

New Tuners for ILC Cavity Application

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Outline

- ◆ Brief Introduction
- ◆ New Tuners for ILC Application
 - Elliptical Cavity
 - Pulsed Operation
 - High Gradient
 - Lorentz Detuning Compensation
 - (Cavity Deformation by Maxwell Stress)

Frequency Tuner

- ◆ RF Accelerating Cavities usually have Tuners.
- ◆ They are used to tune the Cavity Resonance Frequency, in order to minimize the reflected RF power, usually.
- ◆ Tuning Accuracy $\ll$ Resonant Band Width
- ◆ They must cover the Wide Range of the Fabrication Error.
- ◆ Feed-back can be used in CW operation.

Possible Error Sources

Error Sources	Magnitude / Bandwidth	Speed
Fabrication Error	Very Large	Static
Drift (Temperature, Pressure)	Comparable	Slow
Micro-Phonics (Vibration)	Small	Slow
Beam Loading (if ϕ is not 0)	Comparable	Slow
De-tuning Offset	Comparable	Offset
Lorentz De-tuning	Comparable	Fast in Transient

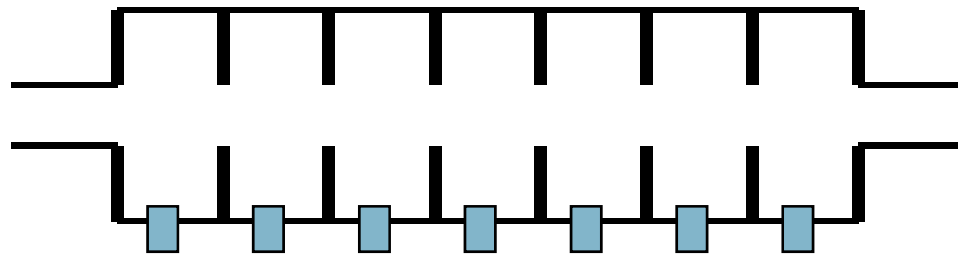
Tuning Principle : by Slater

Volume Change of $\Delta V \rightarrow$ Frequency Change of Δf

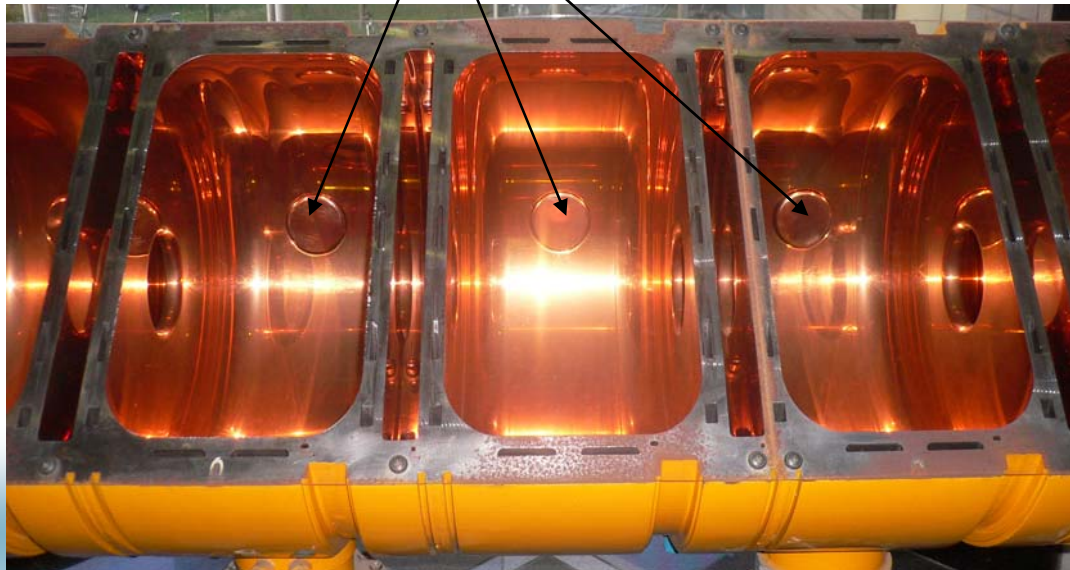
$$\frac{\omega^2}{\omega_0^2} = 1 + \frac{\int_{\Delta V} (\epsilon E^2 - \mu H^2) dV}{2W}$$

$$\frac{\delta f}{f_0} \approx \frac{1}{4W} \int_{\Delta V} (\epsilon E^2 - \mu H^2) dV$$

Normal Conducting

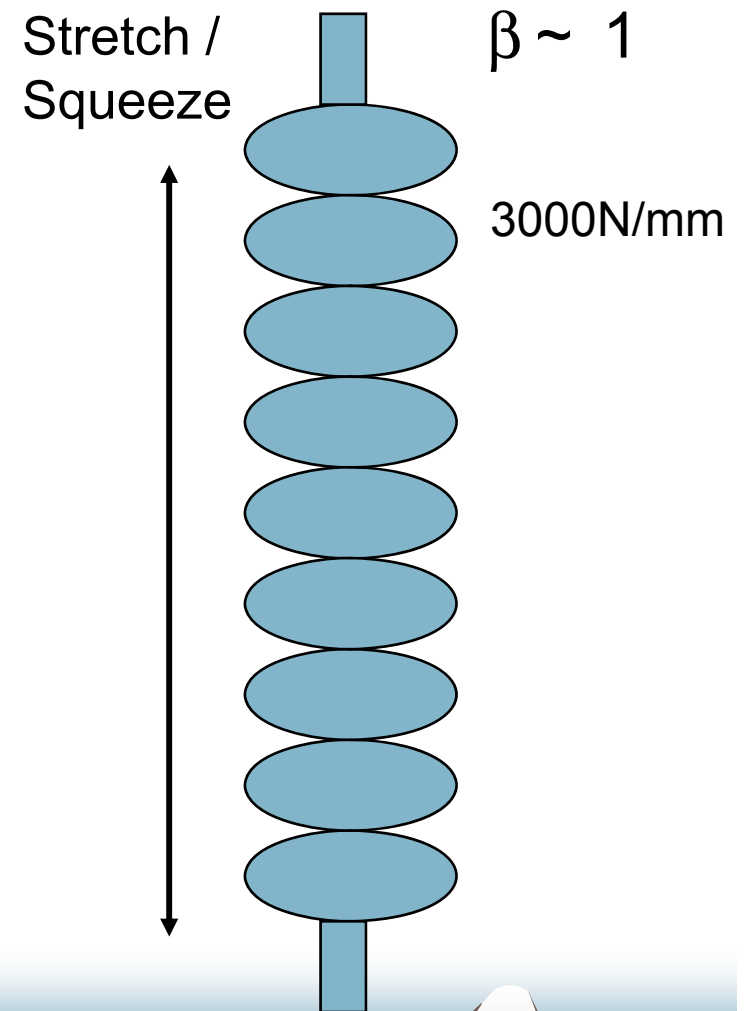


Piston Tuners



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Superconducting



New Tuners

Several Candidates for the ILC Cavity

Requirement

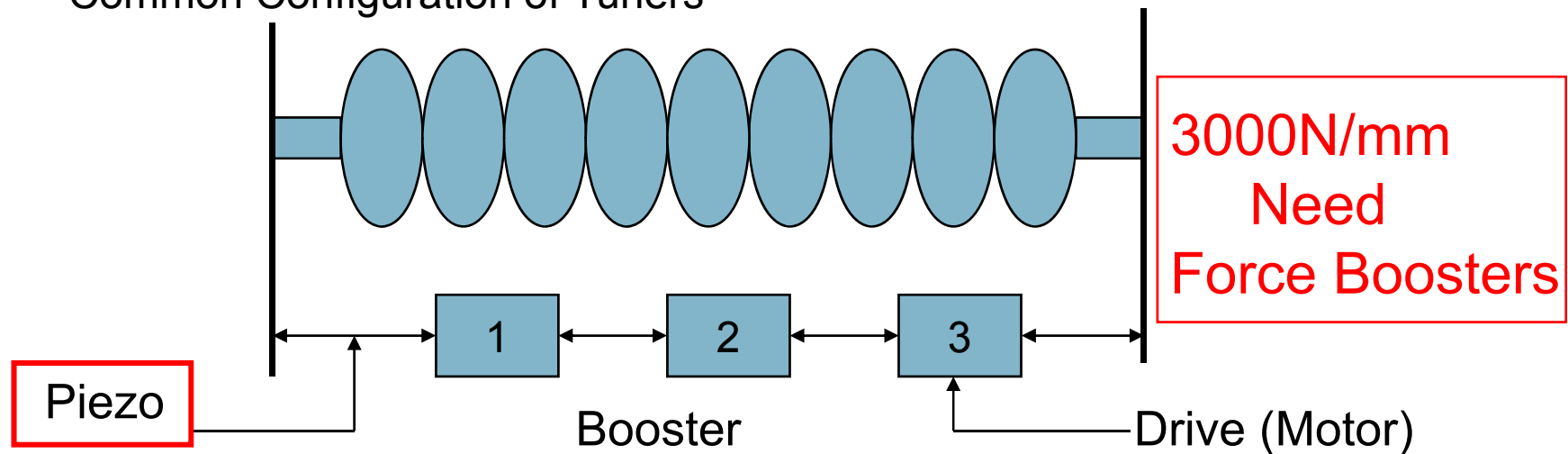
Stroke $> 2\text{mm}$, Axial Force $> 6000\text{N}$

It must not move the Beam Axis.

Compact and Reliable

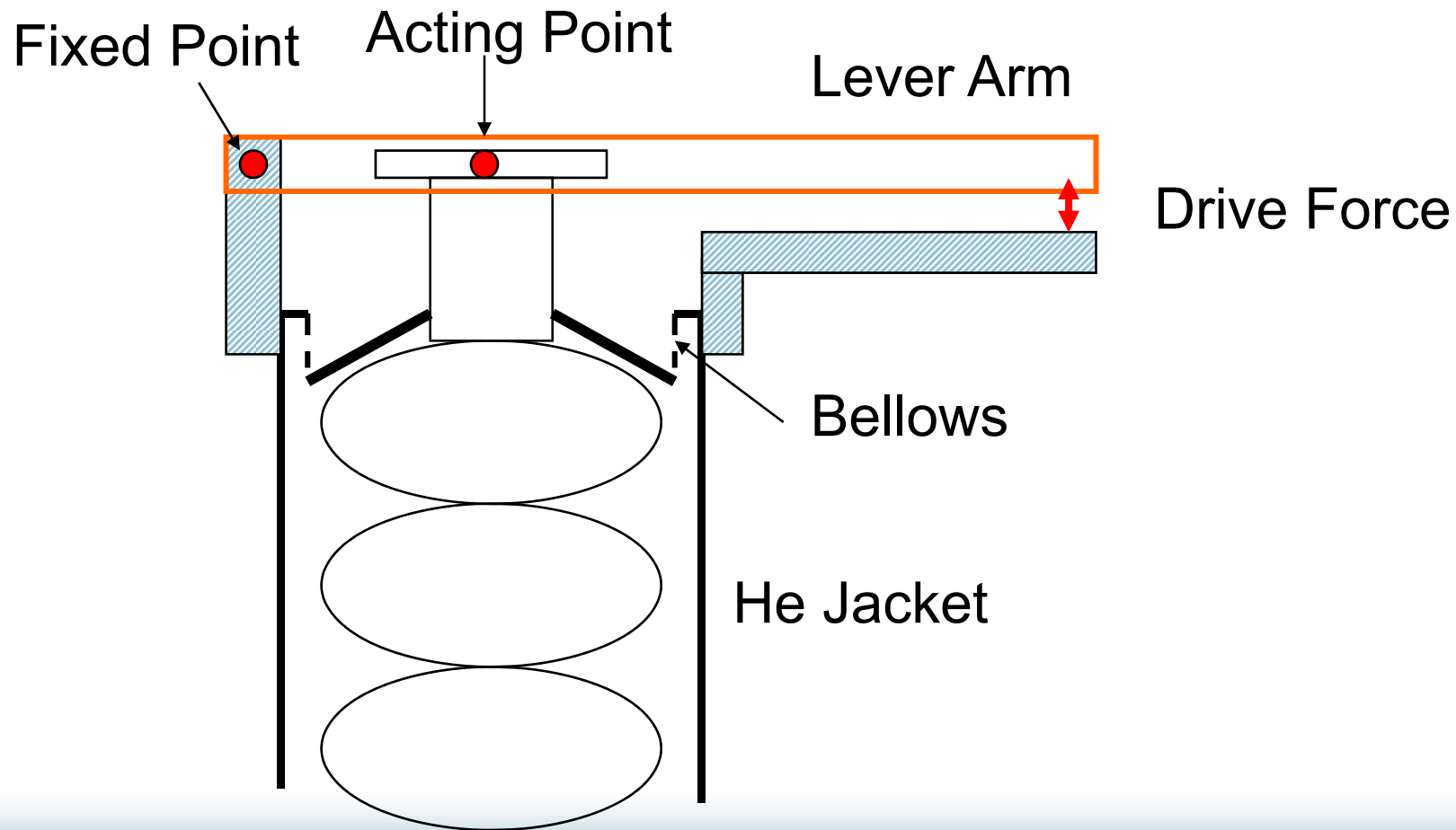
Fast Response $\rightarrow$ Piezo

Common Configuration of Tuners

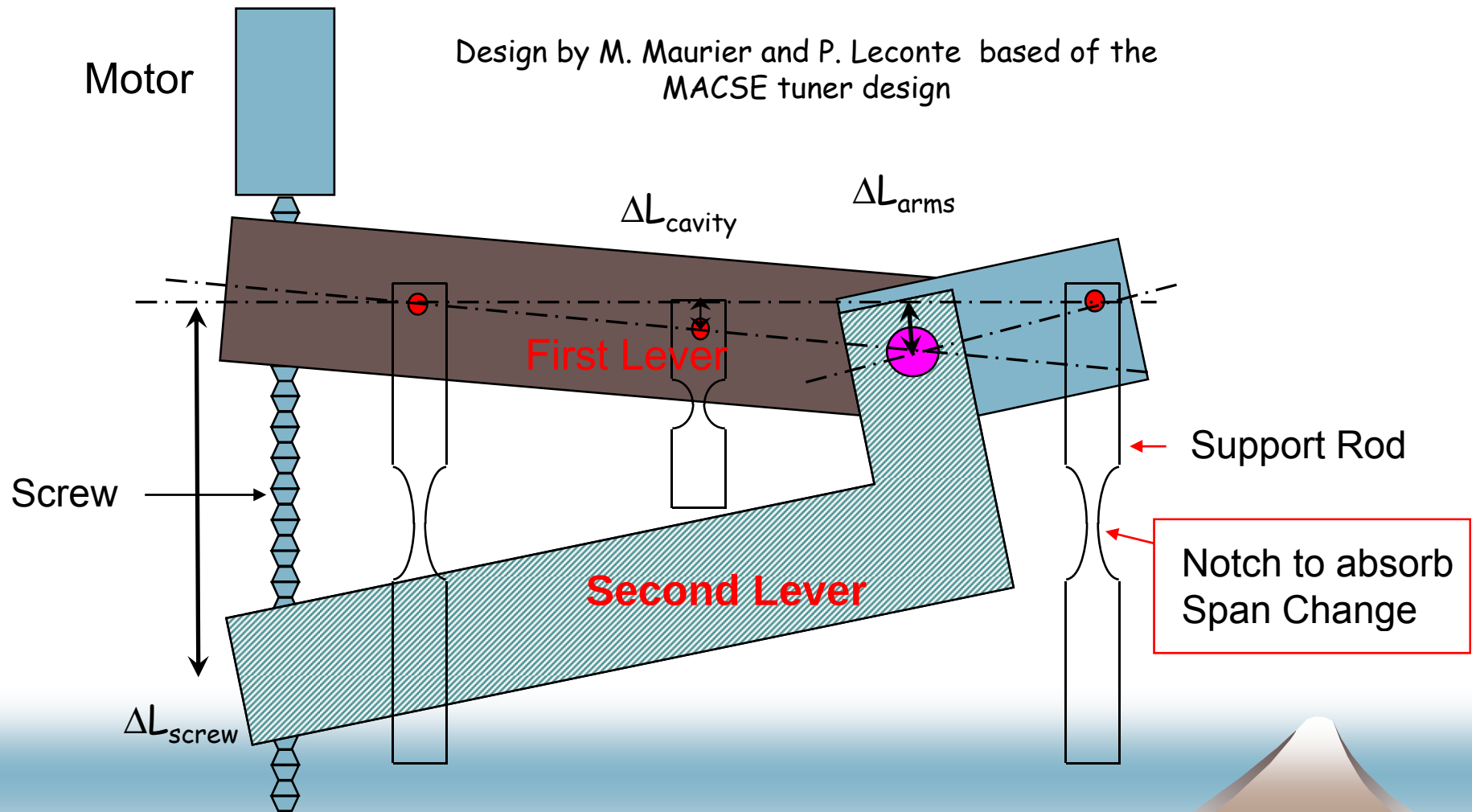


Tuner	Booster-1	Booster-2	Booster-3	Experience
Saclay-1	Lever	Lever	Screw	TTF
Saclay-2	Cam & Lever	Screw		Under Test
Blade	Blade	Lever	Screw	Under Test
Ball-Screw	Large Screw	Worm Gear	Worm Gear	Under Test
Slide Jack	Wedge	Screw	Gear	Under Test

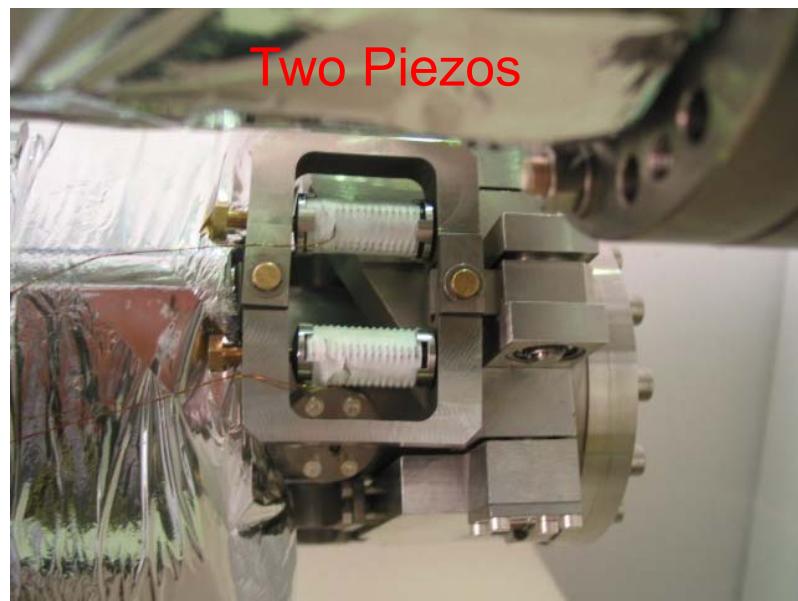
Lever



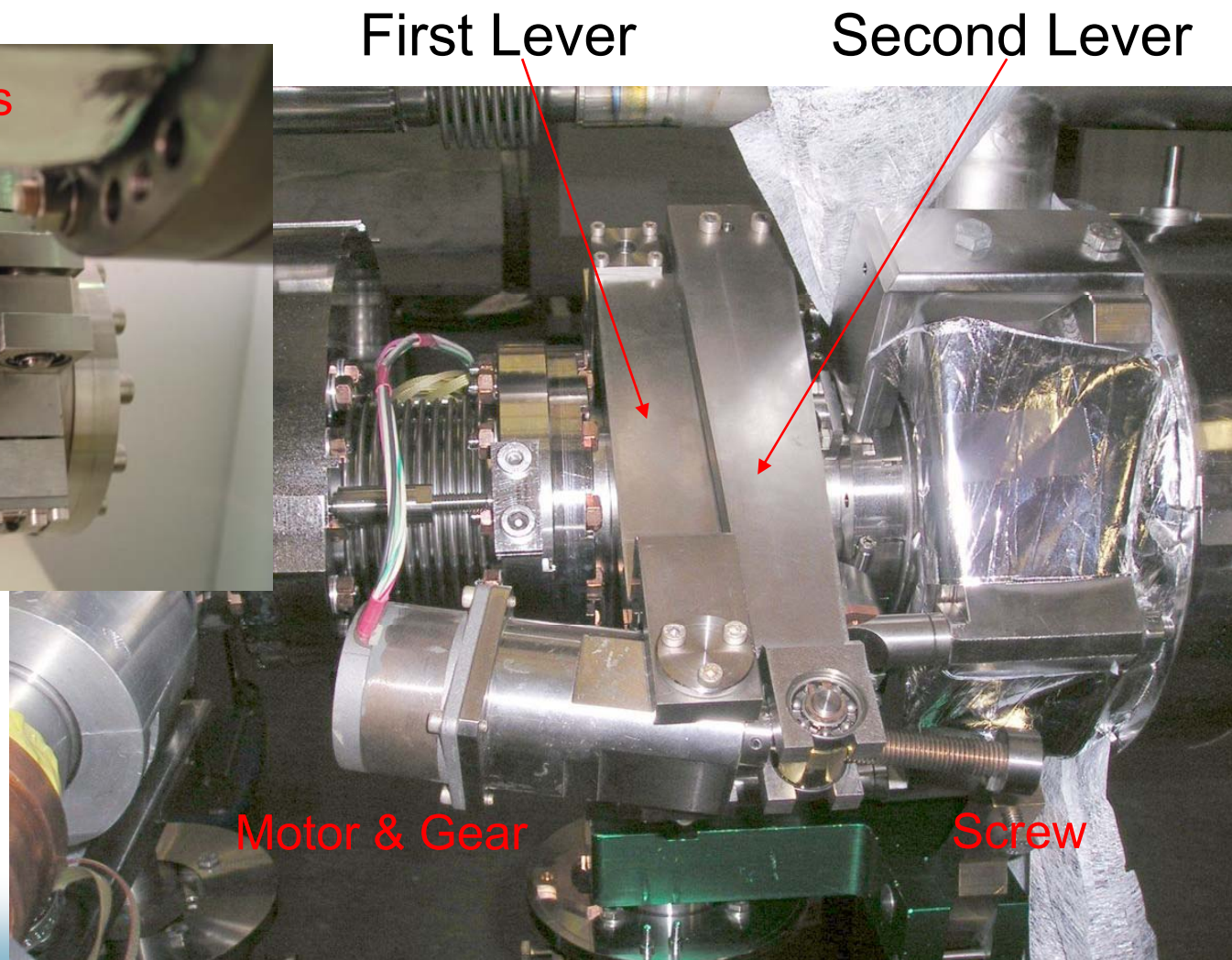
Saclay -1 : Operation Principle



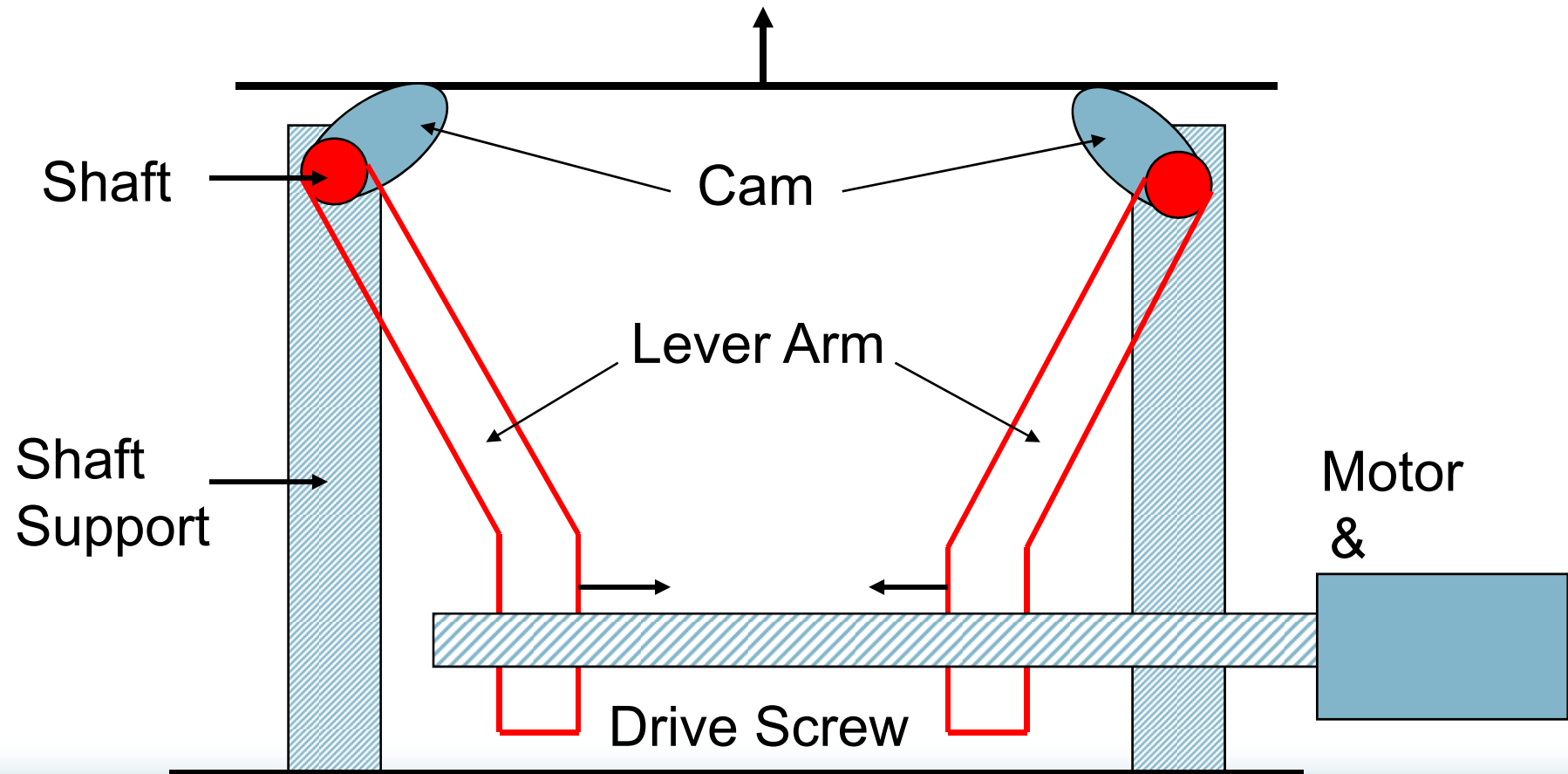
Saclay-1 on a TTF Cavity



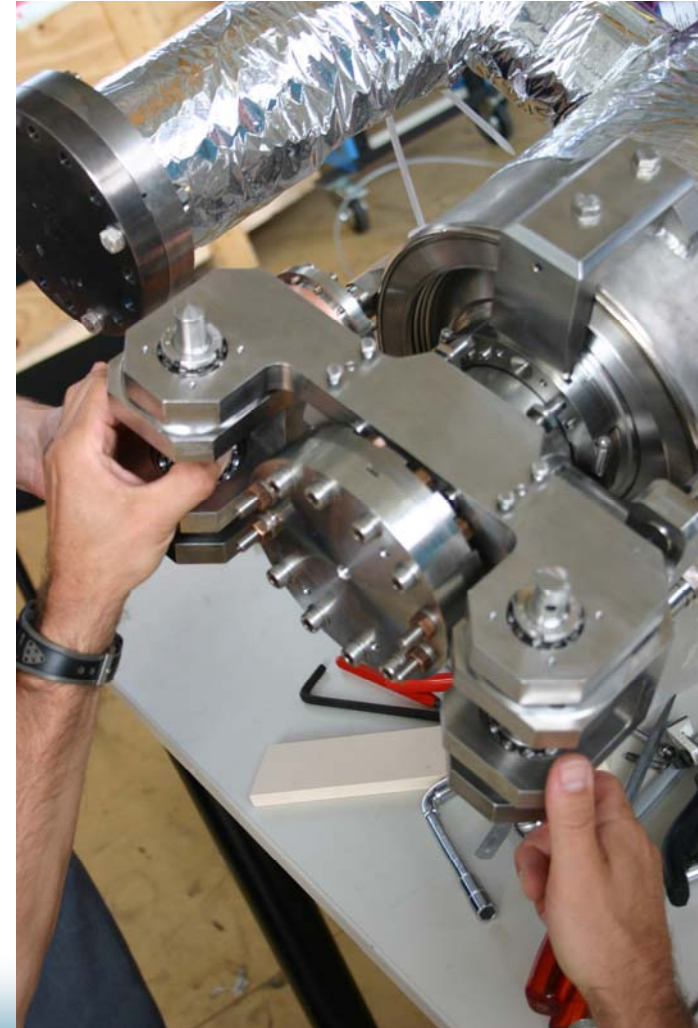
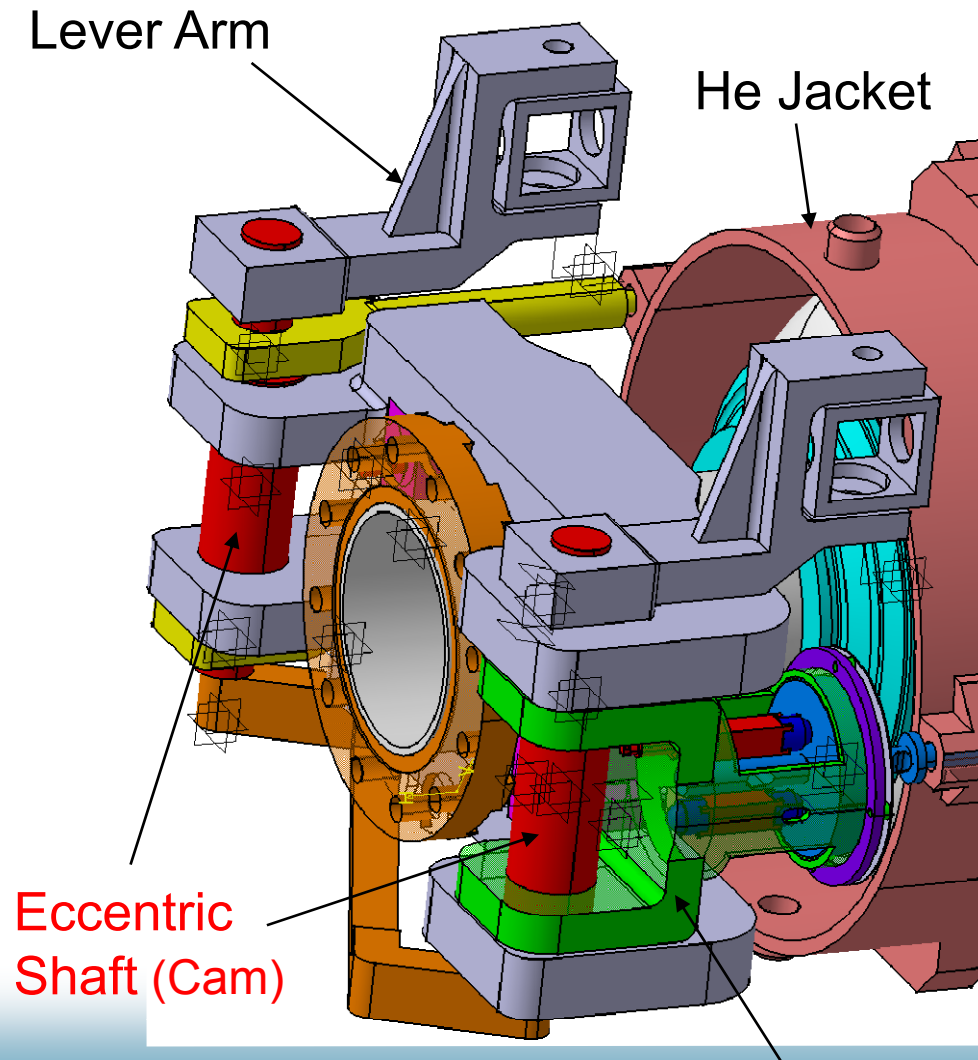
Double Lever
Tuner Stiffness
 $\sim 100 \text{ N}/\mu\text{m}$



Saclay – 2 : Cam & Lever

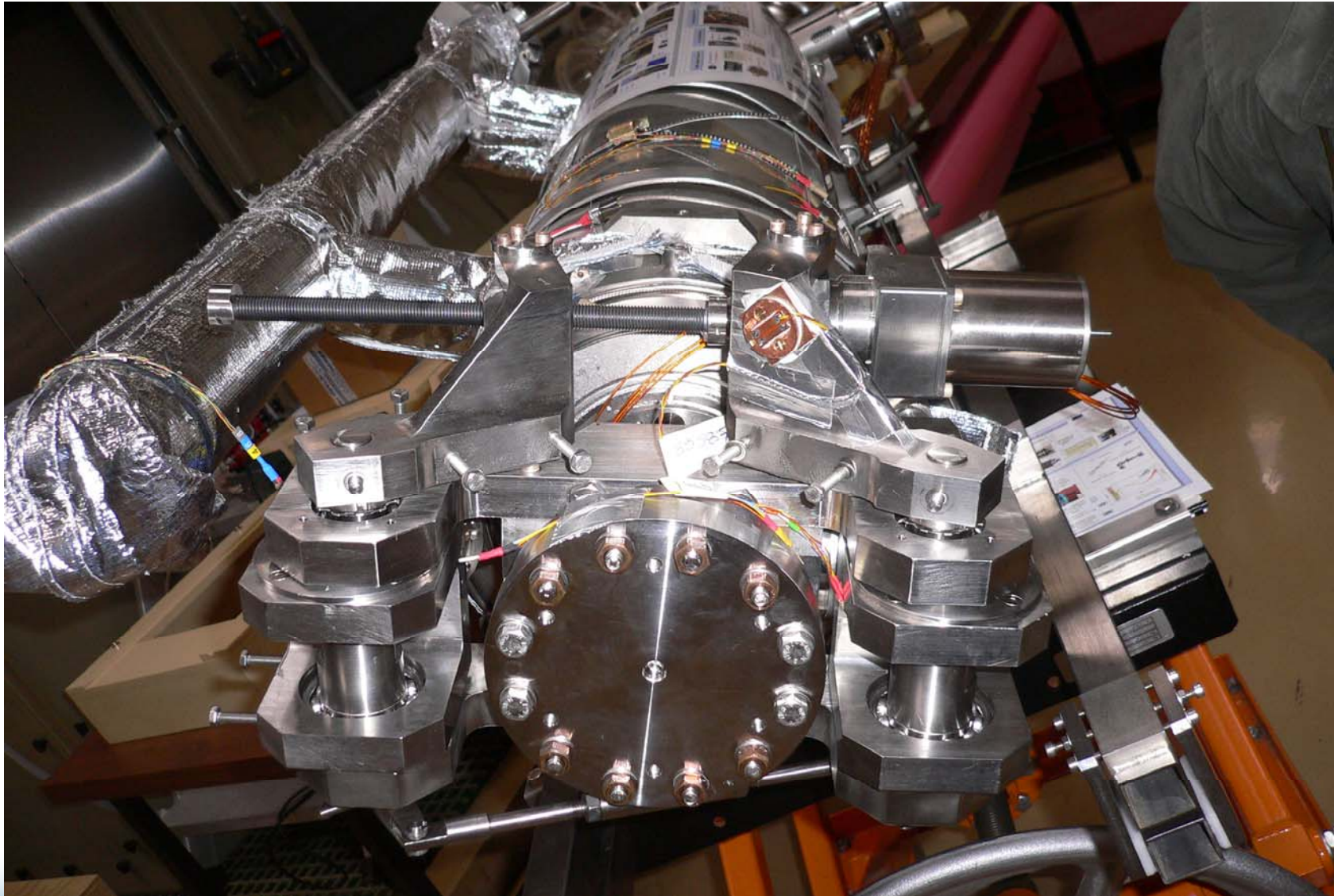


Saclay - 2 : Cam & Lever

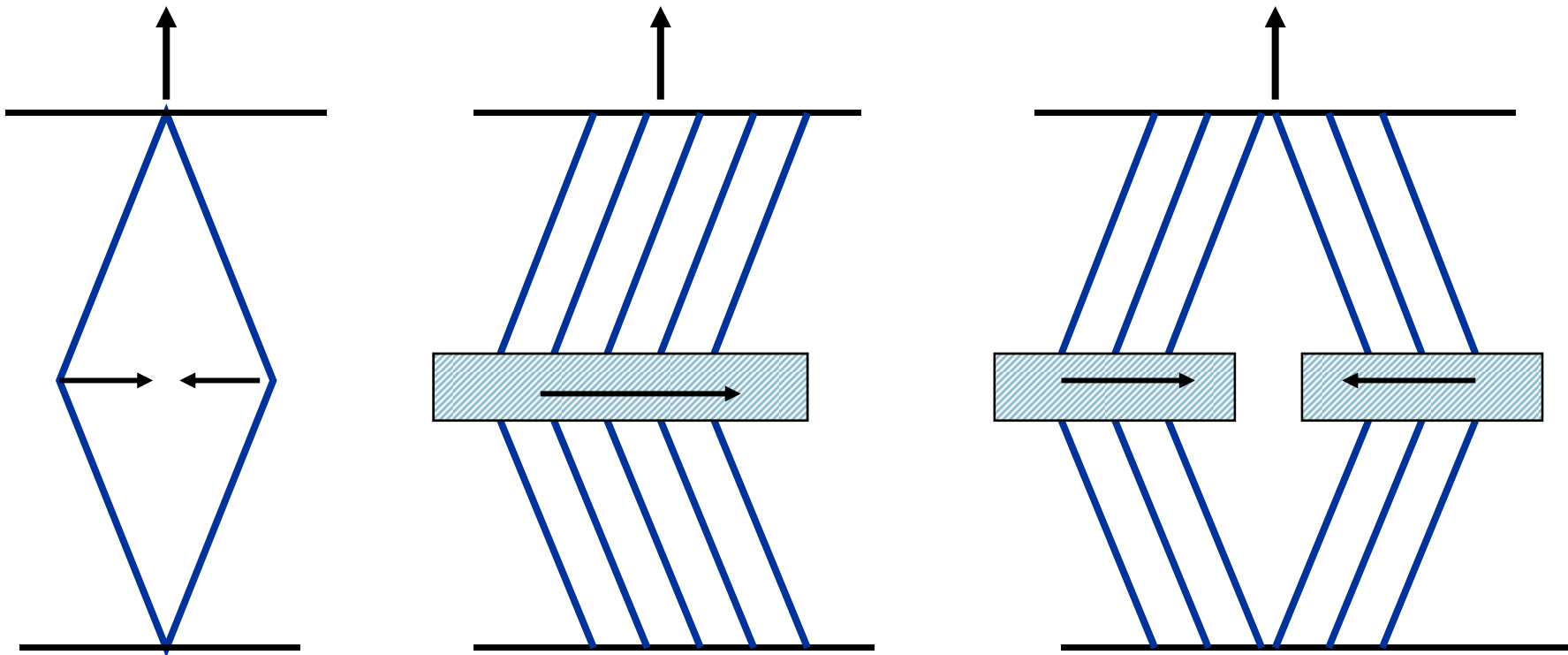


Shaft Support with Piezo

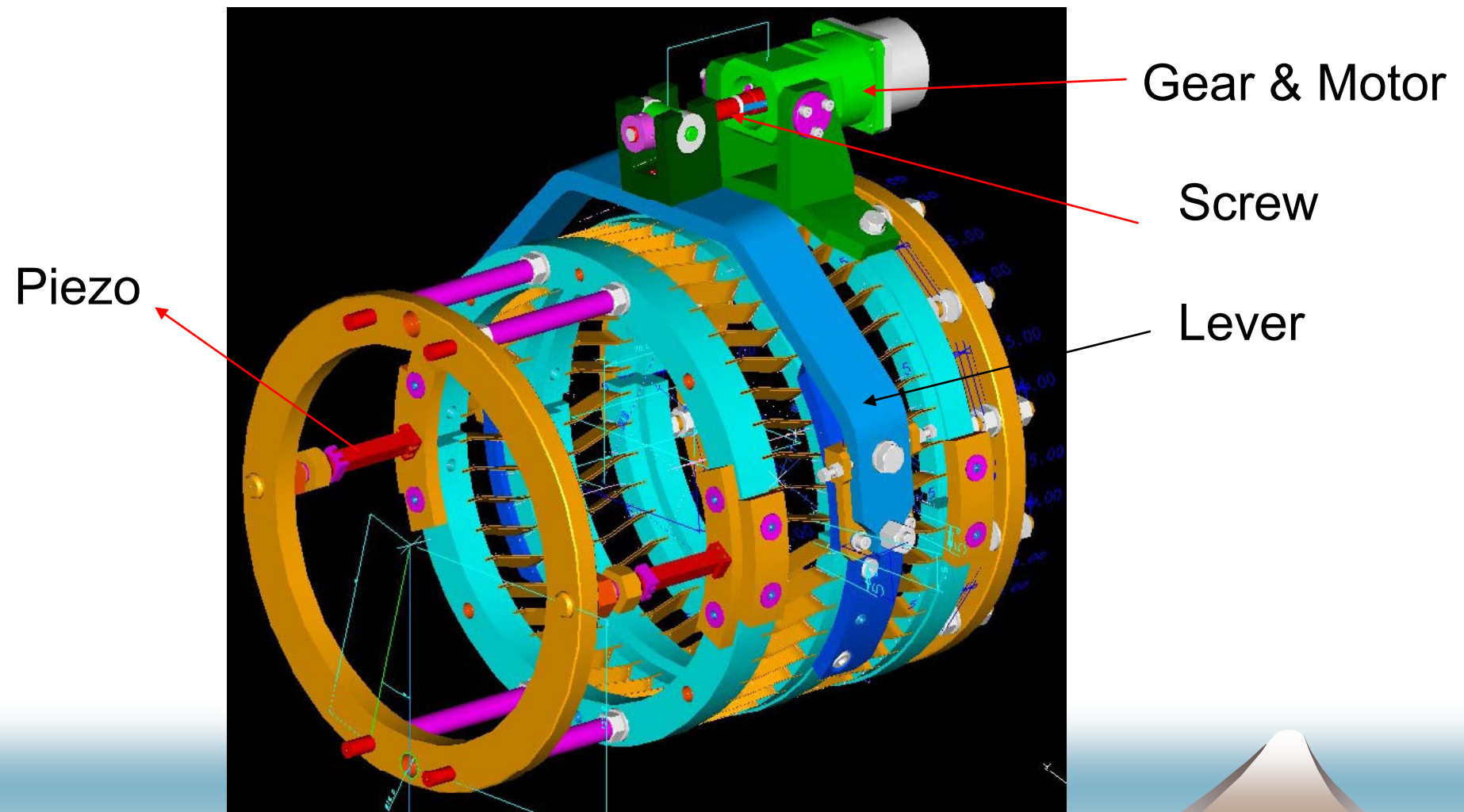
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Blade : Jack System



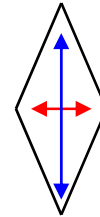
Blade : Jack, Lever & Screw



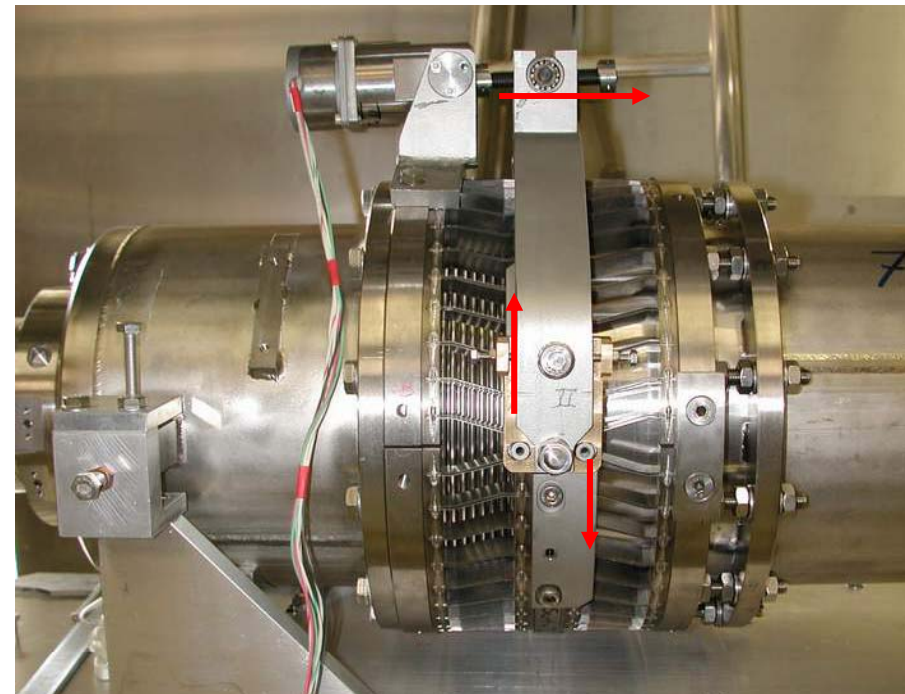
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Blade Tuner 25 N/ μm

Not Stiff, Fatigue of Blade, $K_s=13\text{N}/\mu\text{m}$

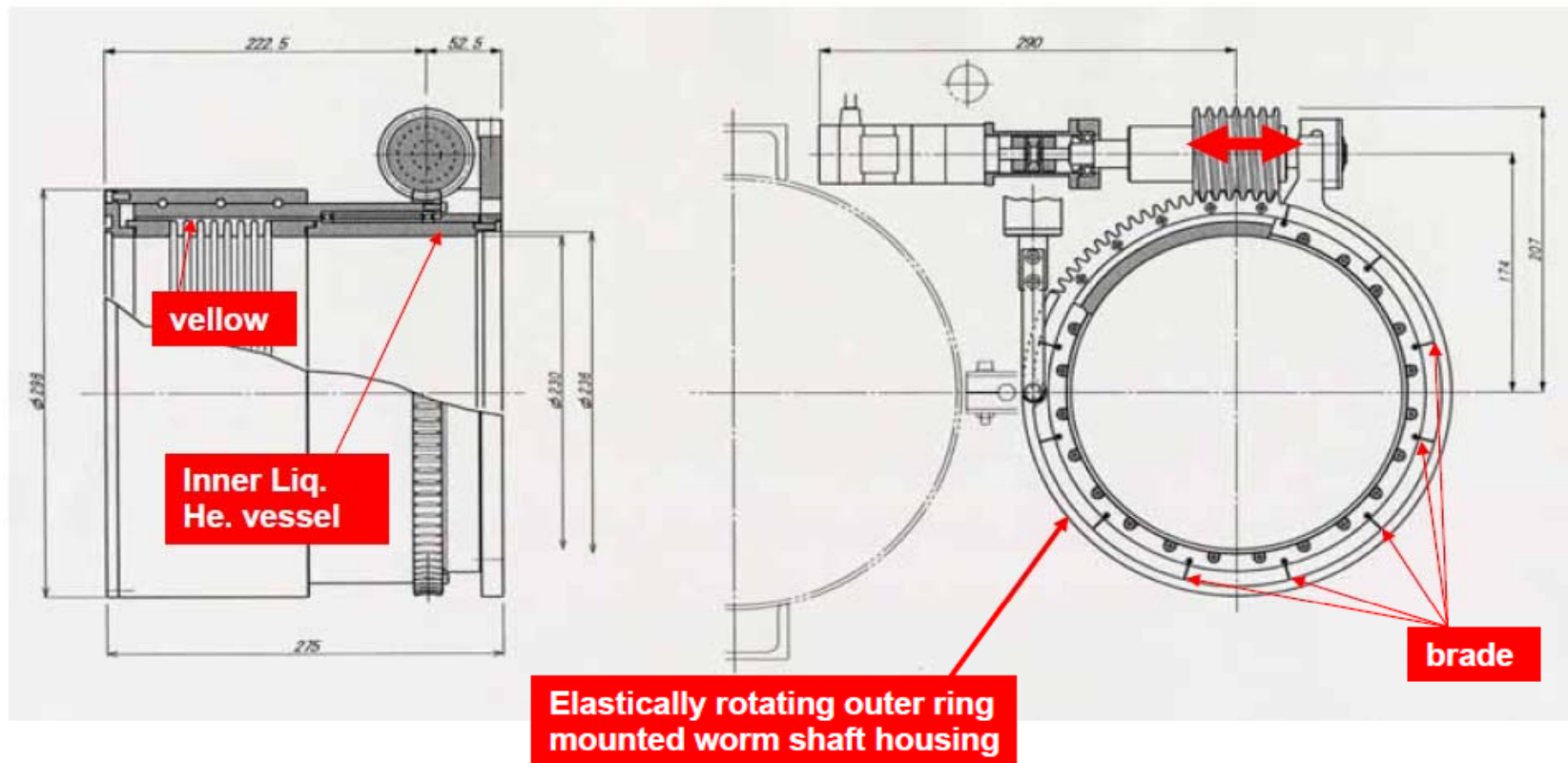
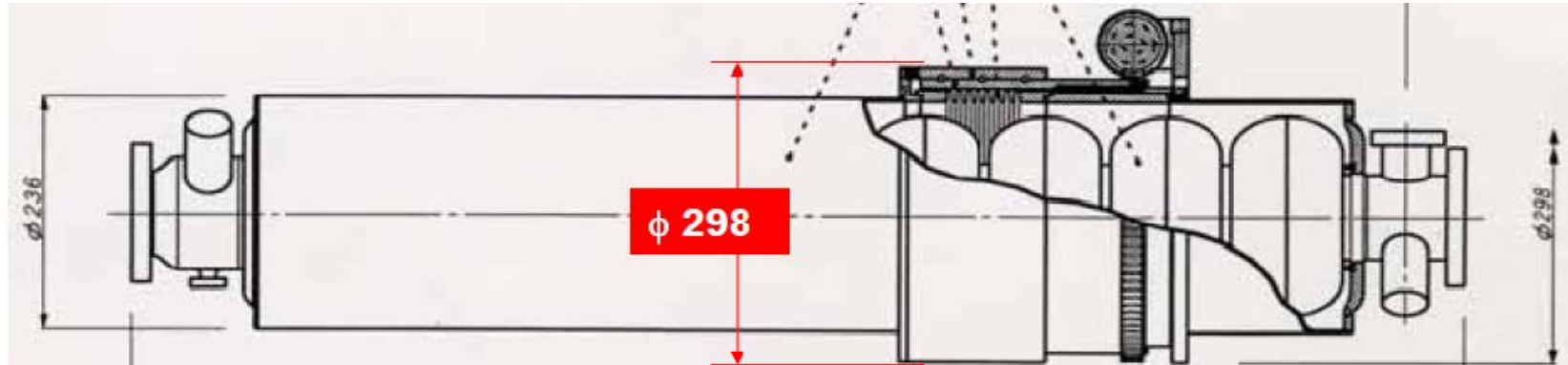


Original DESY



Revised INFN

Ball Screw : Large Ball Screw



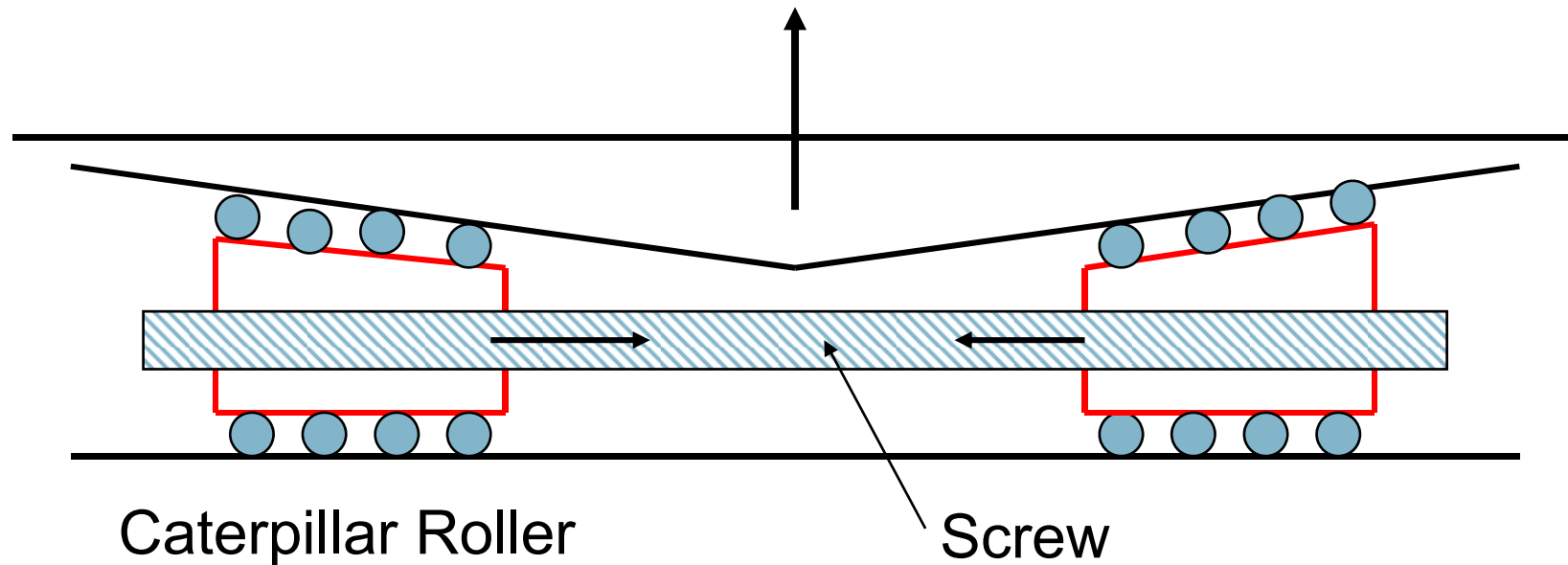
Coaxial Ball Screw 500N/ μm

Need Long Stroke Piezo, Fatigue of Blade

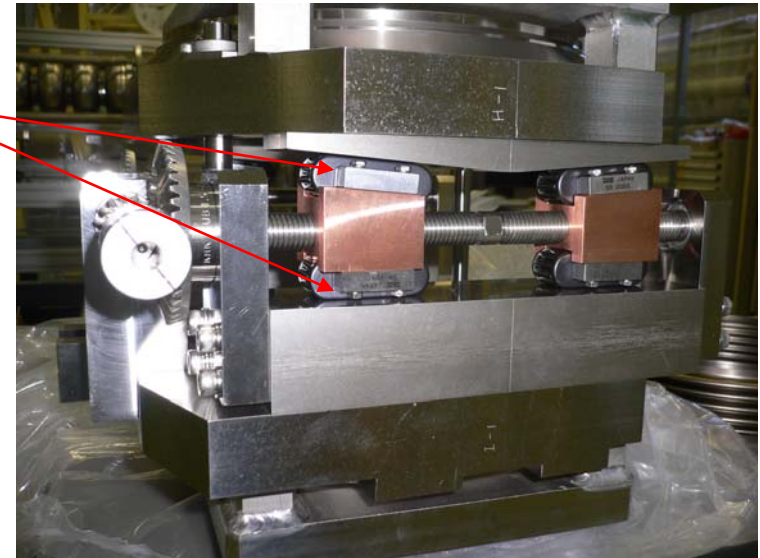
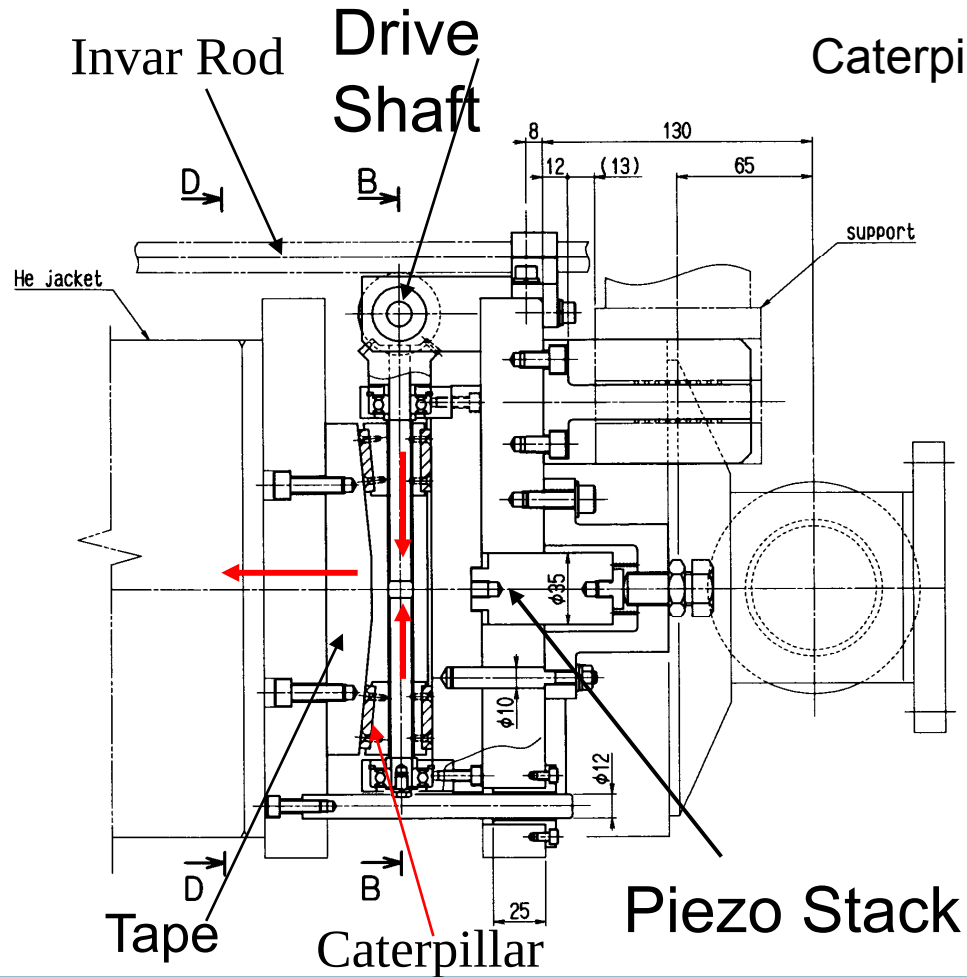


Slide Jack Tuner

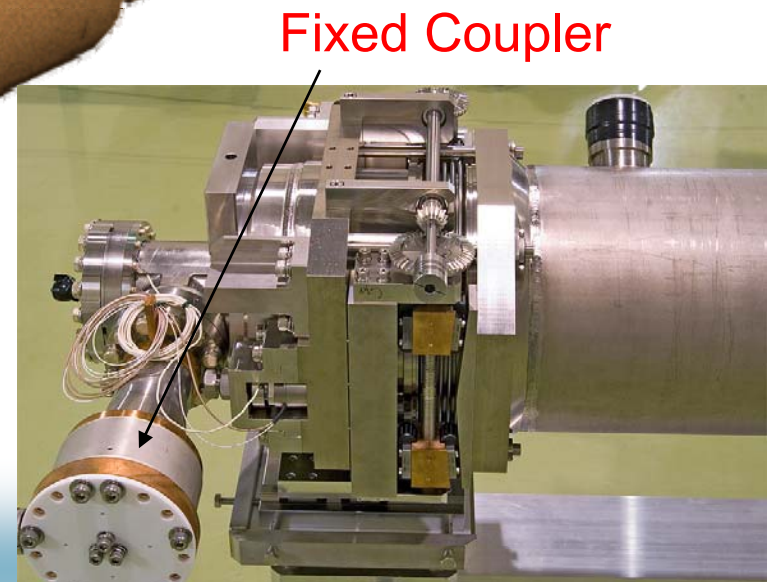
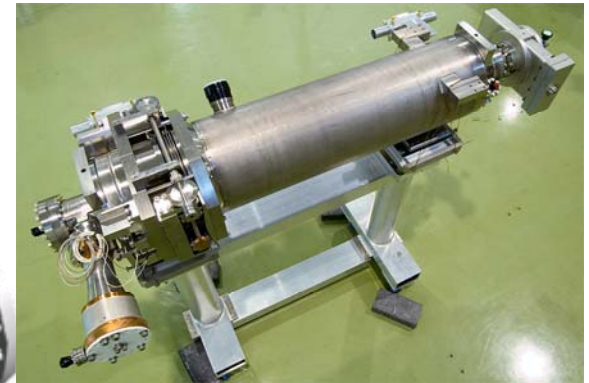
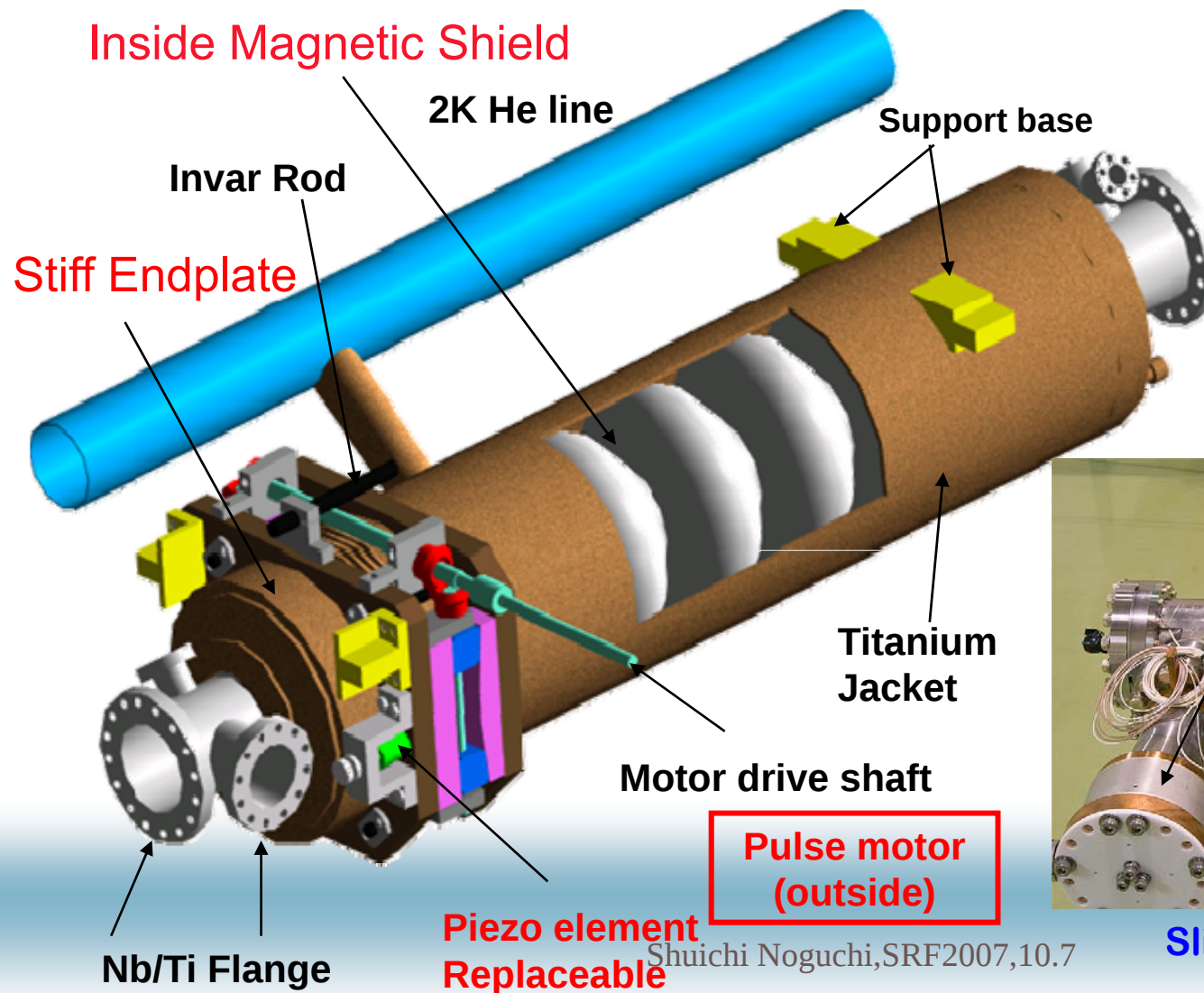
Roller Wedge & Screw



Slide Jack Tuner 290N/ μm



Tesla-like STF Baseline Cavity Package



Slide Jack Tuner

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Summary

- ◆ Several Candidates for ILC Application
- ◆ After Experimental Demonstration of Performances and Comparison from many Aspects, Decision will be done.
- ◆ Some of these Tuners can be used for other Application, with Simplified Design.