Nuclear arms control: 
Help wanted

“Humanity remains one misunderstanding, one misstep, one miscalculation, one pushed button away from annihilation.”
– UN Secretary General Antonio Guterres, 28 September 2021,

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Outline

1. Consequences of nuclear war (4 slides)
2. Danger of accidental nuclear war (2)
3. The folly of ballistic missile defense (5)
4. No change in sight (1)
5. An arms controller’s agenda (2)
6. Activist physicists have made a difference in the past (6)
7. The new US Physicists Coalition for Nuclear Threat Reduction (2)
8. What might European physicists do? (1)
1. Consequences of Nuclear War

Consequences

In 1961, US Strategic Air Command estimated its Single Integrated Operational Plan (SIOP) would kill 400 million in the Soviet Union, China and E. Europe plus ~200 million in W. Europe, Japan, South Asia from radioactive fallout, “one hundred Holocausts.”)*

US megatonnage is down by a factor of ten today but the 1961 estimate did not include the effects of fire or economic collapse. Total consequences of an all-out nuclear war, including indirect effects, could be billions of deaths.

“Necessarily such a weapon goes far beyond any military objective and enters the range of very great natural catastrophes. By its very nature it cannot be confined to a military objective but becomes a weapon which in practical effect is almost one of genocide.”

– Enrico Fermi and Isador Rabi, 30 October 1949

Washington would be destroyed by Russian attack on the Pentagon ~ 1 million deaths.

500 kT airburst over Pentagon

6 km Scaled Hiroshima blast radius (Y^{1/3})

11 km Scaled Hiroshima firestorm radius (Y^{1/2})
Today, most US warheads are aimed at Russian and Chinese nuclear-weapon-related facilities. Fallout from groundbursts on “hard” targets would cause 8-10 million deaths. *This “limited” attack does not include hundreds of “command and control” targets in urban areas.*

* Major U.S. attack on Russian nuclear forces (*The U.S. Nuclear War Plan: Time for a Change* (1200 warheads) https://www.nrdc.org/sites/default/files/us-nuclear-war-plan-report.pdf, 2001) Fig. 4.84.
Impact of a US-Russia nuclear war on the growing season
~400 Mt nuclear explosions on cities on May 15
→ 100 Mt sun-blocking soot in stratosphere from firestorms (7-yr half-life).

First two years: Most of North America, Russia, Europe, China, have Antarctic growing season, aka “nuclear winter”
Mass starvation?

After 40 years, Congress has asked National Academies to evaluate these predictions but, for 1.5 yrs, National Nuclear Security Administration has not issued the contract.
2. Dangers of accidental nuclear war: Intercontinental Ballistic Missiles (ICBMs) are in a launch-on-warning posture

1000 silos (400 contain missiles today)

Russia’s ballistic missiles can destroy US ICBMs with \( \leq 30 \) min. flight time.

1970s: Anticipated “window of vulnerability” as Soviet missiles became more accurate led to “temporary,” launch-on-warning posture in 1978. Result: President’s decision time is less than 10 minutes.

Plan is to put a new generation of ICBMs in those same silos in that same posture until 2080.
False alarms and nuclear “escalation”

**False alarms**

- Of strategic attacks (best known: 2 on US [1979, 80], 1 on SU [1983]).
  
  *Early-warning crews took too much time to confirm warnings were false.*

- In Europe, 1983, NATO exercise was programmed to end with non-executed nuclear attack on E. Europe. Alarmed Soviet command loaded nuclear bombs on fighter-bombers in E. Europe, for a preemptive attack.

**Nuclear threats in military crises**

- 1961 crisis over access to W. Berlin. (*Taiwan is today’s W. Berlin.*)

- 1962 Cuban Missile Crisis occurred after US announced during the Berlin Crisis that it had “nuclear superiority.”

- 2022 Putin nuclear threats if NATO support for Ukraine becomes intolerable.

**Hacking of nuclear command and control**
3. The Folly of Ballistic Missile Defense
3 Presidents, $350 billion. Currently driven by a few Congressional enthusiasts. Others don’t understand and don’t engage.

US Budget for Ballistic Missile Defense

- Nixon BMD “gap”
- 9/11, Bush Jr. takes US out of ABM Treaty
- Putin: hypersonic glide RVs; intercontinental nuclear-powered torpedoes & cruise missiles to underfly
- China’s buildup

“Star Wars” (Reagan-Teller)
Current and foreseeable systems are easy to penetrate*

In vacuum of space, light objects follow same trajectories as heavy objects. Many possible ways to deceive interceptors, e.g., by hiding a warhead in an aluminized balloon among other balloons containing battery-powered heaters to simulate heat from radioactive decay of warhead plutonium.

Recently, an American Physical Society report concluded, “few of the main challenges involved in developing and deploying a reliable and effective ballistic missile defense have been solved, and …many of the hard problems we have identified are likely to remain unsolved during and probably beyond the 15-year time horizon we considered.”

Global warhead stocks have declined since end of the Cold War but are we beginning a new buildup driven in part by BMD?

In 2021, China discovered to be building about 300 ICBM silos (China’s DF-41 ICBM can have 3 warheads)

China’s buildup may be to discourage US nuclear threats if conventional defense of Taiwan fails. Might a US president believe that BMD could protect US from China’s retaliation?
4. No change in sight: new “Triad” designed to last to ~2080

- 400 new ICBMs carrying up to 1200 warheads
- 12 ballistic-missile submarines carrying up to 1300 warheads
- 100 strategic bombers carrying up to ~1000 new cruise missiles
- ~4000 new and refurbished nuclear warheads including ~200 tactical bombs.
- Russia, China also “modernizing.” UK and France have 4 ballistic-missile submarines each, with one at sea at all times. “Minimum deterrents.”

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<tr>
<th>Eisenhower-Kennedy</th>
<th>Reagan-Bush</th>
<th>Obama- Trump-Biden…</th>
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<tr>
<td>15%</td>
<td>10%</td>
<td>~50 billion/yr (+$20 billion/yr for warheads)</td>
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“More bang for the buck”

% of DOD Budget

1960  1980  2000  2020  2040

~6.4% of DOD Budget
5. An arms controller’s agenda

• No first use

• No launch on warning

• A new US-Russia nuclear arms reduction agreement (Last US-Russian nuclear arms control treaty, New START, expires in 2026)

• Engage China in nuclear arms limitations.

• Limit ballistic-missile defense to limit offense-defense arms races

• Nonproliferation Treaty (1970) requires US, Russia, UK, France, China to pursue nuclear disarmament “in good faith” in exchange for 186 other countries committing to not acquire nuclear weapons and to accept IAEA verification on their nuclear activities.

• Treaty for the Prohibition of Nuclear Weapons (61 country parties).
Six states under US nuclear “umbrella” were observers at first meeting of Ban Parties, 21-23 June: Australia, Finland, Germany, Netherlands, Norway, Sweden.
6. Physical scientists have tried & sometimes succeeded in making a
difference: some examples

Niels Bohr was first, but failed. Met separately with President Roosevelt and Prime Minister Churchill during World War II to urge them to discuss the secret US-UK nuclear-weapon project with Stalin in hope of preventing a post-war nuclear arms race.
Bohr’s concerns and activism inspired others.
1955 Russell-Einstein Manifesto and the Pugwash Conferences

“scientists should assemble in conference to appraise the perils that have arisen as a result of the development of weapons of mass destruction, and to discuss a resolution.”

1957… Pugwash Conferences became an international forum for development of East-West understandings on nuclear and conventional arms control and also of multinational treaties: Atmospheric Nuclear Test Ban and Biological and Chemical Weapons Bans.

1995 Nobel Peace Prize to:
- Joseph Rotblat (founder, “leading inspiration” for Pugwash, right)
- Pugwash organization (represented by then Pugwash Secretary General Francesco Calogero)
Ending nuclear testing in the atmosphere (1963)

~ 3 million cancer cases—mostly still in future due to (5700-yr half-life) C-14


Linus Pauling
Nobel Prize in Chemistry, 1954
Nobel Peace Prize, 1963

Andrei Sakharov
Nobel Peace Prize, 1975
When President Johnson didn’t listen to his science advisors, Garwin and Bethe, wrote a *Scientific American* article explaining how easy countermeasures to ballistic missile defense would be. Article educated other physicists (including me) to help educate the public and Congress.

Richard Garwin
2016 (Medal of Freedom)

Hans Bethe
Nobel Prize, 1967
1986 Evgenyi Velikhov (physicist-arms-control advisor to Gorbachev) and Tom Cochran, young physicist with a US NGO, organized in-country verification of Soviet unilateral test moratorium, generating momentum resulting in 1996 Comprehensive Test Ban Treaty
Not just physicists: 1982 mass movement to “freeze” the nuclear arms race culminated in a million-person demonstration in New York. Similar mass demonstrations in Western Europe against intermediate-range missiles. Both helped change Reagan’s mind and encouraged Gorbachev.
7. US Physicists Coalition for Nuclear Threat Reduction  
https://www.aps.org/policy/nuclear

Initially sponsored and funded by the American Physical Society  
**850 US physicists**, including graduate students, since Sept. 2020.

Have actively educated Congress on:

  (Extended for 5 years by Biden and Putin in February 2021)

- **No funding for resumed nuclear weapon tests**.  
  (Senate funding of $10 million for testing preparations was stripped out of Fiscal Year 2021 Defense Authorization Bill.)

- **No first use**.

**Starting in October, Physicists Coalition will become independent of the American Physical Society and free to pick more issues for advocacy.**

**We also plan to establish chapters at US universities.**
Most Recent Physicists Coalition Issue (we failed with the Biden Administration):

No first use or sole purpose of nuclear weapons

**Sole purpose (VP Biden formulation):** Sole purpose of US possession of nuclear weapons is to deter their use by other nuclear-armed states. (Therefore, if other countries get rid of their nuclear weapons, we will too.)

*Many NATO countries*, Japan, South Korea, most members of Congress want US to “**keep all options on the table**” to deter conventional attacks.

**In the past, US made nuclear threats in wartime** (1950s: Korea War and Taiwan Straits Crises; 1960s: Vietnam War). Threats were not effective.*

**Today, Putin is warning of the possibility of Russian nuclear use to limit NATO intervention in support of Ukraine. Also not effective.**

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What might European physicists do?

1. Europe-wide or national counterparts to the US Physicists Coalition?
   Could educate yourselves and then educate empower interested members of:
   
   • European Parliament?
   • Parliaments in countries that have nuclear weapons (France, UK) or host US nuclear weapons (Belgium, Germany, Italy, Netherlands, Turkey)?
   • Parliaments of countries under US “nuclear umbrella” (all of NATO).

2. Chapters at CERN and European Universities?
   • To help regional parliamentarians understand the issues,
   • ”Journal clubs” for self education on key readings in nuclear arms control.
   • Develop courses for interested students

US Physicists Coalition would be happy to cooperate on joint projects. 
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