IR status

2009/10/8 M. Iwasaki (Tokyo)

Accelerator design

- The base design is Nano-beam option
  → There are two final-Q magnets in both L / R sides

- 7x4GeV beam energies
  (To solve the problem on dynamic aperture.)

- Crossing angle becomes 83 mrad
  to put the final-Q magnets closer to the IP

- The QCS chamber radius is 1cm
  → to avoid the resonant cavity structure,
  our IP beam-pipe radius should be 1cm

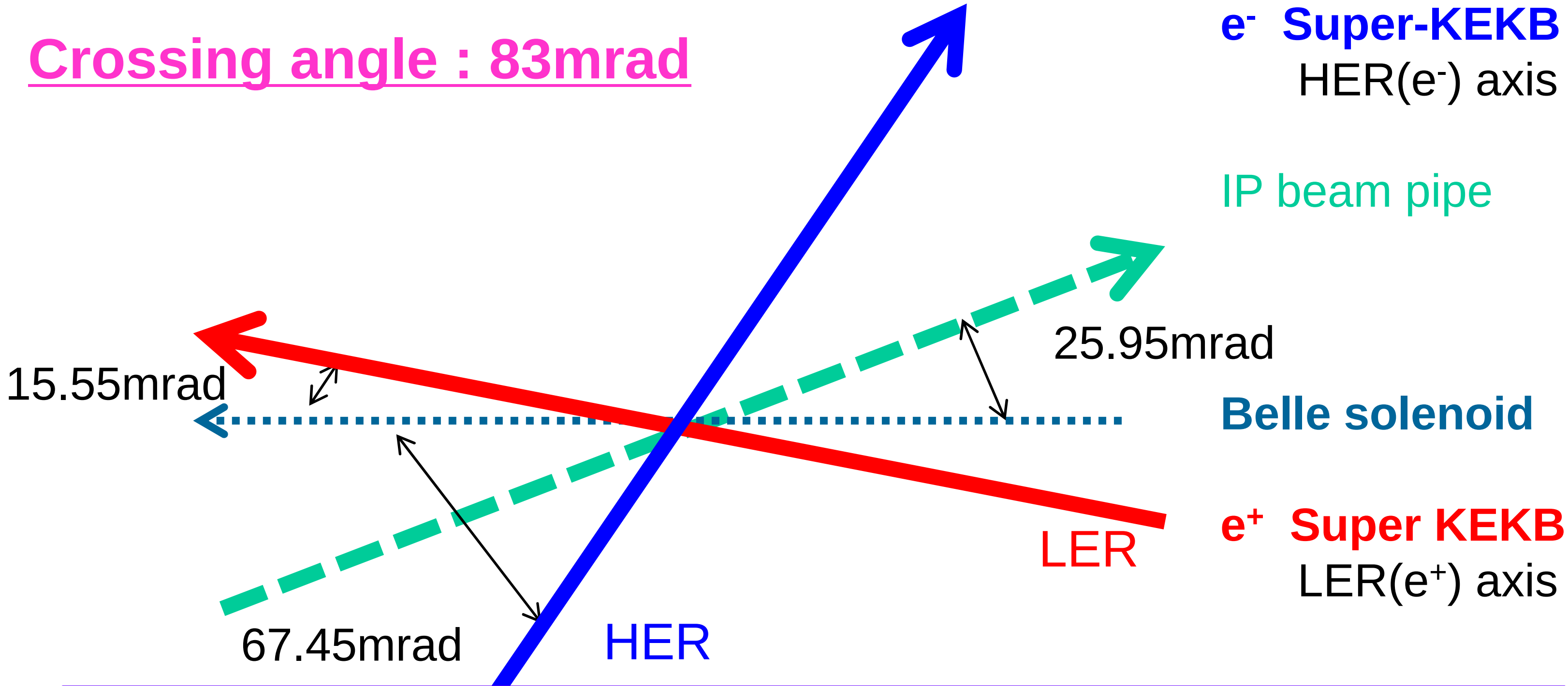
Beam Optics design

To design the IR optics,
there are several constraint

- Current KEKB tunnel geometry
- Separated final focusing Q-magnet geometries
- Local chromaticity correction performance
- Low emittance local chromaticity correction

→ We cannot change the HER direction

Relationship btw Belle-II and Super-KEKB



Beam pipe : center direction of the LER and HER (25.95 mrad from Belle solnoid)

Parameters are not fixed yet

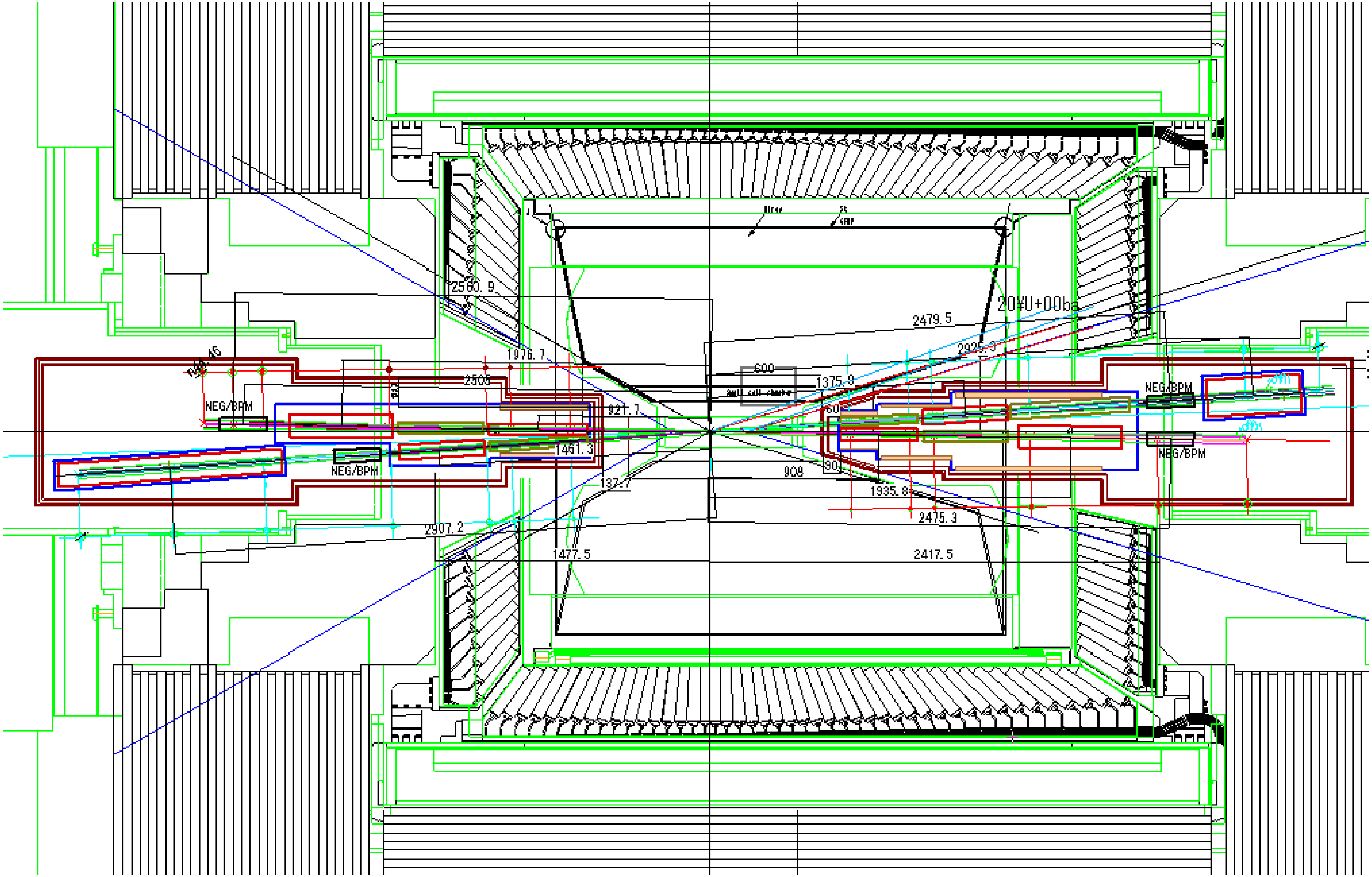
- We need to check the SR direct hit BG
- Rotate Belle-II?!

← Under cost estimation / under discussion / rotation direction is not decided

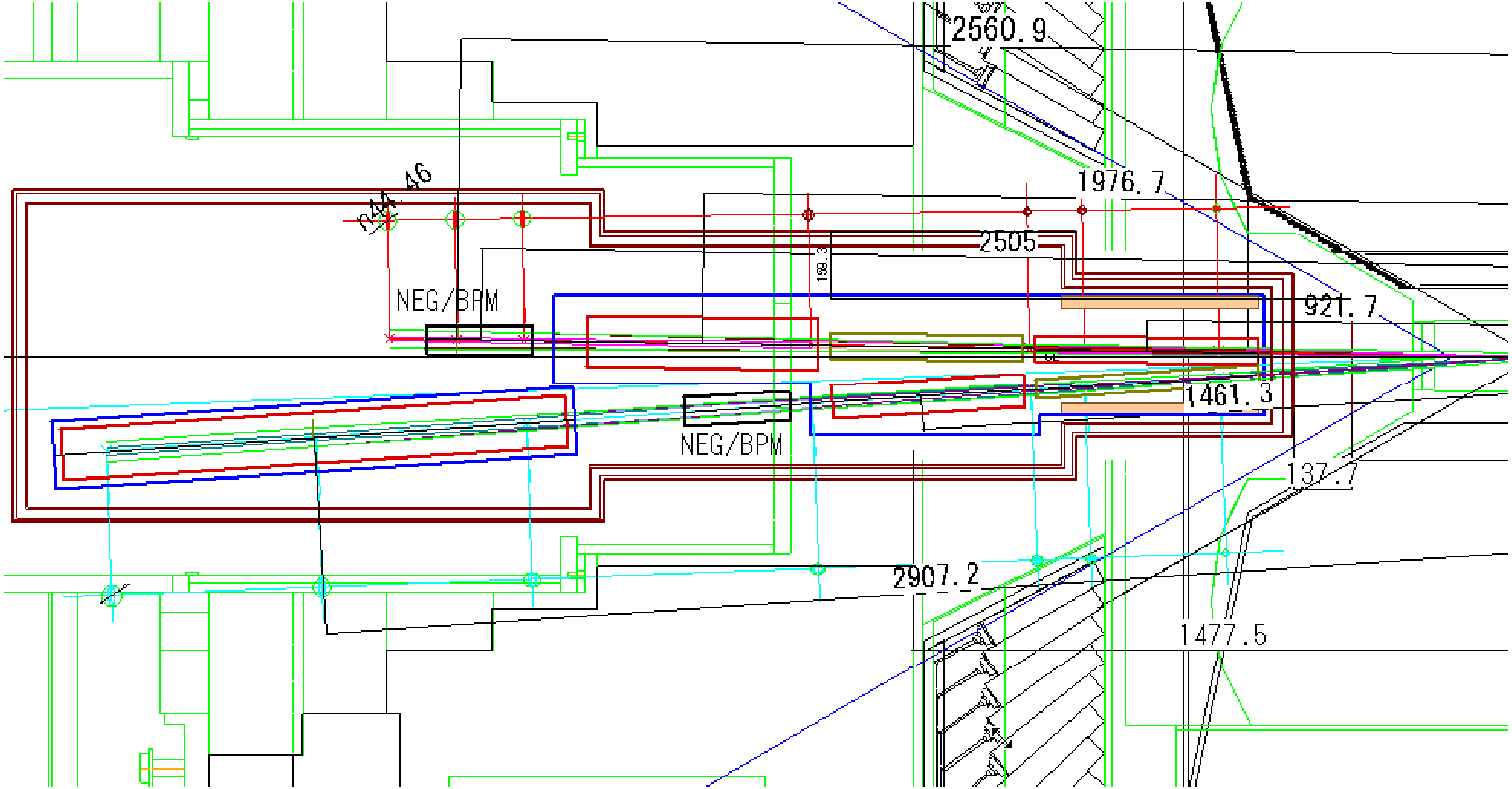
We need very careful discussion with Belle-II and accelerator staffs.

Final Focus Magnet Design

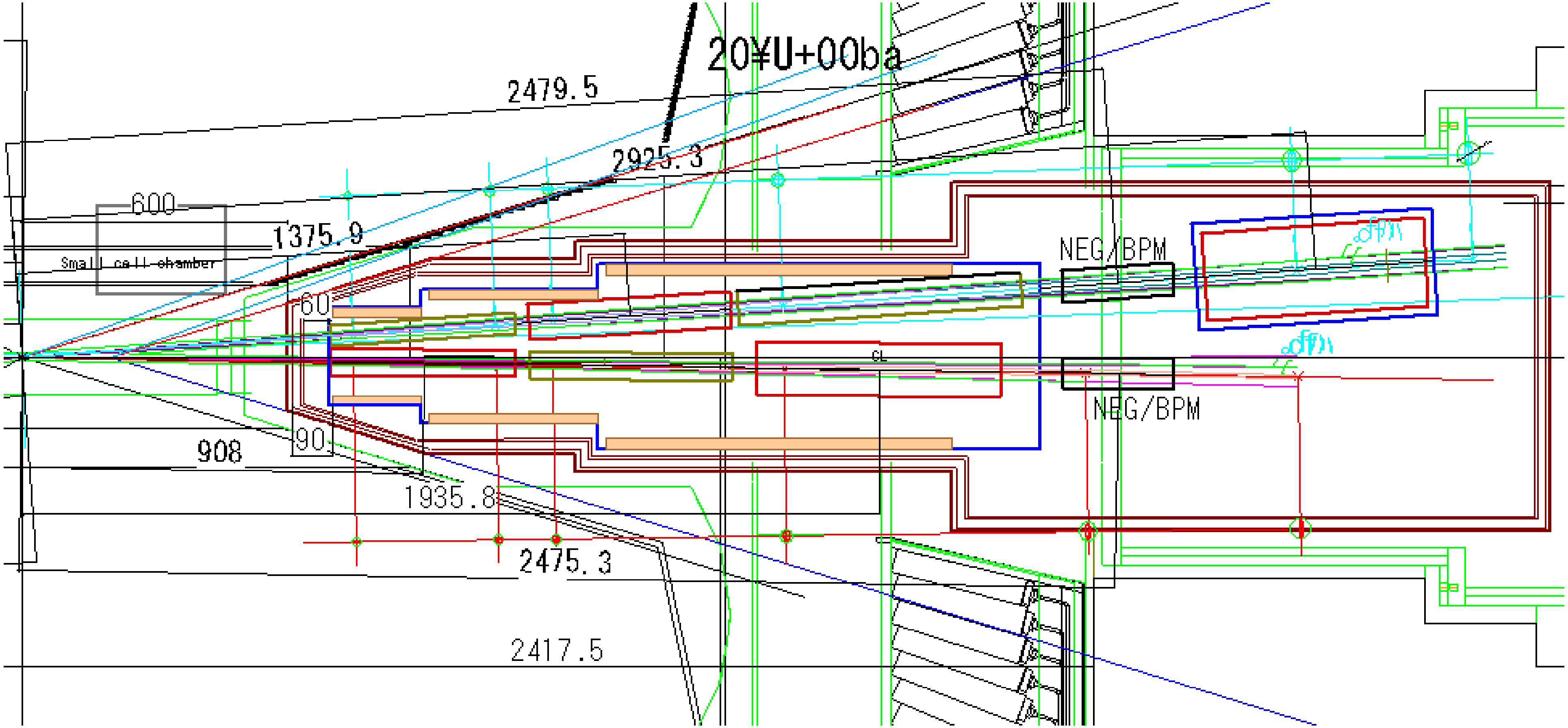
IR Magnets in Belle



IR-magnets in the left side



IR-magnets in the right side



QCS design

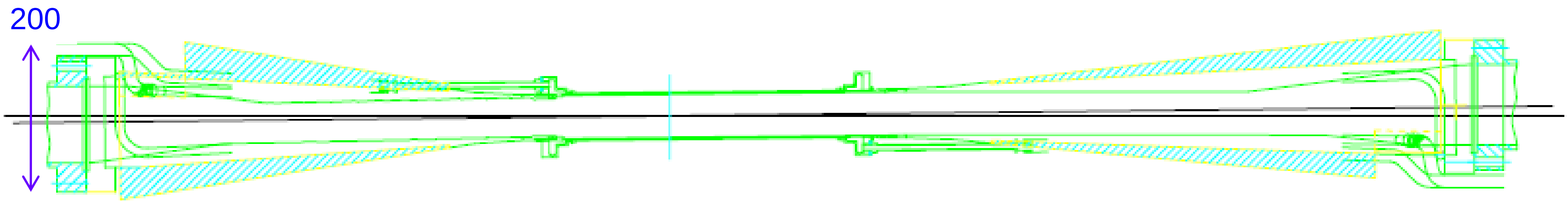
Inner radius =1.05cm

- To avoid the resonant cavity structure,
  IP beam-pipe inner radius = 1cm

- It is difficult to keep good vacuum with
  small-radius long-length (IP+)QCS beam pipes
  → Vacuum level around IP will be 10^{-4} Pa level
  (~100x current KEKB)

IP chamber design

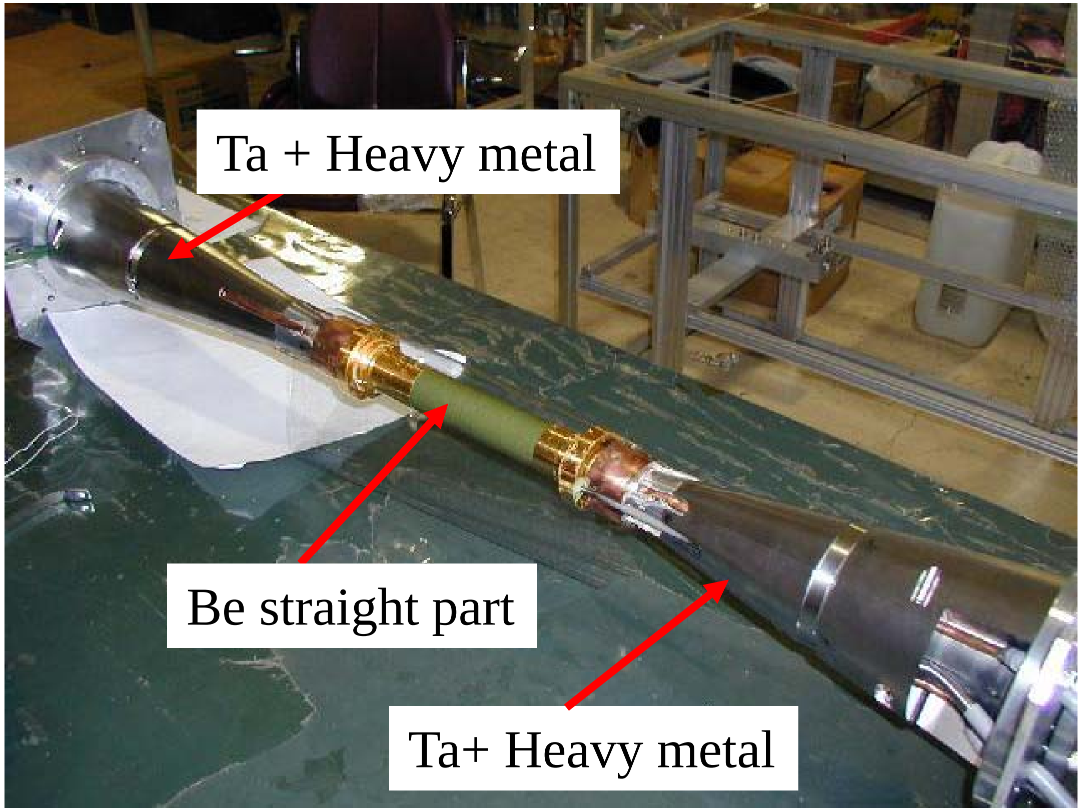
Current Belle IP chamber



- Straight part is made with fragile Be
- Very heavy metal (Tantalum, Tungsten) in both taper part to shield the particle BG (20kg each)
- With cooling system

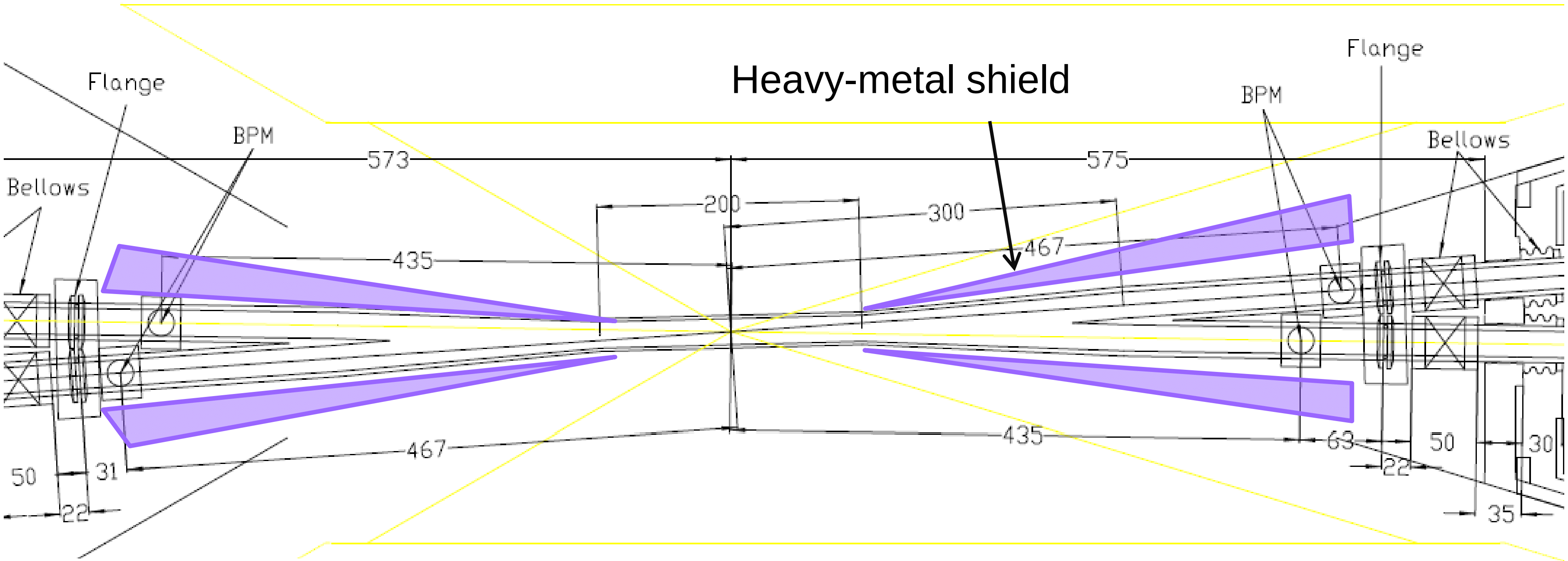
  Be-part by paraffin,

  Heavy metal tapers by water



2009/08 Kanazawa

Belle-II IP chamber



- Size/ shape / materials are not fixed, but based on the same structure as current (Be straight part + heavy metal shields)
- Taper part (in Belle) will be crotch structure
- Assume 1cm radius to the Be straight part
- Beam position monitors are on the IP-beam pipe

Belle-II IP chamber : To do

This time, we assume 1cm radius to Be straight part
→ 1cm radius Be pipe part will be broken with the current support method (heavy shield edges are supported by CDC)

We need to think about the heavy metal shields (20kg in one side)

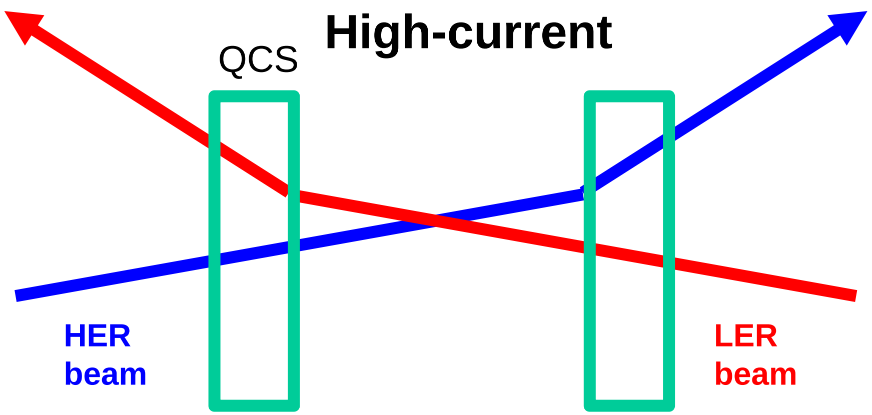
- As light as possible
- Separate design for beam-pipe and shields (Currently taper part and shield are integrated)
- New supporting design
  The heavy shields should be supported by SVD and CDC

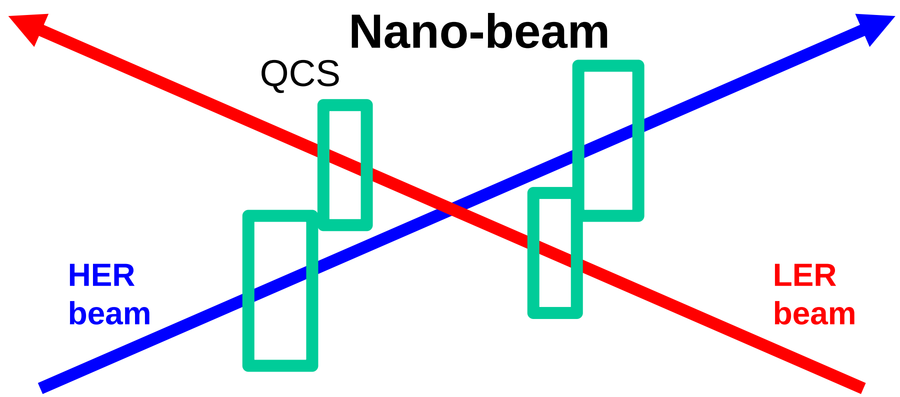
To design the heavy metal shields,
particle BG simulations (Beam-gas and Touschek) are important

Detector BG

Detector BG

	High current option	Nano-beam option
SR (upstream)	**Much higher** Large beam size at Q Very high current	**Lower? Higher?** Small beam size at Q But large bending magnet
SR (back-scatter)	**Higher** Strong QCS B-field	**Much lower** No QCS bending
Radiative-BhaBha	**Higher** Larger crossing angle Strong QCS B-field	**Much lower** Large crossing angle, but no QCS bending
Touschek	**Higher?** Small beam size	**Much higher?** Very small beam size
Beam-gas	**Higher** Very high current	**Higher?** High current





We need to estimate Touscheck and the beam-gas BG using the beam-line simulation

Touschsk→ by Tohoku   Beam-gas → by Tokyo

1. Touschek → Rough estimation based on the life-time
   LER: x20 - 30 higher than current

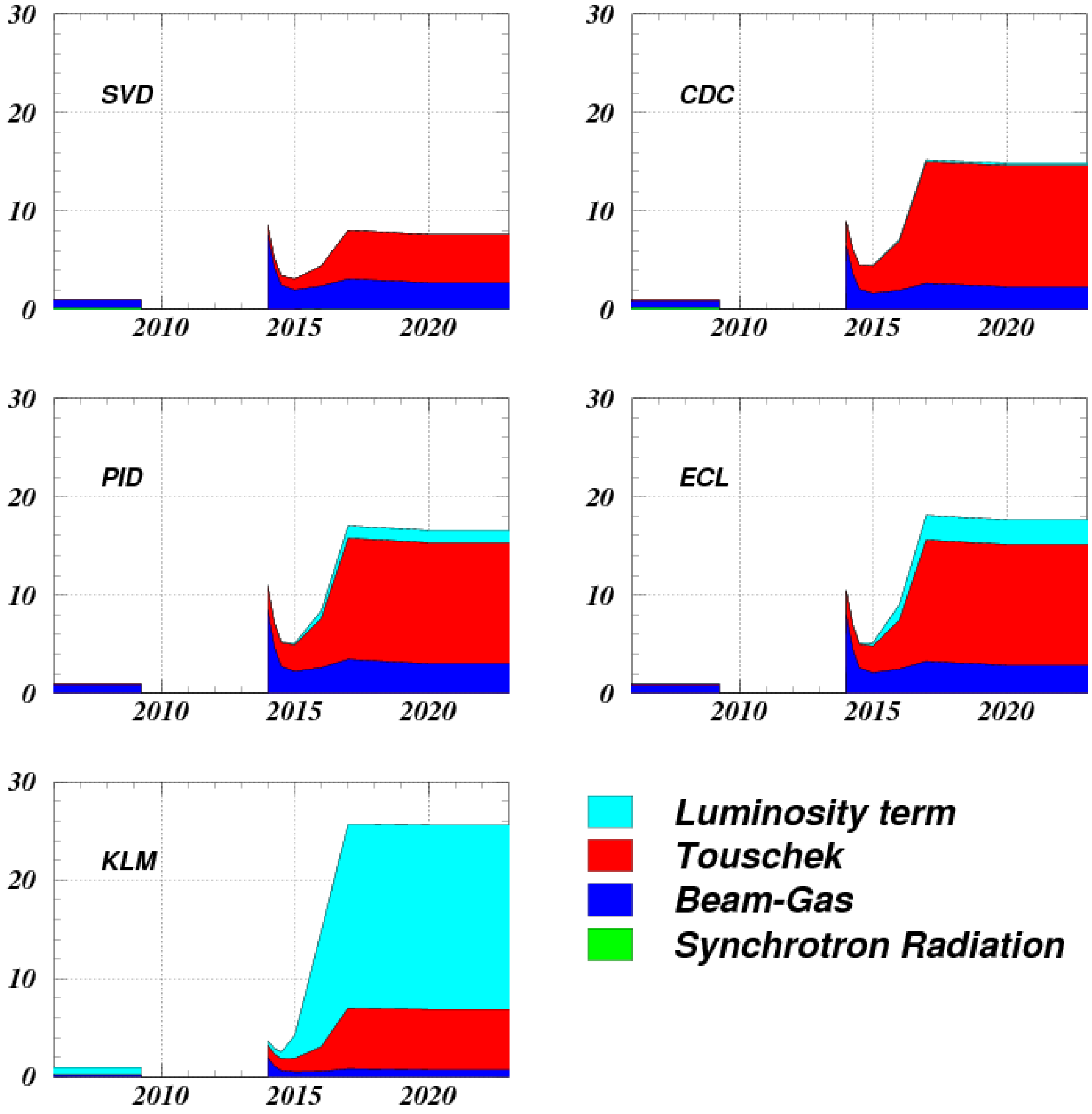
2. Beam-gas
   - Vacuum around IP (+- 2m) will be worse (x100)
     But we think it affects to downstream, not to the detector region
     (The main beam-gas BG to the detector is from upstream)
   - Current status: constructing the beam-line simulation

3. We'll propose the BG estimation run during this fall Belle run
   to estimate the Touschek and beam-gas with single beam.

4. We also did rough estimations based on the optics parameters
   Radiative Bha-Bha 1/40
   Backscattering SR 1/800 of the current Belle

Preliminary BG level expectation

Y.Ushiroda



IR assembly

IR assembly R&D

<u>Problem</u>

QCS beam pipe and QCS cryostat will be integrated

→ SVD/PXD/IP-beampipe
should be directly connected with QCS cryostat

<u>How to connect</u>

1. Remote-controlled vacuum fitting
2. ~~All components (SVD/PXD/beampipe/QCS) are integrated~~

IR assembly : current status

Members:

KEK T.Kohriki + Machine shop

R&D of remote-controlled vacuum fitting

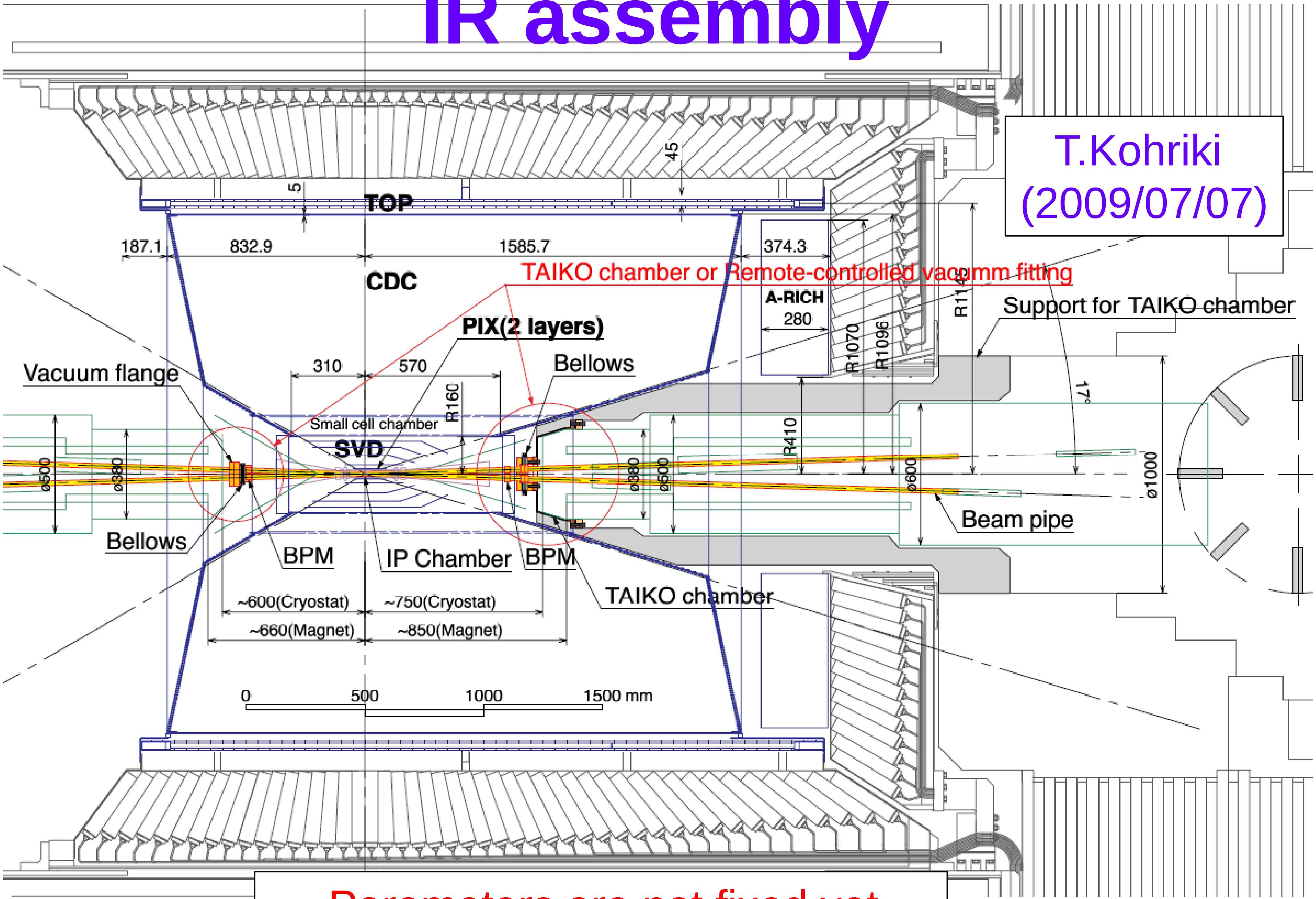
- We start weekly meeting with Kohriki-san and Machine shop

- Currently several ideas for the remote-controlled connection
  (But we didn’t consider the details yet)

- We must do remote-controlled vacuum connection test soon

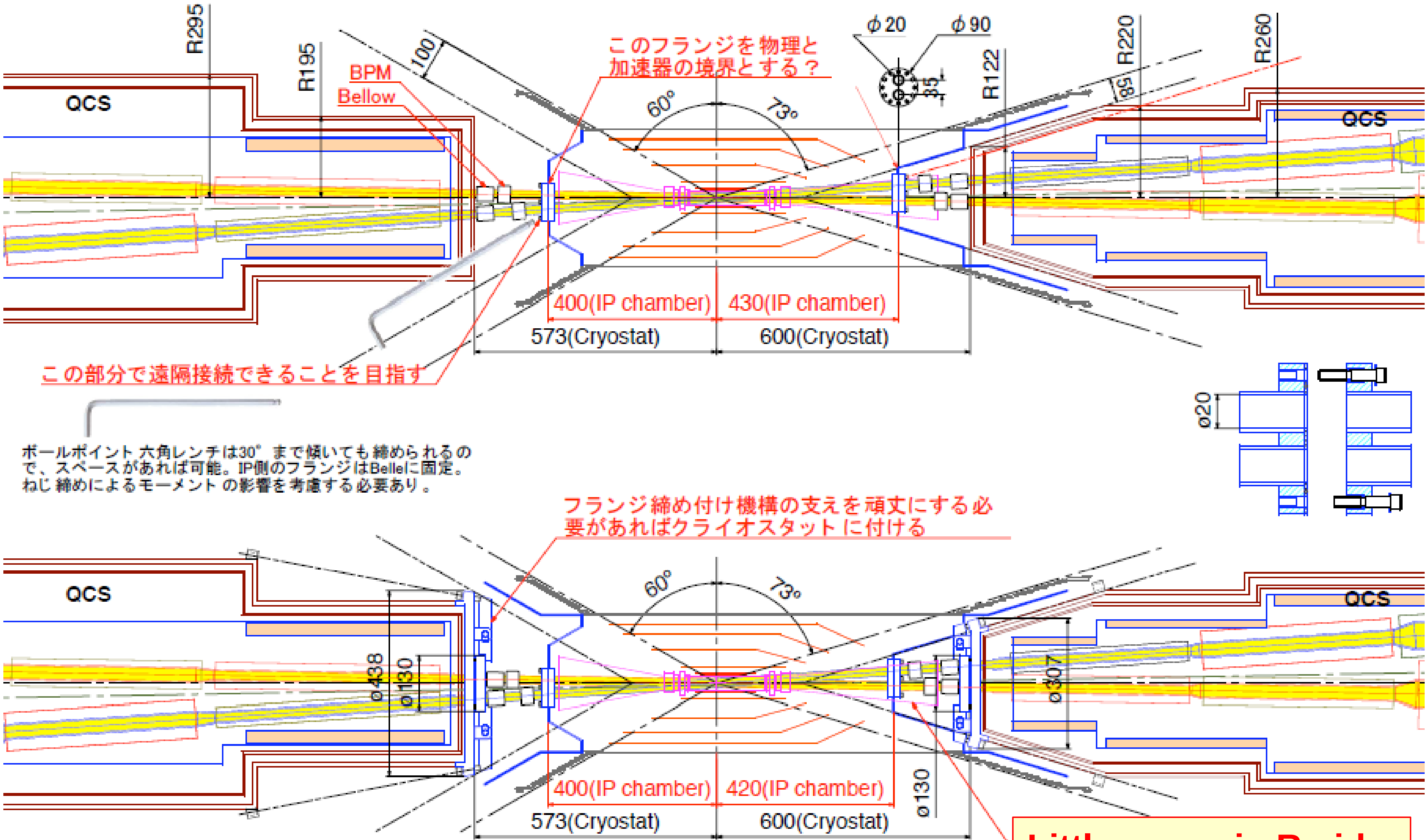
IR assembly

T.Kohriki
(2009/07/07)



Parameters are not fixed yet

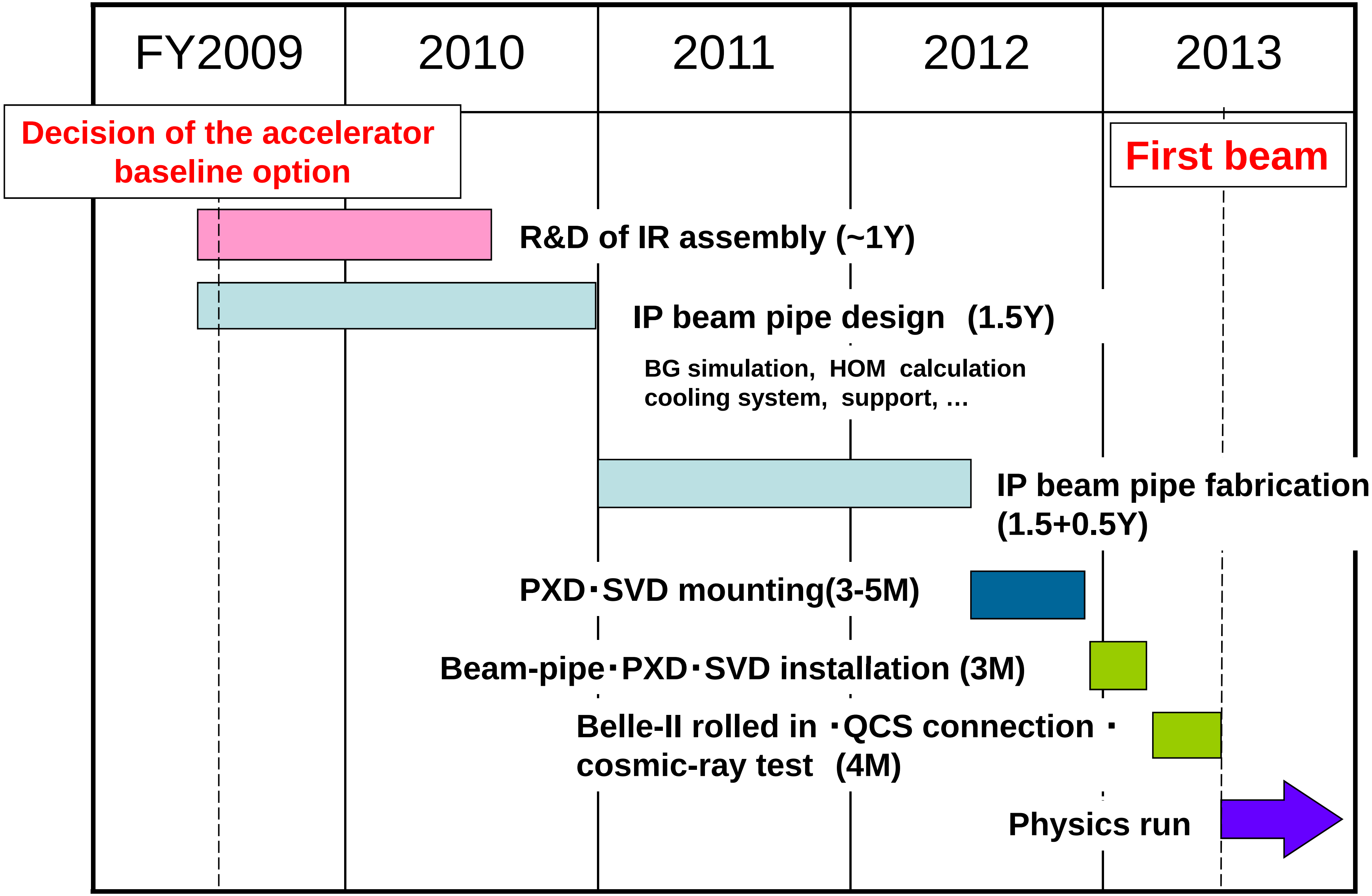
T.Kohriki (2009/10/01)



Parameters / shapes are not fixed

Little space in R-side
Need to design the
IP-chamber shields soon

Schedule


FY2009
2010
2011
2012
2013
Decision of the accelerator baseline option
First beam
R&D of IR assembly (~1Y)
IP beam pipe design (1.5Y)
BG simulation, HOM calculation
cooling system, support, …
IP beam pipe fabrication
(1.5+0.5Y)
PXD･SVD mounting(3-5M)
Beam-pipe･PXD･SVD installation (3M)
Belle-II rolled in ･QCS connection ･
cosmic-ray test (4M)
Physics run

Summary

Super-KEKB design

Nano-beam option is the baseline
7(HER) x 4 (LER) beam energies
Consider 83 mrad crossing angle

To do list

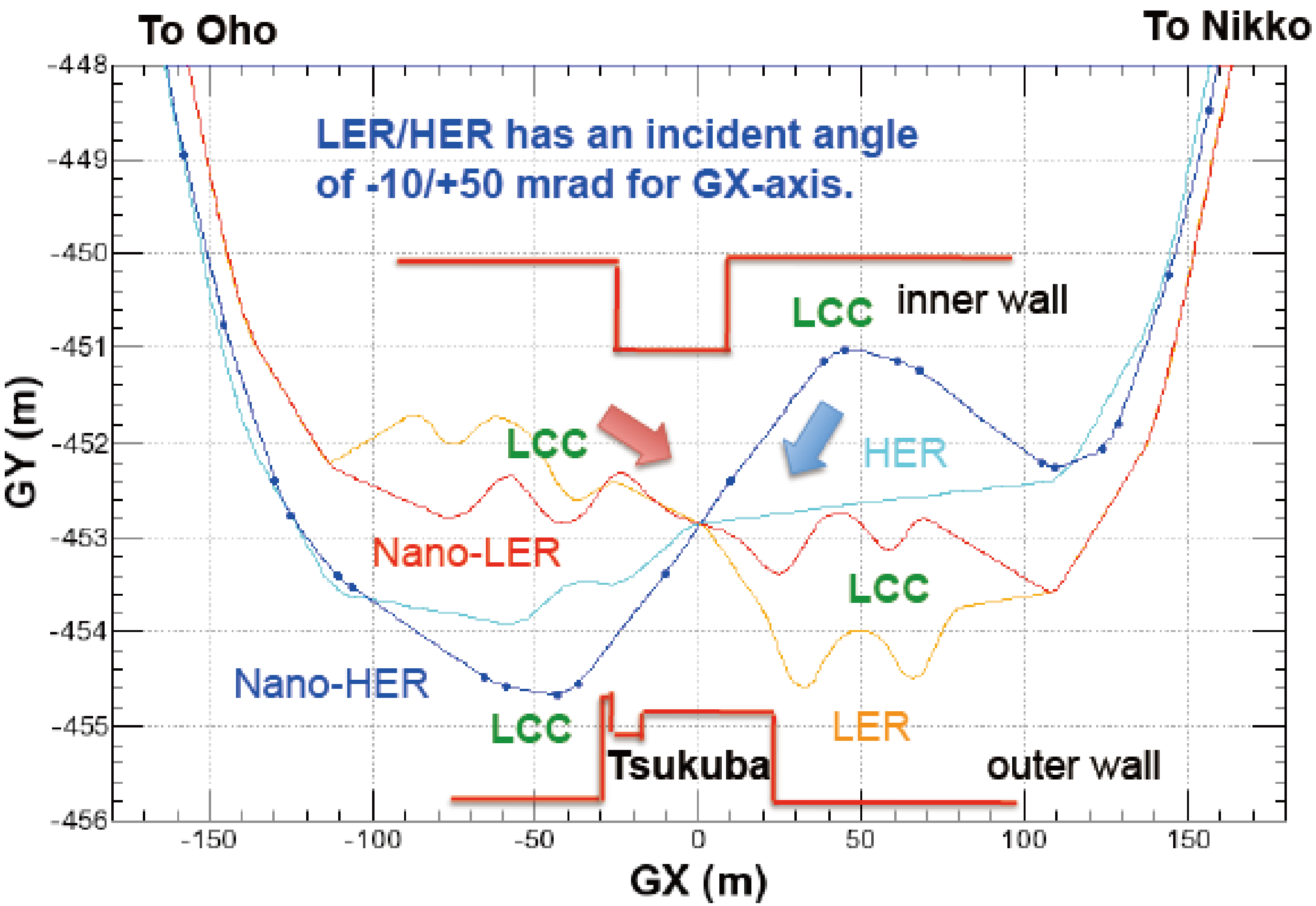
1. Beam-pipe design
   We need heavy metal shield design and its support structure
   (1cm radius Be beam-pipe will be broken with the current support method)
2. Detector BG
   Simulations of Touscheck and the beam-gas BG
3. IP assembly
   In progress. But the IP assembly design and rooms for sub-detectors (PXD/SVD) are highly connected.
   (There is little space in R-side)

Backup

Super-KEKB beam line design

One of constraints is tunnel geometry.

TSUKUBA IR

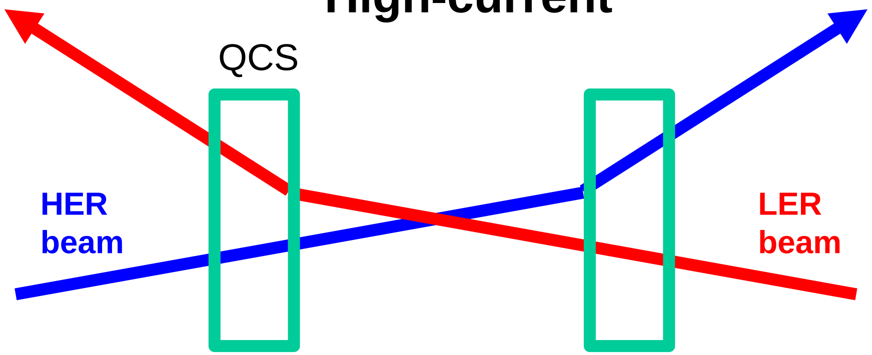


Two machine options

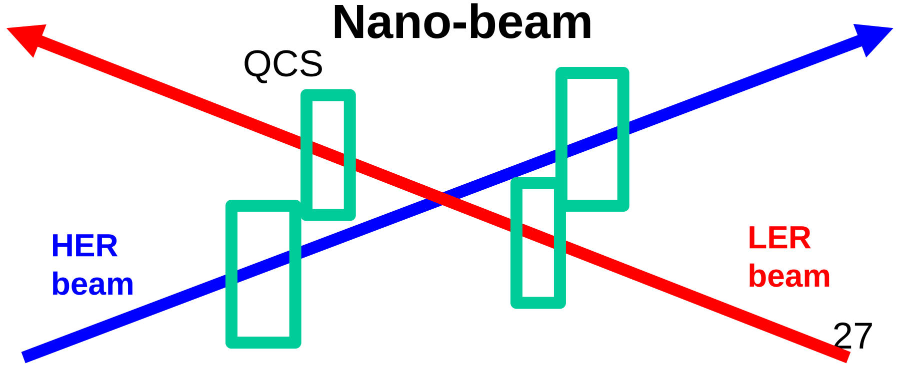
High-current option … SR BG & HOM heating
Nano-beam option … IR assembly & support

	High current (LER/HER)	Nano-beam(LER/HER)
Beam current I (A)	**High current** : 9.4/4.1	~3/~2
Bunch length σ_z (mm)	**Short bunch length** : 5/3	6/6
Emittance ε_x (nm)	24/18	Low emittance : 1/1
β_y (nm)	3/6	Small β : 0.22/0.22
Beam size σ_y	0.85/0.73 (μm)	**Small beam size** : 34/44 (nm)
Final Q-magnet layout	- Common QCS for 2 beams - location 40cm (L) / 65cm (R) Little space in L side	Two separate Q-magnets for each 2 beams **Little space in both L/R sides**

High-current



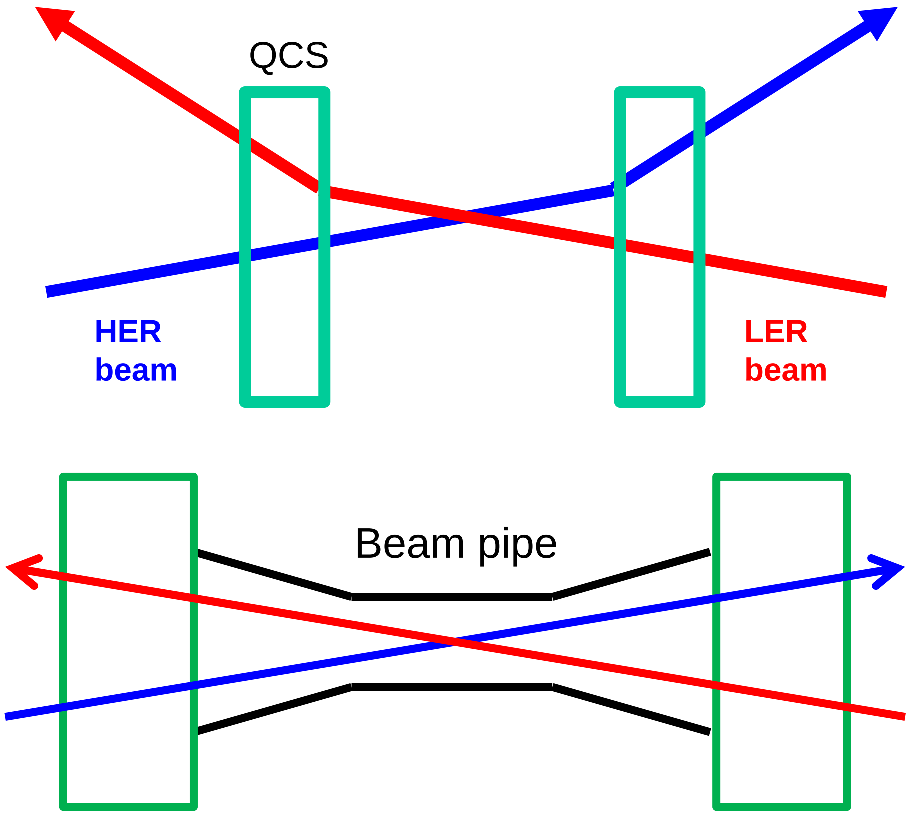
Nano-beam



Final Q layout & beam-pipe

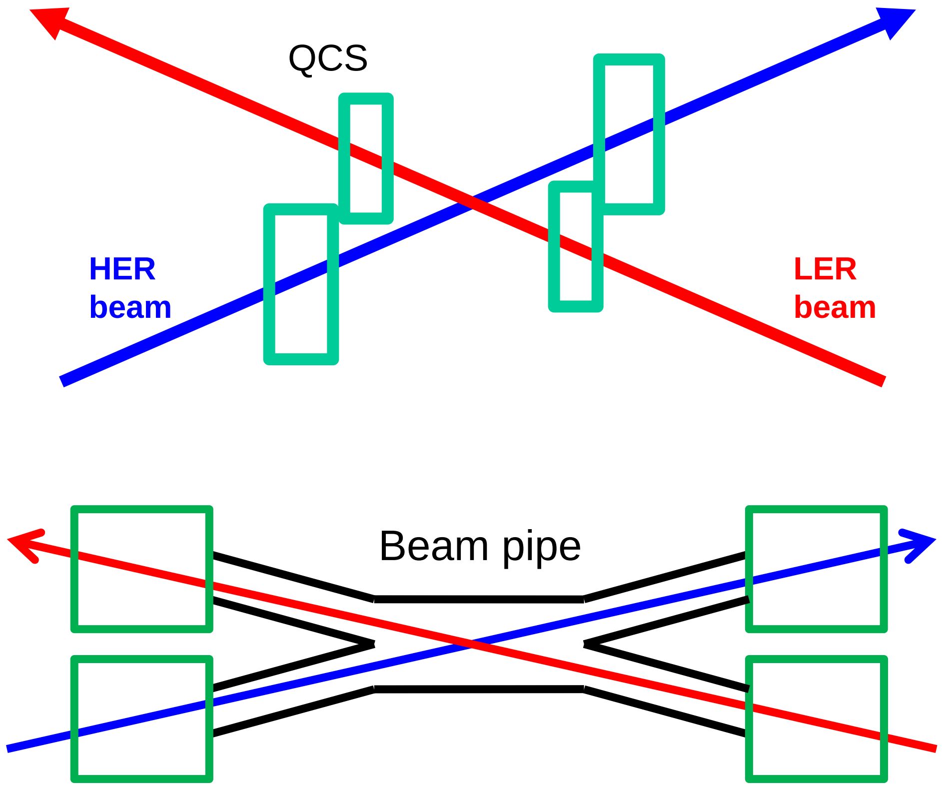
High-current option

Common QCS for 2 beams



Nano-beam option

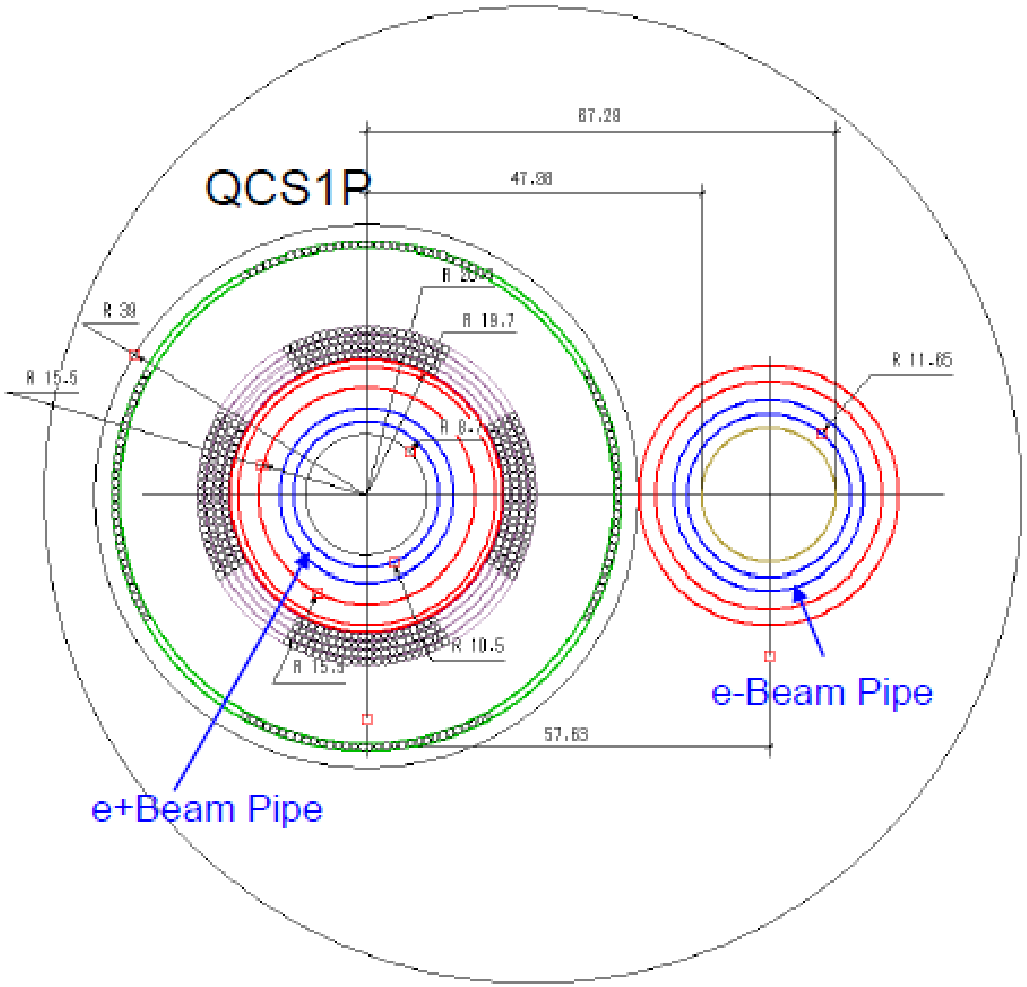
Two-separate Q-magnets for each 2 beams



To connect with the separate Q magnets the IP beam pipe has branch structures (crotch structures)

QCS design QC1P(R/L)

N. Ohuchi (KEK)

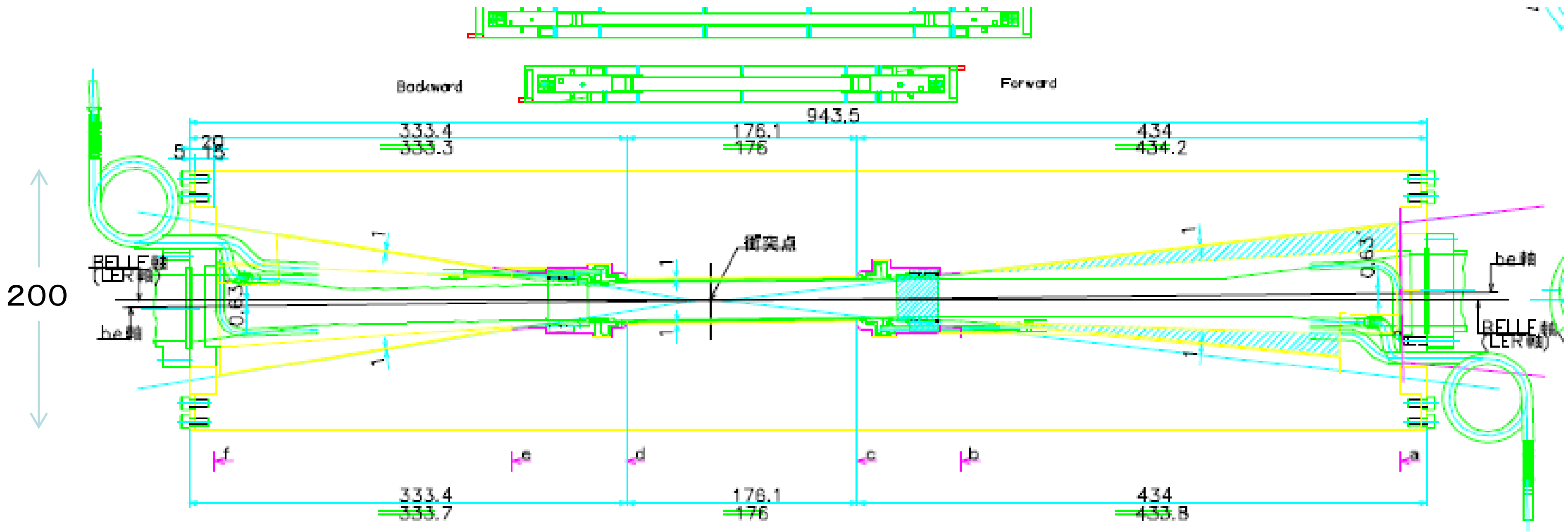


QCS1P Cross Section

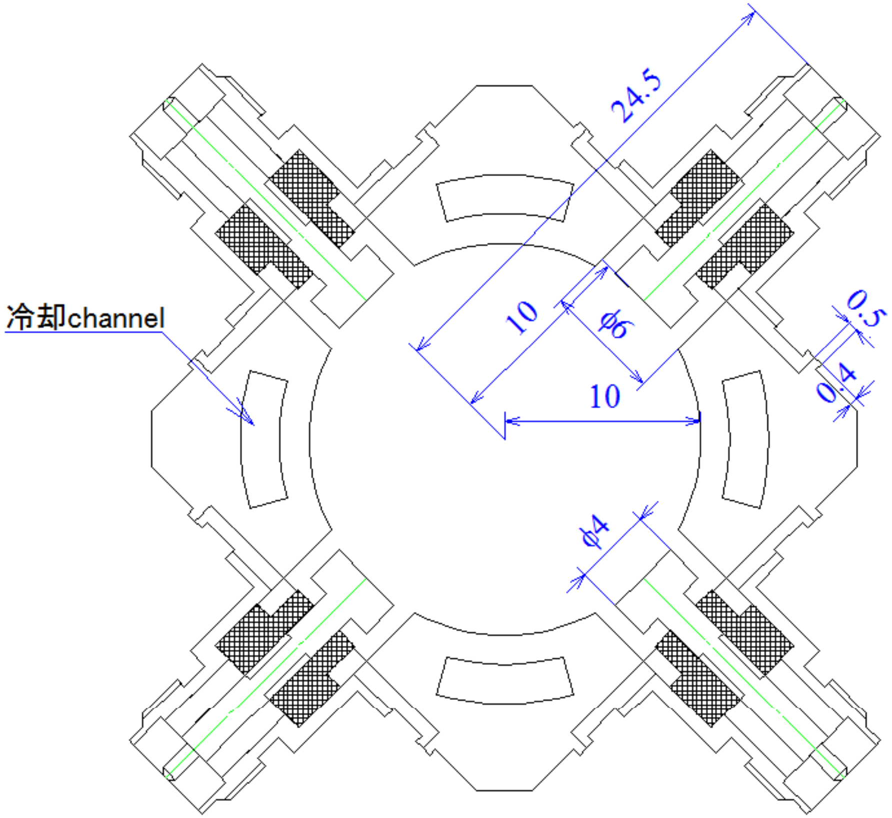
1. Design integral field
   - Int. G=17.683 T(R), 17.772 T (L)
2. Main quadrupole configuration
   - 4 layer coils (wire coil)
     - (1st layer/2/3/4=10 turns/10/11/11)
3. Active shield coil
   - 1 layer coil (16 turns)
4. Superconducting wire
   - Outer dia.=1 mm
   - Cu Ration=1.2
   - Current= 730.53 A(R), 734.21 A(L)
   - Current density (SC area)= 2900 A/mm^2 (R), 2915 A/mm^2(L)
   - Current density (wire)=1318 A/mm^2 (R), 1325 A/mm^2 (L)
5. Cryostat bore=Beam pipe (room temp.)
   - Inner radius=10.5mm
6. Helium vessel bore without LN_2 shield
   - Inner radius=15.5mm

To avoid HOM trap, IP beam-pipe radius < QCS radius
→ **IP beam-pipe Inner radius = 10.5mm**

サイズ（現行BelleのIPチェンバー）



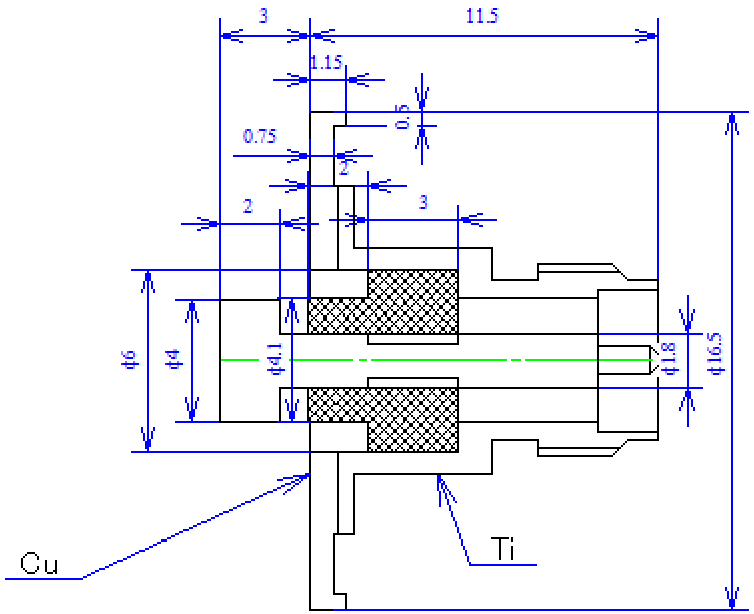
BPM design



チェンバー材質は未定
多分銅。場合によっては外側だけSUSになるかも

ボタン先端はチェンバーのツライチ

フィードスルー



Octpos用を改造
セラミックスは、窒化ケイ素(SN220)
ボタン径は4mm、Gap 1mm
ボタン厚さ2mm

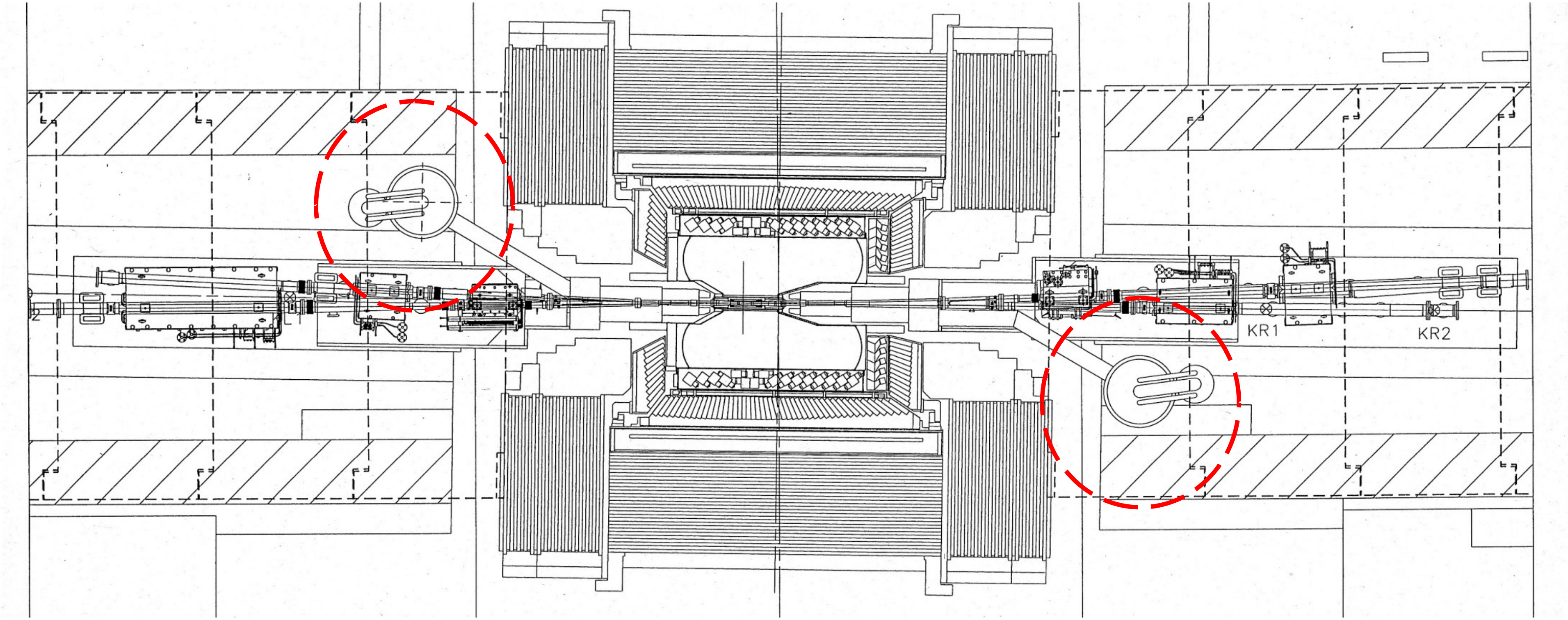
材質は多分チタン、フランジ部だけCuあるいはSUSになる(HIP材をさがす)

衝突点用SMAフィードスルーS1型概略図

作図：飛山真理 9/Jul/2009
修正：飛山真理 16/Jul/2009

縮尺4:1

All integrated??



There are huge components related to the superconducting magnets..

Original drawing: R. Sugahara

Detector BG summary

1. We just start Nano-beam option SR simulation

- Nano-beam SR energy(HER) ~ 1/10 SR energy(High-current)
- Nano-beam SR energy(LER) ~ SR energy(High-current)
- Need to design and implement beam-pipe structure
- If we place beam-pipe parallel to LER

E deposit (to the Be part) ~ 5W ← very low

(but the optics we used was already obsolete..)

- We need further SR BG study

2. We also start the radiative BhaBha simulation

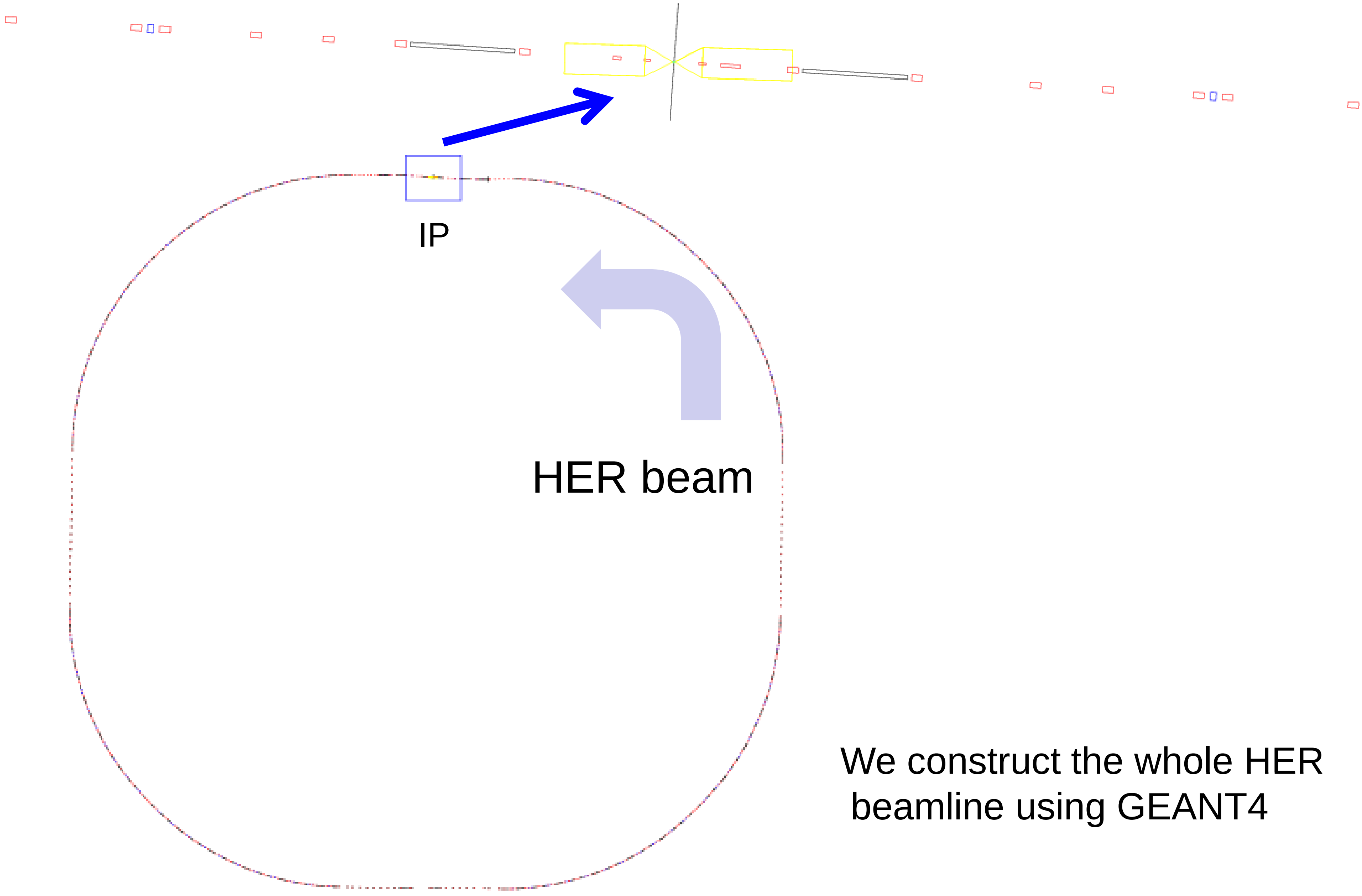
So far only high energy hits to the ECL (No hits from low energy positron)

Need further study (We don't have enough statistics yet)

2. We need to start Touschek / beam-gas BG study

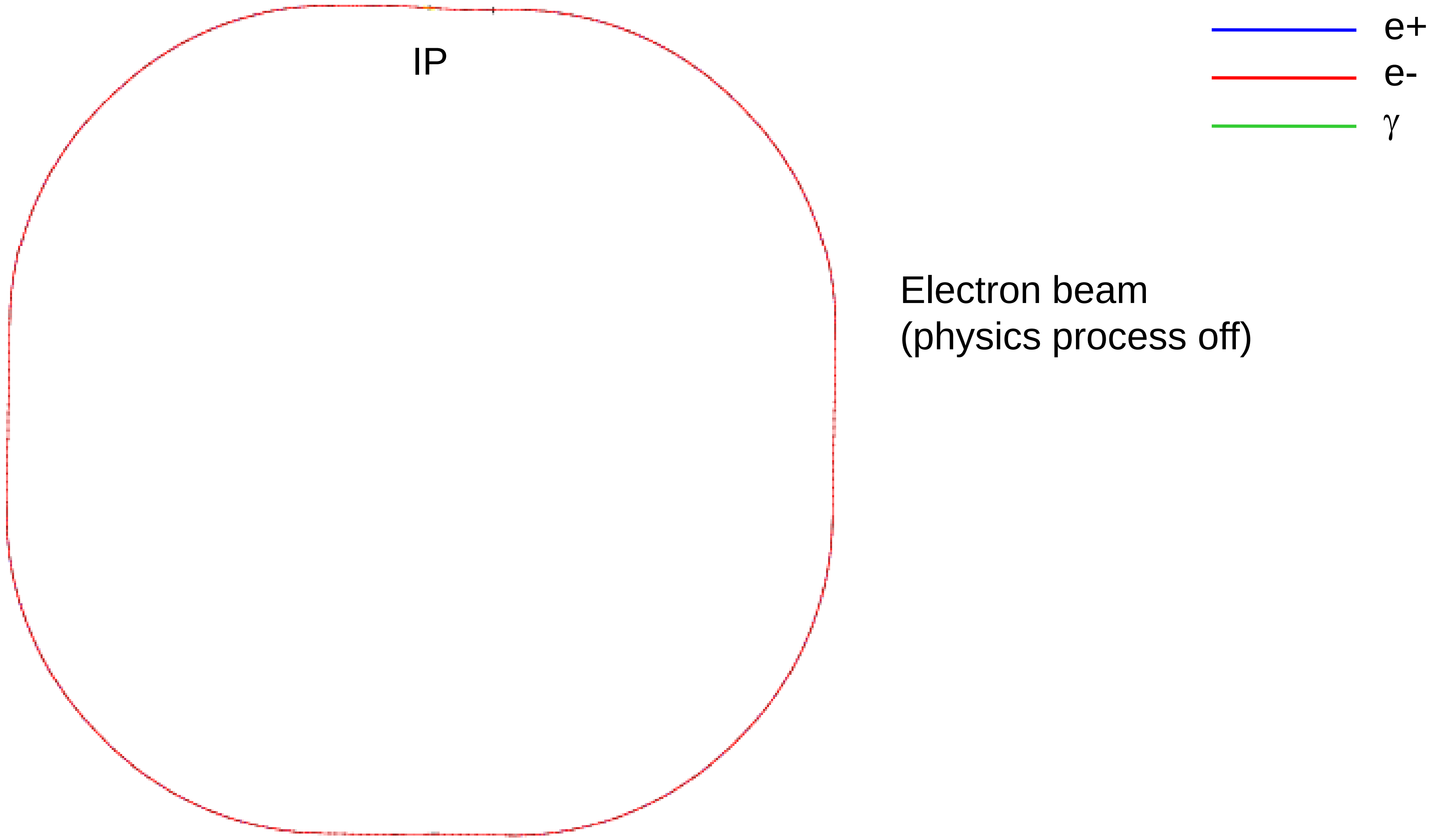
Beam BGsimulations

HER beam-line simulation



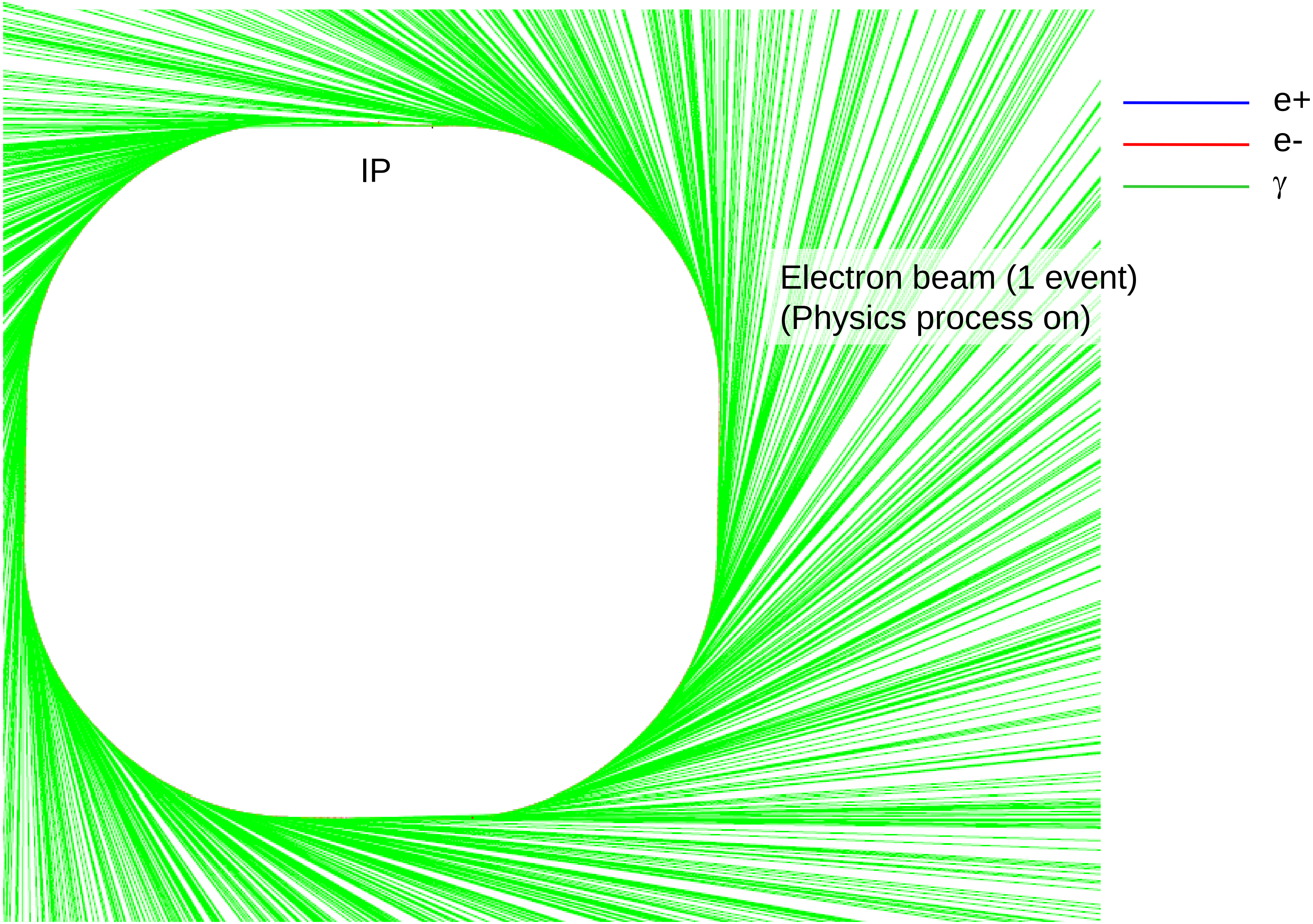
We construct the whole HER beamline using GEANT4

HER beam-line simulation

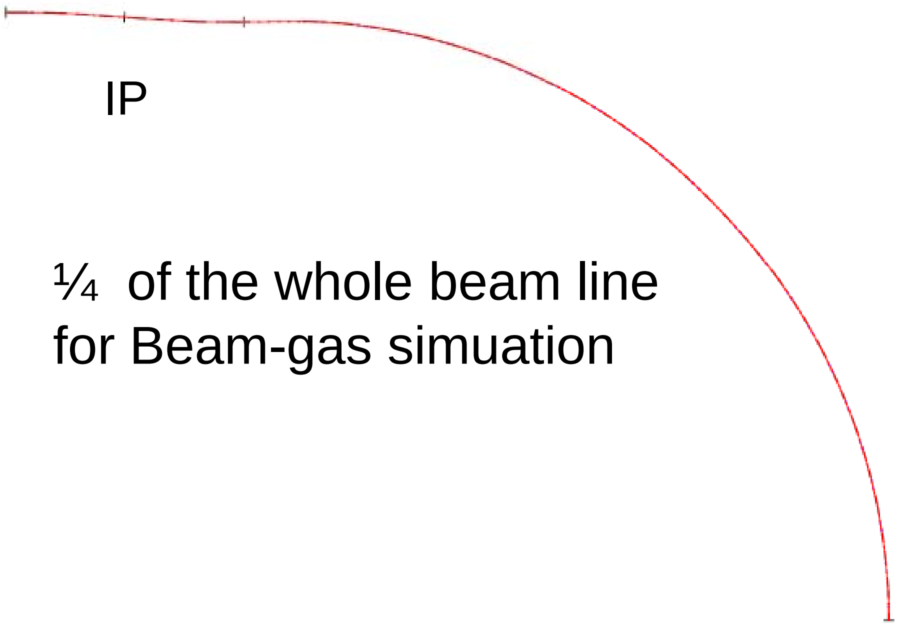


Electron beam
(physics process off)

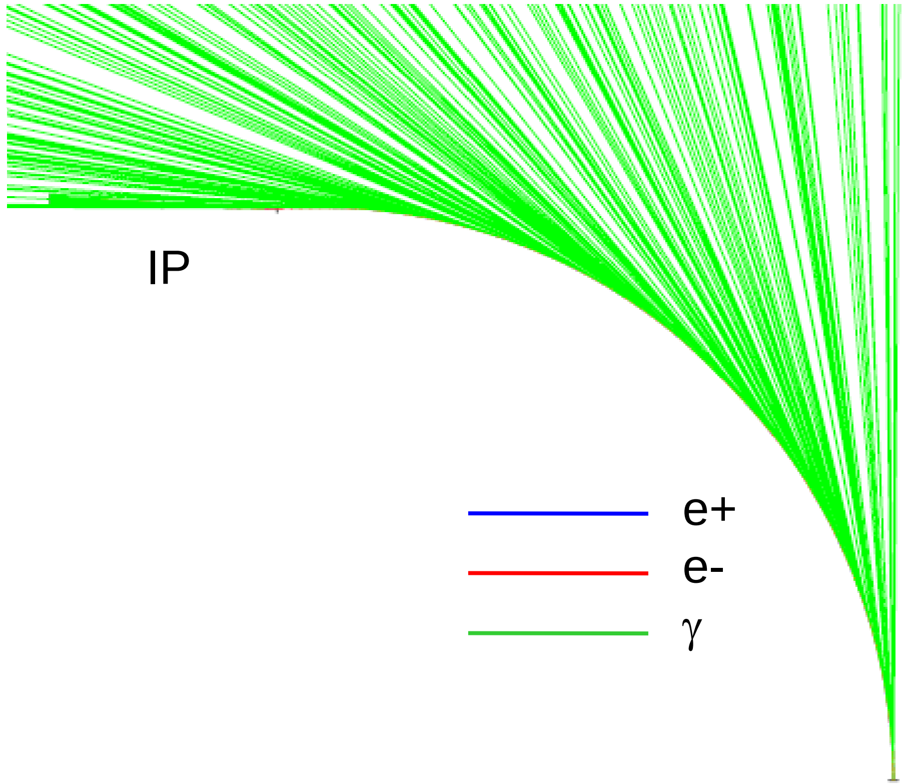
HER beam-line simulation



HER beam-line simulation for beam-gas



¼ of the whole beam line
for Beam-gas simuation



To Do : By changing the vacuum around IP, we'll estimate the beam-gas BG

Experimental Hall
Vibration measurement

H. Yamaoka

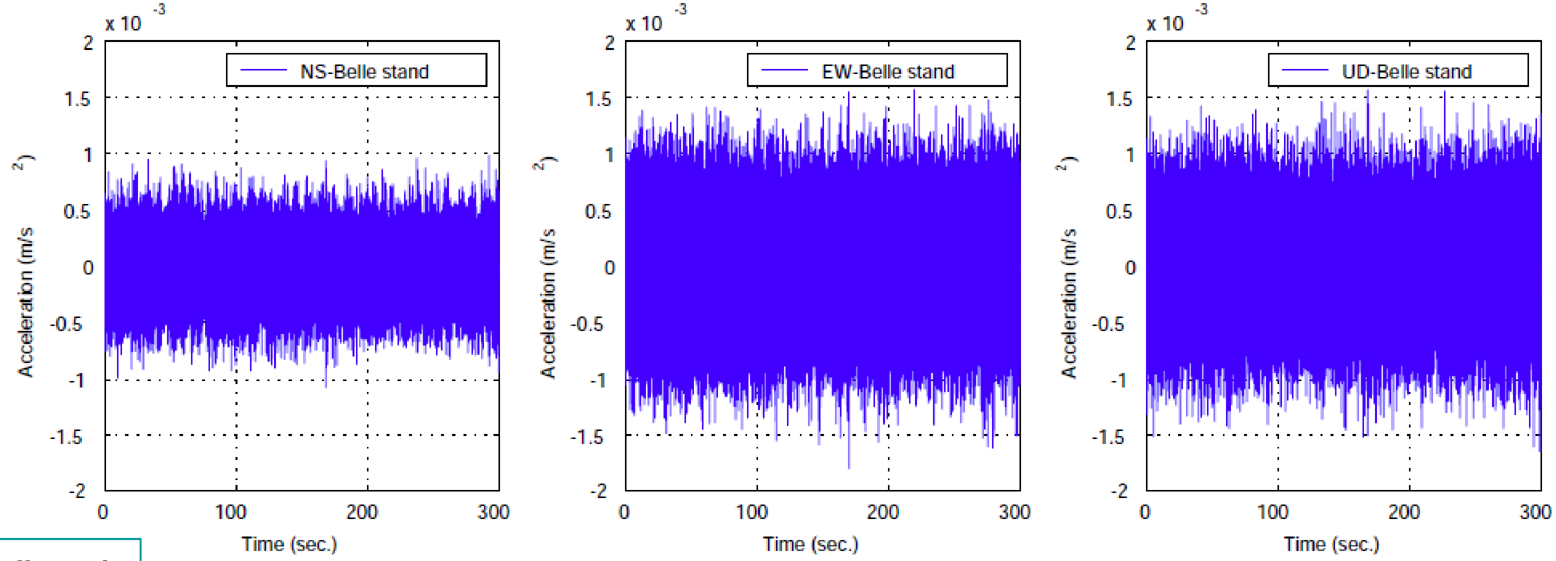
Sep. 18, '09
KEK H. Yamaoka

Raw data (Wave form)

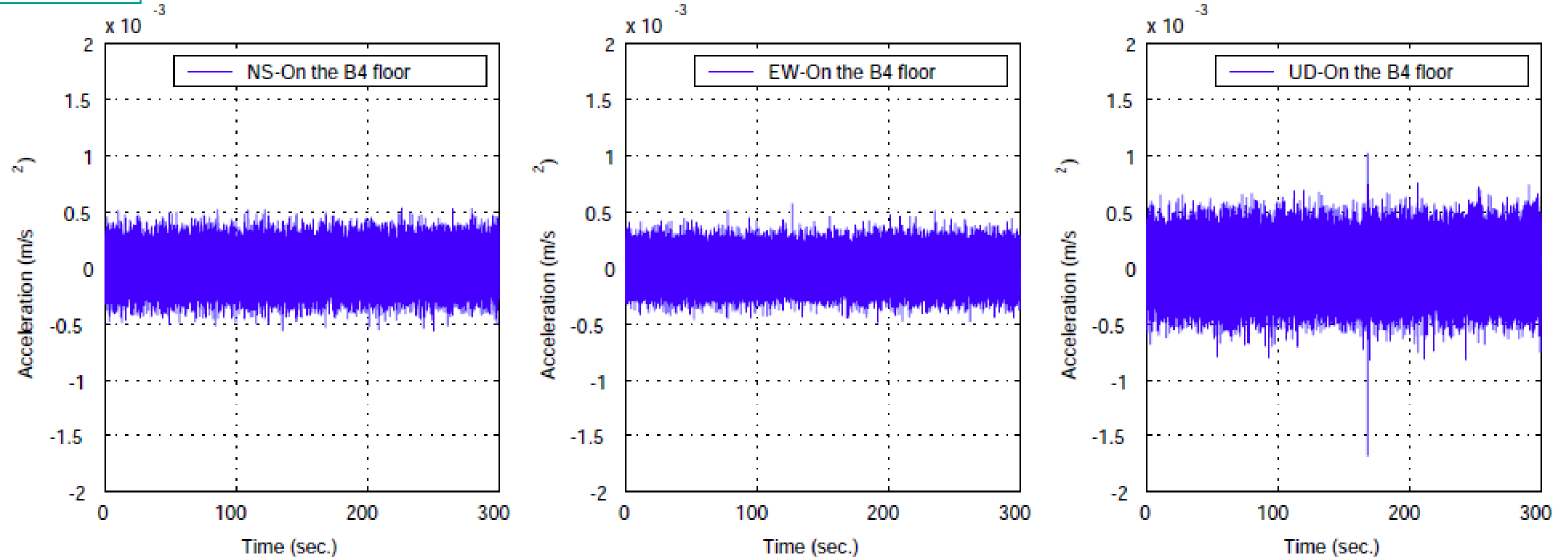
Sep. 18, '09
KEK H. Yamaoka

A(Belle : on the support table)

X: Perpendicular to the beam Y: Beam direction V: Vertical



B(B4 floor)

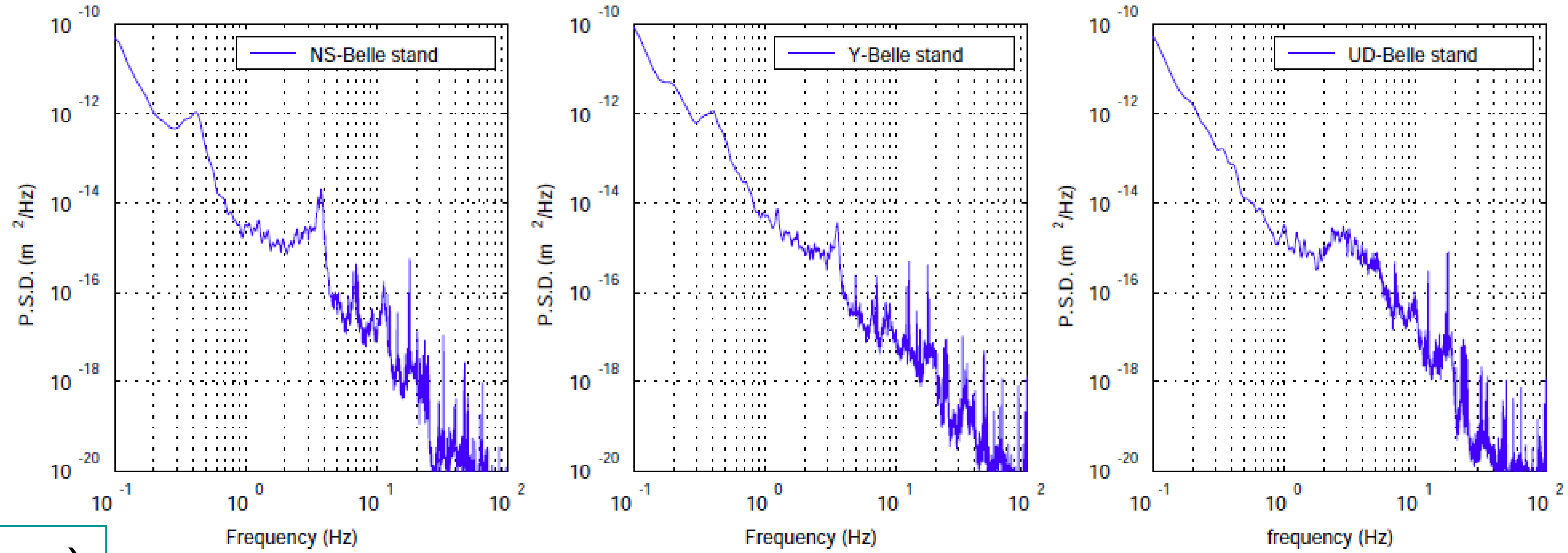


Power Spectrum Density

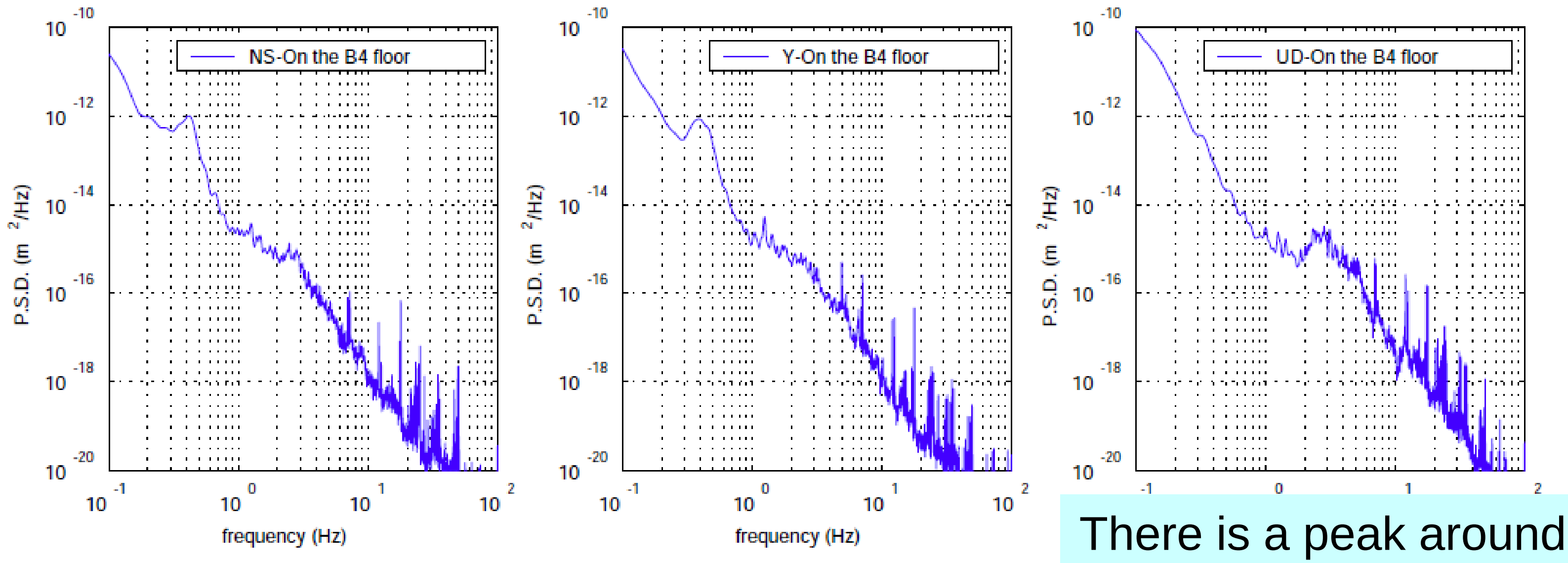
Sep. 18, '09
KEK H. Yamaoka

A(Belle : on the support table)

X: Perpendicular to the beam Y: Beam direction V: Vertical



B(B4 floor)



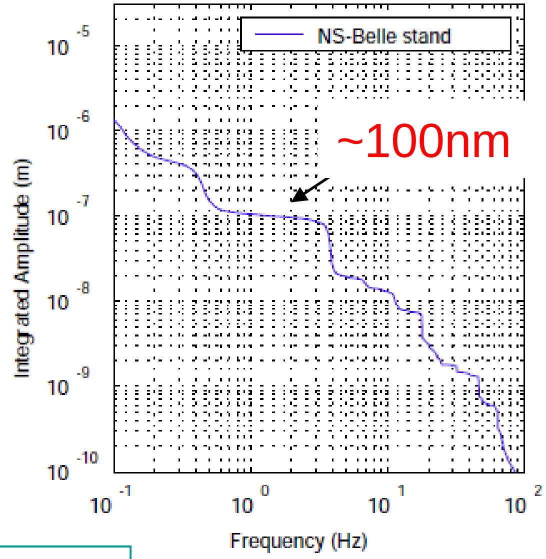
There is a peak around ~3 Hz

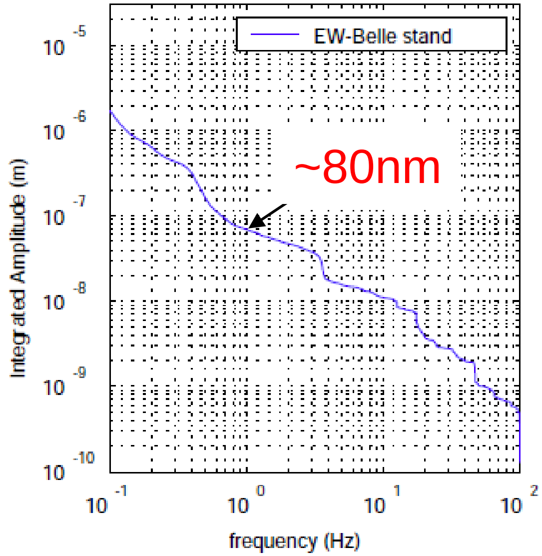
Integrated Amplitude

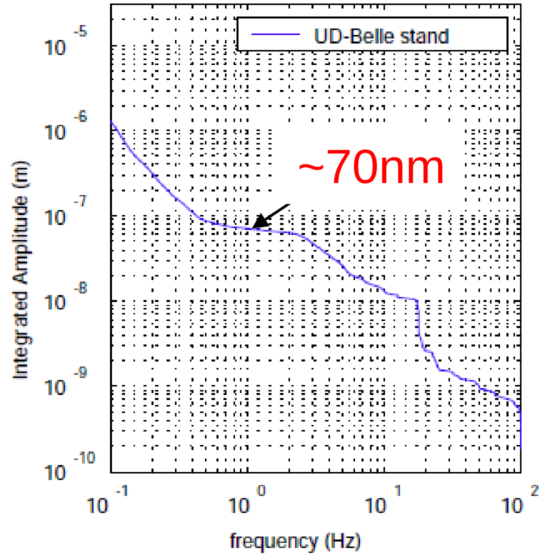
Sep. 18, '09
KEK H. Yamaoka

A(Belle : on the support table)

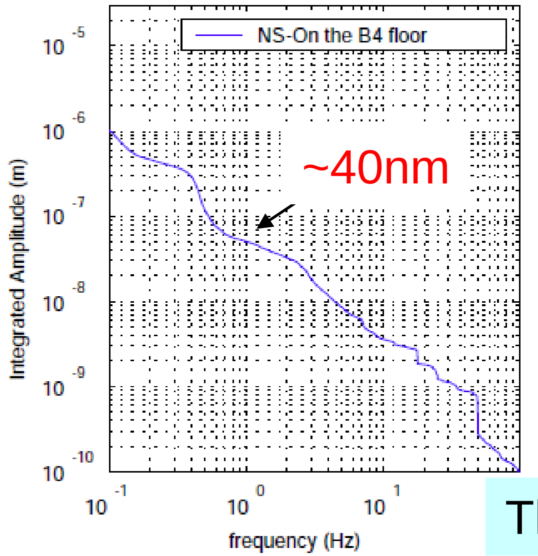
X: Perpendicular to the beam Y: Beam direction V: Vertical

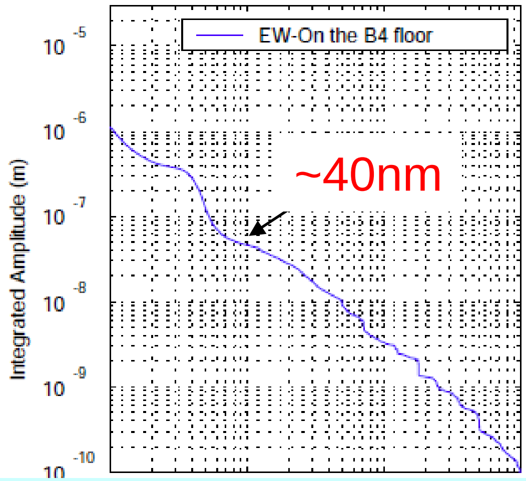


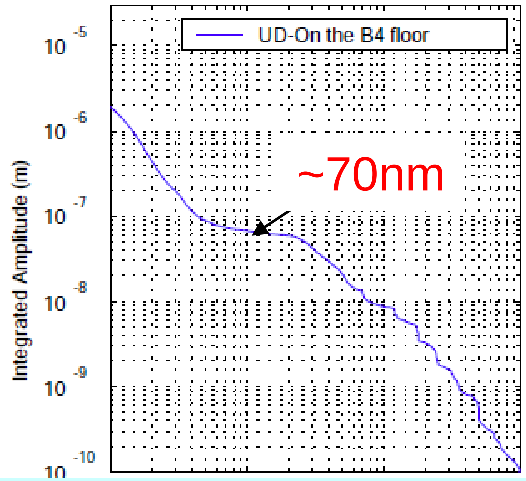




B(B4 floor)







The amplitude around ~3 Hz peak is ~100 nm in the Belle