Kinetic hyper-weapons for future battlefields

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Introduction

Via my company Carbon Devices Ltd, I recently announced my new space launch invention, the Pythagoras Sling. The announcement focused on the excellent potential it offers to accelerate civil space industry development. However, looking at the range of associated technology involved, it is very obvious that it could also be militarised. That often means making a system lean and mean for rapid deployment, but some systems take the opposite approach of being slow to deploy and expensive to build, but being very large and powerful. Many strategic and tactical positions lie between. Hypersonic weapons already exist but sling derivatives could make them even more hyper. This article will introduce a few terrifying weapon concepts that are all feasible this century. I have often blogged on the need to learn to get along soon, because future wars will be fought with very fearsome weapons indeed. Several years ago, I gave a keynote talk to a 'Mad Scientists' event, and my talk introduced 10 new weapons of mass destruction. I have recently added several more. I don't plan to build any of them and hope nobody ever does, but half of winning the battle is being prepared for what might come.

Some weapons are already so powerful that nobody dares use them. As a useful metric, nukes fill that category nicely.

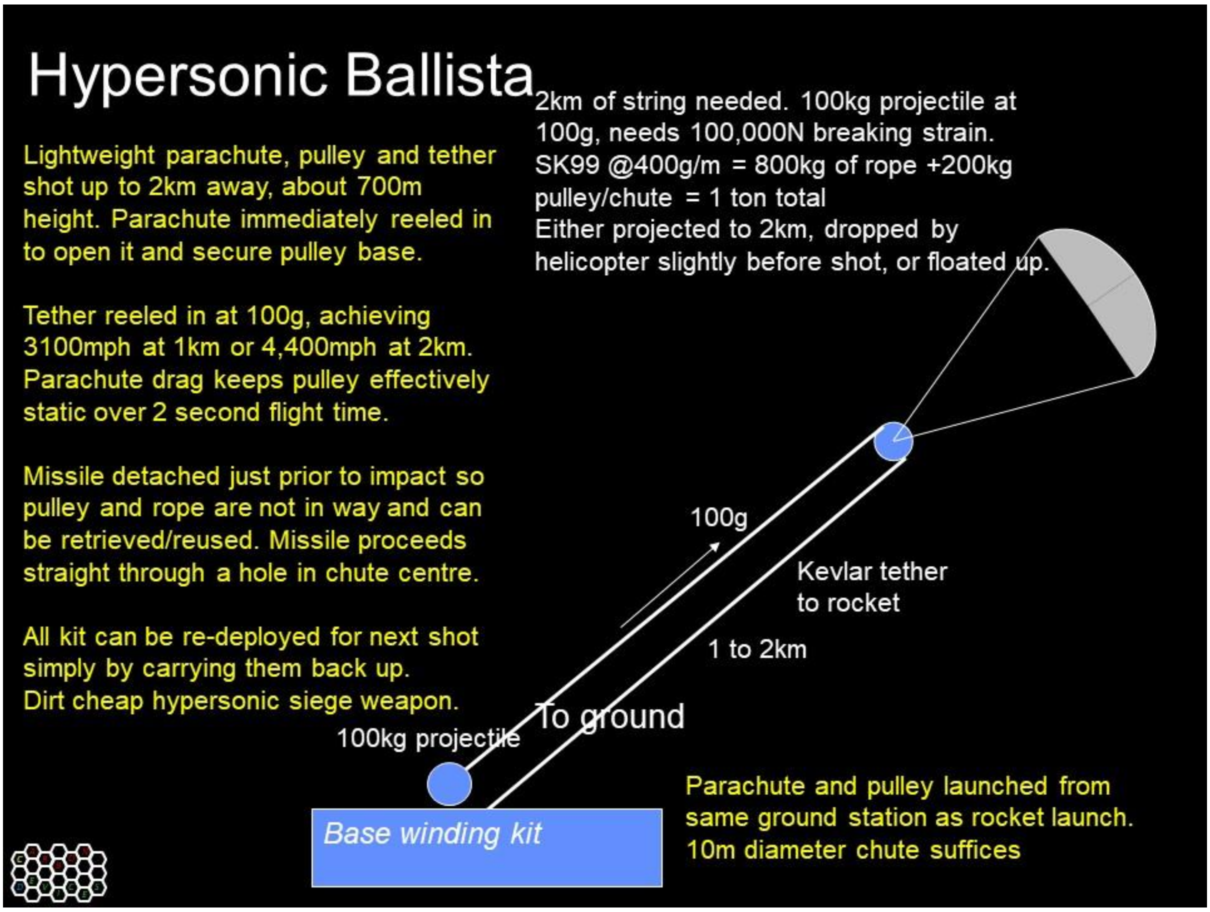
Nuclear missiles are far more powerful than anything else that exists today, and thankfully no country has used any since the 2nd world war. Nuclear weapons rely of Einstein's E=MC2, converting mass directly into energy, and while a low yield 'tactical' nuke might deliver the equivalent of 10-20kton TNT, similar to the only two that have ever been used in anger on Japan in 1945, the very top Satan missile on which mutually assured destruction (MAD) is based can deliver the equivalent of 100 Megatons of TNT. While such weapons have stayed out of the hands of mad dictators and rogue regimes, this may arguably have prevented another world war. However, the world is no longer just a few superpowers that manage to disagree but to peacefully co-exist. Several new entrants that are less predictable and peace-loving are likely to join nuclear powers in the next decades and the world will be more dangerous. The huge gulf that currently exists between 'conventional' and nuclear weapons has made nuclear escalation a very obvious and clear threat that no power has dared cross. However, that gulf will not last much longer, as future weapons start to follow a sort of Moore's Law. In a few decades, non-nuclear weapons will reach into Megaton ranges, considerably overlapping nukes and then exceeding them. Nuclear weapons will no longer be mankind's most powerful weapons in 50 years.

Some other weapons will be very important, but I won't address them in this article. Laser weapons have no theoretical upper limit on their power, so a 'Death Star' is possible, even if it does belong on a very futuristic Star Wars. Other ray guns based on particle beams are also possible only far in the future. Biological and nanotech weapons based on bacterial disassembly into grey goo, zombie viruses, or CRISPR-style GM devices, AI hybrids such as smart yogurt, nerve toxins, mind control technologies and many others will arrive over coming years. By 2050, there will be over 100 ways to destroy human civilisation on Earth, an excellent justification for starting to create extra-terrestrial colonies. Even with a tiny chance of happening each, there is still a 50% chance of human extinction before 2087. However, I've written about them before. I will instead introduce some new kinds of weapons to worry about.

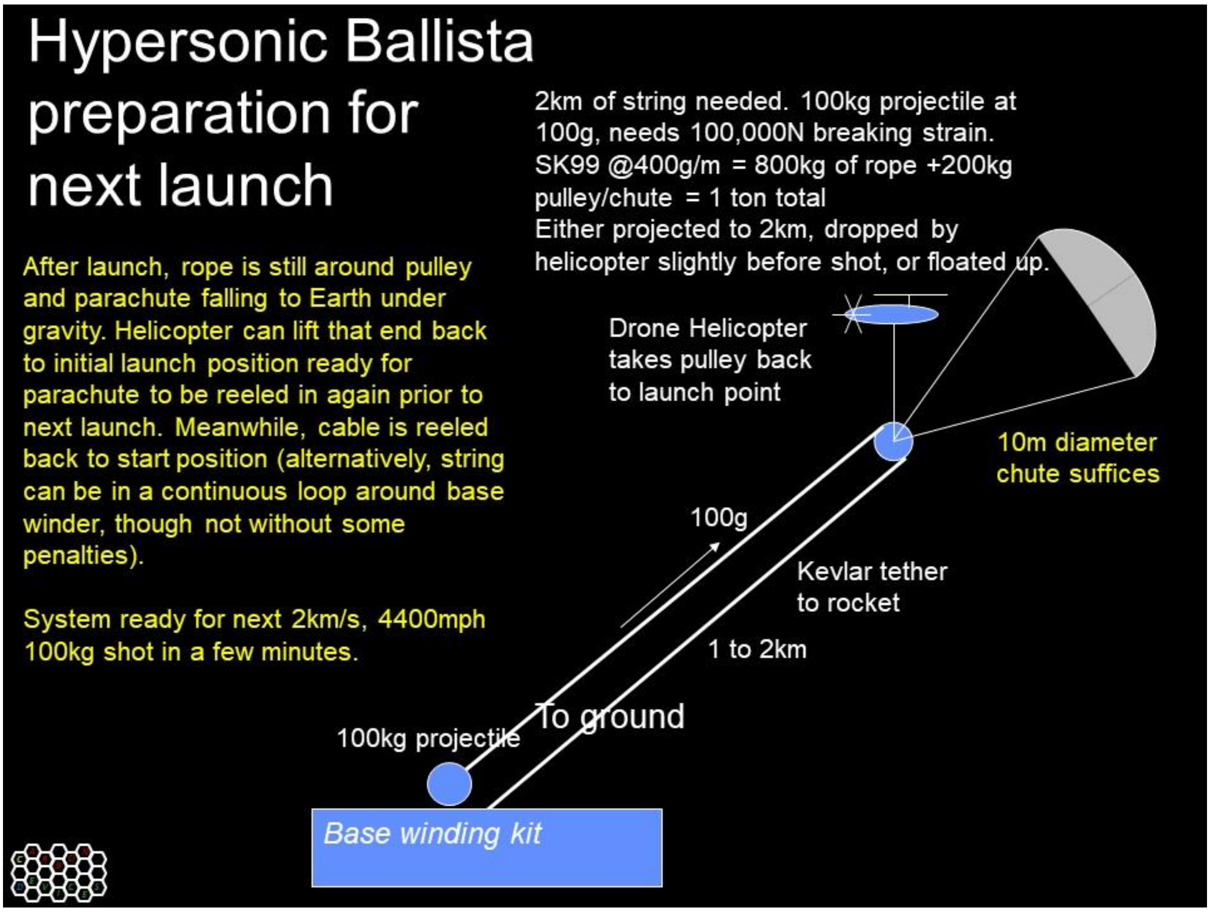
A useful metric to measure future weapons by is today's rail gun, which uses electricity to fire a lump of metal at 2-3km/s with energy of around 30MJ.

Ballista – 20GJ per shot

A 21st century update is already due for the simple catapult or ballista siege weapons. Starting with something you could knock up tomorrow with SK99 cable, a smallish 2km version could achieve 2km/s, 4400mph for a 100kg projectile, 200MJ energy. This picture shows it being used as long range artillery, but it could just as easily be aimed downwards from a mountainside. If a dumb projectile isn't accurate enough, you could use the catapult as a huge starter boost for a very hypersonic missile that can home in for a precise kill.



The system would be ready to fire another lump of depleted uranium or missile of your choice within a few minutes:



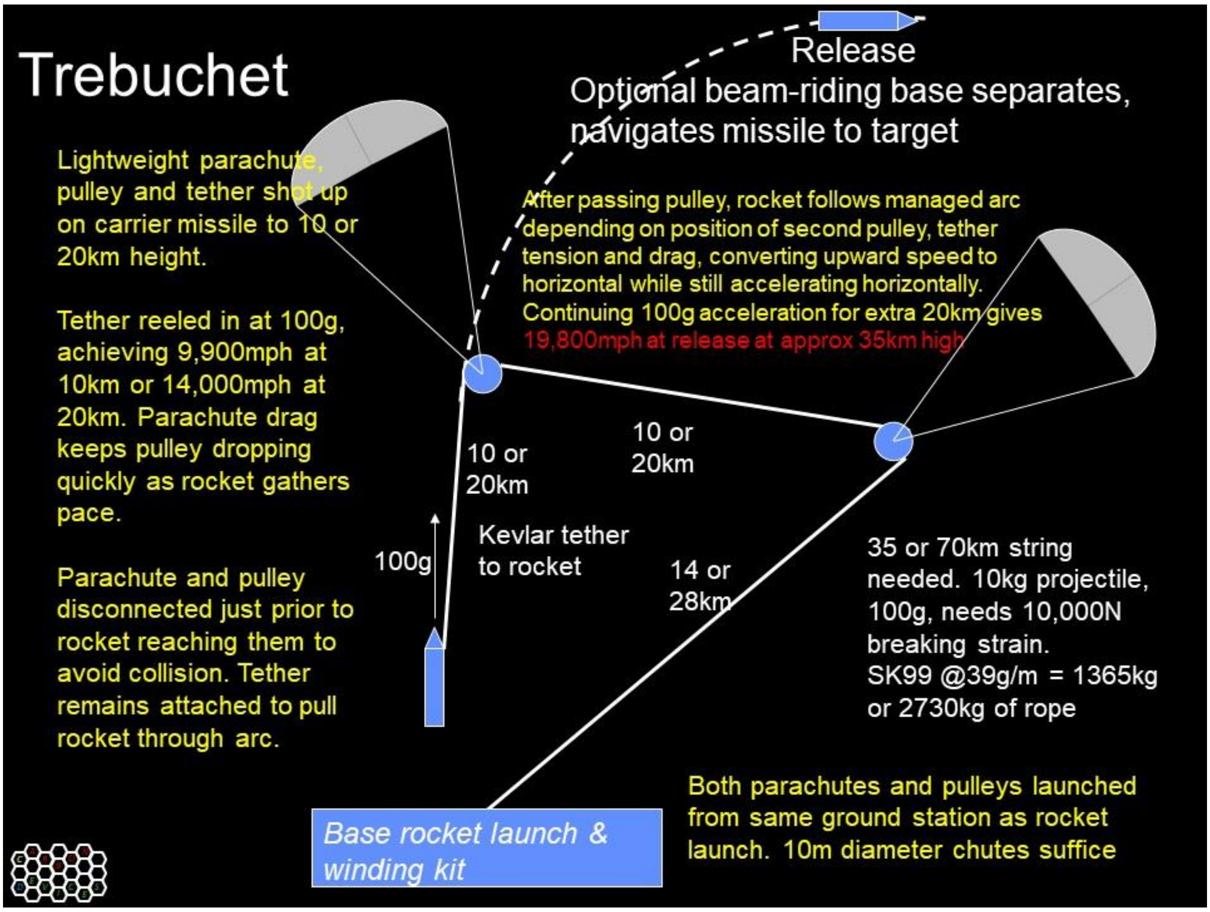
This could be a fairly commonplace piece of rapid-deployment artillery. The helicopter could take the parachute to operating position very quickly and if threaded properly, could have it ready for relaunch in a minute or two. Obviously the helicopter could easily be replaced by a simple drone, provided it can light the weight of the parachute.

With graphene and such a small system, 10,000g acceleration could be feasible which effectively makes this into the equivalent of a 2km long rail gun with similar specs. 100kg would be travelling at 20km/s, 44,000mph and would have energy of 20GJ. Whatever it hits would be gone, and it can fire a shot every minute or two.

With just a little more effort, this system could be modified to act as a deployment system for robot soldiers, a futuristic version of circus human cannonballs. They'd need to be designed to be able to withstand high g forces, but that shouldn't be a big problem. One shot could clear a landing zone, the next could send in a robot, devastation followed quickly by robotic occupation.

Trebuchet – 400GJ per shot

This one is based on my Pythagoras Sling concept. The first thing for a weapon designer to notice about the Pythagoras Sling is its potential to deliver extreme speed and hence energy. For kinetic weapons such as bullets and some missiles, energy climbs with mass of the projectile and with the square of its speed. Even at only 15g acceleration, a sling can get a projectile up to orbital speed, so it can hit anywhere on Earth or in low orbit. However, it is designed for civil launches so is physically large, 150km long, albeit only made of a piece of string and a couple of parachutes. Military payloads can often survive much higher g-forces. Sophisticated missiles can cope with 100s of gs. Let's take an early weapon derivative that could be made soon. I call it a trebuchet because of its similarity to medieval siege weapons.



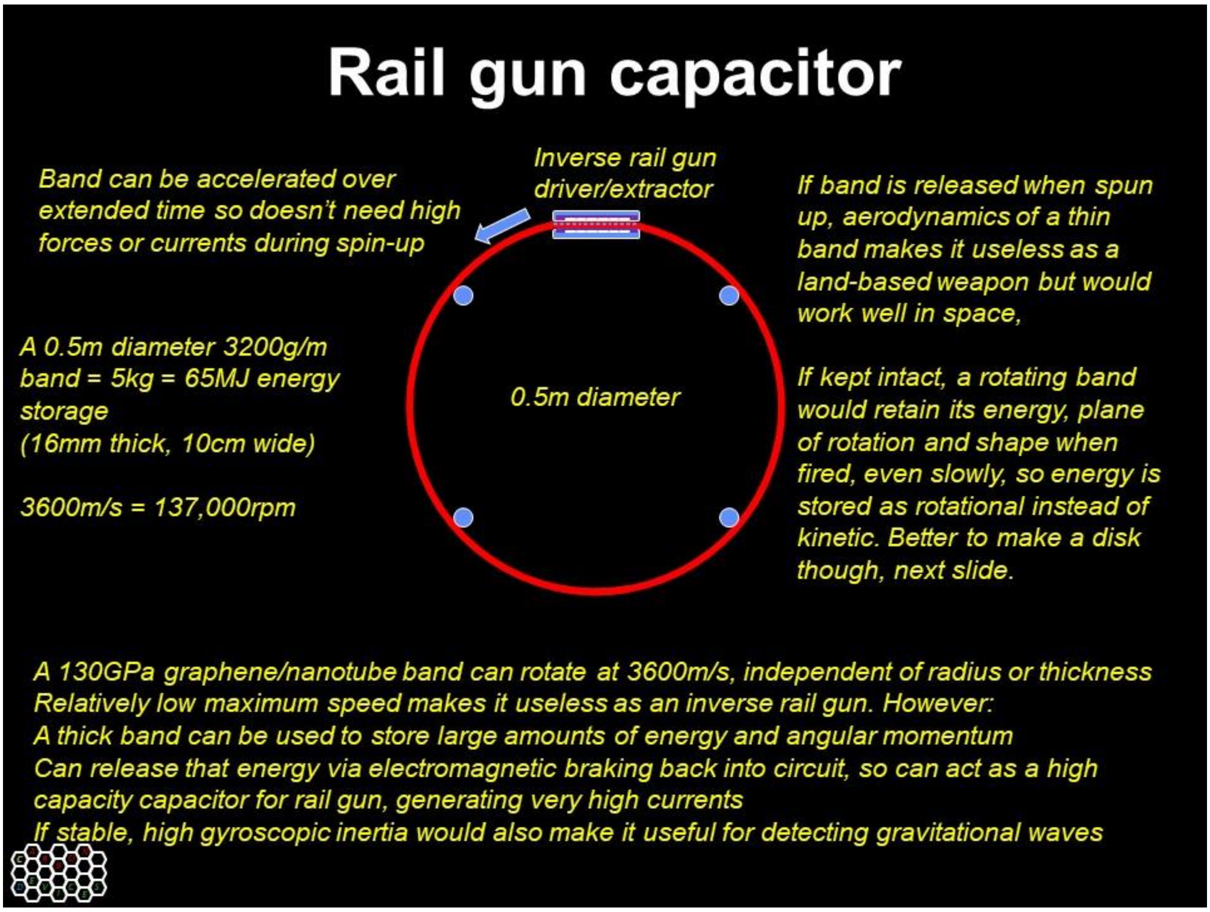
Let's assume that our dumb lump of metal accelerates at 100g, and that we use today's SK99 as the 'string'. A 10kg projectile can be accelerated all the way to full orbital speed, almost 20,000mph in a deployment stretching just 20km wide, small enough to be deployed using fairly small rockets. The projectile doesn't have to go to orbit though. It can be aimed at a target as close as 30-40km away, and would hit it 10 seconds later with a very hot 10kg object travelling at 20,000mph. The energy in such a slug is almost 400MJ, more than ten times more than the best existing rail-gun.

But that is today's materials. With graphene materials available mid-century, a 1 ton projectile could be accelerated at 1000g to hit 3 seconds later at 28km/s, 62000mph, with energy of 400GJ. The limiting factor may no longer be the material for the string, but how fast energy can be dumped into pulling it. I'll discuss mass capacitors shortly. But before that, note that a cluster of rings and threads could be sent up, so a succession of shots could be fired using the same system, each with less power. Maybe 5 shots from 400GJ down to 200GJ might be feasible, total of 1.5TJ

Land-based rail guns with Mass Capacitors – 6.5GJ per shot

Rail guns are all very well, but storing and releasing the energy required is non-trivial. Conventional rail guns that release 32MJ into a metal slug need huge capacitor banks. Undoubtedly capacitors will improve dramatically in coming years, and graphene is expected to be used in many of them. However, energy doesn't have to be stored electrically. Graphene has such high tensile strength that it could be fabricated into rings that are spun using the same sort of linear motors discussed already.

Centrifugal forces obviously limit the speed any material can spin at, even graphene, but a 5kg disk of graphene could be spun up to hold 65MJ of energy. With energy stored in a spinning mass, I call it a mass capacitor. The drive unit can be used equally as an electromagnetic brake to extract that energy and convey it to something else being accelerated.

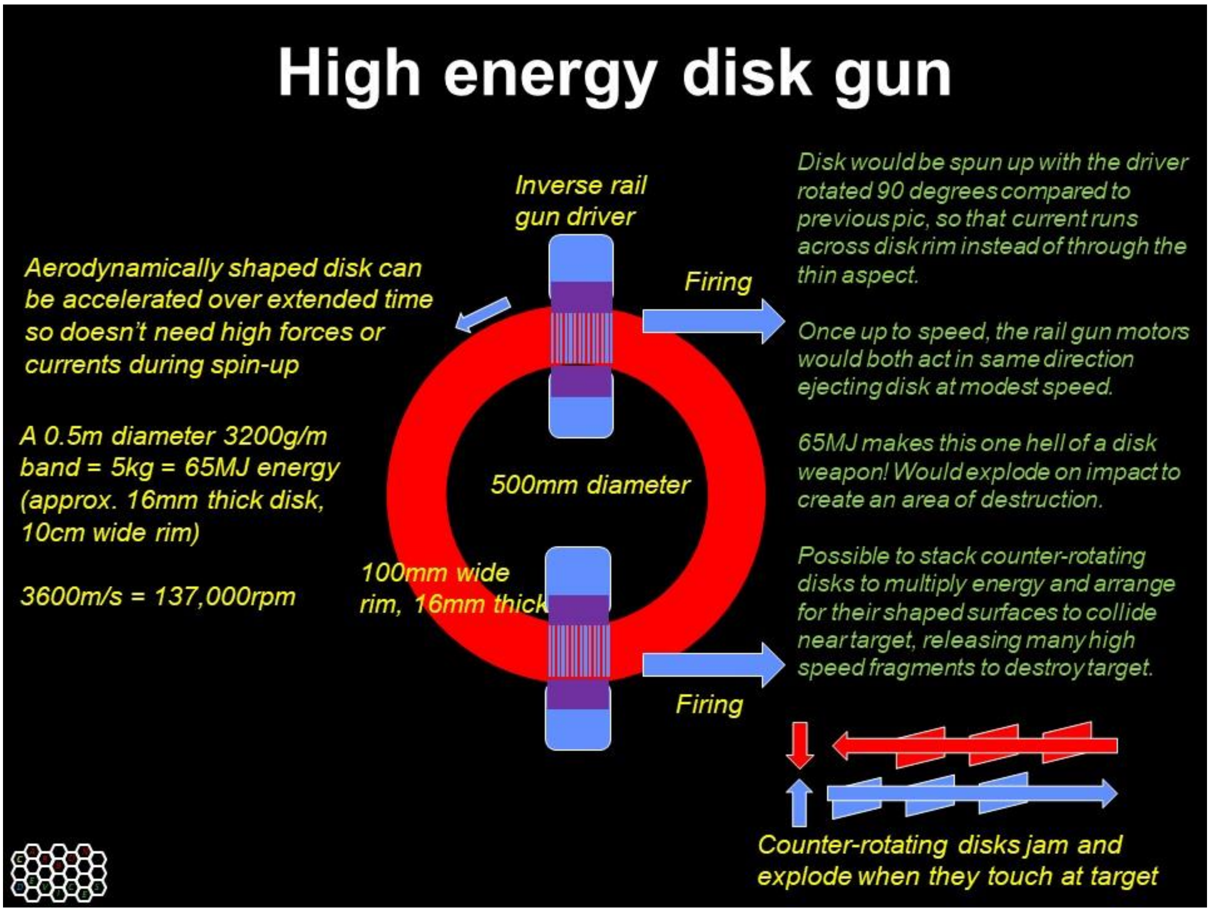


Mass Capacitor

Many such disks could be added to drive a rail gun. 1 ton of these disks (200 of them perhaps stacked in banks of 20) could store 13GJ to pull a lengthy tape with a large projectile. With 50% efficiency, that powers a 6.5GJ per shot rail gun.

Disk guns – 130MJ per shot

But why bother powering a rail gun? Disks that store so much rotational energy are potentially lethal in their own right. 65MJ is already twice the energy of the world's strongest current rail gun, and that could be in each disk. So, redesigning it for that purpose, it's obvious that a future army might have a disk gun that fires dual counter-rotating disks, combining 130MJ into each one, aerodynamically shaped to fly accurately and designed to shatter into large numbers of ultra-high-speed fragments at the target. Although they would be spun up by EM motors, that can be done over time, unlike a rail gun, so power delivery rate could be lower and the disk twins could also be fired by a fairly conventional weapon at modest speeds, since almost all of their energy would be rotational. So this could be a relatively cheap weapon, with the big gun and its mass capacitor banks reserved for harder targets.

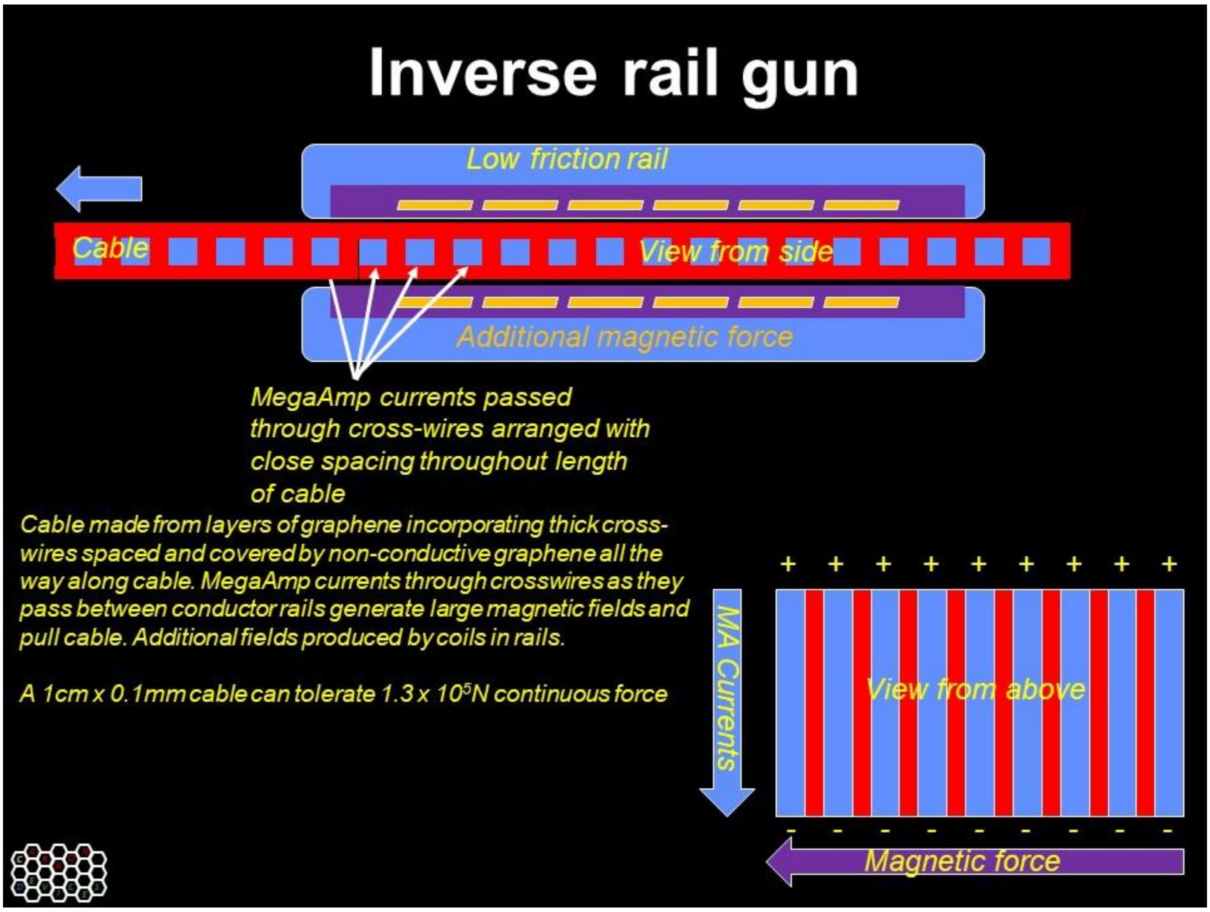


Mass Capacitor barrel bombs – 13GJ per shot

If a bigger bang is required, a number of thicker mass capacitors could be stacked to make much larger mass capacitor 'barrel bombs', with storage of 13GJ per ton, around 3 times the energy density of TNT. Although that is no better than modern explosives per unit weight, and certainly more expensive, mass capacitors would be totally inert until spun up and could be spun down just as safely so they do have some strategic advantages over straight explosive devices. With kinetic storage, the damage delivery mechanism would also be very different, with most of the energy delivered within a fairly constrained plane. So these might be used for niche roles.

Inverse rail gun – economy space version, 6TJ per shot

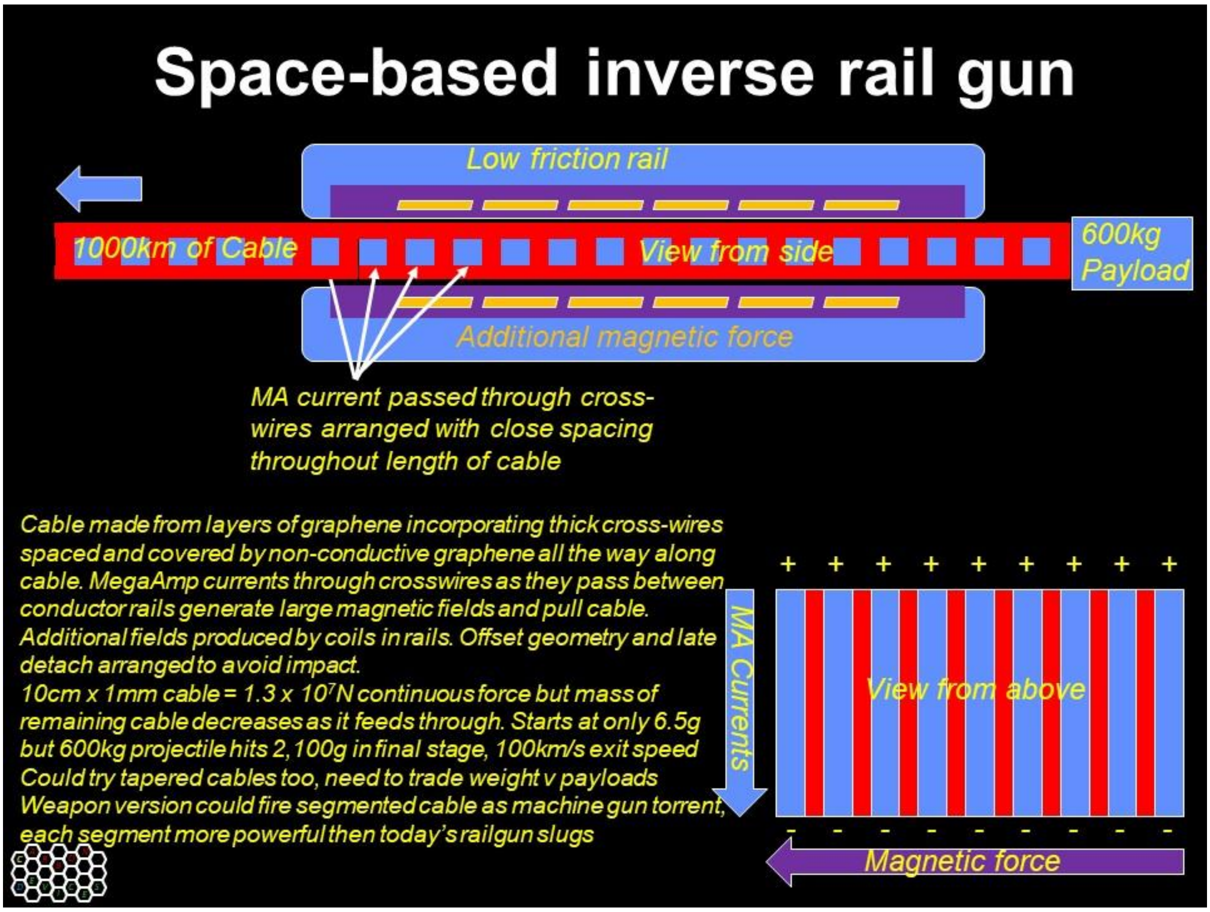
The Pythagoras Sling needed a motor that could pull the string quickly. I feared that a rotating reel would fall apart at the high speeds involved, and that would be problematic. A linear motor that uses purely electromagnetic force has no theoretical upper speed limit other than light speed itself so makes a good start point. This can't be built today because we don't have the sort of cable needed, so it is only feasible when graphene is freely available, but of course isn't needed for the sling until then anyway. A very thin cable 1cm wide and 0.01mm thick can pull with 130kN force and the drive unit can be of arbitrary length to apply that force. A 1000kg projectile could be pulled at 13g, or a 10cm x 1mm tape could pull it at 1300g, for any arbitrary length of tape.

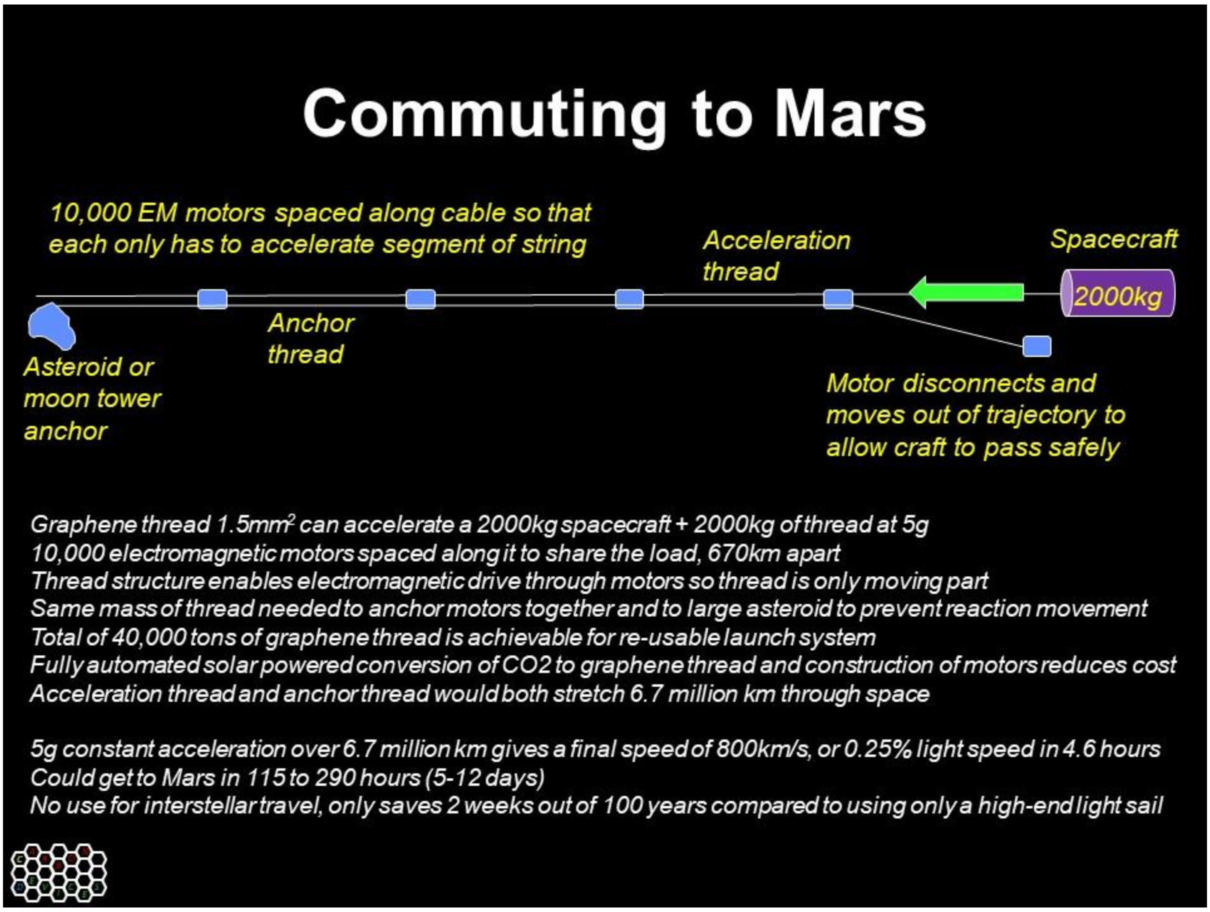


Compact ground-based guns have already been described, but if same device is built in space, where a tape with your projectile on the end can be laid out in a straight line for as far as you want, it can go much faster. For a single drive unit pulling a modest 1000km of tape, tape mass is becoming an issue and payload mass less so. It would start pulling a 600kg projectile at just 6.5g but could end up pulling at 2100g. That gives an exit speed of over 100km/s, perhaps 140km/s, energy of around 6TJ. But if tape mass is the problem, given it’s in space, why not use the tape as the actual ‘bullets’? Before we look at that, let’s consider a larger configuration.

Space based inverse rail gun – space version 1.5PJ per shot (0.36MT TNT), full size version 240MT TNT

The idea that the linear motors are not inherently speed limited and that space is pretty empty caused me to evaluate a large system such as might be built for interplanetary travel. If future graphene cable fabrication is fully automated and given that carbon is abundant, then I considered that 40,000 tons of string might be a sensible limit - we make things around that weight out of steel just to ship oil around. I also worked out how graphene filaments, hence string, could be printed from a spinneret at 200m/s so it wouldn’t take long to make. Laying out 40,000 tons of 1.5 mm2 thread takes 6.7 million miles of space, but space is big. It would be anchored to a suitably large asteroid or a moon tower. Lots of solar powered drive units would be distributed along the whole path, 50,000 of them, but they are simple so would be cheap. I guessed the entire system cost would be acceptable for a Mars supply route or other such project.





The exit speed for human staffed spacecraft would be 800km/s, making the Mars commute a week or so. Cable weight dominates the Mars system, so we could actually consider the cable as part of the weapon, and if segmented to break at exit, it would be a space machine gun rapid-firing 1000s of tons of 1kg segments of graphene at 1000km/s at a rapidly eroding target. Remember there is no aerodynamic resistance in space to slow the string down. The 3000kg of tape exiting in the final second will drop 1.5PJ, 1500TJ onto the target. That's 360kt of TNT, per second. The last 2000 tons (the last 10%) of tape will drop 240Megatons TNT equivalent over 11 minutes, equivalent to 5 of the USA's biggest current nukes. That isn't so much a nuke as a one sided nuclear war.

If considered as a weapon, it is far more powerful than the most powerful nuclear weapons in existence today, but it isn't nuclear. If considered as an asteroid defense system, 1000MT of kinetic energy delivered over 50 minutes or so might help.

Let's look again at making a compact weapon version that could be aimed quickly, with just 1000 tons of 10cm x 1mm tape, so that would be 5000km long, pulling just itself but at around 30g average. That tape would still deliver 1.5PJ, 0.36MT in 3 minutes, and it could fire tape after tape. So a military version would be feasible, still powerful and far faster to build than a sluggish Mars transport system and it's a fair bet that 1000 tons of graphene tape will cost less than a 0.36M nuke too.

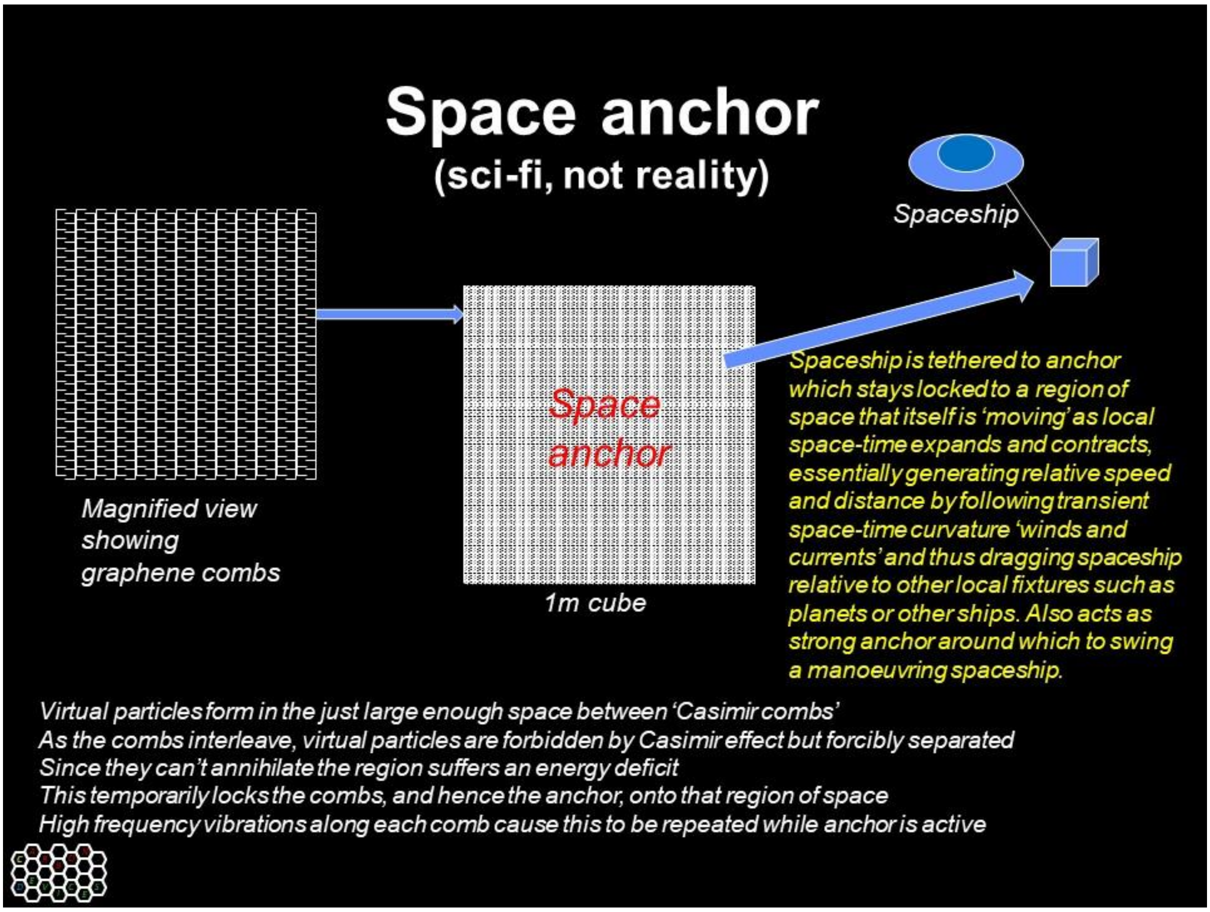
Asteroid diversion – 100MT – 100,000MT

Another kinetic energy weapon that is already often considered is using asteroids themselves, diverting them onto cities or bases to destroy them. Asteroids come in various sizes, so it is entirely possible that a small one could be diverted by attaching a motor or a light sail. The rail guns above could also be used to direct high levels of momentum in any direction required to achieve that. We know that some day we will have to defend against an incoming asteroid and divert it from collision, so it will be essential to have such technology, but obviously a malign power could misuse it.

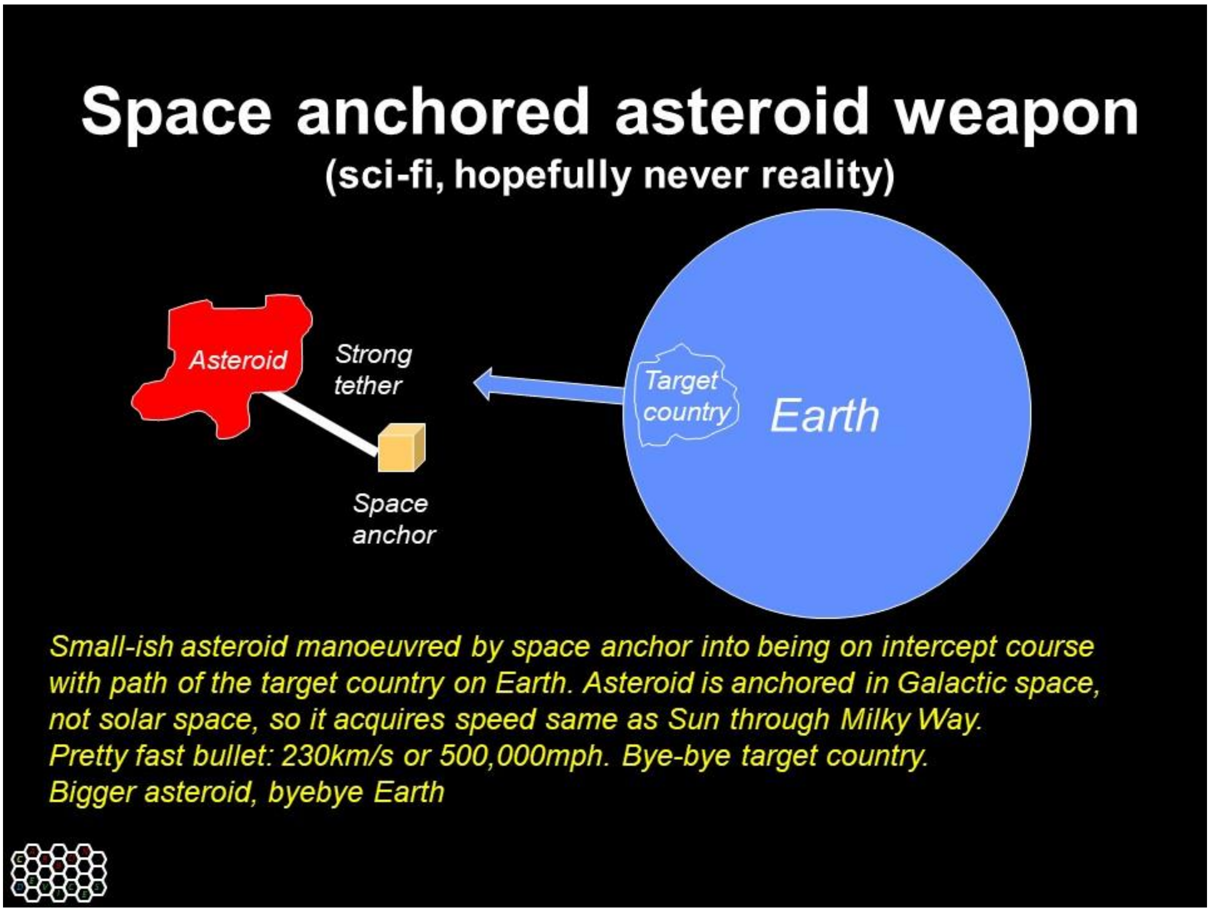
With a typical speed of 17km/s, an asteroid wouldn't be as fast as mid-century rail gun, but would have much larger mass. A 100m cube asteroid of density 3, 3M tons, would have an impact energy of 100MT TNT. A 1km cube of density 3 would have a mass of 3Bn tons. That gives energy of 100,000MT TNT.

Space Anchor weapon

It is often said that 'A faint heart ne'er won a fair maid', so with a mad scientist laugh, I'll introduce what I hope will remain a sci-fi weapon. My sci-fi book Space Anchor is loosely based on concept of the space anchor, a device that uses a sort of quantum lock made from Casimir combs to lock onto the fabric of space-time (it also use a convenient 'Higg's filter' to circumvent mass issues, which is why I am optimistic it will remain sci-fi).



If tethered to something, such as an asteroid, the object will stay in that piece of space time, moving with it as it expands or contracts, but meanwhile, the Earth would carry on moving through space at 230km/s. If the asteroid in question is held in the path of a particular country, a 1km cube of density 3 would have a mass of 3Bn tons. At 230km/s, that gives energy of 8 x 10^22J, or 19TeraTons TNT.



Summary

With the exception of the speculative Space Anchor, all of the above systems seem to me to be feasible mid-century or soon after. The conclusion of this must be that the gulf between conventional and nuclear weapons will not only be eroded but that some electromagnetic tape guns could actually be more powerful than any nuke.

This article has only discussed one type of weapons, those that use kinetic energy. Many other types will be used too, such as cyber, AI, robotic, bio, nano, cogno, lasers and other directed energy weapons and of course chemical explosives and nukes. They may create less noise but some could go all the way to extinction grade weapons.

Future weapons will be hundreds or thousands of times more powerful than those we use today. They will be made because of human nature, and very likely because of AI nature. Not necessarily the ones I have suggested of course, but if a non-specialist engineer can invent a range such as this in a short time, many specialist future AI-upskilled engineers will certainly invent far more diverse and powerful weapons than these. The real point to highlight is that what I have written here almost certainly underestimates future weapon capability. Here I rank the ones I have considered in order of ascending power, showing the overlap with nuclear weapons power range.

I'll finish with a quote from Einstein: "I know not with what weapons World War III will be fought, but World War IV will be fought with sticks and stones."