Institutt for energiteknikk

Ease of use of radiation transport tools for dose rate calculations

Daniel Murphy

Introduction and Aims

- My aims today are:
  - Remind you about the significance of dose rate calculations.
  - Describe the differences in context between radiation transport simulation in nuclear physics and in dose rate calculations.
  - Show you how we can make our lives easier with more user-friendly software for predicting dose rates and get you to appreciate the importance of ease of use in nuclear codes.

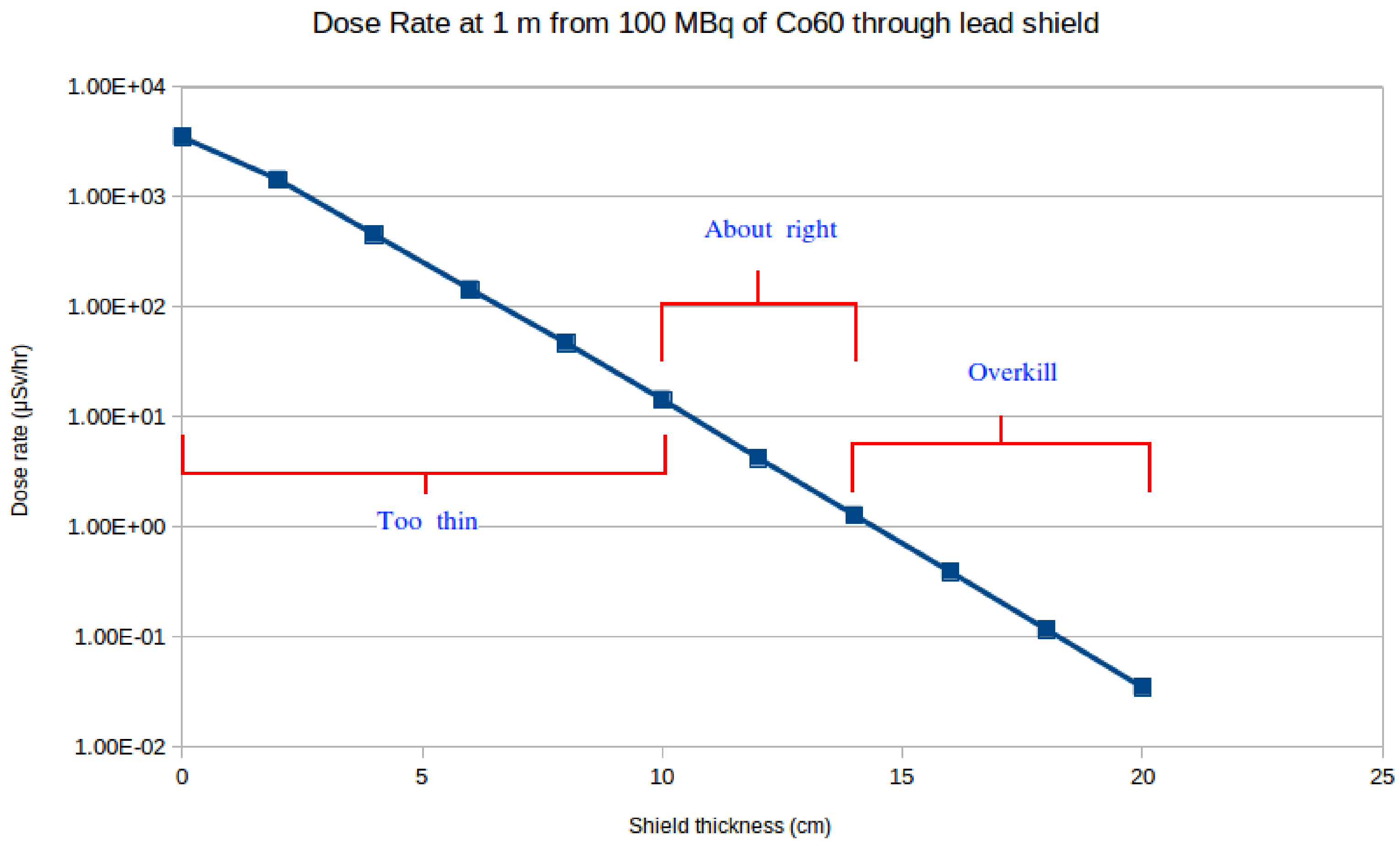
Why caculate dose rates?

- Plan ahead and make sure doses to workers are ALARA (as low as reasonably achievable).

Image: Halden reactor, IFE

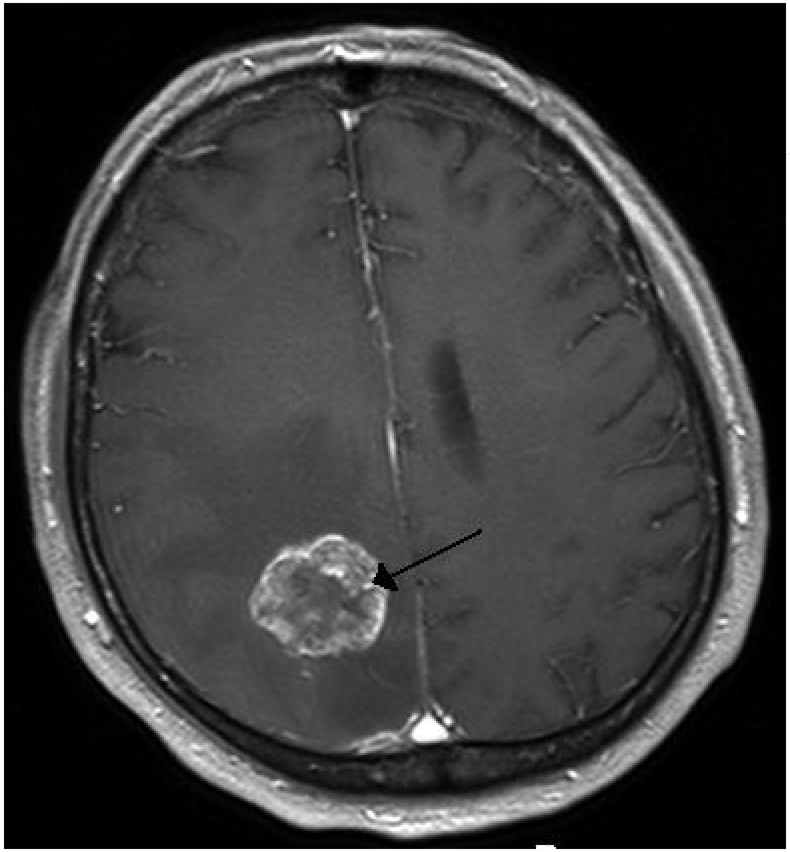
Why caculate dose rates?

- Optimise design of shielding.



Why caculate dose rates?

- Radiation therapy – deliver the correct dose to the right place (i.e. a tumor)



Radiation Transport Calculations in Nuclear Physics

- Radiation transport means modelling the way particles move through and interact with their environment

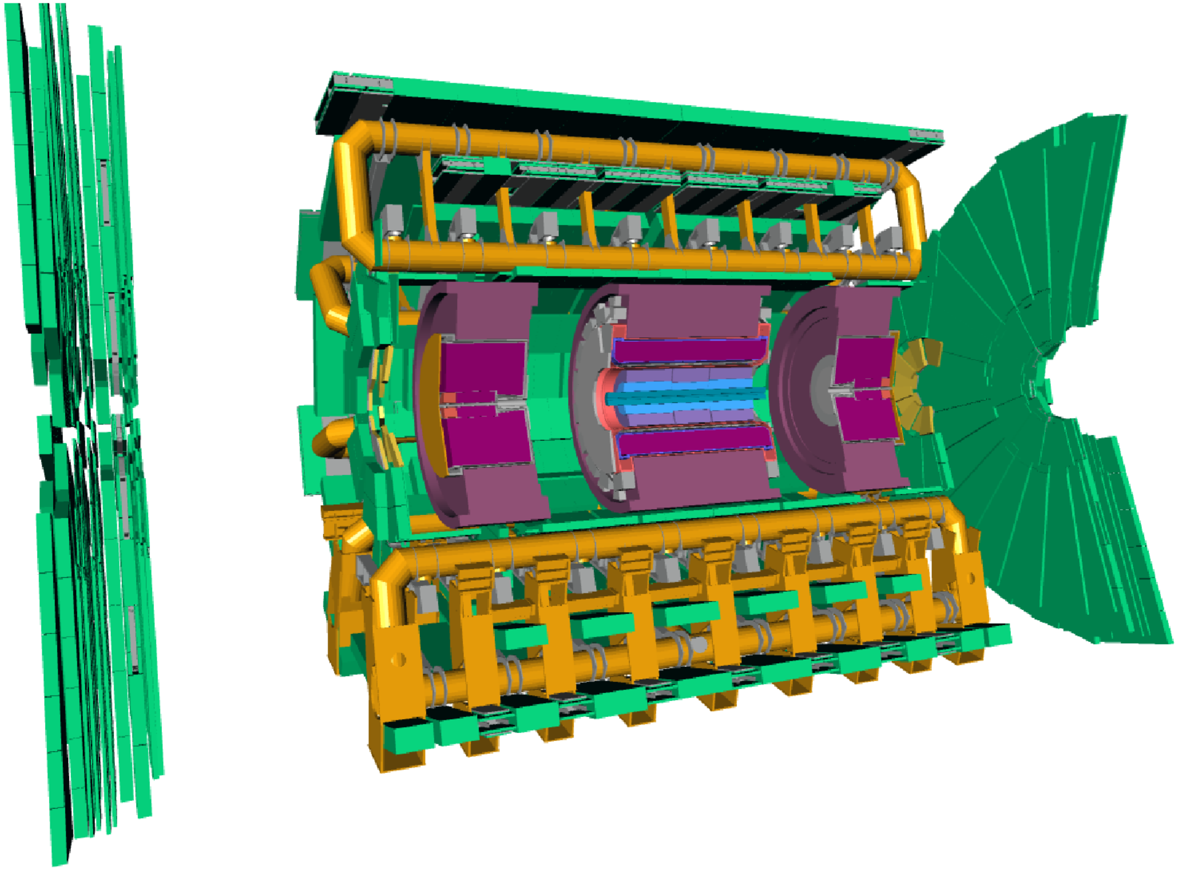


Image: ATLAS Experiment/CERN

Differing contexts – Nuclear Physics vs Dose Rate Assessment

- The context of radiation transport calculations – and therefore the priorities – are not the same in nuclear physics as opposed to dose rate assessments.

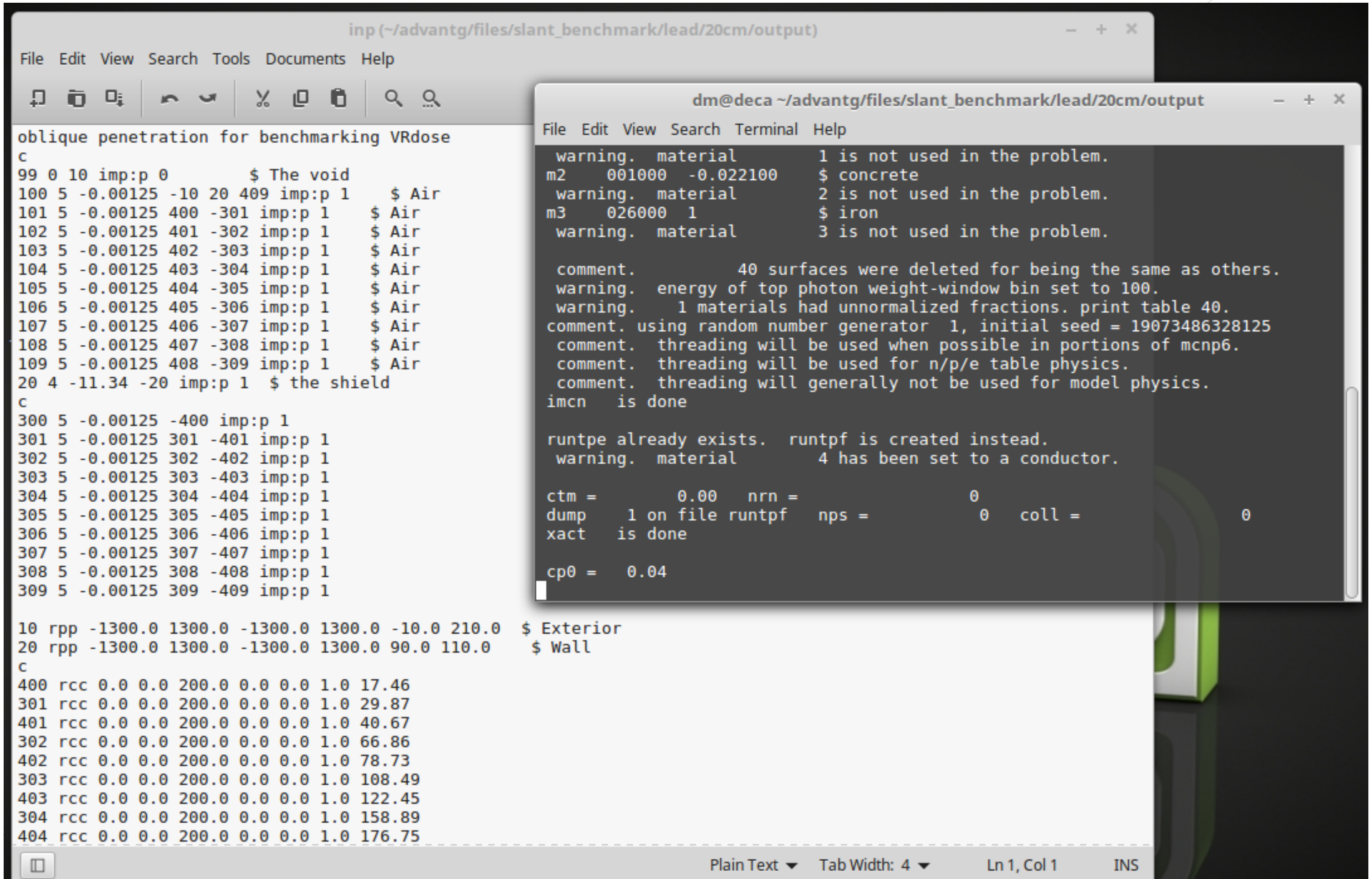
Nuclear Physics Research	Dose Rate Calculations
High accuracy	“Good enough” accuracy
Less time sensitive	Fast answers needed
Expert users	User expertise varies
Detailed models	Simplified models

Tools for radiation transport – Monte Carlo codes

- Uses random numbers to generate particles and move them through the user defined geometry.
- Count particles reaching your detector to calculate detector response, or dose rate, or reaction rate.
- Common codes: GEANT4, MCNP, etc...

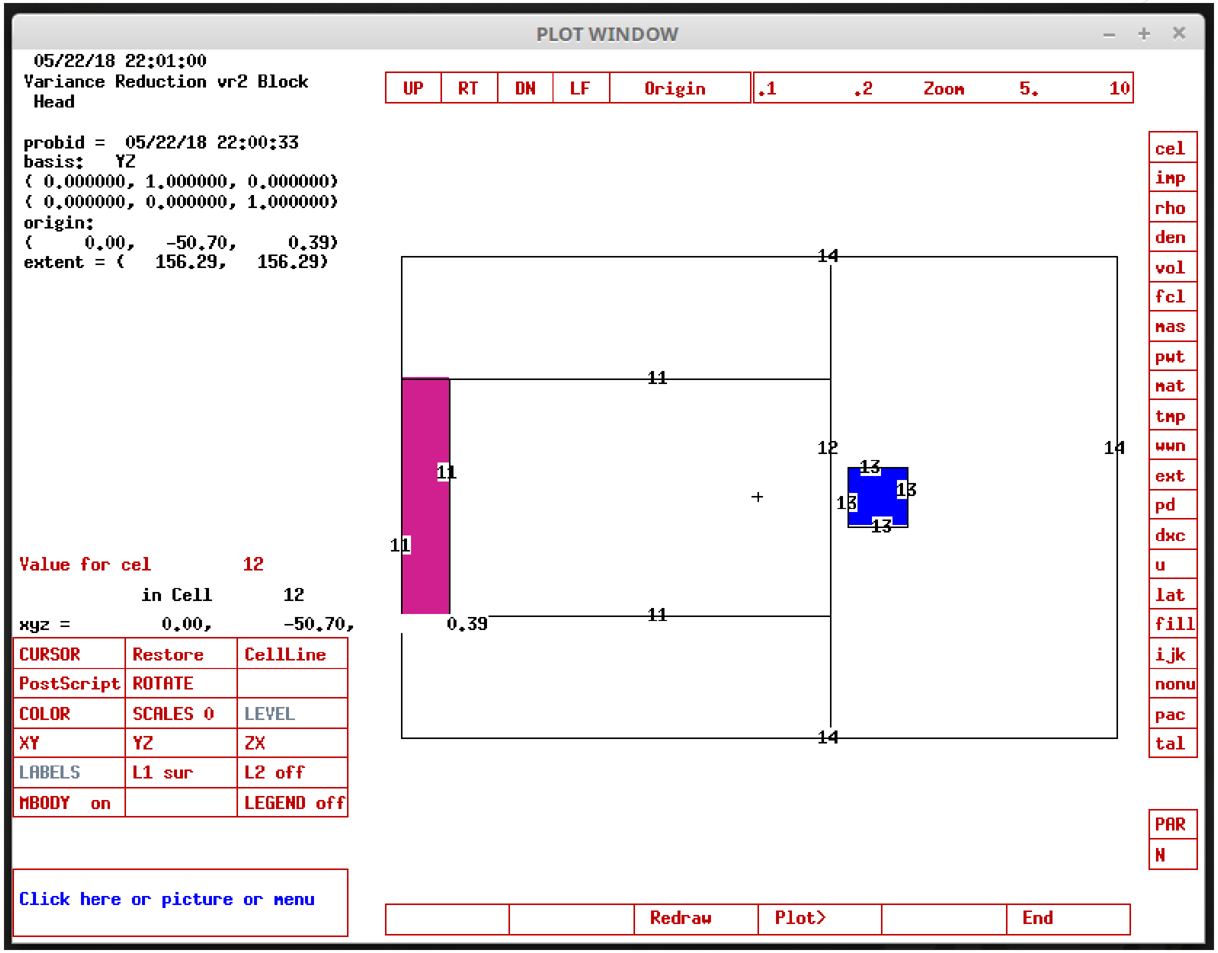
Monte Carlo downsides...

- Tedious text input



Monte Carlo downsides...

- Clunky visualisation



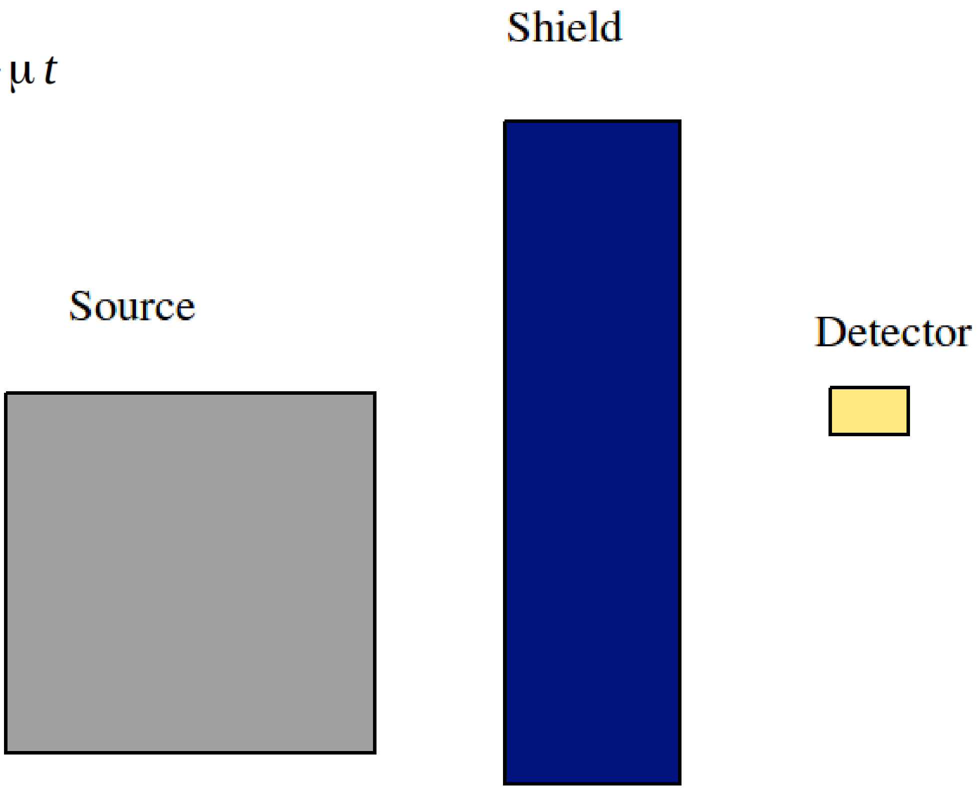
Monte Carlo downsides...

- Difficult to use and slow

So instead we can use... Point Kernel Method

- Discretise a large source and treat it as a collection of point sources.
- Compute the contribution from each point with the equation:

$$\phi = \frac{S}{4\pi r^2} \times B e^{-\mu t}$$



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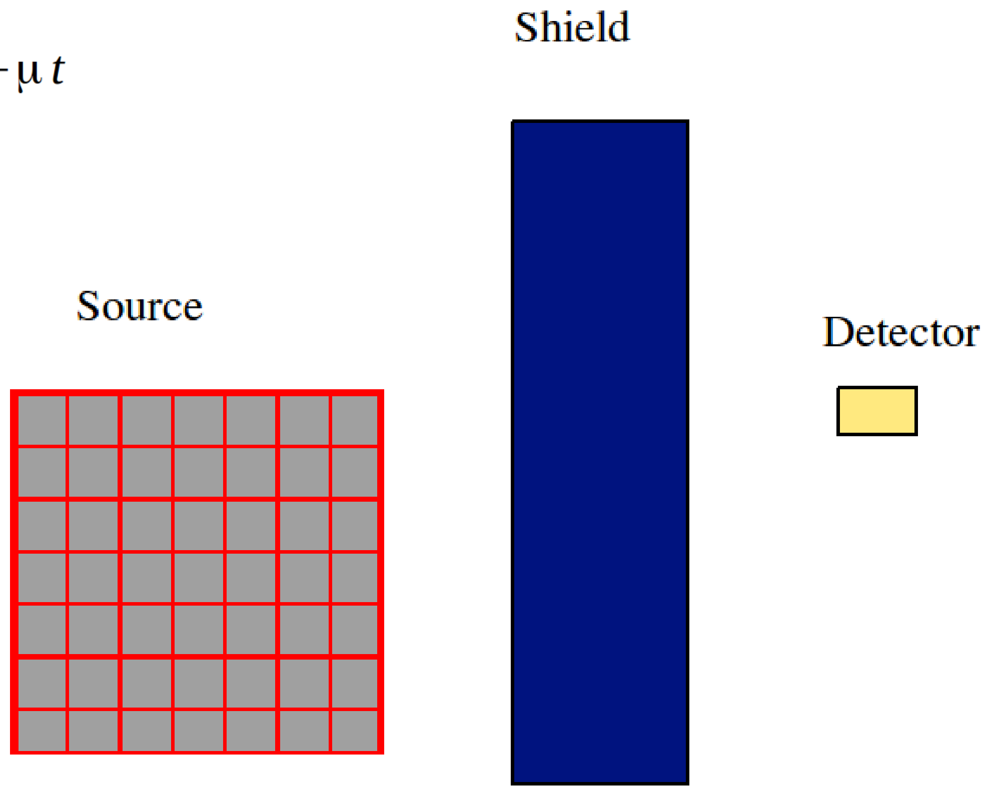

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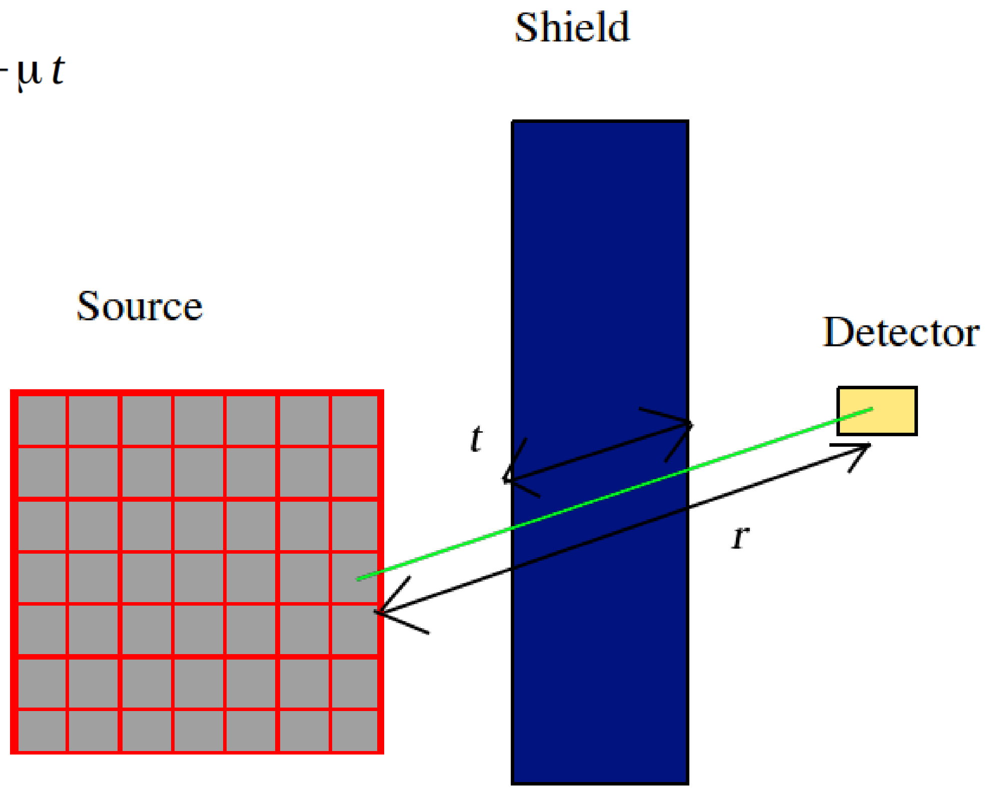

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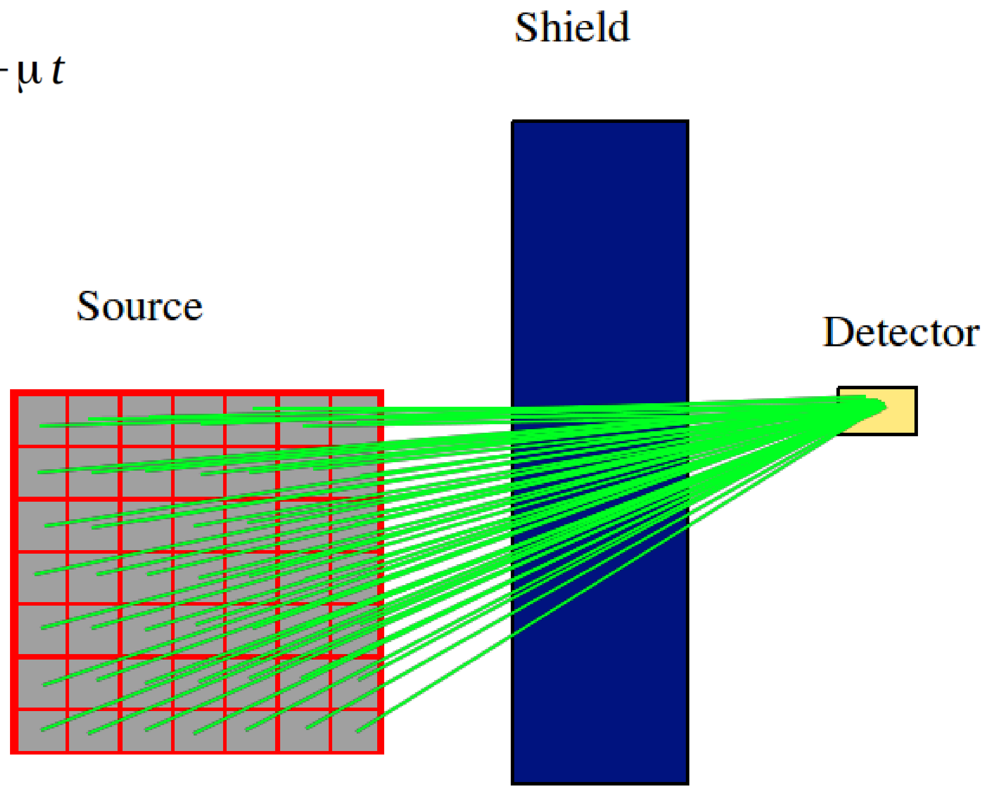
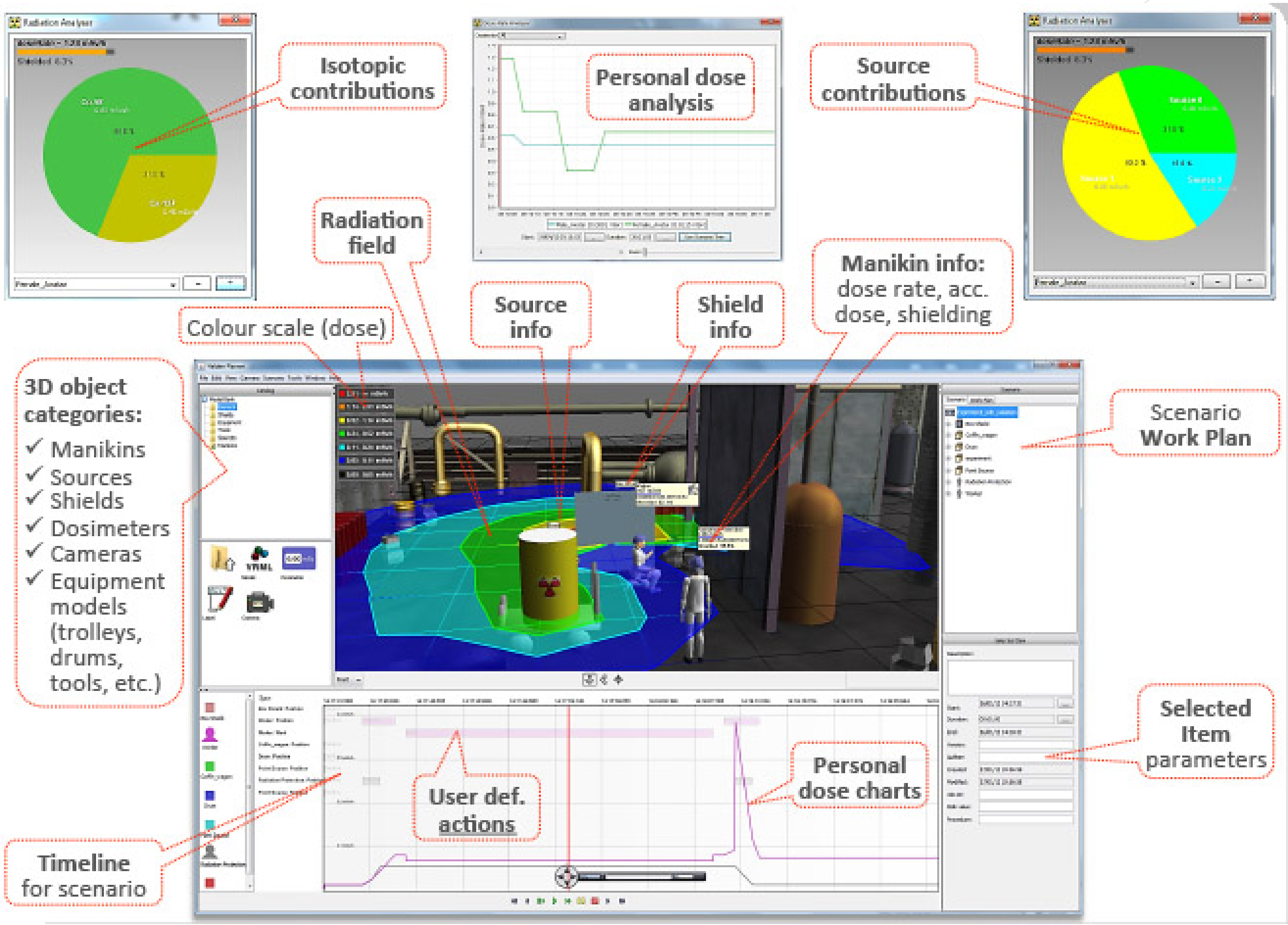


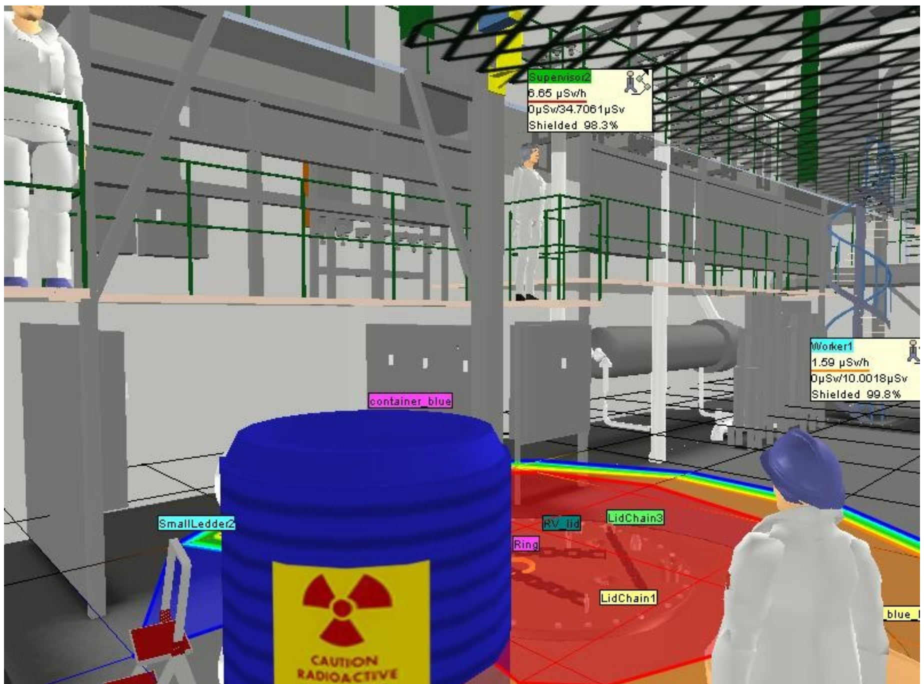
VRdose – A point kernel code from IFE!

- Make things easy for dose assessors with modern GUI, visualisation, and instant results.



VRdose – A point kernel code from IFE

- VR = Vritual Reality. Wokers can practise a task in VR and see how much dose they would receive.



VRdose demonstration

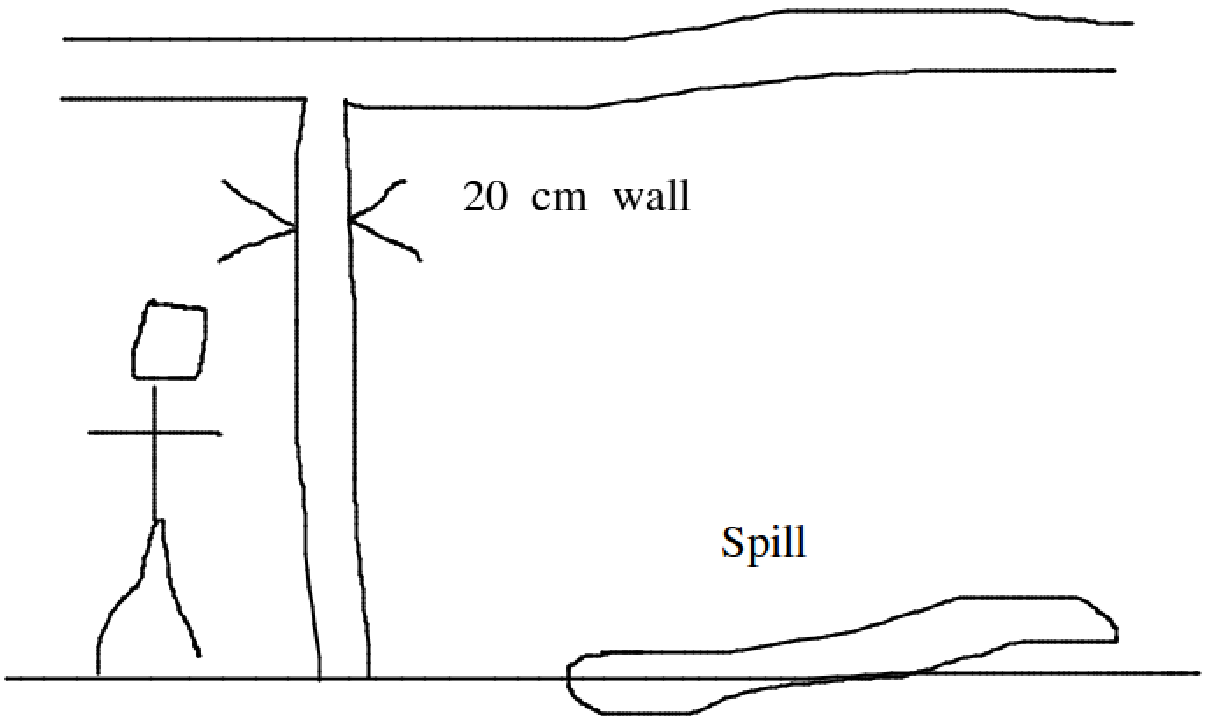
ring ring

Hello, is this the shielding assessment department? We have a problem – we were transporting a sample for analysis and we spilled about 2 litres of it on the floor. It contains about 5 GBq of 137Cs per litre.

Access has been restricted and we are working on a cleanup strategy, but in the meantime there is a corridor adjacent to the room which operators use regularly to access their work area elsewhere in the facility. Is it safe for them to continue using the corridor?

I have emailed you a drawing of the situation.

VRdose demonstration



VRdose demonstration

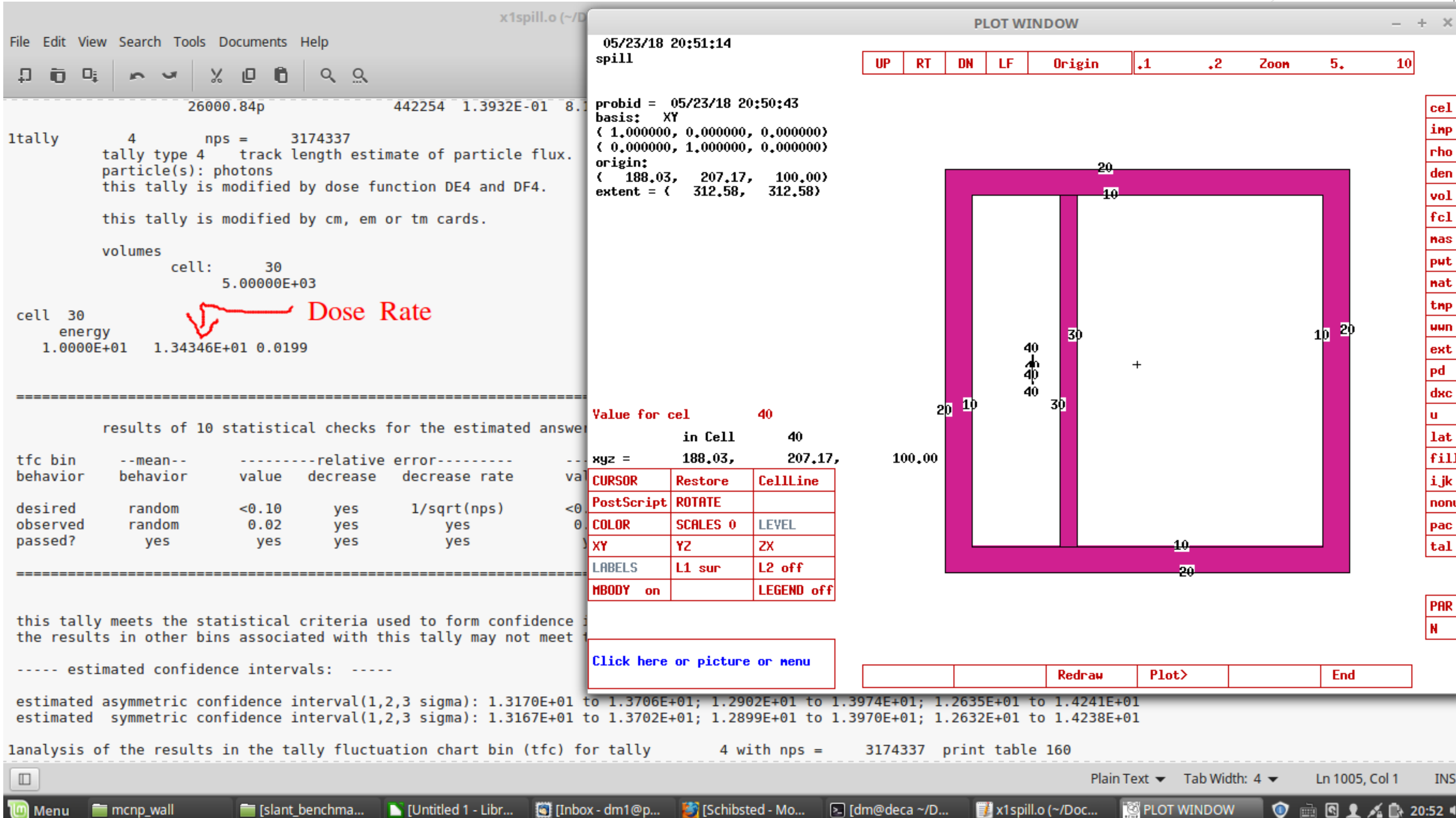
Within a few minutes, we can reply...

I expect the maximum dose rate inside the corridor due to the spill to be around 14 µSv/hr.

I recommend entering the corridor to perform a detector survey - if an elevated dose rate is found directly opposite the location of the spill, then I suggest installing temporary mazel shielding (or similar) equivalent to 1 cm of lead.

Also, in the room with the spill, the dose rate directly above it is likely to be around 400 µSv/hr and around 100 µSv/hr 2m away. What are the options for cleaning it? Let's cooperate on the cleaning strategy.

MCNP for comparison



Conclusions

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With thanks to...

- Istvan Szoke and Tom-Robert Bryntesen – VRdose development
- Bill Beere and Sunniva Siem – My PhD supervisors
- You – Remaining awake

Comments or questions?