IR status

2009/3/19 M. Iwasaki

For Super-KEKB MDI group

U. Tokyo, Tohoku U., and KEK

Introduction

Super-KEKB → High luminosity experiment

To increase the luminosity,

machine parameters will drastically change

Issues of the IR design:

1. Beam background

    High beam current / High power SR emission

2. Heating of IR components

    Short bunch length / High current / High power SR

3. Assembly of inner detectors, beam pipe, and final magnets

    Place final Q magnets closer to IP

IR design is very important in Super-KEB

From KEKB to Super-KEKB 1

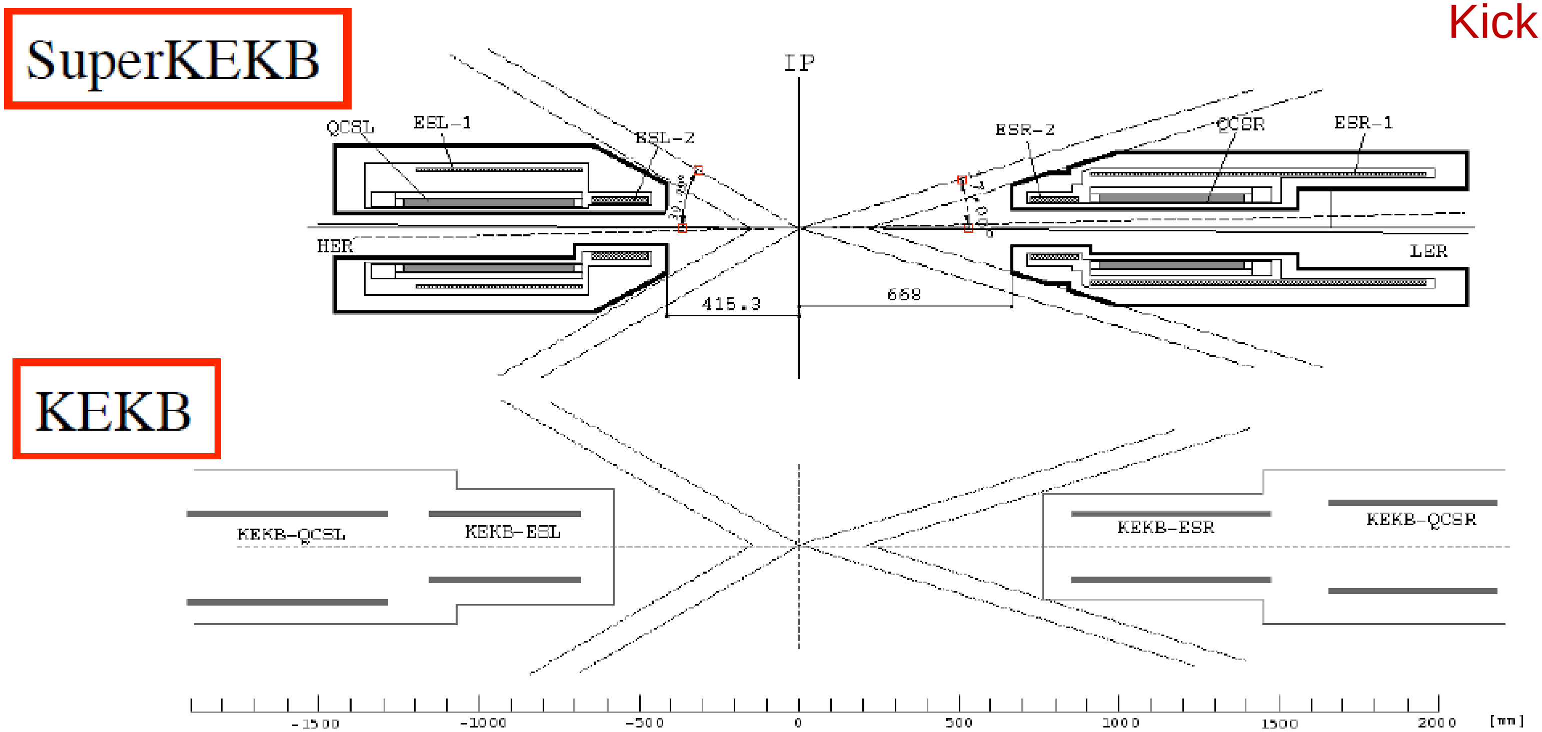
Machine parameters

Y.Funakoshi
Kick off meeting

	Present KEKB LER/HER	KEKB Design LER/HER	Super KEKB LER/HER
β_x^* [m]	0.59/0.56	0.33	0.2 (0.4)
β_y^* [mm]	6.5/5.9	10	3
ε_x [nm]	18/24	18	12
σ_z [mm]	~8/~7	5	3
ϕ_c [mrad]	±11	±11	±15 (Crab)
I_{beam} [A]	1.66/1.34	2.6/1.1	9.4/4.1
L [10^{34}/cm^2/s]	1.71	1	55

From KEKB to Super-KEKB 2
Place QCS magnets closer to IP

Y.Funakoshi
Kick off meeting



The boundary between KEKB and Belle is the same.
ESL and ESR will be divided into two parts (to reduce E.M. force).
QCSL (QCSR) will be overlaid with (the one part of) ESL(ESR).

IP – QCS distance : ~60cm → ~40cm (L side) ~75cm → ~65cm (R side)

There is little space in L-side… We must think about the detector assembly

Two machine parameter options

To avoid the beam instability by Coherent Synchrotron Radiation (CSR),
we must design the longer bunch length for LER ←Oide-san's talk

Currently 2 machine options are considered: ***High-current*** *and* ***Nano-beam***

	High current option (LER/HER)	Nano-beam option (LER/HER)
Beam current I (A)	High current : 9.4/4.1	2.7/1.55
Bunch length σ_z (mm)	Short bunch length : 5/3	6/6
Emittance ε_x (nm) ε_y (nm)	24/18 0.24/0.09	Low emittance : 1/10 0.0035/0.025
β_x β_y (nm)	200/200 3/6	Small β : 35/20 0.35/0.22
Beam size σ_y	0.85/0.73 (μm)	Small beam size : 35/71 (nm)
Distance btw IP and QCS	~40cm (L) / ~65cm (R)	30-40cm each ??

High-current option ... Higher SR BG / HOM heating
Nano-beam option ... IR assembly is difficult

Current status of the IR studies

Detector IR group status

1. Beam Background

SR BG simulation studies (Tokyo / KEK)

Other BG sources … not yet

2. Heating of IR components

HOM heating studies (Tohoku / KEK)

SR heating calculation (KEK) → H. Yamaoka-san's talk

3. Detector assembly

Must consider the detector support / assembly design

We also ask machine talks directly related to the detector:

- IR optics
- QCS design
- IR region assembly

Machine talks

- IR optics H.Koiso (KEK)
- QCS design N.Ohuchi (KEK)
- IR region assembly K.Kanazawa(KEK)

IR Optics

2nd Open Meeting
of the SuperKEKB Collaboration Meeting
Mar. 17, 2009

Haruyo Koiso

High Current Option

H.Koiso (KEK)

SuperKEKB machine parameters

SuperKEKB using traveling focus (only for LER) and negative α				
		LER	HER	
Emittance	ε_x	24	18	nm
	ε_y	0.24	0.09	nm
Beta at IP	β_x*	20	20	cm
	β_y*	3	6	mm
Bunch length	σ_z	5	3	mm
Betatron tune	ν_x/ν_y	.505/.5905	.505/.5905	
Synchrotron tune	ν_s	0.025	0.025	
Beam current	I_+/I_-	9.4	4.1	A
#bunches/harmonic#	N_b/h	5018/5120		
Crossing angle	$2\phi_x$	30 → 0 (crab crossing)		mrad
Beam-beam*1	ξ_x	0.182	0.138	
	ξ_y	0.295	0.513	
Damping	T_x	6000	4000	turns
	T_y	6000	4000	turns
	T_e	3000	2000	turns
Luminosity	L	5.3×10^{35}		$cm^{-2}s^{-1}$

*1: ignore effects of traveling focus

K. Ohmi
Y. Funakoshi

Optics with New Quads

H.Koiso (KEK)

- To take care of the beam-beam effect, βx* 20→40cm

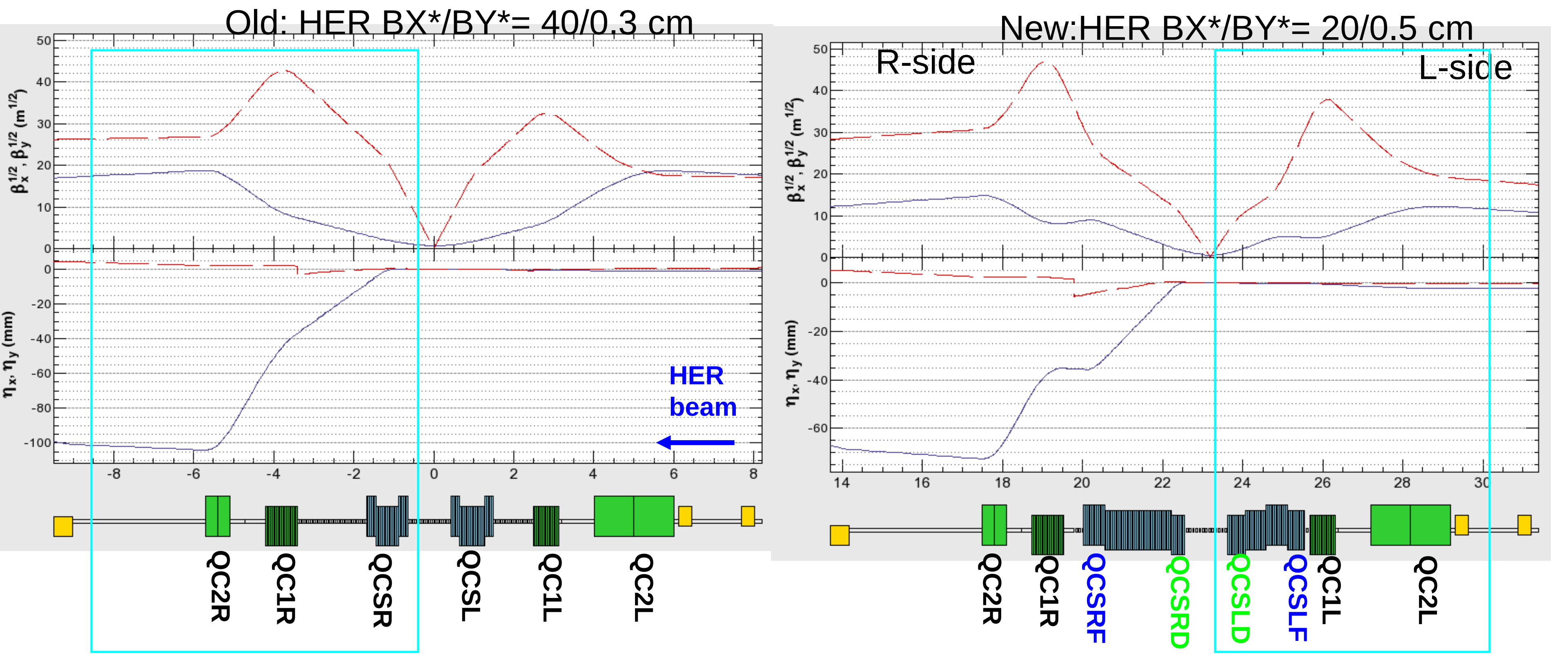
  Luminosity will decrease by ~20%, very large beam size

- βx* 40→20cm again with new quads / reduce β at QC2

  1.9K superconducting and permanent quads.

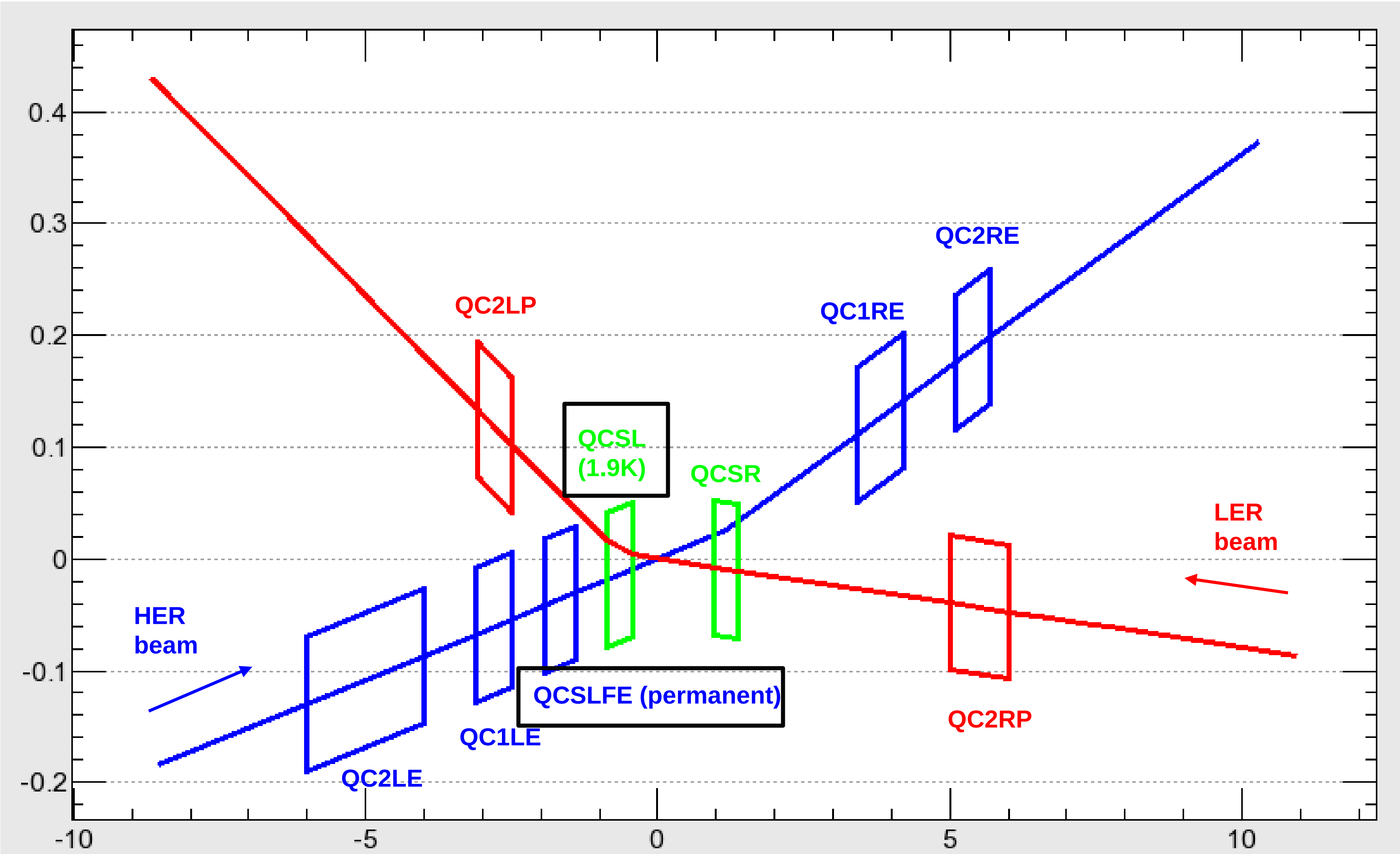
  Additional horizontal focusing quads for HER.

  At present, only L-side is acceptable from the view point of σ_x and SR fan.



Present Layout

H.Koiso (KEK)



L-side: New 1.9K quadrupole (QCSL) , and
Additional horizontal focusing permanent quadrupole (QCSLF) in HER

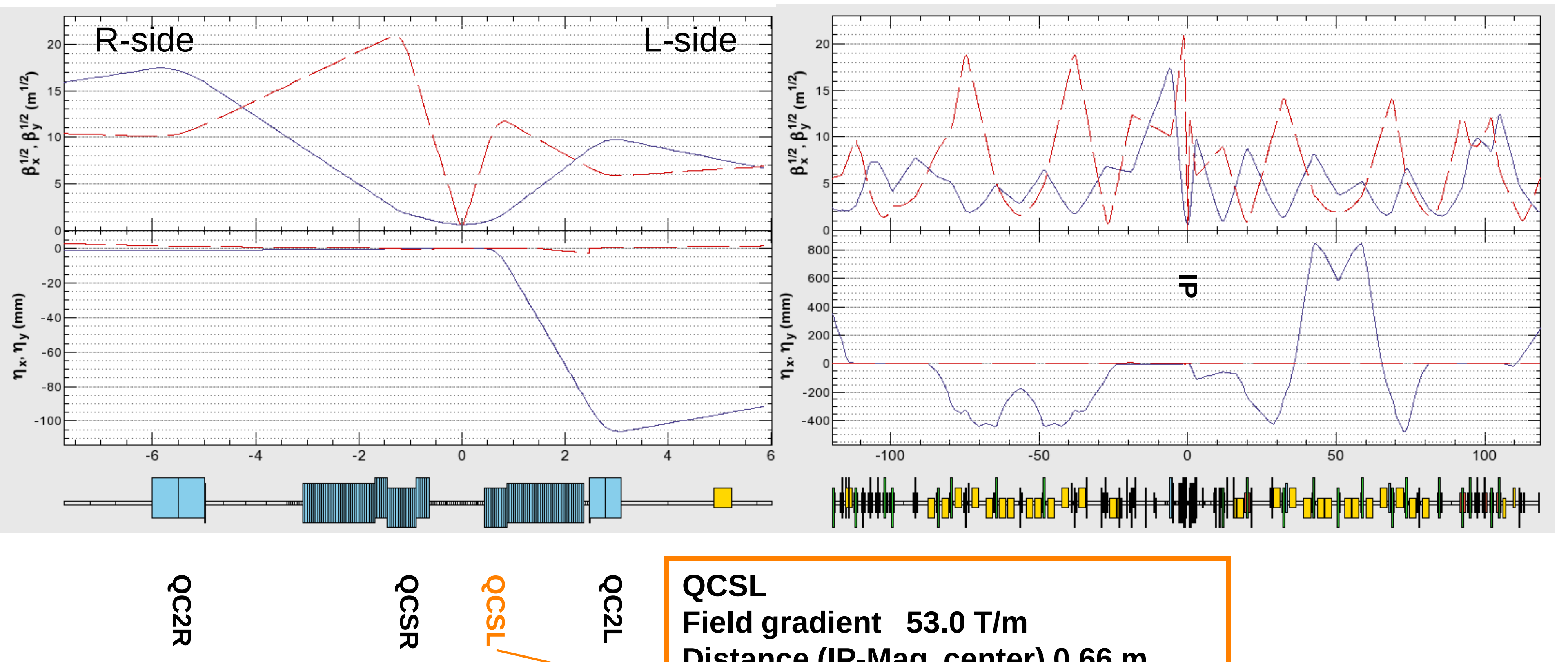
LER Optics

H.Koiso (KEK)

- βx* is still 40 cm, which is limited by R-side.
- Only L-side with a new superconducting quadrupole. (← 1.9K QCSL)
- Field gradient of QCS's is optimized for LER.

IR: BX*/BY*= 40/0.3 cm

Tsukuba: BX*/BY*= 40/0.3 cm



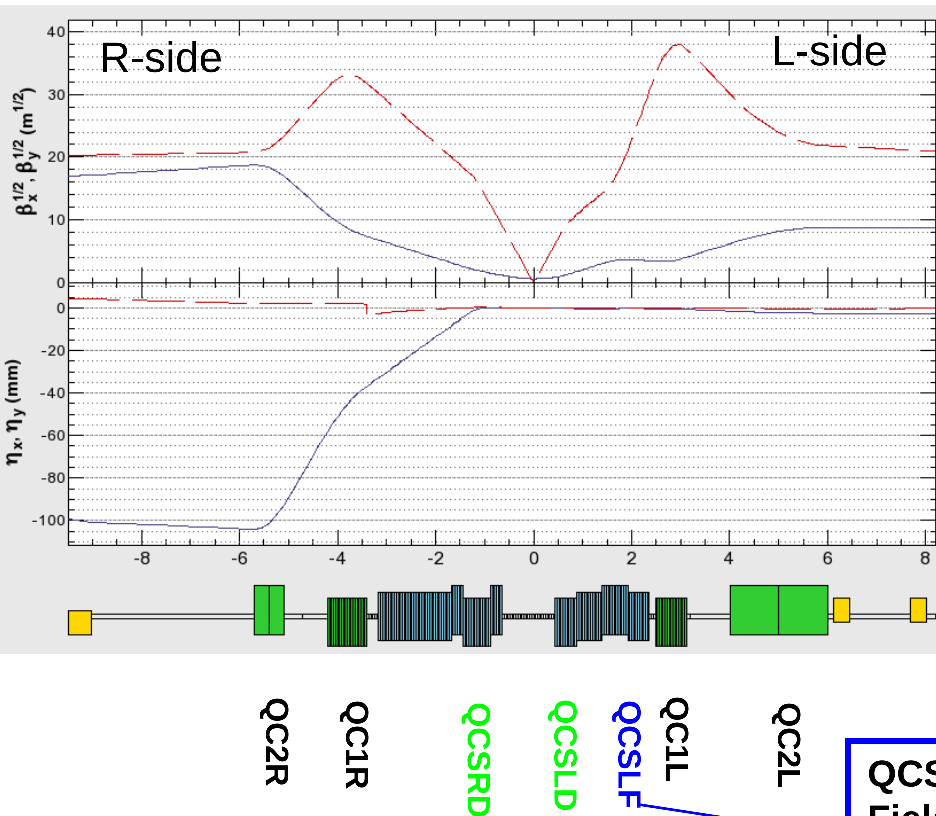
QCSL
Field gradient 53.0 T/m
Distance (IP-Mag. center) 0.66 m
Effective length 0.44 m

H.Koiso (KEK)

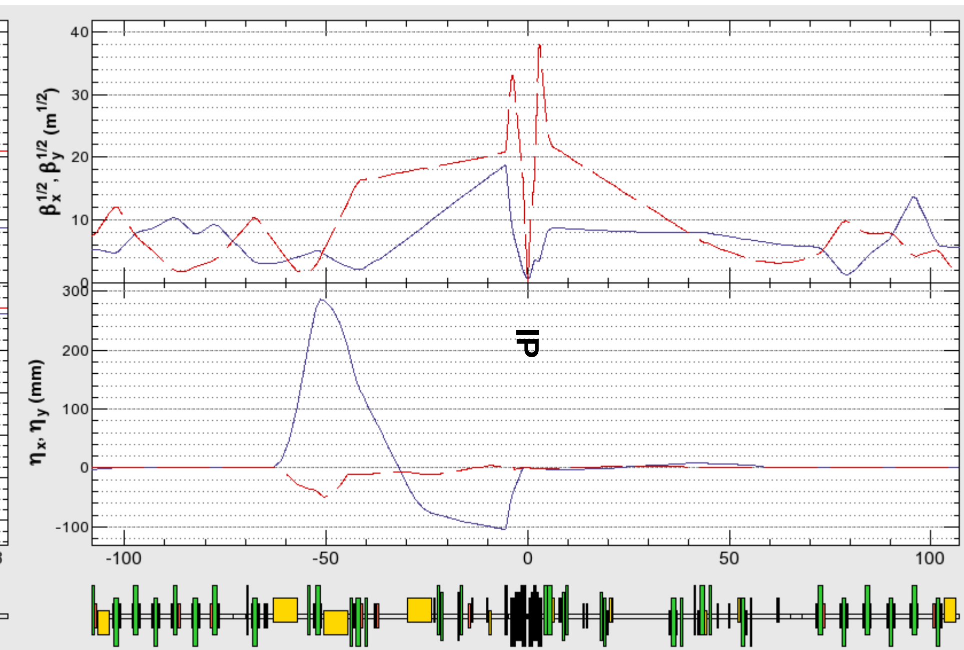
HER Optics

- βx* is 40 cm
- Only L-side with new quadrupoles. (← 1.9K QCSL + permanent QCSLF)

IR: BX*/BY*= 40/0.5 cm



Tsukuba: BX*/BY*= 40/0.5 cm



QCSLF
Field gradient 44.3 T/m

Low Emittance Option

H.Koiso (KEK)

Parameters for Super B Factories

a) b-b simulation, b) geometrical

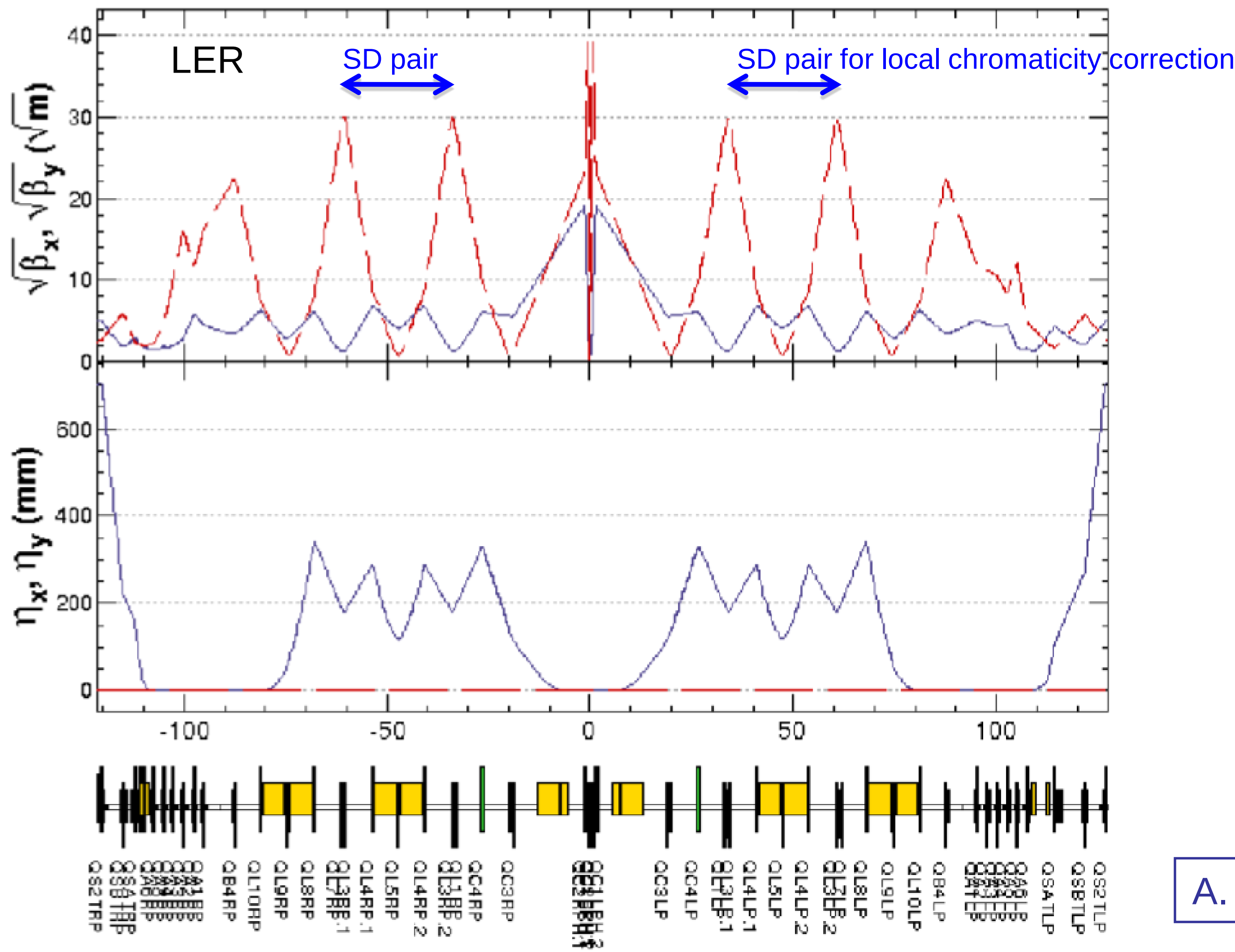
	SuperKEKB	SuperBunch T	SuperBunch H	Super B	Super B New
εx (nm) (L/H)	24/18	1/10	1/10	2.8/1.6	2.8/1.6
εy(nm)	0.24/0.09	0.0035/0.025	0.0035/0.025	0.007/0.004	0.007/0.004
κ (%)	1/0.5	0.35/0.25	0.35/0.25	0.25/0.25	0.25/0.25
βx (mm)	200/200	35/20	35/10	35/20	44/25
βy (mm)	3/6	0.35/0.22	0.35/0.22	0.22/0.39	0.21/0.37
σx (μm)	69/60	5.9/14	5.9/10	9.9/5.66	11/6.32
σy (μm)	0.85/0.73	0.035/0.071	0.035/0.071	0.039/0.039	0.038/0.038
σz (mm)	5/3	6/6	6/6	5/5	5/5
φσz/σx	0/0	31/13	31/18	14/25	14/24
σx/φ(mm)	∞/∞	0.21/0.47	0.20/0.33	0.35/0.20	0.37/0.21
ne	5.25×10^{10}	3.89×10^{10}	8.11×10^{10}	5.52×10^{10}	5.99×10^{10}
np	$12. \times 10^{10}$	6.78×10^{10}	1.39×10^{11}	5.52×10^{10}	5.99×10^{10}
I_{beam} (A)	9.4/4.1	2.70/1.55	2.65/1.55	1.85/1.85	2.0/2.0
#bunch/Cir(m)	5000/3016	2500/3016	1200/3016	1251/1800	1251/1800
φ (mrad) (half crossing angle)	0	30	30	24	30
ξy	0.30/0.51	0.067/0.068	0.139/0.139	0.147/0.150	0.125/0.126
Lum	5.3×10^{35} a)	5.0×10^{35} b)	10×10^{35} b)	11×10^{35} b)	10×10^{35} b)

Y. Funakoshi

Italian version of IP

H.Koiso (KEK)

- BX*/BY* = 20 / .200 mm



A. Morita

Distance between IP and final-Q → 40cm in both L and R sides

H.Koiso (KEK)

Summary

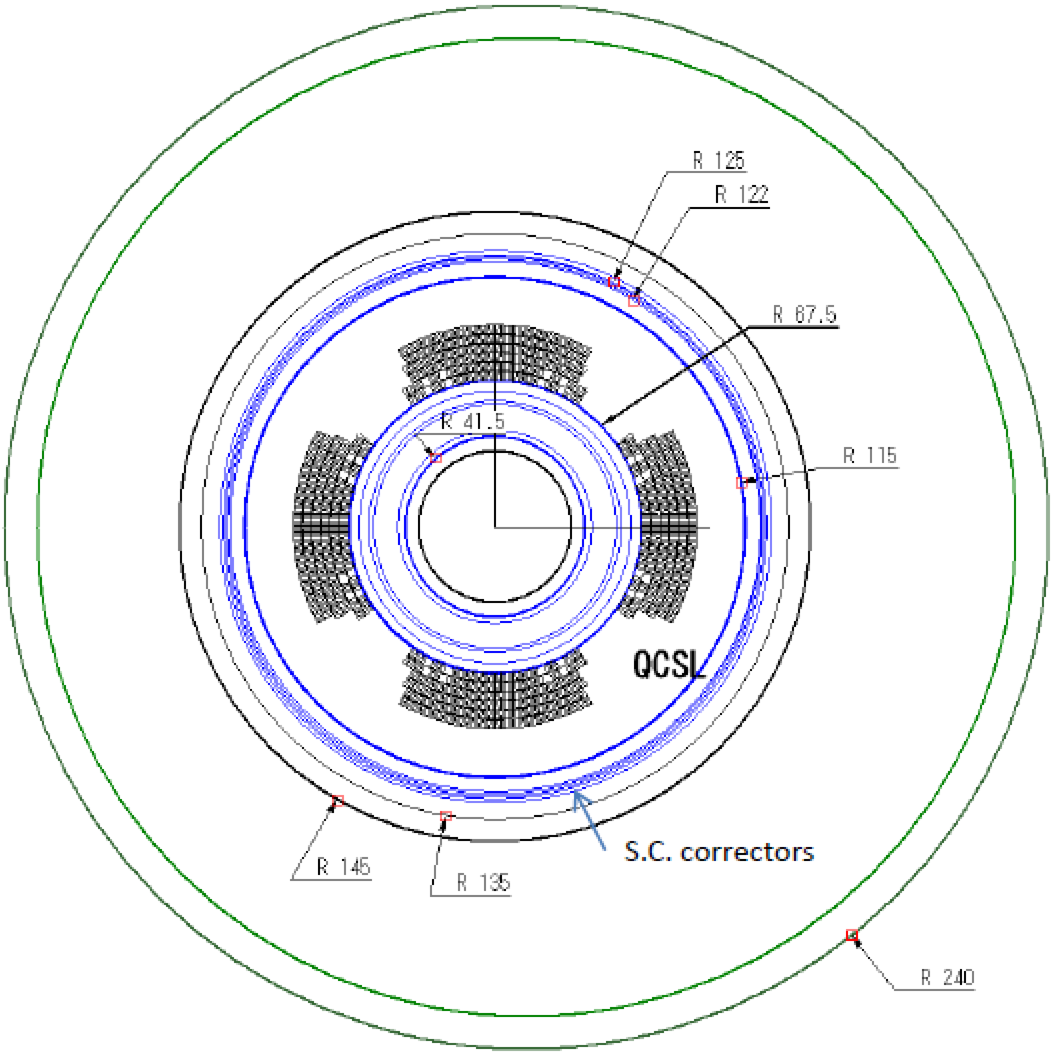
- For high current option, we have not yet found a realistic solution of β_x^* =20 cm. At present, β_x^* remains 40 cm.
- Design of low emittance option has just started.
  - Geometry of IR beam lines
  - New layout with 60 mrad crossing angle

QCS Design
(The 1st consideration for the updated IR)

Norihito Ohuchi, Masafumi Tawada

QCSLD cooled at 1.9 K

N.Ohuchi (KEK)



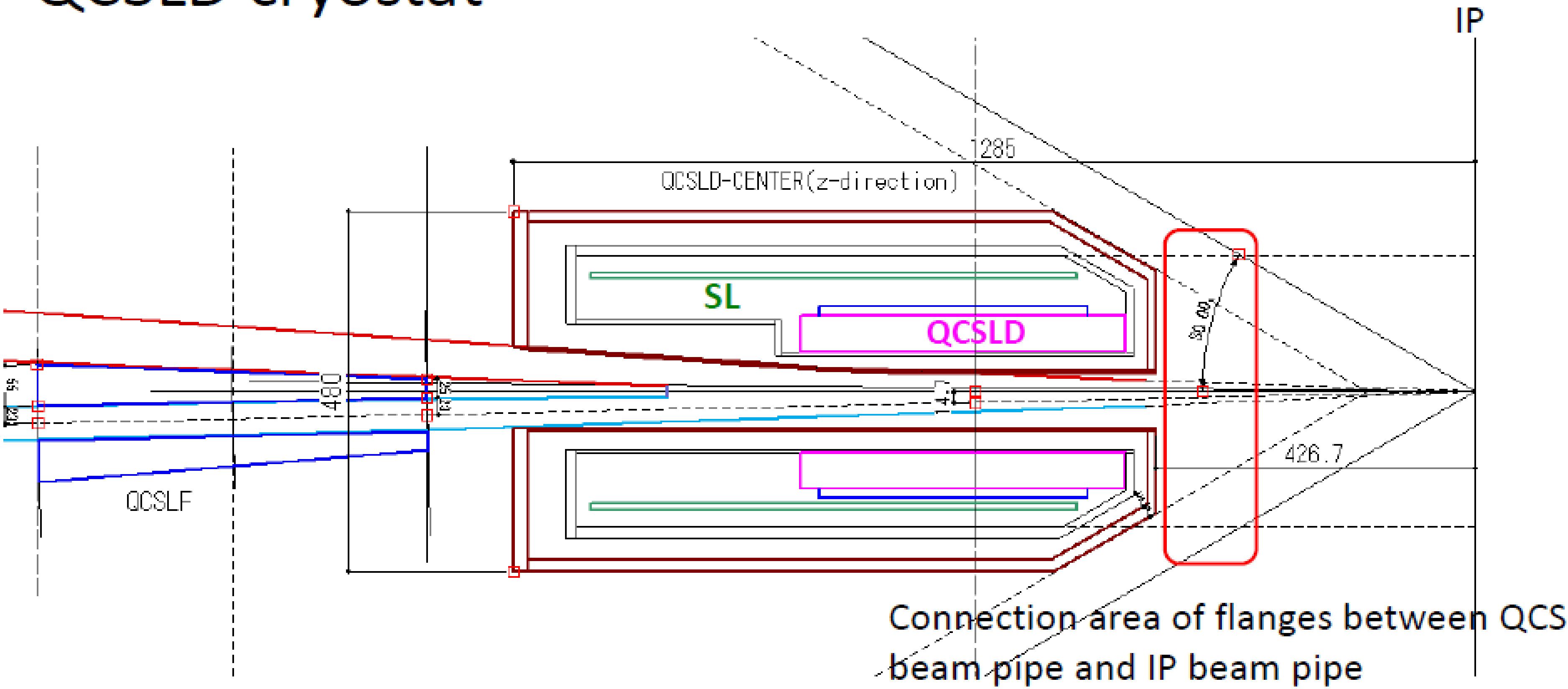
Cross section of magnet cryostat

Design parameters of QCSLD

- 6 layer coils
- Inner coil radius : 67.5 mm
- Outer coil radius : 92.7 mm
- Cable size : 1.1 mm × 4.1 mm
  - Cu ratio = 1.3
- Number of turns : 208 in one pole
  - 1st layer = 29, 2nd layer = 31
  - 3rd layer = 35, 4th layer = 37
  - 5th layer = 37, 6th layer = 39
- *G* by 2D cross section : 121.1 T/m
- Magnet current : 2834.8 A
- Magnetic length : 192.6 mm
- Estimated physical magnet length: 435 mm
- Operation temperature : 1.9 K
- Max. field in the magnet : 7.62 T
  - (without Belle and compensation solenoid fields)
- Operation point w.r.t. SC limit : 74%
- Magnet bore : room temp.

QCSLD cryostat

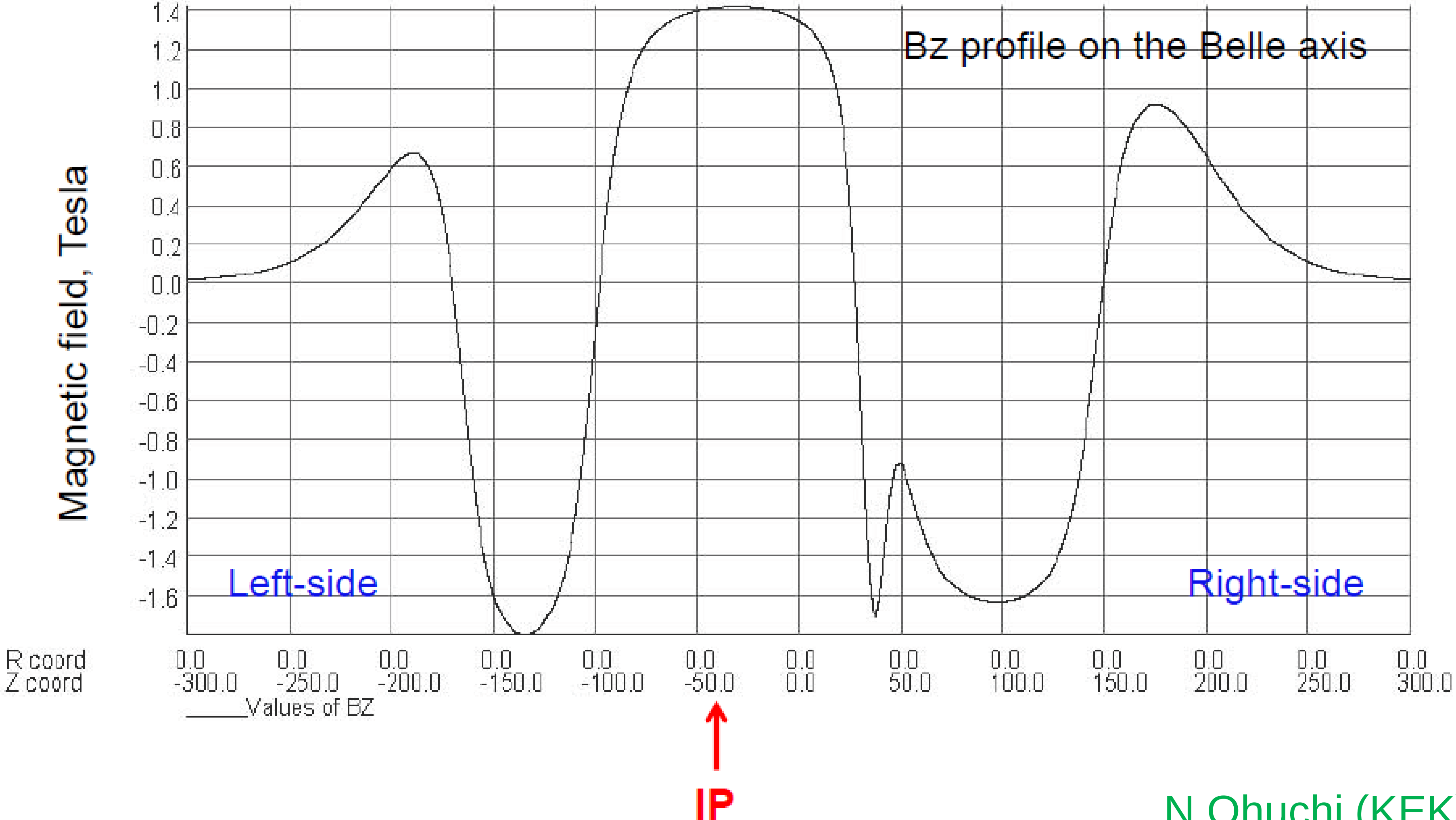
N.Ohuchi (KEK)



The connection between the QCS beam pipe and the IP beam pipe are very difficult.

- In the left side of IP, the QCS cryostat is considered to be inserted into Belle detector with connecting to IP beam pipe and holding SVD and the beam pipe.
- The QCS cryostat bore works as the beam pipe (warm bore).

Field profile by detector solenoid and compensation solenoids



N.Ohuchi (KEK)

N.Ohuchi (KEK)

Summary

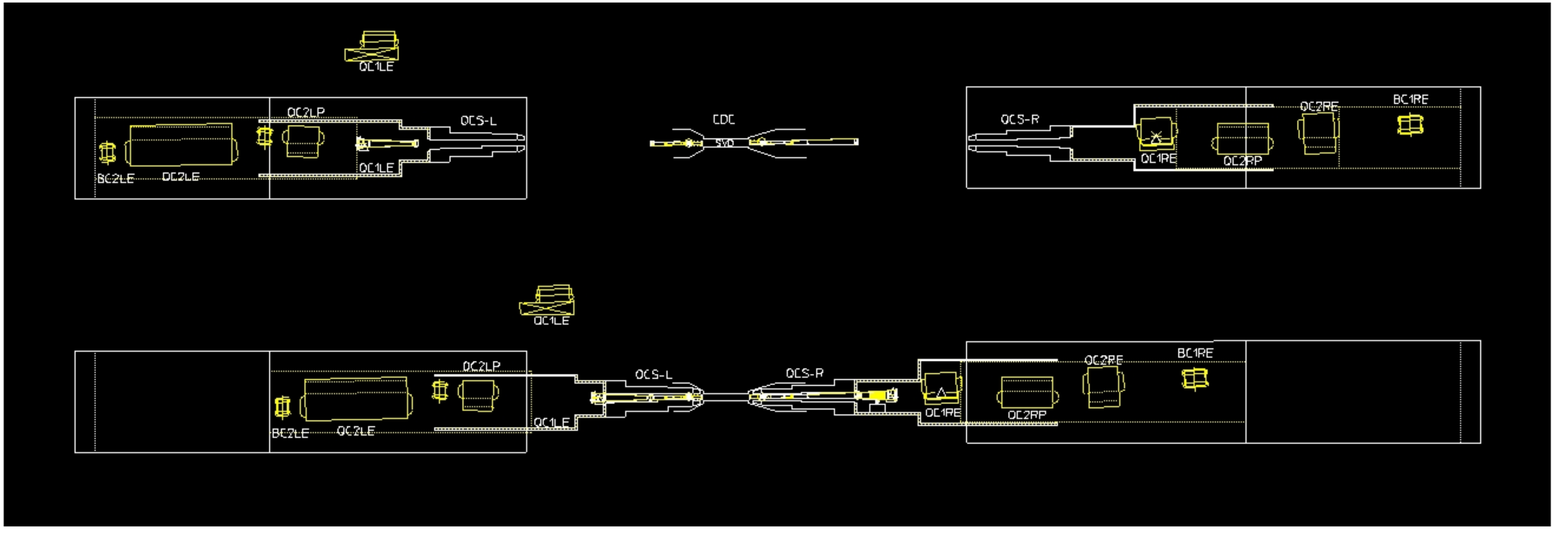
- For the updated IR beam optics:
  - QCSRD: the same design as described in LOI.
    - Magnetic center: Z=1163.3 mm
  - QCSLD: updated magnet design
    - Magnetic center: Z=-666.7mm (Z=-969.4 mm in LOI)
    - The magnets in the cryostat are designed to be cooled at 1.9 K for getting the field gradient of 121.1T/m.
    - In the present design, the front of the cryostat locates at 427 mm from IP.
- For installation of hardware into IR:
  - QCSL cryostat, IP beam pipe and SVD are proposed to be an integrated architecture.

IP Region Assembly

Ken-ichi Kanazawa
KEK
18 March 2009

K.Kanazawa (KEK)

KEKB

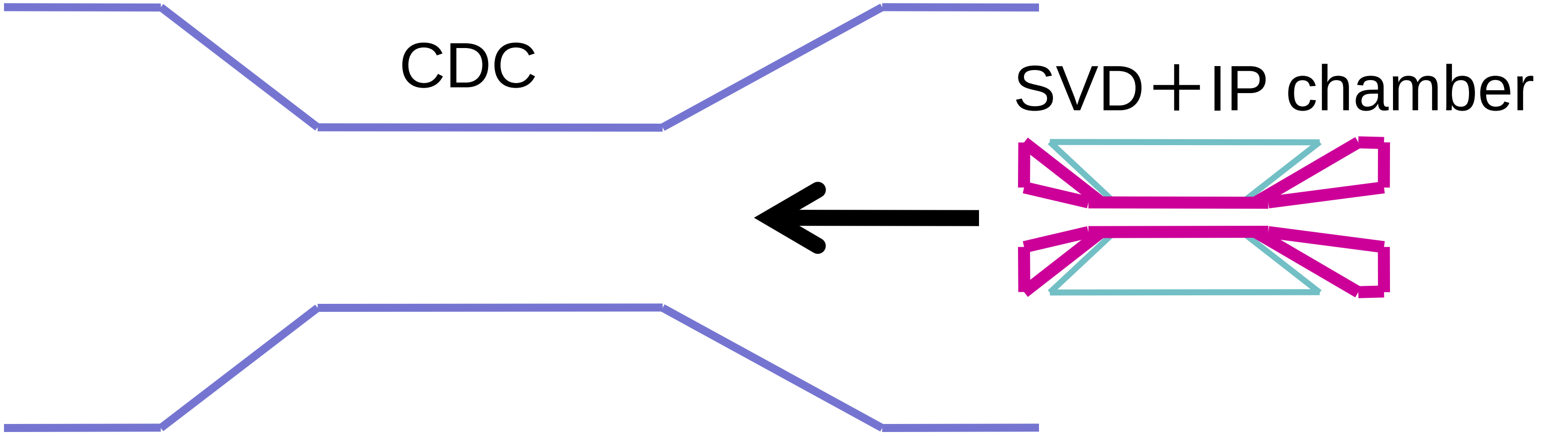


Condition: Vacuum chambers are separate from QCS cryostats.

Step 1: Connect the front half of QCSL chamber and QCSR chamber to IP chamber that is already set at the interaction point. (The end flange of QCSR chamber is temporally removed.)
Step 2: Move forward QCS cryostats.
Step 3: Connect the end half of QCSL chamber with a magic flange to the front half. Attach the end flange to QCSR chamber.

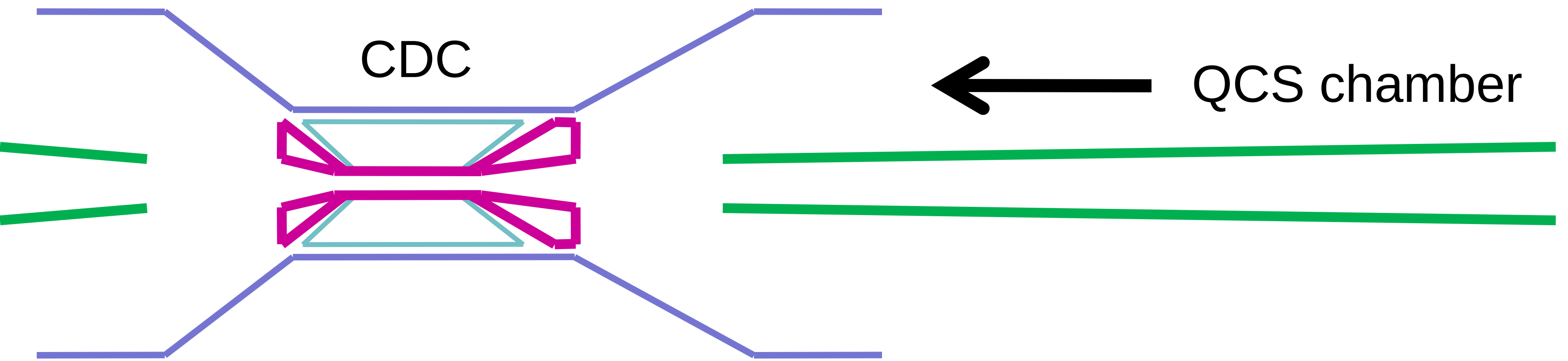
KEKB

Condition: Vacuum chambers are separate from QCS cryostats.



KEKB

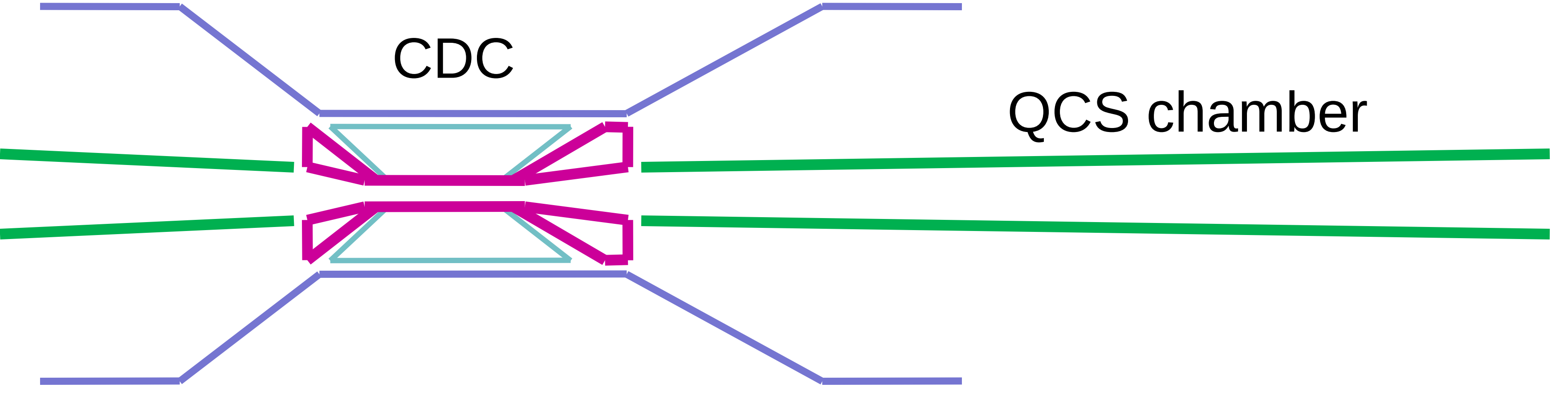
Condition: Vacuum chambers are separate from QCS cryostats.



Step 1: Connect the front half of QCSL chamber and QCSR chamber to IP chamber that is already set at the interaction point. (The end flange of QCSR chamber is temporally removed.)

KEKB

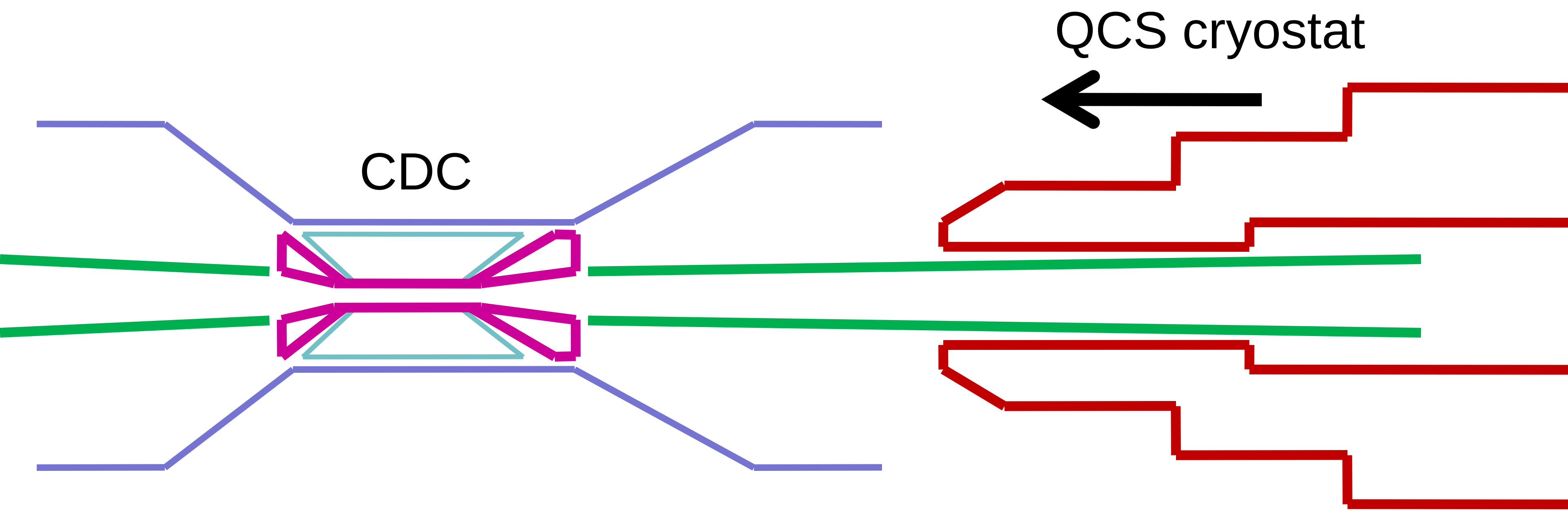
Condition: Vacuum chambers are separate from QCS cryostats.



Step 1: Connect the front half of QCSL chamber and QCSR chamber to IP chamber that is already set at the interaction point. (The end flange of QCSR chamber is temporally removed.)

KEKB

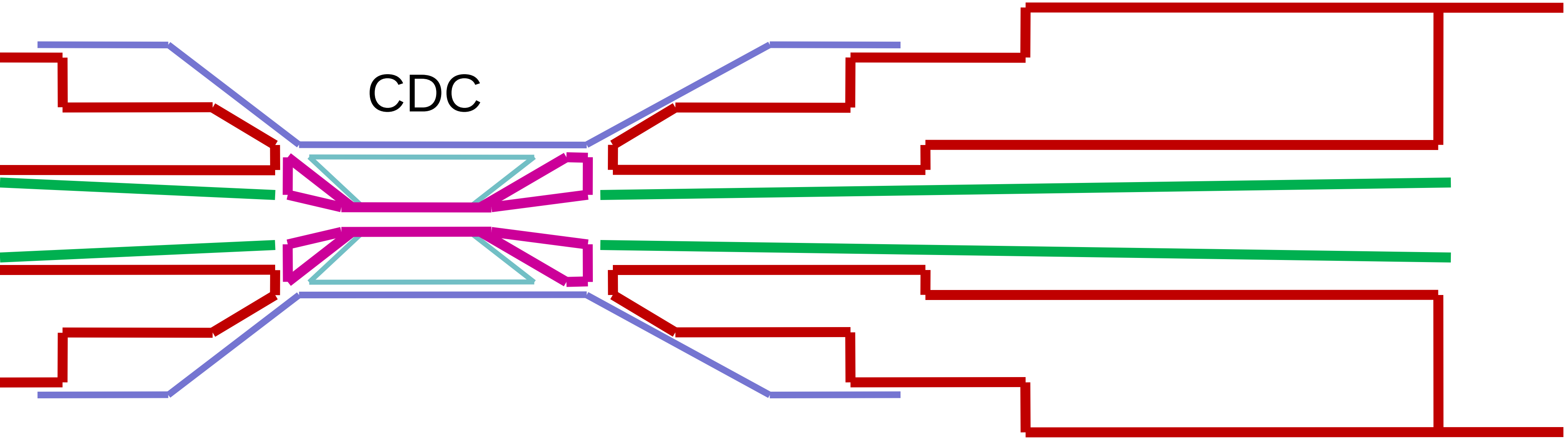
Condition: Vacuum chambers are separate from QCS cryostats.



Step 2: Move forward QCS cryostats.
Step 3: Connect the end half of QCSL chamber with a magic flange to the front half. Attach the end flange to QCSR chamber.

KEKB

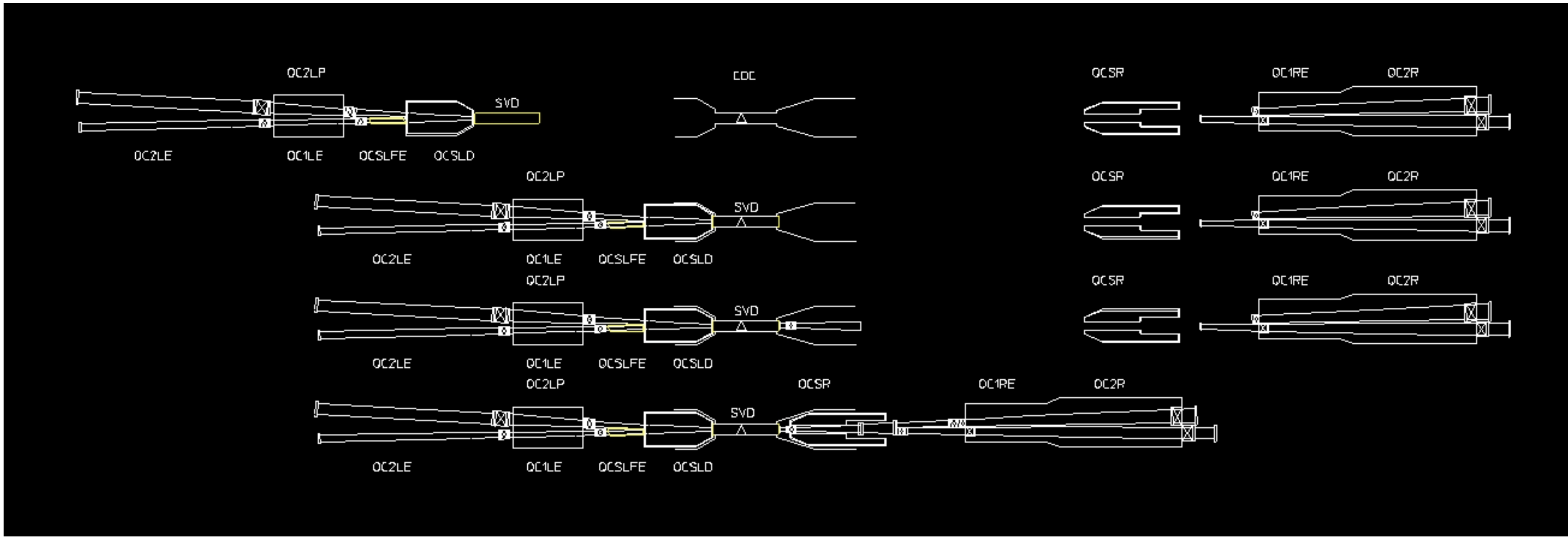
Condition: Vacuum chambers are separate from QCS cryostats.



Step 2: Move forward QCS cryostats.
Step 3: Connect the end half of QCSL chamber with a magic flange to the front half. Attach the end flange to QCSR chamber.

K.Kanazawa (KEK)

SuperKEKB high-current option



Condition: QCSLD cryostat and QCSL chamber forms a single body to ensure a thermal insulation space. Connecting flanges between QCSLD cryostat and IP chamber becomes inaccessible in CDC.

Step 1: Assemble IP chamber and SVD in the front face of QCSLD cryostat in the retreat position.
Step 2: Move forward QCSLD cryostat and SVD assembly.
Step 3: Connect QCSR chamber.
Step 4: Move forward QCSR cryostat.

K.Kanazawa (KEK)

SuperKEKB nano-beam option

Condition: In both QCSL and QCSR, their cryostat and the vacuum chamber (will) form a single body. Connecting flanges between both cryostats and IP chamber becomes inaccessible in CDC.

Off-site assembly will include both cryostats, IP chamber, SVD, and CDC. !!

OR

A sort of ‘automatic flange connecting system’ must be invented. ???
(If this is invented, IP chamber and SVD can be always set at the IP beforehand.)

K.Kanazawa (KEK)

Summary

Design of QCS cryostat	Solution to assemble
Both QCS cryostats are separate from vacuum chambers.	KEKB procedure.
In one QCS, the cryostat forms a single body with the vacuum chamber.	Assemble IP chamber and SVD in the front face of one QCS cryostat in the retreat position. OR Automatic flange connecting system.
In both QCS's, the cryostat forms a single body with the vacuum chamber.	Off-site assembly including both cryostats, IP chamber, SVD, and CDC. OR Automatic flange connecting system.

Detector BG / heating

- Upstream SR simulation M.Iwasaki (Tokyo)
- SR Heating Calculation H.Yamaoka (KEK)
- Backscattering SR simulation C.Ng (Tokyo)

Upstream SR simulation studies

SR power is much higher than current KEKB,
then we start from SR BG estimation

1. Design the IP beam-pipe to avoid HER SR direct hits to the detector
2. Study of the energy deposit to the IP beam-pipe

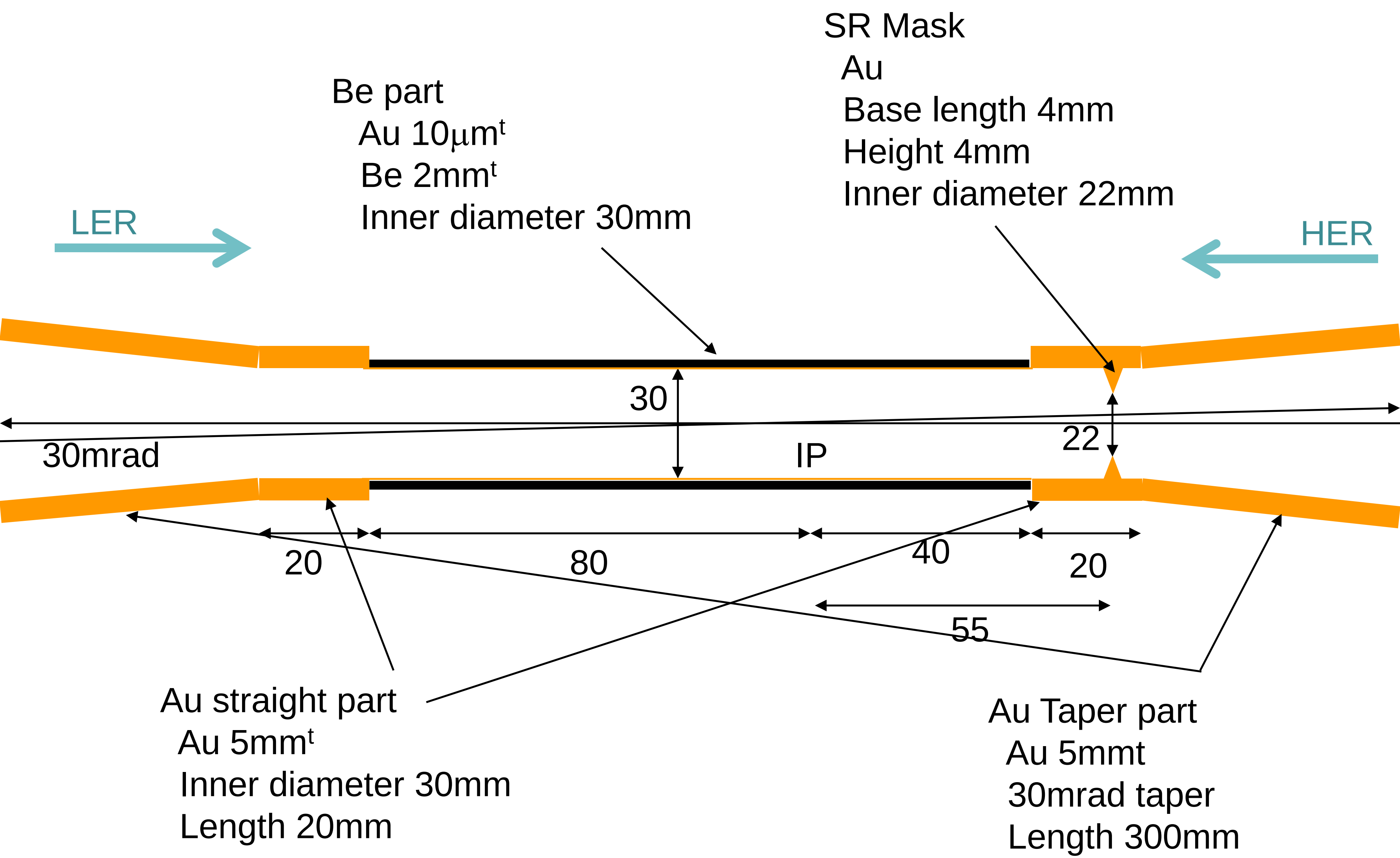
For the SR BG study,
we construct the beam line simulation based on GEANT4.

Simple beam pipe + 1^{st} layer SVD + B-field of Q-magnets

Beam pipe design

S.Uno

We put the beam pipe in our simulation



Conclusion @ MAC Feb.10, 2009

Based on the GEANT4 simulation, SR BG has been studied

1. Upstream SR

- Design of the IP beam-pipe to avoid SR from HER

To avoid the SR direct hit, we should

Locate the beam pipe parallel to HER (22mrad from Belle solenoid), and

Put a 4mm height SR mask

- Study of the energy deposit to the IP beam-pipe

The energy deposit from HER SR will be ~1kW (SR mask) ~1kW (taper)

1kW deposit to the 4mm mask makes ~500 degree temperature rise

→ It is very hard to cool the beam pipe…

2. Backscattered SR

We need more MC statistics to study in detail.

We try to minimize the BG effect in our beam-pipe design,
but SR power is so high that we cannot cool the beam-pipe

New super-KEKB machine parameters with lower SR power are highly appreciated

New super-KEKB optics(1012a)

New super-KEKB optics has just been delivered

- **Beam size at the Q-magnet**

  QC1L / QC2L : ½ of the current one
- **B-field of the Q-magnet**

  QC1L : x1.6 of the current one

  QC2L : same
- **Same magnet length**

In total, SR power is reduced to

80% (QC1L) or 25% (QC2L) of the current one

We'll re-estimate the SR BG based on the new optics

Energy deposit from SR

New optics (1012a) Gaussian beam 5σ tail cut

HER

SR Mask 82W HER taper 60W

LER

SR Mask 18W LER taper 97W IP beam-pipe 17W

- We still have 100W Energy deposit at SR mask.

→ See heating calculation by Yamaoka-san

OLD optics (sqrt 2σ beam)

HER: SR Mask 0.73kW HER taper 0.69kW

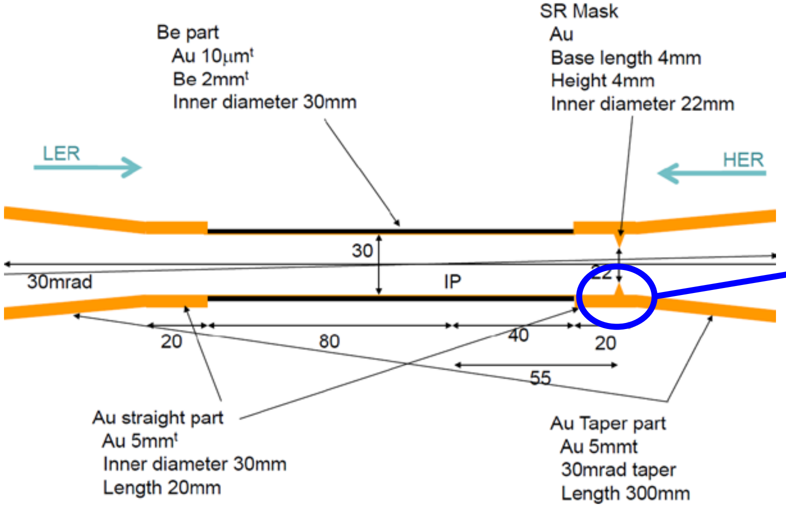
LER : SR Mask 20W LER taper 75W IP beam-pipe 15W

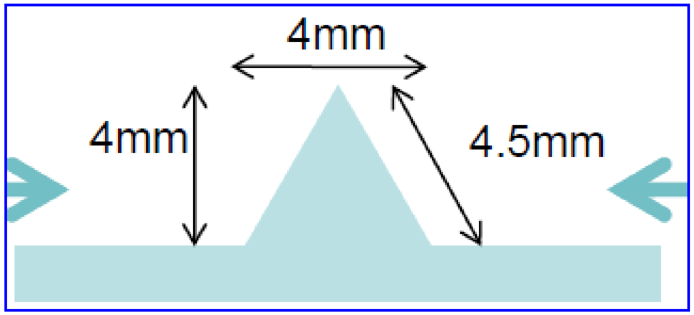
H.Yamaoka (KEK)

SR Heating calculation

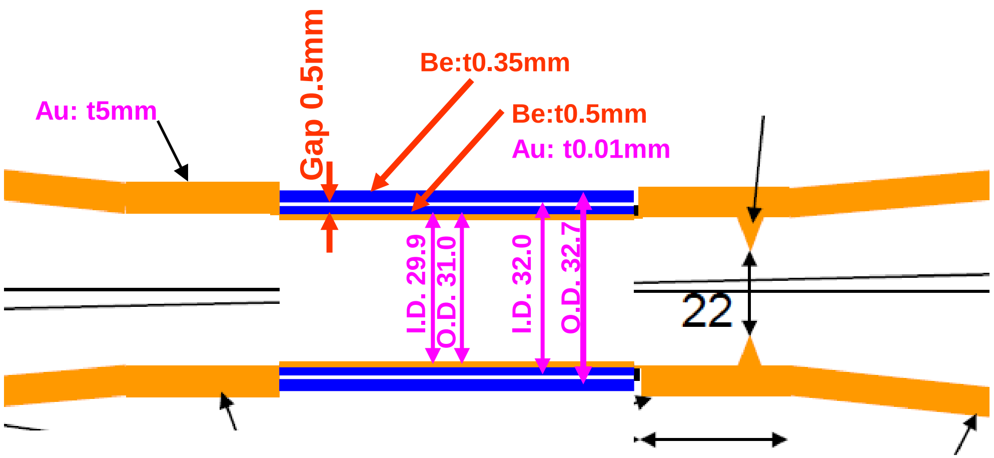
Temperature on the B.P. due to an influence of SR has been calculated.

Configuration-A (Single Be-pipe)



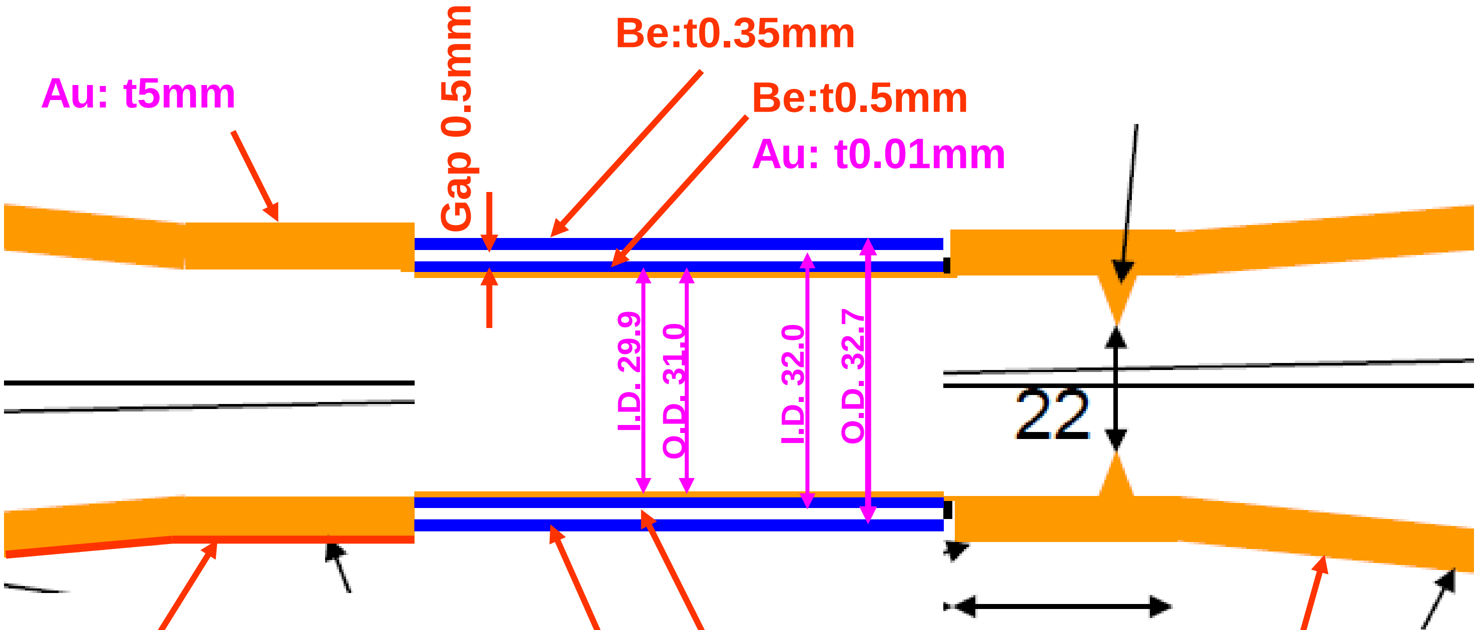


Configuration-B (Double Be-pipe tube)



Calculation-B (Double Be-tube)

H.Yamaoka (KEK)



1. **Outer surface of the Au-Beam Pipe.**
→ 3000W/m²·℃、25℃

2. **In the Be-gap.**
→ 3000W/m²·℃、25℃

3. **Outer surface of Be-gap.**
→ 5W/m²·℃、25℃

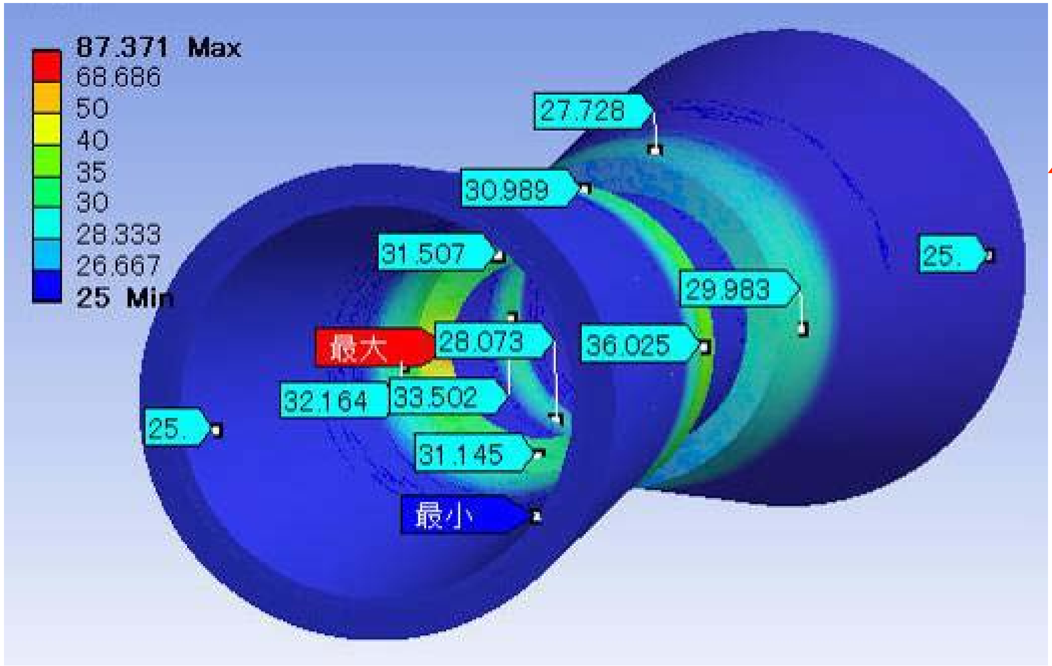
4. **Inside of the B.P.**
→ 0W/m²·℃

1. **Outer surface of the Au-Beam Pipe.**
→ 3000W/m²·℃、25℃

Assumption:
Cooling position → (Be-Gap + Outer surface of the Au-pipe)

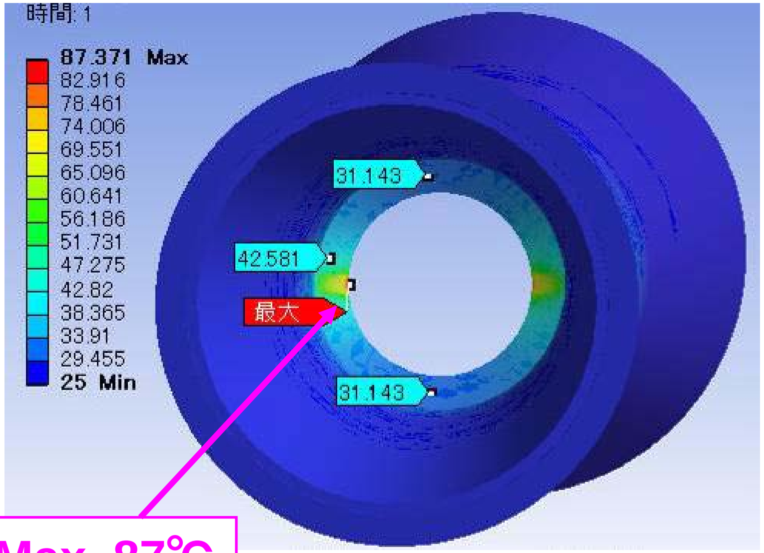
Results (Double Be-tube)

H.Yamaoka (KEK)



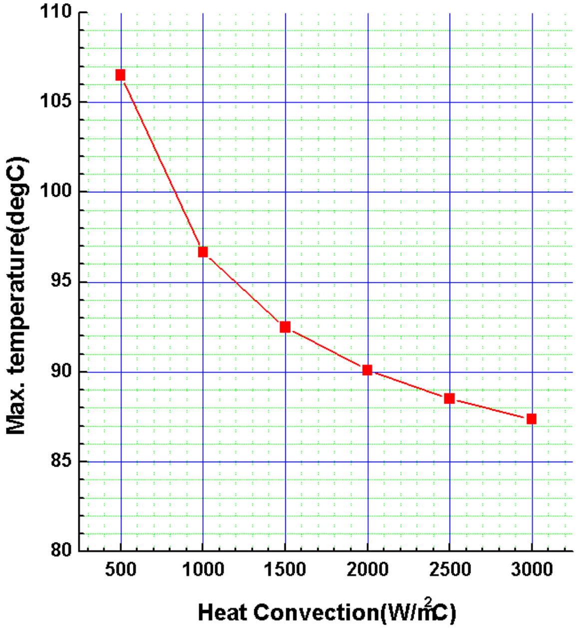
Heat convection

- Outer surface of the Au-B.P.
  → 3000W/m2・℃、25℃
- Inside of Be-gap.
  → 3000W/m2・℃、25℃
- Inside of the B.P.
  → 0W/m²・℃



Max. 87℃

Max. temp. vs. Cooling ability.

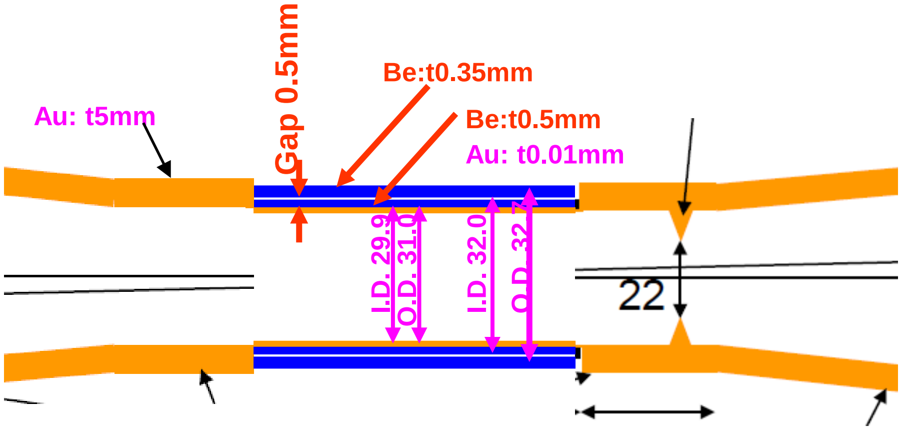


Conclusion

H.Yamaoka (KEK)

Temperature rise on the B.P. has been calculated with two kinds of configurations.

@Configuration-B (Double Be-pipe)



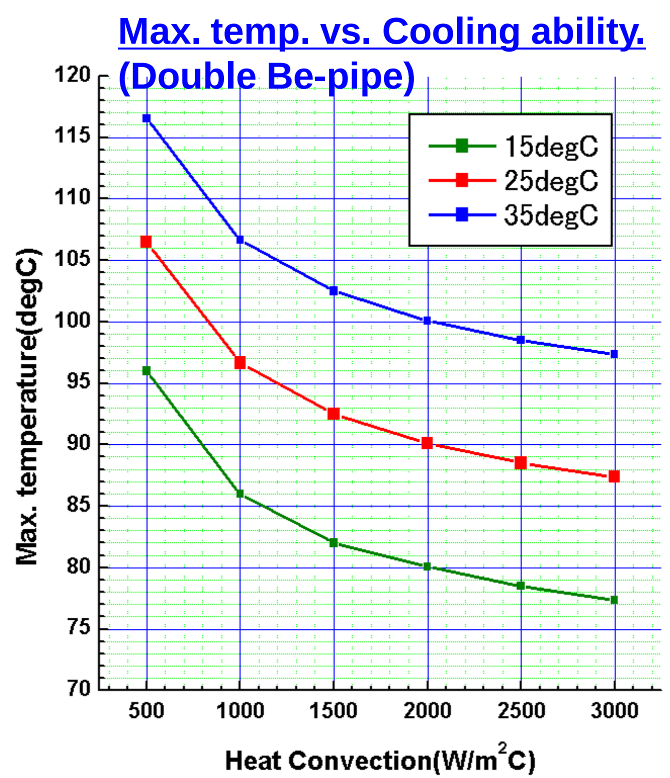
In case of 3000W/m²C, 25degC;

- The maximum temperature is appeared on the SR mask.

→ 87degC

- Temperature at other SR hit positions are around 30-35degC.

→ 5-10degC of temperature rise.

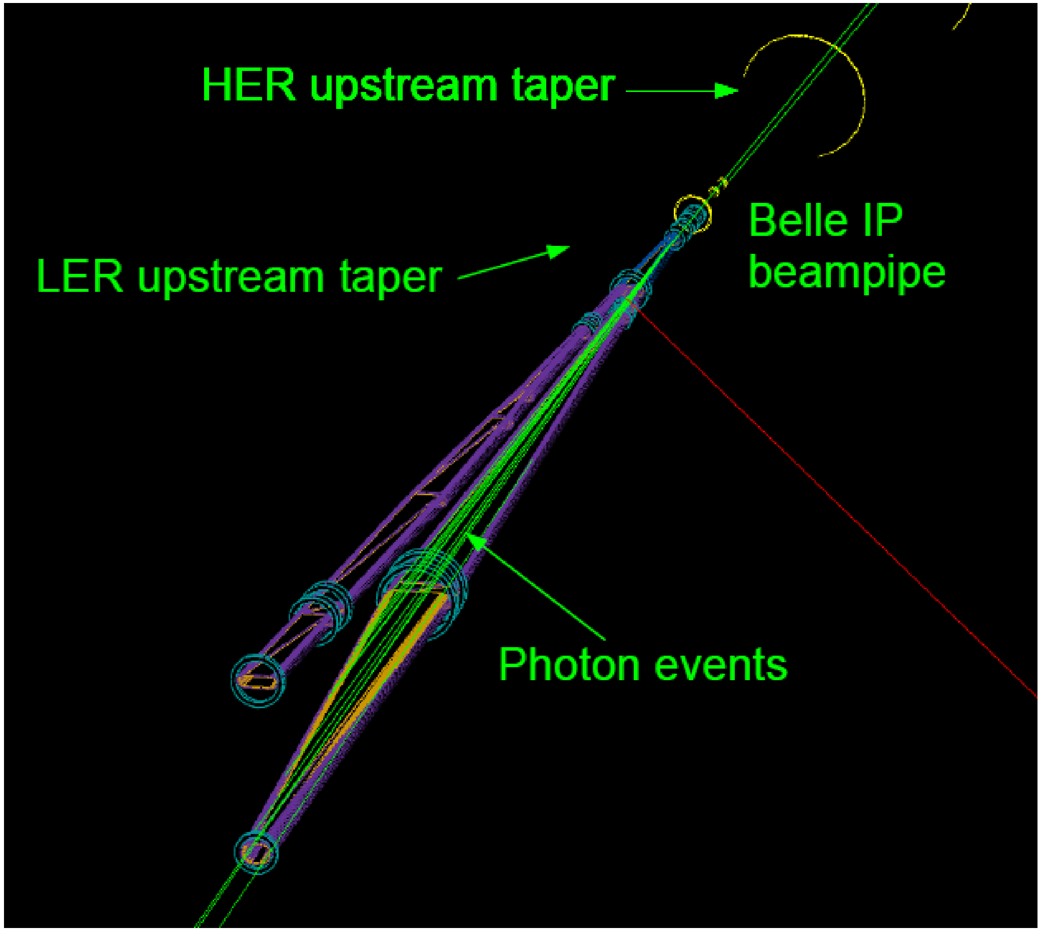


Back scattered SR simulation

Clement Ng (U. Tokyo)

By constructing the realistic beam pipe in our simulation,
we have studied the back scattered SR BG effect.

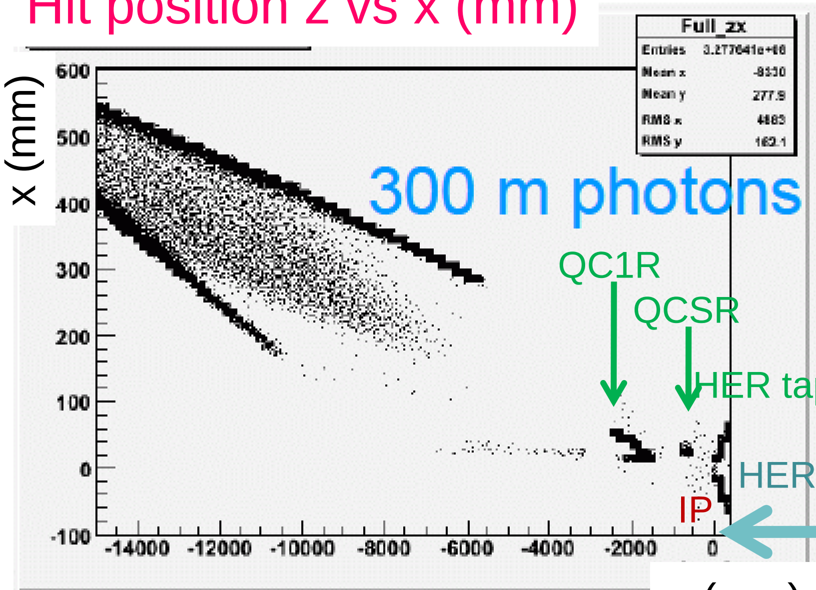
- Beam Pipe material
  6mm Cu + 10um Au
- Construct ±10m from IP
- Input SR data generated
  in the upstream SR studies



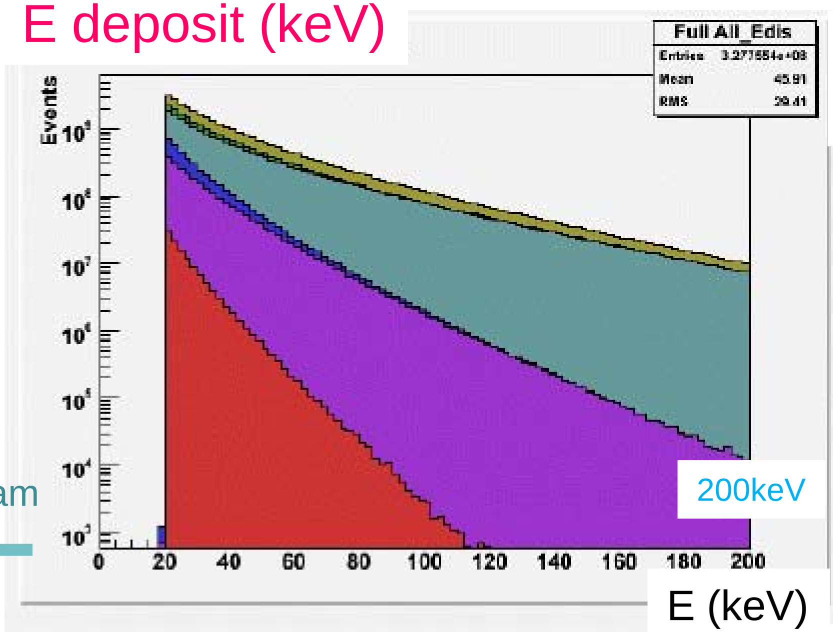
HER SR simulation

C.Ng (Tokyo)

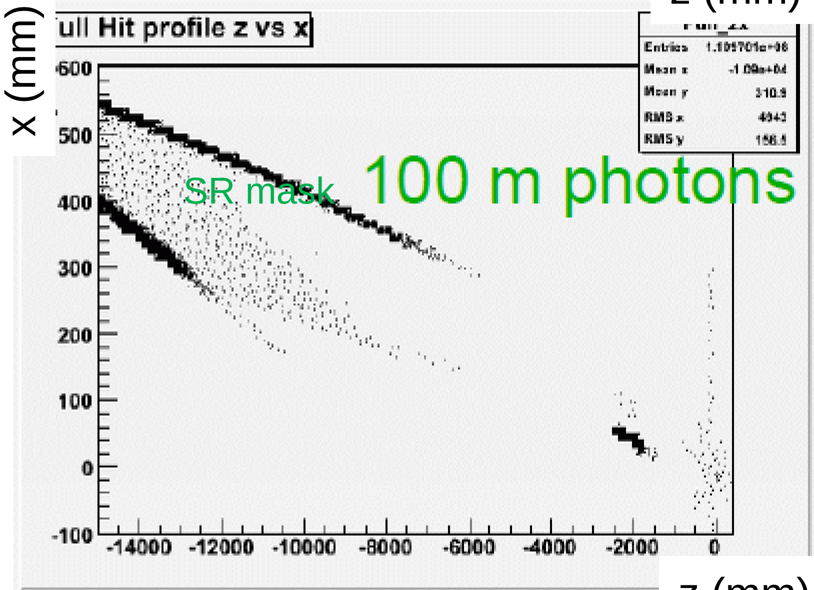
Hit position z vs x (mm)

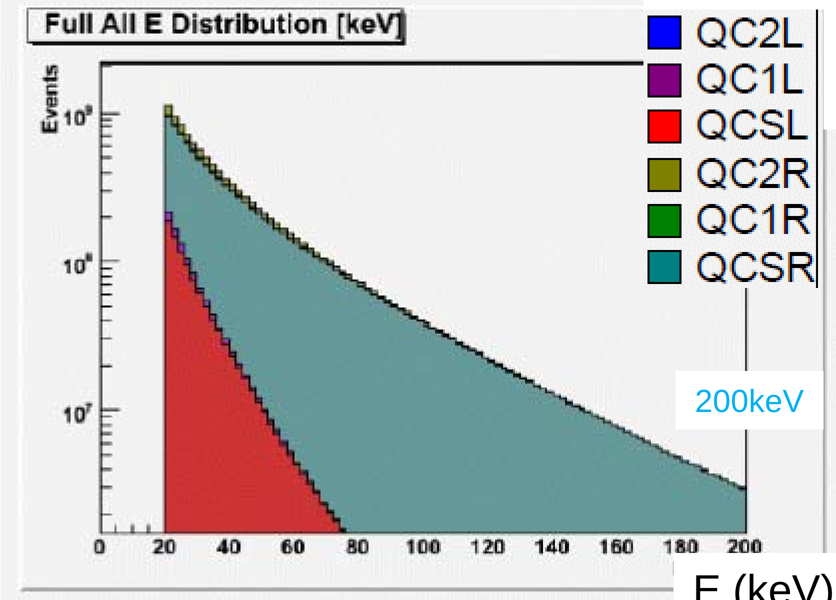


E deposit (keV)



Old optics





New optics

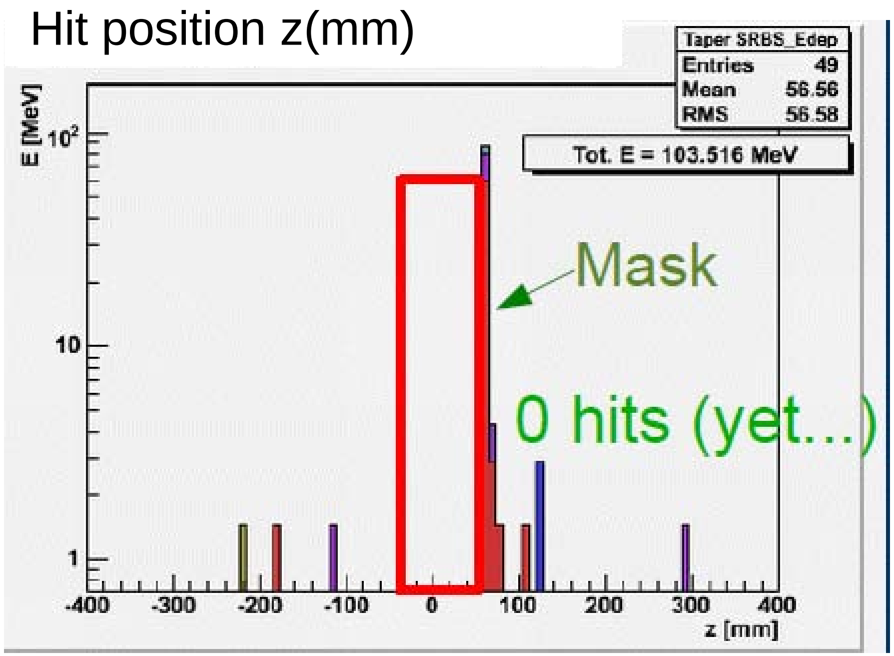
Back scattered photons at IP

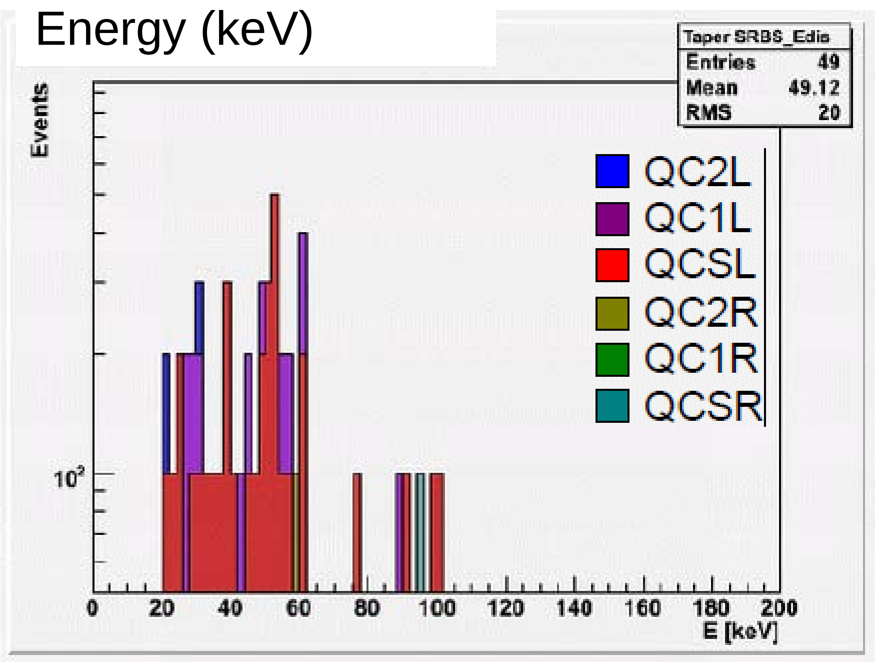
C.Ng (Tokyo)

HER IP region (E_{SR}>20keV)

Vertical scale is scaled for 1-bunch beam, Scale factor = 100

New optics





There are no entries in the IP Be region

We cannot evaluate the SVD occupancy because MC statistics is too small.
After increasing the statistics, we'll study the SVD occupancy

Summary

1. Machine status

- Designing of the nano-beam option is just started
- New 1.9K QCS design has been developed
- Little space in L-side (High-current) or both (nano-beam)

2. Must consider the detector/machine assembly

→ QCS cryostat, beam pipe, and SVD might be integrated

3. SR simulations / heating calculation have been carried out

Design of the cooling system, other sources of the BG

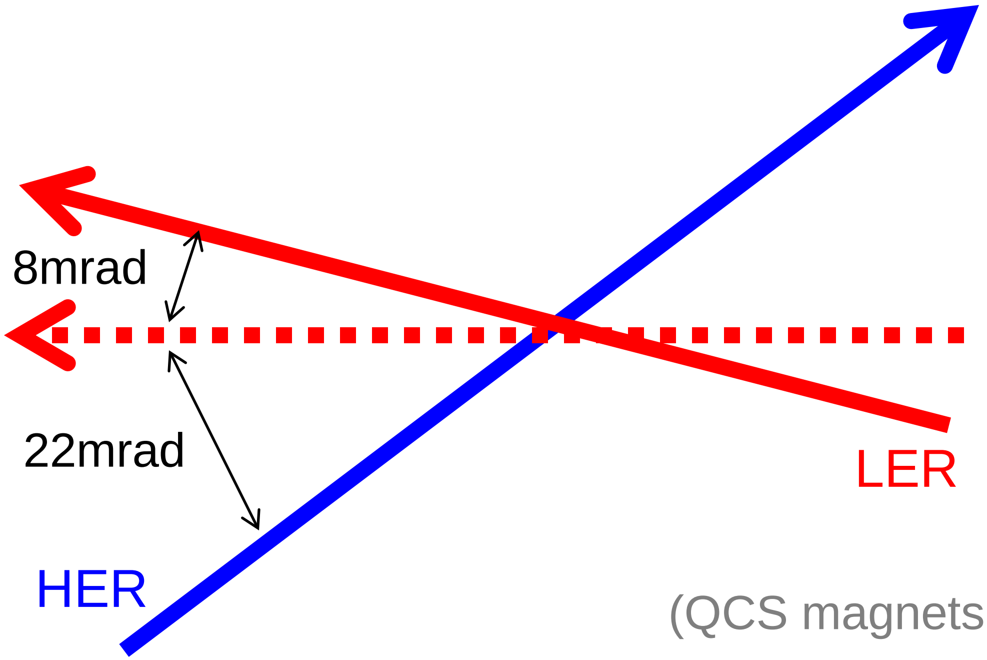
There are many things to do for the MDI group

New contributions are highly appreciated!!

Back up

Relationship between s-Belle and Super-KEKB

In Super-KEKB, crossing angle will be increased : 22mrad → 30mrad



e^- KEKB / Super-KEKB
HER(e^-) axis will not change

e^+ KEKB, Belle solenoid
Belle solenoid will not change

e^+ Super KEKB
LER(e^+) axis will rotate by 8mrad

(QCS magnets will be set parallel to Belle solenoid)

Belle beam pipe (and SVD??) axis at Super-KEKB
- Belle solenoid
- Center of the LER and HER (7mrad from Belle solenoid)
- <u>HER axis (22mrad from Belle solenoid)</u>

Dynamic beam-beam effect

Parameter search for smaller beam size

Y.Funakoshi

	no b-b	nominal			higher emittance			higher βx*			even higher βx*		
ν_{x0}		.503	.505	.510	.503	.505	.510	.503	.505	.510	.503	.505	.510
ε_{x0} [nm]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	12	12	12	12	12
β_{x0}^* [cm]	20	20	20	20	20	20	20	40	40	40	[illegible]	[illegible]	[illegible]
ξ_{x0}	0	.270	.270	.270	.135	.135	.135	.272	.272	.272	.273	.273	.273
ε_x [nm]		81.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82	64.3	46.7	82.3	64.4	46.8
β_x^* [cm]		1.50	1.93	2.77	2.1	2.7	3.8	2.99	3.87	.53	[illegible]	[illegible]	[illegible]
σ_x@QC2RE [mm]	4.0	39.5	30.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Emittance ε (wo dynamic effect)

ε (with dynamic effect)

β (wo dynamic effect)

β (with dynamic effect)

5 times higher ε, 10 times smaller β in x

Dynamic effect at Super-KEKB is very strong

Tow Options

- High current, crab crossing, large beam-beam parameter.
  - A solution for $\beta^*_x = 20 \rightarrow 40$ cm

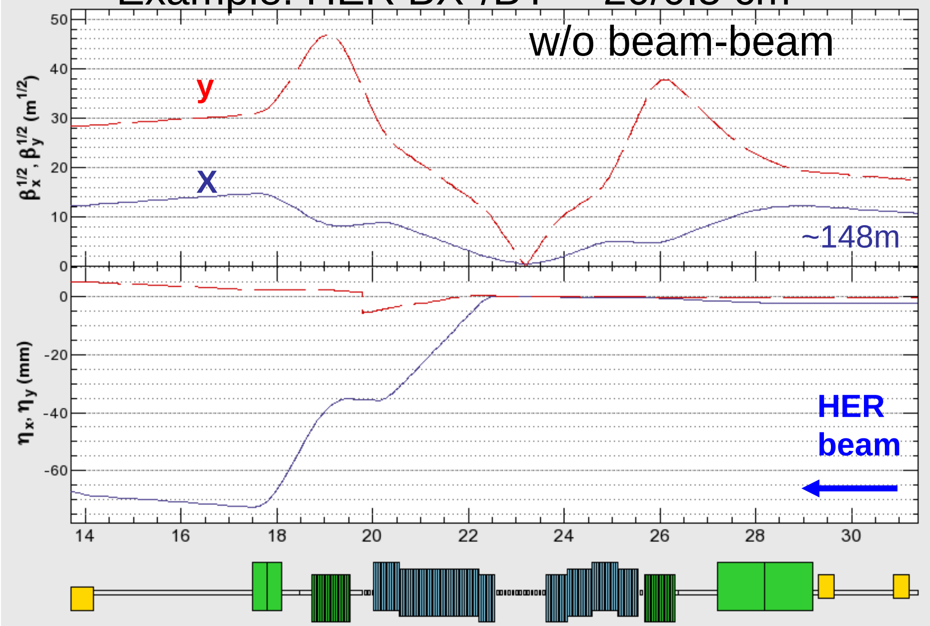
- Low emittance, low β^*, nano-beam.
  - Just started.
  - Crossing angle $30 \rightarrow 60$ mrad

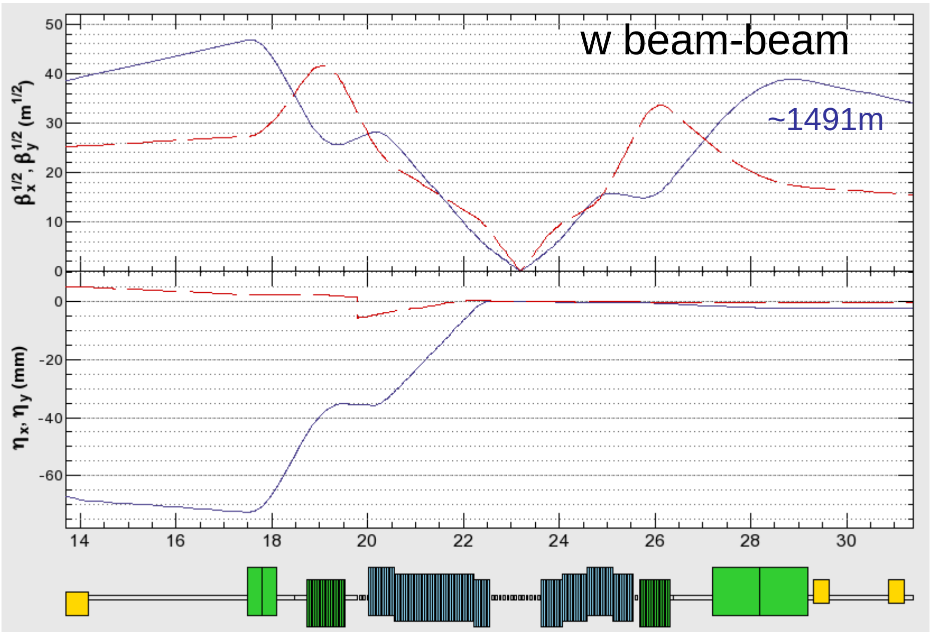
Large Dynamic Effects

- The beam-beam effect must be taken into account in evaluation of physical apertures.
  - Horizontal beam parameters change significantly with ξ_{x0} = 0.276 and ν_x = .505,
    - β_x^* 20 → 1.9 cm
    - ε_x 12 → 65 nm

Y. Funakoshi

Example: HER BX*/BY*= 20/0.5 cm

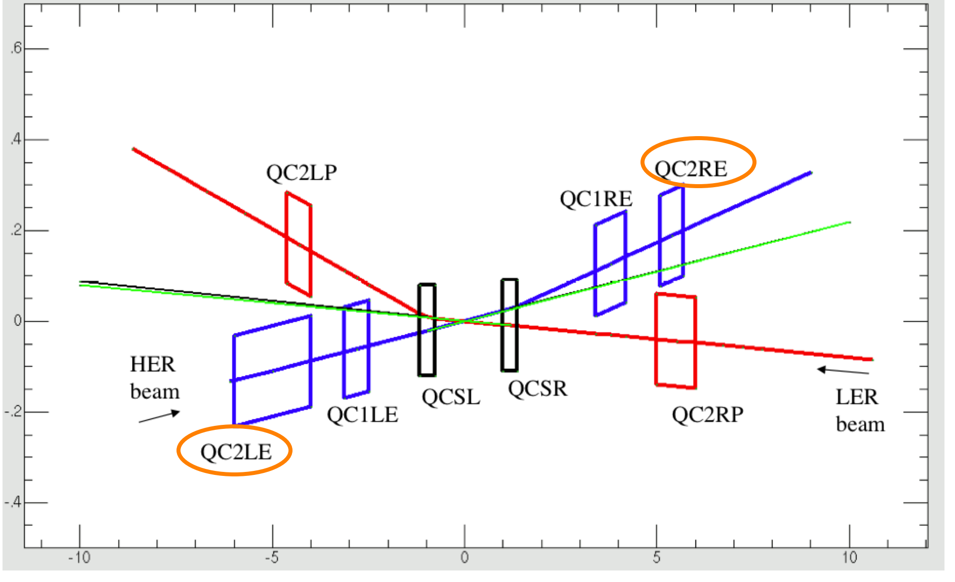


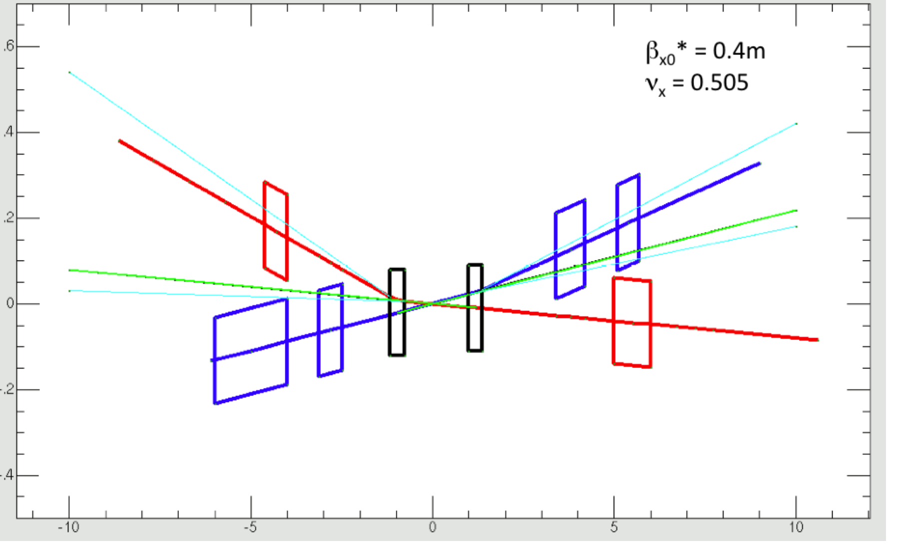


Physical Aperture

- Requirement : 5 σ_x with beam-beam effect
  - Larger than injection aperture.
  - σ_x must be decreased at QC2LE (HER) and QC2RE (HER).
  - SR fan from 3σ_x and 3$\sigma_{x'}$ should also be considered.

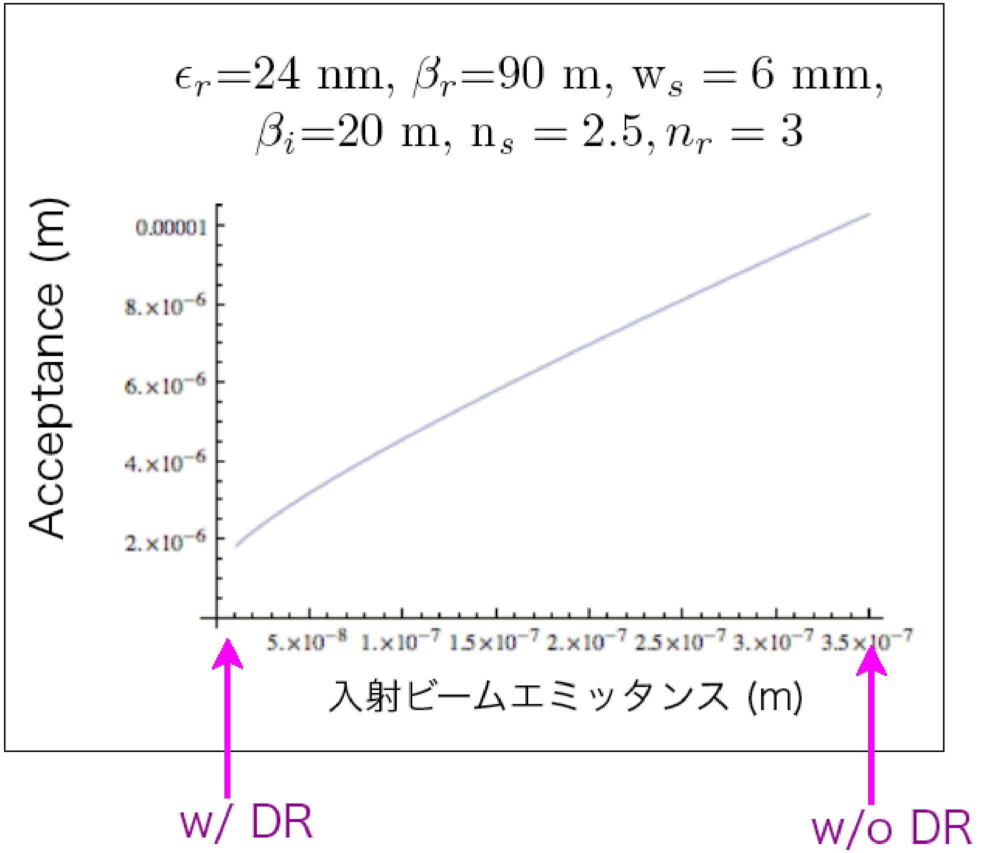
- Increased β_x* 20 → 40 cm
  - Luminosity will decrease by ~20 %.

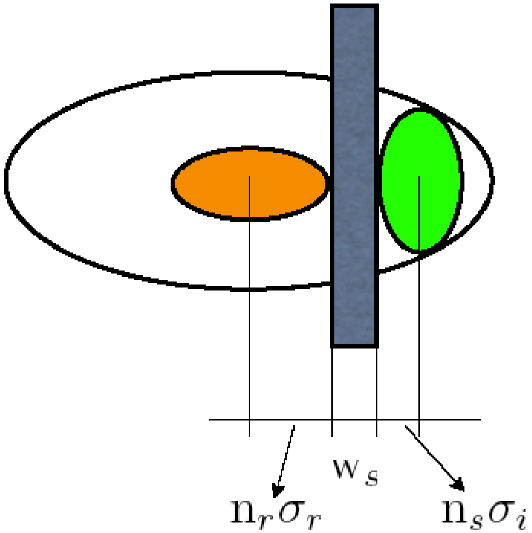




Injection Acceptance

- Injection acceptance is evaluated:
  - HER/LER 4.5E-6/7.5E-6 m w/o Damping Ring
  - HER/LER 1.9E-6/2.6E-6 → ~1.0E-6 m with Damping Ring

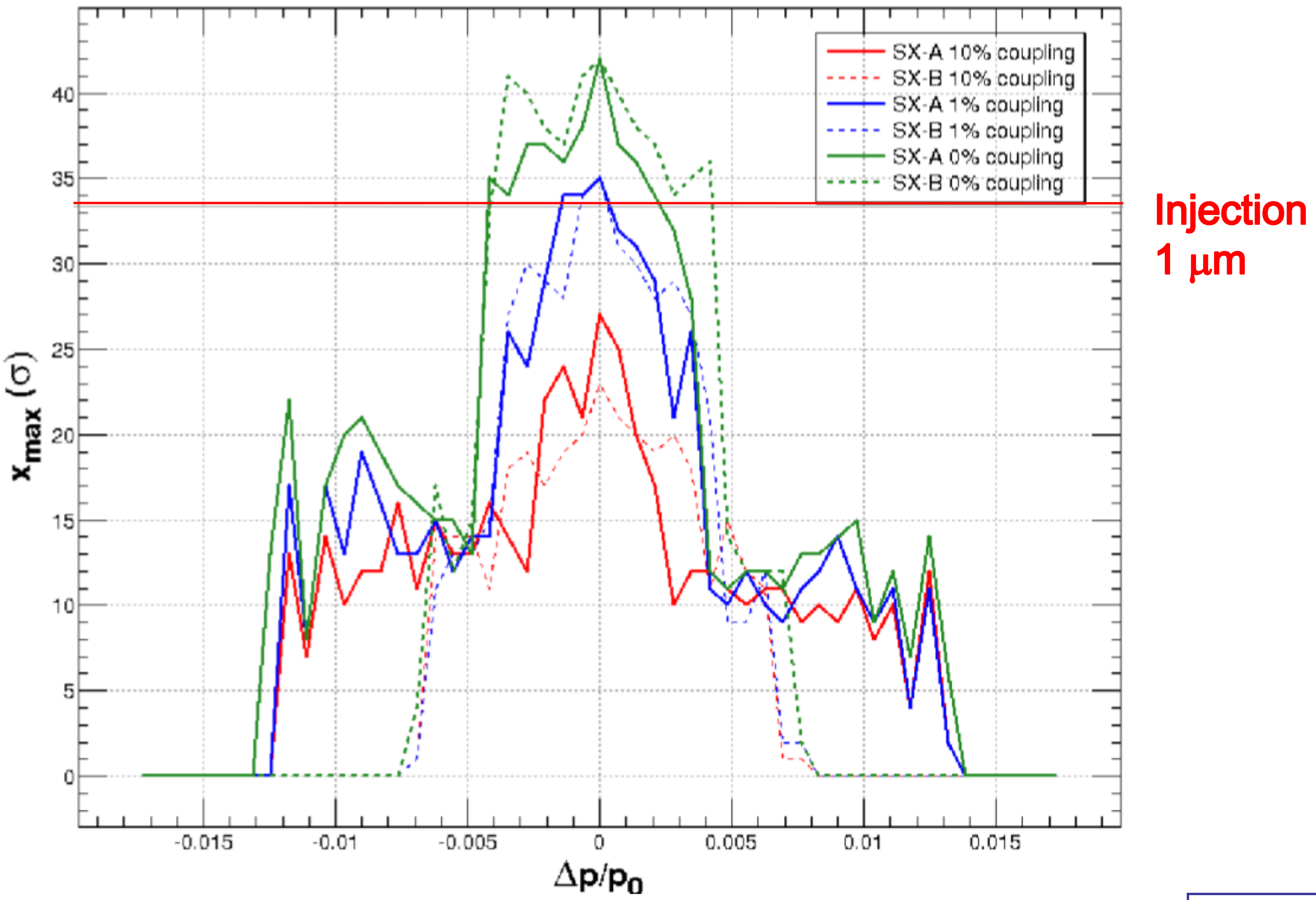




M. Kikuchi

Italian version of IP

- Dynamic aperture



A. Morita

Overview (1)

SR on the chamber wall ~25 kW (~1m)

Copper duct

50 μm gold plating

Bellows

BPM

Bellows

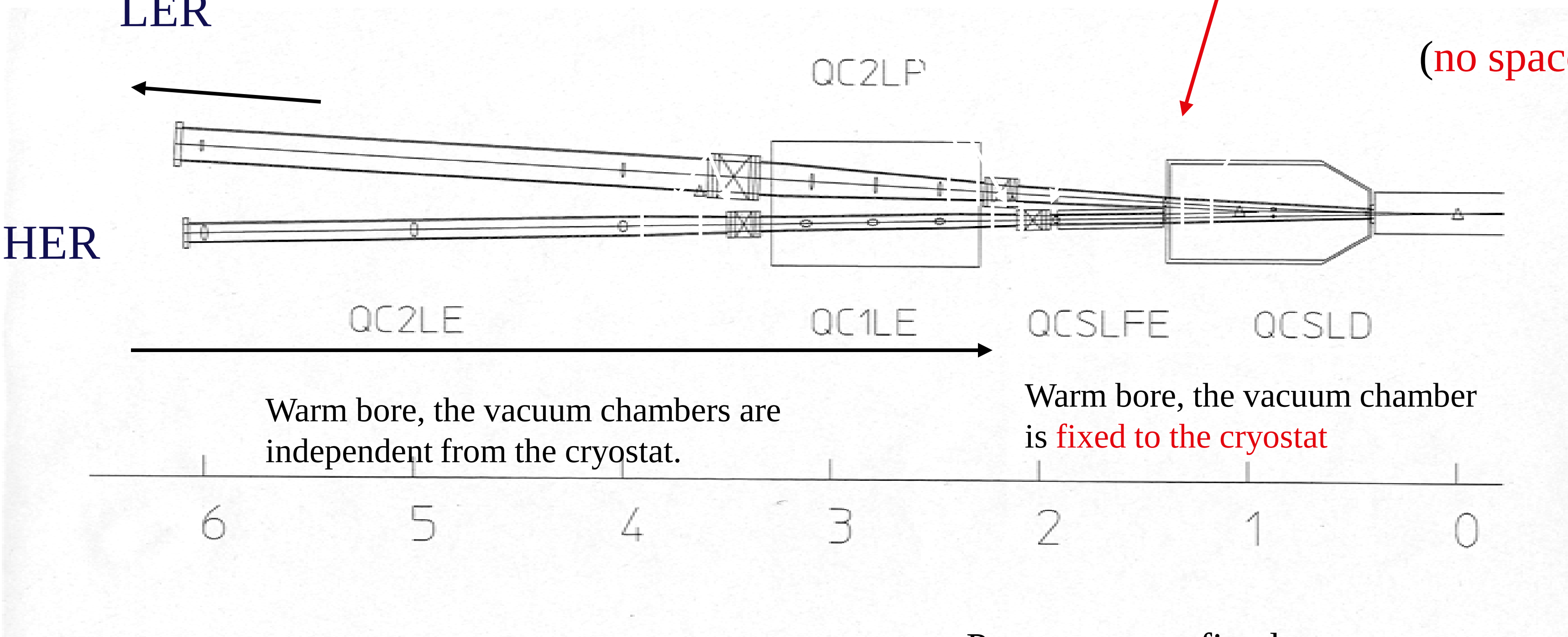
BPM ?

Bellows

(no space !)

LER

HER



Warm bore, the vacuum chambers are independent from the cryostat.

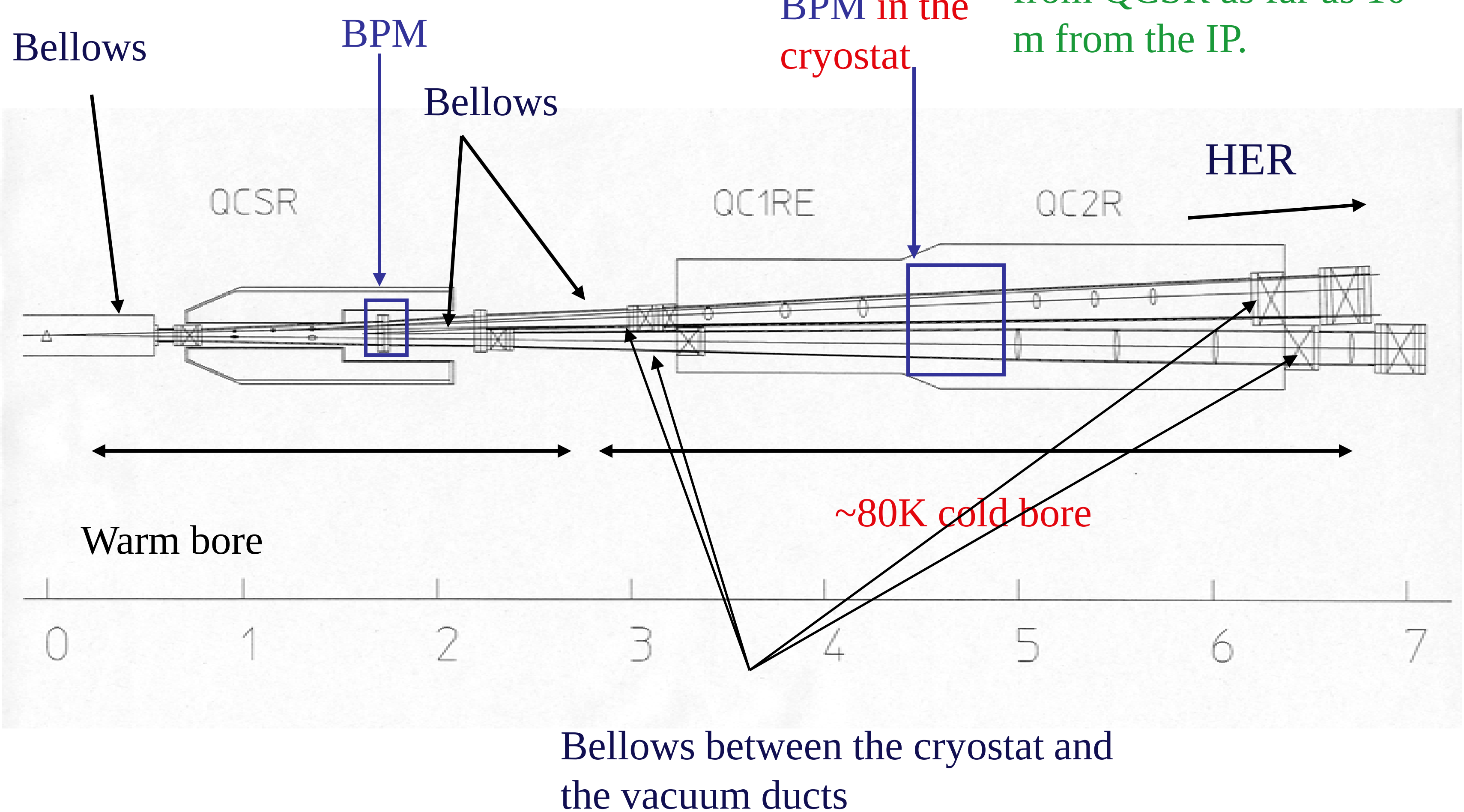
Warm bore, the vacuum chamber is fixed to the cryostat

Pumps are not fixed yet.

Kanazawa

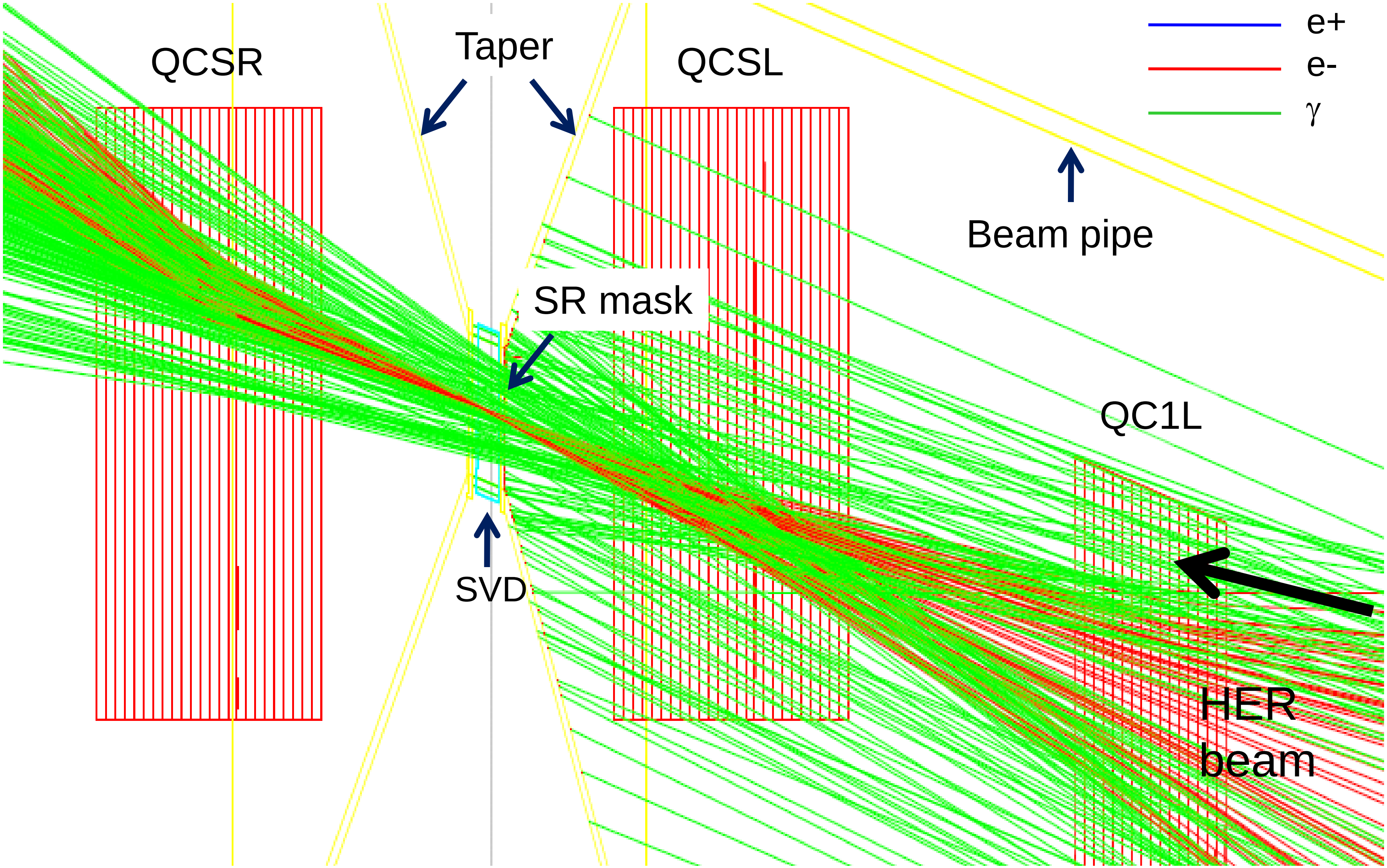
Overview (2)

HER vacuum chamber must have a clearance against the direct SR from QCSR as far as 10 m from the IP.

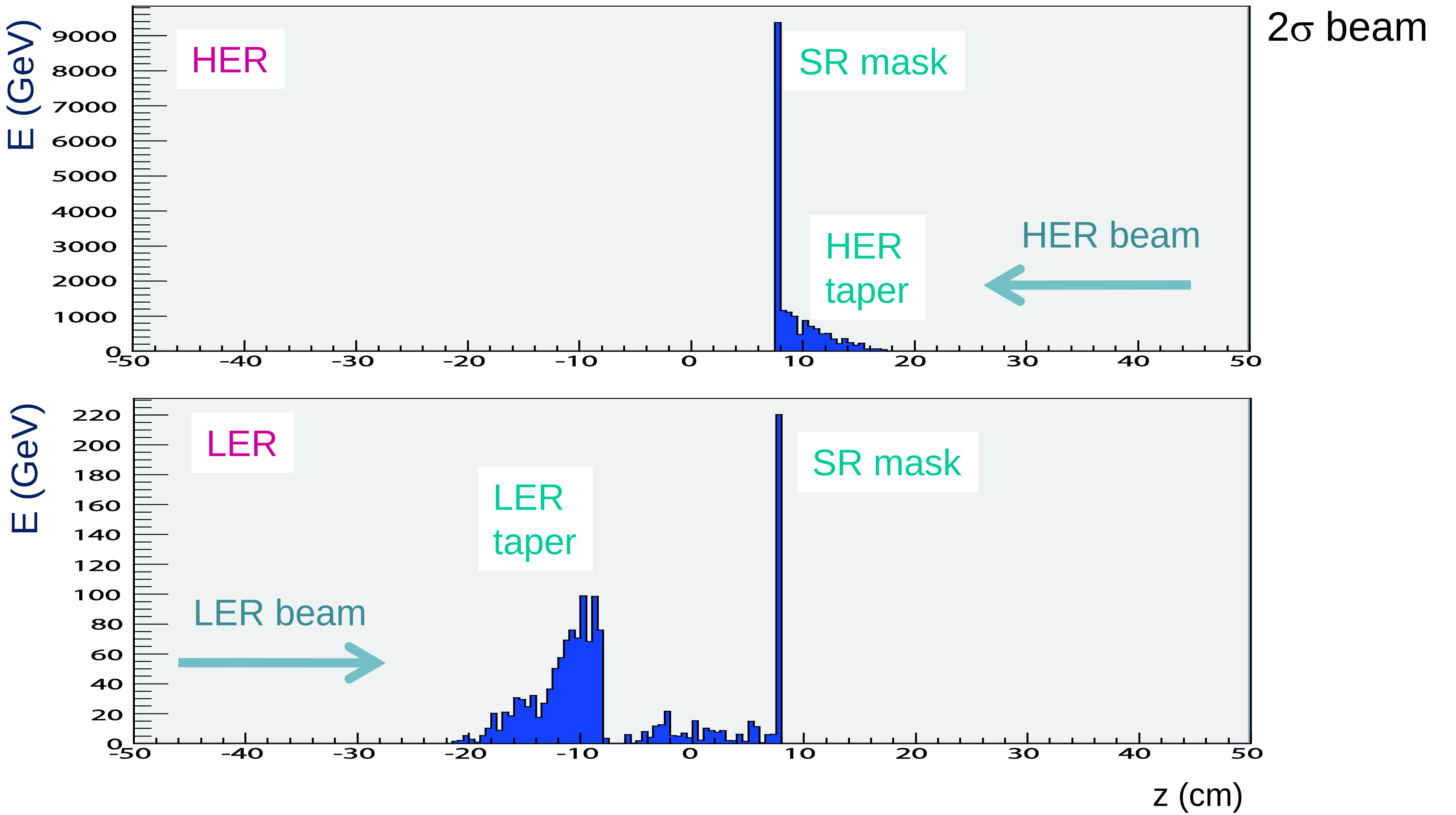


Kanazawa

HER simulation



Energy deposit from upstream SR



Total E deposit to the IP beam pipe

HER ~18000GeV/bunch → 1.4kW

LER ~1400GeV/bunch → 110W

Energy deposit from SR

2σ beam

HER

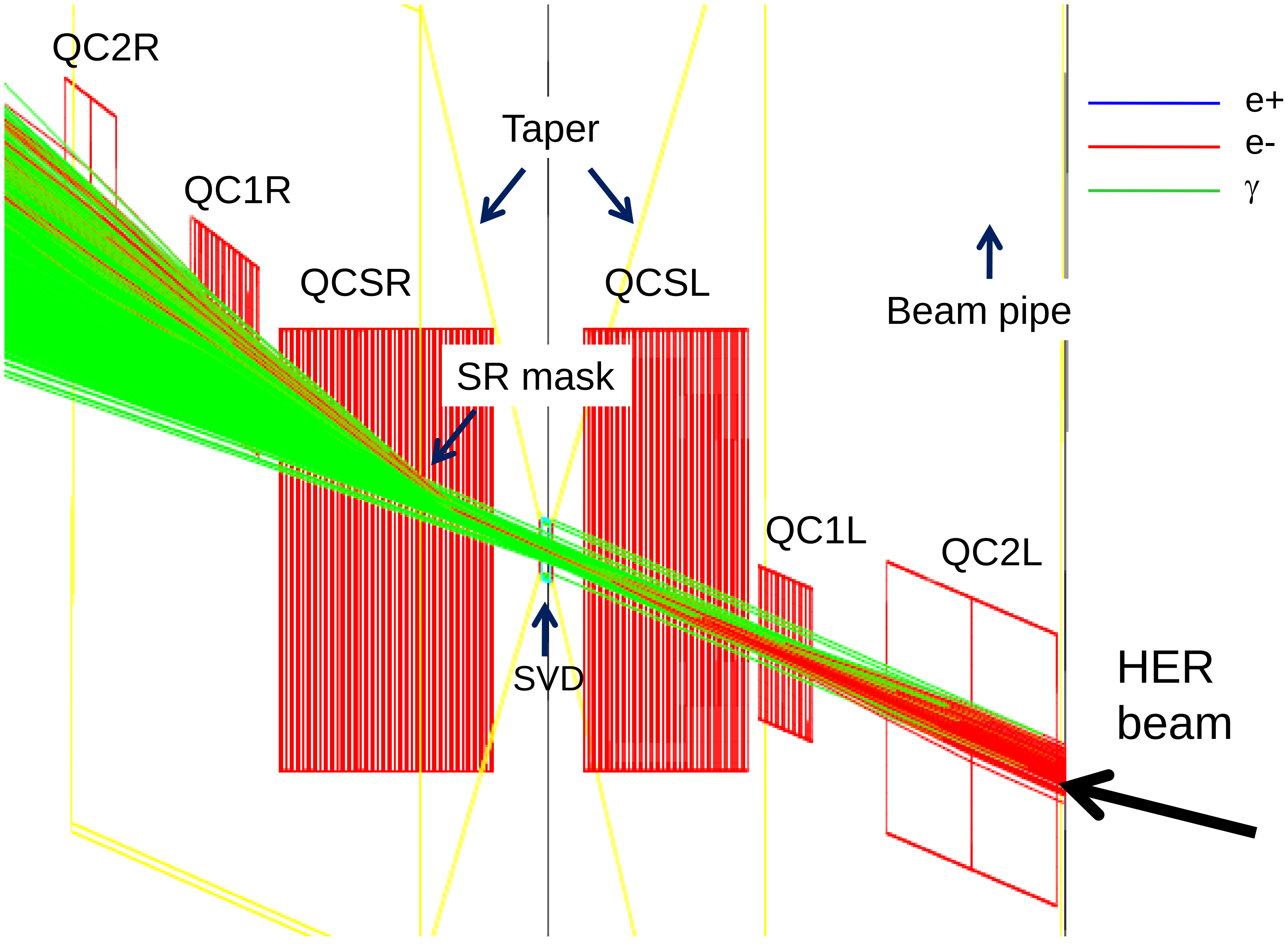
SR Mask 0.73kW HER taper 0.69kW

LER

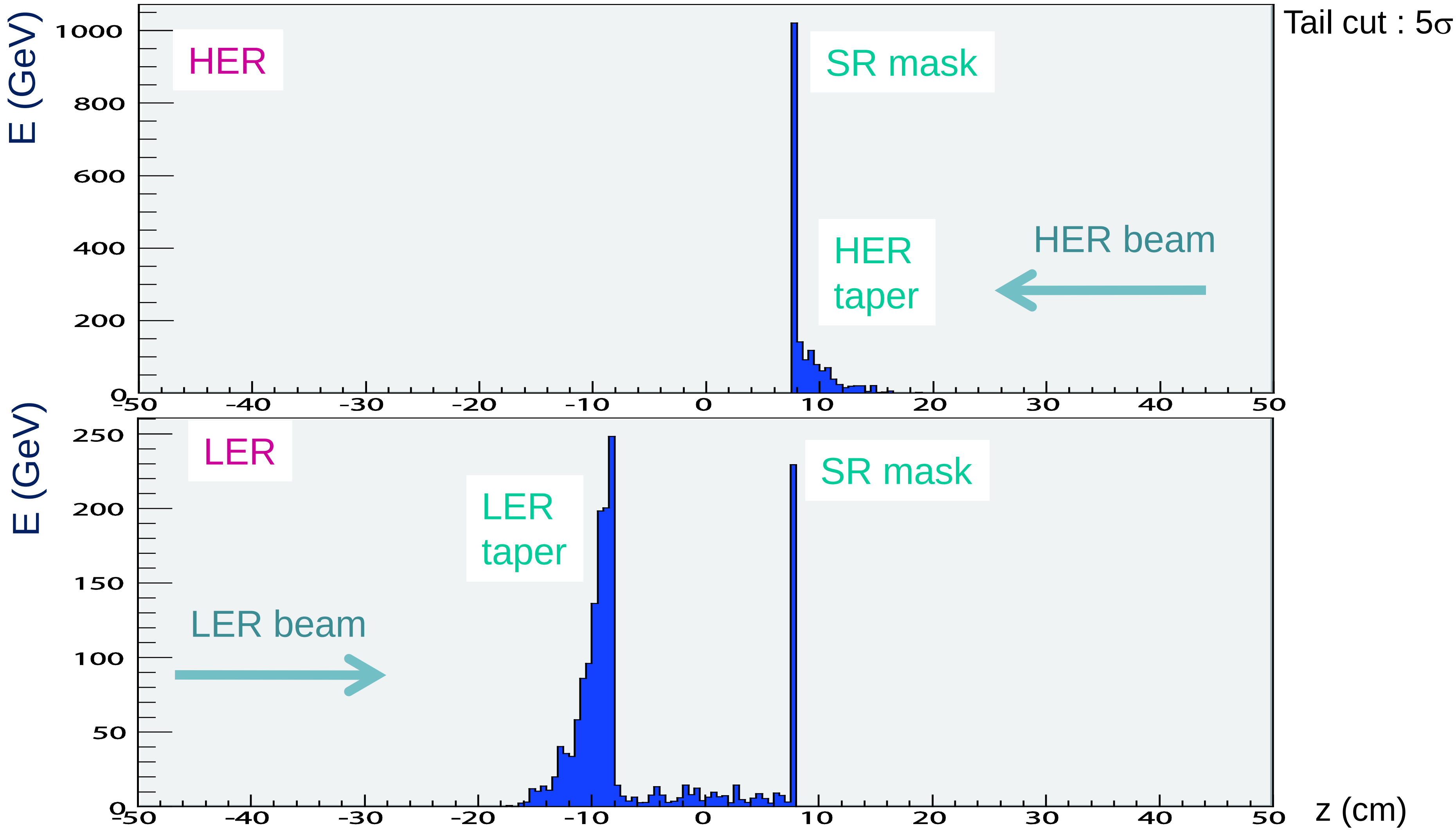
SR Mask 20W LER taper 75W IP beam-pipe 15W

We have ~1kW Energy deposit at 4mm height SR mask...

HER beam-line simulation



Energy deposit from upstream SR



Total E deposit to the IP beam pipe

HER ~1750GeV/bunch → 140W (old: 1.4kW)

LER ~1650GeV/bunch → 130W (old: 110W)

Beam size @ IR Q-magnets

IP

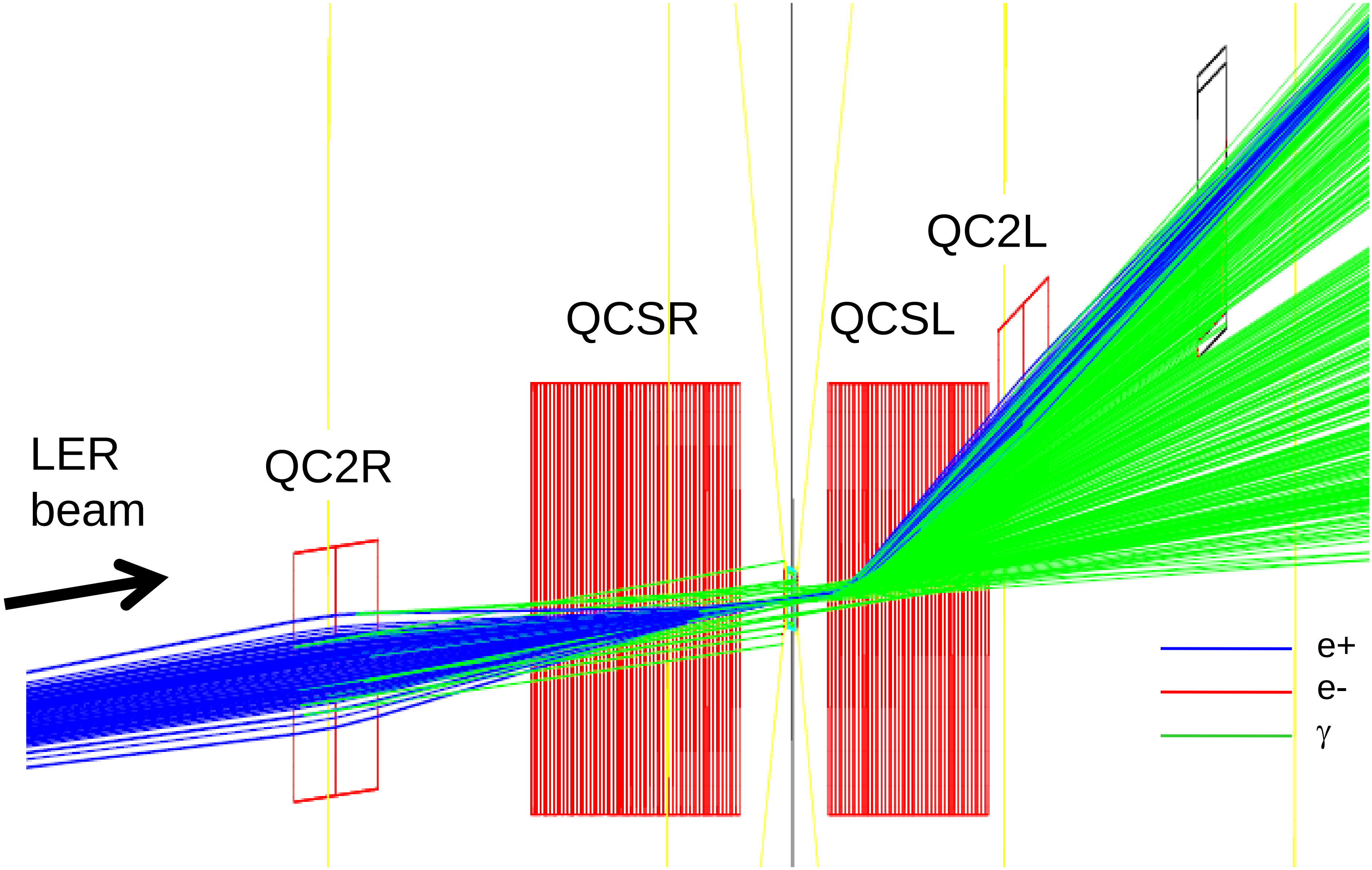
HER Beam

HER	QC2R	QC1R	QCSR	QCSL	QC1L	QC2L
OLD optics	74.5mm ($5\sigma_x$)	30.3	4.4	11.0	31.1	75.2
New optics	69.0 ($5\sigma_x$)	30.1	6.3	14.4	16.5	35.4

LER Beam

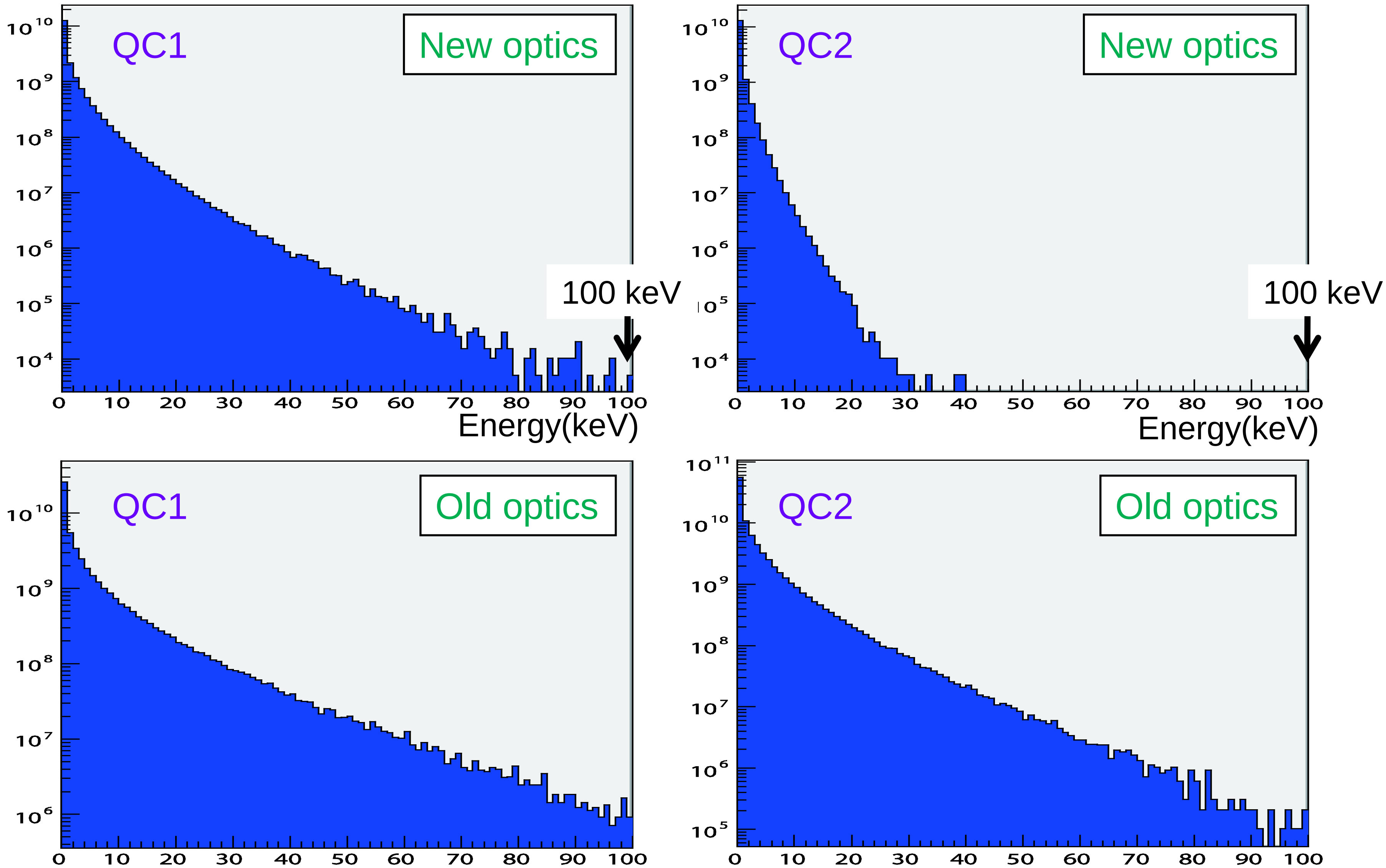
LER	QC2R	QC1R	QCSR	QCSL	QC1L	QC2L
OLD	63.9 ($5\sigma_x$)	52.2	15.1	2.9	29.0	52.1mm
New	66.3 ($5\sigma_x$)	---	10.7	2.9	---	34.4

LER beam-line simulation



HER upstream SR energy

5σ beam

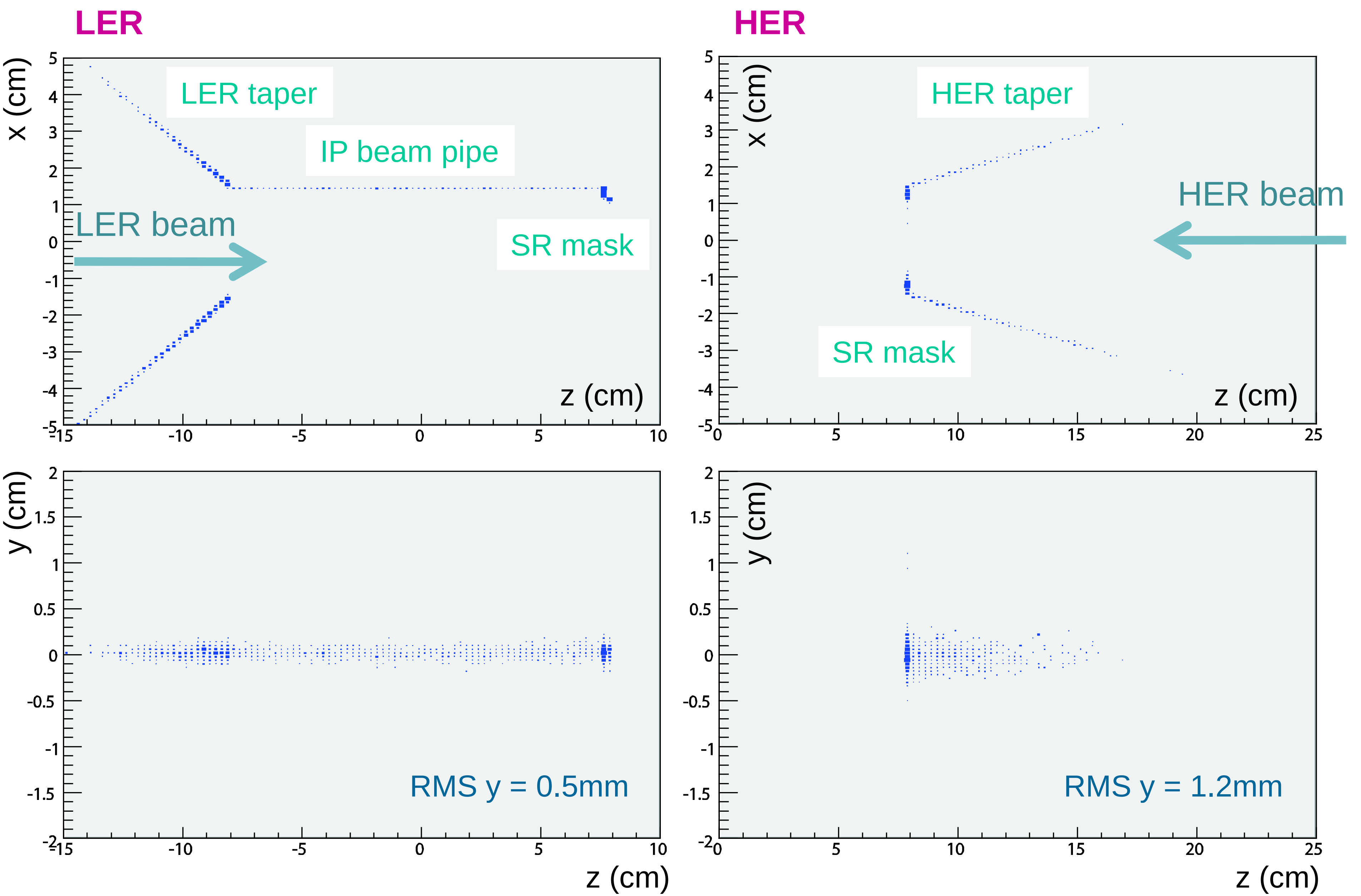


The SR energy from HER is still high

→ We don't want the direct hits from HER SR

(Vertical scale: Scaled for 1-bunch beam)

SR hit to the IP beam pipe



Summary

1. Simulation studies for the Super-KEKB high-current option

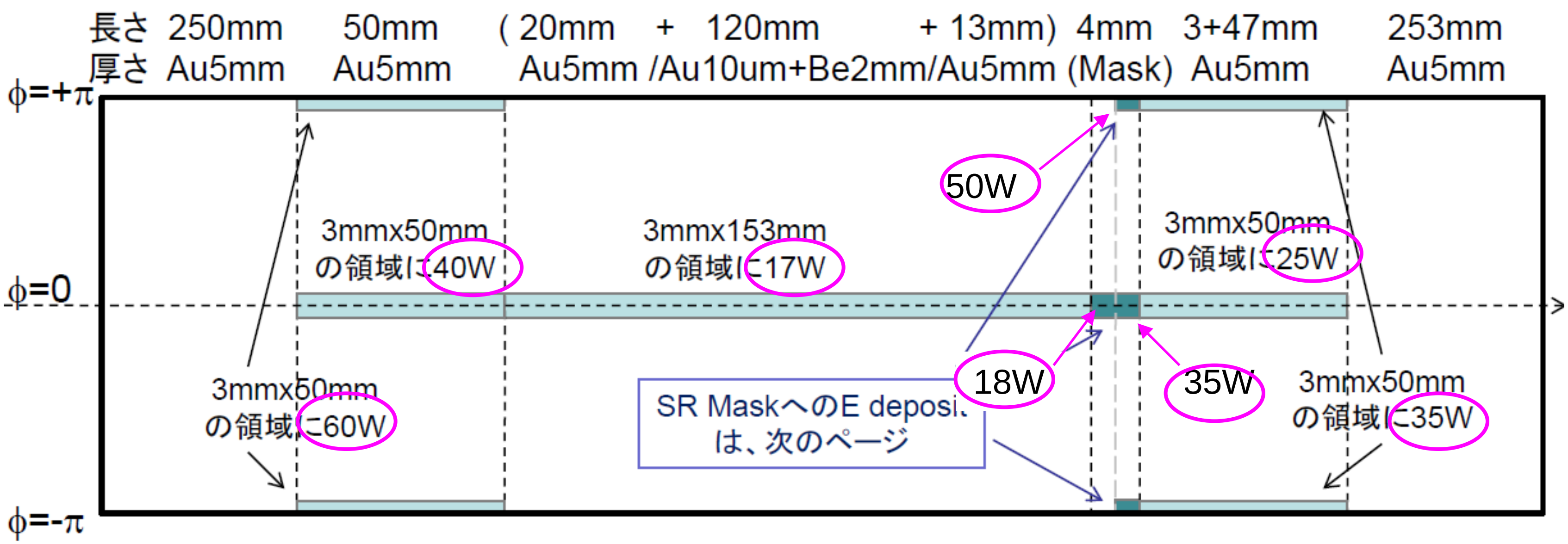
- There expected huge energy deposit of ~1kW from HER SR in the old version Super-KEKB design
- With the current new optics, it is decreased to ~100W (which is x10 of the current KEKB)
- Detailed heating calculation / simulation is needed to design the cooling system (see Yamaoka-san’s talk)
- We need to start the other BG source studies

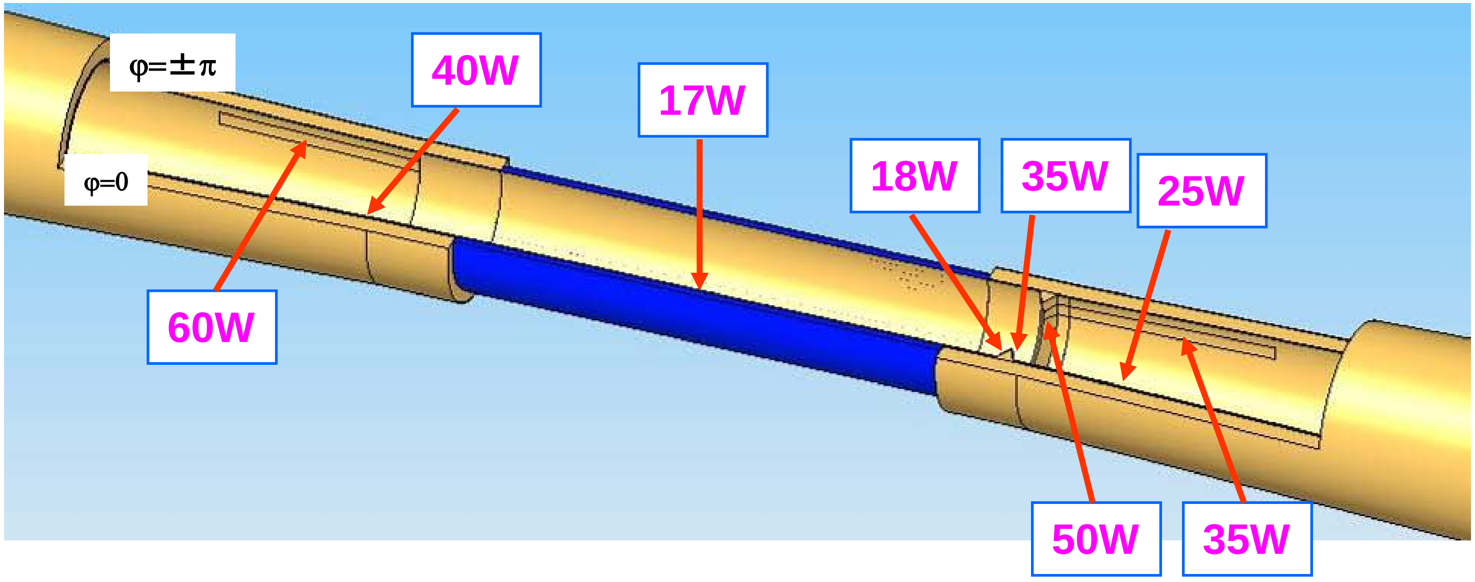
2. We will start the Super-KEKB nano-beam option studies

Lower SR BG and HOM power are expected

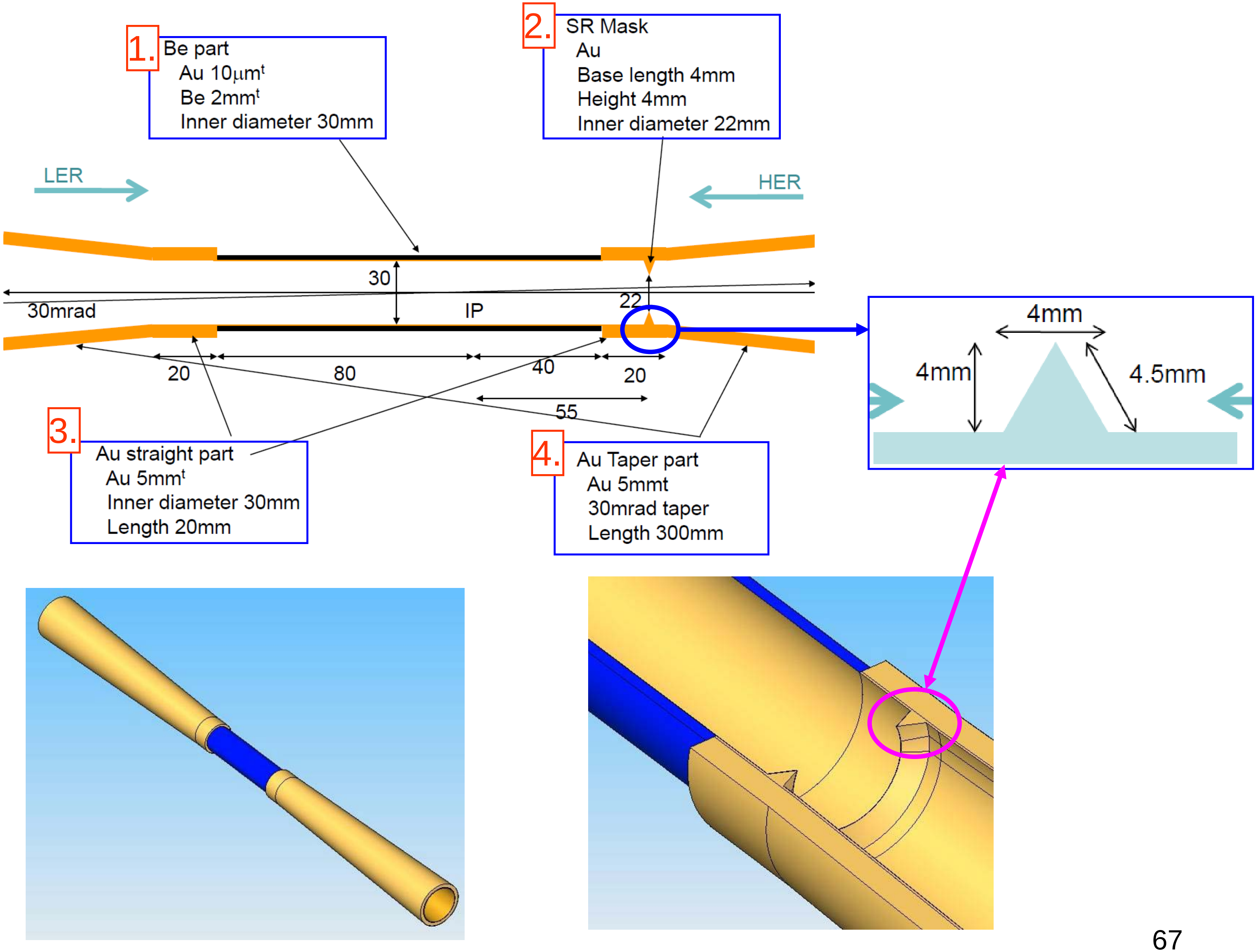
→ Is it possible to use the smaller radius beam-pipe?

Distribution of heat load



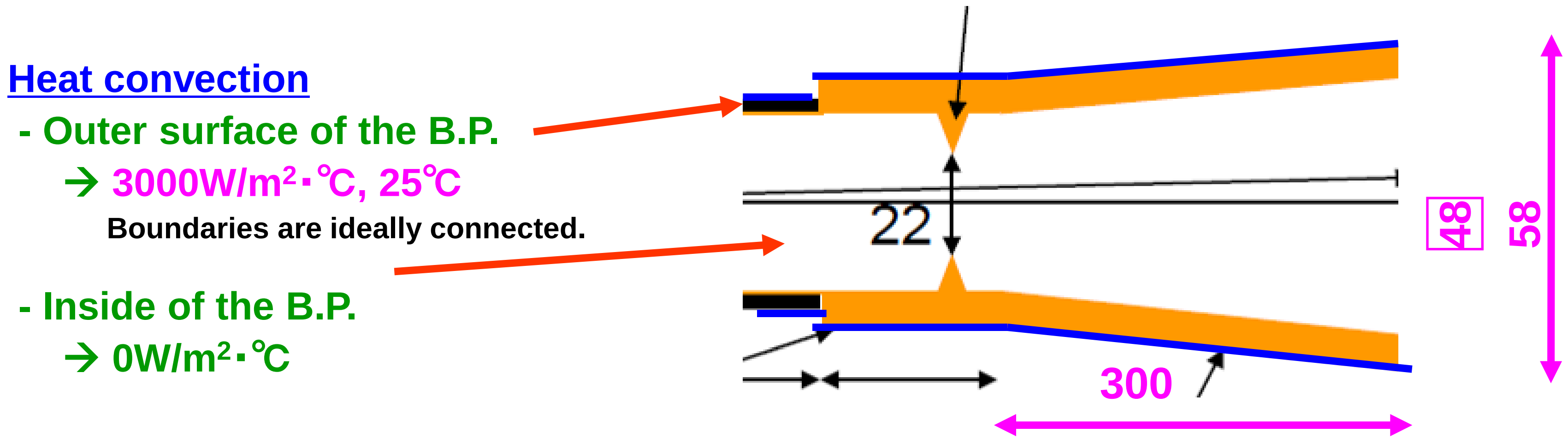


Configuration of B.P. (@Single Be-pipe)



Other assumptions

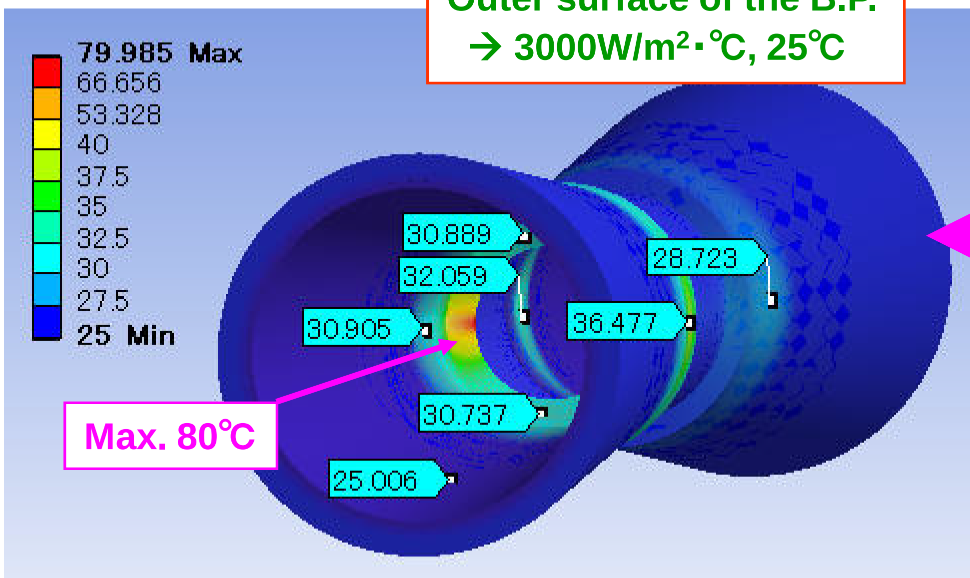
Outer surface of the B.P. is cooled by liquid.



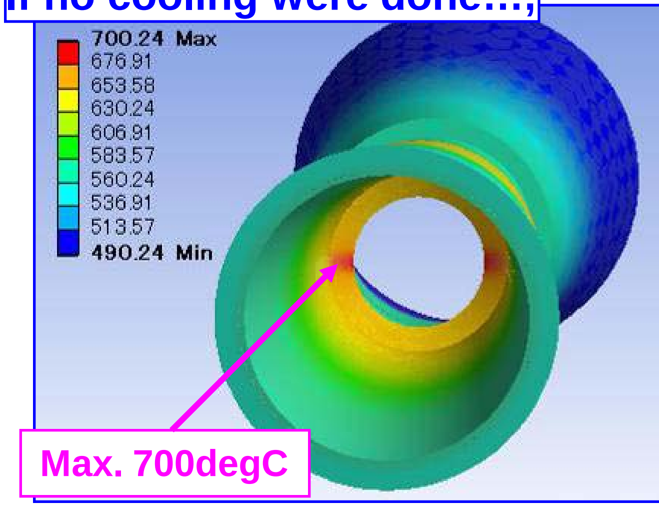
	Au	Be
Thermal conductivity (W/m・℃):	319	216
Specific heat (J/kg・℃):	128	1925

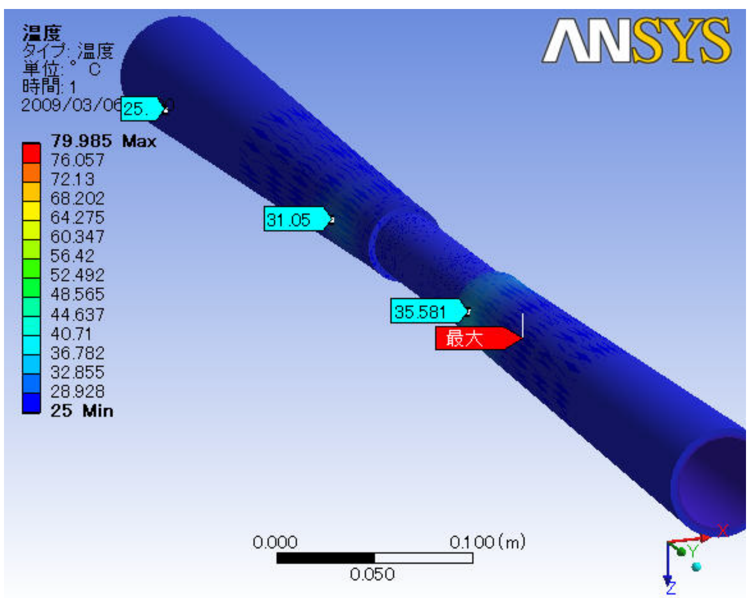
Results (@Single Be-pipe)

Outer surface of the B.P.
→ 3000W/m²·℃, 25℃

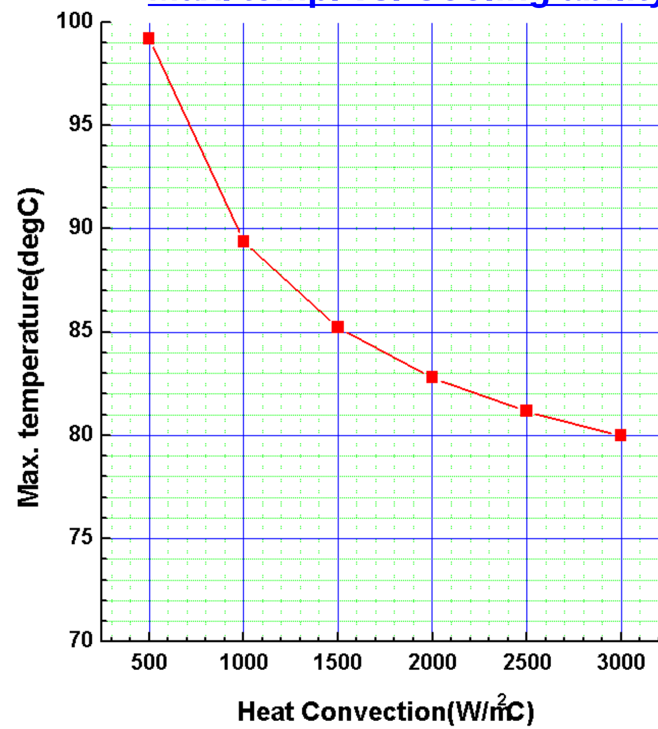


If no cooling were done…,

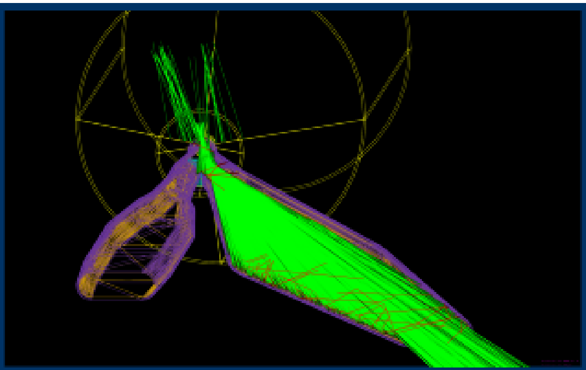




Max. temp. vs. Cooling ability.



Summary and To do...



- A study of SR backscattering from the New KEKB Optics in Geant4 has been performed (statistics of ~100 million photons, 1/100 of a bunch)
- The drop in energy deposit to the IP taper region was 1/10
- The maximum acceptable hits to the IP beampipe according to SVD Occupancy rates is ~50 hits/bunch
- With the simulated statistics no backscatter hits have so far been found in the IP beampipe
- We need to increase the number of statistics by at least 10 fold in order to determine if there will be a occupancy problem; Geometry of IR beampipe also likely to change

IR studies

IR group meeting is held every other week

U. Tokyo, Tohoku U.,

KEK Belle and KEKB team

http://kds.kek.jp/categoryDisplay.py?categId=229