Accelerator and Non-accelerator Detector Reviews

Katherine Copic
October 7, 2012

Detector Reviews

Information about detectors available since the first "Data for Elementary Particle Physics."

Table II

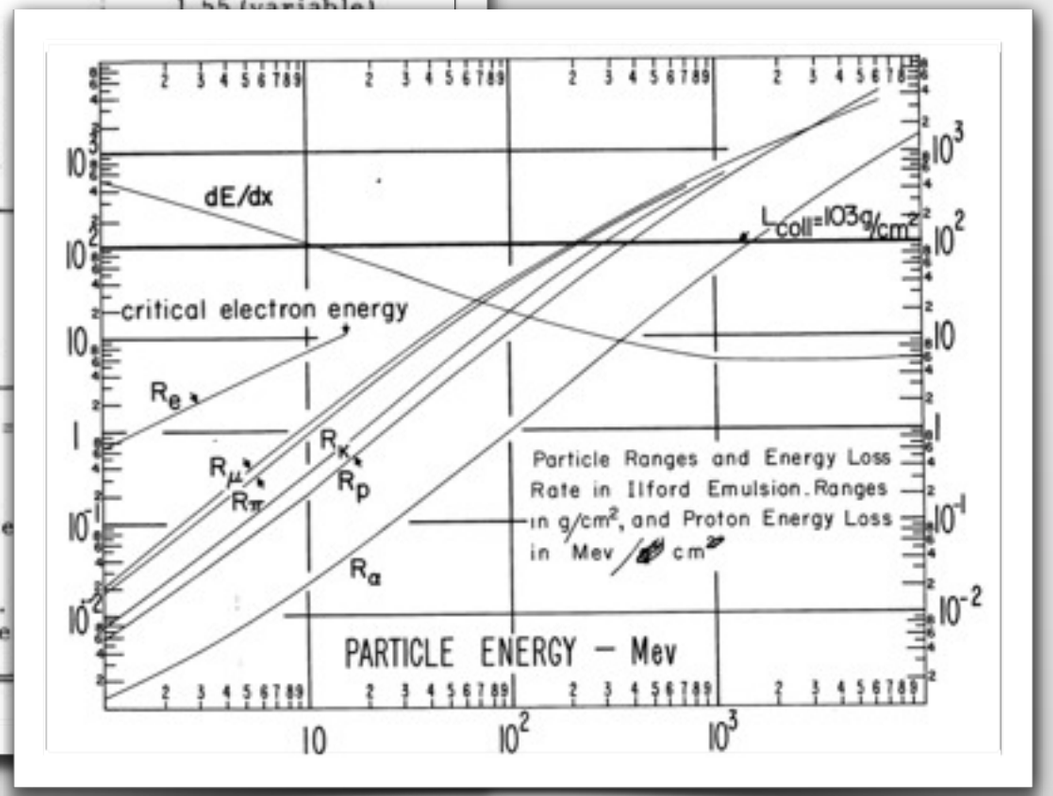
Atomic and nuclear properties (dE/dx, collision mean free path, radiation length, etc.) of materials used as absorbers and detectors

Material	Z	A	Cross section σ [a] (barns)	$-\frac{dE}{dx}$ [b] min Mev / g/cm^2	Collision [a] length, L_{coll} g/cm^2	Collision [a] length, L_{coll} cm	Radiation [c] length, L_{rad} g/cm^2	Radiation [c] length, L_{rad} cm	Density ρ (g/cm^3)
H_2	1	1.01	0.063	4.14	26.5	374	58	819.0	0.0708
Li	3	6.94	0.23	1.72	50.4	94.3	77.5	145	0.534
C	6	12.00	0.33	1.86	60.4	39.0	42.5	27.4	[illegible]
Al	13	26.97	0.57	1.66	79.2	29.3	23.9	8.86	
Cu	29	63.57	1.00	1.45	105.4	11.8	12.8	1.44	
Sn	50	118.70	1.55	1.27	129.7	17.8	8.54	1.17	
Pb	82	207.21	2.20	1.12	156.2	13.8	5.8	0.51	
U	92	238.07	2.42	1.095	163.6	8.75	5.5	0.29	
Hydrogen (bubble chamber, -27.6°K)				0.243 Mev/cm	26.5	452	58	990	
Propane (C_3H_8, bubble chamber)				0.935 Mev/cm	48.9	119.3	44.7	109.0	
Polystyrene (CH scintillator)				2.14 Mev/cm	54.9	52.3	43.4	41.3	
Ilford emulsion				5.49 Mev/cm	103	27.0	11.2	2.91	

[a] $\sigma_{natural} \equiv \pi \left(\frac{\hbar}{m_\pi c}\right)^2 \times A^{2/3} = 63 \text{ mb} \times A^{2/3}$; $L_{collision} \equiv \frac{A}{N_0 \sigma_{natural}} = \frac{A^{1/3}}{N_0 \pi \left(\frac{\hbar}{m_\pi c}\right)^2}$

[b] From range-energy tables of M. Rich and R. Madey, UCRL-2301, March 1954, and of Walte
April 1957.

[c] From Experimental Nuclear Physics, E. Segrè, Ed. (Wiley, New York, 1953), Table 8, p.
The radiation lengths have not been corrected for failure of the Born approximation and seve



Detector Reviews

Particle Detectors for Accelerator-based Physics:

Updated for each book, including newest technologies

2012 Responsible: Jean-Francois Arguin (LBNL -> Montreal)

Particle Detectors for Non-accelerator Physics:

New in 2010 RPP book, revised for 2012

detectors for classical cosmic ray experiments, neutrino oscillation measurements

searches for double-beta decay, dark matter candidates, and magnetic monopoles

2012 Responsible: Don Groom (LBNL)

One of the most-read sections by new graduate students?

At least it was for me!

Accelerator-Based

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31.2.1.2. Microchannel plates . . . 6

31.2.1.3. Hybrid photon detectors . . . 6

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31.3.1. Scintillation mechanism . . . 11

31.3.2. Caveats and cautions . . . 12

31.3.3. Scintillating and wavelength-shifting fibers . . . 13

31.4. Inorganic scintillators: . . . 14

31.5. Cherenkov detectors . . . 19

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Gaseous detectors covered in the previous talk (link).

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31.6.1. Energy loss and charge transport in gases 24
31.6.2. Multi-Wire Proportional and Drift Chambers 29
31.6.3. High Rate Effects 32
31.6.4. Micro-Pattern Gas Detectors 33
31.6.5. Time-projection chambers 37
31.6.6. Transition radiation detectors (TRD's) 41
31.6.7. Resistive-plate chambers 44
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31.7.1. Materials Requirements 46
31.7.2. Detector Configurations 48
31.7.3. Signal Formation 49
31.7.4. Radiation Damage 49
31.8. Low-noise electronics 51

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31.9.2. Hadronic calorimeters 60
31.9.3. Free electron drift velocities in liquid ionization chambers 65
31.10. Superconducting magnets for collider detectors 66
31.10.1. Solenoid Magnets 66
31.10.2. Properties of collider detector magnets 68
31.10.3. Toroidal magnets 70
31.11. Measurement of particle momenta in a uniform magnetic field 70

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In summary: nearly 20 authors (and more reviewers), all sections revised in the last five years.

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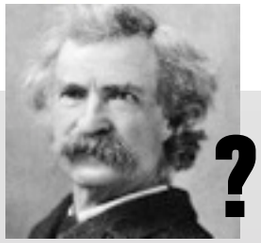

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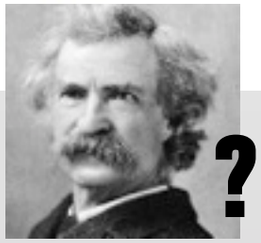

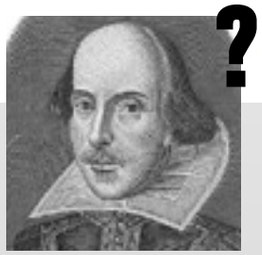

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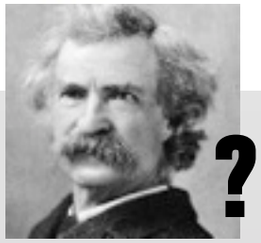
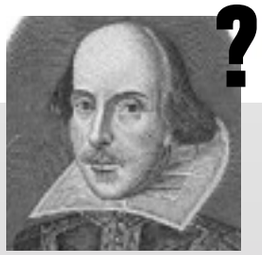

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32.3. Large neutrino detectors . . .

32.3.1. Deep liquid detectors for rare processes . . . 6

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32.3.2.1. The Moon as a target . . . 13

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32.3.2.3. Active Volume Detectors . . . 15

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S.R. Klein (LBNL)

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Plans for the future

A good mix of reference and pedagogy!

- Need to continue to update information, figures & tables, references to stay current
- Could improve the flow of detectors for accelerators with some revised structure, now just a list of detectors
- Continue to stress connections between these two detector reviews and "Passage of particles through matter" which comes directly before them (Responsibles: H. Bichsel (U. of Washington), D.E. Groom (LBNL) S.R. Klein (LBNL))