I did something cool at CERN - ISOLDE

by

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Thesis

for the degree of

Master of Science

Faculty of Mathematics and Natural Sciences
University of Oslo

May 2019

Abstract

To my family, for all their support and encouragement!

Acknowledgements

Supervisors Andreas Görgen and Katarzyna Hadyńska-Klęk
Nuclear Physics Group
Computational Physics Group, Morten Hjorth-Jensen
CERN-ISOLDE, Liam Gaffney
Lillefy, FFU, Fysikkforeningen
My family
Morten, Alex and Astrid
Ina, I love you.

Collaboration details

The sorting and analysis code used in this thesis has been developed at CERN-ISOLDE and can be found at https://github.com/Miniball/MiniballCoulexSort

The code for theoretical predictions of energy used in the calibration was developed by Liam Gaffney who is working at ISOLDE and has to do with analysis of data from Miniball and ISS. kinsim can be found here https://github.com/lpgaff/kinsim

Some calibration code is based on the codes of Ville Virtanen and Liam Gaffney.

Other code/scripts have been written by the author. C++ / Python.

Trond Wiggo Johansen

September, 2019

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Chapter 1

Introduction

Test [1]

Test 2 [**?**]

kinsim [2]

The experiment has been done before, with lower energy (and another target), Malin Klintefjord.

Chapter 2

Theory?

Chapter 3

Coulomb excitation experiment

Table 3.1: Acronyms.

PSB	Proton Synchrotron Booster
ISOLDE	Isotope Separator On-Line DEvice
GPS	General Purpose Separator
HRS	High Resolution Separator
EBIS	Electron Beam Ion Source
REX-EBIS	Radioactive beam EXperiment EBIS
RILIS	Resonance Ionization Laser Ion Source
HIE-ISOLDE	High Intensity and Energy upgrade
RIB	Radioactive Ion Beams
ENSAR2	European Nuclear Science and Applications Research - 2
ISOL	Isotope Separator On-Line

3.1 ISOLDE

ISOLDE http://isolde.web.cern.ch

REX-ISOLDE http://rex-isolde.web.cern.ch

RILIS http://rilis.web.cern.ch

HIE-ISOLDE http://hie-isolde-project.web.cern.ch

MINIBALL http://isolde.web.cern.ch/experiments/miniball and https://www.miniball.york.ac.uk/wiki/Main_Page

ENSAR2 http://www.ensarfp7.eu

Coulex: Coulomb excitation

Ebis: charge breader: release beam with certain energy

3.1.1 Miniball

3.1.2 DSSSD

3.2 Experimental setup

^{140}Sm Coulomb excitation experiment.

Beam: ^{140}Sm(4.65 MeV/u, 651 MeV)

Target: ^{208}Pb

ISOLDE experimental hall:

$$p^+ \rightarrow \text{Ta} \rightarrow \text{Produces the chart of nuclides up to Ta} \rightarrow \text{GPS} \rightarrow \text{RILIS} \rightarrow \text{REX-EBIS} \rightarrow \text{HIE ISOLDE} \rightarrow \text{MINIBALL}$$

GPS: Selects mass 140

RILIS: Selects Sm with laser

REX-EBIS: Excites nucleus in three steps ionizing the atom → nucleus in high charge state

HIE-ISOLDE: Linear accelerator

Small angle: Forward scattering: Larger distance, weaker EM-field, less excitation probability.

Large angle: Backward scattering: Closer distance, stronger EM-field, higher excitation probability.

Chapter 4

Data analysis

ROOT: analysere data
kinsim3 + SRIM

4.1 Calibration

4.1.1 Particle detector

ADC: Analog to digital converter (Mesytec)
TDC: Time to digital converter
DSSSD: Double-Sided Silicon Strip Detector $\implies$ CD
must remove the inner ring from data analysis because of damage

$$gain = \frac{E_{Sm} - E_{Pb\ or\ Ni}}{Ch_{Sm} - Ch_{Pb\ or\ Ni}}$$

$$offset = E_{Sm} - gain \cdot Ch_{Sm}$$

in keV.

4.1.2 Gamma detectors

DGF: Digital γ finder

4.2 Doppler correction

Chapter 5

Experimental results

Chapter 6

Discussion

Chapter 7

Summary and outlook

Appendices

Appendix A

Some Appendix

Appendix B

Some other appendix...

Bibliography

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[2] L. Gaffney. Kinematics simulations for Coulomb-excitation experiments at Miniball, May 2018. URL https://github.com/lpgaff/kinsim.