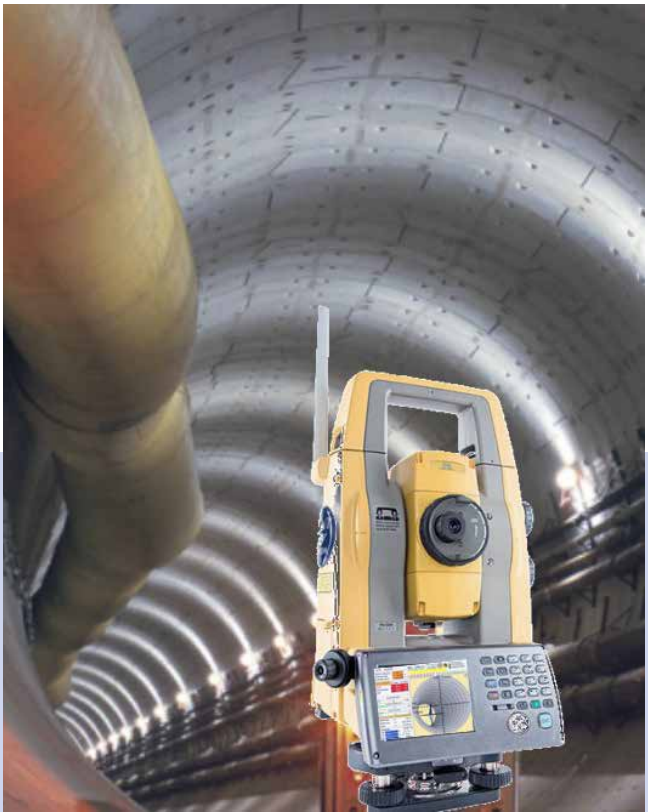
PYXIS

The High-Precision Guidance System for Tunnel Boring Machines

Since **1991, Pyxis** has been one of the most trusted and advanced TBM guidance systems worldwide. Developed by **Bouygues Travaux Publics**, it provides **high-precision positioning, real-time trajectory control**, and **fully optimized ring building** for all TBM types including:

- Single shield
- Hard rock TBM
- Double shield, with or without grippers
- Double shield with parallel thrust or lattice jacks

Pyxis is continuously enhanced across projects, benefiting from feedback from surveyors, TBM operators, production teams and equipment specialists to maintain best-in-class performance.



Key benefits

± **TBM guidance accuracy**
Laser and total-station synergy combined with full sensor redundancy ensures millimetric precision, even in challenging geological conditions.

± **Operational reliability**
Engineered for continuous 24/7 TBM operation with robust fail-safe mechanisms.

± **Optimized ring building**
Predictive algorithms and multi-ring optimization reduce deviation and minimize corrective work.

± **Surveyor-grade tools onboard**
Survey calculations, projections, and reporting fully integrated into the system

± **Seamless integration**
Fully compatible with TBM PLCs and Bouygues' ByOnSite data-acquisition ecosystem

Powerful processing

Pyxis integrates **mission-critical computational modules** that support precise control, safety, and performance throughout TBM operations.

Trajectory control

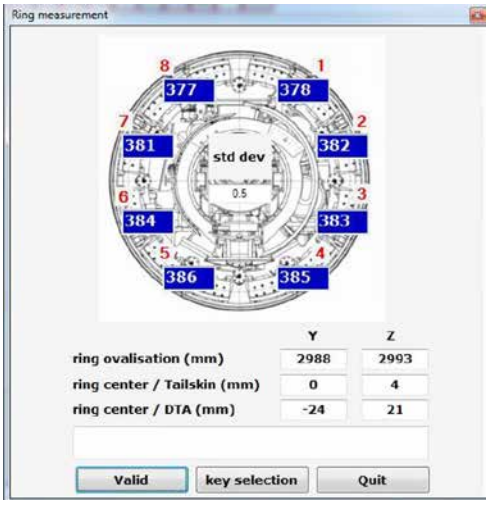
› Continuous real-time computation of TBM position, attitude, and trajectory
› Predictive alignment with the designed tunnel axis
› Automatic generation of catch-up curves with built-in safety handling

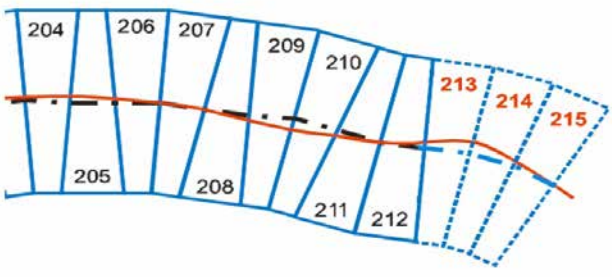
Ring building optimization

› Automated key selection based on project rules
› Visual and numerical scoring of key options
› Real-time preview of catch-up curves for each choice
› Optimization of special rings and multi-ring sequences

Thrust and jack management

› Real-time jack stroke visualization
› Fault detection and jack deactivation
› Debase-mode calculation
› Dedicated views for steering, thrust and articulation jacks





Technical Architecture – Robust & Redundant Measurement Chain

Pyxis relies on a **high-stability, fully redundant measurement architecture** combining optical, inertial, and TBM data sources.

Core Components include

› Total Station measuring TBM position and yaw angle with wired or wireless communication
› High-accuracy laser target connected via optical fiber, ensuring stable measurements
› High-precision inclinometers for roll measurement and pitch redundancy
› Direct TBM PLC interface for data exchange with the central system

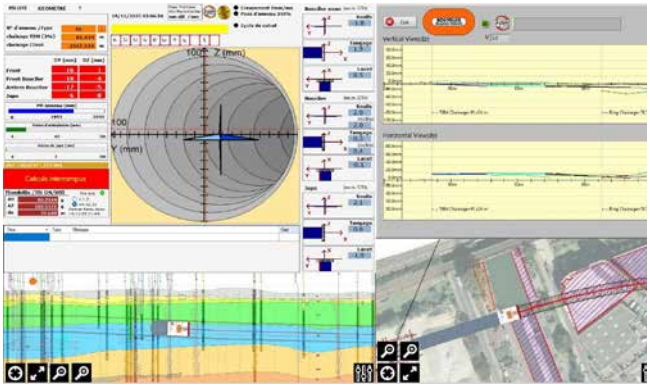
System Advantages

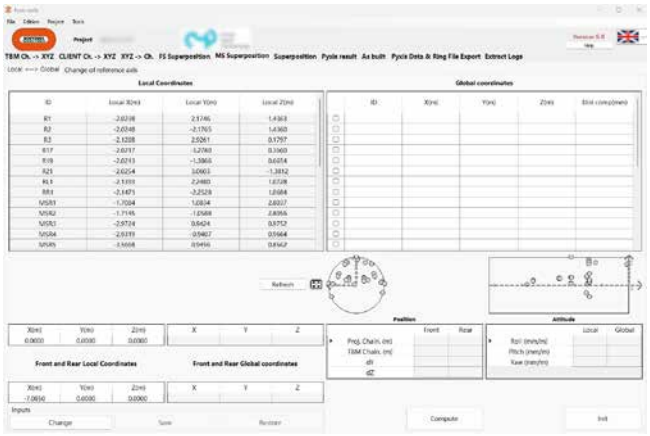
› Maximum sensor redundancy (laser, pitch, roll, jacks, etc.)
› Class 1 low-power coaxial laser: safe, maintenance-free, no alignment required
› Automatic and periodic back-reference checks
› Secure configuration access for surveyors

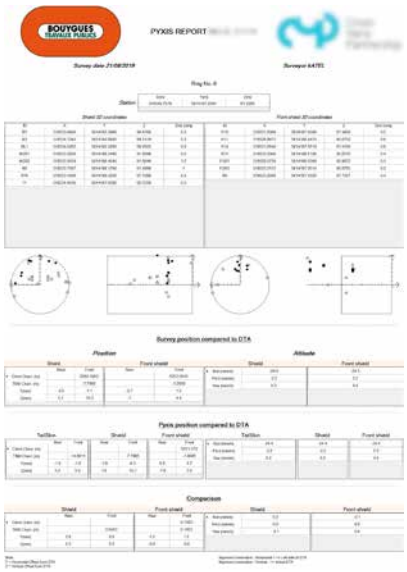
Real-Time Interface – Designed for TBM Pilots & Surveyors

The intuitive interface delivers clear, real-time situational awareness:

› Live 3D tunnel view with front-face DTA (Designed Tunnel Axis)
› Alarm and fault logging with clear diagnostics
› Automatic computation freeze in case of critical faults
› Touch-screen-optimized ergonomics
› Dedicated operator and surveyor menus
› Embedded Total Station status and measurement feedback







High-Value Visualization Tools

Pyxis offers advanced visualization to support trajectory, geology, and environment interpretation:

Trajectory View: Vertical and horizontal alignment, attitude relative to the DTA, TBM movement tendencies and Visual tracking of rings and catch-up curve.

Plan View: TBM and ring positions relative to surface structures, with vector zoom and best-fit alignment tools

Vertical Geology View: TBM and ring positions over geological sections, vector zoom and best-fit function

Data Management & Survey Tools

Pyxis Data Module

- Per-ring data export to excel
- Structured database for reporting and analysis

Pyxis Tools

- Shield position and attitude computation
- Point implantation on TBM
- 3D projection on DTA and chainage computation
- Result comparison and reporting

Ring Geometry Monitoring

- Ring position relative to DTA and tail skin
- Ovalisation detection and assessment

Surveying Interfaces – Total Station Control

TBM operator Interface

- Back-sight validation
- Automatic bearing and Z-level correction
- Integrated leveling functions

Surveyor Interface

- All operators functions
- Dedicated setup wizards
- Advanced workflows for precise alignment and control

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