

Practical Session P1, Tuesday, Aug. 9th, Introduction to μ SR Hardware

This session is an introduction to the experimental hardware that you will be using in the practical sessions next week. You should aim to learn as much as possible, both to augment the lectures and in preparation for the experiments. We encourage you to take your own notes and diagrams to help you learn the details of the experimental set up – in addition to answering the questions noted below.

Orientation: Experimental area, Area Safety Unit Interlock, Counting Room, Beamline

Safety: High Voltage, Magnetic Field, Liquid Cryogenics, Radiation

In the Area: Spectrometer components (magnet, cryostat, muon counter, positron telescopes, alignment), Beamline (snout, vacuum, collimator, final quadrupole triplet), Cabling

Questions¹: What is coincidence counting? How does it suppress noise? What is pileup, and how does it determine an optimum incident muon rate? What is the optimum rate? Why is the muon beam collimated? What is the direction of the muons' spin polarization initially? On what does it depend? What is the direction of the main experimental magnetic field? Why? What is the difference between LF and TF experiments? Draw a diagram of the naming convention for the positron detectors. Define the Asymmetry for various pairs of positron detectors? What is a veto counter and why is it useful? What is a light leak and how could you find it? What is a scintillator? What is a photomultiplier tube (PMT)?

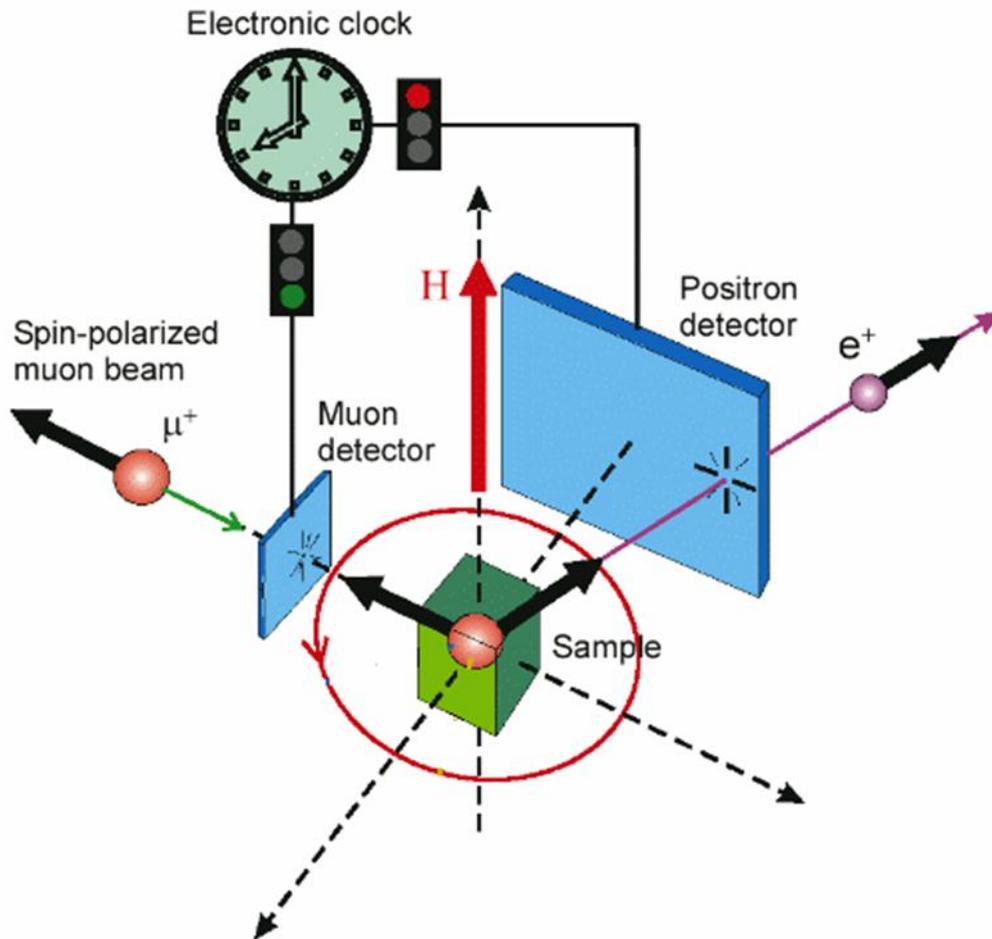
In the Counting Room: Data Acquisition (DAQ) components (NIM units, signal delays, VME crate, TDC, histogramming memory, computer, Visual Scalers), EPICS control system (beamline), CAMP control system, Temperature controller, Data Analysis Computer, BL1A current monitor.

Questions: Even though there is no beam for this session, become familiar with operation of the DAQ: What is a "run" and how is it started and stopped? What is a rig? What is a mode? How can you tell if there are muons (that the beam is on)? How is the experimental magnetic field changed? How is its value known? How is the temperature changed? What is the setpoint? What are the PIDs? What programs allow you to monitor the progress of a run and how are they started. It is 3am, and the proton beam is on, but there are no counts in the muon counter, what things should you check? What is the logbook for? What is a constant fraction discriminator (CFD)?

Detector Demonstrations: Using the Sr-90 or Co-60 source and the scintillation detectors provided. Sketch a typical PMT signal? What is the PMT voltage? How big is the signal? How big is the noise? Where would you set the discriminator threshold level for this detector? What is the timescale of the PMT signal (how wide is the pulse)? Look at the CFD monitor – how is it related to the PMT signal? What is the countrate in the detector in counts per second? What is the uncertainty in this measurement? Describe the steps to set up a coincidence counter? Follow the cables from the detectors on the spectrometer back to the counting room. List all the steps from the PMT to the DAQ.

¹ Try to write answers to these questions in your own words (and diagrams). The practical session leaders may address them directly or you may need to ask. Make the most of your practical session by asking the instructors about any other related questions that might occur to you.

What types of radiation are emitted from Sr-90 and Co-60? How do these differ from the decay of μ^+ and Li-8?



This is a simplified diagram illustrating a μ SR experiment. The clock is started by the muon being registered by the thin muon counter. A stop is produced by the detection of THE corresponding decay positron. The time intervals are then histogrammed and saved. A more detailed discussion of this scheme is presented in practical session P1.