



**UNISIG**

**USC-TS32-5**

MULTIPLE SPINDLE DEEP HOLE DRILLING MACHINE  
FOR HEAT EXCHANGER TUBE SHEETS

## **SPECIFICATIONS AND DESIGN OVERVIEW**

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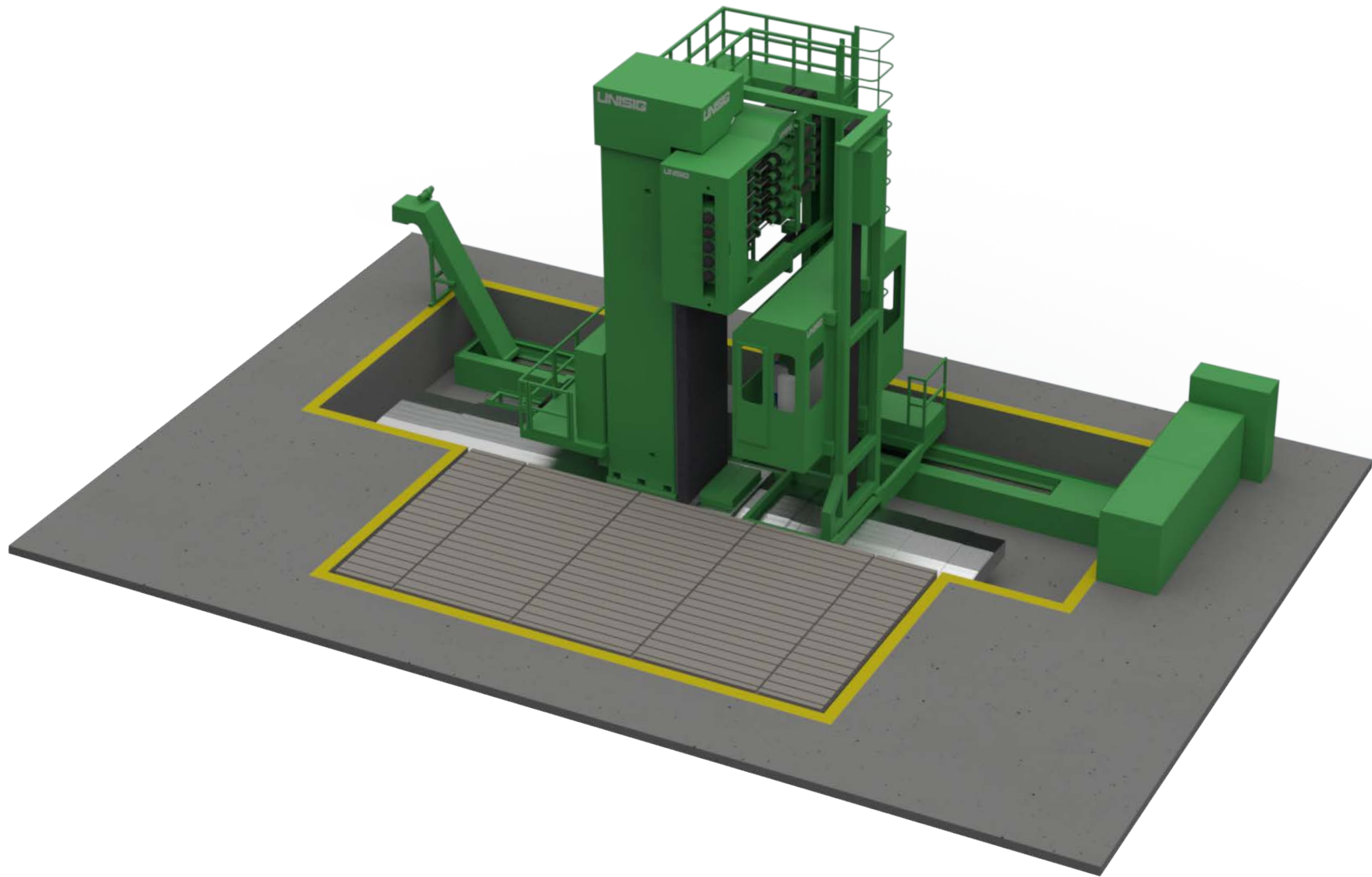
USC-TS32-5

**NUMBER OF SPINDLES:**  
5x, INDEPENDENT

**DRILLING DIAMETER:**  
8-32mm [0.31-1.26 in]

**DRILL DEPTH:**  
750mm [30 in] MAXIMUM

**SPINDLE CENTERS**  
300-450 mm  
[11.81-17.72 in]



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**X-AXIS (HORIZONTAL)**

8,000mm (315.0 in)

**Y-AXIS (VERTICAL)**

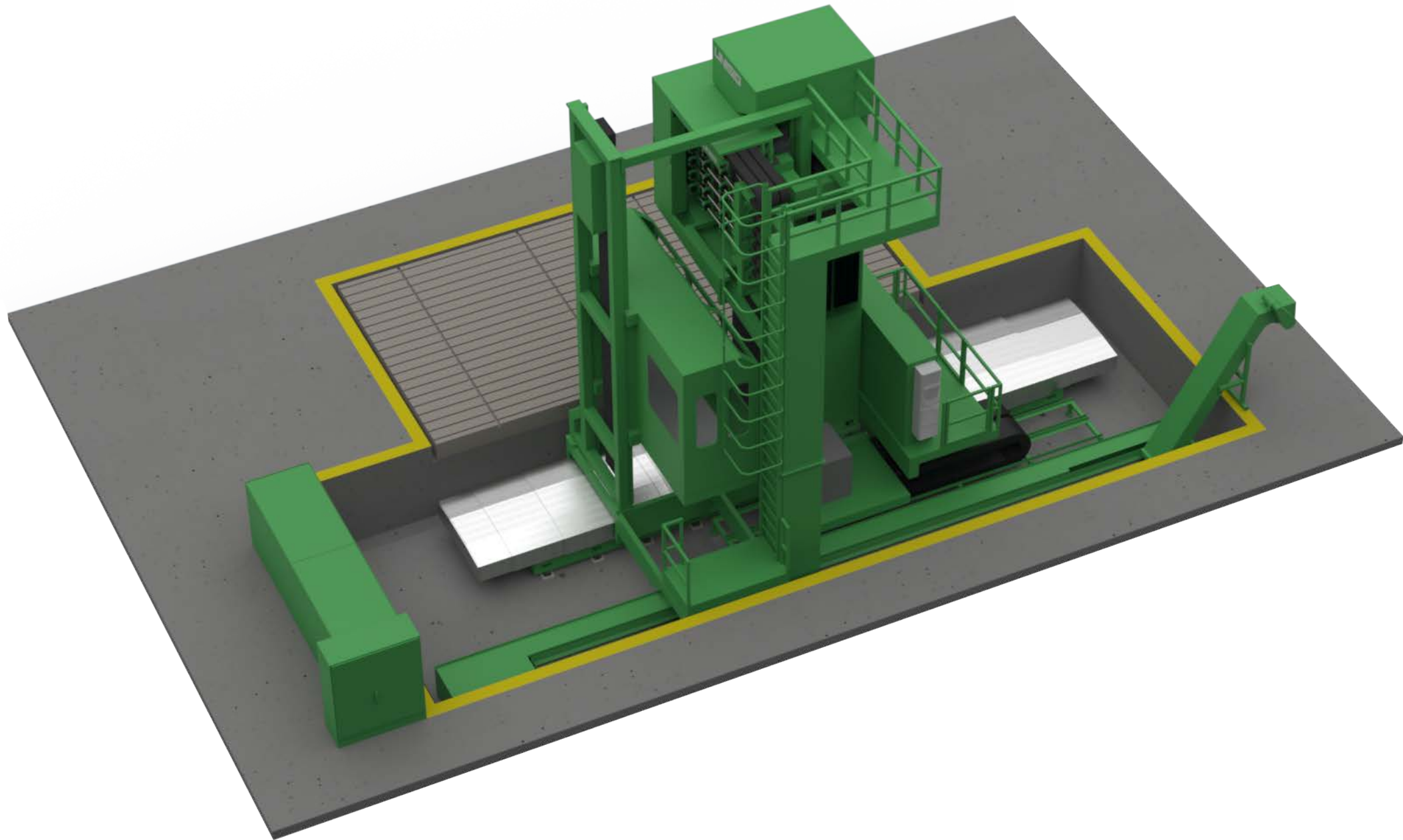
3,500mm [137.8 in]

4,500mm [177.2 in]

OPTION

**RAPID TRAVERSE**

10 m/MIN [394 in/min]



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**SPINDLE POWER**

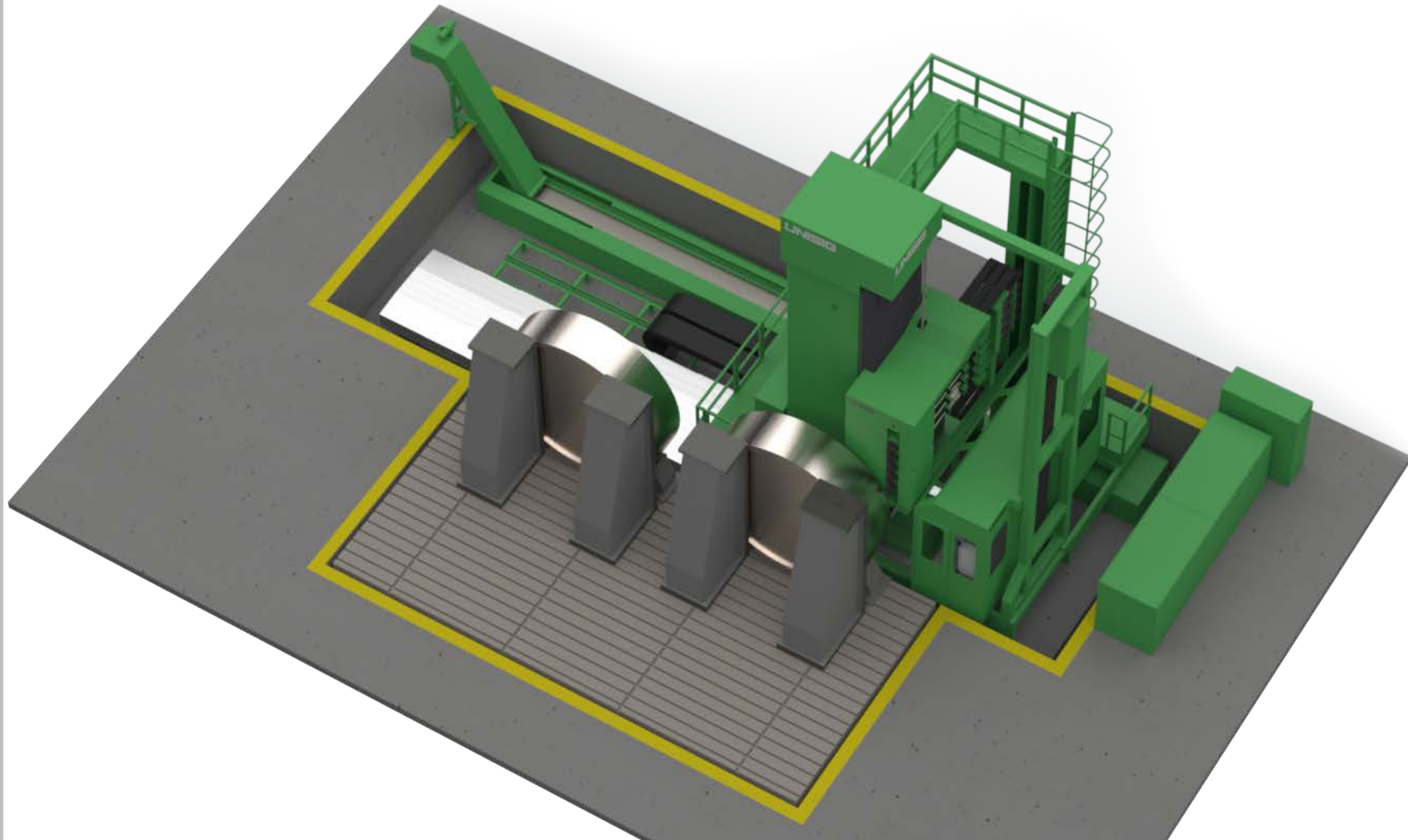
22 Kw [30 hp]

**SPINDLE SPEED**

4000rpm MAXIMUM

**SPINDLE TYPE**

INTEGRAL MOTOR



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**BTA TOOLING**

EXTERNAL COOLANT  
INTERNAL EXHAUST

**GUNDRILL TOOLING**

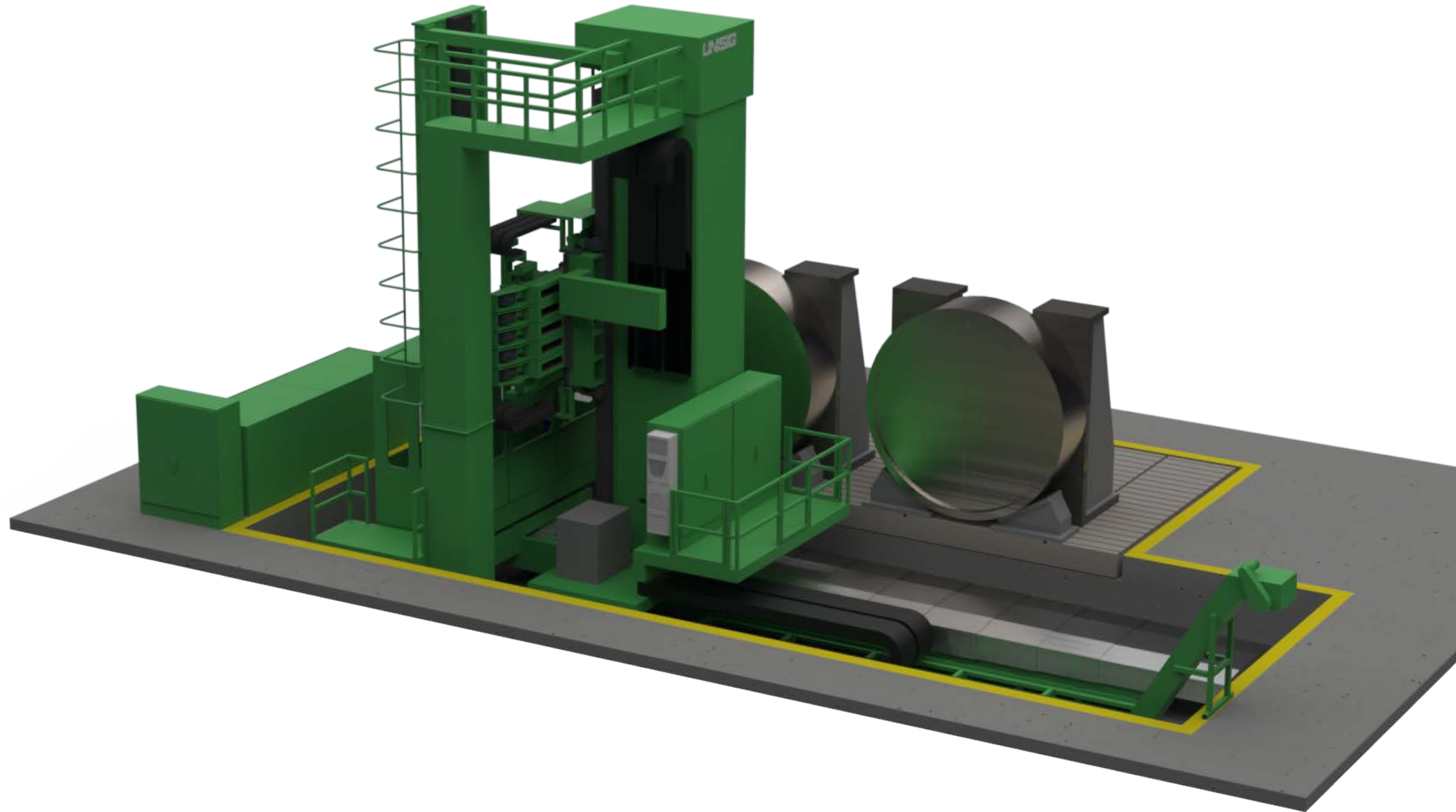
INTERNAL COOLANT  
EXTERNAL EXHAUST

**COOLANT FLOW**

120 L/min [32 GPM]

**COOLANT PRESSURE**

124 bar [1800 psi]

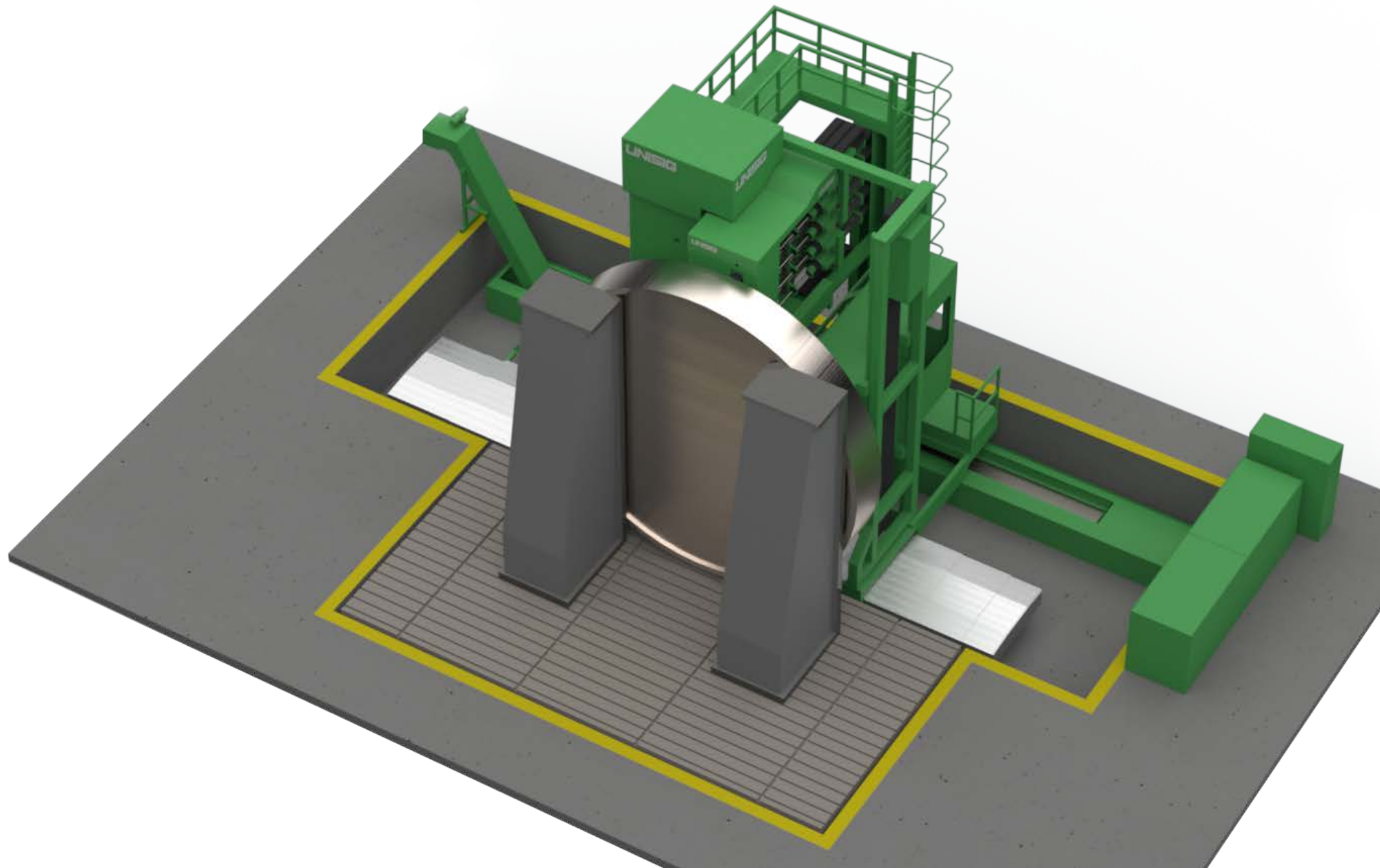


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**CONTROL TYPE**  
SIEMENS 840Dsl

**AXIS CONTROL**  
X, HORIZONTAL  
Y, VERTICAL  
Z1-Z5, DRILLING  
V1-V4, CENTERLINE  
S1-S5, SPINDLE  
C1-C5, PUMP



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**MOTION CONTROL**

**X-AXIS DRIVE**

RACK AND PINION

DUAL SERVO PRELOAD

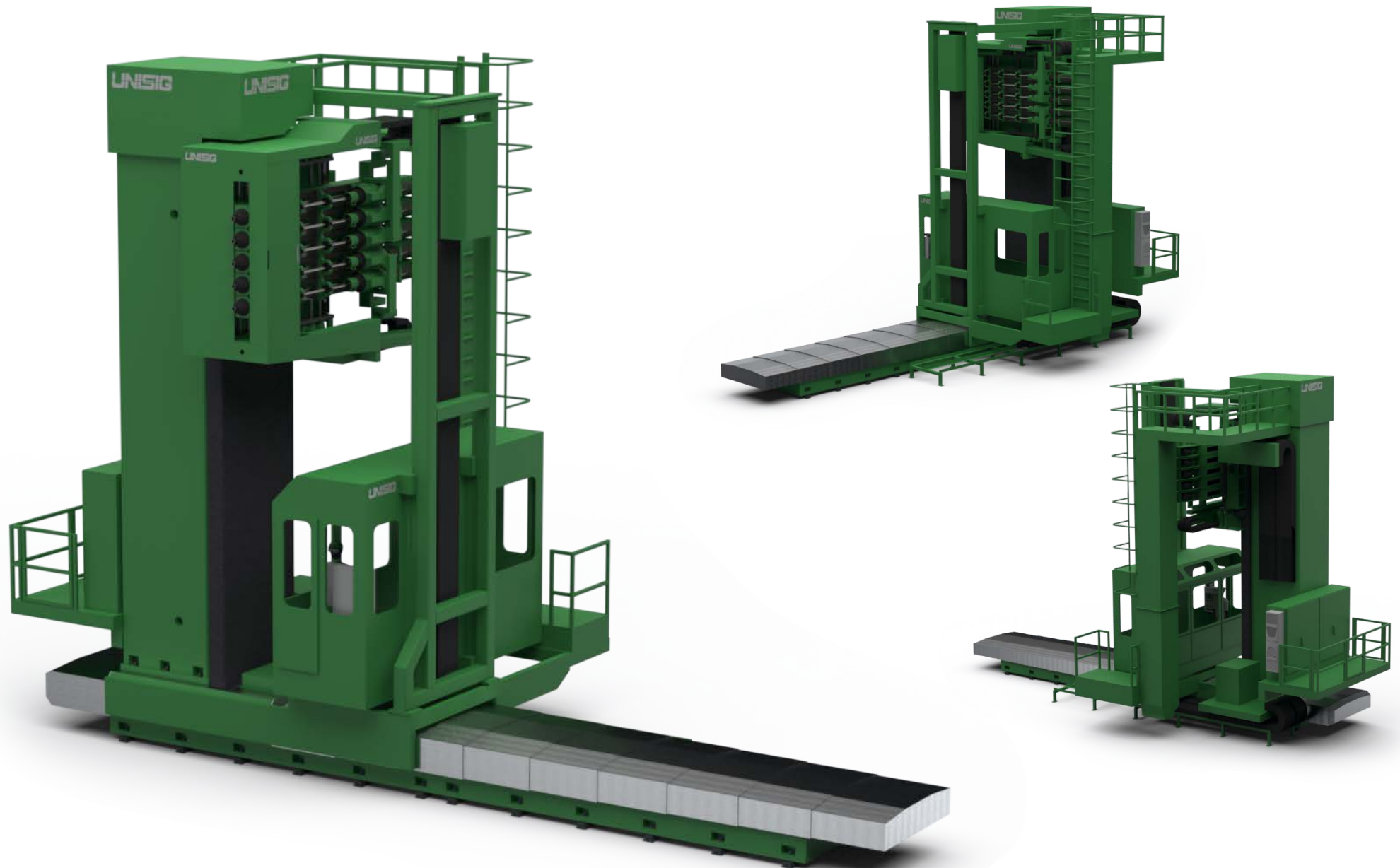
SCALE FEEDBACK

**Y-AXIS DRIVE**

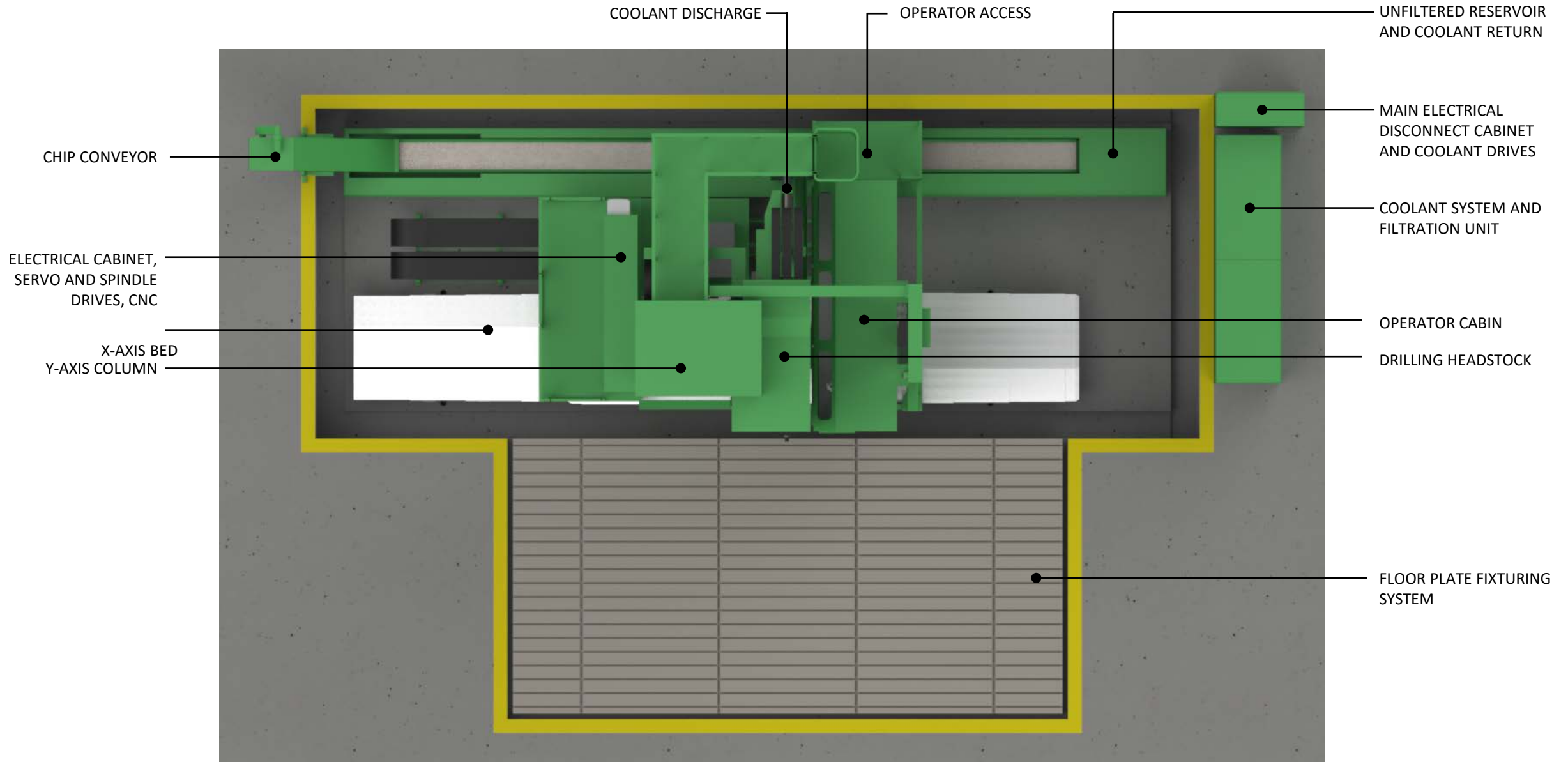
PRELOADED BALL SCREW

COUNTERBALANCE

SCALE FEEDBACK

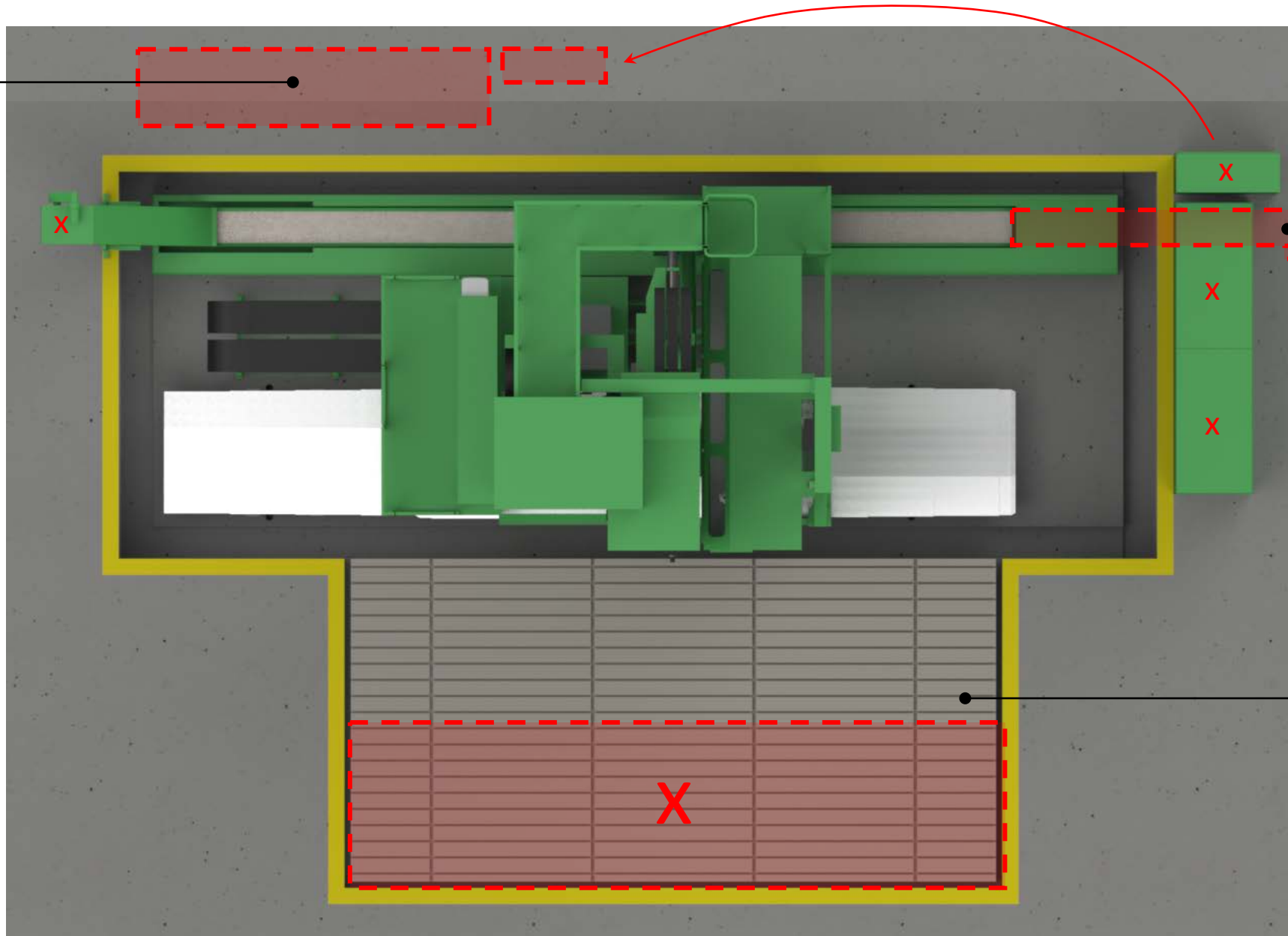


# INSTALLATION CONCEPT



# BUILD TO ORDER INSTALLATION FLEXIBILITY

COOLANT SYSTEM AND  
MAIN ELECTRICAL  
CABINET LOCATIONS

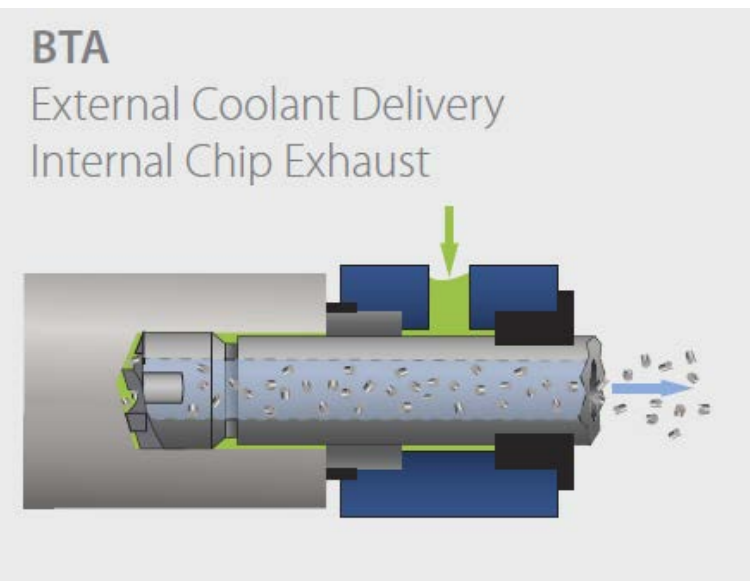


CHIP DISCHARGE  
LOCATION

FLOOR PLATE  
DIMENSIONS

# APPLICATION

# BTA TOOLING OVERVIEW



## Brazed Disposable BTA

Common sizes  
0.53-1.25 inch  
13.5 – 32 mm

Full range  
0.31-2.56 inch  
8 – 65 mm



## Indexable BTA (single-insert)

Common sizes  
0.63-1.10 inch  
16 – 28 mm

Full range  
0.63-1.10 inch  
16 – 28 mm



## Indexable BTA (multi-insert)

Common sizes  
0.98-2.56 inch  
25 – 65 mm

Full range  
0.98-10.00+ inch  
25 – 254+ mm



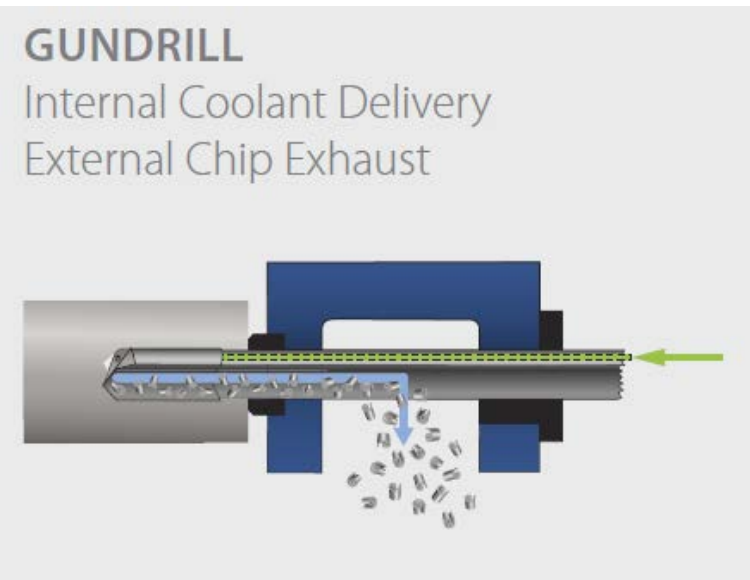
## Spade Drill BTA

Common sizes  
0.53-1.25 inch  
13.5 – 32 mm

Full range  
0.38-4.50 inch  
8 – 114 mm



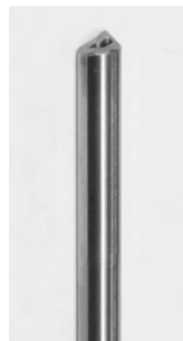
# GUNDRILL TOOLING



## Solid Carbide Gundrill

Common sizes  
0.12-0.25 inch  
3 – 6 mm

Full range  
0.02-0.47 inch  
0.5 – 12 mm



## Carbide tipped Gundrill

Common sizes  
0.12-0.75 inch  
3 – 19 mm

Full range  
0.08-2.00 inch  
2 – 50 mm



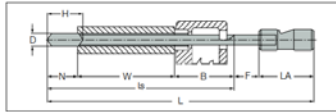
## Indexable Gundrill

Common sizes  
0.63-1.25 inch  
16 – 32 mm

Full range  
0.53-2.00 inch  
13.5 – 50 mm

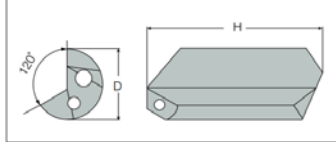


Standard Gundrill Length Calculations



**Example**  
Drilling of a  $\phi 10 \times 500$  depth hole on a gundrill machine with  $\phi 25 \times 70$  mm driver code No. 57 (See page 739)  
 $D=10$   $W=500$   $LA=70$   $B=250$  (or per experience)  
 $L=N+W+B+F+LA$   
 $L=(35-10)+500+250+13+70=858$  (OAL)  
 $LS=N+W+B=770$  (flute length)

Standard Gundrill Carbide Head Length



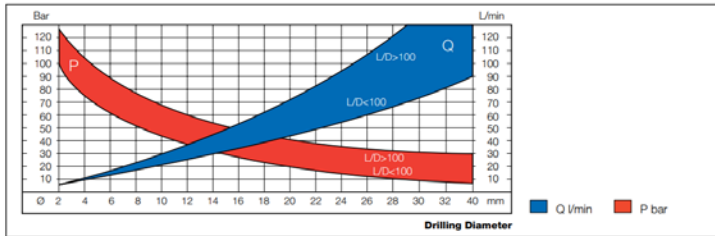
- D= Cutting diameter
- H= Carbide length
- N= Regrinding area = H-D
- W= Hole depth
- B= Chip evacuation area
- = For typical gundrill machines, 250 mm
- = For machining centers, 2xD (minimum 15 mm)
- F= 10 mm.
- LA = Driver length
- LS = Overall length

Ordering Code  
For example:  
D and Ls are available as standard  
STGD-10000-0858-57-IC08

Diameter Range	Head Length
2.50-3.80	20
3.80-4.05	23
4.05-5.05	25
5.05-6.55	30
6.55-11.05	35
11.05-18.35	40
18.35-21.35	45
21.35-23.35	50
23.35-26.35	55
26.35-32.00	65

Note: regrindable length=H-D

Pressure and Coolant Flow Rate for Gundrills



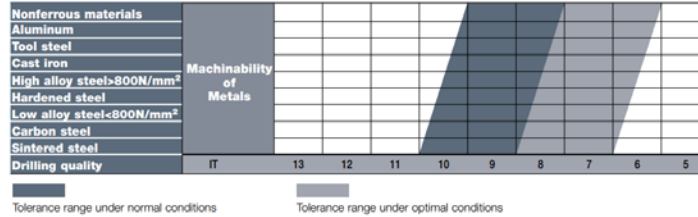
**Gundrill Lubrication and Cooling**  
The best performance is obtained by using oil. On equipment that uses water-soluble fluids (i.e. machining centers and CNC machines), a concentration between 10% and 15% is recommended.

- Guidelines for Optimal Gundrill Performance**
- It is recommended to use a strong coolant flow for efficient chip flushing and cooling of the cutting edge
  - It is recommended to use a filter under 20  $\mu$ m
  - Note: Improper filtration may result in interrupted flow of lubricating oil. This creates a sticky surface on the bearing pads and leads to premature wear of the tool and overloading the coolant pump and spindle seals
  - Temperature of the coolant should be between 20 and 22° C

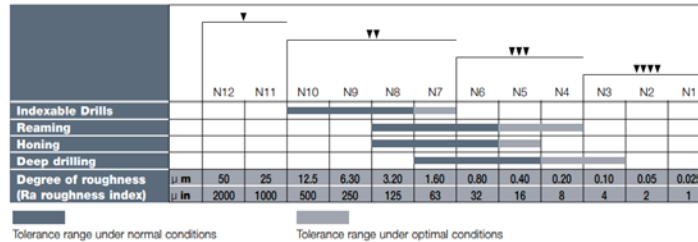
Note: Above 50° C the viscosity of the coolant is reduced by 50% and becomes ineffective.

Drilling Tolerances Obtainable In Deep Hole Drilling

**Deep Drilling Tolerances**  
Gundrill configurations when used under recommended conditions can produce holes with tolerances of IT8-IT9. When operating under optimal conditions, even better tolerances can be achieved.

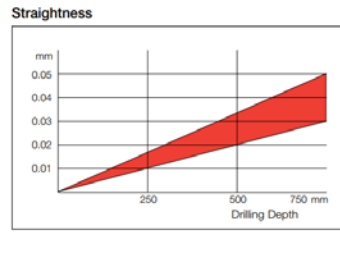
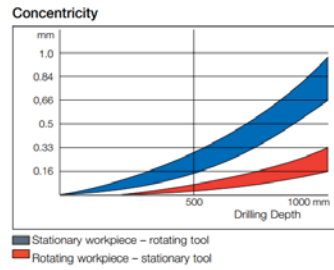


**Surface Quality**  
Surface quality of 0.2 Ra can be achieved when using gundrills under recommended conditions.



- Concentricity and Straightness**  
The resulting quality depends on different factors such as:
- Drilling depth and diameter
  - Type of machining and cutting parameters
  - Quality and uniformity of the workpiece material
  - Machine tool conditions
  - Gundrill support

**Circularity**  
The geometric quality of bores obtained from deep hole drill bits is clearly higher than that obtained with the use of twist drills. It is possible to obtain precision with deviations of less than 4 $\mu$ m.



EXAMPLE FROM TOOLING MANUFACTURER:

**DIAMETER: IT8-IT10**  
0.500" dia = .0011"-.0028" tolerance

**FINISH:**  
N5-N7 = 16-63 Ra

**CIRCULARITY:**  
4 MICRON = 0.0002"

**STRAIGHTNESS, ROTATING TOOL:**  
0.33 - 0.60 mm at 750mm DEEP  
0.013 - 0.024 in at 30in DEEP

UNISIG builds machines with process control, accuracy and power to maximize the performance of today's cutting tools

The machine and process control builds confidence to test the limits of what is possible, and to make it easy to find an optimal operating condition

UNISIG machines also allow users to push tooling manufacturers to develop and improve their product.

# THE PERFECT DEEP HOLE

## TOOLING CONSIDERATIONS

### **Drilling system (BTA or Gundrill):**

Selected for drill diameter size, depth, chip control

### **Drill head:**

Geometry, grade, coating, chip breaker ideal for workpiece material

### **Drill bushing:**

Size, tolerance, finish, hardness, material

### **Cutting fluid:**

Correct viscosity for hole size, EP additives for performance targets

### **Coolant temperature:**

Stable performance with heat from process removed

### **Cutting speed:**

Ideal for workpiece material, coating

### **Chip load/feed rate:**

Ideal for material, cutting edge strength, chip formation

### **Optimization**

Experience with process and workpiece material to achieve highest accuracy, productivity and tool life

## MACHINE CONSIDERATIONS

### **Bushing to workpiece interface**

Rigid, sealed and aligned to workpiece

### **Drill support**

No span longer than 40x deep, additional supports near drill bushing for improved stability

### **Rigidity and Alignment**

Bushing, bar guides, spindle in precision alignment, no vibration or deflection while drilling

### **Cutting fluid delivery**

Adequate flow to flood the head and remove the chips, without excessive pressure buildup that will create forces that change accuracy or process reliability

### **Motion Control**

Zero backlash preloaded feed systems, exact cutting parameter delivery regardless of loads, complete independence of each tool

### **Optimization**

Full control of process variables while drilling, Immediate process feedback from tool, programmable setpoints

## OBJECTIVES:

- PERFECT DEEP HOLES, EVERY SPINDLE, EVERY TIME [10,000+ IN ONE PART]
- ABSOLUTE PROCESS RELIABILITY WITH A SMART MACHINE MONITORING THE PROCESS
- VERY HIGH SPINDLE UTILIZATION
- VERY HIGH TOOL LIFE
- SIMPLE SETUP AND OPERATION

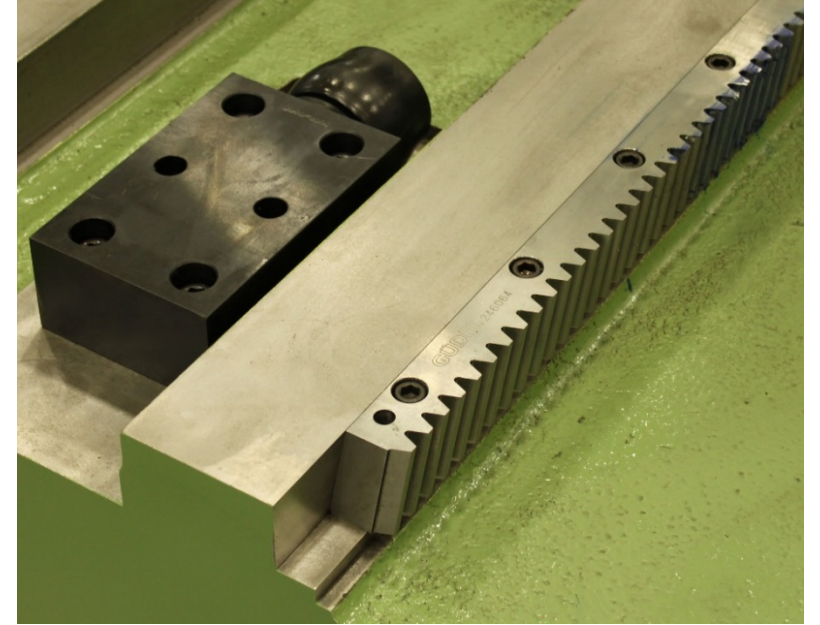
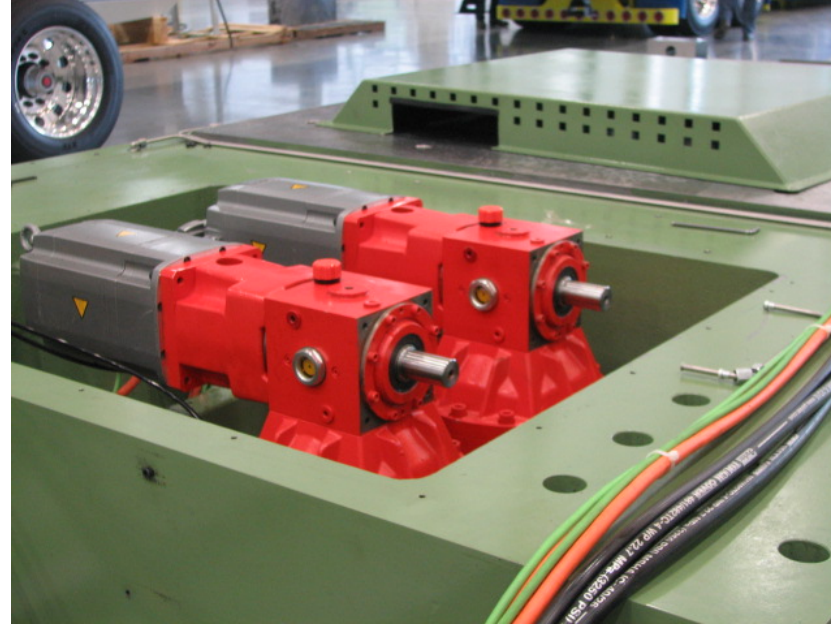
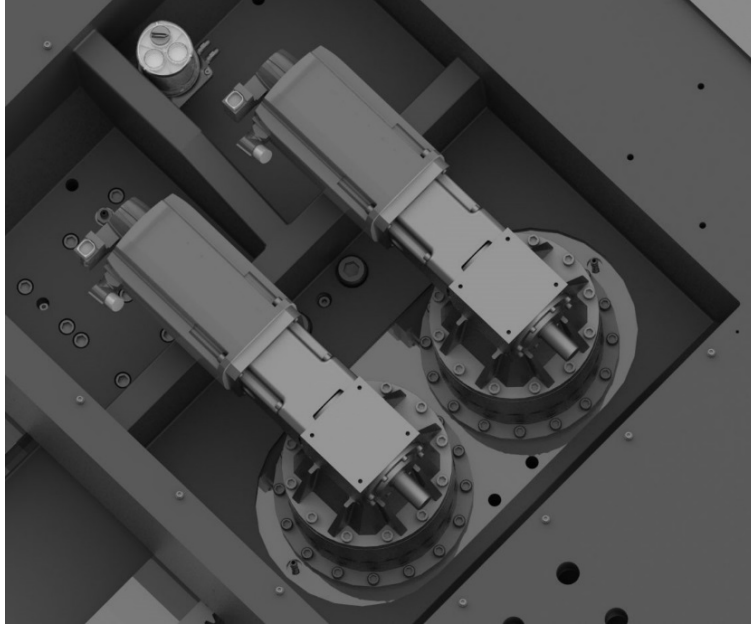
# MACHINE ENGINEERING

## MACHINE BED



- Stable, heavy sectioned gray cast iron (40,000psi premium grade gray iron)
- Lost foam pattern system to allow optimal casting section
- Thermally stress relieved before machining
- Precision machined on 5-sides in a single setup
- Laser inspection of final geometry before additional assembly
- Geometry is corrected at the source of error if required, not compensated later in build

## X-AXIS DRIVE



Ground, heat treated helical rack system is mounted to bed casting

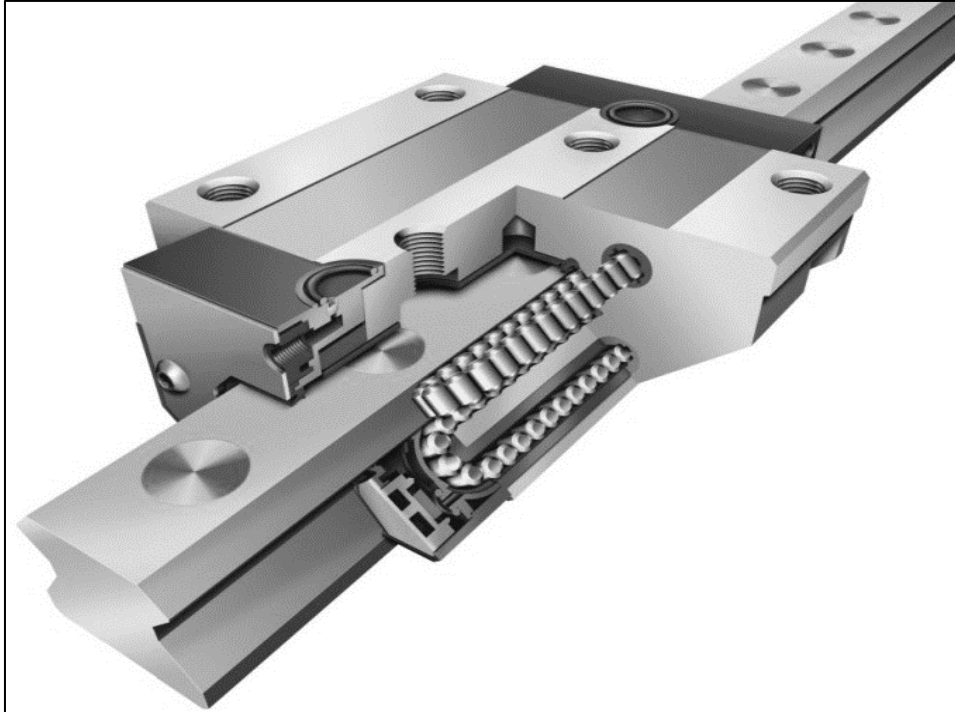
Dual planetary gear reducers with low backlash and extremely high stiffness output gear set drive the X-axis

Independent servo motors are used to generate a preloaded system for controlled motion of large moving loads

Standard Siemens CNC functions are optimized by UNISIG for trouble-free operation

# X-AND Y-AXIS GUIDEWAYS

## INA SERIES RUE100 RECIRCULATING ROLLER BEARING GUIDEWAY SYSTEM



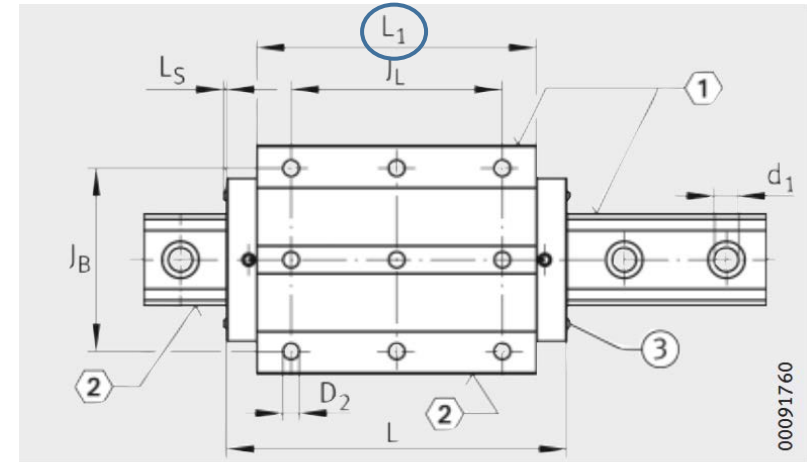
- ULTRA-HIGH RIGIDITY, MINIMAL DEFLECTION
- PRELOADED FOR STIFFNESS
- VERY HIGH ACCURACY
- ZERO MAINTENANCE

EACH RUE100  
CARRIAGE WEIGHS  
**35.7 Kg [78.7 lbs]**  
AND HAS A LOAD  
RATING OF  
**630 kN [141,630 lbf]**

**H HEIGHT =  
120mm [4.72in]**

**B WIDTH =  
100mm [3.94in]**

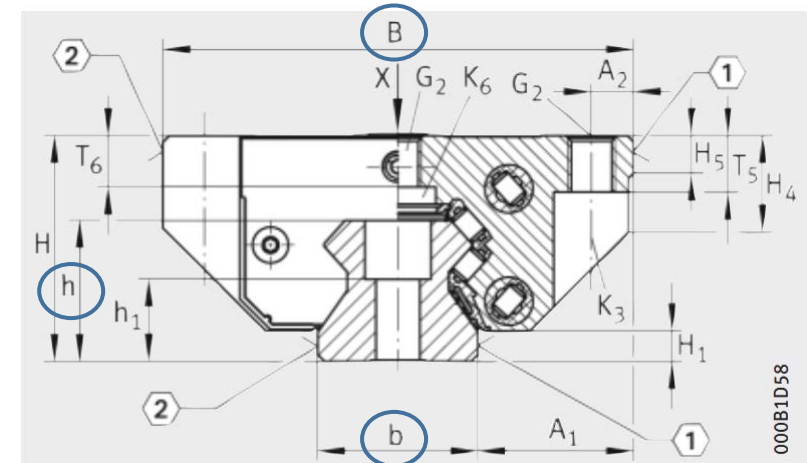
**h HEIGHT =  
80mm [3.15in]**



RUE100-E-L

**L1 LENGTH = 306.5mm [12.07in]**

**B WIDTH = 250mm [9.84in]**



RUE..-E, RUE..-E-L

## X-AND Y-AXIS SCALE FEEDBACK



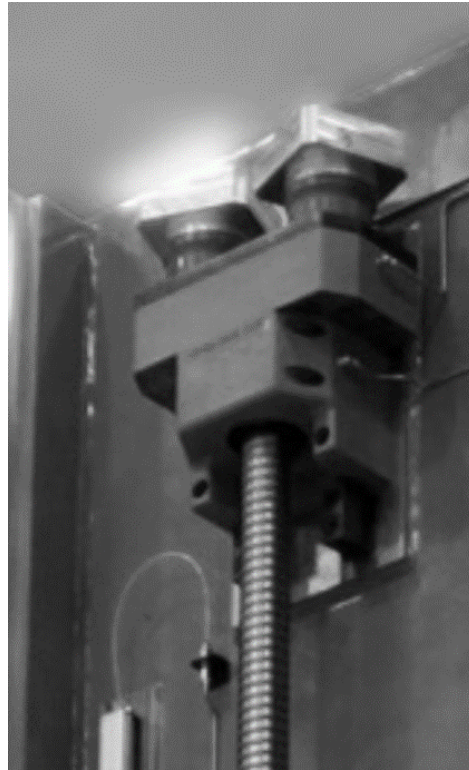
- Heidenhain METALLUR steel scale with absolute feedback on X and Y axis
- Scale accuracy grade +/- 5 micron (+/- 0.0002 in)
- Scale Measuring step +/- 0.010 micron (1/1000x accuracy)
- Laser calibrated at assembly for full travel accuracy
  
- Endat 2.2 interface with Siemens CNC
- Air purge for each scale with dedicated filter/regulator

## Y-AXIS column



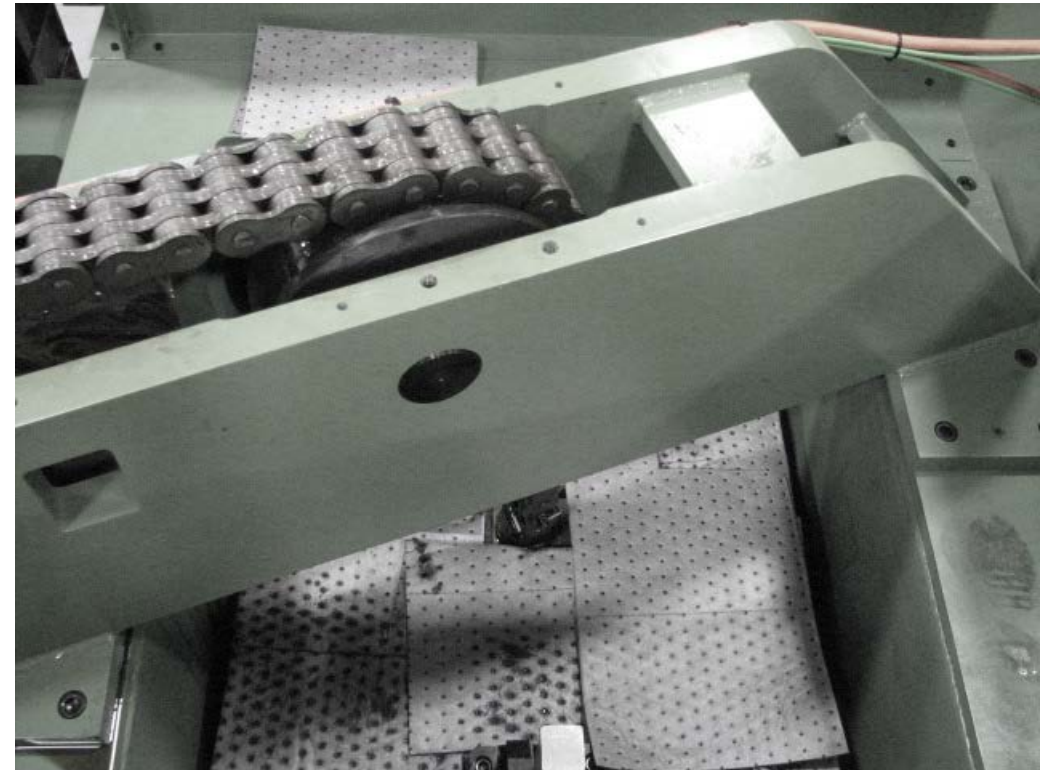
- Double wall column for very high stiffness when headstock is thrusting at top of travel, requires special techniques to produce
- Column is made as one piece from fabricated steel for strength purposes dictated by engineering FEA simulation
- Thermally stress relieved before machining
- Precision machined on 5-sides in a single setup
- Laser inspection of final geometry before additional assembly
- Component geometry is corrected at the source if required (scraped), not compensated later in build

## Y-AXIS Feed



Precision ground ballscrew with double-nut preloaded for rigidity, and safety nut for vertical application

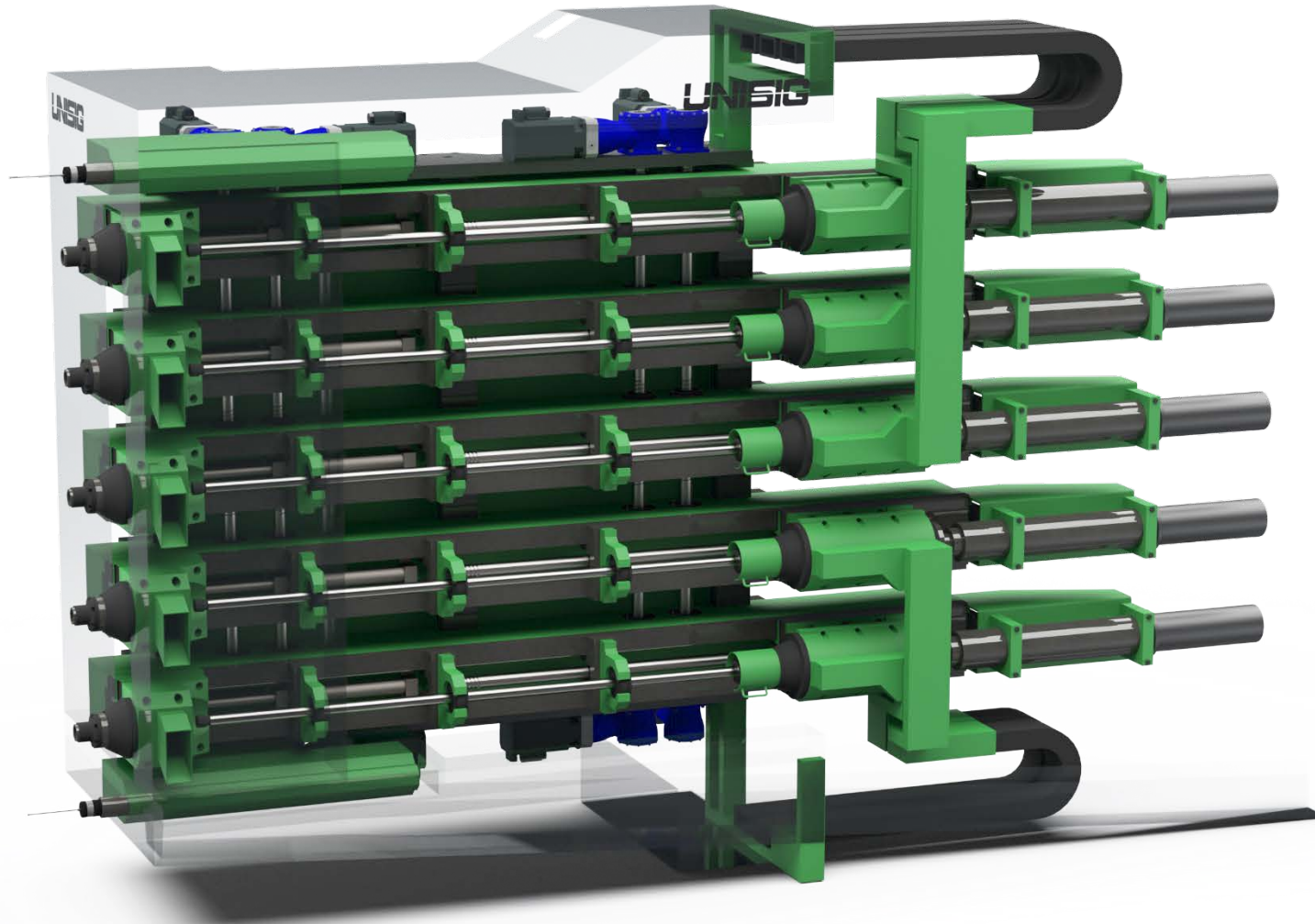
Dual motor drive with heavy gear set for distributed drive force and load capacity



Mechanical counterweight inside column to unload Y-axis ballscrew drive

Less complex solution than a hydraulic counterbalance on machines where rapid axis reversal speed is not a consideration

## USC-TS32-5 HEADSTOCK



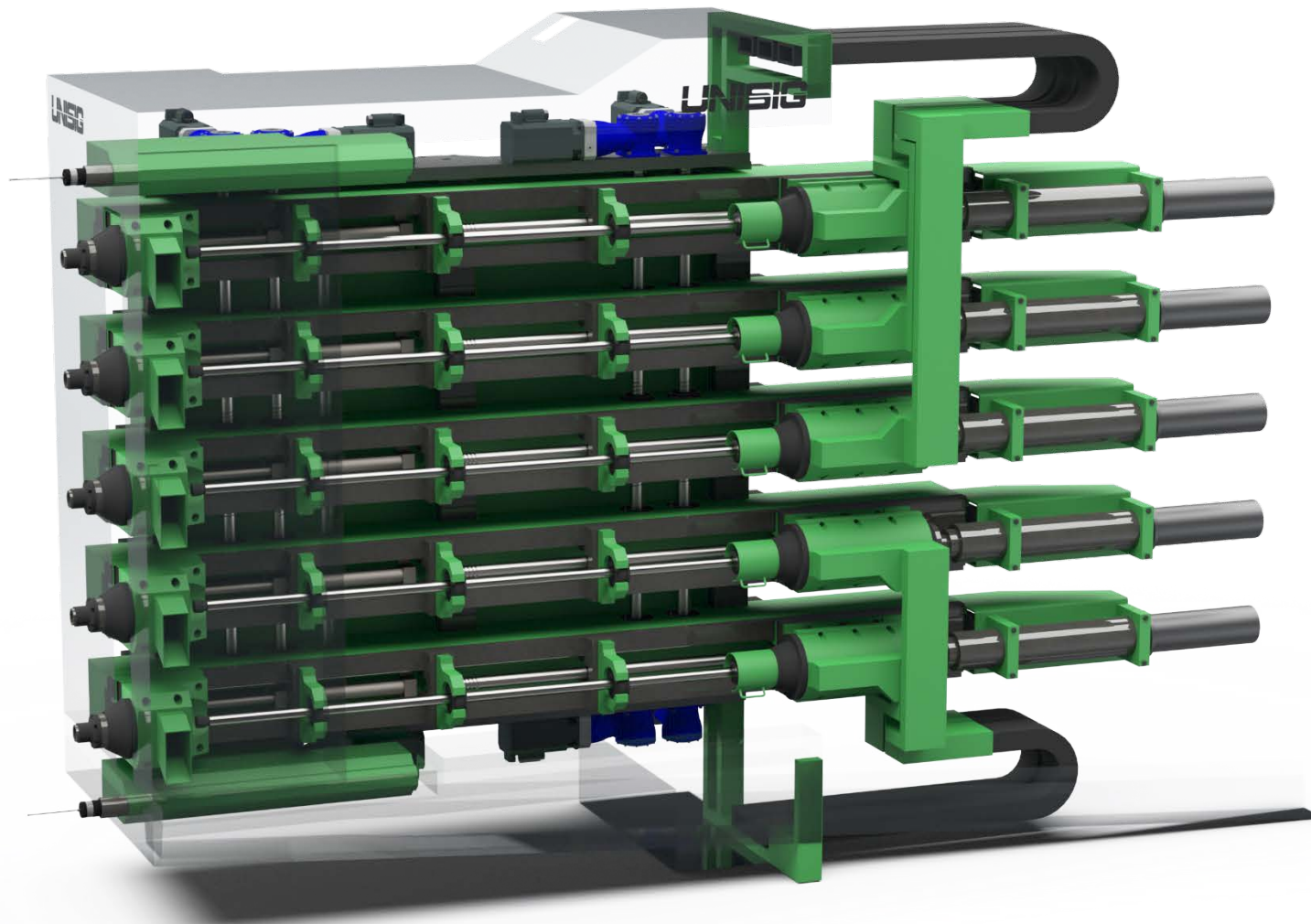
Entire headstock group is mounted to common Y-axis saddle so individual spindle alignment is not impacted by machine axis positioning

(5x) Drilling modules - completely independent operation

CNC Programmable centerline adjustment for drilling pitch

Dual ballscrew lift/lower for each module to assure parallelism regardless of center of gravity shift

## USC-TS32-5 HEADSTOCK



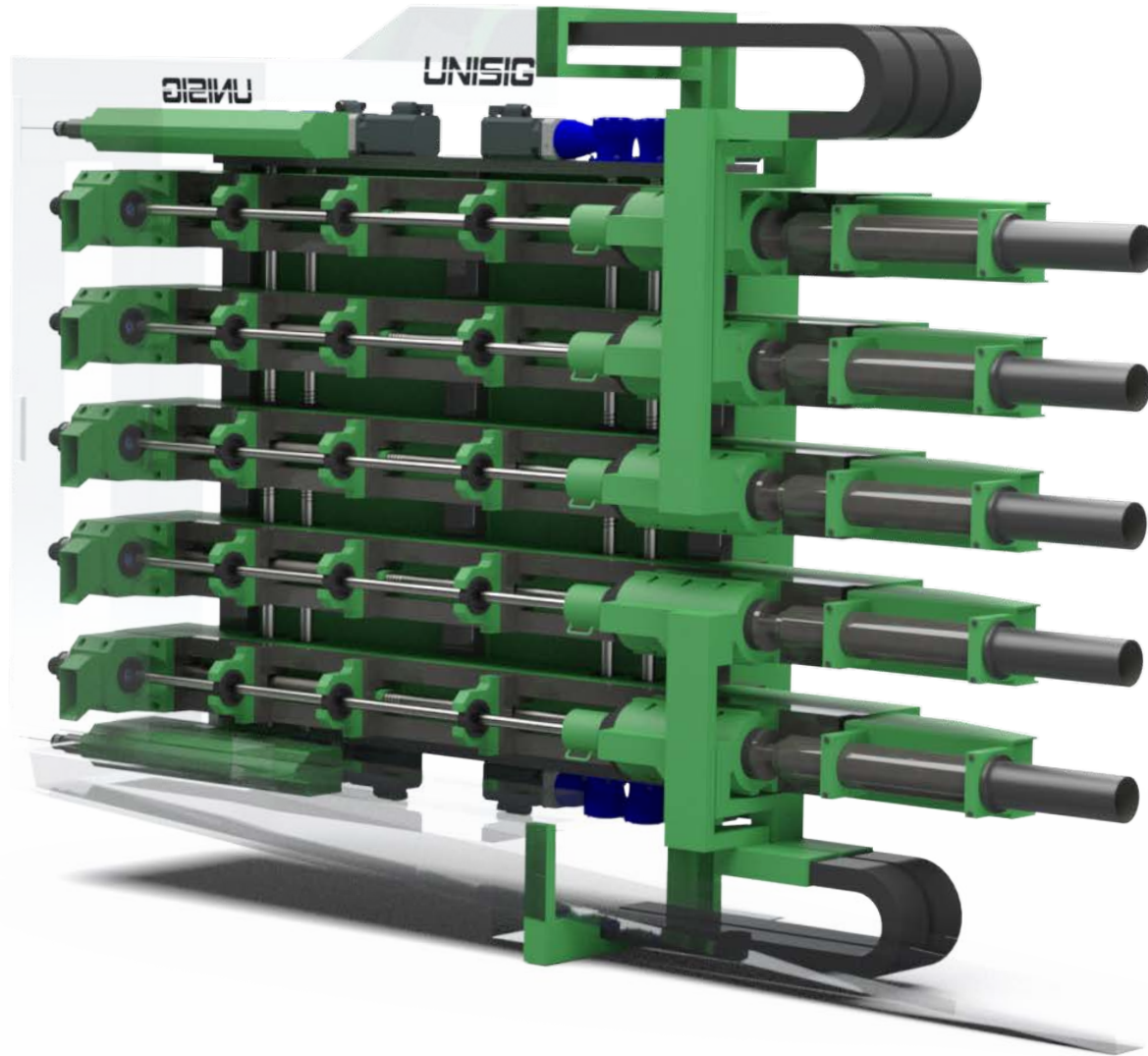
Liquid-cooled, Integral motor spindles for vibration free operation, improved accuracy and low maintenance for high duty cycles.

Long stroke bushing carrier for simplified workpiece setup and to clear workpiece features

Extended nose bushing carriers are available with internal tool support for hard to reach features

Traveling whip guide/vibration dampeners support long tools

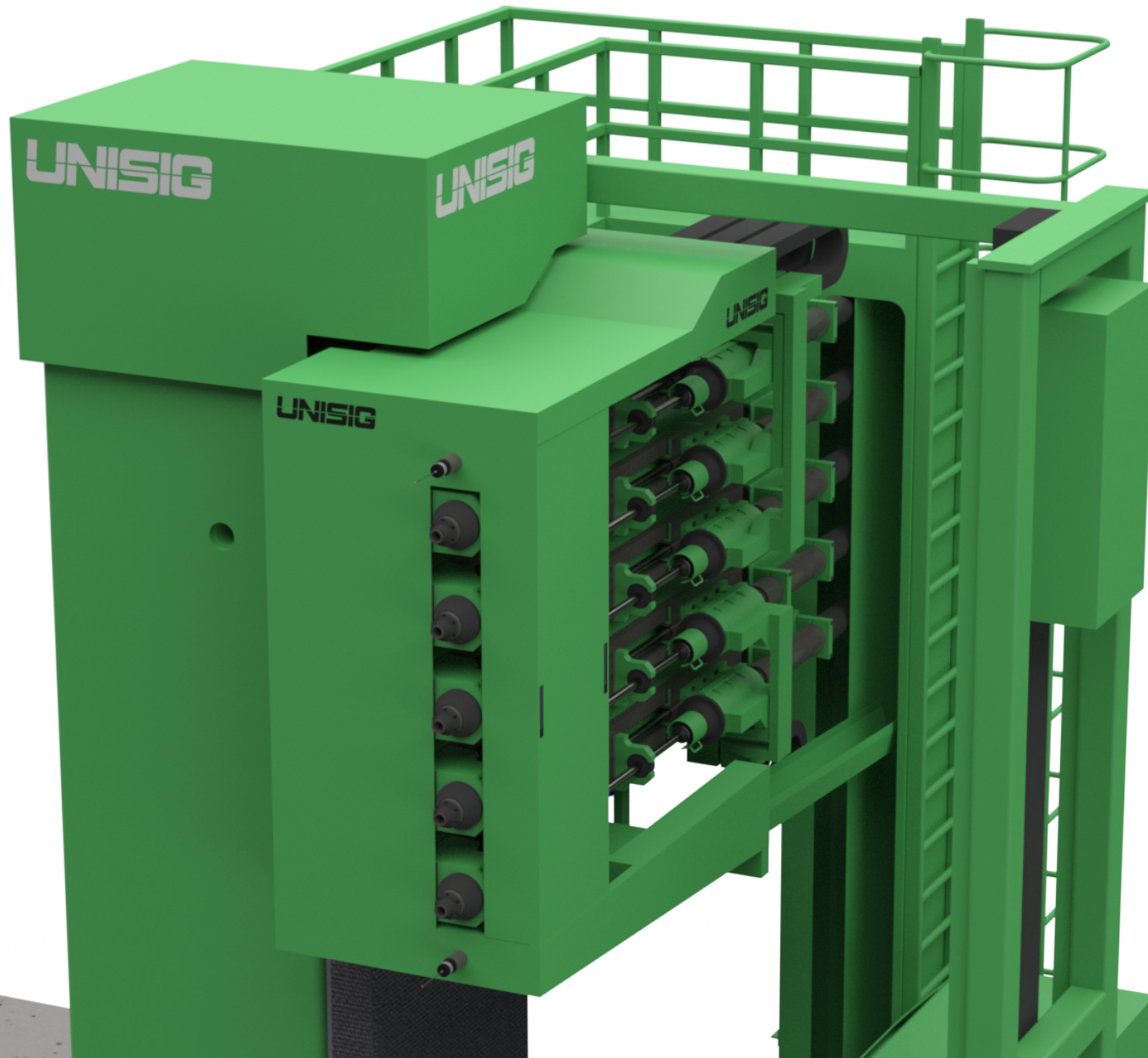
## USC-TS32-5 HEADSTOCK



Telescopic discharge system for BTA chips eliminate elbows and bends to successfully exhaust long stringy chips

Gundrill chip discharge is directed downward by sliding shield and conveyed by flooded trough with parabolic shape to keep chips in suspension

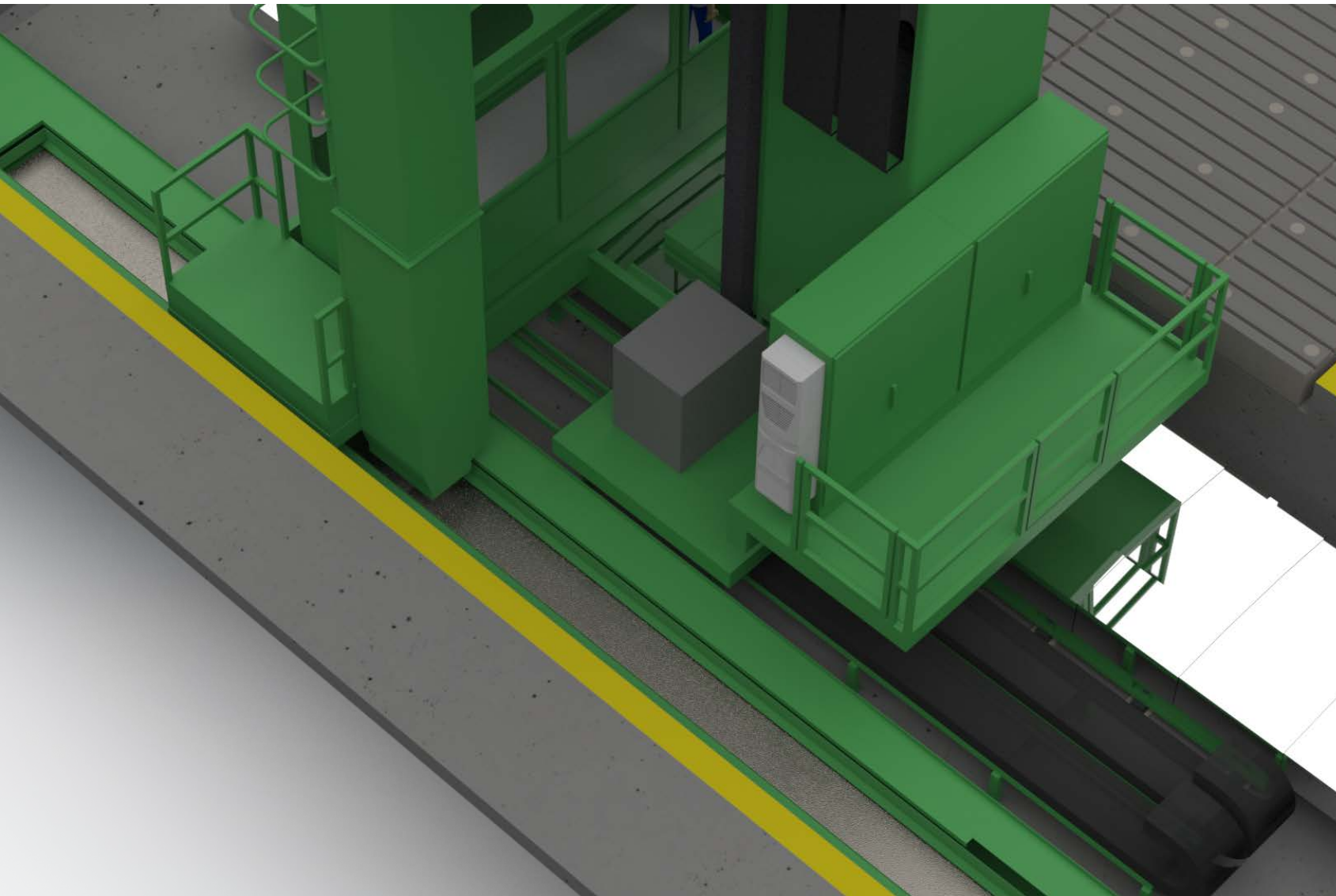
## USC-TS32-5 HEADSTOCK



BTA and Gundrill chips and cutting fluid are discharged to a rear coolant chute without bends or elbows

Unobstructed flow is possible regardless of y-axis position

## USC-TS32-5 HEADSTOCK



Chips and coolant drop onto wide, heavy duty chip conveyor.

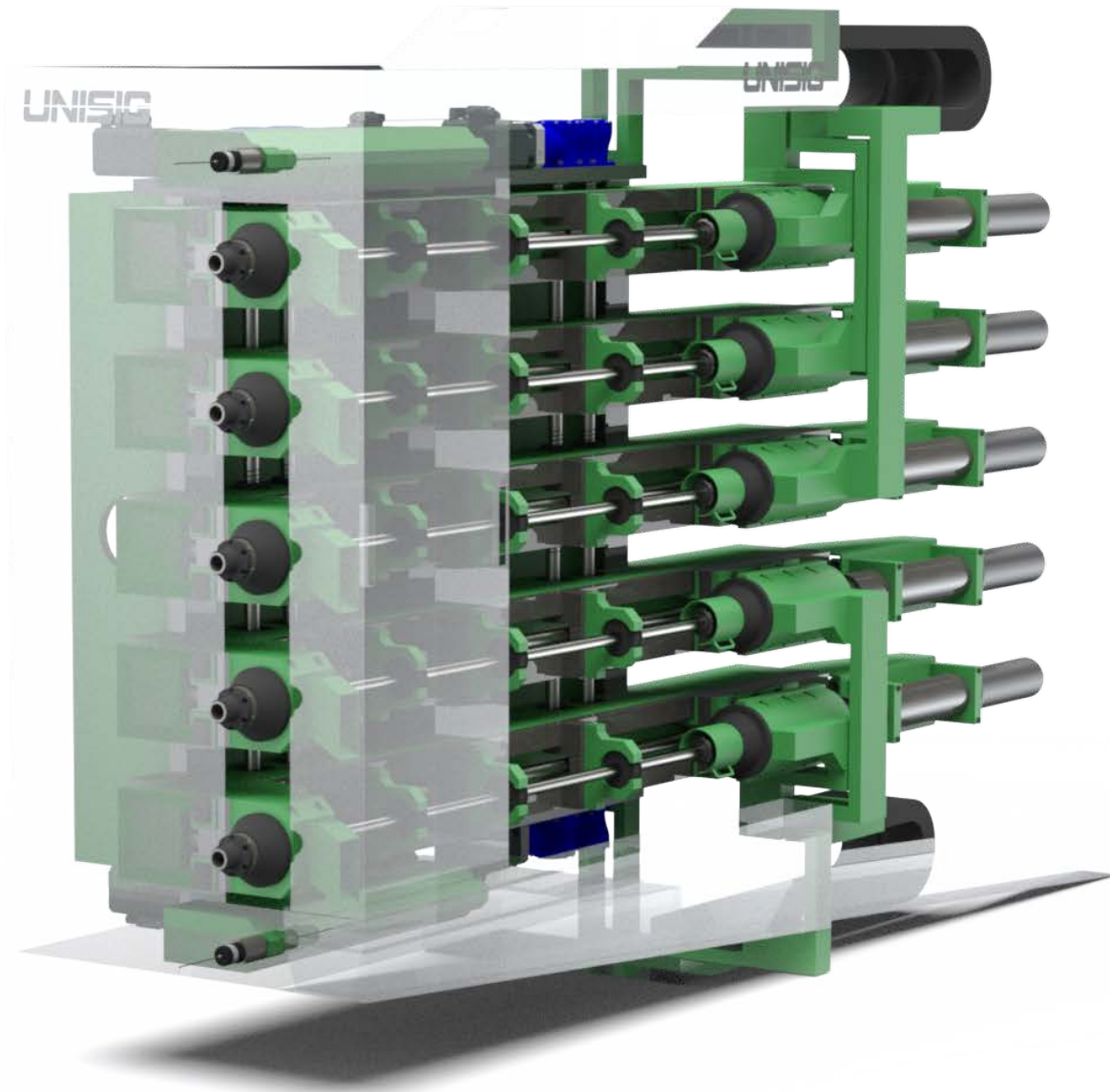
Chip conveyors are designed for high chip loads containing nickel alloys and other tough chips.

Service points at rear chain return allow inspection and maintenance without removing the conveyor.

A variable speed drive matches chain speed to drilling process and chip load



## USC-TS32-5 HEADSTOCK



Bushing location transducers integrate position awareness in CNC for reduced cycle time and crash prevention

Dual Renishaw probes on independent ballscrew driven axis are used to inspect drilled holes at multiple depths, while conserving Y-axis travel

## High Pressure Coolant Pump System



Each tool has a dedicated and completely independent coolant pump circuit

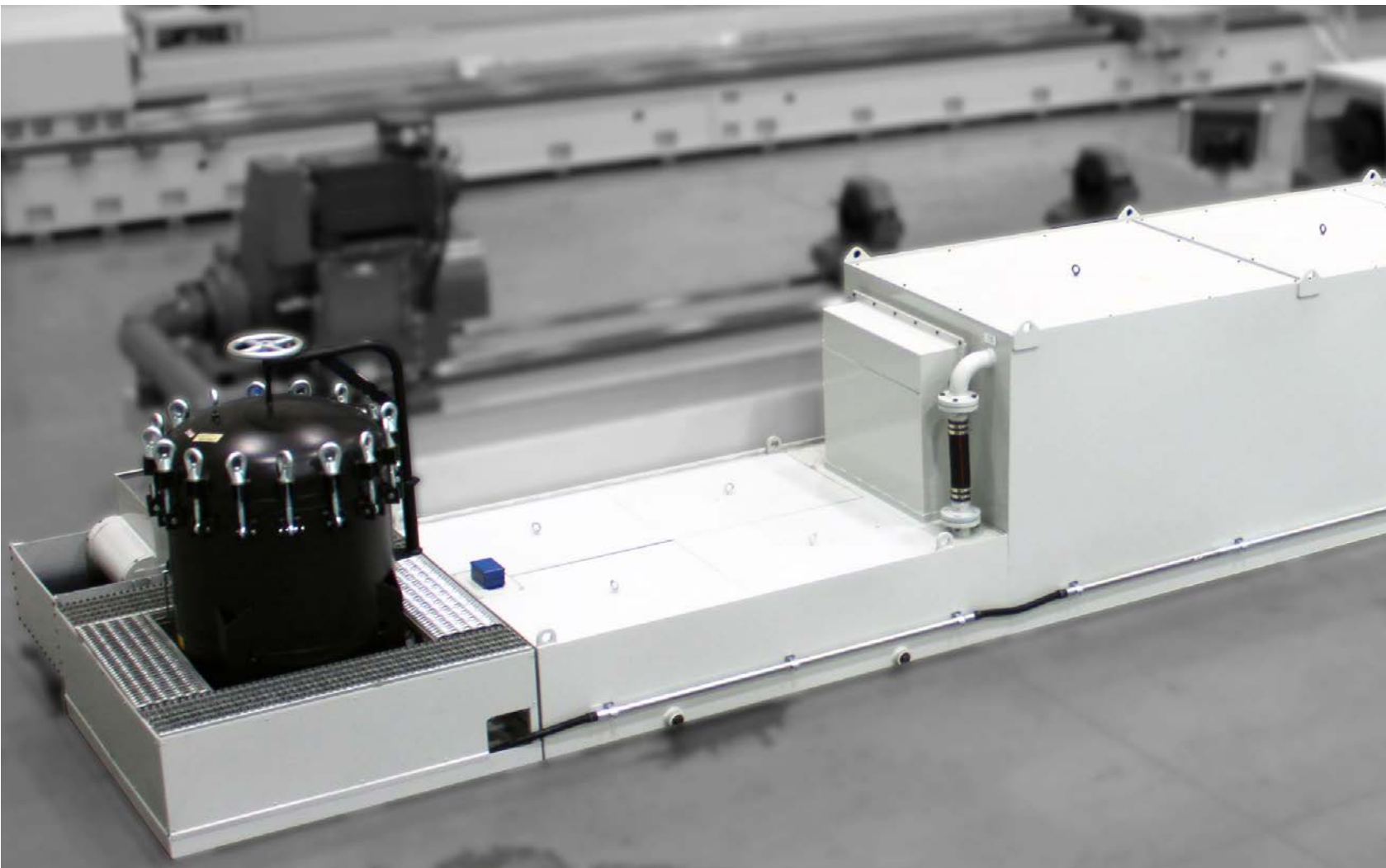
Rugged, fixed displacement pumps are driven by high performance Siemens 1PH8 motors

Flow rate is programmed through variable speed S120 drives controlled by the CNC

Flow rate is not affected by chip formation or hole depth

Coolant Pressure read into the CNC is a result of restriction to flow, and is used as a fault condition, not as a controlling process

## Filter system and coolant reservoir



Coolant from drilling process is pumped through a filter into a clean fluid reservoir.

Reservoir capacity is approximately 10x maximum system flow to allow entrained air to settle out of system

Coolant temperature is controlled by active refrigerant chillers and is programmable

## Hydraulics, Pneumatics, Lubrication

Hydraulics, pneumatics and lubrication systems are planned for efficient installation allowing easy maintenance.

System diagnostics are available through the Machine CNC.



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## CABLE AND HOSE ROUTING

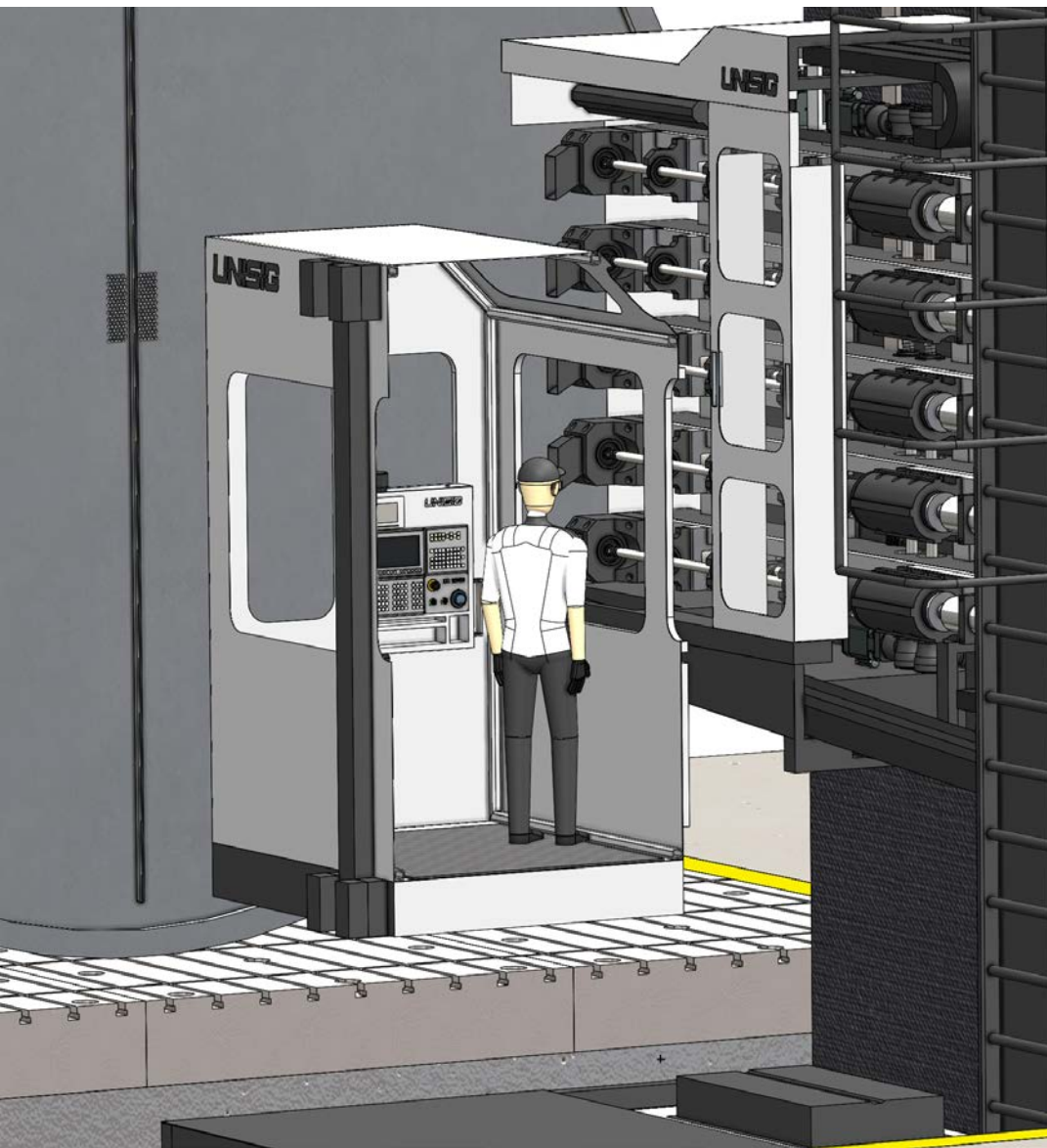
Cable management systems are engineered along with the core machine structure for long term performance.

Planning for installation simplicity, long term maintenance and troubleshooting are part of every UNISIG machine.

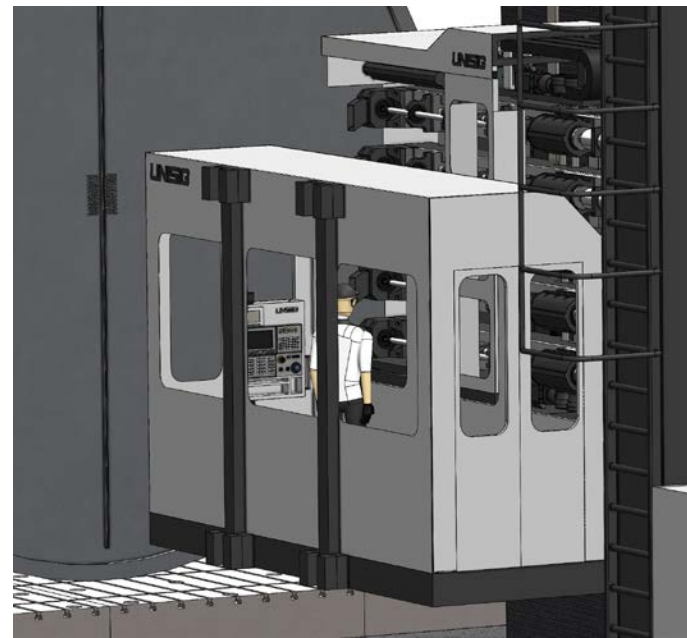
Customer plant standards are followed and designs are submitted for maintenance and engineering approval prior to construction



## ERGONOMICS AND TOOL HEADSTOCK ACCESS

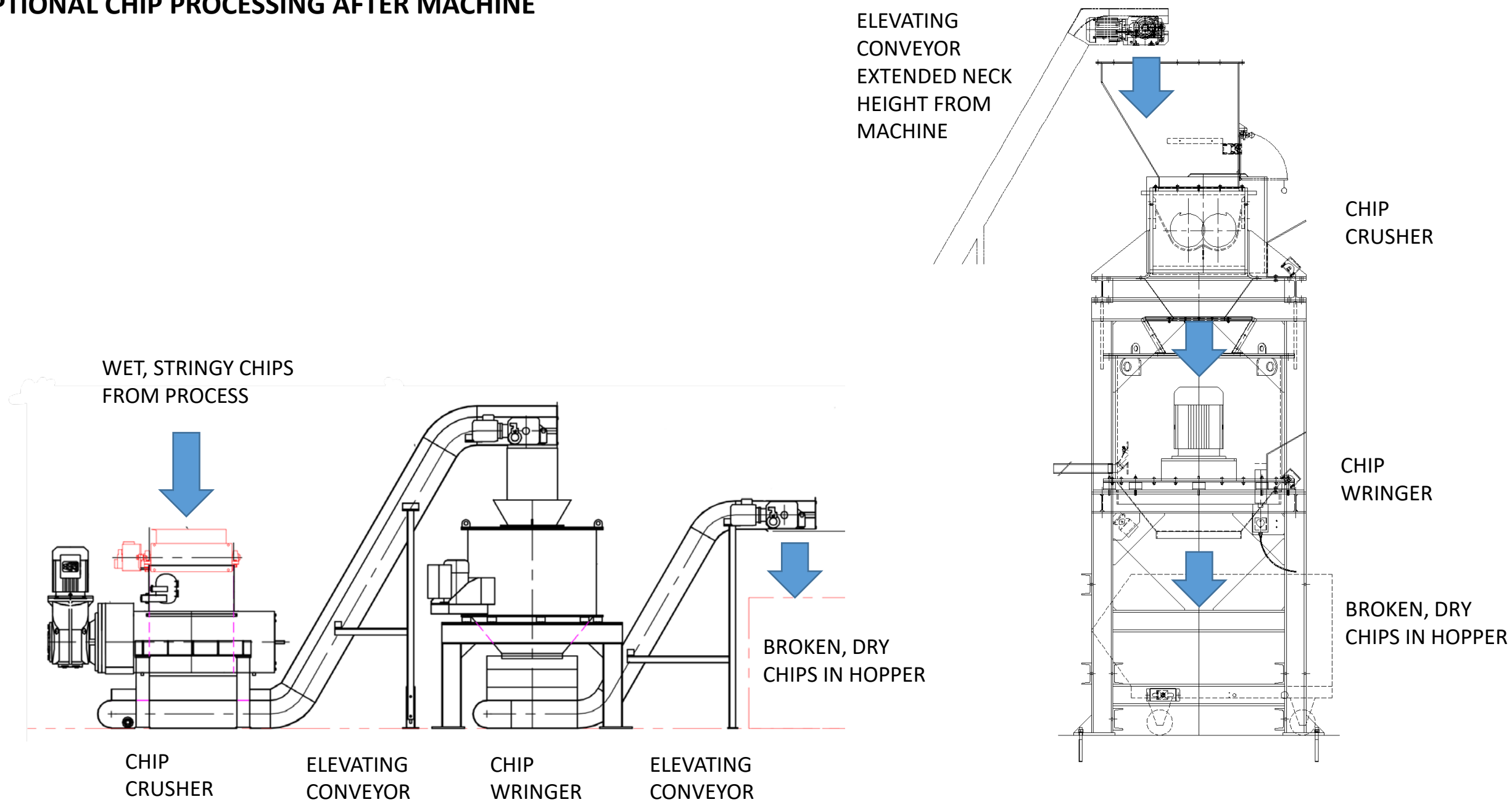


- Narrow width headstock design allows optimal ergonomics for easy operator reach to spindle centerline
- Independent platform allows operator to work at chest height for tooling changes on any spindle
- Operator platform is enclosed with sliding doors on upper half to ensure safety while allowing full access to long tools.



## CHIP PROCESSING OPTIONS

# OPTIONAL CHIP PROCESSING AFTER MACHINE



# **UNISIG COMPONENT MANUFACTURING AND MACHINE ASSEMBLY**

# UNISIG FACTORY FOR LARGE MACHINE BUILDING



## Large workpiece machining at UNISIG

3500 mm x 10,000 mm x 2,200 mm workpiece  
5-side machining in one setup  
Maximum workpiece 50 tons

Vertical gradient temperature-controlled environment  
700 ton isolated, reinforced foundation  
Laser alignment on periodic basis

Full 3D simulation of machine, fixture, tool and workpiece



## Large machine assembly at UNISIG

Main assembly hall equipped with multiple bridge cranes  
Radio controlled coordination for complex part movement

12.5 m [42 ft] vertical clearance  
29 m [95 ft] span  
50 ton lifting capacity

Temperature controlled assembly environment  
Full machine function testing at Factory for acceptance



## Visit **UNISIG** Factory

Wisconsin, USA

Engineering  
Manufacturing  
Assembly  
Demonstration  
Training

30 Minutes from  
Milwaukee (MKE)  
International Airport

1.5 Hours from  
Chicago (ORD)  
International Airport