TO DO LIST for CR working group

Toshiyuki OKUGI, KEK

2015/ 12/ 15

1st Meeting of CR working group

TO DO LIST

1. *Detail beamline design*
   - *BDS beamline*
   - *Positron source*
   - *Electron source*
   - *RTML*

2. *CFS study*
   - *Muon background investigation*
   - *Radiation shield, especially for capture section of PS*
   - *Cold system for super-conducting devices*
   - *AC power line and cooling water pipe arrangement in service tunnel.*
   - *Tunnel penetration in between accelerator tunnel and service tunnel.*

3. *BDS tunnel design*
   - *Tunnel design*
   - *Cost estimation*
   - *Installation and maintenance plans*

Beamline design for undulator positron source

Overall layout will be changed by CR11.

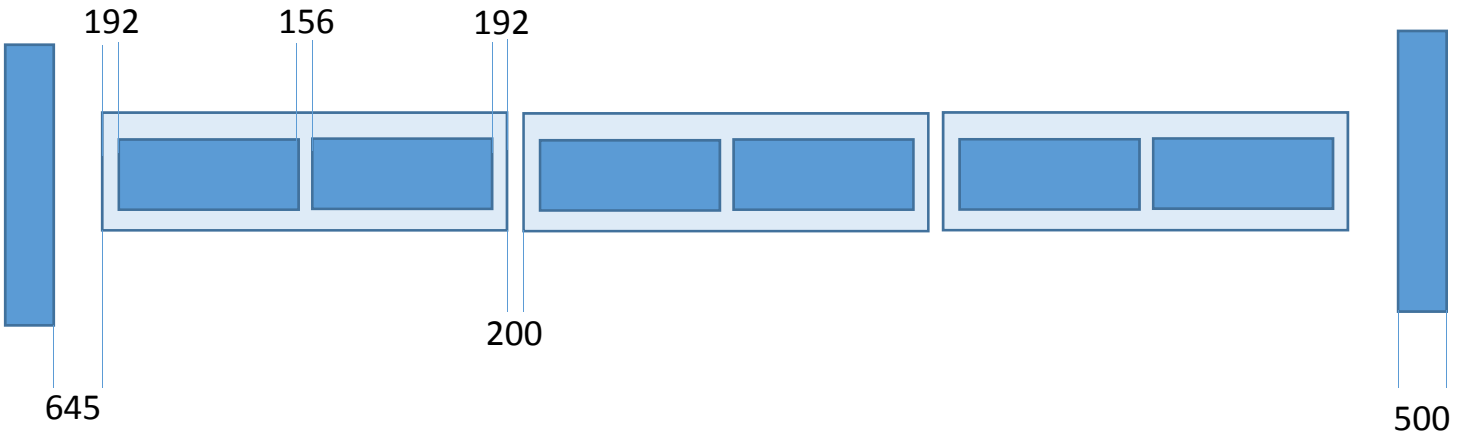
But, we still have the considerations of the optics for undulator positron source.

These issues are not written in TDR explicitly, we don't have to have a change request (?).

Of course, we must make the hardware design.

Undulator Cells in the optics deck

- *A cryomodule consists of two undulators.*
- *Quadrupoles are arranged every three cryomodules.*



NC Quadrupole Magnets

(*) ECM=240GeV is based on A.Ushakov, LCWS2013

	ECM=240GeV(*)	ECM=300GeV	ECM=350GeV	ECM=500GeV
Magnetic Field	79 T/m (0.50T)	98 T/m (0.63T)	115 T/m (0.73T)	164 T/m (1.04T)
Length	0.5 m (12.7mmϕ)			
Number of Quadrupole	23			

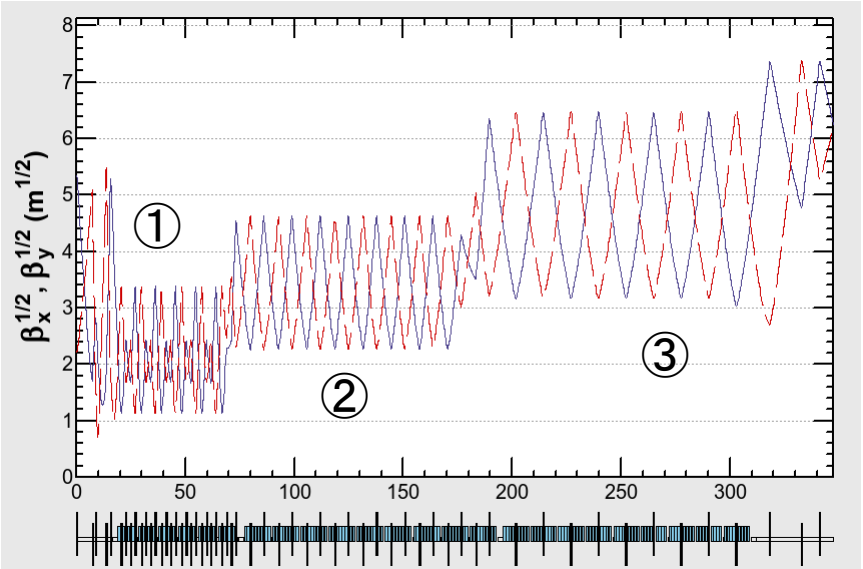
Then, I increased the thickness of quadrupole twice as 0.5m →1.0m, the gap between CM to Quads is reduced 0.645m → *0.395m.*

We should evaluate whether is the gap acceptable or not.

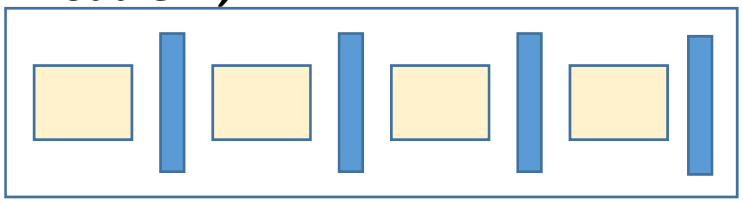
Positron Booster Linac

We will use 3 type of cryomodules in positron booster linac.

Electron booster linac use only type A&B cryomodules for ML.



Module 1 ;



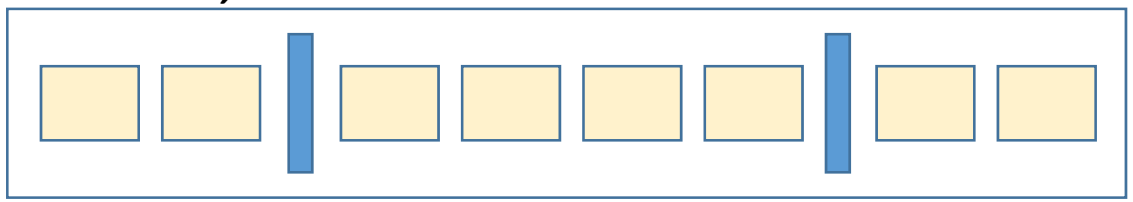
6 modules
- 4 cavities
- 4 quadrupoles

(TDR ; 4 modules
- 6 cavities
- 6 quadrupoles)

Quadrupole SPEC
- 20-cm long
- 36-97 T/m

4T at 2a=80mm

Module 2 ;

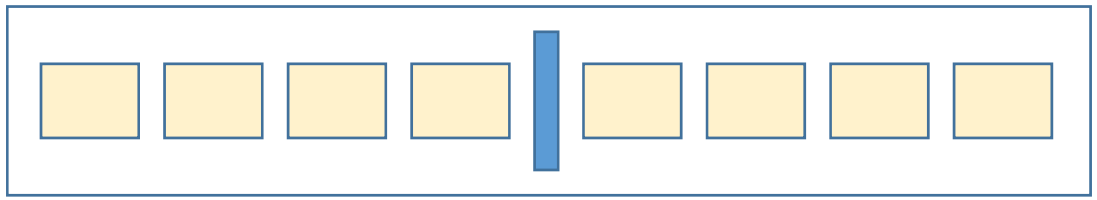


9 modules
- 8 cavities
- 2 quadrupoles

Quadrupole SPEC
- 20-cm long
- 35-99 T/m

4T at 2a=80mm

Module 3 ;



9 modules
- 8 cavities
- 1 quadrupole

(Type B module)

Quadrupole SPEC
- 66-cm long
- 2.3 – 3.8 T/m

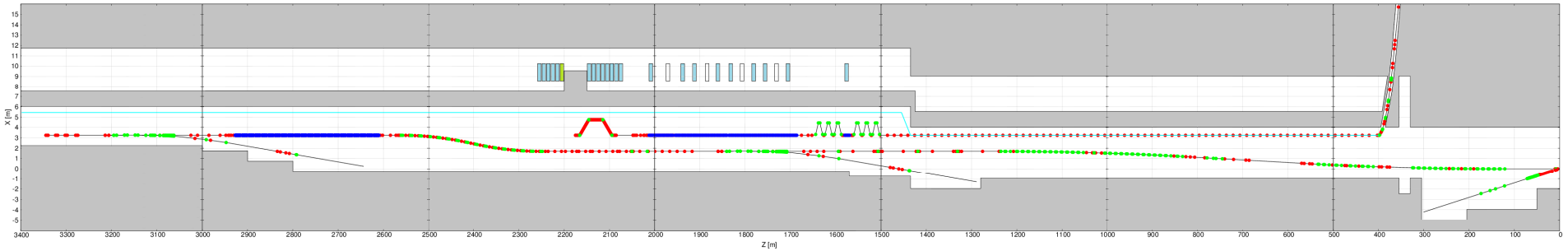
We should design the Module 1&2 with appropriate lengths of qusdrupoles.

Beamline design for BDS beamline

- Abort kicker system

- Laserwire and energy spectrometer chicane

BDS beamline modification to update up to ECM=1TeV



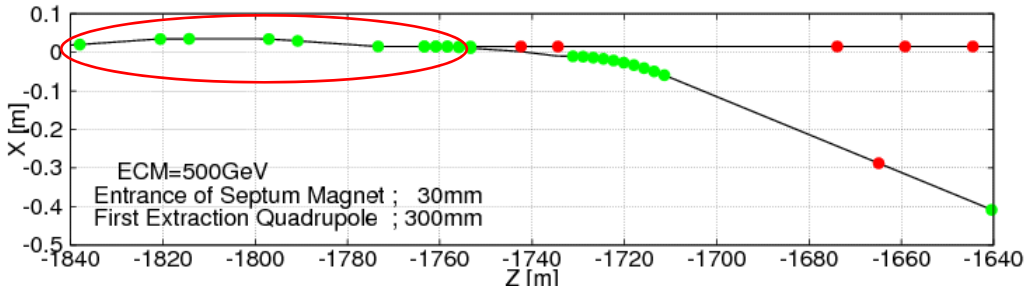
The beam diagnostic section of BDS is designed up to ECM=500GeV in TDR optics deck.

The BDS optics to be used yp to ECM=1TeV was poroposed at ALCW15.

The bending system for polarimeter and energy spectrometer

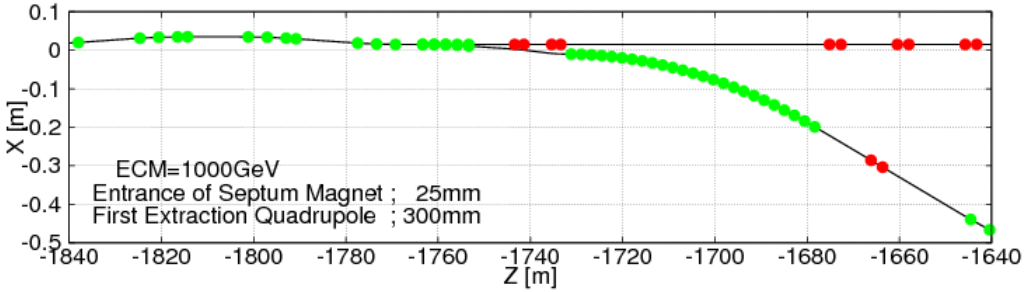
(Horizontal emittance growth)=12% when ECM=1Te -> 3%
i.e.) that of Dog-leg is 4% (J.Jones and D.Angal-Kalinin at IPAC10)

ECM=500GeV



The chicane will lengthen.

ECM=1TeV



T. Okugi at ALCW15

BDS Beam Abort System

Requirement of ILC abort kicker

8.3.1.4 Tune-up and Emergency Extraction System

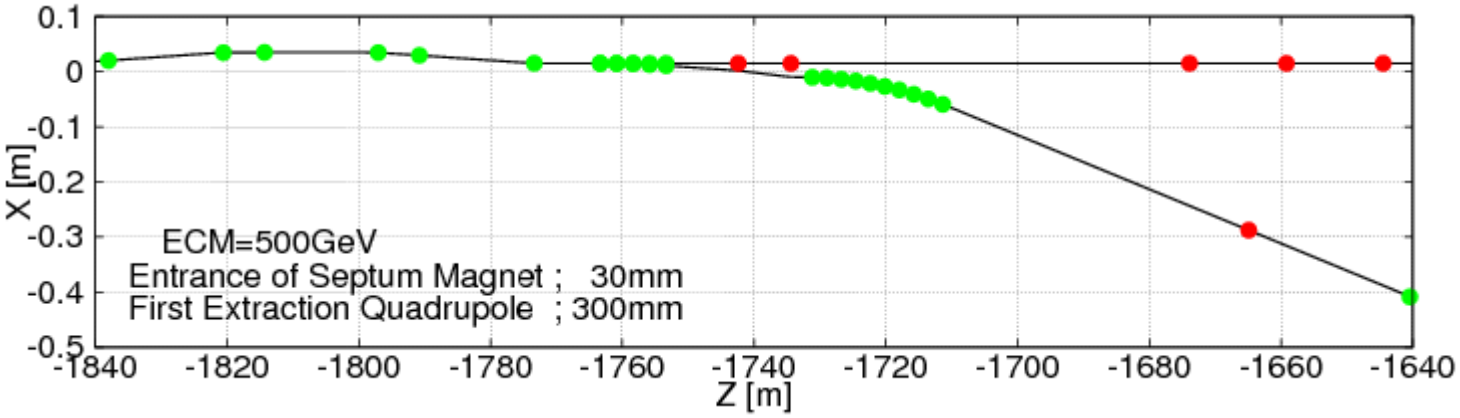
The pulsed extraction system is used to extract beams in the event of an intra-train Machine Protection System (MPS) alarm. It is also used at any time when beams are not desired in the collimation, final-focus, or IR areas, for example during commissioning of the main linacs. The extraction system includes both fast kickers which can rise to full strength in the 300 ns between bunches, and pulsed bends which can rise to full strength in the 200 ms between trains. These are followed by a transfer line with ±10 % momentum acceptance which transports the beam to a full-beam-power water-filled dump. There is a 125 m drift which allows the beam size to grow to an area of $2\pi mm^2$ at the dump. A set of rastering kickers sweep the beam in a 6 cm-radius circle on the dump window. By using the nearby and upstream BPMs in the polarimeter chicane and emittance sections, it is possible to limit the number of errant bunches which pass into the collimation system to 1–2.

800us flat-top

Requirement of kickers for emergency extraction (ECM=500GeV) , proposed at ALCW15

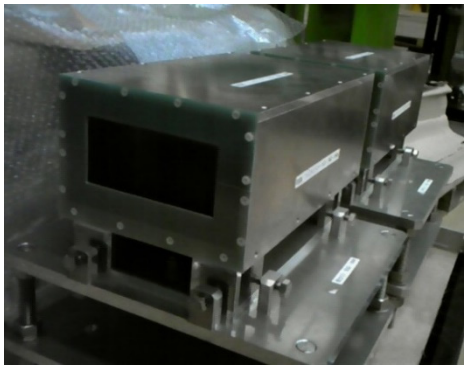
- 9 kickers to abort -> 4kickers
- Magnetic field of 1.3kG. - > 0.85kG
- Pulse length of 800us
- 300ns rise time to full strength for emergency abort.

Very difficult

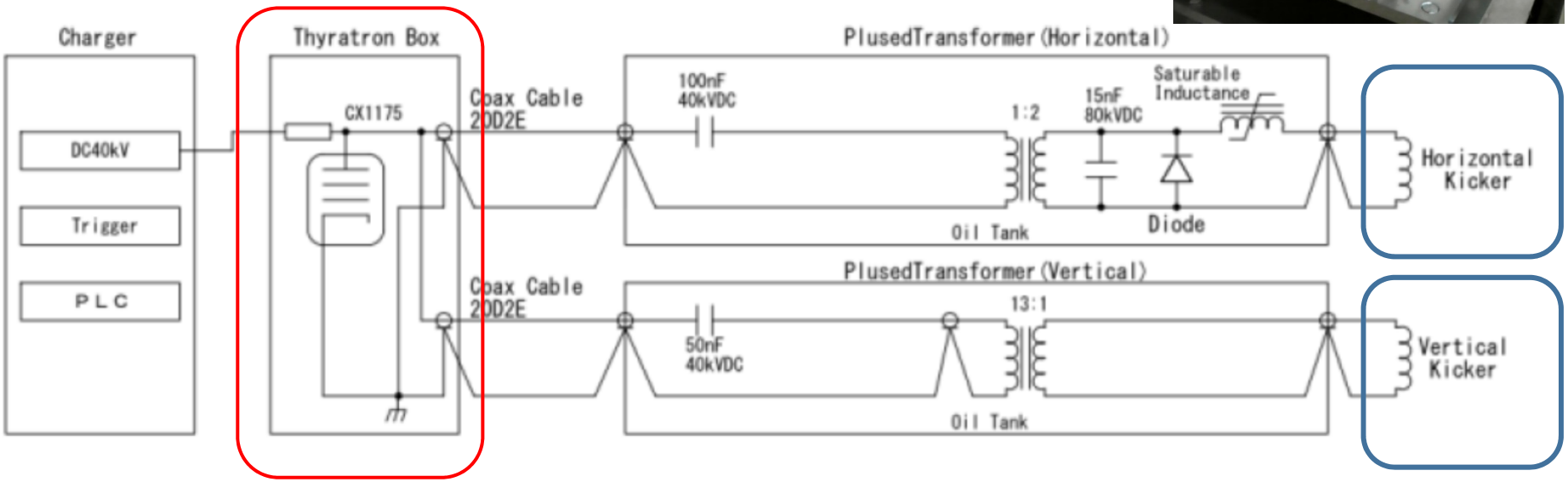


Abort kicker circuit for SuperKEKB

Fire 4 horizontal kickers and 1 vertical kicker by using single thyratron in order to synchronize the kicker timing and avoid the misfiring.



- *Horizontal kicker is using for the beam extraction.*
- *Vertical kicker is using to sweep the beam on dump.*

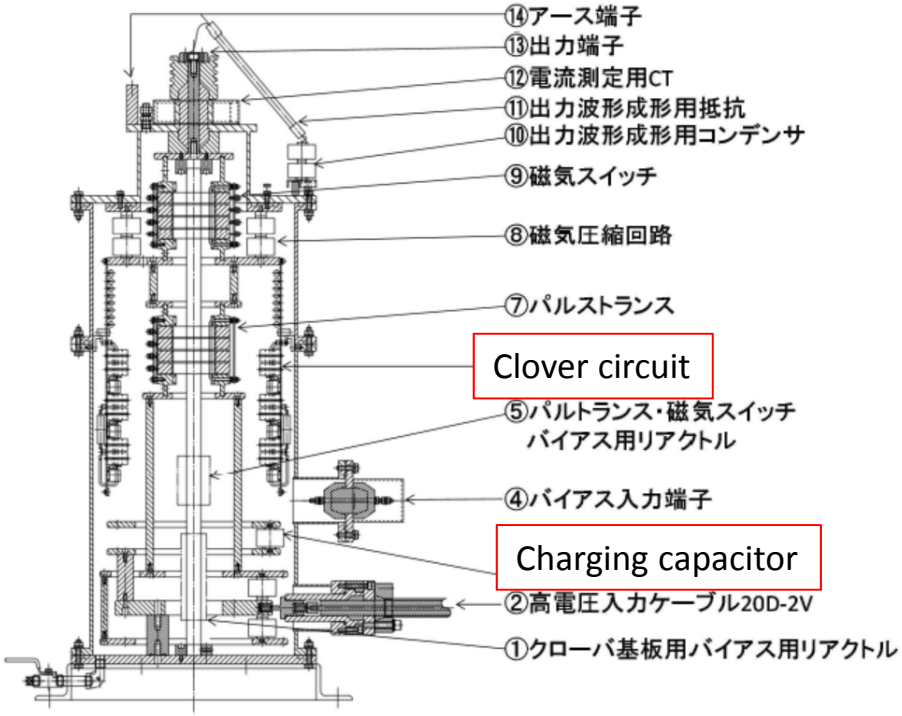


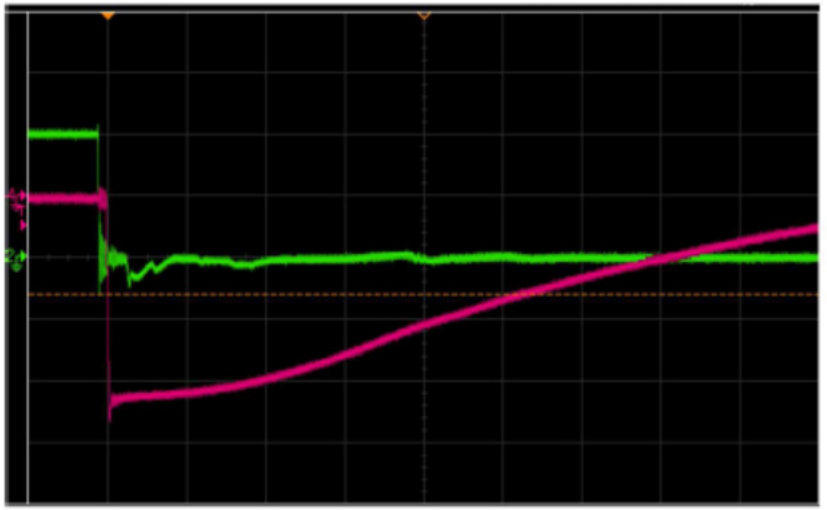
The power is always stored in the capacitors ,
we can generate the single kicker pulse, when the thyratron will be fired.

Horizontal kicker system

Kick angle ; 500 gauss (the ferrite kicker is OK up to 1300 gauss)
Rise time for horizontal kicker ; 200 ns
Pulse width for horizontal kicker ; 10 us

Pulse shape was adjusted by using the pulse clover circuit.

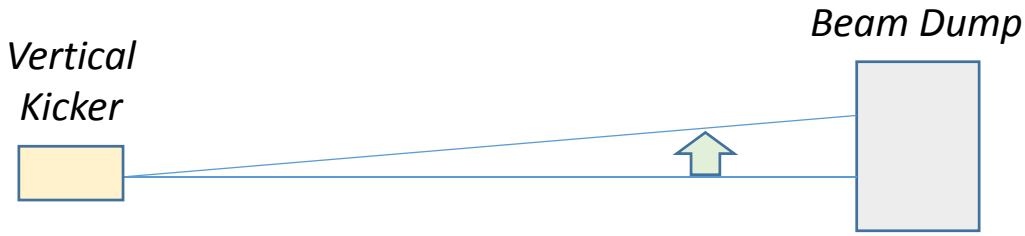




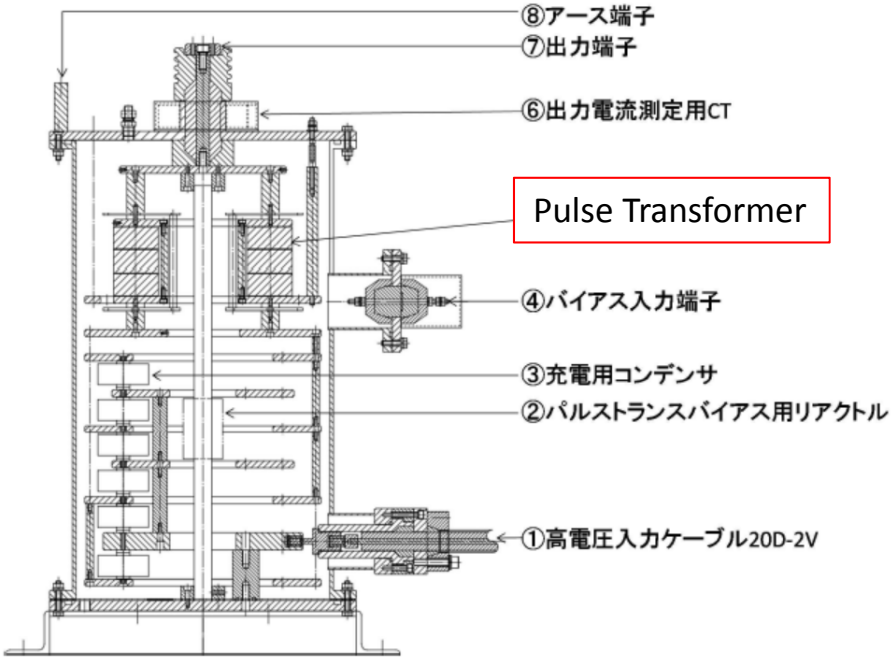
Red : OutputCurrent 500A/div
Green:THY Charge Voltage 20kV/div
TimeRange:5usec/div

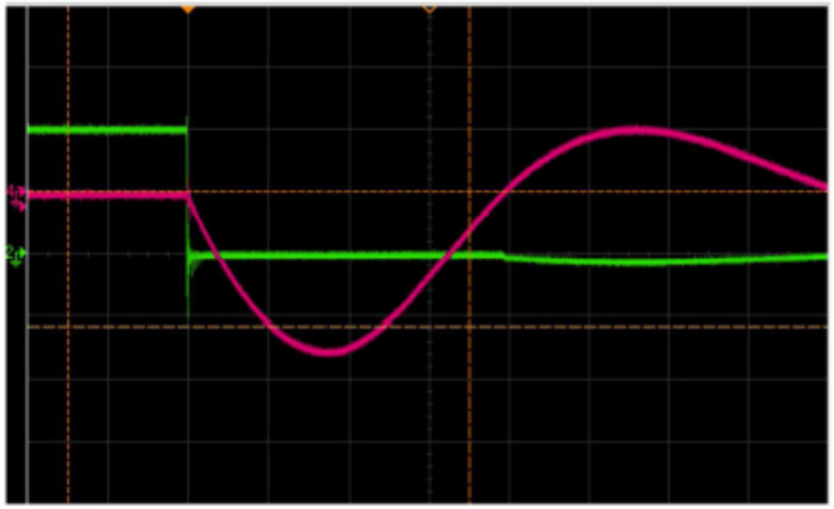
Vertical kicker system

Vertical kicker is using to sweep the beam on dump



Rise time for vertical kicker ; 10 us





Red : OutputCurrent 500A/div
Green:THY Charge Voltage 20kV/div
TimeRange:10usec/div

Capable pulse length for superKEKB type abort kicker

The specification of KEKB abort kicker is 10us,
because the circumference of KEKB ring is 3km.

But, the pulse length of ILC is longer than 800us.

Therefore, I asked to KEK abort kicker group
how long can we extend the pulse length for abort kicker system?

They answered (private communication, not official)

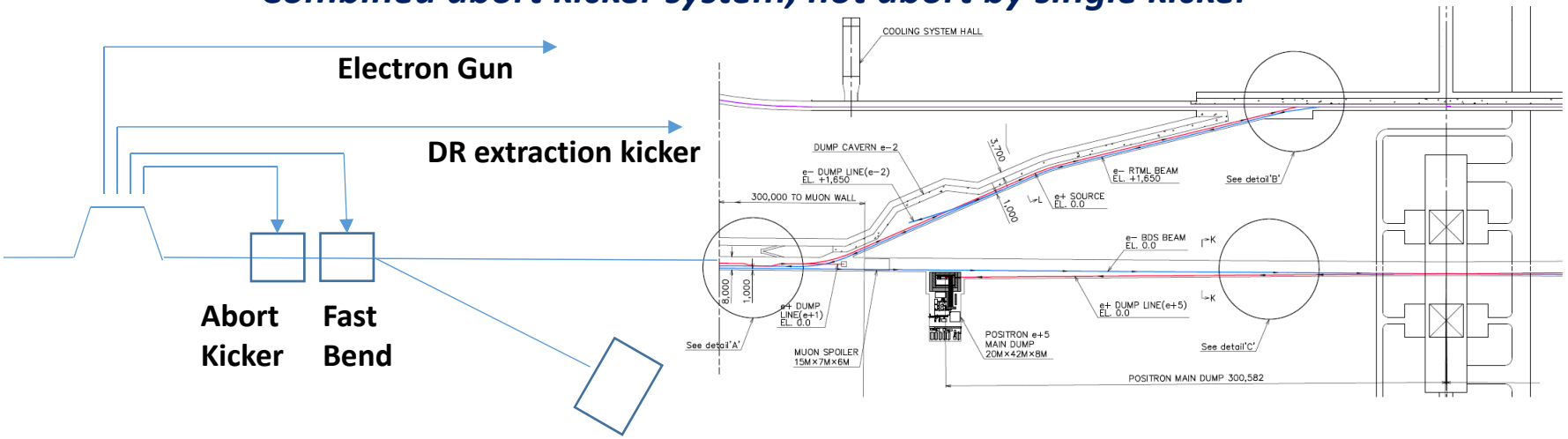
it is maybe possible to extend the pulse length up to 100us
by modifying the clover circuit and capacitors,

but 800us is impossible by using the same philosophy of the kicker system.

Proposal of the abort system

The total pulse length of ILC is more than 700us,
but the pulse length stored in RTML and ML is almost 100us.

Combined abort kicker system, not abort by single kicker



- ***Abort kicker in BDS (100us)***
  kick out the beam stored in ML and RTML,
  when we detected some trouble in BDS diagnostic section.

- ***Extraction kicker trigger is off , then abort the beam to DR abort system***
  kick out the beam stored in DR,
  when we detected some trouble in BDS diagnostic section.

- ***Beam off***
- ***DRRF off or dump in DR***
- ***BDS fast bend will be turned on***
  The beam in next pulse will not be deliver to the BDS.

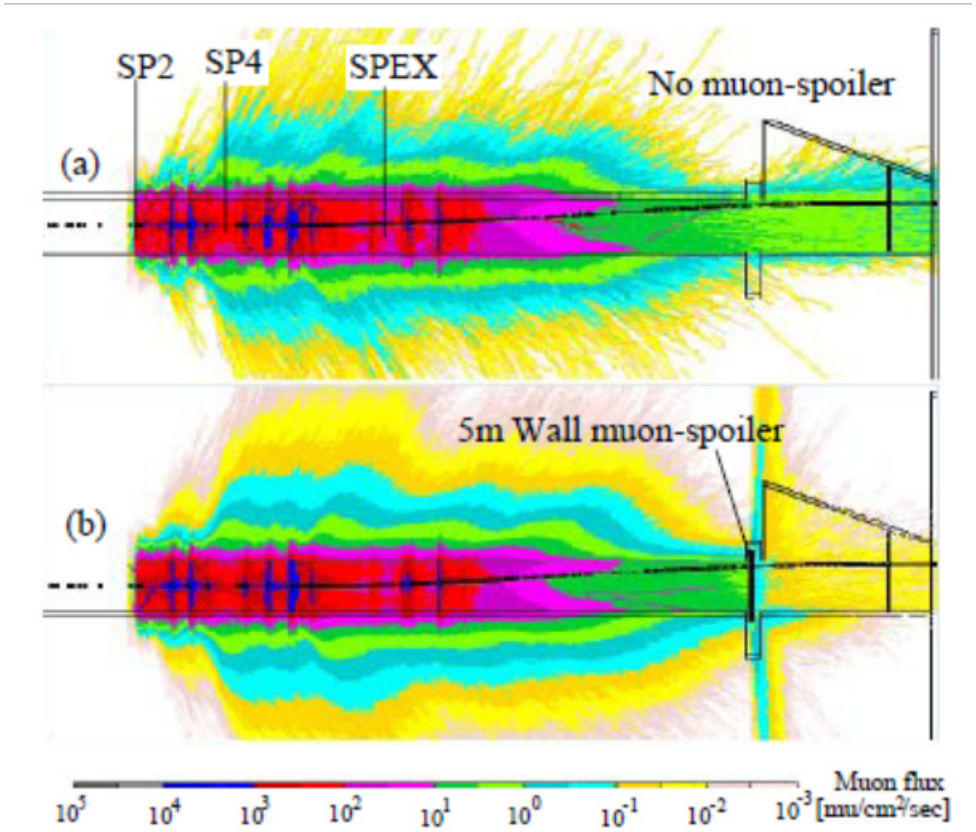
CFS study

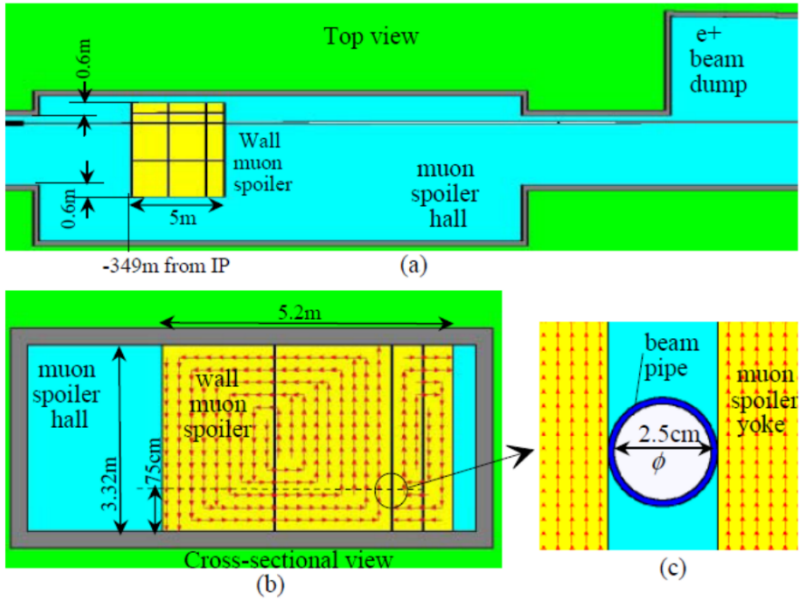
Muon Spoiler Investigation

Muon Spoiler

In order to consider the tunnel cross section,
we should start from the investigation of Muon background.

Lewis Keller and Glen Write will investigate the appropriate tunnel cross section from the point of view of Muon background.





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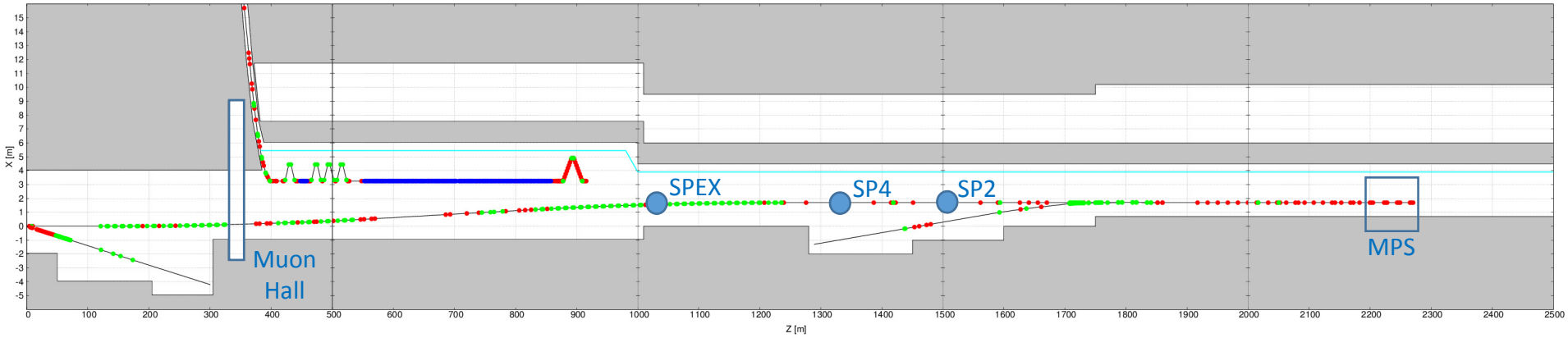
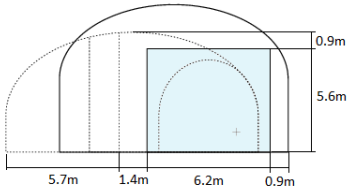
Especially for positron BDS

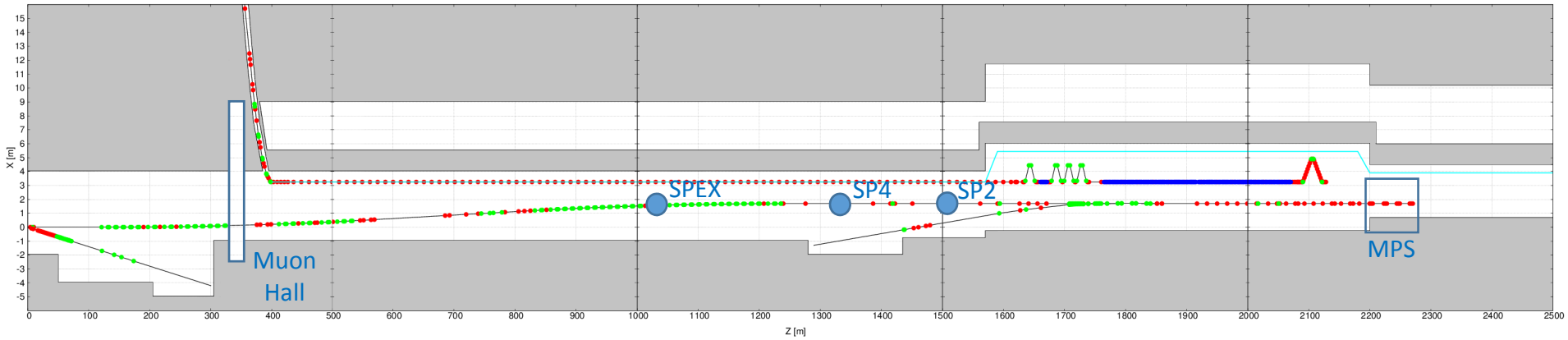
Case 1





- *Radiation Dose from collimators for SC cavities of electron source*
- *Muon background by large cross section of accelerator tunnel (much larger than the electron BDS)*

Case 2



- *Long transport line (about 1km)*

The design of the cold system will strong affect to the tunnel design study of Muon background.

CFS study

- *Radiation shield for undulator positron source*

Radiation shield for positron capture section

Radiation loss scaled to present design.

	SLC maximum	Undulator PS [300GeV]	
		unpolarized	polarized
Beam power to target	40kW	63.1kW	94.7kW
1st acc. structure	**13kW**	3.8kW	5.8kW
Target	9kW	**7kW**	**10kW**

SLC Positron Target Arrangement in Beamline

The positron target was located to the separate area.
- *to restrict the radioactive area.*
- *to protect the devices from the radiation dose .*

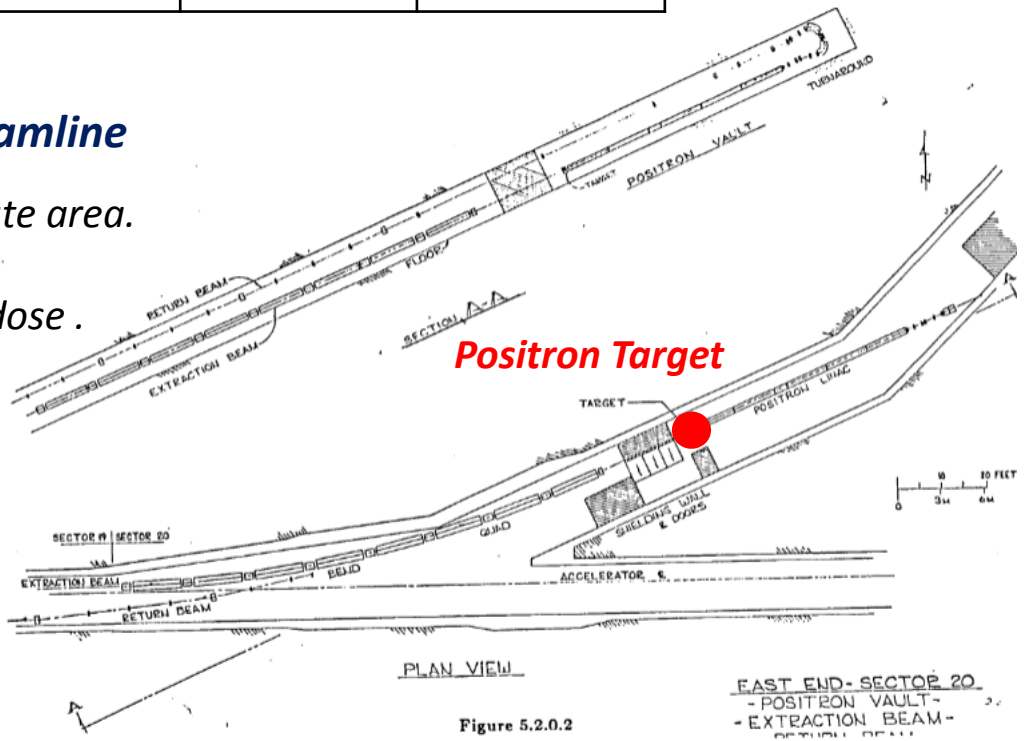


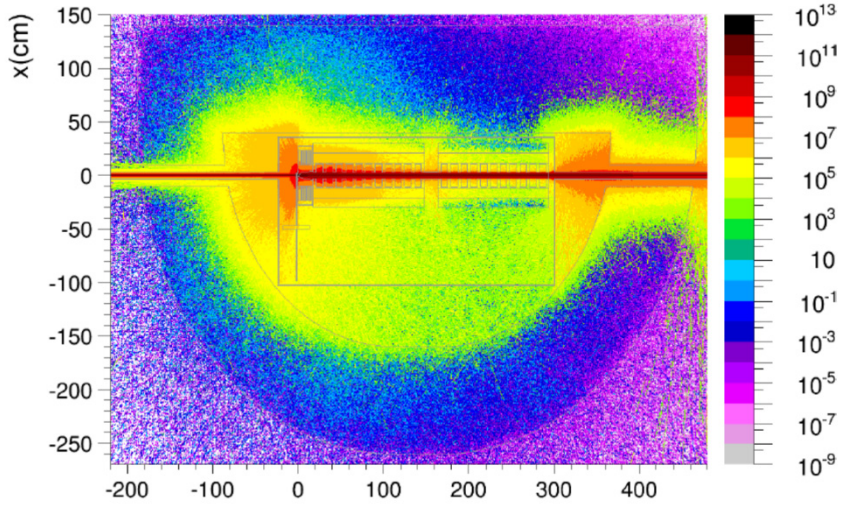
Figure 5.2.0.2

The radiation dose for undulator source also take care of effect to the other components, even though it will be smaller than SLC.

SLC Design Handbook

Radiation dose for capture section for undulator positron source

A.Ushakov (University of Hamburg) at LCWS2015

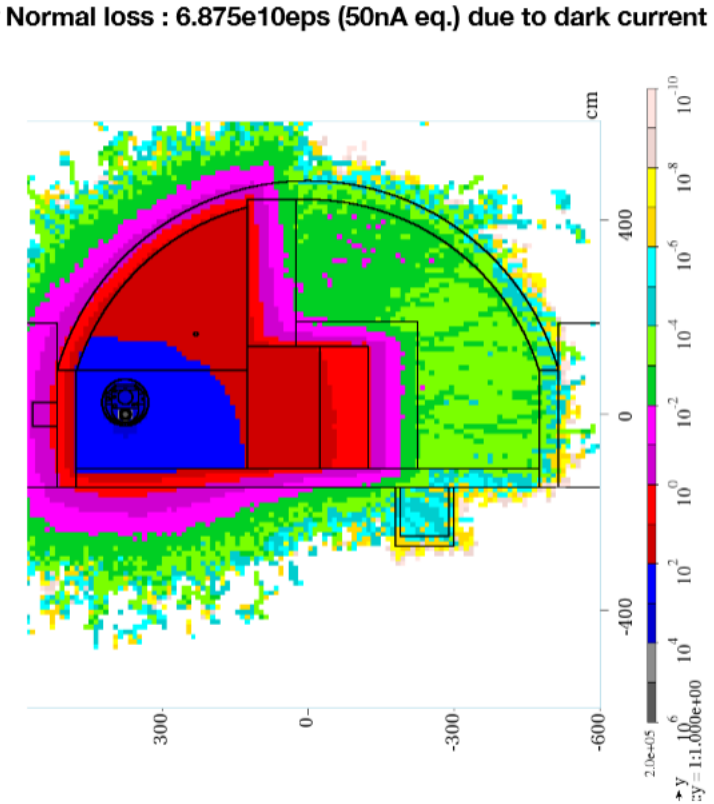


$\dot{D}_{eq}(z \simeq 0, x \simeq 145\,\mathrm{cm}) \approx 60$ mSv/h

Radiation dose out of 1m-thickness concrete shield is less than ML dark current level

Radiation dose for ML dark current

T. Sanami (KEK) at LCWS2015



O(100mSv/h) in accelerator tunnel

The radiation study of capture section is very good start point of the shield design.

TO DO LIST

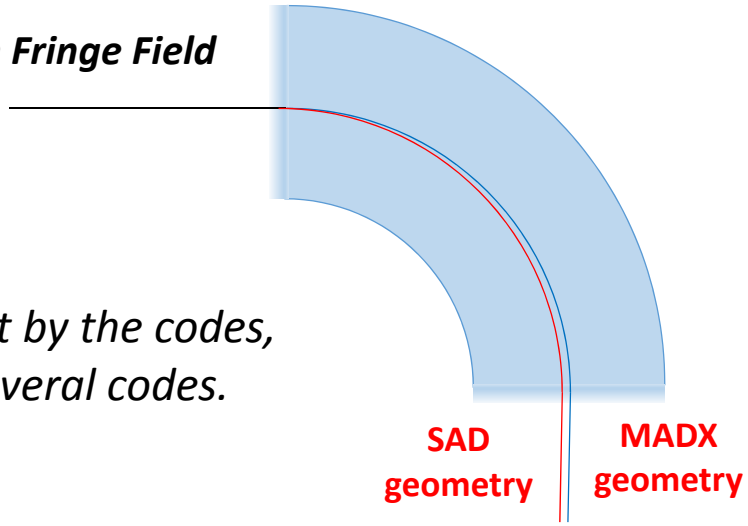
1. *Detail beamline design*
   - *BDS beamline* ⟵ *Glen, Mark and me ?*
   - *Positron source* ⟵ *CR11 and SC magnet specialists ?*
   - *Electron source* ⟵ *Depends on Muon study (Lewis and Glen) ?*
   - *RTML* ⟵ *Mark ? (after tunnel fixed)*

2. *CFS study*
   - *Muon background investigation* ⟵ *Lewis and Glen*
   - *Radiation shield, especially for capture section of PS* ⟵ *A.Ushakov and CFS group?*
   - *Cold system for super-conducting devices* ⟵ *Okamura-san ?*
   - *AC power line and cooling water pipe arrangement in service tunnel.* ⟵ *CFS and me ?*
   - *Tunnel penetration in between accelerator tunnel and service tunnel.* ⟵ *CFS and me ?*

Next step

3. *BDS tunnel design*
   - *Tunnel design*
   - *Cost estimation*
   - *Installation and maintenance plans*

Proposal of the fundamental optics deck definition



The beamline geometries are different by the codes, when we put the fringe field in the several codes.

The ATF2 linear and non-linear optics for SAD/MADX optics decks were almost same.

But, the beamline geometries (X , Z) are different by a few ten micron.

- *The basic optics deck should be define with hard edge magnets.*
- *The fringe field should be put in the individual optics studies, if need.*