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ADMINISTRATIVE AND RESEARCH OFFICE
BUDGET, PROGRAM PLANNING AND
MANAGEMENT DIVISION
FINANCIAL ADMINISTRATION DIVISION
OFFICE OF FEDERAL AWARDS MANAGEMENT (OFAM)

WRITTEN ONLY

TESTIMONY BY LAUREL A. JOHNSTON
DIRECTOR, DEPARTMENT OF BUDGET AND FINANCE
TO THE SENATE COMMITTEE ON WAYS AND MEANS
ON
HOUSE BILL NO. 2559, H.D. 1

March 29, 2018
10:50 A.M.
Room 211

RELATING TO SPECIAL PURPOSE REVENUE BONDS TO ASSIST SPINLAUNCH

House Bill No. 2559, H.D. 1, authorizes the issuance of Special Purpose Revenue Bonds (SPRB) to assist SpinLaunch Inc. with the financing of the planning, design, and construction of a satellite launch system pursuant to Part V, Chapter 39A, Hawaii Revised Statutes.

The Department is providing comments only to advise the Legislature and prospective SPRB parties that should the legislation be approved, approval of the SPRB issuance and conduit loan will require further review of the financing proposal to ensure compliance with all federal, state and credit underwriting requirements. For additional information, please consult our FAQ located at the following link:

<http://budget.hawaii.gov/wp-content/uploads/2012/11/SPRB-FAQ.pdf>.

Thank you for your consideration of our comments.

HB-2559-HD-1

Submitted on: 3/27/2018 12:08:47 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Teresa L. Nakama	Testifying for BIFA	Oppose	No

Comments:

On behalf of the concern citizens of Moku O'Keawe and especially the District of Ka'u, we strongly oppose HB2559 HD1.....This proposed house bill has never consulted with the generational and general population of Moku O'Keawe, especially the residence in the Ka'u District that would be greatly affected by the negative impact of such a project. This proposed project has never been vented with the local population that have voiced their concern against such a proposal.

Respectfully Submitted,

Teresa L. Nakama

Director of BIFA

HB-2559-HD-1

Submitted on: 3/28/2018 10:43:55 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Melodie Aduja	Testifying for Oahu County Committee on Legislative Priorities of the Democratic Party of Hawai'i	Support	No

Comments:

HB-2559-HD-1

Submitted on: 3/27/2018 9:28:57 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
lynne matusow	Individual	Oppose	No

Comments:

This bill must die. This is an unried technology with unknown dangers to our envirnoment and the people who live in the area where it would be positioned. The mainalnd schemers won't talk about how noisy it will be. Kau has resisted space dreams in the past. It was not consulted. The local area representatives are opposed to it. It appear to be the pipe dram of an elected official, not from the Big Island, who saw this fabulous dream on the mainland and decided we need it here. Now that legislator is suggesting that Molokai could be a back up location. Molokai, which has stopped cruise ships from landing, which wants to remain rural. Can we please focus on spending money on real projects that will help us now instead of pipe dreams.

HB-2559-HD-1

Submitted on: 3/27/2018 2:19:21 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Paul S Montague	Individual	Comments	No

Comments:

I have reservations about allowing a large commercial venture in the area adjacent to Pohe Bay in Ka'u. This is one of the last unspoiled beaches in Hawaii and the world. It has cultural historical value and is a Hawksbill Turtle nesting area. It should remain open space and be preserved.

HB-2559-HD-1

Submitted on: 3/27/2018 4:29:07 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
SHAWN LOHAY	Individual	Oppose	No

Comments:

I am an Ocean View resident and I live directly above Pohue Bay and in direct sight of Ka Lae, one of apparently three possible locations for the SPINLAUNCH installation and I am writing to state my vehement opposition to the funding or building of this project in the vicinity of my Home or my Community. I understand Hawaii needs revenue from sources other than Tourism to sustain the economy but launching objects into space from the sacred lands where the Polynesians first landed in these Islands is NOT appropriate in any way.

KILL THE BILL !!! Save KA LAE and POHUE BAY for future generations to enjoy.

HB-2559-HD-1

Submitted on: 3/28/2018 7:13:57 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Sherlene Rosario	Individual	Oppose	No

Comments:

I oppose this bill!!!

HB-2559-HD-1

Submitted on: 3/28/2018 4:50:05 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Patricia Blair	Individual	Oppose	No

Comments:

Absolutely No!

HB-2559-HD-1

Submitted on: 3/27/2018 11:44:11 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Marija Balac	Individual	Oppose	Yes

Comments:

I respectfully wish to voice my clear and loud "No!" to the proposal for SpaceLaunch Inc., to use the vacant land at Po'huÄ“ Bay in Ka'u, Big Island as the site for their satellite launch facility.

Po'huÄ“ Bay is an ecologically sensitive and precious area of Big Island as it is a nesting ground for the endangered Hawksbill Turtles. It also contains anchialine pools, home to regionally endemic species which are increasingly becoming endangered by anthropogenic pressures.

Po'huÄ“ Bay also contains multiple ancient fishing village sites with remnants of old houses, petroglyphs, as well as sacred burial sites. Disturbing these sites in any way during construction of the facility, or by way of accidental landings of launched cargo and/or accidental detonation of rocket fuels and rockets that would assist such launches would be detrimental to Hawaiian cultural heritage, to the sensitive ecology of the area, and to the human populations that live here.

There is also great concern about noise pollution produced by launching of satellites in such close proximity to wildlife and human populations, as this would negatively affect the quality of life for all of us.

The public beach at Po'huÄ“ Bay is frequented by many of us who live in the area, as well as tourists. We know our rights to public access to all Hawaiian beaches and we wish to continue to exercise that right in the future, and most certainly when it comes to this particular beach at Po'huÄ“ Bay.

Can our safety be guaranteed with such a facility being set up and operating in such close proximity to our homes and our precious beach?

Our health, the health of the sensitive eco-system of the Po'huÄ“ Bay area, as well as public safety should be your number one priority and concern and therefore I ask you to vote against this proposal.

With much hope for consideration and gratitude for your time,

â€‹â€‹Masha Balac - HOVE home/land owner and permanent resident

HB-2559-HD-1

Submitted on: 3/27/2018 10:29:02 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Eden Peart	Individual	Oppose	No

Comments:

The Kau community made their strong opposition to this type of project abundantly clear years ago. It is a mistake and an insult to attempt to defy their thoughtful concern and desire for the future of their community.

HB-2559-HD-1

Submitted on: 3/27/2018 10:15:49 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Cory Harden	Individual	Oppose	No

Comments:

Aloha legislators,

Please oppose a spaceport in Ka'u, especially if it's backed with taxpayer money.

How would a disaster be handled? How would rocket fuel be transported safely on rural roads? What would happen to the rural lifestyle?

mahalo,

Cory Harden

HB-2559-HD-1

Submitted on: 3/27/2018 10:00:13 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Koohan Paik	Individual	Oppose	No

Comments:

HB-2559-HD-1

Submitted on: 3/27/2018 9:23:38 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Hawk Jones	Individual	Oppose	No

Comments:

I am writing to you to speak up, speak out, and speak AGAINST HB2559 HD1, a proposal to allow SpinLaunch to set up a facility at Po'huÄ“ Bay to launch satellites into space.

This idea is absolutely ludicrous that you want to put it in our backyard, on a historical and ecologically sensitive site. What absolutely makes me mad beyond reason is that you have not reached out to the community, and continually have moved this project along. When did you do a presentation with a Q&A session for the Ocean View / Ranchos community at the Ocean View Community Center?

The plan for this company is to launch satellites into space at 3,000+ miles per hour via centrifugal force. Considering that the sound barrier is 767 miles per hour - and the size of the launch vehicle, there is no way there is not going to be a sonic boom with every launch. A Boeing 727, at takeoff, creates sound at about 165 decibels. Blow up a pound of TNT from a few yards away and you'll be near 180 decibels. And when something breaks the sound barrier, that sonic boom weighs in at 213 decibels with a shock front that approaches 100 megawatts per square meter. This is what you want to put in at the property adjacent to Po'huÄ“ Bay? Y'all have lost your damm minds.

I also think that you guys have not done your homework. The escape velocity

https://en.wikipedia.org/wiki/Escape_velocity

needed to break Earth's atmosphere is 25,020 miles per hour, or Mach 33. Seems a lot more than the 3,000 miles per hour that they are suggesting they can fling satellites into orbit at.

However in this TechCrunch magazine article it is suggested that 'Alternatively, the catapult could provide some of the power needed with cargo being equipped with supplemental rockets necessary to leave earth's atmosphere.'

<https://techcrunch.com/2018/02/22/spinlaunch-2/>

Look at those things they want to fling into space (reference the launch vehicles in the headline photo of the aforementioned article). What happens when the launch goes wrong and they fling the load into a populated area at these breakneck speeds?

So now you want to launch rockets into space from Po'huÄ“ Bay ..

How many of you have actually been to Po'huÄ“ Bay. It is incredible and pristine. It is a nesting beach of the Hawksbill turtle - a honu that is gorgeous. I've sat on the beach down there from a distance and watched them with there clutch of eggs. Po'huÄ“ deserves protection and preservation. That is what you should be doing and looking into. Why not have Volcano National Parks come and take stewardship of the land down there - with full time rangers to ensure that the area is kept clean and safe, and the Hawksbills are given the protection that they need and deserve?

Now back to the 'Alternative' rocket solution. I lived in Vegas as a kid and remember when the rocket fuel plant blew up out there. Rocket fuel is no joke - it is dangerous, toxic, and extremely volatile. You want to put this on such a sensitive site, and in our backyard - no, just .. NO!

Now back to these missiles (it's what they are) breaking the sound barrier. SpinLaunch proposes that this is going to be much cheaper than traditional launch procedures. So .. business will be "booming" yah? Literally ..

BOOM - BOOM - BOOM

that's what us residents are going to hear down hear if this were to go through .. a lot.

Now let's talk about the site. To do such a set up in a #2 lava flow zone is plain stupid, especially given the fact that the chance of earthquakes out here substantially increases the risk of something going wrong. I remember when 2 or 3 years ago the USGS did a presentation at the Ocean View Community Center where they discussed how the Big Island was basically sitting on a sand bed and was compressing it's bottom foundation causing it to collapse under it's self - The one thing I took away from there was the guy giving the presentation saying that a big one was due for our Island sometime within the next 50 years. That's faster than the blink of an eye geologically speaking. Hey so let's store rocket fuel down there, by pristine, untouched, historically significant, Po'huÄ“ Bay - that is one of the few nesting sites for the endangered Hawksbill turtle .. right down the road from local residents .. nothing could go wrong right. And let's get this done quietly and in Oahu, and not have public forums to meet with the community before we approve this. And let's approve this project that is not based on the realities of physics ... and and and

What are you guys DOING!?!

Kill this now .. reach out to our community .. let's get Po'huÄ“ properly protected.

Do the right thing, please.

Cause we're not going to stand for this.

Respectfully submitted,

Hawk Jones
Ocean View Resident and Land Owner
96737

HB-2559-HD-1

Submitted on: 3/27/2018 7:01:24 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Valerie Barnes	Individual	Oppose	No

Comments:

This proposal is complete nonsense. With so many other ACTUALLY pressing issues facing this state, it's absurd that legislators even submitted this bill. I strongly oppose it.

HB-2559-HD-1

Submitted on: 3/27/2018 6:52:21 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Kathie Griffeth	Individual	Oppose	No

Comments:

Aloha Committee Members,

As a longtime resident of Ocean View, Ka'u District, I have multiple concerns regarding the proposed issuance of revenue bonds for SpinLaunch:

- Unproven science coupled with much peer sketicism does not give confidence that these funds will achieve any benefit to the Island of Hawaii. Repayment, should SpinLaunch's Ceo Steve Yaney concept fail again as his prior \$80million project sale to Google did, Hawai'i Nei will be left with the bill.
- Under a very "stealthy" guise, the location most often reported is the Pohue Bay area, an extremely vital environmental, culturally historic, pristine environment, long sought to be protected.
- The safety of this project is extremely questionable, as is the environmental impact to endangered Hawksbill turtles who nest there.
- This is a rural area, relying on agriculture and native gathering rights much as it has for centuries. This project endangers a long standing way of life as well.
- Our roads and infrastructure our not compatible with the type of business being proposed.

I urge you to oppose this Bill, both House and Senate versions.

Mahalo nui loa,

Kathie Griffeth

Ocean View, Kahuku, Ka'u, Hawaii

HB-2559-HD-1

Submitted on: 3/27/2018 6:29:49 PM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
sharon	Individual	Oppose	Yes

Comments:

NO. A thousand time NO!!!

we already told you years ago!!! NO

Fix our roads, sewers (ðŸ’© flowing into the ocean!),

other infrastructure and House the Homeless!

Mahalo from a 40 yr Elem School Teacher

Peter E. Bosted
P.O. Box 6254, Ocean View, HI 96737

The Hon. Donovan M. Dela Cruz, Chair of Senate Committee on Ways and Means
The Hon. Gilbert S. C. Keith-Agaran, Vice Chair of Senate Committee on Ways and Means
Honorable members of the Senate Committee on Ways and Means

Dear Senators Dela Cruz, Keith-Agaran and Ways and Means Committee members,

Re: HB 2559 HD1 Special Purpose Bonds for Spinlaunch Inc.

I am respectfully opposed to this project as it is very unlikely to measure up to the claims made in Section 1 of this bill.

I have a Ph.D in physics from the Massachusetts Institute of Technology (1980) and I have had a long academic career in physics research, with over 200 articles in refereed physics journals. I am a Fellow of the American Physical Society and am an Adjunct Professor of Physics at the College of William and Mary in Virginia. The calculations presented in this testimony are meant to be illustrative only.

With respect, there are many reasons why the state of Hawai'i should not support the spin-launch method of putting materials into low-earth orbit (LOE).

- 1) The range of payloads is extremely limited, due to the large acceleration forces intrinsic in this type of design. Specifically, this design cannot be used for communications, earth imaging and monitoring, or any other kind of sophisticated satellite as 10,000 g will destroy delicate instrumentation. 10,000 g, is 10,000 times the force of gravity on earth. This corresponds to the pressure experienced by materials roughly 100 miles below the earth's surface. At these depths, corresponding to the upper mantle, rock is liquid and many chemical changes occur. With respect, it is hard to fathom how the payload could be anything except some raw building materials and water.
- 2) It is my considered opinion that this design calls for enormous developments in engineering, and that the project will not be inexpensive, and the cost of launches will likewise be far more costly than conventional launches are now. An enormous amount of research and development is still needed, on issues such as a) how to include a secondary rocket system (needed to get into the right orbit) that can withstand 10,000 g or more; b) how to keep frictional losses low enough at speeds of 7 km/sec (recalling that frictional heating is proportional to speed squared); c) what are the instability modes of the system; d) how to transition into the atmosphere; e) how to store the electrical energy needed for launch in a way that can be very rapidly deployed.

- 3) Given the rapidly decreasing price of conventional rocket launching, it seems highly unlikely that this system will be competitive if and when a working design can come on line.
- 4) A large amount of electricity will be needed to launch a typical 500 kg load into LOE. For LOE, a minimum speed of 7 km/sec is needed. This means that the total kinetic energy of the payload as it leaves the launch site is 12.5 billion Joules. Since there are 3.6 billion Joules in a megawatt-hour, the kinetic energy can also be expressed as 0.4 megawatt hours. Since the figure is not given in the conceptual design report, I take a rough efficiency factor of 100 as the ratio of electrical energy needed to the total energy of the payload. Thus one launch would take about 40 megawatt hours of electrical power. This means an electrical generation facility with one megawatt hour would need to run for 40 hours and store the energy in some way that could be released very quickly for the actual launch. There are no such storage systems in Hawaii at present.
- 5) As the vessel propagates through the atmosphere at hypersonic speeds, it will make a tremendously loud sonic boom. A rough calculation shows that this would be loud enough to cause hearing damage to people within 10 to 20 miles of the launch site. Obviously, this threat is not in the interests of public safety, health and general welfare of those living in Hawai'i.
- 6) In the event of malfunction, the energy stored in the system would be dissipated over a wide area with devastating consequences to people and buildings. Assuming that the total stored energy in the gyrotron is about ten times the payload energy, and using the conversion factor that one gram of TNT equals 4184 Joules, we are talking about the explosive force of roughly 30 tons of TNT. This is enough to destroy a small town.
- 7) The calculations above refer to a full-speed launch. As I understand it, there is some mention of a relatively low velocity launch scheme, followed by rocket propulsion to achieve LOE. With respect, it is hard to fathom any advantages to this idea. Recalling that kinetic energy is proportional to speed squared, and assuming a launch velocity of the speed of sound (about 0.35 km per second), the kinetic energy at launch would only be 1% of that needed for LOE. Therefore the rocket would have to have essentially the same amount (i.e. 99%) of conventional rocket fuel as if it were launched on the ground. These rockets would have to fire at a mere 2 to 3 miles above the earth, less than half the altitude where conventional passenger jets fly. A very large stay-clear area would be needed in case of accident, which is something that is very hard to find in Hawaii.

In conclusion, I believe that the SpinLaunch idea is a poor choice for Hawaii. Even if the technical issues can be overcome, it will be of limited use and have large environmental and safety issues to face. Given that the U.S. military seems to have abandoned research into this technology, based on sound technical grounds, it seems irresponsible for Hawaii to gamble on this highly speculative enterprise.

In my opinion, a better idea for fueling space exploration would be to use our abundant sun resources to split water into liquid hydrogen and oxygen, which are commonly used non-polluting rocket fuels.

Thank you for allowing me to submit testimony.

Yours truly,

Prof. Peter Bosted

Ann Bosted
P.O. Box 6254, Ocean View, HI 96737

The Hon. Donovan M. Dela Cruz, Chair of Senate Committee on Ways and Means
The Hon. Gilbert S. C. Keith-Agaran, Vice Chair of Senate Committee on Ways and Means
Honorable members of the Senate Committee on Ways and Means

Dear Senators Dela Cruz, Keith-Agaran and Ways and Means Committee members,

Re: HB 2559 HD1 Special Purpose Bonds for Spinlaunch Inc.

I am opposed to this project as it appears to be the reincarnation of an old idea that was first proposed in 1979, and which has been discounted and abandoned. That idea now appears to have been dusted off and is being marketed to the legislature as cutting edge technology that will bring prestige and riches to our state.

Based on limited information, SpinLaunch appears to be a reincarnation of the 1997 Derek Tidman *Slingatron* proposal. Mr. Tidman has pursued his Slingatron idea much further and has numerous patents on the concept already which would be a challenge to overcome.

I am attaching the three-page paper copyrighted by Mr. Tidman in 1979 so that you can see where this idea for SpinLaunch originated. You will note that the illustration on page 141 calls for a mountain. Which Hawaiian mountain will be used? If Mauna Kea is used, won't this conflict with the established use by observatories on its summit?

According to Brian Wang writing in nextBIGfuture on February 24, 2018, the US army funded a study of the *Slingatron* in 2006 to "explore the concept's bounding limits and seek to develop uses for the technology within those limits". Why did the military show no further interest in this technology? May I respectfully suggest that the Legislature obtain a copy of the army's findings? Perhaps their report will shed more light on the feasibility of the *SpinLaunch* idea.

Mr. Wang's article makes some interesting points about the Slingatron and SpinLaunch. It would appear that this "spin" technology involves such high acceleration (G) loads, that **it cannot not be used to launch people or delicate loads** - it would be used ONLY for bulk materials such as water, fuel, etc. to support the colonization of the moon or Mars. Mr. Wang's article can be read at

<https://www.nextbigfuture.com/2018/02/spinlaunch-is-using-large-centrifuges-to-accelerate-to-payloads-into-space-target-500000-per-launch.html>

I am chiefly concerned about the seven "selling points" itemized in Section 1 of HB 2559. May I respectfully ask you to consider the following counterpoints to Section 1.?

1. What is the market for bulk materials to be launched? If the load is the size of a microwave oven, that may be only a few gallons of water or fuel. Who would need a few gallons of fuel or water in space for \$500,000?
2. Electrical power would be used only for the initial stage of the launch. No complex delicate rocket engines that use clean fuels could survive the initial accelerations (Gs) in the centrifuge. Hence more robust solid propellant boost motors would be required and those are intrinsically polluting. On the other hand, delicate rocket engines can use existing non-polluting technology (such as liquid hydrogen and oxygen, where the byproduct is non-polluting water vapor) for all launch stages. So this way of launching would be more polluting than conventional methods.
3. How much solar energy would be needed, and can it be stored and then used quickly enough to launch the load? In the case of liquid hydrogen powered rockets, electricity is already a major component to produce the fuel.
4. The construction of this facility would be very expensive and thus one can expect the cost per launch to be equally costly. We all know how much more expensive it is to build a facility in Hawai'i than on the mainland as all building materials need to be imported. Do we have accurate figures for the amounts of steel, iron, aluminum, copper and other components, such as motors, that will be needed?
5. Construction project spending is a great idea, but should we not be focusing on much-needed feasible projects that can directly benefit the state, such as a hospital? If this project is to be a near horizontal orbital speed launch facility, then it would have significant sound and other hazard implications requiring large area restrictions for human entry via land or water including far off shore.
- 6.& 7. Again, if this project is not feasible, how will it help the State, counties and federal government to expand access to space or contribute to space exploration, observation and transportation? Point 5 above argues that this project will actually risk public health, safety and general welfare, not promote it.

I understand that SpinLaunch is not forthcoming with details about this project due to patents pending. May I respectfully suggest that after SpinLaunch has secured the patents needed for this project, the state should then hold an open forum where experts in space technology can offer considered opinions on the feasibility of the project and evaluate the need for loads of bulk materials in low orbit.

Without expert advice, I advocate that the legislature should not support this bill at this time.

Thank you for allowing me to submit testimony.

Yours truly,

Ann Bosted

SLINGATRON DYNAMICS AND LAUNCH TO LEO

Derek A. Tidman

6801 Benjamin Street, McLean, VA 22101

Abstract

A circular mass accelerator concept called a slingatron is described in which a large projectile could be accelerated to high velocity using a relatively low power input (compared to a hypervelocity gun). Two examples are given in which a slingatron could be used to launch an object into Earth orbit. The first would use a slingatron of ring radius 640 meters and a low elevation launch at 8 km/sec. The second case is intended as a small scale test machine of ring radius 40 meters that would launch a projectile vertically at 2 km/sec. The projectile could be an encased light gas gun (like a long rod penetrator) that would, upon reaching its peak altitude of ~160 km, fire a small mass at 7.5 km/sec to the East into LEO before dropping back to Earth for re-use via guided parachute.

A mass accelerator, called a slingatron, has been proposed¹ in which a mass could be accelerated in an evacuated guide tube around a circular path of large radius to high velocity. The slingatron is similar to both the ancient sling and also to a modern synchrotron in that the mass is accelerated around the accelerator ring by a wave in which the mass has phase stability. Work is done on the mass by a small-amplitude gyration of the entire accelerator ring (like a giant hula-hoop) that continually pulls the mass radially inward against its centrifugal force. There is no string to break as in a conventional sling and the process is efficient, even though the ring mass is much larger than the accelerated mass. It is similar to swirling coffee in a cup without a spoon by moving the cup in a small circle. A coriolis force is experienced by the mass in a frame rotating with its instantaneous velocity. Because the ratio of the ring radius to the small gyration radius is large, huge wave speeds can be implemented mechanically and controlled electronically.

The accelerated mass (called a 'sled') must slide around the accelerator ring with a low friction coefficient as it is pushed by centrifugal force against the track inside the guide tube. Frictional

forces can be made small by either using a lubricating film of gas (a gas bearing) between the sled and track, or by magnetically levitating the sled above the track. The gas-bearing sled is much easier to engineer and has the advantages that a room-temperature steel track can be used, and higher bearing pressures (and centrifugal forces) are more easily accommodated.

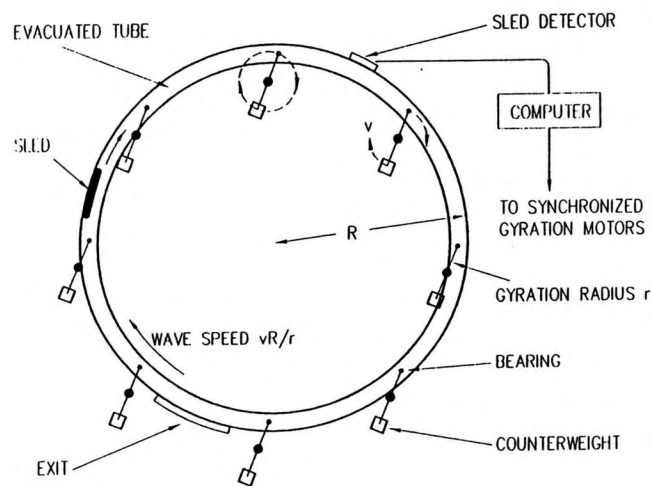


Figure 1
Schematic of a mass accelerated in a slingatron by a phased gyration motion of the entire accelerator tube.

Figure 1 shows the concept. Acceleration can occur provided the synchronized electric motors that drive the small-amplitude gyration are controlled so that at the sled location the guide tube continually moves with a component that is directed inward along the ring radius. Note that the gyration displacement wave travels around the accelerator ring with a speed vR/r where r and v are the radius and speed of the gyration motion. This wave speed is large for $R \gg r$, even though the gyration speed v is relatively small (e.g., in the range of 10's to ~100 meters/sec) for practical mechanical implementation.

There are various ways to implement the ring gyration. Figure 2 shows an example in which the drive units distributed around the accelerator ring use conventional rolling technology to roll the ring plus counterweights around a small gyration circle on circular tracks that support the ring mass against Earth's gravity. The drive units consist of both

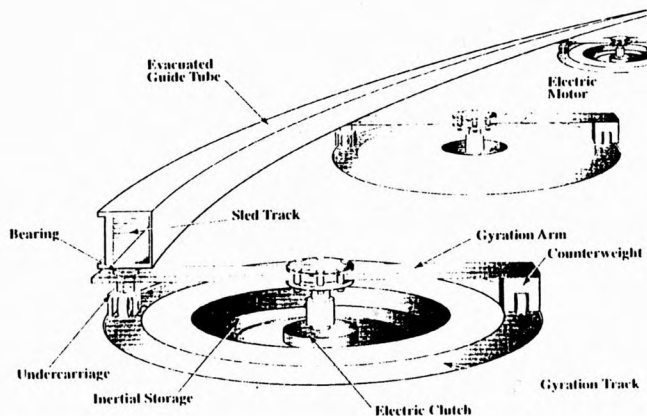


Figure 2
The accelerator ring plus counterweights are rolled around a small circle and propelled by electric motors and inertial storage units distributed around the ring.

electric motors and inertial storage flywheels distributed around the ring. The ring gyration is carried up to an intermediate speed by the motors and then the flywheels are coupled in to provide the surge power as the sled approaches its final velocity.

Figure 2 also shows the ring as having a curved I-beam geometry. This geometry provides lateral restraint for the sled, and allows easy access for operations such as grinding welds and honing the steel track to a polished finish. A large steel ring could thus be constructed out of curved I-beam sections welded together.

The accelerator appears to have a useful range of phase stability, Fig 3, over which the sled can be accelerated by a pre-programmed ramp-up of the gyration frequency. This was observed in a small scale experiment, Fig 4, in which phase stability allowed a pre-programmed acceleration to be used.

DISPLACEMENT OF WAVELENGTH $2\pi R$ TRAVELS AROUND RING AT SPEED vR/r

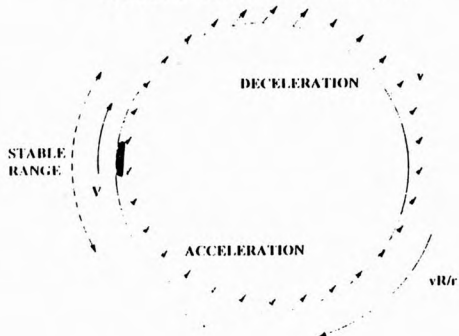


Figure 3
Phase stable acceleration.

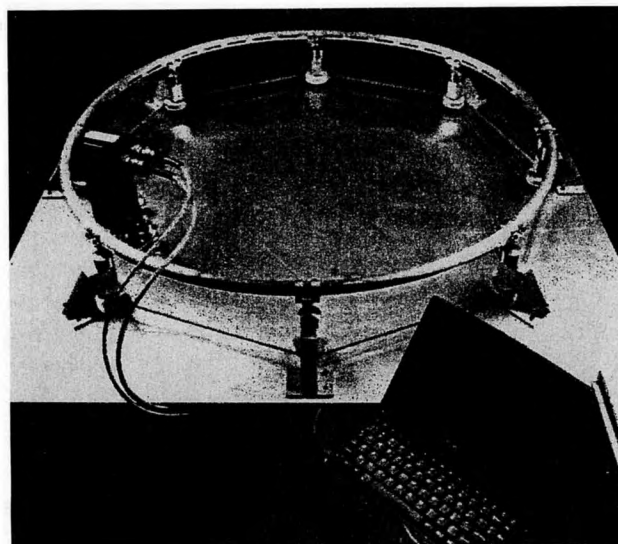


Figure 4
A 'table-top' slingatron of ring diameter 1 meter. The computer-controlled gyration accelerates ball bearing projectiles to above 100 meters/sec.

Note that the ring radius R could range from meters to kilometers depending on the application, Figure 5. The slingatron concept avoids the technical difficulties of electrical pulsed power for such systems since the acceleration process is relatively slow (just as a conventional sling accelerates slowly compared to a conventional or EM gun). This makes it in principle capable of accelerating very large masses to high velocity, possibly including the direct launch of heavy projectiles into space from the Earth's surface ^{2,3}, Figure 6. The need to maintain a low friction coefficient during the acceleration period is the main issue that is expected to limit the accelerator performance for large systems.

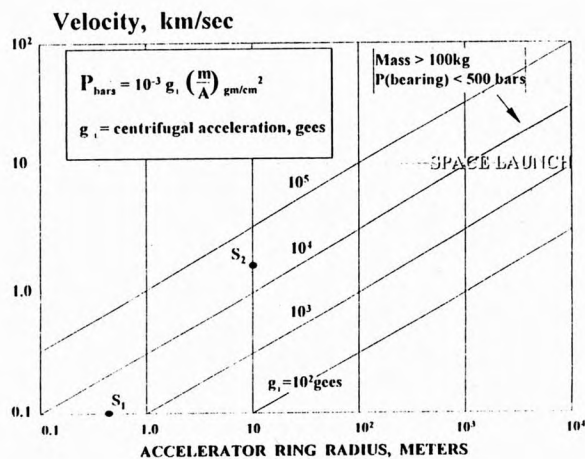


Figure 5
Velocity of accelerated mass as a function of ring radius for various constant values of the centrifugal acceleration.

Consider next the high centrifugal g's experienced by the sled. First note that defense projectiles can be fired out of guns with $> 20,000$ g's and carry electronics etc. It is also instructive to relate the centrifugal g's to the bearing pressure between the sled and the track, Figure 5, for a sense of what materials or structures can tolerate. For example, 200 bars is easily contained in typical laboratory gas bottles. But 200 bars on one side of a steel slab of thickness 2 inches (i.e., $\sim 40 \text{ gm cm}^{-2}$) will accelerate the slab at 5,000 g's, and 400 bars (also in some gas bottles) will accelerate it at 10,000 g's, which is the centrifugal acceleration experienced by an object traveling at 8 km/sec around a circle of radius 640 meters. An injected or evaporatively supplied gas film can be maintained between the sled and the track at the above pressures for low friction. On the issue of efficiency, note first that the gyration power is supplied globally and continuously to the ring as it rolls with a very low rolling friction coefficient around its gyration circle. Sled acceleration is efficient because the sled extracts energy from the gyrating ring faster than the ring's rolling friction dissipates it. The sled gains a velocity increment of $\sim 2(\pi)v\sin(\theta)$ per cycle around the ring, where θ is the angle between the sled and ring velocity vectors. Further, the ratio of the kinetic energy of the sled of mass m to that of the ring of mass M is $mV^2/Mv^2 = mR^2/Mr^2$, and is usually greater than 1 so that little energy remains in the ring at the end of the acceleration process.

RANGE OF LAUNCH DIRECTIONS

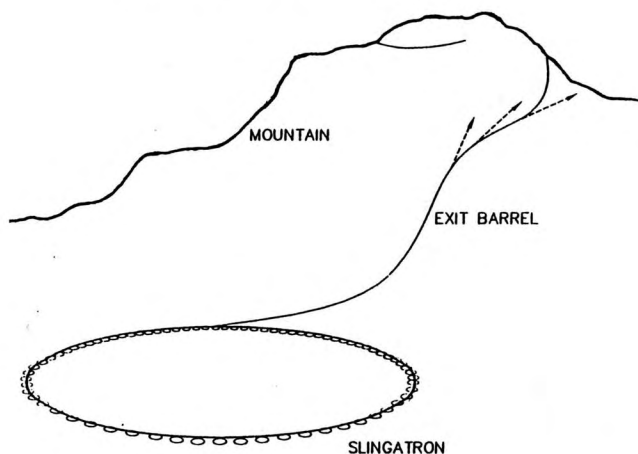


Figure 6
Slingatron Space Launcher in which several exits are located along the barrel as it winds up a mountain so that projectiles could be launched in various directions.

A projectile of mass 500 kg could, for example, be accelerated in a slingatron of ring radius 640 meters (track width ~ 32 cm) to a velocity of 8 km/sec. Its maximum centrifugal acceleration would be 10,000 g's. If launched at an elevation angle of 30 degrees it could be inserted into LEO with a small rocket kick at apogee.

A much smaller scale test system would be a reasonable first step. For example, a slingatron of ring radius 40 meters could accelerate the same elongated projectile to 2 km/sec. If the projectile consisted of a light gas gun (LGG) which was encased for atmospheric transit (essentially an encased long steel tube), it could be launched vertically from the slingatron to an altitude of ~ 160 km, i.e., well above the atmosphere. At peak altitude the LGG could then fire a small mass horizontally at 7.5 km/sec to the East into LEO, and then drop back via guided parachute to base for re-use. The mass in orbit would probably be too small to be useful in this case. However, this small 'pop-up' system could evolve into the full-scale sling launcher described in the preceding paragraph.

References

- (1) D. A. Tidman, 'Sling Launch of a Mass Using Superconducting Levitation', *IEEE Trans. Magnetics*, Vol 32, pp240-247, January 1996. For detailed slingatron dynamics see: 'The Slingatron Mass Accelerator', by D. A. Tidman, submitted to *J. Applied Physics*, 1997.
- (2) John Kross, 'The Slingatron', *Ad Astra*, National Space Society Magazine, vol.8, pp47-51, Sept/Oct 1996.
- (3) D. A. Tidman, R. L. Burton, D. S. Jenkins, and F. D. Witherspoon, 'Sling Launch of Materials into Space', in Proceedings of the Twelfth SSI-Princeton Conference, May 4-5 1995, published in *Space Manufacturing 10*, Ed by Barbara Faughnan, Aug 1995, pages 59-70.

HB-2559-HD-1

Submitted on: 3/28/2018 9:33:01 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
sandra mayville	Individual	Oppose	No

Comments:

HB-2559-HD-1

Submitted on: 3/28/2018 9:32:19 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Deb Schumacher	Individual	Oppose	No

Comments:

Committee members,

I address you today on the subject of the spin launch project proposal, to be constructed on the West Ka'u coastline. There is a long list of reason not to progress with this project and I urge you to stop consideration immediately. Among some of the strongest reasons for ending any support for this project are ; This is a culturaly sensitive area with many historical markings and sites. A pristine coastline supporting endangered honu nesting sites. The site is under consideration for conservation action by the county planning committee, The county developement plan does not include development of any kind for this coastline.The launch site borders a family housing development. There has been no study completed on adverse affects to be expected from noise, traffic, pollution to wildlife including migrating whales, turtles, birds and fish populations. There is extensive local opposition to this project for these and other reasons. This project should not be allowed even if it was 100%private funded. The request for funding of 30 million dollars through bonding is foolish to say the least. So many worthy projects need funding now and this is not one. The project will not help the local population with employment. Jobs must be applied for in California.There will be many county expenses that will be hard to fund, including road developements. There is already a problem with water in this community.Again as a registered voter I urge you to bring this proposal to an end.

Deborah Schumacher

Po box 37 7379 Ocean View, Hawaii

HB-2559-HD-1

Submitted on: 3/28/2018 9:29:17 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Deborah Ward	Individual	Oppose	No

Comments:

Aloha, lawmakers!

SpinLaunch is a stealthy, sneaky outrageous way of avoiding any public discussion of the future of our island. Mufi tried this and was soundly defeated! Please stop this now. The state should not be encouraging this kind of behavior. DO NOT FUND!!!

Sincerely, Deborah Ward

HB-2559-HD-1

Submitted on: 3/28/2018 9:06:46 AM

Testimony for WAM on 3/29/2018 10:50:00 AM

Submitted By	Organization	Testifier Position	Present at Hearing
Roy Eaton	Individual	Oppose	No

Comments:

Committee members,

I address you today on the subject of the spin launch project proposal, to be constructed on the West Ka'u coastline. There is a long list of reason not to progress with this project and I urge you to stop consideration immediately. Among some of the strongest reasons for ending any support for this project are ; This is a culturaly sensitive area with many historical markings and sites. A pristine coastline supporting endangered honu nesting sites. The site is under consideration for conservation action by the county planning commitee, The county developement plan does not include development of any kind for this coastline.The launch site borders a family housing development. There has been no study completed on adverse affects to be expected from noise, traffic, pollution to wildlife including migrating whales, turtles, birds and fish populations. There is extensive local opposition to this project for these and other reasons. This project should not be allowed even if it was 100%private funded. The request for funding of 30 million dollars through bonding is foolish to say the least. So many worthy projects need funding now and this is not one. The project will not help the local population with employment. Jobs must be applied for in California.There will be many county expenses that will be hard to fund, including road developoments. Again as a registered voter I urge you to bring this proposal to an end.

Roy Eaton

P.O. Box 377379

928592 Reef Parkway

Ocean View HI 96737

Aloha Senators of the Ways and Means Committee -

I am writing you to ask that you STOP and vote NO on HB2559 the bill to approve Special Purpose Revenue Bonds to assist SPINLAUNCH. This potential future installation should absolutely not be built in the area between Ka Lae and Pohue Bay under any circumstances. It is a culturally important area, there are endangered Hawksbill turtles there, it is a prime fishing location, it is located in Lave Zone 2, and the growing community of Ocean View does not want to see the installation or hear the sonic booms created by objects traveling 3000mph over the ocean.

I have read the bill and its companion and I will tell you that as a member of the PUBLIC I do not find it is in my interest to see this “development” occur. Additionally, there is zero quantifiable evidence to suggest this proposal will in any way whatsoever have benefit to Public Health, Safety or our General Welfare, in fact I find the opposite to have more potential.

SONIC BOOMS / SONIC WAVES ARE HARMFUL TO HUMANS AND ANIMALS
- **Research at NASA on Human Response to Sonic Booms** [20080046993.pdf](#)

I do understand our state needs to diversify industry and find other revenue streams other than Tourism but this boondoggle has no place here. There must be some other light industrial business that would provide jobs to our local populace, rather than the very few jobs this will create for the general Ocean View resident.

Please vote NO.

Perhaps some of you will consider whether the funding for SPINLAUNCH aligns with the Ka’u Community Development Plan. I suppose none of you have given the attached document any consideration whatsoever. <http://www.hawaii-county-cdp.info/site-resources/pictures/kau/kau-community-development-plan-final-2> I hope the Hawaii Island representatives on the Committee, Senators Kahele & Inouye are aware this plan exists.

Please vote NO on this funding measure.

I am writing again this morning to ask another time that you vote NO on this Bill and discontinue this course of action. This project does not belong in KAU. Even County members agreed Pohue Bay and the surrounding land should be acquired and protected, per the attached resolution. [Resolution 265-12: Purchase of Pohue Bay — Hawaii County ...](#) Their reasons for acquisition are very clearly stated and completely align with my objections to the SpinLaunch project.

Sincerely,

Ms. Shawn Lohay
92-1057 Kona Kai Blvd
Ocean View, HI 96737

Committee members,

I address you today on the subject of the spin launch project proposal, to be constructed on the West Ka'u coastline. There is a long list of reason not to progress with this project and I urge you to stop consideration immediately. Among some of the strongest reasons for ending any support for this project are ; This is a culturaly sensitive area with many historical markings and sites. A pristine coastline supporting endangered honu nesting sites. The site is under consideration for conservation action by the county planning commitee, The county developement plan does not include development of any kind for this coastline.The launch site borders a family housing development. There has been no study completed on adverse affects to be expected from noise, traffic, pollution to wildlife including migrating whales, turtles, birds and fish populations. There is extensive local opposition to this project for these and other reasons. This project should not be allowed even if it was 100%private funded. The request for funding of 30 million dollars through bonding is foolish to say the least. So many worthy projects need funding now and this is not one. The project will not help the local population with employment. Jobs must be applied for in California. There will be many county expenses that will be hard to fund, including road developevents. Again as a registered voter I urge you to bring this proposal to an end.

Roy Eaton

Po box 37 7379 Ocean View, Hawaii

Dated 3/27/18

I am writing to you to speak up, speak out, and speak AGAINST HB2559 HD1 which is up for being passed by the State Senate Committee WAM on Thursday the 29th of March 2018. A proposal to allow State backed private bond issuance, for SpinLaunch to set up a facility in Hawaii (Most likely site to be chosen is Po'huē Bay) to launch satellites into space.

This idea is absolutely ludicrous that you want to put it in our backyard, on a historical and ecologically sensitive site. What absolutely makes me mad beyond reason is that you have not reached out to the community, and continually have moved this project along. When did you do a presentation with a Q&A session for the Ocean View / Ranchos community at the Ocean View Community Center?

The plan for this company is to launch satellites into space at 3,000+ miles per hour via centrifugal force. Considering that the sound barrier is 767 miles per hour - and the size of the launch vehicle, there is no way there is not going to be a sonic boom with every launch. A Boeing 727, at takeoff, creates sound at about 165 decibels. Blow up a pound of TNT from a few yards away and you'll be near 180 decibels. And when something breaks the sound barrier, that sonic boom weighs in at 213 decibels with a shock front that approaches 100 megawatts per square meter. This is what you want to put in at the property adjacent to Po'huē Bay? Y'all have lost your damm minds.

I also think that you guys have not done your homework. The escape velocity

https://en.wikipedia.org/wiki/Escape_velocity

needed to break Earth's atmosphere is 25,020 miles per hour, or Mach 33. Seems a lot more than the 3,000 miles per hour that they are suggesting they can fling satellites into orbit at.

However in this TechCrunch magazine article it is suggested that 'Alternatively, the catapult could provide some of the power needed with cargo being equipped with supplemental rockets necessary to leave earth's atmosphere.'

<https://techcrunch.com/2018/02/22/spinlaunch-2/>

Look at those things they want to fling into space (reference the launch vehicles in the headline photo of the aforementioned article). What happens when the launch goes wrong and they fling the load into a populated area at these breakneck speeds?

So now you want to launch rockets into space from Po'huē Bay ..

How many of you have actually been to Po'huē Bay. It is incredible and pristine. It is a nesting beach of the Hawksbill turtle - a honu that is gorgeous. I've sat on the beach down there from a distance and watched them with there clutch of eggs. Po'huē deserves protection and preservation. That is what you should be doing and looking into. Why not have Volcano National Parks come and take stewardship of the land down there - with full time rangers to ensure that the area is kept clean and safe, and the Hawksbills are given the protection that they need and deserve?

Now back to the 'Alternative' rocket solution. I lived in Vegas as a kid and remember when the rocket fuel plant blew up out there. Rocket fuel is no joke - it is dangerous, toxic, and extremely volatile. You want to put this on such a sensitive site, and in our backyard - no, just .. NO!

Now back to these missiles (it's what they are) breaking the sound barrier. SpinLaunch proposes that this is going to be much cheaper than traditional launch procedures. So .. business will be "booming" yah? Literally ..

BOOM - BOOM - BOOM

that's what us residents are going to hear down here if this were to go through .. a lot.

Now let's talk about the site. To do such a set up in a #2 lava flow zone is plain stupid, especially given the fact that the chance of earthquakes out here substantially increases the risk of something going wrong. I remember when 2 or 3 years ago the USGS did a presentation at the Ocean View Community Center where they discussed how the Big Island was basically sitting on a sand bed and was compressing its bottom foundation causing it to collapse under itself - The one thing I took away from there was the guy giving the presentation saying that a big one was due for our Island sometime within the next 50 years. That's faster than the blink of an eye geologically speaking. Hey so let's store rocket fuel down there, by pristine, untouched, historically significant, Po'huē Bay - that is one of the few nesting sites for the endangered Hawksbill turtle .. right down the road from local residents .. nothing could go wrong right. And let's get this done quietly and in Oahu, and not have public forums to meet with the community before we approve this. And let's approve this project that is not based on the realities of physics ... and and and

What are you guys DOING!?!

Kill this now .. reach out to our community .. let's get Po'huē properly protected.

Do the right thing, please.

Cause we're not going to stand for this.

Respectfully submitted,

Hawk Jones
Ocean View Resident and Land Owner
96737

Aloha legislators,

Please oppose HB 2559 for a Ka'u spaceport. Taxpayer dollars should not go to back up this private venture.

How would a disaster be handled? How would rocket fuel be safely transported over miles of rural roads? What would happen to the rural lifestyle?

mahalo,
Cory Harden

Dear Senator:

We, the undersigned are OPPOSED to this proposed legislation. We have made Ocean View our home. The “town” of Ocean View cannot get a bank, a dentist nor any kind of normal retail or repair shops that you all take for granted on Oahu and other islands because we do not have “county water”. We are required to have a 2nd tap-not happening-on our Lehua Well. The onerous restrictions placed on us to discourage any kind of commercial growth or development. This boondoggle bill being proposed has no fresh water source, the land affected is an endangered species of turtle nesting ground and we do not want wake up to noise, traffic, light pollution and God only knows what else that space station will create. QUIT USING KA'U AS YOUR ASHTRAY. We live here, we vote here and we pay our taxes too.

Karen Pucci
Anna Towner