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Title: Pocket size nuclear reactors?

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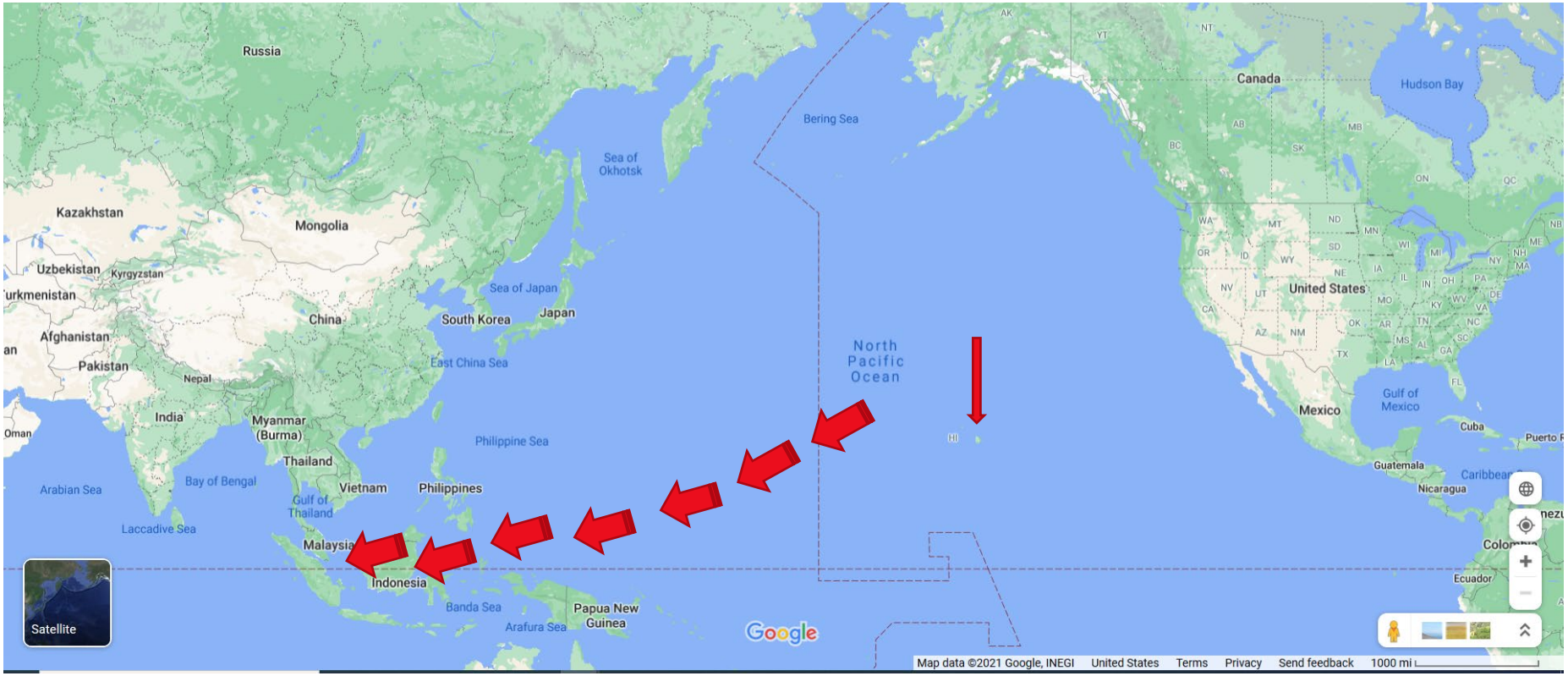
Los Alamos NATIONAL LABORATORY

Pocket size nuclear reactors?

Athena Sagadevan
Safeguards Science and Technology, NEN-1

My Story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Japan
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Education

- Primary and secondary school in Malaysia
  - Science track
  - Physics, radioactive decay
- B.S, M.S in Nuclear Engineering and Radiological Sciences 14’ & 16’ from University of Michigan
- PhD in Nuclear Engineering in 2020 from Texas A&M University

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News / News Stories / 2021 / April / Athena

After an interest in nuclear engineering took her half a world away, Athena Sagadevan never looked back

Reportedly the first Malaysian Indian woman to have a doctorate in nuclear engineering

For the Lab's global security mission, **Athena Sagadevan** is researching safeguards for nuclear microreactors. Small enough to fit on the back of a semi-truck, these fail-safe machines under development will be versatile enough to be deployed to remote locations

Her journey

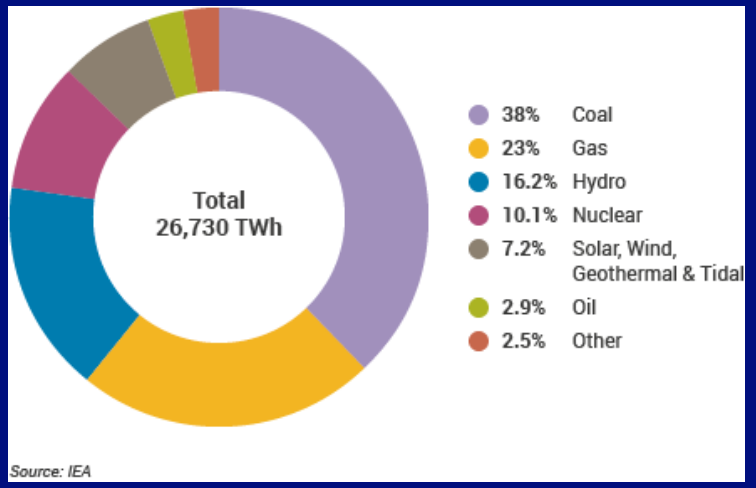
"So many people have contributed to my story. In this journey of finding my home away from home, I've met many who have made me feel welcome, helped me learn the ropes, and provided amazing opportunities for my growth as a scientist."

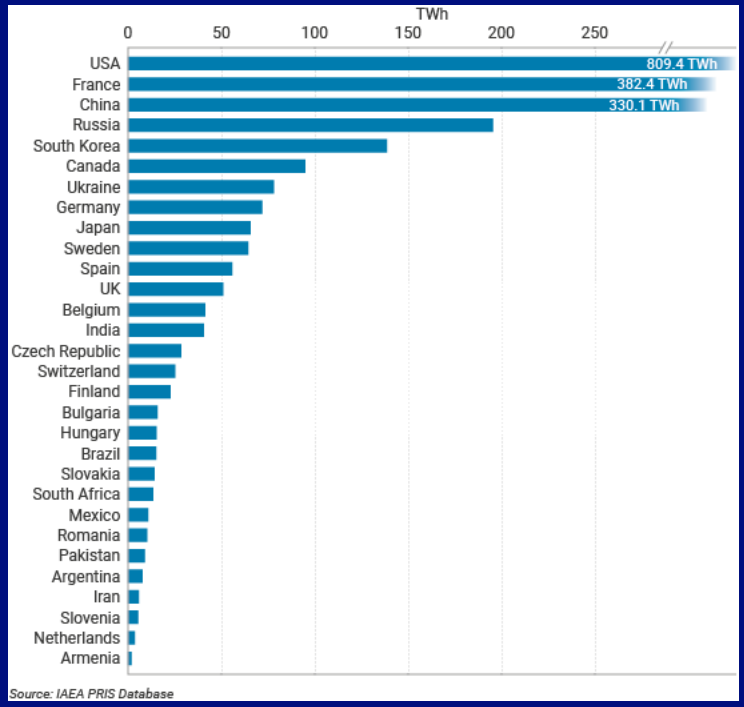
My Work

- Safeguarding nuclear technology
  - Nuclear microreactors
  - Spent nuclear fuel characterization
- Neutron detector development
- Learning and assisting in various training courses

Nuclear Reactors

1. 440 reactors worldwide
2. 94 in USA (20% of energy generation)





But, how does it work?

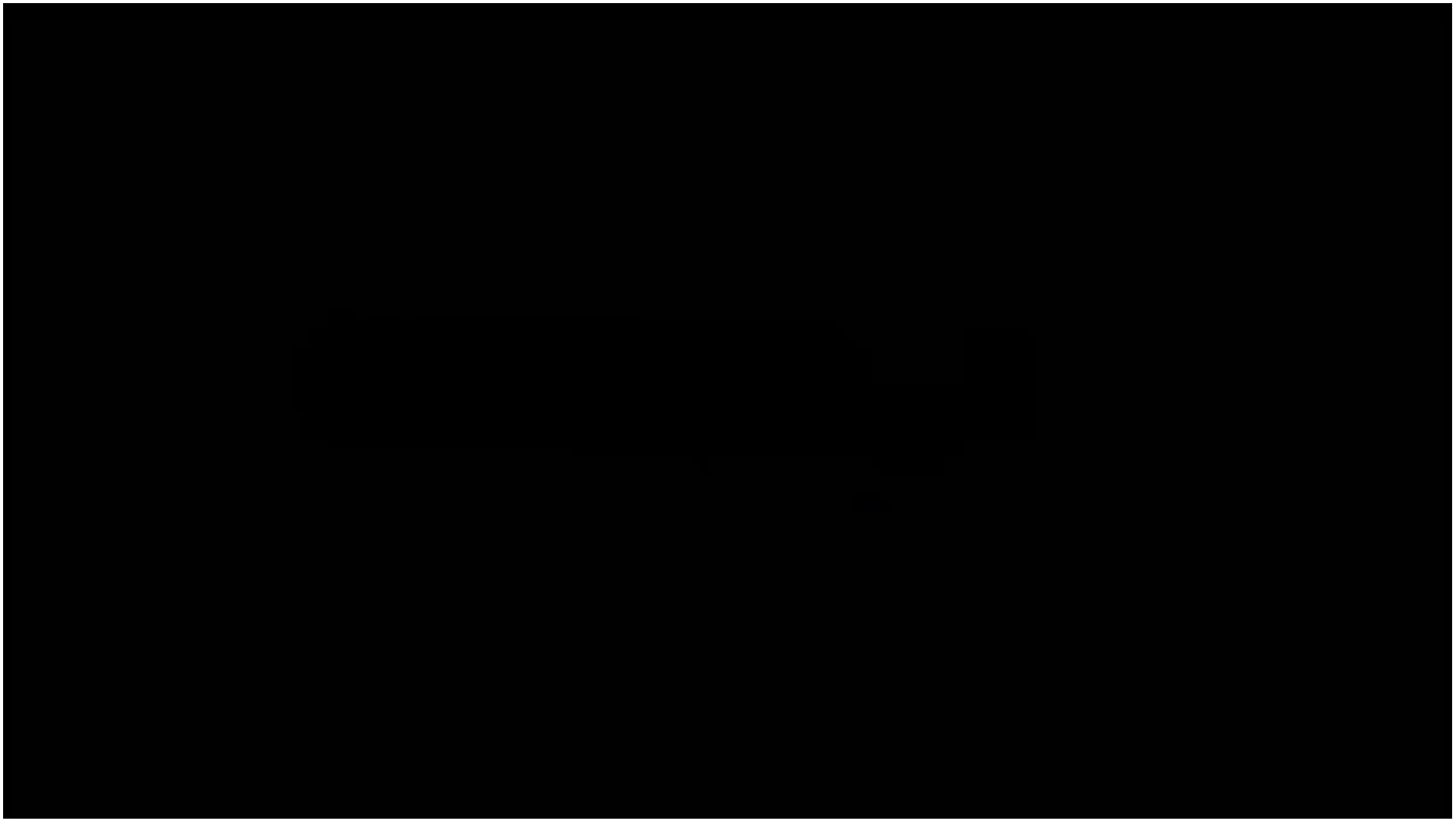
Source” https://en.wikipedia.org/wiki/Pressurized_water_reactor

Disadvantages of regular reactors

1. Very large, provide lots of uninterrupted power
2. Expensive
3. Needs lots of people
4. Long construction time

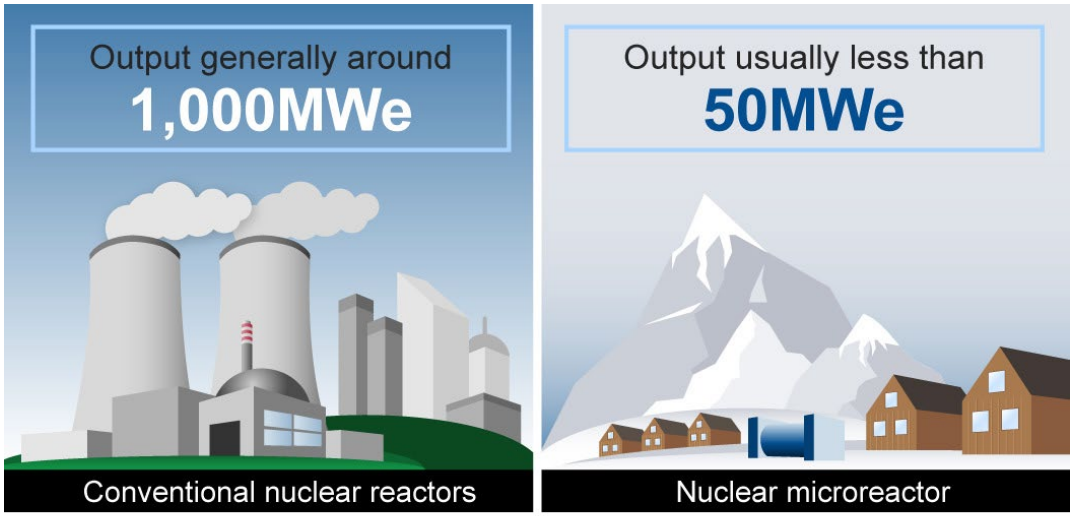
When things go wrong . . .

We need power, and we need in now!



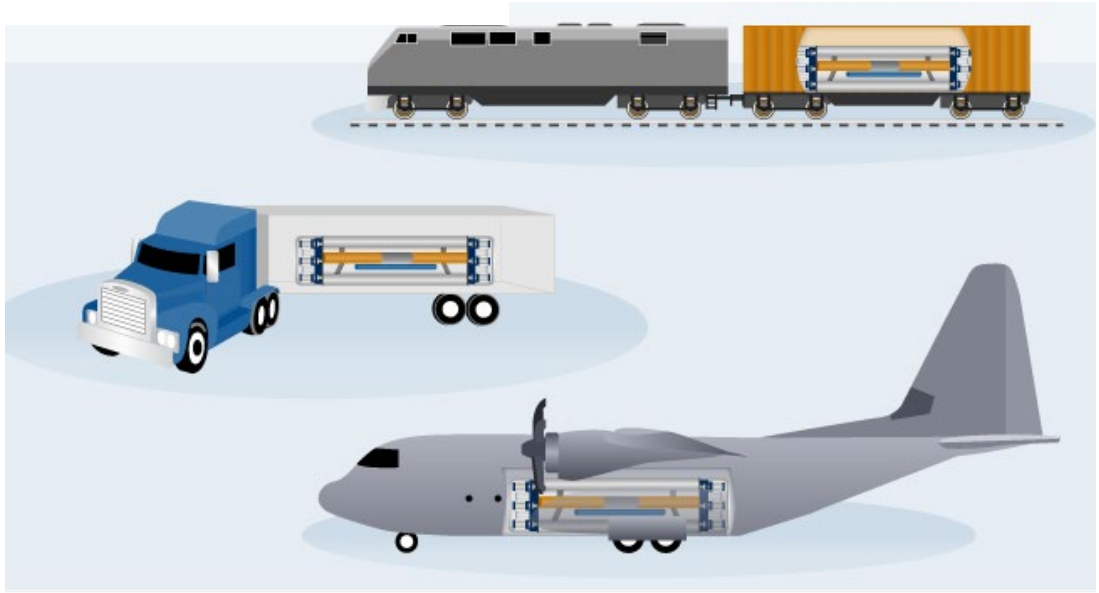
Source: https://www.youtube.com/watch?v=RPI8G6COc8g

Microreactors



Source: GAO. | GAO-20-380SP

- So small, they can fit on a truck!
- Be assembled on site and ready to provide power



Source: GAO. | GAO-20-380SP

Some challenges

- Its out in the middle of nowhere ……
- What if it gets stolen? Oh no!

- Propose nuclear safeguards! This is what I am working on.

- Can we check if the reactor is still there?
- If it is, can we confirm the fuel is all fine?
- What detectors should we use, how many, where?

- Here are some things we considered…

Muon radiography

- Muon radiography measures density (NM has high density)
- Estimate a ~$1-1.5m tracker
- 3D image of the interior – 10cm resolution
- 2 week measurement

Muon radiography measurement and result

Gamma radiography

- 15 MeV X-ray generator
- High dose – safety issue
- Challenge: Imaging detector ‘film’ location

- ~$5m cost
- Better than 1cm resolution
- ~4 hour measurement

Linatron 15 MeV x-ray generator

Neutron interrogation

- 14 MeV neutron generator
- Neutrons interact in low Z materials – not image fuel
- Instead, induce fission and measure emissions
- Questions of efficiency, detector placement, dose, resolution

Phoenix high yield D-T neutron generator

Conclusion

- Science can solve problems!
- Nuclear microreactors have a bright future
- You can do this too!

Dr. Athena Sagadevan
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