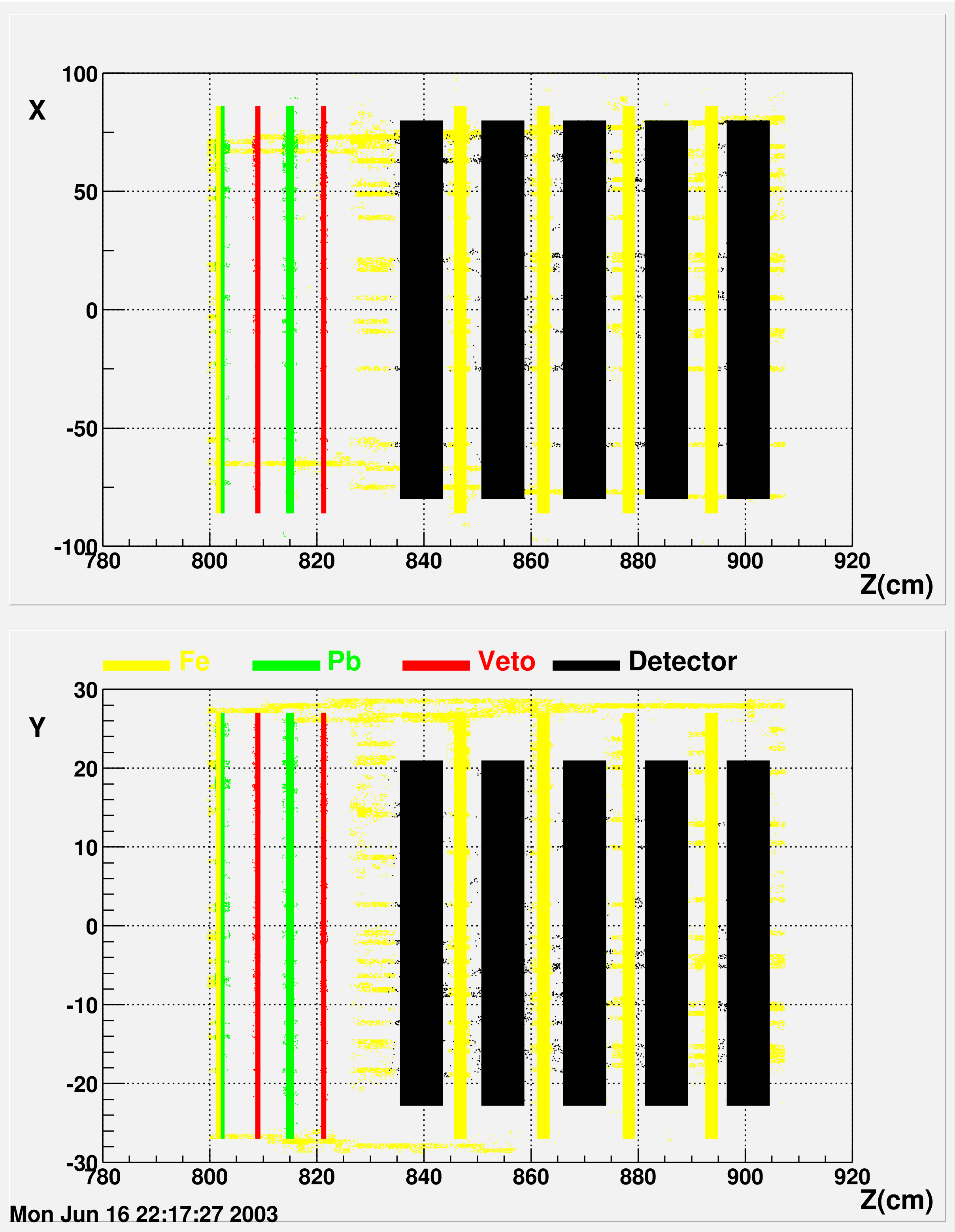
The Neutron Detector
Version e2 $\rightarrow$ e4

June 18, 2003

1 Geometry

The P.Degtyarenko program set .MCWORK has been used with the follwing main features of geometry :

- He^3 target 40 cm surrounded by glass wall;
- space filled by air;
- FFWL-Front Face wall (Fe or Pb box)
  Z$\approx$ 800 cm;
- FBWL-Back Face wall (Fe or Pb box)
  before V1;
- PADD 2 veto counter
  160.00cm x 10.33 cm x 1.0 cm
  first veto counter V1, Z$\approx$ 809 cm,
  second veto counter V2, Z$\approx$ 821 cm;
- PDFW-Paddle Filter wall (Fe or Pb box)
  between V1 and V2, Z$\approx$ 814 cm;
- DHEN 5 scintillator counters (DETS) of the neutron detectors
  box 274.32 cm x 57.38 cm x 107.14 cm
  each DETS has width 10 cm
  Z$\approx$ 840 cm, 854 cm, 869 cm, 884 cm, 899 cm;
- iron boxes $\approx$ 4 cm placed between DETS and before DHEN



X
100
50
0
-50
-100
780
800
820
840
860
880
900
920
Z(cm)
Fe
Pb
Veto
Detector
Y
30
20
10
0
-10
-20
-30
780
800
820
840
860
880
900
920
Z(cm)
Mon Jun 16 22:17:27 2003

Figure 1:

2 Background

For estimates of background of particles coming from the target calculations of P.Degtyarenko were used.Data were taken from his pictures by hand and presented in tables below.

These data were obtained assuming beam current 10 μA and detector solid angle 0.1 sr.

T MeV	mHz γ	mHz e^+	mHz e^-	mHz π^+	mHz π^-	mHz n	mHz p
$>$ 0.10	1945.	7.23	22675.48	0.81	0.62	5.50	3.66
$>$ 0.32	1127.	6.76	19783.22	0.71	0.54	5.14	3.56
$>$ 1.00	497.	6.31	15058.38	0.69	0.53	4.49	3.46
$>$ 3.16	145.5	4.19	11461.97	0.67	0.51	4.19	3.32
$>$ 10.00	14.3	0.93	1291.55	0.66	0.50	3.19	3.19
$>$ 31.62	2.1	0.62	24.69	0.64	0.49	2.12	2.43
$>$ 100.00	1.6	0.36	0.36	0.62	0.41	1.23	1.41
$>$ 316.23	0.5	0.01	0.005	0.36	0.16	0.24	0.27
$>$1000.00	0.04	0.0003	0.0002	0.05	0.04	0.01	0.01

These data are renormilized for present use by the factors :

- for beam current 15 μA $f_1 = 1.5$
- for single paddle solid angle $\Omega = \frac{160.00cmx10.33cm}{(800cm)^2} = 2.58 \cdot 10^{-3} sr,\ f_2 = 2.58 \cdot 10^{-2}$
- $f_3 = 1.5$ proposed by Bogdan for any case.

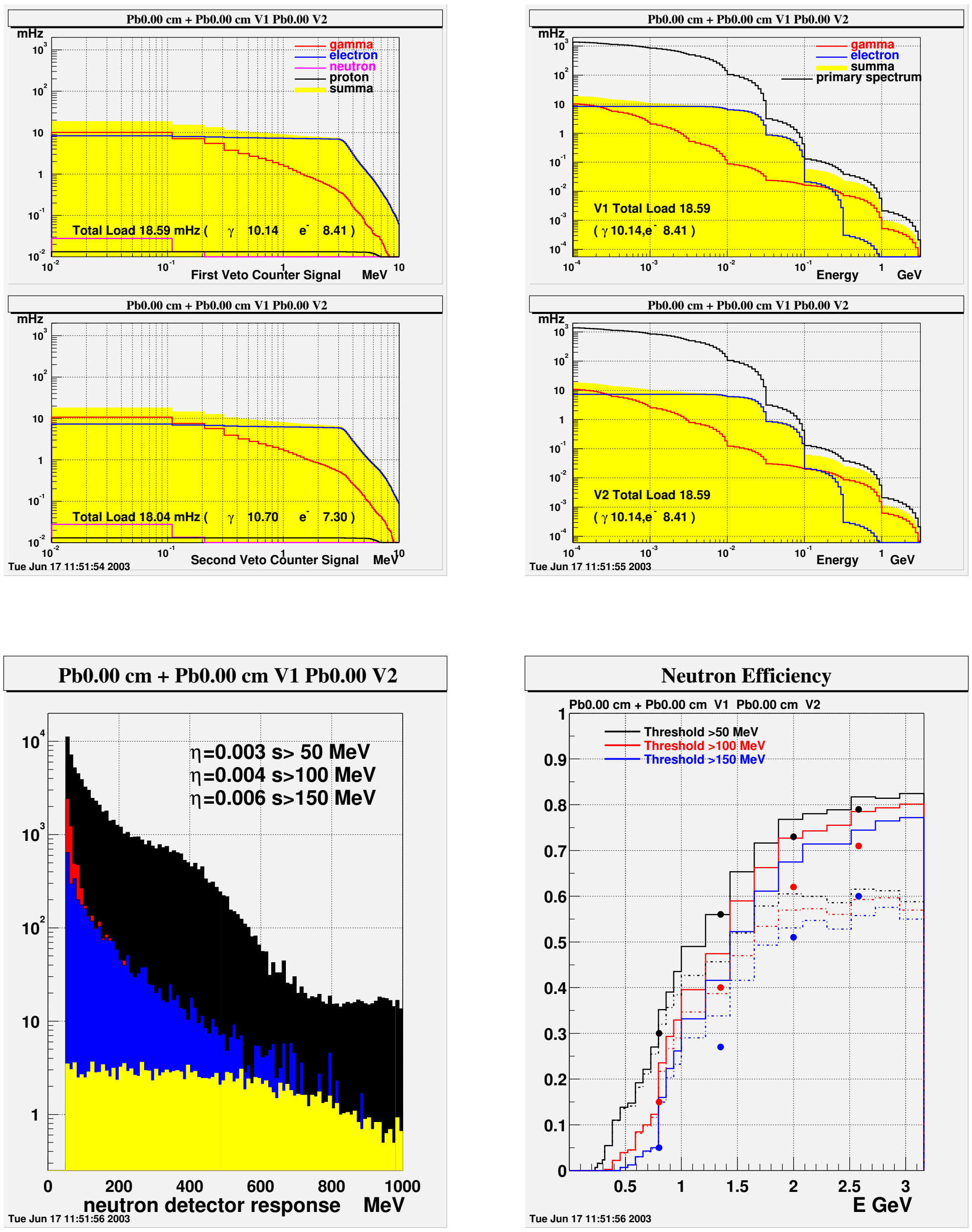
Renormilized data presented in the table below

T MeV	mHz γ	mHz e^+	mHz e^-	mHz π^+	mHz π^-	mHz n	mHz p
$>$ 0.10	110.6	0.41	1289.5	0.046	0.035	0.31	0.21
$>$ 0.32	64.1	0.38	1125.1	0.040	0.031	0.29	0.20
$>$ 1.00	28.3	0.36	856.4	0.039	0.030	0.26	0.197
$>$ 3.16	8.28	0.24	651.8	0.038	0.029	0.24	0.189
$>$ 10.00	0.81	0.05	73.45	0.037	0.028	0.18	0.181
$>$ 31.62	0.12	0.04	1.40	0.036	0.027	0.12	0.138
$>$ 100.00	0.09	0.02	0.02	0.035	0.023	0.07	0.080
$>$ 316.23	0.03	0.0004	0.0003	0.020	0.009	0.01	0.016
$>$1000.00	0.002	0.0000	0.0000	0.003	0.002	0.0004	0.0004

In the following Figures (2, 3, 4 , 5) some set of pictures is presented . All pictures have title according to corresponding configuration of veto counter structure ,that is

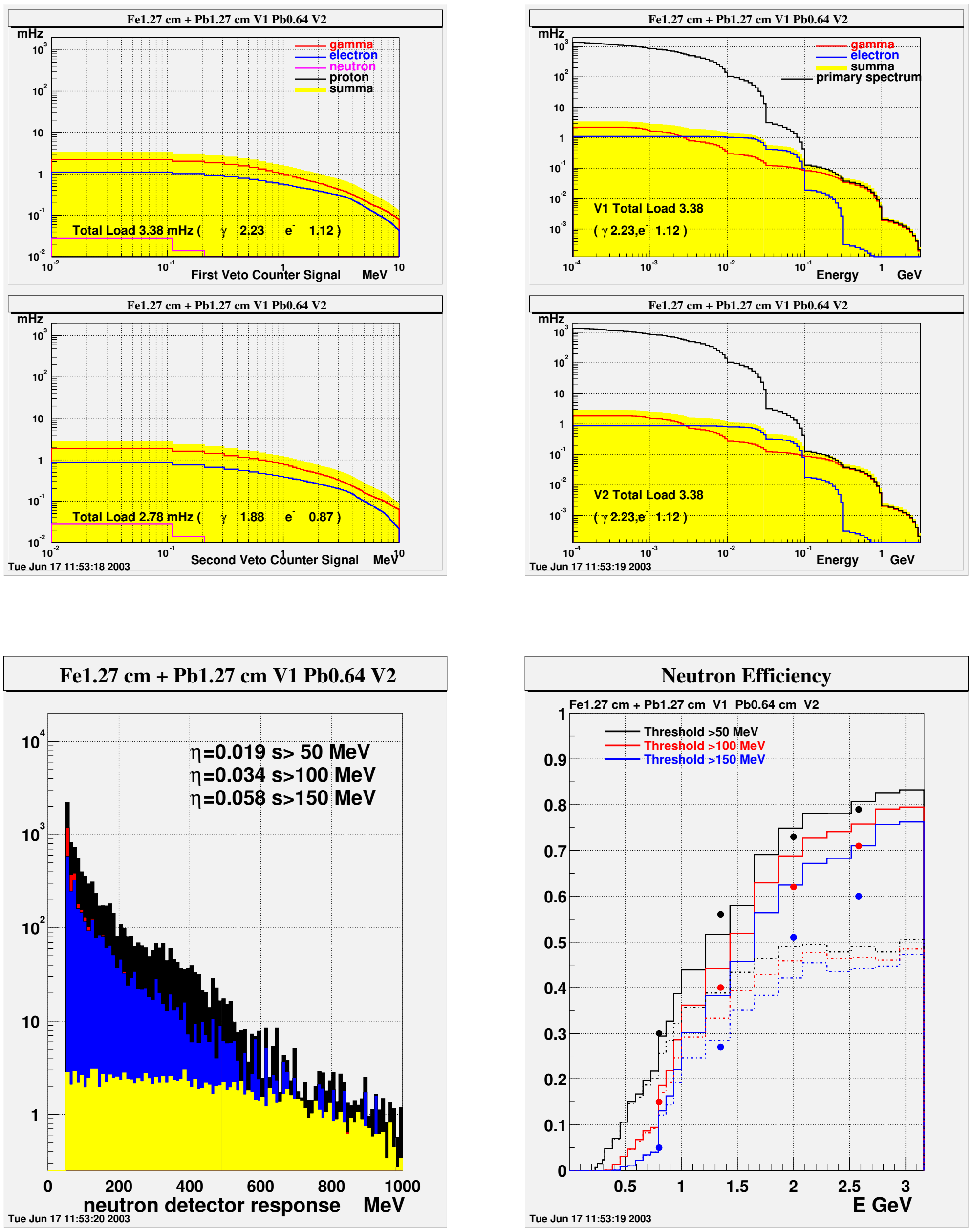
FFWL + FBWL V1 PDFW V2

- LEFT, TOP
  load in mHz as function of V1 (upper) and V2 (lower) threshold. Total load included signals from γ, e^-, *neutrons* and *protons* and filled by yellow.
- RIGHT, TOP
  analogous to previous picture, but as function of momentum threshold
- LEFT, BOTTOM
  Neutron detector response
  - black color - total signal from γ , charged particles, neutrons ;
  - red color - summary signal from charged particles and neutrons ;
  - blue color - signal from neutrons of all energies; ;
  - yellow color - signal from neutrons with momentum greater 1 GeV; ;
  - η - ratio of signal from neutrons with momentum greater 1 GeV to total signal for given thresold (s);
- RIGHT, BOTTOM
  neutron efficiency as a function of momentum
  - solid lines - efficiency without veto counters;
  - dashed lines - if signal in each veto counter less 0.5 MeV.
  - points taken from your Proposal (Table 1, page 33)



Pb0.00 cm + Pb0.00 cm V1 Pb0.00 V2
mHz
gamma
electron
neutron
proton
summa
Total Load 18.59 mHz (γ 10.14 e⁻ 8.41)
First Veto Counter Signal MeV
primary spectrum
V1 Total Load 18.59
(γ 10.14,e⁻ 8.41)
Energy GeV
Total Load 18.04 mHz (γ 10.70 e⁻ 7.30)
Second Veto Counter Signal MeV
V2 Total Load 18.59
(γ 10.14,e⁻ 8.41)
Tue Jun 17 11:51:54 2003
Tue Jun 17 11:51:55 2003
η=0.003 s> 50 MeV
η=0.004 s>100 MeV
η=0.006 s>150 MeV
neutron detector response MeV
Neutron Efficiency
Pb0.00 cm + Pb0.00 cm V1 Pb0.00 cm V2
Threshold >50 MeV
Threshold >100 MeV
Threshold >150 MeV
E GeV
Tue Jun 17 11:51:56 2003

Figure 2:



Fe1.27 cm + Pb1.27 cm V1 Pb0.64 V2
mHz
gamma
electron
neutron
proton
summa
Total Load 3.38 mHz (γ 2.23 e⁻ 1.12)
First Veto Counter Signal MeV
primary spectrum
V1 Total Load 3.38
(γ 2.23,e⁻ 1.12)
Energy GeV
Total Load 2.78 mHz (γ 1.88 e⁻ 0.87)
Second Veto Counter Signal MeV
V2 Total Load 3.38
(γ 2.23,e⁻ 1.12)
Tue Jun 17 11:53:18 2003
Tue Jun 17 11:53:19 2003
η=0.019 s> 50 MeV
η=0.034 s>100 MeV
η=0.058 s>150 MeV
neutron detector response MeV
Tue Jun 17 11:53:20 2003
Neutron Efficiency
Fe1.27 cm + Pb1.27 cm V1 Pb0.64 cm V2
Threshold >50 MeV
Threshold >100 MeV
Threshold >150 MeV
E GeV

Figure 3:

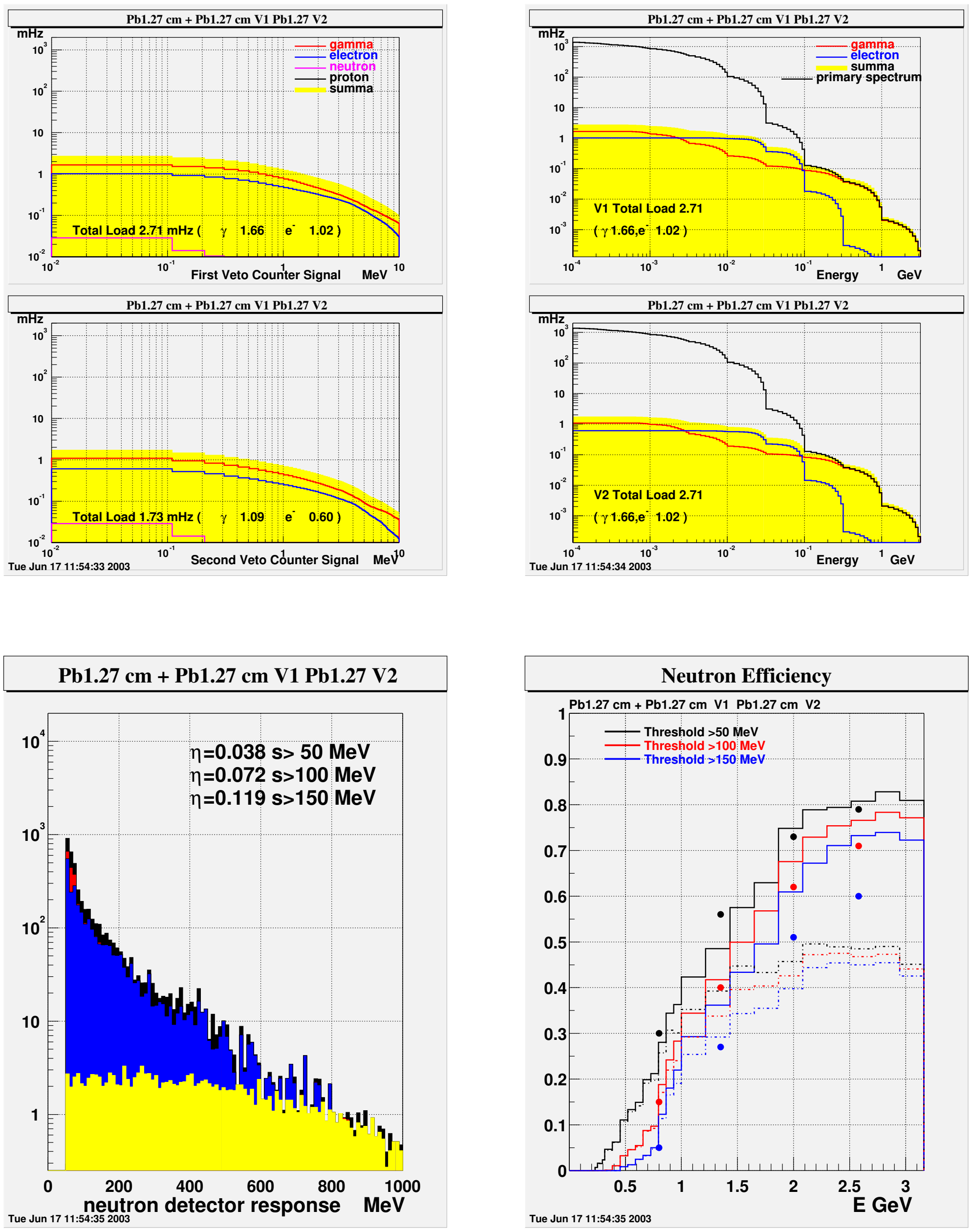

Pb1.27 cm + Pb1.27 cm V1 Pb1.27 V2
mHz
gamma
electron
neutron
proton
summa
Total Load 2.71 mHz (γ 1.66 e⁻ 1.02)
First Veto Counter Signal MeV
Pb1.27 cm + Pb1.27 cm V1 Pb1.27 V2
mHz
gamma
electron
summa
primary spectrum
V1 Total Load 2.71
(γ 1.66,e⁻ 1.02)
Energy GeV
Pb1.27 cm + Pb1.27 cm V1 Pb1.27 V2
mHz
Total Load 1.73 mHz (γ 1.09 e⁻ 0.60)
Second Veto Counter Signal MeV
Tue Jun 17 11:54:33 2003
Pb1.27 cm + Pb1.27 cm V1 Pb1.27 V2
mHz
V2 Total Load 2.71
(γ 1.66,e⁻ 1.02)
Energy GeV
Tue Jun 17 11:54:34 2003
Pb1.27 cm + Pb1.27 cm V1 Pb1.27 V2
η=0.038 s> 50 MeV
η=0.072 s>100 MeV
η=0.119 s>150 MeV
neutron detector response MeV
Tue Jun 17 11:54:35 2003
Neutron Efficiency
Pb1.27 cm + Pb1.27 cm V1 Pb1.27 cm V2
Threshold >50 MeV
Threshold >100 MeV
Threshold >150 MeV
E GeV
Tue Jun 17 11:54:35 2003

Figure 4:

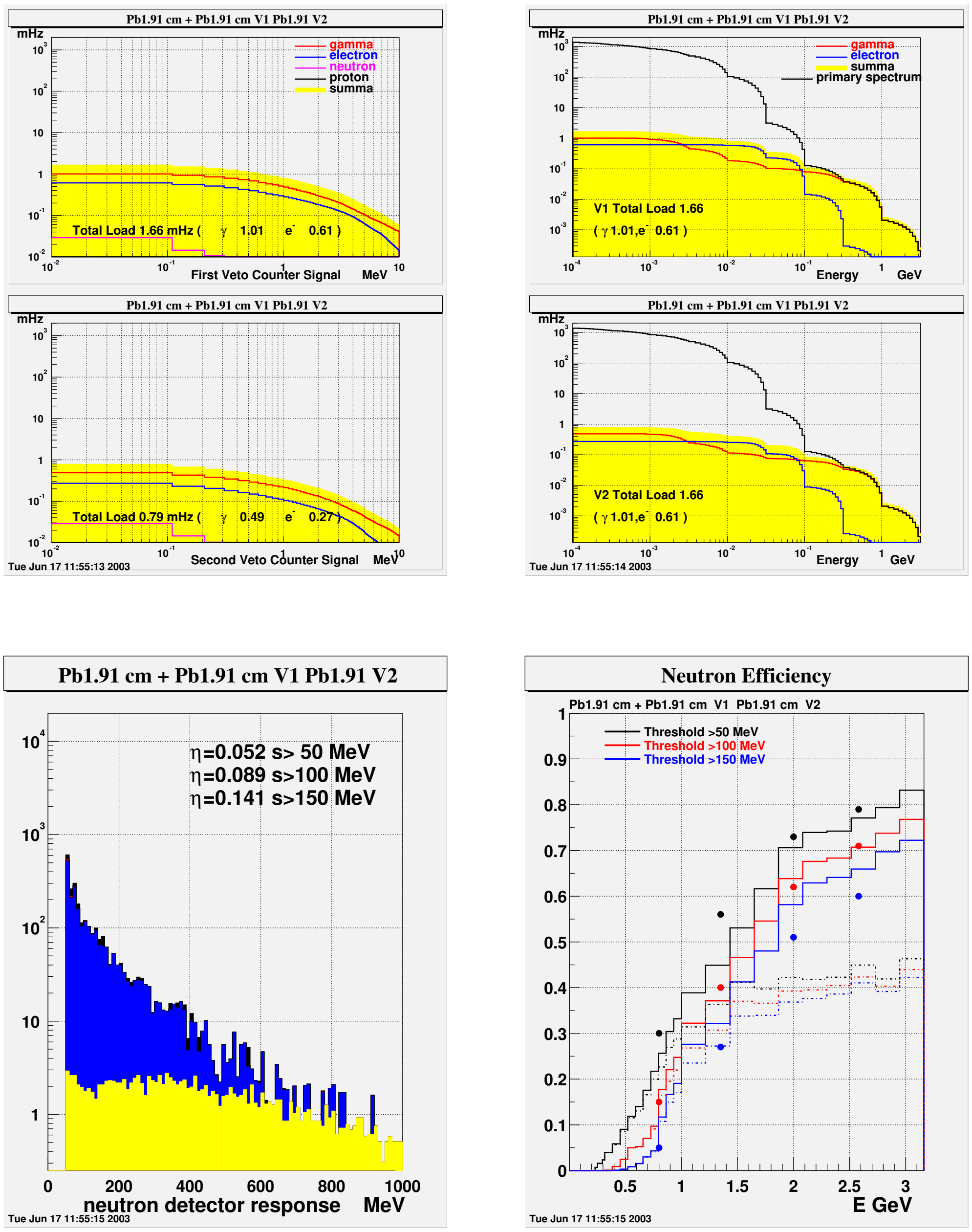

Pb1.91 cm + Pb1.91 cm V1 Pb1.91 V2
mHz
gamma
electron
neutron
proton
summa
Total Load 1.66 mHz (γ 1.01 e⁻ 0.61)
First Veto Counter Signal MeV
primary spectrum
V1 Total Load 1.66
(γ 1.01,e⁻ 0.61)
Energy GeV
Total Load 0.79 mHz (γ 0.49 e⁻ 0.27)
Second Veto Counter Signal MeV
Tue Jun 17 11:55:13 2003
V2 Total Load 1.66
(γ 1.01,e⁻ 0.61)
Tue Jun 17 11:55:14 2003
η=0.052 s> 50 MeV
η=0.089 s>100 MeV
η=0.141 s>150 MeV
neutron detector response MeV
Tue Jun 17 11:55:15 2003
Neutron Efficiency
Pb1.91 cm + Pb1.91 cm V1 Pb1.91 cm V2
Threshold >50 MeV
Threshold >100 MeV
Threshold >150 MeV
E GeV
Tue Jun 17 11:55:15 2003

Figure 5:

3 Tables

	ρ g/cm^3	dE/dx $\frac{MeV}{g/cm^2}$	X_0 cm	X_0 g/cm^2	λ_T g/cm^2	λ_I g/cm^2
Fe	7.87	1.451	1.76	13.84	82.8	131.9
Pb	11.35	1.123	0.56	6.37	116.2	194

Conf	bef V1	between V1 and V2
c0	0	0
c1	Fe 0.635 cm+Fe 0.635 cm=3.94 g/cm^2	Fe 0.635 cm =1.97 g/cm^2
c2	Fe 0.635 cm+Pb 0.635 cm=4.81 g/cm^2	Pb 0.635 cm =2.84 g/cm^2
c3	Pb 1.27 cm+Pb 1.27 cm=11.36 g/cm^2	Pb 0.635 cm =2.84 g/cm^2
c4	Pb 1.27 cm+Pb 1.27 cm=11.36 g/cm^2	Pb 1.27 cm =5.68 g/cm^2
c5	Pb 1.91 cm+Pb 1.91 cm=17.02 g/cm^2	Pb 1.91 cm =8.51 g/cm^2
c6	Pb 2.54 cm+Pb 2.54 cm=22.7 g/cm^2	Pb 2.54 cm =11.35 g/cm^2

Conf	Load		$\frac{neutron}{total\ signal} >$			n	p
	V1 mHz	V2 mHz	50 MeV %	100 MeV %	150 MeV %	eff %	rej %
c0	18.6	18.0	0.3	0.4	0.6	55.5	99.9
c1	11.6	9.05	0.5	0.6	1.1	48.7	99.8
c2	5.75	4.38	1.0	1.8	2.8	48.6	99.8
c3	2.75	2.21	3.0	5.8	9.7	45.9	99.7
c4	2.7	1.73	3.8	7.2	11.9	44.6	99.7
c5	1.1	0.45	5.2	8.9	14.1	40.7	99.7
c6	0.97	0.39	5.5	9.2	14.9	35.3	99.5