Capture Simulation (continued)

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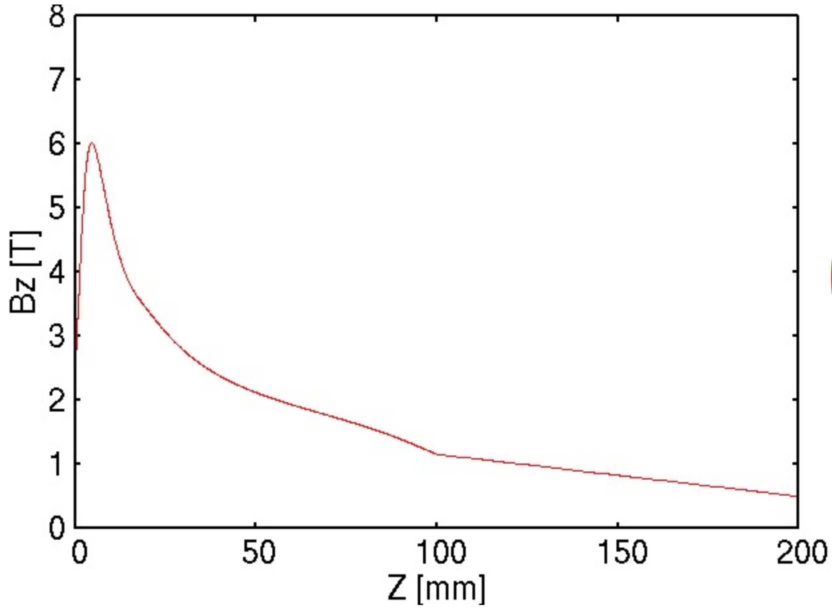
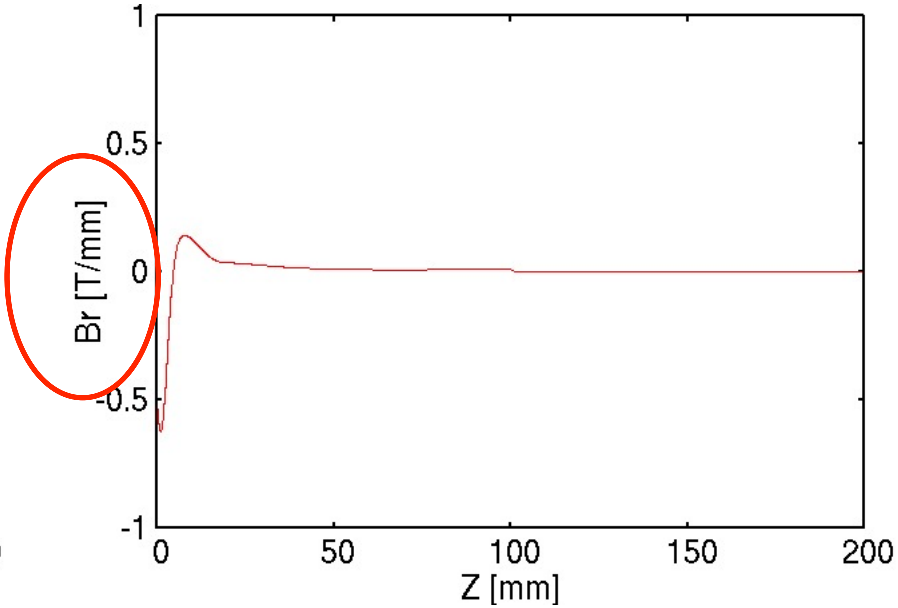
Introduction

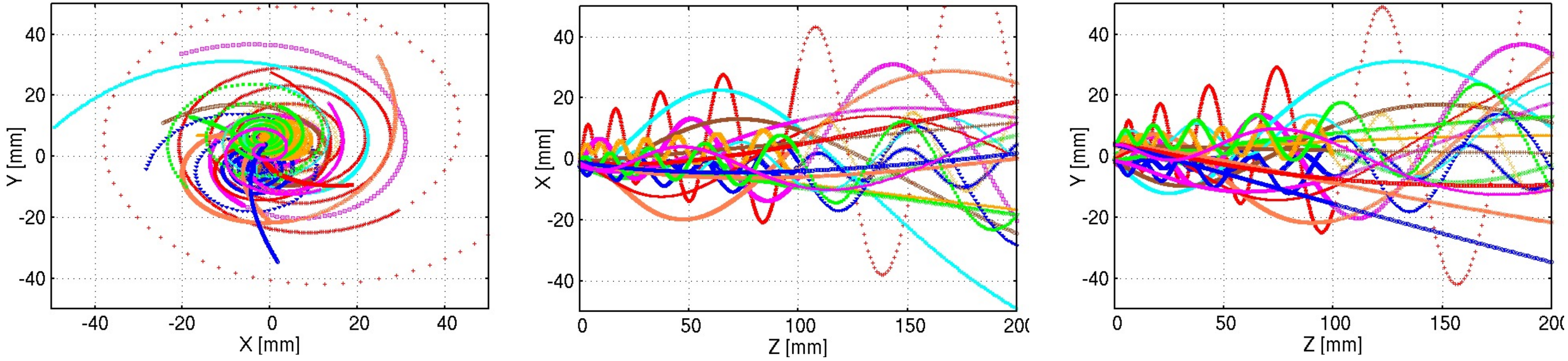
In LCWS, I simulated the positron capture yield as the unit of AMD transverse field Br to T/m, but the actual unit is T/mm.



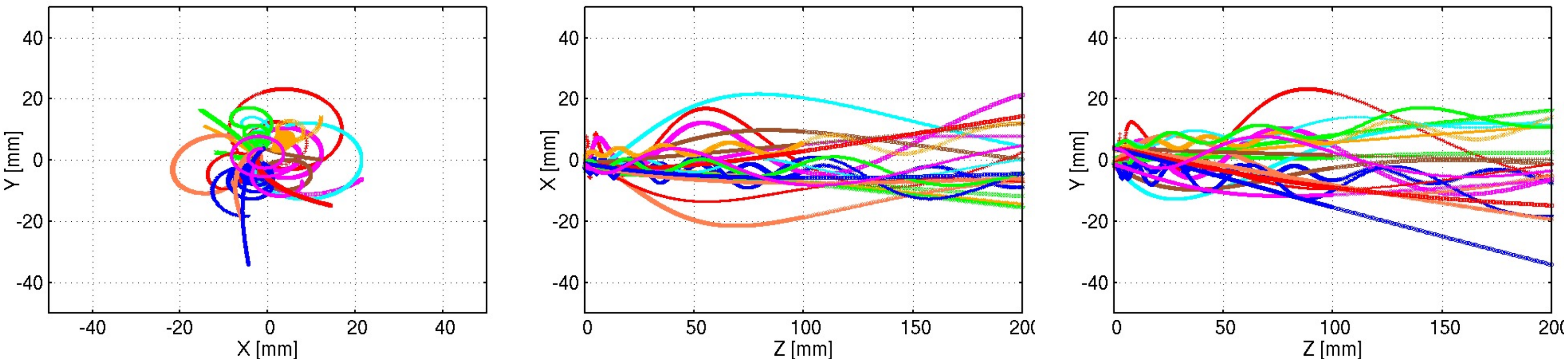


Particle Motion in the AMD

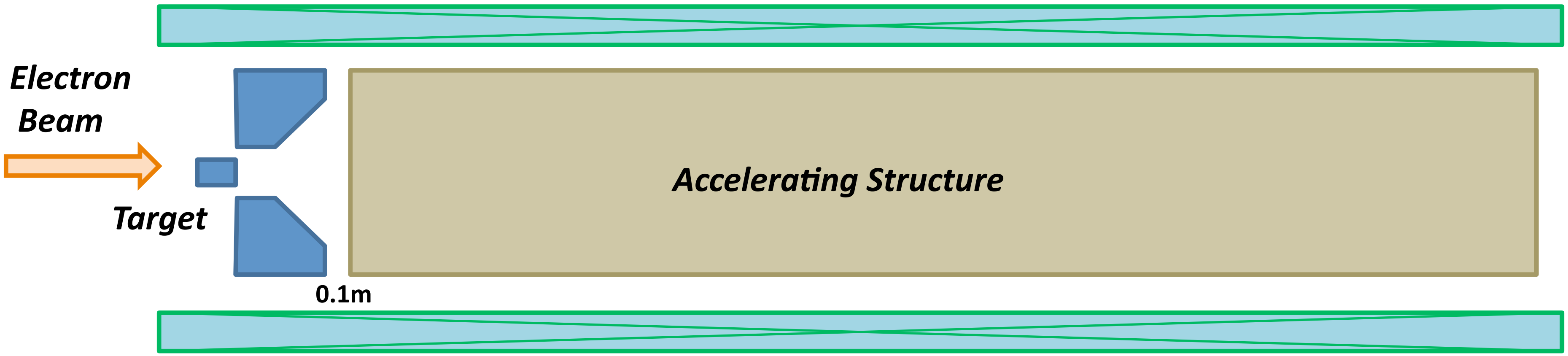
Old Simulation (The unit of Br was T/m)



Present Simulation (The unit of Br is T/mm)



Basic Parameter for Capture Section



Electron Beam

Electron Energy ; E= 6GeV
Spot Size ; sigma= 4mm

Converter Target

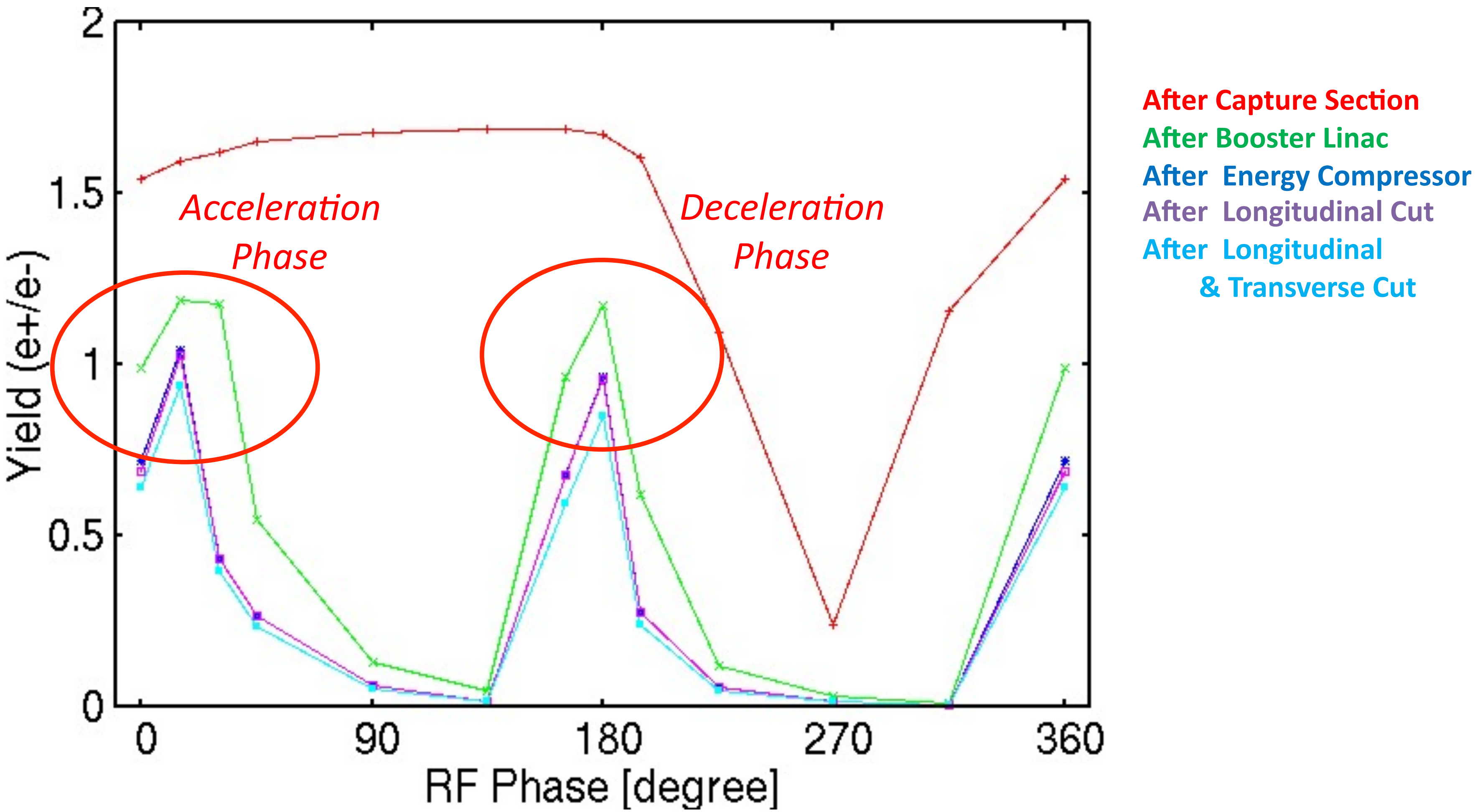
Target Thickness ; t-14mm

Accelerating Structure

Frequency ; 1.3GHz
Energy Gain ; 250MeV
Gradient ; 16.6MV/m
Length ; 15 m

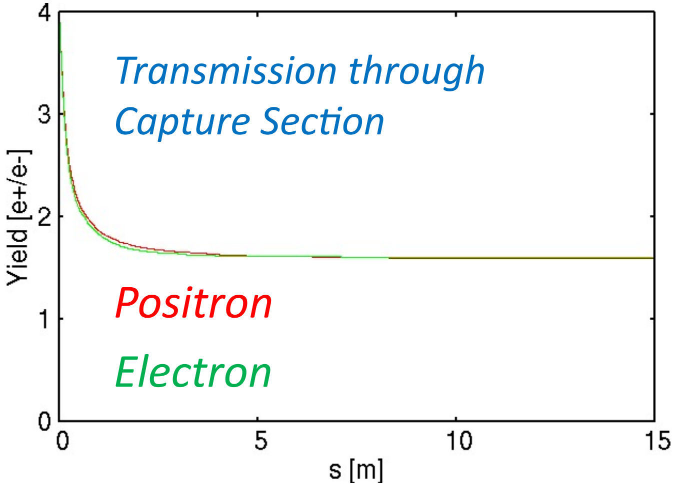
Capture Simulation for various RF Phase in Capture Section

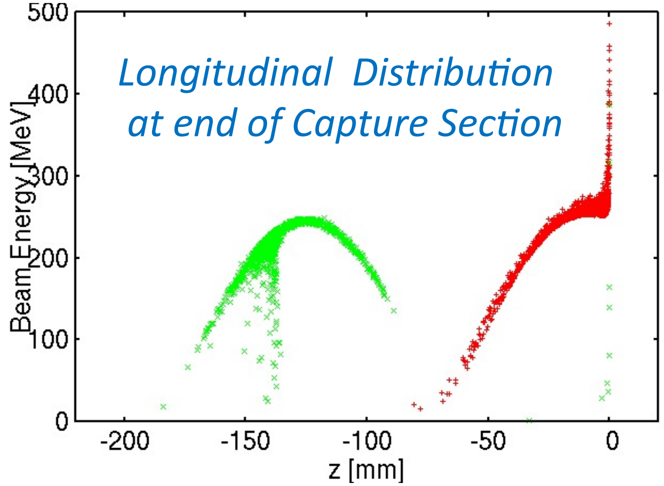
Positron distribution just after target was simulated by T. Takahashi with GEANT4



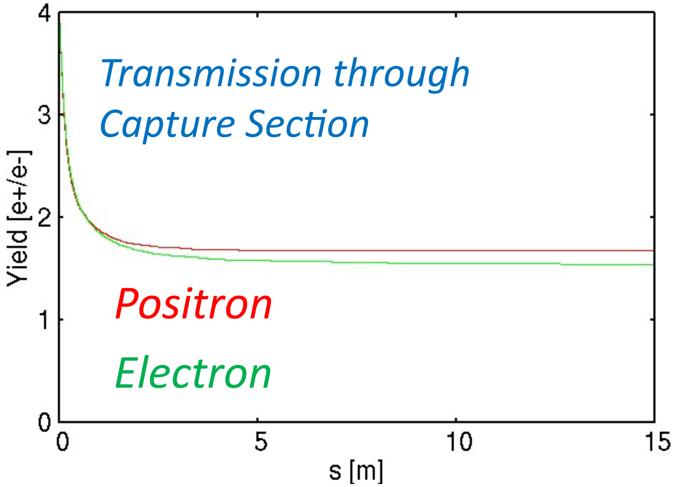
Beam Loading Issue in the Capture Section

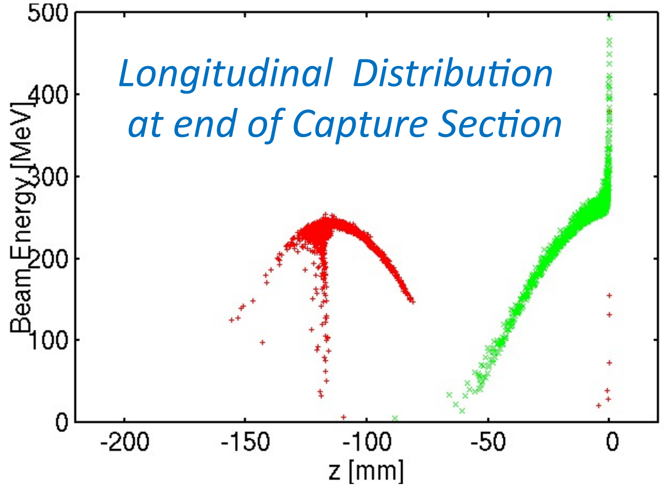
Acceleration Phase





Deceleration Phase



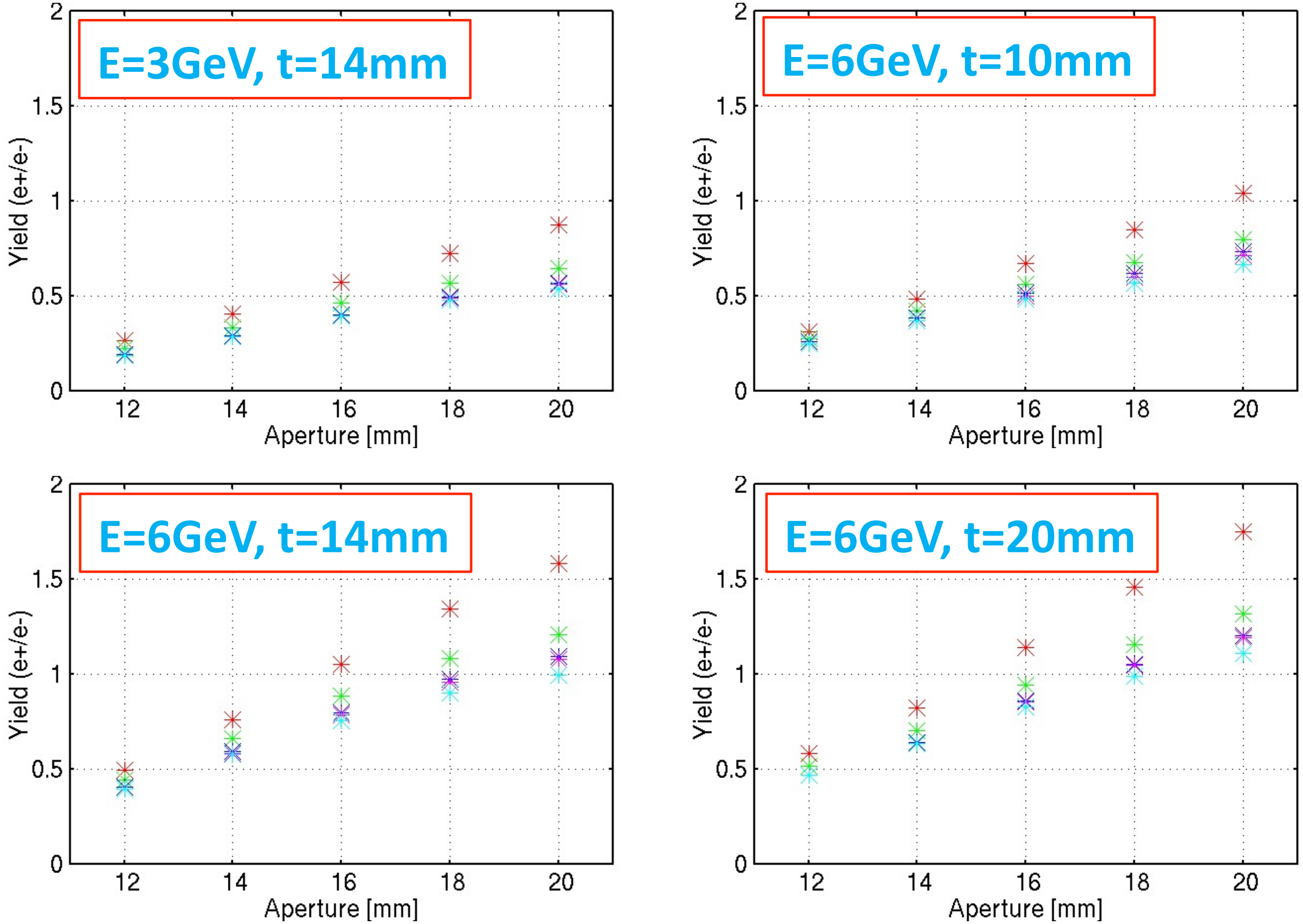


Charge ; almost same amplitude and opposite
Phase ; separated by 180degree

Beam Loading was twice as the loading generated by e+

Capture Simulation for various Injection Electron Beam

Positron distribution just after target was simulated by T. Takahashi with GEANT4



After Capture Section
After Booster Linac
After Energy Compressor
After Longitudinal Cut
After Longitudinal & Transverse Cut

Target
sigma= 4mm

Capture Section
E=250MeV
V = 16.6MV/m
B= 0.5T

Scaled the energy deposit in target to 26J/g

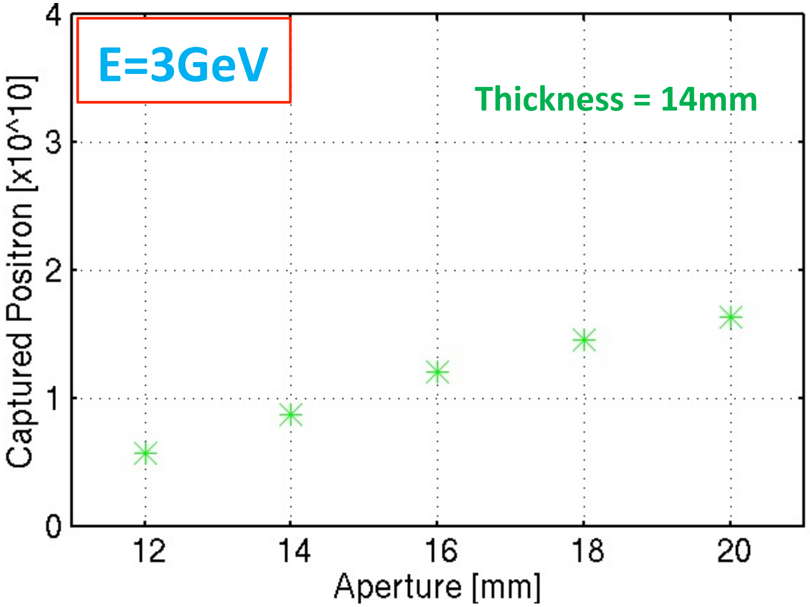
Energy	Thickness	Energy Deposit at 2e10	Scale to 26J/g
3 GeV	14 mm	17 J/g	3.06e10
6 GeV	10 mm	14 J/g	3.71e10
	14 mm	26 J/g	2.00e10
	20 mm	26 J/g	2.00e10

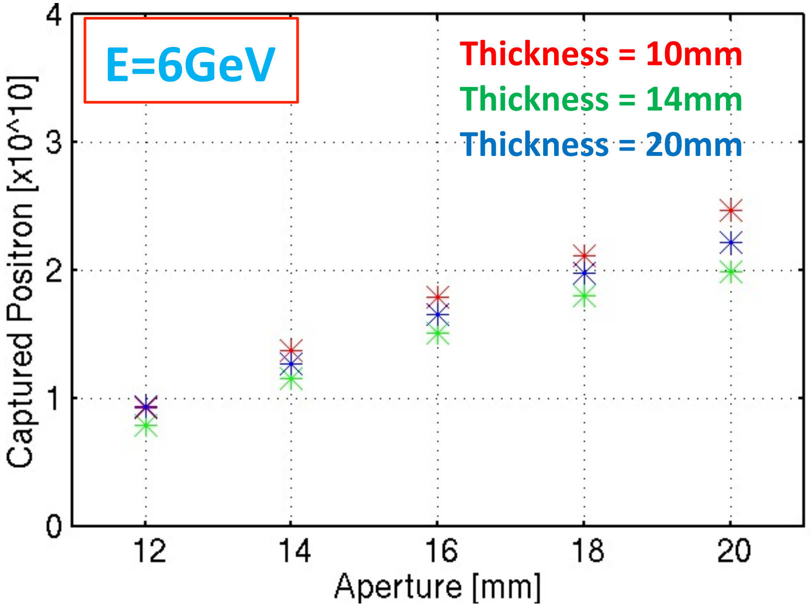
Result of Capture Simulation

after Energy Compressor
with Longitudinal & Transverse Cut

Target
sigma= 4mm

Capture Section
E=250MeV
V = 16.6MV/m
B= 0.5T





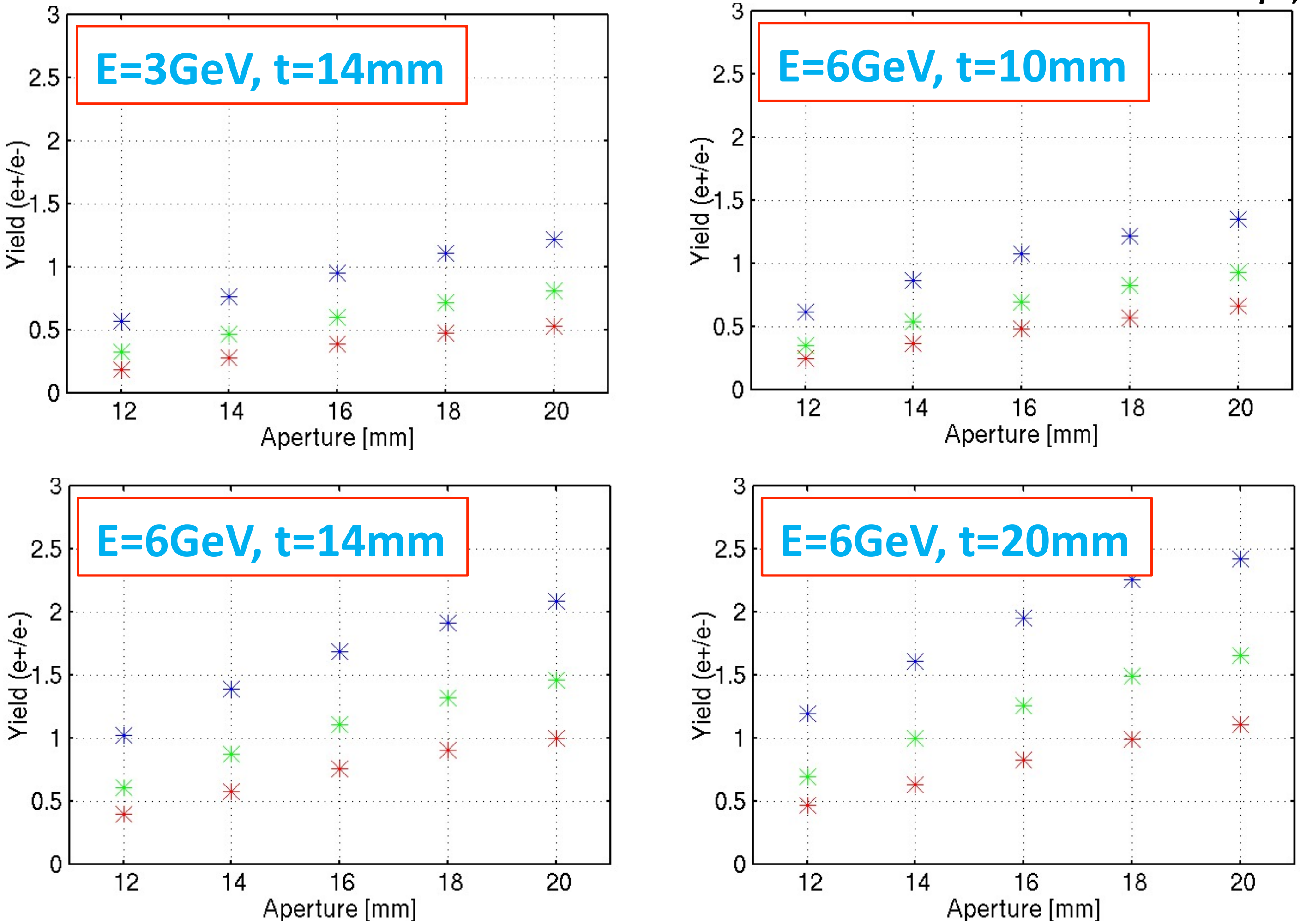
Electron Spot Size Dependence

after Energy Compressor
with Longitudinal & Transverse Cut

(1) Electron Beam Size = 4mm ;
used for the GEANT4 data set

(2) Electron Beam Size = 3mm ;
X=3*X/4, Y=3*Y/4 for (1)

(3) Electron Beam Size = 1mm ;
X=2*X/4, Y=2*Y/2 for (1)



Capture Section
E=250MeV
V = 16.6MV/m
B= 0.5T

The yield is increased, but the target stress also increased. We need optimize.

Checking the impact of various parameters

1) *Gradient of the Capture Linac*
2) *Beam Energy at the entrance of Booster Linac*
3) *Strength of the Solenoid Field*
4) *Aperture of AMD*
5) *Strength of the Maximum Field of AMD*
6) *Distance between Target and AMD*

Gradient of the Capture Linac

Flux Concentrator
a = 12mm (diameter)
B = 6.0T

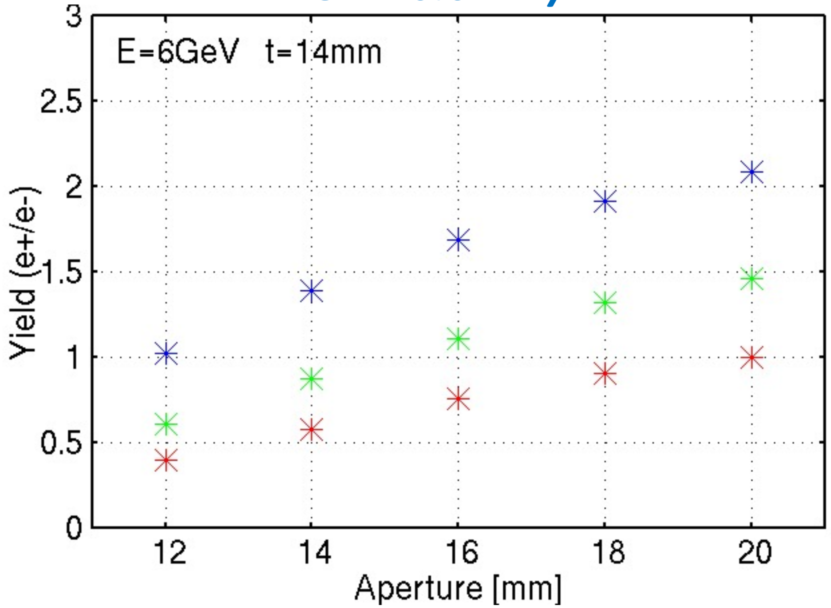
Capture Section
E=250MeV
B= 0.5T

sigma = 4mm
sigma = 3mm
sigma = 2mm

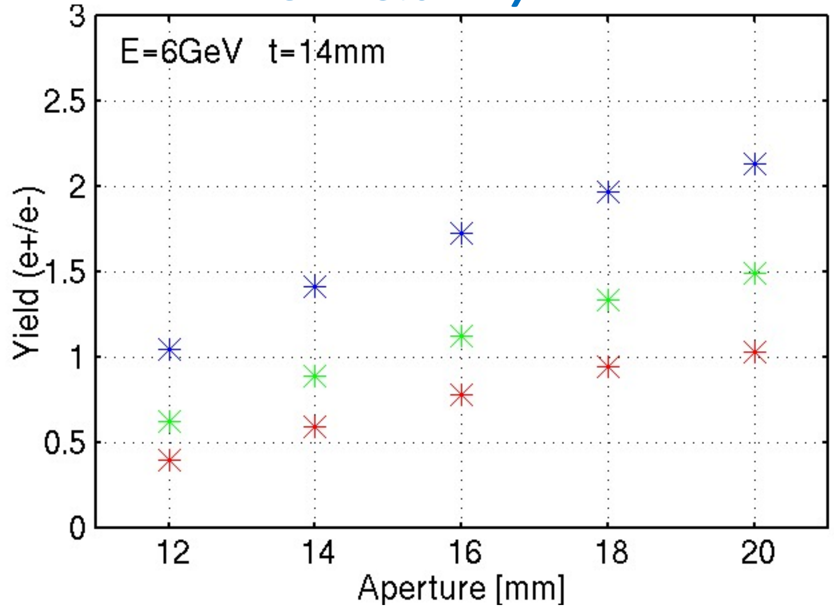
Result of Capture Simulation

after Energy Compressor
with Longitudinal & Transverse Cut

G = 16.6 MV/m



G = 25.0 MV/m



Small impact to the yield

Beam Energy at the entrance of Booster Linac

Flux Concentrator
a = 12mm (diameter)
B = 6.0T

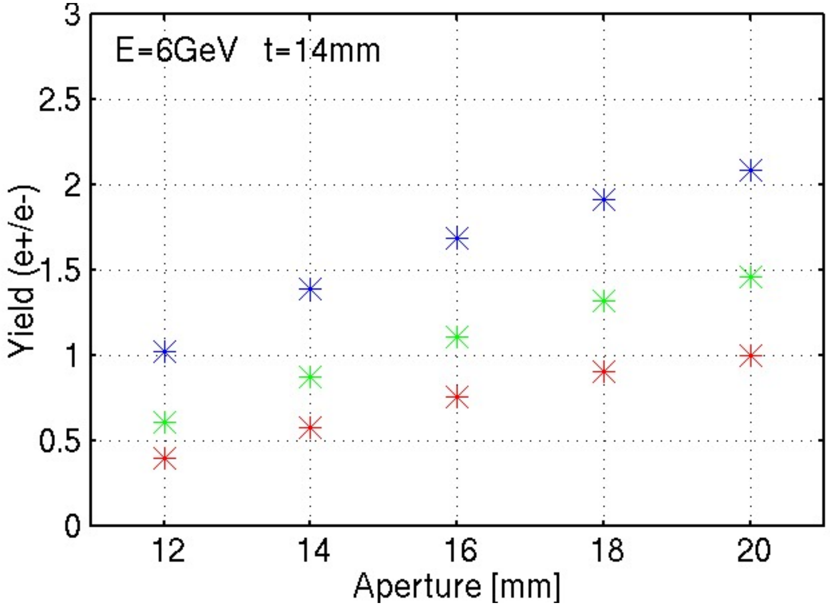
Capture Section
G=16.6MV/m
B= 0.5T

sigma = 4mm
sigma = 3mm
sigma = 2mm

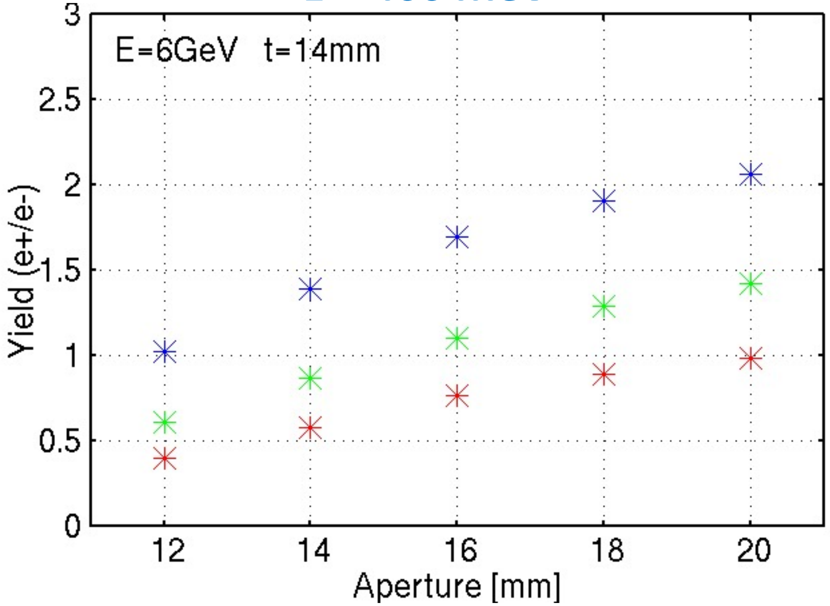
Result of Capture Simulation

after Energy Compressor
with Longitudinal & Transverse Cut

E = 250 MeV



E = 400 MeV



Small impact to the yield

Strength of the Solenoid Field

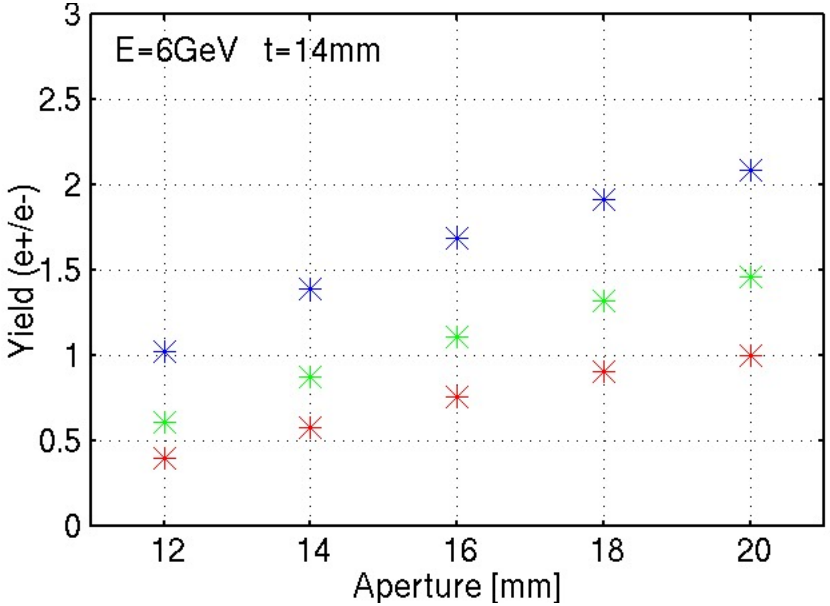
Flux Concentrator
a = 12mm (diameter)
B = 6.0T

Capture Section
G=16.6MV/m
E = 250MeV

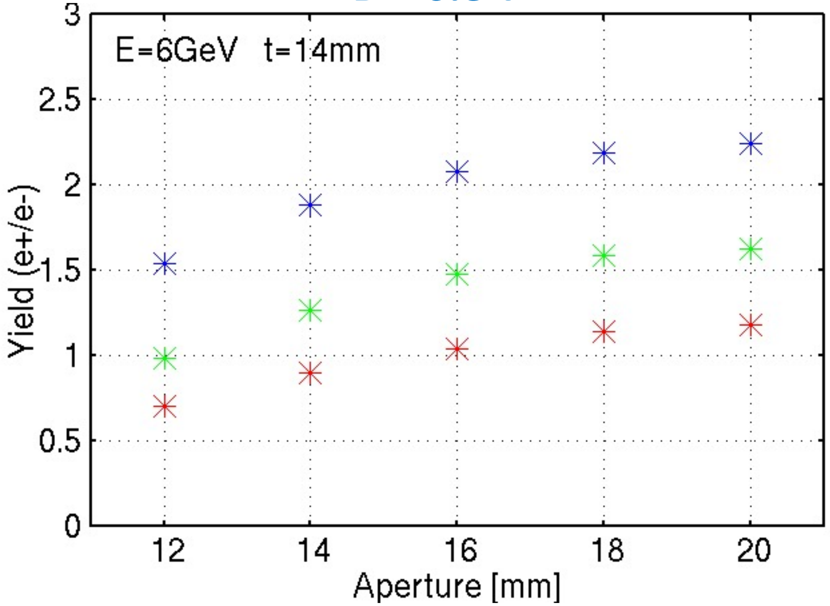
sigma = 4mm
sigma = 3mm
sigma = 2mm

Result of Capture Simulation
after Energy Compressor
with Longitudinal & Transverse Cut

B = 0.5 T



B = 0.8 T



Large impact to the yield, especially when capture section has small aperture.

Aperture of AMD

Flux Concentrator
B = 6.0T

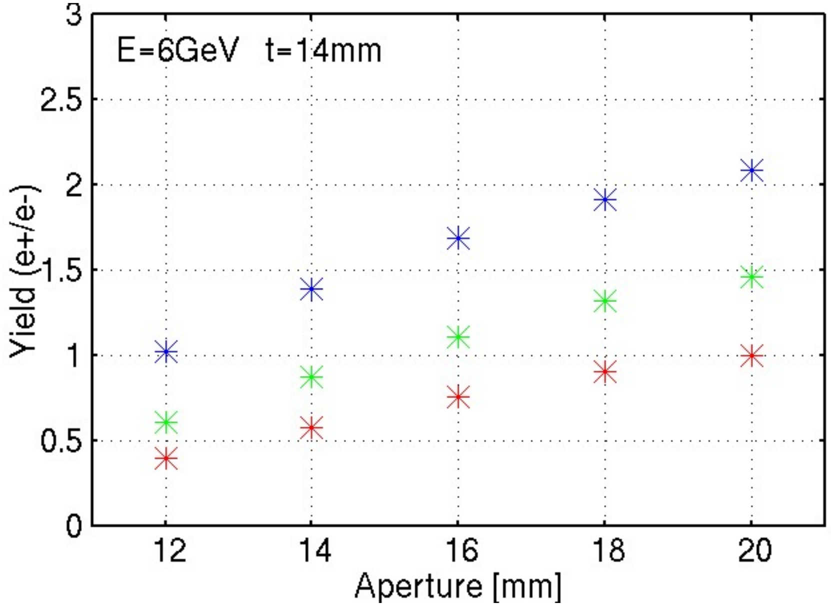
Capture Section
G=16.6MV/m
E = 250MeV
B = 0.5 T

sigma = 4mm
sigma = 3mm
sigma = 2mm

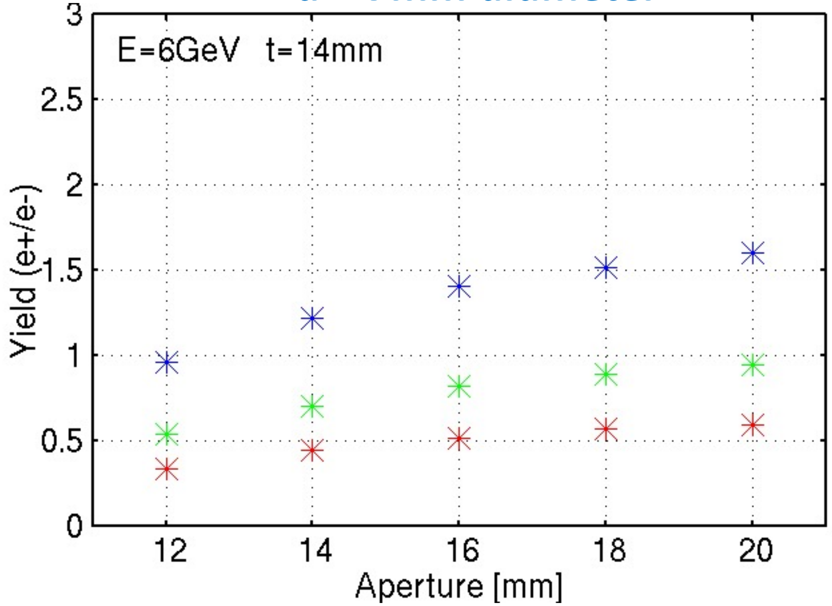
Result of Capture Simulation

after Energy Compressor
with Longitudinal & Transverse Cut

a = 12mm diameter

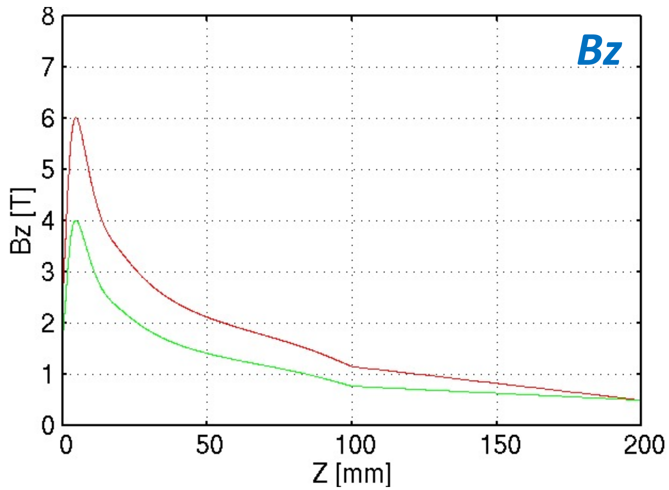


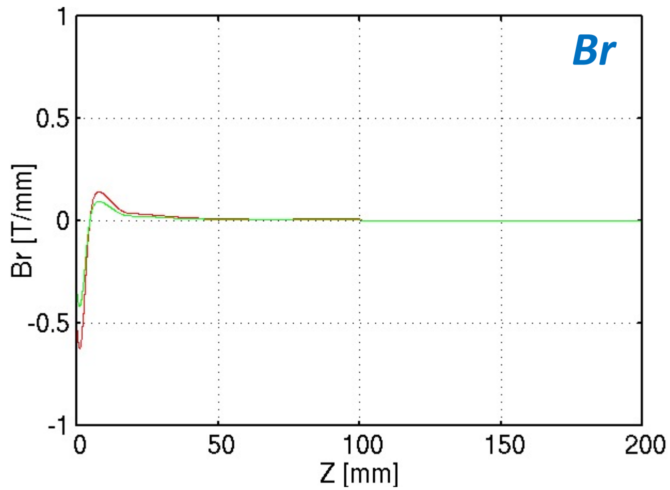
a = 7mm diameter



Large impact to the yield, when capture section has large aperture.

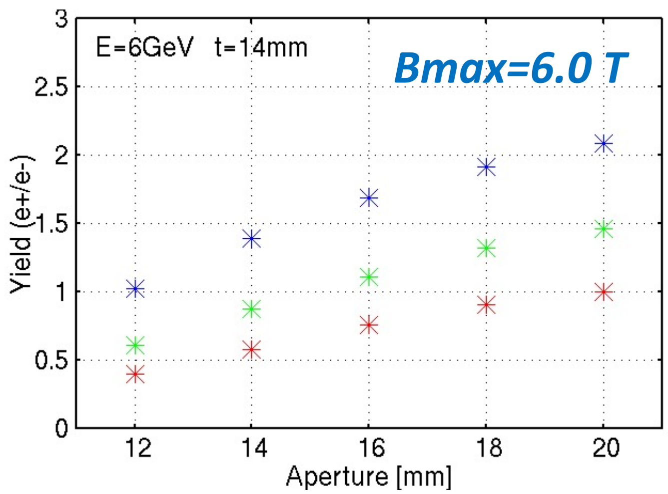
Strength of the Maximum Field of AMD

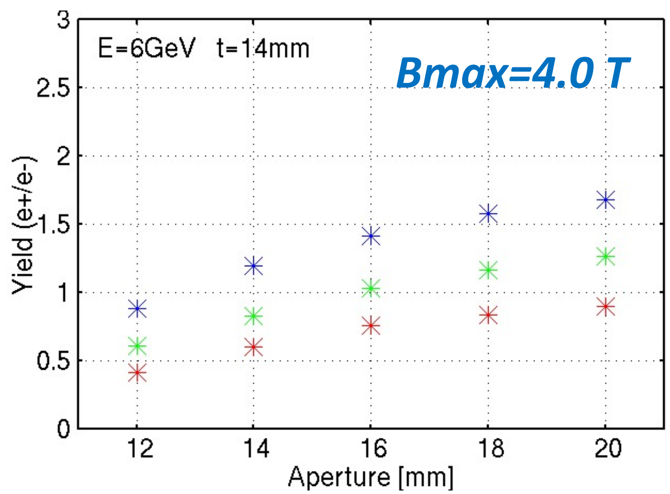




Flux Concentrator
B = 6.0T

Capture Section
G=16.6MV/m
E = 250MeV
B = 0.5 T

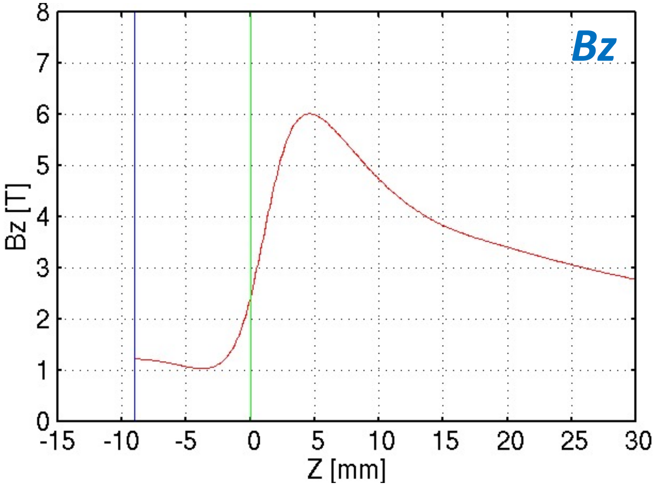


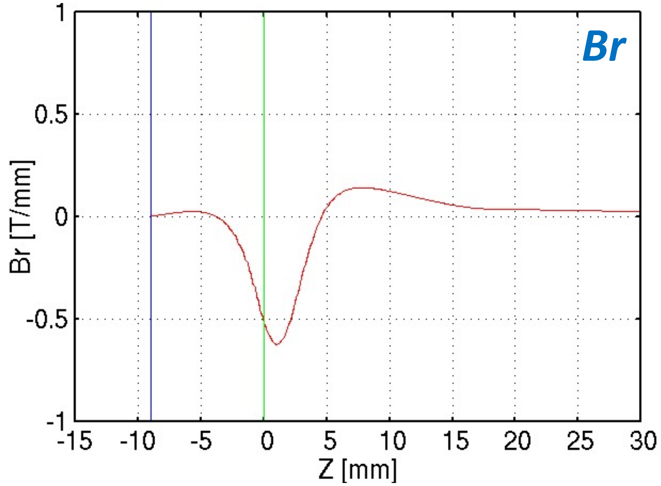


sigma = 4mm
sigma = 3mm
sigma = 2mm

Small impact, when electron spot size is large.

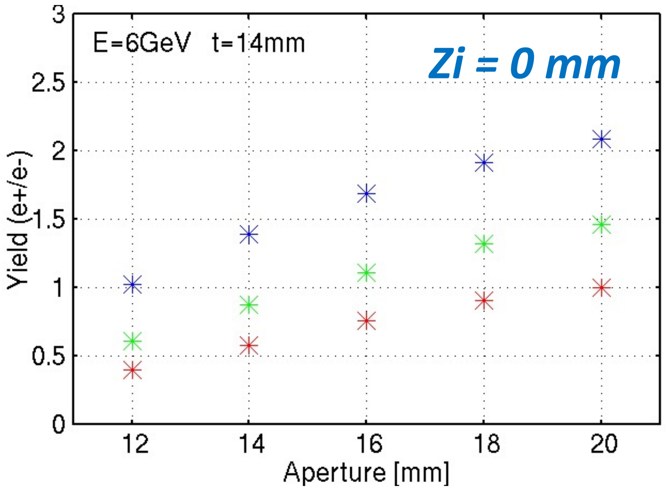
Distance between Target and AMD

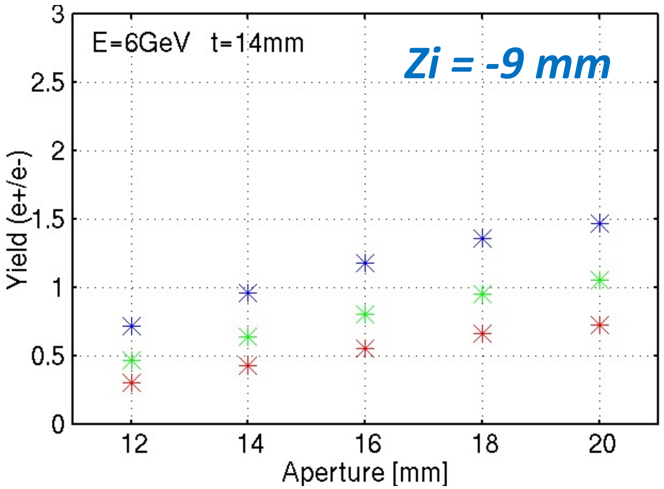




Flux Concentrator
B = 6.0T

Capture Section
G=16.6MV/m
E = 250MeV
B = 0.5 T





sigma = 4mm
sigma = 3mm
sigma = 2mm

Very Large impact !

Summary

The beam loading in the capture section is twice as the loading generated by positron beam.

We need to design the beam loading compensation.

I checked the impact to the positron yield for the following parameters.

Injection Electron Beam

- *Beam Energy*
- *Beam Spot Size*

Positron Converter Target

- *Thickness*

Flux Concentrator

- *Aperture*
- *Field Strength*
- *Distance between target and AMD*

Capture Section

- *Aperture*
- *Gradient of RF Cavity*
- *Beam Energy at the entrance of Booster Linac*
- *Strength of Solenoid Field*

We need optimize above parameters.