

# 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 charge, energy, momentum, and radioactive decay.

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

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

Read the sections on Introduction and Detector before the lab.

During the lab you will:

1. Do the tutorial Parts 1–3 with your partner. Spend at least 30 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 of each of the events listed here and brief relevant reasons for your identification.

Use scientific language - like “charged-particle track of high momentum and not “black line near the center”.

## **Example Identification**

*Event 30:*  $W^+ W^- \rightarrow \tau \nu q \bar{q}$

*Reasons:*

- No signal in  $\mu$  chambers.
- 2 jets of hadrons (from  $q \bar{q}$ ).
- One charged particle track (black line) has momentum greater than energy deposited in electromagnetic calorimeter and energy deposited in hadronic calorimeter, so single hadron (from  $\tau$  decay) rather than  $e$ .
- $\nu$  unseen but balances momentum.

Now try these (in order of difficulty): Event 36: Event 34: Event 33: Event 31: Event 32: