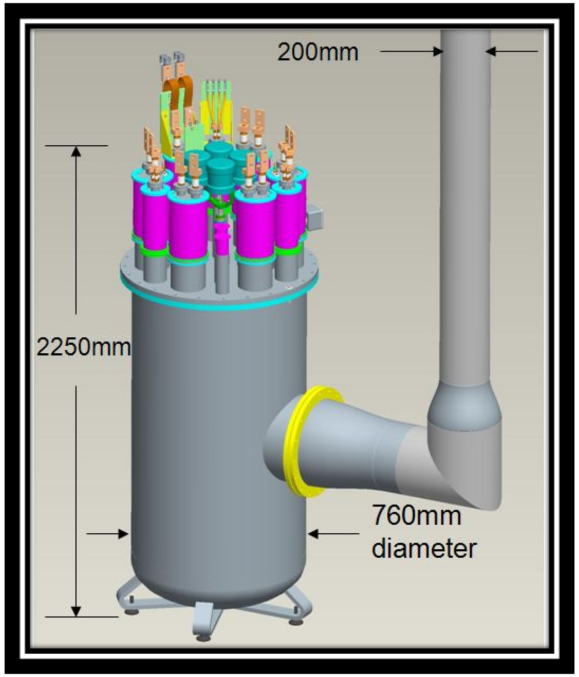
Not so small (ϕ 850mm)

This difficult to install in the detector,
but small vibration (<1nm)
for small cooling water flow.

Vibration Sources 1

Vibration of Helium flow to superconducting QD0

ILC Large Service Cryostat Design



- 12 (1000 Amp) leads.
- 24 (100 Amp) leads.
- 150 instrumentation leads.
- Built to supply 1.8 K Helium to magnets 10 meters away.
- Complex and large but can be positioned remotely from the magnet.

To suppress the vibration, the He temperature is set to 2K in TDR.

The present target vibration is 50nm, and the target value is comparable to Super KEKB.

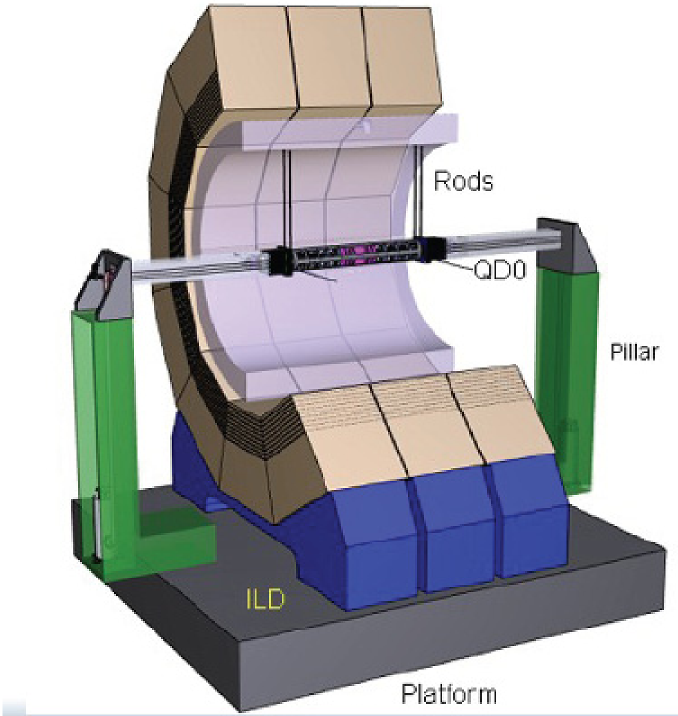
Vibration Sources 2

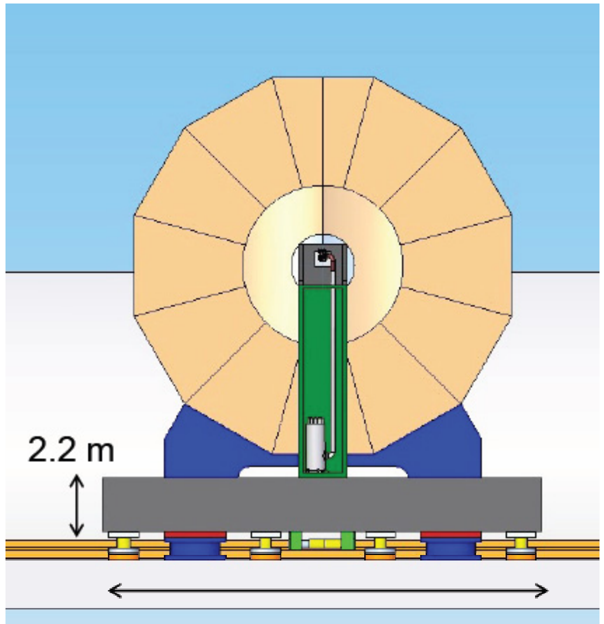
QD0 and detectors are on same base plate

Now we investigated the vibration for

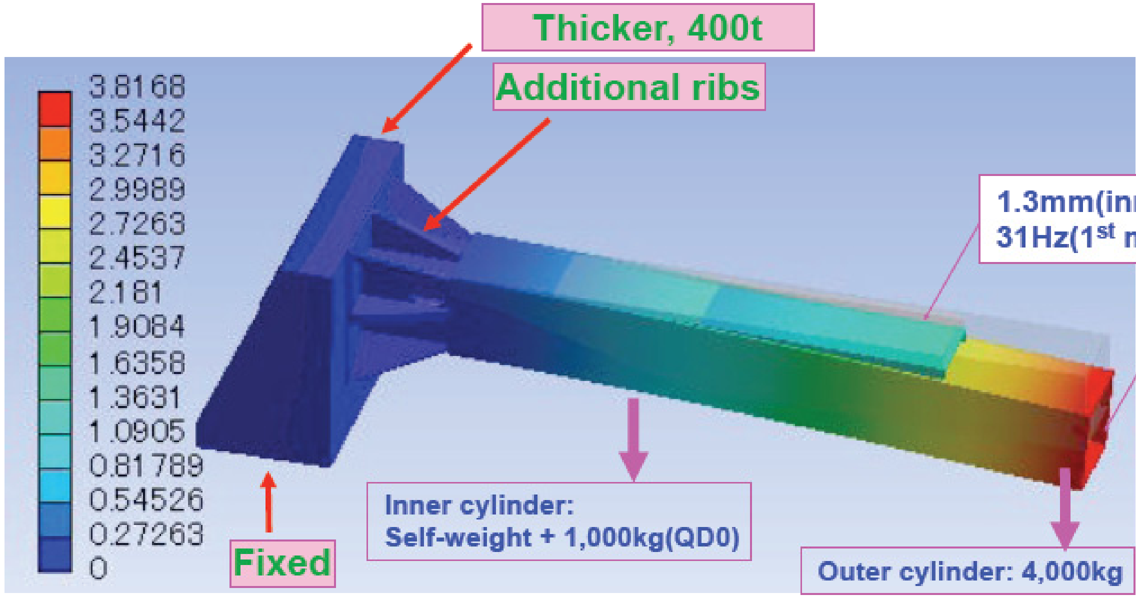
- *Base plate itself (CERN)*
- *QD0 support structure (Yamaoka-san)*

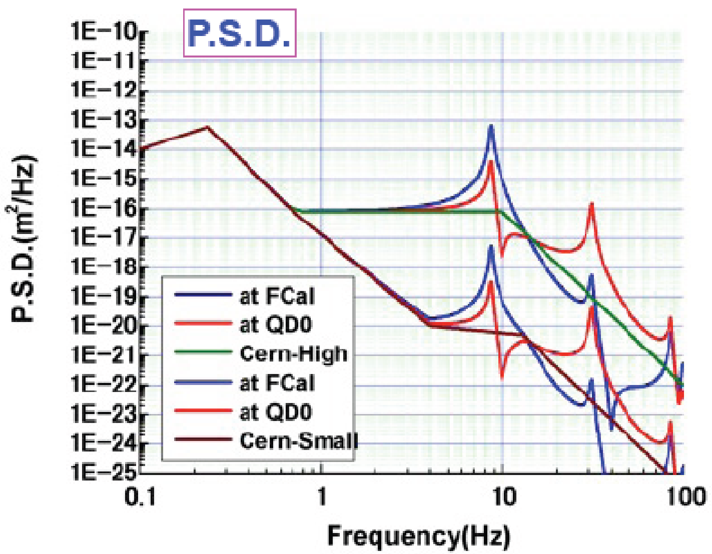
However, the detector has large weight and a lot of vibration sources, and we have not yet evaluated the vibration of the overall system.

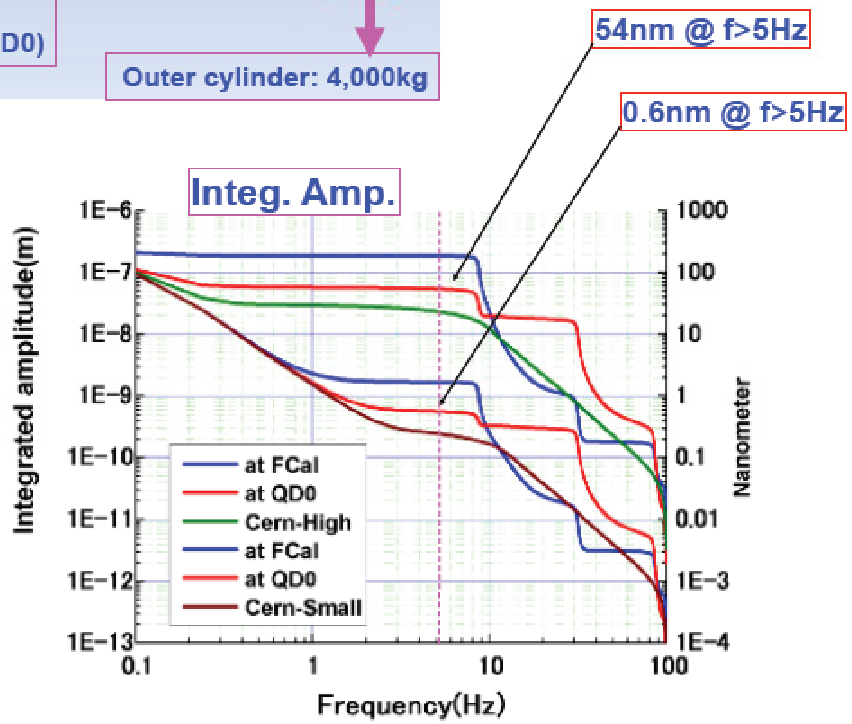




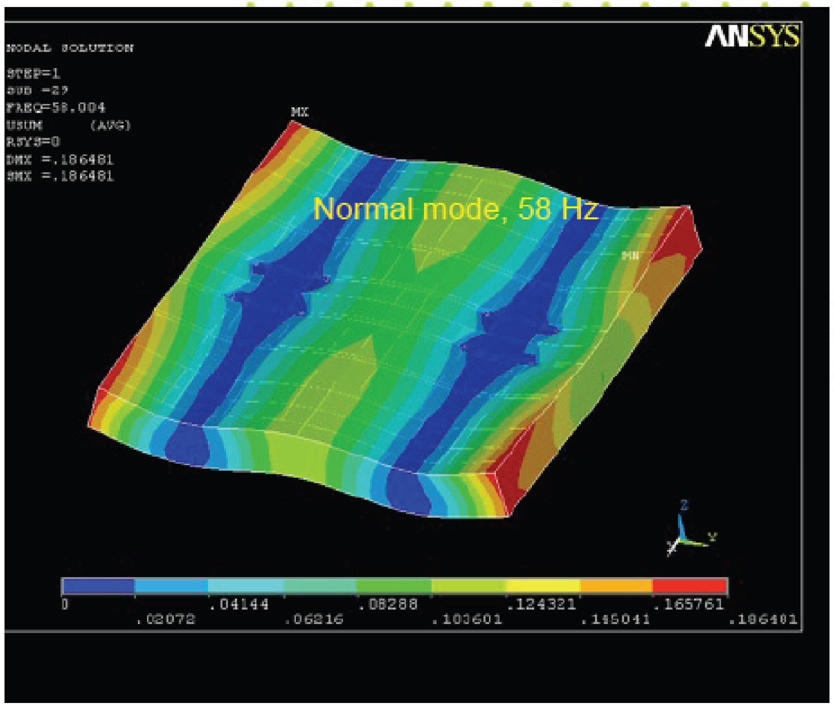
ILD QD0 support, by H. Yamaoka, LCWS2010, Beijing

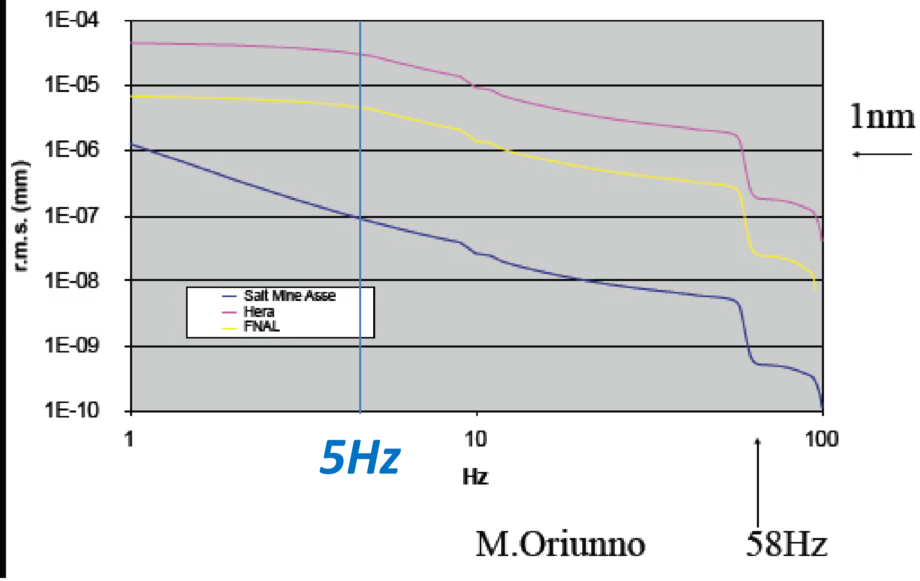






Preliminary
ANSYS analysis of Platform

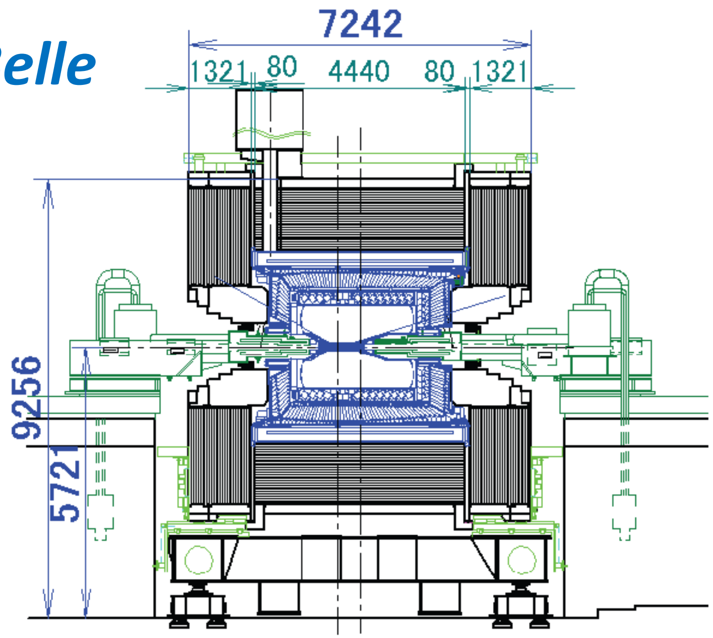




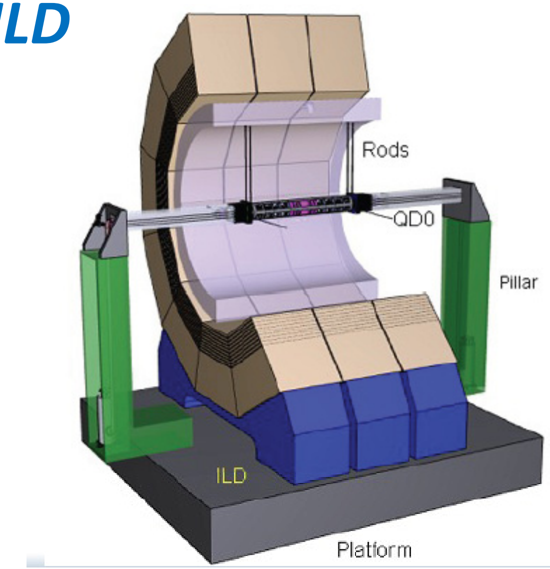
- First look of platform stability look rather promising: resonance frequencies are rather large (e.g. 58Hz) and additional vibration is only several nm

Overall vibration of QD0

Belle



ILD



Integrated amplitude (nm)						
location	1 Hz and up			10 Hz and up		
	X	Y	V	X	Y	V
BELLE Barrel top	196	301	93	9	12	18
BELLE End yoke top	248	354	80	25	17	20
End yoke middle	204	254	121	14	27	19
BELLE table	105	69	71	13	11	13
BELLE floor	50	46	67	4	3	9
KEKB floor	55	45	68	10	5	9
Movable table	90	50	68	12	16	19
QCS boat	250	60	118	15	21	30
QC1RE	241	77	112	52	50	46

M. Masuzawa et al., VIBRATION ISSUES FOR SUPERKEKB

1) The vibration was generated by Helium flow to QD0

2) Since QD0 and detector were on the same base, the vibration was enhanced

2-1) from floor to base (via Massive Detector)

2-2) from base to support boat through arm

2-3) from support boat to QD0

Is the entire vibration of this system less than 50nm at 5Hz (ILC requirement) ?

The proposal of the study of ILC final focus system design

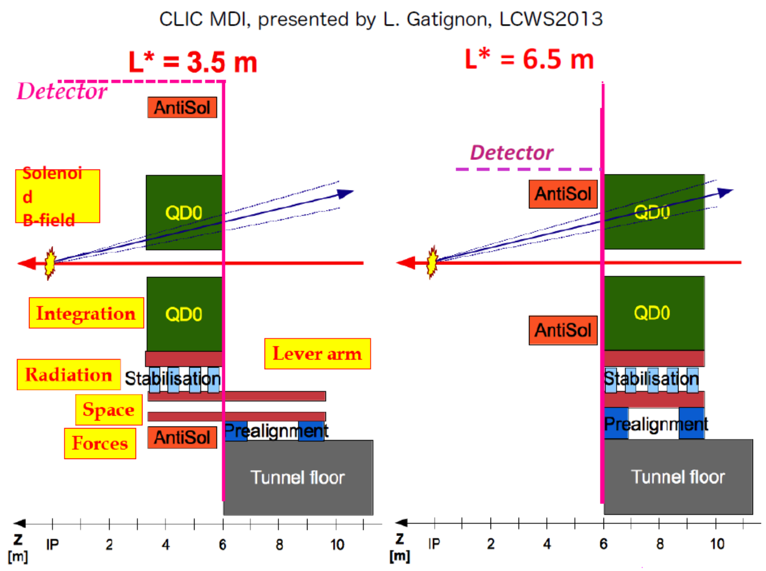
We should evaluate the QD0 vibration with entire detector system to confirm that the relative vibration of two QD0 vibration are less than 50nm above 5Hz .

We will study the final focus system in the collaboration of ILC and CLIC ***(LCC).***

The investigation include

- the comparison the FF optics of ILC and CLIC
*- the study of beam optics with small beta**
- L and type of QD0*
- the IP tuning issues

and so on



Beam Tuning Procedure for ILC

by K.Kubo, Meeting to learn ILC at KEK

Step 1 *; IP Beam size tuning for individual electron or positron beams.*

Step 2 *; IP beam size tuning with 2 single bunch beams.*

Step 3 *; IP beam size tuning with 2 multi-bunch beams.*
(with intra-train feedback)

Step 1 ; IP Beam size tuning for individual beams

This tuning will be done
- at first beam commissioning (before detector installation).
- just after long shutdown.

In order to measure the IP beam size for single beam,
we need the beam size monitor at IP, instead of detector.

The candidate is Shintake monitor tested at ATF2 (The limit is 25nm beam size)

Furthermore, since we must subtract the position jitter shot-by-shot ,
the IP-BPM with 10-20nm resolution also required for preset design ILC QD0 vibration.

In order to adopt this procedure for ILC FF beam tuning,
we must prepare third IP apparatus
- with IP beam size monitor, IP-BPM, QD0 and SF0 for large QD0 vibration scheme.
- with IP beam size monitor, (IP-BPM) for small QD0 vibration scheme.

If we tune the beam with this apparatus ,
- the IP beam size can be confirmed at the third IP is larger than 25nm.
- we will use different QD0, SD0 (partially different machine) for large vibration scheme.

We'd better to consider whether the third IP is necessary of not
*for both large and small QD0 vibration schemes (**strong impact to CFS**) .*

Step 2 ; IP beam size tuning with 2 single bunch beams.

The IP beam size should be evaluate by utilizing the beam-beam collision.

The luminosity of IP beam size monitor to measure with single collision is important.

The candidate is incoherent pair monitor for ILC design.

However, we expect huge beam-beam offset at IP for present large vibration QD0 scheme.
- *we expect large beamstrahlung background to detector.*
- *the strength of the beamstrahlung is larger for larger beam-beam offset.*

We should estimate the incoherent pair monitor can be used for this step 2 procedure both for large and small QD0 vibration schemes.

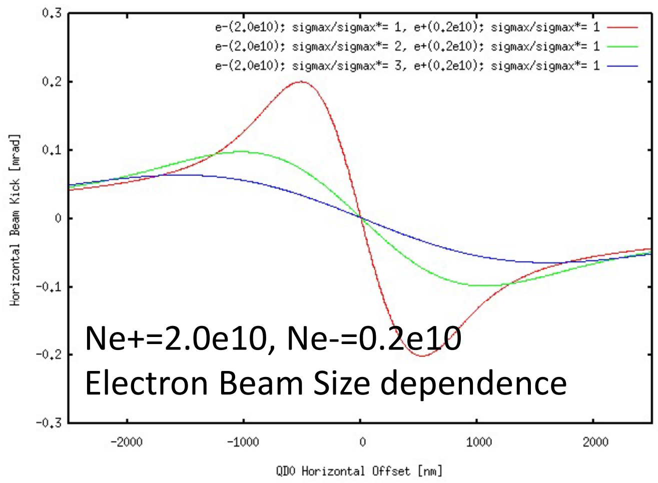
i.e.) take a cut by the beam-beam kick angle to incoherent pair monitor etc.

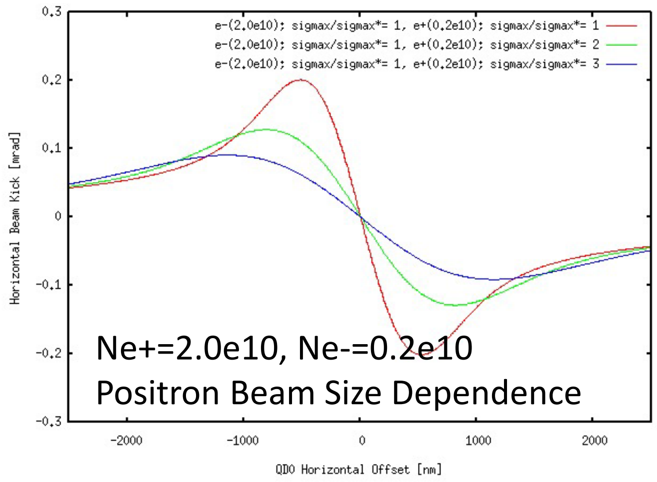
If we cannot use the incoherent pair monitor as single shot monitor,
we should investigate other candidate for the by single shot luminosity or IP beam size monitor.

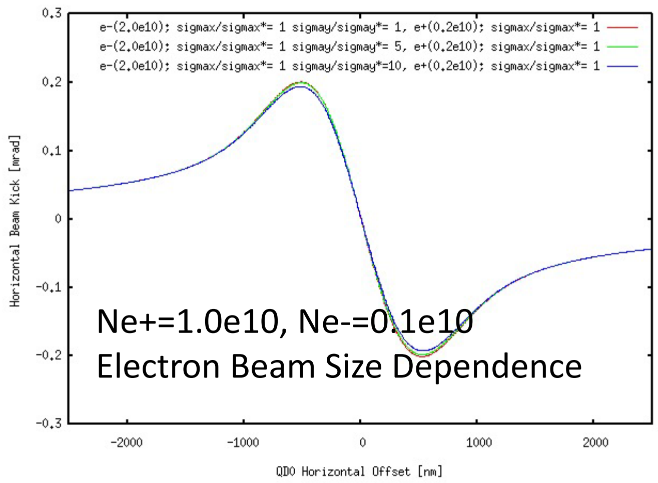
This procedure is important.
If we cannot measure the luminosity of IP beam size by single bunch beam,
we will not start the final focus timing before we establish
- *to make high current muiti-bunch beam both for electron and positron beams.*
- *to tune the main linac with good position correlation within the train.*
- *to establish the intra-train feedback technique.*

Horizontal Beam Size Measurement with kick angle measurement

When the intensity for electron and positron beam was much different, we can evaluate the IP beam size roughly by measuring the correlation between the distance between beams and kicked angle.







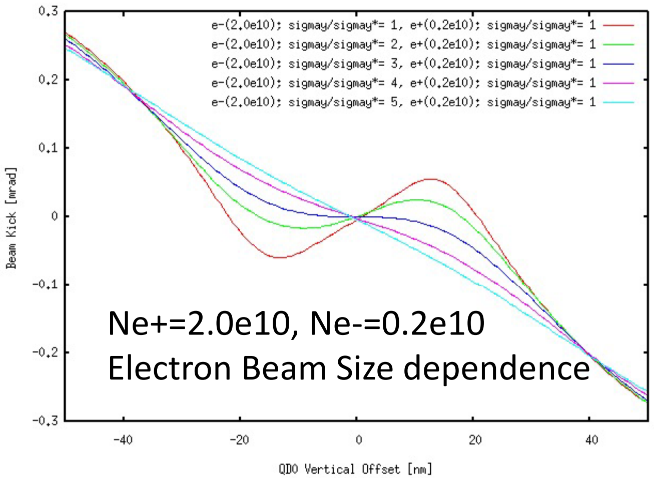
The kick angle has dependence both electron and positron beam size.

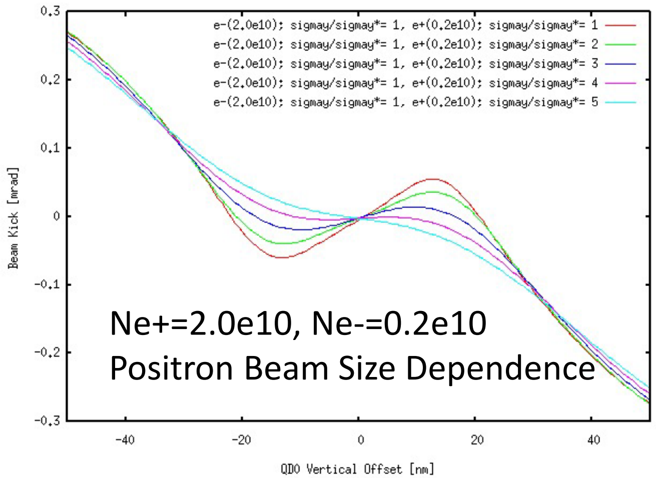
This measurement was difficult when the beams have large position jitter.

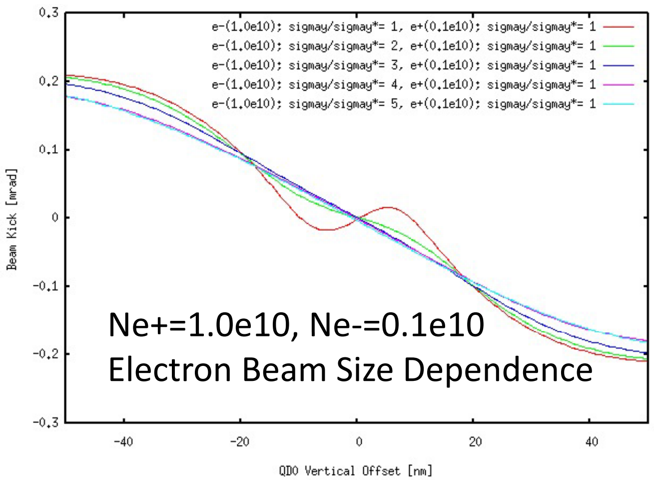
IP beam position jitter should be less than 10nm

Vertical Beam Size Measurement with kick angle measurement

When the intensity for electron and positron beam was much different, we can evaluate the IP beam size roughly by measuring the correlation between the distance between beams and kicked angle.







The kick angle has dependence both electron and positron beam size.

This measurement was difficult when the beams have large position jitter.

IP beam position jitter should be less than 10nm

Step 3 ; IP beam size tuning with 2 multi-bunch beams

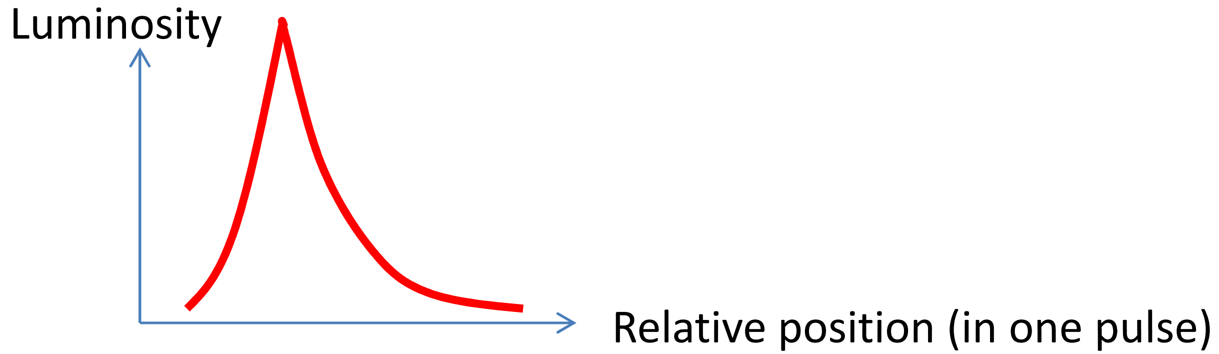
This procedure will be started after we established

- *to make high current muiti-bunch beam both for electron and positron beams.*
- *to tune the main linac with good position correlation within the train.*

It is very important to use the intra-train feedback.

The luminosity is measured with

- *incoherent pair monitor (in the train, if possible)*
- *Bhabha scattering (total luminosity measurement) etc.*



by K.Kubo, Meeting to learn ILC at KEK

Summary of the further study items for ILC FF

1. *We should decide whether the third IP with beam size monitor is necessary or not.*
   Please tell me your opinion for your experience.
   We should discuss this topic with CFS group.

2. *We should estimate the incoherent pair monitor can be used for single beam collision.*
   One student in Tohoku University just start the study about incoherent pair monitor.
   We should discuss this topic with MDI group.

3. *We should evaluate the vibration in between QD0s for present TDR scheme.*
   Now, nobody evaluated the vibration of the entire detector and QD0 system.
   Anyone who can do the evaluation of QD0 vibration?
   We should discuss this topic with MDI group.

4. *We should design the large L* option for ILC final focus with low vibrating QD0s.*
   I propose this topic will study with CLIC final focus group.

5. *By comparing the impact the evaluated QD0 vibration to tuning procedure and reduction of luminosity and difficulty of tuning for large L* optics, we should finally optimize the ILC final focus design.*

Shall we discuss first 4 topics from AWLS2014 (Fermilab)?
I hope all of you can join the discussion!