GLD Interaction Region

T. Tauchi, LCWS2006, Bangalore
10 March 2006

Tolerances in Detectors

Table 1: Tolerances for background in VTX, TPC and CAL.

Sources :	pairs	disrupted beams/pairs	beam halo
Detector	Hits	Neutrons	Muons
VTX	1×10^4 hits/cm^2/train	1×10^{10} n/cm^2/year	-
TPC	4.92×10^5 hits/50μsec	4×10^4 n*/50μsec	$1.2 \times 10^3 \mu$/50μsec
CAL	1×10^{-4} hits/cm^3/100nsec	-	0.03 μ/m^2/100nsec

→ 1μ/30m^2/bunch

* : The neutron conversion efficiency is assumed to be 100% in the TPC.

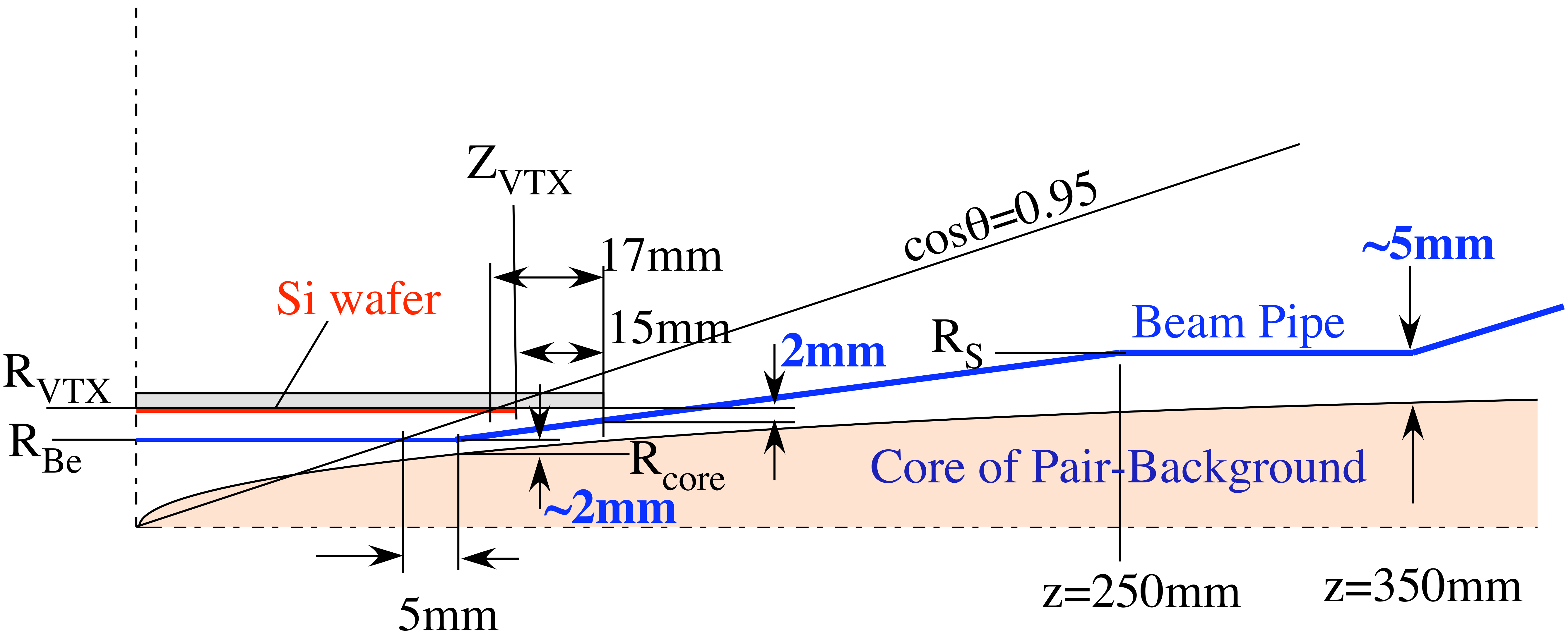
1 hit in TPC consists of 5 pads(1mmx6mm) x 5 buckets(50nsec)
A muon creates 1 pad x 2000 buckets in parallel to the beam line.
A neutron creates 10 hits in TPC.

Note : 0.005μ/bunch by two "tunnel fillers"

→ 0.8μ/150bunches

The 9 and 15m long spoilers at 660 and 350m from IP reduces muons by 10^{-4}

Interaction Region (IR) Design
Beam Pipes etc.



Interaction Region (IR) Design

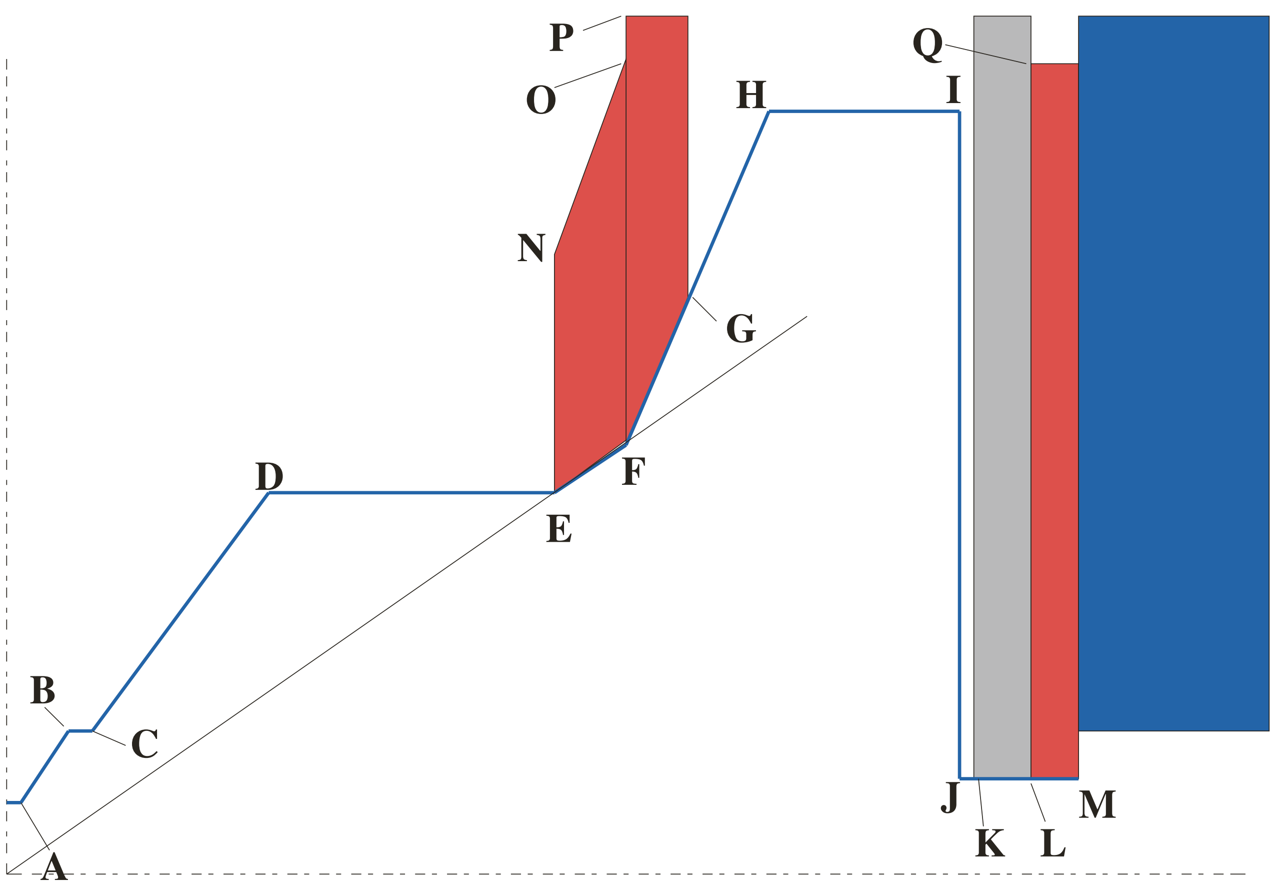
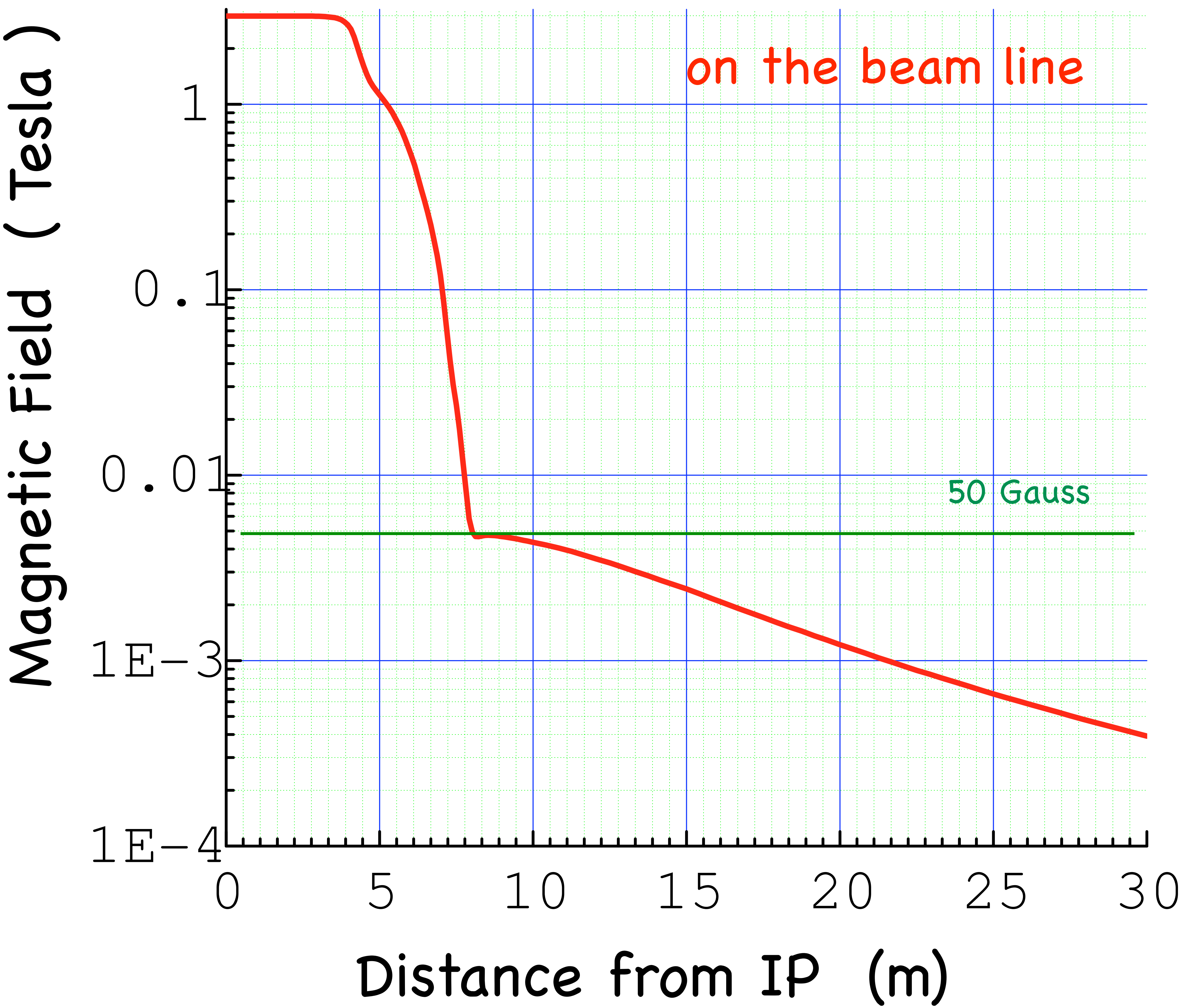


Table 2: IR geometrical data with 2 (20)mrad crossing angle; numbers in parentheses are those at 20 mrad crossing angle, while the others are common at the both angles.

Standard

E_{cm}	500GeV				1TeV	
para.set	Nominal		High Luminosity		High Luminosity-1	
position	R in cm	Z in cm	R in cm	Z in cm	R in cm	Z in cm
A	1.3	4.5	1.9	6.3	1.5	5
B	3(3.2)	25	4.2	25	3.4(3.5)	25
C	3(3.2)	35	4.2	35	3.4(3.5)	35
D	8	110	9(10)	110	8(9)	110
E	8	230	9(10)	230	8(9)	230
F	9.04	260	10.2(11.3)	260	9.04	260
G	11.94	285	12.60(13.26)	285	11.94(12.60)	285
H	16	320	16	320	16	320
I	16	400	16	400	16	400
J	2(2*)	400	2(2*)	400	2(2*)	400
K	2(2*)	405	2(2*)	405	2(2*)	405
L	2(2*)	430	2(2*)	430	2(2*)	430
M	2(2*)	450	2(2*)	450	2(2*)	450
N	13	230	14(15)	230	13(14)	230
O	17.70	260	18.83(19.96)	260	17.70(18.83)	260
P	36	260	36	260	36	260
Q	17.96	430	19.83(21.70)	430	17.96(19.83)	430

* : There are two holes with the same radius for incoming and exit beams at the 20mrad crossing angle.



on the beam line
50 Gauss
Magnetic Field (Tesla)
1
0.1
0.01
1E-3
1E-4
0
5
10
15
20
25
30
Distance from IP (m)

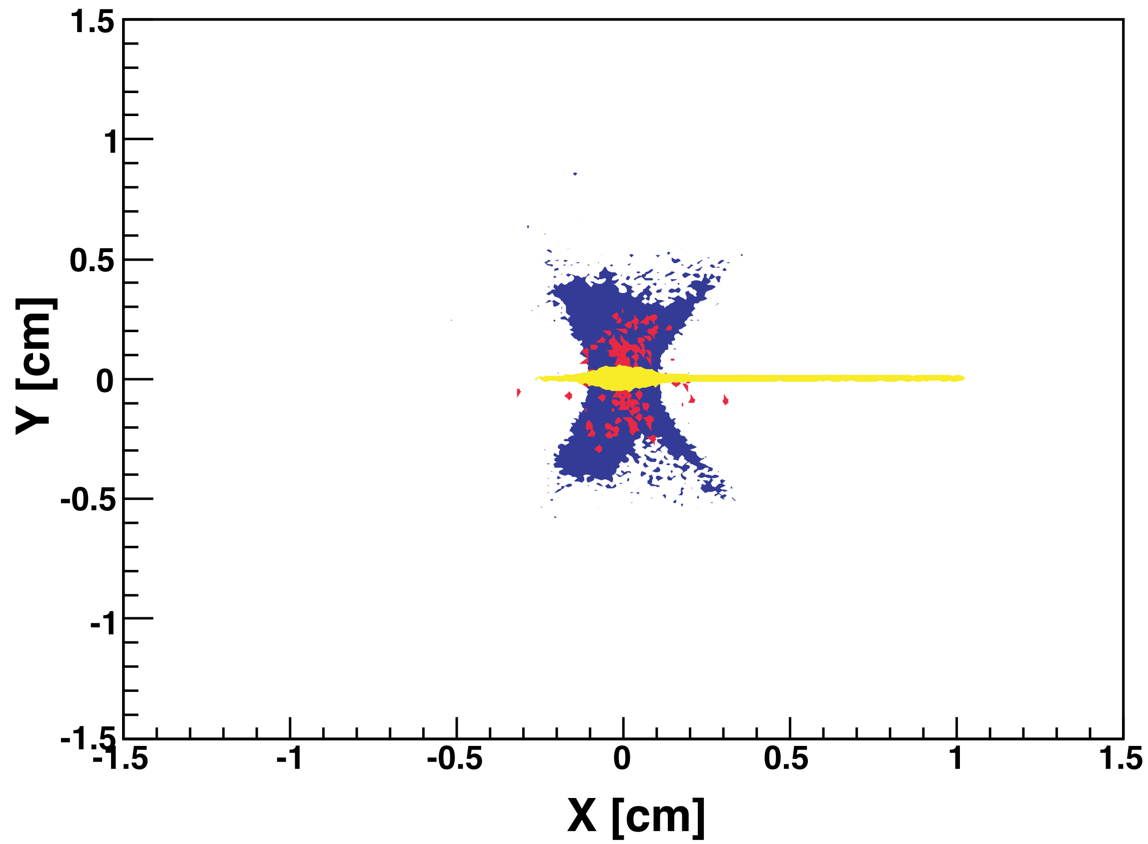
Collimation: Spoilers and Masks

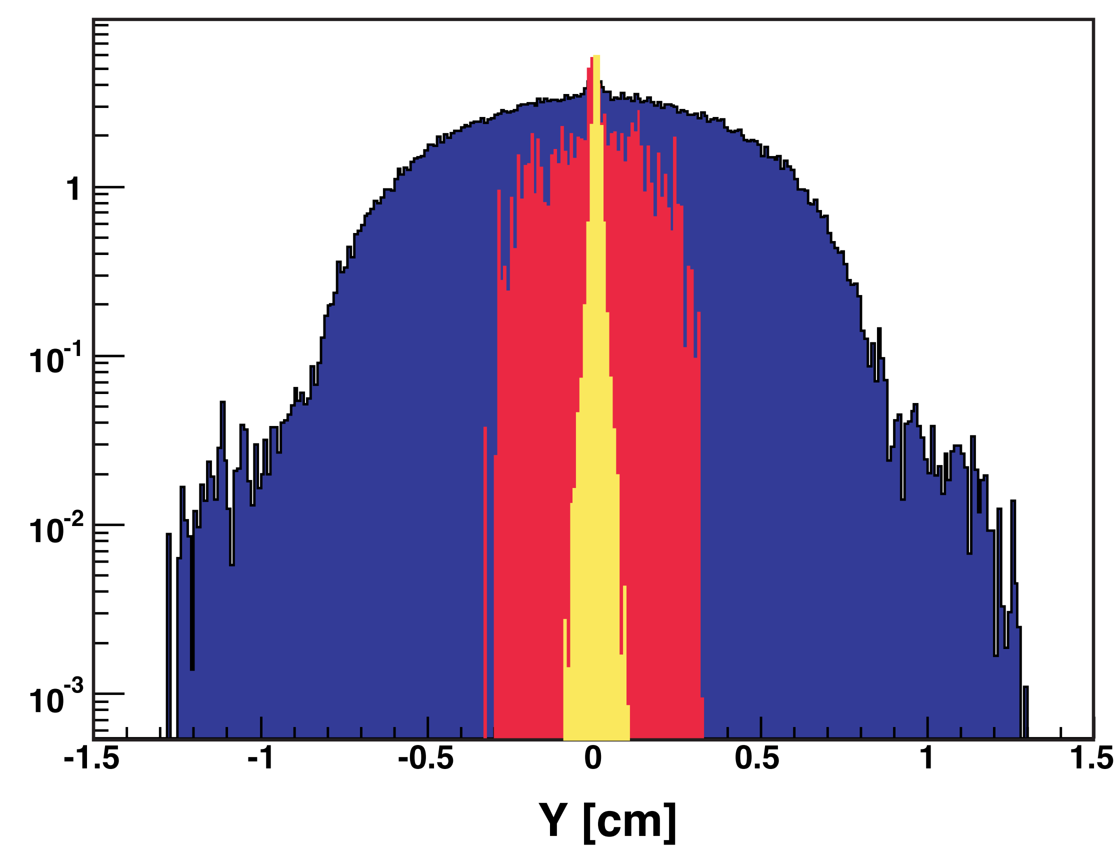
Table 3: Major collimators' location from IP, aperture, length and material (ILCFF9).

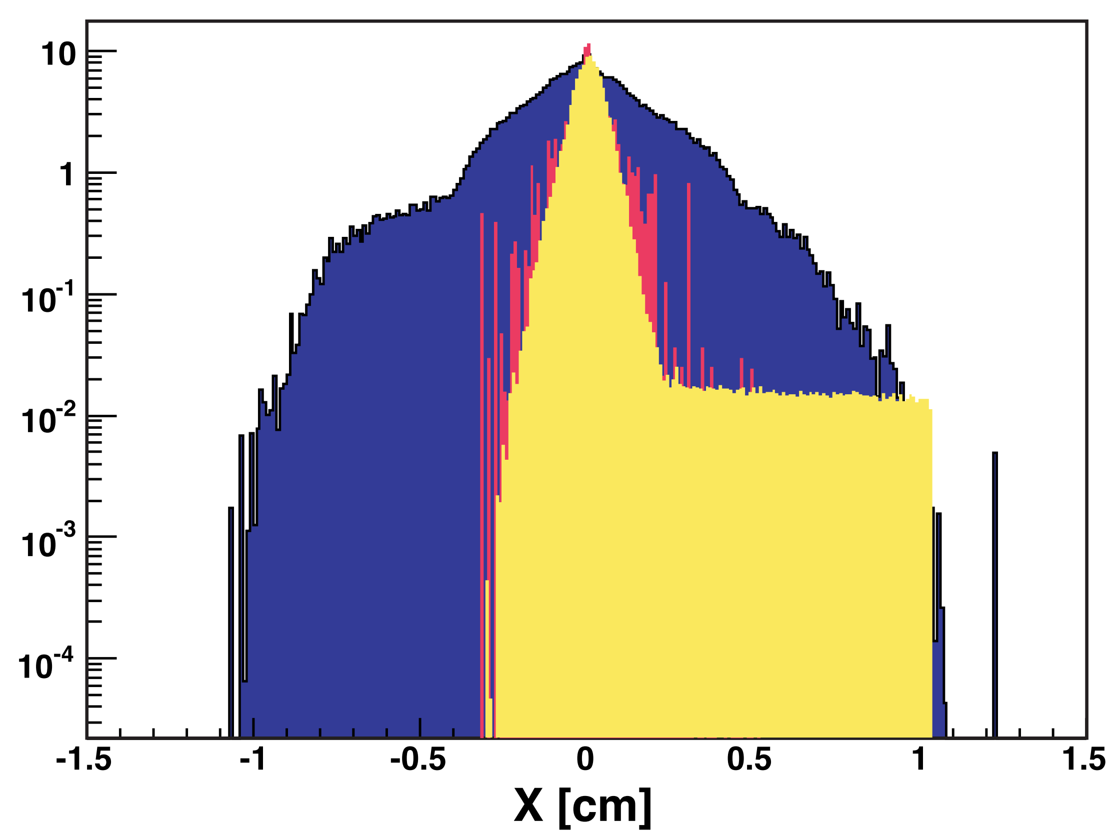
name	Location	Thickness	Material	Aperture			
	m	X_o		x(mm)	y(mm)	$x(\sigma_x)$	$y(\sigma_y)$
SP2	1483.27	0.6	Copper	0.9	0.5	8	65
SP4	1286.02	0.6	Copper	0.9	0.5	8	65
SPEX	990.42	1	Titanium	0.5	0.8	10	62
MSK1	49.81	30	Tungsten	7.8	4.0	16	178
MSK2	13.02	30	Tungsten	7.4	4.5	12	151

Apertures have been optimized by A. Drozhdin for higher B field. (BDIR05)

Synchrotron Radiations at IP, by LCBDS







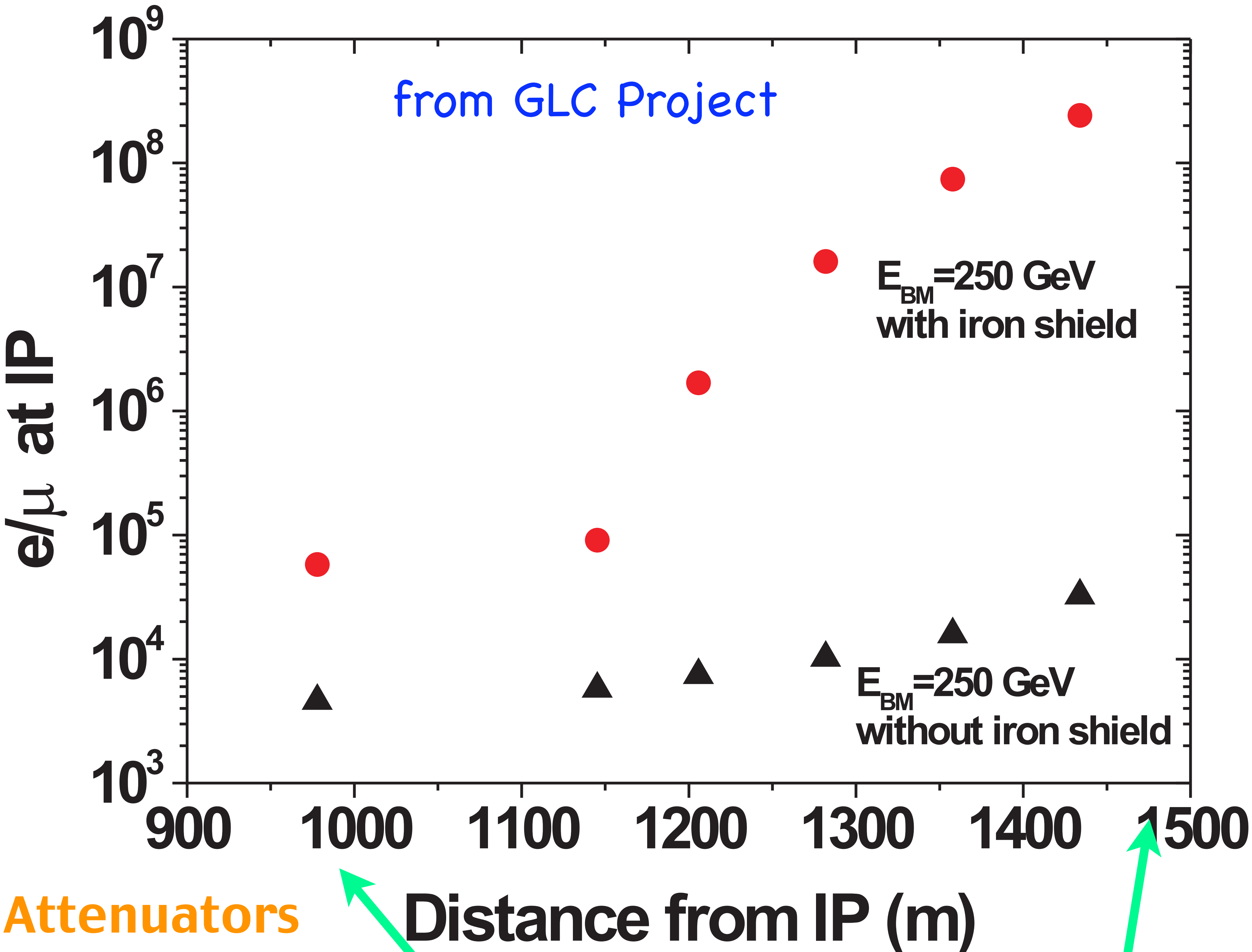
GLD standard :

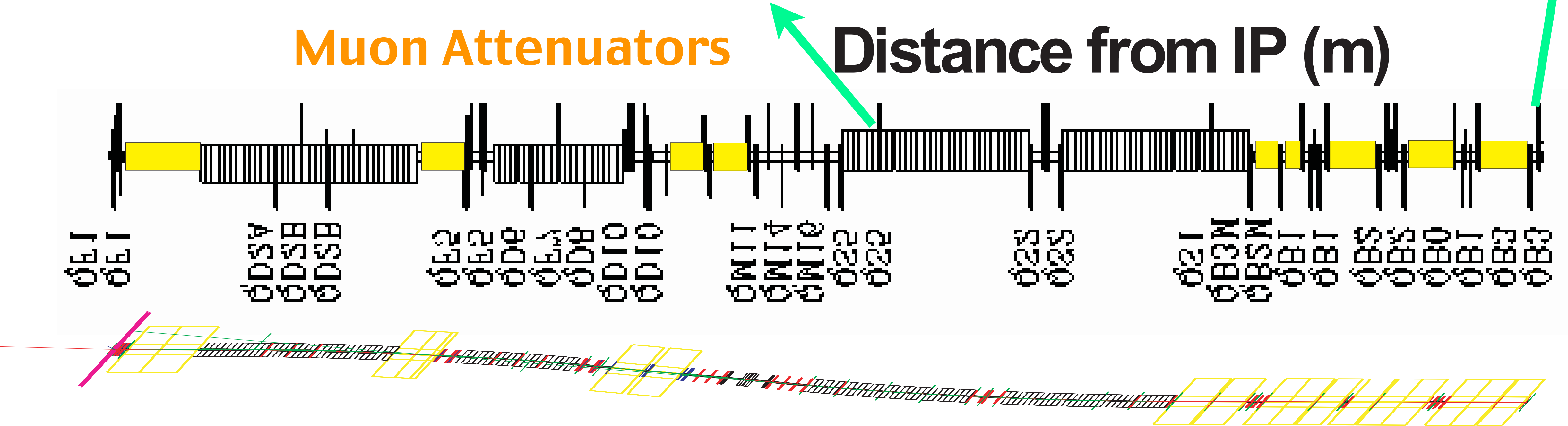
beam pipe radius of 1.5cm

↓

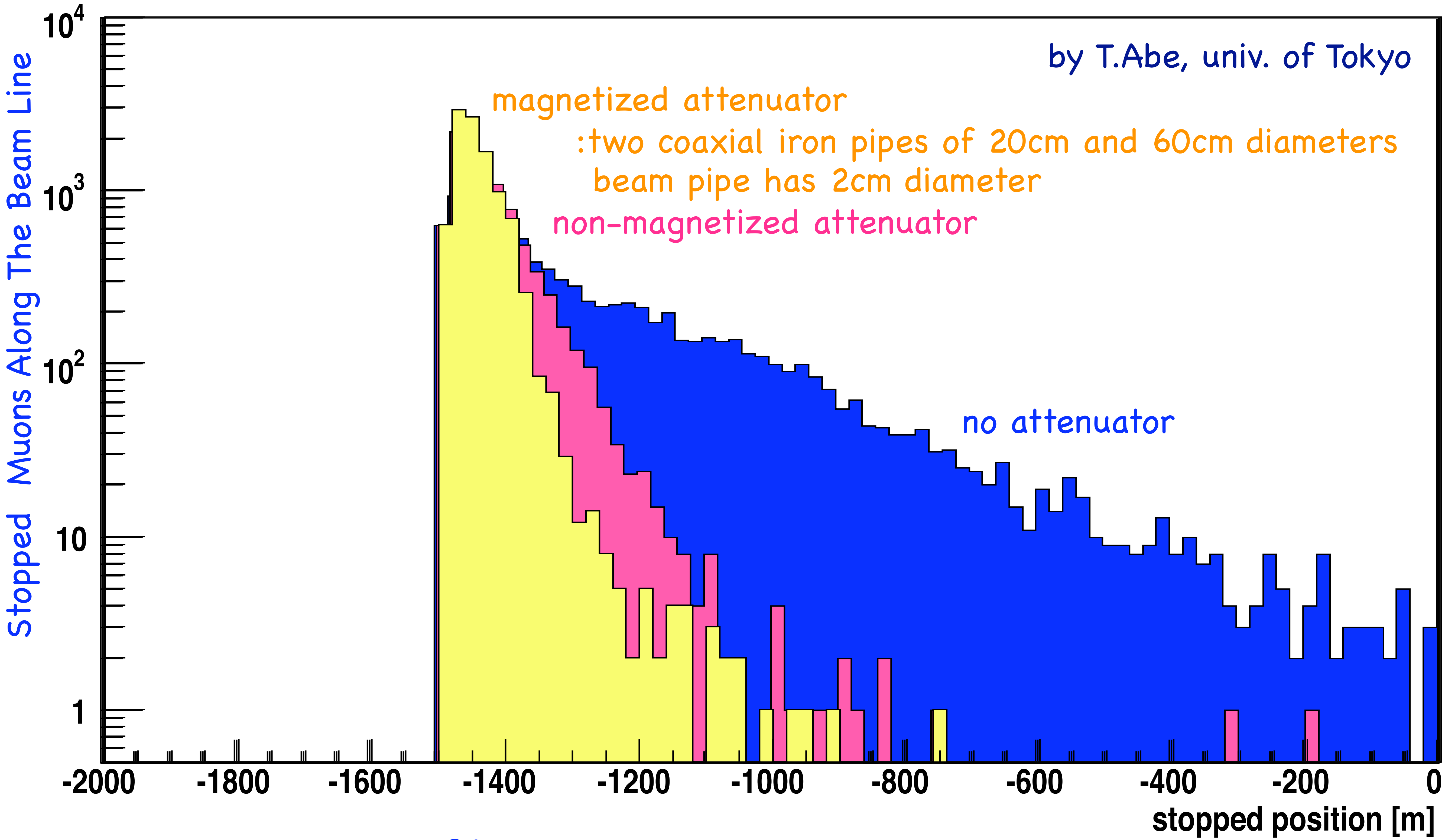
Collimation aperture can be larger.

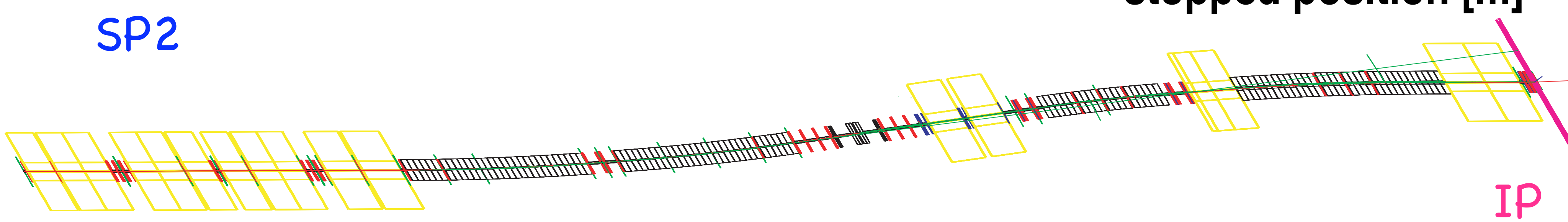
Muons


from GLC Project
e/μ at IP
Distance from IP (m)
E_BM=250 GeV
with iron shield
E_BM=250 GeV
without iron shield
10^3
10^4
10^5
10^6
10^7
10^8
10^9
900
1000
1100
1200
1300
1400
1500


Muon Attenuators

LCBDS simulation :10,000 muons are created at SP2.





$\mu/e(250GeV)$
$=1.2 \times 10^{-4}$

Crossing Angle and DID, anti-DID

crossing angle	DID	anti-DID
2mrad	no	no
20mrad	yes	no
14mrad	yes	yes

DID : polarization, synchrotron radiations

anti- DID : back-scattered photons

Table 4: Various types of QD0 and the first quadrupole magnets at the extraction line, which are relevant in IR region: properties used in the simulation, where L* is the distance from IP and QX1A and QDEX1A at the extraction line.

type	Crossing angle mrad	L* m	Length m	Aperture cm	Outer diameter cm
Large SC	2	4.5	2.5	7	42
Permanent	2	4.5	2.5	2	18
Compact SC	20	4.5	2.2	2	6.1
Permanent	20	4.5	2.2	2	10
QX1A	20	4.5	2.2	2.6	4.78
Compact SC	14	4.5	2.2	2	7.2
QDEX1A	14	6	1.64	3.6	9.2

Table 5: Energy deposits in unit of mW, at QD0, 2mrad crossing angle, where values in parentheses are those for two beams to collide with horizontal offset of $200\sigma_x$.

Energy Deposit (mW) of Pairs in QD0

E_{cm}	Nominal	Low Q	Large Y	Low P	High Lum	High Lum-1
500GeV	93(112)	80(76)	107(103)	158(146)	435(398)	-
1 TeV	464(513)	464(437)	769(687)	928(828)	2180(2260)	1170(1090)

Permanent Q-magnets, Kyoto univ.

Radiation hard : -0.3% with $1x10^{13} n/cm^2$

No artificial vibration : no cooling, electric-current

Compact : no warm-to-cold transition

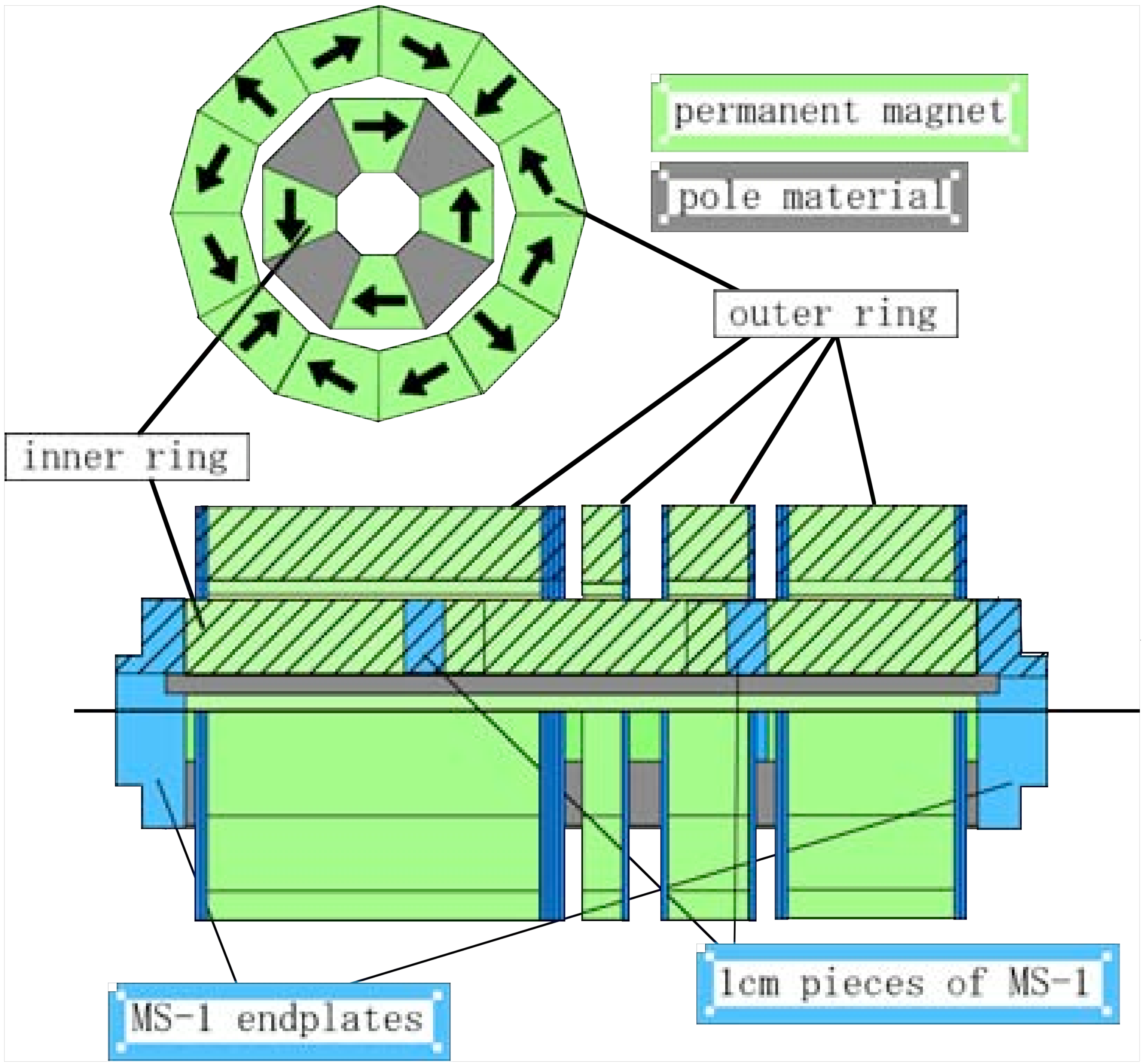


Figure 1: Fabricated Adjustable PMQ.

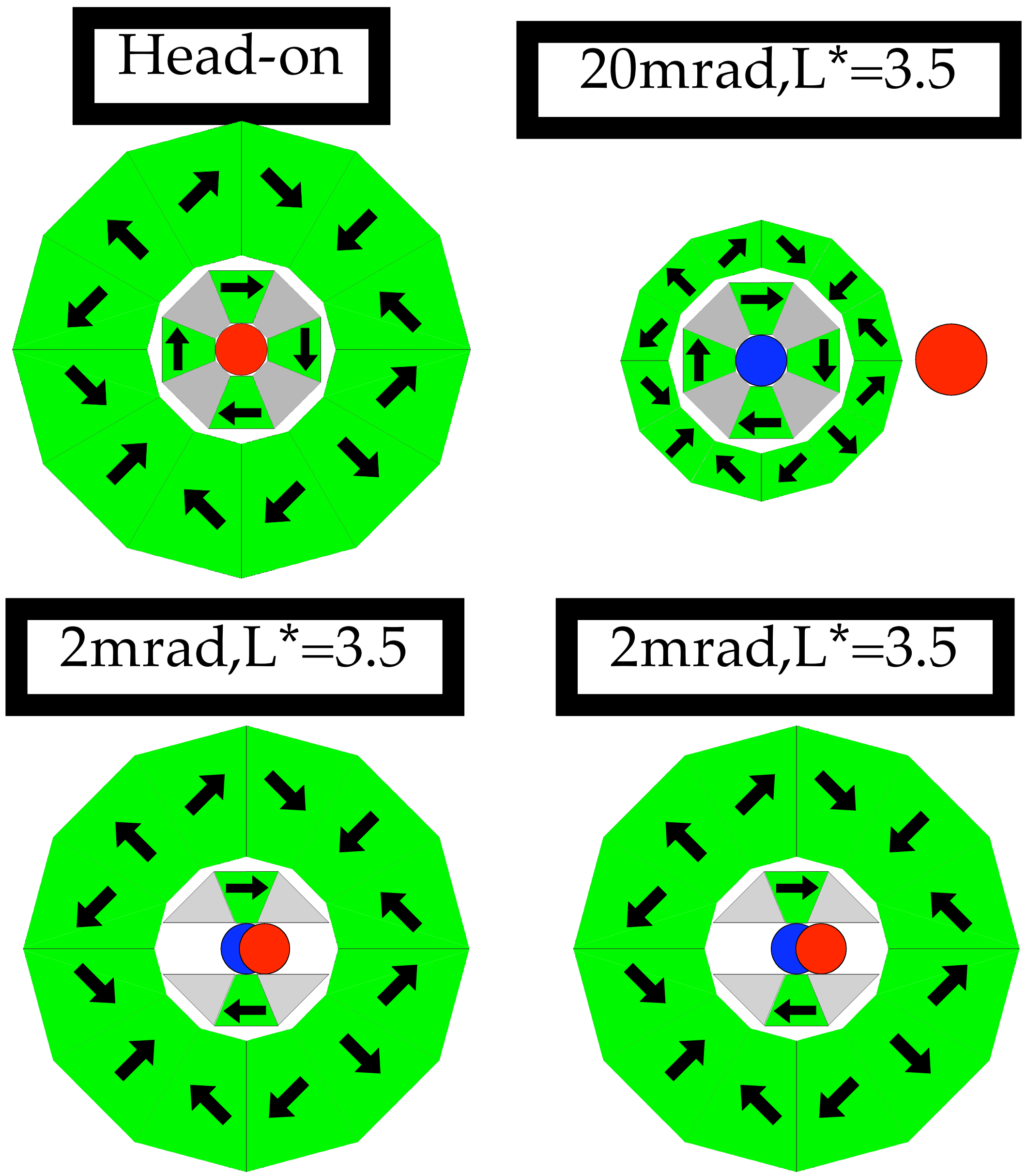
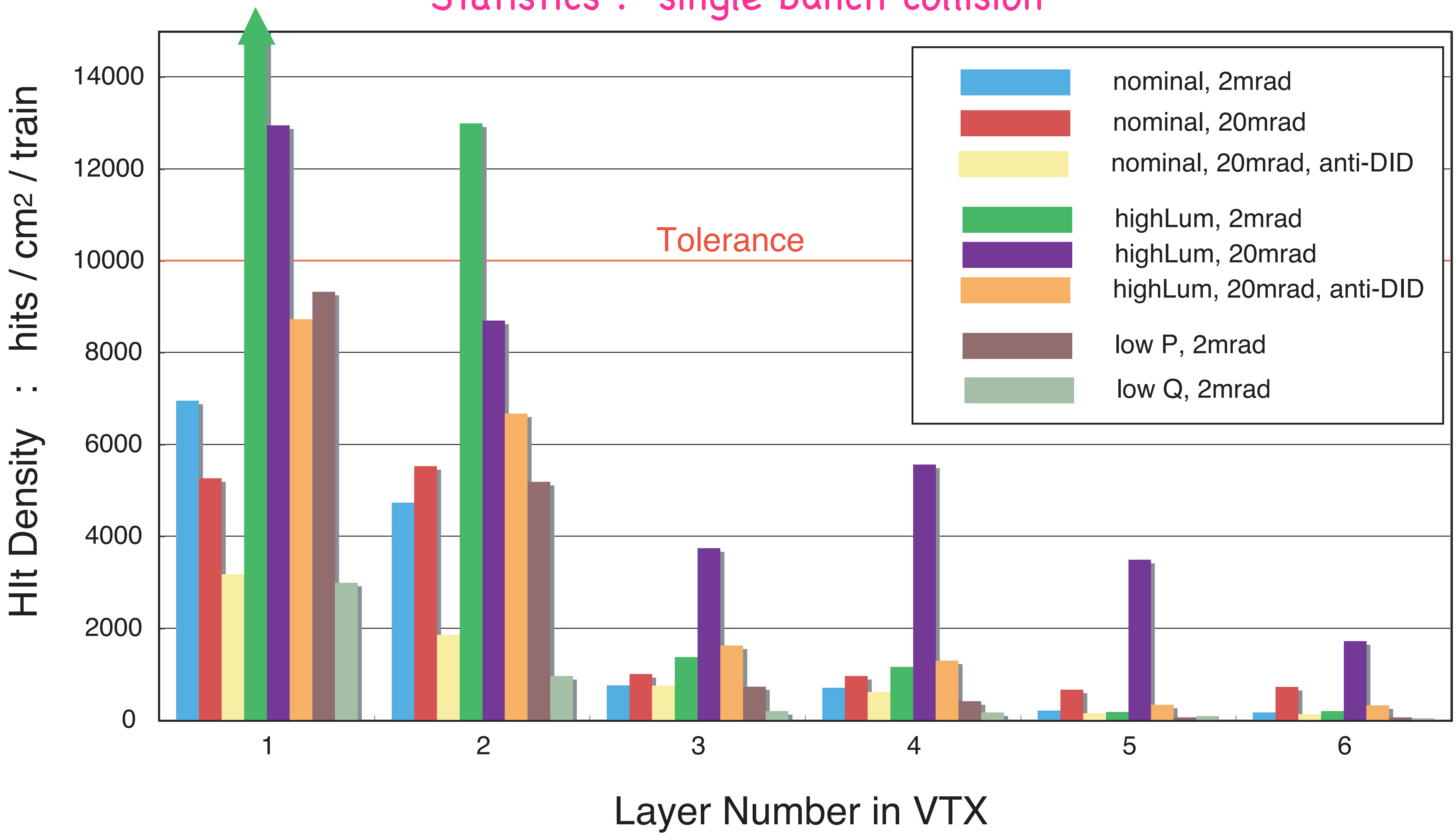


Figure 7. Varieties of PMQ for crossing angles

VTX : Preliminary results

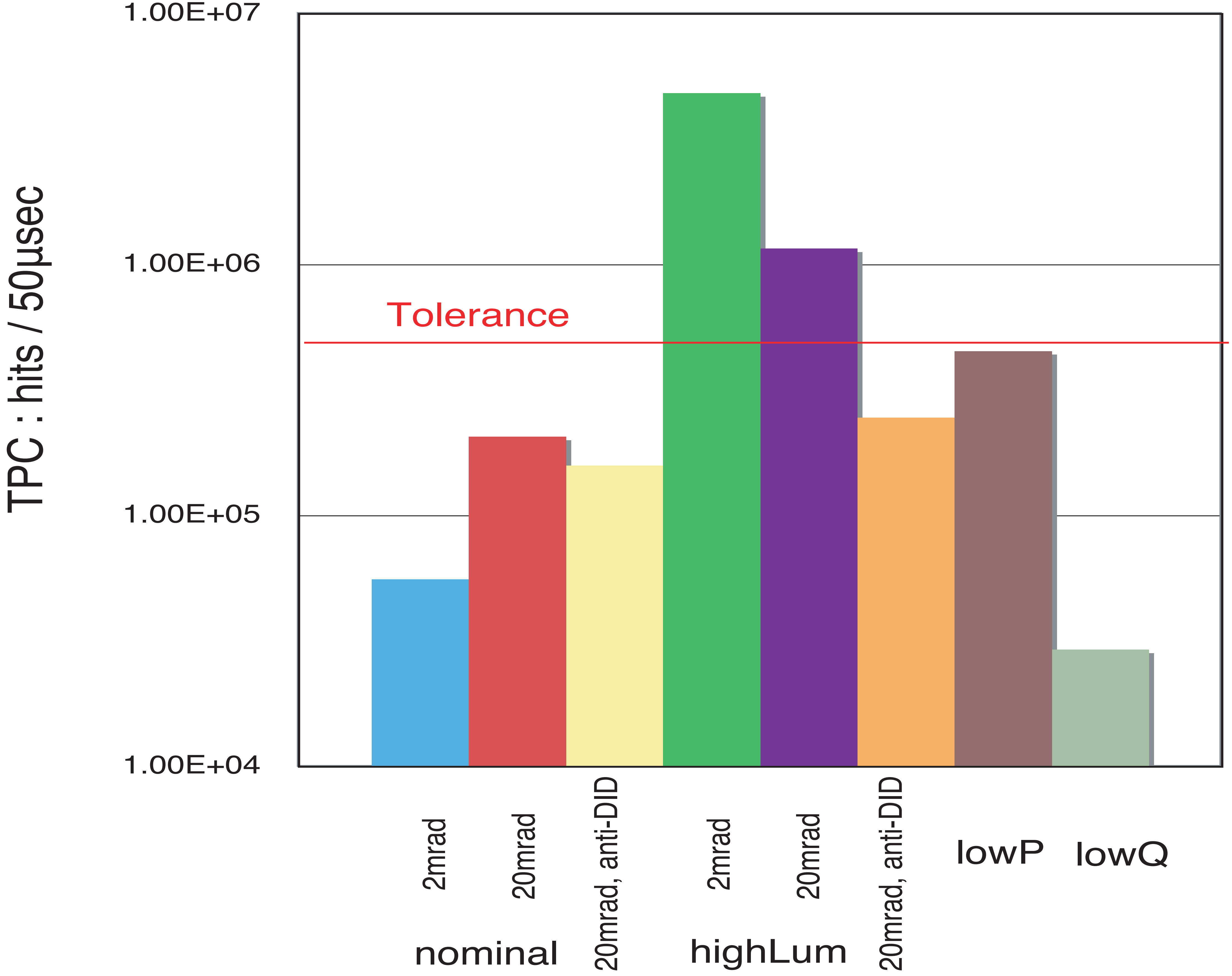
Statistics : single bunch collision



Radius : 1.7(2.4)cm 1.9(2.6)cm 3.2cm 3.4cm 4.8cm 5.0cm

TPC : Preliminary results

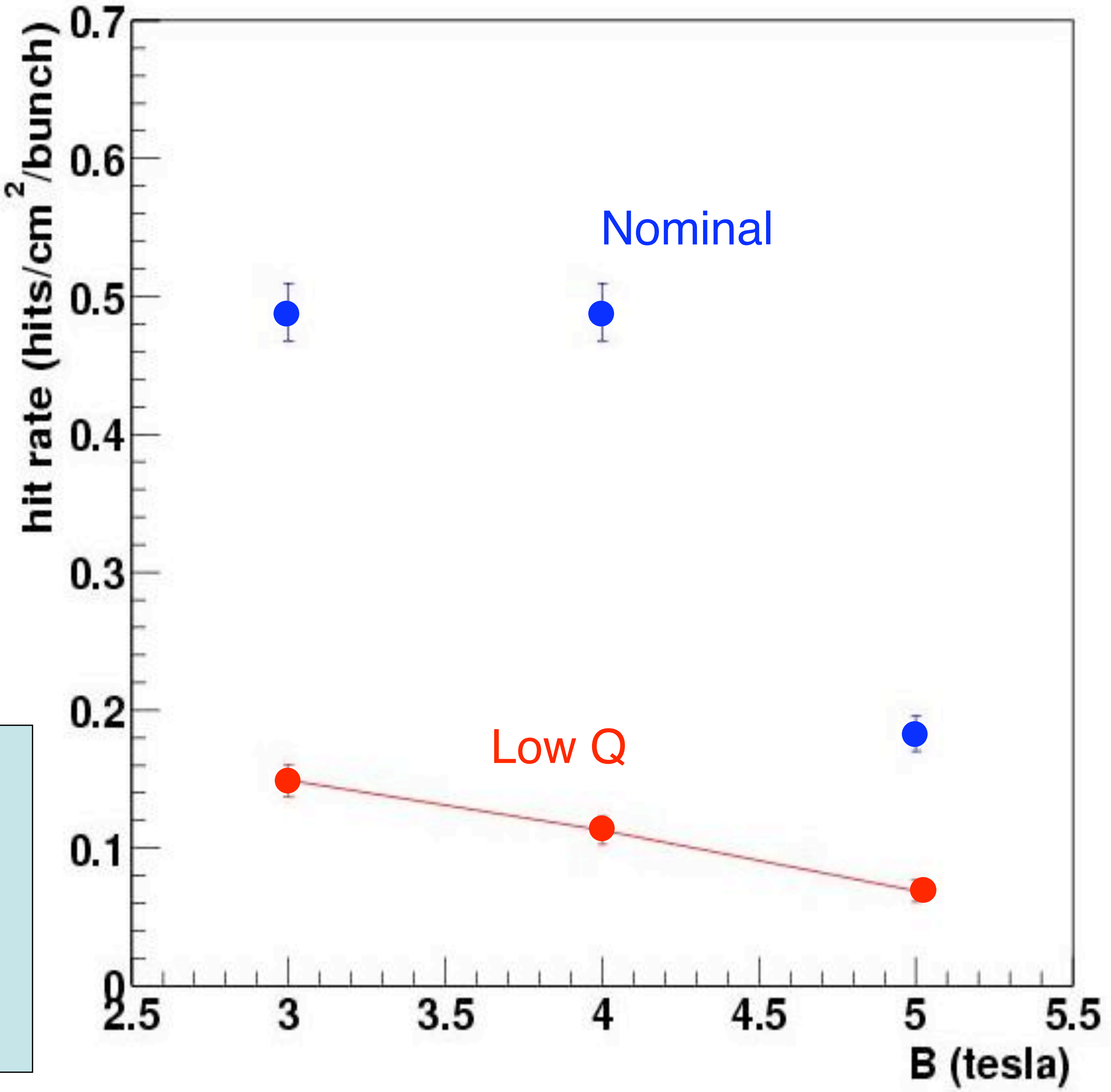
Statistics : single bunch collision



Simulation Study

- Pair background hit rate on the 1st layer of the Vertex Detector (R=24mm)
- Simulation using CAIN and JUPITER
- Hit rate of the Low Q option is ~1/3 of the nominal option, as expected

Pair B.G. hit rate (/cm^2/bunch)		
B(tesla)	Nominal	LowQ
3	0.488	0.149
4	0.48	0.113
5	0.183	0.069



Neutrons

typically, 130 n/TeV : 10^9 n/J

GEANT3, 50 n/TeV in water(dump)
backscattering rate at 1.67×10^{-4}

Tolerance of Energy loss at EXT line

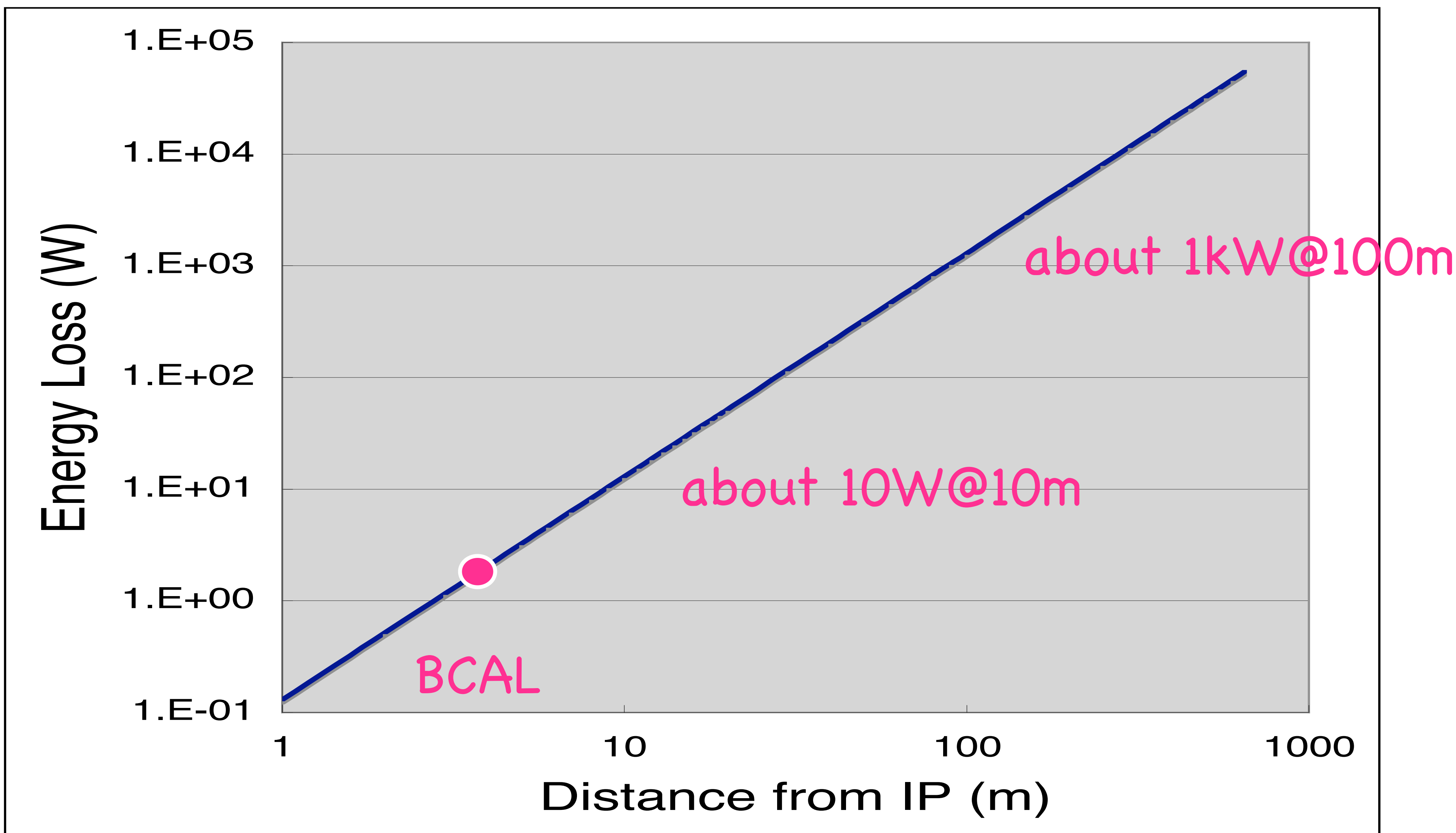
$$E = 0.13\ L^2$$

(as a Guide Line)

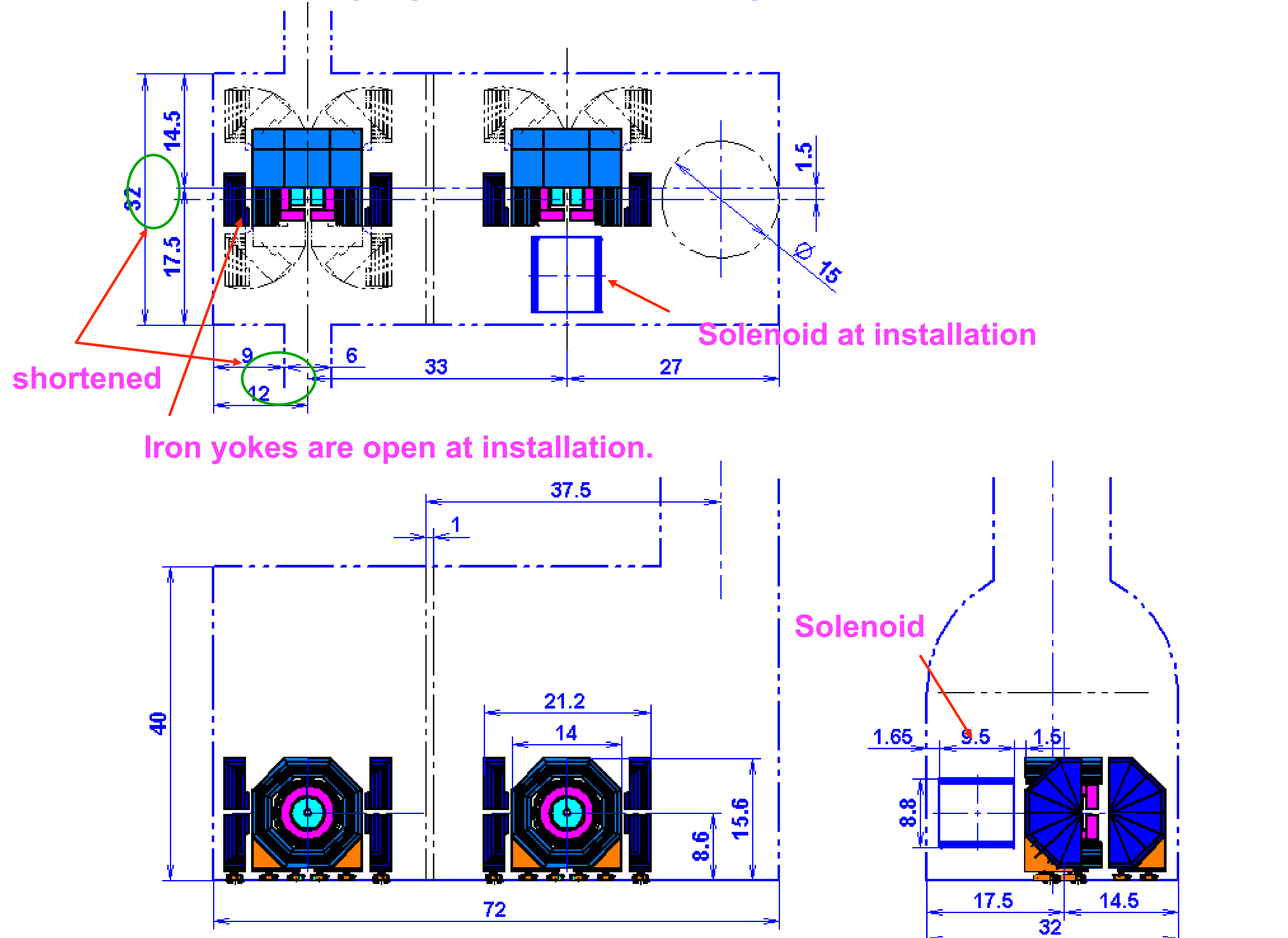
Table 6: Energy deposits due to the pairs in BCAL with the 2mrad crossing angle, where the unit is Watt (W) and values in parenthesis are those at the 20 mrad crossing angle. The tolerance is also listed at BCAL, L=4.3m from IP, which is calculated by E= $0.13L^2$.

- Energy Deposit (W) of Pairs in BCAL

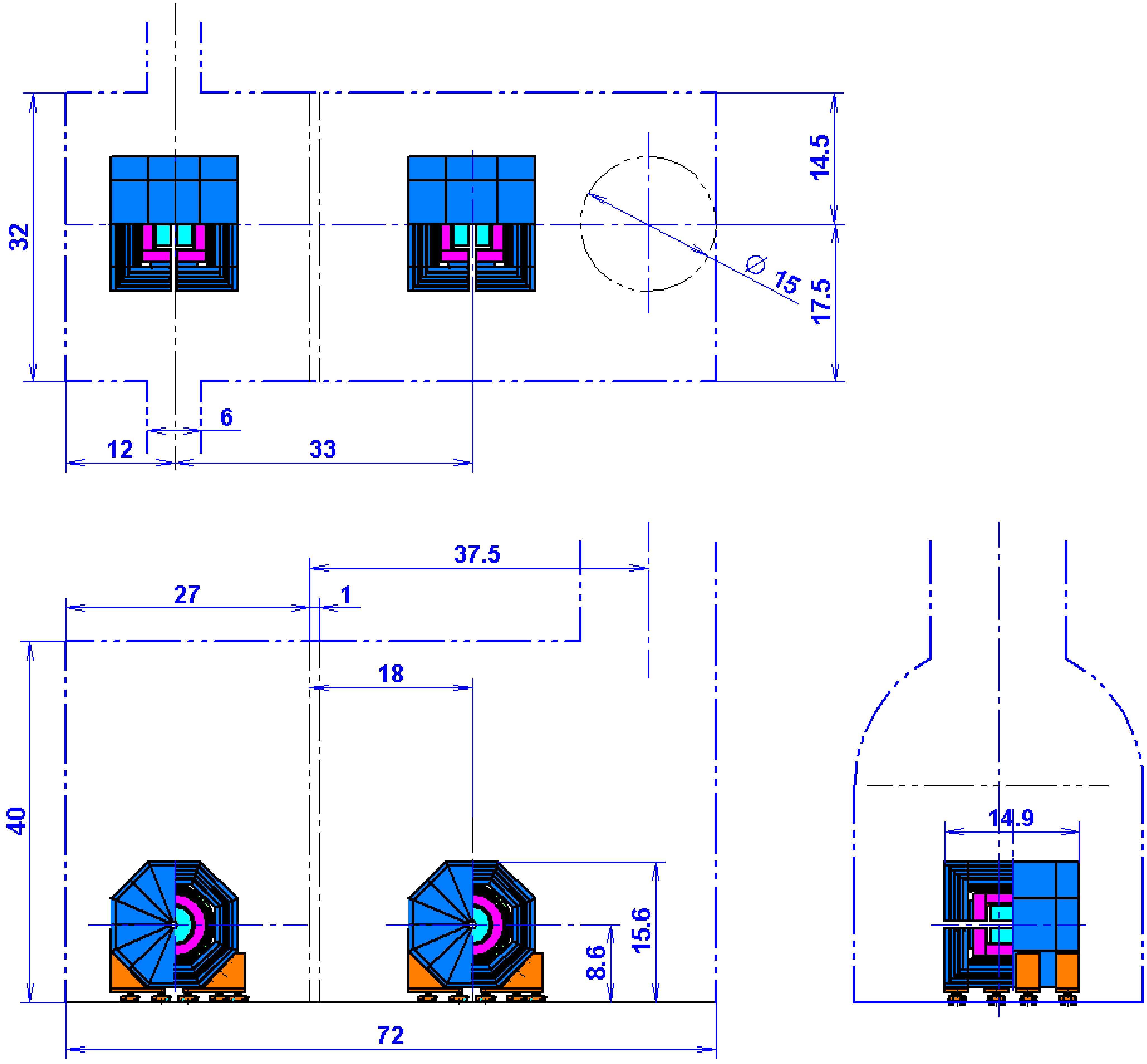
E_{cm}	Nominal	Low Q	High Lum	High Lum-1
500GeV	0.05(0.10)	0.03(0.07)	0.27(0.42)	-
1000GeV	0.12(0.22)	0.07(0.16)	0.68(0.94)	0.32
tolerance	2.4			



New proposal for smaller experimental hall



GLD Detector Position at beam line and at the end of assembling



Opening operation of the end iron yoke