



# Mean Lifetime of Cosmic ray Muons

University of Chicago, July 14–16, 2017

(This is ONE of the THREE experiments that each participant is to perform.)

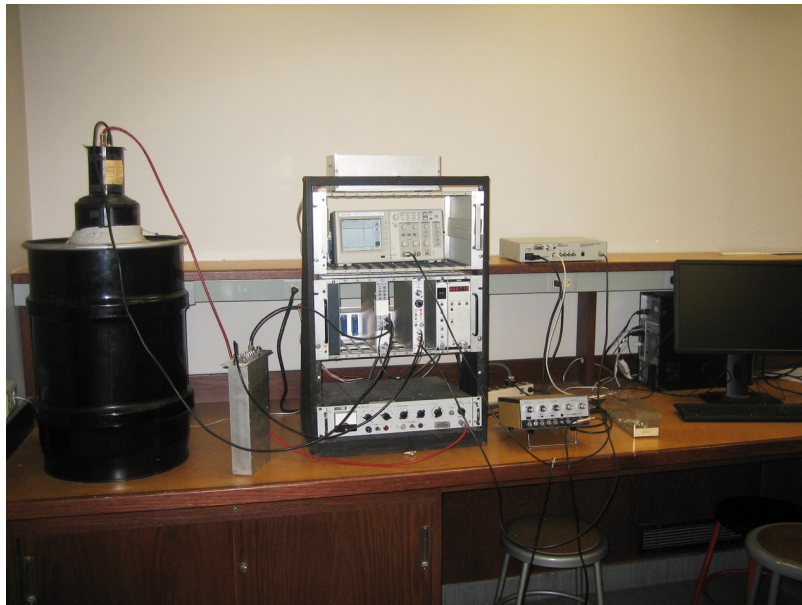
## Mentor



Mark Chantell received his M.S. and Ph.D. in Physics from the University of Arizona. As a research associate at the University of Chicago's Enrico Fermi Institute, Mark did research in experimental high energy astro-particle physics. In 1998 he began working in the physics departments instructional laboratories. He has been involved in all areas of the physics teaching laboratories with an emphasis on teaching and development of experiments for the advanced undergraduate and graduate lab courses.

*Mark Chantell, Ph.D. University of Chicago Kersten Physics Teaching Center, 5720 S. Ellis Ave., Chicago, IL 60637. Email: mc2@uchicago.edu. Telephone: 773-702-7012*

In this experiment, we will detect the arrival of short-lived, cosmic ray muons and measure the time between their arrival and subsequent decay. From the distribution of these times, we will deduce the mean lifetime of the muon and use this lifetime to determine the Fermi coupling constant, the fundamental constant characterizing the weak force.



The apparatus: Tank with organic liquid scintillator; 5" photomultiplier tube; digital oscilloscope; NIM bin with discriminator, time-to-amplitude converter, timer, and scaler; delay box; high voltage power supply; double pulser function generator; pulse height analyzer and software; computer. (Click on photo for a higher resolution view.)

Skills that will be acquired include: Pulse observation and measurement; measurements with a digital scope. Use of a pulse height discriminator to reject noise; calibration and use of a time-to-amplitude converter and pulse height analyzer to measure the distribution of time intervals on the order of microseconds; curve fitting and model testing.

This experiment will use one of the three days of the immersion to adjust and calibrate the system. Data will be collected overnight for adequate statistics.

Participants should bring a lab notebook. A laptop computer would be useful but is not required.

Safety considerations: none.

The cost to implement the experiment is roughly \$5000.

Please note that the Jonathan F. Reichert Foundation has established a grant program ([ALPhA webpage](#); [Foundation website](#)) to help purchase apparatus used in Laboratory Immersions. Limitations and exclusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment.