absorbers for STEPIII

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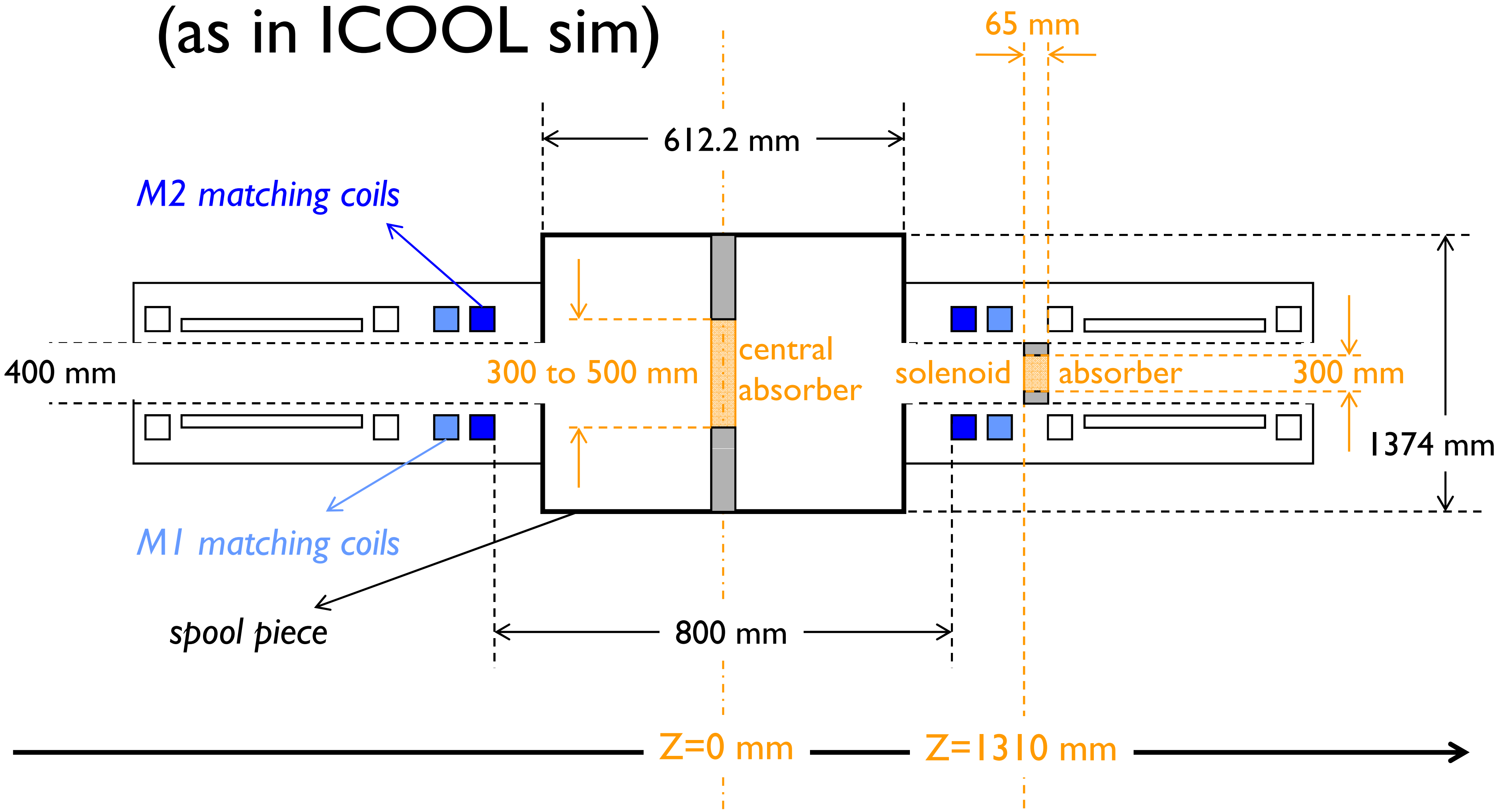
The case:

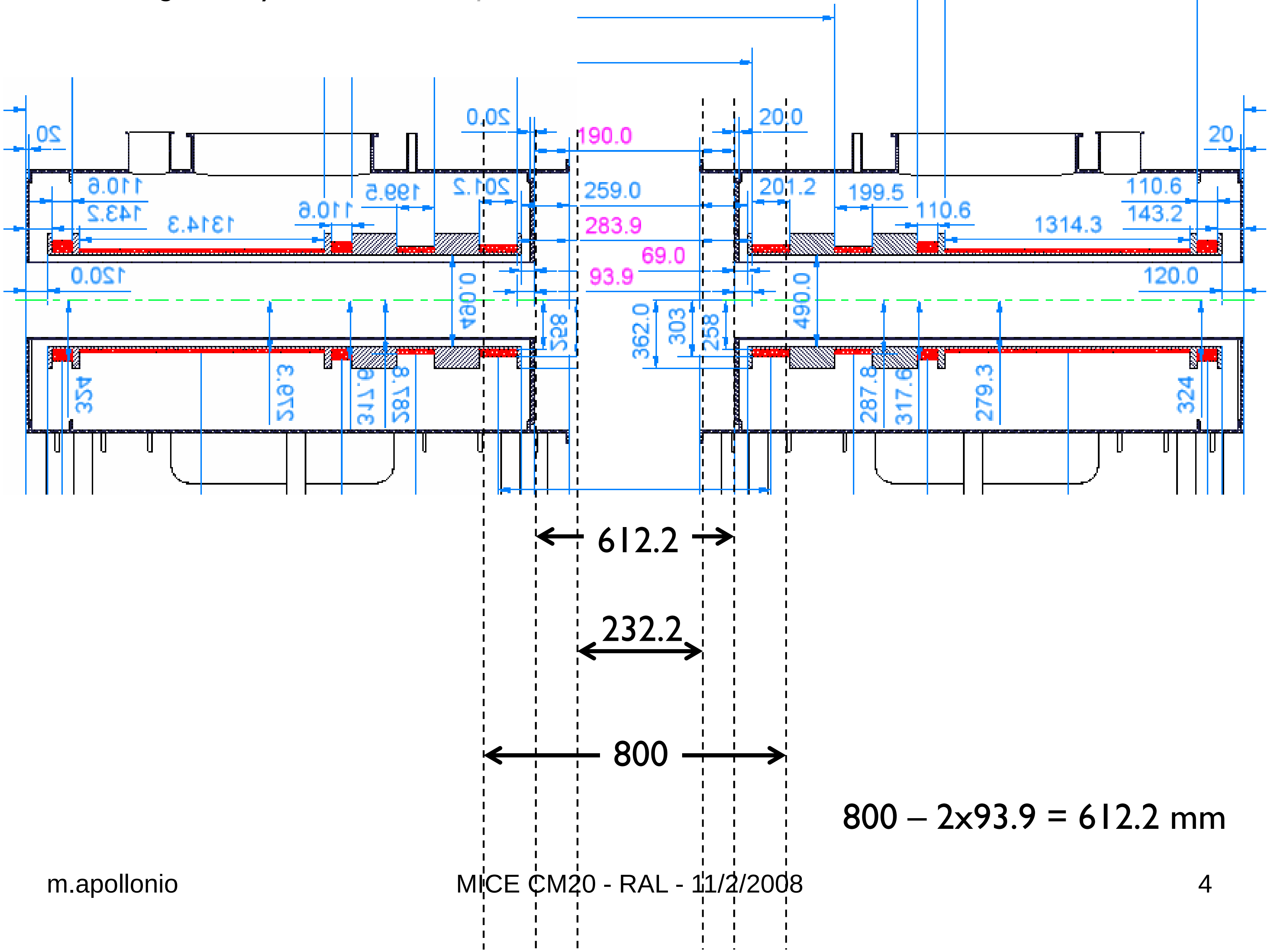
proposal to use a solid LiH target during step III

Possible configurations:

- flip/non flip mode
- centre/in-solenoid absorber
- different radii

geometry highlights and naming conventions (as in ICOOL sim)





800 – 2x93.9 = 612.2 mm

- thickness to produce a ~12 MeV/c momentum drop (as with H_2 abs)

- 6.5 cm of LiH

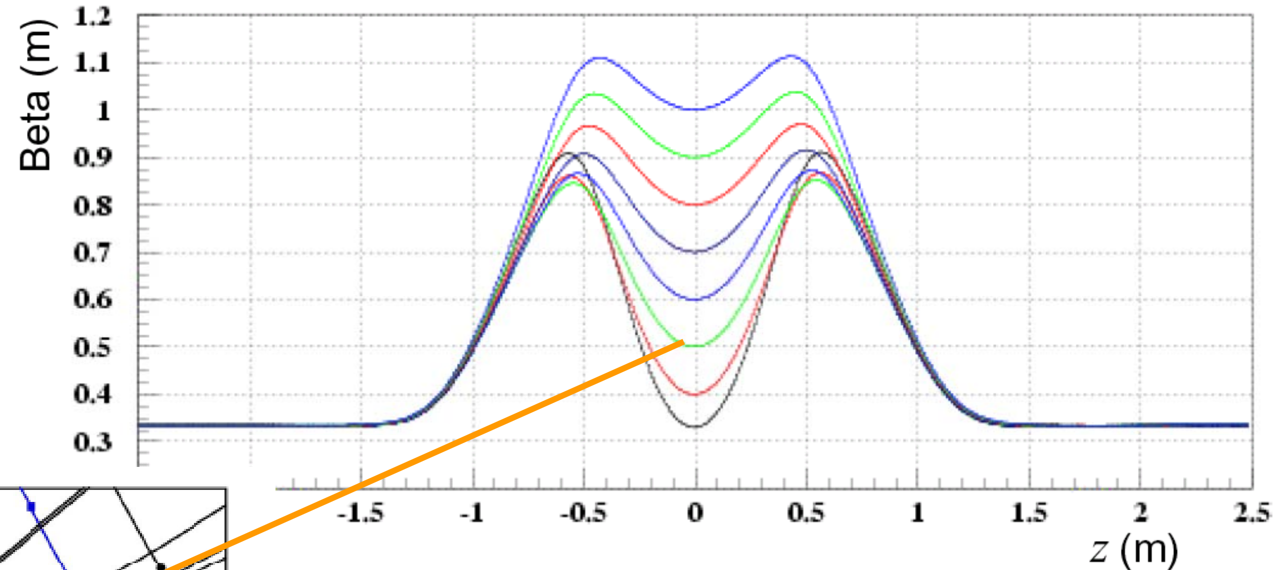
- beta tuning and matching
  - no energy loss (no material)
  - with energy loss (material)
  - emittance change [to be done]

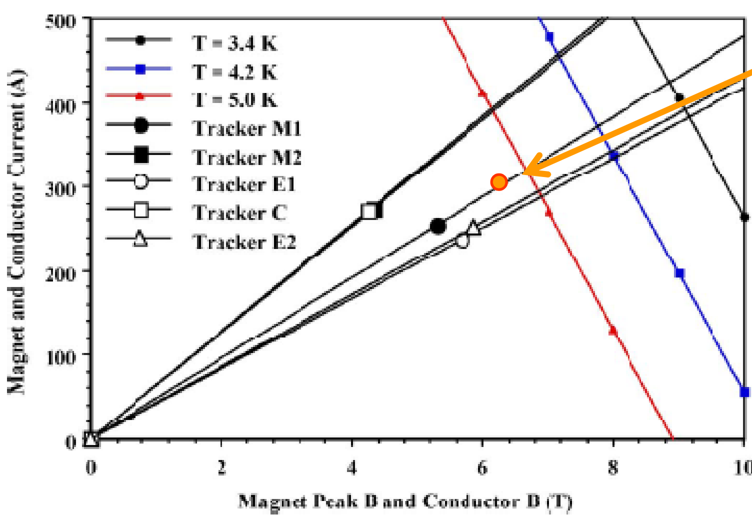
general considerations on beta

Play with M1,M2

but within

- temp margin
- max current



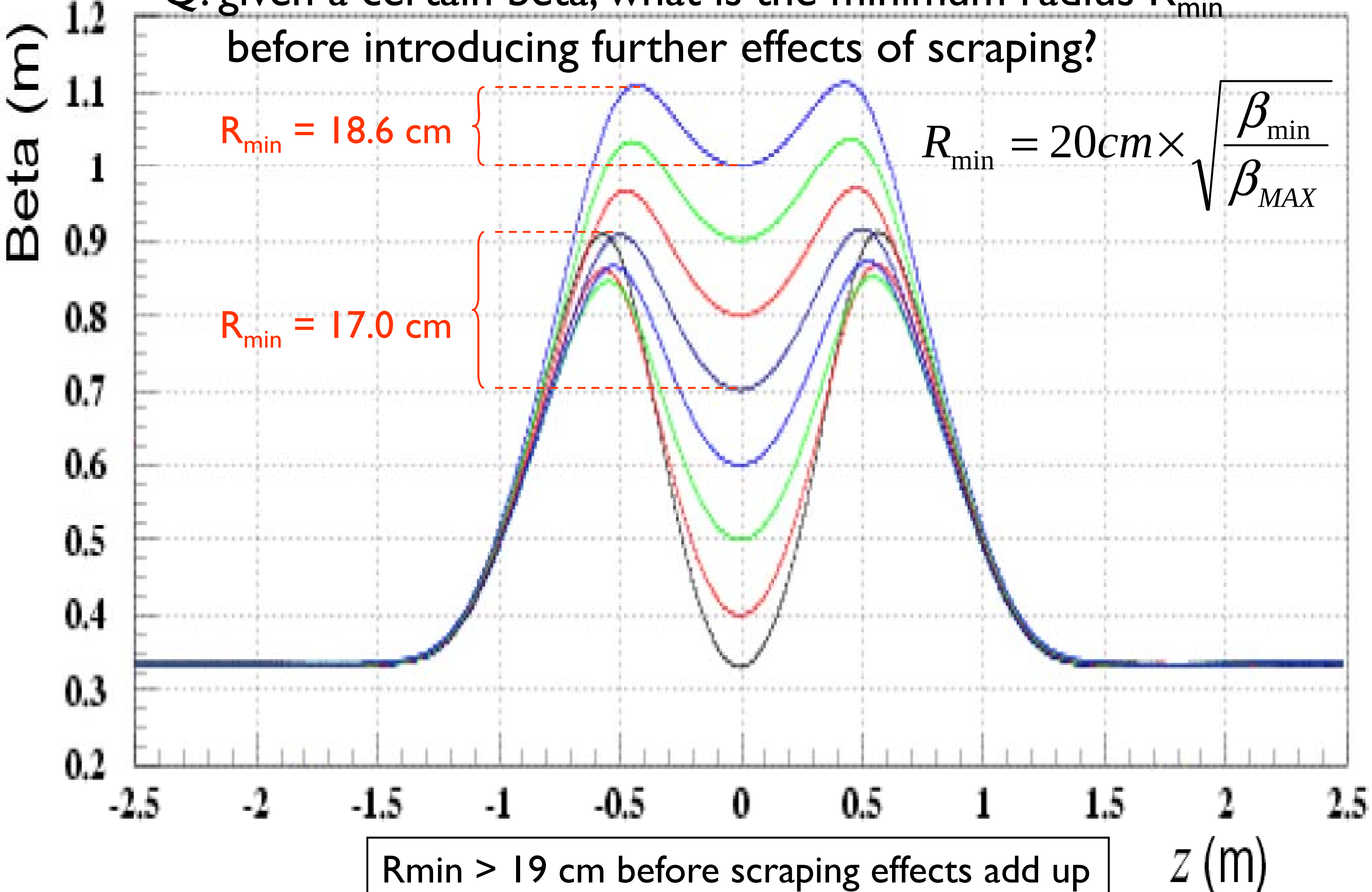


NB: 167 A/mm^2 ~ 300 A

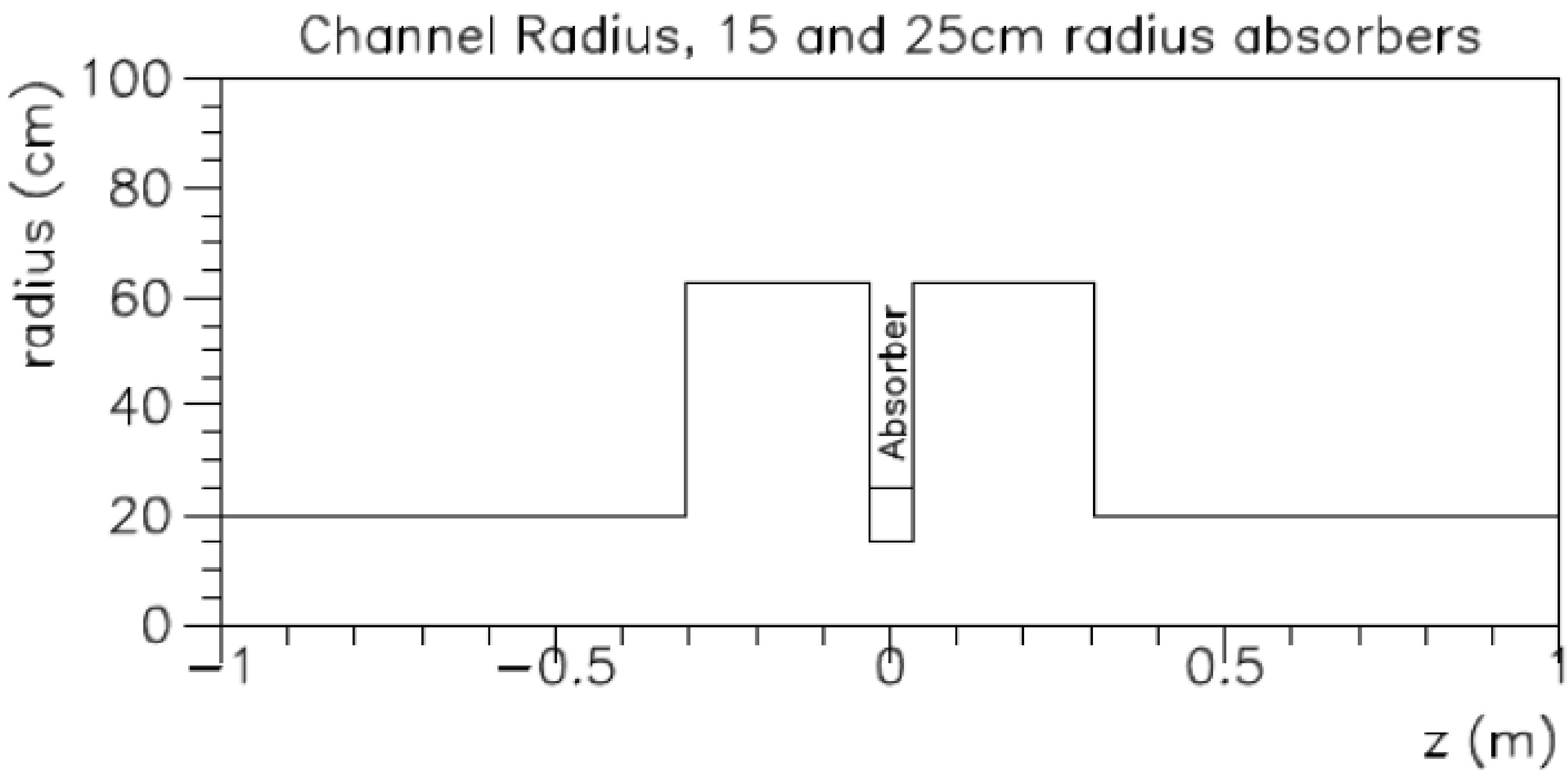
	Beta (cm)	Current density (A/mm^2) Non-Flip 40	Non-Flip 50	Flip mode 50	Flip mode 70
Upstream spectrometer	M2	99.2	111.8	-99.1	-98.8
	M1	164.9	150.1	-165.5	-146.4
Downstream spectrometer	M1	153.6	140.2	154.7	138.6
	M2	97.5	107.1	96.0	94.2

m.apollonio

Q: given a certain beta, what is the minimum radius R_{min} before introducing further effects of scraping?

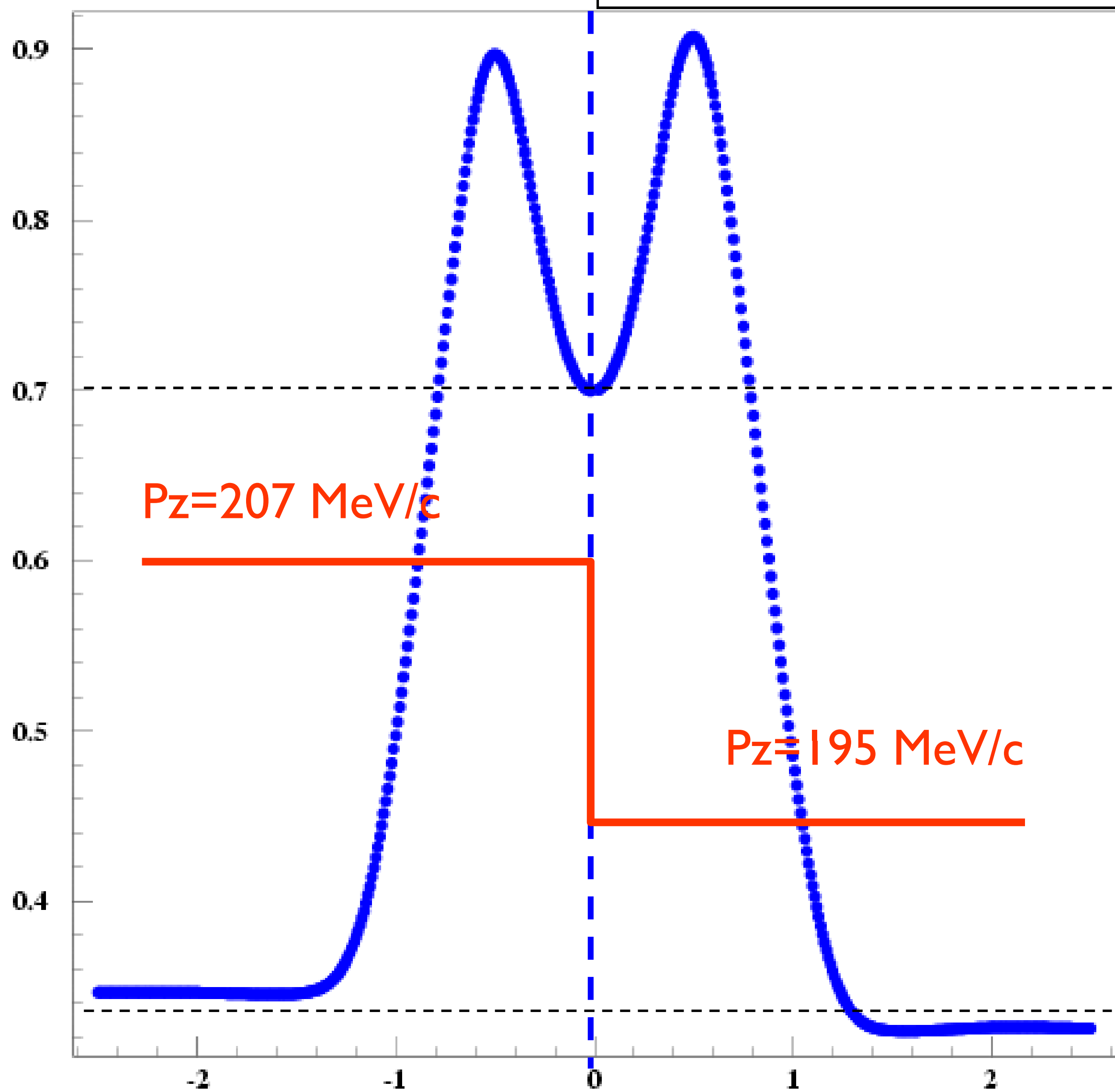


Rmin > 19 cm before scraping effects add up

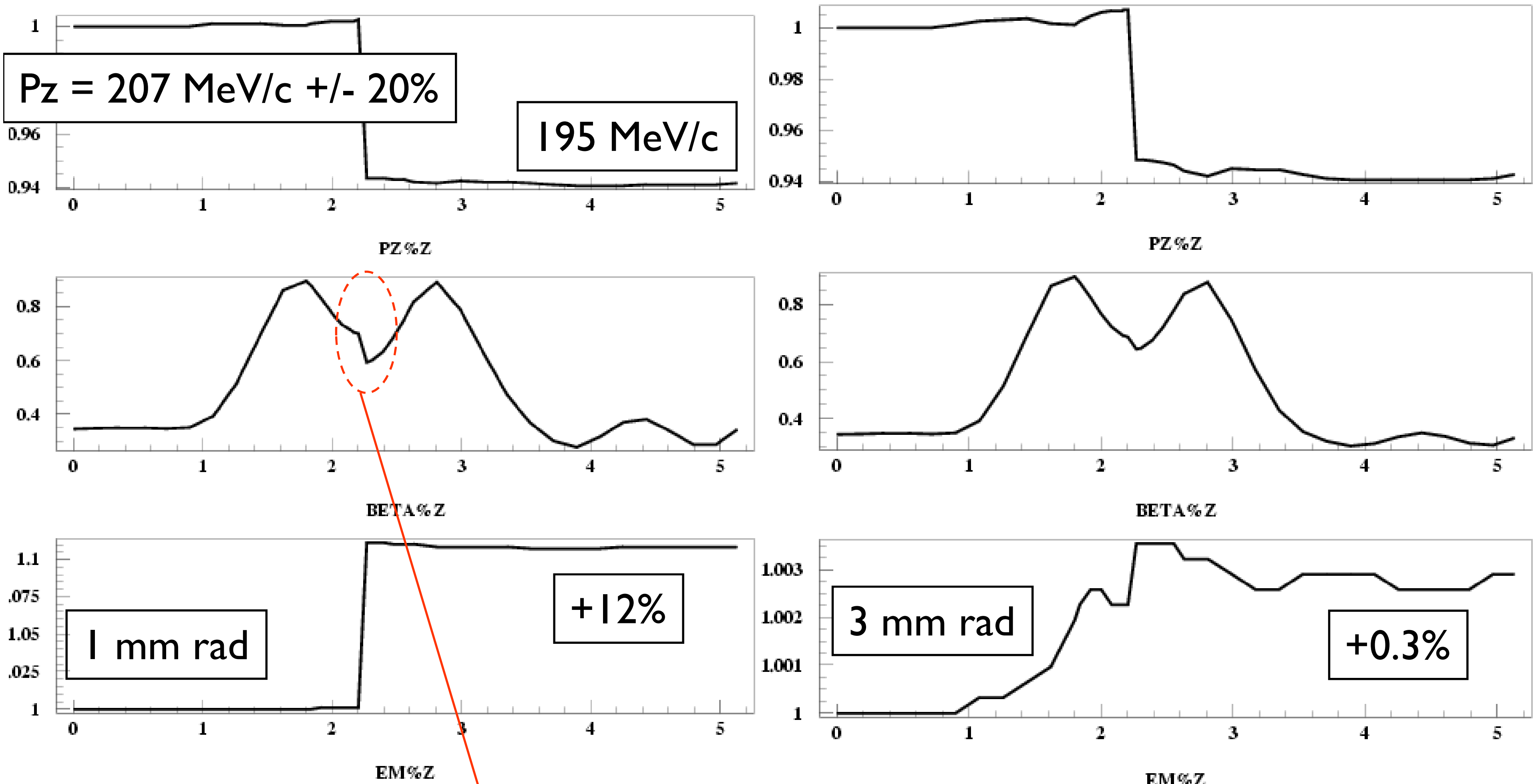

Channel Radius, 15 and 25cm radius absorbers
radius (cm)
100
80
60
40
20
0
Absorber
−1
−0.5
0
0.5
1
z (m)

Define current for 207 → 195 MeV/c

Beta evolved with a step-like Pz change

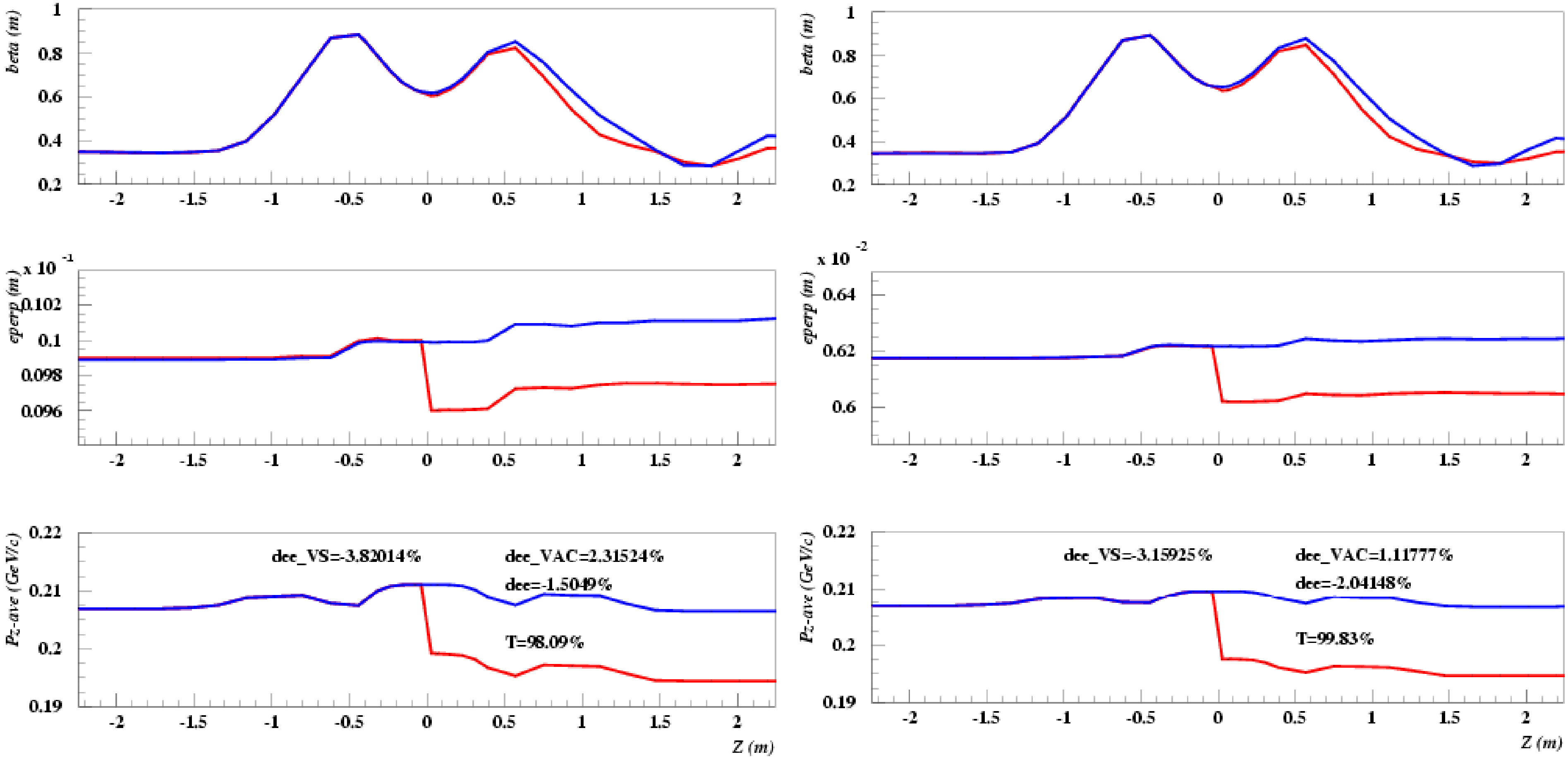


CASE A – absorber in the centre

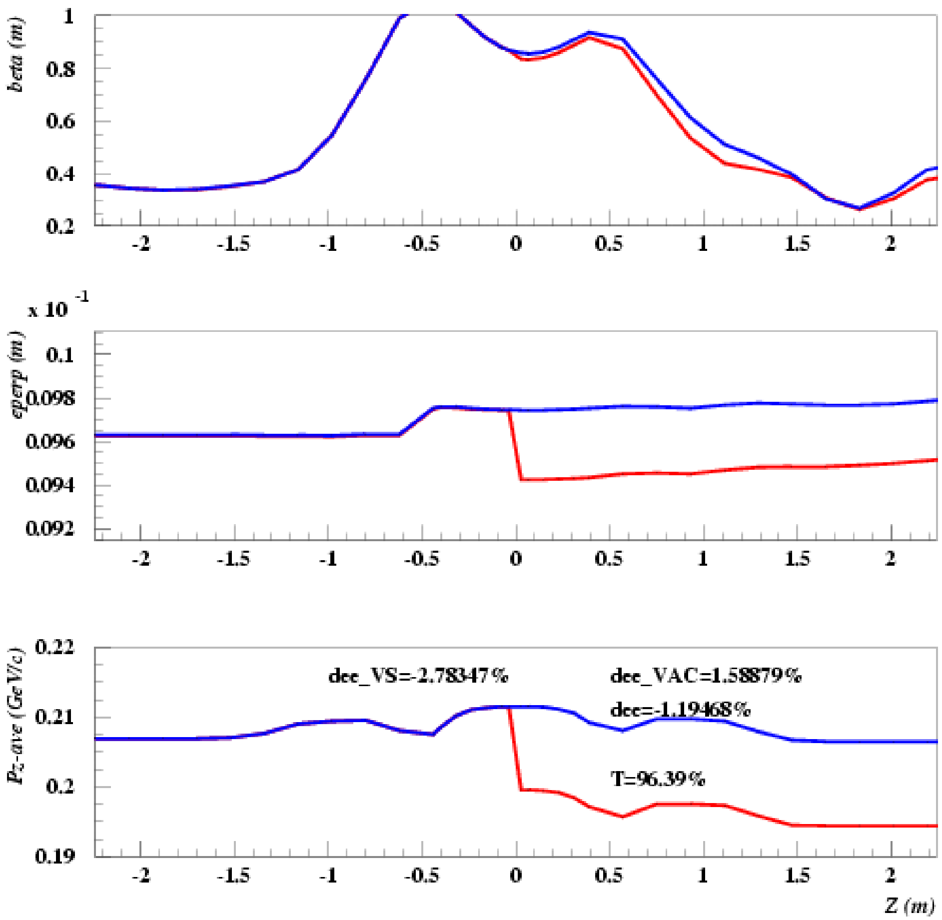


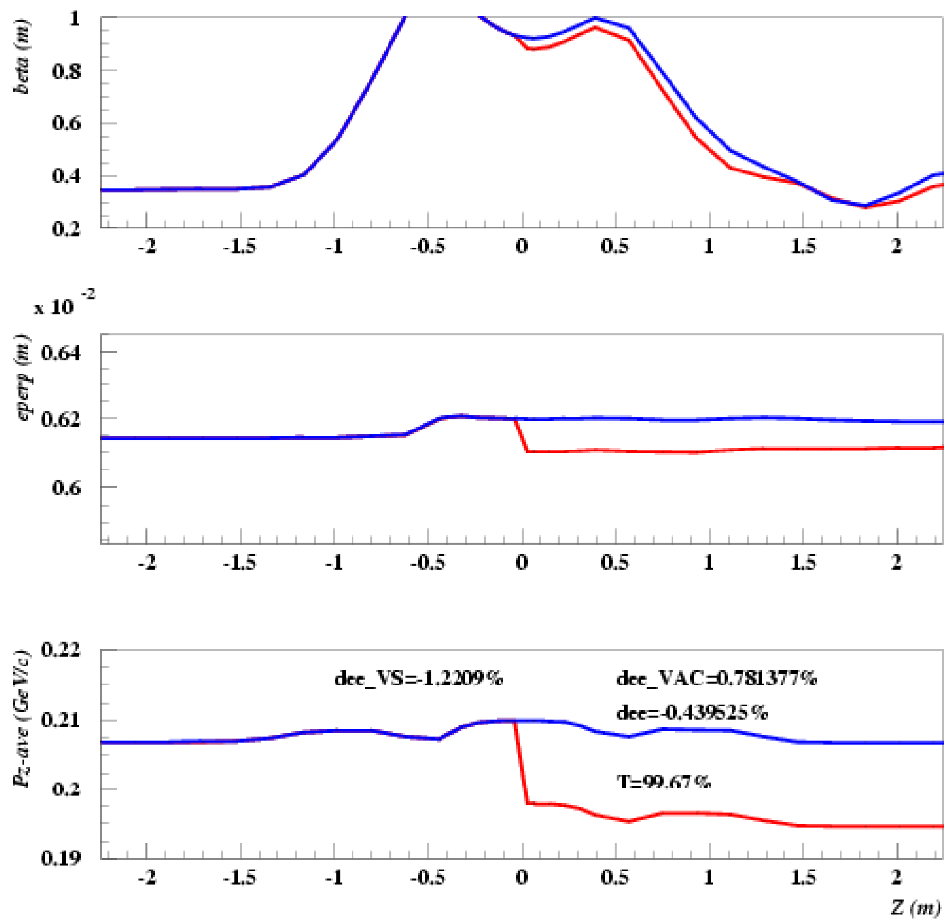
Emi inflation ➔ beta reduction ➔ mismatch

LiH beta=70 cm centre Rabs=25cm



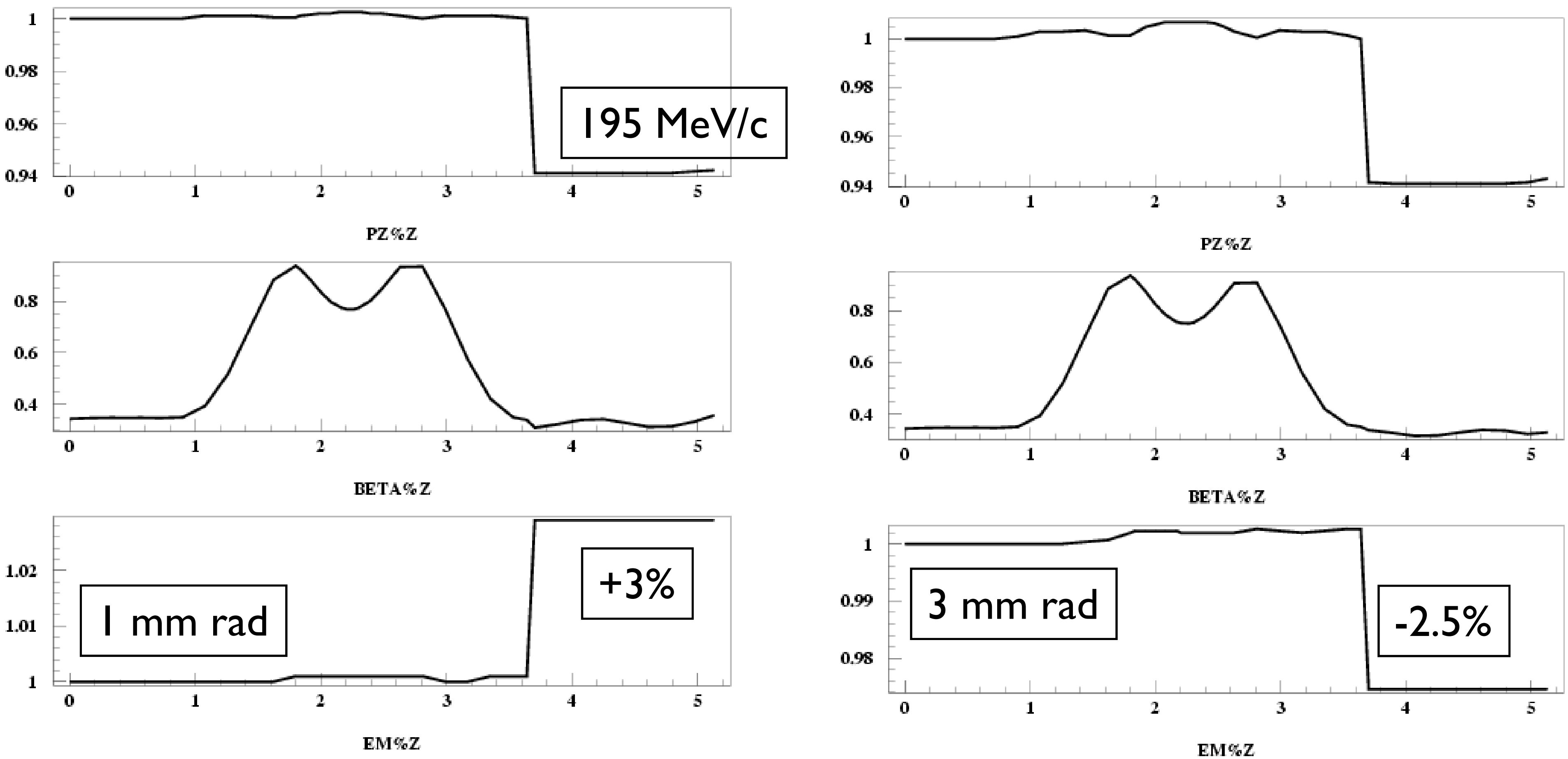
LiH beta=100 cm centre Rabs=25cm



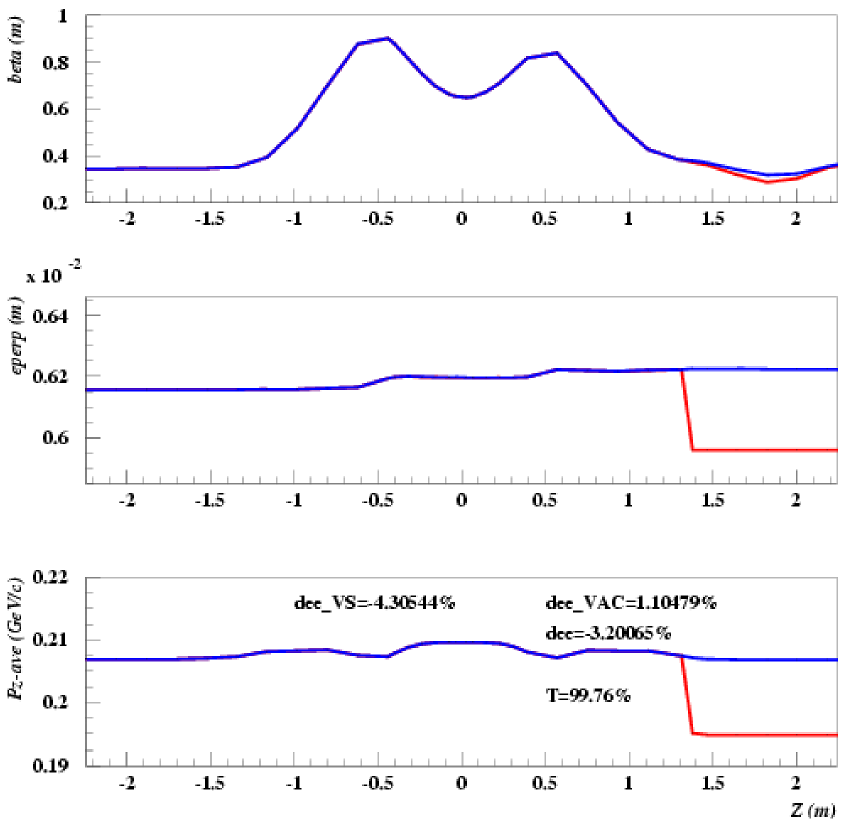


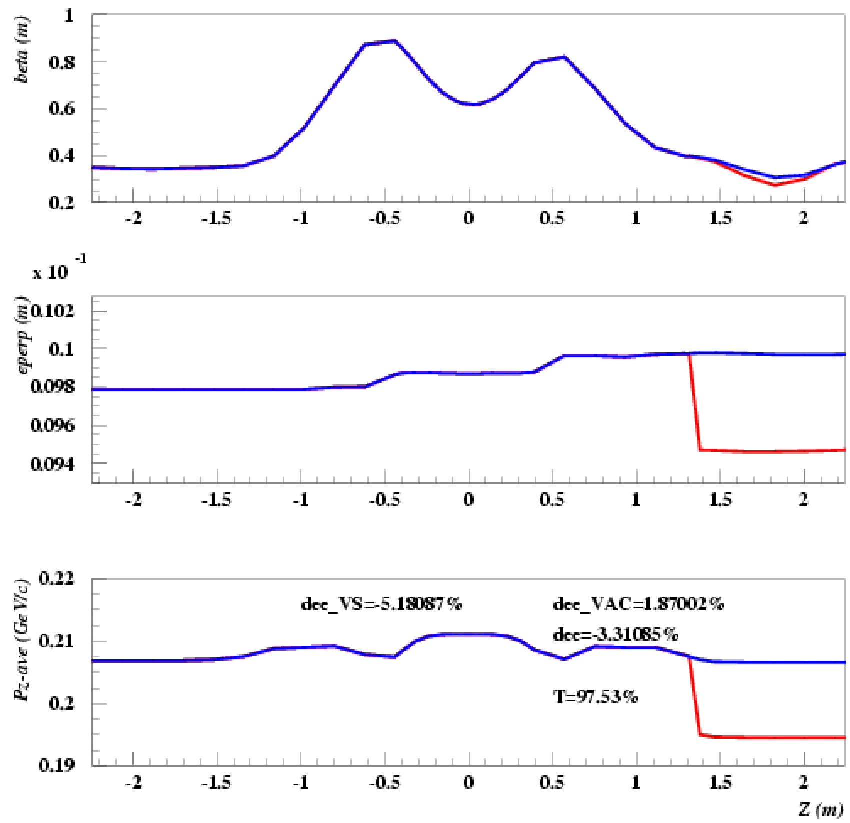
CASE B – absorber inside the II solenoid

Pz = 207 MeV/c +/- 20%



LiH beta=70 cm solenoid Rabs=15cm





SUMMARY TABLE for STEPIII central ABSORBER

10K evts

	Rabs=15 cm								**Rabs=18 cm**							
	□ (cm) = 70				100				□ (cm) = 70				100			
□(mm rad)	De/e(%)	T(%)	VAC	V_sub	De/e(%)	T(%)	VAC	V_sub	De/e(%)	T(%)			De/e(%)	T(%)		
3	0.35	99.97	0.22	0.13	2.71	99.96	0.16	2.55	0.26	99.99			2.81	99.97		
6	-1.95	99.55	1.06	-3.01	-0.935	98.3	0.7	-1.635	-2.07	99.82			-0.41	99.6		
10	-1.935	96.27	2.27	-4.205	-1.58	90.93	1.61	-3.19	-1.62	97.96			-1.5	95.77		
	NON-FLIP															
3	0.39	99.97			2.8	99.96										
6	-2.46	99.54			-1.24	97.83										
10	-2.74	96.04			-2.63	89.73										

	Rabs=20cm								**Rabs=25cm**							
	70				100				70				100			
	De/e(%)	T(%)	VAC	V_sub	De/e(%)	T(%)	VAC	V_sub	De/e(%)	T(%)	VAC	V_sub	De/e(%)	T(%)	VAC	V_sub
3	0.26	99.99	0.225	0.035	2.8	99.98	0.16	2.64	0.26	99.99	0.225	0.035	2.8	99.98	0.16	2.64
6	-2.04	99.83	1.12	-3.16	-0.65	99.67	0.78	-1.43	-2.04	99.83	1.12	-3.16	-0.44	99.67	0.78	-1.22
10	-1.75	98.09	2.35	-4.1	-1.32	96.39	1.59	-2.91	-1.5	98.09	2.315	-3.815	-1.19	96.39	1.59	-2.78
	NON-FLIP															
				0					0.22	99.99			2.54	99.98		
				0					-2.38	99.88			-1	99.7		
				0					-3.01	98.3			-2.29	96.63		

	Rabs=40cm					
	70				100	
3	0.26	99.99		0.26	2.8	99.98
6	-2.04	99.83		-2.04	-0.44	99.67
10	-1.5	98.09		-1.5	-1.19	96.39

SUMMARY TABLE for STEPIII ABSorber in the SOLENOID

	Rabs=15 cm			
	□ (cm) = 70			
□(mm rad)	De/e(%)	T(%)	VAC	V_sub
3	-2.35	100	0.258	-2.608
6	-3.2	99.76	1.1	-4.3
10	-3.31	97.53	1.87	-5.18

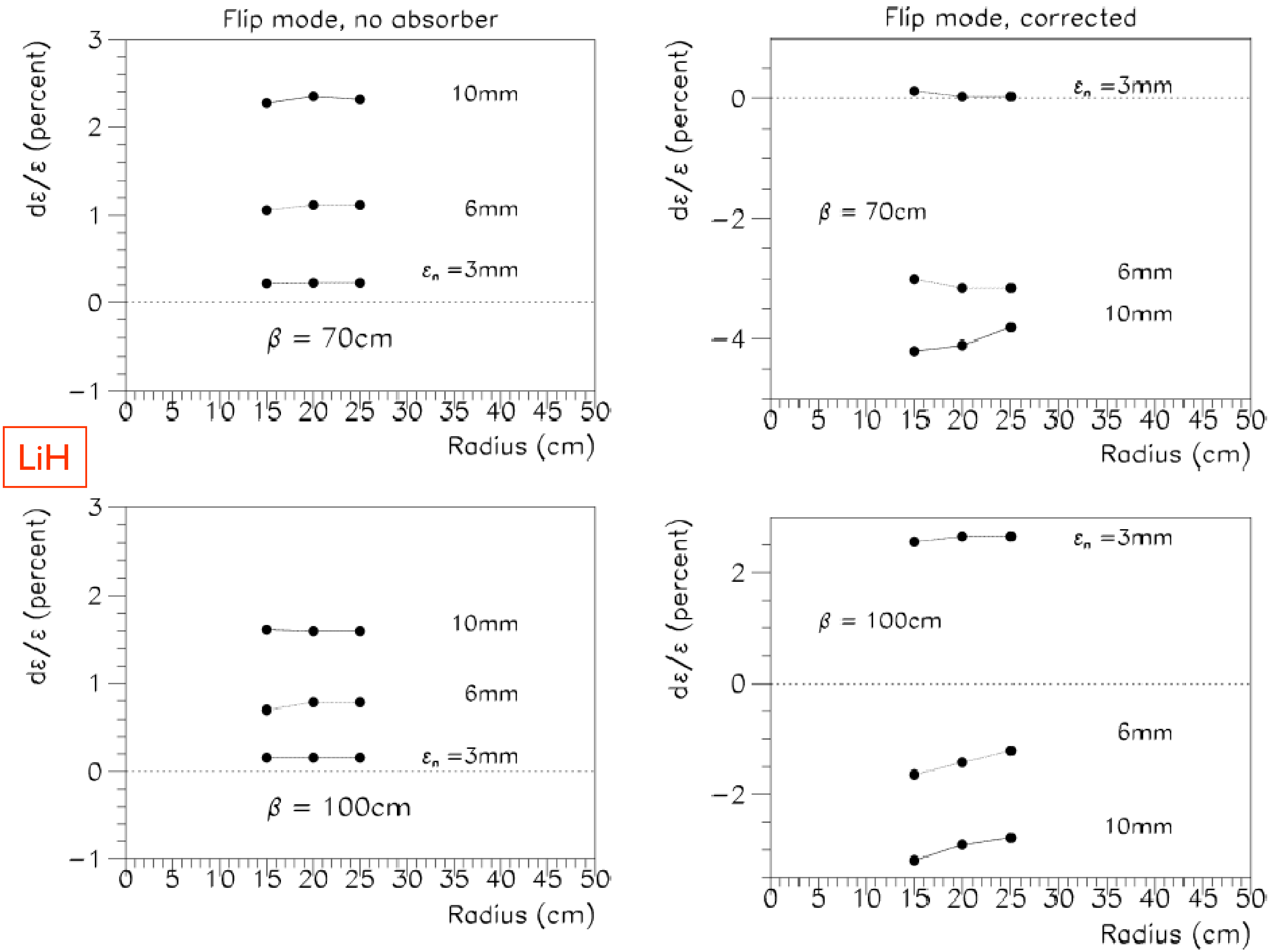
MICE-note 199 "absorbers in MICE step III", MA, J.H.Cobb.

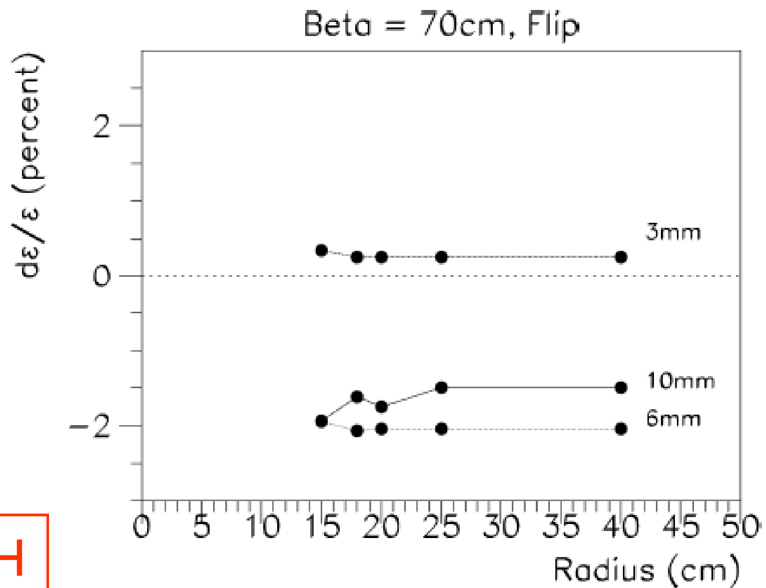
Mice Note 199
1 February 2008
M. Apollonio
J.H. Cobb
Oxford University

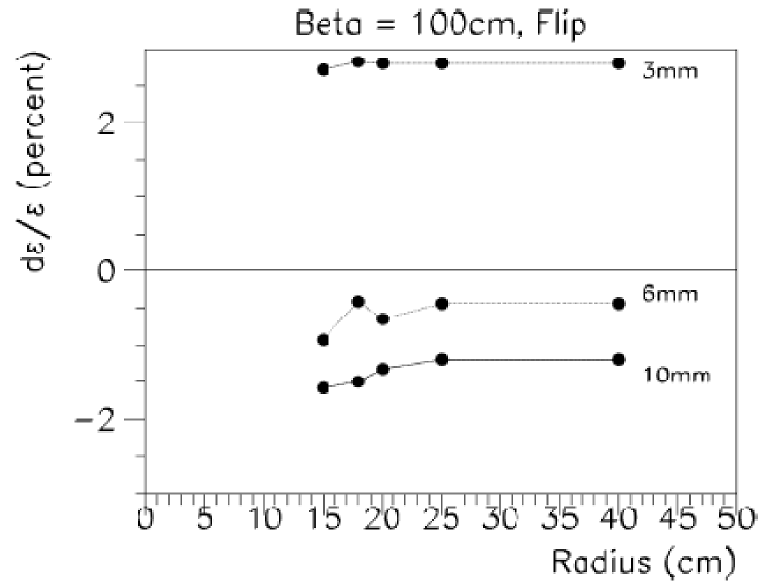
Absorbers for MICE Step III

Abstract

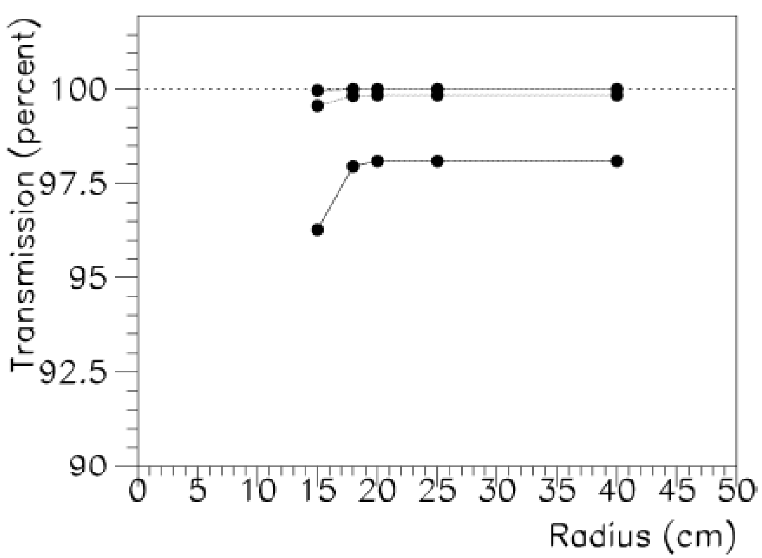
Cooling in Step III of MICE has been studied. It is shown that a few percent cooling can be demonstrated if a lithium hydride absorber is placed centrally between the two spectrometers. The minimum beta function, and hence the maximum cooling, which can be achieved is limited to ~70cm by the 300A power supplies and the temperature margins of the matching coils. The ability to vary the beta function from 70 to 100cm would allow confirmation of the dependence of cooling on β. The absorber radius should be at least 20cm, and preferably ~25cm, so that scraping of the beam is limited by the channel and not the absorber. A surprising result is that the equilibrium emittances are somewhat smaller than predicted by the cooling formula.

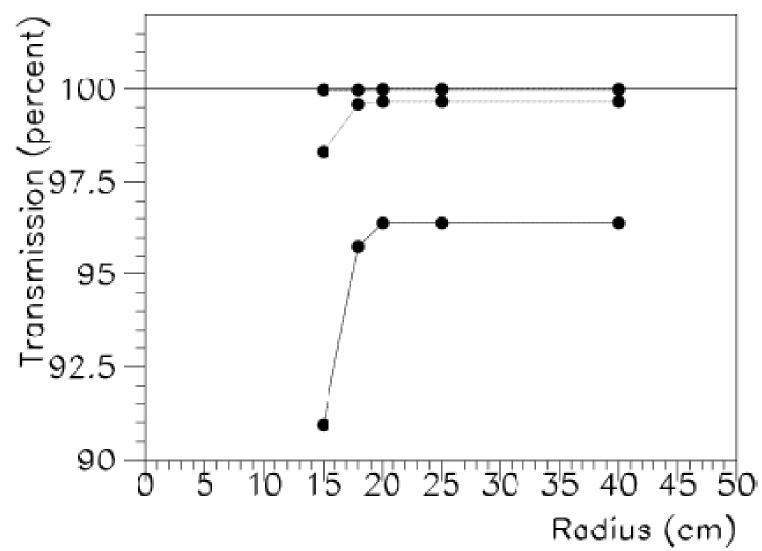

Flip mode, no absorber
dε/ε (percent)
10mm
6mm
ε_n =3mm
β = 70cm
Radius (cm)
Flip mode, corrected
dε/ε (percent)
ε_n =3mm
β = 70cm
6mm
10mm
Radius (cm)
LiH
dε/ε (percent)
10mm
6mm
ε_n =3mm
β = 100cm
Radius (cm)
dε/ε (percent)
ε_n =3mm
β = 100cm
6mm
10mm
Radius (cm)


Beta = 70cm, Flip
dε/ε (percent)
3mm
10mm
6mm
Radius (cm)

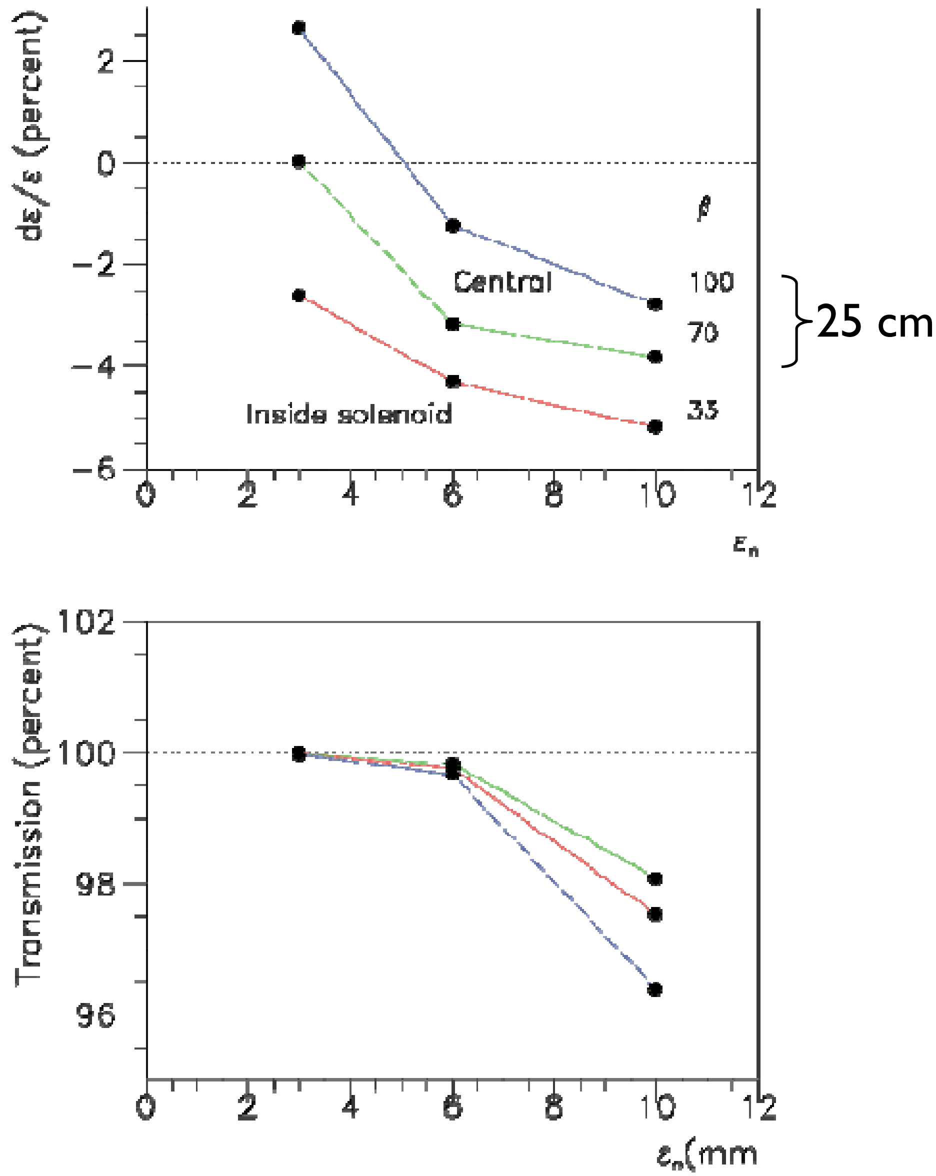

Beta = 100cm, Flip
dε/ε (percent)
3mm
6mm
10mm
Radius (cm)

LiH


Transmission (percent)
Radius (cm)


Transmission (percent)
Radius (cm)

LiH


dε/ε (percent)
2
0
−2
−4
−6
0 2 4 6 8 10 12
ε_n
β
Central
100
70
33
Inside solenoid
25 cm
Transmission (percent)
102
100
98
96
0 2 4 6 8 10 12
ε_n(mm

7 Summary

These studies have shown that cooling of a few percent can be demonstrated in MICE Step III if a lithium hydride absorber is placed centrally between the two spectrometers. The vacuum emittance growth in the channel must be subtracted if cooling is convincingly to be demonstrated. A surprising, and not understood result is that the equilibrium emittances are somewhat smaller than predicted by the cooling formula.

The minimum beta function, and hence the maximum cooling, which can be achieved in Step III is limited to ~70cm by the 300A power supplies and the temperature margins of the matching coils. It has been shown that it is possible to match the channel allowing for the energy loss in the absorber.

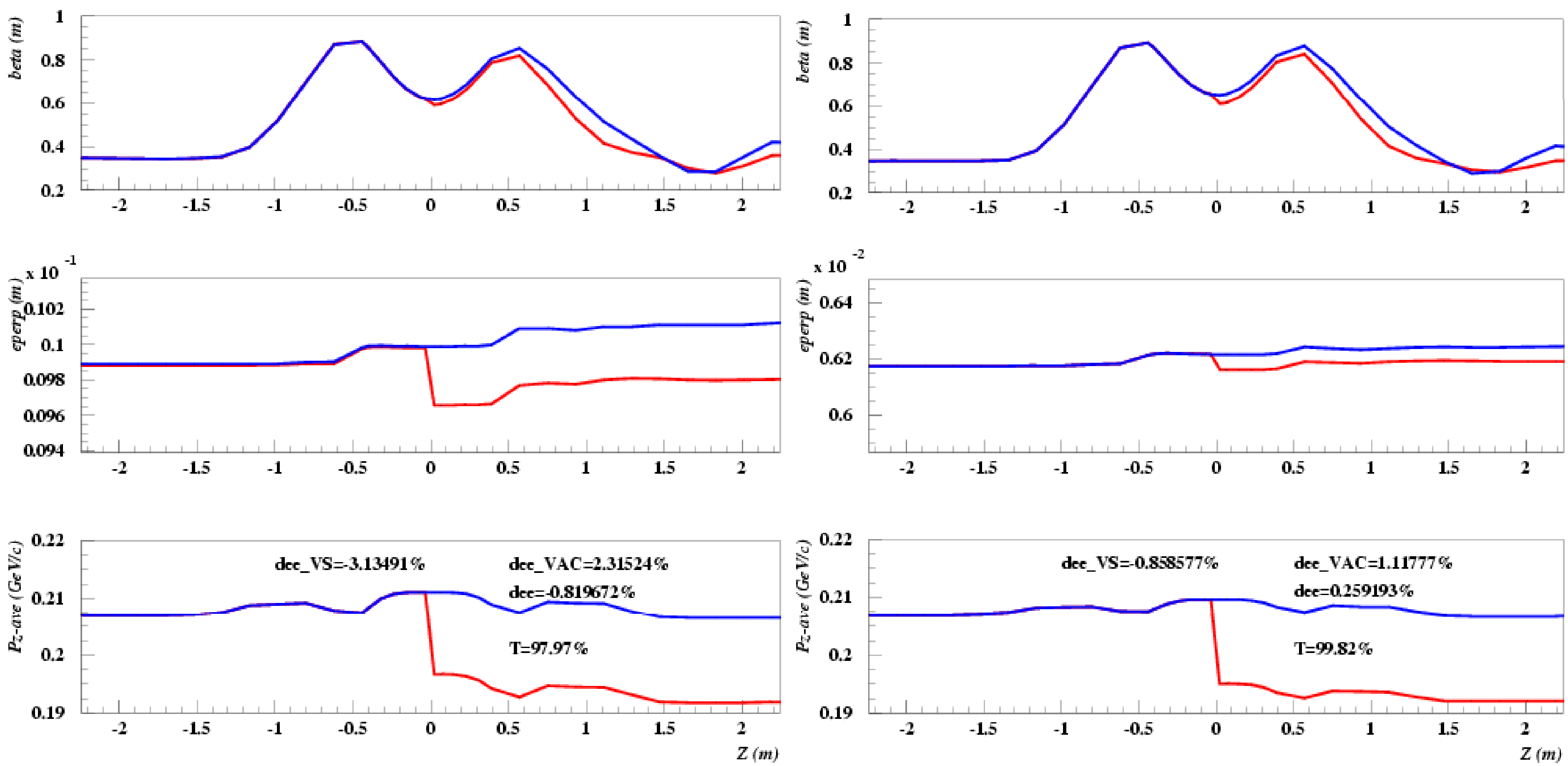
The ability to vary the beta function at the absorber over the, albeit modest, range of 70 to 100cm if the absorber is placed centrally between two spectrometers would allow confirmation of the dependence of cooling on β. It would be impractical to insert an absorber at ~1m within the bore of a spectrometer solenoid to achieve a lower β.

The radius of a solid absorber should be at least 20cm, and preferably ~25cm, so that scraping of the beam is limited by the channel and not the absorber.

OTHER MATERIALS giving -12 MeV/c

	rho (g/cm^3)	dE/dX (MeV/cm)	dE/dX (MeV/g cm^2)	T (cm)
Cu	8.96	13.53	1.51	0.89
[C2H4]n	0.89	2.05	2.3	5.86
C	1.7	3.23	1.9	3.72
Be	1.848	3.23	1.75	3.71
Al	2.699	4.72	1.75	2.54

Polyethilene beta=70 cm centre



Be beta=70 cm centre