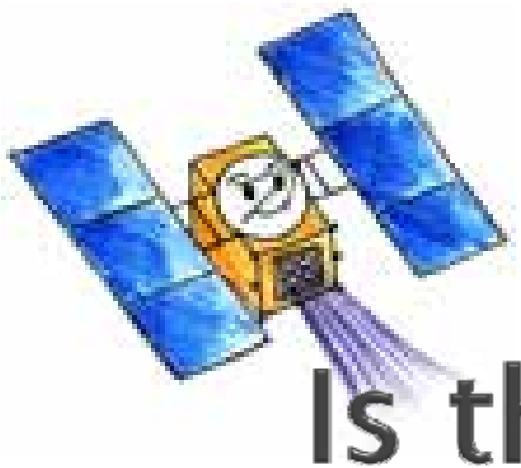


Is the Ball Bouncing or Not?

Let us take the technology of HAYABUSA into consideration based on the Japanese toy "OTEDAMA"

OTEDAMA (Bean Bag)

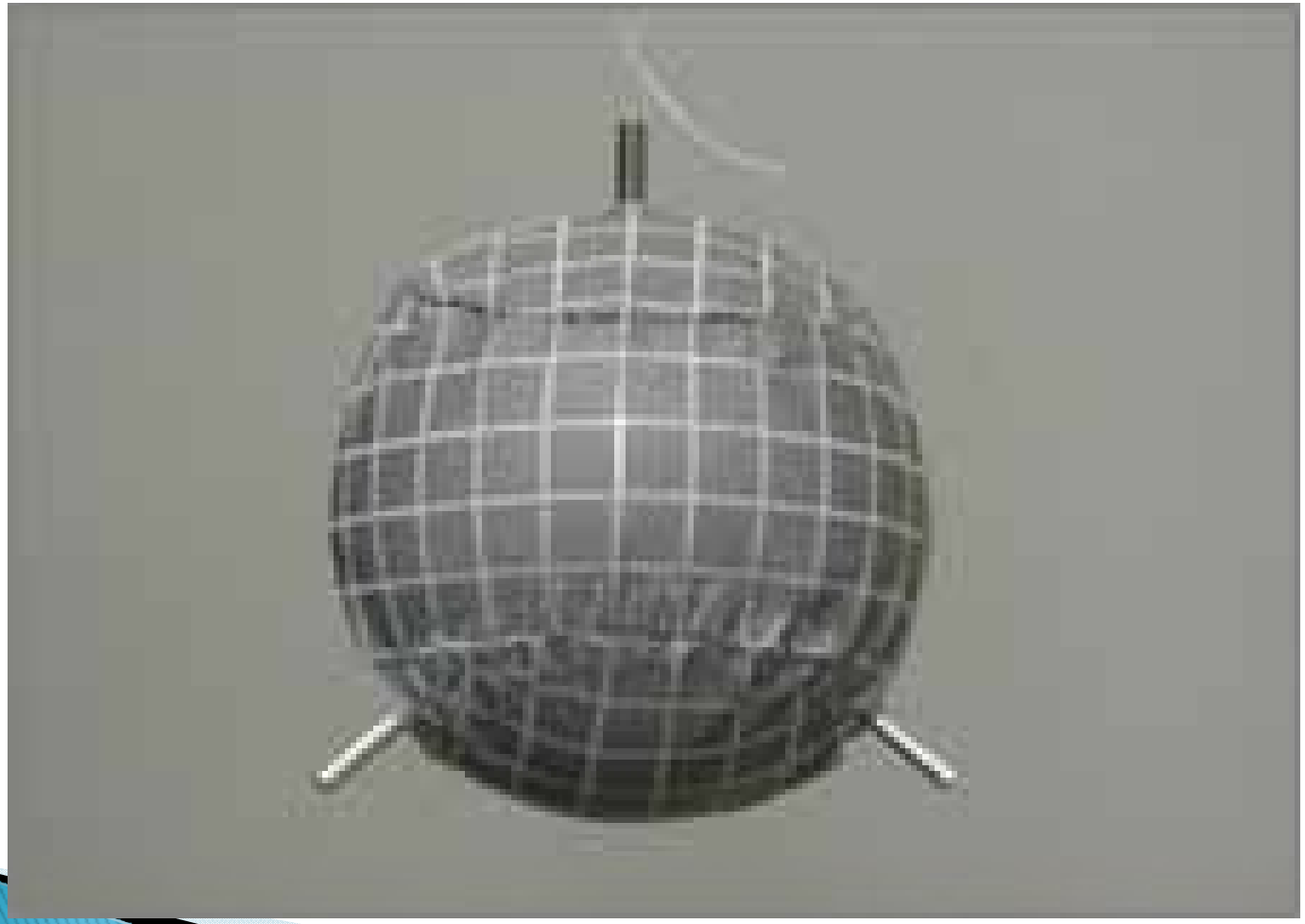
HAYABUSA
(The asteroid explorer)

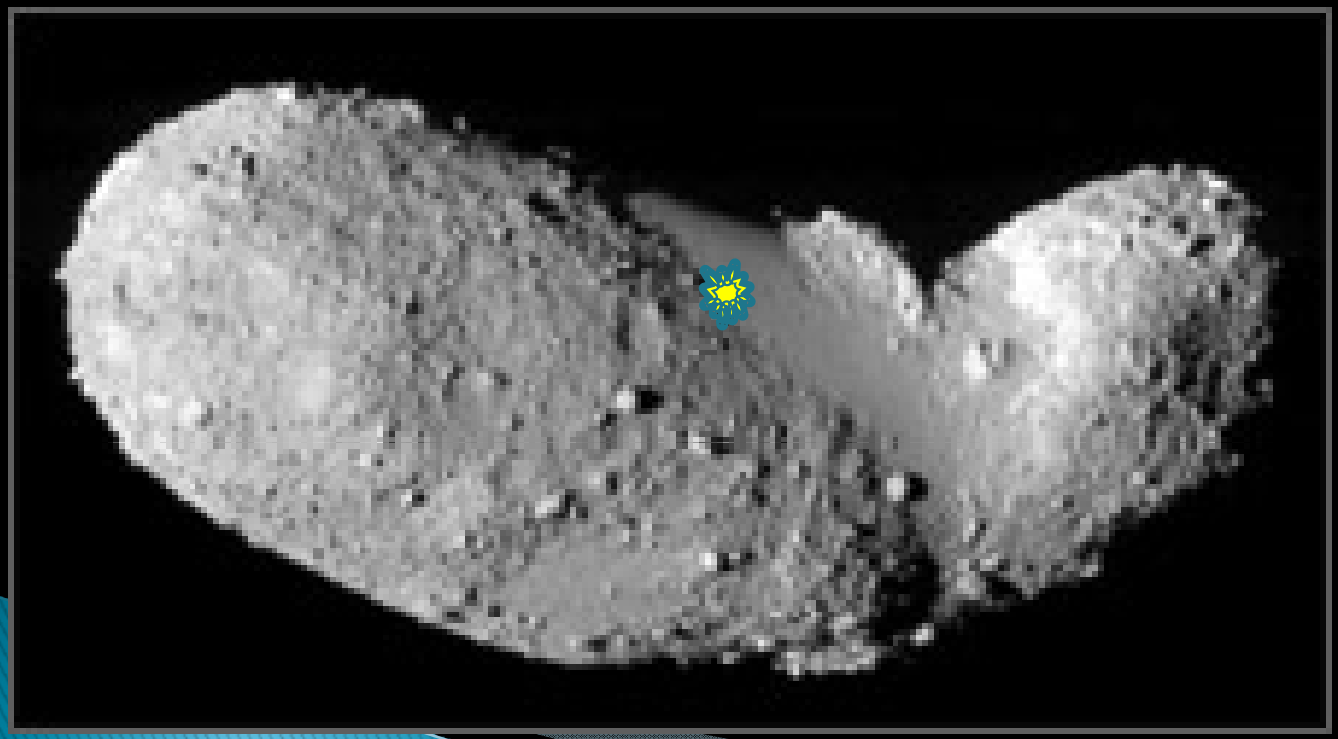
Back to the earth on June 13, 2010

Asteroid ITOKAWA

550m×298m×244m

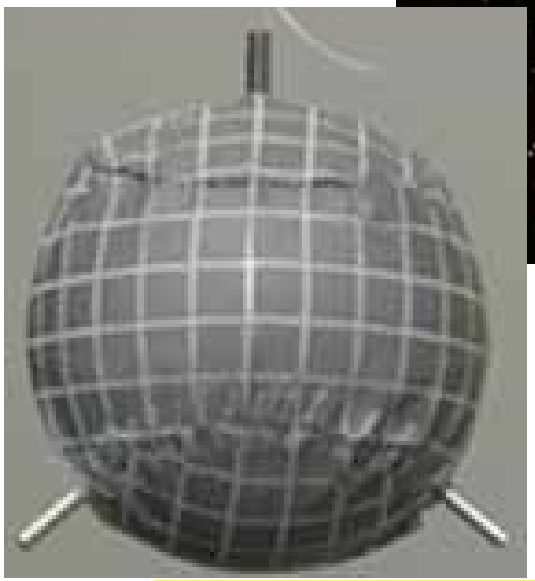
Target Marker

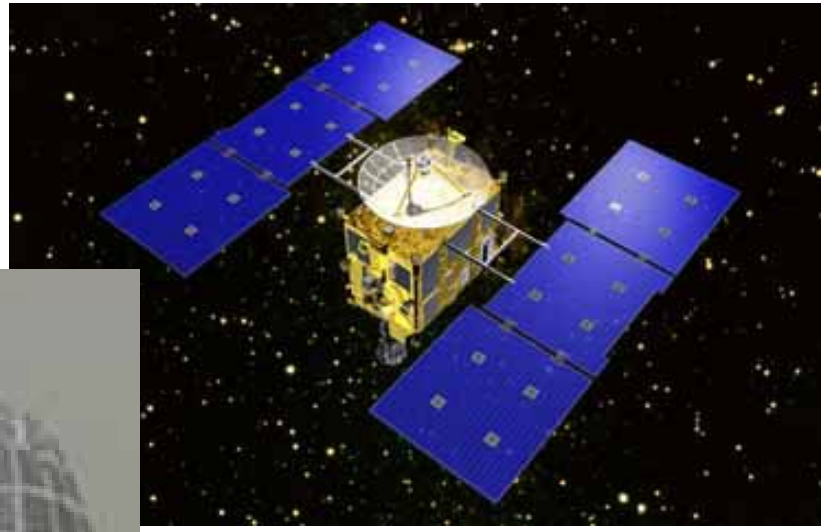




Relationship between····

Target Marker

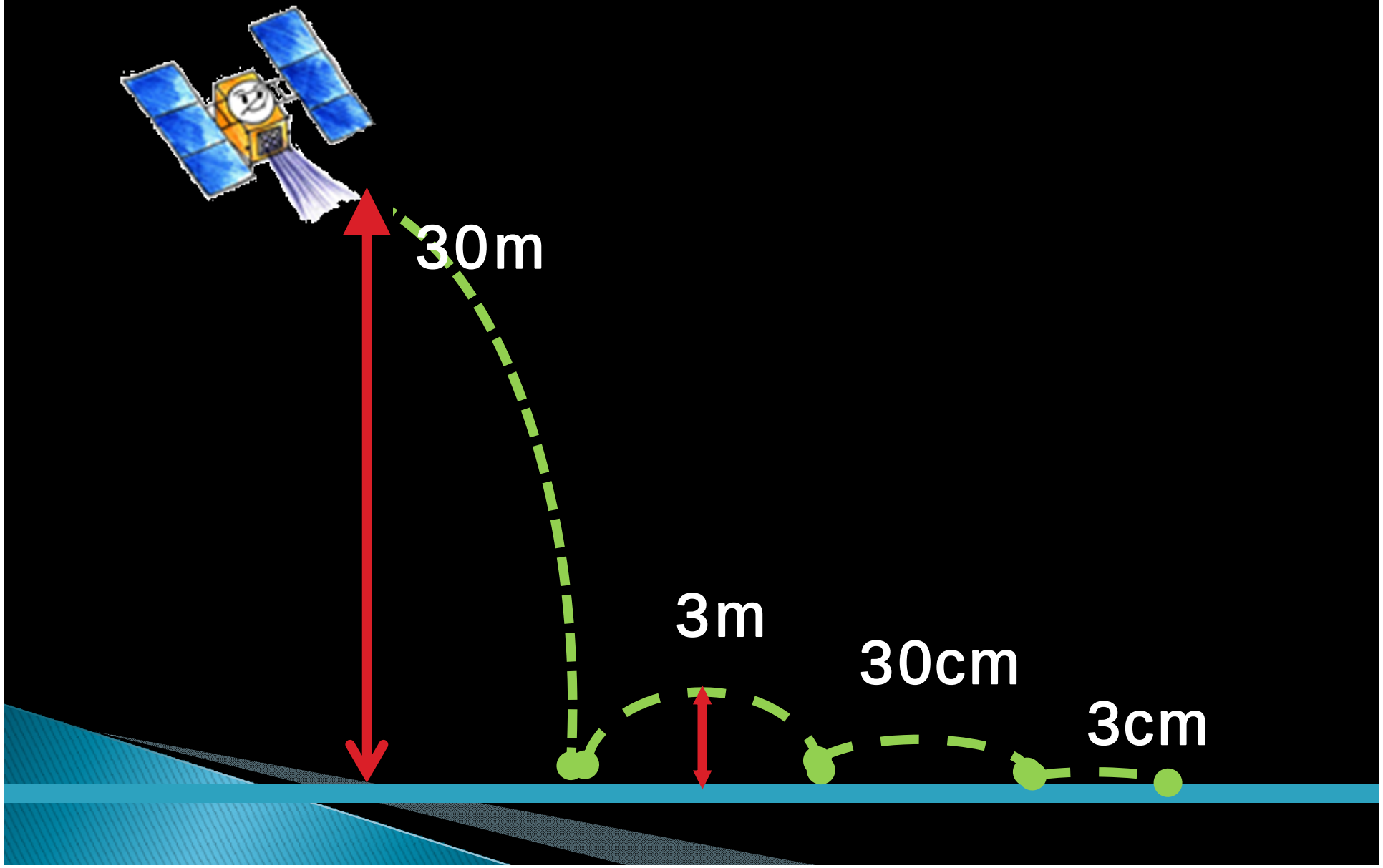




HAYABUSA

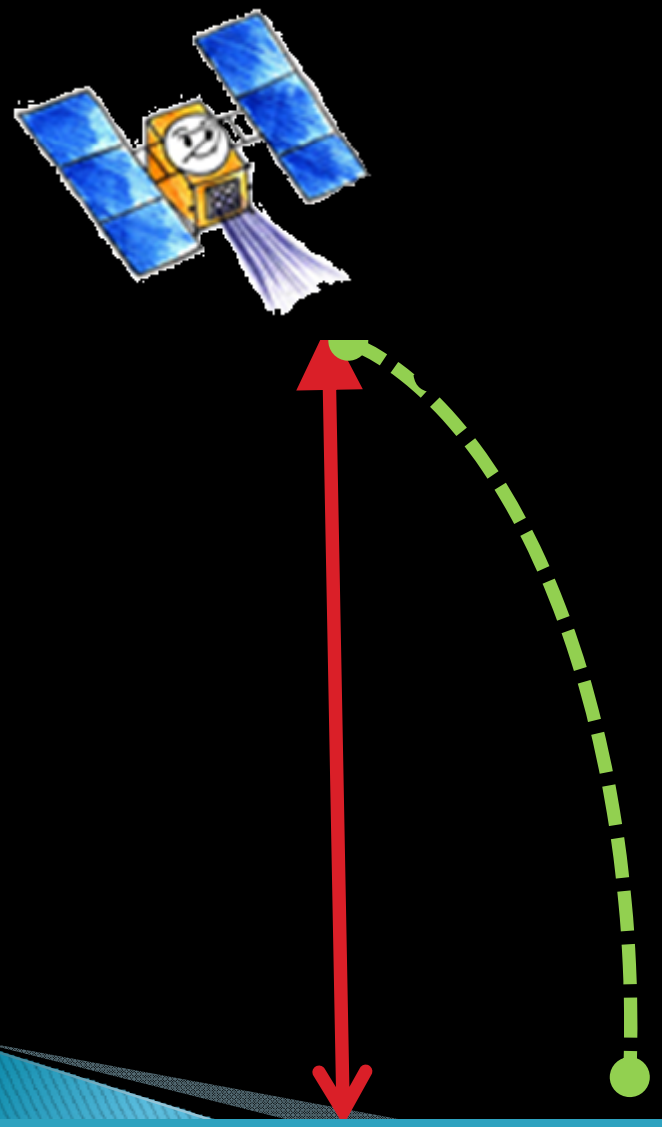
Not bouncing

Coefficient of rebound 0.1



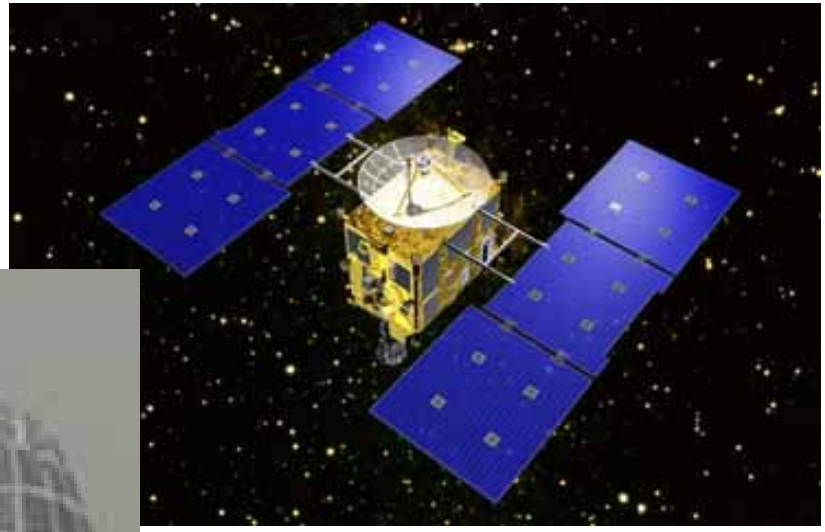
If over 0.1??

Does not return to space! !



Relationship between····

Target Marker



HAYABUSA

OTEDAMA

Does not bounce

Experiment

- *See*
- *How high*
- *Each object bounces?*

1 OTEDAMA

2 Marble

3 Clay ball

4 Super ball

Experiment 1

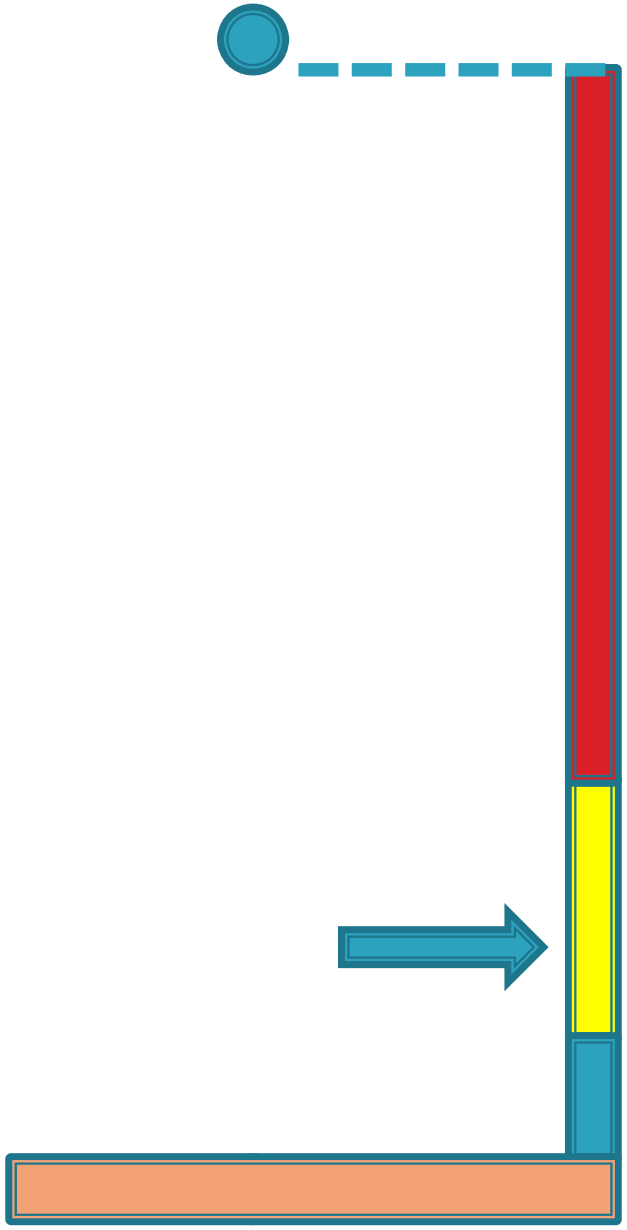
- *See*
- *How high*
- *Each object bounces?*

1 OTEDAMA

2 Marble

3 Clay ball

4 Super ball



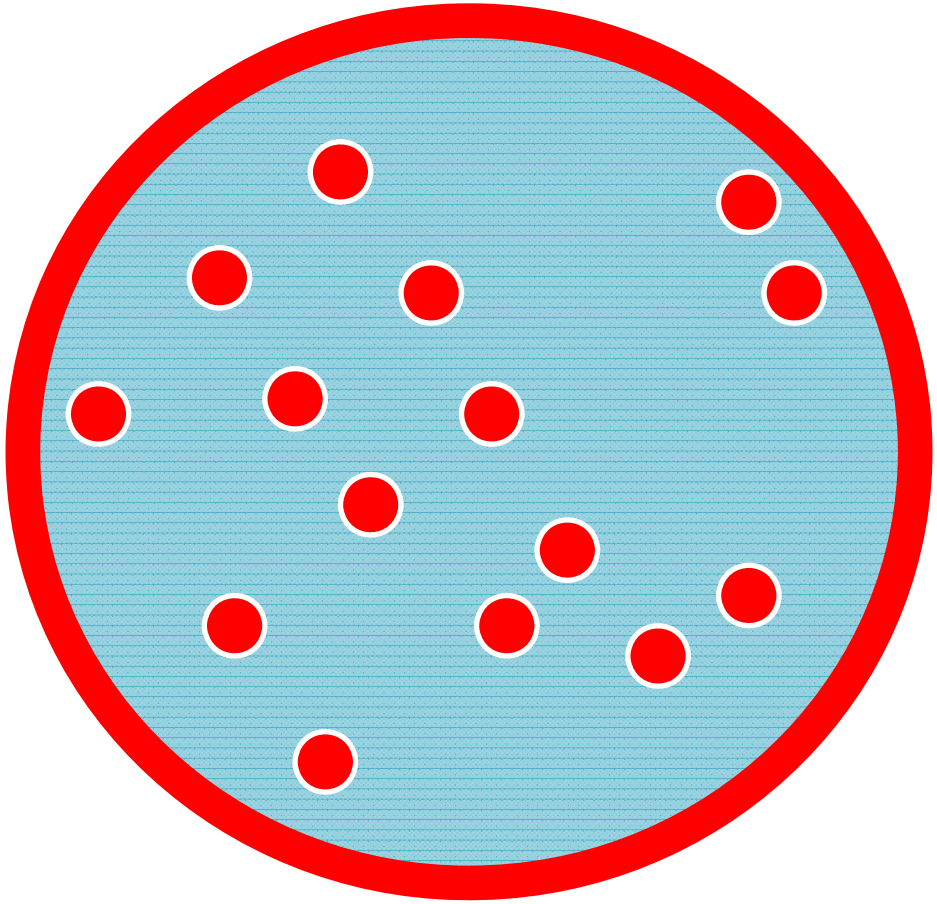
Bounce level (by color)

	expectation	result
OTEDAMA	blue	
Marble		
Cray ball		
Super ball		

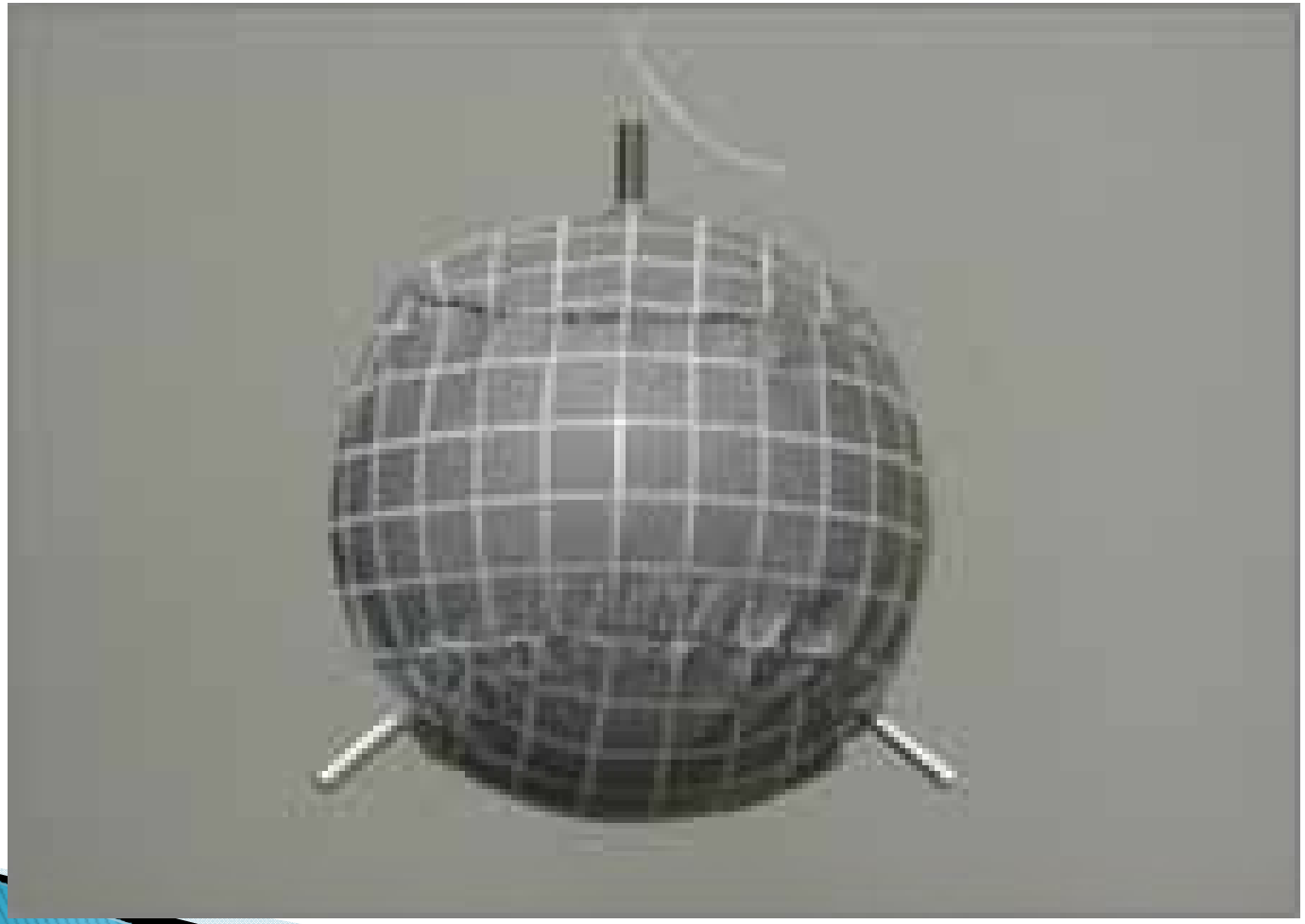
★*The bounce at the blue level is under 0.1*
yellow is under 0.4
red is over 0.3

	Terra cotta	Wood	Corkboard
OTEDAMA	blue	blue	blue
Marble	Yellow red	blue	yellow
Clay ball	blue		
Super ball	red		
Non-bouncing ball	blue	blue	yellow

Structure of the OTEDAMA



Target Marker



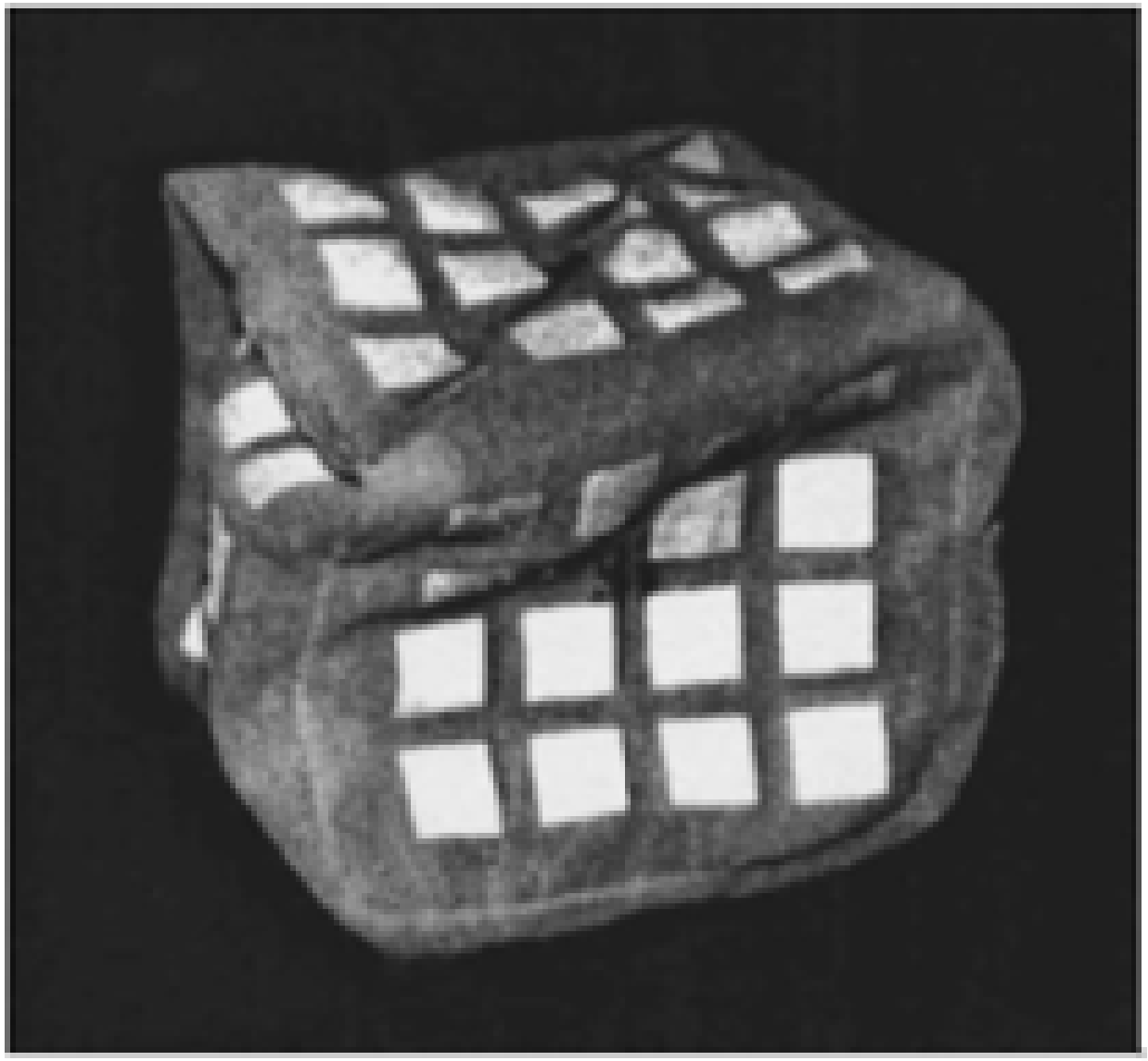
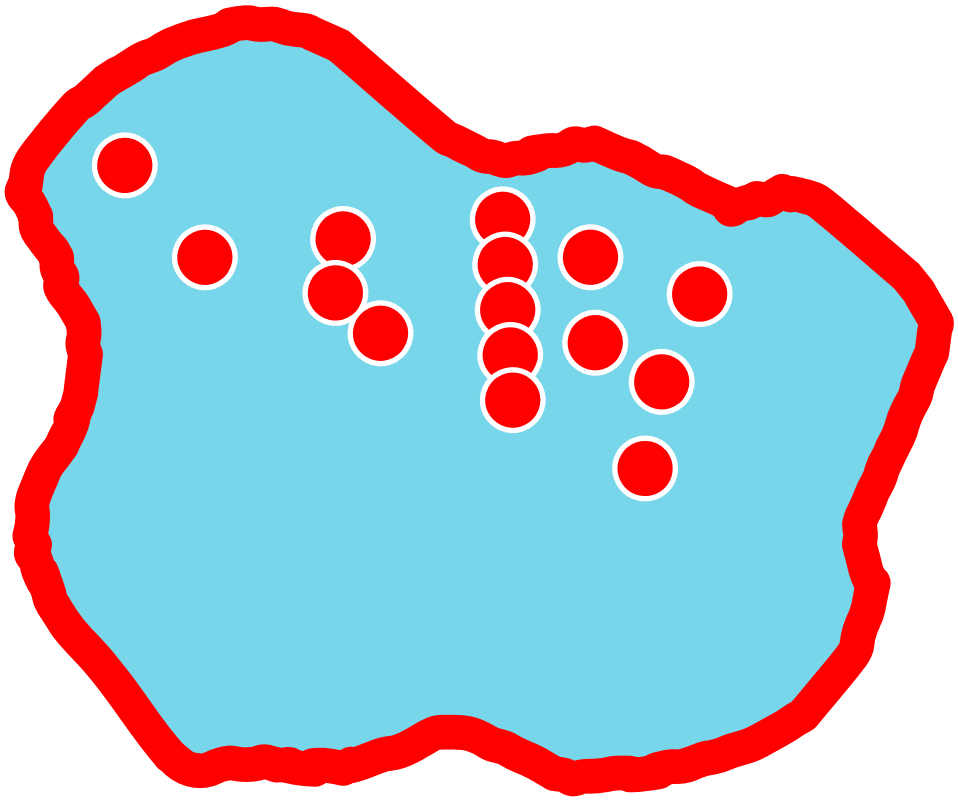
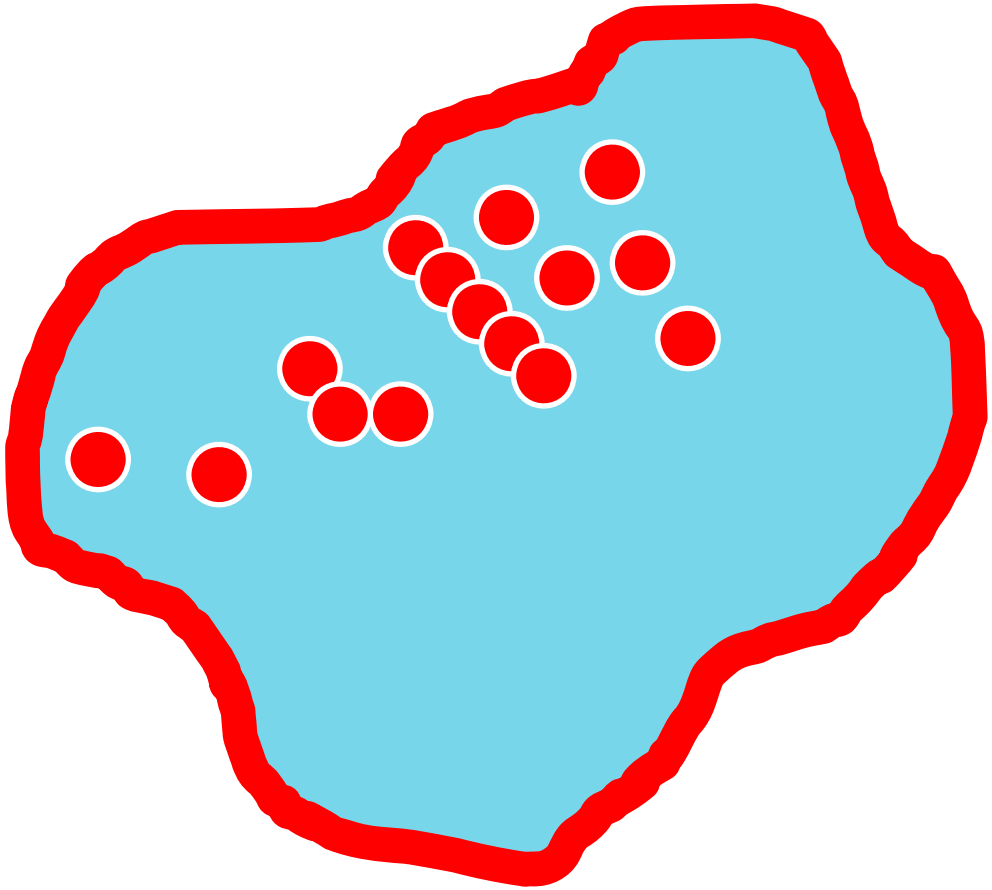
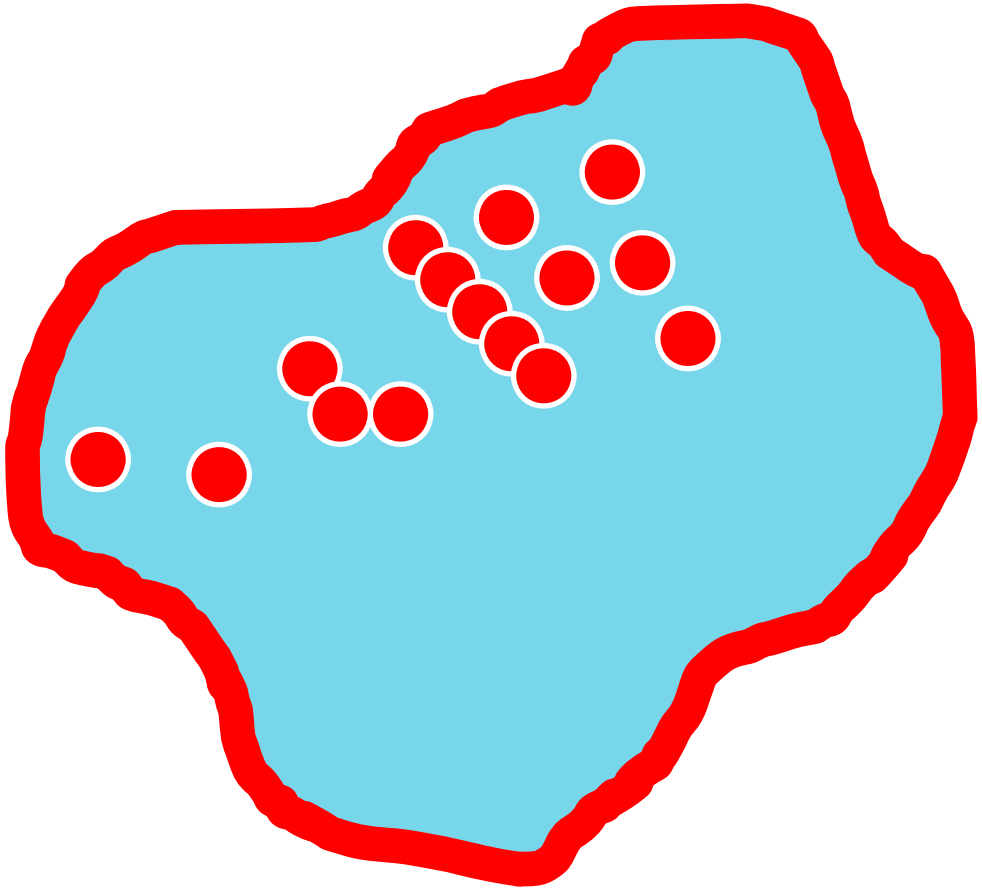


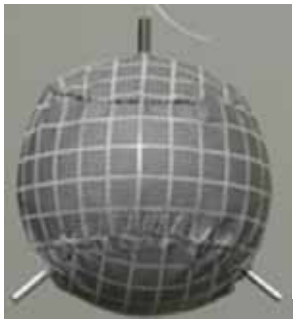
Fig. 7 Photograph of TM (prototype).







Target Marker is…..



- 1. a mark for horizontal measurement
- 2. in a globular form to enable straight return of signals
- 3. strong for using in the space environment.
- 4. light enough to be carried by HAYABUSA.
- 5. a dream ball for 660 thousand people.
- 6. like an OTEDAMA because it does not bounce.

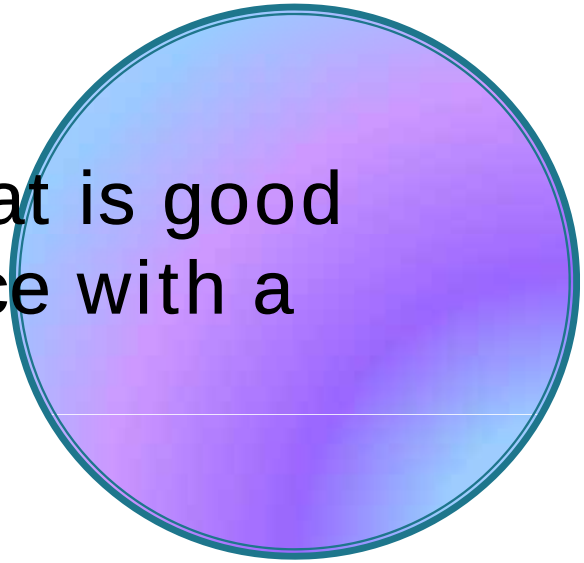
Let us make a Target Marker

1. Adjusting the quantity of pellets.

*Mark the temporary stop at about two places with a vinyl tape

2. Bounce on a table to confirm the condition.

3. When you find a quantity that is good enough, stick the circumference with a vinyl tape.

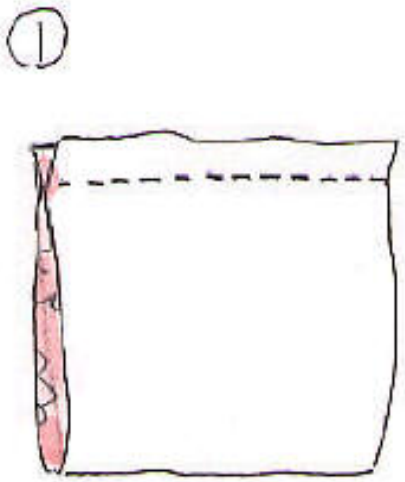


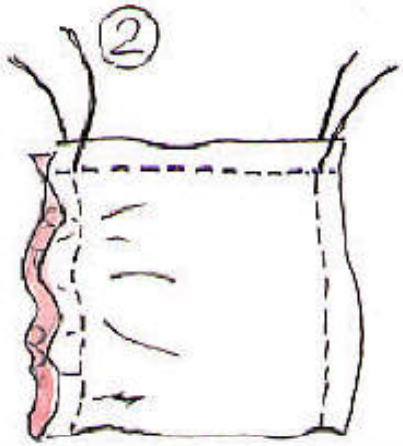
Hope you enjoyed!

- Thank you!! (*^_^*)

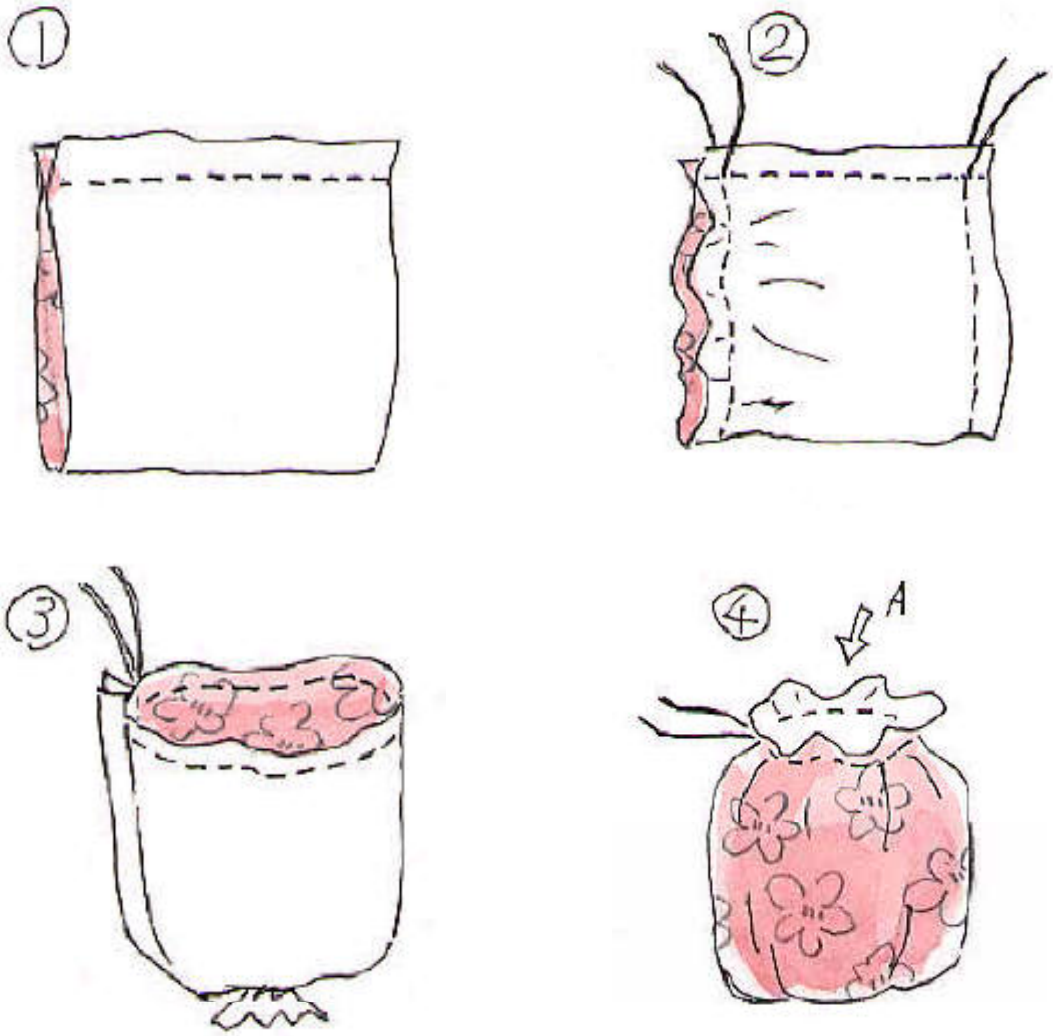
Can you try making an OTEDAMA?

About 40g pellet





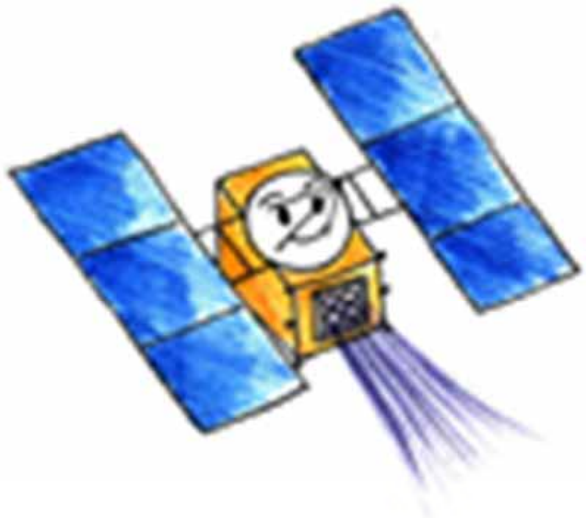
Can you try making an OTEDAMA?



About 40g pellet

Hope you enjoyed!

- Thank you!! (*^_^*)



Junko Katamura


JAXA


ターゲットマーカの中には
このビーズが入っています。

Hello.
I am Junko Katamura.
Let us have some fun together!

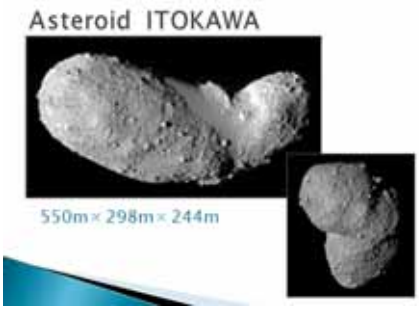
<1.INTRODUCTION>
This is a traditional Japanese toy called "OTEDAMA."
When I was a child, I often played with the OTEDAMA.
It consists of a cloth bag containing beans or rice.
Can you all do this? Follow me. Throw and catch like a cat.
最初は１個だけを使って、投げたお手玉を手の甲で弾ませ、猫の手のようにキャッチする。数回繰り返す。
Throw and toss. Drop it. Throw and toss.

次に、一人２個ずつ。１個を投げている間に、もう１個を手の甲に乗せ、投げたお手玉もキャッチする。
Next, divide yourselves into two groups.
Throw and toss, throw and toss, throw and toss. Drop it.
Throw and toss (Did you miss it?).
If you miss it, it's the turn of the next player.
次に、３，４個のお手玉を用いて遊ぶ。（なので、５人グループも２人と３人に分かれて遊ぶことになる。）１個だけを投げている間に、床の１個を手の甲に乗せる。また投げている間に、落とさないように２個目を乗せる。投げている玉をキャッチできなかったり、手の甲のお手玉が落ちたりしたら、交代。

Next, you make a little bridge with your hand.
Pass an otedama under the bridge.
次に、お手玉を投げている間に、手で作った橋の下をくぐらせる。くぐらせられなかったり、玉が落ちたらミス。

<u><2. About a Target Marker and HAYABUSA></u>
Did you find the Otedama game interesting?
In fact, this "OTEDAMA" is deeply related with Japan's Space exploration.

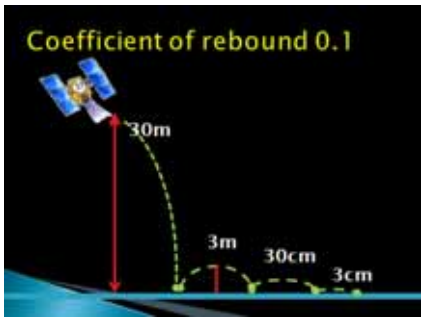
This is the Japanese asteroid explorer "HAYABUSA."
"HAYABUSA" traveled for seven years, and came back to the earth on June 13, 2010.
"HAYABUSA" succeeded in getting some samples from the asteroid "Itokawa".
This sample return mission of returning with samples from the asteroid is the first achievement of its kind in the world.
A detailed investigation of the samples could reveal the secret of birth of the solar system.



This is a Target Marker.
It was used as a mark during the touchdown of Hayabusa on Itokawa and in the sampling phase.
Before the touchdown, HAYABUSA dropped the target marker.
By seeing this “Target Marker”, HAYABUSA could judge the surface speed of ITOKAWA due to its rotation and could land safely.

And this (target marker) was designed not to bounce. This aspect of “not bouncing” is the most important thing that I want to convey to all of you today.
What would have happened had the target marker bounced high?
The target marker would have jumped out and not returned back.
This is because the gravity of "ITOKAWA" is only a few hundred thousandths of the earth.
What would happen if the target marker could bounce normally?
It would not have become stationary on the surface of the asteroid, and the surface movement of Itokawa due to its rotation would not have been known.

The developers of the target marker aimed at a coefficient of rebound of 0.1 or less.
It was planned that “HAYABUSA” would drop the target marker to "ITOKAWA" from a height of 30 meters.
If the coefficient of rebound is 0.1, the height achieved after the first rebound will be 3 m, after the second rebound will be 30



cms, and after the third rebound will be 3 cms.

.

This coefficient of rebound of 0.1 or less is known to be very difficult to achieve under microgravity.

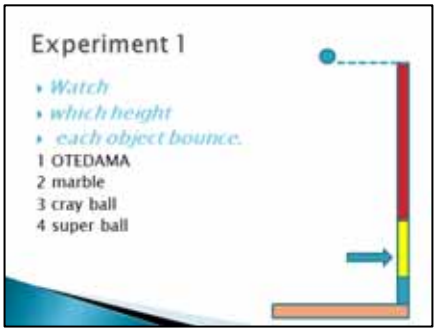
, The merits (strong points) of the "OTEDAMA" were thus adopted.

<3. EXPERIMENT (1)>

Henceforth, this "OTEDAMA" and the plastic ball are dropped at the same time. Watch the bounce.

The plastic ball bounces high. But the "OTEDAMA" does not bounce and remains at the same place.

As a developer, you investigate the bounce of the objects described here.



<4. EXPERIMENT (2)>

There are four objects. A marble, a super ball, a clay ball, and the otedama.

Let us drop these from the top of a ruler.

And watch the height up to which each object bounces. Each ruler is distinguished by a different color such as blue, yellow, and red.

Record the color on this sheet.

You can touch these objects, but please do not test now.

Let us go ahead with these experiments right away!（実験セットを配る）

Let us drop the OTEDAMA first.

Are you ready? 1, 2, 3.

What level does it reach? Blue?　Yes.

The otedama did not bounce. Blue level. (Fill “Blue” in the table）

Next, let us drop the marble.

Did it bounce beyond anticipation?

What level did it reach? Yellow or red?

Yes, between yellow and red.

Next, drop the clay ball.

Are you ready? 1, 2, 3.

The clay ball did not bounce. The level is blue.

Finally, it is the turn of the super ball.

	expectation	result
OTEDAMA	blue	blue
Marble		Yellow red
Clay ball		blue
Super ball		red
(non-bouncing ball)		blue

Did you get the expected result?

It seems that some groups did not get the anticipated result.

I am sorry about that.

I played a little trick and passed a different ball to some groups.

This is the non-bouncing ball and this is the bouncing ball. (落として見せる)

Well, the level of the bouncing ball is red.

Is the level of the non-bouncing ball blue?

Do you want to touch each ball?

Yes. （弾性ボール、非弾性ボールの両方を全グループに渡す）

We have some time, so you all can touch and drop the balls.

5.「弾む・弾まない」について

Look at this chart regarding the result.

The marble and the super ball bounced high.

The clay ball, the OTEDAMA, and this non-bouncing ball hardly bounced.

As far as bouncing is concerned, the characteristics of the material are important.

Marble is very hard, but the super ball is elastic. The clay ball is very soft and non reversible.

Usually, the non-bouncing ball is elastic, but it is made of special rubber that becomes hard at fast speed.

Not only the characteristics of the object but also the characteristics of the surface on which it bounces are very important for the bounce.

The surface we used today was hard tile, and it has bouncing properties.

I change the surface to a wooden board or a corkboard from the hard tile. (次の表を掲示)

	Terra cotta	wood	corkboard
OTEDAMA	blue	blue	blue
Marble	Yellow red	blue	yellow
Clay ball	blue		
Super ball	red		
Non-bouncing ball	blue	blue	yellow

How will the bouncing of the object change? For example marble ……（木の板、コルクボードに落下させる。）

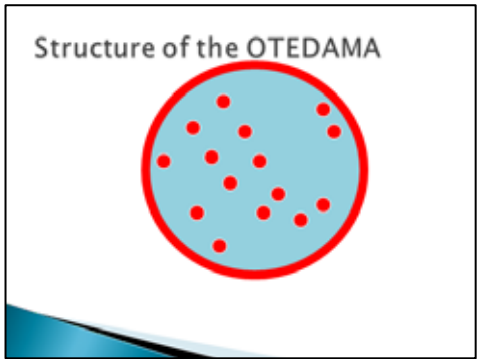
For example, the non-bouncing ball…….

But the OTEDAMA does not bounce on any surface.

６.「お手玉構造」と弾まない理由

Well, I want to explain the structure of the OTEDAMA.

Please watch this figure.



Beans are contained in a cloth bag.
When the OTEDAMA falls, beans collide inside the bag.
The energy for bounce turns into thermal energy.
So the OTEDAMA does not bounce.

If you put some marbles into a bag, it will have the same structure as an OTEDAMA.
Put 10 marbles into a zip bag. This is an easy OTEDAMA structure. Bouncing might stop due to the collision.
Let us do this in a group.

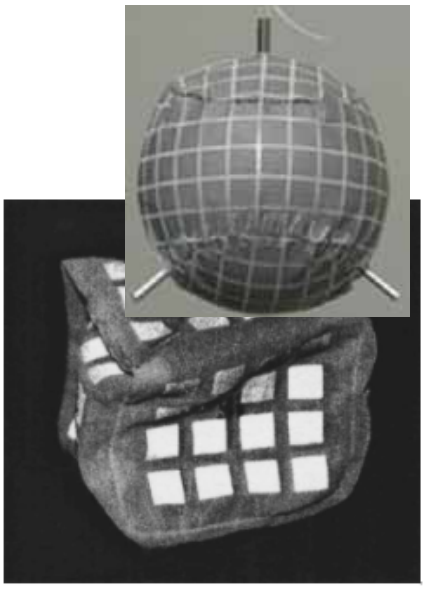


Fig. 7 Photograph of TM (prototype).

< 7 . The real Target Marker >
This is an actual target marker.
It is in the form of a ball and is not a bag like an OTEDAMA.
4 "Horns" are attached so that it may not roll.
And this is a prototype (initial model) of the Target Marker.
Its cloth bag was heat resistant. However, a cloth bag was not used. This was because it was found that due to distortion of the form of the cloth bag, the internal collision does not occur properly resulting in high bouncing under microgravity.
Finally a capsule of aluminum containing polyimide beads was used as the target marker.

Next let us make a structure by using this plastic ball and marbles. Please put in ten marbles like this. （見本を見せる）
Close tightly such that it does not open. （プラスティックボールカプセルは半球をカチッとはめる。）Seal the outside with a vinyl tape.
Closely observe the situation of an internal collision of an OTEDAMA.
The inner collision is smoother than when a zip bag is used.

Now I want to speak to you about the Target Marker.
The Target Marker is.....

1. a mark for measuring in the lateral direction. (Particularly used for measuring the surface speed due to the rotation of Itokawa.)
2. in a globular form to enable easy viewing by

Hayabusa due to the same conditions in any state of collision.
(By putting a flash on the target marker, Hayabusa could locate the target marker on the surface of the asteroid.)

3. strong material to enable use in the severe space environment.
   (A clay ball and non-bouncing ball do not bounce but cannot be used.)
4. as light as possible.
   (All objects carried by HAYABUSA had strict weight limitations.)
5. a dream ball for 880 thousand people.
   (The target marker has been signed by 880,000 people and landed on ITOKAWA before HAYABUSA's touchdown.)
6. a non-bouncing structure like an OTEDAMA.
   (Hope you all have understood the unforeseen relationship between the Otedama and space exploration!)

<8. Let us make a Target Marker>

Next, let us make target marker for you.
By adjusting the quantity of pellets, let us aim at a target marker that does not bounce much. While adjusting the quantity of pellets, bounce on a table to confirm the condition.
Let us mark a temporary stop at about two or three places with a vinyl tape because it would not be good if the capsule opened.
When you find a quantity that is good enough, stick the circumference firmly with a vinyl tape.

If pellets are put in up to the limit in this way (見せる show), will the target marker bounce or not?
You can check here. Also take the reason into consideration.
Hope you enjoyed! Thank you.