IR Vacuum Chamber

Basic design consideration for SuperKEKB

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KEKB Vacuum Group

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Contents

- From KEKB to SuperKEKB
  - Experience in KEKB and Design Principle for SuperKEKB
- Preliminary Design Layout of IR Vacuum Chambers
- Summary and Next Step

From KEKB to SuperKEKB
Synchrotron Radiation (SR) (1)

KEKB

On the whole,
COOLING IS NOT SUFFICIENT.

- For the incoming beam line, SR from far magnets was not considered seriously.

SuperKEKB

- Provide cooling every possible SR irradiation.

From KEKB to SuperKEKB
Synchrotron Radiation (SR) (2)

KEKB

- The exact path of the SR from QCS and its spread were not strictly taken into account in the first design.
- This caused a high temperature at unexpected portions of a vacuum chamber.
  - Deformation of vacuum chamber
  - Motion of magnets.

SuperKEKB

- The design of QC magnets in the LoI looks trying to give a sufficient clearance for the SR down to QC2.
- The design of the beam duct layout also tried to avoid the SR.
- However, the design should be checked against the fact that the two beams and the SR don't lie in the same plane.

From KEKB to SuperKEKB
Detector Background

KEKB

- Back scattering of the SR from QCS by a HER Al beam duct became a noise source. (Cu has a smaller cross section of the back scattering than that of Al.)
- Shields against the detector background should have been incorporated from the first design.

SuperKEKB

- Chamber material: Cu (cooling, shielding, small back scatter of SR)
- Beam ducts avoid the SR down to 8m (HER downstream) and 5m (LER downstream) from IP.
- Shield should be taken into consideration from the first design.

From KEKB to SuperKEKB
Higher Order Mode (HOM) (1)

KEKB

- The HOM power turned into heat in IR is, in the unit of the loss factor, around 474 V/nC. (Estimated from the temperature rise of cooling water)
- Heat up of the bellows will be unacceptable level in Super KEKB

SuperKEKB

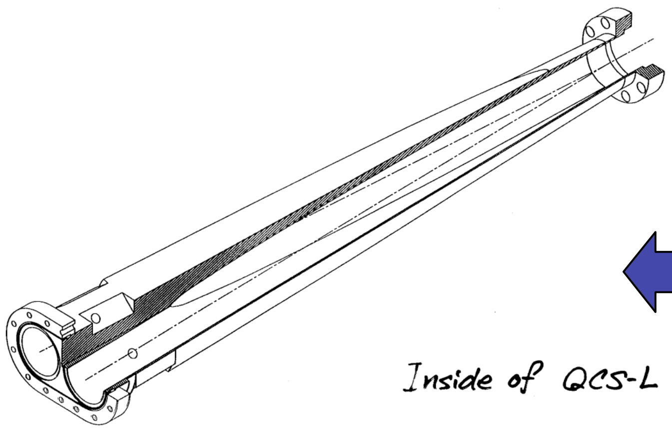
- Extrapolation from KEKB gives as a heat by HOM about 100kW ×(bunch length factor).
- Is the compact HOM absorber possible?
- The cooling for HOM will be a big problem.
- The comb type bellows is expected to be durable.

From KEKB to SuperKEKB

Higher Order Mode (HOM) (2)

KEKB

- Avoid a local cavity structure as possible as one can.
- Flange gap is filled with Helicoflex



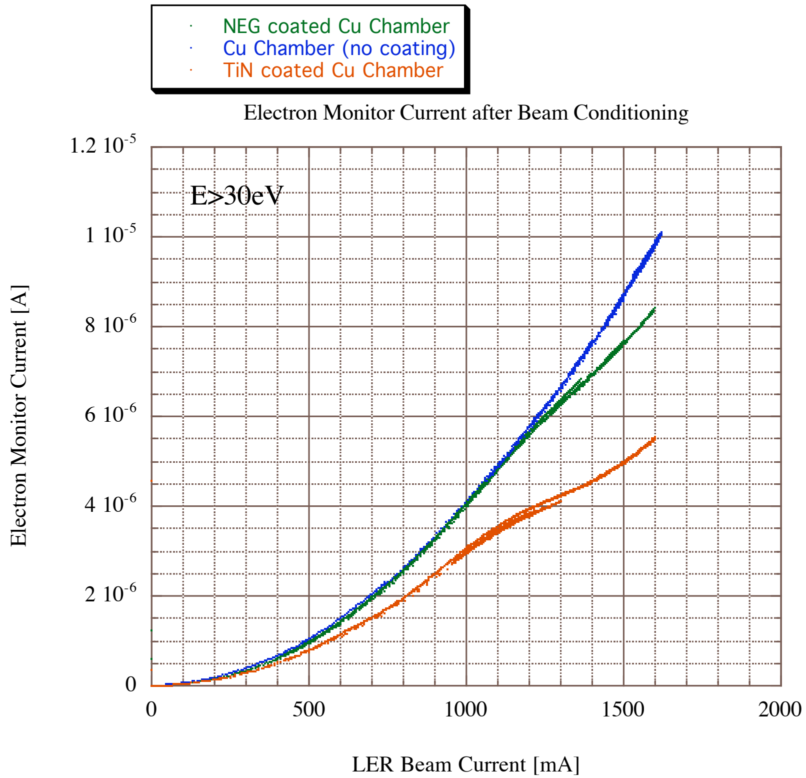
SuperKEKB

- Design principle of the inner shape of chambers is same as KEKB.
- The pump slot must be designed carefully not to cause the heat up of NEG.
- Flange gap will be filled MO type gasket.
- The design of the branching part is simmiler to KEKB.

From KEKB to SuperKEKB
Electron Cloud

KEKB

- No measures



SuperKEKB

- TiN coating for the positron beam duct to reduce multipactoring.
- Solenoid is also necessary to confine photoelectrons.

The reduction of both photoelectron yield and secondary electron yield by a TiN coated chamber.

From KEKB to SuperKEKB
Others

KEKB

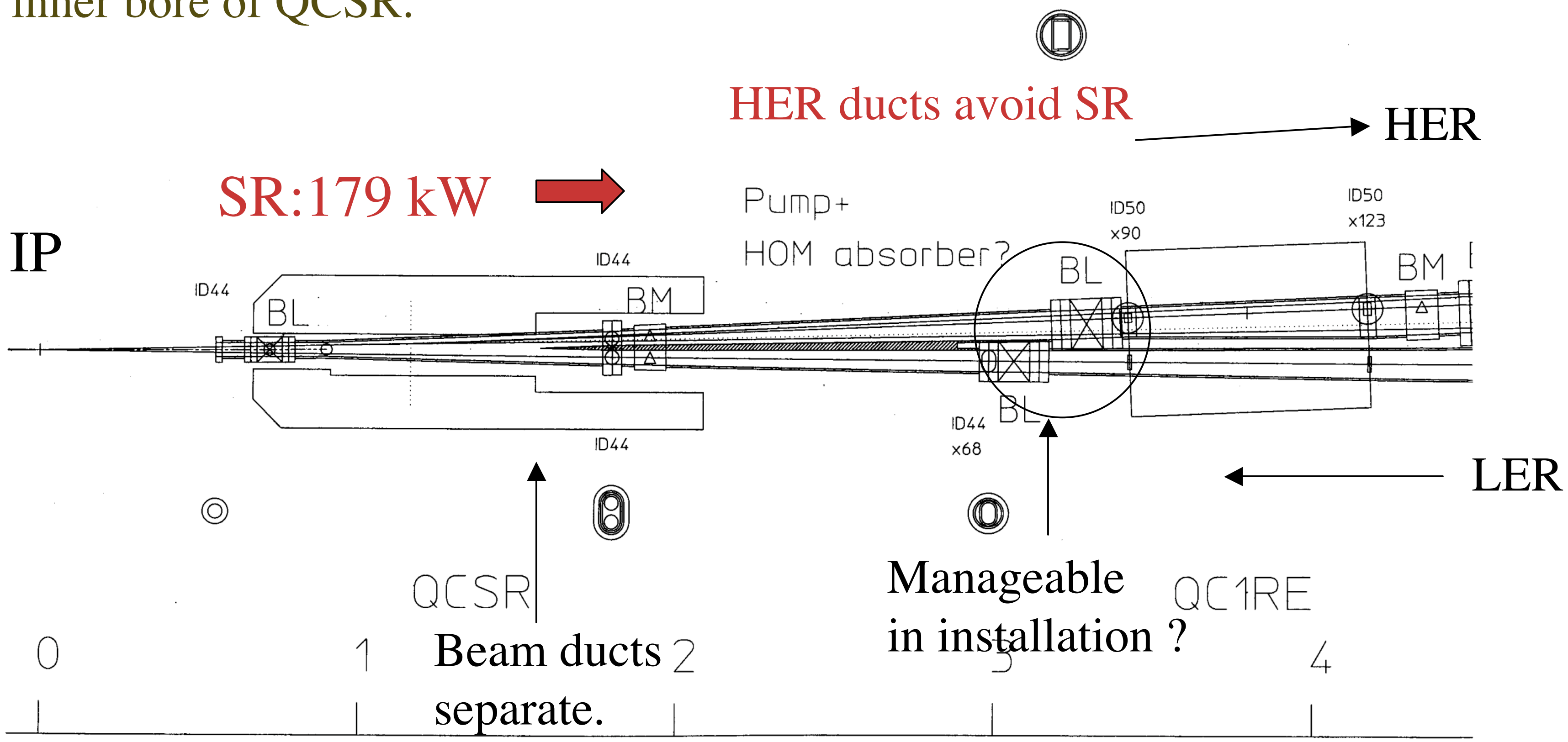
- NEG (Non Evaporable Getter)+Sputter Ion Pump scheme.
- Bellows is welded to a vacuum chamber.
- The pressure of the positron (LER) incoming line (within 10m from IP) is higher than expected.

SuperKEKB

- The same scheme with exchangeable NEG. (as possible as one can)
- Easily repairable design (mechanically detachable bellows etc).
- Denser distribution of pumps.

Beam duct layout   Right hand side (1)

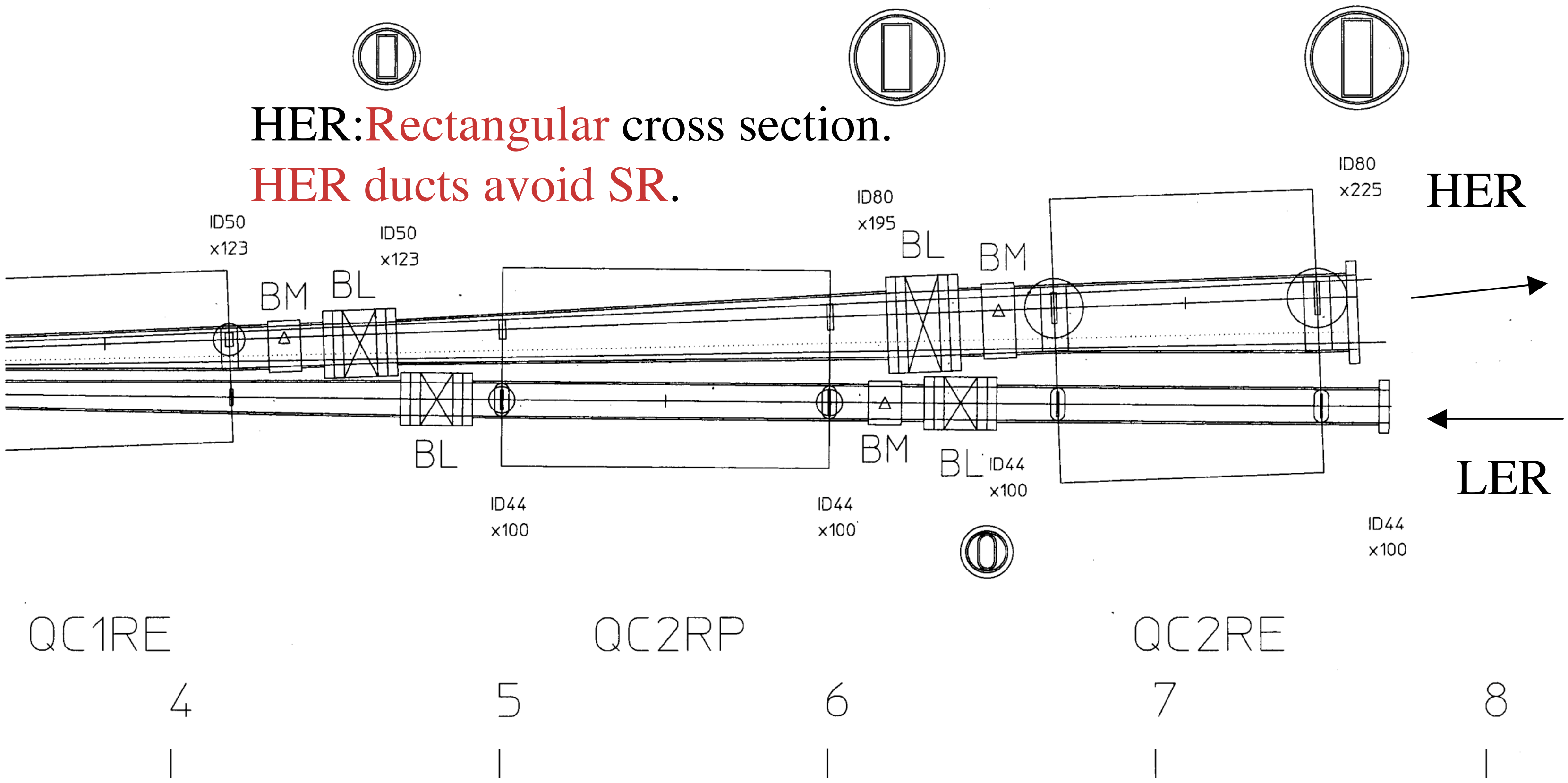
- In HER , all ducts are expected to avoid SR.
- The BPM at the end of the QCS chamber is possible only if the electrodes clear the inner bore of QCSR.



BM:Beam Position Monitor, BL:Bellows

Beam duct layout Right hand side (2)

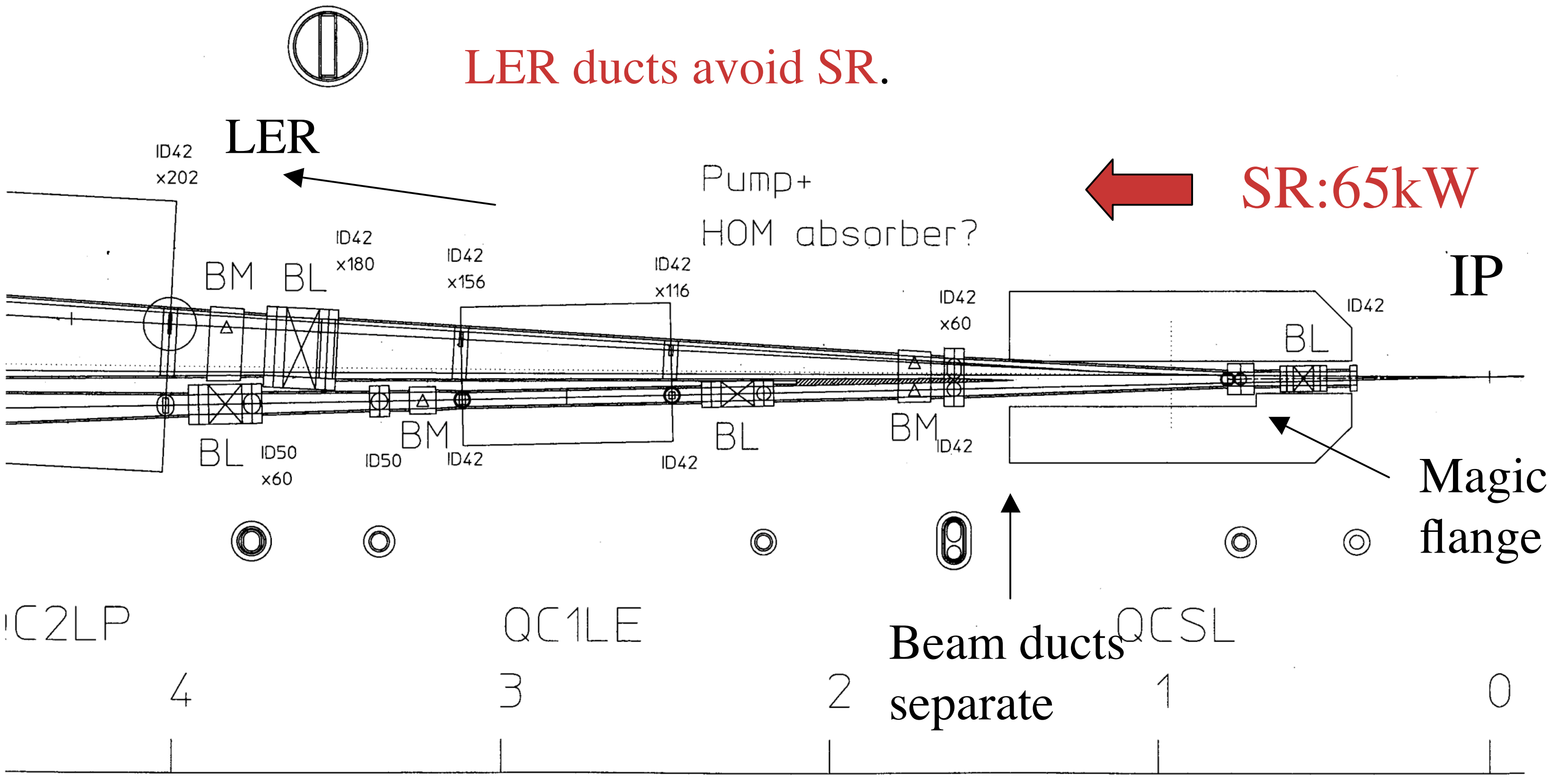
- The space for the pump must be reserved in the magnet.



BM:Beam Position Monitor, BL:Bellows

Beam duct layout   Left hand side (1)

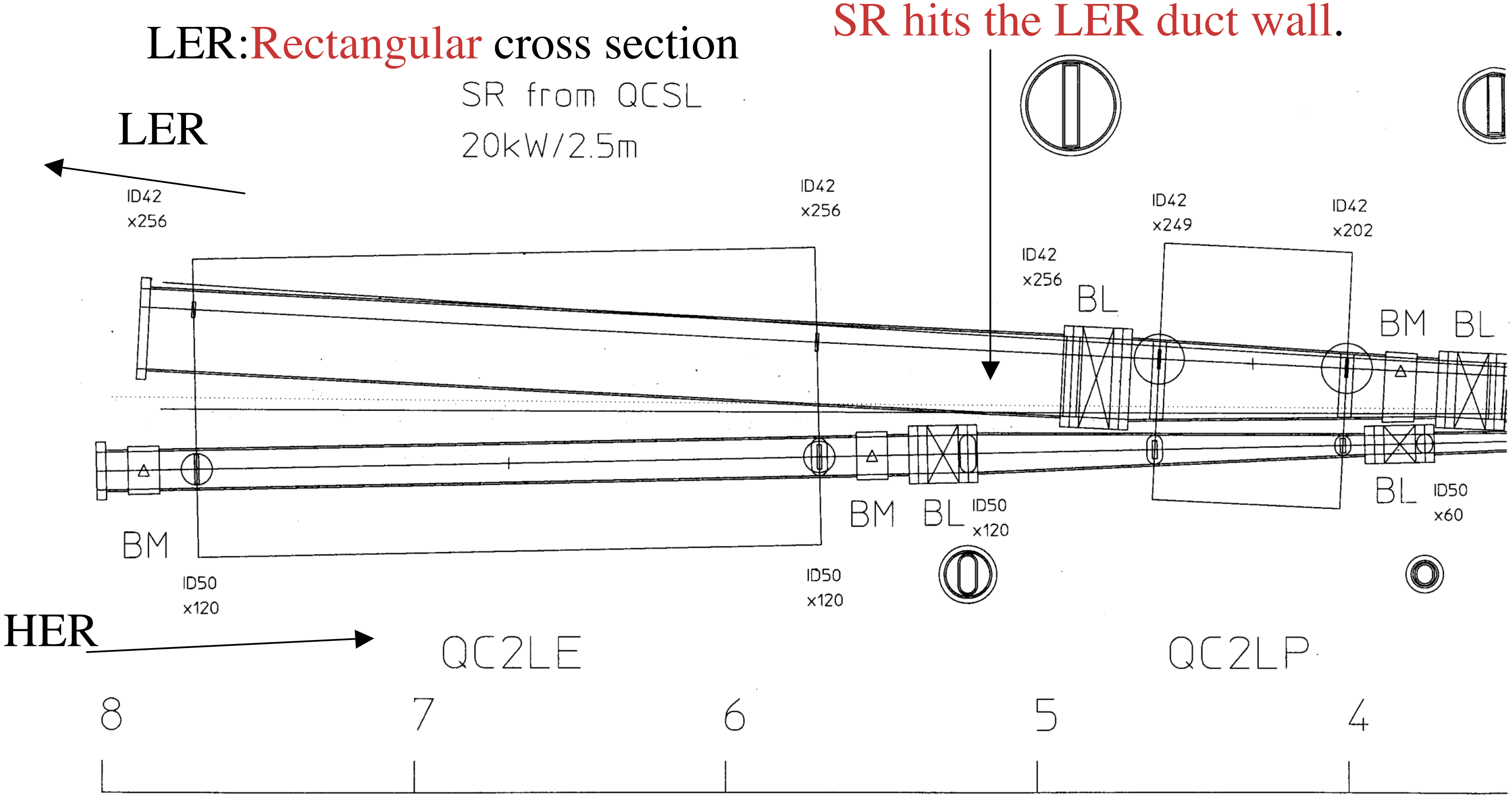
- •Flange connection in the bore of QCS-L (magic flange).
- •The ducts of LER from QCSL to QC2LP escape SR



BM:Beam Position Monitor, BL:Bellows

Beam duct layout Left hand side (2)

- The space for the pump must be reserved in the magnet.



BM:Beam Position Monitor, BL:Bellows

Summary and Next Step (1)

Summary

- Based on the experience in the KEKB IR vacuum system, the new beam duct layout is shown.
  - Two rings separate at about 1.5m from IP.
  - HER downstream ducts avoid SR down to 8m from IP.
  - LER downstream ducts avoid SR down to 5m from IP.
  - The comb type bellows will be used and the flange gap will be filled with MO type gasket.
  - Seeking easy repair

Summary and Next Step (2)

Next Step

- To make the design more concrete:
  - Cooling structures and pumps should be added in the design.
  - The interference with magnets must be checked and be negotiated.
  - Manageability of flange connection should be checked.
  - How to fix a beam duct should be designed.
  - HOM absorber near the branching part should be studied.