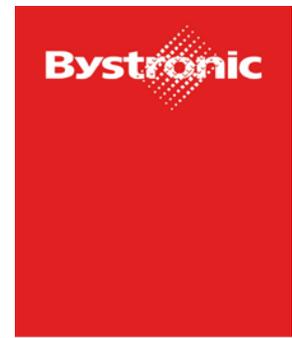


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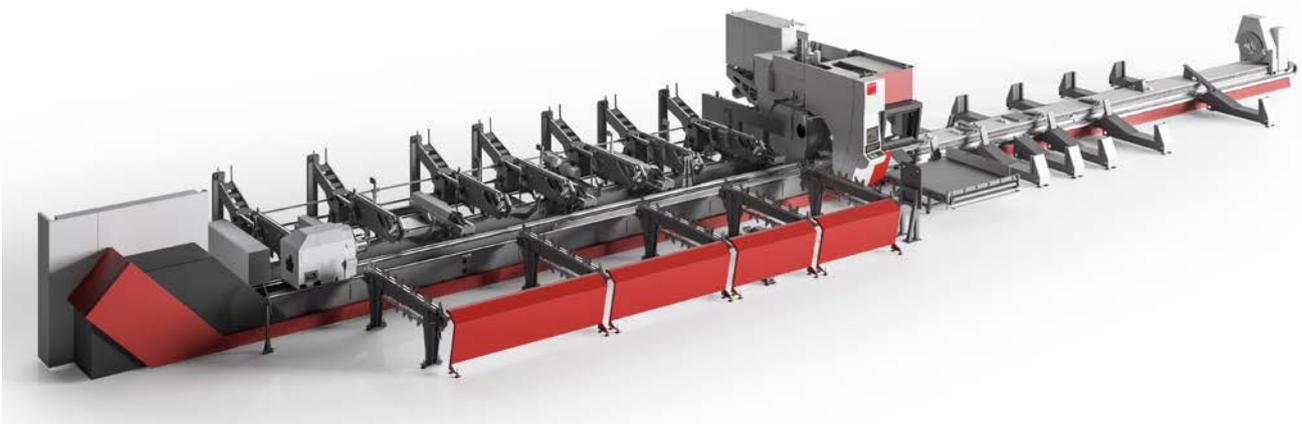
Mr Fergus O'Keefe
Kerry Mechanical Engineering
Kilmeany
Kilmorna
Listowel
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IRELAND

11th May 2020

Technical Specifications

No. QUO-90136-2

Tube M3 series; Machine model: FL 300



This layout may not correspond to the offered machinery.

1 MACHINE OVERVIEW

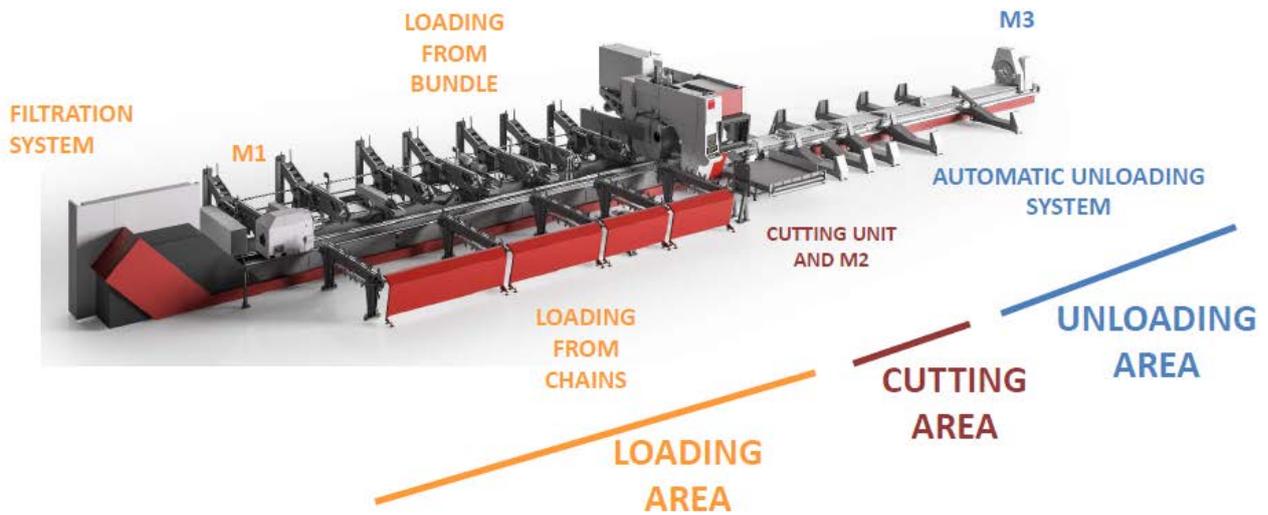
F FL 300 can machine tubes and profiles of different shapes and material and it is designed to be fast, user-friendly, safe, reliable and flexible.

The machine employs **LASER technology** (Light Amplification by Stimulated Emission of Radiation) and processes round tubes ranging from **20 to 323 mm** and squared tubes up to **254x254mm**.

According to different loading configurations, **FL 300 can load tubes up to 12,5 m** and it could be equipped with a **3-Mobile Mandrels (chuck)System** which allows a considerable increase of the productivity and of handling accuracy.

Excellent performance in terms of acceleration and speed as well as the high precision in the whole working field are granted.

The designing of the whole system is carried out with the FEM (Finite Elements Method) structural calculation programs, which enables the dimensional characterization of the structures and the optimisation of strain and deformation related to the applied stress. All commercial components and electronic components are conforming to first-class European standards.



This layout may not correspond to the offered machinery.

2 TECHNICAL FEATURES

TUBE M3 – FL 300	
Tube min length with automatic loading from chains and from single manual loading	3.500 mm
Tune min. length with automatic loading from bundle loader	3.600 mm
Tube max length (according to the different versions)	12.500 mm
Tube max weight*	60 kg/m
Tube sections**	Round, square, rectangular, standard open sections
Dimensions round sections (min, max)	20 mm 254 mm from bundle 324 mm from chain
Dimensions square sections (max)	254x254 mm
Dimensions rectangular sections (min, max)	To be circumscribed in a circle with \varnothing_{\min} 20 mm and \varnothing_{\max} 305 mm (max 250x150 mm)
Laser system strokes inside the cutting area	Y= 375 mm Z = 390mm
Max linear speed of mandrels (chucks)	130 m/min
Cutting head axis speed	Y= 95 m/min Z = 60 m/min
Max rotation speed of mandrels (chucks)	125 r.p.m.
Max piece length on unloading system (according to the different configurations)	12.000mm with 3 rd chuck
axis positioning precision	± 0,025
Numeric Control	TTMotion
MATERIAL FEATURES	
Material type***	Carbon steel, Stainless steel
Surface condition****	Clean surface

Note: these are the main technical features of the machine, anyway some combinations of diameters, lengths, sections, machining should be checked and tested.

* maximum weight loading capacity is calculated on perfectly straight tubes. In case of bending, the torsional forces during the loading/unloading handling could reduce this value.

** Other closed profile to be evaluated by Bystronic. For open profiles refer to par. 3.2.3.

*** The quality and the presence of inclusions and defects can influence the machine performances.

**** The best machine performances can be obtained with tubes and profiles with pickled surface without rust or scales or calamine and with some oil coating.

Bystronic Tube Processing reserves the right to change the technical features of the machine, if technical requirements arise during production and assembly

3 DESCRIPTION OF THE STANDARD MACHINE

3.1 LOADING AREA

3.1.1 Loading system from bundle

The loading system from bundle allows the handling of tubes with maximum length up to 12,5 meters/ 41' and max diameter 254 mm (only round, square, rectangular).

The max. Loading capacity of the bundle loader is 6.000kg.

Only standard closed profiles (round, square and rectangular) are allowed to be loaded using the bundle system. For different shapes of closed profile, Bystronic Tube Processing reserves the possibility to perform specific tests.

The loading of open profiles in bundle system is not allowed.

This system requires no setting up, regardless the tube section and size.

It is equipped with tube lifting system with automatic rewinding belts; in order to bring only one tube to the working area, a device for single tube handling is foreseen. This device features a double motoring and a preliminary check system of tube orientation. Compared to the operator's position, the bundle loader could be installed to the right or to the left and on the front or on the rear side.

The minimum loading length using the bundle system is 3.600 mm.

The loading system works properly with a well-disposed (not randomly) tube bundle.

The singularization of tubes with a diameter (or side length) lower than 20 mm is not assured.

3.1.2 Loading system from chains

The front loading system from chain allows to handle tubes through V supports, which could hold up to five tubes with min length 3.500 mm and max length 12.500 mm.

Through this loading system, also handling of open and special section profile is possible, according to specific indications about the correct orientation.

Compared to the operator's position, the chain loader could be installed to the right or to the left and on the front or on the rear side.

*Loading from chains on the front and loading from bundle on the rear side of the machine.
This layout may not correspond to the offered machinery*

3.1.3 Manipulators for tube loading and supporting during machining

The manipulators are placed into the loading area and enable the tube picking up from the chains and/or bundle and the tube positioning in the mandrels working area through controlled axis movements; once the mandrels have fixed the tube, the manipulators go back in the starting position under the chains. The manipulators support the tube during the cutting operation by means of rollers and/or mask. The translation is activated by brushless motor, precision epicycloidal gearbox with absolute encoder and helical geared pinion, while the lifting is activated by brushless motor with absolute encoder through preloaded screw jack.



3.1.4 Devices for dimension control

The machine is equipped with dimensional control systems of the tube length. In case of loading from bundle, the device will check the tubes during the cutting operation of the previous tube (hidden time).

If the detected length is different compared to the set length, a warning message informs the operator who could stop the cutting operation.

3.1.5 Welding seam detection with camera

The machine is provided with a camera for the automatic detection of the welding seam. The detection of the welding seam is executed by a smart camera, which is interfaced directly with the machine control, and it is equipped with a suitable led illuminator with red light.

The smart camera captures constantly pictures of the surface and compares them to a template, which is located on the CNC memory.

This system allows the operator to create different templates, according to different tube surface situations.

Through a software tool and directly from the HMI of the machine, the operator can easily import the reference template. The detection of the welding seam depends on the environmental light and on the tube surface condition. Due to the optic principle, this system works correctly if the welding seam is well visible by human eye from the external and the surface is free of scratches.

In particular, for round and small tubes, due to the particular light reflection on their external surface, the correct welding seam identification is not ensured.

If the system does not recognize the seam, the control goes automatically to the operator who can input manually the position of the same.



3.2 CUTTING AREA

3.2.1 Machine Frame

The frame of the cutting unit consists of electro-welded and normalised structural steel. This structure is designed with finite element calculation methods to guarantee the absolute flexural and torsion rigidity.

The translation movements on X, Y and Z axis occur on rectified slide ways and multiple roll sliding blocks, pre-charged and in high-precision class.

The movement of the axis occurs by means of brushless motor with absolute encoder.

3.2.2 Chucks

The machine is equipped with two chucks, which have the following features:

- Transfer carriage made of electro-welded and normalized structure one bearing carriage by means of cross and pre-charged roll bearings;
- Advancement through rectified precision helical geared crowned rack, activated by brushless motor, precision epicycloidal gear box and helical geared pinion with slack recovery system with absolute measurements system;
- Rotation activated by brushless motor, precision epicycloid gear box and helical geared pinion with slack recovery system and absolute measurements transducer;
- Angular position transducer for absolute measurement.



The first mandrel/chuck (M1) is expected to clamp the tube ends by means of jaws. The second mandrel/chuck (M2) fixes the tube near the cutting area and allows the transfer of the tube to the cutting area by means of idle rollers positioned directly on the jaws. M2 as well as M1 is equipped with four sliding and self-centring jaws, activated by pneumatic cylinders and synchronized two by two.

As standard, the machine is equipped with a set of jaws for the machining of tubes for the complete range of cutting foreseen for the plant.

3.2.3 Jaws for open profiles

The machine is provided with special jaws with which mandrel/chuck can clamp a wide range of open profiles according with the international standards:

FL 300			
PROFILE TYPE	MIN	MAX	International standard
HEA**	100	200	EN 10365
HEB**	100	160	EN 10365
IPE**	80	220	EN 10365
IPN**	80	220	UNI 5679/DIN 1025-1 :1995
UPN	40	240	UNI EU 54/ DIN 1026-1 :2000
L*	20	200	EN 10056-1

* Not all the combinations are possible please ask to Bystronic Tube Processing to check if the L profile could be managed

** For the profile type indicated with **, it is possible to cut profiles with dimensions >175 mm but it is not possible to load them automatically.

The profiles, which deviate from the above list and from the standard norms, have to be verified by Bystronic Tube Processing.

Due to the particular structure of open profiles, Bystronic Tube Processing does not assure the same precision and cutting quality indicated at par. 10 for the standard closed profiles. In case of particular needs for pieces obtained from open profiles, Bystronic Tube Processing reserves the rights to make special tests on every single piece.

3.2.4 3D laser cutting head

The heart of the system is the cutting unit where the 3D head is installed:

- Axis X: longitudinal movement of the tube generated by M1;
- Axis Y: transversal movement of the cutting head;
- Axis Z: vertical movement of the cutting head;
- Axis B: tilting of the head;
- Axis A: synchronized rotation of mandrel (chuck) 1 and 2.

Bystronic Tube Processing has always believed in the many advantages that three-dimensional cut is able to offer. The company has been developing this technology on cutting plants for both tubes and metal sheet, consolidating its leadership in such application.

The improvement of 3D cut has widened considerably the fields of application where the laser technology can be used, thus making it even more interesting and profitable.

The head holding the focusing lenses is composed of three motorised bodies and is able to perform bevels and transversal cuts.



Through a sensor, it is possible to keep the exact focusing distance from the surface to cut. Furthermore, thanks to this sensor, any eventual collisions between the head and scraps or other parts are avoided.

The system, which adjusts automatically the focusing position, is composed by an adaptive mirror, which is coated, driven by a precision pneumatic servo-valve and cooled.

The system is driven directly by the machine control and it allows to adjust automatically the focal position of the laser ray on the material.

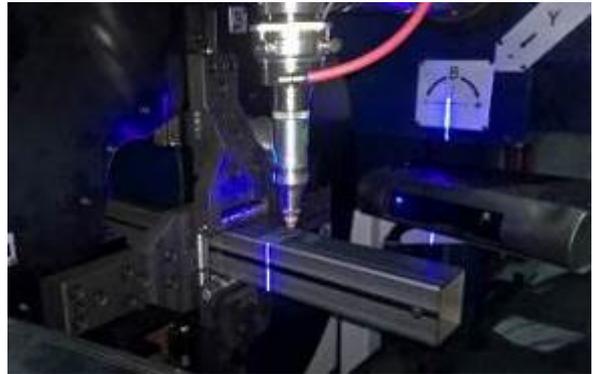
This system allows to adapt the focal spot to the optimal cutting conditions according to the values indicated on the technological tables.

Thanks to the slim shape of the head, it is possible to cut in depth on the internal section of open profiles.

3.2.5 Laserscan

The system is placed inside the cutting cabin and it is composed by two laser devices, which detect the real position of the profile near the cutting area.

During the cutting operation, it compares the real position of the profile with its theoretical position in order to correct the cutting parameter in case of needs. In this way it is possible to obtain high precision cutting performances.



Main features of Laserscan system	
Max. dimension of tubes	180 mm
Type of tubes	Square and rectangular tubes
Centering precision	0,2 mm (this precision is related to tubes with standard quality; the min. precision is not assured on damaged material or on not standard surface)
Limitation on the max. dimension of the unloading piece	With unloading 12 m the limit is 305 mm For all other unloading dimensions the limit is 250 mm

3.3 UNLOADING AREA

3.3.1 Automatic unloading system

3.3.2 The 3 Mobile Mandrels (chucks) System „3MMS“

When the machine foresees an automatic unloading system for tube longer than 6.000mm / 19,7', the machine is equipped with the *3MMS – 3Mobile Mandrels (chucks) System*, 3 mandrels (chucks) for tube carrying into the cutting zone and tube unloading according to specific unloading rules.



The first and the third mandrel (chuck) (M1 and M3) are expected to clamp the tube ends.

Mandrel (chuck) M3 has the same features of mandrel (chuck) M1 as described on paragraph 4.2.2.

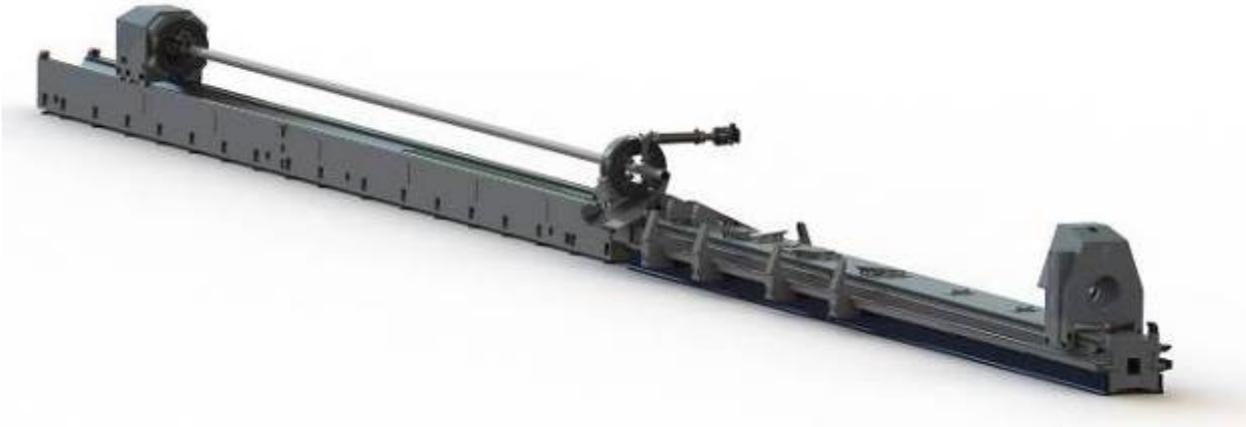
The second mandrel (chuck) (M2) fixes the tube near the cutting area and allows the transfer of the tube from the loading side through the cutting area, and then to the unloading area. M2 as well as M1 and M3 is equipped with four sliding and self-centring jaws, activated by hydraulic cylinders and synchronized two by two.

Being equipped with three mobile mandrels (chucks), the machine is able to grant the maximum optimisation of logistics operations (loading, unloading) and cutting operations independently from the length of the raw tube.

Furthermore, the Bystronic Tube processing 3MMS assures the suitable alignment and support in those cycles where very long tubes are cut, as well as an excellent precision of cutting.

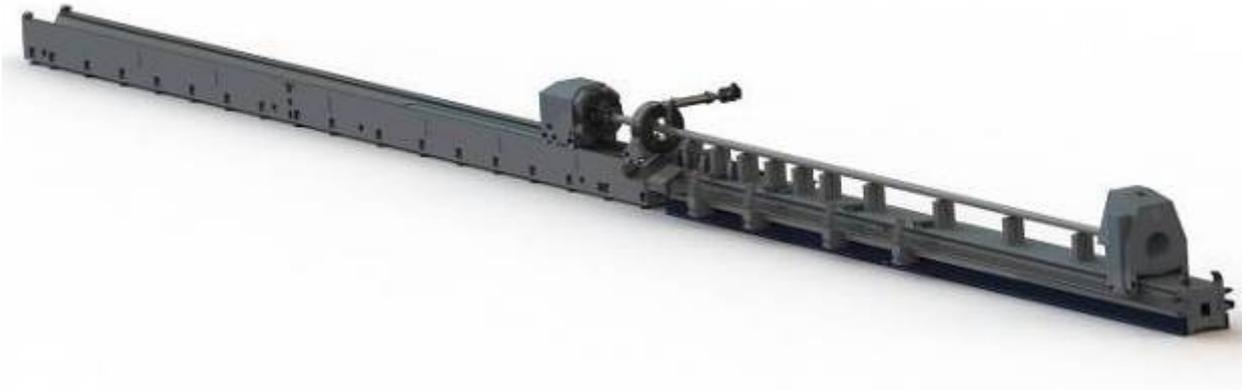
The advantage of 3MMS system can be appreciated in the following diagrams.

1- **Loading tube.** Trimming the first end. M1 and M2 in operation. M3 is standing



In the first phase of cutting process, M1 drives the tube through M2 and then to the cutting area, where the trimming of the first end is performed. The CN controlled manipulators, positioned in the loading area, assist the mandrels (chucks) with the support of the tube. The correct alignment of the tube is granted. M3 does not participate to the cutting process.

2- **Trimming the second end.** 3MMS is working.



The 3MMS enters into function for the cutting of the second end of the tube.

3- **Unloading.** 3MMS is use to place the cut piece at precise zone, according to specific cutting rules. When the distance between the cut piece and the next one is enough the laser working of the next pieces starts.

In order to facilitate the handling, assure the suitable alignment of the tube on the X axis and avoid the bending mainly caused by the high weight, the third mandrel (chuck) M3 clamps the tube during the cutting process. The CN controlled supports, which are positioned in the unloading area, contribute to this process. Once the cutting is completed, M1 unlocks the tube and M3 brings it to the different unloading areas, according to the following unloading rules*:

- Pieces shorter than 2200 mm: unloaded on the front side of the machine near the cutting line on the unloading conveyor.
- Pieces with length between 2200 mm and 9000 mm: unloaded on the front side of the machine. The mandrel 3 move the pipes away from the cutting line in the way that, in

the worst case, the minimum distance between the head of the pipe and the unloading conveyor is 875 mm in the way that long and heavy pipe cannot hit the unloading conveyor. The pieces are unloaded on the sliders

- Pieces between 9000mm and 12000 mm: unloaded on the front side on unloading conveyor

The rules are defined in the way that the centre of mass of the cut piece is between two saddles and mobile slide. It doesn't mean that for each length of pipe the centre of mass is exactly in the middle of the support,

The scraps shorter than 250 mm are unloaded directly into the scrap conveyor by opening the moving slider under the cutting line. Scraps longer than 250 mm had to follow the same rules of the pieces.

* To avoid dangerous crash and ensure the machine and operator safety all the rules are fully automatic and it is not possible for the operator to define how and where unload the different pieces lengths and the scraps.

4 NUMERICAL CONTROL AND AUTOMATION

4.1 NC Numerical Control

The machine is driven by the NC TTMotion, a modern digital NC at 32 bit on industrial hardware and specifically engineered for the 3D laser cutting machines. The man-machine interface has been engineered by Bystronic Tube Processing and it is user-friendly.



This layout may not correspond to the offered machinery.

Following the main technical features:

- Digital NC at 32 bit with 5 independent processes;
- Interpolations up to 10 axes simultaneous;
- Advanced algorithms for high speed and maximum trajectory precision;
- RTCP compensation functions to optimize 3D cutting;
- Distance control between head and piece at high speed and precision;
- I/O communication on digital bus through optical fiber (highly disturb free);
- Editor for the management of the cutting tables;
- Help online and simplified diagnostic functions;
- Connection integrated with the Bystronic Tube Processing remote assistance and with the customer care portal.

4.2 Automation

The axes are moved by brushless motors expressly developed for Bystronic Tube Processing with high level of dynamic and regularity of the movement.

All brushless motors are equipped with absolute optical transducer at high precision which allows to avoid the zero research at the machine starting.

4.3 Safety devices

The whole machine area is protected both with active and passive safety devices.

The outer barriers, for the safe use of the whole systems, are to be made and installed strictly according to the drawings supplied by Bystronic Tube Processing.

5 LASER SOURCE

5.1 CO2 laser source

In this type of laser, the coherent radiation laser emission occurs through the excitation of CO2 molecules, which determines a characteristic emission at a wavelength of 10.6 microns. Modern CO2 resonators get the excitement of the molecules using different manufacturing technologies, including the fast axial flow and SLAB technology.

The characteristic wavelength of the CO2 laser emission makes it essential to plan the cutting and welding machines with appropriate optical paths with mirrors, which require periodic operations of cleaning and maintenance.

The emission of this type of source has always been particularly suited to materials such as carbon steels or stainless steels, with the possibility to be also used on aluminium alloys.

5.2 Fanuc laser source

The CO2 laser source of Fanuc is a reliable, precise and affordable solution.

The machine could be equipped with the following laser sources:

- C4000i-C, 4000W.

Fanuc laser source has a warranty of 2 years.



5.3 Cooling system

Chiller with single no-ferrous circuit and micro-channels, which allows more compact dimensions and lower energy consumptions compared to the traditional solutions.

Following the main technical features depending on the power of the installed laser source:

Cooling capacity	From 36 to 58 kW, depending on the installed source
Flowrate	From 117 to 183 lt/min
Working operation temperature	5° - 50 °C
Temperature of the fluid	It could be settled from 8 to 30 °C

5.4 Optical path

The optical path of laser beam, outside the resonator has the following features:

- Protection with high efficiency mirrors;
- Integrated pressurization and cooling system;
- Mirrors fitted to precision mechanical structures;
- cooling by water circulation.

7 Summary of Features

SUMMARY OF FL 300 FEATURES		
3.1 LOADING AREA	3.1.1 AUTOMATIC LOADING SYSTEM FROM BUNDLE	Automatic loading system from bundle and tube measurement system for tube up to 12.500 mm
	3.1.2 AUTOMATIC LOADING SYSTEM FROM CHAIN	Automatic loading system from chains for tube up to 12.500 mm
	3.1.3 MANIPULATORS	Manipulators for the tube loading and support during the machining
	3.1.4 DEVICES FOR DIMENSIONS CONTROL	Automatic tube length control Tube section orientation control Automatic regulation to select the single tube for cutting
	3.1.5 WELDING CAMERA	Smart-camera for the detection of the welding seam
3.2 CUTTING AREA	3.2.1 MACHINE FRAME	Electro-welded and normalised structural steel
	3.2.2 CHUCKS AND JAWS	N. 2 self-centring mandrels (chucks) with set of jaws for diameter between 20 and 305 mm
	3.2.3 JAWS FOR OPEN PROFILES	Set of clamping jaws for open profiles
	3.2.4 3D LASER CUTTING HEAD	Cutting head with 3 controlled axis and inclination of +/- 45°
	3.2.5 LASERSCAN	Laser device for the correction of the tube bending
	3.2.6 FUME EXTRACTION AND FILTRATION SYSTEM	Fume extraction system into the cutting cabin and filtration (including filter)
	3.2.7 SCRAPS DISCHARGE SYSTEM	Slat conveyor for the removal of scraps
3.3 UNLOADING AREA	3.3.1 AUTOMATIC UNLOADING SYSTEM	Automatic unloading system for tube up to 12.000 mm with 3 rd chuck and N.4 motorized unloading conveyors
4 AUTOMATION OF THE PLANT	4.1 NC NUMERICAL CONTROL	
	4.2 AUTOMATION OF THE PLANT	Automation: electrical system, CN+PLC, sensors and motors, electrical board, local monitor TFT and keyboard
	4.3 SAFETY DEVICES	Active and passive safety devices
5 LASER SOURCE	5.1 CO2 LASER SOURCE	
	5.2 FANUC LASER SOURCE	Fanuc C4000i-C 4kW
	5.3 COOLING SYSTEM	
	5.4 OPTICAL PATH	
6 SOFTWARE	TubeMaster powered by Alma	N. 1 license CAD-CAM Software
	MANUAL	N. 1 use and maintenance manual in English
	SPARE PARTS -KIT PLUS	Including Protection glass, nozzles, lens with lens holder, sensor cable
	MAINTENANCE OF THE INSTALLED SOFTWARE AND TELEPHONE/REMOTE ASSISTANCE	During warranty included
	CE MARKING	CE marking (English)