SIMULATION OF THERMAL SENSOR FOR SPACECRAFT THERMAL CONTROL USING COMSOL

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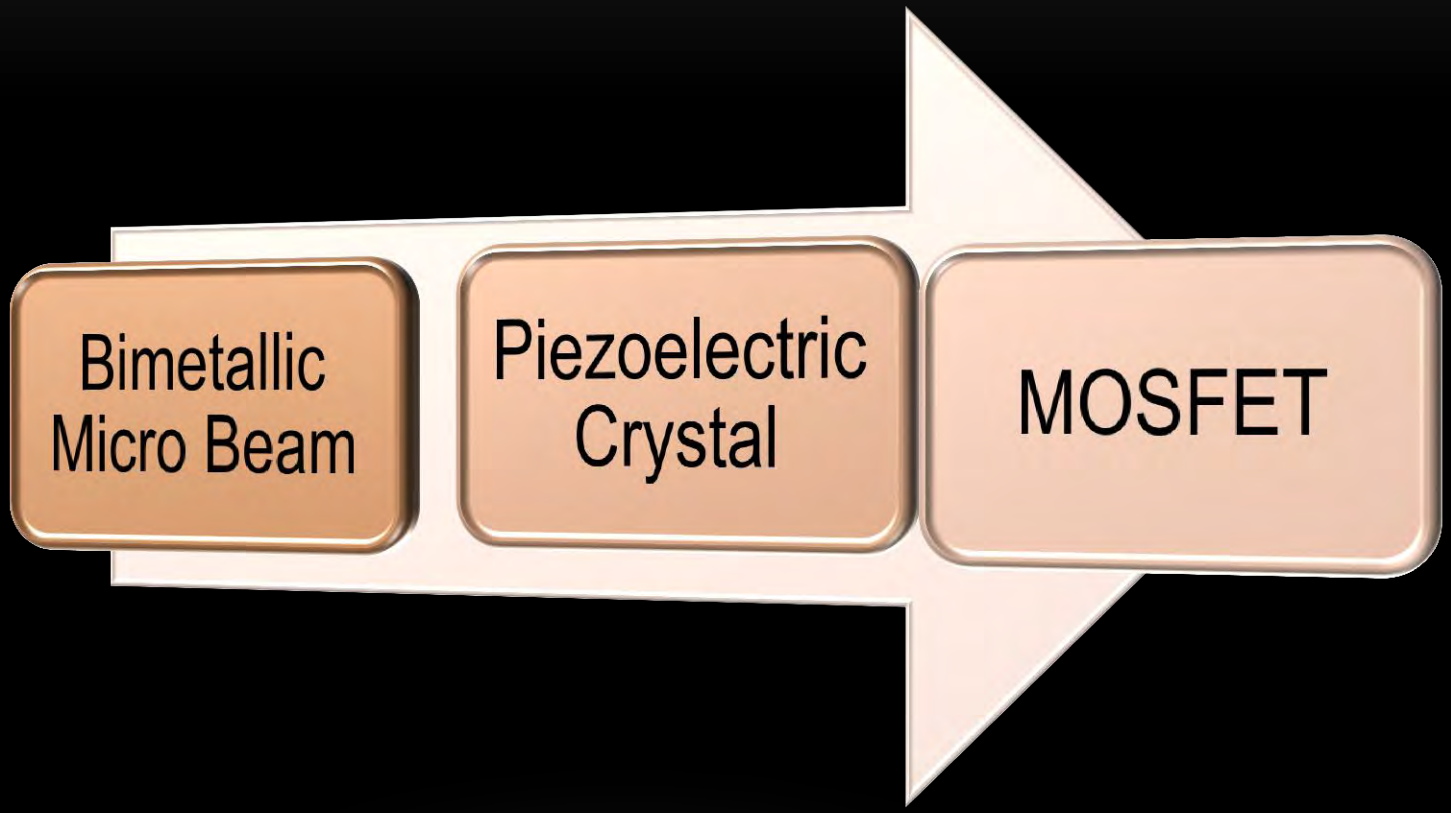
INTRODUCTION

- OVER HEATING IS A MAJOR CAUSE OF FAILURE OF MAJORITY OF SPACE MISSIONS.
- SUCCESS OF THERMAL CONTROL SYSTEM DEPENDS ON DESIGN OF THERMAL CONTROL SYSTEM
- SENSOR ACTUATING THE THERMAL CONTROL SYSTEM PLAYS AN IMPORTANT ROLE IN THE MISSON
- EFFICIENT DESIGN OF THE THERMAL SENSOR . NEED OF THE HOUR

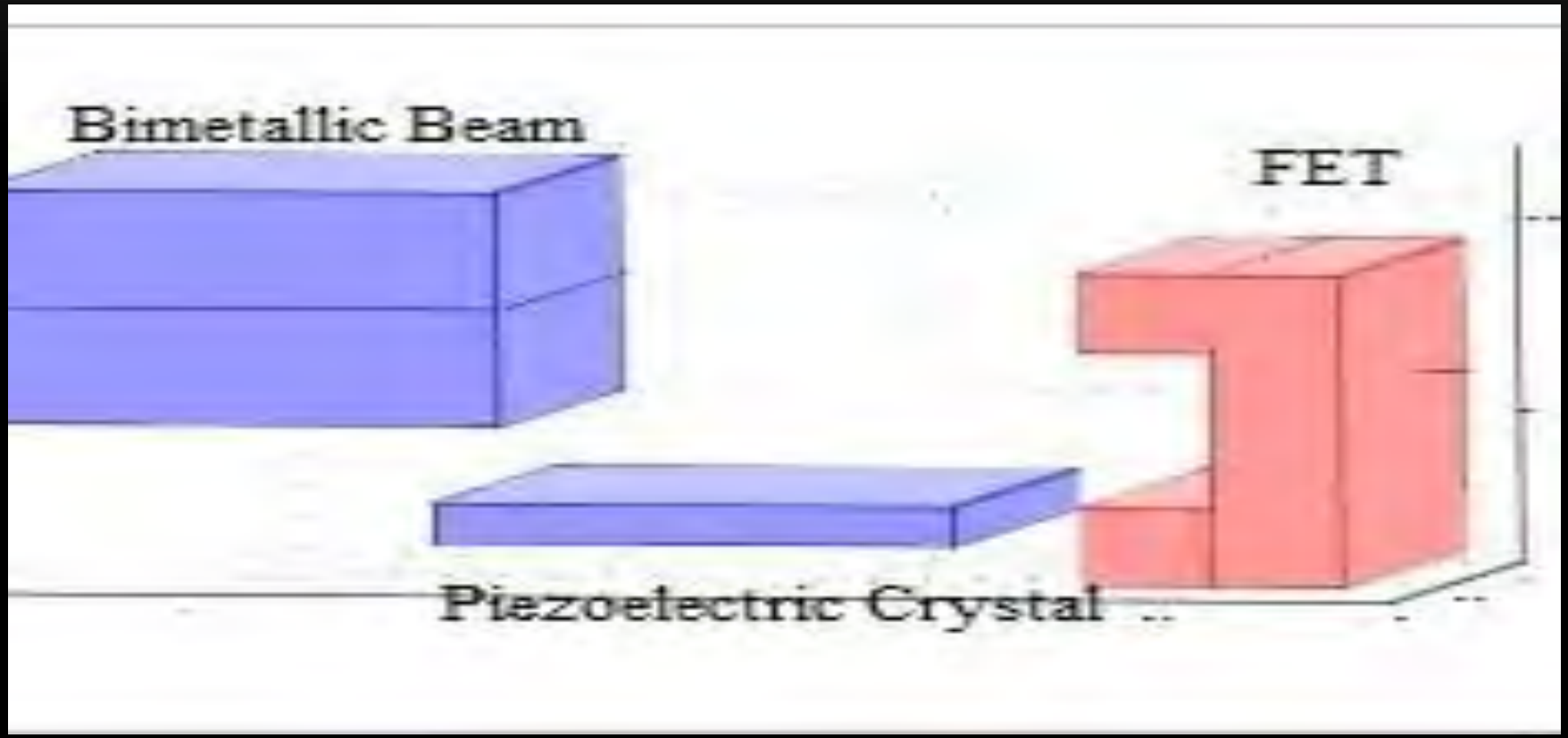
EFFICIENT DESIGN

- COMPATIBLE AND OPERABLE WITH SMALL SIZED OF SATELLITES
- SPONTANEOUS RESPONSE
- EASE OF OPERATION

MECHANSIM



GEOMETRY REPRESENTATION



BIMETALLIC BEAM

- DRIVING FORCE OF THE MECHANSIM
- PRIMARY SENSING ELEMENT
- IN DIRECT CONTACT WITH THE BODY OF THE SATELLITE
- USES DIFFERENCE IN THERMAL EXPANSION COEFFICIENT OF TWO MATERIALS
- STIMULATES THE PIEZOELECTRIC CRYSTAL

GOVERNING EQUATIONS

$(\acute{\alpha}_1 Y_1 - \acute{\alpha}_2 Y_2) \times \Delta T$ Difference in thermal stress

$$\epsilon_x = \frac{1}{E}[\sigma_x - \vartheta(\sigma_y + \sigma_z)] + \alpha\Delta T \text{ Net Strain}$$

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + X = 0 \textit{ Volume Equilibrium}$$

PIEZOELECTRIC CRYSTAL

- THE IMPINGING BIMETALLIC BEAM STIMULATES THE PIEZOELECTRIC CRYSTAL
- COMPRESSION RESULTS IN INDUCED POLARISATION IN THE CRYSTAL AT THE LATTICE LEVEL
- CHARGE SEPERATION RESULTS VOLTAGE DIFFERENCE ACROSS THE TWO FACES OF THE CRYSTAL
- THIS VOLTAGE IS FED TO THE MOSFET

GOVERNING EQUATIONS

$$D = hS + b^{S}E \quad \text{Field Equation}$$

$$\emptyset = N_{\emptyset}\,\widehat{\emptyset} \quad \textit{Interpolation}$$

$$[K^{T}_{u\emptyset}]u + [K_{\emptyset\emptyset}]\emptyset = \{Q\}\ \text{Coupling Equation}$$

MOSFET

VOLTAGE FROM THE PIEZOELECTRIC CYRSTAL FED TO THE GATE AND SOURCE TERMINALS

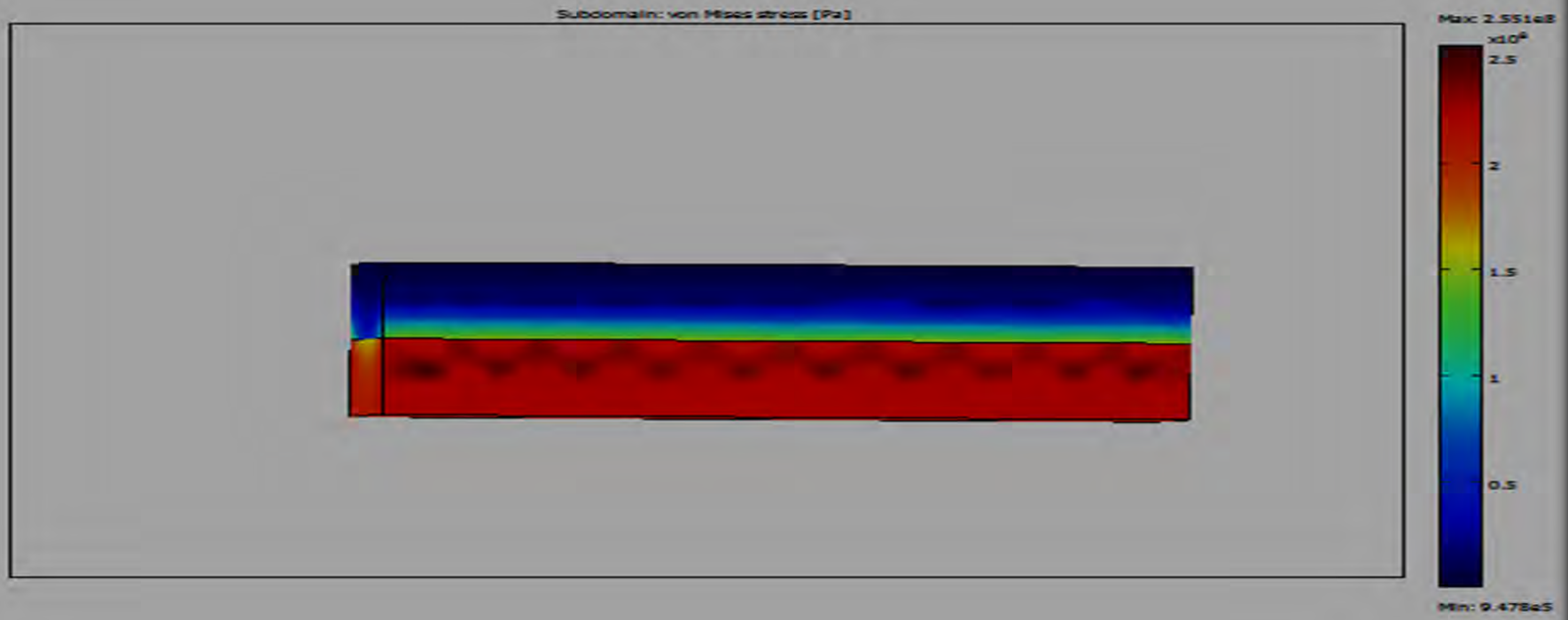
BIAS CRITERIA : GATE SOURCE VOLTAGE GREATER THAN THRESHOLD VOLTAGE MET

CURRENT FLOWS FROM THE SOURCE TO DRAIN TO ACTUATE THE THERMAL CONTROL SYSTEM

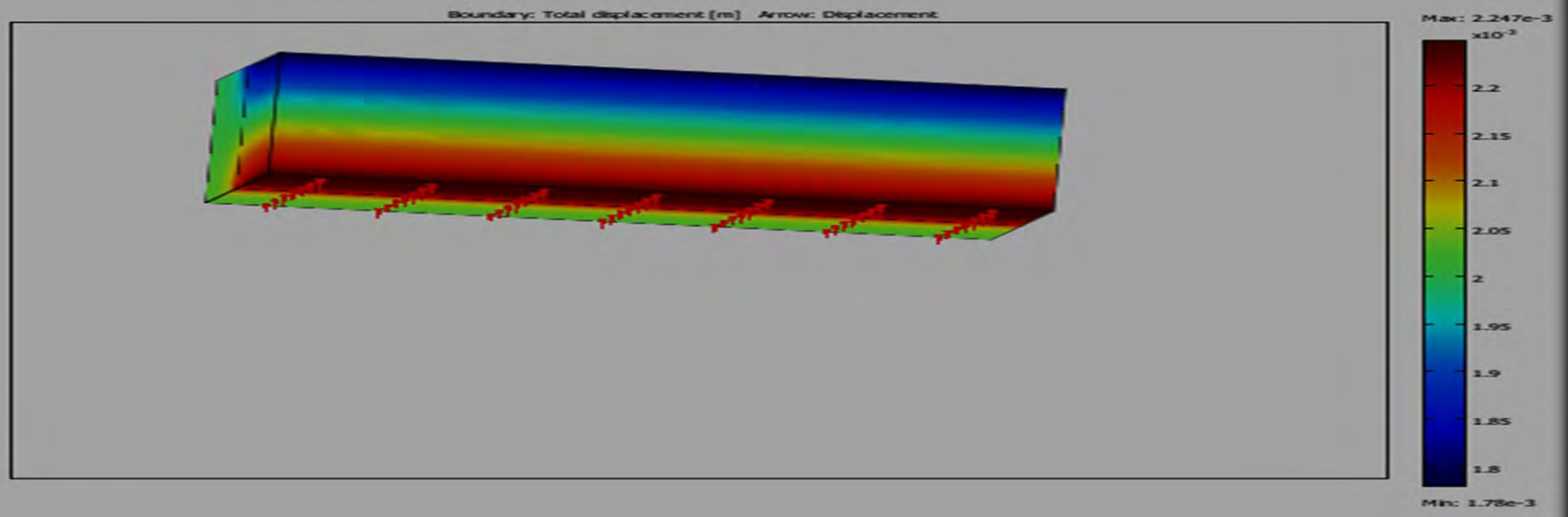
GOVERNING EQUATION

$$(V_{GS} - v(x) - V_t) \times (Wdx) \times C_{ox} = dq$$

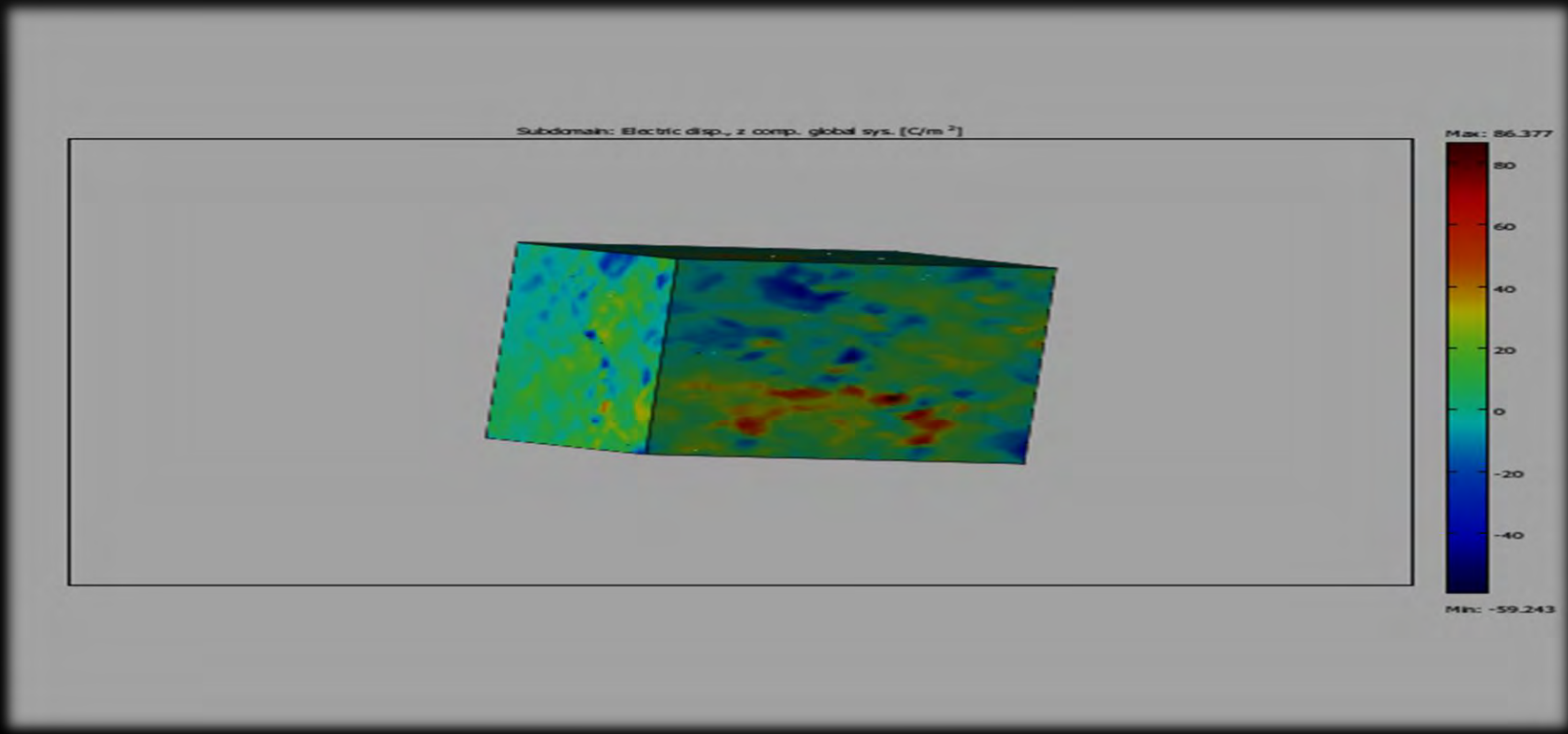
RESULTS – STRESS DISTRIBUTION IN THE BEAM



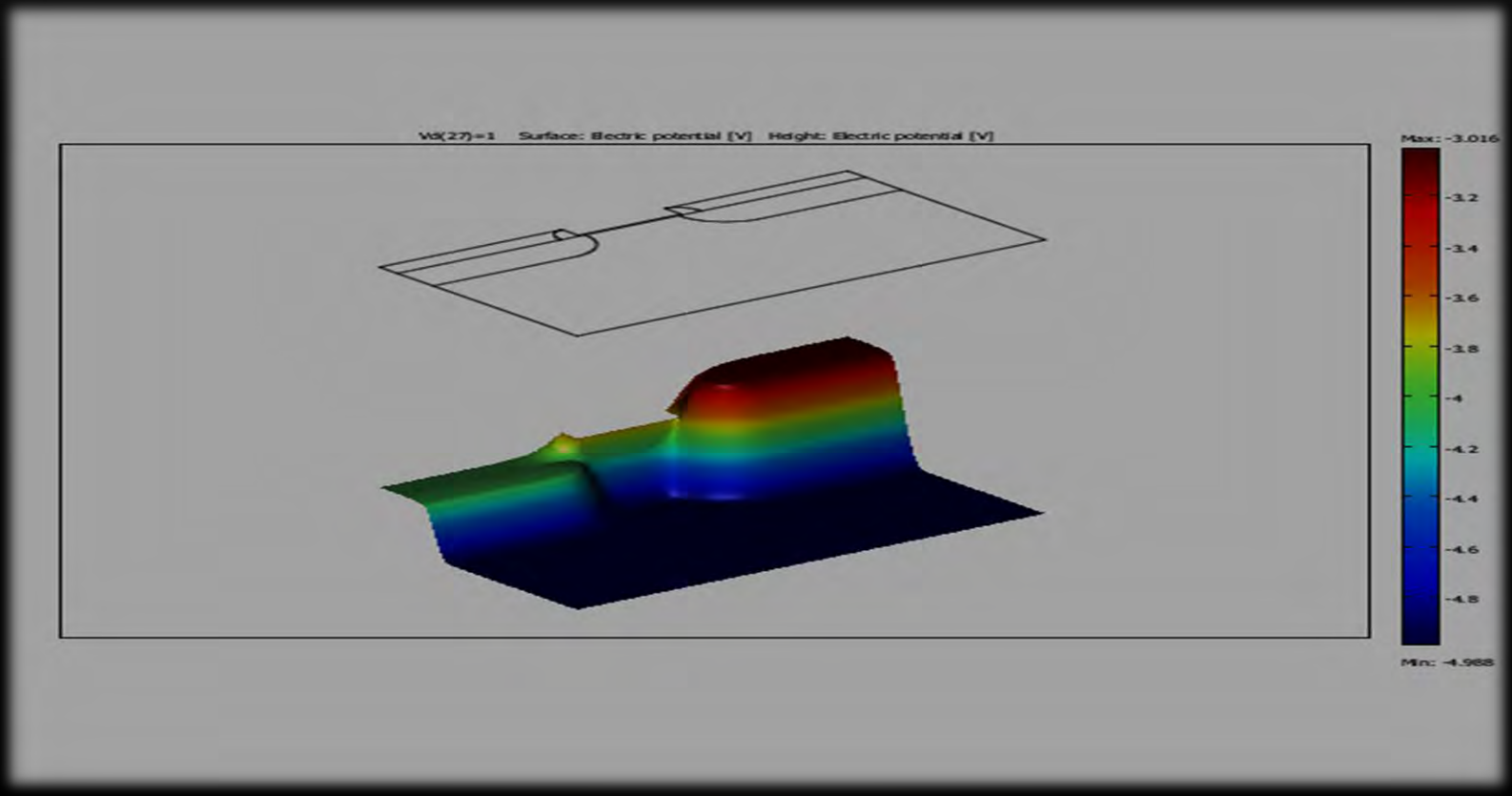
DISPLACEMENT OF THE BEAM



ELECTRIC DISPLACEMENT OF PIEZOELECTRIC CRYSTAL



VOLTAGE DISTRIBUTION ACROSS THE MOSFET



THANK YOU

Questions ....