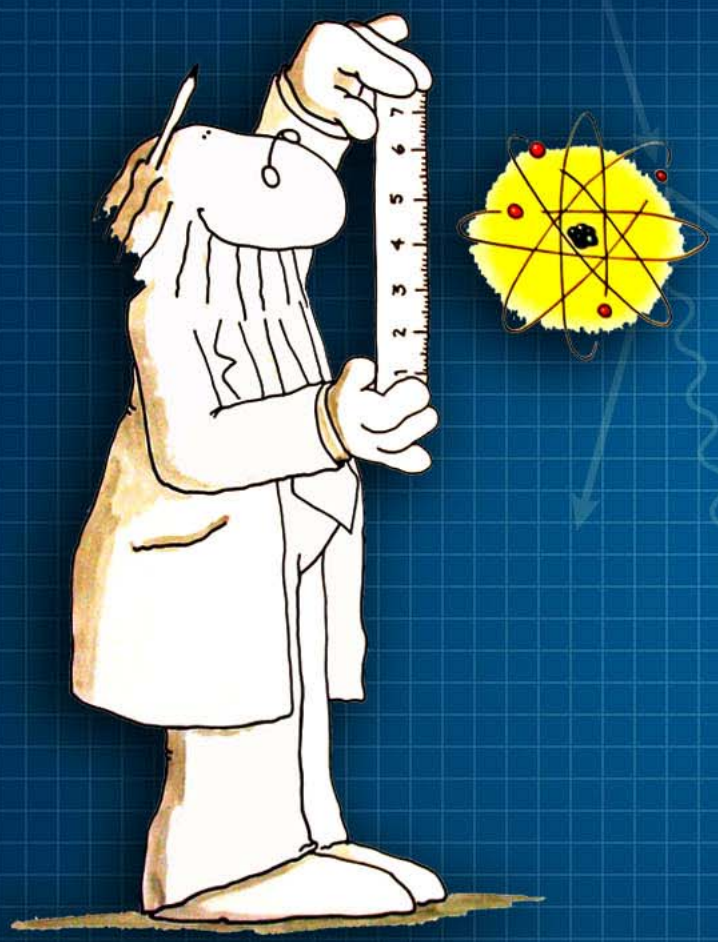
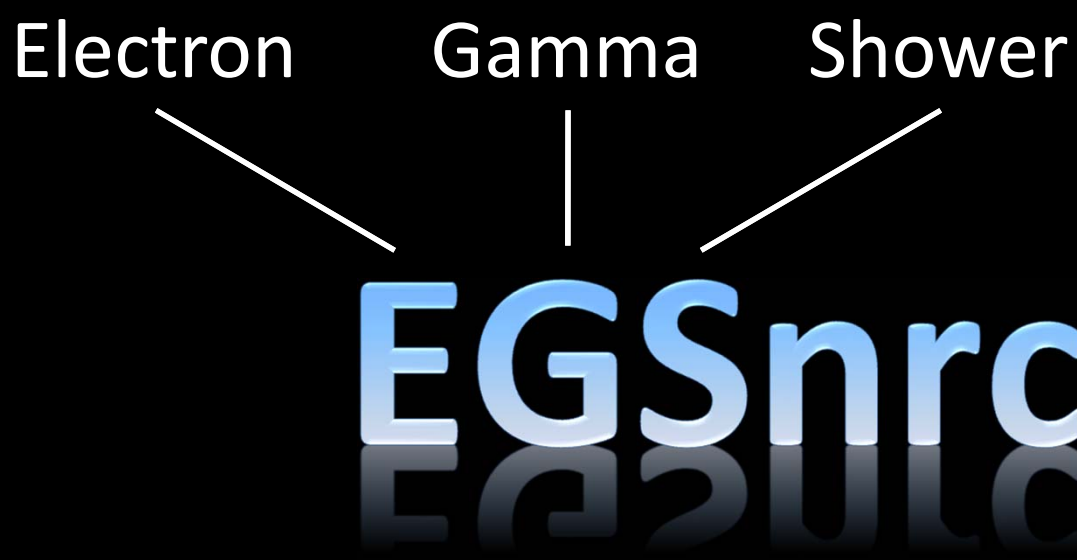


Proposed ICRM GS WG action on MC codes for HPGe detectors - EGSnrc

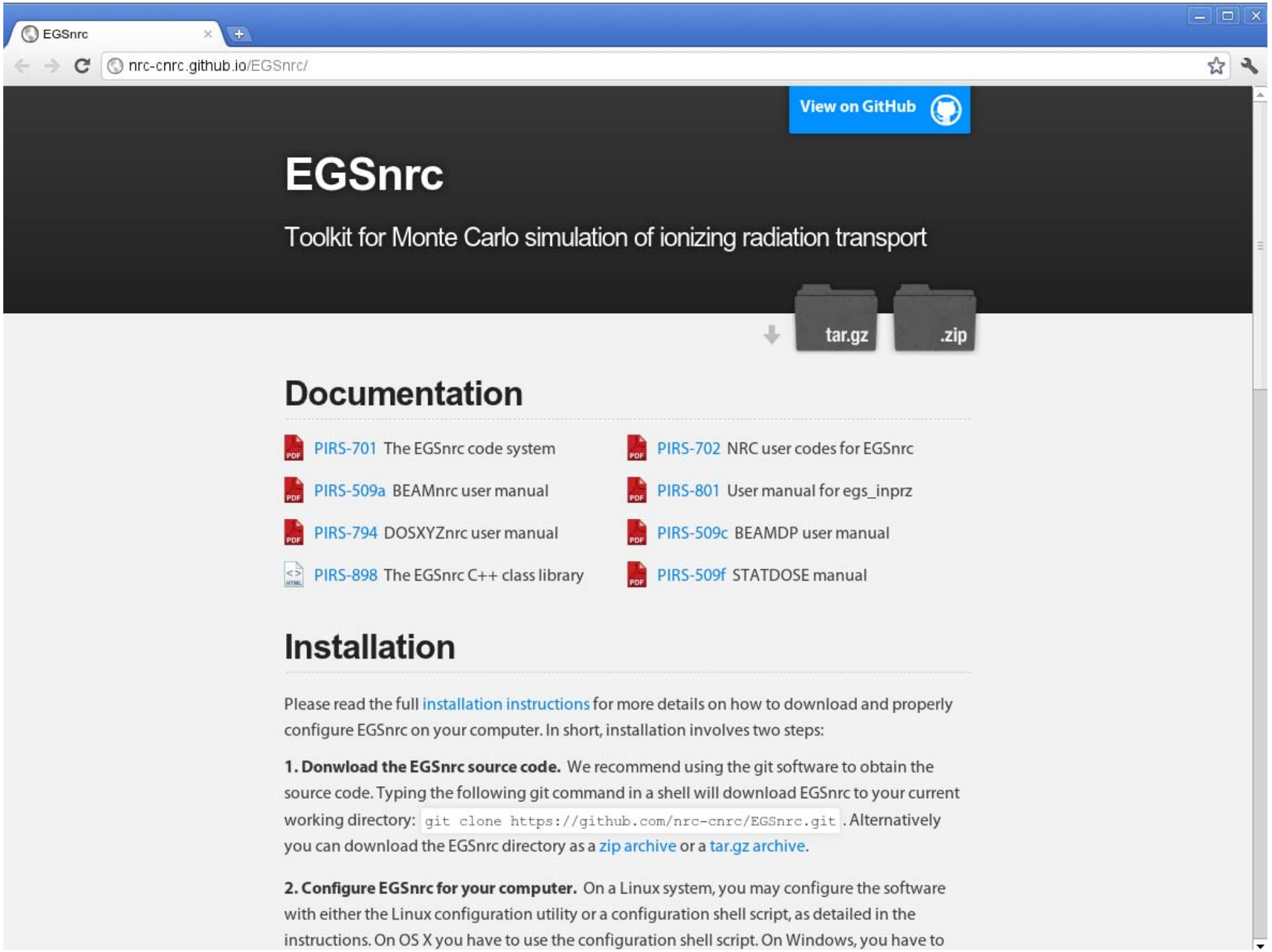
Raphael Galea and Reid Townson

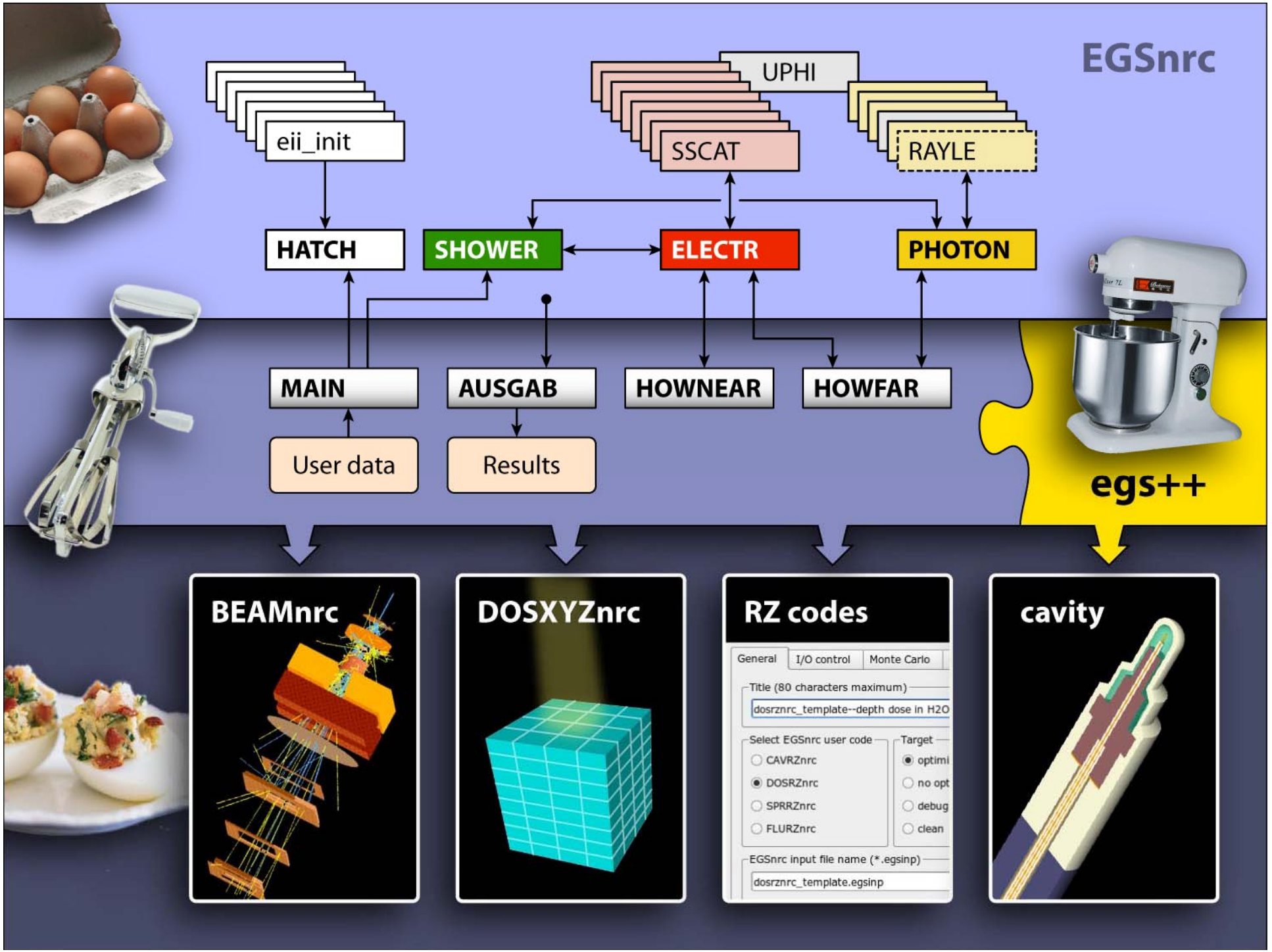
Ionizing Radiation Standards
National Research Council of Canada

June 14, 2018, LNE, Paris, France

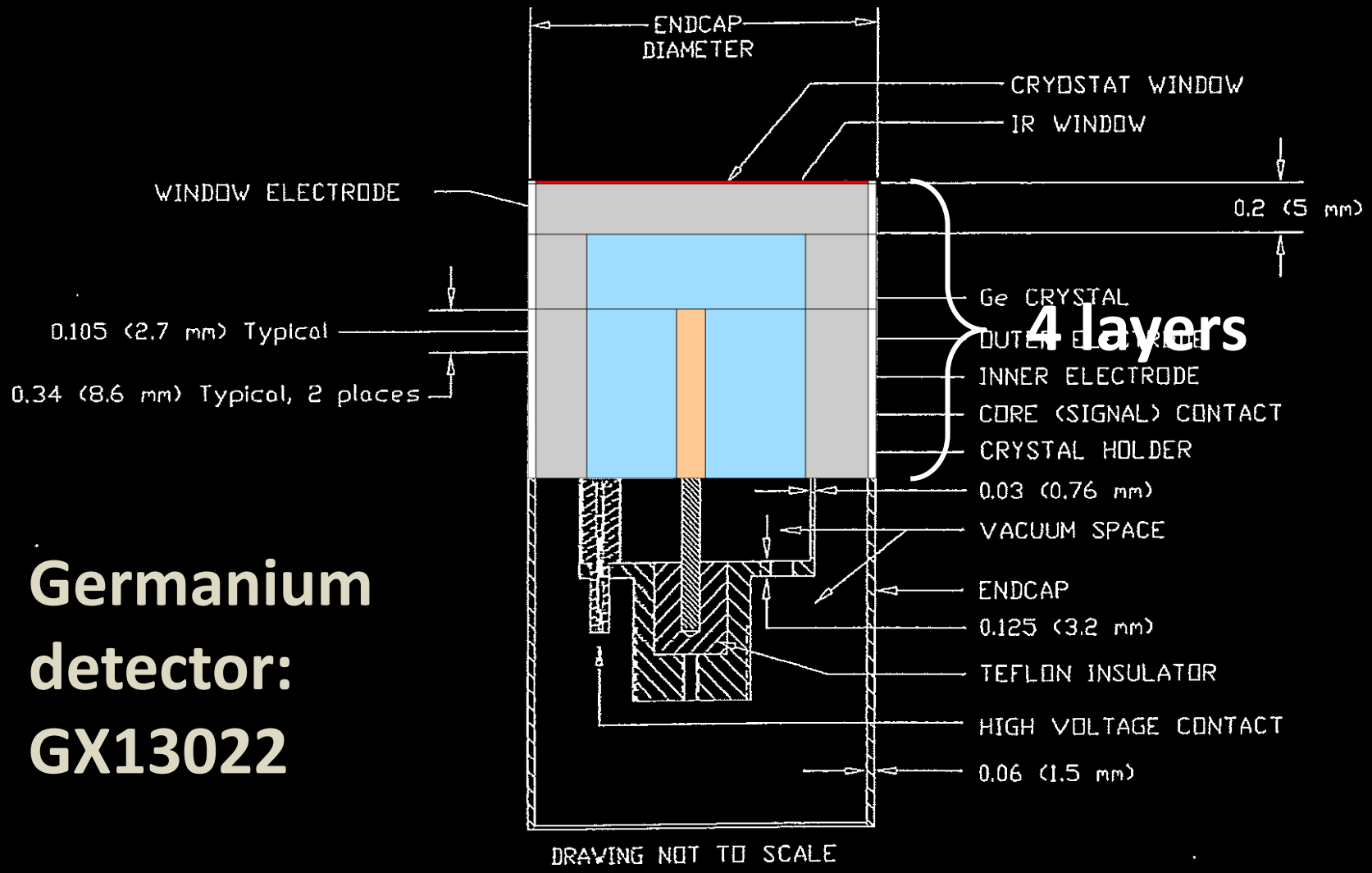


- ✓ **General purpose code:** energies from 1 keV to 10 GeV
- ✓ **Most efficient:** released in 2000 as the new EGS4 version
- ✓ **Most accurate physics:** nominal accuracy at 0.1% level
- ✓ ***Gold standard*** for electron-photon transport


EGSnrc
nrc-cnrc.github.io/EGSnrc/
View on GitHub
EGSnrc
Toolkit for Monte Carlo simulation of ionizing radiation transport
tar.gz
.zip
Documentation
PIRS-701 The EGSnrc code system
PIRS-702 NRC user codes for EGSnrc
PIRS-509a BEAMnrc user manual
PIRS-801 User manual for egs_inprz
PIRS-794 DOSXYZnrc user manual
PIRS-509c BEAMDP user manual
PIRS-898 The EGSnrc C++ class library
PIRS-509f STATDOSE manual
Installation
Please read the full installation instructions for more details on how to download and properly configure EGSnrc on your computer. In short, installation involves two steps:
1. Donwload the EGSnrc source code. We recommend using the git software to obtain the source code. Typing the following git command in a shell will download EGSnrc to your current working directory: git clone https://github.com/nrc-cnrc/EGSnrc.git . Alternatively you can download the EGSnrc directory as a zip archive or a tar.gz archive.
2. Configure EGSnrc for your computer. On a Linux system, you may configure the software with either the Linux configuration utility or a configuration shell script, as detailed in the instructions. On OS X you have to use the configuration shell script. On Windows, you have to


EGSnrc
eii_init
UPHI
SSCAT
RAYLE
HATCH
SHOWER
ELECTR
PHOTON
MAIN
AUSGAB
HOWNEAR
HOWFAR
User data
Results
egs++
BEAMnrc
DOSXYZnrc
RZ codes
General
I/O control
Monte Carlo
Title (80 characters maximum)
dosrznrc_template--depth dose in H2O
Select EGSnrc user code
CAVRZnrc
DOSRZnrc
SPRRZnrc
FLURZnrc
Target
optimi
no opt
debug
clean
EGSnrc input file name (*.egsinp)
dosrznrc_template.egsinp
cavity

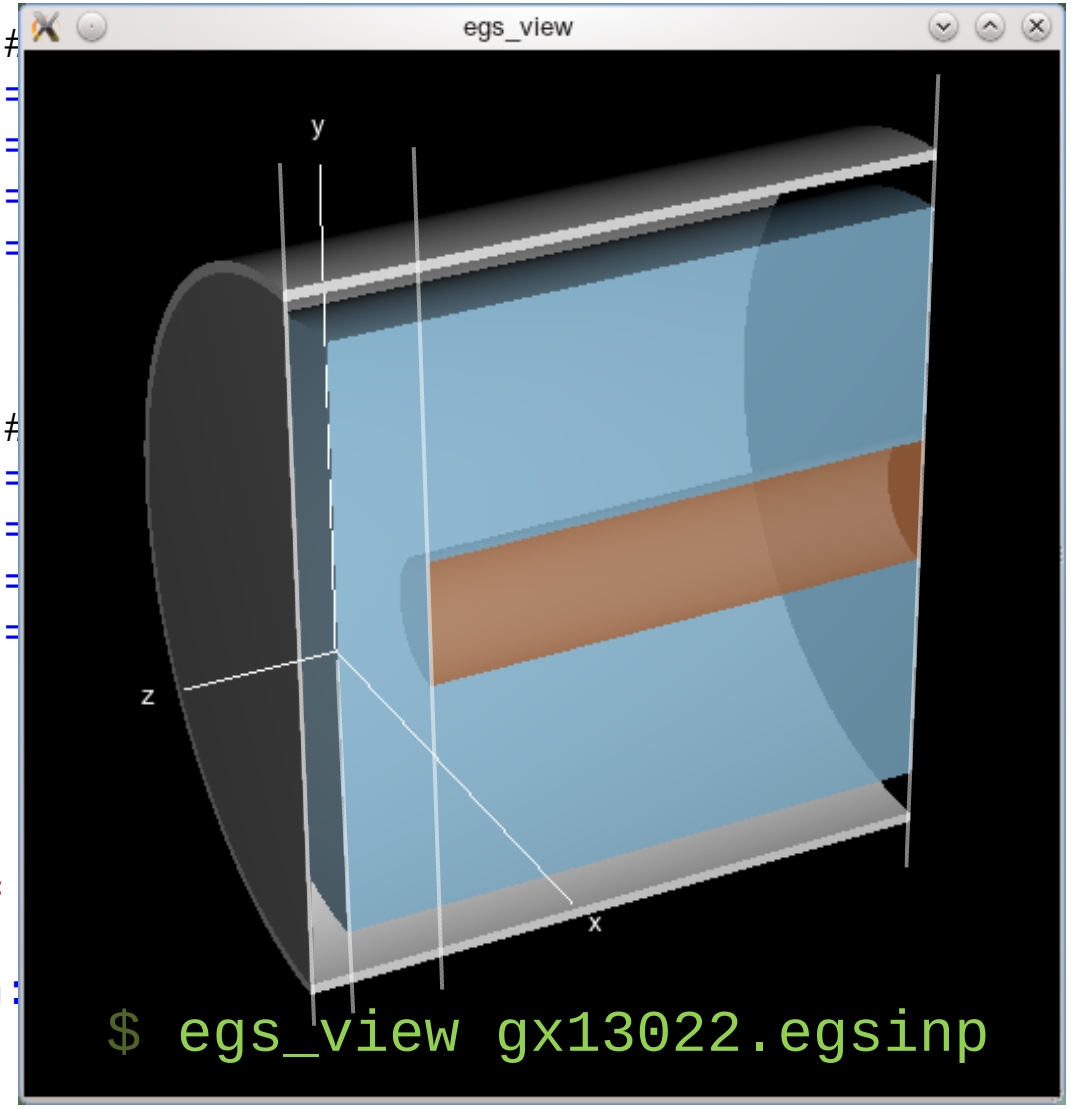
Drive egs++ apps with an *.egsinp file



Germanium detector: GX13022

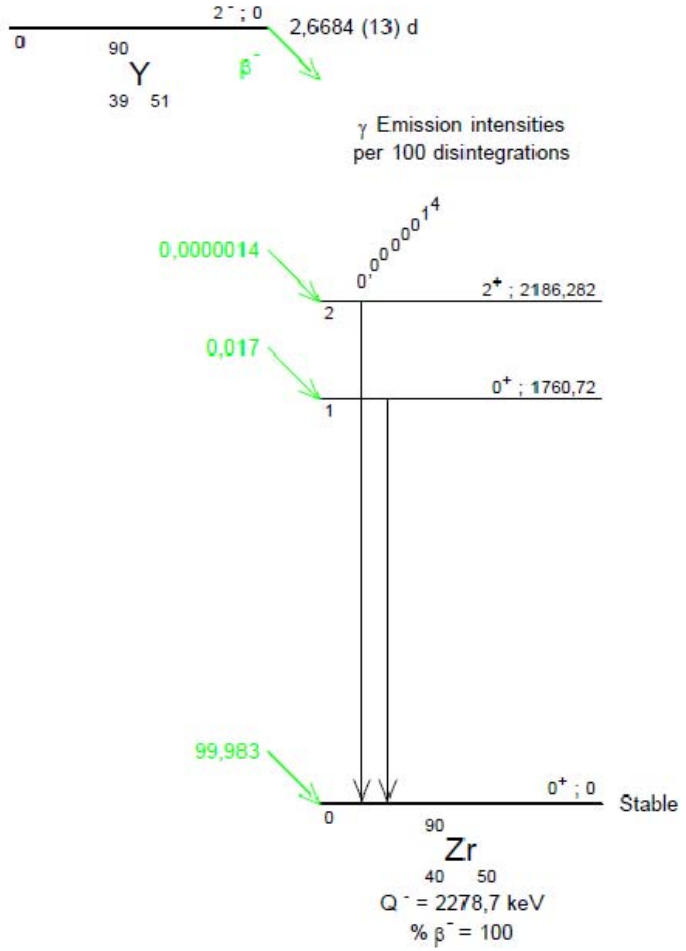
1. Define the egs++ geometry

```
        :start layer:     #
            thickness     =
            top radii     =
            bottom radii  =
            media         =
        :stop layer:


        :start layer:     #
            thickness     =
            top radii     =
            bottom radii  =
            media         =
        :stop layer:

    :stop geometry:

    simulation geometry =

:stop geometry definition:
```



EGS_RadionuclideSource

- A new source of particles, following the decay scheme of a radionuclide.
- EGS_RadionuclideSource extends EGS_BaseSource, and allows for the correlated emissions of photons, electrons and positrons.



Nuclear data from LNHB: http://www.nucleide.org/DDEP_WG/DDEPdata.htm

2. Define the source geometry

```
:start source:

        name            = my_mixture
        library         = egs_radionuclide_source
        activity        = total activity of mixture, assumed constant

        ... optional arguments ...

        :start shape:
                definition of the source shape
        :stop shape:

        :start spectrum:
                Next slide...
        :stop spectrum:

:stop source:
```

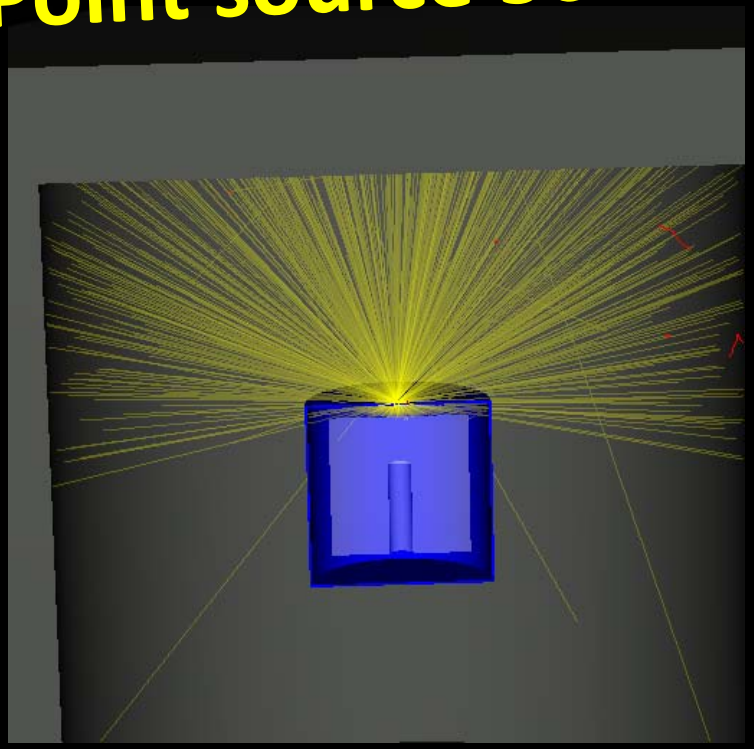
2. Define the source geometry

```
:start source:
        ... (previous) ...
        :start spectrum:
                type            = radionuclide
                nuclide         = name of the nuclide (e.g. Sr-90)

                relative activity = [optional] the relative activity
                        (sampling probability) for this nuclide in a
                        mixture
        :stop spectrum:

        :start spectrum:

                type                    = radionuclide
                nuclide                 = next nuclide (e.g. Y-90)
                relative activity       = ...

        :stop spectrum:
:stop source:
```

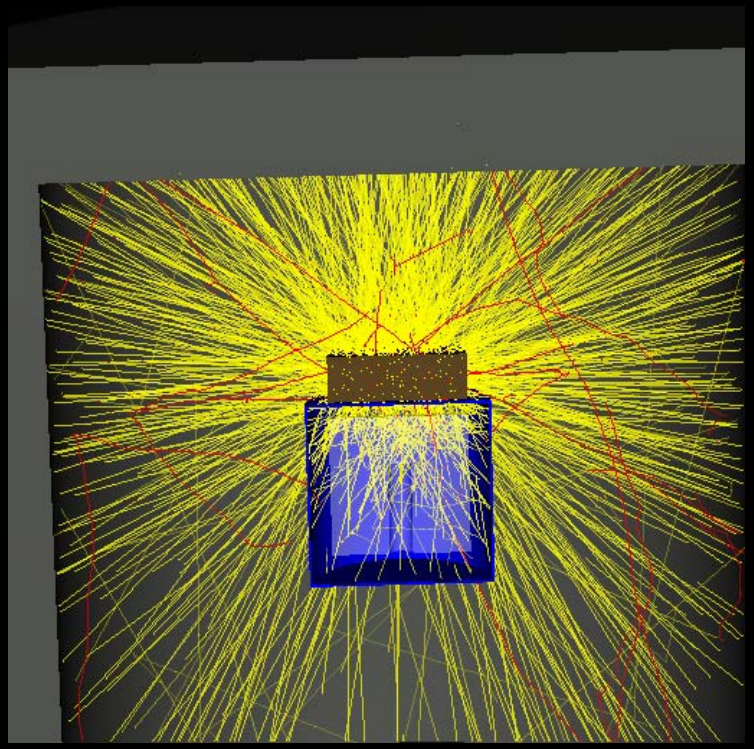
Prepared to submit input files

- 2 detectors.
- 4 source types.

Point source 50 keV

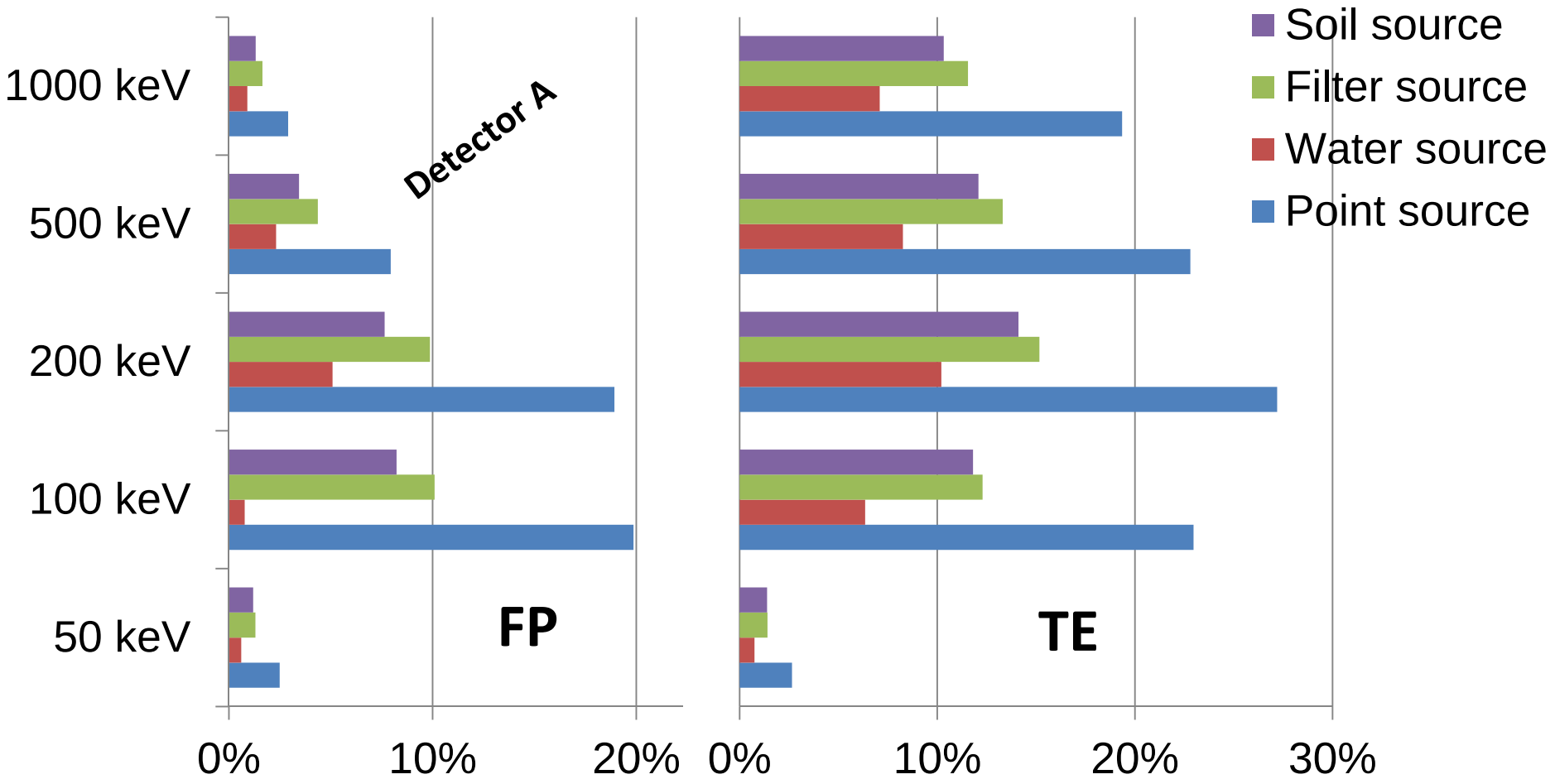


Soil source 1000 keV

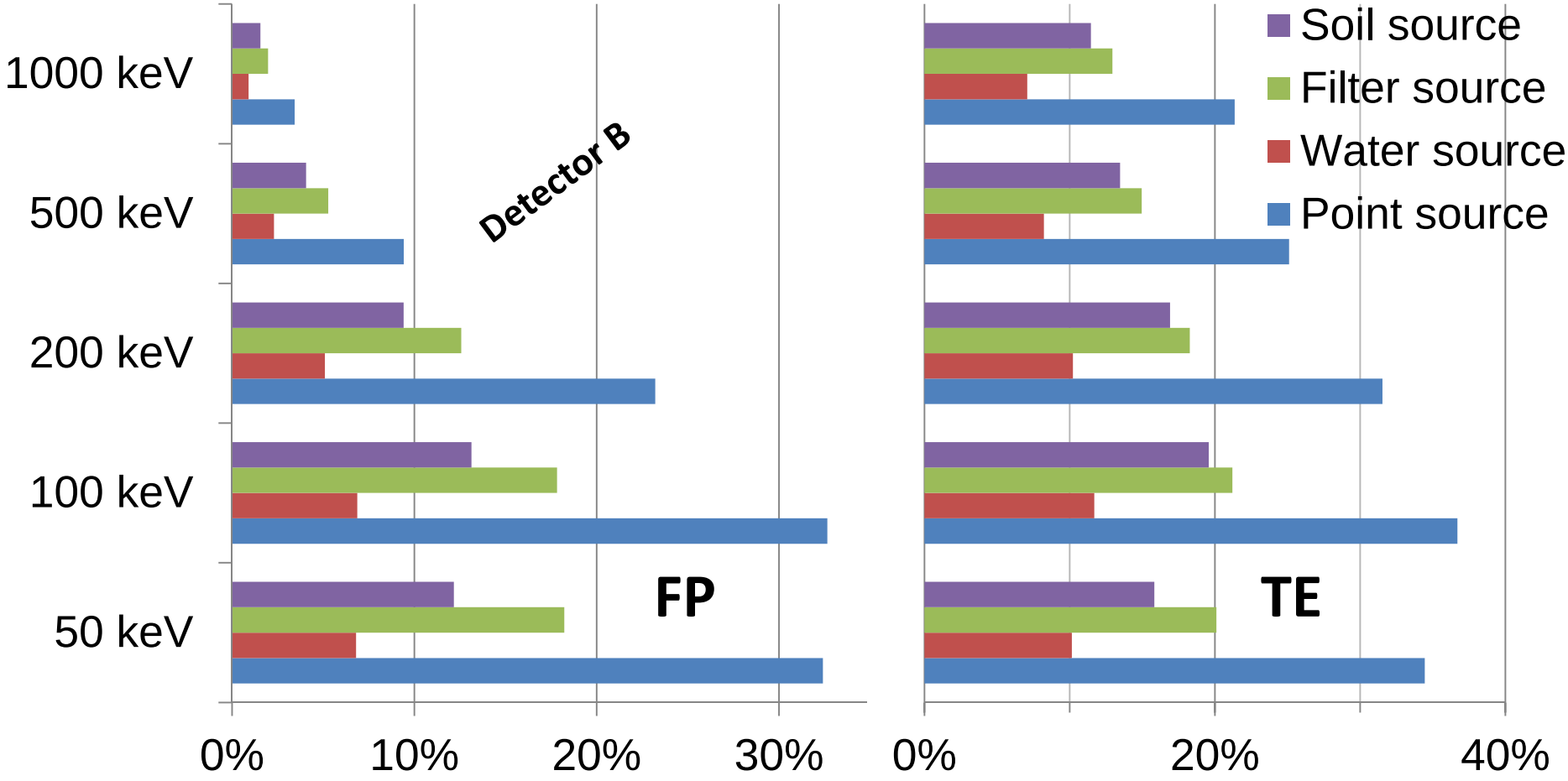


- Use an experimental resolution function to evaluate Full Peak (FP) & Total Efficiencies (TE)

Use an experimental resolution function to evaluate Full Peak (FP) & Total Efficiencies (TE)



Use an experimental resolution function to evaluate Full Peak (FP) & Total Efficiencies (TE)



Conclusions

- EGSnrc is ideally suited to the coding of MC models of HPGe detectors for γ-spectroscopy.
- NRC(Reid) has prepared input files for 2 detector configurations and 4 source types as requested.

Acknowledgements:

Reid Townson for the modeling

Frédéric Tessier for introductory slides

JP Archambault for efficiency calculation code