

# Atomic Bombs

History, Operation and Effects

# History

The development of fission and fusion bombs

# Fission Bomb

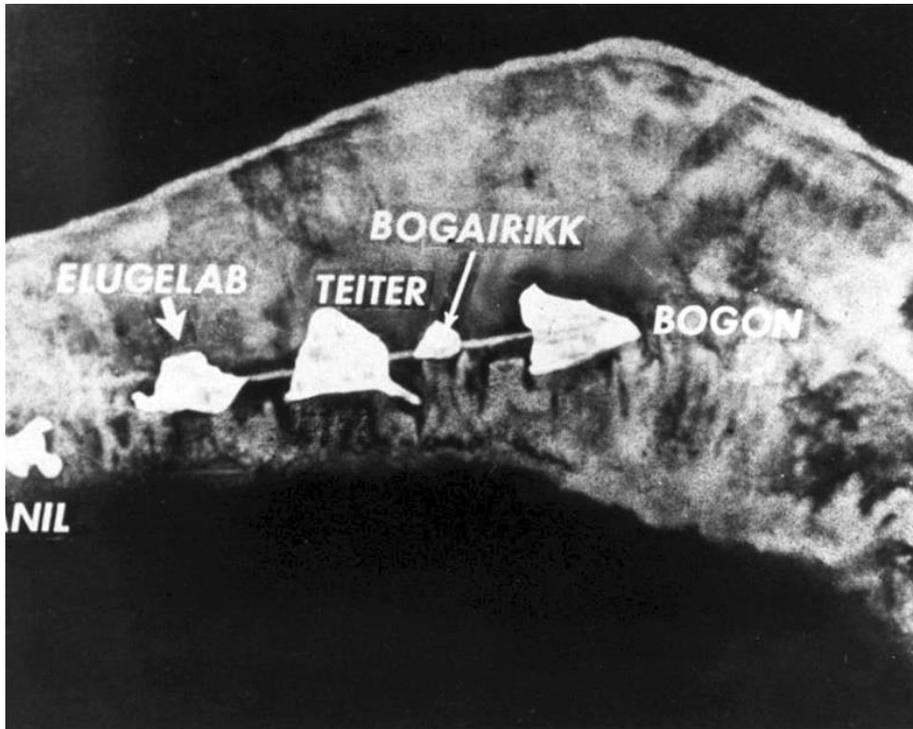
- 1934 **Szilárd** proposes nuclear **chain reaction**  
**Fermi** induces radiation by **bombarding uranium** with neutrons
- 1938 **Hahn** and **Strassman** detect barium after doing that  
**Meitner** interprets this as **fission**
- 1939 Germany and USA **realise military potential**  
**Einstein** **warns Roosevelt** about possibility of Nazi bombs
- 1942 **Manhattan Project** begins
- 1945 **Bombs dropped** on Japan

# Fusion Bomb

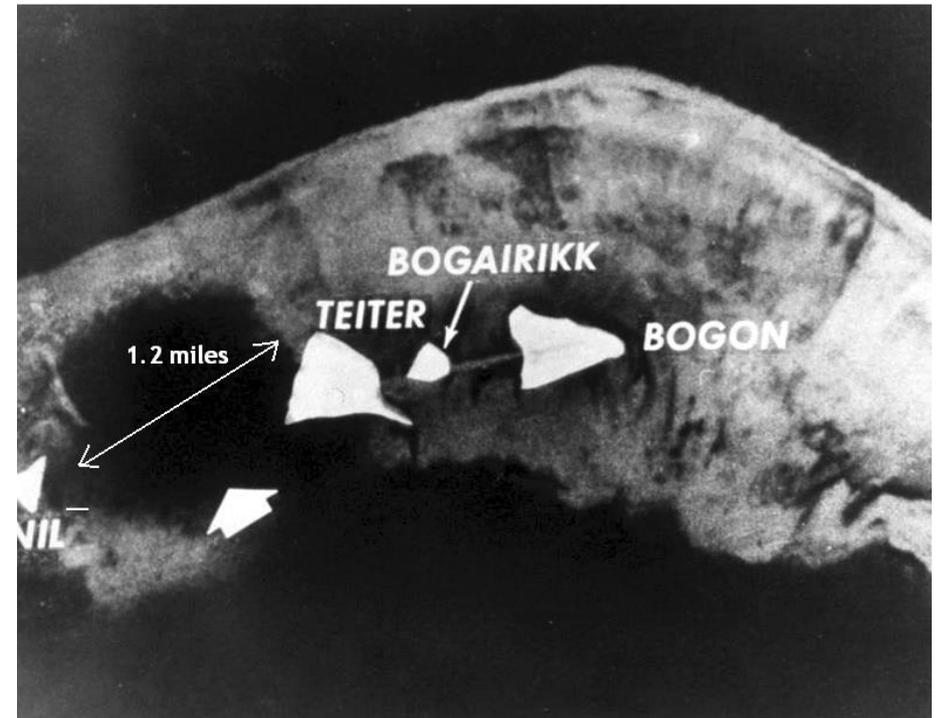
- 1941** **Fermi** mentions the **idea** of fusion bombs  
**Teller** works on the idea
- 1949** First **Soviet** test
- 1952** First **American** test
- 1961** **Tsar Bomba** detonated, largest man-made explosion

# Fusion Bomb

1952 First American test



*Before*



*After*

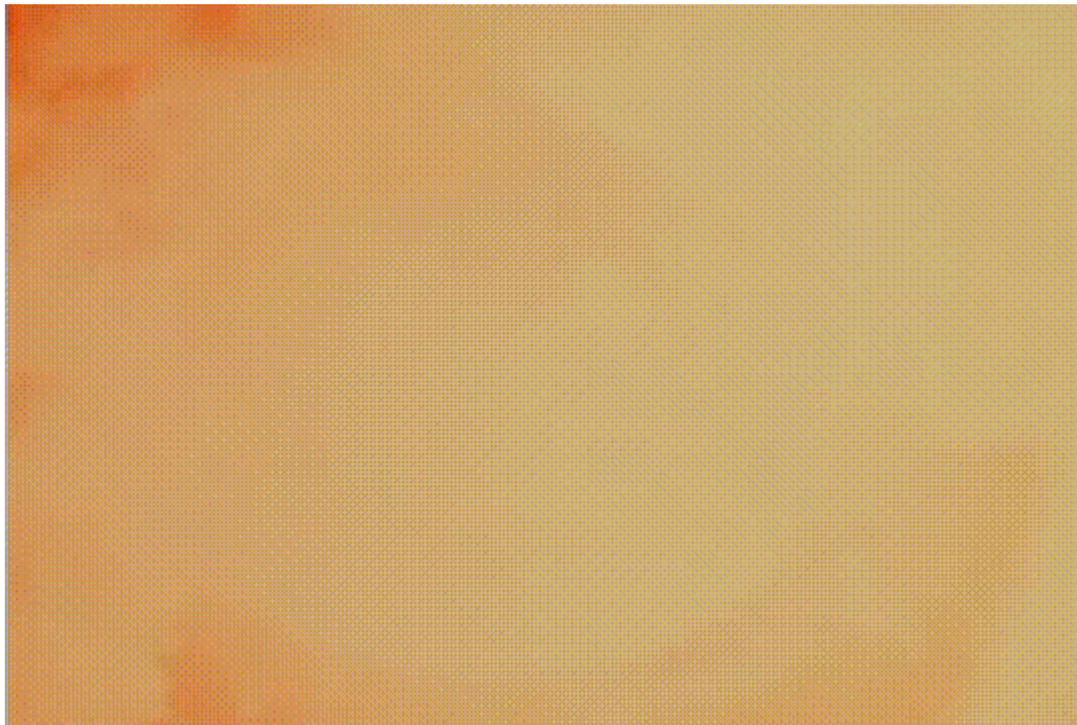
# Tsar Bomba

57 megaton bomb

10 times more powerful than **World War II**

1400 times more powerful than **Hiroshima** and **Nagasaki** combined

Capable of 100 Mt



# Operation

Physical Mechanisms Behind Nuclear Weapons

# Outline

2 main types; **fission** and **fusion**.

Enriched **U-235** used as fuel.

Neutrons created by “**neutron generator**”

Po and Be separated by foil.

Foil broken when subcritical masses come together.

Po emits  $\alpha$  particle.

$\alpha$  particle collides with Be-9 to create Be-8, neutrons released.



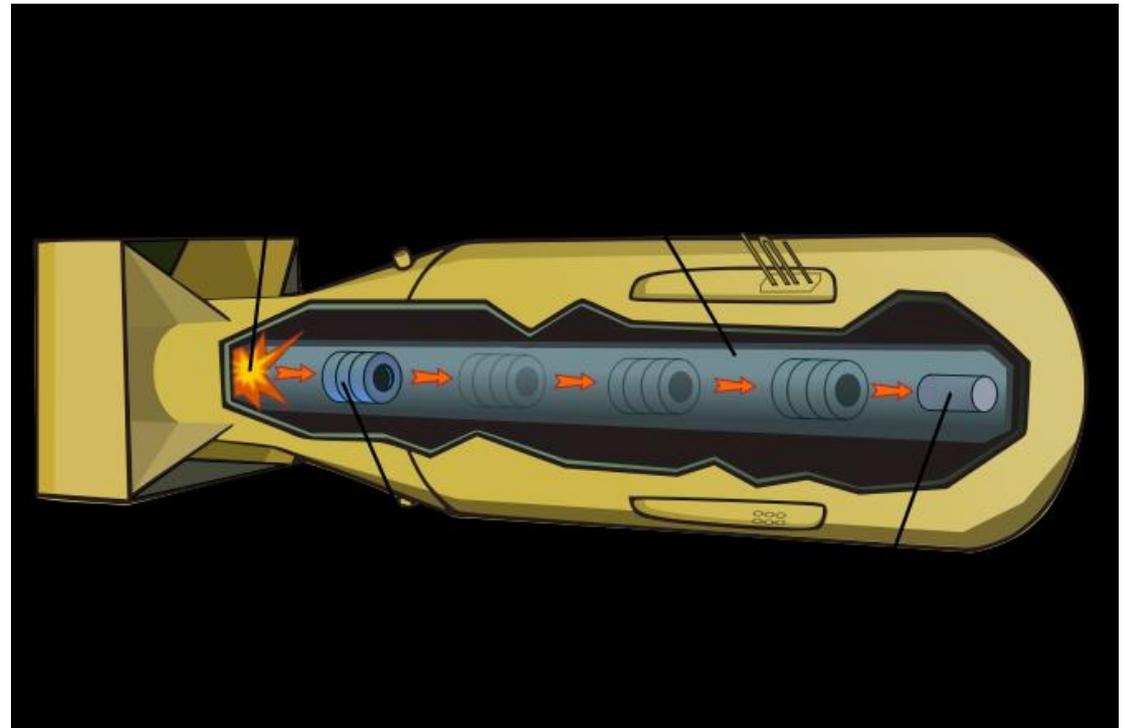
*Sample of enriched  
Uranium*

# Fission Bomb Triggers

Operation

“Gun” which fires one mass into the other

- Explosives fire subcritical masses together
- Strikes sphere and starts process in neutron generator
- Fission initiated leading to the bomb exploding



*“Gun” trigger mechanism*

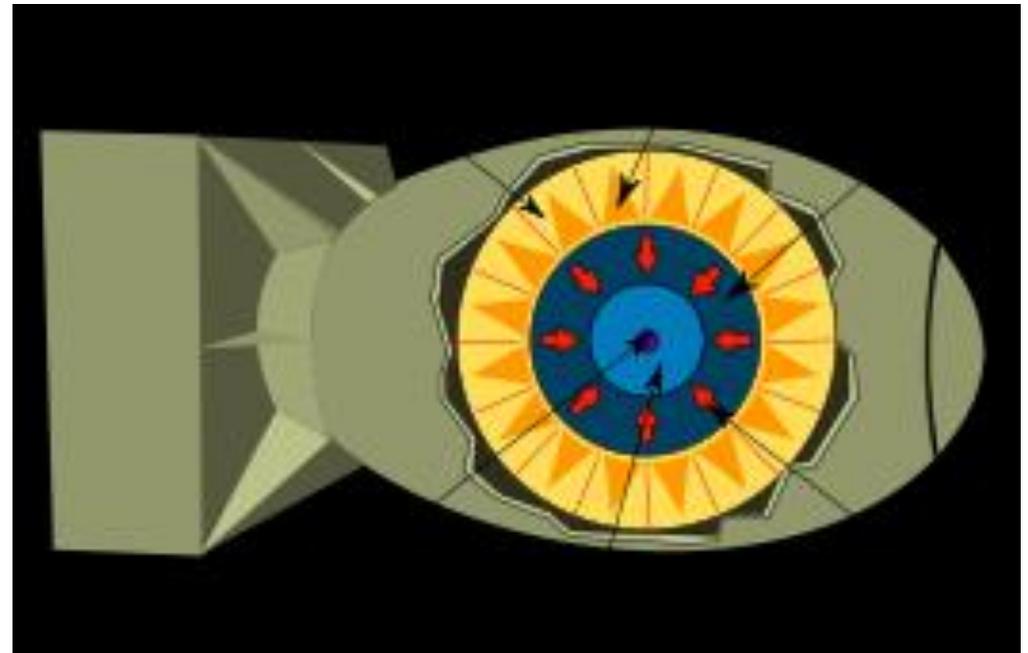
# Fission Bomb Triggers

Operation

## Trigger by implosion

- » U-235 acts as tamper
- » Plutonium-239 core surrounded by explosives

- Explosives fired creating shockwaves
- Core compressed and fission begins
- Bomb explodes



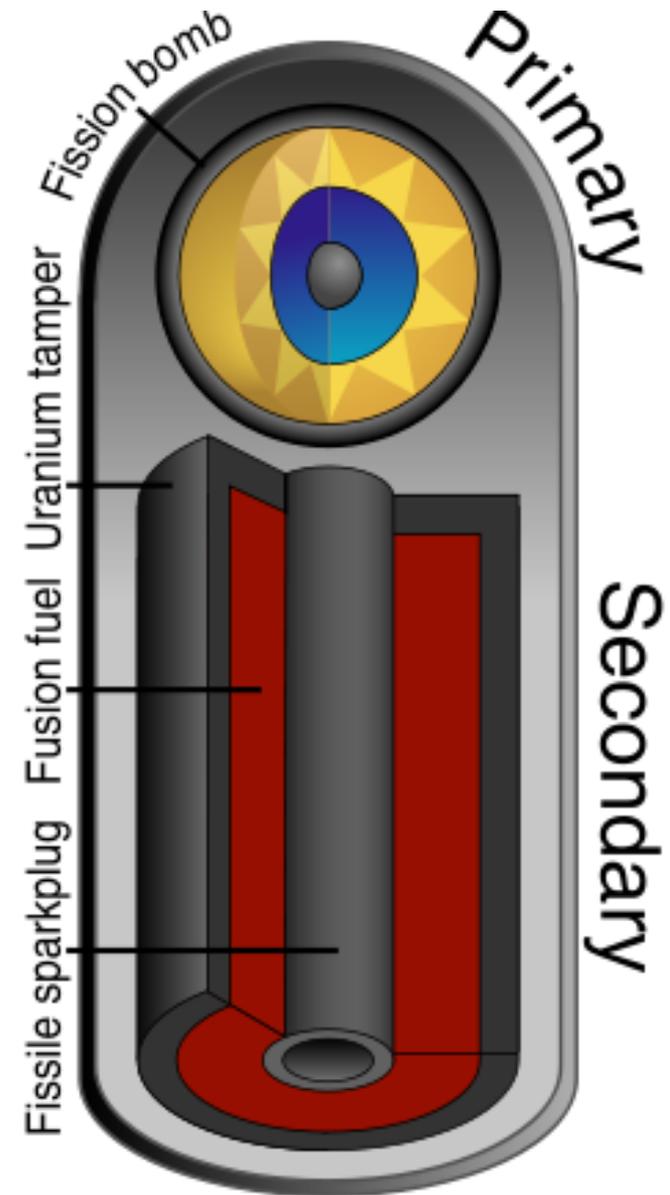
*Implosion trigger mechanism*

# Fusion Bomb

Operation

## Primary boosted-fission component and secondary fusion component.

- Fission bomb explodes giving off X-rays
- Heat causes tamper to expand and burn away, exerting pressure on fuel
- Fuel compressed 30 fold
- Shockwave initiates fission
- Lithium  $\rightarrow$  tritium.
- Pressure and temperature sufficient for fusion.
- Neutron from fusion initiate fission in U-238



*Fusion bomb components*

# Effects

Physical consequences of nuclear detonation

# Effects

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Effects

## Direct Effects

Blast damage

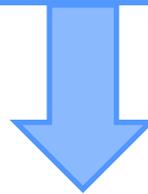
Thermal radiation

## Indirect Effects

Electromagnetic pulse

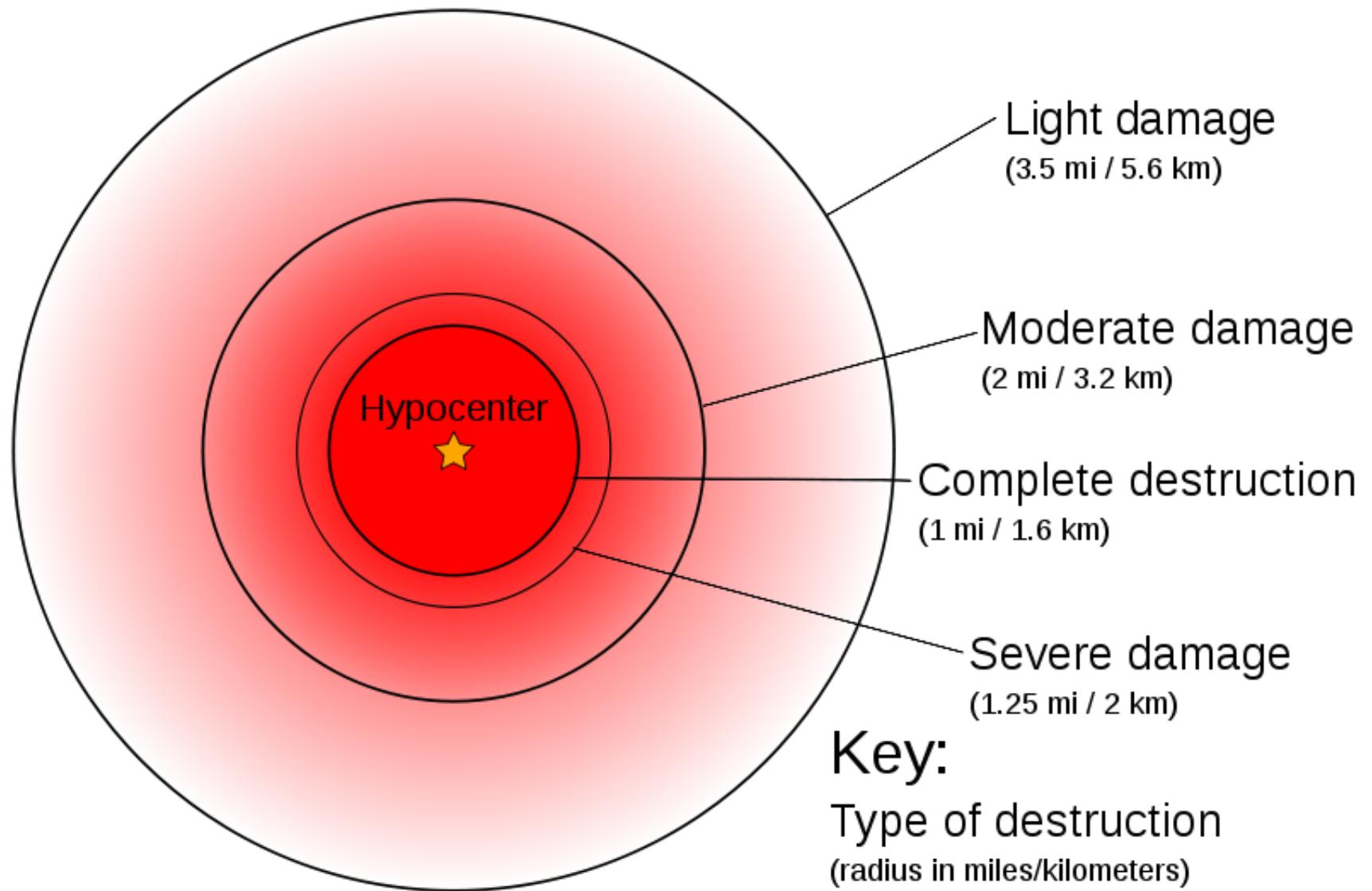
Ionizing radiation

- Blast – 40-50% of total energy
- Thermal radiation – 30-50% of total energy
- Ionizing radiation – 5% of total energy
- Residual radiation – 5-10% of total energy



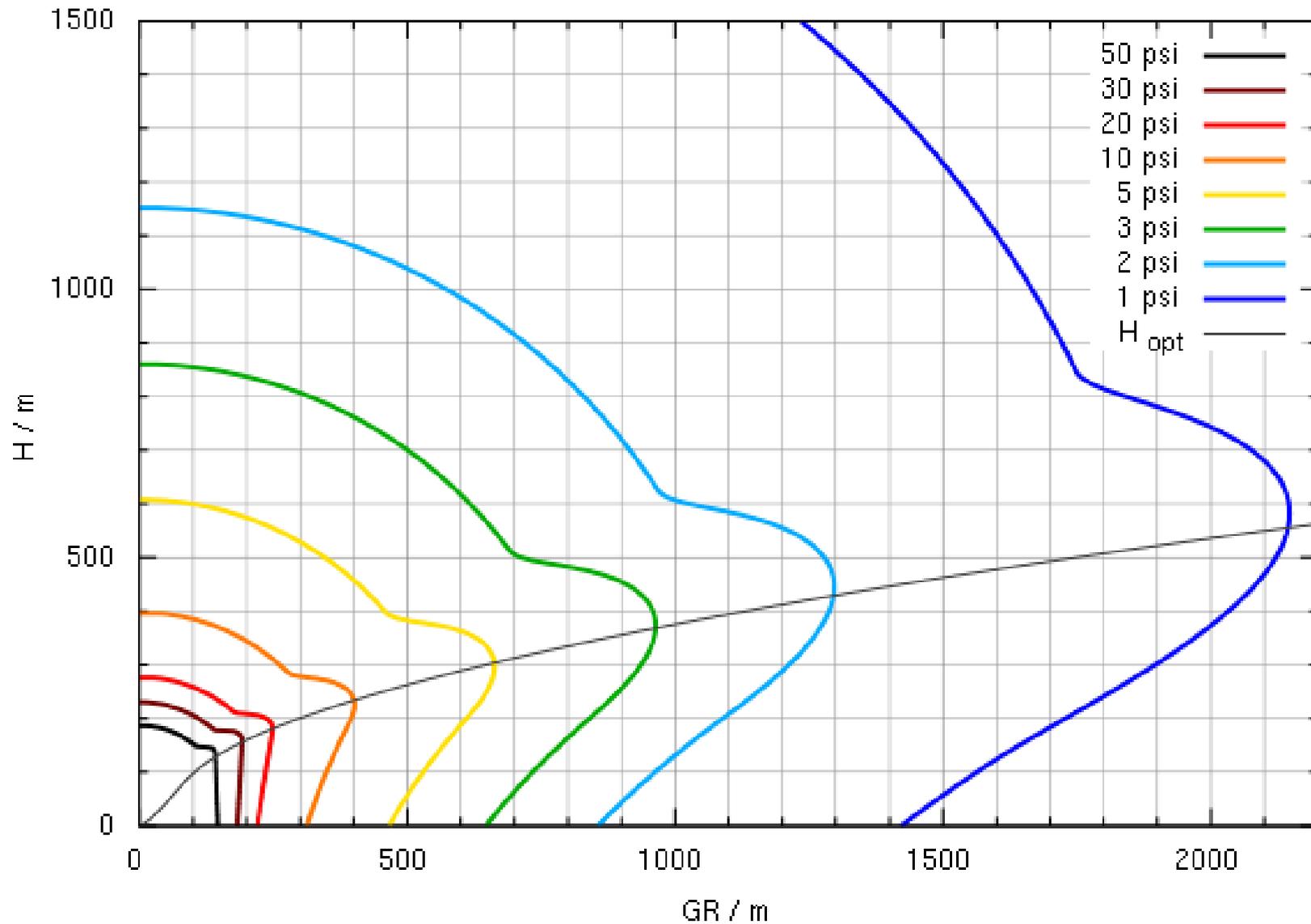
Nuclear radiation

# Blast Damage



Estimate size of the damage caused by the atomic bombings of Hiroshima and Nagasaki [1]

# Optimum Burst Height



Optimum burst height for a given ground range [2]

# Blast Wave Phenomena

Effects

**Static overpressure** - the sharp increase in pressure exerted by the shock wave.

**Dynamic overpressure** - drag exerted by the blast winds required to form the blast wave.



*Effects of the blast wave*

# Thermal Radiation

Effects

Emitted as:

Visible light

Infra-red

UV light

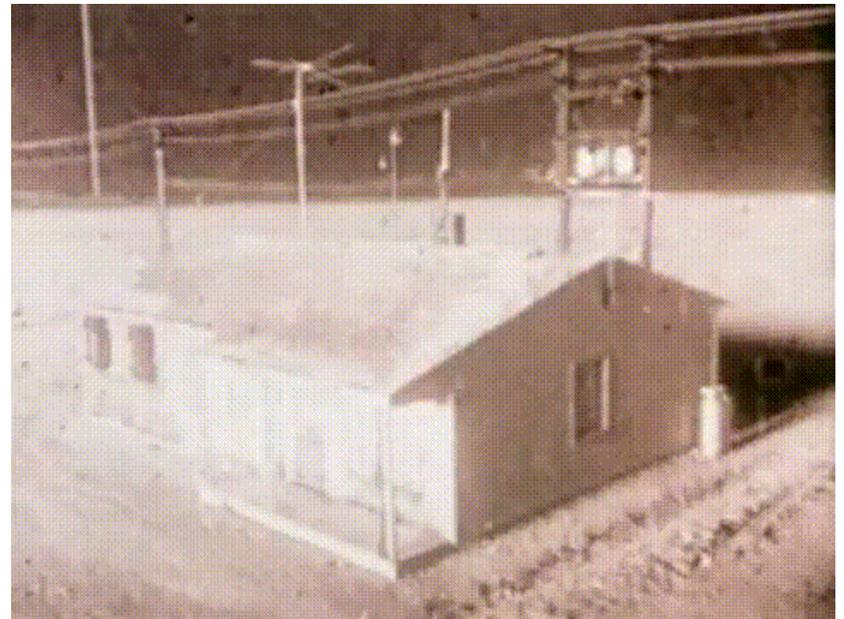
Bigger range than blast range

Main hazards are:

Burns

Eye injuries

Causes fires



*Example of fire due to thermal radiation  
and explosion due to blast wave*

# Electromagnetic Pulse

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Effects

Gamma rays produce high energy electrons through Compton Scattering

These electrons interact with the Earth's magnetic field and create a nuclear electromagnetic pulse

# Ionising Radiation

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Effects

Neutrons

Gamma rays

Alpha particles

Electrons

# Developments

Post-WWII Advancements in Nuclear Weapons

# Hydrogen Bomb

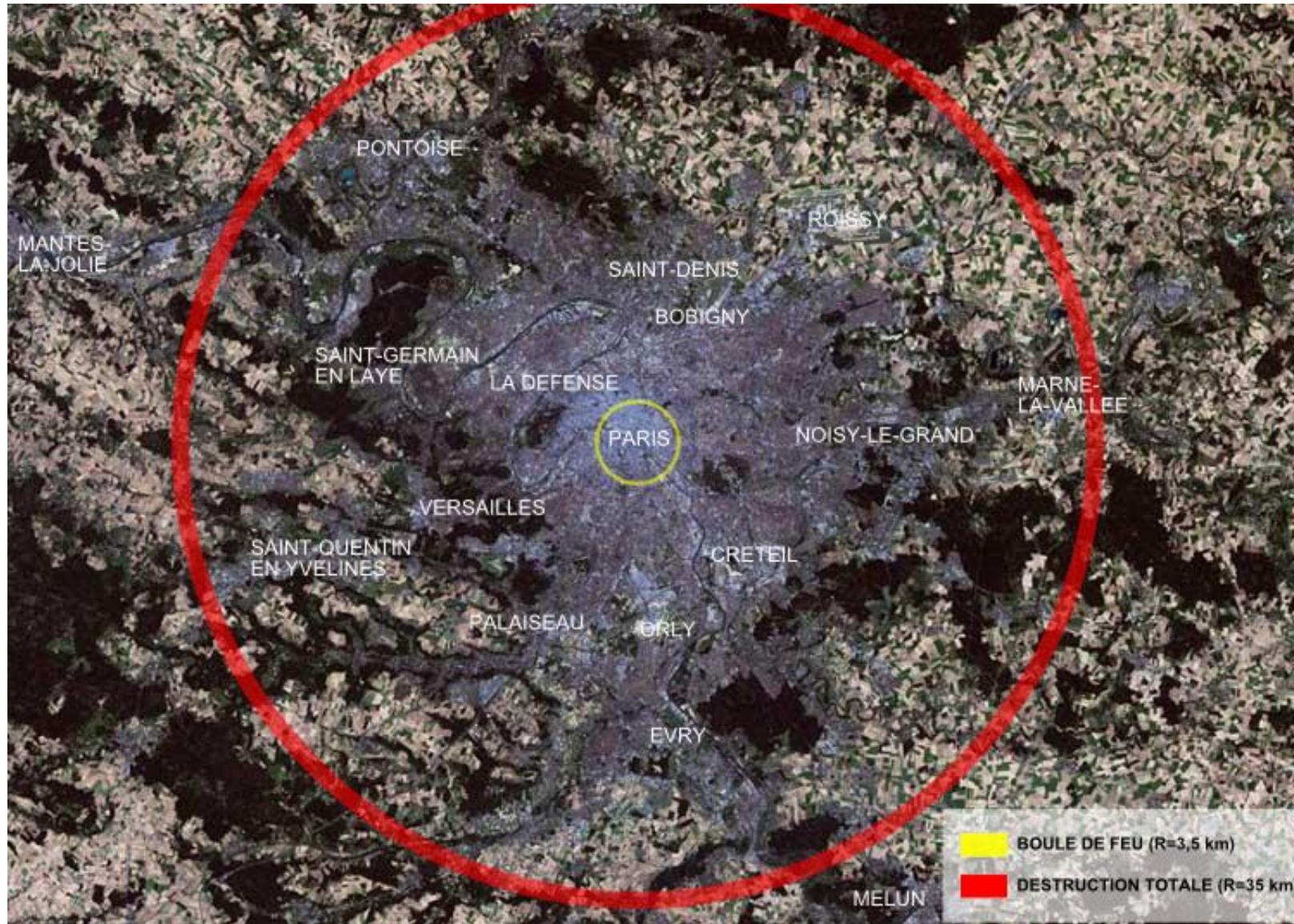
Developments



Tsar Bomba detonation [4]

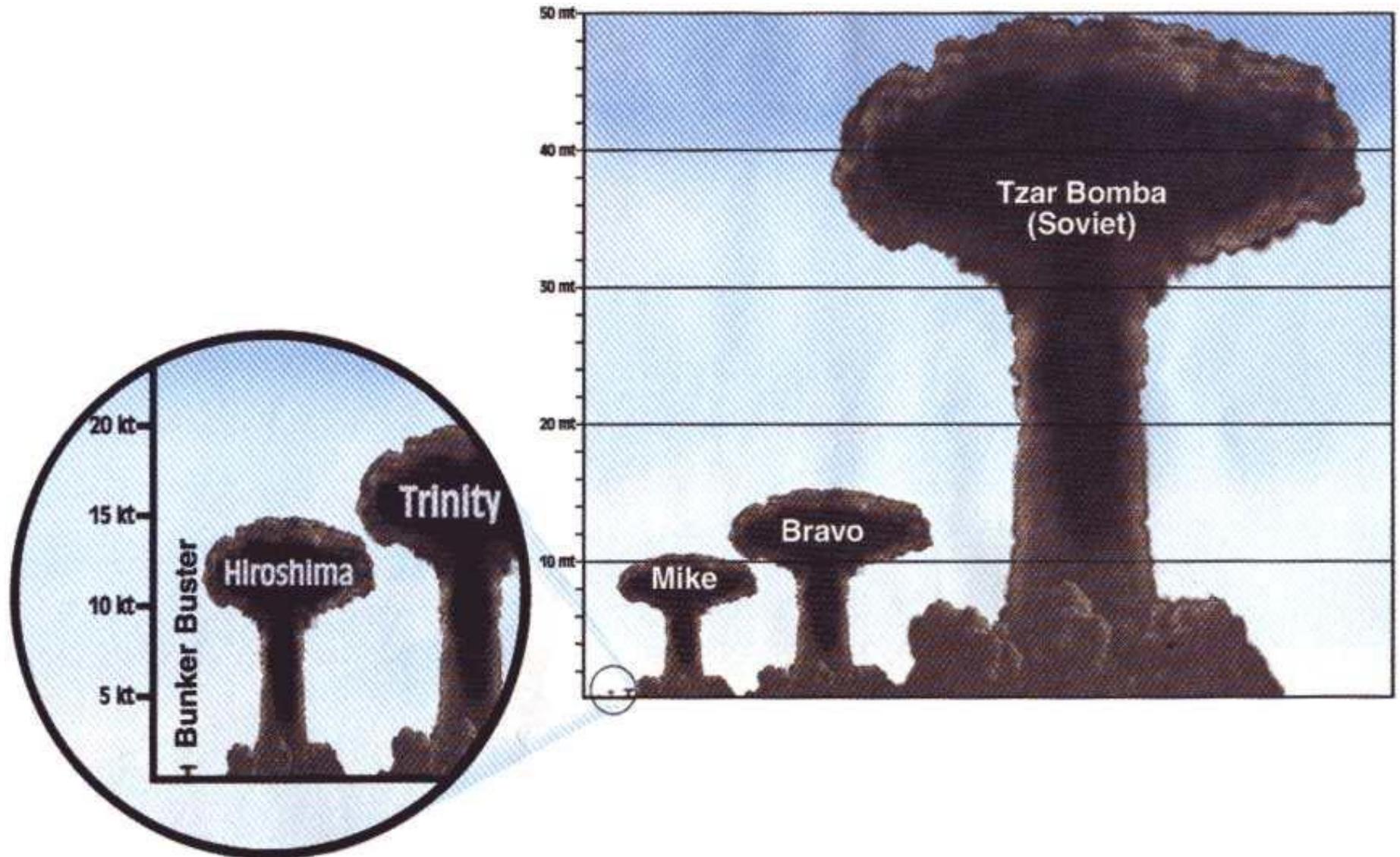
# Destruction Zone

Developments



Zone of total destruction of the Tsar Bomba [5]

# Comparison



# Nuclear Stockpiles

Developments



Number of warheads:

0-150

151-1,000

More than 1,000

Note: All figures are estimates as exact numbers are secret

Source: Federation of American Scientists



*"Now, I am become  
Death, the destroyer of  
worlds."*

- J. Robert Oppenheimer

# Sources

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- [1] - <http://en.wikipedia.org/wiki/File:Abombdamage1945.svg>
- [2] - [http://en.wikipedia.org/wiki/File:Blastcurves\\_psi.svg](http://en.wikipedia.org/wiki/File:Blastcurves_psi.svg)
- [3] - <http://en.wikipedia.org/wiki/File:Nukecloud.png>
- [4] - <http://www.bestcoolfacts.com/the-most-powerful-artificial-explosion-in-human-historytsar-bomba>
- [5] - [http://en.wikipedia.org/wiki/File:Tsar\\_Bomba\\_Paris.png](http://en.wikipedia.org/wiki/File:Tsar_Bomba_Paris.png)
- [6] - <http://blog.markloiseau.com/2010/02/tsar-bomba-the-biggest-bomb-ever/>
- [7] - [http://en.wikipedia.org/wiki/File:US\\_nuclear\\_weapons\\_yield-to-weight\\_comparison.svg](http://en.wikipedia.org/wiki/File:US_nuclear_weapons_yield-to-weight_comparison.svg)
- [8] - <http://www.bbc.co.uk/news/world-17511816>