TU Wien: 142.340 (SV), 142.351 (UE), Uni Wien: 260014 (VU)

Statistical Methods of Data Analysis (this year: english only!)

Lecture: Wolfgang Waltenberger
Exercises: Florian Reindl, Philipp Schreiner, Sahana Narasimha

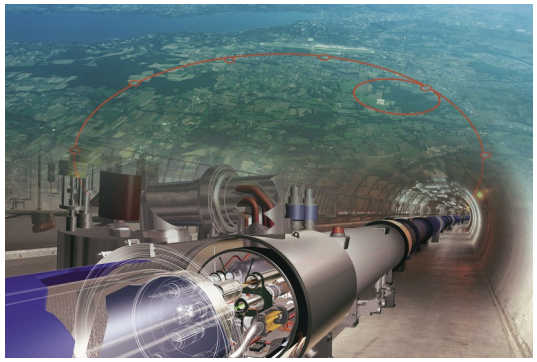
TU Wien: E141 (Atominstitut), Uni Wien: Gruppe Teilchenphysik
all lecturers: Institut für Hochenergiephysik, österr. Akademie der Wissenschaften

HEPHY
INSTITUT FÜR HOCHENERGIEPHYSIK

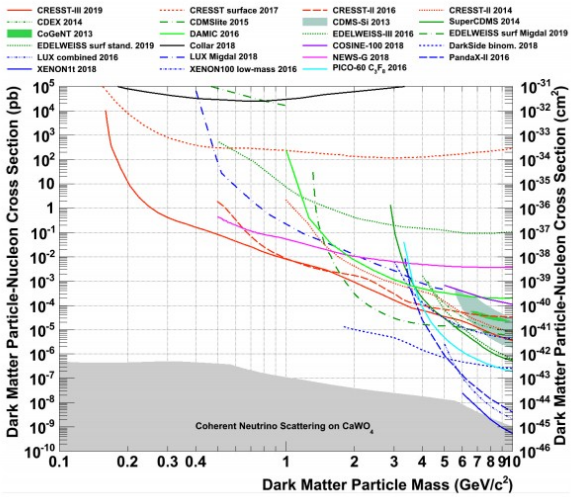
October 2024

Institute for High Energy Physics (HEPHY), ÖAW

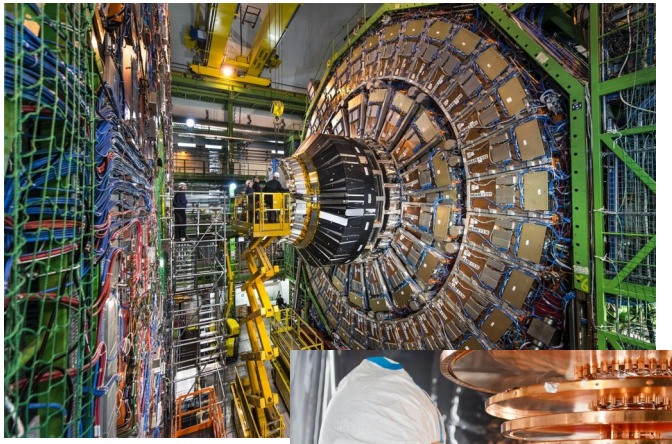
The Institute for High Energy Physics is a non-university research institute of the Austrian Academy of Sciences. Our scientific contributions take place, among others, within the framework of the Large Hadron Collider at CERN (Wolfgang Waltenberger, Sahana Narasimha) and in the European Dark Matter Experiments CRESST and COSINUS at LNGS (Philipp Schreiner, Florian Reindl)
Example: current data volume at LHC ~ 1 Exabyte → Data sciences a central aspect!



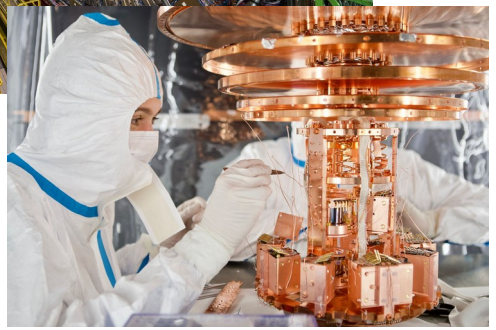
LHC (collider physics)



Statistical “limits” for dark matter candidates



CMS detector



CRESST detector

Lecture 142.340 (260014)

Syllabus:

- Introduction to Probability Theory
- Bayes' Theorem
- Counting Experiments, Discrete Random Variables
- Measurements, Continuous Random Variables
- Random Sampling and Sampling Functions
- Moment Estimators, Maximum Likelihood Estimators, Bayes Estimators
- Hypothesis Testing
- Confidence Intervals and Confidence Intervals
- Linear Models, Regression, and Data Reconciliation
- Bayesian Statistics

Assessment: Final Programming Assignment
Materials: see TISS/TUWEL (TU Wien) / moodle (Uni Wien)

1st Lecture (now): October 7, 2023, 14:00
Postsparkasse, 3.Stock Besprechungsraum 3A, Georg-Coch Platz 2, 1010 Wien

Final Programming Assignment

This year, instead of taking an exam you will be tasked with a final programming assignment. You will be required to submit a jupyter notebook that includes and documents the code but also describes the task, and presents the results in detail, including plots and graphical illustrations. The program must relate to the lecture material (or extend it), and this connection should be clearly evident from the documentation.

The programming language must be python.

The code may later[!] be explicitly reused within a Bachelor's, Master's thesis, or PhD thesis, but it must not be part of another lecture or exercise. The work must significantly exceed the complexity of individual exercise examples. If desired, I am happy to provide feedback on your work. Revision of the work after the feedback round is allowed and explicitly encouraged. Informative visualizations of the results will be highly regarded. Additionally, the work must be presented in a short (10 – 20 minutes) video, e.g., recorded via ZOOM.

Please state your name, student ID, and university in the video. Working in pairs is allowed; however, in this case, the effort must be significantly (>= 50%) greater than for individual submissions.

The assignment is due by february 1st, 2025.

Dates & Places

Monday 07.10. 14:00 - 16:30 (VO), PSK
Monday 14.10. 14:00 - 16:30 (VO), Nikolsdorfergasse 18
Monday 21.10. 14:00 - 16:00 (VO), Nikolsdorfergasse 18
Monday 28.10. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 04.11. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 11.11. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 18.11. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 25.11. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 02.12. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 09.12. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 16.12. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Christmas!
Monday 13.01. 14:00 - 16:30 (VO+UE), Nikolsdorfergasse 18
Monday 20.01. 14:00 - 16:30 (UE), Nikolsdorfergasse 18

Exercises TU Wien, 142.340

Instructors: Philipp Schreiner, Sahana Narasimha, Florian Reindl
First exercises: Friday 28.10.2024 14:00 - 16:30

Nikolsdorfergasse 18, Bibliothek, 1050 Wien

The lecture material will be revisited with pen-and-paper exercises and programming examples

Assessment: Presentation at blackboard (“Kreuzerlübung”), submission of

code, participation

Submission of programs as Jupyter notebooks, via TISS/TUWEL or upload to the TU cloud.

VO+UE for TU students are worth 6 ECTS points. All exercises are obligatory.

Exercise Part Uni Wien, 260014

Instructors: Philipp Schreiner, Sahana Narasimha, Florian Reindl
First exercises: Friday 28.10.2024 14:00 – 16:30,

Nikolsdorfergasse 18, Bibliothek, 1050 Wien

The lecture material will be revisited with pen-and-paper exercises and programming examples

Assessment: Presentation at blackboard, submission of code, participation

Submission of programs as Jupyter notebooks, via moodle

Overall grade for the exercise part (60%) + lecture part (40%).

VU for Uni students is worth 5 ECTS points. Only 5/6 exercises will be obligatory, the other 1/6 optional.

You can find 'skeleton' Python code snippets on TUWEL/Moodle.
They are intended to accelerate your learning curve.

```
#!/usr/bin/env python3

""" Skeleton file, das eure Lernkurve beschleunigen soll,
    fuer Uebung 1.6.
"""

## Importieren der wichtigsten Module fuer die Uebungsaufgabe.
import numpy, scipy.misc, math, scipy.integrate

## scipy.misc.comb ( n, k )  ## n ueber k = n! / ( k! (n-k)! )
## math.sin ( math.pi * x ) ## sin ( pi * x )

## lambda Funktionen erlauben Definitionen in einer einzigen Zeile
## prior = lambda p: p**2 * ( 1 - p )**3  ## prior(.5) = .03125

## Integral von f ueber das Intervall (a,b)
## scipy.integrate.quad ( f, a, b )

## Teile das Intervall (a,b) in n "bins"
## numpy.linspace ( a, b, n )

## Plotten, siehe https://matplotlib.org/
from matplotlib import pyplot as plt
[01]  skeleton1_6.py  Top                                    exptab sw=4 <2,0-1>
"skeleton1_6.py" 36L, 978C
1-$ 0:  2$* 0:
```