IR status

2009/3/18

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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

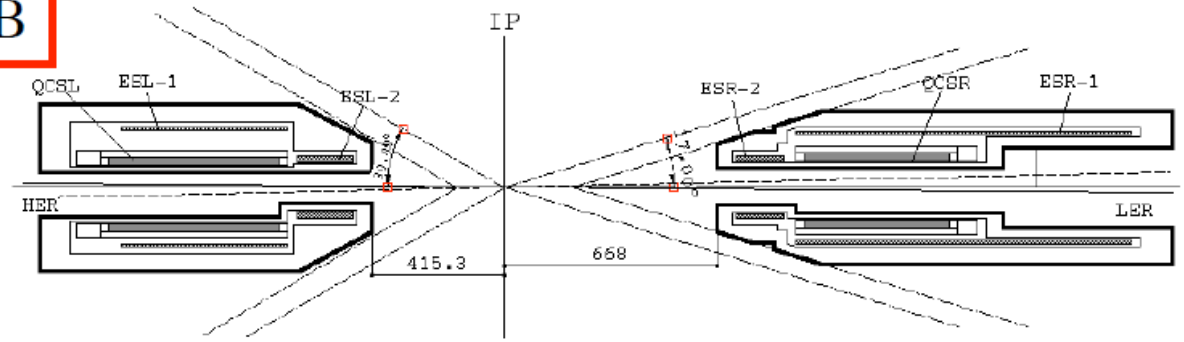
Y.Funakoshi
Kick off meeting

	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

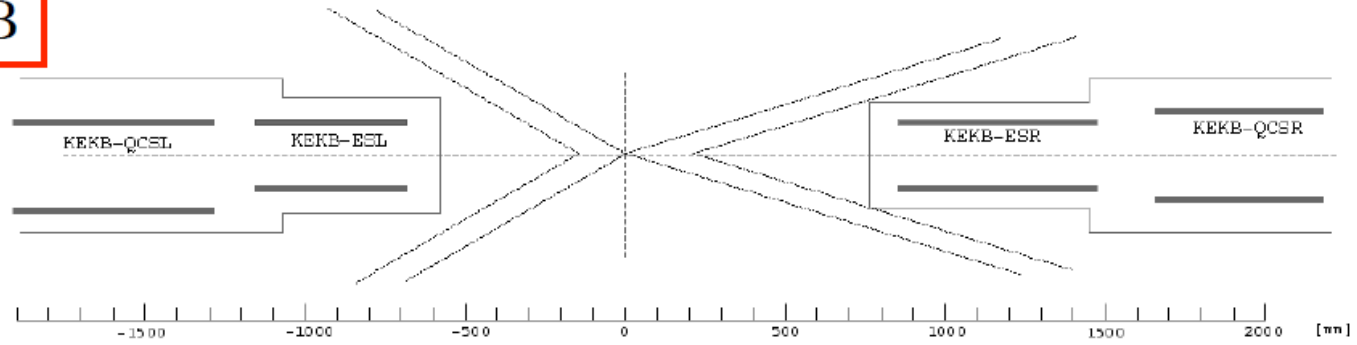
From KEKB to Super-KEKB 2
Place QCS magnets closer to IP

Y.Funakoshi
Kick off meeting

SuperKEKB



KEKB



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 yesterday

*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)	~30cm each ??

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

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

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

Today, we also ask machine talks directly related to the detector:

Machine parameters / optics → H. Koiso-san

QCS design → N. Ohuchi-san

IR region assembly → K. Kanazawa-san

Back up

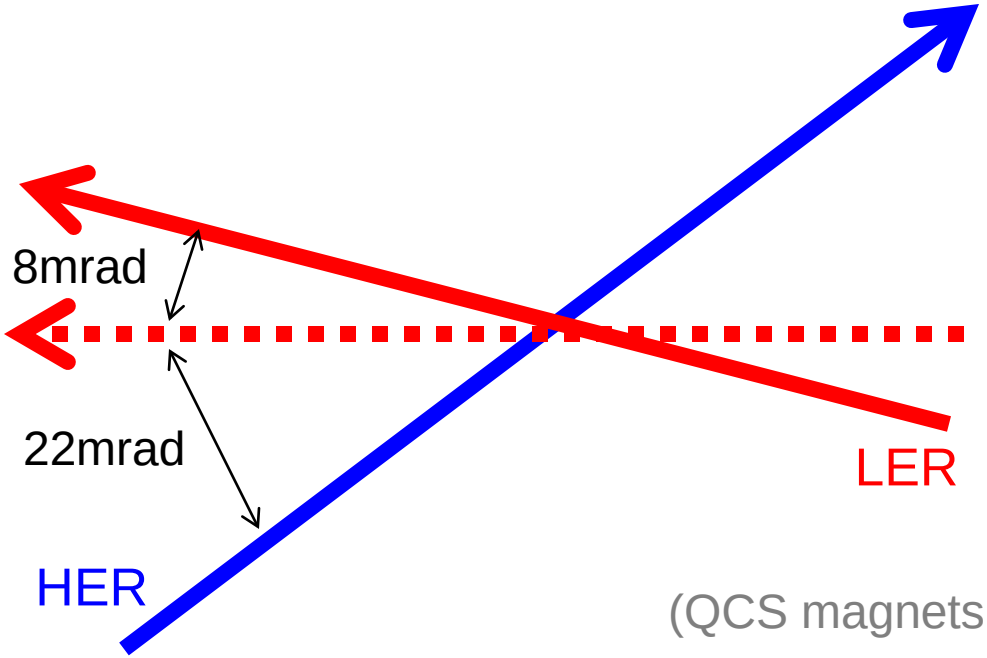
Parameters for Super B Factories

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
$\phi\sigma z/\sigma x$	0/0	31/13	31/18	14/25	14/24
$\sigma x/\phi$(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	$12.\times10^{10}$	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)

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)
- HER axis (22mrad from Belle solenoid)

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]									12	12	12	12	12
β_{x0}^* [cm]	20	20	20	20	20	20	20	40	40	40			
ξ_{x0}	0	.270	.270	.270	.135	.135	.135	.272	.272	.272	.273	.273	.273
ε_x [nm]		81.9							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			
σ_x@ QC2RE [mm]	4.0	39.5	30.9										
Nc													

Emittance ε (wo dynamic effect)

ε (with dynamic effect)

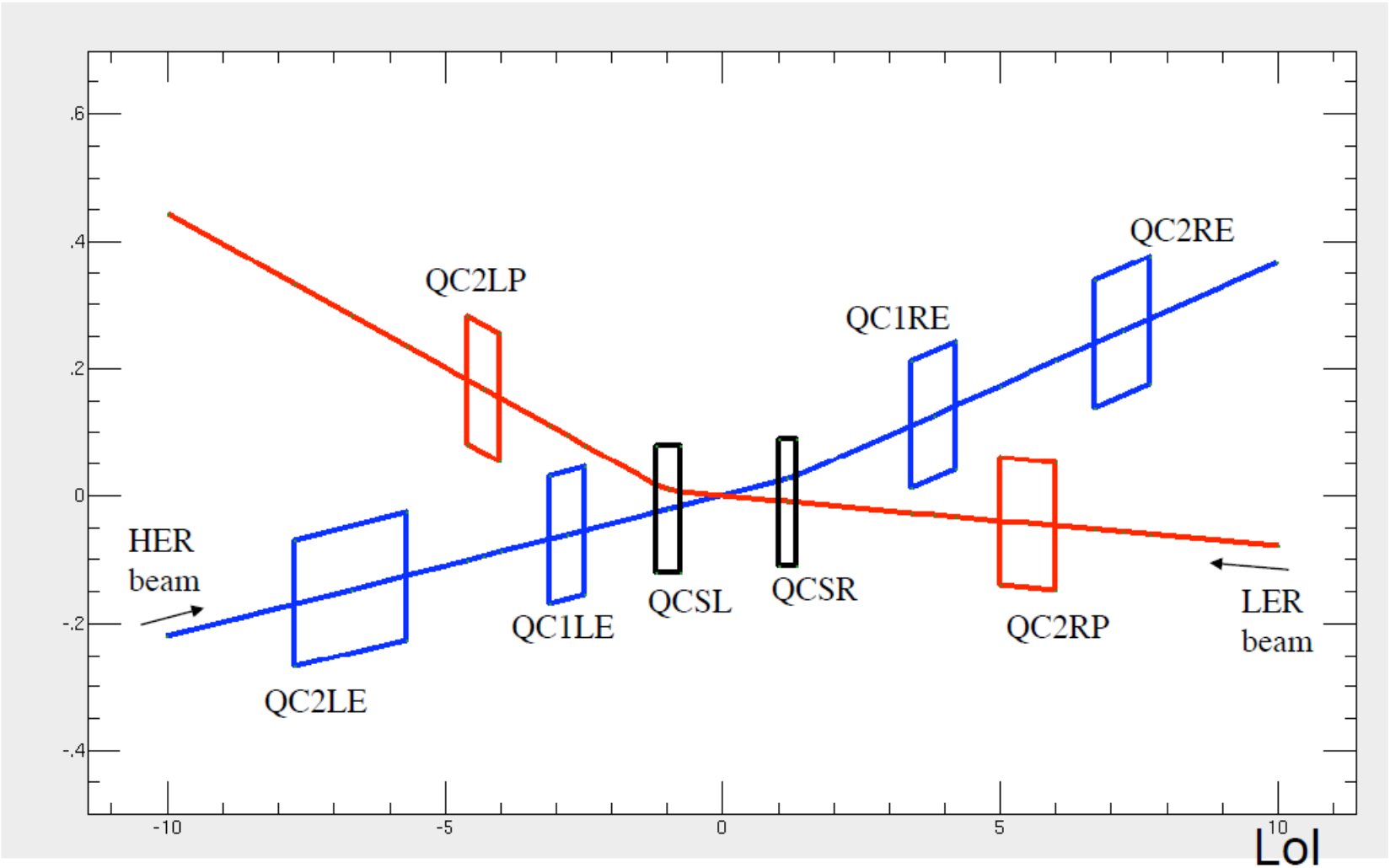
β (wo dynamic effect)

β (with dynamic effect)

5 times higher ε, 10 times smaller β in x

Dynamic effect at Super-KEKB is very strong

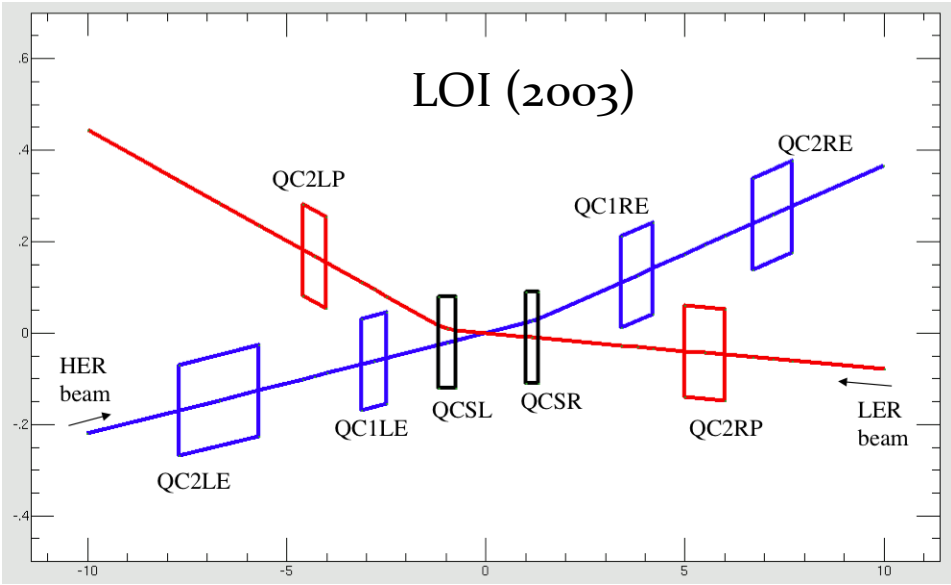
IR magnet layout

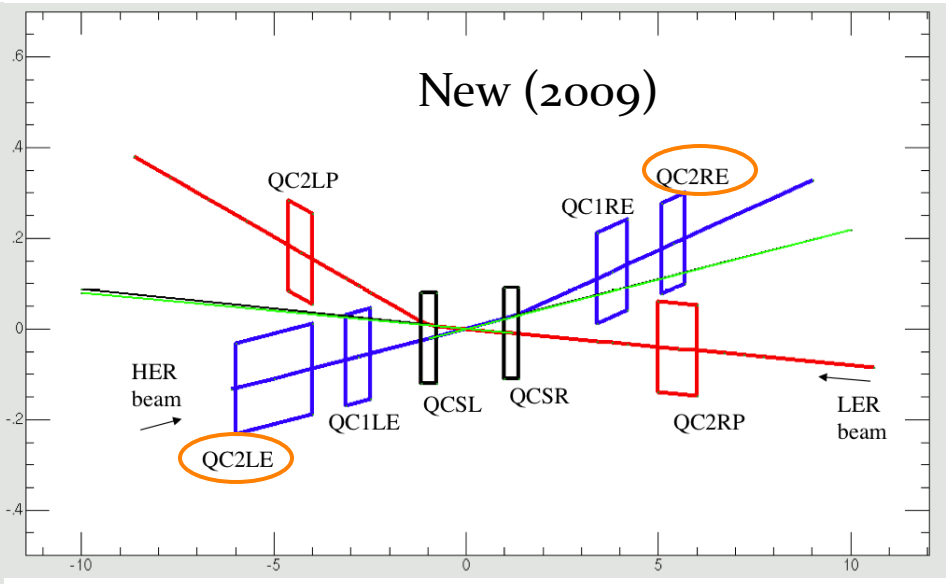


Physical Aperture

- Requirement : 5 σ_x with beam-beam effect
  - Larger than injection aperture
  - σ_x @ QC2LE (HER) and QC2RE (HER) must be decreased.

- Moved QC2LE and QC2RE closer to IP
- Increased β_x^* 20 → 40 cm
  - Luminosity will decrease by ~20 %.





Overview (1)

Copper duct

50 μm gold plating

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

Bellows

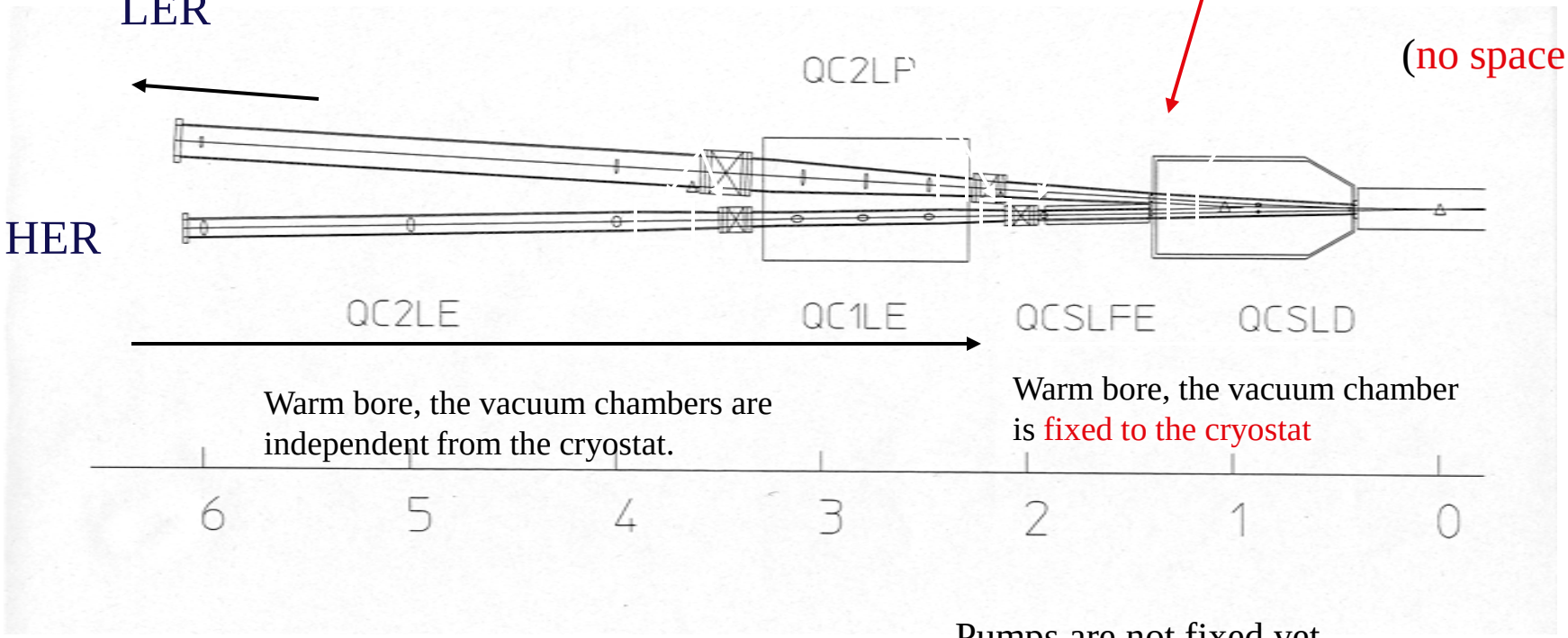
BPM

Bellows

BPM ?

Bellows

(no space !)

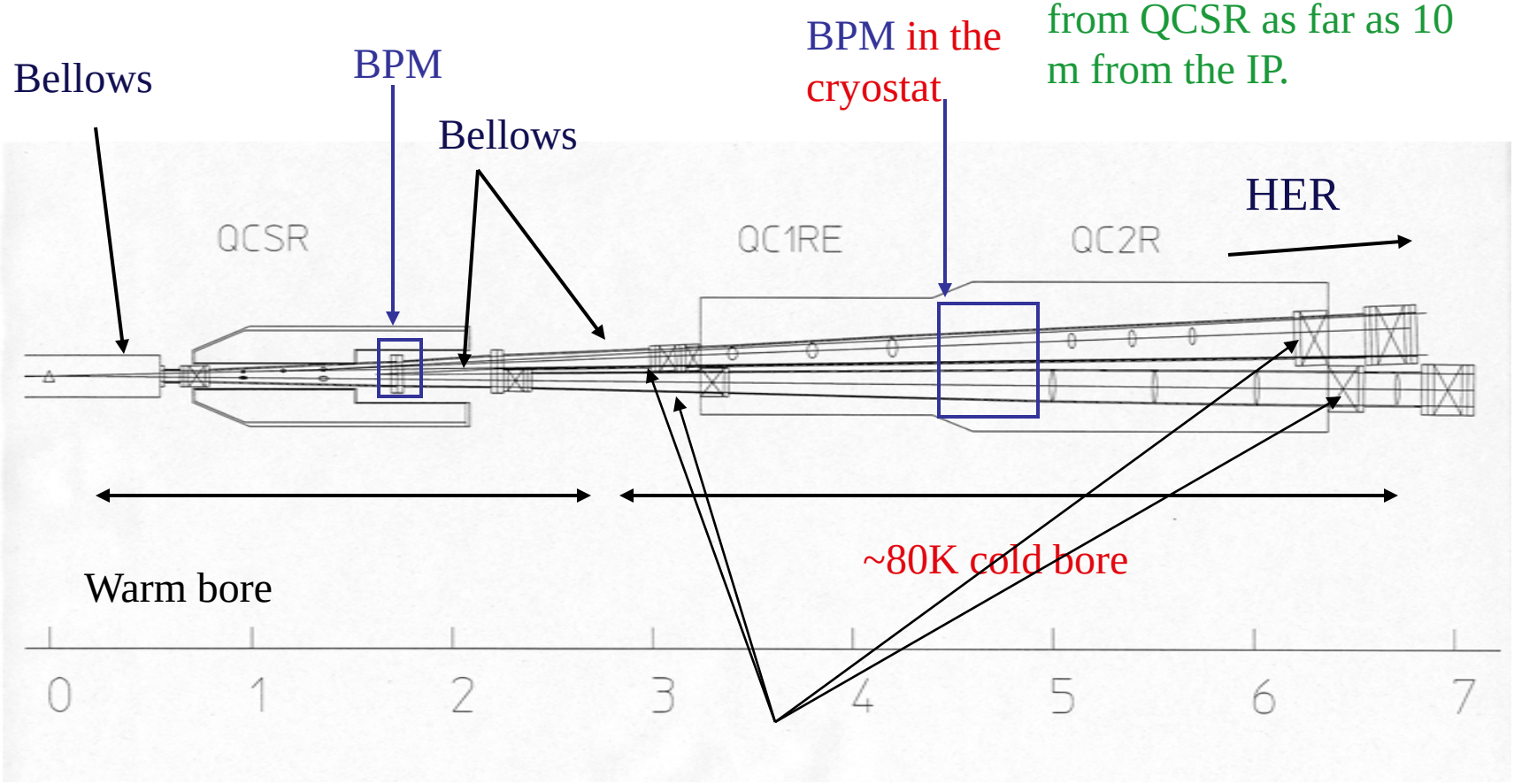


Pumps are not fixed yet.

Kanazawa

Overview (2)

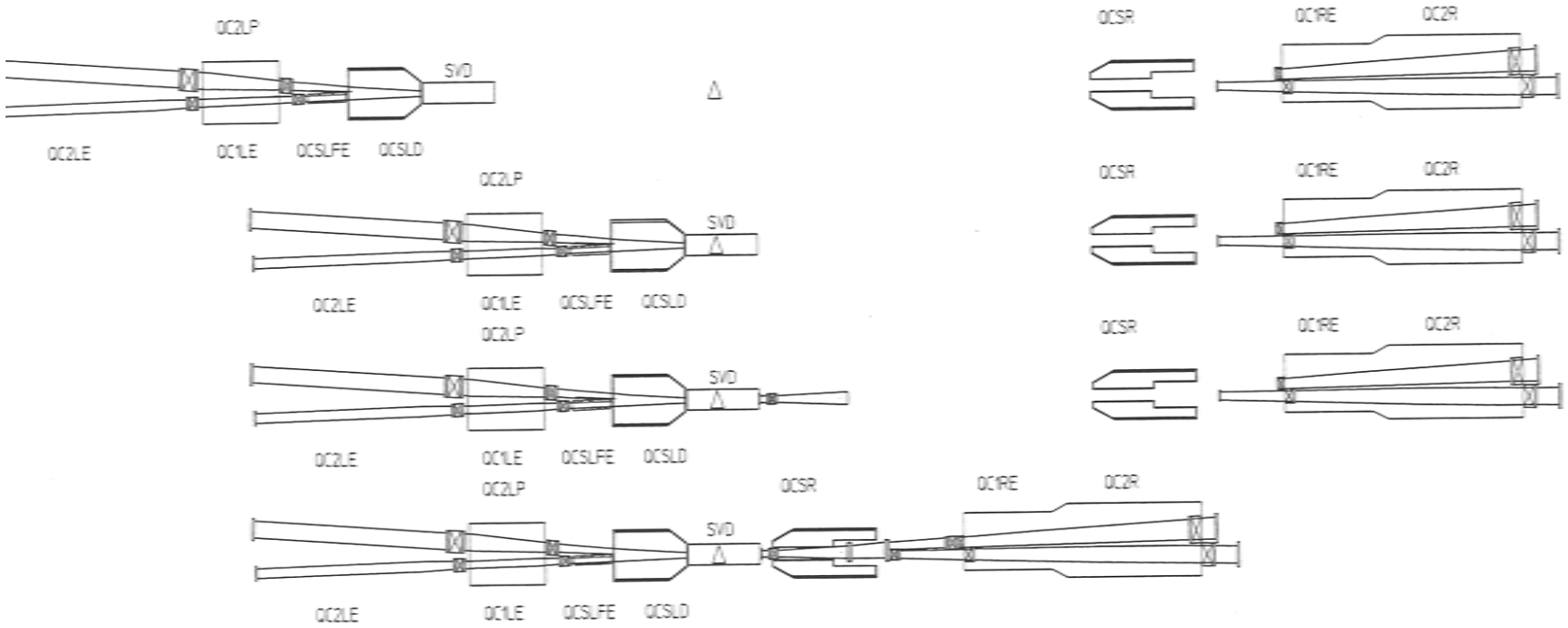
HER vacuum chamber must have a clearance against the direct SR from QCSR as far as 10 m from the IP.



Bellows between the cryostat and the vacuum ducts

Kanazawa

Possible assembling procedure



The connecting flanges of QCSLD chamber and IP chamber become inaccessible during assembling. IP chamber and SVD must be assembled in front of QCSLD outside the Belle detector.

Kanazawa