Homeland Security Task Force Report

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a passion for discovery

U.S. DEPARTMENT OF ENERGY | Office of Science

Outline

- Status of Data Needs document
- How data is used
- Summary of needs:
  - Bread-n-butter data needs
  - Apps
  - Antineutrinos
  - Cosmic rays
  - Correlations
- Pulling it all together

Status of Nuclear Data Needs document

- yeah, err, working on it...

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- aim to finish draft by Dec 2011, finalize by budget briefing time

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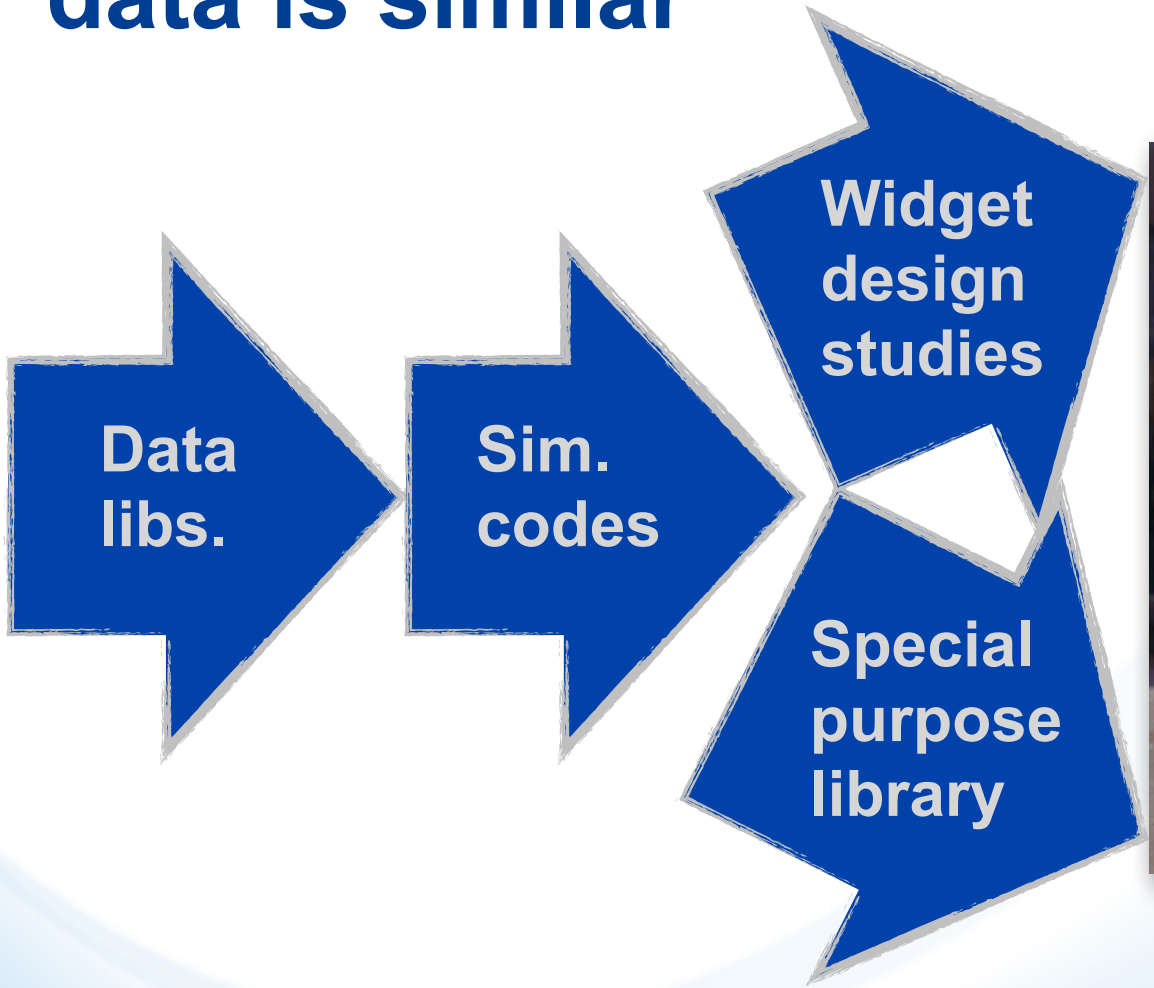
Although we have many users in different fields, the way they use the data is similar



Vintage 1960's smartphone/ detector

We already have many products that feed this pipeline

Data libs.

Sim. codes

Widget design studies

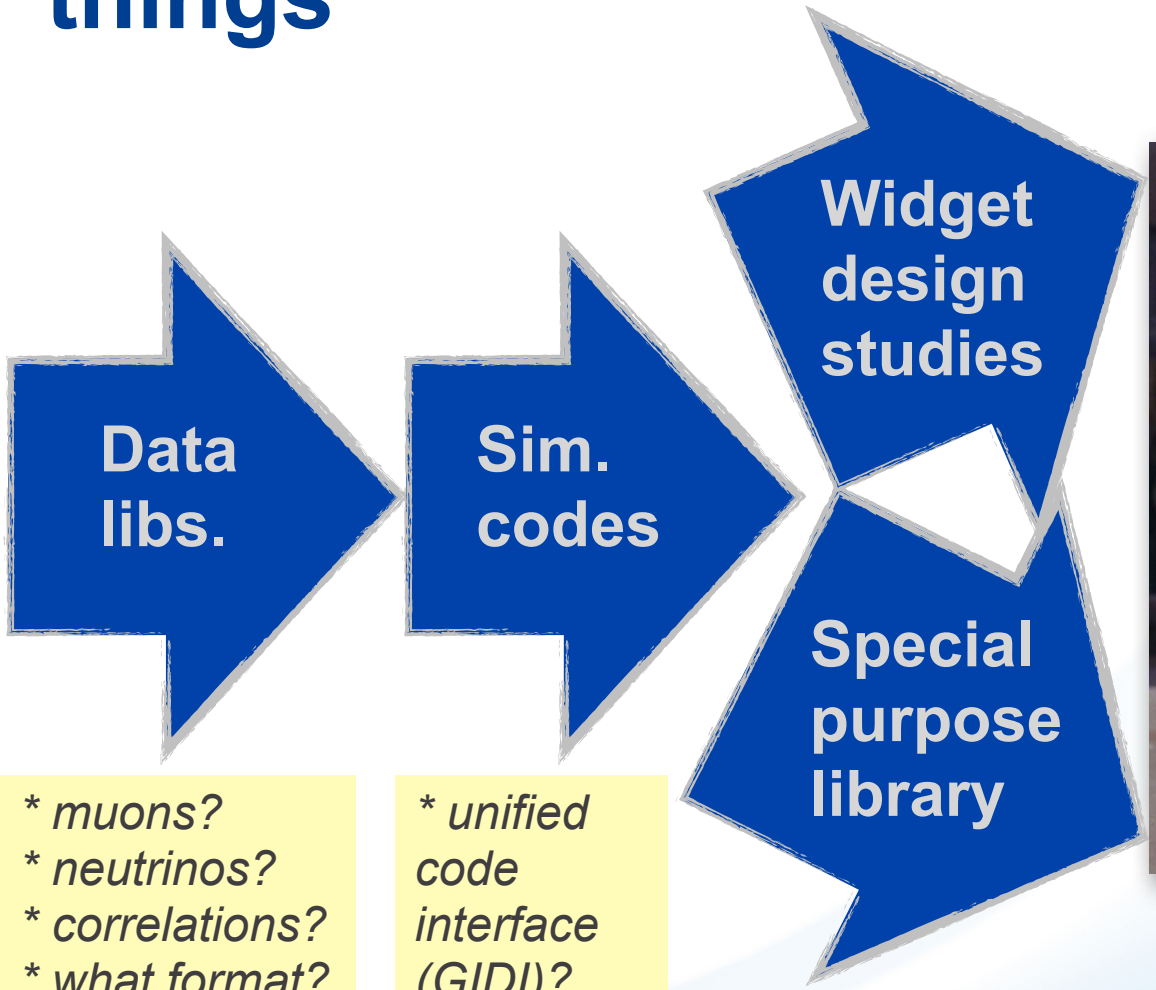
Special purpose library

* *ENDF*
  ** *neutrons*
  ** *decay*
* *NuDat*
* *...*

* *MCNP*
* *GEANT*
* *CINDER*
* *...*

Vintage 1960‘s smartphone/ detector

However, many of the data needs I will discuss require us to rethink things



* *muons?*
* *neutrinos?*
* *correlations?*
* *what format?*
* *...*

* *unified code interface (GIDI)?*
* *...*

Vintage 1960‘s smartphone/ detector

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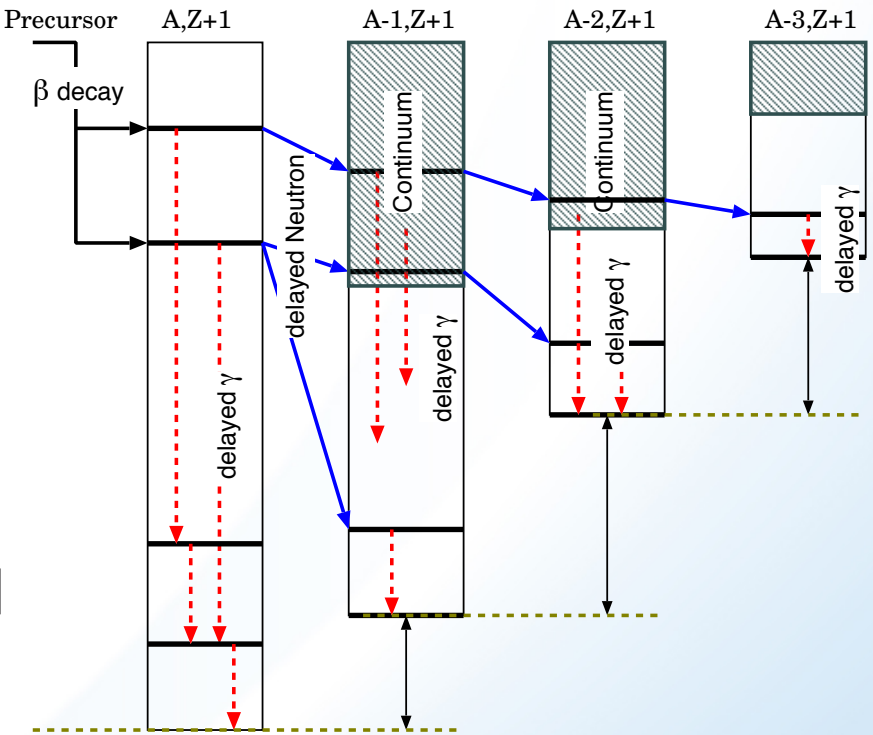
Bread-n-butter data needs

- **Activation cross sections for unstable isotopes**
  - Minor actinides -- bred in by reactors/bombs
  - Prompt and delayed fission products
  - And, things get activated by just being near radiation:
    - Structural materials
    - Air (C, N, O, H, ...)
- **Photonuclear data**
  - NRF state cross sections in SNM
  - Photofission, up to 100 MeV
  - EXFOR is collecting this stuff regularly now

Bread-n-butter data needs (cont.)

- **Decay data**
  - Prompt and delayed fission products, neutrons and gammas
  - Both LANL and BNL have made major progress
  - Toshihiko (LANL): CGM code impressive
  - You should have gone to the mini-session on beta-delayed neutron emitters!



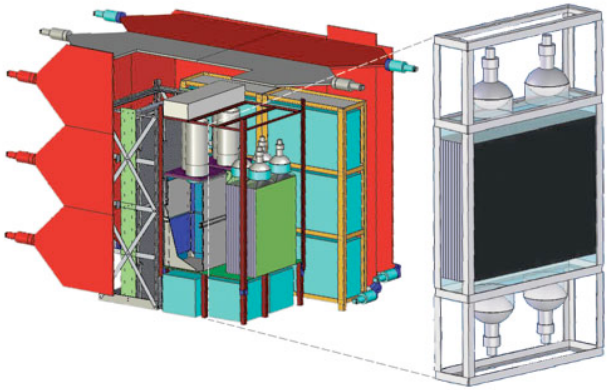
Mobile applications

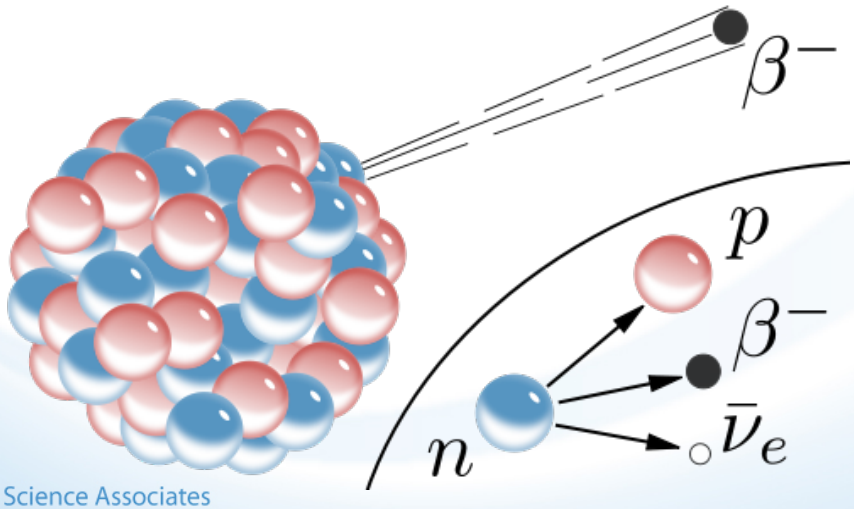
- **Common request of HS folks**
- Android, Mac, BlackBerry
- Start with simple ones - e.g., Wallet Cards
- More complex suitable for tablets
- May replace paper copies
  - always at hand
  - always up-to-date

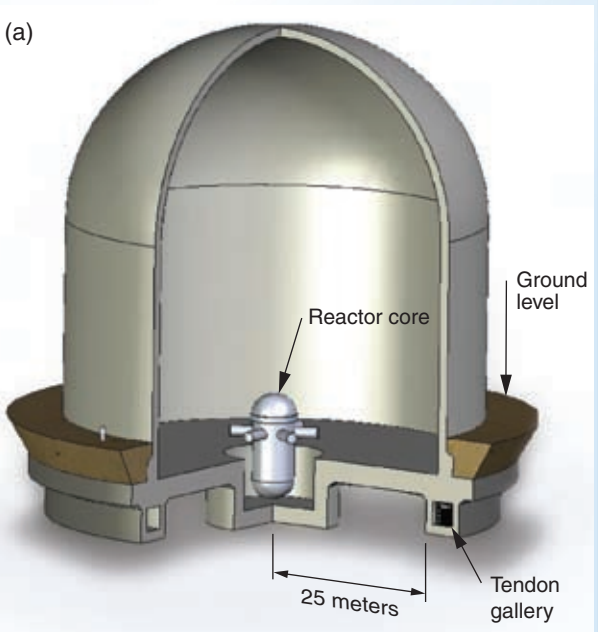
Should be easy to understand and easy to use

Antineutrinos

- LLNL's SONGs detector
  - In place at San Onofre
  - Strong IAEA interest for safeguards
- Antineutrino reaction and elastic cross sections
- Emission spectra from reactors
  - This should be straightforward

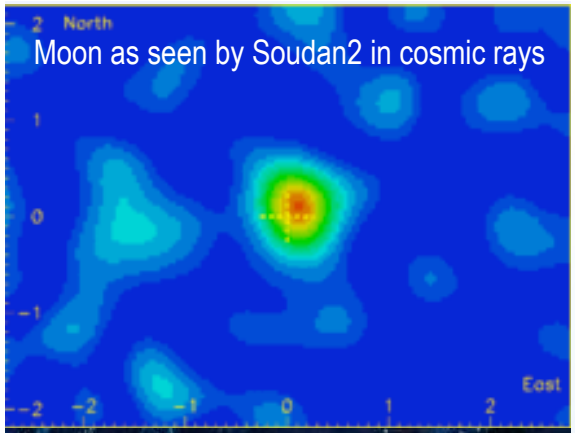




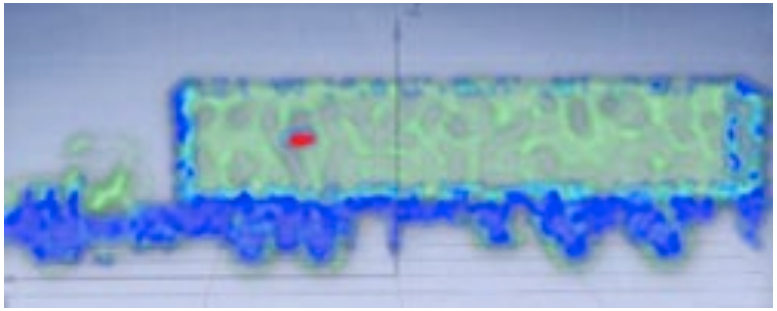


Cosmic rays (esp. muons)

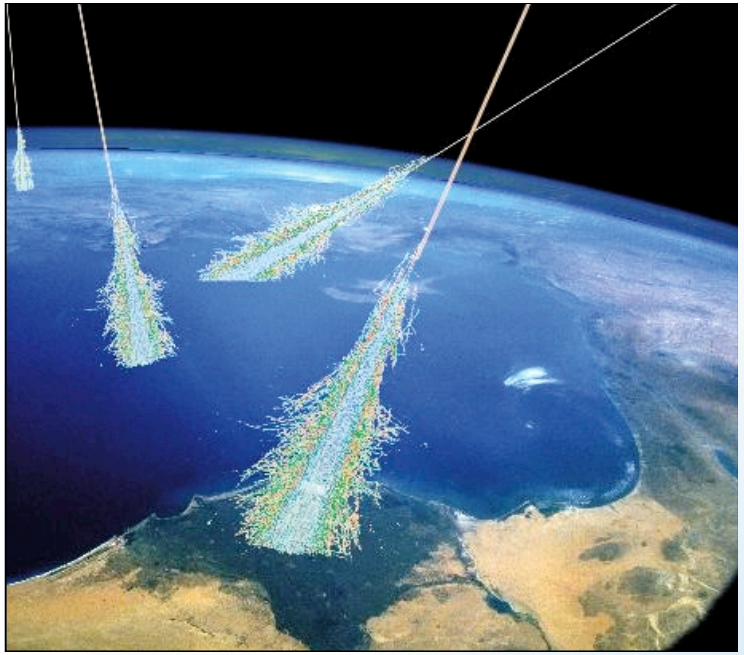
- Source of background
  - nearly all detections schemes considered for homeland security applications
  - ... and also many basic science applications
- At ground level, muons dominate shower particles



One person's background is another person's signal



- Cosmic rays are the muon source for muon tomography developed by LANL.
- Commercialized in the **Multi-Mode Passive Detection System by Decision Sciences Corp.**
- *http://www.decisionsciencescorp.com*

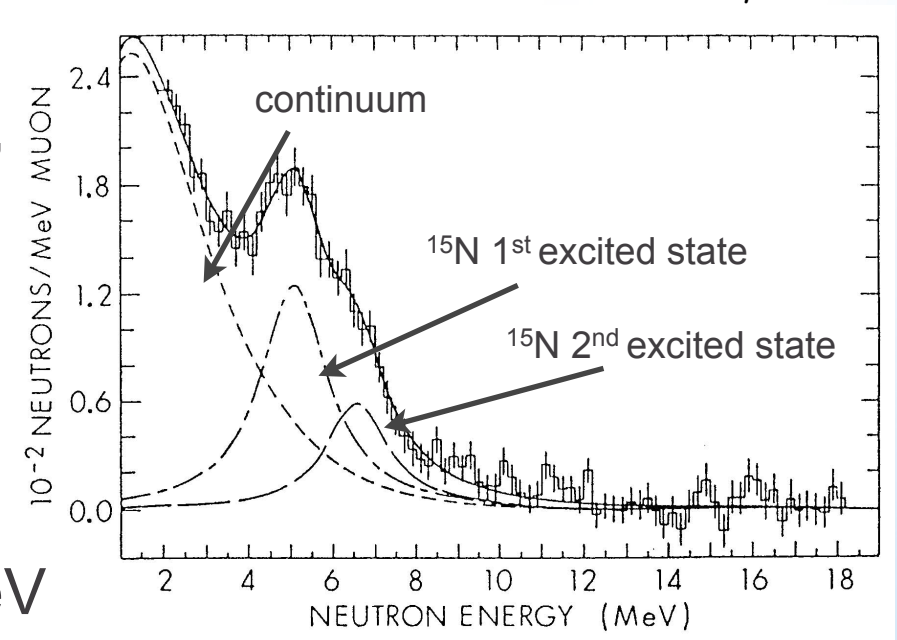


- LLNL's **CRY** code
- Generates showers for use in simulations
- *http://nuclear.llnl.gov*

If we can handle Hauser-Feshbach theory, then muons shouldn't be hard...

$$\mu^- + {}^{16}O \rightarrow {}^{16}N^* + \bar{\nu}_\mu$$

- In hydrogenous material, muons get captured by H, then transfer to nuclei w/ essentially zero energy
- Elementary process is $\mu^- + p \rightarrow n + \nu_\mu$ neutrino carries off 99.1 MeV, neutron gets 5.2 MeV
- Leave nucleus w/ 10-20 MeV of excitation (5 MeV + binding energy)
- Perfect for Hauser-Feshbach



Petr Vogel, "Muon Capture" Cosmogenic Activities and Backgrounds Workshop LBL, Apr. 13-15, 2011

Correlations

- Many detection schemes rely on detecting things either in coincidence or with specific timing
- Beats down background dramatically
- Data needed to support correlated signals often huge:
  - ^{235}U, ^{239}Pu beta delayed gamma data as big has rest of ENDF library
  - This is too big to be used effectively
- ***Better is to have in-line event generators***

Correlations are handled better with in-line event generators

- Fission:
  - fragments, neutrons, gammas, etc.
  - FREYA (LLNL: Vogt)
- Gamma-gamma: need in-line gamma cascade widget
  - GammaWare and RadWare are nice, but neither integrated into transport code
  - Radware, web-based coincidence finder not enough either
  - Following (n,n'), similar reaction
- Decay products: need in-line MC decay widget short-ish timescales < 10 sec.
  - Need inline, Monte-Carlo version of CGM for transport codes
  - Need timing information
- **Needs identified in original *Data Needs Document***

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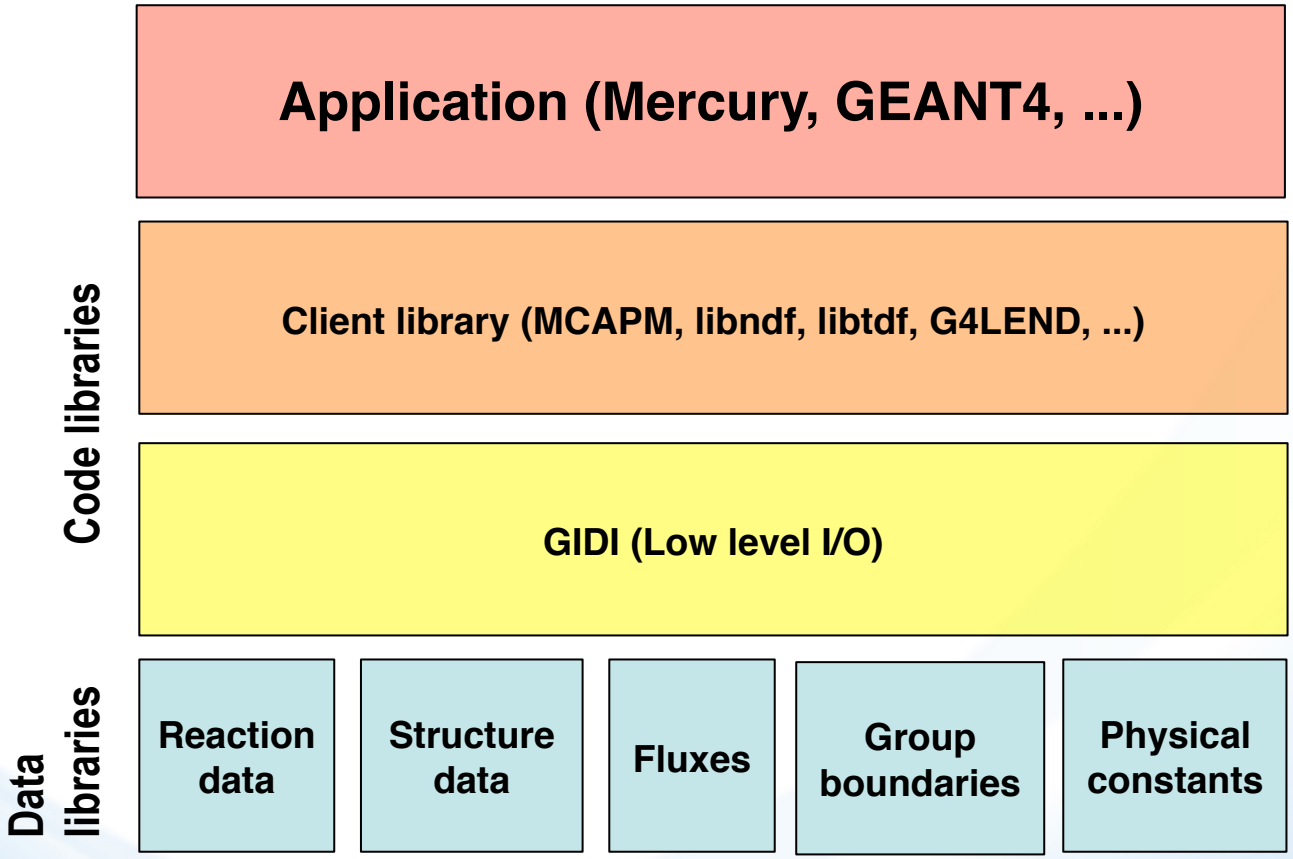
Pulling it all together

- Current state-of-the-art is the ENDF format
  - Inflexible
  - Opaque
  - Punchcard ready
- Need new format + tools to accommodate new data needs
  - GND movement under way
  - New tools from LANL (CGM), LLNL (FREYA) enable new classes of correlations in simulations
- New tools & data need to be integrated into simulation codes

The Generalized Interaction Data Interface (GIDI) allows GND use in applications



Mercury (LLNL)

Geant 4

The biggest need: you!

- After talking to actual people involved in Homeland Security tasks at BNL, LLNL and LANL, there is one thing that keeps coming up: ***they need collaborators***
- ***There are a lot of cool projects to do, so lets get cracking***

Potential collaborator: he has neat toys