

# Reaktorfysik med Python

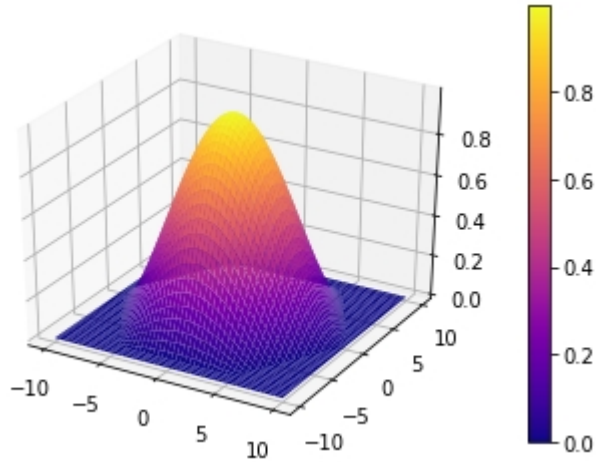
Datalab summary

# Basic format

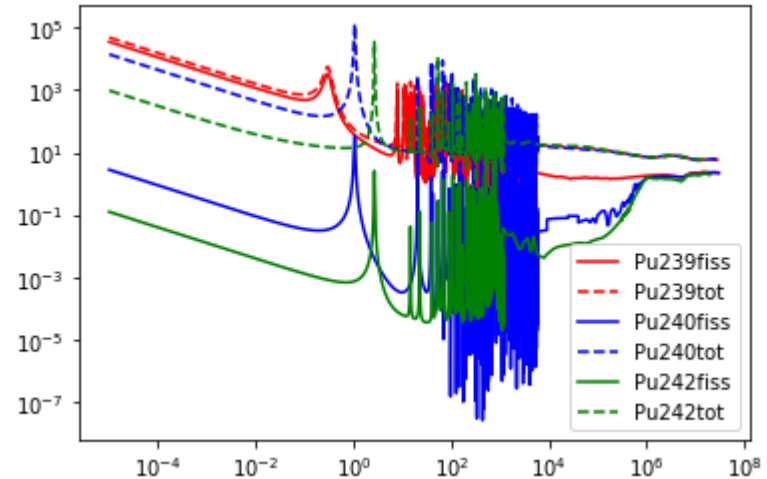
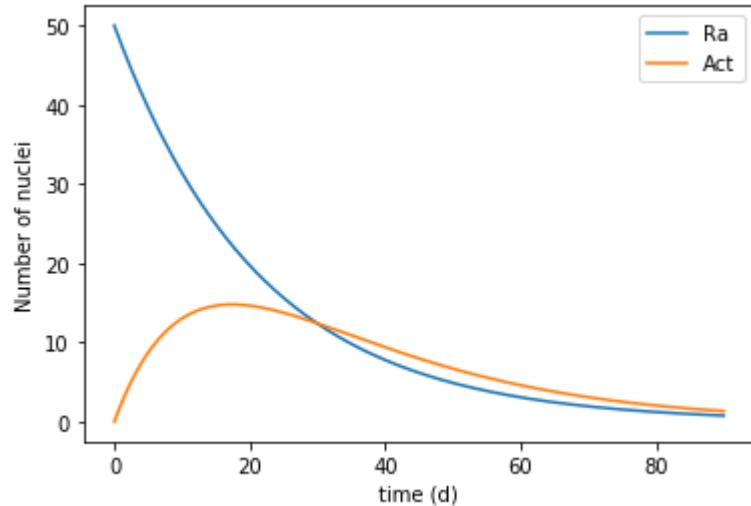
- 1 or 2 prepared notebooks + supplement files
- Lot of text
- Code skeletons
- Exercises/Experiments
- It is possible to perform them outside of class (MOOC?)
- Virtual Ubuntu with preinstalled software (yes, we were not brave enough to go with Docker)

- 1: Intro python (dict, list, for, while, if, else, I/O)
  - 2: Intermediate python I (numpy, matplotlib, scipy, regexp)
  - 3: Intermediate python II (Class, JSON, xml, csv, pandas) HA1
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- 4: Scattering and Monte Carlo intro (pdf sampling)
  - 5: Fission chains (fission trees, criticality calculations) + simple Fixed source MC code
  - 6: openMC intro: PWR pincell (k-inf, spectrum, spatial flux)
  - 7: Numerical diffusion (Absorbing slab, Multiplying slab, power method), Group constant generation HA2
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- 8: Point kinetics, 1&6 delayed groups, inhour plot
  - 9: Subcritical methods (Rossi-alpha, Sjöstrand-method, 1/M)
  - 10: Scripting openMC (criticality search, void coefficient vs mod/fuel)
  - 11: Depletion with openMC (PWR and Magnox) HA3
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# Datalab 1-3



Function definitions  
Reading data  
Plotting  
Solving simple ODE



# Datalab 4-5

Understanding isotropy in CoM

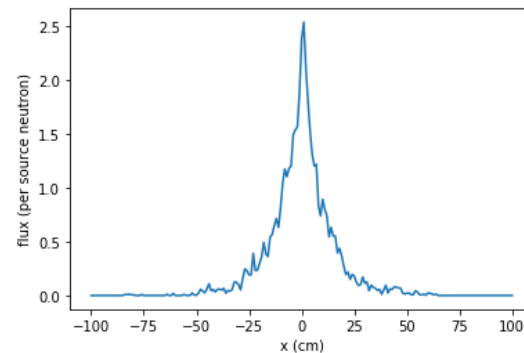
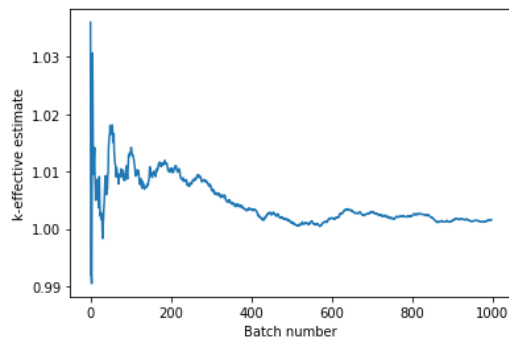
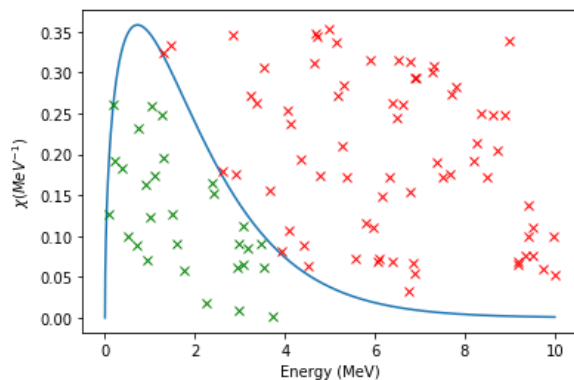
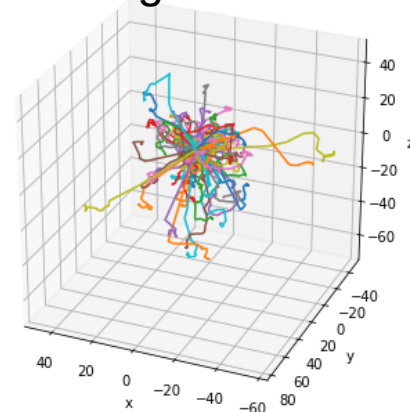
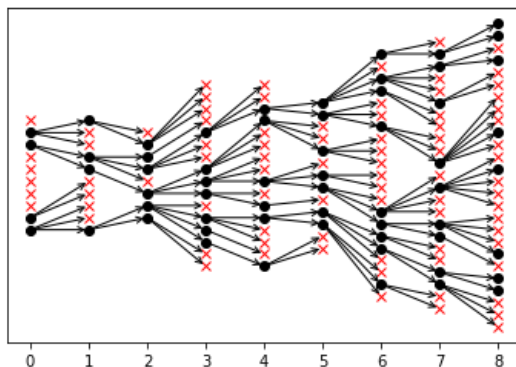
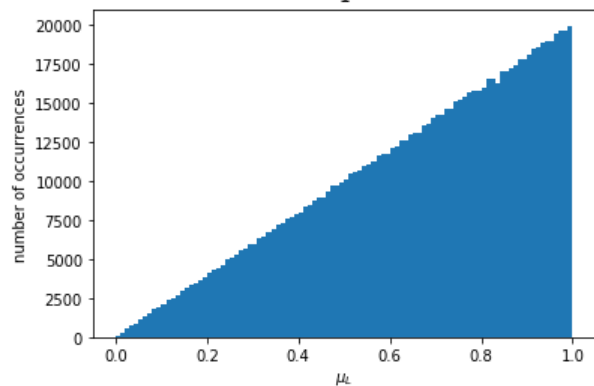
Sampling probability density functions

play with criticality

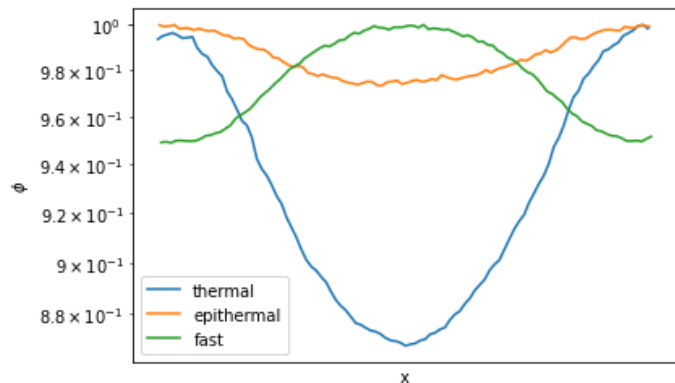
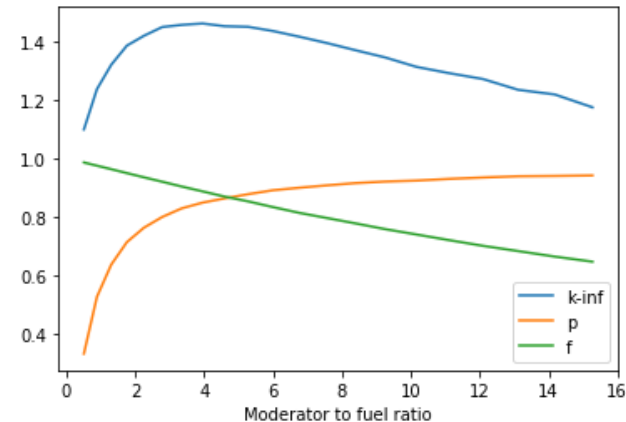
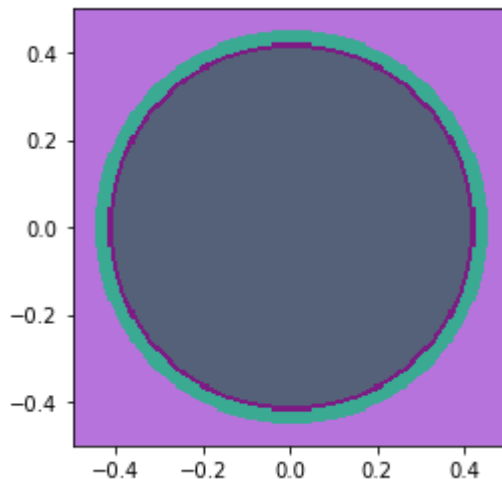
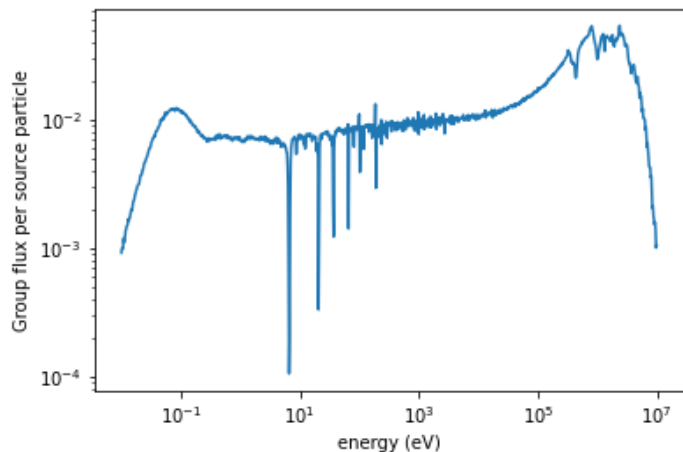
k-eff estimate in batches

3D MC solver

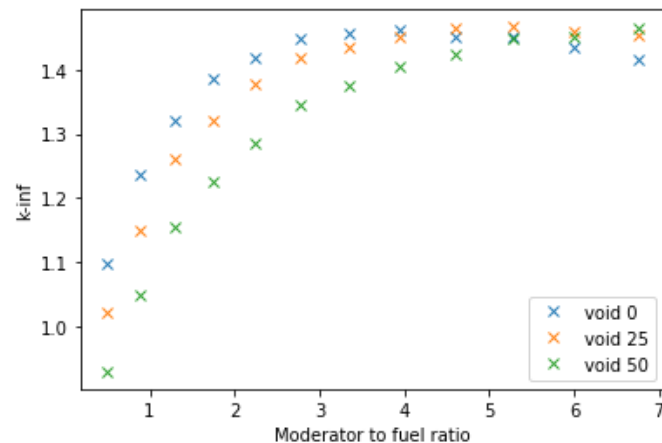
Estimating flux



# Datalab 6&10



Our beloved PWR pin cell  
Looking at basic physics  
Scripting openMC to look  
at some more physics



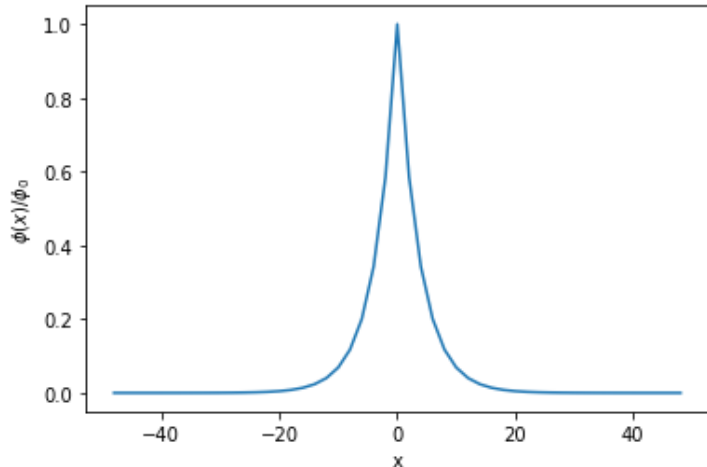
# Datalab 7

Multiplying slab:  
Less easy: create matrix  
Inverse power method

$$-D \frac{d^2 \phi}{dx^2} + \Sigma_a \phi(x) = S(x)$$

$$-D \left( \frac{\phi_{i+1} - 2\phi_i + \phi_{i-1}}{\Delta^2} \right) + \Sigma_a \phi_i = S_i \quad i = 1, 2, \dots$$

$$\underline{\underline{A}} \underline{\underline{\phi}} = \underline{\underline{S}}$$

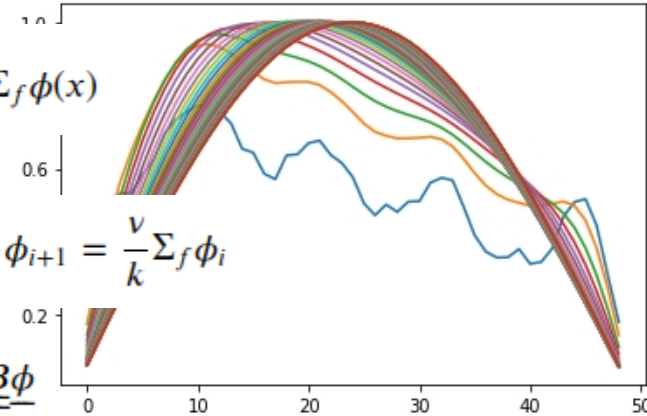


$$-D \frac{d^2 \phi}{dx^2} + \Sigma_a \phi(x) = \frac{\nu}{k} \Sigma_f \phi(x)$$

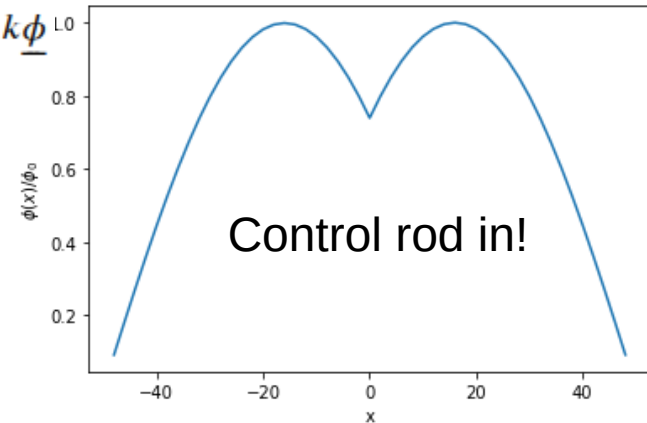
$$-\frac{D}{\Delta^2} \phi_{i-1} + \left( \frac{2D}{\Delta^2} + \Sigma_a \right) \phi_i - \frac{D}{\Delta^2} \phi_{i+1} = \frac{\nu}{k} \Sigma_f \phi_i$$

$$\underline{\underline{A}} \underline{\underline{\phi}} = \frac{1}{k} \underline{\underline{B}} \underline{\underline{\phi}}$$

$$\underline{\underline{A}}^{-1} \underline{\underline{B}} \underline{\underline{\phi}} = \underline{\underline{C}} \underline{\underline{\phi}} = k \underline{\underline{\phi}}$$



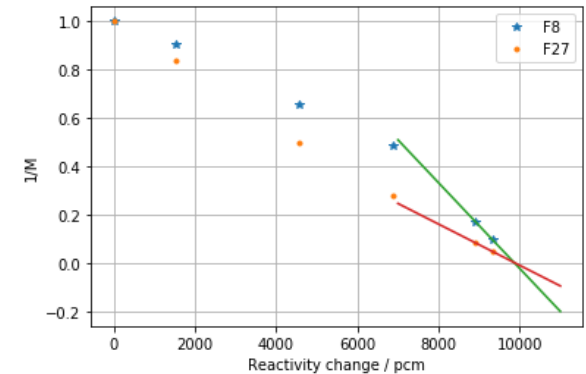
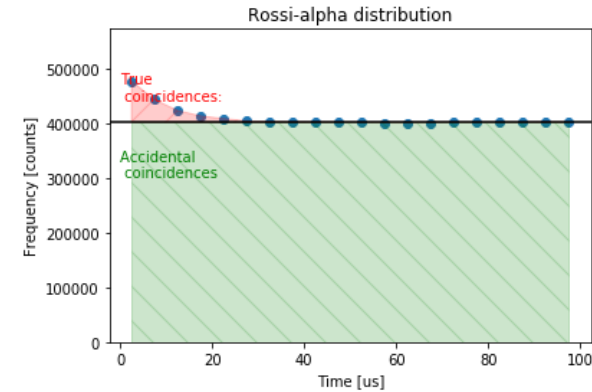
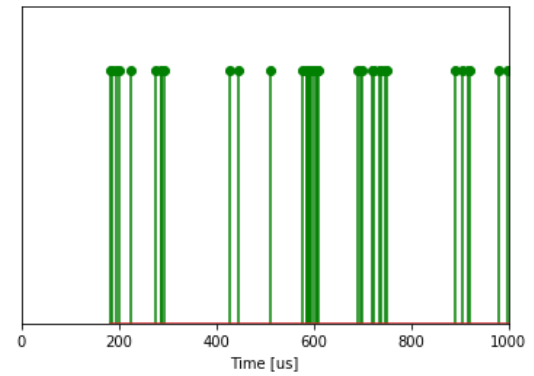
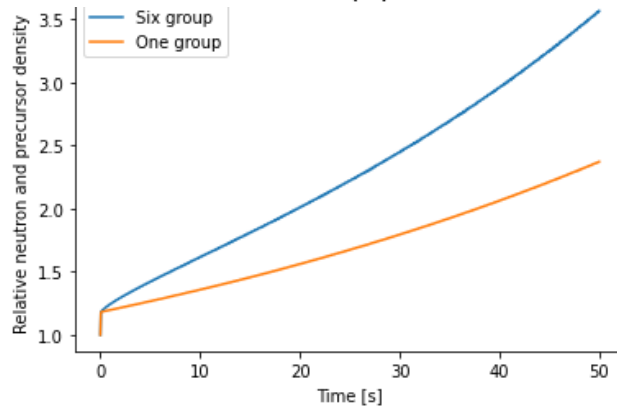
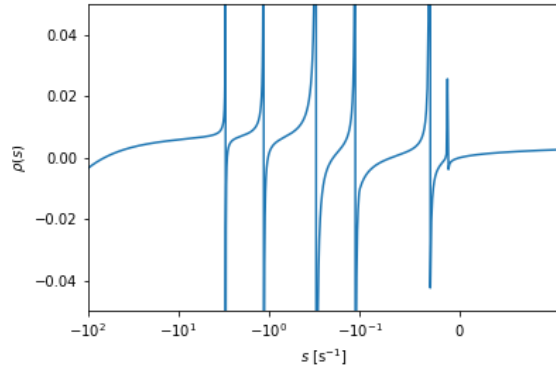
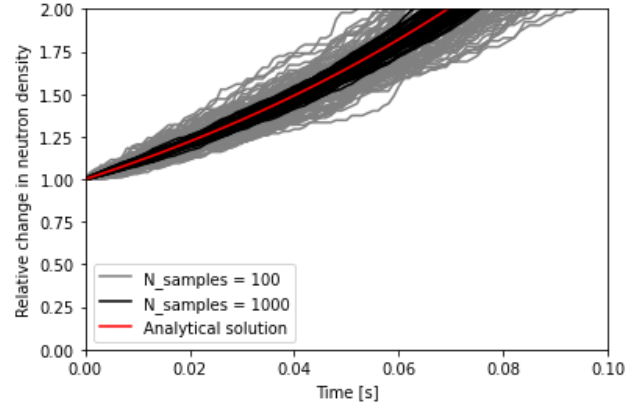
+ Calculate group xs  
By weighting with spectrum  
And with openMC MGXS



# Datalab 8-9

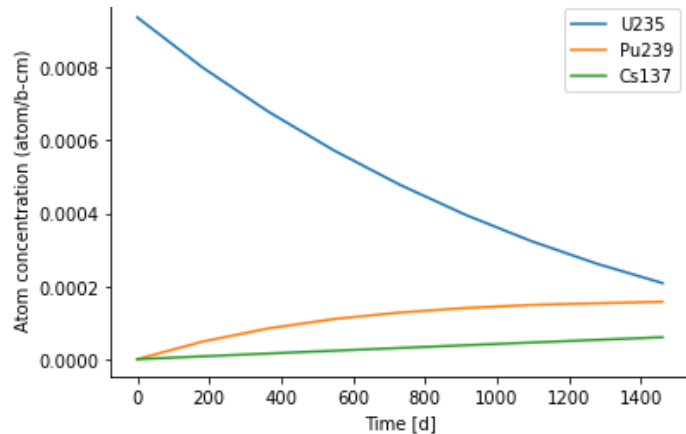
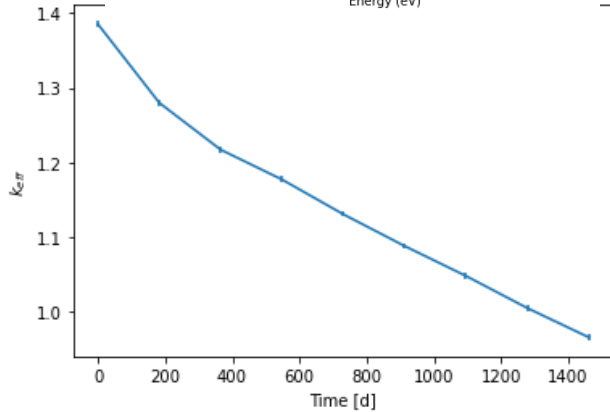
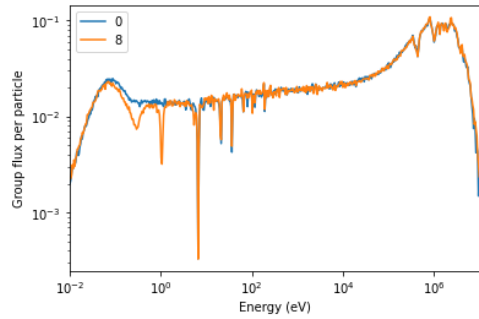
## Point kinetics and subcritical systems

- numerical methods
- root finding
- simple MC simulations
- function fitting





# Datalab 11

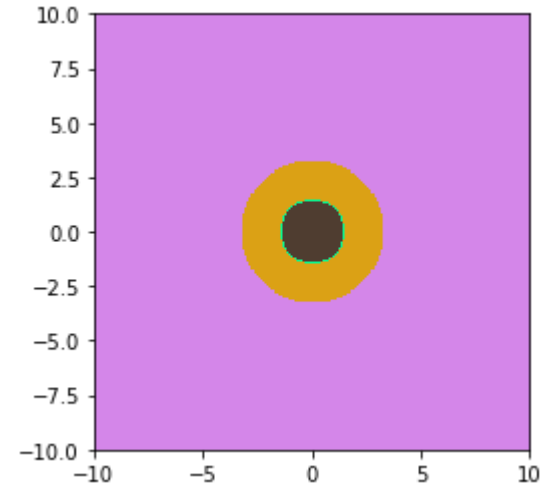


Depletion PWR:

- Understanding method (coupled solver)
- Understanding physics

Starting HA3:

- Magnox Pu production



```
1 R=2.9/2
2 H=52
3 V=R**2*np.pi*H*8120
4
5 p39[-1]*1e24*V/6e23*239
```

26822.072156986553

# Conclusions

- Huge amount of work to do this
- Use what we already developed
- Also lecture note plots are done with python (©UU)
- Seems like a nice format, could be (re)used for other courses