

DEFERRED VERIFICATION

THE ROLE OF NEW VERIFICATION TECHNOLOGIES AND APPROACHES

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Images from IAEA Imagebank, www.flickr.com/photos/ibroomba/3986739735, Altave Omni, U.S. Department of Energy

Revision 2

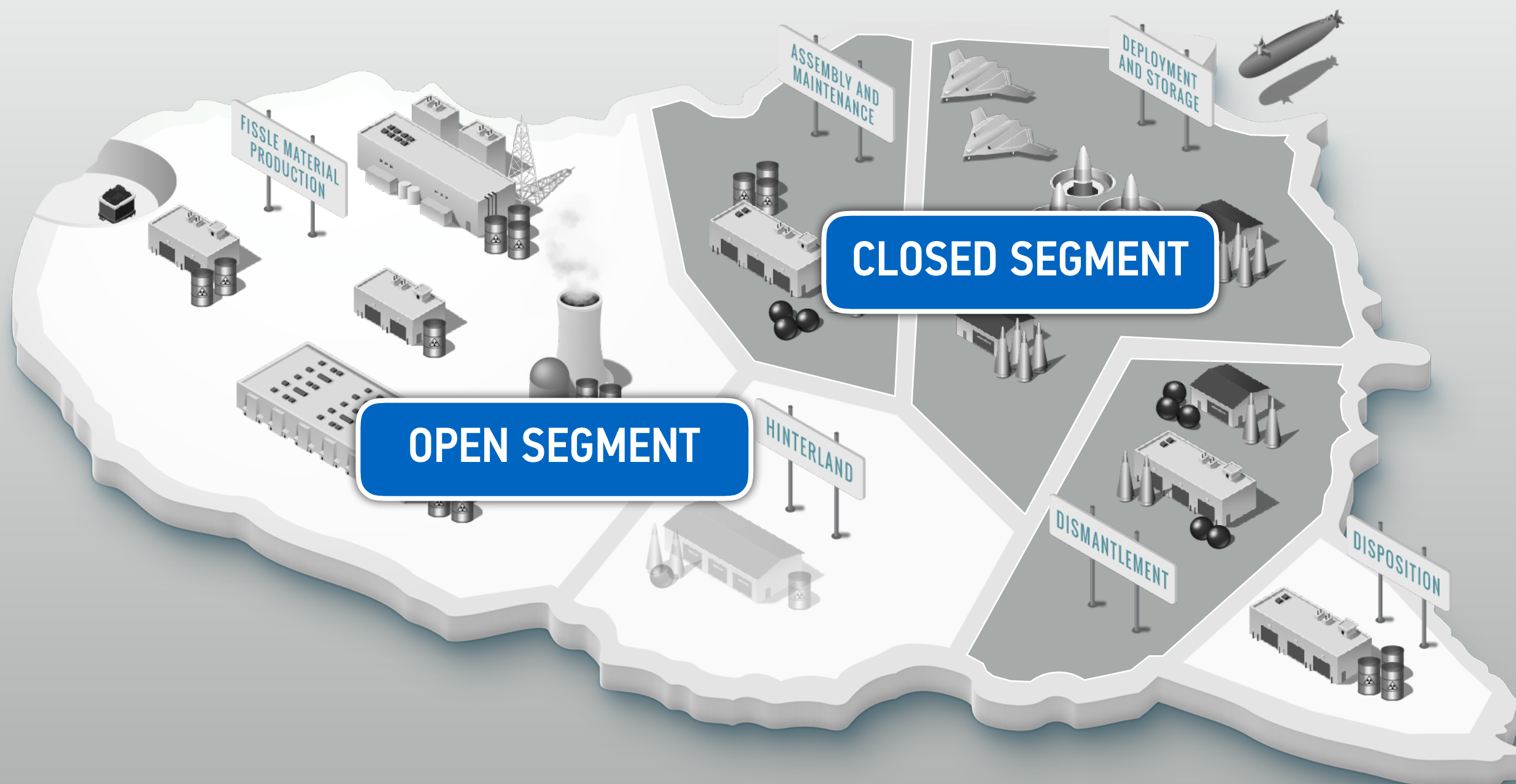
WHAT IS THIS ALL ABOUT?

DEFERRED VERIFICATION: A QUICK OVERVIEW

Pavel Podvig, "Deferred Verification: Verifiable Declarations of Fissile Material Stocks"
59th Annual INMM Meeting, Baltimore, Maryland, July 2018 (Paper #200)

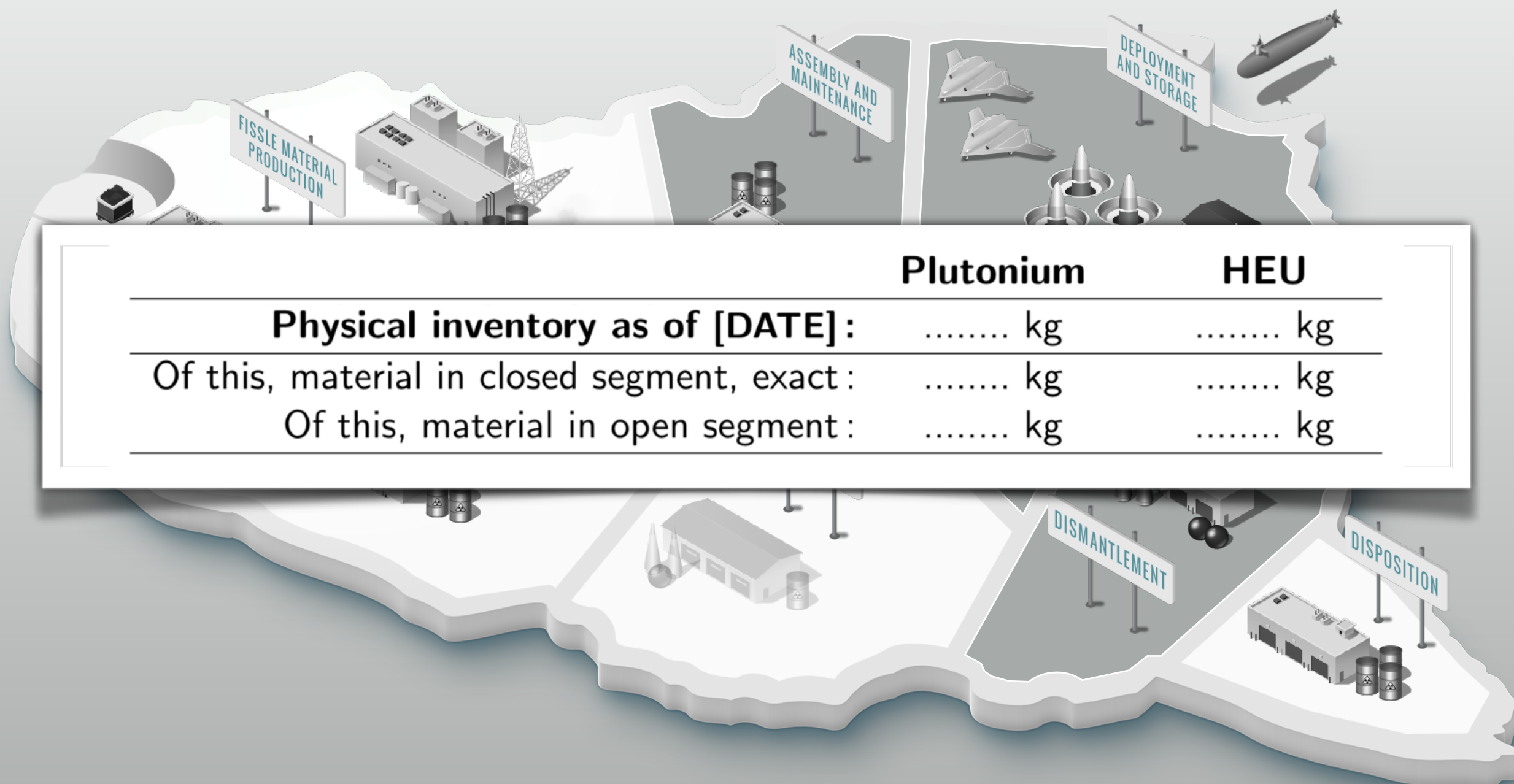
DEFERRED VERIFICATION

DIVIDING UP THE NUCLEAR LANDSCAPE INTO TWO SEGMENTS



DEFERRED VERIFICATION

BASELINE DECLARATION OF FISSILE MATERIAL INVENTORY



	Plutonium	HEU
Physical inventory as of [DATE]: kg kg
Of this, material in closed segment, exact: kg kg
Of this, material in open segment: kg kg

DEFERRED VERIFICATION

SUMMARY OF BASIC CONCEPT



FEATURES OF THE CLOSED SEGMENT

- Includes all items and materials that cannot be made available for inspection
- Inventory must be known and declared with high accuracy
- No access for inspectors to closed segment
- Materials are gradually transferred to open segment; sites “closed out”



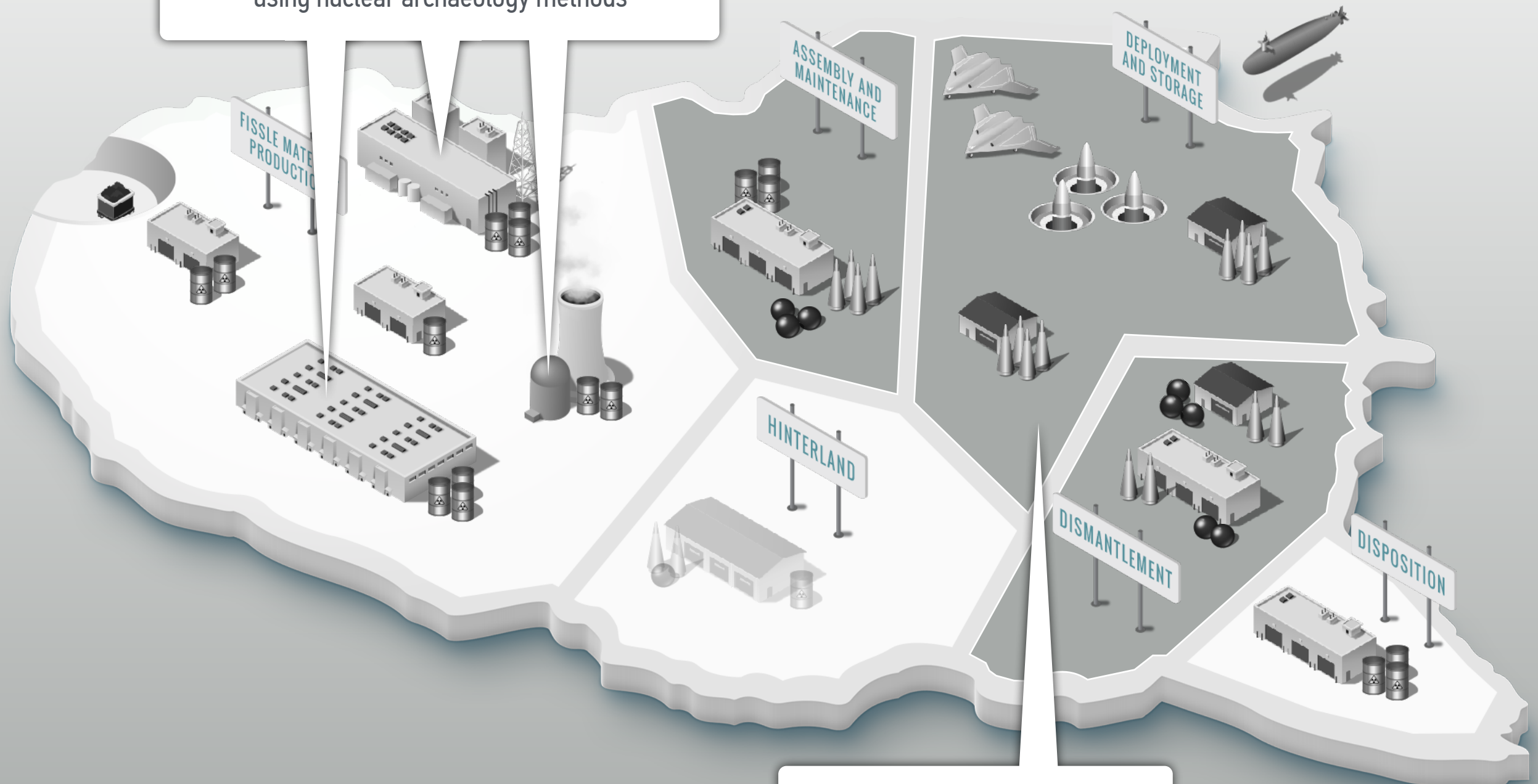
FEATURES OF THE OPEN SEGMENT

- All materials under safeguards; includes all civilian and production sites
- Inspector access anywhere
- Inventory in open segment only known with some uncertainty
- Efforts to reduce uncertainties in open-segment fissile material stockpile

Source: Paul Shambroom (top) and BN-800, IAEA Imagebank, [flickr.com](https://www.flickr.com/photos/iaea-imagebank/) (bottom)

DEFERRED VERIFICATION

Confirming completeness of baseline declarations
using nuclear archaeology methods



Shrinking footprint of
off-limit areas ("closed segment")

DEFERRED VERIFICATION

STRENGTHS ... AND (POTENTIAL) WEAKNESSES



PRO

Would drastically simplify verification of future arms-control agreements *including of an FMCT but also of agreements on deeper nuclear reductions*

No sensitive items (e.g. nuclear warheads) are ever accessed or inspected
Does not need any new verification technologies



CON

Could create new noncompliance scenarios (discussed next)

States may assign excessive amounts of fissile material to closed segment
There may be several reasons for that (most likely “just” convenience)

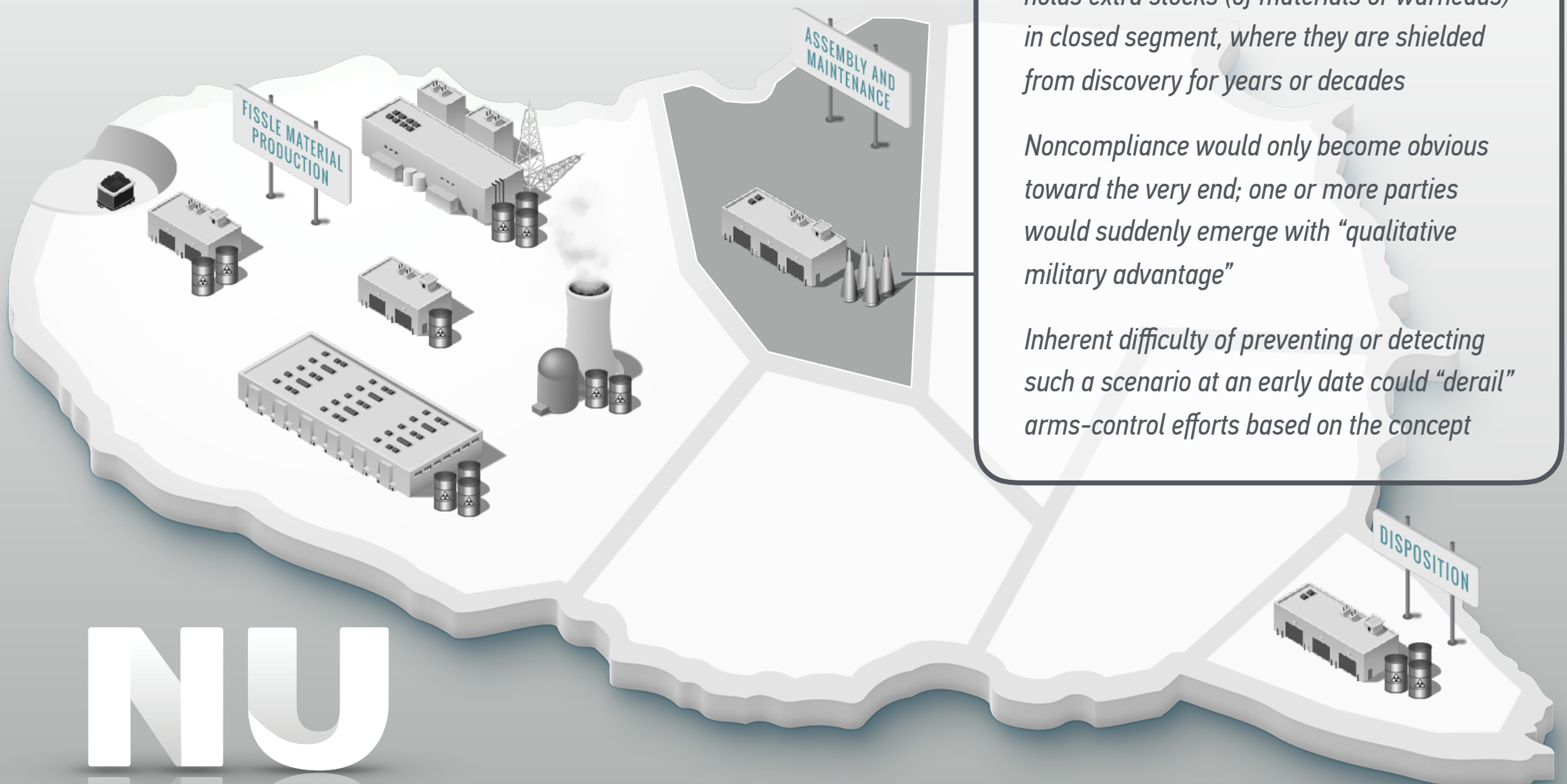
Source: U.S. Department of Energy (top) and UK Nuclear Decommissioning Authority (bottom)

NONCOMPLIANCE SCENARIO(S)

HOW TO CHEAT UNDER DEFERRED VERIFICATION

(HERE ONLY "CLOSED-SEGMENT HEDGE")

CLOSED-SEGMENT HEDGE



NU

www.verification.nu

POSSIBLE STRATEGIES TO STRENGTHEN DEFERRED VERIFICATION

(SELECTION)

MONITORED TRANSFER ZONES

TO BE ESTABLISHED DURING IMPLEMENTATION PHASE



BACKGROUND / CONTEXT

Podvig and Rodgers propose pilot projects for the closed segment
Hosts would declare the exact amounts of material for each of these “sub-segments”
Inventories potentially equivalent to tens of thousands of nuclear weapons,
but it could take many decades before these materials enter the open segment



PURPOSE / CONTRIBUTION OF MONITORED TRANSFER ZONES

Non-intrusive remote monitoring could confirm that materials are not
removed from these zones and serve as a confidence-building measure
Several types of real-time surveillance systems have been
developed for arms-control and international safeguards applications

Source: *Dismantling the Bomb*, DigiComTV, 2010 (top) and Wen L. Hsu, SAND2014-18221PE, SNL (bottom)

UNCONVENTIONAL APPROACHES

(SIMPLE, NON-INTRUSIVE, AND QUICKLY IMPLEMENTABLE)



*Entrance to Storage Magazine at Pantex, Zone 4
Uses 40-ton concrete blocks to prevent unauthorized access
Credit: U.S. DOE*



*Tethered balloons for 24/7 site surveillance
Widely used for civilian and military applications
Credit: Altave Omni, www.altave.com.br*

PERIMETER CONTROL

FOR “VERY LAST” SITES ... TO BE ESTABLISHED DURING COMPLETION PHASE



BACKGROUND / CONTEXT

Military nuclear complex would be relatively consolidated in a world where the number of nuclear weapons is in the low hundreds

Monitoring of the closed segment to address concerns that undeclared stockpile is removed from the site (prior to closeout inspection)



PURPOSE / CONTRIBUTION OF PERIMETER CONTROLLED SITES

Prevent/detect unauthorized removals from a closed-segment site
and deter underdeclaration of fissile material stocks in the first place

Attractive when few sites remain and when fissile material stocks in the closed segment are relatively low, perhaps on the order of 1000 kg

Source: UK Clyde Naval Base, www.onr.org.uk (top), U.S. Department of Energy (bottom)



*Perimeter-control system
at the Votkinsk Machine Building Plant
INF Treaty verification*

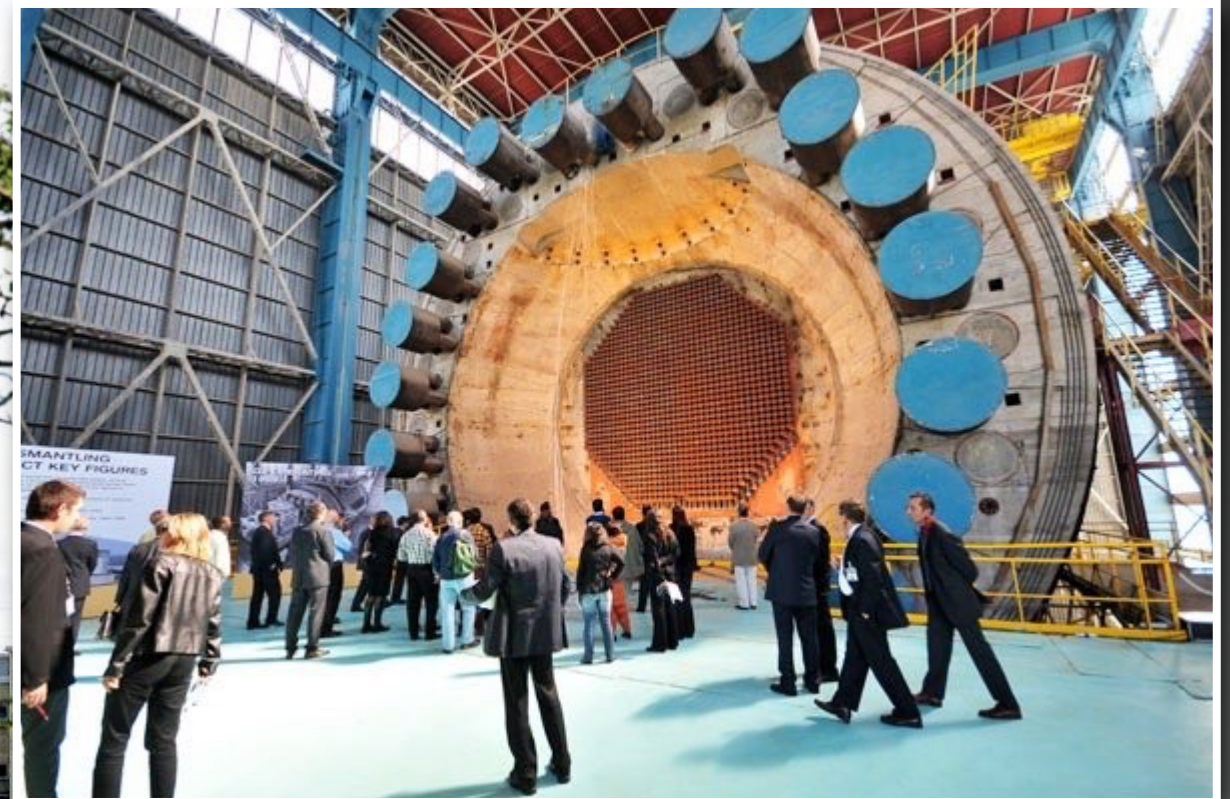
*Tabletop model, Sandia National Laboratories
Source: Author*

ONE MORE THING

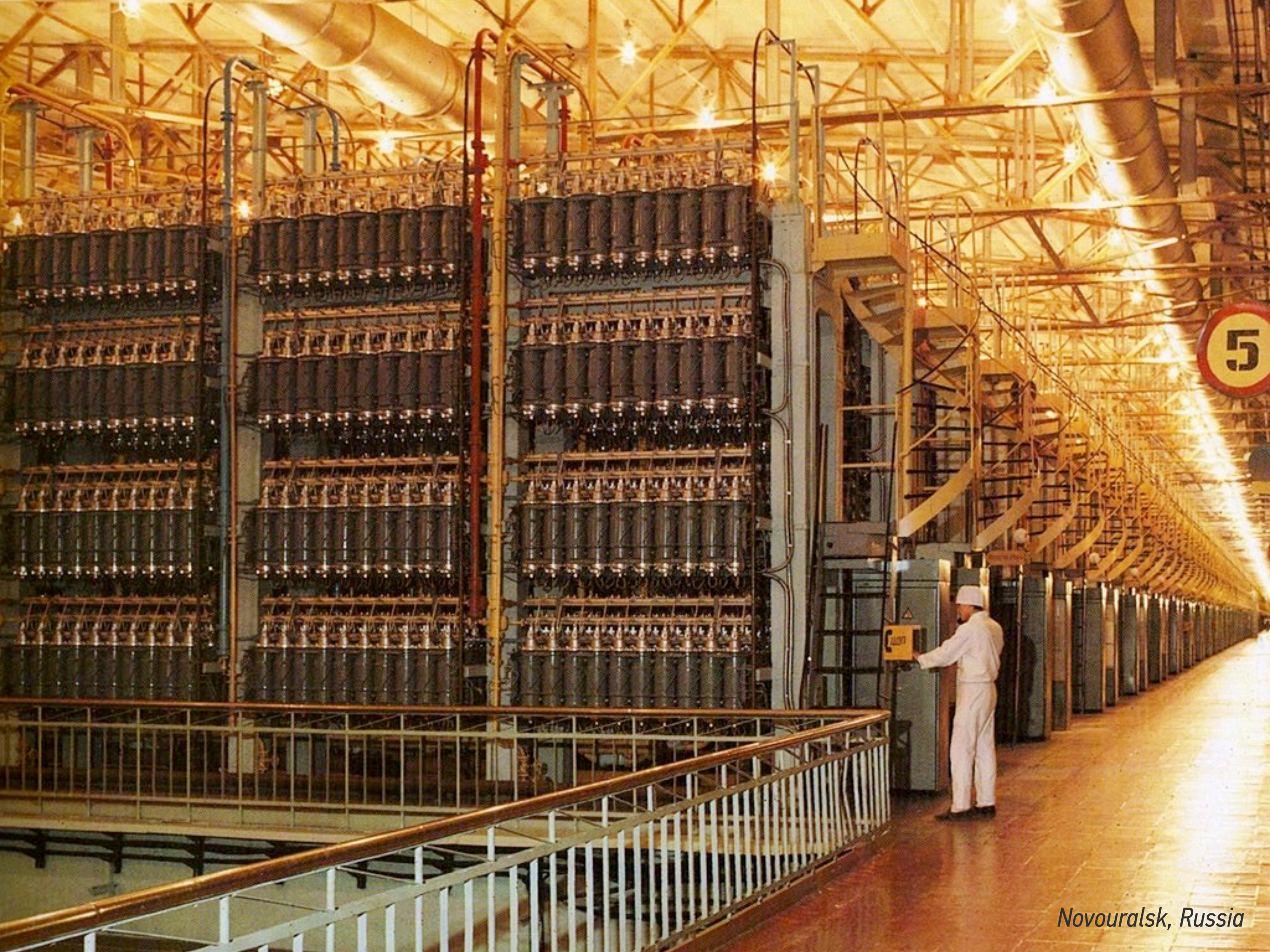
(NUCLEAR ARCHAEOLOGY)

TEST BEDS FOR NUCLEAR ARCHAEOLOGY

RESEARCH, DEVELOPMENT, AND DEMONSTRATION ARE OVERDUE



Left: Windscale Piles, www.sellafieldsites.com
Right: G2/G3, Marcoule, www.francetnp.fr



Novouralsk, Russia

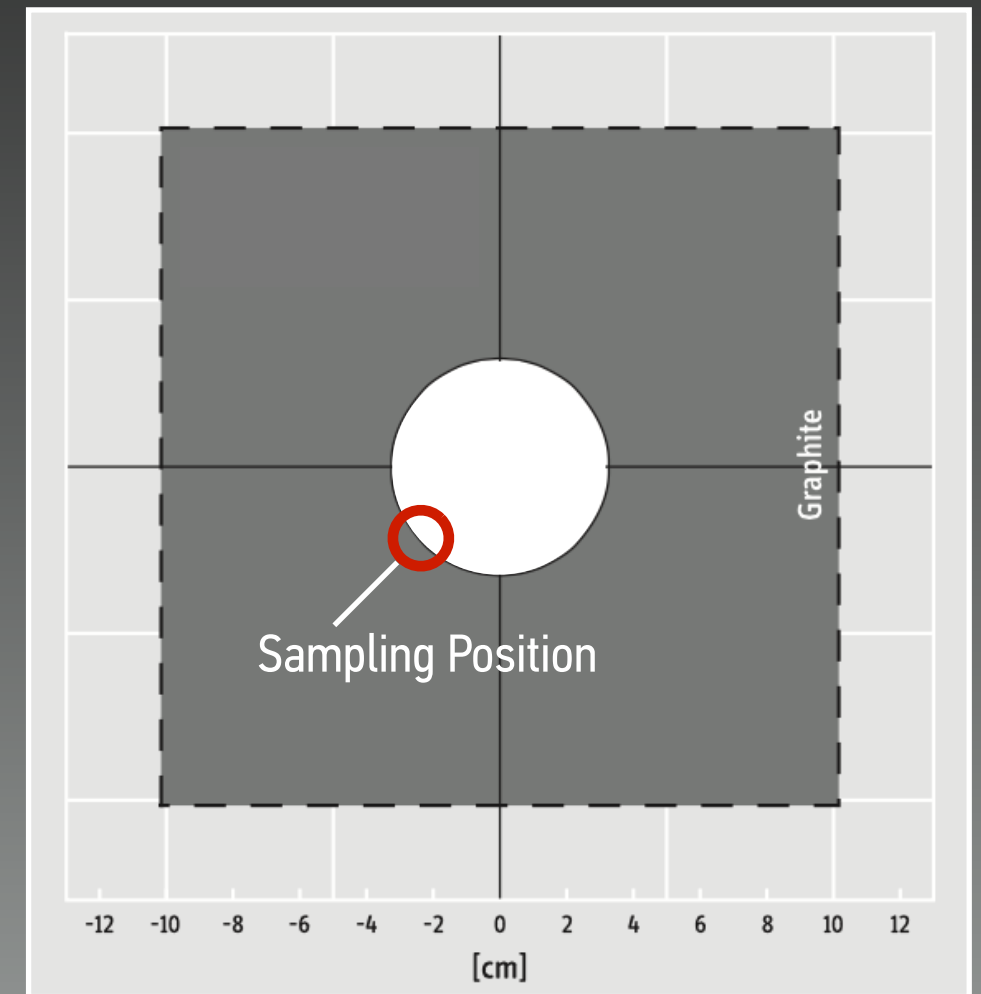
NUCLEAR ARCHAEOLOGY COULD BE USED TO VERIFY A NORTH KOREA'S PLUTONIUM DECLARATION

FORENSIC ANALYSIS OF GRAPHITE SAMPLES COULD CONFIRM TOTAL PLUTONIUM PRODUCTION IN NORTH KOREA WITHIN AN UNCERTAINTY OF ± 3 KG



The banner reads: "Let's protect Dear General Kim Jong Il desperately!"

Credit: CNN/Brian Rokus, 2008



Unit cell of the DPRK Yongbyon reactor

DATA EXCHANGE

AS A BASIS FOR A MORE ROBUST VERIFICATION FRAMEWORK



In May 2008, North Korea made available about 18,000 pages of operating records with information on operation of its plutonium production reactor and the associated reprocessing facility since 1986

CONCLUSION AND NEXT STEPS



DEFERRED VERIFICATION

Offers a fundamentally different approach to nuclear arms-control verification
Nothing new is needed to get started; no sensitive items are ever inspected
Deserves a serious look, ideally, an in-depth assessment comparing the concept to more traditional verification approaches



STRENGTHENING THE CONCEPT

New noncompliance scenarios (in particular, the “closed-segment hedge”) could be largely addressed during implementation phase
Opportunities for R&D on new verification technologies
In particular, on nuclear archaeology, perimeter control, non-intrusive monitoring and secure-information mechanisms (commitment schemes; not discussed)

Source: IAEA Imagebank (top) and www.francetnp.fr (bottom)

