SHIELDING STUDIES FOR THE MUON COLLIDER TARGET

NICHOLAS SOUCHLAS
BNL
Nov 30, 2010

MUON COLLIDER TARGET STATION

COMPONENTS

1. PROJECTILES (PROTON BEAM).

2. TARGET (MERCURY JET).

3. SUPERCONDUCTING COILS (SC) FOR UP TO 14 T MAGNETIC FIELD AROUND INTERACTION AREA (NbSn, NbTi).

4. RESISTIVE COILS FOR ADDITIONAL 6 T MAGNETIC FIELD SO THAT B~20 T AROUND THE INTERACTION AREA.

5. BEAM PIPE(STST Stainless Steel).

6. CRYOGENIC COOLING FOR THE SC SOLENOIDS.

7. MERCURY COLLECTING TANK AND REMOVAL SYSTEM.

8. SHIELDING CONFIGURATIONS (WC BEADS+H_2O).

REQUIREMENTS/LIMITATIONS

PROTON BEAM AND MERCURY JET PARAMETERS ARE OPTIMIZED TO PRODUCE THE MAXIMUM NUMBER OF MUONS.

LIMITATIONS :MAGNETIC FIELD VALUES AND VARIATION DETERMINES IN PART THE SUPERCONDUCTING COILS CONFIGURATION (GEOMETRY), AND DIMENSIONS.

:CRYOGENIC COOLING EXPENSIVE, SO AS LITTLE ENERGY AS POSSIBLE SHOULD BE DEPOSITED IN THE SOLENOIDS.

:AVOID QUENCHING, PEAK VALUES OF DEPOSITED ENERGY BELOW A LIMIT.

:AVOID SOLENOIDS MATERIAL LATTICE/STRUCTURAL DAMAGE FROM IRRADIATION PARTICLES.

:SOLENOIDS STRESS FORCES ALSO BELOW A LIMIT, LIMITS ON SIZE/DIMENSIONS OF SOLENOIDS.

:SPACE FOR SHIELDING MATERIAL IS LIMITED.

CHOOSE A CONFIGURATION/GEOMETRY THAT HAS THE RIGHT BALANCE BETWEEN AVAILABLE SPACE FOR SHIELDING AND VIABLE SOLENOIDS SIZE.

RESULTS OF DEPOSITED ENERGY AND PEAK VALUES FOR THREE DIFFERENT GEOMETRIES WILL BE PRESENTED.

Energy deposition from MARS, MARS+MCNP codes.

STANDARD (STUDY II) GEOMETRY.

STANDARD SHIELDING (80%WC+20% H_2O).

4MW proton beam.

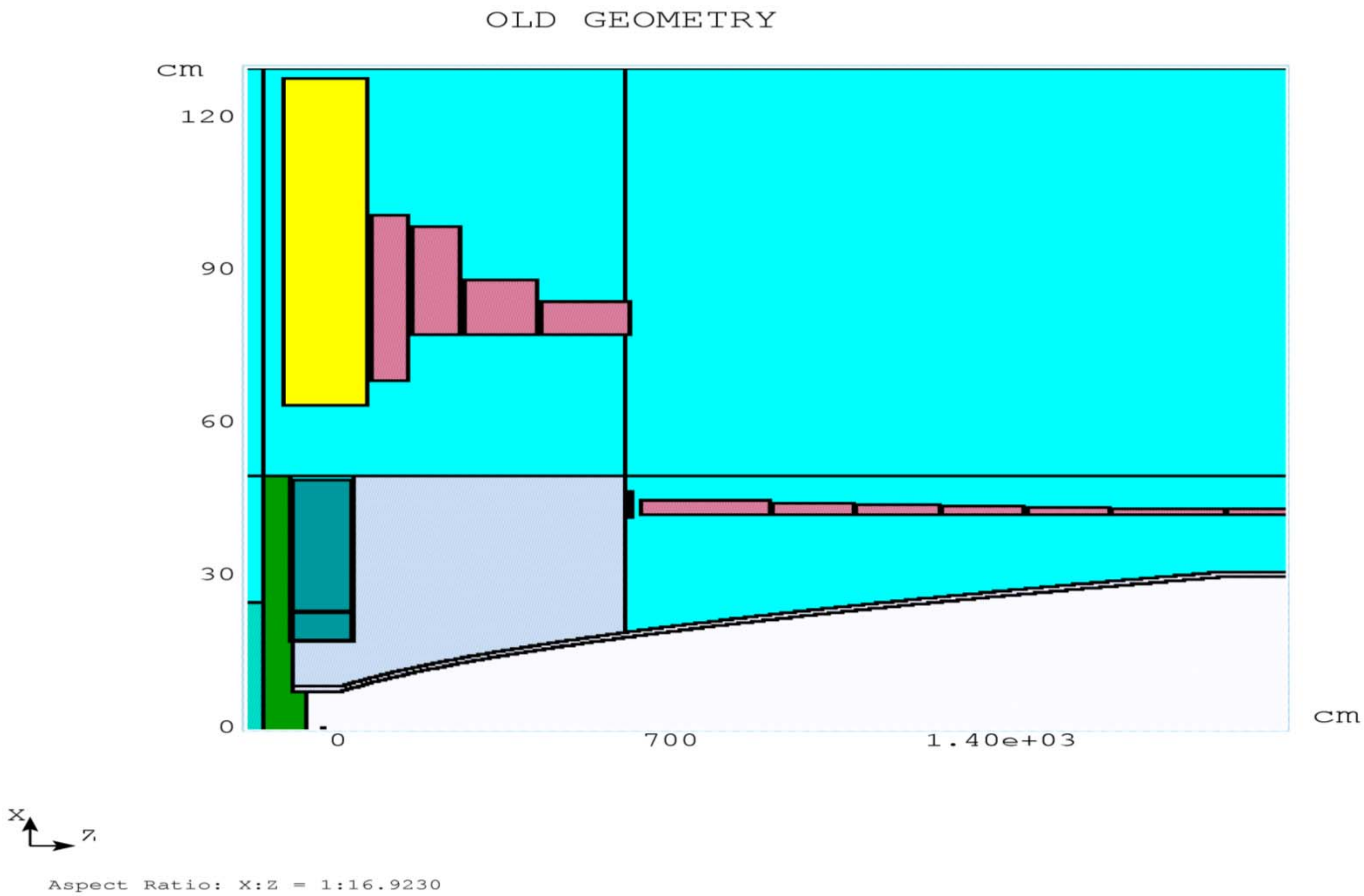
Initially E=24 GeV,

GAUSSIAN PROFILE: $\sigma_x=\sigma_y=0.15$ cm.

Now E=8 GeV,

GAUSSIAN PROFILE: $\sigma_x=\sigma_y=0.12$ cm.

STANDARD (STUDY II) SOLENOID GEOMETRY, 13 SC



SC#1 -120<z<57.8 cm R_{in}=63.3 cm R_{out}=127.8 cm

SC#2 67.8<z<140.7 cm R_{in}=68.6 cm R_{out}=101.1 cm

SC#6-13 632.5<z<218.7 cm R_{in}=42.2 cm R_{out}=45.1-->43.4 cm (TOTAL # SC=13)

DEPOSITED ENERGY WITH 24 GeV AND 8 GeV BEAM (MARS, MARS+MCNP).

Table 0.1:

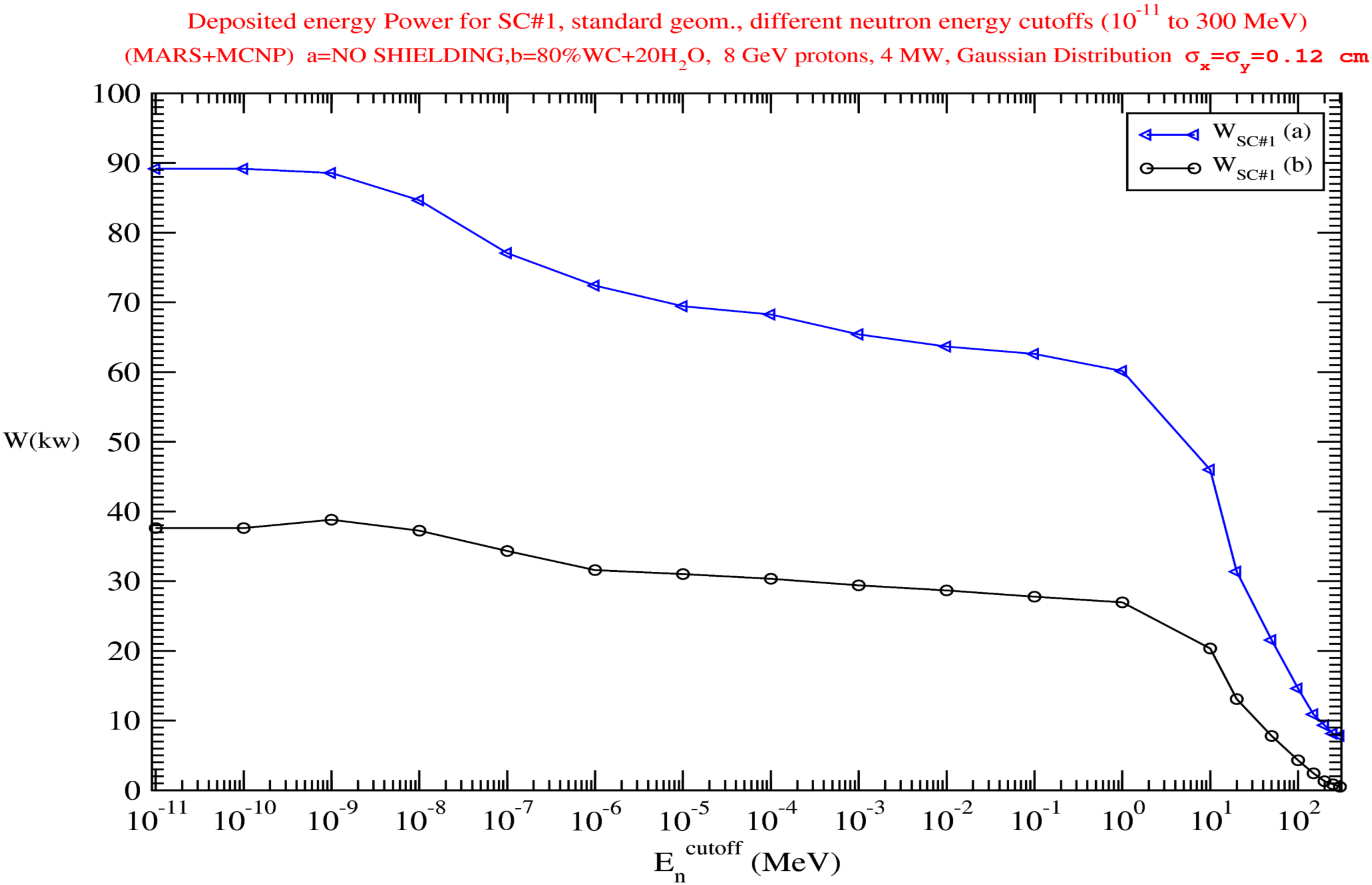
N_p=100,000 , STANDARD GEOMETRY,13 SC COILS
SOLENOID MATERIALS: SC#1-13=SCON (NiTi+Cu+..)
E_p=24 GeV, 4 MW BEAM, Gaussian Distr., $\sigma_x=\sigma_y$=0.15 cm
a= MARS $E_n \geq$0.1 MeV (DEFAULT)
b= MARS+MCNP $E_n \geq 10^{-11}$ MeV
E_p=8 GeV, 4 MW BEAM, Gaussian Distr., $\sigma_x=\sigma_y$=0.12 cm
c= MARS $E_n \geq$0.1 MeV (DEFAULT)
d= MARS+MCNP $E_n \geq 10^{-11}$ MeV

Table 0.2: POWER OF DEPOSITED ENERGY IN kW, DW/W %=((W_x-W_a)/W_a) x100 where x=b,c,d.

		SC#1	%	SC#2-13	%	Total	%
24 GeV	a	14.28	–	14.90	–	29.18	–
	b	22.06	+54.48	16.30	+9.40	38.36	+31.50
8 GeV	c	24.97	+74.86	11.84	-20.54	36.81	+26.15
	d	37.62	+163.45	12.46	-16.38	50.08	+71.62

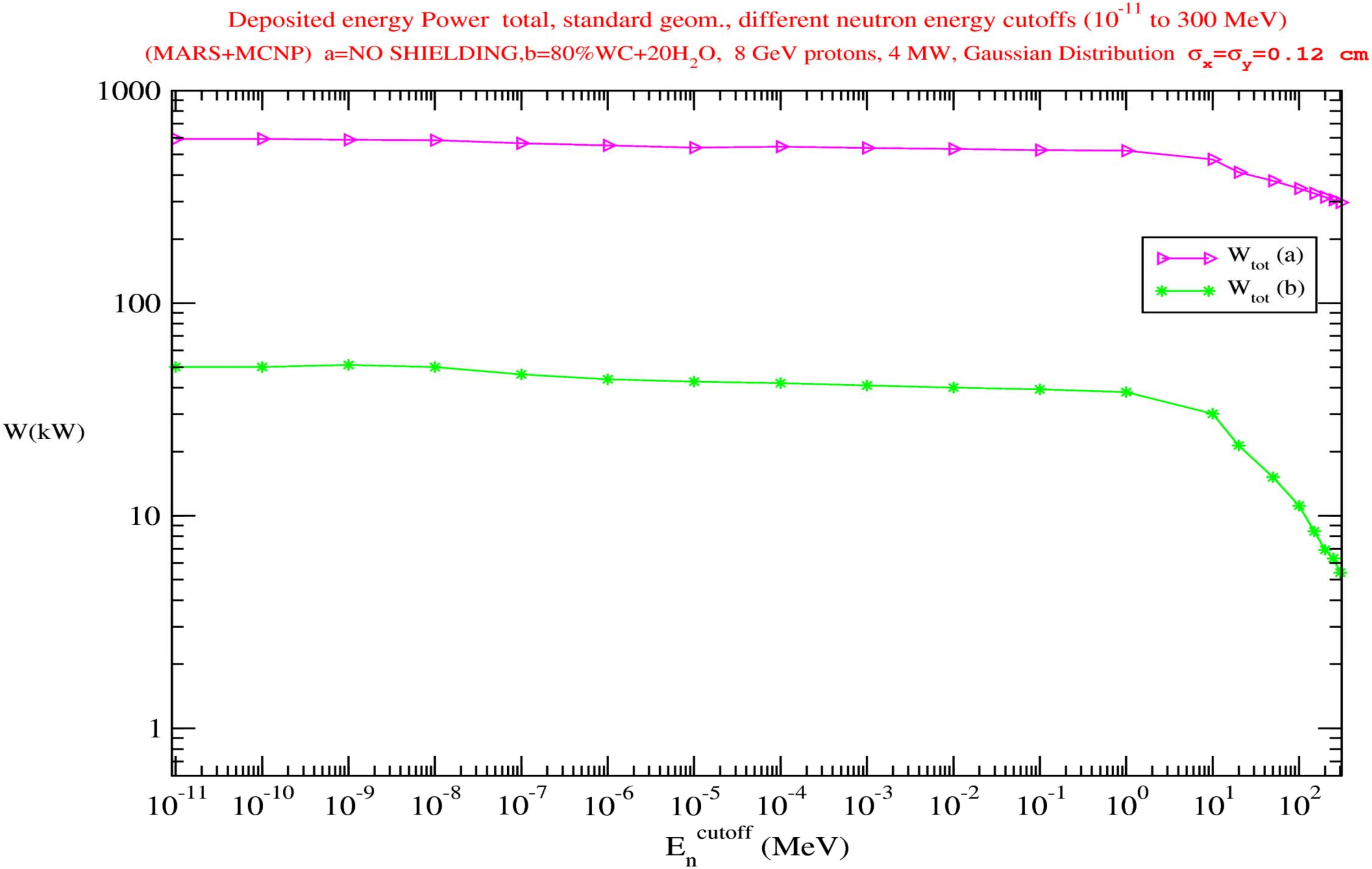
From 24 GeV to 8 GeV, and from a more detail treatment of low energy neutrons:
from ~14 kW to ~38 kW power in SC1 and from ~29 kW to 50 kW in total power.

OFF/ON SHIELDING, DIFFERENT NEUTRON ENERGY CUTOFFS.



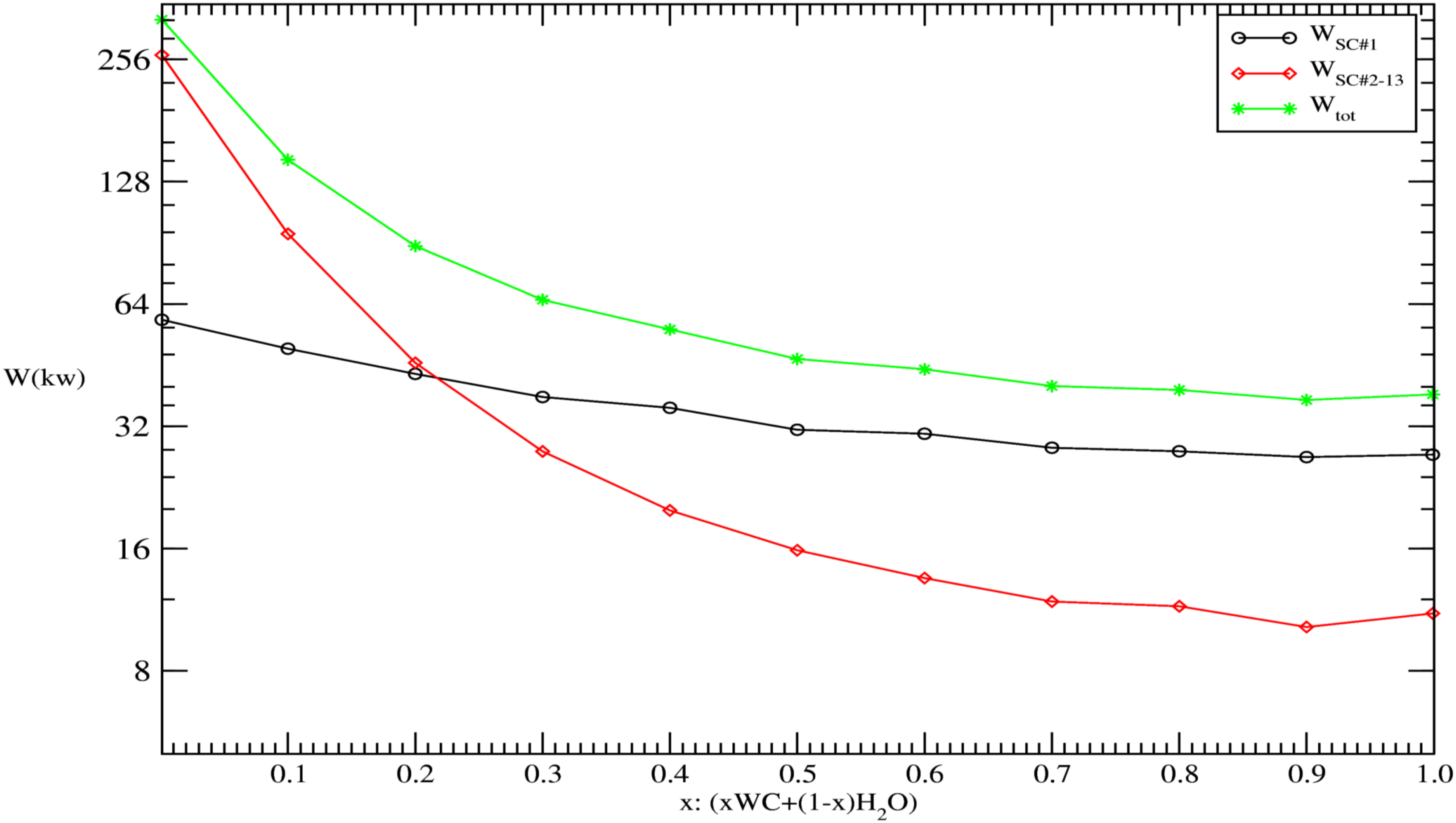
SAME RESULTS FOR SC#2-13

OFF/ON SHIELDING, DIFFERENT NEUTRON ENERGY CUTOFFS.

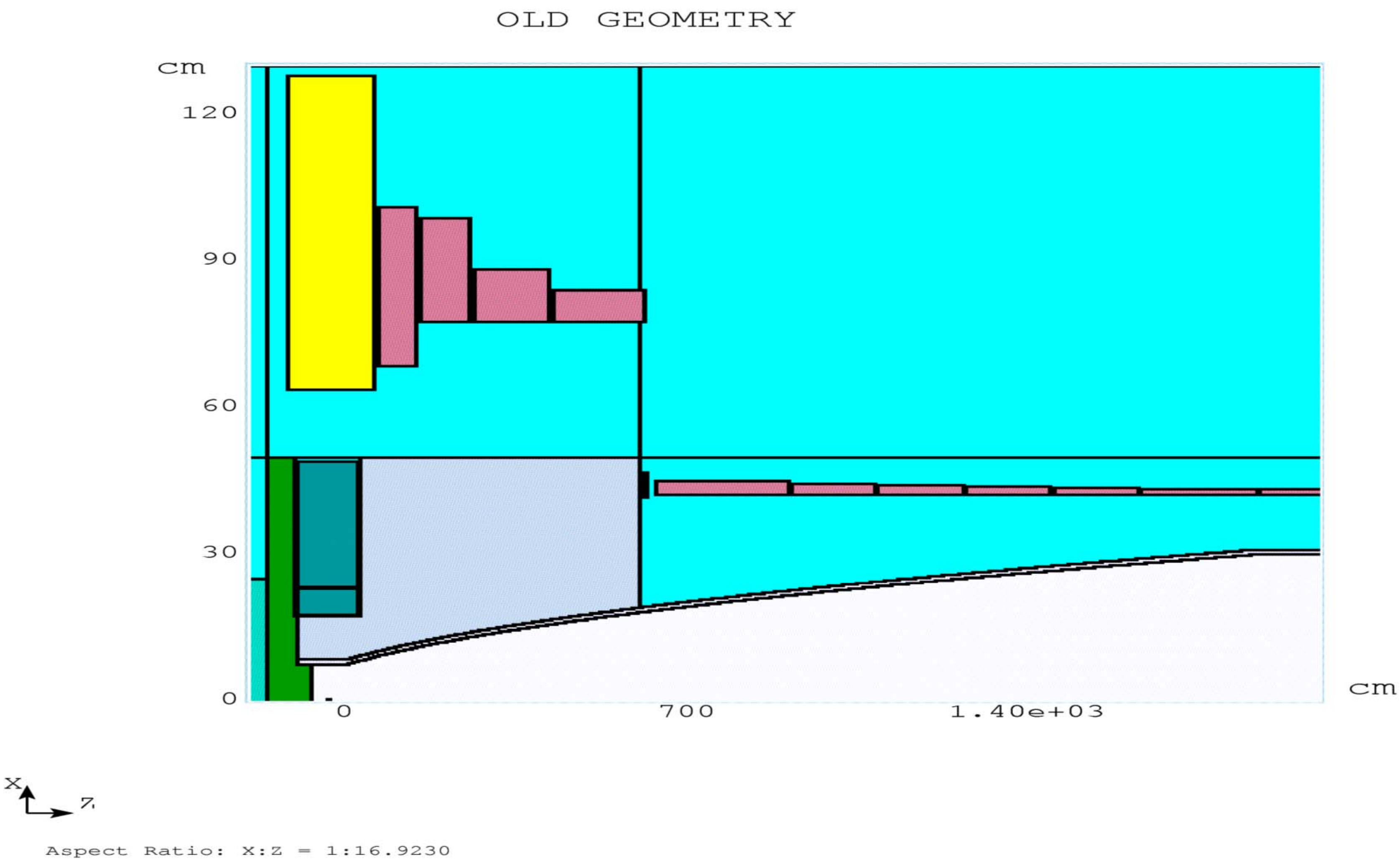


High energy neutrons are a problem even with shielding material.

Deposited energy Power for SC#1, SC#2-13 and total, standard geom., different shielding compositions.
(MARS+MCNP), x WC+(1-x) H_2O shielding, 8 GeV protons, 4 MW, Gaussian Distribution $\sigma_x=\sigma_y=0.12$ cm



Within shielding thickness restrictions, best effect is achieved by maximizing content in high Z material. For WC beads and H_2O, from random sphere packing analysis x~0.63.



REPLACING RESISTIVE MAGNET WITH SHIELDING MATERIAL (80%WC+20% H_2O) REDUCES DEPOSITED ENERGY IN SC#1 FROM ~38 kW TO ~13 kW (A FACTOR OF ~3). (MARS+MCNP WITH NEUTRON ENERGY CUTOFF OF 10^{-11} MeV)

Energy deposition from MARS+MCNP codes.

IDS80 GEOMETRY WITH IRON PLUG
(TO PROVIDE MORE SPACE FOR SHIELDING ESPECIALLY FOR SOLENOIDS AROUND THE INTERACTION AREA).

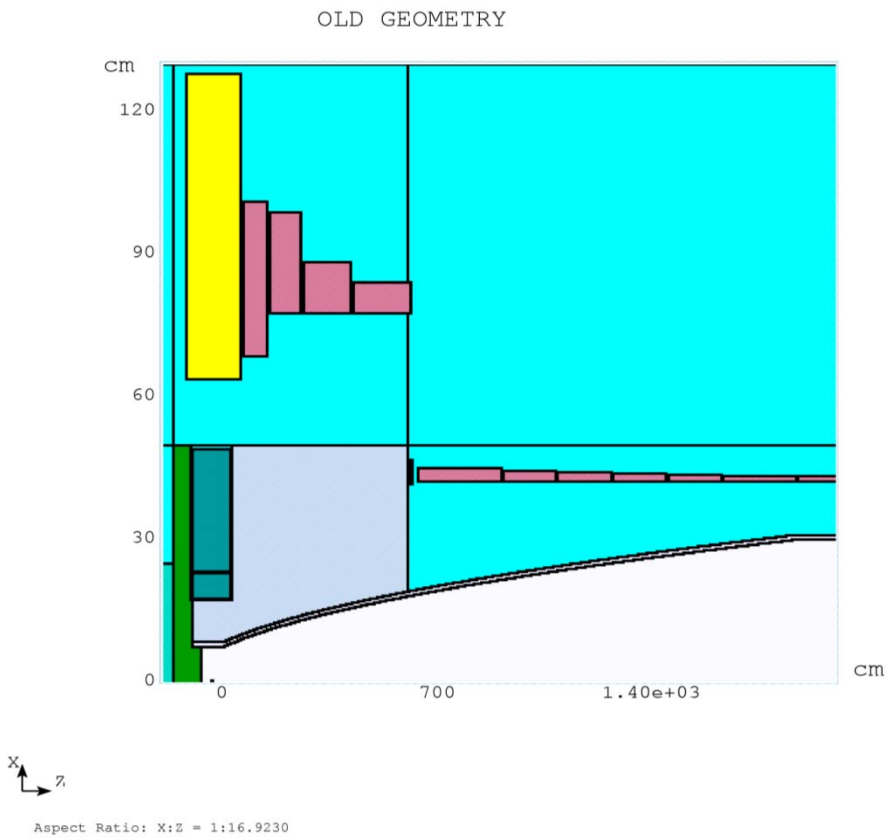
SHIELDING (60%WC+40% H_2O).

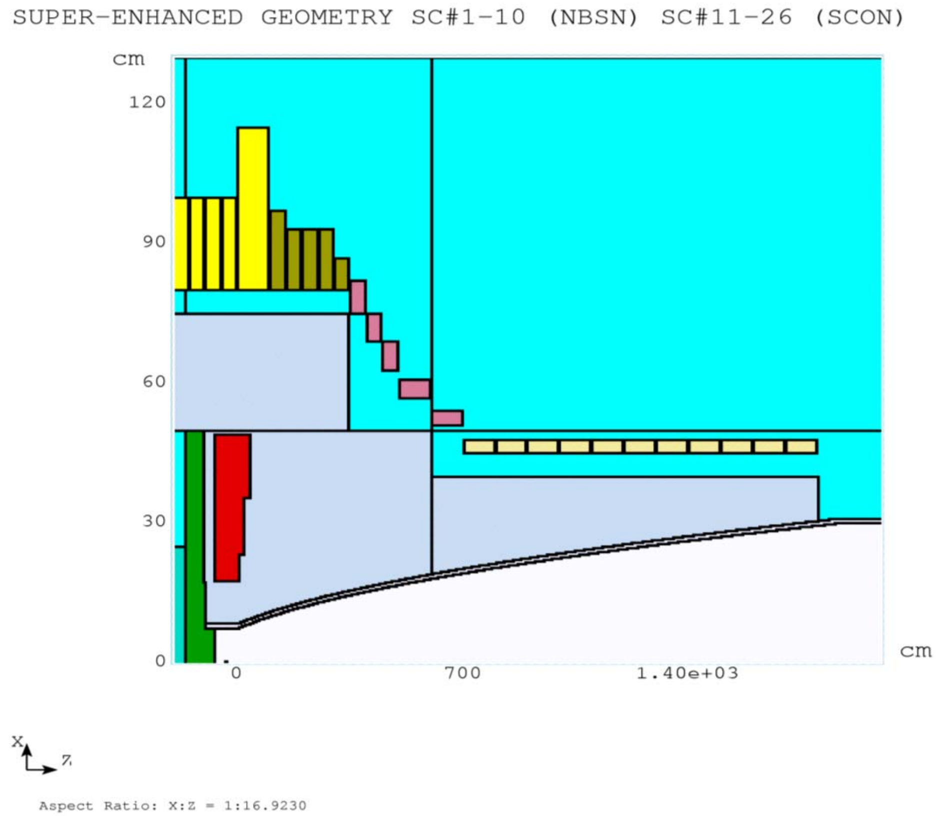
4MW proton beam.

PROTONS ENERGY E=8 GeV.

GAUSSIAN PROFILE: $\sigma_x=\sigma_y=0.12$ cm.

STANDARD (OLD) VS. IDS80 (NEW) SOLENOID GEOMETRY
(IDS80 WITH 60%WC+40% H2O SHIELDING)





NEW: SC#1-10 -200<z<345 cm R_{in}=80.0 cm R_{out}=100 (1-4)/115 (5)/97 (6)/93(7-9)/87(10)cm
SC#11-15 350<z<695 cm R_{in}=75.0-->51 cm R_{out}=82.0-->54 cm
SC#16-26 700<z<1795 cm R_{in}=45 cm R_{out}=48 cm (TOTAL # SC=26)

From 63.3 cm (SC#1) to 80 cm (SC#1-10) inner radius for solenoids around target area: more space for shielding.

MARS+MCNP(NEUTRON ENERGY CUTOFF 10^{-11} MeV)

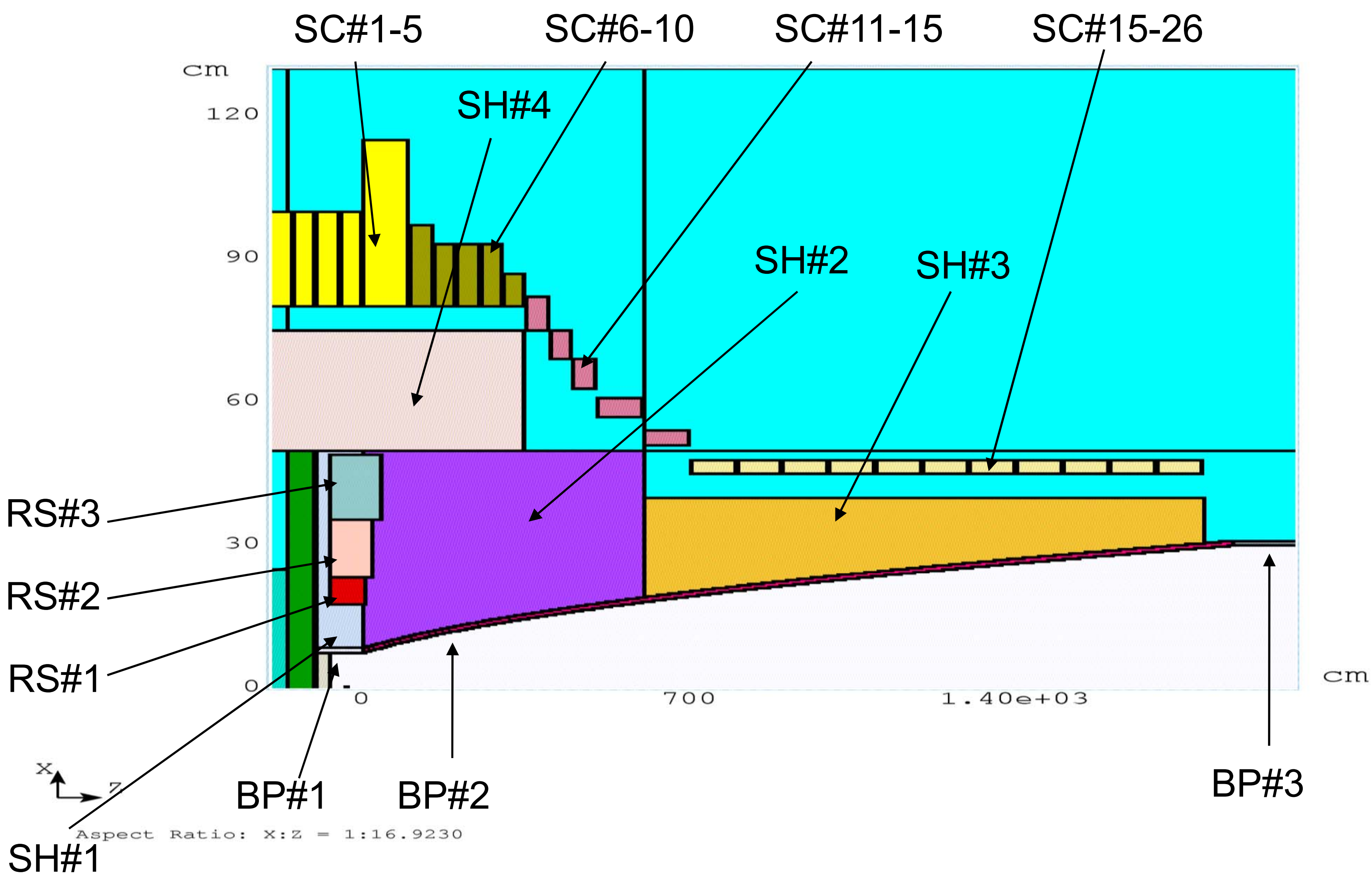
Study II geometry with 80%WC+20% H_2O shielding---->

Enhanced shielding case (IDS80), with 60%WC+40% H_2O shielding:

SC#1: 37.6 kW --------->SC#1-5: 2.4 kW

SC#1-13: 50.0 kW--------->SC#1-26: 3.4 kW

DETAIL STUDY OF IDS80 WITH IRON PLUG
(MARS+MCNP, 10^{-11} MeV NEUTRON ENERGY)



ENERGY DEPOSITED IN SC SOLENOIDS (SC#), SHIELDING (SH#).

NiSn/NiTi	P(kW)	60/40	P(kW)
SC#1-5	2.42	SH#1	967.5
SC#6-10	0.57	SH#2	1107.5
SC#11-15	0.16	SH#3	36.04
SC#16-26	0.31	SH#4	31.83
SC#1-26	3.64	SH#1-4	2142.87

ENERGY DEPOSITED IN RESISTIVE COILS (RS#), BEAM PIPE (BP#), IRON PLUG (IP#).

(Cu)	P(kW)	(STST)	P(kW)	(FeCo)	P(kW)
RS#1	68.25	BP#1	207.50	IP#1	0.24
RS#2	66.05	BP#2	238.40	IP#2	0.11
RS#3	36.50	BP#3	8.02	IP#3	11.35
RS#1-3	170.80	BP#1-3	453.92	IP#1-3	11.70

ENERGY DEPOSITED IN OTHER PARTS AND TOTALS .

TOTALS	P(kW)
SC#1-26	3.64
SH#1-4	2142.87
RS#1-3	170.80
BP#1-3	453.92
IP#1-3	11.70
Hg TARG.	379.90
Hg POOL	9.32
Be WIND.	0.62
TOTAL	3172.77

ABOUT 80% OF THE 4 MW IS ACCOUNDED FOR .

Energy deposition from MARS+MCNP codes
(10^{-11} MeV NEUTRON ENERGY CUTOFF).

IDS80 GEOMETRY WITHOUT IRON PLUG AND YOKE MATERIAL (TO ACCOMODATE ACCESS TO DIFFERENT PARTS OF THE TARGET STATION).

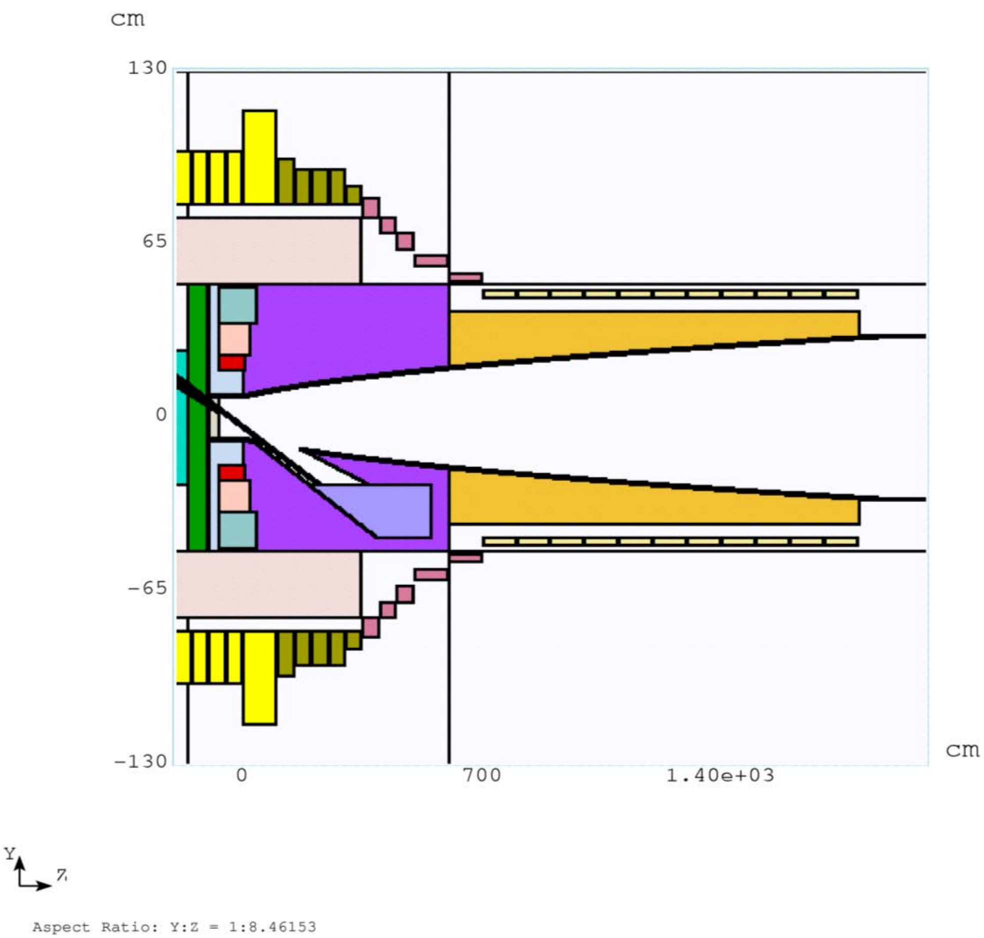
SHIELDING (60%WC+40% H_2O).

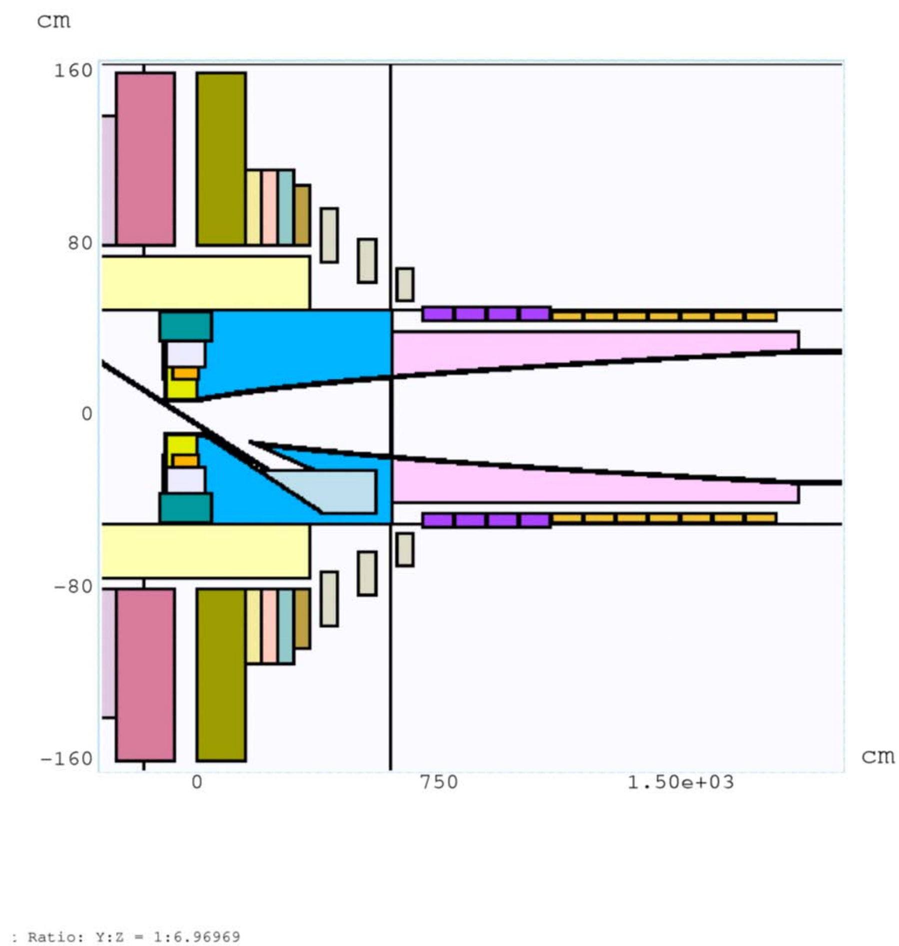
4MW proton beam.

PROTONS ENERGY E=8 GeV.

GAUSSIAN PROFILE: $\sigma_x=\sigma_y=0.12$ cm.

IDS80 GEOMETRY WITH AND WITHOUT IRON PLUG AND YOKE.





NEW: SC#1-7 -300<z<345 cm R_{in}=80.0 cm R_{out}=140 (1)/160 (2,3)/115 (5-6)/108(7) cm(NbSn)

SC#8-10 383<z<667 cm R_{in}=72/63/54 cm R_{out}=97.0/83/69 cm (NbTi)

SC#11-14 700<z<1090 cm R_{in}=45 cm R_{out}=51 cm (NbTi)

SC#15-21 7190<z<1090 cm R_{in}=45 cm R_{out}=49 cm (NbTi) (TOTAL # SC=21)

ENERGY DEPOSITED IN SC SOLENOIDS (SC#), SHIELDING (SH#).

NiSn/NiTi	P(kW)
SC#1	$7.48\ 10^{-4}$
SC#2	0.37
SC#3	2.38
SC#4	0.27
SC#5	0.20
SC#6	0.09
SC#7	0.06
SC#1-7	3.37
SC#8-10	0.27
SC#11-14	0.29
SC#15-21	0.18
SC#1-21	4.11

NiSn/NiTi	P(kW)	60/40	P(kW)
SC#1-7	3.37	SH#1	956.0
SC#8-10	0.27	SH#2	1145.0
SC#11-14	0.29	SH#3	37.15
SC#15-21	0.18	SH#4	33.17
SC#1-21	4.11	SH#1-4	2171.32

ENERGY DEPOSITED IN RESISITVE SOLENOIDS (RS#), BEAM PIPE(BP#).

(Cu)	P(kW)	(STST)	P(kW)
RS#1	64.30	BP#1	204.20
RS#2	68.65	BP#2	253.05
RS#3	37.82	BP#3	5.51
RS#1-3	170.77	BP#1-3	462.76

ENERGY DEPOSITED IN OTHER PARTS AND TOTALS:

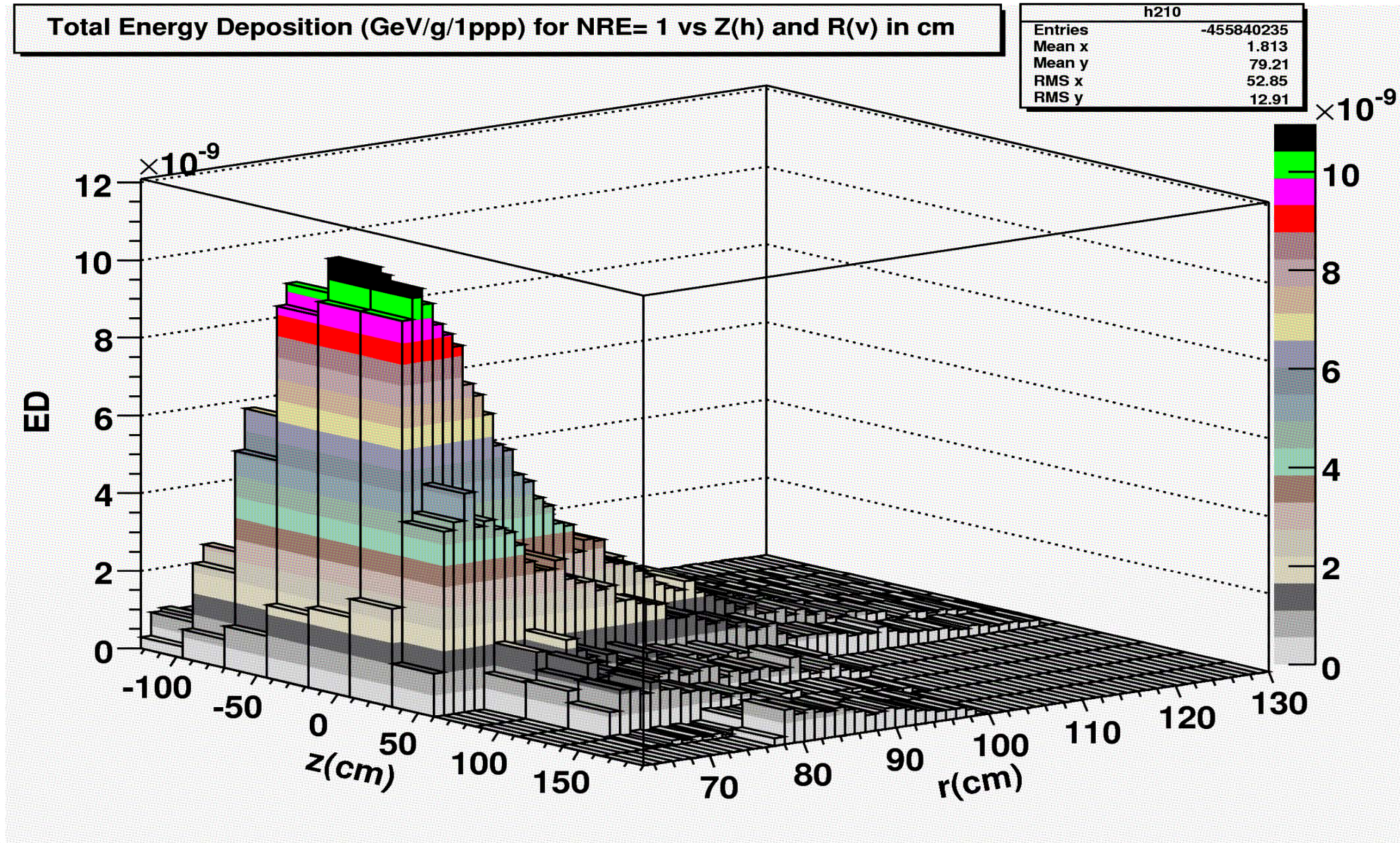
WITH IRON PLUG

TOTALS	P(kW)
SC#1-26	3.64
SH#1-4	2142.87
RS#1-3	170.80
BP#1-3	453.92
IP#1-3	11.70
Hg TARG.	379.90
Hg POOL	9.32
Be WIND.	0.62
TOTAL	3172.77

WITHOUT IRON PLUG/YOKE

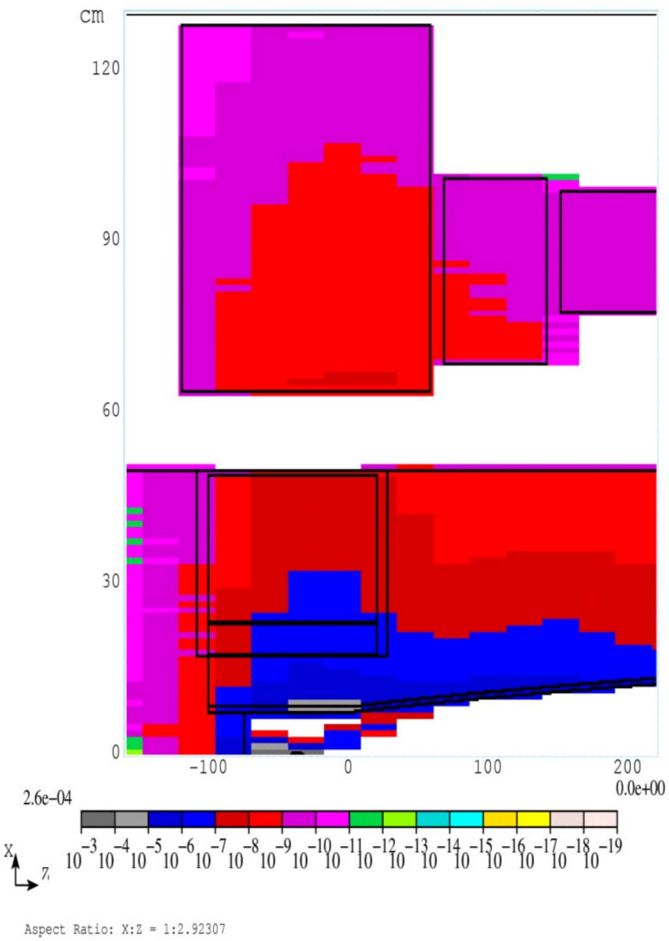
TOTALS	P(kW)
SC#1-21	4.11
SH#1-4	2171.32
RS#1-3	170.77
BP#1-3	462.76
Hg TARG.	374.90
Hg POOL	9.73
Be WIND.	0.53
TOTAL	3194.11

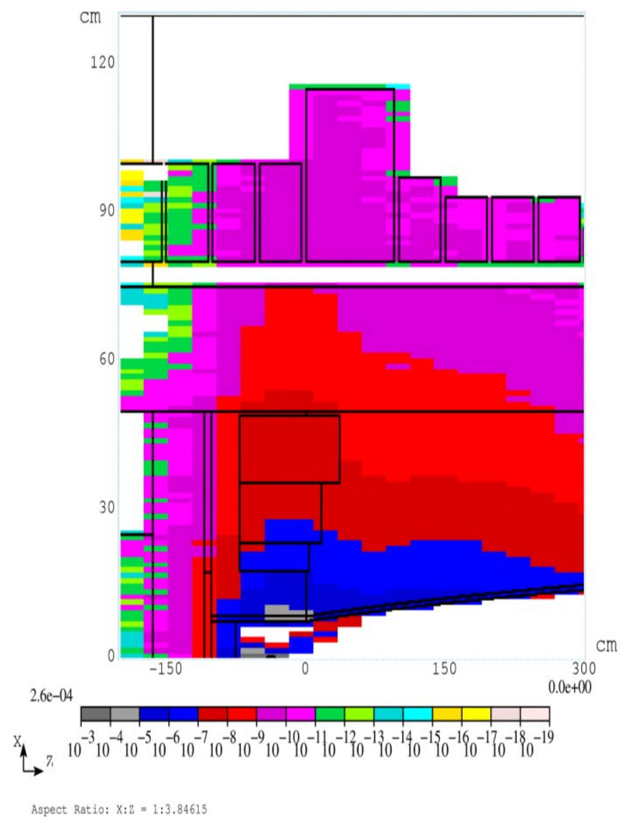
SHIELDING MATERIAL, RESISITVE COILS, BEAM PIPE, Be WINDOW, MERCURY TARGET AND POOL: ABOUT SAME ENERGY FOR BOTH CASES.

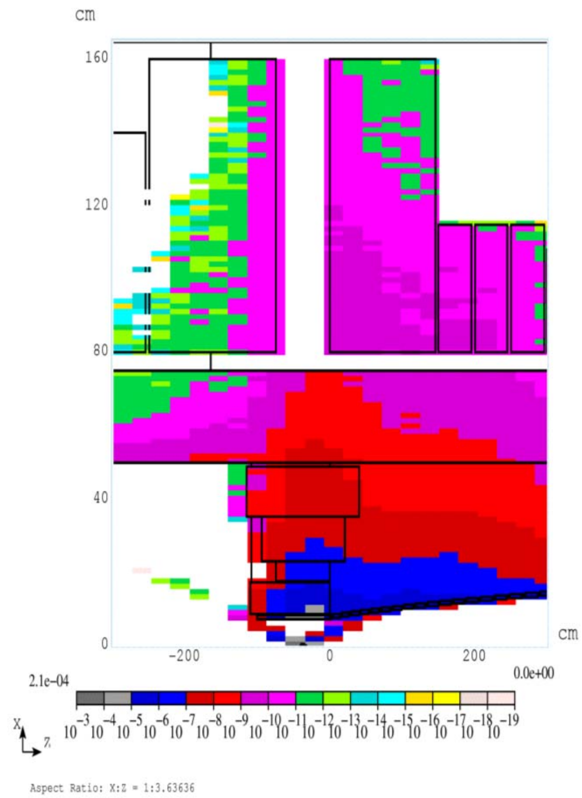


STUDY II GEOMETRY 3D ROOT PLOT OF DEPOSITED ENERGY FOR FIRST TWO SUPER-CONDUCTING SOLENOID:5.5 mW/gr ~(64.5<r<67.0 cm, -20.0<z<32.0 cm)

STUDY II | IDS80 IRON PLUG | IDS80 NO IRON PLUG





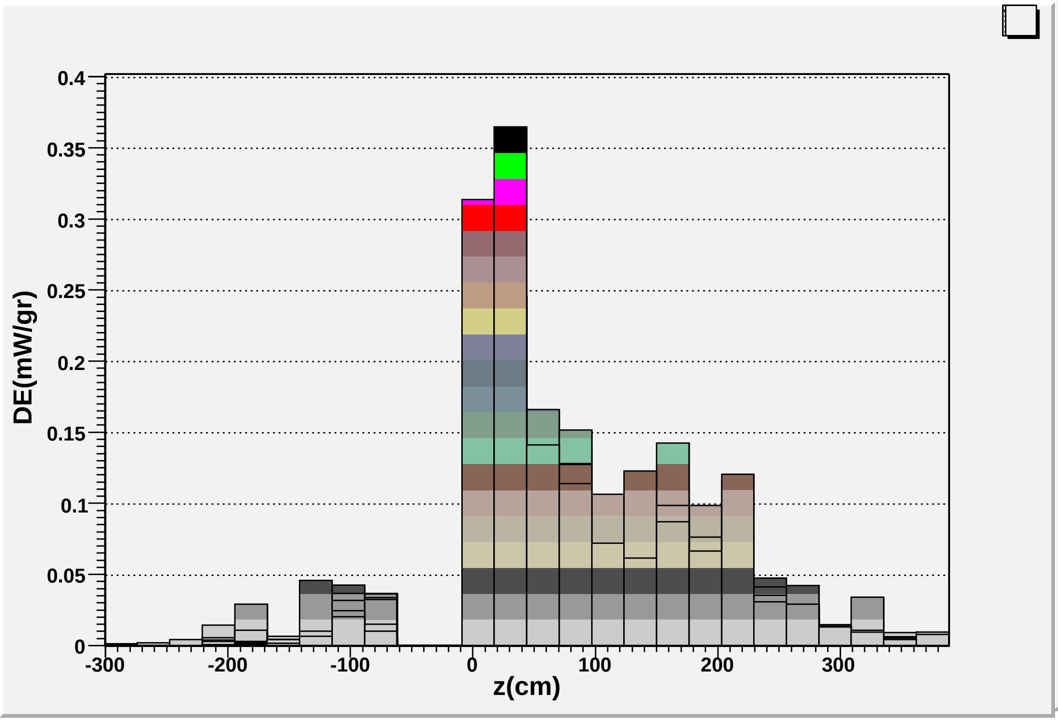


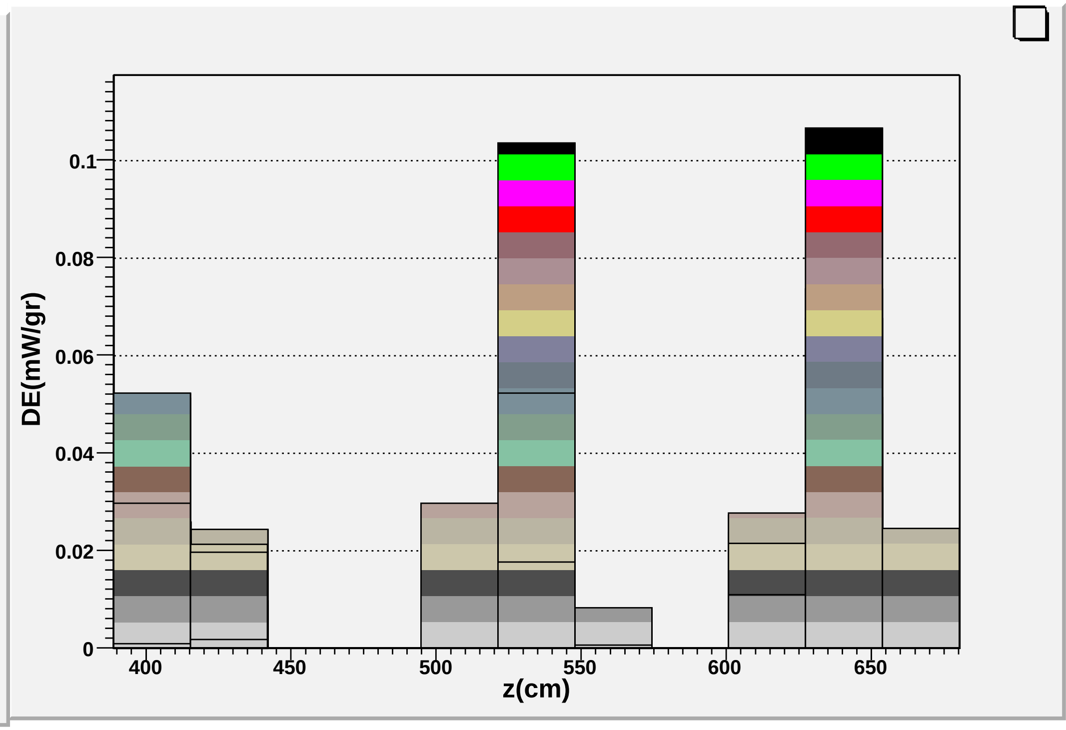
STUDY II PEAK VALUE: ~(5.5 mW/gr in -20.0<z<32.0 cm, 64.5<z<67 cm) SC#1

IDS80 PEAK VALUE: ~(0.36 mW/gr in -42.0<z<9 cm, 80<r<81.2 cm, 82.2<r<84.5 cm) SC#4

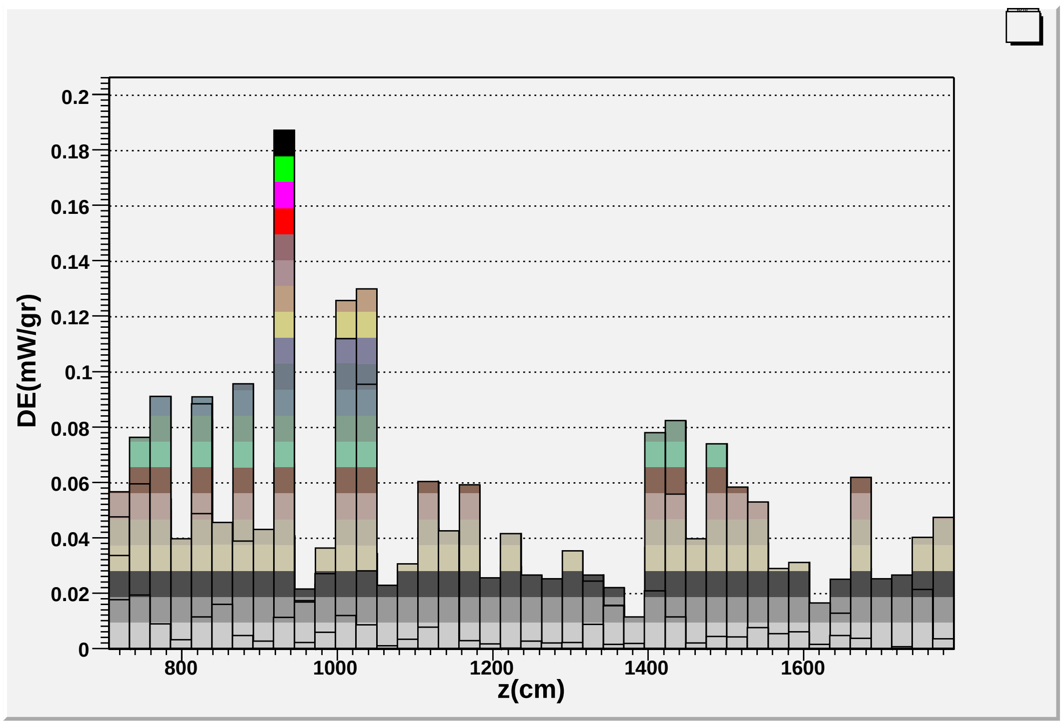
IDS80 NO IRON PLUG PEAK VALUE: ~(0.36 mW/gr -19.0<z<44.0 cm, 80.5<r<81.0 cm) SC#3

IDS80d, no iron plug





Hot spot at z ~ 900 cm may be due to low level of mercury in the pool.



CONCLUSIONS.

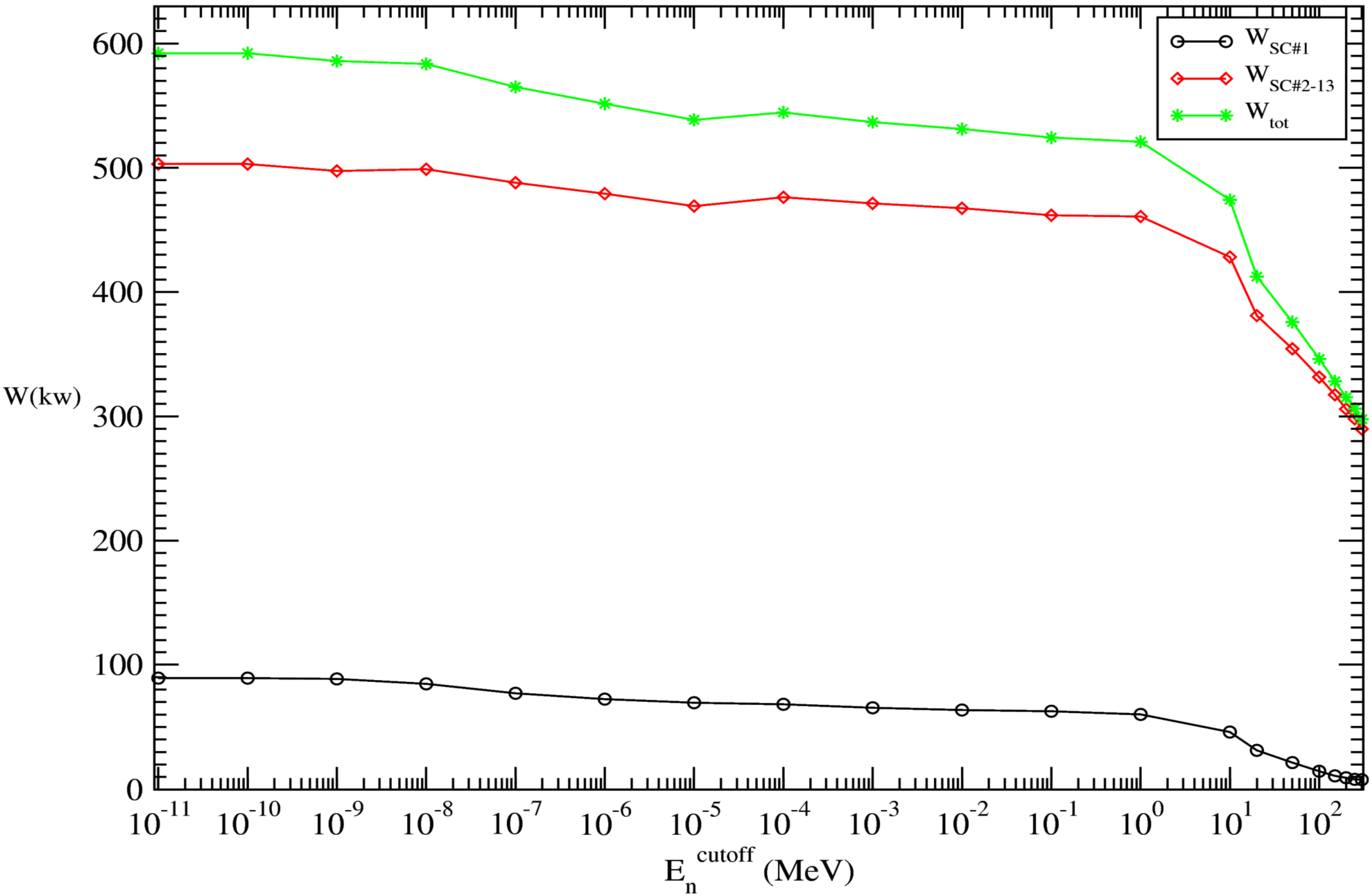
- Low energy neutrons require detail study provided by MCNP.
- High energy neutrons are a problem even with the shielding material.
- Resistive coil significantly reduces the ability for shielding SC1/first group of SC solenoids around interaction region.
- High Z material is required and as much as possible.
- Additional space for shielding material necessary for solenoids especially around the interaction area (IDS80 GEOMETRY WITH IRON PLUG).
- Additional space to accommodate access to different parts of the target station needed (IDS80 GEOMETRY WITHOUT IRON PLUG/YOKE).
- STUDY II geometry~ 50 kW in SC solenoids, 5.5 mW/gr peak values.
- IDS80 geometries~ 3-4 kW in SC solenoids, 0.35 mW/gr peak values.

BACKUP SLIDES

NO SHIELDING, DIFFERENT NEUTRON ENERGY CUTOFFS.

	$E_n \geq E_i$(MeV)	SC#1	%	SC#2-13	%	Total	%
1	$1\ 10^{-11}$	89.15	–	503.00	–	592.15	–
2	$1\ 10^{-10}$	89.15	0	503.00	0	592.15	0
3	$1\ 10^{-9}$	88.55	-0.67	497.40	-1.11	585.90	-1.06
4	$1\ 10^{-8}$	84.64	-5.06	498.90	-0.82	583.55	-1.45
5	$1\ 10^{-7}$	77.05	-13.57	488.00	-2.98	565.05	-4.58
6	$1\ 10^{-6}$	72.40	-18.79	479.15	-4.74	551.55	-6.85
7	$1\ 10^{-5}$	69.45	-22.10	469.15	-6.73	538.60	-9.04
8	$1\ 10^{-4}$	68.25	-23.44	476.25	-5.32	544.50	-8.05
9	$1\ 10^{-3}$	65.40	-26.64	471.35	-6.29	536.75	-9.36
10	$1\ 10^{-2}$	63.65	-28.60	467.50	-7.06	531.15	-10.30
11*	$1\ 10^{-1}$	62.60	-29.78	461.75	-8.20	524.35	-11.45
12	$1\ 10^{0}$	60.15	-32.53	460.80	-8.39	520.95	-12.02
13	$1\ 10^{+1}$	45.98	-48.42	428.25	-14.86	474.23	-19.91
14*	$2\ 10^{+1}$	31.35	-64.83	381.10	-24.23	412.45	-30.35
15	$5\ 10^{+1}$	21.54	-75.84	354.30	-29.56	375.84	-36.53
16	$10\ 10^{+1}$	14.60	-83.62	331.60	-34.08	346.20	-41.54
17	$15\ 10^{+1}$	10.89	-87.78	317.30	-36.92	328.19	-44.58
18	$20\ 10^{+1}$	9.33	-89.53	305.90	-39.18	315.23	-46.77
19	$25\ 10^{+1}$	8.13	-90.88	298.00	-40.76	306.13	-48.30
20	$30\ 10^{+1}$	7.81	-91.24	289.80	-42.39	297.61	-49.74

Deposited energy Power for SC#1, SC#2-13 and total, standard geom., different neutron energy cutoffs (10^{-11} to 300 MeV)
(MARS+MCNP) NO SHIELDING, 8 GeV protons, 4 MW, Gaussian Distribution $\sigma_x=\sigma_y=0.12$ cm

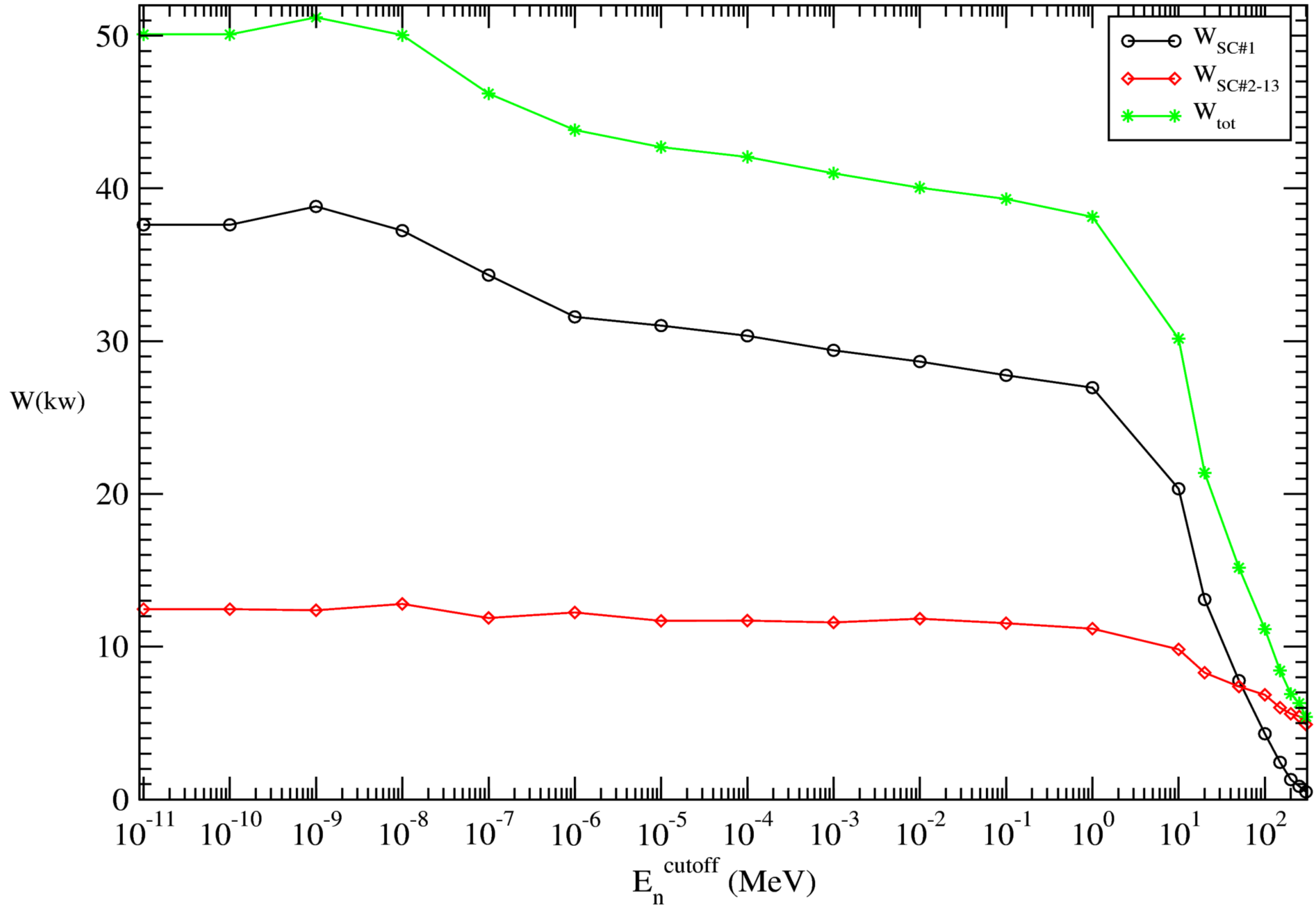


80%WC+20%H_2O SHIELDING, DIFFERENT NEUTRON ENERGY CUTOFFS.

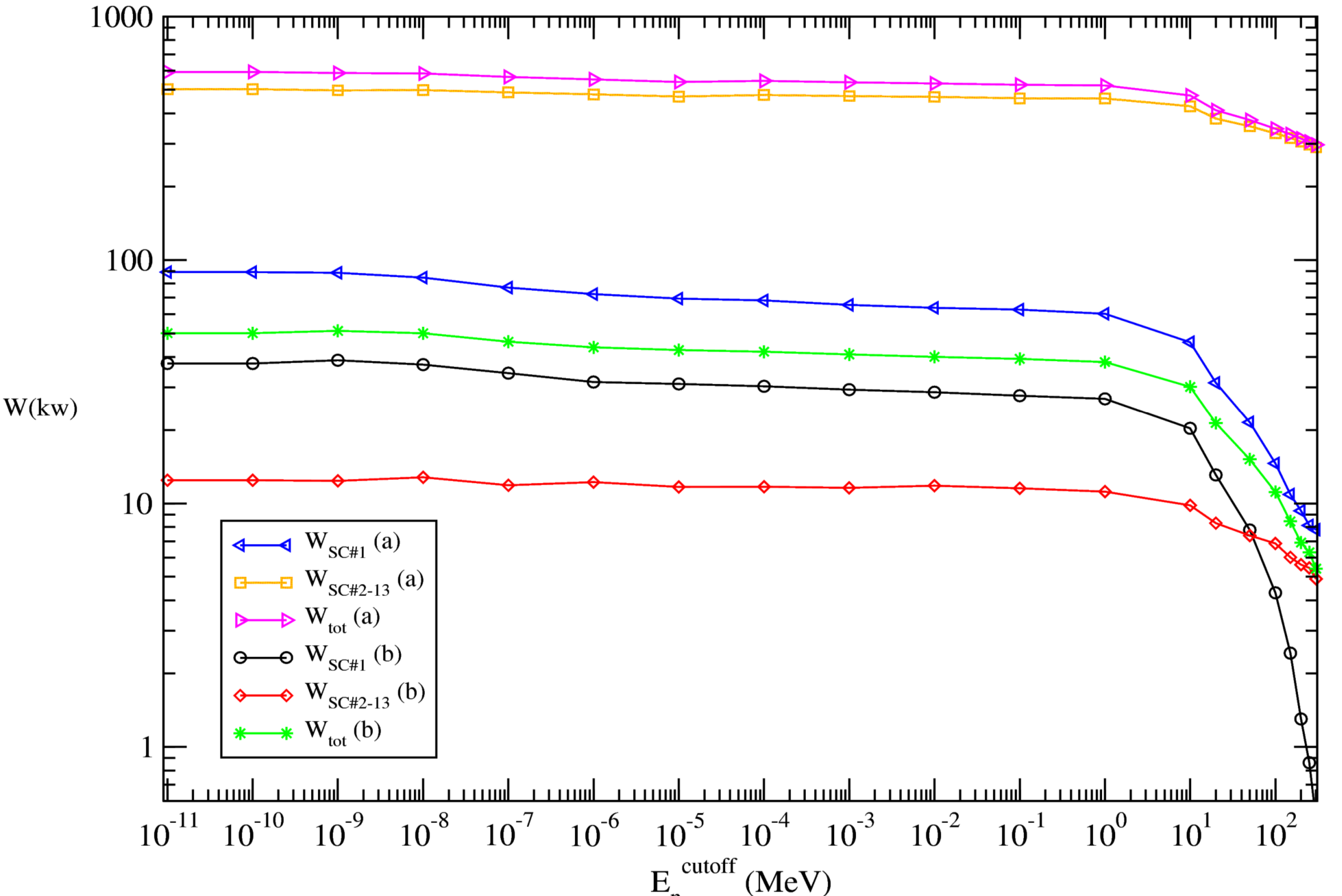
	$E_n \geq E_i$(MeV)	SC#1	%	SC#2-13	%	Total	%
1	$1\ 10^{-11}$	37.62	–	12.46	–	50.08	–
2	$1\ 10^{-10}$	37.62	0	12.46	0	50.08	0
3	$1\ 10^{-9}$	38.82	+3.19	12.38	-0.64	51.20	+2.23
4	$1\ 10^{-8}$	37.24	-1.01	12.80	+2.73	50.04	-0.08
5	$1\ 10^{-7}$	34.33	-8.75	11.88	-4.65	46.21	-7.72
6	$1\ 10^{-6}$	31.59	-16.03	12.24	-1.77	43.83	-12.48
7	$1\ 10^{-5}$	31.02	-17.54	11.69	-6.17	42.71	-14.71
8	$1\ 10^{-4}$	30.35	-19.32	11.71	-6.02	42.06	-16.01
9	$1\ 10^{-3}$	29.40	-21.85	11.59	-6.98	40.99	-18.15
10	$1\ 10^{-2}$	28.67	-23.79	11.83	-5.06	40.05	-20.03
11*	$1\ 10^{-1}$	27.77	-26.18	11.54	-7.38	39.31	-21.51
12	$1\ 10^{0}$	26.96	-28.34	11.18	-10.27	38.14	-23.84
13	$1\ 10^{+1}$	20.34	-45.93	9.83	-21.11	30.17	-39.76
14*	$2\ 10^{+1}$	13.09	-65.20	8.30	-33.39	21.39	-57.29
15	$5\ 10^{+1}$	7.78	-79.31	7.39	-40.69	15.17	-69.71
16	$10\ 10^{+1}$	4.30	-88.57	6.85	-45.02	11.15	-77.74
17	$15\ 10^{+1}$	2.43	-93.54	6.01	-51.77	8.44	-83.15
18	$20\ 10^{+1}$	1.30	-96.54	5.61	-54.98	6.91	-86.20
19	$25\ 10^{+1}$	0.86	-97.71	5.44	-46.34	6.30	-87.42
20	$30\ 10^{+1}$	0.50	-98.67	4.90	-60.67	5.40	-89.22

Deposited energy Power for SC#1, SC#2-13 and total, standard geom., different neutron energy cutoffs (10^{-11} to 300 MeV)

(MARS+MCNP) 80% WC+20% H_2O shielding, 8 GeV protons, 4 MW, Gaussian Distribution $\sigma_x=\sigma_y=0.12$ cm

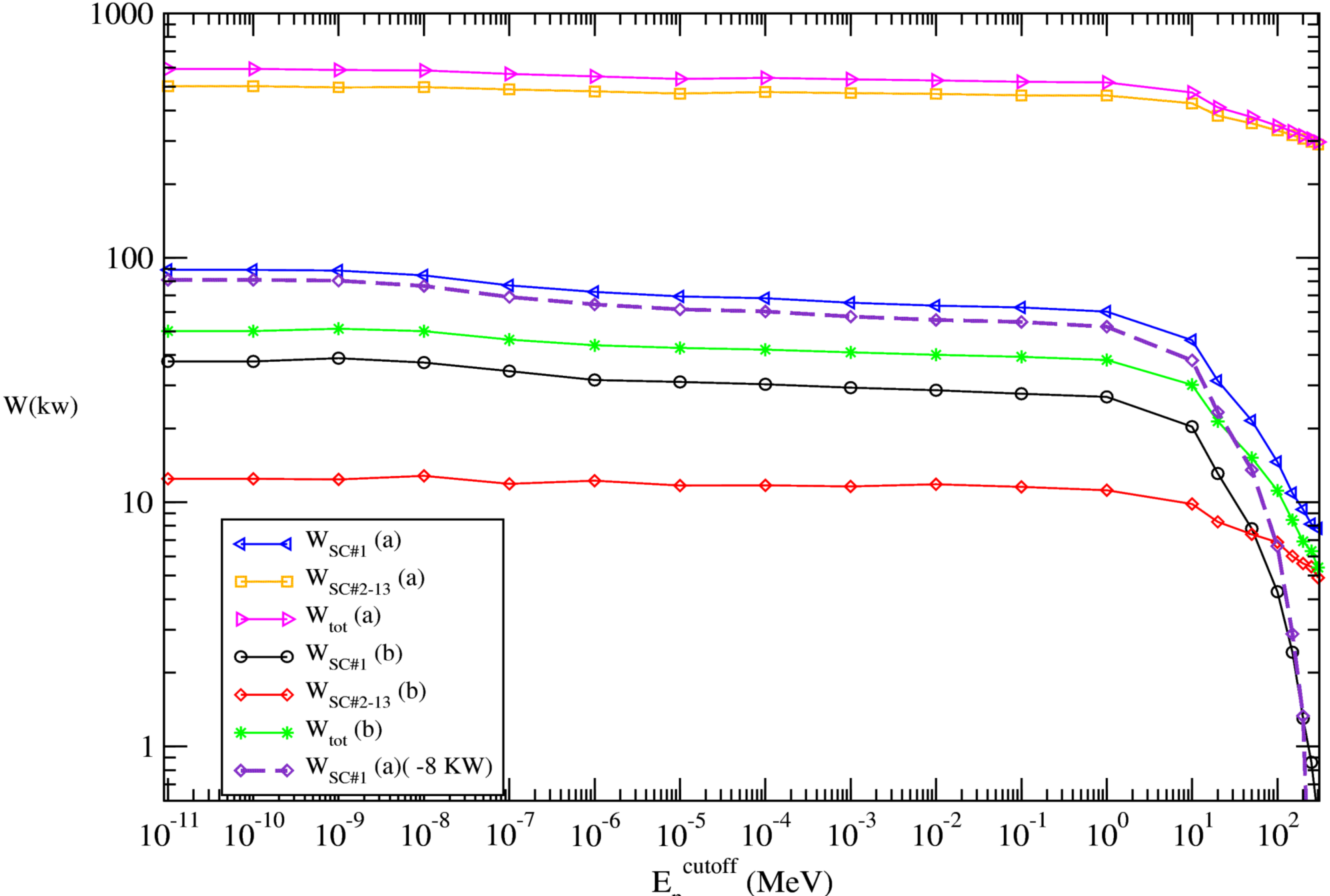


Deposited energy Power for SC#1, SC#2-13 and total, standard geom., different neutron energy cutoffs (10^{-11} to 300 MeV)
(MARS+MCNP) a=NO SHIELDING,b=80%WC+20H_2O, 8 GeV protons, 4 MW, Gaussian Distribution $\sigma_x=\sigma_y=0.12$ cm



Deposited energy Power for SC#1, SC#2-13 and total, standard geom., different neutron energy cutoffs (10^{-11} to 300 MeV)

(MARS+MCNP) a=NO SHIELDING,b=80%WC+20H_2O, 8 GeV protons, 4 MW, Gaussian Distribution $\sigma_x=\sigma_y=0.12$ cm



ENERGY DEPOSITED FOR DIFFERENT COMPOSITIONS OF THE SHIELDING (x WC+(1-x) H_2O)

	SHIELDING	ρ(g/cc)	G1	%	G2	%	Total	%
1	0.1% WC+99.9% H_2O	1.0148	58.50	–	262.30	–	320.80	–
2	10% WC+90% H_2O	2.48	49.67		95.20		144.87	
3	20% WC+80% H_2O	3.96	43.06		45.84		88.90	
4	30% WC+70% H_2O	5.44	37.78		27.75		65.53	
5	40% WC+60% H_2O	6.92	35.53		19.87		55.40	
6	50% WC+50% H_2O	8.4	31.38		15.85		46.85	
7	60% WC+40% H_2O	9.88	30.67		13.54		44.21	
8	70% WC+30% H_2O	11.36	28.34		11.85		40.19	
9	80% WC+20% H_2O	12.84	27.77		11.54		39.31	
10	90% WC+10% H_2O	14.32	26.88		10.26		37.14	
11	99.9% WC+0.1% H_2O	15.79	27.25		11.08		38.33	
1C	0.1% WC+99.9% H_2O	1.0148	31.90	–	221.70	–	253.60	–
2C	10% WC+90% H_2O	2.48	25.35		71.10		96.45	
3C	20% WC+80% H_2O	3.96	21.48		31.46		52.94	
4C	30% WC+70% H_2O	5.44	18.77		18.80		37.57	
5C	40% WC+60% H_2O	6.92	17.02		13.79		30.80	
6C	50% WC+50% H_2O	8.4	15.21		10.62		25.83	
7C	60% WC+40% H_2O	9.88	14.10		9.58		23.68	
8C	70% WC+30% H_2O	11.36	13.26		8.98		22.24	
9C	80% WC+20% H_2O	12.84	13.09		8.30		21.39	
10C	90% WC+10% H_2O	14.32	12.45		8.14		20.58	
11C	99.9% WC+0.1% H_2O	15.79	11.95		7.94		19.89	

DEPOSITED ENERGY BY REMOVING THE MAGNETIC FIELD, USING TWO WAYS: (4=F, B≠0) (4=T, B=0)

Table 0.4: (10/23/2010)

YES/NO MAGNETIC FIELD (SET 4=F OR B=(0,0)) (****)
N_p=100,000 , STANDARD GEOMETRY,13 SC COILS, 2 SC groups:G1=1, G2=2-13
STANDARD SHIELDING WITH: 80% WC+20% H_2O, MARS+MCNP
SOLENOID MATERIALS: SC#1-13=SCON (NiTi+Cu+..)
E_p=8 GeV, 4 MW BEAM, $\sigma_x=\sigma_y$=0.12 cm Gaussian distr.
a= $E_n \geq$0.1 MeV (DEFAULT)
b= $E_n \geq$20 MeV
c=B FIELD OFF(SET PARAM. 4=F IN THE .INP FILE), $E_n \geq$0.1 MeV (DEFAULT)
d=B FIELD OFF(SET PARAM. 4=F IN THE .INP FILE), $E_n \geq$20 MeV
e=B FIELD OFF(SET B=0, 4=T IN THE .INP FILE), $E_n \geq$0.1 MeV (DEFAULT)
f=B FIELD OFF(SET B=0, 4=T IN THE .INP FILE), $E_n \geq$ 20 MeV

Table 0.5: POWER OF DEPOSITED ENERGY IN KW, DW/W %=((W_x-W_a)/W_a) x100 where x=b,c,e, in d and f are the percentage differences with c and e correspondingly (10/23/2010)

	G1	%	G2	%	Total	%
a	27.77	–	11.54	–	39.31	–
b	13.09	-52.86	8.30	-28.08	21.39	-45.59
c	23.27	-16.20	12.63	+9.45	35.90	-8.67
d	11.06	-52.47	8.88	-29.69	19.94	-44.46
e	22.03	-20.67	12.42	+7.63	34.45	-12.36
f	10.87	-50.66	8.61	-30.68	19.48	-43.45

DEPOSITED ENERGY WHEN RESISITIVE COIL IS REPLACED BY SHIELDING MATERIAL.

Table 0.10: (10/18/2010)

REPLACING RC WITH 80% WC+20% H_2O (****)
N_p=100,000 , STANDARD GEOMETRY,13 SC COILS, 2 SC groups:G1=1, G2=2-13
STANDARD SHIELDING WITH: 80% WC+20% H_2O, MARS+MCNP
SOLENOID MATERIALS: SC#1-13=SCON (NiTi+Cu+..)
E_p=8 GeV, 4 MW BEAM, $\sigma_x=\sigma_y$=0.12 cm Gaussian distr.
a= $E_n \geq$0.1 MeV (DEFAULT)
b= $E_n \geq$20 MeV
c=REPLACING RC WITH 80% WC+20% H_2O, $E_n \geq$0.1 MeV (DEFAULT)
d=REPLACING RC WITH 80% WC+20% H_2O, $E_n \geq$20 MeV

Table 0.11: POWER OF DEPOSITED ENERGY IN KW, DW/W %=((W_x-W_a)/W_a) x100 where x=b,c, in d the percentage difference is with c. (10/18/2010)

	G1	%	G2	%	Total	%
a	27.77	–	11.54	–	39.31	–
b	13.09	-52.86	8.30	-28.08	21.39	-45.59
c	9.83	-64.60	10.45	-9.45	20.28	-48.41
d	4.41	-58.28	7.97	-23.73	12.38	-38.95

DEPOSITED ENERGY WITH 24 GeV BEAM.

Table 0.6: (10/26/2010)

E_p=24 GeV, 4 MW BEAM, σ_x=σ_y=0.15 cm Gaussian distr.(****)
N_p=100,000 , STANDARD GEOMETRY,13 SC COILS, 2 SC groups:G1=1, G2=2-13
SOLENOID MATERIALS: SC#1-13=SCON (NiTi+Cu+..)
a= MARS $E_n \geq$0.1 MeV (DEFAULT)
b= MARS $E_n \geq 10^{-11}$ MeV
c= MARS+MCNP $E_n \geq$0.1 MeV (DEFAULT)
d= MARS+MCNP $E_n \geq 10^{-11}$ MeV

Table 0.7: POWER OF DEPOSITED ENERGY IN KW, DW/W %=((W_x-W_a)/W_a) x100 where x=b,c,e, in d is the percentage difference with c. (10/26/2010)

	G1	%	G2	%	Total	%
a	14.28	–	14.90	–	29.18	–
b	15.92	+11.48	14.99	+0.60	30.91	+5.95
c	15.45	+8.19	14.68	-1.48	30.13	+3.26
d	22.06	+42.78	16.30	+8.99	38.36	+27.31

NOTICE: NEW GEOMETRY RESULTS ARE WITHOUT OPTIMIZING PROTON BEAM AND MERCURY TARGET PARAMETERS.