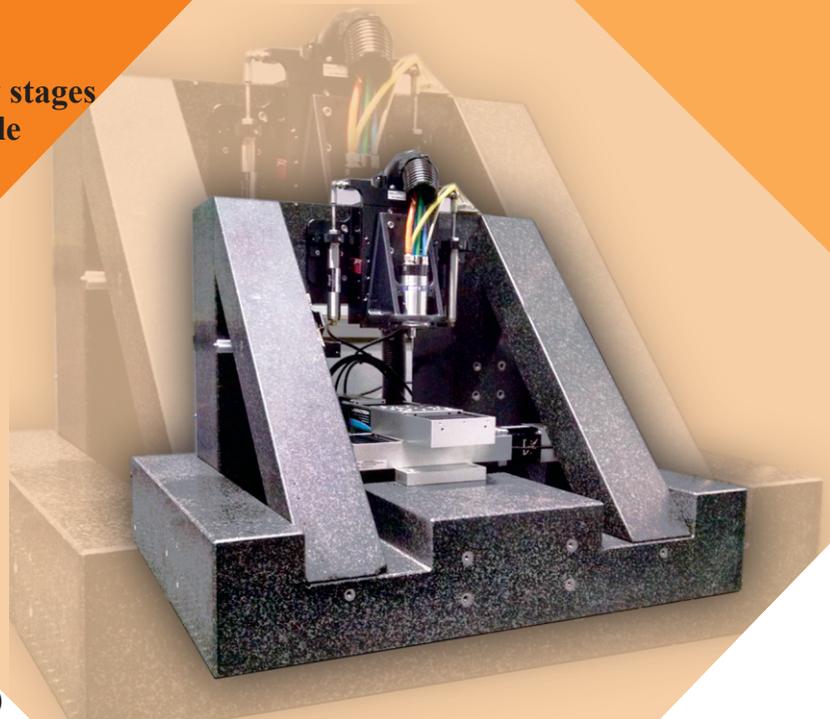




ULTRA HIGH SPEED MICRO MACHINING CENTRE

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 ($R_a \sim 100\text{nm}$)

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

Error Budgeting

Geometry Optimization

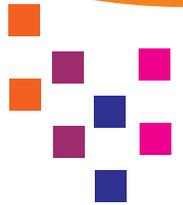
Optimal Design

Design Approach

Static Structure

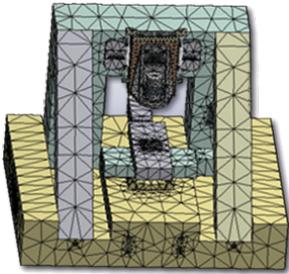
Modal and Dynamic Analysis

Error Budgeting



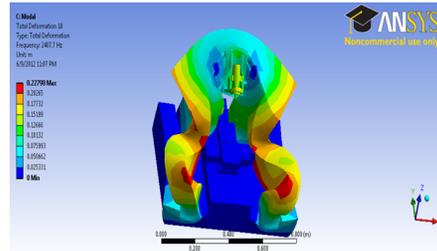
FINITE ELEMENT ANALYSIS

In order to design stiff structure to withstand heavy loads & impacts

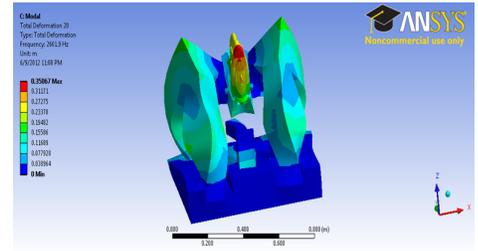


MODAL ANALYSIS

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



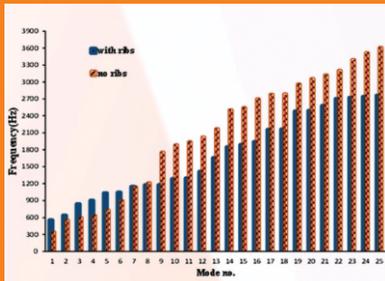
18th mode (2408 Hz)



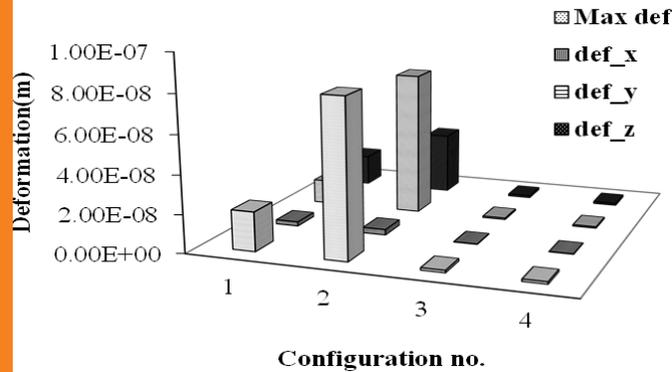
20th mode (2662 Hz)

RIB STRUCTURE

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



components	Ribs	No ribs
No slot	Configuration-1	Configuration-2
Slot	Configuration-3	Configuration-4

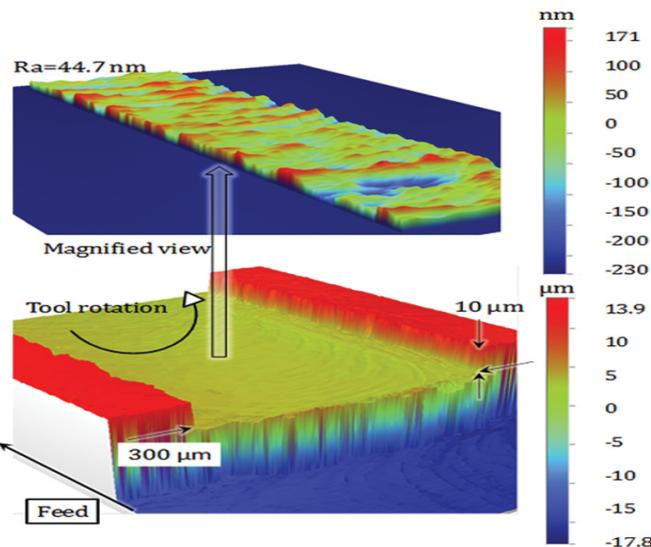
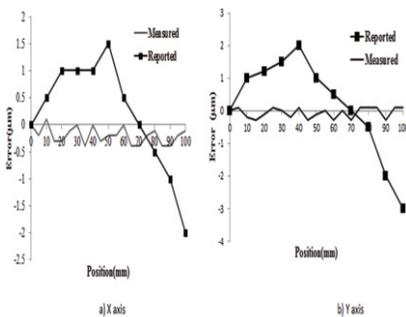


VIBRATION DAMPING

Frequency response analysis shows excellent damping ability with ribs

ERROR BUDGETING

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



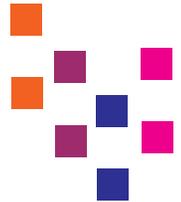
MACHINING RESPONSE

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	0.5 μ m
Accuracy	\pm 0.5 μ m



AXIS Z

Frictionless pneumatic dual counterbalanced mechanism for high precision

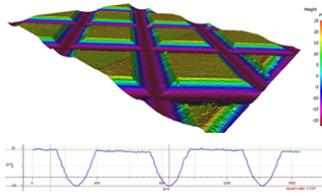
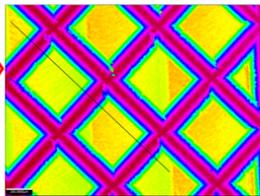
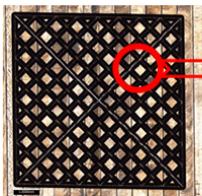
Travel distance	60 mm
Drives	Non contact Direct Drive/Brushless Linear Servomotor
Max. Feed Rate	0.06-6000mm/min
Maximum Load	Vertical 10 kg
Resolution	1 nm
Accuracy	\pm 0.3 μ m

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 μ m)
Tool Shank Dia	3 mm

STATIC AND DYNAMIC RIGIDITY

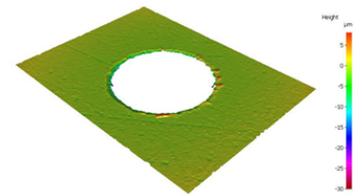
- High thermal stability machine structure due to low thermal expansion and thermal conductivity of granite
- Enhanced vibration isolation due to optimized granite machine structure



100 microm channel grid (mat. SS316 Steel)



Spiral Channel (tool 100 micron)



Micro hole (100 micron)

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