Omni-directional Si-detector Telescope, RRMD-IV

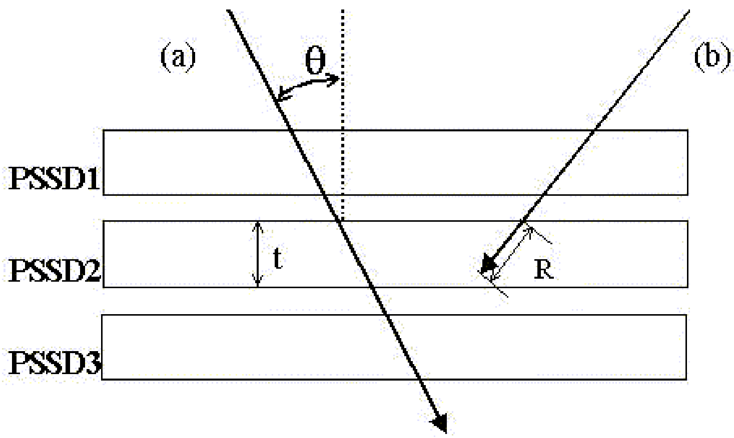
Tadayoshi Doke

Advanced Research Institute for Science and Engineering, Waseda University

Contents:

[Objective and Principle] One of disadvantages of RRMD-III is that its opening angle is limited to ± 60°. The purpose of RRMD-IV is to realize a monitoring system with finite detection efficiencies for all incident directions, which is required in the SAA region. From such a consideration, we made a cubic position sensitive Si-detector telescope (RRMD-IV) that the above requirement is satisfied This telescope is essentially an assembly of a pair of detectors, that is, two layers of position sensitive Si-detectors. In this case, we can not identify the particles stopped in the standard detector. To do so, we need three layers of position sensitive Si-detectors as in RRMD-III. Fortunately, however, the fraction of particles stopped in the standard (middle) detector is less than 1 %. This is the reason why we can use a cubic Si-detector telescope in space.

Method of Measuring LET in Real Time



(a) For a penetrating particle

$$LET = E_d / (t / \cos\theta)$$

(b) For a stopped particle

$$LET = E_d / R$$

E_d: Deposited Energy in the detector

t: Thickness of the detector

θ: Incident angle of a particle

R: Range of a stopped particle in the detector

$$R = R(Z), \quad MZ^2 \propto E \times \Delta E$$

Dose Equivalent (STS-84)

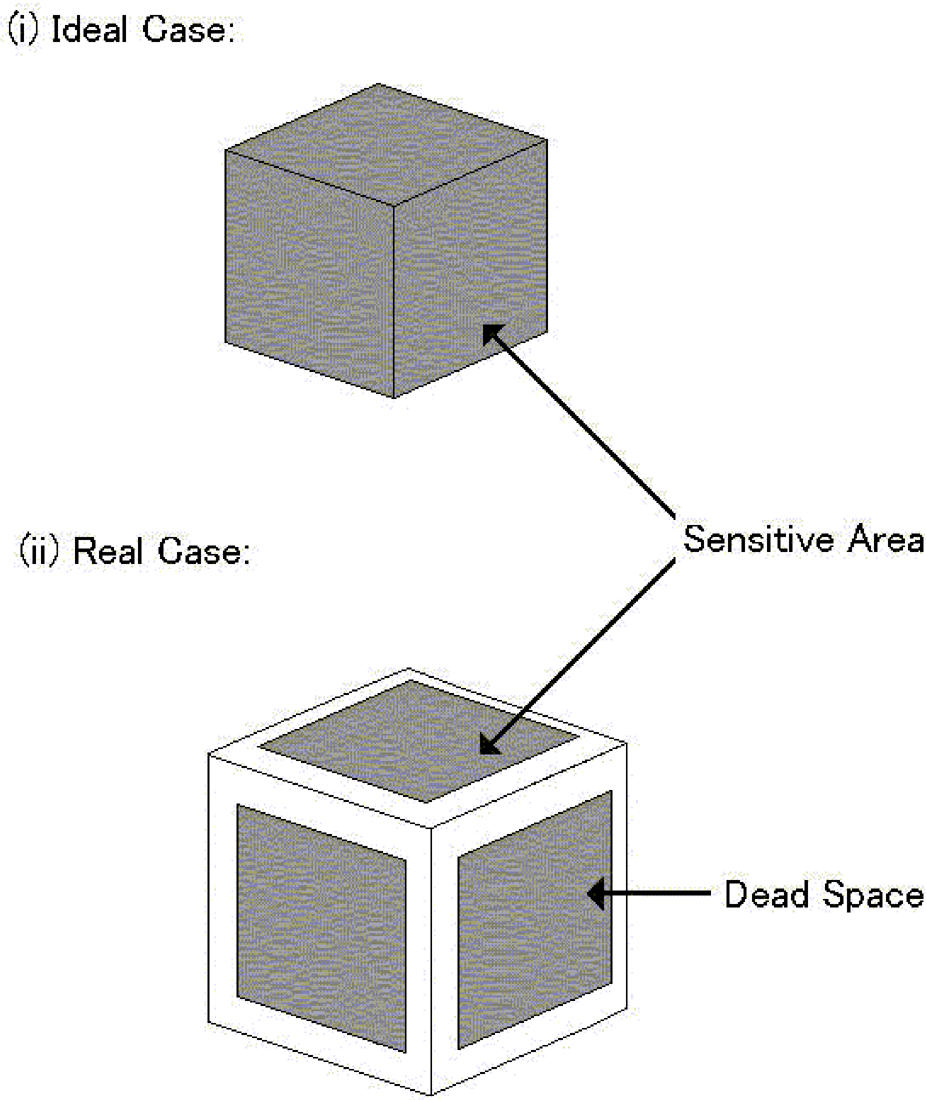
Area	Particles which stops at DSSD2 from the top side	Particles which stops at DSSD2 from the bottom side	Particles which penetrate DSSD2
GCR	1.79 μSv 0.04%	3.15 μSv 0.08%	4050 μSv
SAA	1.32 μSv 0.05%	2.97 μSv 0.11%	2740 μSv

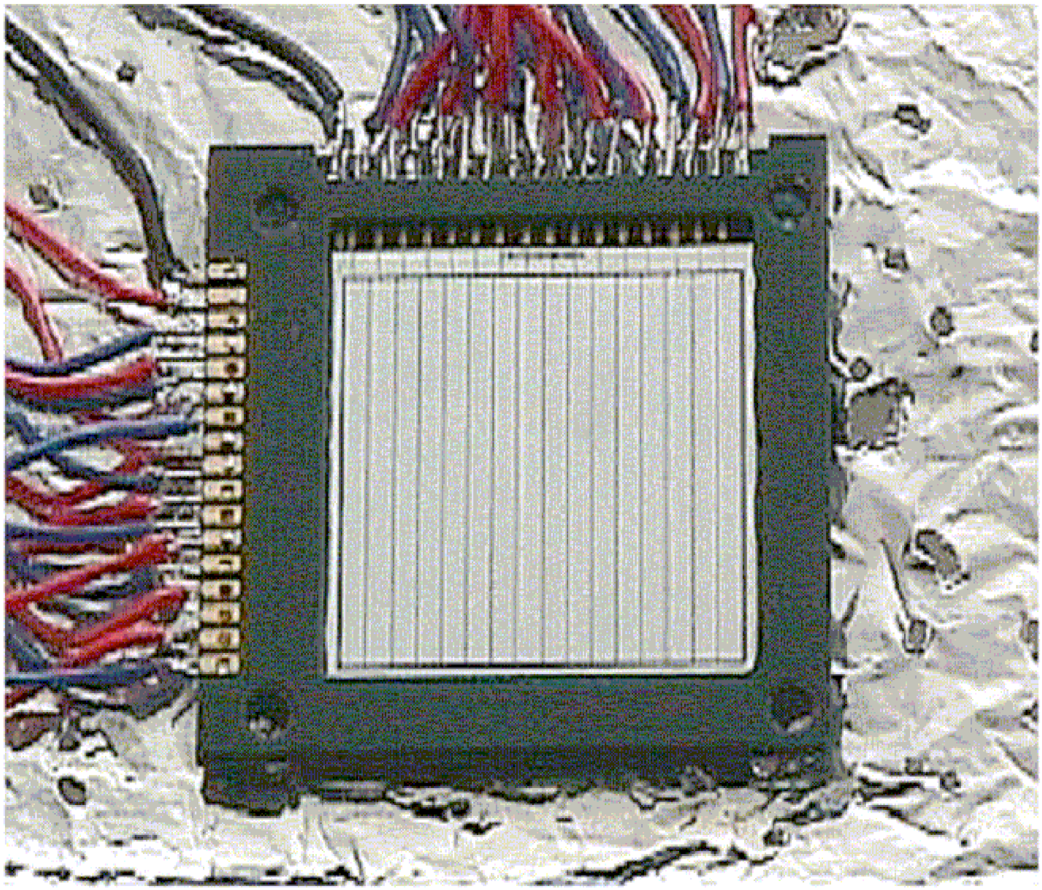
Contribution to total dose equivalent: ***<u>0.14%</u>***

Absorbed Dose (STS-84)

Area	Particles which stops at DSSD2 from the top side	Particles which stops at DSSD2 from the bottom side	Particles which penetrate DSSD2
GCR	1.28 μGy 0.11%	2.55 μGy 0.22%	1150 μGy
SAA	1.23 μGy 0.05%	2.62 μGy 0.11%	2460 μGy

Contribution to total absorbed dose: ***<u>0.21%</u>***

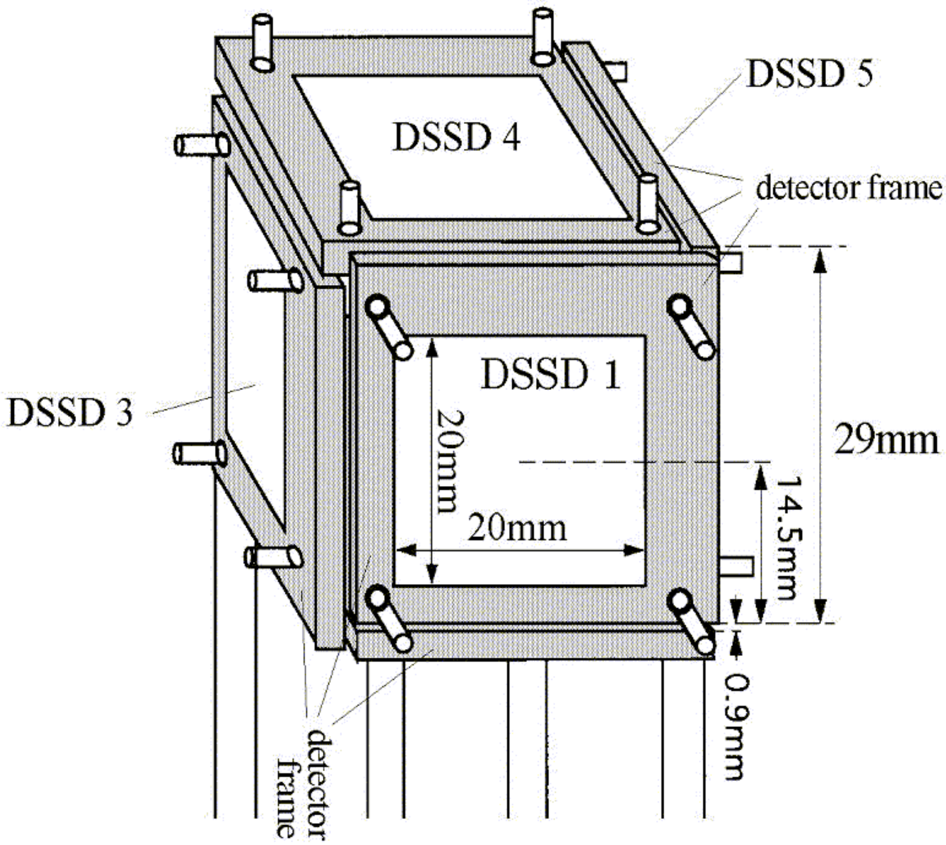

(i) Ideal Case:
(ii) Real Case:
Sensitive Area
Dead Space

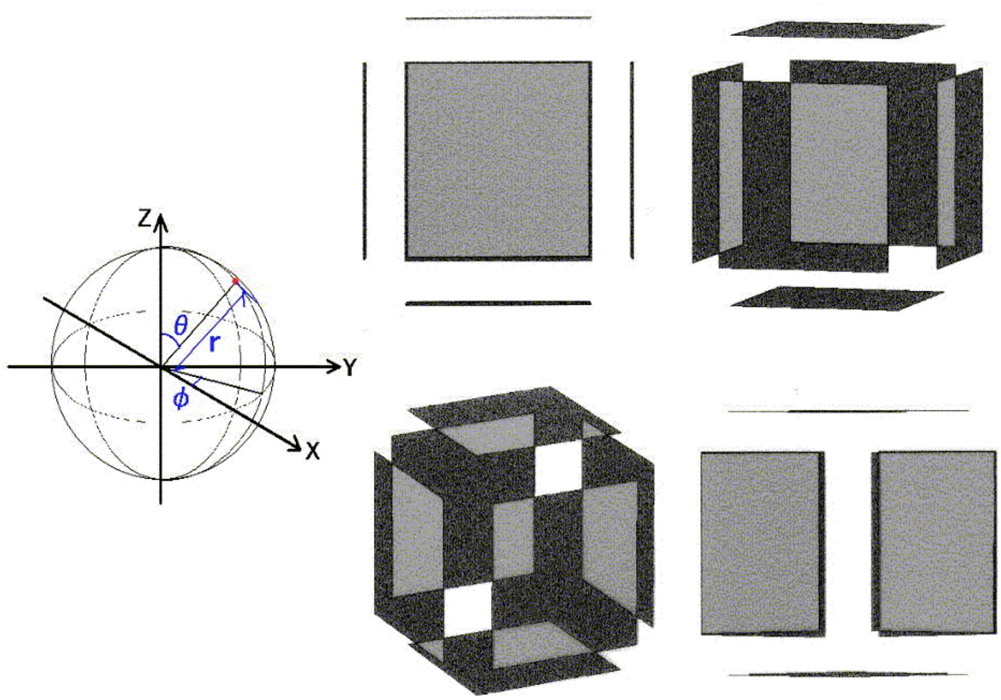


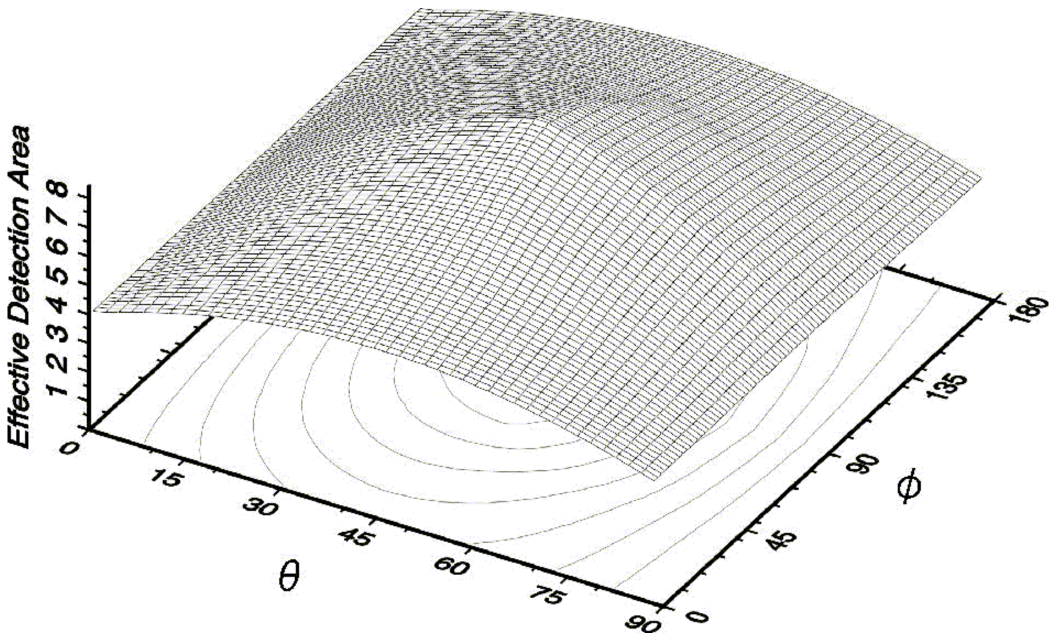
DSSD parameters

**LET range: 0.2keV/μm-water - 600keV/μm-water*

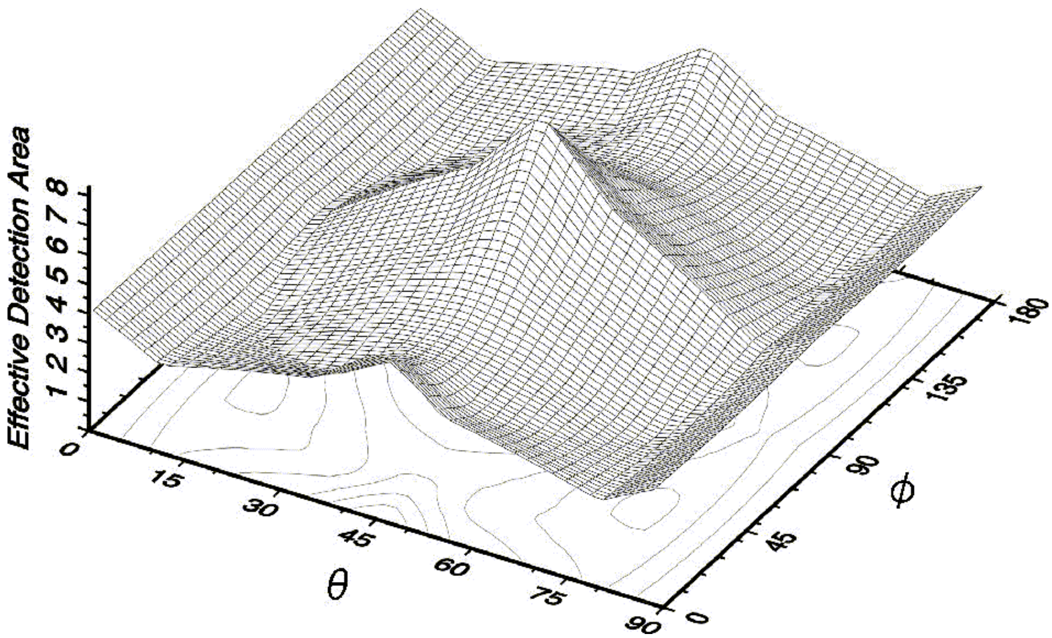
Shape	Square
Type	Ion implantation
Size	23 mm x 23 mm
Number of strips	16
Strip pitch	1.25 mm
Detector Thickness	500 μm
Effective area	20mm x 20mm


DSSD 5
DSSD 4
detector frame
DSSD 1
DSSD 3
20mm
20mm
29mm
14.5mm
0.9mm
detector frame

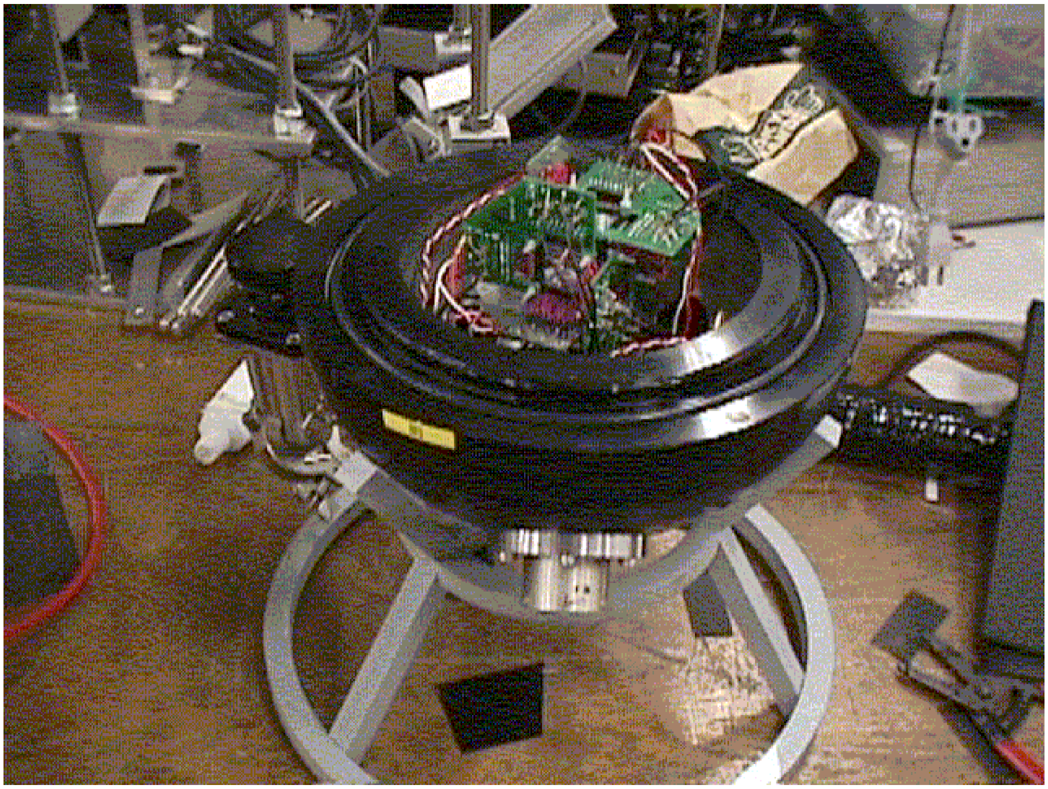

Z
Y
X
θ
r
ϕ

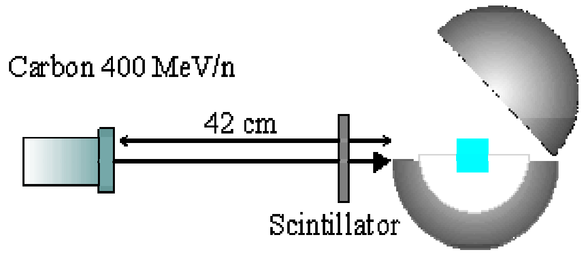


Effective Detection Area
0 1 2 3 4 5 6 7 8
θ
15 30 45 60 75 90
ϕ
0 45 90 135 180

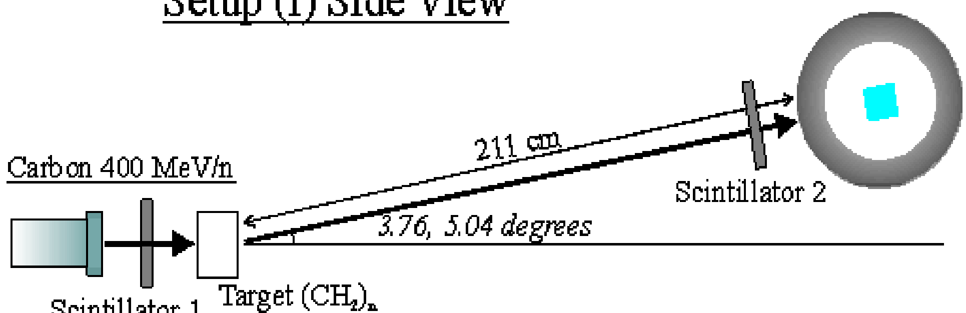


Effective Detection Area
0
1
2
3
4
5
6
7
8
15
30
45
60
75
90
θ
0
45
90
135
180
ϕ

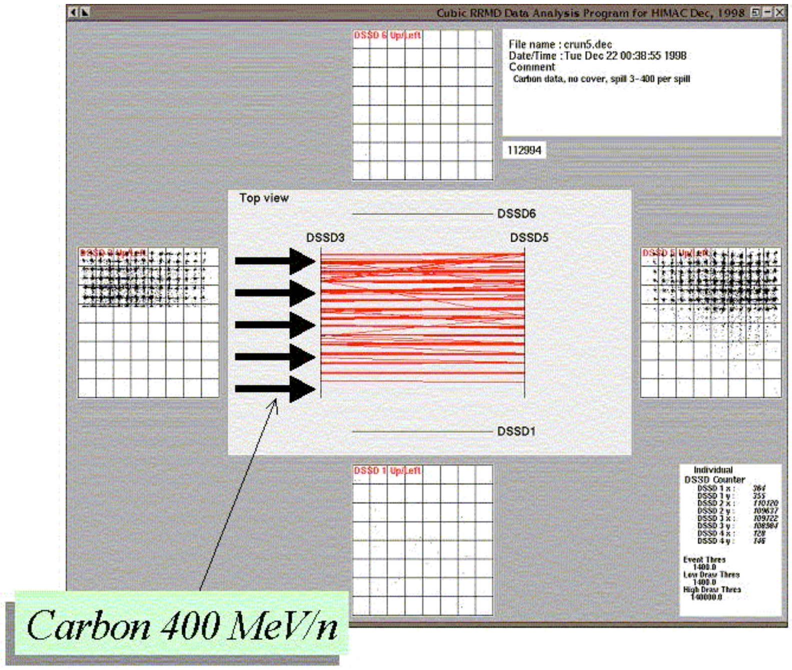




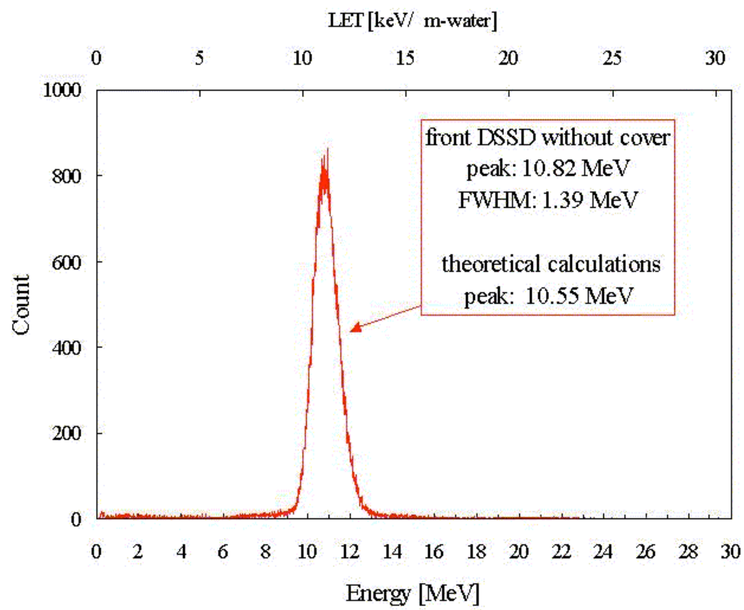
Setup (i) Side View

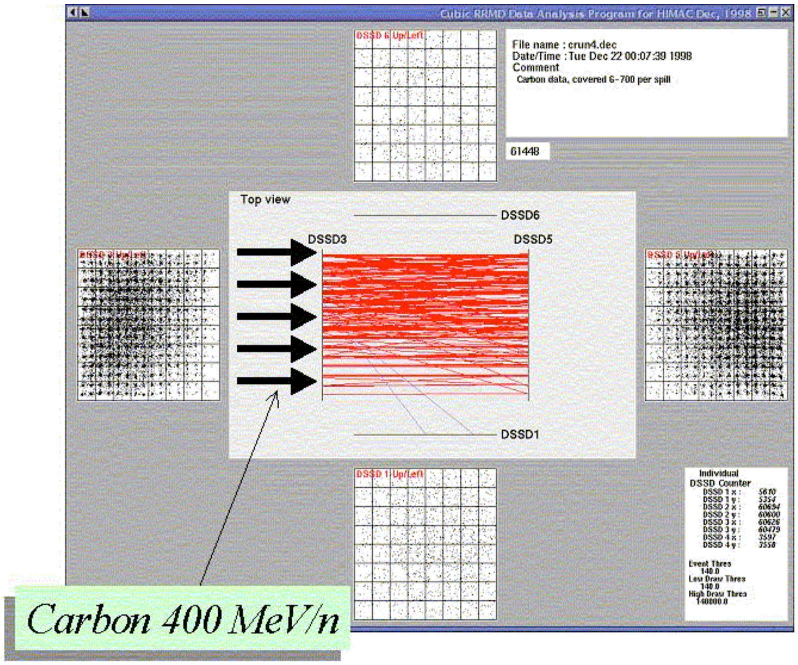


Setup (ii) Top View

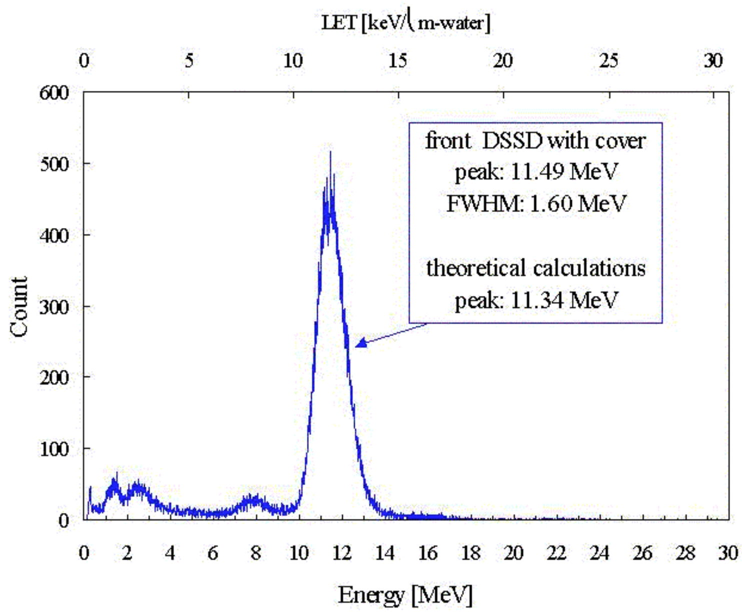


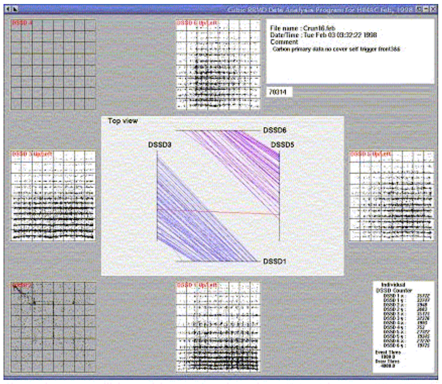
Carbon 400MeV/n deposited energy in the front DSSD



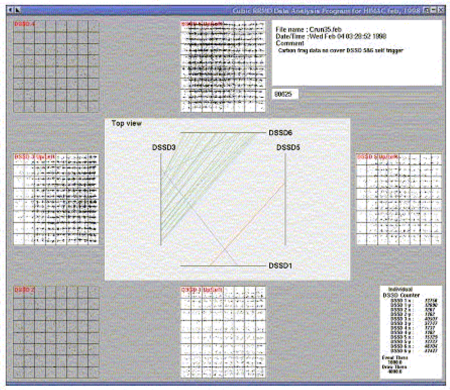


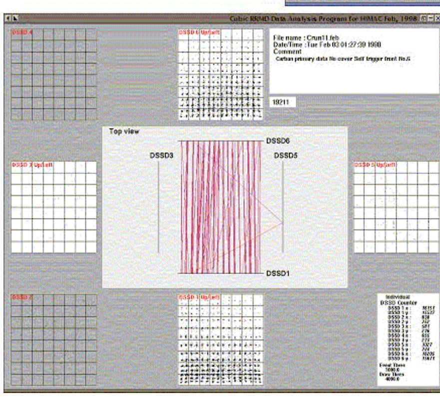
<u>Carbon 400MeV/n deposited energy in the front DSSD with cover</u>

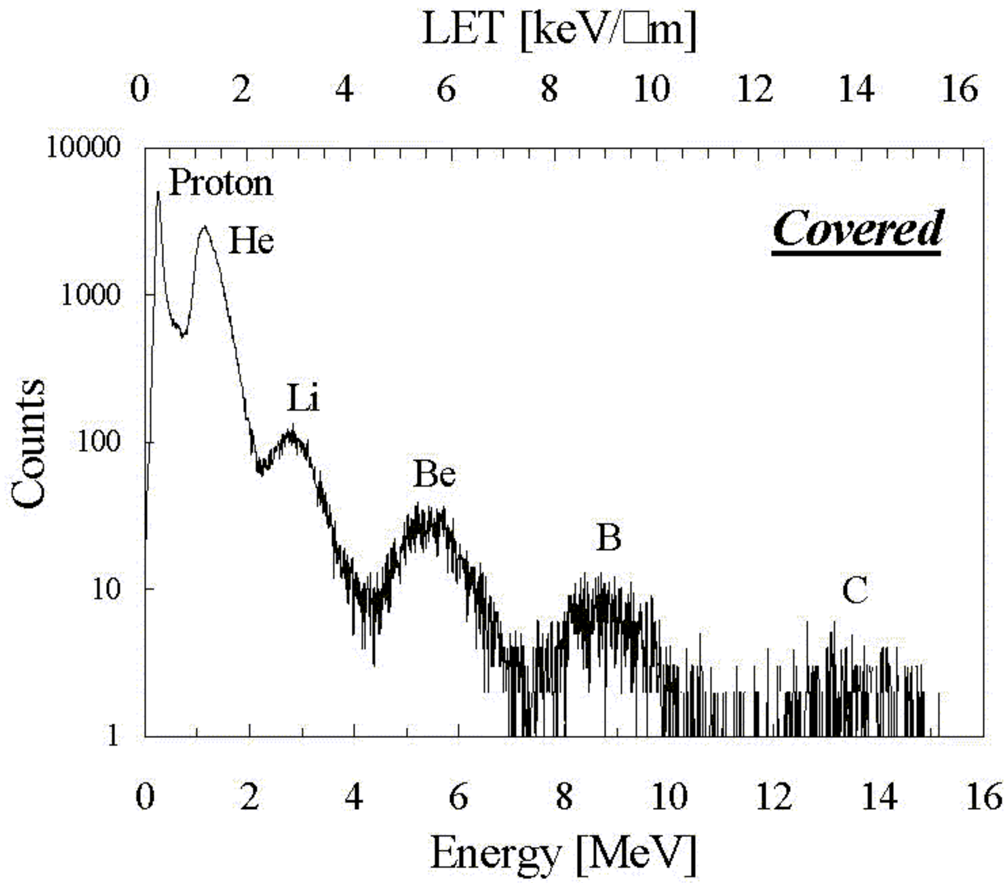




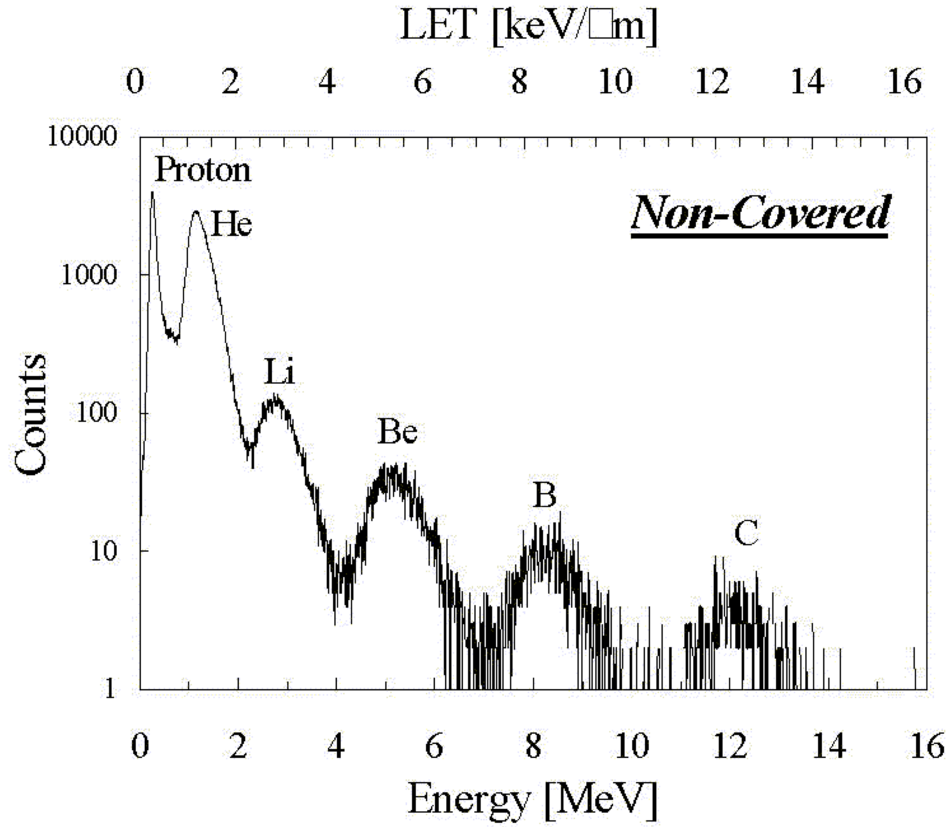
Carbon 400 MeV/n injection of different incident angles

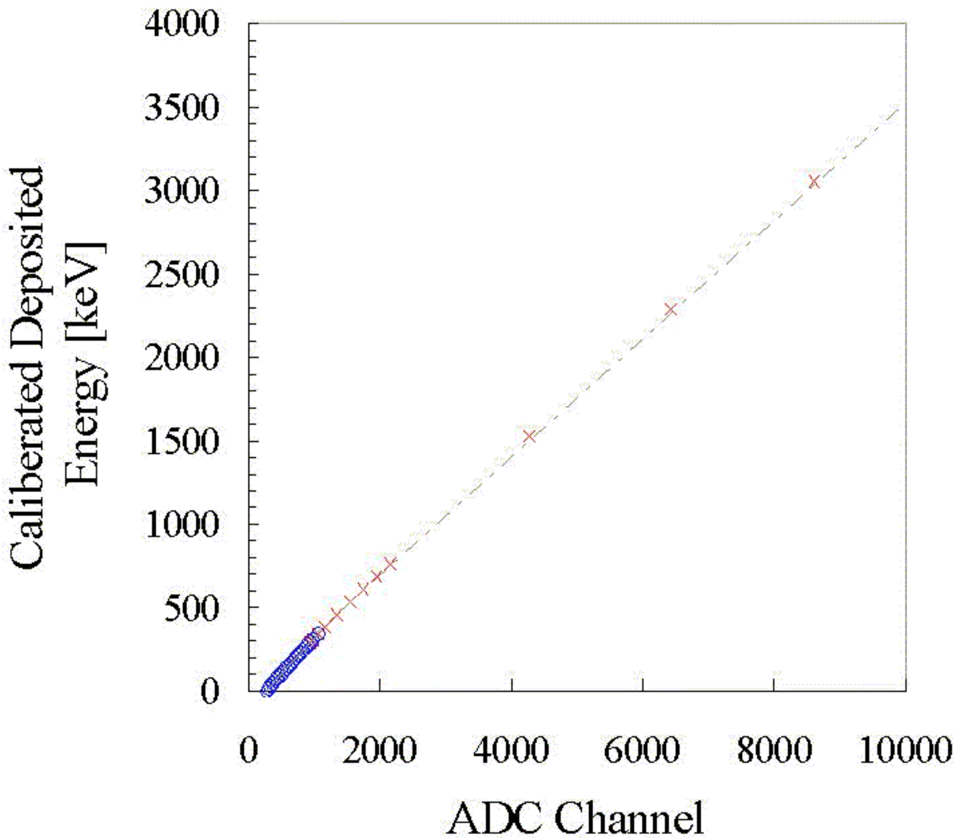




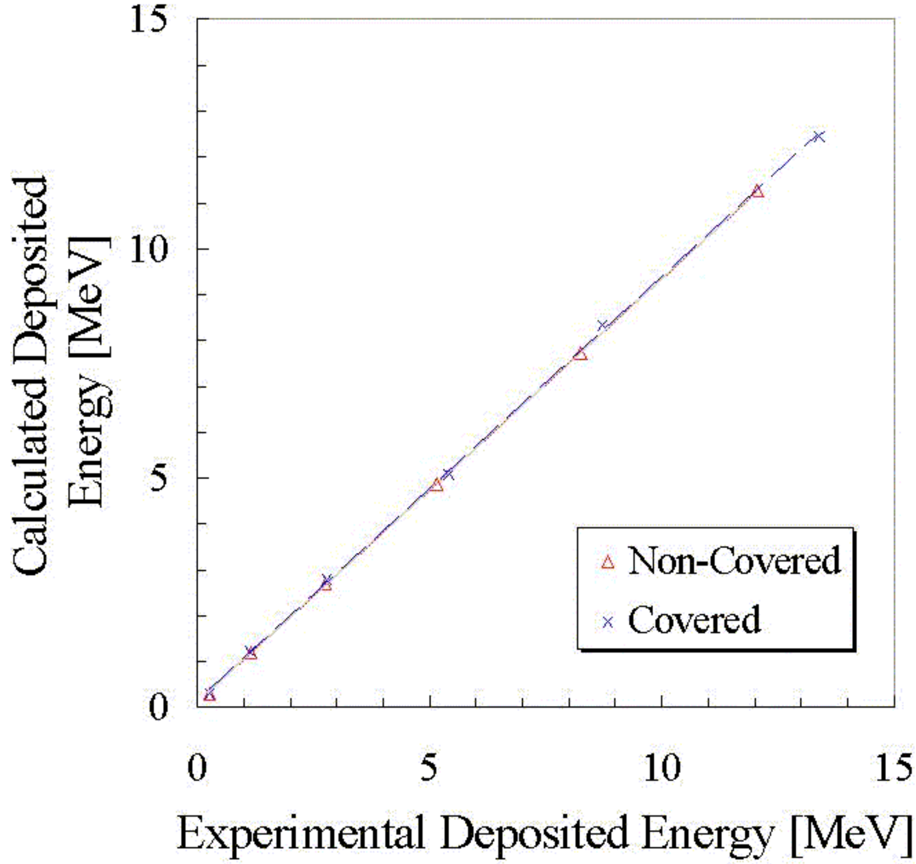


LET [keV/□m]
0 2 4 6 8 10 12 14 16
10000
1000
100
10
1
Counts
Proton
He
Li
Be
B
C
Covered
0 2 4 6 8 10 12 14 16
Energy [MeV]

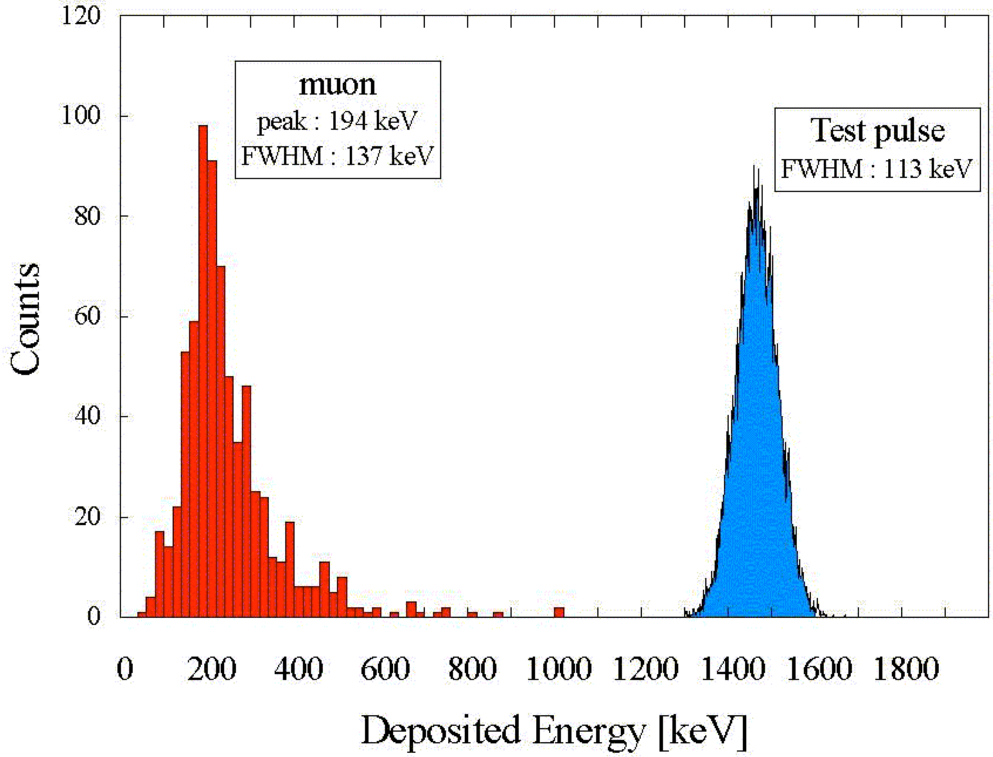

LET [keV/□m]
0
2
4
6
8
10
12
14
16
10000
1000
100
10
1
Counts
Proton
He
Li
Be
B
C
Non-Covered
0
2
4
6
8
10
12
14
16
Energy [MeV]

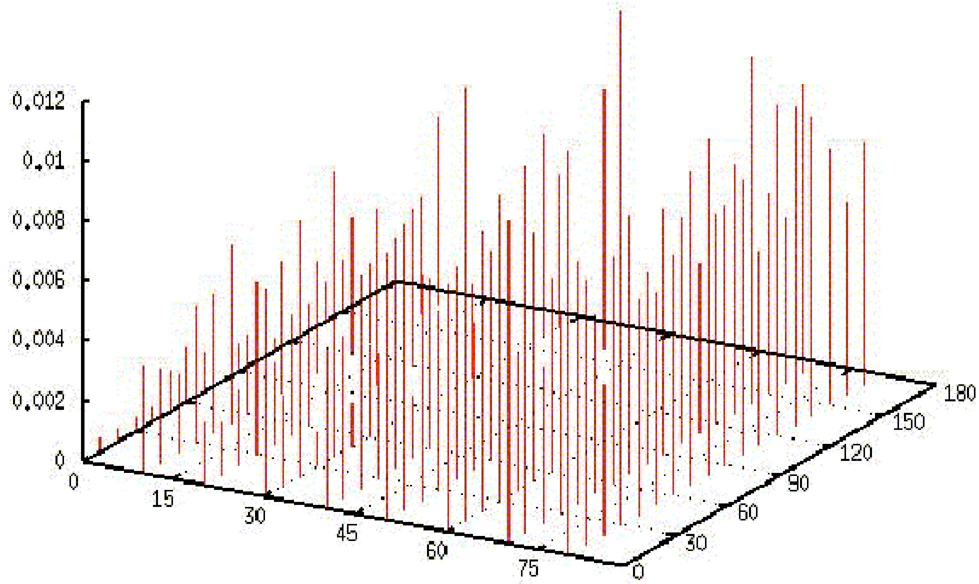


4000
3500
3000
2500
2000
1500
1000
500
0
Caliberated Deposited Energy [keV]
0
2000
4000
6000
8000
10000
ADC Channel



15
10
5
0
0
5
10
15
Calculated Deposited Energy [MeV]
Experimental Deposited Energy [MeV]
Non-Covered
Covered


muon
peak : 194 keV
FWHM : 137 keV
Test pulse
FWHM : 113 keV
Counts
Deposited Energy [keV]
0
20
40
60
80
100
120
0
200
400
600
800
1000
1200
1400
1600
1800


0.012
0.01
0.008
0.006
0.004
0.002
0
0
15
30
45
60
75
0
30
60
90
120
150
180

Conclusion:

The absolute scintillation yields in liquid argon and in liquid xenon for 1 MeV electrons, alpha-particles, fission fragments and relativistic heavy particles were obtained and the flat top response which gives the maximum scintillation yield was found in both liquids. The ratio of the maximum scintillation yields in liquid argon and xenon obtained in this experiment is in good agreement with that obtained by our simple theory. Also, the flat top response can be seen for NaI(Tl) and its W_{ph} agrees to that calculated by optical approximation within the experimental error. These agreements support our simple theory on scintillation from liquid rage gases.