

# Neutrino detectors between nuclear safeguards and security

Implications for the future of nuclear-powered submarines

8th Annual SYP UK Conference  
15 March, 2025

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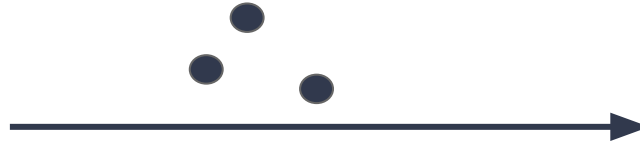
## Emission

Production during e.g.  
uranium fission reaction in  
nuclear reactor → precise



## Travel

Passing through physical  
obstructions and shielding  
over long distances → range



## Detection

# Utility for nuclear safeguards

## Remote monitoring of clandestine nuclear reactors



Figure 4. Reactor area at Yongbyon Nuclear Scientific Research Center on imagery from October 17, 2023. Image Pleiades NEO © Airbus DS 2024. For media options, please contact [thirtyeightnorth@gmail.com](mailto:thirtyeightnorth@gmail.com).

## Tracking nuclear materials for AUKUS & Brazil SSN

### Tracking Nuclear Material Aboard Submarines

June 14, 2022 • Physics 15, s79

Monitoring the fissile material aboard nuclear-powered submarines is notoriously difficult. Researchers may now have a way to safeguard this weapons-grade substance.



gnrph/stock.adobe.com

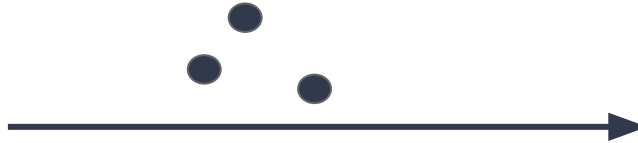
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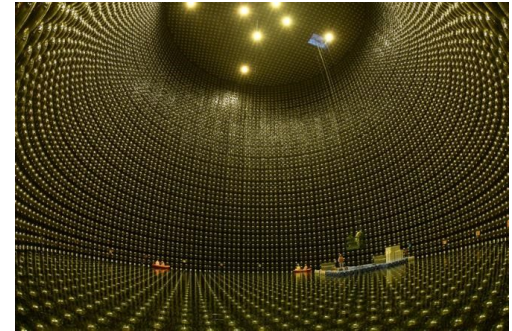
## Travel

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## Detection

Problem → Low interaction  
cross section currently  
requires large detectors + very  
long range monitoring  
unfeasible



# Leveraging natural bodies of water?

Science China / Science

## China adds 'ghost particle' detector to South China Sea observation network

In the darkness of the ocean depths, Chinese scientists are hoping to solve one of the enduring mysteries of the universe

Reading Time: 2 minutes

Why you can trust SCMP



Ling Xin in Ohio

Published: 4:00pm, 8 Feb 2025



# QuSeN: Quantum Sensing of Neutrinos

## Summary

The QuSeN program aims to develop detectors of neutrinos emitted from nuclear reactors and nuclear materials, with greatly increased sensitivity compared to currently used methods. Neutrinos, subatomic particles with a mass near zero, are notoriously difficult to detect.

Current methods for neutrino detection are unable to detect most neutrinos from nuclear activities, and the multi-ton weight of existing neutrino detectors further constrains widescale use.

QuSeN intends to push neutrino detection to the fundamental limits of sensitivity and energy by developing a new class of neutrino detectors that are much lighter, enabling mobility and deployment of detector arrays for distributed sensing. Such neutrino detectors would enable standoff detection and monitoring of nuclear reactors and nuclear materials at greater distances and with faster detection than is possible with detectors in use today.

## FAQs

*As of Dec. 20, 2024*

### Program Manager

Thomas Schenkel  
Program Manager, Defense Sciences Office

[Read bio](#) 

## Opportunity

HR001125S0004

**Publication:** Nov. 5, 2024

**Deadline:** Feb. 3, 2025

[Program solicitation](#)

Does this mean neutrino detectors will render SSBNs useless in the future?



# What would actually change?

## “Ocean Transparency”

→ submarines are trackable already, but neutrino detectors would further improve developing sensor networks to pinpoint SSBNs

Capability

Motive

## “Deterrence”

→ diminished value of sea-based deterrence, but (arguably) no reason to intentionally threaten SSBNs unless in preparation of/amid nuclear war

## Short Term

Development of first mobile detectors

→ strategic chokeholds

## Mid Term

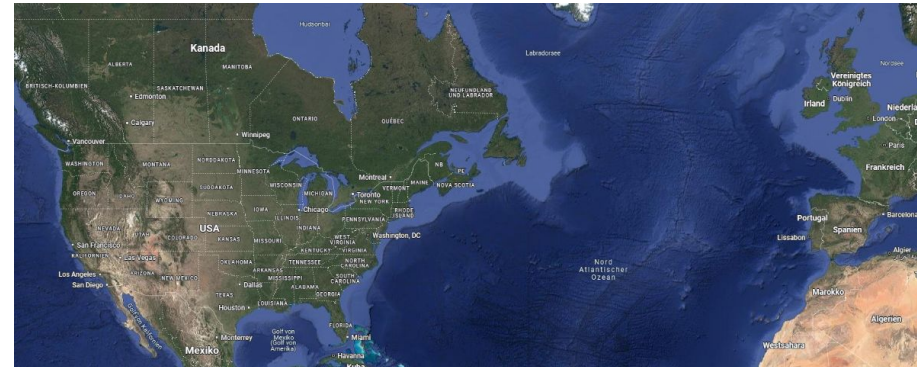
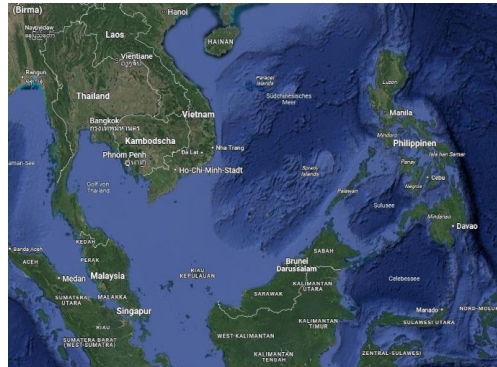
Scaling and spread of technology

→ broader deployment

## Long Term

Maturity and expansion to cover larger areas

→ diminished restrictions from geography



Geography → Short term effects for PRC & R, but how impactful are they really?

# Chase & Kill Capabilities

Detection is not enough.

Submarine needs to be consistently tracked and threatened by military action.



Chinese joint patrols of SSBNs and attack submarines or Soviet Cold War 'Bastion strategy' could still work as a countermeasure.

# Solutions?

Future Arms Control & Defence Planning

# Arms Control

Why limit innovation?

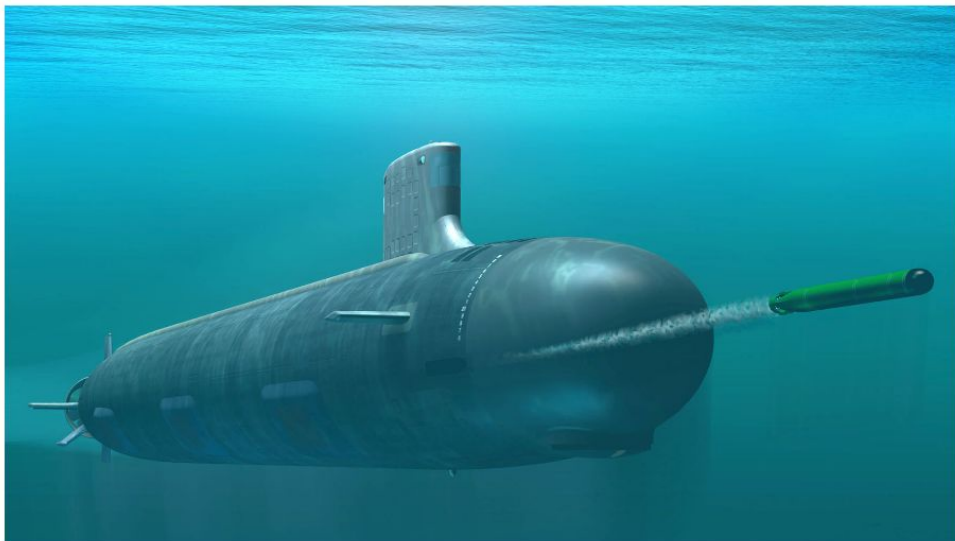
- Potential for military & scientific advances
- Diverging security concerns/costs

How to verify?

- Dual-use dilemma
  - Low distinguishability
  - High integration into sensor network & analysis
- Need to prove absence of detectors

→ **Unlikely**

# Back to Diesel?



Topic: Security Blog Brand: The Buzz Tags: AIP, Military, Navy, Submarines, Technology, U.S. Navy, and US Navy

## Did Sweden Make America's Nuclear Submarines Obsolete?

December 31, 2016 | By: [Sebastien Roblin](#)

## There's a Case for Diesels

By Ensigns Michael Walker and Austin Krusz, U.S. Navy

June 2018 | Proceedings | 144/6/1,384

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*This is the winner in the 2018 Capstone Essay Contest, Submarine Division*

# Takeaways

- Neutrino detectors have great potential to improve scientific knowledge & the nuclear safeguards regime
- Using them for detection of nuclear reactors can pose a potential threat to SSBNs, especially if the technology matures
- But: geography, insufficient kill & chase capabilities, as well as the use of conventional propulsion can limit the impact



More maritime issues  
[syppgermany.com/blue-depths](http://syppgermany.com/blue-depths)



POV: The Chinese neutrino detector in the South China Sea starts glowing all of a sudden

US nuclear submarines:



Our not-so-serious nuclear newsletter  
[syppgermany.com/nrc](http://syppgermany.com/nrc)



# Thanks!