PHYSICS 198-620B

Experimental Techniques in Sub-Atomic Physics

CALORIMETRY

François Corriveau
IPP/McGill University

DAY 1

1. Introduction
   - Principle
   - Particle detection
   - Properties
2. Electromagnetic showers
   - Energy losses e and attenuation γ
   - Critical energy E_c
   - Radiation length X_0
   - Shower examples and models
   - Data vs Simulations: logitudinal and lateral distributions
   - Energy measurements
3. Electromagnetic calorimeters
   - Energy resolution vs different types
   - Fully active calorimeters
     - Examples, shower leakage
     - Properties and performances
   - Sampling calorimeters
     - Ionization techniques
     - Intrinsic sampling fluctuations
     - Performances
     - Scintillation techniques
     - Wavelength shifter readout
     - Trigger signals
     - Time response

DAY 2

4. Hadronic showers
    - Strong interaction and elementary processes
    - Longitudinal distributions
    - Shower model
    - Distributions from induced radioactivity
    - Lateral distributions
    - Shower components, examples
    - Intrinsic e/h ratio: compensation, energy resolution
5. Hadronic calorimetry
    - Dissipation of energy
    - Hadronic shower processes
    - mip, e/mip, γ/mip, p/mip
    - Binding energy loss
    - Neutron cross section
    - Signal amplification
6. Hadronic calorimeters
    - Compensation
        - Methods, saturation effects
        - Neutron response, n/mip
        - e/h ratio vs calorimeter type
    - Hadronic energy resolution
        - n and γ resolutions
        - Binding energy loss
        - Resolution vs calorimeter type
    - Shower containment
    - Radiation damage
7. Particle identification
    - Detection
    - Longitudinal information
        - Additional Si-diode sampling
    - Lateral information

EXAMPLES

8. Review of calorimeters
    - DØ, H1, GEM, ATLAS
    - SLD, RD1, SDC, CDF
9. ZEUS calorimeters
    - Physics at HERA
    - Deep inelastic scattering
    - AFS → HELIOS → ZEUS
    - Barrel calorimeter
    - Forward and rear calorimeters
    - Longitudinal and lateral segmentations
    - Optical chain: scintillator, wavelength shifter
10. ZEUS calorimeter performances
    - Prototype
    - Energy distributions
    - Inter-calibration
    - Linearity
    - e/h ratio
    - Energy resolution
    - Non-uniformities
    - Calibrations: UNO signals, ^{60}Co source, muons
    - Magnetic field dependence
    - Time information
    - DIS events
11. Towards the new generation of detectors
    - Energy Flow techniques
12. References
13. Assignments