IAFF 6101
International Affairs Cornerstone

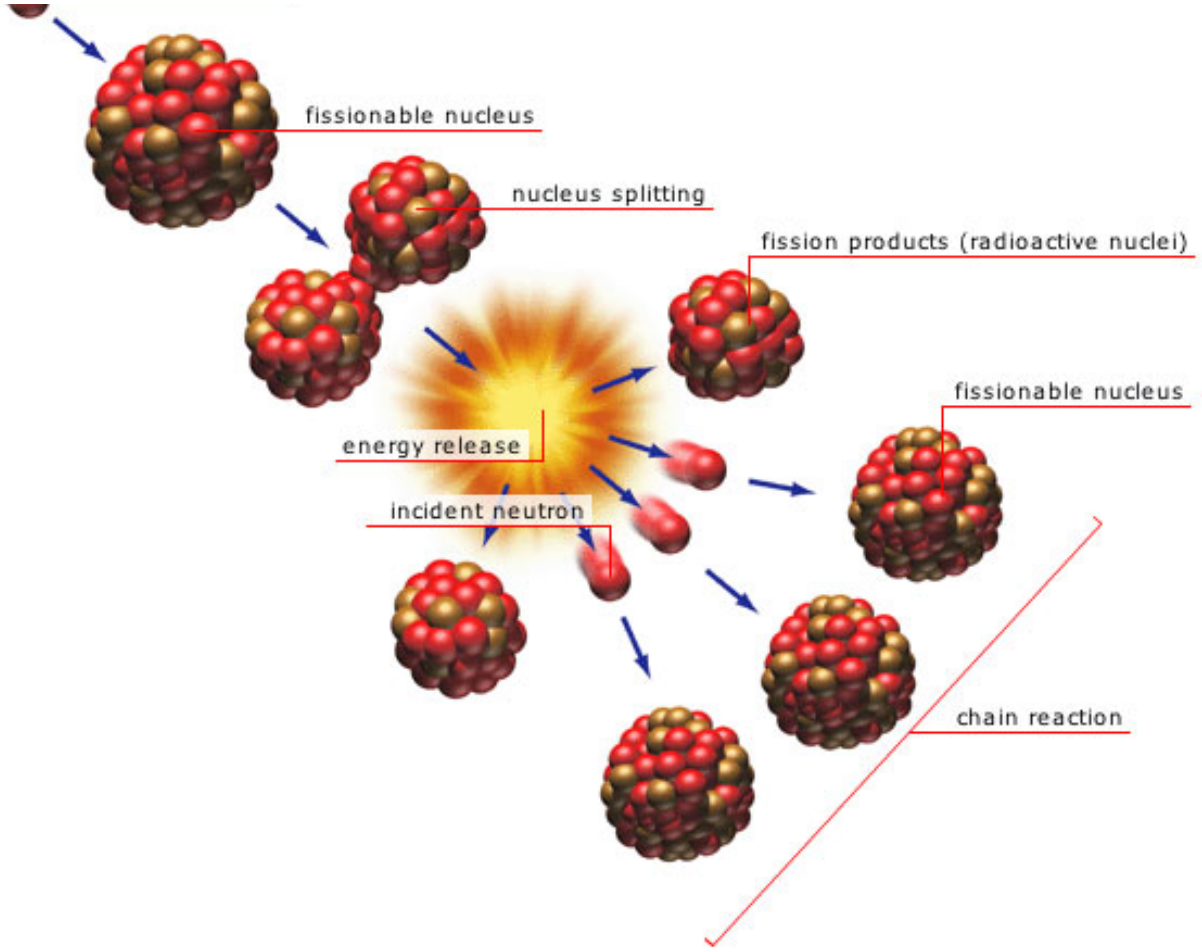
Lecture 6
Nuclear Proliferation

October 18, 2016

Today's Class

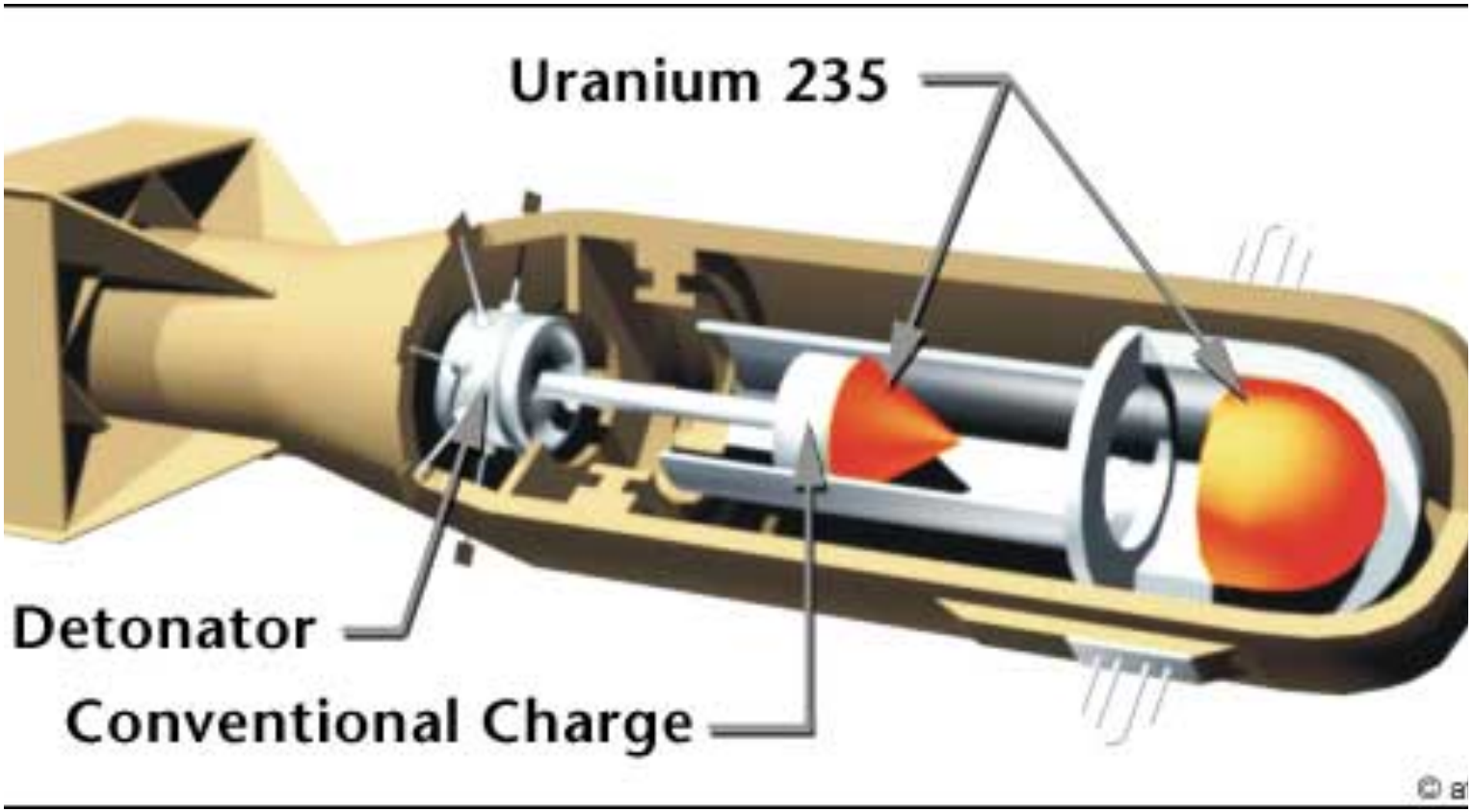
- **Nuclear weapons and nuclear arsenals**
- Technology of proliferation
- Causes of proliferation
- Is proliferation dangerous?
- Iran

Nuclear Fission



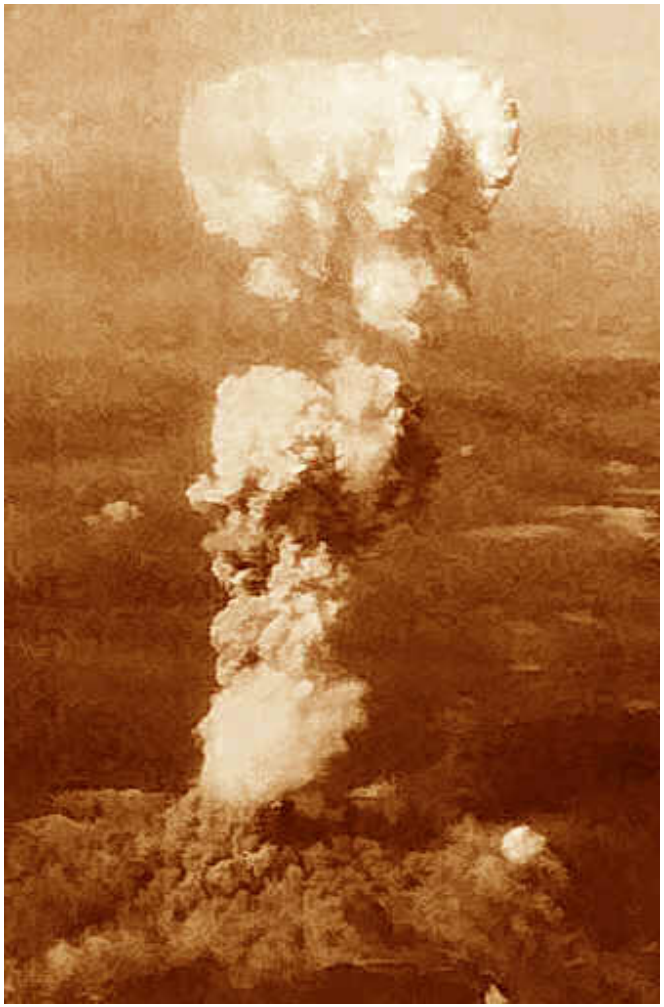
Fission Weapons: “Gun” Type

- U-235



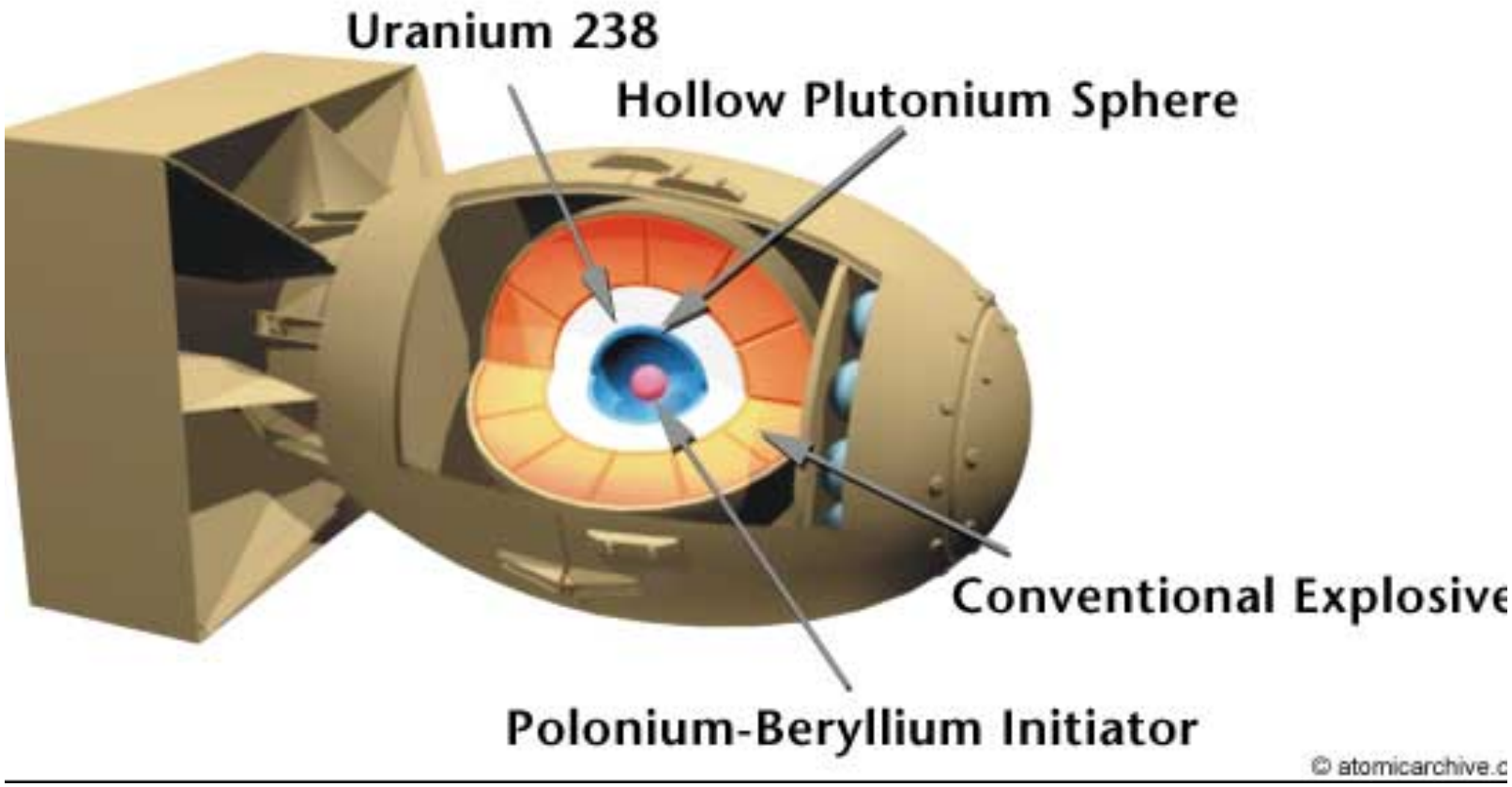
Fission Weapons: “Gun” Type

- Little Boy (Hiroshima)
  - 15 kilotons



Fission Weapons: “Implosion” Type

- U-235 or Pu-239

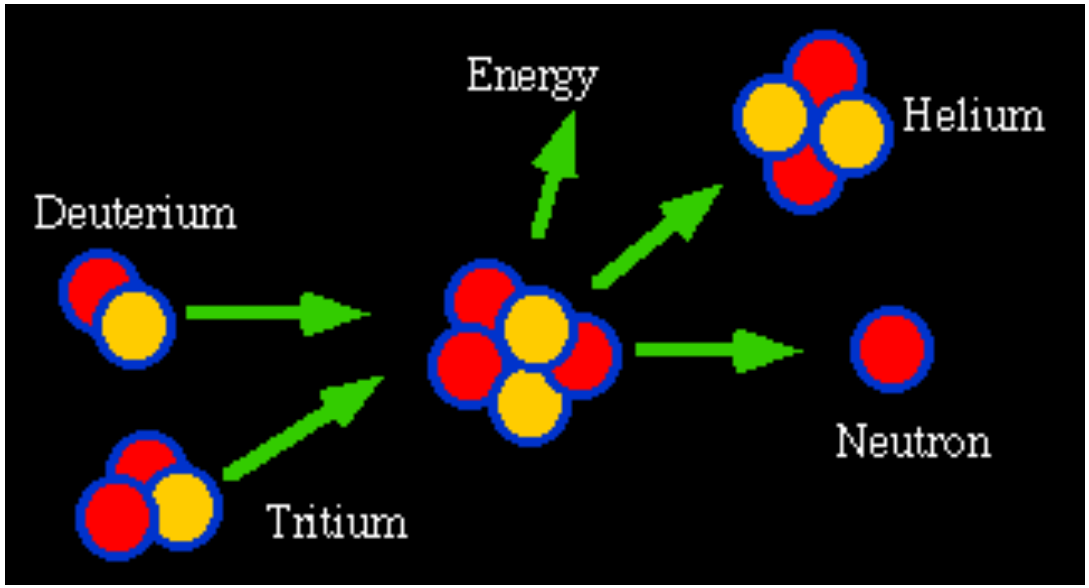


Nagasaki: August 9, 1945

- Fat Man (Nagasaki)
  - 22 kilotons

Fusion Weapons

- "Thermonuclear" or "Hydrogen" bomb
- Fission explosion ignites fusion of hydrogen isotopes
- **Much** more powerful than fission alone
- U.S. first tested in 1952, Soviets in 1953



The Triad: Bombers

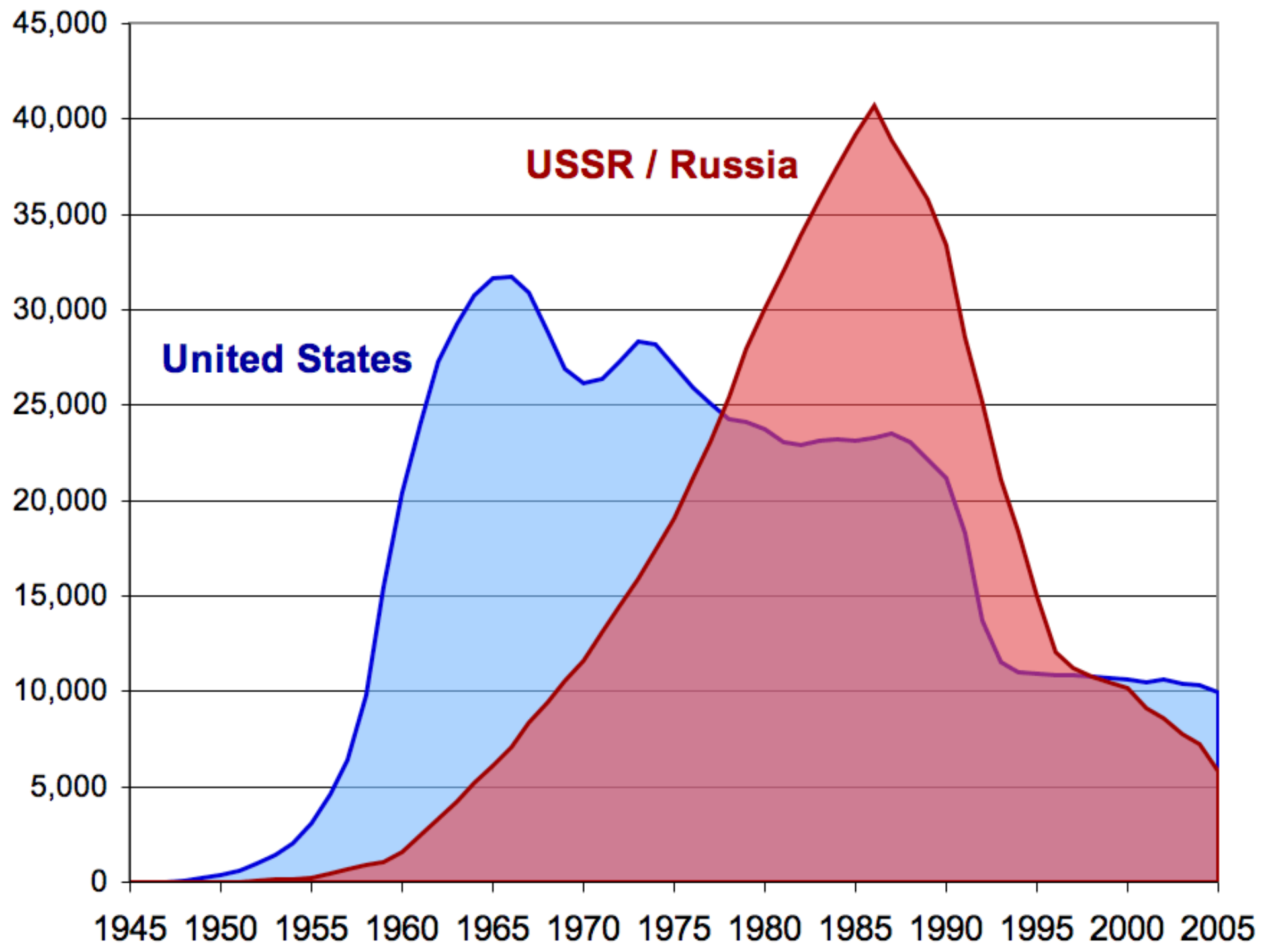
- **B-29, B-36, B-52, B-2**
- **Strengths**
  - You can recall them!
- **Weaknesses**
  - Vulnerability to interception

The Triad: ICBMs

- Land-based intercontinental ballistic missiles
- Multiple warheads possible (MRVs or MIRVs)
- Strengths: reliability, command-and control
- **Weaknesses**: vulnerability

The Triad: SLBMs

- Submarine-launched ballistic missiles
  - Entered service in 1961
- Strengths: nearly invulnerable because they're hard to find
- **Weaknesses**: command-and-control


45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
USSR / Russia
United States
1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005

The Current U.S. Triad

	Warheads	Delivery Vehicles	Type
Bombers	300	60	B-52, B-2
ICBMs	450	450	Minuteman III
SLBMs	1,152	288	Trident II D-5
Total	**1,902**	**798**	

Hans M. Kristensen and Robert S. Norris, "U.S. Nuclear Forces, 2015," *Bulletin of the Atomic Scientists* 71/2 (March/April 2015): 107-19.

Current U.S. and Russian Arsenals

	U.S.	Russia
Operational Warheads	**1,902***	**1,600**
Reserve	2,680	2,700†
Awaiting Dismantlement	2,340	3,500
Total Inventory	**7,100**	**7,800**

* The United States also has 180 non-strategic (tactical) warheads deployed in Europe
† 700 of the warheads in Russia's reserve are strategic warheads; the remaining 2,000 are non-strategic (tactical) warheads
Under the terms of the New START Treaty, deployed warheads for both U.S. and Russia will drop to 1,550

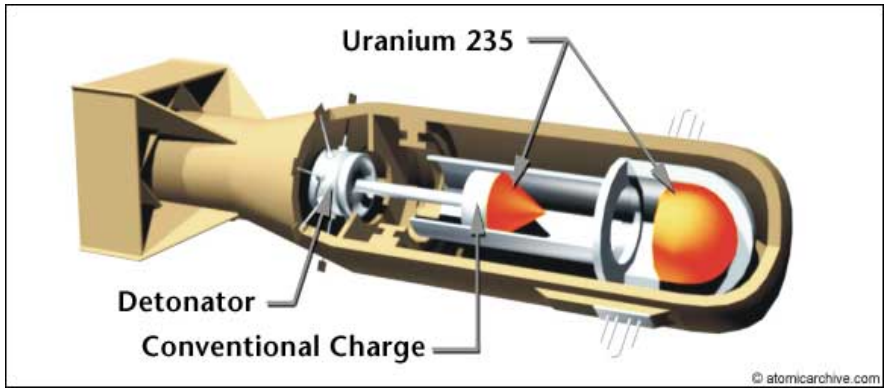
Other Nuclear Arsenals

	Total Inventory	Method of Delivery
France	300	SLBMs, aircraft
China	240	ICBMs, aircraft
Britain	225	SLBMs
Pakistan	120	Aircraft, missiles
India	110	Aircraft, missiles
Israel	80	Aircraft, missiles
North Korea	<10	NA

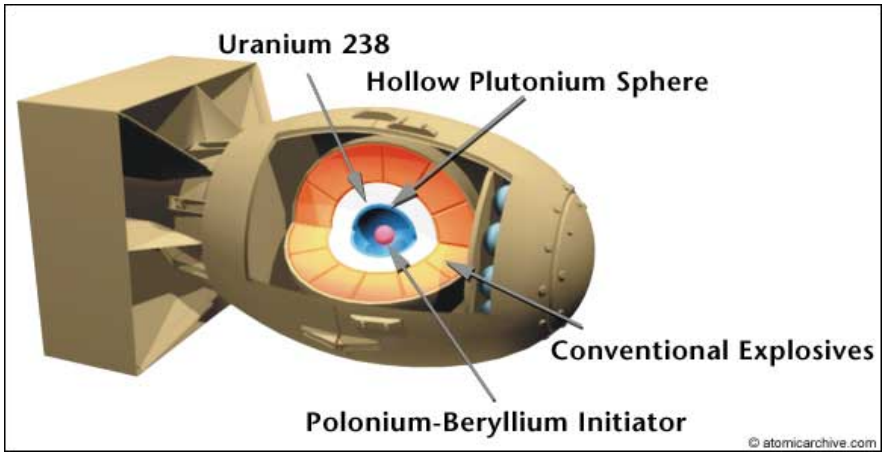
Hans M. Kristensen and Robert S. Norris, "Global Nuclear Inventories, 1945-2013," *Bulletin of the Atomic Scientists* 69/5 (Sept.-Oct. 2013): 75-81.

Two Types of Bomb Fuel

Highly enriched uranium

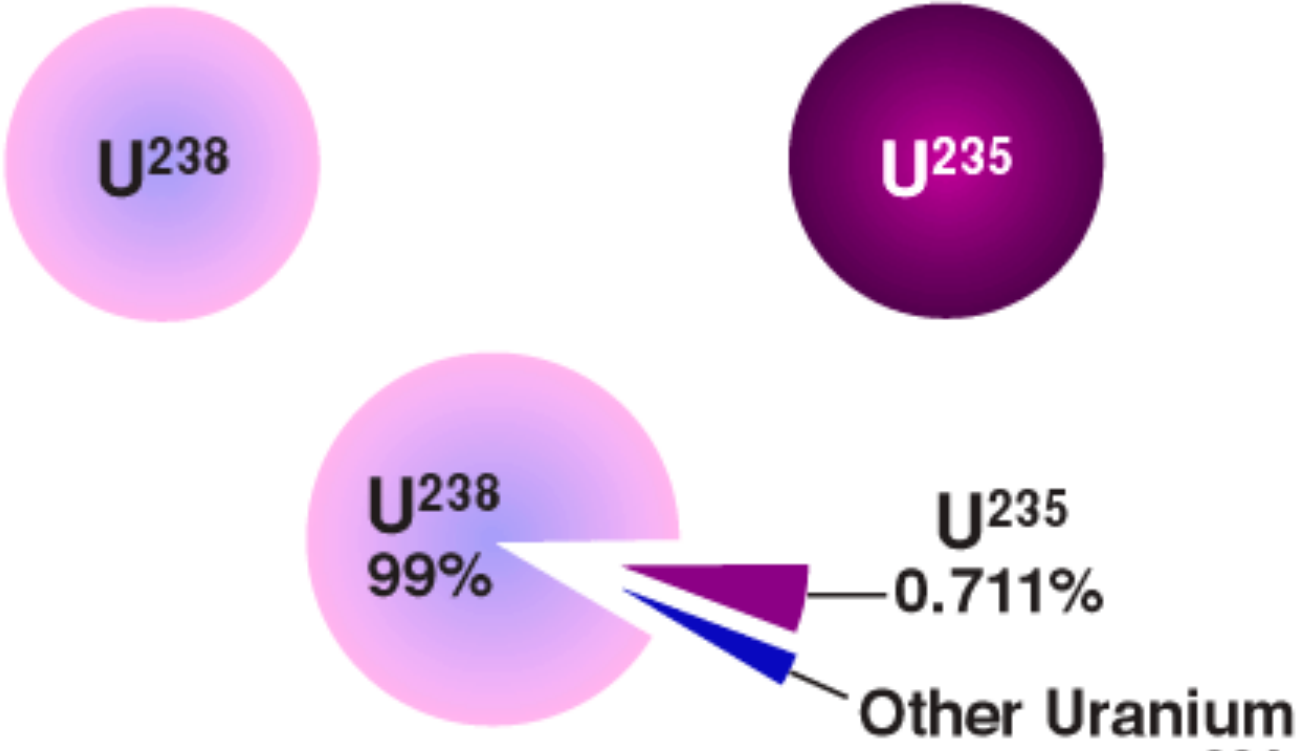


Uranium or Plutonium



Two Types of Uranium

A sample of any given element usually contains different kinds of atoms of that element. These atoms have different masses. These are called isotopes.



Plutonium: Heavy Water Reactor

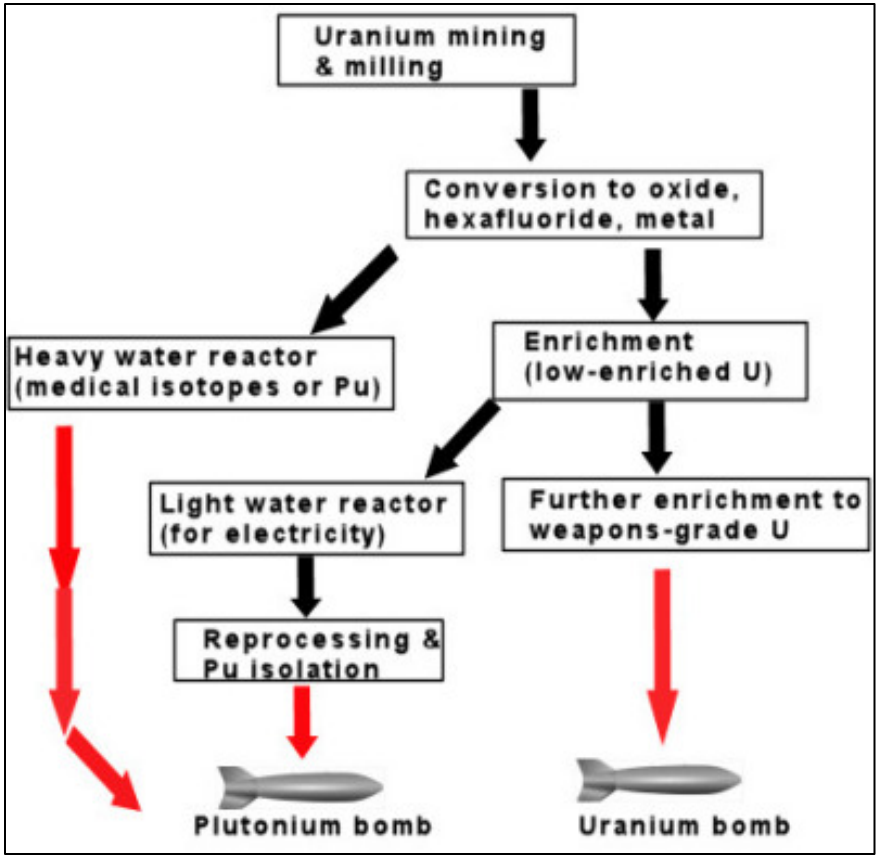
- Use natural uranium as fuel
- Reaction produces plutonium
- Boom!

Plutonium: Light Water Reactor

- Light water reactor, uses LEU as fuel
- Plutonium = byproduct of nuclear reaction
- Must be **reprocessed** from spent nuclear fuel rods in large plants

Electricity or the Bomb?

The same process can lead to both!



31 States With the Capacity to Build Nuclear Weapons, but only 10 have done so

- Argentina
- Austria
- Belgium
- Brazil
- Canada
- ***China***
- Czech Republic
- Denmark
- Finland
- ***France***
- Germany
- Hungary
- ***India***
- ***Israel***
- Japan
- Latvia
- Netherlands
- ***North Korea***
- Norway
- ***Pakistan***
- Romania
- ***Russia***
- Serbia
- Slovakia
- ***South Africa***
- South Korea
- Spain
- Switzerland
- Ukraine
- ***United Kingdom***
- ***United States***

3 Models in Search of a Bomb

Model	Key Variables	Examples
Security	External threat Availability of nuclear-armed ally	USSR, PRC, Israel W. Germany, Japan, S. Korea, Saudi
Domestic	Nuclear bureaucracy Economic liberalization	India Brazil, Argentina
Norms	Global norms about nukes • Prestige • Pariah	 France, Iran Ukraine

Scott D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," *International Security* 21/3 (Winter 1996/97): 54-87.

NPT

- Entered into force in 1970
- Divides the world into nuclear "haves" (U.S., Russia, UK, France, China) and "have nots" (everyone else)
- Grand bargain:
  - "Have nots" promise not to acquire nuclear weapons (Art. II)
  - "Haves" promise
    - Not to transfer nuclear weapons (Art. I)
    - To work toward nuclear disarmament (Art. VI)
    - To help disseminate "peaceful" nuclear technology (Art. IV)
  - Everyone promises not to import/export nuclear tech or materials unless subject to safeguards, and to accept IAEA inspections (Art. III)
- Membership is nearly universal – 190 member states
  - India, Pakistan, Israel, North Korea, South Sudan

IAEA

- Two jobs
  - Promote civilian nuclear technology
  - Monitor nuclear materials
- Like any good institution, the IAEA provides information and monitoring to deter cheating
- Safeguards
- Additional Protocol
  - Collect more information
  - Access more facilities
  - Streamlined access for inspectors
  - Environmental sampling

Supply Side Proliferation Arguments

- Traditional arguments focus on the demand for nuclear weapons

- Recent scholarship emphasizes the supply side
  - Sensitive nuclear assistance – ENR technology, fissile material, weapons or weapons components (Kroenig 2010)
  - Nuclear cooperation agreements – non-military nuclear assistance of various types (Fuhrmann 2012)

- Combining the demand and supply side
  - Countries that receive peaceful nuclear assistance and face a threatening security environment (Fuhrmann 2012)

Two Schools of Thought

- Nuclear optimism
  - Nuclear weapons are a great deterrent
  - Induce caution, reduce uncertainty in war outcomes
  - War more costly → War less likely
  - Based in realism, 3rd image
- Nuclear pessimism
  - States unlikely to deploy weapons securely
  - Risk of accidents, unauthorized use
  - More nukes → War more likely
  - Based in organization theory, 1st and 2nd image

3 Key Questions about Proliferation

- Preventive or preemptive war?
- Secure second-strike arsenals?
- Accidental or unauthorized use?

Nuclear Optimists

- Preemption/Prevention
  - Early stage (Iran): can be done safely, but will have to be done repeatedly
    - Israeli strikes on Osiraq (1981), al-Kibar (2007)
  - Late stage (North Korea): too risky
- Survivability
  - States have big incentives to make forces invulnerable, and it's easy to do so
- Accidental/Unauthorized Use
  - New nuclear states will be very careful; soldiers may be more cautious than civilians

Nuclear Pessimists: Organizations

- Preemption/Prevention
  - Military officers biased toward offensive, have favorable view of preventive war
- Survivability
  - Making weapons survivable not a highly prioritized military mission, conflicts with other organizational goals
- Accidental/Unauthorized Use
  - Complex, tightly coupled systems almost inevitably have accidents
  - Poor weapons design, secrecy, proximity, predelegation, unrest

Nuclear Pessimism: Leaders

- Some leaders too irresponsible to be trusted with highly destructive weaponry
  - Hard to deter, could use them against us
  - Could give them to terrorists, who are impossible to deter
  - **Possession of nuclear weapons could enable regional aggression**

Do Nuclear Weapons Make States More Aggressive?

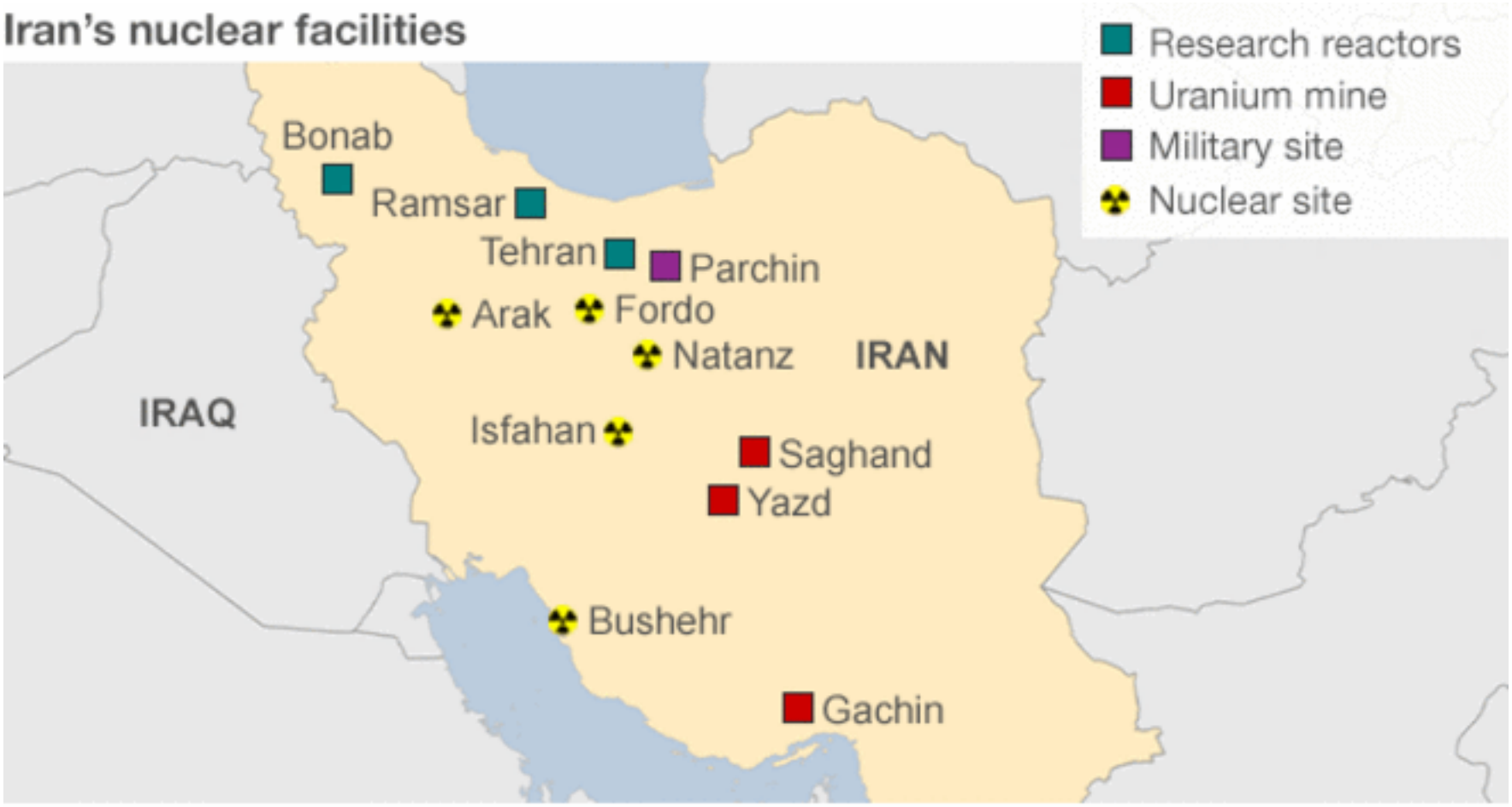
- Common argument is that acquiring nuclear weapons provides states with a shield behind which they can engage in regional aggression
  - Iraq, Iran
- Not a lot of systematic evidence here
  - One problem is that conflict involvement is a predictor of proliferation, which is then argued to beget further conflict
- Latest study finds that new nuclear states are more likely to initiate militarized disputes vs. non-nuclear targets, but not against nuclear targets
- New nuclear states primarily target states with which they have no conflict history – picking new targets rather than going after old foes
  - Suggests an "expansion of interests" story rather than a "nuclear shield" story

Mark S. Bell and Nicholas L. Miller, "Questioning the Effect of Nuclear Weapons on Conflict," *Journal of Conflict Resolution* 59/1 (2015):74-92.

Do Nuclear Weapons Help States Prevail?

- Scholars (mostly) agree that nuclear weapons are useful for **deterrence**
- Scholars disagree about whether nuclear weapons are useful for **compellence** or prevailing in crises
- Yes: Having more nuclear weapons than your adversary enables you to prevail in the competition in risk-taking
  - States with nuclear weapons more likely to prevail in crises over non-nuclear adversaries, but not against nuclear-armed states (Beardsley and Asal 2009)
  - In crises between nuclear-armed adversaries, states with nuclear superiority more likely to prevail (Kroenig 2013)
- No: Threats to use nuclear weapons for offensive purposes often lack credibility
  - States with nuclear weapons not more likely to make successful compellent threats, even against targets that lack nuclear weapons (Fuhrmann and Sechser 2013)
    - Not useful for taking territory
    - Nuclear threats are disproportionate

Iran's nuclear facilities



Source: New Scientist/ Global Security

Uranium Enrichment: Natanz and Fordow

In November 2013, Iran had:

- c. 19,500 centrifuges installed (almost all IR-1)
- Nearly 8 tons of LEU (in form of UF6 gas)
- 432 pounds enriched to 20%

Light Water Reactor: Bushehr

- Started by the Germans in 1970s
- Completed by Russia in 2010; Russians supplying fuel
- Went online in Sept. 2011

Heavy Water Reactor: Arak

- Heavy water production plant running
- Heavy water reactor under construction (AR-40)
- Heavy water plants use natural uranium, produce more plutonium

Joint Comprehensive Plan of Action

- Reduction of installed centrifuges
  - 5,060 at Natanz
  - 1,044 at Fordow for production of medical isotopes—no uranium enrichment
  - All IR-1
- Reduce stockpile of LEU from 10,000kg to 300kg
  - Maintain that level for 15 years
- No enrichment above 3.67%
- Redesign of Arak heavy water reactor to produce less plutonium
  - Spent fuel shipped out of the country
  - No additional heavy water or H.W. reactors for 15 years
- No reprocessing for 15 years
- Intrusive inspections, including implementing NPT Additional Protocol