ULTRA HIGH SPEED MICRO MACHINING CENTRE
Indian Institute of Technology Bombay

- **DYNAMIC STABILITY**
  - High damping granite structure

- **STIFFNESS**
  - Low chip load due to high spindle speeds

- **HIGH ACCURACY AND PRECISION**
  - Stable optimized structure and nano-precision Z-stage

- **VERSATILITY: MILLING AND DRILLING**
  - High torque spindle (~5.6 N-cm)

- **LOW COST**
  - Economical precision ballscrew x-y stages and AC synchronous electric spindle with high-stiffness ceramic bearing

**ADVANCED FEATURES**
- Excellent surface quality (Ra~100nm)
- High spindle speeds upto 170,000RPM
- High feed rates
- Vibration free rigid structure
- Micromachining of difficult-to-cut materials
  - (Tool steels, Ti alloys and Ni superalloys)
Initial Design Consideration

Design of Machine Tools

Machine Tool Model

SELECTION OF OPTIMUM DESIGN
- Static Analysis
- Modal Analysis
- Frequency Response
- Analysis Dynamic Analysis
- Impact Analysis

Design Approach

Static Structure
Modal and Dynamic Analysis
Error Budgeting

Error Budgeting

Geometry Optimization

Optimal Design
FINITE ELEMENT ANALYSIS
In order to design stiff structure to withstand heavy loads & impacts

MODAL ANALYSIS
For selection of optimum structural configuration with reduced deflection at tool tip and other machine components

RIB STRUCTURE
Our studies showed that Vibrational frequencies are curbed by the Ribs hence better stability

ERROR BUDGETING
Precise positioning of slides with nanometric resolution. Calibrated by Zeiss CMM

VIBRATION DAMPING
Frequency response analysis shows excellent damping ability with ribs

MACHINING RESPONSE
Nanometric surface finish achieved with Ultra high speed Micromachining centre
TECHNICAL DESCRIPTION

AXES X, Y
Travel distance 100 mm
Drives Precision Ground Ball Screw/Brushless DC Servomotor
Max. Feed Rate 0.06-6000 mm/min
Maximum Load Horizontal 25 kg
Vertical 10 kg
Side 10 kg
Resolution 0.5μm
Accuracy ±0.5μm

AXIS Z
Frictionless pneumatic dual counterbalanced mechanism for high precision
Travel distance 60 mm
Drives Non contact Direct Drive/Brushless Linear Servomotor
Max. Feed Rate 0.06-6000 mm/min
Maximum Load Vertical 10 kg
Resolution 1 nm
Accuracy ±0.3 μm

SPINDLE
Spindle Speed 5000 -170000 rpm with variable frequency drive
Tool Holder Mega 4S (High accuracy collet system with a runout in collet of 1 μm)
Tool Shank Dia 3 mm

STATIC AND DYNAMIC RIGIDITY
- High thermal stability machine structure due to low thermal expansion and thermal conductivity of granite
- Enhanced vibration isolation due to optimized granite machine structure