

A collection of nuclear warheads arranged in a circle around a globe of the Earth. The warheads are of various designs, some with red and white markings, and some with yellow markings. The globe is centered in the middle of the circle, showing the continents of North and South America. The background is a light blue and white grid pattern.

Az atomfegyverek fizikája

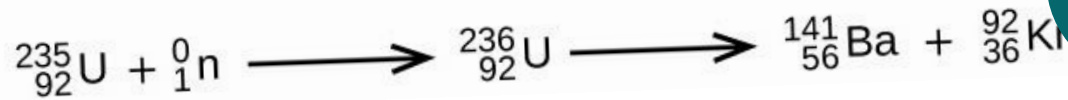
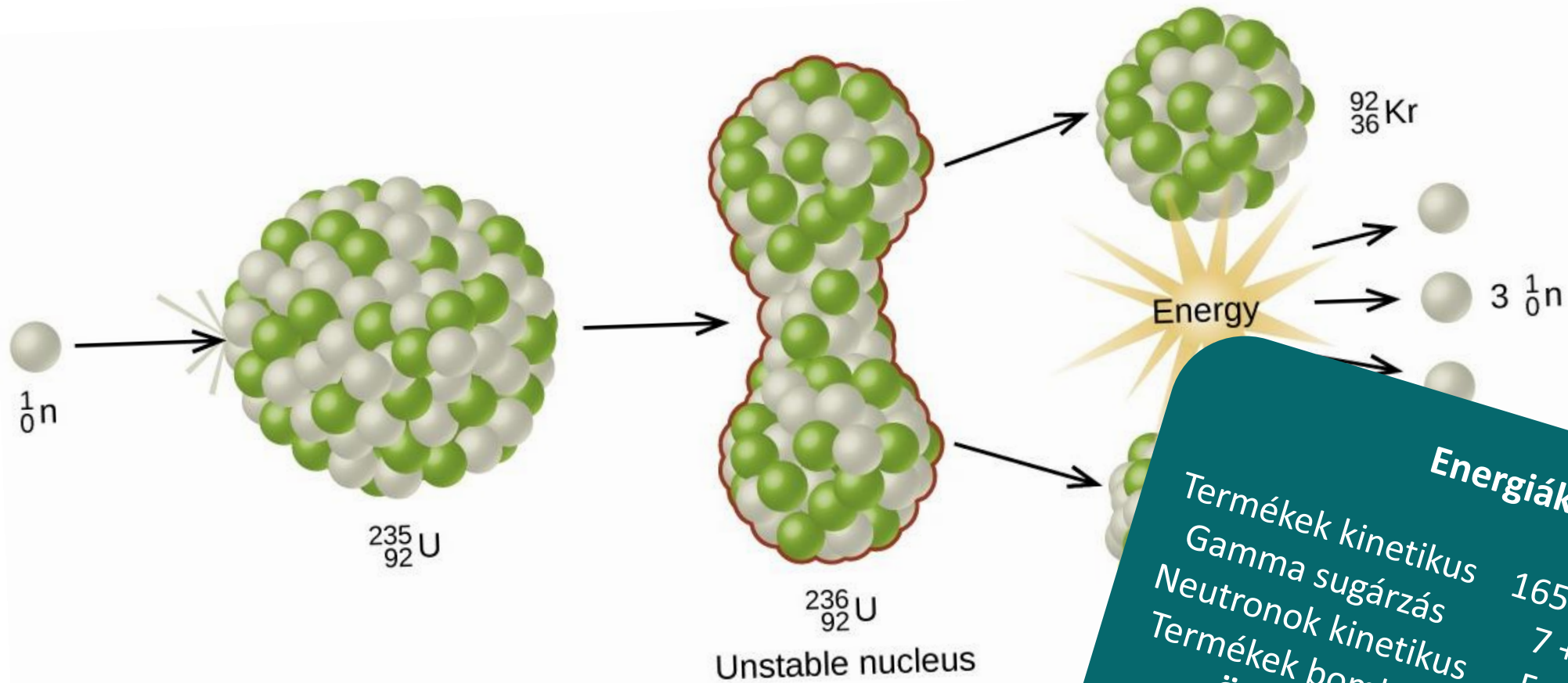
Készítette: Graning Sára

2020

Fő források

<https://nuclearweaponarchive.org/>

https://www.youtube.com/watch?v=zVhQOhxb1Mc&ab_channel=BelferCenter



Energiaák	
Termékek kinetikus	165 +/- 5 MeV
Gamma sugárzás	7 +/- 1 MeV
Neutronok kinetikus	5 +/- 0.5 MeV
Termékek bomlása	23 +/- 2 MeV
Összes	200 +/- 6 MeV

Neutronok

Kritikus tömeg =
önfenntartó
láncreakció
< Szuper-kritikus

Szórás vs. Befogás

- abszorpció v. hasadás
- hatáskeresztmetszetek

Átlag szabad úthossz

- Hasadás :
13 cm - 1 shake
- Szórás:
2.5 cm -> 5x

Probléma: szökés

- Nagyobb tömeg
- Reflektálás
- Magasabb sűrűség

Anyagok

1. Urán

- 235 vs. 238
- Dúsítás
- Hirosima

0.7%
3-5%
20%
85-90%

> 90%

2. Plutónium (Pu-239)

- U-238 $^{238}\text{U} + n = ^{239}\text{U} \xrightarrow{\beta^-} ^{239}\text{Np} \xrightarrow{\beta^-} ^{239}\text{Pu}$
- Nagasaki

Reaktor



Feldolgozás

Energia



Hő



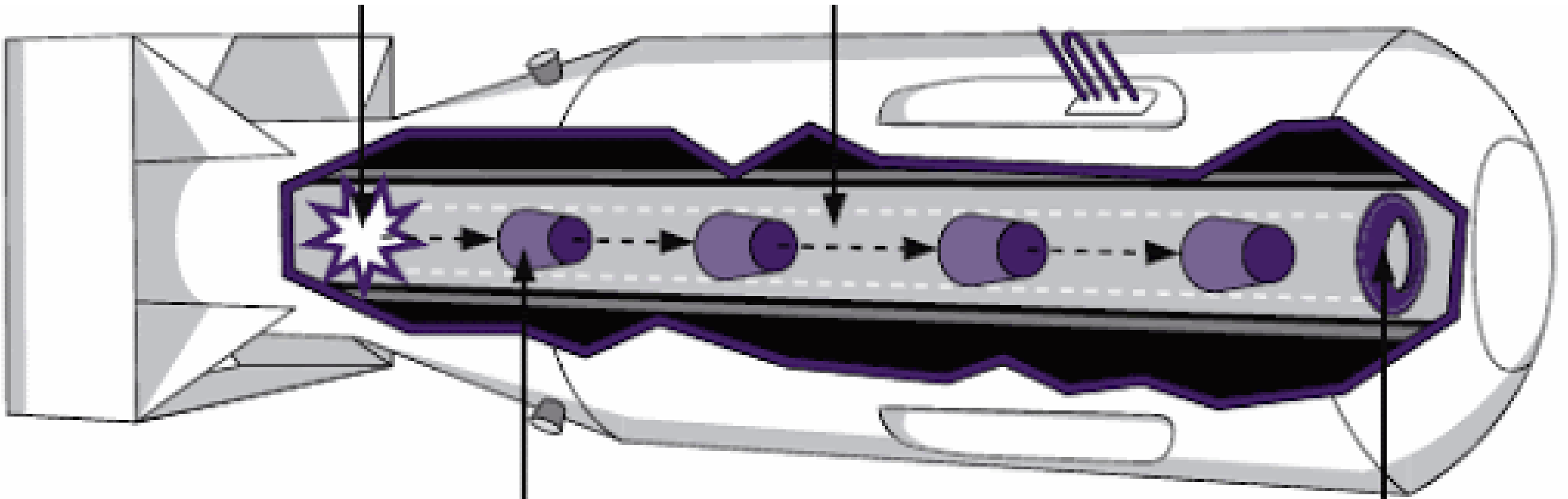
Tágulás



Spontán hasadás

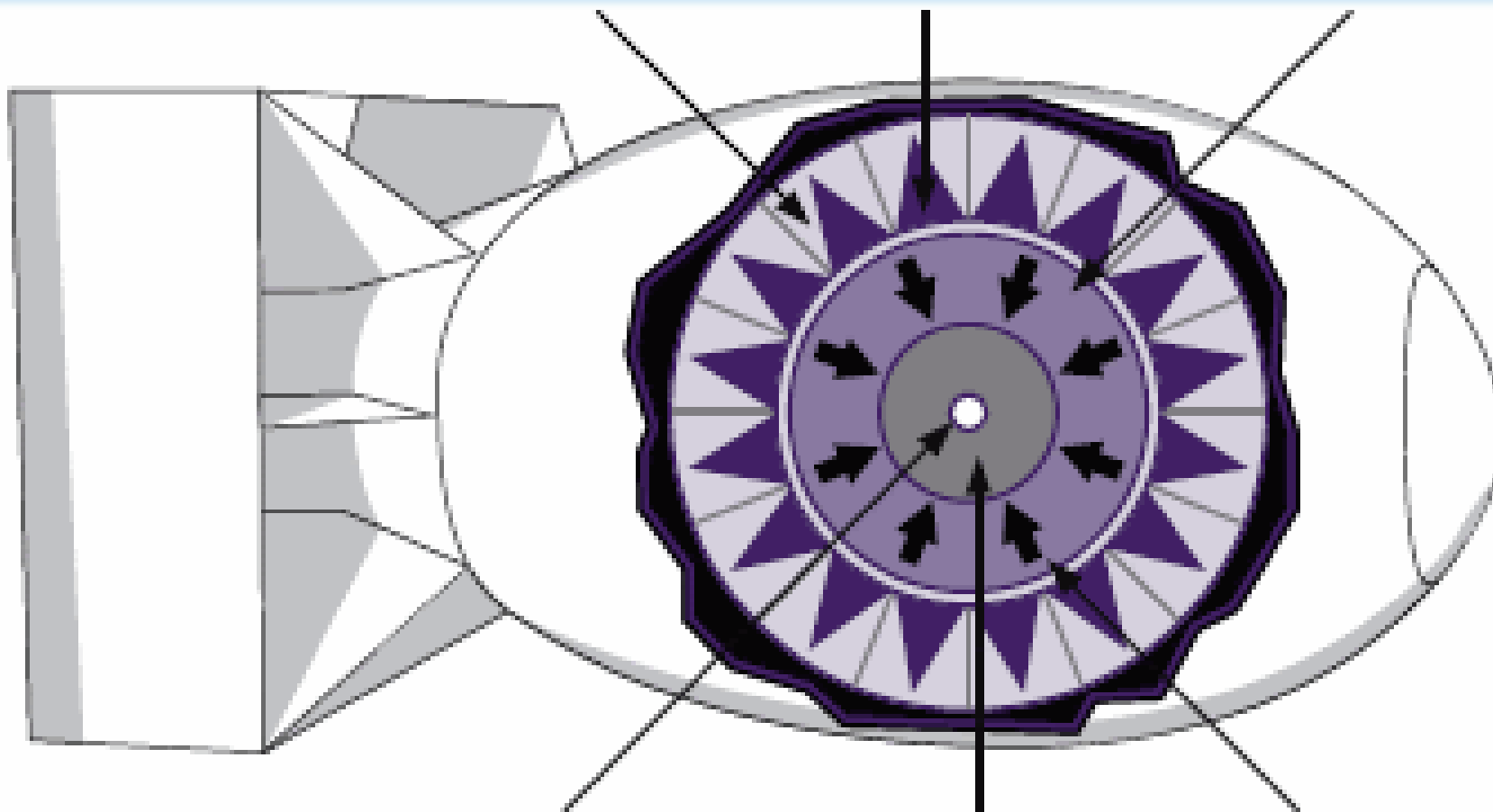
Ágyú típusú (gun type)

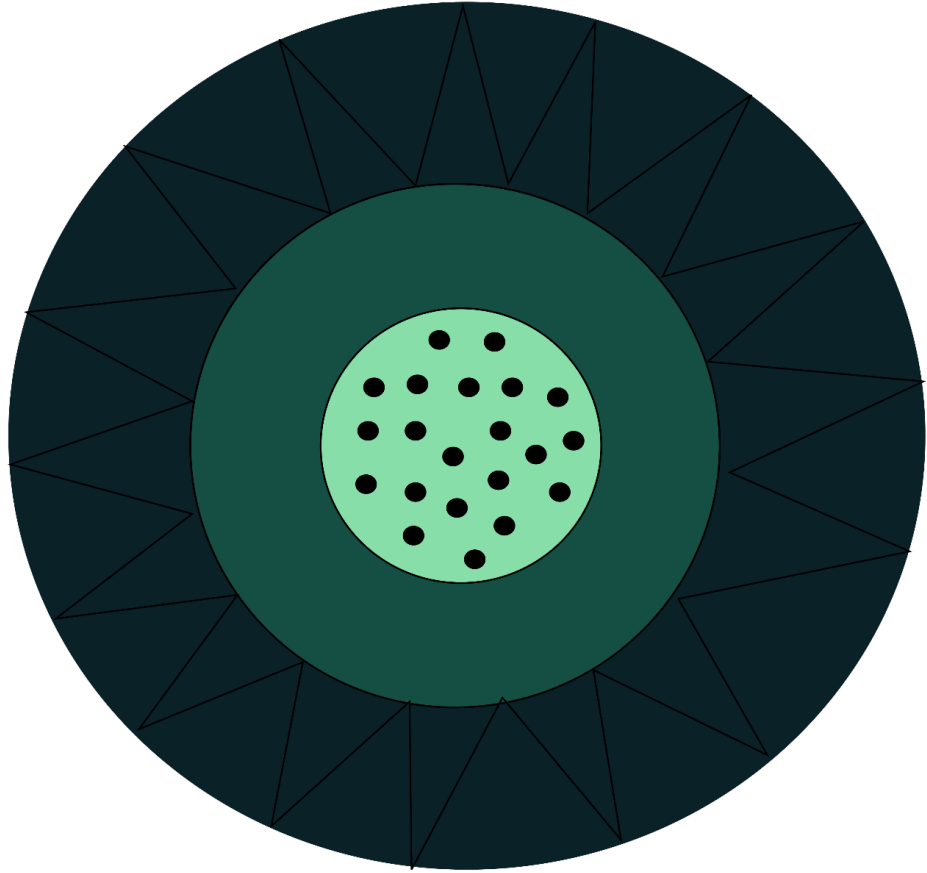
- Alacsony hatásfok, nagy méret
- Plutóniumot nem
- Hirosima

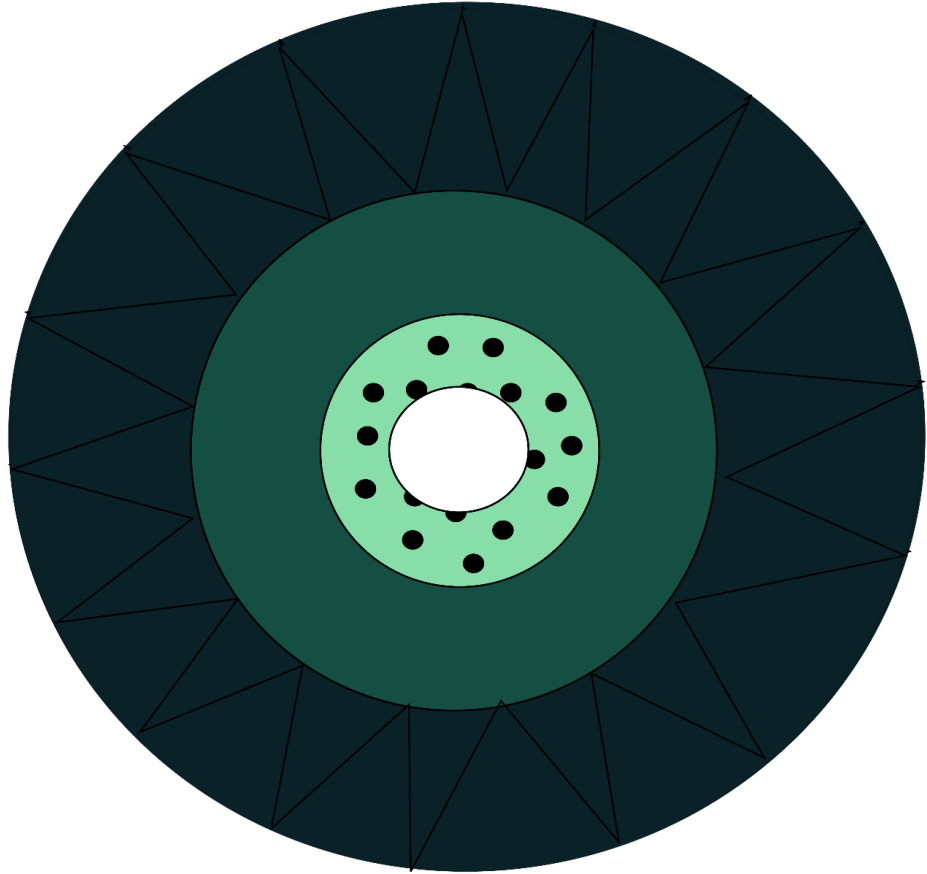


Robbanó lencsés (implosion type)

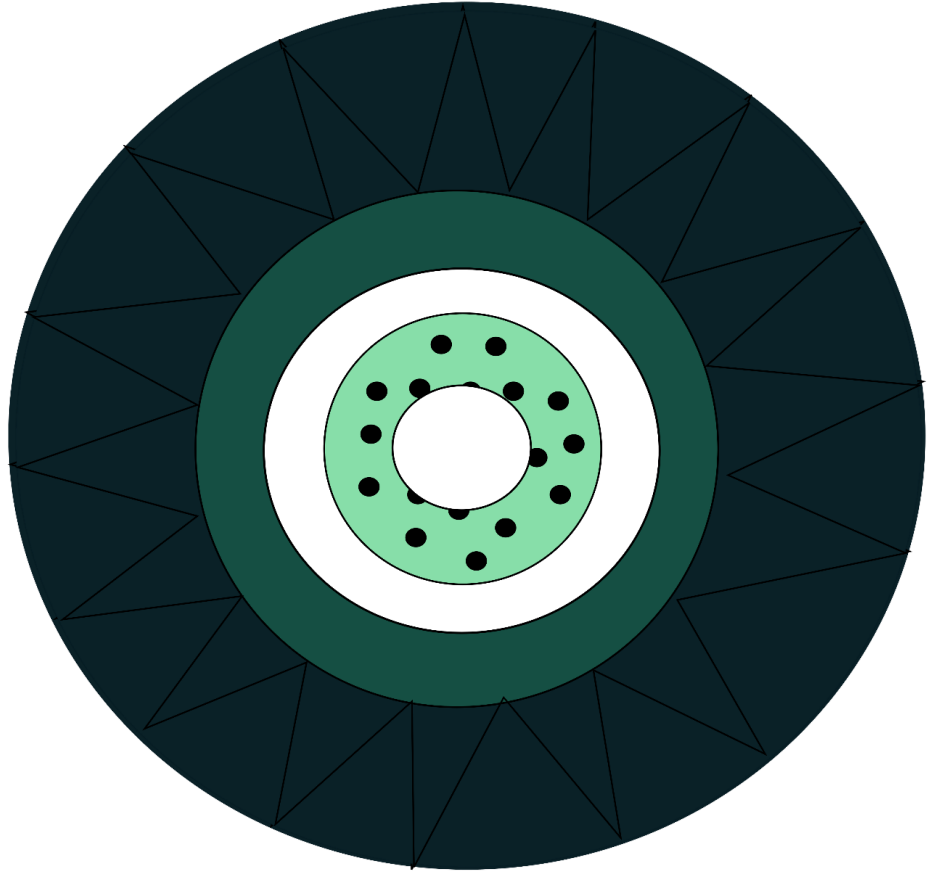
- Sűrűség
- Plutónium
- Nagasaki







Üreges mag



Lebegő mag

Boost – Fúziós erősítés

Trícium

Hasadásnál
hő



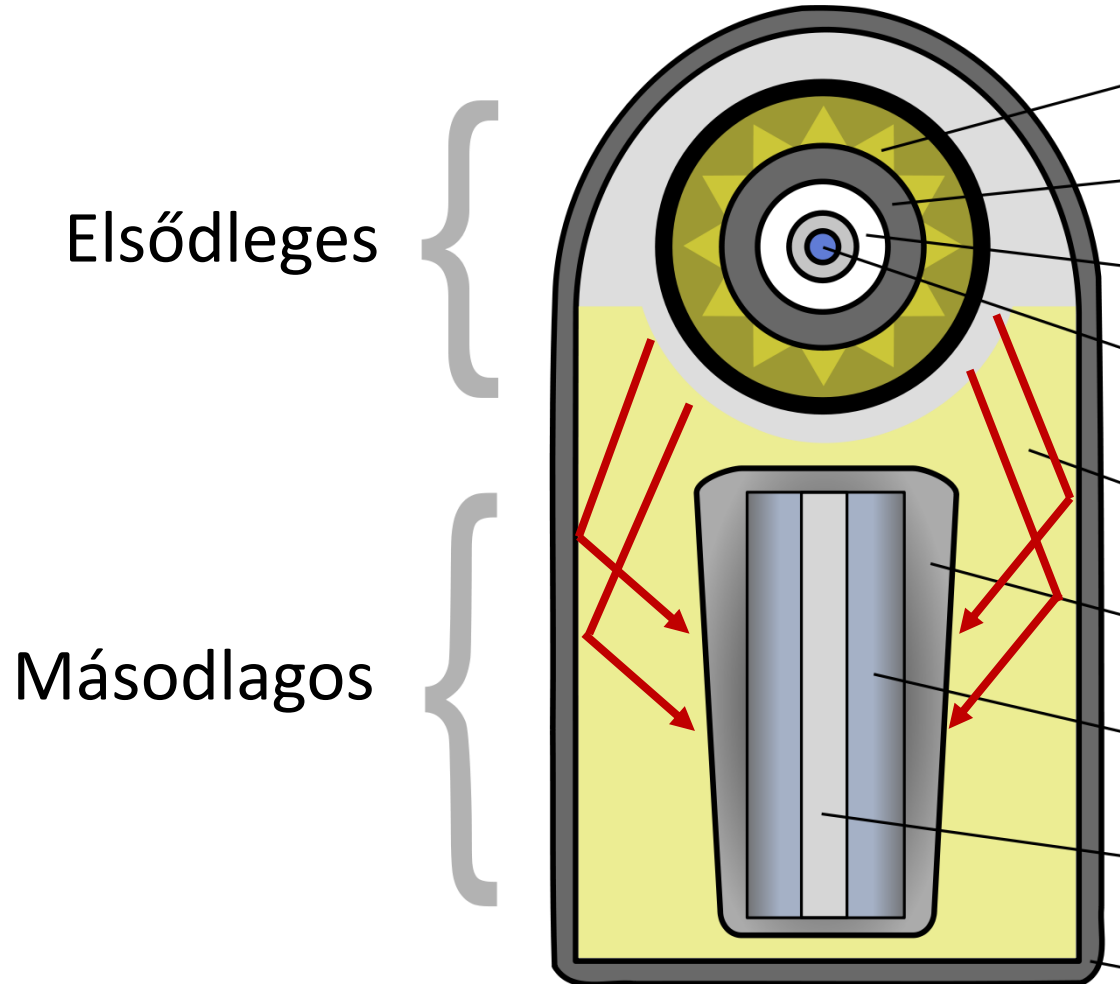
Beindítja a
fúziót



Energia +
neutronok

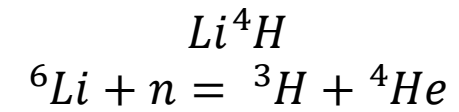


Teller-Ulam elrendezés



- Röntgen + hő

- Fúzió



- Még hasadás -> Erősítés

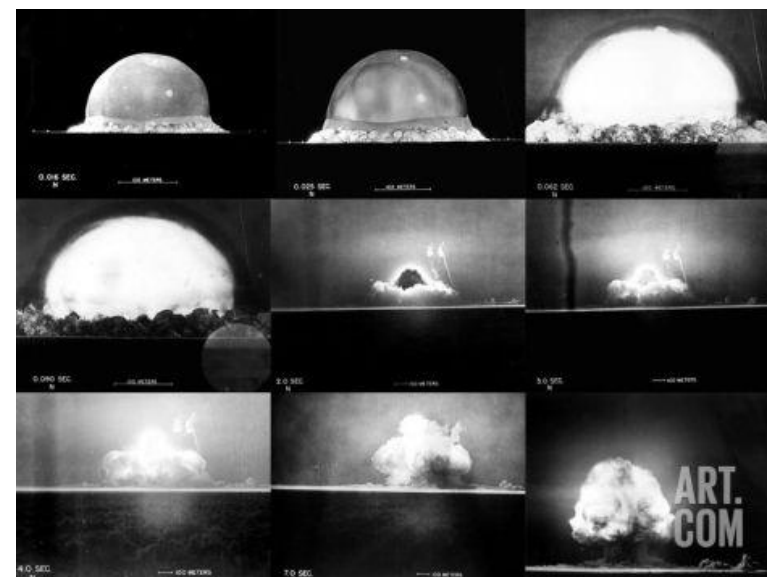
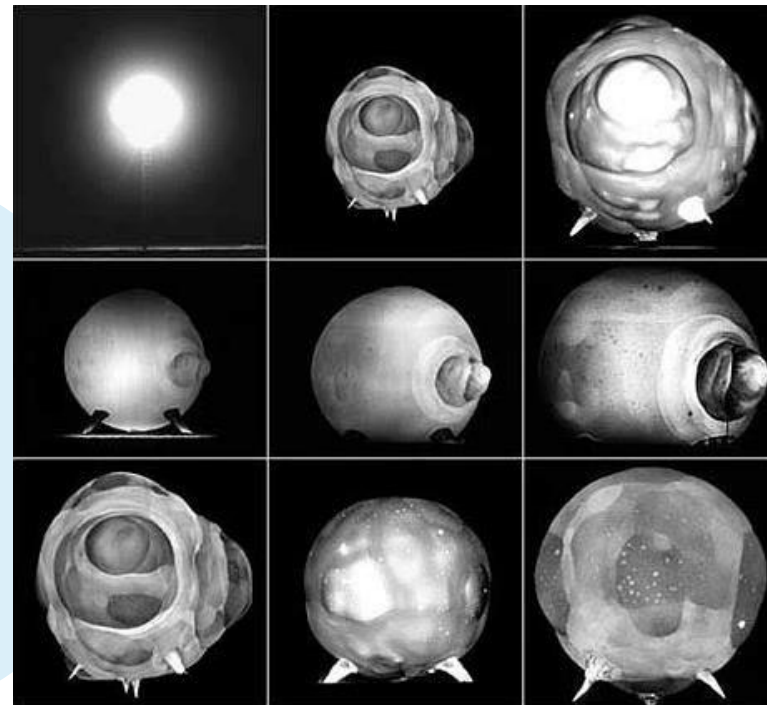
Robbantás helye

Levegőben

- Maximális terület
- Nincsen "fallout"

Földön

- Maximális "fallout"
- Tűzgolyó és gombafelhő



G. I. Taylor és Trinity

Dimenzió analízis

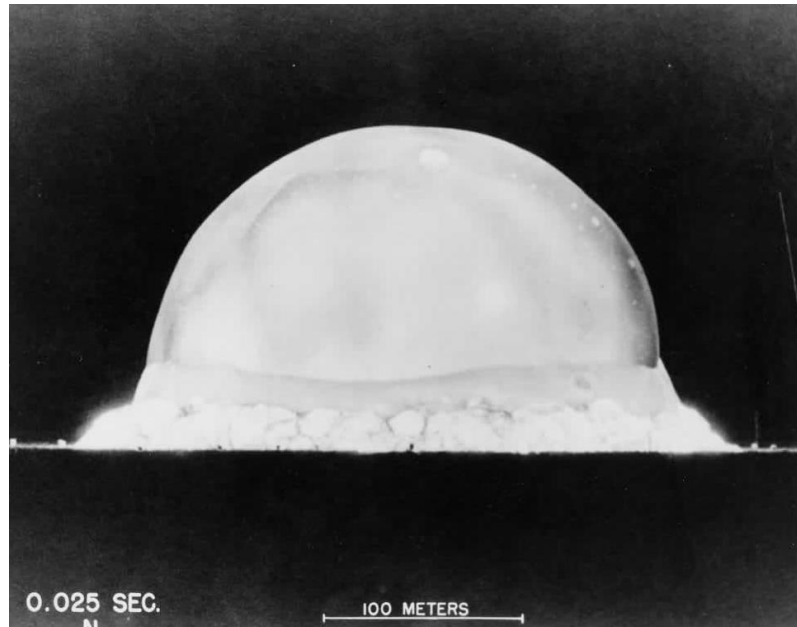
$$r = 80 \text{ m}$$

$$t = 0.006 \text{ t}$$

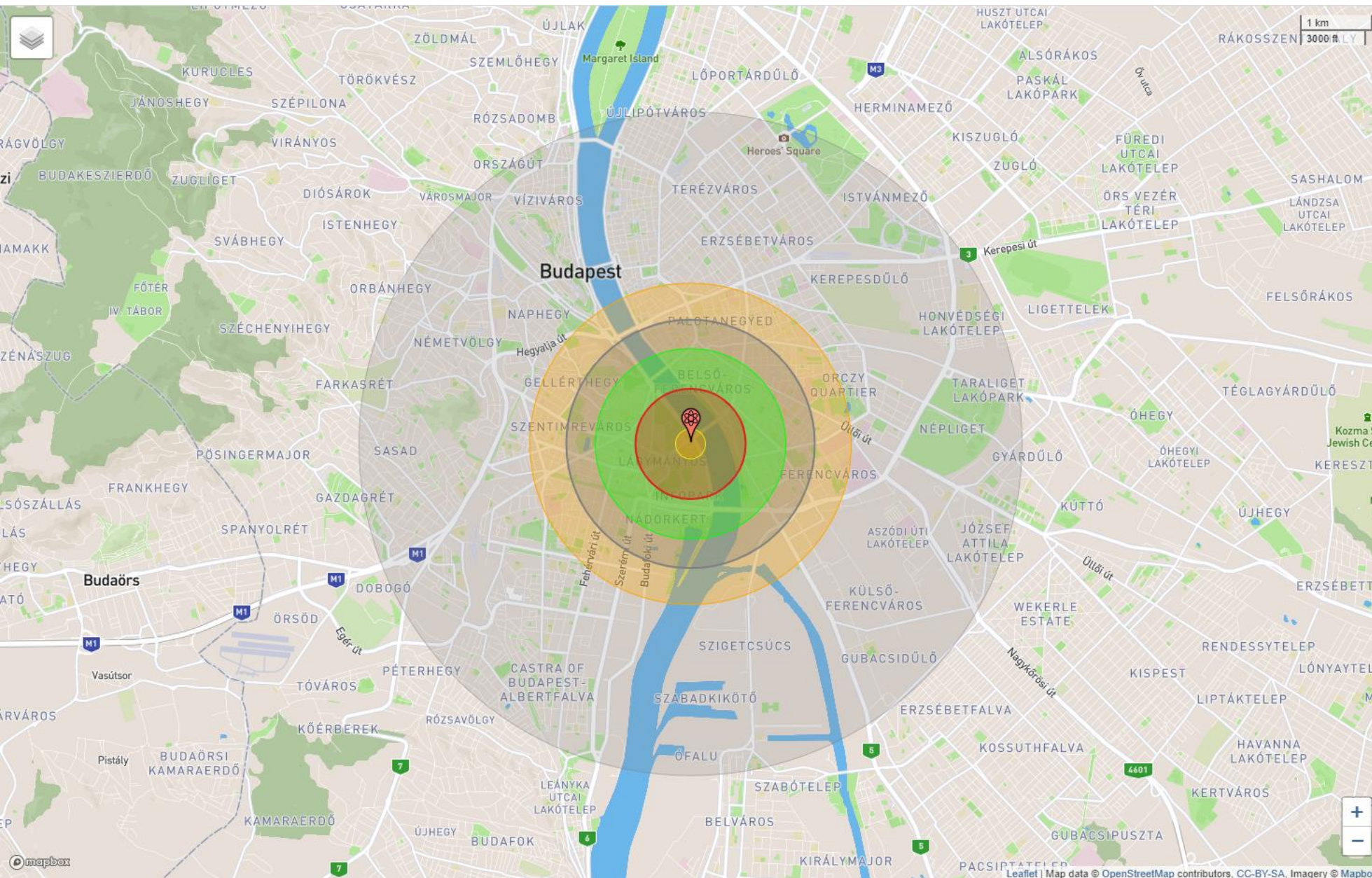
$$\rho = 1.1 \text{ kg/m}^3$$

$$C = 1.033$$

$$E = C \frac{\rho R^5}{t^2} = 1 \times 10^{14} \text{ J}$$



23.9 kt



NUKEMAP 2.7 : FAQ You might also try: [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
Or you can select a preset...
2. Enter a yield (in kilotons):
"Fat Man" - Nagasaki bomb (20 kt)
3. Basic options: Height of burst: [?] Airburst Surface
Other effects: Casualties Radioactive fallout
- Advanced options: ▶
4. Click the "Detonate" button below.

Note that you can drag the target marker after you have detonated the nuke.

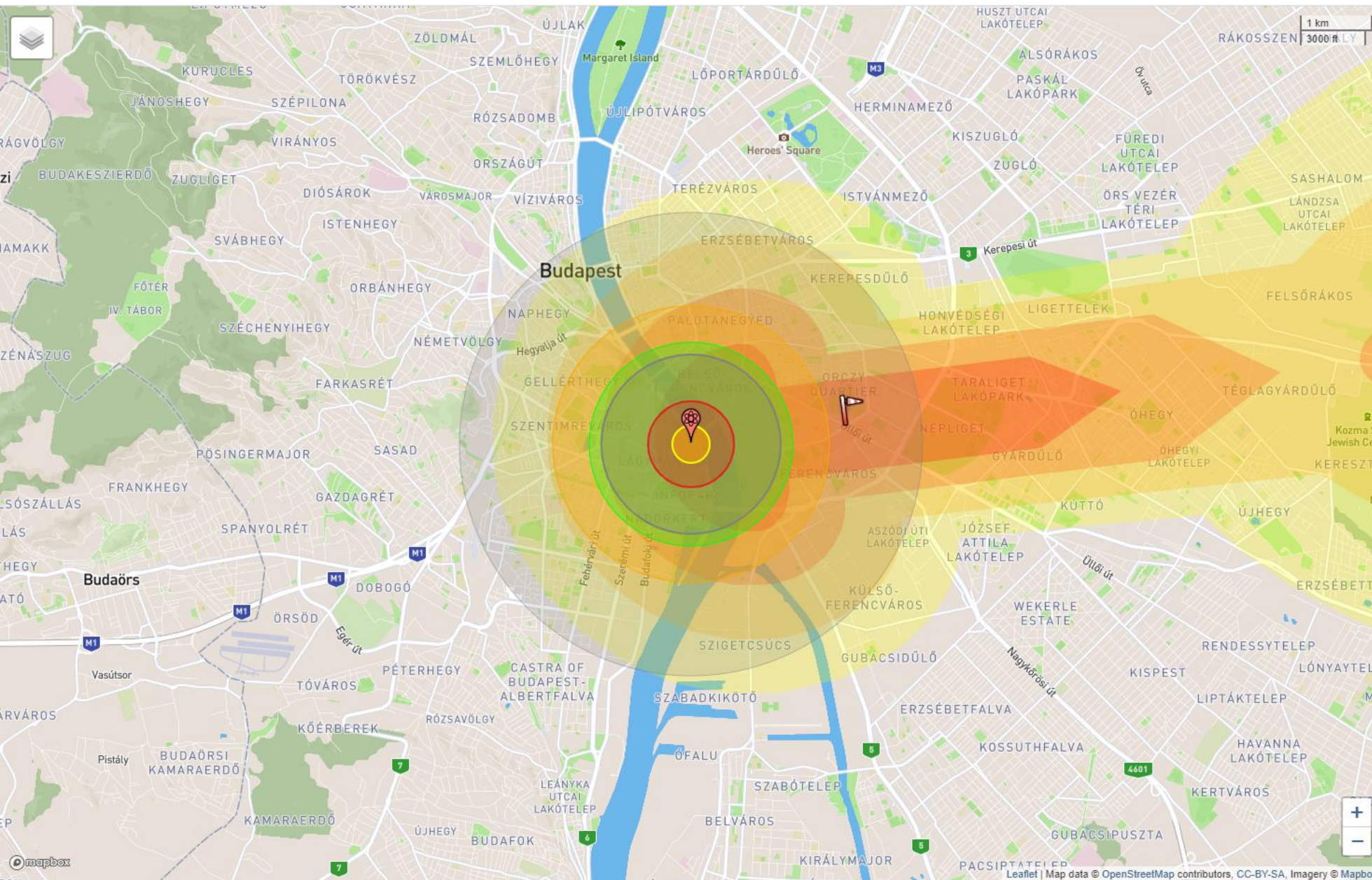
Estimated fatalities:
39,110

Estimated injuries:
111,550

In any given 24-hour period, there are on average 345,172 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 20 kiloton airburst*: ▼
- Fireball radius: 200 m (0.13 km²)
Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized. Minimum burst height for negligible fallout: 180 m.
 - Heavy blast damage radius (20 psi): 0.76 km (1.82 km²)
At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities. Optimal height of burst to maximize this effect is 490 m.
 - Radiation radius (500 rem): 1.31 km (5.42 km²)
500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.
 - Moderate blast damage radius (5 psi): 1.72 km (9.26 km²)
At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities. Optimal height of burst to maximize this effect is 0.85 km.



NUKEMAP 2.7 : FAQ You might also try: [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
 Or you can select a preset...

Or type in the name of a city:

2. Enter a yield (in kilotons):
 Or you can select a preset...

3. Basic options: Height of burst: [Airburst Surface
 Other effects: Casualties Radioactive fallout

Advanced options: ▶

4. Click the "Detonate" button below.

Note that you can drag the target marker after you have detonated the nuke.

Estimated fatalities:

17,940

Estimated injuries:

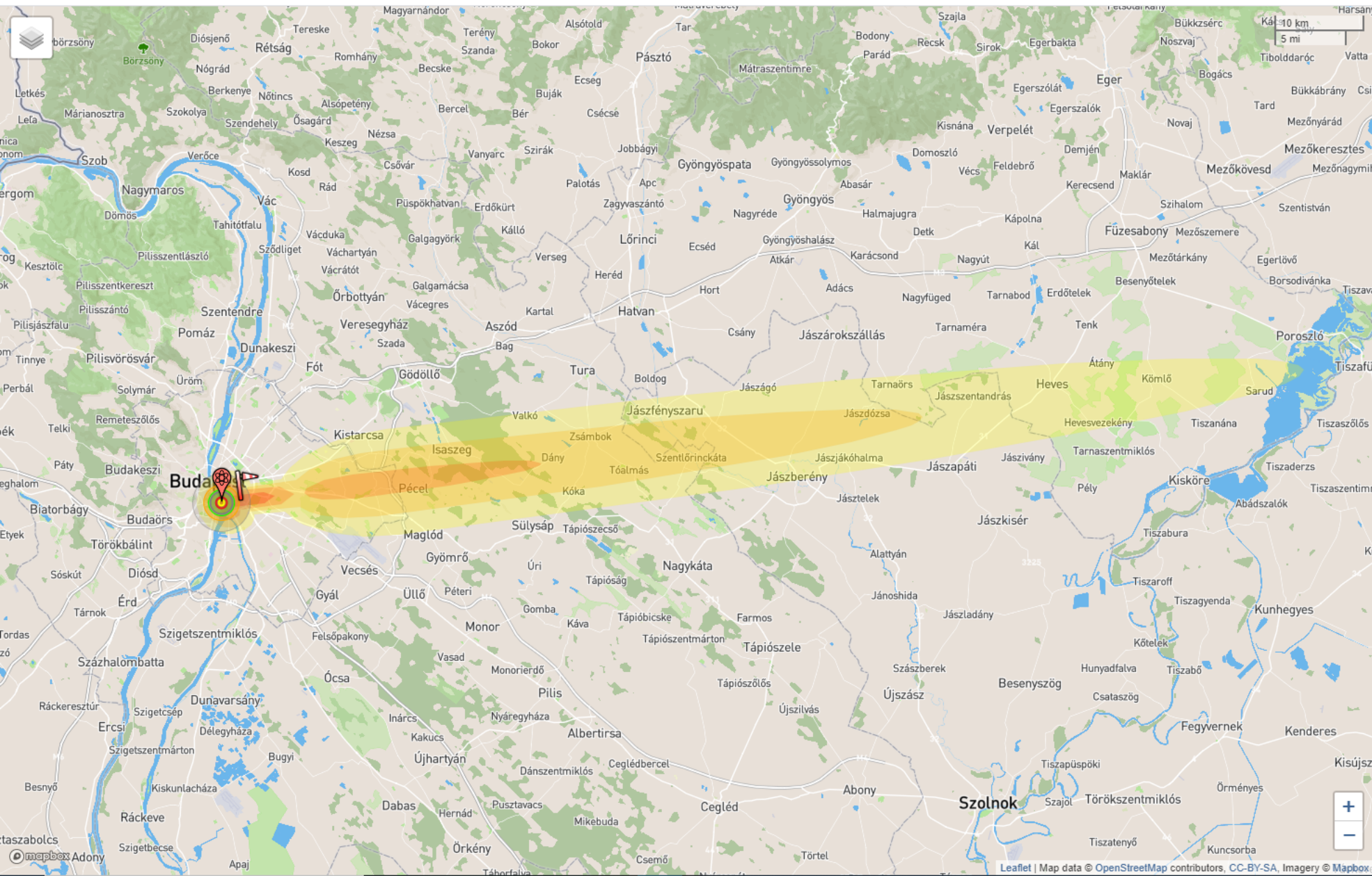
59,510

In any given 24-hour period, there are on average 185,596 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

Effect distances for a 20 kiloton surface burst: ▼

- Fireball radius: 260 m (0.22 km²)
 Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized.
- Heavy blast damage radius (20 psi): 0.59 km (1.1 km²)
 At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities.
- Moderate blast damage radius (5 psi): 1.24 km (4.85 km²)
 At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities.
- Radiation radius (500 rem): 1.41 km (6.22 km²)
 500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.



NUKEMAP 2.7 : [FAQ](#) [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
 Or you can select a preset...

Or type in the name of a city:

2. Enter a yield (in kilotons):
 Or you can select a preset...

3. Basic options: Height of burst: [?] Airburst Surface
 Other effects: Casualties Radioactive fallout

Advanced options: ▶

4. Click the "Detonate" button below.

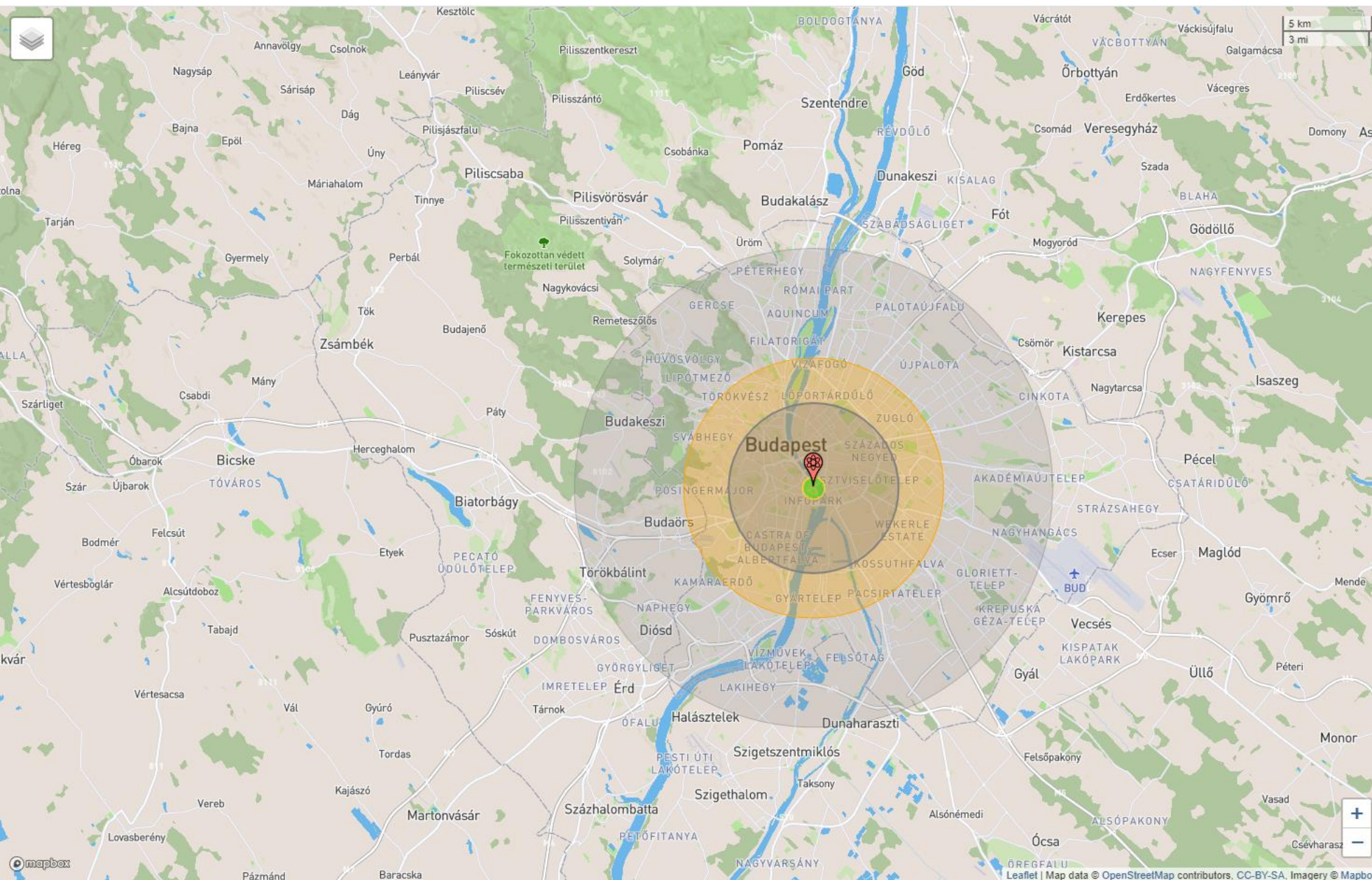
Note that you can drag the target marker after you have detonated the nuke.

Estimated fatalities: **17,940**
 Estimated injuries: **59,510**

In any given 24-hour period, there are on average 185,596 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 20 kiloton surface burst: ▼
- Fireball radius: 260 m (0.22 km²)
 Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized.
 - Heavy blast damage radius (20 psi): 0.59 km (1.1 km²)
 At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities.
 - Moderate blast damage radius (5 psi): 1.24 km (4.85 km²)
 At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities.
 - Radiation radius (500 rem): 1.41 km (6.22 km²)
 500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.



NUKEMAP 2.7 : FAQ You might also try: [MISSILEMAP](#)

- Drag the marker to wherever you'd like to target.**
 Or you can select a preset...
 Or type in the name of a city:
- Enter a yield (in kilotons):**
 TN 80/81 (largest current French warhead) (300 kt)
- Basic options:** Height of burst: [?] Airburst Surface
 Other effects: Casualties Radioactive fallout
- Advanced options:** ▶
- Click the "Detonate" button below.**

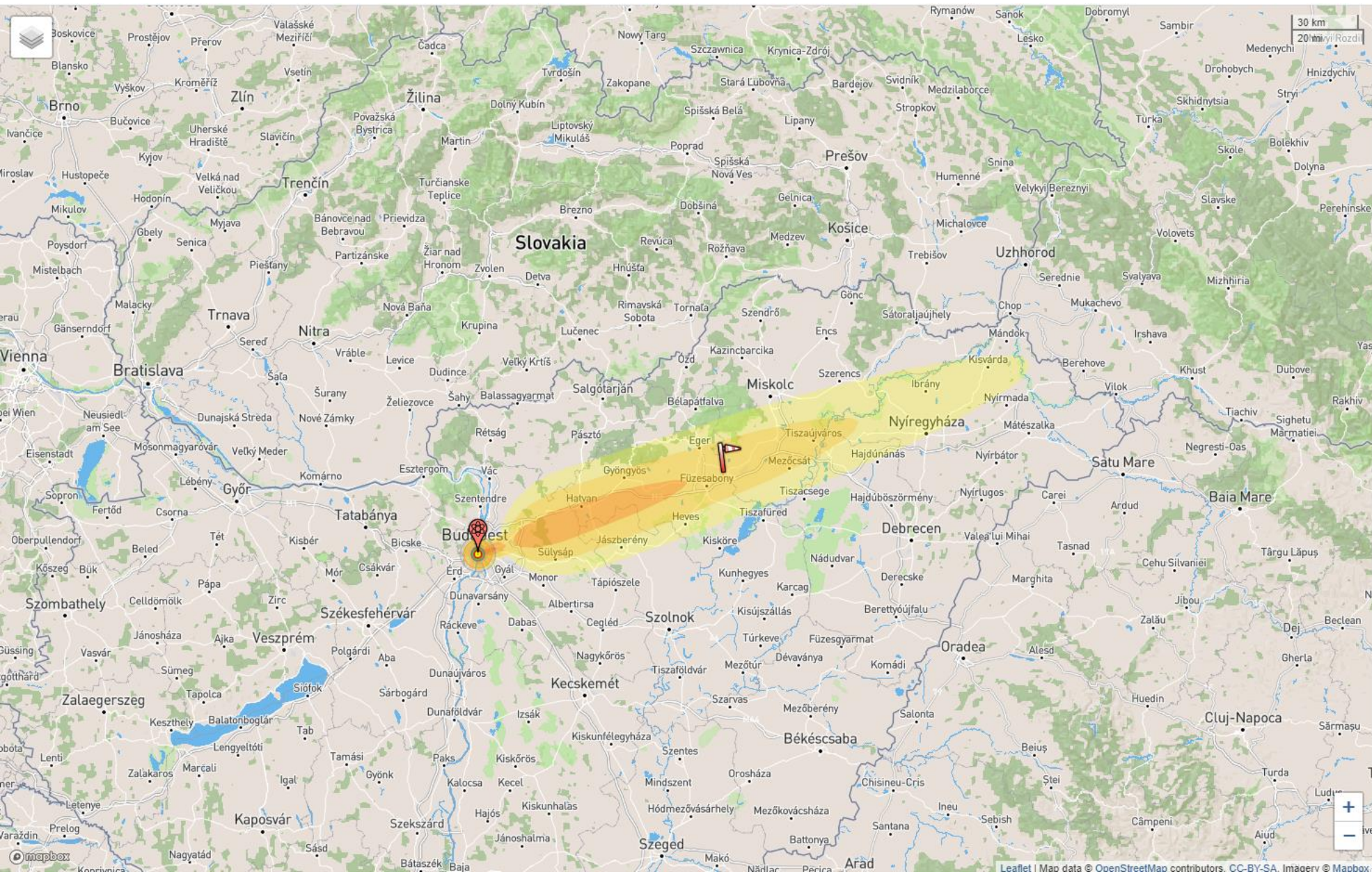
Note that you can drag the target marker after you have detonated the nuke.

Estimated fatalities:
227,370
 Estimated injuries:
619,910

In any given 24-hour period, there are on average 1,695,839 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 300 kiloton airburst*:** ▼
- Radiation radius (500 rem): 460 m (0.67 km²)**
 500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.
 - Fireball radius: 0.6 km (1.12 km²)**
 Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized. Minimum burst height for negligible fallout: 0.54 km.
 - Moderate blast damage radius (5 psi): 4.71 km (69.6 km²)**
 At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities. Optimal height of burst to maximize this effect is 2.09 km.
 - Thermal radiation radius (3rd degree burns): 7.17 km (161 km²)**
 Third degree burns extend throughout the layers of skin, and are often painless because they destroy the pain nerves. They can cause severe scarring or



NUKEMAP 2.7 : FAQ

You might also try: [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
Or you can select a preset...
Or type in the name of a city:
2. Enter a yield (in kilotons):
TN 80/81 (largest current French warhead) (300 kt)
3. Basic options: Height of burst: [?] Airburst Surface
Other effects: Casualties Radioactive fallout
- Advanced options: ▶
4. Click the "Detonate" button below.

Note that you can drag the target marker after you have detonated the nuke.

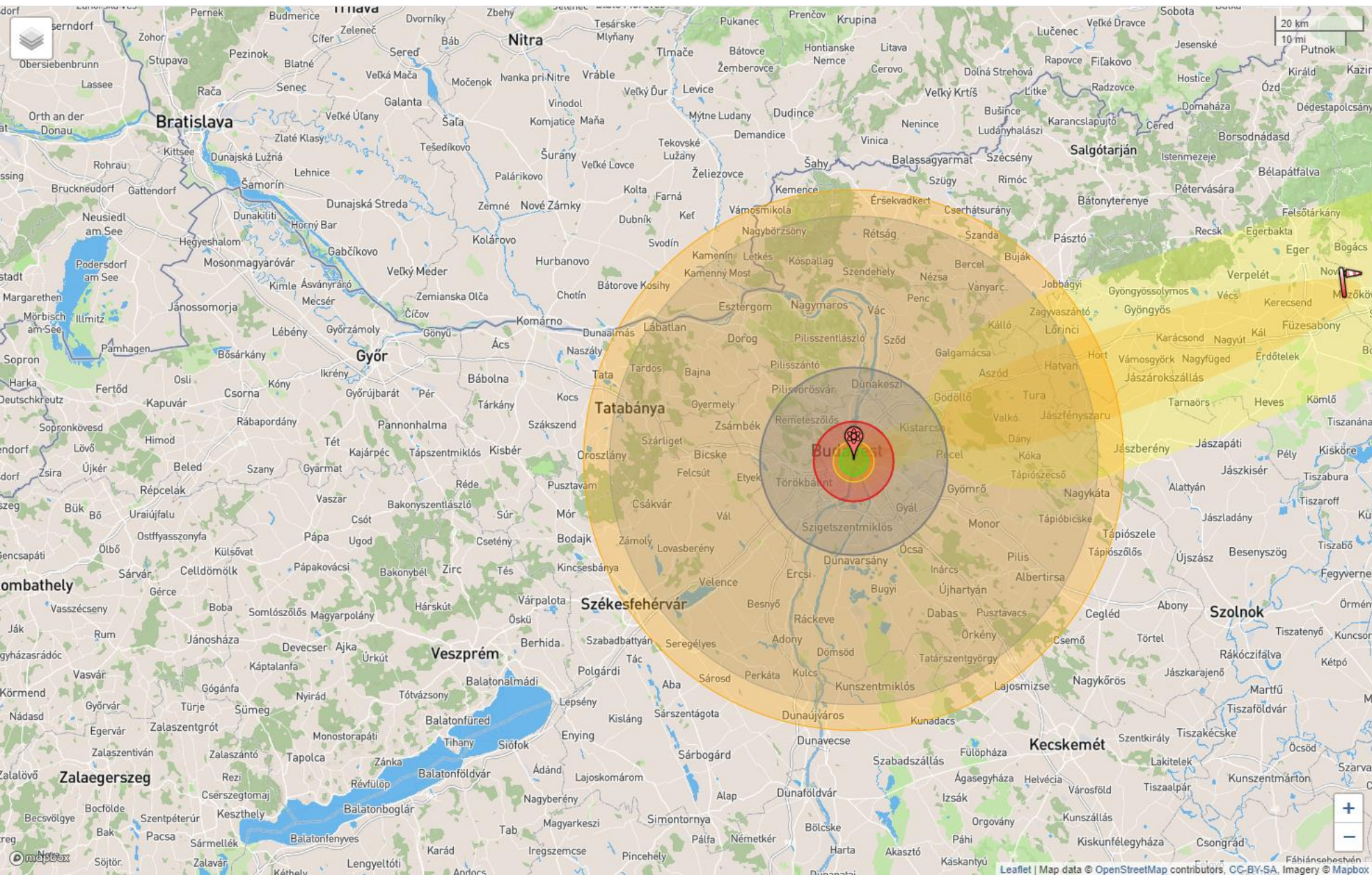
Estimated fatalities:
132,470

Estimated injuries:
302,130

In any given 24-hour period, there are on average 986,998 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 300 kiloton surface burst: ▼
- Fireball radius: 0.78 km (1.89 km²)
Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized.
 - Heavy blast damage radius (20 psi): 1.46 km (6.67 km²)
At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities.
 - Radiation radius (500 rem): 2.14 km (14.4 km²)
500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.
 - Moderate blast damage radius (5 psi): 3.06 km (29.5 km²)
At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities.



NUKEMAP 2.7 : FAQ

You might also try: [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
Or you can select a preset...
2. Enter a yield (in kilotons):
"Tsar Bomba" - largest USSR bomb tested (50 Mt)
3. Basic options: Height of burst: [?] Airburst Surface
Other effects: Casualties Radioactive fallout
- Advanced options: ▶
4. Click the "Detonate" button below.

Note that you can drag the target marker after you have detonated the nuke.

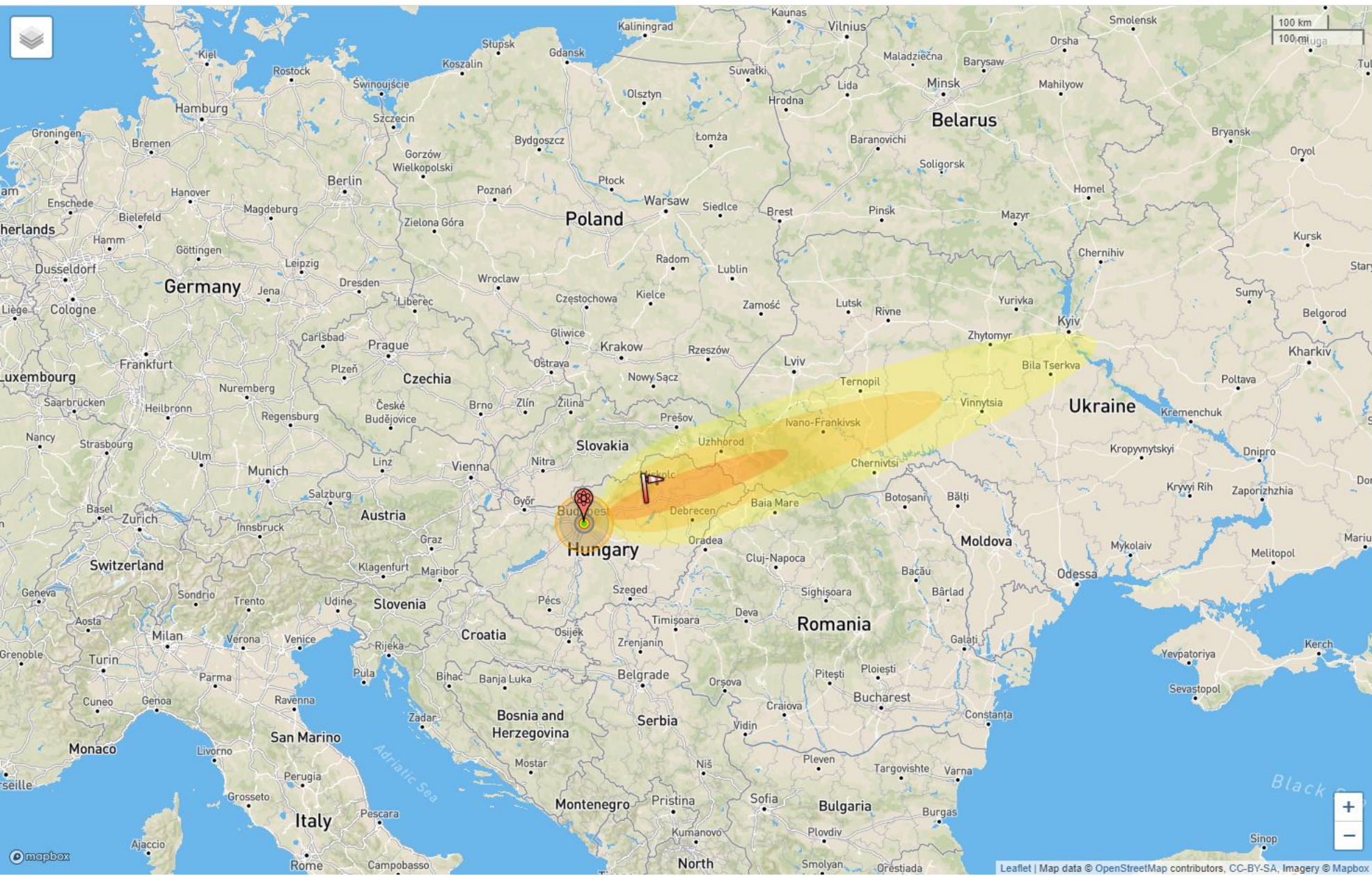
Estimated fatalities:
1,865,550

Estimated injuries:
554,660

In any given 24-hour period, there are on average 3,084,641 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 50 megaton airburst*:
- Radiation radius (500 rem): 3.14 km (30.9 km²)
500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.
 - Fireball radius: 4.62 km (67.1 km²)
Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized. Minimum burst height for negligible fallout: 4.16 km.
 - Heavy blast damage radius (20 psi): 8.91 km (249 km²)
At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities. Optimal height of burst to maximize this effect is 6.7 km.
 - Moderate blast damage radius (5 psi): 20.7 km (1,350 km²)
At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities. Optimal height of burst to maximize this effect is 11.5 km.



NUKEMAP 2.7 : FAQ

You might also try: [MISSILEMAP](#)

1. Drag the marker to wherever you'd like to target.
 Or you can select a preset...

Or type in the name of a city:

2. Enter a yield (in kilotons):
 "Tsar Bomba" - largest USSR bomb tested (50 Mt)

3. Basic options: Height of burst: [?] Airburst Surface
 Other effects: Casualties Radioactive fallout

Advanced options: ▶

4. Click the "Detonate" button below.

Note that you can drag the target marker after you have detonated the nuke.

Estimated fatalities: **1,671,450**
 Estimated injuries: **522,760**
 In any given 24-hour period, there are on average 2,759,967 people in the light (1 psi) blast range of the simulated detonation.

Modeling casualties from a nuclear attack is difficult. These numbers should be seen as evocative, not definitive. Fallout effects are deliberately ignored, because they can depend on what actions people take after the detonation. For more information about the model, [click here](#).

- Effect distances for a 50 megaton surface burst: ▼
- Radiation radius (500 rem): 5.05 km (80.2 km²)
 500 rem ionizing radiation dose; likely fatal, in about 1 month; 15% of survivors will eventually die of cancer as a result of exposure.
 - Fireball radius: 6.01 km (113 km²)
 Maximum size of the nuclear fireball; relevance to damage on the ground depends on the height of detonation. If it touches the ground, the amount of radioactive fallout is significantly increased. Anything inside the fireball is effectively vaporized.
 - Heavy blast damage radius (20 psi): 8.02 km (202 km²)
 At 20 psi overpressure, heavily built concrete buildings are severely damaged or demolished; fatalities approach 100%. Often used as a benchmark for heavy damage in cities.
 - Moderate blast damage radius (5 psi): 16.9 km (894 km²)
 At 5 psi overpressure, most residential buildings collapse, injuries are universal, fatalities are widespread. The chances of a fire starting in commercial and residential damage are high, and buildings so damaged are at high risk of spreading fire. Often used as a benchmark for moderate damage in cities.



Egyéb atomfegyverek

- “Főbélő bomba”
- Fúzió → neutron sugárzás
- Nem alkalmas

Neutron bomba

- “fallout” > robbanás
- Kobalt – Szilárd Leó
- Másodlagos részben

Sózott
bomba

- NEM atombomba
- Radiológiai diszpergáló eszköz
- Terrorizmus
- Nem sokkal halálosabb

Piszkos
bomba

- Alexander Litvinenko
- 2006 nov.
- ^{210}Po

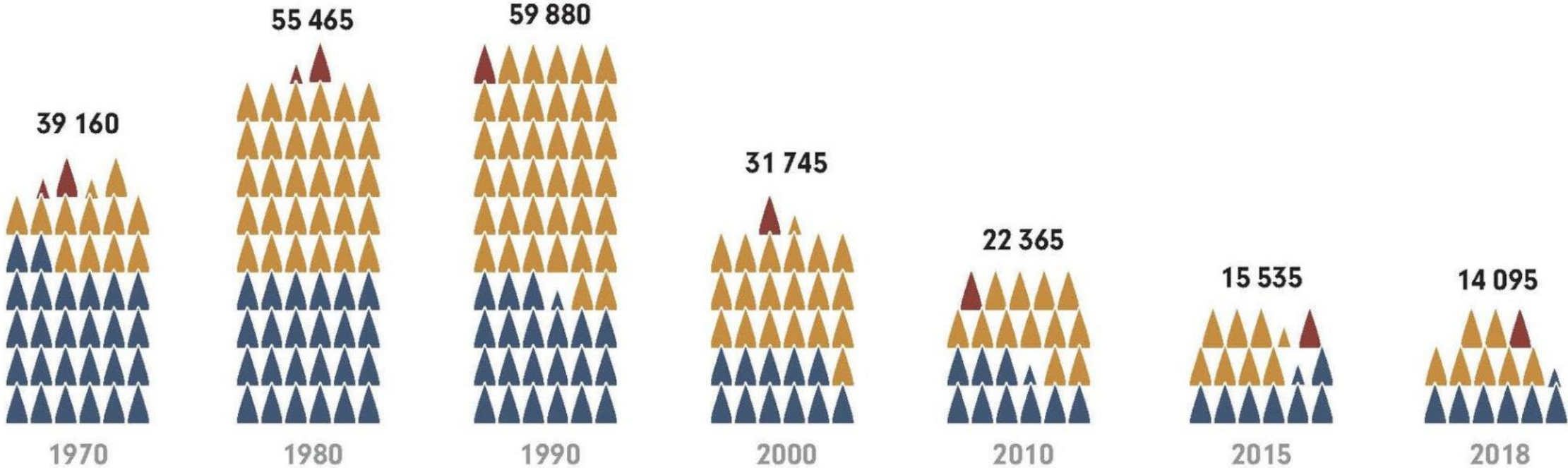
α
mérgezés

NUCLEAR WARHEAD STOCKPILES OF THE FIVE NUCLEAR WEAPON STATES*, 1970-2018

▲ USA ▲ USSR/Russia ▲ China, France, UK

▲ = 1 000 nuclear warheads

* As defined by the 1968 Non-Proliferation Treaty





Köszönöm a
figyelmet!