![COBORN logo]

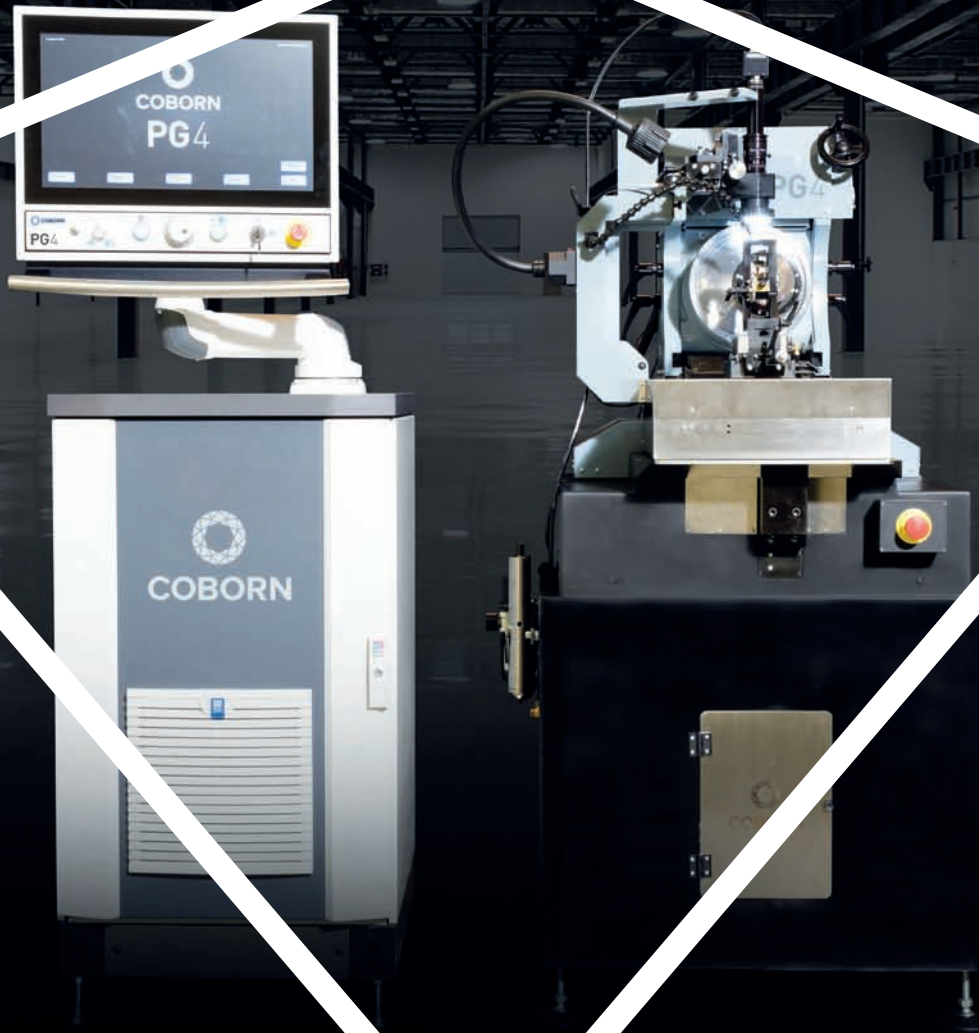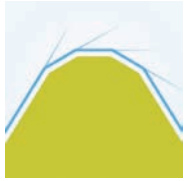# COBORN

ENGINEERED SOLUTIONS

PG SERIES

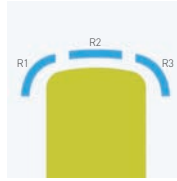# UNIQUE AUTOMATIC FEATURES

Grinding Facets – The 'Blocking Out' of a Cutting Tool Radius

Under program control, the machine will generate up to numerous facets around the radius of a tool.

For each facet, the control will:

- Rotate the wheel spindle to the required planetary position for soft direction grinding
- Advance the wheel a controlled amount and allow the tool to grind and 'float' back to the fixed stop
- Move the tool away from the wheel
- Index the pivot and grind the next facet

Grinding the Radius

- The program will then swing the pivot over the required arc to smooth the flank in conjunction with the radius
- Hard spots 'knarts' can be identified and a sub-arc of pivot rotation selected for focussed attention
- Once the tool is completed the wheel will move away from the tool for inspection / unloading

Simultaneous, Synchronous Axis – Grinding Vectors

The planetary, pivot rotation, wheel traverse, wheel in-feed and rotary module (RM) motions are all programmable and in the basic machine run independently of each other. Optional software is available for the PG4 such that the motion of two or more of these programmable axes can be electronically geared to run with synchronous motion. A repeating sequence of grinding directions or vectors can thus be established enabling complex profiles to be generated, such as elliptical, parabolic, hyperbolic and multiple blended radii.

Multi-Axis Configuration

The pivot and grinding wheel axes feature high precision air bearings and in normal production only these two axes would be running for the very final polishing of a low waviness radius tool. The remaining machine axes incorporate high precision linear or rotary bearings. The camera axis alignment is via micrometers.

SINGLE CRYSTAL DIAMOND GRINDING
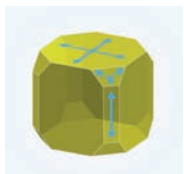
The Structure of Single Crystal Diamond

Like wood, diamond crystals have a 'grain', but unlike wood the 'grain' runs in many possible directions. Diamond can be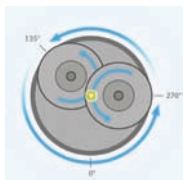 ground easily as long as the grinding direction is across the 'grain' or put another way – parallel to a 'soft' direction of the crystal. The PG4 works in a very different way to a conventional grinding machine. It is useful to understand why.
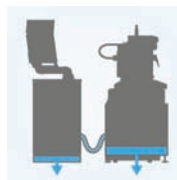
Planetary Motion Wheel Spindle

To achieve the correct grinding direction, the PG4 has a wheel spindle which can be positioned in a planetary manner so that the direction of the grinding wheel's motion at the point where it meets the diamond can be aligned with the soft direction of the facet being ground. This enables rapid material removal rates to be achieved.

For example, with the wheel in the '135°' position, the grinding direction is against the grain and little, if any, material will be removed. At the '270°' position, the diamond is ground rapidly as the grinding direction is now running parallel to a 'soft' direction of the crystal.

The Floating Table with Constant Grinding Load

Because diamond's hardness varies with crystal direction, it is not possible to grind diamond using a positive in-feed mechanism alone. Instead a constant force is used to simply apply a steady grinding pressure. The diamond tool is mounted on a linear motion floating table which is held in contact with the wheel by a dead weight until it meets a fixed stop. The floating table also contains the air-bearing pivot motion which enables precise radii to be formed.

Edge Perfection and Vibrations

Controlled and low waviness SCD tools can only be produced if vibrations at the wheel/diamond interface are eliminated. A composite granite base to damp vibrations and the air-bearings in the wheel and pivot spindles are all necessary to ensure that the ultimate perfect edges are achieved. Operators can also introduce vibrations as they press switches or tap the touch screen, to avoid this vibration, all aspects of human interface have been assigned to a separate tower which is connected to the main grinding machine via an umbilical harness. Once the program starts there is no further need for the operator to touch the grinding machine itself.

PG4 TECHNICAL SPECIFICATION

Area	Specification
Machine dimensions (w x d x h)	790mm x 1310mm x 1900mm
Control tower dimensions (w x d x h)	610mm x 640mm x 1910mm
Machine weight	800kg
Control tower weight	160kg
CNC control system	CNC control with Intel i7 processor running Coborn .net software on a Windows platform
Grinding wheel spindle	2.0kW 0 - 12000 rpm programmable liquid cooled high-precision air spindle
Grinding wheel	Ø 85mm Metal bond wheel or cast iron lap
Pivot spindle	High-precision air spindle with radial error < 0.00005mm
Lubrication	Manual lubrication system
Process inspection	Coborn integrated camera inspection system X60 to X600 magnification
Electrical requirements	380 / 220 3phase 50/60 Hz 16amps
Mechanical options	Rotary axis (RM) programmable, Coning spindles (CS) manual, Work piece clamping systems
Software options	Rotary module, Controlled/low waviness, dxf. import (profile grind), nano positioning module, helical module

Axis	Description	Feedback Resolution	Program Resolution	Travel
X	Wheel head traverse	0.0005mm	0.01mm	100mm
Y	Wheel head infeed	0.0001mm	0.0001mm	45mm
T	Planetary head tilt	Manual	Manual	0 to 20°
B	Planetary head orientation	0.01°	0.1°	360°/continuous
C	Pivot spindle	0.0001°	0.001°	+/- 100°
V	Infeed table	0.000005mm	0.00001mm	30mm
A	Rotary module (Optional)	0.0002°	0.001°	360°/continuous
TPX	Fixture X	Manual	Manual	12mm
TPY	Fixture Y	Manual	Manual	12mm
TPZ	Fixture Z	Manual	Manual	75mm
TPA	Fixture tilt	Manual	Manual	-20 to + 20°
Xc	Camera X	0.01mm	Manual	12mm
Yc	Camera Y	0.01mm	Manual	12mm
Zc	Camera Z	Manual	Manual	80mm

DIMENSIONS AND FOOTPRINT
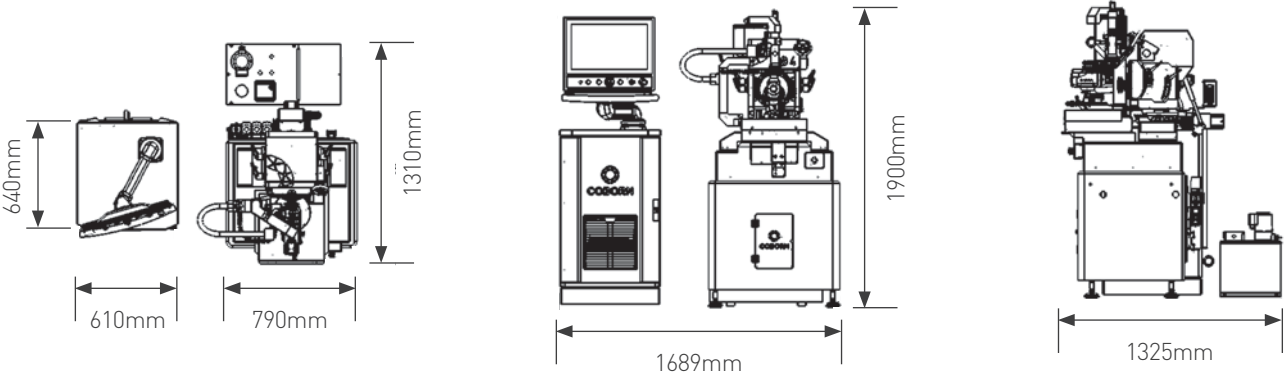
MULTI-FUNCTIONAL CAPABILITIES

CNC GRINDING MACHINE

Ultra-high precision, CNC grinding machine for single crystal diamond tool manufacture.

The new PG4 enables the automated production of ultra-high precision diamond tools.

Launched in 2016, the PG4 is an automatic, ultra-high precision grinding machine designed to meet the most sophisticated of demands from toolmakers working with natural or synthetic single crystal diamond (SCD), manufactured by either high pressure high temperature (HPHT) or chemical vapour deposition (CVD).

Drawing on our 75 years of experience in designing machines for grinding and polishing diamond and related ultra-hard materials, the PG4 now enables many of the laborious and time consuming processes, such as blocking out, to be fully automated and the subsequent final radius polishing to be completed without human intervention.

The PG4 uses high quality air bearings for both wheel spindle and the pivot which are essential pre-requisites for controlled and low waviness SCD tools. Programming is extremely simple and minimal training is required.

The PG4 is an ideal machine for SCD tool manufacturers who are looking to minimise production costs and use their skilled operators in more demanding areas.

TOOL FORMATS

The PG4 is designed to automatically manufacture standard, controlled and, under suitable conditions, low waviness diamond tools. It can be used for making facetted and convex radius tools using: natural diamond, HPHT, synthetic diamond, CVD synthetic diamond.

Low and controlled waviness tools
Elliptical, parabolic, hyperbolic and blended radii profiles
Complex profile tools
Facetted, coned and radiussed indenters

TOOLING
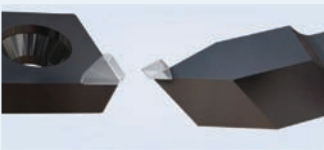
Low and controlled waviness tools

Elliptical, parabolic, hyperbolic and blended radii profiles

Complex profile tools
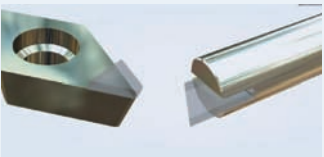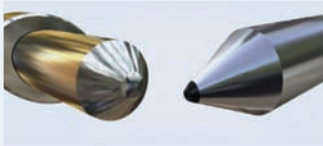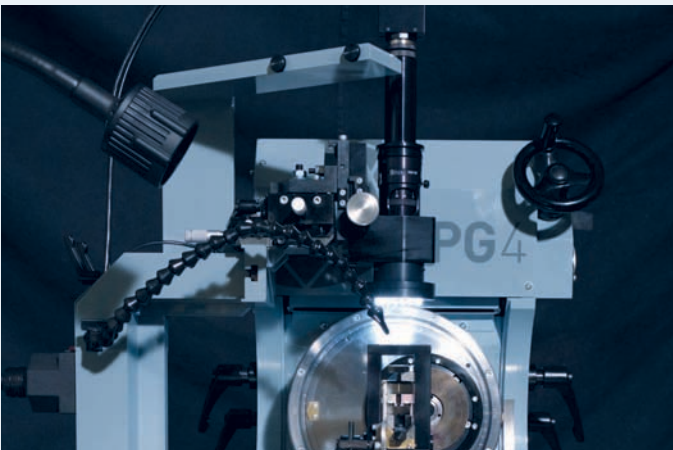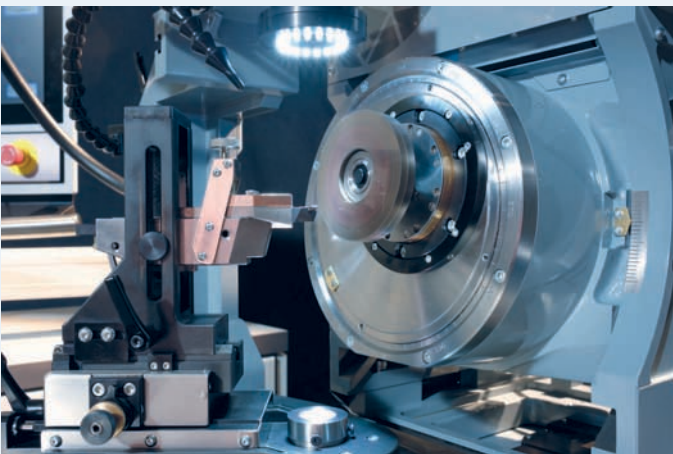

Facetted, coned and radiussed indenters

PG4

Tool inspection
- High resolution touch-screen
- Tool profiles generated from tool program
- Digital zoom and image dragging facility

Tool Post
- X,Y tool position adjustment via micrometers
- Tool height adjustable
- +/-20° tilt cylindrical clearance
- Nest accepts round and square shank tools

GUI Programming
- Simple programming via menus
- Machine operation training in one day
- Rotary axis training in one additional day

Control System
- Fast Windows-based PC and associated drives
- Connects to grinding machine by umbilical harness to avoid vibration transmission
- All units pluggable
- Remote diagnostics via internet
- 3 phase, multi voltage/ multi-frequency supply

Wheel Arbour
- Precision ground and dynamically balanced to gyroscope tolerances
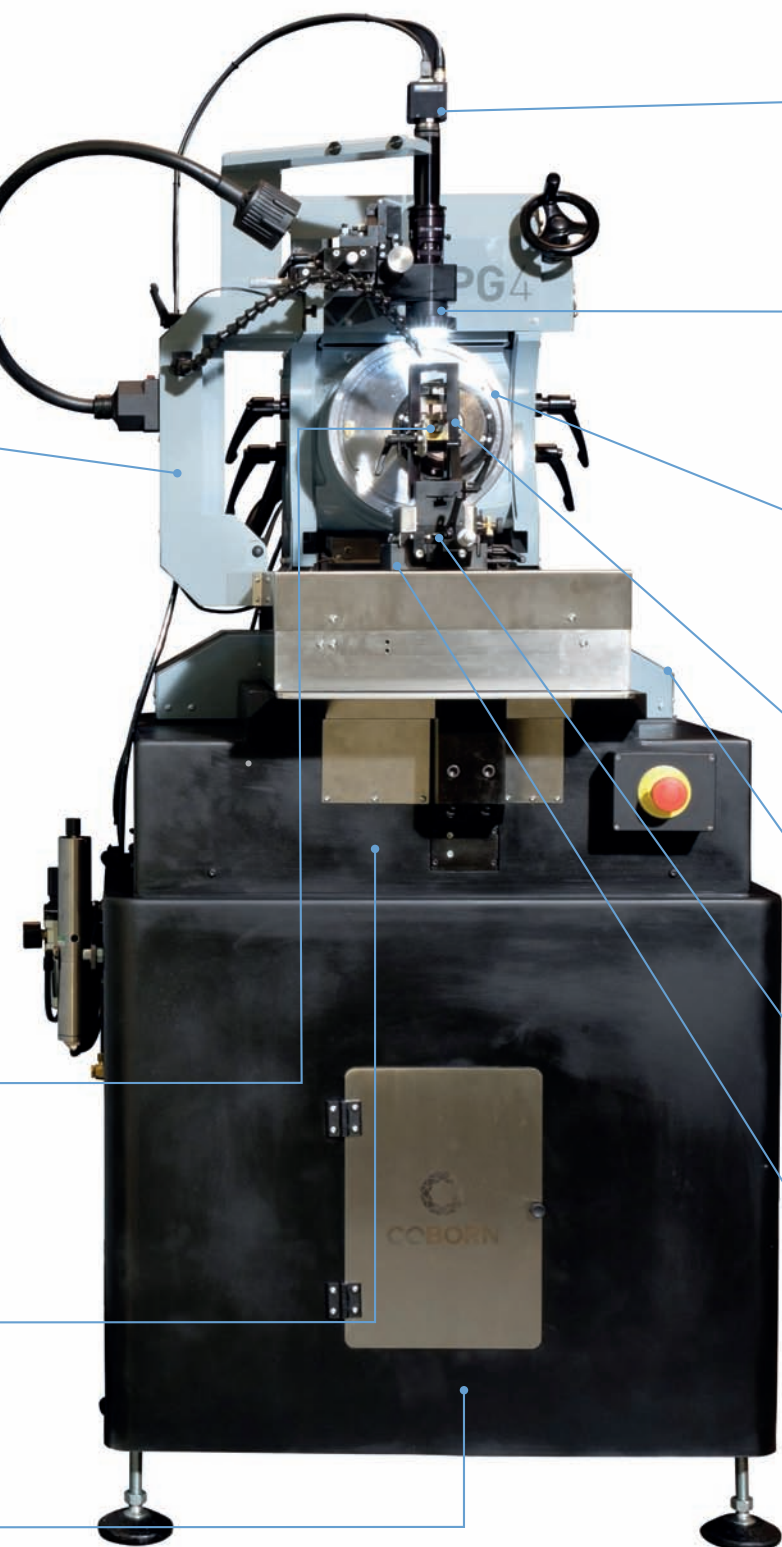- Allows wheels to be removed and replaced from spindle nose quickly and easily

Floating Table
- High precision linear bearings
- Constant load, dead weight systems, 0.5-3.0kg
- 0.5nm in-feed scale

Composite Granite Base
- For optimum vibration damping and thermal stability

Camera
- GigE camera for fast image capture
- X, Y micrometer adjustment for camera alignment

Zoom Lens
- Extra long focal length for in-process inspection
- x60 - x600 magnification
- x1000 magnification - optional extra (inspection only)

Planetary Motion
- Coborn, high precision planetary with rolling element design
- 0.1° planetary position resolution
- AC servo motor drive via non-influencing motor and belt
- Speed, direction and angular position programmable
- 0 - 20° tilt for conical clearance

Air-Bearing Wheel Spindle
- Ultra-high precision air-bearing
- Water cooled to provide thermal stability
- Speed up to 12,000 rpm programmable
- Rotation direction programmable
- Brushless, vibration free integral drive

Wheel Traverse
- Non-influencing linear drive
- Can be synchronised
- Fully programmable speed, and stroke
- Sinusoidal acceleration / deceleration

Projection Light Source
- High intensity LED
- Electronically dimmable
- Cover glass easily replaced

Air-Bearing Pivot
- Ultra high precision air-bearing pivot
- Brushes, vibration free integral drive
- ‹50nm rotational error
- Maximum arc of rotation 182°
- Position resolution 0.001°
- Position & speed programmable

OPTIONAL FIXTURES

Many optional fixtures are available and the most common are shown below. Coborn can also design and supply custom fixtures and tool holding solutions according to customer requirements.
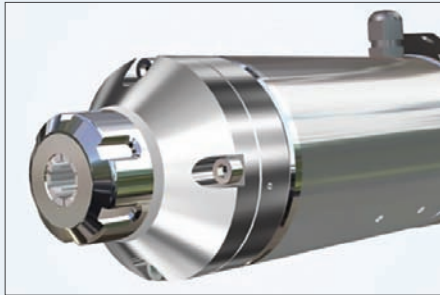
RM76 – Rotary Axis

- For coning, cylindrical grinding and index positioning
- Programmable rotation to 0.001°
- Collet chuck to suit tools up to Ø16mm
- Other adaptors available
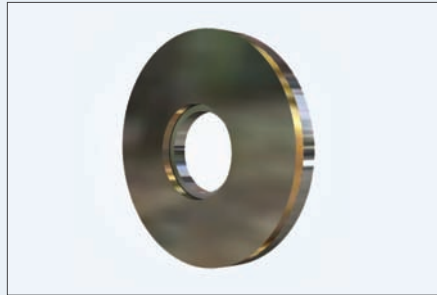
SAM – Metal Bond Wheels

- High quality, porosity free
- Extremely long life, designed for dry grinding
- Dynamically balanced to gyroscopic tolerances

TCS1 – Tool Cooling Unit

- Cools tool shank using sub-zero compressed air
- Removes thermal expansion effects
- Programmable 'on/off'

PS2B – Planetary Scaife Bench

- For top lapping of SCD tools after radius grinding
- Re-sharpening worn tools and general facet work
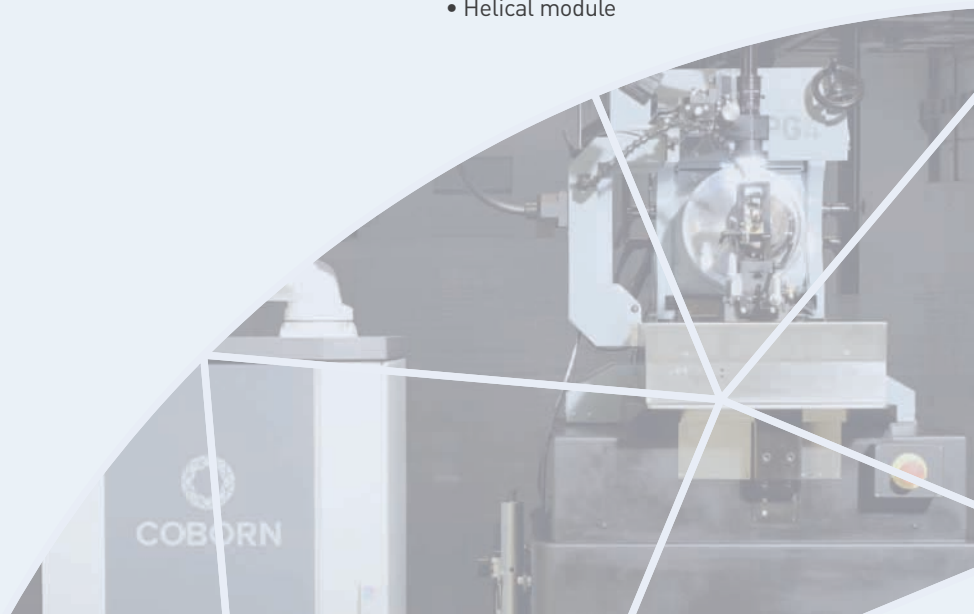- Adjustable planetary motion allows 'set and leave' operation

TRC – Tool Radius Check

- Microscope with image analysis software to measure tool radius and radius waviness
- Generates custom designed QC graphical data sheets which can then be supplied with the associated tool
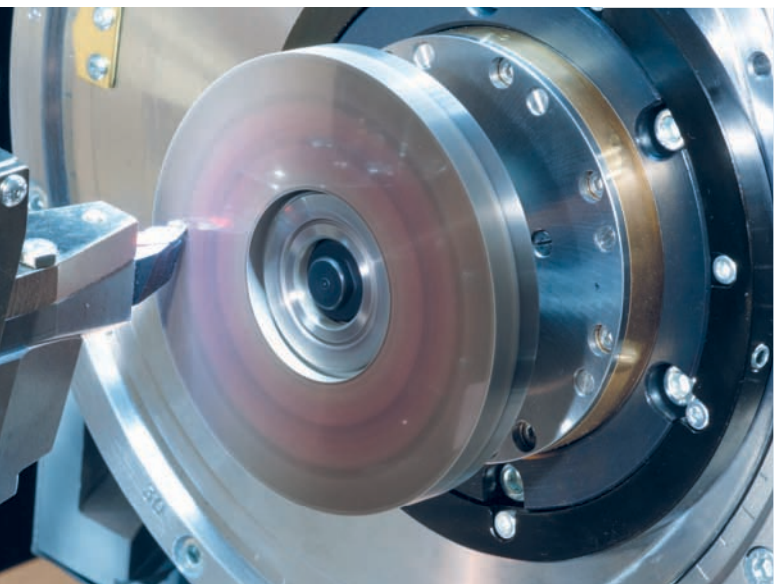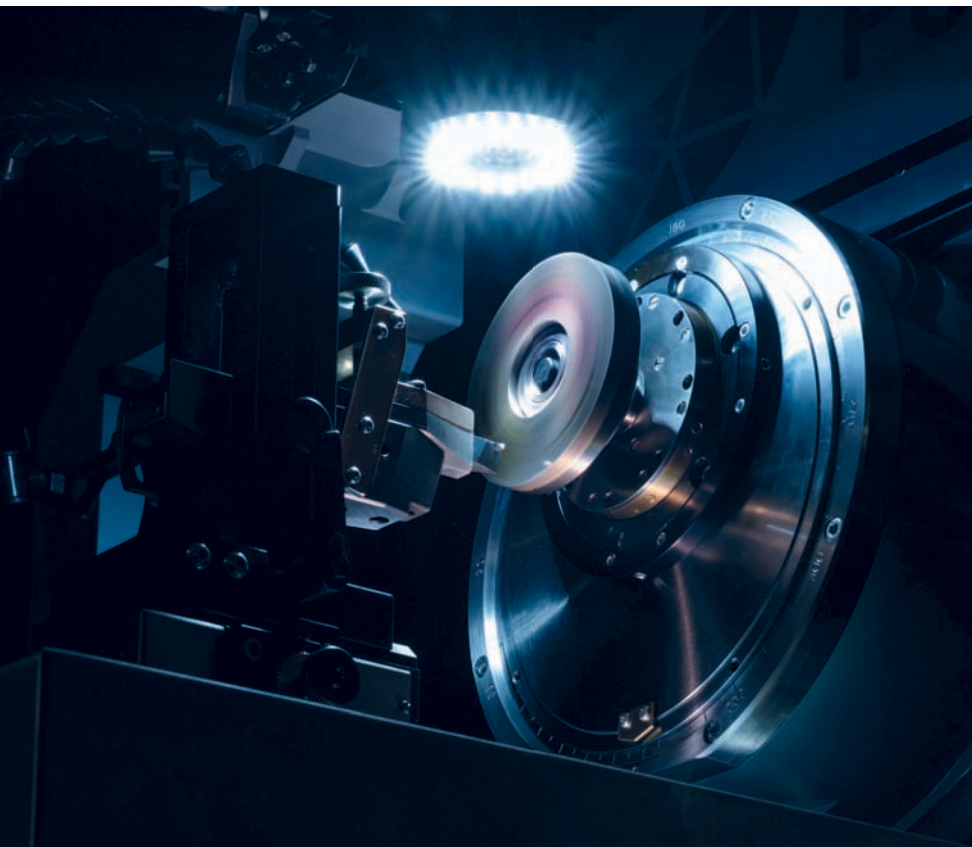
Optional Software Modules

- Synchronized pivot, planetary, traverse, infeed and rotary (RM) motions
- Profile contour deviation
- CAD file import (dxf) module
- Nano positioning module
- Helical module

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PG SERIES

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ENGINEERED SOLUTIONS