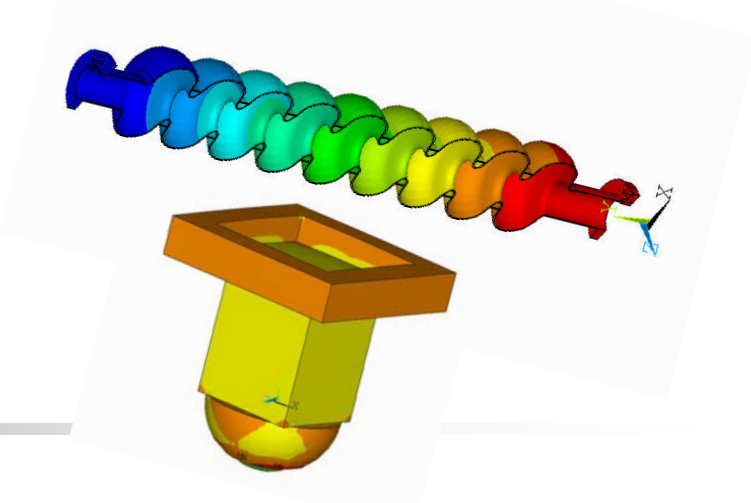
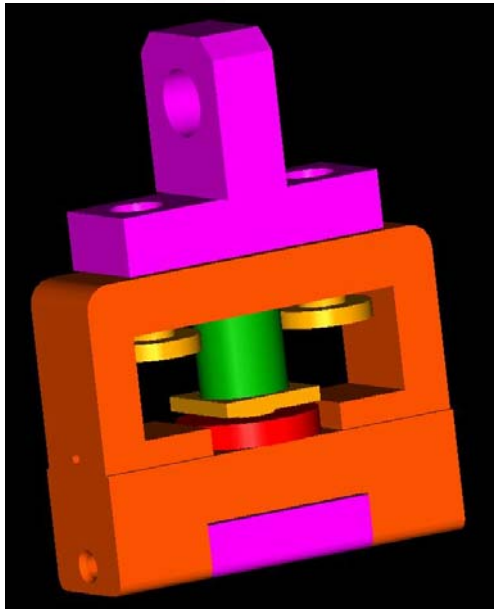
Fermi National Accelerator Laboratory

International Linear Collider at Fermilab

New Fast Tuner Design





Salman Tariq

Accelerator Division

Mechanical Support Department

Tuner Engineering Meeting- TD IB1 Fri. May 12, 2006

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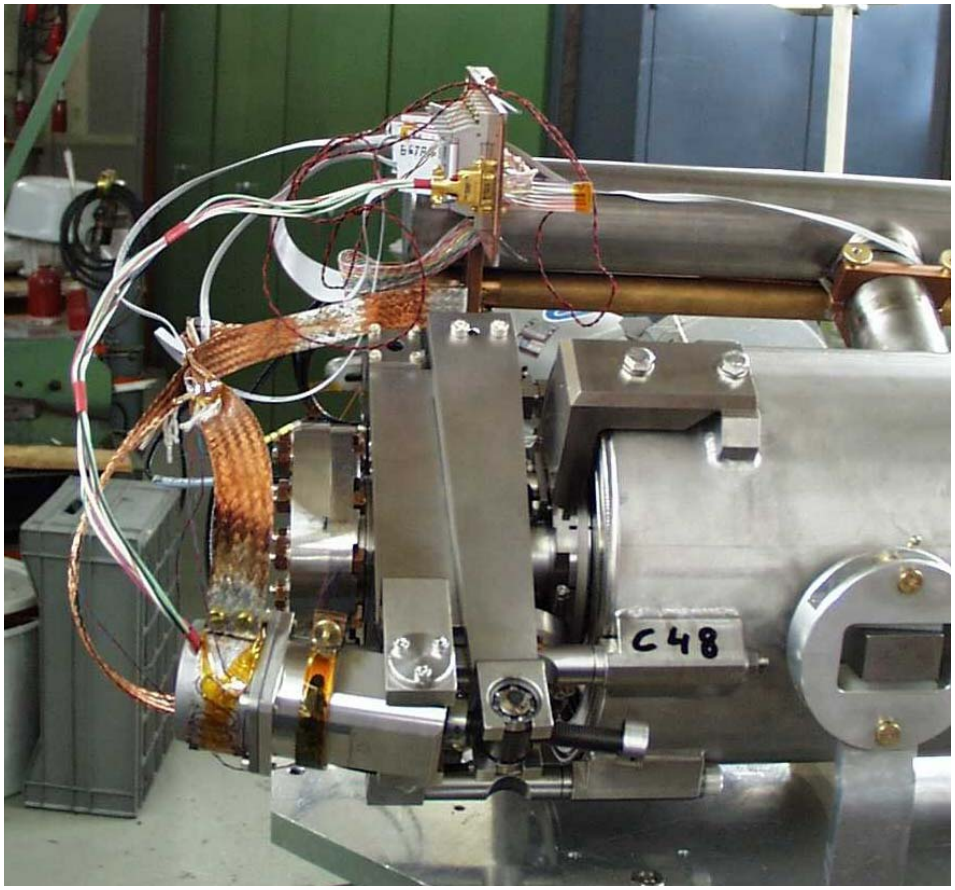
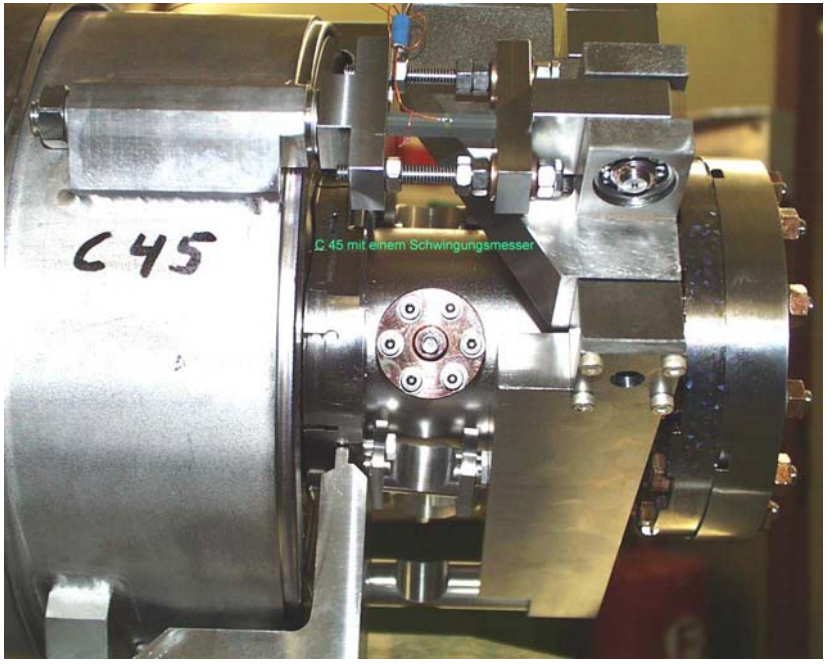
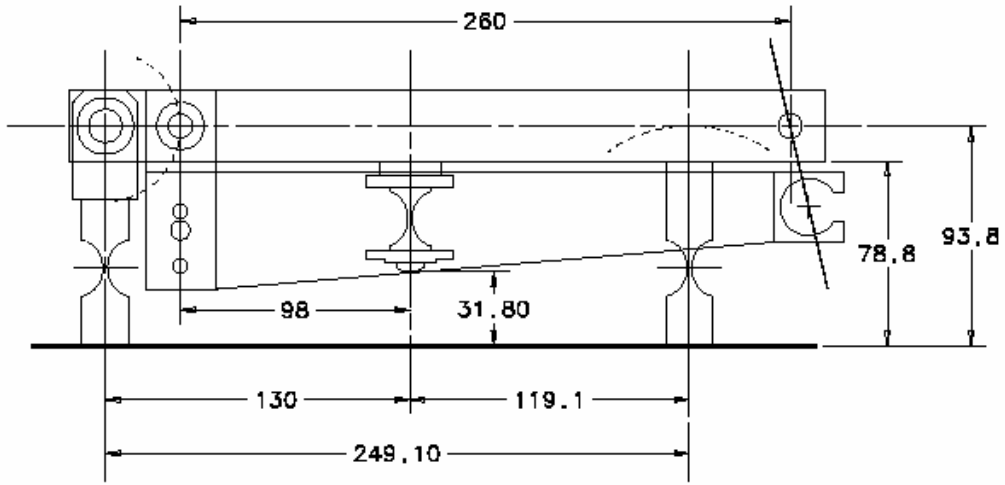
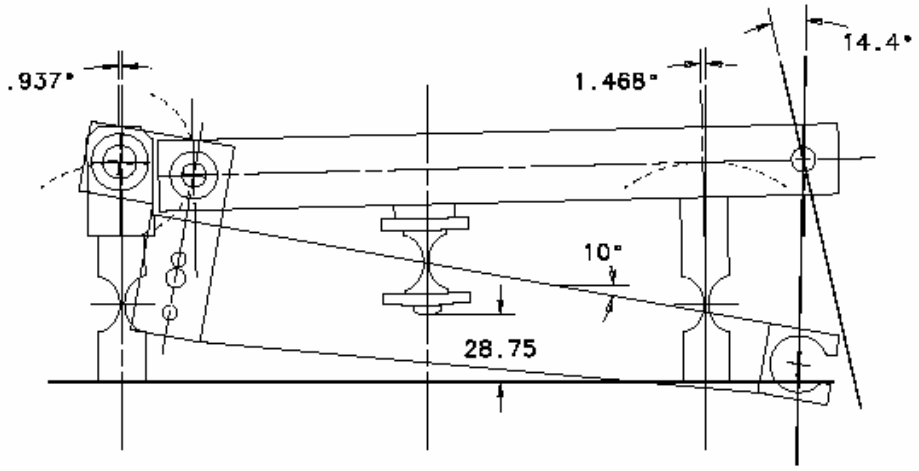
Saclay Lateral Tuner





Lateral Tuner Kinematics

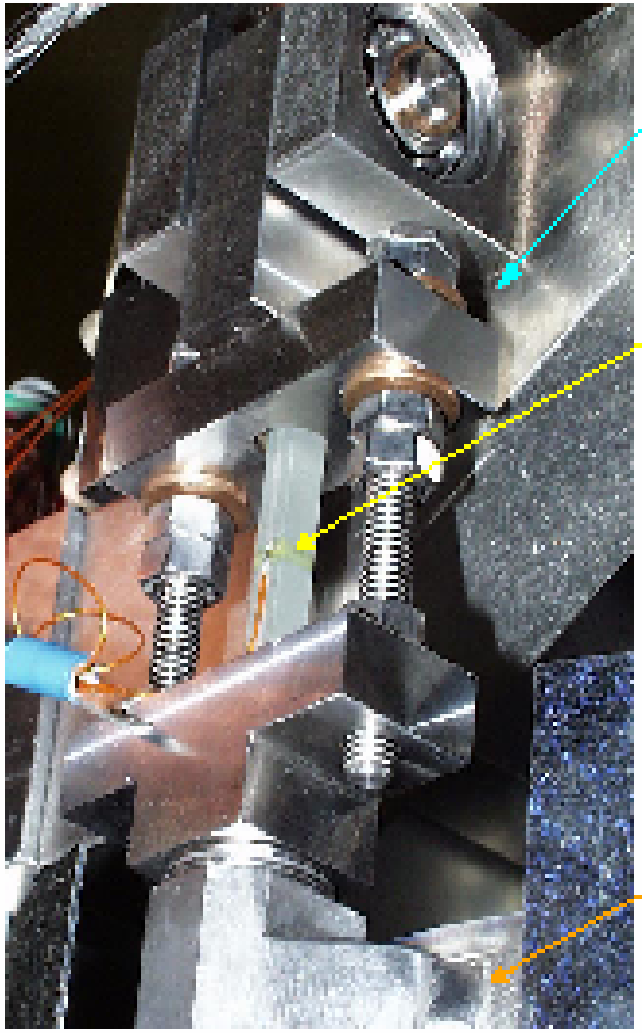


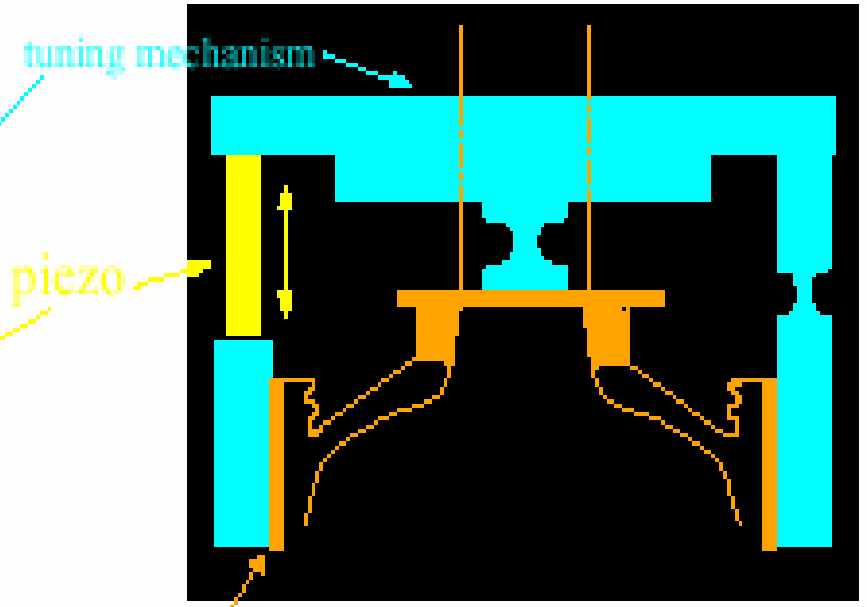


Notes:
1. Based on Desy original design & tuner currently sitting at IB4.
2. Does not utilize spherical stand-off's at flexure support rods.

Saclay (old) Tuner Kinematics
Salman Tariq 8/24/2005
tuner_mechanism_rev1.dwg

Piezoelectric Fast Tuner





Piezo-Actuator:

l=39mm

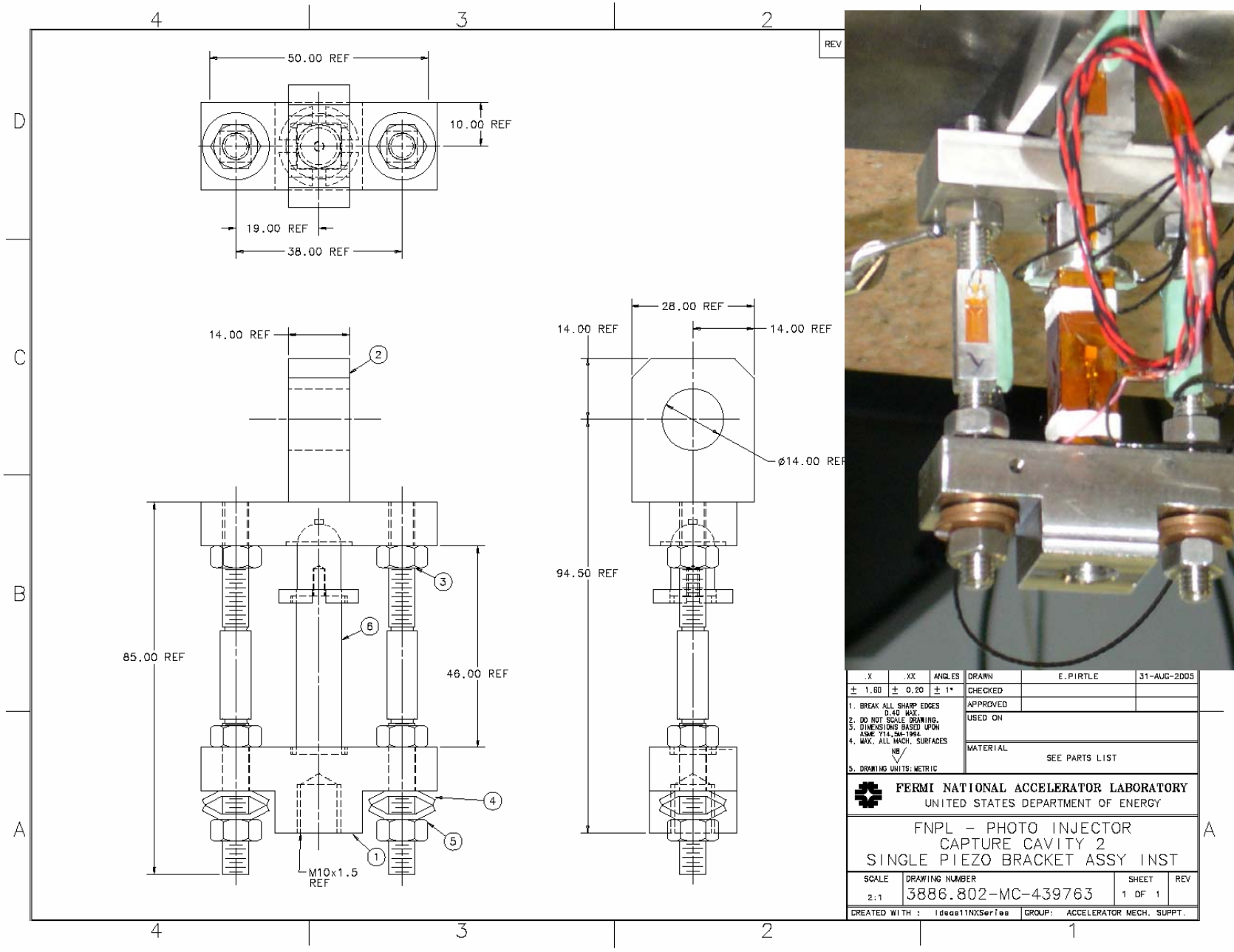
U_{max}=150V

Δ l=3µm at 2K

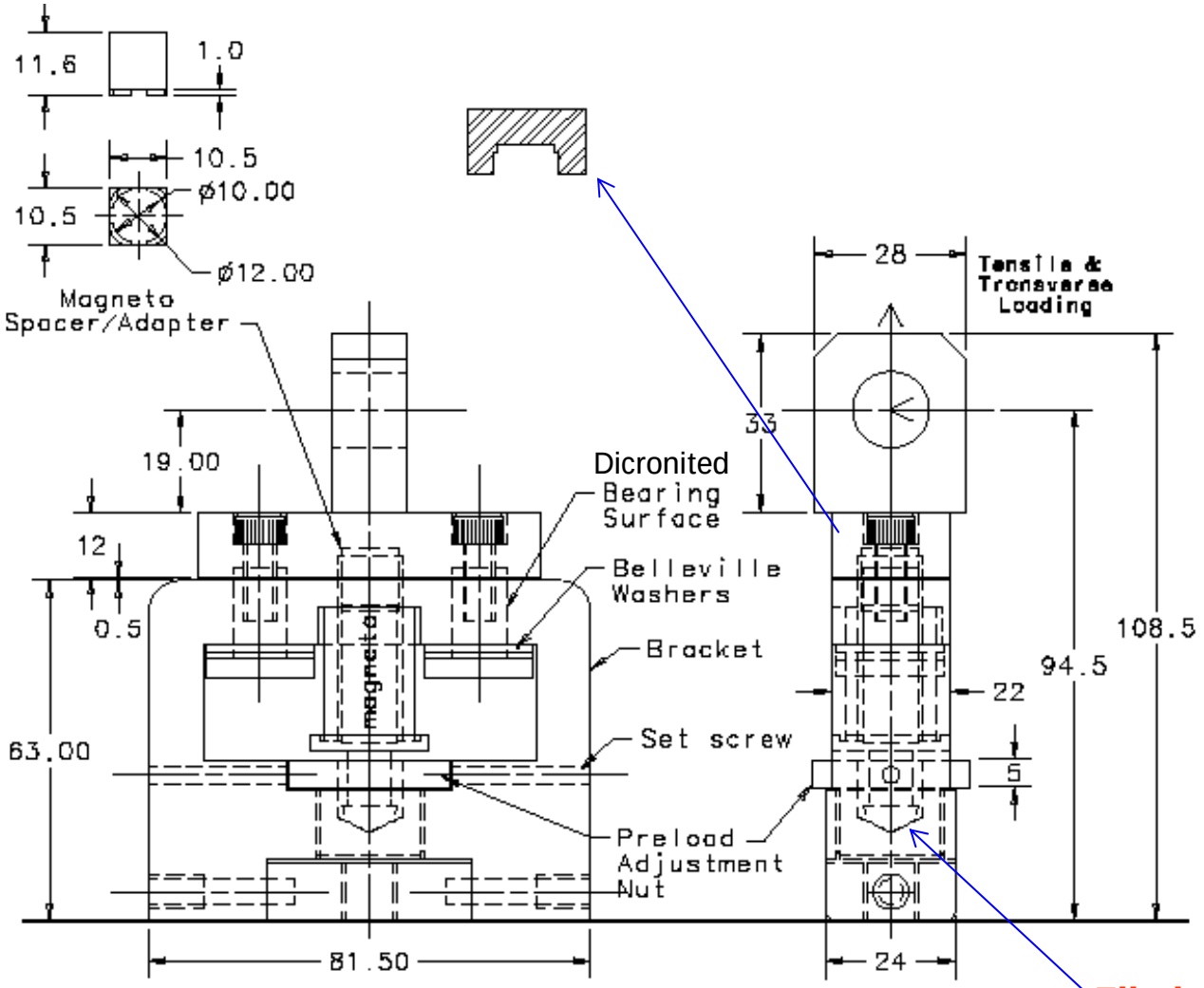
$\Delta f_{max,static}$=500Hz

Courtesy: Lutz Lilje, Desy (5-10-2005)

Existing CC2 Instrumented Piezo Bracket



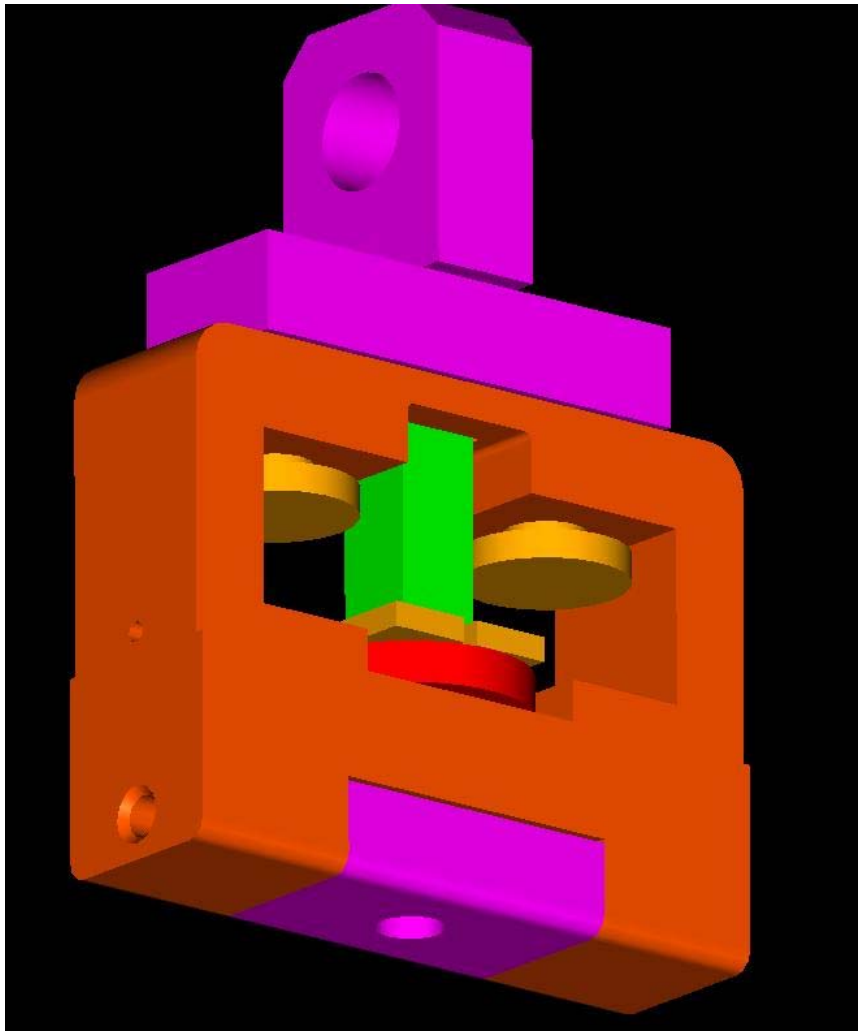
New Fast Tuner Bracket Design to Accommodate Both Magnetostrictive & Piezo Actuators



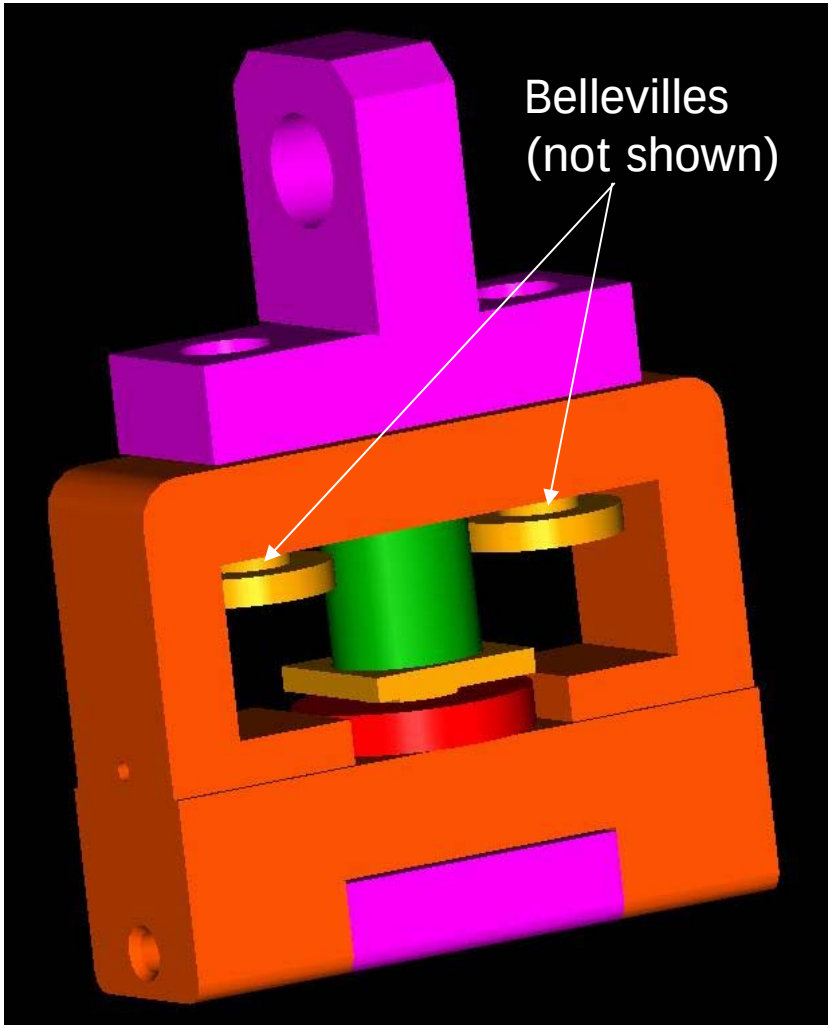
Design Option C:
Single Magnetostrictive
"seeing" Tension

New Fast Tuner Bracket Design

Piezoelectric Element

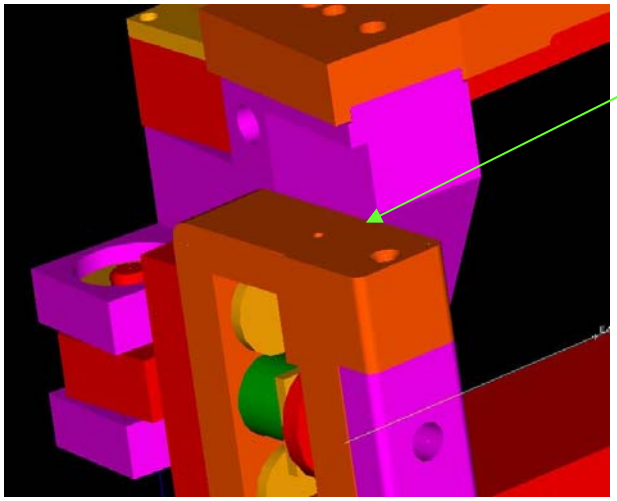


Magnetostrictive Element

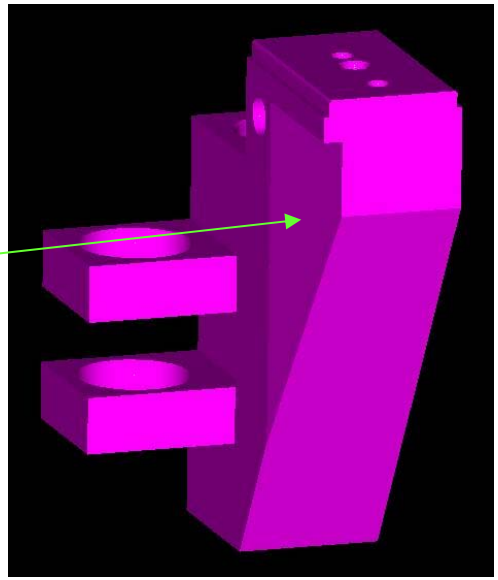


New Fast Tuner Bracket Design:

- Much more robust & rigid design; easy & flexible preload adjustment
- Allows use of both Piezo & Magnetostrictive elements
- Allows direct adjustment of preload using single support screw
- Includes instrumented “bullet” for preload & other feedback data
- Pivot eliminates transverse loads on actuator element
- A second (similar) design with Piezo element ‘always’ in compression is under development



- Small interference with one of the lever parts-- which will require modification (as shown)



Status:

-Drawings complete, ready for fabrication

Few remaining items:

-Selection of belleville spring w/ reqd. stiffness & matl (316L)

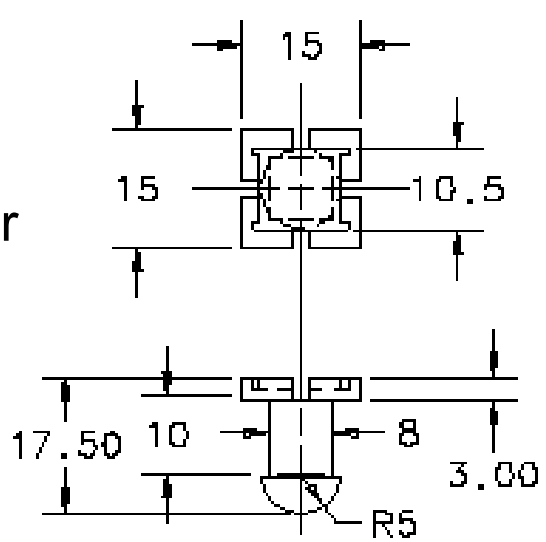
-Bracket to prevent element twisting during preload adjustment

Bullet Details

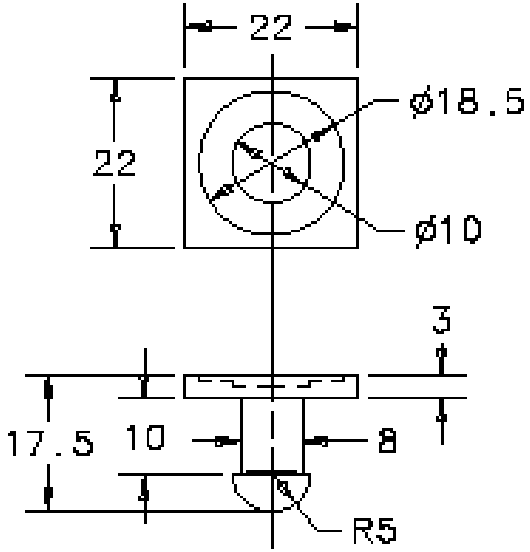
- Proposing an 8x8 Section for better sensitivity & response

$$\varepsilon \propto {}^{1}\!/_{A} = {}^{1}\!/_{w^2}$$

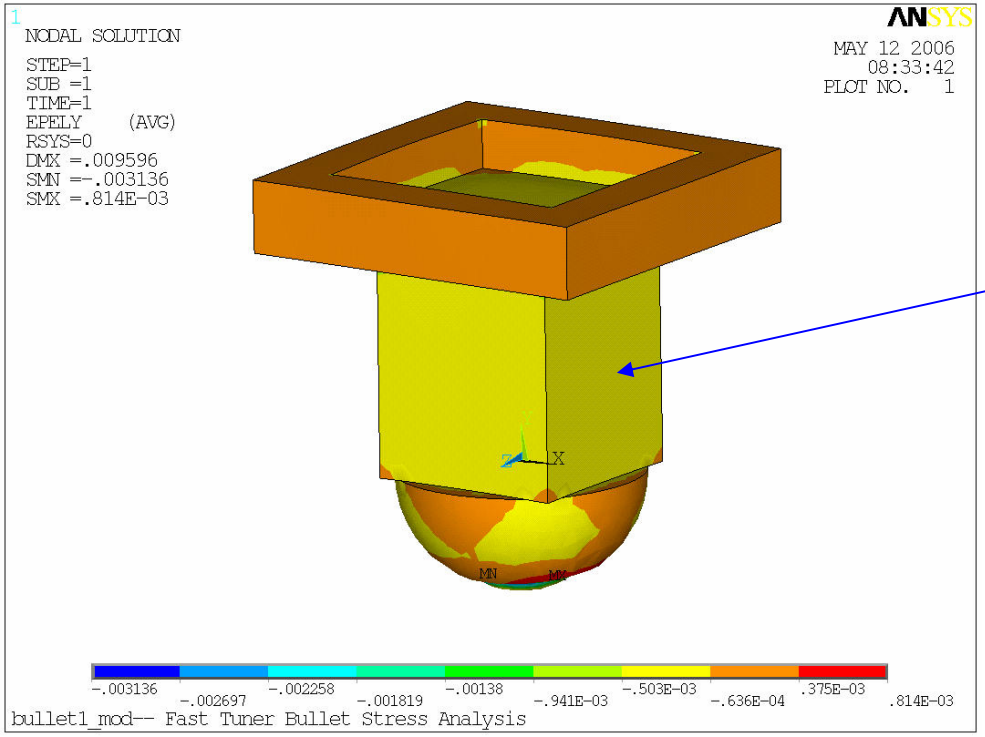
1.56x higher strain than 10x10



Bullet Detail (Piezo)



Bullet Detail (Magneto)



Sample FEA Results:

- 3,500N load (787 lbs)
  $\varepsilon_y = 2.80 \times 10^{-4}$
  (2.83e-04 from simple hand calc.)
- Good uniform strain distribution over SG surface

Bracket Cooldown & Shrinkage

- 316L SS: $\alpha = 17.3 \times 10^{-6}$ /K
  Piezo: $\alpha \approx 4.5 \times 10^{-6}$ /K

From 300K to 2K:

$\Delta L_{Bracket}$ **= 0.135 mm (over 50mm length)**
ΔL_{Piezo} **= 0.0373 mm (for 36mm length element)**

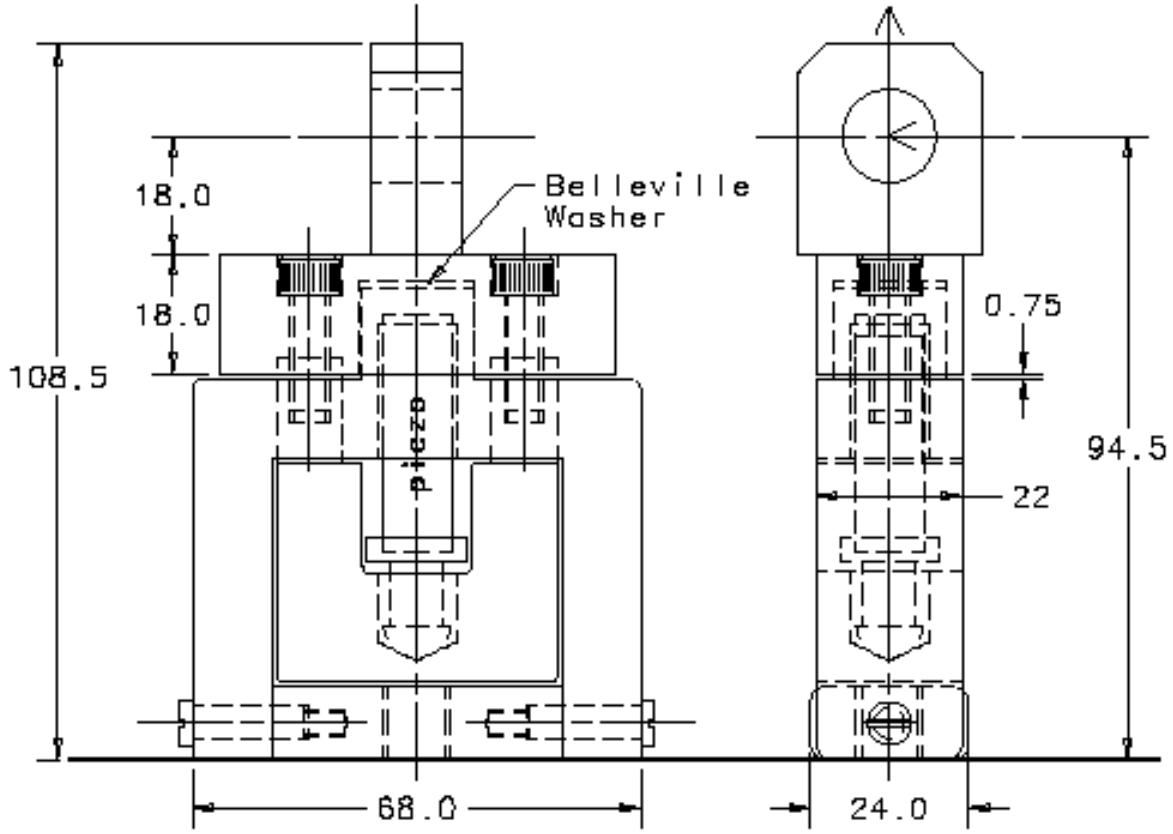
} **0.1mm difference**

If Bellevilles were fully tightened, then this could be the possible cause for seeing such high compressive loads on the Piezo.

With the new design, we can factor in the anticipated shrinkage and apply the preload accordingly– much better precision with large screw preload adjustment compared to the existing setup.

All this should be verified by cold tests of the bracket assembly.

New Piezo Fast Tuner Bracket Design with Piezo Always in Compression



Design Option (A):
Single Piezo in
Compression