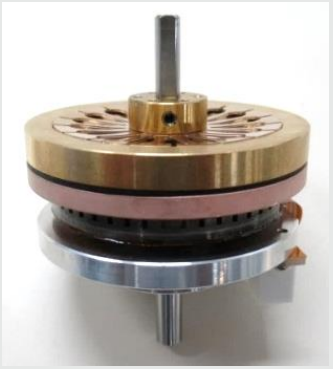
USM (**U**ltra**s**onic **M**otor) Features

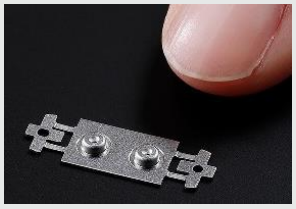
USM is the piezoelectric actuator and has the following features.

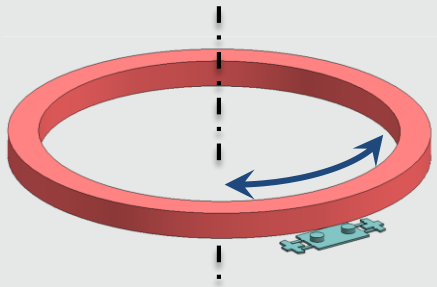
High-speed, compact, quiet linear drive

Driving in a strong magnetic field environment

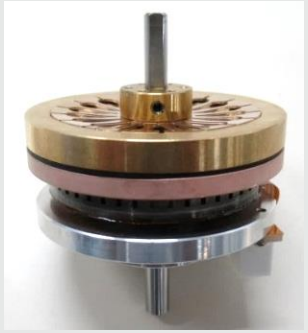


High-speed, high-response, quiet, and compact rotary drive



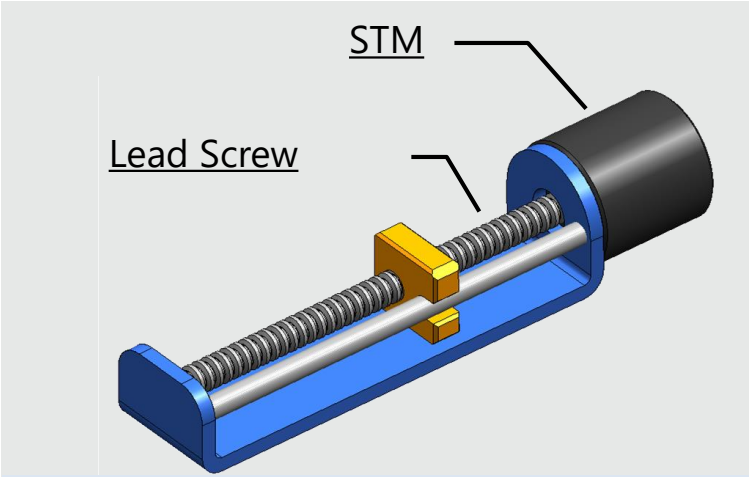


High holding force without energization



Proposal of high-speed, compact and quiet linear drive

Example Configuration of Stepper Motor (STM)+ Lead Screw

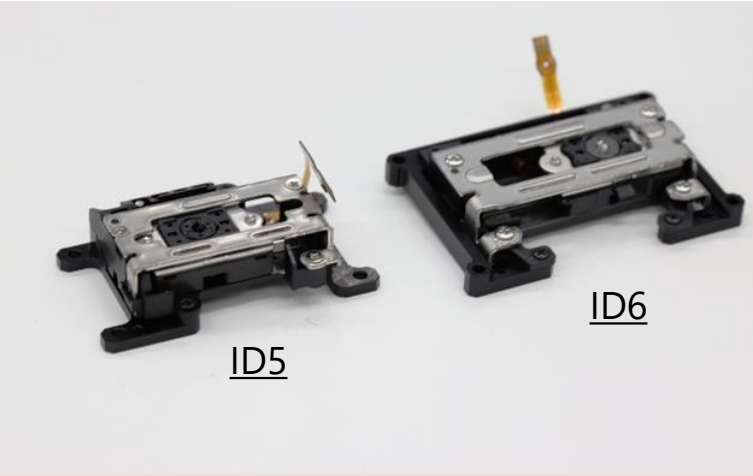


Potential Challenges

- Loud driving noise
- Low in speed

Linear USM

- ID5, ID6



Linear USM has no linear conversion mechanism and can be driven directly and linearly.

Achieves high-speed, quiet driving and downsizing

Example of Lens drive: Comparison of USM and STM

USM

EF-S 18 -135 mm F 3.5 -5.6 IS USM
(Linear USM)

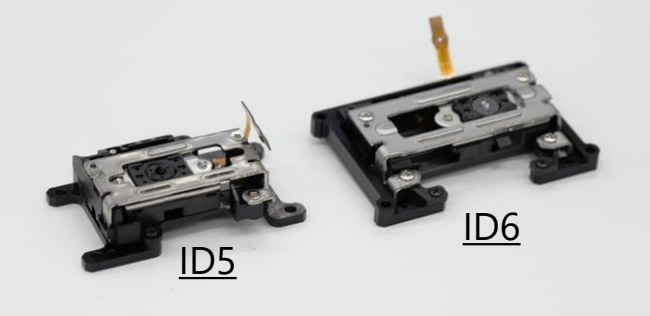
EF-S 18 -135 mm F 3.5 -5.6 IS STM
(STM + Lead Screw)

Auto Focus Performance Comparison Movie (Click Image)
https://www.youtube.com/watch?v=22RseNMLrh0

Approximately 2.5 to 4.3 times faster with linear USM

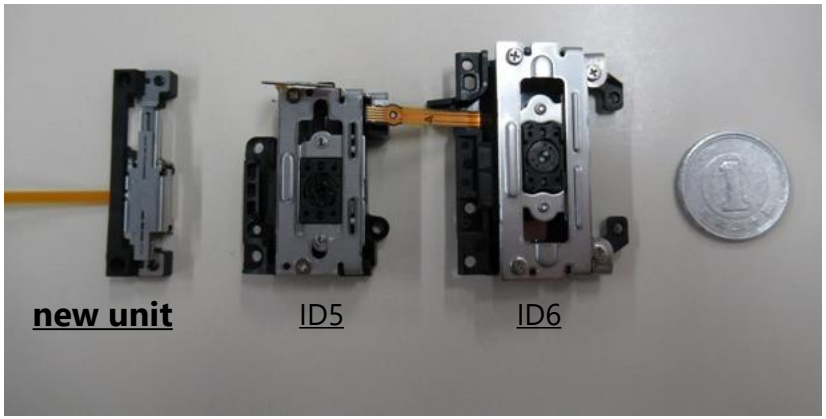
*Comparison with AF speed of STM mounted lens

Example of Custom Response: Proposal of New Small Linear USM Unit

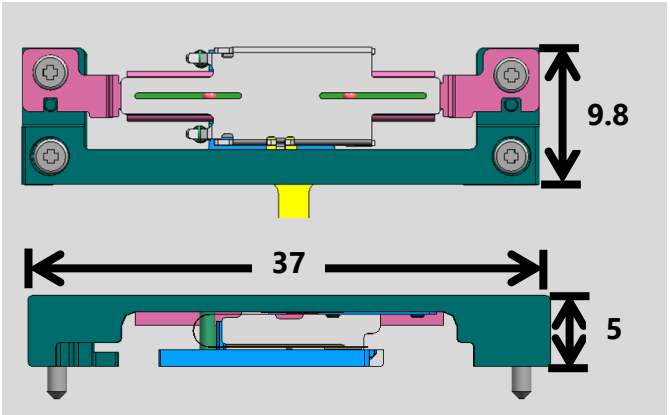


In addition to ID5 and ID6 units (existing lineup) used in Canon lenses, new USM units and drive circuits can be developed for further downsizing.

Custom Example: New Small Linear USM Unit



Appearance of the new unit

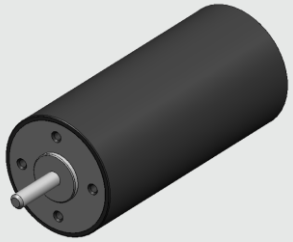


Unit CAD drawing
(Width 9.8mm x Length 37mm x Height 5.0mm)

Proposal of driving under strong magnetic field environment

MRI apparatus
(Example of a strong magnetic field environment)

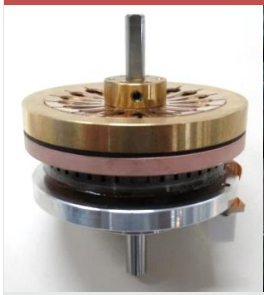
Electromagnetic motor



Possible challenges (under MRI environment)

- Since a magnet is used, it cannot be driven in principle in a strong magnetic field such as under MRI environment.
- It is aspirated into MRI.

USM (non-magnetic type)



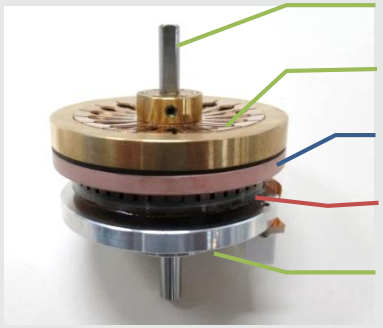
Non-magnetic S50

Non-magnetic circuit

- USM can be driven in principle even in a strong magnetic field.
- In addition, the use of a non-magnetic materials prevent aspiration in a strong magnetic environment such as MRI.

Estimation of pull force and experimental results of drive circuit

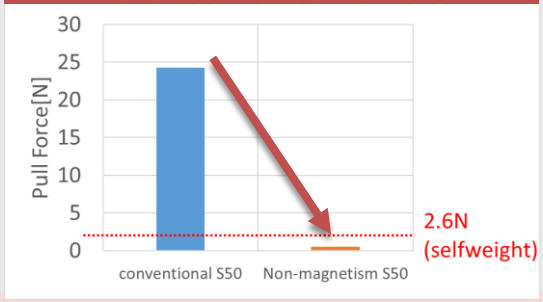
Non-magnetic S50



Shaft
Pressure spring
Rotor
Stator
Bearing

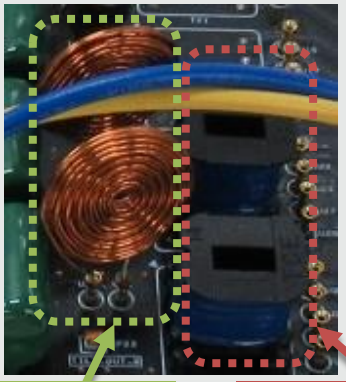
Use of non-magnetic materials

Pull Force @ 1T



The pull force is less than motor weight, 2.6 N

USM drive circuit (high-field correspondence)

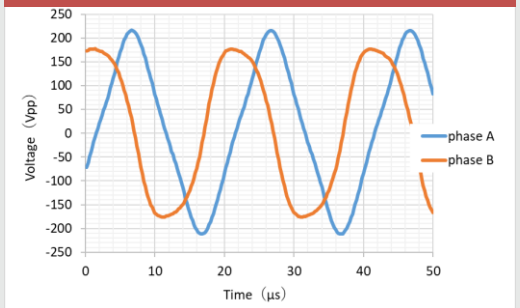


Air core coil

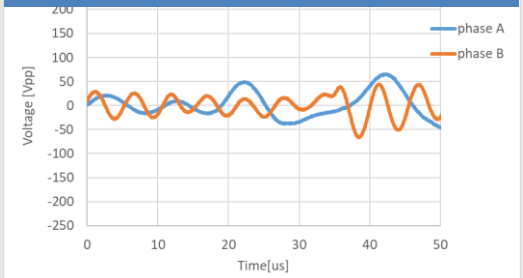
Air core transformer

Drive USM after bringing the magnet closer

Supported Product@ 600 mT

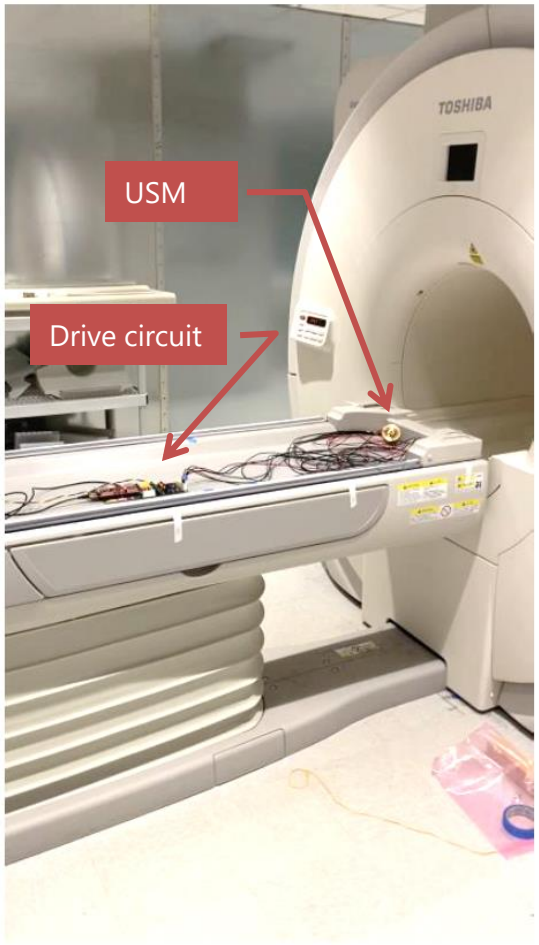


(Reference) Non-supported Product @ 403 mT

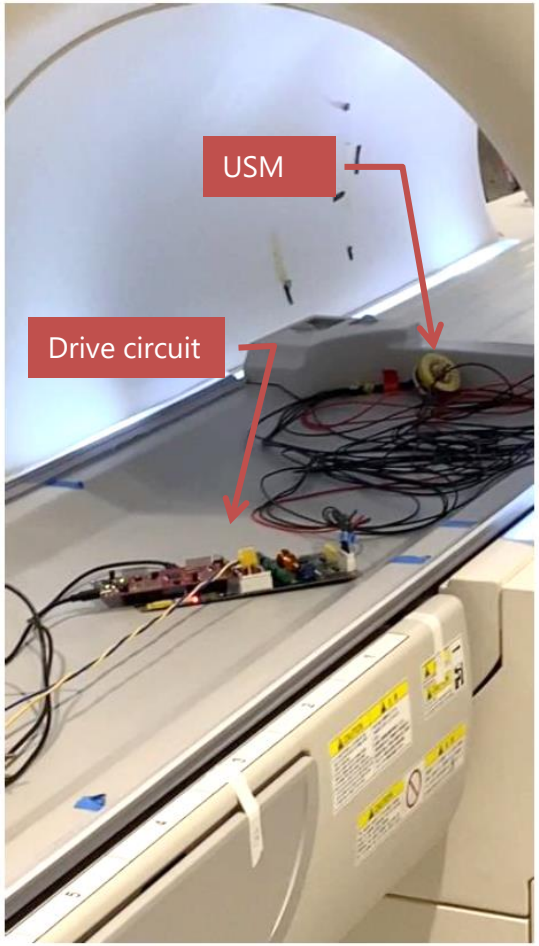


High magnetic field supported product does not disturb waveform and can drive USM

Experimental results under MRI environment



Near MRI bore (1T)

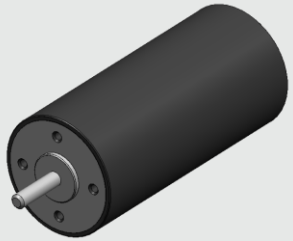


Inside MRI bore (3T)

- USM can be driven under 3T MRI environment.
- Not pulled by MRI.

Proposal of high-speed, high-response, quiet, and compact rotary drive

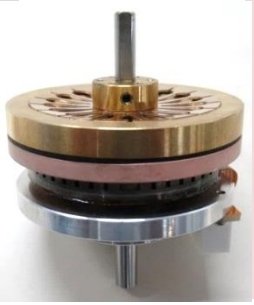
Electromagnetic motor + reduction mechanism (gear reduction or belt drive)



Potential Challenges

- Responsiveness is reduced due to the backlash of the deceleration mechanism.
- The drive noise from the gear is loud.
- The size of the drive system including the deceleration mechanism becomes larger and heavier.

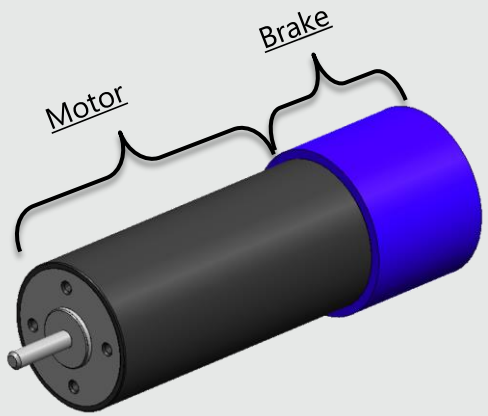
USM



- Since it can be driven directly without the need for a deceleration mechanism, it can be driven quietly with high speed and high response.
- Since there is no deceleration mechanism, downsizing and weight reduction can be realized.
- Linear USM can be rotationally driven by devising its structure.

Proposal of high holding force without energization

Example of electromagnetic motor + brake configuration



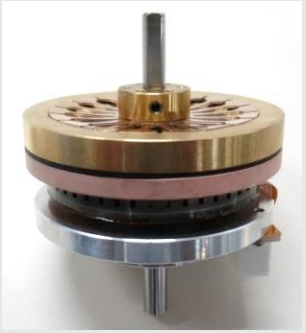
Upsizing with electromagnetic brake

Configuration example in which servo is always applied in VCM

Increasing temperature and power consumption

USM

Linear USM



Rotary USM

- Since the driving force generating portion is held by frictional force, high holding force can be maintained even when no power is supplied.
- Since no brake is required, downsizing is possible.
- Since it can be held without energization, there is no increasing temperature or power consumption during holding.