

# Piezopumps using no physically moving parts

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# Current effort

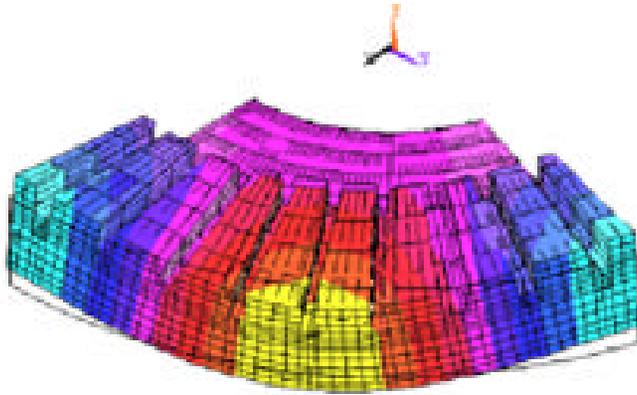
- Design and produce a miniature, low mass, low power-consumption piezoelectrically actuated peristaltic pump.
- Theoretical model the pump to allow interactive design.
- Design and test to meet requirements of a miniature mass spectrometer for *in-situ* sample analysis.
- Test the performance of the pump in simulated planetary conditions.
- demonstration of the capability of the proposed pump.

# USM test facility



# Ultrasonic Motors at JPL

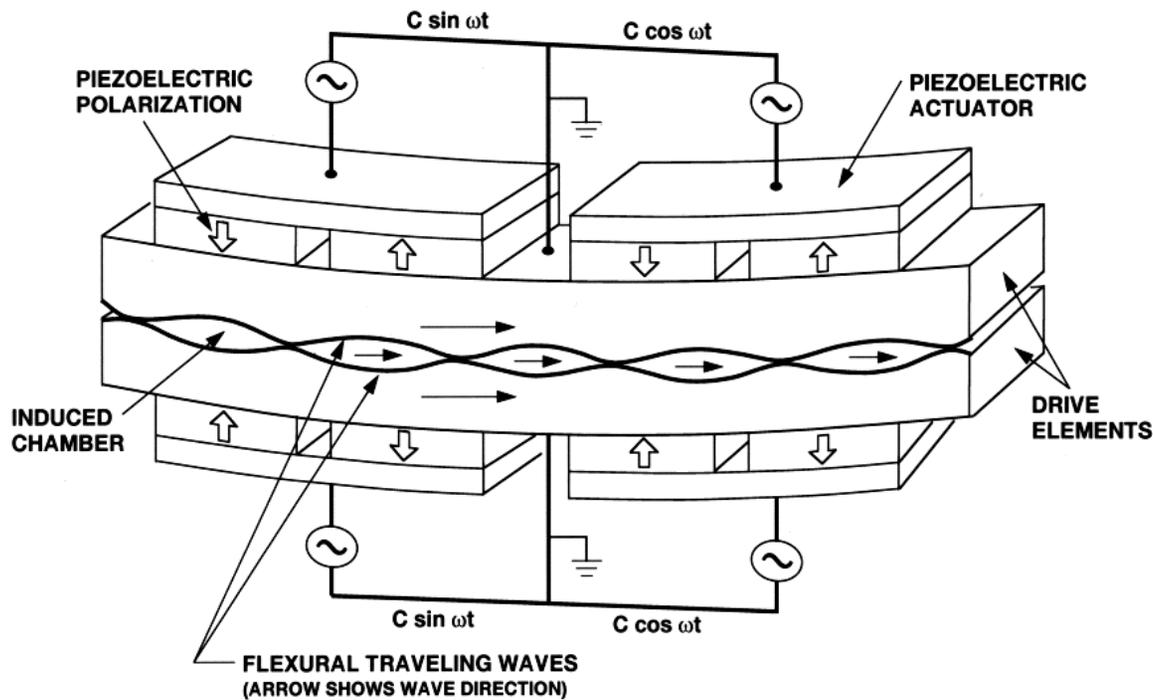
3D FEM



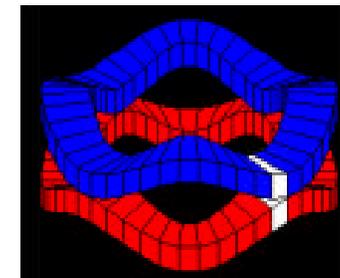
Stator, rotor, piezo-ring and assembled USM



# Piezoelectrically Actuated Miniature Pump (PIEZOPUMP)



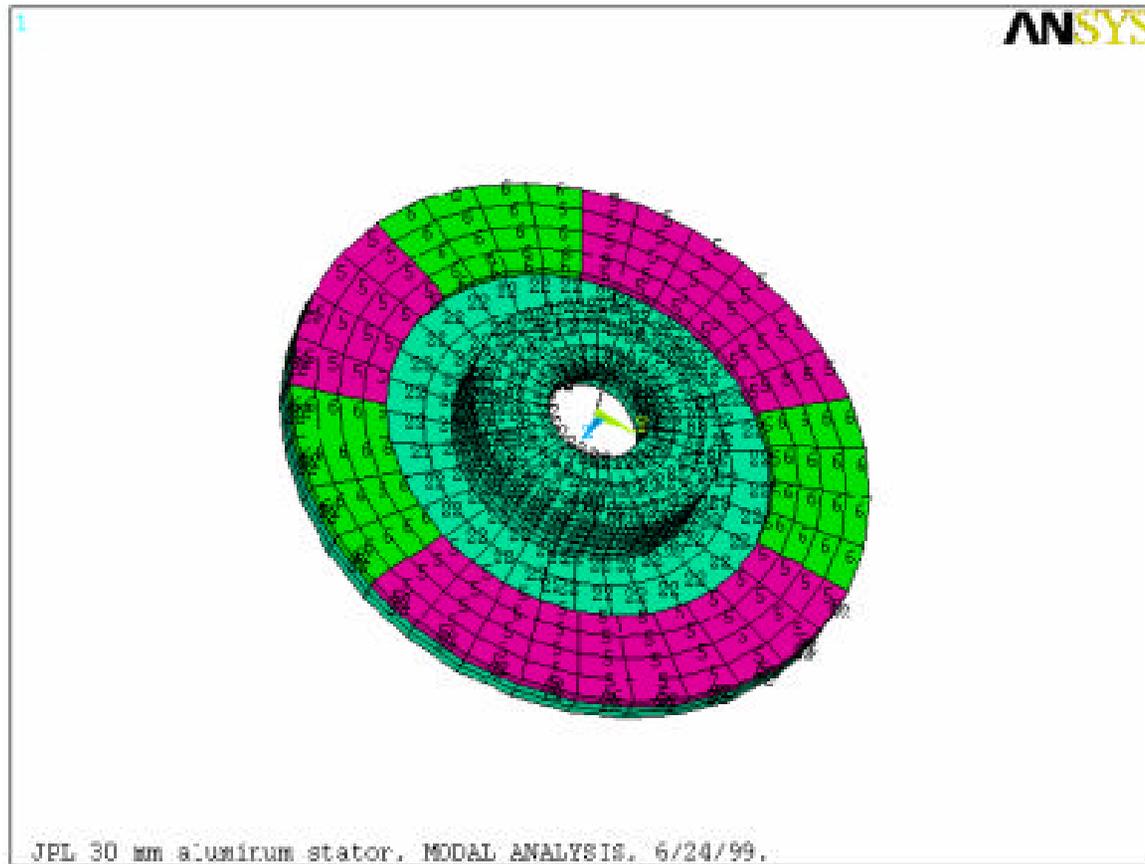
Concept



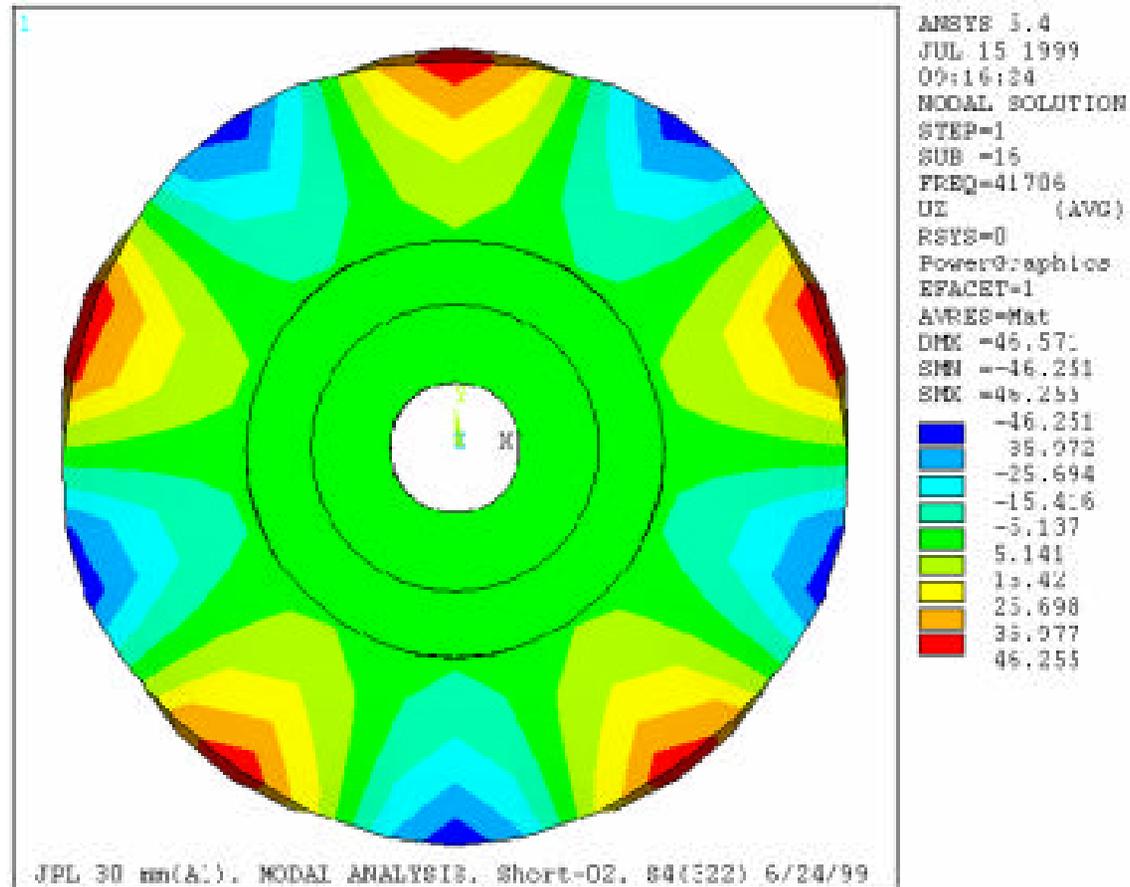
FEM Modeling

# Pump Stator FEM Mesh

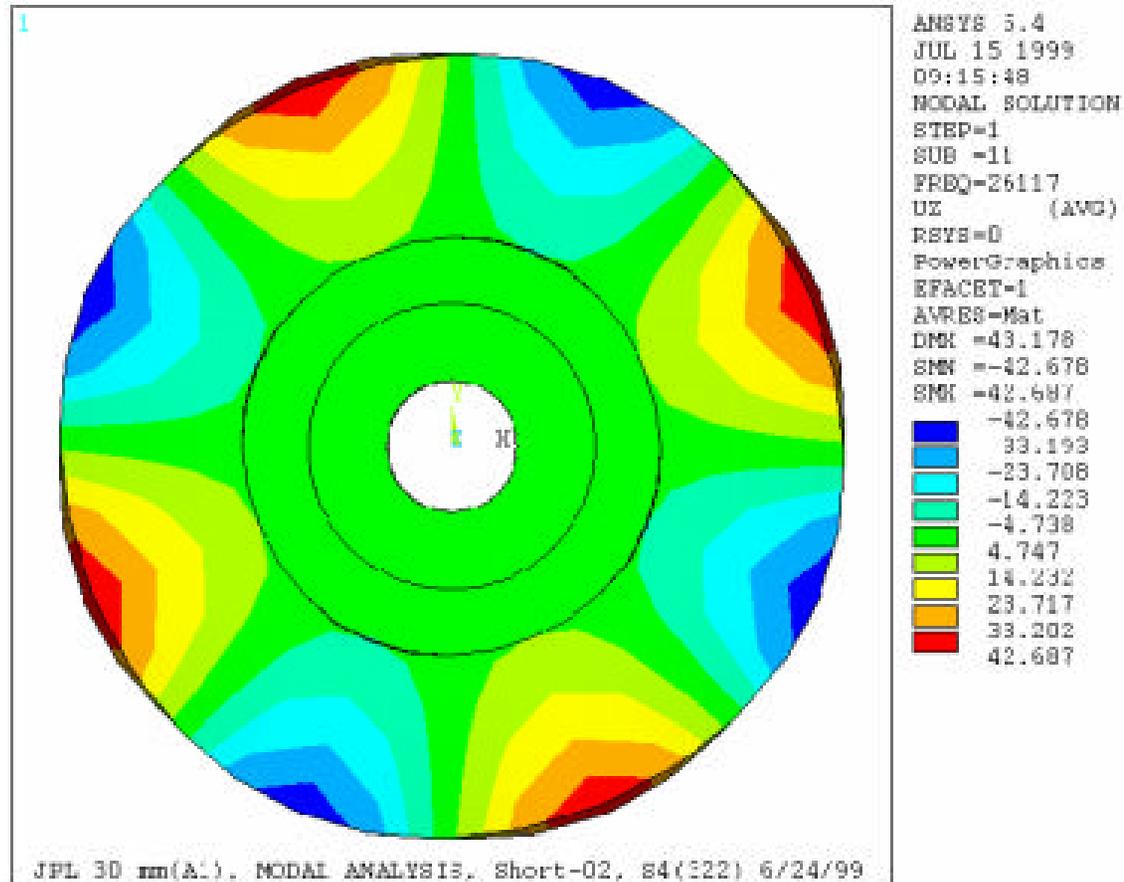
For the modal and harmonic analysis of the 3-wave mode



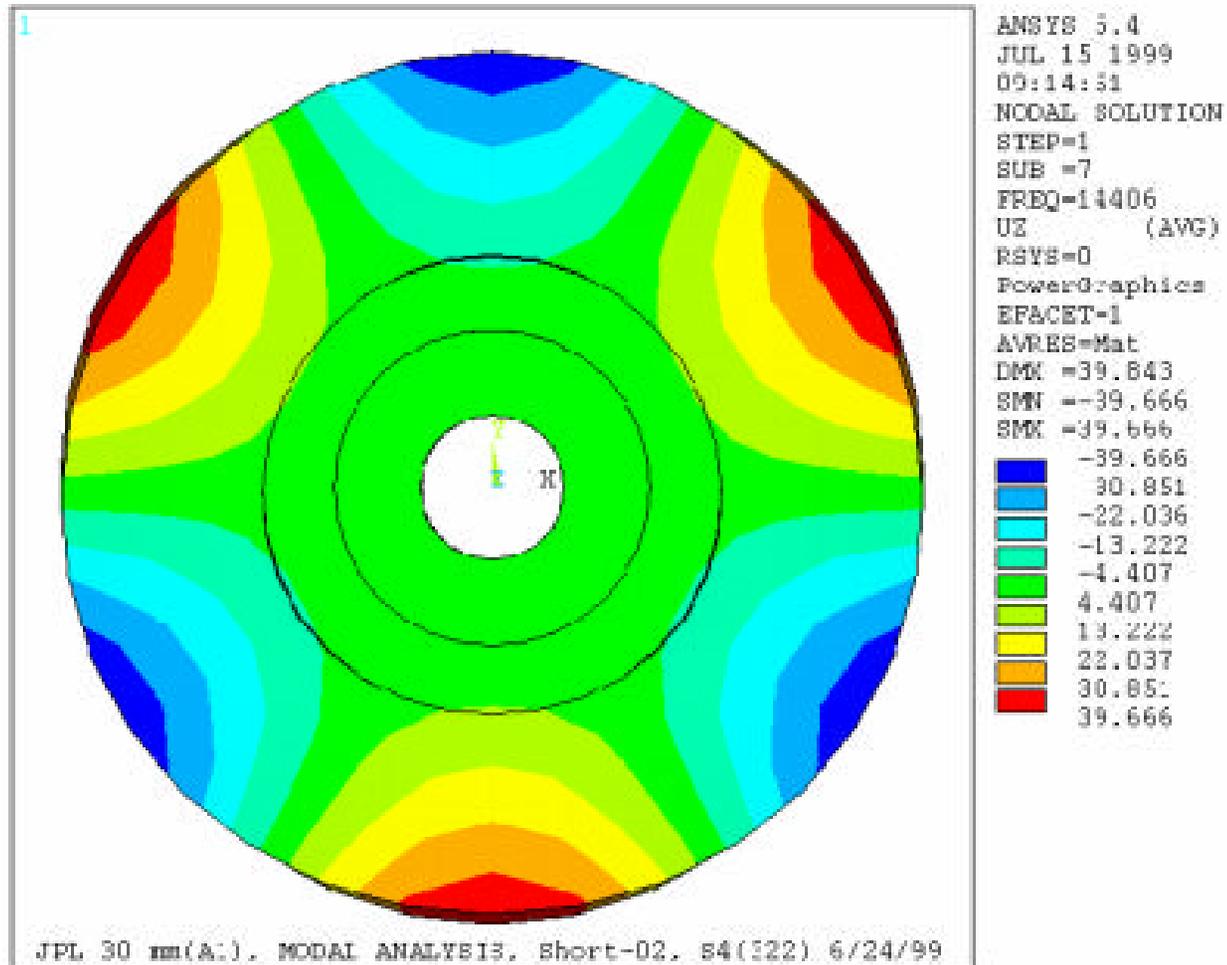
# 5-wave mode at resonance



# 4-wave mode at resonance

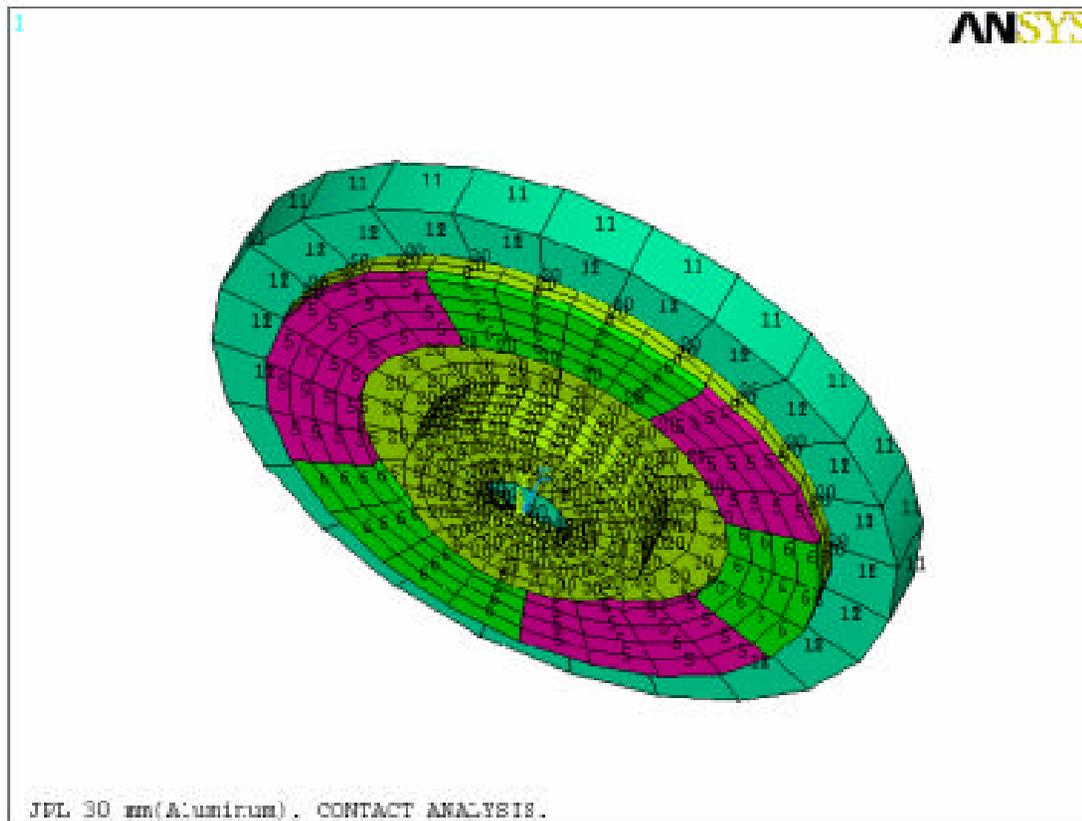


# 3-wave mode at resonance



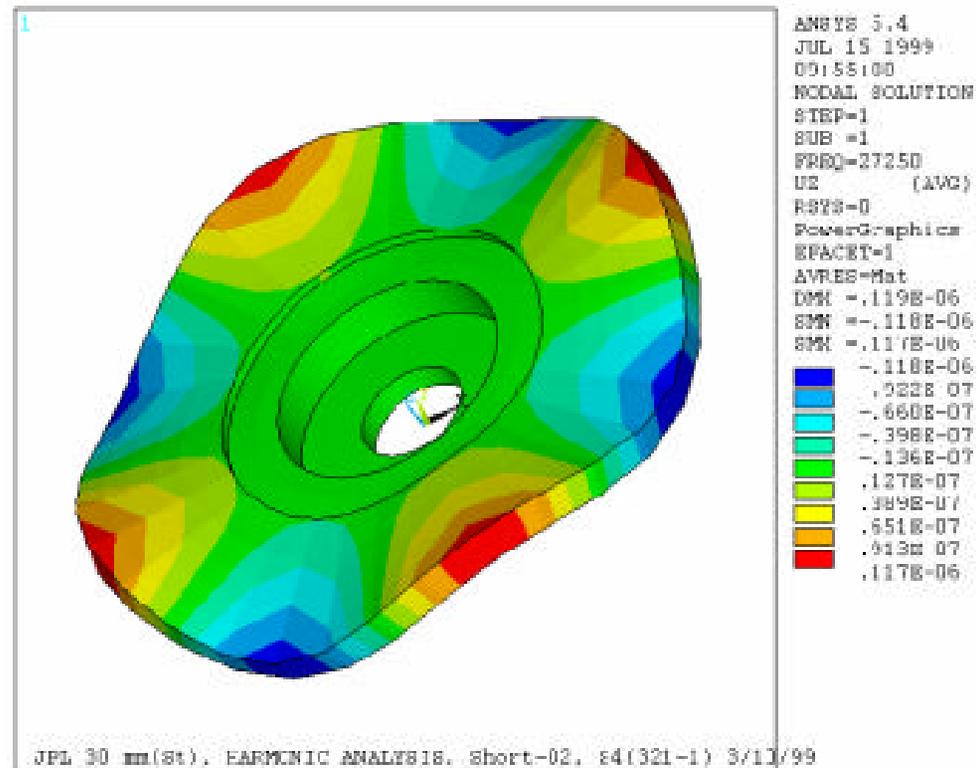
# Pump Stator FEM Mesh

For the contact analysis of the 3-wave mode (complete pump)



# Harmonic analysis of 4-wave steel stator

## Side view

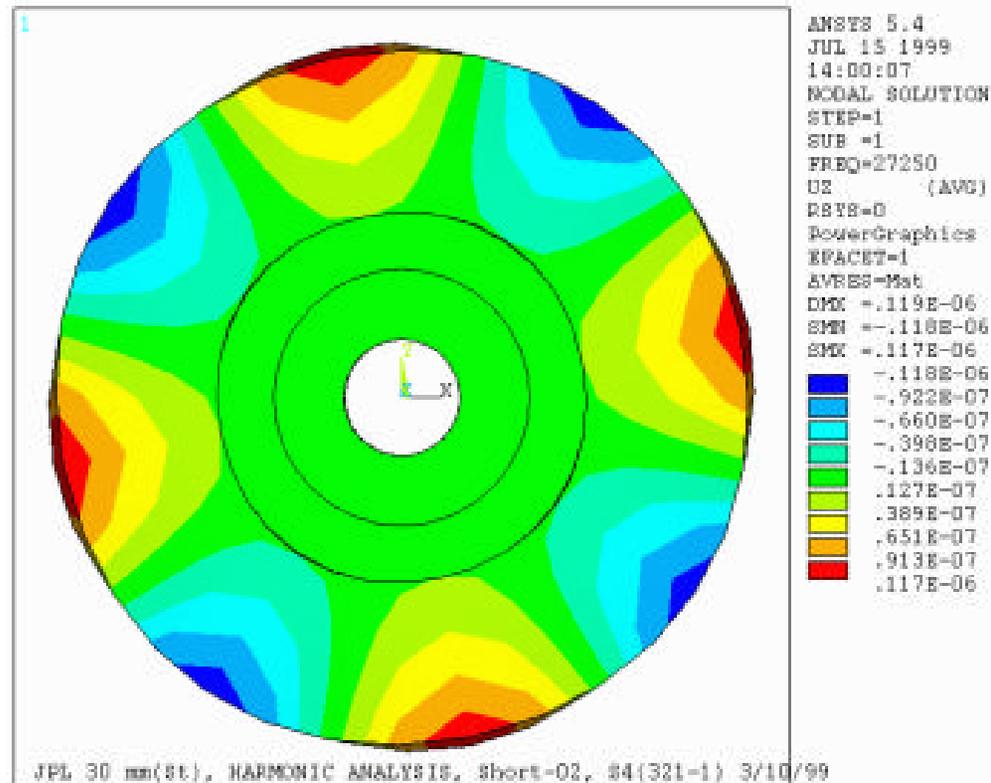


Stator - Made of steel, 30 mm diameter, 2-mm thickness ring.

Piezo-ring - designed as 4-waves with OD =30 mm, ID=20 mm, and t=1 mm.

# Harmonic analysis of 4-wave steel stator

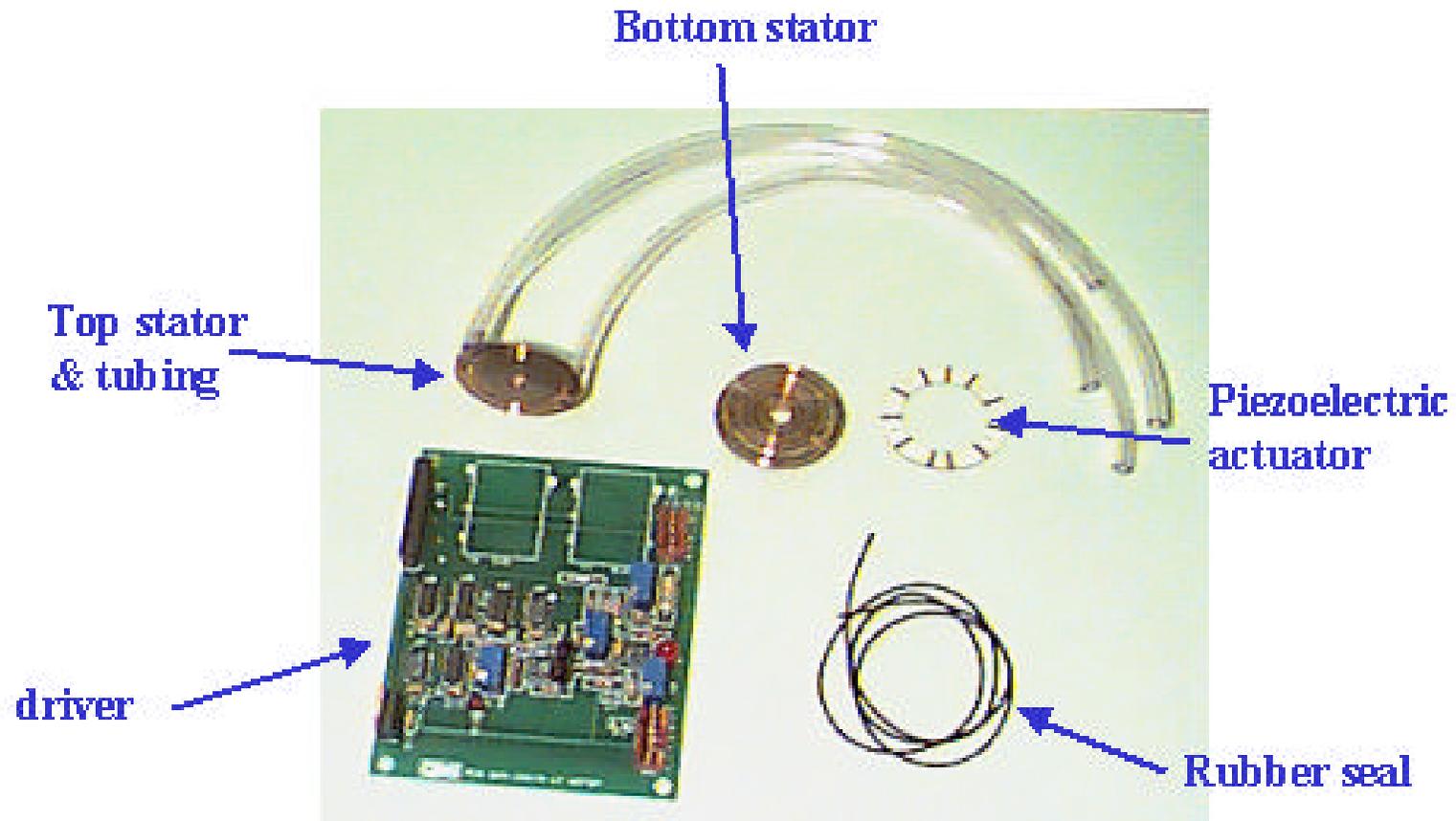
## Front view



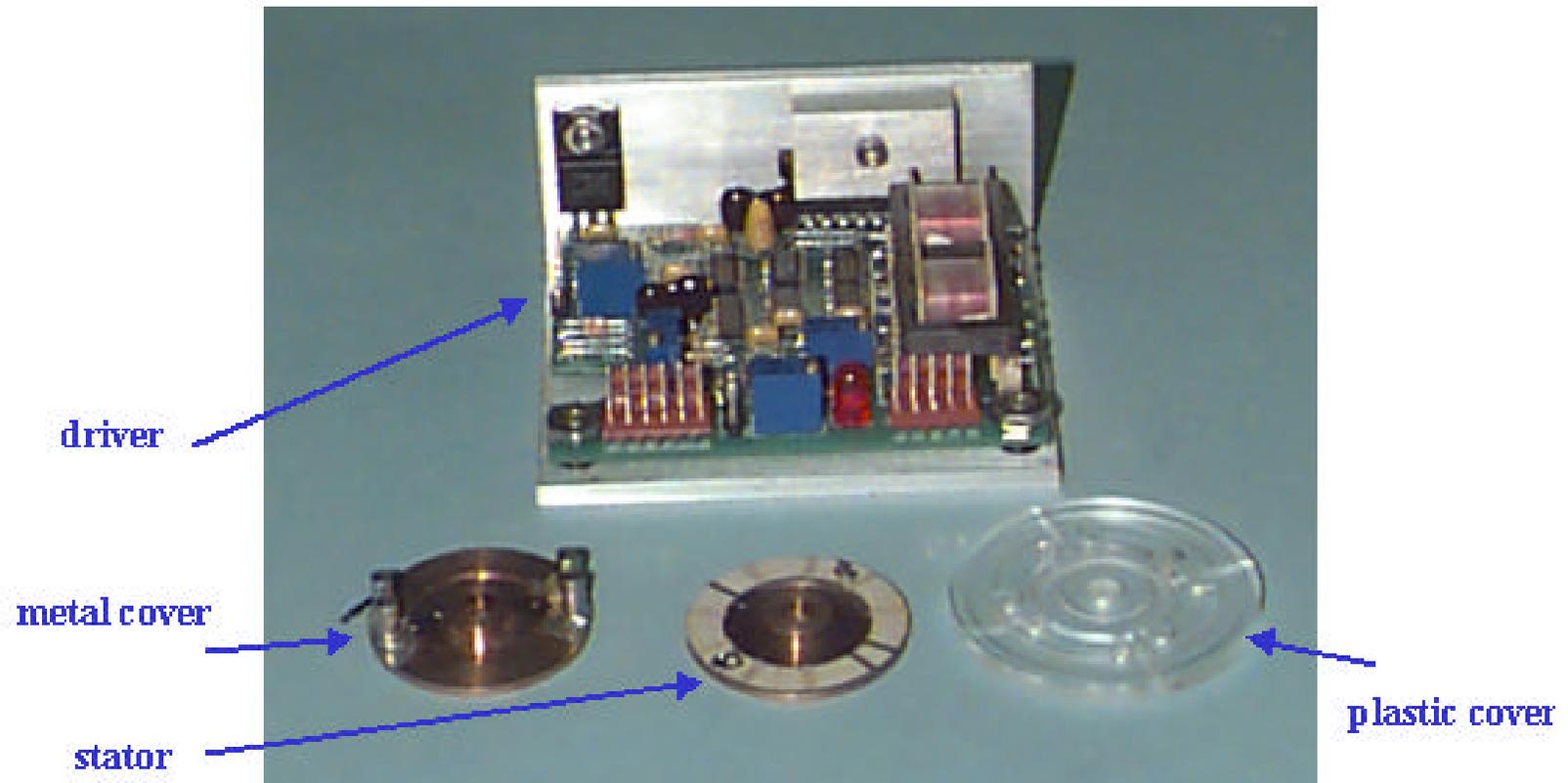
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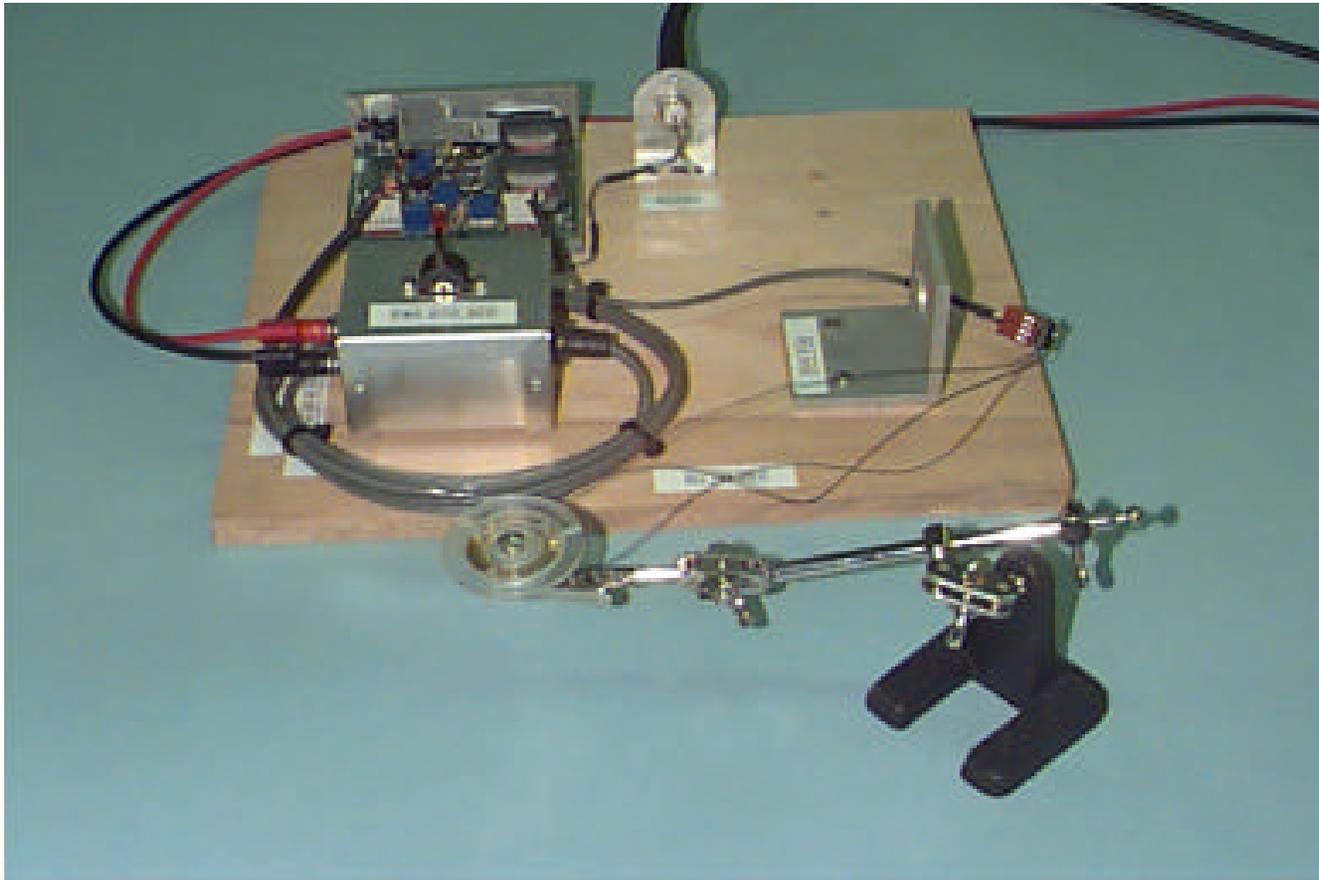
# Piezopump Brassboard 1



# Piezopump Brassboard 2



# Assembled Piezopump



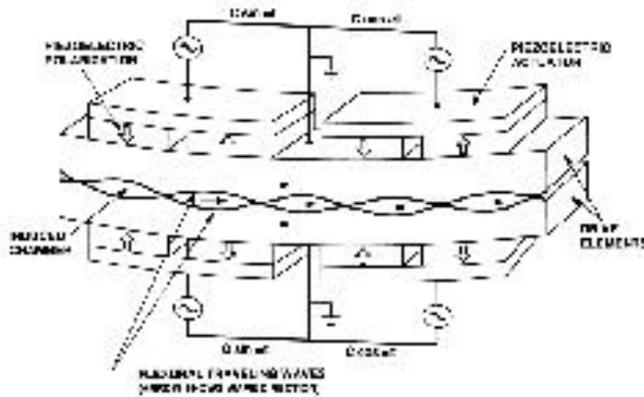
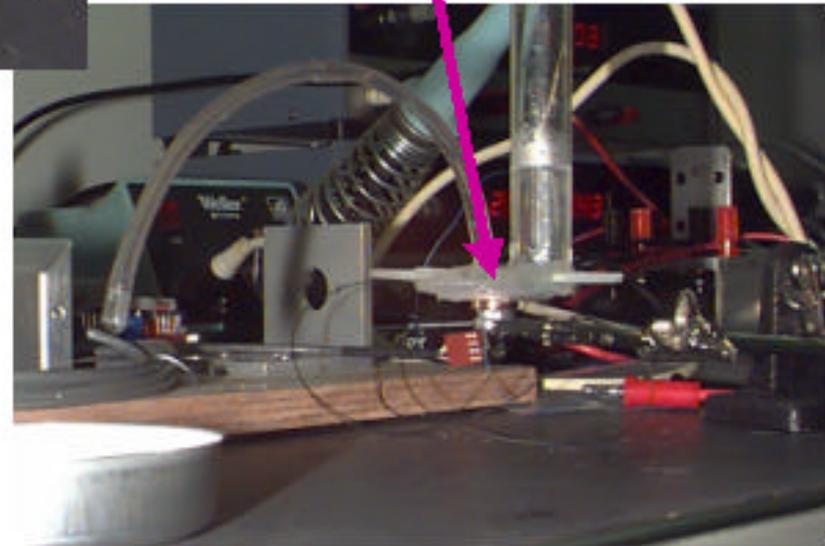
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# Summery

- A new pumping concept was demonstrated using traveling flexural waves.
- The pump operates peristaltically and easily reversed.
- Analytical modeling addressing the contact problem was developed
- Mode and construction material selection are currently under way to optimize the performance



Piezopump



Traveling ultrasonic waves allows to peristaltically pump liquids