Radiation Protection

Estimate of Beam Loss at the KEKB

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KEK

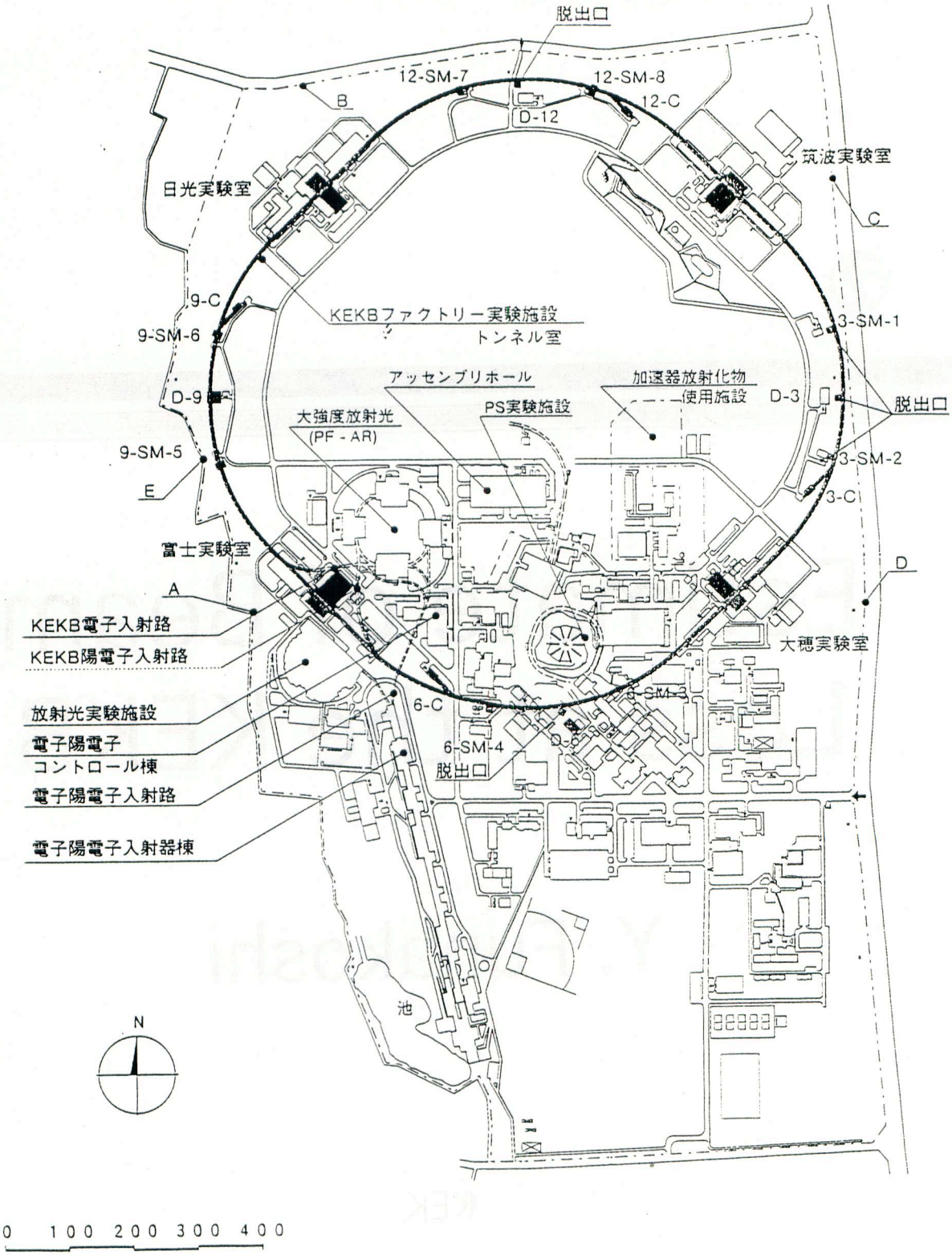


図 2: 本機構における KEKB ファクトリー実験施設の位置

電源室：D3、D6、D9、D12。補助機械室：3SM1、3SM2、6SM3、6SM4、9SM5、9SM6、12SM7、12SM8。電磁石搬入口：3C、6C、9C、12C。A、B、C、D 点は、それぞれ富士・日光・筑波・大穂の各実験室からの最近接敷地境界点を示す。

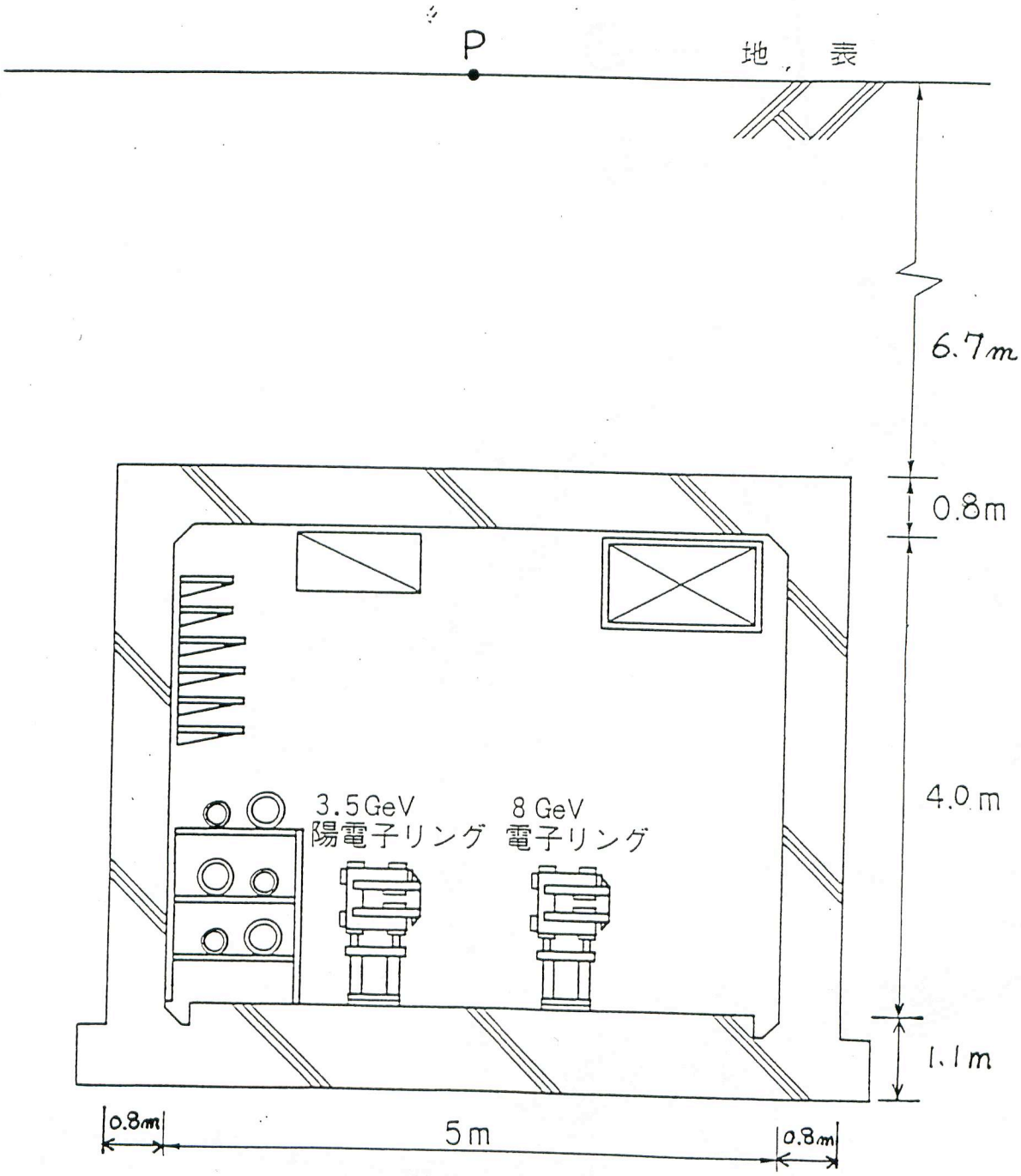
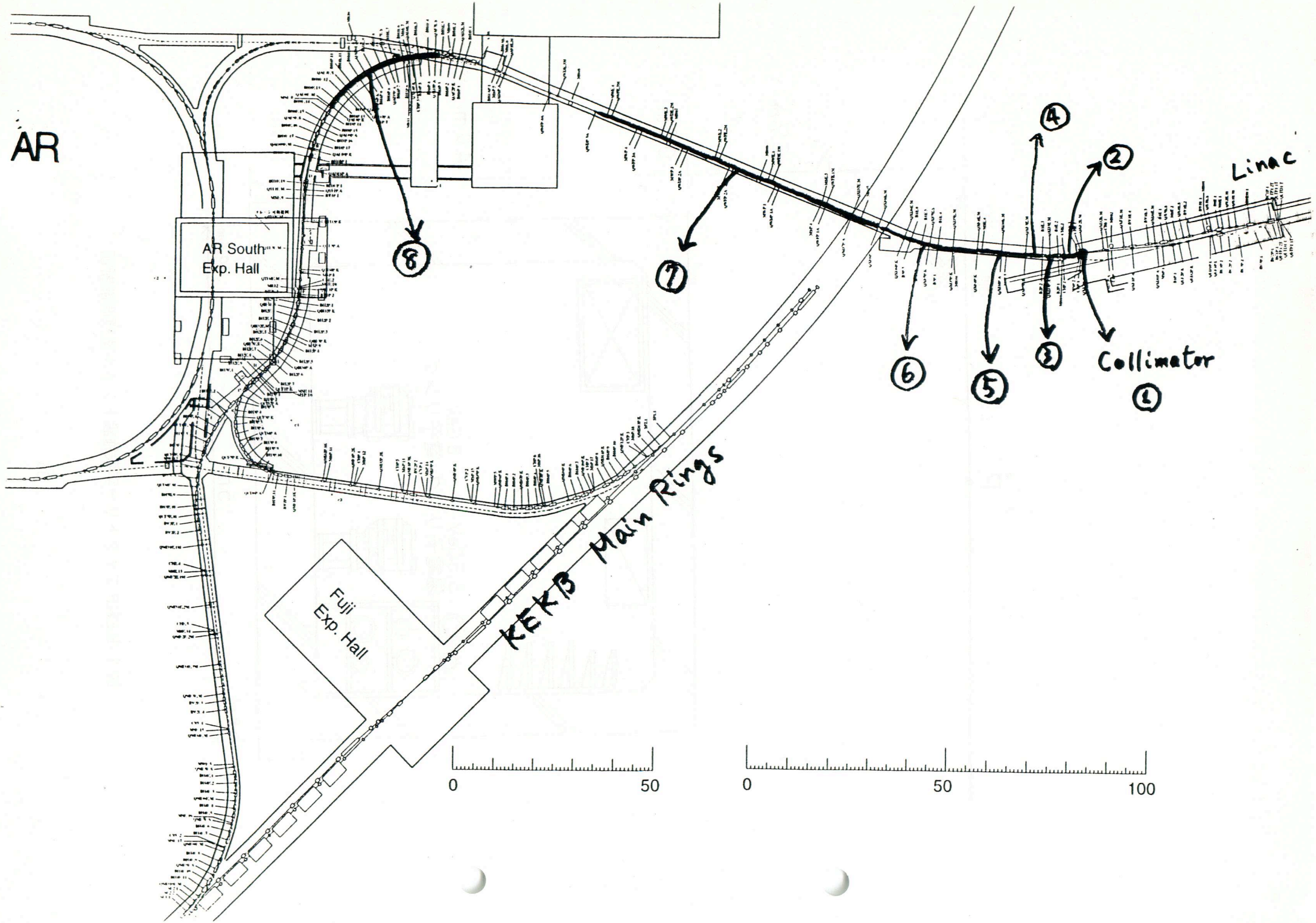
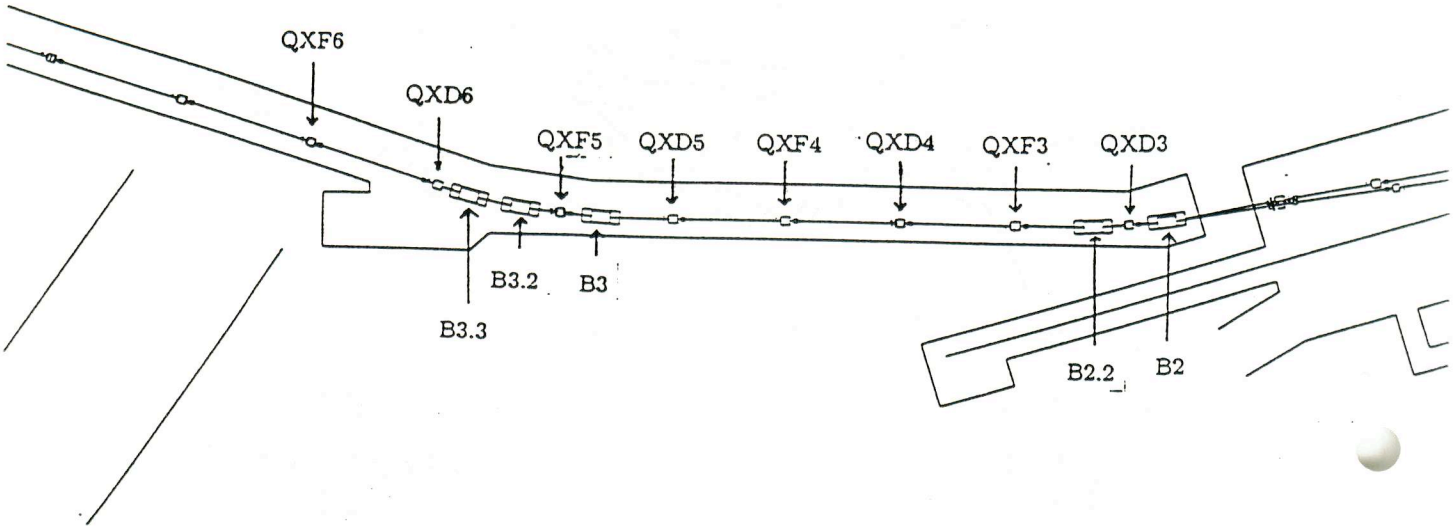
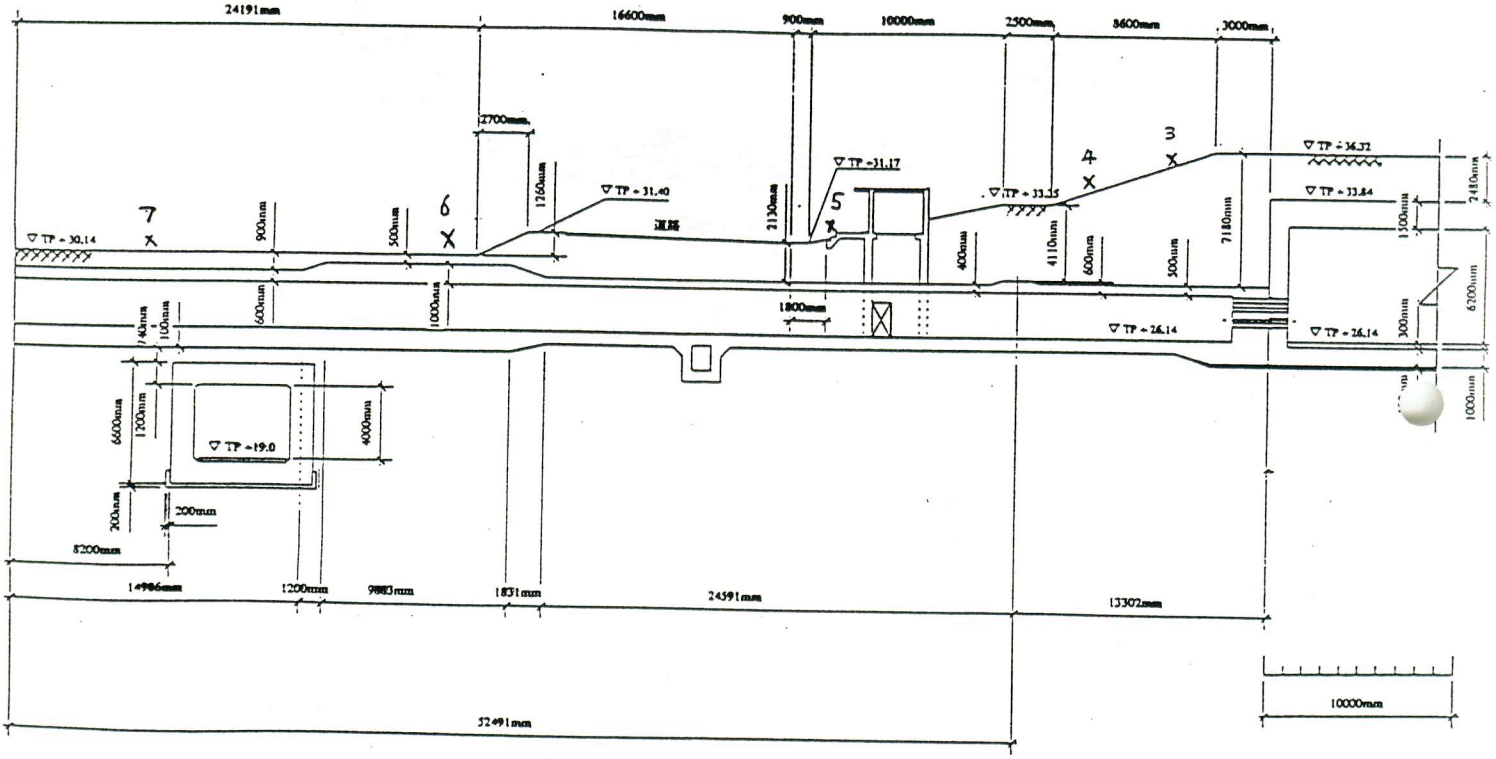


図 3: KEKB ファクトリー実験施設トンネル室標準部断面


AR
AR South
Exp. Hall
Fuji
Exp. Hall
KEKB Main Rings
Linac
Collimator
1
2
3
4
5
6
7
8
0
50
0
50
100





S=1/200mm (A3)

図 3

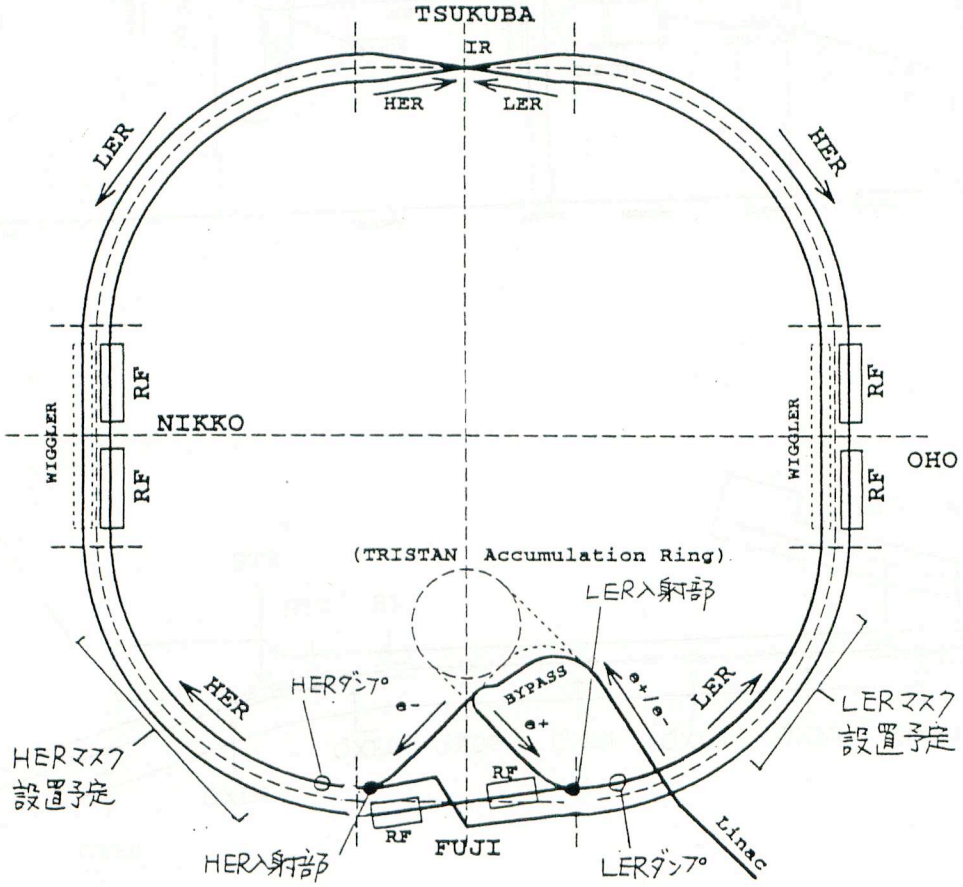

TSUKUBA
IR
HER
LER
LER
HER
RF
RF
WIGGLER
NIKKO
RF
RF
WIGGLER
OHO
(TRISTAN Accumulation Ring)
LERマスク
設置予定
HER
HERダンプ
e-
BYPASS
e+
e+/e-
LER
HERマスク
設置予定
RF
RF
FUJI
HER入射部
LERダンプ
Linac

図 1: リング配置

values to be estimated

- Particle Loss Rate
- Location of Particle Loss
- Collision angles against the vacuum chamber when partices are lost

Related machine operation mode

- Stationary Physics Run
- Beam Tuning Mode
- Others

Classification of Beam Loss

- Stationary Physics Run
  - Injection
    - Beam Loss in the injection line
    - Beam Loss at the injection points
    - Beam Loss in the rings
  - Beam Lifetime
    - Beam-Beam (Radiative Bhabha)
    - Beam-Gas (Bremsstrahlung)
    - Touschek Effect
  - Beam Dump
- Machine Tuning Mode
  - Vacuum Chamber Conditioning
  - Machine Study
- Some other accidental beam losses

⑥Assumption for Estimation

■ Beam Currents :

- ♠ LER(e+)2.6A
- ♠ HER(e-)1.1A

■ Beam Life :

	Beam-Beam	Beam-Gas	Touschek	Total
LER	20.9h	45h	10h	5.9h
HER	8.8h	45h	-	7.4h

■ 5 beam dump / day

Assumtion for Beam Life

- Luminosity
  - $1 \times 10^{34}/cm^2/sec$
- Vacuum Pressure
  - 1×10^{-9} Torr
- Energy Acceptance (except Touschek case)
  - 1%
- Touschek Effect
  - Half of the value obtained from the particle tracking with a machine which has no machine error

Process		Loss location	lost particles/sec
beam life	Beam-Beam	ring	2.16E9
	Beam-Gas		1.00E9
	Touschek		4.51E9
beam dump		beam dump	9.30E9
injection		ring	3.20E9
		injection point	1.10E9
		beam transport*)	0.55E9

*) including loss at collimeters

Averaged partcle loss rate(positron)

Process		Loss location	lost particles/sec
Beam life	Beam-Beam	ring	2.16E9
	Beam-Gas		0.42E9
	Touschek		-
beam dump		beam dump	4.00E9
injection		ring	1.20E9
		injection point	0.41E9
		beam transport*)	0.42E9

*) including loss at collimeters

Averaged partcle loss rate(electron)

	mask	Arc (IP->mask)	Arc beginning	straight	Uniformly lost in Arcs	Uniformly lost around rings
LER	7.44E9	0.13E9	0.59E9	0.85E9	0.75E9	1.12E9
HER	1.62E9	0.28E9	1.25E9	0.07E9	0.32E9	0.25E9

Averaged Particle Loss Rate in the rings (particles/sec)

Energy Loss		Loss position	Loss [%]
from[%]	to[%]		
-1.0	-3.0	mask	27.614
-3.0	-3.8	Arc	5.942
-3.8	-11.2	Arc beginning	27.169
-11.2	-40.3	straight	32.1854
-40.3	-100	within 5m from IP	7.0896

Loss location			Percentage of the lost partilce in the whole beam *)
	from	to	
1	collimeter	0.5 downstream of the collimeters	1.89e-5%
2	0.5 downstream of the collimeters	B2 (Bemd)	0.019%
3	B2 (Bemd)	B2.2 (Bend)	0.028%
4	B2.2 (Bend)	QXF3 (Quadrupole)	0.0024%
5	QXF3 (Quadrupole)	QXF4 (Quadrupole)	0.0025%
6	QXF4 (Quadrupole)	QXF6 (Quadrupole)	0.00019%
7	QXF6 (Quadrupole)	QWFH.3 (Quadrupole)	8.5e-5%
8	QAD3 (Quadrupole)	QAF8 (Quadrupole)	0.00137%

) Percentage(energy of lost particles)/3.5GeV

Paticle loss in the beam transport line(positron)

Loss location			Percentage of the lost partilce in the whole beam *)
	from	to	
1	collimeter	0.5 downstream of the collimeters	0.308%
2	0.5 downstream of the collimeters	B2 (Bend)	
3	B2 (Bend)	B2.2 (Bend)	
4	B2.2 (Bend)	QXF3 (Quadrupole)	-
5	QXF3 (Quadrupole)	QXF4 (Quadrupole)	0.015%
6	QXF4 (Quadrupole)	QXF6 (Quadrupole)	0.00026%
7	QXF6 (Quadrupole)	QWFH.3 (Quadrupole)	-
8	QAD3 (Quadrupole)	QAF8 (Quadrupole)	0.014%

) Percentage(energy of lost particles)/8.0GeV

Paticle loss in the beam transport line(electron)