Leveraging HTC for nuclear security research

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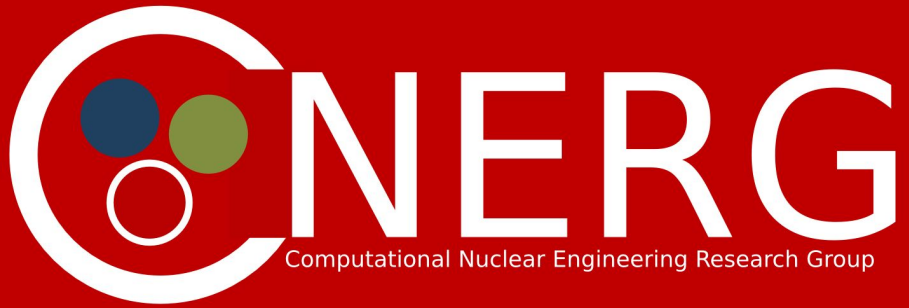


Nuclear Security

The **prevention** and **detection** of and **response to**:

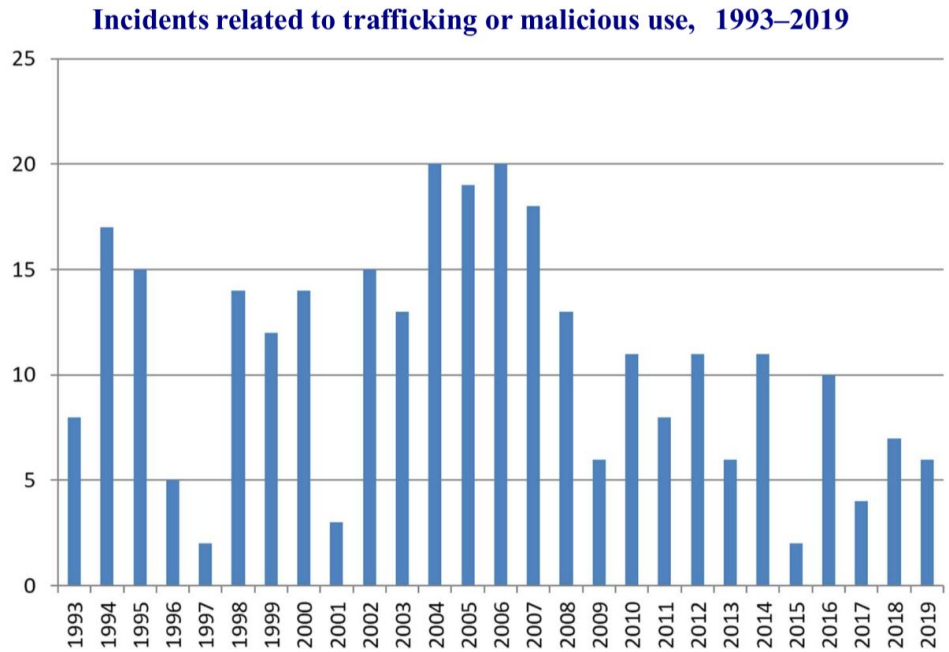
- Theft
- Sabotage
- Unauthorized access
- Illegal transfer
- Other malicious acts

involving:

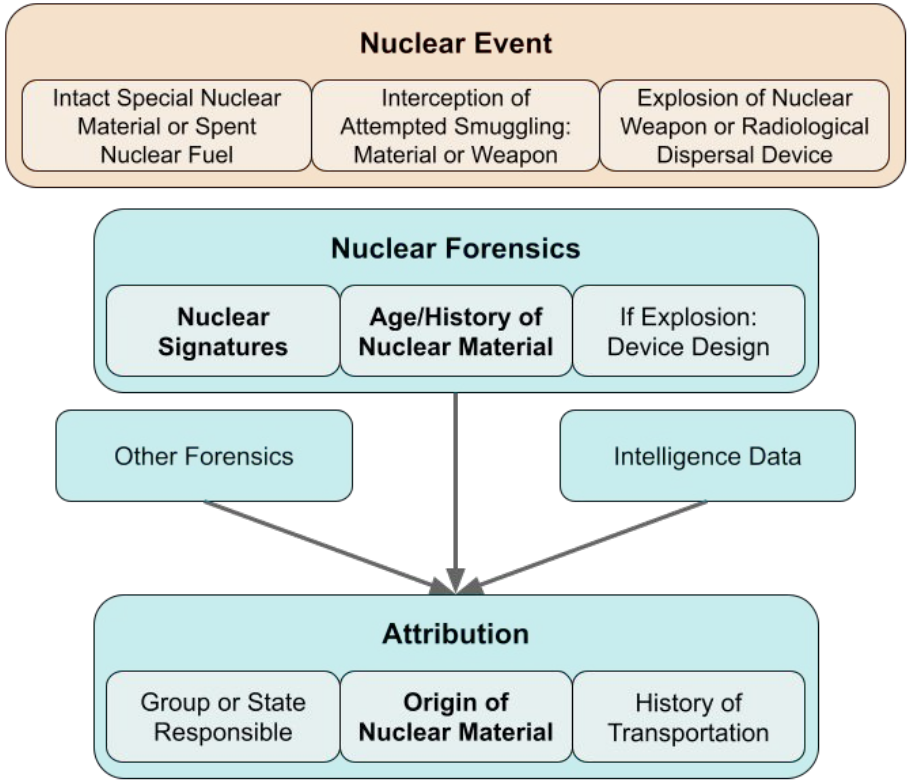
- Nuclear materials
- Other radioactive substances
- Their associated facilities

Definition from IAEA Safety Glossary and graphic obtained from this link

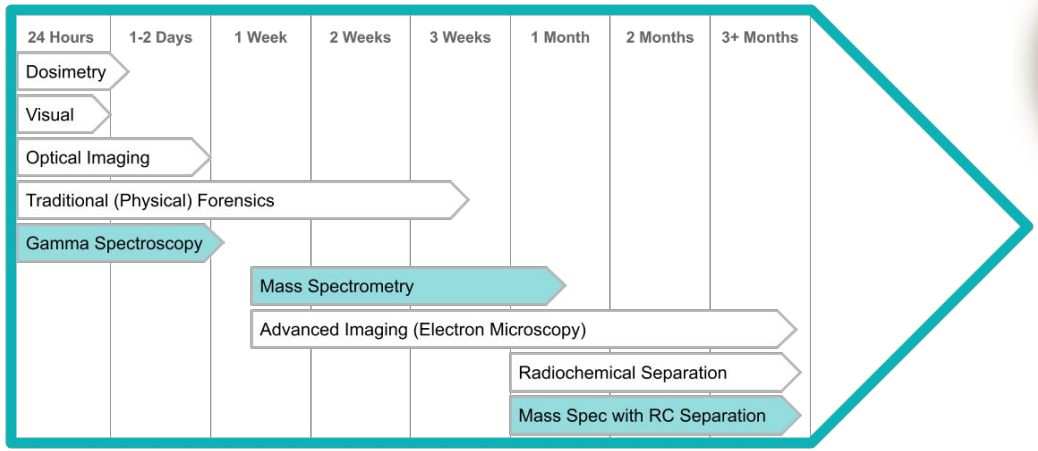
Nuclear Forensics



[IAEA Incident and Trafficking Database 2020 Factsheet: Incidents of nuclear and other radioactive material out of regulatory control]



Nuclear Forensics Investigations



Author recreated from online article by Eric Feigl-Ding

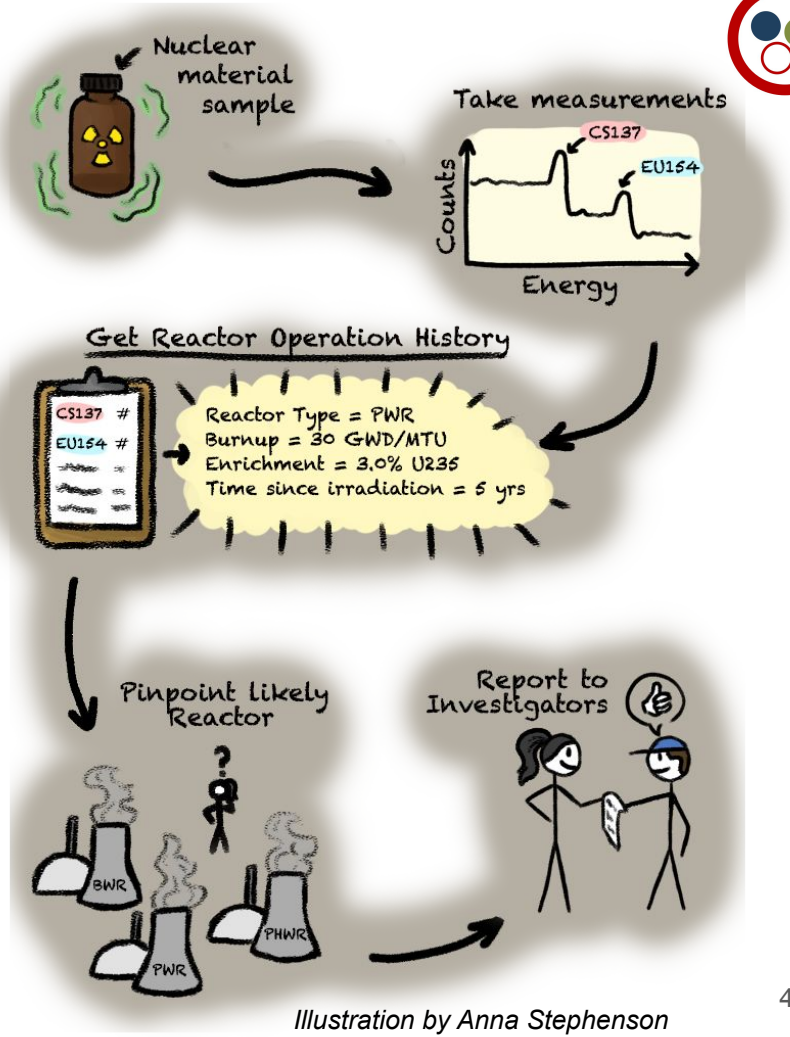


Illustration by Anna Stephenson

Can a computational approach expedite a nuclear forensics investigation?

Can a computational approach expedite a nuclear forensics investigation?

Learning About CHTC

- How I got there:
  - Step 1: Workflow no longer “works” on personal machine
  - Step 2: Complain dramatically to advisor
  - Step 3: CHTC to the rescue
- Phenomenal support:
  - One-on-one introduction/tutorial
  - Lots of email help + office hours
  - Once equipped with some experience, the manual helped a lot (not quite a power user …was cut off mid-montage)

Why CHTC?

- Machine learning-based workflow, ~10s of case variations
  - Algorithm & hyperparameter variations
  - Several labels to predict
- Size of training database(s)

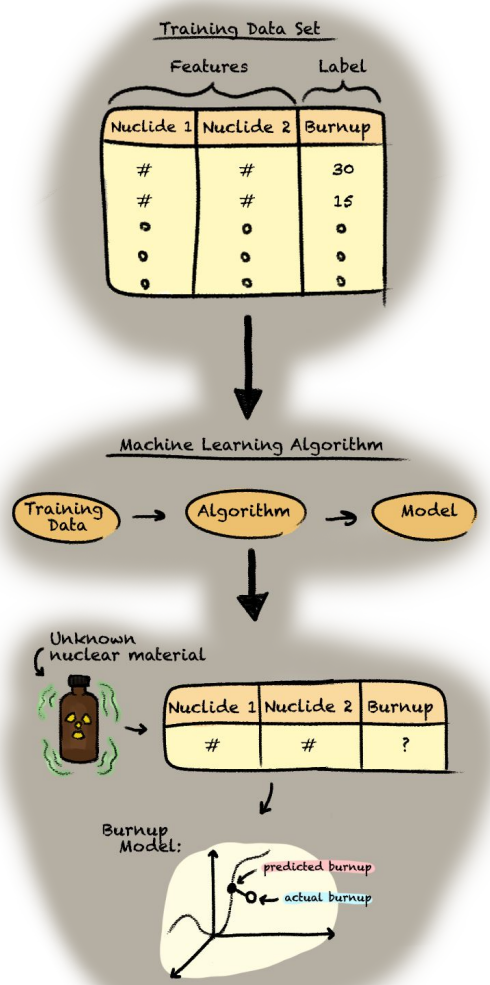


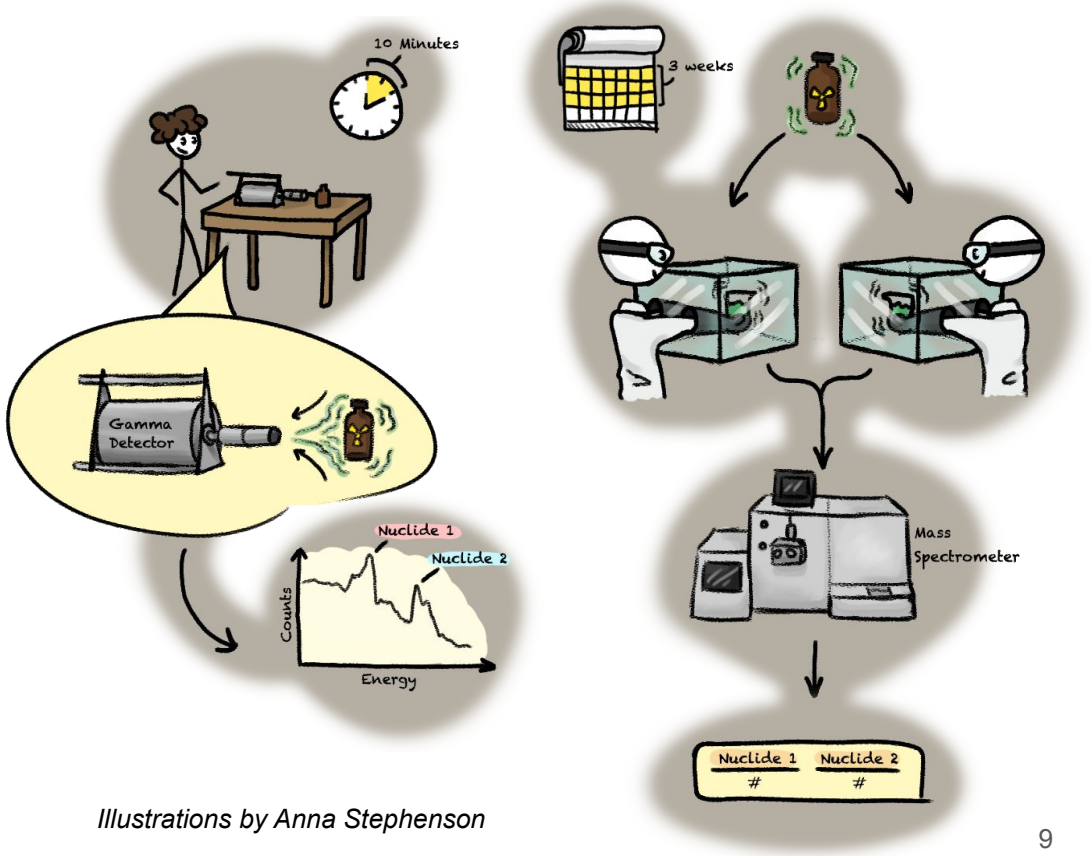
Illustration by Anna Stephenson

Database Dimensions

- Entries: ~500k
- Features (columns):
  - Slow: 29-32
  - Fast: 42-206

Fast Measurements

Slow Measurements



Illustrations by Anna Stephenson

2 Categories of Computation

- **Category 1**: Scikit-learn machine learning (2 algorithms)
  - One job per case submission
  - Some parallelism offered by scikit learn, typically requested ~4-8 CPUs
  - Large memory needs per job, many hours per job
- **Category 2**: 3rd algorithm based on other nuclear forensics work
  - Approx 500k calculations per case
  - 10k jobs per case submission (broke it into chunks ~50 calcs/job to not exceed 10k job limit)
  - Lower memory needs (1 CPU, <2GB) per job, minutes per job

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Progression of CHTC Use

1. Category 1 initially (~2019)
2. Category 2 later (~2020)
3. “Fast Measurements” database creation. One-off use case to run some simulations:
   docker-enabled for specific environment (April 2021)
4. Many Category 1 & 2 case variations:
   expanded to UW Grid and Open Science Grid (~June 2021)

Tangential Support

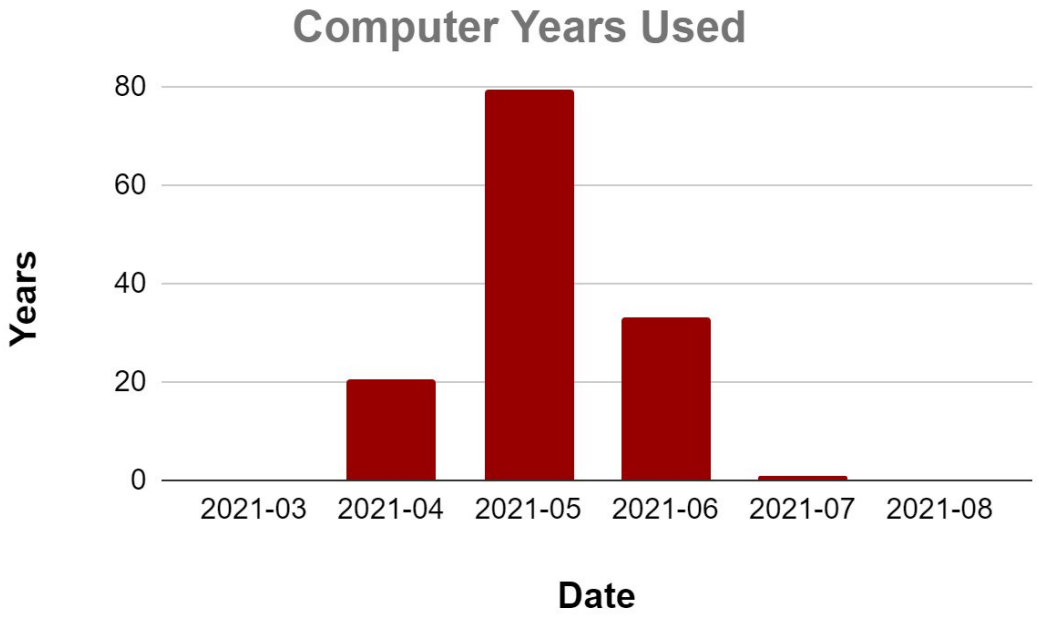
- Squid for large input databases
- Resolved stuck point 1: Migrating to OSG
  - For weeks, jobs kept getting booted!
  - Was misreading memory requirements (two different estimates existed) for awhile
- Resolved stuck point 2: Post-job large data transfers
  - Not feasible from off campus
  - Direct CHTC→UW Research Drive file transfer

Impacts of CHTC: Research

Computing power!

Without it, would have:

- much smaller database
- fewer parameter variations
- couldn't have done a "real world" scenario



Impacts of CHTC: Professional

- I would have gotten my PhD at ~ 171 years old
- Wrote a dissertation chapter for a general audience
- HTC experience helped me in job interviews
  - Knowledge of designing code
  - Knowledge of interacting with job submission systems
- Current job (nuclear methods software engineer) is computationally intensive

Acknowledgements

- Open Science Grid and CHTC!
- WI Institute for Science Literacy
  - http://scifun.org/Thesis_Awards/opotowsky.html
  - Illustrations are by Anna Stephenson
- DHS Nuclear Forensics Graduate Research Fellowship

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- Graduate Engineering Research Scholars
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