SuperB positrons production LINAC

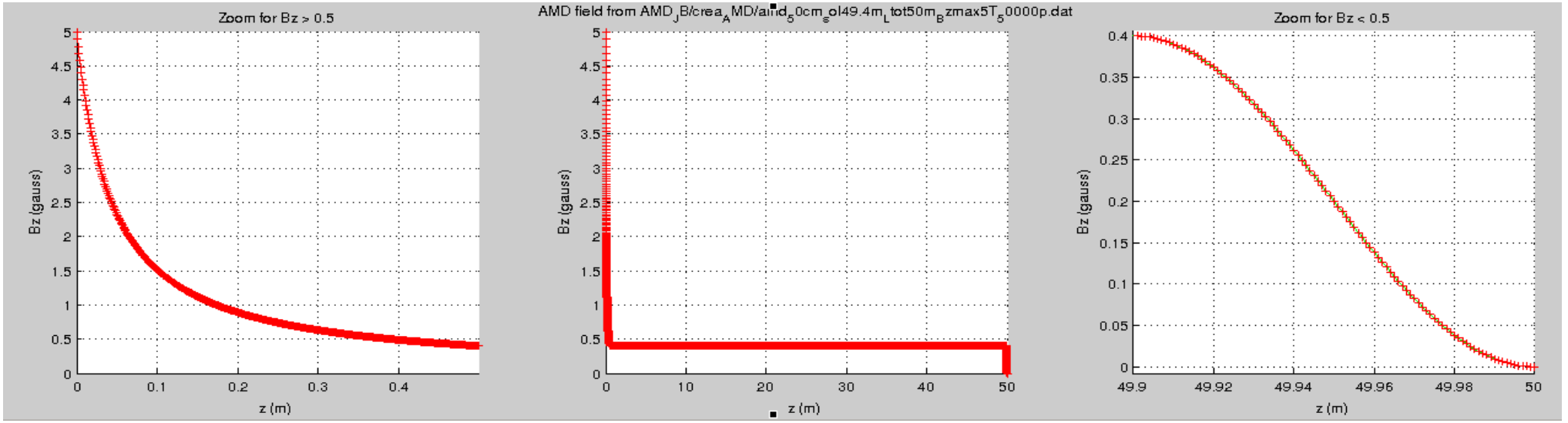
What is the effect of a TM020-2pi/3 3GHz cavity for the decceleration section, before a L-Band LINAC (up to 250-300 MeV) ?

J. Brossard 2012, may 22.

Part I :

Simulation using 1428 MHz “travelling wave, constant gradient” TM010-2pi/3 cavity mode (1st cavity in decceleration mode)

E(e-)=1500 MeV
L_AMD=0.5 m (Bmax=5T Bcst=0.4T)
amd_50cm_sol30m_Ltot30.6m_Bzmax5T_50000p.dat
→ Effect of the “aperture radius” vale (r=15, 20 and 25 mm)

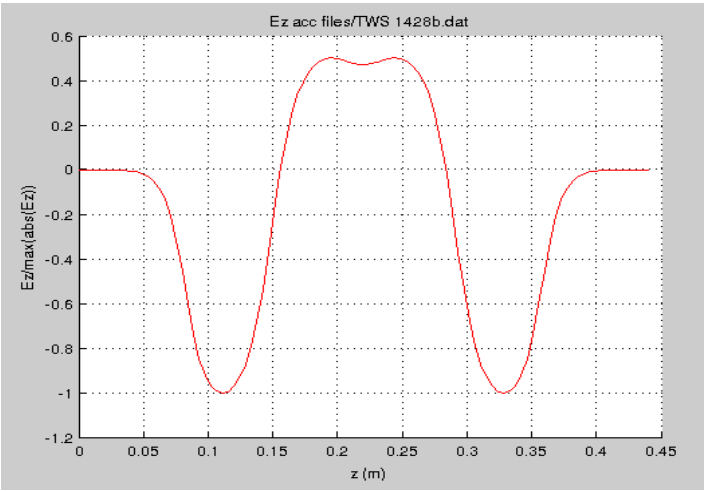


Cavity 1
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=?? Phase=??
Zstop=6.61 m

Cavity 2
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop=12.91 m

Cavity 3
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop=19.21 m

Cavity 4
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop=25.51 m

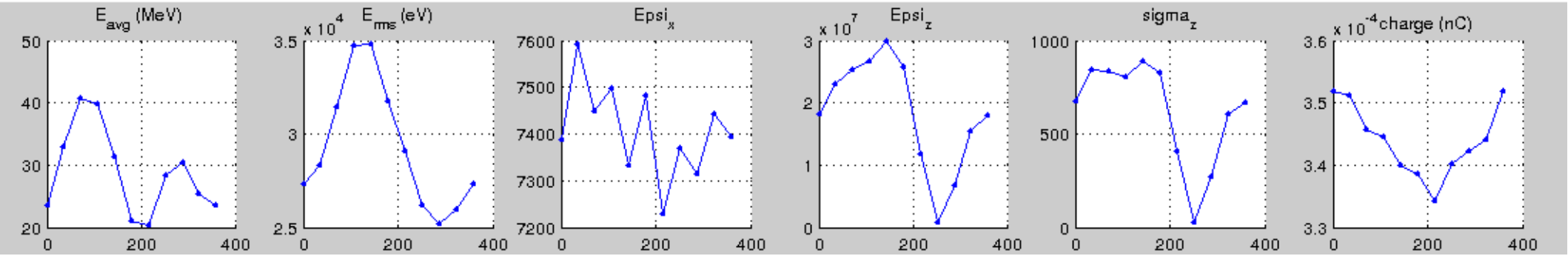


determine_length_TANK_TWS('TWS_1428b.dat',84)
 L_total = 0.43992
 L_coupler_in = 0.11499 m
 L_coupler_out = 0.11499 m
 L_middle = 0.20994
 Tank length = 6.1083 m

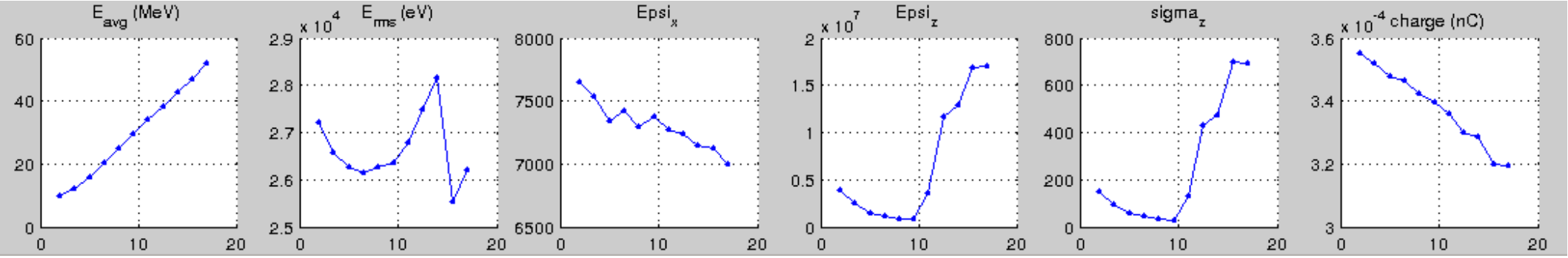
E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		10 000 e+

Search for “optimum”

- phase cavities values
- gradient 1st cavity value
- 10 000 e+ used only (for speed computation)



Bunch length is minimized around phase(1)=250°

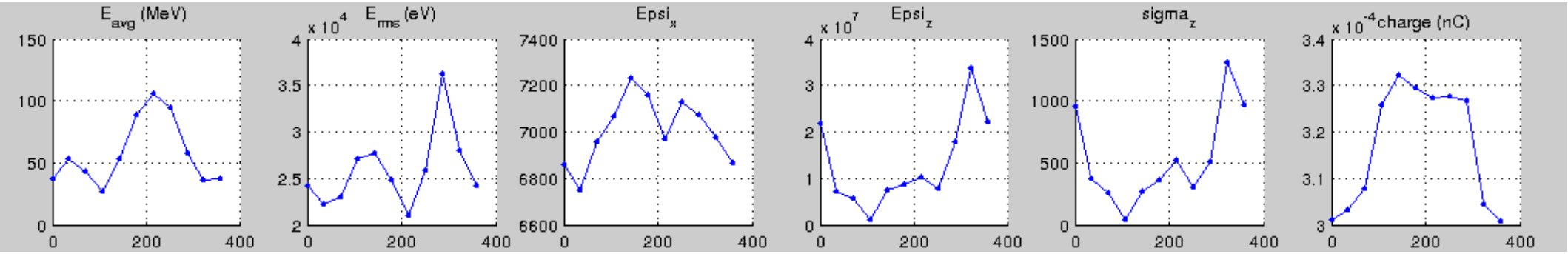


Bunch length is minimized around Eacc=9MV/m

Drift after cav 1 = 0.19 m

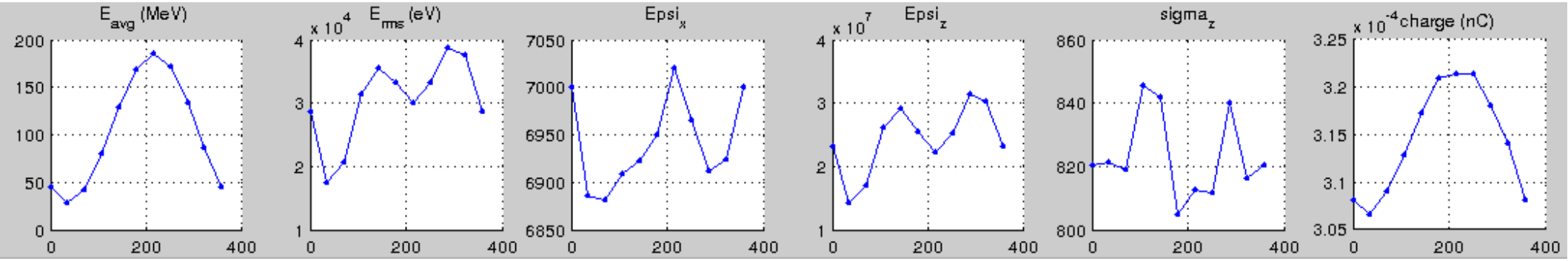
E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		10 000 e+

ZSTOP=12.91 m



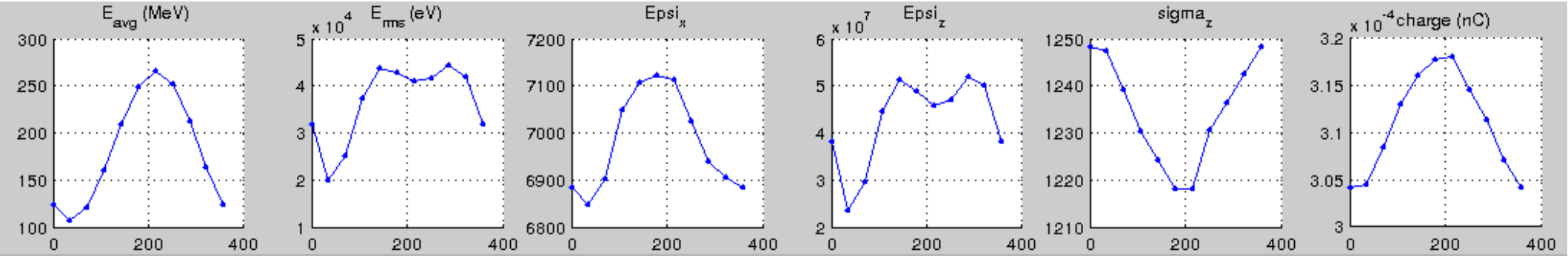
Cav 2 Eacc fixed 20 MV/m phase =220°

ZSTOP=19.21 m



Cav 3 Eacc fixed 20 MV/m phase =220°

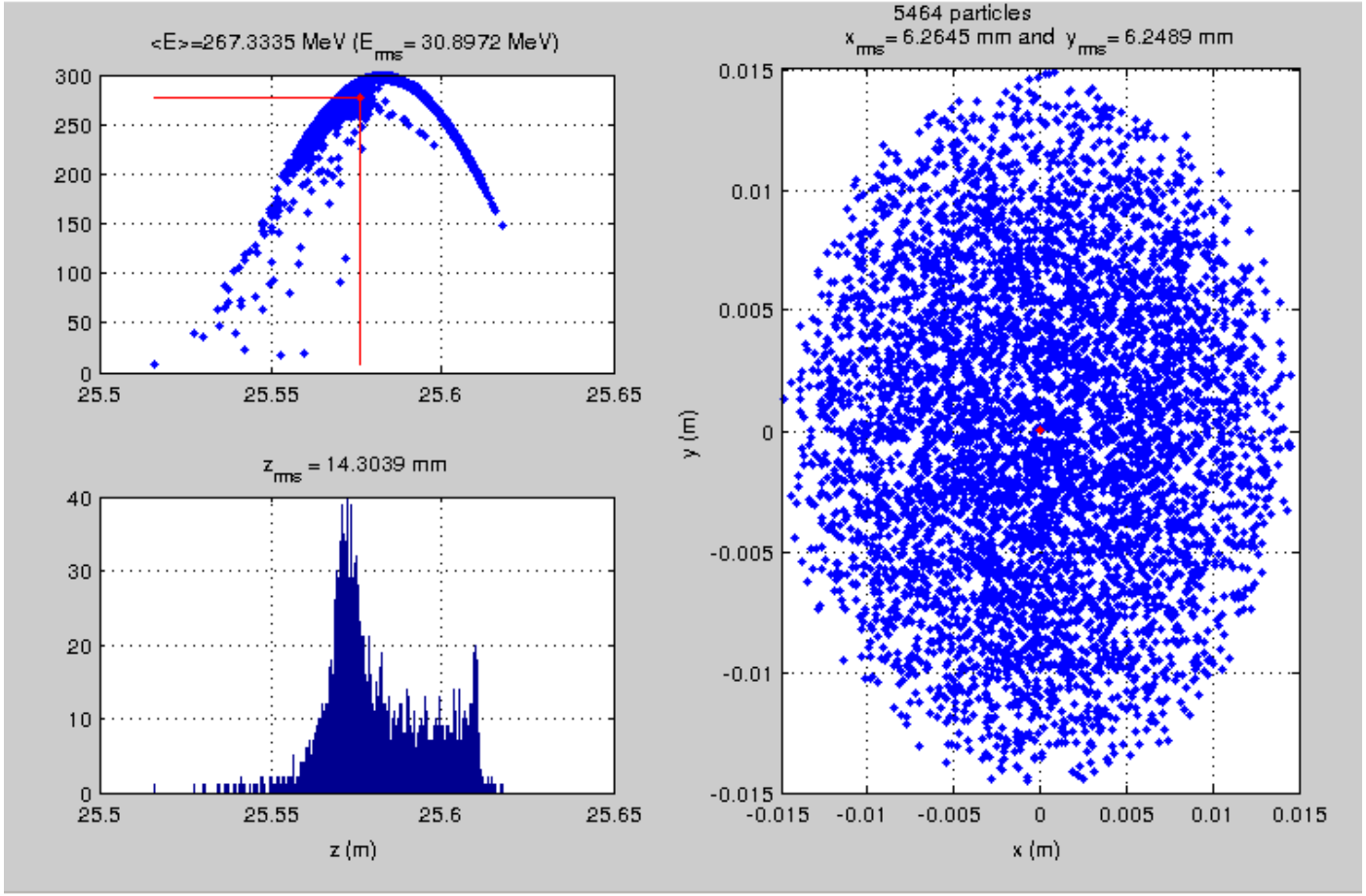
ZSTOP=25.51 m



Cav 4 Eacc fixed 20 MV/m phase =220°

E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)

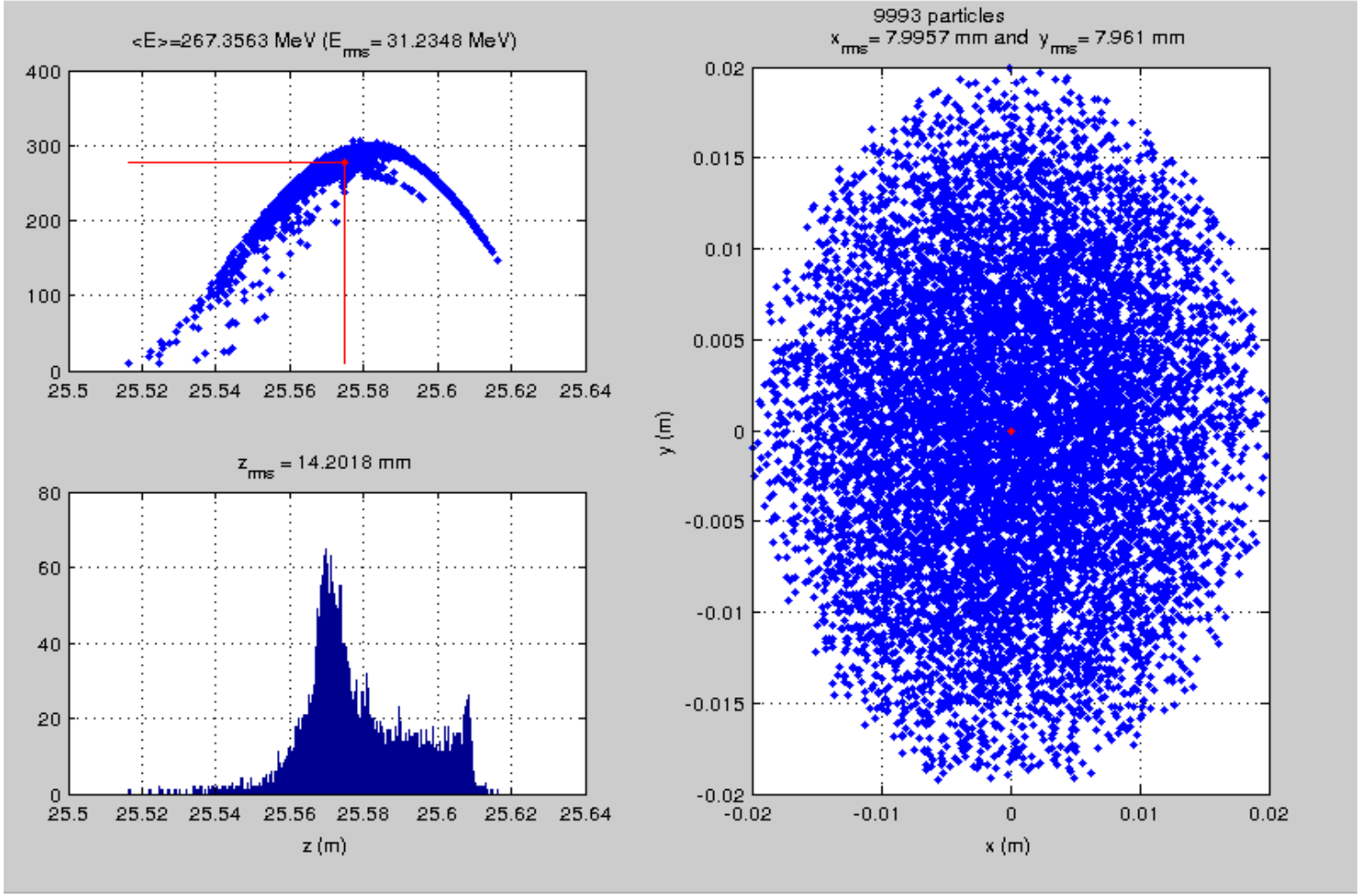



```
The selected beam as the following properties :
rms beam size (x) = 6.2645 mm
rms beam size (xp) = 1.459 mrad
rms beam size (y) = 6.2489 mm
rms beam size (yp) = 1.4312 mrad
rms beam size (z) = 14.3039 mm
rms beam size (zp) = 67.4864 mrad
mean(Ekin) = 262.9061 MeV  (Ecin_rms = 42.905 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*
epsix_trace_rms= 8.9315 (mm.mrad)      alphax= -0.11369        betax= 4.3939 gammax=0.23053
epsiy_trace_rms= 8.7634 (mm.mrad)      alphay= -0.085897       betay= 4.4558 gammay=0.22608
epsiz_trace_rms= 1616.9118 (mm.mrad)   alphaz= 0.20349 betaz= 0.12654 gammaz=8.23       betaz
```

Yield = 5464/(50 000*50 000/196 467)*100= 43%

E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)

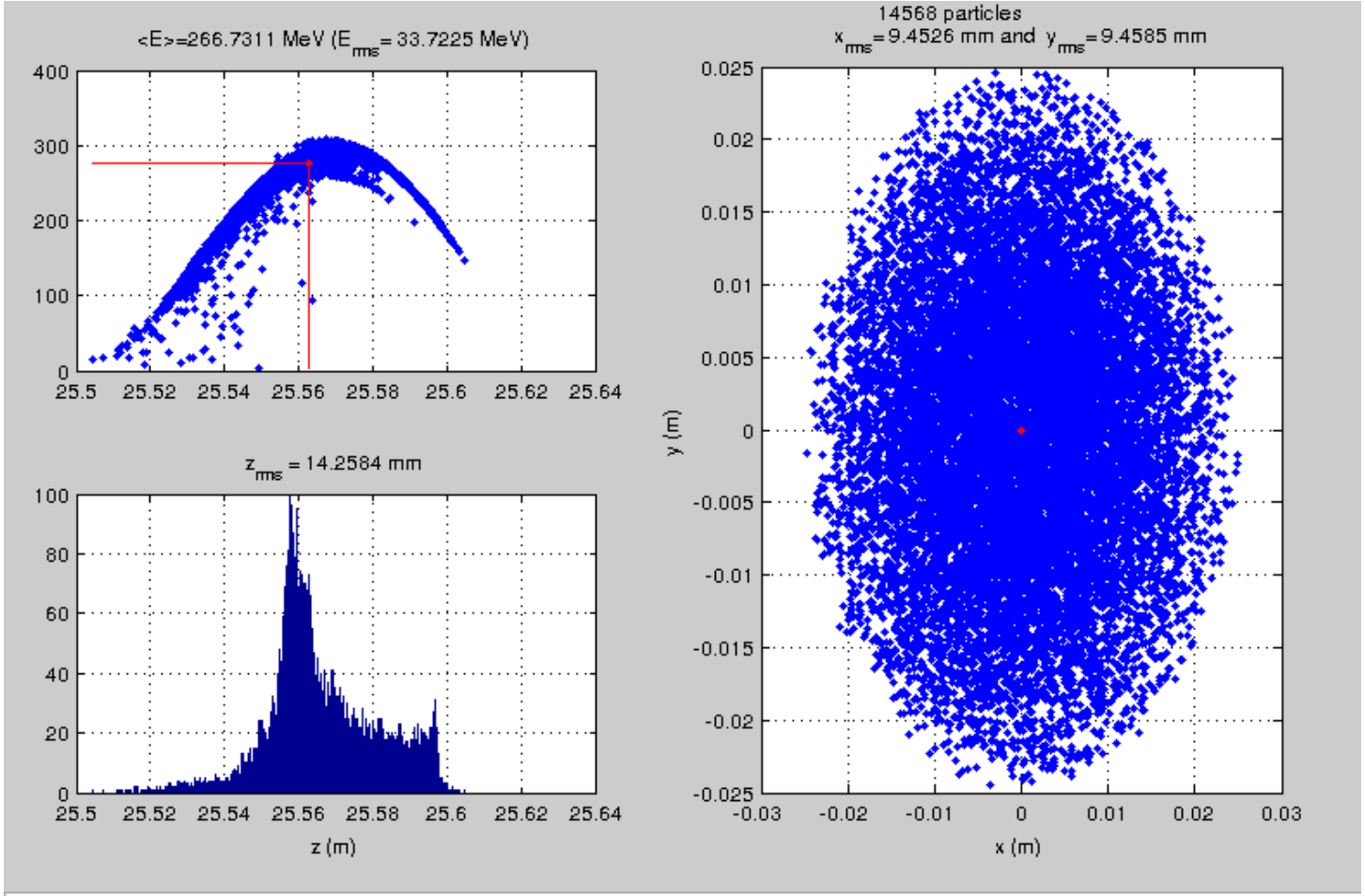



```
The selected beam as the following properties :
rms beam size (x) = 7.9957 mm
rms beam size (xp) = 1.8835 mrad
rms beam size (y) = 7.961 mm
rms beam size (yp) = 1.9 mrad
rms beam size (z) = 14.2018 mm
rms beam size (zp) = 68.8293 mrad
mean(Ekin) = 263.4002 MeV  (Ecin_rms = 42.0402 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*gamm
epsix_trace_rms= 14.7489 (mm.mrad)     alphax= -0.10981        betax= 4.3346 gammax=0.23348     be
epsiy_trace_rms= 14.8649 (mm.mrad)     alphay= -0.071579       betay= 4.2636 gammay=0.23575     be
epsiz_trace_rms= 1653.2363 (mm.mrad)   alphaz= 0.058292        betaz= 0.122 gammaz=8.2247       be
```

Yield =9993/(50 000*50 000/196 467)*100= 79%

E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)



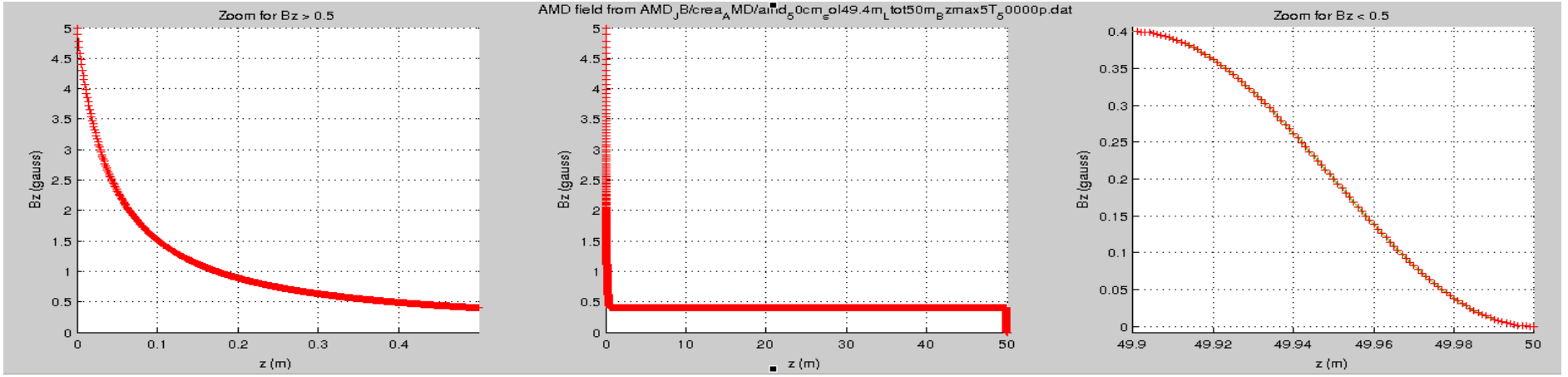

```
The selected beam as the following properties :
rms beam size (x) = 9.4526 mm
rms beam size (xp) = 2.29 mrad
rms beam size (y) = 9.4585 mm
rms beam size (yp) = 2.2892 mrad
rms beam size (z) = 14.2584 mm
rms beam size (zp) = 76.6418 mrad
mean(Ekin) = 262.7492 MeV  (Ecin_rms = 44.1328 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*ga
epsix_trace_rms= 21.2192 (mm.mrad)     alphax= -0.099449       betax= 4.2109 gammax=0.23983
epsiy_trace_rms= 21.2541 (mm.mrad)     alphay= -0.084672       betay= 4.2092 gammay=0.23928
epsiz_trace_rms= 1790.0654 (mm.mrad)   alphaz= -0.10162        betaz= 0.11357 gammaz=8.8958
```

Yield =14 568/(50 000*50 000/196 467)*100= 114%

Part II :

Simulation using 3GHz "travelling wave, constant gradient" TM020-2pi/3 cavity mode (1st cavity in decceleration mode)

E(e-)=1500 MeV
L_AMD=0.5 m (Bmax=5T Bcst=0.4T)
amd_50cm_sol30m_Ltot30.6m_Bzmax5T_50000p.dat
→ Effect of the “aperture radius” vale (r=15, 20 and 25 mm)

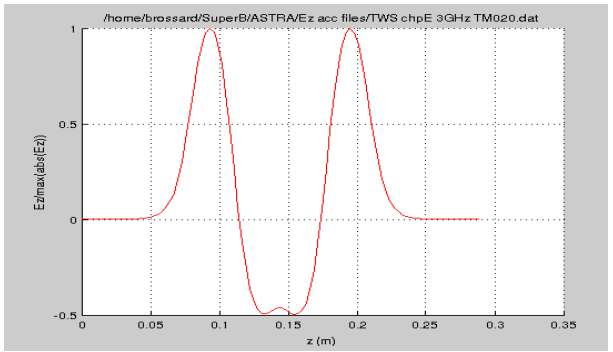


Cavity 1
TWS_3_ENM.dat file
freq=3GHz
L_cav=2.9855 m
Drift=0.19 m
Eacc=?? Phase=??
Zstop=3.49 m

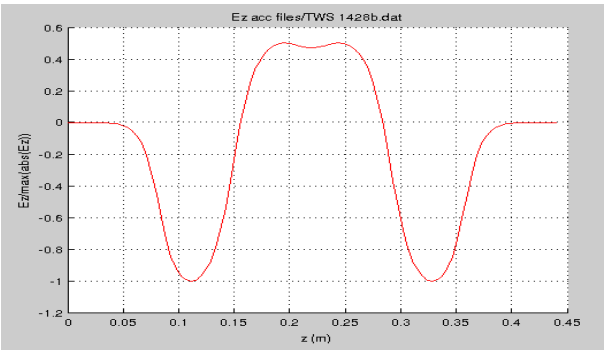
Cavity 2
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop=9.79 m

Cavity 3
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop=16.09 m

Cavity 4
TWS_1428b.dat file
freq=1.428 GHz
L_cav=6.1083 m
Drift=0.19 m
Eacc=20MV/m Phase=??
Zstop= 22.39m



determine_length_TANK_TWS('Ez_acc_files/TWS_chpE_3GHz_TM020.dat',84)
L_total = 0.2882
L_coupler_in = 0.09415 m
L_coupler_out = 0.09415 m
L_middle = 0.0999
Tank length = 2.9855 m

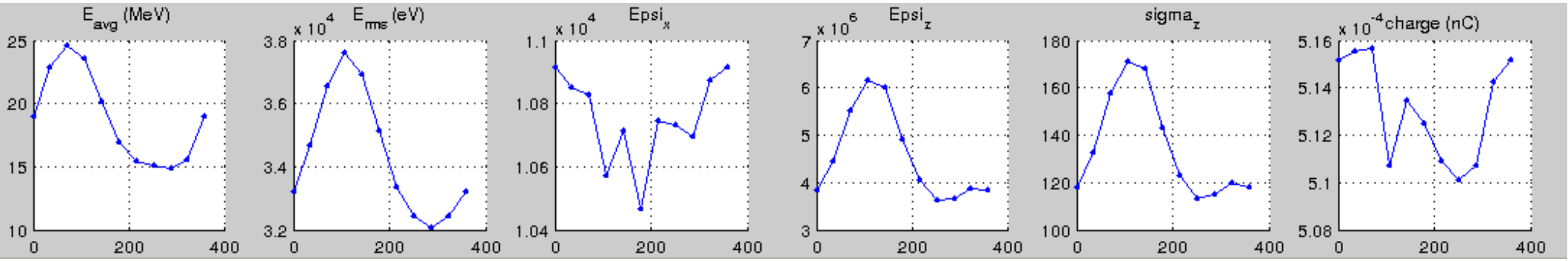


determine_length_TANK_TWS('TWS_1428b.dat',84)
L_total = 0.43992
L_coupler_in = 0.11499 m
L_coupler_out = 0.11499 m
L_middle = 0.20994
Tank length = 6.1083 m

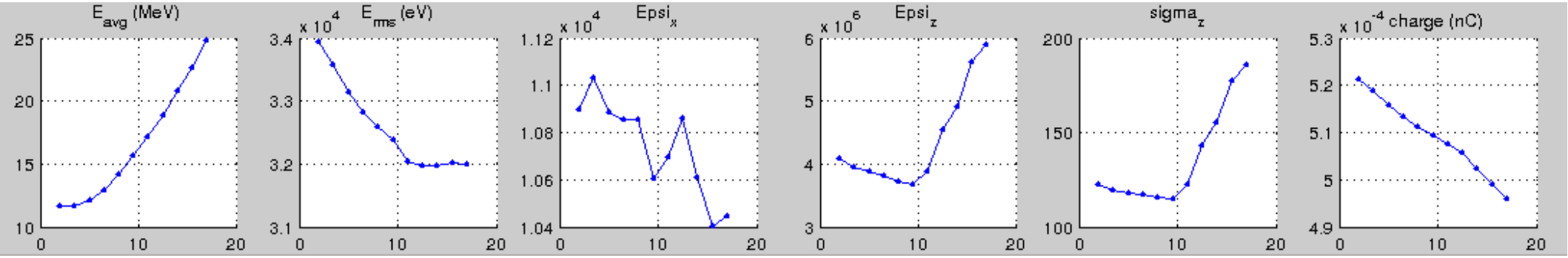
E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		10 000 e+

Search for “optimum”

- phase cavities values
- gradient 1st cavity value
- 10 000 e+ used only (for speed computation)



Bunch length is minimized around phase(1)=250°

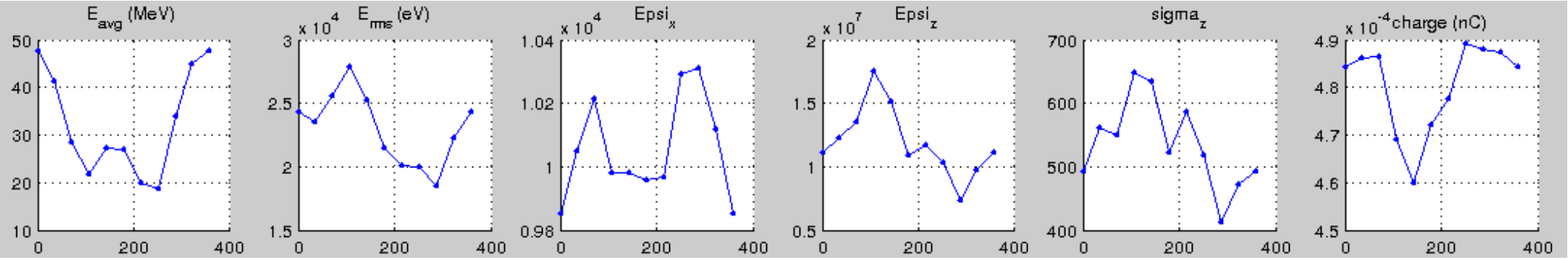


Bunch length is minimized around Eacc=10MV/m

Drift after cav 1 = 0.19 m

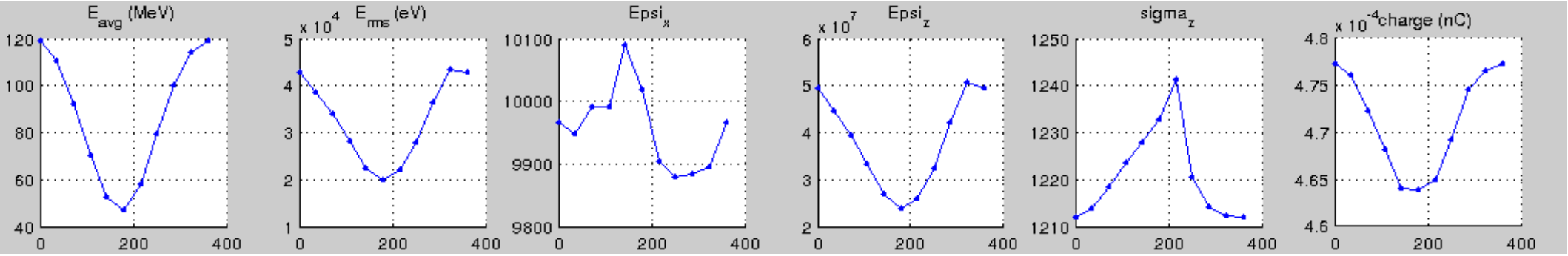
E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		10 000 e+

ZSTOP=9.79 m



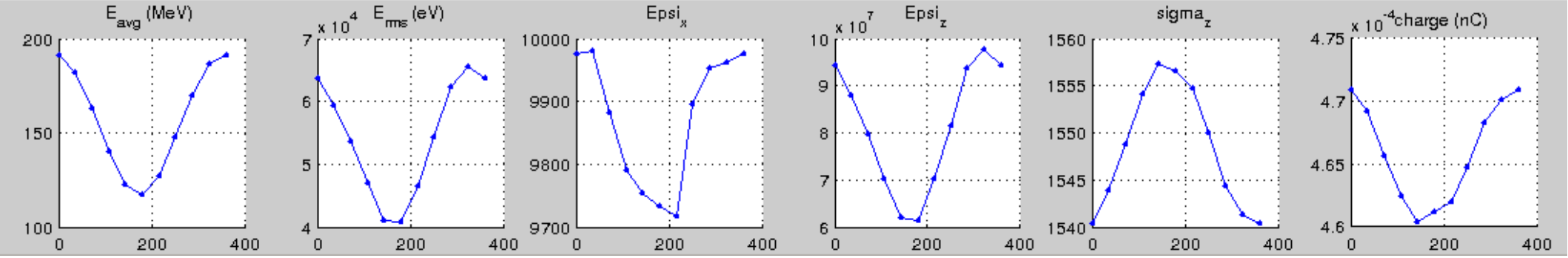
Cav 2 Eacc fixed 20 MV/m phase =0°

ZSTOP=16.09 m



Cav 3 Eacc fixed 20 MV/m phase =0°

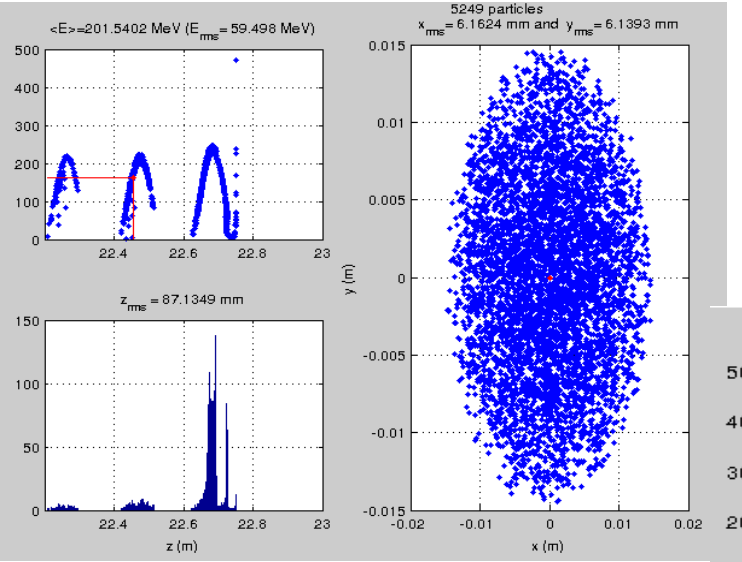
ZSTOP=22.39 m

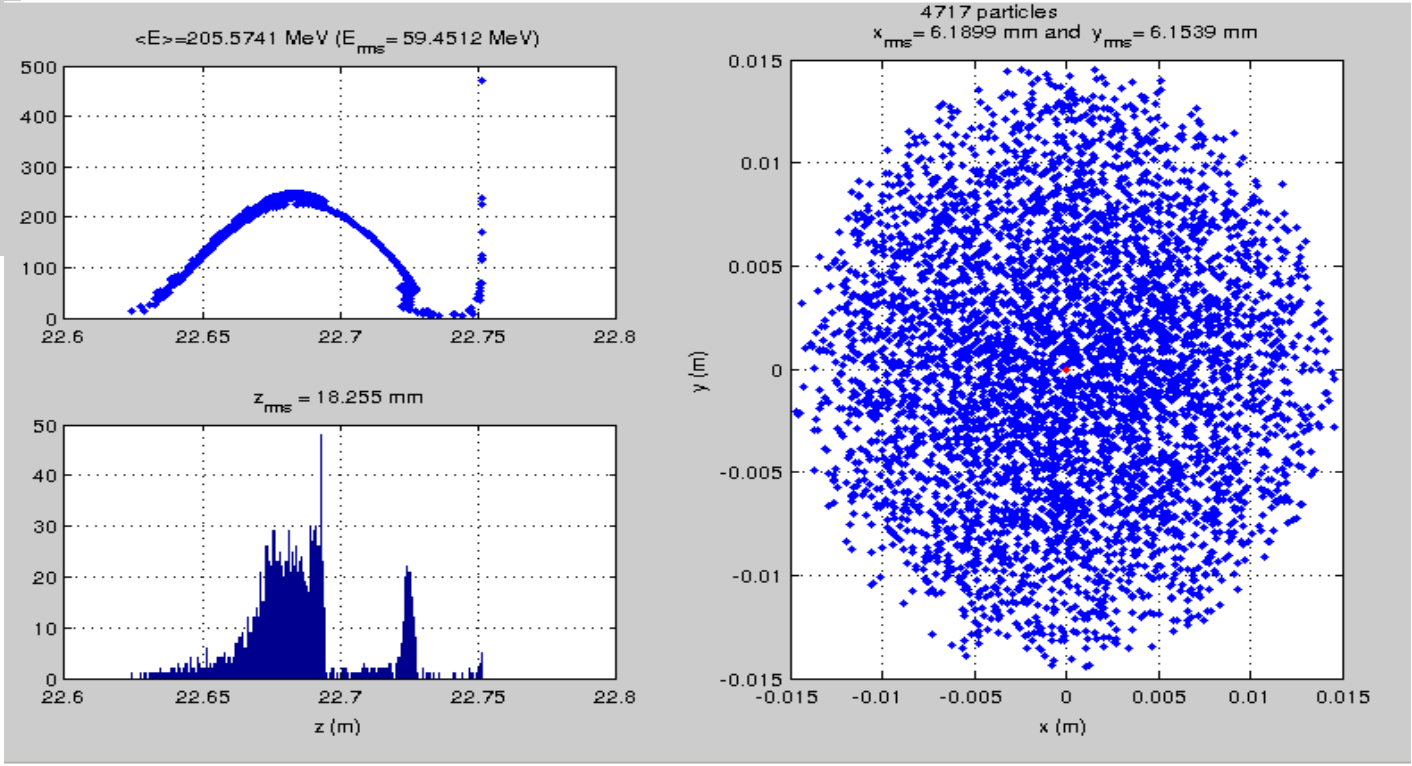


Cav 4 Eacc fixed 20 MV/m phase =0°

E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)





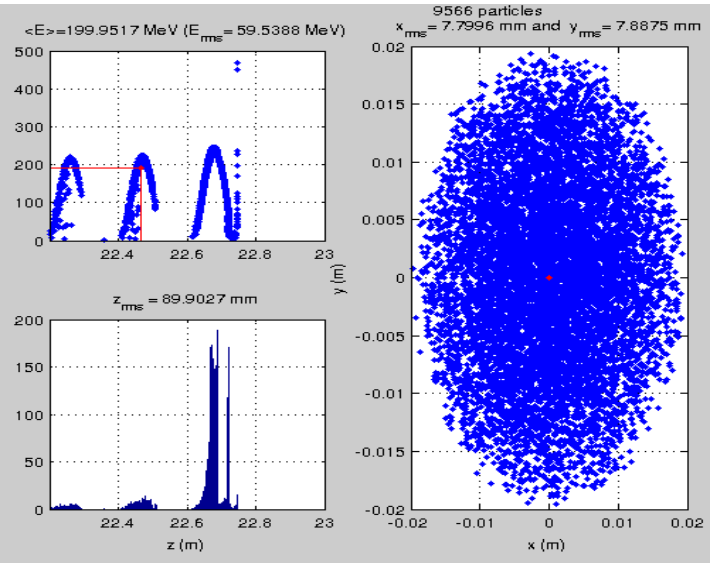
Reference particle is outside the principal bunch !!

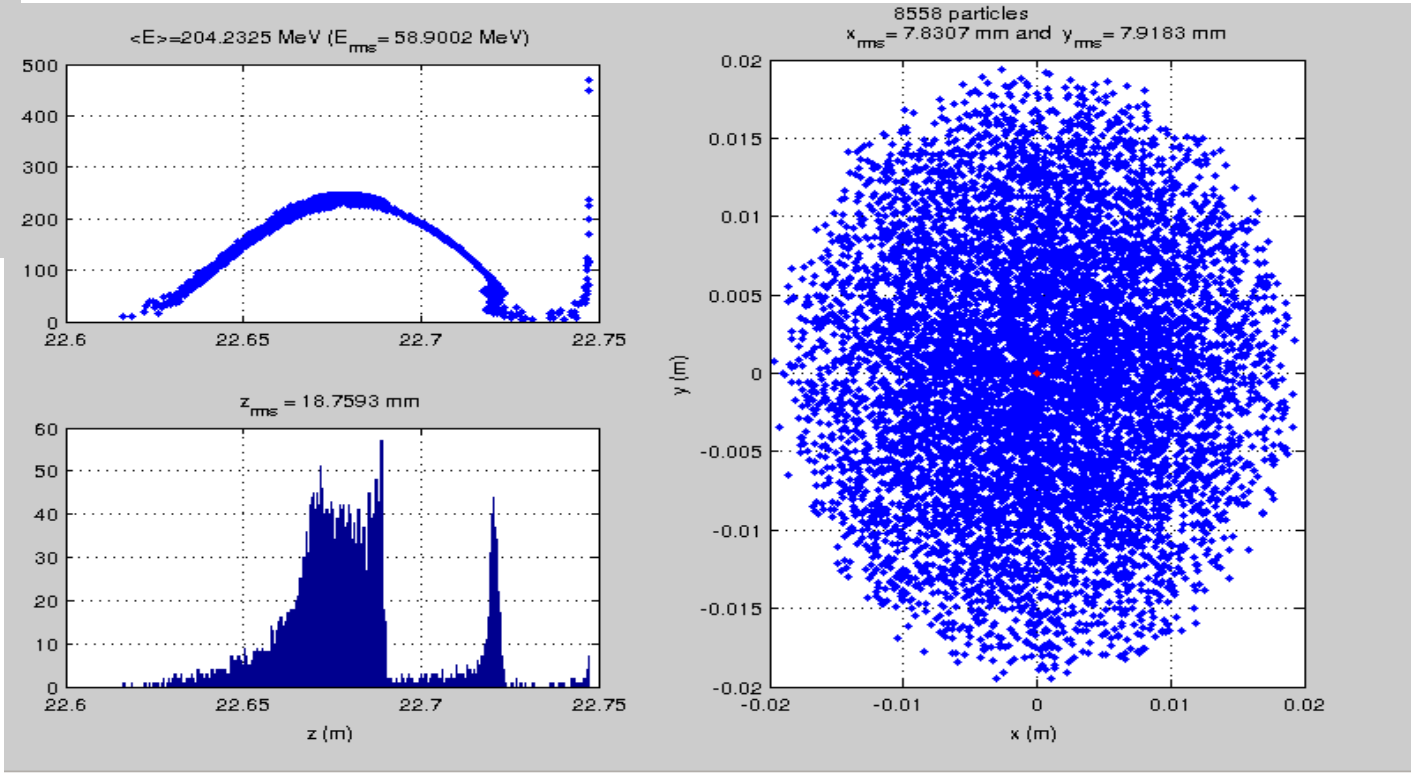
```
The selected beam as the following properties :
rms beam size (x) = 6.1899 mm
rms beam size (xp) = 2.0133 mrad
rms beam size (y) = 6.1539 mm
rms beam size (yp) = 2.0275 mrad
rms beam size (z) = 18.255 mm
rms beam size (zp) = 194.1411 mrad
mean(Ekin) = 196.4206 MeV  (Ecin_rms = 63.1609 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*gamm
epsix_trace_rms= 11.9069 (mm.mrad)     alphax= -0.015211       betax= 3.2179 gammax=0.31084     be
epsiy_trace_rms= 11.9227 (mm.mrad)     alphay= -0.00032751     betay= 3.1763 gammay=0.31483     be
epsiz_trace_rms= 4552.2041 (mm.mrad)   alphaz= 0.58172 betaz= 0.073206 gammaz=18.2827   betaz*gamm
```

Yield = 4717/(50 000*50 000/196 467)*100= 37%

E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)





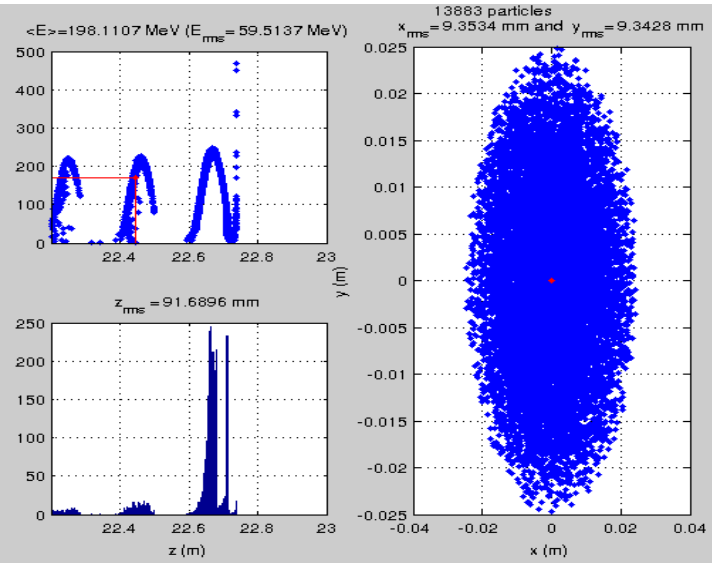
Reference particle is outside the principal bunch !!

```
The selected beam as the following properties :
rms beam size (x) = 7.8307 mm
rms beam size (xp) = 2.5641 mrad
rms beam size (y) = 7.9183 mm
rms beam size (yp) = 2.5298 mrad
rms beam size (z) = 18.7593 mm
rms beam size (zp) = 191.3313 mrad
mean(Ekin) = 194.6738 MeV  (Ecin_rms = 63.8447 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*gamma
epsix_trace_rms= 19.1411 (mm.mrad)     alphax= -0.0053385      betax= 3.2035 gammax=0.31216      bet
epsiy_trace_rms= 19.0938 (mm.mrad)     alphay= 0.018232        betay= 3.2838 gammay=0.30463      bet
epsiz_trace_rms= 4813.7787 (mm.mrad)   alphaz= 0.5069  betaz= 0.073105 gammaz=17.1937   betaz*gamma
```

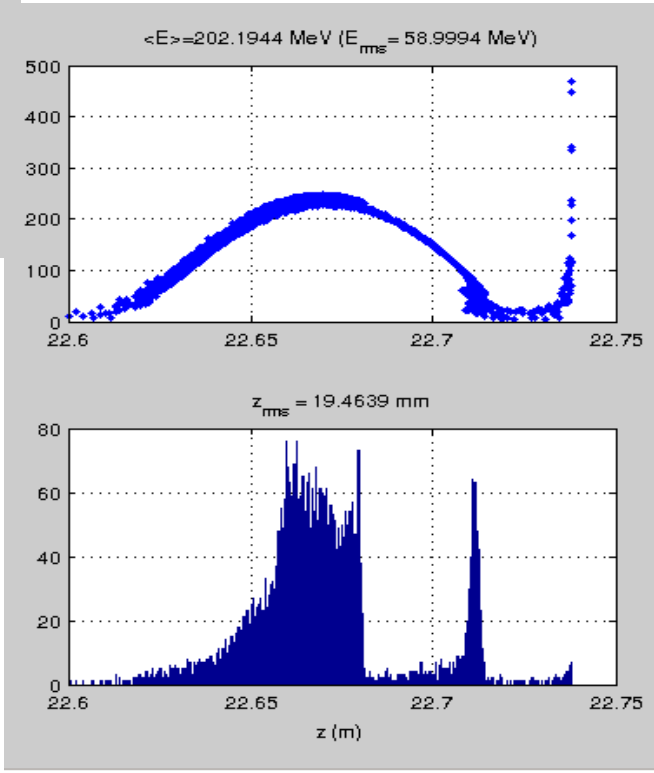
Yield =8558/(50 000*50 000/196 467)*100= 67%

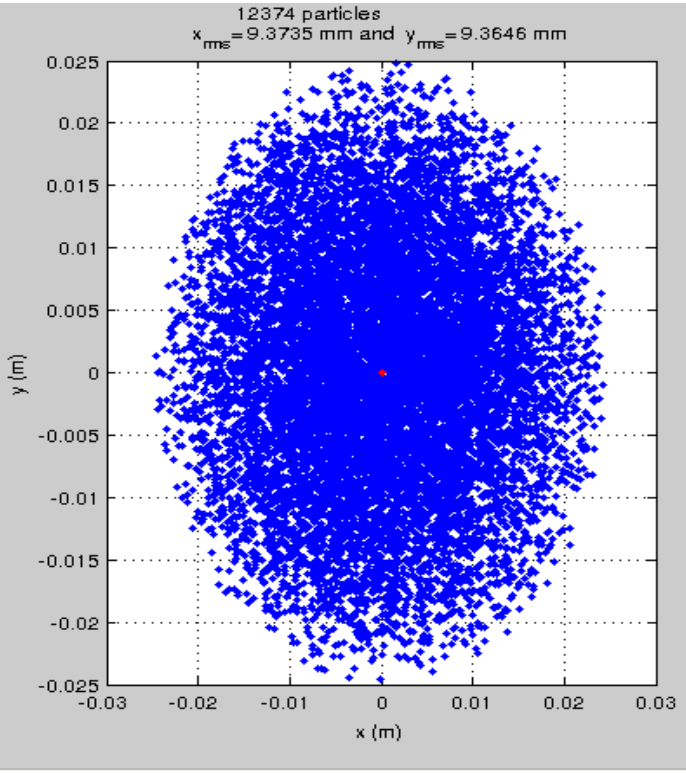
E(e-)=1500 MeV	50 000 points for Bz	Aper=15 mm Aper=20 mm Aper=25 mm
		50 000 e+

ASTRA computation performed using 50 000 e+ (↔ 12 724 impinging e- at 1500 MeV)



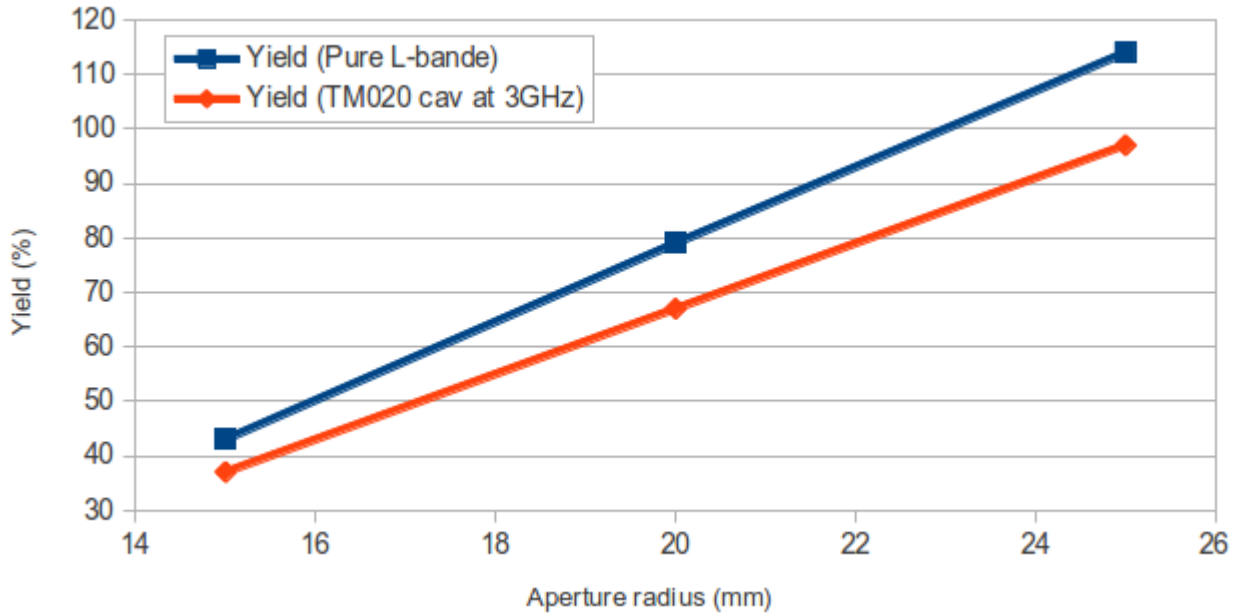
Reference particle is outside the principal bunch !!






```
The selected beam as the following properties :
rms beam size (x) = 9.3735 mm
rms beam size (xp) = 3.0951 mrad
rms beam size (y) = 9.3646 mm
rms beam size (yp) = 3.049 mrad
rms beam size (z) = 19.4639 mm
rms beam size (zp) = 191.9482 mrad
mean(Ekin) = 192.098 MeV  (Ecin_rms = 64.804 MeV)     ( beta*gamma-alpha^1 = 1 )     ( beta*gamma-alp
epsix_trace_rms= 27.56 (mm.mrad)       alphax= 0.022766        betax= 3.188 gammax=0.31384      betax
epsiy_trace_rms= 27.1246 (mm.mrad)     alphay= 0.020783        betay= 3.233 gammay=0.30944      betay
epsiz_trace_rms= 5151.574 (mm.mrad)    alphaz= 0.45769 betaz= 0.073539 gammaz=16.4467   betaz*gammaz-
```

Yield =12 374/(50 000*50 000/196 467)*100= 97%



2nd solution--> 85% of the Yield given by 1st solution