

*What you need to do:*

The detection efficiency calibration of real germanium detector arrays!

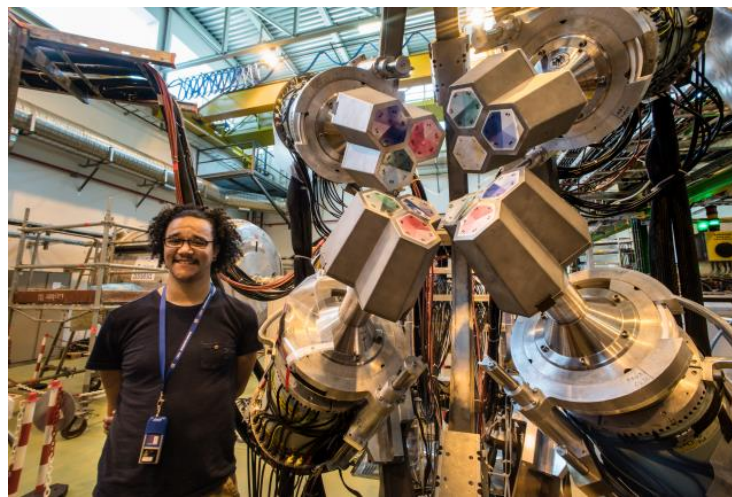
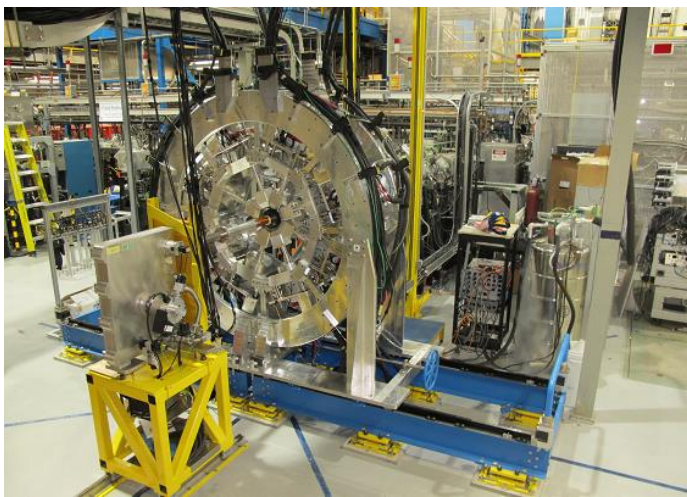
- Install GRSISort
- Fit gamma-ray photopeaks with GRSISort
- Edit and run the RootEffi script
- Submit your fitted peaks, your edited RootEffi script and your efficiency curve ☺

*What you need to know:*

- How semiconductor detectors work
- How to determine the detection efficiency
- How to find nuclear information
- How to compile a code
- How to fit peaks with GRSISort
- How to run a script in ROOT and GRSISort

*GRIFFIN,  
TRIUMF,  
Vancouver,  
Canada*

**64 crystals**

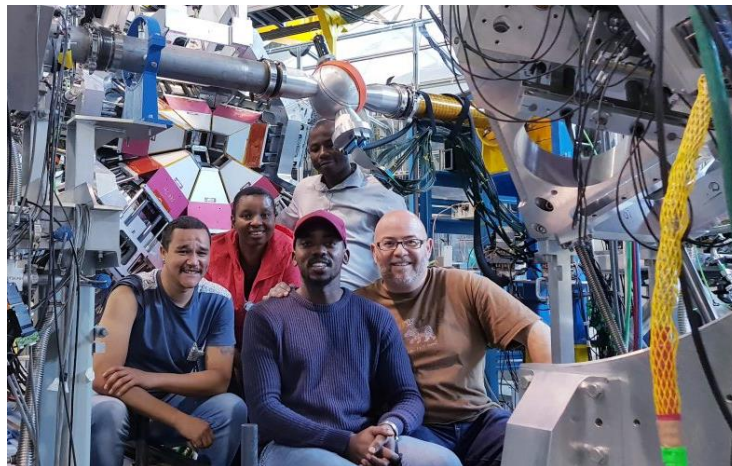


*MINIBALL,  
CERN,  
Geneva,  
Switzerland*

**24 crystals**

*Soccer Ball,  
iThemba LABS,  
Cape Town,  
South Africa*

**52 crystals**

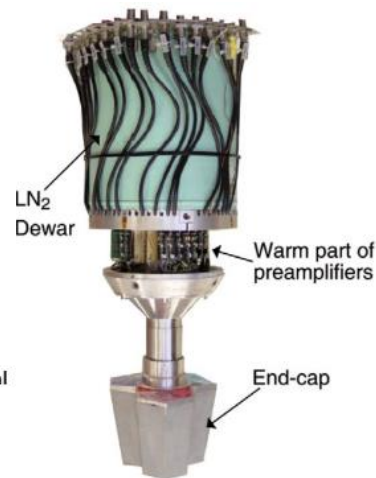
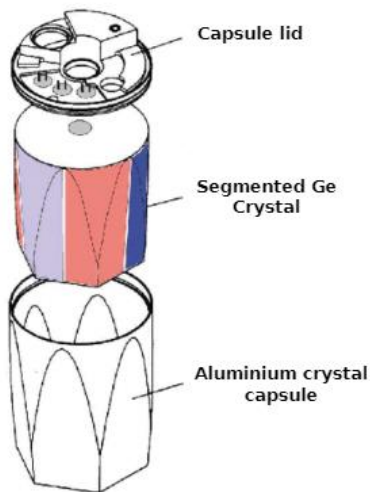
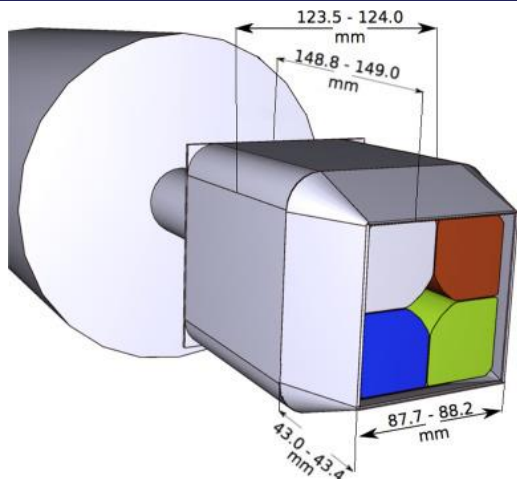


*TIGRESS,  
TRIUMF,  
Vancouver,  
Canada*

**48 crystals**

*GRIFFIN*,  
*TRIUMF*,  
Vancouver,  
Canada

**64 crystals**  
**(16 clovers,**  
**not segmented)**



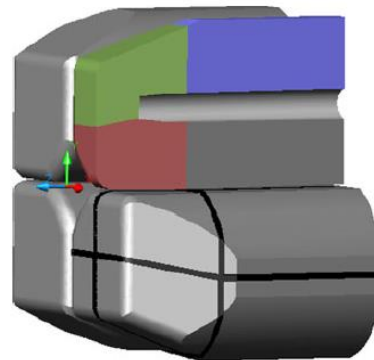
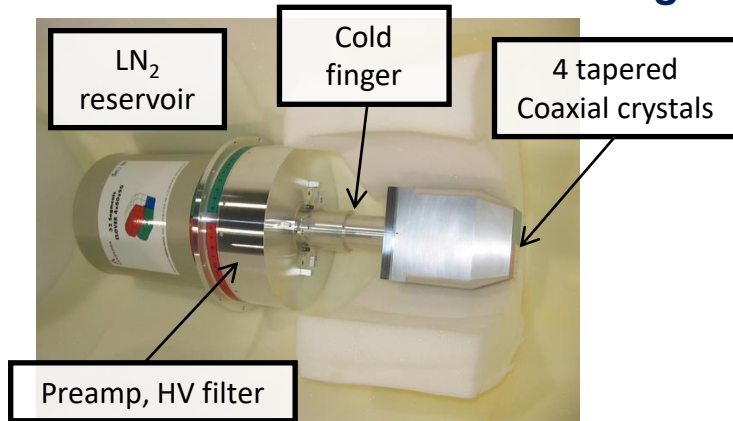
*MINIBALL*,  
*CERN*,  
Geneva,  
Switzerland

**24 crystals**  
**(8 triple clusters,**  
**6-fold**  
**segmented)**

***Closed-end coaxial right cylinders ☺***

*Soccer Ball*,  
*iThemba LABS*,  
Cape Town,  
South Africa

**52 crystals**  
**(13 clovers,**  
**4 segmented and**  
**9 not segmented)**

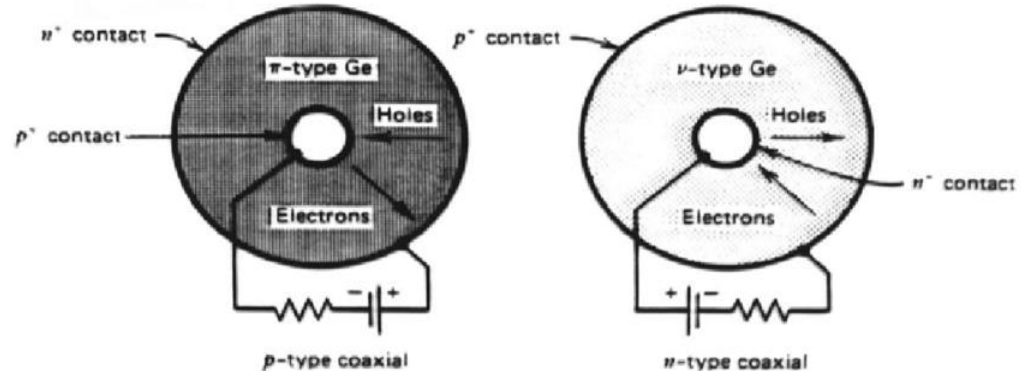
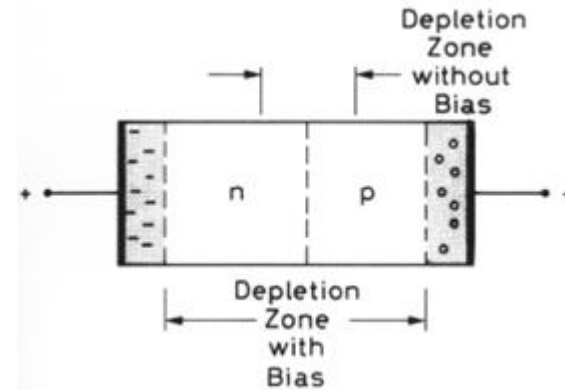
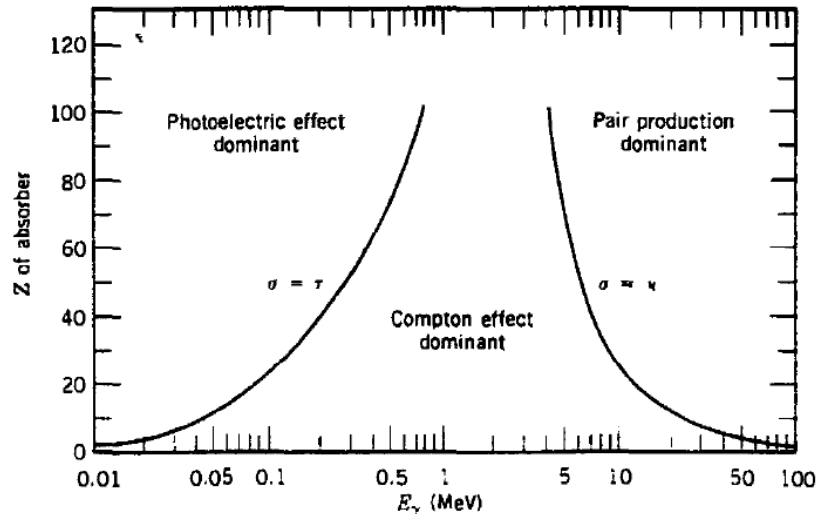


*TIGRESS*,  
*TRIUMF*,  
Vancouver,  
Canada

**48 crystals**  
**(12 clovers,**  
**8-fold**  
**segmented)**



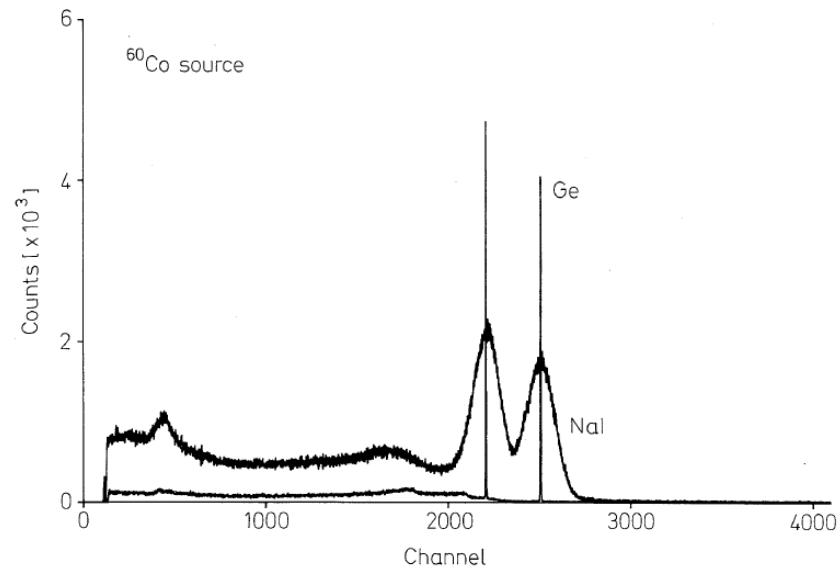
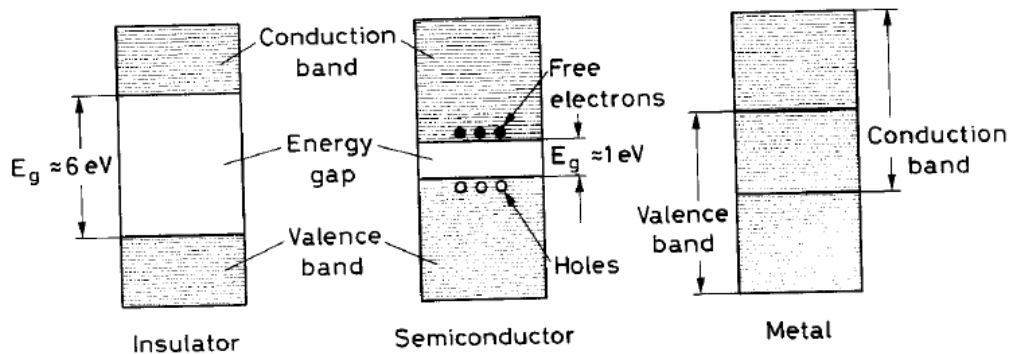
- An external field creates an area depleted of free charge carriers.
- Radiation interacts with the crystal and produces electron-hole pairs.
- The electrons and holes drift towards electrodes and the electric pulse is amplified and processed.



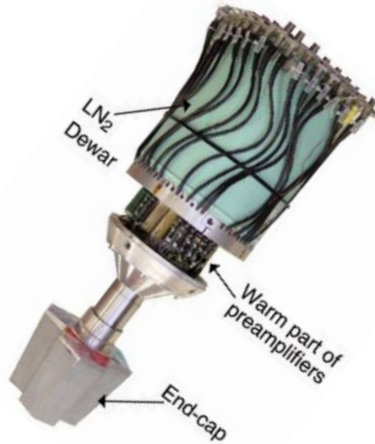
K.S. Krane, *Introductory Nuclear Physics* (1988).

G.F. Knoll, *Radiation Detection and Measurement* (1989).

W.R. Leo, *Techniques for Nuclear and Particle Physics Experiments* (1994).



Material Property	NaI(Tl)	Germanium	Silicon
Type	Scintillator	Semiconductor	Semiconductor
Cooling	No	~ 95 K	No
Density ( $\text{g/cm}^2$ )	3.7	5.3	2.3
Band gap energy (eV)	20	2.9	3.8
Energy resolution at 1332 keV (keV)	13	1.9	



$$\text{Absolute Efficiency } \epsilon_{\gamma} = \frac{\text{Number of } \gamma\text{-rays detected}}{\text{Number of } \gamma\text{-rays emitted}}$$

$$= \frac{N_{\gamma, \text{detected}}}{I_{\gamma} \cdot A \cdot t}$$

← Area of the photopeak  
 ← Data collection time  
 ← Activity of the source  
 ← Absolute intensity of the gamma ray

$$\epsilon_{\gamma}(E) = 10^{p_0 + p_1 \log(E) + p_2 \log^2(E) + p_3 / E^2}$$


 $z^A X$ 

Gamma( $\gamma$ )decay

$$\text{Relative Efficiency } \epsilon_{\gamma} = \frac{\frac{N_{\gamma 1, \text{detected}}}{I_{\gamma 1} \cdot A \cdot t}}{\frac{N_{\gamma 2, \text{detected}}}{I_{\gamma 2} \cdot A \cdot t}} = \frac{N_{\gamma 1, \text{detected}} / I_{\gamma 1}}{N_{\gamma 2, \text{detected}} / I_{\gamma 2}}$$

- Lund/LBNL Nuclear Data Search: <http://nucleardata.nuclear.lu.se/toi/>
- National Nuclear Data Center: <https://www.nndc.bnl.gov/>

## The Lund/LBNL Nuclear Data Search

Version 2.0, February 1999

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<sup>2</sup> Department of Physics, Lund University, Sweden



### WWW Table of Radioactive Isotopes

[Radiation search](#)

[Nuclide search](#)

[Atomic data](#) (X-rays and Auger electrons, very preliminary!)

[Periodic chart interface to the nuclides](#)

[Summary drawings for A=1-277](#) (PDF)

[Nuclear charts](#) (PDF, 333 kbyte)

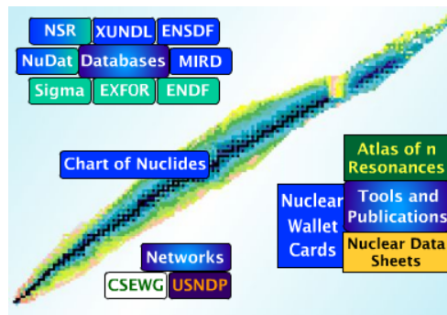
[Database status](#)



### Table of Isotopes (ToI)

[About this service](#)

[ToI home page](#)



Tweets by @NNDC\_BNL

**National Nuclear Data Center**

@NNDC\_BNL

Meet the NNDC:

Boris Pritychenko is a experienced nuclear experimentalist and data compiler. He currently manages the EXFOR and NSR databases, and is also the Editor-in-Chief of Atomic Data and Nuclear Data Tables.

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**Main** | [Structure & Decay](#) | [Reactions](#) | [Bibliography](#) | [Networks & Links](#) | [Publications](#)

**AMDC** Atomic Mass Data Center, *Q-value Calculator*

**Covariances** of Neutron Reactions

**ENSDF** Evaluated Nuclear Structure Data File

**NSR** Nuclear Science References

**NuDat** Nuclear structure & decay Data

**Atlas of Neutron Resonances** Parameters & thermal values

**CSEWG** Cross Section Evaluation Working Group

**IRDF** IRDF International Reactor Dosimetry and Fusion File

**Nuclear Data Sheets** Nuclear structure & decay data journal, *Special Issues* on reaction data

**USNDP** U.S. Nuclear Data Program

**CapGam** Thermal Neutron Capture  $\gamma$ -rays

**EXFOR** Nuclear reaction experimental data

**MIRD** Medical Internal Radiation Dose

**Nuclear Wallet Cards** Ground & isomeric states properties,

**USNDP/CSEWG GForge** Collaboration Server

**Chart of Nuclides** Basic properties of atomic nuclei

**ENDF** Evaluated Nuclear (reaction) Data File, *Sigma*

**NDWG** Nuclear Data Working Group

**NucRates** MACS & Astrophysical reaction rates

**XUNDL** Experimental Un-evaluated Nuclear Data List

- Installation instructions at <https://github.com/UWCNuclear/UbuntuSetUp>
- Open the file with “ grsisort -l Eu152\_**ARRAYNAME**.root ”
- See the list of histograms in the file with “.ls”
- Draw histogram with “ gammaSingles->Draw() ”
- Display rough peak energies by pressing “s”
- Click and drag on x-axis to zoom in, zoom out by pressing “o”
- Click and drag on y-axis to zoom in, right click and click “UnZoom” to zoom out
- Click and click on spectrum to set the fitting boundaries around your peak
- Fit by pressing “f”
- Remove all markers by pressing “n”
- “.q” to quit
- Save screenshots of your fitted peaks and the number of counts (Sum) in your peaks.
- More tools at <https://github.com/GRIFFINCollaboration/GRSISort/wiki/Interactive-Analysis>



- Download with “ git clone <https://github.com/UWCNuclear/RootEffi.git> ”
- Download the data files with “ git clone <https://github.com/UWCNuclear/PeakFitting.git> ”
- In gedit, edit RootEffi.C with the peak areas and uncertainties obtained from your data file.
- Whenever you edit a script, you should save it and close ROOT/GRSISort to run it again.
- To run RootEffi, type in the command line “ grsisort -l RootEffi.C ”  
or “ grsisort -l ” and then “ .x RootEffi.C ”
- Save your edited script and your new efficiency curve
- In one file, submit your fitted peaks, your edited RootEffi script, and your efficiency curve 😊