Tilting At Windmills?

Research, Collaboration, Advocacy and Agenda Setting on Fissile Materials

IPFM
INTERNATIONAL PANEL ON FISSILE MATERIALS

Zia Mian and Alexander Glaser

UCS Summer Symposium on Science and World Affairs, Princeton, NJ, August 1, 2014

Revision 0

About the IPFM

MISSION

Providing the technical basis for policy initiatives to reduce global stocks of military and civilian fissile materials

- Established in 2006, IPFM has 31 members from 18 states
- Publications: annual Global Fissile Material Reports, research reports, and country studies
- www.fissilematerials.org and www.fissilematerials.org/blog

IPFM Members

- Anatoli Diakov (Russia)
- Pervez Hoodbhoy (Pakistan)
- Li Bin (China)
- Rebecca Johnson (United Kingdom)
- Gordon MacKerron (United Kingdom)
- Yves Marignac (France)
- Abdul H. Nayyar (Pakistan)
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- Annette Schaper (Germany)
- Tatsujiro Suzuki (Japan)
- Johan Swahn (Sweden)
- Masa Takubo (Japan)
- Fumihiko Yoshida (Japan)

Global Fissile Material Reports

2008: Scope and Verification of a Fissile Material (Cutoff) Treaty
with country perspectives and draft FM(C)T

2009: A Path to Nuclear Disarmament
with country perspectives

2010: Balancing the Books: [Weapon State] Production and Stocks

2011: Nuclear Weapon and Fissile Material Stockpiles and Production

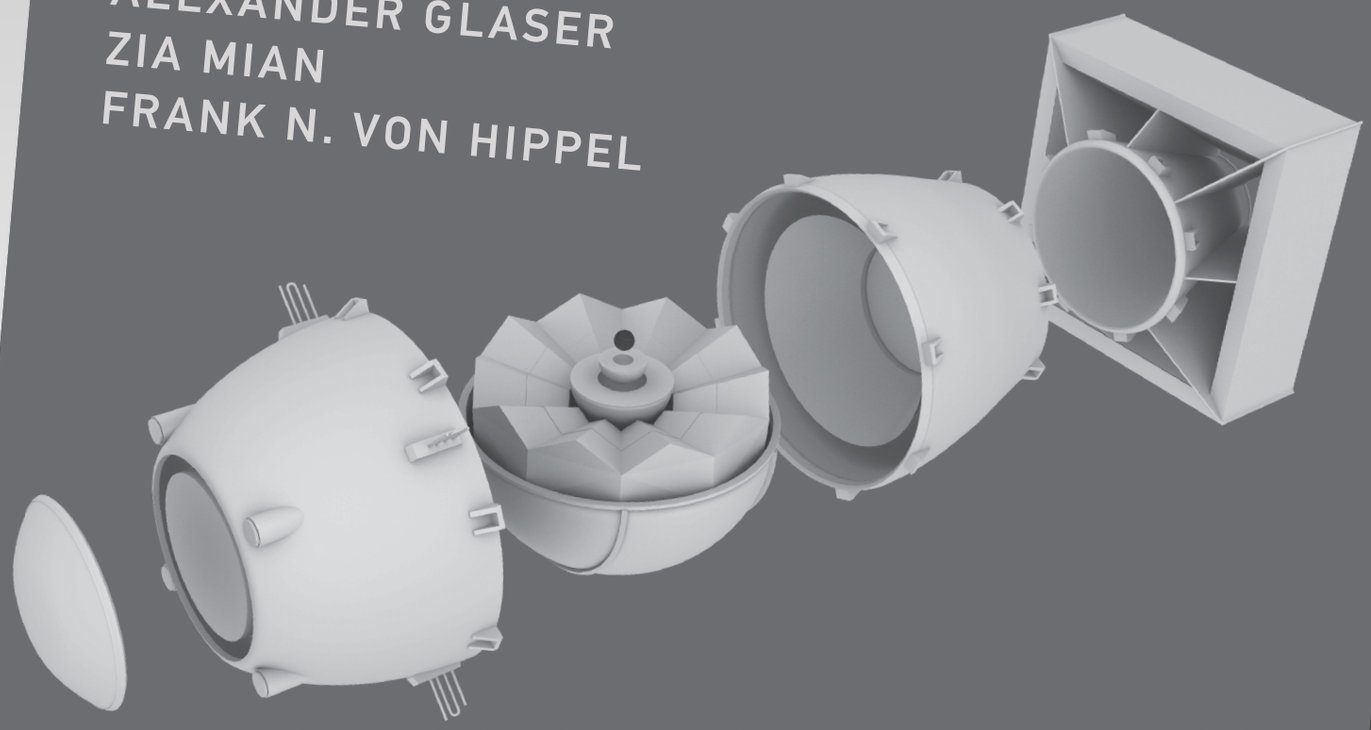
2013: Increasing Transparency
of Nuclear Warhead and Fissile Material Stocks as a Step toward Disarmament

NEXT: Unmaking the Bomb: A Fissile Material Approach
A Fissile Material to Nuclear Disarmament and Nonproliferation, MIT Press, 2014

UNMAKING THE BOMB

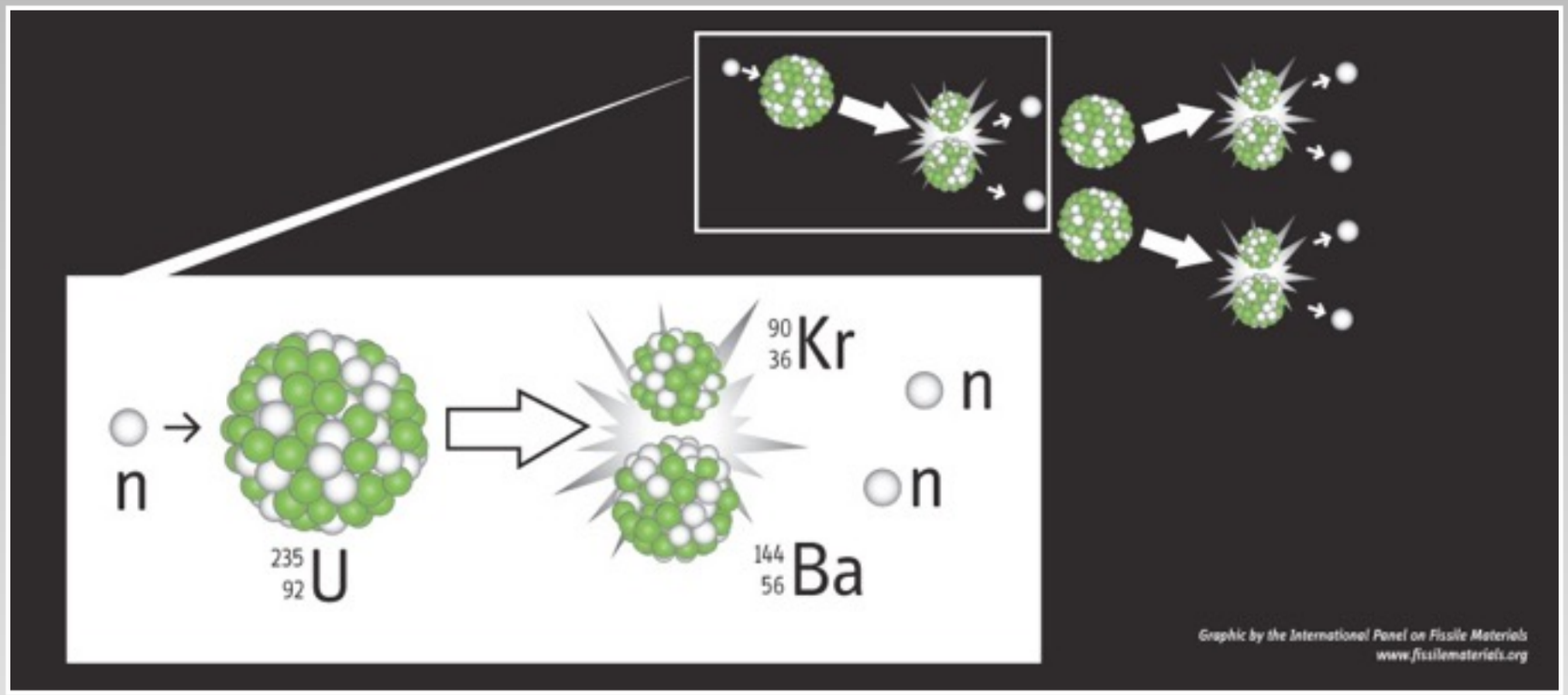
A FISSILE MATERIAL APPROACH TO NUCLEAR DISARMAMENT AND NONPROLIFERATION

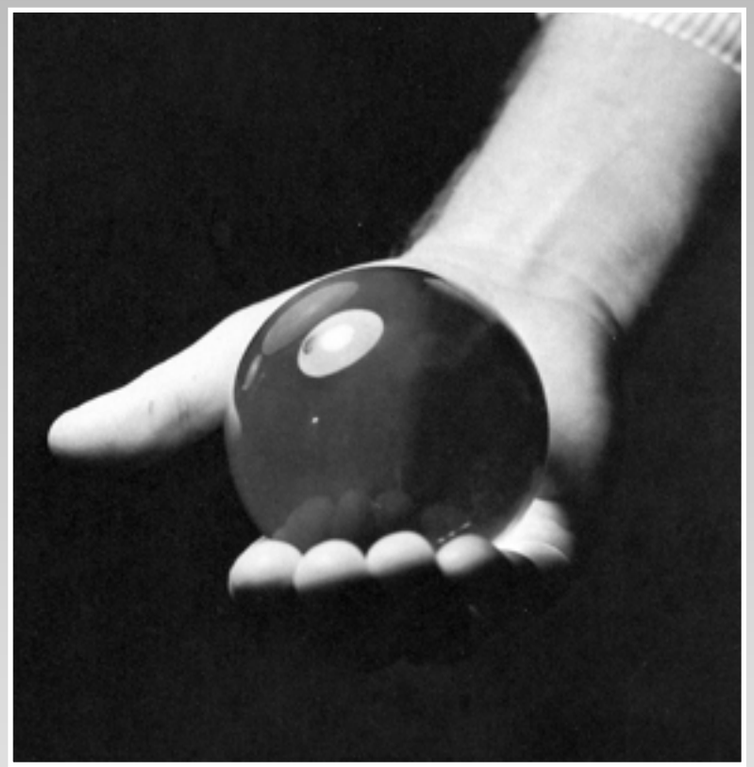
HAROLD A. FEIVESON
ALEXANDER GLASER
ZIA MIAN
FRANK N. VON HIPPEL



MIT Press
www.unmakingthebomb.com
September 26, 2014

Fissile Materials and Nuclear Weapons





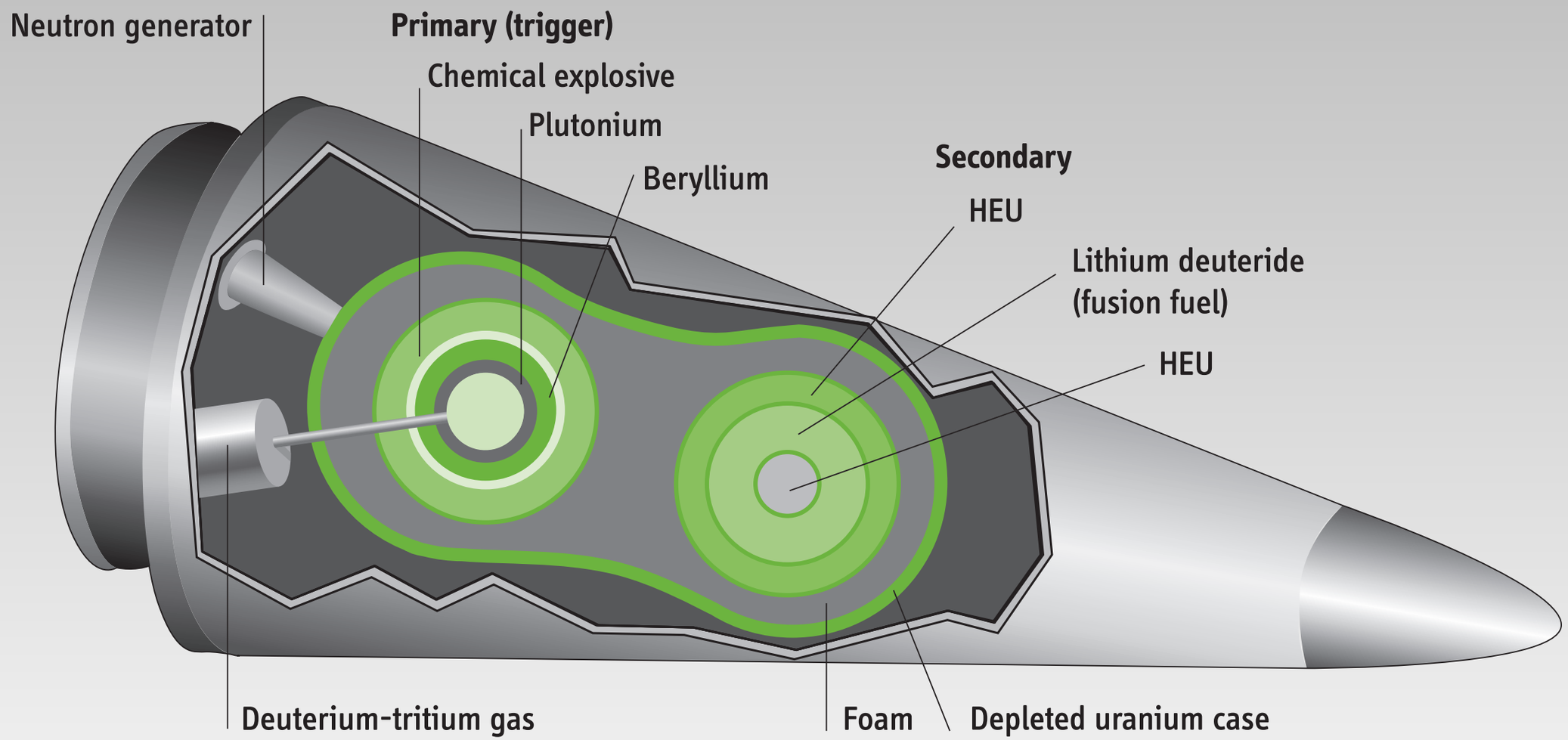
HEU in weapons usually more than 90% enriched in U-235 (0.7% in nature)

The Hiroshima bomb used 60 kg of 80%-enriched HEU

Plutonium (mostly Pu-239) separated from irradiated uranium

The Nagasaki bomb used 6 kg of Plutonium

Verifiably and irreversibly reducing and eliminating nuclear weapons will require openness about national stockpiles of nuclear weapons and fissile materials

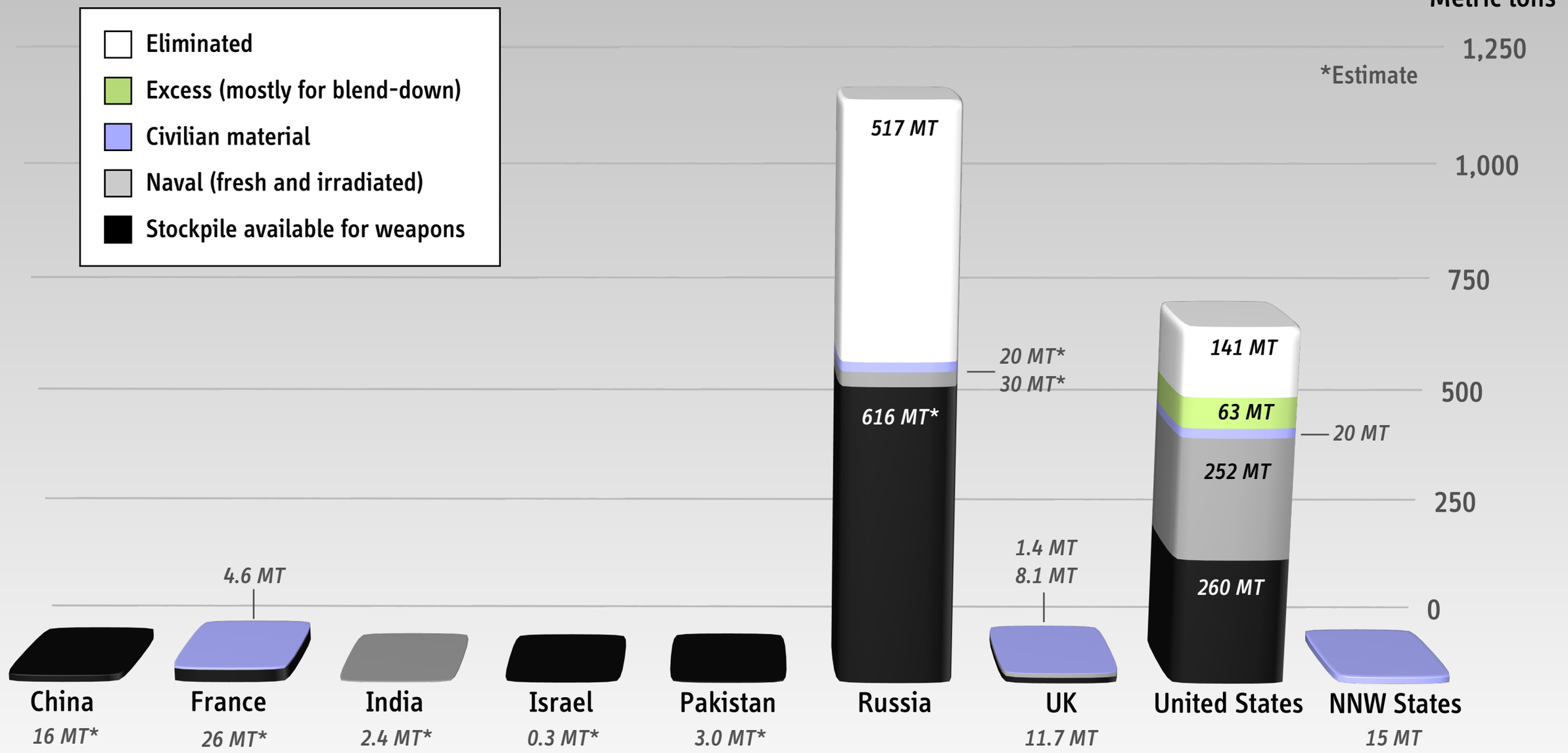


A modern thermonuclear warhead contains on average 3–4 kg of plutonium and 25 kg highly enriched uranium

Adapted from Final Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples Republic of China ("Cox Report"), U.S. House of Representatives, 3 January 1999

Highly Enriched Uranium, mid 2013

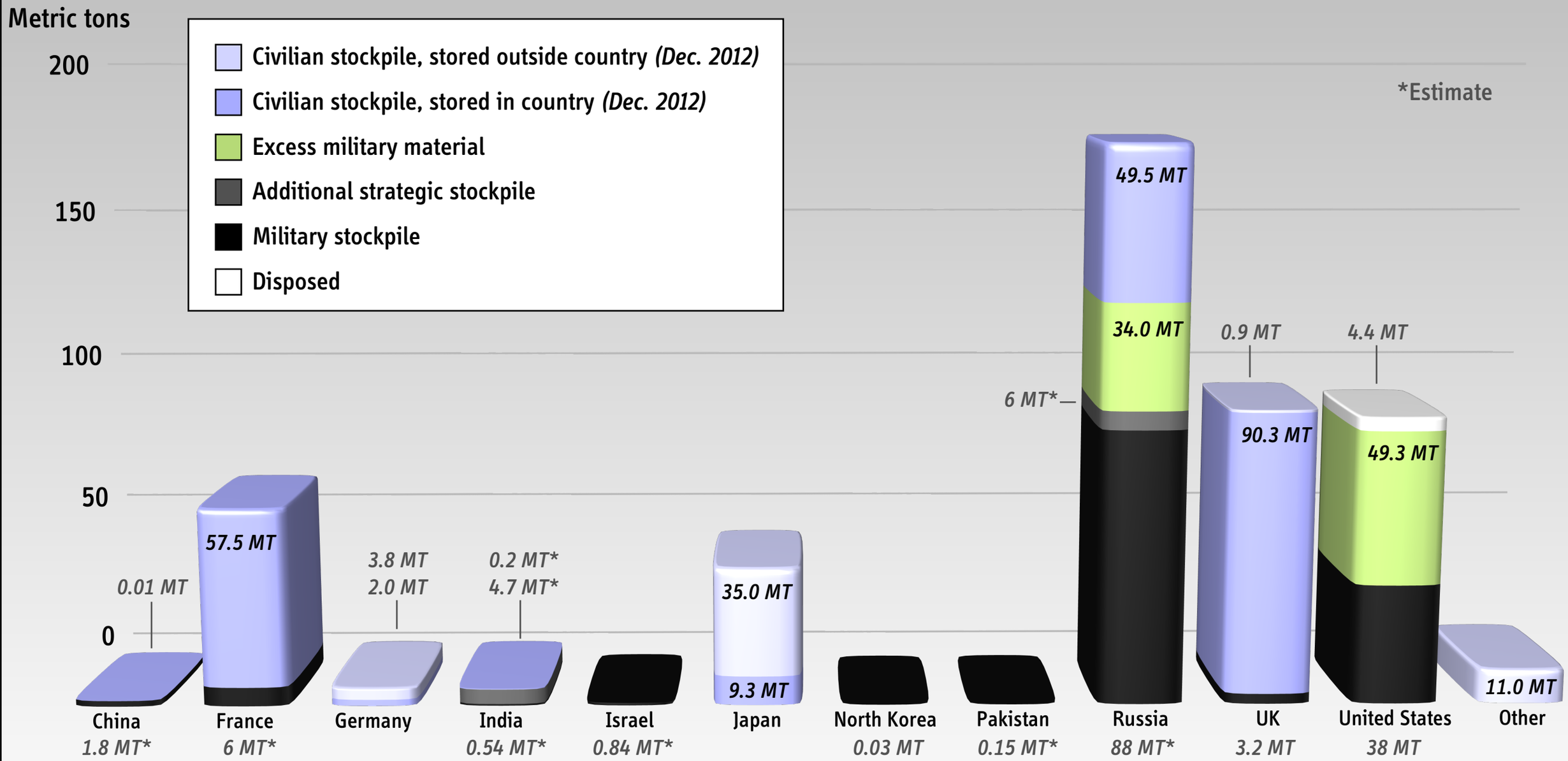
Global stockpile is about 1350 tons, almost 99% is in weapon states



(25 MT of HEU are equivalent to 1,000–2,000 nuclear weapons)

Separated Plutonium, mid 2013

Global stockpile is about 500 tons, more than half is civilian and this stock is growing



(5 MT of plutonium are equivalent to 1,000–1,500 nuclear weapons)

How IPFM Estimates Are Made

The Case of Israel's Plutonium Stockpile

CONF - DEF

Summary of Reactor Design

Power	26 MW Thermal
Moderator	D_2O
Coolant	D_2O
Coolant flow	1800 cubic meters per hour
Inlet temperature	40.8°C
Outlet temperature	51.7°C
Velocity	About 4.2 meters/second

Inconel tubes and lining in primary heat exchanger. Standard equipment in secondary heat exchanger system.

Number of coolant loops	3
Design capacity	13 MW each loop - (on spare)

Primary coolant inlet and outlet at bottom of reactor.

Physical dimensions

Lattice spacing	13.5 cm hexagonal
Calandria diameter	2.57 meters
Graphite reflector	80 cm thick
Iron thermal shield	20 cm thick
Concrete shield	3.80 meters thick
Containment vessel - diameter	36 meters

NOTES ON VISIT TO ISRAEL — DRAFT 5/23/61 CONF-DEF

U. M. Steebler - J. W. Crouch, Jr.

We arrived at Tel Aviv at about 8:15 p.m. on Wednesday, , 1961. We were contacted immediately on deplaning and taken ivate room where we met Mr. Katchalski, Head of the Department ysics of the Weizmann Institute of Science and Mr. M. Gilboa ublic Relations Department of the Ministry of Defence. halski said that the Prime Minister had asked him to greet s one of the scientific advisors to the Prime Minister. Mr. Gilboa r guide and accompanied us everywhere we went. We stayed at the otel - a resort remote from Tel Aviv. The rooms were in 's name.

d on the second day if we were to meet Professor Bergman ised that he is a public political figure and that such a refore seemed undesirable but might be arranged if we really The fact that the Atomic Energy Commission is only an p was also emphasized on a number of occasions in response ons.

dule was suggested which we agreed should be satisfactory. of the following:

y, May 18, 1961 (A.M.) Visit to Swimming Pool Reactor at Nahal Shorek

(P.M.) Visit to Weizmann Institute of Science at Rehovoth.

Mr. Katchalski entertained in the evening.

XXXXXXXX
Y 19, 1961

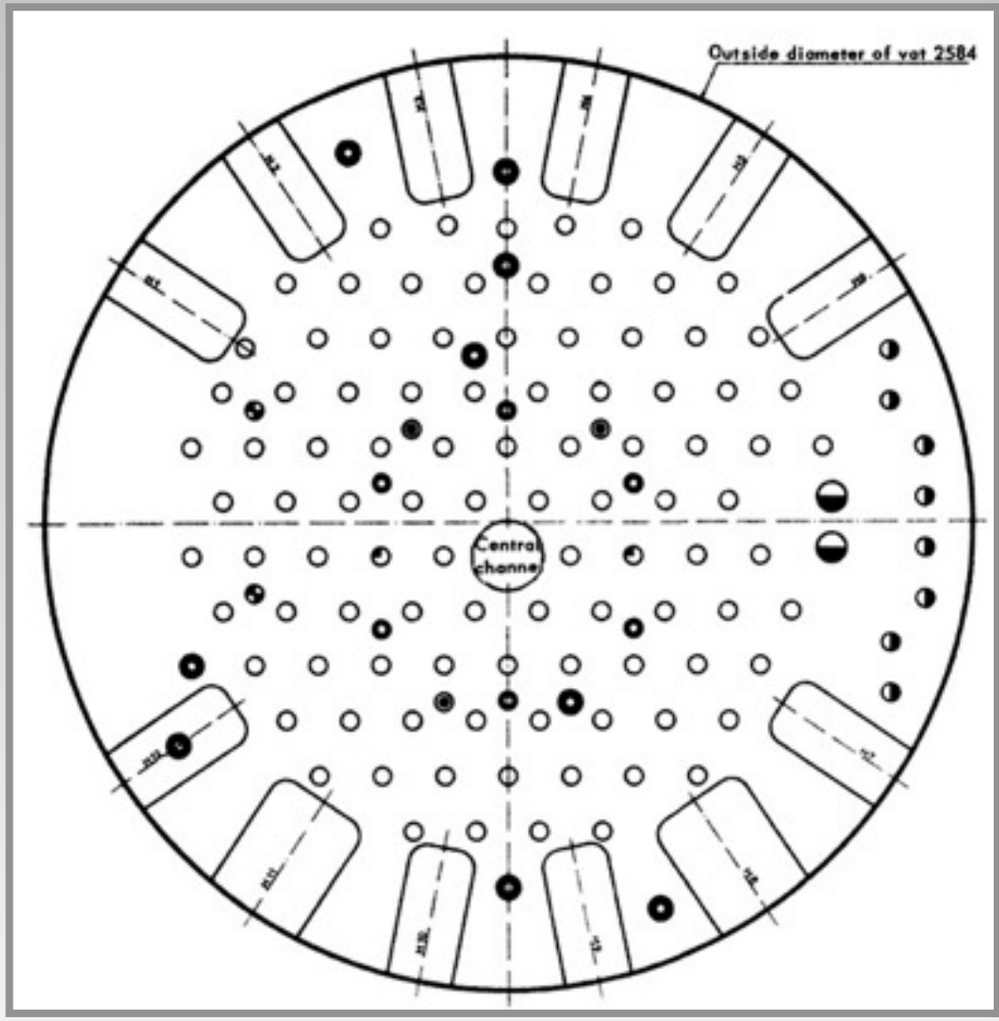
CONFIDENTIAL - DEFENSE INFORMATION

U. M. Staebler and J. W. Crouch, Jr., *Notes on Visit to Israel*, Draft, 23 May 1961
Available at www.gwu.edu/~nsarchiv/israel/documents/first, mirrored at www.ipfmlibrary.org/sta61.pdf

1985 Vanunu Pictures and Testimony

Technical Specifications of “EL-3”

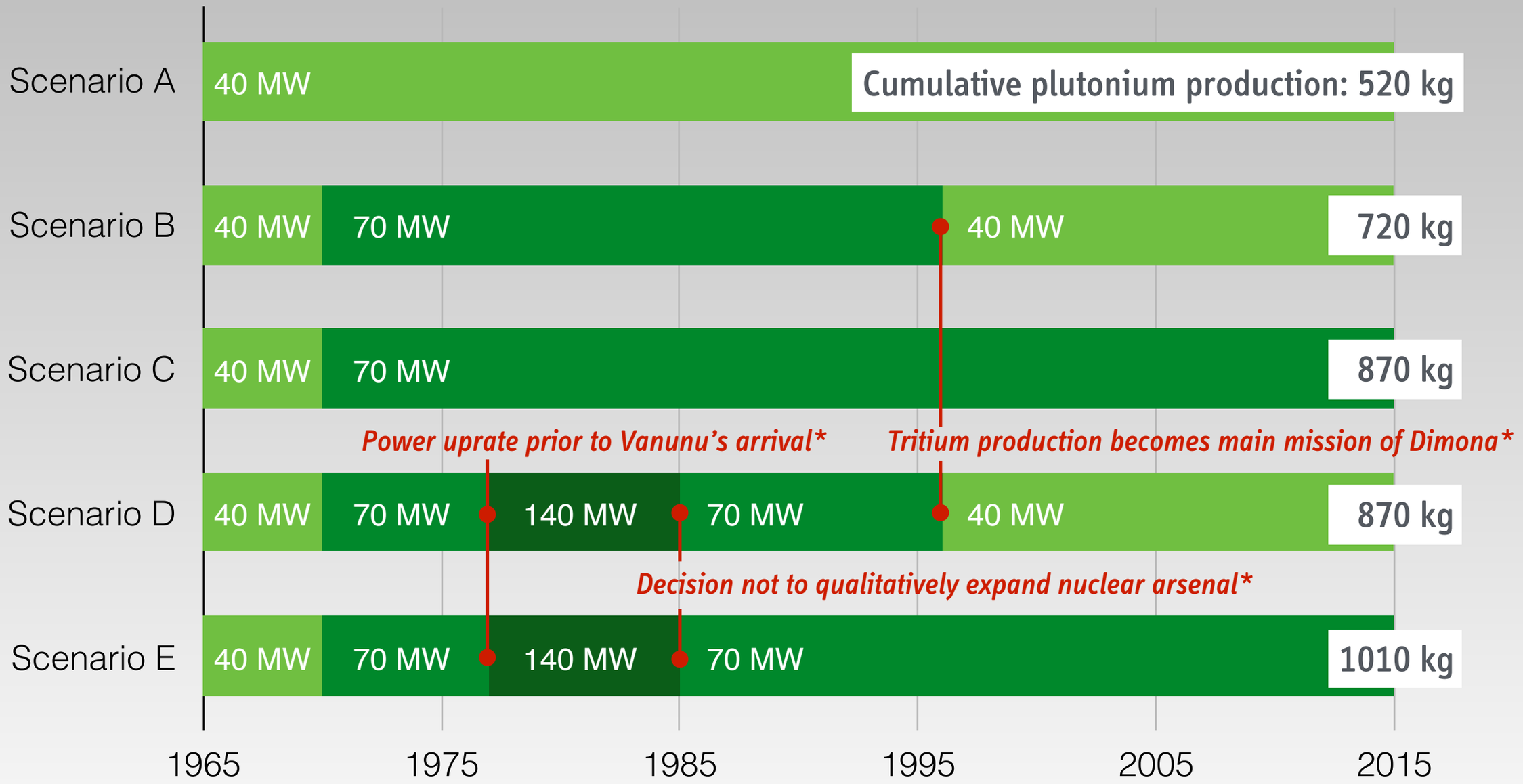
Some data can be used to complement data otherwise unavailable for Dimona



J. Robert, J. Hainzelin, and V. Raievski, “The EL-3 Reactor,” A/CONF. 15/P/335, *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy,* Geneva, 1958, www.ipfmlibrary.org/rob58.pdf

Possible Operational Histories of Dimona

(1965–2015, Production Scenarios A–E)



**Possible circumstances or explanations*

Beginning of full-scale plutonium production at Dimona is uncertain; reactor went critical in 1962 and began operating in late 1963

50 Years of Plutonium Production at Dimona

Estimated plutonium inventory by 2015: 850 kg ± 130 kg

(allowing for possible removals of about 20 kg in nuclear tests)

Current production rate: 10–18 kg/year, depending on Dimona's power level: 40–70 MW

Israel's nuclear arsenal is believed to include 100–150 warheads

If these estimates are correct, Israel has more than enough plutonium to meet its current security needs and *could* cease fissile material production

Plutonium production possibly a "byproduct" today

Main mission of Dimona now most likely tritium production

(Tritium could be produced with alternative non-reactor-based options)

How IPFM Estimates Are Used

The Case of South Asia

What Next?


INFORMATION
BARRIER
CALIBRATE
PASS
FAIL
MEASURE
PRESENT
NOT PROVEN
POWER
OFF
ON
TRACO POWER
TRACO POWER

Demonstrating Methods Required for Nuclear Archaeology

NRX, Canada

Ågesta Reactor (105 MWt), near Stockholm, Sweden

Transparency Matrix, 2014

Information on nuclear warhead and fissile material inventories and status

	United States	Russia	Britain	France	China
Number of total warheads	**Approximate**	**No**	**Yes** (upper limit)	**Yes** (upper limit)	**Relative** (out of date)
Number of deployed warheads	**Yes** (strategic only)	**Yes** (strategic only)	**Yes** (planned)	**Yes**	**No**
Dismantlements	**Yes**	**No**	**Yes** (no details)	**Yes** (no details)	**No**
Verification	**Partial**	**Partial**	**No**	**No**	**No**
Fissile material stockpiles	**Yes**	**No**	**Yes** (no details)	**No**	**No**
Production histories	**Yes**	**No**	**No**	**No**	**No**
Excess/Disposal	**Yes** (nothing new)	**Yes** (nothing new)	**Yes** (nothing new)	**No**	**No**
Verification	**Partial**	**Partial** (but no longer)	**Partial** (some plutonium)	**No**	**No**