Sensitivity studies with NuGrid tools

Christian Ritter, Kathrin Göbel (Goethe University Frankfurt, Germany)

TRIUMF, Canada
10/12/15

Outline

- Nuclear sensitivity
- NUSENSI
- Tutorial

Nuclear sensitivity

- Sensitivity: How sensitivity is the change of rates on my final abundance
  - Which are the strongest affected isotope by a rate?
  - What are the key rates influencing the abundance of isotope?
- Sensitivity factor:

  Species i, rate j

$$S_{i,j} = \frac{\Delta X_i / X_i}{\Delta r_j / r_j}$$

Nuclear sensitivity

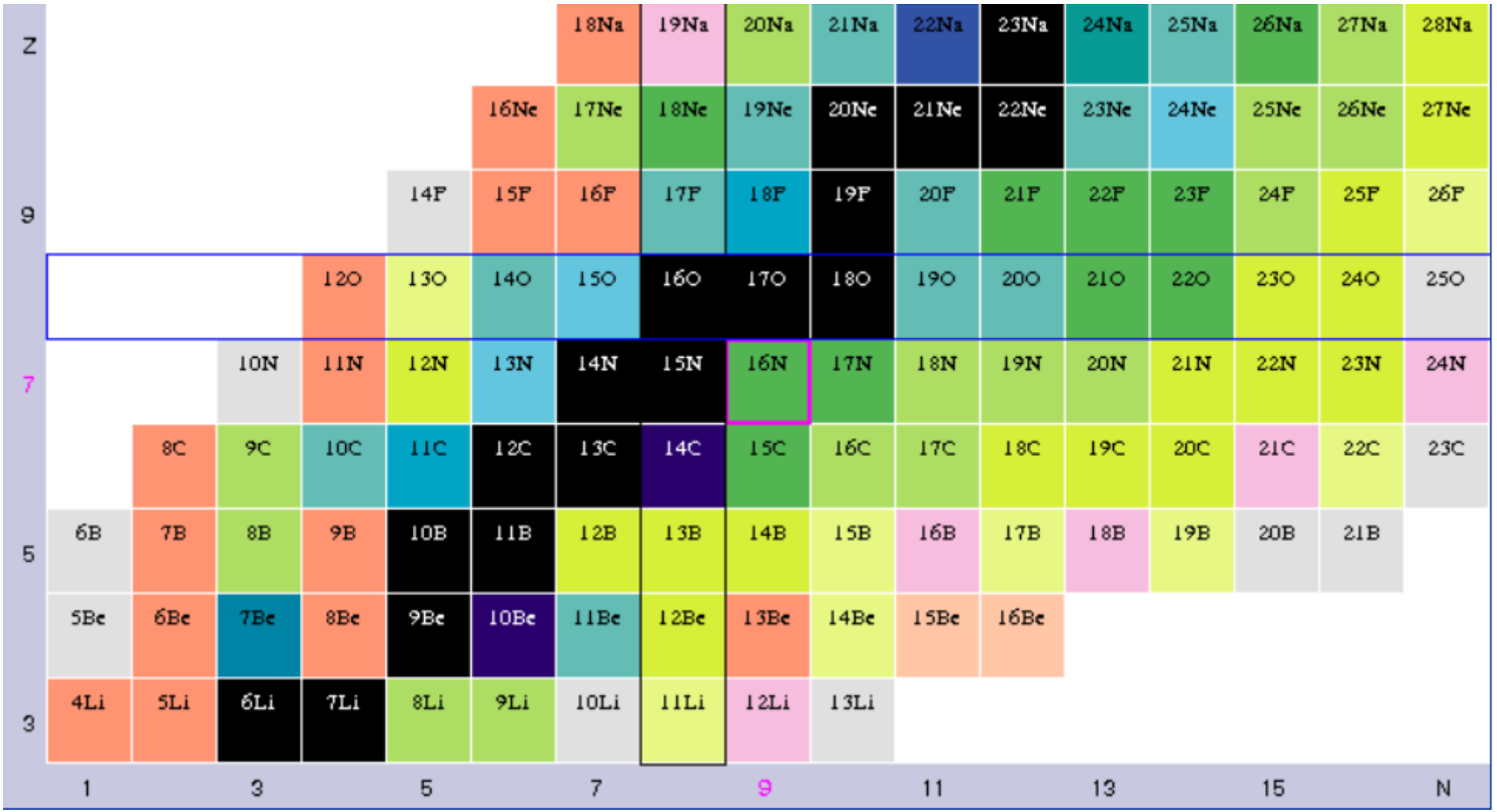
$$S_{i,j} = \frac{\Delta X_i / X_i}{\Delta r_j / r_j} = \frac{\Delta X_i / X_i}{f - 1}$$

$$r_j^1 = f * r_j^0$$

In networksetup.txt

- Local and global sensitivities
- Possible pot-holes:
  - Total abundance not reflected in factors (abundance could be neglible)
  - Decayed abundance important for comparison with observations

Sensitivity study of network



http://www.nndc.bnl.gov/chart/

Very recently accepted in ADNDT

Sensitivity study for s process nucleosynthesis in AGB stars

A. Koloczek[a,b,e], B. Thomas[a,e], J. Glorius[a,b], R. Plag[a,b], M. Pignatari[c,e], R. Reifarth[a,e], C. Ritter[a,d,e], S. Schmidt[a], K. Sonnabend[a]

[a] *Goethe Universität, Frankfurt a.M., 60438, Germany*
[b] *GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, 64291, Germany*
[c] *Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland*
[d] *University of Victoria, FP.O. Bos 3055, Victoria, B.C., V8W 3P6, Canada*
[e] *NuGrid collaboration, http://www.nugridstars.org*

Resutls available in web interface

http://exp-astro.physik.uni-frankfurt.de/sensitivities/

With NuGrid C13 example

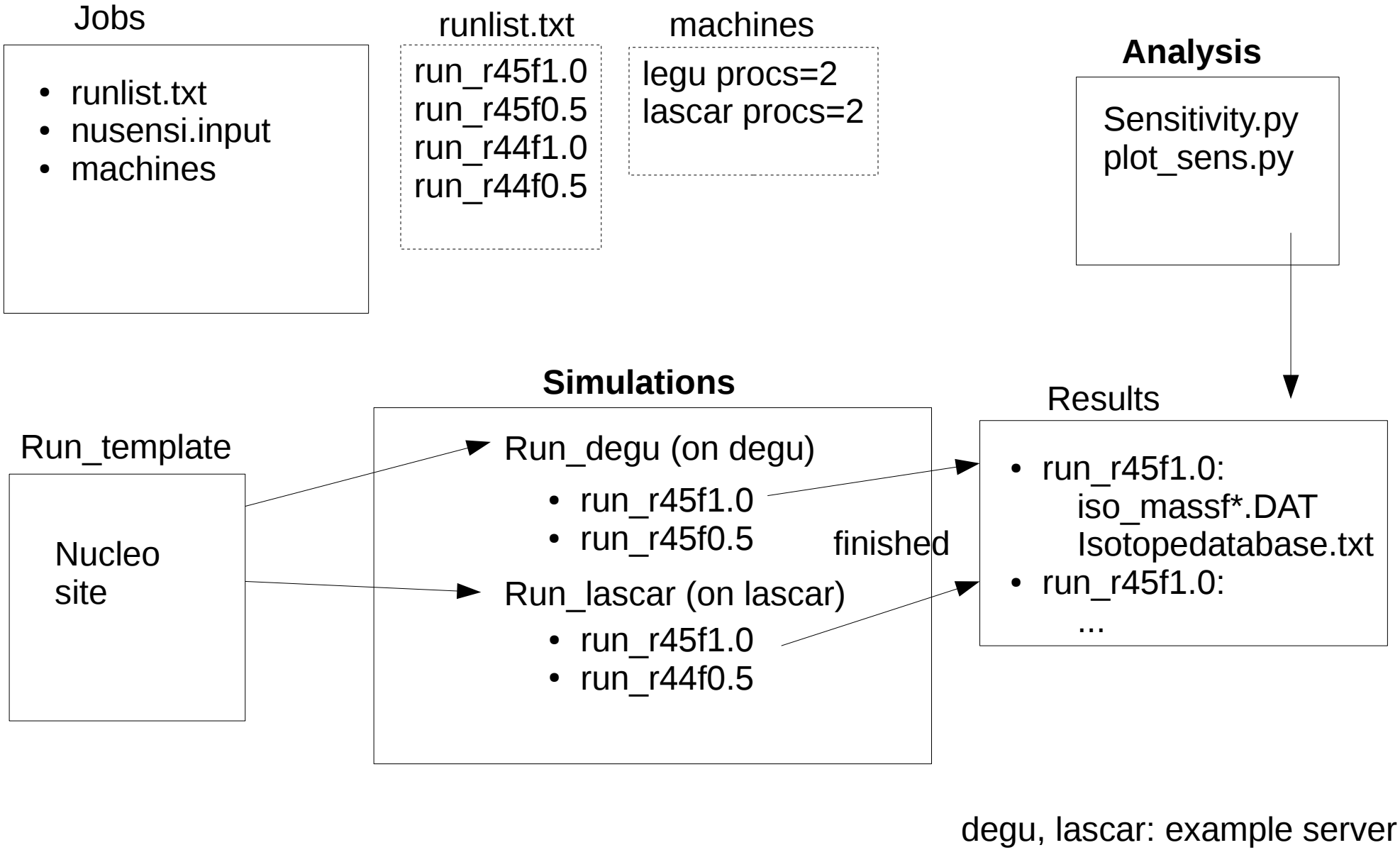
Why NUSENSI?

- Multiple calculations of the same nuclear site needed
  - NuGrid's 1-zone code with recently speed increase of factor ~8 (Sam Jones)
- Different nucleosynthesis sites provided by NuGrid (OzoNE), for example:
  - C13 pocket in AGB star
  - I process
  - Nova
  - Weak s process in massive star

svn://forum.astro.keele.ac.uk/examples

- Distributes PPN calculations over multiple server (1 run – 1 proc)
- Interactive sensitivity analysis suite (python)

Code structure and functional flow



degu, lascar: example server

NUSENSI

Analysis

- Simple python scripts
- Sensitivity matrix

Abunance of default run

reactions

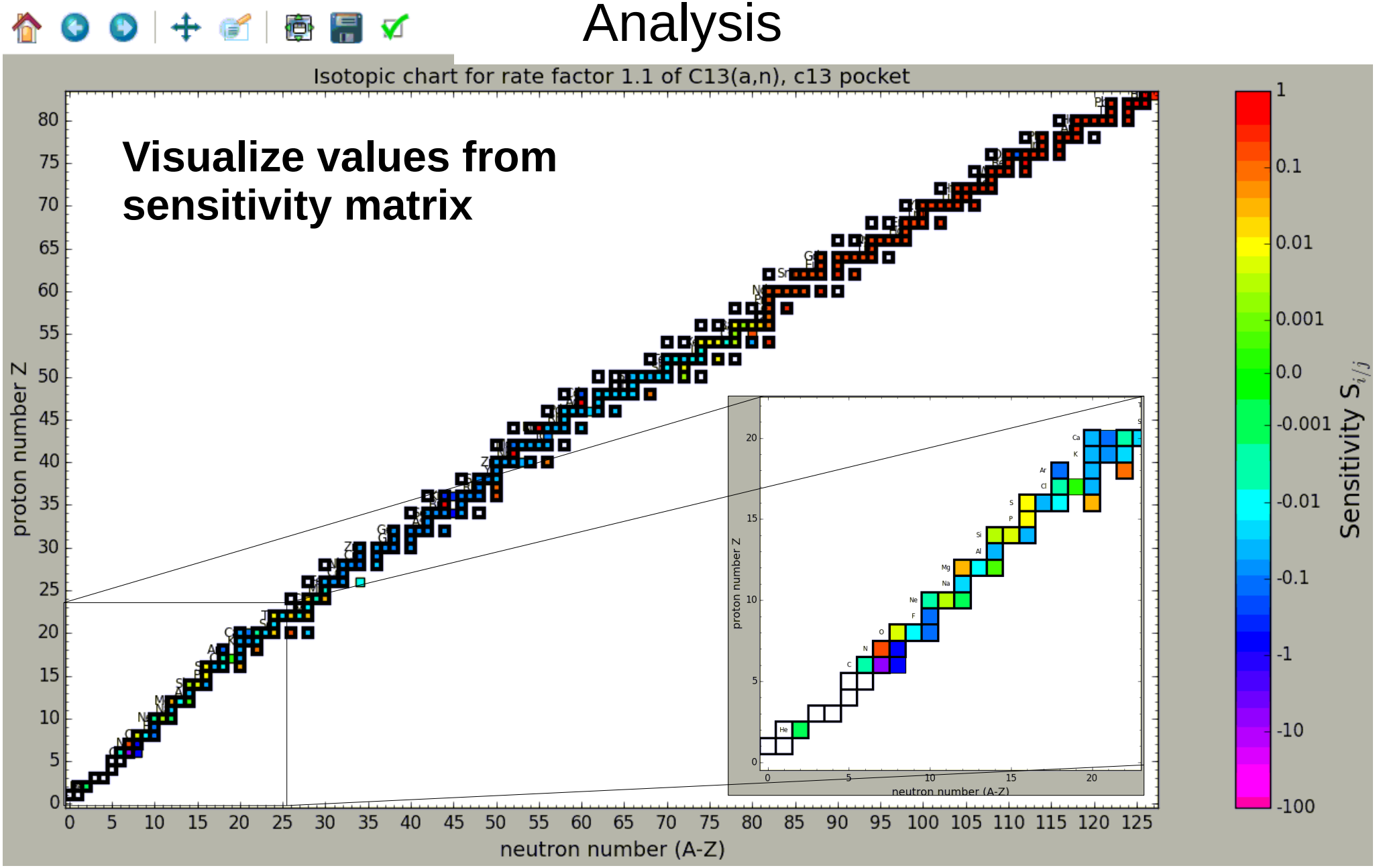
- Instantanious decay
- Error calculation

Isotopes

Isotope	Abu	C 13(a,n)
N-1	6.904E-27	0.000E+00
H-1	1.027E-19	0.000E+00
H-2	2.966E-19	0.000E+00
He-3	1.000E-99	0.000E+00
He-4	4.039E-01	-1.015E-03
Be-7	1.399E-25	0.000E+00
B-8	1.000E-99	0.000E+00
Li-7	1.478E-19	0.000E+00
C-11	3.792E-20	0.000E+00
B-11	2.856E-09	0.000E+00
C-12	2.909E-01	-5.465E-03
C-13	7.868E-09	-7.217E+00

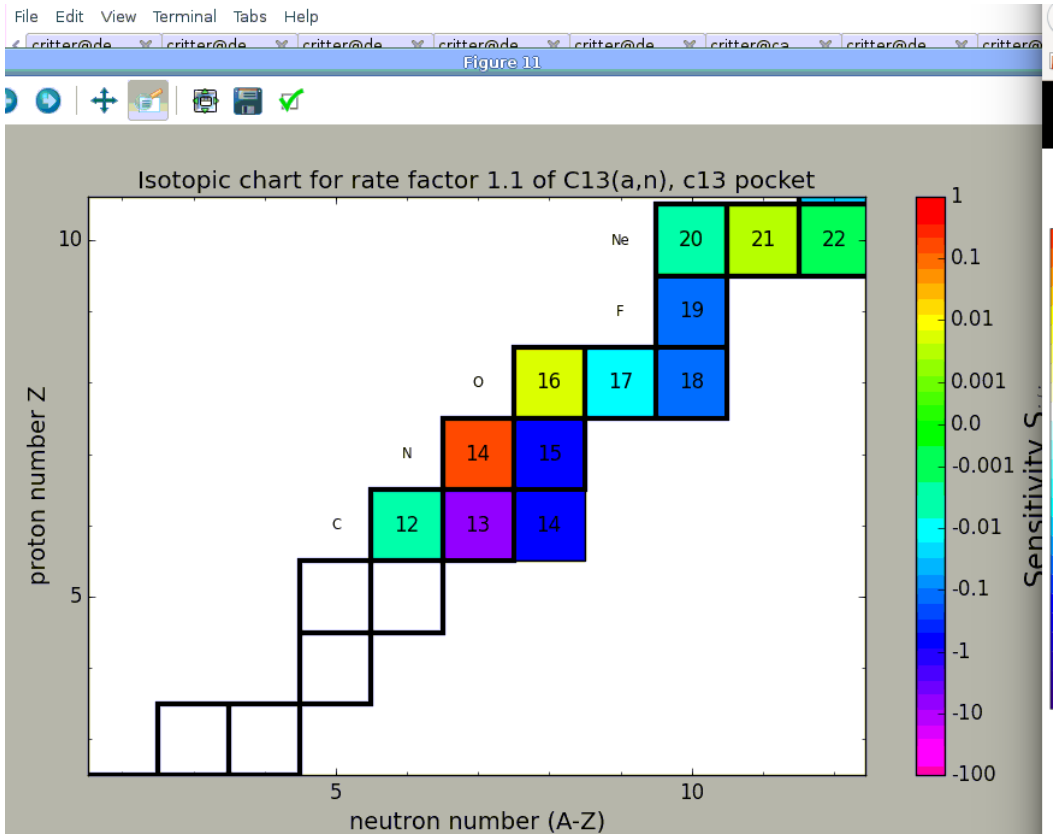
NUSENSI

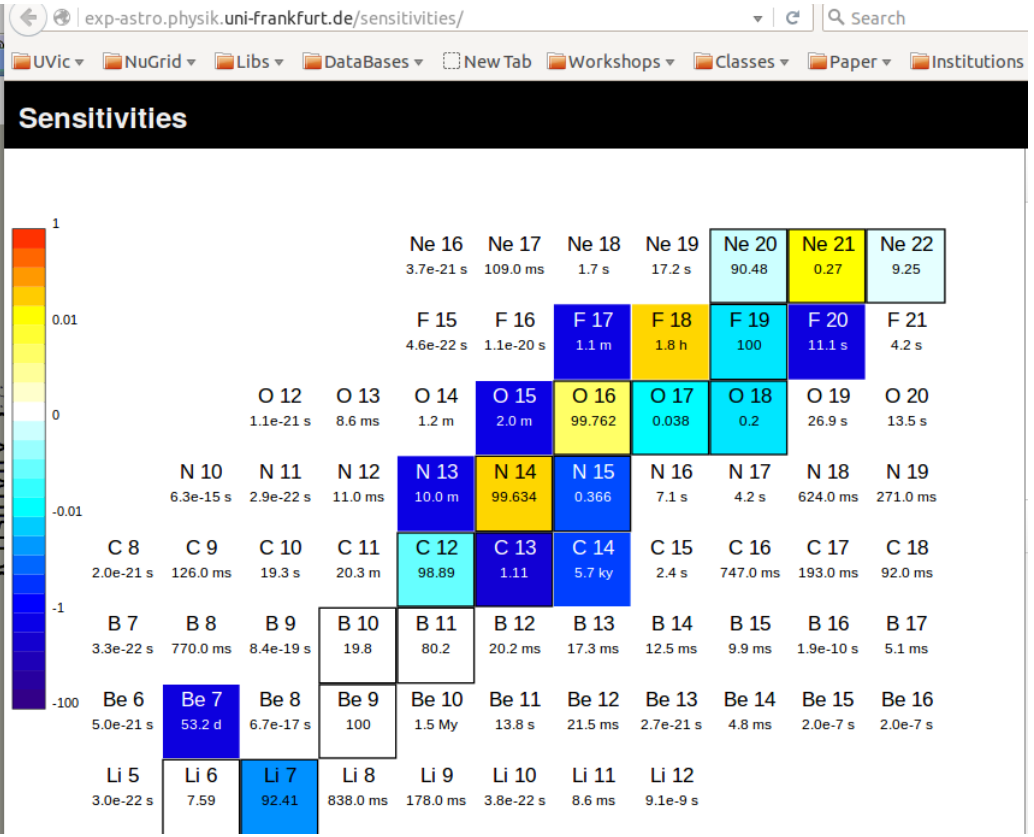
Analysis



Verification: C13-pocket trajectory

Web interface (Ralf Plag, René Reifarth, Kathrin Göbel)





Documentation

- Tutorial
- README files

Tutorial

Sources

- PhD Thesis Koloczek, 2015, http://exp-astro.physik.uni-frankfurt.de/docs/koloczek_15_phd.pdf
- http://exp-astro.physik.uni-frankfurt.de/docs/goebel_nugrid_2015.pdf