ANSEL

Advanced Nuclear Science Education Laboratory

Profs. Frank L.H. Wolfs and W. Udo Schröder

Created with Funds from the
Nuclear Regulatory Commission

Purpose of ANSEL

- Provide participants with *factual* knowledge about our radiation environment,
- Provide hands-on experience in nuclear/radiation detection and handling,
- Provide opportunities to set up and conduct scientific experiments and to critically analyze data obtained,
- Practice critical interpretation of experimental results and their communication in professional fashion.

Regular ANSEL Schedule

Weekly lecture (M TBA, B&L 407) during ≈ 9 weeks

- to introduce & discuss scientific background of experiments; basics of the physics of atomic nuclei;
- to relate principles of radiation detection and measurement to modern applications in physics, chemistry, etc.;
- to introduce principles of data reduction;
- to practice effective ways of scientific communication.

Two weekly lab periods (T&R 2.00–4.40 p.m., B&L 156/171)

- to discuss experimental procedures
- to conduct various experiments
- to prepare and set up data acquisition for long data taking run (individual responsibility)

Students may obtain lab keys from the PAS Main Office.

Students must take the UR course & exam on radiation safety.

Textbooks & References

- Main textbook

  "*Radiation Detection and Measurement*"

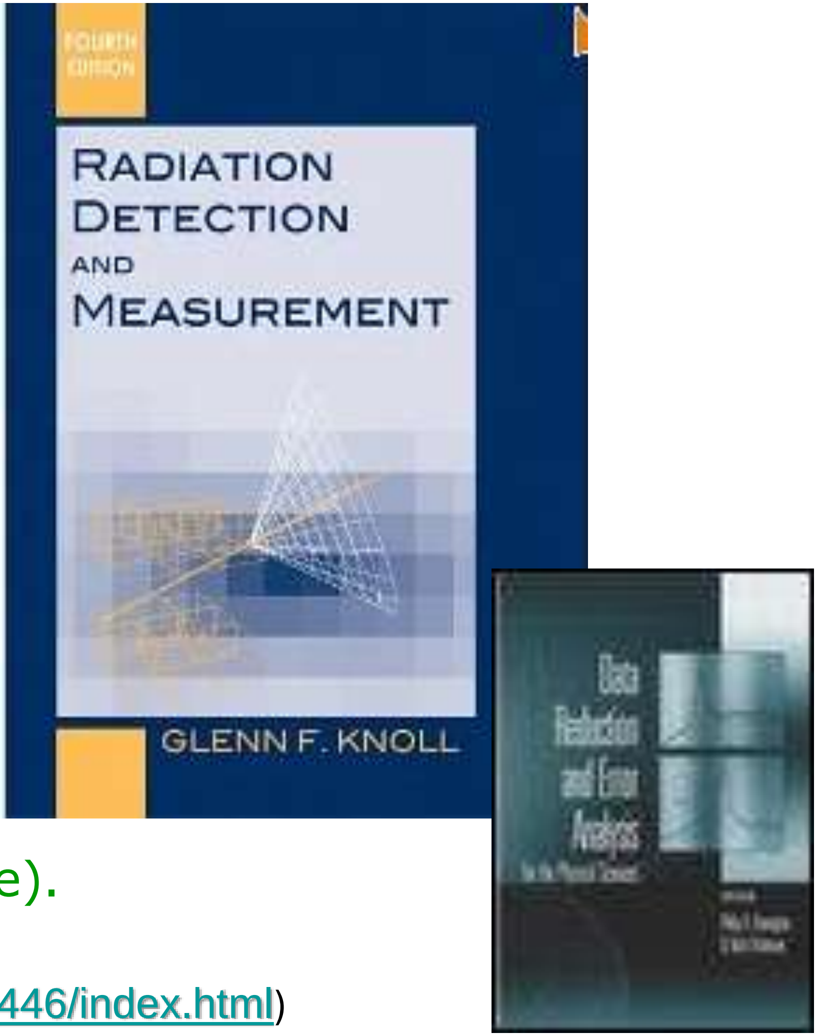
  by Glenn F. Knoll.

- Good reference for data and error analysis:

  "Data Reduction and Error Analys

  by Philip R. Bevington and D. Keith Robinson

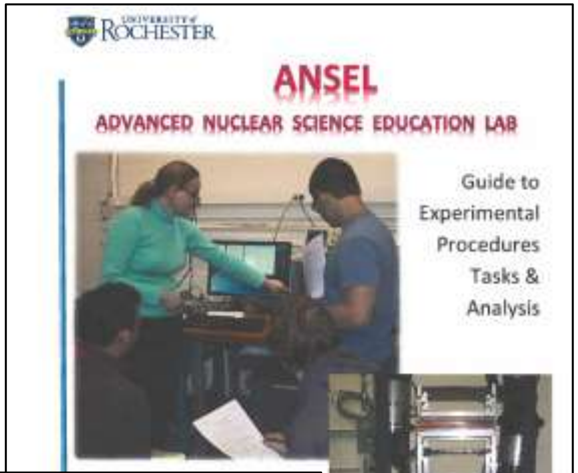
- Various ancillary tables, graphs



→ Bound lab logbooks (UR bookstore).

Course website (www.sas.rochester.edu/chm/courses/chm246_446/index.html)
Data storage, reference materials,
Twiki(http://teacher.pas.rochester.edu:8080/wiki/bin/login/ANSEL/WebHome?origurl=/wiki/bin/view/ANSEL/WebHome)

Resources for Experimentation & Analysis



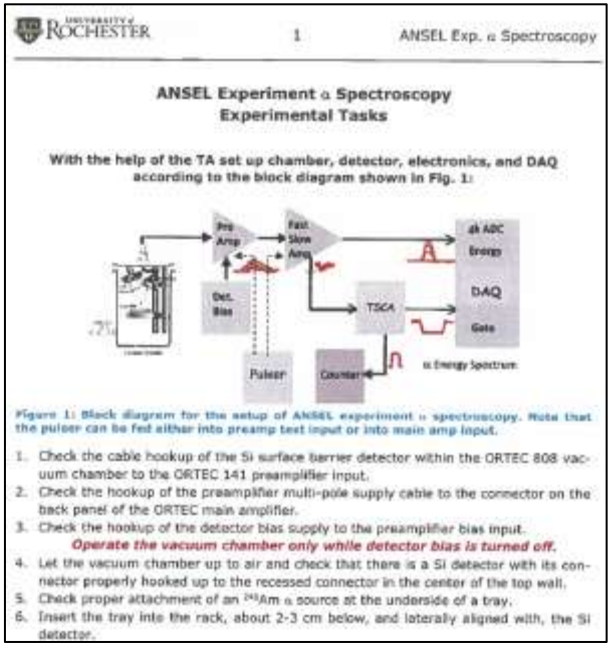
UNIVERSITY of ROCHESTER

ANSEL

ADVANCED NUCLEAR SCIENCE EDUCATION LAB

Guide to
Experimental
Procedures
Tasks &
Analysis

CHM 244W/44



UNIVERSITY of ROCHESTER 1 ANSEL Exp. α Spectroscopy

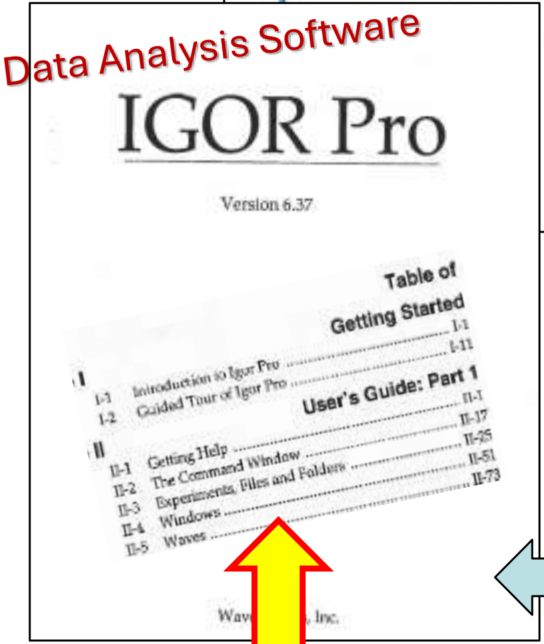
ANSEL Experiment α Spectroscopy
Experimental Tasks

With the help of the TA set up chamber, detector, electronics, and DAQ according to the block diagram shown in Fig. 1:

Figure 1: Block diagram for the setup of ANSEL experiment α spectroscopy. Note that the pulser can be fed either into preamp test input or into main amp input.

1. Check the cable hookup of the Si surface barrier detector within the ORTEC 808 vacuum chamber to the ORTEC 141 preamplifier input.
2. Check the hookup of the preamplifier multi-pole supply cable to the connector on the back panel of the ORTEC main amplifier.
3. Check the hookup of the detector bias supply to the preamplifier bias input.
   Operate the vacuum chamber only while detector bias is turned off.
4. Let the vacuum chamber up to air and check that there is a Si detector with its connector properly hooked up to the recessed connector in the center of the top wall.
5. Check proper attachment of an ^{241}Am α source at the underside of a tray.
6. Insert the tray into the rack, about 2-3 cm below, and laterally aligned with, the Si detector.

Data Analysis Software



IGOR Pro

Version 6.37

Table of

Getting Started

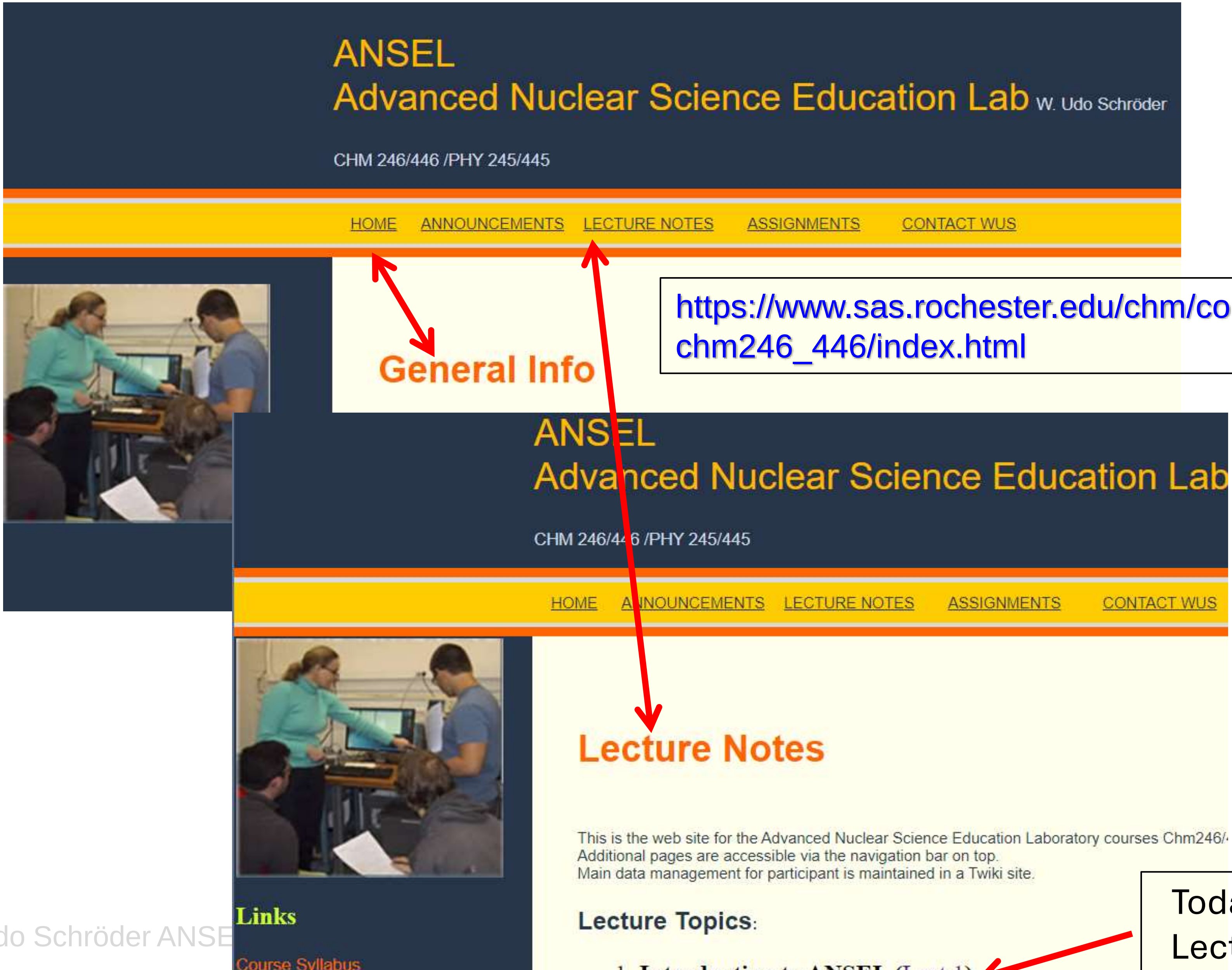
User's Guide: Part 1

Wav , Inc.

ANSEL Manual contains Task Sheets → define goals of experiments and data analysis, give guides to perform successful experiments.

IGOR = data processing software (PC & MAC) to treat and reduce data produced with available DAQ hardware

Resources: ANSEL Course Website 2024



ANSEL

Advanced Nuclear Science Education Lab W. Udo Schröder

CHM 246/446 /PHY 245/445

HOME ANNOUNCEMENTS LECTURE NOTES ASSIGNMENTS CONTACT WUS

General Info

ANSEL

Advanced Nuclear Science Education Lab

CHM 246/446 /PHY 245/445

HOME ANNOUNCEMENTS LECTURE NOTES ASSIGNMENTS CONTACT WUS

Links

Course Syllabus

Lecture Notes

This is the web site for the Advanced Nuclear Science Education Laboratory courses Chm246/
Additional pages are accessible via the navigation bar on top.
Main data management for participant is maintained in a Twiki site.

Lecture Topics:

https://www.sas.rochester.edu/chm/courses/chm246_446/index.html

Today's Lecture

Resources: ANSEL TWiki

1. The ANSEL Twiki*:

- Download software & useful lab materials like equipment manuals.
- Upload expt. data, analysis setups, etc.

Now>>>> *Quick review of the ANSEL TWiki*.

2. Software:

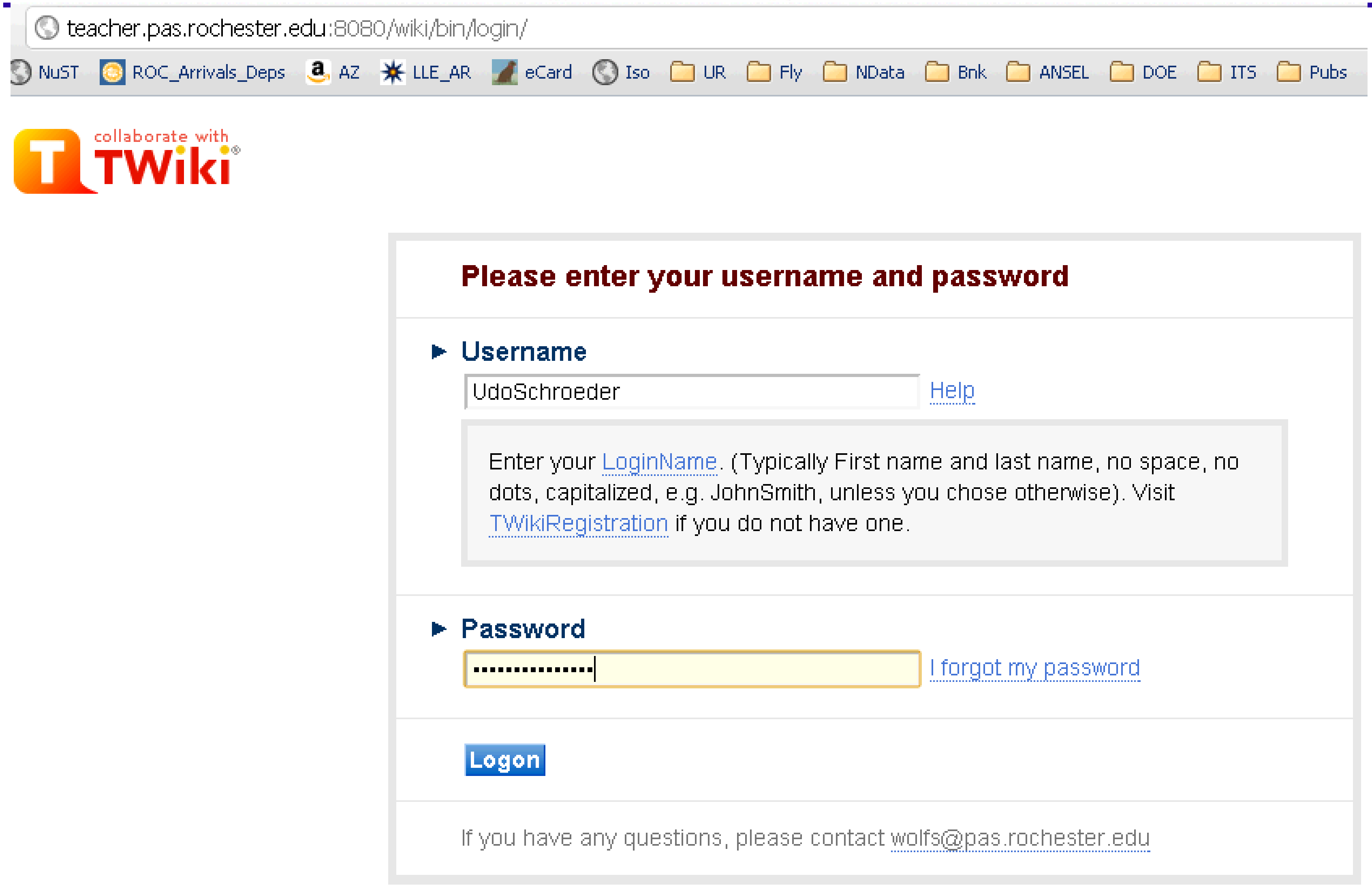
- Data collected during the experiments can be stored in event-by-event data files for off-line analysis.
- All experiments provide data files in ASCII format, which can be processed with a variety of tools.
- Samples of analysis using **Igor** will be provided. Igor is available at no cost for use in this course and runs on Windows and Mac OS. It is available on the ANSEL TWiki.

3. Room access:

- Access to the lab rooms requires a key which can be obtained from the main office (B&L 206). The $20 deposit will be recovered upon return of the key).

*Maintained by F. L. H. Wolfs

http://teacher.pas.rochester.edu:8080/wiki/bin/view/ANSEL



Please enter your username and password

Username

UdoSchroeder

Help

Enter your LoginName. (Typically First name and last name, no space, no dots, capitalized, e.g. JohnSmith, unless you chose otherwise). Visit TWikiRegistration if you do not have one.

Password

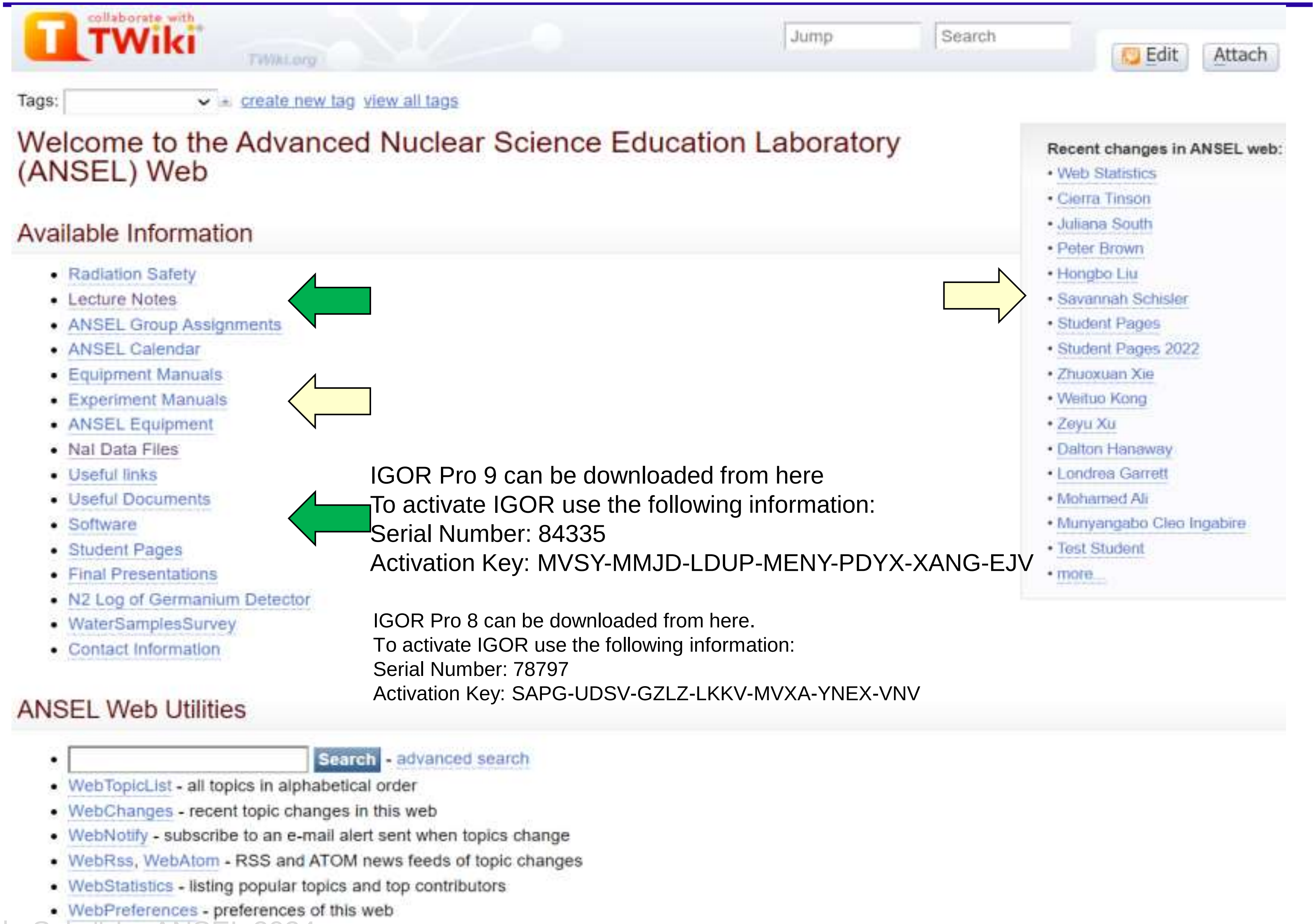
•••••••••••••••

I forgot my password

Logon

If you have any questions, please contact wolfs@pas.rochester.edu

Use of ANSEL TWiki



Tags: create new tag view all tags

Welcome to the Advanced Nuclear Science Education Laboratory (ANSEL) Web

Available Information

- Radiation Safety
- Lecture Notes
- ANSEL Group Assignments
- ANSEL Calendar
- Equipment Manuals
- Experiment Manuals
- ANSEL Equipment
- NaI Data Files
- Useful links
- Useful Documents
- Software
- Student Pages
- Final Presentations
- N2 Log of Germanium Detector
- WaterSamplesSurvey
- Contact Information

Recent changes in ANSEL web:

- Web Statistics
- Cierra Tinson
- Juliana South
- Peter Brown
- Hongbo Liu
- Savannah Schisler
- Student Pages
- Student Pages 2022
- Zhuoxuan Xie
- Weituo Kong
- Zeyu Xu
- Dalton Hanaway
- Londrea Garrett
- Mohamed Ali
- Munyangabo Cleo Ingabire
- Test Student
- more...

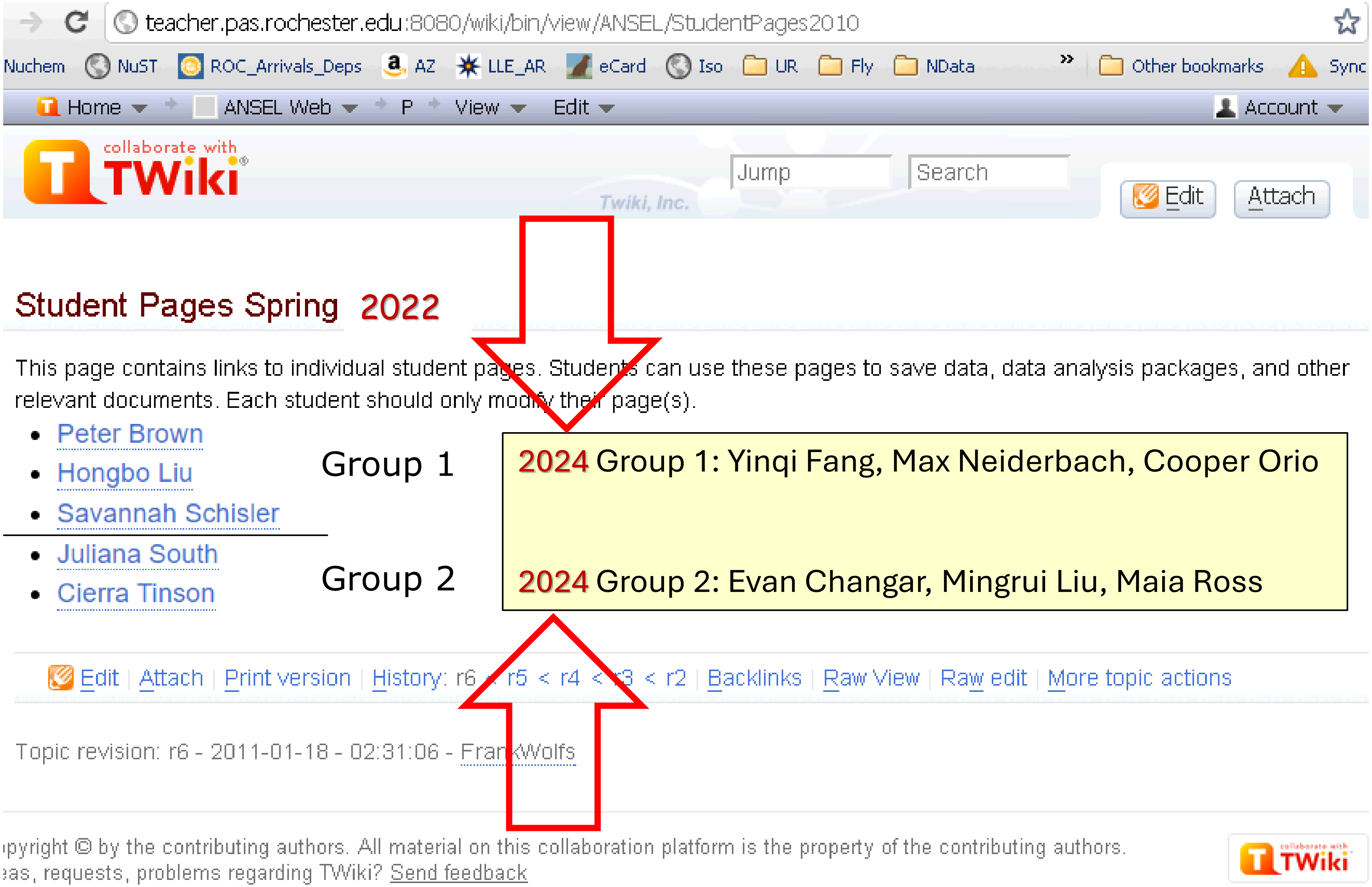
IGOR Pro 9 can be downloaded from here
To activate IGOR use the following information:
Serial Number: 84335
Activation Key: MVSY-MMJD-LDUP-MENY-PDYX-XANG-EJV

IGOR Pro 8 can be downloaded from here.
To activate IGOR use the following information:
Serial Number: 78797
Activation Key: SAPG-UDSV-GZLZ-LKKV-MVXA-YNEX-VNV

ANSEL Web Utilities

- Search - advanced search
- WebTopicList - all topics in alphabetical order
- WebChanges - recent topic changes in this web
- WebNotify - subscribe to an e-mail alert sent when topics change
- WebRss, WebAtom - RSS and ATOM news feeds of topic changes
- WebStatistics - listing popular topics and top contributors
- WebPreferences - preferences of this web

Use of ANSEL TWiki



Student Pages Spring 2022

This page contains links to individual student pages. Students can use these pages to save data, data analysis packages, and other relevant documents. Each student should only modify their page(s).

Group 1

- Peter Brown
- Hongbo Liu
- Savannah Schisler

Group 2

- Juliana South
- Cierra Tinson

2024 Group 1: Yinqi Fang, Max Neiderbach, Cooper Orio

2024 Group 2: Evan Changar, Mingrui Liu, Maia Ross

Edit | Attach | Print version | History: r6 < r5 < r4 < r3 < r2 | Backlinks | Raw View | Raw edit | More topic actions

Topic revision: r6 - 2011-01-18 - 02:31:06 - FrankWolfs

Resources

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*Maintained by F. L. H. Wolfs

Course Grade Components

1. Preparation for experiment.

   1a. Homework problems/assignments (PHYS445/CHM446 credits)

2. Written lab reports for each of the main experiments to be conducted in the course.

Please note:

- Although the experiments will be conducted by teams of students, each student is required to document progress of experiment in a separate dedicated logbook.
- Data analysis and lab report for each experiment must be produced individually and separately by each student.
- Analysis of statistical and systematic uncertainties is an important component of each lab report.
- Lab reports should be typed and "publication ready." Appropriate report style is defined in the AIP Style Manual (single column!). An equivalent MS Word template is also available.

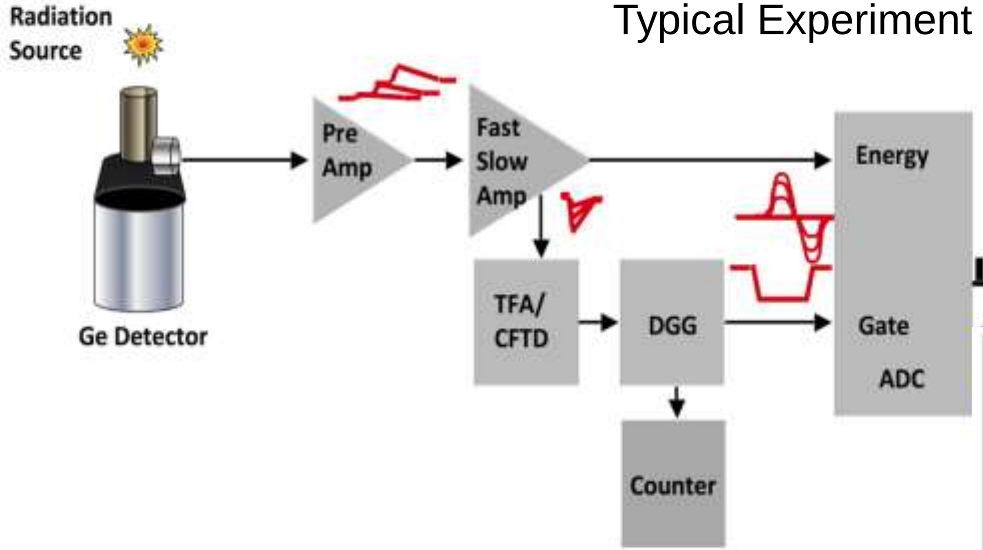
3. Oral presentation about one of the experiments (or related topic) at the end of the semester.

Questions?

→ Survey over ANSEL experiments

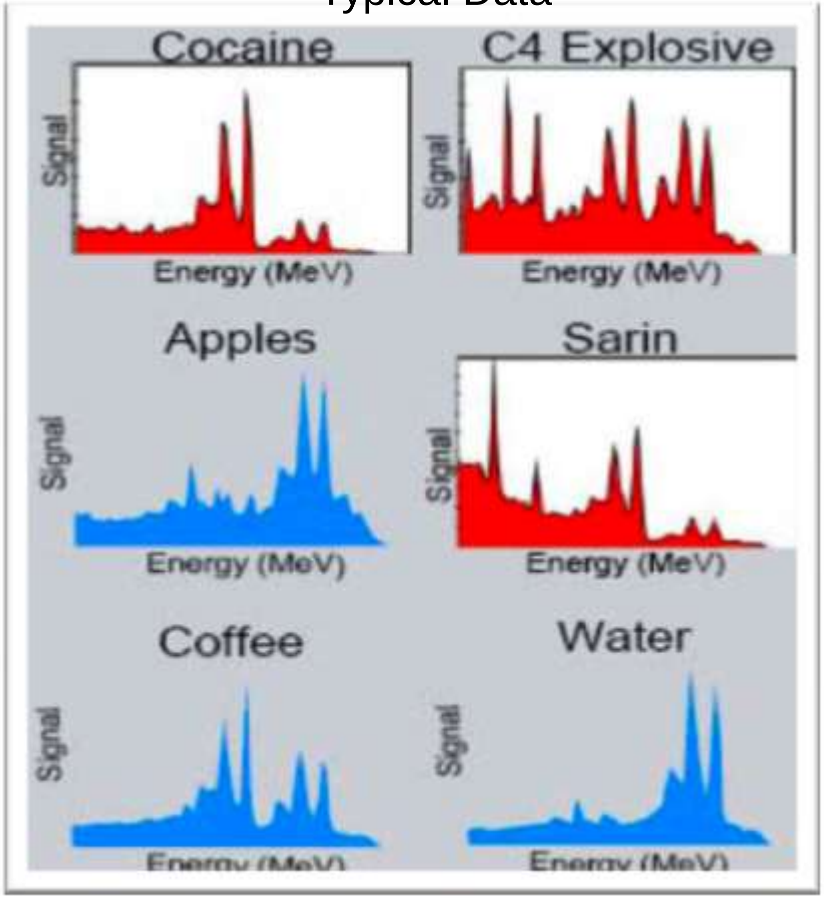
ANSEL Experiment: Gamma-ray (γ) spectroscopy

Typical Experiment



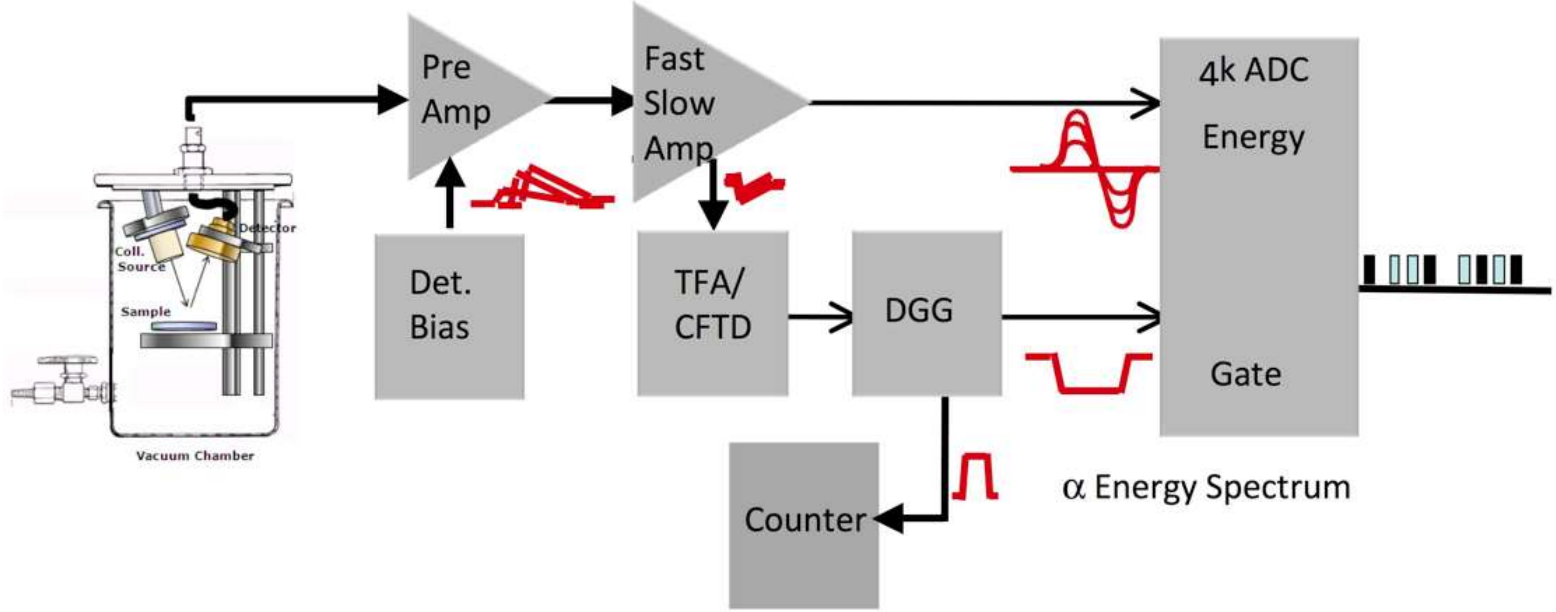
Basic nuclear structure. Identification of materials, objects of unknown origin, imaging

Typical Data



- Practice γ–ray detection/ identification using different detectors.
- Practice electronic signal processing, logic.
- Detector calibration.
- Statistical analysis.

ANSEL Experiment: Alpha spectroscopy

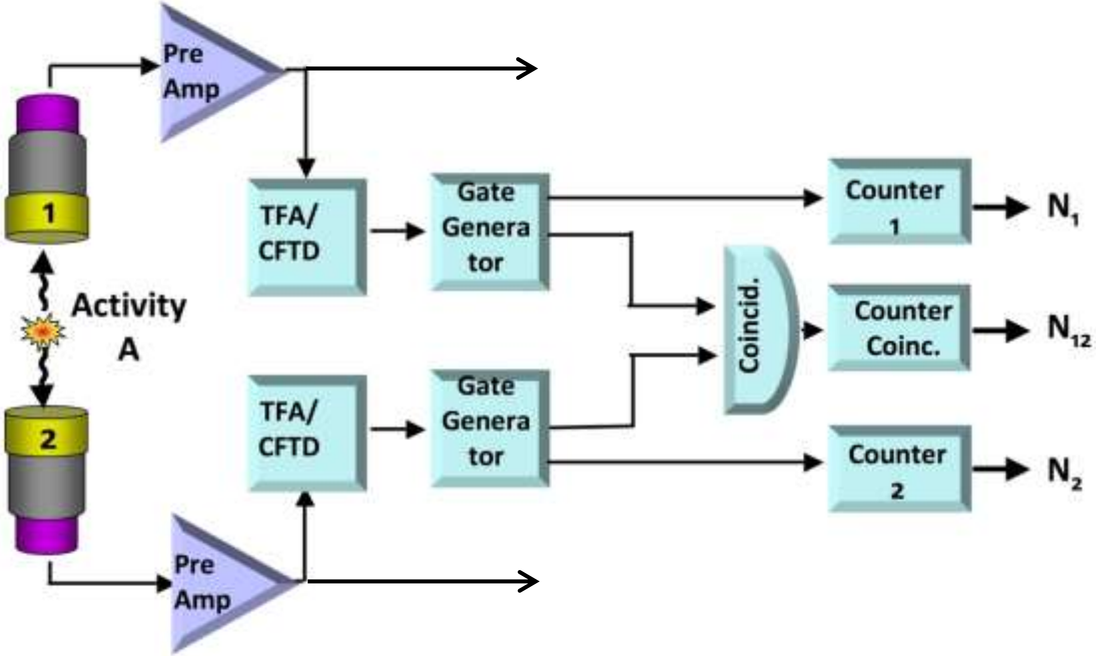


- Destruction-free material testing:
  Use Bethe-Bloch theory to determine thickness of thin films.
  (Use Rutherford-backscattering to determine material composition.)

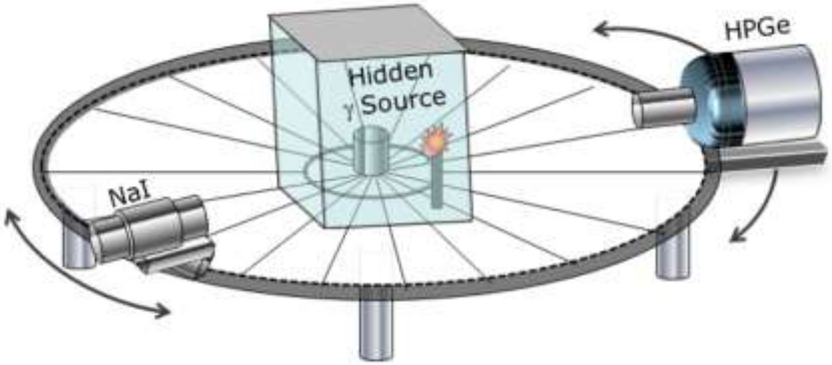
- Demonstrate & explain interaction of particles with matter
- Calibration and optimization of signal processing of silicon detectors.
- Linearity measurements using a pulse generator.

ANSEL Experiment: Coincidence measurements

- Basic nuclear structure from patterns of nuclear decay chains.
- Imaging multi-dim



- Use specific $(\gamma-\gamma)$ decay patterns for 3D imaging. Examples: gamma ray tracing (PET) to locate an unknown radiation source.
- How to define and detect simultaneous (coincident) events



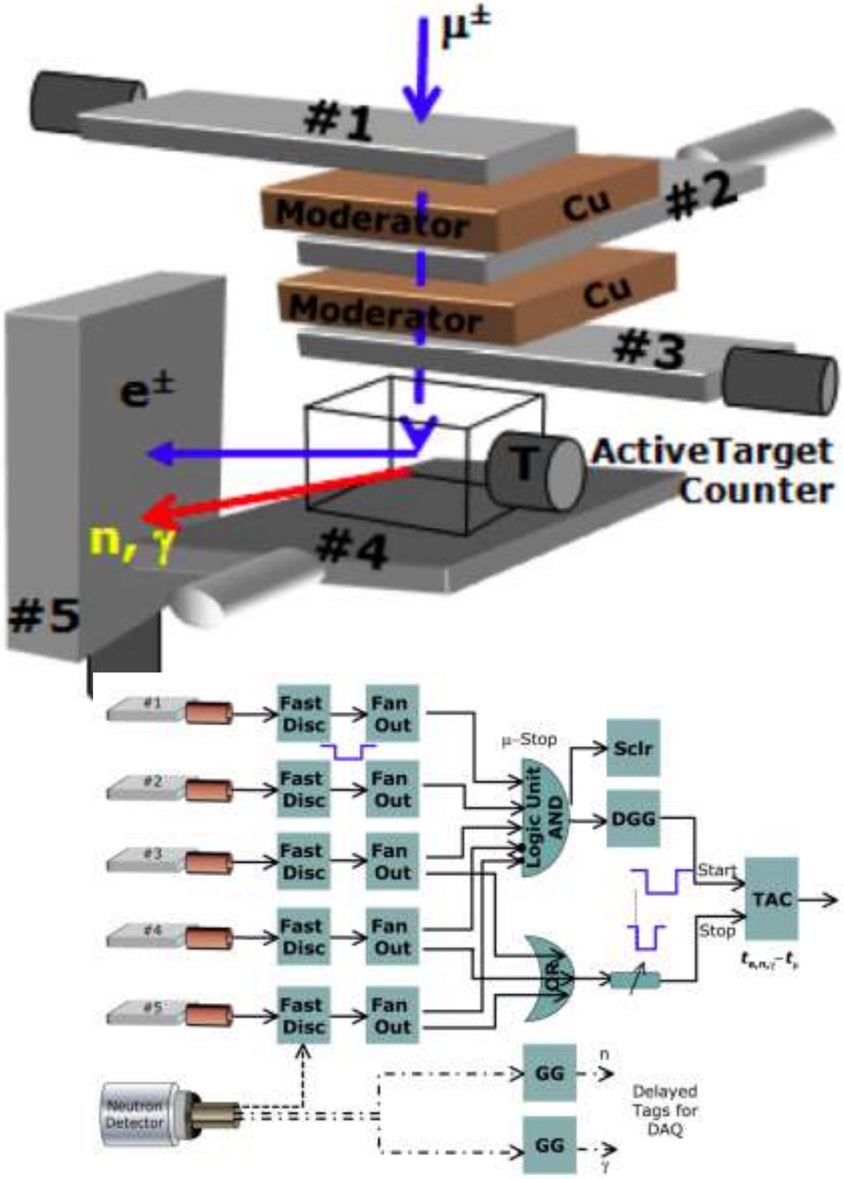
ANSEL Experiment: Muon radiography

- Radiation in our natural environment: Cosmic rays.

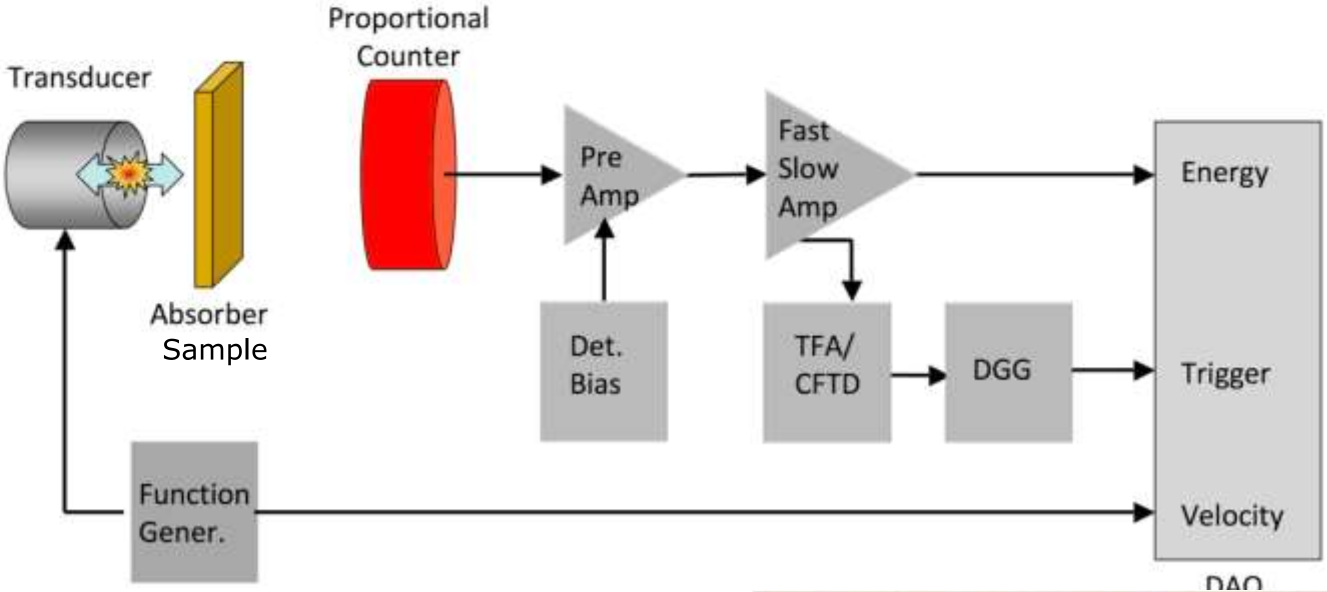
- Identify cosmic muons, measure interactions with organic matter.
  Measure muon stopping power and lifetime.

- Complex experiment, practice definition & use of electronic logic: coincidences (to identify muons) and anti-coincidence techniques (to tag stopped muons).

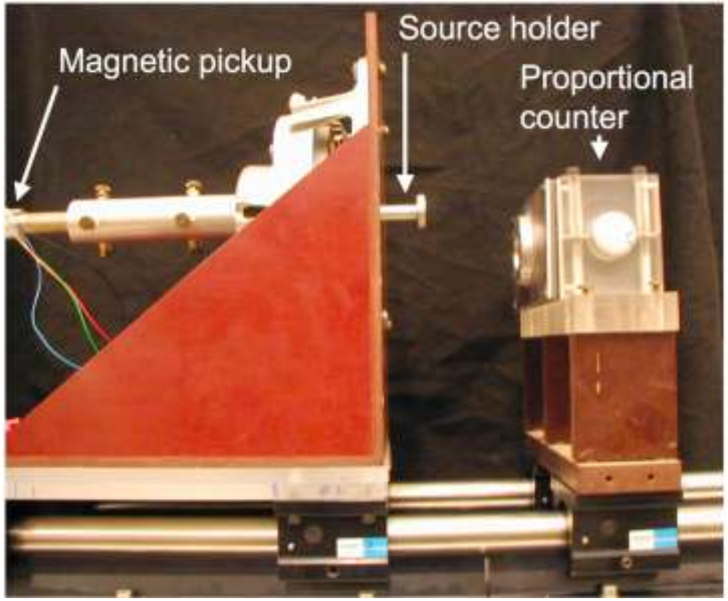
- (Direct detection of the muon-decay products.)



ANSEL Experiment: Mössbauer precision spectroscopy



- Ultra-sensitive γ spectroscopy, precise determination of interactions of nuclei with atomic electrons/lattice.
- Use in chemistry, fundamental physics, solid state physics
- Scanning of Doppler-shifted γ- ray energies using a moving source and absorbers=samples to be studied.



Course Schedule (before Spring break)

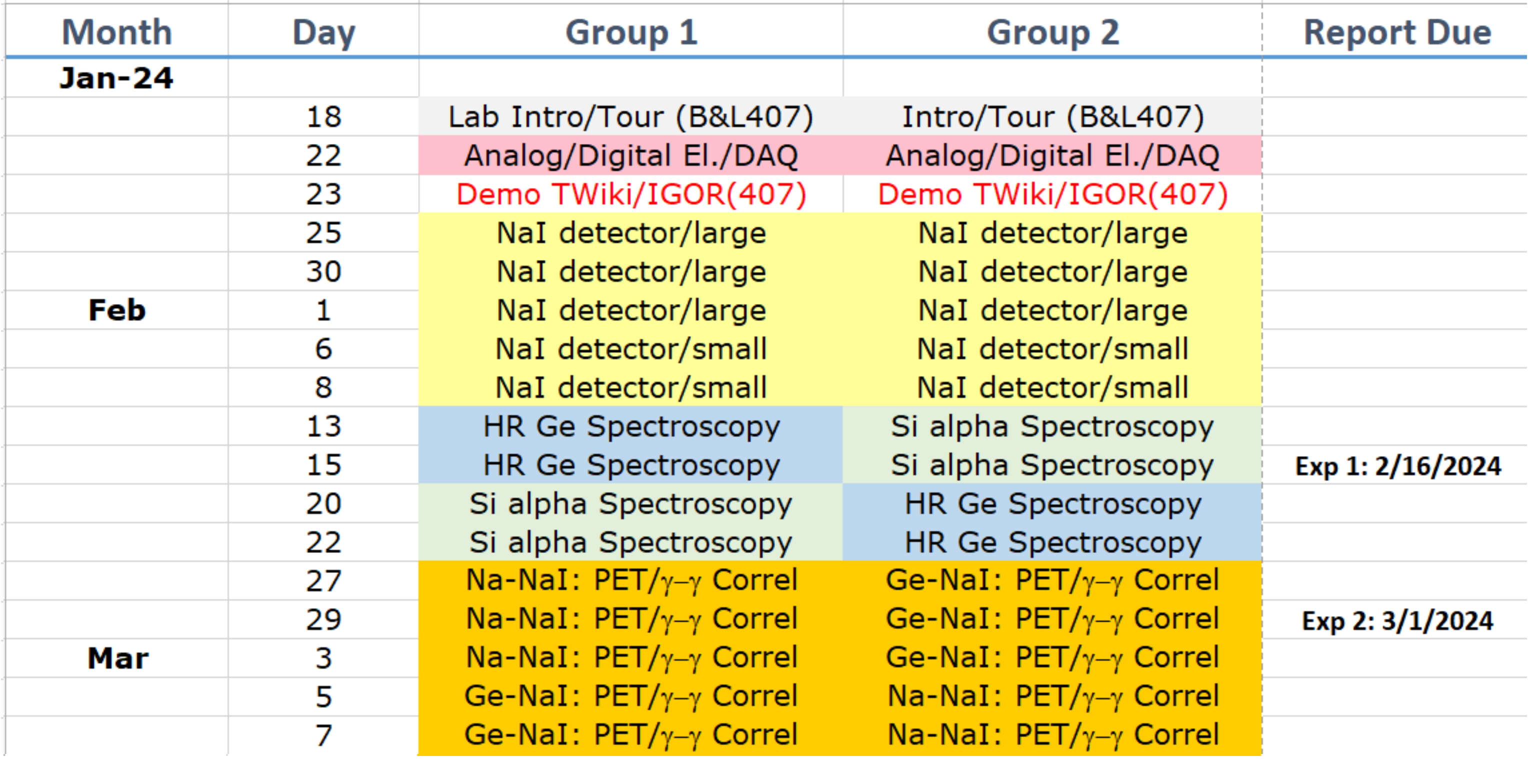
- Week of 1/14 2024:
  - 1/18: Lecture 1 (2:00 p.m., B&L 407), Intro to ANSEL Experiments & Tour
- Week of 1/21:
  - 1/22 (9 a.m., B&L 407) Lecture 2 (Electronic signal processing.)
  - 1/23 (2 p.m., B&L 407): Intro to data acquisition (DDC-8) and data analysis (Igor)- Student Practice (Laptop)
  - 1/25 & 1/30 (2 p.m., B&L 156/171): Lab Experiment 1 (large/small NaI). Demo practice oscilloscope (Expt. 0). Experiment 1 (Spectroscopy with NaI detectors) analysis
- Week of 1/28 :

Students take Web-Radiation safety training.
Pass exam following course presentation (before Jan 31), to be able to continue with the course.

Experiment/Lecture Schedule

Take Web-Radiation safety training by end of January.

Exam at the end of radsafety web presentation needs to be passed, in order to be able to continue with the course.



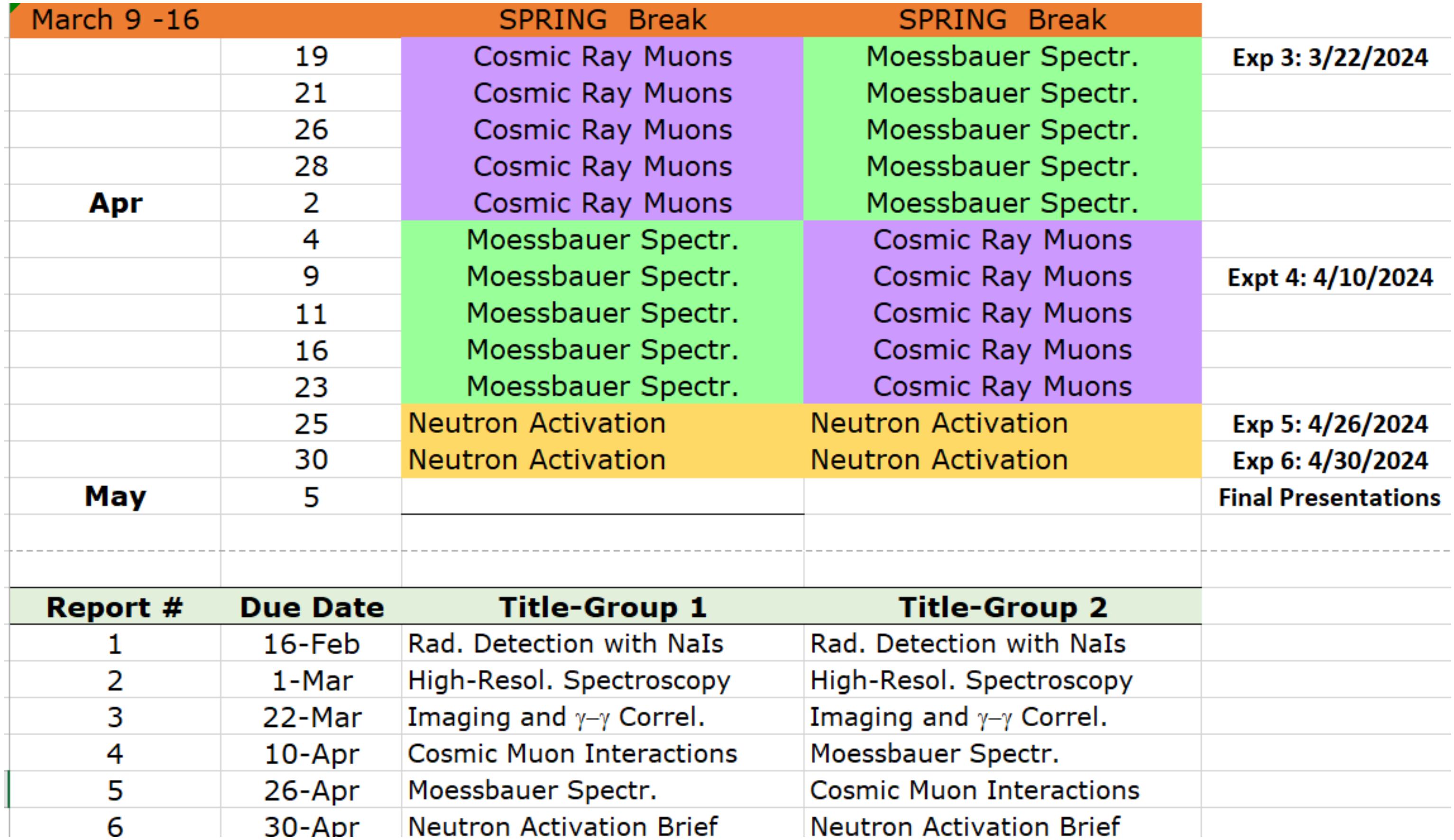
Month	Day	Group 1	Group 2	Report Due
Jan-24				
	18	Lab Intro/Tour (B&L407)	Intro/Tour (B&L407)	
	22	Analog/Digital El./DAQ	Analog/Digital El./DAQ	
	23	Demo TWiki/IGOR(407)	Demo TWiki/IGOR(407)	
	25	NaI detector/large	NaI detector/large	
	30	NaI detector/large	NaI detector/large	
Feb	1	NaI detector/large	NaI detector/large	
	6	NaI detector/small	NaI detector/small	
	8	NaI detector/small	NaI detector/small	
	13	HR Ge Spectroscopy	Si alpha Spectroscopy	
	15	HR Ge Spectroscopy	Si alpha Spectroscopy	**Exp 1: 2/16/2024**
	20	Si alpha Spectroscopy	HR Ge Spectroscopy	
	22	Si alpha Spectroscopy	HR Ge Spectroscopy	
	27	Na-NaI: PET/γ–γ Correl	Ge-NaI: PET/γ–γ Correl	
	29	Na-NaI: PET/γ–γ Correl	Ge-NaI: PET/γ–γ Correl	**Exp 2: 3/1/2024**
Mar	3	Na-NaI: PET/γ–γ Correl	Ge-NaI: PET/γ–γ Correl	
	5	Ge-NaI: PET/γ–γ Correl	Na-NaI: PET/γ–γ Correl	
	7	Ge-NaI: PET/γ–γ Correl	Na-NaI: PET/γ–γ Correl	

Spring Break March 9-16

Lab lectures during weeks 1-6 to help with timely experiment preparation.

Experiment/Lecture Schedule

Take Web-Radiation safety training by end of January.
Exam at the end of radsafety web presentation needs to be passed, in order to be able to continue with the course.

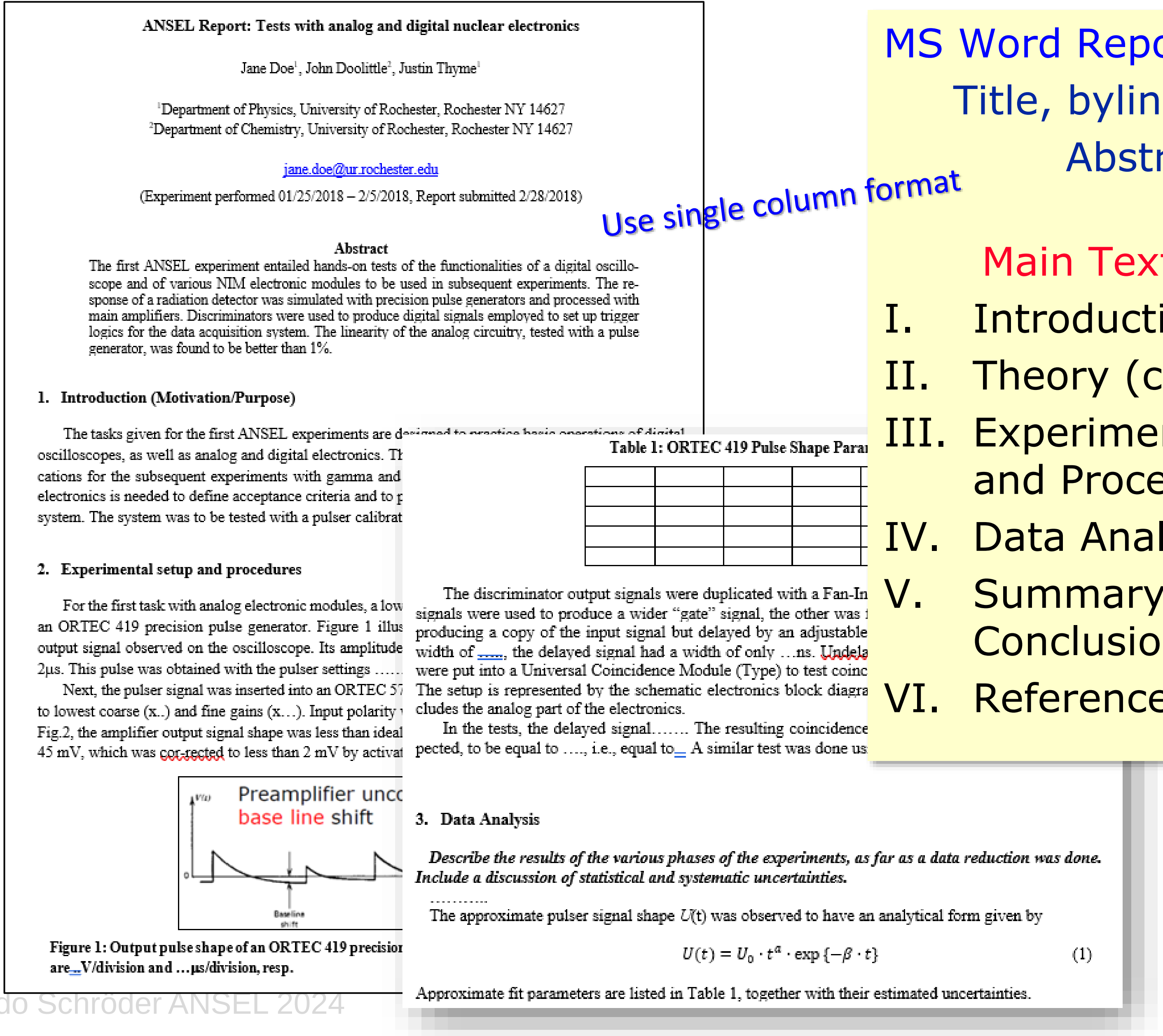


March 9 -16		SPRING Break	SPRING Break	
	19	Cosmic Ray Muons	Moessbauer Spectr.	**Exp 3: 3/22/2024**
	21	Cosmic Ray Muons	Moessbauer Spectr.	
	26	Cosmic Ray Muons	Moessbauer Spectr.	
	28	Cosmic Ray Muons	Moessbauer Spectr.	
Apr	2	Cosmic Ray Muons	Moessbauer Spectr.	
	4	Moessbauer Spectr.	Cosmic Ray Muons	
	9	Moessbauer Spectr.	Cosmic Ray Muons	**Expt 4: 4/10/2024**
	11	Moessbauer Spectr.	Cosmic Ray Muons	
	16	Moessbauer Spectr.	Cosmic Ray Muons	
	23	Moessbauer Spectr.	Cosmic Ray Muons	
	25	Neutron Activation	Neutron Activation	**Exp 5: 4/26/2024**
	30	Neutron Activation	Neutron Activation	**Exp 6: 4/30/2024**
May	5			**Final Presentations**

Report #	**Due Date**	**Title-Group 1**	**Title-Group 2**
1	16-Feb	Rad. Detection with NaIs	Rad. Detection with NaIs
2	1-Mar	High-Resol. Spectroscopy	High-Resol. Spectroscopy
3	22-Mar	Imaging and $\gamma-\gamma$ Correl.	Imaging and $\gamma-\gamma$ Correl.
4	10-Apr	Cosmic Muon Interactions	Moessbauer Spectr.
5	26-Apr	Moessbauer Spectr.	Cosmic Muon Interactions
6	30-Apr	Neutron Activation Brief	Neutron Activation Brief

Lab lectures during weeks 1-6 to help with timely experiment preparation.

ANSEL Lab Reports: Template



ANSEL Report: Tests with analog and digital nuclear electronics

Jane Doe[1], John Doolittle[2], Justin Thyme[1]

[1]Department of Physics, University of Rochester, Rochester NY 14627
[2]Department of Chemistry, University of Rochester, Rochester NY 14627

jane.doe@ur.rochester.edu

(Experiment performed 01/25/2018 – 2/5/2018, Report submitted 2/28/2018)

Abstract

The first ANSEL experiment entailed hands-on tests of the functionalities of a digital oscilloscope and of various NIM electronic modules to be used in subsequent experiments. The response of a radiation detector was simulated with precision pulse generators and processed with main amplifiers. Discriminators were used to produce digital signals employed to set up trigger logics for the data acquisition system. The linearity of the analog circuitry, tested with a pulse generator, was found to be better than 1%.

1. Introduction (Motivation/Purpose)

The tasks given for the first ANSEL experiments are designed to practice basic operations of digital oscilloscopes, as well as analog and digital electronics. Th
cations for the subsequent experiments with gamma and
electronics is needed to define acceptance criteria and to p
system. The system was to be tested with a pulser calibrat

2. Experimental setup and procedures

For the first task with analog electronic modules, a low
an ORTEC 419 precision pulse generator. Figure 1 illus
output signal observed on the oscilloscope. Its amplitude
2μs. This pulse was obtained with the pulser settings ……
Next, the pulser signal was inserted into an ORTEC 57
to lowest coarse (x..) and fine gains (x…). Input polarity
Fig.2, the amplifier output signal shape was less than ideal
45 mV, which was cor-rected to less than 2 mV by activat

Preamplifier unco
base line shift

Figure 1: Output pulse shape of an ORTEC 419 precisio
are V/division and …μs/division, resp.

Table 1: ORTEC 419 Pulse Shape Para

The discriminator output signals were duplicated with a Fan-In
signals were used to produce a wider "gate" signal, the other was
producing a copy of the input signal but delayed by an adjustable
width of ….., the delayed signal had a width of only …ns. Undela
were put into a Universal Coincidence Module (Type) to test coinc
The setup is represented by the schematic electronics block diagra
cludes the analog part of the electronics.

In the tests, the delayed signal……. The resulting coincidence
pected, to be equal to …., i.e., equal to A similar test was done us

3. Data Analysis

Describe the results of the various phases of the experiments, as far as a data reduction was done. Include a discussion of statistical and systematic uncertainties.

…………

The approximate pulser signal shape $U(t)$ was observed to have an analytical form given by

$$U(t) = U_0 \cdot t^{a} \cdot \exp\{-\beta \cdot t\} \qquad (1)$$

Approximate fit parameters are listed in Table 1, together with their estimated uncertainties.

Use single column format

MS Word Report Template
Title, bylines, dates
Abstract

Main Text

I. Introduction
II. Theory (contingent)
III. Experimental Setup and Procedures
IV. Data Analysis
V. Summary and Conclusions
VI. References

ANSEL Report Contents

Abstract: Brief description of experiment goals and main results.

Structure of Main Report

Introduction: General background and goals of experiment.

Theory: Discuss essential ideas underlying experiment, note and explain formulas used in analysis and interpretation; provide references. Can be omitted in purely technical experiments.

Experimental setup & procedures: Describe briefly experimental detector and electronics setup, note geometry and electronic/DAQ adjustments in sufficient detail for a repeat. Note observations. Include diagrams and sketches of geometric & logic setup.

Data Analysis and discussion: Show raw data, describe systematic and statistical errors and their sources. Show, tabulate and illustrate main quantitative results. Compare to theoretical predictions or literature results.

Summary and conclusions: Describe briefly execution and results of experiments and their comparison to expectations. Suggestions.

Rubrics Example: Mössbauer Experiment

Comments apply to an excellent report graded A-.

1. **General Presentation**
   Abstract: Comprehensive, clear structure of report.
   Narrative, Tasks: Extensive, comprehensive discussions, executed most but not all tasks.

2. **Understanding theoretical background**
   Foundational Principles of MB Spectroscopy:
   Good explanation for recoilless emission/absorption, not for non-res. (background) absorption.
   The Doppler Effect for Photons:
   Math. derivation is missing, plausibility explanation of shape is missing

3. **Experimental Setup**
   Diagrams of general setup and electronics: sketches are shown.
   Principles of measurement have been well explained.
   Anticipated results of measurements Quantitative form given for shape of velocity spectrum for non-resonant absorption.

4. **Experimental Methods, Detail**
   Detection with PC as gas amplification counter with multiple response (escape lines) explained.
   Absorption/transmission as functions of gamma energy well explained
   Energy calibration fit shown.

5. **Velocity Spectrum**
   Discussed how discriminator window was set on PC energy wave.
   Raw velocity spectrum shown, corrected spectrum shown
   Function T(v) not derived or shown. Some misconceptions about resonance absorption vs total absorption.

6. **Results, Completeness, Accuracy**
   Correct absorption dips for isomer shifts and quadrupole HF splittings. However, no comparison to literature, and only brief discussion of nuclear or lattice properties.

ANSEL Lab Tour

See course website for a virtual version

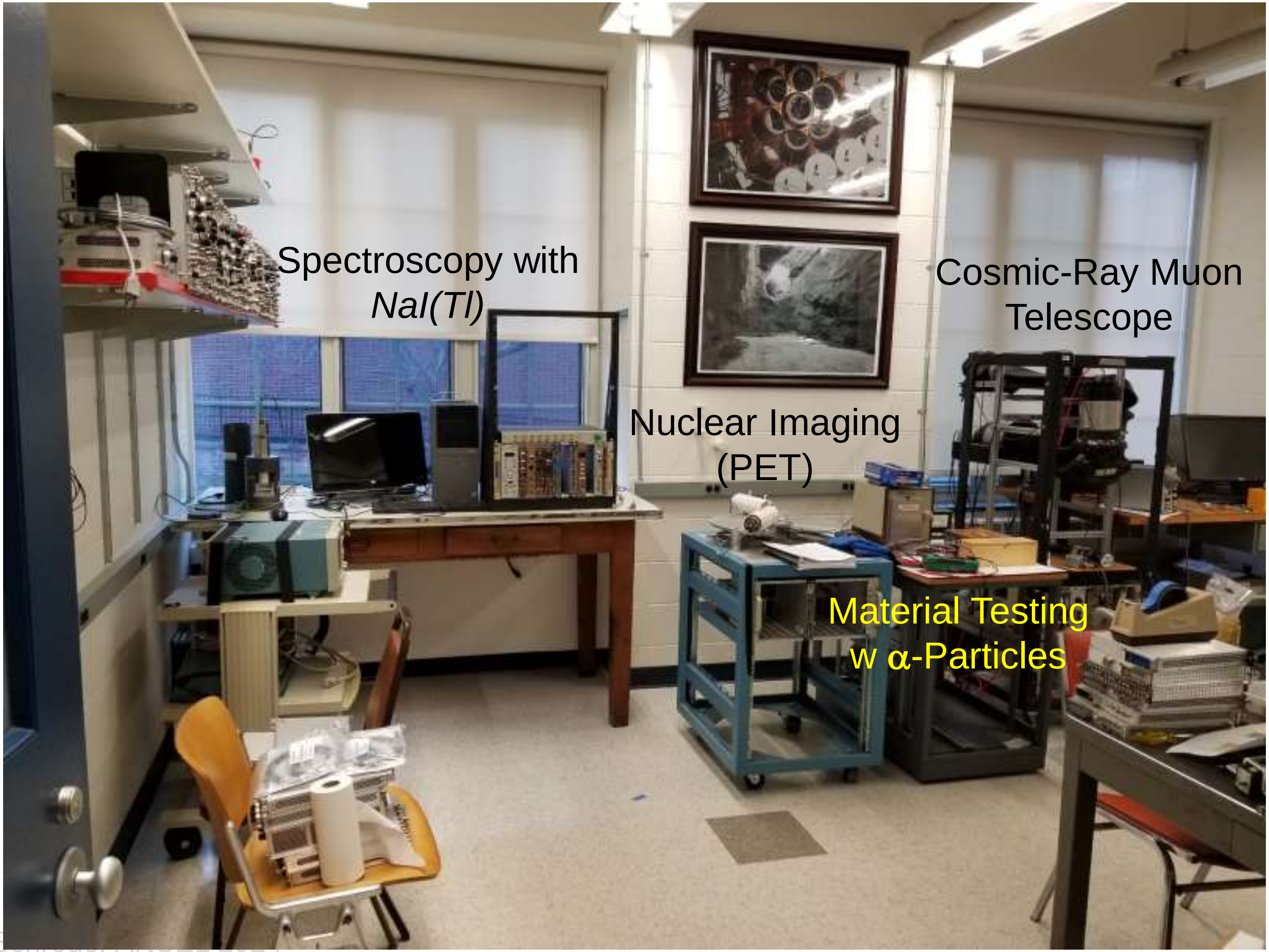
Virtual Tour ANSEL Lab: Bausch & Lomb Building

Entrance at Quadrangle

Virtual Tour ANSEL Lab: B&L 156

Warm-up Room

Virtual Tour ANSEL Lab: B&L 152



Spectroscopy with *NaI(Tl)*

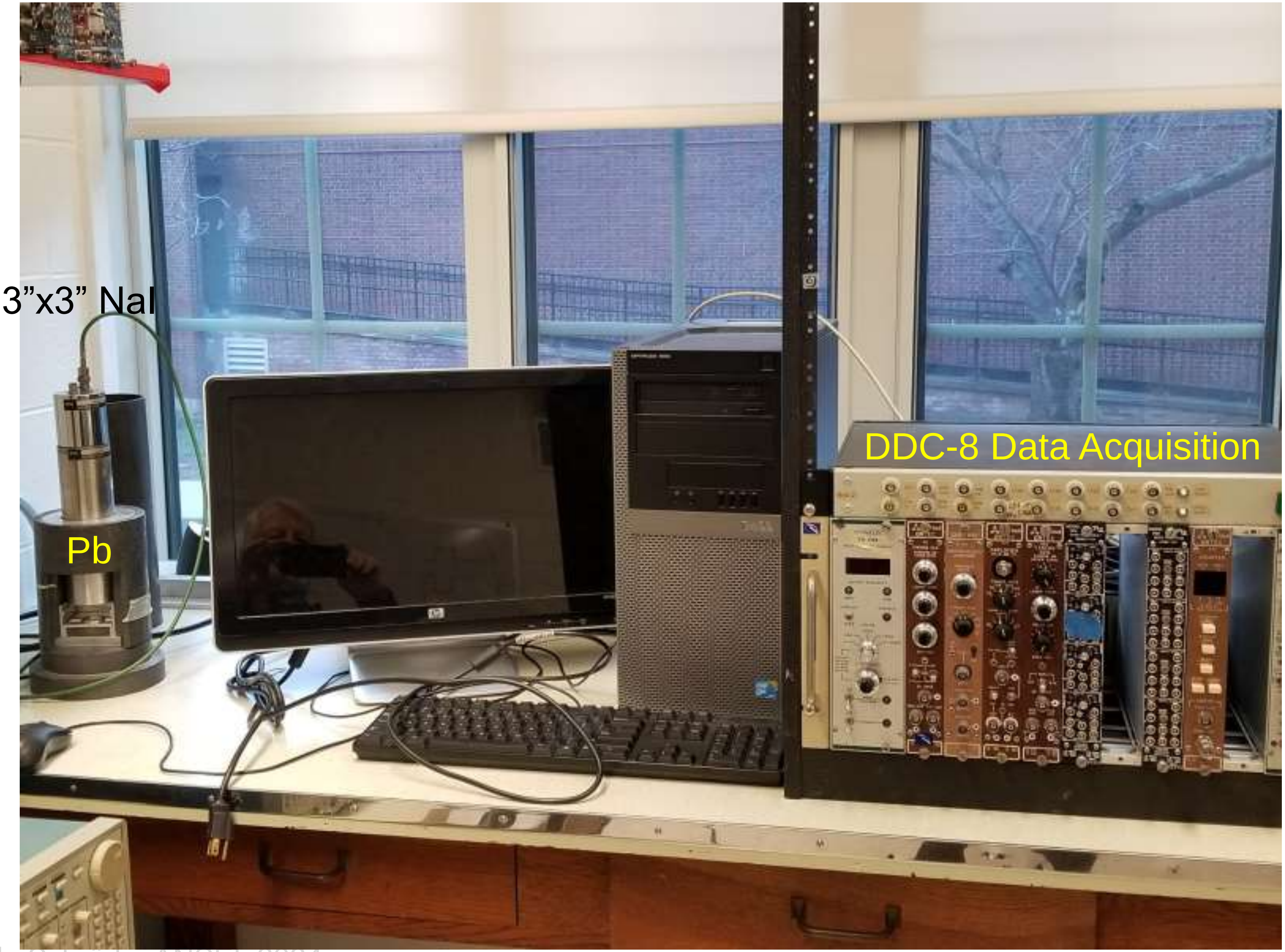
Cosmic-Ray Muon Telescope

Nuclear Imaging (PET)

Material Testing w α-Particles

Virtual Tour ANSEL Lab: B&L 152

Virtual Tour ANSEL Lab: B&L 152



Virtual Tour ANSEL Lab: B&L 152

3"x3" NaI

Pb Shield

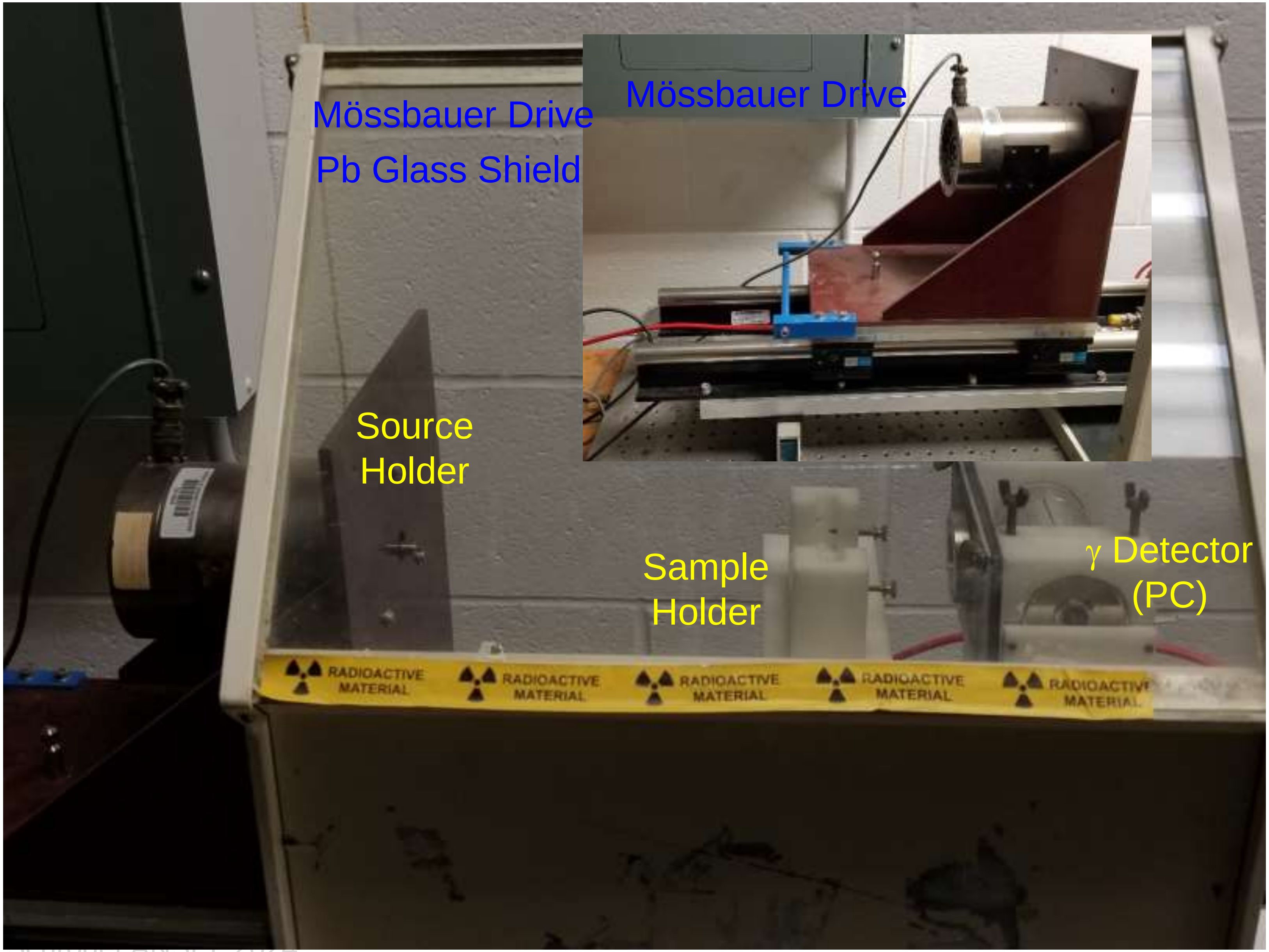
Sample→
Source

Radioactive Calibration Sources

cquisition

Virtual Tour ANSEL Lab: B&L 171 Mössbauer Expt.

Virtual Tour ANSEL Lab: B&L 171 Mössbauer Expt.

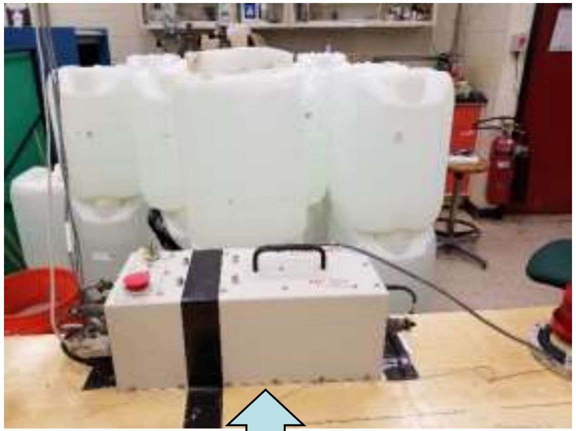


Virtual Tour ANSEL Lab: Hutchison Hall

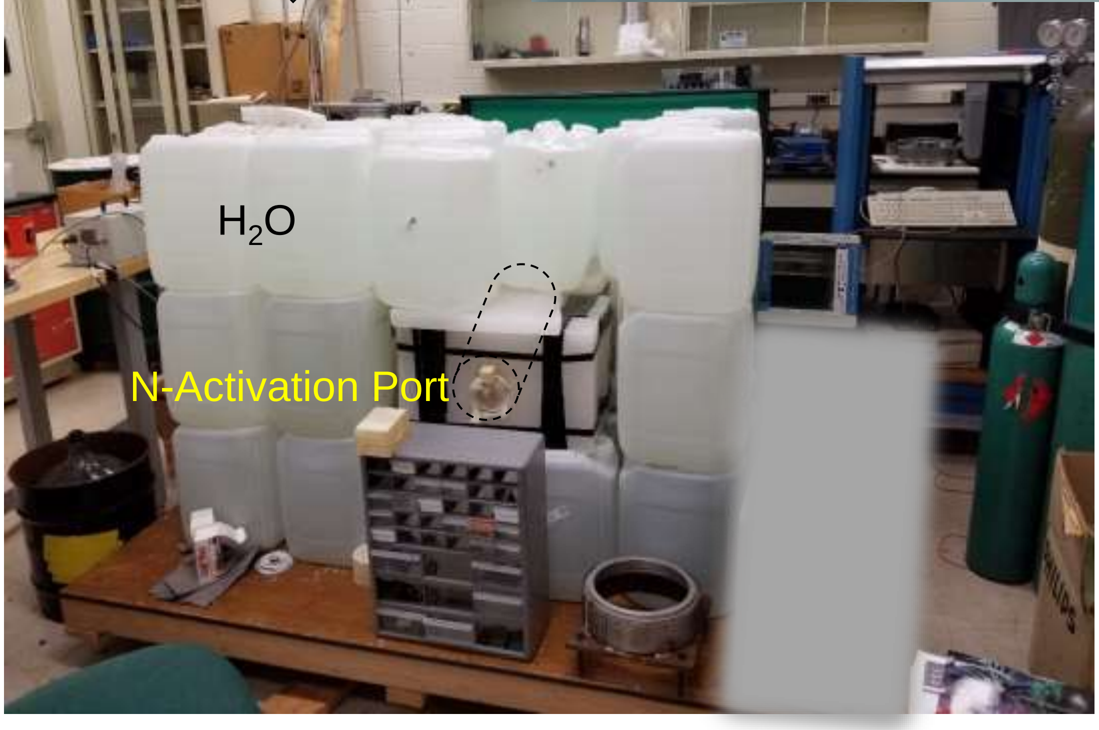
Hutchison Hall Rooms 441/442

Neutron Generator Hutchison Hall Room 442

Neutron generator produces neutrons of E_n=2.45 MeV energy. “Castle” of water canisters and paraffine plates for neutron shielding/absorption.
Paraffine for moderating neutrons to thermal energies E_n~25 meV → efficient capture by materials → “neutron activated” → material analysis



Generator control electronics



Neutron Activator Hutchison Hall Room 442

Paraffine filled n-Activator drum has strong Am-Be neutron source in its center→ thermal neutrons

End of ANSEL Tour

Have a Good
and Interesting
Semester !