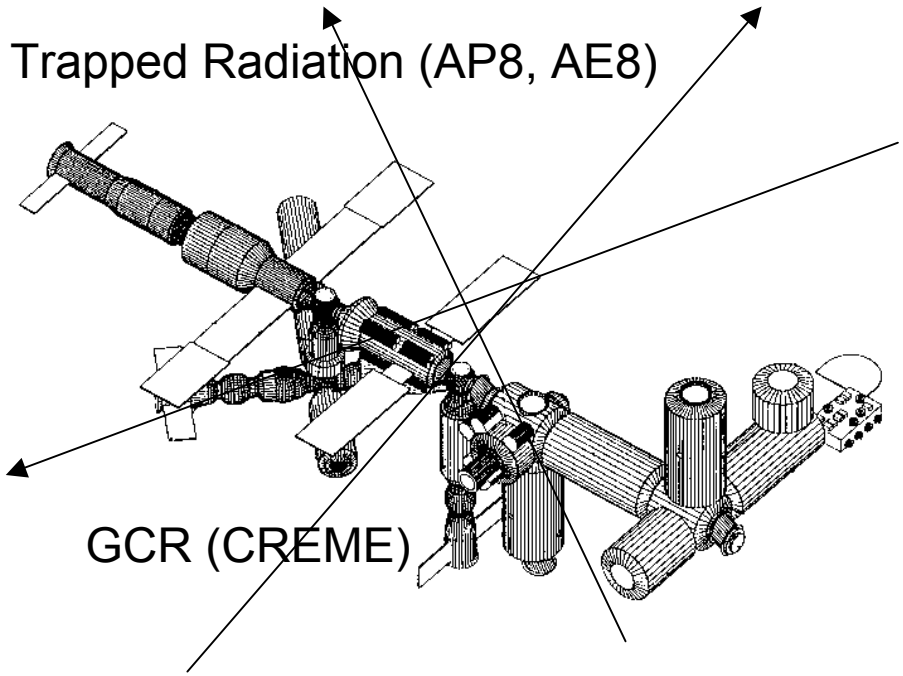
New Passive Personal Dosimeter for Japanese ISS Crewmembers - Concept and Status-

Tatsuto Komiyama,[1] Shizu Yabe, [1] Yu Koike, [1] Shoichi Tachibana, [1] Aiko Nagamatsu, [1] Mitsuyo Masukawa, [1] Noriaki Ishioka, [1] Hiroko Tawara, [2] Shigeki Kamigaichi,[3] Hidenori Kumagai[4]

1. National Space Development Agency of Japan (JAPAN)
2. High Energy Accelerator Organization
3. Ministry of Education, Culture, Sports, Science and Technology
4. Advanced Engineering Services Co., LTD

To Seek Goals of the New Passive Personal Dosimeter

- Calculation Test Configuration



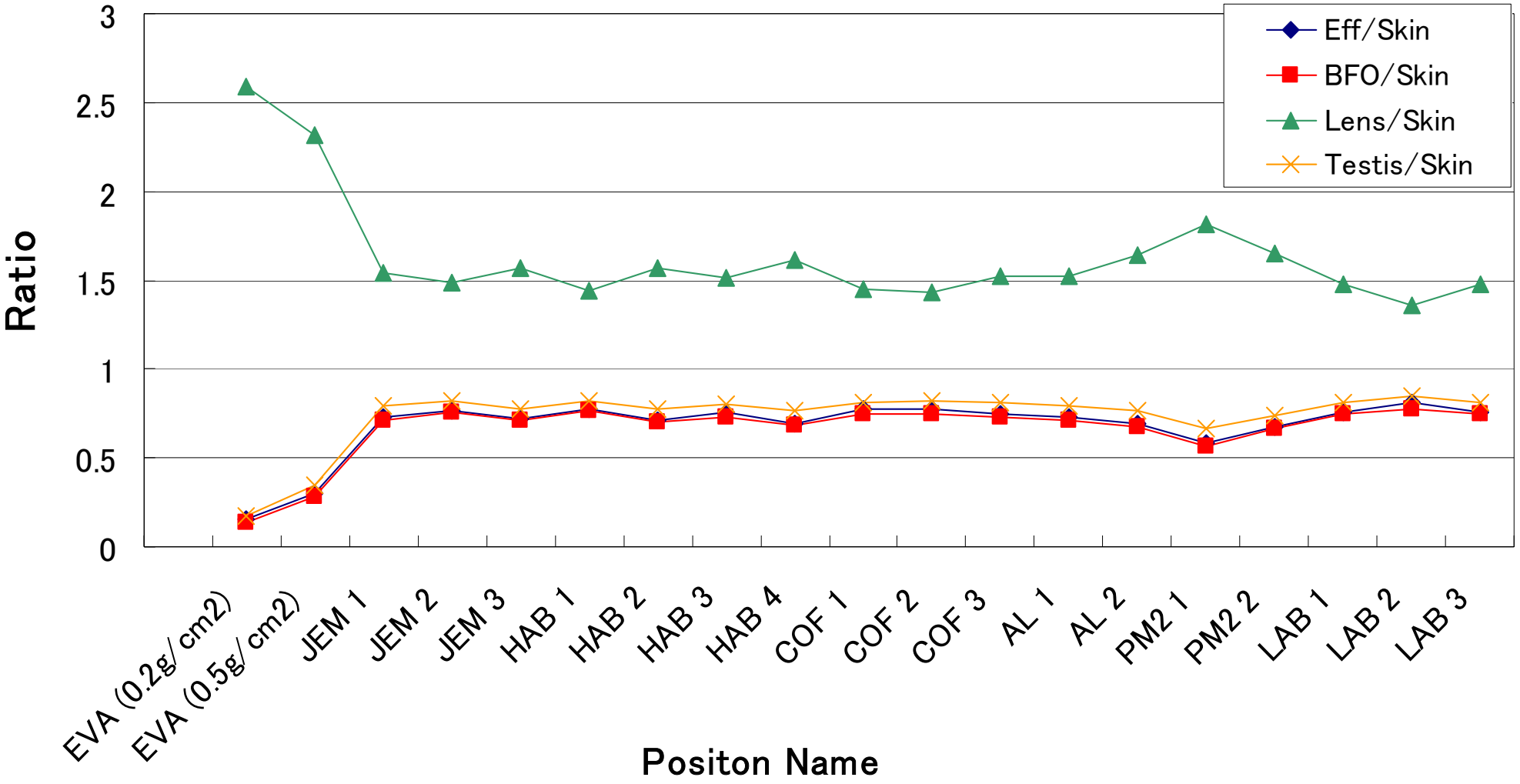
Crew Doses
in Several Positions of ISS

- Effective Dose
- BFO Dose
- Skin Dose
- Lens Dose
- Testis Dose

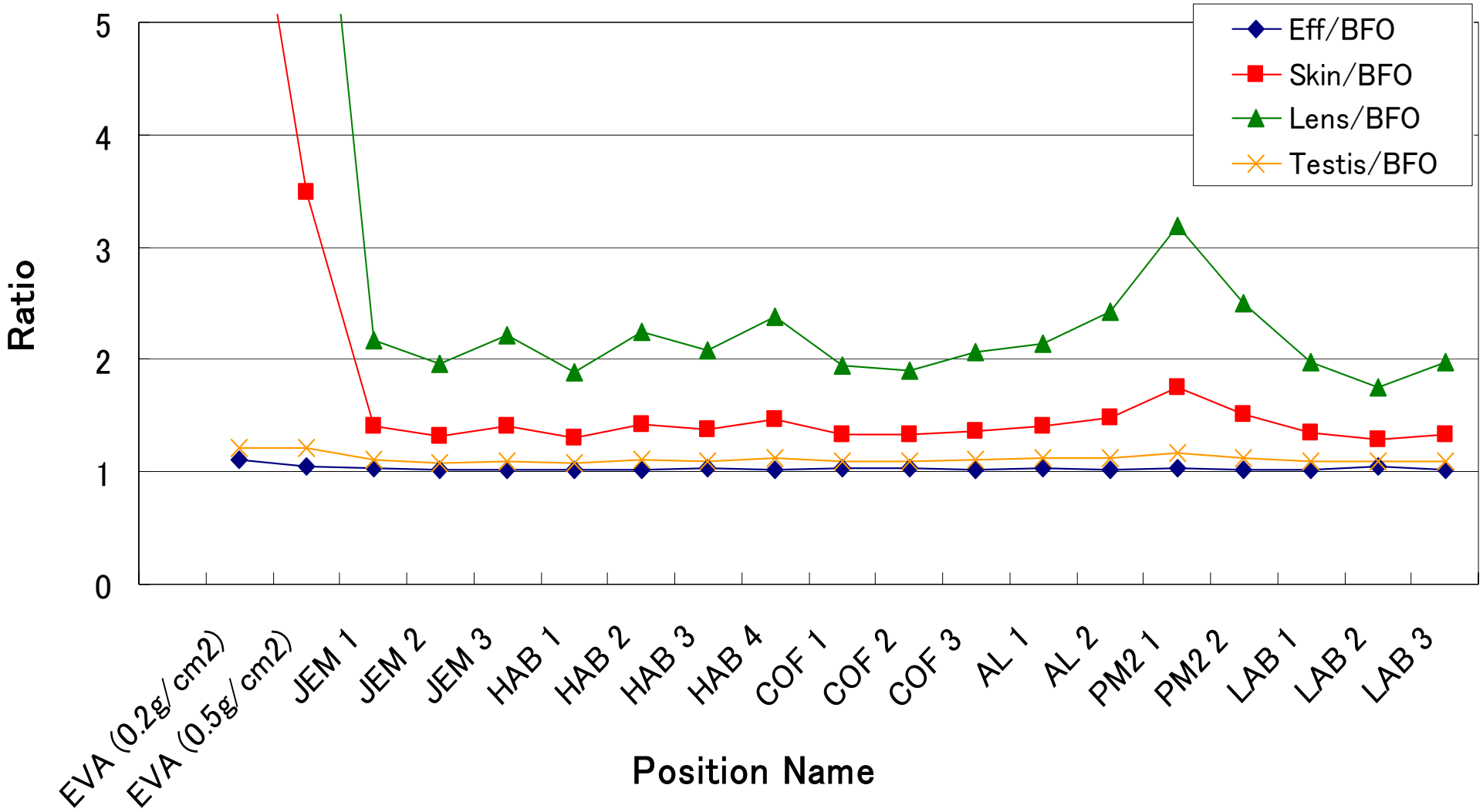
Predicted Crew Doses in Several Positions of ISS

Position name	Solar MIN (mSv/day)					Solar MAX (mSv/day)				
	Effective Dose	BFO	Skin	Lens	Testis	Effective Dose	BFO	Skin	Lens	Testis
EVA (0.2g/cm2)	2.22	2	14.27	36.92	2.43	1.48	1.11	16.62	39.69	1.31
EVA (0.5g/cm2)	2.01	1.92	6.7	15.49	2.32	1.21	1.07	6.37	14.62	1.26
JEM 1	0.66	0.64	0.9	1.39	0.71	0.41	0.4	0.53	0.79	0.43
JEM 2	0.6	0.59	0.78	1.16	0.64	0.38	0.37	0.47	0.69	0.39
JEM 3	0.71	0.7	0.99	1.55	0.77	0.44	0.43	0.58	0.89	0.47
HAB 1	0.56	0.55	0.72	1.04	0.59	0.35	0.34	0.44	0.62	0.37
HAB 2	0.76	0.75	1.07	1.68	0.83	0.47	0.46	0.62	0.95	0.5
HAB 3	0.64	0.62	0.85	1.29	0.68	0.4	0.39	0.51	0.75	0.42
HAB 4	0.87	0.85	1.25	2.02	0.96	0.53	0.52	0.72	1.12	0.57
COF 1	0.58	0.56	0.75	1.09	0.61	0.36	0.35	0.45	0.65	0.38
COF 2	0.56	0.54	0.72	1.03	0.59	0.35	0.34	0.43	0.62	0.37
COF 3	0.7	0.69	0.94	1.43	0.76	0.44	0.43	0.56	0.84	0.46
AL 1	0.71	0.69	0.97	1.48	0.77	0.44	0.43	0.57	0.86	0.47
AL 2	0.96	0.94	1.39	2.28	1.06	0.58	0.56	0.79	1.26	0.63
PM2 1	1.06	1.03	1.81	3.28	1.2	0.62	0.61	1.02	1.8	0.68
PM2 2	0.84	0.82	1.24	2.05	0.92	0.51	0.5	0.73	1.18	0.55
LAB 1	0.59	0.58	0.78	1.15	0.63	0.37	0.36	0.47	0.68	0.39
LAB 2	0.47	0.45	0.58	0.79	0.49	0.29	0.29	0.36	0.48	0.3
LAB 3	0.57	0.56	0.75	1.11	0.61	0.36	0.35	0.45	0.65	0.37

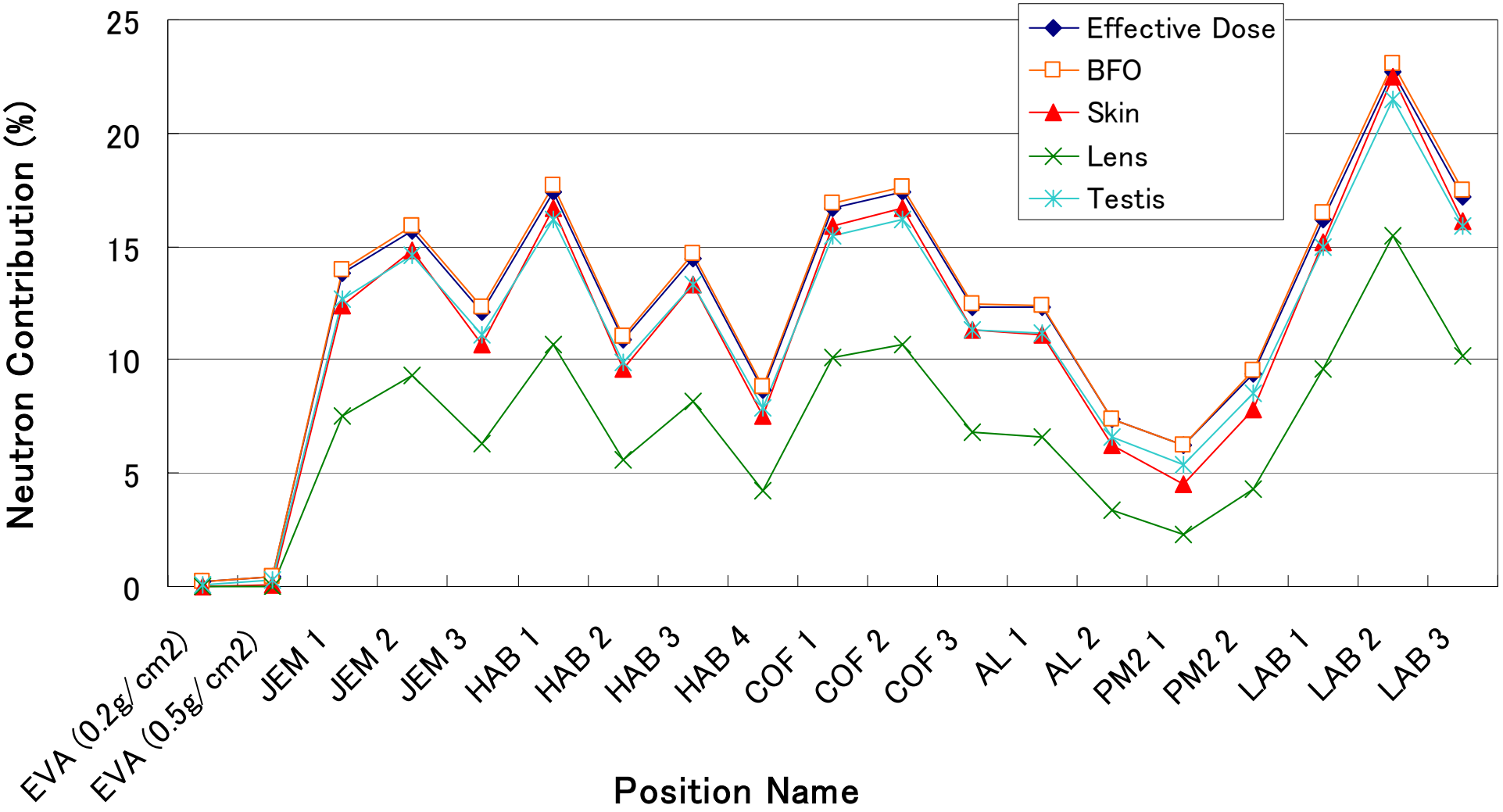
Ratios of Crew Doses to Skin Doses (Solar MIN, Prediction)



Ratios of Crew Doses to BFO Doses (Solar MIN, Prediction)



Neutron Contribution to Crew Doses (Solar MIN, Prediction)

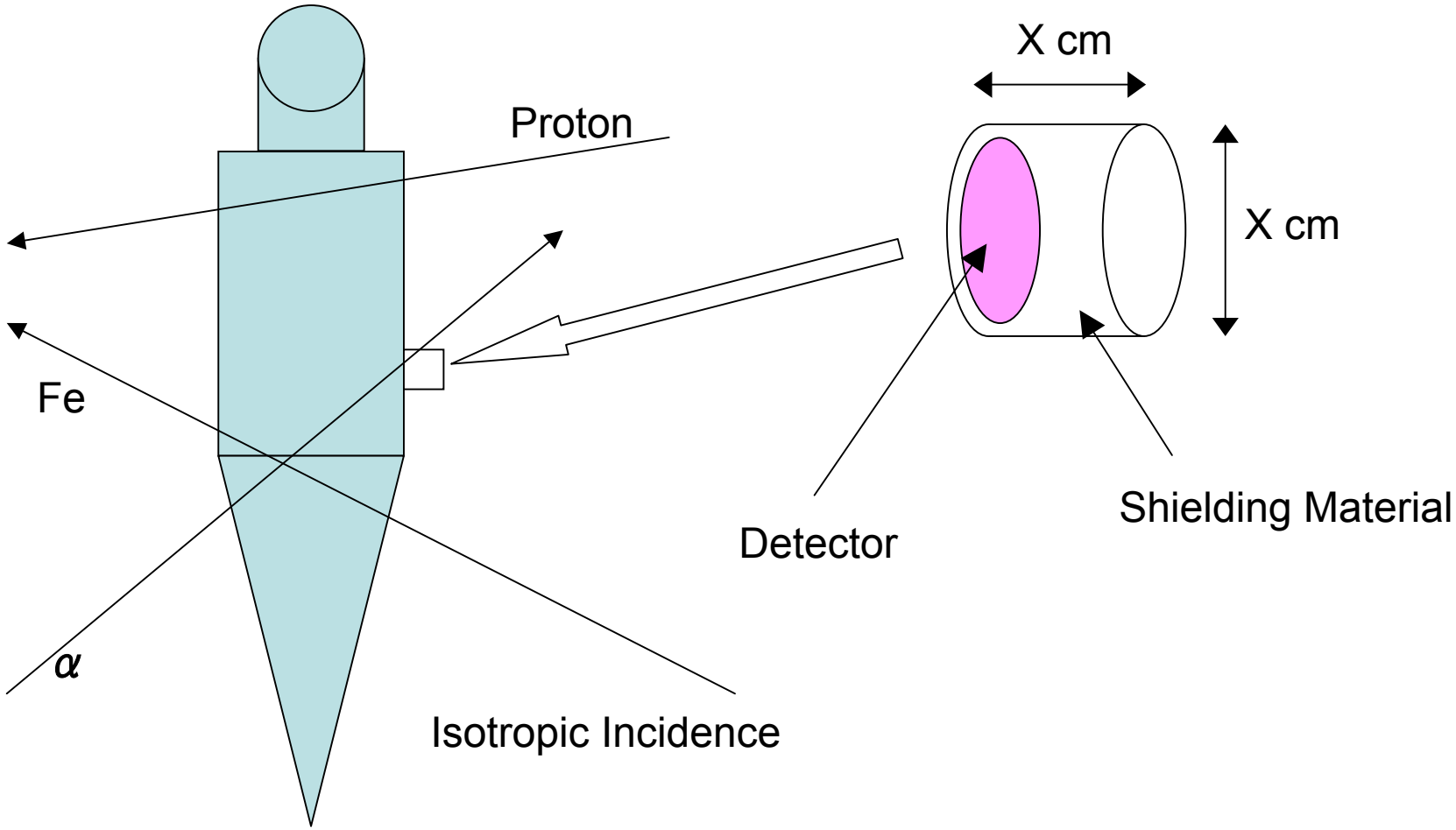


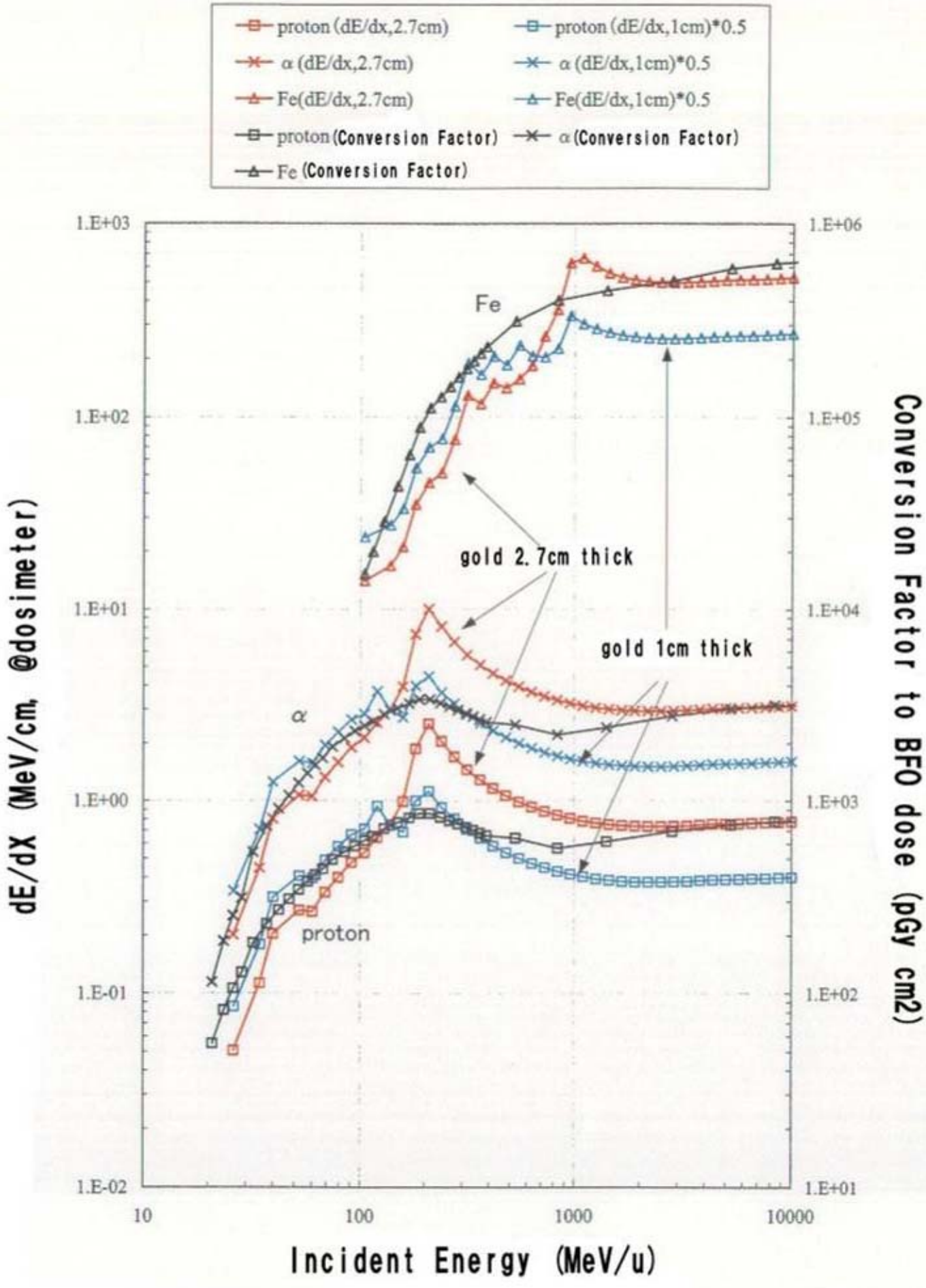
Goals of the New Passive Personal Dosimeter

- To be able to measure skin dose equivalent, including neutron contribution, and
- To be able to measure BFO dose equivalent, including neutron contribution.

To Seek an Appropriate Material to Simulate Shielding of BFO

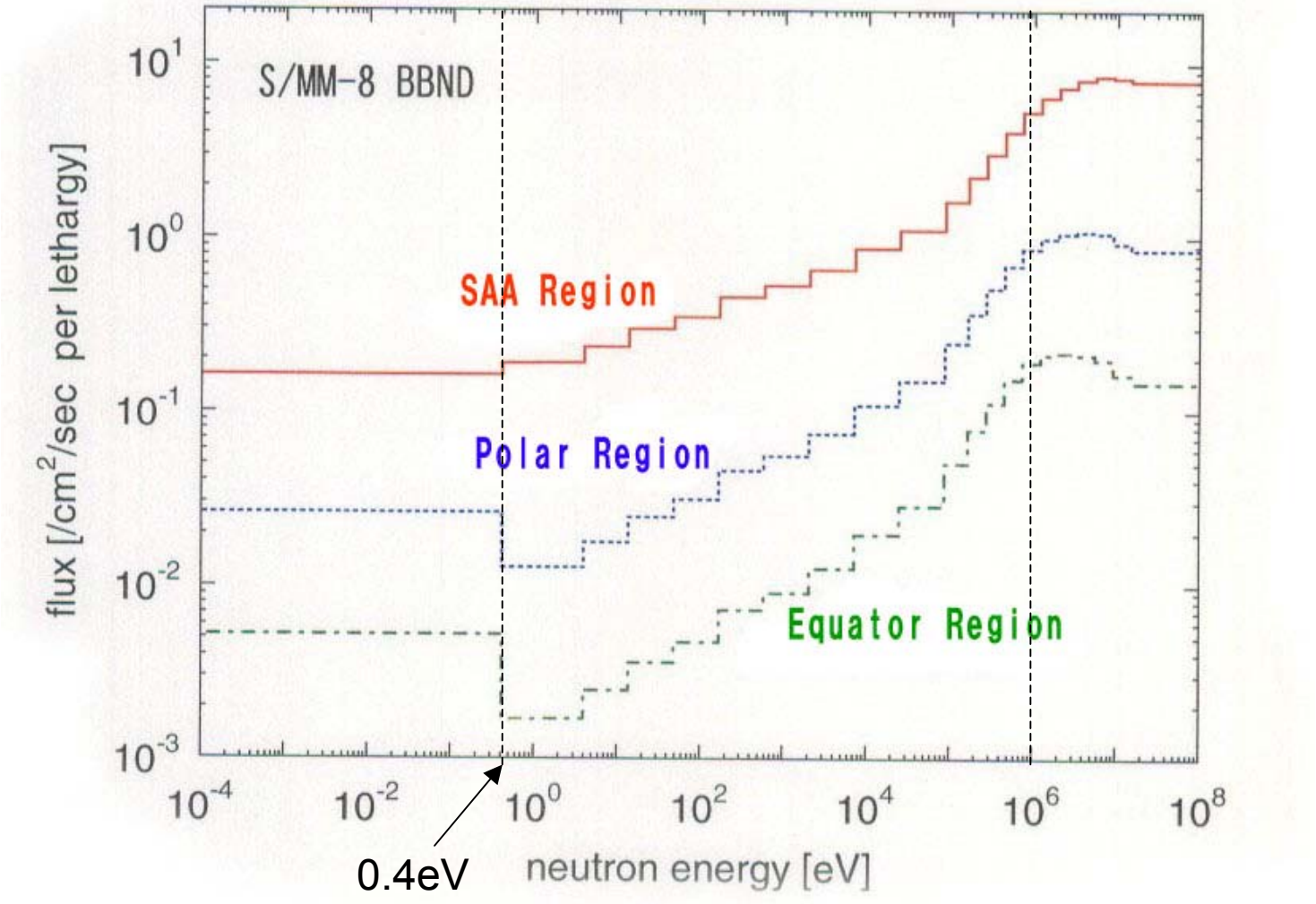
- Calculation Test Configuration




proton (dE/dx,2.7cm)
proton (dE/dx,1cm)*0.5
α (dE/dx,2.7cm)
α (dE/dx,1cm)*0.5
Fe(dE/dx,2.7cm)
Fe(dE/dx,1cm)*0.5
proton (Conversion Factor)
α (Conversion Factor)
Fe (Conversion Factor)
Fe
gold 2.7cm thick
gold 1cm thick
α
proton
dE/dX (MeV/cm, @dosimeter)
Conversion Factor to BFO dose (pGy cm2)
Incident Energy (MeV/u)
1.E+03
1.E+02
1.E+01
1.E+00
1.E-01
1.E-02
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
10
100
1000
10000

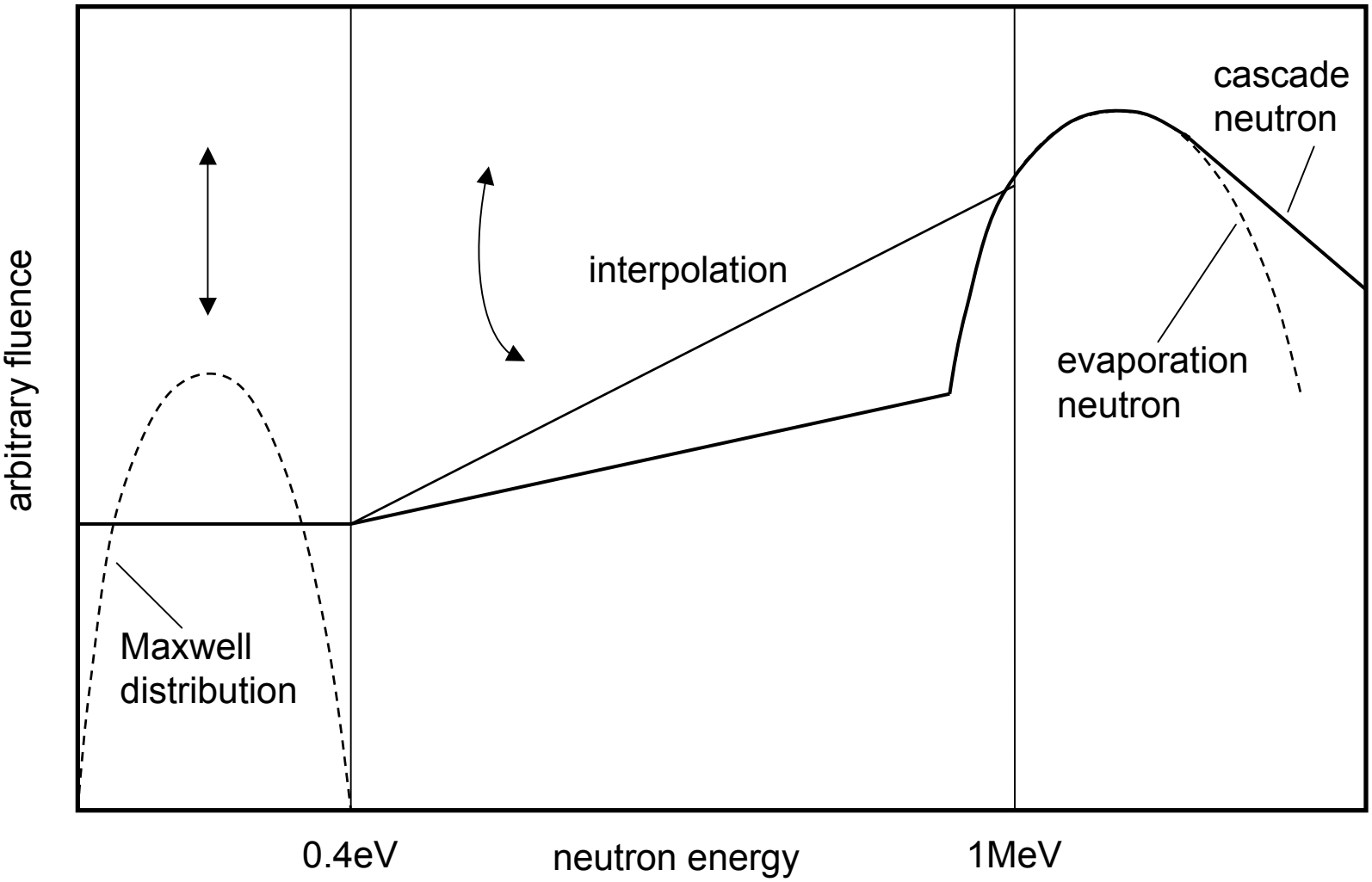
To Seek an Appropriate Method to Measure Neutron Contribution

- Neutron Spectrum measured by the BBND in the S/MM#8



To Seek an Appropriate Method to Measure Neutron Contribution (cont.)

- General Idea of Neutron Energy Spectrum



To Seek an Appropriate Method to Measure Neutron Contribution (cont.)

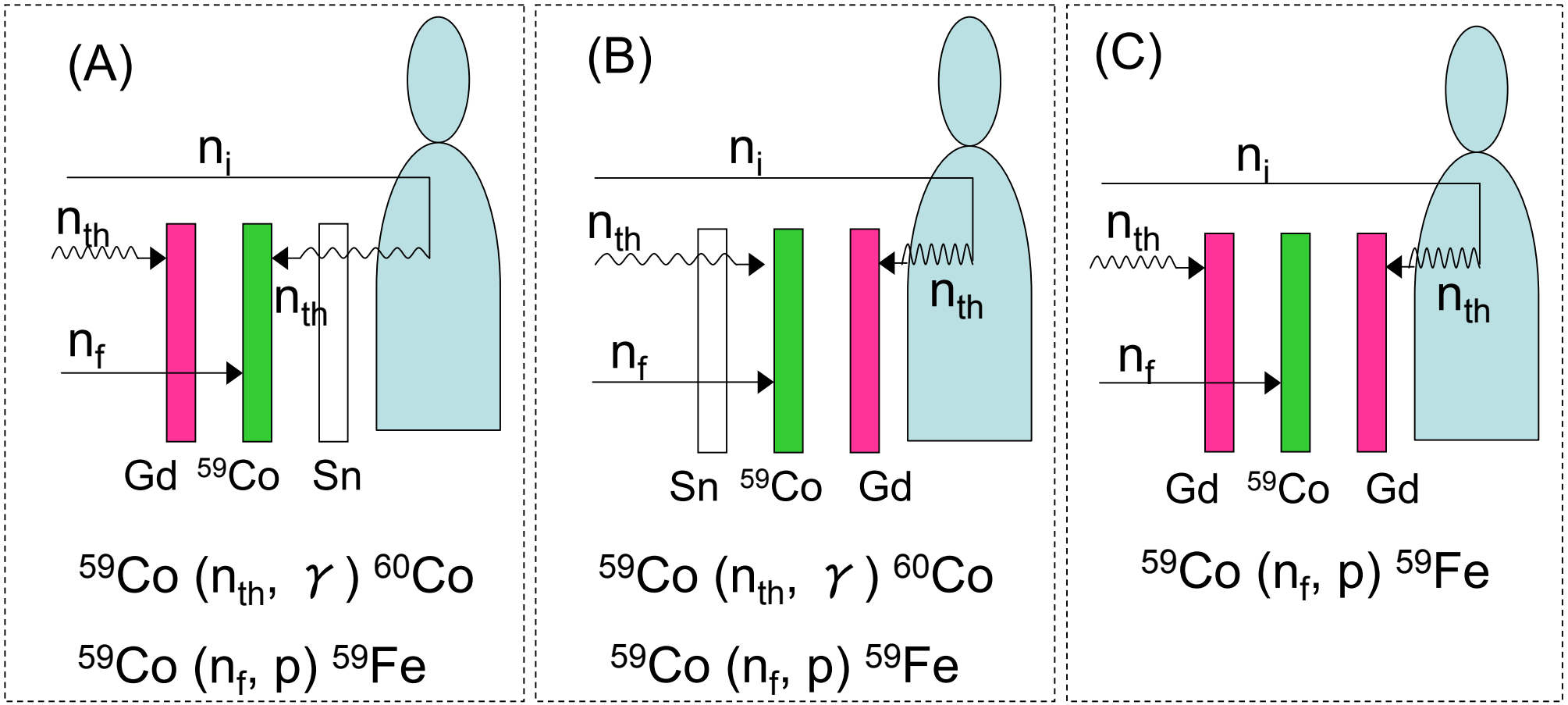
- Study to Measure Fast Neutron (>1MeV) Fluence under the Mixed Environment with Proton

Nuclear Reaction	Half Life (days)	Energy of γ-ray (keV)	Natural Isotopic Abundance (%)	Enriched Isotopic Abundance (%)	Cross Section (MAX) (b)	Radioactivity after 90days ISS Flight (Bq/cm2)
32S (n, p) 32P	14.262	(100% β)	95.02	99.89	0.35	3.25E-03
46Ti (n, p) 46Sc	83.79	889.277 1120.545	8.25	86.1	0.27	1.67E-03
54Fe (n, p) 54Mn	312.3	834.848	5.85	97.29	0.5	1.56E-03
58Ni (n, p) 58Co	70.82	810.764	68.08	99.93	0.65	6.99E-03
45Sc (n, p) 45Ca	162.61	12.4	100	100	0.1	2.27E-04
59Co (n, p) 59Fe	44.503	1099.251 1291.596	100	100	0.05	7.97E-04
89Y (n, p) 89Sr	50.53	908.96	100	100	0.03	1.05E-04

To Seek an Appropriate Method to Measure Neutron Contribution (cont.)

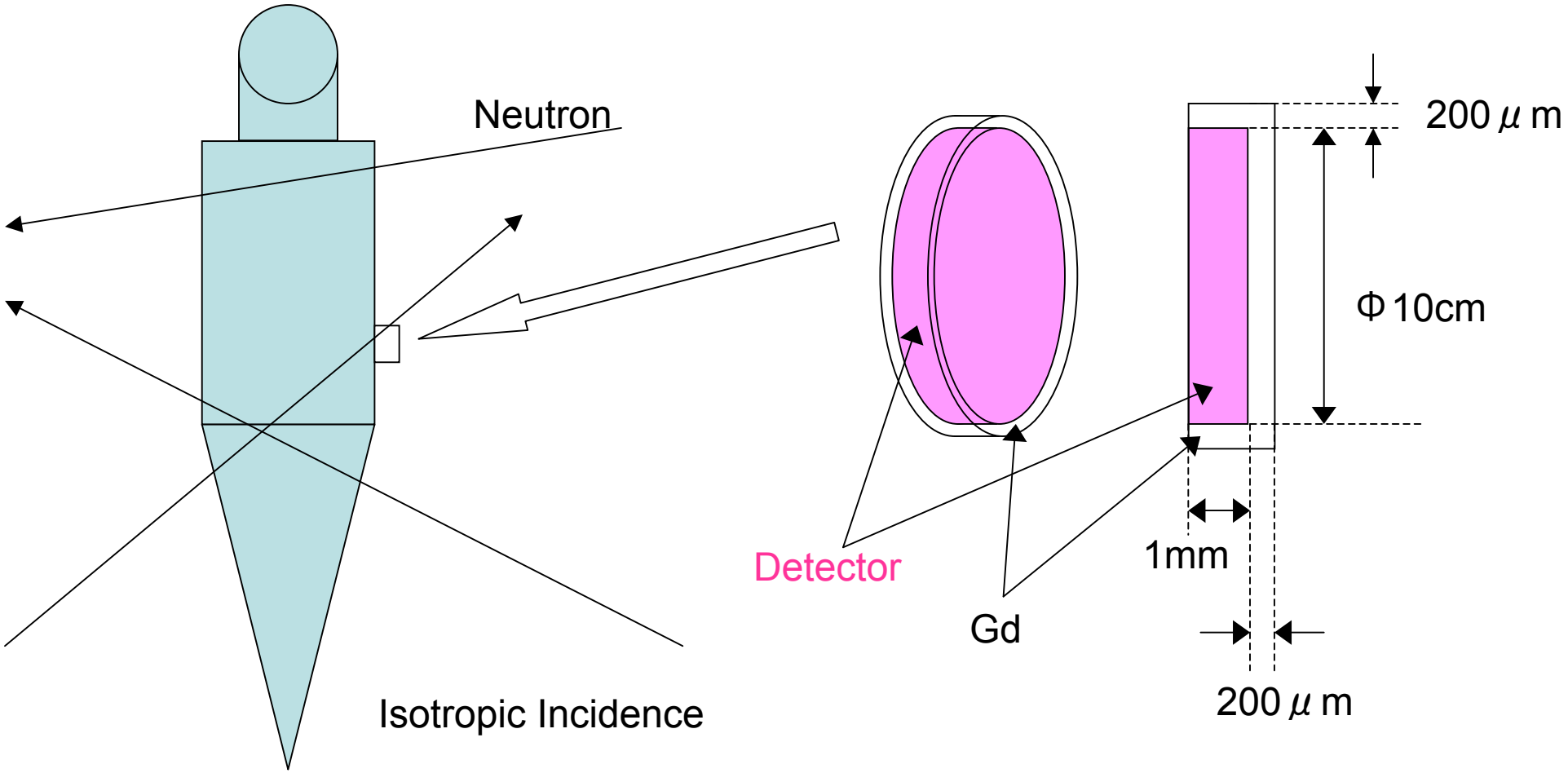
Radioactivity (A) – Radioactivity (C) ⇒ Fluence of n_i (0.4eV < ni < 1MeV)

Radioactivity (B) – Radioactivity (C) ⇒ Fluence of n_{th} (< 0.4eV)



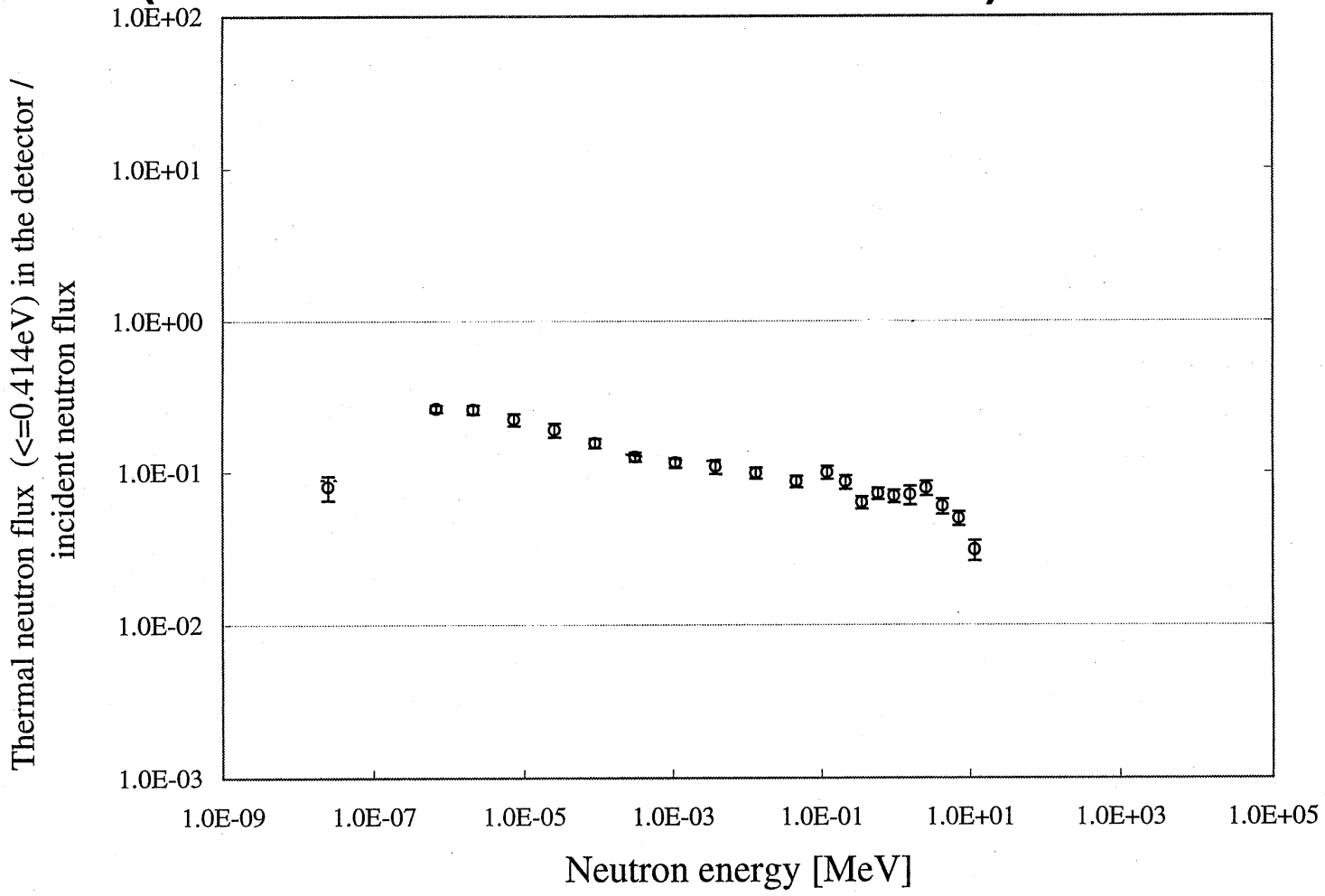
To Seek an Appropriate Method to Measure Neutron Contribution (cont.)

- Calculation Test Configuration for Investigating Albedo

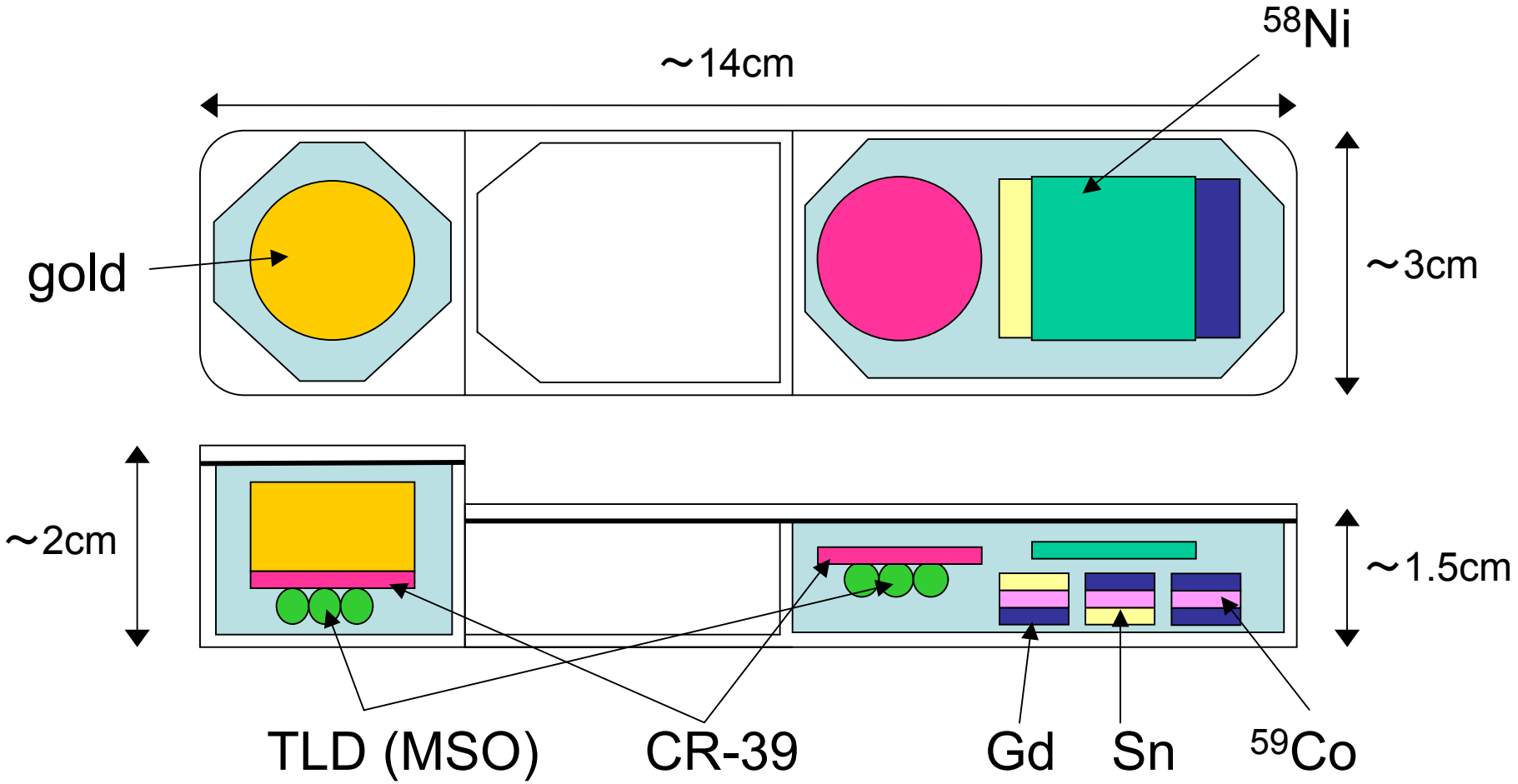


To Seek an Appropriate Method to Measure Neutron Contribution (cont.)

- **Albedo (Result of the Calculation Test)**



Conceptional Image of the New Passive Personal Dosimeter



Remained Issues

- Influence of impurities in the enriched ^{58}Ni,
- Influence of radioactive decay,
- Aging effect of CR-39, and
- I/F to crewmembers.

Aging Effect of CR-39 (preliminary results)