WANDA ideas

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U.S. DEPARTMENT OF ENERGY

- Dosimetry
- Radiation damage
- Atomic data
- Workflow

- **Dosimetry**
- **Radiation damage**
- **Atomic data**
- **Workflow**

“Dose”, “Dosage” and “Dosimetry” mean different things to different people

- **Medical doctor vs. Health physicist vs. Nuclear engineer vs. Nuclear physicist**
- **There is no one number**
  - *Depends on radiation source* (neutron, photon, electron, proton, HI, …)
  - *Depends on energy* (gamma vs. X-ray)
  - *Depends on what is being irradiated, and in a very detailed way!* (a patient, a radworker or a piece of equipment)
  - *Depends on your goal* (do you want to know how much radiation is made or how much is absorbed)

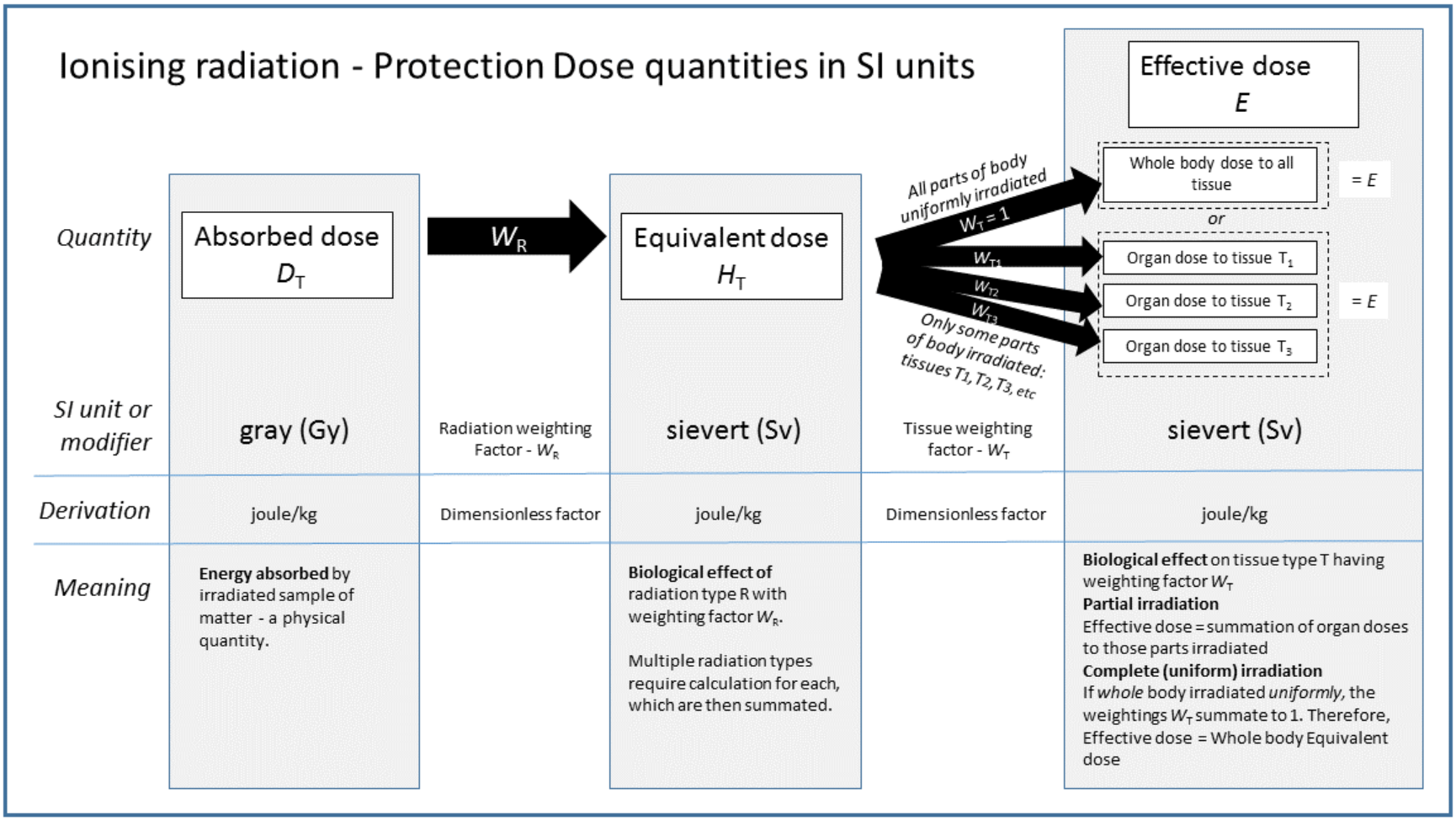
When I say there is no one number, I am serious

TABLE I. Damage metrics relevant to silicon semiconductors.

#	Metric	Units
1	Total dose	rad(Si)
2	Displacement dose	rad(Si)
3	Ionizing dose	rad(Si)
4	1-MeV(Si)-Equivalent Fluence	1-MeV(Si)-Eqv./cm^2
5	NRT damage energy	eV-b
6	Frenkel pair density	FP/μ
7	Track density	Tracks/μ
8	Minority carrier lifetime	μs
9	Cumulative LET distribution	MeV-cm^2/mg

P. Griffin, A. Koning, D. Rochman, ANS RSPD 2018 contribution #25461

Dosing people is very complicated!



Graphic by Doug Sim, https://commons.wikimedia.org/wiki/File:SI_Radiation_dose_units.png

Should instead to focus on the source and the use case

- **Fission Reactor**
  - Neutrons (thermal & fast)
  - Decay products
- **Fusion Reactor**
  - Neutrons (14 MeV)
  - Decay products
- **Accelerator**
  - Decay products
- **Space radiation**
  - CP, electrons, high energy photons
- **Waste**
  - Decay products
- **Radiation protection**
  - for workers,
  - for equipment
    - Big questions about long term radiation damage in older reactors
- **Radiation therapy**
- **Understanding fluence of machine**
- **Related task: reaction monitor**

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Who is using electro-, photo-atomic data

- **GEANT4** (POC: Maria Garzia Pia, INFN Genova)
- **PHITS** (https://phits.jaea.go.jp) (POC: T. Furuta, JAEA)
- **FLUKA** (fluka.org)
- **MCNP**
- **PENELOPE** (POC: F. Salvat, U. Barcelona)
  - Integrated into **penORNL**
- **EGS**, obsolete but forked into
  - **EGSnrc** (https://nrc-cnrc.github.io/EGSnrc)
  - **EGS5** integrated into PHITS
- **ITS** (POC: Brian Franke, SNL)
- **SCEPTRE** (POC: Clif Drumm, SNL)
- **CEPXS** (SNL)
- New codes:
  - **FRENSIE** (U. Wisconsin),
  - **P++** (RPI)

We need options for validating electro- or photo- atomic data

- Shielding benchmarks?
- **Lockwood energy deposition experiment**
- Hanson angular scattering
- Tabata charge deposition
- …

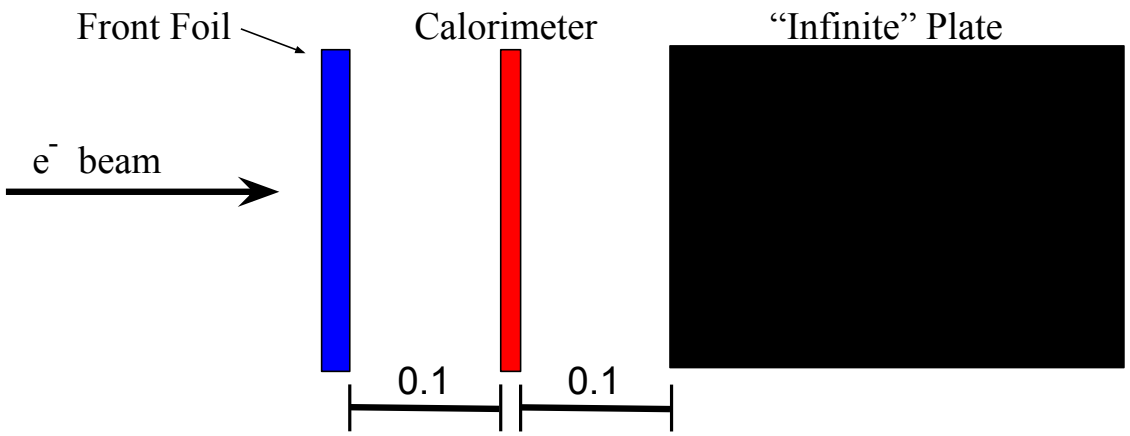

Fig. 2. The experimental setup of the Lockwood experiment consisting of a front foil, calorimeter foil, and "infinite" plate all of the same material and contained in vacuum.

L. Kersting, D. Henderson, A. Robinson, E. Moll, ANS RPSD 2018–20th Topical Meeting of the Radiation Protection & Shielding Division of ANS, Santa Fe, NM, August 26–31, 2018, on CD-ROM, American Nuclear Society, LaGrange Park, IL (2018)

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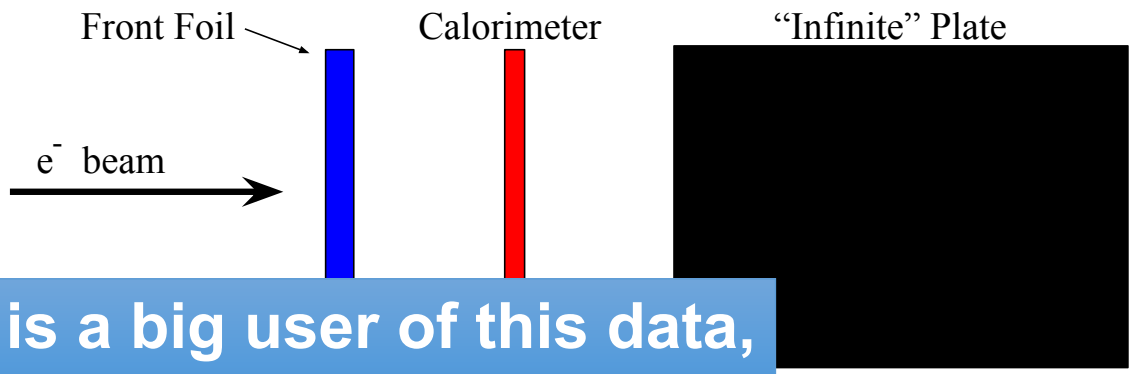

Sandia is a big user of this data, can they help with validation?

Fig. 2. The experimental setup of the Lockwood experiment consisting of a front foil, calorimeter foil, and "infinite" plate all of the same material and contained in vacuum.

We need to identify who can help address atomic data shortcomings

- Electro-, photo-atomic data & atomic relaxation data maintained by Red Cullen
  - Retired several years ago
  - Does this for fun, but how much longer?
  - Not accountable to any sponsor

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Workflow improvements?

- Quality assurance standards
- Improved and automated Phase II testing
- More and better covariances