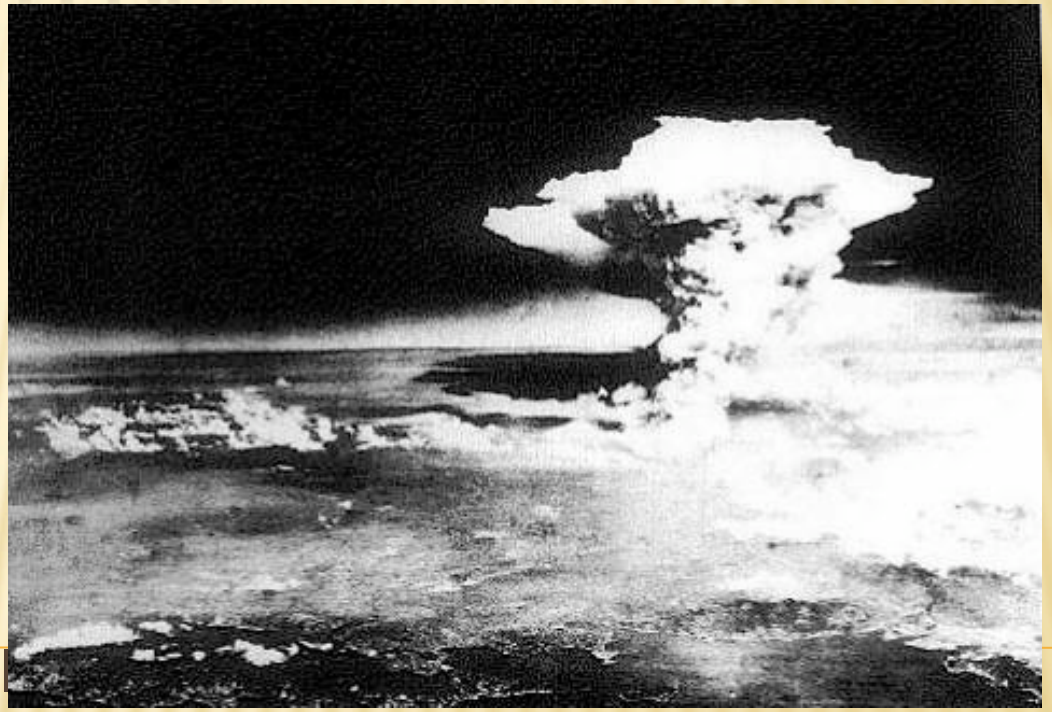
NUCLEAR FORENSICS: PREPARING FOR THE EXPERIMENT ONE HOPES NEVER TO DO



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PRODUCT WARNING INFORMATION

- This talk is at the intersection of physics and national security policy
- It has no equations and no data
- The interesting figures are lifted from the Internet
- It does not guarantee a happy ending
- However, the area is important and an immensely rewarding one in which to work

Be careful, or you could end up doing this sort of thing

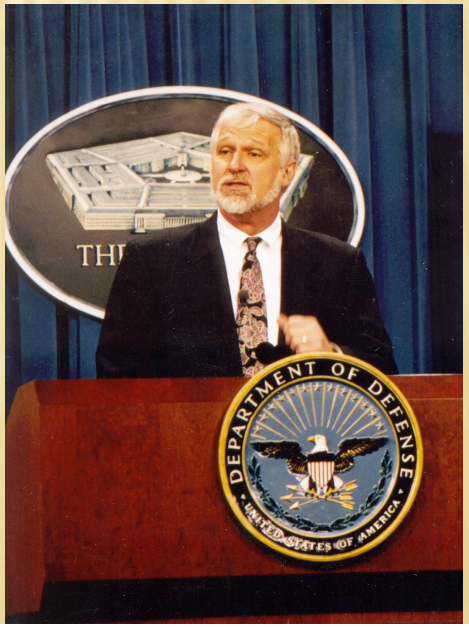
DETONATION OF A NUCLEAR WEAPON IN THE US IS CONSIDERED TO BE THE GREATEST THREAT FACING THE COUNTRY

- President Clinton expressed this threat
- President Bush expressed this threat
- President Obama has expressed this threat
- The danger is not just the human, environmental, infrastructure and economic cost, but the threat to democratic principles resulting from the reaction to the event

Nuclear forensics plays a role in both preventing and responding to such an event

I'VE HAD BOTH TECHNICAL AND POLITICAL INVOLVEMENT WITH THIS SUBJECT

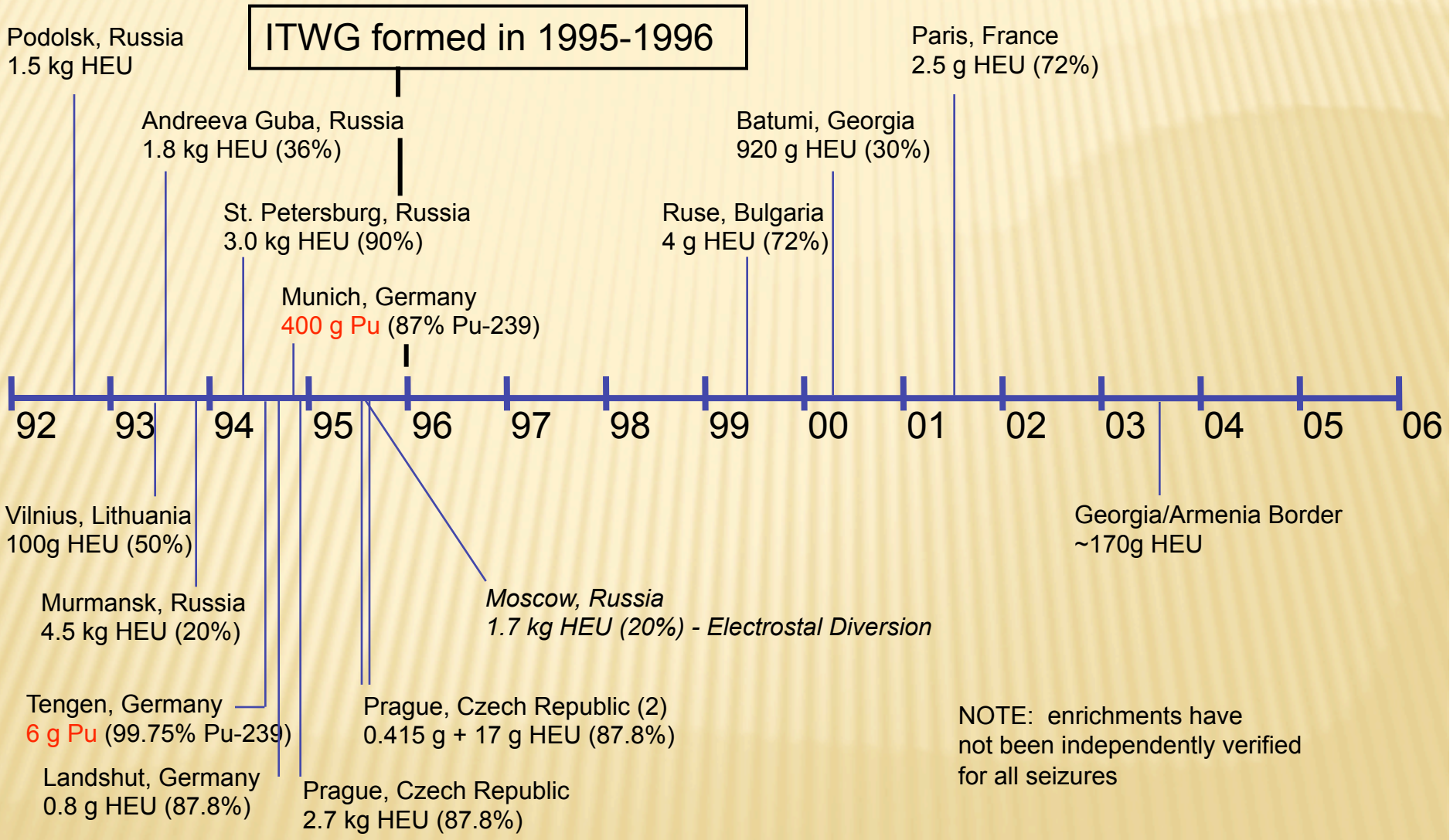
- After the First Gulf War, I did nuclear forensics in Iraq
- At LLNL, I created the lab and group that developed AMS capabilities to measure actinide isotopic fractions
- At DTRA, I started the national program in post-detonation forensics
- In retirement, I serve on review panels evaluating and guiding national activities in nuclear forensics



THE FORENSICS PROBLEM SPLITS INTO PRE-DETONATION AND POST DETONATION ACTIVITIES

- Pre-detonation activities focus on interdiction and identification of materials in transit
  - These are inherently multinational
  - Use unclassified research techniques
  - Move at a normal law enforcement or intelligence timescales
- Post-detonation activities will focus on characterizing and understanding the device
  - These will start as unilateral – and may remain so
  - The techniques are a mix of classified and unclassified
  - The timescale will be screaming panic

AN INTERNATIONAL TECHNICAL WORKING GROUP WAS BORN OVER A DECADE AGO TO ADDRESS POST-COLD WAR NUCLEAR TRAFFICKING



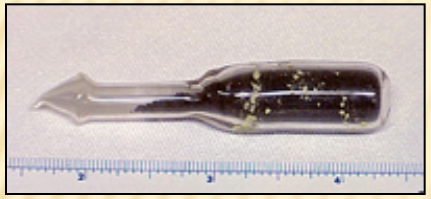
NOTE: enrichments have not been independently verified for all seizures

As of May 2006

CREDIBLE TECHNICAL NUCLEAR FORENSICS CONCLUSIONS RELY UPON A PROCESS OF COLLECTION, ANALYSIS, AND EVALUATION

1. Collection

Interdiction or Garnering Materials



2. Analyses

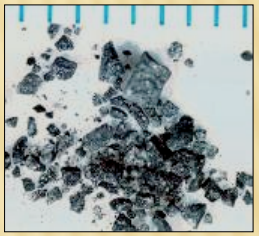
Analyses of Materials

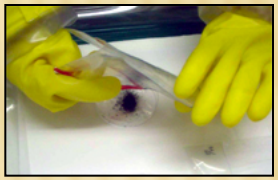
Nuclear Forensics

- Isotopic Composition
- Chemical Composition
- Physical Structure
- Pathways Analyses

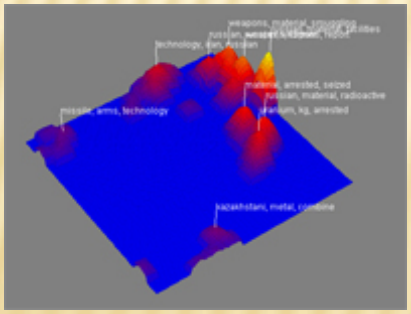
Traditional Forensics

- Latent Fingerprints
- Genetic Markers
- Explosives
- Fibers, Residues, etc.

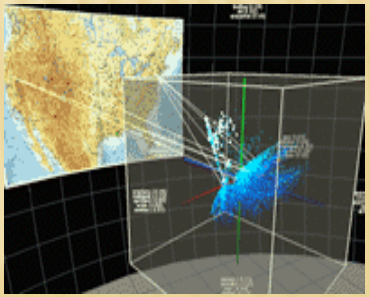




3. Evaluation



Evaluation Tools (KMAS) and Expert Interpretation



Technical Nuclear Forensics Conclusions

MULTIPLE FORENSICS SIGNATURES BUILD CONFIDENCE IN THE INTERPRETATION OF THE SOURCES, ROUTES, AND PERPETRATORS INVOLVED IN THE NUCLEAR SMUGGLING ENTERPRISE

Non-nuclear forensics

Nuclear material forensics

Wax material fingerprint

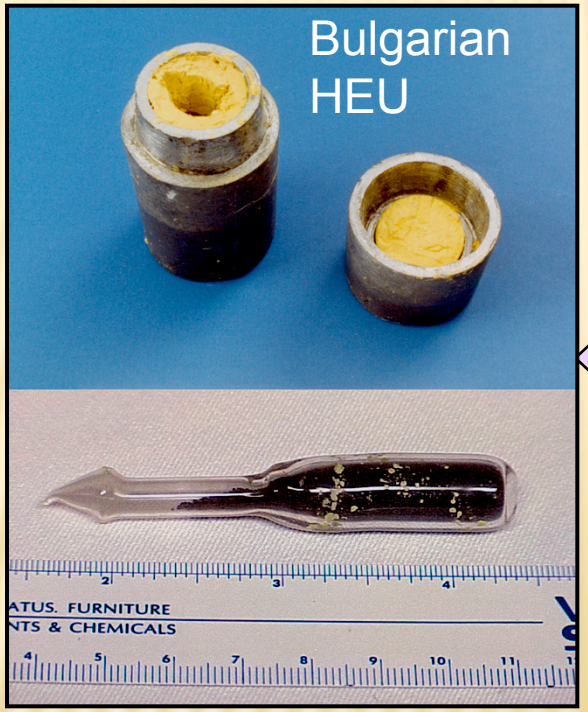
Wax colorant

Paper origin

Pb metallurgy

Pb isotopics

Ampoule material



Morphology

Stoichiometry

Impurity elements

Residual radionuclides

Age-dating

U & Pu isotopics

Highly-enriched uranium (~4 grams)
Trace plutonium

THERE IS A ROBUST AND EFFECTIVE INTERNATIONAL PROGRAM IN PRE – DETONATION FORENSICS

- However
  - There are no universal databases of nuclear materials properties
  - Different states have different classification rules about weapons materials
  - Nuclear fuel data (alloys, cladding, burnable poisons) is restricted for obvious commercial reasons
  - Different states have very different views on the nuclear risks to themselves
  - Some states watch but do not yet play

POST–DETONATION NUCLEAR FORENSICS IS NOT A NEW SUBJECT

- All the necessary technical tools were well developed and exercised in the Cold War
  - Against the nuclear weapons tests of other states
  - But our goal was design information, not attribution
- What is new is the need to execute this task fast, in public, and against an unknown perpetrator
- Success will require sharing information and resources and exercising and evaluating multiple agencies together – not a common governmental core competency

WHAT IS NEW IS A CHALLENGE POSED BY HANS MARK IN 1990

- He pointed out that relaxation in US-Soviet tensions made use of a single weapon more likely
- That such a weapon would likely be used in tribal, sectarian, or terrorist application
- That the weapon might be unattributed
- …and that we had not prepared to work that problem

I got religion on this issue then and became a real pain to many organizations – but remember that classical investigative techniques might solve the problem

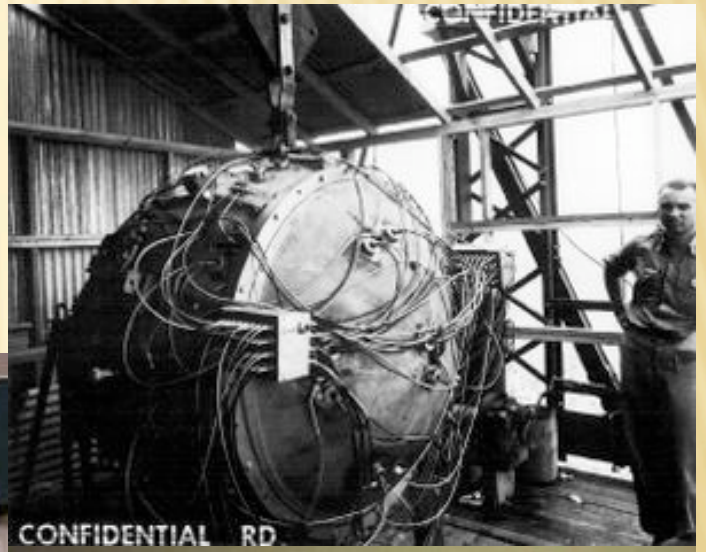
AN UNATTRIBUTED WEAPON COULD HAVE MULTIPLE SOURCES

- One intentionally smuggled in by a peer state
- One lost by a peer state and used by a terrorist
- One built by a rogue state with a small covert weapons program
- One built by terrorists from materials supplied or lost by a weapons state
- One sold by a weapons state
- One diverted from the inventory of a collapsing weapons state

The goal of forensics is to try to differentiate among these cases

AN UNATTRIBUTED DEVICE COULD BE OF VARYING SIZE AND SOPHISTICATION

- Here are three candidates
  - The Trinity Device
  - One of our weapons -- a SADM
  - A hypothetical Russian suitcase bomb



AUTHORITY AND ABILITY ARE WIDELY DISPERSED FOR THIS PROBLEM

- The Intelligence Community owns the National Technical Means that detect an explosion and measure yield
- The FBI owns response to terrorism and development of evidence for prosecution
- State and local authorities own the consequence management issue – assisted by the Federal Government
- DOE owns the analytical tools and the weapons codes to work the inverse problem
- DHS has the responsibility for “Securing the Homeland”
- State has the authority to manage response overseas
- DoD has responsibility for operations overseas and, inevitably, the resources to back everyone else up

The multiple interactions and handoffs in this community are now tested in exercises against the clock

THE PRESIDENT'S QUESTIONS ARE:

- Was it really nuclear and was it ours or Russian?
- How big is the event?
- Is there another one?
- What steps do we now take to prevent a subsequent event?
- How did it get there?
- Where did it come from?
- Who did it?

ANSWERS WE CAN REALLY GIVE – EVENTUALLY

- It was really nuclear and the yield was?
  - From NTM – Maybe!
- It used Plutonium or Uranium
  - Field measurements
- It had 14 MeV neutrons
  - Field measurements
- Efficiency of burn of the fuel
  - From fuel isotopics in recovered samples
- Weight of the fuel, hence device sophistication
  - From combining yield and efficiency
- Fuel production technique
  - From stable isotopic signatures in recovered samples
- Design details and sophistication
  - By comparing all signatures with forward runs of design codes

All this data combined with intelligence and FBI information may lead to attribution

EARLY YIELD DETERMINATION WILL COME FROM SATELLITES

- Both GPS and DSP constellations carry optical nuclear detectors
  - Quaintly called “Bhangmeters”
- Originally designed for treaty monitoring, they have forensic value
- Exact sensitivity, accuracy, and system response time are classified

IN THE PRESENT CONSTRUCT OF THE FORENSICS PROGRAM

- The intelligence community has to deliver yield information quickly
- FBI and DoD have to expedite access to the site and provide transport and chain of custody of the samples
  - Though it may be possible to grab airborne samples rapidly with RPVs or fighter aircraft
- The national labs have to operate 24X7 in analysis mode
- An oversight group has to vet technical results and inferences
- The FBI and intelligence Community have to practice integrating technical results with other data
- The political establishment demanding an answer has to understand what is possible – and on what timeline
- The public has to be informed and reassured

And all this has to work under hysterical pressure!

THE PROGRAM OPERATES AT VARYING LEVELS OF OPENNESS

- Databases of nuclear materials are a mix of unclassified and classified, open and proprietary
- Sample and information acquisition methods may be open or classified
- Most of the analytical techniques are well established research tools, are peer-reviewed, and meet the "Daubert" criteria for admission in court
- The weapons codes used to draw design inferences are obviously classified and will remain so
- The ease of exchange of information depends on to whom one is talking – much information flow depends upon personal relationships

DEFINING OUR POLICY GOALS IS ESSENTIAL TO INTERNATIONAL COLLABORATION

- Our priorities post-detonation are:
  - Sustain the authority and credibility of the Government
  - Determine the probability of further events
  - Manage the consequences of the present event
  - Motivate the population to take appropriate protective measures
  - Determine the source of the weapon and the likely perpetrators
  - Decide what prosecution or retribution steps to take
- We need foreign participation to:
  - Provide data on fissionable materials before the event
  - Tighten materials and information controls before the event
  - Assist us in pursuit and capture of perpetrators after the event

We do not want to overplay forensics as deterrent activity, confusing attribution with retribution

IN TERMS OF TECHNOLOGY

- We need new systems and instrumentation for rapid sample acquisition and in-field analysis
- We need to revamp our in-lab equipment and optimize it for the speed of this task
- We need a new generation of experts
- We need to use our weapons codes to model the thousands of device cases that we might see – almost all of which look nothing like our own weapons

IN TERMS OF OPERATIONS

- We need to decide how many events we anticipate handling
  - And staff appropriately
- We need to exercise all components of the program regularly against real cases and with real timelines
- We need to institutionalize the review and feedback process as the Military does in its war gaming
- We need to train the Cabinet Members in their roles and what can be expected
  - And ensure that this knowledge carries across changes of Administrations
  - And deal with the average tour of duty of twenty-seven months of a Presidential Appointee

IN TERMS OF PRACTICE

- Exercises for this capability need to be run at all the levels appropriate for emergency response:
  - Tabletop
  - Step play
  - Full field and home exercises with the clock running
- The exercises should be used to evaluate and determine:
  - Doctrine
  - Policy questions for investigation
  - Organization
  - Equipment
  - R&D for future needs
- Results of these exercises should influence careers and budgets
  - As they do in the military

IN TERMS OF COMMUNICATION

- The Government needs to :
  - Decide what to say about the program to the public
  - Determine who is the best spokesman at the best time
  - Consider how its messages will be heard by multiple constituencies
    - Agencies
    - Members of Congress
    - The citizenry at large
    - Foreign governments and populations
  - Subject itself to tests of performance in this area

Poor communication in these situations can make matters worse!

THE CURRENT STATE OF THE GAME

- The US has a competent and practiced program of post-detonation forensics
- The policy decision needed is to resource it appropriately in the defense, counter-proliferation, and non-proliferation portfolio
- The program needs then to be explained to the public and the international community and to be practiced against its possible need – here or abroad

WHAT'S IN PLAY THAT WOULD AFFECT THE PROGRAM?

- The recent APS/AAAS unclassified study of the program endorsed it and made strong resource recommendations
- The NAS classified review in progress will be able to address research and operational needs more deeply
- There is a proposal for Track II talks with the Russians on this subject – opening the most important door
- In the reshaping of the nuclear weapons program that is now in progress, the nuclear counter terrorism component will likely have a much larger role

I HAVE SEVERAL IMPORTANT ACKNOWLEDGEMENTS TO MAKE

- To Hans Mark, for sensitizing me to this issue eighteen years ago
- To Deputy Secretary of Defense John Hamre, for being willing to give me $25M a year when I was Director of DTRA to work a problem that might not have had a solution
- To David Smith at Livermore, for the loan of some great visuals
- To an unnamed agency for supplying the scenario
- To many people at DTRA, Los Alamos, Sandia and Livermore, for following me into a dark place and actually coming out on the far side with technical and operational success
- And to you, for listening to this strange talk at the intersection of physics and politics