Simulation studies of the Touschek effect

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About Touschek scattering

What is Touschek scattering ?

Movable collimators

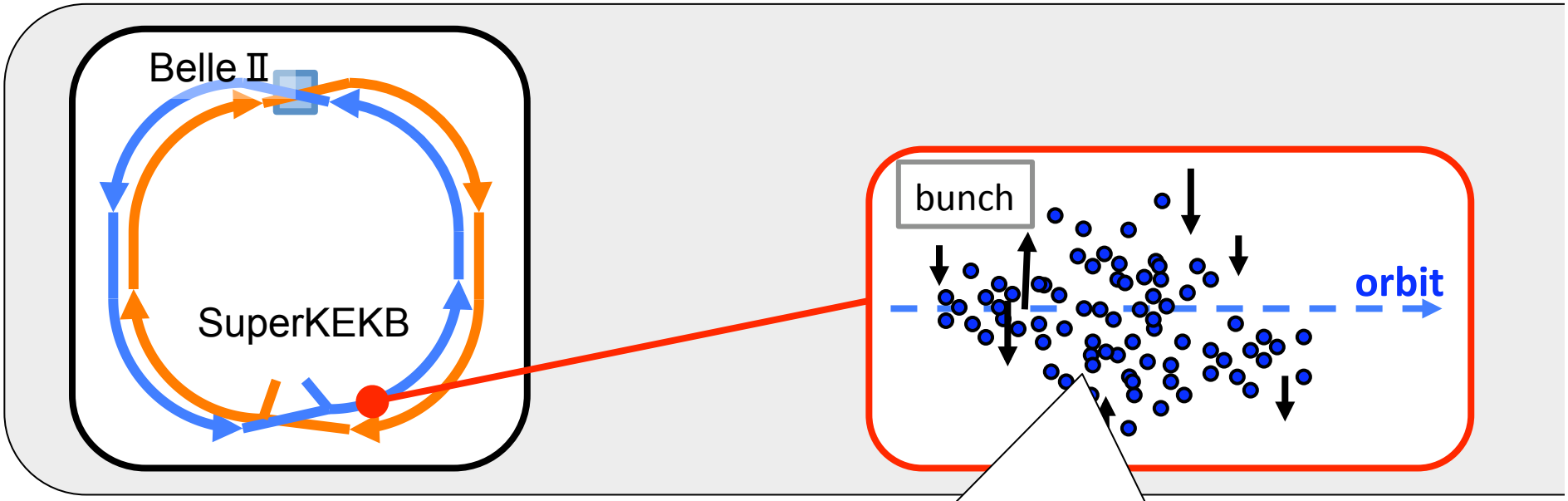
Placed around accelerator ring for background reduction.

Geometry implementation

for full detector simulation

What is Touschek scattering (1) ?

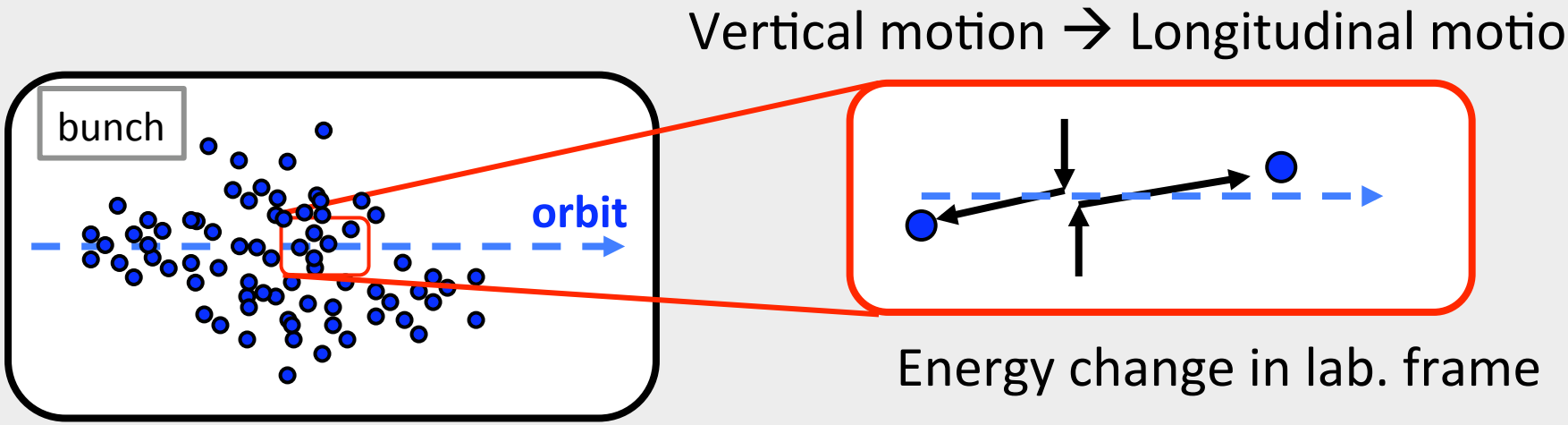
SuperKEKB ring has 2500 bunches
Each bunch consists of 10^{11} e-/e+



oscillation motion perpendicular to the orbit
(“betatron oscillation”)

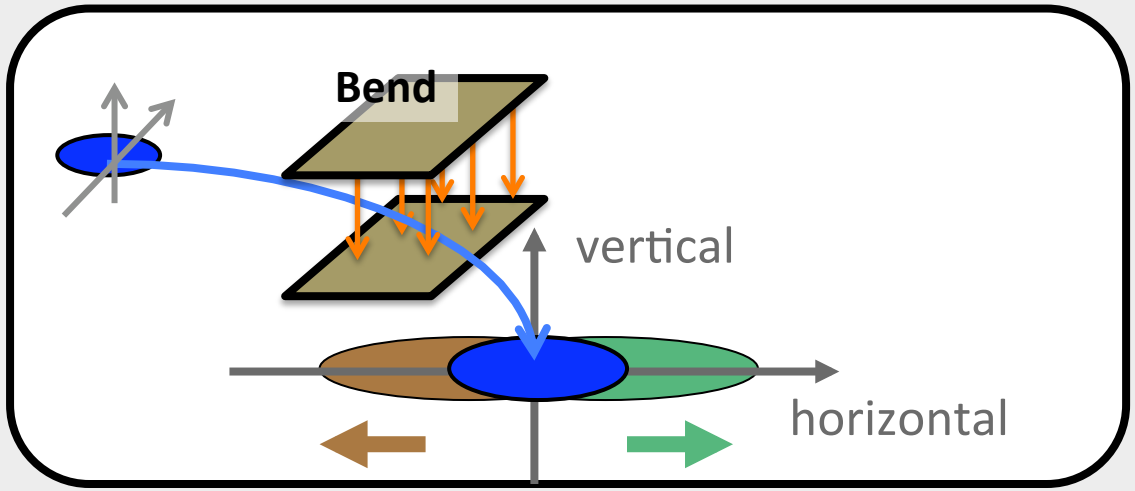
What is Touschek scattering (2) ?

They collide each other within a bunch.



What is Touschek scattering (3) ?

Bending angle is different from correct energy.



This is the Touschek scattering

Orbit deviation ▶ Hit beam pipe ▶ **Background**

Touschek scattering rate

Scattering rate per particle is ...

$$(\mathrm{Rate}) \propto \frac{N}{E^3 \cdot \sigma}$$

N # of particle per bunch

E Beam energy

σ Beam size

	SuperKEKB HER	SuperKEKB LER
Beam energy	7.0 GeV	4.0 GeV
Beam current	2.6 A	3.6 A

LER simulation is urgent !

HER cannot be neglected !
Simulation study is on going.

Touschek loss rate

How much Touschek background will increase from KEKB?

	KEKB LER	SuperKEKB LER
Beam energy	3.5 GeV	4.0 GeV
Beam current	1.7 A	3.6 A
Touschek lifetime	~7000 sec	600 sec
Loss rate (Total ring)	**8 W** **12 GHz e+**	**240 W** **380 GHz e+**

Reason for the increase

Beam size
→ Small

Beam current
→ High

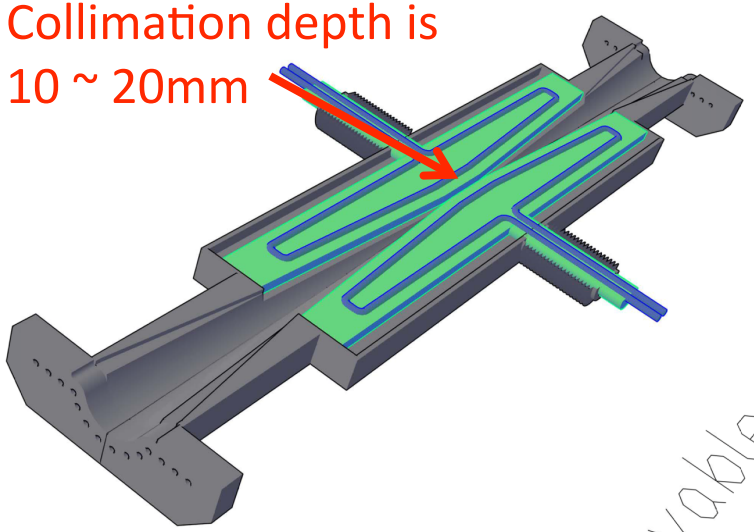
30 times higher loss rate in total ring!

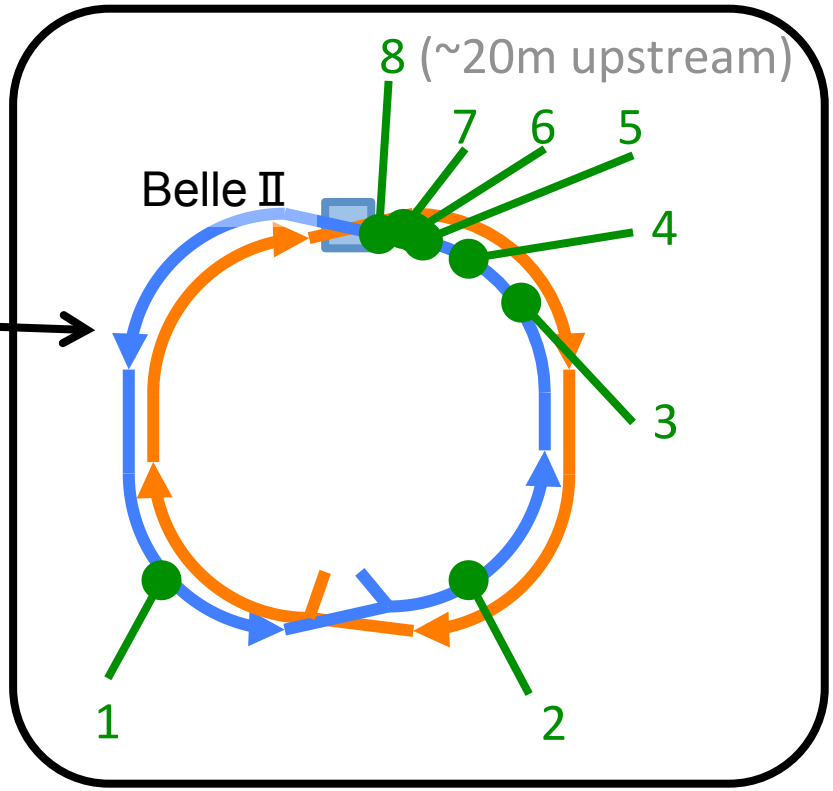
Horizontal collimator

To minimize the loss in the interaction region (near Belle II) … ,

We put 8 horizontal collimators in the ring.
(They stop the scattered off-momentum particles)

Collimation depth is
10 ~ 20mm

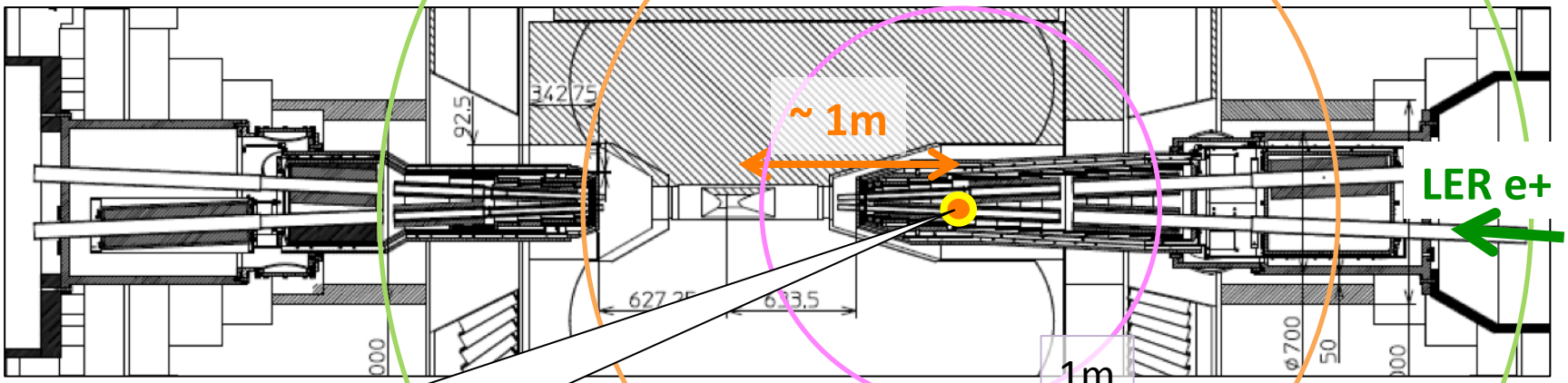




LER Touschek loss in interaction region

Beam loss at IR is 0.9 GHz at ~ 1 m upstream from IP.

Assumption:
collimator has 100% stop ability

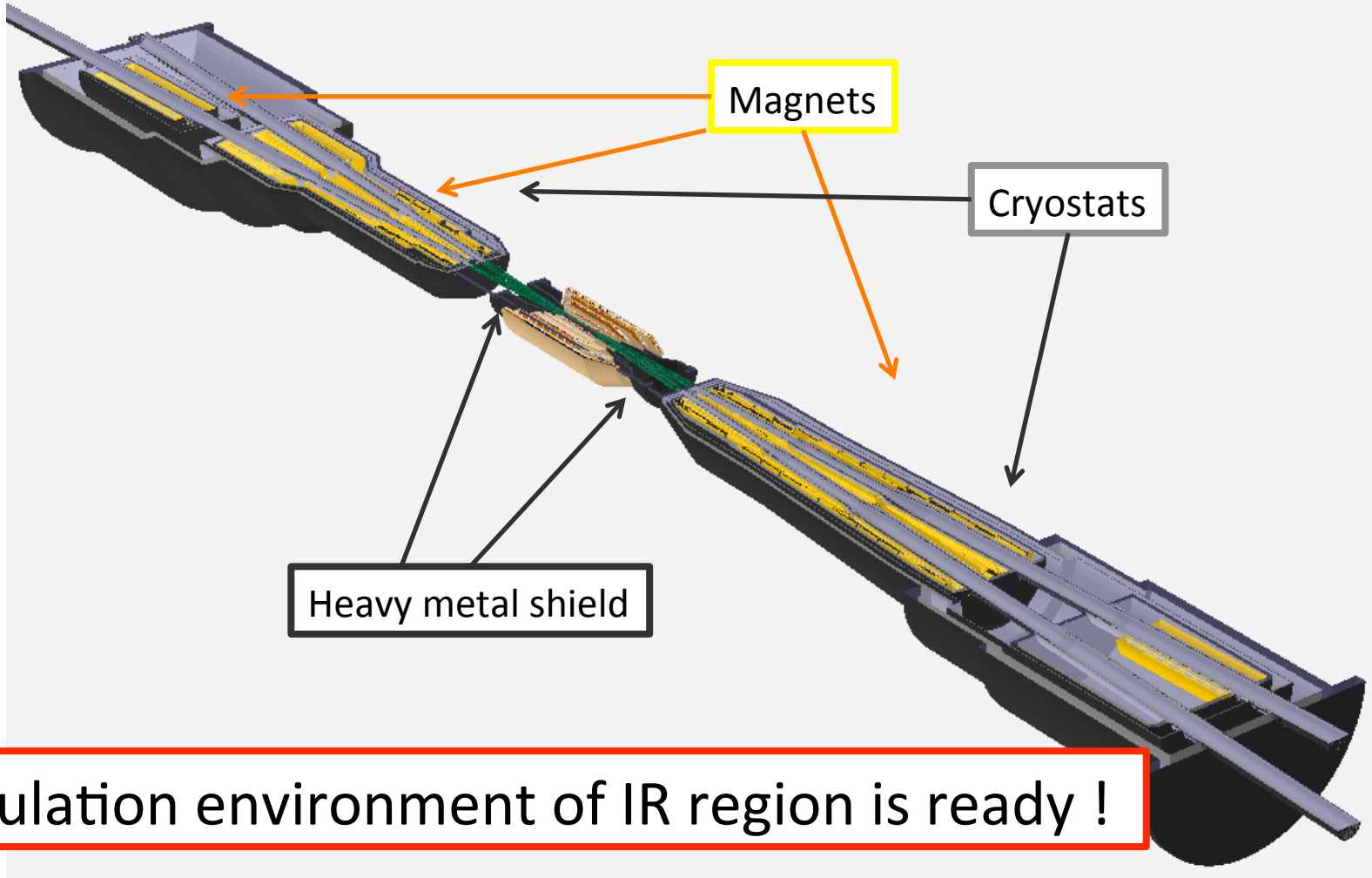


EM shower & **neutrons**
are generated

IR geometry should be implemented for the simulation.

Geometry implementation

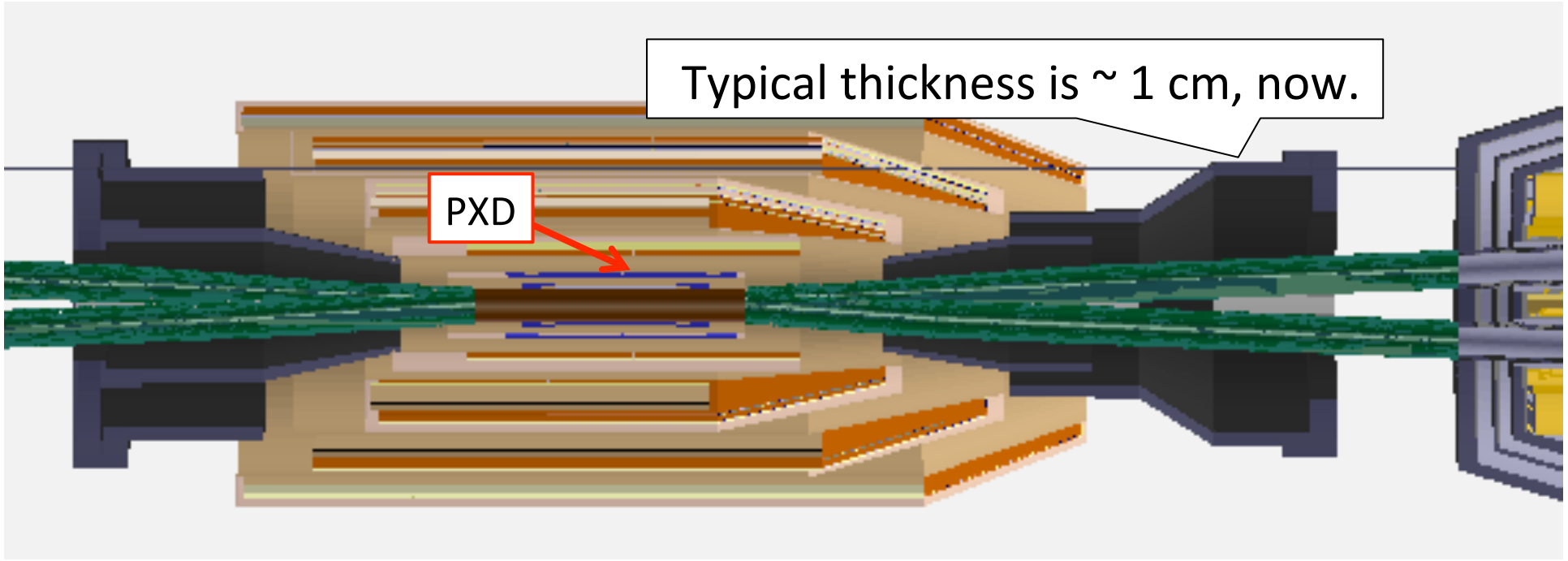
Every details in the IR region: Q magnets, cryostats, beam-pipes, heavy metal shield etc.. are now implemented !



Simulation environment of IR region is ready !

Heavy metal shield in simulation

Design of heavy-metal shield is newest one.



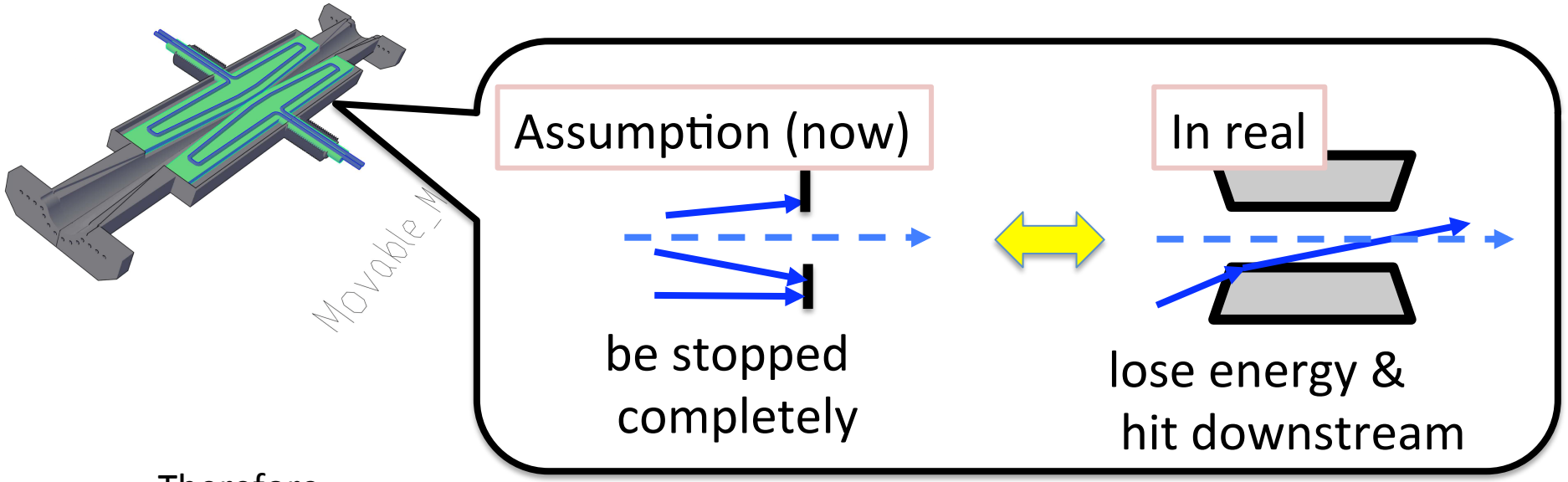
→ The design is dependent on the simulation result

Thicken more, if we need more thickness to stop EM shower.

(but more support will be needed).

⚠ Notice

1 For the collimator head material,
graphite (not heavy metal) might be used to avoid melting.



Therefore,

Result of the background rate might be increased.

Farther study is on going

2 **Background from HER is not included in the result**

Summary

Touschek effect is a big problem as background source !

Done!

8 collimators decrease Touschek loss at interaction region !

It seems to be good value, but do not forget the assumption of last page.

Full detector simulation is now ready !

First result will be shown in the next talk !

Thank you.