

## Exam questions for the course Measurement of Ionizing Radiation

### Particle Passage through Matter

1. Describe the main processes in the interaction of heavy charged particles with matter, indicate the derivation of Bohr's equation for  $dE/dx$ ! What are the quantum mechanical corrections that lead to the Bethe-Bloch equation?
2. What is the Bragg curve, what does the range of charged particles in matter depend on?
3. Describe the main processes in the interaction of photons with matter!

### Gas detectors

4. Describe a gas detector of ionizing particles in cylindrical geometry and explain the basic operating modes!
5. What is the multiplication factor in proportional gas counters? What about the multiplication factor in a Geiger-Müller tube?
6. Describe the mechanisms of ionization and recombination in a gas!
7. Describe the relationship between the average number of ion pairs created and the energy resolution of the detector! What is the Fano factor?
8. Describe the diffusion of  $e^-$  and ions in a gas, and their motion in the presence of an electric field! Explain the spatial shape of the charge avalanche in gas detectors!
9. Derive the time course of the signal at the anode in a cylindrical proportional counter!
10. How does a differentiator work, what is its influence on the signal obtained from a cylindrical proportional counter?
11. Describe a multi-wire proportional chamber!
12. Describe a travel chamber!

### Semiconductor detectors

13. What are the general properties of semiconductors that are used in semiconductor detectors? Explain the formation of a depleted layer in a semiconductor, what are the spatial distribution of charges and the electric field?

14. What is a "dead current"? How do we place metal contacts on a semiconductor detector?
15. Derive the time dependence of the signal in a semiconductor detector!
16. What are diffused diodes, what are their advantages and disadvantages? What is a surface barrier detector (Schotky barrier), advantages and disadvantages?
17. How do we obtain a p-i-n detector (Si-Li detector), what are its properties?
18. Describe a Ge-Li detector, a typical manufacturing method and its properties!
19. Describe position-sensitive semiconductor detectors and their properties!

#### Scintillation detectors

20. What are scintillators, their general properties?
21. Describe the mechanism of scintillators in organic scintillators, their properties, examples!
22. Describe the mechanism of scintillators in inorganic scintillators, their properties, examples!
23. What is the linearity of the energy response in scintillation detectors?
24. Describe the operation of a photomultiplier and the important properties of individual components!
25. How do we detect neutrons?

#### Particle identification

26. How do time-of-flight meters work, usefulness in the case of separating kaons and pions?
27. Explain particle identification using multiple measurements of specific ionization!
28. What is Cherenkov radiation, what are the basic types of substances used as emitters?
29. How does a Cherenkov threshold counter work?
30. How does a Cherenkov ring detector work?
31. What is transient radiation, how is it used to identify particles?

32. Which particle identification methods are useful for individual momentum quantities, what are the limitations?

#### Protection against ionizing radiation

33. What is the time course of radioactive decay, what is activity? What is decay and half-life?

34. How do we divide the biological consequences of radiation? Describe the specifics of individual types of consequences!

35. What is absorbed, equivalent and effective radiation dose?

36. What is the purpose and what are the principles of the radiological protection system, what are the dose limits for individual categories of exposed persons?