Design and build of an ultra-precision diamond machining system

Task
- Define a specification of a diamond machining system capable of producing aluminum parts for the Meso scale machine system.
- Perform necessary design and procurement.
- Build and commission the system.
- Process an aluminum frame getting 25 nm RMS roughness and flatness of less than 5 µm.
- Commercially machines get flatness around 15-20 µm in micro-scale workpieces.

Pre-existing system
- Pre-existing structure
  - Three pneumatic test support.
  - 5-axis Kinematic machine.
  - Vibration dampening performance.
  - Old 5-axis Grinding Machines.

Sliding Table
- Purpose of Sliding Air Bearing Table
  - Moving the same time a precision to another.
  - Holding the frame in the right position during processing.
  - Moving the sliding air bearing to avoid stick-slip on the machine surface.
  - The table has to be perfectly flat and parallel to the scale to process in a perfect surface.
  - Provides very high positional accuracy.
  - Generates a frictionless motion.
  - 10 µm of motion error.
Motor: Antrieb M-10 MC-142.
Controller: Antrieb M-10 MC-142.
Encoder: Renishaw linear encoder.
Amplifier: Antrieb M-10 MC-142.

Electrical
- Controllers
  - Antrieb M-10 MC-142.
  - 4-axis controller.
- Encoder
  - Absolute encoder.
- Motor: Antrieb M-10 MC-142.
- Encoder: Renishaw linear encoder.
- Feedback: Absolute encoder.

Spindle
- Spindle
  - High speed: 20,000 rpm
  - Integrated Cooling System
  - Output Power: 1,500 W
  - Max RPM: 12,000 RPM
  - 3 Phase Power Supply 220V
- Fly-cutter
  - 203 mm in Diameter Aluminium Disk
  - Single Point Diamond
  - Counterbalance etc.
- X-axis Motor
  - Antrieb M-10 MC-142
  - Maximum Force: 120 N
  - Stroke: 500 mm
- Y-axis Motor
  - Antrieb M-10 MC-142
  - Maximum Force: 120 N
  - Stroke: 500 mm

Safety
- Purpose of the Safety Covers
  - Prevent from approaching moving parts (spindle and table) during the machining.
  - Protect the operator from the fly-cutter in case of a failure,
  - Contains metal doors.
  - Allows the operator to safely see the machine.
  - Enable the operator to load and unload the product by using a door.
  - Transparent, resistant, stable, easy to use, poly carbonate sheet.
  - 8 mm thick.

Platform
- Platform
  - Allow frame setting.
  - Three points system.
  - Four surface frame.
  - Positioning with absolute encoder.

Outcome
Every component of the machine has been designed, purchased, delivered, and at the moment of poster printing (15-04-2014 10 of 12 weeks) the assembly stage is in progress following an accurate assembly plan. All the setting and alignment features have been designed and tested. The electrical components are ready to be integrated on the structure.