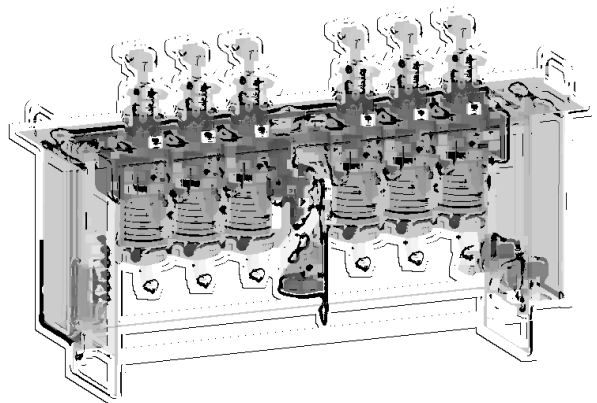


The **MCF**: a high performance device designed for **flow rate and angle measurement** enabling you to **verify, regulate and qualify** complete **DIESEL** injection systems using unit pumps, inline pumps and distribution pumps.

MCF

Multi Cylinder Flowmeter



The **MCF** is an instantaneous **mass flowmeter** enabling the simultaneous flow control of **2 to 12 injectors**.

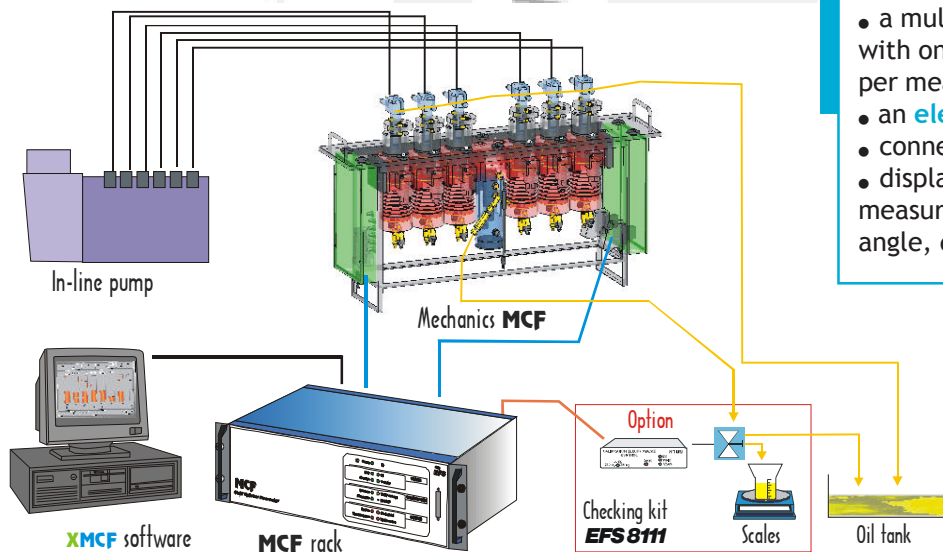
It has been designed to replace the test-tube systems found in test benches.

It features numerous exclusive advantages: fast accurate **measurements** of all injection parameters, for each injector at each revolution:



- Flow rate
- Angle
- Duration

SYNOPTIC



The **MCF** is made up of:

- a multi-cylinder **mechanics** with one injection chamber per measurement channel,
- an **electronic driving rack**,
- connection cables
- display **software** for the measurements (flow rate, angle, duration).

2

The **MCF** is available in versions with 2,4 or 6 injectors (using a single mechanics) and 8,10 or 12 injectors (using two mechanics).

Overview



SOFTWARE

The main screen of the **XMCF** software provides you with instantaneous display of the volumes injected, as well as the duration and angle for each cylinder.



You qualify the flow rate and angle of your system with precision.



PHASING THE PUMP

On request, the **MCF** will automatically detect the injection start point for each injector. This enables you to phase the pump.

Angle tuning in progress...

Channel	Status description	Angle(°)
1	Angle tuning detected with success.	265.4
2	Angle tuning detected with success.	24.6
3	Detection in progress...	---
4		
5		
6		

Cancel

Angle tuning in progress...

Channel	Status description	Angle(°)
1	Angle tuning detected with success.	265.4
2	Angle tuning detected with success.	24.6
3	Angle tuning detected with success.	145
4	Angle tuning detected with success.	324.8
5	Angle tuning detected with success.	204.8
6	Detection in progress...	---

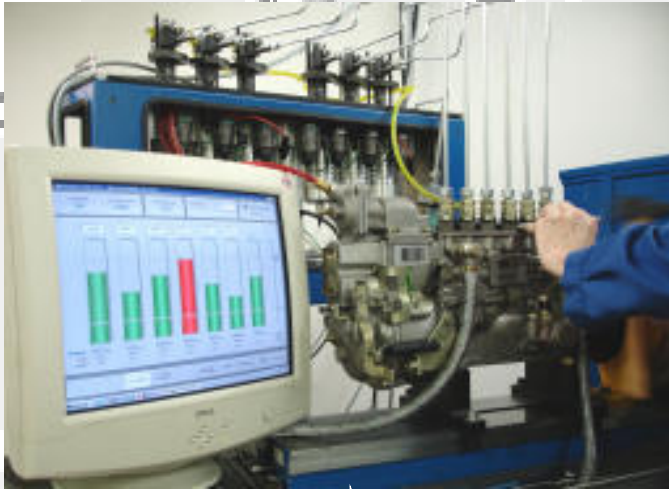
Cancel

You can phase the pump simply by pressing F9.

4

Key features

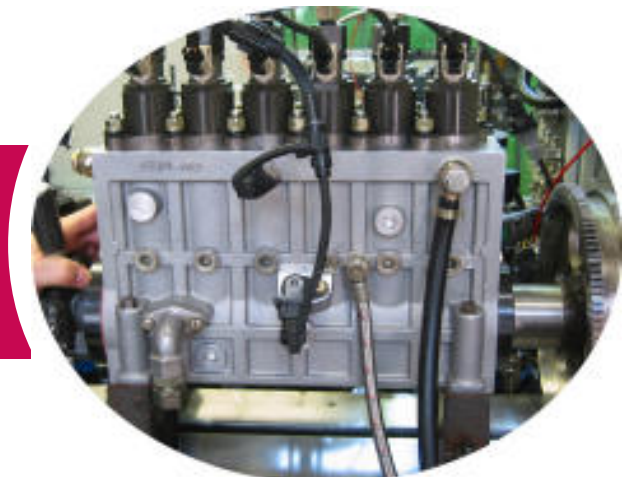
CALIBRATING THE PUMP



You can adjust the pump very quickly using the instantaneous display of the values injected per injector.



- Rapid measurements
- Instantaneous comparison between the 6 channels.



QUALITY CONTROL

The **MCF** enables you to **qualify all the operational parameters** of an injection system with a single device.

RAPIDITY

Viewing **all the injection channels side-by-side** enables you to see the effects of any **adjustments immediately**.

REPEATABILITY

The injection system qualification is **identical** from one MCF to the next.



Multi Cylinder Flowmeter

REPRODUCIBILITY

Measurement variability caused by the **MCF** never exceeds **0.2mg** per injection.

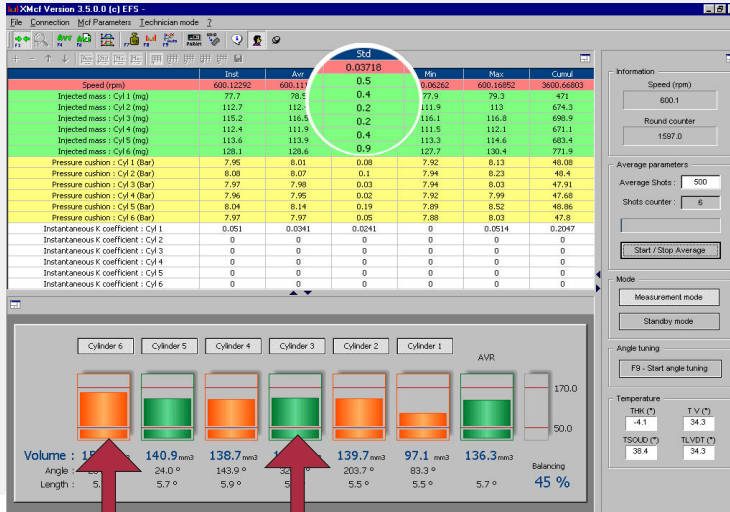
6

Key features

STABILITY OF EACH CYLINDER OF THE PUMP

In order to analyze injection quality, each **injector** must be accurate and above all, **stable**. This injection stability parameter is only available if we can **compare "injection by injection"**. This information is vital in order to **avoid excess consumption and excess pollution** arising from the injection.

The **standard deviation** enables you to verify **injection stability**.



UNSTABLE channel (orange) **STABLE channel (green)**

General parameters

Number of sample for sliding average :

Stability detection

Stability threshold :

By means of its measurement principle where each injection is analysed independently, the **MCF** is the only **multi-injector flowmeter** capable of specifying the **injection stability** of each cylinder of the pump.

You determine a **threshold** in order to monitor the **stability** of each **cylinder**.

You can detect anomalies on each measurement channel.



QUALITY: DATA SHARING

AND STORAGE

An **EFS bench** equipped with an **MCF**, enables you to **define and execute cycles or recipe procedures**. At the end of the cycle, all the data and the results obtained are saved into an Excel[®] spreadsheet and are **transmitted to a remote supervision system** via a computer network connection.

Cam ID: number 0 Result: SUCCESS Modified: 0 Bench ID: 3			Date: 08/03/2007 Recipe: test1 Version: 1 Bench Group: 1 EFS ID: 8369		Operator Name: Smith Speed Tolerance (Rpm): 10 Oil Pressure Tol (MPa): 0.01 Oil Temperature Tol (°C):4			
Step	Speed	Balance	Volume Mean	Volume Std	Angle Mean	Angle Std	Duration Mean	Duration Std
	Rpm	%	mm3	mm3	°	°	°	°
injector 1								
1	-400	11.3	123.7	0.3	306.3	0.1	5.2	0.2
2	-700	12	138.2	0.5	310.2	0.1	5.4	0.2
3	-1150	17.3	121.7	0.9	315.7	0	7.4	0.1
injector 2								
1	-400	11.3	119	0.2	186.4	0.1	5.1	0.2
2	-700	10.4	132.7	0.4	190.3	0.1	5.4	0.3
3	-1150	17.3	110.5	0.9	196.1	0.1	7	0.1
injector 3								
1	-400	11.3	120.8	0.2	246.4	0	5.2	0.2
2	-700	11.7	137.7	0.4	250.2	0.1	5.1	0.5
3	-1150	17.3	116.4	1	255.9	0	7	0.1
injector 4								
1	-400	11.3	128	0.3	126.2	0.1	5.2	0.2
2	-700	11.5	143.6	0.6	130	0.2	6	0.8
3	-1150	17.3	124.9	0.9	135.6	0.3	7.3	0.1
injector 5								
1	-400	11.3	114.4	0.3	6.3	0.1	4.9	0.1
2	-700	11.5	127.3	0.5	10.2	0.1	5.2	0.1
3	-1150	17.3	104.7	0.6	16.3	0.1	6.7	0.1
injector 6								
1	-400	11.3	122.1	0.3	66.4	0.1	5	0.1
2	-700	12	139.6	0.5	70.1	0.2	5.8	0.9
3	-1150	17.3	123.3	1.2	75.6	0.3	7.2	0.1

The **duration** of a **cycle** is very **brief**. In the above example, it only takes 90 seconds to measure a cycle of 3 steps.

Fully automatic, exhaustive tests.

8

Key features

AUTO DIAGNOSTIC

FEATURES OF THE MCF

Cylinder diagnostic

	6	5	4	3	2	1
EV -> Vol Ch. : Leakage detected						
EV -> Vol Ch. : Opening delay too high						
EV -> Vol Ch. : Draining slope too low						
EV -> Vol Ch. : Opened						
EV -> Vol Ch. : Opening delay (ms)	3.000	2.166	3.250	2.666	2.750	2.750

EV -> Tank : Opening delay too high						
EV -> Tank : Draining slope too low						
EV -> Tank : Opened						
EV -> Tank : Opening delay (ms)	3.083	3.083	3.249	2.750	2.916	2.916

Volumic chamber EV

Leakage detected	
Opening delay too high	
Draining slope too low	
EV open	

Non-return valve to volumic chamber

Leakage detected	
------------------	--

Cylinder diagnostic

	6	5	4	3	2	1
Pressure Sensor : Not connected						
Pressure Sensor : Offset detected						
Injector : Leakage detected						
Pressure chamber : Leakage detected						

Close

This **display** defines and clearly **locates** the **faulty part** that needs changing.

You are alerted if a defective part starts to disrupt the measurements.



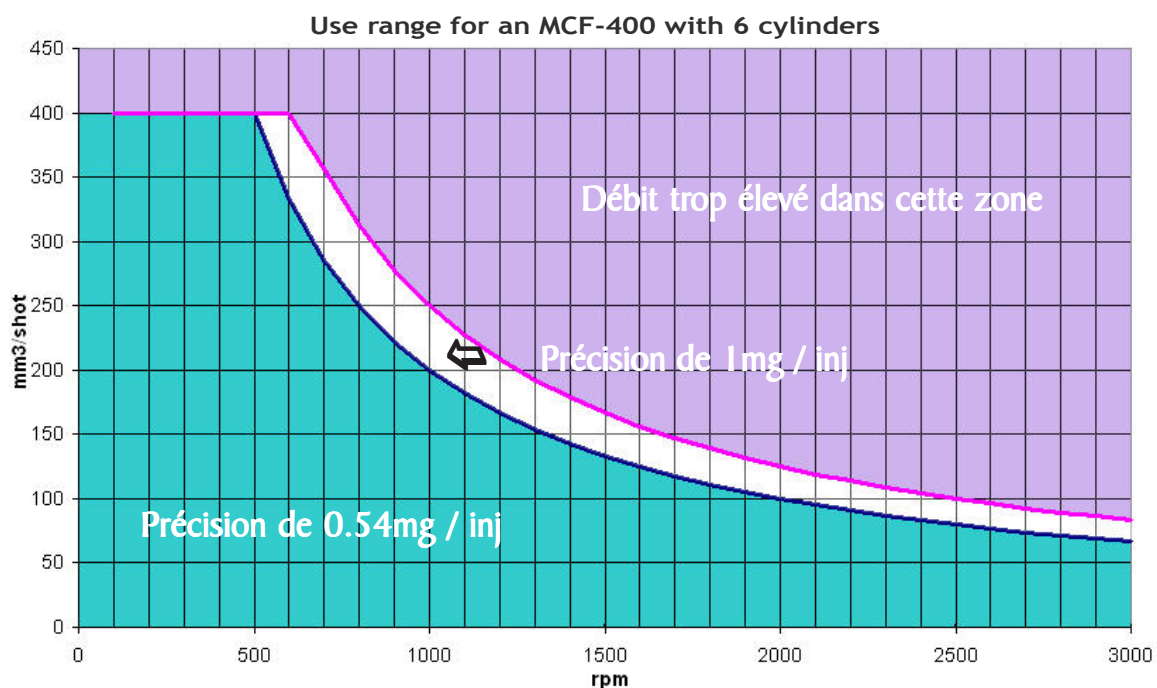
Measurement accuracy: ± 0.54 mg per injection or ± 0.68 mm³

Maximal values including all sources of uncertainty measured on a bench in conformity with the ISO 4008 standard with precision scales at 10 mg over 500 injections or 0.02 mg per injection.

A verification kit can be sold with the system. It will enable you to verify at anytime that the device is working correctly. (Verification time: 10 minutes).

- **Measurement reproducibility:**
0.2 mg if the mass injected < 100 mg otherwise 0.4 mg

MEASUREMENT RANGE



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Technical specifications

SPECIFICATIONS

Injection measurement	
Test fluid	Recommended standardized fluid: ISO 4113
Maximum injection temperature	200 °C
Measurement principle (patented)	<ul style="list-style-type: none"> • Measurement by analysis of the over-pressure generated by the injection in a sealed chamber filled with test fluid • Continuous autocalibration by volume measurement • Display of the standardized volume at 40 °C • Conversion of the volume injected into a mass, using the test fluid density
Type of measurement	<ul style="list-style-type: none"> • measurement at each revolution • simultaneous measurement of each of the measurement channels
Back pressure in the injection chamber	8 bars
Maximum quantity injected per channel	Depending on reference - see page 15
Measurement accuracy	Depending on reference - see page 15
Calibration	By weighing the average of a large number of injections (typically 500).
Angular measurement	
Injection angle (for each channel)	In degrees (resolution 0,1 degree)
Injection duration (for each channel)	In degrees (resolution 0,1 degree)
Injector assembly	
Type of assembly	Rotating leaving the pump pipes clear
Injector fastening	With M20 x 1,5 screws or with a clamp
Sealing	With clip BS
Synchronisation	
Synchronization signals	<ul style="list-style-type: none"> • Angular encoder 2x3600 pulses with 1/ rev signal (signals A,/A,B,/B,T0,/T0) • Encoder power supply 5 V-200 mA provided by the rack
Speed	From 30 to 3000 rpm
Communication interface	
Ethernet link, MODBUS Ethernet protocol. The device is delivered with the XMCF user software.	
Cooling circuit	
Cooling fluid	Identical to injection fluid
Pressure	6 bars
Flow	4 l/mn
Temperature	40 °C
Spatial requirements	
Mechanics	L : 84 cm,W : 25 cm , H : 45 cm
Electronics	19" 3U
Length of connection cables	6 m (as standard) ou 8 m (on request)
Electrical supply	
Power supply voltage	230 V 50 Hz
Consumption	60 VA



EFS can offer you a **made-to-measure solution**, designed to meet your needs

MCF INSTALLED IN AN EFS BENCH

You're looking for a **turnkey solution**? EFS recommends a fully automatic **bench equipped with an MCF**.

Site requirements

- A tri-phase electrical supply
- A cooling circuit (can be provided by EFS)
- Spatial requirements (L : 3 m, W : 3 m, H : 2.5 m).



12

Set-up alternatives

INDEPENDENT MCF SYSTEM



You already have a **bench** and wish to **increase its efficiency**? EFS recommends the **independent MCF**. It can be connected to your bench **without modifying it** and is designed to replace your old test tube system.

This system can be adjusted both vertically and horizontally to adapt to your high-pressure reference tubes.

Spatial requirements:

- Space necessary (L : 1.5 m, W : 0.6 m, H : 2 m).

Connections necessary:

- Universal mains power supply 110-240V AC 50-60Hz
- 3 tubes to be immersed in the primary tank of the bench (cooling circuit inlet/outlet and measurement output)
- Speed information for 30 to 3600/rev and 1/rev.

CUSTOMIZED MCF INSTALLATION

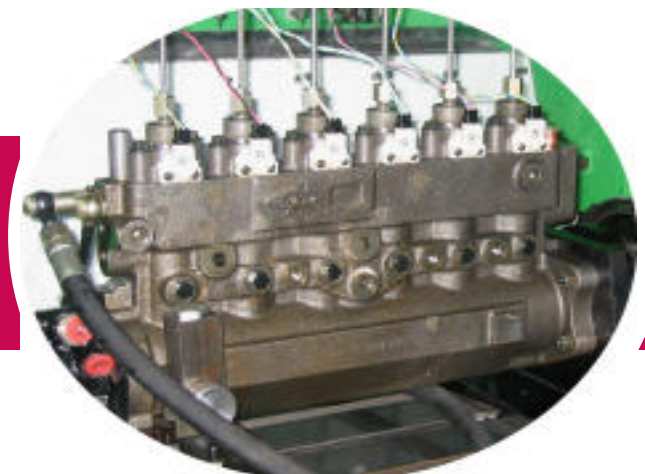
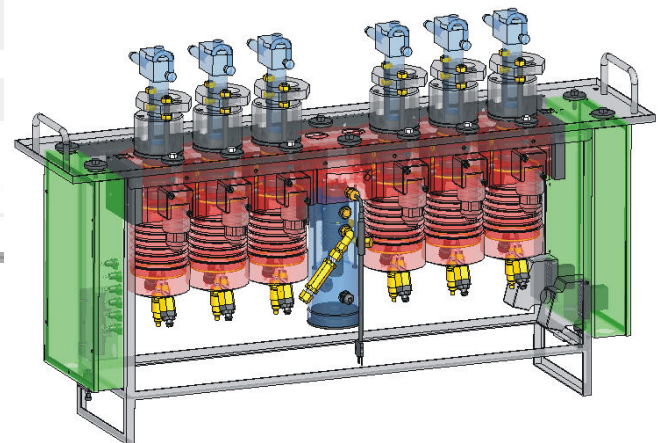
You want to equip your existing bench with a **new flow rate measurement system**, but you don't have room for an independent MCF? EFS can provide you with a customized installation, fully adapted to your needs.

Adaptations necessary

- Dependent on the existing set-up, please contact us.

Connections and requirements

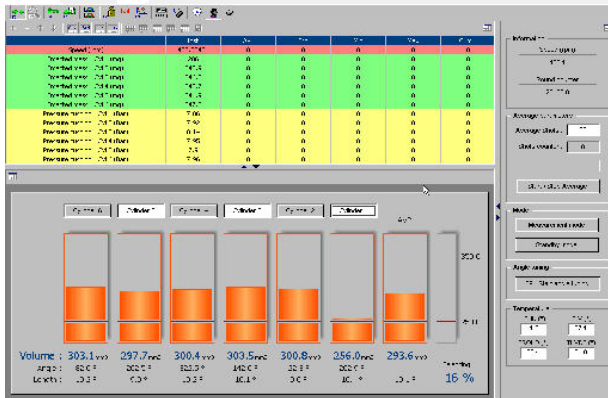
- See the specifications table.



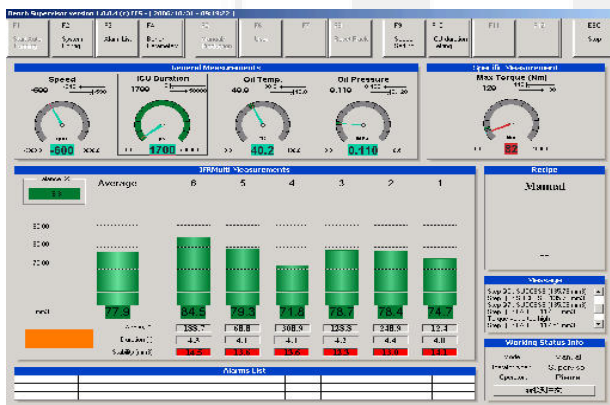
XMCF SOFTWARE

The **XMCF** is the set-up and user software for the **MCF**.

2 features set this software apart: a **simple, intuitive display** ideal for a production setting and an **elaborate parameter interface** enabling numerous functions, such as measurement of flow rate, standard deviation, injection angles and duration and rotation speed.



User screen for the independent MCF.



User screen in a bench fitted with an MCF (includes the bench controls).

This software runs under Windows98[®], Windows2000[®] or WindowsXP[®] and uses an Ethernet connection.

REFERENCES

EFS BENCH WITH MCF

- ITB 430 with MCF 8342 - 250mm³
(for inline pumps or distribution pumps)
- ITB 440 with MCF 8342 - 400mm³
(for unit pumps).
- ITB 440 avec MCF 8342 - 600mm³
(for unit pumps).

INDEPENDENT MCF

- 8448 - 250mm³
- 8448 - 400mm³
- 8448 - 600mm³

CUSTOM-ADAPTED MCF

- 8342 - 250mm³
- 8342 - 400mm³
- 8342 - 600mm³

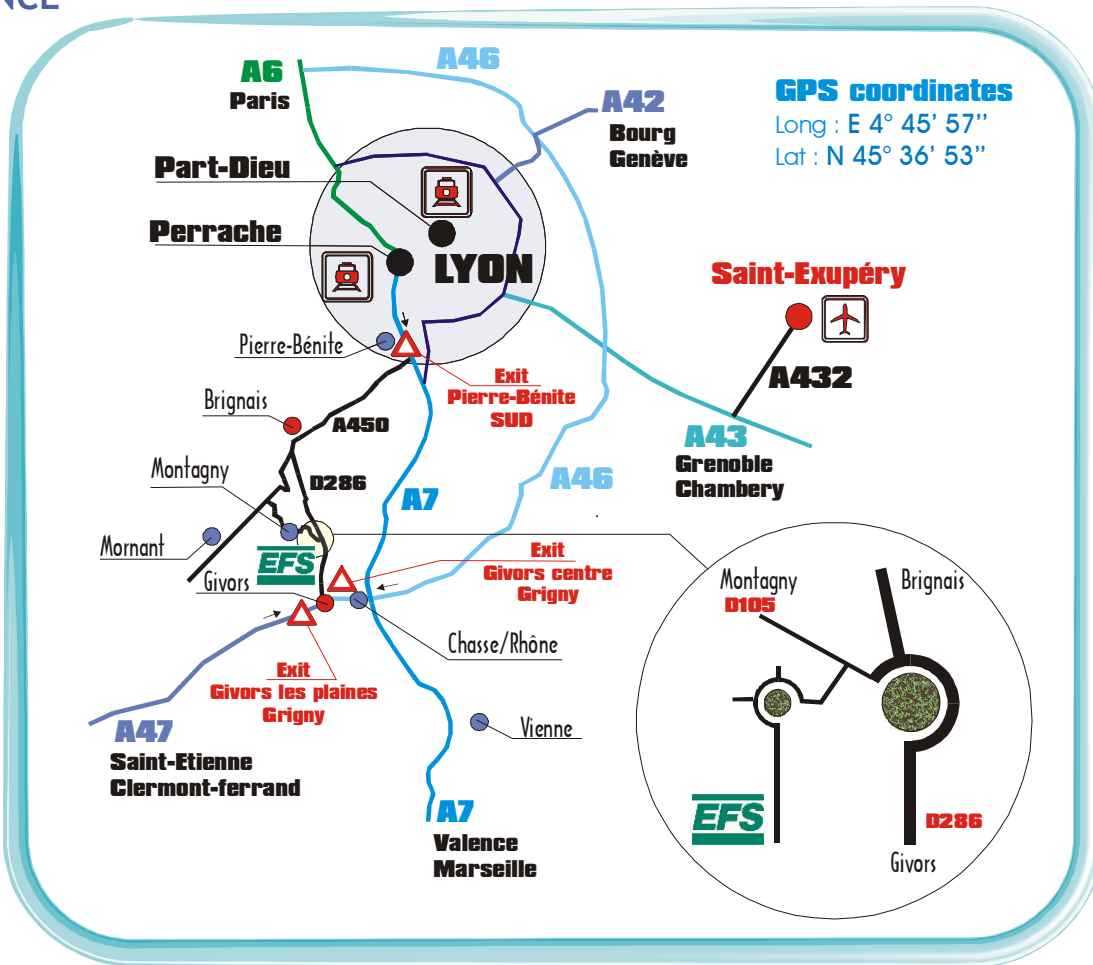
If you're looking for a more detailed analysis of a single injection channel: multi-injection measurement at each revolution and injection law analysis, consider the **IFR**. Please contact EFS for further information.



SITE ADDRESS

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MONTAGNY (69700)
FRANCE**

MAP



SUBSIDIARIES IN CHINA AND THE USA to provide technical support (installation, training, maintenance, calibration).

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Brochure
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24-04-08