

# Reducing Injection noise

## "How to cool down the beam?"

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**KEK**

# Particle background

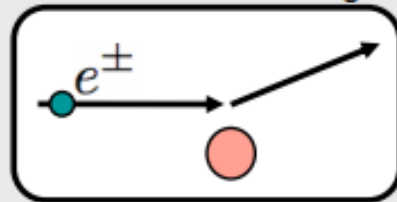
## 3 kinds of scattering

2

Beam-gas scattering (collision with nuclear of remaining gas)

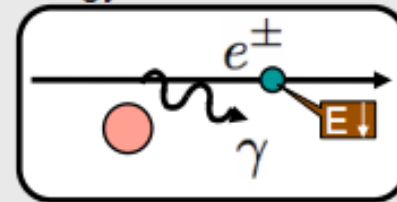
### Coulomb scattering

Direction → change



### Bremsstrahlung

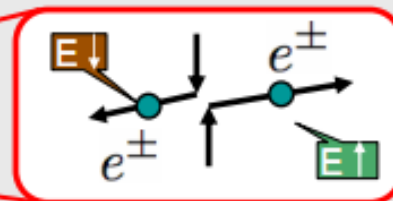
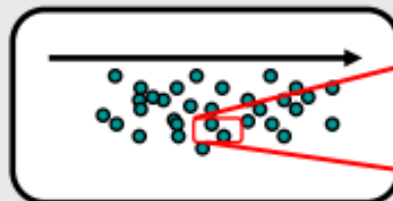
Energy → decrease



Beam-beam scattering (collision with beam particle)

### Touschek effect

Energy → increase  $E↑$   
& Energy → decrease  $E↓$



Scatter

→ Deviate orbit

→ Hit beam pipe

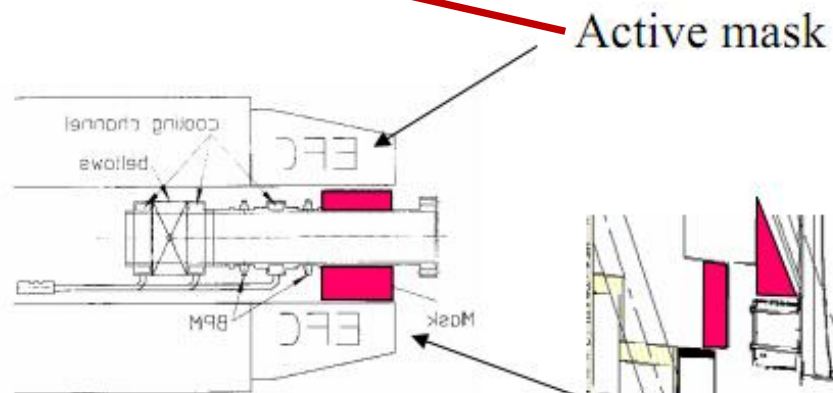
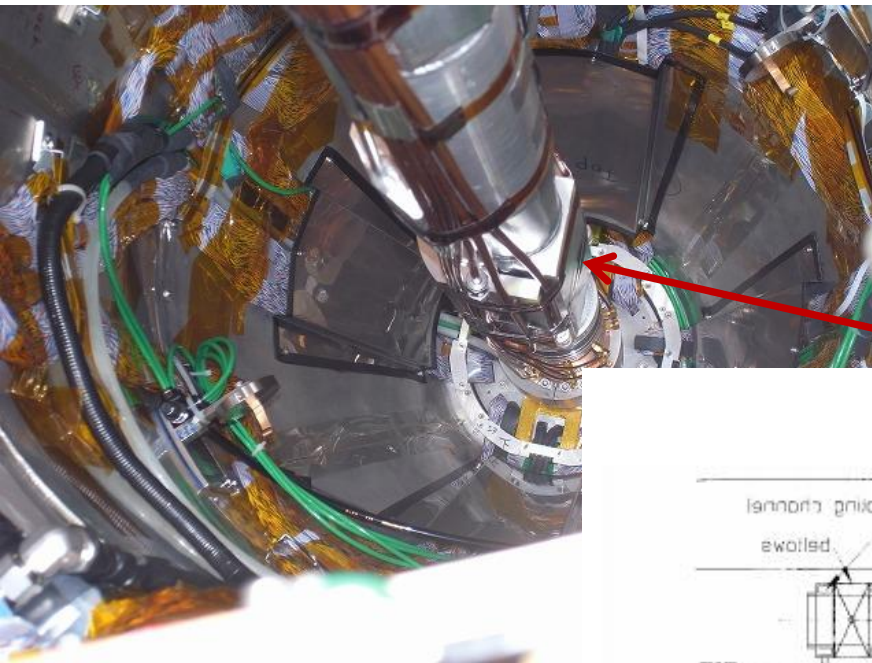
→ Background

The source of injection noise is similar with Touschek BG.

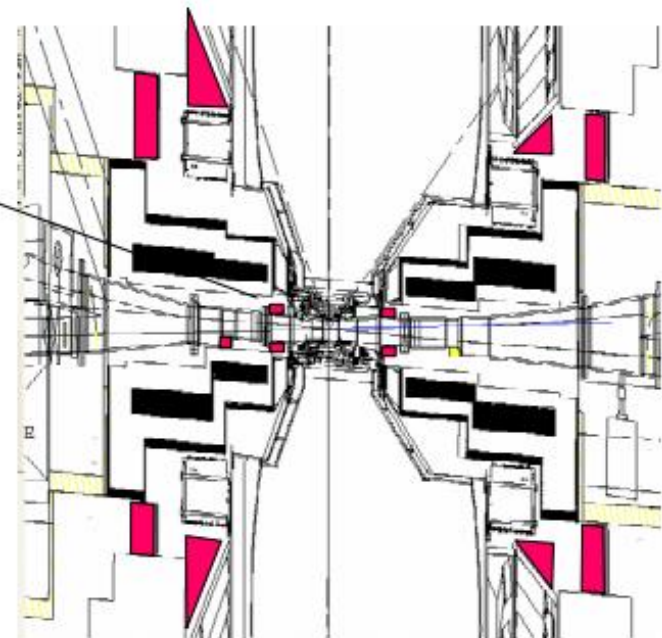
# Masks

- Belle experienced huge particle (shower) background. There are holes parallel to the beam direction. The hole just outside of the vacuum chamber resulted in shower around SVD and CDC.
- The hole close to the end-cap detector resulted in large background at the low-angle end cap CsI.
  - *We should take care for cabling and piping along QC cryostat*
- **Fixed type masks**
  - Located on near Belle detector to avoid the off-momentum BG
- **Movable masks**
  - To protect Belle from the beam background (located near arc-section of beam line).
  - During physics run and injection period.

# Fixed type masks



Adding masks to vacant spaces to stop the stray particles.



# The Beam mask position at KEKB

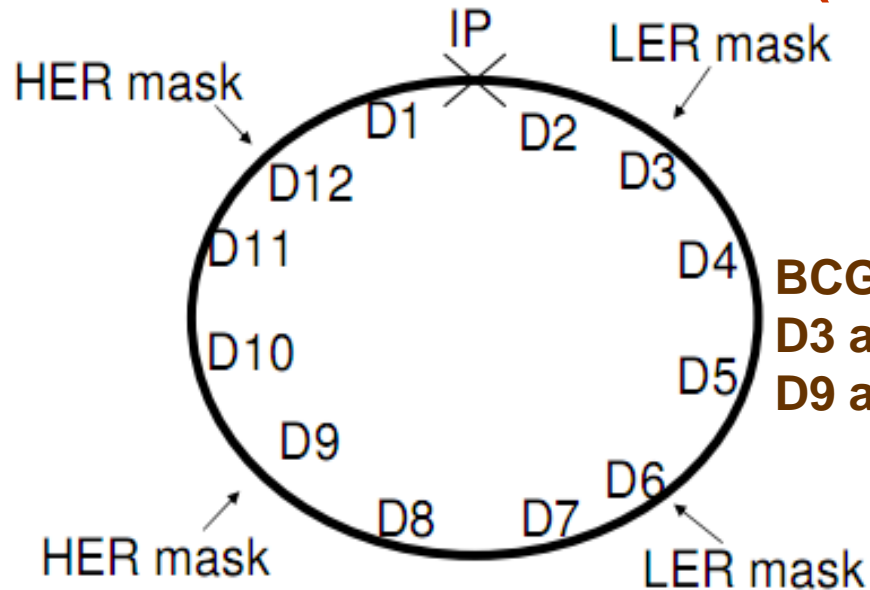
The noise can reduce by optimizing moving mask.

CCG monitor

**\*Need simulation and mask R&D(fine control) !**

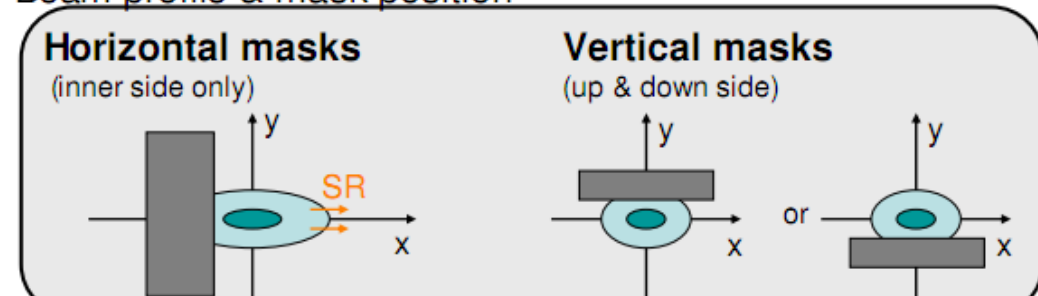
Vacuum [nTorr]  
( ~factor 2 error)

	HER	LER
D1	0.14	0.18
D2	0.21	0.24
D3	0.12	0.18
D4	0.24	0.67
D5	0.18	3.32
D6	0.12	0.30
D7	0.21	1.13
D8	0.40	0.39
D9	0.26	0.11
D10	0.21	0.67
D11	0.20	0.68
D12	0.22	0.10



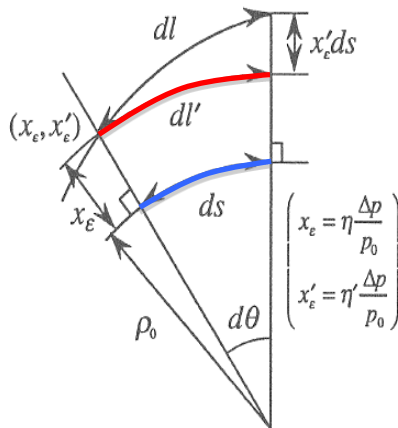
**BCG shifter controlled**  
D3 and D6 for LER  
D9 and D12 for HER

Beam profile & mask position



**Vertical masks will be useless on nano-scheme**

# Where movable mask should be located?



$\eta$ : Dispersion function:  
The position function of beam particle by energy difference

Located on Large  $\eta$  with Large beta for each axis

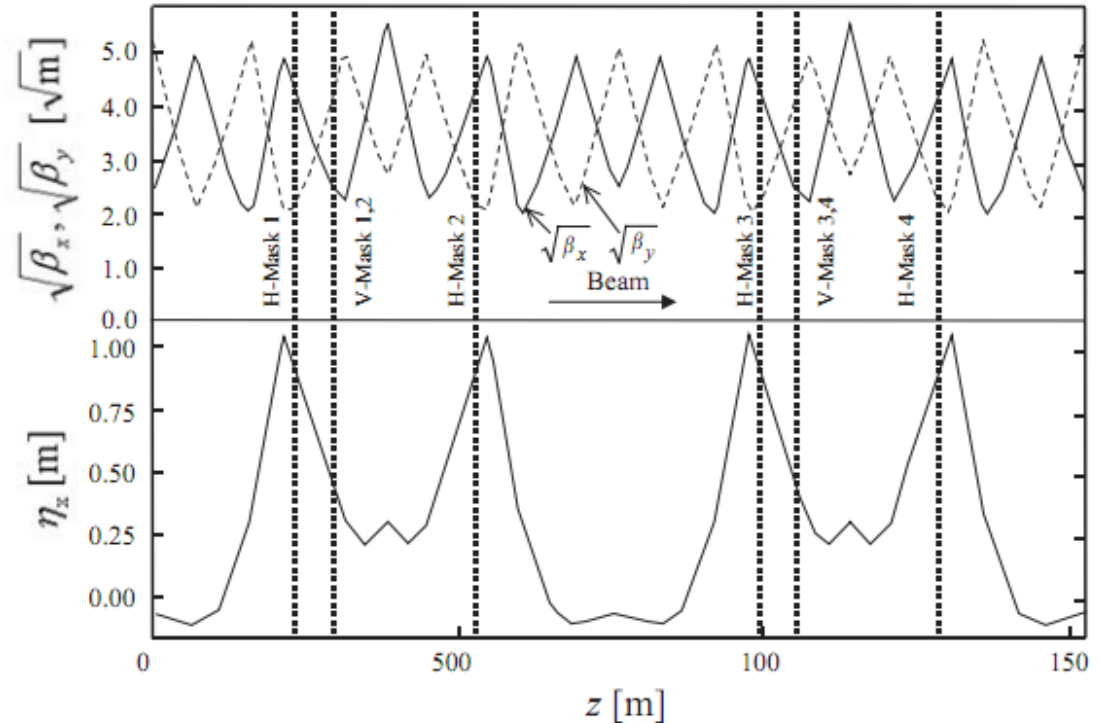


Fig. 2. Location of movable masks in the beam lattice diagram (LER). Horizontal axis is the distance along the ring (about 150 m). Vertical axis is the root of horizontal and vertical beta functions ( $\sqrt{\beta_x}(\sqrt{m})$ ,  $\sqrt{\beta_y}(\sqrt{m})$ ) and the dispersion function ( $\eta_x$  (m)).

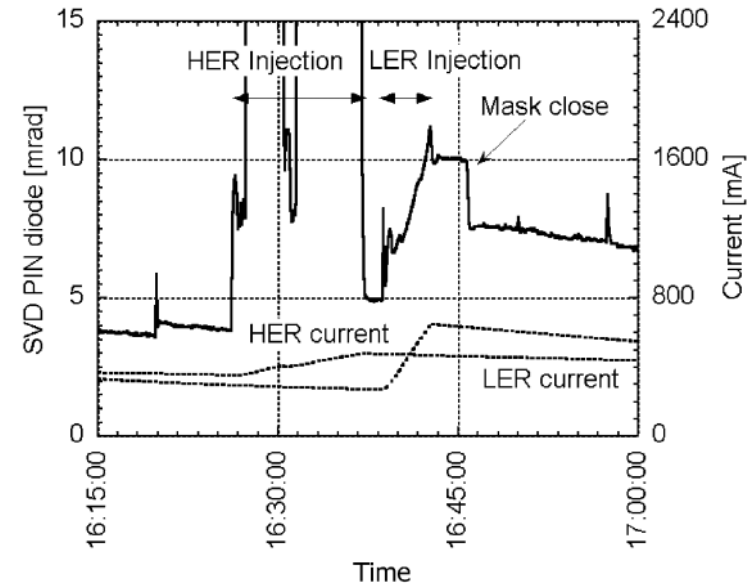
# Who and how to control?

BCG shifters has been adjusting mask positions to get the best background condition. (BCG: Belle Commission Group)

The best position is not same for the physics run and the injection time.

The best position is not stable.

- Tail of the storage beam changes time to time.
- The condition of the injection beam is not stable.



- **KEKB started at 1999.**
  - **Not continuous injection**
  - **First version of movable mask has problem by HOM heating (can not increase luminosity)**
  - **Shielding problem near QCS (off momentum BG went into Belle.)**
- **2<sup>nd</sup> version (2000)**
  - **Not continuous injection**
  - **Materials(tungsten) have added near QCS**
  - **Movable masks have been updated**



# What we should discuss?

- **Items:**
  - **Should summarize requirements for movable beam masks**
    - Vertical masks were mainly used on KEKB
    - We can only use Horizontal masks at SuperKEKB
    - The control precision (0.1mm @KEKB)
    - *Problem: We did not start beam mask design (!)*
  - **The position of fixed type masks**
    - Now we only worry for near IP region.
    - The decision of SVD structure may affect for BG shielding.