

## Drilling Simulator Capabilities:

sample cells

	Bit < 6"1/2	Bit < 8"1/2
Inside mud pressure	50 MPa	10 MPa
Over burden pressure	70 MPa	20 MPa
Confining pressure	50 MPa	10 MPa
Pore pressure	50 MPa	10 MPa
Rock sample length	480 mm	450 mm
Drilling length	480 mm	450 mm

- Automatic control by ROP or WOB display : Limits: WOB maxi: 25 tons  
ROP maxi: 90 m/h
- Rotation with continuous variation from 0 to 900 rpm (rotary speed variations programmed, if needed)
- Mud flow rate from 0 to 600 l/min
- All mud types with temperature control system ( > 100 °C)
- Data acquisition : - 100 controlled measurements (30 recorded and 70 monitored)  
- Acquisition frequency from 1 to 3000 Hz
- 6 reference rocks : 1 shale, 2 limestone and 3 sandstone
- Directional:
  - steerability and walk angle measurements
  - friction coefficient measurements
  - up to 1,5 tons lateral force
  - up to 12" 1/4 bit diameter

## Drillability Cell Capabilities:

- Cutter forces maxi : 8000 N
- Rotation speed : 0 - 60 rpm
- Hydrostatic mud pressure : 0 - 50 MPa
- High speed camera : 50 - 3000 scan/s
- 6 reference rocks : see simulator reference rocks

## Hydraulic Simulator Capabilities:

- Rotation speed : 0 - 1000 rpm
- Mud flow rate : 0 - 3000 l/min
- Mud pressure : 0 - 4 MPa
- High speed video camera : 50 - 3000 scan/s

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## Drilling Laboratory



Today, PDC Drill Bits are used to more and more complex drilling operations and the objectives are always the same : achieve a high penetration rate, finish the drilling phase and hit the target. The Paris School of Mines/ARMINES, which is an independent research center, has developed many full scale test to obtain a full laboratory PDC Drill Bit Characterization and to highlight the potential of each PDC Drill Bit. Based in Pau, in the south of France, near the Pyrenees mountain and the beautiful Basque coast, the Paris School of Mines Drilling Laboratory conducts research projects and provides services for costumers in the field of oil and gas drilling.



## FULL SIZE DRILLING SIMULATOR

### Drillability Test

Characterization of drilling behavior of any type of full scale drilling bits can be done in only few days. The Drilling Test Facility is able to test roller cone or fixed cutter bits up to 8"1/2 in diameter and simulates the deep hole drilling conditions. The tests consist of drilling rock sample under constant WOB or constant ROP. The rock was held in a pressure vessel and after the test, the bit and the bottom hole pattern can be examined immediately.



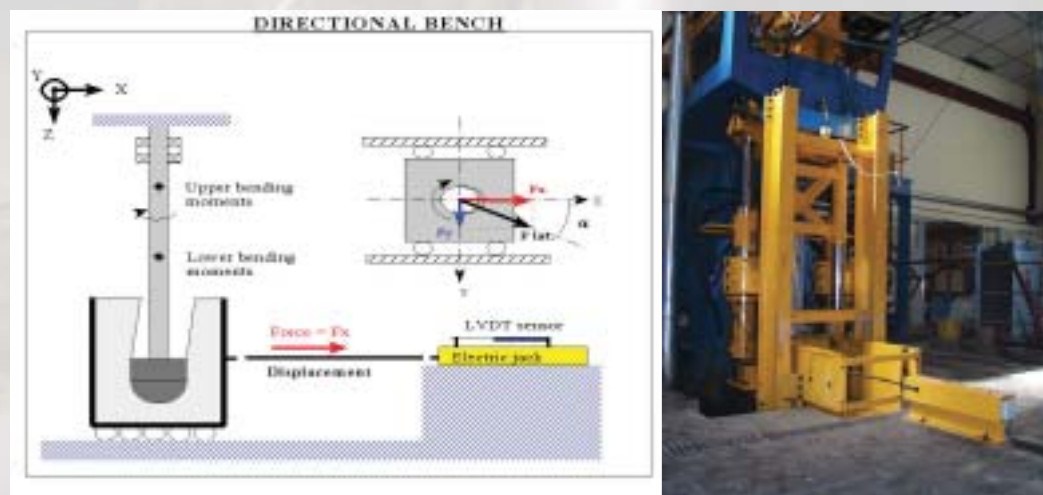
Principle of the DTF

Cross-section of the drilled sample

Drilling Test Facility

### Directional Test

Drilling tests for characterizing the directional behavior of drill bits are conducted at the Paris School of Mines since 1999. These tests allow the evaluation of the steerability and the walk tendency of a given drill bit. The tests are performed using the drilling bench fitted out with a special apparatus. This consists of applying a side force on the bit by pulling laterally the rock sample. The computation of the magnitude and the direction of the lateral force on the bit enables to calculate the drill bit directional response.



Principle of the directional test

Directional Drilling Test bench

## HYDRAULIC SIMULATOR

Controlling bit hydraulics efficiently requires a complete knowledge of fluid behavior at the bottom hole characterized by the fluid velocity profile or the resulting pressure distribution. The Paris School of Mines has developed special tests and procedures with the hydraulic bench simulator to quantify these parameters. Two kinds of tests can be done:

- Test with paint made to evaluate the pressure distribution and the fluid velocity on the bit face
- Test with small particles injected in the fluid to visualize, with a high speed camera, their positions on the bit face.



Hydraulic Bench Facility

Example of paint and small particles results tests

## SINGLE CUTTER DRILLABILITY CELL

To improve the drill bit performance, a better understanding of the cutter-rock interaction is necessary. Single cutter tests are done with deep-hole drilling conditions in the drillability cell. During the cutting process, you can visualize with the high speed camera, the cutting mechanism and the rock-chip formation while recording the forces versus time.



Drillability cell

The PDC cutting process recorded with the high speed camera