Particle Physics Identification

The event pictures in the software used for this lab were made available by the OPAL collaboration at CERN.

This software was originally developed by Terry Wyatt from the University of Manchester with assistance from David Ward, Andrew McNabb and Nigel Watson

It was further modified and placed in its present form by David Dunbar from the University of Wales Swansea and Simon Dalley of Southern Methodist University

Why: To study the fundamental laws of physics one must investigate the behavior of the smallest particles in nature.

What: Tracks of particles produced in collisions of electrons and positrons will be identified by comparing them to the behavior of known particles in terms of electric charge, energy, momentum, and radioactive decay products.

How: Data from the Opal experiment at CERN’s Large Electron-Positron (LEP) collider are used.

Go to http://www.physics.smu.edu/~sdalley/particlelab/home.html

Spend about 15 minutes reading the sections on Introduction and Detector before starting the lab.

During the lab you will:

1. Do the tutorial Parts 1–3 with your partner. Spend about least 45 minutes on it to master the material. When you feel you are ready, the instructor will test whether you can proceed by picking at random one of the tutorial events and asking you to identify it (you cannot use the tutorial guide).

2. If you pass that test, next go to Part 4, writing your identification only for the events listed at the bottom of this page and brief relevant reasons for each identification. Most of the credit is given for relevant reasons. Try to use scientific language - like “charged-particle track of high momentum” rather than “black line near the center”.

Example from Part 4

Event 30

Identification: W⁺ W⁻ → τ ν q q

Reasons:

- No signal in μ chambers.
- 2 jets of hadrons from q q.
- One charged particle track (black line) in the inner tracking chamber, has momentum greater than the energy deposited in electromagnetic calorimeter, and has energy deposited in hadronic calorimeter. So single hadron from τ decay rather than e.
- ν unseen but balances momentum.

Now try these from Part 4: Event 36; Event 34; Event 33; Event 31; Event 32.